



The synchronous rectification control IC for QR / LLC converter

MM3667A Series

Description

MM3667 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. 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

- It supports Half-Bridge LLC resonant converter and Quasi-Resonant flyback converter.
- Supports a wide range of operating frequencies
- Adjustable turn-OFF threshold voltage
- Equipped with standby mode

Main specifications

- VD pin input voltage : 6V~15V (max.17V)
- Operating voltage range : 6V~15V (max.17V)
- Supply Current : Typ. 0.66mA (VCC=12V)
- Operating frequency : Max. 500kHz (LLC) 200kHz(QR)

Package

- SOP-8J

Application

- TV
- High-Power AC-DC Adaptor
- Gaming Consoles
- High-Power SMPS





Model Name

M M 3 6 6 7 A F F E
|-----| | | | |

Series name

(A) (B) (C) (D)

(A)Function Type

A	For LLC,QR converter
B	For QR converter

(B)Package

F	SOP-8J
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(C)Type of packing

F	F Housing
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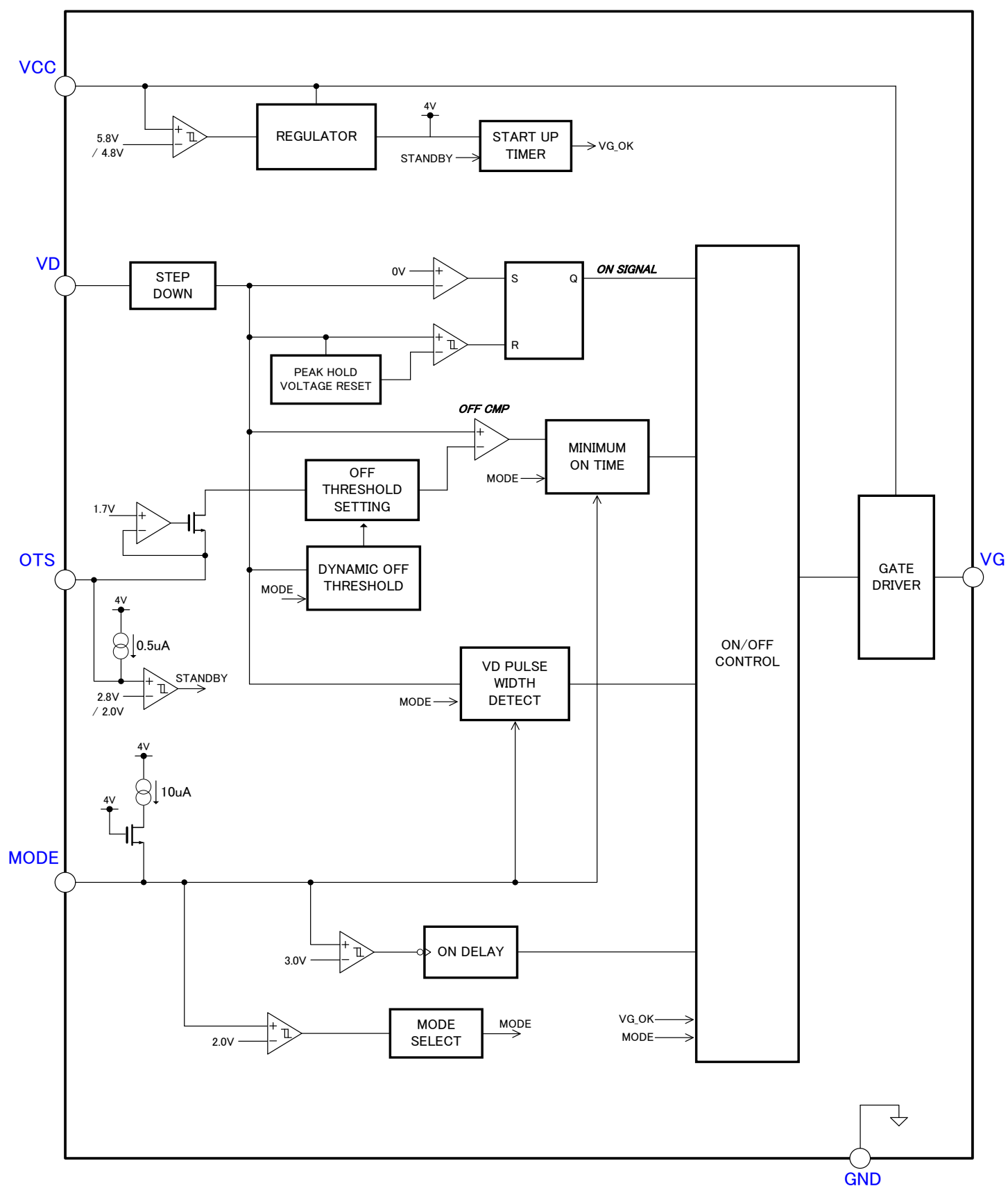
(D)Taping material

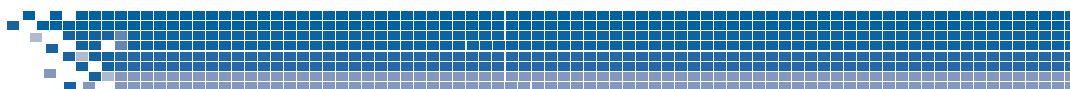
E	Emboss tape
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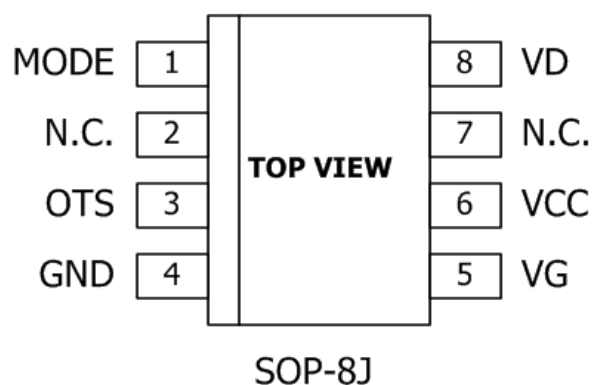
Block Diagram





Pin Configuration

SOP-8J



Pin No.	Pin name	Function
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 Maximun Ratings

(Ta=25°C, unless otherwise specified)

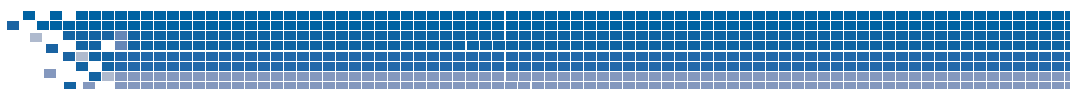
Item	Symbol	Min.	Max.	Unit
Supply Voltage	V _{CCmax}	-0.3	17	V
VD Input Voltage	V _{VDmax}	※1	17	V
VD Output Current	I _{VDmax}	-1	-	mA
MODE Input Voltage	V _{MODEmax}	-0.3	5.5	V
OTS Input Voltage	V _{OTSmax}	-0.3	4	V
Storage Temperature	T _{stg}	-40	150	°C
Power Dissipation (alone)	Pd	-	300	mW

*1 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

(Ta=25°C, unless otherwise specified)

Item	Symbol	Min.	Max.	Unit
Operating Ambient Temperature	T _{opr}	-25	105	°C
Operating Supply Voltage	V _{CCOPR}	6	15	V
VD Pin Peak Voltage	V _{VDPEAK}	4.5	15	V
MODE Pin Input Voltage	V _{MODE}	-	5	V
OTS Pin Input Voltage	V _{OTS}	-	3.9	V
Switching Frequency (LLC)	f _{sw_LL}	25	500	kHz
Switching Frequency (QR)	f _{sw_QR}	25	200	kHz



Electrical Characteristics

(Ta=25°C, unless otherwise specified)

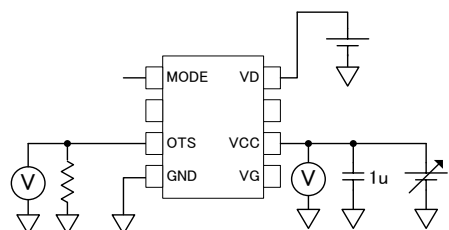
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	※2
Supply Section							
VCC Turn On Threshold	V _{CC_START}		5.6	5.8	6	V	A
VCC Turn Off Threshold	V _{CC_STOP}		4.6	4.8	5	V	A
Supply Current (LLC)	I _{CC_LLC1}	Cload=6000pF, fsw=100kHz, Rmode=270kΩ	-	7.8	9	mA	B
Single Supply Current (LLC)	I _{CC_LLC2}	Cload=0pF, fsw=100kHz, Rmode=270kΩ	-	0.66	0.79	mA	B
Supply Current (QR)	I _{CC_QR1}	Cload=6000pF, fsw=100kHz, Rmode=10kΩ	-	7.8	9	mA	B
Single Supply Current (QR)	I _{CC_QR2}	Cload=0pF, fsw=100kHz, Rmode=10kΩ	-	0.65	0.78	mA	B
Standby Mode Current	I _{CC_STBY}	VOTS=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=2→9V	-	70	120	ns	E
Fall Time	t _F	Cload=6000pF, VG=9→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_LLC}	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}	ROTS=51kΩ	-16.6	-11.6	-6.6	mV	F
		ROTS=100kΩ	-10.6	-5.6	-0.6	mV	F
VD Input Resistance	R _{VD}	VD=12V	12	15	18	kΩ	G
Operation Mode Setting							
LLC Mode Condition	V _{MODE_LLC}		1.8	2	2.2	V	H
Threshold Voltage of VG detection	V _{VGDET}		2.8	3	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}	Rmode=270kΩ	0.39	0.56	0.73	us	I
VD Peak Pulse Width Detect(QR)	t _{VDPW_QR}	Rmode=10kΩ	0.20	0.29	0.38	us	I
		Rmode=150kΩ	1.20	1.71	2.22	us	I
Minimum On Time	t _{MOT}	Rmode=10kΩ	0.26	0.37	0.48	us	I
		Rmode=150kΩ	2.2	3.1	4	us	I
Dynamic Off-Threshold Time	t _{DOT}	f _{sw} =100kHz	1.8	2.4	3	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	2.3	V	C
Standby On/Off Hysteresis	V _{STBY_HYS}	V _{STBY_ON} -V _{STBY_OFF}	-	0.8	-	V	-

*2 The test circuit symbols.

