CEC1302

Low Power Crypto Embedded Controller

Product Features

- ARM® Cortex®-M4 Processor Core
  - 32-Bit ARM v7-M Instruction Set Architecture
  - Hardware Floating Point Unit (FPU)
  - Single 4GByte Addressing Space (Von Neumann Model)
  - Little-Endian Byte Ordering
  - Bit-Banding Feature Included
  - NVIC Nested Vectored Interrupt Controller
    - Up to 240 Individually-Vectored Interrupt Sources Supported
    - 8 Levels of Priority, Individually Assignable By Vector
    - Chip-Level Interrupt Aggregator supported, to expand number of interrupt sources or reduce number of vectors
  - System Tick Timer
  - Complete ARM-Standard Debug Support
    - JTAG-Based DAP Port, Comprised of SWJ-DP and AHB-AP Debugger Access Functions
    - Full DWT Hardware Functionality: 4 Data Watchpoints and Execution Monitoring
    - Full FPB Hardware Breakpoint Functionality: 6 Execution Breakpoints and 2 Literal (Data) Breakpoints
  - Comprehensive ARM-Standard Trace Support
    - Full DWT Hardware Trace Functionality for Watchpoint and Performance Monitoring
    - Full ITM Hardware Trace Functionality for Instrumented Firmware Support and Profiling
    - Full ETM Hardware Trace Functionality for Instruction Trace
    - Full TPIU Functionality for Trace Output Communication
- 128K SRAM (Code and Data)
  - 96K Optimized for Code
  - 32K Optimized for Data
- Multi-purpose AES Cryptographic Engine
  - Hardware support for ECB, CTR, CBC and OFB AES modes
  - Support for 128-bit, 192-bit and 256-bit key length
  - DMA interface to SRAM, shared with Hash engine
- Cryptographic Hash Engine
  - Support for SHA-1 & SHA-256
  - DMA interface to SRAM, shared with AES engine
- Public Key Cryptographic Engine
  - Hardware support for RSA and Elliptic Curve public key algorithms
  - RSA keys length from 512 to 2048 bits
  - ECC Prime Field keys up to 256 bits
- Cryptographic Features
  - True Random Number Generator
    - 1K bit FIFO
  - Secure Boot from ROM
    - Hardware based root of trust
  - Support Secure Firmware Updates
- Two SPI Memory Interfaces
  - 3-pin Full Duplex serial communication interface
  - Two Private and Two Shared Chip Selects
  - DMA Support
- Battery Backed (VCC0/VBAT) Resources
  - Power Fail Register
  - Power-Fail Status Register
  - Battery backed 64 byte memory
- Real Time Clock (RTC)
  - VCC0 (VBAT) Powered
  - 32KHz Crystal Oscillator
  - 32KHz Clock output available under VCC1 power
  - Time-of-Day and Calendar Registers
  - Programmable Alarms
  - Supports Leap Year and Daylight Savings Time
- Hibernation Timers
- General Purpose Analog to Digital Converter
  - 10-bit conversion precision
  - 10-bit conversion per channel is completed in less than 12us
  - 5 ADC channels
    - 10-bit Conversion with 2.9mV resolution
    - 0 to 3.3 VDC Conversion Range
  - Optional continuous sampling at a programmable rate
  - Internal Analog Voltage Reference (3.0V +/- 1%)
- Watch Dog Timer
- Four Programmable 16-bit and Two 32-bit Timers
  - Wake-capable Auto-reloading Timers
- Four Programmable Pulse-Width Modulator Outputs
  - Independent Clock Rates
  - 16-Bit Duty Cycle Granularity
  - Operational in both Full on and Standby modes

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- Four I^2C/SMBus 2.0 Host Controllers
  - Allows Master or Dual Slave Operation
  - Controllers are Fully Operational on Standby Power
  - DMA-driven I^2C Network Layer Hardware
  - I^2C Datalink Compatibility Mode
  - Multi-Master Capable
  - Supports Clock Stretching
  - Programmable Bus Speeds
    - 400 KHz Fast-mode Capable
    - 1 Mbps Fast-mode Plus Capable
  - Hardware Bus Access "Fairness" Interface
  - SMBus Time-outs Interface
  - 5 Ports
  - 2 Port Flexible Multiplexing
- Keyboard Matrix Scan Interface
  - 18 x 8 Interrupt/Wake Capable Multiplexed Keyboard Scan Matrix
  - Row Predrive Option
- Four Breathing/Blinking LED Interfaces
  - Programmable Blink Rates
  - Piecewise Linear Breathing LED Output Controller
  - Operational in EC Sleep States
- Dual Fan Tachometer Inputs
- RPM-Based Fan Speed Control Algorithm
  - Utilizes one TACH input and one PWM output
  - 3% accurate from 500 RPM to 16k RPM
  - Automatic Tachometer feedback
  - Aging Fan or Invalid Drive Detection
  - Spin Up Routine
  - Ramp Rate Control
  - RPM-based Fan Speed Control Algorithm
- Glue Logic Functionality Supporting System Deep Sleep
- Integrated Power-on Reset Generator
  - VCC1_RST# open drain output
  - Accepts External driven Reset
- Anti-Glitch Protection on Power-on
- All Blocks Support Low Power Sleep Modes
- General Purpose Input/Output Pins
  - Low Power
  - High Configurability
- Two pin Debug Port with standard 16C550A register interface
- BC-Link Interconnection Bus
  - One High Speed Bus Master Controller
  - Connects to a Microchip GPIO Expander
- Package
  - 144-pin WFBGA

Description

The CEC1302 incorporates a high-performance 32-bit ARM® Cortex®-M4 embedded microcontroller with 128 Kilobytes of SRAM and 32 Kilobytes of Boot ROM. It communicates with the system host using the I2C bus.

The CEC1302 has two SPI memory interfaces that allow the EC to read its code from external SPI flash memory: private SPI and/or shared SPI. The Shared SPI interface allows for EC code to be stored in a shared SPI chip. The private SPI memory interface provides for a dedicated SPI flash that is only accessible by the EC.

The CEC1302 provides support for loading EC code from the private or shared SPI flash device on a VCC1 power-on. Before executing the EC code loaded from a SPI Flash Device, the CEC1302 validates the EC code using a digital signature encoded according to PKCS #1. The signature uses RSA-2048 encryption and SHA-256 hashing. This provides automated detection of invalid EC code that may be a result of malicious or accidental corruption. It occurs before each boot of the host processor, thereby ensuring a HW based root of trust not easily thwarted via physical replacement attack.

The CEC1302 is directly powered by two separate suspend supply planes (VBAT and VCC1) and senses the runtime power plane (VCC) to provide “Instant On” and system power management functions. It also contains an integrated VCC1 Reset Interface and a system Power Management Interface that supports low-power states and can drive state changes as a result of hardware wake events.

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1.0 PIN CONFIGURATION

1.1 Description

The Pin Configuration chapter includes a Pin List, Pin Description, Pin Multiplexing and Package Outline.

1.2 Terminology and Symbols for Pins/Buffers

Term	Definition
Pin Ref. Number	There is a unique reference number for each pin name.
#	The '#' sign at the end of a signal name indicates an active-low signal
n	The lowercase 'n' preceding a signal name indicates an active-low signal
PWR	Power
I	Digital Input
IS	Input with Schmitt Trigger
I_AN	Analog Input
O	Push-Pull Output
OD	Open Drain Output
IO	Bi-directional pin
IOD	Bi-directional pin with Open Drain Output
PIO	Programmable as Input, Output, Open Drain Output, Bi-directional or Bi-directional with Open Drain Output.
PCI_I	Input. These pins meet the PCI 3.3V AC and DC Characteristics. (Note 1-1)
PCI_O	Output. These pins meet the PCI 3.3V AC and DC Characteristics. (Note 1-1)
PCI_OD	Open Drain Output. These pins meet the PCI 3.3V AC and DC Characteristics. (Note 1-1)
PCI_IO	Input/Output These pins meet the PCI 3.3V AC and DC Characteristics. (Note 1-1)
PCI_ICLK	Clock Input. These pins meet the PCI 3.3V AC and DC Characteristics and timing. (Note 1-2)
PCI_PIO	Programmable as Input, Output, Open Drain Output, Bi-directional or Bi-directional with Open Drain Output. These pins meet the PCI 3.3V AC and DC Characteristics. (Note 1-1).

Note 1-1 See the "PCI Local Bus Specification," Revision 2.1, Section 4.2.2.

Note 1-2 See the "PCI Local Bus Specification," Revision 2.1, Section 4.2.2 and 4.2.3.

1.3 Pin List

The Pin List is shown in Table 1-1.

Note:	The Pin Ref. Number is a numerical reference for the ball number in the package.

Note 1: The XTAL2 pin can be used as a single ended clock input. See Note 9 in Section 1.6, "Notes for Tables in this Chapter," on page 36.

2: See Note 10 in Section 1.6, "Notes for Tables in this Chapter," on page 36 for information about the SPI pins.

3: The VCC1_RST#/GPIO131 pin cannot be used as a GPIO pin. The input path to the VCC1_RST# logic is always active and will cause a reset if this pin is set low in GPIO mode.

4: The GPIO041 pin defaults to output low. This pin must be reprogrammed to the GPIO function upon power-up.

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Note: Table 1-1, "CEC1302 144 WFBGA Pin Configuration" shows the mapping between Pin Ref. Number and 144 WFBGA ball number.

TABLE 1-1: CEC1302 144 WFBGA PIN CONFIGURATION

Pin Ref. Number	144 WFBGA Number	Pin Name
1	C3	GPIO036
2	F5	GPIO153/PVT_SCLK
3	F6	GPIO122/SHD_SCLK
4	A2	GPIO011/KSO16
5	A1	KSO13/GPIO006
6	B1	KSO12/GPIO005
7	B2	KSO11/GPIO107
8	C2	KSO10/GPIO004
9	C1	KSO09/GPIO106
10	D2	KSO08/GPIO003
11	D1	VSS
12	E2	KSO07/GPIO002
13	E1	KSO06/GPIO001
14	G5	VCC1
15	F1	CAP
16	G2	KSO05/GPIO104/TFDP_CLK
17	H3	KSO04/GPIO103/TFDP_DATA/XNOR
18	H1	KSO03/GPIO102/JTAG_TDO
19	J1	KSO02/GPIO101/JTAG_TDI
20	H2	KSO01/GPIO100/JTAG_TMS
21	J2	KSO00/GPIO000/JTAG_TCK
22	K1	KSI7/GPIO043
23	K3	KSI6/GPIO042
24	K2	KSI5/GPIO040
25	L1	KSI4/GPIO142/TRACECLK
26	L2	KSI3/GPIO032/TRACEDATA0
27	L3	KSI2/GPIO144/TRACEDATA1
28	M2	KSI1/GPIO126/TRACEDATA2
29	M1	KSI0/GPIO125/TRACEDATA3
30	N2	GPIO031
31	N1	GPIO127
32	M3	Reserved/GPIO052
33	N3	GPIO147
34	M4	GPIO151
35	L4	Reserved/GPIO051
36	E3	VSS
37	H5	VCC1
38	N5	ADC4/GPIO062
39	M5	ADC3/GPIO061
40	L5	AVCC
41	N6	GPIO206
42	M6	ADC2/GPIO060
43	L6	ADC1/GPIO057
44	N7	ADC0/GPIO056
45	M7	AVSS
46	N8	Reserved/GPIO112
47	A5	VSS
48	M8	Reserved/GPIO114
49	J3	JTAG_RST#
50	L8	Reserved/GPIO113
51	L9	Reserved/GPIO111
52	N9	Reserved/GPIO120
53	N10	LRESET#/GPIO116
54	M9	Reserved/GPIO117
55	M10	Reserved/GPIO014
56	F3	VSS
57	L10	Reserved/GPIO115
58	J5	VCC1
59	N11	Reserved/GPIO041
60	N12	nRESET_OUT/GPIO121
61	N13	Reserved/GPIO050
62	L11	Reserved/GPIO065
63	M12	GPIO035
64	M13	GPIO027
65	L12	GPIO033
66	K11	Reserved/GPIO046
67	J12	Reserved/GPIO047
68	K12	VBAT
69	L13	XTAL2
70	K13	VSS_VBAT
71	J13	XTAL1
72	J11	VCC_PWRGD/GPIO063

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Pin Ref. Number	144 WFBGA Number	Pin Name
73	H13	GPIO110
74	H11	GPIO130
75	H12	32KHZ_OUT/GPIO013
76	G13	Reserved/GPIO026
77	H8	VCC1_RST#/GPIO131
78	G8	GPIO141/PWM3/LED3
79	G12	VSS
80	G9	GPIO132
81	G11	GPIO007/KSO14
82	J9	VSS
83	F13	GPIO010/KSO15
84	J6	VCC1
85	F11	GPIO143/RSMRST#
86	D13	GPIO162/RXD
87	F7	GPIO165/TXD/SHD_CS1#
88	E13	GPIO023/I2C1_DAT0
89	E12	GPIO022/I2C1_CLK0
90	E11	GPIO021/I2C2_DAT0
91	D11	GPIO020/I2C2_CLK0
92	D12	GPIO105/TACH1
93	C13	GPIO145
94	F9	GPIO164/PVT_MISO
95	E9	GPIO124/SHD_MISO
96	F8	GPIO146/PVT_CS0#
97	E8	GPIO150/SHD_CS0#
98	B12	GPIO157/BC_CLK
99	B13	GPIO160/BC_DAT
100	A12	GPIO161/BC_INT#
101	A13	GPIO140/TACH2/TACH2PWM_IN
102	E7	GPIO045/PVT_CS1#
103	C11	GPIO053
104	J8	VSS
105	A11	GPIO152
106	H6	VCC1
107	A10	GPIO030
108	B10	GPIO012/KSO17
109	B9	I2C0_DAT1/GPIO017
110	A9	I2C0_CLK1/GPIO134
111	A8	I2C0_DAT0/GPIO016
112	C8	I2C0_CLK0/GPIO015
113	A7	LED0/GPIO154
114	B8	LED1/GPIO155
115	C7	LED2/GPIO156
116	B7	GPIO163
117	C10	VSS
118	A6	GPIO136/PWM1
119	G6	VCC1
120	B6	GPIO133/PWM0
121	C5	GPIO034/PWM2/TACH2PWM_OUT
122	A4	GPIO135
123	B4	GPIO044
124	C4	GPIO066
125	B3	GPIO025/I2C3_DAT0
126	A3	GPIO024/I2C3_CLK0
127	E6	GPIO054/PVT_MOSI
128	E5	GPIO064/SHD_MOSI
129	G3	GPIO067
130	F2	GPIO055
131	G1	GPIO210
132	N4	GPIO211
133	L7	GPIO200
134	J7	GPIO123
135	H7	VCC1
136	F12	GPIO202
137	C12	GPIO201
138	H9	VSS
139	B11	GPIO203
140	C9	VSS
141	C6	GPIO204
142	M11	NC
143	D3	VSS
144	B5	VSS

Note: The NC pin in the 144 WFBGA package should be left unconnected on the board.

The pin name to package ball mapping of the 144 pin WFBGA package is shown in FIGURE 1-1:

FIGURE 1-1: CEC1302 PIN NAME TO 144-PIN WFBGA BALL MAPPING (TOP)

	1	2	3	4	5	6	7
A	KSO13/GPIO006	GPIO011/KSO16	GPIO024/I2C3_CLK0	GPIO135	VSS	GPIO136/PWM1	LED0/GPIO154
B	KSO12/GPIO005	KSO11/GPIO107	GPIO025/I2C3_DAT0	GPIO044	VSS	GPIO133/PWM0	GPIO163
C	KSO09/GPIO106	KSO10/GPIO004	GPIO036	GPIO066	GPIO034/PWM2/TACH2PWM_OUT	GPIO204	LED2/GPIO156
D	VSS	KSO08/GPIO003	VSS	No Ball	No Ball	No Ball	No Ball
E	KSO06/GPIO001	KSO07/GPIO002	VSS	No Ball	GPIO064/SHD_MOSI	GPIO054/PVT_MOSI	GPIO045/PVT_CS1#
F	CAP	GPIO055	VSS	No Ball	GPIO153/PVT_SCLK	GPIO122/SHD_SCLK	GPIO165/TXD/SHD_CS1#
G	GPIO210	KSO05/GPIO104/TFDP_CLK	GPIO067	No Ball	VCC1	VCC1	No Ball
H	KSO03/GPIO102/JTAG_TDO	KSO01/GPIO100/JTAG_TMS	KSO04/GPIO103/TFDP_DATA/XNOR	No Ball	VCC1	VCC1	VCC1
J	KSO02/GPIO101/JTAG_TDI	KSO00/GPIO000/JTAG_TCK	JTAG_RST#	No Ball	VCC1	VCC1	GPIO123
K	KSI7/GPIO043	KSI5/GPIO040	KSI6/GPIO042	No Ball	No Ball	No Ball	No Ball
L	KSI4/GPIO142/TRACECLK	KSI3/GPIO032/TRACEDATA0	KSI2/GPIO144/TRACEDATA1	Reserved/GPIO051	AVCC	ADC1/GPIO057	GPIO200
M	KSI0/GPIO125/TRACEDATA3	KSI1/GPIO126/TRACEDATA2	Reserved/GPIO052	GPIO151	ADC3/GPIO061	ADC2/GPIO060	AVSS
N	GPIO127	GPIO031	GPIO147	GPIO211	ADC4/GPIO062	GPIO206	ADC0/GPIO056

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8	9	10	11	12	13	
I2C0_DAT0/GPIO016	I2C0_CLK1/GPIO134	GPIO030	GPIO152	GPIO161/BC_INT#	GPIO140/TACH2/TACH2PWM_IN	A
LED1/GPIO155	I2C0_DAT1/GPIO017	GPIO012/KSO17	GPIO203	GPIO157/BC_CLK	GPIO160/BC_DAT	B
I2C0_CLK0/GPIO015	VSS	VSS	GPIO053	GPIO201	GPIO145	C
No Ball	No Ball	No Ball	GPIO020/I2C2_CLK0	GPIO105/TACH1	GPIO162/RXD	D
GPIO150/SHD_CS0#	GPIO124/SHD_MISO	No Ball	GPIO021/I2C2_DAT0	GPIO022/I2C1_CLK0	GPIO023/I2C1_DAT0	E
GPIO146/PVT_CS0#	GPIO164/PVT_MISO	No Ball	GPIO143/RSMRST#	GPIO202	GPIO010/KSO15	F
GPIO141/PWM3/LED3	GPIO132	No Ball	GPIO007/KSO14	VSS	Reserved/GPIO026	G
VCC1_RST#/GPIO131	VSS	No Ball	GPIO130	32KHZ_OUT/GPIO013	GPIO110	H
VSS	VSS	No Ball	VCC_PWRGD/GPIO063	Reserved/GPIO047	XTAL1	J
No Ball	No Ball	No Ball	Reserved/GPIO046	VBAT	VSS_VBAT	K
Reserved/GPIO113	Reserved/GPIO111	Reserved/GPIO115	Reserved/GPIO065	GPIO033	XTAL2	L
Reserved/GPIO114	Reserved/GPIO117	Reserved/GPIO014	NC	GPIO035	GPIO027	M
Reserved/GPIO112	Reserved/GPIO120	LRESET#/GPIO116	Reserved/GPIO041	nRESET_OUT/GPIO121	Reserved/GPIO050	N

1.3.1 NON 5 VOLT TOLERANT PINS

There are no 5 Volt tolerant pins in the CEC1302.

1.3.2 POR GLITCH PROTECTED PINS

All pins in the CEC1302 have POR output glitch protection. POR output glitch protection ensures that pins will have a steady-state output during VCC1 POR.

In addition, signals in Table 1-2 have additional drive low POR circuitry. Signals in Table 1-2 refer to Pin Reference Numbers as defined in Table 1.

These pins are anti-glitch, driven low on VCC1 POR.

TABLE 1-2: GLITCH PROTECTED POR DRIVE LOW PINS

Pin Reference Number	Pin Name
60	nRESET_OUT/GPIO121
77	VCC1_RST#/GPIO131
85	GPIO143/RSMRST#
125	GPIO025/I2C3_DAT0

Note: The GPIO025/I2C3_DAT0 pin is driven low, glitch free, while VCC1 is coming up. However, after VCC1 is up and stable, the pin becomes an input (i.e., tri-stated Open Drain type), as shown in Table 1-32, “Multiplexing Table (16 of 18),” on page 33.

The following signals require a pull-down on the board:

- nRESET_OUT/GPIO121
- GPIO143/RSMRST#

Note: These glitch protected pins have no backdrive protection. See Section 1.3.3, "Non Backdrive Protected Pins".

1.3.3 NON BACKDRIVE PROTECTED PINS

Table 1-3 lists pins which do not have backdrive protection. Signals in Table 1-3 refer to Pin Reference Numbers as defined in Table 1.

These pins have no backdrive protection. If VCC1 is off must insure that none of these pins is above 0V to prevent backdrive onto the VCC1 supply.

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TABLE 1-3: NON BACKDRIVE PROTECTED PINS

Pin Reference Number	Pin Name
38	ADC4/GPIO062
39	ADC3/GPIO061
42	ADC2/GPIO060
43	ADC1/GPIO057
44	ADC0/GPIO056
46	Reserved/GPIO112
48	Reserved/GPIO114
50	Reserved/GPIO113
51	Reserved/GPIO111
52	Reserved/GPIO120
53	LRESET#/GPIO116
54	Reserved/GPIO117
55	Reserved/GPIO014
57	Reserved/GPIO115
60	nRESET_OUT/GPIO121
69	XTAL2
71	XTAL1
77	VCC1_RST#/GPIO131
80	GPIO132
85	GPIO143/RSMRST#
125	GPIO025/I2C3_DAT0

1.4 Pin Description

1.4.1 OVERVIEW

The following tables describe the signal functions in the CEC1302 pin configuration. See Section 1.6, "Notes for Tables in this Chapter," on page 36 for notes that are referenced in the Pin Description tables.

1.4.2 BC-LINK INTERFACE

TABLE 1-4: BC-LINK INTERFACE

BC-Link Interface			(3 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
98	BC_CLK	BC-Link Master clock	
99	BC_DAT	BC-Link Master data I/O	Note 7
100	BC_INT#	BC-Link Master interrupt	

1.4.3 JTAG INTERFACE

TABLE 1-5: JTAG INTERFACE

JTAG Interface			(5 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
21	JTAG_TCK	JTAG Test Clock	
19	JTAG_TDI	JTAG Test Data In	
18	JTAG_TDO	JTAG Test Data Out	
20	JTAG_TMS	JTAG Test Mode Select	
49	JTAG_RST#	JTAG Test Reset (active low)	Note 2

Note: JTAG_TDO is a push-pull output. This function is not configured through the associated GPIO Pin Control Register; however the drive strength is configured through the associated GPIO Pin Control Register 2.

1.4.4 MASTER CLOCK INTERFACE

TABLE 1-6: MASTER CLOCK INTERFACE

Master Clock Interface			(3 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
71	XTAL1	32.768 KHz Crystal Output	Note 9
69	XTAL2	32.768 KHz Crystal Input (single-ended 32.768 KHz clock input)	Note 9
75	32KHZ_OUT	32.768 KHz Digital Output	

1.4.5 ANALOG DATA ACQUISITION INTERFACE

TABLE 1-7: ANALOG DATA ACQUISITION

Analog Data Acquisition Interface			(5 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
44	ADC0	ADC channel 0	Note 8
43	ADC1	ADC channel 1	Note 8
42	ADC2	ADC channel 2	Note 8
39	ADC3	ADC channel 3	Note 8
38	ADC4	ADC channel 4	Note 8

1.4.6 FAN TACHOMETER AND PWM INTERFACE

TABLE 1-8: FAN TACHOMETER AND PWM INTERFACE

PWM & TACHOMETER			(6 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
92	TACH1	Fan Tachometer Input 2	
101	TACH2PWM_IN	Tach input to RPM-Based Fan Speed Control Algorithm	
120	PWM0	Pulse Width Modulator Output 0	
118	PWM1	Pulse Width Modulator Output 1	
78	PWM3	Pulse Width Modulator Output 3	
121	TACH2PWM_OUT	Pulse Width Modulator Output from RPM Based Fan Speed Control Algorithm	

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1.4.7 GENERAL PURPOSE I/O INTERFACE

TABLE 1-9: GPIO INTERFACE

GPIO Interface			
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
See Pin Configuration Table	GPIO	General Purpose Input Output Pins	Note 12

Note: No GPIO pin should be left floating in a system. If a GPIO pin is not in use, it should be either tied high, tied low, or pulled to either power or ground through a resistor.

1.4.8 MISCELLANEOUS FUNCTIONS

TABLE 1-10: MISCELLANEOUS FUNCTIONS

MISC Functions			(12 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
113	LED0	LED (Bllinking/Breathing PWM) Output 0	
114	LED1	LED (Bllinking/Breathing PWM) Output 1	
115	LED2	LED (Bllinking/Breathing PWM) Output 2	
78	LED3	LED (Bllinking/Breathing PWM) Output 3	
16	TFDP_CLK	Trace FIFO debug port - clock	
17	TFDP_DATA	Trace FIFO debug port - data	
60	nRESET_OUT	EC-driven External System Reset	Note 6
72	VCC_PWRGD	System Main Power Indication	
77	VCC1_RST#	Reset Generator Output	
85	RSMRST#	Resume Reset Output	Note 6
17	XNOR	Test Output	
53	LRESET#	Reset Signal	Note 1

Note: See Section 1.6, "Notes for Tables in this Chapter," on page 36 for numbered notes.

a) The nRESET_OUT pin function is an external output signal version of the internal signal nSIO_RESET. See the iRESET_OUT bit in the Power Reset Control (PWR_RST_CTRL) Register on page 62 and nSIO_RESET in Table 3-6, “Definition of Reset Signals,” on page 44.

b) XNOR is a push-pull output. This function is not configured through the associated GPIO Pin Control Register; however the drive strength is configured through the associated GPIO Pin Control Register 2.

c) The Resume Reset Output (RSMRST#) pin drives low as a push-pull output following a VCC1 power-on until firmware reconfigures the GPIO143 control register. This pin may be used to hold the system in reset until the CEC1302 firmware is ready to release it.

d) The LRESET# system reset pin requires an external weak pull-up resistor to VCC1 of 10k-100k ohms. See Note 1 in Section 1.6, "Notes for Tables in this Chapter," on page 36.

1.4.9 POWER INTERFACE

TABLE 1-11: POWER INTERFACE

Power Interface			(24 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
70	VSS_VBAT	VBAT associated ground	
68	VBAT	VBAT supply	
15	CAP	Internal Voltage Regulator Capacitor	Note 3
11, 36, 47, 56, 79, 82, 104, 138, 117, 140, 143, 144	VSS	VCC1 associated ground	
14, 37, 58, 135, 84, 106, 119	VCC1	VCC1 supply	
45	AVSS	Analog ADC supply associated ground	
40	AVCC	Analog ADC VCC1 associated Supply	

APPLICATION NOTE: See FIGURE 3-1: Recommended Battery Circuit on page 42.

1.4.10 I2C/SMBUS INTERFACE

TABLE 1-12: I2C/SMBUS INTERFACE

I2C/SMBus Interface			(10 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
112	I2C0_CLK0	I2C/SMBus Controller 0 Port 0 Clock	
111	I2C0_DAT0	I2C/SMBus Controller 0 Port 0 Data	
110	I2C0_CLK1	I2C/SMBus Controller 0 Port 1 Clock	
109	I2C0_DAT1	I2C/SMBus Controller 0 Port 1 Data	
89	I2C1_CLK0	I2C/SMBus Controller 1 Clock	
88	I2C1_DAT0	I2C/SMBus Controller 1 Data	
91	I2C2_CLK0	I2C/SMBus Controller 2 Clock	
90	I2C2_DAT0	I2C/SMBus Controller 2 Data	
126	I2C3_CLK0	I2C/SMBus Controller 3 Clock	
125	I2C3_DAT0	I2C/SMBus Controller 3 Data	

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1.4.11 KEYBOARD SCAN INTERFACE

TABLE 1-13: KEYBOARD SCAN INTERFACE

Keyboard Scan Interface			(26 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
29	KSI0	Keyboard Scan Matrix Input 0	Note 11
28	KSI1	Keyboard Scan Matrix Input 1	Note 11
27	KSI2	Keyboard Scan Matrix Input 2	Note 11
26	KSI3	Keyboard Scan Matrix Input 3	Note 11
25	KSI4	Keyboard Scan Matrix Input 4	Note 11
24	KSI5	Keyboard Scan Matrix Input 5	Note 11
23	KSI6	Keyboard Scan Matrix Input 6	Note 11
22	KSI7	Keyboard Scan Matrix Input 7	Note 11
21	KSO00	Keyboard Scan Matrix Output 0	
20	KSO01	Keyboard Scan Matrix Output 1	
19	KSO02	Keyboard Scan Matrix Output 2	
18	KSO03	Keyboard Scan Matrix Output 3	
17	KSO04	Keyboard Scan Matrix Output 4	
16	KSO05	Keyboard Scan Matrix Output 5	
13	KSO06	Keyboard Scan Matrix Output 6	
12	KSO07	Keyboard Scan Matrix Output 7	
10	KSO08	Keyboard Scan Matrix Output 8	
9	KSO09	Keyboard Scan Matrix Output 9	
8	KSO10	Keyboard Scan Matrix Output 10	
7	KSO11	Keyboard Scan Matrix Output 11	
6	KSO12	Keyboard Scan Matrix Output 12	
5	KSO13	Keyboard Scan Matrix Output 13	
81	KSO14	Keyboard Scan Matrix Output 14	
83	KSO15	Keyboard Scan Matrix Output 15	
4	KSO16	Keyboard Scan Matrix Output 16	
108	KSO17	Keyboard Scan Matrix Output 17	

1.4.12 SPI CONTROLLER INTERFACE

TABLE 1-14: SPI CONTROLLER INTERFACE

SPI Controllers Interface			(10 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
3	SHD_SCLK	Shared SPI Clock	Note 10
128	SHD_MOSI	Shared SPI Output	Note 10
95	SHD_MISO	Shared SPI Input	Note 10
97	SHD_CS0#	Shared SPI Chip Select 0	Note 10
87	SHD_CS1#	Shared SPI Chip Select 1	
2	PVT_SCLK	Private SPI Clock	Note 10
127	PVT_MOSI	Private SPI Output	Note 10
94	PVT_MISO	Private SPI Input	Note 10
96	PVT_CS0#	Private SPI Chip Select 0	Note 10
102	PVT_CS1#	Private SPI Chip Select 1	

1.4.13 TRACE DEBUG INTERFACE

TABLE 1-15: TRACE DEBUG INTERFACE

Trace Debug Interface			(5 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
25	TRACECLK	Trace Clock	
26	TRACEDATA0	Trace Data 0	
27	TRACEDATA1	Trace Data 1	
28	TRACEDATA2	Trace Data 2	
29	TRACEDATA3	Trace Data 3	

The Trace Debug Interface is enabled using the TRACE_EN bit in the ETM TRACE Enable register defined in Chapter 27.0, "EC Subsystem Registers".

Note: These pins are push-pull outputs when enabled as the Trace Debug Interface pin functions. This functionality is not configured through the associated GPIO Pin Control Register; however the drive strength of these pins is configured through the associated GPIO Pin Control Register 2.

1.4.14 UART PORT

TABLE 1-16: UART PORT

UART Port			(2 Pins)
Pin Ref. Number	**Signal Name**	**Description**	**Notes**
86	RXD	UART Receive Data	
87	TXD	UART Transmit Data	

1.5 Pin Multiplexing

Multifunction Pin Multiplexing in the CEC1302 is controlled by the GPIO Interface and illustrated in the Multiplexing Tables that follow. See Section 1.6, "Notes for Tables in this Chapter," on page 36 for notes that are referenced in the Pin Multiplexing tables. See Section 14.8.1, "Pin Control Register," on page 153 for Pin Multiplexing programming details. See also Section 14.7, "Pin Multiplexing Control," on page 151.

Pin signal functions that exhibit power domain emulation (see Multiplexing Tables below) have a different power supply designation in the “Emulated Power Well” column and “Signal Power Well“ columns of the Multiplexing Tables in Section 1.5.2.

1.5.1 VCC2 POWER DOMAIN EMULATION

The System Runtime Supply power VCC2 is not connected to the CEC1302. The VCC_PWRGD signal is used to indicate when power is applied to the System Runtime Supply.

Pin signal functions with VCC2 power domain emulation are documented in the Multiplexing Tables as “Signal Power Well“= VCC1 and “Emulated Power Well” = VCC2. These pins are powered by VCC1 and controlled by the VCC_PWRGD signal input. Outputs on VCC2 power domain emulation pin signal functions are tri-stated when VCC_PWRGD is not asserted and are functional when VCC_PWRGD is active. Inputs on VCC2 power domain emulation pin signal functions are gated according as defined by the Gated State column in the following tables.

Power well emulation for GPIOs and for signals that are multiplexed with GPIO signals is controlled by the Power Gating Signals field in the GPIO Pin Control Register.

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1.5.2 MULTIPLEXING TABLES

In the following tables, the columns have the following meanings:

MUX

If the pin has an associated GPIO, then the MUX column refers to the Mux Control field in the GPIO Pin Control Register. Setting the Mux Control field to value listed in the row will configure the pin for the signal listed in the Signal column on the same row. The row marked “Default” is the setting that is assigned on system reset.

If there is no GPIO associated with a pin, then the pin has a single function.

Signal

This column lists the signals that can appear on each pin, as configured by the MUX control.

Buffer Type

Pin buffer types are defined in Table 29-4, “DC Electrical Characteristics,” on page 283.

Note that all GPIO pins are of buffer type PIO, which may be configured as input/output, push-pull/OD etc. via the GPIO Pin Control Register and Pin Control Register 2. There are some pins where the buffer type is configured by the alternate function selection, in which case that buffer type is shown in this column.

Default Operation

This column gives the pin behavior following the power-up of VCC1. All GPIO pins are programmable after this event. This default pin behavior corresponds to the row marked “Default” in the MUX column.

Note:	An internal pull-up resistor is indicated by (PU) and and internal pull-down is indicated by (PD). These are configured via the GPIO Pin Control Register.

Signal Power Well

This column defines the power well that powers the pin.

Emulated Power Well

Power well emulation for GPIOs and for signals that are multiplexed with GPIO signals is controlled by the Power Gating Signals field in the GPIO Pin Control Register.

Power well emulation for signals that are not multiplexed with GPIO signals is defined by the entries in this column.

See Section 1.5.1, "VCC2 Power Domain Emulation".

Note:	The Glitch Protected POR Drive Low Pins are configured as “always on”, as indicated by “ON” in this column.

Gated State

This column defines the internal value of an input signal when either its emulated power well is inactive or it is not selected by the GPIO alternate function MUX. A value of “No Gate” means that the internal signal always follows the pin even when the emulated power well is inactive.

Note:	Gated state is only meaningful to the operation of input signals. A gated state on an output pin defines the internal behavior of the GPIO MUX and does not imply pin behavior.

TABLE 1-17: MULTIPLEXING TABLE (1 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
1	Default: 0	GPIO036	PIO	I (PU)	VCC1	VCC1	No Gate	
1	1	Reserved	Reserved		Reserved	Reserved		
1	2	Reserved	Reserved		Reserved	Reserved		
1	3	Reserved	Reserved		Reserved	Reserved		
2	Default: 0	GPIO153	PIO	I	VCC1	VCC1	No Gate	Note 10
2	1	PVT_SCLK	PIO		VCC1	VCC1		Note 10
2	2	Reserved	Reserved		Reserved	Reserved		
2	3	Reserved	Reserved		Reserved	Reserved		
3	Default: 0	GPIO122	PIO	I (PD)	VCC1	VCC1	No Gate	Note 10
3	1	SHD_SCLK	PIO		VCC1	VCC1		Note 10
3	2	Reserved	Reserved		Reserved	Reserved		
3	3	Reserved	Reserved		Reserved	Reserved		
4	Default: 0	GPIO011	PIO	IOD (PD)	VCC1	VCC1	No Gate	
4	1	Reserved	Reserved		Reserved	Reserved		
4	2	Reserved	Reserved		Reserved	Reserved		
4	3	KSO16	PIO		VCC1	VCC1		
5	0	GPIO006	PIO		VCC1	VCC1	No Gate	
5	1	Reserved	Reserved		Reserved	Reserved		
5	2	Reserved	Reserved		Reserved	Reserved		
5	Default: 3	KSO13	PIO	O-4mA	VCC1	VCC1		
6	0	GPIO005	PIO		VCC1	VCC1	No Gate	
6	1	Reserved	Reserved		Reserved	Reserved		
6	2	Reserved	Reserved		Reserved	Reserved		
6	Default: 3	KSO12	PIO	O-4mA (PD)	VCC1	VCC1		
7	0	GPIO107	PIO		VCC1	VCC1	No Gate	
7	1	Reserved	Reserved		Reserved	Reserved		
7	2	Reserved	Reserved		Reserved	Reserved		
7	Default: 3	KSO11	PIO	O-4mA	VCC1	VCC1		
8	0	GPIO004	PIO		VCC1	VCC1	No Gate	
8	1	Reserved	Reserved		Reserved	Reserved		
8	2	Reserved	Reserved		Reserved	Reserved		
8	Default: 3	KSO10	PIO	O-4mA	VCC1	VCC1		

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TABLE 1-18: MULTIPLEXING TABLE (2 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
9	0	GPIO106	PIO		VCC1	VCC1	No Gate	
9	1	Reserved	Reserved		Reserved	Reserved		
9	2	Reserved	Reserved		Reserved	Reserved		
9	Default: 3	KSO09	PIO	O-4mA	VCC1	VCC1		
10	0	GPIO003	PIO		VCC1	VCC1	No Gate	
10	1	Reserved	Reserved		Reserved	Reserved		
10	2	Reserved	Reserved		Reserved	Reserved		
10	Default: 3	KSO08	PIO	O-4mA	VCC1	VCC1		
11		VSS	PWR		PWR	PWR		
11								
11								
11								
12	0	GPIO002	PIO		VCC1	VCC1	No Gate	
12	1	Reserved	Reserved		Reserved	Reserved		
12	2	Reserved	Reserved		Reserved	Reserved		
12	Default: 3	KSO07	PIO	O-4mA	VCC1	VCC1		
13	0	GPIO001	PIO		VCC1	VCC1	No Gate	
13	1	Reserved	Reserved		Reserved	Reserved		
13	2	Reserved	Reserved		Reserved	Reserved		
13	Default: 3	KSO06	PIO	O-4mA	VCC1	VCC1		
14		VCC1	PWR		PWR	PWR		
14								
14								
14								
15		CAP	PWR		PWR	PWR		Note 3
15								
15								
15								
16	0	GPIO104	PIO		VCC1	VCC1	No Gate	
16	1	TFDP_CLK	PIO		VCC1	VCC1		
16	2	Reserved	Reserved		Reserved	Reserved		
16	Default: 3	KSO05	PIO	O-4mA	VCC1	VCC1		

TABLE 1-19: MULTIPLEXING TABLE (3 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
17	0	GPIO103	PIO		VCC1	VCC1	No Gate	
17	1	TFDP_DATA	PIO		VCC1	VCC1		
17	2	Reserved	Reserved		Reserved	Reserved		
17	Default: 3	KSO04	PIO	O-4mA	VCC1	VCC1		
18	0	GPIO102	PIO		VCC1	VCC1	No Gate	
18	1	Reserved	Reserved		Reserved	Reserved		
18	2	Reserved	Reserved		Reserved	Reserved		
18	Default: 3	KSO03	PIO	O-4mA	VCC1	VCC1		
19	0	GPIO101	PIO		VCC1	VCC1	No Gate	
19	1	Reserved	Reserved		Reserved	Reserved		
19	2	Reserved	Reserved		Reserved	Reserved		
19	Default: 3	KSO02	PIO	O-4mA	VCC1	VCC1		
20	0	GPIO100	PIO		VCC1	VCC1	No Gate	
20	1	Reserved	Reserved		Reserved	Reserved		
20	2	Reserved	Reserved		Reserved	Reserved		
20	Default: 3	KSO01	PIO	O-4mA	VCC1	VCC1		
21	0	GPIO000	PIO		VCC1	VCC1	No Gate	
21	1	Reserved	Reserved		Reserved	Reserved		
21	2	Reserved	Reserved		Reserved	Reserved		
21	Default: 3	KSO00	PIO	O-4mA	VCC1	VCC1		
22	0	GPIO043	PIO		VCC1	VCC1	No Gate	
22	1	Reserved	Reserved		Reserved	Reserved		
22	2	Reserved	Reserved		Reserved	Reserved		
22	Default: 3	KSI7	PIO	I	VCC1	VCC1	Low	Note 11
23	0	GPIO042	PIO		VCC1	VCC1	No Gate	
23	1	Reserved	Reserved		Reserved	Reserved		
23	2	Reserved	Reserved		Reserved	Reserved		
23	Default: 3	KSI6	PIO	I	VCC1	VCC1	Low	Note 11
24	0	GPIO040	PIO		VCC1	VCC1	No Gate	
24	1	Reserved	Reserved		Reserved	Reserved		
24	2	Reserved	Reserved		Reserved	Reserved		
24	Default: 3	KSI5	PIO	I	VCC1	VCC1	Low	Note 11

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TABLE 1-20: MULTIPLEXING TABLE (4 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
25	0	GPIO142	PIO		VCC1	VCC1	No Gate	
25	1	Reserved	Reserved		Reserved	Reserved		
25	2	Reserved	Reserved		Reserved	Reserved		
25	Default: 3	KSI4	PIO	I	VCC1	VCC1	Low	Note 11
26	0	GPIO032	PIO		VCC1	VCC1	No Gate	
26	1	Reserved	Reserved		Reserved	Reserved		
26	2	Reserved	Reserved		Reserved	Reserved		
26	Default: 3	KSI3	PIO	I	VCC1	VCC1	Low	Note 11
27	0	GPIO144	PIO		VCC1	VCC1	No Gate	
27	1	Reserved	Reserved		Reserved	Reserved		
27	2	Reserved	Reserved		Reserved	Reserved		
27	Default: 3	KSI2	PIO	I	VCC1	VCC1	Low	Note 11
28	0	GPIO126	PIO		VCC1	VCC1	No Gate	
28	1	Reserved	Reserved		Reserved	Reserved		
28	Default: 2	KSI1	PIO	I	VCC1	VCC1	Low	Note 11
28	3	Reserved	Reserved		Reserved	Reserved		
29	0	GPIO125	PIO		VCC1	VCC1	No Gate	
29	1	Reserved	Reserved		Reserved	Reserved		
29	Default: 2	KSI0	PIO	I	VCC1	VCC1	Low	Note 11
29	3	Reserved	Reserved		Reserved	Reserved		
30	Default: 0	GPIO031	PIO	I (PU)	VCC1	VCC1	No Gate	
30	1	Reserved	Reserved		Reserved	Reserved		
30	2	Reserved	Reserved		Reserved	Reserved		
30	3	Reserved	Reserved		Reserved	Reserved		
31	Default: 0	GPIO127	PIO	I	VCC1	VCC1	No Gate	
31	1	Reserved	Reserved		Reserved	Reserved		
31	2	Reserved	Reserved		Reserved	Reserved		
31	3	Reserved	Reserved		Reserved	Reserved		
32	0	GPIO052	PIO		VCC1	VCC1	No Gate	
32	1	Reserved	Reserved		Reserved	Reserved		
32	2	Reserved	Reserved		Reserved	Reserved		
32	Default: 3	Reserved	Reserved		Reserved	Reserved		

TABLE 1-21: MULTIPLEXING TABLE (5 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
33	Default: 0	GPIO147	PIO	I (PU)	VCC1	VCC1	No Gate	
33	1	Reserved	Reserved		Reserved	Reserved		
33	2	Reserved	Reserved		Reserved	Reserved		
33	3	Reserved	Reserved		Reserved	Reserved		
34	Default: 0	GPIO151	PIO	I (PU)	VCC1	VCC1	No Gate	
34	1	Reserved	Reserved		Reserved	Reserved		
34	2	Reserved	Reserved		Reserved	Reserved		
34	3	Reserved	Reserved		Reserved	Reserved		
35	0	GPIO051	PIO		VCC1	VCC1	No Gate	
35	1	Reserved	Reserved		Reserved	Reserved		
35	2	Reserved	Reserved		Reserved	Reserved		
35	Default: 3	Reserved	Reserved		Reserved	Reserved		
36		VSS	PWR		PWR	PWR		
36								
36								
36								
37		VCC1	PWR		PWR	PWR		
37								
37								
37								
38	0	GPIO062	PIO		VCC1	VCC1	No Gate	
38	Default: 1	ADC4	I_AN	I_AN	AVCC1_ADC	AVCC1_ADC	Low	Note 8
38	2	Reserved	Reserved		Reserved	Reserved		
38	3	Reserved	Reserved		Reserved	Reserved		
39	0	GPIO061	PIO		VCC1	VCC1	No Gate	
39	Default: 1	ADC3	I_AN	I_AN	AVCC1_ADC	AVCC1_ADC	Low	Note 8
39	2	Reserved	Reserved		Reserved	Reserved		
39	3	Reserved	Reserved		Reserved	Reserved		
40		AVCC	PWR		PWR	PWR		
40								
40								
40								

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TABLE 1-22: MULTIPLEXING TABLE (6 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
41	Default: 0	GPIO206	PIO	I	VCC1	VCC1	No Gate	
41	1	Reserved	Reserved		Reserved	Reserved		
41	2	Reserved	Reserved		Reserved	Reserved		
41	3	Reserved	Reserved		Reserved	Reserved		
42	0	GPIO060	PIO		VCC1	VCC1	No Gate	
42	Default: 1	ADC2	I_AN	I_AN (PU)	AVCC1_ADC	AVCC1_ADC	Low	Note 8
42	2	Reserved	Reserved		Reserved	Reserved		
42	3	Reserved	Reserved		Reserved	Reserved		
43	0	GPIO057	PIO		VCC1	VCC1	No Gate	
43	Default: 1	ADC1	I_AN	I_AN	AVCC1_ADC	AVCC1_ADC	Low	Note 8
43	2	Reserved	Reserved		Reserved	Reserved		
43	3	Reserved	Reserved		Reserved	Reserved		
44	0	GPIO056	PIO		VCC1	VCC1	No Gate	
44	1	ADC0	I_AN		AVCC1_ADC	AVCC1_ADC	Low	Note 8
44	2	Reserved	Reserved		Reserved	Reserved		
44	Default: 3	ADC0	I_AN	I_AN	AVCC1_ADC	AVCC1_ADC	Low	Note 8
45		AVSS	PWR		PWR	PWR		
45								
45								
45								
46	0	GPIO112	PCI_PIO		VCC1	VCC1	No Gate	
46	1	Reserved	Reserved		Reserved	Reserved		
46	2	Reserved	Reserved		Reserved	Reserved		
46	Default: 3	Reserved	Reserved		Reserved	Reserved		
47		VSS	PWR		PWR	PWR		
47								
47								
47								
48	0	GPIO114	PCI_PIO		VCC1	VCC1	No Gate	
48	1	Reserved	Reserved		Reserved	Reserved		
48	2	Reserved	Reserved		Reserved	Reserved		
48	Default: 3	Reserved	Reserved		Reserved	Reserved		

TABLE 1-23: MULTIPLEXING TABLE (7 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
49	Default: 0	JTAG_RST#	I	I	VCC1	VCC1	No Gate	Note 2
49	1	Reserved	Reserved		Reserved	Reserved		
49	2	Reserved	Reserved		Reserved	Reserved		
49	3	Reserved	Reserved		Reserved	Reserved		
50	0	GPIO113	PCI_PIO		VCC1	VCC1	No Gate	
50	1	Reserved	Reserved		Reserved	Reserved		
50	2	Reserved	Reserved		Reserved	Reserved		
50	Default: 3	Reserved	Reserved		Reserved	Reserved		
51	0	GPIO111	PCI_PIO		VCC1	VCC1	No Gate	
51	1	Reserved	Reserved		Reserved	Reserved		
51	2	Reserved	Reserved		Reserved	Reserved		
51	Default: 3	Reserved	Reserved		Reserved	Reserved		
52	0	GPIO120	PCI_PIO		VCC1	VCC1	No Gate	
52	1	Reserved	Reserved		Reserved	Reserved		
52	2	Reserved	Reserved		Reserved	Reserved		
52	Default: 3	Reserved	Reserved		Reserved	Reserved		
53	0	GPIO116	PCI_PIO		VCC1	VCC1	No Gate	
53	Default: 1	LRESET#	PCI_I	PCI_I	VCC1	VCC1	Low	
53	2	Reserved	Reserved		Reserved	Reserved		
53	3	Reserved	Reserved		Reserved	Reserved		
54	0	GPIO117	PCI_PIO		VCC1	VCC1	No Gate	
54	1	Reserved	Reserved		Reserved	Reserved		
54	2	Reserved	Reserved		Reserved	Reserved		
54	Default: 3	Reserved	Reserved		Reserved	Reserved		
55	0	GPIO014	PCI_PIO		VCC1	VCC1	No Gate	
55	1	Reserved	Reserved		Reserved	Reserved		
55	2	Reserved	Reserved		Reserved	Reserved		
55	Default: 3	Reserved	Reserved		Reserved	Reserved		
56		VSS	PWR		PWR	PWR		
56								
56								
56								

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TABLE 1-24: MULTIPLEXING TABLE (8 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
57	0	GPIO115	PCI_PIO		VCC1	VCC1	No Gate	
57	1	Reserved	Reserved		Reserved	Reserved		
57	2	Reserved	Reserved		Reserved	Reserved		
57	Default: 3	Reserved	Reserved		Reserved	Reserved		
58		VCC1	PWR		PWR	PWR		
58								
58								
58								
59	0	GPIO041	PIO		VCC1	VCC1	No Gate	
59	Default: 1	Reserved	PIO	O-8mA (PD) LOW	VCC1	ON		Note 12
59	2	Reserved	Reserved		Reserved	Reserved		
59	Default: 3	Reserved	Reserved		Reserved	Reserved		
60	0	GPIO121	PIO		VCC1	VCC1	No Gate	
60	Default: 1	nRESET_OUT	PIO	O-8mA	VCC1	ON		Note 6
60	2	Reserved	Reserved		Reserved	Reserved		
60	3	Reserved	Reserved		Reserved	Reserved		
61	0	GPIO050	PIO		VCC1	VCC1	No Gate	
61	1	Reserved	Reserved		Reserved	Reserved		
61	2	Reserved	Reserved		Reserved	Reserved		
61	Default: 3	Reserved	Reserved		Reserved	Reserved		
62	0	GPIO065	PIO		VCC1	VCC1	No Gate	
62	1	Reserved	Reserved		Reserved	Reserved		
62	2	Reserved	Reserved		Reserved	Reserved		
62	Default: 3	Reserved	Reserved		Reserved	Reserved		
63	Default: 0	GPIO035	PIO	I (PU)	VCC1	VCC1	No Gate	
63	1	Reserved	Reserved		Reserved	Reserved		
63	2	Reserved	Reserved		Reserved	Reserved		
63	3	Reserved	Reserved		Reserved	Reserved		
64	Default: 0	GPIO027	PIO	I (PU)	VCC1	VCC1	No Gate	
64	1	Reserved	Reserved		Reserved	Reserved		
64	2	Reserved	Reserved		Reserved	Reserved		
64	3	Reserved	Reserved		Reserved	Reserved		

TABLE 1-25: MULTIPLEXING TABLE (9 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
65	Default: 0	GPIO033	PIO	I (PU)	VCC1	VCC1	No Gate	
65	1	Reserved	Reserved		Reserved	Reserved		
65	2	Reserved	Reserved		Reserved	Reserved		
65	3	Reserved	Reserved		Reserved	Reserved		
66	0	GPIO046	PIO		VCC1	VCC1	No Gate	
66	1	Reserved	Reserved		Reserved	Reserved		
66	2	Reserved	Reserved		Reserved	Reserved		
66	Default: 3	Reserved	Reserved		Reserved	Reserved		
67	0	GPIO047	PIO		VCC1	VCC1	No Gate	
67	1	Reserved	Reserved		Reserved	Reserved		
67	2	Reserved	Reserved		Reserved	Reserved		
67	Default: 3	Reserved	Reserved		Reserved	Reserved		
68		VBAT	PWR		PWR	PWR		
68								
68								
68								
69	Default: 0	XTAL2	ICLK		VBAT	VBAT		Note 9
69	1	Reserved	Reserved		Reserved	Reserved		
69	2	Reserved	Reserved		Reserved	Reserved		
69	3	Reserved	Reserved		Reserved	Reserved		
70		VSS_VBAT	PWR		PWR	PWR		
70								
70								
70								
71	Default: 0	XTAL1	OCLK		VBAT	VBAT		Note 9
71	1	Reserved	Reserved		Reserved	Reserved		
71	2	Reserved	Reserved		Reserved	Reserved		
71	3	Reserved	Reserved		Reserved	Reserved		
72	0	GPIO063	PIO		VCC1	VCC1	No Gate	
72	Default: 1	VCC_PWRGD	PIO	I	VCC1	VCC1	High	
72	2	Reserved	Reserved		Reserved	Reserved		
72	3	Reserved	Reserved		Reserved	Reserved		

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TABLE 1-26: MULTIPLEXING TABLE (10 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
73	Default: 0	GPIO110	PIO	I	VCC1	VCC1	No Gate	
73	1	Reserved	Reserved		Reserved	Reserved		
73	2	Reserved	Reserved		Reserved	Reserved		
73	3	Reserved	Reserved		Reserved	Reserved		
74	Default: 0	GPIO130	PIO	I	VCC1	VCC1	No Gate	
74	1	Reserved	Reserved		Reserved	Reserved		
74	2	Reserved	Reserved		Reserved	Reserved		
74	3	Reserved	Reserved		Reserved	Reserved		
75	0	GPIO013	PIO		VCC1	VCC1	No Gate	
75	1	Reserved	Reserved		Reserved	Reserved		
75	Default: 2	32KHZ_OUT	PIO	O-4mA	VCC1	VCC1		
75	3	Reserved	Reserved		Reserved	Reserved		
76	0	GPIO026	PIO		VCC1	VCC1	No Gate	
76	1	Reserved	Reserved		Reserved	Reserved		
76	2	Reserved	Reserved		Reserved	Reserved		
76	Default: 3	Reserved	Reserved		Reserved	Reserved		
77	0	GPIO131	PIO		VCC1	VCC1	No Gate	
77	Default: 1	VCC1_RST#	PIO	OD-4mA	VCC1	ON	High	
77	2	Reserved	Reserved		Reserved	Reserved		
77	3	Reserved	Reserved		Reserved	Reserved		
78	Default: 0	GPIO141	PIO	I	VCC1	VCC1	No Gate	
78	1	PWM3	PIO		VCC1	VCC1		
78	2	LED3	PIO		VCC1	VCC1		
78	3	Reserved	Reserved		Reserved	Reserved		
79	0	Reserved	Reserved		Reserved	Reserved		
79	Default: 1	VSS	PWR		PWR	PWR	Reserved	
79	2	Reserved	Reserved		Reserved	Reserved		
79	3	Reserved	Reserved		Reserved	Reserved		
80	Default: 0	GPIO132	PIO	I	VCC1	VCC1	No Gate	
80	1	Reserved	Reserved		Reserved	Reserved		
80	2	Reserved	Reserved		Reserved	Reserved		
80	3	Reserved	Reserved		Reserved	Reserved		

TABLE 1-27: MULTIPLEXING TABLE (11 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
81	Default: 0	GPIO007	PIO	I	VCC1	VCC1	No Gate	
81	1	Reserved	Reserved		Reserved	Reserved		
81	2	Reserved	Reserved		Reserved	Reserved		
81	3	KSO14	PIO		VCC1	VCC1		
82		VSS	PWR		PWR	PWR		
82								
82								
82								
83	Default: 0	GPIO010	PIO	I	VCC1	VCC1	No Gate	
83	1	Reserved	Reserved		Reserved	Reserved		
83	2	Reserved	Reserved		Reserved	Reserved		
83	3	KSO15	PIO		VCC1	VCC1		
84		VCC1	PWR		PWR	PWR		
84								
84								
84								
85	Default: 0	GPIO143	PIO	I	VCC1	ON	No Gate	
85	1	RSMRST#	PIO		VCC1	VCC1		Note 6
85	2	Reserved	Reserved		Reserved	Reserved		
85	3	Reserved	Reserved		Reserved	Reserved		
86	Default: 0	GPIO162	PIO	I	VCC1	VCC1	No Gate	
86	1	RXD	PIO		VCC1	VCC1	High	
86	2	Reserved	Reserved		Reserved	Reserved		
86	3	Reserved	Reserved		Reserved	Reserved		
87	Default: 0	GPIO165	PIO	I	VCC1	VCC1	No Gate	
87	1	TXD	PIO		VCC1	VCC1	High	
87	2	SHD_CS1#	PIO		VCC1	VCC1	High	
87	3	Reserved	Reserved		Reserved	Reserved		
88	Default: 0	GPIO023	PIO	I	VCC1	VCC1	No Gate	Note 5
88	1	Reserved	Reserved		Reserved	Reserved		
88	2	I2C1_DAT0	PIO		VCC1	VCC1	High	
88	3	Reserved	Reserved		Reserved	Reserved		

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TABLE 1-28: MULTIPLEXING TABLE (12 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
89	Default: 0	GPIO022	PIO	I	VCC1	VCC1	No Gate	Note 5
89	1	Reserved	Reserved		Reserved	Reserved		
89	2	I2C1_CLK0	PIO		VCC1	VCC1	High	
89	3	Reserved	Reserved		Reserved	Reserved		
90	Default: 0	GPIO021	PIO	I	VCC1	VCC1	No Gate	
90	1	Reserved	Reserved		Reserved	Reserved		
90	2	I2C2_DAT0	PIO		VCC1	VCC1	High	
90	3	Reserved	Reserved		Reserved	Reserved		
91	Default: 0	GPIO020	PIO	I	VCC1	VCC1	No Gate	
91	1	Reserved	Reserved		Reserved	Reserved		
91	2	I2C2_CLK0	PIO		VCC1	VCC1	High	
91	3	Reserved	Reserved		Reserved	Reserved		
92	Default: 0	GPIO105	PIO	I	VCC1	VCC1	No Gate	
92	1	TACH1	PIO		VCC1	VCC1	Low	
92	2	Reserved	Reserved		Reserved	Reserved		
92	3	Reserved	Reserved		Reserved	Reserved		
93	Default: 0	GPIO145	PIO	I (PU)	VCC1	VCC1	No Gate	
93	1	Reserved	Reserved		Reserved	Reserved		
93	2	Reserved	Reserved		Reserved	Reserved		
93	3	Reserved	Reserved		Reserved	Reserved		
94	Default: 0	GPIO164	PIO	I	VCC1	VCC1	No Gate	Note 10
94	1	PVT_MISO	PIO		VCC1	VCC1	Low	Note 10
94	2	Reserved	Reserved		Reserved	Reserved		
94	3	Reserved	Reserved		Reserved	Reserved		
95	Default: 0	GPIO124	PIO	I	VCC1	VCC1	No Gate	Note 10
95	1	SHD_MISO	PIO		VCC1	VCC1	Low	Note 10
95	2	Reserved	Reserved		Reserved	Reserved		
95	3	Reserved	Reserved		Reserved	Reserved		
96	Default: 0	GPIO146	PIO	I	VCC1	VCC1	No Gate	Note 4, Note 10
96	1	PVT_CS0#	PIO		VCC1	VCC1	High	Note 10
96	2	Reserved	Reserved		Reserved	Reserved		
96	3	Reserved	Reserved		Reserved	Reserved		

TABLE 1-29: MULTIPLEXING TABLE (13 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
97	Default: 0	GPIO150	PIO	I	VCC1	VCC1	No Gate	Note 10
97	1	SHD_CS0#	PIO		VCC1	VCC1	High	Note 10
97	2	Reserved	Reserved		Reserved	Reserved		
97	3	Reserved	Reserved		Reserved	Reserved		
98	Default: 0	GPIO157	PIO	I (PU)	VCC1	VCC1	No Gate	
98	1	BC_CLK	PIO		VCC1	VCC1		
98	2	Reserved	Reserved		Reserved	Reserved		
98	3	Reserved	Reserved		Reserved	Reserved		
99	Default: 0	GPIO160	PIO	I (PU)	VCC1	VCC1	No Gate	
99	1	BC_DAT	PIO		VCC1	VCC1	Low	Note 7
99	2	Reserved	Reserved		Reserved	Reserved		
99	3	Reserved	Reserved		Reserved	Reserved		
100	Default: 0	GPIO161	PIO	I (PU)	VCC1	VCC1	No Gate	
100	1	BC_INT#	PIO		VCC1	VCC1	High	
100	2	Reserved	Reserved		Reserved	Reserved		
100	3	Reserved	Reserved		Reserved	Reserved		
101	Default: 0	GPIO140	PIO	I	VCC1	VCC1	No Gate	
101	1	TACH2	PIO		VCC1	VCC1	Low	
101	2	Reserved	Reserved		Reserved	Reserved		
101	3	TACH2PWM_IN	PIO		VCC1	VCC1	Low	
102	Default: 0	GPIO045	PIO	I	VCC1	VCC1	No Gate	
102	1	Reserved	Reserved		Reserved	Reserved		
102	2	PVT_CS1#	PIO		VCC1	VCC1	High	
102	3	Reserved	Reserved		Reserved	Reserved		
103	Default: 0	GPIO053	PIO	I	VCC1	VCC1	No Gate	
103	1	Reserved	Reserved		Reserved	Reserved		
103	2	Reserved	Reserved		Reserved	Reserved		
103	3	Reserved	Reserved		Reserved	Reserved		
104		VSS	PWR		PWR	PWR		
104								
104								
104								

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TABLE 1-30: MULTIPLEXING TABLE (14 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
105	Default: 0	GPIO152	PIO	I	VCC1	VCC1	No Gate	
105	1	Reserved	Reserved		Reserved	Reserved		
105	2	Reserved	Reserved		Reserved	Reserved		
105	3	Reserved	Reserved		Reserved	Reserved		
106		VCC1	PWR		PWR	PWR		
106								
106								
106								
107	Default: 0	GPIO030	PIO	I	VCC1	VCC1	No Gate	
107	1	Reserved	Reserved		Reserved	Reserved		
107	2	Reserved	Reserved		Reserved	Reserved		
107	3	Reserved	Reserved		Reserved	Reserved		
108	Default: 0	GPIO012	PIO	I	VCC1	VCC1	No Gate	
108	1	Reserved	Reserved		Reserved	Reserved		
108	2	Reserved	Reserved		Reserved	Reserved		
108	3	KSO17	PIO		VCC1	VCC1		
109	0	GPIO017	PIO		VCC1	VCC1	No Gate	
109	1	Reserved	Reserved		Reserved	Reserved		
109	Default: 2	I2C0_DAT1	PIO	IOD-4mA	VCC1	VCC1	High	
109	3	Reserved	Reserved		Reserved	Reserved		
110	0	GPIO134	PIO		VCC1	VCC1	No Gate	
110	1	Reserved	Reserved		Reserved	Reserved		
110	Default: 2	I2C0_CLK1	PIO	IOD-4mA	VCC1	VCC1	High	
110	3	Reserved	Reserved		Reserved	Reserved		
111	0	GPIO016	PIO		VCC1	VCC1	No Gate	
111	1	Reserved	Reserved		Reserved	Reserved		
111	Default: 2	I2C0_DAT0	PIO	IOD-4mA	VCC1	VCC1	High	
111	3	Reserved	Reserved		Reserved	Reserved		
112	0	GPIO015	PIO		VCC1	VCC1	No Gate	
112	1	Reserved	Reserved		Reserved	Reserved		
112	Default: 2	I2C0_CLK0	PIO	IOD-4mA	VCC1	VCC1	High	
112	3	Reserved	Reserved		Reserved	Reserved		

TABLE 1-31: MULTIPLEXING TABLE (15 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
113	0	GPIO154	PIO		VCC1	VCC1	No Gate	
113	1	Reserved	Reserved		Reserved	Reserved		
113	Default: 2	LED0	PIO	OD-12mA	VCC1	VCC1		
113	3	Reserved	Reserved		Reserved	Reserved		
114	0	GPIO155	PIO		VCC1	VCC1	No Gate	
114	1	Reserved	Reserved		Reserved	Reserved		
114	Default: 2	LED1	PIO	OD-12mA	VCC1	VCC1		
114	3	Reserved	Reserved		Reserved	Reserved		
115	0	GPIO156	PIO		VCC1	VCC1	No Gate	
115	1	Reserved	Reserved		Reserved	Reserved		
115	Default: 2	LED2	PIO	OD-12mA	VCC1	VCC1		
115	3	Reserved	Reserved		Reserved	Reserved		
116	Default: 0	GPIO163	PIO	I	VCC1	VCC1	No Gate	
116	1	Reserved	Reserved		Reserved	Reserved		
116	2	Reserved	Reserved		Reserved	Reserved		
116	3	Reserved	Reserved		Reserved	Reserved		
117		VSS	PWR		PWR	PWR		
117								
117								
117								
118	Default: 0	GPIO136	PIO	I	VCC1	VCC1	No Gate	
118	1	PWM1	PIO		VCC1	VCC1		
118	2	Reserved	Reserved		Reserved	Reserved		
118	3	Reserved	Reserved		Reserved	Reserved		
119		VCC1	PWR		PWR	PWR		
119								
119								
119								
120	Default: 0	GPIO133	PIO	I	VCC1	VCC1	No Gate	
120	1	PWM0	PIO		VCC1	VCC1		
120	2	Reserved	Reserved		Reserved	Reserved		
120	3	Reserved	Reserved		Reserved	Reserved		

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TABLE 1-32: MULTIPLEXING TABLE (16 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
121	Default: 0	GPIO034	PIO	I	VCC1	VCC1	No Gate	
121	1	PWM2	PIO		VCC1	VCC1		
121	2	Reserved	Reserved		Reserved	Reserved		
121	3	TACH2PWM_OUT	PIO		VCC1	VCC1		
122	Default: 0	GPIO135	PIO	I	VCC1	VCC1	No Gate	
122	1	Reserved	Reserved		Reserved	Reserved		
122	2	Reserved	Reserved		Reserved	Reserved		
122	3	Reserved	Reserved		Reserved	Reserved		
123	Default: 0	GPIO044	PIO	I	VCC1	VCC1	No Gate	
123	1	Reserved	Reserved		Reserved	Reserved		
123	2	Reserved	Reserved		Reserved	Reserved		
123	3	Reserved	Reserved		Reserved	Reserved		
124	Default: 0	GPIO066	PIO	I	VCC1	VCC1	No Gate	
124	1	Reserved	Reserved		Reserved	Reserved		
124	2	Reserved	Reserved		Reserved	Reserved		
124	3	Reserved	Reserved		Reserved	Reserved		
125	Default: 0	GPIO025	PIO	I	VCC1	ON	No Gate	
125	1	Reserved	Reserved		Reserved	Reserved		
125	2	I2C3_DAT0	PIO		VCC1	VCC1	High	
125	3	Reserved	Reserved		Reserved	Reserved		
126	Default: 0	GPIO024	PIO	I (PU)	VCC1	VCC1	No Gate	
126	1	Reserved	Reserved		Reserved	Reserved		
126	2	I2C3_CLK0	PIO		VCC1	VCC1	High	
126	3	Reserved	Reserved		Reserved	Reserved		
127	Default: 0	GPIO054	PIO	I	VCC1	VCC1	No Gate	Note 10
127	1	PVT_MOSI	PIO		VCC1	VCC1		Note 10
127	2	Reserved	Reserved		Reserved	Reserved		
127	3	Reserved	Reserved		Reserved	Reserved		
128	Default: 0	GPIO064	PIO	I	VCC1	VCC1	No Gate	Note 10
128	1	SHD_MOSI	PIO		VCC1	VCC1		Note 10
128	2	Reserved	Reserved		Reserved	Reserved		
128	3	Reserved	Reserved		Reserved	Reserved		

TABLE 1-33: MULTIPLEXING TABLE (17 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
129	Default: 0	GPIO067	PIO	I (PD)	VCC1	ON	No Gate	
129	1	Reserved	Reserved		Reserved	Reserved		
129	2	Reserved	Reserved		Reserved	Reserved		
129	3	Reserved	Reserved		Reserved	Reserved		
130	Default: 0	GPIO055	PIO	I (PD)	VCC1	ON	No Gate	
130	1	Reserved	Reserved		Reserved	Reserved		
130	2	Reserved	Reserved		Reserved	Reserved		
130	3	Reserved	Reserved		Reserved	Reserved		
131	Default: 0	GPIO210	PIO	I (PD)	VCC1	ON	No Gate	
131	1	Reserved	Reserved		Reserved	Reserved		
131	2	Reserved	Reserved		Reserved	Reserved		
131	3	Reserved	Reserved		Reserved	Reserved		
132	Default: 0	GPIO211	PIO	I (PD)	VCC1	ON	No Gate	
132	1	Reserved	Reserved		Reserved	Reserved		
132	2	Reserved	Reserved		Reserved	Reserved		
132	3	Reserved	Reserved		Reserved	Reserved		
133	Default: 0	GPIO200	PIO	I (PD)	VCC1	ON	No Gate	
133	1	Reserved	Reserved		Reserved	Reserved		
133	2	Reserved	Reserved		Reserved	Reserved		
133	3	Reserved	Reserved		Reserved	Reserved		
134	Default: 0	GPIO123	PIO	I (PD)	VCC1	ON	No Gate	
134	1	Reserved	Reserved		Reserved	Reserved		
134	2	Reserved	Reserved		Reserved	Reserved		
134	3	Reserved	Reserved		Reserved	Reserved		
135		VCC1	PWR		PWR	PWR		
135								
135								
135								
136	Default: 0	GPIO202	PIO	I (PD)	VCC1	ON	No Gate	
136	1	Reserved	Reserved		Reserved	Reserved		
136	2	Reserved	Reserved		Reserved	Reserved		
136	3	Reserved	Reserved		Reserved	Reserved		

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TABLE 1-34: MULTIPLEXING TABLE (18 OF 18)

Pin Ref. Number	MUX	Signal	Buffer Type	Default Operation	Signal Power Well	Emulated Power Well	Gated State	Notes
137	Default: 0	GPIO201	PIO	I (PD)	VCC1	ON	No Gate	
137	1	Reserved	Reserved		Reserved	Reserved		
137	2	Reserved	Reserved		Reserved	Reserved		
137	3	Reserved	Reserved		Reserved	Reserved		
138		VSS	PWR		PWR	PWR		
138								
138								
138								
139	Default: 0	GPIO203	PIO	I (PD)	VCC1	ON	No Gate	
139	1	Reserved	Reserved		Reserved	Reserved		
139	2	Reserved	Reserved		Reserved	Reserved		
139	3	Reserved	Reserved		Reserved	Reserved		
140		VSS	PWR		PWR	PWR		
140								
140								
140								
141	Default: 0	GPIO204	PIO	I (PD)	VCC1	ON	No Gate	
141	1	Reserved	Reserved		Reserved	Reserved		
141	2	Reserved	Reserved		Reserved	Reserved		
141	3	Reserved	Reserved		Reserved	Reserved		
142		NC						
142								
142								
142								
143		VSS	PWR		PWR	PWR		
143								
143								
143								
144		VSS	PWR		PWR	PWR		
144								
144								
144								

1.6 Notes for Tables in this Chapter

Note 1	The LRESET# pin requires an external weak pull-up resistor to VCC1 of 10k-100k ohms. If the LRESET# pin is assigned to the GPIO function rather than LRESET#, the internal LRESET# signal is gated low, and therefore the nRESET_OUT function, the UART and the GPIO blocks will not operate properly.
Note 2	When the JTAG_RST# pin is not asserted (logic '1'), the JTAG_TDI, JTAG_TDO, JTAG_TCK, JTAG_TMS signal functions in the JTAG interface are unconditionally routed to the interface; the Pin Control register for these pins has no effect. When the JTAG_RST# pin is asserted (logic '0'), the JTAG_TDI, JTAG_TDO, JTAG_TCK, JTAG_TMS signal functions in the JTAG interface are not routed to the interface and the Pin Control Register for these pins controls the muxing. The pin control registers can not be used to route the JTAG interface to the pins. The System Board Designer should terminate this pin in all functional states using jumpers and pull-up or pull down resistors, etc.
Note 3	An external cap must be connected as close to the CAP pin/ball as possible with a routing resistance and CAP ESR of less than 100mohms. The capacitor value is 1uF and must be ceramic with X5R or X7R dielectric. The cap pin/ball should remain on the top layer of the PCB and traced to the CAP. Avoid adding vias to other layers to minimize inductance.
Note 4	A pull-down is required on the GPIO146/PVT_CS0# pin if there is no private SPI flash device on the board.
Note 5	This I2C port supports 1Mbps (pin 88, GPIO023/I2C1_DAT0 and pin 89, GPIO022/I2C1_CLK0). For 1Mbps I2C recommended capacitance/pull-up relationships from Intel, refer to the Shark Bay platform guide, Intel ref number 486714. Refer to the PCH - SMBus 2.0/SMLink Interface Design Guidelines, Table 20-5 Bus Capacitance/Pull-Up Resistor Relationship.
Note 6	The following glitch protected pins require a pull-down on the board: pin 60, nRESET_OUT/GPIO121 and pin 85, GPIO143/RSMRST#. The nRESET_OUT pin will drive low when VCC1 comes on and stays low until the iRESET_OUT bit is cleared after VCC PWRGD asserts. The RSMRST# pin also drives low (as a GPIO push-pull output) following a VCC1 power-on until firmware deasserts it by writing the GPIO data bit to '1'. The GPIO143/RSMRST# pin operates in this manner as a GPIO; the RSMRST# function is not a true alternate function and the GPIO143 control register must not be changed from the GPIO default function.
Note 7	The BC DAT pin requires a weak pull up resistor (100 K Ohms).
Note 8	The voltage on the ADC pins must not exceed 3.6 V or damage to the device will occur.
Note 9	The XTAL1 pin should be left floating when using the XTAL2 pin for the single ended clock input.
Note 10	The SPI pins are configured to their SPI function by ROM boot code as follows. Shared SPI pins are configured to the following SPI functions: SHD_CLK, SHD_MOSI, SHD_MISO and SHD_CS0#. If the PVT_CS0# pin (pin 96) is sampled high, then the private SPI pins are configured to the following SPI functions after a successful load from flash: PVT_CLK, PVT_MOSI, PVT_MISO and PVT_CS0#; otherwise these pins are left as the GPIO function. It is recommended that user code reconfigures the shared SPI pins to the GPIO input function before releasing RSMRST#.
Note 11	The KSI[7:0] pins have the internal pull-up enabled by ROM boot code. Therefore the Buffer Type on these pins is I (PU) after the ROM boot code runs.

1.7 Pin States After VCC1 Power-On

Pins that default to IOD or OD in the Multiplexing Tables are open drain and come up tri-stated after VCC1 power-on. Pins that default to I are inputs and also come up tri-stated (high-z).

Table 1-35 shows pins that have specific states after VCC1 power-on.

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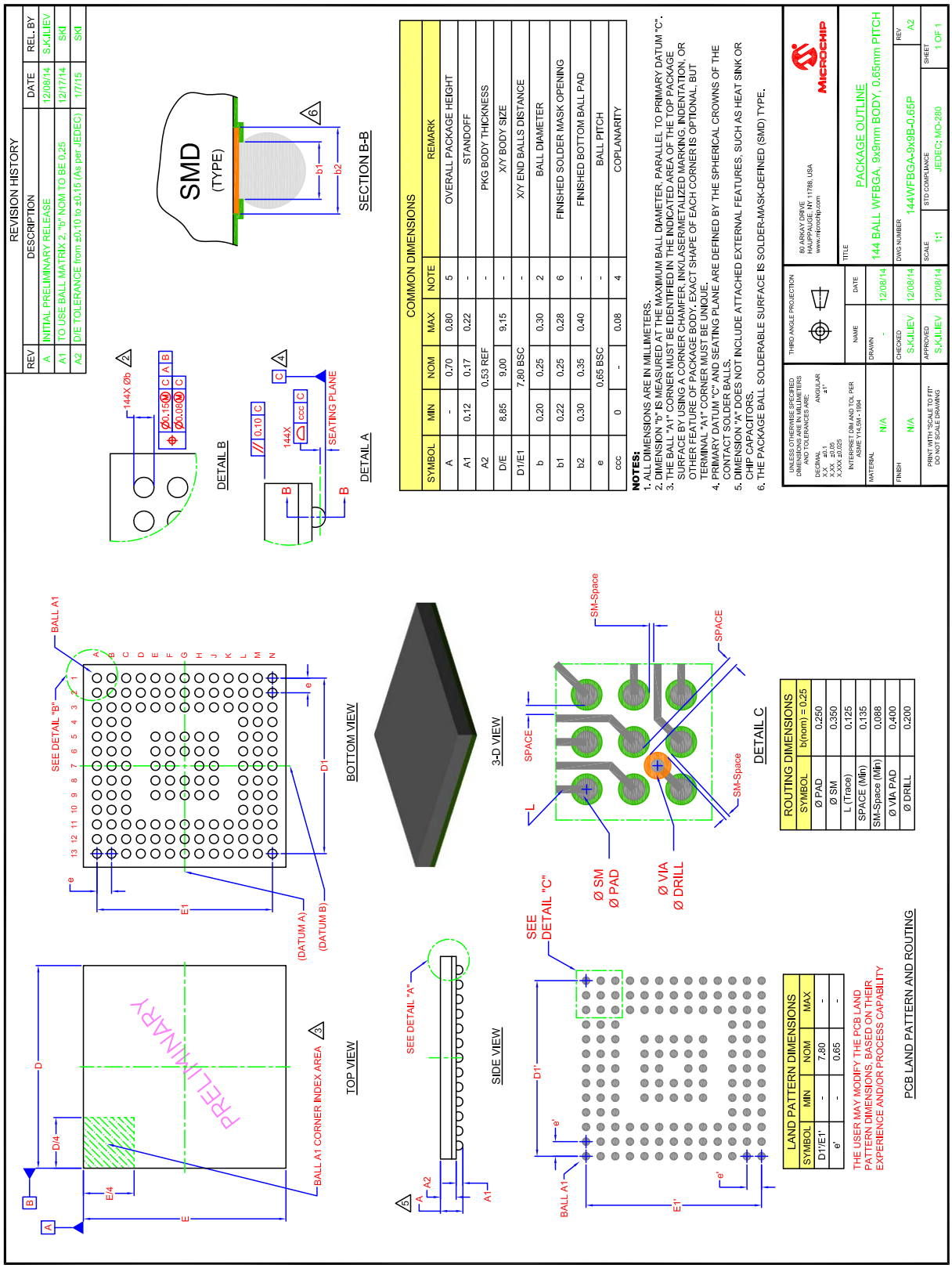
TABLE 1-35: PIN STATES AFTER VCC1 POWER-ON

Pin Reference Number	Pin Name	Pin State after VCC1 Power-on
21	KSO00/GPIO000/JTAG_TCK	Push-pull - High
20	KSO01/GPIO100/JTAG_TMS	Push-pull - High
19	KSO02/GPIO101/JTAG_TDI	Push-pull - High
18	KSO03/GPIO102/JTAG_TDO	Push-pull - High
17	KSO04/GPIO103/TFDP_DATA/XNOR	Push-pull - High
16	KSO05/GPIO104/TFDP_CLK	Push-pull - High
13	KSO06/GPIO001	Push-pull - High
12	KSO07/GPIO002	Push-pull - High
10	KSO08/GPIO003	Push-pull - High
9	KSO09/GPIO106	Push-pull - High
8	KSO10/GPIO004	Push-pull - High
7	KSO11/GPIO107	Push-pull - High
6	KSO12/GPIO005	Push-pull - High
5	KSO13/GPIO006	Push-pull - High
113	LED0/GPIO154	OD - low
114	LED1/GPIO155	OD - low
115	LED2/GPIO156	OD - low
66	Reserved/GPIO046	IOD - low
61	Reserved/GPIO050	IOD - low
35	Reserved/GPIO051	IOD - low
60	nRESET_OUT/GPIO121	Glitch Protected - driven low while VCC1 is rising. The pin becomes a push-pull output after VCC1 is up and stable (requires a pull-down on the board)
77	VCC1_RST#/GPIO131	Glitch Protected - driven low while VCC1 is rising. The pin becomes OD after VCC1 is up and stable (requires a pull-up on the board)
85	GPIO143/RSMRST#	Glitch Protected - driven low while VCC1 is rising. The pin becomes a push-pull output after VCC1 is up and stable (requires a pull-down on the board)
125	GPIO025/I2C3_DAT0	Glitch Protected - driven low while VCC1 is rising. The pin becomes an input (i.e., tri-stated OD type) after VCC1 is up and stable.

1.8 Package Outline

FIGURE 1-2: 144-PIN WFBGA PACKAGE OUTLINE



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2.0 BLOCK OVERVIEW

This Chapter provides an overview of the blocks in the CEC1302.

The block diagram of the CEC1302 is shown in Figure 2-1.

FIGURE 2-1: BLOCK DIAGRAM

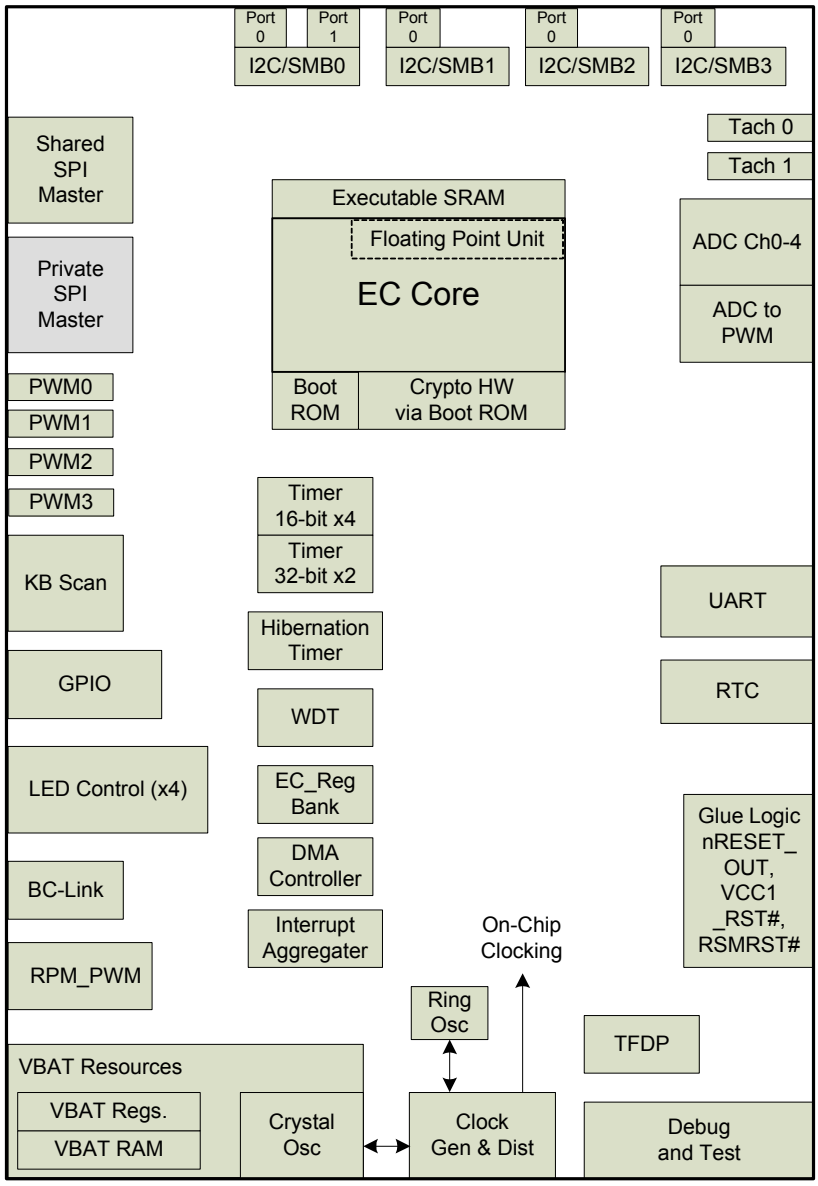

Table 2-1 lists Address Ranges for each of the blocks.

TABLE 2-1: BLOCK ADDRESS RANGES

Feature	Base Address (Hex)
UART	400F1C00
Legacy (Fast KB)	400F1800
RTC	400F2C00
GPIO	40081000
JTAG	40080000
PCR	40080100
Interrupts	4000C000
DMA	40002400
16 bit timer	40000C00
16 bit timer	40000C20
16 bit timer	40000C40
16 bit timer	40000C60
32 bit timer	40000C80
32 bit timer	40000CA0
I2C/SMB	4000AC00
I2C/SMB	4000B000
I2C/SMB	4000B400
I2C/SMB	40001800
64 Byte VBAT RAM	4000A800
VBAT Registers	4000A400
RPM FAN	4000A000
KeyScan	40009C00
Hibernation Timer	40009800
GP-SPI	40009400
GP-SPI	40009480
ADC	40007C00
PWM	40005800
PWM	40005810
PWM	40005820
PWM	40005830
TACH	40006000
TACH	40006010
WDT	40000400
TFDP	40008C00
BC-Link	4000BC00
B/B LED	4000B800
B/B LED	4000B900
B/B LED	4000BA00
B/B LED	4000BB00
PKE	4000BD00
RNG	4000BE00
HASH	4000D000
AES	4000D200
EC_REG_BANK	4000FC00
Data Space SRAM	00118000
Code Space SRAM	00100000
ROM	00000000

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3.0 POWER, CLOCKS, AND RESETS

3.1 Introduction

The Power, Clocks, and Resets (PCR) chapter identifies all the power supplies, clock sources, and reset inputs to the chip and defines all the derived power, clock, and reset signals. In addition, this section identifies Power, Clock, and Reset events that may be used to generate an interrupt event, as well as, the Chip Power Management Features.

3.2 References

No references have been cited for this chapter.

3.3 Interrupts

The Power, Clocks, and Resets logic generates no events

3.4 Power

3.4.1 POWER SOURCES

Table 3-1 lists the power supplies from which the CEC1302 draws current. These current values are defined in Section 29.4, "Power Consumption," on page 287.

TABLE 3-1: POWER SOURCE DEFINITIONS

Power Well	Nominal Voltage	Description	Source
VCC1	3.3V	Main Battery Pack Supply Power Well. This is the “Always-on” supply.	Pin Interface
VBAT (VCC0) (Note 3-1)	3.0V	System Battery Back-up Power Well. This is the “coin-cell” battery.	Pin Interface

Note: The Minimum rise/fall time requirement on VCC1 is 200us.

Note: The Minimum rise time requirement on VBAT is 100us.

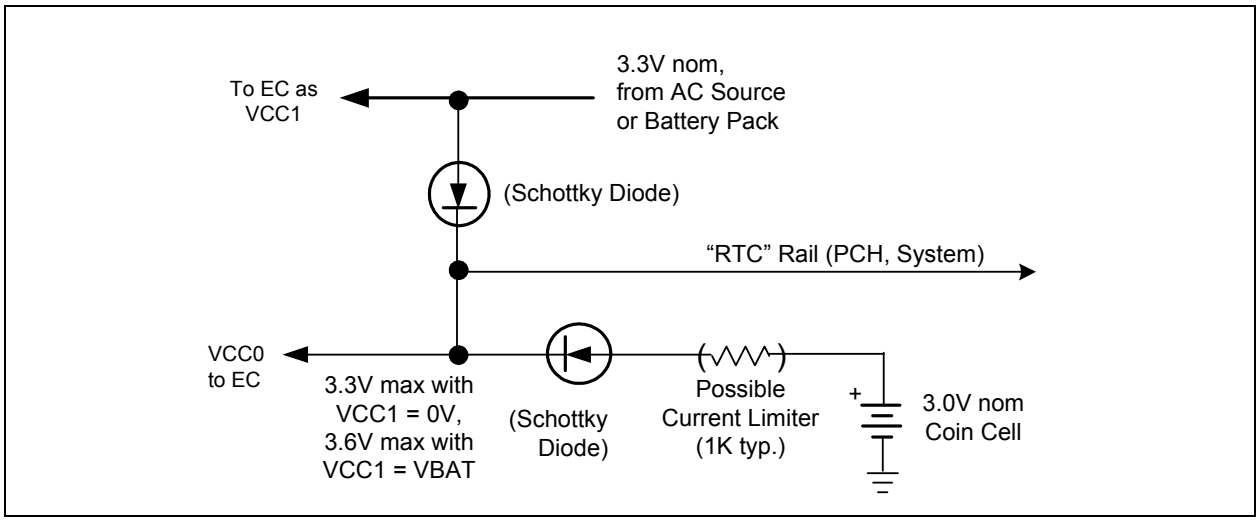
Note 3-1 Note on Battery Replacement: Microchip recommends removing all power sources to the device defined in Table 3-1, "Power Source Definitions" before removing and replacing the battery. In addition, upon removing the battery, ground the battery pin before replacing the battery.

APPLICATION NOTE: Battery Circuit Requirement:

- VCC0 must always be present if VCC1 is present.

The following circuit is recommended to fulfill this requirement:

FIGURE 3-1: RECOMMENDED BATTERY CIRCUIT



3.4.2 POWER GOOD SIGNALS

The power good timing and thresholds are defined in the Section 30.1, "Voltage Thresholds and Power Good Timing," on page 288.

TABLE 3-2: POWER GOOD SIGNAL DEFINITIONS

Power Good Signal	Description	Source
VCC1GD	VCC1GD is an internal power good signal used to indicate when the VCC1 rail is on and stable.	VCC1GD is asserted following a delay after the VCC1 power well exceeds its preset voltage threshold. VCC1GD is de-asserted as soon as this voltage drops below this threshold.
PWRGD	PWRGD is used to indicate when the main power rail voltage is on and stable.	VCC_PWRGD Input pin

3.4.3 SYSTEM POWER SEQUENCING

The following table defines the behavior of the Power Sources in each of the defined ACPI power states.

