MAX16150

nanoPower Pushbutton On/Off Controller and Battery Freshness Seal

General Description

The MAX16150A/MAX16150B are extremely low-power, pushbutton, on/off controllers with a switch debouncer and built-in latch. These devices accept a noisy input from a mechanical switch and produce a clean, latched output, as well as a one-shot interrupt output, in response to a switch closure exceeding the debounce period at PB_IN. The MAX16150A de-asserts the latched output when the switch closure period exceeds the shutdown period, while the MAX16150B does not de-assert the latched output in response to switch closure. For the MAX16150B, a longer switch closure results in a longer interrupt signal.

The MAX16150A/MAX16150B operate from a supply range of +1.3V to +5.5V and consume less than 20nA of supply current to ensure minimal battery drain in low-power applications, as well as to allow use as a battery "freshness seal". The robust switch input (PB_IN) accepts up to ±60V levels and is ±15kV ESD-protected for use in harsh environments. The latched output can serve as a logic signal to control a regulator, or it can serve as a switch to connect the load directly to the power supply when load current is low, providing 20mA of output current with less than 100mV voltage drop. A separate INT output provides a system interrupt whenever a valid pushbutton signal is detected. An asynchronous CLR input allows an external signal to force the latched output to the off state.

The MAX16150A and MAX16150B operate over the -40°C to +125°C temperature range are available in a 1mm x 1.5mm, 6-bump wafer-level package (WLP) and a 6-pin thin SOT-23 package.

Applications

- Portable Instruments
- Handheld Consumer Electronics
- Industrial Equipment
- Disposable Low-Power Electronics

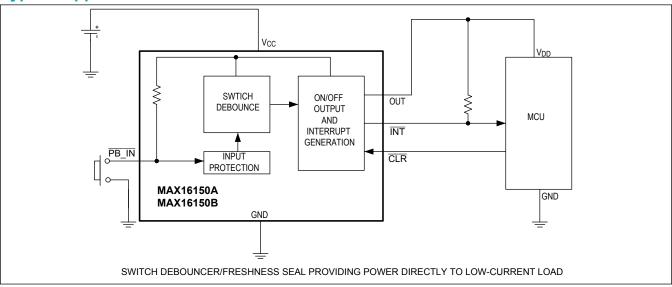
Benefits and Features

- Low Power
 - · 20nA (Max) Standby Current
- · Debounces Noisy Switches
 - 50ms and 2s Debounce Timing Options
 - · 8s and 16s Shutdown Timing Periods
- Latched Output Supplies 20mA Load Current With Less Than 100mV Drop
- One-Shot INT Output on Each Switch Closure
- 32ms INT Duration
- Pushbutton Input Handles Up to ±60V
- ±15kV HBM ESD Protection
- SOT23-6 and 1mm x 1.5mm, 6-bump WLPs

Ordering Information appears at end of data sheet.



Typical Application Circuit



MAX16150

nanoPower Pushbutton On/Off Controller and Battery Freshness Seal

Absolute Maximum Ratings

| V _{CC} to GND0.3V to +6V | Operating Temperature Range | 40°C to +125°C |
|---|--------------------------------|----------------|
| PB_IN to GND60V to +60V | Junction Temperature | +150°C |
| CLR, INT, OUT to GND | Storage Temperature Range | 40°C to +150°C |
| Continuous Power Dissipation (Multilayer Board) SOT23-6 (T _A = | Soldering Temperature (reflow) | +260°C |
| +70°C, derate 8.70mW/°C above +70°C.)696mW | | |
| Continuous Power Dissipation (Multilayer Board) WLP (TA = | | |
| +70°C, derate 10.50mW/°C above +70°C.)840mW | | |

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Package Information

SOT23-6

| Package Code | U6+1 |
|--|----------------|
| Outline Number | 21-0058 |
| Land Pattern Number | <u>90-0175</u> |
| Thermal Resistance, Single Layer Board: | |
| Junction-to-Ambient (θ _{JA}) | N/A |
| Junction-to-Case Thermal Resistance (θ _{JC}) | 80°C/W |
| Thermal Resistance, Four Layer Board: | · |
| Junction-to-Ambient (θ _{JA}) | 115°C/W |
| Junction-to-Case Thermal Resistance (θ _{JC}) | 80°C/W |

