1ch Gate Driver Providing Galvanic Isolation

2500Vrms Isolation Voltage

BM60055FV-C

General Description

The BM60055FV-C is a gate driver with an isolation voltage of 2500Vrms, I/O delay time of 250ns, minimum input pulse width of 170ns. It incorporates the fault signal output function (FLT_UVLO, FLT_SC, FLT_OT), under voltage lockout (UVLO) function, short circuit protection (SCP) function, over temperature protection (OT) function, over current protection (OC) function, Soft turn off function, 2 level turn off function, active miller clamping function, switching controller function and output state feedback function (OSFB).

Key Specifications

- Isolation Voltage: 2500 [Vrms] (Max)
- Maximum Gate Drive Voltage: 24 [V] (Max)
- I/O Delay Time: 250 [ns] (Max)
- Minimum Input Pulse Width: 170 [ns] (Max)

Package	**W(Typ) x D(Typ) x H(Max)**
SSOP-B28W	9.2mm x 10.4mm x 2.4mm

Features

- Fault Signal Output Function
- Under Voltage Lockout Function
- Short Circuit Protection Function
- Over Current Protection Function
- Over Temperature Protection
- Temperature Compensation of OC
- Soft Turn Off Function of SCP
- 2 Level Turn Off Function
- Active Miller Clamping
- Switching Controller
- Output State Feedback Function
- UL1577 Recognized:File No. E356010
- AEC-Q100 Qualified *(Note 1)*

(*Note 1*:Grade1)

Applications

- Automotive isolated IGBT/MOSFET inverter gate drive.
- Automotive DC-DC converter.
- Industrial inverters system.
- UPS system.

Typical Application Circuit

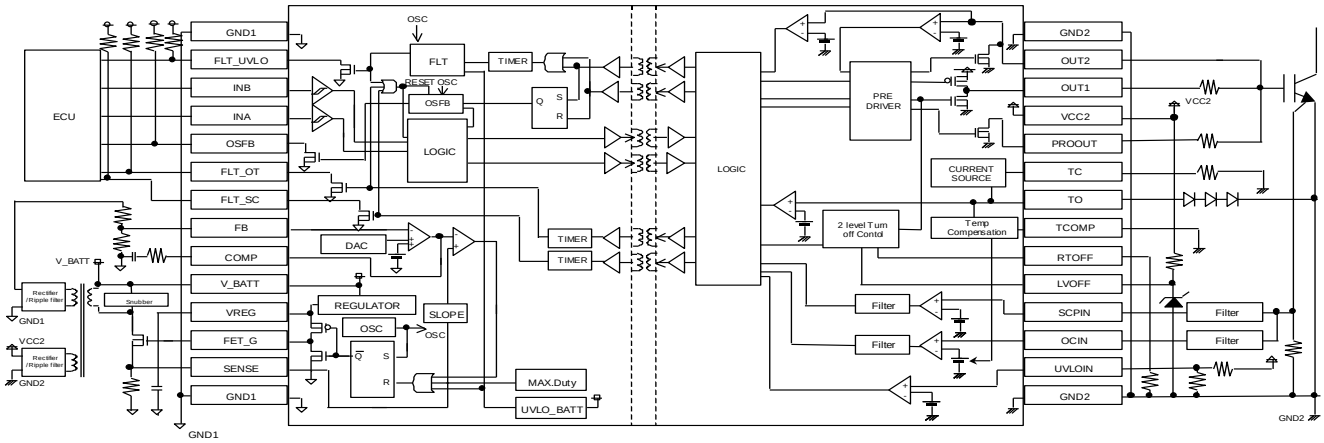


Figure 1. Typical Application Circuit

Contents

Recommended Range Of External Constants

Pin Name	Symbol	Recommended Value			Unit
		Min	Typ	Max	
TC	R_{TC}	1.25	-	50	kΩ
RTOFF	R_{RTOFF}	4.6	10	30	kΩ
V_BATT	C_{VBATT}	3	-	-	µF
VCC2	C_{VCC2}	0.4	-	-	µF
VREG	C_{VREG}	0.1	1	10	µF

Pin Configuration

(TOP VIEW)

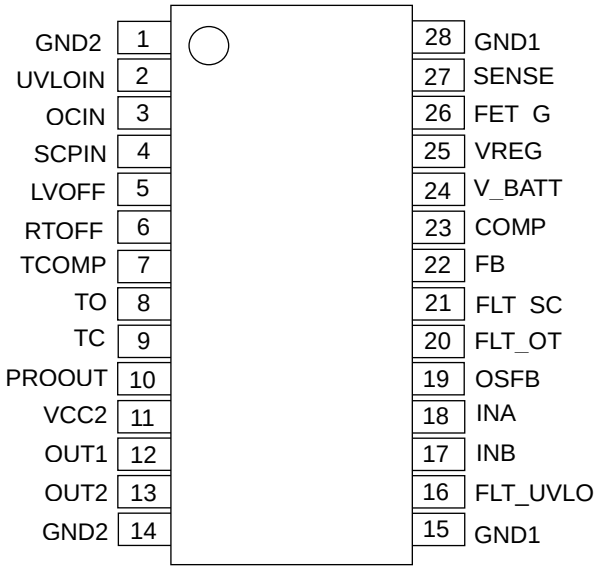


Figure 2. Pin configuration

Pin Descriptions

Pin No.	Pin Name	Function
1	GND2	Output-side ground pin
2	UVLOIN	Output-side UVLO setting pin
3	OCIN	Over current detection pin
4	SCPIN	Short circuit detection pin
5	LVOFF	2-level turn off level setting pin
6	RTOFF	2-level turn off time setting pin
7	TCOMP	Temperature compensation pin of OC
8	TO	Constant current output pin / Over temperature detection pin
9	TC	Constant current setting resistor connection pin
10	PROOUT	Soft turn-off pin
11	VCC2	Output-side power supply pin
12	OUT1	Output pin
13	OUT2	Input and output pin for miller clamp / Gate voltage input pin
14	GND2	Output-side ground pin
15	GND1	Input-side ground pin
16	FLT_UVLO	Fault (UVLO) output pin
17	INB	Control input pin B
18	INA	Control input pin A
19	OSFB	Output state feedback output pin
20	FLT_OT	Fault (OT) output pin
21	FLT_SC	Fault (SCP) output pin
22	FB	Error amplifier inverting input pin for switching controller
23	COMP	Error amplifier output pin for switching controller
24	V_BATT	Main power supply pin
25	VREG	Power supply pin for driving MOSFET for switching controller
26	FET_G	MOSFET control pin for switching controller
27	SENSE	Current feedback resistor connection pin for switching controller
28	GND1	Input-side ground pin

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Main Power Supply Voltage	$V_{BATTMAX}$	-0.3 to +40.0*(Note 2)*	V
Output-Side Supply Voltage	V_{CC2MAX}	-0.3 to +30.0*(Note 3)*	V
INA, INB Pin Input Voltage	V_{INMAX}	-0.3 to +7.0*(Note 2)*	V
FLT_UVLO Pin, FLT_SC Pin, FLT_OT Pin, OSFB Pin Input Voltage	V_{FLTMAX}	-0.3 to +7.0*(Note 2)*	V
FLT_UVLO Pin, FLT_SC Pin, FLT_OT Pin, OSFB Pin Output Current	I_{FLT}	10	mA
FB Pin Input Voltage	V_{FBMAX}	-0.3 to +7.0*(Note 2)*	V
COMP Pin Input Voltage	$V_{COMPMAX}$	-0.3 to +7.0*(Note 2)*	V
SENSE Pin Input Voltage	$V_{SENSEMAX}$	-0.3 to +7.0*(Note 2)*	V
FET_G Pin Output Current (Peak5µs)	I_{FET_GPEAK}	1000	mA
SCPIN Pin, OCIN Pin Input Voltage	$V_{SCPINMAX}$, $V_{OCINMAX}$	-0.3 to +6.0*(Note 3)*	V
UVLOIN Pin Input Voltage	$V_{UVLOINMAX}$	-0.3 to V_{CC2}+0.3*(Note 3)*	V
LVOFF Pin Input Voltage	$V_{LVOFFINMAX}$	-0.3 to V_{CC2}+0.3*(Note 3)*	V
TCOMP Pin Input Voltage	$V_{TCOMPINMAX}$	-0.3 to V_{CC2}+0.3*(Note 3)*	V
TO Pin Input Voltage	V_{TOMAX}	-0.3 to V_{CC2}+0.3*(Note 3)*	V
TO Pin Output Current	I_{TOMAX}	8	mA
OUT1 Pin Output Current (Peak5µs)	$I_{OUT1PEAK}$	5000*(Note 4)*	mA
OUT2 Pin Output Current (Peak5µs)	$I_{OUT2PEAK}$	5000*(Note 4)*	mA
PROOUT Pin Output Current (Peak30µs)	$I_{PROOUTPEAK10}$	2000*(Note 4)*	mA
Operating Temperature Range	Topr	-40 to +125	°C
Storage Temperature Range	Tstg	-55 to +150	°C
Junction Temperature	Tjmax	+150	°C

(Note 2) Relative to GND1
(Note 3) Relative to GND2
(Note 4) Should not exceed Tj=150°C
Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Thermal Resistance*(Note5)*

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s*(Note 7)*	2s2p*(Note 8)*	
Junction to Ambient	θ_{JA}	112.9	64.4	°C/W
Junction to Top Characterization Parameter*(Note 6)*	Ψ_{JT}	34	23	°C/W

*(Note 5)*Based on JESD51-2A(Still-Air)
*(Note 6)*The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.
*(Note 7)*Using a PCB board based on JESD51-3.
*(Note 8)*Using a PCB board based on JESD51-7.

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	114.3mm x 76.2mm x 1.57mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	70µm

Layer Number of Measurement Board	Material	Board Size
4 Layers	FR-4	114.3mm x 76.2mm x 1.6mmt

Top		2 Internal Layers		Bottom	
Copper Pattern	Thickness	Copper Pattern	Thickness	Copper Pattern	Thickness
Footprints and Traces	70µm	74.2mm x 74.2mm	35µm	74.2mm x 74.2mm	70µm

Recommended Operating Conditions (Ta= -40°C to +125°C)

Parameter	Symbol	Min	Max	Units
Main Power Supply Voltage	V_{BATT}*(Note 9)*	4.5	30.0	V
Output-side Supply Voltage	V_{CC2}*(Note 10)*	9	24	V
Output side UVLO voltage	V_{UV2TH}*(Note10)*	6	-	V

(Note 9) GND1 reference
(Note 10) GND2 reference

Insulation Related Characteristics

Parameter	Symbol	Characteristic	Unit
Insulation Resistance (V_{IO}=500V)	R_S	$>10^9$	Ω
Insulation Withstand Voltage / 1min	V_{ISO}	2500	Vrms
Insulation Test Voltage / 1sec	V_{ISO}	3000	Vrms

Electrical Characteristics

(Unless otherwise specified Ta=-40°C to +125°C, V_{BATT}=4.5V to 30V, V_{CC2}=9V to 24V)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
General						
Main Power Supply Circuit Current 1	I_{BATT1}	0.5	1.3	2.2	mA	FET_G Pin switching operation
Main Power Supply Circuit Current 2	I_{BATT2}	0.4	1.2	2.1	mA	FET_G Pin No Switching
Output Side Circuit Current	I_{CC2}	1.8	3.2	4.8	mA	R_{TC}=10kΩ
Switching Power Supply Controller						
FET_G Output Voltage H1	V_{FETGH1}	4.5	5.0	5.5	V	I_{FET_G}=0A(open)
FET_G Output Voltage H2	V_{FETGH2}	4.0	4.5	-	V	V_BATT=4.5V I_{FET_G}=0A(open)
FET_G Output Voltage L	V_{FETGL}	0	-	0.3	V	I_{FET_G}=0A(open)
FET_G ON-Resistance (Source-side)	R_{ONGH}	3	6	12	Ω	I_{FET_G}=10mA
FET_G ON-Resistance (Sink-side)	R_{ONGL}	0.3	0.6	1.3	Ω	I_{FET_G}=10mA
Oscillation Frequency	f_{OSC_SW}	80	100	120	kHz	
Soft-start Time	t_{SS}	-	-	50	ms	
FB Pin Threshold Voltage	V_{FB}	1.47	1.50	1.53	V	
FB Pin Input Current	I_{FB}	-0.8	0	+0.8	μA	
COMP Pin Sink Current	$I_{COMPSINK}$	-160	-80	-40	μA	
COMP Pin Source Current	$I_{COMPSOURCE}$	40	80	160	μA	
Over Voltage Detection Threshold	V_{OVTH}	1.60	1.65	1.70	V	
Under Voltage Detection Threshold	V_{UVTH}	1.23	1.30	1.37	V	
Over-Current Detection Threshold	V_{OCTH}	0.17	0.20	0.23	V	
V_BATT UVLO OFF Voltage	$V_{UVLOBATTH}$	4.05	4.25	4.45	V	
V_BATT UVLO ON Voltage	$V_{UVLOBATTL}$	3.95	4.15	4.35	V	
Maximum ON DUTY	D_{ONMAX}	75	85	95	%	
Protection Holding Time	$t_{DCDCRLS}$	20	40	60	ms	
Logic Block						
Logic High Level Input Voltage	V_{INH}	3.5	-	-	V	INA, INB
Logic Low Level Input Voltage	V_{INL}	-	-	1.5	V	INA, INB
Logic Pull-Down Resistance	R_{IND}	25	50	100	kΩ	INA, INB
Logic Input Filtering Time	t_{INFIL}	70	120	170	ns	INA, INB
Output						
OUT1 ON-Resistance (Source-side)	R_{ONH}	0.25	0.60	1.35	Ω	I_{OUT1}=40mA
OUT1 ON-Resistance (Sink-side)	R_{ONL}	0.05	0.40	1.15	Ω	I_{OUT1}=40mA
OUT1 Maximum Current	I_{OUTMAX}	5.0	-	-	A	V_{CC2}=15V Guaranteed by design
PROOUT ON-Resistance	R_{ONPRO}	0.35	0.70	1.45	Ω	I_{PROOUT}=40mA
Turn ON time	t_{PON}	130	190	250	ns	
Turn OFF time	t_{POFF}	130	190	250	ns	
Propagation Distortion	t_{PDIST}	-60	0	+60	ns	t_{POFF} - t_{PON}

Electrical Characteristics - continued

(Unless otherwise specified Ta=-40°C to +125°C, V_{BATT}=4.5V to 30V, V_{CC2}=9V to 24V)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Rise Time	t_{RISE}	-	30	50	ns	Load=1nF
Fall Time	t_{FALL}	-	30	50	ns	Load=1nF
OUT2 ON-Resistance	R_{ON2}	0.1	0.45	1.2	Ω	I_{OUT2}=40mA
OUT2 ON Threshold Voltage	V_{OUT2ON}	2.7	3.0	3.3	V	
Common Mode Transient Immunity	CM	100	-	-	kV/µs	Design assurance
Protection Functions						
Output-side UVLO OFF Threshold Voltage	V_{UVLO2H}	0.95	1.00	1.05	V	
Output-side UVLO ON Threshold Voltage	V_{UVLO2L}	0.85	0.90	0.95	V	
Output-side UVLO Filtering Time	$t_{UVLO2FIL}$	1.5	2.0	2.5	µs	
Output-side UVLO Delay Time (OUT)	$t_{DUVLO2OUT}$	1.5	2.2	2.9	µs	
Output-side UVLO Delay Time (FLT_UVLO)	$t_{DUVLO2FLT}$	1.5	-	65	µs	
Over Current Detection Voltage1	V_{OCDET}	0.658	0.700	0.742	V	TCOMP=VCC2
Over Current Detection Voltage2	V_{OCDET}	0.394	0.420	0.441	V	TO=4V TCOMP=GND2
Over Current Detection Voltage3	V_{OCDET}	0.658	0.700	0.742	V	TO=3V TCOMP=GND2
Over Current Detection Voltage4	V_{OCDET}	0.874	0.930	0.986	V	TO=2.2V TCOMP=GND2
Over Current Detection Filtering Time	t_{DOCFIL}	0.70	1.00	1.30	µs	
Over Current Detection Delay Time (OUT)	V_{DOCOUT}	0.73	1.03	1.33	µs	OUT1=30kΩ Pull down
Over Current Detection Delay Time (PROUT)	$V_{DOCPROUT}$	0.73	1.03	1.33	µs	PROOUT=30kΩ Pull up
Over Current Detection Delay Time (FLT_SC)	V_{DOCFLT_SC}	0.75	1.05	1.35	µs	
Short Circuit Detection Voltage	V_{SCPDET}	0.95	1.00	1.05	V	
Short Circuit Detection Filtering Time	t_{SCPFIL}	0.10	0.20	0.30	µs	
Short Circuit Detection Delay Time (OUT)	$t_{DSCPOUT}$	0.17	0.23	0.38	µs	OUT1=30kΩ Pull down
Short Circuit Detection Delay Time (PROOUT)	$t_{DSCPPROOUT}$	0.19	0.25	0.40	µs	PROOUT=30kΩ Pull up
Short Circuit Detection Delay Time (FLT_SC)	$t_{DSCPFLT\_SC}$	0.23	0.29	0.44	µs	
TC Pin Voltage	V_{TC}	0.975	1.000	1.025	V	
TO Pin Output Current	I_{TO}	0.97	1.00	1.03	mA	R_{TC}=10kΩ
TO Pin Disconnect Detection Voltage	V_{TOH}	7	8	9	V	

