Gate Driver Providing Galvanic isolation Series

Isolation voltage 2500Vrms
1ch Gate Driver Providing Galvanic Isolation

BM6104FV-C

General Description

The BM6104FV-C is a gate driver with isolation voltage 2500Vrms, I/O delay time of 150ns, and minimum input pulse width of 90ns, and incorporates the fault signal output functions, undervoltage lockout (UVLO) function, and short current protection (SCP, DESAT) function.

Features

- Providing Galvanic Isolation
- Active Miller Clamping
- Fault Signal Output Function (Adjustable Output Holding Time)
- Undervoltage Lockout Function
- Short Current Protection Function (Adjustable Reset Time)
- Soft Turn-Off Function For Short Current Protection (Adjustable Turn-Off Time)
- Supporting Negative VEE2
- Output State Feedback Function
- UL1577 Recognized:File No. E356010
- AEC-Q100 Qualified(Note 1)
  (Note 1:Grade1)

Key Specifications

- Isolation Voltage: 2500Vrms
- Maximum Gate Drive Voltage: 24V
- I/O Delay Time: 150ns(Max)
- Minimum Input Pulse Width: 90ns(Max)

Package

	W(Typ) x D(Typ) x H(Max)
SSOP-B20W	6.50mm x 8.10mm x 2.01mm

Applications

- IGBT Gate Driver
- MOSFET Gate Driver

Typical Application Circuits

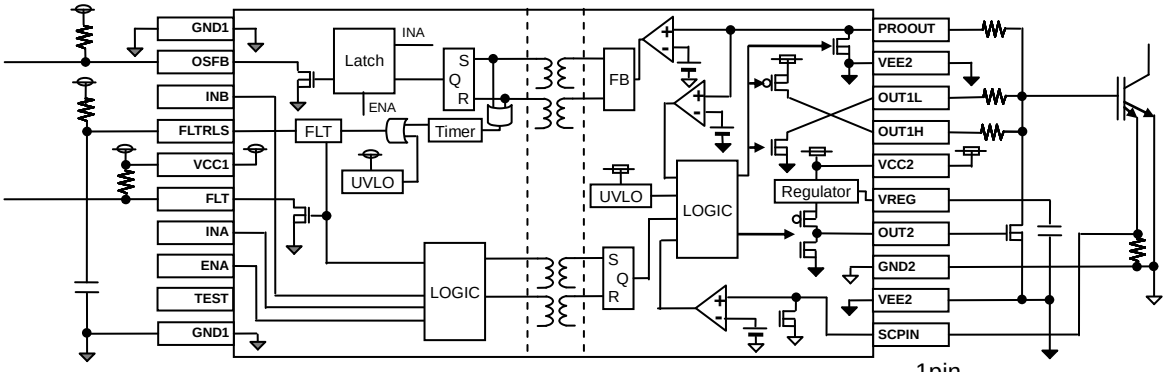


Figure 1. For using 4-pin IGBT (for using SCP function)

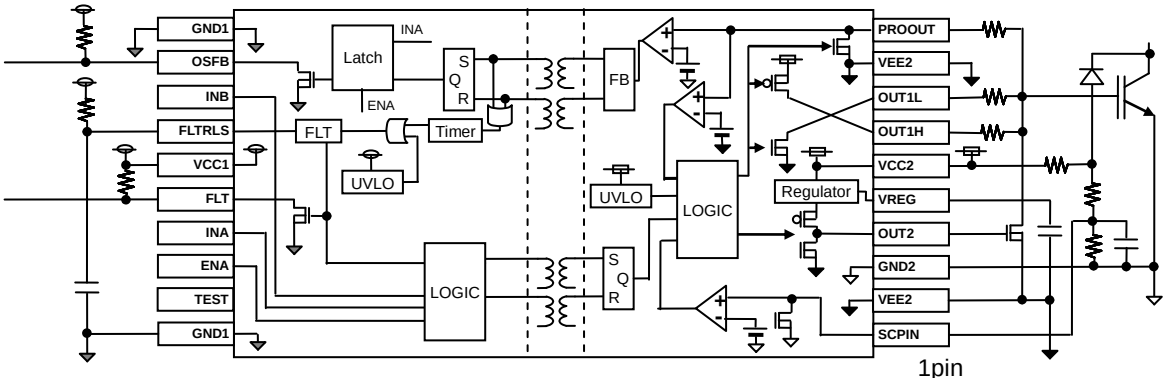


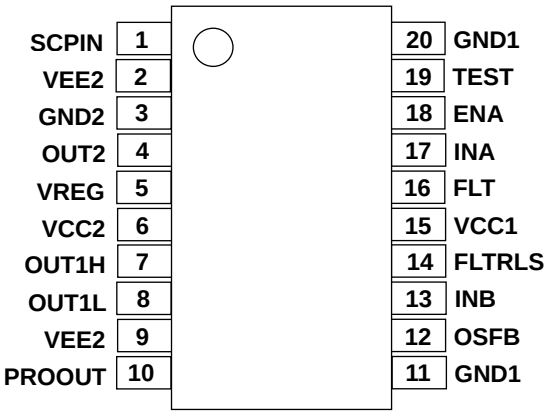
Figure 2. For using 3-pin IGBT (for using DESAT function)

Recommended Range Of External Constants

Pin Name	Symbol	Recommended Value			Unit
		Min	Typ	Max	
FLTRLS	C_{FLTRLS}	-	0.01	0.47	µF
	R_{FLTRLS}	50	200	1000	kΩ
VREG	C_{VREG}	1.0	3.3	10.0	µF
VCC1	C_{VCC1}	0.1	1.0	-	µF
VCC2	C_{VCC2}	0.33	-	-	µF

Pin Configurations

(TOP VIEW)



Pin Descriptions

Pin No.	Pin Name	Function
1	SCPIN	Short current detection pin
2	VEE2	Output-side negative power supply pin
3	GND2	Output-side ground pin
4	OUT2	MOSFET control pin for Miller Clamp
5	VREG	Power supply pin for driving MOSFET for Miller Clamp
6	VCC2	Output-side positive power supply pin
7	OUT1H	Source side output pin
8	OUT1L	Sink side output pin
9	VEE2	Output-side negative power supply pin
10	PROOUT	Soft turn-off pin
11	GND1	Input-side ground pin
12	OSFB	Output state feedback output pin
13	INB	Control input pin B
14	FLTRLS	Fault output holding time setting pin
15	VCC1	Input-side power supply pin
16	FLT	Fault output pin
17	INA	Control input pin A
18	ENA	Input enabling signal input pin
19	TEST	Mode setting pin
20	GND1	Input-side ground pin

Description of pins and cautions on layout of board

1) VCC1 (Input-side power supply pin)
The VCC1 pin is a power supply pin on the input side. To suppress voltage fluctuations due to the current to drive internal transformers, connect a bypass capacitor between the VCC1 and the GND1 pins.

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

3) VCC2 (Output-side positive power supply pin)
The VCC2 pin is a positive power supply pin on the output side. To reduce voltage fluctuations due to OUT1H/L pin output current and due to the current to drive internal transformers, connect a bypass capacitor between the VCC2 and the GND2 pins.

4) VEE2 (Output-side negative power supply pin)
The VEE2 pin is a power supply pin on the output side. To suppress voltage fluctuations due to OUT1H/L pin output current and due to the current to drive internal transformers, connect a bypass capacitor between the VEE2 and the GND2 pins. To use no negative power supply, connect the VEE2 pin to the GND2 pin.

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

6) IN (Control input terminal)
The IN is a pin used to determine output logic.

ENA	INB	INA	OUT1H	OUT1L
H	X	X	Hi-Z	L
L	H	L	Hi-Z	L
L	H	H	Hi-Z	L
L	L	L	Hi-Z	L
L	L	H	H	Hi-Z

7) FLT (Fault output pin)
The FLT pin is an open drain pin used to output a fault signal when a fault occurs (i.e., when the undervoltage lockout function (UVLO) or short current protection function (SCP) is activated).

Pin	FLT
While in normal operation	Hi-Z
When an Fault occurs (When UVLO or SCP is activated)	L

8) FLTRLS (Fault output holding time setting pin)
The FLTRLS is a pin used to make setting of time to hold a Fault signal. Connect a capacitor between the FLTRLS pin and the GND1 pin, and a resistor between it and the VCC1 pin.
The Fault signal is held until the FLTRLS pin voltage exceeds a voltage set with the V_{FLTRLS} parameter. To set holding time to 0 ms, do not connect the capacitor. Short-circuiting the FLTRLS pin to the VCC1 pin will cause a high current to flow in the FLTRLS pin and, in an open state, may cause the IC to malfunction. To avoid such trouble, be sure to connect a resistor between the FLTRLS and the VCC1 pins.

9) OUT1H, OUT1L (Output pin)
The OUT1H pin is a source side pin used to drive the gate of a power device, and the OUT1L pin is a sink side pin used to drive the gate of a power device.

10) OUT2 (MOSFET control pin for Miller Clamp)
The OUT2 is a pin for controlling the external MOS switch to prevent the increase in gate voltage due to the miller current of the power device connected to OUT1H/L pin.

11) VREG (Power supply pin for driving the MOSFET for Miller Clamp)
The VREG pin is a power supply pin for Miller Clamp (typ 10V). Be sure to connect a capacitor between VREG pin and VEE2 pin to prevent oscillation and to reduce voltage fluctuations due to OUT2 pin output current.

12) PROOUT (Soft turn-off pin)
The PROOUT is a pin used to put the soft turn-off function of a power device in operation when the SCP function is activated. This pin combines with the gate voltage monitoring pin for Miller Clamp function and OSFB function which output the gate state.

13) SCPIN (Short current detection pin)
The SCPIN is a pin used to detect current for short current protection. When the SCPIN pin voltage exceeds V_{SCDET} (typ 0.7V), the SCP function will be activated. This may cause the IC to malfunction in an open state. To avoid such trouble, short-circuit the SCPIN pin to the GND2 pin if the short current protection is not used. In order to prevent the wrong detection due to noise, the noise mask time t_{SCPMSK} (typ 0.8µs) is set.

14) OSFB (Output state feedback output pin)

The OSFB pin is an open drain pin used to output the gate state. If the IN and the OUT1H/L pin are at the same level, the OSFB pin output the “Hi-Z” level, otherwise the OSFB pin output the “L” level and hold “L” until ENA=H or UVLO on low voltage side is activated.

15) TEST(Mode setting pin)

The TEST pin is an operation mode setting pin. This pin is usually connected to GND1 pin. If the TEST pin is connected to the VCC1 pin, Input-side UVLO function is disabled.

Description of functions and examples of constant setting

1) Miller Clamp function

When OUT1H/L=Hi-Z/L and PROOUT pin voltage < V_{OUT2ON} (typ 2V), H is output from OUT2 pin and the external MOS switch is turned ON. When OUT1H/L=H/Hi-Z, L is output from OUT2 pin and the external MOS switch is turned OFF. While the short-circuit protection function is activated, L is output from OUT2 pin and the external MOS switch is turned OFF.

Short current	SCPIN	IN	PROOUT	OUT2
Detected	Not less than V_{SCDET}	X	X	L
Not detected	X	L	Not less than V_{OUT2ON}	L
	X	L	less than V_{OUT2ON}	H
	X	H	X	L

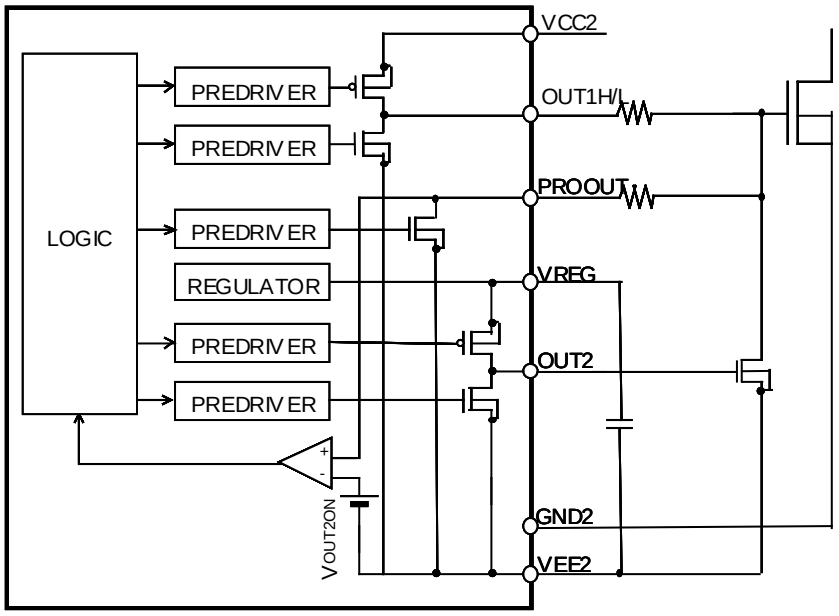


Figure 3. Block diagram of Miller Clamp function.