WLP-6

| Package Code | W60C1+2 | |
|--|--------------------------------|--|
| Outline Number | <u>21-100258</u> | |
| Land Pattern Number | Refer to Application Note 1891 | |
| Thermal Resistance, Four-Layer Board: | | |
| Junction-to-Ambient (θ _{JA}) | 95.15°C/W | |
| Junction-to-Case Thermal Resistance (θ _{JC}) | N/A | |

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

Electrical Characteristics

 $(V_{CC} = V_{MIN} \text{ to } V_{MAX}, T_A = -40^{\circ}\text{C} \text{ to } +125^{\circ}\text{C}, \text{ Limits over the operating temperature range and relevant supply voltage range are guaranteed by production and/or characterization. Typical values are at <math>T_A = +25^{\circ}\text{C}$ and $V_{CC} = +3.3\text{V}$)

| PARAMETER | SYMBOL | CON | DITIONS | MIN | TYP | MAX | UNITS |
|---|----------------------|---|--|---------------------------|------|------|---------------------------------------|
| Operating Voltage Range | V _{CC} | | | 1.3 | | 5.5 | V |
| | la- | V_{CC} = 5V, OUT not asserted, $\overline{PB_IN}$ not connected40°C \leq T _A \leq +70°C | | | | 20 | |
| Power Supply Current | I _{SB} | V _{CC} = 5V, OUT no connected40°C ≤ | ot asserted, PB_IN not ≤ T _A ≤ +85°C | | 10 | 40 | nA |
| | Icc | During PB_IN dete | During PB_IN detection or INT assertion | | 15 | 30 | μA |
| | I _{SB_UVLO} | V _{CC} < 1.3V, I _{OUT} = connected, CLR ne | | | 2 | 5 | uA |
| Timing Accuracy | | Deviation from nom debounce time (t _{DE} and interrupt time (| 3), shutoff time (t _{SO}), | -20 | ±5 | +20 | % |
| Input High Voltage | V | CLR and PB_IN | 2.7V to 5.5V | 70 | | | 9/1/ |
| Input High Voltage | V _{IH} | CLR and PB_IN | 1.3V to 2.7V | 80 | | | %V _{CC} |
| Input Low Voltage | V _{IL} | CLR and PB_IN | | | | 30 | %V _{CC} |
| Minimum Input High Time Detected | | PB_IN | | | 600 | | μs |
| PB_IN Hysteresis | | | | | 100 | | mV |
| PB_IN PullUp Resistance | | 0 > V _{PB_IN} < V _{CC} | | 1200 | 1400 | 2000 | kΩ |
| PB_IN Input Current | I _{IN} | V _{PB_IN} = ±60V | | -170 | | +170 | μA |
| PB_IN Voltage Range | | Continuous; 0V ≤ V | ′ _{CC} ≤ 5.0V | -60 | | +60 | V |
| | | Transient; 0V ≤ V _C | _C ≤ 5.5V | -60 | | +60 | _ v |
| CLR Input Current | I _{CLR} | | | -10 | ±1 | +10 | nA |
| CLR Falling Edge to OUT Low Propagation Delay | t _{CO} | $R_L = 10k\Omega$, $C_L = 10$ | 00pF | | 200 | | ns |
| CLR Lockout Time | | Period following ris during which transi ignored. | | 51.2 | 64 | 76.8 | ms |
| | Voi | V _{CC} = 3.3V, I _{SINK} = 1.6mA | | | | 0.4 | |
| | V _{OL} | V _{CC} = 1.3V, I _{SINK} | = 200µA | | | 0.2 |] |
| OUT Output Voltage | V _{OH} | V _{CC} = 3.3V, I _{SOUF} | RCE = 20mA | V _{CC} - 0.1 | | | V |
| | | V _{CC} = 2.0V, I _{OUT} | = 2mA | V _{CC} - 0.02 | | | |
| | | V _{CC} = 1.3V, I _{SOUR} | CE = 500uA | V _{CC} - 0.02 | | | |
| INT Output Voltage | Va | V _{CC} = 3.3V, I _{SINK} | = 1mA | | | 0.2 | V |
| iivi Output voitage | V _{OL_INT} | V _{CC} = 1.3V, I _{SINK} = 200μA | | | | 0.2 | \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ |
| INT Leakage Current | | | | -10 | ±1 | +10 | nA |

