

The Synchronous Rectification control IC for AC-DC converter Monolithic IC MM3667 Series

Outline

This IC is secondary side synchronous rectification control IC to drive MOSFETs in isolated AC-DC converter. It is able to achieve very high efficiency by replacing secondary rectifier diode with MOSFET and MM3667. It is possible to correspond to various efficiency restrictions.

And it is effective for the miniaturization of the power supply by the heat sink reduction and so on.

MM3667 Supports the Half-Bridge LLC resonant converter and Quasi-Resonant flyback converter.

MM3667 controls Turn-ON/OFF of MOSFET by detecting the voltage between Drain and Source of MOSFET. This Turn-OFF threshold voltage is adjustable by the external resistor.

MM3667 has standby mode. Using this mode, the standby power requirement is able to be suppressed to low.

This IC uses SOP-8J package and supports flow conditions.

Features

1. Supply Voltage 6~15V
2. Gate Output Voltage 6~15V
It is equal to Supply Voltage
3. It supports Half-Bridge LLC resonant converter and Quasi-Resonant flyback converter
4. Frequency 25k~200kHz (QR mode)
25k~500kHz (LLC mode)
5. Adjustable Turn-OFF Threshold Voltage
6. Equipped with Standby Mode

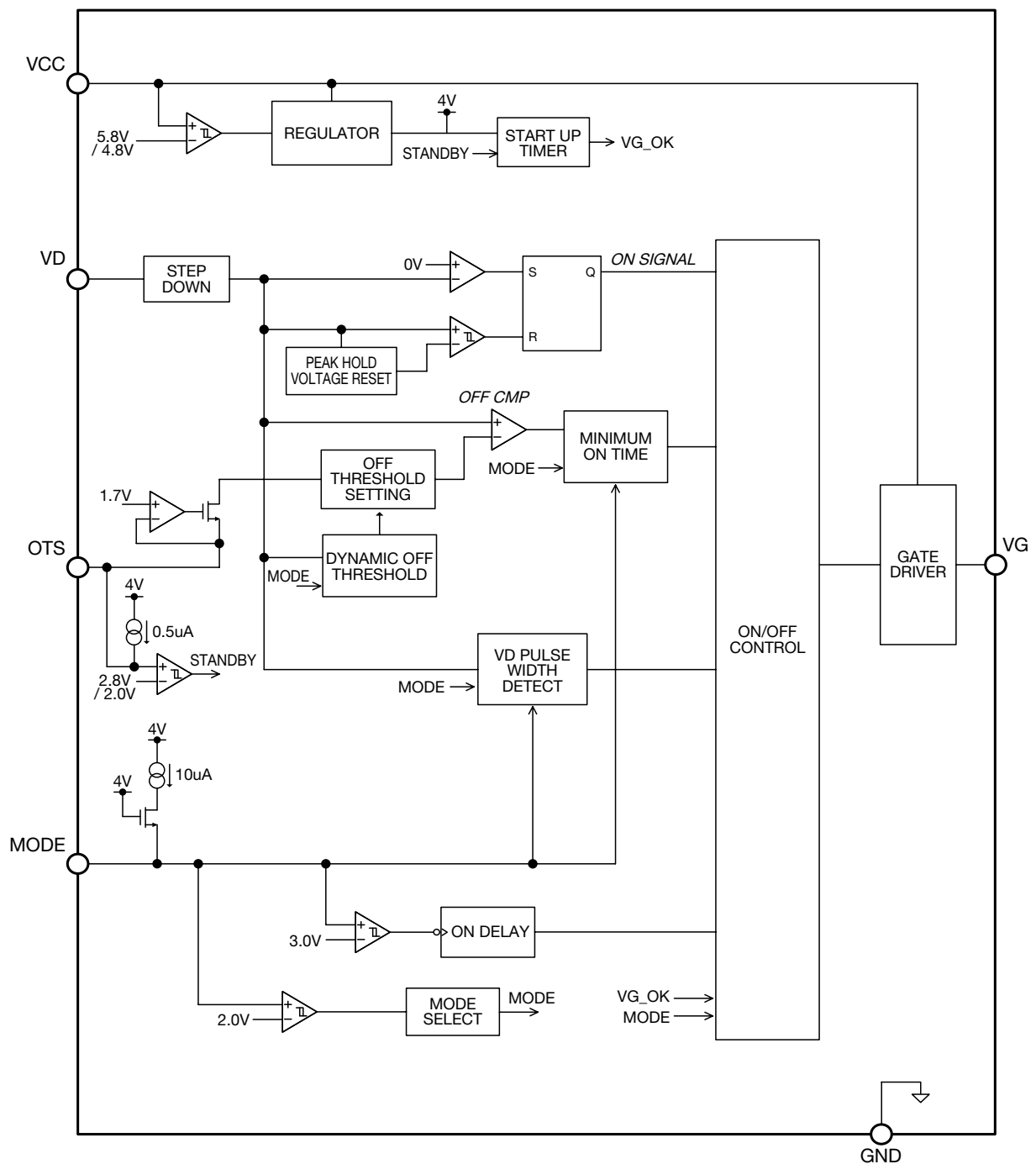
Package

SOP-8J

Applications

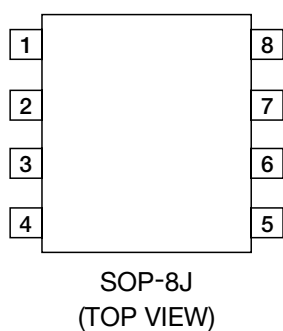
1. LCD TV
2. High-Power AC/DC Adaptor
3. Gaming Consoles
4. High-Power Switch Mode Power Supply
5. Others

Block Diagram



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Pin Assignment



1	MODE
2	N.C.
3	OTS
4	GND
5	VG
6	VCC
7	N.C.
8	VD

Pin Description

Pin No.	Pin name	Functions
1	MODE	Operation Mode Setting / Internal Timer Setting / VG detection of another line
2	N.C.	No Connection
3	OTS	Turn-Off Threshold Setting / Standby Mode Detection
4	GND	Ground / MOSFET Source Connection
5	VG	Gate Driver Output
6	VCC	IC Power Input / Gate Driver Voltage Source
7	N.C.	No Connection
8	VD	MOSFET Drain Voltage Detection

Absolute Maximum Ratings (Except where noted otherwise Ta=25°C)

Item	Symbol	Ratings	Units
VCC Supply Voltage	V _{CCMAX}	-0.3~17.0	V
VD Input Voltage	V _{VDMAX}	17.0 (Note1)	V
VD Output Current	I _{VDMAX}	-1	mA
MODE Input Voltage	V _{MODEMAX}	-0.3~5.5	V
OTS Input Voltage	V _{OTSMAX}	-0.3~4.0	V
Storage Temperature	T _{stg}	-40~150	°C
Power Dissipation (alone)	P _d	300	mW

Note1 : When VD pin input voltage is shifted to minus, parasitic diode of ESD protection device is turned-on. To protect the parasitic diode, please adjust the external resistor to reduce the VD pin output current under 1mA.