Electrical Characteristics - continued

(Unless otherwise specified Ta=-40°C to +125°C, V_{BATT}=4.5V to 30V, V_{CC2}=9V to 24V)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Over Temperature Detection Voltage(ON)	$V_{OTDETON}$	1.96	2.0	2.04	V	
Over Temperature Detection Voltage(OFF)	$V_{OTDETOFF}$	2.15	2.2	2.25	V	
Over Temperature Detection Delay time (OUT)	t_{DOTOUT}	2	10	30	µs	OUT1=30kΩ Pull down
Over Temperature Detection Delay Time (FLT_OT)	t_{DOTFLT}	1	-	35	µs	
FLT_UVLO, FLT_SC, FLT_OT ON-Resistance	R_{ONFLT}	-	30	80	Ω	I_{FLT}=5mA
Fault (UVLO) Output Holding Time	t_{UVLO_FLTRLS}	20	40	60	ms	
Fault (SCP) Output Holding Time	t_{SCP_FLTRLS}	20	40	60	ms	
2-Level Turn Off Voltage Offset 1	V_{LVOFF1}	-300	-150	0	mV	V_{CC2}=15V, LVOFF=12V
2-Level Turn Off Voltage Offset 2	V_{LVOFF2}	-350	-200	-50	mV	V_{CC2}=15V, LVOFF=8V
2-Level Turn Off Enable Threshold Voltage	$V_{LVOFFTH}$	0.7	1.0	1.3	V	
2-Level Turn Off Time	t_{RTOFF}	1.93	2.3	2.67	µs	R_{RTOFF}=16kΩ
Gate State H Detection Threshold Voltage	V_{OSFBH}	4.5	5.0	5.5	V	
Gate State L Detection Threshold Voltage	V_{OSFBL}	4.0	4.5	5.0	V	
OSFB Output ON-Resistance	R_{OSFB}	-	30	80	Ω	I_{OSFB}=5mA

UL1577 Ratings Table

Following values are described in UL Report.

Parameter	Value	Unit	Conditions
Side 1 (Input Side) Circuit Current	1.3	mA	V_{BATT}=14V,OUT1=L
Side 2 (Output Side) Circuit Current	3.2	mA	V_{CC2}=15V, OUT1=L
Side 1 (Input Side) Consumption Power	18.2	mW	V_{BATT}=14V,OUT1=L
Side 2 (Output Side) Consumption Power	48	mW	V_{CC2}=15V, OUT1=L
Isolation Voltage	2500	Vrms	
Maximum Operating (Ambient) Temperature	125	°C	
Maximum Junction Temperature	150	°C	
Maximum Storage Temperature	150	°C	
Maximum Data Transmission Rate	2.9	MHz	

Typical Performance Curves

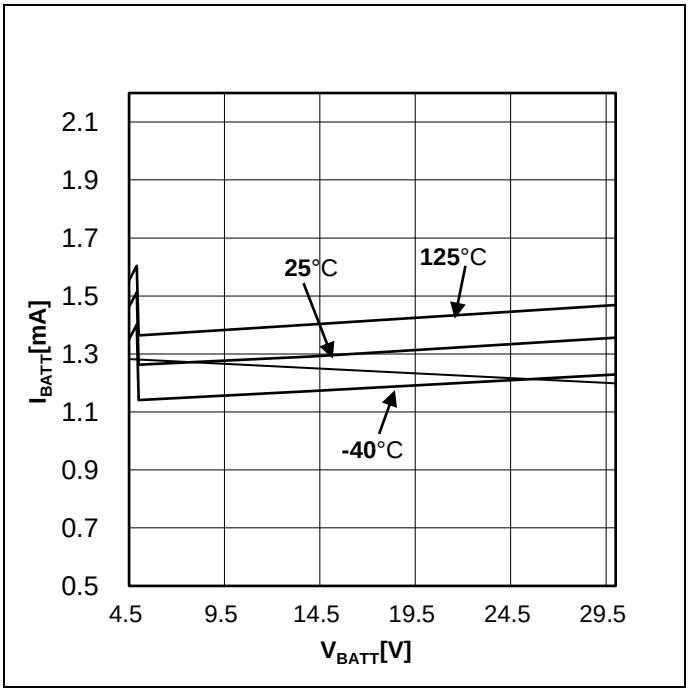


Figure 3. Main Power Supply Circuit Current 1
(FET_G Pin switching operation)

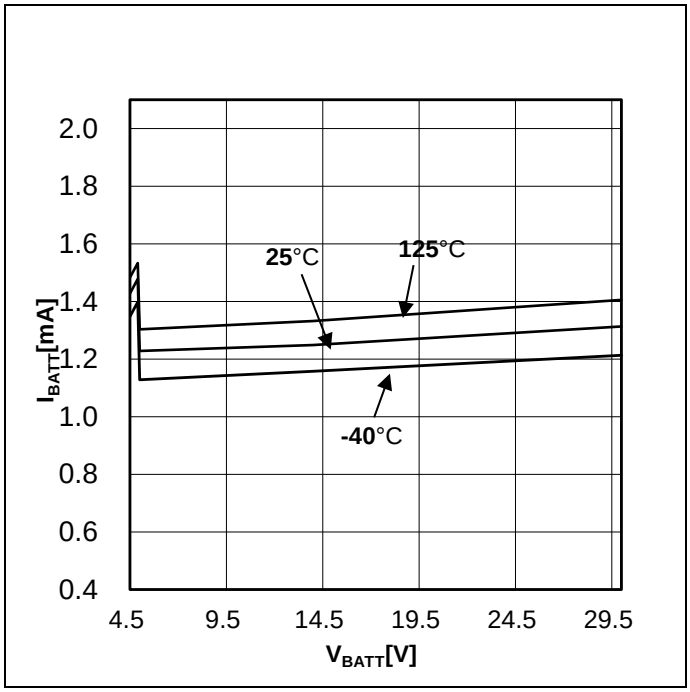


Figure 4. Main Power Supply Circuit Current 2
(FET_G Pin No Switching)

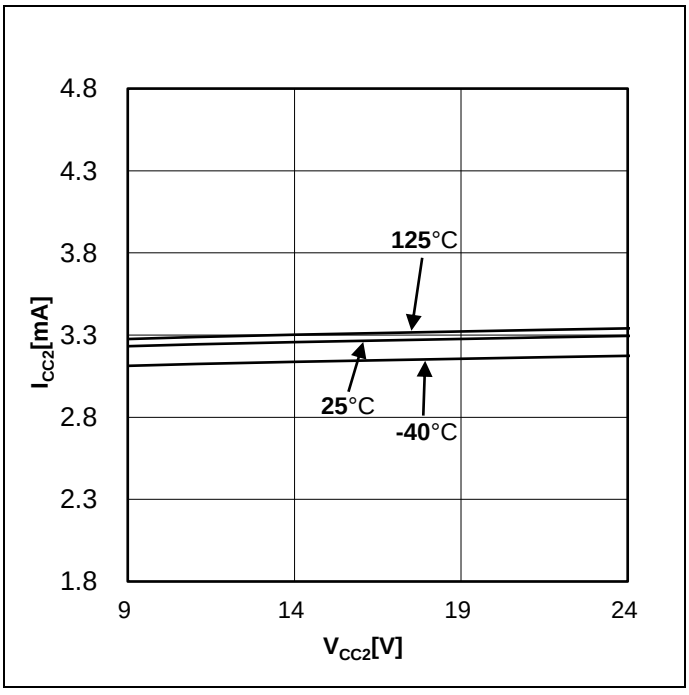


Figure 5. Output Side Circuit Current
(R_{TC}=10kΩ)

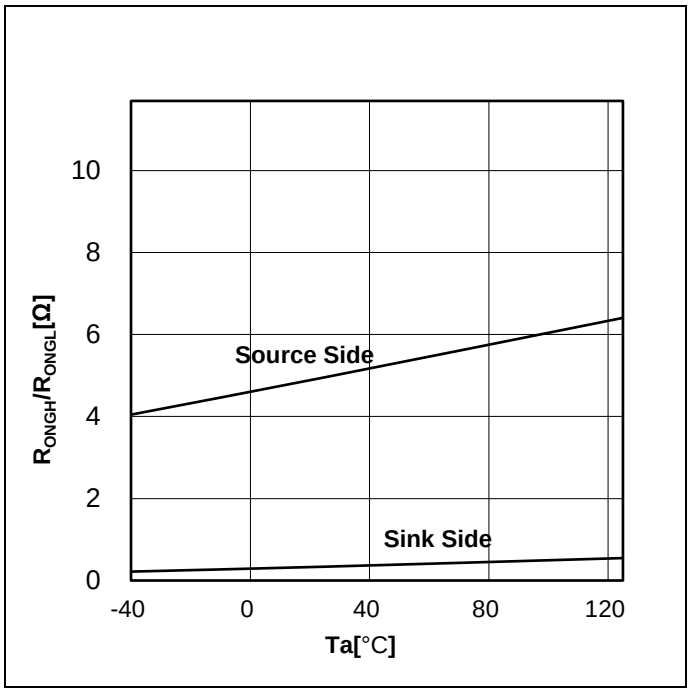


Figure 6. FET_G ON-Resistance
(I_{FET_G}=10mA)

