

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

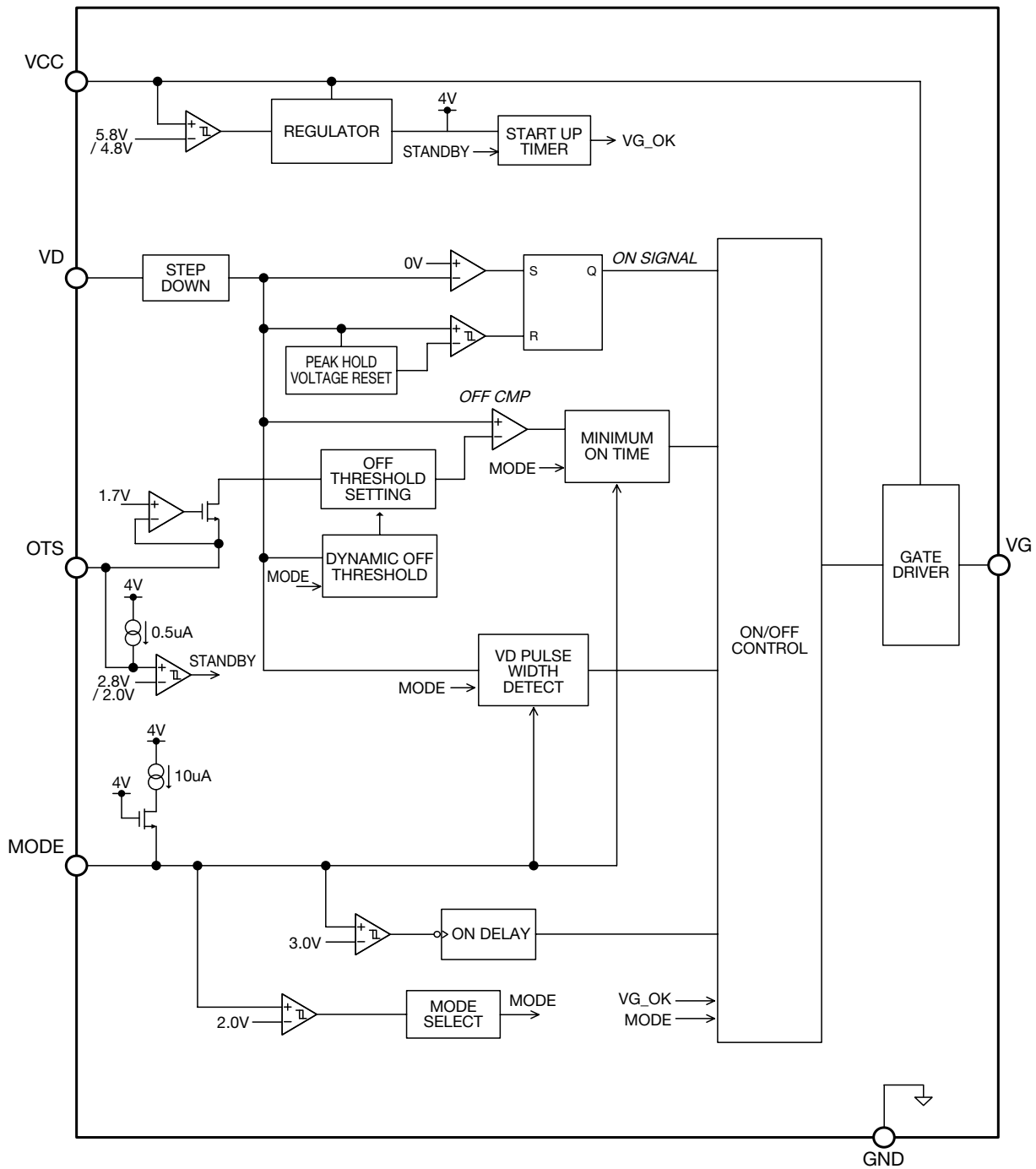
Package

SOP-8J

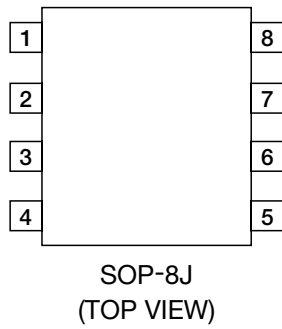
Applications

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

Block Diagram



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 | VCCMAX | -0.3~17.0 | V |
| VD Input Voltage | VVDMAX | 17.0 (Note1) | V |
| VD Output Current | IVDMAX | -1 | mA |
| MODE Input Voltage | VMODEMAX | -0.3~5.5 | V |
| OTS Input Voltage | VOTSMAX | -0.3~4.0 | V |
| Storage Temperature | Tstg | -40~150 | °C |
| Power Dissipation (alone) | Pd | 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 | Topr | -25~105 | °C |
| Operating Supply Voltage | VCCOPR | 6.0~15.0 | V |
| VD Pin Peak Voltage | VVDPEAK | 4.5~15.0 | V |
| MODE Pin Input Voltage | VMODE | 5.0 Max. | V |
| OTS Pin Input Voltage | VOTS | 3.9 Max. | V |
| Switching Frequency on Half-Bridge LLC converter | fsw_LL | 25~500 | kHz |
| Switching Frequency on Quasi-Resonant converter | fsw_QR | 25~200 | kHz |