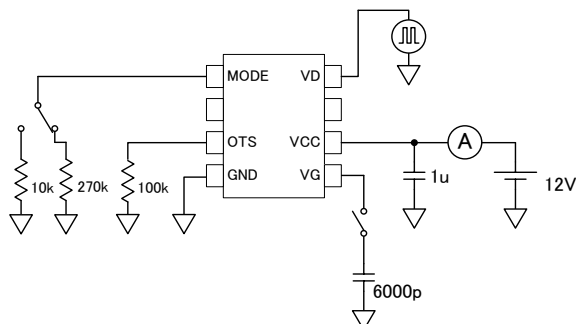


Test Circuit

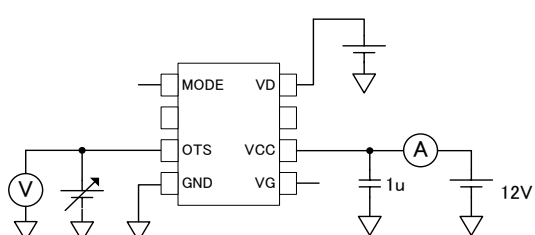
TEST CIRCUIT A



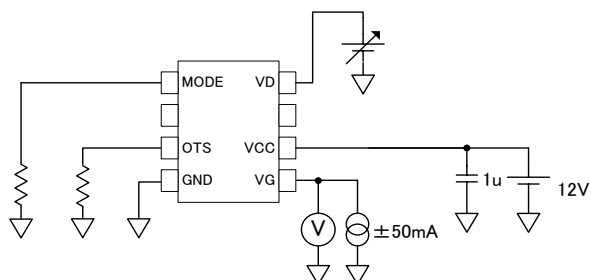
TEST CIRCUIT B



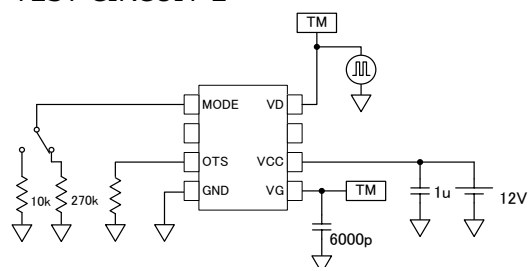
TEST CIRCUIT C



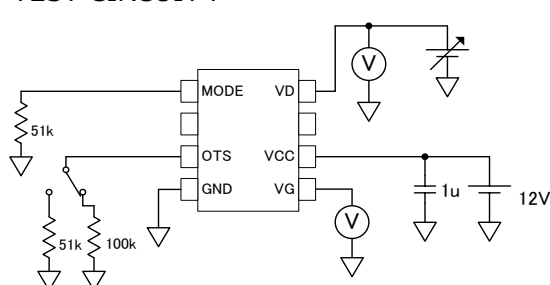
TEST CIRCUIT D



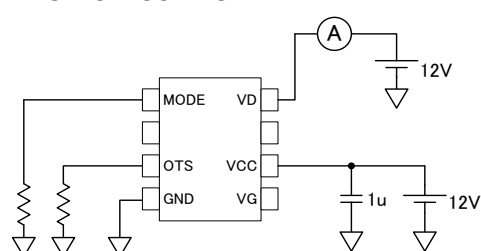
TEST CIRCUIT E



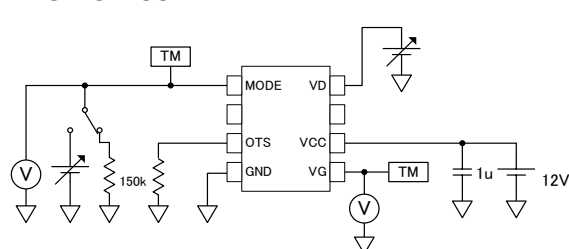
TEST CIRCUIT F



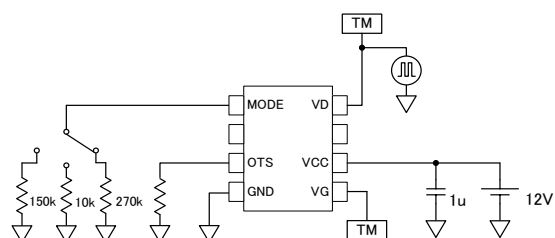
TEST CIRCUIT G



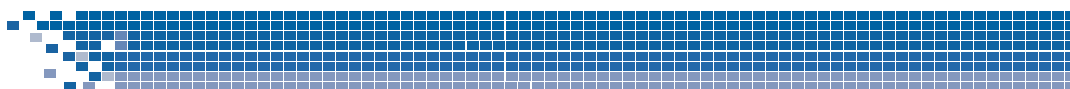
TEST CIRCUIT H



TEST CIRCUIT I



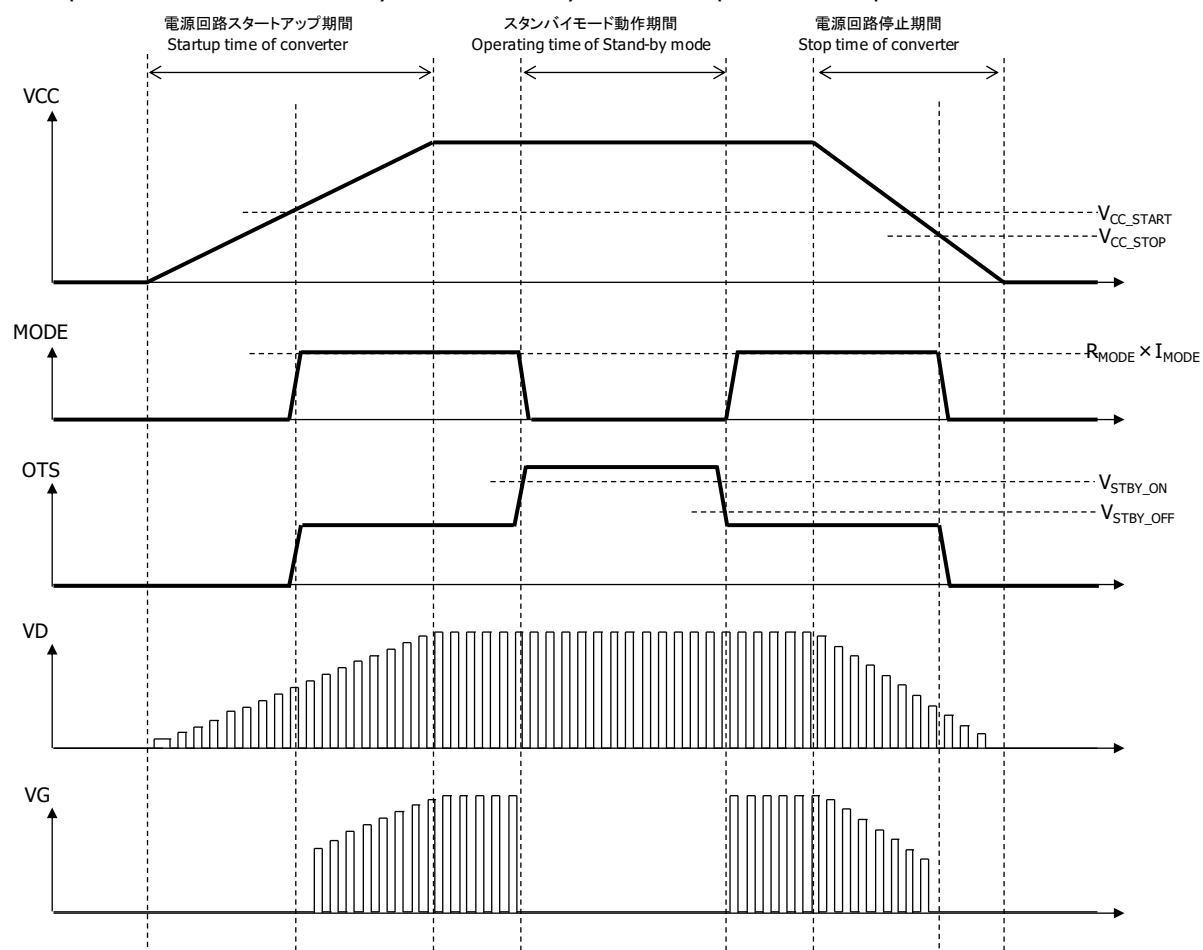
TM:Time Measure Module



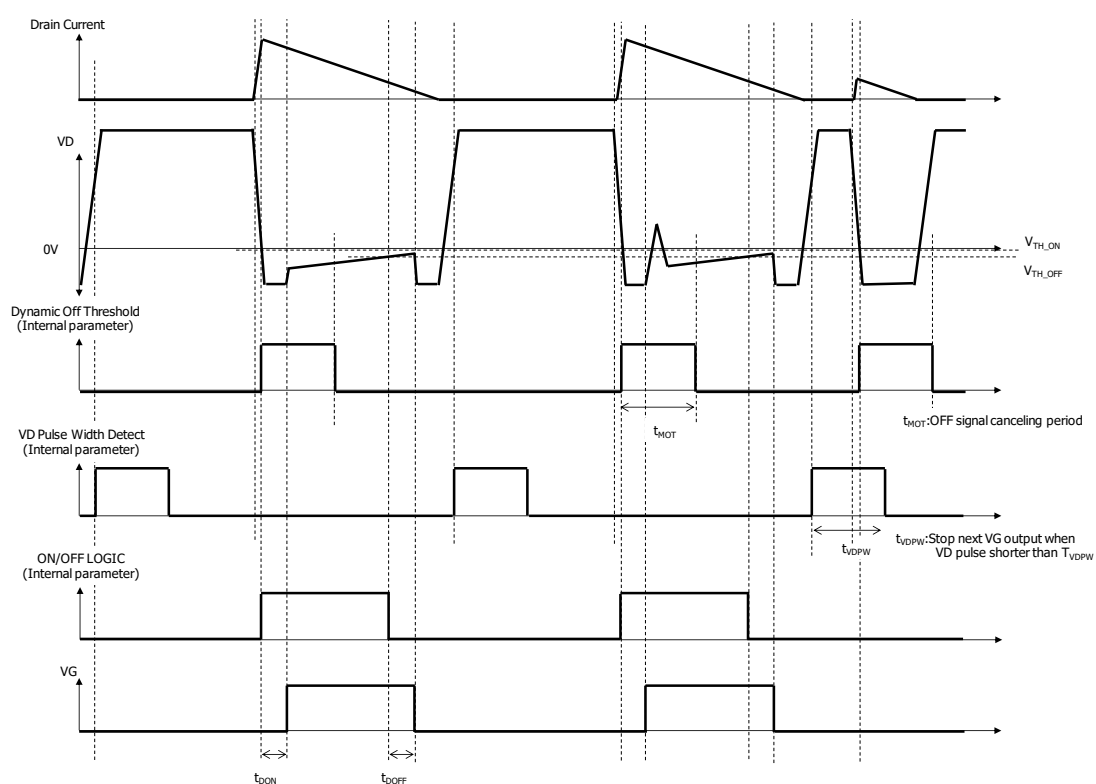
Timing Chart

Example of operation on Quasi-Resonant converter

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



Operation for VD input signal

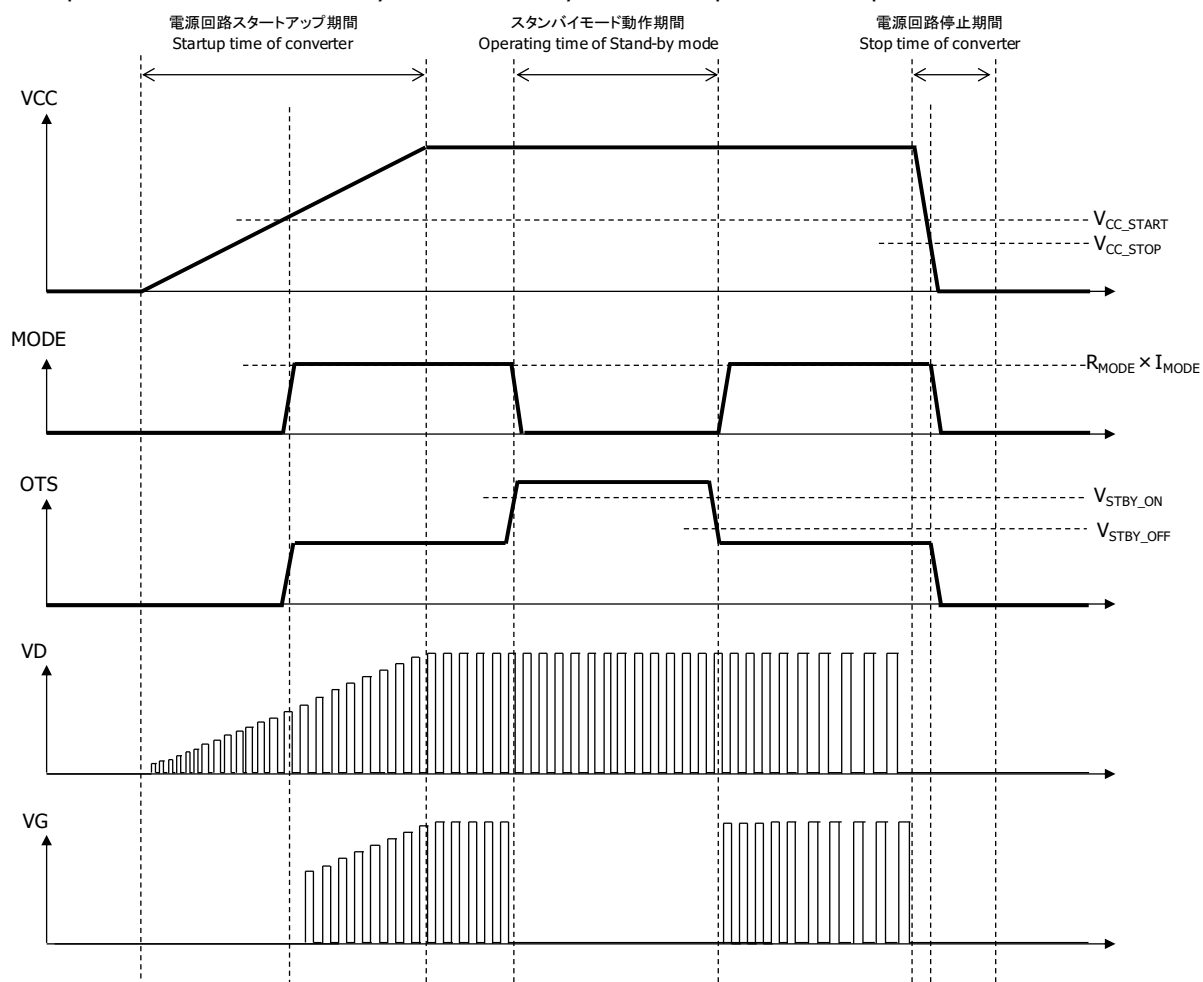