Typical Performance Curves – continued

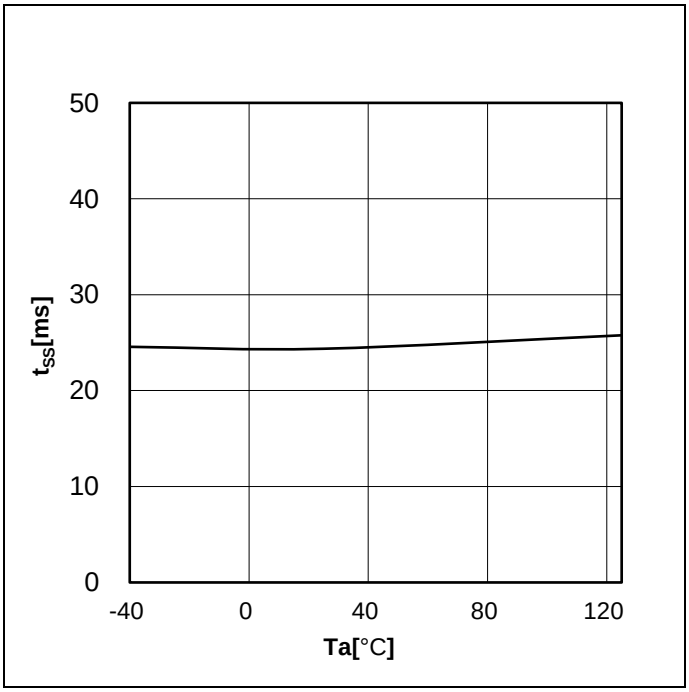


Figure 7. Soft-start Time

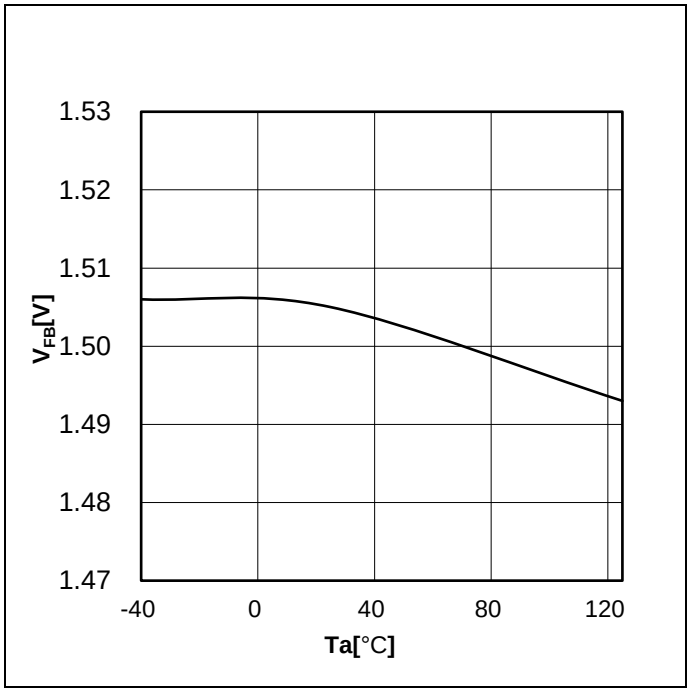


Figure 8. FB Pin Threshold Voltage

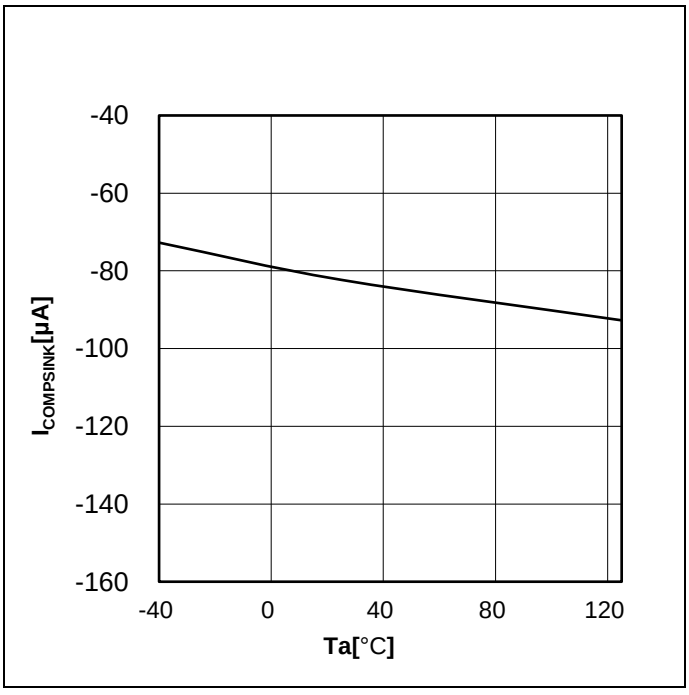


Figure 9. COMP Pin Sink Current

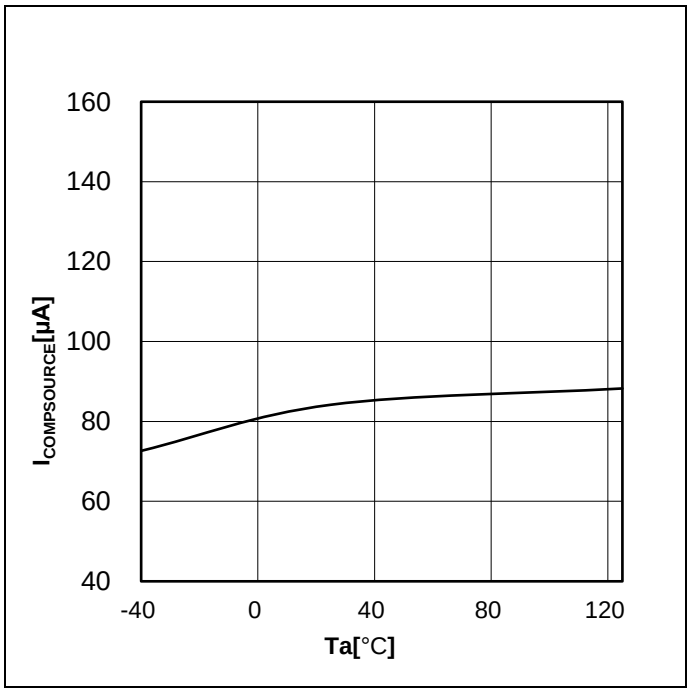


Figure 10. COMP Pin Source Current

Typical Performance Curves - continued

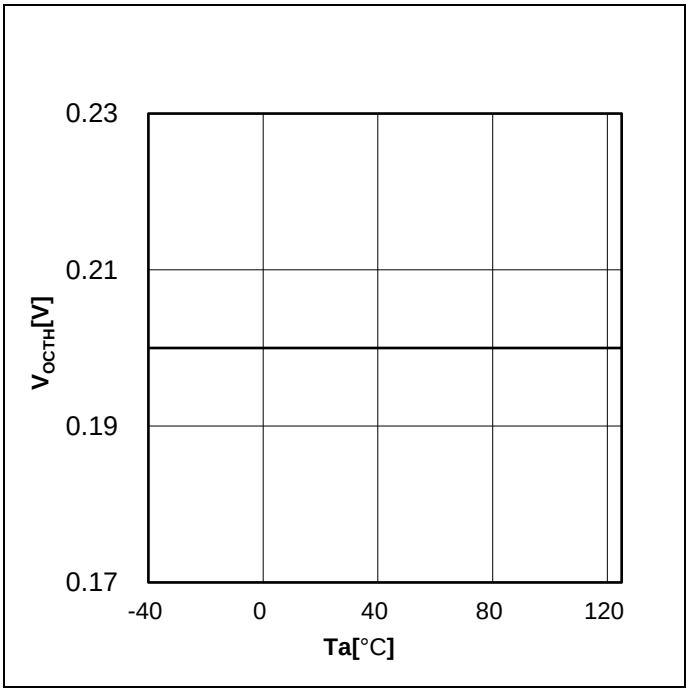


Figure 11. Over-Current Detection Threshold

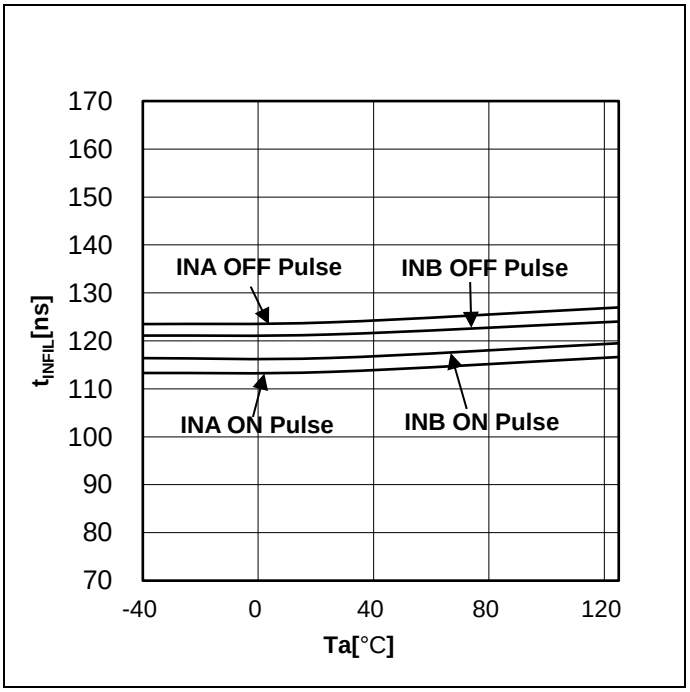


Figure 12. Logic input Filtering Time (INA,INB)

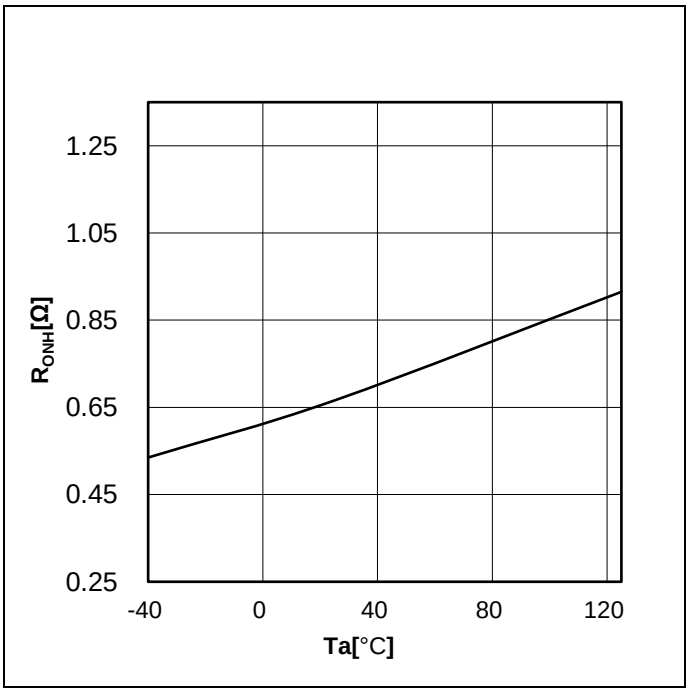


Figure 13. OUT1 Source ON-Resistance (I_{OUT1}=40mA)

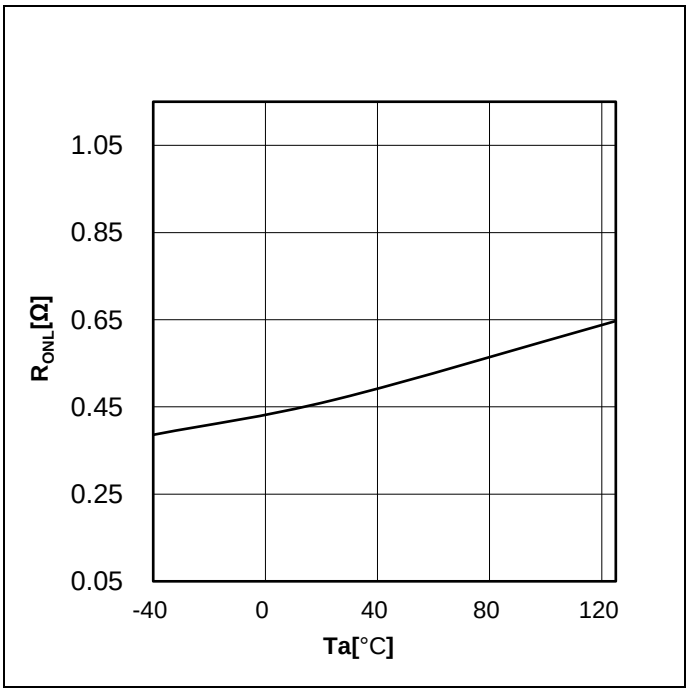


Figure 14. OUT1 Sink ON-Resistance (I_{OUT1}=40mA)

Typical Performance Curves - continued

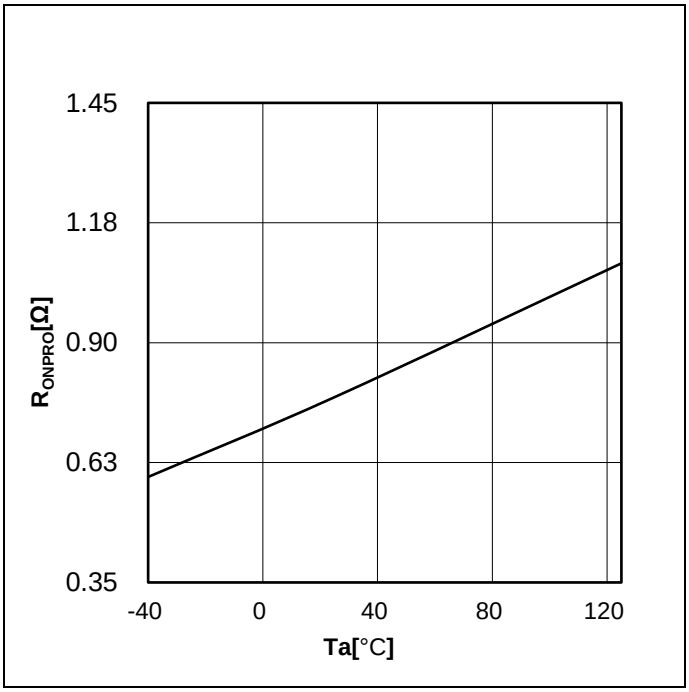


Figure 15. PROOUT ON-Resistance
(I_{PROOUT}=40mA)

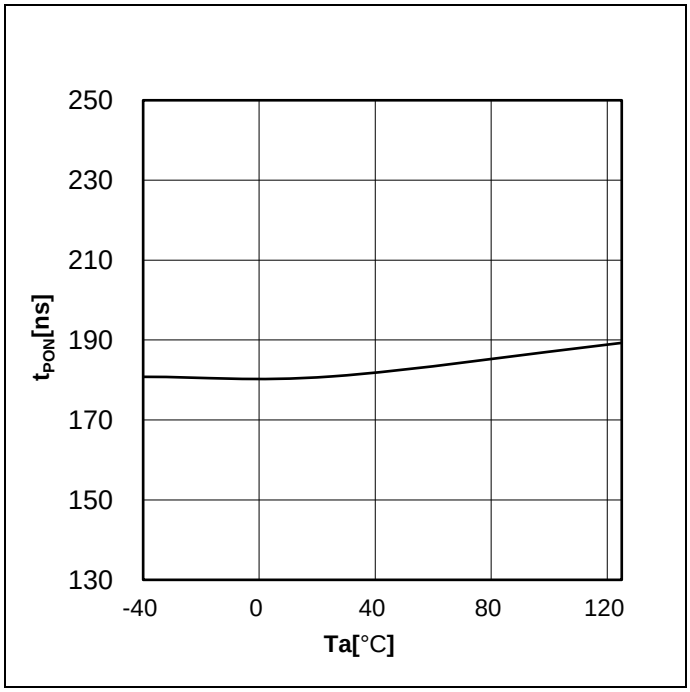


Figure 16. Turn ON time

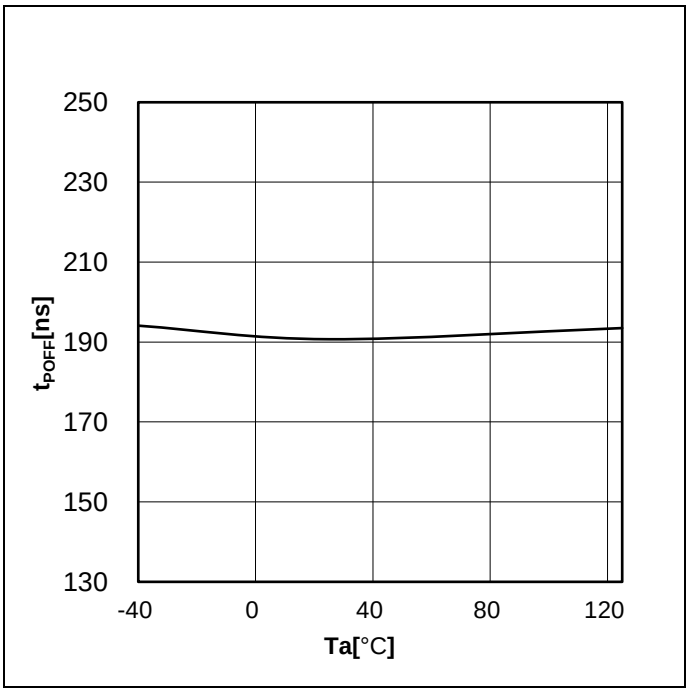


Figure 17. Turn OFF time

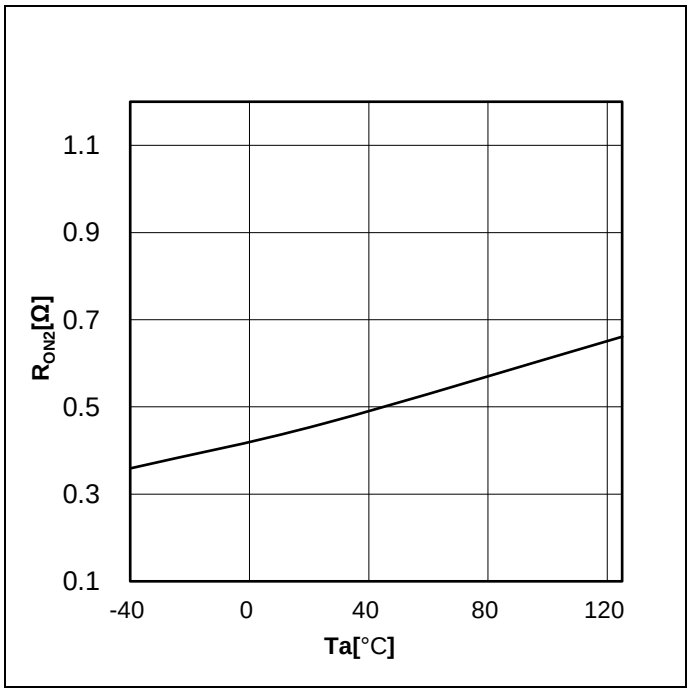


Figure 18. OUT2 ON Resistance
(I_{OUT2}=40mA)

Typical Performance Curves - continued

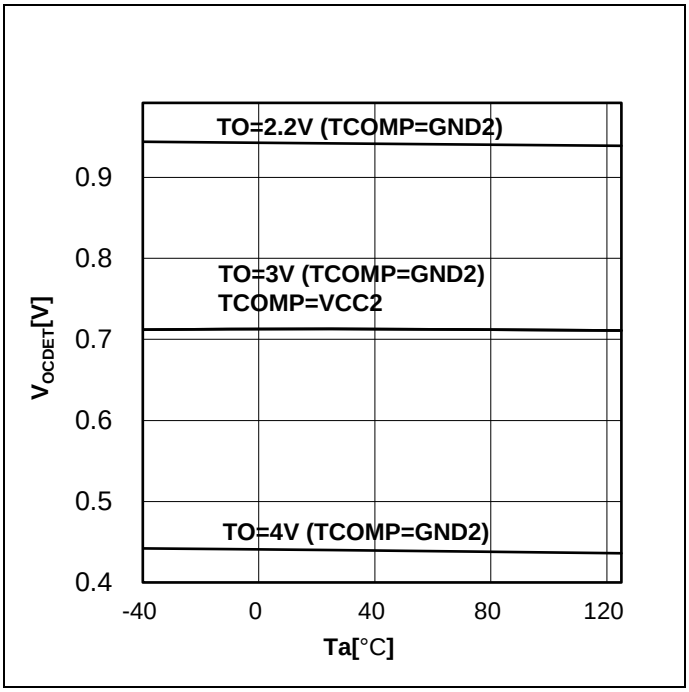


Figure 19. Over Current Detection Voltage

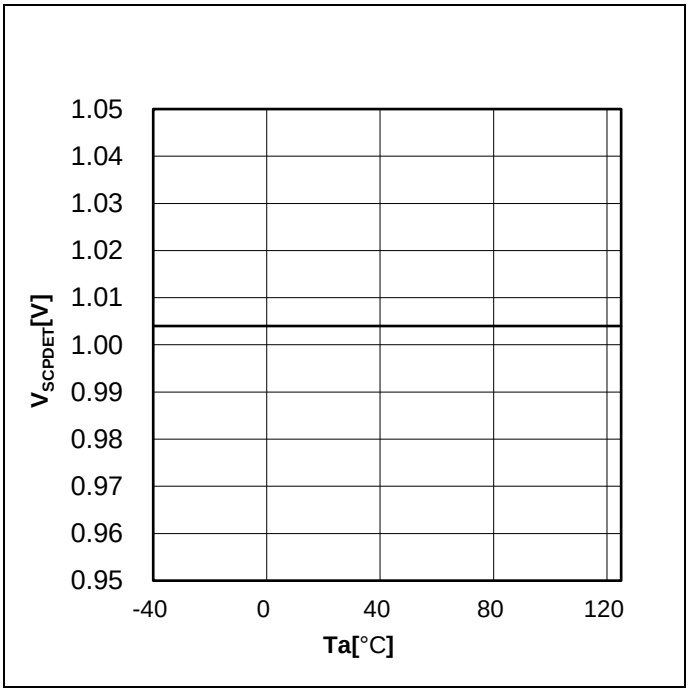


Figure 20. Short Circuit Detection Voltage

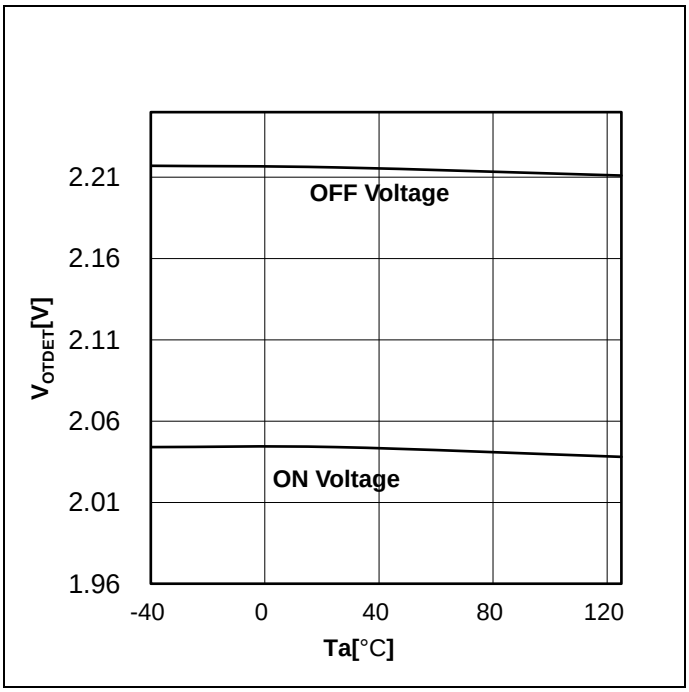


Figure 21. Over Temperature Detection Voltage

Description of Pins and Cautions on Layout of Board

1. V_BATT (Main power supply pin)
   This is the main power supply pin. Connect a bypass capacitor between V_BATT and GND1 in order to suppress voltage variations. Make sure that power is supplied even when the switching power supply is not used, since the internal reference voltage of the input side of chip is generated from this power supply.