TABLE 3-3: TYPICAL POWER SUPPLIES VS. ACPI POWER STATES

Supply Name	ACPI Power State						Description
	S0 (FULL ON)	S1 (POS)	S3 (STR)	S4 (STD)	S5 (Soft Off)	G3 (MECH Off)	
VCC1	ON	ON	ON	ON	ON	OFF	CEC1302 "Always-on" Supply. (Note 3-2)
VBAT (VCC0)	ON	ON	ON	ON (Note 3-3)	ON (Note 3-3)	ON (Note 3-3)	CEC1302 Battery Back-up Supply

Note 3-2 VCC1 power supply is always on while the battery pack or ac power is applied to the system.

Note 3-3 This device requires that the VBAT power is on when the VCC1 power supply is on. External circuitry, a diode isolation circuit, is implemented on the motherboard to extend the battery life. This external circuitry ensures the VBAT pin will derive power from the VCC1 power well when it is on. Therefore, the VBAT supply will never appear to be off when the VCC1 rail is on. See APPLICATION NOTE: on page 41.

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3.5 Clocks

The following section defines the CEC1302 clocks that are generated or referenced.

TABLE 3-4: CLOCK DEFINITIONS

Clock Name	Frequency	Description	Source
SUSCLK	32.768 KHz	32.768 kHz Suspend Well Clock Source is a single-ended input that is an accurate 32.768KHz clock. (Note 3-4)	Pin Interface (XTAL2)
32.768 kHz Crystal Oscillator	32.768 KHz	A 32.768 KHz parallel resonant crystal connected between the XTAL1 and XTAL2 pins.	Pin Interface (XTAL1 and XTAL2)
48 MHz Ring Oscillator	48MHz	The 48 MHz Ring Oscillator is a high-accuracy, low power, low start-up latency 48 MHz Ring Oscillator.	Enabled by VCC1 Power (Note 3-5). May be stopped by Chip Power Management Features.
24MHz_Clk	24 MHz	Derived clock for UART	48 MHz Ring Oscillator
16MHz_Clk	16MHz	Derived clock for I2C/SMBus Controller	48 MHz Ring Oscillator
1.8432MHz_Clk	1.843 MHz	Derived clock for UART	48 MHz Ring Oscillator
100kHz_Clk	100 kHz	Derived for several blocks in the EC Subsystem, including, but not limited to, PWM, TACH.	48 MHz Ring Oscillator
32KHz_Clk	32.768 KHz	Internal 32kHz clock domain	Pin Interface: XTAL2: 32KHz Crystal input/ single-ended clock source input pin. XTAL1: 32KHz Crystal output The XOSEL bit configures the source of this clock domain as either a single-ended 32.768 KHz clock input (SUSCLK) or the 32.768 kHz Crystal Oscillator (Note 3-6). If neither of these is available, this clock domain is derived from the 48 MHz Ring Oscillator.

Note 3-4 The chipset will not produce a valid 32KHz clock until about 5 ms (PCH) or 110 ms (ICH) after the deassertion of RSMRST#. See chipset specification for the actual timing.

Note 3-5 The 48 MHz Ring Oscillator is reset by VCC1GD.

Note 3-6 The Clock Enable Register contains the XOSEL bit and the 32K_EN bit (see Section 5.7.2, "Clock Enable Register," on page 68). The 32.768 KHz Oscillator provides a stable timebase for the 48 MHz Ring Oscillator as well as the clock source for the 32KHz Clock Domain. After VBAT POR there is a 500ms max time for the 48 MHz Ring Oscillator to become accurate.

3.5.1 32KHZ CLOCK SWITCHING

The 32kHz clock switching logic switches the clock source of the 32kHz clock domain to be either the single-ended 32.768 KHz clock input or the 32.768 kHz Crystal Oscillator. If neither of these is available, this clock domain is derived from the 48 MHz Ring Oscillator.

Following a VBAT_POR, the XOSEL bit and the 32K_EN bit in the Clock Enable Register are programmed to configure the source of this clock domain.

If the single-ended 32.768 KHz clock input is configured as the source of the 32kHz clock domain, then following a VCC1_RESET, the time for this clock domain to become accurate at 32.768kHz after the SUSCLK input goes active is 100us (max).

If the 32.768 kHz Crystal Oscillator is configured as the source of the 32kHz clock domain, then following a VCC1_RESET, there is 100us (max) delay time for this clock domain to become accurate at 32.768kHz.

3.5.2 CLOCK DOMAINS VS. ACPI POWER STATES

Table 3-5, "Typical CEC1302 Clocks vs. ACPI Power States" shows the relationship between ACPI power states and CEC1302 clock domains:

TABLE 3-5: TYPICAL CEC1302 CLOCKS VS. ACPI POWER STATES

Clock Name	ACPI Power State						Description
	S0 (FULL ON)	S1 (POS)	S3 (STR)	S4 (STD)	S5 (Soft Off)	G3 (MECH Off)	
SUSCLK	ON	ON	ON	ON	ON	OFF	This clock is the system suspend clock source. (Note 3-4).
32.768 kHz Crystal Oscillator	ON	ON	ON	ON	ON	ON	This clock is generated from a 32.768 KHz parallel resonant crystal connected between the XTAL1 and XTAL2 pins.
32KHz_Clk	ON	ON	ON	ON	ON	ON/ OFF	This clock domain is generated from the 32KHz clock input (SUSCLK) when available or the crystal oscillator pins. Otherwise it is generated internally from the 48 MHz Ring Oscillator.
48 MHz Ring Oscillator	ON	ON	ON	ON	ON	OFF	This clock is powered by the CEC1302 suspend supply (VCC1) but may start and stop as described in Section 3.7, "Chip Power Management Features," on page 46 (see also Note 3-2).

3.6 Resets

TABLE 3-6: DEFINITION OF RESET SIGNALS

Reset	Description	Source
VBAT_POR	Internal VBAT Reset signal. This signal is used to reset VBAT powered registers.	VBAT_POR is a pulse that is asserted at the rising edge of VCC1GD if the VBAT voltage is below a nominal 1.25V. VBAT_POR is also asserted as a level if, while VCC1GD is not asserted (‘0’), the coin cell is replaced with a new cell that delivers at least a nominal 1.25V. In this latter case VBAT_POR is de-asserted when VCC1GD is asserted. No action is taken if the coin cell is replaced, or if the VBAT voltage falls below 1.25 V nominal, while VCC1GD is asserted.

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TABLE 3-6: DEFINITION OF RESET SIGNALS (CONTINUED)

Reset	Description	Source
VCC1_RESET	Internal VCC1 Reset signal. This signal is used to reset VCC1 powered registers.	VCC1_RESET is asserted when VCC1GD is low and is deasserted when VCC1GD is high. The VCC1_RST# pin asserted as input will also cause a VCC1_RESET. A WDT_RESET event will also cause a VCC1_RESET assertion.
LRESET#	System reset signal connected to the LRESET# pin.	Pin Interface, LRESET# pin. See Note 3-7.
nSIO_RESET	Performs a reset when VCC is turned off or when the system host asserts the LRESET# pin.	nSIO_RESET is a signal that is asserted if VCC1GD is low, PWRGD is low, or LRESET# is asserted low and may be deasserted when these three signals are all high. The iRESET_OUT bit controls the deassertion of nSIO_RESET. See Note 3-7. A WDT_RESET event will also cause an nSIO_RESET assertion.
WDT_RESET	Internal WDT Reset signal. This signal resets VCC1 powered registers with the exception of the WDT Event Count register. Note that the glitch protect circuits do not activate on a WDT reset. WDT_RESETdoes not reset VBAT registers or logic.	A WDT_RESET is asserted by a WDT Event. **Note:** This event is indicated by the WDT bit in the Power-Fail and Reset Status Register
EC_PROC_ RESET	Internal reset signal to reset the processor in the EC Subsystem.	An EC_PROC_ RESET is a stretched version of the VCC1_RESET. This reset asserts at the same time that VCC1_RESET asserts and is held asserted for 1ms after the VCC1_RESET deasserts.

Note 3-7 If the LRESET# pin is assigned to the GPIO function rather than LRESET#, the internal LRESET# signal is gated low, and therefore the nRESET_OUT function will not operate properly.

3.6.1 INTEGRATED VCC1 POWER ON RESET (VCC1_RST#)

The VCC1_RST# pin is used to control the power up sequence for external devices. The VCC1_RST# timing is shown in Section 30.1.1, "VCC1_RST# Timing," on page 288.

The following summarizes the operation of the VCC1_RST# signal.

- The VCC1_RST# pin is both a reset input and an output to the system.
- The VCC1_RST# output provides a POR reset during power up transition
- The VCC1_RST# output has Output Pin Glitch Protection
- The VCC1_RST# output stretches an external driven reset by 1ms (typ).
- The VCC1_RST# input detects an externally driven reset and places the CEC1302 into a VCC1 POR state.

The VCC1_RST# is an open drain pin. An external pull-up is required for the VCC1_RST# signal to be high.

Note: The external pull-up on the VCC1_RST# pin must be chosen to meet the timing in Table 30-2, “VCC1_RST# Rise Time,” on page 288.

The following sequence illustrates the interaction between the internally and externally driven assertion of VCC1_RST#:

1. The Integrated VCC1 Power On Reset Generator insures VCC1_RST# is driven low during a VCC1 POR from VCC1 = 1V to 2.4V (typ) without glitches.
2. The VCC1_RST# pin is driven low during the POR transition until VCC1 > 2.4V (typ) and then the VCC1_RST# pin remains low afterwards for 1ms (typ) delay window. The VCC1_RST# input is not examined during the 1ms (typ) delay window; therefore, the system input and/or the external pin termination may be modified (i.e. drive it low, let it float, etc.)
   - The VCC1_RST# input is not examined during the POR transition while VCC1 < 2.4V (typ); therefore, the system input to the VCC1_RST# pin may modify the output termination (i.e. drive it low, let it float, etc.).

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3. The VCC1_RST# pin is driven low during the 1ms (typ) delay window. The CEC1302 is in the VCC1_POR state during this time.
4. After the 1ms (typ) window, the VCC1_RST# pin open drain output from the CEC1302 is not driven/released. The strap option pins are sampled at this time.
5. The CEC1302 will remain in the VCC1 POR for 2.65us (min) after the VCC1_RST# pin is released The VCC1_RST# input pin is ignored during this time.
6. The VCC1_RST# pin input is sampled at 2.65us (min) after the VCC1_RST# pin is released.
   - If the VCC1_RST# pin is high when sampled, then the EC starts executing.
   - If the VCC1_RST# pin is low when sampled, the pin is being driven externally (i.e., the system is forcing a reset):
   - The VCC1_RST# pin is driven low for 1ms (typ), then sampled at 2.65us (min) after the VCC1_RST# pin is released (see step 3).

Note 1: The minimum low pulse provided to initiate reset = 20ns.

2: There is no glitch protection or noise filtering (i.e. a vary narrow noise pulse cause a reset).

3.7 Chip Power Management Features

This device is designed to always operate in its lowest power state during normal operation. In addition, this device offers additional programmable options to put individual logical blocks to sleep as defined in Section 3.7.1, "Block Low Power Modes," on page 46.

3.7.1 BLOCK LOW POWER MODES

All power related control signals are generated and monitored centrally in the chip's Power, Clocks, and Resets (PCR) block. The power manager of the PCR block uses a sleep interface to communicate with all the blocks. The sleep interface consists of three signals:

- **sleep_en (request to sleep the block)** is generated by the PCR block. A group of sleep_en signals are generated for every clock segment. Each group consists of a sleep_en signal for every block in that clock segment.
- **clk_req (request clock on)** is generated by every block. They are grouped by blocks on the same clock segment. The PCR monitors these signals to see when it can gate off clocks.
- **reset_en (reset on sleep)** bits determine if the block (including registers) will be reset when it enters sleep mode.

A block can always drive clk_req low synchronously, but it MUST drive it high asynchronously since its internal clocks are gated and it has to assume that the clock input itself is gated. Therefore the block can only drive clk_req high as a result of a register access or some other input signal.

The following table defines a block's power management protocol:

Power State	sleep_en	clk_req	Description
Normal operation	Low	Low	Block is idle and NOT requesting clocks. The block gates its own internal clock.
Normal operation	Low	High	Block is NOT idle and requests clocks.
Request sleep	Rising Edge	Low	Block is IDLE and enters sleep mode immediately. The block gates its own internal clock. The block cannot request clocks again until sleep_en goes low.
Request sleep	Rising Edge	High then Low	Block is not IDLE and will stop requesting clocks and enter sleep when it finishes what it is doing. This delay is block specific, but should be less than 1 ms. The block gates its own internal clock. After driving clk_req low, the block cannot request clocks again until sleep_en goes low.
Register Access	X	High	Register access to a block is always available regardless of sleep_en. Therefore the block ungates its internal clock and drives clk_req high during the access. The block will regate its internal clock and drive clk_req low when the access is done.

A wake event clears all sleep enable bits momentarily, and then returns the sleep enable bits back to their original state. The block that needs to respond to the wake event will do so. See Section 9.8.1, "WAKE Generation," on page 97.

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The Sleep Enable, Clock Required and Reset Enable registers are defined in Section 3.8, "EC-Only Registers," on page 47.

3.8 EC-Only Registers

TABLE 3-7: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 3-8)
PCR	0	EC	32-bit internal address space	4008_0100h

Note 3-8 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 3-8: POWER, CLOCKS AND RESET VCC1-POWERED REGISTERS SUMMARY

Offset	Register Name
00h	Chip Sleep Enable Register (CHIP_SLP_EN)
04h	Chip Clock Required Status Registers (CHIP_CLK_REQ_STS)
08h	EC Sleep Enable Register (EC_SLP_EN)
0Ch	EC Clock Required Status Registers (EC_CLK_REQ_STS)
10h	Host Sleep Enable Register (HOST_SLP_EN)
14h	Host Clock Required Status Registers (HOST_CLK_REQ)
18h	System Sleep Control Register (SYS_SLP_CNTRL)
20h	Processor Clock Control Register (PROC_CLK_CNTRL)
24h	EC Sleep Enable 2 Register (EC_SLP_EN2)
28h	EC Clock Required 2 Status Register (EC_CLK_REQ2_STS)
2Ch	Slow Clock Control Register (SLOW_CLK_CNTRL)
30h	Oscillator ID Register (CHIP_OSC_ID)
34h	PCR chip sub-system power reset status (CHIP_PWR_RST_STS)
38h	Chip Reset Enable Register (CHIP_RST_EN)
3Ch	Host Reset Enable Register (HOST_RST_EN)
40h	EC Reset Enable Register (EC_RST_EN)
44h	EC Reset Enable 2 Register (EC_RST_EN2)
48h	Power Reset Control (PWR_RST_CTRL) Register

Note: All register addresses are naturally aligned on 32-bit boundaries. Offsets for registers that are smaller than 32 bits are reserved and must not be used for any other purpose.

3.9 Sleep Enable and Clock Required Registers

The following are the Sleep Enable and Clock Required registers for the CEC1302.

3.9.1 CHIP SLEEP ENABLE REGISTER (CHIP_SLP_EN)

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:2	RESERVED	RES		
1	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
0	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET

Note 3-9 MCHP Reserved bits in the sleep_en registers must be written to 1 in order for the chip to be put into sleep mode.

3.9.2 CHIP CLOCK REQUIRED STATUS REGISTERS (CHIP_CLK_REQ_STS)

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:2	RESERVED	RES		
1	MCHP Reserved	R	0h	VCC1_RESET
0	MCHP Reserved	R	-	VCC1_RESET

3.9.3 EC SLEEP ENABLE REGISTER (EC_SLP_EN)

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	TIMER16_1 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. See Note 3-10 on page 49.	R/W	0h	VCC1_RESET
30	TIMER16_0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. See Note 3-10 on page 49.	R/W	0h	VCC1_RESET
29	EC_REG_BANK Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
28:23	RESERVED	RES		
22	PWM3 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
21	PWM2 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET

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Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
20	PWM1 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
19:12	RESERVED	RES		
11	TACH1 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
10	SMB0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
9	WDT Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
8	PROCESSOR Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
7	TFDP Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
6	DMA Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
5	PMC Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
4	PWM0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
3	RESERVED	RES		
2	TACH0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
1	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
0	INT Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET

Note 3-10 The basic timers in this device have an auto-reload mode. When this mode is selected, the block's clk_req equation is always asserted, which will prevent the device from gating its clock tree and going to sleep. When the firmware intends to put the device to sleep, none of the timers should be in auto-reload mode. Alternatively, use the timer's HALT function inside the control register to stop the timer in auto-reload mode so it can go to sleep.

3.9.4 EC CLOCK REQUIRED STATUS REGISTERS (EC_CLK_REQ_STS)

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	TIMER16_1 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
30	TIMER16_0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
29	EC_REG_BANK Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
28:23	RESERVED	RES		
22	PWM3 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
21	PWM2 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
20	PWM1 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
19:12	RESERVED	RES		
11	TACH1 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
10	SMB0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
9	WDT Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
8	PROCESSOR Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	1h	VCC1_RESET
7	TFDP Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
6	DMA Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
5	PMC Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
4	PWM0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
3	RESERVED	RES		

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Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
2	TACH0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
1	MCHP Reserved (Note 3-9)	R	0h	VCC1_RESET
0	INT Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET

3.9.5 HOST SLEEP ENABLE REGISTER (HOST_SLP_EN)

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:19	RESERVED	RES		
18	RTC Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
17	RESERVED	RES		
16:12	MCHP Reserved (Note 3-9)	RES	0h	VCC1_RESET
11:2	RESERVED	RES		
1	UART 0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
0	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET

3.9.6 HOST CLOCK REQUIRED STATUS REGISTERS (HOST_CLK_REQ)

Offset	14h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:19	RESERVED	RES		
18	RTC Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
17	RESERVED	RES		
16:12	MCHP Reserved	RES	0h	VCC1_RESET
11:2	RESERVED	RES		
1	UART 0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	-	VCC1_RESET
0	MCHP Reserved	R	-	VCC1_RESET

3.9.7 SYSTEM SLEEP CONTROL REGISTER (SYS_SLP_CNTRL)

Offset	18h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:3	RESERVED	RES		
2	Core regulator standby 0: keep regulator fully operational when sleeping. 1: standby the regulator when sleeping. Allows enough power for chip static operation for memory retention.	R/W	0h	VCC1_RESET
1	Ring oscillator output gate 0: keep ROSC ungated when sleeping. 1: gate the ROSC output when sleeping.	R/W	0h	VCC1_RESET
0	Ring oscillator power down 0: keep ROSC operating when sleeping. 1: disable ROSC when sleeping. Clocks will start on wakeup, but there is a clock lock latency penalty.	R/W	0h	VCC1_RESET

The System Sleep States shown in Table 3-9 and determined by the bits in this register, are only entered if all blocks are sleeping; that is, if the sleep enable bits are set for all blocks and no clocks are required.

TABLE 3-9: SYSTEM SLEEP CONTROL BIT ENCODING

D2	D1	D0	Wake Latency (TYP)	Description
0	0	0	0	The Core regulator and the Ring Oscillator remain powered and running during sleep cycles (SYSTEM HEAVY SLEEP 1) (DEFAULT)
0	1	0	0	The Core regulator remains powered and the Ring oscillator is running but gated during sleep cycles (SYSTEM HEAVY SLEEP 2)
0	X	1	200us (Note 3-11)	The Core regulator remains powered and the Ring oscillator is powered down during sleep cycles (SYSTEM HEAVY SLEEP 3)
1	X	1	1ms	The Core regulator is suspended and the Ring oscillator is powered down during sleep cycles. (SYSTEM DEEPEST SLEEP)

Note 3-11 This is the latency following a wake event until the 48 MHz Ring Oscillator is locked and clocking the system.

3.9.8 PROCESSOR CLOCK CONTROL REGISTER (PROC_CLK_CNTRL)

Offset	20h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	RESERVED	RES		
7:0	Processor Clock Divide Value 1: divide 48 MHz Ring Oscillator by 1. 4: divide 48 MHz Ring Oscillator by 4. 16: divide 48 MHz Ring Oscillator by 16. 48: divide 48 MHz Ring Oscillator by 48. No other values are supported.	R/W	4h	VCC1_RESET

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3.9.9 EC SLEEP ENABLE 2 REGISTER (EC_SLP_EN2)

Offset	24h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:29	RESERVED	RES		
28	AES and HASH Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. Register access to this block is not available in sleep mode.	R/W	0h	VCC1_RESET
27	RNG Sleep Enable 0: block is free to use clocks as necessary. 1: block is powered off immediately. Clock required will de-assert.	R/W	0h	VCC1_RESET
26	PKE Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. Register access to this block is not available in sleep mode.	R/W	0h	VCC1_RESET
25	LED3 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
24	TIMER32_1 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. See Note 3-10 on page 49.	R/W	0h	VCC1_RESET
23	TIMER32_0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. See Note 3-10 on page 49.	R/W	0h	VCC1_RESET
22	TIMER16_3 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. See Note 3-10 on page 49.	R/W	0h	VCC1_RESET
21	TIMER16_2_Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment. See Note 3-10 on page 49.	R/W	0h	VCC1_RESET
20	SPI1 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
19	BCM Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
18	LED2 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
17	LED1 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
16	LED0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET

Offset	24h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15	SMB3 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
14	SMB2 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
13	SMB1 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
12	RPM-PWM Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
11	KEYSCAN Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
10	HTIMER Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
9	SPI0 Sleep Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
8	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
7	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
6	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
5	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
4	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
3	ADC Sleep Enable (Note 3-12) 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
2:0	Reserved	R		

Note 3-12 The ADC VREF must be powered down in order to get the lowest deep sleep current. The ADC VREF Power down bit, ADC_VREF_PD_REF is in the EC Subsystem Registers ADC VREF PD on page 273.

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3.9.10 EC CLOCK REQUIRED 2 STATUS REGISTER (EC_CLK_REQ2_STS)

Offset	28h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:29	RESERVED	RES		
28	AES and HASH Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
27	RNG Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
26	PKE Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
25	LED3 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
24	TIMER32_1 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
23	TIMER32_0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
22	TIMER16_3 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
21	TIMER16_2_Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
20	SPI1 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
19	BCM Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
18	LED2 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
17	LED1 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
16	LED0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
15	SMB3 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
14	SMB2 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET

Offset	28h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
13	SMB1 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
12	RPM-PWM Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
11	KEYSCAN Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
10	HTIMER Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
9	SPI0 Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
8	MCHP Reserved	R	0h	VCC1_RESET
7	MCHP Reserved	R	0h	VCC1_RESET
6	MCHP Reserved	R	0h	VCC1_RESET
5	MCHP Reserved	R	0h	VCC1_RESET
4	MCHP Reserved	R	0h	VCC1_RESET
3	ADC Clock Required 0: block does NOT need clocks. 1: block requires clocks.	R	0h	VCC1_RESET
2:0	RESERVED	RES		

3.9.11 SLOW CLOCK CONTROL REGISTER (SLOW_CLK_CNTRL)

Offset	2Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:10	RESERVED	RES		
9:0	Slow Clock (100 kHz) Divide Value Configures the 100kHz_Clk. 0: Clock off n: divide by n. **Note:** The default setting is for 100 kHz.	R/W	1E0h	VCC1_RESET

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3.9.12 OSCILLATOR ID REGISTER (CHIP_OSC_ID)

Offset	30h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:9	RESERVED	RES		
8	OSC_LOCK Oscillator Lock Status	R	0h	VCC1_RESET
7:0	MCHP Reserved	R	N/A	VCC1_RESET

3.9.13 PCR CHIP SUB-SYSTEM POWER RESET STATUS (CHIP_PWR_RST_STS)

Offset	34h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:11	RESERVED	RES		
10	32K_ACTIVE This bit monitors the state of the 32K clock input. This status bit detects edges on the clock input but does not validate the frequency. 0: The 32K clock input is not present. The internal 32K clock is derived from the ring oscillator 1: The 32K clock input is present. The internal 32K clock is derived from the pin and the ring oscillator is synchronized to the external 32K clock.	R	-	VCC1_RESET
9:7	RESERVED	RES		
6	VCC1 reset status Indicates the status of VCC1_RESET. 0 = No reset occurred since the last time this bit was cleared. 1 = A reset occurred. **Note:** The bit will not clear if a write 1 is attempted at the same time that a VCC1_RST_N occurs, this way a reset event is never missed.	R/WC	1h	VCC1_RESET
5	VBAT reset status Indicates the status of VBAT_POR. 0 = No reset occurred while VCC1 was off or since the last time this bit was cleared. 1 = A reset occurred. **Note:** The bit will not clear if a write 1 is attempted at the same time that a VBAT_RST_N occurs, this way a reset event is never missed.	R/WC	-	VCC1_RESET
4	RESERVED	RES		
3	SIO_Reset Status Indicates the status of nSIO_RESET. 0 = reset active. 1 = reset not active.	R	xh	Note 3-13

Offset	34h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
2	VCC Reset Status Indicates the status of PWRGD. 0 = reset active (PWRGD not asserted). 1 = reset not active (PWRGD asserted).	R	xh	Note 3-13
1:0	RESERVED	RES		

Note 3-13 This read-only status bit always reflects the current status of the event and is not affected by any Reset events.

3.9.14 CHIP RESET ENABLE REGISTER (CHIP_RST_EN)

Offset	38h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:2	RESERVED	RES		
1	MCHP Reserved	R	0h	VCC1_RESET
0	MCHP Reserved	R/W	0h	VCC1_RESET

Note: If a block is configured such that it is to be reset when it goes to sleep, then registers within the block may not be writable when the block is asleep.

3.9.15 HOST RESET ENABLE REGISTER (HOST_RST_EN)

Offset	3Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:19	RESERVED	RES		
18	RTC Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
17	RESERVED	RES		
16:12	MCHP Reserved	RES	0h	VCC1_RESET
11:2	RESERVED	RES		
1	UART 0 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
0	MCHP Reserved	R/W	0h	VCC1_RESET

Note: If a block is configured such that it is to be reset when it goes to sleep, then registers within the block may not be writable when the block is asleep.

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3.9.16 EC RESET ENABLE REGISTER (EC_RST_EN)

Offset	40h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	TIMER16_1 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
30	TIMER16_0 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
29	EC_REG_BANK Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
28:23	RESERVED	RES		
22	PWM3 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
21	PWM2 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
20	PWM1 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
19:12	RESERVED	RES		
11	TACH1 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
10	SMB0 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
9	WDT Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
8	PROCESSOR Sleep Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
7	TFDP Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
6	DMA Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
5	PMC Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
4	PWM0 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
3	RESERVED	RES		

Offset	40h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
2	TACH0 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
1	MCHP Reserved (Note 3-9)	R/W	0h	VCC1_RESET
0	INT Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET

Note: If a block is configured such that it is to be reset when it goes to sleep, then registers within the block may not be writable when the block is asleep.

3.9.17 EC RESET ENABLE 2 REGISTER (EC_RST_EN2)

Offset	44h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:29	RESERVED	RES		
28	AES and HASH Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
27	RNG Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
26	PKE Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
25	LED3 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
24	TIMER32_1 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
23	TIMER32_0 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
22	TIMER16_3 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
21	TIMER16_2_Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
20	SPI1 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET

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Offset	44h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
19	BCM Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
18	LED2 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
17	LED1 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
16	LED0 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
15	SMB3 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
14	SMB2 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
13	SMB1 Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
12	RPM-PWM Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
11	KEYSCAN Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
10	HTIMER Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
9	SPI0 Reset Enable 0: block is free to use clocks as necessary. 1: block is commanded to sleep at next available moment.	R/W	0h	VCC1_RESET
8	MCHP Reserved	R/W	0h	VCC1_RESET
7	MCHP Reserved	R/W	0h	VCC1_RESET
6	MCHP Reserved	R/W	0h	VCC1_RESET
5	MCHP Reserved	R/W	0h	VCC1_RESET
4	MCHP Reserved	R/W	0h	VCC1_RESET
3	ADC Reset Enable 0: block will not be reset on sleep. 1: block will be reset on sleep.	R/W	0h	VCC1_RESET
2:0	RESERVED	RES		

Note: If a block is configured such that it is to be reset when it goes to sleep, then registers within the block may not be writable when the block is asleep.

3.9.18 POWER RESET CONTROL (PWR_RST_CTRL) REGISTER

Offset	48h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:1	RESERVED	RES		
0	iRESET_OUT The iRESET_OUT bit is used by firmware to control the internal nSIO_RESET signal function and the external nRESET_OUT pin. The external pin nRESET_OUT is always driven by nSIO_RESET. Firmware can program the state of iRESET_OUT except when the VCC PWRGD bit is not asserted (‘0’), in which case iRESET_OUT is ‘don’t care’ and nSIO_RESET is asserted (‘0’) (TABLE 3-10:). The internal nSIO_RESET signal is asserted when iRESET_OUT is asserted even if the nRESET_OUT pin is configured as an alternate function. The iRESET_OUT bit must be cleared to take the Host out of reset.	R/W	1h	VCC1_RESET

TABLE 3-10: iRESET_OUT BIT BEHAVIOR

VCC PWRGD	iRESET_OUT	nSIO_RESET & nRESET_OUT	Description
0	X	0 (ASSERTED)	The iRESET_OUT bit does not affect the state of nSIO_RESET when VCC PWRGD is not asserted.
1	1	0 (ASSERTED)	The iRESET_OUT bit can only be written by firmware when VCC PWRGD is asserted.
	0	1 (NOT ASSERTED)	

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4.0 SECURITY FEATURES

4.1 Overview

This device includes a set of components that can support a high level of system security. Hardware support is provided for:

- Authentication, using public key algorithms
- Integrity, using Secure Hash Algorithms (SHA)
- Privacy, using symmetric encryption (Advanced Encryption Standard, AES)
- Entropy, using a true Random Number Generator

4.2 References

- American National Standards Institute, “Public Key Cryptography for the Financial Services Industry: Key Agreement and Key Transport Using Elliptic Curve Cryptography”, X9.63-2011, December 2011
- American National Standards Institute, “Public Key Cryptography for the Financial Servic3es Industry: The Elliptic Curve Digital Signature Algorithm (ECDSA)”, X9.62-2005, November 2005
- International Standards Organization, “Information Technology - Security techniques - Cryptographic techniques based on elliptic curves -- Part 2: Digital Signatures”, ISO/IEC 15946-2, December 2002
- National Institute of Standards and Technology, “Secure Hash Standard (SHS)”, FIPS Pub 180-4, March 2012
- National Institute of Standards and Technology, “Digital Signature Standard (DSS)”, FIPS Pub 186-3, June 2009
- National Institute of Standards and Technology, “Advanced Encryption Standard (AES)”, FIPS Pub 197, November 2001
- National Institute of Standards and Technology, “Recommendation for Block Cipher Modes of Operation”, FIPS SP 800-38A, 2001
- RSA Laboratories, “PKCS#1 v2.2: RSA Cryptography Standard”, October 2012

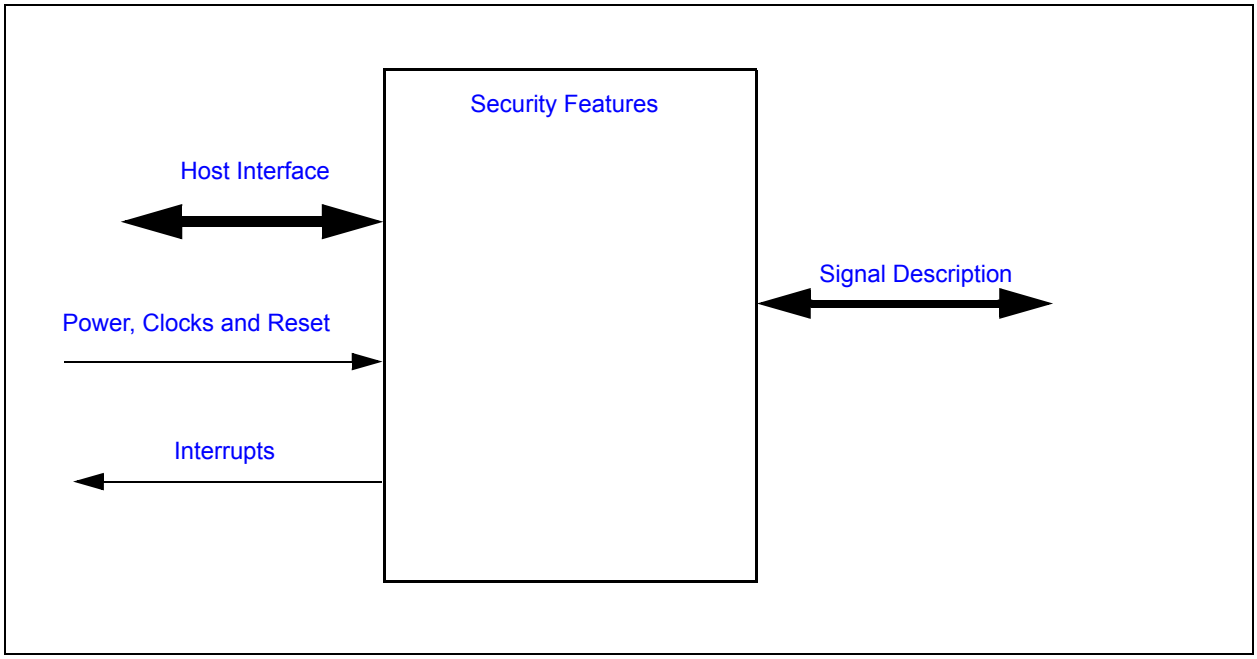
4.3 Terminology

There is no terminology defined for this section.

4.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 4-1: I/O DIAGRAM OF BLOCK



4.5 Signal Description

There are no external signals for this block.

4.6 Host Interface

Registers for the cryptographic hardware are accessible by the EC.

4.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

4.7.1 POWER DOMAINS

TABLE 4-1: POWER SOURCES

Name	Description
VCC1	The Security Features are all implemented on this single power domain.

4.7.2 CLOCK INPUTS

This block does not require any special clock inputs. All register accesses are synchronized to the host clock.

4.7.3 RESETS

TABLE 4-2: RESET SIGNALS

Name	Description
VCC1_RESET	This signal resets all the logic and registers to their initial default state.

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4.8 Interrupts

This section defines the interrupt sources generated from this block.

Source	Description
Public Key Engine	
PKE_ERROR	Public Key Engine core error detected
PKE_END	Public Key Engine completed processing
Symmetric Encryption	
AES	Symmetric Encryption block completed processing
Cryptographic Hashing	
HASH	HASH
Random Number Generator	
RNG	Random Number Generator filled its FIFO

4.9 Low Power Modes

The Security Features blocks may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

4.10 Description

The security hardware incorporates the following functions.

4.10.1 SYMMETRIC ENCRYPTION/DECRYPTION

Standard AES encryption and decryption, with key sizes of 128 bits, 192 bits and 256 bits, are supported with a hardware accelerator. AES modes that can be configured include Electronic Code Block (ECB), Cipher Block Chaining (CBC), Counter Mode (CTR), Output Feedback (OFB) and Cipher Feedback (CFB).

4.10.2 CRYPTOGRAPHIC HASHING

Standard SHA hash algorithms, including SHA-1 and SHA-256 are supported by hardware.

4.10.3 PUBLIC KEY CRYPTOGRAPHIC ENGINE

The Public Key Crypto engine supports RSA (with & without CRT) with key sizes of 512 bits, 1024 bits and 2048 bits. It also supports Elliptic Curve operations with standard NIST prime field curves P-192, P-224, P-256.

A large variety of public key algorithms and operations are supported directly in hardware:

- High-level prime field PK Algorithms:
  - RSA – Encryption
  - RSA – Decryption
  - RSA – Signature Generation
  - RSA – Signature Verification
  - CRT – Key Parameter Generation
  - CRT – Decryption
  - DSA – Key Gen
  - DSA – Signature Generation
  - DSA – Signature Verification
  - Private Key Generation
- Standard PK crypto primitives for ECC:
  - Point Addition
  - Point Doubling
  - Point Multiplication
  - Check parameters a and b
  - Check n

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  - Check Point Coordinates
  - Check_Point_On_Curve
- Standard prime field primitive arithmetic operations:
  - Modular Addition
  - Modular Subtraction
  - Modular Multiplication
  - Modular Reduction
  - Modular Division
  - Modular Inversion
  - Multiplication
  - Modular Inversion
  - Modular Reduction
  - Modular Exponentiation (RSA)

The Public Key Engine includes a 16KB cryptographic SRAM, which can be accessed by the EC when the engine is not in operation. With its private SRAM memory, the Public Key Engine can process public key operations independently of the EC.

4.10.4 TRUE RANDOM NUMBER GENERATOR

A true Random Number Generator, which includes a 1K bit FIFO for pre-calculation of random bits.

4.10.5 API FUNCTIONS

The API functions include the following:

- Functions that support loading data from a SPI Flash device
- Functions that support generating a SHA Hash on a block of data
- Functions that support RSA public key decryption of data

4.11 EC-Only Registers

TABLE 4-3: CRYPTOGRAPHIC SRAM

Block Instance	Start Address	End Address	Size
Cryptographic SRAM	4100_0000	4010_3FFF	16KB

TABLE 4-4: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 4-1)
PKE	0	EC	32-bit internal address space	4000_BD00h
RNG	0	EC	32-bit internal address space	4000_BE00h
HASH	0	EC	32-bit internal address space	4000_D000h
AES	0	EC	32-bit internal address space	4000_D200h

Note 4-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

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5.0 VBAT REGISTER BANK

5.1 Introduction

This chapter defines a bank of registers powered by VBAT.

5.2 Interface

This block is designed to be accessed internally by the EC via the register interface.

5.3 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

5.3.1 POWER DOMAINS

TABLE 5-1: POWER SOURCES

Name	Description
VBAT	The VBAT Register Bank are all implemented on this single power domain.

5.3.2 CLOCK INPUTS

This block does not require any special clock inputs. All register accesses are synchronized to the host clock.

5.3.3 RESETS

TABLE 5-2: RESET SIGNALS

Name	Description
VBAT_POR	This reset signal, which is an input to this block, resets all the logic and registers to their initial default state.

5.4 Interrupts

TABLE 5-3: INTERRUPT SIGNALS

Name	Description
PFR_Status	This interrupt signal from the Power-Fail and Reset Status Register indicates VBAT RST and WDT events.

5.5 Low Power Modes

The VBAT Register Bank is designed to always operate in the lowest power consumption state.

5.6 Description

The VBAT Register Bank block is a block implemented for aggregating miscellaneous battery-backed registers required the host and by the Embedded Controller (EC) Subsystem that are not unique to a block implemented in the EC sub-system.

5.7 EC-Only Registers

TABLE 5-4: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 5-1)
VBAT_REG_BANK	0	EC	32-bit internal address space	4000A400h

Note 5-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 5-5: RUNTIME REGISTER SUMMARY

Offset	Register Name
00h	Power-Fail and Reset Status Register
04h	MCHP Reserved
08h	Clock Enable Register

5.7.1 POWER-FAIL AND RESET STATUS REGISTER

The Power-Fail and Reset Status Register collects and retains the VBAT RST and WDT event status when VCC1 is unpowered.

Address	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	**VBAT_RST** The VBAT RST bit is set to '1' by hardware when a VBAT_POR is detected. This is the register default value. To clear VBAT RST EC firmware must write a '1' to this bit; writing a '0' to VBAT RST has no affect.	R/WC	1	VBAT_POR
6	Reserved	RES	-	-
5	**WDT** The WDT bit is asserted ('1') following a Watch-Dog Timer Forced Reset (WDT Event). To clear the WDT bit EC firmware must write a '1' to this bit; writing a '0' to the WDT bit has no affect.	R/WC	0	VBAT_POR
4:1	Reserved	RES	-	-
0	**DET32K_IN** 0 = No clock detected on the XTAL[1:2] pins. 1= Clock detected on the XTAL[1:2] pins.	R	X	VBAT_POR

5.7.2 CLOCK ENABLE REGISTER

Address	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:2	RESERVED	RES	-	-
1	32K_EN This bit controls the 32.768 KHz Crystal Oscillator as defined in Table 5-6.	R/W	0b	VBAT_POR
0	XOSEL This bit controls whether a crystal or single ended clock source is used. 1= the 32.768 KHz Crystal Oscillator is driven by a single-ended 32.768 KHz clock source connected to the XTAL2 pin. 0= the 32.768 KHz Crystal Oscillator requires a 32.768 KHz parallel resonant crystal connected between the XTAL1 and XTAL2 pins (default).	R/W	0b	VBAT_POR

APPLICATION NOTE: The XOSEL bit should be correctly configured by firmware before the 32K_EN bit is assserted.

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TABLE 5-6: 32K_EN BIT

32K_EN	32.768 KHz Crystal Oscillator	Description
0	OFF	VBAT_POR default.
1	ON	The 32.768 KHz Crystal Oscillator can only be enabled by firmware (Note 5-2).

Note 5-2 the 48MHz Ring Oscillator must not stop before 40 μs min after the 32K_EN bit is asserted.

6.0 ARM M4F BASED EMBEDDED CONTROLLER

6.1 Introduction

This chapter contains a description of the ARM M4F Embedded Controller (EC).

The EC is built around an ARM® Cortex®-M4F Processor provided by Arm Ltd. (the “ARM M4F IP”). The ARM Cortex® M4F is a full-featured 32-bit embedded processor, implementing the ARMv7-M THUMB instruction set and FPU instruction set in hardware.

The ARM M4F IP is configured as a Von Neumann, Byte-Addressable, Little-Endian architecture. It provides a single unified 32-bit byte-level address, for a total direct addressing space of 4GByte. It has multiple bus interfaces, but these express priorities of access to the chip-level resources (Instruction Fetch vs. Data RAM vs. others), and they do not represent separate addressing spaces.

The ARM M4F IP has configurable options, which are selected as follows.

- **Little-Endian** byte ordering is selected at all times (hard-wired)
- **Bit Banding** feature is included for efficient bit-level access.
- **Floating-Point Unit (FPU)** is included, to implement the Floating-Point instruction set in hardware
- **Debug** features are included at “Ex+” level, defined as follows:
- **DWT** Unit provides 4 Data Watchpoint comparators and Execution Monitoring
- **FPB** Unit provides HW Breakpointing with 6 Instruction and 2 Literal (Read-Only Data) address comparators. The FPB comparators are also available for Patching: remapping Instruction and Literal Data addresses.
- **Trace** features are included at “Full” level, defined as follows:
- **DWT** for reporting breakpoints and watchpoints
- **ITM** for profiling and to timestamp and output messages from instrumented firmware builds
- **ETM** for instruction tracing, and for enhanced reporting of Core and DWT events
- The ARM-defined **HTM** trace feature is **not currently included**.
- **NVIC** Interrupt controller with 8 priority levels and up to 240 individually-vectored interrupt inputs.
- A Microchip-defined Interrupt Aggregator function (at chip level) may be used to group multiple interrupts onto single NVIC inputs.
- The ARM-defined **WIC** feature is **not currently included**.
- Microchip Interrupt Aggregator function (at chip level) is expected to provide Wake control instead.
- The ARM-defined **MPU** feature is **not currently included**.
- Memory Protection functionality is not expected to be necessary.

6.2 References

- ARM Limited: Cortex®-M4 Technical Reference Manual, DDI0439C, 29 June 2010
- ARM Limited: ARM®v7-M Architecture Reference Manual, DDI0403D, November 2010
- NOTE: Filename DDI0403D_arm_architecture_v7m_reference_manual_errata_markup_1_0.pdf
- ARM® Generic Interrupt Controller Architecture version 1.0 Architecture Specification, IHI0048A, September 2008
- ARM Limited: AMBA® Specification (Rev 2.0), IHI0011A, 13 May 1999
- ARM Limited: AMBA® 3 AHB-Lite Protocol Specification, IHI0033A, 6 June 2006
- ARM Limited: AMBA® 3 ATB Protocol Specification, IHI0032A, 19 June 2006
- ARM Limited: Cortex-M™ System Design Kit Technical Reference Manual, DDI0479B, 16 June 2011
- ARM Limited: CoreSight™ v1.0 Architecture Specification, IHI0029B, 24 March 2005
- ARM Limited: CoreSight™ Components Technical Reference Manual, DDI0314H, 10 July 2009
- ARM Limited: ARM® Debug Interface v5 Architecture Specification, IHI0031A, 8 February 2006
- ARM Limited: ARM® Debug Interface v5 Architecture Specification ADIv5.1 Supplement, DSA09-PRDC-008772, 17 August 2009
- ARM Limited: Embedded Trace Macrocell™ (ETMv1.0 to ETMv3.5) Architecture Specification, IHI0014Q, 23 September 2011
- ARM Limited: CoreSight™ ETM™-M4 Technical Reference Manual, DDI0440C, 29 June 2010

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6.3 Terminology

6.3.1 ARM IP TERMS AND ACRONYMS

- Cortex-M4F
- The ARM designation for the specific IP selected for this product: a Cortex M4 processor core containing a hardware Floating Point Unit (FPU).
- ARMv7
- The identifying name for the general architecture implemented by the **Cortex-M** family of IP products.
- Note that **ARMv7** has no relationship to the older “ARM 7” product line, which is classified as an “ARMv3” architecture, and is very different.
- FPU
- Floating-Point Unit: a subblock included in the Core for implementing the Floating Point instruction set in hardware.
- NVIC
- Nested Vectored Interrupt Controller subblock. Accepts external interrupt inputs. See documents ARM Limited: ARM®v7-M Architecture Reference Manual, DDI0403D, November 2010 and ARM® Generic Interrupt Controller Architecture version 1.0 Architecture Specification, IHI0048A, September 2008.
- FPB
- FLASH Patch Breakpoint subblock. Provides either Remapping (Address substitution) or Breakpointing (Exception or Halt) for a set of Instruction addresses and Data addresses. See Section 8.3 of ARM Limited: Cortex®-M4 Technical Reference Manual, DDI0439C, 29 June 2010.
- DAP
- Debug Access Port, a subblock consisting of **DP** and **AP** subblocks
- DP
- Any of the ports in the **DAP** subblock for connection to an off-chip Debugger. A single **SWJ-DP** option is currently selected for this function, providing **JTAG** connectivity.
- SWJ-DP
- Serial Wire / **JTAG** Debug Port, the **DP** option selected by Microchip for the **DAP**.
- AP
- Any of the ports on the **DAP** subblock for accessing on-chip resources on behalf of the Debugger, independent of processor operations. A single **AHB-AP** option is currently selected for this function.
- AHB-AP
- AHB Access Port, the **AP** option selected by Microchip for the **DAP**.
- MEM-AP
- A generic term for an **AP** that connects to a memory-mapped bus on-chip. For this product, this term is synonymous with the AHB Access Port, **AHB-AP**.
- ROM Table
- A ROM-based data structure in the Debug section that allows an external Debugger and/or a FW monitor to determine which of the Debug features are present.
- DWT
- Data Watchdog and Trace subblock. This contains comparators and counters used for data watchpoints and Core activity tracing.
- ETM
- Embedded Trace Macrocell subblock. Provides enhancements for Trace output reporting, mostly from the **DWT** subblock. It adds enhanced instruction tracing, filtering, triggering and timestamping.
- ITM
- Instrumentation Trace Macrocell subblock. Provides a HW Trace interface for “printf”-style reports from instrumented firmware builds, with timestamping also provided.
- TPIU
- Trace Port Interface Unit subblock. Multiplexes and buffers Trace reports from the ETM and ITM subblocks.
- TPA
- Trace Port Analyzer: any off-chip device that uses the **TPIU** output.
- ATB

- Interface standard for Trace data to the **TPIU** from **ETM** and/or **ITM** blocks, Defined in **AMBA 3**. See ARM Limited: AMBA® 3 ATB Protocol Specification, IHI0032A, 19 June 2006.
- AMBA
- The collective term for bus standards originated by ARM Limited.
- **AMBA 3** defines the IP's **AHB-Lite** and **ATB** bus interfaces.
- **AMBA 2** (AMBA Rev. 2.0) defines the EC's **AHB** bus interface.
- AHB
- Advanced High-Performance Bus, a system-level on-chip **AMBA 2** bus standard. See ARM Limited: AMBA® Specification (Rev 2.0), IHI0011A, 13 May 1999.
- AHB-Lite
- A Single-Master subset of the **AHB** bus standard: defined in the **AMBA 3** bus standard. See ARM Limited: AMBA® 3 AHB-Lite Protocol Specification, IHI0033A, 6 June 2006.
- PPB
- Private Peripheral Bus: A specific **APB** bus with local connectivity within the EC.
- APB
- Advanced Peripheral Bus, a limited 32-bit-only bus defined in **AMBA 2** for I/O register accesses. This term is relevant only to describe the **PPB** bus internal to the EC core. See ARM Limited: AMBA® Specification (Rev 2.0), IHI0011A, 13 May 1999.
- MPU
- Memory Protection Unit. This is an optional subblock that is **not currently included**.
- HTM
- AHB Trace Macrocell. This is an optional subblock that is **not currently included**.
- WIC
- Wake-Up Interrupt Controller. This is an optional subblock that is **not currently included**.

6.3.2 MICROCHIP TERMS AND ACRONYMS

- **PMU**
- This Processor Memory Unit is a module that may be present at the chip level containing any memory resources that are closely-coupled to the CEC1302 EC. It manages accesses from both the EC processor and chip-level bus masters.
- Interrupt Aggregator
- This is a module that may be present at the chip level, which can combine multiple interrupt sources onto single interrupt inputs at the EC, causing them to share a vector.

6.4 ARM M4F IP Interfaces

This section defines only the interfaces to the ARM IP itself. For the interfaces of the entire block, see Section 6.5, "Block External Interfaces," on page 74.

The CEC1302 IP has the following major external interfaces, as shown in FIGURE 6-1: ARM M4F Based Embedded Controller I/O Block Diagram on page 74:

- ICode AHB-Lite Interface
- DCode AHB-Lite Interface
- System AHB-Lite Interface
- Debug (JTAG) Interface
- Trace Port Interface
- Interrupt Interface

The EC operates on the model of a single 32-bit addressing space of byte addresses (4Gbytes, Von Neumann architecture) with Little-Endian byte ordering. On the basis of an internal decoder (part of the Bus Matrix shown in Figure 6-1), it routes Read/Write/Fetch accesses to one of three external interfaces, or in some cases internally (shown as the PPB interface).

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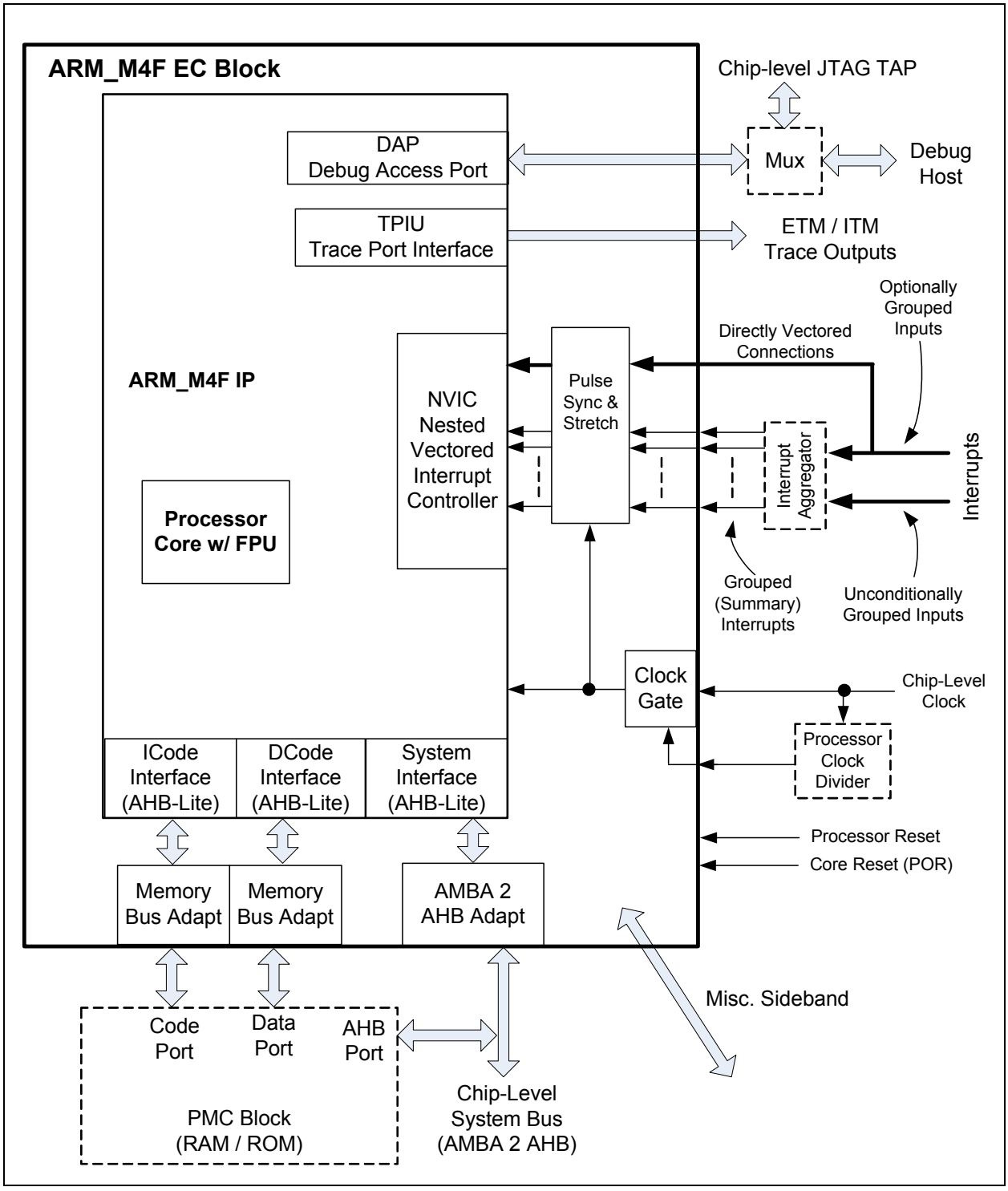
The EC executes instructions out of closely-coupled memory via the ICode Interface. Data accesses to closely-coupled memory are handled via the DCode Interface. The EC accesses the rest of the on-chip address space via the System AHB-Lite interface. The Debugger program in the host can probe the EC and all EC addressable memory via the JTAG debug interface.

Aliased addressing spaces are provided at the chip level so that specific bus interfaces can be selected explicitly where needed. For example, the EC's Bit Banding feature uses the System AHB-Lite bus to access resources normally accessed via the DCode or ICode interface.

6.5 Block External Interfaces

FIGURE 6-1: ARM M4F BASED EMBEDDED CONTROLLER I/O BLOCK DIAGRAM



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6.6 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

6.6.1 POWER DOMAINS

TABLE 6-1: POWER SOURCES

Name	Description
VCC1	The ARM M4F Based Embedded Controller is powered by VCC1.

6.6.2 CLOCK INPUTS

6.6.2.1 Basic Clocking

The basic clocking comes from a free-running Clock signal provided from the chip level.

TABLE 6-2: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	The EC clock derived from the 48 MHz Ring Oscillator is the clock source to the ARM M4F Based Embedded Controller. Division of the clock rate is allowed, according to the Processor Clock Enable. **Note:** The EC clock is controlled from the chip-level Power, Clocks, and Reset (PCR) circuitry. See Section 3.9.8, "Processor Clock Control Register (PROC_CLK_CNTRL)," on page 52.

6.6.2.2 System Tick Clocking

The System Tick clocking is controlled by a signal from chip-level logic. It is the 48 MHz Ring Oscillator divided by the following:

- ((Processor Clock Divide Value)x2)+1.

6.6.2.3 Debug JTAG Clocking

The Debug JTAG clocking comes from chip-level logic, which may multiplex or gate this clock. See Section 6.9.3, "Debugger Access Support," on page 78.

6.6.2.4 Trace Clocking

The Clock for the Trace interface is identical to the 48 MHz Ring Oscillator input.

6.6.3 RESETS

The reset interface from the chip level is given below.

TABLE 6-3: RESET SIGNALS

Name	Description
EC_PROC_ RESET	The ARM M4F Based Embedded Controller is reset by EC_PROC_ RESET.

6.7 Interrupts

The ARM M4F Based Embedded Controller is equipped with an Interrupt Interface to respond to interrupts. These inputs go to the IP's NVIC block after a small amount of hardware processing to ensure their detection at varying clock rates. See FIGURE 6-1: ARM M4F Based Embedded Controller I/O Block Diagram on page 74.

As shown in Figure 6-1, an Interrupt Aggregator block may exist at the chip level, to allow multiple related interrupts to be grouped onto the same NVIC input, and so allowing them to be serviced using the same vector. This may allow the same interrupt handler to be invoked for a group of related interrupt inputs. It may also be used to expand the total number of interrupt inputs that can be serviced.

Connections to the chip-level system are given in Table 9-3, "Interrupt Event Aggregator Routing Summary," on page 98.

The NMI (Non-Maskable Interrupt) connection is tied off and not used.

6.7.1 NVIC INTERRUPT INTERFACE

The NVIC interrupt unit can be wired to up to 240 interrupt inputs from the chip level. The interrupts that are actually connected from the chip level are defined in Table 9-3, “Interrupt Event Aggregator Routing Summary,” on page 98.

All NVIC interrupt inputs can be programmed as either pulse or level triggered. They can also be individually masked, and individually assigned to their own hardware-managed priority level.

6.7.2 NVIC RELATIONSHIP TO EXCEPTION VECTOR TABLE ENTRIES

The Vector Table consists of 4-byte entries, one per vector. Entry 0 is not a vector, but provides an initial Reset value for the Main Stack Pointer. Vectors start with the Reset vector, at Entry #1. Entries up through #15 are dedicated for internal exceptions, and do not involve the NVIC.

NVIC entries in the Vector Table start with Entry #16, so that NVIC Interrupt #0 is at Entry #16, and all NVIC interrupt numbers are incremented by 16 before accessing the Vector Table.

The number of connections to the NVIC determines the necessary minimum size of the Vector Table, as shown below. It can extend as far as 256 entries (255 vectors, plus the non-vector entry #0).

A Vector entry is used to load the Program Counter (PC) and the EPSR.T bit. Since the Program Counter only expresses code addresses in units of two-byte Halfwords, bit[0] of the vector location is used to load the EPSR.T bit instead, selecting THUMB mode for exception handling. Bit[0] must be ‘1’ in all vectors, otherwise a UsageFault exception will be posted (INVSTATE, unimplemented instruction set). If the Reset vector is at fault, the exception posted will be HardFault instead.

TABLE 6-4: EXCEPTION AND INTERRUPT VECTOR TABLE LAYOUT

Table Entry	Exception Number	Exception
Special Entry for Reset Stack Pointer		
0	(none)	Holds Reset Value for the Main Stack Pointer. Not a Vector.
Core Internal Exception Vectors start here		
1	1	Reset Vector (PC + EPSR.T bit)
2	2	NMI (Non-Maskable Interrupt) Vector
3	3	HardFault Vector
4	4	MemManage Vector
5	5	BusFault Vector
6	6	UsageFault Vector
7	(none)	(Reserved by ARM Ltd.)
8	(none)	(Reserved by ARM Ltd.)
9	(none)	(Reserved by ARM Ltd.)
10	(none)	(Reserved by ARM Ltd.)
11	11	SVCall Vector
12	12	Debug Monitor Vector
13	(none)	(Reserved by ARM Ltd.)
14	14	PendSV Vector
15	15	SysTick Vector
NVIC Interrupt Vectors start here		
16	16	NVIC Interrupt #0 Vector
. . .	. . .	. . .
n + 16	n + 16	NVIC Interrupt #n Vector
. . .	. . .	. . .

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TABLE 6-4: EXCEPTION AND INTERRUPT VECTOR TABLE LAYOUT (CONTINUED)

Table Entry	Exception Number	Exception
max + 16	max + 16	NVIC Interrupt #max Vector (Highest-numbered NVIC connection.)
. . .	. . .	. Table size may (but need not) extend further. . .
255	255	NVIC Interrupt #239 (Architectural Limit of Exception Table)

6.8 Low Power Modes

The ARM processor low power modes are handled through the Power, Clocks, and Resets registers, not directly through the ARM core registers. See Section 3.7, "Chip Power Management Features," on page 46.

The ARM processor can enter Sleep or Deep Sleep mode internally. This action will cause an output signal Clock Required to be turned off, allowing clocks to be stopped from the chip level. However, Clock Required will still be held active, or set to active, unless all of the following conditions exist:

- No interrupt is pending.
- An input signal Sleep Enable from the chip level is active.
- The Debug JTAG port is inactive (reset or configured not present).

In addition, regardless of the above conditions, a chip-level input signal Force Halt may halt the processor and remove Clock Required.

6.9 Description

6.9.1 BUS CONNECTIONS

There are three bus connections used from CEC1302 EC block, which are directly related to the IP bus ports. See FIGURE 6-1: ARM M4F Based Embedded Controller I/O Block Diagram on page 74.

For the mapping of addresses at the chip level, see Chapter 2.0, "Block Overview," on page 40.

6.9.1.1 Closely Coupled Instruction Fetch Bus

As shown in Figure 6-1, the AHB-Lite ICode port from the IP is converted to a more conventional SRAM memory-style bus and connected to the on-chip memory resources with routing priority appropriate to Instruction Fetches.

6.9.1.2 Closely Coupled Data Bus

As shown in Figure 6-1, the AHB-Lite DCode port from the IP is converted to a more conventional SRAM memory-style bus and connected to the on-chip memory resources with routing priority appropriate to fast Data Read/Write accesses.

6.9.1.3 Chip-Level System Bus

As shown in Figure 6-1, the AHB-Lite System port from the IP is converted from AHB-Lite to fully arbitrated multi-master capability (the AMBA 2 defined AHB bus: see ARM Limited: AMBA® Specification (Rev 2.0), IHI0011A, 13 May 1999). Using this bus, all addressable on-chip resources are available. The multi-mastering capability supports the Microchip DMA and EMI features if present, as well as the Bit-Banding feature of the IP itself.

As also shown in Figure 6-1, the Closely-Coupled memory resources are also available through this bus connection using aliased addresses. This is required in order to allow Bit Banding to be used in these regions, but it also allows them to be accessed by DMA and other bus masters at the chip level.

APPLICATION NOTE: Registers with properties such as Write-1-to-Clear (W1C), Read-to-Clear and FIFOs need to be handled with appropriate care when being used with the bit band alias addressing scheme. Accessing such a register through a bit band alias address will cause the hardware to perform a read-modify-write, and if a W1C-type bit is set, it will get cleared with such an access. For example, using a bit band access to the Interrupt Aggregator, including the Interrupt Enables and Block Interrupt Status to clear an IRQ will clear all active IRQs.

6.9.2 INSTRUCTION PIPELINING

There are no special considerations except as defined by ARM documentation.

6.9.3 DEBUGGER ACCESS SUPPORT

An external Debugger accesses the chip through a JTAG standard interface. The debugger itself, however, is not an ARM product, and its capabilities will depend on the third-party product selected for code development and debug.

As shown in FIGURE 6-1: ARM M4F Based Embedded Controller I/O Block Diagram on page 74, there may be other resources at the chip level that share the JTAG port pins; for example chip-level Boundary Scan. See Section 1.4.3, "JTAG Interface," on page 12 for configuring the JTAG pins at the chip level for Debug purposes.

6.9.3.1 Debug and Access Ports (SWJ-DP and AHB-AP Subblocks)

These two subblocks work together to provide access to the chip for the Debugger using the Debug JTAG connection, as described in Chapter 4 of the ARM Limited: ARM® Debug Interface v5 Architecture Specification, IHI0031A, 8 February 2006.

6.9.4 BREAKPOINT, WATCHPOINT AND TRACE SUPPORT

See ARM Limited: ARM® Debug Interface v5 Architecture Specification, IHI0031A, 8 February 2006 and also ARM Limited: ARM® Debug Interface v5 Architecture Specification ADIv5.1 Supplement, DSA09-PRDC-008772, 17 August 2009. A summary of functionality follows.

Breakpoint and Watchpoint facilities can be programmed to do one of the following:

- Halt the processor. This means that the external Debugger will detect the event by periodically polling the state of the EC.
- Transfer control to an internal Debug Monitor firmware routine, by triggering the Debug Monitor exception (see Table 6-4, “Exception and Interrupt Vector Table Layout,” on page 76).

6.9.4.1 Instrumentation Support (ITM Subblock)

The Instrumentation Trace Macrocell (ITM) is for profiling software. This uses non-blocking register accesses, with a fixed low-intrusion overhead, and can be added to a Real-Time Operating System (RTOS), application, or exception handler. If necessary, product code can retain the register access instructions, avoiding probe effects.

6.9.4.2 HW Breakpoints and ROM Patching (FPB Subblock)

The Flash Patch and Breakpoint (FPB) block. This block can remap sections of ROM, typically Flash memory, to regions of RAM, and can set breakpoints on code in ROM. This block can be used for debug, and to provide a code or data patch to an application that requires field updates to a product in ROM.

6.9.4.3 Data Watchpoints and Trace (DWT Subblock)

The Debug Watchpoint and Trace (DWT) block provides watchpoint support, program counter sampling for performance monitoring, and embedded trace trigger control.

6.9.4.4 Trace Interface (ETM and TPIU)

The Embedded Trace Macrocell (ETM) provides instruction tracing capability. For details of functionality and usage, see also ARM Limited: Embedded Trace Macrocell™ (ETMv1.0 to ETMv3.5) Architecture Specification, IHI0014Q, 23 September 2011 and ARM Limited: CoreSight™ ETM™-M4 Technical Reference Manual, DDI0440C, 29 June 2010.

The Trace Port Interface Unit (TPIU) provides the external interface for the ITM, DWT and ETM.

See Section 1.4.13, "Trace Debug Interface," on page 16 for configuring the Trace pins at the chip level for Trace output.

6.10 ARM Configuration

In order to function correctly, it is necessary to set the ARM Auxiliary Control Register (ACTLR), located at address 0xE000E008, to 0x02. This sets bit[1], DISDEFWBUF, to 1. This must be done as soon as possible after Power On Reset, or register corruption may occur.

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7.0 RAM AND ROM

SRAM

The 128KBytes SRAM (Code or Data) is allocated as follows:

- 96K Optimized for Code
- 32K Optimized for Data.

Note:	120KBytes are available for application code as follows: 96K Optimized for Code, 24K Optimized for Data.

The distinction between “96KB optimized for instructions” and “32KB optimized for data” SRAMs: is as follows:
The CEC1302 has two blocks of SRAM, one of 96KB and one of 32KB. Both can be used for either instructions or data. As long as the ARM fetches instructions from one SRAM and does loads and stores to the other, code and data accesses operate in parallel and there are no wait states. If on the same cycle the ARM fetches an instruction and does a load or a store to the same SRAM, either the code fetch will be delayed by one cycle or the data access will be delayed by one cycle. The 96KB SRAM is optimized for instructions, in that if the ARM accesses this SRAM for both instructions and data on the same cycle, the instruction fetch will complete in one cycle and the load/store will be delayed for one cycle. The 32KB SRAM is optimized for data, in that if the ARM accesses this SRAM for both instructions and data on the same cycle, the load/store will complete in once cycle and the instruction fetch will be delayed for one cycle. In both cases, the SRAM arbiter ensures that the arbitration loser will win on subsequent cycles and thus will not be locked out of the SRAM indefinitely. User applications, therefore, are free to allocate code and data anywhere in the 128KB SRAM address space, except that there will be an occasional small performance hit if both code and data are allocated in the same SRAM.

The application loader in the CEC1302 ROM requires the top 8KB of the 32KB SRAM in order to perform its functions. The user can therefore load a maximum of 120KB into SRAM using the ROM loader. Once the ROM application loader has completed its operation, the entire 128KB address space can be allocated to whatever functions, code or data, the user wishes.

The SRAM is located at EC Base address 00100000h in 32-bit internal address space.

Note:	120KB is available for application code in the address range 00100000h to 0011DFFFh

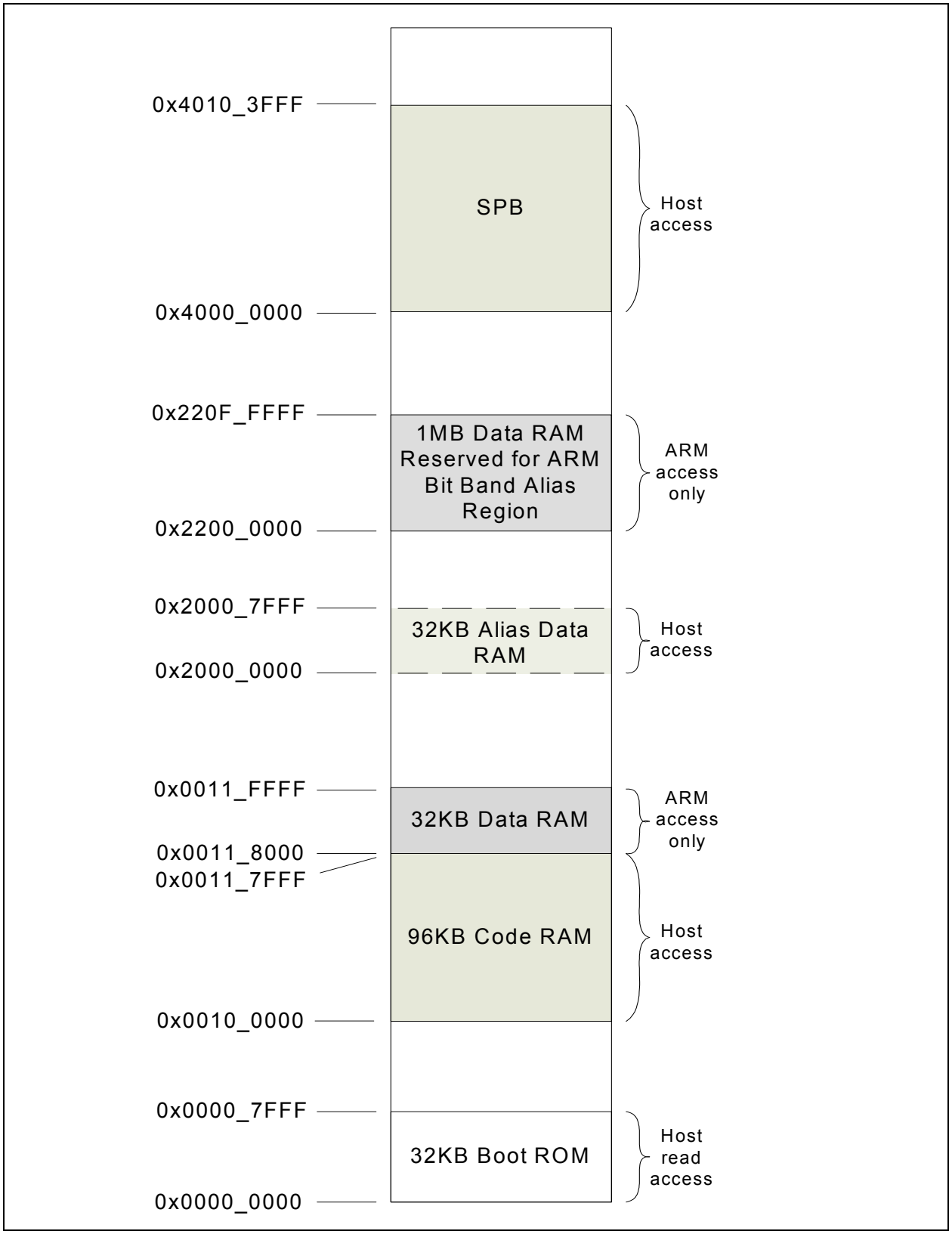
ROM

The 32KByte Boot ROM is located at EC Base address 00000000h in 32-bit internal address space.

Note:	30KB is available for application code in the address range 00000000h to 000077FFh

The memory map of the RAM and ROM is represented as follows:

FIGURE 7-1: MEMORY LAYOUT



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8.0 UART

8.1 Introduction

The 16550 UART (Universal Asynchronous Receiver/Transmitter) is a full-function Two Pin Serial Port that supports the standard RS-232 Interface.

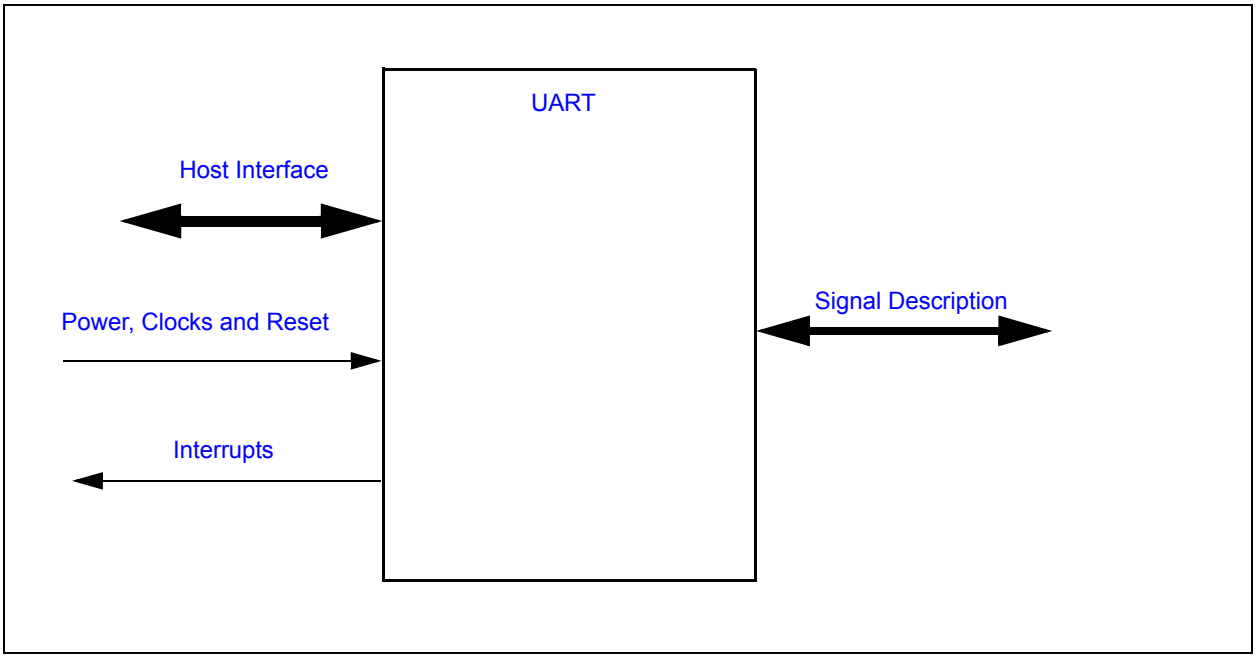
8.2 References

1. EIA Standard RS-232-C specification

8.3 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 8-1: I/O DIAGRAM OF BLOCK



8.4 Signal Description

TABLE 8-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
TXD	Output	Transmit serial data output.
RXD	Input	Receiver serial data input.

8.5 Host Interface

The UART is accessed by host software via a registered interface, as defined in Section 8.10, "Configuration Registers"and Section 8.11, "Runtime Registers".

8.6 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

8.6.1 POWER DOMAINS

TABLE 8-2: POWER SOURCES

Name	Description
VCC1	This Power Well is used to power the registers and logic in this block.

8.6.2 CLOCK INPUTS

TABLE 8-3: CLOCK INPUTS

Name	Description
1.8432MHz_Clk	The UART requires a 1.8432 MHz ± 2% clock input for baud rate generation.
24MHz_Clk	24 MHz ± 2% clock input. This clock may be enabled to generate the baud rate, which requires a 1.8432 MHz ± 2% clock input.

8.6.3 RESETS

TABLE 8-4: RESET SIGNALS

Name	Description
VCC1_RESET	This reset is asserted when VCC1 is applied.
nSIO_RESET	This is an alternate reset condition, typically asserted when the main power rail is asserted.
RESET	This reset is determined by the POWER bit signal. When the power bit signal is 1, this signal is equal to nSIO_RESET. When the power bit signal is 0, this signal is equal to VCC1_RESET.

8.7 Interrupts

This section defines the Interrupt Sources generated from this block.

TABLE 8-5: SYSTEM INTERRUPTS

Source	Description
UART	The UART interrupt event output indicates if an interrupt is pending. See Table 8-13, “Interrupt Control Table,” on page 89.

TABLE 8-6: EC INTERRUPTS

Source	Description
UART	The UART interrupt event output indicates if an interrupt is pending. See Table 8-13, “Interrupt Control Table,” on page 89.

8.8 Low Power Modes

The UART may be put into a low power state by the chip’s Power, Clocks, and Reset (PCR) circuitry.

8.9 Description

The UART is compatible with the 16450, the 16450 ACE registers and the 16C550A. The UART performs serial-to-parallel conversions on received characters and parallel-to-serial conversions on transmit characters. Two sets of baud rates are provided. When the 1.8432 MHz source clock is selected, standard baud rates from 50 to 115.2K are available. When the source clock is 32.26 MHz, baud rates from 126K to 2,016K are available. The character options are programmable for 1 start; 1, 1.5 or 2 stop bits; even, odd, sticky or no parity; and prioritized interrupts. The UART contains a programmable baud rate generator that is capable of dividing the input clock signal by 1 to 65535. The UART is also

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capable of supporting the MIDI data rate. Refer to the Configuration Registers for information on disabling, powering down and changing the base address of the UART. The UART interrupt is enabled by programming OUT2 of the UART to logic “1.” Because OUT2 is logic “0,” it disables the UART's interrupt. The UART is accessible by both the Host and the EC.

8.9.1 PROGRAMMABLE BAUD RATE

The Serial Port contains a programmable Baud Rate Generator that is capable of dividing the internal clock source by any divisor from 1 to 65535. The clock source is either the 1.8432MHz_Clk clock source or the 24MHz_Clk clock source. The output frequency of the Baud Rate Generator is 16x the Baud rate. Two eight bit latches store the divisor in 16 bit binary format. These Divisor Latches must be loaded during initialization in order to ensure desired operation of the Baud Rate Generator. Upon loading either of the Divisor Latches, a 16 bit Baud counter is immediately loaded. This prevents long counts on initial load. If a 0 is loaded into the BRG registers, the output divides the clock by the number 3. If a 1 is loaded, the output is the inverse of the input oscillator. If a two is loaded, the output is a divide by 2 signal with a 50% duty cycle. If a 3 or greater is loaded, the output is low for 2 bits and high for the remainder of the count.

The following tables show possible baud rates.

TABLE 8-7: UART BAUD RATES USING CLOCK SOURCE 1.8432MHz_Clk

Desired Baud Rate	BAUD_CLOCK_SEL	Divisor Used to Generate 16X Clock
50	0	2304
75	0	1536
110	0	1047
134.5	0	857
150	0	768
300	0	384
600	0	192
1200	0	96
1800	0	64
2000	0	58
2400	0	48
3600	0	32
4800	0	24
7200	0	16
9600	0	12
19200	0	6
38400	0	3
57600	0	2
115200	0	1

TABLE 8-8: UART BAUD RATES USING CLOCK SOURCE 24MHz_Clk

Desired Baud Rate	BAUD_CLOCK_SEL	Divisor Used to Generate 16X Clock
125000	1	12
136400	1	11
150000	1	10
166700	1	9
187500	1	8
214300	1	7
250000	1	6

TABLE 8-8: UART BAUD RATES USING CLOCK SOURCE 24MHz_Clk (CONTINUED)

Desired Baud Rate	BAUD_CLOCK_SEL	Divisor Used to Generate 16X Clock
300000	1	5
375000	1	4
500000	1	3
750000	1	2
1500000	1	1

8.10 Configuration Registers

The registers listed in the Configuration Register Summary table are for a single instance of the UART. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the Configuration Register Base Address Table.

FIGURE 8-2: CONFIGURATION REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Logical Device Number	Host	Address Space	Base Address
UART	0		EC	32-bit internal address space	400F_1F00h

Each Configuration register access through the Host Access Port is via its LDN and its Host Access Port Index. EC access is a relative offset to the EC Base Address.

TABLE 8-9: CONFIGURATION REGISTER SUMMARY

Offset	Register Name (Mnemonic)
30h	Activate Register
F0h	Configuration Select Register

8.10.1 ACTIVATE REGISTER

Offset	30h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:1	Reserved	R	-	-
0	ACTIVATE When this bit is 1, the UART logical device is powered and functional. When this bit is 0, the UART logical device is powered down and inactive.	R/W	0b	RESET

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8.10.2 CONFIGURATION SELECT REGISTER

Offset	F0h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:3	Reserved	R	-	-
2	POLARITY 1=The UART_TX and UART_RX pins functions are inverted 0=The UART_TX and UART_RX pins functions are not inverted	R/W	0b	RESET
1	POWER 1=The RESET reset signal is derived from nSIO_RESET 0=The RESET reset signal is derived from VCC1_RESET	R/W	1b	RESET
0	CLK_SRC 1=The UART Baud Clock is derived from an external clock source 0=The UART Baud Clock is derived from one of the two internal clock sources	R/W	0b	RESET

8.11 Runtime Registers

The registers listed in the Runtime Register Summary table are for a single instance of the UART. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in Runtime Register Base Address Table.

TABLE 8-10: RUNTIME REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 8-1)
UART	0	EC	32-bit internal address space	400F_1C00h

Note 8-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 8-11: RUNTIME REGISTER SUMMARY

DLAB (Note 8-2)	Offset	Register Name (Mnemonic)
0	0h	Receive Buffer Register
0	0h	Transmit Buffer Register
1	0h	Programmable Baud Rate Generator LSB Register
1	1h	Programmable Baud Rate Generator MSB Register
0	1h	Interrupt Enable Register
x	02h	FIFO Control Register
x	02h	Interrupt Identification Register
x	03h	Line Control Register
x	04h	Modem Control Register
x	05h	Line Status Register
x	06h	Modem Status Register
x	07h	Scratchpad Register

Note 8-2 DLAB is bit 7 of the Line Control Register.

8.11.1 RECEIVE BUFFER REGISTER

Offset	0h (DLAB=0)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	RECEIVED_DATA This register holds the received incoming data byte. Bit 0 is the least significant bit, which is transmitted and received first. Received data is double buffered; this uses an additional shift register to receive the serial data stream and convert it to a parallel 8 bit word which is transferred to the Receive Buffer register. The shift register is not accessible.	R	0h	RESET

8.11.2 TRANSMIT BUFFER REGISTER

Offset	0h (DLAB=0)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	TRANSMIT_DATA This register contains the data byte to be transmitted. The transmit buffer is double buffered, utilizing an additional shift register (not accessible) to convert the 8 bit data word to a serial format. This shift register is loaded from the Transmit Buffer when the transmission of the previous byte is complete.	W	0h	RESET

8.11.3 PROGRAMMABLE BAUD RATE GENERATOR LSB REGISTER

Offset	00h (DLAB=1)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	BAUD_RATE_DIVISOR_LSB See Section 8.9.1, "Programmable Baud Rate".	R/W	0h	RESET

8.11.4 PROGRAMMABLE BAUD RATE GENERATOR MSB REGISTER

Offset	01h (DLAB=1)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	BAUD_CLK_SEL 1=If CLK_SRC is '0', the baud clock is derived from the 1.8432MHz_-Clk. If CLK_SRC is '1', this bit has no effect 1=If CLK_SRC is '0', the baud clock is derived from the 24MHz_Clk. If CLK_SRC is '1', this bit has no effect	R/W	0h	RESET
6:0	BAUD_RATE_DIVISOR_MSB See Section 8.9.1, "Programmable Baud Rate".	R/W	0h	RESET

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8.11.5 INTERRUPT ENABLE REGISTER

The lower four bits of this register control the enables of the five interrupt sources of the Serial Port interrupt. It is possible to totally disable the interrupt system by resetting bits 0 through 3 of this register. Similarly, setting the appropriate bits of this register to a high, selected interrupts can be enabled. Disabling the interrupt system inhibits the Interrupt Identification Register and disables any Serial Port interrupt out of the CEC1302. All other system functions operate in their normal manner, including the Line Status and MODEM Status Registers. The contents of the Interrupt Enable Register are described below.

Offset	01h (DLAB=0)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:4	Reserved	R	-	-
3	EMSI This bit enables the MODEM Status Interrupt when set to logic “1”. This is caused when one of the Modem Status Register bits changes state.	R/W	0h	RESET
2	ELSI This bit enables the Received Line Status Interrupt when set to logic “1”. The error sources causing the interrupt are Overrun, Parity, Framing and Break. The Line Status Register must be read to determine the source.	R/W	0h	RESET
1	ETHREI This bit enables the Transmitter Holding Register Empty Interrupt when set to logic “1”.	R/W	0h	RESET
0	ERDAI This bit enables the Received Data Available Interrupt (and timeout interrupts in the FIFO mode) when set to logic “1”.	R/W	0h	RESET

8.11.6 FIFO CONTROL REGISTER

This is a write only register at the same location as the Interrupt Identification Register.

Note:	DMA is not supported.

Offset	02h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:6	RECV_FIFO_TRIGGER_LEVEL These bits are used to set the trigger level for the RCVR FIFO interrupt.	W	0h	RESET
5:4	Reserved	R	-	-
3	DMA_MODE_SELECT Writing to this bit has no effect on the operation of the UART. The RXRDY and TXRDY pins are not available on this chip.	W	0h	RESET
2	CLEAR_XMIT_FIFO Setting this bit to a logic “1” clears all bytes in the XMIT FIFO and resets its counter logic to “0”. The shift register is not cleared. This bit is self-clearing.	W	0h	RESET
1	CLEAR_RECv_FIFO Setting this bit to a logic “1” clears all bytes in the RCVR FIFO and resets its counter logic to “0”. The shift register is not cleared. This bit is self-clearing.	W	0h	RESET

Offset	02h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
0	EXRF Enable XMIT and RECV FIFO. Setting this bit to a logic “1” enables both the XMIT and RCVR FIFOs. Clearing this bit to a logic “0” disables both the XMIT and RCVR FIFOs and clears all bytes from both FIFOs. When changing from FIFO Mode to non-FIFO (16450) mode, data is automatically cleared from the FIFOs. This bit must be a 1 when other bits in this register are written to or they will not be properly programmed.	W	0h	RESET

TABLE 8-12: RECV FIFO TRIGGER LEVELS

Bit 7	Bit 6	RECV FIFO Trigger Level (BYTES)
0	0	1
	1	4
1	0	8
	1	14

8.11.7 INTERRUPT IDENTIFICATION REGISTER

By accessing this register, the host CPU can determine the highest priority interrupt and its source. Four levels of priority interrupt exist. They are in descending order of priority:

1. Receiver Line Status (highest priority)
2. Received Data Ready
3. Transmitter Holding Register Empty
4. MODEM Status (lowest priority)

Information indicating that a prioritized interrupt is pending and the source of that interrupt is stored in the Interrupt Identification Register (refer to Table 8-13). When the CPU accesses the IIR, the Serial Port freezes all interrupts and indicates the highest priority pending interrupt to the CPU. During this CPU access, even if the Serial Port records new interrupts, the current indication does not change until access is completed. The contents of the IIR are described below.

Offset	02h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:6	FIFO_EN These two bits are set when the FIFO CONTROL Register bit 0 equals 1.	R	0h	RESET
5:4	Reserved	R	-	-
3:1	INTID These bits identify the highest priority interrupt pending as indicated by Table 8-13, "Interrupt Control Table". In non-FIFO mode, Bit[3] is a logic “0”. In FIFO mode Bit[3] is set along with Bit[2] when a time-out interrupt is pending.	R	0h	RESET

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Offset	02h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
0	IPEND This bit can be used in either a hardwired prioritized or polled environment to indicate whether an interrupt is pending. When bit 0 is a logic '0' an interrupt is pending and the contents of the IIR may be used as a pointer to the appropriate internal service routine. When bit 0 is a logic '1' no interrupt is pending.	R	1h	RESET

TABLE 8-13: INTERRUPT CONTROL TABLE

FIFO Mode Only	Interrupt Identification Register			Interrupt SET and RESET Functions			
Bit 3	**Bit 2**	**Bit 1**	**Bit 0**	**Priority Level**	**Interrupt Type**	**Interrupt Source**	**Interrupt Reset Control**
0	0	0	1	-	None	None	-
	1	1	0	Highest	Receiver Line Status	Overrun Error, Parity Error, Framing Error or Break Interrupt	Reading the Line Status Register
		0		Second	Received Data Available	Receiver Data Available	Read Receiver Buffer or the FIFO drops below the trigger level.
1					Character Timeout Indication	No Characters Have Been Removed From or Input to the RCVR FIFO during the last 4 Char times and there is at least 1 char in it during this time	Reading the Receiver Buffer Register
0	0	1		Third	Transmitter Holding Register Empty	Transmitter Holding Register Empty	Reading the IIR Register (if Source of Interrupt) or Writing the Transmitter Holding Register
	0	0		Fourth	MODEM Status	Clear to Send or Data Set Ready or Ring Indicator or Data Carrier Detect	Reading the MODEM Status Register

8.11.8 LINE CONTROL REGISTER

Offset	03h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	DLAB Divisor Latch Access Bit (DLAB). It must be set high (logic “1”) to access the Divisor Latches of the Baud Rate Generator during read or write operations. It must be set low (logic “0”) to access the Receiver Buffer Register, the Transmitter Holding Register, or the Interrupt Enable Register.	R/W	0h	RESET
6	BREAK_CONTROL Set Break Control bit. When bit 6 is a logic “1”, the transmit data output (TXD) is forced to the Spacing or logic “0” state and remains there (until reset by a low level bit 6) regardless of other transmitter activity. This feature enables the Serial Port to alert a terminal in a communications system.	R/W	0h	RESET
5	STICK_PARITY Stick Parity bit. When parity is enabled it is used in conjunction with bit 4 to select Mark or Space Parity. When LCR bits 3, 4 and 5 are 1 the Parity bit is transmitted and checked as a 0 (Space Parity). If bits 3 and 5 are 1 and bit 4 is a 0, then the Parity bit is transmitted and checked as 1 (Mark Parity). If bit 5 is 0 Stick Parity is disabled. Bit 3 is a logic “1” and bit 5 is a logic “1”, the parity bit is transmitted and then detected by the receiver in the opposite state indicated by bit 4.	R/W	0h	RESET
4	PARITY_SELECT Even Parity Select bit. When bit 3 is a logic “1” and bit 4 is a logic “0”, an odd number of logic “1”'s is transmitted or checked in the data word bits and the parity bit. When bit 3 is a logic “1” and bit 4 is a logic “1” an even number of bits is transmitted and checked.	R/W	0h	RESET
3	ENABLE_PARITY Parity Enable bit. When bit 3 is a logic “1”, a parity bit is generated (transmit data) or checked (receive data) between the last data word bit and the first stop bit of the serial data. (The parity bit is used to generate an even or odd number of 1s when the data word bits and the parity bit are summed).	R/W	0h	RESET
2	STOP_BITS This bit specifies the number of stop bits in each transmitted or received serial character. Table 8-14 summarizes the information.	R/W	0h	RESET
1:0	WORD_LENGTH These two bits specify the number of bits in each transmitted or received serial character. The encoding of bits 0 and 1 is as follows:	R/W	0h	RESET

TABLE 8-14: STOP BITS

Bit 2	Word Length	Number of Stop Bits
0	--	1
1	5 bits	1.5
	6 bits	2
	7 bits	
	8 bits	

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Note: The receiver will ignore all stop bits beyond the first, regardless of the number used in transmitting.