Recommended Operating Conditions (Except where noted otherwise Ta=25°C)

Item	Symbol	Ratings	Units
Operating Ambient Temperature	T _{opr}	-25~105	°C
Operating Supply Voltage	V _{CCOPR}	6.0~15.0	V
VD Pin Peak Voltage	V _{VDPEAK}	4.5~15.0	V
MODE Pin Input Voltage	V _{MODE}	5.0 Max.	V
OTS Pin Input Voltage	V _{OTS}	3.9 Max.	V
Switching Frequency on Half-Bridge LLC converter	f _{sw_LL}	25~500	kHz
Switching Frequency on Quasi-Resonant converter	f _{sw_QR}	25~200	kHz

Electrical Characteristics

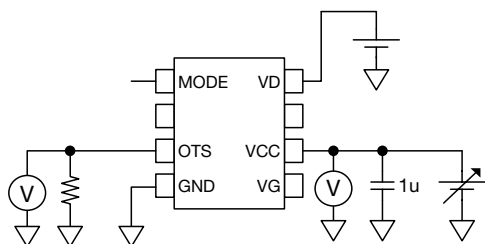
(Except where noted otherwise VCC=12V, Ta=25°C)

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units	Measuring Circuit
Supply Section							
VCC Turn On Threshold	V _{CC_START}		5.6	5.8	6.0	V	A
VCC Turn Off Threshold	V _{CC_STOP}		4.6	4.8	5.0	V	A
Supply Current (LLC)	I _{CC_LL1}	Cload=6000pF, fsw=100kHz, R _{MODE} =270kΩ		7.8	9.0	mA	B
Single Supply Current (LLC)	I _{CC_LL2}	Cload=0pF, fsw=100kHz, R _{MODE} =270kΩ		0.66	0.79	mA	B
Supply Current (QR)	I _{CC_QR1}	Cload=6000pF, fsw=100kHz, R _{MODE} =10kΩ		7.8	9.0	mA	B
Single Supply Current (QR)	I _{CC_QR2}	Cload=0pF, fsw=100kHz, R _{MODE} =10kΩ		0.65	0.78	mA	B
Standby Mode Current	I _{CC_STBY}	V _{OTS} =3.5V		165	230	uA	C
Gate Driver Output							
VG Output High Voltage	V _{GH}	IG=50mA	11.3	11.7	11.9	V	D
VG Output Low Voltage	V _{GL}	IG=-50mA		0.15	0.3	V	D
Rise Time	t _r	Cload=6000pF VG=2V→9V		70	120	ns	E
Fall Time	t _f	Cload=6000pF VG=9V→2V		50	70	ns	E
Turn-On Propagation Delay (QR)	t _{DON_QR}	Cload=6000pF VD=V _{TH_ON} →VG=2V		100	200	ns	E
Turn-On Propagation Delay (LLC)	t _{DON_LL1}	Cload=6000pF VD=V _{TH_ON} →VG=2V		150	250	ns	E
VG detection delay	t _{VGDELAY}		480	580	680	ns	H
Turn-Off Propagation Delay	t _{DOFF}	Cload=6000pF VD=V _{TH_OFF} →VG=9V		80	200	ns	E
Drain Voltage Detector							
Turn-On Threshold Voltage	V _{TH_ON}		-0.2	0	0.2	V	F
Turn-Off Threshold Voltage	V _{TH_OFF}	R _{OTS} =51kΩ	-16.6	-11.6	-6.6	mV	F
		R _{OTS} =100kΩ	-10.6	-5.6	-0.6	mV	F
VD Input Resistance	R _{VD}	VD=12V	12	15	18	kΩ	G

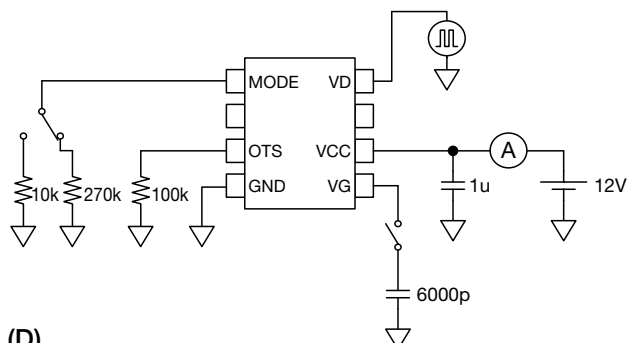
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units	Measuring Circuit
Operation Mode Setting							
LLC Mode Condition	V _{MODE_LLC}		1.8	2.0	2.2	V	H
Threshold Voltage of VG detection	V _{VGDET}		2.8	3.0	3.2	V	H
QR Mode Condition	V _{MODE_QR}				1.6	V	H
MODE Pin Output Current	I _{MODE}		8.75	10	11.25	uA	H
Timer Section							
VD Peak Pulse Width Detect (LLC)	t _{VDPW_LLC}	R _{MODE} =270kΩ	0.39	0.56	0.73	us	I
VD Peak Pulse Width Detect (QR)	t _{VDPW_QR}	R _{MODE} =10kΩ	0.2	0.29	0.38	us	I
		R _{MODE} =150kΩ	1.20	1.71	2.22	us	I
Minimum On Time	t _{MOT}	R _{MODE} =10kΩ	0.26	0.37	0.48	us	I
		R _{MODE} =150kΩ	2.2	3.1	4.0	us	I
Dynamic Off-Threshold Time	t _{DOT}	f _{sw} =100kHz	1.8	2.4	3.0	us	I
		f _{sw} =300kHz	0.81	1.05	1.29	us	I
Standby Mode							
Standby Mode On Voltage	V _{STBY_ON}		2.5	2.8	3.1	V	C
Standby Mode Off Voltage	V _{STBY_OFF}		1.7	2.0	2.3	V	C
Standby On/Off Hysteresis	V _{STBY_HYS}	V _{STBY_ON} –V _{STBY_OFF}		0.8		V	

Measuring Circuit

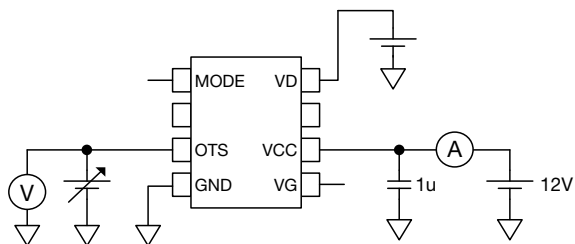
(A)



