ICL8201

AC/DC Buck Controller with PFC for LED Lamps

Data Sheet

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Power Management & Multimarket

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Revision History

Major changes since previous revision

Date	Version	Changed By	Change Description
2015-05-25	2.0		First Release

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ICL8201 – Single-Stage Floating Buck Controller IC with Power Factor Correction for LED Lamps

Product Highlights

- **Low external component count for smallest form factors and easy design-in**
- **IC concept allows standard single chokes without auxiliary winding**
- **True universal AC line input voltage or DC supply**
- **Compensation of sudden line input voltage changes**
- **Supports wide output voltage**
- **Capable of providing an average LED output current up to 800 mA at 50% Duty Cycle**
- **Typical ± 5% output current accuracy over line, load and temperature variation**
- **Supports PF > 90% / iATHD < 20% over a wide line input voltage range**
- **System efficiency up to 90%**
- **Thermally-optimized package PG-SOT23-6-1 for small form factor designs**
- **Smooth start-up with minimized current overshoot**
- **Advanced cascode topology eliminates the requirement of high voltage startup cell**
- **External power switch supports fast time-to-light and high operating temperature**
- **Operation specified for junction temperature up to T_j = 150 °C**

IC Features

- **Critical Conduction operation mode without detection winding**
- **Constant t_{ON} operation with variable frequency 40 kHz to 150 kHz**
- **Integrated low-side MOSFET for rated peak current up to 2.65A**
- **Digital soft-start**
- **Fully integrated protection:**
  - Short load
  - Support open load
  - Short winding at buck inductor
  - Over-current protection (power limitation)
  - Intelligent Over-Temperature Protection @ Tjmax = 150 °C
  - V_{CC} Under-Voltage Lock-Out
  - Short-to-GND of CS pin and Con pin
  - Floating CS pin and Con pin
  - Phase cut dimmer-safe

Target Applications

- A-lamps
- GU10 lamps
- PAR lamps
- Candelabra lamps
- Down lights
- T8 lamps

1 Block Diagram

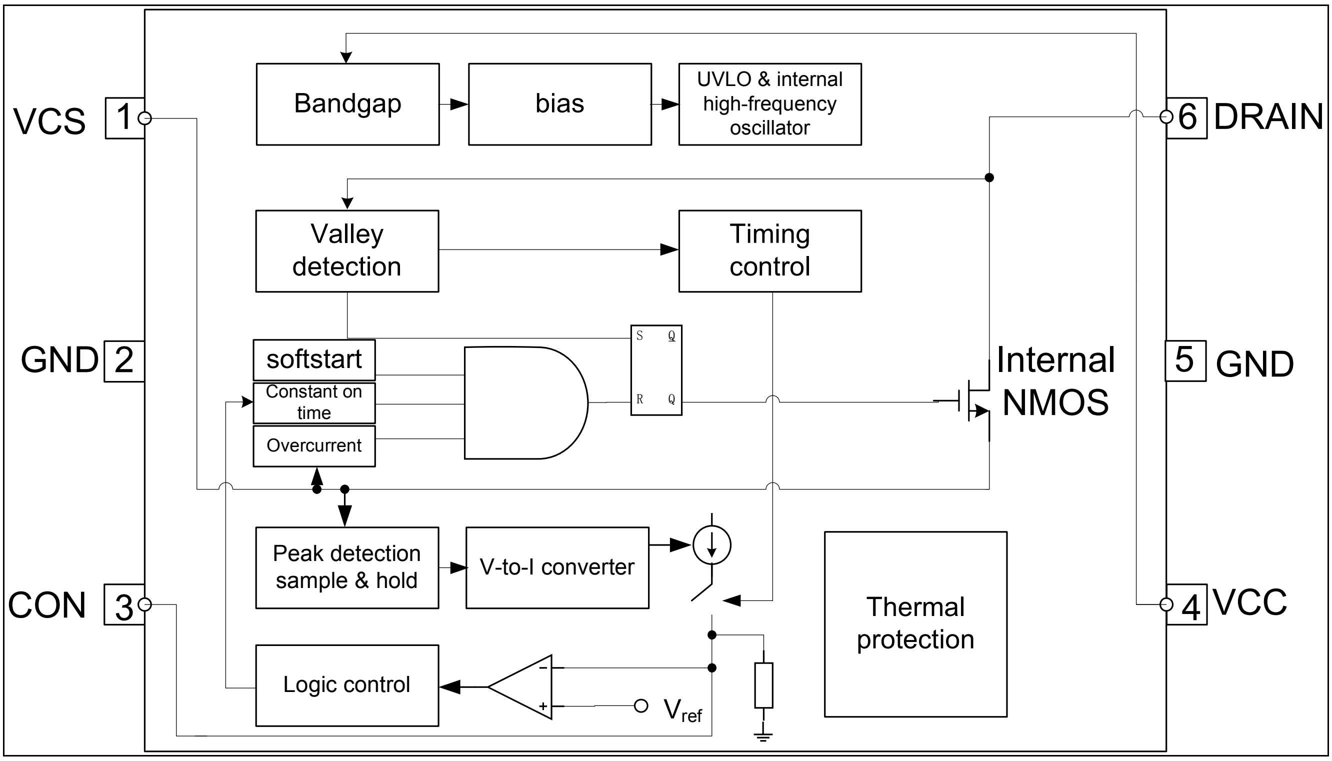

Figure 1 Internal Block Diagram

2 IC and Application Feature Overview

2.1 Application Feature SET

Table 1 Application Feature SET

Single Choke	Transformer Free	Support the use of Standard Chokes
BOM Count	< 22 Components	
Form Factor	Fit into: E14 / GU10 Sockets	
AC Line IN: Wide Range Opportunity	$80V_{ACIN}$ - $325V_{ACIN}$	Real Wide Range Design / Regulation of sudden Line Jumps
Star up behaviour		Smooth Start Up of LED Current
Expected Efficiency	86% up to 90%	
Maximum Junction Temperature	$T_{JunctionMAX}$ = 150°C	
Maximum Ambient Temperature	$T_{AmbientMAX}$ = 105°C	Temperature of PCB inside Bulb

2.2 IC Feature SET

Table 2 IC Feature SET

IC Operation MODE	Critical Conduction / DCM Op. / Constant t_{ON}	DCM Operation with Critical Conduction Operation
Package	PG-SOT23-6-1 / R_{thja} = 264K/W / 6 PINs	No Cooling Area ON PCB
Active PINs	4 active PINs + 2 GND	V_{CC} / Con / V_{CS} / DRAIN / GND
MOS Stage inside	$R_{DSON25°C}$ = 0.370 Ω / I_{SWpeak}= 0.5A	Low Voltage Low Side MOSFET Integrated
Operating Condition	V_{CCOp} = 10V / I_{CCOp} around 0.82mA	@ active Gates for Applications up to 15W
f_{RUN}	40kHz up to 150kHz	Operating Frequency Range
Soft-Start	24ms Digital	
Internal System Accuracy (overall)	< 5% Up to T_{Jmax} = 150°C	Stable Overall Accuracy in a wide Temperature Range up to T_J

2.3 Regulation Feature SET

Table 3 Regulation Feature SET

Line Regulation	I_{LED} Variation < ± 5%	85V < $V_{ACINnom}$ < 325V
Load Regulation	I_{LED} Variation < ± 5%	V_{FLED} from 20V up to 60% VIN
Constant OUTPUT Current Operation	I_{LED} Variation < ± 5%	

Compensation of Magnetic Impact		L_P Variation ± < 20%
Power Factor	Supports : EN61000-3-2	> 70% up to ~ 99%
iATHD	Supports : EN61000-3-2	< 20%
Harmonic Distortion	Supports : EN61000-3-2	PASS
Lightning Surge	Supports: EN61000-4-5	PASS
EMI	Supports: EN55015	PASS

2.4 Protection Feature SET

Table 4 Protection Feature SET

V_{CS} Short (PIN 1) to GND	V_{CSth} < 0.1V & V_{Drain} > 0.25V during t_{ON} $t_{Blanking}$ = 200ns Blanking Time	Start UP / RUN Mode	Latch
V_{CS} Open (PIN 1)	V_{CSth} > 1.2V & $T_{Blanking}$=100ns After LEB triggered With 3 continuous switching cycle	Start UP / RUN Mode	Latch
V_{Con} Short (PIN 3) to GND	V_{Conth} < 0.2V & $t_{Blanking}$=5ms	Start UP	Latch
V_{Con} OPEN (PIN 3)	V_{Con} > 1.5V & $t_{Blanking}$ = 18µs	Start UP	Latch
Floating Load Protection (FLP)	V_{CSth} < 0.12V & Start UP: After soft-start with 160ms blanking time Run MODE: After: 160ms Blanking Time	Start UP / RUN Mode Disabled during OTP	Latch
Short OUTPUT	V_{CSth} > 0.62V & No Zero current Detection for continuous 126 Switching Cycles	Start UP / RUN Mode	Latch
Short Winding (Main Choke)	V_{CSth} > 1.2V & $T_{Blanking}$=100ns After LEB triggered With 3 continuous switching cycle	Start UP / RUN Mode	Latch
Power Limitation	V_{CSth} = 0.9V Cycle by Cycle	RUN Mode	Limiting

iOTP Intelligent Over Temperature Protection	T_J > 150°C ± 10°C I_{OUT} from 100% to 50%	Start UP / RUN Mode	De-rating within 7 digital Steps
V_{CC} Under Voltage (UVLO)	V_{CC} < 6.0V	Start UP / RUN Mode	Auto Restart
Dimmer Input Acceptable	UVLO	Start UP / RUN Mode	Auto Restart
iATHD Feature	On Time Reduction	RUN Mode Disabled during OTP	N.A.
Soft Start digital 24 ms	V_{CSth} = 0.1V till 3 ms V_{CSth} = 0.2V till 6 ms V_{CSth} = 0.3V till 9 ms V_{CSth} = 0.4V till 24 ms	Start UP	Limiting

3 Pin Configuration and Functionality

3.1 Pin Configuration with PG-SOT23-6-1

Table 5 Pin configuration

Pin	Symbol	Function
1	V_{CS}	Current Sense
2	GND	Ground
3	Con	Constant Current / Output Current Ripple
4	V_{CC}	Supply Voltage
5	GND	Ground
6	DRAIN	DRAIN of integrated MOSFET

3.2 Package

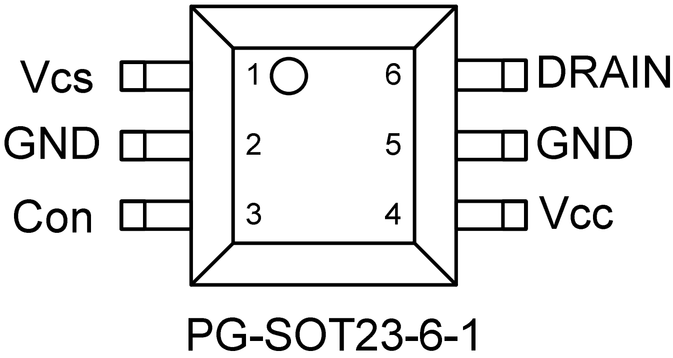

Figure 2 Pin configuration PG-SOT23-6-1 (top view)

3.3 Pin Description

Vcs (current sense, pin 1)

This pin is directly connected to the shunt resistor, which is located between the source terminal of the integrated low-side MOSFET and ground.

Internal clamping structures and filtering measures allow sensing of the source current for the low-side power MOSFET without additional filter components.

This pin is for power limitation, output average current regulation & the integrated protection features.

GND (ground, pin 2)

This pin is connected to ground and represents the ground level of the IC for the supply voltage, gate drive and sense signals.

Con (constant current, pin 3)

Regulate the constant current in the output stage of the Floating BUCK converter.

Vcc (supply voltage, pin 4)

This pin provides the power supply of the ground-related section of the IC. There is a UVLO turn-on threshold at 7.5 V ($V_{CC.ON}$) and a UVLO turn-off threshold at 6.0 V ($V_{CC.OFF}$). The maximum V_{CC} supply voltage level is 18.0 V. The chip supply current is typically at I_{VCC} = 0.82 mA.

GND (ground, pin 5)

This pin is connected to ground and represents the ground level of the IC for the supply voltage, gate drive and sense signals.

DRAIN (DRAIN, pin 6)

This pin is connected to the drain of the internal low side MOSFET. It is also used for protection features.