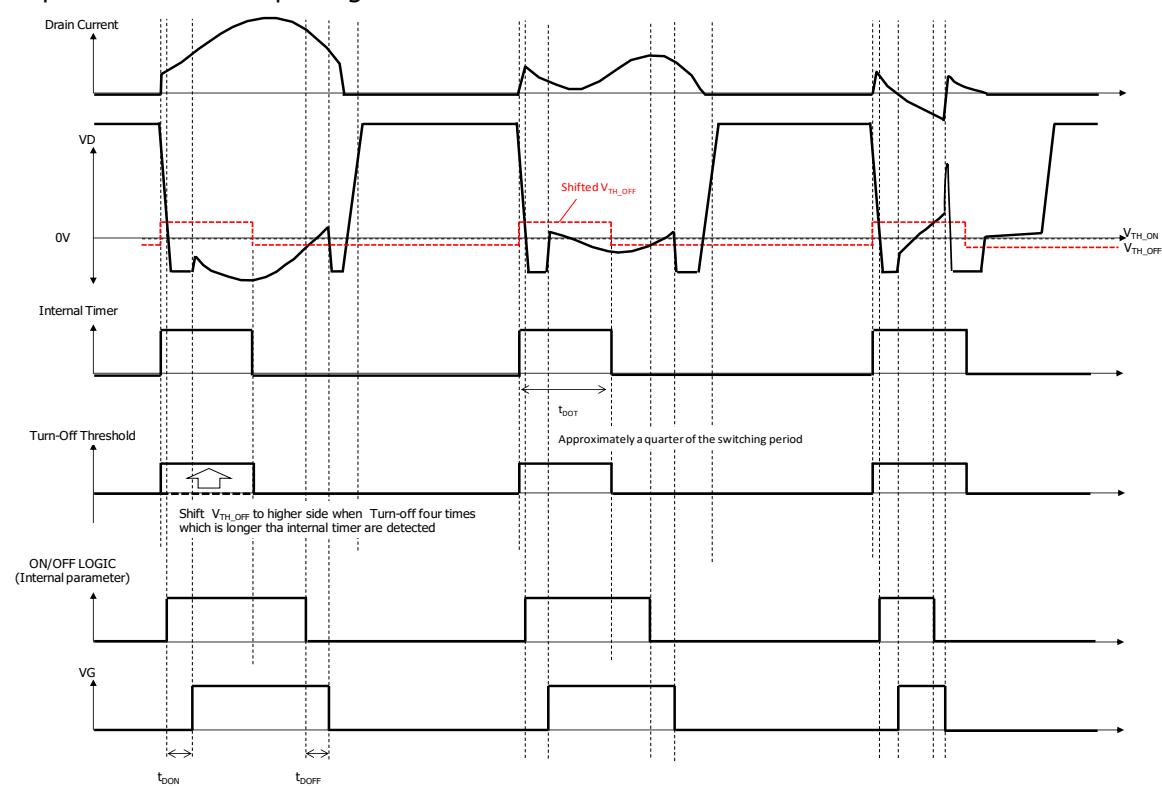
Timing Chart

Example of operation on Half-Bridge LLC converter

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



Operation for VD input signal

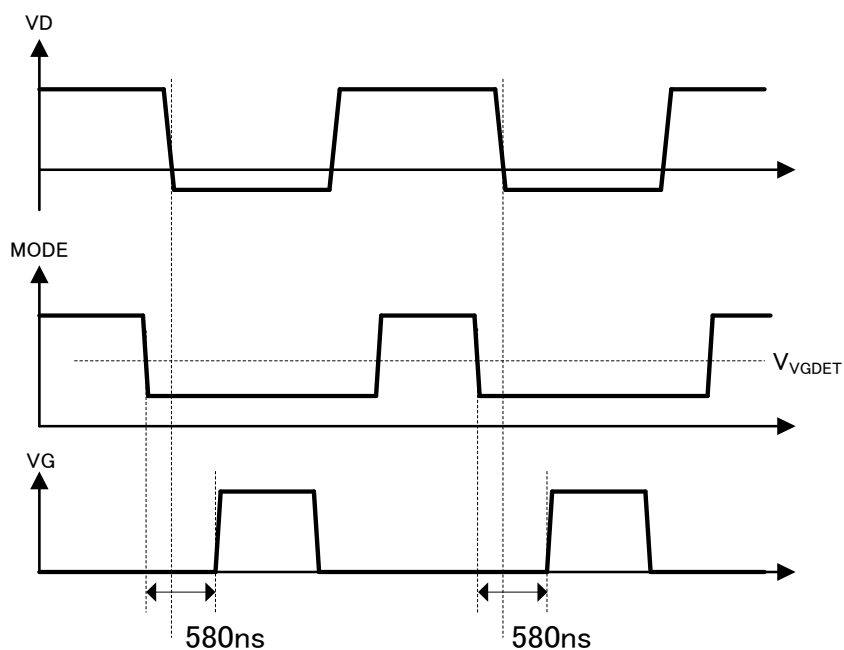




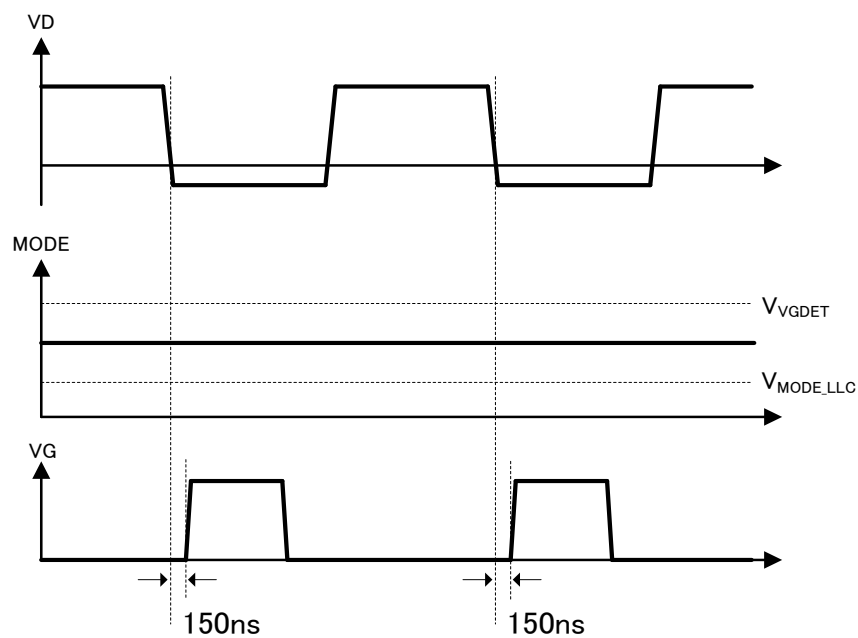
Timing Chart

The function of VG detection delay

Condition1: Using this function



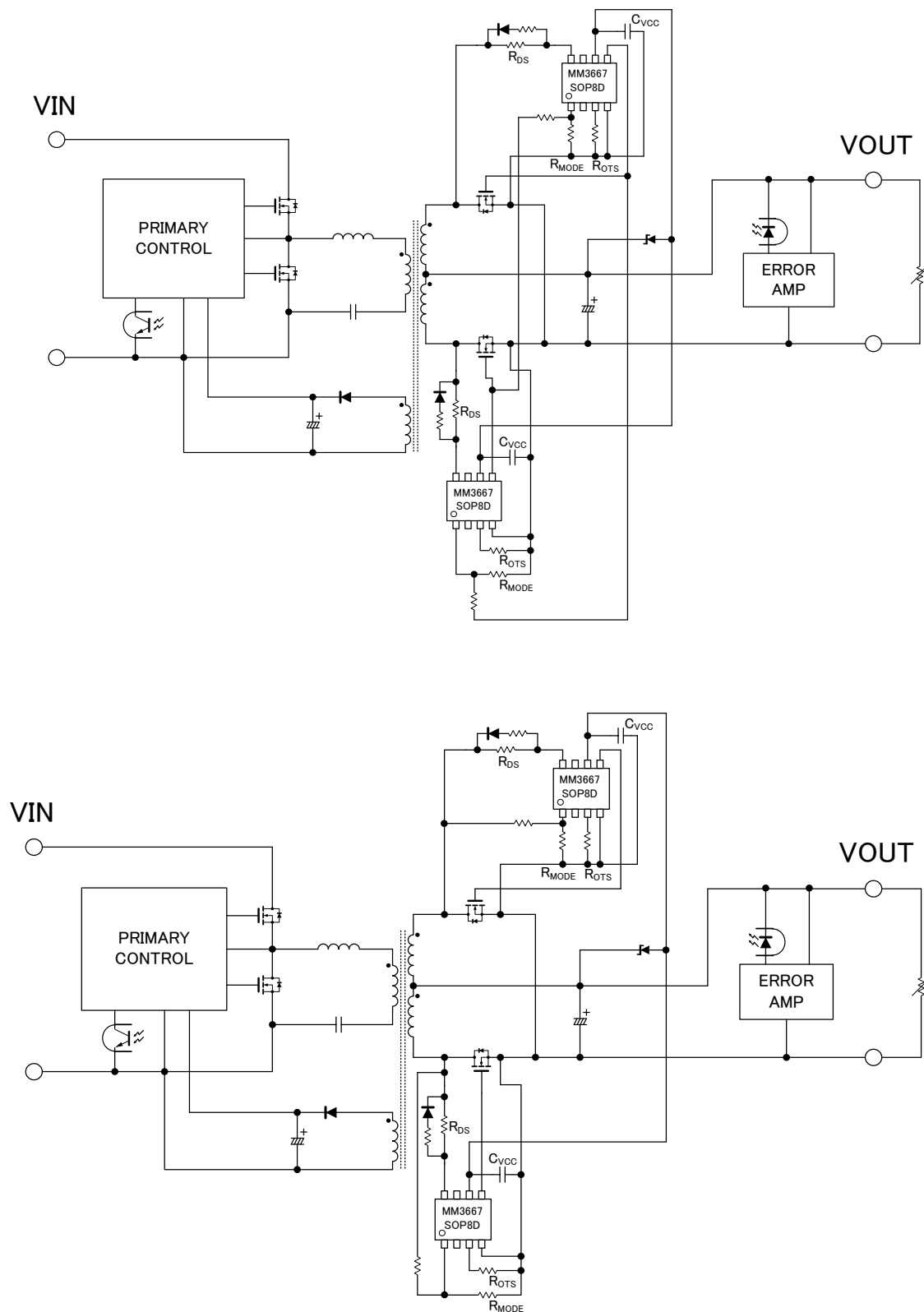
Condition2 : Not using this function





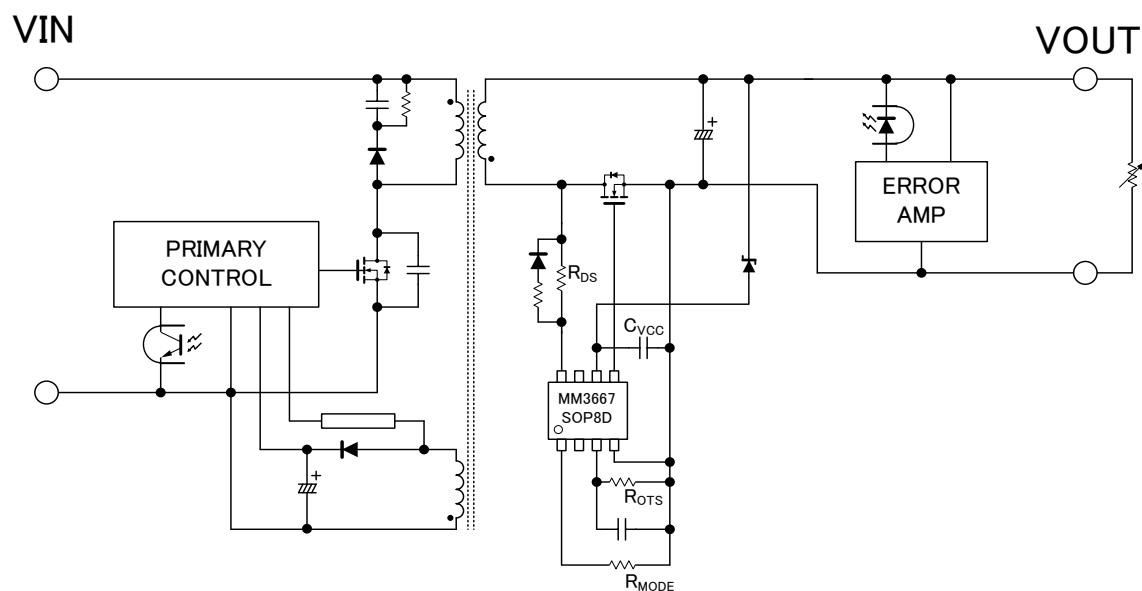
Typical Application Circuit

An example of application circuit for the Half-Bridge LLC converter



Typical Application Circuit

An example of application circuit for the Quasi-Resonant Flyback converter



Application hints

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.

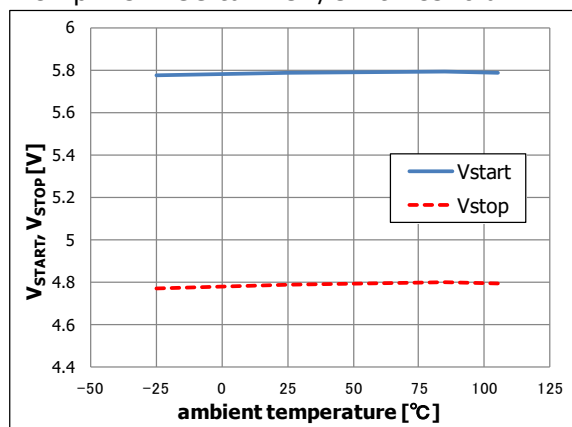