2. GND1 (Input-side ground pin)
   The GND1 pin is a ground pin for the input side.

3. GND2 (Output-side ground pin)
   The GND2 pin is a ground pin for the output side. Connect GND2 pin to the emitter / source of the output device.

4. INA, INB (Control input pin A, Control input pin B)
   They are pins for determining the output logic.

INB	INA	OUT1
H	L	L
H	H	L
L	L	L
L	H	H

5. FLT_UVLO, FLT_SC, FLT_OT (Fault output pins)
   These pins have open drains that output fault signals when faults occur (i.e., when the under voltage lockout function (UVLO) or short circuit protection function (SCP) or over current protection function (OC) or over temperature protection (OT) is activated).

State	FLT_UVLO	FLT_SC	FLT_OT
While in normal operation	Hi-Z	Hi-Z	Hi-Z
V_BATT UVLO or VCC2 UVLO or TO pin open	L	Hi-Z	Hi-Z
SCP or OC	Hi-Z	L	Hi-Z
OT	Hi-Z	Hi-Z	L

6. OSFB (Output pin for monitoring gate condition)
   This is an open drain pin which outputs the state of gate logic of the output element monitored with OUT2 pin.

OUT2(input)	OSFB
H	Hi-Z
L	L

7. FB (Error amplifier inverting input pin for switching controller)
   This is a voltage feedback pin of the switching controller. This pin combine with voltage monitoring at over voltage protection function and under voltage protection function for switching controller. When over voltage or under voltage protection is activated, switching controller will be at OFF state (FET_G pin outputs Low). When the protection holding time ($t_{DCDCRLS}$) is completed, the protection function will be released. Under voltage function is not activated during soft-start time.

8. COMP (Error amplifier output pin for switching controller)
   This is the gain control pin of the switching controller. Connect a phase compensation capacitor and resistor. When the switching controller is not used, connect it to GND1.

9. VREG (Power supply pin for the driving MOSFET of the switching controller)
   This is the power supply pin for the driving MOSFET of the switching controller transformer drive. Be sure to connect a capacitor between VREG and GND1 even when the switching controller is not used, in order to prevent oscillation and to suppress voltage variation due to FET_G output current.

Description of Pins and Cautions on Layout of Board – continued

10. FET_G (MOSFET control pin for switching controller)
    This is a MOSFET control pin for the switching controller transformer drive. Leave it open when the switching controller is not used.

11. SENSE (Connection to the current feedback resistor of the switching controller)
    This is a pin connected to the resistor of the switching controller current feedback. FET_G pin output duty is controlled by the voltage value of this pin. This pin combines with current monitoring at over current protection function for switching controller. When over current protection is activated, switching controller will be at minimum duty state (FET_G pin outputs pulse of minimum duty).

12. OUT1(Output pin)
    The OUT1 pin is a gate driving pin.

13. OUT2 (Miller clamp pin)
    The OUT2 pin is for preventing the increase in gate voltage due to the Miller current of the power device connected to the OUT pin. It also functions as a pin for monitoring gate voltage for miller clamp function and for output state feedback function. If both functions are not used, short-circuit the OUT2 pin to the GND2 pin.

14. PROOUT (Soft turn-OFF pin)
    This pin is for soft turn-OFF of output pin when short-circuit protection or over current protection is in action.

15. SCPIN (Short circuit current detection pin)
    This pin is used to detect current for short circuit protection. When the SCPIN voltage exceeds the voltage set with the V_{SCPDET} parameter, the SCP function will be activated, this will make the IC function in an open state. To avoid such trouble, connect a resistor between the SCPIN and the GND2 or short the SCPIN pin to GND2 when the SCP function is not used.

16. OCIN (Over current detection pin)
    This pin is used to detect current for over current protection. When the OCIN voltage exceeds the voltage set with the V_{OCDET} parameter, the OC function will be activated, this will make the IC function in an open state. To avoid such trouble, connect a resistor between the OCIN and the GND2 or short the OCIN pin to GND2 when the OC function is not used.

17. TCOMP (Temperature compensation pin)
    This pin is for temperature compensation of over current detection. If the function is used, connect TCOMP to GND2. If the function is not used, connect TCOMP to VCC2.

18. LVOFF (2-level turn off level setting pin)
    The LVOFF pin is a pin used to make setting of 2-level turn off voltage. The voltage of LVOFF pin is 2-level turn off level. When the $V_{LVOFF} > V_{LVOFFTH,}$ 2-level turn off function is activated.

19. RTOFF (2-level turn off time setting pin)
    The RTOFF pin is a pin used to make the setting of 2-level turn off time. Connect a resistor R_{RTOFF} between the RTOFF pin and the GND2 pin.

20. TC (Resistor connection pin for setting constant current source output)
    The TC pin is a resistor connection pin for setting the constant current output. If an arbitrary resistance value is connected between TC and GND2, it is possible to set the constant current value output from TO.

21. TO (Constant current output / sensor voltage input pin)
    The TO pin is constant current output / voltage input pin. It can be used as a temperature protection input by connecting an element with arbitrary impedance between TO pin and GND2. Furthermore, the TO pin disconnect detection function is built-in.

22. UVLOIN (Output-side UVLO setting input pin)
    The UVLOIN pin is a pin for deciding UVLO setting value of VCC2. The threshold value of UVLO can be set by dividing the resistance voltage of VCC2 and inputting such value.

Description of Functions and Examples of Constant Setting

1. Fault Status Output

This function is used to output a fault signal from the FLT_UVLO pin when the under voltage lockout function (UVLO) is activated, the FLT_SC pin when the short circuit protection function (SCP) or over current protection (OC) is activated, and the FLT_OT pin when the over temperature protection (OT) is activated.

The functions of UVLO and SCP/OC is to hold the fault signal until fault output holding time (t_{UVLO_FLTRLS}, t_{SCP_FLTRLS},) is completed.

Status	FLT_UVLO pin
Normal	Hi-Z
UVLO	L

Status	FLT_SC pin
Normal	Hi-Z
SCP, OC	L

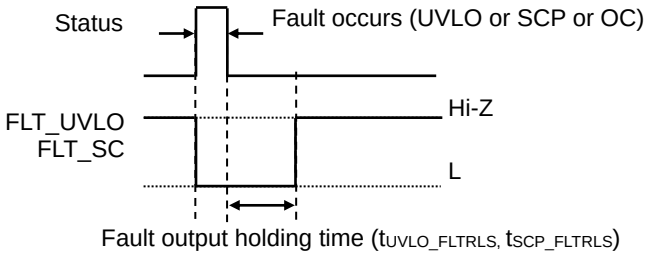


Figure 22. Fault Status Output Timing Chart (SCP/OC,UVLO)

The OT function holds the fault signal until TO pin voltage goes high above $V_{TODETOFF}$.

Status	FLT_OT pin
Normal	Hi-Z
OT	L

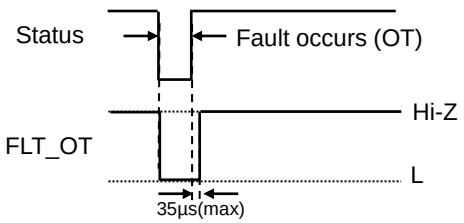


Figure 23. Fault Status Output Timing Chart (OT)

When UVLO function is activated during SCP or OC, the Fault output holding time occurs after UVLO cancellation.

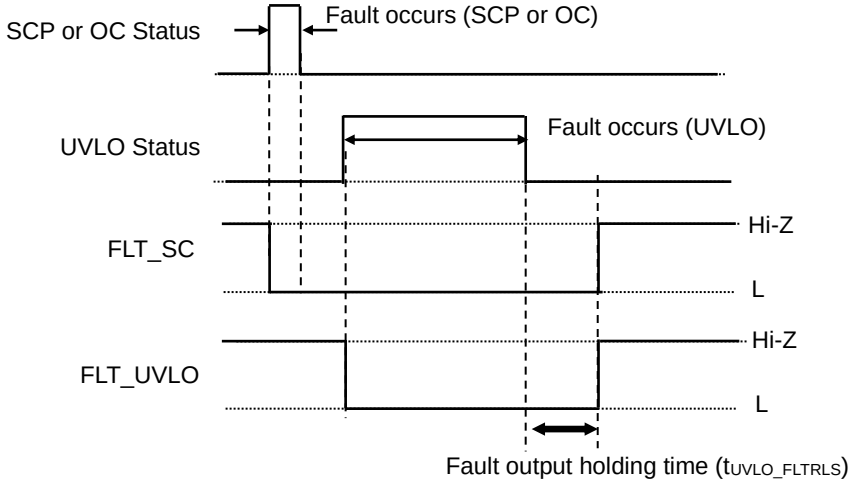


Figure 24. Fault Status Output Timing Chart (SCP/OC and UVLO)

Description of Functions and Examples of Constant Setting – continued

2. Under Voltage Lockout (UVLO) Function

BM60055FV-C incorporates the under voltage lockout (UVLO) function on V_BATT and VCC2. When the power supply voltage drops to the UVLO ON voltage, OUT1 turns off and the FLT_UVLO pin will both output the “L” signal.
When the power supply voltage rises to the UVLO OFF voltage, these pins will be reset. However, during the fault output holding time set in “Fault status output” section, the OUT1 pin and the FLT_UVLO pin will hold the “L” signal. In addition, to prevent mis-triggering due to noise, mask time is set on both low and high voltage sides.

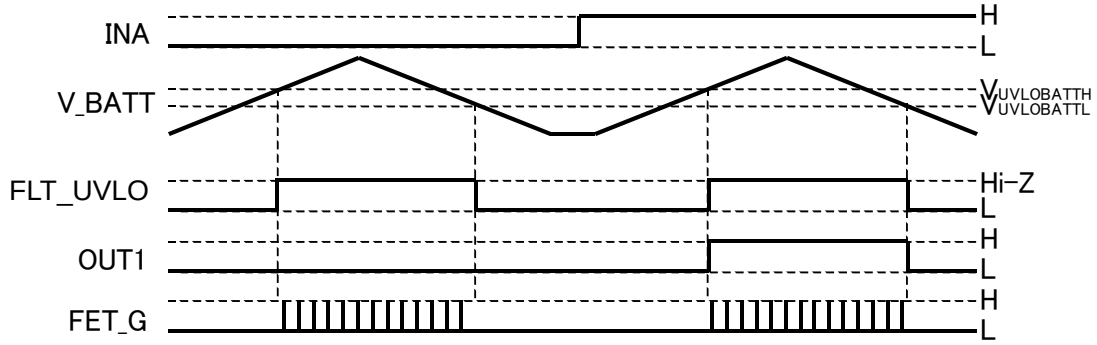


Figure 25. V_BATT UVLO Function Operation Timing Chart

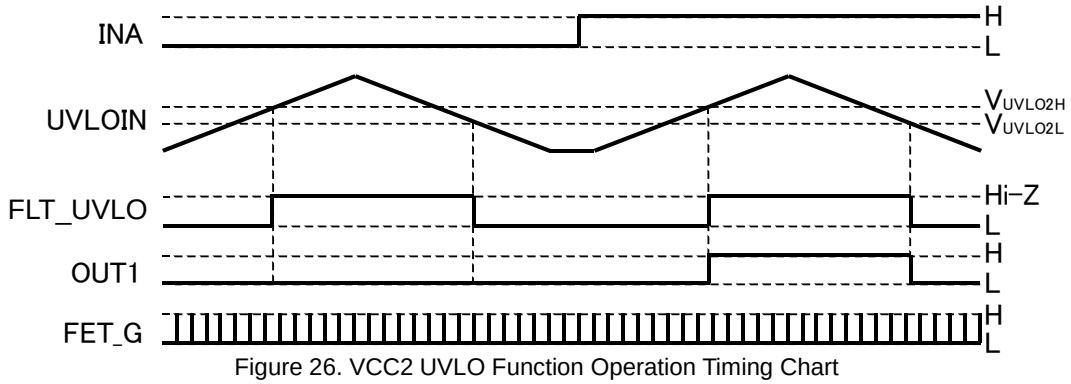


Figure 26. VCC2 UVLO Function Operation Timing Chart

When $V_{LVOFF} < V_{LVOFFTH}$, normal turn off is activated.

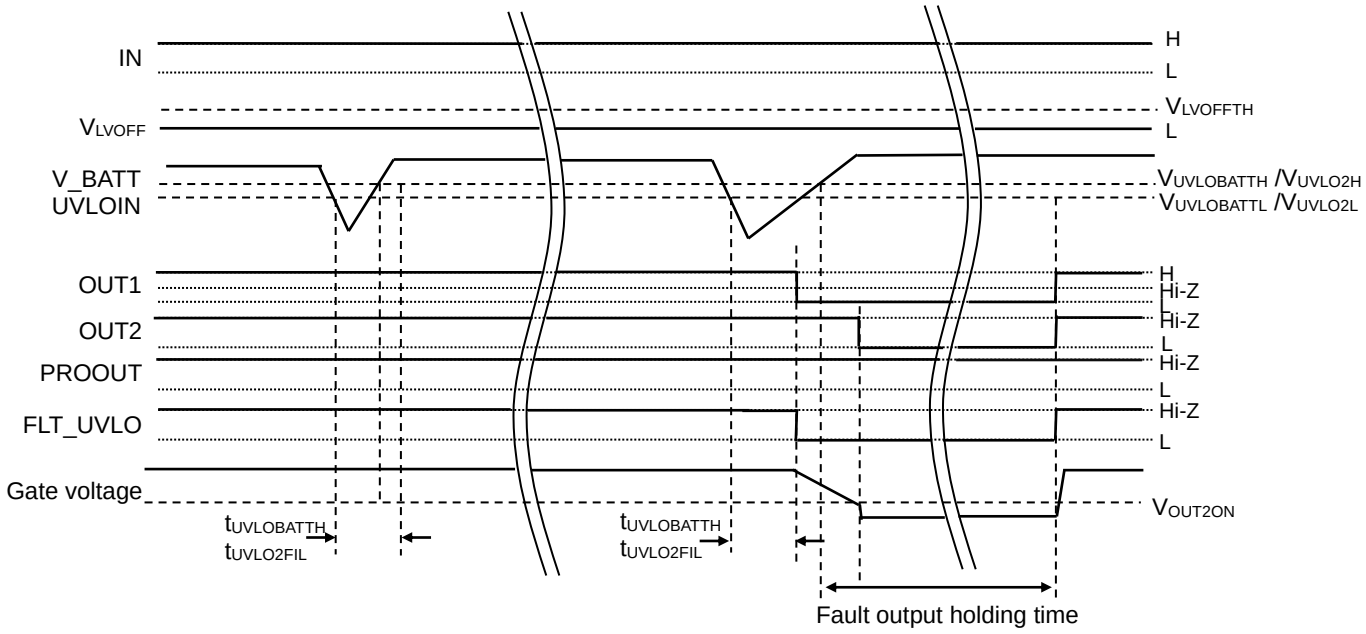


Figure 27. UVLO Operation Timing Chart (Normal Turn off)

Description of Functions and Examples of Constant Setting – continued

When $V_{LVOFF} > V_{LVOFFTH}$, 2-level turn off is activated.