TABLE 8-15: SERIAL CHARACTER

Bit 1	Bit 0	Word Length
0	0	5 Bits
0	1	6 Bits
1	0	7 Bits
1	1	8 Bits

The Start, Stop and Parity bits are not included in the word length.

8.11.9 MODEM CONTROL REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:5	Reserved	R	-	-
4	LOOPBACK This bit provides the loopback feature for diagnostic testing of the Serial Port. When bit 4 is set to logic “1”, the following occur: 1. The TXD is set to the Marking State (logic “1”). 2. The receiver Serial Input (RXD) is disconnected. 3. The output of the Transmitter Shift Register is “looped back” into the Receiver Shift Register input. 4. All MODEM Control inputs (nCTS, nDSR, nRI and nDCD) are disconnected. 5. The four MODEM Control outputs (nDTR, nRTS, OUT1 and OUT2) are internally connected to the four MODEM Control inputs (nDSR, nCTS, RI, DCD). 6. The Modem Control output pins are forced inactive high. 7. Data that is transmitted is immediately received. This feature allows the processor to verify the transmit and receive data paths of the Serial Port. In the diagnostic mode, the receiver and the transmitter interrupts are fully operational. The MODEM Control Interrupts are also operational but the interrupts' sources are now the lower four bits of the MODEM Control Register instead of the MODEM Control inputs. The interrupts are still controlled by the Interrupt Enable Register.	R/W	0h	RESET
3	OUT2 Output 2 (OUT2). This bit is used to enable an UART interrupt. When OUT2 is a logic “0”, the serial port interrupt output is forced to a high impedance state - disabled. When OUT2 is a logic “1”, the serial port interrupt outputs are enabled.	R/W	0h	RESET
2	OUT1 This bit controls the Output 1 (OUT1) bit. This bit does not have an output pin and can only be read or written by the CPU.	R/W	0h	RESET
1	RTS This bit controls the Request To Send (nRTS) output. Bit 1 affects the nRTS output in a manner identical to that described above for bit 0.	R/W	0h	RESET

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
0	DTR This bit controls the Data Terminal Ready (nDTR) output. When bit 0 is set to a logic “1”, the nDTR output is forced to a logic “0”. When bit 0 is a logic “0”, the nDTR output is forced to a logic “1”.	R/W	0h	RESET

8.11.10 LINE STATUS REGISTER

Offset	05h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	FIFO_ERROR This bit is permanently set to logic “0” in the 450 mode. In the FIFO mode, this bit is set to a logic “1” when there is at least one parity error, framing error or break indication in the FIFO. This bit is cleared when the LSR is read if there are no subsequent errors in the FIFO.	R	0h	RESET
6	TRANSMIT_ERROR Transmitter Empty. Bit 6 is set to a logic “1” whenever the Transmitter Holding Register (THR) and Transmitter Shift Register (TSR) are both empty. It is reset to logic “0” whenever either the THR or TSR contains a data character. Bit 6 is a read only bit. In the FIFO mode this bit is set whenever the THR and TSR are both empty,	R	0h	RESET
5	TRANSMIT_EMPTY Transmitter Holding Register Empty Bit 5 indicates that the Serial Port is ready to accept a new character for transmission. In addition, this bit causes the Serial Port to issue an interrupt when the Transmitter Holding Register interrupt enable is set high. The THRE bit is set to a logic “1” when a character is transferred from the Transmitter Holding Register into the Transmitter Shift Register. The bit is reset to logic “0” whenever the CPU loads the Transmitter Holding Register. In the FIFO mode this bit is set when the XMIT FIFO is empty, it is cleared when at least 1 byte is written to the XMIT FIFO. Bit 5 is a read only bit.	R	0h	RESET
4	BREAK_INTERRUPT Break Interrupt. Bit 4 is set to a logic “1” whenever the received data input is held in the Spacing state (logic “0”) for longer than a full word transmission time (that is, the total time of the start bit + data bits + parity bits + stop bits). The BI is reset after the CPU reads the contents of the Line Status Register. In the FIFO mode this error is associated with the particular character in the FIFO it applies to. This error is indicated when the associated character is at the top of the FIFO. When break occurs only one zero character is loaded into the FIFO. Restarting after a break is received, requires the serial data (RXD) to be logic “1” for at least 1/2 bit time. Bits 1 through 4 are the error conditions that produce a Receiver Line Status Interrupt BIT 3 whenever any of the corresponding conditions are detected and the interrupt is enabled	R	0h	RESET

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Offset	05h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
3	FRAME_ERROR Framing Error. Bit 3 indicates that the received character did not have a valid stop bit. Bit 3 is set to a logic “1” whenever the stop bit following the last data bit or parity bit is detected as a zero bit (Spacing level). This bit is reset to a logic “0” whenever the Line Status Register is read. In the FIFO mode this error is associated with the particular character in the FIFO it applies to. This error is indicated when the associated character is at the top of the FIFO. The Serial Port will try to resynchronize after a framing error. To do this, it assumes that the framing error was due to the next start bit, so it samples this 'start' bit twice and then takes in the 'data'.	R	0h	RESET
2	PARITY ERROR Parity Error. Bit 2 indicates that the received data character does not have the correct even or odd parity, as selected by the even parity select bit. This bit is set to a logic “1” upon detection of a parity error and is reset to a logic “0” whenever the Line Status Register is read. In the FIFO mode this error is associated with the particular character in the FIFO it applies to. This error is indicated when the associated character is at the top of the FIFO.	R	0h	RESET
1	OVERRUN_ERROR Overrun Error. Bit 1 indicates that data in the Receiver Buffer Register was not read before the next character was transferred into the register, thereby destroying the previous character. In FIFO mode, an overrun error will occur only when the FIFO is full and the next character has been completely received in the shift register, the character in the shift register is overwritten but not transferred to the FIFO. This bit is set to a logic “1” immediately upon detection of an overrun condition, and reset whenever the Line Status Register is read.	R	0h	RESET
0	DATA_READY Data Ready. It is set to a logic ‘1’ whenever a complete incoming character has been received and transferred into the Receiver Buffer Register or the FIFO. Bit 0 is reset to a logic ‘0’ by reading all of the data in the Receive Buffer Register or the FIFO.	R	0h	RESET

8.11.11 MODEM STATUS REGISTER

Offset	06h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	DCD This bit is the complement of the Data Carrier Detect (nDCD) input. If bit 4 of the MCR is set to logic ‘1’, this bit is equivalent to OUT2 in the MCR.	R	0h	RESET
6	RI# This bit is the complement of the Ring Indicator (nRI) input. If bit 4 of the MCR is set to logic ‘1’, this bit is equivalent to OUT1 in the MCR.	R	0h	RESET

Offset	06h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
5	DSR This bit is the complement of the Data Set Ready (nDSR) input. If bit 4 of the MCR is set to logic ‘1’, this bit is equivalent to DTR in the MCR.	R	0h	RESET
4	CTS This bit is the complement of the Clear To Send (nCTS) input. If bit 4 of the MCR is set to logic ‘1’, this bit is equivalent to nRTS in the MCR.	R	0h	RESET
3	DCD Delta Data Carrier Detect (DDCD). Bit 3 indicates that the nDCD input to the chip has changed state. NOTE: Whenever bit 0, 1, 2, or 3 is set to a logic ‘1’, a MODEM Status Interrupt is generated.	R	0h	RESET
2	RI Trailing Edge of Ring Indicator (TERI). Bit 2 indicates that the nRI input has changed from logic ‘0’ to logic ‘1’.	R	0h	RESET
1	DSR Delta Data Set Ready (DDSR). Bit 1 indicates that the nDSR input has changed state since the last time the MSR was read.	R	0h	RESET
0	CTS Delta Clear To Send (DCTS). Bit 0 indicates that the nCTS input to the chip has changed state since the last time the MSR was read.	R	0h	RESET

Note: The Modem Status Register (MSR) only provides the current state of the UART MODEM control lines in Loopback Mode. The CEC1302 does not support external connections for the MODEM Control inputs (nCTS, nDSR, nRI and nDCD) or for the four MODEM Control outputs (nDTR, nRTS, OUT1 and OUT2).

8.11.12 SCRATCHPAD REGISTER

Offset	07h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	SCRATCH This 8 bit read/write register has no effect on the operation of the Serial Port. It is intended as a scratchpad register to be used by the programmer to hold data temporarily.	R/W	0h	RESET

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9.0 EC INTERRUPT AGGREGATOR

9.1 Introduction

The EC Interrupt Aggregator works in conjunction with the processor's interrupt interface to handle hardware interrupts and exceptions.

Exceptions are synchronous to instructions, are not maskable, and have higher priority than interrupts. All three exceptions - reset, memory error, and instruction error - are hardwired directly to the processor. Interrupts are typically asynchronous and are maskable.

Interrupts classified as wake events can be recognized without a running clock, e.g., while the CEC1302 is in sleep state.

This chapter focuses on the EC Interrupt Aggregator. Please refer to embedded controller's documentation for more information on interrupt and exception handling.

9.2 References

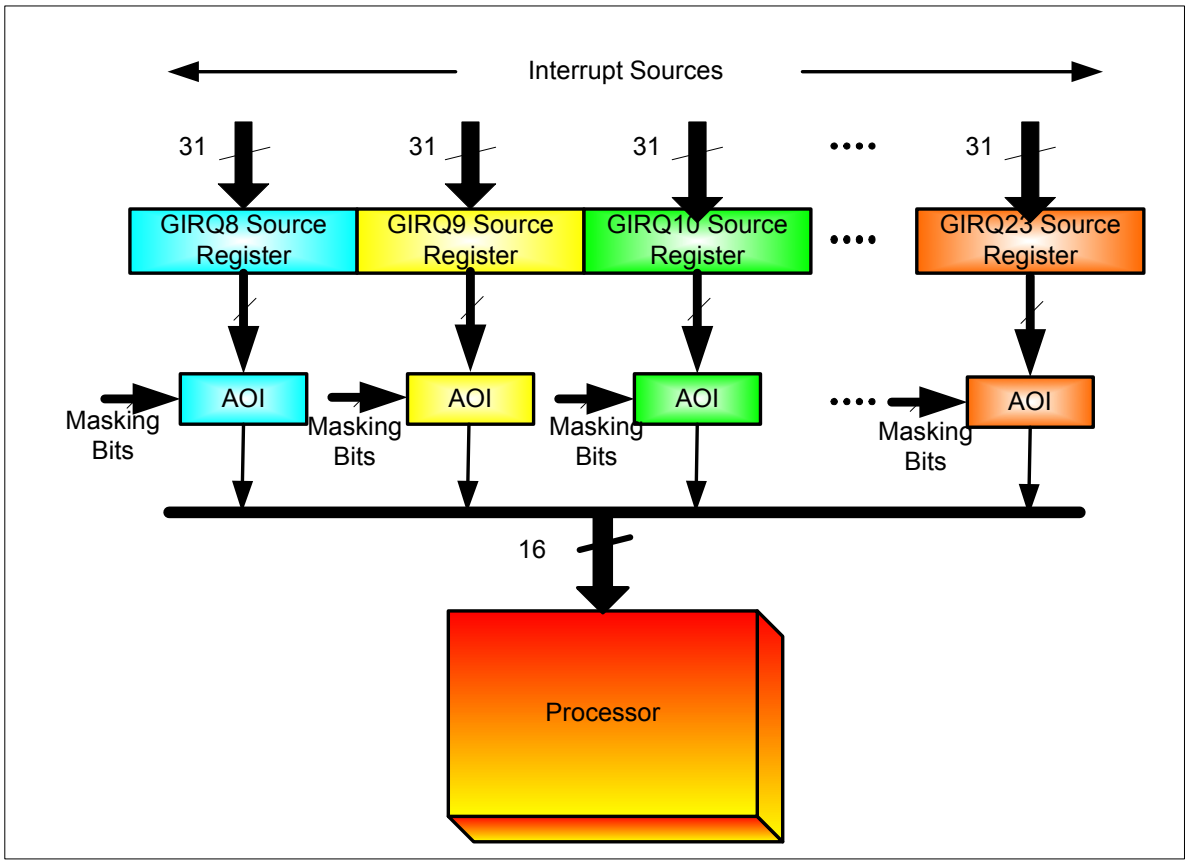
None

9.3 Terminology

None

9.4 Interface

FIGURE 9-1: BLOCK DIAGRAM OF EC Interrupt Aggregator



9.4.1 SIGNAL INTERFACE

This block is not accessible from the pin interface.

9.4.2 HOST INTERFACE

The registers defined for the EC Interrupt Aggregator are only accessible by the embedded controller via the EC-Only Registers.

9.5 Power, Clocks and Reset

9.5.1 BLOCK POWER DOMAIN

TABLE 9-1: BLOCK POWER

Power Well Source	Effect on Block
VCC1	The EC Interrupt Aggregator block and registers operate on this single power well.

9.5.2 BLOCK CLOCKS

None

9.5.3 BLOCK RESET

TABLE 9-2: BLOCK RESETS

Reset Name	Reset Description
VCC1_RESET	This signal is used to indicate when the VCC1 logic and registers in this block are reset.

9.6 Interrupts

This block aggregates all the interrupts targeted for the embedded controller into the Source Registers defined in Section 9.9, "EC-Only Registers," on page 105. The unmasked bits of each source register are then OR'd together and routed to the embedded controller's interrupt interface. The name of each Source Register identifies the IRQ number of the interrupt port on the embedded controller.

9.7 Low Power Modes

This block always automatically adjusts to operate in the lowest power mode.

9.8 Description

The interrupt generation logic is made of 16 groups of signals, each of which consist of a Status register, a Enable register and a Result register.

The Status and Enable are latched registers. The Result register is a bit by bit AND function of the Source and Enable registers. All the bits of the Result register are OR'ed together and AND'ed with the corresponding bit in the Block Select register to form the interrupt signal that is routed to the ARM interrupt controller.

The Result register bits may also be enabled to the NVIC block via the NVIC_EN bit in the Interrupt Control register. See Chapter 27.0, "EC Subsystem Registers"

Section 9.8.1 shows a representation of the interrupt structure.

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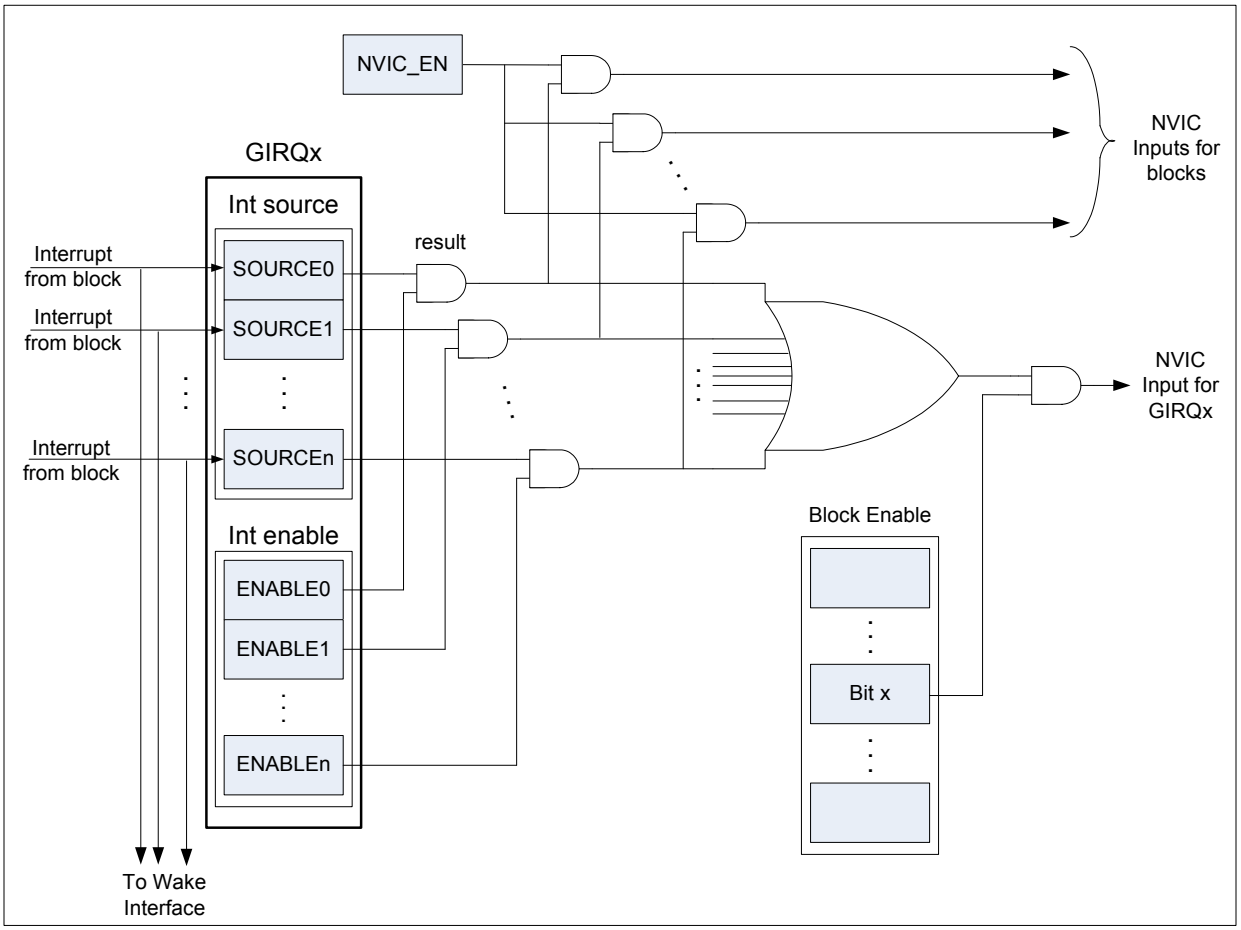
FIGURE 9-2: INTERRUPT STRUCTURE



9.8.1 WAKE GENERATION

The EC Interrupt Aggregator notifies the Chip Power Management Features to wake the system when it detects a wake capable event has occurred. This logic requires no clocks.

The interrupt sources AND'ed with the corresponding Enable bit will be OR'ed to produce a wake event

The wake up sources are identified with a "Y" in the "WAKE" column of the Bit definitions table for each IRQ's Source Register.

9.8.1.1 Configuring Wake Interrupts

All GPIO inputs are wake-capable. In order for a GPIO input to wake the CEC1302 from a sleep state, the Interrupt Detection field of the GPIO Pin Control Register must be set to Rising Edge Triggered, Falling Edge Triggered, or Either Edge Triggered. If the Interrupt Detection field is set to any other value, a GPIO input will not trigger a wake interrupt.

Some of the Wake Capable Interrupts are triggered by activity on pins that are shared with a GPIO. These interrupts will only trigger a wake if the Interrupt Detection field of the corresponding GPIO Pin Control Register is set to Rising Edge Triggered, Falling Edge Triggered, or Either Edge Triggered.

APPLICATION NOTE: JTAG debug accesses are not wake capable. EC firmware must enable an interrupt on the falling edge of the GPIO associated with JTAG_CLK if JTAG debug accesses are required while the CEC1302 is in a sleep mode in which the main clock is turned off.

9.8.2 INTERRUPT SUMMARY

Table 9-3, "Interrupt Event Aggregator Routing Summary" summarizes the interrupts, wake capabilities and NVIC vector locations.

Table 9-4, "EC Interrupt Structure" summarizes the interrupts, priorities and vector locations.

TABLE 9-3: INTERRUPT EVENT AGGREGATOR ROUTING SUMMARY

Interrupt	Aggregator IRQ	Aggregator Bit	Wake Event	Aggregated NVIC	Direct NVIC Interrupt
GPIO140	GIRQ8	0	Yes	57	N/A
GPIO141	GIRQ8	1			
GPIO142	GIRQ8	2			
GPIO143	GIRQ8	3			
GPIO144	GIRQ8	4			
GPIO145	GIRQ8	5			
GPIO146	GIRQ8	6			
GPIO147	GIRQ8	7			
GPIO150	GIRQ8	8			
GPIO151	GIRQ8	9			
GPIO152	GIRQ8	10			
GPIO153	GIRQ8	11			
GPIO154	GIRQ8	12			
GPIO155	GIRQ8	13			
GPIO156	GIRQ8	14			
GPIO157	GIRQ8	15			
GPIO160	GIRQ8	16			
GPIO161	GIRQ8	17			
GPIO162	GIRQ8	18			
GPIO163	GIRQ8	19			
GPIO164	GIRQ8	20			
GPIO165	GIRQ8	21			

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TABLE 9-3: INTERRUPT EVENT AGGREGATOR ROUTING SUMMARY (CONTINUED)

Interrupt	Aggregator IRQ	Aggregator Bit	Wake Event	Aggregated NVIC	Direct NVIC Interrupt
GPIO100	GIRQ9	0	Yes	58	N/A
GPIO101	GIRQ9	1			
GPIO102	GIRQ9	2			
GPIO103	GIRQ9	3			
GPIO104	GIRQ9	4			
GPIO105	GIRQ9	5			
GPIO106	GIRQ9	6			
GPIO107	GIRQ9	7			
GPIO110	GIRQ9	8			
GPIO111	GIRQ9	9			
GPIO112	GIRQ9	10			
GPIO113	GIRQ9	11			
GPIO114	GIRQ9	12			
GPIO115	GIRQ9	13			
GPIO116	GIRQ9	14			
GPIO117	GIRQ9	15			
GPIO120	GIRQ9	16			
GPIO121	GIRQ9	17			
GPIO122	GIRQ9	18			
GPIO123	GIRQ9	19			
GPIO124	GIRQ9	20			
GPIO125	GIRQ9	21			
GPIO126	GIRQ9	22			
GPIO127	GIRQ9	23			
GPIO130	GIRQ9	24			
GPIO131	GIRQ9	25			
GPIO132	GIRQ9	26			
GPIO133	GIRQ9	27			
GPIO134	GIRQ9	28			
GPIO135	GIRQ9	29			
GPIO136	GIRQ9	30			

TABLE 9-3: INTERRUPT EVENT AGGREGATOR ROUTING SUMMARY (CONTINUED)

Interrupt	Aggregator IRQ	Aggregator Bit	Wake Event	Aggregated NVIC	Direct NVIC Interrupt
GPIO040	GIRQ10	0	Yes	59	N/A
GPIO041	GIRQ10	1			
GPIO042	GIRQ10	2			
GPIO043	GIRQ10	3			
GPIO044	GIRQ10	4			
GPIO045	GIRQ10	5			
GPIO046	GIRQ10	6			
GPIO047	GIRQ10	7			
GPIO050	GIRQ10	8			
GPIO051	GIRQ10	9			
GPIO052	GIRQ10	10			
GPIO053	GIRQ10	11			
GPIO054	GIRQ10	12			
GPIO055	GIRQ10	13			
GPIO056	GIRQ10	14			
GPIO057	GIRQ10	15			
GPIO060	GIRQ10	16			
GPIO061	GIRQ10	17			
GPIO062	GIRQ10	18			
GPIO063	GIRQ10	19			
GPIO064	GIRQ10	20			
GPIO065	GIRQ10	21			
GPIO066	GIRQ10	22			
GPIO067	GIRQ10	23			

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TABLE 9-3: INTERRUPT EVENT AGGREGATOR ROUTING SUMMARY (CONTINUED)

Interrupt	Aggregator IRQ	Aggregator Bit	Wake Event	Aggregated NVIC	Direct NVIC Interrupt
GPIO000	GIRQ11	0	Yes	60	N/A
GPIO001	GIRQ11	1			
GPIO002	GIRQ11	2			
GPIO003	GIRQ11	3			
GPIO004	GIRQ11	4			
GPIO005	GIRQ11	5			
GPIO006	GIRQ11	6			
GPIO007	GIRQ11	7			
GPIO010	GIRQ11	8			
GPIO011	GIRQ11	9			
GPIO012	GIRQ11	10			
GPIO013	GIRQ11	11			
GPIO014	GIRQ11	12			
GPIO015	GIRQ11	13			
GPIO016	GIRQ11	14			
GPIO017	GIRQ11	15			
GPIO020	GIRQ11	16			
GPIO021	GIRQ11	17			
GPIO022	GIRQ11	18			
GPIO023	GIRQ11	19			
GPIO024	GIRQ11	20			
GPIO025	GIRQ11	21			
GPIO026	GIRQ11	22			
GPIO027	GIRQ11	23			
GPIO030	GIRQ11	24			
GPIO031	GIRQ11	25			
GPIO032	GIRQ11	26			
GPIO033	GIRQ11	27			
GPIO034	GIRQ11	28			
GPIO035	GIRQ11	29			
GPIO036	GIRQ11	30			
I2C0 / SMB0	GIRQ12	0	No	61	0
I2C1 / SMB1	GIRQ12	1			1
I2C2 / SMB2	GIRQ12	2			2
I2C3 / SMB3	GIRQ12	3			3
I2C0_0_WK	GIRQ12	4	Yes		N/A
I2C0_1_WK	GIRQ12	5			
I2C2_0_WK	GIRQ12	6			
I2C1_0_WK	GIRQ12	7			
I2C3_0_WK	GIRQ12	8			

TABLE 9-3: INTERRUPT EVENT AGGREGATOR ROUTING SUMMARY (CONTINUED)

Interrupt	Aggregator IRQ	Aggregator Bit	Wake Event	Aggregated NVIC	Direct NVIC Interrupt
DMA0	GIRQ13	16	No	62	4
DMA1	GIRQ13	17			5
DMA2	GIRQ13	18			6
DMA3	GIRQ13	19			7
DMA4	GIRQ13	20			8
DMA5	GIRQ13	21			9
DMA6	GIRQ13	22			10
DMA7	GIRQ13	23			11
DMA8	GIRQ13	24			81
DMA9	GIRQ13	25			82
DMA10	GIRQ13	26			83
DMA11	GIRQ13	27			84
UART_0	GIRQ15	0	No	64	13
Reserved	GIRQ15	1			N/A
MCHP Reserved	GIRQ15	2			14
Reserved	GIRQ15	3			N/A
Reserved	GIRQ15	4			N/A
Reserved	GIRQ15	5			N/A
MCHP Reserved	GIRQ15	6			15
MCHP Reserved	GIRQ15	7			16
MCHP Reserved	GIRQ15	8			17
MCHP Reserved	GIRQ15	9			18
MCHP Reserved	GIRQ15	10			19
MCHP Reserved	GIRQ15	11			20
MCHP Reserved	GIRQ15	12			21
MCHP Reserved	GIRQ15	13			22
MCHP Reserved	GIRQ15	14			23
MCHP Reserved	GIRQ15	15			24
MCHP Reserved	GIRQ15	16			40
MCHP Reserved	GIRQ16	3	No	65	25

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TABLE 9-3: INTERRUPT EVENT AGGREGATOR ROUTING SUMMARY (CONTINUED)

Interrupt	Aggregator IRQ	Aggregator Bit	Wake Event	Aggregated NVIC	Direct NVIC Interrupt
TACH_0	GIRQ17	0	No	66	26
TACH_1	GIRQ17	1	No		27
MCHP Reserved	GIRQ17	2	Yes		N/A
MCHP Reserved	GIRQ17	3	Yes		
MCHP Reserved	GIRQ17	4	Yes		
MCHP Reserved	GIRQ17	5	Yes		
BC_INT_N_WK	GIRQ17	6	Yes		
ADC_SNGL	GIRQ17	10	No		28
ADC_RPT	GIRQ17	11	No		29
MCHP Reserved	GIRQ17	12	No		30
MCHP Reserved	GIRQ17	13	No		31
MCHP Reserved	GIRQ17	14	No		32
MCHP Reserved	GIRQ17	15	No		33
MCHP Reserved	GIRQ17	16	No		34
MCHP Reserved	GIRQ17	17	No		35
RTC	GIRQ17	18	Yes		91
RTC ALARM	GIRQ17	19	Yes		92
HTIMER	GIRQ17	20	Yes		38
KSC_INT	GIRQ17	21	No		39
KSC_INT wake	GIRQ17	22	Yes		N/A
RPM_INT Stall	GIRQ17	23	No		41
RPM_INT Spin	GIRQ17	24	No		42
PFR_STS	GIRQ17	25	No		43
PWM_WDT0	GIRQ17	26	No		44
PWM_WDT1	GIRQ17	27	No		45
PWM_WDT2	GIRQ17	28	No		46
BCM_INT Err	GIRQ17	29	No		47
BCM_INT Busy	GIRQ17	30	No		48
SPI0 TX	GIRQ18	0	No	67	36
SPI0 RX	GIRQ18	1			37
SPI1 TX	GIRQ18	2			55
SPI1 RX	GIRQ18	3			56
PWM_WDT3	GIRQ18	4			85
PKE ERROR	GIRQ18	5			86
PKE END	GIRQ18	6			87
RNG	GIRQ18	7			88
AES	GIRQ18	8			89
HASH	GIRQ18	9			90
VCC_PWRGD	GIRQ19	0	Yes	68	N/A
LRESET#	GIRQ19	1			

TABLE 9-3: INTERRUPT EVENT AGGREGATOR ROUTING SUMMARY (CONTINUED)

Interrupt	Aggregator IRQ	Aggregator Bit	Wake Event	Aggregated NVIC	Direct NVIC Interrupt
GPIO200	GIRQ20	0	Yes	69	N/A
GPIO201	GIRQ20	1			
GPIO202	GIRQ20	2			
GPIO203	GIRQ20	3			
GPIO204	GIRQ20	4			
N/A	GIRQ20	5			
GPIO206	GIRQ20	6			
N/A	GIRQ20	7			
GPIO210	GIRQ20	8			
GPIO211	GIRQ20	9			
TIMER_16_0	GIRQ23	0	No	72	49
TIMER_16_1	GIRQ23	1			50
TIMER_16_2	GIRQ23	2			51
TIMER_16_3	GIRQ23	3			52
TIMER_32_0	GIRQ23	4			53
TIMER_32_1	GIRQ23	5			54

TABLE 9-4: EC INTERRUPT STRUCTURE

Vector	Name	Link Register	Priority (Default)	Relative Priority	Byte Offset
0	Reset	-	High	H1	00h
1	Memory Error	ILINK2	High	H2	08h
2	Instruction Error	ILINK2	High	H3	10h
3	IRQ3-Reserved	ILINK1	level 1 (low)	L27	18h
4	IRQ4-Reserved	ILINK1	level 1 (low)	L26	20h
5	IRQ5-Reserved	ILINK1	level 1 (low)	L25	28h
6	IRQ6-Reserved	ILINK2	level 2 (mid)	M2	30h
7	IRQ7-Reserved	ILINK2	level 2 (mid)	M1	38h
8	IRQ8	ILINK1	level 1 (low)	L24	40h
9	IRQ9	ILINK1	level 1 (low)	L23	48h
10	IRQ10	ILINK1	level 1 (low)	L22	50h
11	IRQ11	ILINK1	level 1 (low)	L21	58h
12	IRQ12	ILINK1	level 1 (low)	L20	60h
13	IRQ13	ILINK1	level 1 (low)	L19	68h
14	IRQ14	ILINK1	level 1 (low)	L18	70h
15	IRQ15	ILINK1	level 1 (low)	L17	78h
16	IRQ16	ILINK1	level 1 (low)	L16	80h
17	IRQ17	ILINK1	level 1 (low)	L15	88h
18	IRQ18	ILINK1	level 1 (low)	L14	90h
19	IRQ19	ILINK1	level 1 (low)	L13	98h
20	IRQ20	ILINK1	level 1 (low)	L12	A0h
21	IRQ21	ILINK1	level 1 (low)	L11	A8h
22	IRQ22	ILINK1	level 1 (low)	L10	B0h

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TABLE 9-4: EC INTERRUPT STRUCTURE (CONTINUED)

Vector	Name	Link Register	Priority (Default)	Relative Priority	Byte Offset
23	IRQ23	ILINK1	level 1 (low)	L9	B8h
24	IRQ24	ILINK1	level 1 (low)	L8	C0h
25	IRQ25	ILINK1	level 1 (low)	L7	C8h
26	IRQ26	ILINK1	level 1 (low)	L6	D0h
27	IRQ27	ILINK1	level 1 (low)	L5	D8h
28	IRQ28	ILINK1	level 1 (low)	L4	E0h
29	IRQ29	ILINK1	level 1 (low)	L3	E8h
30	IRQ30	ILINK1	level 1 (low)	L2	F0h
31	IRQ31	ILINK1	level 1 (low)	L1	F8h

Note: IRQ Vector 31 is the highest L1 Priority

9.8.3 DISABLING INTERRUPTS

The Block Enable Clear Register and Block Enable Set Register should not be used for disabling and enabling interrupts for software operations i.e., critical sections. The ARM enable disable mechanisms should be used.

9.9 EC-Only Registers

The configuration registers listed in EC-Only Register Summary table are for a single instance of the EC Interrupt Aggregator. The addresses of each register listed in the summary table are defined as a relative offset to the host “Begin Address” defined in the EC-Only Register Base Address Table.

TABLE 9-5: EC-ONLY REGISTER ADDRESS RANGE TABLE

Instance Name	Instance Number	Host	Address Space	Begin Address (Note 9-1)
Interrupt Aggregator	0	EC	32-bit internal address space	4000_C000h

Note 9-1 The Begin Address indicates the location of the first register accessable at offset 00h in the Interrupt Aggregator EC-Only address space.

TABLE 9-6: EC-ONLY REGISTER SUMMARY

Offset	Register Name
00h	GIRQ8 Source Register
04h	GIRQ8 Enable Set Register
08h	GIRQ8 Result Register
0Ch	GIRQ8 Enable Clear Register
14h	GIRQ9 Source Register
18h	GIRQ9 Enable Set Register
1Ch	GIRQ9 Result Register
20h	GIRQ9 Enable Clear Register
28h	GIRQ10 Source Register
2Ch	GIRQ10 Enable Set Register
30h	GIRQ10 Result Register
34h	GIRQ10 Enable Clear Register

TABLE 9-6: EC-ONLY REGISTER SUMMARY (CONTINUED)

Offset	Register Name
3Ch	GIRQ11 Source Register
40h	GIRQ11 Enable Set Register
44h	GIRQ11 Result Register
48h	GIRQ11 Enable Clear Register
50h	GIRQ12 Source Register
54h	GIRQ12 Enable Set Register
58h	GIRQ12 Result Register
5Ch	GIRQ12 Enable Clear Register
64h	GIRQ13 Source Register
68h	GIRQ13 Enable Set Register
6Ch	GIRQ13 Result Register
70h	GIRQ13 Enable Clear Register
78h	GIRQ14 Source Register
7Ch	GIRQ14 Enable Set Register
80h	GIRQ14 Result Register
84h	GIRQ14 Enable Clear Register
8Ch	GIRQ15 Source Register
90h	GIRQ15 Enable Set Register
94h	GIRQ15 Result Register
98h	GIRQ15 Enable Clear Register
A0h	GIRQ16 Source Register
A4h	GIRQ16 Enable Set Register
A8h	GIRQ16 Result Register
ACh	GIRQ16 Enable Clear Register
B4h	GIRQ17 Source Register
B8h	GIRQ17 Enable Set Register
BCh	GIRQ17 Result Register
C0h	GIRQ17 Enable Clear Register
C8h	GIRQ18 Source Register
CCh	GIRQ18 Enable Set Register
D0h	GIRQ18 Result Register
D4h	GIRQ18 Enable Clear Register
DCh	GIRQ19 Source Register
E0h	GIRQ19 Enable Set Register
E4h	GIRQ19 Result Register
E8h	GIRQ19 Enable Clear Register
F0h	GIRQ20 Source Register
F4h	GIRQ20 Enable Set Register
F8h	GIRQ20 Result Register
FCh	GIRQ20 Enable Clear Register
104h	GIRQ21 Source Register
108h	GIRQ21 Enable Set Register
10Ch	GIRQ21 Result Register
110h	GIRQ21 Enable Clear Register

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TABLE 9-6: EC-ONLY REGISTER SUMMARY (CONTINUED)

Offset	Register Name
118h	GIRQ22 Source Register
11Ch	GIRQ22 Enable Set Register
120h	GIRQ22 Result Register
124h	GIRQ22 Enable Clear Register
12Ch	GIRQ23 Source Register
130h	GIRQ23 Enable Set Register
134h	GIRQ23 Result Register
138h	GIRQ23 Enable Clear Register
200h	Block Enable Set Register
204h	Block Enable Clear Register
208h	Block IRQ Vector Register

All of the GIRQx Source, Enable, and Result registers have the same format. The following tables define the generic format for each of these registers. The bit definitions are defined in the sections that follow.

Note: The behavior of the enable bit controlled by the GIRQx Enable Set and GIRQx Enable Clear Registers, the GIRQx Source bit, and the GIRQx Result bit are illustrated in Section 9.8.1, "WAKE Generation," on page 97.

TABLE 9-7: GIRQX SOURCE REGISTER

Offset	-			32-bit		**Size**	
Power	VCC1			0000_0000h		VCC1_RESET **Default**	
Bit	**D31**	**D30**	**D29**	• • •	**D2**	**D1**	**D0**
Type	R	R/WC except for reserved bits, which are R					
Bit Name	Reserved	See Tables in the following subsections					

The R/WC bits are sticky status bits indicating the state of interrupt source before the interrupt enable bit.

TABLE 9-8: GIRQX ENABLE SET REGISTER

Offset	-			32-bit		**Size**	
POWER	VCC1			0000_0000h		VCC1_RESET **Default**	
BIT	**D31**	**D30**	**D29**	• • •	**D2**	**D1**	**D0**
TYPE	R	R/WS except for reserved bits, which are R					
BIT NAME	Reserved	See Tables in the following subsections					

GIRQ Enable Set [31:0]

Each GIRQx bit can be individually enabled to assert an interrupt event.

0= Writing a zero has no effect.

1= Writing a one will enable respective GIRQx.

Reading always returns the current value of the GIRQx ENABLE bit. The state of the GIRQx ENABLE bit is determined by the corresponding GIRQx Enable Set bit and the GIRQx Enable Clear bit. (0=disabled, 1-enabled)

TABLE 9-9: GIRQX RESULT REGISTER

Offset	-					32-bit	EC Size	
POWER	VCC1					8000_0000h	VCC1_RESET Default	
BIT	D31	D30	D29	• • •	D2		D1	D0
TYPE	R	R						
BIT NAME	'1'	See Tables in the following subsections						

GIRQx Interrupt Result

Bits D30 down to D0 are defined in the following subsections reflect the state of the GIRQx interrupt source after the enable bit. The GIRQx result bits are OR'd together to generate the IRQx vector.

Bit D31

Bit D31 is hard-coded to '1'.

TABLE 9-10: GIRQX ENABLE CLEAR REGISTER

Offset	-					32-bit	Size	
POWER	VCC1					0000_0000h	VCC1_RESET Default	
BIT	D31	D30	D29	• • •	D2		D1	D0
TYPE	R	R/WC except for reserved bits, which are R						
BIT NAME	Reserved	See Tables in the following subsections						

GIRQx Enable Clear[31:0]

Each GIRQx bit can be individually disabled to assert an interrupt event.

0= Writing a zero has no effect.

1= Writing a one will disable respective GIRQx.

Reading always returns the current value of the GIRQx ENABLE bit. The state of the GIRQx ENABLE bit is determined by the corresponding GIRQx Enable Set bit and the GIRQx Enable Clear bit. (0=disabled, 1-enabled)

9.9.1 GIRQ8

TABLE 9-11: BIT DEFINITIONS FOR GIRQ8 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[7:0]	GPIO[147:140]	GPIO_Event	Y	Bits[0:7] are controlled by the GPIO_Events generated by GPIO140 through GPIO147, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.

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TABLE 9-11: BIT DEFINITIONS FOR GIRQ8 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[15:8]	GPIO[157:150]	GPIO_Event	Y	Bits[8:15] are controlled by the GPIO_Events generated by GPIO150 through GPIO157, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[21:16]	GPIO[165:160]	GPIO_Event	Y	Bits[16:21] are controlled by the GPIO_Events generated by GPIO160 through GPIO165, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[30:22]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.2 GIRQ9

TABLE 9-12: BIT DEFINITIONS FOR GIRQ9 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[7:0]	GPIO[107:100]	GPIO_Event	Y	Bits[0:7] are controlled by the GPIO_Events generated by GPIO100 through GPIO107, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[15:8]	GPIO[117:110]	GPIO_Event	Y	Bits[8:15] are controlled by the GPIO_Events generated by GPIO110 through GPIO117, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[23:16]	GPIO[127:120]	GPIO_Event	Y	Bits[16:23] are controlled by the GPIO_Events generated by GPIO120 through GPIO127, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.

TABLE 9-12: BIT DEFINITIONS FOR GIRQ9 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[30:24]	GPIO[136:130]	GPIO_Event	Y	Bits[24:30] are controlled by the GPIO_Events generated by GPIO130 through GPIO136, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.3 GIRQ10

TABLE 9-13: BIT DEFINITIONS FOR GIRQ10 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[7:0]	GPIO[047:040]	GPIO_Event	Y	Bits[0:7] are controlled by the GPIO_Events generated by GPIO040 through GPIO047, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[15:8]	GPIO[057:050]	GPIO_Event	Y	Bits[8:15] are controlled by the GPIO_Events generated by GPIO050 through GPIO057, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[23:16]	GPIO[067:060]	GPIO_Event	Y	Bits[16:23] are controlled by the GPIO_Events generated by GPIO060 through GPIO067, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[30:24]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

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9.9.4 GIRQ11

TABLE 9-14: BIT DEFINITIONS FOR GIRQ11 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[7:0]	GPIO[007:000]	GPIO_Event	Y	Bits[0:7] are controlled by the GPIO_Events generated by GPIO000 through GPIO007, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[15:8]	GPIO[017:010]	GPIO_Event	Y	Bits[8:15] are controlled by the GPIO_Events generated by GPIO010 through GPIO017, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[23:16]	GPIO[027:020]	GPIO_Event	Y	Bits[16:23] are controlled by the GPIO_Events generated by GPIO020 through GPIO027, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[30:24]	GPIO[036:030]	GPIO_Event	Y	Bits[24:30] are controlled by the GPIO_Events generated by GPIO030 through GPIO036, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.5 GIRQ12

TABLE 9-15: BIT DEFINITIONS FOR GIRQ12 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
0	I2C0 / SMB0	SMB	N	I2C/SMBus controller 0 interrupt. This interrupt is signaled when the I2C/SMBus controller 0 asserts its interrupt request.
1	I2C1 / SMB1	SMB	N	I2C/SMBus controller 1 interrupt. This interrupt is signaled when the I2C/SMBus controller 1 asserts its interrupt request.
2	I2C2 / SMB2	SMB	N	I2C/SMBus controller 2 interrupt. This interrupt is signaled when the I2C/SMBus controller 2 asserts its interrupt request.

TABLE 9-15: BIT DEFINITIONS FOR GIRQ12 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
3	I2C3 / SMB3	SMB	N	I2C/SMBus controller 3 interrupt. This interrupt is signaled when the I2C/SMBus controller 3 asserts its interrupt request.
4	I2C0_0_WK	SMB	Y	I2C/SMBus controller 0 (port 0) Wake interrupt. This interrupt is signaled when there is activity on the I2C/SMBus controller 0 port 0 data pin, I2C0_DAT0 (see Note 9-2 on page 118).
5	I2C0_1_WK	SMB	Y	I2C/SMBus controller 0 (port 1) Wake interrupt. This interrupt is signaled when there is activity on the I2C/SMBus controller 0 port 1 data pin, I2C0_DAT1 (see Note 9-2 on page 118).
6	I2C2_0_WK	SMB	Y	I2C/SMBus controller 2 (port 0) Wake interrupt. This interrupt is signaled when there is activity on the I2C/SMBus controller 2 (port 0) data pin, I2C2_DAT0 (see Note 9-2 on page 118).
7	I2C1_0_WK	SMB	Y	I2C/SMBus controller 1 (port 0) Wake interrupt. This interrupt is signaled when there is activity on the I2C/SMBus controller 1 port 0 data pin, I2C1_DAT0 (see Note 9-2 on page 118).
8	I2C3_0_WK	SMB	Y	I2C/SMBus controller 3 (port 0) Wake interrupt. This interrupt is signaled when there is activity on the I2C/SMBus controller 3 port 0 data pin, I2C3_DAT0 (see Note 9-2 on page 118).
[30:9]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.6 GIRQ13

TABLE 9-16: BIT DEFINITIONS FOR GIRQ13 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[15:0]	Reserved	Reserved	N	Reserved
16	IRQ_DMA0	DMA0	N	Direct Memory Access Channel 0
17	IRQ_DMA1	DMA1	N	Direct Memory Access Channel 1
18	IRQ_DMA2	DMA2	N	Direct Memory Access Channel 2
19	IRQ_DMA3	DMA3	N	Direct Memory Access Channel 3
20	IRQ_DMA4	DMA4	N	Direct Memory Access Channel 4
21	IRQ_DMA5	DMA5	N	Direct Memory Access Channel 5
22	IRQ_DMA6	DMA6	N	Direct Memory Access Channel 6
23	IRQ_DMA7	DMA7	N	Direct Memory Access Channel 7
24	IRQ_DMA8	DMA8	N	Direct Memory Access Channel 8
25	IRQ_DMA9	DMA9	N	Direct Memory Access Channel 9
26	IRQ_DMA10	DMA10	N	Direct Memory Access Channel 10
27	IRQ_DMA11	DMA11	N	Direct Memory Access Channel 11

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TABLE 9-16: BIT DEFINITIONS FOR GIRQ13 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[30:28]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.7 GIRQ14

TABLE 9-17: BIT DEFINITIONS FOR GIRQ14 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[1:0]	Reserved	Reserved	N	Reserved
2	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
[30:3]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.8 GIRQ15

TABLE 9-18: BIT DEFINITIONS FOR GIRQ15 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
0	UART_0	UART	N	The UART interrupt event output indicates if an interrupt is pending. See Table 8-13, “Interrupt Control Table,” on page 89.
1	Reserved	Reserved	N	Reserved
2	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
5:3	Reserved	Reserved	N	Reserved
6	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
7	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
8	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
9	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
10	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
11	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
12	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
13	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
14	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
15	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
16	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
[30:17]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.9 GIRQ16

TABLE 9-19: BIT DEFINITIONS FOR GIRQ16 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[2:0]	Reserved	Reserved	N	Reserved
3	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
[30:4]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.10 GIRQ17

TABLE 9-20: BIT DEFINITIONS FOR GIRQ17 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
0	IRQ_TACH0	TACH	N	This internal signal is generated from the OR'd result of the status events, as defined in the TACHx Status Register..
1	IRQ_TACH1	TACH	N	This internal signal is generated from the OR'd result of the status events, as defined in the TACHx Status Register.
2	MCHP Reserved	MCHP Reserved	Y	MCHP Reserved
3	MCHP Reserved	MCHP Reserved	Y	MCHP Reserved
4	MCHP Reserved	MCHP Reserved	Y	MCHP Reserved
5	MCHP Reserved	MCHP Reserved	Y	MCHP Reserved
6	BC_INT_N_WK	BC_LINK	Y	Interrupt from the BC_LINK Companion BC_INT# pin (see Note 9-2 on page 118).
[9:7]	Reserved	Reserved	N	Reserved
10	ADC_SNGL	ADC_Single_Int	N	Interrupt signal from ADC controller to EC for Single-Sample ADC conversion
11	ADC_RPT	ADC_Repeat_Int	N	Interrupt signal from ADC controller to EC for Repeated ADC conversion
12	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
13	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
14	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
15	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
16	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
17	MCHP Reserved	MCHP Reserved	N	MCHP Reserved
18	RTC	RTC	Y	RTC Interrupt
19	RTC ALARM	RTC ALARM	Y	RTC Alarm Interrupt
20	HTIMER	HTIMER	Y	Signal indicating that the hibernation timer is enabled and has expired.
21	KEYSCAN	KSC_INT	N	Keyboard Scan Interface runtime interrupt
22	KEYSCAN wake	KSC_INT_WAKE	Y	Keyboard Scan Interface wake interrupt
23	RPM_INT Stall	Fan Stall Status Interrupt	N	RPM-PWM Interface DRIVE_FAIL & FAN_SPIN indication

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TABLE 9-20: BIT DEFINITIONS FOR GIRQ17 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
24	RPM_INT Spin	Fan Fail/Spin Status Interrupt	N	RPM-PWM Interface SPIN indication
25	PFR_Status	PFR_Status	N	Power-Fail and Reset Status Register events (VBAT POR and WDT).
26	PWM_WDT[0]	PWM_WDT	N	PWM watchdog time out interrupt from Blinking/Breathing PWM block
27	PWM_WDT[1]	PWM_WDT	N	PWM watchdog time out interrupt from Blinking/Breathing PWM block
28	PWM_WDT[2]	PWM_WDT	N	PWM watchdog time out interrupt from Blinking/Breathing PWM block
29	BCM_ERR	BCM_INT Err	N	BC_LINK Master Error Flag Interrupt
30	BCM_BUSY_CLR	BCM_INT Busy	N	BC_LINK Master Busy Clear Flag Interrupt
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.11 GIRQ18

TABLE 9-21: BIT DEFINITIONS FOR GIRQ18 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
0	SPI0 TX	TXBE_STS	N	SPI controller 0 Interrupt output to EC driven by TXBE status bit
1	SPI0 RX	RXBF_STS	N	SPI controller 0 Interrupt output to EC driven by RXBE status bit
2	SPI1 TX	TXBE_STS	N	SPI controller 1 Interrupt output to EC driven by TXBE status bit
3	SPI1 RX	RXBF_STS	N	SPI controller 1 Interrupt output to EC driven by RXBE status bit
4	PWM_WDT[3]	PWM_WDT	N	PWM watchdog time out interrupt from Blinking/Breathing PWM block
5	PKE ERROR	PKE ERROR	N	PKE core error detected
6	PKE END	PKE END	N	PKE core finished processing data
7	RNG	RNG	N	Interrupt from RNG block
8	AES	AES	N	Interrupt from AES block
9	HASH	HASH	N	Interrupt from HASH block
[30:10]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.12 GIRQ19

TABLE 9-22: BIT DEFINITIONS FOR GIRQ19 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
0	VCC_PWRGD	VCC_PWRGD	Y	VCC_PWRGD interrupt from pin (see Note 9-2 on page 118).
1	LRESET#	LRESET#	Y	LRESET# interrupt from pin (see Note 9-2 on page 118).
[30:2]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.13 GIRQ20

TABLE 9-23: BIT DEFINITIONS FOR GIRQ20 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[4:0]	GPIO[204:200]	GPIO_Event	Y	Bits[0:4] are controlled by the GPIO_Events generated by GPIO200 through GPIO204, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
5	Reserved	Reserved	N	Reserved
6	GPIO206	GPIO_Event	Y	Bit 6 is controlled by the GPIO_Events generated by GPIO206. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
7	Reserved	Reserved	N	Reserved
[9:8]	GPIO[211:210]	GPIO_Event	Y	Bits[8:9] are controlled by the GPIO_Events generated by GPIO210 through GPIO211, respectively. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function.
[11:10]	MCHP Reserved	MCHP Reserved	N/A	MCHP Reserved
[30:12]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

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9.9.14 GIRQ21

TABLE 9-24: BIT DEFINITIONS FOR GIRQ21 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[1:0]	MCHP Reserved	n/a	n/a	n/a
[30:2]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.15 GIRQ22

TABLE 9-25: BIT DEFINITIONS FOR GIRQ22 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
[30:0]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

9.9.16 GIRQ23

TABLE 9-26: BIT DEFINITIONS FOR GIRQ23 SOURCE, ENABLE, AND RESULT REGISTERS

Bit	Block Instance Name	Source Name	Wake	Source Description
0	16-bit Timer_0	TIMER_32_x	N	This interrupt event fires when a 32-bit timer x reaches its limit. This event is sourced by the tEVENT_INTERRUPT status bit if enabled.
1	16-bit Timer_1	TIMER_32_x	N	This interrupt event fires when a 32-bit timer x reaches its limit. This event is sourced by the tEVENT_INTERRUPT status bit if enabled.
2	16-bit Timer_2	TIMER_32_x	N	This interrupt event fires when a 32-bit timer x reaches its limit. This event is sourced by the tEVENT_INTERRUPT status bit if enabled.
3	16-bit Timer_3	TIMER_32_x	N	This interrupt event fires when a 32-bit timer x reaches its limit. This event is sourced by the tEVENT_INTERRUPT status bit if enabled.
4	32-bit Timer_0	TIMER_32_x	N	This interrupt event fires when a 32-bit timer x reaches its limit. This event is sourced by the tEVENT_INTERRUPT status bit if enabled.
5	32-bit Timer_1	TIMER_32_x	N	This interrupt event fires when a 32-bit timer x reaches its limit. This event is sourced by the tEVENT_INTERRUPT status bit if enabled.
[30:6]	Reserved	Reserved	N	Reserved
31	n/a	n/a	N	See Table 9-7, "GIRQx Source Register", Table 9-8, "GIRQx Enable Set Register", Table 9-10, "GIRQx Enable Clear Register", and Table 9-9, "GIRQx Result Register" for a definition of this bit for the Source, Enable, and Result registers.

Note 9-2 All wakeup interrupts associated with pins must be configured as falling edge interrupts through the associated GPIO control register.

9.9.17 BLOCK ENABLE SET REGISTER

Offset	200h					32-bit	**Size**	
POWER	VCC1					0000_0000h	VCC1_RESET **Default**	
BIT	**D31**	**D30**	**D29**	**D28**	**D27**	**D26**	**D25**	**D24**
TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved							
BIT	**D23**	**D22**	**D21**	**D20**	**D19**	**D18**	**D17**	**D16**
TYPE	R/WS	R/WS	R/WS	R/WS	R/WS	R/WS	R/WS	R/WS
BIT NAME	IRQ Vector Enable Set [23:16]							
BIT	**D15**	**D14**	**D13**	**D12**	**D11**	**D10**	**D9**	**D8**
TYPE	R/WS	R/WS	R/WS	R/WS	R/WS	R/WS	R/WS	R/WS
BIT NAME	IRQ Vector Enable Set [15:8]							
BIT	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved							

IRQ Vector Enable Set [31:0]

Each IRQ Vector can be individually enabled to assert an interrupt event to the EC.

0= Writing a zero has no effect.

1= Writing a one will enable respective IRQ*i*.

Reading always returns the current value of the IRQ i VECTOR ENABLE bit. The state of the IRQ i VECTOR ENABLE bit is determined by the corresponding IRQ i Vector Enable Set bit and the IRQ i Vector Enable Clear bit. (0=disabled, 1-enabled).

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9.9.18 BLOCK ENABLE CLEAR REGISTER

Offset	204h					32-bit	Size	
POWER	VCC1					0000_0000h	VCC1_RESET Default	
BIT	D31	D30	D29	D28	D27	D26	D25	D24
TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved							
BIT	D23	D22	D21	D20	D19	D18	D17	D16
TYPE	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC
BIT NAME	IRQ Vector Enable Clear [23:16]							
BIT	D15	D14	D13	D12	D11	D10	D9	D8
TYPE	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC	R/WC
BIT NAME	IRQ Vector Enable Clear [15:8]							
BIT	D7	D6	D5	D4	D3	D2	D1	D0
TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved							

IRQ Vector Enable Clear[31:0]

Each IRQ Vector can be individually disabled to assert an interrupt event to the EC.

0= Writing a zero has no effect.

1= Writing a one will disable respective IRQ*i* vector.

Reading always returns the current value of the IRQ i VECTOR ENABLE bit. The state of the IRQ i VECTOR ENABLE bit is determined by the corresponding IRQ i Vector Enable Set bit and the IRQ i Vector Enable Clear bit. (0=disabled, 1-enabled).

9.9.19 BLOCK IRQ VECTOR REGISTER

Offset	208h					32-bit	Size	
POWER	VCC1					0000_0000h	VCC1_RESET Default	
BIT	D31	D30	D29	D28	D27	D26	D25	D24
TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved							
BIT	D23	D22	D21	D20	D19	D18	D17	D16
TYPE	R	R	R	R	R	R	R	R
BIT NAME	IRQ Vector [23:16]							
BIT	D15	D14	D13	D12	D11	D10	D9	D8
TYPE	R	R	R	R	R	R	R	R
BIT NAME	IRQ Vector [15:8]							
BIT	D7	D6	D5	D4	D3	D2	D1	D0
TYPE	R	R	R	R	R	R	R	R
BIT NAME	Reserved							

IRQ Vector [31:0]

Each read only bit reflects the current state of the IRQ *i* vector to the EC.

Note:	If the IRQ *i* vector is disabled via the Block Enable Clear Register the corresponding IRQ *i* vector to the EC is forced to 0. If the IRQ *i* vector is enabled, the corresponding IRQ *i* vector to the EC represents the current status of the IRQ event.

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10.0 WATCHDOG TIMER (WDT)

10.1 Introduction

The function of the Watchdog Timer is to provide a mechanism to detect if the internal embedded controller has failed.

When enabled, the Watchdog Timer (WDT) circuit will generate a WDT Event if the user program fails to reload the WDT within a specified length of time known as the WDT Interval.

10.2 References

No references have been cited for this chapter.

10.3 Terminology

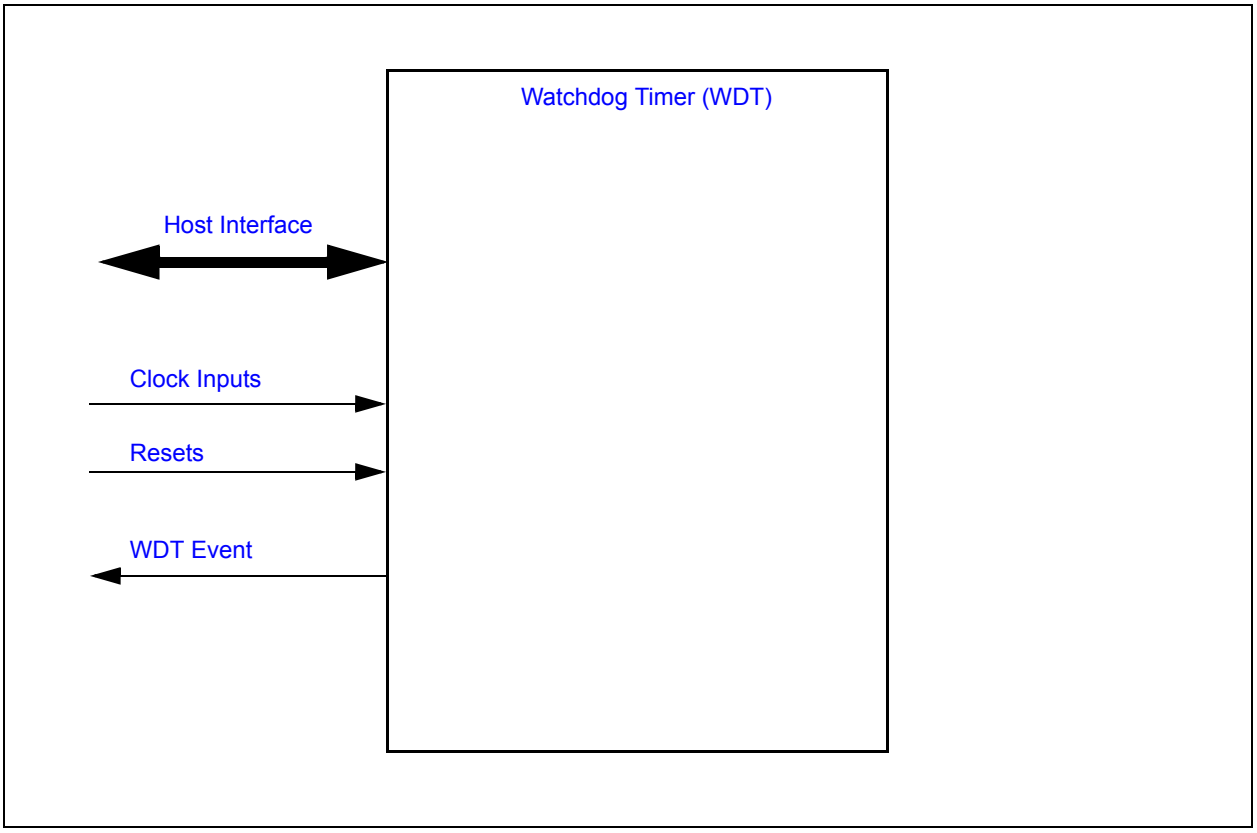
There is no terminology defined for this chapter.

10.4 Interface

This block is designed to be accessed internally via a registered host interface or externally via the signal interface.

10.5 Host Interface

FIGURE 10-1: I/O DIAGRAM OF BLOCK



The registers defined for the Watchdog Timer (WDT) are accessible by the embedded controller as indicated in Section 10.8, "EC-Only Registers". All registers accesses are synchronized to the host clock and complete immediately. Register reads/writes are not delayed by the 32KHz_Clk.

10.6 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

10.6.1 POWER DOMAINS

TABLE 10-1: POWER SOURCES

Name	Description
VCC1	The logic and registers implemented in this block reside on this single power well.

10.6.2 CLOCK INPUTS

TABLE 10-2: CLOCK INPUTS

Name	Description
32KHz_Clk	The 32KHz_Clk clock input is the clock source to the Watchdog Timer functional logic, including the counter.

10.6.3 RESETS

TABLE 10-3: RESET SIGNALS

Name	Description
VCC1_RESET	Power on Reset to the block. This signal resets all the register and logic in this block to its default state.

TABLE 10-4: RESET OUTPUT EVENT

Source	Description
WDT Event	Pulse generated when WDT expires. This signal is used to reset the embedded controller and its subsystem. The event is cleared after an VCC1_RESET.

10.7 Description

10.7.1 WDT OPERATION

10.7.1.1 WDT Activation Mechanism

The WDT is activated by the following sequence of operations during normal operation:

1. Load the WDT Load Register with the count value.
2. Set the WDT Enable bit in the WDT Control Register.

The WDT Activation Mechanism starts the WDT decrementing counter.

10.7.1.2 WDT Deactivation Mechanism

The WDT is deactivated by the clearing the WDT Enable bit in the WDT Control Register. The WDT Deactivation Mechanism places the WDT in a low power state in which clock are gated and the counter stops decrementing.

10.7.1.3 WDT Reload Mechanism

The WDT must be reloaded within periods that are shorter than the programmed watchdog interval; otherwise, the WDT will underflow and a WDT Event will be generated and the WDT Status bit will be set in the WDT Control Register. It is the responsibility of the user program to continually execute code which reloads the watchdog timer, causing the counter to be reloaded

There are three methods of reloading the WDT: a write to the WDT Load Register, a write to the WDT Kick Register, or WDT event.

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10.7.1.4 WDT Interval

The WDT Interval is the time it takes for the WDT to decrements from the WDT Load Register value to 0000h. The WDT Count Register value takes 33/32KHz_Clk seconds (ex. 33/32.768 KHz = 1.007ms) to decrement by 1 count.

10.8 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the Watchdog Timer (WDT). The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 10-5: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
WDT	0	EC	32-bit internal address space	4000_0400h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 10-6: EC-ONLY REGISTER SUMMARY

Offset	Register Name (Mnemonic)
00h	WDT Load Register
04h	WDT Control Register
08h	WDT Kick Register
0Ch	WDT Count Register

10.8.1 WDT LOAD REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:0	WDT Load Writing this field reloads the Watch Dog Timer counter.	R/W	Fh	VCC1_RESET

10.8.2 WDT CONTROL REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:2	RESERVED	R	-	-
1	WDT Status WDT_RST is set by hardware if the last reset of CEC1302 was caused by an underflow of the WDT. See Section 10.7.1.3, "WDT Reload Mechanism," on page 122 for more information. This bit must be cleared by the EC firmware writing a ‘1’ to this bit. Writing a ‘0’ to this bit has no effect.	R/WC	0b	VCC1_RESET

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
0	WDT Enable In WDT Operation, the WDT is activated by the sequence of operations defined in Section 10.7.1.1, "WDT Activation Mechanism" and deactivated by the sequence of operations defined in Section 10.7.1.2, "WDT Deactivation Mechanism". 0 = block disabled 1 = block enabled **Note:** The default of the WDT is inactive.	R/W	0b	VCC1_RESET

10.8.3 WDT KICK REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	Kick The WDT Kick Register is a strobe. Reads of the WDT Kick Register return 0. Writes to the WDT Kick Register cause the WDT to reload the WDT Load Register value and start decrementing when the WDT Enable bit in the WDT Control Register is set to '1'. When the WDT Enable bit in the WDT Control Register is cleared to '0', writes to the WDT Kick Register have no effect.	W	n/a	VCC1_RESET

10.8.4 WDT COUNT REGISTER

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:0	WDT Count This read-only register provide the current WDT count.	R	Fh	VCC1_RESET

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11.0 BASIC TIMER

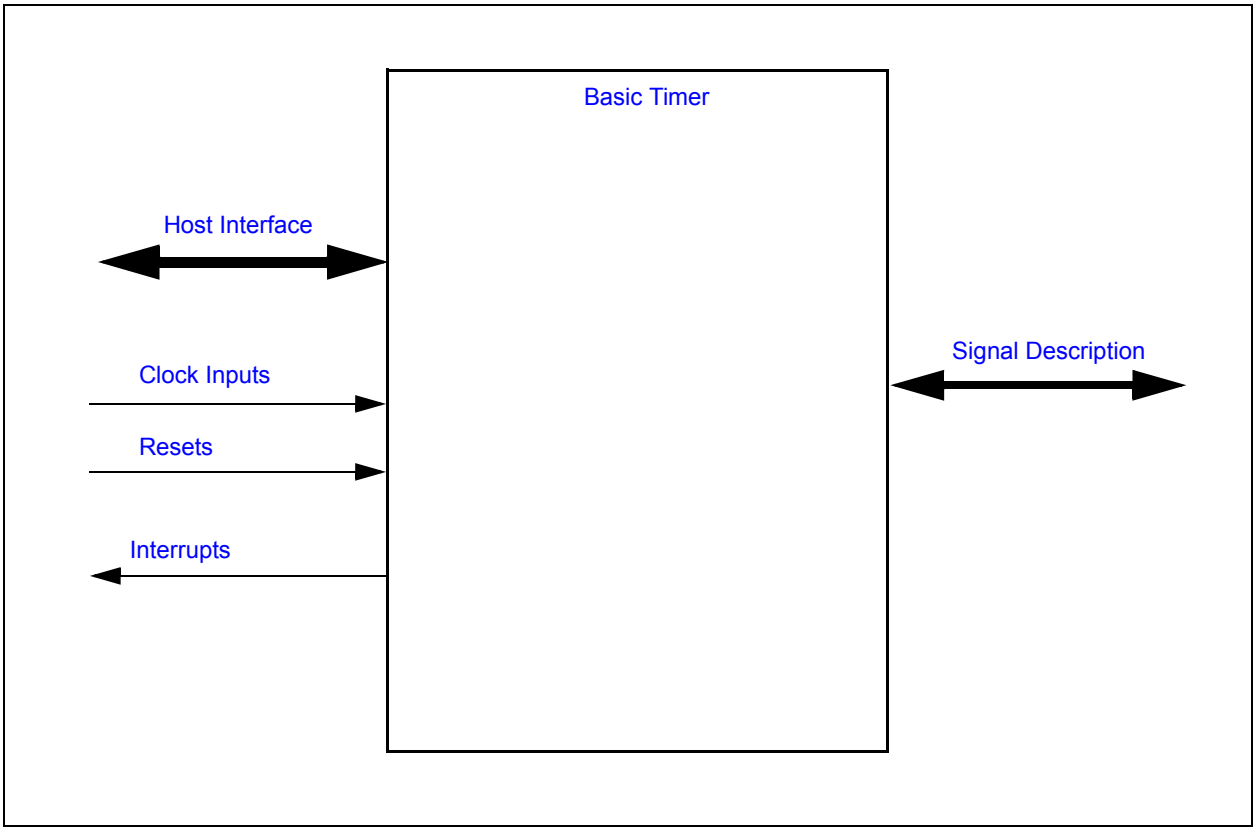
11.1 Introduction

This timer block offers a simple mechanism for firmware to maintain a time base. This timer may be instantiated as 16 bits or 32 bits. The name of the timer instance indicates the size of the timer.

11.2 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 11-1: I/O DIAGRAM OF BLOCK



11.3 Signal Description

There are no external signals for this block.

11.4 Host Interface

The embedded controller may access this block via the registers defined in Section 11.9, "EC-Only Registers," on page 127.

11.5 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

11.5.1 POWER DOMAINS

TABLE 11-1: POWER SOURCES

Name	Description
VCC1	The timer control logic and registers are all implemented on this single power domain.

11.5.2 CLOCK INPUTS

TABLE 11-2: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This is the clock source to the timer logic. The Pre-scaler may be used to adjust the minimum resolution per bit of the counter.

11.5.3 RESETS

TABLE 11-3: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal, which is an input to this block, resets all the logic and registers to their initial default state.
Soft Reset	This reset signal, which is created by this block, resets all the logic and registers to their initial default state. This reset is generated by the block when the **SOFT_RESET** bit is set in the Timer Control Register register.
Timer_Reset	This reset signal, which is created by this block, is asserted when either the VCC1_RESET or the Soft Reset signal is asserted. The VCC1_RESET and Soft Reset signals are OR'd together to create this signal.

11.6 Interrupts

TABLE 11-4: EC INTERRUPTS

Source	Description
TIMER_16_*x*	This interrupt event fires when a 16-bit timer *x* reaches its limit. This event is sourced by the EVENT_INTERRUPT status bit if enabled.
TIMER_32_*x*	This interrupt event fires when a 32-bit timer *x* reaches its limit. This event is sourced by the tEVENT_INTERRUPT status bit if enabled.

11.7 Low Power Modes

The Basic Timer may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry. This block is only be permitted to enter low power modes when the block is not active.

The sleep state of this timer is as follows:

- Asleep while the block is not Enabled
- Asleep while the block is not running (start inactive).
- Asleep while the block is halted (even if running).

The block is active while start is active.

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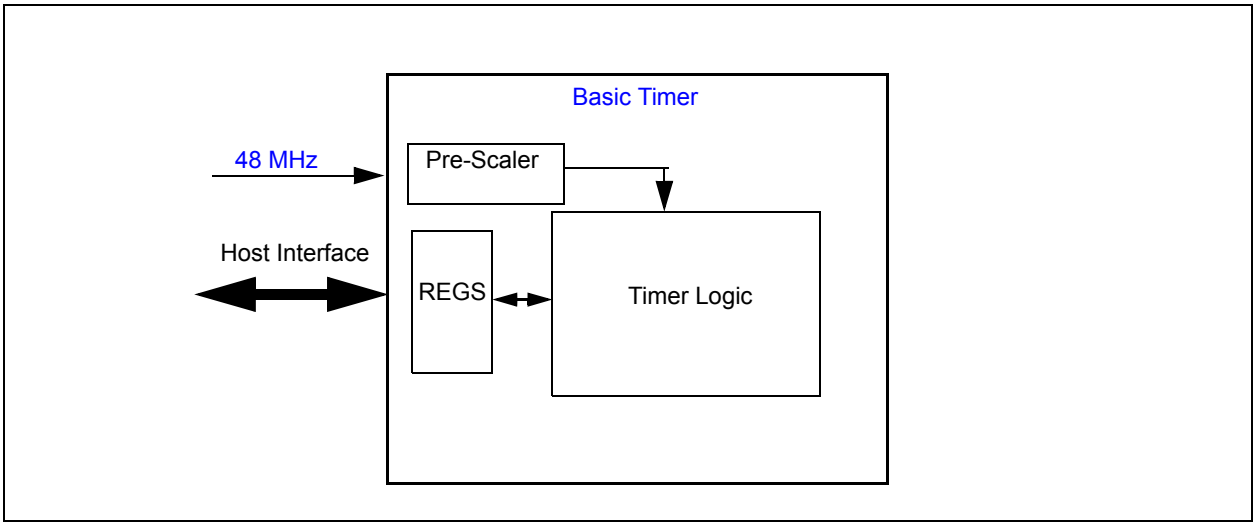
11.8 Description

FIGURE 11-2: BLOCK DIAGRAM



This timer block offers a simple mechanism for firmware to maintain a time base in the design. The timer may be enabled to execute the following features:

- Programmable resolution per LSB of the counter via the Pre-scale bits in the Timer Control Register
- Programmable as either an up or down counter
- One-shot or Continuous Modes
- In one-shot mode the Auto Restart feature stops the counter when it reaches its limit and generates a level event.
- In Continuous Mode the Auto Restart feature restarts that counter from the programmed preload value and generates a pulse event.
- Counter may be reloaded, halted, or started via the Timer Control register
- Block may be reset by either a Power On Reset (POR) or via a Soft Reset.

11.9 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the Basic Timer. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 11-5: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
TIMER16 (16-bit Timer)	0	EC	32-bit internal address space	4000_0C00h
TIMER16 (16-bit Timer)	1	EC	32-bit internal address space	4000_0C20h
TIMER16 (16-bit Timer)	2	EC	32-bit internal address space	4000_0C40h
TIMER16 (16-bit Timer)	3	EC	32-bit internal address space	4000_0C60h
TIMER32 (32-bit Timer)	0	EC	32-bit internal address space	4000_0C80h
TIMER32 (32-bit Timer)	1	EC	32-bit internal address space	4000_0CA0h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 11-6: RUNTIME REGISTER SUMMARY

Offset	Register Name
00h	Timer Count Register
04h	Timer Preload Register
08h	Timer Status Register
0Ch	Timer Int Enable Register
10h	Timer Control Register

11.9.1 TIMER COUNT REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	COUNTER This is the value of the Timer counter. This is updated by Hardware but may be set by Firmware. If it is set while the Hardware Timer is operating, functionality can not be maintained. When read, it is buffered so single byte reads will be able to catch the full 4 byte register without it changing. The size of the Counter is indicated by the instance name. Bits 0 to (size-1) are r/w counter bits. Bits 31 down to size are reserved. Reads return 0 and writes have no effect.	R/W	0h	Timer_Reset

11.9.2 TIMER PRELOAD REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	PRE_LOAD This is the value of the Timer pre-load for the counter. This is used by H/W when the counter is to be restarted automatically; this will become the new value of the counter upon restart. The size of the Pre-Load value is the same as the size of the counter. The size of the Counter is indicated by the instance name. Bits 0 to (size-1) are r/w pre-load bits. Bits 31 down to size are reserved. Reads return 0 and writes have no effect.	R/W	0h	Timer_Reset

11.9.3 TIMER STATUS REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	Reserved	R	-	-
0	EVENT_INTERRUPT This is the interrupt status that fires when the timer reaches its limit. This may be level or a self clearing signal cycle pulse, based on the AUTO_RESTART bit in the Timer Control Register. If the timer is set to automatically restart, it will provide a pulse, otherwise a level is provided.	R/WC	0h	Timer_Reset

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11.9.4 TIMER INT ENABLE REGISTER

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	Reserved	R	-	-
0	EVENT_INTERRUPT_ENABLE This is the interrupt enable for the status EVENT_INTERRUPT bit in the Timer Status Register	R/W	0h	Timer_Reset

11.9.5 TIMER CONTROL REGISTER

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	PRE_SCALE This is used to divide down the system clock through clock enables to lower the power consumption of the block and allow slow timers. Updating this value during operation may result in erroneous clock enable pulses until the clock divider restarts. The number of clocks per clock enable pulse is (Value + 1); a setting of 0 runs at the full clock speed, while a setting of 1 runs at half speed.	R/W	0h	Timer_Reset
15:8	Reserved	R	-	-
7	HALT This is a halt bit. This will halt the timer as long as it is active. Once the halt is inactive, the timer will start from where it left off. 1=Timer is halted. It stops counting. The clock divider will also be reset. 0=Timer runs normally	R/W	0h	Timer_Reset
6	RELOAD This bit reloads the counter without interrupting it operation. This will not function if the timer has already completed (when the START bit in this register is ‘0’). This is used to periodically prevent the timer from firing when an event occurs. Usage while the timer is off may result in erroneous behavior.	R/W	0h	Timer_Reset

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
5	START This bit triggers the timer counter. The counter will operate until it hits its terminating condition. This will clear this bit. It should be noted that when operating in restart mode, there is no terminating condition for the counter, so this bit will never clear. Clearing this bit will halt the timer counter. Setting this bit will: • Reset the clock divider counter. • Enable the clock divider counter. • Start the timer counter. • Clear all interrupts. Clearing this bit will: • Disable the clock divider counter. • Stop the timer counter.	R/W	0h	Timer_Reset
4	SOFT_RESET This is a soft reset. This is self clearing 1 cycle after it is written.	WO	0h	Timer_Reset
3	AUTO_RESTART This will select the action taken upon completing a count. 1=The counter will automatically restart the count, using the contents of the Timer Preload Register to load the Timer Count Register The interrupt will be set in edge mode 0=The counter will simply enter a done state and wait for further control inputs. The interrupt will be set in level mode.	R/W	0h	Timer_Reset
2	COUNT_UP This selects the counter direction. When the counter in incrementing the counter will saturate and trigger the event when it reaches all F's. When the counter is decrementing the counter will saturate when it reaches 0h. 1=The counter will increment 0=The counter will decrement	R/W	0h	Timer_Reset
1	Reserved	R	-	-
0	ENABLE This enables the block for operation. 1=This block will function normally 0=This block will gate its clock and go into its lowest power state	R/W	0h	Timer_Reset

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12.0 HIBERNATION TIMER

12.1 Introduction

The Hibernation Timer can generate a wake event to the Embedded Controller (EC) when it is in a hibernation mode. This block supports wake events up to 2 hours in duration. The timer is a 16-bit binary count-down timer that can be programmed in 30.5µs and 0.125 second increments for period ranges of 30.5µs to 2s or 0.125s to 136.5 minutes, respectively. Writing a non-zero value to this register starts the counter from that value. A wake-up interrupt is generated when the count reaches zero.

12.2 References

No references have been cited for this chapter

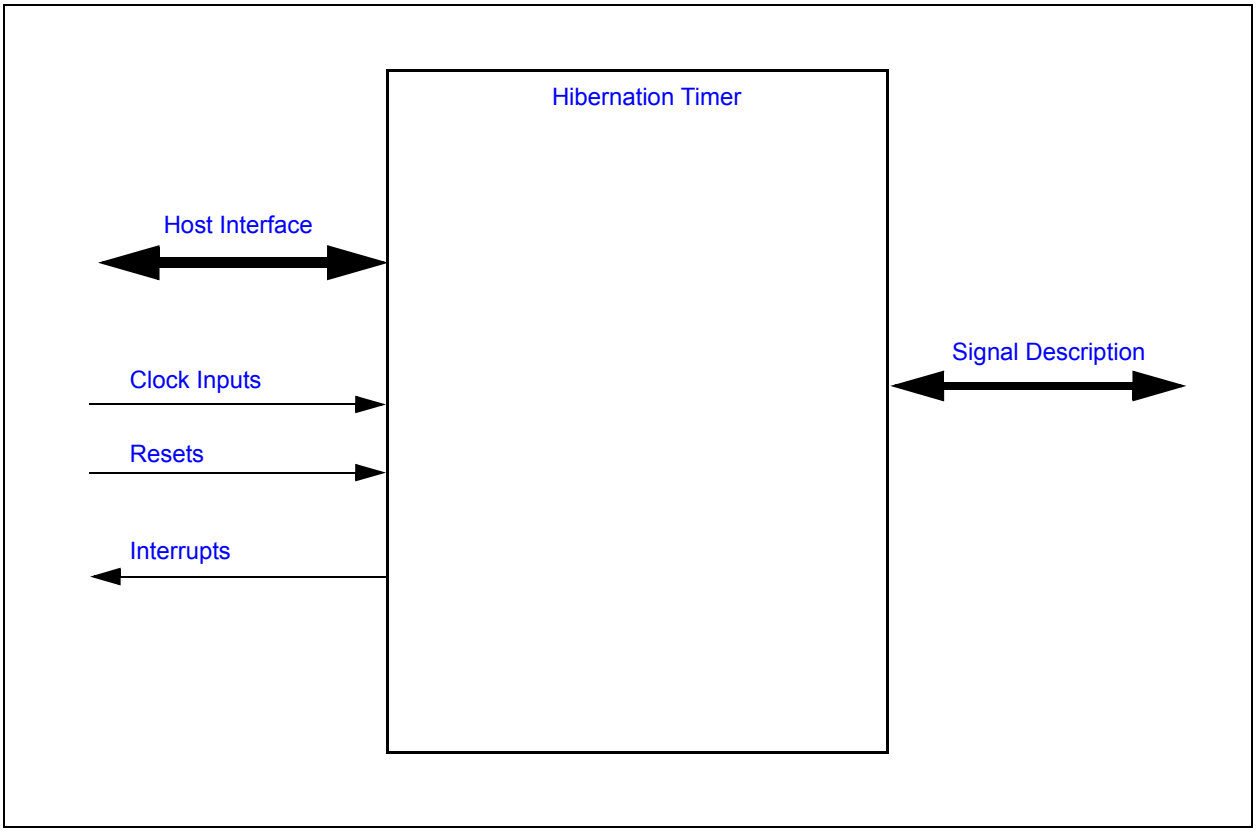
12.3 Terminology

No terms have been cited for this chapter.

12.4 Interface

This block is an IP block designed to be incorporated into a chip. It is designed to be accessed externally via the pin interface and internally via a registered host interface. The following diagram illustrates the various interfaces to the block.

FIGURE 12-1: HIBERNATION TIMER INTERFACE DIAGRAM



12.5 Signal Description

There are no external signals for this block.

12.6 Host Interface

The registers defined for the Hibernation Timer are accessible by the various hosts as indicated in Section 12.10, "EC-Only Registers".

12.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

12.7.1 POWER DOMAINS

TABLE 12-1: POWER SOURCES

Name	Description
VCC1	The timer control logic and registers are all implemented on this single power domain.

12.7.2 CLOCK INPUTS

TABLE 12-2: CLOCK INPUTS

Name	Description
32KHz_Clk	This is the clock source to the timer logic. The Pre-scaler may be used to adjust the minimum resolution per bit of the counter. if the main oscillator is stopped then an external 32.768kHz clock source must be active for the Hibernation Timer to continue to operate.

12.7.3 RESETS

TABLE 12-3: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal, which is an input to this block, resets all the logic and registers to their initial default state.

12.8 Interrupts

This section defines the interrupt Interface signals routed to the chip interrupt aggregator.

Each instance of the Hibernation Timer in the CEC1302 can be used to generate interrupts and wake-up events when the timer decrements to zero. The Hibernation Timer interrupt is are routed to the HTIMER bit in the GIRQ17 Source Register.

TABLE 12-4: INTERRUPT INTERFACE SIGNAL DESCRIPTION TABLE

Name	Direction	Description
HTIMER	Output	Signal indicating that the timer is enabled and decrements to 0. This signal is used to generate an Hibernation Timer interrupt event.

12.9 Low Power Modes

The Hibernation Timer may be put into a low power state by the chip Power, Clocks, and Reset (PCR) circuitry.

The timer operates off of the 32KHz_Clk, and therefore will operate normally when 48 MHz Ring Oscillator is stopped.

The sleep enable inputs have no effect on the Hibernation Timer and the clock required outputs are only asserted during register read/write cycles for as long as necessary to propagate updates to the block core.

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12.10 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the Hibernation Timer. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 12-5: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
Hibernation Timer	0	EC	32-bit internal address space	4000_9800h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 12-6: HIBERNATION TIMER SUMMARY

Offset	Register Name
00h	HTimer Preload Register
04h	HTimer Control Register
08h	HTimer Count Register

12.10.1 HTIMER PRELOAD REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:0	HT_PRELOAD This register is used to set the Hibernation Timer Preload value. Writing this register to a non-zero value resets the down counter to start counting down from this programmed value. Writing this register to 0000h disables the hibernation counter. The resolution of this timer is determined by the CTRL bit in the HTimer Control Register. Writes to the HTimer Control Register are completed with an EC bus cycle.	R/W	000h	VCC1_RESET

12.10.2 HTIMER CONTROL REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:1	Reserved	R	-	-
0	CTRL 1= The Hibernation Timer has a resolution of 0.125s per LSB, which yields a maximum time in excess of 2 hours. 0= The Hibernation Timer has a resolution of 30.5µs per LSB, which yields a maximum time of ~2seconds.	R	0000h	VCC1_RESET

12.10.3 HTIMER COUNT REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:0	COUNT The current state of the Hibernation Timer.	R	0000h	VCC1_RESET

13.0 RTC WITH DATE AND DST ADJUSTMENT

13.1 Introduction

This block provides the capabilities of an industry-standard 146818B Real-Time Clock module, without CMOS RAM. Enhancements to this architecture include:

- Industry standard Day of Month Alarm field, allowing for monthly alarms
- Configurable, automatic Daylight Savings adjustment
- Week Alarm for periodic interrupts and wakes based on Day of Week
- System Wake capability on interrupts.

13.2 References

1. Motorola 146818B Data Sheet, available on-line
2. Intel Lynx Point PCH EDS specification

13.3 Terminology

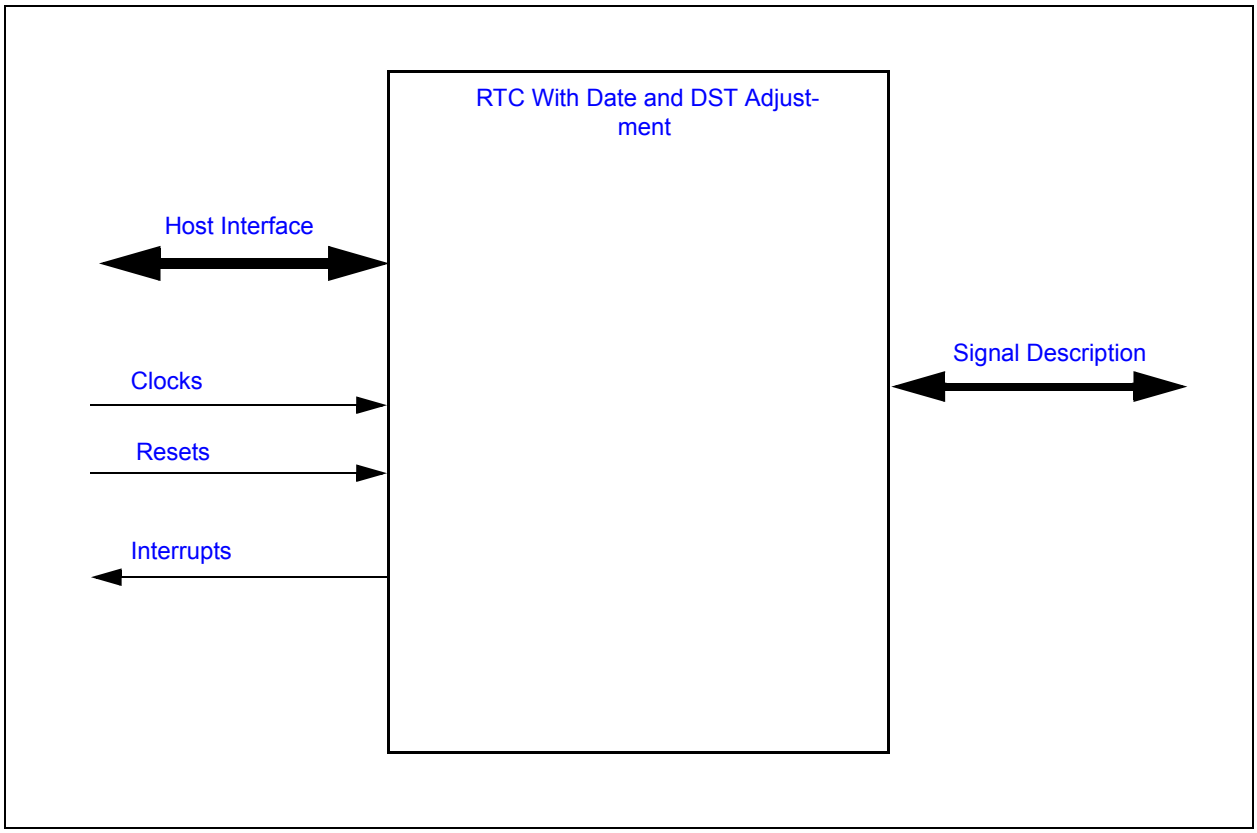
Time and Date Registers:

This is the set of registers that are automatically counted by hardware every 1 second while the block is enabled to run and to update. These registers are: **Seconds**, **Minutes**, **Hours**, **Day of Week**, **Day of Month**, **Month**, and **Year**.

13.4 Interface

This block's connections are entirely internal to the chip.

FIGURE 13-1: I/O DIAGRAM OF BLOCK



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13.5 Signal Description

There are no external signals.

13.6 Host Interface

The registers defined for the RTC With Date and DST Adjustment are accessible by the host and EC.

13.7 Power, Clocks and Resets

This section defines the Power, Clock, and Reset parameters of the block.

13.7.1 POWER DOMAINS

TABLE 13-1: POWER SOURCES

Name	Description
VBAT	This power well sources all of the internal registers and logic in this block.
VCC1	This power well sources only bus communication. The block continues to operate internally while this rail is down.

13.7.2 CLOCKS

TABLE 13-2: CLOCKS

Name	Description
32KHz_Clk	This 32KHz clock input drives all internal logic, and will be present at all times that the VBAT well is powered.