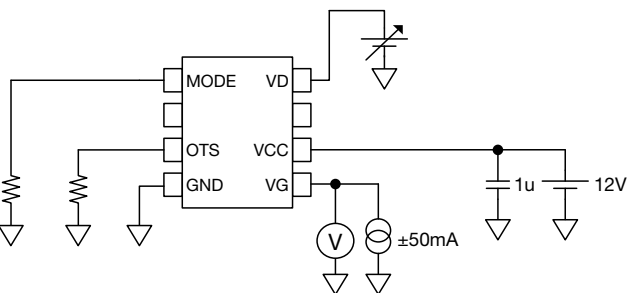
(B)



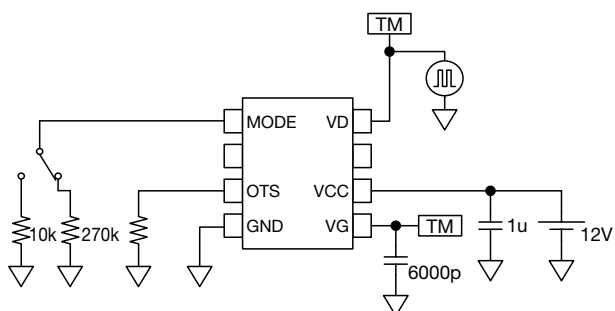
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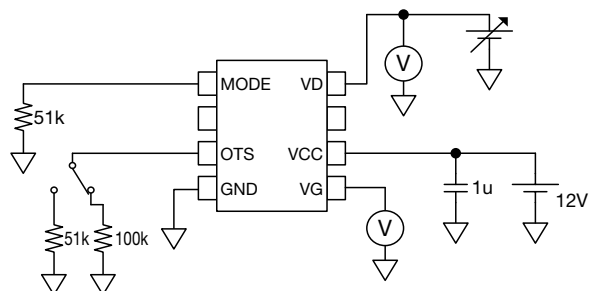
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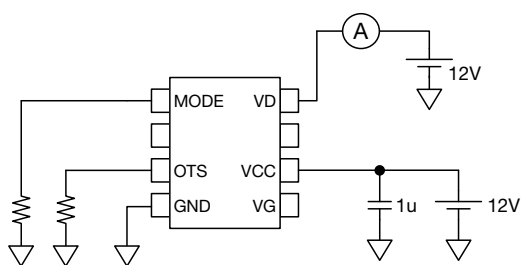
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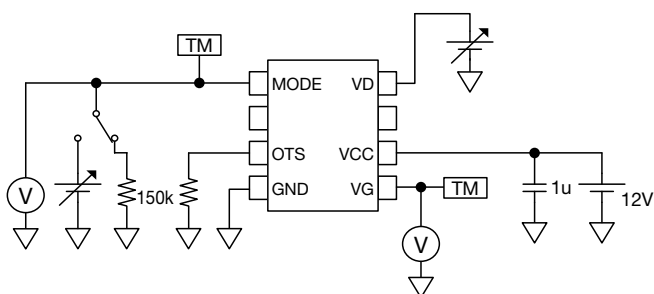
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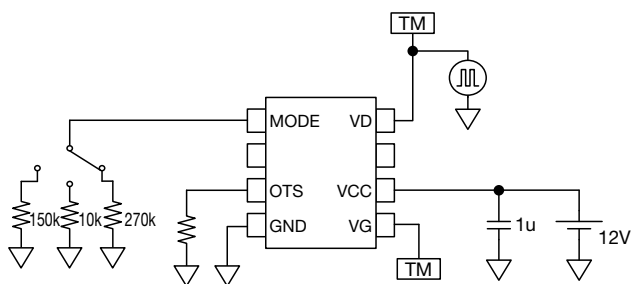
(G)



(H)



(I)