4 Functional Description

4.1 Typical Application Circuit

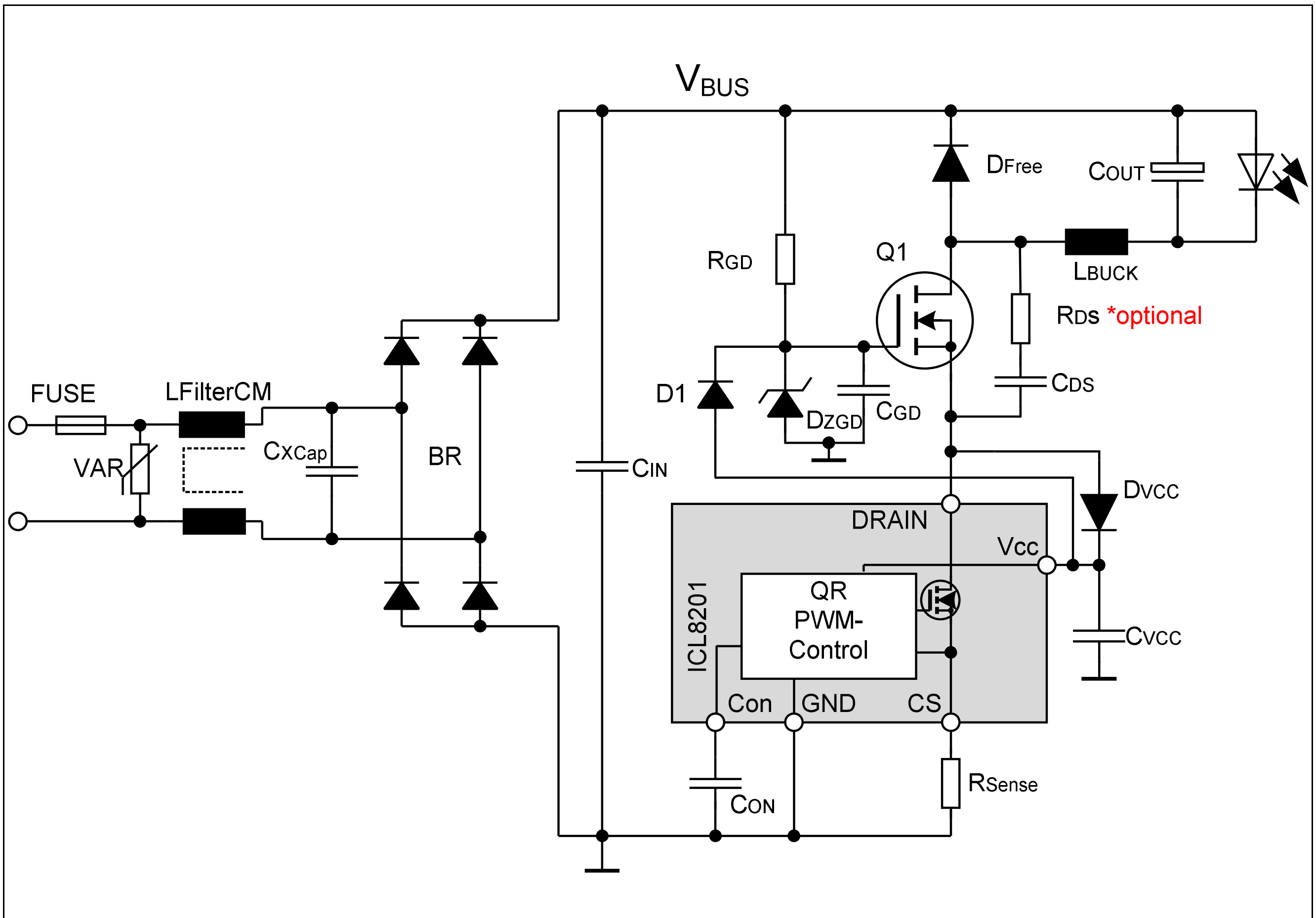

Figure 3 Application Circuit of a LED Driver in a Floating BUCK Topology

Description

The ICL8201 is a cascode structure current mode controller for non-isolated single-choke floating BUCK topologies. The device is tailored for LED applications and provides constant current operation with low output current ripple in a real universal line input voltage range as well as load compensation for a wide output voltage range.

The low PIN count PG-SOT23-6-1 package supports small form factor and low-cost designs. The high level of integration enables a minimum of effort for addition of external components. The ICL8201 control concept supports DC and AC input as well as high Power Factor Correction (PFC), high efficiency levels and reduced EMI designs in critical conduction operation mode without zero crossing detection winding. Along with outstanding integrated regulation and protection features, the cascode arrangement simplifies V_{CC} supply of the IC, that eliminates the need of a depletion MOS. The regulation is done without detecting the AC line input voltage or sensing the output voltage. All these features are implemented with a minimum amount of external components. The device operates in a wide junction temperature range from -25°C to 150°C. The highly efficient integrated low-voltage MOSFET will eliminate the need for any additional thermal management.

4.2 Internal Functional Description

4.2.1 V_{CC} Pre-Charging and Typical V_{CC} voltage profile During Start-up

In ICL8201, a startup cell is not needed. As shown in Figure 4, once the mains input voltage is applied, a rectified voltage V_{BUS} appears across the capacitor C_{IN}. The pull up resistor R_{GD} provides a current to charge the C_{GD} capacitor and gradually generate one voltage level for the gate of external power MOSFET Q_1. If voltage over C_{GD} is high enough, V_{CC} capacitor will be charged through external LED load, choke inductor L_{BUCK}, external power MOSFET Q_1, and diode D_{VCC}. Because capacitor C_{GD} is quite small (around 10nF), so charging this capacitor and consequently charging V_{CC} capacitor C_{VCC} will be within very short time. There is one zener diode, D_{ZGD} which is used to clamp voltage over C_{GD} and its breakdown voltage can be 12V, so during startup, V_{CC} voltage will be charged up to 12V - $V_{threshold}$ - V_F (where $V_{threshold}$ is threshold voltage of power MOSFET Q_1 and V_F is forward voltage of D_{VCC}).

When V_{CC} voltage reach UVLO turn-on threshold (which is 7.5V), the whole chip will be turned on and system will enter into normal operation after soft start. During normal operation, V_{CC} capacitor will be charged through bypass capacitor C_{DS} and power MOSFET (when V_{CC} is lower than 12V - $V_{threshold}$ - V_F).

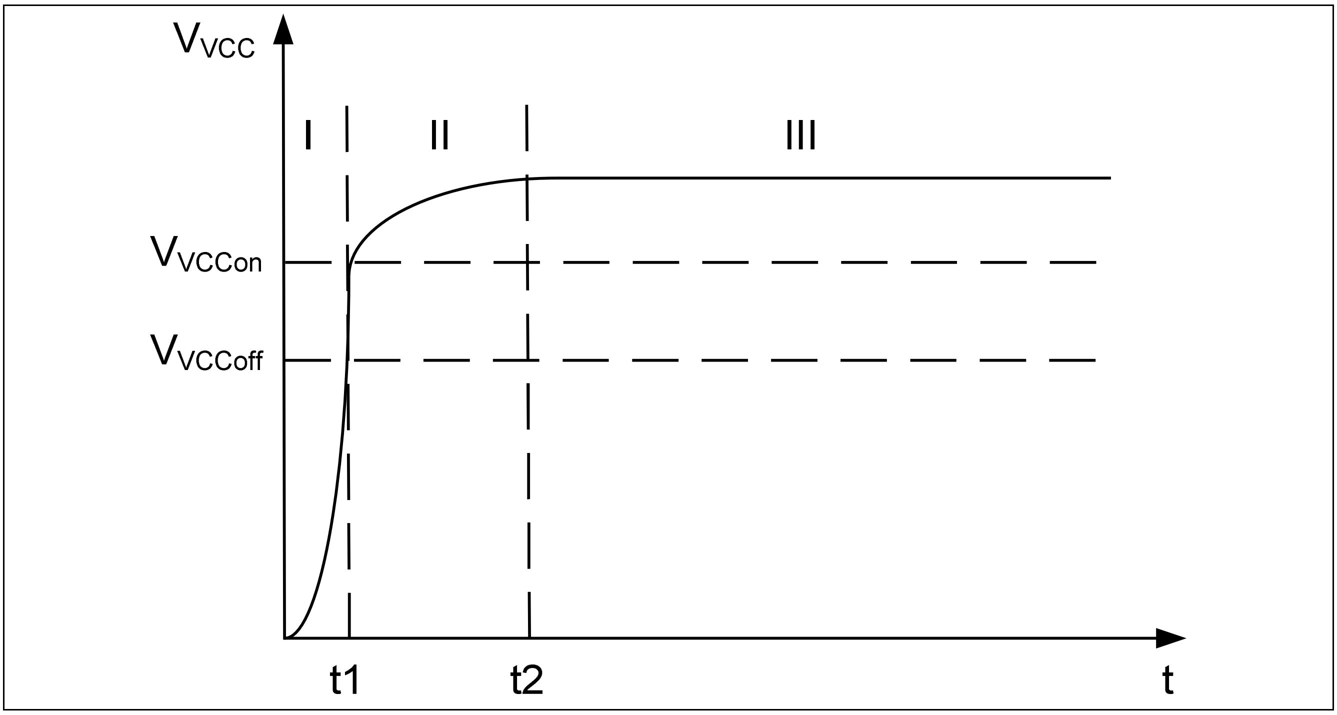

Figure 4 V_{CC} voltage at start up

When the V_{CC} voltage exceeds the V_{CC} turned-on threshold $V_{VCC.ON}$ at time t1, the IC begins to operate with soft-start. V_{CC} capacitor will be charged through bypass capacitor C_{DS}, as shown in **Figure 6.** After some time, when V_{CC} voltage is high enough, it will be clamped by the external Zener diode D_{ZGD}.

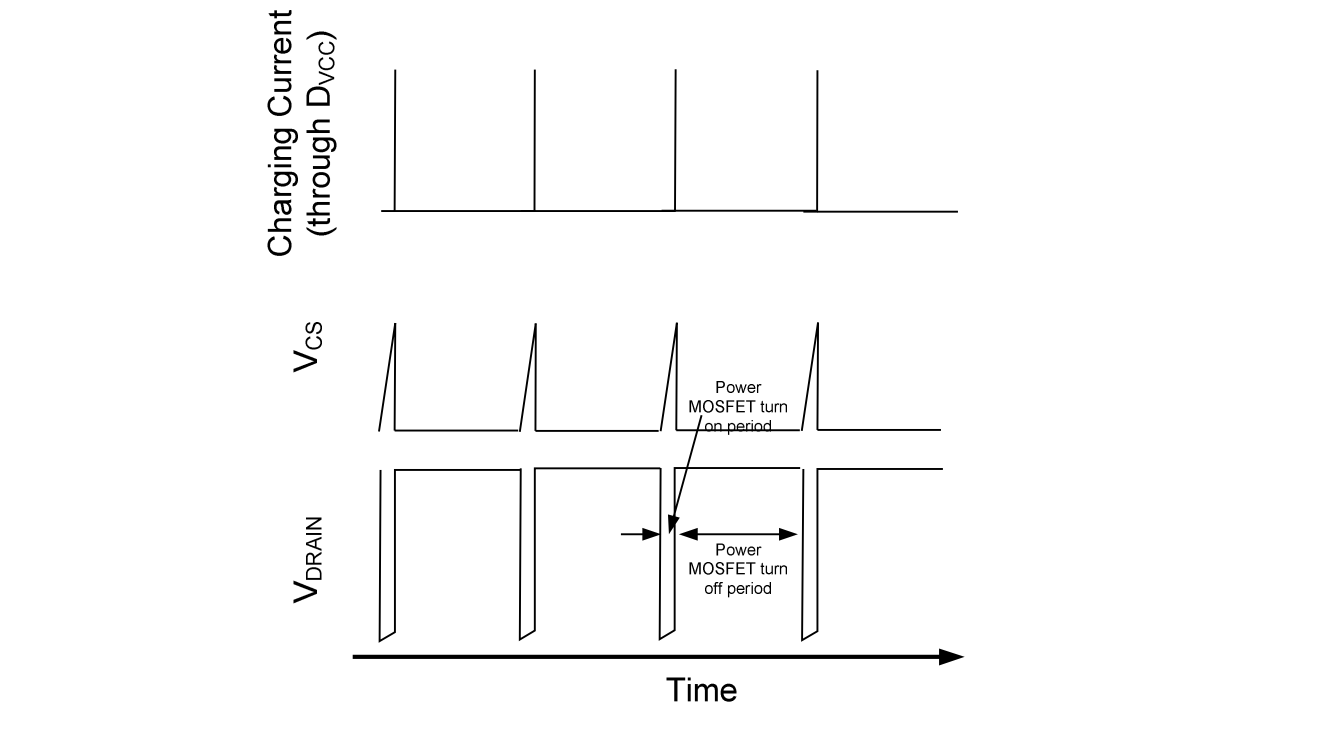

Figure 5 Charging current to V_{CC} capacitor during normal operation

4.2.2 Soft Start

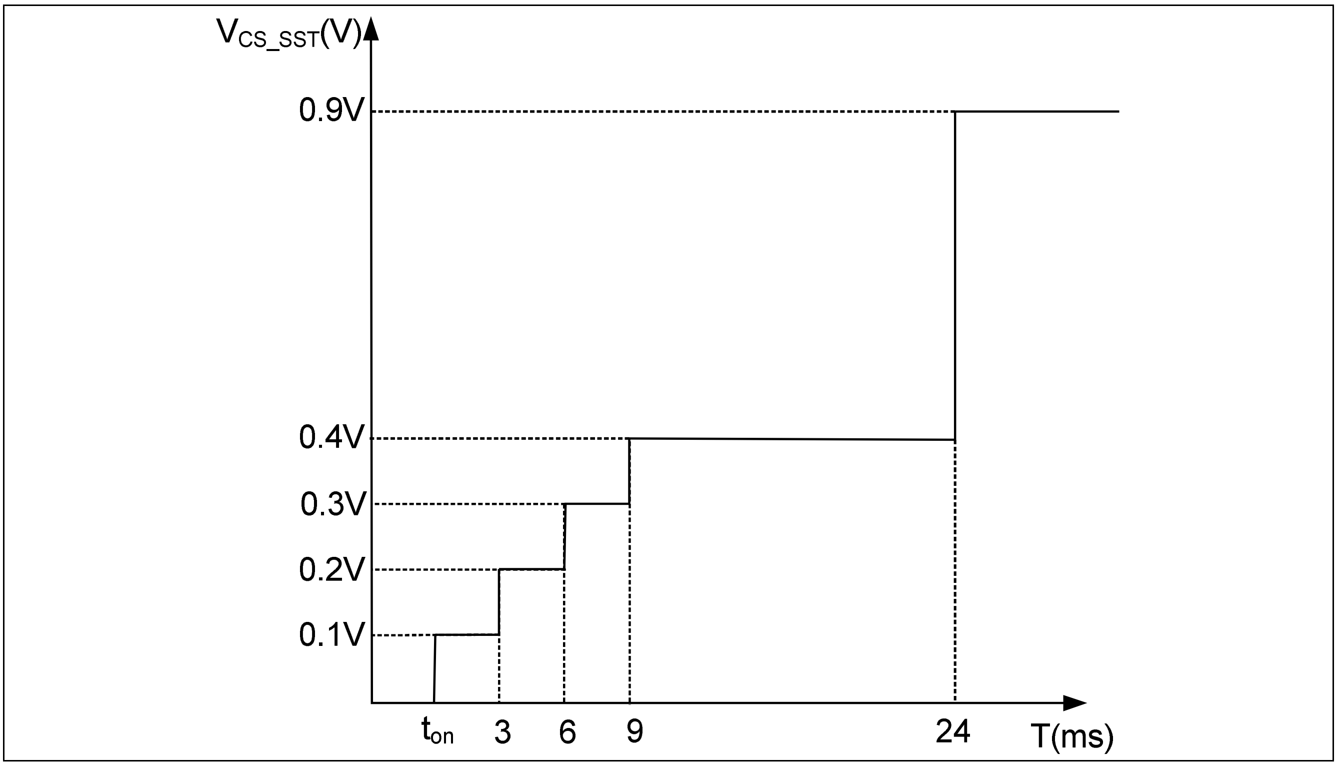

Figure 6 Soft-Start profile

As shown in Figure 7, at time t_{on}, the IC begins to operate with a soft-start. By using this soft-start, the switching stresses for the switch, diode and choke inductor are minimized. The Soft-Start implemented in ICL8201 is a digital time-based function. The preset soft-start time is t_{SS} (24ms) with 4 steps. If not limited by other functions, the peak voltage on Vcs pin will increase step by step from 0.1V to 0.4V finally.