13.7.3 RESETS

TABLE 13-3: RESET SIGNALS

Name	Description
VBAT_POR	This reset signal is used in the RTC_RST signal to reset all of the registers and logic in this block. It directly resets the Soft Reset bit in the RTC Control Register.
RTC_RST	This reset signal resets all of the registers and logic in this block, except for the Soft Reset bit in the RTC Control Register. It is triggered by VBAT_POR, but can also be triggered by a Soft Reset from the RTC Control Register.
VCC1_RESET	This reset signal is used to inhibit the bus communication logic, and isolates this block from VCC1 powered circuitry on-chip. Otherwise it has no effect on the internal state.

13.8 Interrupts

TABLE 13-4: SYSTEM INTERRUPTS

Source	Description
RTC	This interrupt source for the SIRQ logic is generated when any of the following events occur: • Update complete. This is triggered, at 1-second intervals, when the Time register updates have completed • Alarm. This is triggered when the alarm value matches the current time (and date, if used) • Periodic. This is triggered at the chosen programmable rate

TABLE 13-5: EC INTERRUPTS

Source	Description
RTC	This interrupt is signaled to the Interrupt Aggregator when any of the following events occur: • Update complete. This is triggered, at 1-second intervals, when the Time register updates have completed • Alarm. This is triggered when the alarm value matches the current time (and date, if used) • Periodic. This is triggered at the chosen programmable rate
RTC ALARM	This wake interrupt is signaled to the Interrupt Aggregator when an Alarm event occurs.

13.9 Low Power Modes

The RTC has no low-power modes. It runs continuously while the VBAT well is powered.

13.10 Description

This block provides the capabilities of an industry-standard 146818B Real-Time Clock module, excluding the CMOS RAM and the SQW output. See the following registers, which represent enhancements to this architecture. These enhancements are listed below.

See the Date Alarm field of Register D for a Day of Month qualifier for alarms.

See the Week Alarm Register for a Day of Week qualifier for alarms.

See the registers Daylight Savings Forward Register and Daylight Savings Backward Register for setting up hands-off Daylight Savings adjustments.

See the RTC Control Register for enhanced control over the block's operations.

13.11 Runtime Registers

The addresses of each register listed in this table are defined as a relative offset to the host "Base Address" defined in Runtime Register Base Address Table.

TABLE 13-6: RUNTIME REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
RTC	0	EC	32-bit internal Address Space	400F_2C00h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance. Add the register's Offset to this value to obtain the direct address of the register.

TABLE 13-7: RUNTIME REGISTER SUMMARY

Offset	Register Name (Mnemonic)
00h	Seconds Register
01h	Seconds Alarm Register
02h	Minutes Register
03h	Minutes Alarm Register
04h	Hours Register
05h	Hours Alarm Register
06h	Day of Week Register
07h	Day of Month Register
08h	Month Register
09h	Year Register

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TABLE 13-7: RUNTIME REGISTER SUMMARY (CONTINUED)

Offset	Register Name (Mnemonic)
0Ah	Register A
0Bh	Register B
0Ch	Register C
0Dh	Register D
0Eh	(reserved)
0Fh	(reserved)
10h	RTC Control Register
14h	Week Alarm Register
18h	Daylight Savings Forward Register
1Ch	Daylight Savings Backward Register
20h	MCHP Reserved

Note: This extended register set occupies offsets that have historically been used as CMOS RAM. Code ported to use this block should be examined to ensure that it does not assume that RAM exists in this block.

13.11.1 SECONDS REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	SECONDS Displays the number of seconds past the current minute, in the range 0--59. Presentation may be selected as binary or BCD, depending on the DM bit in Register B. Values written must also use the format defined by the current setting of the DM bit.	R/W	00h	RTC_RST

13.11.2 SECONDS ALARM REGISTER

Offset	01h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	SECONDS_ALARM Holds a match value, compared against the Seconds Register to trigger the Alarm event. Values written to this register must use the format defined by the current setting of the DM bit in Register B. A value of 11xxxxxxb written to this register makes it don't-care (always matching).	R/W	00h	RTC_RST

13.11.3 MINUTES REGISTER

Offset	02h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	MINUTES Displays the number of minutes past the current hour, in the range 0--59. Presentation may be selected as binary or BCD, depending on the DM bit in Register B. Values written must also use the format defined by the current setting of the DM bit.	R/W	00h	RTC_RST

13.11.4 MINUTES ALARM REGISTER

Offset	03h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	MINUTES_ALARM Holds a match value, compared against the Minutes Register to trigger the Alarm event. Values written to this register must use the format defined by the current setting of the DM bit in Register B. A value of 11xxxxxxb written to this register makes it don't-care (always matching).	R/W	00h	RTC_RST

13.11.5 HOURS REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	HOURS_AM_PM In 12-hour mode (see bit "24/12" in register B), this bit indicates AM or PM. 1=PM 0=AM	R/W	0b	RTC_RST
6:0	HOURS Displays the number of the hour, in the range 1--12 for 12-hour mode (see bit "24/12" in register B), or in the range 0--23 for 24-hour mode. Presentation may be selected as binary or BCD, depending on the DM bit in Register B. Values written must also use the format defined by the current setting of the DM bit.	R/W	00h	RTC_RST

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13.11.6 HOURS ALARM REGISTER

Offset	05h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	HOURS_ALARM Holds a match value, compared against the Hours Register to trigger the Alarm event. Values written to this register must use the format defined by the current settings of the DM bit and the 24/12 bit in Register B. A value of 11xxxxxxb written to this register makes it don't-care (always matching).	R/W	00h	RTC_RST

13.11.7 DAY OF WEEK REGISTER

Offset	06h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	DAY_OF_WEEK Displays the day of the week, in the range 1 (Sunday) through 7 (Saturday). Numbers in this range are identical in both binary and BCD notation, so this register's format is unaffected by the DM bit.	R/W	00h	RTC_RST

13.11.8 DAY OF MONTH REGISTER

Offset	07h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	DAY_OF_MONTH Displays the day of the current month, in the range 1--31. Presentation may be selected as binary or BCD, depending on the DM bit in Register B. Values written must also use the format defined by the current setting of the DM bit.	R/W	00h	RTC_RST

13.11.9 MONTH REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	MONTH Displays the month, in the range 1--12. Presentation may be selected as binary or BCD, depending on the DM bit in Register B. Values written must also use the format defined by the current setting of the DM bit.	R/W	00h	RTC_RST

13.11.10 YEAR REGISTER

Offset	09h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	YEAR Displays the number of the year in the current century, in the range 0 (year 2000) through 99 (year 2099). Presentation may be selected as binary or BCD, depending on the DM bit in Register B. Values written must also use the format defined by the current setting of the DM bit.	R/W	00h	RTC_RST

13.11.11 REGISTER A

Offset	0Ah			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	UPDATE_IN_PROGRESS '0' indicates that the Time and Date registers are stable and will not be altered by hardware soon. '1' indicates that a hardware update of the Time and Date registers may be in progress, and those registers should not be accessed by the host program. This bit is set to '1' at a point 488us (16 cycles of the 32K clock) before the update occurs, and is cleared immediately after the update. See also the Update-Ended Interrupt, which provides more useful status.	R	0b	RTC_RST
6:4	DIVISION_CHAIN_SELECT This field provides general control for the Time and Date register updating logic. 11xb=Halt counting. The next time that 010b is written, updates will begin 500ms later. 010b=Required setting for normal operation. It is also necessary to set the Block Enable bit in the RTC Control Register to '1' for counting to begin 000b=Reserved. This field should be initialized to another value before Enabling the block in the RTC Control Register Other values Reserved	R/W	000b	RTC_RST
3:0	RATE_SELECT This field selects the rate of the Periodic Interrupt source. See Table 13-8	R/W	0h	RTC_RST

TABLE 13-8: REGISTER A FIELD RS: PERIODIC INTERRUPT SETTINGS

RS (hex)	Interrupt Period
0	Never Triggered
1	3.90625 ms
2	7.8125 ms
3	122.070 us
4	244.141 us
5	488.281 us
6	976.5625 us

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TABLE 13-8: REGISTER A FIELD RS: PERIODIC INTERRUPT SETTINGS (CONTINUED)

RS (hex)	Interrupt Period
7	1.953125 ms
8	3.90625 ms
9	7.8125 ms
A	15.625 ms
B	31.25 ms
C	62.5 ms
D	125 ms
E	250 ms
F	500 ms

13.11.12 REGISTER B

Offset	0Bh			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	UPDATE_CYCLE_INHIBIT In its default state '0', this bit allows hardware updates to the Time and Date registers, which occur at 1-second intervals. A '1' written to this field inhibits updates, allowing these registers to be cleanly written to different values. Writing '0' to this bit allows updates to continue.	R/W	0b	RTC_RST
6	PERIODIC_INTERRUPT_ENABLE 1=Alows the Periodic Interrupt events to be propagated as interrupts 0=Periodic events are not propagates as interrupts	R/W	0b	RTC_RST
5	ALARM_INTERRUPT_ENABLE 1=Alows the Alarm Interrupt events to be propagated as interrupts 0=Alarm events are not propagates as interrupts	R/W	0b	RTC_RST
4	UPDATE_ENDED_INTERRUPT_ENABLE 1=Alows the Update Ended Interrupt events to be propagated as interrupts 0=Update Ended events are not propagates as interrupts	R/W	0b	RTC_RST
3	Reserved	R	-	-
2	DATA_MODE 1=Binary Mode for Dates and Times 0=BCD Mode for Dates and Times	R/W	0b	RTC_RST
1	HOUR_FORMAT_24_12 1=24-Hour Format for Hours and Hours Alarm registers. 24-Hour format keeps the AM/PM bit off, with value range 0--23 0=12-Hour Format for Hours and Hours Alarm registers. 12-Hour format has an AM/PM bit, and value range 1--12	R/W	0b	RTC_RST

Offset	0Bh			
Bits	**Description**	**Type**	**Default**	**Reset Event**
0	DAYLIGHT_SAVINGS_ENABLE 1=Enables automatic hardware updating of the hour, using the registers Daylight Savings Forward and Daylight Savings Backward to select the yearly date and hour for each update 0=Automatic Daylight Savings updates disabled	R/W	0b	RTC_RST

Note: The DATA_MODE and HOUR_FORMAT_24_12 bits affect only how values are presented as they are being read and how they are interpreted as they are being written. They do not affect the internal contents or interpretations of registers that have already been written, nor do they affect how those registers are represented or counted internally. This mode bits may be set and cleared dynamically, for whatever I/O data representation is desired by the host program.

13.11.13 REGISTER C

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	INTERRUPT_REQUEST_FLAG 1=Any of bits[6:4] below is active after masking by their respective Enable bits in Register B. 0=No bits in this register are active This bit is automatically cleared by every Read access to this register.	RC	0b	RTC_RST
6	PERIODIC_INTERRUPT_FLAG 1=A Periodic Interrupt event has occurred since the last time this register was read. This bit displays status regardless of the Periodic Interrupt Enable bit in Register B 0=A Periodic Interrupt event has not occurred This bit is automatically cleared by every Read access to this register.	RC	0b	RTC_RST
5	ALARM_FLAG 1=An Alarm event has occurred since the last time this register was read. This bit displays status regardless of the Alarm Interrupt Enable bit in Register B. 0=An Alarm event has not occurred This bit is automatically cleared by every Read access to this register.	RC	0b	RTC_RST

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Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
4	UPDATE_ENDED_INTERRUPT_FLAG 1=A Time and Date update has completed since the last time this register was read. This bit displays status regardless of the Update-Ended Interrupt Enable bit in Register B. Presentation of this status indicates that the Time and Date registers will be valid and stable for over 999ms 0=A Time and Data update has not completed since the last time this register was read This bit is automatically cleared by every Read access to this register.	RC	0b	RTC_RST
3:0	Reserved	R	-	-

13.11.14 REGISTER D

Offset	0Dh			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:6	Reserved	R	-	-
5:0	DATE_ALARM This field, if set to a non-zero value, will inhibit the Alarm interrupt unless this field matches the contents of the Month register also. If this field contains 00h (default), it represents a don't-care, allowing more frequent alarms.	R/W	00h	RTC_RST

13.11.15 RTC CONTROL REGISTER

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:4	Reserved	R	-	-
3	ALARM_ENABLE 1=Enables the Alarm features 0=Disables the Alarm features	R/W	0b	RTC_RST
2	Microchip Reserved	R/W	0b	RTC_RST
1	SOFT_RESET A '1' written to this bit position will trigger the RTC_RST reset, resetting the block and all registers except this one and the Test Register. This bit is self-clearing at the end of the reset.	R/W	0b	VBAT_POR
0	BLOCK_ENABLE This bit must be '1' in order for the block to function internally. Registers may be initialized first, before setting this bit to '1' to start operation.	R/W	0b	RTC_RST

13.11.16 WEEK ALARM REGISTER

Offset	14h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	ALARM_DAY_OF_WEEK This register, if written to a value in the range 1--7, will inhibit the Alarm interrupt unless this field matches the contents of the Day of Week Register also. If this field is written to any value 11xxxxxxb (like the default FFh), it represents a don't-care, allowing more frequent alarms, and will read back as FFh until another value is written.	R/W	FFh	RTC_RST

13.11.17 DAYLIGHT SAVINGS FORWARD REGISTER

Offset	18h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	DST_FORWARD_AM_PM This bit selects AM vs. PM, to match bit[7] of the Hours Register if 12-Hour mode is selected in Register B at the time of writing.	R/W	0b	RTC_RST
30:24	DST_FORWARD_HOUR This field holds the matching value for bits[6:0] of the Hours register. The written value will be interpreted according to the 24/12 Hour mode and DM mode settings at the time of writing.	R/W	00h	RTC_RST
23:19	Reserved	R	-	-
18:16	DST_FORWARD_WEEK This value matches an internally-maintained week number within the current month. Valid values for this field are: 5=Last week of month 4 =Fourth week of month 3=Third week of month 2=Second week of month 1=First week of month	R/W	0h	RTC_RST
15:11	Reserved	R	-	-
10:8	DST_FORWARD_DAY_OF_WEEK This field matches the Day of Week Register bits[2:0].	R/W	0h	RTC_RST
7:0	DST_FORWARD_MONTH This field matches the Month Register.	R/W	00h	RTC_RST

This is a 32-bit register, accessible also as individual bytes. When writing as individual bytes, ensure that the DSE bit (in Register B) is off first, or that the block is disabled or stopped (SET bit), to prevent a time update while this register may have incompletely-updated contents.

When enabled by the DSE bit in Register B, this register defines an hour and day of the year at which the Hours register will be automatically incremented by 1 additional hour.

There are no don't-care fields recognized. All fields must be already initialized to valid settings whenever the DSE bit is '1'.

Fields other than Week and Day of Week use the current setting of the DM bit (binary vs. BCD) to interpret the information as it is written to them. Their values, as held internally, are not changed by later changes to the DM bit, without subsequently writing to this register as well.

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Note:	An Alarm that is set inside the hour after the time specified in this register will not be triggered, because that one-hour period is skipped. This period includes the exact time (0 minutes: 0 seconds) given by this register, through the 59 minutes: 59 seconds point afterward.

13.11.18 DAYLIGHT SAVINGS BACKWARD REGISTER

Offset	1Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	DST_BACKWARD_AM_PM This bit selects AM vs. PM, to match bit[7] of the Hours register if 12-Hour mode is selected in Register B at the time of writing.	R/W	0b	RTC_RST
30:24	DST_BACKWARD_HOUR This field holds the matching value for bits[6:0] of the Hours register. The written value will be interpreted according to the 24/12 Hour mode and DM mode settings at the time of writing.	R/W	00h	RTC_RST
23:19	Reserved	R	-	-
18:16	DST_BACKWARD_WEEK This value matches an internally-maintained week number within the current month. Valid values for this field are: 5=Last week of month 4 =Fourth week of month 3=Third week of month 2=Second week of month 1=First week of month	R/W	0h	RTC_RST
15:11	Reserved	R	-	-
10:8	DST_BACKWARD_DAY_OF_WEEK This field matches the Day of Week Register bits[2:0].	R/W	0h	RTC_RST
7:0	DST_BACKWARD_MONTH This field matches the Month Register.	R/W	00h	RTC_RST

This is a 32-bit register, accessible also as individual bytes. When writing as individual bytes, ensure that the DSE bit (in Register B) is off first, or that the block is disabled or stopped (SET bit), to prevent a time update while this register may have incompletely-updated contents.

When enabled by the DSE bit in Register B, this register defines an hour and day of the year at which the Hours register increment will be inhibited from occurring. After triggering, this feature is automatically disabled for long enough to ensure that it will not retrigger the second time this Hours value appears, and then this feature is re-enabled automatically.

There are no don’t-care fields recognized. All fields must be already initialized to valid settings whenever the DSE bit is ‘1’.

Fields other than Week and Day of Week use the current setting of the DM bit (binary vs. BCD) to interpret the information as it is written to them. Their values, as held internally, are not changed by later changes to the DM bit, without subsequently writing to this register as well.

Note:	An Alarm that is set inside the hour before the time specified in this register will be triggered twice, because that one-hour period is repeated. This period will include the exact time (0 minutes: 0 seconds) given by this register, through the 59 minutes: 59 seconds point afterward.

14.0 GPIO INTERFACE

14.1 General Description

The CEC1302 GPIO Interface provides general purpose input monitoring and output control, as well as managing many aspects of pin functionality; including, multi-function Pin Multiplexing Control, GPIO Direction control, PU/PD (PU_PD) resistors, asynchronous wakeup and synchronous Interrupt Detection (int_det), GPIO Direction, and Polarity control, as well as control of pin drive strength and slew rate.

Features of the GPIO Interface include:

- Inputs:
  - Asynchronous rising and falling edge wakeup detection
  - Interrupt High or Low Level
- On Output:
  - Push Pull or Open Drain output
- Pull up or pull down resistor control
- Interrupt and wake capability available for all GPIOs
- Programmable pin drive strength and slew rate limiting
- Group- or individual control of GPIO data.
- Multiplexing of all multi-function pins are controlled by the GPIO interface

14.2 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

14.2.1 POWER DOMAINS

TABLE 14-1: POWER SOURCES

Name	Description
VCC1	The registers and logic in this block are powered by VCC1.

14.2.2 CLOCK INPUTS

TABLE 14-2: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	The 48 MHz Ring Oscillator is used for synchronizing the GPIO inputs.

14.2.3 RESETS

TABLE 14-3: RESET SIGNALS

Name	Description
VCC1_RESET	This reset is asserted when VCC1 is applied.
nSIO_RESET	This is an alternate reset condition, typically asserted when the main power rail is asserted. This reset is used for VCC Power Well Emulation.

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14.3 Interrupts

This section defines the Interrupt Sources generated from this block.

TABLE 14-4: INTERRUPTS

Source	Description
GPIO_Event	Each pin in the GPIO Interface has the ability to generate an interrupt event. This event may be used as a wake event. The GPIO Interface can generate an interrupt source event on a high level, low level, rising edge and falling edge, as configured by the Interrupt Detection (int_det) bits in the Pin Control Register associated with the GPIO signal function. **Note:** The minimum pulse width ensured to generate an interrupt/wakeup event is 5ns.

14.4 Accessing GPIOs

There are two ways to access GPIO output data. Bit [10] is used to determine which GPIO output data bit affects the GPIO output pin.

- Output GPIO Data
  - Outputs to individual GPIO ports are grouped into 32-bit GPIO Output Registers.
- Alternative GPIO data
  - Alternatively, each GPIO output port is individually accessible via Bit [16] in the port's Pin Control Register. On reads, Bit [16] returns the programmed value, not the value on the pin.

There are two ways to access GPIO input data.

- Input GPIO Data
  - Inputs from individual GPIO ports are grouped into 32-bit GPIO Input Registers and always reflect the current state of the GPIO input from the pad.
- GPIO input from pad
  - Alternatively, each GPIO input port is individually accessible via Bit [24] in the port's Pin Control Register. Bit [24] always reflects the current state of GPIO input from the pad.

14.5 GPIO Indexing

Each GPIO signal function name consists of a 4-character prefix ("GPIO") followed by a 3-digit octal-encoded index number. In the CEC1302 GPIO indexing is done sequentially starting from 'GPIO000.'

14.6 GPIO Multiplexing Control

Pin multiplexing depends upon the Mux Control bits in the Pin Control Register. There are two Pin Control Registers for each GPIO signal function.

The CEC1302 Pin Control Register address offsets shown in the following tables depends on the GPIO Index number. Pin Control Register defaults are also shown in these tables.

Note 1: Pin Control Register 2 default values are not shown in these tables.

2: The GPIO143/RSMRST# pin operates as described in Section 1.6, "Notes for Tables in this Chapter," on page 36 when it is configured as a GPIO; the RSMRST# function is not a true alternate function. For proper RSMRST# operation on the pin, the GPIO143 control register must not be changed from the GPIO default function.

3: The VCC1_RST#/GPIO131 pin cannot be used as a GPIO pin. The input path to the VCC1_RST# logic is always active and will cause a reset if this pin is set low in GPIO mode.

4: The KSI[7:0] pins have the internal pullups enabled by ROM boot code. Therefore the Pin Control Reg. POR Value is as follows after the ROM boot code runs:

GPIO043 = 00003001h
GPIO042 = 00003001h

GPIO040 = 00003001h
GPIO142 = 00003001h
GPIO032 = 00003001h
GPIO144 = 00003001h
GPIO126 = 00002001h
GPIO125 = 00002001h

TABLE 14-5: PIN CONTROL REGISTERS

GPIO Name (Octal)	Pin Control Reg. Offset (Hex)	Pin Control Reg. POR Value (Hex)	POR Default Signal Function	Mux Control = 00	Mux Control = 01	Mux Control = 10	Mux Control = 11
GPIO000	0000	00003000	KSO00	GPIO000	Reserved	Reserved	KSO00
GPIO001	0004	00003000	KSO06	GPIO001	Reserved	Reserved	KSO06
GPIO002	0008	00003000	KSO07	GPIO002	Reserved	Reserved	KSO07
GPIO003	000C	00003000	KSO08	GPIO003	Reserved	Reserved	KSO08
GPIO004	0010	00003000	KSO10	GPIO004	Reserved	Reserved	KSO10
GPIO005	0014	00003002	KSO12	GPIO005	Reserved	Reserved	KSO12
GPIO006	0018	00003000	KSO13	GPIO006	Reserved	Reserved	KSO13
GPIO007	001C	00000000	GPIO007	GPIO007	Reserved	Reserved	KSO14
GPIO010	0020	00000000	GPIO010	GPIO010	Reserved	Reserved	KSO15
GPIO011	0024	00000002	GPIO011	GPIO011	Reserved	Reserved	KSO16
GPIO012	0028	00000000	GPIO012	GPIO012	Reserved	Reserved	KSO17
GPIO013	002C	00002000	32KHZ_OUT	GPIO013	Reserved	32KHZ_OUT	Reserved
GPIO014	0030	00003000	Reserved	GPIO014	Reserved	Reserved	Reserved
GPIO015	0034	00002100	I2C0_CLK0	GPIO015	Reserved	I2C0_CLK0	Reserved
GPIO016	0038	00002100	I2C0_DAT0	GPIO016	Reserved	I2C0_DAT0	Reserved
GPIO017	003C	00002100	I2C0_DAT1	GPIO017	Reserved	I2C0_DAT1	Reserved
GPIO020	0040	00000000	GPIO020	GPIO020	Reserved	I2C2_CLK0	Reserved
GPIO021	0044	00000000	GPIO021	GPIO021	Reserved	I2C2_DAT0	Reserved
GPIO022	0048	00000000	GPIO022	GPIO022	Reserved	I2C1_CLK0	Reserved
GPIO023	004C	00000000	GPIO023	GPIO023	Reserved	I2C1_DAT0	Reserved
GPIO024	0050	00000001	GPIO024	GPIO024	Reserved	I2C3_CLK0	Reserved
GPIO025	0054	00000000	GPIO025	GPIO025	Reserved	I2C3_DAT0	Reserved
GPIO026	0058	00003100	Reserved	GPIO026	Reserved	Reserved	Reserved
GPIO027	005C	00000001	GPIO027	GPIO027	Reserved	Reserved	Reserved
GPIO030	0060	00000000	GPIO030	GPIO030	Reserved	Reserved	Reserved
GPIO031	0064	00000001	GPIO031	GPIO031	Reserved	Reserved	Reserved
GPIO032	0068	00003000	KSI3	GPIO032	Reserved	Reserved	KSI3
GPIO033	006C	00000001	GPIO033	GPIO033	Reserved	Reserved	Reserved
GPIO034	0070	00000000	GPIO034	GPIO034	PWM2	Reserved	TACH2PWM_OUT
GPIO035	0074	00000001	GPIO035	GPIO035	Reserved	Reserved	Reserved
GPIO036	0078	00000001	GPIO036	GPIO036	Reserved	Reserved	Reserved
GPIO040	0080	00003000	KSI5	GPIO040	Reserved	Reserved	KSI5

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GPIO Name (Octal)	Pin Control Reg. Offset (Hex)	Pin Control Reg. POR Value (Hex)	POR Default Signal Function	Mux Control = 00	Mux Control = 01	Mux Control = 10	Mux Control = 11
GPIO041	0084	00001002	Reserved	GPIO041	Reserved	Reserved	Reserved
GPIO042	0088	00003000	KSI6	GPIO042	Reserved	Reserved	KSI6
GPIO043	008C	00003000	KSI7	GPIO043	Reserved	Reserved	KSI7
GPIO044	0090	00000000	GPIO044	GPIO044	Reserved	Reserved	Reserved
GPIO045	0094	00000000	GPIO045	GPIO045	Reserved	PVT_CS1#	Reserved
GPIO046	0098	00003100	Reserved	GPIO046	Reserved	Reserved	Reserved
GPIO047	009C	00003100	Reserved	GPIO047	Reserved	Reserved	Reserved
GPIO050	00A0	00003100	Reserved	GPIO050	Reserved	Reserved	Reserved
GPIO051	00A4	00003100	Reserved	GPIO051	Reserved	Reserved	Reserved
GPIO052	00A8	00003100	Reserved	GPIO052	Reserved	Reserved	Reserved
GPIO053	00AC	00000000	GPIO053	GPIO053	Reserved	Reserved	Reserved
GPIO054	00B0	00000000	GPIO054	GPIO054	PVT_MOSI	Reserved	Reserved
GPIO055	00B4	0000000C	GPIO055	GPIO055	Reserved	Reserved	Reserved
GPIO056	00B8	00003000	ADC0	GPIO056	ADC0	Reserved	Reserved
GPIO057	00BC	00001000	ADC1	GPIO057	ADC1	Reserved	Reserved
GPIO060	00C0	00001001	ADC2	GPIO060	ADC2	Reserved	Reserved
GPIO061	00C4	00001000	ADC3	GPIO061	ADC3	Reserved	Reserved
GPIO062	00C8	00001000	ADC4	GPIO062	ADC4	Reserved	Reserved
GPIO063	00CC	00001000	VCC_PWRGD	GPIO063	VCC_PWRGD	Reserved	Reserved
GPIO064	00D0	00000000	GPIO064	GPIO064	SHD_MOSI	Reserved	Reserved
GPIO065	00D4	00003100	Reserved	GPIO065	Reserved	Reserved	Reserved
GPIO066	00D8	00000000	GPIO066	GPIO066	Reserved	Reserved	Reserved
GPIO067	00DC	0000000C	GPIO067	GPIO067	Reserved	Reserved	Reserved
GPIO100	0100	00003000	KSO01	GPIO100	Reserved	Reserved	KSO01
GPIO101	0104	00003000	KSO02	GPIO101	Reserved	Reserved	KSO02
GPIO102	0108	00003000	KSO03	GPIO102	Reserved	Reserved	KSO03
GPIO103	010C	00003000	KSO04	GPIO103	TFDP_DATA	Reserved	KSO04
GPIO104	0110	00003000	KSO05	GPIO104	TFDP_CLK	Reserved	KSO05
GPIO105	0114	00000000	GPIO105	GPIO105	TACH1	Reserved	Reserved
GPIO106	0118	00003000	KSO09	GPIO106	Reserved	Reserved	KSO09
GPIO107	011C	00003000	KSO11	GPIO107	Reserved	Reserved	KSO11
GPIO110	0120	00000000	GPIO110	GPIO110	Reserved	Reserved	Reserved

GPIO Name (Octal)	Pin Control Reg. Offset (Hex)	Pin Control Reg. POR Value (Hex)	POR Default Signal Function	Mux Control = 00	Mux Control = 01	Mux Control = 10	Mux Control = 11
GPIO111	0124	00003000	Reserved	GPIO111	Reserved	Reserved	Reserved
GPIO112	0128	00003000	Reserved	GPIO112	Reserved	Reserved	Reserved
GPIO113	012C	00003000	Reserved	GPIO113	Reserved	Reserved	Reserved
GPIO114	0130	00003000	Reserved	GPIO114	Reserved	Reserved	Reserved
GPIO115	0134	00003000	Reserved	GPIO115	Reserved	Reserved	Reserved
GPIO116	0138	00001000	LRESET#	GPIO116	LRESET#	Reserved	Reserved
GPIO117	013C	00003000	Reserved	GPIO117	Reserved	Reserved	Reserved
GPIO120	0140	00003000	Reserved	GPIO120	Reserved	Reserved	Reserved
GPIO121	0144	00001000	nRESET_OUT	GPIO121	nRESET_OUT	Reserved	Reserved
GPIO122	0148	00000000	GPIO122	GPIO122	SHD_SCLK	Reserved	Reserved
GPIO123	014C	0000000C	GPIO123	GPIO123	Reserved	Reserved	Reserved
GPIO124	0150	00000000	GPIO124	GPIO124	SHD_MISO	Reserved	Reserved
GPIO125	0154	00002000	KSI0	GPIO125	Reserved	KSI0	Reserved
GPIO126	0158	00002000	KSI1	GPIO126	Reserved	KSI1	Reserved
GPIO127	015C	00000000	GPIO127	GPIO127	Reserved	Reserved	Reserved
GPIO130	0160	00000000	GPIO130	GPIO130	Reserved	Reserved	Reserved
GPIO131	0164	00001100	VCC1_RST#	GPIO131	VCC1_RST#	Reserved	Reserved
GPIO132	0168	00000000	GPIO132	GPIO132	Reserved	Reserved	Reserved
GPIO133	016C	00000000	GPIO133	GPIO133	PWM0	Reserved	Reserved
GPIO134	0170	00002100	I2C0_CLK1	GPIO134	Reserved	I2C0_CLK1	Reserved
GPIO135	0174	00000000	GPIO135	GPIO135	Reserved	Reserved	Reserved
GPIO136	0178	00000000	GPIO136	GPIO136	PWM1	Reserved	Reserved
GPIO140	0180	00000000	GPIO140	GPIO140	TACH2	Reserved	TACH2PWM_IN
GPIO141	0184	00000000	GPIO141	GPIO141	PWM3	LED3	Reserved
GPIO142	0188	00003000	KSI4	GPIO142	Reserved	Reserved	KSI4
GPIO143	018C	00000200	GPIO143	GPIO143	RSMRST#	Reserved	Reserved
GPIO144	0190	00003000	KSI2	GPIO144	Reserved	Reserved	KSI2
GPIO145	0194	00000001	GPIO145	GPIO145	Reserved	Reserved	Reserved
GPIO146	0198	00000000	GPIO146	GPIO146	PVT_CS0#	Reserved	Reserved
GPIO147	019C	00000001	GPIO147	GPIO147	Reserved	Reserved	Reserved
GPIO150	01A0	00000000	GPIO150	GPIO150	SHD_CS0#	Reserved	Reserved
GPIO151	01A4	00000001	GPIO151	GPIO151	Reserved	Reserved	Reserved

GPIO Name (Octal)	Pin Control Reg. Offset (Hex)	Pin Control Reg. POR Value (Hex)	POR Default Signal Function	Mux Control = 00	Mux Control = 01	Mux Control = 10	Mux Control = 11
GPIO152	01A8	00000000	GPIO152	GPIO152	Reserved	Reserved	Reserved
GPIO153	01AC	00000000	GPIO153	GPIO153	PVT_SCLK	Reserved	Reserved
GPIO154	01B0	00002000	LED0	GPIO154	Reserved	LED0	Reserved
GPIO155	01B4	00002000	LED1	GPIO155	Reserved	LED1	Reserved
GPIO156	01B8	00002000	LED2	GPIO156	Reserved	LED2	Reserved
GPIO157	01BC	00000001	GPIO157	GPIO157	BC_CLK	Reserved	Reserved
GPIO160	01C0	00000001	GPIO160	GPIO160	BC_DAT	Reserved	Reserved
GPIO161	01C4	00000001	GPIO161	GPIO161	BC_INT#	Reserved	Reserved
GPIO162	01C8	00000000	GPIO162	GPIO162	RXD	Reserved	Reserved
GPIO163	01CC	00000000	GPIO163	GPIO163	Reserved	Reserved	Reserved
GPIO164	01D0	00000000	GPIO164	GPIO164	PVT_MISO	Reserved	Reserved
GPIO165	01D4	00000000	GPIO165	GPIO165	TXD	SHD_CS1#	Reserved
GPIO200	0200	0000000C	GPIO200	GPIO200	Reserved	Reserved	Reserved
GPIO201	0204	0000000C	GPIO201	GPIO201	Reserved	Reserved	Reserved
GPIO202	0208	0000000C	GPIO202	GPIO202	Reserved	Reserved	Reserved
GPIO203	020C	0000000C	GPIO203	GPIO203	Reserved	Reserved	Reserved
GPIO204	0210	0000000C	GPIO204	GPIO204	Reserved	Reserved	Reserved
GPIO206	0218	00000000	GPIO206	GPIO206	Reserved	Reserved	Reserved
GPIO210	0220	0000000C	GPIO210	GPIO210	Reserved	Reserved	Reserved
GPIO211	0224	0000000C	GPIO211	GPIO211	Reserved	Reserved	Reserved

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Note 1: The value of the Pin Control Register 2 for each pin is not shown in the tables above. The default value can be determined by the current value shown in the “Default Operation” column of the Multiplexing Tables in Section 1.5.2, "Multiplexing Tables," on page 17 as follows:

2mA: 00000000h
4mA: 00000010h
8mA: 00000020h
12mA: 00000030h

2: The default slew rate is slow.

3: The GPIO041 pin defaults to output low. This pin must be reprogrammed to the GPIO function upon power-up.

14.7 Pin Multiplexing Control

Pin multiplexing depends upon the Mux Control bits in the Pin Control Register. There is a Pin Control Register for each GPIO signal function. TABLE 14-5: shows default of the register for each GPIO pin.

The registers listed in the Register Summary table are for a single instance of the CEC1302. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the Register Base Address Table.

TABLE 14-6: REGISTER BASE ADDRESS TABLE

Instance Name	Instance Number	Host	Address Space	Base Address (Note 14-1)
GPIO	0	EC	32-bit internal address space	4008_1000h

Note 14-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 14-7: REGISTER SUMMARY

Offset	Register Name
000h - 01Ch	GPIO000-GPIO007 Pin Control Register
020h - 03Ch	GPIO010-GPIO017 Pin Control Register
040h - 05Ch	GPIO020-GPIO027 Pin Control Register
060h - 078h	GPIO030-GPIO036 Pin Control Register
080h - 09Ch	GPIO040-GPIO047 Pin Control Register
0A0h - 0BCh	GPIO050-GPIO057 Pin Control Register
0C0h - 0DCh	GPIO060-GPIO067 Pin Control Register
100h - 11Ch	GPIO100-GPIO107 Pin Control Register
120h - 13Ch	GPIO110-GPIO117 Pin Control Register
140h - 15Ch	GPIO120-GPIO127 Pin Control Register
160h - 178h	GPIO130-GPIO136 Pin Control Register
180h - 19Ch	GPIO140-GPIO147 Pin Control Register
1A0h - 1BCh	GPIO150-GPIO157 Pin Control Register
1C0h - 1D4h	GPIO160-GPIO165 Pin Control Register
200h - 210h	GPIO200-GPIO204 Pin Control Register
218h	GPIO206 Pin Control Register
220h - 224h	GPIO210-GPIO211 Pin Control Register
280h (Note 14-2)	Output GPIO[000:036]
284h (Note 14-2)	Output GPIO[040:076]
288h (Note 14-2)	Output GPIO[100:127]

TABLE 14-7: REGISTER SUMMARY (CONTINUED)

Offset	Register Name
28Ch (Note 14-2)	Output GPIO[140:176]
290h (Note 14-2)	Output GPIO[200:236]
300h (Note 14-2)	Input GPIO[000:036]
304h (Note 14-2)	Input GPIO[040:076]
308h (Note 14-2)	Input GPIO[100:127]
30Ch (Note 14-2)	Input GPIO[140:176]
310h (Note 14-2)	Input GPIO[200:236]
500h - 51Ch	GPIO000-GPIO007 Pin Control Register 2
520h - 53Ch	GPIO010-GPIO017 Pin Control Register 2
540h - 55Ch	GPIO020-GPIO027 Pin Control Register 2
560h - 578h	GPIO030-GPIO036 Pin Control Register 2
580h - 59Ch	GPIO040-GPIO047 Pin Control Register 2
5A0h - 5BCh	GPIO050-GPIO057 Pin Control Register 2
5C0h - 5DCh	GPIO060-GPIO067 Pin Control Register 2
5E0h - 5FCh	GPIO100-GPIO107 Pin Control Register 2
600h	GPIO110 Pin Control Register 2
604h - 623h	MCHP Reserved (Note 14-2)
624h - 63Ch	GPIO121-GPIO127 Pin Control Register 2
640h - 658h	GPIO130-GPIO136 Pin Control Register 2
660h - 67Ch	GPIO140-GPIO147 Pin Control Register 2
680h - 69Ch	GPIO150-GPIO157 Pin Control Register 2
6A0h - 6B4h	GPIO160-GPIO165 Pin Control Register 2
720h - 730h	GPIO200-GPIO204 Pin Control Register 2
738h	GPIO206 Pin Control Register 2
740h - 744h	GPIO210-GPIO211 Pin Control Register 2

Note 14-2 There is no Pin Control Register 2 for GPIO111-GPIO117 and GPIO120, which are PCI_PIO buffer type pins. The drive strength and slew rate are not configurable on these pins.

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14.8 Pin Control Registers

Two Pin Control Registers are implemented for each GPIO. The Pin Control Register format is described in Section 14.8.1, "Pin Control Register," on page 153. The Pin Control Register 2 format is described in Section 14.8.2, "Pin Control Register 2," on page 156. Pin Control Register address offsets and defaults are defined in Table 14-5, “Pin Control Registers,” on page 148.

14.8.1 PIN CONTROL REGISTER

Offset	See Note 14-3			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:25	RESERVED	RES	-	-
24	GPIO input from pad On reads, Bit [24] reflects the state of GPIO input from the pad regardless of setting of Bit [10]. **Note:** This bit is forced high when the selected power well is off as selected by the Power Gating Signal bits. See bits[3:2].	R	Note 14-3	VCC1_RESET
23:17	RESERVED	RES	-	-
16	Alternative GPIO data If enabled by the Output GPIO Write Enable bit, the Alternative GPIO data bit determines the level on the GPIO pin when the pin is configured for the GPIO output function. On writes: If enabled via the Output GPIO Write Enable 0: GPIO[x] out = ‘0’ 1: GPIO[x] out = ‘1’ **Note:** If disabled via the Output GPIO Write Enable then the GPIO[x] out pin is unaffected by writing this bit. On reads: Bit [16] returns the last programmed value, not the value on the pin.	R/W	Note 14-3	VCC1_RESET
15:14	RESERVED	RES	-	-
13:12	Mux Control The Mux Control field determines the active signal function for a pin. 00 = GPIO Function Selected 01 = Signal Function 1 Selected 10 = Signal Function 2 Selected 11 = Signal Function 3 Selected	R/W	Note 14-3	VCC1_RESET
11	Polarity 0 = Non-inverted 1 = Inverted When the Polarity bit is set to ‘1’ and the Mux Control bits are greater than ‘00,’ the selected signal function outputs are inverted and Interrupt Detection (int_det) sense defined in Table 14-8, "Edge Enable and Interrupt Detection Bits Definition" is inverted. When the Mux Control field selects the GPIO signal function (Mux = ‘00’), the Polarity bit does not effect the output. Regardless of the state of the Mux Control field and the Polarity bit, the state of the pin is always reported without inversion in the GPIO input register.	R/W	Note 14-3	VCC1_RESET

Offset	See Note 14-3			
Bits	**Description**	**Type**	**Default**	**Reset Event**
10	Output GPIO Write Enable Every GPIO has two mechanisms to set a GPIO data output: Output GPIO Bit located in the GPIO Output Registers and the Alternative GPIO data bit located in bit 16 of this register. This control bit determines the source of the GPIO output. 0 = Alternative GPIO data write enabled When this bit is zero the Alternative GPIO data write is enabled and the Output GPIO is disabled. 1 = Output GPIO enable When this bit is one the Alternative GPIO data write is disabled and the Output GPIO is enabled. **Note:** See description in Section 14.4, "Accessing GPIOs".	R/W	Note 14-3	VCC1_RESET
9	GPIO Direction 0 = Input 1 = Output The GPIO Direction bit controls the buffer direction only when the Mux Control field is '00' selecting the pin signal function to be GPIO. When the Mux Control field is greater than '00' (i.e., a non-GPIO signal function is selected) the GPIO Direction bit has no affect and the selected signal function logic directly controls the pin direction.	R/W	Note 14-3	VCC1_RESET
8	Output Buffer Type 0 = Push-Pull 1 = Open Drain **Note:** Unless explicitly stated otherwise, pins with (I/O/OD) or (O/OD) in their buffer type column in the tables in are compliant with the following Programmable OD/PP Multiplexing Design Rule: Each compliant pin has a programmable open drain/push-pull buffer controlled by the Output Buffer Type bit in the associated Pin Control Register. The state of this bit controls the mode of the interface buffer for all selected functions, including the GPIO function.	R/W	Note 14-3	VCC1_RESET
7	Edge Enable (edge_en) 0 = Edge detection disabled 1 = Edge detection enabled **Note:** See Table 14-8, "Edge Enable and Interrupt Detection Bits Definition".	R/W	Note 14-3	VCC1_RESET
6:4	Interrupt Detection (int_det) The interrupt detection bits determine the event that generates a GPIO_Event. **Note:** See Table 14-8, "Edge Enable and Interrupt Detection Bits Definition".	R/W	Note 14-3	VCC1_RESET

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Offset	See Note 14-3			
Bits	**Description**	**Type**	**Default**	**Reset Event**
3:2	Power Gating Signals The Power Gating Signals provide the GPIO pin Power Emulation options. The pin will be tristated when the selected power well is off (i.e., gated) as indicated. The Emulated Power Well column defined in the Multiplexing Tables in Section 1.5, "Pin Multiplexing," on page 16 indicates the emulation options supported for each signal. The Signal Power Well column defines the actual buffer power supply per function. 00 = VCC1 Power Rail The output buffer is tristated when VCC1GD = 0. 01 = VCC2 Power Rail The output buffer is tristated when PWRGD = 0. 10 = Reserved 11 = Reserved	R/W	Note 14-3	VCC1_RESET
1:0	PU/PD (PU_PD) These bits are used to enable an internal pull-up. 00 = None 01 = Pull Up Enabled 10 = Pull Down Enabled (Note 14-4) 11 = None	R/W	Note 14-3	VCC1_RESET

Note 14-3 See Section 14.7, "Pin Multiplexing Control," on page 151 for the offset and default values for each GPIO Pin Control Register.

Note 14-4 The Pin Control Registers for GPIO111-GPIO117 and GPIO120, which are PCI_PIO buffer type pins, do not have an internal pull-down. This configuration option has no effect on the pin.

TABLE 14-8: EDGE ENABLE AND INTERRUPT DETECTION BITS DEFINITION

Edge Enable	Interrupt Detection Bits			Selected Function
D7	**D6**	**D5**	**D4**	
0	0	0	0	Low Level Sensitive
0	0	0	1	High Level Sensitive
0	0	1	0	Reserved
0	0	1	1	Reserved
0	1	0	0	Interrupt events are disabled
0	1	0	1	Reserved
0	1	1	0	Reserved
0	1	1	1	Reserved
1	1	0	1	Rising Edge Triggered
1	1	1	0	Falling Edge Triggered
1	1	1	1	Either edge triggered

Note: Only edge triggered interrupts can wake up the main ring oscillator. The GPIO must be enabled for edge-triggered interrupts and the GPIO interrupt must be enabled in the interrupt aggregator in order to wake up the ring when the ring is shut down.

APPLICATION NOTE: All GPIO interrupt detection configurations default to '0000', which is low level interrupt. Having interrupt detection enabled will un-gated the clock to the GPIO module whenever the interrupt is active, which increases power consumption. Interrupt detection should be disabled when not required to save power; this is especially true for pin interfaces.

14.8.2 PIN CONTROL REGISTER 2

Offset	See Note 14-3			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:6	RESERVED	RES	-	-
5:4	Drive Strength These bits are used to select the drive strength on the pin. 00 = 2mA 01 = 4mA 10 = 8mA 11 = 12mA	R/W	Note 1: on page 151	VCC1_RESET
3:1	RESERVED	RES	-	-
0	Slew Rate This bit is used to select the slew rate on the pin. 0 = slow (half frequency) 1 = fast	R/W	0	VCC1_RESET

14.8.3 GPIO OUTPUT REGISTERS

If enabled by the Output GPIO Write Enable bit, the GPIO Output bits determine the level on the GPIO pin when the pin is configured for the GPIO output function.

On writes:

If enabled via the Output GPIO Write Enable

0: GPIO[x] out = ‘0’

1: GPIO[x] out = ‘1’

If disabled via the Output GPIO Write Enable then the GPIO[x] out pin is unaffected by writing this bit.

On reads:

Bit [16] returns the last programmed value, not the value on the pin.

Note:	Bits associated with GPIOs that are not implemented are shown as Reserved.

14.8.3.1 Output GPIO[000:036]

Offset	280h (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	RESERVED	RES	-	-
30:24	GPIO[036:030] Output	R/W	00h	VCC1_RESET
23:16	GPIO[027:020] Output	R/W	00h	VCC1_RESET
15:8	GPIO[017:010] Output	R/W	00h	VCC1_RESET
7:0	GPIO[007:000] Output	R/W	00h	VCC1_RESET

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14.8.3.2 Output GPIO[040:076]

Offset	284h (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:24	RESERVED	RES	-	-
23:16	GPIO[067:060] Output	R/W	00h	VCC1_RESET
15:8	GPIO[057:050] Output	R/W	00h	VCC1_RESET
7:0	GPIO[047:040] Output	R/W	00h	VCC1_RESET

14.8.3.3 Output GPIO[100:127]

Offset	288h (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	RESERVED	RES	-	-
30:24	GPIO[136:130] Output	R/W	00h	VCC1_RESET
23:16	GPIO[127:120] Output	R/W	00h	VCC1_RESET
15:8	GPIO[117:110] Output	R/W	00h	VCC1_RESET
7:0	GPIO[107:100] Output	R/W	00h	VCC1_RESET

14.8.3.4 Output GPIO[140:176]

Offset	28Ch (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:22	RESERVED	RES	-	-
21:16	GPIO[165:160] Output	R/W	00h	VCC1_RESET
15:8	GPIO[157:150] Output	R/W	00h	VCC1_RESET
7:0	GPIO[147:140] Output	R/W	00h	VCC1_RESET

14.8.3.5 Output GPIO[200:236]

Offset	290h (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	RESERVED	RES	-	-
30:24	RESERVED	RES	-	-
23:12	RESERVED	RES	-	-
11:10	MCHP Reserved	R/W	00h	VCC1_RESET
9:8	GPIO[211:210] Output	R/W	00h	VCC1_RESET
7	RESERVED	RES	-	-
6	GPIO206 Output	R/W	00h	VCC1_RESET
5	RESERVED	RES	-	-
4:0	GPIO[204:200] Output	R/W	00h	VCC1_RESET

14.8.4 GPIO INPUT REGISTERS

The GPIO Input Registers can always be used to read the state of a pin, even when the pin is in an output mode and/or when a signal function other than the GPIO signal function is selected; i.e., the Pin Control Register Mux Control bits are not equal to '00.'

The MSbit of the Input GPIO registers have been implemented as a read/write scratch pad bit to support processor specific instructions.

Note:	Bits associated with GPIOs that are not implemented are shown as Reserved.

14.8.4.1 Input GPIO[000:036]

Offset	300h (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	Scratchpad Bit	R/W	0b	VCC1_RESET
30:24	GPIO[036:030] Input	R	00h	VCC1_RESET
23:16	GPIO[027:020] Input	R	00h	VCC1_RESET
15:8	GPIO[017:010] Input	R	00h	VCC1_RESET
7:0	GPIO[007:000] Input	R	00h	VCC1_RESET

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14.8.4.2 Input GPIO[040:076]

Offset	304h (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	Scratchpad Bit	R/W	0b	VCC1_RESET
30:24	RESERVED	R	-	-
23:16	GPIO[067:060] Input	R	00h	VCC1_RESET
15:8	GPIO[057:050] Input	R	00h	VCC1_RESET
7:0	GPIO[047:040] Input	R	00h	VCC1_RESET

14.8.4.3 Input GPIO[100:127]

Offset	308h (Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	Scratchpad Bit	R/W	0b	VCC1_RESET
30:24	GPIO[136:130] Input	R	00h	VCC1_RESET
23:16	GPIO[127:120] Input	R	00h	VCC1_RESET
15:8	GPIO[117:110] Input	R	00h	VCC1_RESET
7:0	GPIO[107:100] Input	R	00h	VCC1_RESET

14.8.4.4 Input GPIO[140:176]

Offset	30Ch(Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	Scratchpad Bit	R/W	0b	VCC1_RESET
30:22	Reserved	R	00h	VCC1_RESET
21:16	GPIO[165:160] Input	R	00h	VCC1_RESET
15:8	GPIO[157:150] Input	R	00h	VCC1_RESET
7:0	GPIO[147:140] Input	R	00h	VCC1_RESET

14.8.4.5 Input GPIO[200:236]

Offset	310h(Note 14-2)			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31	Scratchpad Bit	R/W	0b	VCC1_RESET
30:24	Scratchpad Bits	R/W	00h	VCC1_RESET
23:16	Scratchpad Bits	R/W	00h	VCC1_RESET
15:12	RESERVED	RES	-	-
11:10	MCHP Reserved	R/W	00h	VCC1_RESET
9:8	GPIO[211:210] Input	R/W	00h	VCC1_RESET
7	RESERVED	RES	-	-
6	GPIO206 Input	R/W	00h	VCC1_RESET
5	RESERVED	RES	-	-
4:0	GPIO[204:200] Input	R/W	00h	VCC1_RESET

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15.0 INTERNAL DMA CONTROLLER

15.1 Introduction

The Internal DMA Controller transfers data to/from the source from/to the destination. The firmware is responsible for setting up each channel. Afterwards either the firmware or the hardware may perform the flow control. The hardware flow control exists entirely inside the source device. Each transfer may be 1, 2, or 4 bytes in size, so long as the device supports a transfer of that size. Every device must be on the internal 32-bit address space.

15.2 References

No references have been cited for this chapter

15.3 Terminology

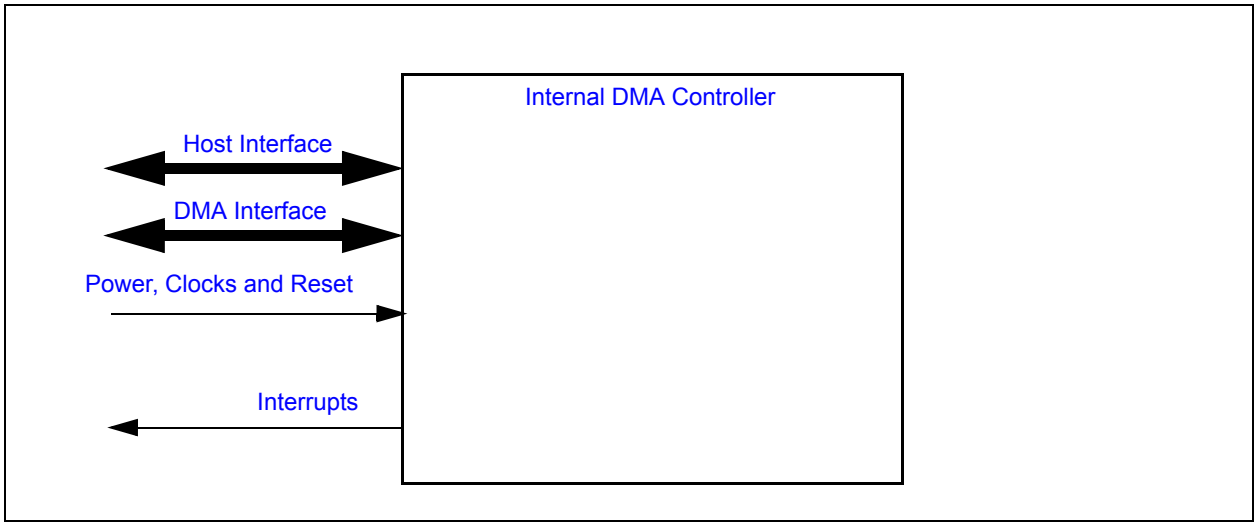
TABLE 15-1: TERMINOLOGY

Term	Definition
DMA Transfer	This is a complete **DMA Transfer** which is done after the **Master Device** terminates the transfer, the Firmware Aborts the transfer or the DMA reaches its transfer limit. A DMA Transfer may consist of one or more data packets.
Data Packet	Each data packet may be composed of 1, 2, or 4 bytes. The size of the data packet is limited by the max size supported by both the source and the destination. Both source and destination will transfer the same number of bytes per packet.
Channel	The Channel is responsible for end-to-end (source-to-destination) Data Packet delivery.
Device	A Device may refer to a Master or Slave connected to the DMA Channel. Each DMA Channel may be assigned one or more devices.
Master Device	This is the master of the DMA, which determines when it is active. The Firmware is the master while operating in Firmware Flow Control. The Hardware is the master while operating in Hardware Flow Control. The Master Device in Hardware Mode is selected by **DMA Channel Control:Hardware Flow Control Device**. It is the index of the **Flow Control** Port.
Slave Device	The Slave Device is defined as the device associated with the targeted Memory Address.
Source	The DMA Controller moves data from the Source to the Destination. The Source provides the data. The Source may be either the Master or Slave Controller.
Destination	The DMA Controller moves data from the Source to the Destination. The Destination receives the data. The Destination may be either the Master or Slave Controller.

15.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 15-1: INTERNAL DMA CONTROLLER I/O DIAGRAM



15.4.1 SIGNAL DESCRIPTION

This block doesn't have any external signals that may be routed to the pin interface. This DMA Controller is intended to be used internally to transfer large amounts of data without the embedded controller being actively involved in the transfer.

15.4.2 HOST INTERFACE

The registers defined for the Internal DMA Controller are accessible by the various hosts as indicated in Section 15.9, "EC-Only Registers".

15.4.3 DMA INTERFACE

Each DMA Master Device that may engage in a DMA transfer must have a compliant DMA interface. The following table lists the DMA Devices in the CEC1302.

TABLE 15-2: DMA CONTROLLER DEVICE SELECTION

Device Name	Device Number (Note 15-1)	Controller Source
SMBus 0 Controller	0	Slave
	1	Master
SMBus 1 Controller	2	Slave
	3	Master
SMBus 2 Controller	4	Slave
	5	Master
SMBus 3 Controller	6	Slave
	7	Master
SPI 0 Controller	8	Transmit
	9	Receive
SPI 1 Controller	10	Transmit
	11	Receive

Note 15-1 The Device Number is programmed into field HARDWARE_FLOW_CONTROL_DEVICE of the DMA Channel N Control register.

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TABLE 15-3: DMA CONTROLLER MASTER DEVICES SIGNAL LIST

Device Name	Dev Num (15.5)	Device Signal Name	Direction	Description
SMBus 0 Controller	0	SMB_SDMA_Req	INPUT	DMA request control from SMBus Slave channel.
		SMB_SDMA_Term	INPUT	DMA termination control from SMBus Slave channel.
		SMB_SDMA_Done	OUTPUT	DMA termination control from DMA Controller to Slave channel.
	1	SMB_MDMA_Req	INPUT	DMA request control from SMBus Master channel.
		SMB_MDMA_Term	INPUT	DMA termination control from SMBus Master channel.
		SMB_MDMA_Done	OUTPUT	DMA termination control from DMA Controller to Master channel.
SMBus 1 Controller	2	SMB_SDMA_Req	INPUT	DMA request control from SMBus Slave channel.
		SMB_SDMA_Term	INPUT	DMA termination control from SMBus Slave channel.
		SMB_SDMA_Done	OUTPUT	DMA termination control from DMA Controller to Slave channel.
	3	SMB_MDMA_Req	INPUT	DMA request control from SMBus Master channel.
		SMB_MDMA_Term	INPUT	DMA termination control from SMBus Master channel.
		SMB_MDMA_Done	OUTPUT	DMA termination control from DMA Controller to Master channel.
SMBus 2 Controller	4	SMB_SDMA_Req	INPUT	DMA request control from SMBus Slave channel.
		SMB_SDMA_Term	INPUT	DMA termination control from SMBus Slave channel.
		SMB_SDMA_Done	OUTPUT	DMA termination control from DMA Controller to Slave channel.
	5	SMB_MDMA_Req	INPUT	DMA request control from SMBus Master channel.
		SMB_MDMA_Term	INPUT	DMA termination control from SMBus Master channel.
		SMB_MDMA_Done	OUTPUT	DMA termination control from DMA Controller to Master channel.

TABLE 15-3: DMA CONTROLLER MASTER DEVICES SIGNAL LIST (CONTINUED)

Device Name	Dev Num (15.5)	Device Signal Name	Direction	Description
SMBus 3 Controller	6	SMB_SDMA_Req	INPUT	DMA request control from SMBus Slave channel.
		SMB_SDMA_Term	INPUT	DMA termination control from SMBus Slave channel.
		SMB_SDMA_Done	OUTPUT	DMA termination control from DMA Controller to Slave channel.
	7	SMB_MDMA_Req	INPUT	DMA request control from SMBus Master channel.
		SMB_MDMA_Term	INPUT	DMA termination control from SMBus Master channel.
		SMB_MDMA_Done	OUTPUT	DMA termination control from DMA Controller to Master channel.
SPI 0 Controller	8	SPI_SDMA_Req	INPUT	DMA request control from SPI TX channel.
		SPI_SDMA_Term	INPUT	DMA termination control from SPI TX channel. Not supported.
		SPI_SDMA_Done	OUTPUT	DMA termination control from DMA Controller to TX Channel. Not supported.
	9	SPI_MDMA_Req	INPUT	DMA request control from SPI RX channel.
		SPI_MDMA_Term	INPUT	DMA termination control from SPI RX channel. Not supported.
		SPI_MDMA_Done	OUTPUT	DMA termination control from DMA Controller to RX channel. Not supported.
SPI 1 Controller	10	SPI_SDMA_Req	INPUT	DMA request control from SPI TX channel.
		SPI_SDMA_Term	INPUT	DMA termination control from SPI TX channel. Not supported.
		SPI_SDMA_Done	OUTPUT	DMA termination control from DMA Controller to TX Channel. Not supported.
	11	SPI_MDMA_Req	INPUT	DMA request control from SPI RX channel.
		SPI_MDMA_Term	INPUT	DMA termination control from SPI RX channel. Not supported.
		SPI_MDMA_Done	OUTPUT	DMA termination control from DMA Controller to RX channel. Not supported.

15.5 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

15.5.1 POWER DOMAINS

TABLE 15-4: POWER SOURCES

Name	Description
VCC1	This power well sources the registers and logic in this block.

15.5.2 CLOCK INPUTS

TABLE 15-5: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This clock signal drives selected logic (e.g., counters).

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15.5.3 RESETS

TABLE 15-6: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal resets all of the registers and logic in this block.
RESET	This reset is generated if either the VCC1_RESET is asserted or the SOFT_RESET is asserted.

15.6 Interrupts

This section defines the Interrupt Sources generated from this block.

TABLE 15-7: INTERRUPTS

Source	Description
DMA0	Direct Memory Access Channel 0 This signal is generated by the STATUS_DONE bit.
DMA1	Direct Memory Access Channel 1 This signal is generated by the STATUS_DONE bit.
DMA2	Direct Memory Access Channel 2 This signal is generated by the STATUS_DONE bit.
DMA3	Direct Memory Access Channel 3 This signal is generated by the STATUS_DONE bit.
DMA4	Direct Memory Access Channel 4 This signal is generated by the STATUS_DONE bit.
DMA5	Direct Memory Access Channel 5 This signal is generated by the STATUS_DONE bit.
DMA6	Direct Memory Access Channel 6 This signal is generated by the STATUS_DONE bit.
DMA7	Direct Memory Access Channel 7 This signal is generated by the STATUS_DONE bit.
DMA8	Direct Memory Access Channel 8 This signal is generated by the STATUS_DONE bit.
DMA9	Direct Memory Access Channel 9 This signal is generated by the STATUS_DONE bit.
DMA10	Direct Memory Access Channel 10 This signal is generated by the STATUS_DONE bit.
DMA11	Direct Memory Access Channel 11 This signal is generated by the STATUS_DONE bit.

15.7 Low Power Modes

The Internal DMA Controller may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

When the block is commanded to go to sleep it will place the DMA block into sleep mode only after all transactions on the DMA have been completed. For Firmware Flow Controlled transactions, the DMA will wait until it hits its terminal count and clears the Go control bit. For Hardware Flow Control, the DMA will go to sleep after either the terminal count is hit, or the Master device flags the terminate signal.

15.8 Description

The CEC1302 features a 12 channel DMA controller. The DMA controller can autonomously move data from/to any DMA capable master device to/from any populated memory location. This mechanism allows hardware IP blocks to transfer large amounts of data into or out of memory without EC intervention.

The DMA has the following characteristics:

- Data is only moved 1 Data Packet at a time
- Data only moves between devices on the accessible via the internal 32-bit address space

- The DMA Controller has 12 DMA Channels
- Each DMA Channel may be configured to communicate with any DMA capable device on the 32-bit internal address space. Each device has been assigned a device number. See Section 15.4.3, "DMA Interface," on page 162.

The controller will accesses SRAM buffers only with incrementing addresses (that is, it cannot start at the top of a buffer, nor does it handle circular buffers automatically). The controller does not handle chaining (that is, automatically starting a new DMA transfer when one finishes).

15.8.1 CONFIGURATION

The DMA Controller is enabled via the ACTIVATE bit in DMA Main Control register.

Each DMA Channel must also be individually enabled via the CHANNEL_ACTIVATE bit in the DMA Channel N Activate to be operational.

Before starting a DMA transaction on a DMA Channel the host must assign a DMA Master to the channel via HARDWARE_FLOW_CONTROL_DEVICE. The host must not configure two different channels to the same DMA Master at the same time.

Data will be transfered between the DMA Master, starting at the programmed DEVICE_ADDRESS, and the targeted memory location, starting at the MEMORY_START_ADDRESS. The address for either the DMA Master or the targeted memory location may remain static or it may increment. To enable the DMA Master to increment its address set the INCREMENT_DEVICE_ADDRESS bit. To enable the targeted memory location to increment its addresses set the INCREMENT_MEMORY_ADDRESS. The DMA transfer will continue as long as the target memory address being accessed is less than the MEMORY_END_ADDRESS. If the DMA Controller detects that the memory location it is attempting to access on the Target is equal to the MEMORY_END_ADDRESS it will notify the DMA Master that the transaction is done. Otherwise the Data will be transferred in packets. The size of the packet is determined by the TRANSFER_SIZE.

15.8.2 OPERATION

The DMA Controller is designed to move data from one memory location to another.

15.8.2.1 Establishing a Connection

A DMA Master will initiate a DMA Transaction by requesting access to a channel. The DMA arbiter, which evaluates each channel request using a basic round robin algorithm, will grant access to the DMA master. Once granted, the channel will hold the grant until it decides to release it, by notifying the DMA Controller that it is done.

Note:	If Firmware wants to prevent any other channels from being granted while it is active it can set the LOCK_CHANNEL bit.

15.8.2.2 Initiating a Transfer

Once a connection is established the DMA Master will issue a DMA request to start a DMA transfer. If Firmware wants to have a transfer request serviced it must set the RUN bit to have its transfer requests serviced.

Firmware can initiate a transaction by setting the TRANSFER_GO bit. The DMA transfer will remain active until either the Master issues a Terminate or the DMA Controller signals that the transfer is DONE. Firmware may terminate a transaction by setting the TRANSFER_ABORT bit.

Note:	Before initiating a DMA transaction via firmware the hardware flow control mus be disabled via the DISABLE_HARDWARE_FLOW_CONTROL bit.

Data may be moved from the DMA Master to the targeted Memory address or from the targeted Memory Address to the DMA Master. The direction of the transfer is determined by the TRANSFER_DIRECTION bit.

Once a transaction has been initiated firmware can use the STATUS_DONE bit to determine when the transaction is completed. This status bit is routed to the interrupt interface. In the same register there are additional status bits that indicate if the transaction completed successfully or with errors. This bits are OR'd together with the STATUS_DONE bit to generate the interrupt event. Each status be may be individually enabled/disabled from generating this event.

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15.9 EC-Only Registers

The DMA Controller consists of a Main Block and a number of Channels. Table 15-9, "Main EC-Only Register Summary" lists the registers in the Main Block and Table 15-10, "Channel EC-Only Register Summary" lists the registers in each channel. The addresses of each register listed in these tables are defined as a relative offset to the “Base Address” defined in the EC-Only Register Base Address Table. The Base Address for the Main Block and each Channel is defined in the table:

TABLE 15-8: EC-ONLY REGISTER BASE ADDRESS TABLE

Instance Name	Channel Number	Host	Address Space	Base Address
DMA Controller	Main Block	EC	32-bit internal address space	4000_2400h
DMA Controller	0	EC	32-bit internal address space	4000_2410h
DMA Controller	1	EC	32-bit internal address space	4000_2430h
DMA Controller	2	EC	32-bit internal address space	4000_2450h
DMA Controller	3	EC	32-bit internal address space	4000_2470h
DMA Controller	4	EC	32-bit internal address space	4000_2490h
DMA Controller	5	EC	32-bit internal address space	4000_24B0h
DMA Controller	6	EC	32-bit internal address space	4000_24D0h
DMA Controller	7	EC	32-bit internal address space	4000_24F0h
DMA Controller	8	EC	32-bit internal address space	4000_2510h
DMA Controller	9	EC	32-bit internal address space	4000_2530h
DMA Controller	10	EC	32-bit internal address space	4000_2550h
DMA Controller	11	EC	32-bit internal address space	4000_2570h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 15-9: MAIN EC-ONLY REGISTER SUMMARY

Offset	REGISTER NAME (Mnemonic)
00h	DMA Main Control
04h	DMA Data Packet

15.9.1 DMA MAIN CONTROL

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:2	Reserved	R	-	-
1	SOFT_RESET Soft reset the entire module. This bit is self-clearing.	W	0b	-
0	ACTIVATE Enable the blocks operation. 1=Enable block. Each individual channel must be enabled separately. 0=Disable all channels.	R/WS	0b	RESET

15.9.2 DMA DATA PACKET

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	DATA_PACKET Debug register that has the data that is stored in the Data Packet. This data is read data from the currently active transfer source.	R	0000h	-

TABLE 15-10: CHANNEL EC-ONLY REGISTER SUMMARY

Offset	Register Name (Mnemonic) (Note 15-2)
00h	DMA Channel N Activate
04h	DMA Channel N Memory Start Address
08h	DMA Channel N Memory End Address
0Ch	DMA Channel N Device Address
10h	DMA Channel N Control
14h	DMA Channel N Interrupt Status
18h	DMA Channel N Interrupt Enable

Note 15-2 The letter 'N' following DMA Channel indicates the Channel Number. Each Channel implemented will have these registers to determine that channel's operation.

15.9.3 DMA CHANNEL N ACTIVATE

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:1	Reserved	R	-	-
0	CHANNEL_ACTIVATE Enable this channel for operation. The DMA Main Control:Activate must also be enabled for this channel to be operational.	R/W	0h	RESET

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15.9.4 DMA CHANNEL N MEMORY START ADDRESS

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	MEMORY_START_ADDRESS This is the starting address for the Memory device. This field is updated by Hardware after every packet transfer by the size of the transfer, as defined by DMA Channel Control:Channel Transfer Size while the DMA Channel Control:Increment Memory Address is Enabled. The Memory device is defined as the device that is the slave device in the transfer. ex. With Hardware Flow Control, the Memory device is the device that is not connected to the Hardware Flow Controlling device. **Note:** This field is only as large as the maximum allowed AHB Address Size in the system. If the HADDR size is 24 Bits, then Bits [31:24] will be RESERVED.	R/W	0000h	RESET

15.9.5 DMA CHANNEL N MEMORY END ADDRESS

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	MEMORY_END_ADDRESS This is the ending address for the Memory device. This will define the limit of the transfer, so long as DMA Channel Control:Increment Memory Address is Enabled. When the Memory Start Address is equal to this value, the DMA will terminate the transfer and flag the status DMA Channel Interrupt:Status Done. **Note:** This field is only as large as the maximum allowed AHB Address Size in the system. If the HADDR size is 24 Bits, then Bits [31:24] will be RESERVED.	R/W	0000h	RESET

15.9.6 DMA CHANNEL N DEVICE ADDRESS

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:0	DEVICE_ADDRESS This is the Master Device address. This is used as the address that will access the Device on the DMA. The Device is defined as the Master of the DMA transfer; as in the device that is controlling the Hardware Flow Control. This field is updated by Hardware after every Data Packet transfer by the size of the transfer, as defined by DMA Channel Control:Transfer Size while the DMA Channel Control:Increment Device Address is Enabled. **Note:** This field is only as large as the maximum allowed AHB Address Size in the system. If the HADDR size is 24 Bits, then Bits [31:24] will be RESERVED.	R/W	0000h	RESET

15.9.7 DMA CHANNEL N CONTROL

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:26	Reserved	R	-	-
25	TRANSFER_ABORT This is used to abort the current transfer on this DMA Channel. The aborted transfer will be forced to terminate immediately.	R/W	0h	RESET
24	TRANSFER_GO This is used for the **Firmware Flow Control** DMA transfer. This is used to start a transfer under the **Firmware Flow Control**. Do not use this in conjunction with the **Hardware Flow Control**; **DMA Channel Control:Disable Hardware Flow Control** must be set in order for this field to function correctly.	R/W	0h	RESET
23	Reserved	R	-	-
22:20	TRANSFER_SIZE This is the transfer size in Bytes of each Data Packet transfer. **Note:** The transfer size must be a legal transfer size. Valid sizes are 1, 2 and 4 Bytes.	R/W	0h	RESET
19	DISABLE_HARDWARE_FLOW_CONTROL This will Disable the **Hardware Flow Control**. When disabled, any DMA Master device attempting to communicate to the DMA over the **DMA Flow Control Interface (Ports: dma_req, dma_term, and dma_done)** will be ignored. This should be set before using the DMA channel in **Firmware Flow Control** mode.	RW	0h	RESET

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Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
18	LOCK_CHANNEL This is used to lock the arbitration of the Channel Arbiter on this channel once this channel is granted. Once this is locked, it will remain on the arbiter until it has completed it transfer (either the Transfer Aborted, Transfer Done or Transfer Terminated conditions). **Note:** This setting may starve other channels if the locked channel takes an excessive period of time to complete.	RW	0h	RESET
17	INCREMENT_DEVICE_ADDRESS This will enable an auto-increment to the **DMA Channel Device Address.** **1:** Increment the **DMA Channel Device Address** by **DMA Channel Control:Transfer Size** after every **Data Packet transfer** **0:** Do nothing	RW	0h	RESET
16	INCREMENT_MEMORY_ADDRESS This will enable an auto-increment to the **DMA Channel Memory Address.** 1=Increment the DMA Channel Memory Address by DMA Channel Control:Transfer Size after every Data Packet transfer 0=Do nothing **Note:** *If this is not set, the DMA will never terminate the transfer on its own. It will have to be terminated through the* Hardware Flow Control *or through a* DMA Channel Control:Transfer Abort.	RW	0h	RESET
15:9	HARDWARE_FLOW_CONTROL_DEVICE This is the device that is connected to this channel as its **Hardware Flow Control** master. The **Flow Control Interface** is a bus with each master concatenated onto it. This selects which bus index of the concatenated **Flow Control Interface** bus is targeted towards this channel. The **Flow Control Interface** Port list is **dma_req, dma_term,** and **dma_done**.	RW	0h	RESET
8	TRANSFER_DIRECTION This determines the direction of the DMA Transfer. 1=Data Packet Read from **Memory Start Address** followed by Data Packet Write to **Device Address** 0=Data Packet Read from **Device Address** followed by Data Packet Write to **Memory Start Address**	RW	0h	RESET
7:6	Reserved	R	-	-
5	BUSY This is a status signal. 1=The DMA Channel is busy (FSM is not IDLE) 0=The DMA Channel is not busy (FSM is IDLE)	RO	0h	RESET

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
4:3	STATUS This is a status signal. The status decode is listed in priority order with the highest priority first. 3: Error detected by the DMA 2: The DMA Channel is externally done, in that the Device has terminated the transfer over the **Hardware Flow Control** through the Port **dma_term** 1: The DMA Channel is locally done, in that **Memory Start Address** equals **Memory End Address** 0: DMA Channel Control:Run is Disabled (0x0) **Note:** This functionality has been replaced by the Interrupt field, and as such should never be used. The field will not flag back appropriately timed status, and if used may cause the firmware to become out-of-sync with the hardware. This field has multiple non-exclusive statuses, but may only display a single status. As such, multiple statuses may be TRUE, but this will appear as though only a single status has been triggered.	R	0h	RESET
2	DONE This is a status signal. It is only valid while **DMA Channel Control:Run** is Enabled. This is the inverse of the **DMA Channel Control:Busy** field, except this is qualified with the **DMA Channel Control:Run** field. 1=Channel is done 0=Channel is not done or it is OFF	RO	0h	RESET
1	REQUEST This is a status field. 1= There is a transfer request from the Master Device 0= There is no transfer request from the Master Device	RO	0h	RESET
0	RUN This is a control field. **Note:** This bit only applies to **Hardware Flow Control** mode. 1= This channel is enabled and will service transfer requests 0=This channel is disabled. All transfer requests are ignored	RW	0h	RESET

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15.9.8 DMA CHANNEL N INTERRUPT STATUS

Offset	14h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:3	Reserved	R	-	-
2	STATUS_DONE This is an interrupt source register. This flags when the DMA Channel has completed a transfer successfully on its side. A completed transfer is defined as when the DMA Channel reaches its limit; **Memory Start Address** equals **Memory End Address**. A completion due to a **Hardware Flow Control Terminate** will not flag this interrupt. 1=**Memory Start Address** equals **Memory End Address** 0=**Memory Start Address** does not equal **Memory End Address**	R/WC	0h	RESET
1	STATUS_FLOW_CONTROL This is an interrupt source register. This flags when the DMA Channel has encountered a **Hardware Flow Control Request** after the DMA Channel has completed the transfer. This means the Master Device is attempting to overflow the DMA. 1=Hardware Flow Control is requesting after the transfer has completed 0=No Hardware Flow Control event		0h	RESET
0	STATUS_BUS_ERROR This is an interrupt source register. This flags when there is an Error detected over the internal 32-bit Bus. **1:** Error detected.	R/WC	0h	RESET

15.9.9 DMA CHANNEL N INTERRUPT ENABLE

Offset	18h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:3	Reserved	R	-	-
2	STATUS_ENABLE_DONE This is an interrupt enable for **DMA Channel Interrupt:Status Done.** 1=Enable Interrupt 0=Disable Interrupt	R/W	0h	RESET
1	STATUS_ENABLE_FLOW_CONTROL_ERROR This is an interrupt enable for **DMA Channel Interrupt:Status Flow Control Error.** 1=Enable Interrupt 0=Disable Interrupt	R/W	0h	RESET
0	STATUS_ENABLE_BUS_ERROR This is an interrupt enable for **DMA Channel Interrupt:Status Bus Error.** 1=Enable Interrupt 0=Disable Interrupt	R/W	0h	RESET

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16.0 I2C/SMBUS INTERFACE

16.1 Introduction

The CEC1302 I2C/SMBus Interface includes one instance of the I2C/SMBus controller core. This chapter describes aspects of the I2C/SMBus Interface that are unique to the CEC1302 instantiations of this core; including, Power Domain, Resets, Clocks, Interrupts, Registers and the Physical Interface. For a *General Description, Features, Block Diagram, Functional Description, Registers Interface and other core-specific details, see* Ref [1] (note: in this chapter, *italicized text* typically refers to SMBus controller core interface elements as described in Ref [1]).

16.2 References

1. SMBus Controller Core Interface, Revision 3.4, Core-Level Architecture Specification, SMSC, 7/16/12

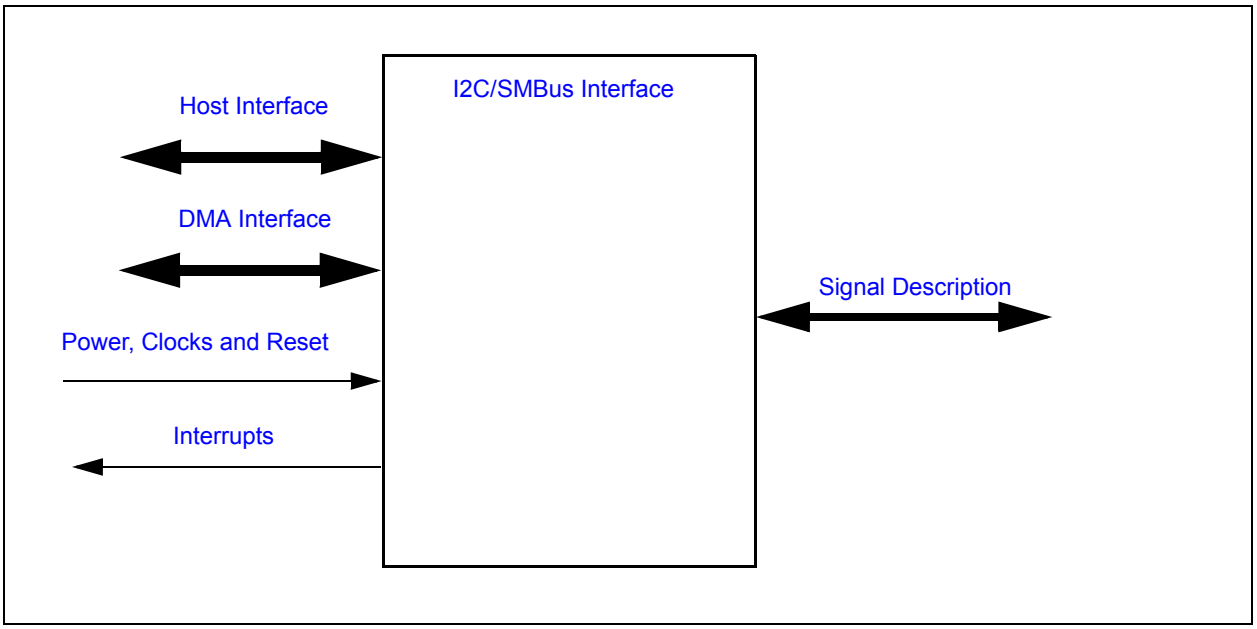
16.3 Terminology

There is no terminology defined for this chapter.

16.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface. In addition, this block is equipped with

FIGURE 16-1: I/O DIAGRAM OF BLOCK



16.5 Signal Description

The Signal Description Table lists the signals that are typically routed to the pin interface.

TABLE 16-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
SMB_DAT0	Input/Output	SMBus Data Port 0
SMB_CLK0	Input/Output	SMBus Clock Port 0
SMB_DAT1	Input/Output	SMBus Data Port 1
SMB_CLK1	Input/Output	SMBus Clock Port 1

Note: The SMB block signals that are shown in Table 16-1 are routed to the SMB pins as listed in Table 16-2.

TABLE 16-2: SIGNAL TO PIN NAME LOOKUP TABLE

Block Name	Pin Name	Description
SMBx_DATn	I2Cx_DATn	I2C/SMBus Controller x Port n Data
SMBx_CLKn	I2Cx_CLKn	I2C/SMBus Controller x Port n Clock

16.6 Host Interface

The registers defined for the I2C/SMBus Interface are accessible as indicated in Section 16.12, "SMBus Registers".

16.7 DMA Interface

This block is designed to communicate with the Internal DMA Controller. This feature is defined in the SMBus Controller Core Interface specification (*See* Ref [1]).

Note: For a description of the Internal DMA Controller implemented in this design see Chapter 15.0, "Internal DMA Controller".

16.8 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

16.8.1 POWER DOMAINS

TABLE 16-3: POWER SOURCES

Name	Description
VCC1	This power well sources the registers and logic in this block.

16.8.2 CLOCK INPUTS

TABLE 16-4: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This is the clock signal drives the SMBus controller core. The core also uses this clock to generate the SMB_CLK on the pin interface.
16MHz_Clk	This is the clock signal is used for baud rate generation.

16.8.3 RESETS

TABLE 16-5: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal resets all of the registers and logic in the SMBus controller core.

16.9 Interrupts

TABLE 16-6: EC INTERRUPTS

Source	Description
SMB	SMBus Activity Interrupt Event

16.10 Low Power Modes

The I2C/SMBus Interface may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

16.11 Description

16.11.1 SMBUS CONTROLLER CORE

The CEC1302 I2C/SMBus Interface behavior is defined in the SMBus Controller Core Interface specification (*See* Ref [1]).

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16.11.2 PHYSICAL INTERFACE

The I2C/SMBus Interface has two physical ports, selected by the *PORT SEL [3:0]* bits in the *Configuration Register* as described in Ref [1].

Note 1: SMBus controller 0 uses port 0 and port 1. SMBus controllers 1-3 use port 0.

2: The buffer type for these pins must be configured as open-drain outputs in the GPIO Configuration registers associated with the GPIO signals that share the ports.

16.12 SMBus Registers

The registers listed in the *SMBus Core Register Summary* table in the SMBus Controller Core Interface specification (Ref [1]) are for a single instance of the SMBus Controller Core. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the following table:

TABLE 16-7: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 16-1)
SMBus Controller	0	EC	32-bit internal address space	4000_1800h
SMBus Controller	1	EC	32-bit internal address space	4000_AC00h
SMBus Controller	2	EC	32-bit internal address space	4000_B000h
SMBus Controller	3	EC	32-bit internal address space	4000_B400h

Note 16-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

17.0 TACH

17.1 Introduction

This block monitors TACH output signals (or locked rotor signals) from various types of fans, and determines their speed.

17.2 References

No references have been cited for this feature.

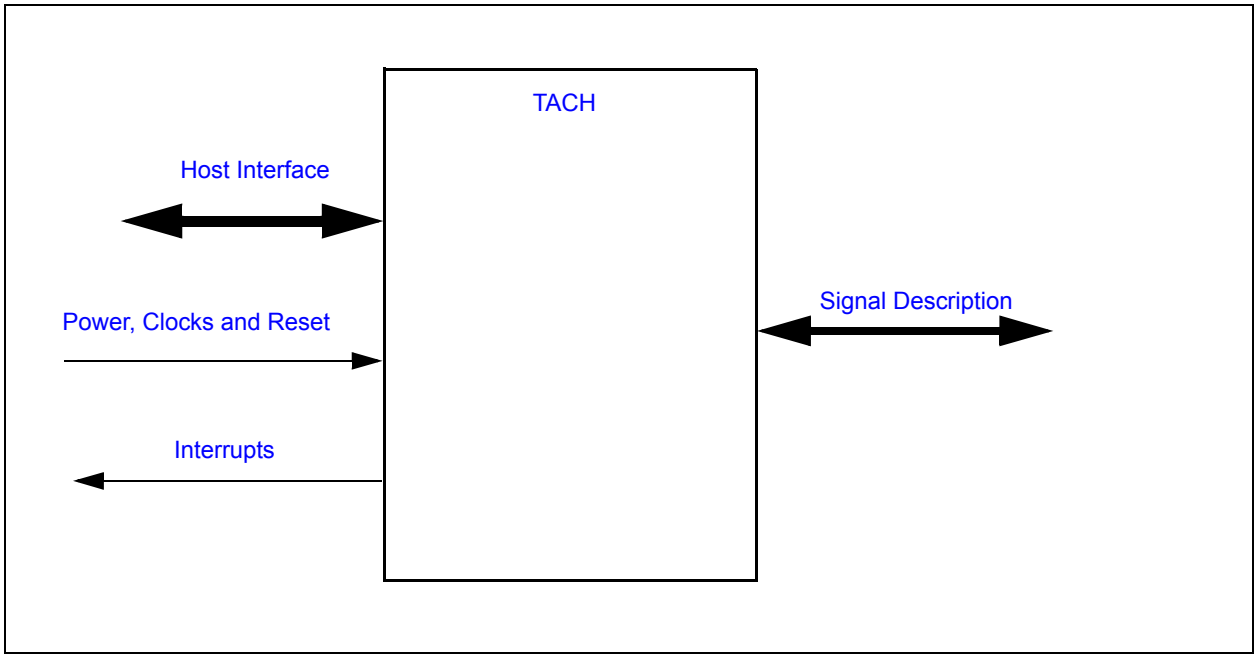
17.3 Terminology

There is no terminology defined for this section.

17.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 17-1: I/O DIAGRAM OF BLOCK



17.5 Signal Description

TABLE 17-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
TACH INPUT	Input	Tachometer signal from TACHx Pin.

17.6 Host Interface

The registers defined for the TACH are accessible by the various hosts as indicated in Section 17.11, "EC-Only Registers".

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17.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

17.7.1 POWER DOMAINS

Name	Description
VCC1	The logic and registers implemented in this block are powered by this power well.

17.7.2 CLOCK INPUTS

Name	Description
100kHz_Clk	This is the clock input to the tachometer monitor logic. In Mode 1, the TACH is measured in the number of these clocks.

17.7.3 RESETS

Name	Description
VCC1_RESET	This signal resets all the registers and logic in this block to their default state.

17.8 Interrupts

This section defines the Interrupt Sources generated from this block.

Source	Description
TACH	This internal signal is generated from the OR'd result of the status events, as defined in the TACHx Status Register.

17.9 Low Power Modes

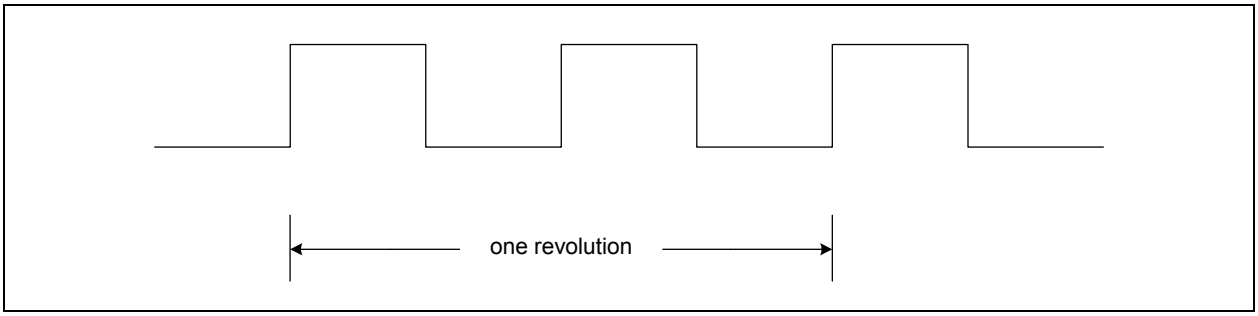
The TACH may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

17.10 Description

The TACH block monitors Tach output signals or locked rotor signals generated by various types of fans. These signals can be used to determine the speed of the attached fan. This block is designed to monitor fans at fan speeds from 100 RPMs to 30,000 RPMs.

Typically, these are DC brushless fans that generate (with each revolution) a 50% duty cycle, two-period square wave, as shown in Figure 17-2 below.

FIGURE 17-2: FAN GENERATED 50%DUTY CYCLE WAVEFORM



In typical systems, the fans are powered by the main power supply. Firmware may disable this block when it detects that the main power rail has been turned off by either clearing the <enable> TACH_ENABLE bit or putting the block to sleep via the supported Low Power Mode interface (see Low Power Modes).

17.10.1 MODES OF OPERATION

The Tachometer block supports two modes of operation. The mode of operation is selected via the TACH_READING_-MODE_SELECT bit.

17.10.1.1 Free Running Counter

In Mode 0, the Tachometer block uses the TACH input as the clock source for the internal TACH pulse counter (see TACHX_COUNTER). The counter is incremented when it detects a rising edge on the TACH input. In this mode, the firmware may periodically poll the TACHX_COUNTER field to determine the average speed over a period of time. The firmware must store the previous reading and the current reading to compute the number of pulses detected over a period of time. In this mode, the counter continuously increments until it reaches FFFFh. It then wraps back to 0000h and continues counting. The firmware must ensure that the sample rate is greater than the time it takes for the counter to wrap back to the starting point.

Note:	Tach interrupts should be disabled in Mode 0.

17.10.1.2 Mode 1 -- Number of Clock Pulses per Revolution

In Mode 1, the Tachometer block uses its 100kHz_Clk clock input to measure the programmable number of TACH pulses. In this mode, the internal TACH pulse counter (TACHX_COUNTER) returns the value in number of 100kHz_Clk pulses per programmed number of TACH_EDGES. For fans that generate two square waves per revolution, these bits should be configured to five edges.

When the number of edges is detected, the counter is latched and the COUNT_READY_STATUS bit is asserted. If the COUNT_READY_INT_EN bit is set a TACH interrupt event will be generated.

17.10.2 OUT-OF-LIMIT EVENTS

The TACH Block has a pair of limit registers that may be configured to generate an event if the Tach indicates that the fan is operating too slow or too fast. If the <TACH reading> exceeds one of the programmed limits, the TACHx High Limit Register and the TACHx Low Limit Register, the bit TACH_OUT_OF_LIMIT_STATUS will be set. If the TACH_OUT_OF_LIMIT_STATUS bit is set, the Tachometer block will generate an interrupt event.