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

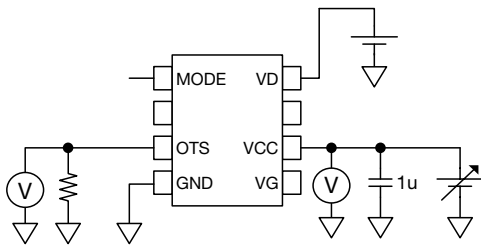
| Item | Symbol | Measurement conditions | Min. | Typ. | Max. | Units | Measuring Circuit |
|---------------------------------|-----------------------|--|-------|-------|------|-------|-------------------|
| Supply Section | | | | | | | |
| VCC Turn On Threshold | V _{CC_START} | | 5.6 | 5.8 | 6.0 | V | A |
| VCC Turn Off Threshold | V _{CC_STOP} | | 4.6 | 4.8 | 5.0 | V | A |
| Supply Current (LLC) | I _{CC_LLC1} | Cl _{oad} =6000pF, f _{sw} =100kHz, R _{MODE} =270kΩ | | 7.8 | 9.0 | mA | B |
| Single Supply Current (LLC) | I _{CC_LLC2} | Cl _{oad} =0pF, f _{sw} =100kHz, R _{MODE} =270kΩ | | 0.66 | 0.79 | mA | B |
| Supply Current (QR) | I _{CC_QR1} | Cl _{oad} =6000pF, f _{sw} =100kHz, R _{MODE} =10kΩ | | 7.8 | 9.0 | mA | B |
| Single Supply Current (QR) | I _{CC_QR2} | Cl _{oad} =0pF, f _{sw} =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} | I _G =50mA | 11.3 | 11.7 | 11.9 | V | D |
| VG Output Low Voltage | V _{GL} | I _G =-50mA | | 0.15 | 0.3 | V | D |
| Rise Time | t _r | Cl _{oad} =6000pF V _G =2V→9V | | 70 | 120 | ns | E |
| Fall Time | t _f | Cl _{oad} =6000pF V _G =9V→2V | | 50 | 70 | ns | E |
| Turn-On Propagation Delay (QR) | t _{DON_QR} | Cl _{oad} =6000pF V _D =V _{TH_ON} →V _G =2V | | 100 | 200 | ns | E |
| Turn-On Propagation Delay (LLC) | t _{DON_LLC} | Cl _{oad} =6000pF V _D =V _{TH_ON} →V _G =2V | | 150 | 250 | ns | E |
| VG detection delay | t _{VGDELAY} | | 480 | 580 | 680 | ns | H |
| Turn-Off Propagation Delay | t _{DOFF} | Cl _{oad} =6000pF V _D =V _{TH_OFF} →V _G =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} | V _D =12V | 12 | 15 | 18 | kΩ | G |

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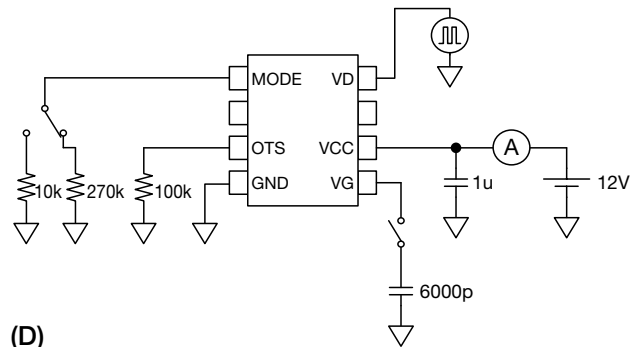
| Item | Symbol | Measurement conditions | Min. | Typ. | Max. | Units | Measuring Circuit |
|-----------------------------------|------------------------|---|------|------|-------|-------|-------------------|
| Operation Mode Setting | | | | | | | |
| LLC Mode Condition | V _{MODE_LL} C | | 1.8 | 2.0 | 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_LL} C | 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

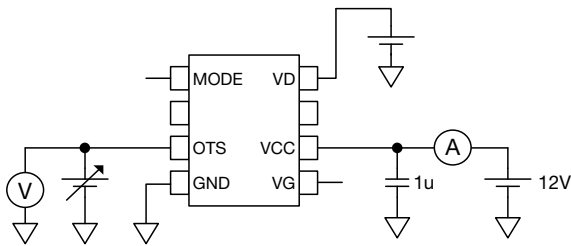
(A)



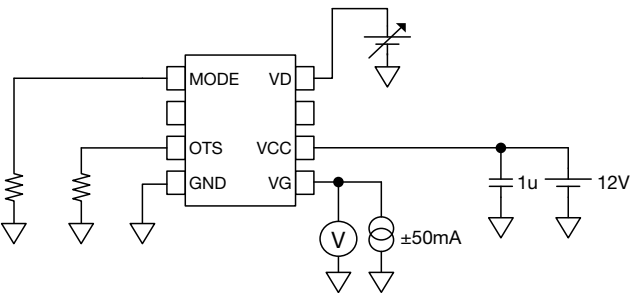
(B)



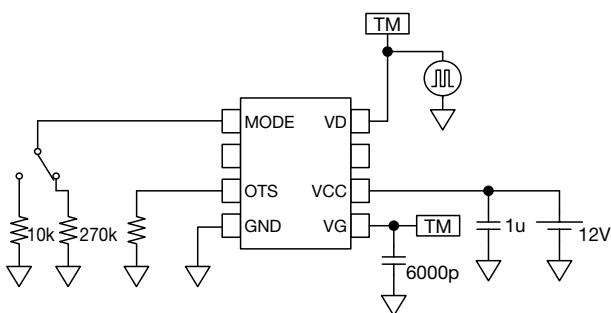
(C)



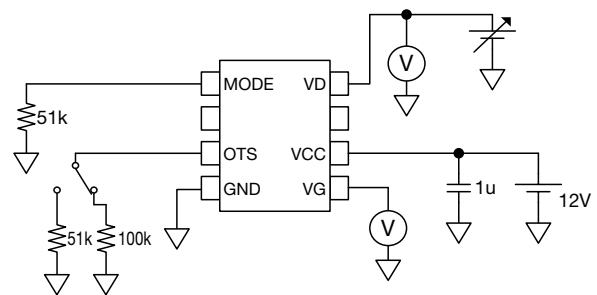
(D)



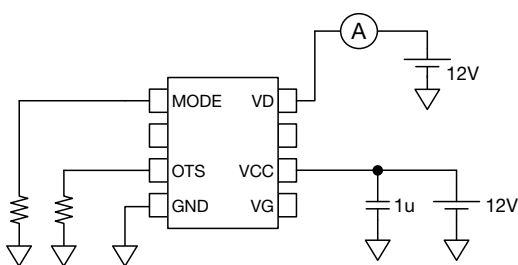
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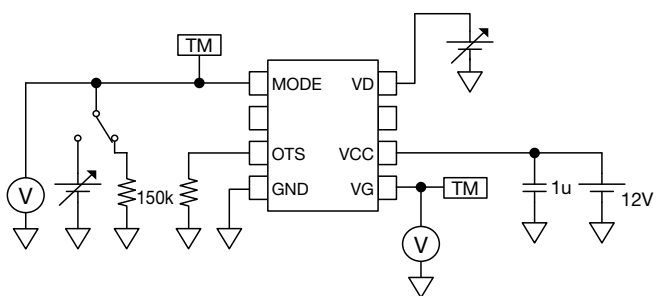
(F)