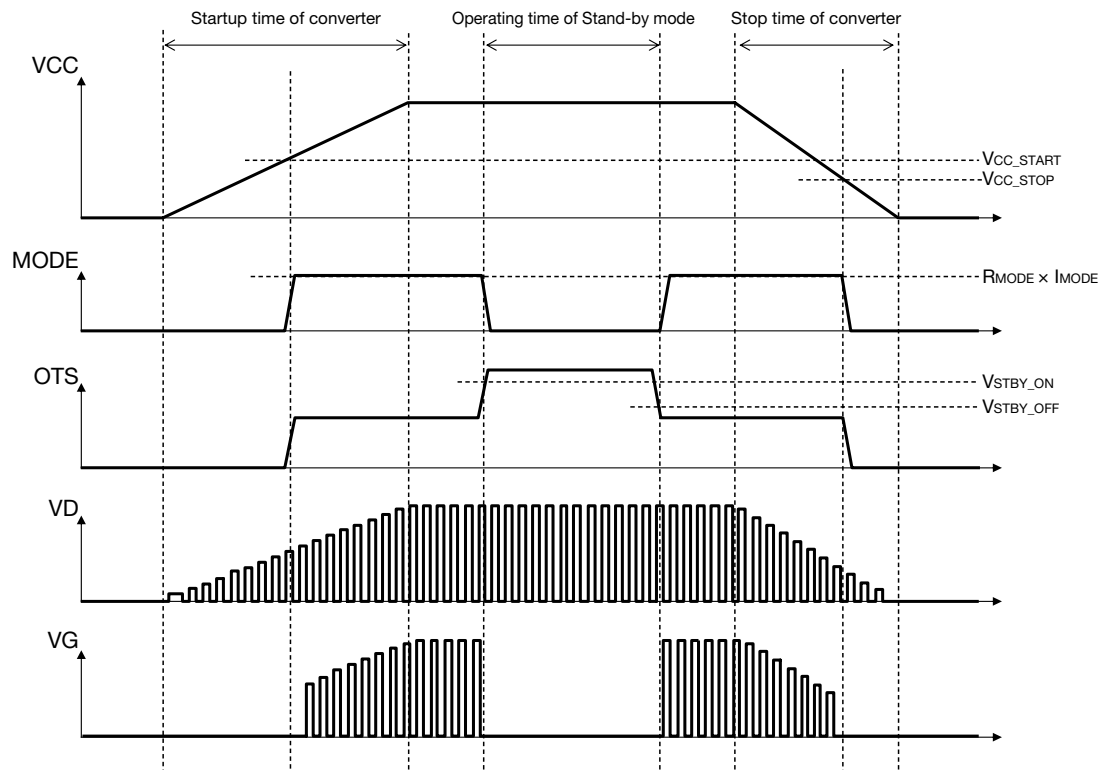


* TM : Time Measure module

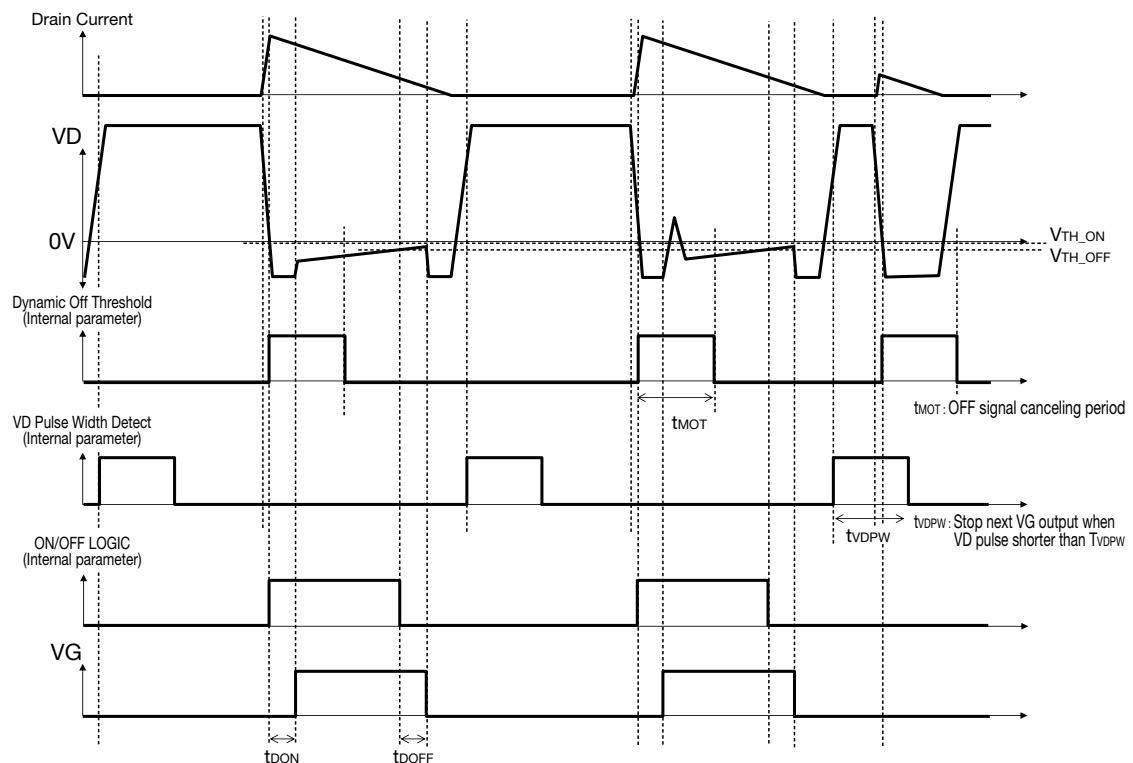
Timing Chart

(1) Example of operation on Quasi-Resonant converter

- IC operation start ~ Standby on ~ Standby off ~ IC operation stop

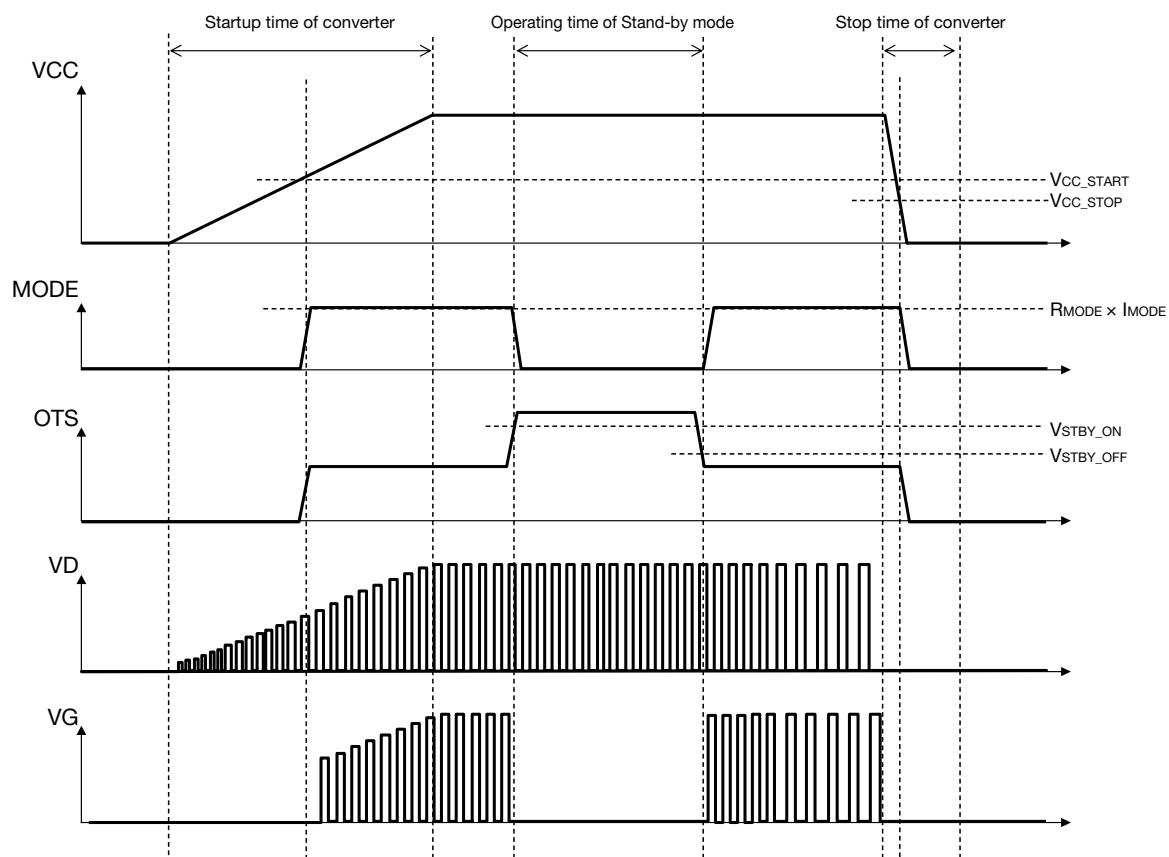


- Operation for VD input signal

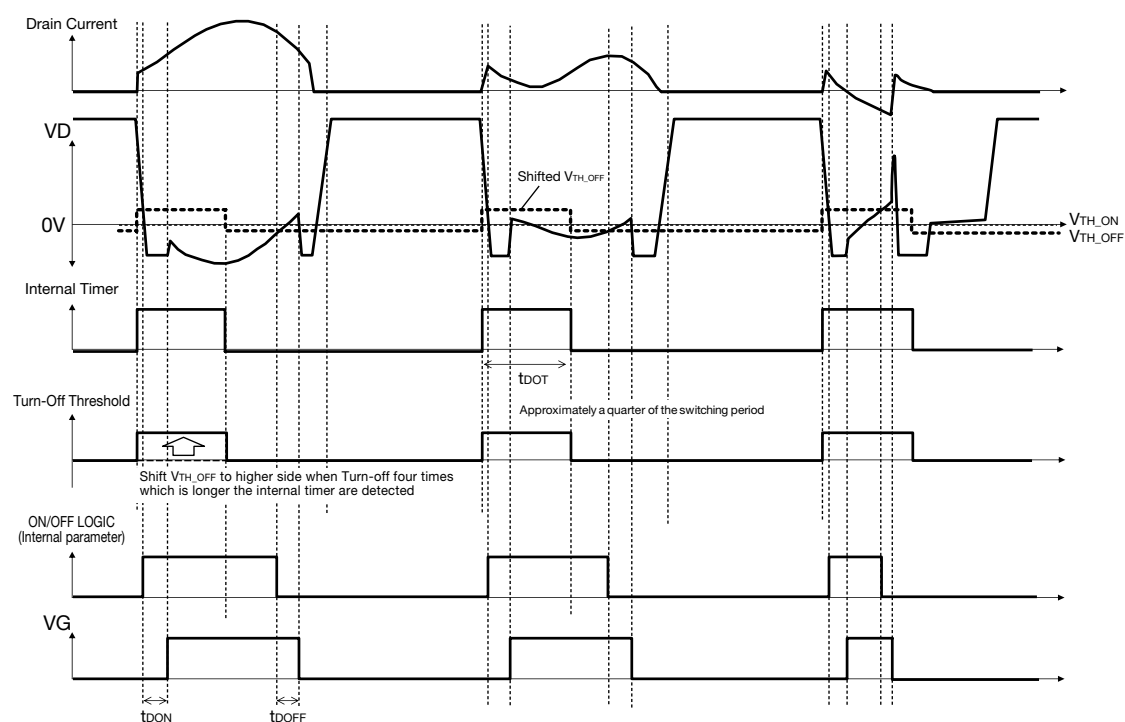


(2) Example of operation on Half-Bridge LLC converter

