Datasheet, Version 2.0, August 2001

Preliminary Data

CoolSET™-F2

ICE2A765P

ICE2B765P

Off-Line SMPS Current Mode Controller with integrated 650V CoolMOS™

Power Management & Supply

Infineon technologies

Never stop thinking.

CoolSET™-F2

Revision History:	**2001-08-20**	Datasheet
Previous Version:	V1.2	

Page	Subjects (major changes since last revision)
	ICE2A765P is added

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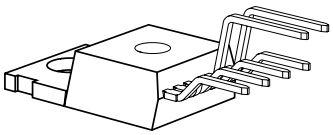
Off-Line SMPS Current Mode Controller with integrated 650V CoolMOS™

Product Highlights

- **Isolated Drain Package**
- **Lowest Standby Power Dissipation**
- **Enhanced Protection Functions all with Auto Restart Mode**



P-TO220-6-3

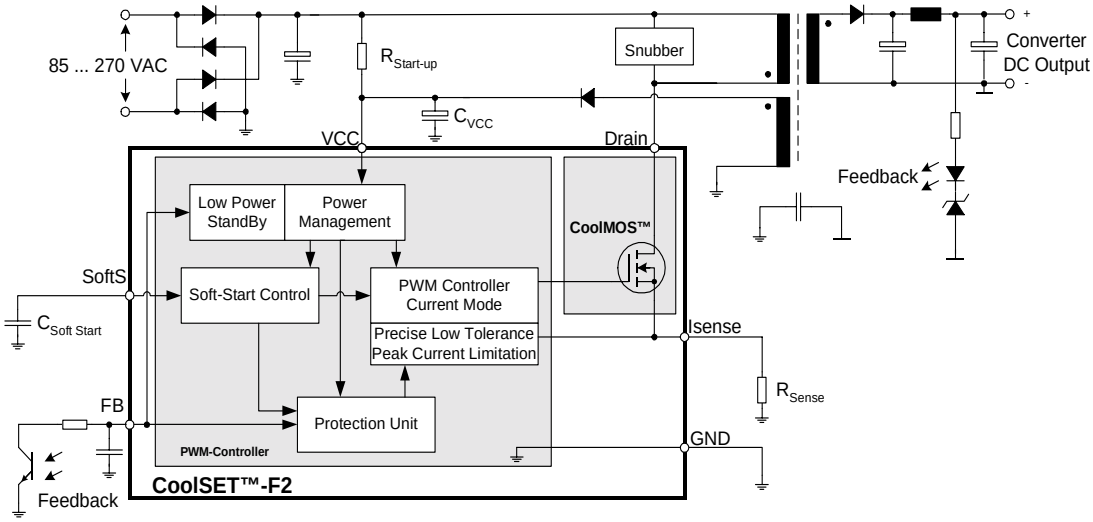
Features

- 650V Avalanche Rugged CoolMOS™
- Only few external Components required
- Input Undervoltage Lockout
- 67kHz/100kHz Switching Frequency
- Max Duty Cycle 72%
- Low Power Standby Mode to support "Blue Angle" Norm
- Thermal Shut Down with Auto Restart
- Overload and Open Loop Protection
- Overvoltage Protection during Auto Restart
- Adjustable Peak Current Limitation via External Resistor
- Overall Tolerance of Current Limiting < ±5%
- Internal Leading Edge Blanking
- User defined Soft Start
- Soft Switching for Low EMI

Description

The second generation COOLSET™-F2 provides several special enhancements to satisfy the needs for low power standby and protection features. In standby mode frequency reduction is used to lower the power consumption and support a stable output voltage in this mode. The frequency reduction is limited to 20kHz / 21.5 kHz (typ.) to avoid audible noise. In case of failure modes like open loop, overvoltage or overload due to short circuit the device switches in Auto Restart Mode which is controlled by the internal protection unit. By means of the internal precise peak current limitation the dimension of the transformer and the secondary diode can be lower which leads to more cost efficiency.

Typical Application



Type	Ordering Code	Package	U_{DS}	F_{OSC}	R_{DSON} [1]	230VAC ±15% [2]	85-265 VAC [2]
ICE2A765P	Q67040-S4533	P-TO-220-6-3	650V	100kHz	0.5Ω	240W	130W
ICE2B765P	Q67040-S4532	P-TO-220-6-3	650V	67kHz	0,5Ω	240W	130W

1) typ. value @ T=25°C
2) Maximum practical continous power in an open frame design at 75°C ambient, Tj=125°C, Rth=2.7K/W

Table of Contents Page

1 Pin Configuration and Functionality

1.1 Pin Configuration

Pin	Symbol	Function
1	Drain	650V[1] CoolMOS™ Drain
3	Isense	650V[1] CoolMOS™ Source
4	GND	Controller Ground
5	VCC	Controller Supply Voltage
6	SoftS	Soft-Start
7	FB	Feedback

1) at T_j = 110°C

Package P-TO220-6-3

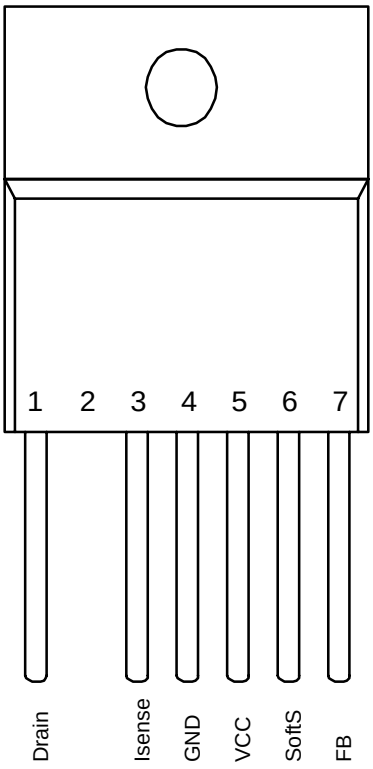


Figure 1 Pin Configuration (top view)

1.2 Pin Functionality

SoftS (Soft Start & Auto Restart Control)

This pin combines the function of Soft Start in case of Start Up and Auto Restart Mode and the controlling of the Auto Restart Mode in case of an error detection.

FB (Feedback)

The information about the regulation is provided by the FB Pin to the internal Protection Unit and to the internal PWM-Comparator to control the duty cycle.

Isense (Current Sense)

The Current Sense pin senses the voltage developed on the series resistor inserted in the source of the integrated CoolMOS™. When Isense reaches the internal threshold of the Current Limit Comparator, the Driver output is disabled. By this means the Over Current Detection is realized.

Furthermore the current information is provided for the PWM-Comparator to realize the Current Mode.

Drain (Drain of integrated CoolMOS™)

Pin Drain is the connection to the Drain of the internal CoolMOS™.

VCC (Power supply)

This pin is the positiv supply of the IC. The operating range is between 8.5V and 21V.

To provide overvoltage protection the driver gets disabled when the voltage becomes higher than 16.5V during Start Up Phase.

GND (Ground)

This pin is the ground of the primary side of the SMPS.