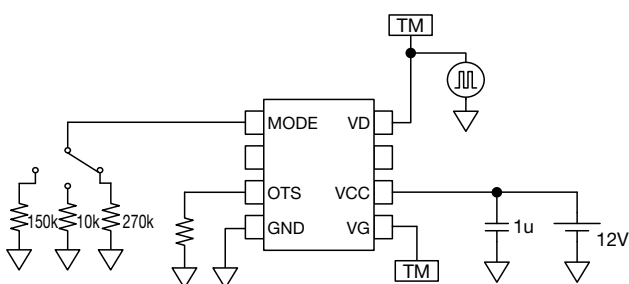
(G)



(H)



(I)



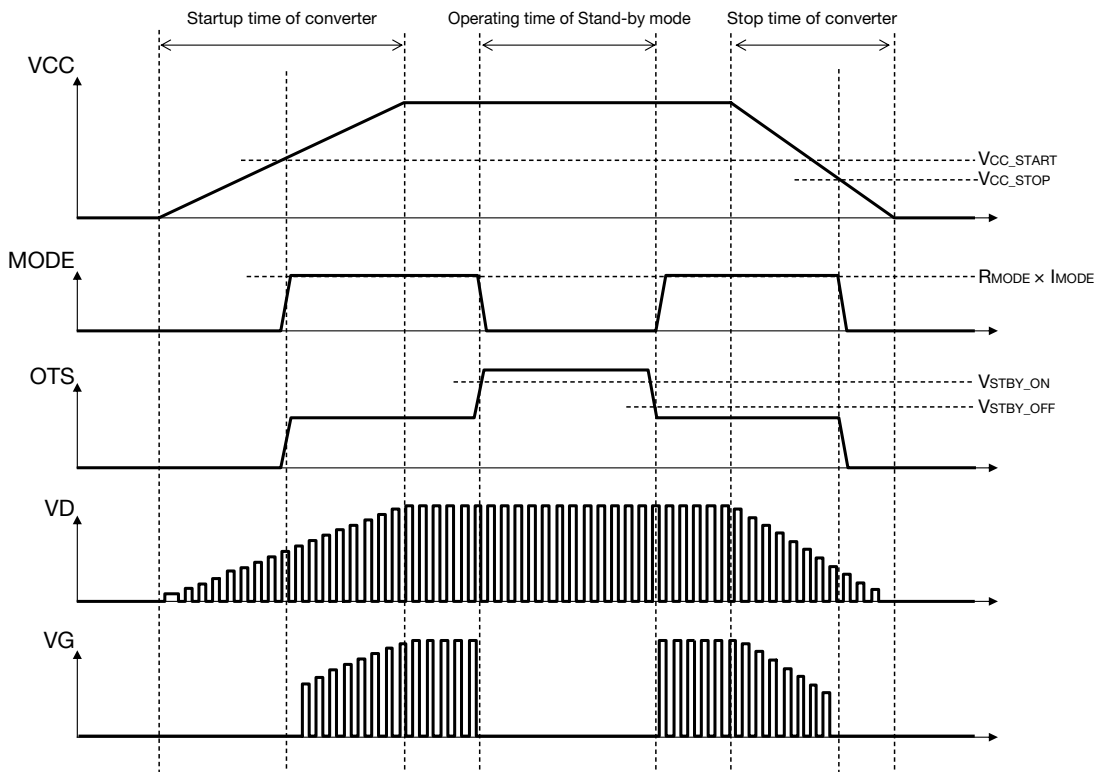
* TM : Time Measure module

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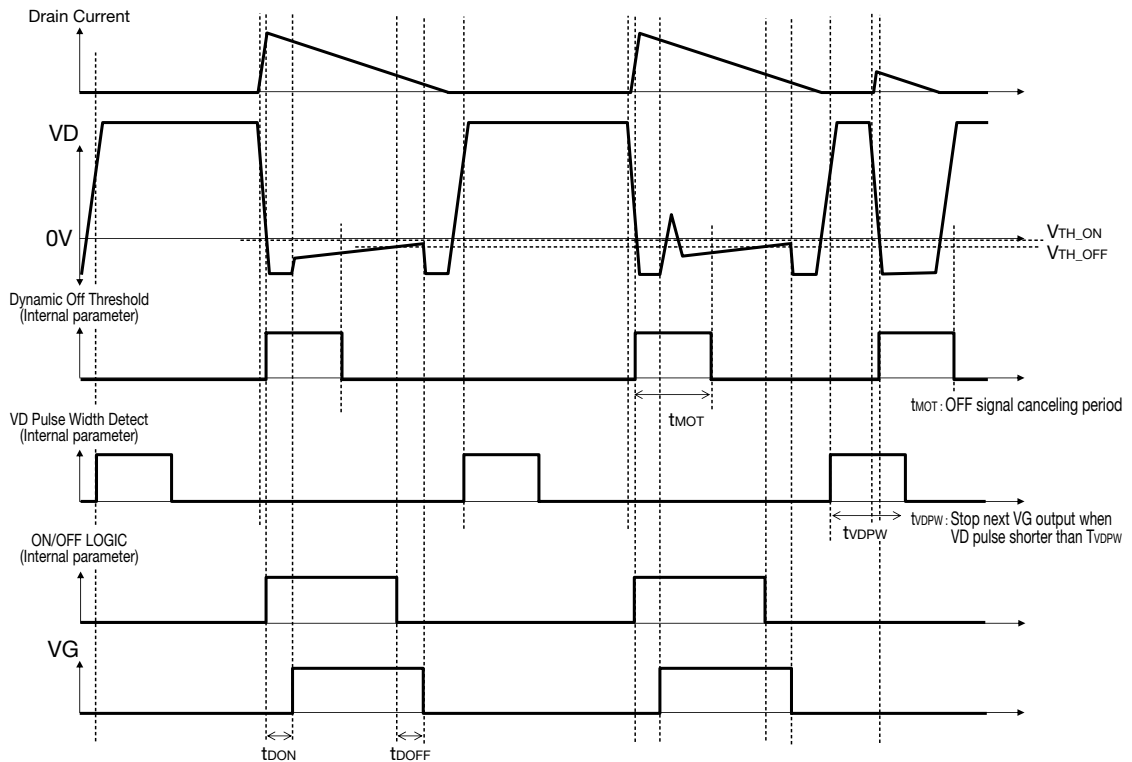
Timing Chart