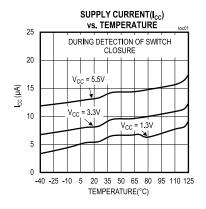
Electrical Characteristics (continued)

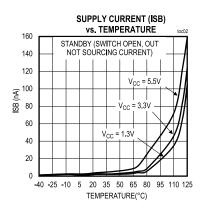
 $(V_{CC} = V_{MIN} \text{ to } V_{MAX}, T_A = -40^{\circ}\text{C} \text{ to } +125^{\circ}\text{C}, \text{ Limits over the operating temperature range and relevant supply voltage range are guaranteed by production and/or characterization. Typical values are at <math>T_A = +25^{\circ}\text{C}$ and $V_{CC} = +3.3\text{V}$)

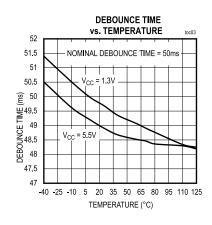
| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|--------------------------|------------------|-------------------------------------|---------------------|-------|-----|-------|-------|
| Interment Dulge Duration | | Beginning at t _{DB} . | | 25.6 | 32 | 38.4 | mo |
| Interrupt Pulse Duration | ^t INT | Beginning at end of t _{SO} | | 102.4 | 128 | 153.6 | ms |
| ESD Protection | | PB_IN | Human Body Model | ±15 | | kV | |

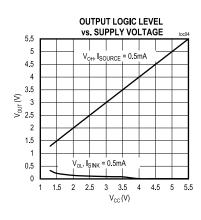
Typical Operating Characteristics

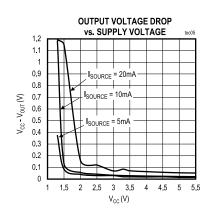
(V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)