2 Representative Blockdiagram

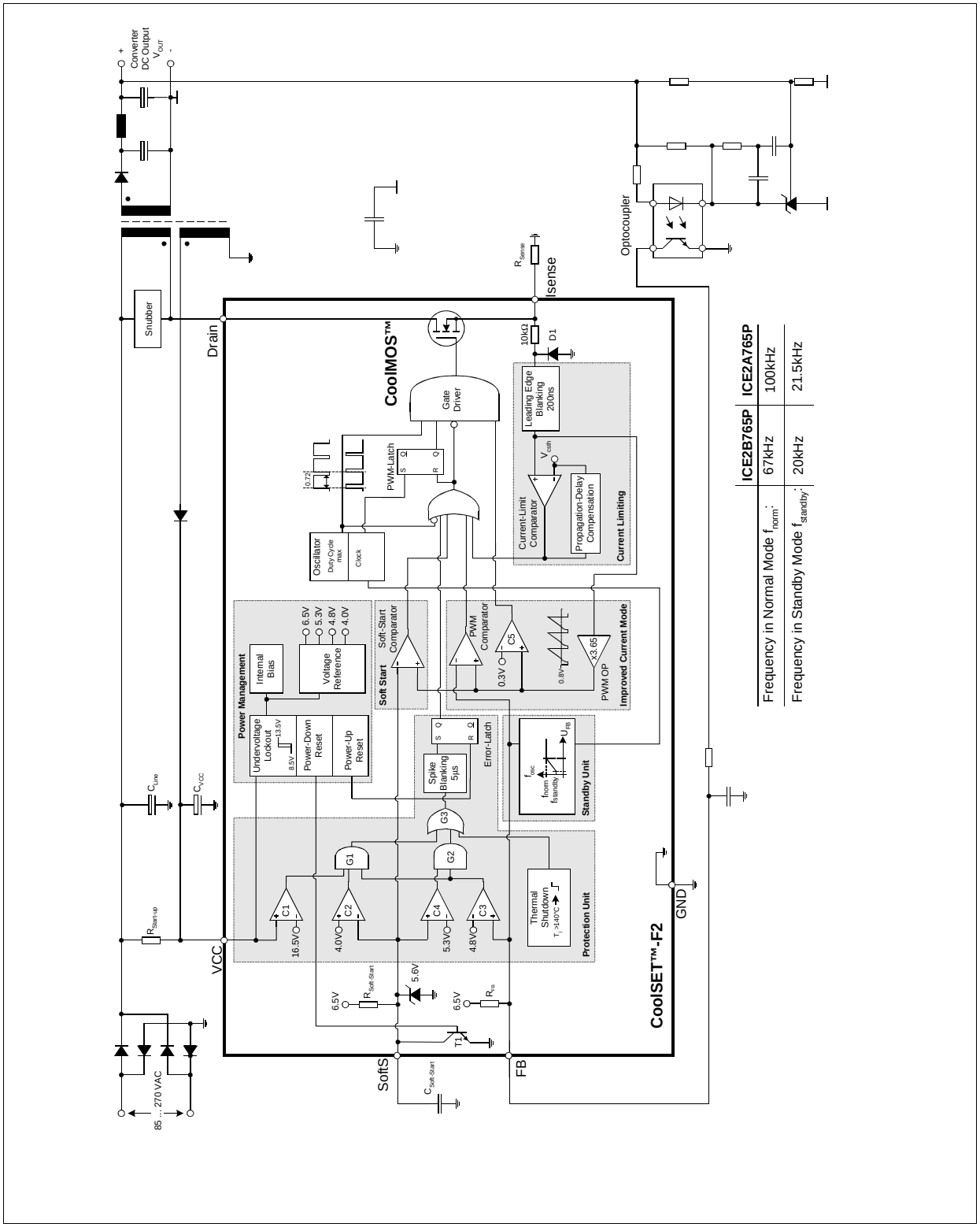


Figure 2 Representative Blockdiagram

3 Functional Description

3.1 Power Management

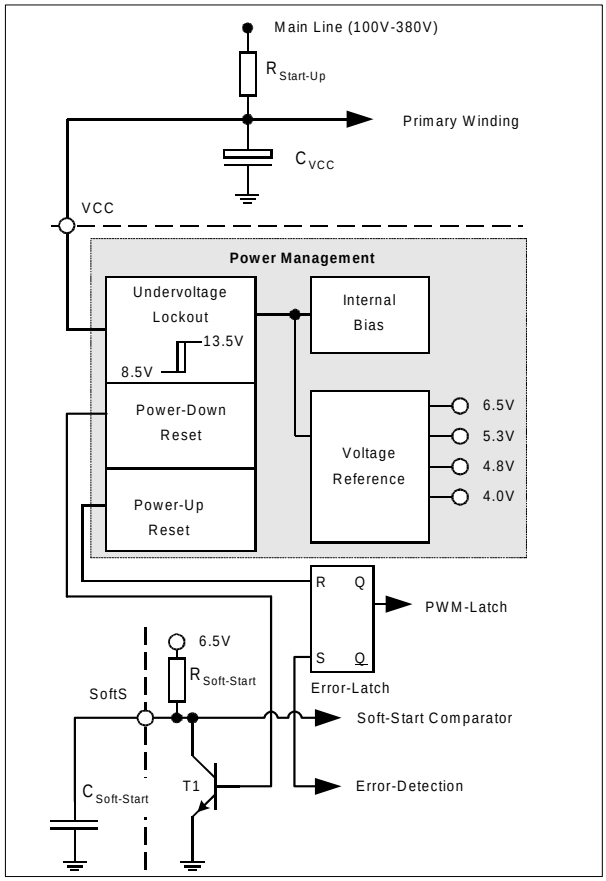


Figure 3 Power Management

The Undervoltage Lockout monitors the external supply voltage V_{VCC}. In case the IC is inactive the current consumption is max. 55µA. When the SMPS is plugged to the main line the current through $R_{Start-up}$ charges the external Capacitor C_{VCC}. When V_{VCC} exceeds the on-threshold V_{CCon}=13.5V the internal bias circuit and the voltage reference are switched on. After it the internal bandgap generates a reference voltage V_{REF}=6.5V to supply the internal circuits. To avoid uncontrolled ringing at switch-on a hysteresis is implemented which means that switch-off is only after active mode when Vcc falls below 8.5V.

In case of switch-on a Power Up Reset is done by reseting the internal error-latch in the protection unit.

When V_{VCC} falls below the off-threshold V_{CCoff}=8.5V the internal reference is switched off and the Power Down reset let T1 discharging the soft-start capacitor $C_{Soft-Start}$ at pin SoftS. Thus it is ensured that at every switch-on the voltage ramp at pin SoftS starts at zero.

3.2 Improved Current Mode

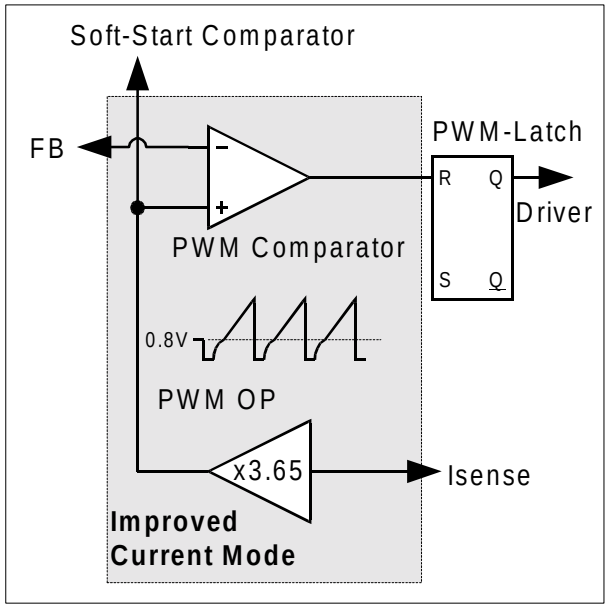


Figure 4 Current Mode

Current Mode means that the duty cycle is controlled by the slope of the primary current. This is done by comparison the FB signal with the amplified current sense signal.

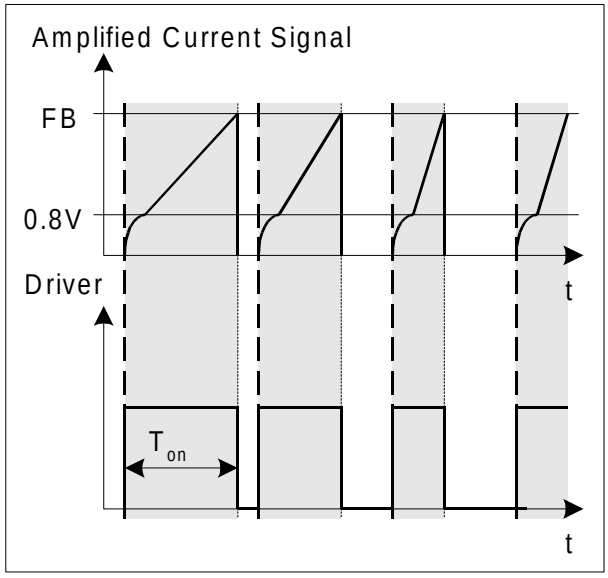


Figure 5 Pulse Width Modulation

In case the amplified current sense signal exceeds the FB signal the on-time T_{on} of the driver is finished by reseting the PWM-Latch (see Figure 5).

The primary current is sensed by the external series resistor R_{Sense} inserted in the source of the integrated CoolMOS™. By means of Current Mode the regulation of the secondary voltage is insensitive on line variations. Line variation causes varition of the increasing current slope which controls the duty cycle. The external R_{Sense} allows an individual adjustment of the maximum source current of the integrated CoolMOS™.

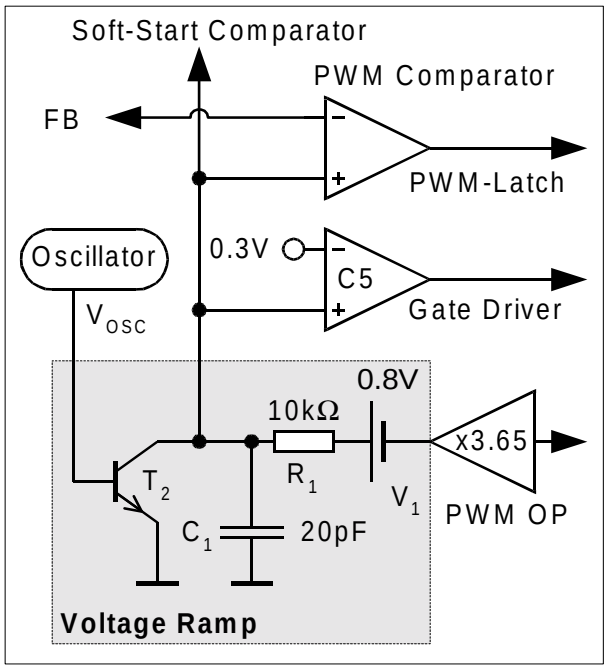


Figure 6 Improved Current Mode

To improve the Current Mode during light load conditions the amplified current ramp of the PWM-OP is superimposed on a voltage ramp, which is built by the switch T_2, the voltage source V_1 and the 1st order low pass filter composed of R_1 and C_1(see Figure 6, Figure 7). Every time the oscillator shuts down for max. duty cycle limitation the switch T2 is closed by V_{OSC}. When the oscillator triggers the Gate Driver T2 is opened so that the voltage ramp can start.

In case of light load the amplified current ramp is to small to ensure a stable regulation. In that case the Voltage Ramp is a well defined signal for the comparison with the FB-signal. The duty cycle is then controlled by the slope of the Voltage Ramp.

By means of the C5 Comparator the Gate Driver is switched-off until the voltage ramp exceeds 0.3V. It allows the duty cycle to be reduced continously till 0% by decreasing V_{FB} below that threshold.