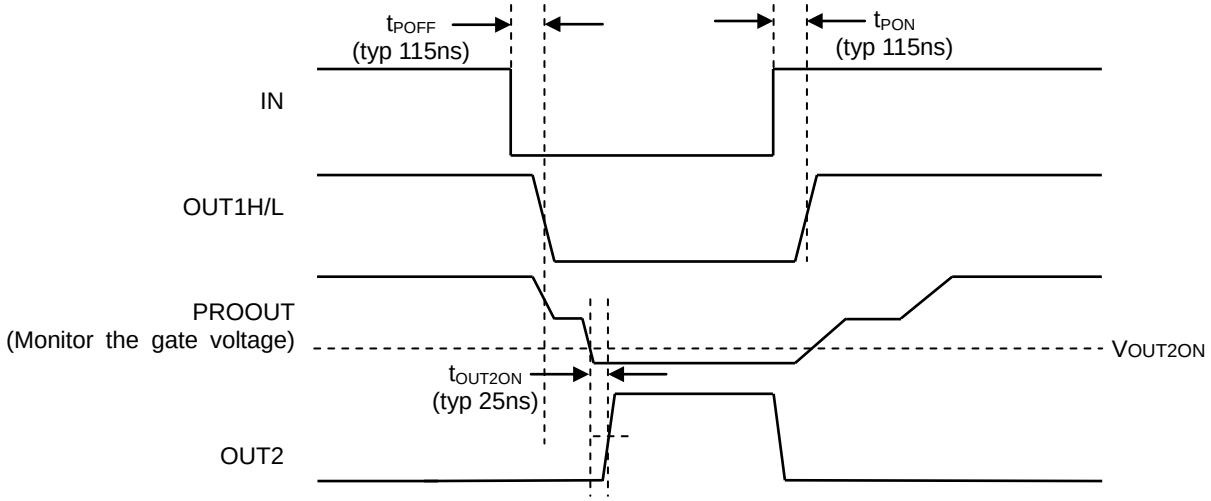


Figure 4. Timing chart of Miller Clamp function

2) Fault status output

This function is used to output a fault signal from the FLT pin when a fault occurs (i.e., when the undervoltage lockout function (UVLO) or short current protection function (SCP) is activated) and hold the Fault signal until the set Fault output holding time is completed. The Fault output holding time t_{FLTRLS} is given as the following equation with the settings of capacitor C_{FLTRLS} and resistor R_{FLTRLS} connected to the FLTRLS pin. For example, when C_{FLTRLS} is set to 0.01μF and R_{FLTRLS} is set to 200kΩ, the holding time will be set to 2 ms.

t_{FLTRLS} [ms]= C_{FLTRLS} [µF]•R_{FLTRLS} [kΩ]

To set the fault output holding time to “0” ms, only connect the resistor R_{FLTRLS}.

Status	FLT pin
Normal	Hi-Z
Fault occurs	L

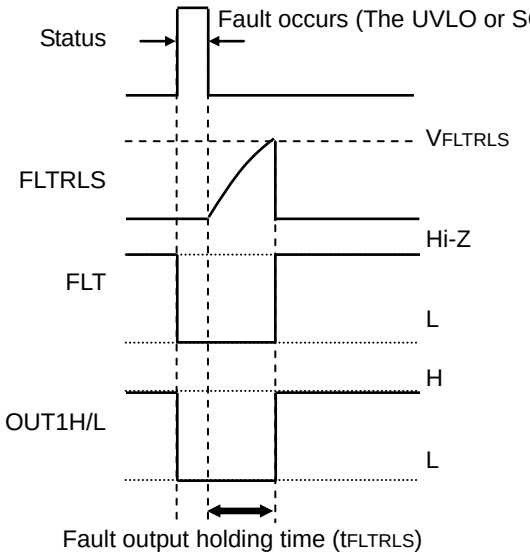


Figure 5. Fault Status Output Timing Chart

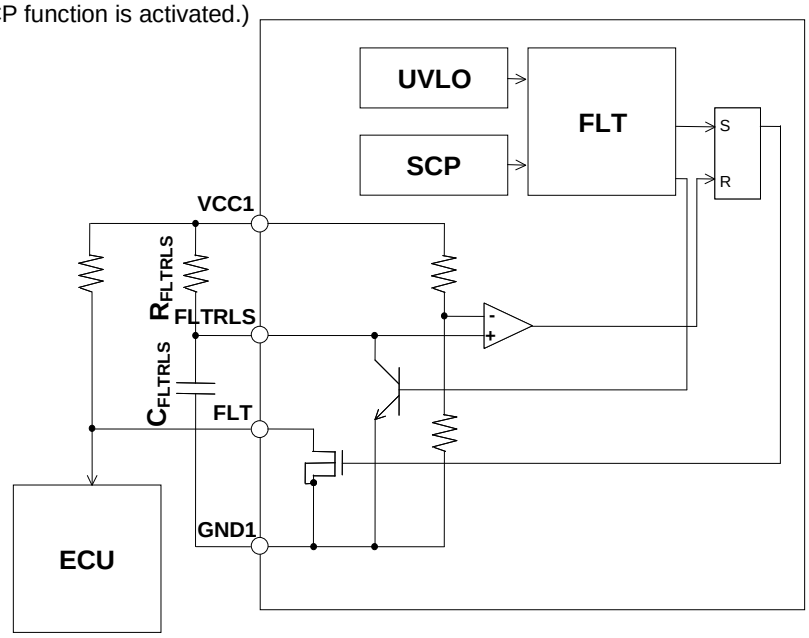


Figure 6. Fault Output Block Diagram

3) Undervoltage Lockout (UVLO) function

The BM6104FV-C incorporates the undervoltage lockout (UVLO) function both on the low and the high voltage sides. When the power supply voltage drops to the UVLO ON voltage (low voltage side typ 3.4V, high voltage side typ 9.05V), the OUT1 and the FLT pin both will output the “L” signal. When the power supply voltage rises to the UVLO OFF voltage (low voltage side typ 3.5V, high voltage side typ 9.55V), these pins will be reset. However, during the fault output holding time set in “2) Fault status output” section, the OUT1 pin and the FLT pin will hold the “L” signal. In addition, to prevent malfunctions due to noises, mask time $t_{UVLO1MSK}$ (typ 10µs) and $t_{UVLO2MSK}$ (typ 10µs) are set on both low and high voltage sides.

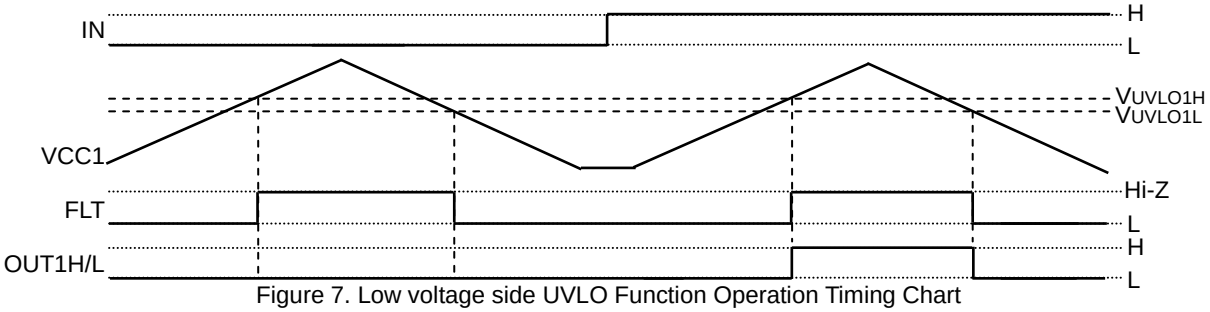


Figure 7. Low voltage side UVLO Function Operation Timing Chart

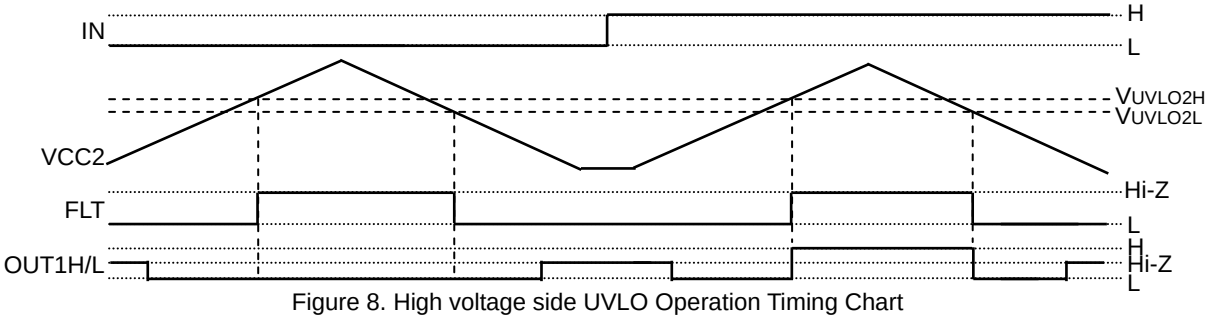


Figure 8. High voltage side UVLO Operation Timing Chart

4) Short current protection function (SCP, DESAT)

When the SCPIN pin voltage exceeds V_{SCDET} (typ 0.7V), the SCP function will be activated. When the SCP function is activated, the OUT1H/L pin voltage will be set to the “Hi-Z/HiZ” level first, and then the PROOUT pin voltage to the “L” level (soft turn-off).Next, after t_{STO} (min 30µs, max 110µs) has passed after the short-circuit current falls below the threshold value, OUT1H/L pin becomes HiZ/L and PROOUT pin becomes L. Finally, when the fault output holding time set in “2) fault status output” section on page 5 is completed, the SCP function will be released.

$V_{COLLECTOR}/V_{DRAIN}$ which Desaturation Protection starts operation (V_{DESAT}) and the blanking time (t_{BLANK}) can be calculated by the formula below;

$$V_{DESAT}[V] = V_{SCDET} \bullet \frac{R3+R2}{R3} - V_{F_{D1}}$$

$$V_{CC2_{MIN}}[V] > V_{SCDET} \bullet \frac{R3+R2+R1}{R3}$$

$$t_{BLANKoutemal}[s] = -\frac{R2+R1}{R3+R2+R1} \bullet R3 \bullet (C_{BLANK} + 24 \bullet 10^{-12}) \bullet \ln(1 - \frac{R3+R2+R1}{R3} \bullet \frac{V_{SCDET}}{V_{CC2}}) + 0.2 \bullet 10^{-6}$$

V_{DESAT}	Reference Value		
	R1	R2	R3
4.0V	15 kΩ	39 kΩ	6.8 kΩ
4.5V	15 kΩ	43 kΩ	6.8 kΩ
5.0V	15 kΩ	36 kΩ	5.1 kΩ
5.5V	15 kΩ	39 kΩ	5.1 kΩ
6.0V	15 kΩ	43 kΩ	5.1 kΩ
6.5V	15 kΩ	62 kΩ	6.8 kΩ
7.0V	15 kΩ	68 kΩ	6.8 kΩ
7.5V	15 kΩ	82 kΩ	7.5 kΩ
8.0V	15 kΩ	91 kΩ	8.2 kΩ
8.5V	15 kΩ	82 kΩ	6.8 kΩ
9.0V	15 kΩ	130 kΩ	10 kΩ
9.5V	15 kΩ	91 kΩ	6.8 kΩ
10.0V	15 kΩ	130 kΩ	9.1 kΩ