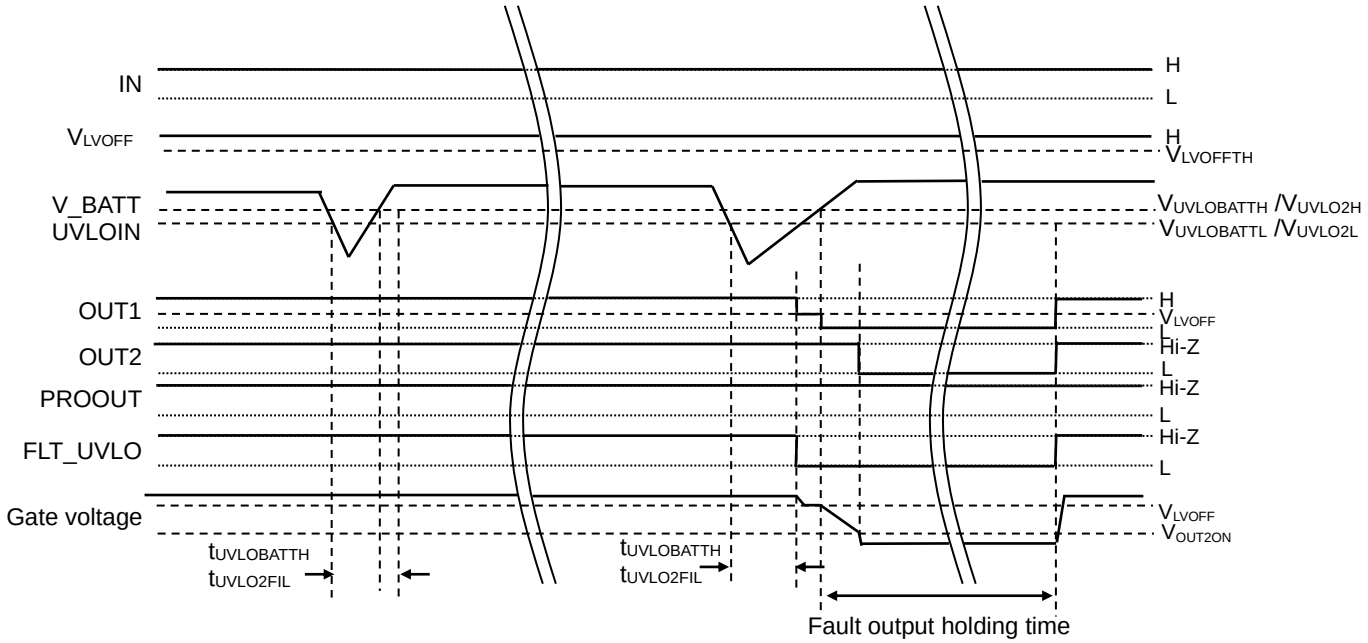


Figure 28. UVLO Operation Timing Chart (2 level turn off)

3. Short Circuit Protection (SCP) Function
When the SCPIN pin voltage exceeds a voltage set with the V_{SCPDET} parameter, the SCP function will be activated. When the SCP function is activated, soft turn off is activated.

When the SCP function is activated, OUT1 pin voltage will be set to the "Hi-Z" level and the PROOUT pin voltage will be set to "L" level first. Next, OUT2 pin voltage < V_{OUT2ON}, internal MOS of OUT2 pin is turned ON (miller clamping) and OUT1 will become L.

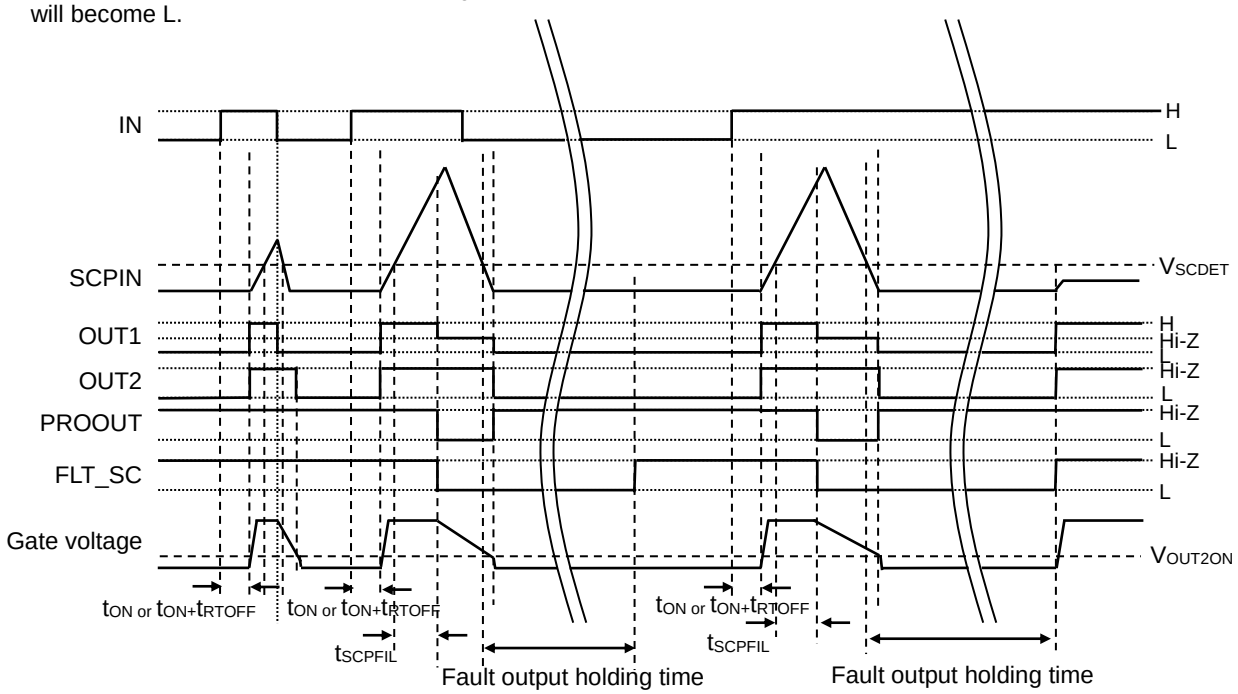


Figure 29. SCP Operation Timing Chart

Description of Functions and Examples of Constant Setting – continued

4. Over Current Protection (OC) Function

When the OCIN pin voltage exceeds a voltage set with the V_{OCDET} parameter, the OC function will be activated. When the OC function is activated, soft turn off is activated.

When the OC function is activated, OUT1 pin voltage will be set to the “Hi-Z” level and the PROOUT pin voltage will be set to “L” level first. Next, OUT2 pin voltage < V_{OUT2ON}, internal MOS of OUT2 pin is turned ON (miller clamping) and OUT1 will become L.

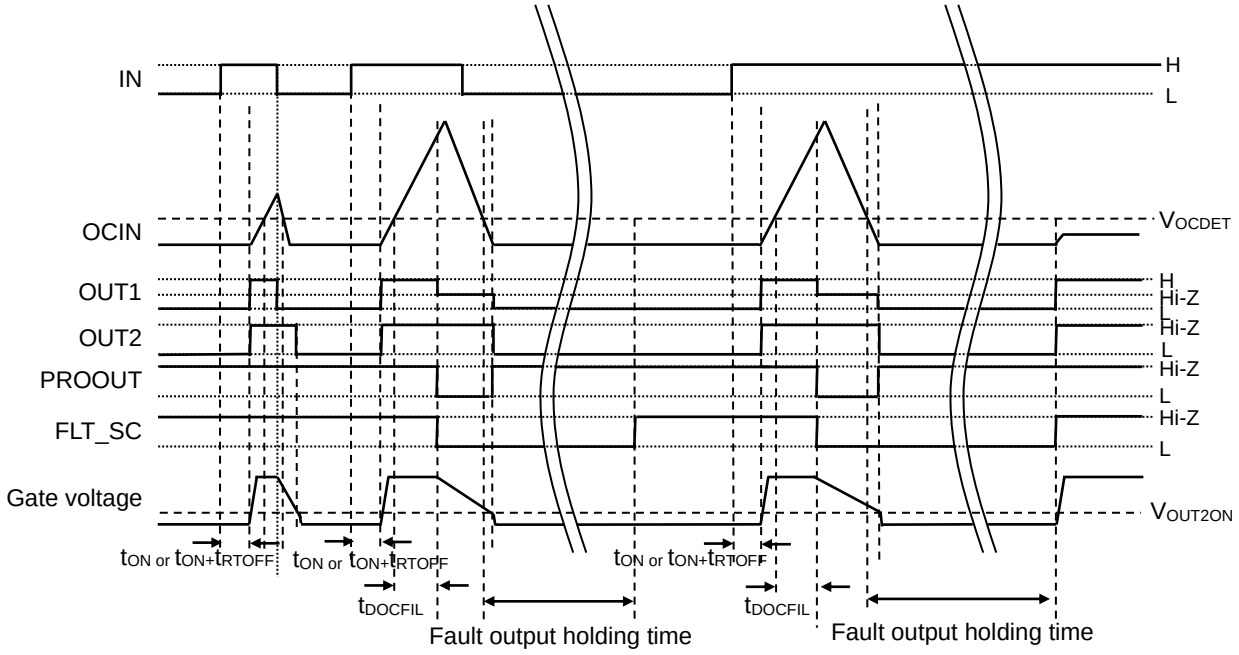


Figure 30. OC Operation Timing Chart

Description of Functions and Examples of Constant Setting – continued

5. 2-Level Turn Off

When $V_{LVOFF} > V_{LVOFFTH}$, 2-level turn off is activated.
2-level turn off time t_{RTOFF} and voltage level V_{LVOFF} is adjustable by external elements of RTOFF pin and LVOFF pin.
The values of the 2-level turn off level V_{LVOFF} is determined by the values of the voltage of LVOFF pin.
The values of the 2-level turn off time t_{RTOFF} is determined by the values of the resistor R_{RTOFF} according to the following formula (typical values):

$$t_{RTOFF} = 0.145 \times R_{RT}[k\Omega] + 0.05 \quad \text{[us]}$$

The propagation delay time (ON) of the OUT1 is delayed for the same time as the 2-level turn off time t_{RTOFF}.
When $V_{LVOFF} < V_{LVOFFTH}$, turn on time does not include 2-level turn off time and normal turn off is activated.

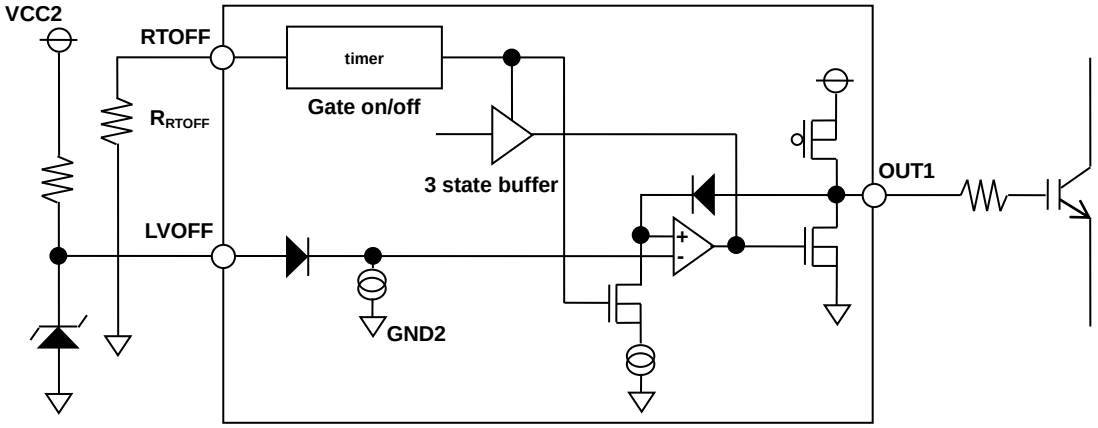


Figure 31. 2 level turn off function block diagram

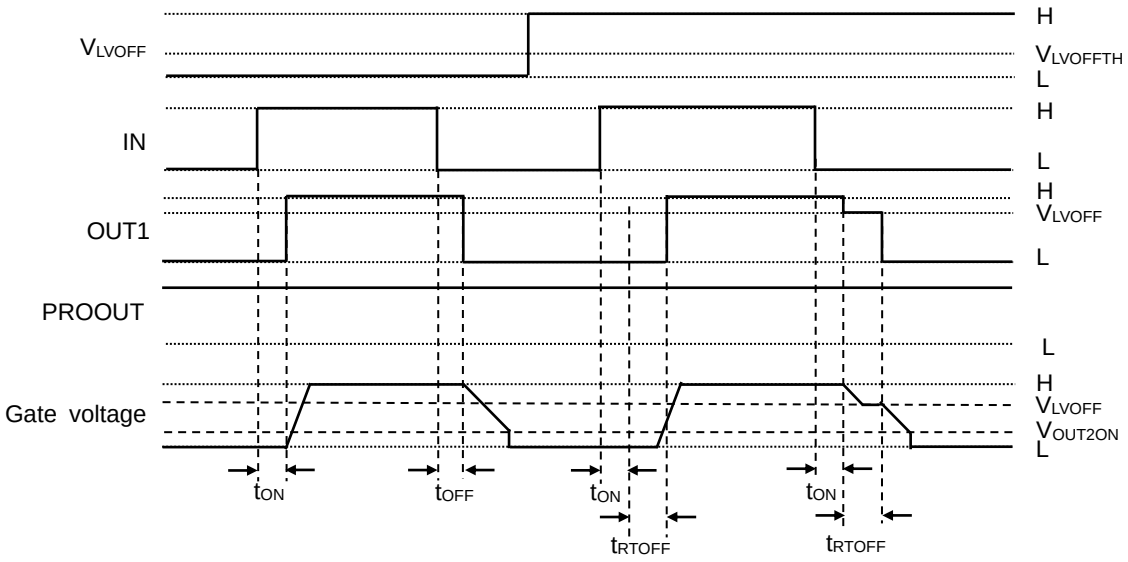


Figure 32. Timing Chart of Turn Off

Description of Functions and Examples of Constant Setting – continued

6. Temperature Compensation of OC
   When TCOMP = GND2, temperature compensation of OC is activated.
   If the function is not used, connect TCOMP to VCC2.

TCOMP=GND2

The temperature of OC detection voltage can be compensated in accordance with TO voltage.

$$V_{OC} = -0.283 \times V_{TO} + 1.552 \quad [V]$$

TCOMP=VCC2

$$V_{OC} = 0.7 \quad [V]$$

Description of Functions and Examples of Constant Setting – continued

7. Miller Clamping

When OUT1=L and OUT2 pin voltage < V_{OUT2ON}, internal MOS of OUT2 pin is turned ON, and Miller clamp function operates.