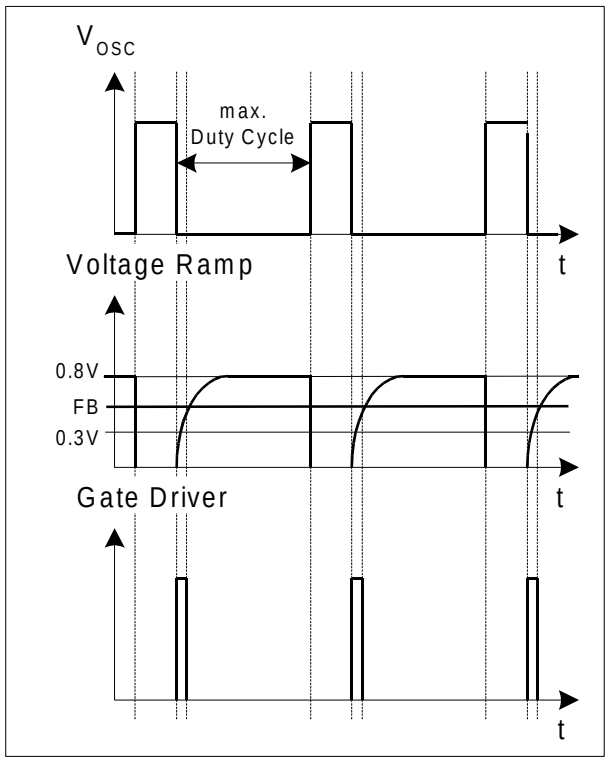


Figure 7 Light Load Conditions

3.2.1 PWM-OP

The input of the PWM-OP is applied over the internal leading edge blanking to the external sense resistor R_{Sense} connected to pin ISense. R_{Sense} converts the source current into a sense voltage. The sense voltage is amplified with a gain of 3.65 by PWM OP. The output of the PWM-OP is connected to the voltage source V1. The voltage ramp with the superimposed amplified current singal is fed into the positive inputs of the PWM-Comparator, C5 and the Soft-Start-Comparator.

3.2.2 PWM-Comparator

The PWM-Comparator compares the sensed current signal of the integrated CoolMOS™ with the feedback signal V_{FB} (see Figure 8). V_{FB} is created by an external optocoupler or external transistor in combination with the internal pullup resistor R_{FB} and provides the load information of the feedback circuitry. When the amplified current signal of the integrated CoolMOS™ exceeds the signal V_{FB} the PWM-Comparator switches off the Gate Driver.

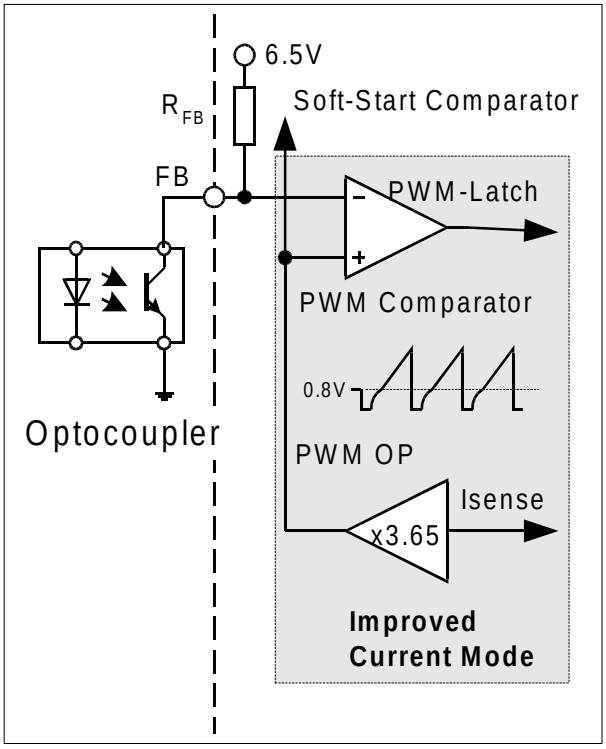


Figure 8 PWM Controlling

3.3 Soft-Start

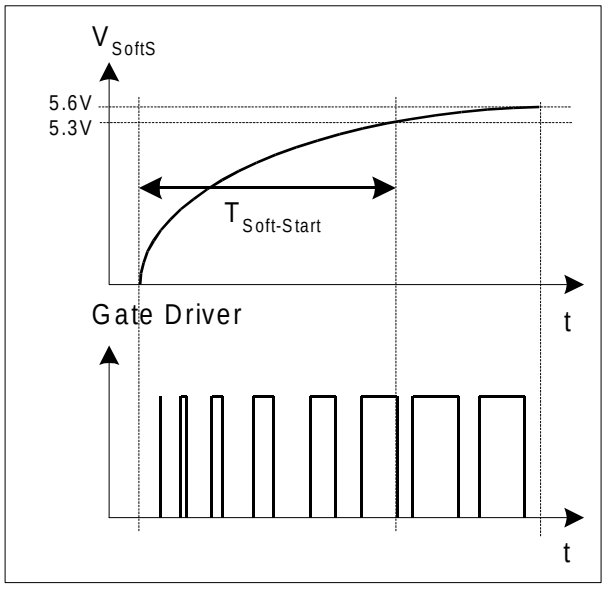


Figure 9 Soft-Start Phase

The Soft-Start is realized by the internal pullup resistor $R_{Soft\text{-}Start}$ and the external Capacitor $C_{Soft\text{-}Start}$ (see Figure 2). The Soft-Start voltage V_{SoftS} is generated by charging the external capacitor $C_{Soft\text{-}Start}$ by the internal pullup resistor $R_{Soft\text{-}Start}$. The Soft-Start-Comparator compares the voltage at pin SoftS at the negative input with the ramp signal of the PWM-OP at the positive input. When Soft-Start voltage V_{SoftS} is less than Feedback voltage V_{FB} the Soft-Start-Comparator limits the pulse width by reseting the PWM-Latch (see Figure 9). In addition to Start-Up, Soft-Start is also activated at each restart attempt during Auto Restart. By means of the above mentioned $C_{Soft\text{-}Start}$ the Soft-Start can be defined by the user. The Soft-Start is finished when V_{SoftS} exceeds 5.3V. At that time the Protection Unit is activated by Comparator C4 and senses the FB by Comparator C3 wether the voltage is below 4.8V which means that the voltage on the secondary side of the SMPS is settled. The internal Zener Diode at SoftS with breaktrough voltage of 5.6V is to prevent the internal circuit from saturation (see Figure 10).

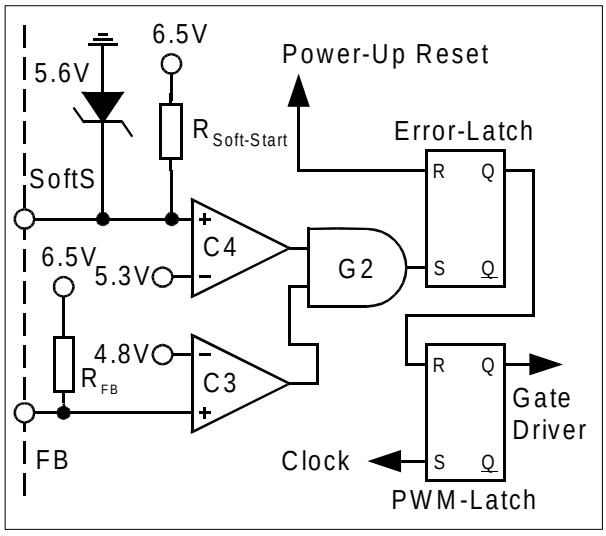


Figure 10 Activation of Protection Unit

The Start-Up time $T_{Start\text{-}Up}$ within the converter output voltage V_{OUT} is settled must be shorter than the Soft-Start Phase $T_{Soft\text{-}Start}$ (see Figure 11).

$$C_{Soft-Start} = \frac{T_{Soft-Start}}{R_{Soft-Start} \times 1{,}69}$$

By means of Soft-Start there is an effective minimization of current and voltage stresses on the integrated CoolMOS™, the clamp circuit and the output overshoot and prevents saturation of the transformer during Start-Up.

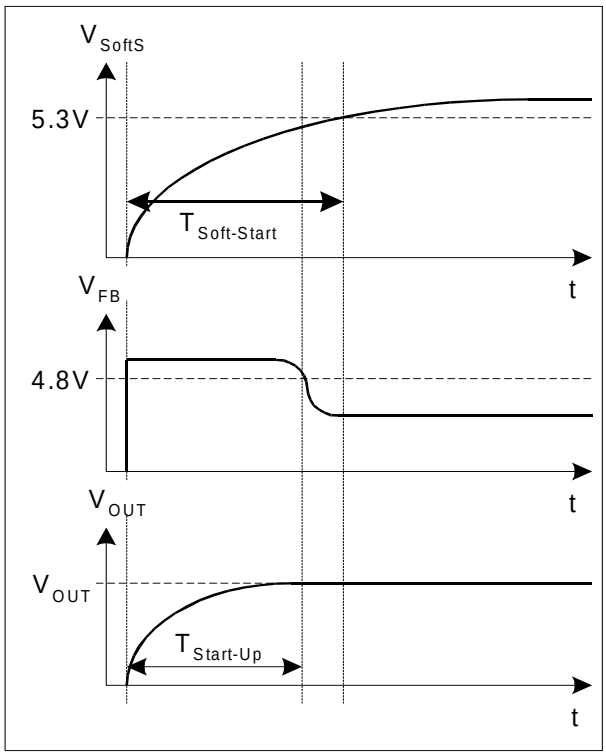


Figure 11 Start Up Phase

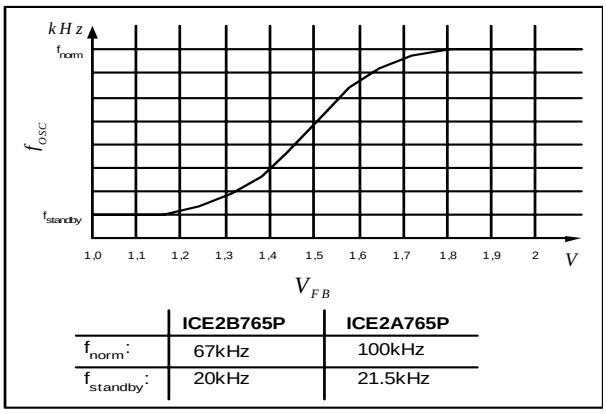
3.4 Oscillator and Frequency Reduction

3.4.1 Oscillator

The oscillator generates a frequency f_{switch} = 67kHz/ 100kHz. A resistor, a capacitor and a current source and current sink which determine the frequency are integrated. The charging and discharging current of the implemented oscillator capacitor are internally trimmed, in order to achieve a very accurate switching frequency. The ratio of controlled charge to discharge current is adjusted to reach a max. duty cycle limitation of D_{max}=0.72.