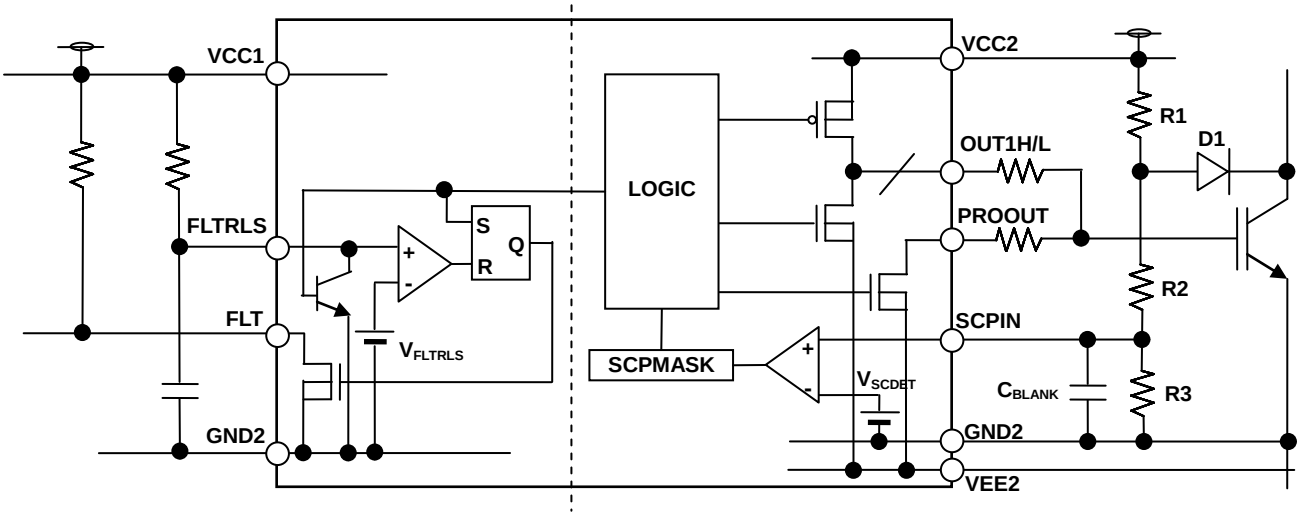


Figure 9. Block Diagram for DESAT

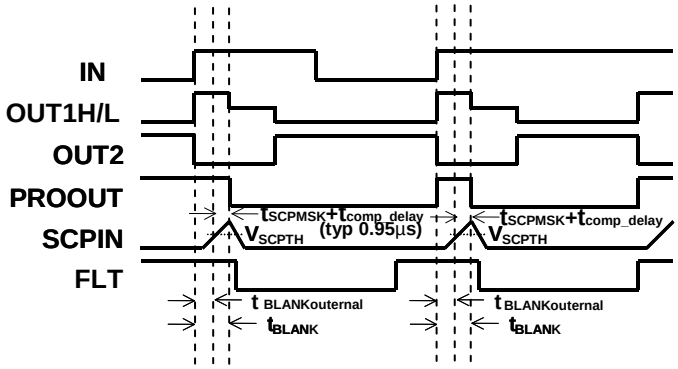
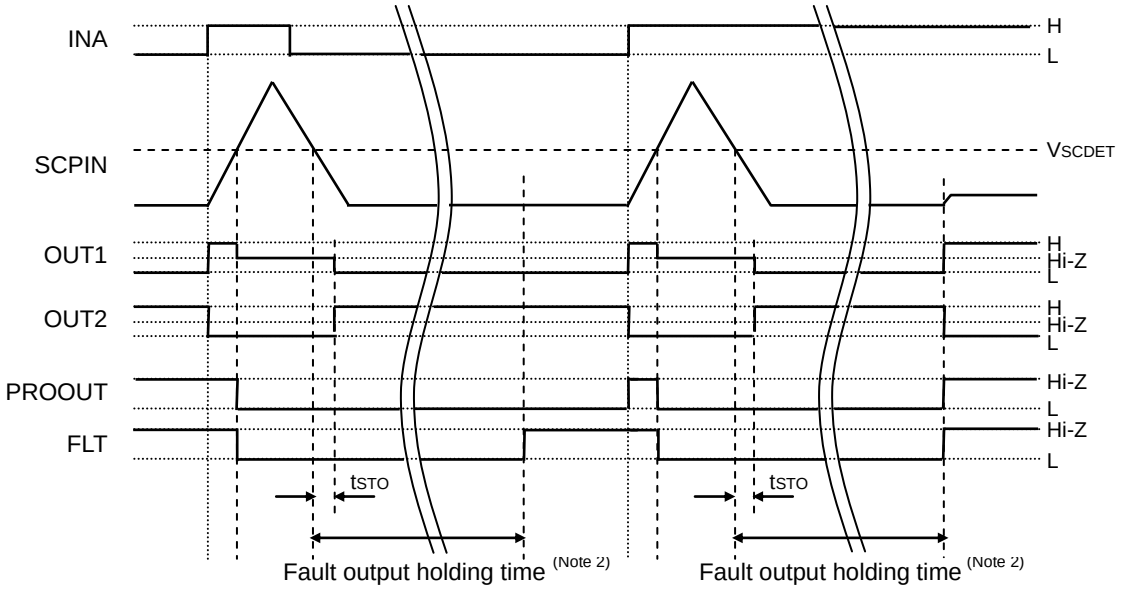


Figure 10. DESAT Operation Timing Chart



(Note 2): "2) Fault status output" section on page 5

Figure 11. SCP Operation Timing Chart

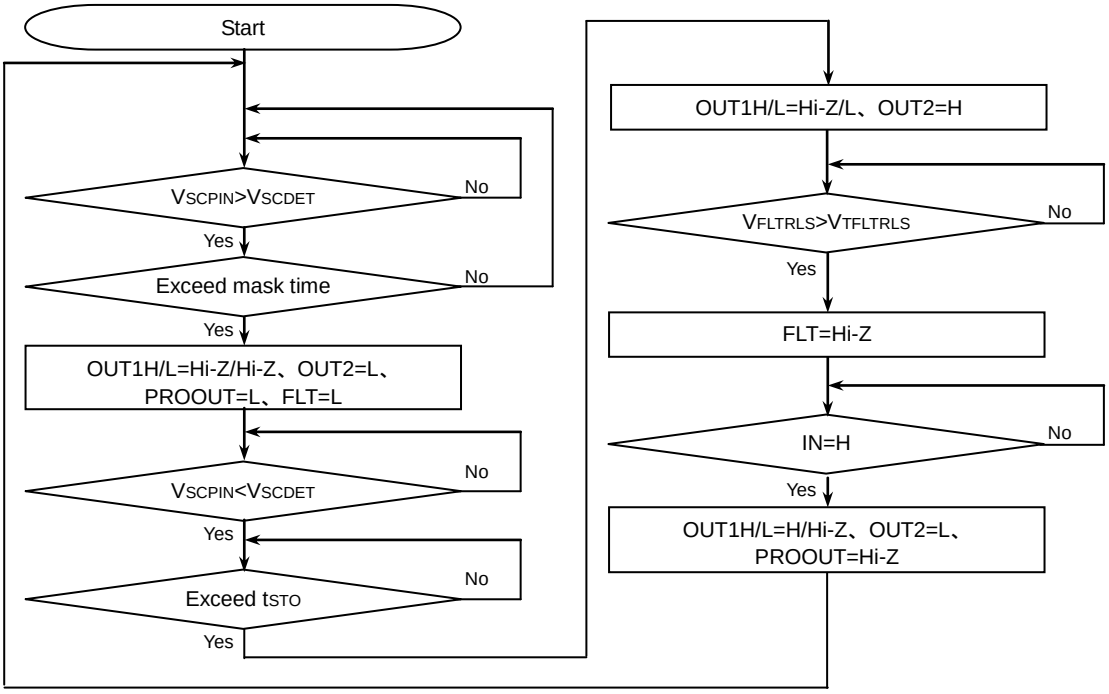


Figure 12. SCP Operation Status Transition Diagram

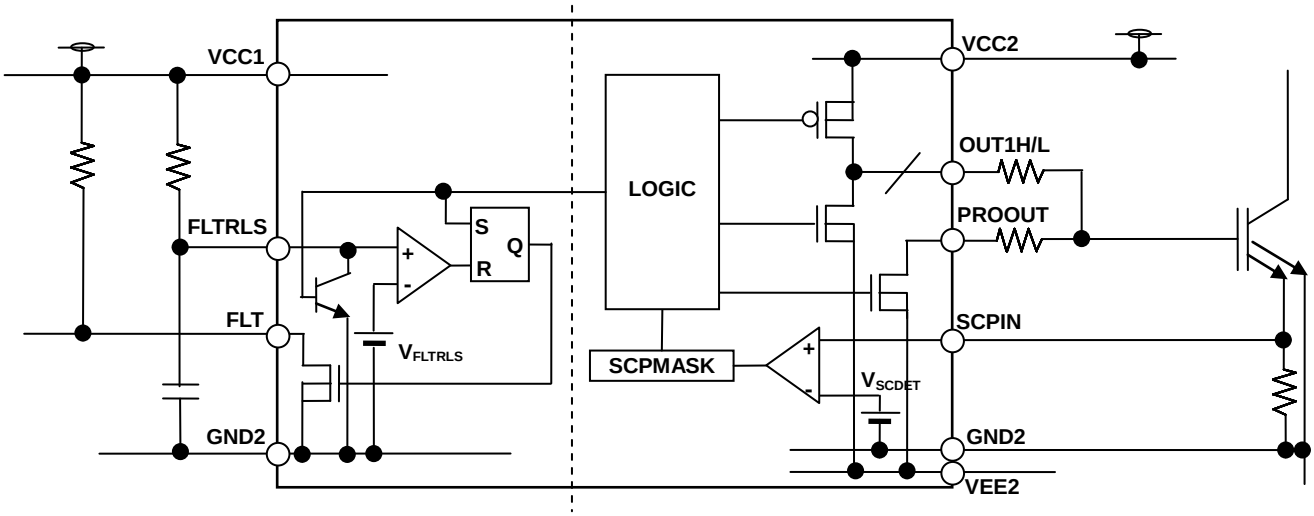


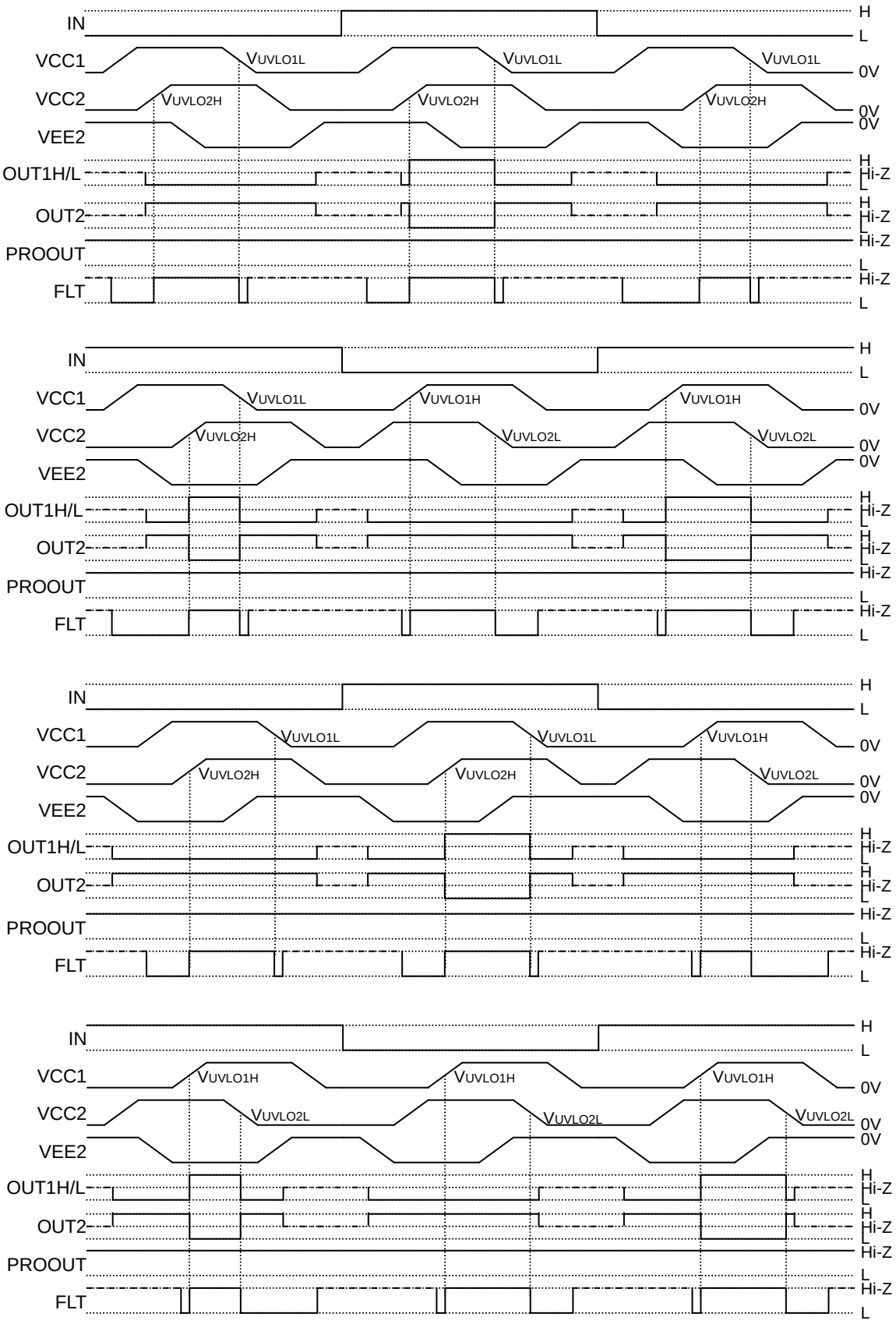
Figure 13. Block Diagram for SCP

5）I/O condition table

No.	Status	Input							Output					
		VCC1	VCC2	SCPIN	ENA	INB	INA	PROOUT	OUT1H	OUT1L	OUT2	PROOUT	FLT	OSFB
1	SCP	○	○	H	L	L	H	X	Hi-Z	Hi-Z	L	L	L	Hi-Z
2	VCC1UVLO	UVLO	X	L	X	X	X	H	Hi-Z	L	L	Hi-Z	L	Hi-Z
3		UVLO	X	L	X	X	X	L	Hi-Z	L	H	Hi-Z	L	Hi-Z
4	VCC2UVLO	X	UVLO	L	X	X	X	H	Hi-Z	L	L	Hi-Z	L	Hi-Z
5		X	UVLO	L	X	X	X	L	Hi-Z	L	H	Hi-Z	L	Hi-Z
6	Disable	○	○	L	H	X	X	H	Hi-Z	L	L	Hi-Z	Hi-Z	Hi-Z
7		○	○	L	H	X	X	L	Hi-Z	L	H	Hi-Z	Hi-Z	Hi-Z
8	INB Active	○	○	L	L	H	X	H	Hi-Z	L	L	Hi-Z	Hi-Z	L
9		○	○	L	L	H	X	L	Hi-Z	L	H	Hi-Z	Hi-Z	Hi-Z
10	Normal Operation L Input	○	○	L	L	L	L	H	Hi-Z	L	L	Hi-Z	Hi-Z	L
11		○	○	L	L	L	L	L	Hi-Z	L	H	Hi-Z	Hi-Z	Hi-Z
12	Normal Operation H Input	○	○	L	L	L	H	H	H	Hi-Z	L	Hi-Z	Hi-Z	Hi-Z
13		○	○	L	L	L	H	L	H	Hi-Z	L	Hi-Z	Hi-Z	L

○: VCC1 or VCC2 > UVLO, X:Don't care

6) Power supply startup / shutoff sequence



: Since the VCC2 to VEE2 pin voltage is low and the output MOS does not turn ON, the output pins become Hi-Z conditions.