(1) Example of operation on Quasi-Resonant converter

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



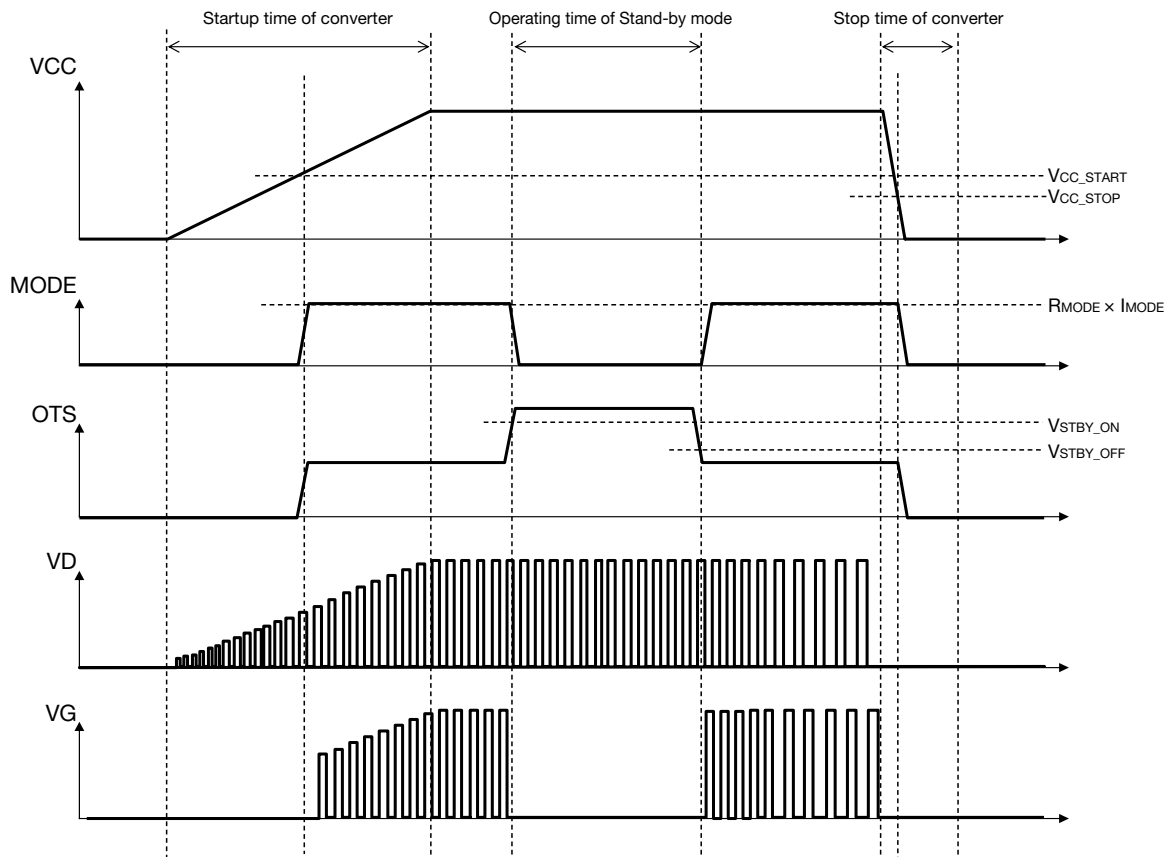
- Operation for VD input signal



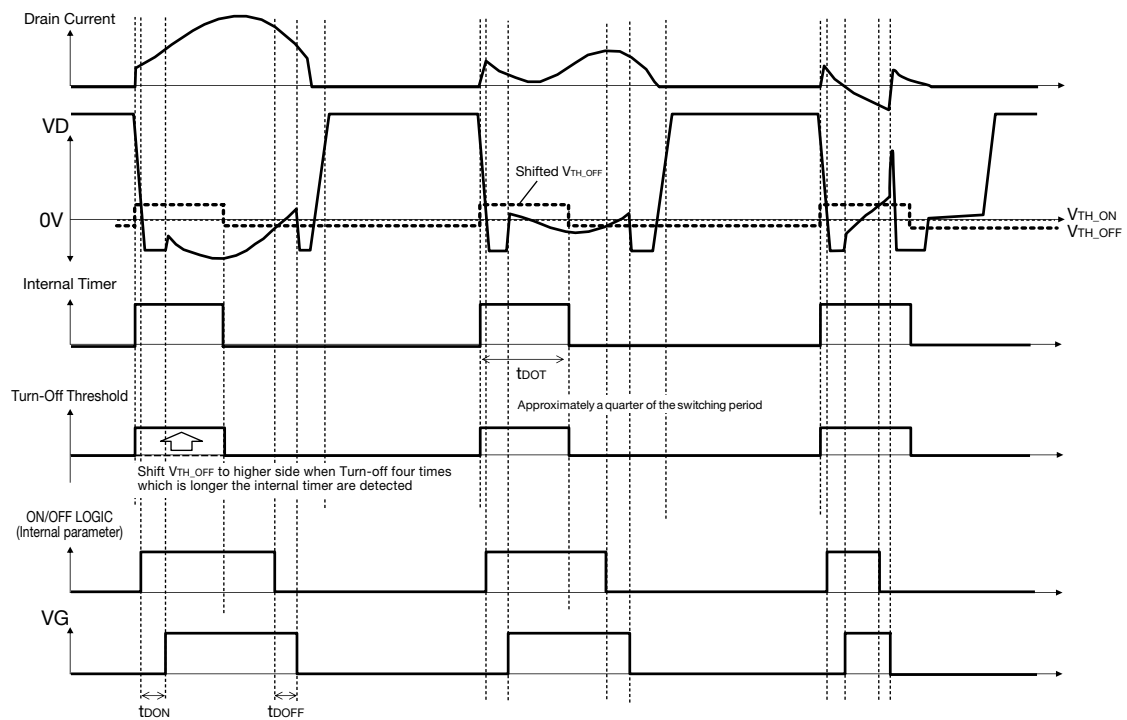
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(2) Example of operation on Half-Bridge LLC converter