17.11 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the TACH. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 17-2: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
TACH	0	EC	32-bit internal address space	4000_6000h
TACH	1	EC	32-bit internal address space	4000_6010h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 17-3: TACH REGISTER SUMMARY

Offset	Register Name (Mnemonic)
00h	TACHx Control Register
04h	TACHx Status Register
08h	TACHx High Limit Register
0Ch	TACHx Low Limit Register

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17.11.1 TACHX CONTROL REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	TACHX_COUNTER This 16-bit field contains the latched value of the internal Tach pulse counter, which may be configured by the Tach Reading Mode Select field to operate as a free-running counter or to be gated by the Tach input signal. If the counter is free-running (Mode 0), the internal Tach counter increments (if enabled) on transitions of the raw Tach input signal and is latched into this field every time it is incremented. The act of reading this field will not reset the counter, which rolls over to 0000h after FFFFh. The firmware will compute the delta between the current count reading and the previous count reading, to determine the number of pulses detected over a programmed period. If the counter is gated by the Tach input and clocked by 100kHz_Clk (Mode 1), the internal counter will be latched into the reading register when the programmed number of edges is detected or when the counter reaches FFFFh. The internal counter is reset to zero after it is copied into this register. **Note:** In Mode 1, a counter value of FFFFh means that the Tach did not detect the programmed number of edges in 655ms. A stuck fan can be detected by setting the TACHx High Limit Register to a number less than FFFFh. If the internal counter then reaches FFFFh, the reading register will be set to FFFFh and an out-of-limit interrupt can be sent to the EC.	R	00h	VCC1_RESET
15	TACH_INPUT_INT_EN 1=Enable Tach Input toggle interrupt from Tach block 0=Disable Tach Input toggle interrupt from Tach block	R/W	0b	VCC1_RESET
14	COUNT_READY_INT_EN 1=Enable Count Ready interrupt from Tach block 0=Disable Count Ready interrupt from Tach block	R/W	0b	VCC1_RESET
13	Reserved	R	-	-
12:11	TACH_EDGES A Tach signal is a square wave with a 50% duty cycle. Typically, two Tach periods represents one revolution of the fan. A Tach period consists of three Tach edges. This programmed value represents the number of Tach edges that will be used to determine the interval for which the number of 100kHz_Clk pulses will be counted 11b=9 Tach edges (4 Tach periods) 10b=5 Tach edges (2 Tach periods) 01b=3 Tach edges (1 Tach period) 00b=2 Tach edges (1/2 Tach period)	R/W	00b	VCC1_RESET

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
10	TACH_READING_MODE_SELECT 1=Counter is incremented on the rising edge of the 100kHz_Clk input. The counter is latched into the TACHX_COUNTER field and reset when the programmed number of edges is detected. 0=Counter is incremented when Tach Input transitions from low-to-high state (default)	R/W	0b	VCC1_RESET
9	Reserved	R	-	-
8	FILTER_ENABLE This filter is used to remove high frequency glitches from Tach Input. When this filter is enabled, Tach input pulses less than two 100kHz_Clk periods wide get filtered. 1= Filter enabled 0= Filter disabled (default) It is recommended that the Tach input filter always be enabled.	R/W	0b	VCC1_RESET
7:2	Reserved	R	-	-
1	TACH_ENABLE This bit gates the clocks into the block. When clocks are gated, the TACHx pin is tristated. When re-enabled, the internal counters will continue from the last known state and stale status events may still be pending. Firmware should discard any status or reading values until the reading value has been updated at least one time after the enable bit is set. 1= TACH Monitoring enabled, clocks enabled. 0= TACH Idle, clocks gated	R/W	0b	VCC1_RESET
0	TACH_OUT_OF_LIMIT_ENABLE This bit is used to enable the TACH_OUT_OF_LIMIT_STATUS bit in the TACHx Status Register to generate an interrupt event. 1=Enable interrupt output from Tach block 0=Disable interrupt output from Tach block (default)	R/W	0b	VCC1_RESET

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17.11.2 TACHX STATUS REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:4	Reserved	R	-	-
3	COUNT_READY_STATUS This status bit is asserted when the Tach input changes state and when the counter value is latched. This bit remains cleared to '0' when the TACH_READING_MODE_SELECT bit in the TACHx Control Register is '0'. When the TACH_READING_MODE_SELECT bit in the TACHx Control Register is set to '1', this bit is set to '1' when the counter value is latched by the hardware. It is cleared when written with a '1'. If COUNT_READY_INT_EN in the TACHx Control Register is set to 1, this status bit will assert the Tach Interrupt signal. 1=Reading ready 0=Reading not ready	R/WC	0b	VCC1_RESET
2	TOGGLE_STATUS This bit is set when Tach Input changes state. It is cleared when written with a '1'. If TACH_INPUT_INT_EN in the TACHx Control Register is set to '1', this status bit will assert the Tach Interrupt signal. 1=Tach Input changed state (this bit is set on a low-to-high or high-to-low transition) 0=Tach stable	R/WC	0b	VCC1_RESET
1	TACH_PIN_STATUS This bit reflects the state of Tach Input. This bit is a read only bit that may be polled by the embedded controller. 1= Tach Input is high 0= Tach Input is low	R	0b	VCC1_RESET
0	TACH_OUT_OF_LIMIT_STATUS This bit is set when the Tach Count value is greater than the high limit or less than the low limit. It is cleared when written with a '1'. To disable this status event set the limits to their extreme values. If TACH_OUT_OF_LIMIT_ENABLE in the TACHx Control Register is set to 1', this status bit will assert the Tach Interrupt signal. 1=Tach is outside of limits 0=Tach is within limits	R/WC	0b	VCC1_RESET

Note 1: Some fans offer a Locked Rotor output pin that generates a level event if a locked rotor is detected. This bit may be used in combination with the Tach pin status bit to detect a locked rotor signal event from a fan.

2: Tach Input may come up as active for Locked Rotor events. This would not cause an interrupt event because the pin would not toggle. Firmware must read the status events as part of the initialization process, if polling is not implemented.

17.11.3 TACHX HIGH LIMIT REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	Reserved	-	-	-
15:0	TACH_HIGH_LIMIT This value is compared with the value in the TACHX_COUNTER field. If the value in the counter is greater than the value programmed in this register, the TACH_OUT_OF_LIMIT_STATUS bit will be set. The TACH_OUT_OF_LIMIT_STATUS status event may be enabled to generate an interrupt to the embedded controller via the TACH_OUT_OF_LIMIT_ENABLE bit in the TACHx Control Register.	R/W	FFFFh	VCC1_RESET

17.11.4 TACHX LOW LIMIT REGISTER

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	Reserved	R	-	-
15:0	TACHX_LOW_LIMIT This value is compared with the value in the TACHX_COUNTER field of the TACHx Control Register. If the value in the counter is less than the value programmed in this register, the TACH_OUT_OF_LIMIT_STATUS bit will be set. The TACH_OUT_OF_LIMIT_STATUS status event may be enabled to generate an interrupt to the embedded controller via the TACH_OUT_OF_LIMIT_ENABLE bit in the TACHx Control Register To disable the TACH_OUT_OF_LIMIT_STATUS low event, program 0000h into this register.	R/W	0000h	VCC1_RESET

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18.0 PWM

18.1 Introduction

This block generates a PWM output that can be used to control 4-wire fans, blinking LEDs, and other similar devices. Each PWM can generate an arbitrary duty cycle output at frequencies from less than 0.1 Hz to 24 MHz. The PWM controller can also used to generate the PROCHOT output and Speaker output.

The PWMx Counter ON Time registers and PWMx Counter OFF Time registers determine the operation of the PWM_OUTPUT signals. See Section 18.11.1, "PWMx Counter ON Time Register," on page 188 and Section 18.11.2, "PWMx Counter OFF Time Register," on page 189 for a description of the PWM_OUTPUT signals.

18.2 References

There are no standards referenced in this chapter.

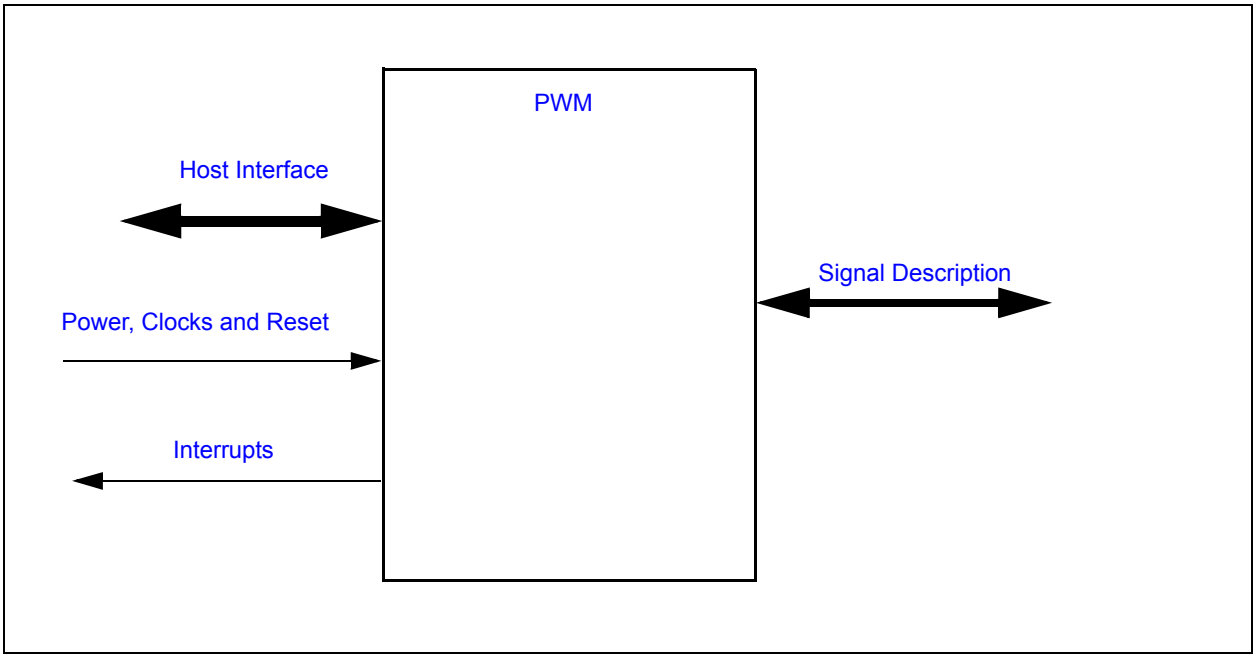
18.3 Terminology

There is no terminology defined for this section.

18.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 18-1: I/O DIAGRAM OF BLOCK



There are no external signals for this block.

18.5 Signal Description

TABLE 18-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
PWM_OUTPUT	OUTPUT	Pulse Width Modulated signal to PWMx pin.

18.6 Host Interface

The registers defined for the PWM Interface are accessible by the various hosts as indicated in Section 18.11, "EC-Only Registers".

18.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

18.7.1 POWER DOMAINS

TABLE 18-2: POWER SOURCES

Name	Description
VCC1	The PWM logic and registers are powered by this single power source.

18.7.2 CLOCK INPUTS

TABLE 18-3: CLOCK INPUTS

Name	Description
100kHz_Clk	100kHz_Clk clock input for generating low PWM frequencies, such as 10 Hz to 100 Hz.
48 MHz Ring Oscillator	48 MHz Ring Oscillator clock input for generating high PWM frequencies, such as 15 kHz to 30 kHz.

18.7.3 RESETS

TABLE 18-4: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal resets all the logic in this block to its initial state including the registers, which are set to their defined default state.

18.8 Interrupts

The PWM block does not generate any interrupt events.

18.9 Low Power Modes

The PWM may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry. When the PWM is in the sleep state, the internal counters reset to 0 and the internal state of the PWM and the PWM_OUTPUT signal set to the OFF state.

18.10 Description

The PWM_OUTPUT signal is used to generate a duty cycle of specified frequency. This block can be programmed so that the PWM signal toggles the PWM_OUTPUT, holds it high, or holds it low. When the PWM is configured to toggle, the PWM_OUTPUT alternates from high to low at the rate specified in the PWMx Counter ON Time Register and PWMx Counter OFF Time Register.

The following diagram illustrates how the clock inputs and registers are routed to the PWM Duty Cycle & Frequency Control logic to generate the PWM output.

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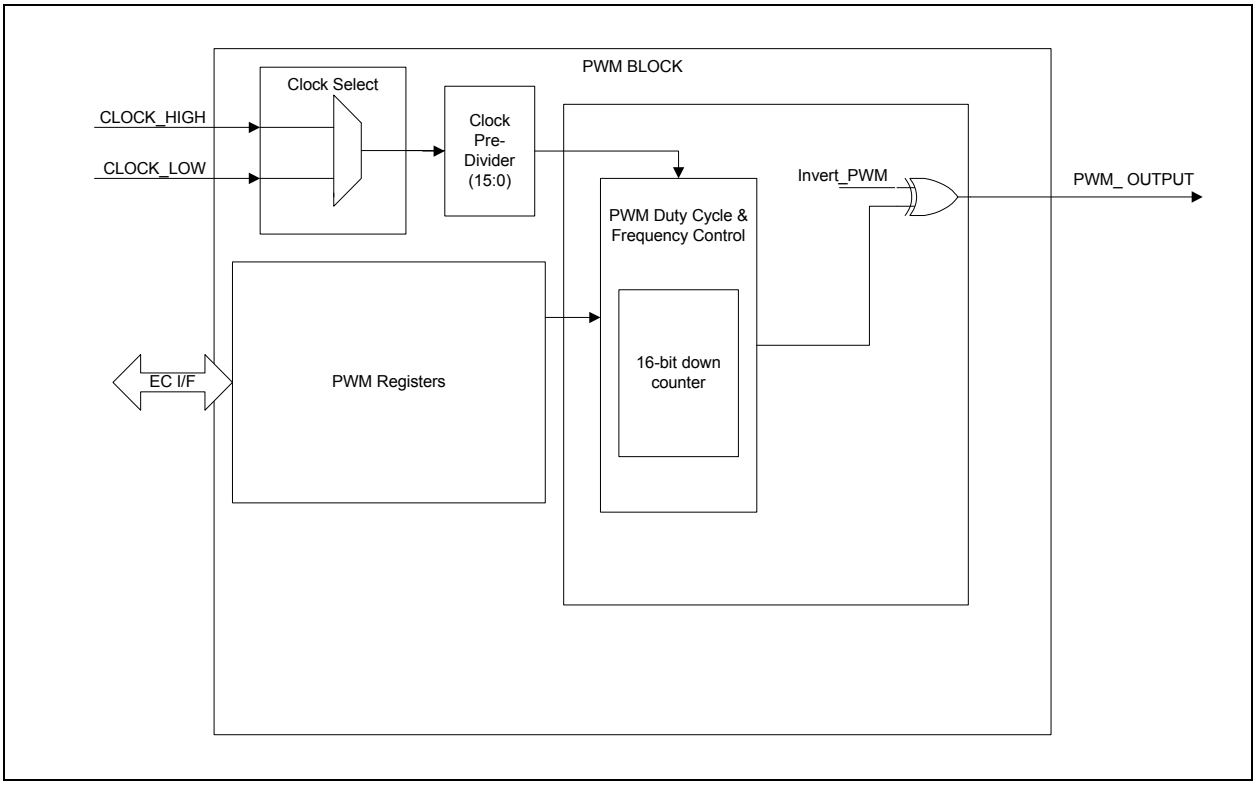
FIGURE 18-2: BLOCK DIAGRAM OF PWM CONTROLLER



Note: In Figure 18-2, the 48 MHz Ring Oscillator is represented as CLOCK_HIGH and 100kHz_Clk is represented as CLOCK_LOW.

The PWM clock source to the PWM Down Counter, used to generate a duty cycle and frequency on the PWM, is determined through the Clock select[1] and Clock Pre-Divider[6:3] bits in the PWMx Configuration Register register.

The PWMx Counter ON/OFF Time registers determine both the frequency and duty cycle of the signal generated on PWM_OUTPUT as described below.

The PWM frequency is determined by the selected clock source and the total on and off time programmed in the PWMx Counter ON Time Register and PWMx Counter OFF Time Register registers. The frequency is the time it takes (at that clock rate) to count down to 0 from the total on and off time.

The PWM duty cycle is determined by the relative values programmed in the PWMx Counter ON Time Register and PWMx Counter OFF Time Register registers.

The PWM Frequency Equation and PWM Duty Cycle Equation are shown below.

FIGURE 18-3: PWM FREQUENCY EQUATION

$$\text{PWM Frequency} = \frac{1}{(PreDivisor + 1)} \times \frac{(ClockSourceFrequency)}{(PWMCounterOnTime + PWMCounterOffTime)}$$

In Figure 18-3, the ClockSourceFrequency variable is the frequency of the clock source selected by the Clock Select bit in the PWMx Configuration Register, and PreDivisor is a field in the PWMx Configuration Register. The PWMCounterOnTime, PWMCounterOffTime are registers that are defined in Section 18.11, "EC-Only Registers".

FIGURE 18-4: PWM DUTY CYCLE EQUATION

$$\text{PWM Duty Cycle} = \frac{PWMCounterOnTime}{(PWMCounterOnTime + PWMCounterOffTime)}$$

The PWMx Counter ON Time Register and PWMx Counter OFF Time Register registers should be accessed as 16-bit values.

18.11 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the PWM. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 18-5: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
PWM	0	EC	32-bit internal address space	4000_5800h
PWM	1	EC	32-bit internal address space	4000_5810h
PWM	2	EC	32-bit internal address space	4000_5820h
PWM	3	EC	32-bit internal address space	4000_5830h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 18-6: EC-ONLY REGISTER SUMMARY

Offset	Register Name (Mnemonic)
00h	PWMx Counter ON Time Register
04h	PWMx Counter OFF Time Register
08h	PWMx Configuration Register

18.11.1 PWMX COUNTER ON TIME REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	Reserved	R	-	-
15:0	PWMX_COUNTER_ON_TIME This field determine both the frequency and duty cycle of the PWM signal. When this field is set to zero and the PWMX_COUNTER_OFF_TIME is not set to zero, the PWM_OUTPUT is held low (Full Off).	R/W	0000h	VCC1_RESET

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18.11.2 PWMX COUNTER OFF TIME REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	Reserved	R	-	-
15:0	PWMX_COUNTER_OFF_TIME This field determine both the frequency and duty cycle of the PWM signal. When this field is set to zero, the PWM_OUTPUT is held high (Full On).	R/W	FFFFh	VCC1_RESET

18.11.3 PWMX CONFIGURATION REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:7	Reserved	R	-	-
6:3	CLOCK_PRE_DIVIDER The Clock source for the 16-bit down counter (see PWMx Counter ON Time Register and PWMx Counter OFF Time Register) is determined by bit D1 of this register. The Clock source is then divided by the value of Pre-Divider+1 and the resulting signal determines the rate at which the down counter will be decremented. For example, a Pre-Divider value of 1 divides the input clock by 2 and a value of 2 divides the input clock by 3. A Pre-Divider of 0 will disable the Pre-Divider option.	R/W	0000b	VCC1_RESET
2	INVERT 1= PWM_OUTPUT ON State is active low 0=PWM_OUTPUT ON State is active high	R/W	0b	VCC1_RESET
1	CLOCK_SELECT This bit determines the clock source used by the PWM duty cycle and frequency control logic. 1=CLOCK_LOW 0=CLOCK_HIGH	R/W	0b	VCC1_RESET
0	PWM_ENABLE 1=Enabled (default) 0=Disabled (gates clocks to save power) **Note:** When the PWM enable bit is set to 0 the internal counters are reset and the internal state machine is set to the OFF state. In addition, the PWM_OUTPUT signal is set to the inactive state as determined by the Invert bit. The PWMx Counter ON Time Register and PWMx Counter OFF Time Register are not affected by the PWM enable bit and may be read and written while the PWM enable bit is 0.	R/W	0b	VCC1_RESET

19.0 RPM-PWM INTERFACE

19.1 Introduction

The RPM-PWM Interface is closed-loop RPM based Fan Control Algorithm that monitors the fan's speed and automatically adjusts the drive to maintain the desired fan speed.

The RPM-PWM Interface functionality consists of a closed-loop "set-and-forget" RPM based fan controller.

19.2 References

No references have been cited for this chapter

19.3 Terminology

There is no terminology defined for this chapter.

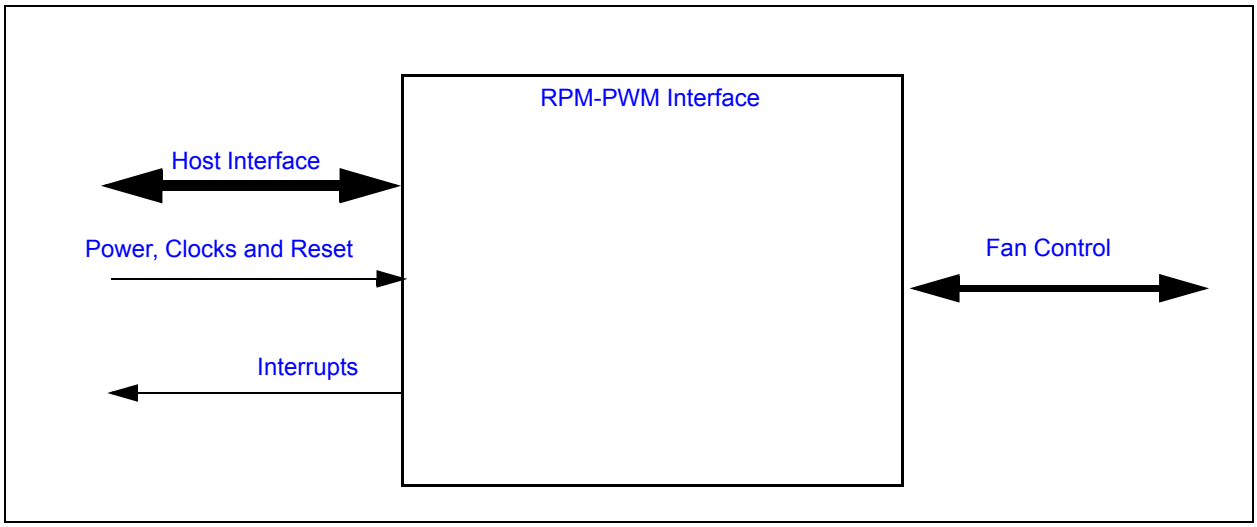
19.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

The registers in the block are accessed by embedded controller code at the addresses shown in Section 19.9, "Fan Control Register Bank".

Figure 19-1 illustrates and categorizes the RPM-PWM Interface block signals. These signals are described in Table 19-1.

FIGURE 19-1: RPM-PWM INTERFACE I/O DIAGRAM



19.4.1 FAN CONTROL

The Fan Control Signal Description Table lists the signals that are routed to/from the block.

TABLE 19-1: FAN CONTROL SIGNAL DESCRIPTION TABLE

Name	Direction	Description
TACH	Input	Tachometer input from fan
PWM	Output	PWM fan drive output

19.4.2 HOST INTERFACE

The registers defined for the RPM-PWM Interface are accessible by the various hosts as indicated in Section 19.9, "Fan Control Register Bank".

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19.5 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

19.5.1 POWER DOMAINS

TABLE 19-2: POWER SOURCES

Name	Description
VCC1	This power well sources the registers and logic in this block.

19.5.2 CLOCK INPUTS

TABLE 19-3: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This clock signal drives selected logic (e.g., counters).

19.5.3 RESETS

TABLE 19-4: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal resets all of the registers and logic in this block.

19.6 Interrupts

This section defines the Interrupt Sources generated from this block.

TABLE 19-5: INTERRUPTS

Source	Description
Fan Fail/Spin Status Interrupt	The DRIVE_FAIL & FAN_SPIN bits in the Fan Status Register are logically ORed and routed to the FAIL_SPIN Interrupt
Fan Stall Status Interrupt	The FAN_STALL bit in the Fan Status Register is routed to the FAN_STALL Interrupt

19.7 Low Power Modes

The RPM-PWM Interface may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

19.8 Description

This section defines the functionality of the block.

19.8.1 GENERAL OPERATION

The RPM-PWM Interface is an RPM based Fan Control Algorithm that monitors the fan's speed and automatically adjusts the drive to maintain the desired fan speed. This RPM based Fan Control Algorithm controls a PWM output based on a tachometer input.

19.8.2 FAN CONTROL MODES OF OPERATION

The RPM-PWM Interface has two modes of operation for the PWM Fan Driver. They are:

1. Manual Mode - in this mode of operation, the user directly controls the fan drive setting. Updating the Fan Driver Setting Register (see Section 19.9.1, "Fan Setting Register") will update the fan drive based on the programmed ramp rate (default disabled).

- The Manual Mode is enabled by clearing the EN_ALGO bit in the Fan Configuration Register (see Section 19.9.3, "Fan Configuration 1 Register").
- Whenever the Manual Mode is enabled the current drive settings will be changed to what was last used by the RPM control algorithm.
- Setting the drive value to 00h will disable the PWM Fan Driver.
- Changing the drive value from 00h will invoke the Spin Up Routine.

2. Using RPM based Fan Control Algorithm - in this mode of operation, the user determines a target tachometer reading and the drive setting is automatically updated to achieve this target speed.

TABLE 19-6: FAN CONTROLS ACTIVE FOR OPERATING MODE

Manual Mode	Algorithm
Fan Driver Setting (read / write)	Fan Driver Setting (read only)
EDGES[1:0] (Fan Configuration)	EDGES[1:0] (Fan Configuration)
UPDATE[2:0] (Fan configuration)	UPDATE[2:0] (Fan configuration)
LEVEL (Spin Up Configuration)	LEVEL (Spin Up Configuration)
SPINUP_TIME[1:0] (Spin Up Configuration)	SPINUP_TIME[1:0] (Spin Up Configuration)
Fan Step	Fan Step
-	Fan Minimum Drive
Valid TACH Count	Valid TACH Count
-	TACH Target
TACH Reading	TACH Reading
RANGE[2:0] (Fan Configuration 2)	RANGE[2:0] (Fan Configuration 2)
-	DRIVE_FAIL_CNT[2:0] (Spin Up Config) and Drive Fail Band

19.8.3 RPM BASED FAN CONTROL ALGORITHM

The RPM-PWM Interface includes an RPM based Fan Control Algorithm.

The fan control algorithm uses Proportional, Integral, and Derivative terms to automatically approach and maintain the system's desired fan speed to an accuracy directly proportional to the accuracy of the clock source. Figure 19-2, "RPM based Fan Control Algorithm" shows a simple flow diagram of the RPM based Fan Control Algorithm operation.

The desired tachometer count is set by the user inputting the desired number of 32.768KHz cycles that occur per fan revolution. The user may change the target count at any time. The user may also set the target count to FFh in order to disable the fan driver.

For example, if a desired RPM rate for a 2-pole fan is 3000 RPMs, the user would input the hexadecimal equivalent of 1312d (52_00h in the TACH Target Registers). This number represents the number of 32.768KHz cycles that would occur during the time it takes the fan to complete a single revolution when it is spinning at 3000RPMs (see Section 19.9.11, "TACH Target Register" and Section 19.9.12, "TACH Reading Register").

The RPM-PWM Interface's RPM based Fan Control Algorithm has programmable configuration settings for parameters such as ramp-rate control and spin up conditions. The fan driver automatically detects and attempts to alleviate a stalled/stuck fan condition while also asserting the interrupt signal. The RPM-PWM Interface works with fans that operate up to 16,000 RPMs and provide a valid tachometer signal. The fan controller will function either with an externally supplied 32.768KHz clock source or with its own internal 32KHz oscillator depending on the required accuracy.

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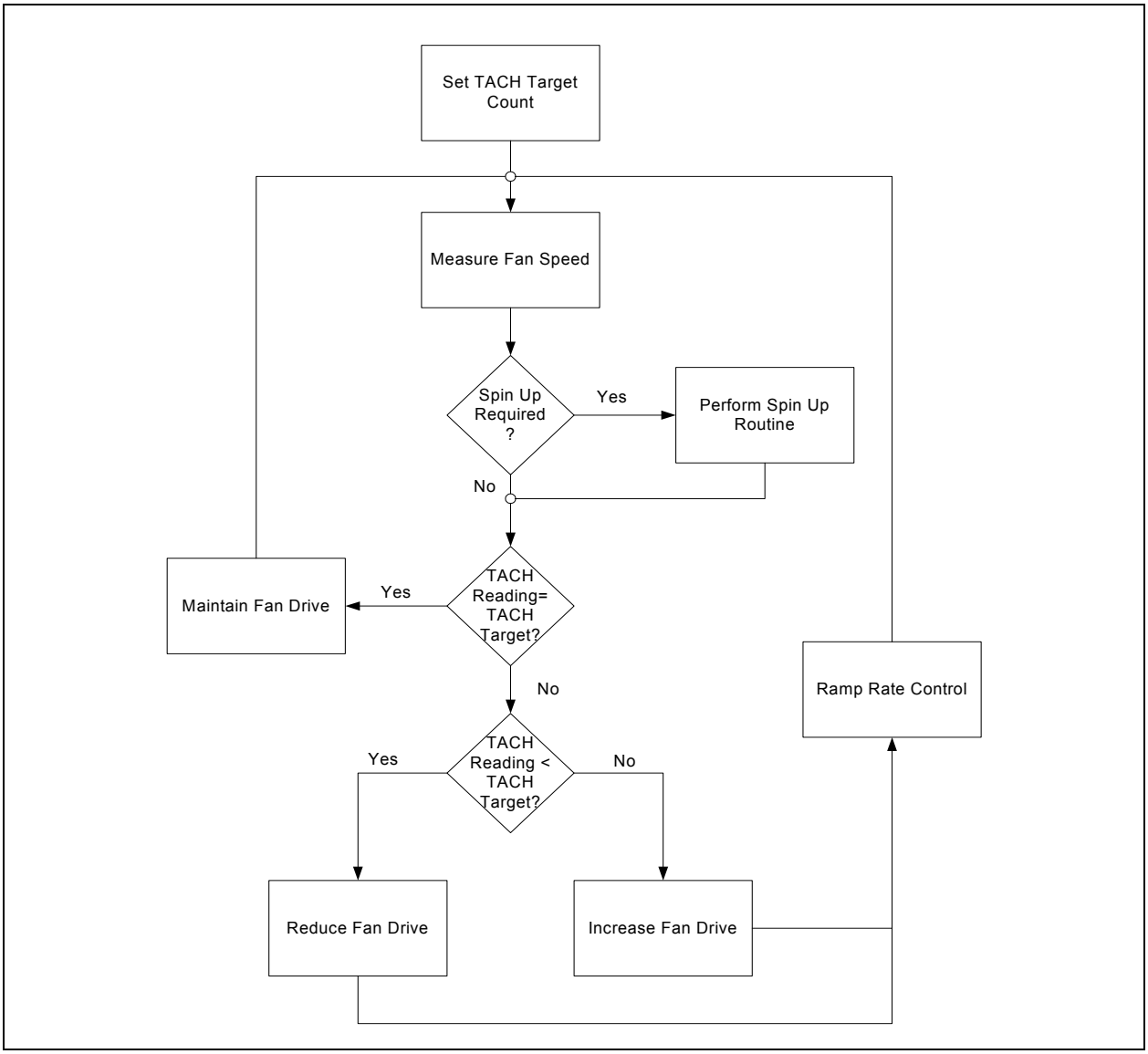
FIGURE 19-2: RPM BASED FAN CONTROL ALGORITHM



19.8.3.1 Programming the RPM Based Fan Control Algorithm

The RPM based Fan Control Algorithm powers-up disabled. The following registers control the algorithm. The RPM-PWM Interface fan control registers are pre-loaded with defaults that will work for a wide variety of fans so only the TACH Target Register is required to set a fan speed. The other fan control registers can be used to fine-tune the algorithm behavior based on application requirements.

1. Set the Valid TACH Count Register to the minimum tachometer count that indicates the fan is spinning.
2. Set the Spin Up Configuration Register to the spin up level and Spin Time desired.
3. Set the Fan Step Register to the desired step size.
4. Set the Fan Minimum Drive Register to the minimum drive value that will maintain fan operation.
5. Set the Update Time, and Edges options in the Fan Configuration Register.
6. Set the TACH Target Register to the desired tachometer count.
7. Enable the RPM based Fan Control Algorithm by setting the EN_ALGO bit.

19.8.3.2 Tachometer Measurement

In both modes of operation, the tachometer measurement operates independently of the mode of operation of the fan driver and RPM based Fan Speed Control algorithm. Any tachometer reading that is higher than the Valid TACH Count (see Section 19.9.9, "Valid TACH Count Register") will flag a stalled fan and trigger an interrupt.

When measuring the tachometer, the fan must provide a valid tachometer signal at all times to ensure proper operation. The tachometer measurement circuitry is programmable to detect the fan speed of a variety of fan configurations and architectures including 1-pole, 2-pole (default), 3-pole, and 4-pole fans.

APPLICATION NOTE: The tachometer measurement works independently of the drive settings. If the device is put into manual mode and the fan drive is set at a level that is lower than the fan can operate (including zero drive), the tachometer measurement may signal a Stalled Fan condition and assert an interrupt.

STALLED FAN

If the TACH Reading Register exceeds the user-programmable Valid TACH Count setting, it will flag the fan as stalled and trigger an interrupt. If the RPM based Fan Control Algorithm is enabled, the algorithm will automatically attempt to restart the fan until it detects a valid tachometer level or is disabled.

The FAN_STALL Status bit indicates that a stalled fan was detected. This bit is checked conditionally depending on the mode of operation.

- Whenever the Manual Mode is enabled or whenever the drive value is changed from 00h, the FAN_STALL interrupt will be masked for the duration of the programmed Spin Up Time (see Table 19-17, “Spin time,” on page 203) to allow the fan an opportunity to reach a valid speed without generating unnecessary interrupts.
- In Manual Mode, whenever the TACH Reading Register exceeds the Valid TACH Count Register setting, the FAN_STALL status bit will be set.
- When the RPM based Fan Control Algorithm, the stalled fan condition is checked whenever the Update Time is met and the fan drive setting is updated. It is not a continuous check.

19.8.3.3 Spin Up Routine

The RPM-PWM Interface also contains programmable circuitry to control the spin up behavior of the fan driver to ensure proper fan operation. The Spin Up Routine is initiated under the following conditions:

- The TACH Target High Byte Register value changes from a value of FFh to a value that is less than the Valid TACH Count (see Section 19.9.9, "Valid TACH Count Register").
- The RPM based Fan Control Algorithm’s measured tachometer reading is greater than the Valid TACH Count.
- When in Manual Mode, the Drive Setting changes from a value of 00h.

When the Spin Up Routine is operating, the fan driver is set to full scale for one quarter of the total user defined spin up time. For the remaining spin up time, the fan driver output is set a a user defined level (30% to 65% drive).

After the Spin Up Routine has finished, the RPM-PWM Interface measures the tachometer. If the measured tachometer reading is higher than the Valid TACH Count Register setting, the FAN_SPIN status bit is set and the Spin Up Routine will automatically attempt to restart the fan.

APPLICATION NOTE: When the device is operating in manual mode, the FAN_SPIN status bit may be set if the fan drive is set at a level that is lower than the fan can operate (excluding zero drive which disables the fan driver). If the FAN_SPIN interrupt is unmasked, this condition will trigger an errant interrupt.

Figure 19-3, "Spin Up Routine" shows an example of the Spin Up Routine in response to a programmed fan speed change based on the first condition above.

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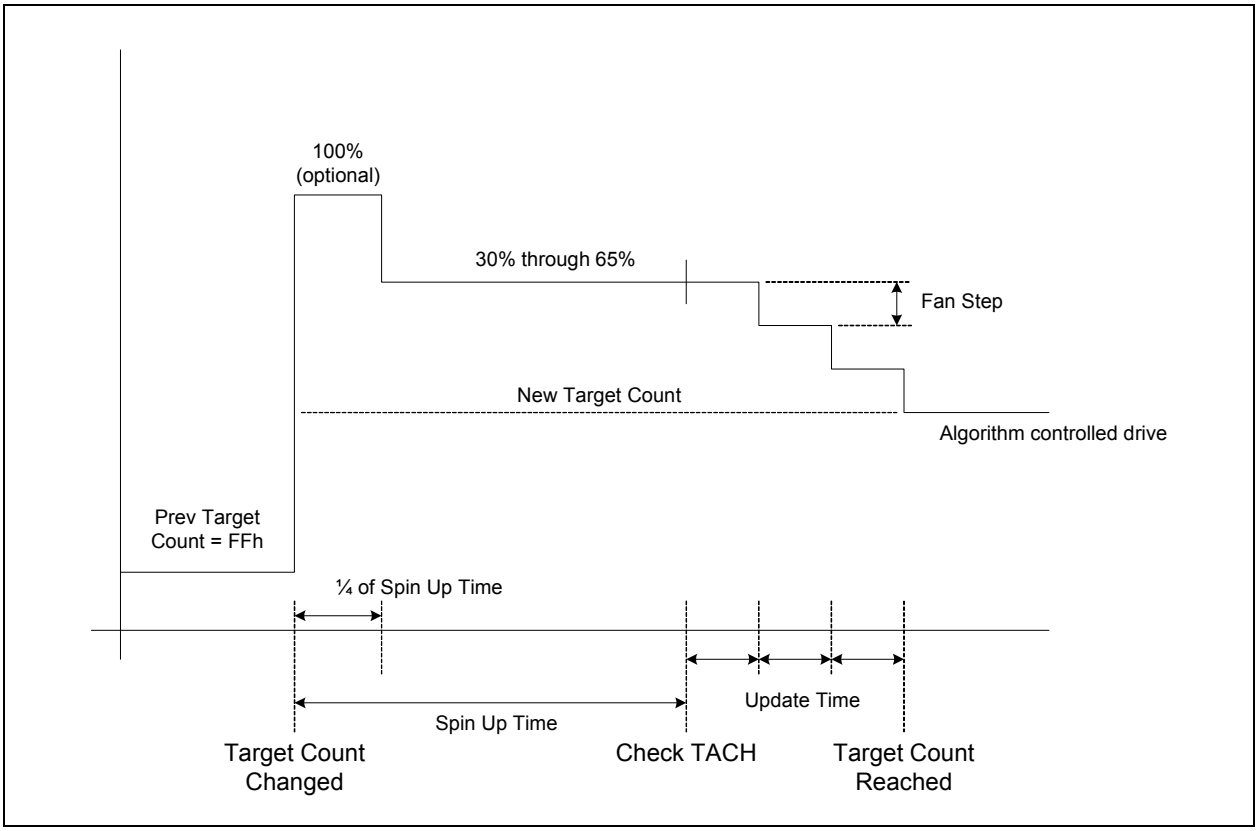
FIGURE 19-3: SPIN UP ROUTINE



19.8.4 PWM DRIVER

The RPM-PWM Interface contains an optional, programmable 8-bit PWM driver which can serve as part of the RPM based Fan Speed Control Algorithm or in Manual Mode.

When enabled, the PWM driver can operate in four programmable frequency bands. The lower frequency bands offer frequencies in the range of 9.5Hz to 4.8kHz while the higher frequency options offer frequencies of 21Hz or 25.2kHz.

19.8.5 ALERTS AND LIMITS

Figure 19-4, "Interrupt Flow" shows the interactions of the interrupts for fan events.

If the Fan Driver detects a drive fail, spin-up or stall event, the interrupt signal will be asserted (if enabled).

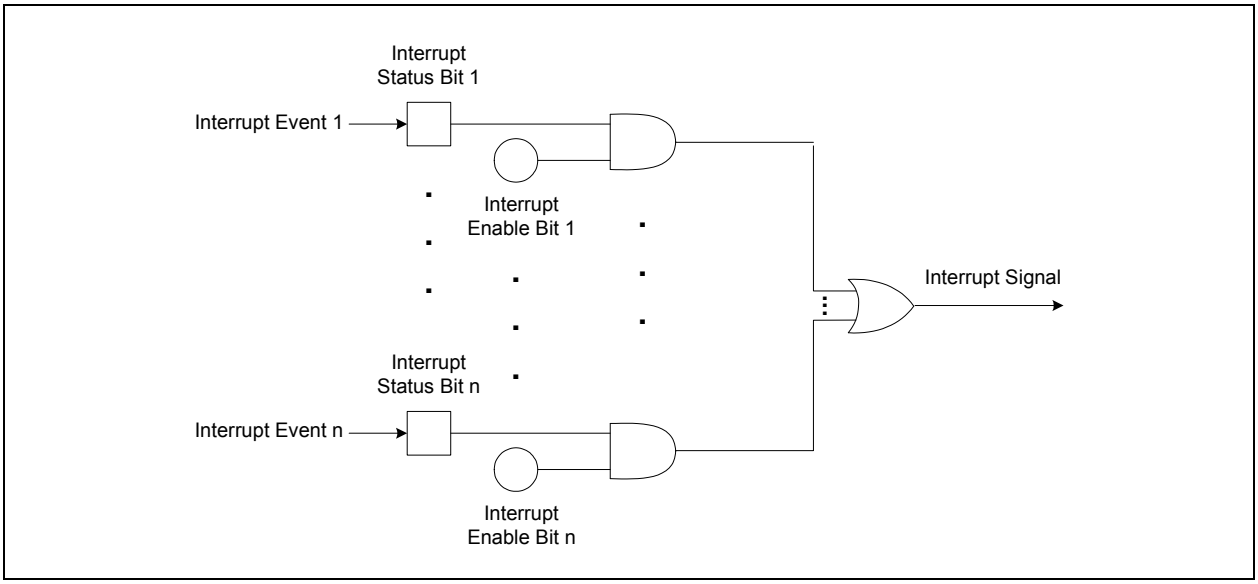
All of these interrupts can be masked from asserting the interrupt signal individually. If any bit of either Status register is set, the interrupt signal will be asserted provided that the corresponding interrupt enable bit is set accordingly.

The Status register will be updated due to an active event, regardless of the setting of the individual enable bits. Once a status bit has been set, it will remain set until the Status register bit is written to 1 (and the error condition has been removed).

If the interrupt signal is asserted, it will be cleared immediately if either the status or enable bit is cleared.

See Section 19.6, "Interrupts," on page 191.

FIGURE 19-4: INTERRUPT FLOW



19.9 Fan Control Register Bank

The registers listed in the Table 19-8, "Fan Control Register Summary" are for a single instance of the RPM-PWM Interface block. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in Table 19-7, "Fan Control Register Bank Base Address Table".

TABLE 19-7: FAN CONTROL REGISTER BANK BASE ADDRESS TABLE

Instance Name	Instance Number	Host	Address Space	Base Address (Note 19-1)
RPM-PWM Interface	0	EC	32-bit internal address space	4000_A000h

Note 19-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 19-8: FAN CONTROL REGISTER SUMMARY

Register Name	Offset
Fan Setting	00h
PWM Divide	01h
Fan Configuration 1	02h
Fan Configuration 2	03h
MCHP Reserved	04h
Gain	05h
Fan Spin Up Configuration	06h
Fan Step	07h
Fan Minimum Drive	08h
Valid Tach Count	09h
Fan Drive Fail Band Low Byte	0Ah
Fan Drive Fail Band High Byte	0Bh
Tach Target Low Byte	0Ch
Tach Target High Byte	0Dh
Tach Reading Low Byte	0Eh

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TABLE 19-8: FAN CONTROL REGISTER SUMMARY (CONTINUED)

Register Name	Offset
Tach Reading High Byte	0Fh
PWM Driver Base Frequency	10h
Fan Status	11h

19.9.1 FAN SETTING REGISTER

The Fan Setting Registers are used to control the output of the Fan Driver. The driver setting operates independently of the Polarity bit for the PWM output. That is, a setting of 00h will mean that the fan drive is at minimum drive while a value of FFh will mean that the fan drive is at maximum drive.

If the Spin Up Routine is invoked, reading from the registers will return the current fan drive setting that is being used by the Spin Up Routine instead of what was previously written into these registers.

The Fan Driver Setting Registers, when the RPM based Fan Control Algorithm is enabled, are read only. Writing to the register will have no effect and the data will not be stored. Reading from the register will always return the current fan drive setting.

If the INT_PWRGD pin is de-asserted, the Fan Driver Setting Register will be made read only. Writing to the register will have no effect and reading from the register will return 000h.

When the RPM based Fan Control Algorithm is disabled, the current fan drive setting that was last used by the algorithm is retained and will be used.

If the Fan Driver Setting Register is set to a value of 00h, all tachometer related status bits will be masked until the setting is changed. Likewise, the FAN_SHORT bit will be cleared and masked until the setting is changed.

The contents of the register represent the weighting of each bit in determining the final duty cycle. The output drive for a PWM output is given by the following equation:

- Drive = (FAN_SETTING VALUE/255) x 100%.

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	FAN_SETTING[7:0] The Fan Driver Setting used to control the output of the Fan Driver.	R/W	00h	VCC1_RESET

19.9.2 PWM DIVIDE REGISTER

The PWM Divide Register determines the final PWM frequency. The base frequency set by the PWM_BASE[1:0] bits is divided by the decimal equivalent of the register settings.

The final PWM frequency is derived as the base frequency divided by the value of this register as shown in the equation below:

- PWM_Frequency = base_clk / PWM_D

Where:

- base_clk = The base frequency set by the PWMx_CFG[1:0] bits
- PWM_D = the divide setting set by the PWM Divide Register.

Offset	01h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	PWM_DIVIDE[7:0] The PWM Divide value determines the final frequency of the PWM driver. The driver base frequency is divided by the PWM Divide value to determine the final frequency.	R/W	01h	VCC1_RESET

19.9.3 FAN CONFIGURATION 1 REGISTER

The Fan Configuration Register 1 controls the general operation of the RPM based Fan Control Algorithm used by the fan driver.

Offset	02h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	EN_ALGO Enables the RPM based Fan Control Algorithm. • '0' - (default) the control circuitry is disabled and the fan driver output is determined by the Fan Driver Setting Register. • '1' - the control circuitry is enabled and the Fan Driver output will be automatically updated to maintain the programmed fan speed as indicated by the TACH Target Register.	R/W	0b	VCC1_RESET
6:5	RANGE[1:0] Adjusts the range of reported and programmed tachometer reading values. The RANGE bits determine the weighting of all TACH values (including the Valid TACH Count, TACH Target, and TACH reading) as shown in Table 19-9, "Range Decode".	R/W	01b	VCC1_RESET
4:3	EDGES[1:0] Determines the minimum number of edges that must be detected on the TACH signal to determine a single rotation. A typical fan measured 5 edges (for a 2-pole fan). Increasing the number of edges measured with respect to the number of poles of the fan will cause the TACH Reading registers to indicate a fan speed that is higher or lower than the actual speed. In order for the FSC Algorithm to operate correctly, the TACH Target must be updated by the user to accommodate this shift. The Effective Tach Multiplier shown in Table 19-10, "Minimum Edges for Fan Rotation" is used as a direct multiplier term that is applied to the Actual RPM to achieve the Reported RPM. It should only be applied if the number of edges measured does not match the number of edges expected based on the number of poles of the fan (which is fixed for any given fan). Contact Microchip for recommended settings when using fans with more or less than 2 poles.	R/W	01b	VCC1_RESET
2:0	UPDATE[2:0] Determines the base time between fan driver updates. The Update Time, along with the Fan Step Register, is used to control the ramp rate of the drive response to provide a cleaner transition of the actual fan operation as the desired fan speed changes. The Update Time is set as shown in Table 19-11, "Update Time". **APPLICATION NOTE:** This ramp rate control applies for all changes to the active PWM output including when the RPM based Fan Speed Control Algorithm is disabled.	R/W	011b	VCC1_RESET

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TABLE 19-9: RANGE DECODE

Range [1:0]		Reported Minimum RPHM	TACH Count Multiplier
1	0		
0	0	500	1
0	1	1000 (default)	2
1	0	2000	4
1	1	4000	8

TABLE 19-10: MINIMUM EDGES FOR FAN ROTATION

Edges 1:0]		Minimum TACH Edges	Number of Fan Poles	Effective TACH Multiplier (Based on 2 Pole Fans) If Edges Changed
1	0			
0	0	3	1	0.5
0	1	5	2 (default)	1
1	0	7	3	1.5
1	1	9	4	2

TABLE 19-11: UPDATE TIME

Update [2:0]			TACH Count Multiplier (ms)
2	1	0	
0	0	0	100
0	0	1	200
0	1	0	300
0	1	1	400 (default)
1	0	0	500
1	0	1	800
1	1	0	1200
1	1	1	1600

19.9.4 FAN CONFIGURATION 2 REGISTER

The Fan Configuration 2 Register controls the tachometer measurement and advanced features of the RPM based Fan Control Algorithm.

Offset	03h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	MCHP Reserved	R/W	0b	VCC1_RESET
6	EN_RRC Enables the ramp rate control circuitry during the Manual Mode of operation. • '0' (default) - The ramp rate control circuitry for the Manual Mode of operation is disabled. When the Fan Drive Setting values are changed and the RPM based Fan Control Algorithm is disabled, the fan driver will be set to the new setting immediately. • '1' - The ramp rate control circuitry for the Manual Mode of operation is enabled. The PWM setting will follow the ramp rate controls as determined by the Fan Step and Update Time settings. The maximum PWM step is capped at the Fan Step setting and is updated based on the Update Time as given by Table 19-11, "Update Time".	R/W	0b	VCC1_RESET
5	DIS_GLITCH Disables the low pass glitch filter that removes high frequency noise injected on the TACH pin. • '0' (default) - The glitch filter is enabled. • '1' - The glitch filter is disabled.	R/W	0b	VCC1_RESET
4:3	DER_OPT[1:0] Control some of the advanced options that affect the derivative portion of the RPM based fan control algorithm as shown in Table 19-12, "Derivative Options". These bits only apply if the Fan Speed Control Algorithm is used.	R/W	11b	VCC1_RESET
2:1	ERR_RNG[1:0] Control some of the advanced options that affect the error window. When the measured fan speed is within the programmed error window around the target speed, the fan drive setting is not updated. These bits only apply if the Fan Speed Control Algorithm is used. See Table 19-13, "Error Range Options".	R/W	01b	VCC1_RESET
0	POLARITY Determines the polarity of the PWM driver. This does NOT affect the drive setting registers. A setting of 0% drive will still correspond to 0% drive independent of the polarity. • '0' (default) - the Polarity of the PWM driver is normal. A drive setting of 00h will cause the output to be set at 0% duty cycle and a drive setting of FFh will cause the output to be set at 100% duty cycle. • '1' - The Polarity of the PWM driver is inverted. A drive setting of 00h will cause the output to be set at 100% duty cycle and a drive setting of FFh will cause the output to be set at 0% duty cycle.	R/W	0b	VCC1_RESET

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TABLE 19-12: DERIVATIVE OPTIONS

DER_OPT[1:0]		Operation	NOTE (see Section 19.9.7, "Fan Step Register")
1	0		
0	0	No derivative options used	PWM steps are limited to the maximum PWM drive step value in Fan Step Register
0	1	Basic derivative. The derivative of the error from the current drive setting and the target is added to the iterative PWM drive setting (in addition to proportional and integral terms)	PWM steps are limited to the maximum PWM drive step value in Fan Step Register
1	0	Step derivative. The derivative of the error from the current drive setting and the target is added to the iterative PWM drive setting and is not capped by the maximum PWM drive step. This allows for very fast response times	PWM steps are not limited to the maximum PWM drive step value in Fan Step Register (i.e., maximum fan step setting is ignored)
1	1	Both the basic derivative and the step derivative are used effectively causing the derivative term to have double the effect of the derivative term (default).	PWM steps are not limited to the maximum PWM drive step value in Fan Step Register (i.e., maximum fan step setting is ignored)

TABLE 19-13: ERROR RANGE OPTIONS

ERR_RNGX[1:0]		Operation
1	0	
0	0	0 RPM
0	1	50 RPM (default)
1	0	100 RPM
1	1	200 RPM

19.9.5 GAIN REGISTER

The Gain Register The Gain Register stores the gain terms used by the proportional and integral portions of the RPM based Fan Control Algorithm. These terms will affect the FSC closed loop acquisition, overshoot, and settling as would be expected in a classic PID system.

This register only applies if the Fan Speed Control Algorithm is used.

Offset	05h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:6	RESERVED	R/W	00h	-
5:4	GAIND[1:0] The derivative gain term. See Table 19-14, "Gain Decode".	R/W	10h	VCC1_RESET
3:2	GAINI[1:0] The integral gain term. See Table 19-14, "Gain Decode".	R/W	10h	VCC1_RESET
1:0	GAINP[1:0] The proportional gain term. See Table 19-14, "Gain Decode".	R/W	10h	VCC1_RESET

TABLE 19-14: GAIN DECODE

GAIND or GAINP or GAINI [1:0]		Respective Gain Factor
1	**0**	
0	0	1x
0	1	2x
1	0	4x (default)
1	1	8x

19.9.6 FAN SPIN UP CONFIGURATION REGISTER

The Fan Spin Up Configuration Register controls the settings of Spin Up Routine.

Offset	06h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:6	DRIVE_FAIL_CNT[1:0] Determines how many update cycles are used for the Drive Fail detection function as shown in Table 19-15, "DRIVE_FAIL_CNT[1:0] Bit Decode". This circuitry determines whether the fan can be driven to the desired Tach target. These settings only apply if the Fan Speed Control Algorithm is enabled.	R/W	00b	VCC1_RESET
5	NOKICK Determines if the Spin Up Routine will drive the fan to 100% duty cycle for 1/4 of the programmed spin up time before driving it at the programmed level. • '0' (default) - The Spin Up Routine will drive the PWM to 100% for 1/4 of the programmed spin up time before reverting to the programmed spin level. • '1' - The Spin Up Routine will not drive the PWM to 100%. It will set the drive at the programmed spin level for the entire duration of the programmed spin up time.	R/W	0b	VCC1_RESET
4:2	SPIN_LVL[2:0] SPIN_LVL[2:0] - Determines the final drive level that is used by the Spin Up Routine as shown in Table 19-16, "Spin Level".	R/W	110b	VCC1_RESET
1:0	SPINUP_TIME[1:0] Determines the maximum Spin Time that the Spin Up Routine will run for. If a valid tachometer measurement is not detected before the Spin Time has elapsed, an interrupt will be generated. When the RPM based Fan Control Algorithm is active, the fan driver will attempt to re-start the fan immediately after the end of the last spin up attempt. The Spin Time is set as shown in Table 19-17, "Spin time".	R/W	01b	VCC1_RESET

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TABLE 19-15: DRIVE_FAIL_CNT[1:0] BIT DECODE

DRIVE_FAIL_CNT[1:0]		Number of Update Periods
1	0	
0	0	Disabled - the Drive Fail detection circuitry is disabled
0	1	16 - the Drive Fail detection circuitry will count for 16 update periods
1	0	32 - the Drive Fail detection circuitry will count for 32 update periods
1	1	64 - the Drive Fail detection circuitry will count for 64 update periods

TABLE 19-16: SPIN LEVEL

SPIN_LVL[2:0]			Spin Up Drive Level
2	1	0	
0	0	0	30%
0	0	1	35%
0	1	0	40%
0	1	1	45%
1	0	0	50%
1	0	1	55%
1	1	0	60% (default)
1	1	1	65%

TABLE 19-17: SPIN TIME

SPINUP_TIME[1:0]		Total Spin Up Time
1	0	
0	0	250 ms
0	1	500 ms (default)
1	0	1 sec
1	1	2 sec

19.9.7 FAN STEP REGISTER

The Fan Step Register, along with the Update Time, controls the ramp rate of the fan driver response calculated by the RPM based Fan Control Algorithm for the Derivative Options field values of “00” and “01” in the Fan Configuration 2 Register (see Table 19-12, “Derivative Options,” on page 201).

The value of the register represents the maximum step size the fan driver will take for each update (see Section 19.9.3, "Fan Configuration 1 Register," on page 198).

When the maximum step size limitation is applied, if the necessary fan driver delta is larger than the Fan Step, it will be capped at the Fan Step setting and updated every Update Time ms.

The maximum step size is ignored for the Derivative Options field values of “10” and “11”.

Offset	07h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:6	RESERVED	R/W	00h	-
5:0	FAN_STEP[5:0] The Fan Step value represents the maximum step size the fan driver will take between update times	R/W	10h	VCC1_RESET

19.9.8 FAN MINIMUM DRIVE REGISTER

the Fan Minimum Drive Register stores the minimum drive setting for the RPM based Fan Control Algorithm. The RPM based Fan Control Algorithm will not drive the fan at a level lower than the minimum drive unless the target Fan Speed is set at FFh (see "TACH Target Registers").

During normal operation, if the fan stops for any reason (including low drive), the RPM based Fan Control Algorithm will attempt to restart the fan. Setting the Fan Minimum Drive Registers to a setting that will maintain fan operation is a useful way to avoid potential fan oscillations as the control circuitry attempts to drive it at a level that cannot support fan operation.

These registers only apply if the Fan Speed Control Algorithm is used.

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	MIN_DRIVE[7:0] The minimum drive setting.	R/W	66h	VCC1_RESET

APPLICATION NOTE: To ensure proper operation, the Fan Minimum Drive register must be set prior to setting the Tach Target High and Low Byte registers, and then the Tach Target registers can be subsequently updated. At a later time, if the Fan Minimum Drive register is changed to a value higher than current Fan value, the Tach Target registers must also be updated.

19.9.9 VALID TACH COUNT REGISTER

The Valid TACH Count Register stores the maximum TACH Reading Register value to indicate that the fan is spinning properly. The value is referenced at the end of the Spin Up Routine to determine if the fan has started operating and decide if the device needs to retry. See the equation in the TACH Reading Registers section for translating the RPM to a count.

If the TACH Reading Register value exceeds the Valid TACH Count Register (indicating that the Fan RPM is below the threshold set by this count), a stalled fan is detected. In this condition, the algorithm will automatically begin its Spin Up Routine.

APPLICATION NOTE: The automatic invoking of the Spin Up Routine only applies if the Fan Speed Control Algorithm is used. If the FSC is disabled, then the device will only invoke the Spin Up Routine when the PWM setting changes from 00h.

If a TACH Target setting is set above the Valid TACH Count setting, that setting will be ignored and the algorithm will use the current fan drive setting.

These registers only apply if the Fan Speed Control Algorithm is used.

Offset	09h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	VALID_TACH_CNT[7:0] The maximum TACH Reading Register value to indicate that the fan is spinning properly.	R/W	F5h	VCC1_RESET

19.9.10 FAN DRIVE FAIL BAND REGISTER

The Fan Drive Fail Band Registers store the number of Tach counts used by the Fan Drive Fail detection circuitry. This circuitry is activated when the fan drive setting high byte is at FFh. When it is enabled, the actual measured fan speed is compared against the target fan speed.

This circuitry is used to indicate that the target fan speed at full drive is higher than the fan is actually capable of reaching. If the measured fan speed does not exceed the target fan speed minus the Fan Drive Fail Band Register settings for a period of time longer than set by the DRIVE_FAIL_CNTx[1:0] bits in the Fan Spin Up Configuration Register on page 202, the DRIVE_FAIL status bit will be set and an interrupt generated.

These registers only apply if the Fan Speed Control Algorithm is used.

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Offset	0Ah			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:3	FAN_DRIVE_FAIL_BAND[12:0] The number of Tach counts used by the Fan Drive Fail detection circuitry	RES	0000000000000b	VCC1_RESET
2:0	RESERVED	R/W	000b	-

19.9.11 TACH TARGET REGISTER

The TACH Target Registers hold the target tachometer value that is maintained for the RPM based Fan Control Algorithm.

If the algorithm is enabled, setting the TACH Target Register High Byte to FFh will disable the fan driver (or set the PWM duty cycle to 0%). Setting the TACH Target to any other value (from a setting of FFh) will cause the algorithm to invoke the Spin Up Routine after which it will function normally.

These registers only apply if the Fan Speed Control Algorithm is used.

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:3	TACH_TARGET[12:0] The target tachometer value.	RES	1111111111111b	VCC1_RESET
2:0	RESERVED	R/W	000b	-

19.9.12 TACH READING REGISTER

The TACH Reading Registers' contents describe the current tachometer reading for the fan. By default, the data represents the fan speed as the number of 32.768kHz clock periods that occur for a single revolution of the fan.

The Equation below shows the detailed conversion from tachometer measurement (COUNT) to RPM.

$$RPM = \frac{1}{Poles} \times \frac{(n-1)}{COUNT \times \frac{1}{m}} \times fTACH \times 60$$

where:

- Poles = number of poles of the fan (typically 2)
- f_{TACH} = the frequency of the tachometer measurement clock
- n = number of edges measured (typically 5 for a 2 pole fan)
- m = the multiplier defined by the RANGE bits
- COUNT = TACH Reading Register value (in decimal)

The following equation shows the simplified translation of the TACH Reading Register count to RPM assuming a 2-pole fan, measuring 5 edges, with a frequency of 32.768kHz.

$$RPM = \frac{3932160 \times m}{COUNT}$$

Offset	0Eh			
Bits	**Description**	**Type**	**Default**	**Reset Event**
15:3	TACH_READING[12:0] The current tachometer reading value.	RES	1111111111111b	VCC1_RESET
2:0	RESERVED	R/W	000b	-

19.9.13 PWM DRIVER BASE FREQUENCY REGISTER

- The PWM Driver Base Register controls the base PWM frequency range.

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:2	RESERVED	RES	000000b	-
1:0	PWM_BASE[1:0] Determines the frequency range of the PWM fan driver (when enabled) as shown in Table 19-18.	R/W	00b	VCC1_RESET

TABLE 19-18: PWM_BASE[1:0] DECODE

PWM_BASE[1:0]		PWM Frequency
1	**0**	
0	0	26.83KHz
0	1	20.87kHz
1	0	4.82kHz
1	1	2.41KHz

19.9.14 FAN STATUS REGISTER

The bits in this register are routed to interrupts.

Offset	11h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:6	RESERVED	RES	00b	-
5	DRIVE_FAIL The bit Indicates that the RPM-based Fan Speed Control Algorithm cannot drive the Fan to the desired target setting at maximum drive. • '0' - The RPM-based Fan Speed Control Algorithm can drive Fan to the desired target setting. • '1' - The RPM-based Fan Speed Control Algorithm cannot drive Fan to the desired target setting at maximum drive.	R/WC	0b	VCC1_RESET
4:2	RESERVED	RES	000b	-

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Offset	11h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
1	FAN_SPIN The bit Indicates that the Spin up Routine for the Fan could not detect a valid tachometer reading within its maximum time window. • '0' - The Spin up Routine for the Fan detected a valid tachometer reading within its maximum time window. • '1' - The Spin up Routine for the Fan could not detect a valid tachometer reading within its maximum time window.	R/WC	0b	VCC1_RESET
0	**FAN_STALL** The bit Indicates that the tachometer measurement on the Fan detects a stalled fan. • '0' - Stalled fan not detected. • '1' - Stalled fan not detected.	R/WC	0b	VCC1_RESET

20.0 GENERAL PURPOSE SERIAL PERIPHERAL INTERFACE

20.1 Overview

The General Purpose Serial Peripheral Interface (GP-SPI) may be used to communicate with various peripheral devices, e.g., EEPROMS, DACs, ADCs, that use a standard Serial Peripheral Interface.

Characteristics of the GP-SPI Controller include:

- 8-bit serial data transmitted and received simultaneously over two data pins in Full Duplex mode with options to transmit and receive data serially on one data pin in Half Duplex (Bidirectional) mode.
- An internal programmable clock generator and clock polarity and phase controls allowing communication with various SPI peripherals with specific clocking requirements.
- SPI cycle completion that can be determined by status polling or interrupts.
- The ability to read data in on both SPDIN and SPDOUT in parallel. This allows this SPI Interface to support dual data rate read accesses for emerging double rate SPI flashes
- Support of back-to-back reads and writes without clock stretching, provided the host can read and write the data registers within one byte transaction time.

20.2 References

No references have been cited for this feature.

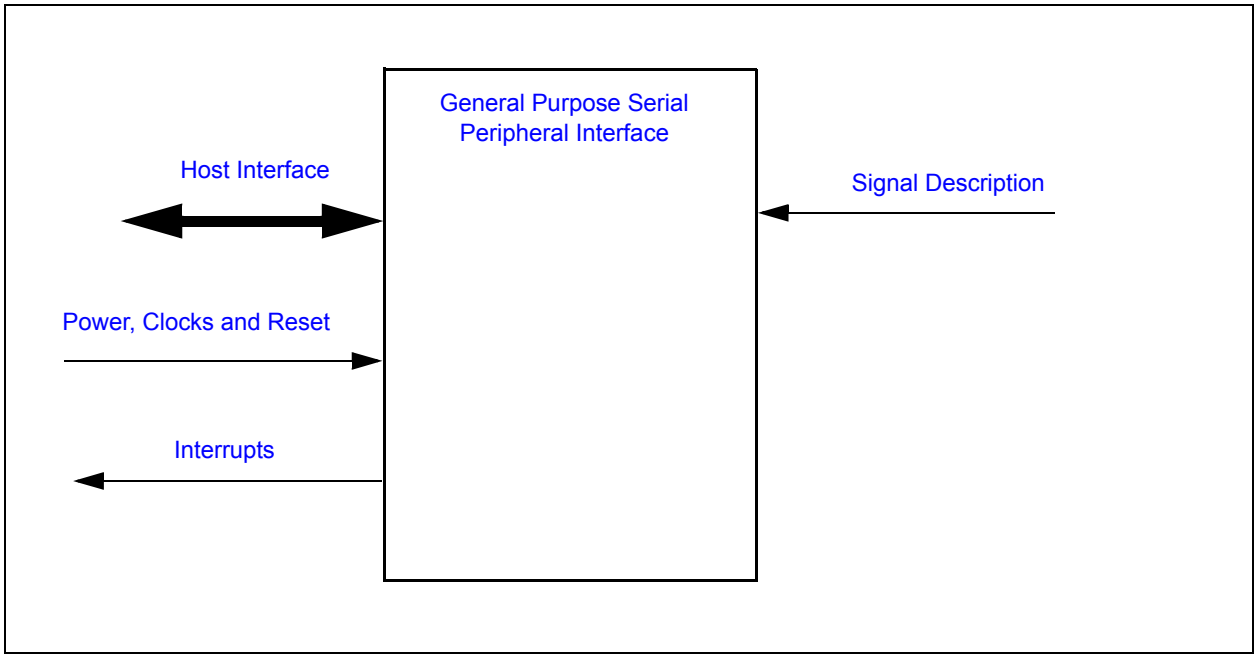
20.3 Terminology

No terminology for this block.

20.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 20-1: I/O DIAGRAM OF BLOCK



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20.5 Signal Description

TABLE 20-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
SPDIN	Input	Serial Data In pin
SPDOUT	Input/Output	Serial Data Output pin. Switches to input when used in double-data-rate mode
SPI_CLK	Output	SPI Clock output used to drive the SPCLK pin.
SPI_CS#	Output	SPI chip select

Note: The SPI block signals that are shown in Table 20-1 are routed to the SPI pins as listed in Table 20-2.

TABLE 20-2: SIGNAL TO PIN NAME LOOKUP TABLE

Block Name	Pin Name
SPDIN	SHD_MISO, PVT_MISO
SPDOUT	SHD_MOSI, PVT_MOSI
SPI_CLK	SHD_SCLK, PVT_SCLK
SPI_CS#	SHD_CS0#, PVT_CS0#

20.6 Host Interface

The registers defined for the General Purpose Serial Peripheral Interface are accessible by the various hosts as indicated in Section 20.12, "EC-Only Registers".

20.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

20.7.1 POWER DOMAINS

TABLE 20-3: POWER SOURCES

Name	Description
VCC1	The logic and registers implemented in this block are powered by this power well.

20.7.2 CLOCK INPUTS

TABLE 20-4: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This is a clock source for the SPI clock generator.
2MHz	This is a clock source for the SPI clock generator.

20.7.3 RESETS

TABLE 20-5: RESET SIGNALS

Name	Description
VCC1_RESET	This signal resets all the registers and logic in this block to their default state.

20.8 Interrupts

This section defines the Interrupt Sources generated from this block.

TABLE 20-6: EC INTERRUPTS

Source	Description
TXBE_STS	Transmit buffer empty status (TXBE), in the SPI Status Register, sent as an interrupt request to the Interrupt Aggregator.
RXBF_STS	Receive buffer full status (RXBF), in the SPI Status Register, sent as an interrupt request to the Interrupt Aggregator.

These status bits are also connected respectively to the DMA Controller's SPI Controller TX and RX requests signals.

20.9 Low Power Modes

The GP-SPI Interface may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

20.10 Description

The Serial Peripheral Interface (SPI) block is a master SPI block used to communicate with external SPI devices. The SPI master is responsible for generating the SPI clock and is designed to operate in Full Duplex, Half Duplex, and Dual modes of operation. The clock source may be programmed to operated at various clock speeds. The data is transmitted serially via 8-bit transmit and receive shift registers. Communication with SPI peripherals that require transactions of varying lengths can be achieved with multiple 8-bit cycles.

This block has many configuration options: The data may be transmitted and received either MSbit or LSbit first; The SPI Clock Polarity may be either active high or active low; Data may be sampled or presented on either the rising of falling edge of the clock (referred to as the transmit clock phase); and the SPI_CLK SPDOUT frequency may be programmed to a range of values as illustrated in Table 20-7, "SPI_CLK Frequencies". In addition to these many programmable options, this feature has several status bits that may be enabled to notify the host that data is being transmitted or received.

20.10.1 INITIATING AN SPI TRANSACTION

All SPI transactions are initiated by a write to the TX_DATA register. No read or write operations can be initiated until the Transmit Buffer is Empty, which is indicated by a one in the TXBE status bit.

If the transaction is a write operation, the host writes the TX_DATA register with the value to be transmitted. Writing the TX_DATA register causes the TXBE status bit to be cleared, indicating that the value has been registered. If empty, the SPI Core loads this TX_DATA value into an 8-bit transmit shift register and begins shifting the data out. Loading the value into the shift register causes the TXBE status bit to be asserted, indicating to software that the next byte can be written to the TX_DATA register.

If the transaction is a read operation, the host initiates a write to the TX_DATA register in the same manner as the write operation. Unlike the transmit command, the host must clear the RXBF status bit by reading the RX_DATA register before writing the TX_DATA register. This time, the host will be required to poll the RXBF status bit to determine when the value in the RX_DATA register is valid.

Note 1: If the SPI interface is configured for Half Duplex mode, the host must still write a dummy byte to receive data.

2: Since RX and TX transactions are executed by the same sequence of transactions, data is always shifted into the RX_DATA register. Therefore, every write operation causes data to be latched into the RX_DATA register and the RXBF bit is set. This status bit should be cleared before initiating subsequent transactions. The host utilizing this SPI core to transmit SPI Data must discard the unwanted receive bytes.

3: The length and order of data sent to and received from a SPI peripheral varies between peripheral devices. The SPI must be properly configured and software-controlled to communicate with each device and determine whether SPIRD data is valid slave data.

The following diagrams show sample single byte and multi-byte SPI Transactions.

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FIGURE 20-2: SINGLE BYTE SPI TX/RX TRANSACTIONS (FULL DUPLEX MODE)

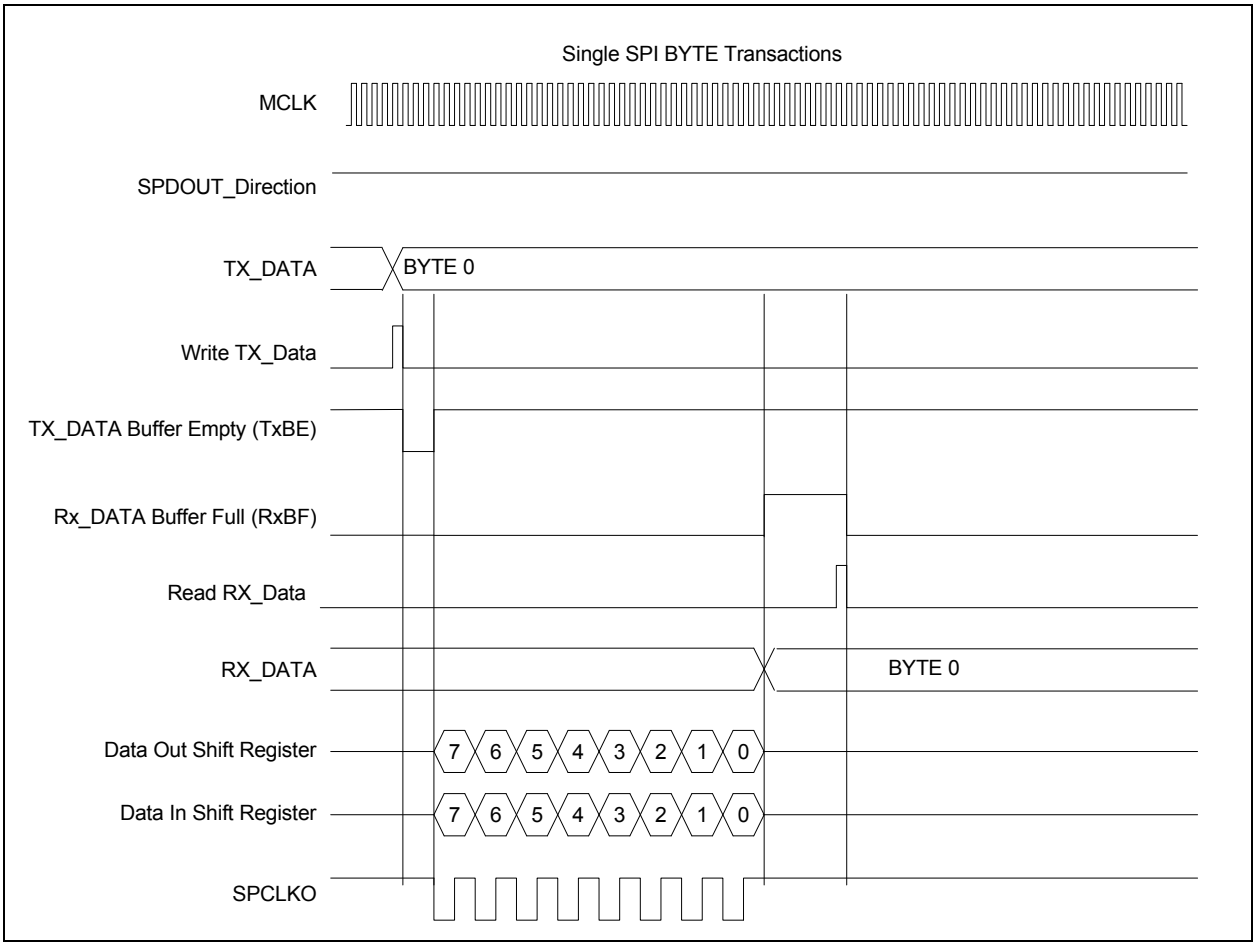
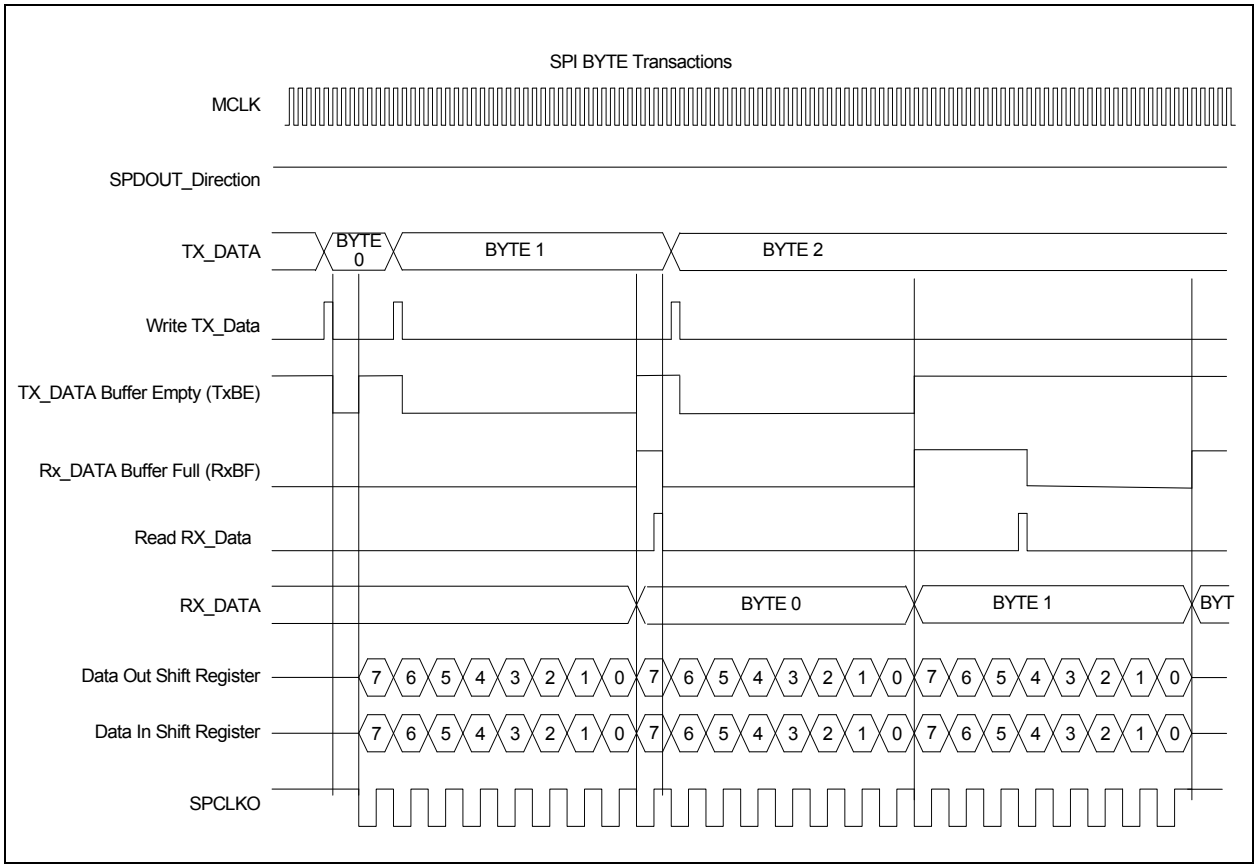


FIGURE 20-3: MULTI-BYTE SPI TX/RX TRANSACTIONS (FULL DUPLEX MODE)



The data may be configured to be transmitted MSB or LSB first. This is configured by the LSBF bit in the SPI Control Register. The transmit data is shifted out on the edge as selected by the TCLKPH bit in the SPI Clock Control Register. All received data can be sampled on a rising or falling SPI_CLK edge using the RCLKPH bit in the SPI Clock Control Register This clock setting must be identical to the clocking requirements of the current SPI slave.

Note:	Common peripheral devices require a chip select signal to be asserted during a transaction. Chip selects for SPI devices may be controlled by CEC1302 GPIO pins.

There are three types of transactions that can be implemented for transmitting and receiving the SPI data. They are Full Duplex, Half Duplex, and Dual Mode. These modes are define in Section 20.10.3, "Types of SPI Transactions".

20.10.2 DMA MODE

Transmit and receive operations can use a DMA channel. Note that only one DMA channel may be enabled at a time. Setting up the DMA Controller involves specifying the device (Flash GP-SPI), direction (transmit/receive), and the start and end addresses of the DMA buffers in the closely couple memory. Please refer to the DMA Controller chapter for register programming information.

SPI transmit / DMA write: the GP-SPI block's transmit empty (TxBE) status signal is used as a write request to the DMA controller, which then fetches a byte from the DMA transmit buffer and writes it to the GP-SPI's SPI TX Data Register (SPITD). As content of the latter is transferred to the internal Tx shift register from which data is shifted out onto the SPI bus bit by bit, the Tx Empty signal is again asserted, triggering the DMA fetch-and-write cycle. The process continues until the end of the DMA buffer is reached - the DMA controller stops responding to an active Tx Empty until the buffer's address registers are reprogrammed.

SPI receive / DMA read: the AUTO_READ bit in the SPI Control Register must be set. The driver first writes (dummy data) to the SPI TX Data Register (SPITD) to initiate the toggling of the SPI clock, enabling data to be shifted in. After one byte is received, the Rx Full (RxBF) status signal, used as a read request to the DMA controller, is asserted. The

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DMA controller then reads the received byte from the GP-SPI's SPI RX Data Register (SPIRD) and stores it in the DMA receive buffer. With AUTO_READ set, this read clears both the RxBF and TxBE. Clearing TxBE causes (dummy) data from the SPI TX Data Register (SPITD) to be transferred to the internal shift register, mimicking the effect of the aforementioned write to the SPI TX Data Register (SPITD) by the driver. SPI clock is toggled again to shift in the second read byte. This process continues until the end of the DMA buffer is reached - the DMA controller stops responding to an active Tx Empty until the buffer's address registers are reprogrammed.

20.10.3 TYPES OF SPI TRANSACTIONS

The GP-SPI controller can be configured to operate in three modes: Full Duplex, Half Duplex, and Dual Mode.

20.10.3.1 Full Duplex

In Full Duplex Mode, serial data is transmitted and received simultaneously by the SPI master over the SPDOUT and SPDIN pins. To enable Full Duplex Mode clear SPDIN Select.

When a transaction is completed in the full-duplex mode, the RX_DATA shift register always contains received data (valid or not) from the last transaction.

20.10.3.2 Half Duplex

In Half Duplex Mode, serial data is transmitted and received sequentially over a single data line (referred to as the SPDOUT pin). To enable Half Duplex Mode set SPDIN Select to 01b. The direction of the SPDOUT signal is determined by the BIOEN bit.

- To transmit data in half duplex mode set the BIOEN bit before writing the TX_DATA register.
- To receive data in half duplex mode clear the BIOEN bit before writing the TX_DATA register with a dummy byte.

Note:	The Software driver must properly drive the BIOEN bit and store received data depending on the transaction format of the specific slave device.

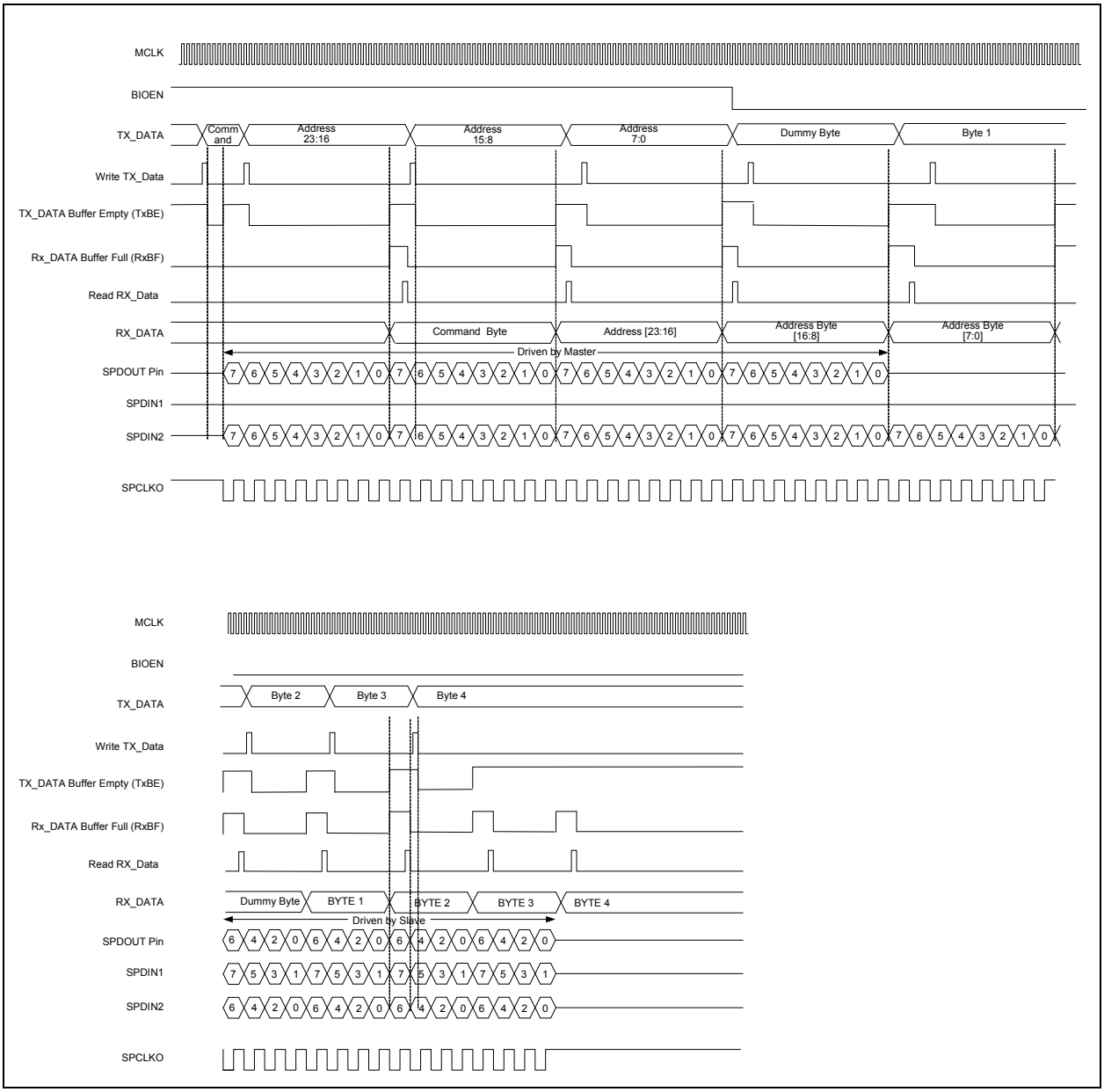
20.10.3.3 Dual Mode of Operation

In Dual Mode, serial data is transmitted sequentially from the SPDOUT pin and received in by the SPI master from the SPDOUT and SPDIN pins. This essentially doubles the received data rate and is often available in SPI Flash devices. To enable Dual Mode of operation the SPI core must be configured to receive data in path on the SPDIN1 and SPDIN2 inputs via SPDIN Select. The BIOEN bit determines if the SPI core is transmitting or receiving. The setting of this bit determines the direction of the SPDOUT signal. The SPDIN Select bits are configuration bits that remain static for the duration of a dual read command. The BIOEN bit must be toggled to indicate when the SPI core is transmitting and receiving.

- To transmit data in dual mode set the BIOEN bit before writing the TX_DATA register.
- To receive data in dual mode clear the BIOEN bit before writing the TX_DATA register with a dummy byte. The even bits (0,2,4,and 6) are received on the SPDOUT pin and the odd bits (1,3,5,and 7) are received on the SPDIN pin. The hardware assembles these received bits into a single byte and loads them into the RX_DATA register accordingly.

The following diagram illustrates a Dual Fast Read Command that is supported by some SPI Flash devices.

FIGURE 20-4: DUAL FAST READ FLASH COMMAND



Note:	When the SPI core is used for flash commands, like the Dual Read command, the host discards the bytes received during the command, address, and dummy byte portions of the transaction.

20.10.4 HOW BIOEN BIT CONTROLS DIRECTION OF SPDOUT BUFFER

When the SPI is configured for Half Duplex mode or Dual Mode the SPDOUT pin operates as a bi-directional signal. The BIOEN bit is used to determine the direction of the SPDOUT buffer when a byte is transmitted. Internally, the BIOEN bit is sampled to control the direction of the SPDOUT buffer when the TX_DATA value is loaded into the transmit shift register. The direction of the buffer is never changed while a byte is being transmitted.

Since the TX_DATA register may be written while a byte is being shifted out on the SPDOUT pin, the BIOEN bit does not directly control the direction of the SPDOUT buffer. An internal DIRECTION bit, which is a latched version of the BIOEN bit determines the direction of the SPDOUT buffer. The following list summarizes when the BIOEN bit is sampled.

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- The DIRECTION bit is equal to the BIOEN bit when data is not being shifted out (i.e., SPI interface is idle).
- The hardware samples the BIOEN bit when it is shifting out the last bit of a byte to determine if the buffer needs to be turned around for the next byte.
- The BIOEN bit is also sampled any time the value in the TX_DATA register is loaded into the shift register to be transmitted.

If a TAR (Turn-around time) is required between transmitting and receiving bytes on the SPDOUT signal, software should allow all the bytes to be transmitted before changing the buffer to an input and then load the TX_DATA register to begin receiving bytes. If TAR greater than zero is required, software must wait for the transmission in one direction to complete before writing the TX_DATA register to start sending/receiving in the opposite direction. This allows the SPI block to operate the same as legacy Microchip SPI devices.

20.10.5 CONFIGURING THE SPI CLOCK GENERATOR

The SPI controller generates the SPI_CLK signal to the external SPI device. The frequency of the SPI_CLK signal is determined by one of two clock sources and the Preload value of the clock generator down counter. The clock generator toggles the SPI_CLK output every time the counter underflows, while data is being transmitted.

Note:	When the SPI interface is in the idle state and data is not being transmitted, the SPI_CLK signal stops in the inactive state as determined by the configuration bits.

The clock source to the down counter is determined by Bit CLKSRC. Either the main system clock or the 2MHz clock can be used to decrement the down counter in the clock generator logic.

The SPI_CLK frequency is determined by the following formula:

$$\text{SPI_CLK_FREQ} = \left(\left(\frac{1}{2} \times \text{REFERENCE_CLOCK} \right) / \text{PRELOAD} \right)$$

The REFERENCE_CLOCK frequency is selected by CLKSRC in the SPI Clock Control Register and PRELOAD is the PRELOAD field of the SPI Clock Generator Register. The frequency can be either the 48 MHz Ring Oscillator clock or a 2MHz clock. When the PRELOAD value is 0, the REFERENCE_CLOCK is always the 48 MHz Ring Oscillator clock and the CLKSRC bit is ignored.

Sample SPI Clock frequencies are shown in the following table:

TABLE 20-7: SPI_CLK FREQUENCIES

Clock Source	PRELOAD	SPI_CLK Frequency
Don't Care	0	48MHz
48MHz	1	24MHz
48MHz	2	12MHz (default)
48MHz	3	6MHz
48MHz	63	381KHz
2MHz	1	1MHz
2MHz	2	500KHz
2MHz	3	333KHz
2MHz	63	15.9KHz

20.10.6 CONFIGURING SPI MODE

In practice, there are four modes of operation that define when data should be latched. These four modes are the combinations of the SPI_CLK polarity and phase.