: Since the VCC1 pin voltage is low and the FLT output MOS does not turn ON, the output pins become Hi-Z conditions.

Figure 14. Power supply startup / shutoff sequence

Absolute Maximum Ratings

Parameter	Symbol	Limits	Unit
Input-Side Supply Voltage	V_{CC1}	-0.3～+7.0(Note 3)	V
Output-Side Positive Supply Voltage	V_{CC2}	-0.3～+30.0(Note 4)	V
Output-Side Negative Supply Voltage	V_{EE2}	-15.0～+0.3(Note 4)	V
Maximum Difference Between Output-Side Positive and Negative Voltages	V_{MAX2}	36.0	V
INA, INB, ENA Pin Input Voltage	V_{IN}	-0.3～+VCC1+0.3 or 7.0(Note 3)	V
OSFB, FLT Pin Input Voltage	V_{FLT}	-0.3～+VCC1+0.3 or 7.0(Note 3)	V
FLTRLS Pin Input Voltage	V_{FLTRLS}	-0.3～+VCC1+0.3 or 7.0(Note 3)	V
SCPIN Pin Input Voltage	V_{SCPIN}	-0.3~VCC2+0.3(Note 4)	V
VREG Pin Output Current	I_{VREG}	10	mA
OUT1H, OUT1L, PROOUT Pin Output Current (Peak 10μs)	$I_{OUT1PEAK}$	5.0(Note 5)	A
OUT2 Pin Output Current (Peak 10μs)	$I_{OUT2PEAK}$	1.0(Note 5)	A
OSFB Output Current	I_{OSFB}	10	mA
FLT Output Current	I_{FLT}	10	mA
Power Dissipation	P_d	1.19(Note 6)	W
Operating Temperature Range	T_{opr}	-40～+125	°C
Storage Temperature Range	T_{stg}	-55～+150	°C
Junction Temperature	T_{jmax}	+150	°C

(Note 3) Relative to GND1.
(Note 4) Relative to GND2.
(Note 5) Should not exceed Pd and Tj=150°C.
(Note 6) Derate above Ta=25°C at a rate of 9.5mW/°C. Mounted on a glass epoxy of 70 mm × 70 mm × 1.6 mm.
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.

Recommended Operating Ratings

Parameter	Symbol	Min	Max	Units
Input-Side Supply Voltage(Note 7)	V_{CC1}	4.5	5.5	V
Output-Side Positive Supply Voltage(Note 8)	V_{CC2}	10	24	V
Output-Side Negative Supply Voltage(Note 8)	V_{EE2}	-12	0	V
Maximum Difference Between Output-Side Positive and Negative Voltages	V_{MAX2}	10	32	V

(Note 7) Relative to GND1.
(Note 8) Relative to GND2.

Insulation Related Characteristics

Parameter	Symbol	Characteristic	Units
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 T_a=-40°C~125°C, V_{CC1}=4.5V~5.5V, V_{CC2}=10V~24V, V_{EE2}=-12V~0V）

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
General						
Input Side Circuit Current 1	I_{CC11}	0.38	0.51	0.64	mA	OUT1=L
Input Side Circuit Current 2	I_{CC12}	0.38	0.51	0.64	mA	OUT1=H
Input Side Circuit Current 3	I_{CC13}	0.47	0.62	0.77	mA	INA=10kHz, Duty=50%
Input Side Circuit Current 4	I_{CC14}	0.54	0.72	0.90	mA	INA=20kHz, Duty=50%
Output Side Circuit Current 1	I_{CC21}	1.5	2.0	2.5	mA	VCC2=14V, OUT1=L
Output Side Circuit Current 2	I_{CC22}	1.3	1.8	2.3	mA	VCC2=14V, OUT1=H
Output Side Circuit Current 3	I_{CC23}	1.6	2.2	2.8	mA	VCC2=18V, OUT1=L
Output Side Circuit Current 4	I_{CC24}	1.3	1.9	2.5	mA	VCC2=18V, OUT1=H
Output Side Circuit Current 5	I_{CC25}	1.8	2.5	3.2	mA	VCC2=24V, OUT1=L
Output Side Circuit Current 6	I_{CC26}	1.5	2.1	2.7	mA	VCC2=24V, OUT1=H
Logic Block						
Logic High Level Input Voltage	V_{INH}	2.0	-	V_{CC1}	V	INA, INB, ENA
Logic Low Level Input Voltage	V_{INL}	0	-	0.8	V	INA, INB, ENA
Logic Pull-Down Resistance	R_{IND}	25	50	100	kΩ	INA, INB
Logic Pull-Up Resistance	R_{INU}	25	50	100	kΩ	ENA
Logic Input Mask Time	t_{INMSK}	-	-	90	ns	INA, INB
ENA Mask Time	t_{ENAMSK}	4	10	20	µs	ENA
Output						
OUT1H ON Resistance	R_{ONH}	0.7	1.8	4.0	Ω	I_{OUT1H}=40mA
OUT1L ON Resistance	R_{ONL}	0.4	0.9	2.0	Ω	I_{OUT1L}=40mA
OUT1 Maximum Current	I_{OUTMAX}	3.0	4.5	-	A	VCC2=18V Guaranteed by design
PROOUT ON Resistance	R_{ONPRO}	0.4	0.9	2.0	Ω	I_{PROOUT}=40mA
Turn ON Time	t_{PONA}	90	115	150	ns	INA=PWM, INB=L
	t_{PONB}	100	125	160	ns	INA=H, INB=PWM
Turn OFF Time	t_{POFFA}	90	115	150	ns	INA=PWM, INB=L
	t_{POFFB}	80	105	140	ns	INA=H, INB=PWM
Propagation Distortion	t_{PDISTA}	-25	0	20	ns	t_{POFFA} - t_{PONA}
	t_{PDISTB}	-45	-20	0	ns	t_{POFFB} - t_{PONB}
Rise Time	t_{RISE}	-	50	-	ns	10nF between OUT1-VEE2
Fall Time	t_{FALL}	-	50	-	ns	10nF between OUT1-VEE2
OUT2 ON Resistance (Source)	R_{ON2H}	2.0	4.5	9.0	Ω	I_{OUT2}=10mA
OUT2 ON Resistance (Sink)	R_{ON2L}	1.5	3.5	7.0	Ω	I_{OUT2}=10mA
OUT2 ON Threshold Voltage	V_{OUT2ON}	1.8	2	2.2	V	Relative to VEE2
OUT2 Output Delay Time	t_{OUT2ON}	-	25	50	ns	
VREG Output Voltage	V_{REG}	9	10	11	V	Relative to VEE2
Common Mode Transient Immunity	CM	100	-	-	kV/µs	Design assurance

Electrical Characteristics

（Unless otherwise specified Ta=-40°C~125°C, V_{CC1}=4.5V~5.5V, V_{CC2}=10V~24V, V_{EE2}=-12V~0V）

Protection functions						
VCC1 UVLO OFF Voltage	V_{UVLO1H}	3.35	3.50	3.65	V	
VCC1 UVLO ON Voltage	V_{UVLO1L}	3.25	3.40	3.55	V	
VCC1 UVLO Mask Time	$t_{UVLO1MSK}$	4	10	30	μs	
VCC2 UVLO OFF Voltage	V_{UVLO2H}	8.95	9.55	10.15	V	
VCC2 UVLO ON Voltage	V_{UVLO2L}	8.45	9.05	9.65	V	
VCC2 UVLO Mask Time	$t_{UVLO2MSK}$	4	10	30	μs	
SCPIN Input Voltage	V_{SCPIN}	-	0.1	0.22	V	I_{SCPIN}=1mA
SCP Threshold Voltage	V_{SCDET}	0.665	0.700	0.735	V	
SCP Detection Mask Time	t_{SCPMSK}	0.55	0.8	1.05	μs	
Soft Turn OFF Release Time	t_{STO}	30		110	μs	
OSFB Threshold Voltage H	V_{OSFBH}	4.5	5.0	5.5	V	Respective to GND2
OSFB Threshold Voltage L	V_{OSFBL}	4.0	4.5	5.0	V	Respective to GND2
OSFB Output Low Voltage	V_{OSFBOL}	-	0.18	0.40	V	I_{OSFB}=5mA
OSFB Filter Time	t_{OSFBON}	1.5	2.0	2.6	μs	
FLT Output Low Voltage	V_{FLTL}	-	0.18	0.40	V	I_{FLT}=5mA
FLTRLS Threshold	$V_{TFLTRLS}$	$0.64 \times V_{CC1}$ -0.1	$0.64 \times V_{CC1}$	$0.64 \times V_{CC1}$ +0.1	V	

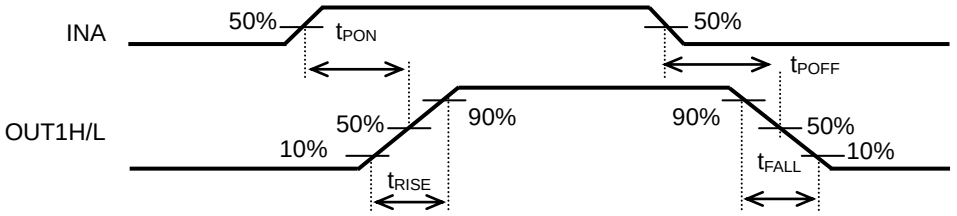


Figure 15. INA-OUT1 Timing Chart

Typical Performance Curves

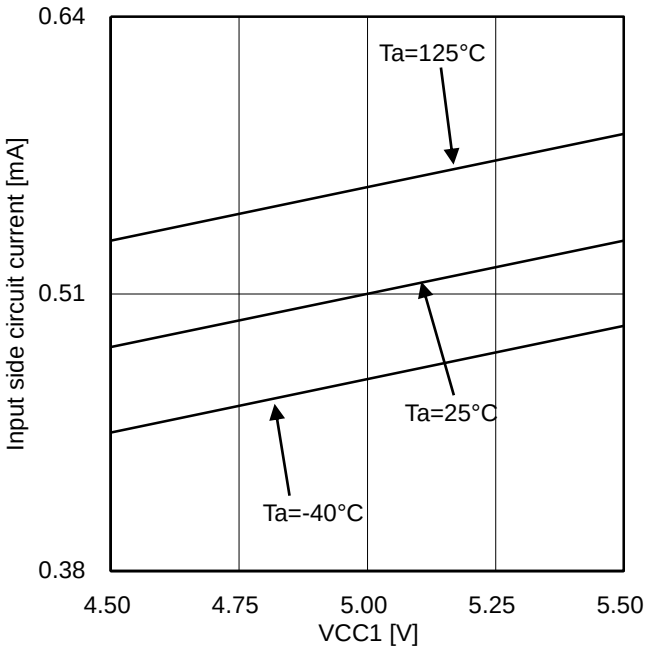


Figure 16. Input side circuit current vs. VCC1
(OUT1=L)

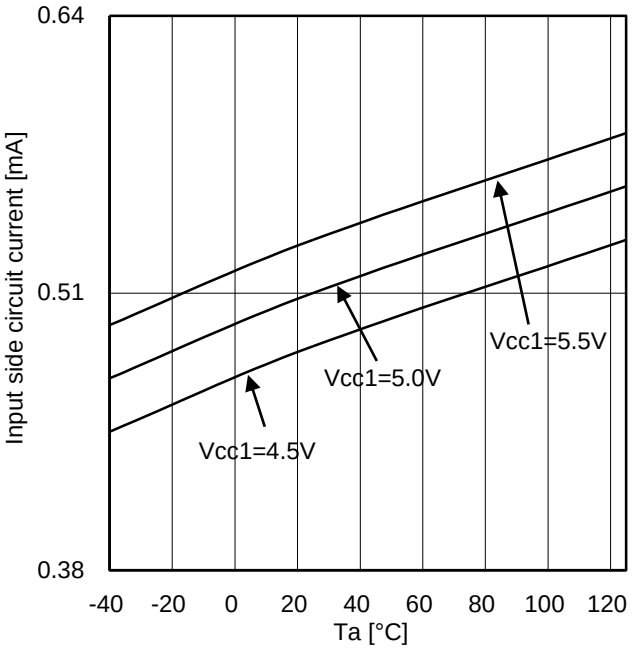


Figure 17. Input side circuit current vs. Temperature
(OUT1=L)

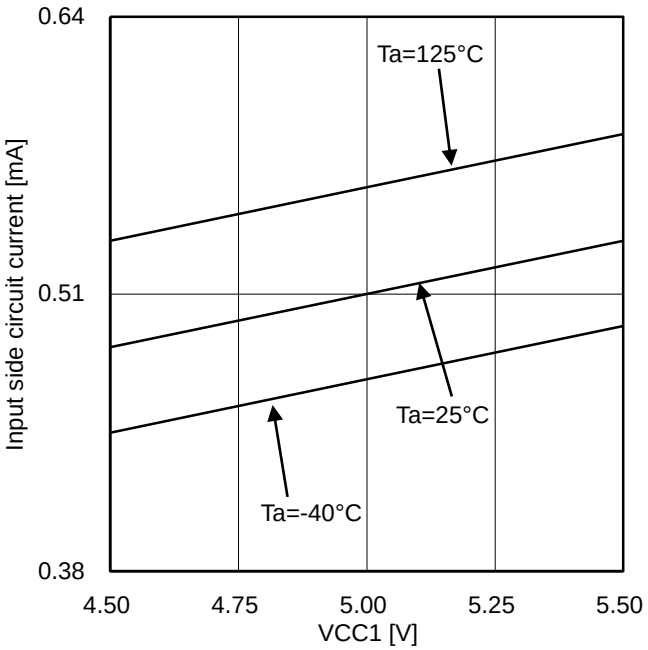


Figure 18. Input side circuit current vs. VCC1
(OUT1=H)