Please refer to an application note for the setting methods of neighboring parts.



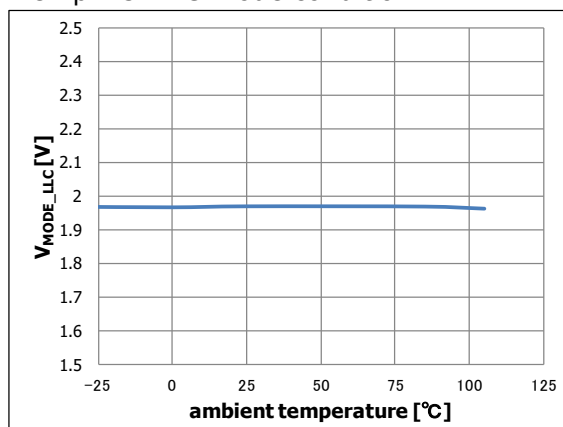
Typical Performance Characteristics

(Ta=25°C, unless otherwise specified)

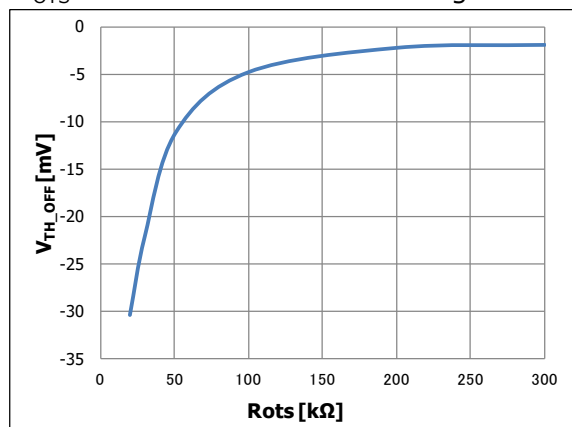
Temp. vs. VCC turn On/Off threshold



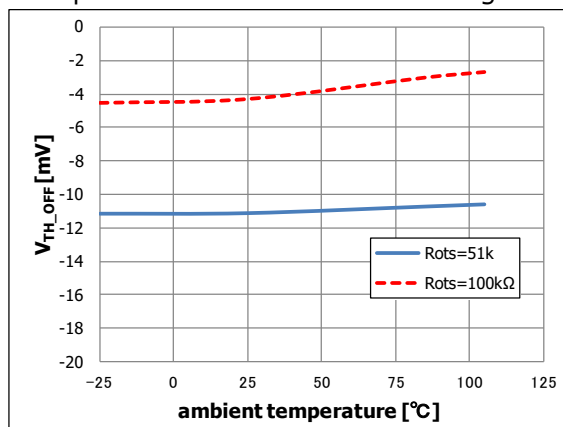
Temp. vs. LLC mode condition



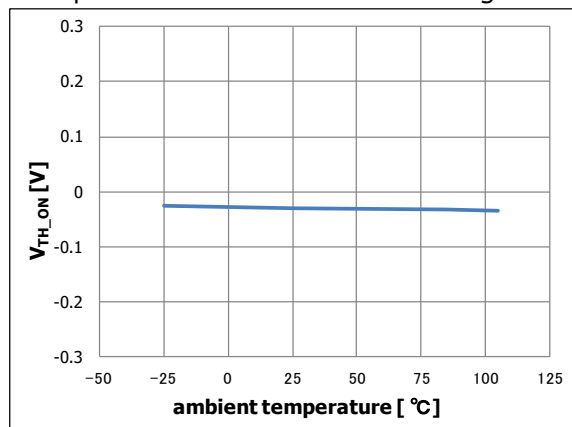
R_{OTS} vs. Turn-Off Threshold Voltage



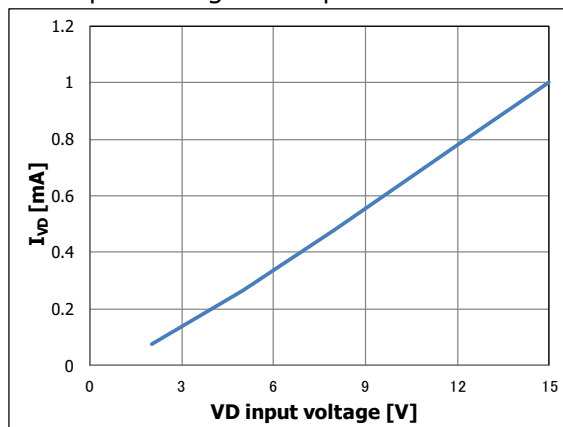
Temp. vs. Turn-Off Threshold Voltage



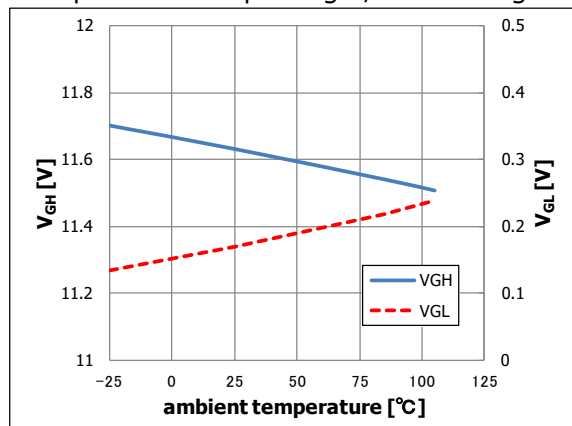
Temp. vs. Turn-On Threshold Voltage



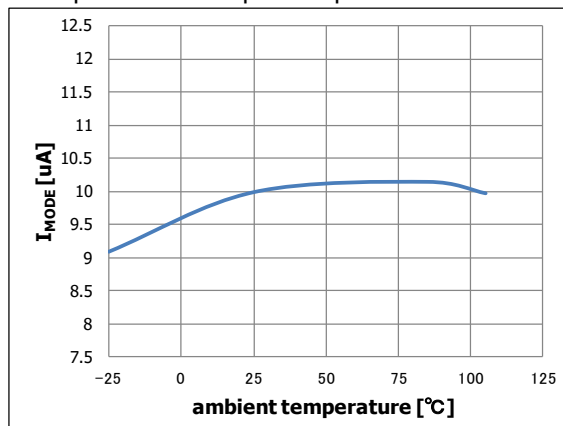
VD Input Voltage vs. Input Current



Temp. vs. VG output High / Low voltage



Temp. vs. MODE pin output current

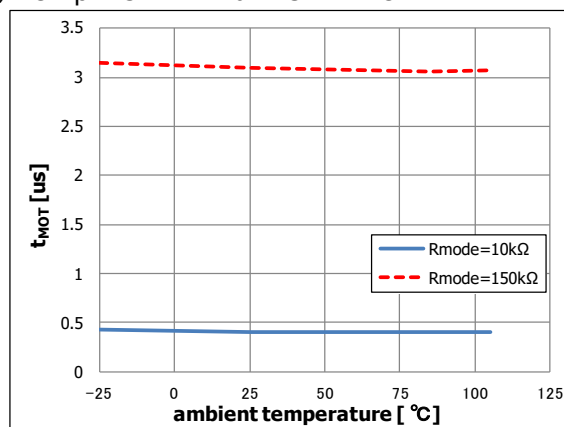
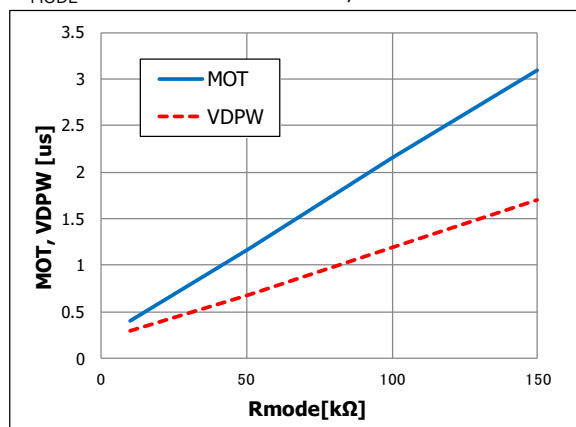