IN	OUT2 pin input voltage	OUT2
L	Not more than V_{OUT2ON}	L
H	X	Hi-Z

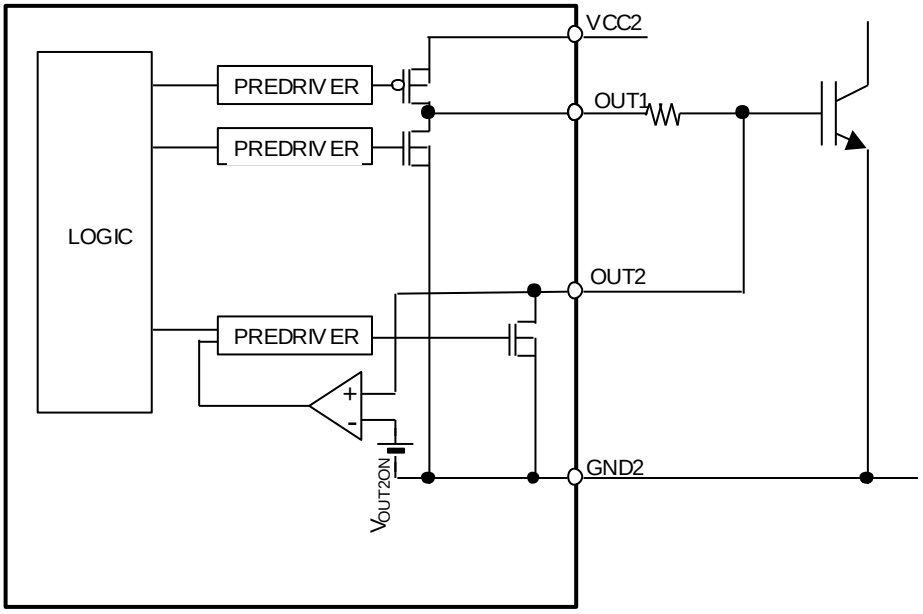


Figure 33. Block Diagram of Miller Clamp Function

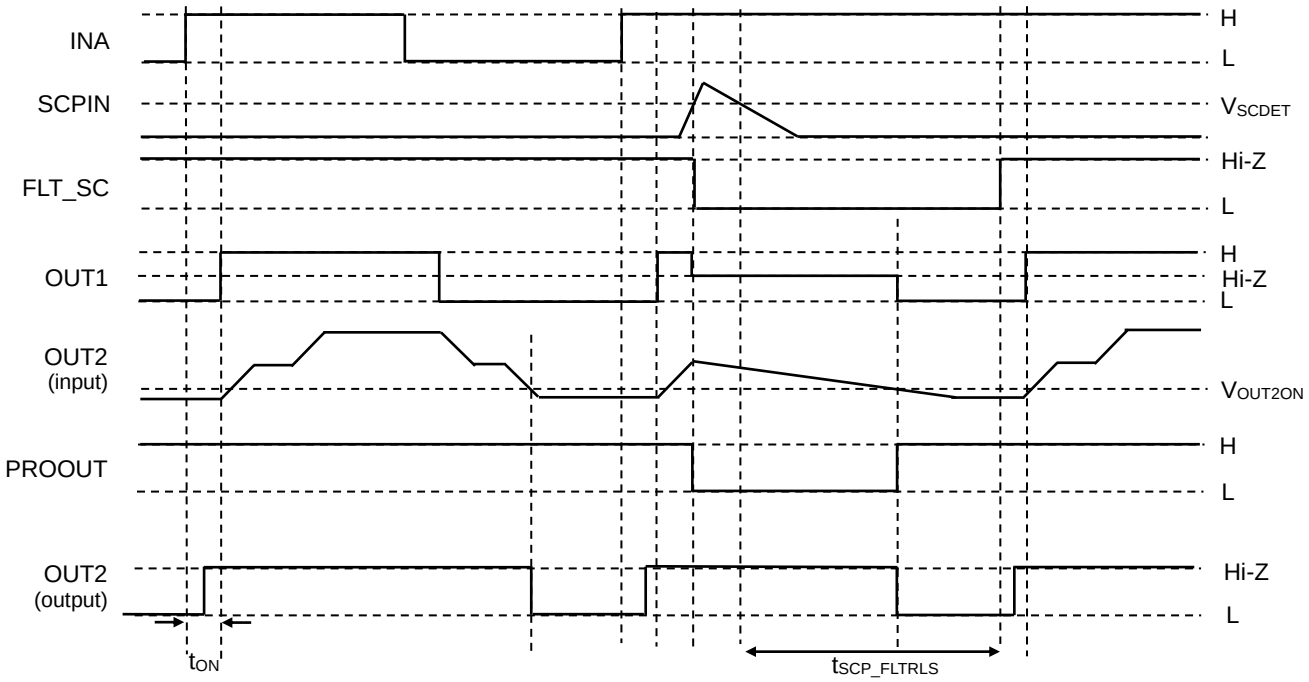


Figure 34. Timing chart of Miller Clamp Function

Description of Functions and Examples of Constant Setting – continued

8. Over Temperature Protection Function

Constant current is supplied from TO pin from the built-in constant current circuit. This current value can be adjusted in accordance with the resistance value connected between TC and GND2. Furthermore, TO pin has voltage input function, and when the TO pin voltage < $V_{OTDETON}$, OUT1 turns off and FLT_OT becomes L. When the TO pin voltage goes high above $V_{OTDETOFF}$, the OT function will be released.

$$\text{Constant current value} = \frac{V_{TC} \times 10}{R_{TC}}$$

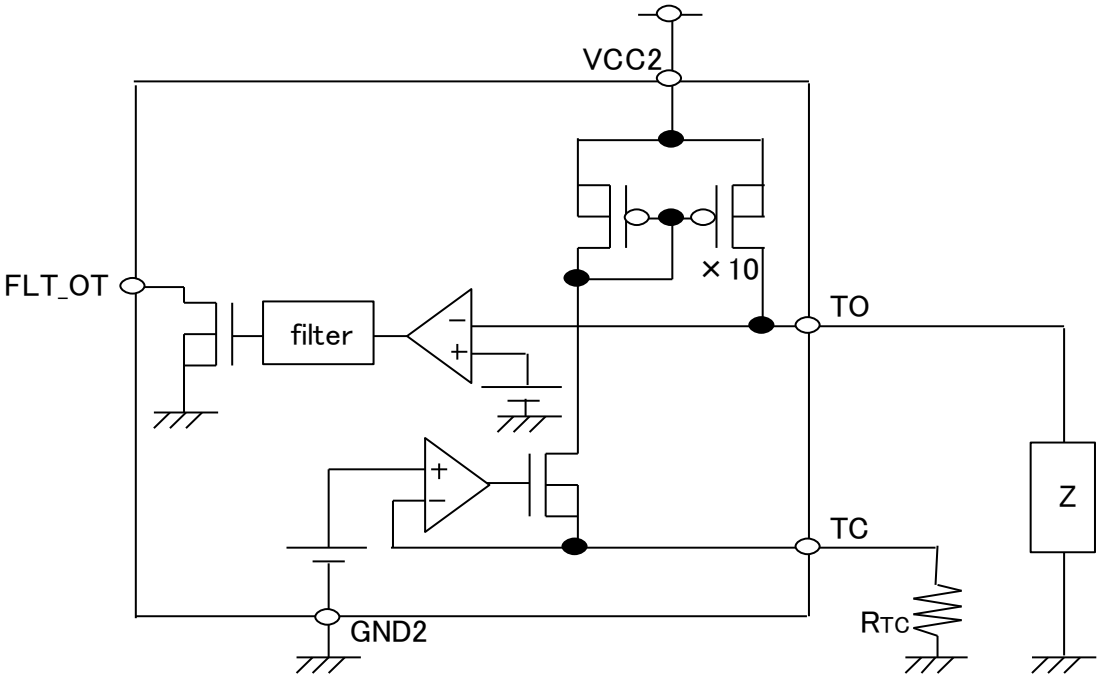


Figure 35. Block Diagram of Temperature Monitor Function

When $V_{LVOFF} < V_{LVOFFTH}$, normal turn off is activated.

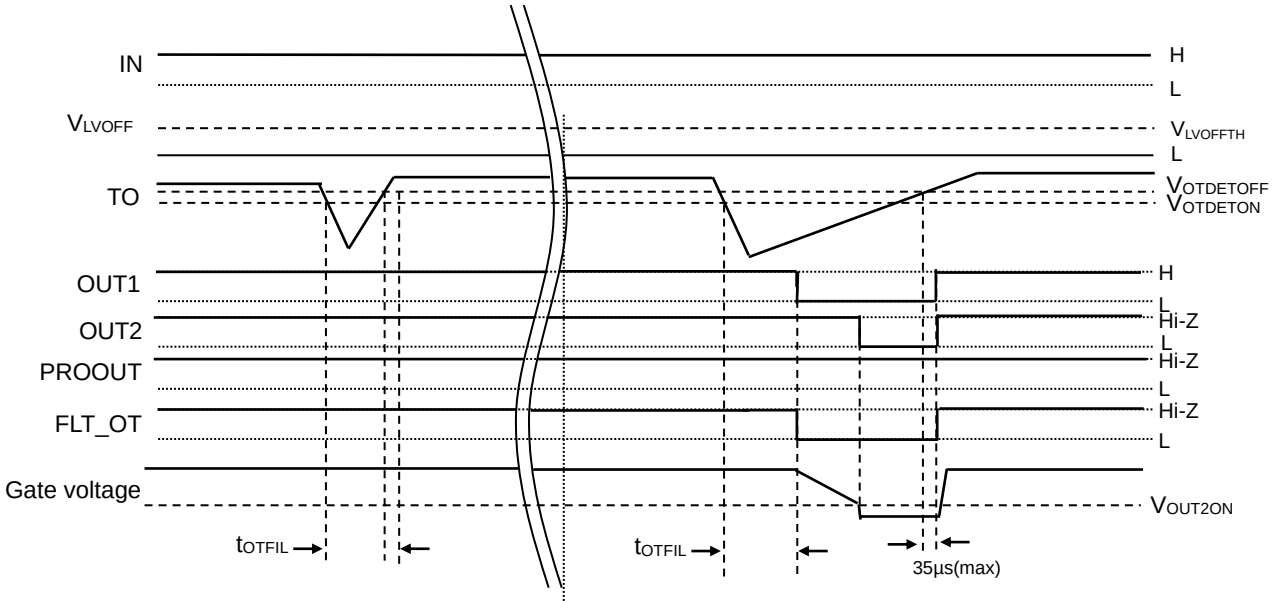


Figure 36. OT Operation Timing Chart (Normal turn off)

Description of Functions and Examples of Constant Setting – continued

When $V_{LVOFF} > V_{LVOFFTH}$, 2-level turn off is activated.

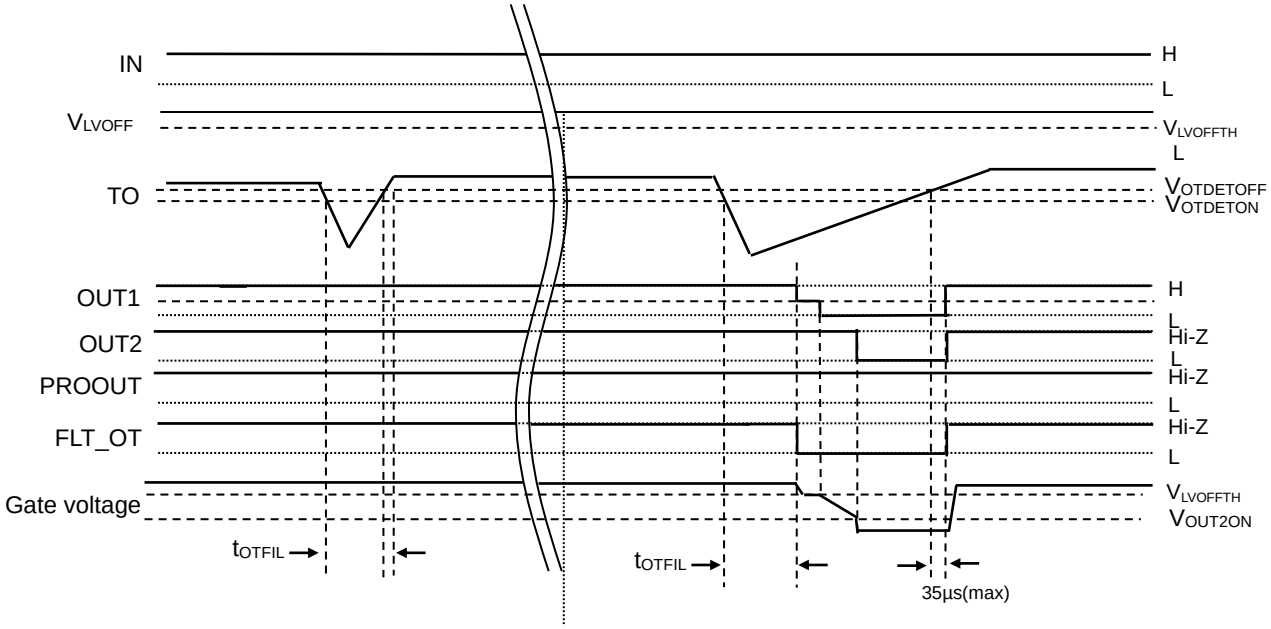


Figure 37. OT Operation Timing Chart (2 level turn off)

9. Switching Controller

(1) Basic action

This IC has a built-in switching power supply controller which repeats ON/OFF synchronizing with internal clock. When V_BATT voltage is supplied ($V_{BATT} > V_{UVLOBATTH}$), FET_G pin starts switching by soft-start. Output voltage is determined by the following equation by external resistance and winding ratio "n" of flyback transformer (n= V_{OUT2} side winding number/V_{OUT1} side winding number)

$$V_{OUT2} = V_{FB} \times \{(R_1 + R_2)/R_2\} \times n[V]$$

(2) MAX DUTY

When, for example, output load is large, and voltage level of SENSE pin does not reach current detection level, output is forcibly turned OFF by Maximum On Duty (D_{ONMAX}).

(3) Pin conditions when the switching power supply controller is not used

Implement pin connection as shown below when switching power supply is not used.

Pin Number	Pin Name	Treatment Method
22	FB	Connect to VREG
23	COMP	Connect to GND1
24	V_BATT	Connect power supply
25	VREG	Connect capacitor
26	FET_G	No connection
27	SENSE	Connect to GND1

10. Output State Feedback Function

When the gate logic of output device monitored with OUT2 pin is H, a logic H is the output from OSFB pin. When OUT2 pin is L, a logic L is the output from OSFB pin.

Description of Functions and Examples of Constant Setting - continued

11. I/O Condition Table

No.	Status	Input									Output						
		V_BATT	SCPIN	TO	VCC2	OCIN	LVOFF	INB	INA	OUT2	OUT1	OUT2	PROOUT	FLT_UVLO	FLT_SC	FLT_OT	OSFB
1	V_BATT UVLO SCP	UVLO	H	X	X	X	X	L	H	H	Z	Z	L	L	L*	Z	L
2		UVLO	H	X	X	X	X	L	H	L	L	L	Z	L	Z	Z	L
3		UVLO	H	X	X	X	X	X	L	H	L	Z	Z	L	Z	Z	L
4		UVLO	H	X	X	X	X	X	L	L	L	L	Z	L	Z	Z	L
5	V_BATT UVLO OT	UVLO	L	L	X	L	H	X	X	H	T	Z	Z	L	Z	L	L
6		UVLO	L	L	X	L	H	X	X	L	T	L	Z	L	Z	L	L
7		UVLO	L	L	X	L	L	X	X	H	L	Z	Z	L	Z	L	L
8		UVLO	L	L	X	L	L	X	X	L	L	L	Z	L	Z	L	L
9	V_BATT UVLO VCC2 UVLO	UVLO	L	H	L	X	H	X	X	H	T	Z	Z	L	Z	Z	L
10		UVLO	L	H	L	X	H	X	X	L	T	L	Z	L	Z	Z	L
11		UVLO	L	H	X	L	L	X	X	H	L	Z	Z	L	Z	Z	L
12		UVLO	L	H	X	L	L	X	X	L	L	L	Z	L	Z	Z	L
13	V_BATT UVLO OC	UVLO	L	H	H	H	X	L	H	H	Z	Z	L	L	L*	Z	L
14		UVLO	L	H	H	H	X	L	H	L	L	L	Z	L	Z	Z	L
15		UVLO	L	H	H	H	X	X	L	H	L	Z	Z	L	Z	Z	L
16		UVLO	L	H	H	H	X	X	L	L	L	L	Z	L	Z	Z	L
17	V_BATT UVLO	UVLO	L	H	H	L	H	X	X	H	T	Z	Z	L	Z	Z	L
18		UVLO	L	H	H	L	H	X	X	L	T	L	Z	L	Z	Z	L
19		UVLO	L	H	H	L	L	X	X	H	L	Z	Z	L	Z	Z	L
20		UVLO	L	H	H	L	L	X	X	L	L	L	Z	L	Z	Z	L
21	SCP OT VCC2 UVLO	○	H	L	L	X	X	L	H	H	Z	Z	L	L	L*	Z	L
22		○	H	L	L	X	X	L	H	L	L	L	Z	L	Z	Z	L
23		○	H	L	L	X	X	X	L	H	L	Z	Z	L	Z	Z	L
24		○	H	L	L	X	X	X	L	L	L	L	Z	L	Z	Z	L
25	SCP OT	○	H	L	H	X	X	L	H	H	Z	Z	L	Z	L*	L	Z
26		○	H	L	H	X	X	L	H	L	L	L	Z	Z	Z	L	L
27		○	H	L	H	X	X	X	L	H	L	Z	Z	Z	Z	L	Z
28		○	H	L	H	X	X	X	L	L	L	L	Z	Z	Z	L	L
29	SCP VCC2 UVLO	○	H	H	L	X	X	L	H	H	Z	Z	L	L	L*	Z	L
30		○	H	H	L	X	X	L	H	L	L	L	Z	L	Z	Z	L
31		○	H	H	L	X	X	X	L	H	L	Z	Z	L	Z	Z	L
32		○	H	H	L	X	X	X	L	L	L	L	Z	L	Z	Z	L

○: V_BATT > UVLO, X: Don't care, Z: Hi-Z, T: 2-level turn off,
L*: 40ms low pulse, SCP or OC is prior to the others.