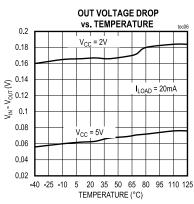


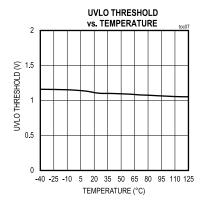


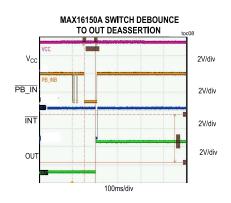


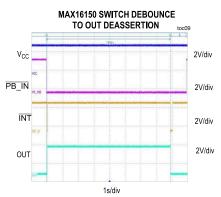






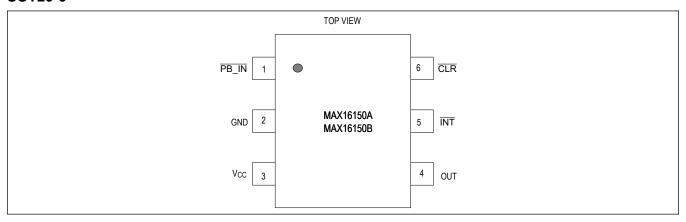




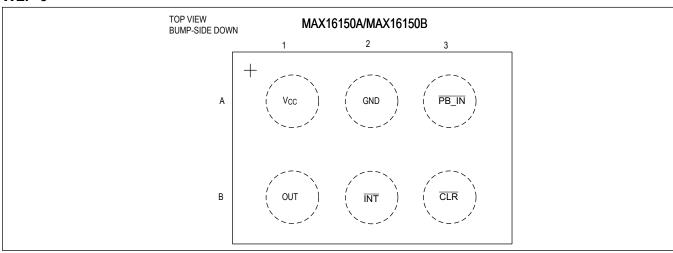


Pin Configurations

SOT23-6



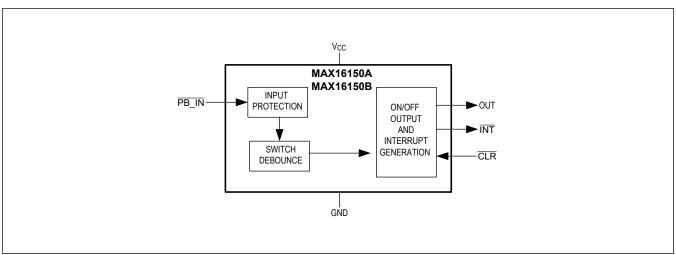
WLP-6



Pin Description

| PIN | | NAME | FUNCTION | |
|---------|-------|-----------------|--|--|
| SOT23-6 | WLP-6 | NAME | FUNCTION | |
| 1 | А3 | PB_IN | Pushbutton Input. $\overline{PB_IN}$ is internally pulled up to V_{CC} . Holding $\overline{PB_IN}$ low for a period greater than the debounce time (t_{DB}) forces OUT to latch high and generates a one-shot pulse at \overline{INT} . For the MAX16150A, holding $\overline{PB_IN}$ low for a period greater than the shutdown period (t_{SO}) de-asserts OUT. For the MAX16150B, holding $\overline{PB_IN}$ low for a period greater than shutdown period (t_{SO}) generates an extended interrupt pulse but does not de-assert OUT. | |
| 2 | A2 | GND | Ground | |
| 3 | A1 | V _{CC} | Power Supply Input. Bypass with a 0.1µF capacitor to ground. | |
| 4 | B1 | OUT | Active-High, Push-Pull Latched Output. OUT is connected to V _{CC} when high. | |
| 5 | B2 | ĪNT | Active-Low, Open-Drain Interrupt/Reset Output. $\overline{\text{INT}}$ is a one-shot output pulse. $\overline{\text{INT}}$ asserts for the interrupt timeout period when $\overline{\text{PB_IN}}$ is held low for a period greater than the debounce time (tDB). $\overline{\text{INT}}$ is high-impedance when de-asserted, even when pulled above VCC. | |
| 6 | ВЗ | CLR | Clear Input. Pulling CLR low de-asserts the latched OUT signal. If OUT is already de-asserted when CLR is pulled low, the state of OUT is unchanged. | |

Block Diagram



Detailed Description

The MAX16150A/MAX16150B are pushbutton on/off controllers with a switch debouncer and latched output for controlling system power. A switch closure that pulls $\overline{PB_IN}$ low and is stable for a period greater than or equal to the debounce time (t_{DB}) causes OUT to assert high. Driving \overline{CLR} low causes OUT to de-assert. For the MAX16150A, a switch closure period greater than or equal to the shutdown period (t_{SO}) will cause OUT to de-assert. Each debounced switch closure also initiates a one-shot \overline{INT} output. See $\overline{Table~1}$ for details on the values of t_{DB} , t_{SO} , and other timing intervals.

| Table 1. MAX16150A vs | 5. MAX16150B IN | NPUT TIMING CI | HARACTERISTIC | ;s |
|-----------------------|-----------------|----------------|---------------|--------|
| | | | | |

| VERS | ION | DEBOUNCE TIME (t _{DB}) | SHUTDOWN PERIOD (t _{SO}) | INTERRUPT PERIOD (SWITCH CLOSURE > tDB) | INTERRUPT PERIOD (SWITCH CLOSURE > t _{SO}) | SWITCH CLOSURE > tSO |
|-------|------|----------------------------------|---------------------------------------|---|--|----------------------|
| MAX16 | 150A | 50ms | 8s | 32ms | 128ms | OUT De-asserts |
| MAX16 | 150B | 2s | 16s | 32ms | 128ms | OUT Stays Asserted |