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

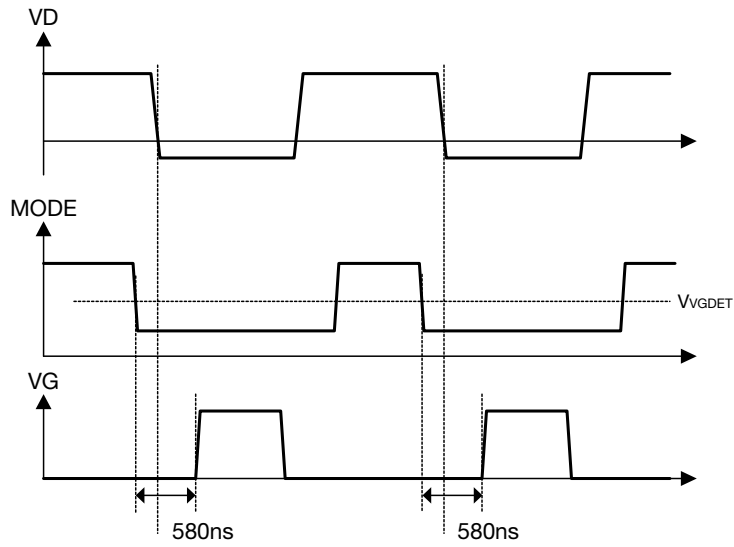


- Operation for VD input signal

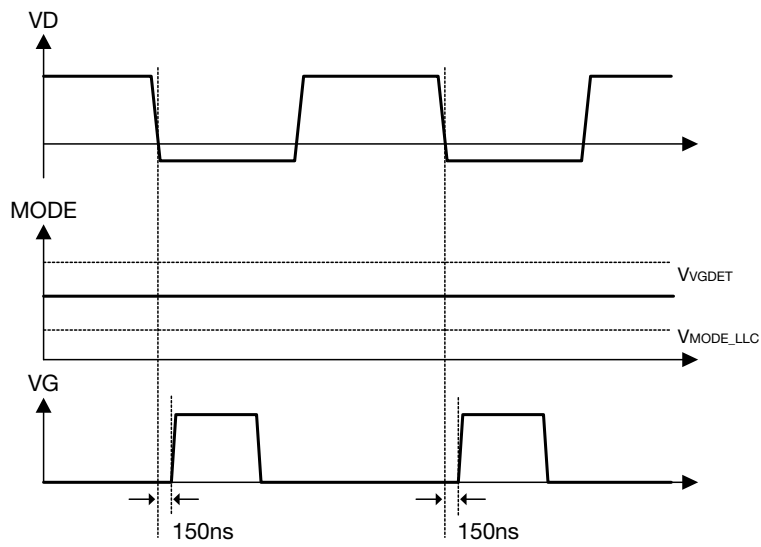


(3) The function of VG detection delay

Condition1 : Using this function

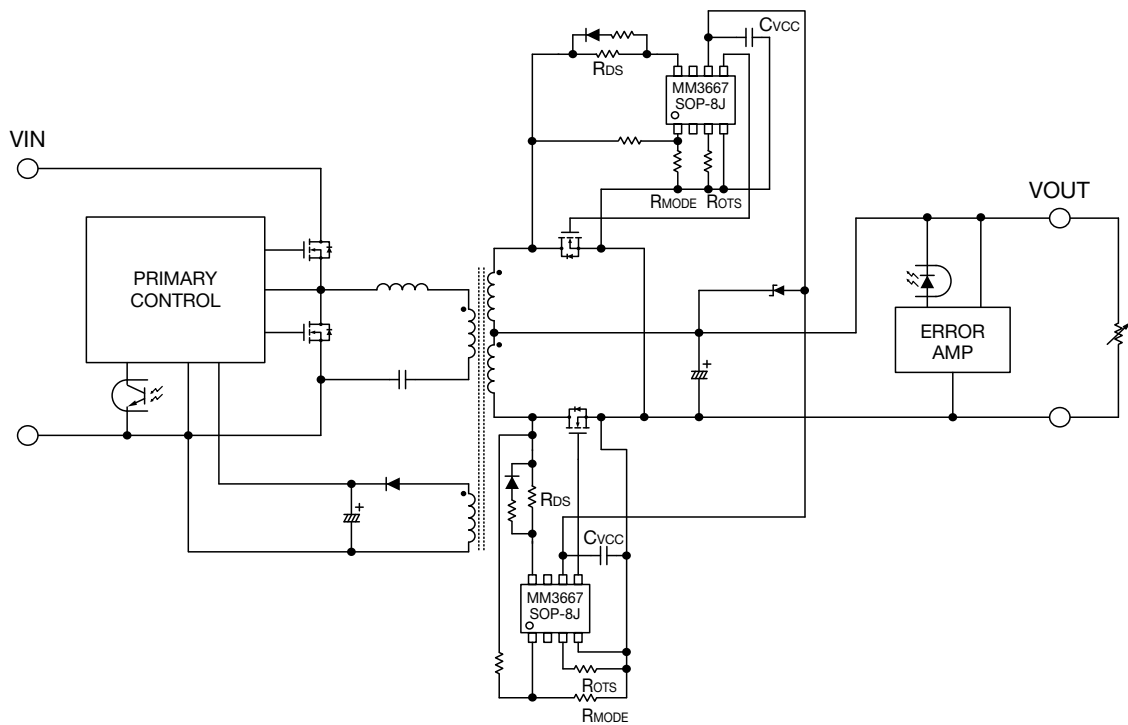
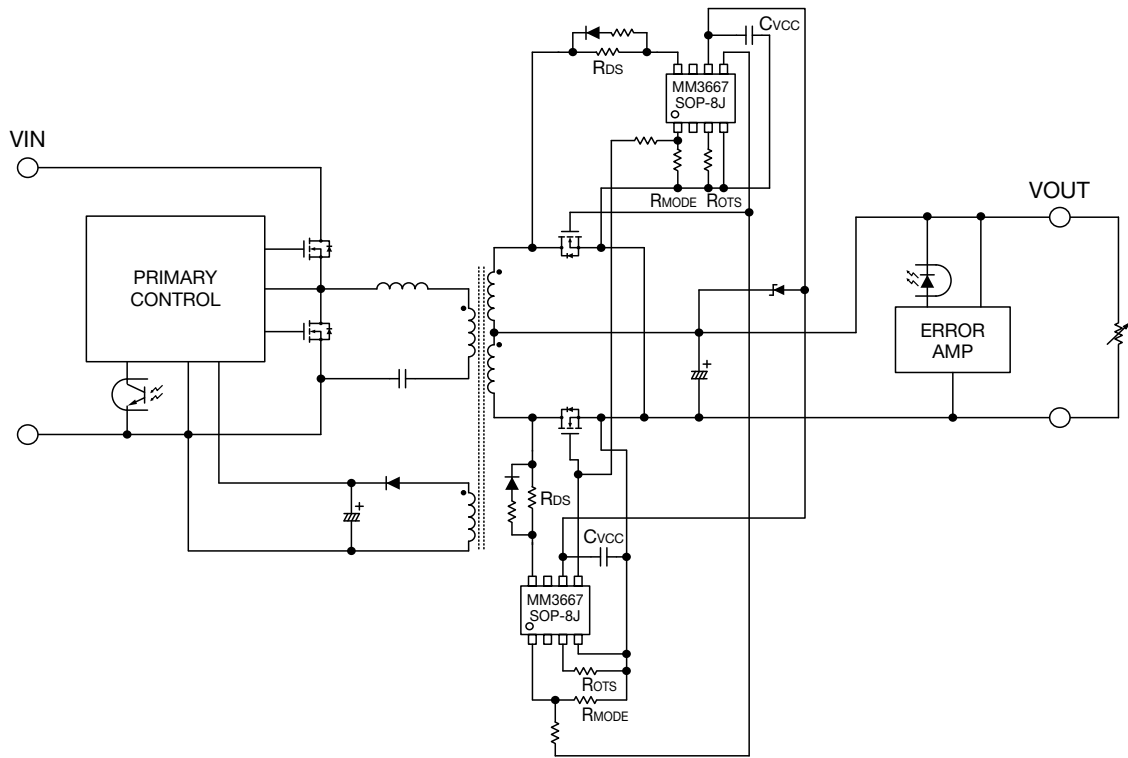