The output of the clock generator may be inverted to create an active high or active low clock pulse. This is used to determine the inactive state of the SPI_CLK signal and is used for determining the first edge for shifting the data. The polarity is selected by CLKPOL in the SPI Clock Control Register.

The phase of the clock is selected independently for receiving data and transmitting data. The receive phase is determine by RCLKPH and the transmit phase is determine by TCLKPH in the SPI Clock Control Register.

The following table summarizes the effect of CLKPOL, RCLKPH and TCLKPH.

TABLE 20-8: SPI DATA AND CLOCK BEHAVIOR

CLKPOL	RCLKPH	TCLKPH	Behavior
0	0	0	Inactive state is low. First edge is rising edge. Data is sampled on the rising edge. Data is transmitted on the falling edge. Data is valid before the first rising edge.
0	0	1	Inactive state is low. First edge is rising edge. Data is sampled on the rising edge. Data is transmitted on the rising edge.
0	1	0	Inactive state is low. First edge is rising edge. Data is sampled on the falling edge. Data is transmitted on the falling edge. Data is valid before the first rising edge.
0	1	1	Inactive state is low. First edge is rising edge. Data is sampled on the falling edge. Data is transmitted on the rising edge.
1	0	0	Inactive state is high. First edge is falling edge. Data is sampled on the falling edge. Data is transmitted on the rising edge. Data is valid before the first falling edge.
1	0	1	Inactive state is high. First edge is falling edge. Data is sampled on the falling edge. Data is transmitted on the falling edge.
1	1	0	Inactive state is high. First edge is falling edge. Data is sampled on the rising edge. Data is transmitted on the rising edge. Data is valid before the first falling edge.
1	1	1	Inactive state is high. First edge is falling edge. Data is sampled on the rising edge. Data is transmitted on the falling edge.

20.11 SPI Examples

20.11.1 FULL DUPLEX MODE TRANSFER EXAMPLES

20.11.1.1 Read Only

The slave device used in this example is a MAXIM MAX1080 10 bit, 8 channel ADC:

- The SPI block is activated by setting the enable bit in SPIAR - SPI Enable Register
- The SPIMODE bit is de-asserted '0' to enable the SPI interface in Full Duplex mode.
- The CLKPOL and TCLKPH bits are de-asserted '0', and RCLKPH is asserted '1' to match the clocking requirements of the slave device.
- The LSBF bit is de-asserted '0' to indicate that the slave expects data in MSB-first order.
- Assert CS# using a GPIO pin.
- Write a valid command word (as specified by the slave device) to the SPITD - SPI TX_Data Register with TXFE asserted '1'. The SPI master automatically clears the TXFE bit indicating the byte has been put in the TX buffer. If the shift register is empty the TX_DATA byte is loaded into the shift register and the SPI master reasserts the TXFE bit. Once the data is in the shift register the SPI master begins shifting the data value onto the SPDOUT pin and drives the SPCLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.

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- A dummy 8 bit data value (any value) is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting the dummy data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses from the first transmit bytes:
  - The first SPI cycle is complete, RXBF bit is asserted '1', and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is invalid since the last cycle was initiated solely to transmit command data to the slave. This particular slave device drives '0' on the SPDIN pin to the master while it is accepting command data. This SPIRD data is ignored.
  - Once the first SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPCLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- The final SPI cycle is initiated when another dummy 8 bit data value (any value) is written to the TX_DATA register. Note that this value may be another dummy value or it can be a new 8 bit command to be sent to the ADC. The new command will be transmitted while the final data from the last command is received simultaneously. This overlap allows ADC data to be read every 16 SPCLK cycles after the initial 24 clock cycle.The SPI master automatically clears the TXFE bit, but does not begin shifting the dummy data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses, the second SPI cycle is complete:
  - The first SPI cycle is complete, RXBF bit is asserted '1', and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is the first half of a valid 16 bit ADC value. SPIRD is read and stored.
  - Once the second SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the data value onto the SPDOUT pin, and drives the SPCLK pin. Data on the SPDIN pin is also sampled on each clock.
- After 8 SPI_CLK pulses, the final SPI cycle is complete, TXBF is asserted '1', and the SPINT interrupt is asserted (if enabled). The data now contained in SPIRD - SPI RX_Data Register is the second half of a valid 16 bit ADC value. SPIRD is read and stored.
- If a command was overlapped with the received data in the final cycle, #CS should remain asserted and the SPI master will initiate another SPI cycle. If no new command was sent, #CS is released and the SPI is idle.

20.11.1.2 Read/Write

The slave device used in this example is a Fairchild NS25C640 FM25C640 64K Bit Serial EEPROM. The following subsections describe the read and write sequences.

Read

- The SPI block is activated by setting the enable bit in SPIAR - SPI Enable Register
- The SPIMODE bit is de-asserted '0' to enable the SPI interface in Full Duplex mode.
- The CLKPOL, TCLKPH and RCLKPH bits are de-asserted '0' to match the clocking requirements of the slave device.
- The LSBF bit is de-asserted '0' to indicate that the slave expects data in MSB-first order.
- Assert CS# low using a GPIO pin.
- Write a valid command word (as specified by the slave device) to the SPITD - SPI TX_Data Register with TXFE asserted '1'. The SPI master automatically clears the TXFE bit indicating the byte has been put in the TX buffer. If the shift register is empty the TX_DATA byte is loaded into the shift register and the SPI master reasserts the TXFE bit. Once the data is in the shift register the SPI master begins shifting the data value onto the SPDOUT pin and drives the SPI_CLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, EEPROM address A15-A8 is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting the dummy data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.

- After 8 SPI_CLK pulses from the first transmit byte (Command Byte transmitted):
  - The first SPI cycle is complete, RXBF bit is asserted '1', and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is invalid since the last cycle was initiated solely to transmit command data to the slave. This particular slave device tri-states the SPDIN pin to the master while it is accepting command data. This SPIRD data is ignored.

Note:	External pull-up or pull-down is required on the SPDIN pin if it is tri-stated by the slave device.

  - Once the first SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (EEPROM address A15-A8) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPI_CLK pin. Data on the SPDIN pin is also sampled on each clock. Note: The particular slave device ignores address A15-A13.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, EEPROM address A7-A0 is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting this data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses from the second transmit byte (Address Byte (MSB) transmitted):
  - EEPROM address A15-A8 has been transmitted to the slave completing the second SPI cycle. Once again, the RXBF bit is asserted '1' and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is invalid since the last cycle was initiated solely to transmit address data to the slave.
  - Once the second SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (EEPROM address A7-A0) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPCLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, a dummy byte is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting this data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses, the third SPI cycle is complete (Address Byte (LSB) transmitted):
  - EEPROM address A7-A0 has been transmitted to the slave completing the third SPI cycle. Once again, the RXBF bit is asserted '1' and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is invalid since the last cycle was initiated solely to transmit address data to the slave.
  - Once the third SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (dummy byte) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPCLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- If only one receive byte is required, the host would not write any more value to the TX_DATA register until this transaction completes. If more than one byte of data is to be received, another dummy byte would be written to the TX_DATA register (one dummy byte per receive byte is required). The SPI master automatically clears the TXFE bit when the TX_DATA register is written, but does not begin shifting this data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses, the fourth SPI cycle is complete (First Data Byte received):
  - The dummy byte has been transmitted to the slave completing the fourth SPI cycle. Once again, the RXBF bit is asserted '1' and the SPINT interrupt is asserted, if enabled. Unlike the command and address phases, the data now contained in SPIRD - SPI RX_Data Register is the 8-bit EEPROM data since the last cycle was initiated to receive data from the slave.
  - Once the fourth SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (if any) and loads it into the TX shift register. This process will be repeated until all the desired data is received.
- The host software will read and store the EEPROM data value in SPIRD - SPI RX_Data Register.

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- If no more data needs to be received by the master, CS# is released and the SPI is idle. Otherwise, master continues reading the data by writing a dummy value to the TX_DATA register after every 8 SPI_CLK cycles.

Write

- The SPI block is activated by setting the enable bit in SPIAR - SPI Enable Register
- The SPIMODE bit is de-asserted '0' to enable the SPI interface in Full Duplex mode.
- The CLKPOL, TCLKPH and RCLKPH bits are de-asserted '0' to match the clocking requirements of the slave device.
- The LSBF bit is de-asserted '0' to indicate that the slave expects data in MSB-first order.
- Assert WR# high using a GPIO pin.
- Assert CS# low using a GPIO pin.
- Write a valid command word (as specified by the slave device) to the SPITD - SPI TX_Data Register with TXFE asserted '1'. The SPI master automatically clears the TXFE bit indicating the byte has been put in the TX buffer. If the shift register is empty the TX_DATA byte is loaded into the shift register and the SPI master reasserts the TXFE bit. Once the data is in the shift register the SPI master begins shifting the data value onto the SPDOUT pin and drives the SPI_CLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, EEPROM address A15-A8 is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting the dummy data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses from the first transmit byte (Command Byte transmitted):
  - The first SPI cycle is complete, RXBF bit is asserted '1', and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is invalid since the last cycle was initiated solely to transmit command data to the slave. This particular slave device tri-states the SPDIN pin to the master while it is accepting command data. This SPIRD data is ignored.

USER'S NOTE: External pull-up or pull-down is required on the SPDIN pin if it is tri-stated by the slave device.

  - Once the first SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (EEPROM address A15-A8) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPI_CLK pin. Data on the SPDIN pin is also sampled on each clock. Note: The particular slave device ignores address A15-A13.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, EEPROM address A7-A0 is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting this data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses from the second transmit byte (Address Byte (MSB) transmitted):
  - EEPROM address A15-A8 has been transmitted to the slave completing the second SPI cycle. Once again, the RXBF bit is asserted '1' and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is invalid since the last cycle was initiated solely to transmit address data to the slave.
  - Once the second SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (EEPROM address A7-A0) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPCLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, a data byte (D7:D0) is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting this data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses, the third SPI cycle is complete (Address Byte (LSB) transmitted):
  - EEPROM address A7-A0 has been transmitted to the slave completing the third SPI cycle. Once again, the RXBF bit is asserted '1' and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD -

SPI RX_Data Register is invalid since the last cycle was initiated solely to transmit address data to the slave.
- Once the third SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (data byte D7:D0) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPCLK pin. Data on the SPDIN pin is also sampled on each clock.

- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- If only one data byte is to be written, the host would not write any more values to the TX_DATA register until this transaction completes. If more than one byte of data is to be written, another data byte would be written to the TX_DATA register. The SPI master automatically clears the TXFE bit when the TX_DATA register is written, but does not begin shifting this data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses, the fourth SPI cycle is complete (First Data Byte transmitted):
  - The data byte has been transmitted to the slave completing the fourth SPI cycle. Once again, the RXBF bit is asserted '1' and the SPINT interrupt is asserted, if enabled. Like the command and address phases, the data now contained in SPIRD - SPI RX_Data Register is invalid since the last cycle was initiated to transmit data to the slave.
  - Once the fourth SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (if any) and loads it into the TX shift register. This process will be repeated until all the desired data is transmitted.
- If no more data needs to be transmitted by the master, CS# and WR# are released and the SPI is idle.

20.11.2 HALF DUPLEX (BIDIRECTIONAL MODE) TRANSFER EXAMPLE

The slave device used in this example is a National LM74 12 bit (plus sign) temperature sensor.

- The SPI block is activated by setting the enable bit in SPIAR - SPI Enable Register
- The SPIMODE bit is asserted '1' to enable the SPI interface in Half Duplex mode.
- The CLKPOL, TCLKPH and RCLKPH bits are de-asserted '0' to match the clocking requirements of the slave device.
- The LSBF bit is de-asserted '0' to indicate that the slave expects data in MSB-first order.
- BIOEN is asserted '0' to indicate that the first data in the transaction is to be received from the slave.
- Assert CS# using a GPIO pin.

//Receive 16-bit Temperature Reading

- Write a dummy command byte (as specified by the slave device) to the SPITD - SPI TX_Data Register with TXFE asserted '1'. The SPI master automatically clears the TXFE bit indicating the byte has been put in the TX buffer. If the shift register is empty the TX_DATA byte is loaded into the shift register and the SPI master reasserts the TXFE bit. Once the data is in the shift register the SPI master begins shifting the data value onto the SPDOUT pin and drives the SPI_CLK pin. This data is lost because the output buffer is disabled. Data on the SPDIN pin is sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, another dummy byte is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting the dummy data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses from the first receive byte
  - The first SPI cycle is complete, RXBF bit is asserted '1', and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is the first half of the 16 bit word containing the temperature data.
  - Once the first SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (dummy byte 2) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPI_CLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.

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//Transmit next reading command

- BIOEN is asserted '1' to indicate that data will now be driven by the master.
- Next, a command byte is written to the TX_DATA register. This value is the first half of a 16 bit command to be sent to temperature sensor peripheral. The SPI master automatically clears the TXFE bit, but does not begin shifting the command data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty. This data will be transmitted because the output buffer is enabled. Data on the SPDIN pin is sampled on each clock.
- After 8 SPI_CLK pulses from the second receive byte:
  - The second SPI cycle is complete, RXBF bit is asserted '1', and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is the second half of the 16 bit word containing the temperature data.
  - Once the first SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (command byte 1) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPI_CLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Next, the second command byte is written to the TX_DATA register. The SPI master automatically clears the TXFE bit, but does not begin shifting the command data value onto the SPDOUT pin. This byte will remain in the TX_DATA register until the TX shift register is empty.
- After 8 SPI_CLK pulses from the first transmit byte:
  - The third SPI cycle is complete, RXBF bit is asserted '1', and the SPINT interrupt is asserted, if enabled. The data now contained in SPIRD - SPI RX_Data Register is invalid, since this command was used to transmit the first command byte to the SPI slave.
  - Once the first SPI cycle is completed, the SPI master takes the pending data in the TX_DATA register (command byte 2) and loads it into the TX shift register. Loading the shift register automatically asserts the TXFE bit, begins shifting the dummy data value onto the SPDOUT pin, and drives the SPI_CLK pin. Data on the SPDIN pin is also sampled on each clock.
- Once the TXFE bit is asserted the SPI Master is ready to transmit or receive its next byte. Before writing the next TX_DATA value, software must clear the RXBF status bit by reading the SPIRD - SPI RX_Data Register.
- Since no more data needs to be transmitted, the host software will wait for the RXBF status bit to be asserted indicating the second command byte was transmitted successfully.
- CS# is de-asserted.

20.12 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the General Purpose Serial Peripheral Interface. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 20-9: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
General Purpose Serial Peripheral Interface (GP-SPI)	0	EC	32-bit internal address space	4000_9400h
	1	EC	32-bit internal address space	4000_9480h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

Note: The Shared SPI controller is instance 0 and the Private SPI is instance 1 of the General Purpose Serial Peripheral Interface (GP-SPI) block.

TABLE 20-10: EC-ONLY REGISTER SUMMARY

Offset	Register Name
0h	SPI Enable Register
4h	SPI Control Register
8h	SPI Status Register
Ch	SPI TX_Data Register
10h	SPI RX_Data Register
14h	SPI Clock Control Register
18h	SPI Clock Generator Register

20.12.1 SPI ENABLE REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:1	Reserved	R	-	-
0	ENABLE 1=Enabled. The device is fully operational 0=Disabled. Clocks are gated to conserve power and the SPDOUT and SPI_CLK signals are set to their inactive state	R/W	0h	VCC1_RESET

20.12.2 SPI CONTROL REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:7	Reserved	R	-	-
6	CE SPI Chip Select Enable. 1= SPI_CS# output signal is asserted, i.e., driven to logic ‘0’ 0= SPI_CS# output signal is deasserted, i.e., driven to logic ‘1’	R/W	0h	VCC1_RESET
5	AUTO_READ Auto Read Enable. 1=A read of the SPI RX_DATA Register will clear both the RXBF status bit and the TXBE status bit 0=A read of the SPI RX_DATA Register will clear the RXBF status bit. The TXBE status bit will not be modified	R/W	0h	VCC1_RESET
4	SOFT_RESET Soft Reset is a self-clearing bit. Writing zero to this bit has no effect. Writing a one to this bit resets the entire SPI Interface, including all counters and registers back to their initial state.	R/W	0h	VCC1_RESET
3:2	SPDIN_SELECT The SPDIN Select which SPI input signals are enabled when the BIOEN bit is configured as an input. 1xb=SPDIN1 and SPDIN2. Select this option for Dual Mode 01b=SPDIN2 only. Select this option for Half Duplex 00b=SPDIN1 only. Select this option for Full Duplex	R/W	0h	VCC1_RESET

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Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
1	BIOEN Bidirectional Output Enable control. When the SPI is configured for Half Duplex mode or Dual Mode the SPDOUT pin operates as a bi-directional signal. The BIOEN bit is used by the internal DIRECTION bit to control the direction of the SPDOUT buffers. The direction of the buffer is never changed while a byte is being transmitted. 1=The SPDOUT_Direction signal configures the SPDOUT signal as an output. 0=The SPDOUT_Direction signal configures the SPDOUT signal as an input. See Section 20.10.4, "How BIOEN Bit Controls Direction of SPD-OUT Buffer" for details on the use of BIOEN.	R/W	1h	VCC1_RESET
0	LSBF Least Significant Bit First 1= The data is transferred in LSB-first order. 0= The data is transferred in MSB-first order. (default)	R/W	0h	VCC1_RESET

20.12.3 SPI STATUS REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:3	Reserved	R	-	-
2	ACTIVE	R	0h	VCC1_RESET
1	RXBF Receive Data Buffer Full status. When this bit is ‘1’ the Rx_Data buffer is full. Reading the SPI RX_Data Register clears this bit. This signal may be used to generate a SPI_RX interrupt to the EC. 1=RX_Data buffer is full 0=RX_Data buffer is not full	R	0h	VCC1_RESET
0	TXBE Transmit Data Buffer Empty status. When this bit is ‘1’ the Tx_Data buffer is empty. Writing the SPI TX_Data Register clears this bit. This signal may be used to generate a SPI_TX interrupt to the EC. 1=TX_Data buffer is empty 0=TX_Data buffer is not empty	R	1h	VCC1_RESET

20.12.4 SPI TX_DATA REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	TX_DATA A write to this register when the Tx_Data buffer is empty (TXBE in the SPI Status Register is '1') initiates a SPI transaction. The byte written to this register will be loaded into the shift register and the TXBE flag will be asserted. This indicates that the next byte can be written into the TX_DATA register. This byte will remain in the TX_-DATA register until the SPI core has finished shifting out the previ-ous byte. Once the shift register is empty, the hardware will load the pending byte into the shift register and once again assert the TxBE bit. The TX_DATA register must not be written when the TXBE bit is zero. Writing this register may overwrite the transmit data before it is loaded into the shift register.	R/W	0h	VCC1_RESET

20.12.5 SPI RX_DATA REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	RX_DATA This register is used to read the value returned by the external SPI device. At the end of a byte transfer the RX_DATA register contains serial input data (valid or not) from the last transaction and the RXBF bit is set to one. This status bit indicates that the RX_DATA register has been loaded with a the serial input data. The RX_DATA register should not be read before the RXBF bit is set. The RX_DATA register must be read, clearing the RXBF status bit before writing the TX_DATA register. The data in the receive shift register is only loaded into the RX_DATA register when this bit is cleared. If a data byte is pending in the receive shift register the value will be loaded immediately into the RX_DATA register and the RXBF status flag will be asserted. Software should read the RX_-DATA register twice before starting a new transaction to make sure the RX_DATA buffer and shift register are both empty.	R/W	0h	VCC1_RESET

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20.12.6 SPI CLOCK CONTROL REGISTER

This register should not be changed during an active SPI transaction.

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:5	Reserved	R	-	-
4	CLKSRC Clock Source for the SPI Clock Generator. This bit should not be changed during a SPI transaction. When the field PRELOAD in the SPI Clock Generator Register is 0, this bit is ignored and the Clock Source is always the main system clock (the equivalent of setting this bit to '0'). 1=2MHz 0=48 MHz Ring Oscillator	R/W	0h	VCC1_RESET
3	Reserved	R	-	-
2	CLKPOL SPI Clock Polarity. 1=The SPI_CLK signal is high when the interface is idle and the first clock edge is a falling edge 0=The SPI_CLK is low when the interface is idle and the first clock edge is a rising edge	R/W	0h	VCC1_RESET
1	RCLKPH Receive Clock Phase, the SPI_CLK edge on which the master will sample data. The receive clock phase is not affected by the SPI Clock Polarity. 1=Valid data on SPDIN signal is expected after the first SPI_CLK edge. This data is sampled on the second and following even SPI_CLK edges (i.e., sample data on falling edge) 0=Valid data is expected on the SPDIN signal on the first SPI_CLK edge. This data is sampled on the first and following odd SPI_-CLK edges (i.e., sample data on rising edge)	R/W	1h	VCC1_RESET
0	TCLKPH Transmit Clock Phase, the SPCLK edge on which the master will clock data out. The transmit clock phase is not affected by the SPI Clock Polarity. 1=Valid data is clocked out on the first SPI_CLK edge on SPDOUT signal. The slave device should sample this data on the second and following even SPI_CLK edges (i.e., sample data on falling edge) 0=Valid data is clocked out on the SPDOUT signal prior to the first SPI_CLK edge. The slave device should sample this data on the first and following odd SPI_CLK edges (i.e., sample data on rising edge)	R/W	0h	VCC1_RESET

20.12.7 SPI CLOCK GENERATOR REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	Reserved	R	-	-
5:0	PRELOAD SPI Clock Generator Preload value.	R/W	2h	VCC1_RESET

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21.0 BLINKING/BREATHING PWM

21.1 Introduction

LEDs are used in computer applications to communicate internal state information to a user through a minimal interface. Typical applications will cause an LED to blink at different rates to convey different state information. For example, an LED could be full on, full off, blinking at a rate of once a second, or blinking at a rate of once every four seconds, in order to communicate four different states.

As an alternative to blinking, an LED can “breathe”, that is, oscillate between a bright state and a dim state in a continuous, or apparently continuous manner. The rate of breathing, or the level of brightness at the extremes of the oscillation period, can be used to convey state information to the user that may be more informative, or at least more novel, than traditional blinking.

The blinking/breathing hardware is implemented using a PWM. The PWM can be driven either by the 48 MHz clock or by a 32.768 KHz clock input. When driven by the 48 MHz clock, the PWM can be used as a standard 8-bit PWM in order to control a fan. When used to drive blinking or breathing LEDs, the 32.768 KHz clock source is used.

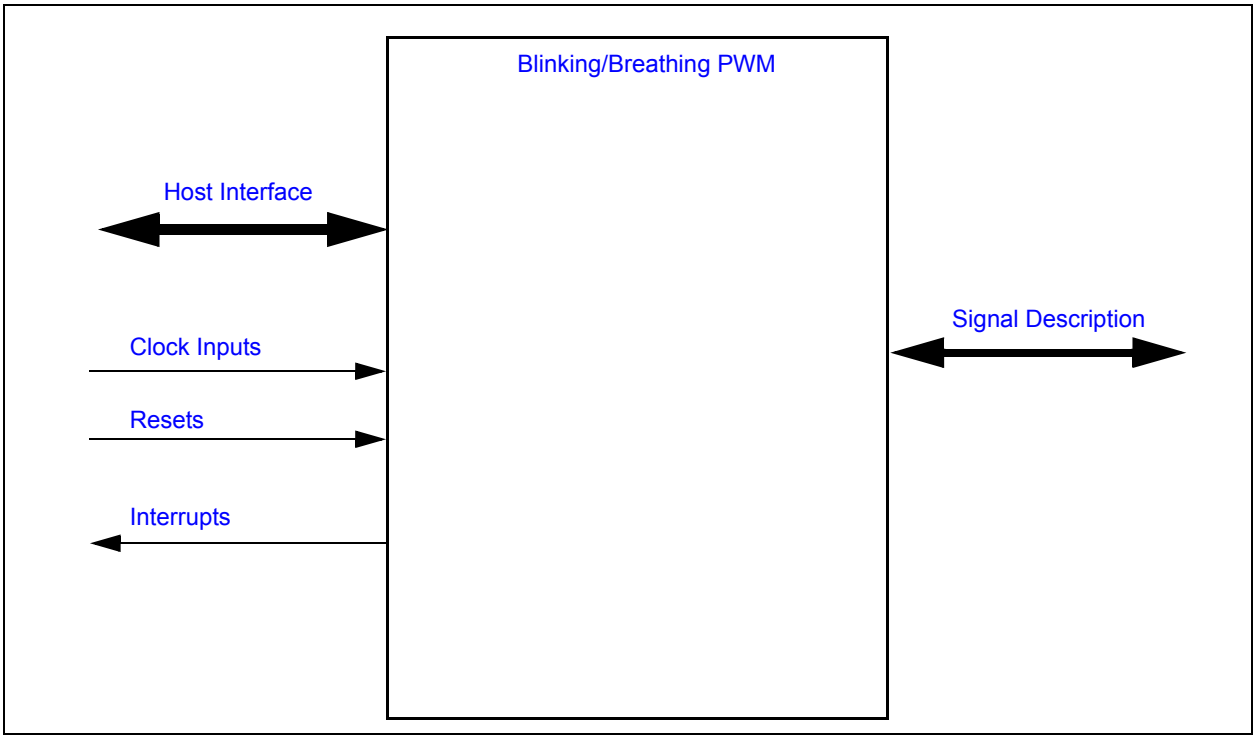
Features:

- Each PWM independently configurable
- Each PWM configurable for LED blinking and breathing output
- Highly configurable breathing rate from 60ms to 1min
- Non-linear brightness curves approximated with 8 piece wise-linear segments
- All LED PWMs can be synchronized
- Each PWM configurable for 8-bit PWM support
- Multiple clock rates
- Configurable Watchdog Timer

21.2 Interface

This block is designed to drive a pin on the pin interface and to be accessed internally via a registered host interface.

FIGURE 21-1: I/O DIAGRAM OF BLOCK



21.3 Signal Description

TABLE 21-1: SIGNAL DESCRIPTION

Name	Direction	Description
PWM Output	Output	Output of PWM By default, the PWM pin is configured to be active high: when the PWM is configured to be fully on, the pin is driving high. When the PWM is configured to be fully off, the pin is low. If firmware requires the Blinking/Breathing PWM to be active low, the Polarity bit in the GPIO Pin Control Register associated with the PWM can be set to 1, which inverts the output polarity.

21.4 Host Interface

The blinking/breathing PWM block is accessed by a controller over the standard register interface.

21.5 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

21.5.1 POWER DOMAINS

TABLE 21-2: POWER SOURCES

Name	Description
VCC1	Main power. The source of main power for the device is system dependent.

21.5.2 CLOCK INPUTS

TABLE 21-3: CLOCK INPUTS

Name	Description
32KHz_Clk	32.768 KHz clock
48 MHz Ring Oscillator	48 MHz clock

21.5.3 RESETS

TABLE 21-4: RESET SIGNALS

Name	Description
VCC1_RESET	Block reset

21.6 Interrupts

Each PWM can generate an interrupt. The interrupt is asserted for one 48 MHz clock period whenever the PWM WDT times out. The PWM WDT is described in Section 21.8.3.1, "PWM WDT," on page 232.

Note: PWM_WDT[0], PWM_WDT[1], PWM_WDT[2], PWM_WDT[3] bits in the GIRQ17 and GIRQ18 registers are the interrupt source bits for the three instances of the Blinking/Breathing PWM in the CEC1302.

TABLE 21-5: EC INTERRUPTS

Source	Description
PWM_WDT	PWM watchdog time out

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21.7 Low Power Mode

The Blinking/Breathing PWM may be put into a low power mode by the chip-level power, clocks, and reset (PCR) circuitry. The low power mode is only applicable when the Blinking/Breathing PWM is operating in the General Purpose PWM mode. When the low speed clock mode is selected, the blinking/breathing function continues to operate, even when the 48 MHz clock is stopped. Low power mode behavior is summarized in the following table:

TABLE 21-6: LOW POWER MODE BEHAVIOR

CLOCK_SOURCE	CONTROL	Mode	Low Power Mode	Description
X	'00'b	PWM 'OFF'	Yes	32.768 KHz clock is required.
X	'01'b	Breathing	Yes	
1	'10'b	General Purpose PWM	No	48 MHz clock is required, even when a sleep command to the block is asserted.
0	'10'b	Blinking	Yes	32.768 KHz clock is required.
X	'11'b	PWM 'ON'	Yes	

Note: In order for the CEC1302 to enter its.heavy and deep sleep states, the SLEEP_ENABLE input for all Blinking/Breathing PWM instances must be asserted, even if the PWMs are configured to use the low speed clock.

21.8 Description

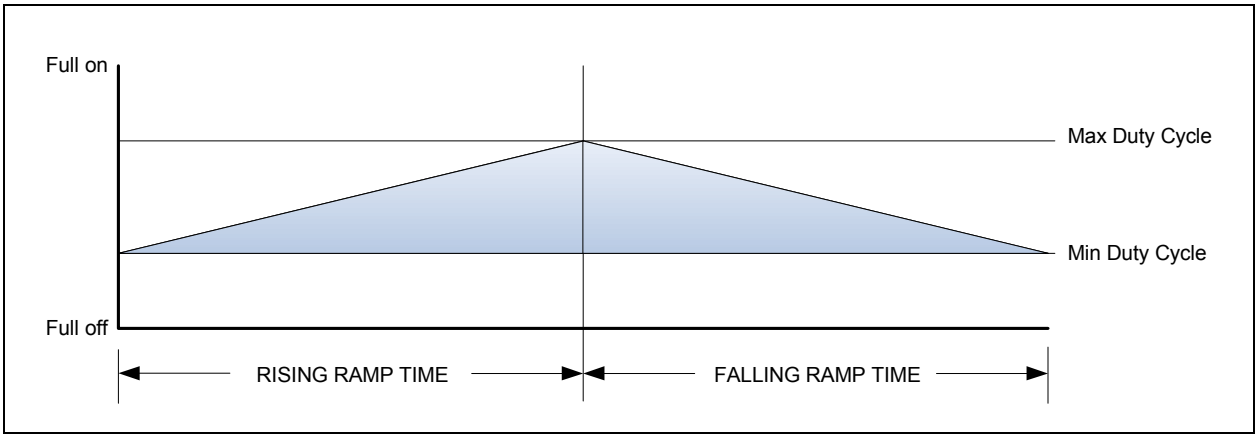
21.8.1 BREATHING

If an LED blinks rapidly enough, the eye will interpret the light as reduced brightness, rather than a blinking pattern. Therefore, if the blinking period is short enough, modifying the duty cycle will set the apparent brightness, rather than a blinking rate. At a blinking rate of 128Hz or greater, almost all people will perceive a continuous light source rather than an intermittent pattern.

Because making an LED appear to breathe is an aesthetic effect, the breathing mechanism must be adjustable or customers may find the breathing effect unattractive. There are several variables that can affect breathing appearance, as described below.

The following figure illustrates some of the variables in breathing:

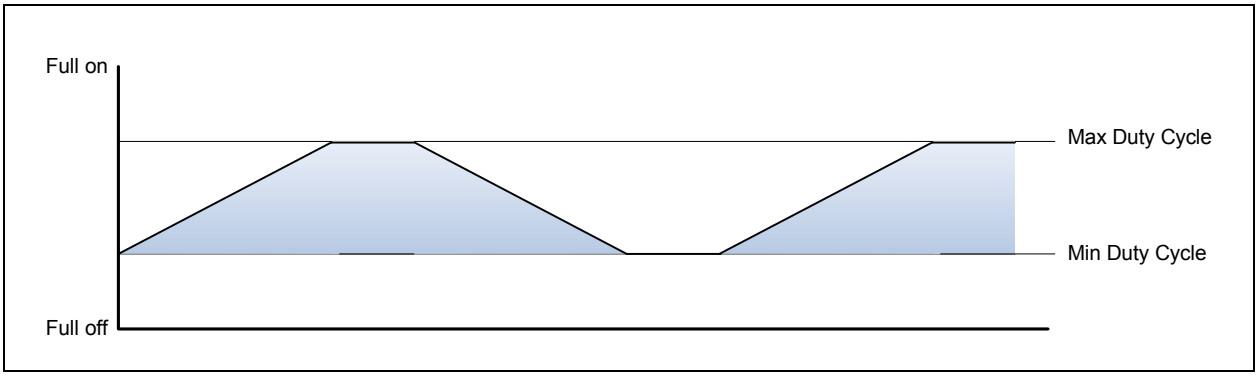
FIGURE 21-2: BREATHING LED EXAMPLE



The breathing range of and LED can range between full on and full off, or in a range that falls within the full-on/full-off range, as shown in this figure. The ramp time can be different in different applications. For example, if the ramp time was 1 second, the LED would appear to breathe quickly. A time of 2 seconds would make the LED appear to breathe more leisurely.

The breathing pattern can be clipped, as shown in the following figure, so that the breathing effect appears to pause at its maximum and minimum brightnesses:

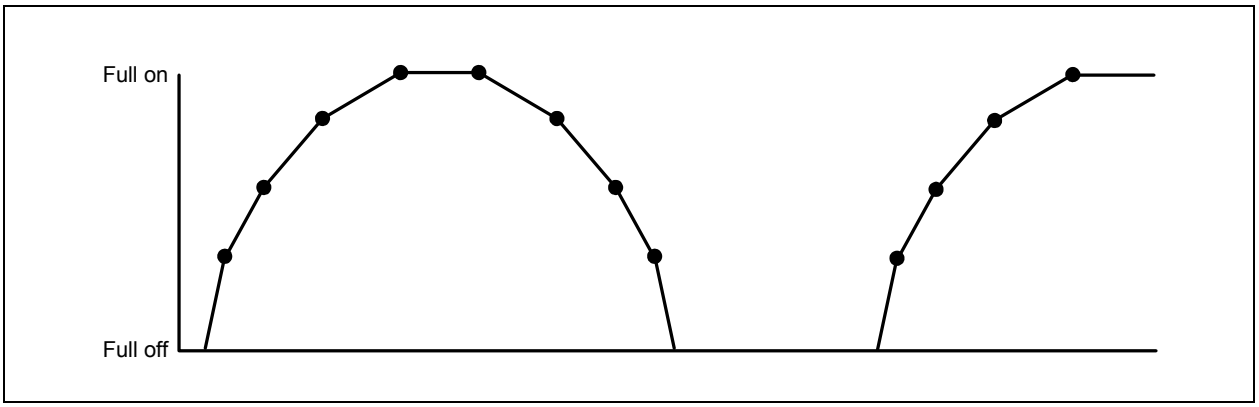
FIGURE 21-3: CLIPPING EXAMPLE



The clipping periods at the two extremes can be adjusted independently, so that for example an LED can appear to breathe (with a short delay at maximum brightness) followed by a longer “resting” period (with a long delay at minimum brightness).

The brightness can also be changed in a non-linear fashion, as shown in the following figure:

FIGURE 21-4: EXAMPLE OF A SEGMENTED CURVE



In this figure, the rise and fall curves are implemented in 4 linear segments and are the rise and fall periods are symmetric.

The breathing mode uses the 32.768 KHz clock for its time base.

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21.8.2 BLINKING

When configured for blinking, a subset of the hardware used in breathing is used to implement the blinking function. The PWM (an 8-bit accumulator plus an 8-bit duty cycle register) drives the LED directly. The Duty Cycle register is programmed directly by the user, and not modified further. The PWM accumulator is configured as a simple 8-bit up counter. The counter uses the 32.768 KHz clock, and is pre-scaled by the Delay counter, to slow the PWM down from the 128Hz provided by directly running the PWM on the 32.768 KHz clock.

With the pre-scaler, the blink rate of the LED could be as fast as 128Hz (which, because it is blinking faster than the eye can distinguish, would appear as a continuous level) to 0.03125Hz (that is, with a period of 7.8ms to 32 seconds). Any duty cycle from 0% (0h) to 100% (FFh) can be configured, with an 8-bit precision. An LED with a duty cycle value of 0h will be fully off, while an LED with a duty cycle value of FFh will be fully on.

In Blinking mode the PWM counter is always in 8-bit mode.

Table 21-7, "LED Blink Configuration Examples" shows some example blinking configurations:

TABLE 21-7: LED BLINK CONFIGURATION EXAMPLES

Prescale	Duty Cycle	Blink Frequency	Blink
000h	00h	128Hz	full off
000h	FFh	128Hz	full on
001h	40h	64Hz	3.9ms on, 11.6ms off
003h	80h	32Hz	15.5ms on, 15.5ms off
07Fh	20h	1Hz	125ms on, 0.875s off
0BFh	16h	0.66Hz	125ms on, 1.375s off
0FFh	10h	0.5Hz	125ms on, 1.875s off
180h	0Bh	0.33Hz	125ms on, 2.875s off
1FFh	40h	0.25Hz	1s on, 3s off

The Blinking and General Purpose PWM modes share the hardware used in the breathing mode. The Prescale value is derived from the LD field of the LED_DELAY register and the Duty Cycle is derived from the MIN field of the LED_LIMITS register.

TABLE 21-8: BLINKING MODE CALCULATIONS

Parameter	Unit	Equation
Frequency	Hz	(32KHz_Clk frequency) /(PRESCALE + 1)/255
'H' Width	Seconds	(1/PERIOD) x (DutyCycle/255)
'L' Width	Seconds	(1/PERIOD) x (255 - DutyCycle)

21.8.3 GENERAL PURPOSE PWM

When used in the Blinking configuration with the 48 MHz Ring Oscillator, the LED module can be used as a general-purpose programmable Pulse-Width Modulator with an 8-bit programmable pulse width. It can be used for fan speed control, sound volume, etc. With the 48 MHz Ring Oscillator source, the PWM frequency can be configured in the range shown in Table 21-9.

TABLE 21-9: PWM CONFIGURATION EXAMPLES

Prescale	PWM Frequency
000h	187.5 KHz
001h	93.75 KHz
003h	46.875 KHz
006h	26.8 KHz
00Bh	15.625 KHz
07Fh	1.46 KHz
1FFh	366 Hz
FFFh	46 Hz

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TABLE 21-10: GENERAL PURPOSE PWM MODE CALCULATIONS

Parameter	Unit	Equation
Frequency	Hz	(48 MHz Ring Oscillator frequency) / (PRESCALE + 1) / 255
'H' Width	Seconds	(1/PERIOD) x (DutyCycle/255)
'L' Width	Seconds	(1/PERIOD) x (255 - DutyCycle)

21.8.3.1 PWM WDT

When the PWM is configured as a general-purpose PWM (in the Blinking configuration with the 48 MHz clock), the PWM includes a Watch Dog Timer (WDT). The WDT consists of an internal 8-bit counter and an 8-bit reload value (the field WDTLD in LED Configuration Register register). The internal counter is loaded with the reset value of WDTLD (14h, or 4 seconds) on system VCC1_RESET and loaded with the contents of WDTLD whenever either the LED Configuration Register register is written or the MIN byte in the LED Limits Register register is written (the MIN byte controls the duty cycle of the PWM).

Whenever the internal counter is non-zero, it is decremented by 1 for every tick of the 5 Hz clock. If the counter decrements from 1 to 0, a WDT Terminal Count causes an interrupt to be generated and reset sets the CONTROL bit in the LED Configuration Register to 3h, which forces the PWM to be full on. No other PWM registers or fields are affected.

If the 5 Hz clock halts, the watchdog timer stops decrementing but retains its value, provided the device continues to be powered. When the 5 Hz clock restarts, the watchdog counter will continue decrementing where it left off.

Setting the WDTLD bits to 0 disables the PWM WDT. Other sample values for WDTLD are:

01h = 200 ms

02h = 400 ms

03h = 600 ms

04h = 800 ms

...

14h = 4seconds

FFh = 51 seconds

21.9 Implementation

In addition to the registers described in Section 21.10, "EC-Only Registers", the PWM is implemented using a number of components that are interconnected differently when configured for breathing operation and when configured for blinking/PWM operation.

21.9.1 BREATHING CONFIGURATION

The **PSIZE** parameter can configure the PWM to one of three modes: 8-bit, 7-bit and 6-bit. The **PERIOD CTR** counts ticks of its input clock. In 8-bit mode, it counts from 0 to 255 (that is, 256 steps), then repeats continuously. In this mode, a full cycle takes 7.8ms (128Hz). In 7-bit mode it counts from 0 to 127 (128 steps), and a full cycle takes 3.9ms (256Hz). In 6-bit mode it counts from 0 to 63 (64 steps) and a full cycle takes 1.95ms (512Hz).

The output of the LED circuit is asserted whenever the **PERIOD CTR** is less than the contents of the **DUTY CYCLE** register. The appearance of breathing is created by modifying the contents of the **DUTY CYCLE** register in a continuous manner. When the LED control is off the internal counters and registers are all reset to 0 (i.e. after a write setting the RESET bit in the LED Configuration Register Register.) Once enabled, the **DUTY CYCLE** register is increased by an amount determined by the LED_STEP register and at a rate determined by the **DELAY** counter. Once the duty cycle reaches its maximum value (determined by the field MAX), the duty cycle is held constant for a period determined by the field HD. Once the hold time is complete, the **DUTY CYCLE** register is decreased, again by an amount determined by the LED_STEP register and at a rate determined by the **DELAY** counter. When the duty cycle then falls at or below the minimum value (determined by the field MIN), the duty cycle is held constant for a period determined by the field HD. Once the hold time is complete, the cycle repeats, with the duty cycle oscillating between MIN and MAX.

The rising and falling ramp times as shown in FIGURE 21-3: Clipping Example on page 230 can be either symmetric or asymmetric depending on the setting of the SYMMETRY bit in the LED Configuration Register Register. In Symmetric mode the rising and falling ramp rates have mirror symmetry; both rising and falling ramp rates use the same (all) 8

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segments fields in each of the following registers (see Table 21-11): the LED Update Stepsize Register register and the LED Update Interval Register register. In Asymmetric mode the rising ramp rate uses 4 of the 8 segments fields and the falling ramp rate uses the remaining 4 of the 8 segments fields (see Table 21-11).

The parameters MIN, MAX, HD, LD and the 8 fields in LED_STEP and LED_INT determine the brightness range of the LED and the rate at which its brightness changes. See the descriptions of the fields in Section 21.10, "EC-Only Registers", as well as the examples in Section 21.9.3, "Breathing Examples" for information on how to set these fields.

TABLE 21-11: SYMMETRIC BREATHING MODE REGISTER USAGE

Rising/ Falling Ramp Times in Figure 21-3, "Clipping Example"	**Duty Cycle**	**Segment Index**	**Symmetric Mode Register Fields Utilized**	
X	000xxxxxb	000b	STEP[0]/INT[0]	Bits[3:0]
X	001xxxxxb	001b	STEP[1]/INT[1]	Bits[7:4]
X	010xxxxxb	010b	STEP[2]/INT[2]	Bits[11:8]
X	011xxxxxb	011b	STEP[3]/INT[3]	Bits[15:12]
X	100xxxxxb	100b	STEP[4]/INT[4]	Bits[19:16]
X	101xxxxxb	101b	STEP[5]/INT[5]	Bits[23:20]
X	110xxxxxb	110b	STEP[6]/INT[6]	Bits[27:24]
X	111xxxxxb	111b	STEP[7]/INT[7]	Bits[31:28]
Note: In Symmetric Mode the Segment_Index[2:0] = Duty Cycle Bits[7:5]				

TABLE 21-12: ASYMMETRIC BREATHING MODE REGISTER USAGE

Rising/ Falling Ramp Times in Figure 21-3, "Clipping Example"	**Duty Cycle**	**Segment Index**	**Asymmetric Mode Register Fields Utilized**	
Rising	00xxxxxxb	000b	STEP[0]/INT[0]	Bits[3:0]
Rising	01xxxxxxb	001b	STEP[1]/INT[1]	Bits[7:4]
Rising	10xxxxxxb	010b	STEP[2]/INT[2]	Bits[11:8]
Rising	11xxxxxxb	011b	STEP[3]/INT[3]	Bits[15:12]
falling	00xxxxxxb	100b	STEP[4]/INT[4]	Bits[19:16]
falling	01xxxxxxb	101b	STEP[5]/INT[5]	Bits[23:20]
falling	10xxxxxxb	110b	STEP[6]/INT[6]	Bits[27:24]
falling	11xxxxxxb	111b	STEP[7]/INT[7]	Bits[31:28]
Note: In Asymmetric Mode the Segment_Index[2:0] is the bit concatenation of following: Segment_Index[2] = (FALLING RAMP TIME in Figure 21-3, "Clipping Example") and Segment_Index[1:0] = Duty Cycle Bits[7:6].				

21.9.2 BLINKING CONFIGURATION

The Delay counter and the PWM counter are the same as in the breathing configuration, except in this configuration they are connected differently. The Delay counter is clocked on either the 32.768 KHz clock or the 48 MHz clock, rather than the output of the PWM. The PWM counter is clocked by the zero output of the Delay counter, which functions as a prescalar for the input clocks to the PWM. The Delay counter is reloaded from the LD field of the LED_DELAY register. When the LD field is 0 the input clock is passed directly to the PWM counter without prescaling. In Blinking/PWM mode the PWM counter is always 8-bit, and the PSIZE parameter has no effect.

The frequency of the PWM pulse waveform is determined by the formula:

$$f_{PWM} = \frac{f_{clock}}{(256 \times (LD + 1))}$$

where f_{PWM} is the frequency of the PWM, f_{clock} is the frequency of the input clock (32.768 KHz clock or 48 MHz clock) and LD is the contents of the LD field.

Note: At a duty cycle value of 00h (in the MIN register), the LED output is fully off. At a duty cycle value of 255h, the LED output is fully on. Alternatively, In order to force the LED to be fully on, firmware can set the CONTROL field of the Configuration register to 3 (always on).

The other registers in the block do not affect the PWM or the LED output in Blinking/PWM mode.

21.9.3 BREATHING EXAMPLES

21.9.3.1 Linear LED brightness change

In this example, the brightness of the LED increases and diminishes in a linear fashion. The entire cycle takes 5 seconds. The rise time and fall time are 1.6 seconds, with a hold time at maximum brightness of 200ms and a hold time at minimum brightness of 1.6 seconds. The LED brightness varies between full off and full on. The PWM size is set to 8-bit, so the time unit for adjusting the PWM is approximately 8ms. The registers are configured as follows:

TABLE 21-13: LINEAR EXAMPLE CONFIGURATION

Field	Value							
PSIZE	8-bit							
MAX	255							
MIN	0							
HD	25 ticks (200ms)							
LD	200 ticks (1.6s)							
Duty cycle most significant bits	000b	001b	010b	011b	100b	101b	110b	1110
LED_INT	8	8	8	8	8	8	8	8
LED_STEP	10	10	10	10	10	10	10	10

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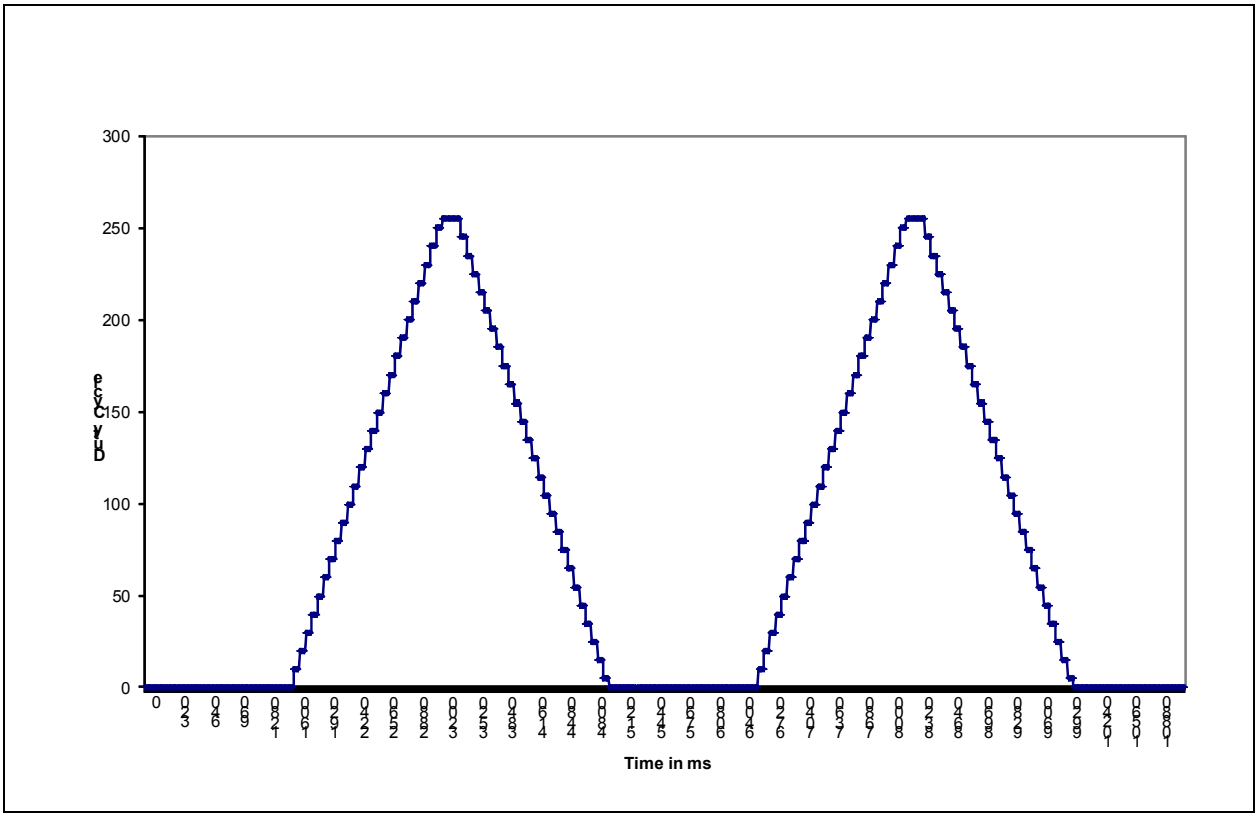
FIGURE 21-5: LINEAR BRIGHTNESS CURVE EXAMPLE



21.9.3.2 Non-linear LED brightness change

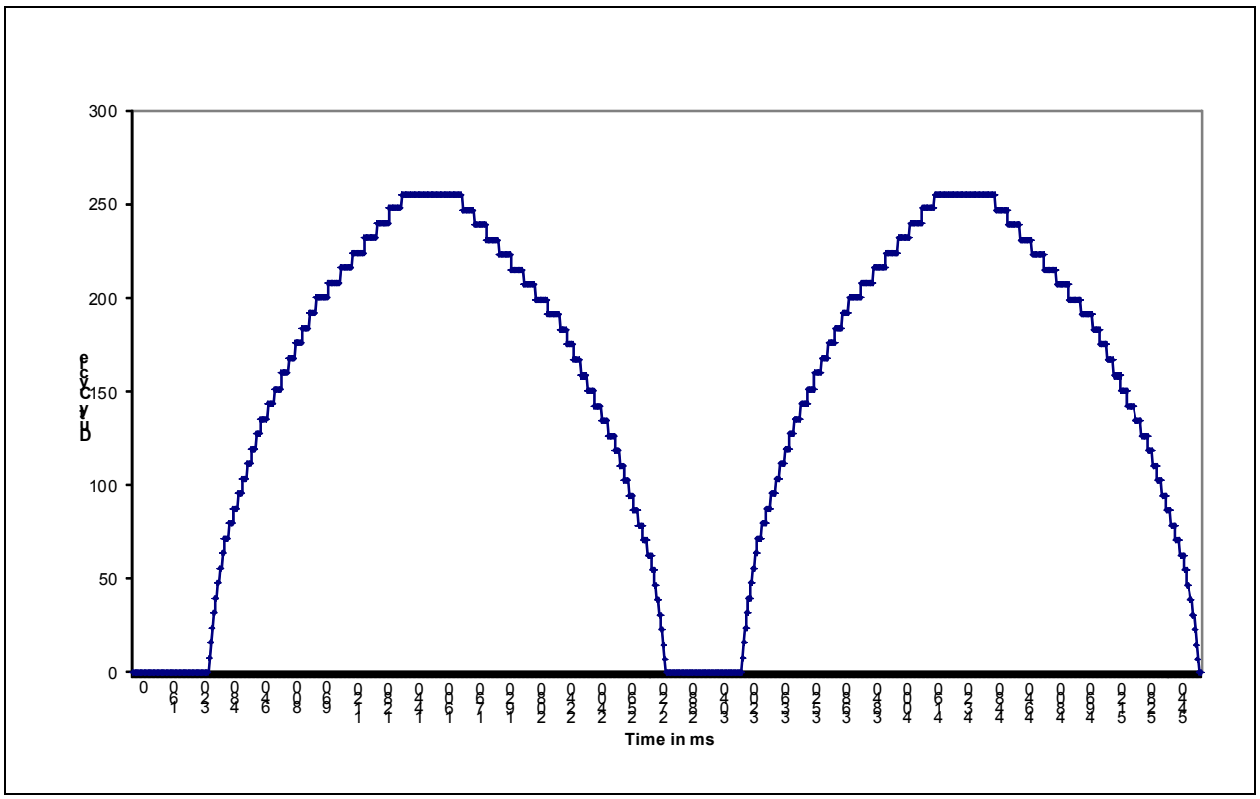
In this example, the brightness of the LED increases and diminishes in a non-linear fashion. The brightness forms a curve that is approximated by four piece wise-linear line segments. The entire cycle takes about 2.8 seconds. The rise time and fall time are about 1 second, with a hold time at maximum brightness of 320ms and a hold time at minimum brightness of 400ms. The LED brightness varies between full off and full on. The PWM size is set to 7-bit, so the time unit for adjusting the PWM is approximately 4ms. The registers are configured as follows:

TABLE 21-14: NON-LINEAR EXAMPLE CONFIGURATION

Field	Value							
PSIZE	7-bit							
MAX	255 (effectively 127)							
MIN	0							
HD	80 ticks (320ms)							
LD	100 ticks (400ms)							
Duty cycle most significant bits	000b	001b	010b	011b	100b	101b	110b	1110
LED_INT	2	3	6	6	9	9	16	16
LED_STEP	4	4	4	4	4	4	4	4

The resulting curve is shown in the following figure:

FIGURE 21-6: NON-LINEAR BRIGHTNESS CURVE EXAMPLE



21.10 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the Blinking/Breathing PWM. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 21-15: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
Blinking/Breathing PWM	0	EC	32-bit internal address space	4000_B800h
Blinking/Breathing PWM	1	EC	32-bit internal address space	4000_B900h
Blinking/Breathing PWM	2	EC	32-bit internal address space	4000_BA00h
Blinking/Breathing PWM	3	EC	32-bit internal address space	4000_BB00h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

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TABLE 21-16: EC-ONLY REGISTER SUMMARY

Offset	Register Name (Mnemonic)
00h	LED Configuration Register
04h	LED Limits Register
08h	LED Delay Register
0Ch	LED Update Stepsize Register
10h	LED Update Interval Register

In the following register definitions, a “PWM period” is defined by time the PWM counter goes from 000h to its maximum value (FFh in 8-bit mode, FEh in 7-bit mode and FCh in 6-bit mode, as defined by the PSCALE field in register LED_CFG). The end of a PWM period occurs when the PWM counter wraps from its maximum value to 0.

The registers in this block can be written 32-bits, 16-bits or 8-bits at a time. Writes to LED Configuration Register take effect immediately. Writes to LED Limits Register are held in a holding register and only take effect only at the end of a PWM period. The update takes place at the end of every period, even if only one byte of the register was updated. This means that in blink/PWM mode, software can change the duty cycle with a single 8-bit write to the MIN field in the LED_LIMIT register. Writes to LED Delay Register, LED Update Stepsize Register and LED Update Interval Register also go initially into a holding register. The holding registers are copied to the operating registers at the end of a PWM period only if the Enable Update bit in the LED Configuration Register is set to 1. If LED_CFG is 0, data in the holding registers is retained but not copied to the operating registers when the PWM period expires. To change an LED breathing configuration, software should write these three registers with the desired values and then set LED_CFG to 1. This mechanism ensures that all parameters affecting LED breathing will be updated consistently, even if the registers are only written 8 bits at a time.

21.10.1 LED CONFIGURATION REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	Reserved	R	-	-
16	SYMMETRY 1=The rising and falling ramp times are in Asymmetric mode. Table 21-12, "Asymmetric Breathing Mode Register Usage" shows the application of the Stepsize and Interval registers to the four segments of rising duty cycles and the four segments of falling duty cycles. 0=The rising and falling ramp times (as shown in Figure 21-2, "Breathing LED Example") are in Symmetric mode. Table 21-11, "Symmetric Breathing Mode Register Usage" shows the application of the Stepsize and Interval registers to the 8 segments of both rising and falling duty cycles.	R/W	0b	VCC1_RESET
15:8	WDT_RELOAD The PWM Watchdog Timer counter reload value. On system reset, it defaults to 14h, which corresponds to a 4 second Watchdog timeout value.	R/W	14h	VCC1_RESET
7	RESET Writes of’1’ to this bit resets the PWM registers to their default values. This bit is self clearing. Writes of ‘0’ to this bit have no effect.	W	0b	VCC1_RESET

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
6	ENABLE_UPDATE This bit is set to 1 when written with a '1'. Writes of '0' have no effect. Hardware clears this bit to 0 when the breathing configuration registers are updated at the end of a PWM period. The current state of the bit is readable any time. This bit is used to enable consistent configuration of LED_DELAY, LED_STEP and LED_INT. As long as this bit is 0, data written to those three registers is retained in a holding register. When this bit is 1, data in the holding register are copied to the operating registers at the end of a PWM period. When the copy completes, hardware clears this bit to 0.	R/WS	0b	VCC1_RESET
5:4	PWM_SIZE This bit controls the behavior of PWM: 3=Reserved 2=PWM is configured as a 6-bit PWM 1=PWM is configured as a 7-bit PWM 0=PWM is configured as an 8-bit PWM	R/W	0b	VCC1_RESET
3	SYNCHRONIZE When this bit is '1', all counters for all LEDs are reset to their initial values. When this bit is '0' in the LED Configuration Register for all LEDs, then all counters for LEDs that are configured to blink or breathe will increment or decrement, as required. To synchronize blinking or breathing, the SYNCHRONIZE bit should be set for at least one LED, the control registers for each LED should be set to their required values, then the SYNCHRONIZE bits should all be cleared. If the all LEDs are set for the same blink period, they will all be synchronized.	R/W	0b	VCC1_RESET
2	CLOCK_SOURCE This bit controls the base clock for the PWM. It is only valid when CNTRL is set to blink (2). 1=Clock source is the 48 MHz clock 0=Clock source is the 32.768 KHz clock	R/W	0b	VCC1_RESET
1:0	CONTROL This bit controls the behavior of PWM: 3=PWM is always on 2=LED blinking (standard PWM) 1=LED breathing configuration 0=PWM is always off. All internal registers and counters are reset to 0. Clocks are gated	R/W	00b 11b	VCC1_RESET WDT TC

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21.10.2 LED LIMITS REGISTER

This register may be written at any time. Values written into the register are held in an holding register, which is transferred into the actual register at the end of a PWM period. The two byte fields may be written independently. Reads of this register return the current contents and not the value of the holding register.

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	Reserved	R	-	-
15:8	MAXIMUM In breathing mode, when the current duty cycle is greater than or equal to this value the breathing apparatus holds the current duty cycle for the period specified by the field HD in register LED_DELAY, then starts decrementing the current duty cycle	R/W	0h	VCC1_RESET
7:0	MINIMUM In breathing mode, when the current duty cycle is less than or equal to this value the breathing apparatus holds the current duty cycle for the period specified by the field LD in register LED_DELAY, then starts incrementing the current duty cycle In blinking mode, this field defines the duty cycle of the blink function.	R/W	0h	VCC1_RESET

21.10.3 LED DELAY REGISTER

This register may be written at any time. Values written into the register are held in an holding register, which is transferred into the actual register at the end of a PWM period if the Enable Update bit in the LED Configuration register is set to 1. Reads of this register return the current contents and not the value of the holding register.

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:24	Reserved	R	-	-
23:12	HIGH_DELAY In breathing mode, the number of PWM periods to wait before updating the current duty cycle when the current duty cycle is greater than or equal to the value MAX in register LED_LIMIT. 4095=The current duty cycle is decremented after 4096 PWM periods … 1=The delay counter is bypassed and the current duty cycle is decremented after two PWM period 0=The delay counter is bypassed and the current duty cycle is decremented after one PWM period	R/W	000h	VCC1_RESET
11:0	LOW_DELAY The number of PWM periods to wait before updating the current duty cycle when the current duty cycle is greater than or equal to the value MIN in register LED_LIMIT. 4095=The current duty cycle is incremented after 4096 PWM periods … 0=The delay counter is bypassed and the current duty cycle is incremented after one PWM period In blinking mode, this field defines the prescalar for the PWM clock	R/W	000h	VCC1_RESET

21.10.4 LED UPDATE STEPSIZE REGISTER

This register has eight segment fields which provide the amount the current duty cycle is adjusted at the end of every PWM period. Segment field selection is decoded based on the segment index. The segment index equation utilized depends on the SYMMETRY bit in the LED Configuration Register Register)

- In Symmetric Mode the Segment_Index[2:0] = Duty Cycle Bits[7:5].
- In Asymmetric Mode the Segment_Index[2:0] is the bit concatenation of following: Segment_Index[2] = (FALLING RAMP TIME in Figure 21-3, "Clipping Example") and Segment_Index[1:0] = Duty Cycle Bits[7:6].

This register may be written at any time. Values written into the register are held in an holding register, which is transferred into the actual register at the end of a PWM period if the Enable Update bit in the LED Configuration register is set to 1. Reads of this register return the current contents and not the value of the holding register.

In 8-bit mode, each 4-bit STEPSIZE field represents 16 possible duty cycle modifications, from 1 to 16 as the duty cycle is modified between 0 and 255:

15: Modify the duty cycle by 16

...

1: Modify the duty cycle by 2

0: Modify the duty cycle by 1

In 7-bit mode, the least significant bit of the 4-bit field is ignored, so each field represents 8 possible duty cycle modifications, from 1 to 8, as the duty cycle is modified between 0 and 127:

14, 15: Modify the duty cycle by 8

...

2, 3: Modify the duty cycle by 2

0, 1: Modify the duty cycle by 1

In 6-bit mode, the two least significant bits of the 4-bit field is ignored, so each field represents 4 possible duty cycle modifications, from 1 to 4 as the duty cycle is modified between 0 and 63:

12, 13, 14, 15: Modify the duty cycle by 4

8, 9, 10, 11: Modify the duty cycle by 3

4, 5, 6, 7: Modify the duty cycle by 2

0, 1, 2, 3: Modify the duty cycle by 1

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:28	UPDATE_STEP7 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 111.	R/W	0h	VCC1_RESET
27:24	UPDATE_STEP6 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 110.	R/W	0h	VCC1_RESET
23:20	UPDATE_STEP5 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 101	R/W	0h	VCC1_RESET
19:16	UPDATE_STEP4 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 100.	R/W	0h	VCC1_RESET
15:12	UPDATE_STEP3 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 011.	R/W	0h	VCC1_RESET

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Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
11:8	UPDATE_STEP2 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 010.	R/W	0h	VCC1_RESET
7:4	UPDATE_STEP1 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 001.	R/W	0h	VCC1_RESET
3:0	UPDATE_STEP0 Amount the current duty cycle is adjusted at the end of every PWM period when the segment index is equal to 000.	R/W	0h	VCC1_RESET

21.10.5 LED UPDATE INTERVAL REGISTER

This register has eight segment fields which provide the number of PWM periods between updates to current duty cycle. Segment field selection is decoded based on the segment index. The segment index equation utilized depends on the SYMMETRY bit in the LED Configuration Register Register)

- In Symmetric Mode the Segment_Index[2:0] = Duty Cycle Bits[7:5]
- In Asymmetric Mode the Segment_Index[2:0] is the bit concatenation of following: Segment_Index[2] = (FALLING RAMP TIME in Figure 21-3, "Clipping Example") and Segment_Index[1:0] = Duty Cycle Bits[7:6].

This register may be written at any time. Values written into the register are held in an holding register, which is transferred into the actual register at the end of a PWM period if the Enable Update bit in the LED Configuration register is set to 1. Reads of this register return the current contents and not the value of the holding register.

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:28	UPDATE_INTERVAL7 The number of PWM periods between updates to current duty cycle when the segment index is equal to 111b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET
27:24	UPDATE_INTERVAL6 The number of PWM periods between updates to current duty cycle when the segment index is equal to 110b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET
23:20	UPDATE_INTERVAL5 The number of PWM periods between updates to current duty cycle when the segment index is equal to 101b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
19:16	UPDATE_INTERVAL4 The number of PWM periods between updates to current duty cycle when the segment index is equal to 100b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET
15:12	UPDATE_INTERVAL3 The number of PWM periods between updates to current duty cycle when the segment index is equal to 011b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET
11:8	UPDATE_INTERVAL2 The number of PWM periods between updates to current duty cycle when the segment index is equal to 010b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET
7:4	UPDATE_INTERVAL1 The number of PWM periods between updates to current duty cycle when the segment index is equal to 001b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET
3:0	UPDATE_INTERVAL0 The number of PWM periods between updates to current duty cycle when the segment index is equal to 000b. 15=Wait 16 PWM periods … 0=Wait 1 PWM period	R/W	0h	VCC1_RESET

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22.0 KEYBOARD SCAN INTERFACE

22.1 Overview

The Keyboard Scan Interface block provides a register interface to the EC to directly scan an external keyboard matrix of size up to 18x8.

The maximum configuration of the Keyboard Scan Interface is 18 outputs by 8 inputs. For a smaller matrix size, firmware should configure unused KSO pins as GPIOs or another alternate function, and it should mask out unused KSIs and associated interrupts.

22.2 References

No references have been cited for this feature.

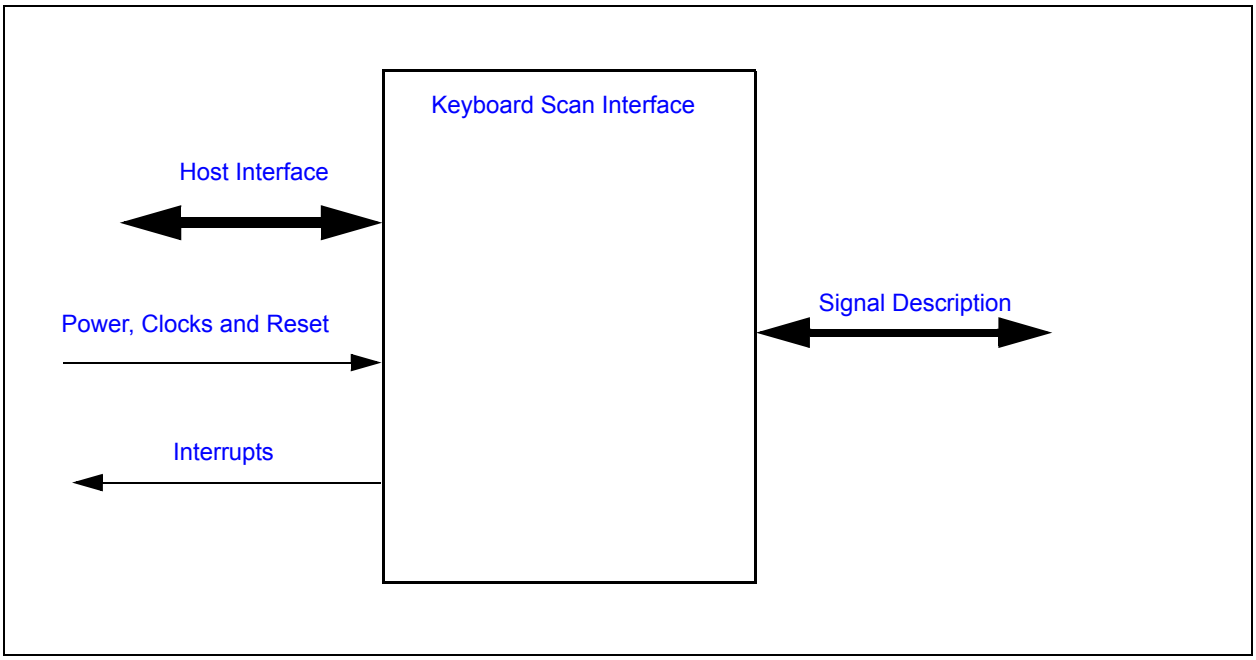
22.3 Terminology

There is no terminology defined for this section.

22.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 22-1: I/O DIAGRAM OF BLOCK



22.5 Signal Description

TABLE 22-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
KSI[7:0]	Input	Column inputs from external keyboard matrix.
KSO[17:0]	Output	Row outputs to external keyboard matrix.

22.6 Host Interface

The registers defined for the Keyboard Scan Interface are accessible by the various hosts as indicated in Section 22.11, "EC-Only Registers".

22.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

22.7.1 POWER DOMAINS

TABLE 22-2: POWER SOURCES

Name	Description
VCC1	The logic and registers implemented in this block are powered by this power well.

22.7.2 CLOCK INPUTS

TABLE 22-3: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This is the clock source for Keyboard Scan Interface logic.

22.7.3 RESETS

TABLE 22-4: RESET SIGNALS

Name	Description
VCC1_RESET	This signal resets all the registers and logic in this block to their default state.

22.8 Interrupts

This section defines the Interrupt Sources generated from this block.

TABLE 22-5: EC INTERRUPTS

Source	Description
KSC_INT	Interrupt request to the Interrupt Aggregator.
KSC_INT_WAKE	Wake-up request to the Interrupt Aggregator's wake-up interface.

22.9 Low Power Modes

The Keyboard Scan Interface automatically enters a low power mode whenever it is not actively scanning the keyboard matrix. The block is also placed in a low-power state when it is disabled by the KSEN bit. When the interface is in a low-power mode it will not prevent the chip from entering a sleep state. When the interface is active it will inhibit the chip sleep state until the interface has re-entered its low power mode.

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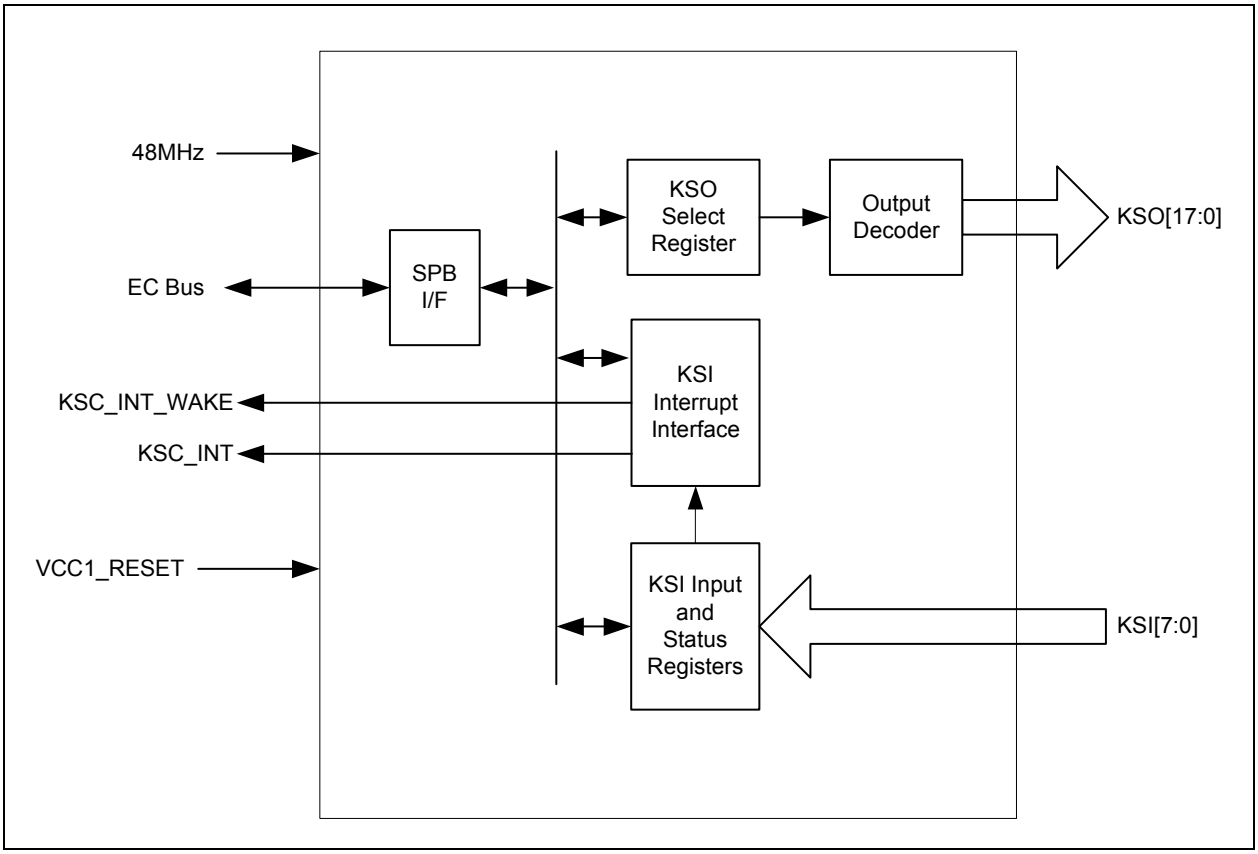
22.10 Description

FIGURE 22-2: Keyboard Scan Interface Block Diagram



During scanning the firmware sequentially drives low one of the rows (KSO[17:0]) and then reads the column data line (KSI[7:0]). A key press is detected as a zero in the corresponding position in the matrix. Keys that are pressed are debounced by firmware. Once confirmed, the corresponding keycode is loaded into host data read buffer in the 8042 Host Interface module. Firmware may need to buffer keycodes in memory in case this interface is stalled or the host requests a Resend.

22.10.1 INITIALIZATION OF KSO PINS

If the Keyboard Scan Interface is not configured for PREDRIVE Mode, KSO pins should be configured as open-drain outputs. Internal or external pull-ups should be used so that the GPIO functions that share the pins do not have a floating input when the KSO pins are tri-stated.

If the Keyboard Scan Interface is configured for PREDRIVE Mode, KSO pins must be configured as push-pull outputs. Internal or external pull-ups should be used to protect the GPIO inputs associated with the KSO pins from floating inputs.

22.10.2 PREDRIVE MODE

There is an optional Predrive Mode that can be enabled to actively drive the KSO pins high before switching to open-drain operation. The PREDRIVE ENABLE bit in the Keyscan Extended Control Register is used to enable the PRE-DRIVE option. Timing for the Predive mode is shown in Section 30.5, Keyboard Scan Matrix Timing.

22.10.2.1 Predrive Mode Programming

The following precautions should be taken to prevent output pad damage during Predrive Mode Programming.

22.10.2.2 Asserting PREDRIVE_ENABLE

1. Disable Key Scan Interface (KSEN = '1')
2. Enable Predrive function (PREDRIVE_ENABLE = '1')
3. Program buffer type for all KSO pins to "push-pull”
4. Enable Keyscan Interface (KSEN ='0')

22.10.2.3 De-asserting PREDRIVE_ENABLE

1. Disable Key Scan Interface (KSEN = '1')
2. Program buffer type for all KSO pins to "open-drain”
3. Disable Predrive function (PREDRIVE_ENABLE = '0')
4. Enable Keyscan Interface (KSEN ='0')

22.10.3 INTERRUPT GENERATION

To support interrupt-based processing, an interrupt can optionally be generated on the high-to-low transition on any of the KSI inputs. A running clock is not required to generate interrupts.

22.10.3.1 Runtime interrupt

KSC_INT is the block’s runtime active-high level interrupt. It is connected to the interrupt interface of the Interrupt Aggregator, which then relays interrupts to the EC.

Associated with each KSI input is a status register bit and an interrupt enable register bit. A status bit is set when the associated KSI input goes from high to low. If the interrupt enable bit for that input is set, an interrupt is generated. An Interrupt is de-asserted when the status bit and/or interrupt enable bit is clear. A status bit cleared when written to a ‘1’.

Interrupts from individual KSIs are logically ORed together to drive the KSC_INT output port. Once asserted, an interrupt is not asserted again until either all KSI[7:0] inputs have returned high or the has changed.

22.10.3.2 Wake-up Interrupt

KSC_INT_WAKE is the block’s wakeup interrupt. It is routed to the Interrupt Aggregator.

During sleep mode, i.e., when the bus clock is stopped, a high-to-low transition on any KSI whose interrupt enable bit is set causes the KSC_INT_WAKE to be asserted. Also set is the associated status bit in the EC Clock Required 2 Status Register (EC_CLK_REQ2_STS). KSC_WAKEUP_INT remains active until the bus clock is started.

The aforementioned transition on KSI also sets the corresponding status bit in the KSI STATUS Register. If enabled, a runtime interrupt is also asserted on KSC_INT when the bus clock resumes running.

22.10.4 WAKE PROGRAMMING

Using the Keyboard Scan Interface to ‘wake’ the CEC1302 can be accomplished using either the Keyboard Scan Interface wake interrupt, or using the wake capabilities of the GPIO Interface pins that are multiplexed with the Keyboard Scan Interface pins. Enabling the Keyboard Scan Interface wake interrupt requires only a single interrupt enable access and is recommended over using the GPIO Interface for this purpose.

22.11 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the Keyboard Scan Interface. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 22-6: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
Keyboard Scan Interface	0	EC	32-bit internal address space	4000_9C00h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

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TABLE 22-7: EC-ONLY REGISTER SUMMARY

Offset	Register Name
0h	Reserved
4h	KSO Select Register
8h	KSI INPUT Register
Ch	KSI STATUS Register
10h	KSI INTERRUPT ENABLE Register
14h	Keyscan Extended Control Register

22.11.1 KSO SELECT REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:4	Reserved	R	-	-
7	KSO_INVERT This bit controls the output level of KSO pins when selected. 0= KSO[x] driven low when selected 1= KSO[x] driven high when selected.	R/W	0b	VCC1_RESET
6	KSEN This field enables and disables keyboard scan 0= Keyboard scan enabled 1= Keyboard scan disabled. All KSO output buffers disabled.	R/W	1h	VCC1_RESET
5	KSO_ALL 0=When key scan is enabled, KSO output controlled by the KSO_SELECT field. 1=KSO[x] driven high when selected.	R/W	0b	VCC1_RESET
4:0	KSO_SELECT This field selects a KSO line (00000b = KSO[0] etc.) for output according to the value off KSO_INVERT in this register. See Table 22-8, "KSO Select Decode"	R/W	0h	VCC1_RESET

TABLE 22-8: KSO SELECT DECODE

KSO Select [4:0]	KSO Selected
00h	KSO00
01h	KSO01
02h	KSO02
03h	KSO03
04h	KSO04
05h	KSO05
06h	KSO06
07h	KSO07
08h	KSO08
09h	KSO09
0Ah	KSO10

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TABLE 22-8: KSO SELECT DECODE (CONTINUED)

KSO Select [4:0]	KSO Selected
0Bh	KSO11
0Ch	KSO12
0Dh	KSO13
0Eh	KSO14
0Fh	KSO15
10h	KSO16
11h	KSO17

TABLE 22-9: KEYBOARD SCAN OUT CONTROL SUMMARY

KSO_INVERTt	KSEN	KSO_ALL	KSO_SELECT	Description
X	1	x	x	Keyboard Scan disabled. KSO[17:0] output buffers disabled.
0	0	0	10001b-00000b	KSO[Drive Selected] driven low. All others driven high
1	0	0	10001b-00000b	KSO[Drive Selected] driven high. All others driven low
0	0	0	11111b-10010b	All KSO's driven high
1	0	0	11111b-10010b	All KSO's driven low
0	0	1	x	All KSO's driven high
1	0	1	x	All KSO's driven low

22.11.2 KSI INPUT REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	KSI This field returns the current state of the KSI pins.	R	0h	VCC1_RESET

22.11.3 KSI STATUS REGISTER

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	KSI_STATUS Each bit in this field is set on the falling edge of the corresponding KSI input pin. A KSI interrupt is generated when its corresponding status bit and interrupt enable bit are both set. KSI interrupts are logically ORed together to produce KSC_INT and KSC_INT_WAKE. Writing a '1' to a bit will clear it. Writing a '0' to a bit has no effect.	R/WC	0h	VCC1_RESET

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22.11.4 KSI INTERRUPT ENABLE REGISTER

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	KSI_INT_EN Each bit in KSI_INT_EN enables interrupt generation due to high-to-low transition on a KSI input. An interrupt is generated when the corresponding bits in KSI_STATUS and KSI_INT_EN are both set.	R/W	0h	VCC1_RESET

22.11.5 KEYSCAN EXTENDED CONTROL REGISTER

Offset	14h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
32:1	Reserved	R	-	-
0	PREDRIVE_ENABLE PREDRIVE_ENABLE enables the PREDRIVE mode to actively drive the KSO pins high for approximately 100 ns before switching to open-drain operation. 0=Disable predrive on KSO pins 1=Enable predrive on KSO pins.	RW	0	VCC1_RESET

23.0 BC-LINK MASTER

23.1 Overview

This block provides BC-Link™ connectivity to a slave device. The BC-Link™ protocol includes a start bit to signal the beginning of a message and a turnaround (TAR) period for bus transfer between the Master and Companion devices.

23.2 References

No references have been cited for this feature.

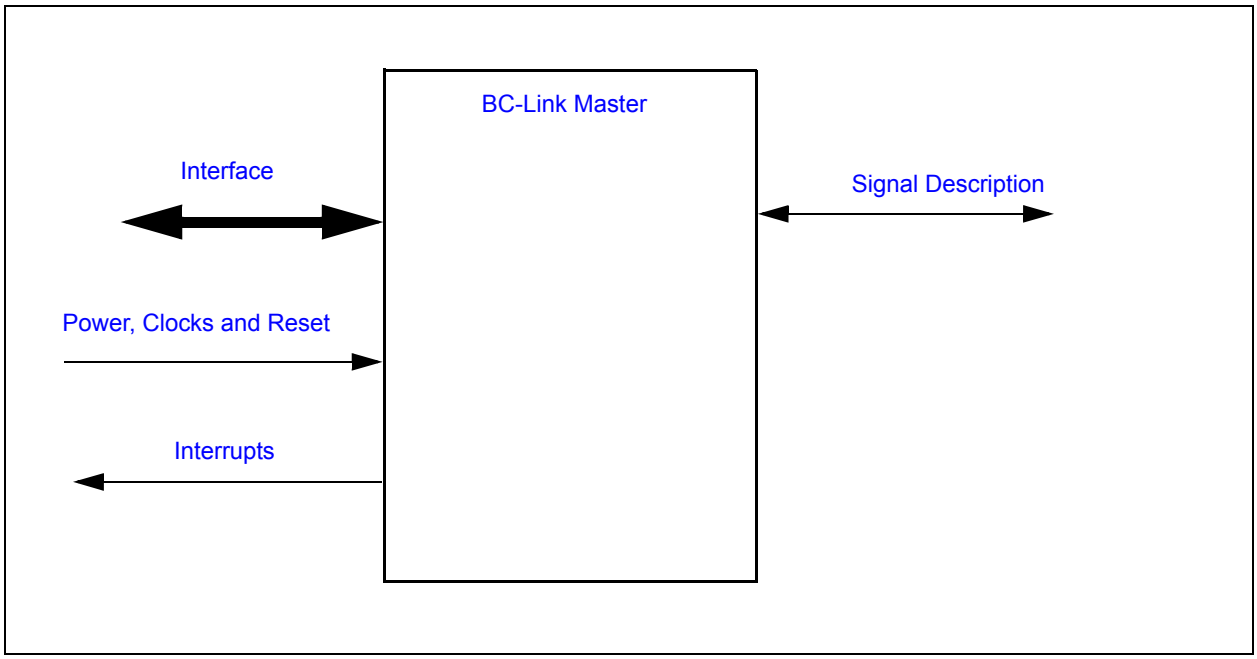
23.3 Terminology

There is no terminology defined for this section.

23.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 23-1: I/O DIAGRAM OF BLOCK



23.5 Signal Description

TABLE 23-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
BCM_CLK	Output	BC-Link output clock
BCM_DAT	Input/Output	Bidirectional data line
BCM_INT#	Input	Input from the companion device

Note: A weak pull-up resistor is recommended on the data line (100KΩ).

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The maximum speed at which the BC-Link Master Interface can operate reliably depends on the drive strength of the BC-Link BCM_CLK and BCM_DAT pins, as well as the nature of the connection to the Companion device (over ribbon cable or on a PC board). The following table shows the recommended maximum speeds over a PC board as well as a 12 inch ribbon cable for selected drive strengths. The frequency is set with the BC-Link Clock Select Register.

TABLE 23-2: BC-LINK MASTER PIN DRIVE STRENGTH VS. FREQUENCY

Pin Drive Strength	Max Freq on PC Board	Min Value in BC-Link Clock Select Register	Max Freq over Ribbon cable	Min Value in BC-Link Clock Select Register
16mA	24Mhz	1	16Mhz	2

23.6 Host Interface

The registers defined for the BC-Link Master Interface are accessible by the various hosts as indicated in Section 23.11, "EC-Only Registers".

23.7 Power, Clocks and Reset

23.7.1 POWER DOMAINS

TABLE 23-3: POWER SOURCES

Name	Description
VCC1	The logic and registers implemented in this block are powered by this power well.

23.7.2 CLOCK INPUTS

TABLE 23-4: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This is the clock source for Keyboard Scan Interface logic.

23.7.3 RESETS

TABLE 23-5: RESET SIGNALS

Name	Description
VCC1_RESET	This signal resets all the registers and logic in this block to their default state.

23.8 Interrupts

This section defines the Interrupt Sources generated from this block.

TABLE 23-6: EC INTERRUPTS

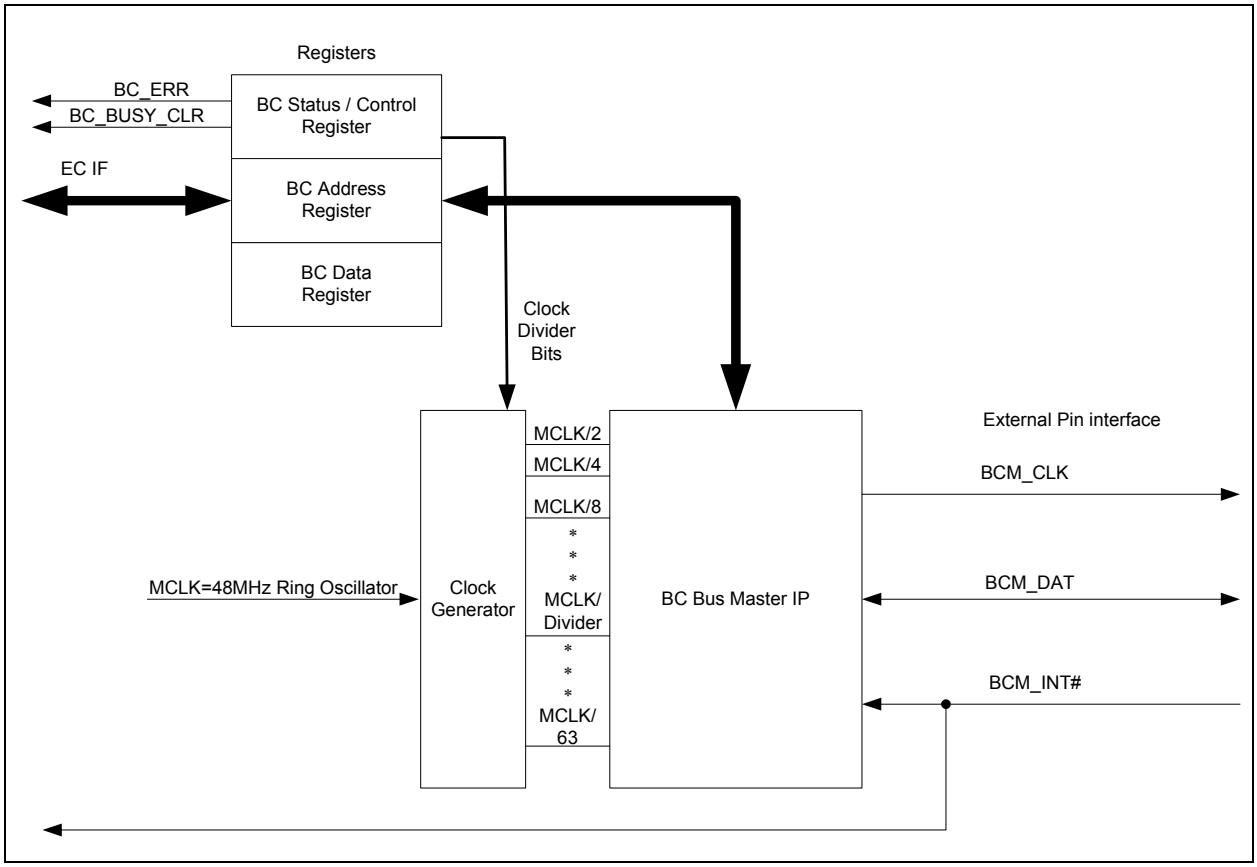
Source	Description
BCM_INT Busy	Interrupt request to the Interrupt Aggregator, generated from the status event BUSYdefined in the BC-Link Status Register.
BCM_INT Err	Interrupt request to the Interrupt Aggregator, generated from the status event defined in the BC-Link Status Register.
BC_INT_N_WK	Wake-up request to the Interrupt Aggregator's wake-up interface for BC-Link Master port. In order to enable BC-Link wakeup interrupts, the pin control registers for the BC_INT# pin must be programmed to Input, Falling Edge Triggered, non-inverted polarity detection.

23.9 Low Power Modes

The BC-Link Master Interface automatically enters a low power mode whenever it is not active (that is, whenever the BUSY bit in the BC-Link Status Register is '0'). When the interface is in a low-power mode it will not prevent the chip from entering a sleep state. When the interface is active it will inhibit the chip sleep state until the interface has re-entered its low power mode.