3.4.2 Frequency Reduction

The frequency of the oscillator is depending on the voltage at pin FB. The dependence is shown in Figure 12. This feature allows a power supply to operate at lower frequency at light loads thus lowering the switching losses while maintaining good cross regulation performance and low output ripple. In case of low power the power consumption of the whole SMPS can now be reduced very effective. The minimal reachable frequency is limited to 20kHz / 21.5 kHz to avoid audible noise in any case.



	ICE2B765P	ICE2A765P
f_{norm}:	67kHz	100kHz
$f_{standby}$:	20kHz	21.5kHz

Figure 12 Frequency Dependence

3.5 Current Limiting

There is a cycle by cycle current limiting realised by the Current-Limit Comparator to provide an overcurrent detection. The source current of the integrated CoolMOS™ is sensed via an external sense resistor R_{Sense} . By means of R_{Sense} the source current is transformed to a sense voltage V_{Sense}. When the voltage V_{Sense} exceeds the internal threshold voltage V_{csth} the Current-Limit-Comparator immediately turns off the gate drive. To prevent the Current Limiting from distortions caused by leading edge spikes a Leading Edge Blanking is integrated at the Current Sense. Furthermore a Propagation Delay Compensation is added to support the immedeate shut down of the CoolMOS™ in case of overcurrent.

3.5.1 Leading Edge Blanking

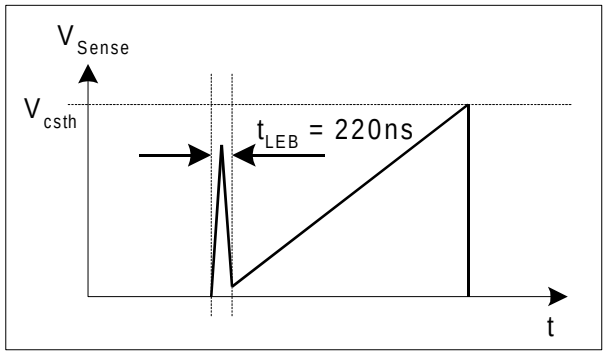


Figure 13 Leading Edge Blanking

Each time when CoolMOS™ is switched on a leading spike is generated due to the primary-side capacitances and secondary-side rectifier reverse recovery time. To avoid a premature termination of the switching pulse this spike is blanked out with a time constant of t_{LEB} = 220ns. During that time the output of

the Current-Limit Comparator cannot switch off the gate drive.

3.5.2 Propagation Delay Compensation

In case of overcurrent detection by I_{Limit} the shut down of CoolMOS™ is delayed due to the propagation delay of the circuit and the CoolMOS™. This delay causes an overshoot of the peak current I_{peak} which depends on the ratio of dI/dt of the peak current (see Figure 14).

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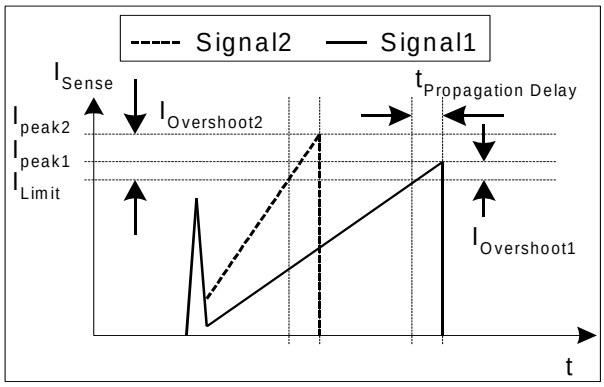


Figure 14 Current Limiting

The overshoot of Signal2 is bigger than of Signal1 due to the steeper rising waveform.

A propagation delay compensation is integrated to bound the overshoot dependent on dI/dt of the rising primary current. That means the propagation delay time between exceeding the internal current sense threshold V_{csth} and the switch off of CoolMOS™ is compensated over temperature within a range of at least (see Figure 16):

$$0 \leq R_{Sense} \times \frac{dI_{peak}}{dt} \leq 1\frac{dV_{Sense}}{dt}$$

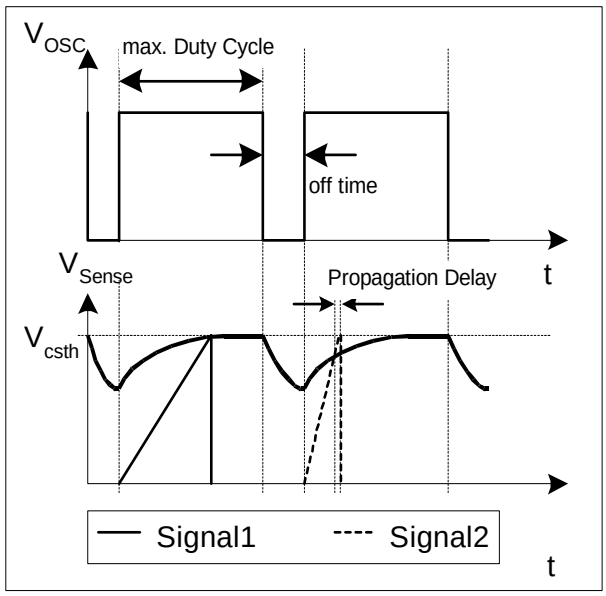


Figure 15 Dynamic Voltage Threshold V_{csth}

The propagation delay compensation is done by means of a dynamic threshold voltage V_{csth} (see Figure 15). In case of a steeper slope the detection of the overcurrent take place earlier to compensate the propagation delay. Every time when the internal oscillator starts the switch on the threshold voltage V_{csth} starts at a certain level and rises until max. duty cycle is reached. During the off time of the oscillaltor V_{csth} decreases to the starting level.

E.g. I_{peak} = 0.5A with R_{Sense} = 2 . Without propagation delay compensation the current sense threshold is set to a static voltage level V_{csth}=1V. A current ramp of dI/dt = 0.4A/µs, that means dV_{Sense}/dt = 0.8V/µs, and a propagation delay time of i.e. $t_{Propagation\ Delay}$ =180ns leads then to a I_{peak} overshoot of 12%. By means of propagation delay compensation the overshoot is only about 2% (see Figure 16). So current limiting is now capable in a very accurate way.

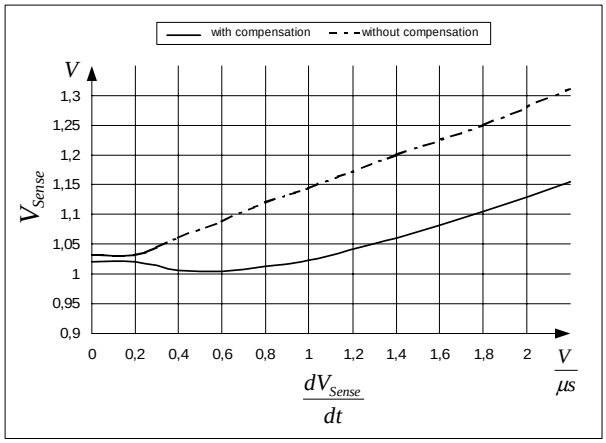


Figure 16 Overcurrent Shutdown

3.6 PWM-Latch

The oscillator clock output applies a set pulse to the PWM-Latch when initiating CoolMOS™ conduction. After setting the PWM-Latch can be reset by the PWM-OP, the Soft-Start-Comparator, the Current-Limit-Comparator, Comparator C3 or the Error-Latch of the Protection Unit. In case of reseting the driver is shut down immediately.

3.7 Driver

The driver-stage drives the gate of the CoolMOS™ and is optimized to minimize EMI and to provide high circuit efficiency. This is done by reducing the switch on slope when reaching the CoolMOS™ threshold. This is achieved by a slope control of the rising edge at the driver's output (see Figure 17).

Thus the leading switch on spike is minimized. When CoolMOS™ is switched off, the falling shape of the driver is slowed down when reaching 2V to prevent an overshoot below ground. Furthermore the driver circuit is designed to eliminate cross conduction of the output stage. At voltages below the undervoltage lockout threshold V_{VCCoff} the gate drive is active low.

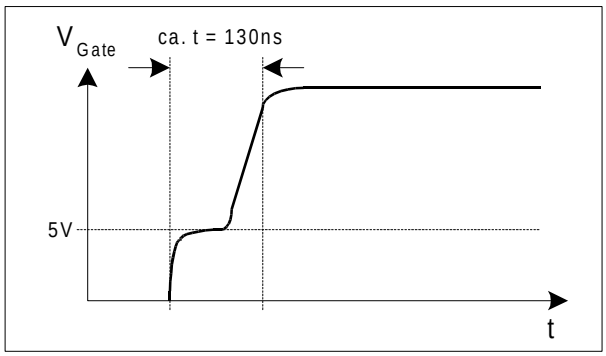


Figure 17 Gate Rising Slope

3.8 Protection Unit (Auto Restart Mode)

An overload, open loop and overvoltage detection is integrated within the Protection Unit. These three failure modes are latched by an Error-Latch. Additional thermal shutdown is latched by the Error-Latch. In case of those failure modes the Error-Latch is set after a blanking time of 5µs and the CoolMOS™ is shut down. That blanking prevents the Error-Latch from distortions caused by spikes during operation mode.