After soft start, the peak V_{CS} is limited by 0.9V current limitation.

4.2.3 Normal Regulation Operation

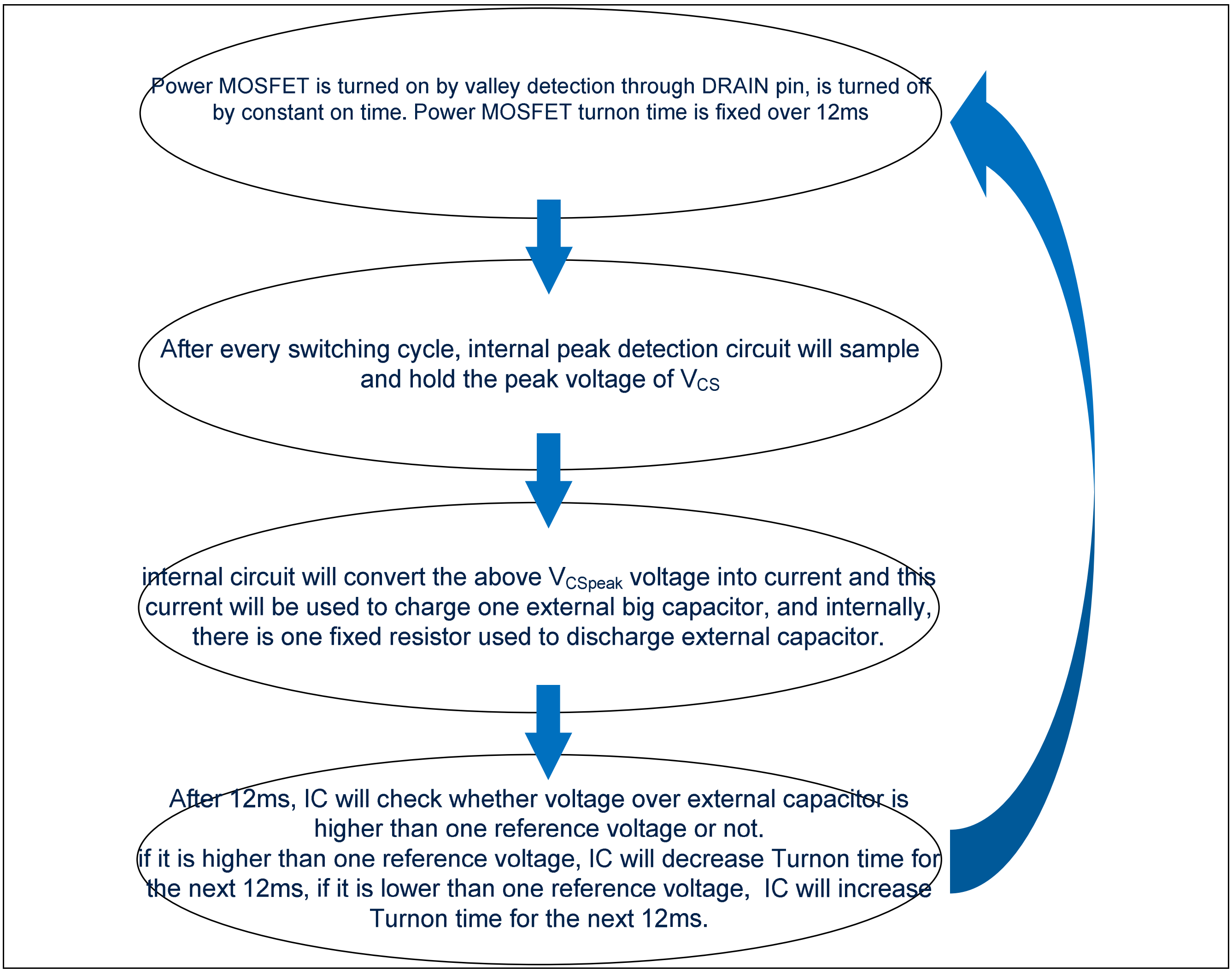

Figure 7 Normal regulation operation of ICL8201

4.2.4 Zero Current Detection

In the ICL8201 system, when power MOSFET is being turned on, current through choke inductor L_{BUCK} will linearly ramp up, when power MOSFET is being turned off, current through choke inductor will linearly ramp down until 0A.

Later when current through choke inductor reaches 0A, system will start to oscillate. In order to turn on power MOSFET when current through choke inductor reduce to 0A, it is necessary to do zero current detection for system.

As shown in Figure 9, zero current detection is achieved by the following circuit.

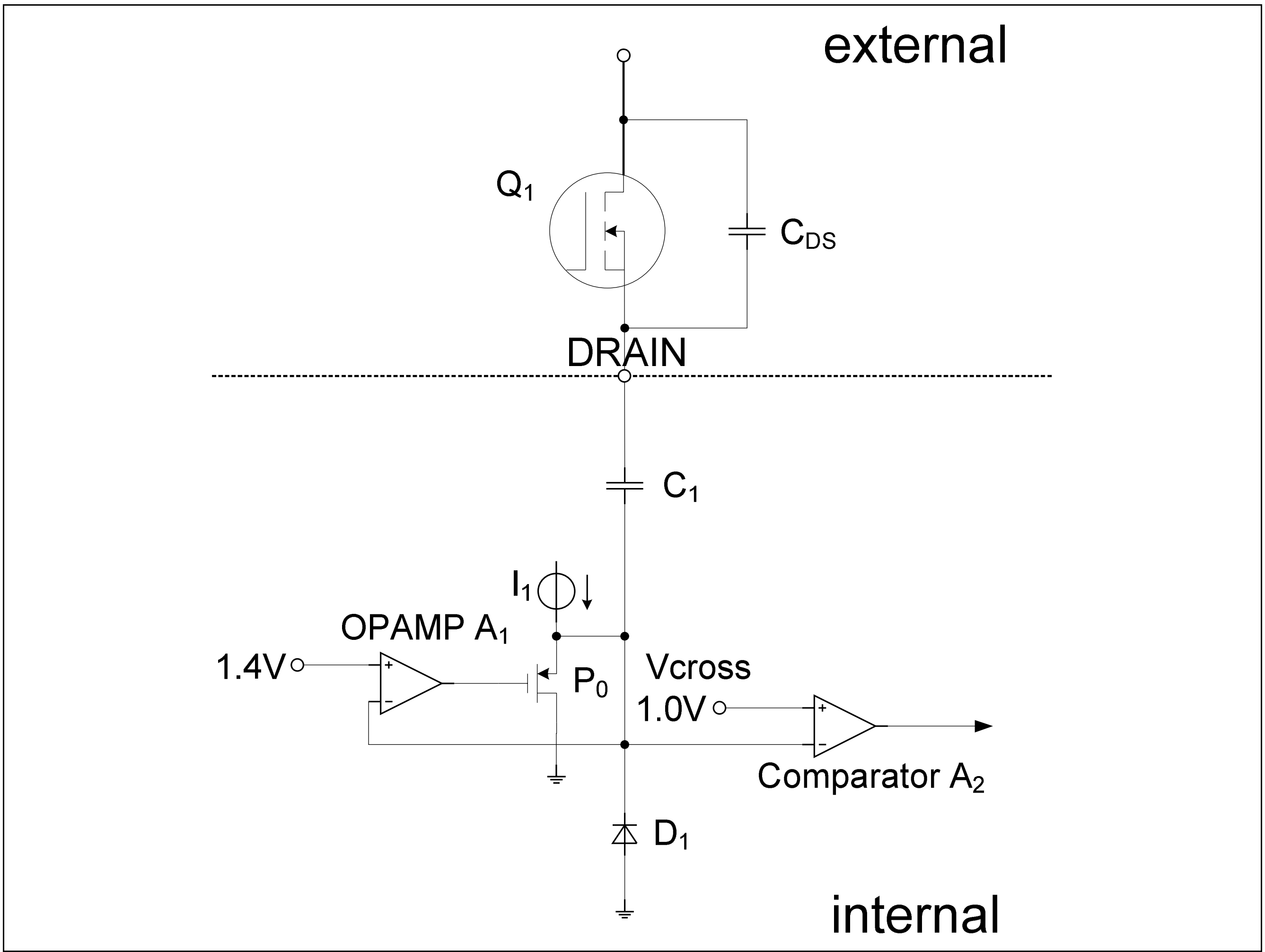

Figure 8 Zero current detection circuit implemented in ICL8201

The above block diagram shown in Figure 9, where capacitor C_{DS} is used to couple the high frequency signal to IC Drain and internally IC will accept the oscillation signal and do zero current detection. Internally, capacitor C_1 will be used to further couple oscillation signal at DRAIN pin into low voltage signal; current source I_1 and operational amplifier is used to ensure the maximum V_{cross} voltage to be 1.4V when there is no oscillation at the Drain pin; diode D_1 is used to clamp point V_{cross} voltage not lower than -0.7V when power MOSFET is being turned on; when there is some high frequency signal transferred to point V_{cross}, the V_{cross} will be pulled down, and there is one comparator which is used to detect if V_{cross} is lower than 1.0V. When V_{cross} is lower than 1.0V, zero current point is detected. The typical DRAIN voltage Slew Rate necessary for zero current detection is 50V/µs for a delta V_{DRAIN} of 0.5V and 2.5V/µs for a delta V_{DRAIN} of 0.8V.
As shown in Figure 10, upper side power MOSFET drain voltage and lower side power MOSFET drain & current through choke inductor with zero current detection used.

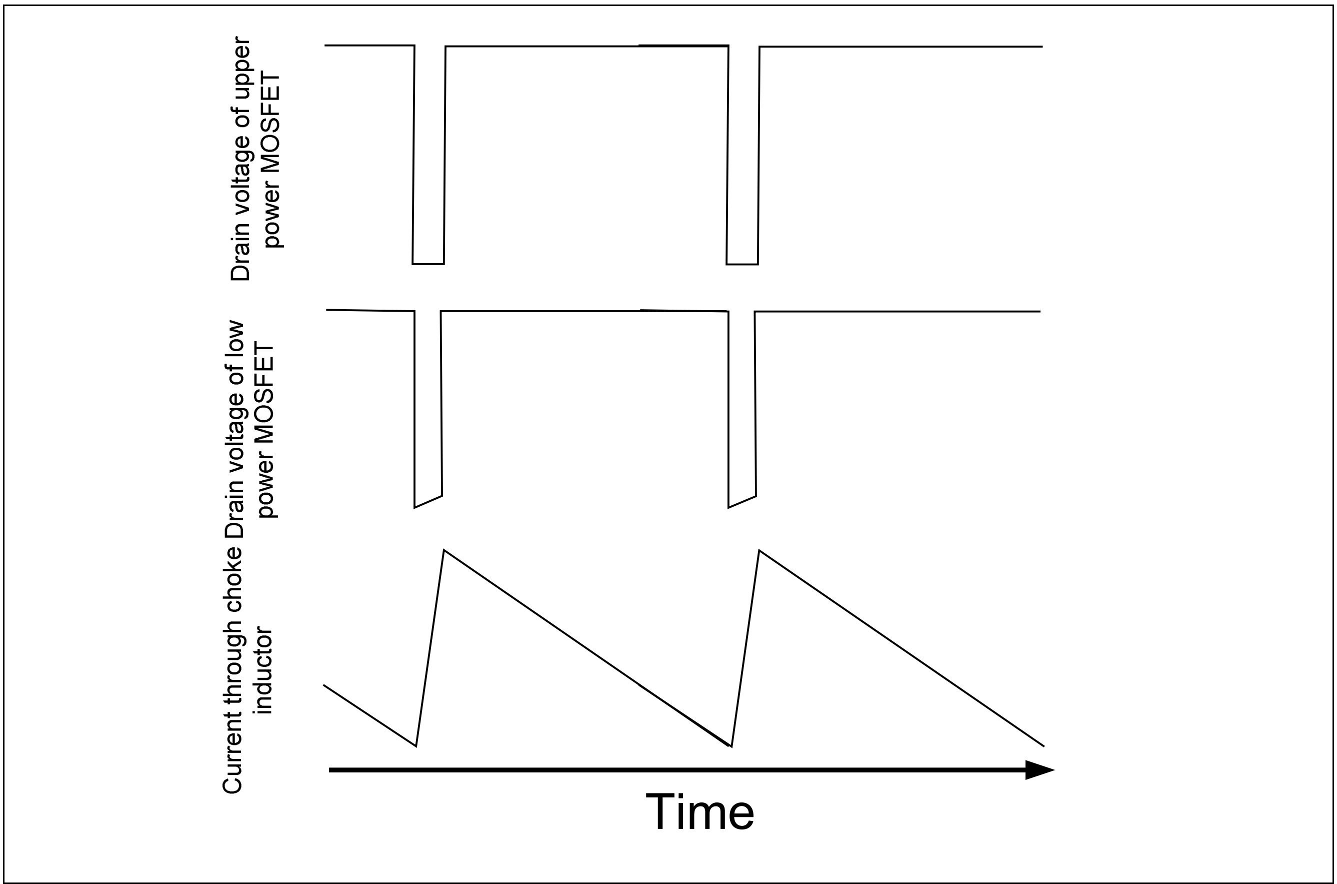

Figure 9 Waveform to show how is the drain voltage and current through choke inductor behave when zero current detection used

4.2.5 Peak Detection

In order to do output current measurement and regulation, it is necessary to do V_{CS} voltage peak detection. As shown in Figure 11, the peak voltage value of V_{CS} is sample and hold for output current regulation purpose.