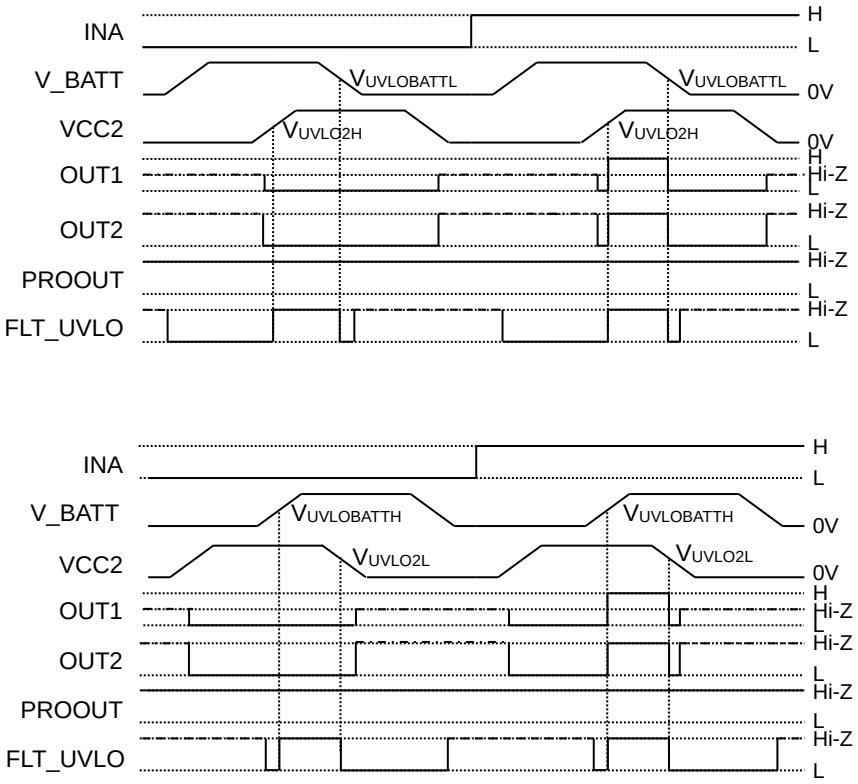
Description of Functions and Examples of Constant Setting – continued

No.	Status	Input									Output						
		V_BATT	SCPIN	TO	VCC2	OCIN	LVOFF	INB	INA	OUT2	OUT1	OUT2	PROOUT	FLT_UVLO	FLT_SC	FLT_OT	OSFB
33	OT VCC2 UVLO	○	L	L	L	L	H	X	X	H	T	Z	Z	L	Z	Z	L
34		○	L	L	L	L	H	X	X	L	T	L	Z	L	Z	Z	L
35		○	L	L	L	L	L	X	X	H	L	Z	Z	L	Z	Z	L
36		○	L	L	L	L	L	X	X	L	L	L	Z	L	Z	Z	L
37	SCP	○	H	H	H	X	X	L	H	H	Z	Z	L	Z	L*	Z	Z
38		○	H	H	H	X	X	L	H	L	L	L	Z	Z	Z	Z	L
39		○	H	H	H	X	X	X	L	H	Z	Z	Z	Z	Z	Z	Z
40		○	H	H	H	X	X	X	L	L	L	L	Z	Z	Z	Z	L
41	OT	○	L	L	H	L	H	X	X	H	T	Z	Z	Z	Z	L	Z
42		○	L	L	H	L	H	X	X	L	T	L	Z	Z	Z	L	L
43		○	L	L	H	L	L	X	X	H	L	Z	Z	Z	L	L	Z
44		○	L	L	H	L	L	X	X	L	L	L	Z	Z	L	L	L
45	VCC2 UVLO	○	L	H	L	L	H	X	X	H	T	Z	Z	L	Z	Z	L
46		○	L	H	L	L	H	X	X	L	T	L	Z	L	Z	Z	L
47		○	L	H	L	L	L	X	X	H	Z	Z	Z	L	Z	Z	L
48		○	L	H	L	L	L	X	X	L	L	L	Z	L	Z	Z	L
49	OC	○	L	H	H	H	X	L	H	H	Z	Z	L	Z	L*	Z	Z
50		○	L	H	H	H	X	L	H	L	L	L	Z	Z	Z	Z	L
51		○	L	H	H	H	X	X	L	H	L	L	Z	Z	Z	Z	Z
52		○	L	H	H	H	X	X	L	L	L	L	Z	Z	Z	Z	L
53	Normal	○	L	H	H	L	H	H	X	H	T	Z	Z	Z	Z	Z	Z
54		○	L	H	H	L	H	H	X	L	T	L	Z	Z	Z	Z	L
55		○	L	H	H	L	L	H	X	H	L	Z	Z	Z	Z	Z	Z
56		○	L	H	H	L	L	H	X	L	L	L	Z	Z	Z	Z	L
57		○	L	H	H	L	H	L	H	H	H	Z	Z	Z	Z	Z	Z
58		○	L	H	H	L	H	L	H	L	H	Z	Z	Z	Z	Z	L
59		○	L	H	H	L	L	L	H	H	H	Z	Z	Z	Z	Z	Z
60		○	L	H	H	L	L	L	H	L	H	Z	Z	Z	Z	Z	L
61		○	L	H	H	L	H	L	L	H	T	Z	Z	Z	Z	Z	Z
62		○	L	H	H	L	H	L	L	L	T	L	Z	Z	Z	Z	L
63		○	L	H	H	L	L	L	L	H	L	Z	Z	Z	Z	Z	Z
64		○	L	H	H	L	L	L	L	L	L	L	Z	Z	Z	Z	L

○: V_BATT > UVLO, X: Don't care, Z: Hi-Z, T: 2-level turn off,
L*: 40ms low pulse, SCP or OC is prior to the others.

Description of Functions and Examples of Constant Setting - continued

12. Power Supply Startup / Shutdown Sequence



-·-·-·-· : Since the VCC2 to GND2 pin voltage is low and the output MOS does not turn ON, the output pins become Hi-Z conditions.

- - - - - - - :Since the V_BATT pin voltage is low and the FLT_UVLO output MOS does not turn ON, the output pins become Hi-Z conditions.

Figure 38. Power Supply Startup / Shutdown Sequence

Selection of Components Externally Connected

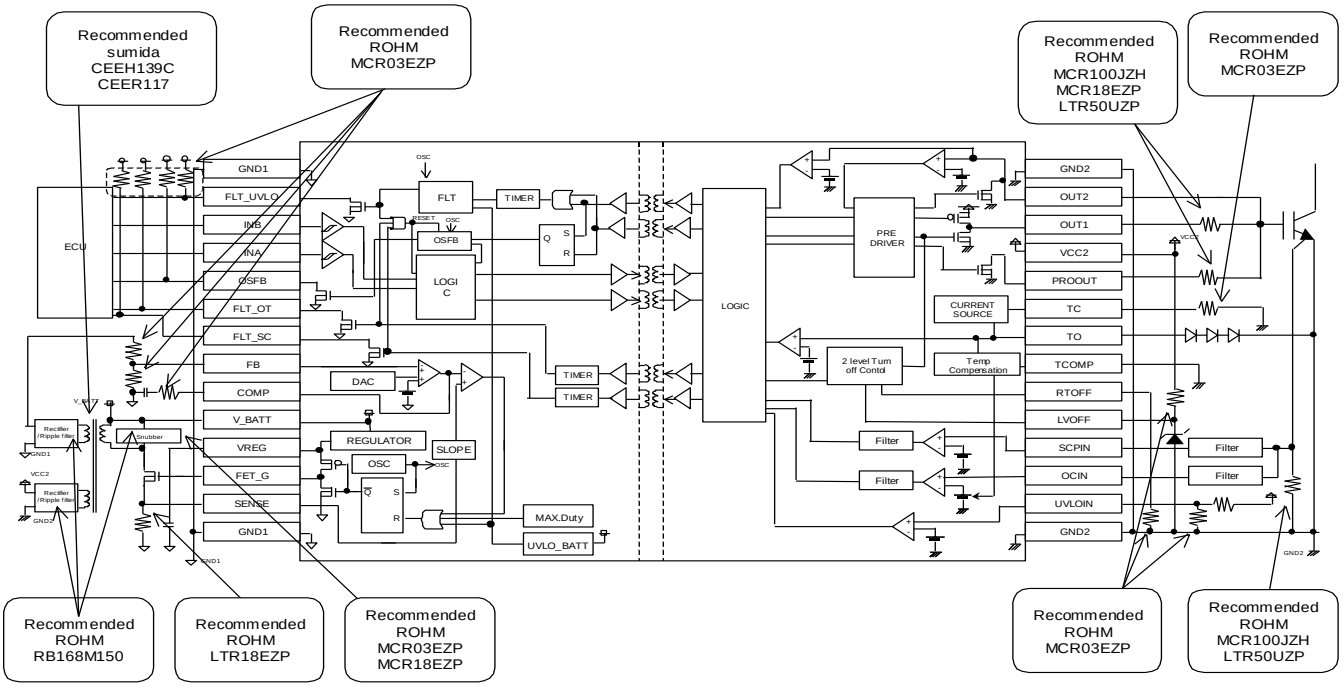


Figure 39. For using switching power supply controller

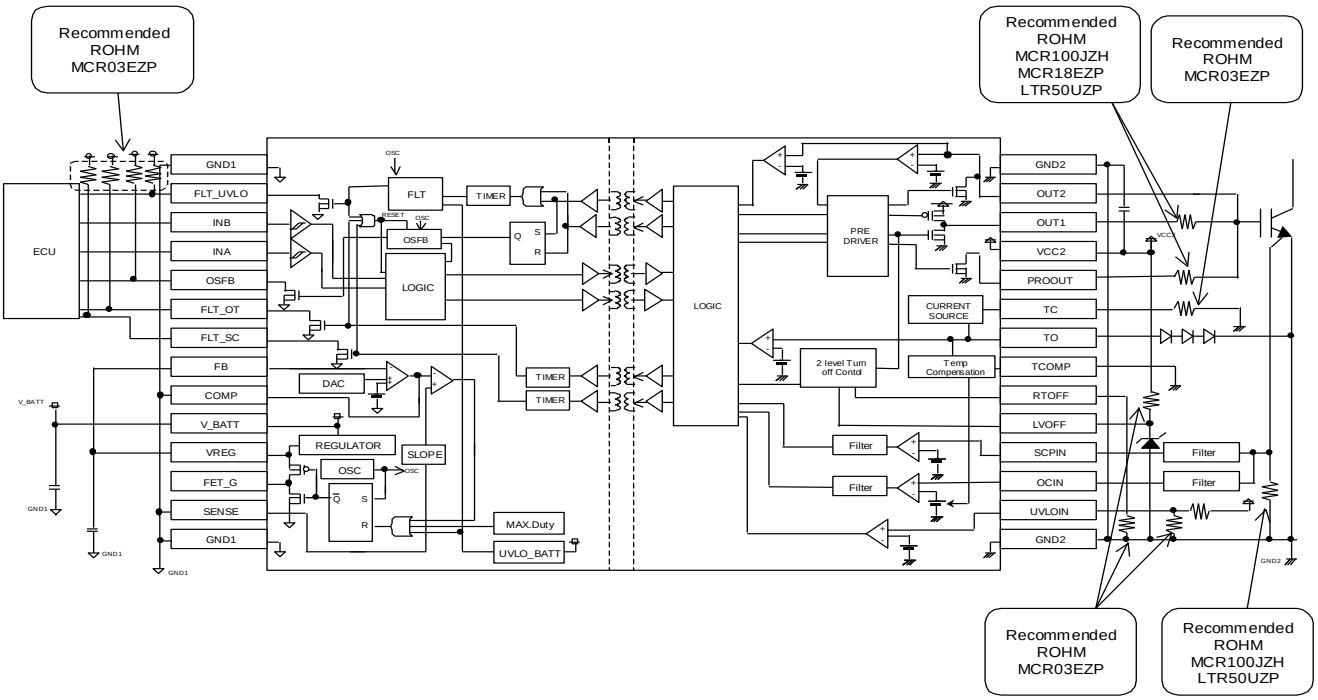
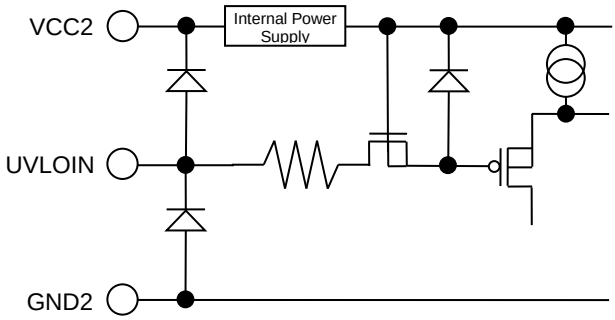
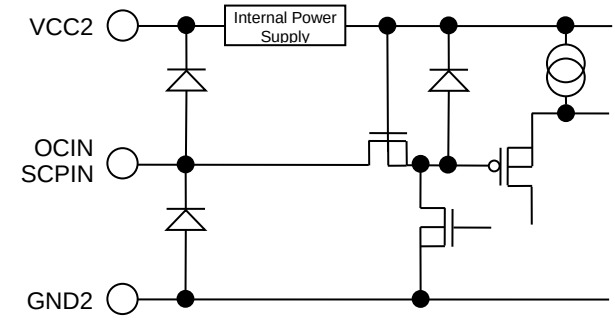
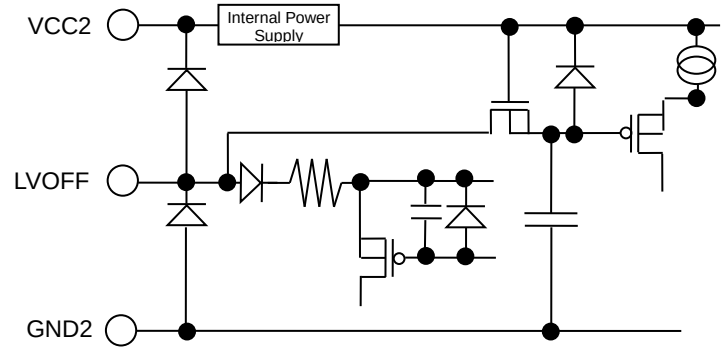
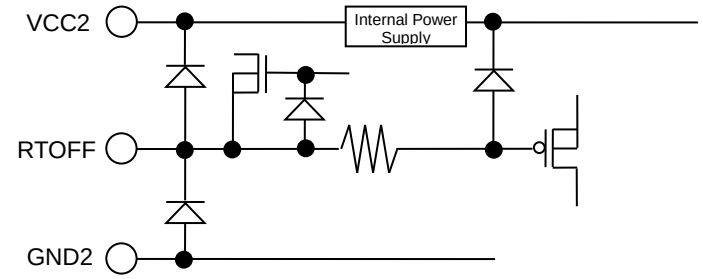
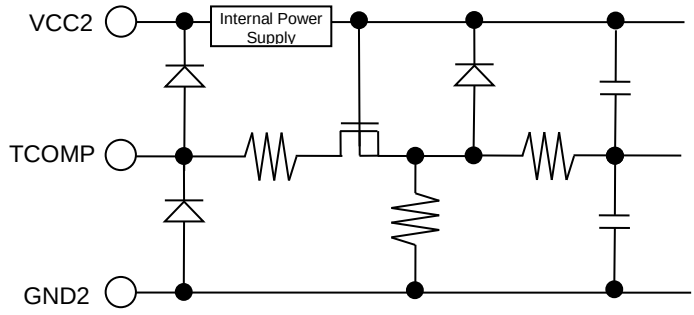
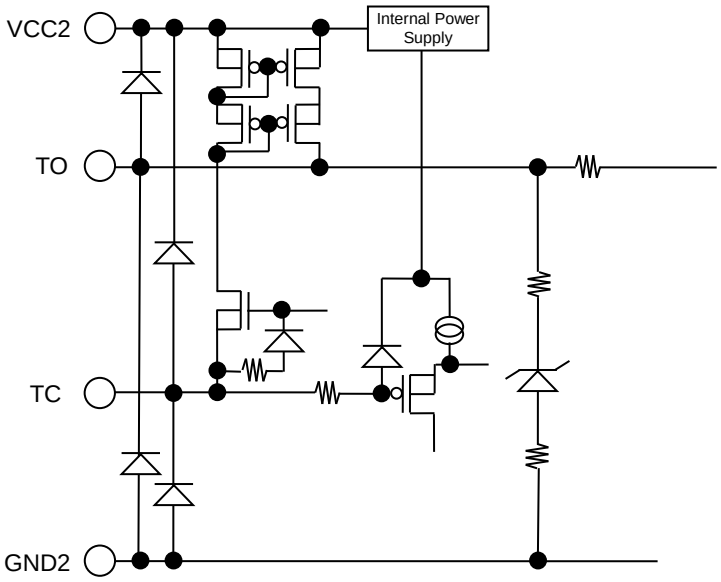
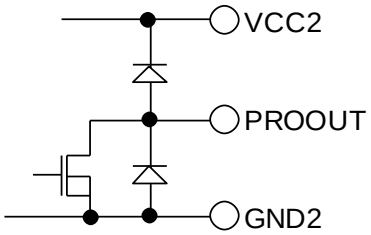
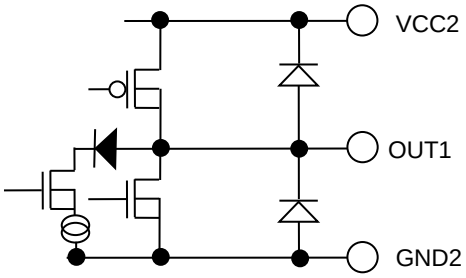
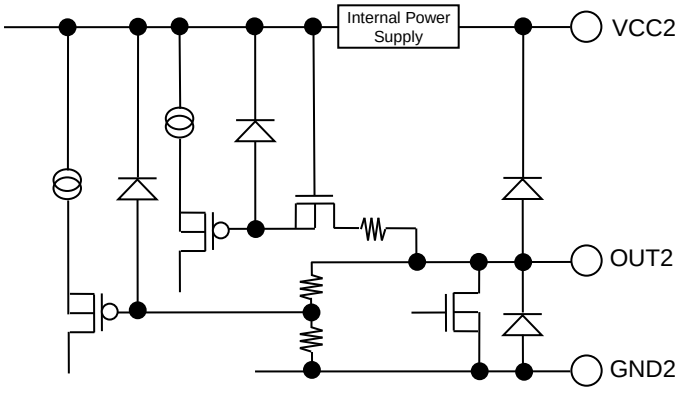