• IC operation start ~ Standby on ~ Standby off ~ IC operation stop

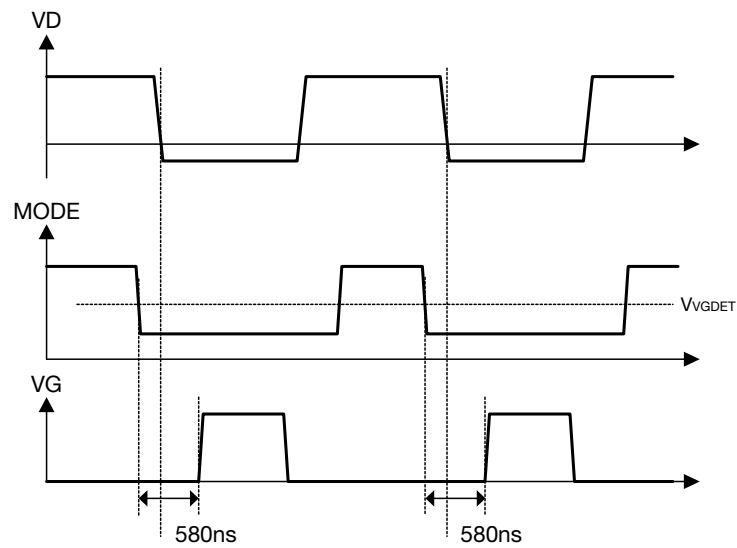


• Operation for VD input signal

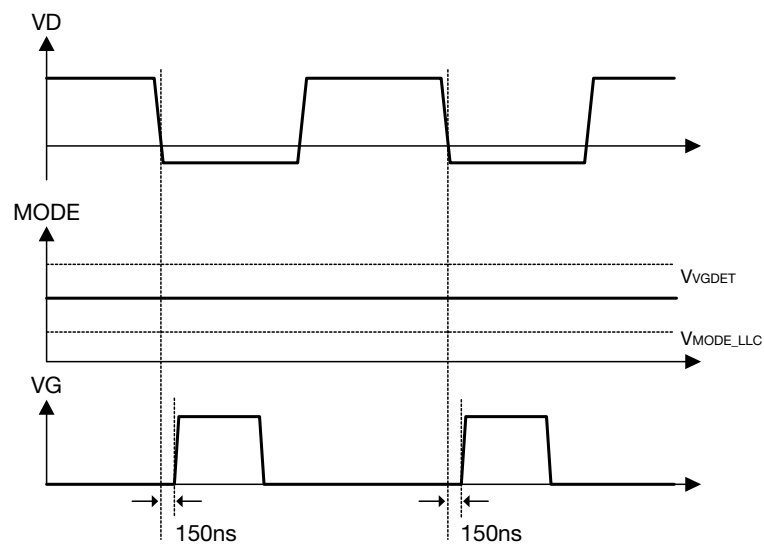


(3) The function of VG detection delay

Condition1 : Using this function

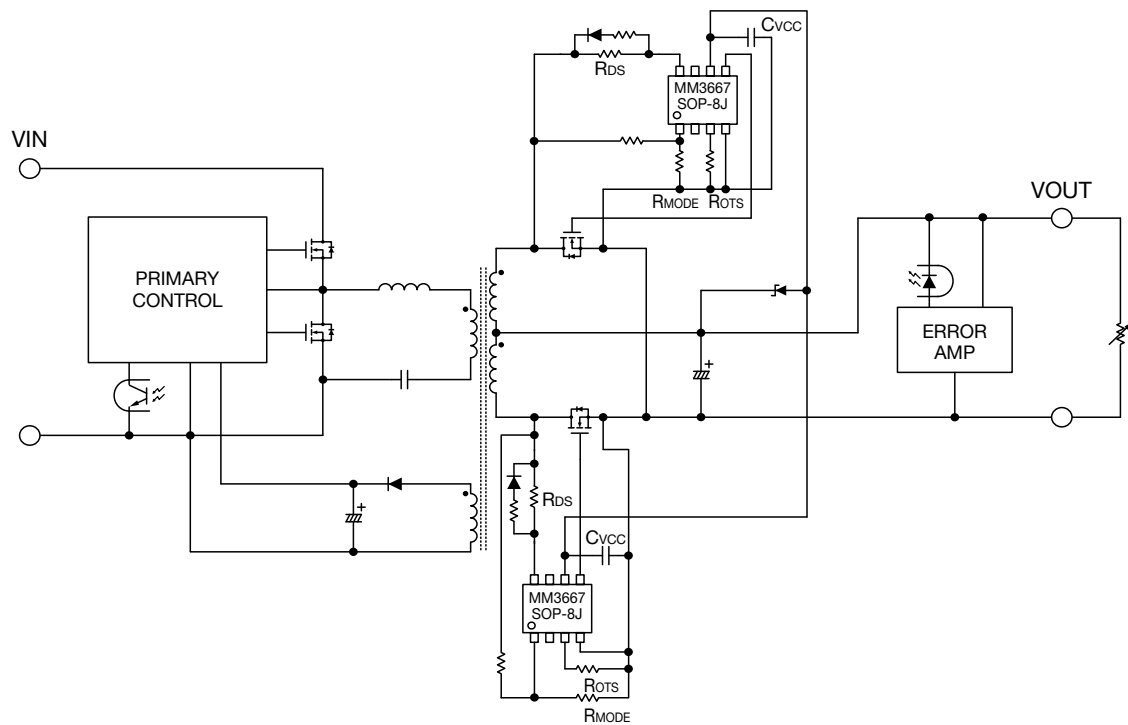
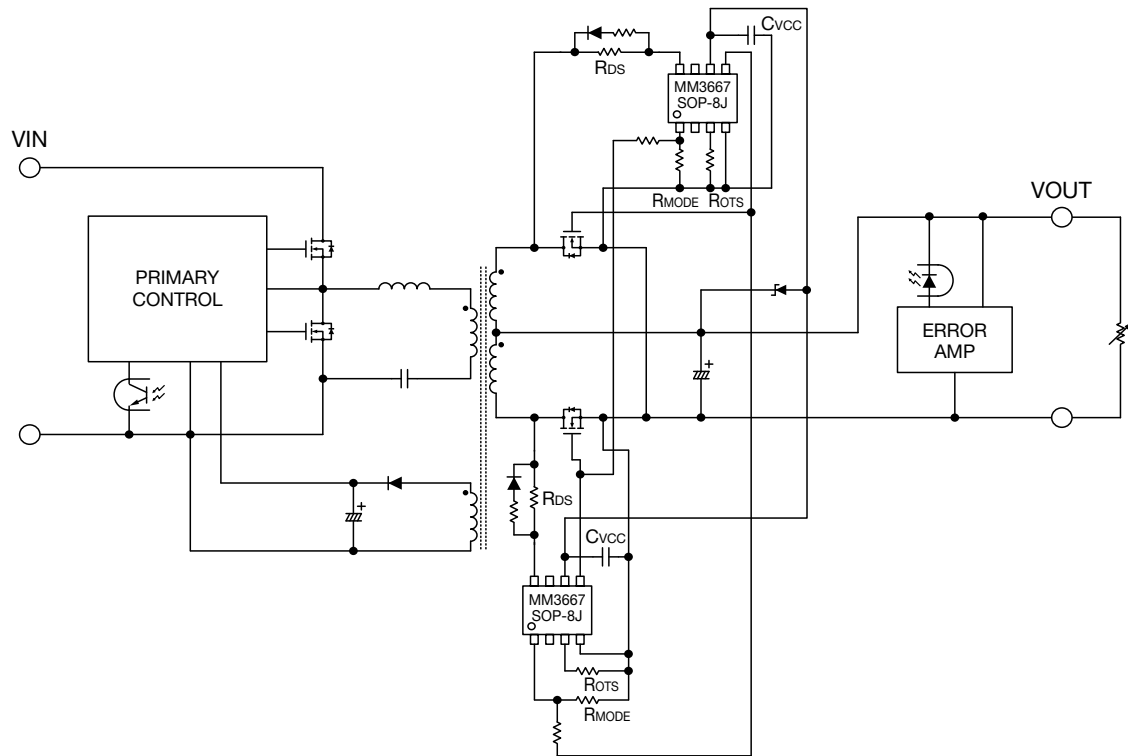


Condition2 : Not using this function

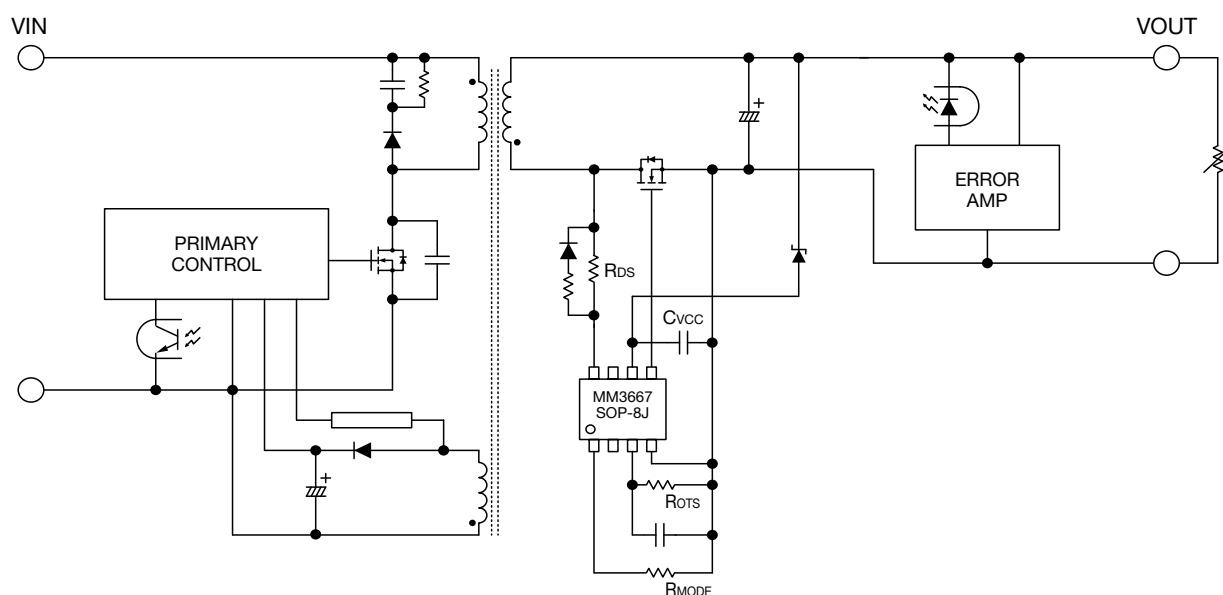


Application Circuit

- Example of application circuit for the Half-Bridge LLC converter



- Example of application circuit for the Quasi-Resonant Flyback converter



Application notes

The above circuit shows one example of connection of MM3667.

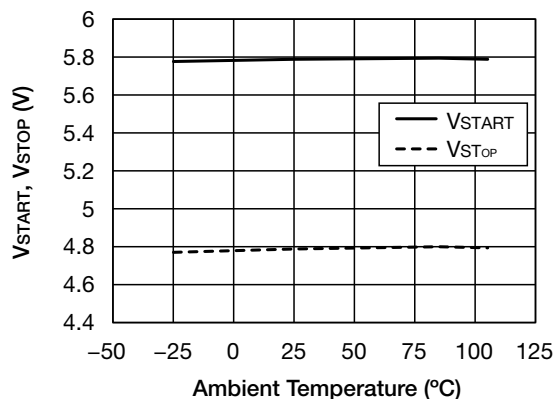
Constants of the best wiring and parts in the surrounding are different depending on the specification of the power supply. Please use MM3667 after it examines enough.