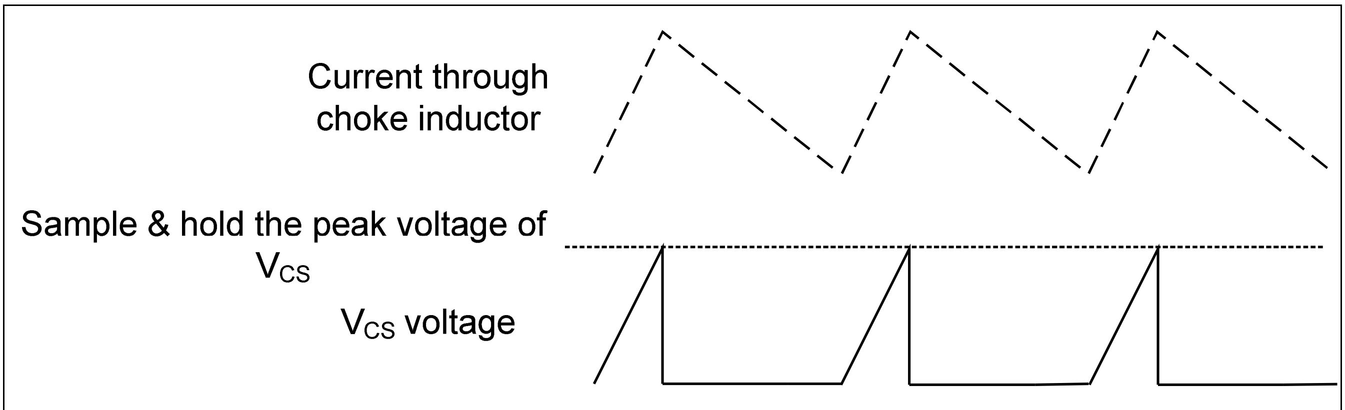

Figure 10 Waveform to show peak detection of V_{CS} signal

4.2.6 Voltage to Current Converter

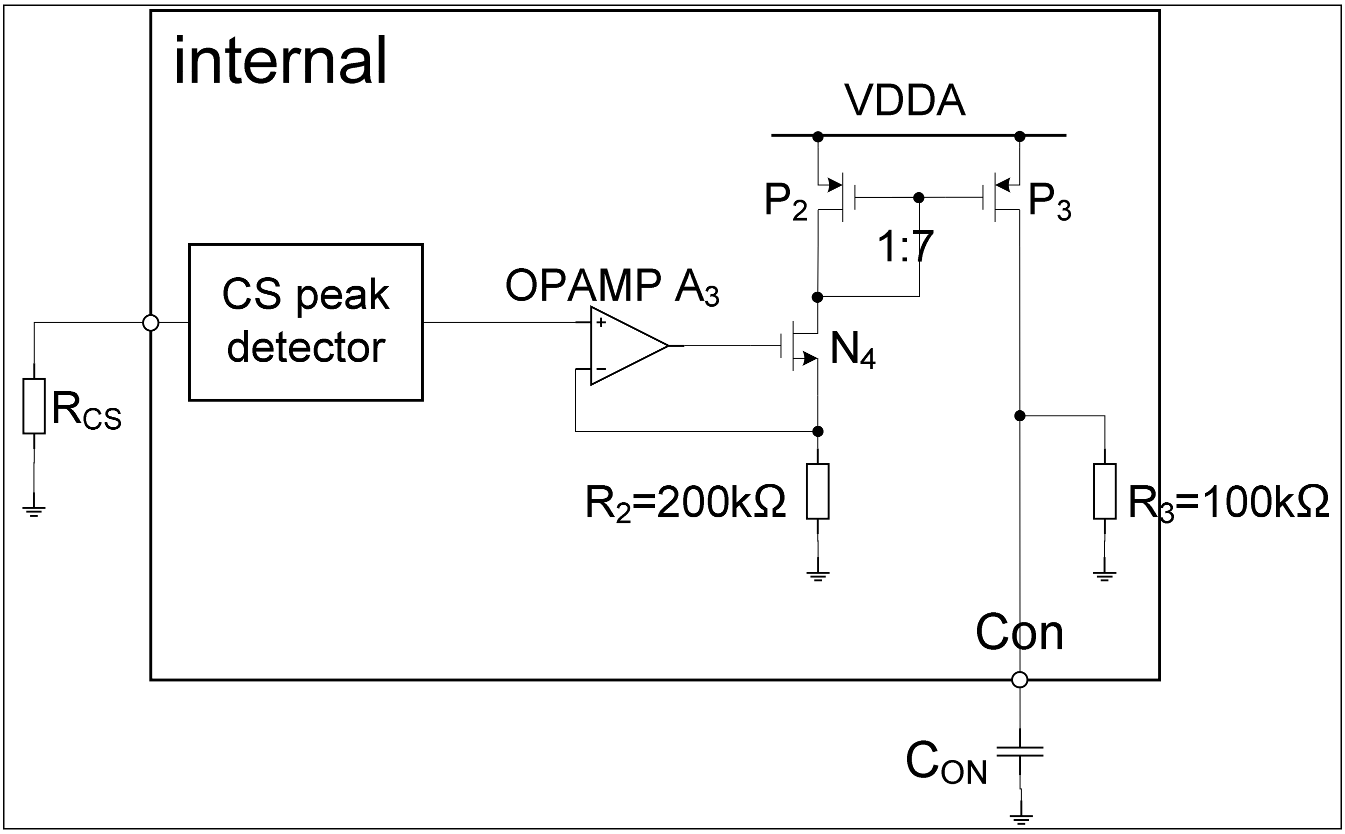

Figure 11 Block diagram to show peak detection & Voltage to Current block with current mirror circuit diagram

From the above block diagram, at first V_{CS} peak voltage is sample and hold, which will be applied to one Voltage to Current converter block, this voltage to Current converter block includes OPAMP A_3, NMOS transistor N_4 and resistor R_2.
The current I_{CSpeak} will be equal to V_{CSpeak} / R_2. This I_{CSpeak} will be mirrored by P_2 and P_3 into 7-times current source to charge external capacitor C_{ON}. Also there is one resistor R_3 which is connected from Con to GND. The external C_{ON} works together with this internal resistor R_3 establish the C_{on} voltage which will be applied to the internal coarse and fine tuning block to determine the ON time, T_{ON}.

4.2.7 ON time generation

ICL8201 uses constant on time control method, it can accept universal input voltage with wide output voltage range. The On time range is between 0.8µs and 20µs. The On Time is preset to 800ns during start up. The percentage of On time change is dependent on V_{Con} voltage. V_{Con} voltage is sensed every 12ms typically. The percentage of On time change with respect to V_{Con} voltage is shown in Table 2.

Table 6 Tuning mechanism used in ICL8201

V_{Con} voltage	On time
V_{Con}>1.8V	Decrease by 50%
1.8V>V_{Con}>1.6V	Decrease by 10%
1.6V>V_{Con}>1.5V	Decrease by 0.2%
1.4V<V_{Con} <1.5V	Increase by 0.2%
1.2V<V_{Con}<1.4V	Increase by 10%
V_{Con}<1.2V	Increase by 50%

4.2.8 How to calculate output average current

The average of the V_{CS} peak voltage divided by external sense resistor R_{CS} will be the 2 times of the average current through choke inductor. Output average current only depends on sense resistor value, in order to get target output average current, equation 5.1 can be followed

$$I_{output} = \frac{1}{2} \times \frac{1.5}{3.5 \times (R_{CS})} \tag{5.1}$$

Where R_{cs} is sense resistor value and 3.5 is Peak V_{CS} amplifier gain, 1.5V is C_{ON} threshold voltage.

4.2.9 Leading Edge Blanking

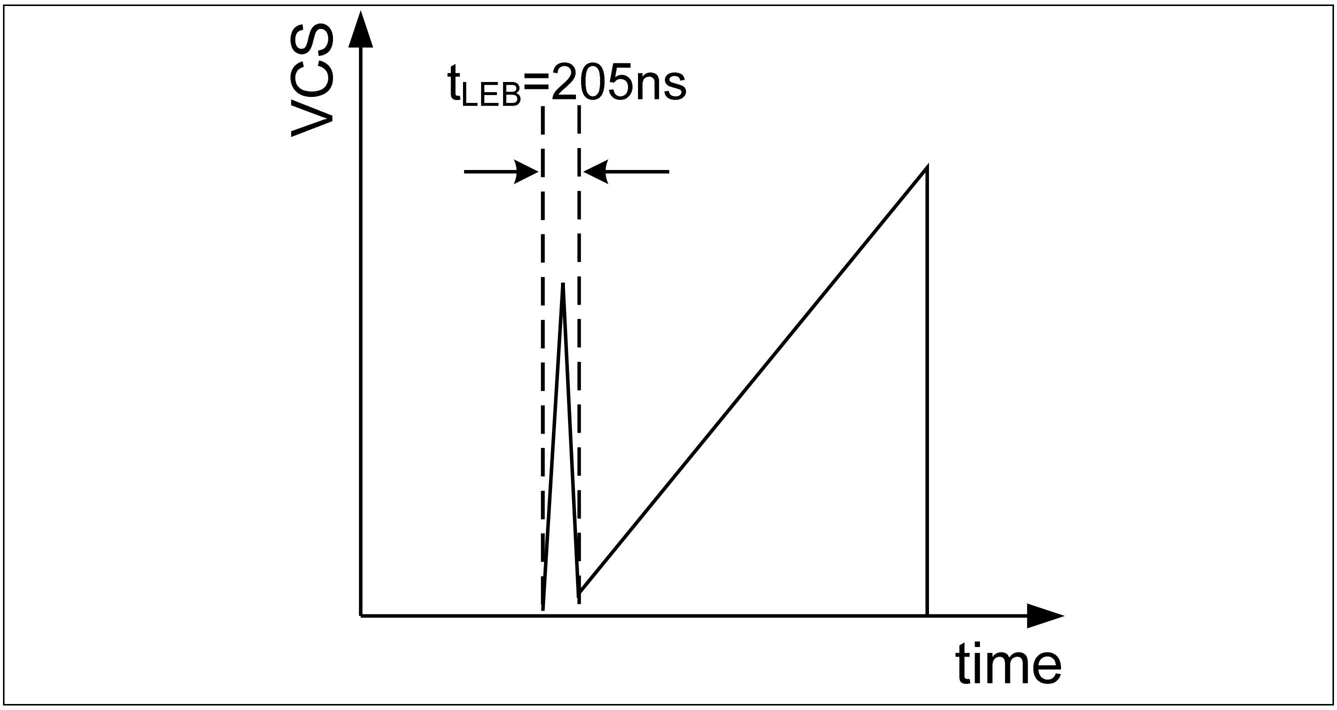

Figure 12 Leading Edge Blanking

Whenever the power MOSFET is switched on, a leading edge spike is generated due to parasitic capacitances. This spike can cause the gate drive to switch off unintentionally. In order to avoid a premature termination of the switching pulse, this spike is blanked out with a time constant of t_{LEB}=205ns.

4.2.10 Driver Stage

Cascode topology is adopted in ICL8201 system, one fixed voltage (for example: 12V) is applied to the Gate of the upper side power MOSFET, then if lower side power MOSFET is turned on, the whole current path will be turned on; if lower side power MOSFET is turned off, the whole current path will also be turned off.

4.3 System Functional description

4.3.1 Start-Up behaviour

4.3.1.1 Start-Up: Into Normal Operation

Start-up is executed in 3 phases: UVLO, power-up and soft start, as shown in figure 14. When the bus voltage is applied, the V_{CC} capacitor C_{VCC} is charged up until V_{CC} reaches the V_{CC} 'ON' threshold of $V_{CC.ON}$ = 7.5 V. After exceeding this threshold, the IC powers up into the soft start. V_{CON} is charged up, the internal MOSFET starts switching.

There is one fast charge function which is used to charge Con pin quickly to 1.5V after IC start to work.