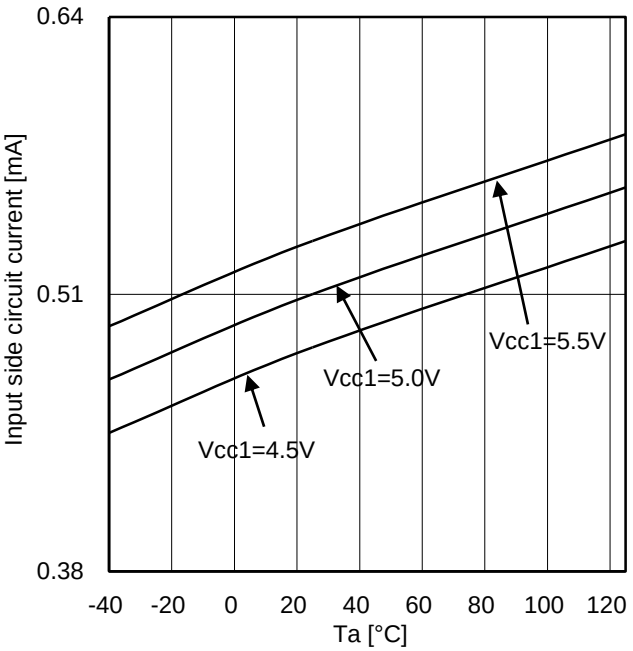


Figure 19. Input side circuit current vs. Temperature
(OUT1=H)

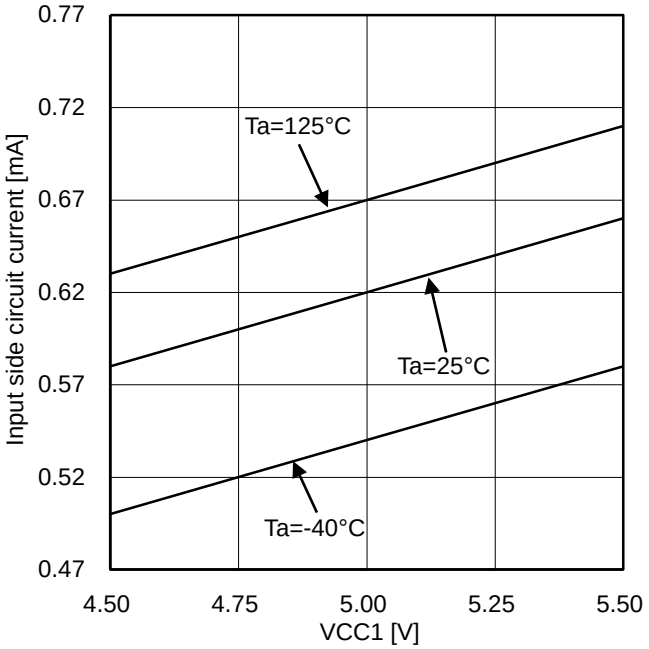


Figure 20. Input side circuit current vs. VCC1
(INA=10 kHz, Duty=50%)

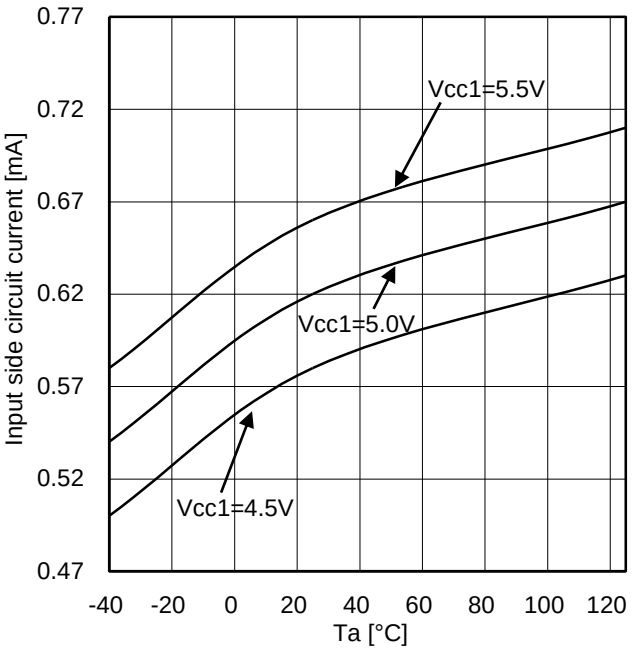


Figure 21. Input side circuit current vs. Temperature
(INA=10 kHz, Duty=50%)

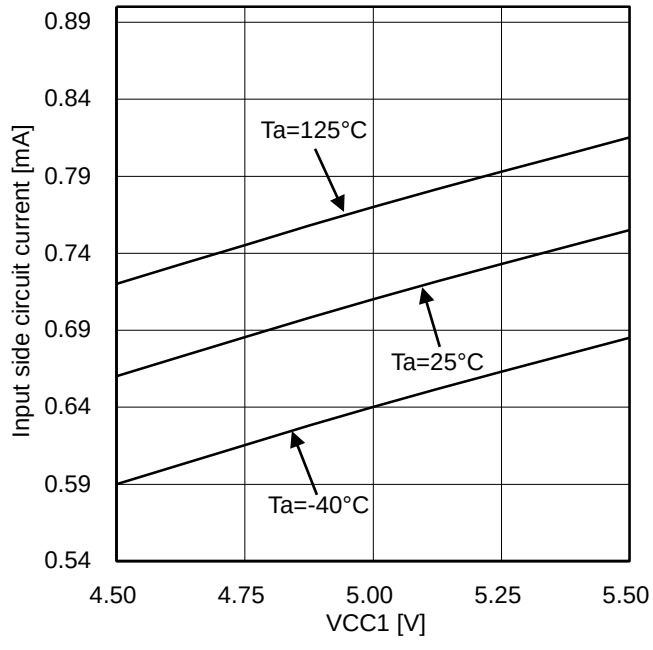


Figure 22. Input side circuit current vs. VCC1
(INA=20 kHz, Duty=50%)

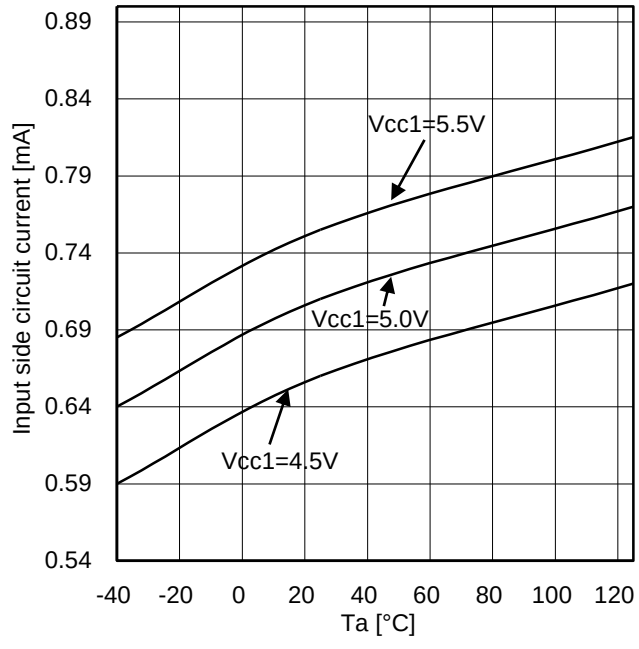


Figure 23. Input side circuit current vs. Temperature
(INA=20 kHz, Duty=50%)

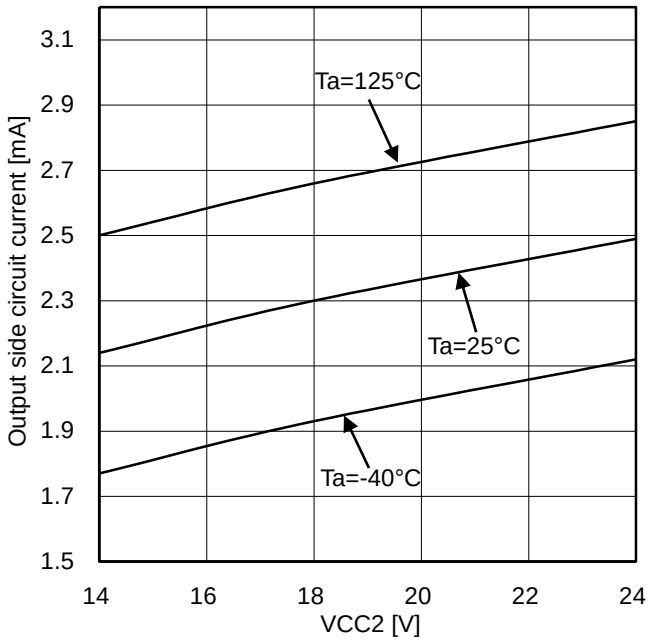


Figure 24. Output side circuit current vs. VCC2 (OUT1=L)

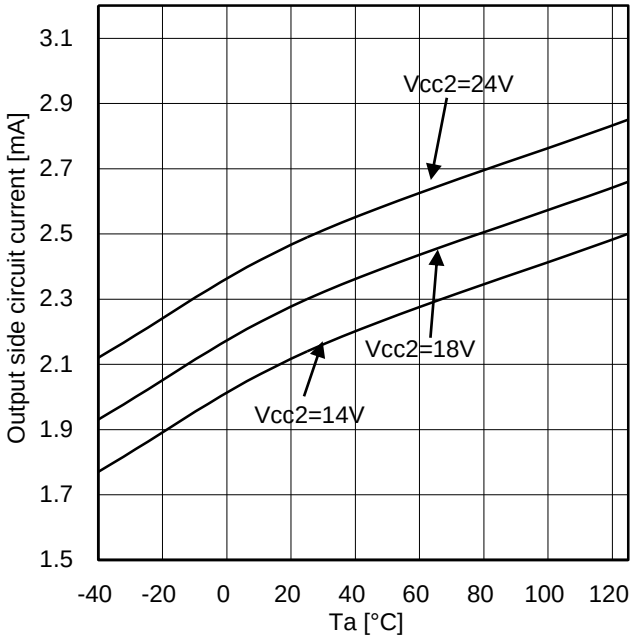


Figure 25. Output side circuit current vs. Temperature (OUT1=L)

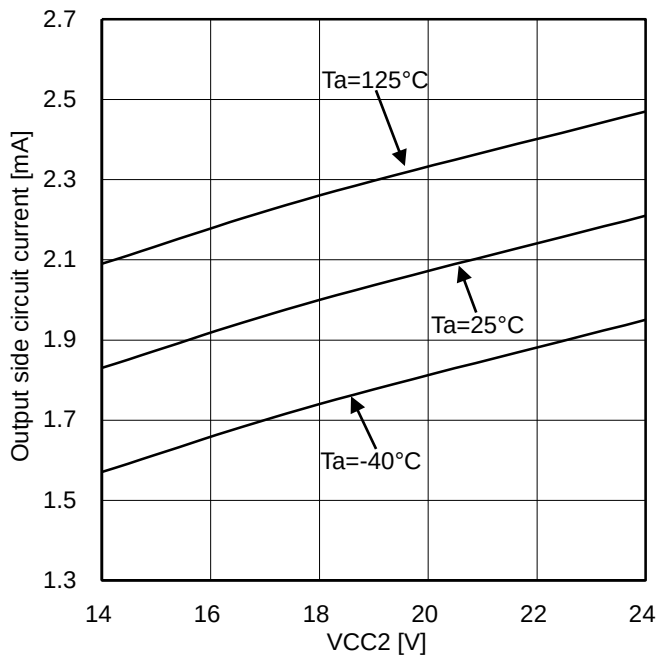


Figure 26. Output side circuit current vs. VCC2 (OUT1=H)

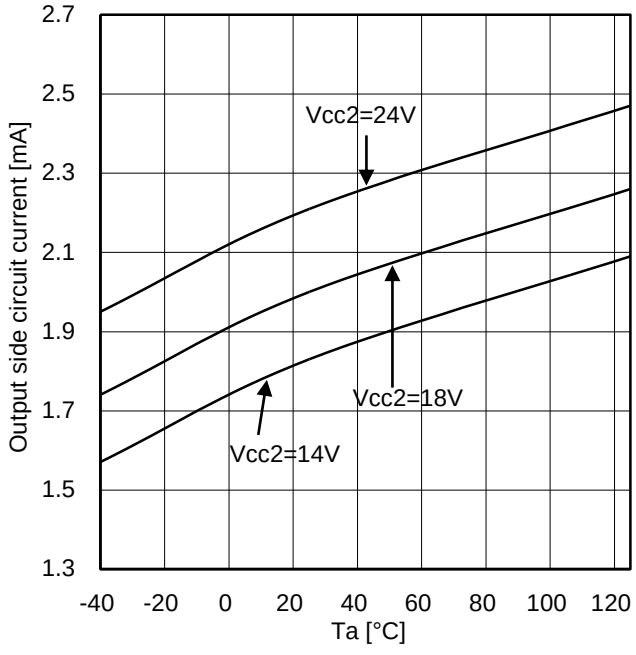


Figure 27. Output side circuit current vs. Temperature (OUT1=H)