Please refer to an application note for the setting methods of neighboring parts.

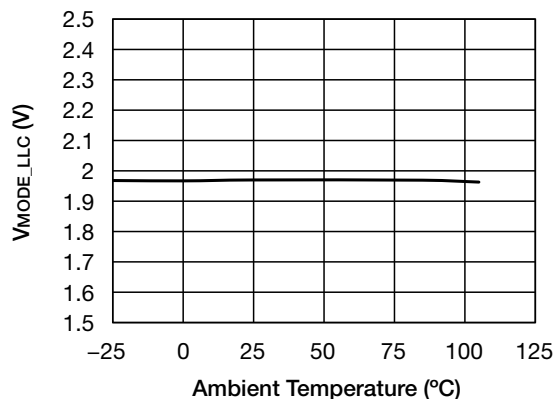
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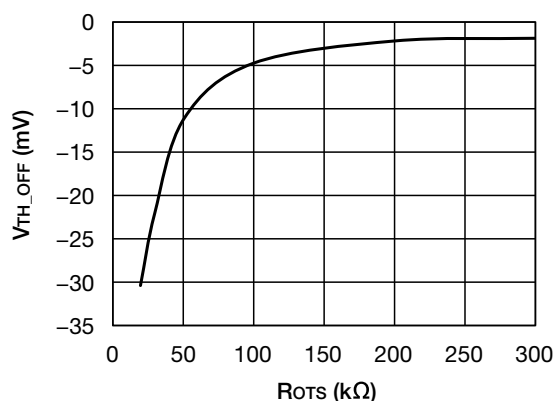
Temp. - VCC Turn On/Off Threshold