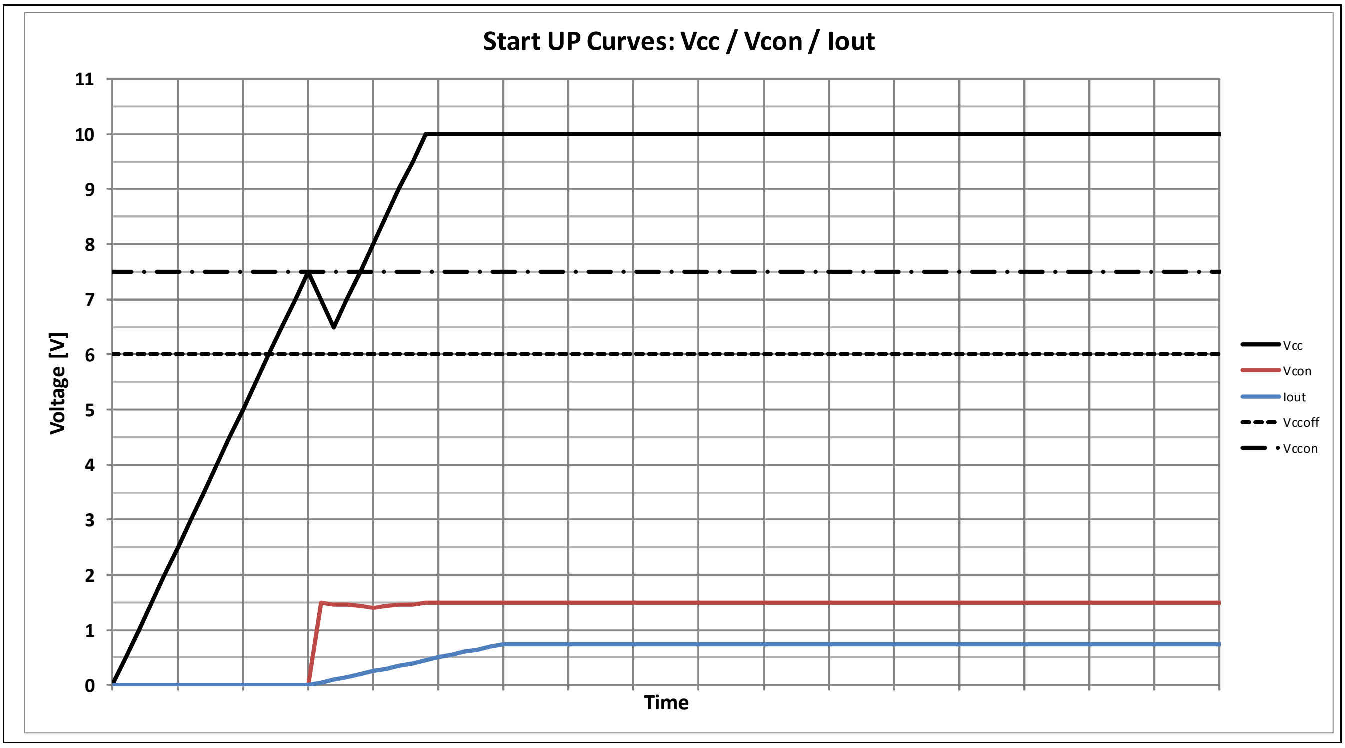

Figure 13 Start Up

4.3.1.2 Start-Up: Soft-Start Phase

During the digital Soft-Start phase, the current sensing voltage V_{CS} is limited from 0.1 V up to 0.4 V. After the soft start phase (24 ms), the peak current sensing voltage threshold is set to V_{CS} = 0.9 V for current limitation. Two additional thresholds are set in order to detect output short and short winding conditions. The first set to be $V_{CSthShort}$ = 0.6 V with no zero current detection as protection against short OUTPUT and second set to be $V_{CSthShort}$ = 1.2 V when a short winding at the BUCK choke, L_{BUCK}, happens. In figure 15, shows the voltage behavior during start-up into normal operation.

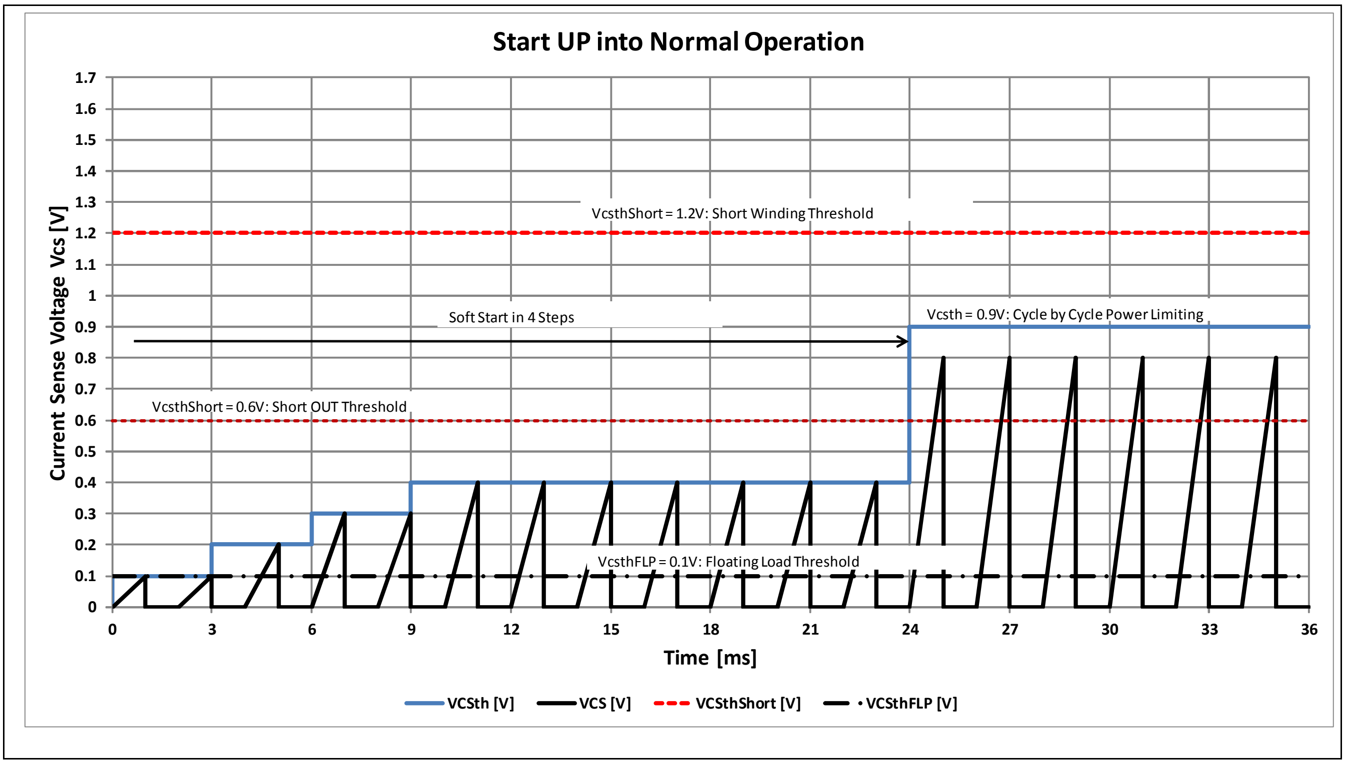

Figure 14 Soft-Start

4.3.1.3 Start-Up: Short Output

During the digital Soft-Start phase, a short output is detected when the current sensing voltage V_{CS} exceeds the $V_{CSthShort}$ = 0.6 V threshold and the internal zero current detection signal is missing. The controller stops working after a consecutive 126 switching cycles and enters into the LATCH OFF mode.

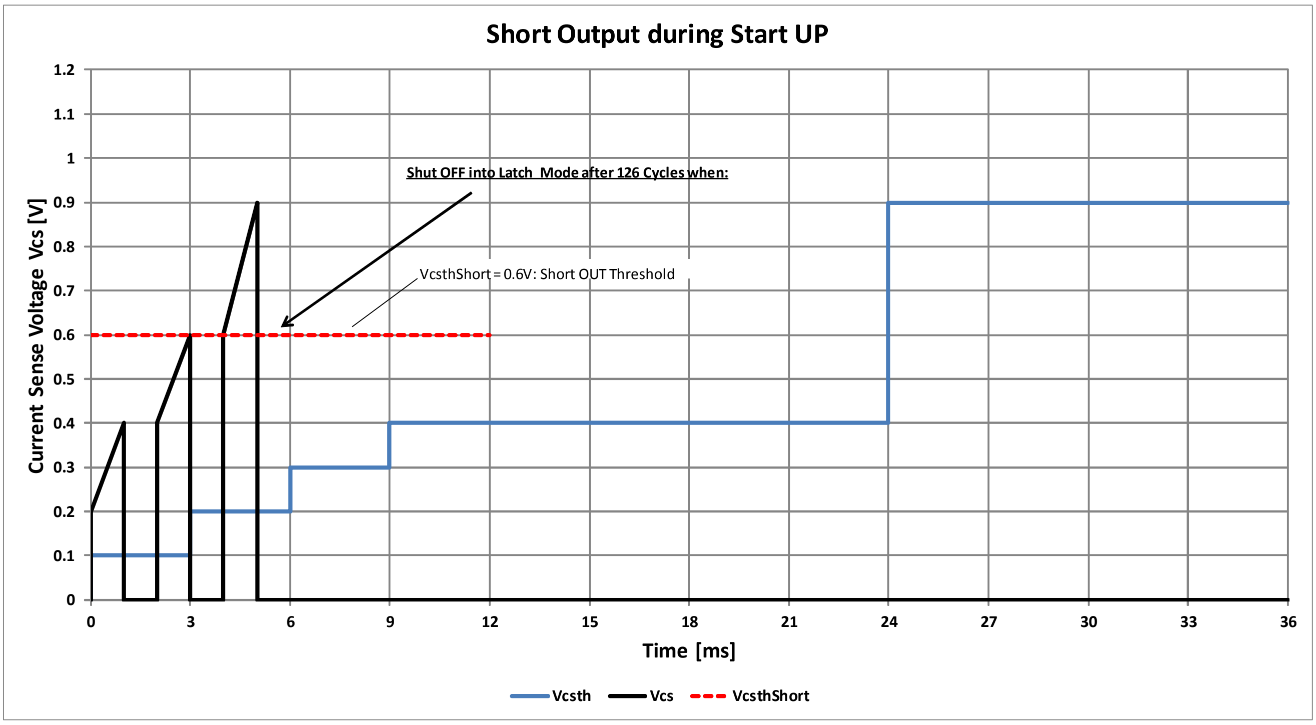

Figure 15 Short Output

4.3.1.4 Start-Up: Floating Load Protection

There is no effective floating load protection available. The risks during open or floating load are that the output voltage will be charged to the same voltage as input. If output capacitor, C_{OUT}, is not selected above the rated input voltage, it is recommended to include an output clamp circuit to prevent output capacitor, C_{OUT}, from operating above its rated voltage during open or floating load conditions.

An open output (floating load) is detected when the current sensing voltage V_{CS} stays below $V_{CSthFLP}$ = 0.12 V for 24 ms (soft start time) + 160 ms. After this blanking time, the controller stops working and enters into the LATCH OFF mode.

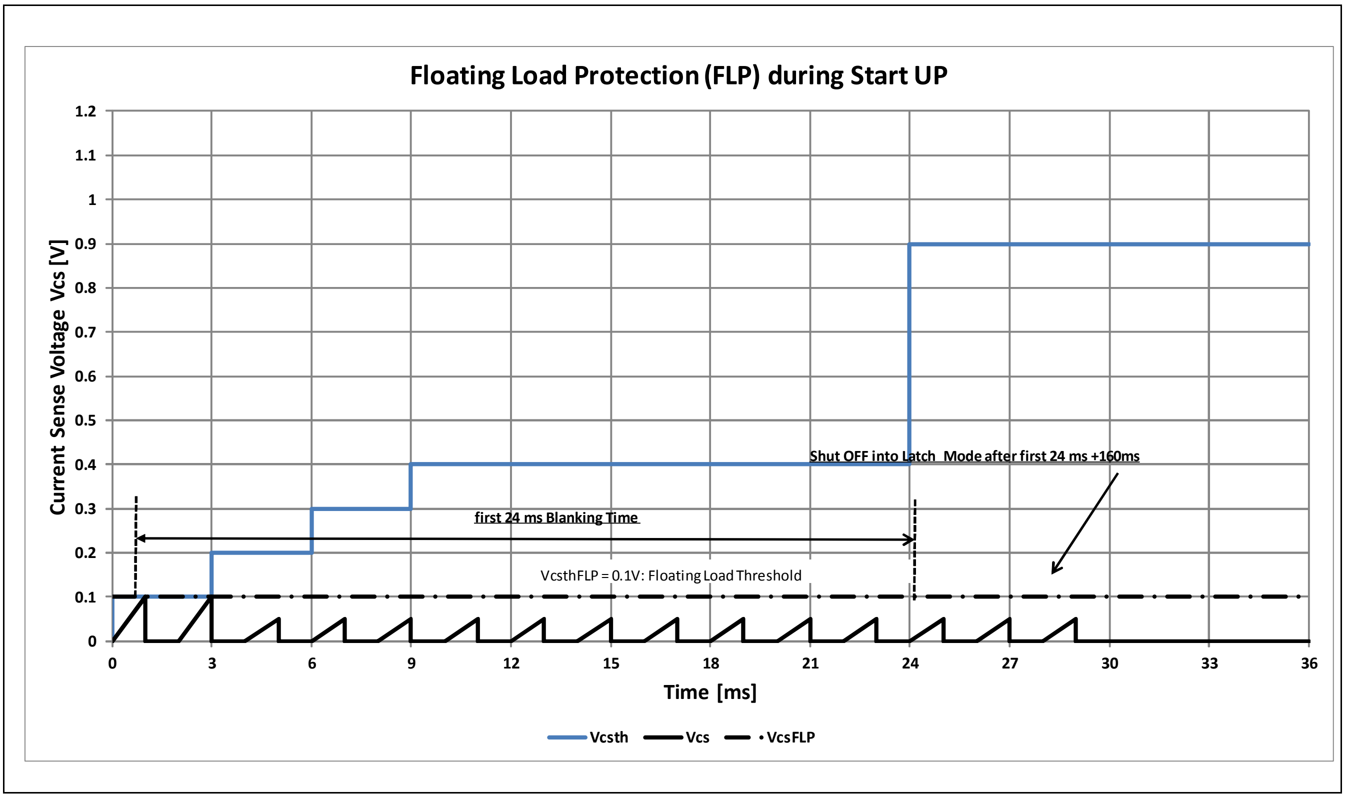

Figure 16 Floating Load Protection

4.3.1.5 Start-Up and Run Mode: Short Winding Protection

A short winding (short on L_{BUCK}) is detected when the current sensing voltage V_{CS} exceeds the $V_{CSthShort}$ = 1.2 V threshold with a blanking time of 100ns and triggered after LEB signal with 3 continuous switching cycles. The controller stops working and enters into the LATCH OFF mode.