Condition2 : Not using this function

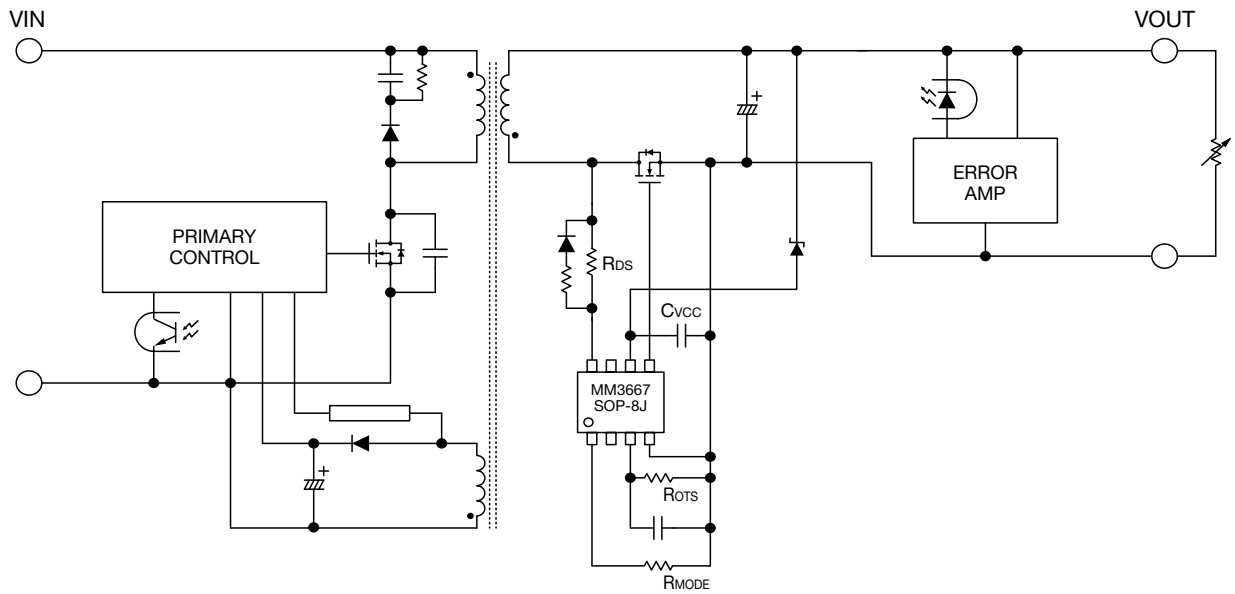


Application Circuit

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



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



Application notes

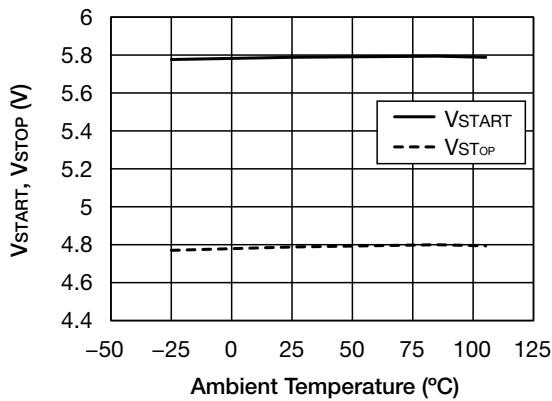
The above circuit shows one example of connection of MM3667.

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.

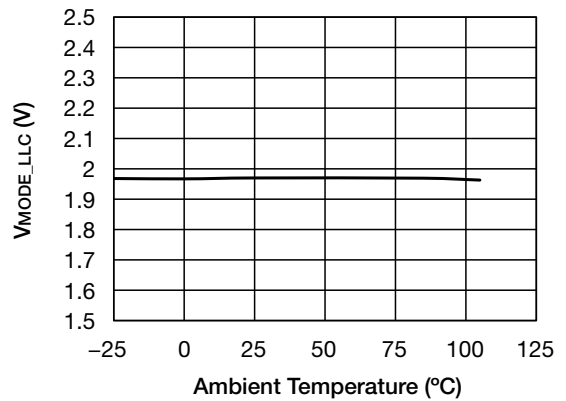
Please refer to an application note for the setting methods of neighboring parts.