Operation

The MAX16150A/MAX16150B operate from supply voltages between +1.3V and +5.5V, consuming less than 20nA of supply current when OUT is in the de-asserted state and $\overline{PB_IN}$ is unconnected. Whenever OUT is de-asserted, the state of \overline{CLR} is ignored. After asserting OUT, \overline{CLR} continues to be ignored for a period of 2x the \overline{INT} period. For low-power applications (up to about 20mA output current), OUT can drive the load directly with minimal voltage drop. Each debounced switch closure causes \overline{INT} to assert. A switch closure longer than t_{SO} results in \overline{INT} asserting for a period that is 4x longer than the nominal \overline{INT} period. This longer \overline{INT} can be used to signal the system to perform a specific function, or to initiate a shutdown process. Closing the switch for a time longer than this extended \overline{INT} period will not cause \overline{INT} to be re-asserted or the \overline{INT} period to be extended.

The MAX16150A de-asserts OUT when $\overline{PB_IN}$ is held low for a period equal to or greater than the shutdown period, t_{SO} . Holding $\overline{PB_IN}$ of the MAX16150B low for a period equal to or greater than the shutdown period (t_{SO}) does not de-assert OUT. Instead the MAX16150B outputs a longer interrupt signal.

Note that, when V_{CC} is first applied (for example, when the battery is initially installed), OUT may initially be in either the asserted or the de-asserted state. To change the state, use either the PB_IN or CLR input as appropriate.

Very brief high periods (less than approximately 600µs) at $\overline{PB_IN}$ are ignored, so that fast switch bounces don't interrupt the debounce logic, while valid short presses and releases cause the debouncer to reset.

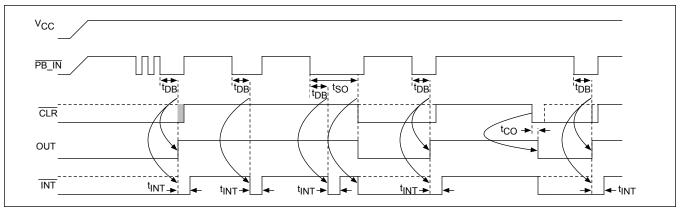


Figure 1. MAX16150A Timing Diagram

Figure 1 shows the timing diagram of the MAX16150A. A switch closure of a duration greater than t_{DB} causes OUT to

assert. A switch closure of a duration greater than t_{SO} causes OUT to de-assert. Typically, $\overline{\text{INT}}$ and $\overline{\text{CLR}}$ are pulled up either to OUT or to a regulated voltage controlled by OUT as depicted in $\overline{\text{Figure 1}}$. As such, $\overline{\text{INT}}$ and $\overline{\text{CLR}}$ are pulled low while OUT is de-asserted. If pulled up to a constant supply voltage, $\overline{\text{INT}}$ and $\overline{\text{CLR}}$ will behave as shown by the horizontal dashed lines while OUT is de-asserted.

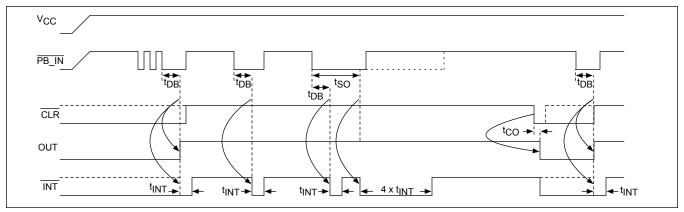


Figure 2. MAX16150B Timing Diagram

Figure 2 shows the timing diagram for the MAX16150B. A switch closure of a duration greater than t_{DB} causes OUT to assert. A switch closure of a duration greater than t_{SO} does not cause OUT to de-assert. Instead, it causes an extended interrupt. Typically, \overline{INT} and \overline{CLR} are pulled up either to OUT or to a regulated voltage controlled by OUT as depicted in the figure above. As such, \overline{INT} and \overline{CLR} are pulled low while OUT is de-asserted. If pulled up to a constant supply voltage, \overline{INT} and \overline{CLR} will behave as shown by the horizontal dashed lines while OUT is de-asserted.