3.8.1 Overload & Open loop with normal load

Figure 18 shows the Auto Restart Mode in case of overload or open loop with normal load. The detection of open loop or overload is provided by the Comparator C3, C4 and the AND-gate G2 (see Figure19). The detection is activated by C4 when the voltage at pin SoftS exceeds 5.3V. Till this time the IC operates in the Soft-Start Phase. After this phase the comparator C3 can set the Error-Latch in case of open loop or overload which leads the feedback voltage V_{FB} to exceed the threshold of 4.8V. After latching VCC decreases till 8.5V and inactivates the IC. At this time the external Soft-Start capacitor is discharged by the internal transistor T1 due to Power Down Reset. When the IC is inactive V_{VCC} increases till V_{CCon} = 13.5V by charging the Capacitor C_{VCC} by means of the Start-Up Resistor $R_{Start-Up}$. Then the Error-Latch is reset by Power Up Reset and the external Soft-Start capacitor $C_{Soft-Start}$ is charged by the internal pullup resistor $R_{Soft-Start}$. During the Soft-Start Phase which ends when the voltage at pin SoftS exceeds 5.3V the detection of overload and open loop by C3 and G2 is inactive. In this way the Start Up Phase is not detected as an overload.

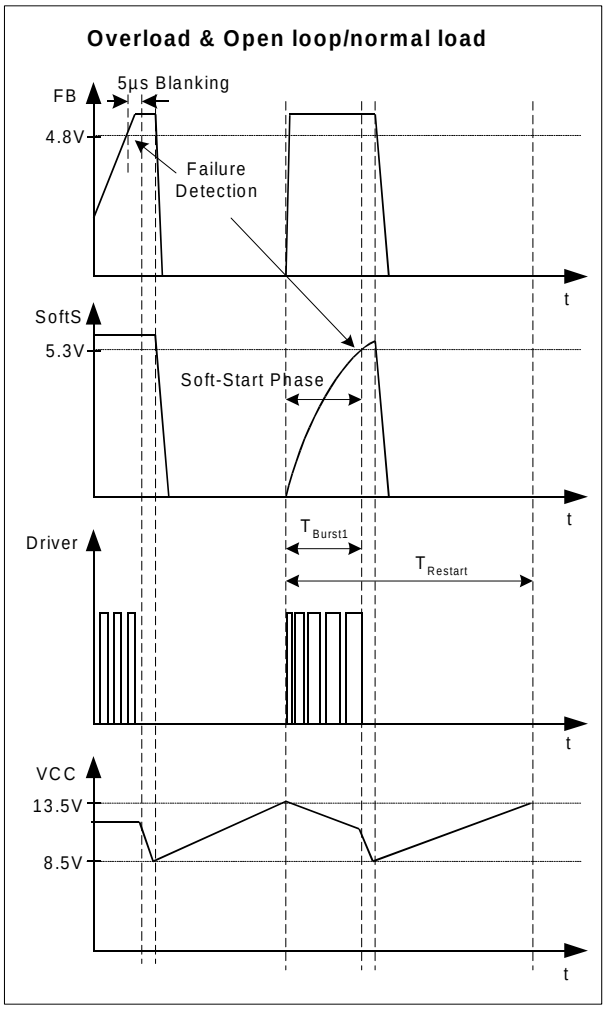


Figure 18 Auto Restart Mode

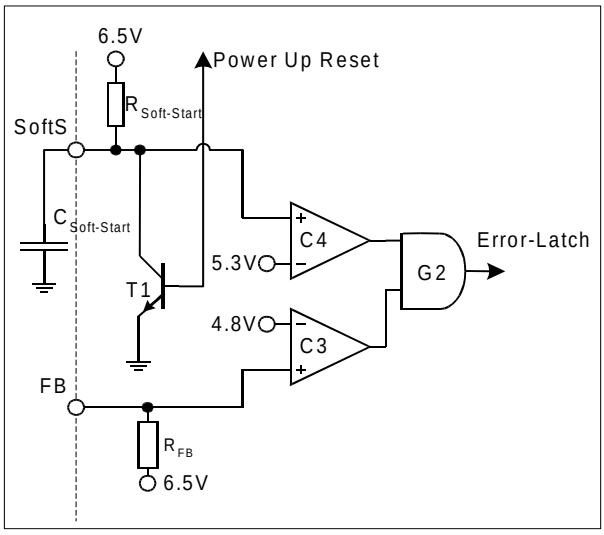


Figure 19 FB-Detection

But the Soft-Start Phase must be finished within the Start Up Phase to force the voltage at pin FB below the failure detection threshold of 4.8V.

3.8.2 Overvoltage due to open loop with no load

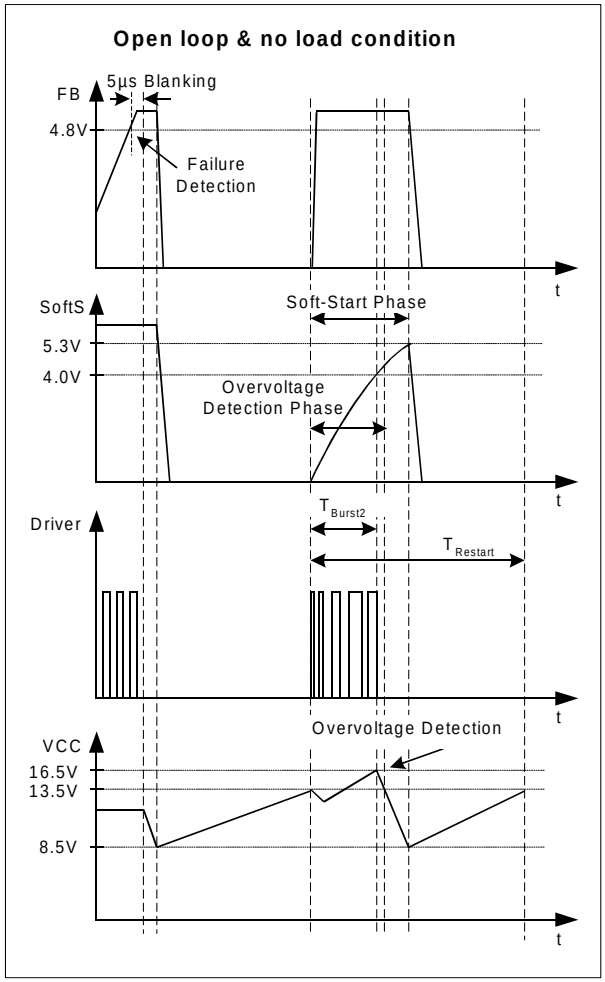


Figure 20 Auto Restart Mode

Figure 20 shows the Auto Restart Mode for open loop and no load condition. In case of this failure mode the converter output voltage increases and also VCC. An additional protection by the comparators C1, C2 and the AND-gate G1 is implemented to consider this failure mode (see Figure 21).The overvoltage detection is provided by Comparator C1 only in the first time during the Soft-Start Phase till the Soft-Start voltage exceeds the threshold of the Comparator C2 at 4.0V and the voltage at pin FB is above 4.8V. When VCC exceeds 16.5V during the overvoltage detection phase C1 can set the Error-Latch and the Burst Phase during Auto Restart Mode is finished earlier. In that case T_{Burst2} is shorter than $T_{Soft-Start}$. By means of C2 the normal operation mode is prevented from overvoltage

detection due to varying of VCC concerning the regulation of the converter output. When the voltage V_{SoftS} is above 4.0V the overvoltage detection by C1 is deactivated.

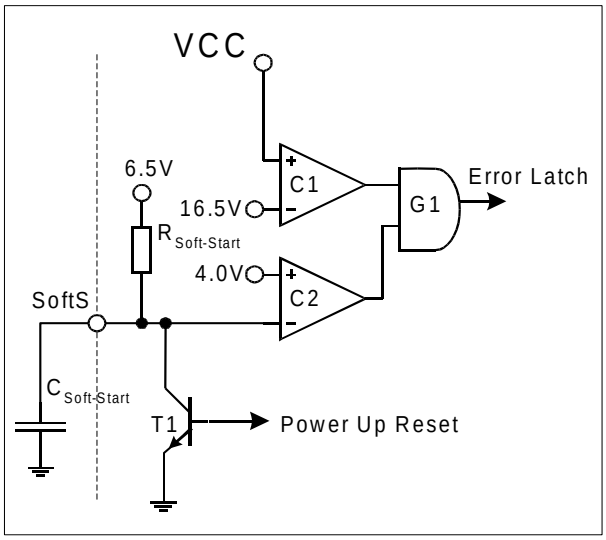


Figure 21 Overvoltage Detection

3.8.3 Thermal Shut Down

Thermal Shut Down is latched by the Error-Latch when junction temperature T_j of the pwm controller is exceeding an internal threshold of 140°C. In that case the IC switches in Auto Restart Mode.

Note: All the values which are mentioned in the functional description are typical. Please refer to Electrical Characteristics for min/max limit values.

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

Note: Absolute maximum ratings are defined as ratings, which when being exceeded may lead to destruction of the integrated circuit. For the same reason make sure, that any capacitor that will be connected to pin 6 (VCC) is discharged before assembling the application circuit.