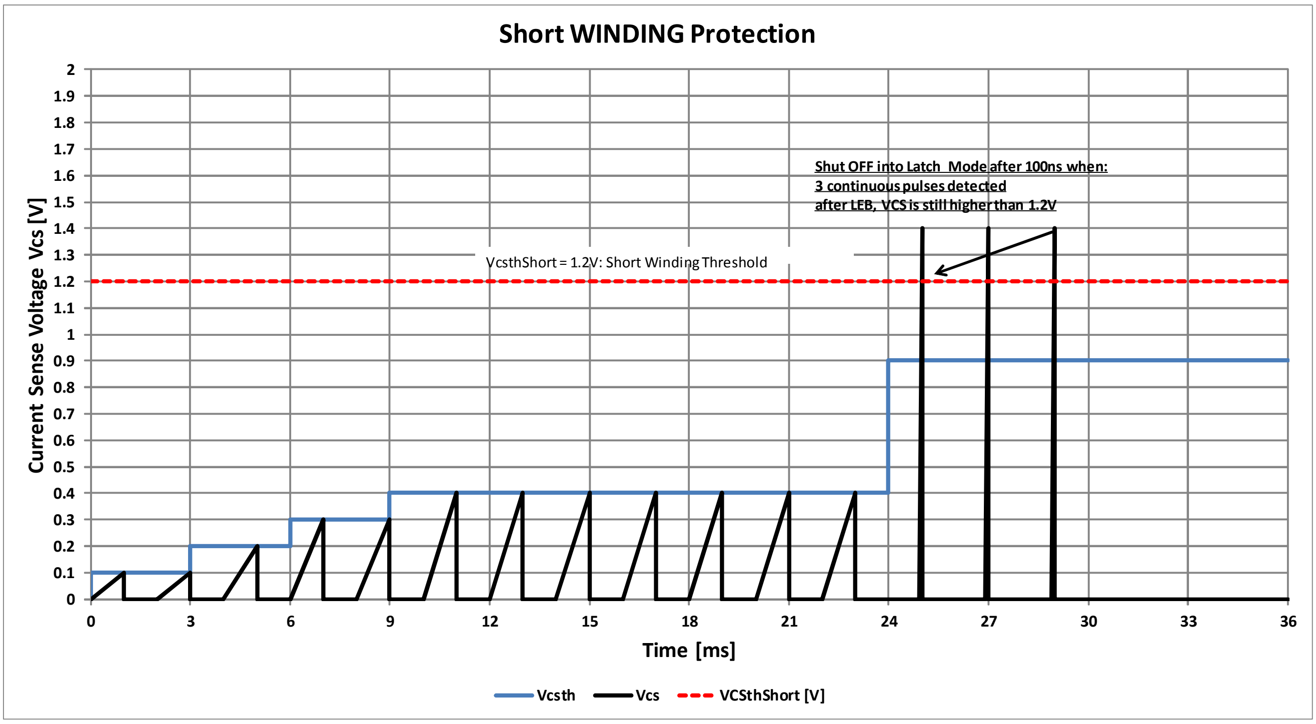

Figure 17 Short Winding Protection

4.3.2 Run Mode behaviour

4.3.2.1 Typical Curves during RUN Mode

The chart below shows the typical curves of a BUCK converter:

The black signal is the drain-to-source voltage of the MOSFET
The blue signal is the MOSFET current during ON time
The red signal shows the inductor current through the BUCK choke
The red signal is the voltage at the BUCK choke
Purple is the current through the free-wheeling diode when the MOSFET is turned OFF

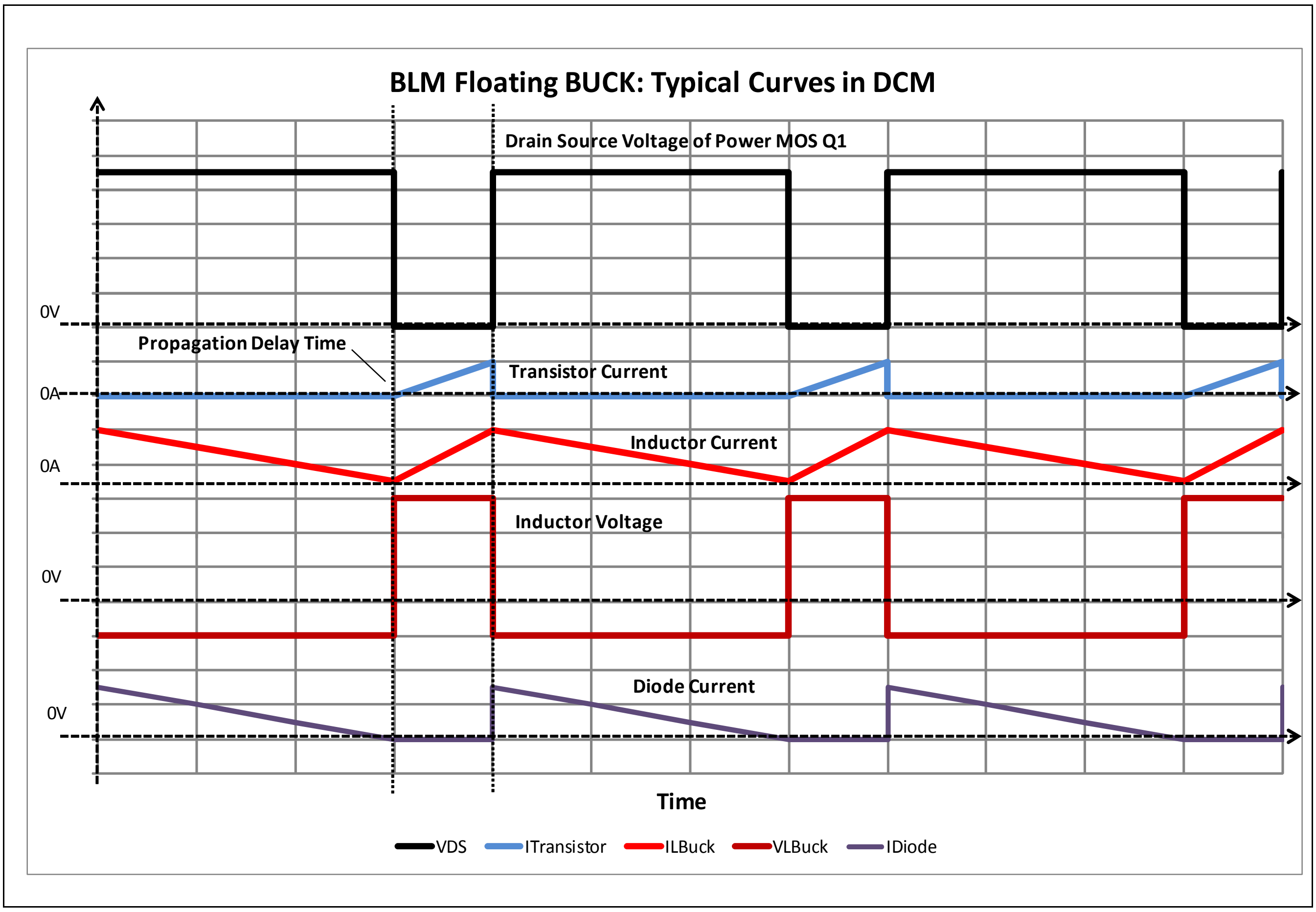

Figure 18 Typical Curves for Floating BUCK Topology

4.3.2.2 Run Mode: Short Output

During normal operation (RUN mode), a short output is detected when the current sensing voltage V_{CS} exceeds the $V_{CSthShort}$ = 0.6 V threshold and the internal zero current detection signal is missing. The controller stops working after 126 switching cycles and enters into the LATCH OFF mode.

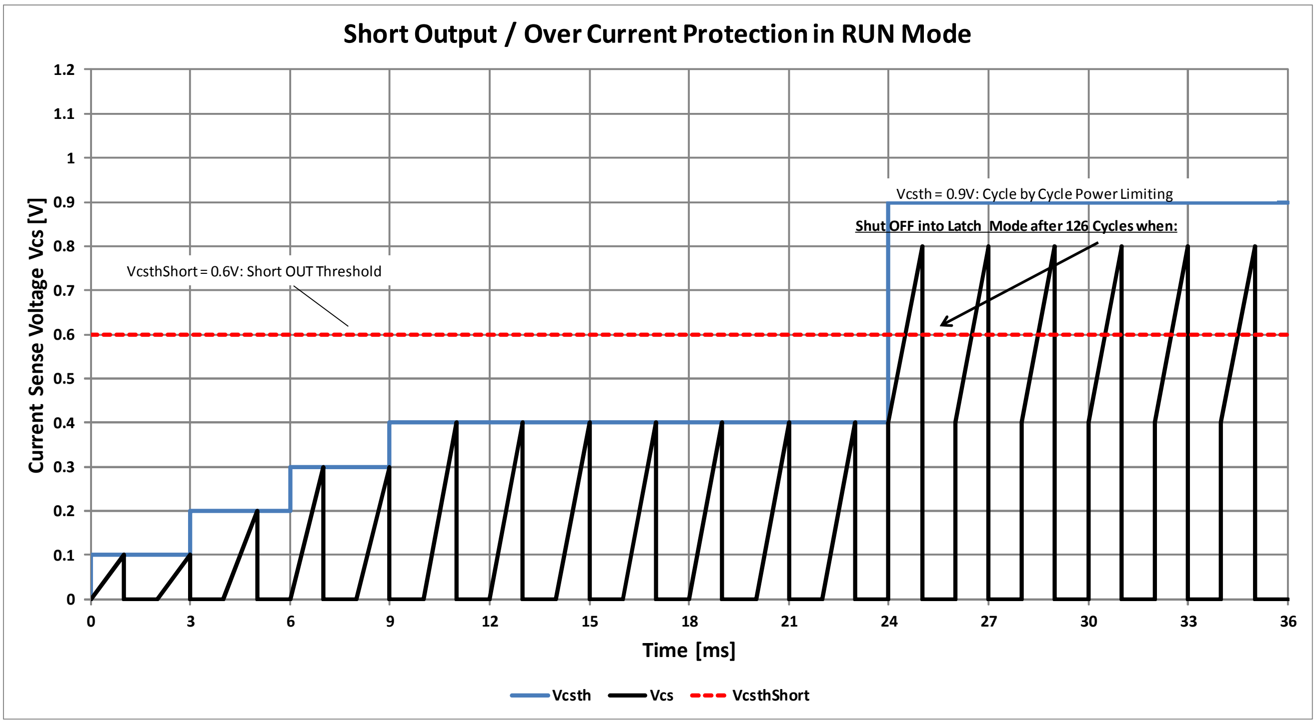

Figure 19 **Short Output During Run Mode**

4.3.2.3 Run Mode: Floating Load Protection

There is no effective floating load protection available. The risks during open or floating load are that the output voltage will be charged to the same voltage as input. If output capacitor, C_{OUT}, is not selected above the rated input voltage, it is recommended to include an output clamp circuit to prevent output capacitor, C_{OUT}, from operating above its rated voltage during open or floating load conditions.

An open output (floating load) is detected when the current sensing voltage V_{CS} stays below the $V_{CSthFLP}$ = 0.12 V threshold. The controller stops working after 160 ms blanking time and enters into the LATCH OFF mode.

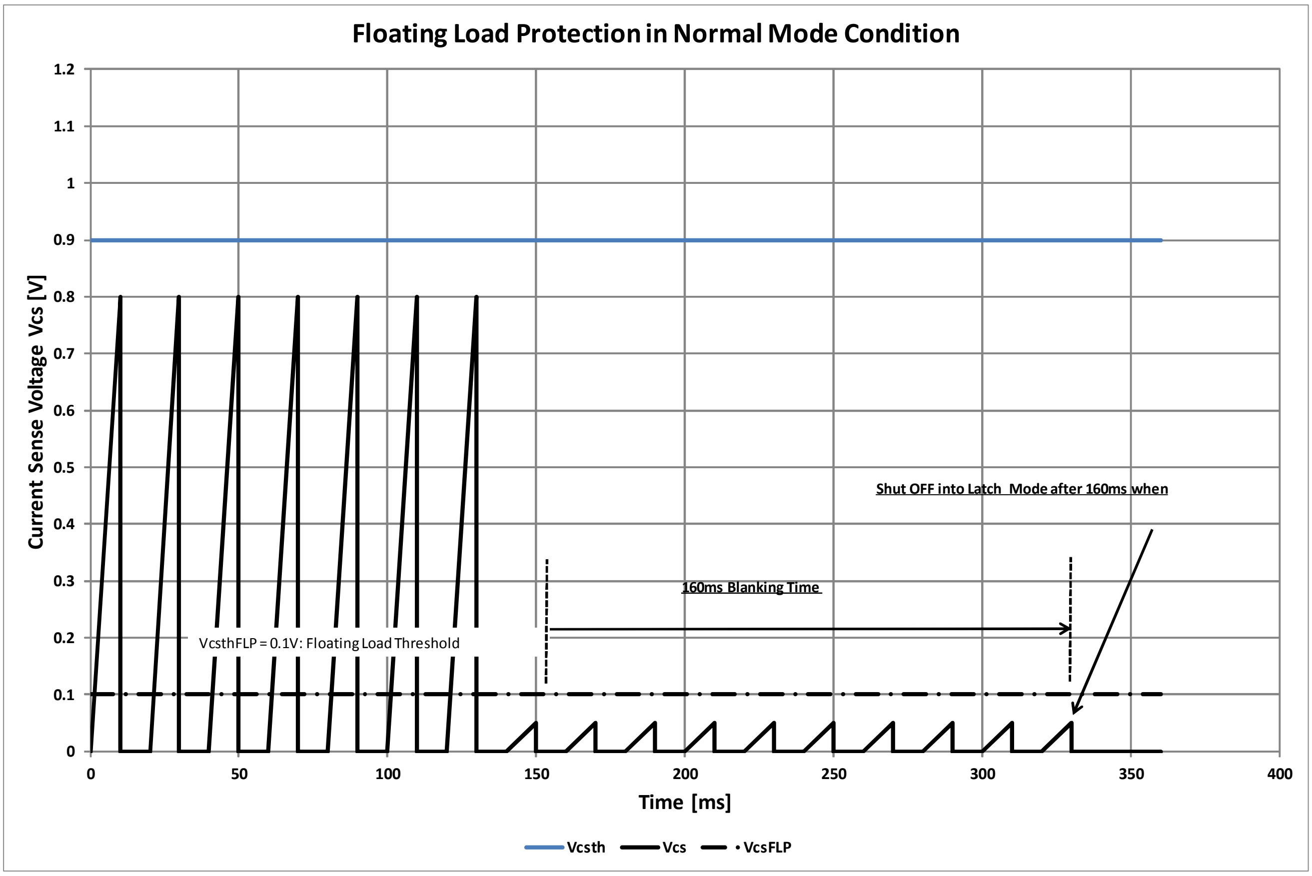

Figure 20 Floating Load Protection in Run Mode

4.3.3 Intelligent Over-Temperature Protection (iOTP)

The chart below shows the digital integrated intelligent over-temperature protection. In the event of overheating of the IC (T_j > 150 °C), the integrated thermal sensing on the IC reduces the output current (black signal) in 7 digital steps down to 50% of the target value of I_{OUT}. This thermal downgrading is independent of time. When the temperature decreases, the IC returns in reverse into the value which is allowed, or back to the target value of I_{OUT}. If the temperature continues to increase and exceeds T_j > 160 °C, the IC will enter LATCH OFF mode.