Robust Switch Input

The switch input (PB_IN) has overvoltage clamping diodes to protect against damaging fault conditions. Switch input voltages can safely swing ±60V relative to ground.

±15kV ESD Protection

ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The MAX16150A/MAX16150B have extra protection against static electricity to protect against ESD of ±15kV at the switch input without damage. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. A design advantage of these devices is that they continue working without latchup after an ESD event, which eliminates the need to power-cycle the device. ESD protection can be tested in various ways; this product is characterized for protection to ±15kV using the Human Body Model.

Human Body Model

<u>Figure 3</u> shows the Human Body Model, while <u>Figure 4</u> shows the current waveform it generates when discharged into a low-impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a $1.5k\Omega$ resistor.

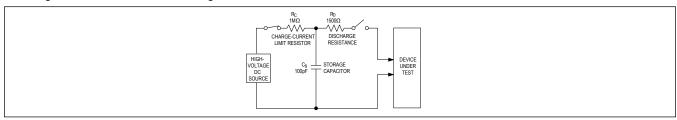


Figure 3. Human Body ESD Test Model

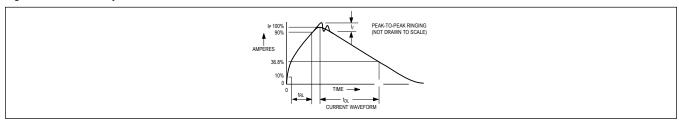


Figure 4. Human Body Current Waveform

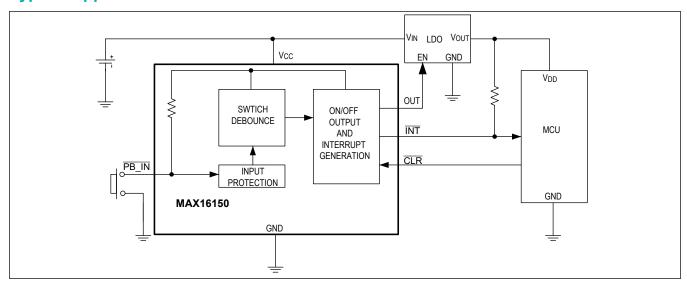
Applications Information

Powering the Load

OUT is capable of driving light loads. When the supply current of circuitry is less than about 20mA, the voltage drop from V_{CC} to OUT is less than 100mV. The <u>Typical Application Circuit</u>, located at the beginning of this document, shows OUT providing power directly to the load.

Some systems require higher power supply current than the output of the MAX16150 can provide. For those cases, OUT can be used as an enable signal for the voltage regulator powering the system. This *Typical Application Circuit* shows an LDO providing power to the load. The LDO's enable input is driven by OUT. A debounced pushbutton at PB_IN of the MAX16150 causes OUT to assert high, thereby enabling the LDO.

Typical Application Circuit



Ordering Information

| PART NUMBER | TEMP RANGE | PIN-PACKAGE |
|----------------|-----------------|-------------|
| MAX16150AWT+T* | -40°C to +125°C | 6 WLP |
| MAX16150AUT+T* | -40°C to +125°C | 6 SOT23 |
| MAX16150BWT+T | -40°C to +125°C | 6 WLP |
| MAX16150BUT+T* | -40°C to +125°C | 6 SOT23 |

⁺ Denotes a lead(Pb)-free/RoHS-compliant package.

T = Tape-and-reel.

^{*}Future product—contact factory for availability.

MAX16150

nanoPower Pushbutton On/Off Controller and Battery Freshness Seal

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|--------------------|---------------|-----------------|------------------|
| 0 | 1/19 | Initial release | _ |

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at https://www.maximintegrated.com/en/storefront/storefront.html.

Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.

ПОСТАВКА ЭЛЕКТРОННЫХ КОМПОНЕНТОВ

многоканальный

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001 Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

Данный компонент на территории Российской Федерации Вы можете приобрести в компании MosChip.

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

Офис по работе с юридическими лицами:

105318, г. Москва, ул. Щербаковская д. 3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru moschip.ru_6 moschip.ru_4 moschip.ru_9