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Drain Source Voltage	V_{DS}	-	650	V	T_j=110°C
Pulsed Drain Current, t_p limited by max. T_j=150°C	I_D	-	21	A	
Avalanche energy, repetitive t_{AR} limited by max. T_j=150°C[1)]	E_{AR}	-	0.5	mJ	
Avalanche current, repetitive t_{AR} limited by max. T_j=150°C	I_{AR}	-	7	A	
V_{CC} Supply Voltage	V_{CC}	-0.3	22	V	
FB Voltage	V_{FB}	-0.3	6.5	V	
SoftS Voltage	V_{SoftS}	-0.3	6.5	V	
ISense	I_{Sense}	-0.3	3	V	
Junction Temperature	T_j	-40	150	°C	Controller & CoolMOS™ limited by internal circuitry
Storage Temperature	T_S	-50	150	°C	
ESD Capability[2)]	V_{ESD}	-	2	kV	Human Body Model

1) Repetetive avalanche causes additional power losses that can be calculated as $P_{\Delta V}=E_{AR}*f$

2) Equivalent to discharging a 100pF capacitor through a 1.5 kΩ series resistor

4.2 Thermal Impedance

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Thermal Resistance Junction-Ambient	R_{thJA}	-	74	K/W	Free standing with no heatsink
Junction-Case	R_{thJC}	-	2.5	K/W	

4.3 Operating Range

Note: Within the operating range the IC operates as described in the functional description.

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
V_{CC} Supply Voltage	V_{CC}	V_{CCoff}	21	V	
Junction Temperature of Controller	T_{JCon}	-25	130	°C	limited due to thermal shut down of controller
Junction Temperature of CoolMOS™	$T_{JCoolMOS}$	-25	130	°C	

4.4 Characteristics

Note: The electrical characteristics involve the spread of values guaranteed within the specified supply voltage and junction temperature range T_J from – 25 °C to 125 °C.Typical values represent the median values, which are related to 25°C. If not otherwise stated, a supply voltage of V_{CC} = 15 V is assumed.

4.4.1 Supply Section

Parameter		Symbol	Limit Values			Unit	Test Condition
			min.	typ.	max.		
Start Up Current		I_{VCC1}	-	27	55	µA	V_{CC}=V_{CCon} -0.1V
Supply Current with Inactiv Gate		I_{VCC2}	-	5.3	6.6	mA	V_{SoftS} = 0 I_{FB} = 0
Supply Current with activ Gate	ICE2A765P	I_{VCC3}	-	8.5	9.8	mA	V_{SoftS} = 5V I_{FB} = 0
	ICE2B765P	I_{VCC3}	-	7.1	8.3	mA	V_{SoftS} = 5V I_{FB} = 0
VCC Turn-On Threshold VCC Turn-Off Threshold VCC Turn-On/Off Hysteresis		V_{CCon} V_{CCoff} V_{CCHY}	13 - 4.5	13.5 8.5 5	14 - 5.5	V V V	

4.4.2 Internal Voltage Reference

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Trimmed Reference Voltage	V_{REF}	6.37	6.50	6.63	V	measured at pin FB

4.4.3 Control Section

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Oscillator Frequency ICE2A765P	f_{OSC1}	93	100	107	kHz	V_{FB} = 4V
Oscillator Frequency ICE2B765P	f_{OSC3}	62	67	72	kHz	V_{FB} = 4V
Reduced Osc. Frequency ICE2A765P	f_{OSC2}	-	21.5	-	kHz	V_{FB} = 1V
Reduced Osc. Frequency ICE2B765P	f_{OSC4}	-	20	-	kHz	V_{FB} = 1V
Frequency Ratio f_{osc1}/f_{osc2} ICE2A765P		4.5	4.65	4.9		
Frequency Ratio f_{osc3}/f_{osc4} ICE2B765P		3.18	3.35	3.53		
Max Duty Cycle	D_{max}	0.67	0.72	0.77		
Min Duty Cycle	D_{min}	0	-	-		V_{FB} < 0.3V
PWM-OP Gain	A_V	3.45	3.65	3.85		
Max. Level of Voltage Ramp	$V_{Max\text{-}Ramp}$	-	0.80	-	V	
V_{FB} Operating Range Min Level	V_{FBmin}	0.3	-	-	V	
V_{FB} Operating Range Max level	V_{FBmax}	-	-	4.6	V	
Feedback Resistance	R_{FB}	3.0	3.7	4.9	kΩ	
Soft-Start Resistance	$R_{Soft\text{-}Start}$	42	50	62	kΩ	

4.4.4 Protection Unit

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Over Load & Open Loop Detection Limit	V_{FB2}	4.65	4.8	4.95	V	V_{SoftS} > 5.5V
Activation Limit of Overload & Open Loop Detection	V_{SoftS1}	5.15	5.3	5.46	V	V_{FB} > 5V
Deactivation Limit of Overvoltage Detection	V_{SoftS2}	3.88	4.0	4.12	V	V_{FB} > 5V V_{CC} > 17.5V
Overvoltage Detection Limit	V_{VCC1}	16	16.5	17.2	V	V_{SoftS} < 3.8V V_{FB} > 5V
Latched Thermal Shutdown	T_{jSD}	130	140	150	°C	guaranteed by design
Spike Blanking	t_{Spike}	-	5	-	µs	

4.4.5 Current Limiting

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Peak Current Limitation (incl. Propagation Delay Time) (see Figure 7)	V_{csth}	0.95	1.00	1.05	V	dV_{sense} / dt = 0.6V/µs
Leading Edge Blanking	t_{LEB}	-	220	-	ns	

4.4.6 CoolMOS™ Section

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Drain Source Breakdown Voltage	$V_{(BR)DSS}$	600 650	- -	- -	V V	T_j=25°C T_j=110°C
Effective output capacitance, energy related	$C_{o(er)}$	-	30	-	pF	V_{DS} =0V to 640V
Drain Source On-Resistance	R_{DSon}	- -	0.45 0.95	0.54 1.14	Ω Ω	T_j=25°C T_j=125°C
Zero Gate Voltage Drain Current	I_{DSS}	-	0.5	-	µA	V_{VCC}=0V
Rise Time	t_{rise}	-	50[1)]	-	ns	
Fall Time	t_{fall}	-	30[1)]	-	ns	