Characteristics (Except where noted otherwise $T_a=25^\circ\text{C}$)

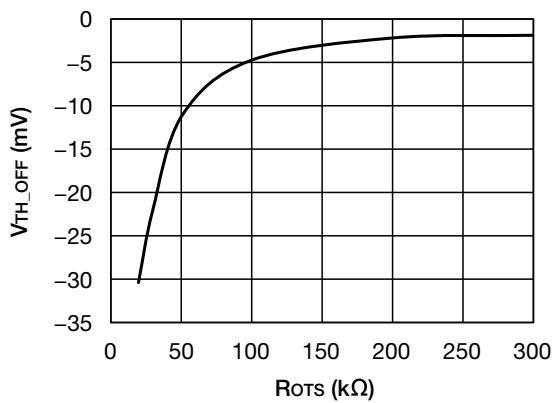
■ Temp. - VCC Turn On/Off Threshold



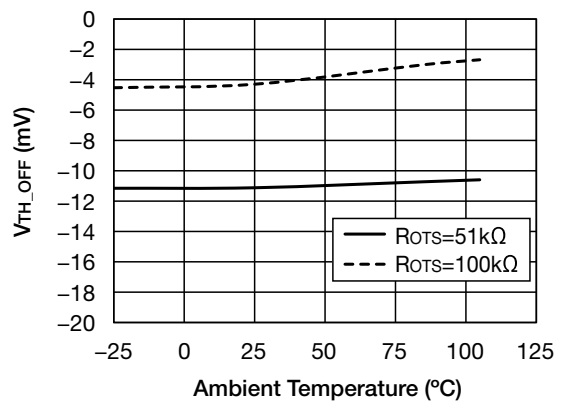
■ Temp. - LLC Mode Condition



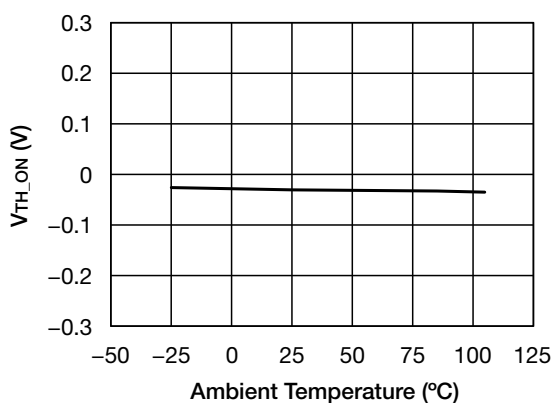
■ ROTs - Turn-Off Threshold Voltage



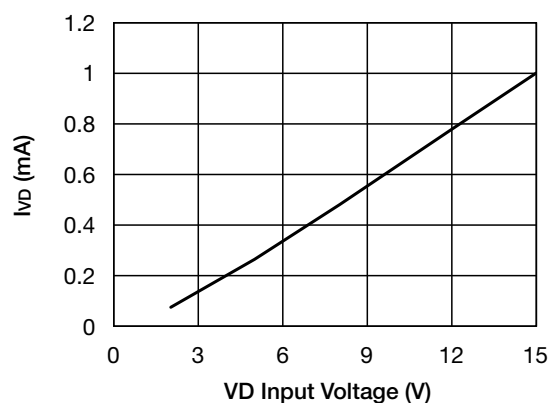
■ Temp. - Turn-Off Threshold Voltage



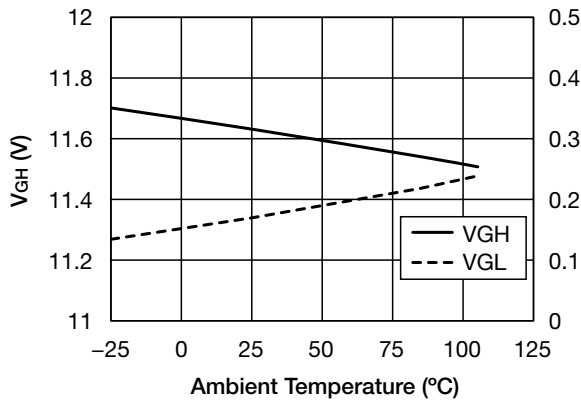
■ Temp. - Turn-On Threshold Voltage



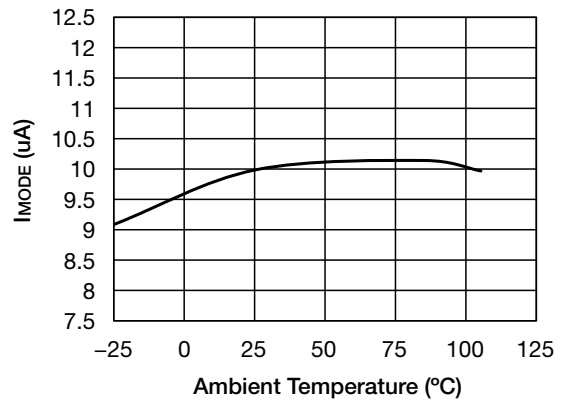
■ VD Input Voltage - Input Current



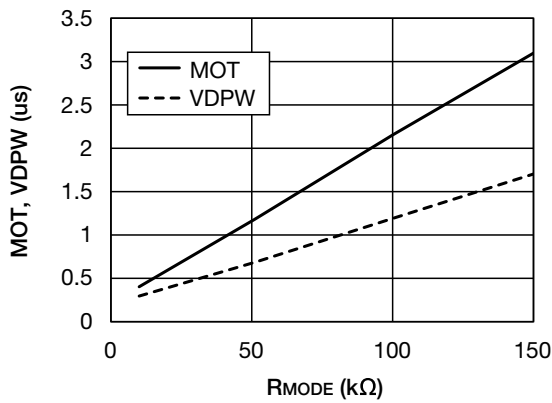
Temp. - VG Output High / Low Voltage



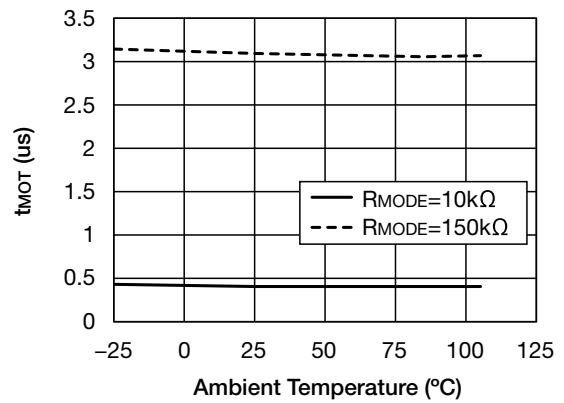
Temp. - MODE Pin Output Current