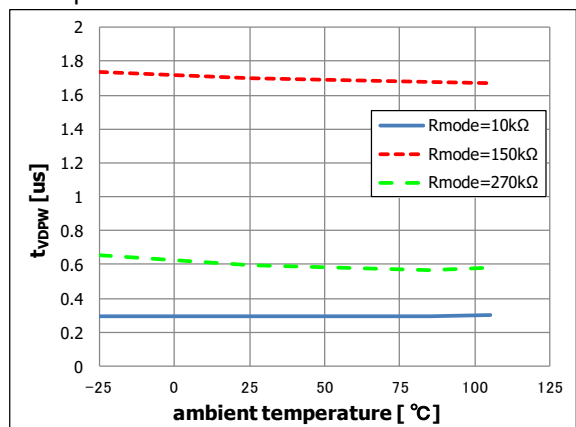
Typical Performance Characteristics

(Ta=25°C, unless otherwise specified)

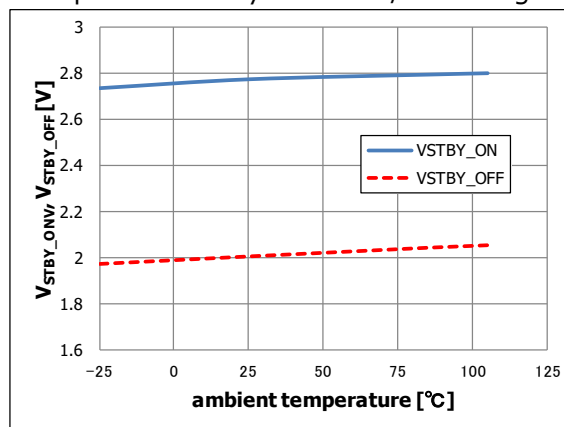
R_{MODE} vs. Minimum On Time, VD Peak Pulse Width Detect(QR) Temp. vs. Minimum On Time



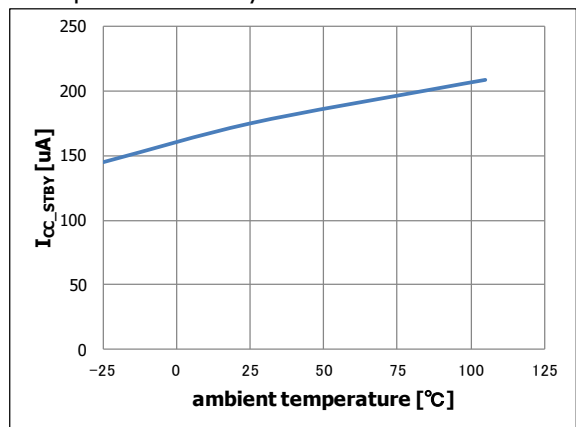
Temp. vs. VD Peak Pulse Width Detect



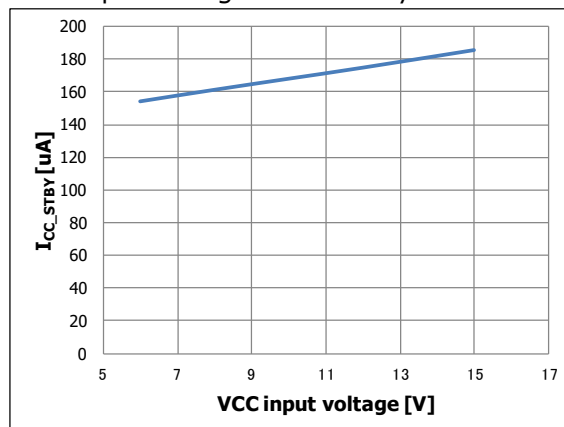
Temp. vs. Standby mode On/Off voltage



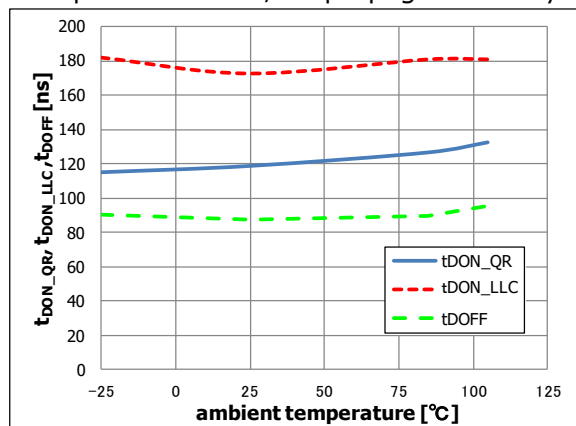
Temp. vs. Standby mode current



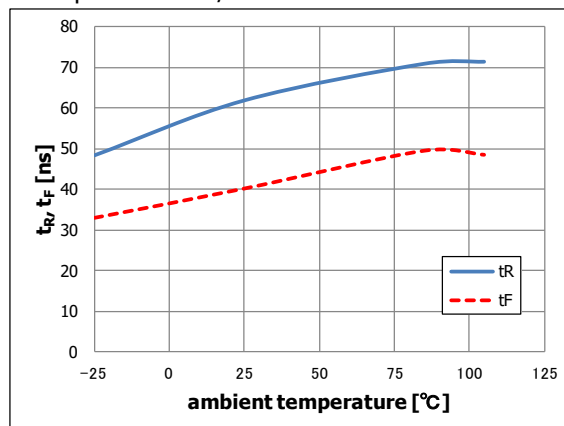
VCC input voltage vs. Standby mode current

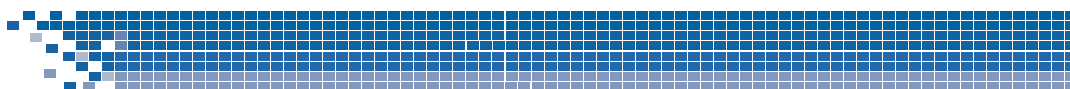


Temp. vs. Turn-On/Off propagation delay



Temp. vs. Rise / Fall time

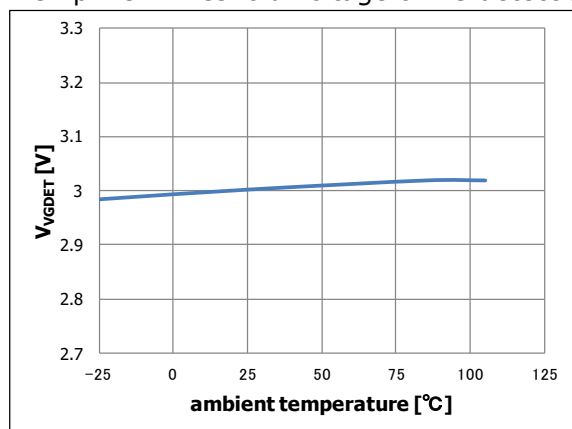




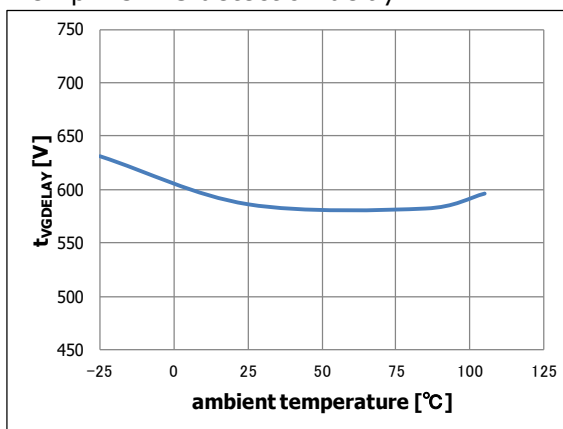
Typical Performance Characteristics

(Ta=25°C, unless otherwise specified)

Temp. vs. Threshold voltage of VG detection



Temp. vs. VG detection delay

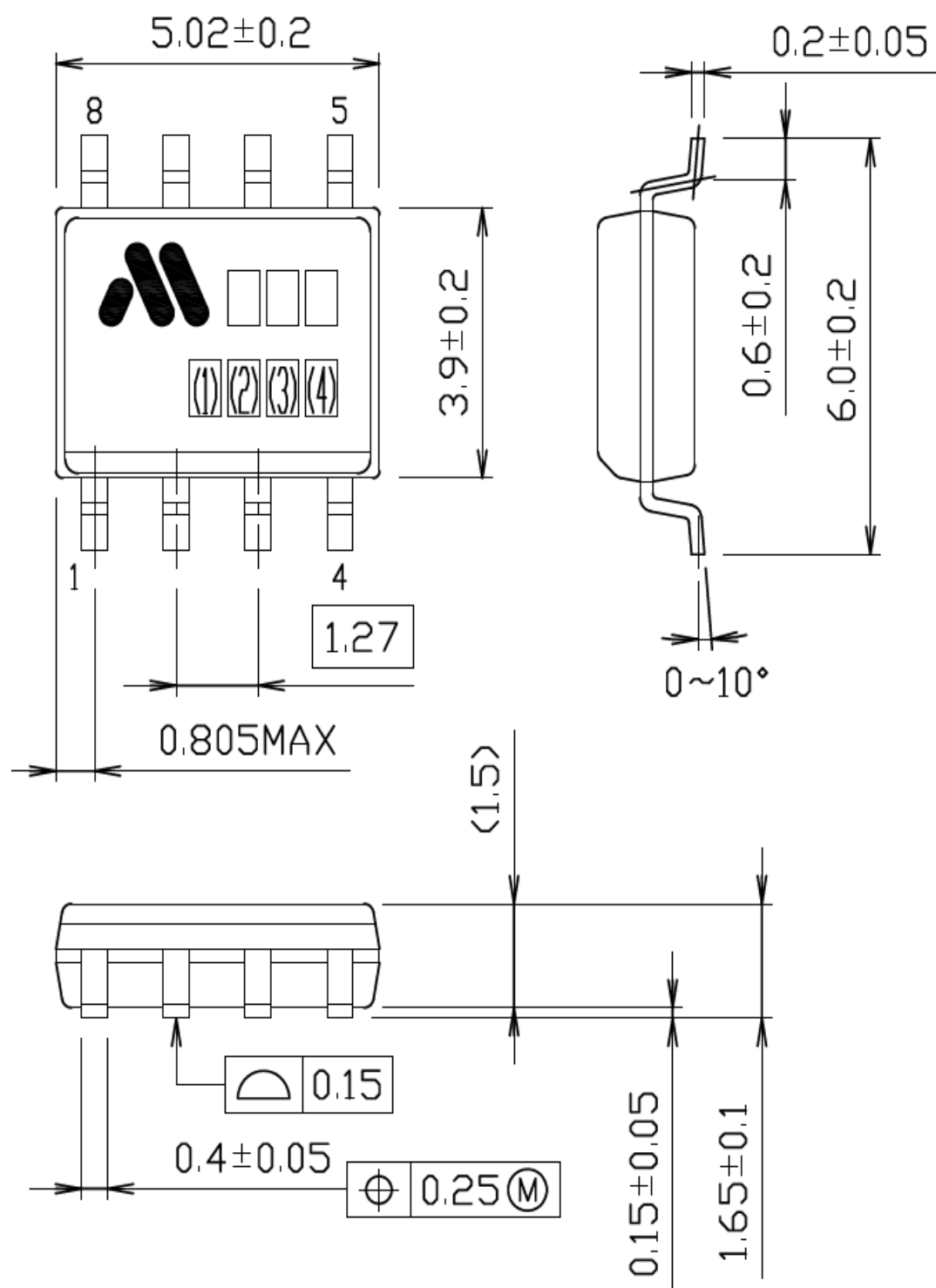


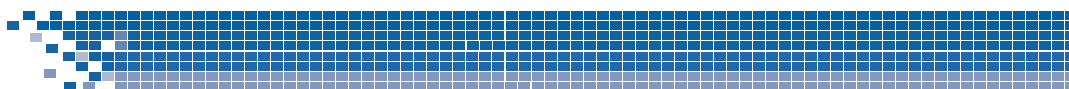


Dimensions

Package : SOP-8J

UNIT	mm
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The synchronous rectification control IC for AC-DC QR converter

MM3667B Series

Description

MM3667B 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 MM3667B. 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.

MM3667B supports the Quasi-Resonant flyback converter.

MM3667B 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.