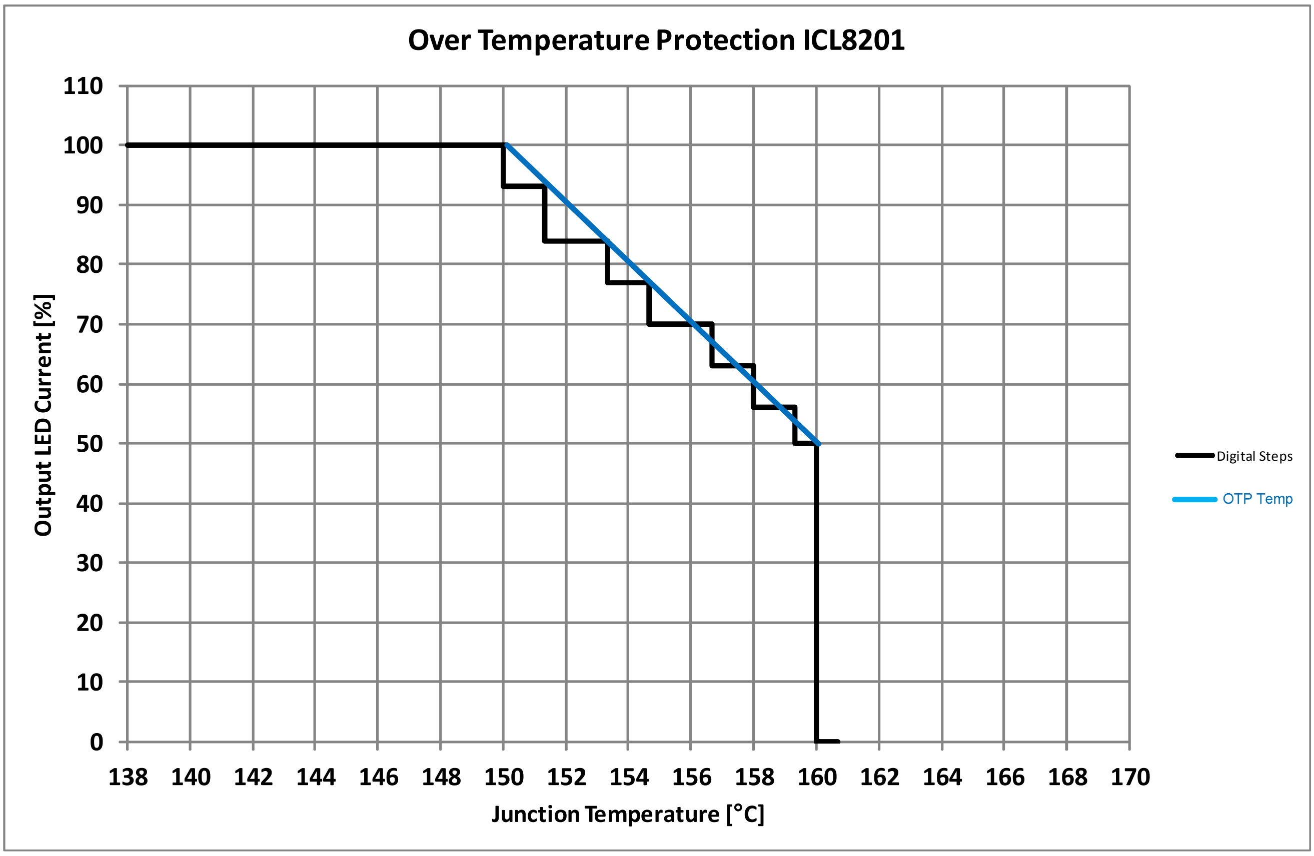

Figure 21 Intelligent Over-Temperature Protection iOTP

4.3.4 IC Working and Typical BUCK Curves

4.3.4.1 Critical Conduction operation with Constant T_{ON} Time and variable Frequency

The chart below shows the working behavior over one AC half-cycle in critical conduction operation with constant t_{ON} time (see Gate Voltage) with variable frequency. The red signal shows the primary current through the MOSFET during ON time. The secondary (free-wheeling diode) current is shown in black.

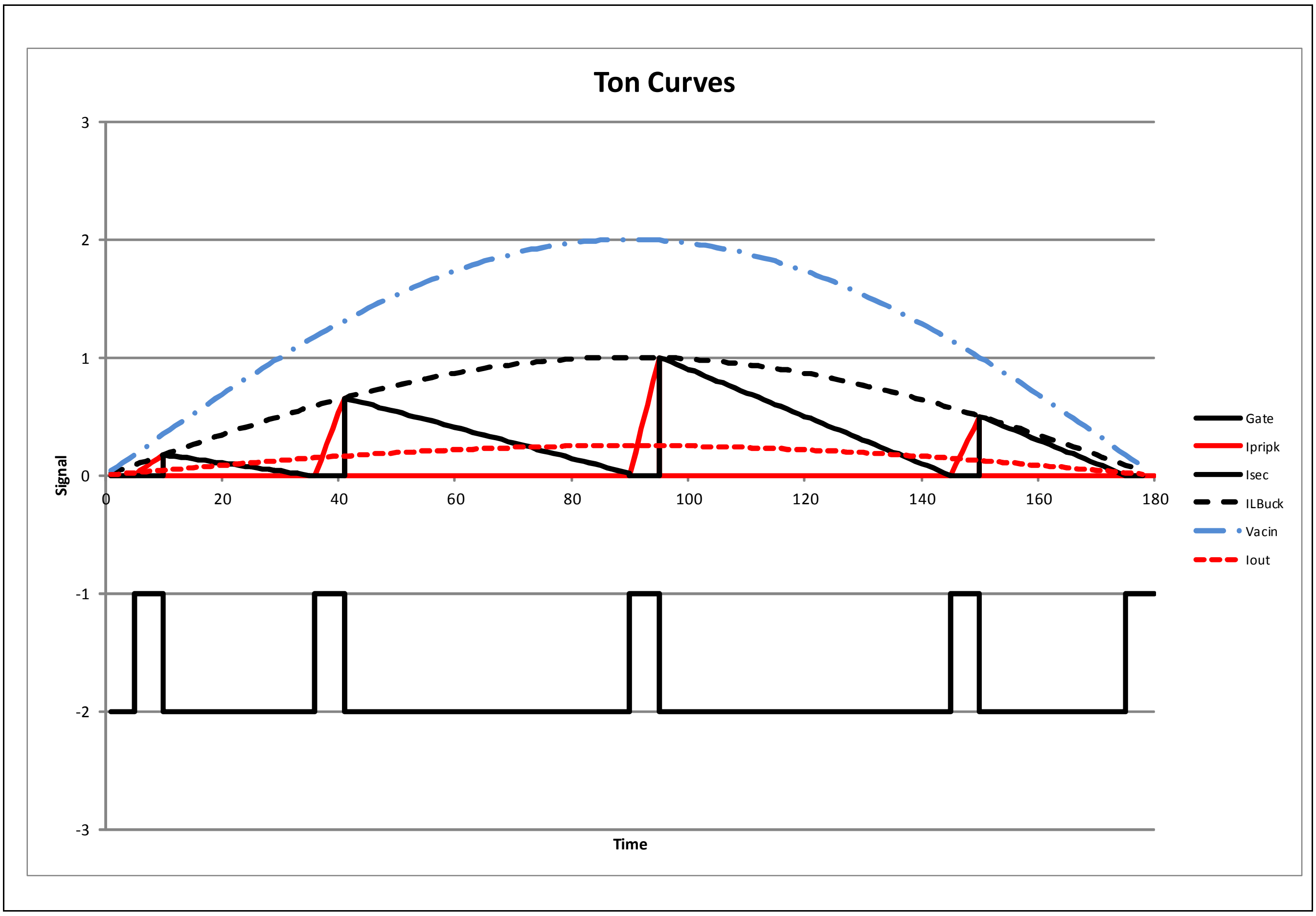

Figure 22 T_{ON} Characteristics

4.3.4.2 Typical Curves of a BUCK Converter

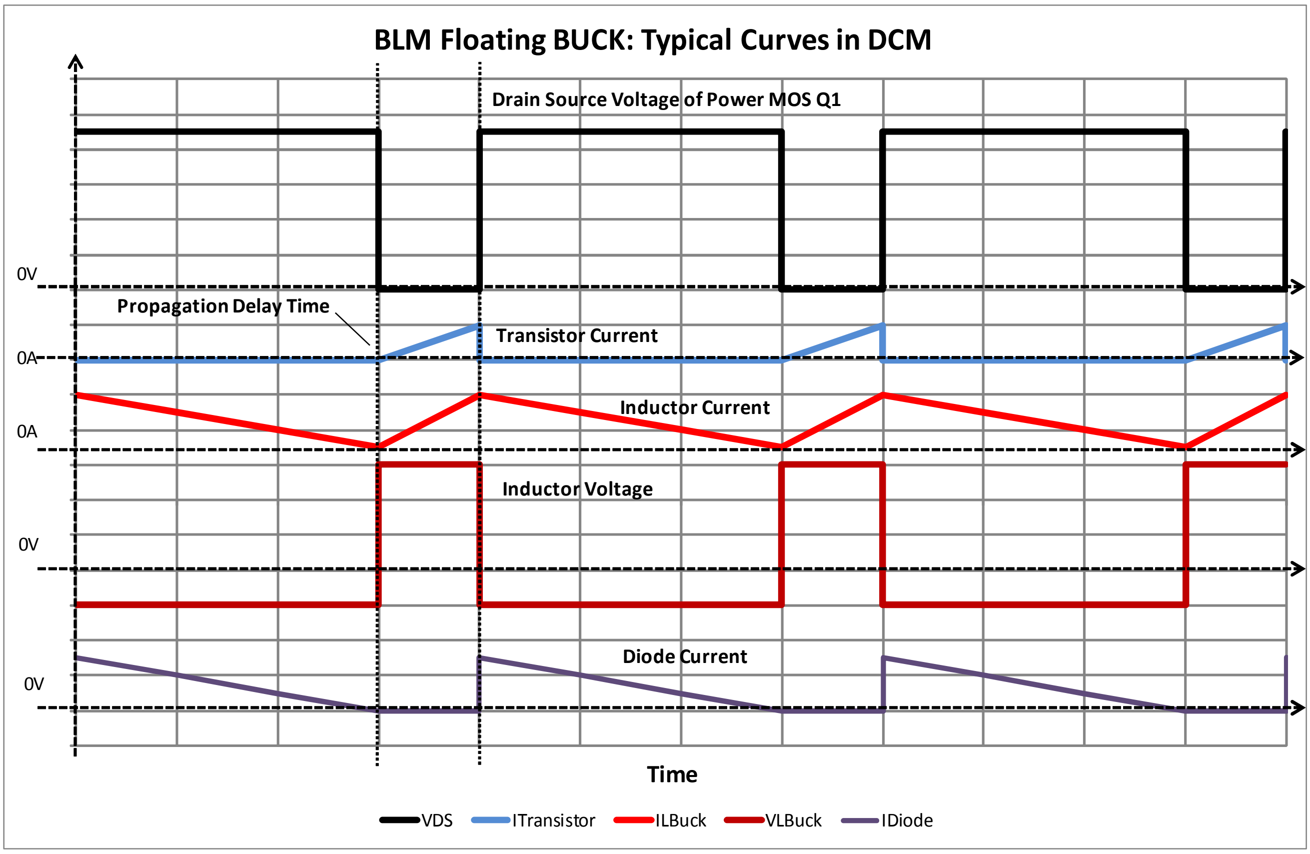

Figure 23 Typical Curves of a Floating BUCK converter

5 Absolute Maximum Ratings and thermal Characteristics

5.1 Absolute Maximum Ratings

Absolute maximum ratings are defined as ratings, which when exceeded may lead to destruction of the Integrated Circuit. For the same reason make sure that any capacitor connected to pin 3 (V_{CC}) is discharged before assembling the application circuit.