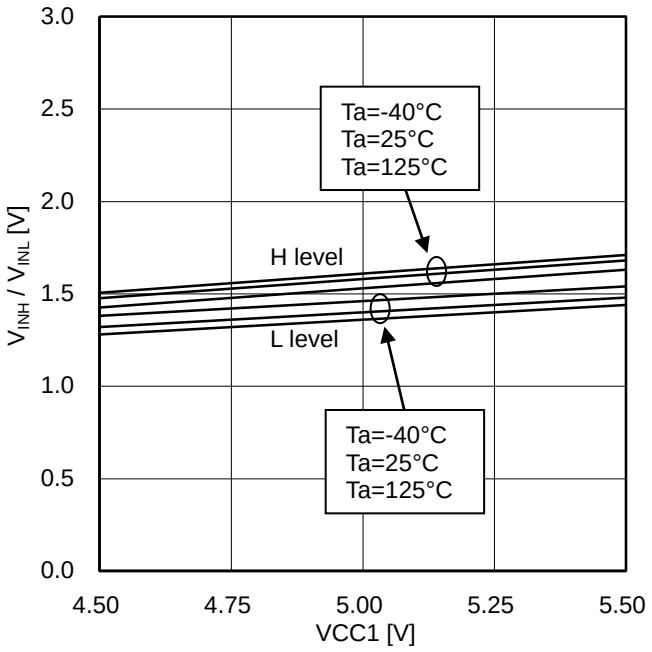


Figure 28. Logic (INA/INB/ENA) High/Low level input voltage vs. VCC1

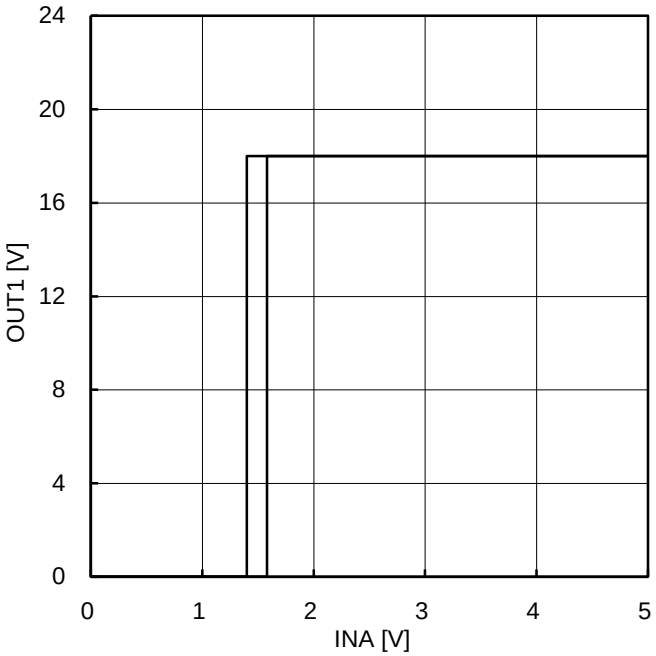


Figure 29. OUT1 vs. INA input voltage (VCC1=5V, VCC2=18V, Ta=25°C)

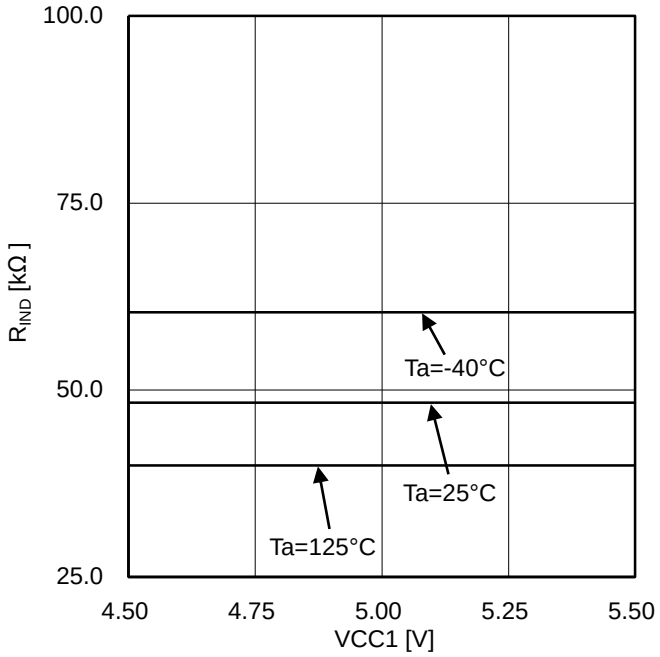


Figure 30. Logic pull-down resistance vs. VCC1

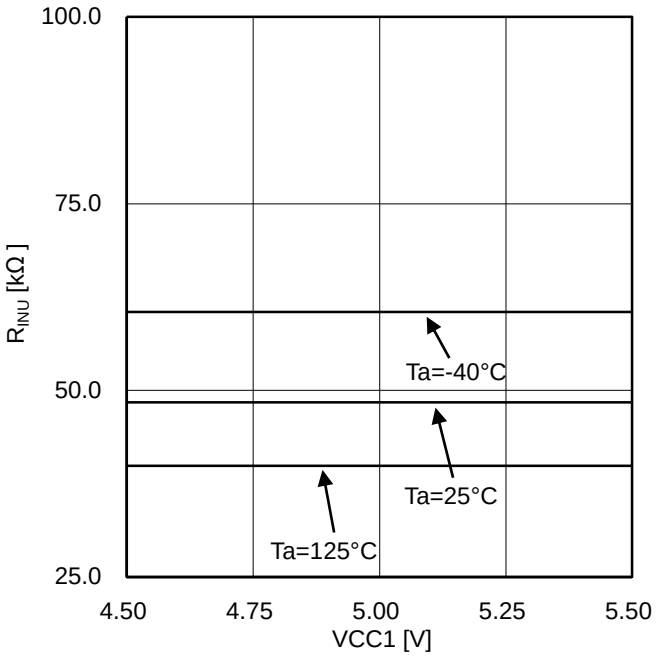


Figure 31. Logic pull-up resistance vs. VCC1

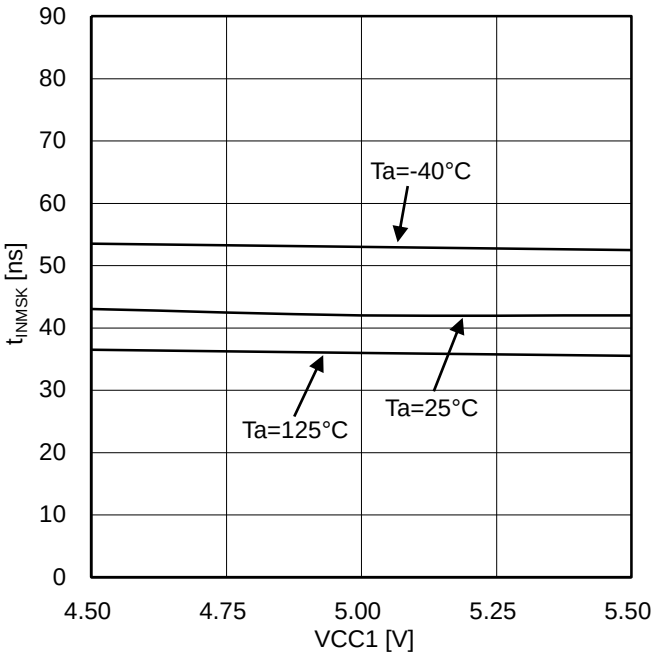


Figure 32. Logic (INA/INB) input mask time vs. VCC1 (High pulse)

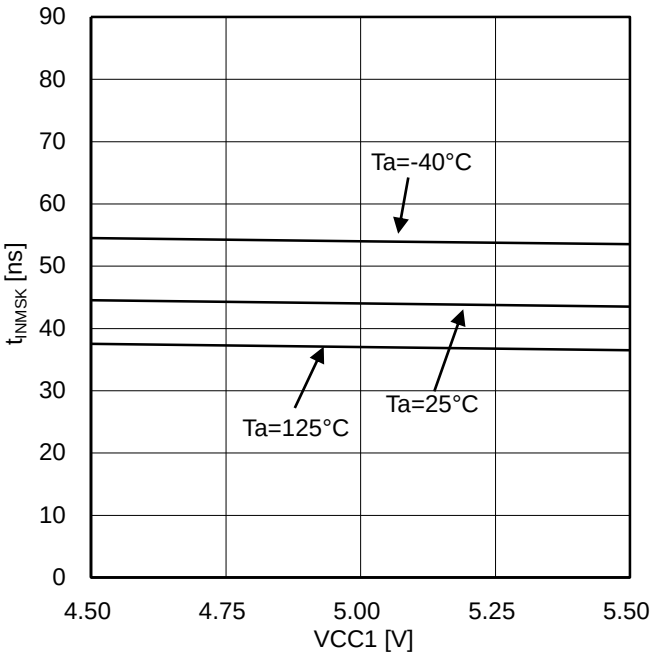


Figure 33. Logic (INA/INB) input mask time vs. VCC1 (Low pulse)