23.10 Description

FIGURE 23-2: BC-LINK MASTER BLOCK DIAGRAM



23.10.1 BC-LINK MASTER READ OPERATION

The BC-Link Read protocol requires two reads of the BC-Link Data Register. The two reads drive a two state-state machine: the two states are Read#1 and Read#2. The Read#1 of the Data Register starts the read protocol on the BC-Link pins and sets the BUSY bit in the BC-Link Status Register. The contents of the data read during Read#1 by the EC is stale and is not to be used. After the BUSY bit in the BC-Link Status Register autonomously clears to '0', the Read#2 of the Data Register transfers the data read from the peripheral/BC-Link companion chip to the EC.

1. Software starts by checking the status of the BUSY bit in the Status Register. If the BUSY bit is '0', proceed. If BUSY is '1', firmware must wait until it is '0'.
2. Software writes the address of the register to be read into the BC-Link Address Register.
3. Software then reads the Data Register. This read returns random data. The read activates the BC-Link Master state machine to transmit the read request packet to the BC-Link companion. When the transfer initiates, the hardware sets the BUSY bit to a '1'.
4. The BC-Link Companion reads the selected register and transmits the read response packet to the BC-Link Master. The Companion will ignore the read request if there is a CRC error; this will cause the Master state machine to time-out and issue a BC_ERR Interrupt.

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5. The Master state machine loads the Data Register, issues a BUSY Bit Clear interrupt and clears the BUSY bit to ‘0’.
6. Software, after either receiving the Bit Clear interrupt, or polling the BUSY bit until it is ‘0’, checks the BC_ERR bit in the Status Register.
7. Software can now read the Data Register which contains the valid data if there was no BC Bus error.
8. If a Bus Error occurs, firmware must issue a soft reset by setting the RESET bit in the Status Register to ‘1’.
9. The read can re-tried once BUSY is cleared.

Note:	Steps 3 thorough 7 should be completed as a contiguous sequence. If not the interface could be presenting incorrect data when software thinks it is accessing a valid register read.

23.10.2 BC-LINK MASTER WRITE OPERATION

1. Software starts by checking the status of the BUSY bit in the BC-Link Status Register. If the BUSY bit is ‘0’, proceed. If BUSY is ‘1’, firmware must wait until it is ‘0’.
2. Software writes the address of the register to be written into the BC-Link Address Register.
3. Software writes the data to be written into the addressed register in to the BC-Link Data Register.
4. The write to the Data Register starts the BC_Link write operation. The Master state machine sets the BUSY bit.
5. The BC-Link Master Interface transmits the write request packet.
6. When the write request packet is received by the BC-Link companion, the CRC is checked and data is written to the addressed companion register.
7. The companion sends an ACK if the write is completed. A time-out will occur approximately 16 BC-Link clocks after the packet is sent by the Master state machine. If a time-out occurs, the state machine will set the BC_ERR bit in the Status Register to ‘1’ approximately 48 clocks later and then clear the BUSY bit.
8. The Master state machine issues the Bit Clear interrupt and clears the BUSY bit after receiving the ACK from the Companion
9. If a Bus Error occurs, firmware must issue a soft reset by setting the RESET bit in the Status Register to ‘1’.
10. The write can re-tried once BUSY is cleared.

23.11 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the BC-Link Master interface. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in the EC-Only Register Base Address Table.

TABLE 23-7: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 23-1)
BC-LINK	0	EC	32-bit internal address space	4000_BC00h

Note 23-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 23-8: EC-ONLY REGISTER SUMMARY

Register Name	EC Offset
BC-Link Status Register	00h
BC-Link Address Register	04h
BC-Link Data Register	08h
BC-Link Clock Select Register	0Ch

23.11.1 BC-LINK STATUS REGISTER

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:4	Reserved	R	-	-
7	RESET When this bit is ‘1’the BC_Link Master Interface will be placed in reset and be held in reset until this bit is cleared to ‘0’. Setting RESET to ‘1’ causes the BUSY bit to be set to ‘1’. The BUSY remains set to ‘1’ until the reset operation of the BC Interface is completed, which takes approximately 48 BC clocks. The de-assertion of the BUSY bit on reset will not generate an interrupt, even if the BC_BUSY_CLR_INT_EN bit is ‘1’. The BUSY bit must be polled in order to determine when the reset operation has completed.	R/W	1h	VCC1_RESET
6	BC_ERR This bit indicates that a BC Bus Error has occurred. If an error occurs this bit is set by hardware when the BUSY bit is cleared. This bit is cleared when written with a ’1’. An interrupt is generated If this bit is ‘1’ and BC_ERR_INT_EN bit is ‘1’. Errors that cause this interrupt are: • Bad Data received by the BASE (CRC Error) • Time-out caused by the COMPANION not responding. All COMPANION errors cause the COMPANION to abort the operation and the BASE to time-out.	R/WC	0h	VCC1_RESET
5	BC_ERR_INT_EN This bit is an enable for generating an interrupt when the BC_ERR bit is set by hardware. When this bit is ‘1’, the interrupt signal is enabled. When this bit is ‘0’, the interrupt is disabled.	R/W	0b	VCC1_RESET
4	BC_BUSY_CLR_INT_EN This bit is an enable for generating an interrupt when the BUSY bit in this register is cleared by hardware. When this bit is set to ‘1’, the interrupt signal is enabled. When the this bit is cleared to ‘0’, the interrupt is disabled. When enabled, the interrupt occurs after a BC Bus read or write.	R/W	0h	VCC1_RESET
3:1	Reserved	R	-	-
0	BUSY This bit is asserted to ‘1’ when the BC interface is transferring data and on reset. Otherwise it is cleared to ‘0’. When this bit is cleared by hardware, an interrupt is generated if the BC_BUSY_CLR_INT_EN bit is set to ‘1’.	R	1h	VCC1_RESET

23.11.2 BC-LINK ADDRESS REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	ADDRESS Address in the Companion for the BC-Link transaction.	R/W	0h	VCC1_RESET

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23.11.3 BC-LINK DATA REGISTER

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	DATA As described in Section 23.10.1, "BC-Link Master READ Operation" and Section 23.10.2, "BC-Link Master WRITE Operation", this register hold data used in a BC-Link transaction.	R/W	0h	VCC1_RESET

23.11.4 BC-LINK CLOCK SELECT REGISTER

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	Reserved	R	-	-
7:0	DIVIDER The BC Clock is set to the Master Clock divided by this field, or 48MHz/ (Divider +1). The clock divider bits can only can be changed when the BC Bus is in soft RESET (when either the Reset bit is set by software or when the BUSY bit is set by the interface). Example settings for DIVIDER are shown in Table 23-9, "Example Frequency Settings".	R/W	4h	VCC1_RESET

TABLE 23-9: EXAMPLE FREQUENCY SETTINGS

Divider	Frequency
0	48MHz
1	24MHz
2	16MHz
3	12MHz
4	9.6MHz
15	2.18MHz
2A	1.12MHz

24.0 TRACE FIFO DEBUG PORT (TFDP)

24.1 Introduction

The TFDP serially transmits Embedded Controller (EC)-originated diagnostic vectors to an external debug trace system.

24.2 References

No references have been cited for this chapter.

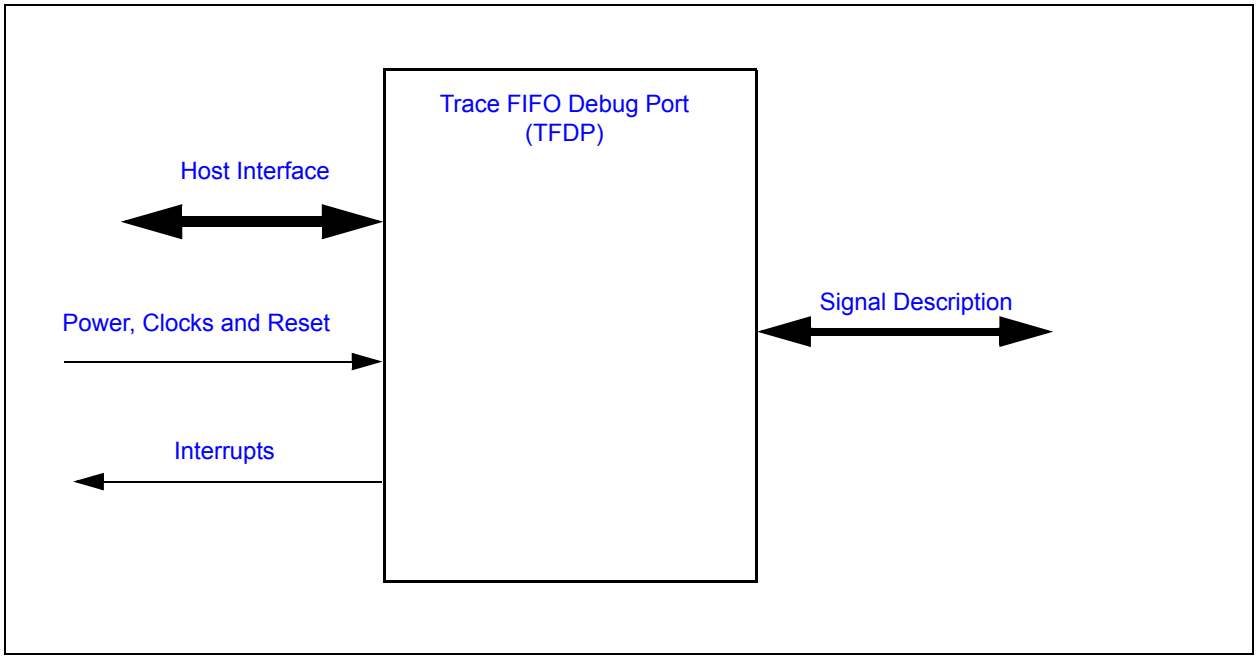
24.3 Terminology

There is no terminology defined for this chapter.

24.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 24-1: I/O DIAGRAM OF BLOCK



24.5 Signal Description

The Signal Description Table lists the signals that are typically routed to the pin interface.

TABLE 24-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
TFDP Clk	Output	Derived from EC Bus Clock.
TFDP Data	Output	Serialized data shifted out by TFDP Clk.

24.6 Host Interface

The registers defined for the Trace FIFO Debug Port (TFDP) are accessible by the various hosts as indicated in Section 24.11, "EC-Only Registers".

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24.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

24.7.1 POWER DOMAINS

TABLE 24-2: POWER SOURCES

Name	Description
VCC1	This power well sources all of the registers and logic in this block.

24.7.2 CLOCK INPUTS

TABLE 24-3: CLOCK INPUTS

Name	Description
48 MHz Ring Oscillator	This clock input is used to derive the TFDP Clk.

24.7.3 RESETS

TABLE 24-4: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal resets all of the registers and logic in this block.

24.8 Interrupts

There are no interrupts generated from this block.

24.9 Low Power Modes

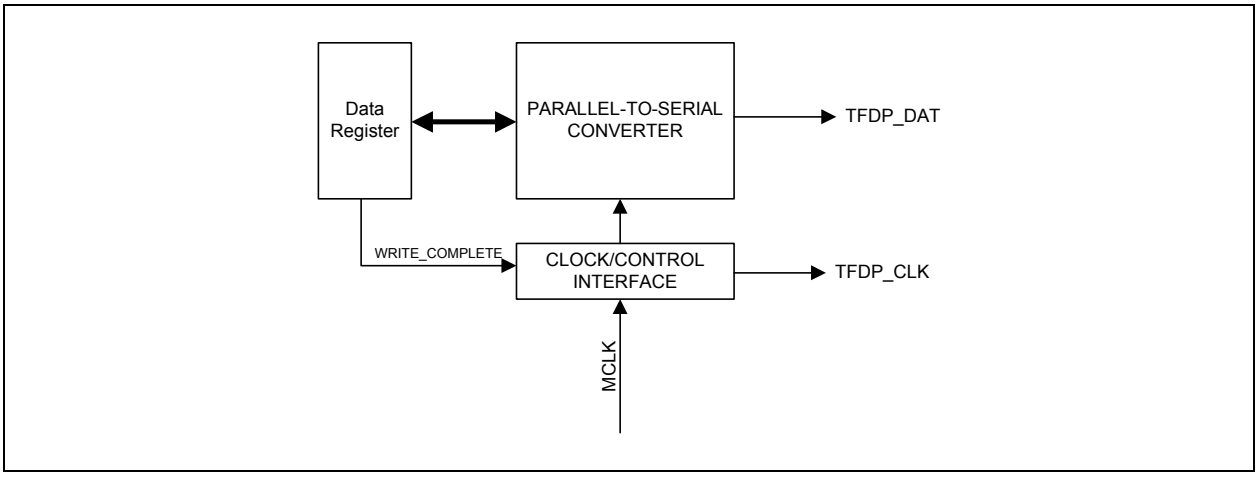
The Trace FIFO Debug Port (TFDP) may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

24.10 Description

The TFDP is a unidirectional (from processor to external world) two-wire serial, byte-oriented debug interface for use by processor firmware to transmit diagnostic information.

The TFDP consists of the Debug Data Register, Debug Control Register, a Parallel-to-Serial Converter, a Clock/Control Interface and a two-pin external interface (TFDP Clk, TFDP Data).

FIGURE 24-2: BLOCK DIAGRAM OF TFDP DEBUG PORT

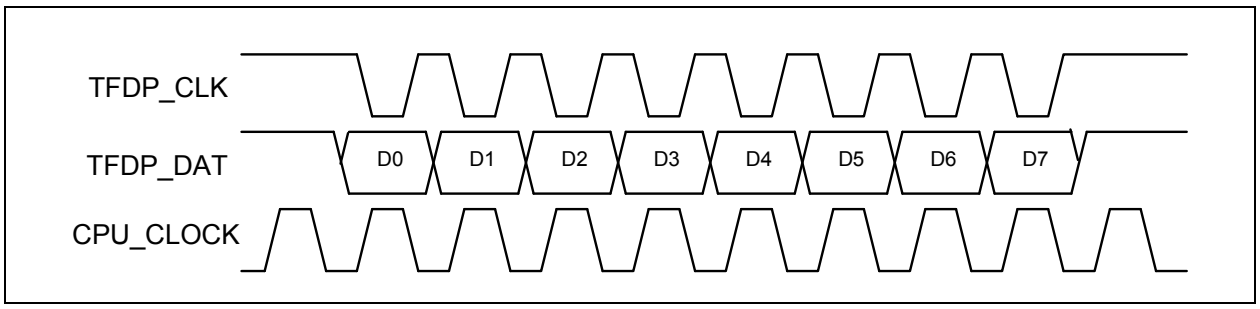


The firmware executing on the embedded controller writes to the Debug Data Register to initiate a transfer cycle. At first, data from the Debug Data Register is shifted into the LSB. Afterwards, it is transmitted at the rate of one byte per transfer cycle.

Data is transferred in one direction only from the Debug Data Register to the external interface. The data is shifted out at the clock edge. The clock edge is selected by the EDGE_SEL bit in the Debug Control Register. After being shifted out, valid data is provided at the opposite edge of the TFDP_CLK. For example, when the EDGE_SEL bit is '0' (default), valid data is maintained at the falling edge of TFDP_CLK. The Setup Time (to the falling edge of TFDP_CLK) is 10 ns, minimum. The Hold Time is 1 ns, minimum.

When the Serial Debug Port is inactive, the TFDP_CLK and TFDP_DAT outputs are '1.' The EC Bus Clock clock input is the transfer clock.

FIGURE 24-3: DATA TRANSFER



24.11 EC-Only Registers

The registers listed in the EC-Only Register Summary table are for a single instance of the Trace FIFO Debug Port (TFDP). The addresses of each register listed in this table are defined as a relative offset to the host "Base Address" defined in the EC-Only Register Base Address Table.

TABLE 24-5: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address
TFDP Debug Port	0	EC	32-bit internal address space	4000_8C00h

The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 24-6: EC-ONLY REGISTER SUMMARY

Offset	Register Name (Mnemonic)
00h	Debug Data Register
04h	Debug Control Register

24.11.1 DEBUG DATA REGISTER

The Debut Data Register is Read/Write. It always returns the last data written by the TFDP or the power-on default '00h'.

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:0	DATA Debug data to be shifted out on the TFDP Debug port. While data is being shifted out, the Host Interface will 'hold-off' additional writes to the data register until the transfer is complete.	R/W	00h	VCC1_RESET

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24.11.2 DEBUG CONTROL REGISTER

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7	Reserved	R	-	-
6:4	IP_DELAY Inter-packet Delay. The delay is in terms of TFDP Debug output clocks. A value of 0 provides a 1 clock inter-packet period, while a value of 7 provides 8 clocks between packets:	R/W	000b	VCC1_RESET
3:2	DIVSEL Clock Divider Select. The TFDP Debug output clock is determined by this field, according to Table 24-7, "TFDP Debug Clocking":	R/W	00b	VCC1_RESET
1	EDGE_SEL 1= Data is shifted out on the falling edge of the debug clock 0= Data is shifted out on the rising edge of the debug clock (Default)	R/W	0b	VCC1_RESET
0	EN Enable. 1=Clock enabled 0=Clock is disabled (Default)	R/W	0b	VCC1_RESET

TABLE 24-7: TFDP DEBUG CLOCKING

divsel	TFDP Debug Clock
00	24 MHz
01	12 MHz
10	6 MHz
11	Reserved

25.0 ANALOG TO DIGITAL CONVERTER

25.1 Introduction

This block is designed to convert external analog voltage readings into digital values. It consists of a single successive-approximation Analog-Digital Converter that can be shared among five inputs.

Note:	Transitions on ADC GPIOs are not permitted when Analog to Digital Converter readings are being taken.

25.2 References

No references have been cited for this chapter

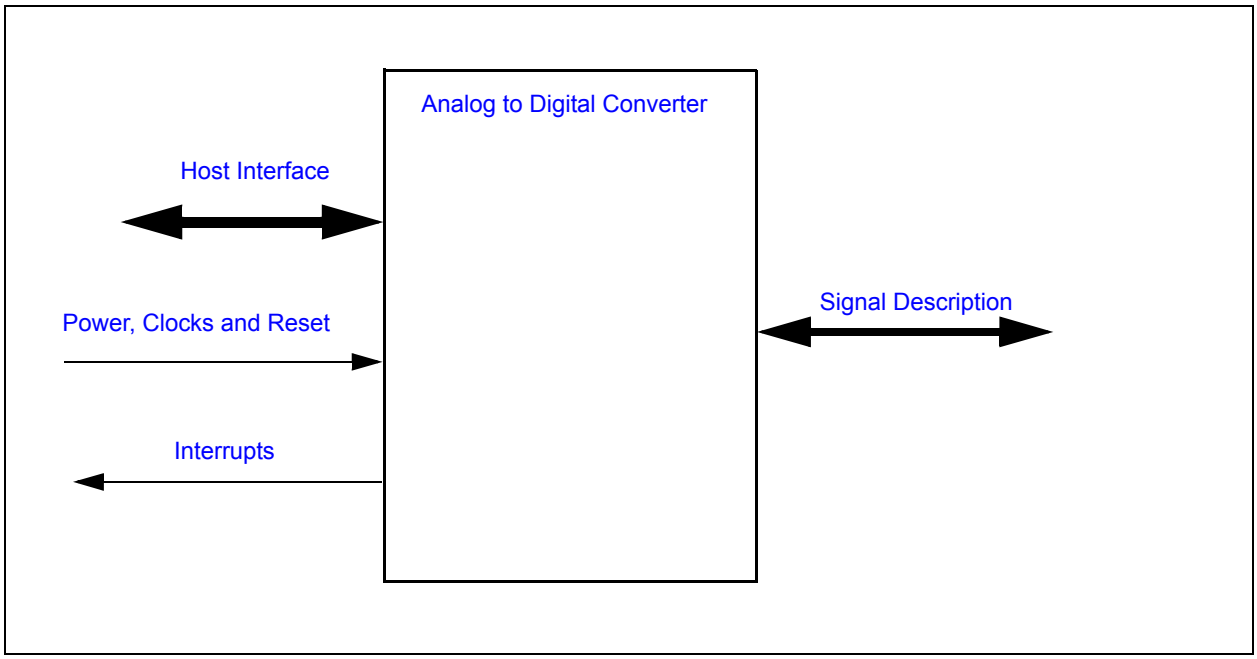
25.3 Terminology

No terminology is defined for this chapter

25.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 25-1: I/O DIAGRAM OF BLOCK



25.5 Signal Description

The Signal Description Table lists the signals that are typically routed to the pin interface.

TABLE 25-1: SIGNAL DESCRIPTION TABLE

Name	Direction	Description
ADC 4:0	Input	ADC Analog Voltage Input 4:0 from pins

Note:	VREF_ADC, the Analog Voltage Reference of 3.0V, is internally generated in the IP block.

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25.6 Host Interface

The registers defined for the Trace FIFO Debug Port are accessible by the various hosts as indicated in Section 25.11, "EC-Only Registers".

25.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

25.7.1 POWER DOMAINS

TABLE 25-2: POWER SOURCES

Name	Description
VCC1	This power well sources the registers tn this block.
AVCC	This power well sources of the logic in this block, except where noted.
AVSS	This is the ground signal for the block.

25.7.2 CLOCK INPUTS

TABLE 25-3: CLOCK INPUTS

Name	Description
1.2MHz	This derived clock signal drives selected logic (1.2 MHz clock with a 50% duty cycle).

25.7.3 RESETS

TABLE 25-4: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal resets all of the registers and logic in this block.

25.8 Interrupts

TABLE 25-5: EC INTERRUPTS

Source	Description
ADC_Single_Int	Interrupt signal from ADC controller to EC for Single-Sample ADC conversion.
ADC_Repeat_Int	Interrupt signal from ADC controller to EC for Repeated ADC conversion.

25.9 Low Power Modes

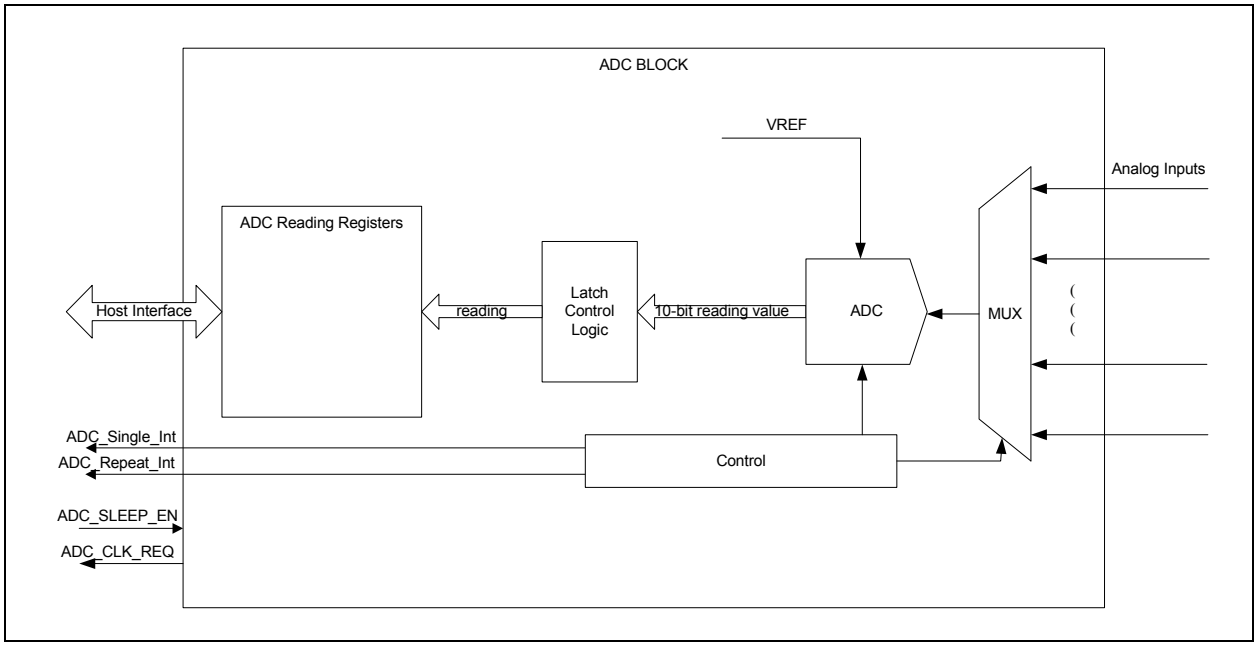
The ADC may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry.

The ADC is designed to conserve power when it is either sleeping or disabled. It is disabled via the Activate Bit and sleeps when the ADC_SLEEP_EN signal is asserted. The sleeping state only controls clocking in the ADC and does not power down the analog circuitry. For lowest power consumption, the ADC Activate bit must be set to '0.'

Note:	The ADC VREF must be powered down in order to get the lowest deep sleep current. The ADC VREF Power down bit, ADC_VREF_PD_REF is in the EC Subsystem Registers ADC VREF PD on page 273.

25.10 Description

FIGURE 25-2: ADC BLOCK DIAGRAM



The CEC1302 features a five channel successive approximation Analog to Digital Converter. The ADC architecture features excellent linearity and converts analog signals to 10 bit words. Conversion takes less than 12 microseconds per 10-bit word. The five channels are implemented with a single high speed ADC fed by a five input analog multiplexer. The multiplexer cycles through the five voltage channels, starting with the lowest-numbered channel and proceeding to the highest-number channel, selecting only those channels that are programmed to be active.

The input range on the voltage channels spans from 0V to the internal voltage reference. With an internal voltage reference of 3.0V, this provides resolutions of 2.9mV. The range can easily be extended with the aid of resistor dividers. The accuracy of any voltage reading depends on the accuracy and stability of the voltage reference input.

Note:	The ADC pins are 3.3V tolerant.

The ADC conversion cycle starts either when the Start_Single bit in the ADC to set to 1 or when the ADC Repeat Timer counts down to 0. When the Start_Single is set to 1 the conversion cycle converts channels enabled by configuration bits in the ADC Single Register. When the Repeat Timer counts down to 0 the conversion cycle converts channels enabled by configuration bits in the ADC Repeat Register. When both the Start_Single bit and the Repeat Timer request conversions the Start_Single conversion is completed first.

Conversions always start with the lowest-numbered enabled channel and proceed to the highest-numbered enabled channel.

Note:	If software repeatedly sets Start_Single to 1 at a rate faster than the Repeat Timer count down interval, the conversion cycle defined by the ADC Repeat Register will not be executed.

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25.10.1 REPEAT MODE

- Repeat Mode will start a conversion cycle of all ADC channels enabled by bits Rpt_En[4:0] in the ADC Repeat Register. The conversion cycle will begin after a delay determined by Start_Delay[15:0] in the ADC Delay Register.
- After all channels enabled by Rpt_En[4:0] are complete, Repeat_Done_Status will be set to 1. This status bit is cleared when the next repeating conversion cycle begins to give a reflection of when the conversion is in progress.
- As long as Start_Repeat is 1 the ADC will repeatedly begin conversion cycles with a period defined by Repeat_Delay[15:0].
- If the delay period expires and a conversion cycle is already in progress because Start_Single was written with a 1, the cycle in progress will complete, followed immediately by a conversion cycle using Rpt_En[4:0] to control the channel conversions.

25.10.2 SINGLE MODE

- The Single Mode conversion cycle will begin without a delay. After all channels enabled by Single_En[4:0] are complete, Single_Done_Status will be set to 1. When the next conversion cycle begins the bit is cleared.
- If Start_Single is written with a 1 while a conversion cycle is in progress because Start_Repeat is set, the conversion cycle will complete, followed immediately by a conversion cycle using Single_En[4:0] to control the channel conversions.

25.11 EC-Only Registers

The registers listed in the Table 25-7, "Analog to Digital Converter Register Summary" are for a single instance of the Analog to Digital Converter block. The addresses of each register listed in this table are defined as a relative offset to the host “Base Address” defined in Table 25-6, "Analog to Digital Converter Base Address Table".

TABLE 25-6: ANALOG TO DIGITAL CONVERTER BASE ADDRESS TABLE

Instance Name	Instance Number	Host	Address Space	Base Address (Note 25-1)
ADC	0	EC	32-bit internal address space	4000_7C00h

Note 25-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

TABLE 25-7: ANALOG TO DIGITAL CONVERTER REGISTER SUMMARY

Offset	Register Name (Mnemonic)
00h	ADC Control Register
04h	ADC Delay Register
08h	ADC Status Register
0Ch	ADC Single Register
10h	ADC Repeat Register
14h	ADC Channel 0 Reading Register
18h	ADC Channel 1 Reading Register
1Ch	ADC Channel 2 Reading Register
20h	ADC Channel 3 Reading Register
24h	ADC Channel 4 Reading Register

25.11.1 ADC CONTROL REGISTER

The ADC Control Register is used to control the behavior of the Analog to Digital Converter.

Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:8	RESERVED	RES		
7	**Single_Done_Status** This bit is cleared when it is written with a 1. Writing a 0 to this bit has no effect. This bit can be used to generate an EC interrupt. 0: ADC single-sample conversion is not complete. This bit is cleared whenever an ADC conversion cycle begins for a single conversion cycle. 1: ADC single-sample conversion is completed. This bit is set to 1 when all enabled channels in the single conversion cycle.	R/WC	0h	VCC1_RESET
6	**Repeat_Done_Status** This bit is cleared when it is written with a 1. Writing a 0 to this bit has no effect. This bit can be used to generate an EC interrupt. 0: ADC repeat-sample conversion is not complete. This bit is cleared whenever an ADC conversion cycle begins for a repeating conversion cycle. 1: ADC repeat-sample conversion is completed. This bit is set to 1 when all enabled channels in a repeating conversion cycle complete.	R/WC	0h	VCC1_RESET
5	RESERVED	RES		
4	**Soft Reset** 1: writing one causes a reset of the ADC block hardware (not the registers) 0: writing zero takes the ADC block out of reset	R/W	0h	VCC1_RESET
3	**Power_Saver_Dis** 0: Power saving feature is enabled. The Analog to Digital Converter controller powers down the ADC between conversion sequences. 1: Power saving feature is disabled.	R/W	0h	VCC1_RESET
2	**Start_Repeat** 0: The ADC Repeat Mode is disabled. Note: This setting will not terminate any conversion cycle in process, but will inhibit any further periodic conversions. 1: The ADC Repeat Mode is enabled. This setting will start a conversion cycle of all ADC channels enabled by bits Rpt_En[4:0] in the ADC Repeat Register.	R/W	0h	VCC1_RESET
1	**Start_Single** 0: The ADC Single Mode is disabled. 1: The ADC Single Mode is enabled. This setting starts a single conversion cycle of all ADC channels enabled by bits Single_En[4:0] in the ADC Single Register. **Note:** This bit is self-clearing	R/W	0h	VCC1_RESET

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Offset	00h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
0	**Activate** 0: The ADC is disabled and placed in its lowest power state. Note: Any conversion cycle in process will complete before the block is shut down, so that the reading registers will contain valid data but no new conversion cycles will begin. 1: ADC block is enabled for operation. Start_Single or Start_Repeat can begin data conversions by the ADC. Note: A reset pulse is sent to the ADC core when this bit changes from 0 to 1.	R/W	0h	VCC1_RESET

25.11.2 ADC DELAY REGISTER

The ADC Delay register determines the delay from setting Start_Repeat in the ADC Control Register and the start of a conversion cycle. This register also controls the interval between conversion cycles in repeat mode.

Offset	04h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:16	**Repeat_Delay[15:0]** This field determines the interval between conversion cycles when Start_Repeat is 1. The delay is in units of 40µs. A value of 0 means no delay between conversion cycles, and a value of 0xFFFF means a delay of 2.6 seconds. This field has no effect when Start_Single is written with a 1.	R/W	0000h	VCC1_RESET
15:0	**Start_Delay[15:0]** This field determines the starting delay before a conversion cycle is begun when Start_Repeat is written with a 1. The delay is in units of 40µs. A value of 0 means no delay before the start of a conversion cycle, and a value of 0xFFFF means a delay of 2.6 seconds. This field has no effect when Start_Single is written with a 1.	R/W	0000h	VCC1_RESET

25.11.3 ADC STATUS REGISTER

The ADC Status Register indicates whether the ADC has completed a conversion cycle.

Offset	08h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:5	RESERVED	RES		
4:0	**ADC_Ch_Status[4:0]** **All bits are cleared by being written with a '1'.** 0: conversion of the corresponding ADC channel is not complete 1: conversion of the corresponding ADC channel is complete Note: for enabled single cycles, the Single_Done_Status bit in the ADC Control Register is also set after all enabled channel conversion are done; for enabled repeat cycles, the Repeat_Done_Status in the ADC Control Register is also set after all enabled channel conversion are done.	R/WC	00h	VCC1_RESET

25.11.4 ADC SINGLE REGISTER

The ADC Single Register is used to control which ADC channel is captured during a Single-Sample conversion cycle initiated by the Start_Single bit in the ADC Control Register.

APPLICATION NOTE: Do not change the bits in this register in the middle of a conversion cycle to insure proper operation.

Offset	0Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:5	RESERVED	RES		
4:0	**Single_En[4:0]** 0: single cycle conversions for this channel are disabled 1: single cycle conversions for this channel are enabled Each bit in this field enables the corresponding ADC channel when a single cycle of conversions is started when the Start_Single bit in the ADC Control Register is written with a 1.	R/W	00h	VCC1_RESET

25.11.5 ADC REPEAT REGISTER

The ADC Repeat Register is used to control which ADC channels are captured during a repeat conversion cycle initiated by the Start_Repeat bit in the ADC Control Register.

Offset	10h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:5	RESERVED	RES		
4:0	**Rpt_En[4:0]** 0: repeat conversions for this channel are disabled 1: repeat conversions for this channel are enabled Each bit in this field enables the corresponding ADC channel for each pass of the Repeated ADC Conversion that is controlled by bit Start_Repeat in the ADC Control Register.	R/W	00h	VCC1_RESET

25.11.6 ADC CHANNEL READING REGISTERS

All 5 ADC channels return their results into a 32-bit reading register. In each case the low 10 bits of the reading register return the result of the Analog to Digital conversion and the upper 22 bits return 0. Table 25-7, “Analog to Digital Converter Register Summary,” on page 263 shows the addresses of all the reading registers.

Note: The ADC Channel Reading Registers access require single 16, or 32 bit reads; i.e., two 8 bit reads cannot ensure data coherency.

Offset	See Table 25-7, "Analog to Digital Converter Register Summary"			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:10	RESERVED	RES		
9:0	**ADCx_[9:0]** This read-only field reports the 10-bit output reading of the Input ADCx.	R/W	000h	VCC1_RESET

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26.0 VBAT-POWERED RAM

26.1 Overview

The VBAT Powered RAM provides a 64 Byte Random Accessed Memory that is operational while the main power rail is operational, and will retain its values powered by battery power while the main rail is unpowered.

26.2 References

No references have been cited for this feature.

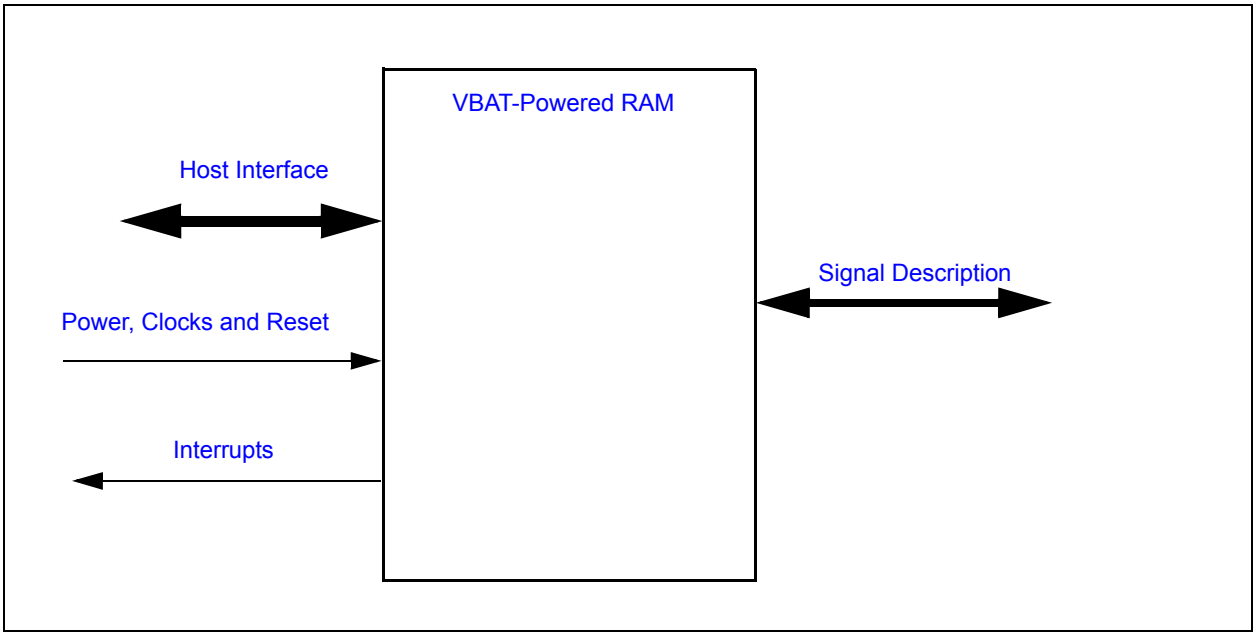
26.3 Terminology

There is no terminology defined for this section.

26.4 Interface

This block is designed to be accessed externally via the pin interface and internally via a registered host interface.

FIGURE 26-1: I/O DIAGRAM OF BLOCK



26.5 Signal Description

There are no external signals for this block.

26.6 Host Interface

The registers defined for the Keyboard Scan Interface are accessible by the various hosts as indicated in Section 26.11, "Registers".

26.7 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

26.7.1 POWER DOMAINS

TABLE 26-1: POWER SOURCES

Name	Description
VCC1	The main power well used when the VBAT RAM is accessed by the EC.
VBAT	The power well used to retain memory state while the main power rail is unpowered.

26.7.2 CLOCK INPUTS

No special clocks are required for this block.

26.7.3 RESETS

TABLE 26-2: RESET SIGNALS

Name	Description
VBAT_POR	This signal resets all the registers and logic in this block to their default state.

26.8 Interrupts

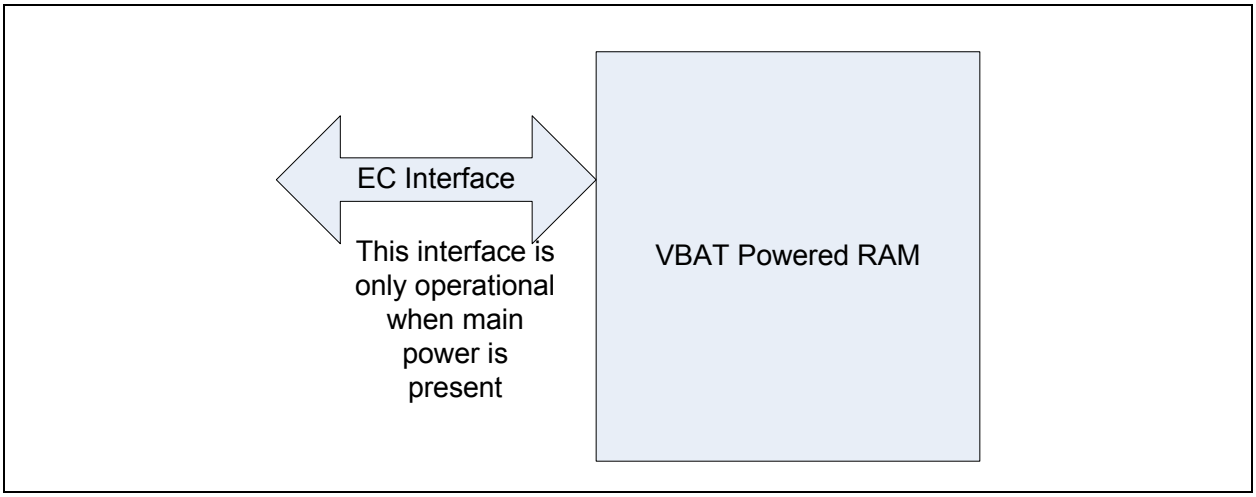
This block does not generate any interrupts.

26.9 Low Power Modes

The VBAT-Powered RAM automatically enters a low power mode whenever it is not being accessed by the EC. There is no chip-level Sleep Enable input.

26.10 Description

FIGURE 26-2: VBAT RAM BLOCK DIAGRAM



The VBAT Powered RAM provides a 64 Byte Random Accessed Memory that is operational while VCC1 is powered, and will retain its values powered by VBAT while VCC1 is unpowered. The RAM is organized as a 16 words x 32-bit wide for a total of 64 bytes.

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26.11 Registers

26.11.1 REGISTERS SUMMARY

The registers listed in the Table 26-3, "EC-Only Register Base Address Table" are for a single instance of the Keyboard Scan Interface block. Each 32-bit RAM location is an offset from the EC base address.

TABLE 26-3: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 26-1)
VBAT-Powered RAM	0	EC	32-bit internal address space	4000_A800h

Note 26-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

27.0 EC SUBSYSTEM REGISTERS

27.1 Introduction

This chapter defines a bank of registers associated with the EC Subsystem.

27.2 References

None

27.3 Interface

This block is designed to be accessed internally by the EC via the register interface.

27.4 Power, Clocks and Reset

This section defines the Power, Clock, and Reset parameters of the block.

27.4.1 POWER DOMAINS

TABLE 27-1: POWER SOURCES

Name	Description
VCC1	The EC Subsystem Registers are all implemented on this single power domain.

27.4.2 CLOCK INPUTS

This block does not require any special clock inputs. All register accesses are synchronized to the host clock.

27.4.3 RESETS

TABLE 27-2: RESET SIGNALS

Name	Description
VCC1_RESET	This reset signal, which is an input to this block, resets all the logic and registers to their initial default state.

27.5 Interrupts

This block does not generate any interrupt events.

27.6 Low Power Modes

The EC Subsystem Registers may be put into a low power state by the chip's Power, Clocks, and Reset (PCR) circuitry. When this block is commanded to sleep it will still allow read/write access to the registers.

27.7 Description

The EC Subsystem Registers block is a block implemented for aggregating miscellaneous registers required by the Embedded Controller (EC) Subsystem that are not unique to a block implemented in the EC subsystem.

27.8 EC-Only Registers

TABLE 27-3: EC-ONLY REGISTER BASE ADDRESS TABLE

Block Instance	Instance Number	Host	Address Space	Base Address (Note 27-1)
EC_REG_BANK	0	EC	32-bit internal address space	4000_FC00h

Note 27-1 The Base Address indicates where the first register can be accessed in a particular address space for a block instance.

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TABLE 27-4: REGISTER SUMMARY

Offset	Register Name
04h	MCHP Reserved
08h	MCHP Reserved
0Ch	MCHP Reserved
10h	MCHP Reserved
14h	AHB Error Control
18h	Interrupt Control
1Ch	ETM TRACE Enable
20h	JTAG Enable
24h	MCHP Reserved
28h	WDT Event Count
2Ch	MCHP Reserved
30h	MCHP Reserved
34h	MCHP Reserved
38h	ADC VREF PD
3Ch	MCHP Reserved
40h	MCHP Reserved

27.8.1 AHB ERROR CONTROL

Offset	14h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
7:1	Reserved	R	-	-
0	AHB_ERROR_DISABLE 0: EC memory exceptions are enabled. 1: EC memory exceptions are disabled.	RW	0h	VCC1_RESET

27.8.2 INTERRUPT CONTROL

Offset	18h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:1	Reserved	R	-	-
0	NVIC_EN This bit enables Alternate NVIC IRQ's Vectors. The Alternate NVIC Vectors provides each interrupt event with a dedicated (direct) NVIC vector. 0 = Alternate NVIC vectors disabled 1= Alternate NVIC vectors enabled	R/W	1b	VCC1_RESET

27.8.3 ETM TRACE ENABLE

Offset	1Ch			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:1	Reserved	R	-	-
0	TRACE_EN This bit enables the ARM TRACE debug port (ETM/ITM). The Trace Debug Interface pins are forced to the TRACE functions. 0 = ARM TRACE port disabled 1= ARM TRACE port enabled	R/W	0b	VCC1_RESET

27.8.4 JTAG ENABLE

Offset	20h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:1	Reserved	R	-	-
0	JTAG_EN This bit enables the JTAG debug port. 0 = JTAG port disabled. JTAG cannot be enabled (i.e., the TRST# pin is ignored and the JTAG signals remain in their non-JTAG state). 1= JTAG port enabled. A high on TRST# enables JTAG	R/W	0b	VCC1_RESET

27.8.5 WDT EVENT COUNT

Offset	28h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:4	Reserved	R	-	-
3:0	WDT_COUNT These EC R/W bits are cleared to 0 on VCC1 POR, but not on a WDT. **Note:** This field is written by Boot ROM firmware to indicate the number of times a WDT fired before loading a good EC code image.	R/W	0b	VCC1_RESET

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27.8.6 ADC VREF PD

Offset	38h			
Bits	**Description**	**Type**	**Default**	**Reset Event**
31:1	Reserved	R	-	-
0	**ADC_VREF_PD_REF** ADC VREF Power down 0=on 1=off	R/W	0b	VCC1_RESET

28.0 TEST MECHANISMS

28.1 Introduction

This section defines the XNOR Chain for board test.

Other test mechanisms for the ARM are described in Chapter 6.0, "ARM M4F Based Embedded Controller".

28.2 XNOR Chain

28.2.1 OVERVIEW

The XNOR Chain test mode provides a means to confirm that all CEC1302 pins are in contact with the motherboard during assembly and test operations.

An example of an XNOR Chain test structure is illustrated below in 28.2.3Figure 28-1. When the XNOR Chain test mode is enabled all pins, except for the Excluded Pins shown in Section 28.2.2, are disconnected from their internal functions and forced as inputs to the XNOR Chain. This allows a single input pin to toggle the XNOR Chain output if all other input pins are held high or low. The XNOR Chain output is the Test Output Pin, pin 17: KSO04/GPIO103/TFDP_-DATA/XNOR.

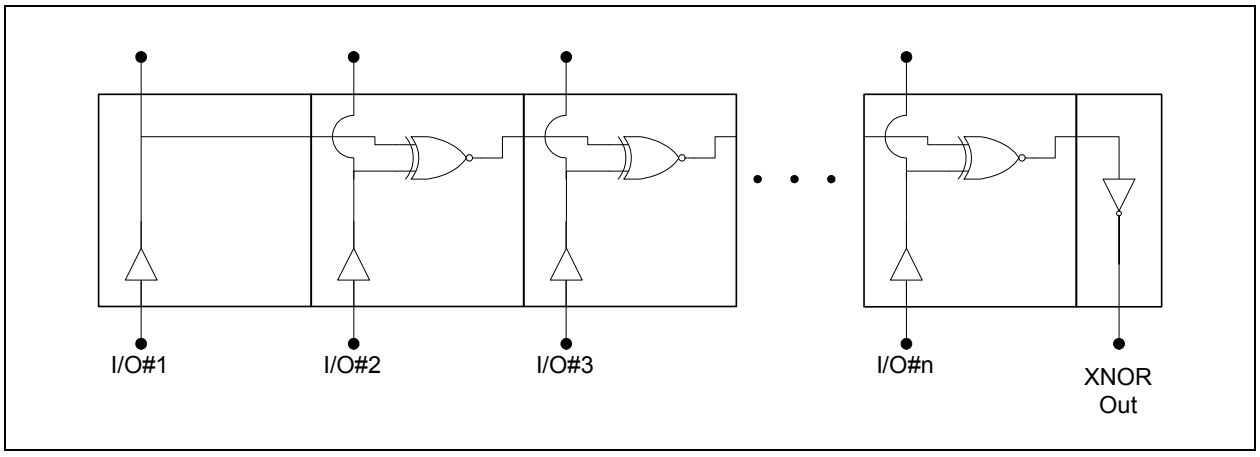
The tests that are performed when the XNOR Chain test mode is enabled require the board-level test hardware to control the device pins and observe the results at the XNOR Chain output pin; e.g., as described in Section 28.2.3, "Test Procedure," on page 275.

28.2.2 EXCLUDED PINS

All pins in the pinout are included in the XNOR chain, except the following:

- Power Pins (VCC1, AVCC, VBAT)
- Ground Pins (VSS, AVSS, VSS_VBAT)
- CAP
- Crystal pins (XTAL1, XTAL2)
- Test Output Pin, pin 17: KSO04/GPIO103/TFDP_DATA/XNOR
- Test Port (JTAG_RST#, KSO02/GPIO101/JTAG_TDI, KSO03/GPIO102/JTAG_TDO, KSO01/GPIO100/JTAG_TMS, and KSO00/GPIO000/JTAG_TCK)

FIGURE 28-1: XNOR CHAIN TEST STRUCTURE



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28.2.3 TEST PROCEDURE

28.2.3.1 Setup

Warning: Ensure power supply is off during Setup.

1. Connect JTAG_RST# to ground.
2. Connect the VSS, AVSS, VSS_VBAT pins to ground.
3. Connect the VCC1, AVCC, VBAT pins to an unpowered 3.3V power source.
4. Connect an oscilloscope or voltmeter to the Test Output pin.
5. All other pins should be tied to ground.

Note:	There are 101 pins in the XNOR Chain.

28.2.3.2 Testing

1. Turn on the 3.3V power source.
2. Enable the XNOR Chain as defined in Section 28.2.3.3, "Procedure to Enable the XNOR Chain".

Note:	At this point all inputs to the XNOR Chain are low, except for the JTAG_RST# pin, and the output on the Test Output pin is non-inverted from its initial state, which is dependent on the number of pins in the chain. If the number of input pins in the chain is an even number, the initial state of the Test Output Pin, pin 17: KSO04/GPIO103/TFDP_DATA/XNOR is low. If the number of input pins in the chain is an odd number, the initial state of the Test Output Pin, pin 17: KSO04/GPIO103/TFDP_DATA/XNOR is high.

3. Bring one pin in the chain high. The output on the Test Output Pin, pin 17: KSO04/GPIO103/TFDP_DATA/XNOR pin should toggle. Then individually toggle each of the remaining pins in the chain. Each time an input pin is toggled either high or low the Test Output Pin, pin 17: KSO04/GPIO103/TFDP_DATA/XNOR pin should toggle.
4. Once the XNOR test is completed, exit the XNOR Chain Test Mode by cycling VCC1 power.

28.2.3.3 Procedure to Enable the XNOR Chain

//BEGIN PROCEDURE TO ENTER XNOR CHAIN

////////////////////////////////////

//Reset Test Interface

////////////////////////////////////

force JTAG_RST# = 0

force KSO00/GPIO000/JTAG_TCK = 0

force KSO02/GPIO101/JTAG_TDI = 0

force KSO01/GPIO100/JTAG_TMS = 1

Wait 100 ns

////////////////////////////////

//Come out of reset

////////////////////////////////

force TRST#/JTAG_RST# = 1

Wait 100 ns

force KSO00/GPIO000/JTAG_TCK = 1

force KSO00/GPIO000/JTAG_TCK = 0

force KSO00/GPIO000/JTAG_TCK = 1

force KSO00/GPIO000/JTAG_TCK = 0

```
force KSO00/GPIO000/JTAG_TCK = 1
force KSO00/GPIO000/JTAG_TCK = 0
force KSO00/GPIO000/JTAG_TCK = 1
force KSO00/GPIO000/JTAG_TCK = 0

////////////////////////////////
//Sequence 1
// Write IR with 7h
////////////////////////////////
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //1N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //2N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 1
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //3N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 1
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //4N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //5N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0

////////////////////////////////////
//SHIFT IR 0x7h
////////////////////////////////////
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //6N
force KSO02/GPIO101/JTAG_TDI = 1
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //7N
force KSO02/GPIO101/JTAG_TDI = 1
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //8N
force KSO02/GPIO101/JTAG_TDI = 1
```


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```
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //9N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 1; //Next will be EXIT1_IR
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //10N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 1; //Next will be UPDATE_IR
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //11N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0; //Next will be IDLE
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //12N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0; //Next will be IDLE
Wait 0 ns

////////////////////////////////////////////////////////
// Sequence 2
// DIR=0, CMD[2:0]=1, DATA[7:0]=01\h, ADDR[7:0]=88\h
////////////////////////////////////////////////////////
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //1N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 1
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //2N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //3N
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0

//////////////////////////////////////////
//DIR 0 - Write
//////////////////////////////////////////
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR1)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
```

```
//////////////////////////////////////////
//CMD 1 - Test
//////////////////////////////////////////
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR2)
force KSO02/GPIO101/JTAG_TDI = 1
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR3)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR4)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0

//////////////////////////////////////////
//DATA 0x01 - XNOR_EN
//////////////////////////////////////////
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR5)
force KSO02/GPIO101/JTAG_TDI = 1
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR6)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR7)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR8)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
```


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```
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR9)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR10)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR11)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR12)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0

////////////////////////////////////////////////////////////
//ADDRESS 0x88 - Customer Control
////////////////////////////////////////////////////////////
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR13)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR14)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR15)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR16)
force KSO02/GPIO101/JTAG_TDI = 1
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
```

force KSO00/GPIO000/JTAG_TCK = 0; //N (DR17)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 1//`TP_GPIO102.Check(1);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR18)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR19)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (DR20)
force KSO02/GPIO101/JTAG_TDI = 1
force KSO01/GPIO100/JTAG_TMS = 1
force KSO00/GPIO000/JTAG_TCK = 1; //P
**Verify KSO03/GPIO102/JTAG_TDO = 0//`TP_GPIO102.Check(0);
force KSO00/GPIO000/JTAG_TCK = 0; //N (E1_DR)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 1
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //N (UP_DR)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //N (EXTRA CLK)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
force KSO00/GPIO000/JTAG_TCK = 1; //P
force KSO00/GPIO000/JTAG_TCK = 0; //N (EXTRA CLK)
force KSO02/GPIO101/JTAG_TDI = 0
force KSO01/GPIO100/JTAG_TMS = 0
Wait 100 ns

//
//FINISHED PROCEDURE TO ENTER XNOR
//

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29.0 ELECTRICAL SPECIFICATIONS

29.1 Maximum Ratings*

*Stresses exceeding those listed could cause permanent damage to the device. This is a stress rating only and functional operation of the device at any other condition above those indicated in the operation sections of this specification is not implied.

Note:	When powering this device from laboratory or system power supplies, it is important that the Absolute Maximum Ratings not be exceeded or device failure can result. Some power supplies exhibit voltage spikes on their outputs when the AC power is switched on or off. In addition, voltage transients on the AC power line may appear on the DC output. If this possibility exists, it is suggested that a clamp circuit be used.

29.1.1 ABSOLUTE MAXIMUM THERMAL RATINGS

TABLE 29-1: ABSOLUTE MAXIMUM THERMAL RATINGS

Parameter	Maximum Limits
Operating Temperature Range	0^{o}C to +70^{o}C
Storage Temperature Range	-55^{o} to +150^{o}C
Lead Temperature Range	Refer to JEDEC Spec J-STD-020B

29.1.2 ABSOLUTE MAXIMUM SUPPLY VOLTAGE RATINGS

TABLE 29-2: ABSOLUTE POWER SUPPLY RATINGS

Symbol	Parameter	Maximum Limits
VBAT	3.0V Battery Backup Power Supply with respect to ground	-0.3V to +3.63V
VCC1	3.3V Suspend Power Supply with respect to ground	-0.3V to +3.63V
VCC2	3.3V Main Power Supply with respect to ground	-0.3V to +3.63V

29.1.3 ABSOLUTE MAXIMUM I/O VOLTAGE RATINGS

Parameter	Maximum Limits
Voltage with respect to ground on any pin without back-drive protection	-0.3V to (Power Supply used to power the buffer) + 0.3V (Note 29-1)

Note 29-1 The Power Supply used to power the buffer is shown in the Signal Power Well column of the Pin Multiplexing Tables in **Section 1.0 "Pin Configuration"**.

29.2 Operational Specifications

29.2.1 POWER SUPPLY OPERATIONAL CHARACTERISTICS

TABLE 29-3: POWER SUPPLY OPERATING CONDITIONS

Symbol	Parameter	MIN	TYP	MAX	Units
VBAT	Battery Backup Power Supply	2.0	3.0	3.6	V
VCC1	Suspend Power Supply	3.135	3.3	3.465	V

Note:	The specification for the VCC1 supply is +/- 5%.

29.2.2 AC ELECTRICAL SPECIFICATIONS

The clock rise and fall times use the standard input thresholds of 0.8V and 2.0V unless otherwise specified and the capacitive values listed in Section 29.2.2, "AC Electrical Specifications," on page 282.

29.2.3 CAPACITIVE LOADING SPECIFICATIONS

The following table defines the maximum capacitive load validated for the buffer characteristics listed in Table 29-4, “DC Electrical Characteristics,” on page 283.

CAPACITANCE T_A = 25°C; fc = 1MHz; V_{cc} = 3.3 VDC

Note:	All output pins, except pin under test, tied to AC ground.

Parameter	Symbol	Limits			Unit	Notes
		MIN	TYP	MAX		
Input Capacitance of PCI_I and PCI_IO pins	C_{IN}			Note 29-2	pF	
Input Capacitance of PCI_CLK pin	C_{IN}			Note 29-2	pF	
Output Load Capacitance supported by PCI_IO, PCI_O, and PCI_OD	C_{OUT}			Note 29-2	pF	
SUSCLK Input Capacitance	C_{IN}			10	pF	
Input Capacitance (all other input pins)	C_{IN}			10	pF	Note 29-3
Output Capacitance (all other output pins)	C_{OUT}			20	pF	Note 29-4

Note 29-2 The PCI buffers are designed to meet the defined PCI Local Bus Specification, Rev. 2.1, electrical requirements.

Note 29-3 All input buffers can be characterized by this capacitance unless otherwise specified.

Note 29-4 All output buffers can be characterized by this capacitance unless otherwise specified.

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29.2.4 DC ELECTRICAL CHARACTERISTICS FOR I/O BUFFERS

TABLE 29-4: DC ELECTRICAL CHARACTERISTICS

Parameter	Symbol	MIN	TYP	MAX	Units	Comments
PIO Type Buffer						
All PIO Buffers						Internal PU/PD selected via the GPIO Pin Control Register.
Pull-up current	I_{PU}	39	84	162	µA	
Pull-down current	I_{PD}	39	65	105	µA	
I Type Input Buffer						TTL Compatible Schmitt Trigger Input
Low Input Level	V_{ILI}			0.3x VCC1	V	
High Input Level	V_{IHI}	0.7x VCC1			V	
Tolerance				3.63	V	This buffer is not 5V tolerant.
Schmitt Trigger Hysteresis	V_{HYS}		400		mV	
O-2 mA Type Buffer						
Low Output Level	V_{OL}			0.4	V	I_{OL} = 2 mA
High Output Level	V_{OH}	VCC1-0.4			V	I_{OH} = -2 mA
Tolerance						This buffer is not 5V tolerant.
IO-2 mA Type Buffer	–	–	–	–	–	Same characteristics as an I and an O-2mA.
OD-2 mA Type Buffer						
Low Output Level	V_{OL}			0.4	V	V_{OL} = 2 mA
Tolerance						This buffer is not 5V tolerant.
IOD-2 mA Type Buffer	–	–	–	–	–	Same characteristics as an I and an OD-2mA.
O-4 mA Type Buffer						
Low Output Level	V_{OL}			0.4	V	I_{OL} = 4 mA
High Output Level	V_{OH}	VCC1-0.4			V	I_{OH} = -4 mA
Tolerance						This buffer is not 5V tolerant.
IO-4 mA Type Buffer	–	–	–	–	–	Same characteristics as an I and an O-4mA.
OD-4 mA Type Buffer						
Low Output Level	V_{OL}			0.4	V	V_{OL} = 4 mA
Tolerance						This buffer is not 5V tolerant.
IOD-4 mA Type Buffer	–	–	–	–	–	Same characteristics as an I and an OD-4mA.

TABLE 29-4: DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Symbol	MIN	TYP	MAX	Units	Comments
O-8 mA Type Buffer Low Output Level High Output Level Tolerance	 V_{OL} V_{OH}	 VCC1-0.4		 0.4	 V V	 I_{OL} = 8 mA I_{OH} = -8 mA This buffer is not 5V tolerant.
IO-8 mA Type Buffer	_	_	_	_	_	Same characteristics as an I and an O-8mA.
OD-8 mA Type Buffer Low Output Level Tolerance	 V_{OL}			 0.4	 V	 V_{OL} = 8 mA This buffer is not 5V tolerant.
IOD-8 mA Type Buffer	_	_	_	_	_	Same characteristics as an I and an OD-8mA.
O-12 mA Type Buffer Low Output Level High Output Level Tolerance	 V_{OL} V_{OH}	 VCC1-0.4		 0.4	 V V	 I_{OL} = 12mA I_{OH} = -12mA This buffer is not 5V tolerant.
IO-12 mA Type Buffer	_	_	_	_	_	Same characteristics as an I and an O-12mA.
OD-12 mA Type Buffer Low Output Level Tolerance	 V_{OL}			 0.4	 V	 I_{OL} = 12mA This buffer is not 5V tolerant.
IOD-12 mA Type Buffer	_	_	_	_	_	Same characteristics as an I and an OD-12mA.
I_AN Type Buffer						
I_AN Type Buffer (Analog Input Buffer)	I_AN					Voltage range on pins: -0.3V to +3.63V These buffers are not 5V tolerant buffers and they are not backdrive protected

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TABLE 29-4: DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Symbol	MIN	TYP	MAX	Units	Comments
PCI_PIO Type Buffer						
All PCI_PIO Buffers Pull-up current	 I_{PU}	 0.6	 1	 1.5	 mA	Internal PU is selected via the GPIO Pin Control Register.
PCI_CLK Type Buffer PCI_IO Type Buffers PCI_OD Type Buffer	PCI_ICLK PCI_IO PCI_O PCI_I PCI_OD					See *PCI Local Bus Specification Rev. 2.1* These buffers are not not 5V tolerant buffers and they are not backdrive protected.
Crystal oscillator						
XTAL1 (OCLK)	The CEC1302 crystal oscillator design requires a 32.768 KHz parallel resonant crystal with load caps in the range 4-18pF. Refer to “Application Note PCB Layout Guide for CEC1302” for more information.					
XTAL2 (ICLK) Low Input Level High Input Level	 V_{ILI} V_{ILH}	 2.0	 	 0.4 	 V V	 VIN = 0 to VCC1

29.2.4.1 Pin Leakage

Leakage characteristics for all pins is shown in the following table:

TABLE 29-5: PIN LEAKAGE

(T_A = 0°C to +70°C)

Parameter	Symbol	MIN	TYP	MAX	Units	Comments
Leakage Current	I_{IL}			+/-2	µA	VIN=0V to VCC1

29.2.4.2 Backdrive Protection

All signal pins are Backdrive Protected except those listed in the Pin Configuration chapter as non-backdrive protected.

TABLE 29-6: BACKDRIVE PROTECTION

(T_A = 0°C to +70°C)

Parameter	Symbol	MIN	TYP	MAX	Units	Comments
Input Leakage	I_{IL}	-2		+2	µA	VIN=3.47V@VCC1=0V

29.2.5 ADC ELECTRICAL CHARACTERISTICS

TABLE 29-7: ADC CHARACTERISTICS

Parameter	MIN	TYP	MAX	Units
Analog Supply Voltage, AVCC	3.135	3.3	3.465	V
Resolution	–	–	10	Bits
Accuracy	–	1	–	LSB
Differential Non Linearity, DNL	-1	–	+1	LSB
Integral Non Linearity, INL	-1.5	–	+1.5	LSB
Gain Error, E_{GAIN}	-2	–	2	LSB
Offset Error, E_{OFFSET}	-2	–	2	LSB
Conversion Time	–	–	12	µs/channel
Input Impedance	3	–	–	MΩ

Note: The AVCC power supply accuracy is shown as 3.3V +/- 5%.

29.3 Thermal Characteristics

TABLE 29-8: THERMAL OPERATING CONDITIONS

Rating	Symbol	Min.	Typical	Max.	Unit
Consumer Temperature Devices					
Operating Junction Temperature Range	T_J	—	—	+125	°C
Operating Ambient Temperature Range	T_A	0	—	+70	°C
Power Dissipation: Internal Chip Power Dissipation: $P_{INT} = V_{CC}1 \times I_{VCC}1$ from Table 29-10 (e.g., 3.45V x 9.75mA = 33.64mW) I/O Pin Power Dissipation: $I/O = S (\{V_{CC}1 – V_{OH}\} \times I_{OH}) + S (V_{OL} \times I_{OL})$	P_D	$P_{INT} + P_{I/O}$			W
Maximum Allowed Power Dissipation	P_{DMAX}	$(T_J – T_A)/\theta_{JA}$			W

TABLE 29-9: THERMAL PACKAGING CHARACTERISTICS

Characteristics	Symbol	Typical	Max.	Unit	Notes
Package Thermal Resistance, 144-pin WFBGA	θ_{JA}	50.0	—	°C/W	**1**
	θ_{JC}	17.0	—	°C/W	**1**
Note 1: Junction to ambient thermal resistance, Theta-$_{JA}$ (θ_{JA}) and Junction to case thermal resistance, Theta-$_{JC}$ (θ_{JC}) numbers are achieved by package simulations.					

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29.4 Power Consumption

TABLE 29-10: VCC1 SUPPLY CURRENT, I_VCC1

VCC2	VCC1	System State	48 MHz Ring Oscillator Frequency	Typical (3.3V, 25^0 C)	Max (3.465V, 70^0 C)	Units	Comments
On/Off	On	S5	48MHz	7.75	9.25	mA	FULL ON, 48MHz
On/Off	On	S5	12MHz	5.25	7.00	mA	FULL ON, 12MHz
On/Off	On	S5	3MHz	4.75	6.25	mA	FULL ON, 3MHz
On/Off	On	S5	1MHz	4.50	6.00	mA	FULL ON, 1MHz
On/Off	On	S5	12MHz	2.00	2.75	mA	Heavy Sleep 1 (Note 29-1)
On/Off	On	S5	Off	0.65	1.25	mA	Heavy Sleep 2 (Note 29-1)
On/Off	On	S5	Off	0.33	0.95	mA	Heavy Sleep 3 (Note 29-1)
On/Off	On	S5	Off	0.30	0.90	mA	Deepest Sleep (Note 29-1)

Note: FULL ON is defined as follows: The processor is not sleeping, the Core regulator and the Ring Oscillator remain powered, and at least one block is not sleeping.

Note 29-1 The sleep states are defined in the System Sleep Control Register in the Power, Clocks and Resets Chapter. See Table 3-9, “System Sleep Control Bit Encoding,” on page 52.

TABLE 29-11: VBAT SUPPLY CURRENT, I_VBAT (VBAT=3.0V)

VCC2	VCC1	System State	48 MHz Ring Oscillator Frequency	Typical (3.0V, 25^0 C)	Max (3.0V, 70^0 C)	Units	Comments
Off	Off	S5	Off	2.50	6.50	uA	32kHz crystal oscillator
Off	Off	S5	Off	2.00	6.00	uA	External 32kHz clock on XTAL2 pin

TABLE 29-12: VBAT SUPPLY CURRENT, I_VBAT (VBAT=3.3V)

VCC2	VCC1	System State	48 MHz Ring Oscillator Frequency	Typical (3.3V, 25^0 C)	Max (3.3V, 70^0 C)	Units	Comments
Off	Off	S5	Off	2.75	6.75	uA	32kHz crystal oscillator
Off	Off	S5	Off	2.50	6.25	uA	External 32kHz clock on XTAL2 pin

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30.0 TIMING DIAGRAMS

Note: Timing values are preliminary and may change after characterization.

30.1 Voltage Thresholds and Power Good Timing

30.1.1 VCC1_RST# TIMING

FIGURE 30-1: VCC1_RST# TIMING

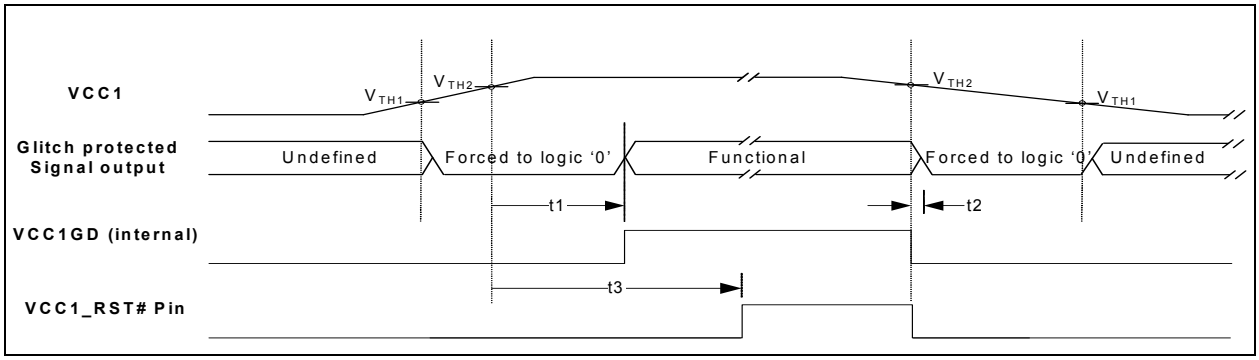

TABLE 30-1: VCC1_RST# TIMING

Parameters	Symbol	MIN	TYP	MAX	Unit	Notes
VCC1 Threshold for Pin Glitch Protection active	V_{TH1}	0.9	1	1.1	V	
VCC1 Power Good Threshold	V_{TH2}	2.16	2.4	2.64	V	
VCC1 Rise Time (Off to VCC1 =$V_{Threshold}$)	V_{Rise}	200			µs	
VCC1 Fall Time (VCC1 =$V_{Threshold}$) to Off	V_{Fall}	200			µs	
VCC1 > V_{TH2} to VCC1GD (internal) asserted	t1		600		µs	
VCC1 < V_{TH2} to VCC1GD (internal) deas-serted and VCC1_RST# pin asserted	t2		100		ns	
VCC1 > V_{TH2} to VCC1_RST# pin deasserted	t3		1		ms	Note 30-1

Note 30-1 The ARM starts executing instructions when EC_PROC_ RESET deasserts, which has the same timing as t3.

FIGURE 30-2: VCC1_RST# RISE TIME

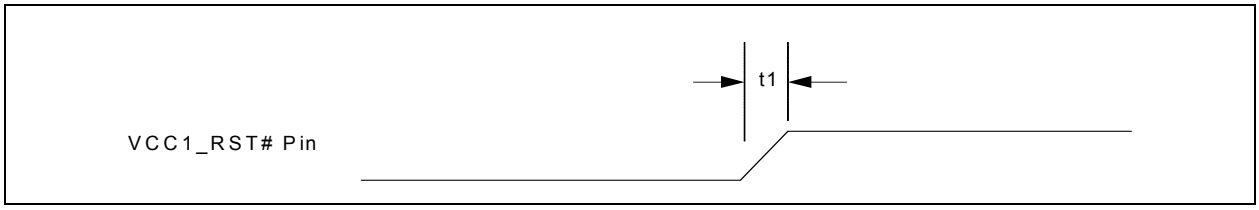

TABLE 30-2: VCC1_RST# RISE TIME

Parameters	Symbol	MIN	TYP	MAX	Units	Notes
VCC1_RST# Rise Time	t1			2.65	µs	Note 30-1

Note 30-1 This corresponds to the time 2.65us (min) after the VCC1_RST# pin is released, the VCC1_RST# pin input is sampled. See Section 3.6.1, "Integrated Vcc1 Power On Reset (VCC1_RST#)," on page 45.

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30.1.2 VBAT THRESHOLDS AND VBAT_POR

FIGURE 30-3: VBAT THRESHOLDS AND VBAT_POR

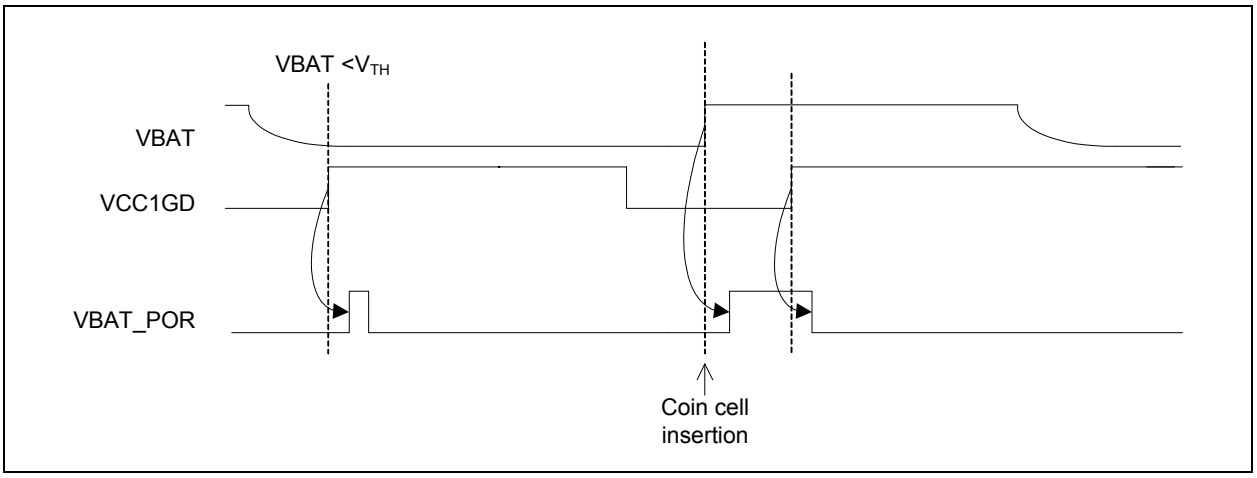

TABLE 30-3: VBAT THRESHOLDS AND VBAT_POR

Parameters	Symbol	MIN	TYP	MAX	Units	Notes
VBAT Power On Reset Threshold	V_{TH}	1.125	1.25	1.375	V	Note 30-2
VBAT Rise Time (Off to VBAT =$V_{Threshold}$)	V_{Rise}	100			µs	

Note 30-2 VBAT is monitored on two events: coin cell insertion and VCC1GD assertion. If VBAT is below VTH when VCC1GD is asserted a VBAT_POR is generated.

30.2 Clocking AC Timing Characteristics

FIGURE 30-4: CLOCK TIMING DIAGRAM

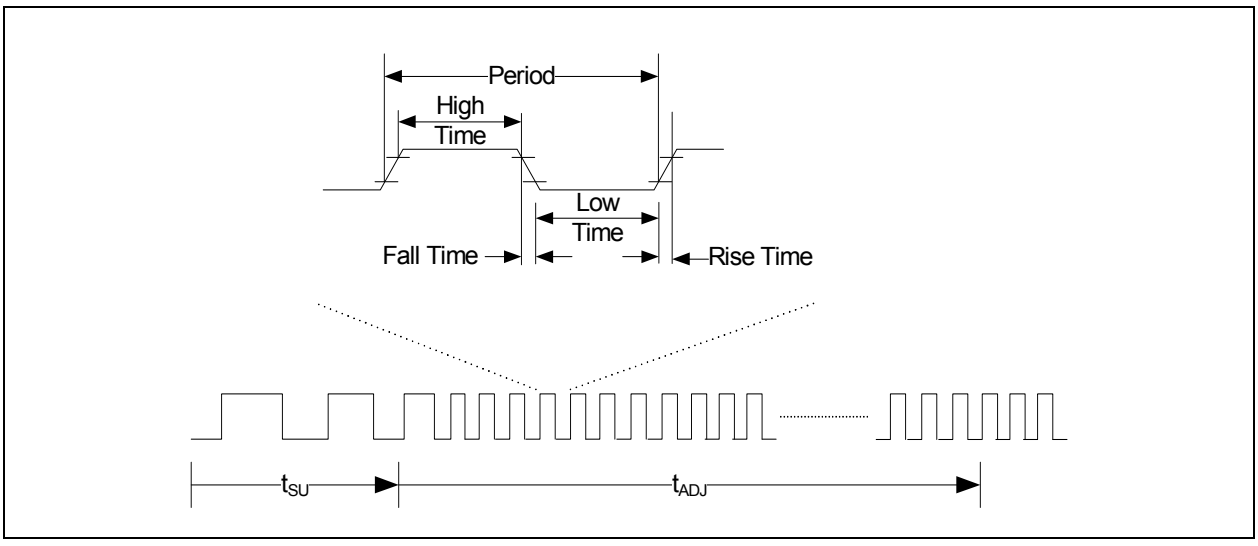

TABLE 30-4: CLOCK TIMING PARAMETERS

Clock	Parameters	Symbol	MIN	TYP	MAX	Units
48 MHz Ring Oscillator	Start-up accuracy (without 32 kHz present)	f_{SU}	22	-	53	MHz
	Start-up delay from 0 MHz to Start-up accuracy	t_{SU}	-	-	6	µs
	Operating Frequency (with 32 kHz present after frequency lock to 48 MHz)	f_{OP}	47.04	48	48.95	MHz
	Adjustment Delay from Start-up accuracy to Operating accuracy (time to attain frequency lock - with 32 kHz present)	t_{ADJ}	0.03	-	4 (Note 30-1)	ms
	Operating Frequency (with 32 kHz removed after frequency locked to 48 MHz)	f_{OP}	43.2 (Note 30-3)	-	52.8 (Note 30-3)	MHz
SUSCLK	Operating Frequency	-	-	32.768	-	kHz
	Period	-	(Note 30-2)	30.52	(Note 30-2)	µs
	High Time	-	10			us
	Low Time	-	10			us
	Fall Time	-	-	-	1	us
	Rise Time	-	-	-	1	us

Note 30-1 This time only applies if the external 32KHz clock input is available.

Note 30-2 SUSCLK is required to have an accuracy of +/- 100 ppm.

Note 30-3 The drift in frequency after frequency lock if the 32kHz clock is removed is determined by varying temperature while voltage is held constant.

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30.3 GPIO Timings

FIGURE 30-5: GPIO TIMING

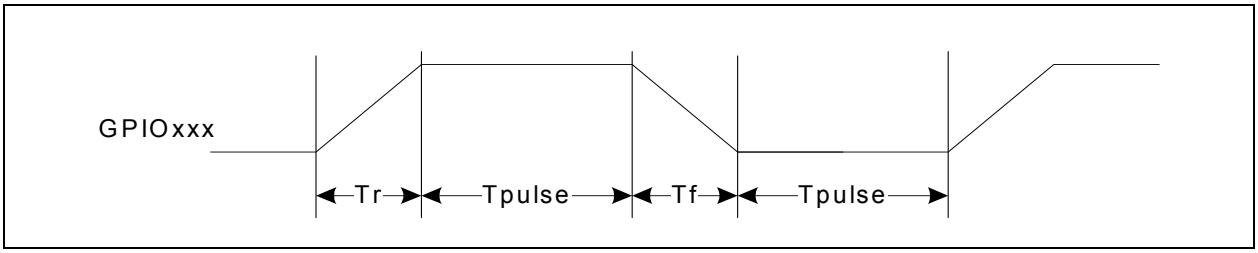

TABLE 30-5: GPIO TIMING PARAMETERS

Symbol	Parameter	MIN	TYP	MAX	Unit	Notes
t_R	GPIO Rise Time (push-pull)	0.54		1.31	ns	Pad type = IO2 C_L=2pF
t_F	GPIO Fall Time	0.52		1.27	ns	
t_R	GPIO Rise Time (push-pull)	0.58		1.46	ns	Pad type = IO4 C_L=5pF
t_F	GPIO Fall Time	0.62		1.48	ns	
t_R	GPIO Rise Time (push-pull)	0.80		2.00	ns	Pad type = IO8 C_L=10pF
t_F	GPIO Fall Time	0.80		1.96	ns	
t_R	GPIO Rise Time (push-pull)	1.02		2.46	ns	Pad type = IO12 C_L=20pF
t_F	GPIO Fall Time	1.07		2.51	ns	
t_{pulse}	GPIO Pulse Width	60			ns	

30.4 Serial Port (UART) Data Timing

FIGURE 30-6: SERIAL PORT DATA

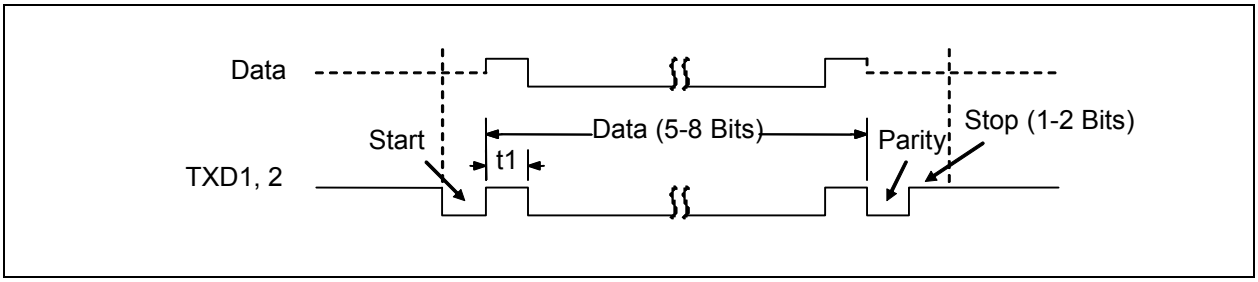

TABLE 30-6: SERIAL PORT DATA PARAMETERS

Name	Description	MIN	TYP	MAX	Units
t1	Serial Port Data Bit Time		t_{BR} (Note 30-1)		nsec

Note 30-1 tBR is 1/Baud Rate. The Baud Rate is programmed through the Baud_Rate_Divisor bits located in the Programmable Baud Rate Generator registers. The selectable baud rates are listed in Table 8-7, "UART Baud Rates using Clock Source 1.8432MHz_Clk" and Table 8-8, "UART Baud Rates using Clock Source 24MHz_Clk". Some of the baud rates have some percentage of error because the clock does not divide evenly. This error can be determined from the values in these baud rate tables.

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30.5 Keyboard Scan Matrix Timing

TABLE 30-7: ACTIVE PRE DRIVE MODE TIMING

Parameter	Symbol	Value			Units
		MIN	TYP	MAX	
Active Predrive Mode	$t_{PREDRIVE}$	40.87	41.7	42.5	ns

30.6 PWM Timing

FIGURE 30-7: PWM OUTPUT TIMING

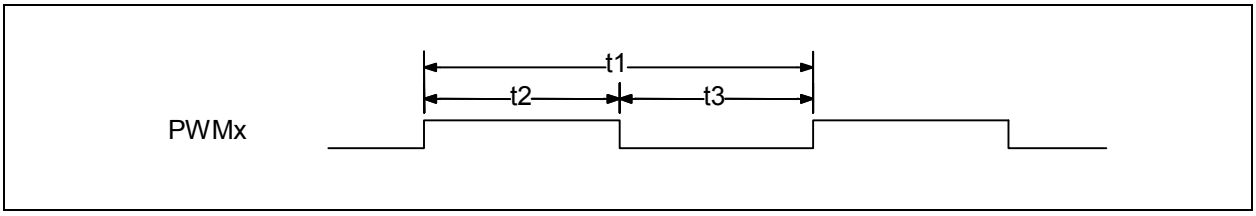

TABLE 30-8: PWM TIMING PARAMETERS

Name	Description	MIN	TYP	MAX	Units
t1	Period	42ns		23.3sec	
t_f	Frequency	0.04Hz		24MHz	
t2	High Time	0		11.65	sec
t3	Low Time	0		11.65	sec
t_d	Duty cycle	0		100	%

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30.7 Fan Tachometer Timing

FIGURE 30-8: FAN TACHOMETER INPUT TIMING

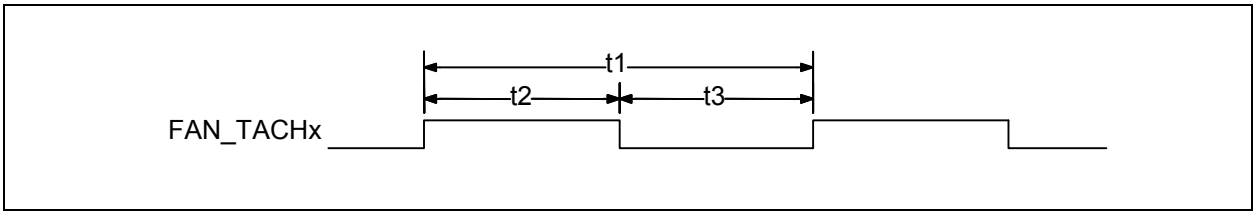

TABLE 30-9: FAN TACHOMETER INPUT TIMING PARAMETERS

Name	Description	MIN	TYP	MAX	Units
t1	Pulse Time	100			µsec
t2	Pulse High Time	20			
t3	Pulse Low Time	20			

Note: t_{TACH} is the clock used for the tachometer counter. It is 30.52 * prescaler, where the prescaler is programmed in the Fan Tachometer Timebase Prescaler register.