MM3667B 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

- It supports Quasi-Resonant flyback converter.
- Adjustable Turn-OFF threshold voltage
- Equipped with standby mode
- Equipped with automatic adjustment function of the minimum on-time

Main specifications

- VD pin input voltage : 6V~15V (Absolute max. 17V)
- Operating Supply Voltage : 6V~15V (Absolute max. 17V)
- Supply Current : Typ. 0.65mA (VCC=12V)
- Frequency : Max. 170kHz

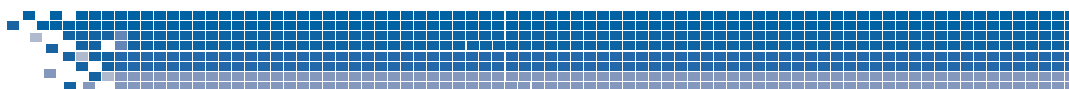
Package

- SOP-8J

Application

- High-Power AC/DC Adaptor
- High-Power SMPS





Model Name

M M 3 6 6 7 B F F E
|-----| | | |

Series name

(A) (B) (C) (D)

(A)Function Type

A	For LLC,QR converter
B	For QR converter

(B)Package

F	SOP-8J
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(C)Type of packing

F	F Housing
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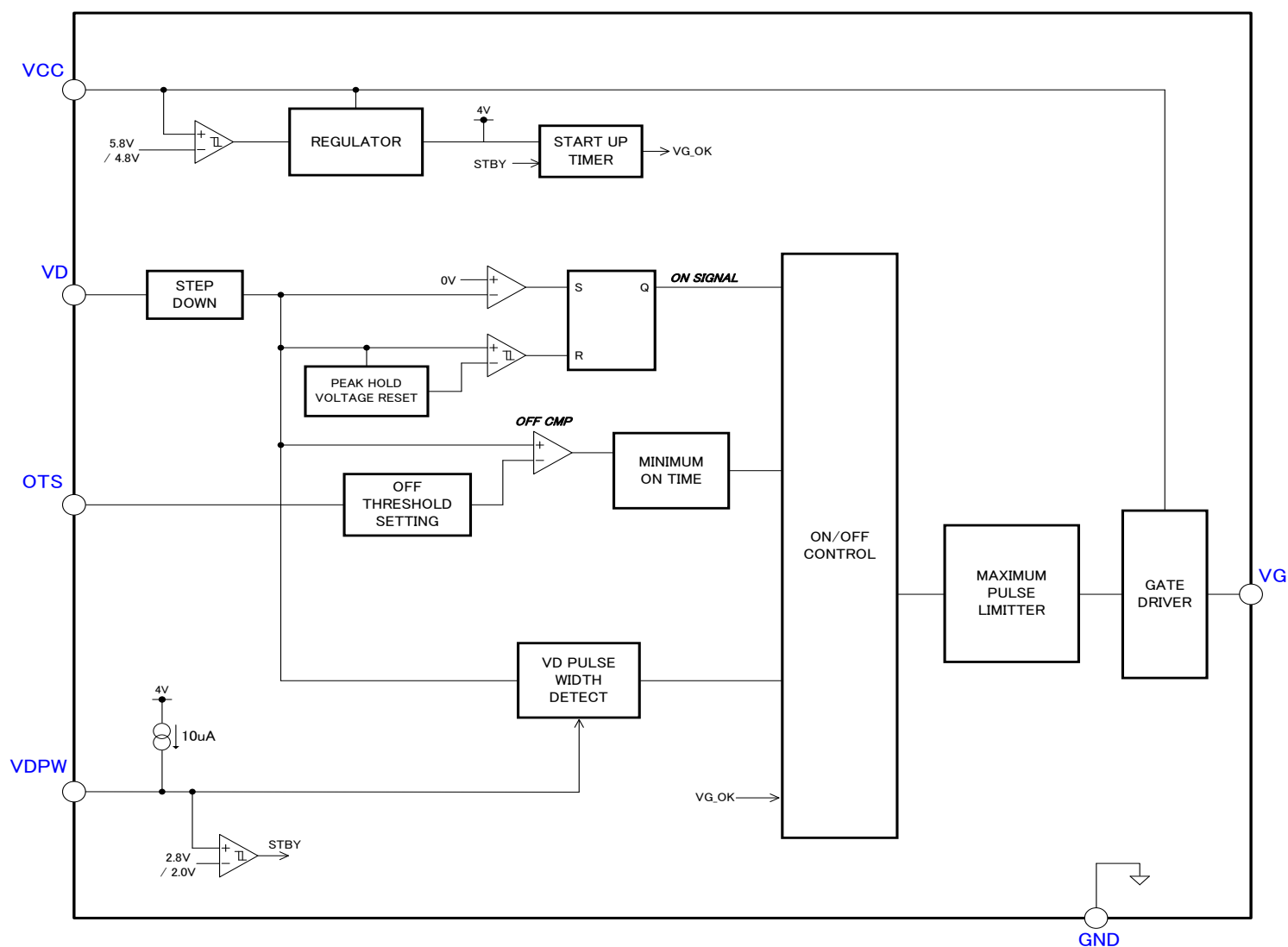
(D)Taping material

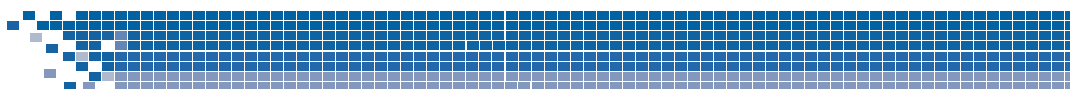
E	Emboss tape
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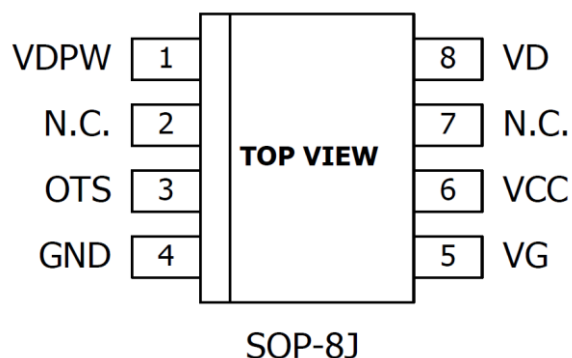
Block Diagram





Pin Configuration

SOP-8J



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

Absolute Maximun Ratings

(Ta=25°C, unless otherwise specified)

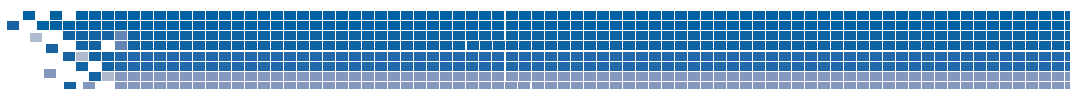
Item	Symbol	Min.	Max.	Unit
Supply Voltage	V_{CCmax}	-0.3	17	V
VD Input Voltage	V_{VDmax}	※1	17	V
VD Output Current	I_{VDmax}	-1	-	mA
VDPW Input Voltage	$V_{MODEmax}$	-0.3	4	V
OTS Input Voltage	V_{OTSmax}	-0.3	4	V
Storage Temperature	T_{stg}	-40	150	°C
Power Dissipation (alone)	P_d	-	300	mW

*1 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

(Ta=25°C, unless otherwise specified)

Item	Symbol	Min.	Max.	Unit
Operating Ambient Temperature	T_{opr}	-25	105	°C
Operating Supply Voltage	V_{CCOPR}	6	15	V
VD Pin Peak Voltage	V_{VDPEAK}	4.5	15	V
VDPW Pin Input Voltage	V_{MODE}	-	3.9	V
OTS Pin Input Voltage	V_{OTS}	-	3.9	V
Switching Frequency	f_{sw}	-	170	kHz



Electrical Characteristics

(Ta=25°C, unless otherwise specified)

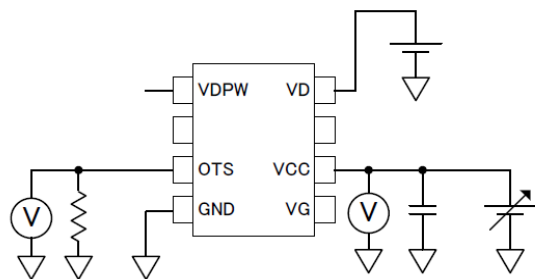
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	※2
Supply Section							
VCC Turn On Threshold	V _{CC_START}		5.6	5.8	6	V	A
VCC Turn Off Threshold	V _{CC_STOP}		4.6	4.8	5	V	A
IC Supply Current	I _{CC}	Cload=open, fsw=100kHz	-	0.65	0.78	mA	B
Standby Mode Current	I _{CC_STBY}	Standby Mode	-	165	230	uA	C
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=2→9V	-	70	120	ns	E
Fall Time	t _F	Cload=6000pF VG=9→2V	-	50	70	ns	E
Turn-On Propagation Delay	t _{DON}	Cload=6000pF VD=V _{TH_ON} →VG=2V	-	100	200	ns	E
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}	ROTS=51kΩ	-16.6	-11.6	-6.6	mV	F
		ROTS=100kΩ	-10.6	-5.6	-0.6	mV	F
VD Input Resistance	R _{VD}	VD=12V	12	15	18	kΩ	C
Timer Section							
VD Peak Pulse Width Detect	t _{VDPW}	R _{VDPW} =10kΩ	0.32	0.48	0.64	us	E
		R _{VDPW} =150kΩ	2.25	3.35	4.45	us	E
Minimum On Time	t _{MOT}	t _{VDH} =1us	0.26	0.37	0.48	us	E
		t _{VDH} =3us	0.73	1.03	1.31	us	E
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	2.3	V	C
Standby On/Off Hysteresis	V _{STBY_HYS}	V _{STBY_ON} -V _{STBY_OFF}	-	0.8	-	V	-
VDPW Pin							
VDPW Pin Output Current	I _{VDPW}		8.75	10	11.25	uA	C

*2 The test circuit symbols.