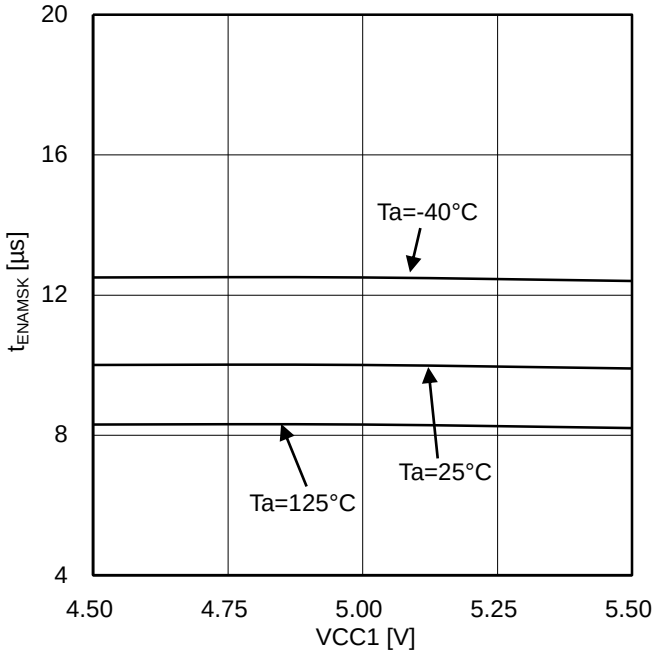


Figure 34. ENA mask time vs. VCC1

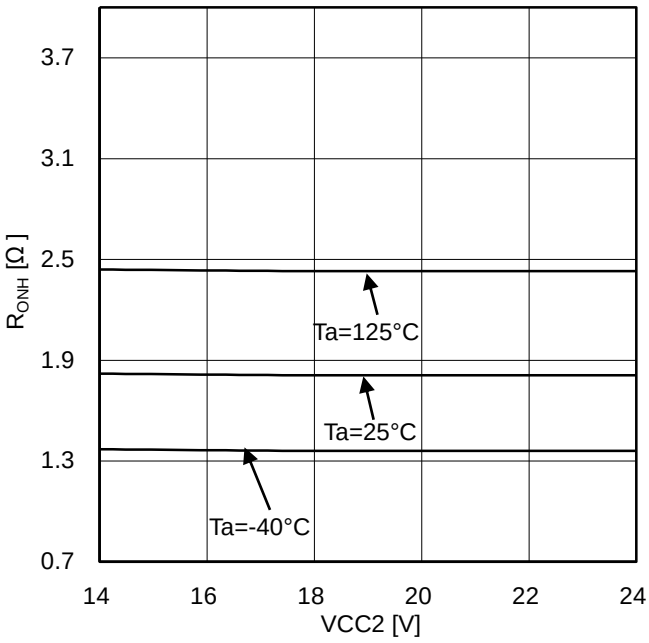


Figure 35. OUT1H ON resistance vs. VCC2

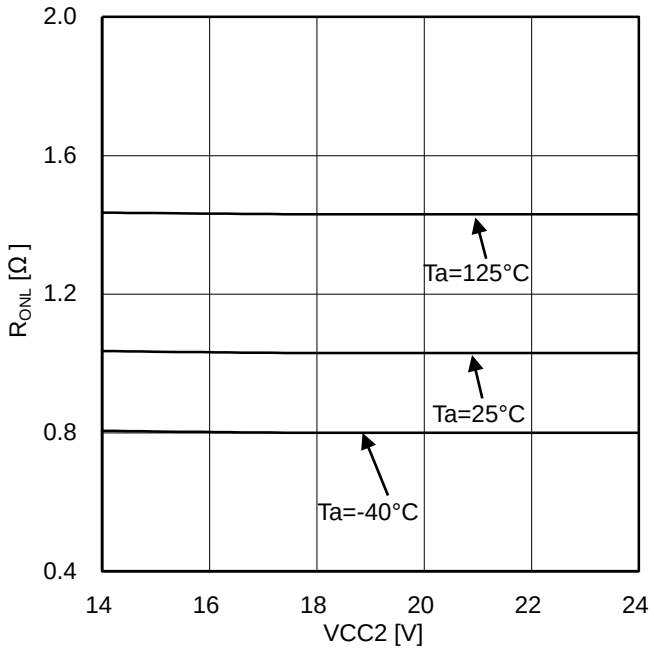


Figure 36. OUT1L ON resistance vs. VCC2

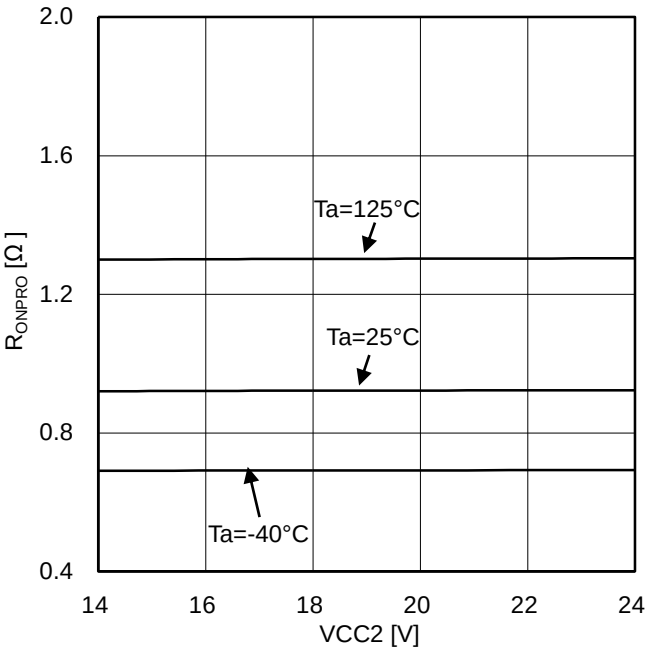


Figure 37. PROOUT ON resistance vs. VCC2

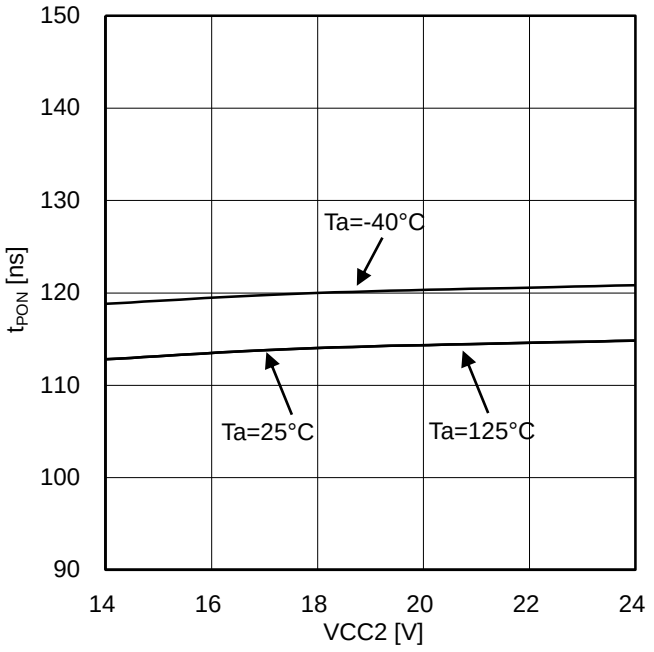


Figure 38. Turn ON time vs VCC2
(INA=PWM, INB=L)

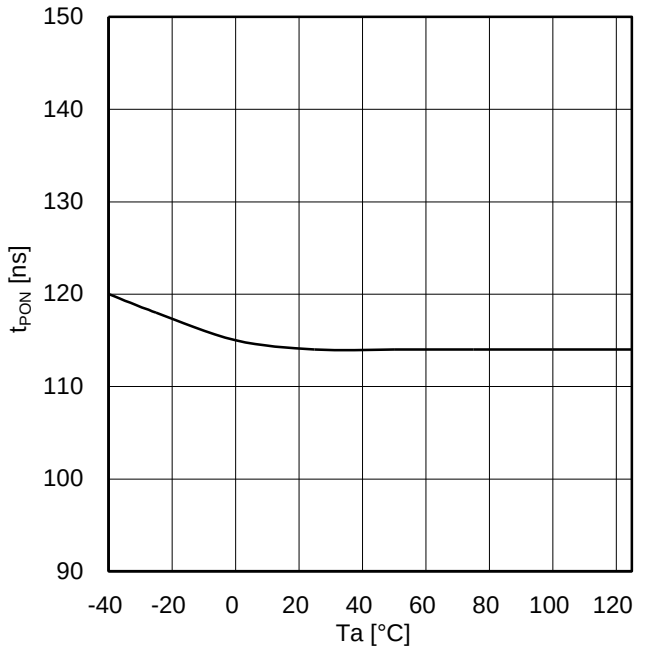


Figure 39. Turn ON time vs Temperature
(VCC2=24V, INA=PWM, INB=L)

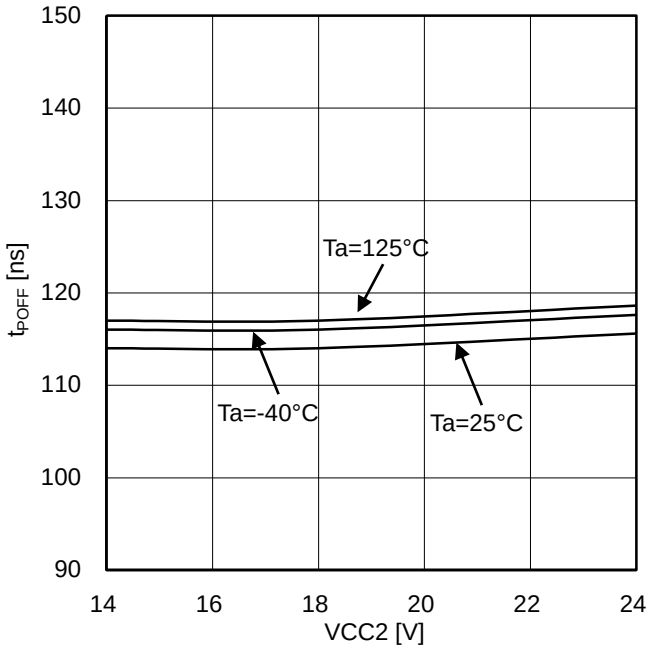


Figure 40. Turn OFF time vs. VCC2
(INA=PWM, INB=L)

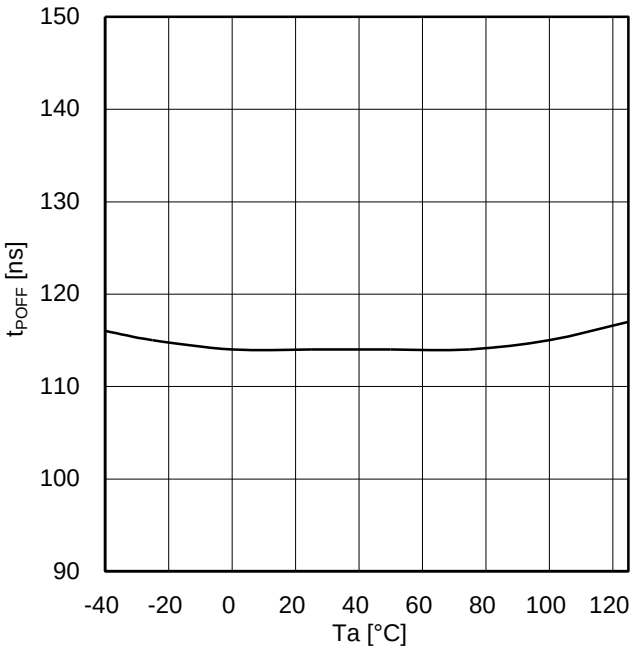


Figure 41. Turn OFF time vs. Temperature
(VCC2=24V, INA=PWM, INB=L)

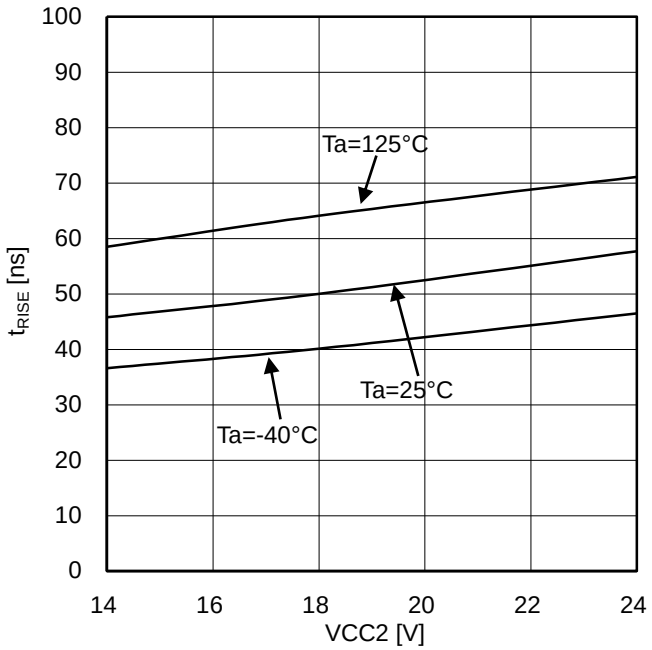


Figure 42. Rise time vs. VCC2
(10nF between OUT1-VEE2)

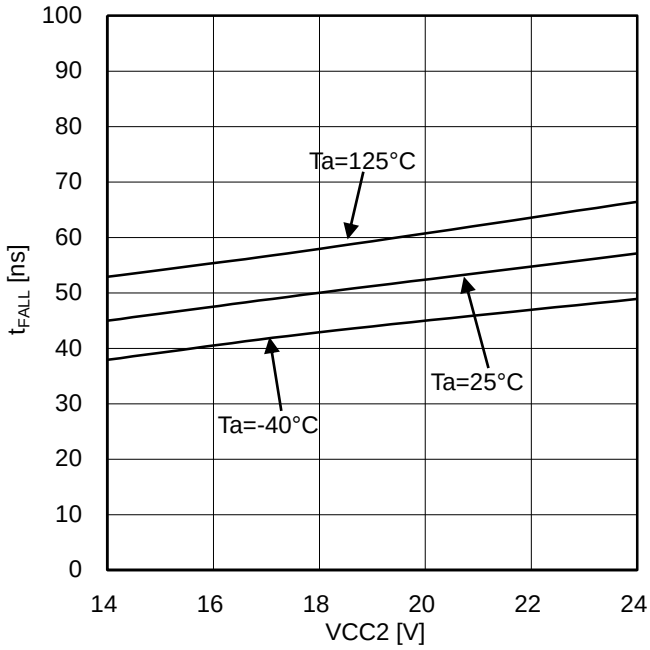


Figure 43. Fall time vs. VCC2
(10nF between OUT1-VEE2)