Figure 40. For non-using switching power supply controller

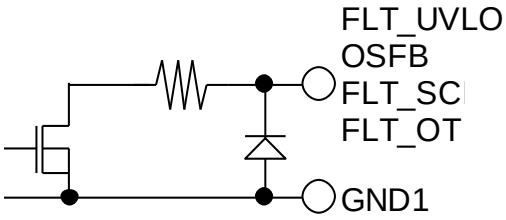
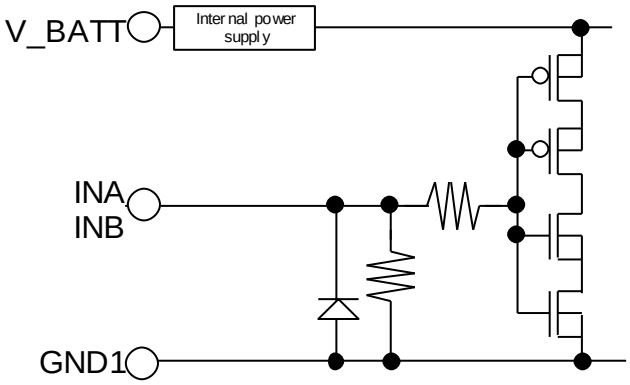
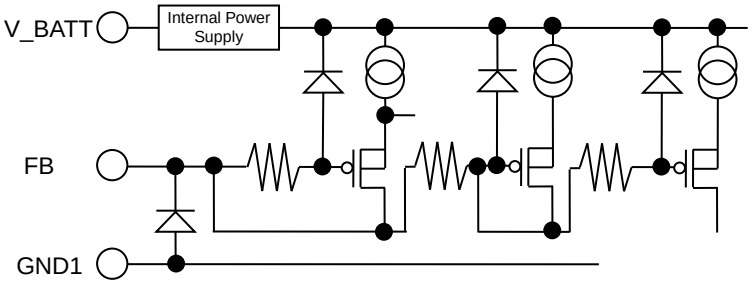
I/O Equivalent Circuit

Pin No.	Pin Name / Pin Function	Input Output Equivalent Circuit Diagram
2	UVLOIN Output-side UVLO setting pin	
3	OCIN Over current detection pin	
4	SCPIN Short circuit detection pin	
5	LVOFF 2-level turn off level setting pin	
6	RTOFF 2-level turn off time setting pin	
7	TCOMP Temperature compensation pin of OC	

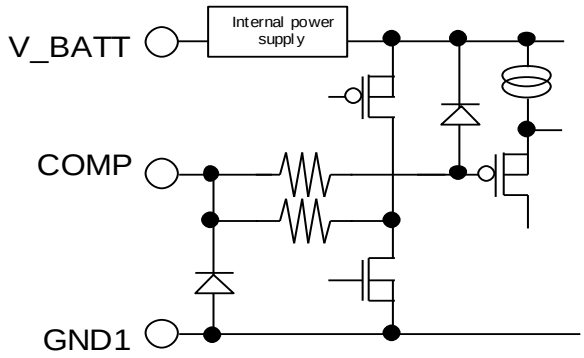
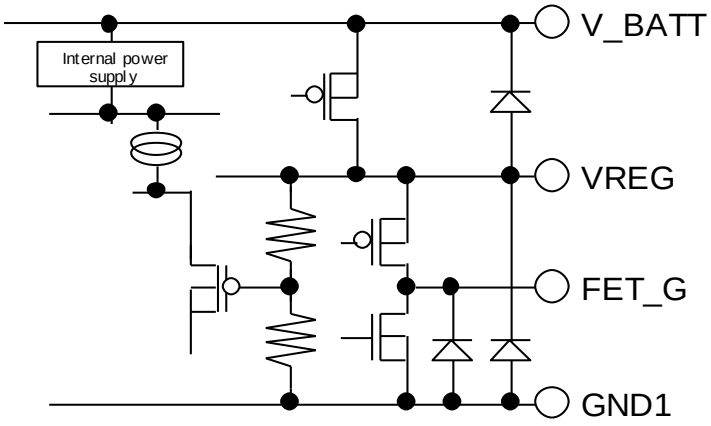
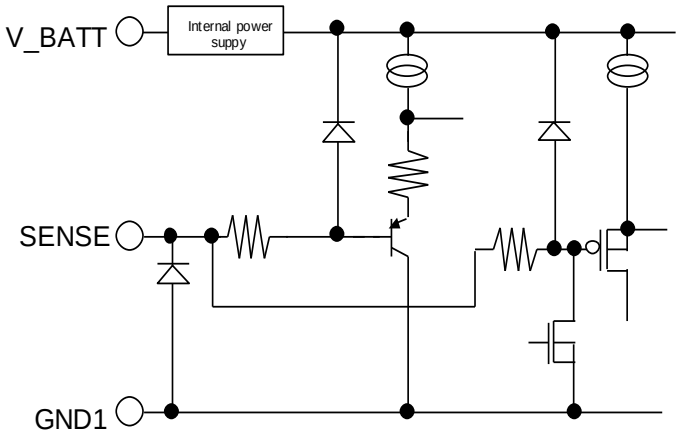
I/O Equivalent Circuit - continued

Pin No.	Pin Name / Pin Function	Input Output Equivalent Circuit Diagram
8	TO	
	Constant current output pin / Over temperature detection pin	
9	TC	
	Constant current setting resistor connection pin	
10	PROOUT	
	Soft turn-off pin	
12	OUT1	
	Output pin	
13	OUT2	
	Input and output pin for miller clamp / Gate voltage input pin	

I/O Equivalent Circuit - continued

Pin No.	Pin Name / Pin Function	Input Output Equivalent Circuit Diagram
16	FLT_UVLO Fault (UVLO) output pin	
19	OSFB Output state feedback output pin	
20	FLT_OT Fault (OT) output pin	
21	FLT_SC Fault (SCP) output pin	
17	INB Control input pin B	
18	INA Control input pin A	
22	FB Error amplifier inverting input pin for switching controller	

I/O Equivalent Circuit - continued

Pin No.	Pin Name / Pin Function	Input Output Equivalent Circuit Diagram
23	COMP Error amplifier output pin for switching controller	
25	VREG Power supply pin for driving MOS FET for switching controller	
26	FET_G MOS FET control pin for switching controller	
27	SENSE Current feedback resistor connection pin for switching controller	

Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6. **Recommended Operating Conditions**
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. **Inter-pin Short and Mounting Errors**
    Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

Operational Notes – continued

11. Unused Input Pins

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

12. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

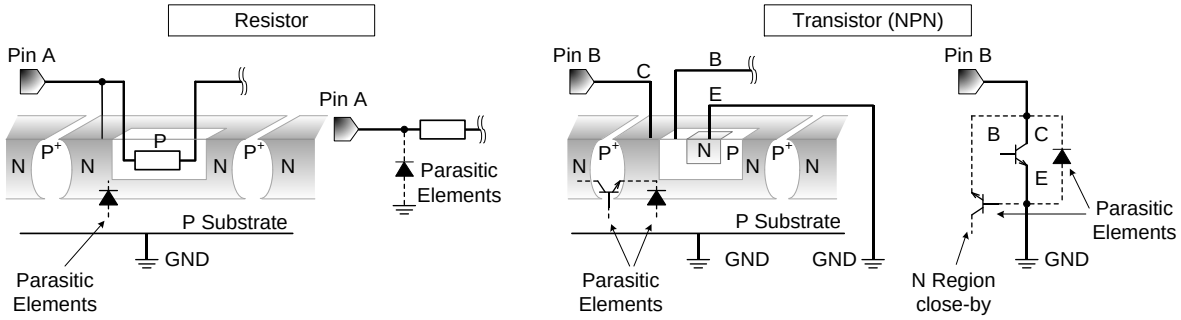


Figure 41. Example of monolithic IC structure

13. Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

Ordering Information

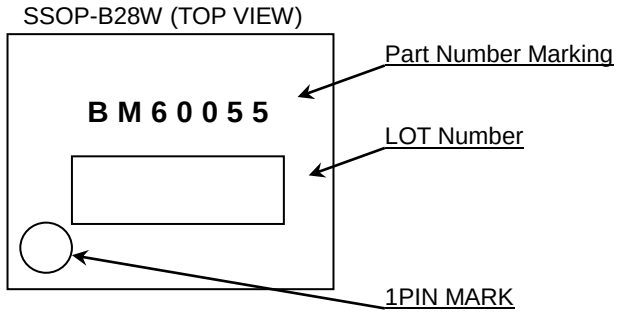
B M 6 0 0 5 5 F V	-	C E 2

Part Number

Package
FV : SSOP-B28W

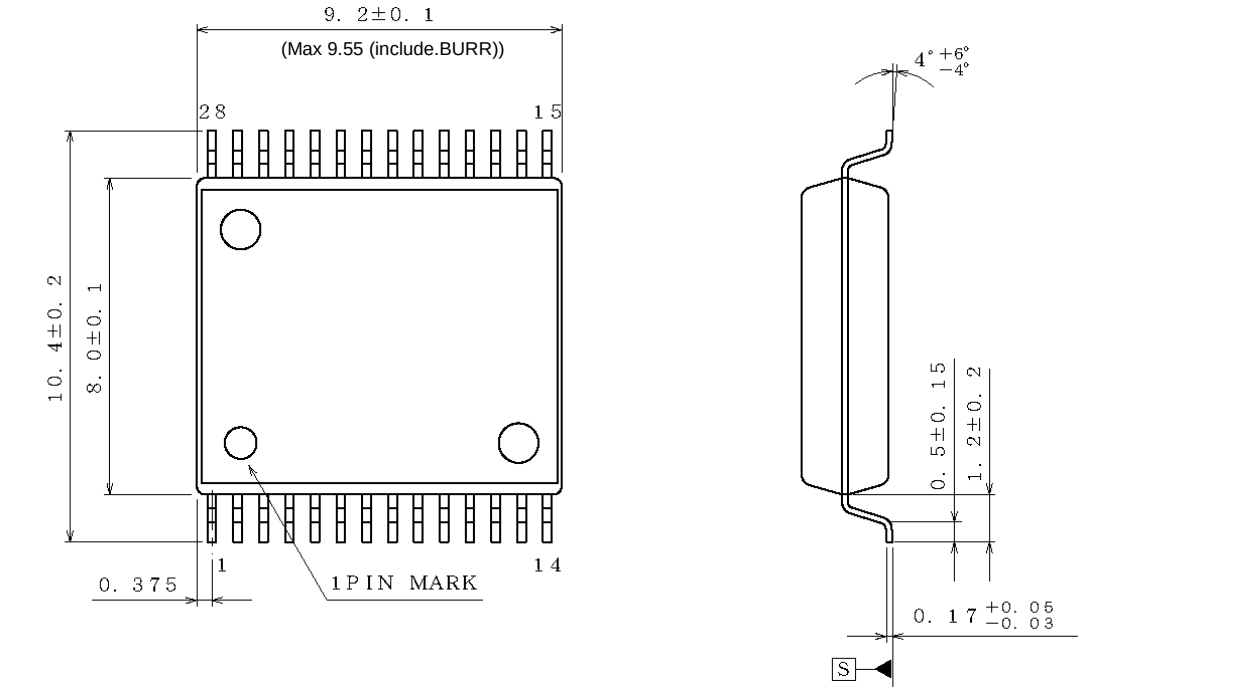
Product class
C : for Automotive applications
Packaging and forming specification
E2 : Embossed tape and reel
(SSOP-B28W)

Marking Diagrams



Physical Dimension, Tape and Reel Information

Package Name	SSOP-B28W

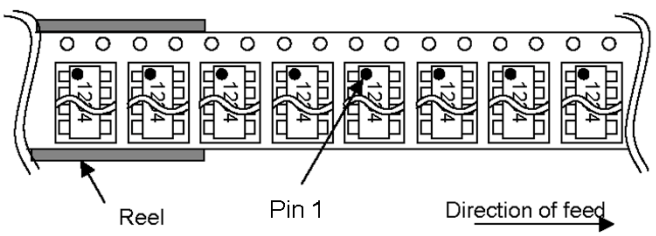


PKG : SSOP−B28W
Drawing No. ; EX072−5001

(UNIT : mm)

< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	1500pcs
Direction of feed	E2 The direction is the pin 1 of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand



Revision History

Date	Revision	Changes
15.Feb.2016	001	New Release
06.Jun.2016	002	Modify typo (p.1-9,11-12,14-24,27) Clarified the description and context (p.25-26, 29-32)
03.Apr.2018	003	p. 9 Adding UL1577 Ratings Table

Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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