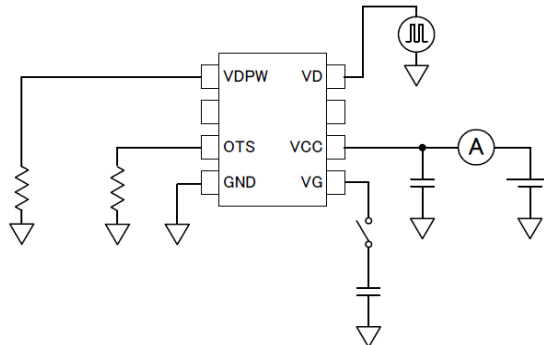


Test Circuit

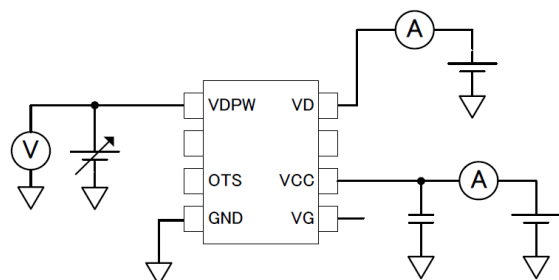
TEST CIRCUIT A



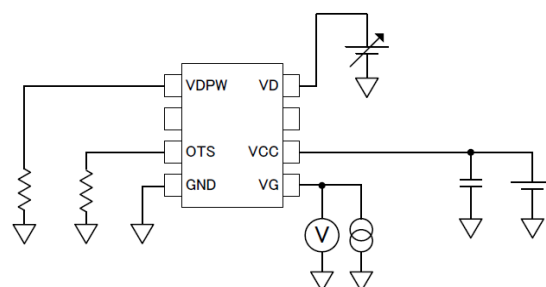
TEST CIRCUIT B



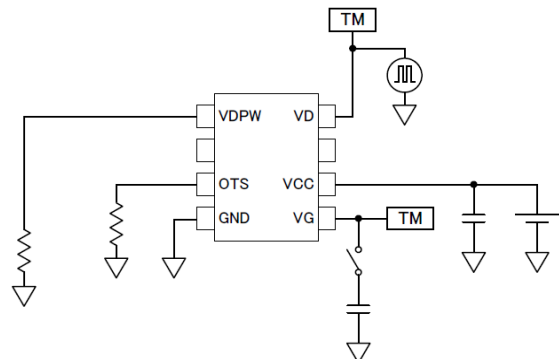
TEST CIRCUIT C



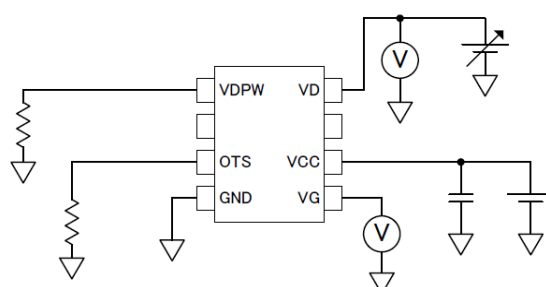
TEST CIRCUIT D



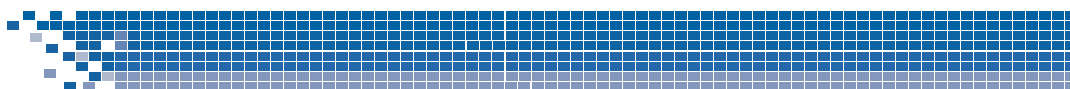
TEST CIRCUIT E



TEST CIRCUIT F



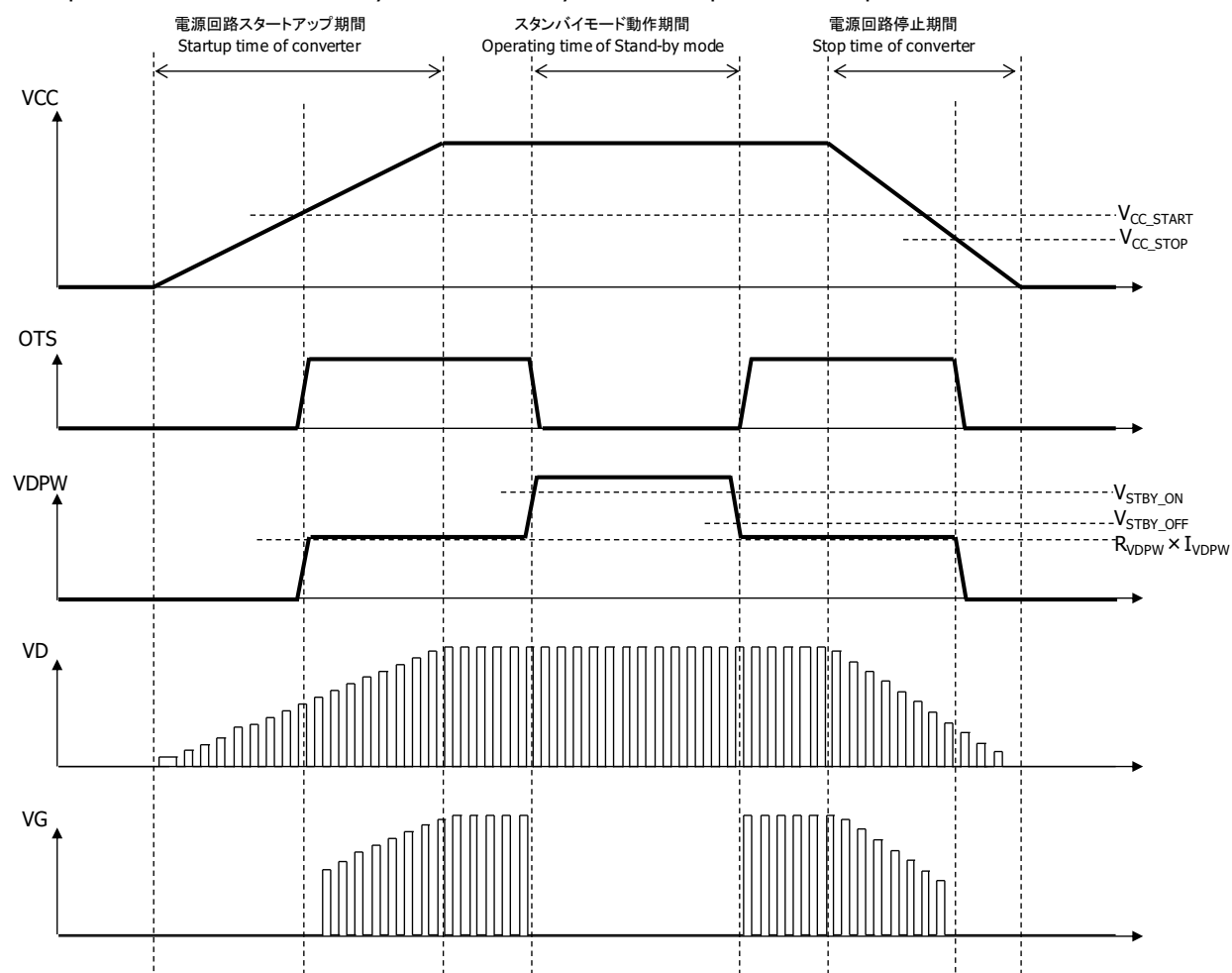
TM:Time Measure Module



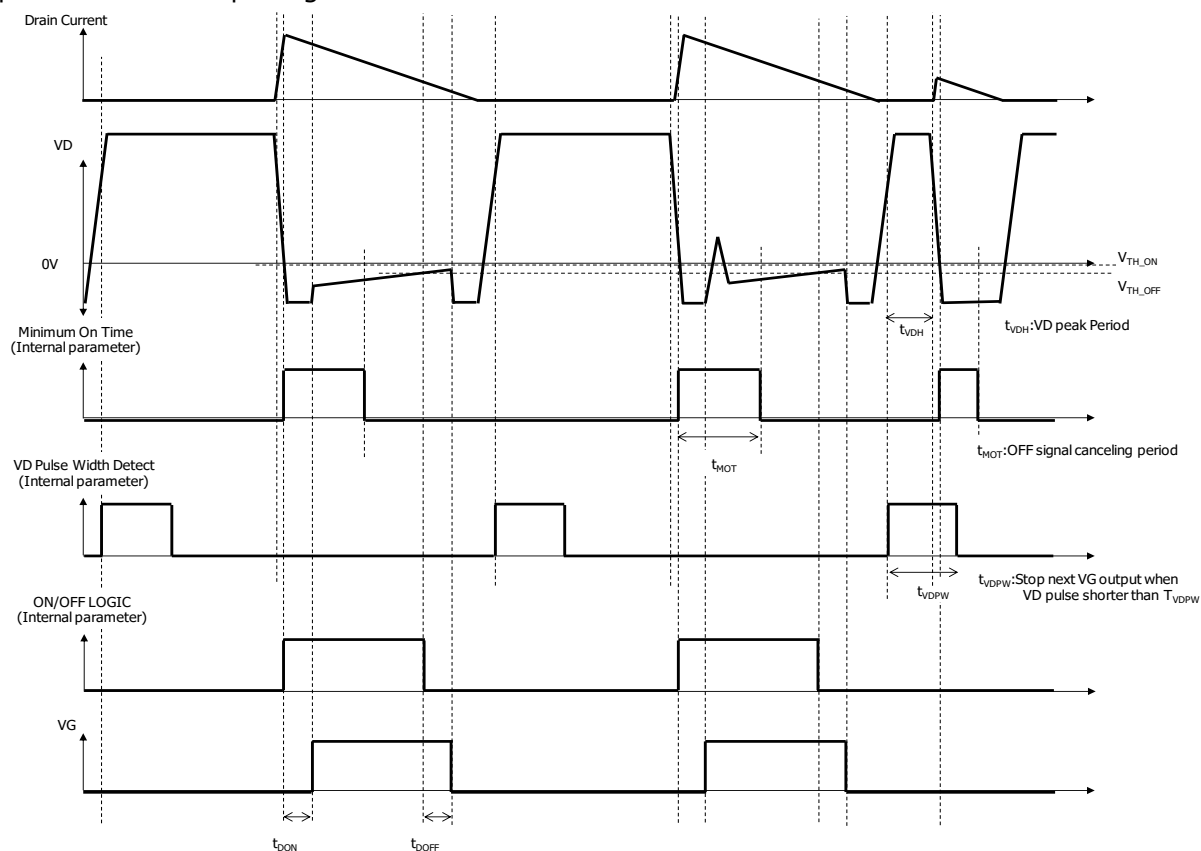
Timing Chart

Example of operation on Quasi-Resonant converter

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

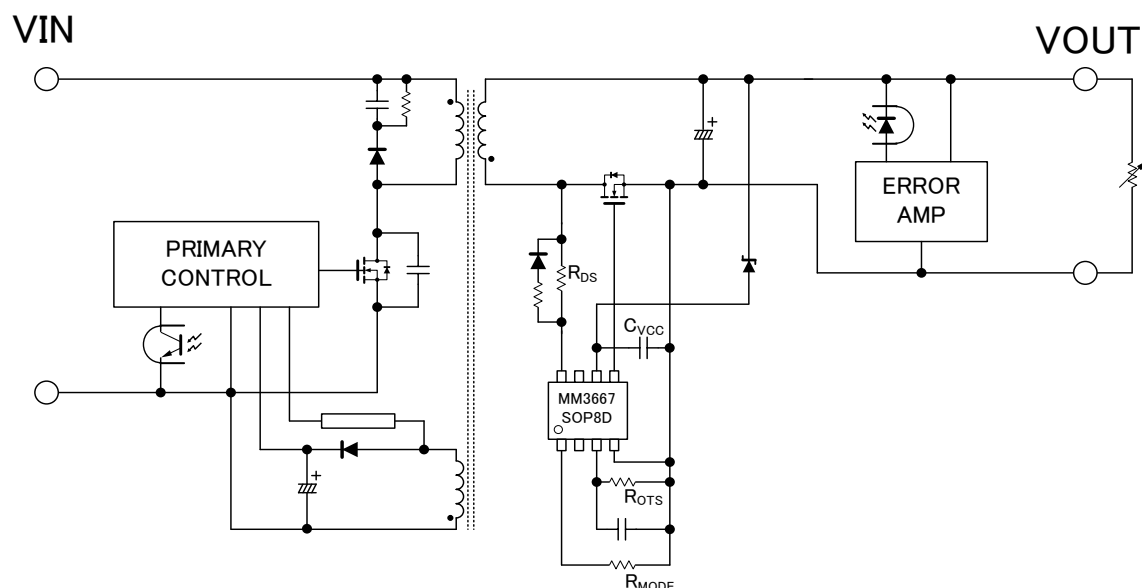


Operation for VD input signal



Typical Application Circuit

An example of application circuit for the Quasi-Resonant Flyback converter



Application hints

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.

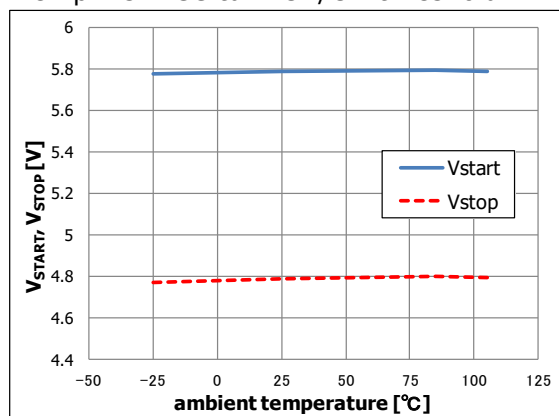
Please refer to an application note for the setting methods of neighboring parts.