Table 7 Absolute Maximum Ratings

Parameter	Symbol	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Supply voltage	V_{CC}	-0.3	-	18	V	-
Con	V_{Con}	-0.3	-	3.3	V	-
V_{CS}	V_{CS}	-0.3	-	3.3	V	-
DRAIN	V_{DRAIN}	-0.3	-	27	V	-
Maximum Peak Drain current	$I_{DRAINPeak}$	-	-	2.65	A	*For DC Input less than 31% Duty Cycle*
Maximum DC Drain current	I_{DRAIN}	-	-	400	mA	
CS Shunt Resistor	R_{CS}	0.34	-	-	Ω	
ESD capability at all pins	V_{ESD_HBM}	-	-	2	kV	HBM according to. JESD22-A114

Attention:** **Stresses above the maximum values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

5.2 Thermal Characteristics

Table 8 Maximum Thermal Resistance

Parameter	Symbol	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Junction temperature range	T_j	-25	-	150	°C	
Storage temperature range	T_{STG}	-65	-	150	°C	
Total power dissipation	P_{tot}	-	-	0.12	W	
Junction-ambient point[1]	R_{thja}	-	264	-	K/W	Based on footprint only at 105 °C ambient temperature.

1 For calculation of R_{thJS}, please refer to application note AN077 (Thermal Resistance Calculation)

The major part of the IC power dissipation is caused by the switch resistance in the conductive state. Therefore **Equation 6.1** is an initial estimation used to calculate the power dissipation of the IC:

$$P_{out} = R_{ON} \times I_{OUT}^2 \quad (6.1)$$

6 Electrical Characteristics

All voltages without the high-side signals are measured in reference to ground (pin 2 & 5). The voltage levels are valid if other ratings are not violated.

6.1 DC Characteristics

All parameters at T_{amb} = +25 °C, unless otherwise specified.

Table 9 DC Characteristics

Parameter	Symbol	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Operating supply voltage	V_{CC}	$V_{CC.OFF}$	-	18	V	-
Under-Voltage Lock-Out	$V_{CC.OFF}$	5.7	6.0	6.5	V	IC deactivated[1]
	$V_{CC.ON}$	7.2	7.5	8.0	V	IC operating
Supply current consumption open load	$I_{CC.open.load}$	0.60	0.82	1.10	mA	I_{LED}=0 mA
Supply current consumption during latch	$I_{CC.latch}$	0.10	0.14	0.21	mA	V_{CC}=5.5V, V_{CS}=0.85V
Short winding current protection VCS threshold	$V_{CS.OCP}$	1.16	1.20	1.27	V	
Output load short protection VCS threshold	$V_{CS.OLP}$	0.58	0.62	0.66	V	No zero current crossing is detected
Output load short protection blanking time	$t_{out.SO}$	-	126	-	Switching cycle	
Output floating load protection VCS threshold voltage	$V_{CS.FLP}$	0.08	0.12	0.17	V	
Output floating load protection blanking time	$T_{out.FLP}$	-	160	-	ms	
Peak VCS limitation voltage threshold	V_{CSpeak}	0.84	0.90	0.96	V	
Soft thermal protection temperature threshold	$T_{OTP.start}$	140	150	160	°C	Junction temperature
Soft thermal protection temperature range	$T_{OTP.range}$	-	10	-	°C	Junction temperature
Hard thermal protection temperature threshold	$T_{OTP.off}$	150	160	170	°C	Junction temperature
Peak VCS amplifier gain	G	-	3.5	-	V/V	
Con threshold voltage	$V_{Con.TH}$	1.47	1.50	1.53	V	

1 IC is deactivated once the supply voltage drops below $V_{CC.OFF}$ and becomes operative once the supply voltage rises above $V_{CC.ON}$

6.2 Switching Characteristics

All parameters at T_{amb} = +25 °C, unless otherwise specified.

Table 10 Switching Characteristics

Parameter	Symbol	Values			Unit	Test Condition
		Min.	Typ.	Max.		
Switching frequency	f_{switch}	40	-	150	kHz	
Minimum On time	t_{onmin}	-	-	800	ns	
Maximum On time	t_{onmax}	20	-	-	µs	
Maximum Off time	t_{offmax}	30	40	-	µs	
Leading Edge Blanking Time	t_{LEB}	110	205	300	ns	
Preset Soft-Start time	t_{SS}	17	24	31	ms	
LED Output current drift over supply voltage	$I_{out\cdot Vs}$	-	±5	-	%	
LED Output current drift over temperature	$I_{out\cdot Ts}$	-	±5	-	%	For ambient temperature -25°C to +85°C
LED Output current drift over load	$I_{out\cdot load}$	-	±5	-	%	V_{OUT} = 20V up to 60% V_{IN}
Switch on resistance	$R_{ON\cdot 25°C}$	-	370	470	mΩ	I_{SWpeak}=0.5 A, T_J=+25°C
Switch on resistance	$R_{ON\cdot 150°C}$	-	530	610	mΩ	I_{SWpeak}=0.5 A, T_J=+150°C

7 Application Example

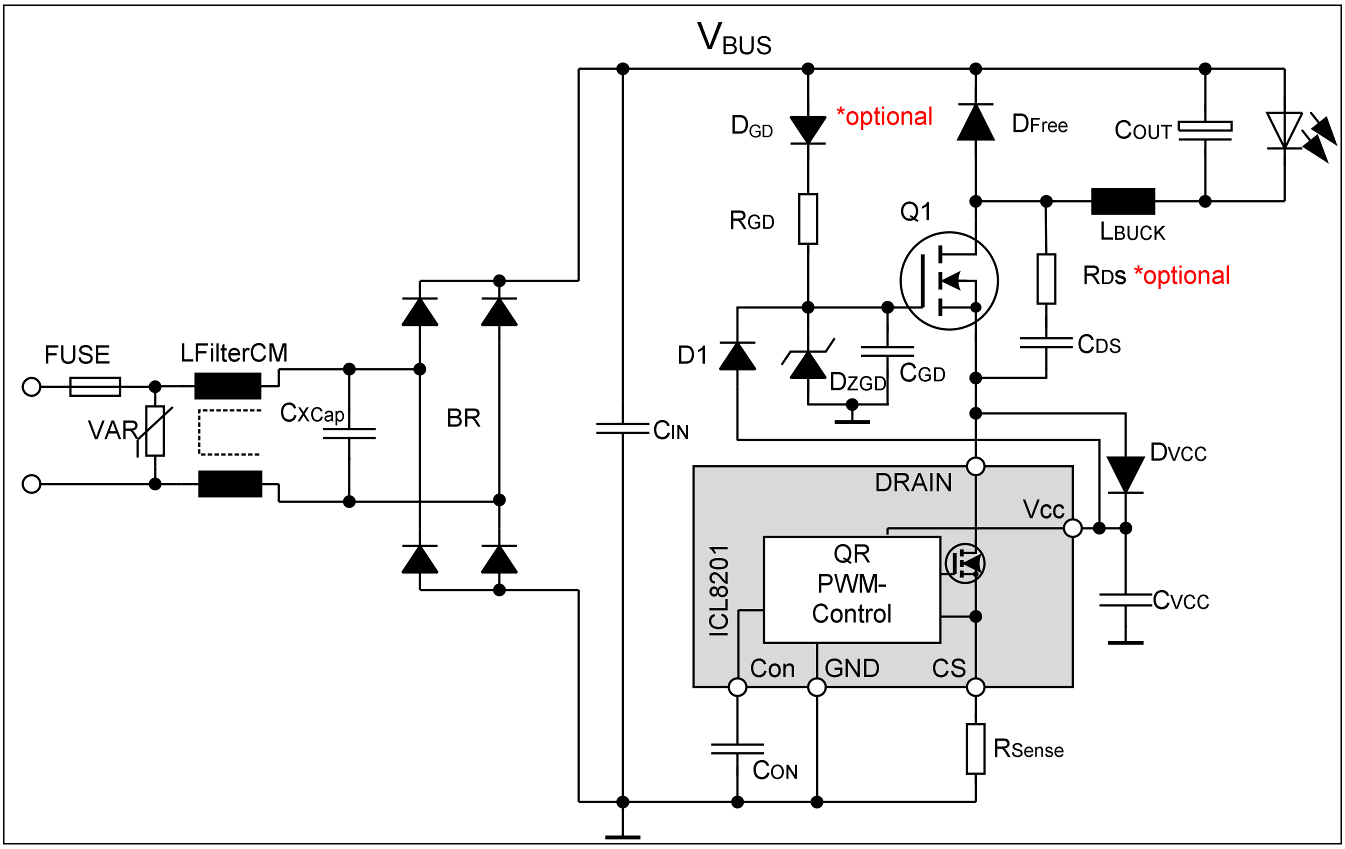

Figure 24 Application Circuit for a 10W LED Lamp

8 Bill of Materials

ICL8201 BOM : Floating BUCK Single Choke			
Design: Demonstrator	QR Floating BUCK using ICL8201		
Input Voltage: V_{ACIN} =	110 - 275		V_{ACIN}
LED Voltage: V_{LED} =	24		V_{OUT}
LED Current: I_{LED} =	350		mA
Nr.	Component	Value	Package
1	FUSE	OnBoard	-
2	Varistor	175V / S10K275	EPCOS
3	IC	ICL8201	PG-SOT23-6-1
4	Q	500V CoolMOS	DSO
5	BR	DBL106	SMD
6	D_{FREE}	MURS160	SMB
7	D_{ZGD}	BZX84C20	MiniMelf
8	D_{VCC}	LL4148	MiniMelf
9	D_1	LL4148	MiniMelf
10	C_{XCap}	47nF / 275V~X	RM5
11	C_{IN}	33nF / 400VAC	RM5
12	C_{VCC}	10µF / 35V	1206 Ceramic
13	C_{GD}	100nF / 50V	1206 Ceramic
14	C_{DS}	120pF / 400V	1206 Ceramic
15	C_{ON}	2.2µF / 50V	1206 Ceramic
16	C_{OUT}	10µF	
17	$L_{FilterCM}$	2X45mH/0.3A	Wurth: 750311650
18	L_{BUCK}	470µH	Single Choke Buck Inductor
19	R_{GD}	1.0MΩ	RM10
20	R_{SENSE}	0.5Ω	1206

Figure 25 Bill of Materials(BOM)

9 Package Outline

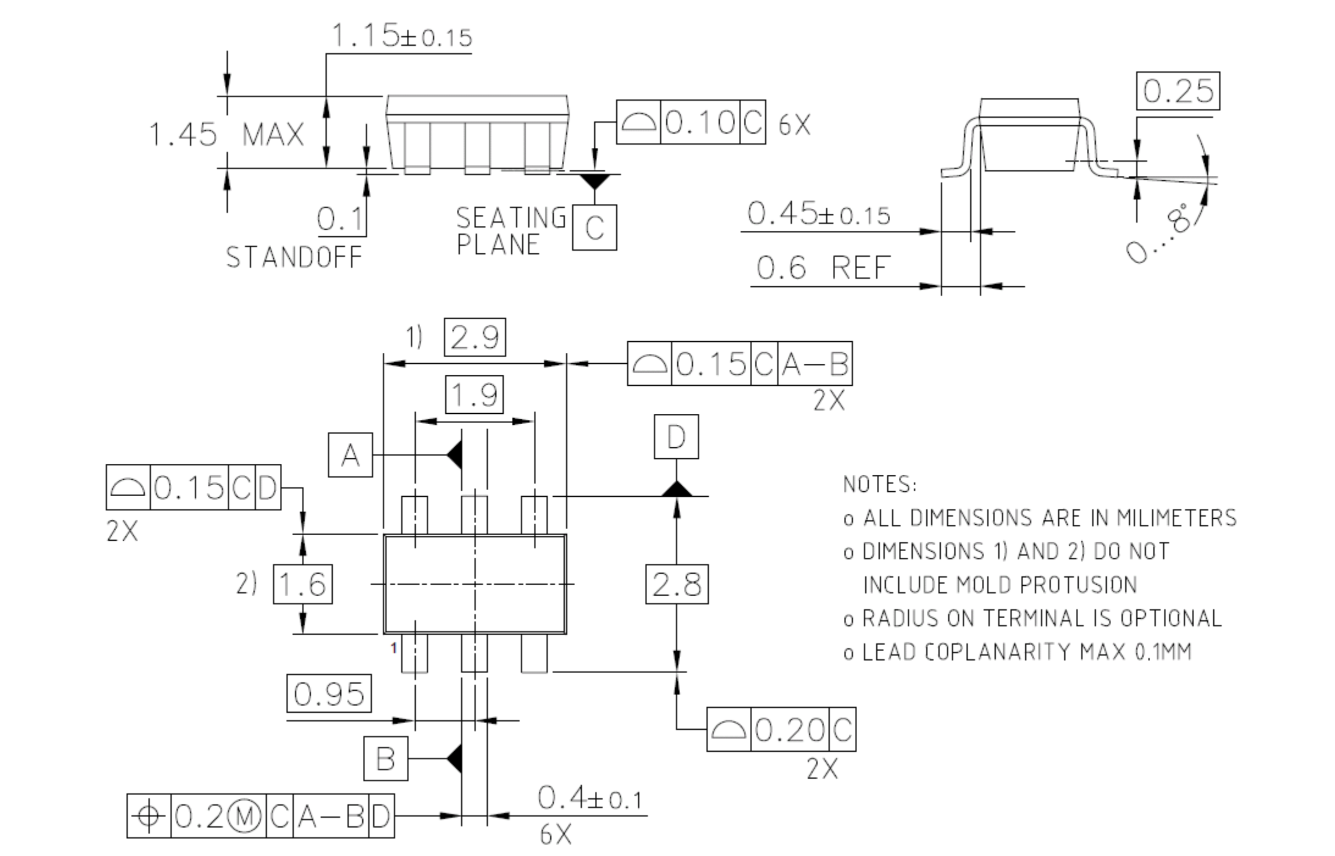

Figure 26 Package Outline (dimensions in mm)

w w w . i n f i n e o n . c o m

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