[1)] Measured in a Typical Flyback Converter Application

5 Typical Performance Characteristics

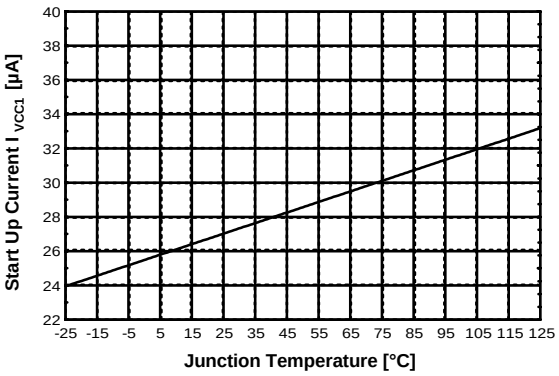


Figure 22 Start Up Current I_{VCC1} vs. T_j

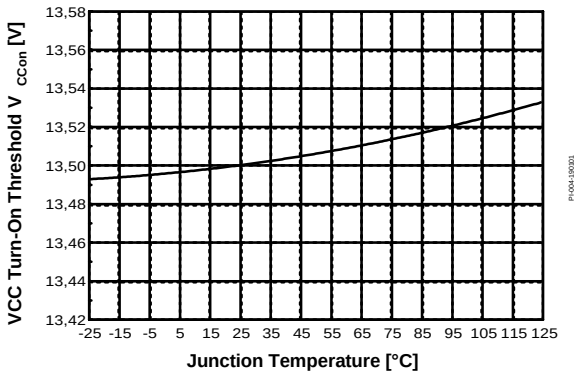


Figure 25 VCC Turn-On Threshold V_{VCCon} vs. T_j

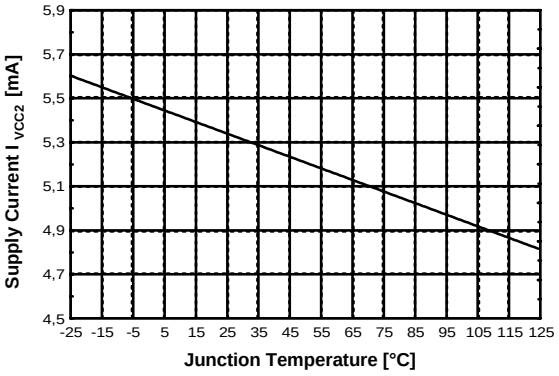


Figure 23 Static Supply Current I_{VCC2} vs. T_j

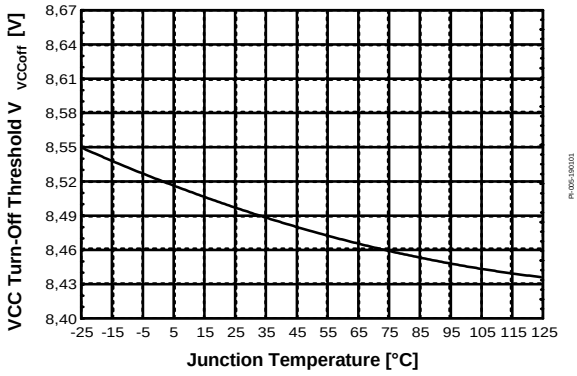


Figure 26 VCC Turn-Off Threshold V_{VCCoff} vs. T_j

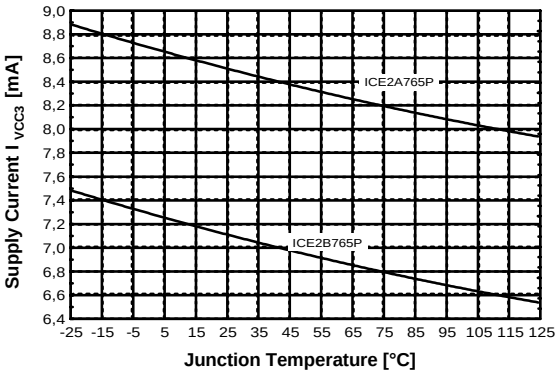


Figure 24 Supply Current I_{VCC3} vs. T_j

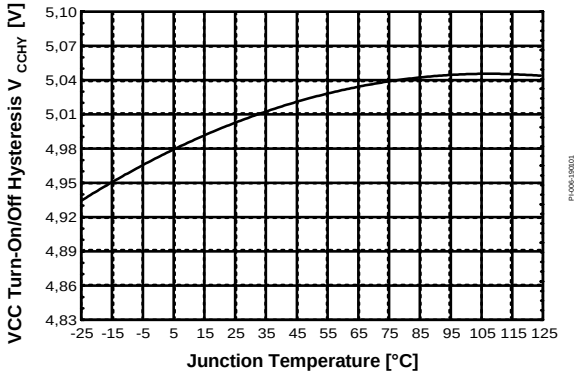


Figure 27 VCC Turn-On/Off HysteresisV_{VCCHY} vs. T_j

Typical Performance Characteristics

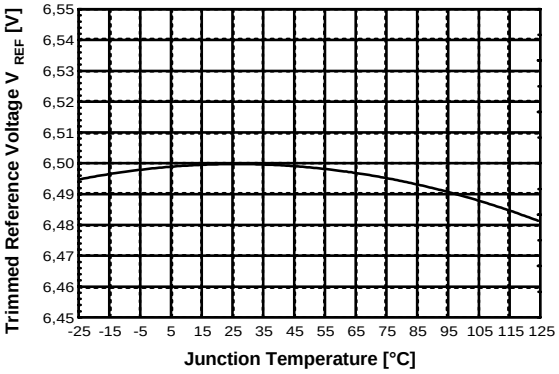


Figure 28 Trimmed Reference V_{REF} vs. T_j

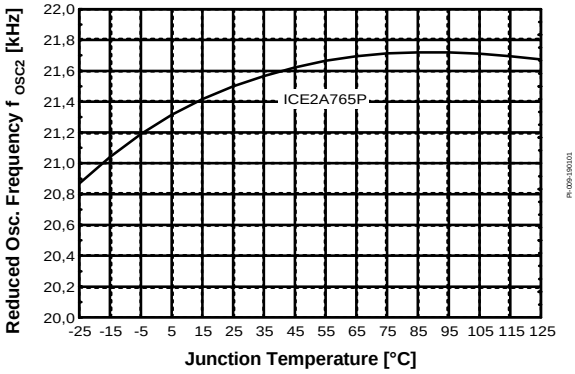


Figure 31 Reduced Osc. Frequency f_{OSC2} vs. T_j

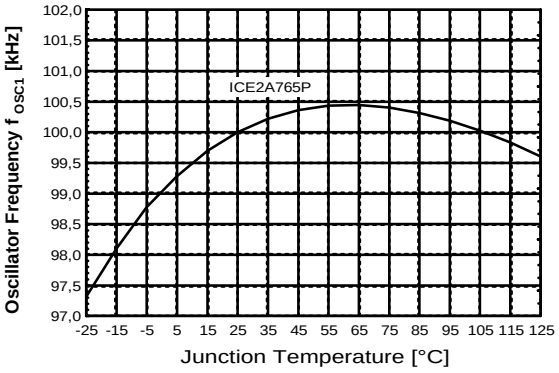


Figure 29 Oscillator Frequency f_{OSC1} vs. T_j

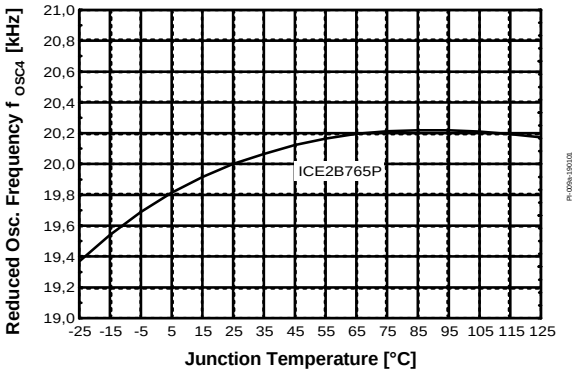


Figure 32 Reduced Osc. Frequency f_{OSC4} vs. T_j

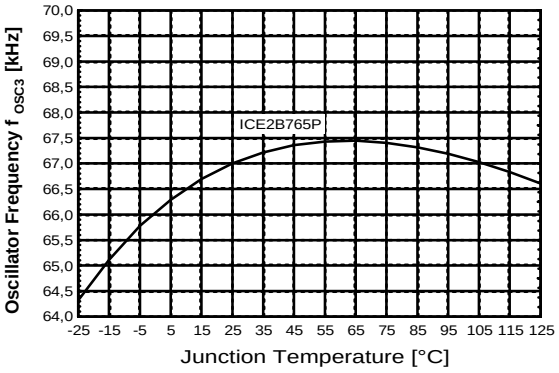


Figure 30 Oscillator Frequency f_{OSC3} vs. T_j

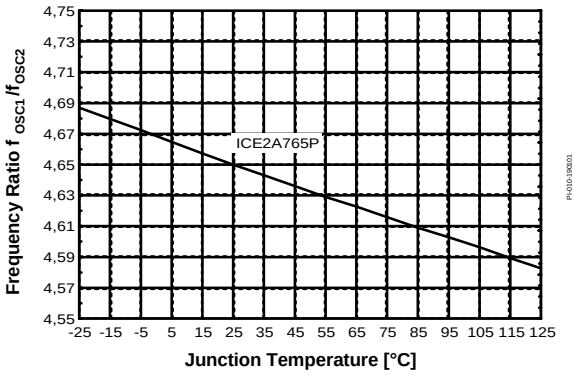


Figure 33 Frequency Ratio f_{OSC1} / f_{OSC2} vs. T_j

Typical Performance Characteristics

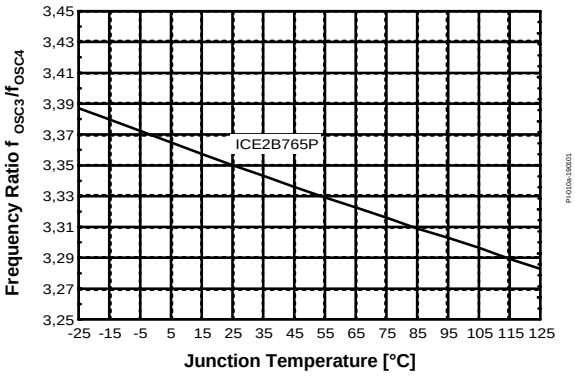


Figure 34 Frequency Ratio f_{OSC3} / f_{OSC4} vs. T_j

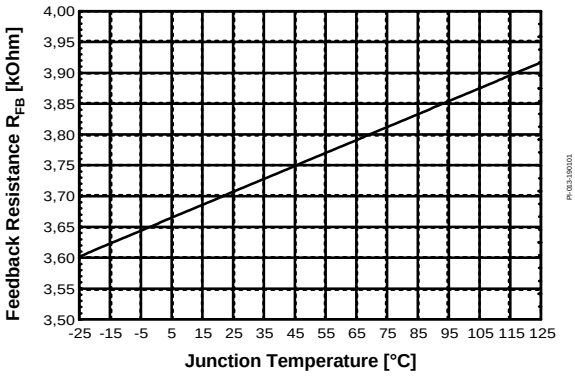


Figure 37 Feedback Resistance R_{FB} vs. T_j

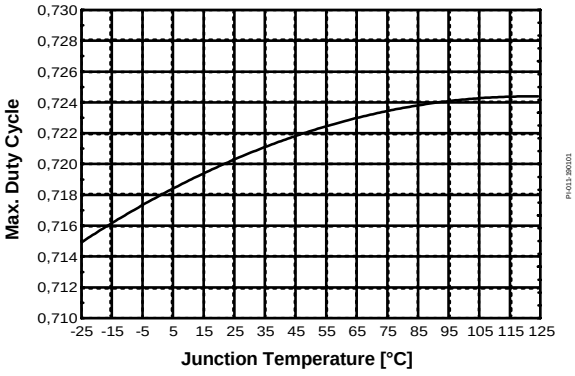


Figure 35 Max. Duty Cycle vs. T_j

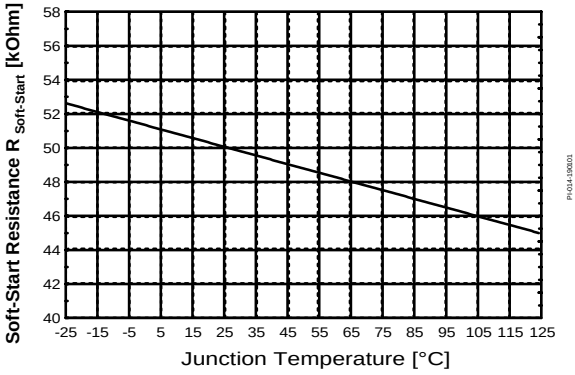


Figure 38 Soft-Start Resistance $R_{Soft\text{-}Start}$ vs. T_j

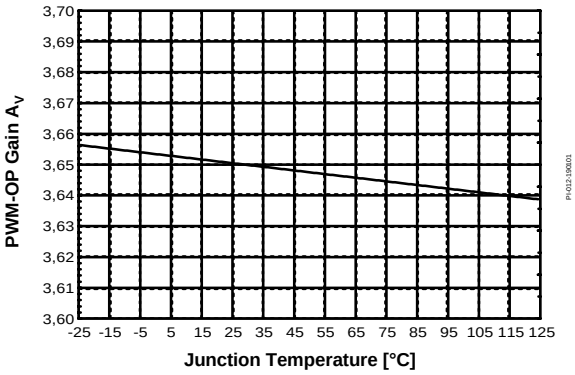