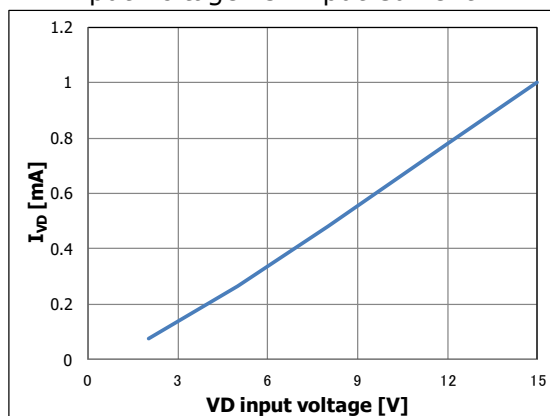
Typical Performance Characteristics

(Ta=25°C, unless otherwise specified)

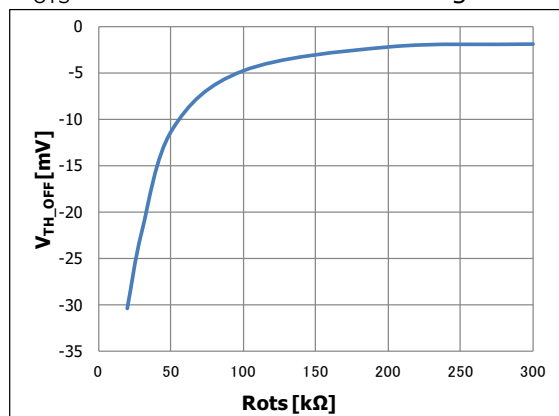
Temp. vs. VCC turn On/Off threshold



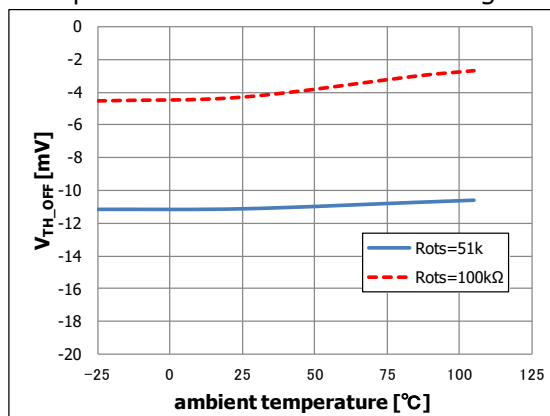
VD Input Voltage vs. Input Current



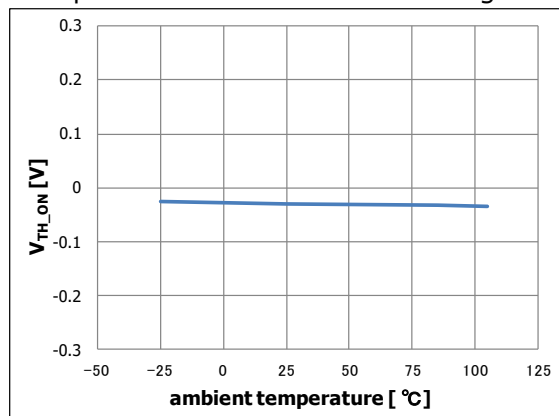
R_{OTS} vs. Turn-Off Threshold Voltage



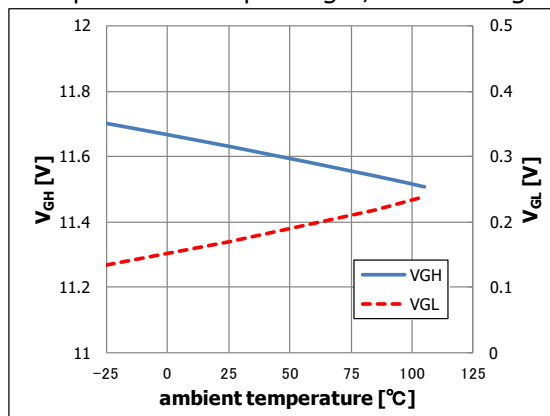
Temp. vs. Turn-Off Threshold Voltage



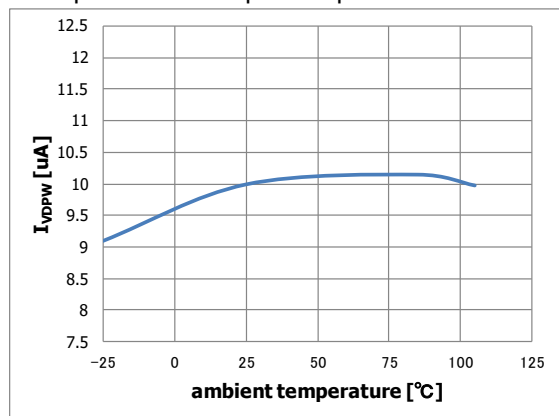
Temp. vs. Turn-On Threshold Voltage



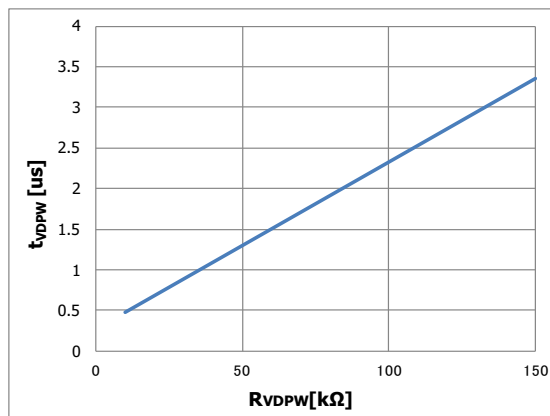
Temp. vs. VG output High / Low voltage



Temp. vs. VDPW pin output current



R_{VDPW} vs. VD Peak Pulse Width Detect

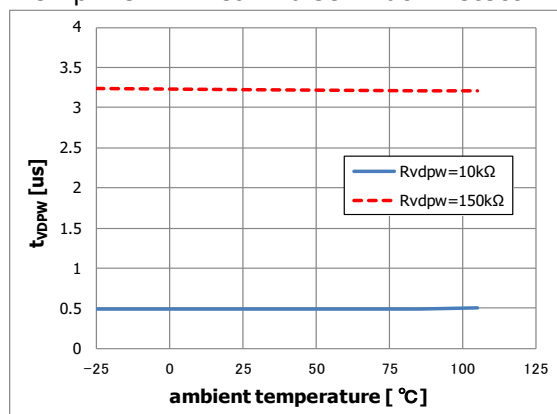




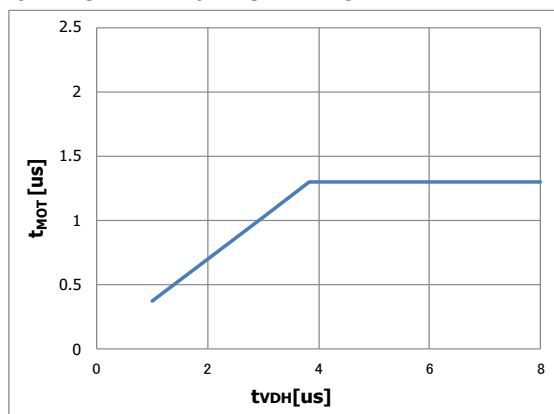
Typical Performance Characteristics

(Ta=25°C, unless otherwise specified)

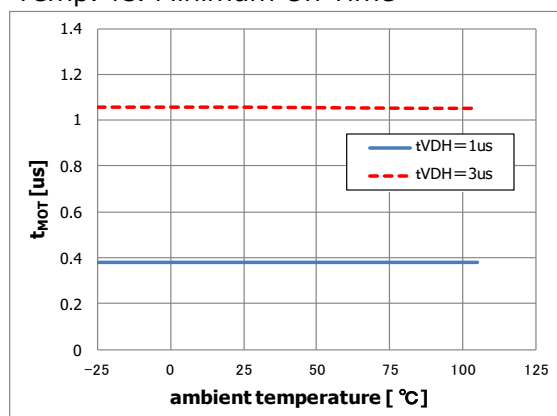
Temp. vs. VD Peak Pulse Width Detect



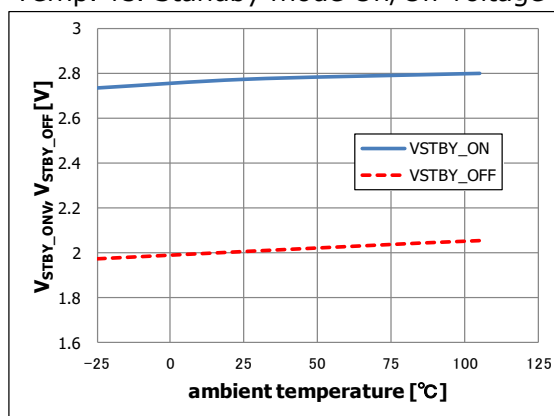
t_{VDH} vs. Minimum On Time



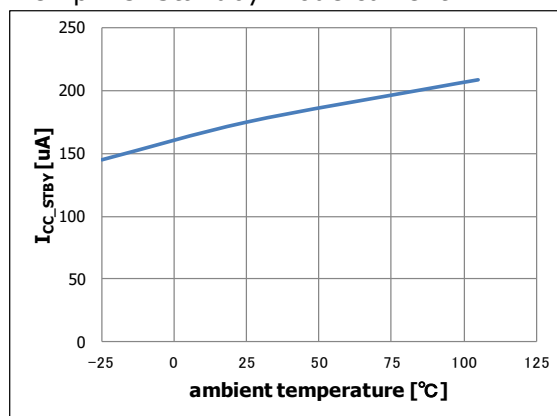
Temp. vs. Minimum On Time



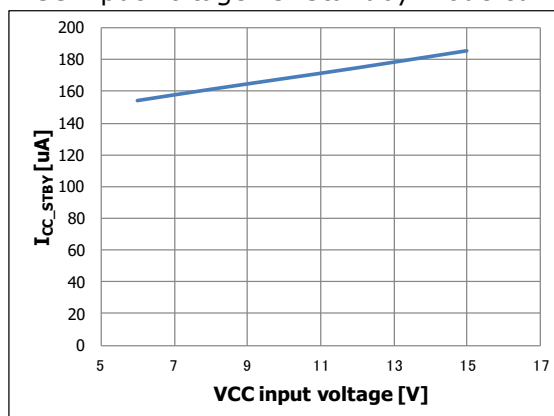
Temp. vs. Standby mode On/Off voltage



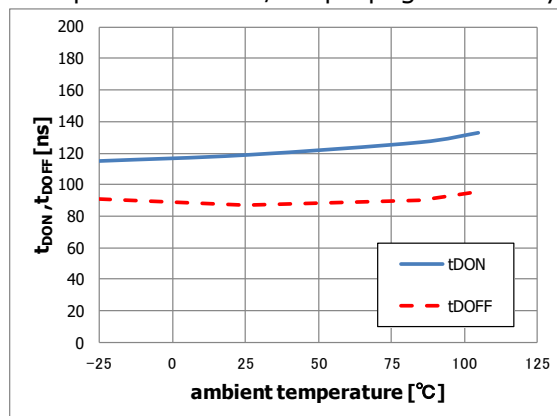
Temp. vs. Standby mode current



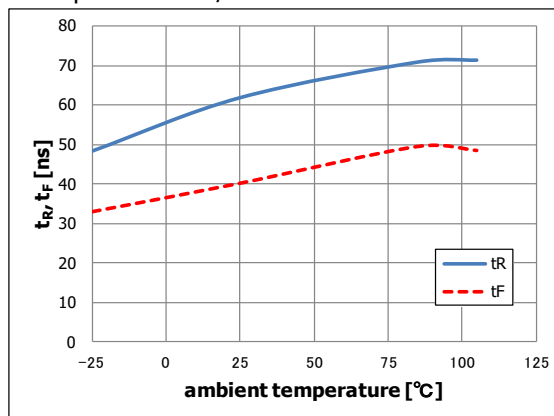
VCC input voltage vs. Standby mode current



Temp. vs. Turn-On/Off propagation delay



Temp. vs. Rise / Fall time





Dimensions

Package : SOP-8J

UNIT	mm
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