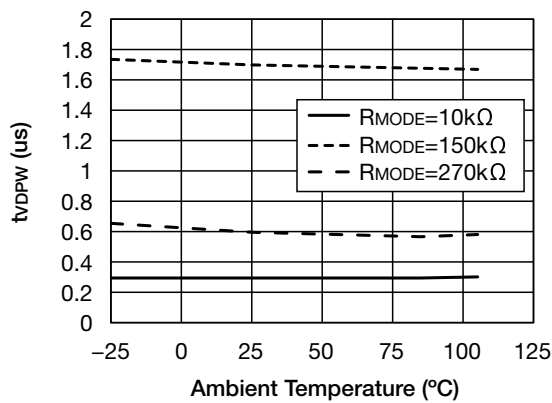
RMODE - Minimum On Time, VD Peak Pulse Width Detect(QR)



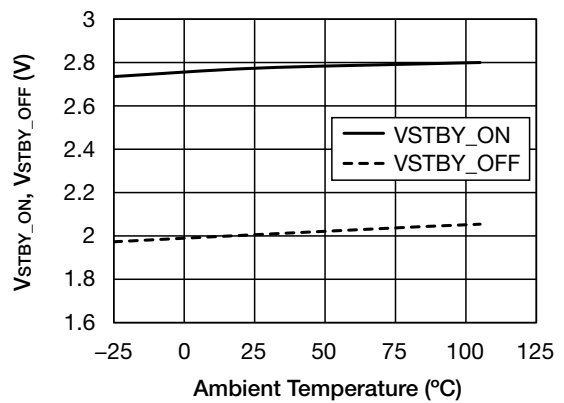
Temp. - Minimum On Time



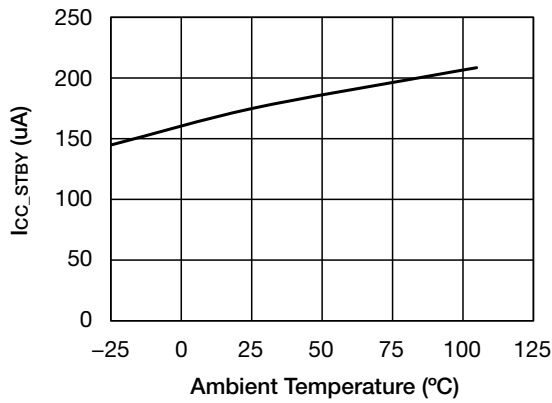
Temp. - VD Peak Pulse Width Detect



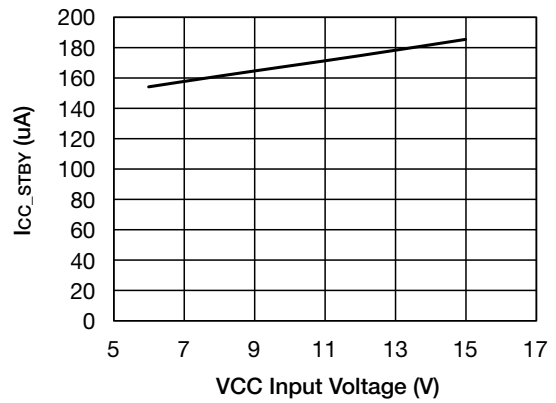
Temp. - Standby Mode On/Off Voltage



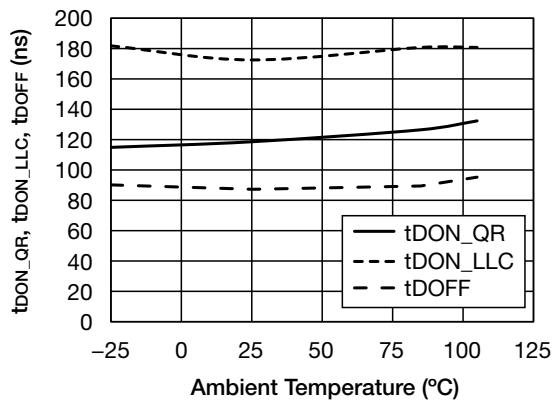
Temp. - Standby Mode Current



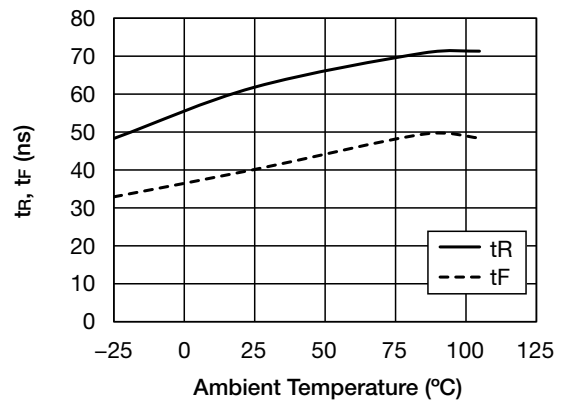
VCC Input Voltage - Standby Mode Current



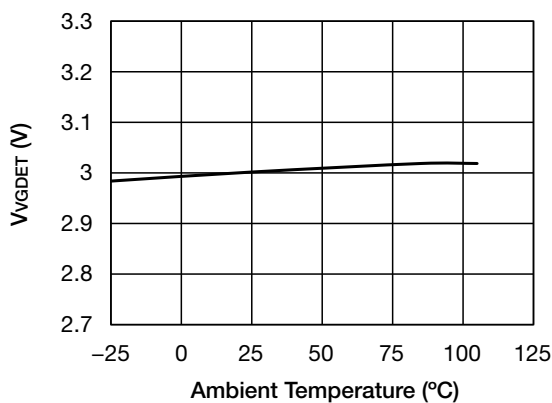
Temp. - Turn-On/Off Propagation Delay



Temp. - Rise / Fall Time



Temp. - Threshold Voltage of VG Detection



Temp. - VG Detection Delay