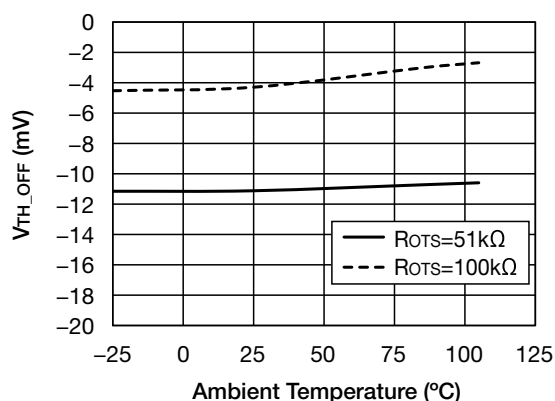
Temp. - LLC Mode Condition



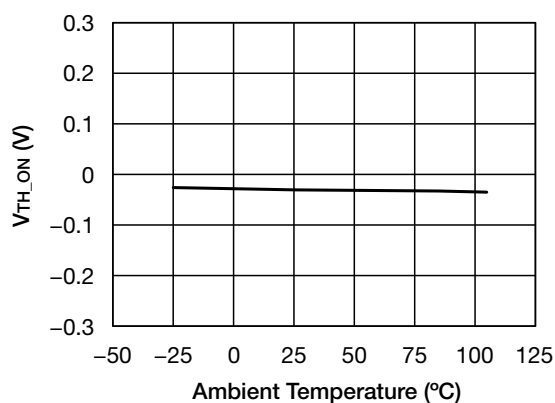
ROTS - Turn-Off Threshold Voltage



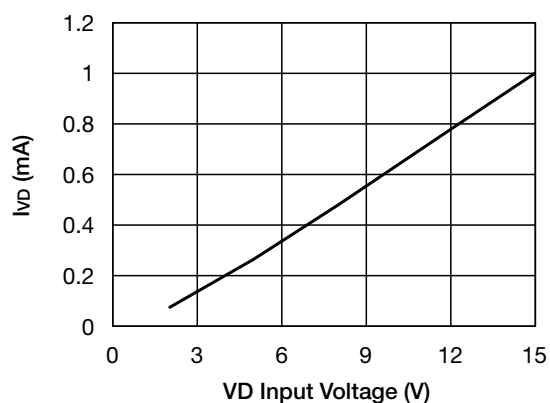
Temp. - Turn-Off Threshold Voltage



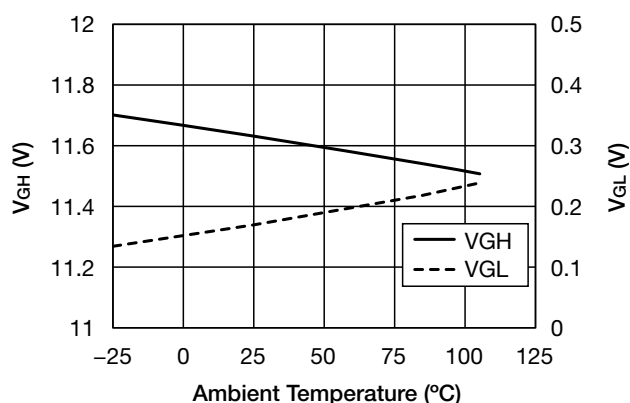
Temp. - Turn-On Threshold Voltage



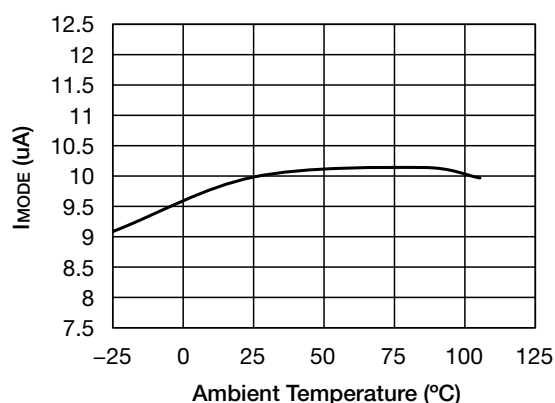
VD Input Voltage - Input Current



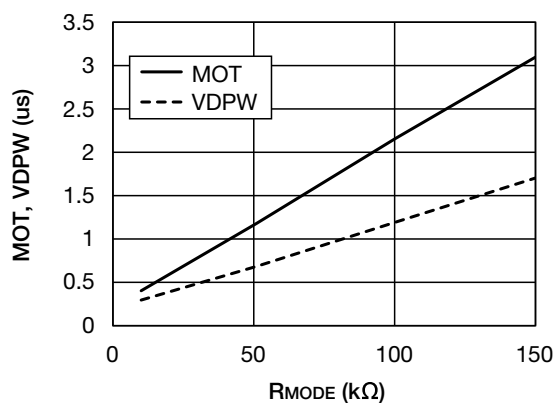
■ Temp. - VG Output High / Low Voltage



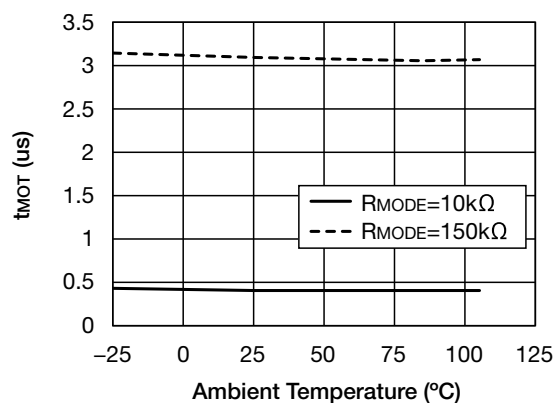
■ Temp. - MODE Pin Output Current



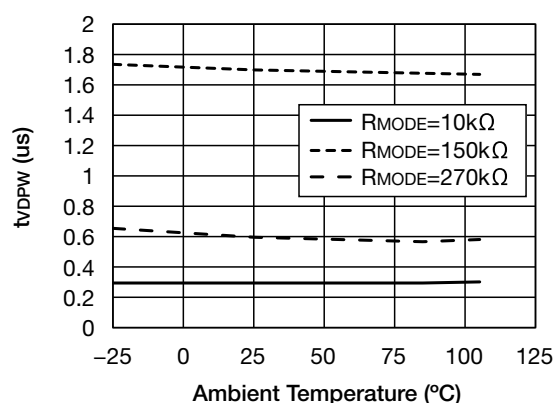
■ RMODE - Minimum On Time, VD Peak Pulse Width Detect(QR)



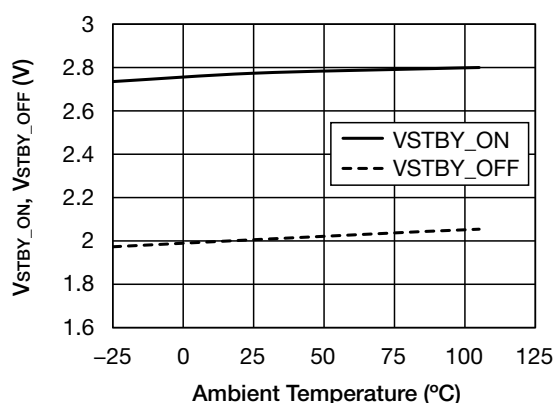
■ Temp. - Minimum On Time



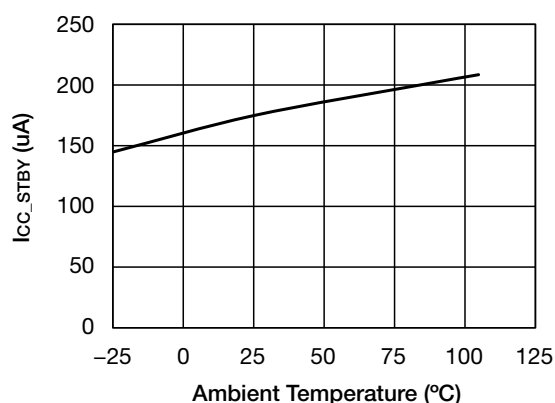
■ Temp. - VD Peak Pulse Width Detect



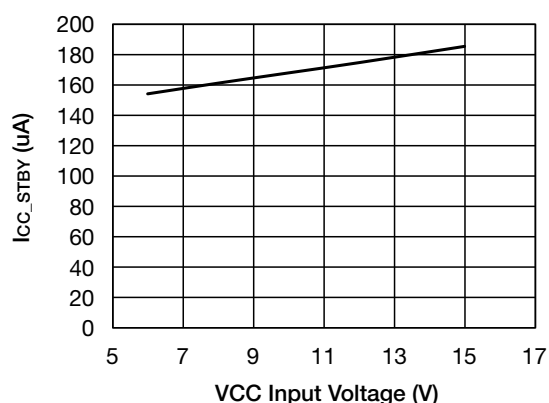
■ Temp. - Standby Mode On/Off Voltage



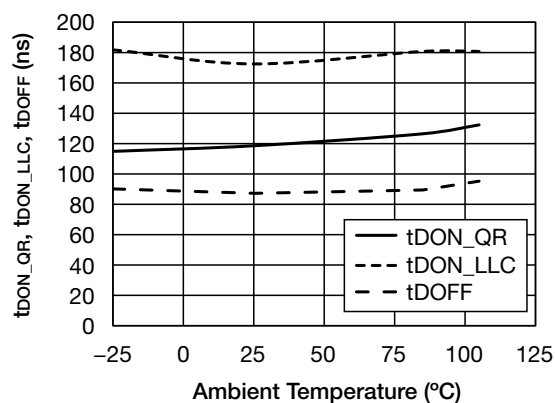
■ Temp. - Standby Mode Current



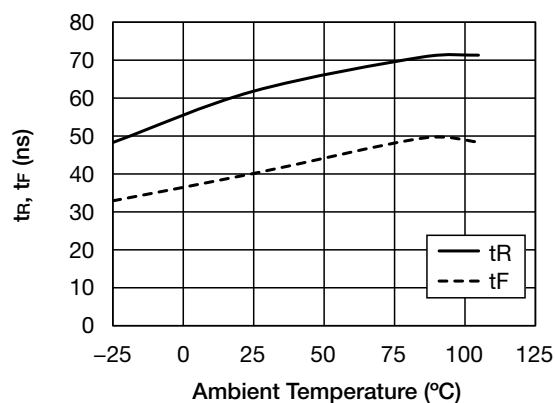
■ VCC Input Voltage - Standby Mode Current



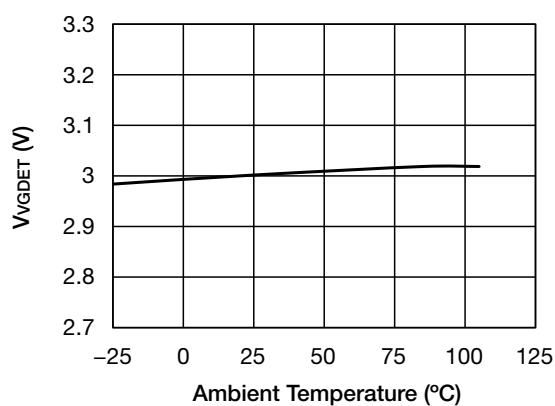
■ Temp. - Turn-On/Off Propagation Delay



■ Temp. - Rise / Fall Time



■ Temp. - Threshold Voltage of VG Detection



■ Temp. - VG Detection Delay