Figure 36 PWM-OP Gain A_V vs. T_j

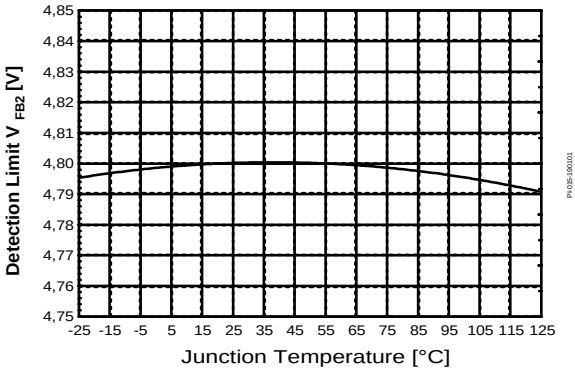


Figure 39 Detection Limit V_{FB2} vs. T_j

Typical Performance Characteristics

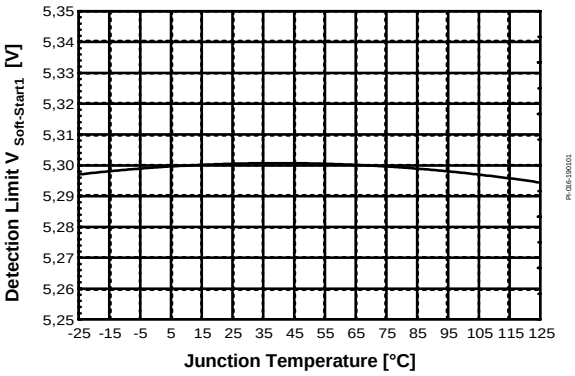


Figure 40 Detection Limit $V_{Soft\text{-}Start1}$ vs. T_j

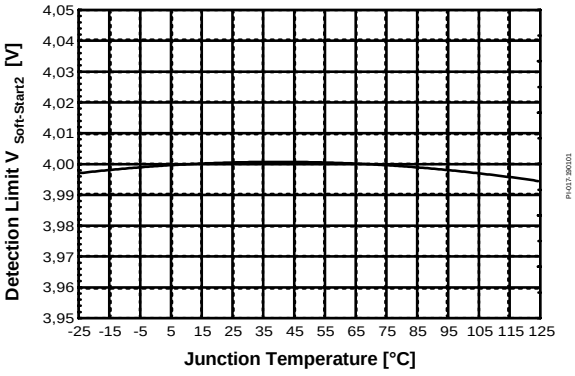


Figure 41 Detection Limit $V_{Soft\text{-}Start2}$ vs. T_j

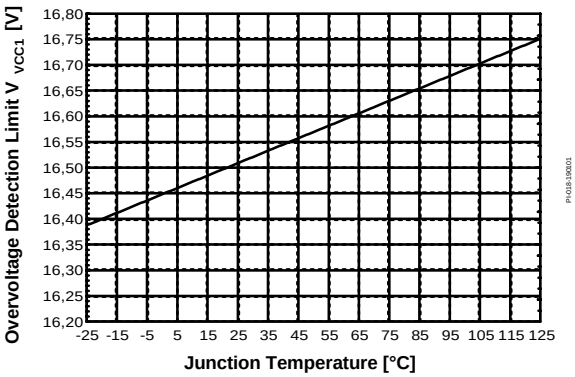


Figure 42 Overvoltage Detection Limit V_{VCC1} vs. T_j

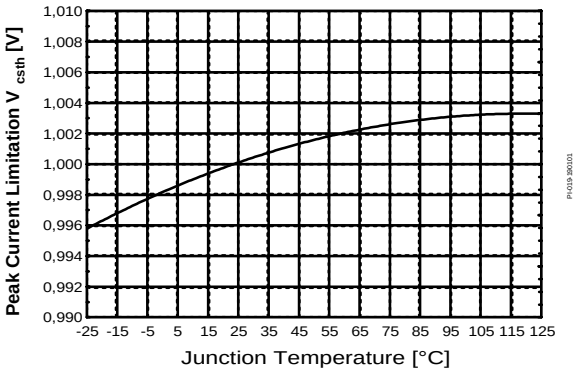


Figure 43 Peak Current Limitation V_{csth} vs. T_j

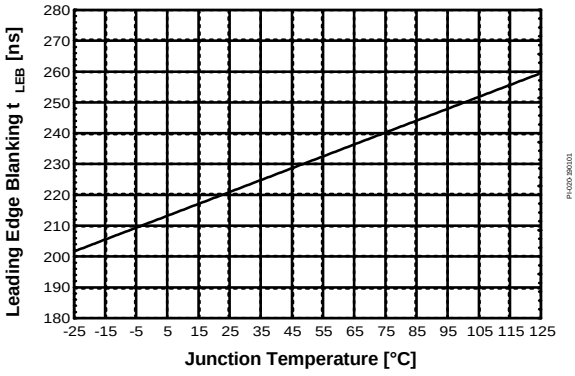


Figure 44 Leading Edge Blanking V_{VCC1} vs. T_j

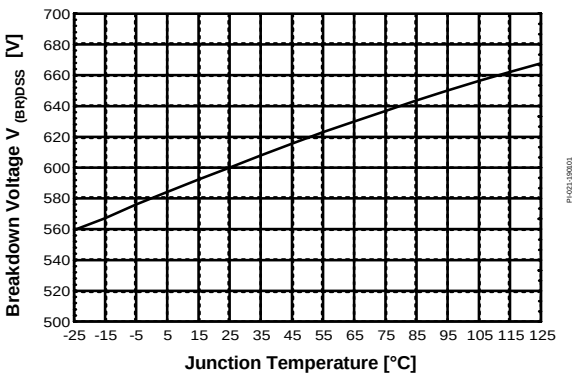


Figure 45 Breakdown Voltage $V_{BR(DSS)}$ vs. T_j

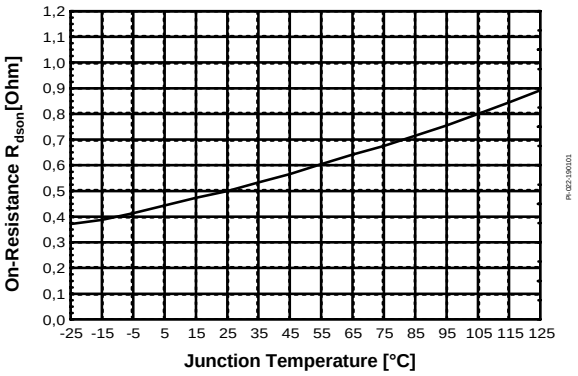
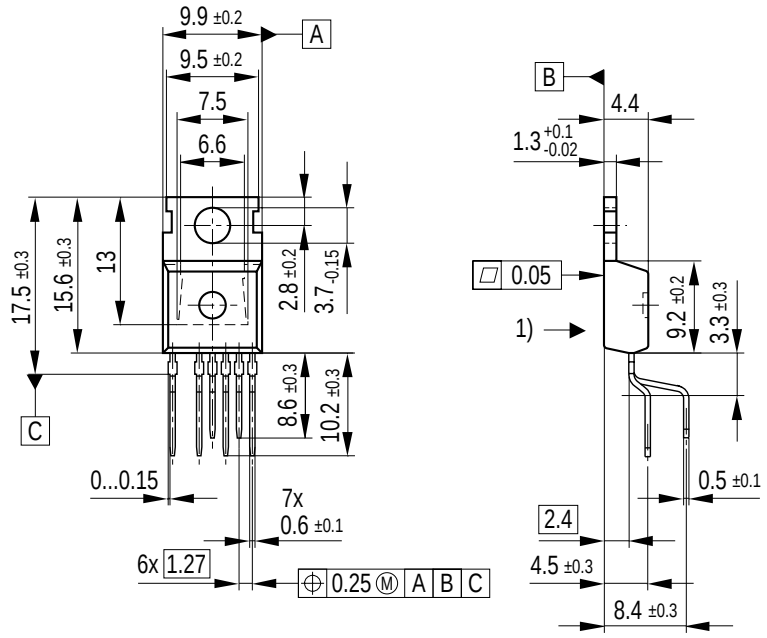


Figure 46 Drain Source On-Resistance R_{DSon} vs. T_j

6 Outline Dimension

P-TO220-6-3



1) Shear and punch direction no burrs this surface.
– – - Back side, heatsink contour
All metal surfaces tin plated, except area of cut.

Figure 47

Dimensions in mm

Total Quality Management

Qualität hat für uns eine umfassende Bedeutung. Wir wollen allen Ihren Ansprüchen in der bestmöglichen Weise gerecht werden. Es geht uns also nicht nur um die Produktqualität – unsere Anstrengungen gelten gleichermaßen der Lieferqualität und Logistik, dem Service und Support sowie allen sonstigen Beratungs- und Betreuungsleistungen.

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Unternehmensweit orientieren wir uns dabei auch an „top“ (Time Optimized Processes), um Ihnen durch größere Schnelligkeit den entscheidenden Wettbewerbsvorsprung zu verschaffen.

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