30.8 Blinking/Breathing PWM Timing

FIGURE 30-9: BLINKING/BREATHING PWM OUTPUT TIMING

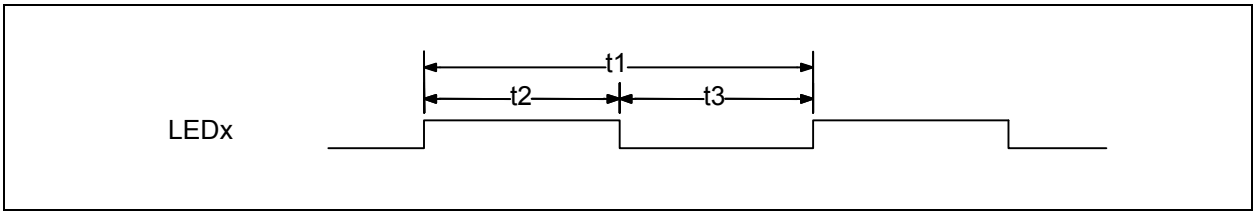

TABLE 30-10: BLINKING/BREATHING PWM TIMING PARAMETERS, BLINKING MODE

Name	Description	MIN	TYP	MAX	Units
t1	Period	7.8ms		32sec	
t_f	Frequency	0.03125		128	Hz
t2	High Time	0		16	sec
t3	Low Time	0		16	sec
t_d	Duty cycle	0		100	%

TABLE 30-11: BLINKING/BREATHING PWM TIMING PARAMETERS, GENERAL PURPOSE

Name	Description	MIN	TYP	MAX	Units
t1	Period	5.3us		21.8ms	
t_f	Frequency	45.8Hz		187.5kHz	
t2	High Time	0		10.9	ms
t3	Low Time	0		10.9	ms
t_d	Duty cycle	0		100	%

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30.9 I²C/SMBus Timing

FIGURE 30-10: I²C/SMBUS TIMING

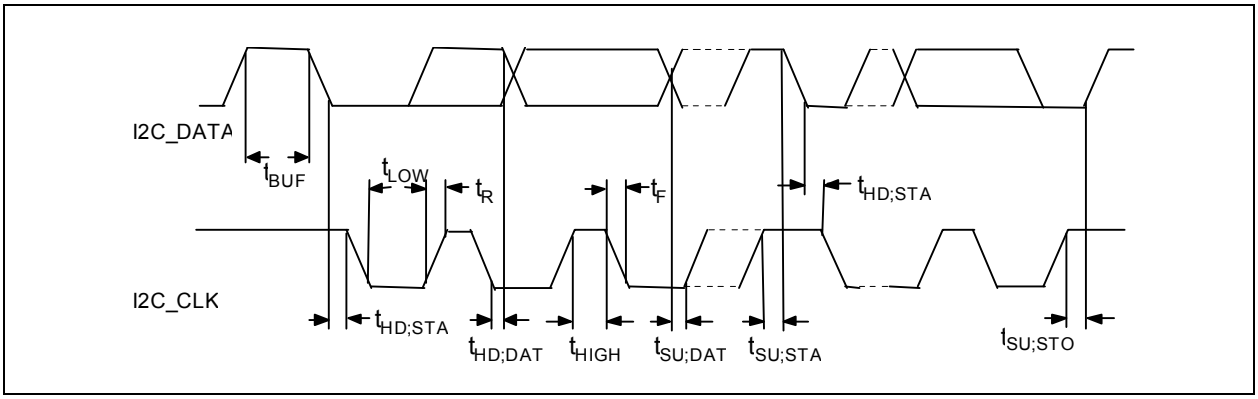
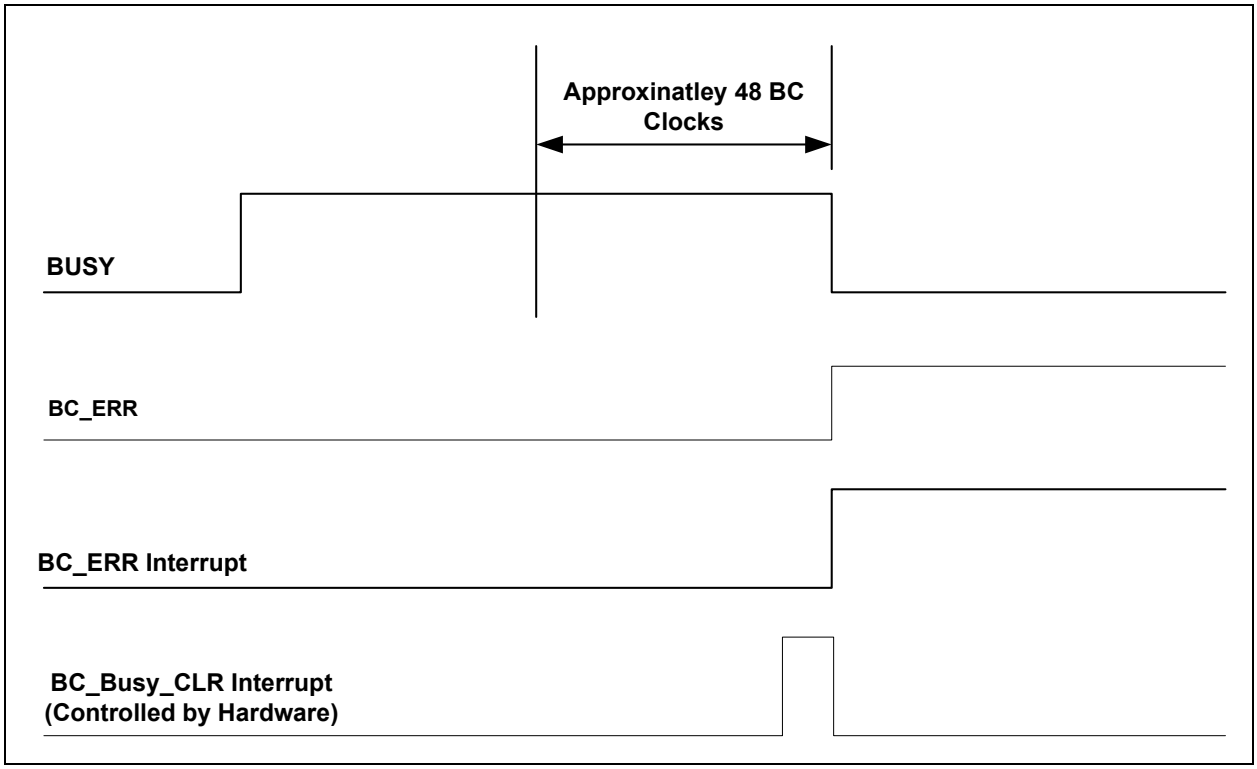


TABLE 30-12: I²C/SMBUS TIMING PARAMETERS

Symbol	Parameter	Standard-Mode		Fast-Mode		Fast-Mode Plus		Units
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
f_{SCL}	SCL Clock Frequency		100		400		1000	kHz
t_{BUF}	Bus Free Time	4.7		1.3		0.5		µs
$t_{SU;STA}$	START Condition Set-Up Time	4.7		0.6		0.26		µs
$t_{HD;STA}$	START Condition Hold Time	4.0		0.6		0.26		µs
t_{LOW}	SCL LOW Time	4.7		1.3		0.5		µs
t_{HIGH}	SCL HIGH Time	4.0		0.6		0.26		µs
t_R	SCL and SDA Rise Time		1.0		0.3		0.12	µs
t_F	SCL and SDA Fall Time		0.3		0.3		0.12	µs
$t_{SU;DAT}$	Data Set-Up Time	0.25		0.1		0.05		µs
$t_{HD;DAT}$	Data Hold Time	0		0		0		µs
$t_{SU;STO}$	STOP Condition Set-Up Time	4.0		0.6		0.26		µs

30.10 BC-Link Master Interrupt Timing

FIGURE 30-11: BC-LINK ERR INTERRUPT TIMING



30.11 BC-Link Master Timing

FIGURE 30-12: BC-LINK READ TIMING

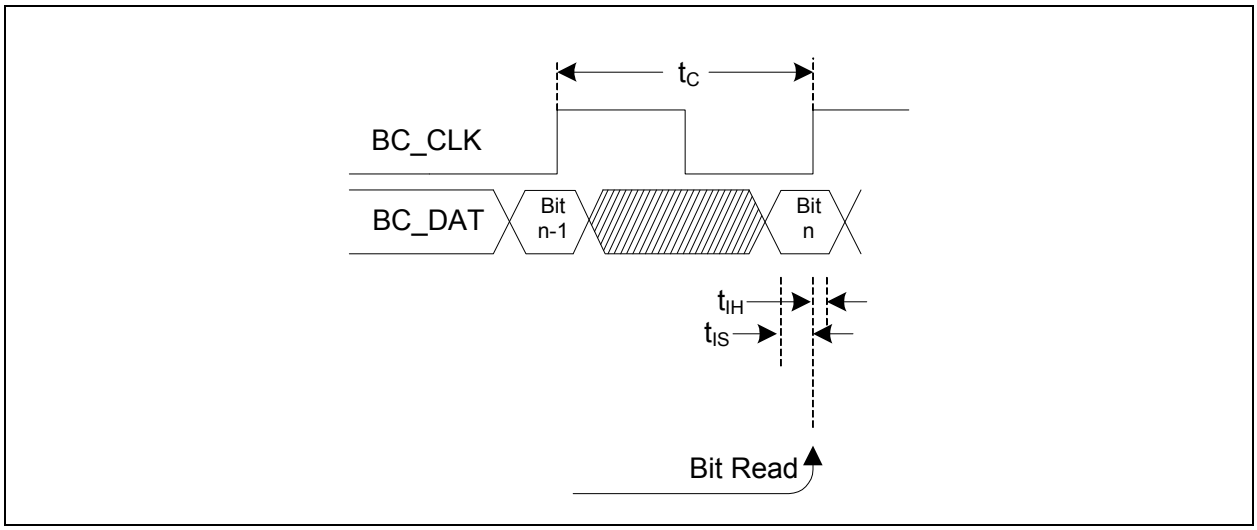


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FIGURE 30-13: BC-LINK WRITE TIMING

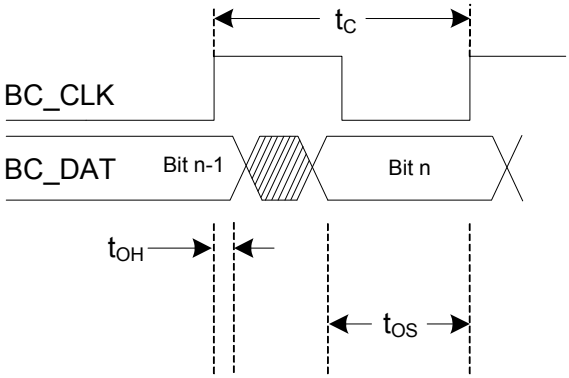

TABLE 30-13: BC-LINK MASTER TIMING DIAGRAM PARAMETERS

Name	Description	MIN	TYP	MAX	Units
t_c(High Speed)	High Spec BC Clock Frequency	23.5	24	24.5	MHz
	High Spec BC Clock Period	40.8	41.67	42.5	ns
t_{OS}	BC-Link Master DATA output setup time before rising edge of CLK.			t_c-t_{OH-MAX}	nsec
t_{OH}	BC-Link Master Data hold time after falling edge of CLK			10	nsec
t_{IS}	BC-Link Master DATA input setup time before rising edge of CLK.	15			nsec
t_{IH}	BC-Link Master DATA input hold time after rising edge of CLK.	0			nsec

Note 1: The BC-Link Master DATA input (t_{IH} in Table 30-13) must be stable before next rising edge of CLK.

2: The BC-Link Clock frequency is limited by the application usage model (see BC-Link Master Section 23.5, Signal Description). The BC-Link Clock frequency is controlled by the BC-Link Clock Select Register. The tc(High Speed) parameter implies both BC-link master and companion devices are located on the same circuit board and a high speed clock setting is possible.

Note: The timing budget equation is as follows for data from BC-Link slave to master:

Tc > TOD(master-clk) + Tprop(clk) +TOD(slave) + Tprop(slave data) + TIS(master).

30.12 Serial Peripheral Interface (SPI) Timings

FIGURE 30-14: SPI CLOCK TIMING

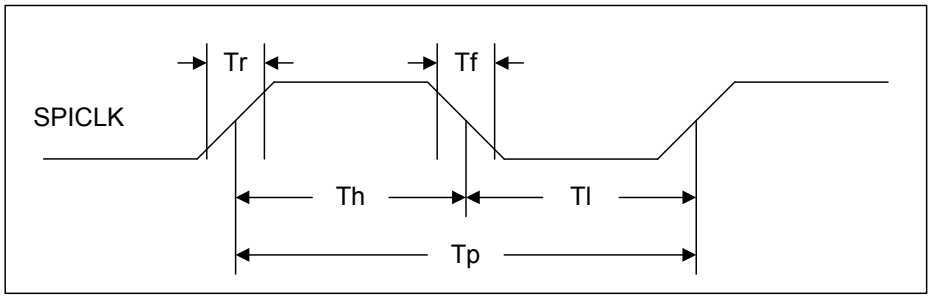

TABLE 30-14: SPI CLOCK TIMING PARAMETERS

NAME	DESCRIPTION	MIN	TYP	MAX	UNITS
Tr	SPI Clock Rise Time. Measured from 10% to 90%.			10% of SPCLK Period	ns
Tf	SPI Clock Fall Time. Measured from 90% to 10%.			10% of SPCLK Period	ns
Th/Tl	SPI Clock High Time/SPI Clock Low Time	40% of SPCLK Period	50% of SPCLK Period	60% of SPCLK Period	ns
Tp	SPI Clock Period – As selected by SPI Clock Generator Register	20.8 (Note 30-1)		62492.25	ns

Note 30-1 This timing value applies when the 48MHz ring oscillator is at its 48MHz operating frequency (with 32 kHz present after frequency lock to 48MHz).

FIGURE 30-15: SPI SETUP AND HOLD TIMES, CLKPOL=0, TCLKPH=0, RCLKPH=0

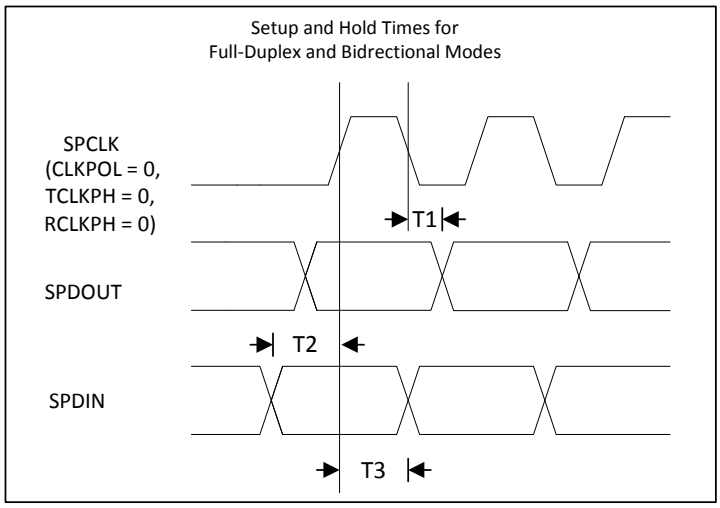

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FIGURE 30-16: SPI SETUP AND HOLD TIMES, CLKPOL=0, TCLKPH=0, RCLKPH=1

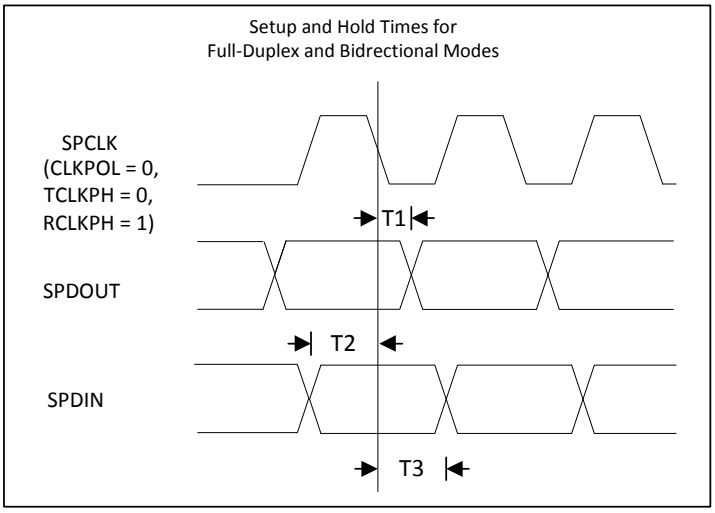


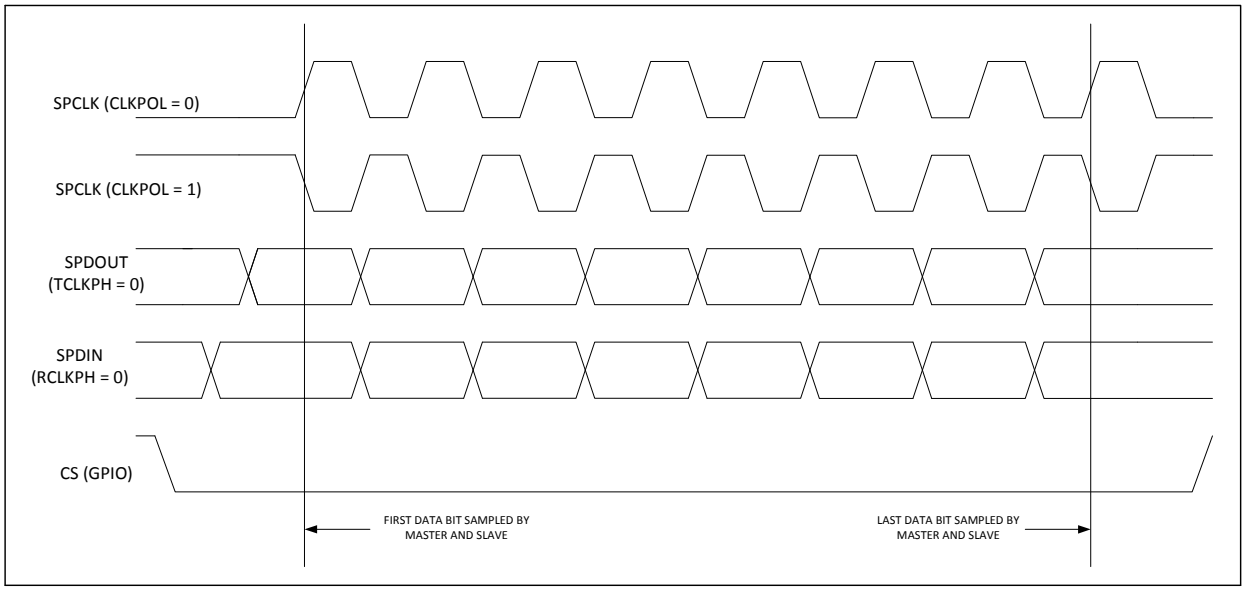
TABLE 30-15: SPI SETUP AND HOLD TIMES PARAMETERS

NAME	DESCRIPTION	MIN	TYP	MAX	UNITS
T1	Data Output Delay			5	ns
T2	Data IN Setup Time	10			ns
T3	Data IN Hold Time	0			ns

30.12.1 SPI INTERFACE TIMINGS

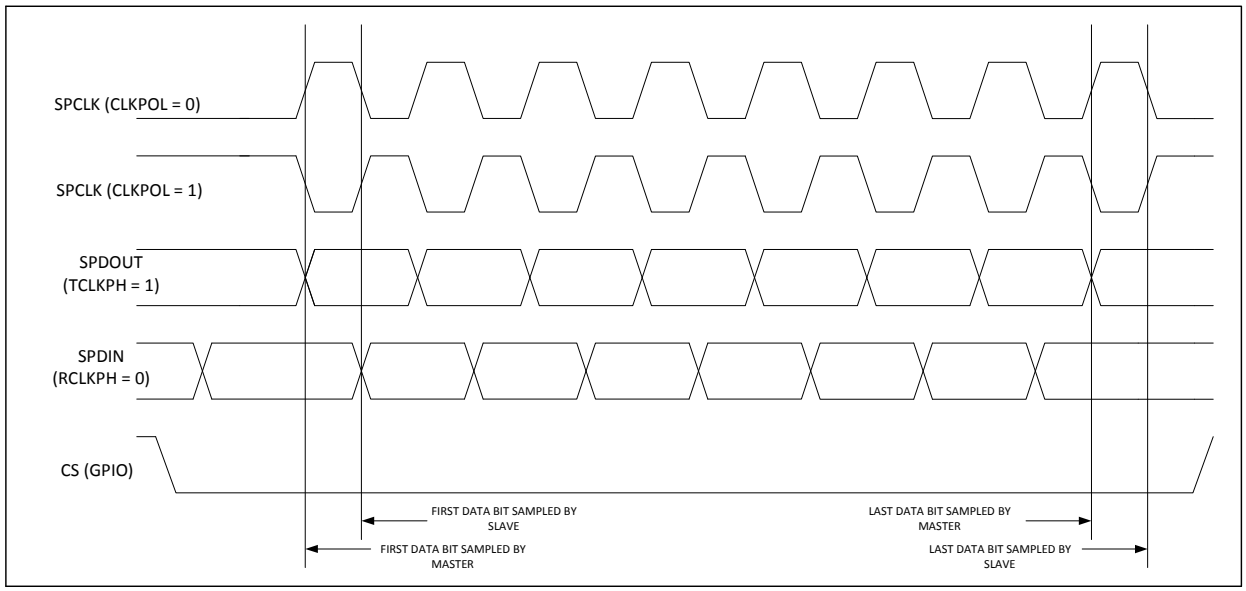
The following timing diagrams represent a single-byte transfer over the SPI interface using different SPCLK phase settings. Data bits are transmitted in bit order starting with the MSB (LSBF='0') or the LSB (LSBF='1'). See the SPI Control Register for information on the LSBF bit. The CS signal in each diagram is a generic bit-controlled chip select signal required by most peripheral devices. This signal and additional chip selects can be GPIO controlled. Note that these timings for Full Duplex Mode are also applicable to Half Duplex (or Bi-directional) mode.

FIGURE 30-17: INTERFACE TIMING, FULL DUPLEX MODE (TCLKPH = 0, RCLKPH = 0)



In this mode, data is available immediately when a device is selected and is sampled on the first and following odd SPCLK edges by the master and slave.

FIGURE 30-18: SPI INTERFACE TIMING, FULL DUPLEX MODE (TCLKPH = 1, RCLKPH = 0)



In this mode, the master requires an initial SPCLK edge before data is available. The data from slave is available immediately when the slave device is selected. The data is sampled on the first and following odd edges by the master. The data is sampled on the second and following even SPCLK edges by the slave.

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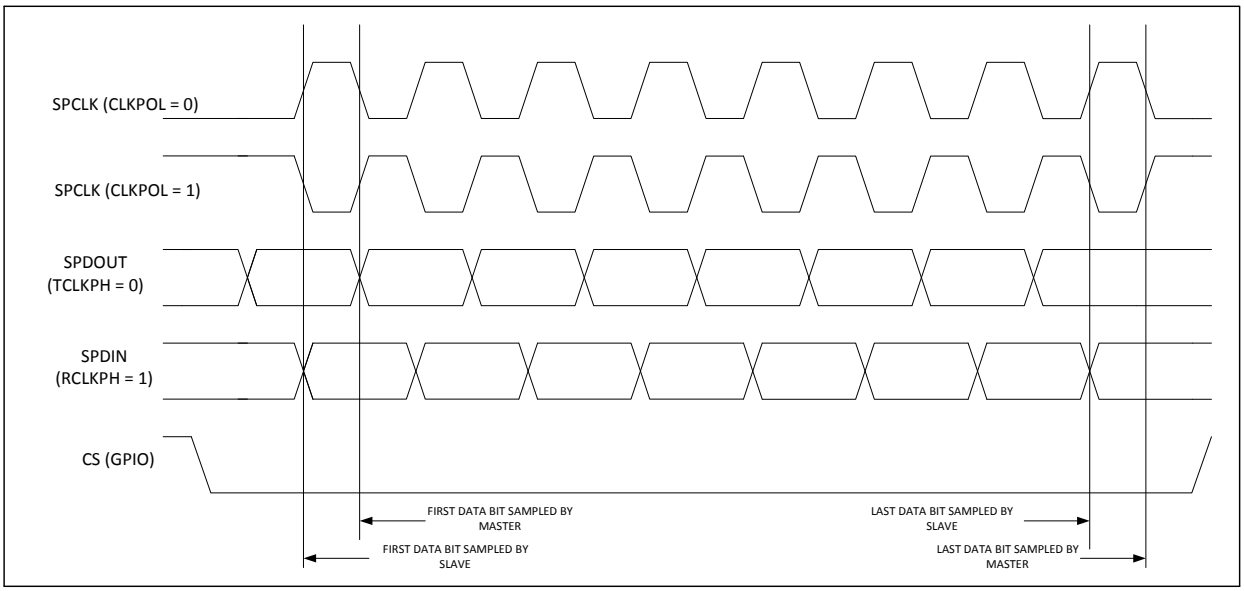
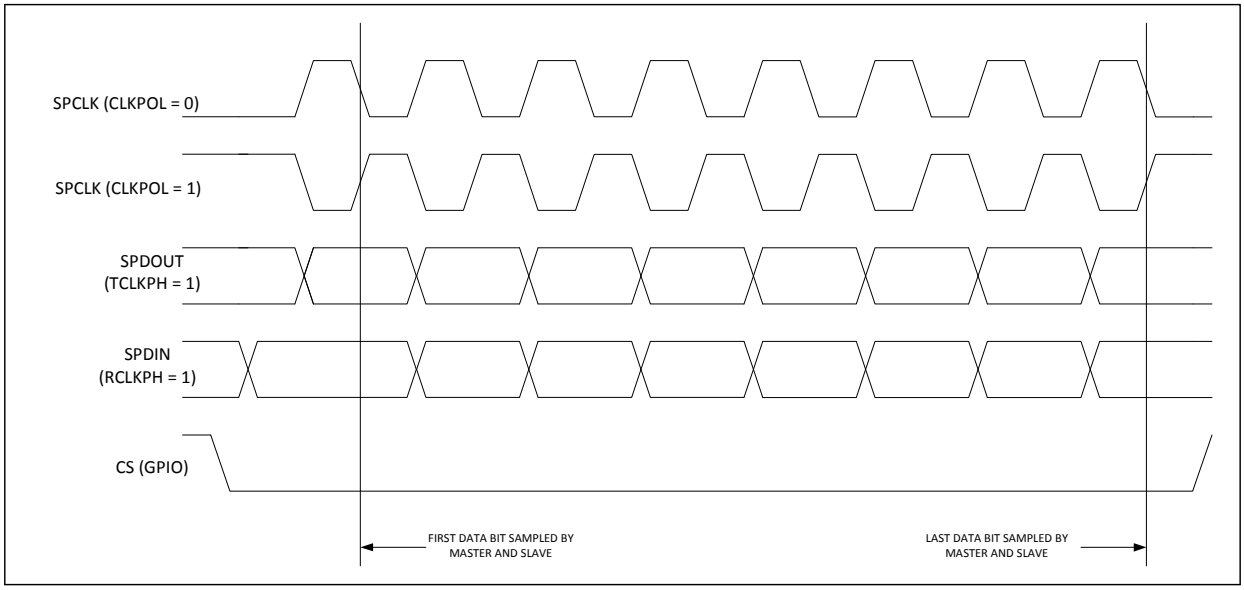
FIGURE 30-19: SPI INTERFACE TIMING, FULL DUPLEX MODE (TCLKPH = 0, RCLKPH = 1)



In this mode, the data from slave is available immediately when the slave device is selected. The slave device requires an initial SPCLK edge before data is available. The data is sampled on the second and following even SPCLK edges by the master. The data is sampled on the first and following odd edges by the slave.

FIGURE 30-20: SPI INTERFACE TIMING - FULL DUPLEX MODE (TCLKPH = 1, RCLKPH = 1)



In this mode, the master and slave require an initial SPCLK edge before data is available. Data is sampled on the second and following even SPCLK edges by the master and slave.

30.13 Serial Debug Port Timing

FIGURE 30-21: SERIAL DEBUG PORT TIMING PARAMETERS

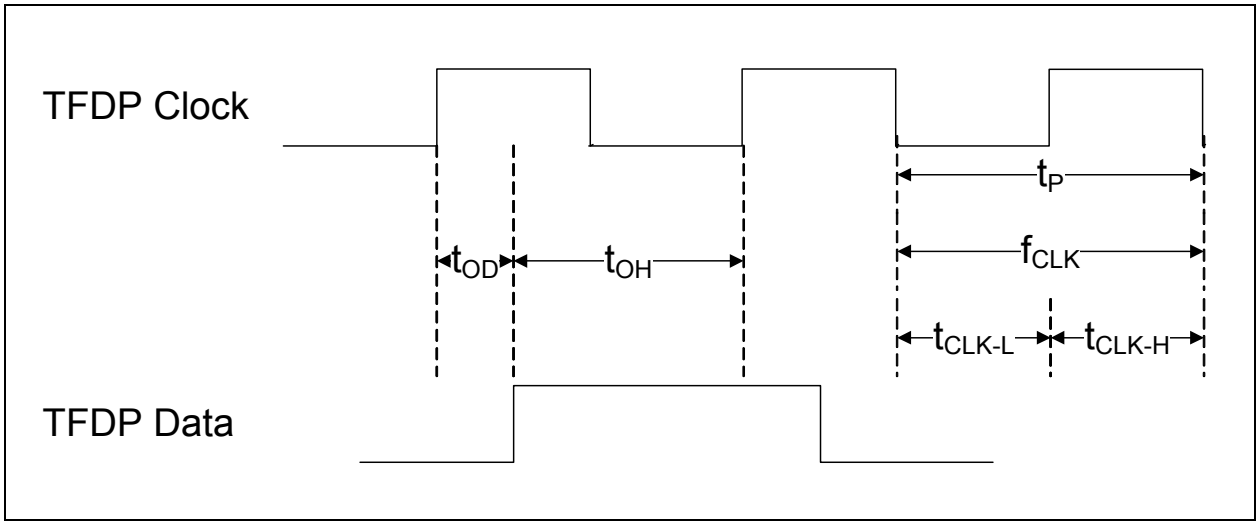


TABLE 30-16: SERIAL DEBUG PORT INTERFACE TIMING PARAMETERS

Name	Description	MIN	TYP	MAX	Units
f_{clk}	TFDP Clock frequency (Note 30-2)	6	-	24	MHz
t_P	TFDP Clock Period.	1/fclk			µs
t_{OD}	TFDP Data output delay after falling edge of MSCLK.			5	nsec
t_{OH}	TFDP Data hold time after falling edge of TFDP Clock	$t_P - t_{OD}$			nsec
t_{CLK-L}	TFDP Clock Low Time	$t_P/2 - 3$		$t_P/2 + 3$	nsec
t_{CLK-H}	TFDP Clock high Time (see Note 30-2)	$t_P/2 - 3$		$t_P/2 + 3$	nsec

Note 30-2 When the clock divider for the embedded controller is an odd number value greater than 2h, then $t_{CLK-L} = t_{CLK-H} + 15$ ns. When the clock divider for the embedded controller is 0h, 1h, or an even number value greater than 2h, then $t_{CLK-L} = t_{CLK-H}$.

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30.14 JTAG Interface Timing

FIGURE 30-22: JTAG POWER-UP & ASYNCHRONOUS RESET TIMING

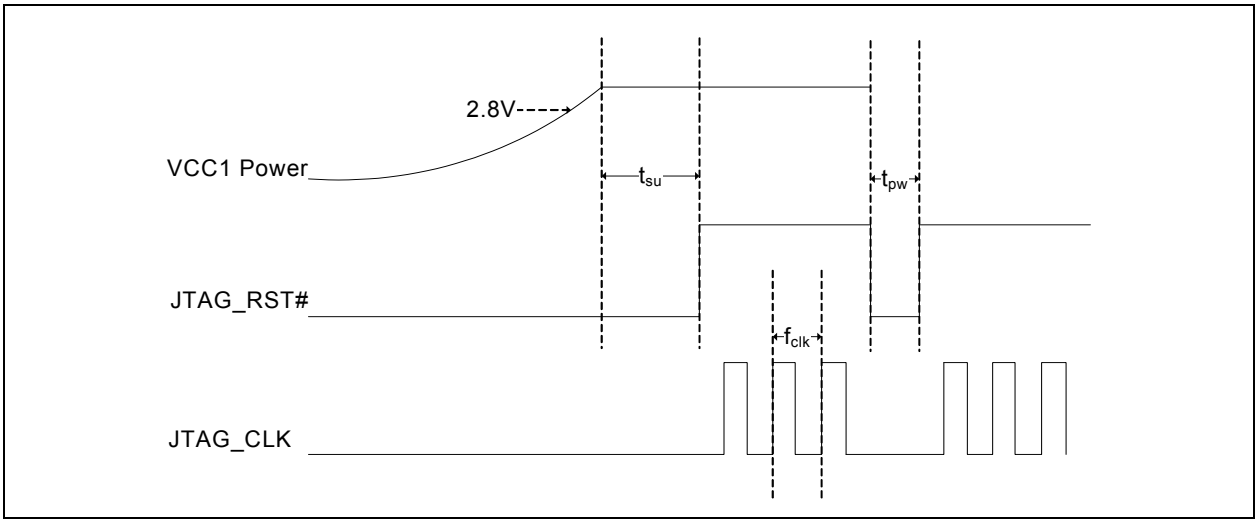

FIGURE 30-23: JTAG SETUP & HOLD PARAMETERS

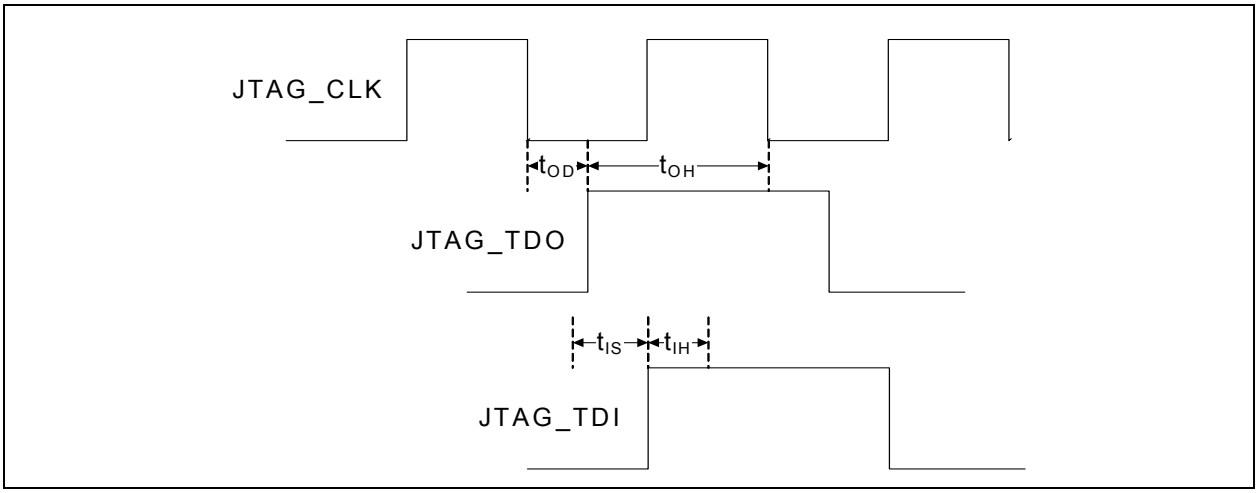

TABLE 30-17: JTAG INTERFACE TIMING PARAMETERS

Name	Description	MIN	TYP	MAX	Units
t_{su}	JTAG_RST# de-assertion after VCC1 power is applied	5			ms
t_{pw}	JTAG_RST# assertion pulse width	500			nsec
f_{clk}	JTAG_CLK frequency (see note)			48	MHz
t_{OD}	TDO output delay after falling edge of TCLK.	5		10	nsec
t_{OH}	TDO hold time after falling edge of TCLK	1 TCLK - t_{OD}			nsec
t_{IS}	TDI setup time before rising edge of TCLK.	5			nsec
t_{IH}	TDI hold time after rising edge of TCLK.	5			nsec

Note: f_{clk} is the maximum frequency to access a JTAG Register.

31.0 MEMORY MAP

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
0	32K ROM	0	32K ROM	32K ROM
100000	128K SRAM	0	128K SRAM	128K SRAM
40000400	Watchdog Timer Interface	0	WDT Registers	WDT Load Register
40000404	Watchdog Timer Interface	0	WDT Registers	WDT Control Register
40000408	Watchdog Timer Interface	0	WDT Registers	WDT Kick Register
4000040C	Watchdog Timer Interface	0	WDT Registers	WDT Count Register
40000C00	Basic Timer	0	Basic_Timer_EC_Only	Timer Count
40000C04	Basic Timer	0	Basic_Timer_EC_Only	Timer Preload
40000C08	Basic Timer	0	Basic_Timer_EC_Only	Timer Status
40000C0C	Basic Timer	0	Basic_Timer_EC_Only	Timer Interrupt Enable
40000C10	Basic Timer	0	Basic_Timer_EC_Only	Timer Control
40000C20	Basic Timer	1	Basic_Timer_EC_Only	Timer Count
40000C24	Basic Timer	1	Basic_Timer_EC_Only	Timer Preload
40000C28	Basic Timer	1	Basic_Timer_EC_Only	Timer Status
40000C2C	Basic Timer	1	Basic_Timer_EC_Only	Timer Interrupt Enable
40000C30	Basic Timer	1	Basic_Timer_EC_Only	Timer Control
40000C40	Basic Timer	2	Basic_Timer_EC_Only	Timer Count
40000C44	Basic Timer	2	Basic_Timer_EC_Only	Timer Preload
40000C48	Basic Timer	2	Basic_Timer_EC_Only	Timer Status
40000C4C	Basic Timer	2	Basic_Timer_EC_Only	Timer Interrupt Enable
40000C50	Basic Timer	2	Basic_Timer_EC_Only	Timer Control
40000C60	Basic Timer	3	Basic_Timer_EC_Only	Timer Count
40000C64	Basic Timer	3	Basic_Timer_EC_Only	Timer Preload
40000C68	Basic Timer	3	Basic_Timer_EC_Only	Timer Status
40000C6C	Basic Timer	3	Basic_Timer_EC_Only	Timer Interrupt Enable
40000C70	Basic Timer	3	Basic_Timer_EC_Only	Timer Control
40000C80	Basic Timer	4	Basic_Timer_EC_Only	Timer Count
40000C84	Basic Timer	4	Basic_Timer_EC_Only	Timer Preload
40000C88	Basic Timer	4	Basic_Timer_EC_Only	Timer Status
40000C8C	Basic Timer	4	Basic_Timer_EC_Only	Timer Interrupt Enable
40000C90	Basic Timer	4	Basic_Timer_EC_Only	Timer Control
40000CA0	Basic Timer	5	Basic_Timer_EC_Only	Timer Count
40000CA4	Basic Timer	5	Basic_Timer_EC_Only	Timer Preload
40000CA8	Basic Timer	5	Basic_Timer_EC_Only	Timer Status
40000CAC	Basic Timer	5	Basic_Timer_EC_Only	Timer Interrupt Enable
40000CB0	Basic Timer	5	Basic_Timer_EC_Only	Timer Control
40001800	SMB Device Interface	0	SMB_EC_Only	Status Register
40001800	SMB Device Interface	0	SMB_EC_Only	Control Register

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40001801	SMB Device Interface	0	SMB_EC_Only	Reserved
40001804	SMB Device Interface	0	SMB_EC_Only	Own Address Register
40001806	SMB Device Interface	0	SMB_EC_Only	Reserved
40001808	SMB Device Interface	0	SMB_EC_Only	Data
40001809	SMB Device Interface	0	SMB_EC_Only	Reserved
4000180C	SMB Device Interface	0	SMB_EC_Only	SMBus Master Command Register
40001810	SMB Device Interface	0	SMB_EC_Only	SMBus Slave Command Register
40001814	SMB Device Interface	0	SMB_EC_Only	PEC Register
40001815	SMB Device Interface	0	SMB_EC_Only	Reserved
40001818	SMB Device Interface	0	SMB_EC_Only	DATA_TIMING2
40001819	SMB Device Interface	0	SMB_EC_Only	Reserved
40001820	SMB Device Interface	0	SMB_EC_Only	Completion Register
40001824	SMB Device Interface	0	SMB_EC_Only	Idle Scaling Register
40001828	SMB Device Interface	0	SMB_EC_Only	Configuration Register
4000182C	SMB Device Interface	0	SMB_EC_Only	Bus Clock Register
4000182E	SMB Device Interface	0	SMB_EC_Only	Reserved
40001830	SMB Device Interface	0	SMB_EC_Only	Block ID Register
40001831	SMB Device Interface	0	SMB_EC_Only	Reserved
40001834	SMB Device Interface	0	SMB_EC_Only	Revision Register
40001835	SMB Device Interface	0	SMB_EC_Only	Reserved
40001838	SMB Device Interface	0	SMB_EC_Only	Bit-Bang Control Register
40001839	SMB Device Interface	0	SMB_EC_Only	Reserved
4000183C	SMB Device Interface	0	SMB_EC_Only	Clock Sync
40001840	SMB Device Interface	0	SMB_EC_Only	Data Timing Register
40001844	SMB Device Interface	0	SMB_EC_Only	Time-Out Scaling Register
40001848	SMB Device Interface	0	SMB_EC_Only	SMBus Slave Transmit Buffer Register
40001849	SMB Device Interface	0	SMB_EC_Only	Reserved
4000184C	SMB Device Interface	0	SMB_EC_Only	SMBus Slave Receive Buffer Register
4000184D	SMB Device Interface	0	SMB_EC_Only	Reserved
40001850	SMB Device Interface	0	SMB_EC_Only	SMBus Master Transmit Bufer Register
40001851	SMB Device Interface	0	SMB_EC_Only	Reserved
40001854	SMB Device Interface	0	SMB_EC_Only	SMBus Master Receive Buffer Register
40001855	SMB Device Interface	0	SMB_EC_Only	Reserved
40002400	DMA	0	DMA Main	DMA Main Control Register
40002401	DMA	0	DMA Main	DMA Reserved
40002404	DMA	0	DMA Main	DMA Data Register
40002410	DMA	0	DMA_CH0	DMA Activate Register
40002414	DMA	0	DMA_CH0	DMA Memory Start Address Register

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40002418	DMA	0	DMA_CH0	DMA Memory End Address Register
4000241C	DMA	0	DMA_CH0	AHB Address Register
40002420	DMA	0	DMA_CH0	DMA Control Register
40002424	DMA	0	DMA_CH0	DMA Channel Interrupt Status
40002428	DMA	0	DMA_CH0	DMA Channel Interrupt Enable
4000242C	DMA	0	DMA_CH0	DMA Test Register
40002430	DMA	0	DMA_CH1	DMA Activate Register
40002434	DMA	0	DMA_CH1	DMA Memory Start Address Register
40002438	DMA	0	DMA_CH1	DMA Memory End Address Register
4000243C	DMA	0	DMA_CH1	AHB Address Register
40002440	DMA	0	DMA_CH1	DMA Control Register
40002444	DMA	0	DMA_CH1	DMA Channel Interrupt Status
40002448	DMA	0	DMA_CH1	DMA Channel Interrupt Enable
4000244C	DMA	0	DMA_CH1	DMA Test Register
40002450	DMA	0	DMA_CH2	DMA Activate Register
40002454	DMA	0	DMA_CH2	DMA Memory Start Address Register
40002458	DMA	0	DMA_CH2	DMA Memory End Address Register
4000245C	DMA	0	DMA_CH2	AHB Address Register
40002460	DMA	0	DMA_CH2	DMA Control Register
40002464	DMA	0	DMA_CH2	DMA Channel Interrupt Status
40002468	DMA	0	DMA_CH2	DMA Channel Interrupt Enable
4000246C	DMA	0	DMA_CH2	DMA Test Register
40002470	DMA	0	DMA_CH3	DMA Activate Register
40002474	DMA	0	DMA_CH3	DMA Memory Start Address Register
40002478	DMA	0	DMA_CH3	DMA Memory End Address Register
4000247C	DMA	0	DMA_CH3	AHB Address Register
40002480	DMA	0	DMA_CH3	DMA Control Register
40002484	DMA	0	DMA_CH3	DMA Channel Interrupt Status
40002488	DMA	0	DMA_CH3	DMA Channel Interrupt Enable
4000248C	DMA	0	DMA_CH3	DMA Test Register
40002490	DMA	0	DMA_CH4	DMA Activate Register

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40002494	DMA	0	DMA_CH4	DMA Memory Start Address Register
40002498	DMA	0	DMA_CH4	DMA Memory End Address Register
4000249C	DMA	0	DMA_CH4	AHB Address Register
400024A0	DMA	0	DMA_CH4	DMA Control Register
400024A4	DMA	0	DMA_CH4	DMA Channel Interrupt Status
400024A8	DMA	0	DMA_CH4	DMA Channel Interrupt Enable
400024AC	DMA	0	DMA_CH4	DMA Test Register
400024B0	DMA	0	DMA_CH5	DMA Activate Register
400024B4	DMA	0	DMA_CH5	DMA Memory Start Address Register
400024B8	DMA	0	DMA_CH5	DMA Memory End Address Register
400024BC	DMA	0	DMA_CH5	AHB Address Register
400024C0	DMA	0	DMA_CH5	DMA Control Register
400024C4	DMA	0	DMA_CH5	DMA Channel Interrupt Status
400024C8	DMA	0	DMA_CH5	DMA Channel Interrupt Enable
400024CC	DMA	0	DMA_CH5	DMA Test Register
400024D0	DMA	0	DMA_CH6	DMA Activate Register
400024D4	DMA	0	DMA_CH6	DMA Memory Start Address Register
400024D8	DMA	0	DMA_CH6	DMA Memory End Address Register
400024DC	DMA	0	DMA_CH6	AHB Address Register
400024E0	DMA	0	DMA_CH6	DMA Control Register
400024E4	DMA	0	DMA_CH6	DMA Channel Interrupt Status
400024E8	DMA	0	DMA_CH6	DMA Channel Interrupt Enable
400024EC	DMA	0	DMA_CH6	DMA Test Register
400024F0	DMA	0	DMA_CH7	DMA Activate Register
400024F4	DMA	0	DMA_CH7	DMA Memory Start Address Register
400024F8	DMA	0	DMA_CH7	DMA Memory End Address Register
400024FC	DMA	0	DMA_CH7	AHB Address Register
40002500	DMA	0	DMA_CH7	DMA Control Register
40002504	DMA	0	DMA_CH7	DMA Channel Interrupt Status
40002508	DMA	0	DMA_CH7	DMA Channel Interrupt Enable
4000250C	DMA	0	DMA_CH7	DMA Test Register

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40002510	DMA	0	DMA_CH8	DMA Activate Register
40002514	DMA	0	DMA_CH8	DMA Memory Start Address Register
40002518	DMA	0	DMA_CH8	DMA Memory End Address Register
4000251C	DMA	0	DMA_CH8	AHB Address Register
40002520	DMA	0	DMA_CH8	DMA Control Register
40002524	DMA	0	DMA_CH8	DMA Channel Interrupt Status
40002528	DMA	0	DMA_CH8	DMA Channel Interrupt Enable
4000252C	DMA	0	DMA_CH8	DMA Test Register
40002530	DMA	0	DMA_CH9	DMA Activate Register
40002534	DMA	0	DMA_CH9	DMA Memory Start Address Register
40002538	DMA	0	DMA_CH9	DMA Memory End Address Register
4000253C	DMA	0	DMA_CH9	AHB Address Register
40002540	DMA	0	DMA_CH9	DMA Control Register
40002544	DMA	0	DMA_CH9	DMA Channel Interrupt Status
40002548	DMA	0	DMA_CH9	DMA Channel Interrupt Enable
4000254C	DMA	0	DMA_CH9	DMA Test Register
40002550	DMA	0	DMA_CH10	DMA Activate Register
40002554	DMA	0	DMA_CH10	DMA Memory Start Address Register
40002558	DMA	0	DMA_CH10	DMA Memory End Address Register
4000255C	DMA	0	DMA_CH10	AHB Address Register
40002560	DMA	0	DMA_CH10	DMA Control Register
40002564	DMA	0	DMA_CH10	DMA Channel Interrupt Status
40002568	DMA	0	DMA_CH10	DMA Channel Interrupt Enable
4000256C	DMA	0	DMA_CH10	DMA Test Register
40002570	DMA	0	DMA_CH11	DMA Activate Register
40002574	DMA	0	DMA_CH11	DMA Memory Start Address Register
40002578	DMA	0	DMA_CH11	DMA Memory End Address Register
4000257C	DMA	0	DMA_CH11	AHB Address Register
40002580	DMA	0	DMA_CH11	DMA Control Register
40002584	DMA	0	DMA_CH11	DMA Channel Interrupt Status
40002588	DMA	0	DMA_CH11	DMA Channel Interrupt Enable

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000258C	DMA	0	DMA_CH11	DMA Test Register
40005800	PWM	0	PWM_EC_Only	PWM Counter ON Time Register
40005804	PWM	0	PWM_EC_Only	PWM Counter OFF Time Register
40005808	PWM	0	PWM_EC_Only	PWM Configuration Register
4000580C	PWM	0	PWM_EC_Only	Reserved
40005810	PWM	1	PWM_EC_Only	PWM Counter ON Time Register
40005814	PWM	1	PWM_EC_Only	PWM Counter OFF Time Register
40005818	PWM	1	PWM_EC_Only	PWM Configuration Register
4000581C	PWM	1	PWM_EC_Only	Reserved
40005820	PWM	2	PWM_EC_Only	PWM Counter ON Time Register
40005824	PWM	2	PWM_EC_Only	PWM Counter OFF Time Register
40005828	PWM	2	PWM_EC_Only	PWM Configuration Register
4000582C	PWM	2	PWM_EC_Only	Reserved
40005830	PWM	3	PWM_EC_Only	PWM Counter ON Time Register
40005834	PWM	3	PWM_EC_Only	PWM Counter OFF Time Register
40005838	PWM	3	PWM_EC_Only	PWM Configuration Register
4000583C	PWM	3	PWM_EC_Only	Reserved
40006000	TACH	0	TACH_EC_ONLY	TACH Control Register
40006004	TACH	0	TACH_EC_ONLY	TACH Status Register
40006008	TACH	0	TACH_EC_ONLY	TACH High Limit Register
4000600C	TACH	0	TACH_EC_ONLY	TACH Low Limit Register
40006010	TACH	1	TACH_EC_ONLY	TACH Control Register
40006014	TACH	1	TACH_EC_ONLY	TACH Status Register
40006018	TACH	1	TACH_EC_ONLY	TACH High Limit Register
4000601C	TACH	1	TACH_EC_ONLY	TACH Low Limit Register
40007C00	ADC	0	ADC Registers	ADC Control Register
40007C04	ADC	0	ADC Registers	ADC Delay Register
40007C08	ADC	0	ADC Registers	ADC Status Register
40007C0C	ADC	0	ADC Registers	ADC Single Register
40007C10	ADC	0	ADC Registers	ADC Repeat Register
40007C14	ADC	0	ADC Registers	ADC Channel 0 Reading Registers
40007C18	ADC	0	ADC Registers	ADC Channel 1 Reading Registers

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40007C1C	ADC	0	ADC Registers	ADC Channel 2 Reading Registers
40007C20	ADC	0	ADC Registers	ADC Channel 3 Reading Registers
40007C24	ADC	0	ADC Registers	ADC Channel 4 Reading Registers
40007C54	ADC	0	ADC Registers	ADC Test Register
40007C58	ADC	0	ADC Registers	ADC Test Register
40007C78	ADC	0	ADC Registers	ADC Test Register
40007C7C	ADC	0	ADC Registers	ADC Configuration Register
40008C00	Trace FIFO Debug Port	0	TFDP	Data
40008C04	Trace FIFO Debug Port	0	TFDP	Control
40009400	EC GP-SPI	0	GP-SPI_EC_Only	SPI Enable Register
40009404	EC GP-SPI	0	GP-SPI_EC_Only	SPI Control Register
40009408	EC GP-SPI	0	GP-SPI_EC_Only	SPI Status Register
4000940C	EC GP-SPI	0	GP-SPI_EC_Only	SPI TX_Data Register
40009410	EC GP-SPI	0	GP-SPI_EC_Only	SPI RX_Data Register
40009414	EC GP-SPI	0	GP-SPI_EC_Only	SPI Clock Control Register
40009418	EC GP-SPI	0	GP-SPI_EC_Only	SPI Clock Generator Register
40009480	EC GP-SPI	1	GP-SPI_EC_Only	SPI Enable Register
40009484	EC GP-SPI	1	GP-SPI_EC_Only	SPI Control Register
40009488	EC GP-SPI	1	GP-SPI_EC_Only	SPI Status Register
4000948C	EC GP-SPI	1	GP-SPI_EC_Only	SPI TX_Data Register
40009490	EC GP-SPI	1	GP-SPI_EC_Only	SPI RX_Data Register
40009494	EC GP-SPI	1	GP-SPI_EC_Only	SPI Clock Control Register
40009498	EC GP-SPI	1	GP-SPI_EC_Only	SPI Clock Generator Register
40009800	Hibernation Timer	0	Registers	HTimer x Preload Register
40009804	Hibernation Timer	0	Registers	Hibernation Timer x Control Register
40009808	Hibernation Timer	0	Registers	Hibernation Timer x Count Register
40009C00	Keyboard Matrix Scan Support	0	Registers	Reserved
40009C04	Keyboard Matrix Scan Support	0	Registers	KSO Select Register
40009C08	Keyboard Matrix Scan Support	0	Registers	KSI Input Register
40009C0C	Keyboard Matrix Scan Support	0	Registers	KSI Status Register
40009C10	Keyboard Matrix Scan Support	0	Registers	KSI Interrupt Enable Register
40009C14	Keyboard Matrix Scan Support	0	Registers	Keyscan Extended Control Register
4000A000	RPM Fan Control	0	RPM_FAN	Fan Setting

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000A001	RPM Fan Control	0	RPM_FAN	PWM Divide
4000A002	RPM Fan Control	0	RPM_FAN	Fan Configuration 1
4000A003	RPM Fan Control	0	RPM_FAN	Fan Configuration 2
4000A004	RPM Fan Control	0	RPM_FAN	MCHP Reserved
4000A005	RPM Fan Control	0	RPM_FAN	Gain
4000A006	RPM Fan Control	0	RPM_FAN	Fan Spin Up Configuration
4000A007	RPM Fan Control	0	RPM_FAN	Fan Step
4000A008	RPM Fan Control	0	RPM_FAN	Fan Minimum Drive
4000A009	RPM Fan Control	0	RPM_FAN	Valid Tach Count
4000A00A	RPM Fan Control	0	RPM_FAN	Fan Drive Fail Band Low Byte
4000A00B	RPM Fan Control	0	RPM_FAN	Fan Drive Fail Band High Byte
4000A00C	RPM Fan Control	0	RPM_FAN	Tach Target Low Byte
4000A00D	RPM Fan Control	0	RPM_FAN	Tach Target High Byte
4000A00E	RPM Fan Control	0	RPM_FAN	Tach Reading Low Byte
4000A00F	RPM Fan Control	0	RPM_FAN	Tach Reading High Byte
4000A010	RPM Fan Control	0	RPM_FAN	PWM Driver Base Frequency
4000A011	RPM Fan Control	0	RPM_FAN	Fan Status
4000A012	RPM Fan Control	0	RPM_FAN	Reserved
4000A014	RPM Fan Control	0	RPM_FAN	RPM Fan Test
4000A015	RPM Fan Control	0	RPM_FAN	RPM Fan Test1
4000A016	RPM Fan Control	0	RPM_FAN	RPM Fan Test2
4000A017	RPM Fan Control	0	RPM_FAN	RPM Fan Test3
4000A400	VBAT Registers	0	VBAT_EC_REG_BANK	Power-Fail and Reset Status Register
4000A404	VBAT Registers	0	VBAT_EC_REG_BANK	Control
4000A800	VBAT Powered RAM	0	Registers	VBAT Backed Memory
4000AC00	SMB Device Interface	1	SMB_EC_Only	Control Register
4000AC00	SMB Device Interface	1	SMB_EC_Only	Status Register
4000AC01	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC04	SMB Device Interface	1	SMB_EC_Only	Own Address Register
4000AC06	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC08	SMB Device Interface	1	SMB_EC_Only	Data
4000AC09	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC0C	SMB Device Interface	1	SMB_EC_Only	SMBus Master Command Register
4000AC10	SMB Device Interface	1	SMB_EC_Only	SMBus Slave Command Register
4000AC14	SMB Device Interface	1	SMB_EC_Only	PEC Register
4000AC15	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC18	SMB Device Interface	1	SMB_EC_Only	DATA_TIMING2
4000AC19	SMB Device Interface	1	SMB_EC_Only	Reserved

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000AC20	SMB Device Interface	1	SMB_EC_Only	Completion Register
4000AC24	SMB Device Interface	1	SMB_EC_Only	Idle Scaling Register
4000AC28	SMB Device Interface	1	SMB_EC_Only	Configuration Register
4000AC2C	SMB Device Interface	1	SMB_EC_Only	Bus Clock Register
4000AC2E	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC30	SMB Device Interface	1	SMB_EC_Only	Block ID Register
4000AC31	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC34	SMB Device Interface	1	SMB_EC_Only	Revision Register
4000AC35	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC38	SMB Device Interface	1	SMB_EC_Only	Bit-Bang Control Register
4000AC39	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC3C	SMB Device Interface	1	SMB_EC_Only	Clock Sync
4000AC40	SMB Device Interface	1	SMB_EC_Only	Data Timing Register
4000AC44	SMB Device Interface	1	SMB_EC_Only	Time-Out Scaling Register
4000AC48	SMB Device Interface	1	SMB_EC_Only	SMBus Slave Transmit Buffer Register
4000AC49	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC4C	SMB Device Interface	1	SMB_EC_Only	SMBus Slave Receive Buf-fer Register
4000AC4D	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC50	SMB Device Interface	1	SMB_EC_Only	SMBus Master Transmit Bufer Register
4000AC51	SMB Device Interface	1	SMB_EC_Only	Reserved
4000AC54	SMB Device Interface	1	SMB_EC_Only	SMBus Master Receive Buffer Register
4000AC55	SMB Device Interface	1	SMB_EC_Only	Reserved
4000B000	SMB Device Interface	2	SMB_EC_Only	Control Register
4000B000	SMB Device Interface	2	SMB_EC_Only	Status Register
4000B001	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B004	SMB Device Interface	2	SMB_EC_Only	Own Address Register
4000B006	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B008	SMB Device Interface	2	SMB_EC_Only	Data
4000B009	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B00C	SMB Device Interface	2	SMB_EC_Only	SMBus Master Command Register
4000B010	SMB Device Interface	2	SMB_EC_Only	SMBus Slave Command Register
4000B014	SMB Device Interface	2	SMB_EC_Only	PEC Register
4000B015	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B018	SMB Device Interface	2	SMB_EC_Only	DATA_TIMING2
4000B019	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B020	SMB Device Interface	2	SMB_EC_Only	Completion Register
4000B024	SMB Device Interface	2	SMB_EC_Only	Idle Scaling Register
4000B028	SMB Device Interface	2	SMB_EC_Only	Configuration Register

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000B02C	SMB Device Interface	2	SMB_EC_Only	Bus Clock Register
4000B02E	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B030	SMB Device Interface	2	SMB_EC_Only	Block ID Register
4000B031	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B034	SMB Device Interface	2	SMB_EC_Only	Revision Register
4000B035	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B038	SMB Device Interface	2	SMB_EC_Only	Bit-Bang Control Register
4000B039	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B03C	SMB Device Interface	2	SMB_EC_Only	Clock Sync
4000B040	SMB Device Interface	2	SMB_EC_Only	Data Timing Register
4000B044	SMB Device Interface	2	SMB_EC_Only	Time-Out Scaling Register
4000B048	SMB Device Interface	2	SMB_EC_Only	SMBus Slave Transmit Buffer Register
4000B049	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B04C	SMB Device Interface	2	SMB_EC_Only	SMBus Slave Receive Buffer Register
4000B04D	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B050	SMB Device Interface	2	SMB_EC_Only	SMBus Master Transmit Bufer Register
4000B051	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B054	SMB Device Interface	2	SMB_EC_Only	SMBus Master Receive Buffer Register
4000B055	SMB Device Interface	2	SMB_EC_Only	Reserved
4000B400	SMB Device Interface	3	SMB_EC_Only	Control Register
4000B400	SMB Device Interface	3	SMB_EC_Only	Status Register
4000B401	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B404	SMB Device Interface	3	SMB_EC_Only	Own Address Register
4000B406	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B408	SMB Device Interface	3	SMB_EC_Only	Data
4000B409	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B40C	SMB Device Interface	3	SMB_EC_Only	SMBus Master Command Register
4000B410	SMB Device Interface	3	SMB_EC_Only	SMBus Slave Command Register
4000B414	SMB Device Interface	3	SMB_EC_Only	PEC Register
4000B415	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B418	SMB Device Interface	3	SMB_EC_Only	DATA_TIMING2
4000B419	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B420	SMB Device Interface	3	SMB_EC_Only	Completion Register
4000B424	SMB Device Interface	3	SMB_EC_Only	Idle Scaling Register
4000B428	SMB Device Interface	3	SMB_EC_Only	Configuration Register
4000B42C	SMB Device Interface	3	SMB_EC_Only	Bus Clock Register
4000B42E	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B430	SMB Device Interface	3	SMB_EC_Only	Block ID Register

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000B431	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B434	SMB Device Interface	3	SMB_EC_Only	Revision Register
4000B435	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B438	SMB Device Interface	3	SMB_EC_Only	Bit-Bang Control Register
4000B439	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B43C	SMB Device Interface	3	SMB_EC_Only	Clock Sync
4000B440	SMB Device Interface	3	SMB_EC_Only	Data Timing Register
4000B444	SMB Device Interface	3	SMB_EC_Only	Time-Out Scaling Register
4000B448	SMB Device Interface	3	SMB_EC_Only	SMBus Slave Transmit Buffer Register
4000B449	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B44C	SMB Device Interface	3	SMB_EC_Only	SMBus Slave Receive Buffer Register
4000B44D	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B450	SMB Device Interface	3	SMB_EC_Only	SMBus Master Transmit Bufer Register
4000B451	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B454	SMB Device Interface	3	SMB_EC_Only	SMBus Master Receive Buffer Register
4000B455	SMB Device Interface	3	SMB_EC_Only	Reserved
4000B800	LED	0	EC-Only Registers	LED Configuration
4000B804	LED	0	EC-Only Registers	LED Limits
4000B808	LED	0	EC-Only Registers	LED Delay
4000B80C	LED	0	EC-Only Registers	LED Update Stepsize
4000B810	LED	0	EC-Only Registers	LED Update Interval
4000B900	LED	1	EC-Only Registers	LED Configuration
4000B904	LED	1	EC-Only Registers	LED Limits
4000B908	LED	1	EC-Only Registers	LED Delay
4000B90C	LED	1	EC-Only Registers	LED Update Stepsize
4000B910	LED	1	EC-Only Registers	LED Update Interval
4000BA00	LED	2	EC-Only Registers	LED Configuration
4000BA04	LED	2	EC-Only Registers	LED Limits
4000BA08	LED	2	EC-Only Registers	LED Delay
4000BA0C	LED	2	EC-Only Registers	LED Update Stepsize
4000BA10	LED	2	EC-Only Registers	LED Update Interval
4000BB00	LED	3	EC-Only Registers	LED Configuration
4000BB04	LED	3	EC-Only Registers	LED Limits
4000BB08	LED	3	EC-Only Registers	LED Delay
4000BB0C	LED	3	EC-Only Registers	LED Update Stepsize
4000BB10	LED	3	EC-Only Registers	LED Update Interval
4000BC00	BC-Link Master	0	Registers	BC-Link Status Register
4000BC04	BC-Link Master	0	Registers	BC-Link Address Register
4000BC08	BC-Link Master	0	Registers	BC-Link Data Register

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000BC0C	BC-Link Master	0	Registers	BC-Link Clock Select Register
4000BD00	Public Key Crypto Engine	0	PKE Registers	PK_ConfigReg
4000BD04	Public Key Crypto Engine	0	PKE Registers	PK_CommandReg
4000BD08	Public Key Crypto Engine	0	PKE Registers	PK_ControlReg
4000BD0C	Public Key Crypto Engine	0	PKE Registers	PK_StatusReg
4000BD10	Public Key Crypto Engine	0	PKE Registers	PK_VersionReg
4000BD14	Public Key Crypto Engine	0	PKE Registers	PK_LoadMicroCodeReg
4000BE00	Non Deterministic Random Number Generator	0	NDRNG Registers	ControlReg
4000BE04	Non Deterministic Random Number Generator	0	NDRNG Registers	FIFOLevelReg
4000BE08	Non Deterministic Random Number Generator	0	NDRNG Registers	VersionReg
4000C000	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ8 Source Register
4000C004	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ8 Enable Set Register
4000C008	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ8 Result Register
4000C00C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ8 Enable Clear Register
4000C014	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ9 Source Register
4000C018	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ9 Enable Set Register
4000C01C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ9 Result Register
4000C020	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ9 Enable Clear Register
4000C028	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ10 Source Register
4000C02C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ10 Enable Set Register
4000C030	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ10 Result Register
4000C034	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ10 Enable Clear Register
4000C03C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ11 Source Register
4000C040	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ11 Enable Set Register
4000C044	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ11 Result Register
4000C048	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ11 Enable Clear Register
4000C050	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ12 Source Register

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000C054	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ12 Enable Set Register
4000C058	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ12 Result Register
4000C05C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ12 Enable Clear Register
4000C064	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ13 Source Register
4000C068	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ13 Enable Set Register
4000C06C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ13 Result Register
4000C070	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ13 Enable Clear Register
4000C078	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ14 Source Register
4000C07C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ14 Enable Set Register
4000C080	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ14 Result Register
4000C084	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ14 Enable Clear Register
4000C08C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ15 Source Register
4000C090	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ15 Enable Set Register
4000C094	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ15 Result Register
4000C098	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ15 Enable Clear Register
4000C0A0	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ16 Source Register
4000C0A4	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ16 Enable Set Register
4000C0A8	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ16 Result Register
4000C0AC	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ16 Enable Clear Register
4000C0B4	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ17 Source Register
4000C0B8	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ17 Enable Set Register
4000C0BC	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ17 Result Register
4000C0C0	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ17 Enable Clear Register
4000C0C8	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ18 Source Register
4000C0CC	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ18 Enable Set Register

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000C0D0	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ18 Result Register
4000C0D4	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ18 Enable Clear Register
4000C0DC	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ19 Source Register
4000C0E0	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ19 Enable Set Register
4000C0E4	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ19 Result Register
4000C0E8	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ19 Enable Clear Register
4000C0F0	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ20 Source Register
4000C0F4	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ20 Enable Set Register
4000C0F8	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ20 Result Register
4000C0FC	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ20 Enable Clear Register
4000C104	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ21 Source Register
4000C108	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ21 Enable Set Register
4000C10C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ21 Result Register
4000C110	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ21 Enable Clear Register
4000C118	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ22 Source Register
4000C11C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ22 Enable Set Register
4000C120	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ22 Result Register
4000C124	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ22 Enable Clear Register
4000C12C	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ23 Source Register
4000C130	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ23 Enable Set Register
4000C134	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ23 Result Register
4000C138	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	GIRQ23 Enable Clear Register
4000C200	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	Block Enable Set Register
4000C204	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	Block Enable Clear Register
4000C208	EC Interrupt Aggregator (INTS)	0	INTS_EC_ONLY	Block IRQ Vector Register

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000D000	AES Crypto Engine & Hash Function	0	HASH Registers	SHAMode register
4000D004	AES Crypto Engine & Hash Function	0	HASH Registers	NbBlock register
4000D008	AES Crypto Engine & Hash Function	0	HASH Registers	Control
4000D00C	AES Crypto Engine & Hash Function	0	HASH Registers	Status
4000D010	AES Crypto Engine & Hash Function	0	HASH Registers	Version
4000D014	AES Crypto Engine & Hash Function	0	HASH Registers	GenericValue register
4000D018	AES Crypto Engine & Hash Function	0	HASH Registers	Initial Hash Source Address
4000D01C	AES Crypto Engine & Hash Function	0	HASH Registers	Data Source Address
4000D020	AES Crypto Engine & Hash Function	0	HASH Registers	Hash Result Destination Address
4000D200	AES Crypto Engine & Hash Function	0	AES Registers	ConfigReg
4000D204	AES Crypto Engine & Hash Function	0	AES Registers	CommandReg
4000D208	AES Crypto Engine & Hash Function	0	AES Registers	ControlReg
4000D20C	AES Crypto Engine & Hash Function	0	AES Registers	StatusReg
4000D210	AES Crypto Engine & Hash Function	0	AES Registers	VersionReg
4000D214	AES Crypto Engine & Hash Function	0	AES Registers	NbHeaderReg
4000D218	AES Crypto Engine & Hash Function	0	AES Registers	LastHeaderReg
4000D21C	AES Crypto Engine & Hash Function	0	AES Registers	NbBlockReg
4000D220	AES Crypto Engine & Hash Function	0	AES Registers	LastBlockReg
4000D224	AES Crypto Engine & Hash Function	0	AES Registers	DMAInReg
4000D228	AES Crypto Engine & Hash Function	0	AES Registers	DMAOutReg
4000D300	AES Crypto Engine & Hash Function	0	AES Registers	Key1Reg
4000D320	AES Crypto Engine & Hash Function	0	AES Registers	IVReg
4000D340	AES Crypto Engine & Hash Function	0	AES Registers	Key2Reg
4000FC00	EC_REG_BANK	0	EC_REG_BANK	Reserved
4000FC04	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC08	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
4000FC0C	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC10	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC11	EC_REG_BANK	0	EC_REG_BANK	Reserved
4000FC14	EC_REG_BANK	0	EC_REG_BANK	AHB Error Control
4000FC15	EC_REG_BANK	0	EC_REG_BANK	Reserved
4000FC18	EC_REG_BANK	0	EC_REG_BANK	Interrupt Control
4000FC1C	EC_REG_BANK	0	EC_REG_BANK	ETM Trace Enable
4000FC20	EC_REG_BANK	0	EC_REG_BANK	JTAG Enable
4000FC24	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC28	EC_REG_BANK	0	EC_REG_BANK	WDT Event Count
4000FC2C	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC30	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC34	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC38	EC_REG_BANK	0	EC_REG_BANK	ADC VREF PD
4000FC3C	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
4000FC40	EC_REG_BANK	0	EC_REG_BANK	MCHP Reserved
40080000	JTAG	0	JTAG_EC_Only	JTAG Message OBF
40080004	JTAG	0	JTAG_EC_Only	JTAG Message IBF
40080008	JTAG	0	JTAG_EC_Only	JTAG OBF Status
40080009	JTAG	0	JTAG_EC_Only	JTAG IBF Status
4008000C	JTAG	0	JTAG_EC_Only	JTAG DBG Ctrl
40080100	PCR	0	PCR	Chip Sleep Enable Register
40080104	PCR	0	PCR	Chip Clock Required Register
40080108	PCR	0	PCR	EC Sleep Enables Register
4008010C	PCR	0	PCR	EC Clock Required Status Register
40080110	PCR	0	PCR	Host Sleep Enables Register
40080114	PCR	0	PCR	Host Clock Required Status Register
40080118	PCR	0	PCR	CHIP_PCR_ADDR_SYS_SLEEP_CTRL_0
40080120	PCR	0	PCR	Processor Clock Control
40080124	PCR	0	PCR	EC Sleep Enable 2 Register
40080128	PCR	0	PCR	EC Clock Required 2 Status Register
4008012C	PCR	0	PCR	Slow Clock Control
40080130	PCR	0	PCR	Oscillator ID Register
40080134	PCR	0	PCR	Reserved
40080138	PCR	0	PCR	Chip Reset Enable
4008013C	PCR	0	PCR	Host Reset Enable
40080140	PCR	0	PCR	EC Reset Enable

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40080144	PCR	0	PCR	EC Reset Enable 2
40080148	PCR	0	PCR	PCR Clock Reset Control
40081000	GPIO	0	GPIO Registers	GPIO000 Pin Control
40081004	GPIO	0	GPIO Registers	GPIO001 Pin Control
40081008	GPIO	0	GPIO Registers	GPIO002 Pin Control
4008100C	GPIO	0	GPIO Registers	GPIO003 Pin Control
40081010	GPIO	0	GPIO Registers	GPIO004 Pin Control
40081014	GPIO	0	GPIO Registers	GPIO005 Pin Control
40081018	GPIO	0	GPIO Registers	GPIO006 Pin Control
4008101C	GPIO	0	GPIO Registers	GPIO007 Pin Control
40081020	GPIO	0	GPIO Registers	GPIO010 Pin Control
40081024	GPIO	0	GPIO Registers	GPIO011 Pin Control
40081028	GPIO	0	GPIO Registers	GPIO012 Pin Control
4008102C	GPIO	0	GPIO Registers	GPIO013 Pin Control
40081030	GPIO	0	GPIO Registers	GPIO014 Pin Control
40081034	GPIO	0	GPIO Registers	GPIO015 Pin Control
40081038	GPIO	0	GPIO Registers	GPIO016 Pin Control
4008103C	GPIO	0	GPIO Registers	GPIO017 Pin Control
40081040	GPIO	0	GPIO Registers	GPIO020 Pin Control
40081044	GPIO	0	GPIO Registers	GPIO021 Pin Control
40081048	GPIO	0	GPIO Registers	GPIO022 Pin Control
4008104C	GPIO	0	GPIO Registers	GPIO023 Pin Control
40081050	GPIO	0	GPIO Registers	GPIO024 Pin Control
40081054	GPIO	0	GPIO Registers	GPIO025 Pin Control
40081058	GPIO	0	GPIO Registers	GPIO026 Pin Control
4008105C	GPIO	0	GPIO Registers	GPIO027 Pin Control
40081060	GPIO	0	GPIO Registers	GPIO030 Pin Control
40081064	GPIO	0	GPIO Registers	GPIO031 Pin Control
40081068	GPIO	0	GPIO Registers	GPIO032 Pin Control
4008106C	GPIO	0	GPIO Registers	GPIO033 Pin Control
40081070	GPIO	0	GPIO Registers	GPIO034 Pin Control
40081074	GPIO	0	GPIO Registers	GPIO035 Pin Control
40081078	GPIO	0	GPIO Registers	GPIO036 Pin Control
40081080	GPIO	0	GPIO Registers	GPIO040 Pin Control
40081084	GPIO	0	GPIO Registers	GPIO041 Pin Control
40081088	GPIO	0	GPIO Registers	GPIO042 Pin Control
4008108C	GPIO	0	GPIO Registers	GPIO043 Pin Control
40081090	GPIO	0	GPIO Registers	GPIO044 Pin Control
40081094	GPIO	0	GPIO Registers	GPIO045 Pin Control
40081098	GPIO	0	GPIO Registers	GPIO046 Pin Control
4008109C	GPIO	0	GPIO Registers	GPIO047 Pin Control
400810A0	GPIO	0	GPIO Registers	GPIO050 Pin Control
400810A4	GPIO	0	GPIO Registers	GPIO051 Pin Control

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
400810A8	GPIO	0	GPIO Registers	GPIO052 Pin Control
400810AC	GPIO	0	GPIO Registers	GPIO053 Pin Control
400810B0	GPIO	0	GPIO Registers	GPIO054 Pin Control
400810B4	GPIO	0	GPIO Registers	GPIO055 Pin Control
400810B8	GPIO	0	GPIO Registers	GPIO056 Pin Control
400810BC	GPIO	0	GPIO Registers	GPIO057 Pin Control
400810C0	GPIO	0	GPIO Registers	GPIO060 Pin Control
400810C4	GPIO	0	GPIO Registers	GPIO061 Pin Control
400810C8	GPIO	0	GPIO Registers	GPIO062 Pin Control
400810CC	GPIO	0	GPIO Registers	GPIO063 Pin Control
400810D0	GPIO	0	GPIO Registers	GPIO064 Pin Control
400810D4	GPIO	0	GPIO Registers	GPIO065 Pin Control
400810D8	GPIO	0	GPIO Registers	GPIO066 Pin Control
400810DC	GPIO	0	GPIO Registers	GPIO067 Pin Control
40081100	GPIO	0	GPIO Registers	GPIO100 Pin Control
40081104	GPIO	0	GPIO Registers	GPIO101 Pin Control
40081108	GPIO	0	GPIO Registers	GPIO102 Pin Control
4008110C	GPIO	0	GPIO Registers	GPIO103 Pin Control
40081110	GPIO	0	GPIO Registers	GPIO104 Pin Control
40081114	GPIO	0	GPIO Registers	GPIO105 Pin Control
40081118	GPIO	0	GPIO Registers	GPIO106 Pin Control
4008111C	GPIO	0	GPIO Registers	GPIO107 Pin Control
40081120	GPIO	0	GPIO Registers	GPIO110 Pin Control
40081124	GPIO	0	GPIO Registers	GPIO111 Pin Control
40081128	GPIO	0	GPIO Registers	GPIO112 Pin Control
4008112C	GPIO	0	GPIO Registers	GPIO113 Pin Control
40081130	GPIO	0	GPIO Registers	GPIO114 Pin Control
40081134	GPIO	0	GPIO Registers	GPIO115 Pin Control
40081138	GPIO	0	GPIO Registers	GPIO116 Pin Control
4008113C	GPIO	0	GPIO Registers	GPIO117 Pin Control
40081140	GPIO	0	GPIO Registers	GPIO120 Pin Control
40081144	GPIO	0	GPIO Registers	GPIO121 Pin Control
40081148	GPIO	0	GPIO Registers	GPIO122 Pin Control
4008114C	GPIO	0	GPIO Registers	GPIO123 Pin Control
40081150	GPIO	0	GPIO Registers	GPIO124 Pin Control
40081154	GPIO	0	GPIO Registers	GPIO125 Pin Control
40081158	GPIO	0	GPIO Registers	GPIO126 Pin Control
4008115C	GPIO	0	GPIO Registers	GPIO127 Pin Control
40081160	GPIO	0	GPIO Registers	GPIO130 Pin Control
40081164	GPIO	0	GPIO Registers	GPIO131 Pin Control
40081168	GPIO	0	GPIO Registers	GPIO132 Pin Control
4008116C	GPIO	0	GPIO Registers	GPIO133 Pin Control
40081170	GPIO	0	GPIO Registers	GPIO134 Pin Control

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40081174	GPIO	0	GPIO Registers	GPIO135 Pin Control
40081178	GPIO	0	GPIO Registers	GPIO136 Pin Control
40081180	GPIO	0	GPIO Registers	GPIO140 Pin Control
40081184	GPIO	0	GPIO Registers	GPIO141 Pin Control
40081188	GPIO	0	GPIO Registers	GPIO142 Pin Control
4008118C	GPIO	0	GPIO Registers	GPIO143 Pin Control
40081190	GPIO	0	GPIO Registers	GPIO144 Pin Control
40081194	GPIO	0	GPIO Registers	GPIO145 Pin Control
40081198	GPIO	0	GPIO Registers	GPIO146 Pin Control
4008119C	GPIO	0	GPIO Registers	GPIO147 Pin Control
400811A0	GPIO	0	GPIO Registers	GPIO150 Pin Control
400811A4	GPIO	0	GPIO Registers	GPIO151 Pin Control
400811A8	GPIO	0	GPIO Registers	GPIO152 Pin Control
400811AC	GPIO	0	GPIO Registers	GPIO153 Pin Control
400811B0	GPIO	0	GPIO Registers	GPIO154 Pin Control
400811B4	GPIO	0	GPIO Registers	GPIO155 Pin Control
400811B8	GPIO	0	GPIO Registers	GPIO156 Pin Control
400811BC	GPIO	0	GPIO Registers	GPIO157 Pin Control
400811C0	GPIO	0	GPIO Registers	GPIO160 Pin Control
400811C4	GPIO	0	GPIO Registers	GPIO161 Pin Control
400811C8	GPIO	0	GPIO Registers	GPIO162 Pin Control
400811CC	GPIO	0	GPIO Registers	GPIO163 Pin Control
400811D0	GPIO	0	GPIO Registers	GPIO164 Pin Control
400811D4	GPIO	0	GPIO Registers	GPIO165 Pin Control
40081200	GPIO	0	GPIO Registers	GPIO200 Pin Control
40081204	GPIO	0	GPIO Registers	GPIO201 Pin Control
40081208	GPIO	0	GPIO Registers	GPIO202 Pin Control
4008120C	GPIO	0	GPIO Registers	GPIO203 Pin Control
40081210	GPIO	0	GPIO Registers	GPIO204 Pin Control
40081214	GPIO	0	GPIO Registers	Reserved
40081218	GPIO	0	GPIO Registers	GPIO206 Pin Control
4008121C	GPIO	0	GPIO Registers	Reserved
40081220	GPIO	0	GPIO Registers	GPIO210 Pin Control
40081224	GPIO	0	GPIO Registers	GPIO211 Pin Control
40081280	GPIO	0	GPIO Registers	Output GPIO[000:036]
40081284	GPIO	0	GPIO Registers	Output GPIO[040:076]
40081288	GPIO	0	GPIO Registers	Output GPIO[100:136]
4008128C	GPIO	0	GPIO Registers	Output GPIO[140:176]
40081290	GPIO	0	GPIO Registers	Output GPIO[200:236]
40081300	GPIO	0	GPIO Registers	Input GPIO[000:036]
40081304	GPIO	0	GPIO Registers	Input GPIO[040:076]
40081308	GPIO	0	GPIO Registers	Input GPIO[100:136]
4008130C	GPIO	0	GPIO Registers	Input GPIO[140:176]

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40081310	GPIO	0	GPIO Registers	Input GPIO[200:236]
40081314	GPIO	0	GPIO Registers	Reserved
40081500	GPIO	0	GPIO Registers	GPIO000 Pin Control 2
40081504	GPIO	0	GPIO Registers	GPIO001 Pin Control 2
40081508	GPIO	0	GPIO Registers	GPIO002 Pin Control 2
4008150C	GPIO	0	GPIO Registers	GPIO003 Pin Control 2
40081510	GPIO	0	GPIO Registers	GPIO004 Pin Control 2
40081514	GPIO	0	GPIO Registers	GPIO005 Pin Control 2
40081518	GPIO	0	GPIO Registers	GPIO006 Pin Control 2
4008151C	GPIO	0	GPIO Registers	GPIO007 Pin Control 2
40081520	GPIO	0	GPIO Registers	GPIO010 Pin Control 2
40081524	GPIO	0	GPIO Registers	GPIO011 Pin Control 2
40081528	GPIO	0	GPIO Registers	GPIO012 Pin Control 2
4008152C	GPIO	0	GPIO Registers	GPIO013 Pin Control 2
40081530	GPIO	0	GPIO Registers	GPIO014 Pin Control 2
40081534	GPIO	0	GPIO Registers	GPIO015 Pin Control 2
40081538	GPIO	0	GPIO Registers	GPIO016 Pin Control 2
4008153C	GPIO	0	GPIO Registers	GPIO017 Pin Control 2
40081540	GPIO	0	GPIO Registers	GPIO020 Pin Control 2
40081544	GPIO	0	GPIO Registers	GPIO021 Pin Control 2
40081548	GPIO	0	GPIO Registers	GPIO022 Pin Control 2
4008154C	GPIO	0	GPIO Registers	GPIO023 Pin Control 2
40081550	GPIO	0	GPIO Registers	GPIO024 Pin Control 2
40081554	GPIO	0	GPIO Registers	GPIO025 Pin Control 2
40081558	GPIO	0	GPIO Registers	GPIO026 Pin Control 2
4008155C	GPIO	0	GPIO Registers	GPIO027 Pin Control 2
40081560	GPIO	0	GPIO Registers	GPIO030 Pin Control 2
40081564	GPIO	0	GPIO Registers	GPIO031 Pin Control 2
40081568	GPIO	0	GPIO Registers	GPIO032 Pin Control 2
4008156C	GPIO	0	GPIO Registers	GPIO033 Pin Control 2
40081570	GPIO	0	GPIO Registers	GPIO034 Pin Control 2
40081574	GPIO	0	GPIO Registers	GPIO035 Pin Control 2
40081578	GPIO	0	GPIO Registers	GPIO036 Pin Control 2
40081580	GPIO	0	GPIO Registers	GPIO040 Pin Control 2
40081584	GPIO	0	GPIO Registers	GPIO041 Pin Control 2
40081588	GPIO	0	GPIO Registers	GPIO042 Pin Control 2
4008158C	GPIO	0	GPIO Registers	GPIO043 Pin Control 2
40081590	GPIO	0	GPIO Registers	GPIO044 Pin Control 2
40081594	GPIO	0	GPIO Registers	GPIO045 Pin Control 2
40081598	GPIO	0	GPIO Registers	GPIO046 Pin Control 2
4008159C	GPIO	0	GPIO Registers	GPIO047 Pin Control 2
400815A0	GPIO	0	GPIO Registers	GPIO050 Pin Control 2
400815A4	GPIO	0	GPIO Registers	GPIO051 Pin Control 2

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
400815A8	GPIO	0	GPIO Registers	GPIO052 Pin Control 2
400815AC	GPIO	0	GPIO Registers	GPIO053 Pin Control 2
400815B0	GPIO	0	GPIO Registers	GPIO054 Pin Control 2
400815B4	GPIO	0	GPIO Registers	GPIO055 Pin Control 2
400815B8	GPIO	0	GPIO Registers	GPIO056 Pin Control 2
400815BC	GPIO	0	GPIO Registers	GPIO057 Pin Control 2
400815C0	GPIO	0	GPIO Registers	GPIO060 Pin Control 2
400815C4	GPIO	0	GPIO Registers	GPIO061 Pin Control 2
400815C8	GPIO	0	GPIO Registers	GPIO062 Pin Control 2
400815CC	GPIO	0	GPIO Registers	GPIO063 Pin Control 2
400815D0	GPIO	0	GPIO Registers	GPIO064 Pin Control 2
400815D4	GPIO	0	GPIO Registers	GPIO065 Pin Control 2
400815D8	GPIO	0	GPIO Registers	GPIO066 Pin Control 2
400815DC	GPIO	0	GPIO Registers	GPIO067 Pin Control 2
400815E0	GPIO	0	GPIO Registers	GPIO100 Pin Control 2
400815E4	GPIO	0	GPIO Registers	GPIO101 Pin Control 2
400815E8	GPIO	0	GPIO Registers	GPIO102 Pin Control 2
400815EC	GPIO	0	GPIO Registers	GPIO103 Pin Control 2
400815F0	GPIO	0	GPIO Registers	GPIO104 Pin Control 2
400815F4	GPIO	0	GPIO Registers	GPIO105 Pin Control 2
400815F8	GPIO	0	GPIO Registers	GPIO106 Pin Control 2
400815FC	GPIO	0	GPIO Registers	GPIO107 Pin Control 2
40081600	GPIO	0	GPIO Registers	GPIO110 Pin Control 2
40081604	GPIO	0	GPIO Registers	GPIO111 Pin Control 2
40081608	GPIO	0	GPIO Registers	GPIO112 Pin Control 2
4008160C	GPIO	0	GPIO Registers	GPIO113 Pin Control 2
40081610	GPIO	0	GPIO Registers	GPIO114 Pin Control 2
40081614	GPIO	0	GPIO Registers	GPIO115 Pin Control 2
40081618	GPIO	0	GPIO Registers	GPIO116 Pin Control 2
4008161C	GPIO	0	GPIO Registers	GPIO117 Pin Control 2
40081620	GPIO	0	GPIO Registers	GPIO120 Pin Control 2
40081624	GPIO	0	GPIO Registers	GPIO121 Pin Control 2
40081628	GPIO	0	GPIO Registers	GPIO122 Pin Control 2
4008162C	GPIO	0	GPIO Registers	GPIO123 Pin Control 2
40081630	GPIO	0	GPIO Registers	GPIO124 Pin Control 2
40081634	GPIO	0	GPIO Registers	GPIO125 Pin Control 2
40081638	GPIO	0	GPIO Registers	GPIO126 Pin Control 2
4008163C	GPIO	0	GPIO Registers	GPIO127 Pin Control 2
40081640	GPIO	0	GPIO Registers	GPIO130 Pin Control 2
40081644	GPIO	0	GPIO Registers	GPIO131 Pin Control 2
40081648	GPIO	0	GPIO Registers	GPIO132 Pin Control 2
4008164C	GPIO	0	GPIO Registers	GPIO133 Pin Control 2
40081650	GPIO	0	GPIO Registers	GPIO134 Pin Control 2

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
40081654	GPIO	0	GPIO Registers	GPIO135 Pin Control 2
40081658	GPIO	0	GPIO Registers	GPIO136 Pin Control 2
40081660	GPIO	0	GPIO Registers	GPIO140 Pin Control 2
40081664	GPIO	0	GPIO Registers	GPIO141 Pin Control 2
40081668	GPIO	0	GPIO Registers	GPIO142 Pin Control 2
4008166C	GPIO	0	GPIO Registers	GPIO143 Pin Control 2
40081670	GPIO	0	GPIO Registers	GPIO144 Pin Control 2
40081674	GPIO	0	GPIO Registers	GPIO145 Pin Control 2
40081678	GPIO	0	GPIO Registers	GPIO146 Pin Control 2
4008167C	GPIO	0	GPIO Registers	GPIO147 Pin Control 2
40081680	GPIO	0	GPIO Registers	GPIO150 Pin Control 2
40081684	GPIO	0	GPIO Registers	GPIO151 Pin Control 2
40081688	GPIO	0	GPIO Registers	GPIO152 Pin Control 2
4008168C	GPIO	0	GPIO Registers	GPIO153 Pin Control 2
40081690	GPIO	0	GPIO Registers	GPIO154 Pin Control 2
40081694	GPIO	0	GPIO Registers	GPIO155 Pin Control 2
40081698	GPIO	0	GPIO Registers	GPIO156 Pin Control 2
4008169C	GPIO	0	GPIO Registers	GPIO157 Pin Control 2
400816A0	GPIO	0	GPIO Registers	GPIO160 Pin Control 2
400816A4	GPIO	0	GPIO Registers	GPIO161 Pin Control 2
400816A8	GPIO	0	GPIO Registers	GPIO162 Pin Control 2
400816AC	GPIO	0	GPIO Registers	GPIO163 Pin Control 2
400816B0	GPIO	0	GPIO Registers	GPIO164 Pin Control 2
400816B4	GPIO	0	GPIO Registers	GPIO165 Pin Control 2
40081720	GPIO	0	GPIO Registers	GPIO200 Pin Control 2
40081724	GPIO	0	GPIO Registers	GPIO201 Pin Control 2
40081728	GPIO	0	GPIO Registers	GPIO202 Pin Control 2
4008172C	GPIO	0	GPIO Registers	GPIO203 Pin Control 2
40081730	GPIO	0	GPIO Registers	GPIO204 Pin Control 2
40081738	GPIO	0	GPIO Registers	GPIO206 Pin Control 2
40081740	GPIO	0	GPIO Registers	GPIO210 Pin Control 2
40081744	GPIO	0	GPIO Registers	GPIO211 Pin Control 2
400F1C00	M16C550A UART	0	UART_EC_Only	UART Programmable BAUD Rate Generator (LSB) Register
400F1C00	M16C550A UART	0	UART_EC_Only	UART Receive Buffer Register
400F1C00	M16C550A UART	0	UART_EC_Only	UART Transmit Buffer Register
400F1C01	M16C550A UART	0	UART_EC_Only	UART Programmable BAUD Rate Generator (MSB) Register
400F1C01	M16C550A UART	0	UART_EC_Only	UART Interrupt Enable Register

Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
400F1C02	M16C550A UART	0	UART_EC_Only	UART FIFO Control Register
400F1C02	M16C550A UART	0	UART_EC_Only	UART Interrupt Identification Register
400F1C03	M16C550A UART	0	UART_EC_Only	UART Line Control Register
400F1C04	M16C550A UART	0	UART_EC_Only	UART Modem Control Register
400F1C05	M16C550A UART	0	UART_EC_Only	UART Line Status Register
400F1C06	M16C550A UART	0	UART_EC_Only	UART Modem Status Register
400F1C07	M16C550A UART	0	UART_EC_Only	UART Scratchpad Register
400F1C00	M16C550A UART	0	UART_Runtime	UART Transmit Buffer Register
400F1C00	M16C550A UART	0	UART_Runtime	UART Programmable BAUD Rate Generator (LSB) Register
400F1C00	M16C550A UART	0	UART_Runtime	UART Receive Buffer Register
400F1C01	M16C550A UART	0	UART_Runtime	UART Interrupt Enable Register
400F1C01	M16C550A UART	0	UART_Runtime	UART Programmable BAUD Rate Generator (MSB) Register
400F1C02	M16C550A UART	0	UART_Runtime	UART FIFO Control Register
400F1C02	M16C550A UART	0	UART_Runtime	UART Interrupt Identification Register
400F1C03	M16C550A UART	0	UART_Runtime	UART Line Control Register
400F1C04	M16C550A UART	0	UART_Runtime	UART Modem Control Register
400F1C05	M16C550A UART	0	UART_Runtime	UART Line Status Register
400F1C06	M16C550A UART	0	UART_Runtime	UART Modem Status Register
400F1C07	M16C550A UART	0	UART_Runtime	UART Scratchpad Register
400F1F30	M16C550A UART	0	UART_Config	UART Activate Register
400F1FF0	M16C550A UART	0	UART_Config	UART Config Select Register
400F2C00	RTC	0	RTC	Seconds
400F2C01	RTC	0	RTC	Seconds Alarm
400F2C02	RTC	0	RTC	Minutes
400F2C03	RTC	0	RTC	Minutes Alarm
400F2C04	RTC	0	RTC	Hours
400F2C05	RTC	0	RTC	Hours Alarm
400F2C06	RTC	0	RTC	Day of Week
400F2C07	RTC	0	RTC	Day of Month
400F2C08	RTC	0	RTC	Month

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Address (Hex)	HW Block Instance Name	HW Block Instance No.	Reg. Bank Name	Reg. Instance Name
400F2C09	RTC	0	RTC	Year
400F2C0A	RTC	0	RTC	Register A
400F2C0B	RTC	0	RTC	Register B
400F2C0C	RTC	0	RTC	Register C
400F2C0D	RTC	0	RTC	Register D
400F2C10	RTC	0	RTC	RTC Control
400F2C14	RTC	0	RTC	Week Alarm
400F2C18	RTC	0	RTC	Daylight Savings Forward
400F2C1C	RTC	0	RTC	Daylight Savings Backward
400F2C20	RTC	0	RTC	RTC Test Mode

APPENDIX A: REVISION HISTORY

TABLE A-1: DATA SHEET REVISION HISTORY

Revision	Section/Figure/Entry	Correction
DS00002022B (03-10-16)	Cover Page	Changed title from “Keyboard and Embedded Controller for Notebook PC” to “Low Power Crypto Embedded Controller”
DS00002022A (10-30-15)	First Release	

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PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.[1]	X	-	XX	-	XXX[2]	-	[X][3]
Device	Total SRAM		Version/ Revision		Package		Tape and Reel Option

Device:	CEC1302[1]		
Total SRAM:	D	=	128kB
Version/Revision:	C0	=	Standard Version
Package:	SZ	=	144 pin WFBGA[2]
Tape and Reel Option:	Blank	=	Tray packaging
	TR	=	Tape and Reel[3]

Examples:

a) CEC1302D-C0-SZ = 128kB SRAM, Standard Version, 144-pin WFBGA, Tray packaging

Note 1: These products meet the halogen maximum concentration values per IEC61249-2-21.

Note 2: All package options are RoHS compliant. For RoHS compliance and environmental information, please visit http://www.microchip.com/pagehandler/en-us/aboutus/ehs.html .

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