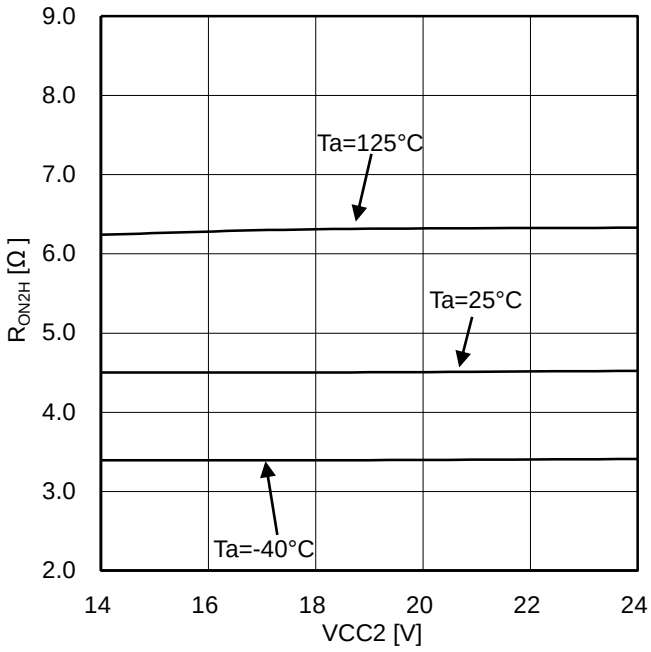


Figure 44. OUT2 ON resistance (Source) vs. VCC2

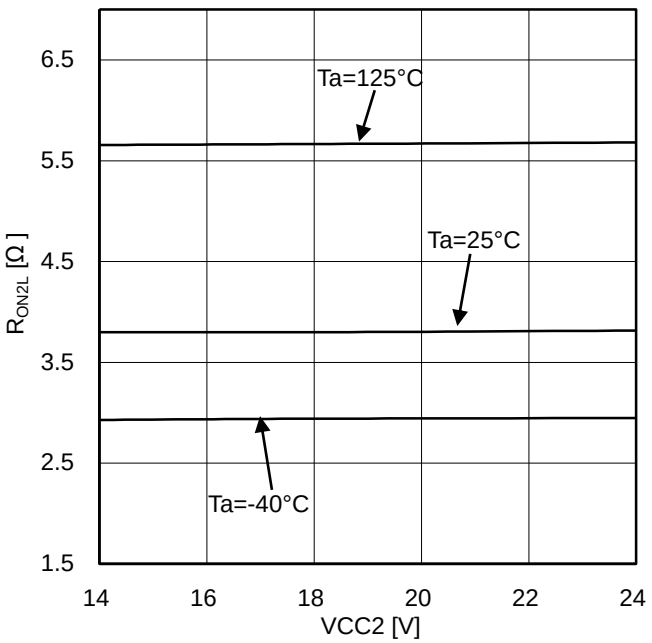


Figure 45. OUT2 ON resistance (Sink) vs. VCC2

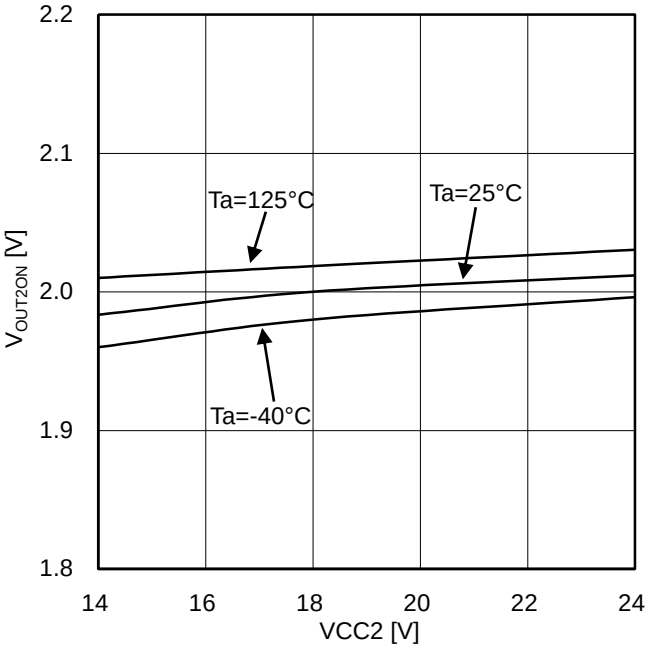


Figure 46. OUT2 ON threshold voltage vs. VCC2

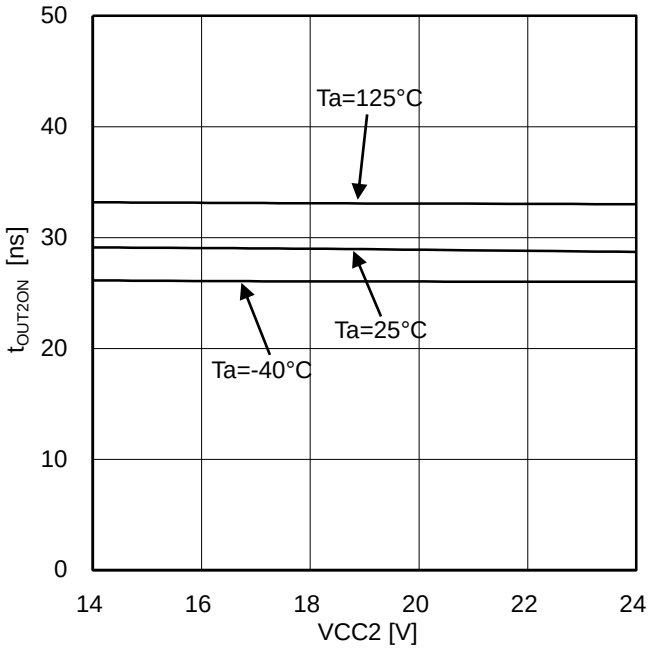


Figure 47. OUT2 output delay time vs. VCC2

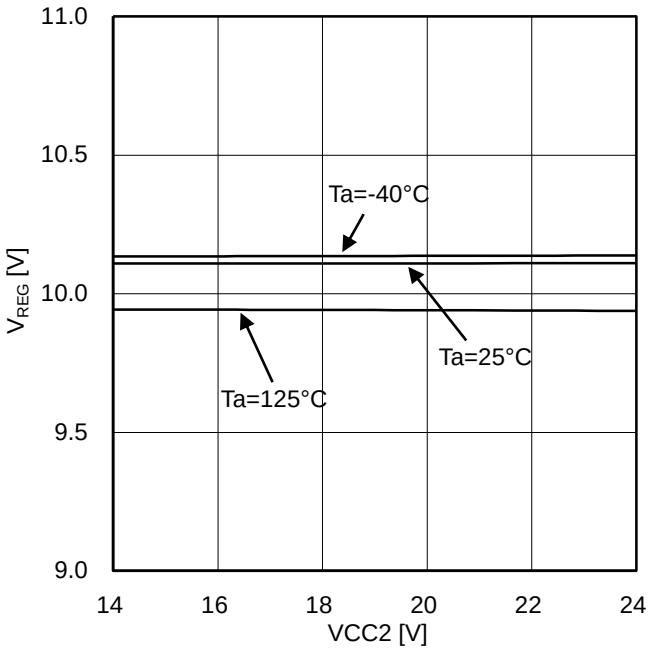


Figure 48. VREG output voltage vs. VCC2

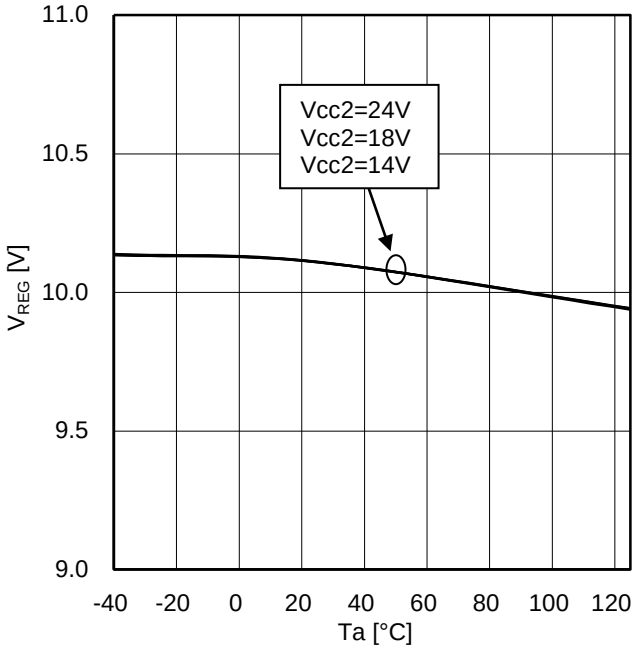


Figure 49. VREG output voltage vs. Temperature

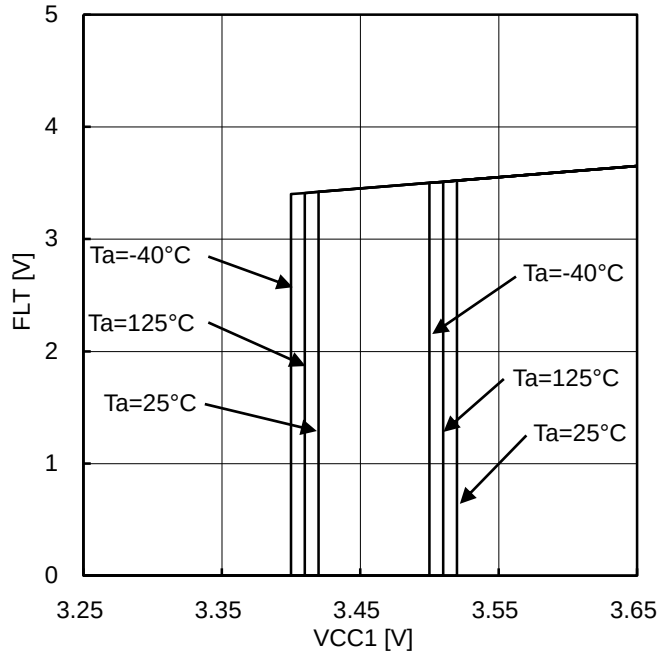


Figure 50. FLT vs. VCC1
(VCC1 UVLO ON/OFF voltage)

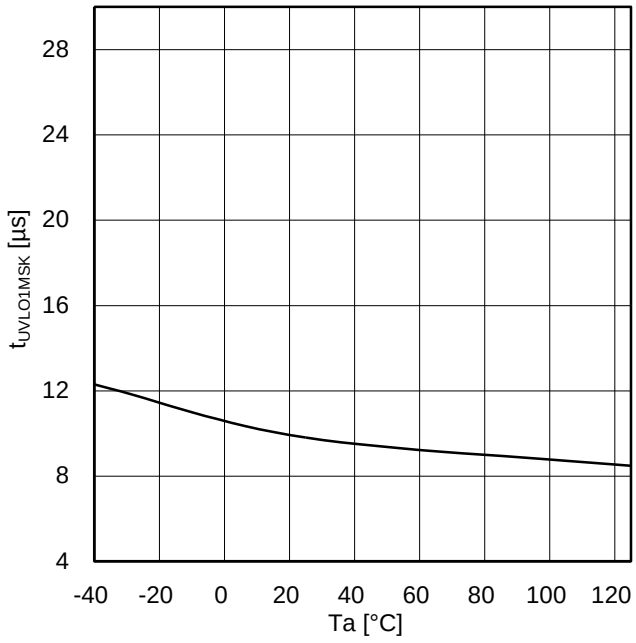


Figure 51. VCC1 UVLO mask time vs. Temperature

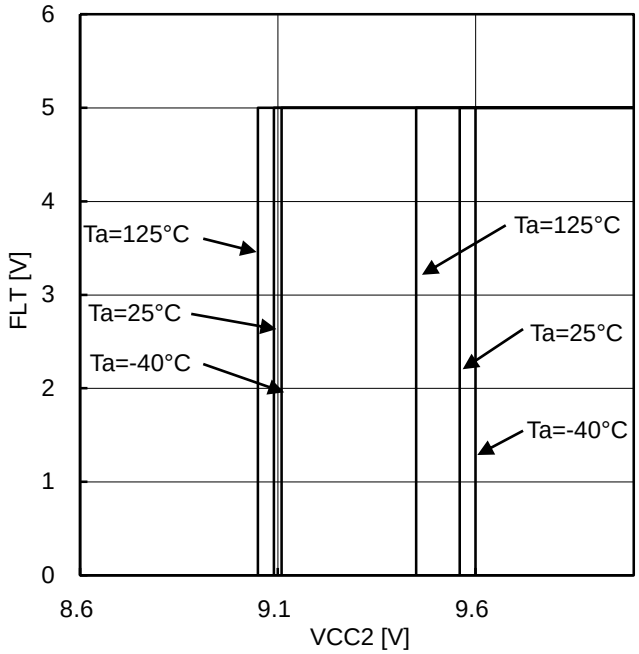


Figure 52. FLT vs. VCC2
(VCC2 UVLO ON/OFF voltage, VCC1=5V)

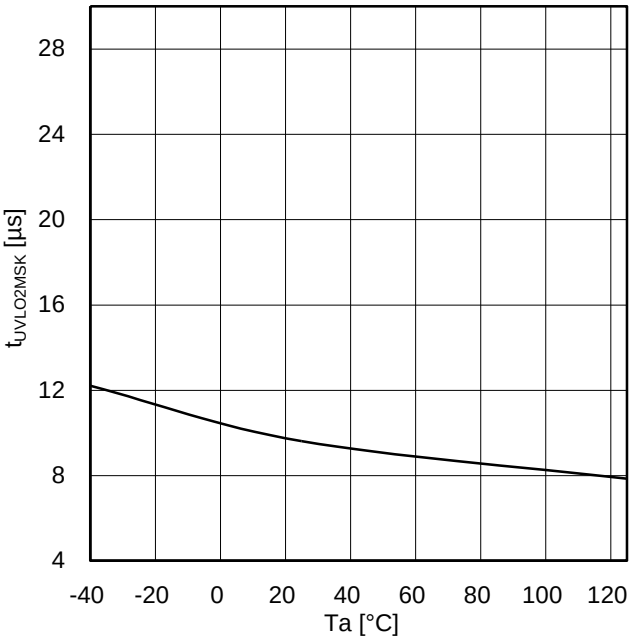


Figure 53. VCC2 UVLO mask time vs. Temperature

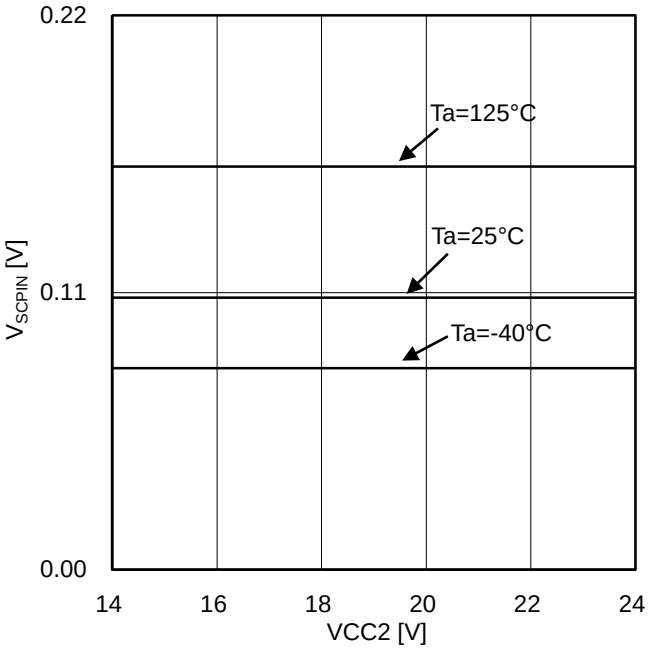


Figure 54. SCPIN Input voltage vs. VCC2
(ISCPIN=1mA)

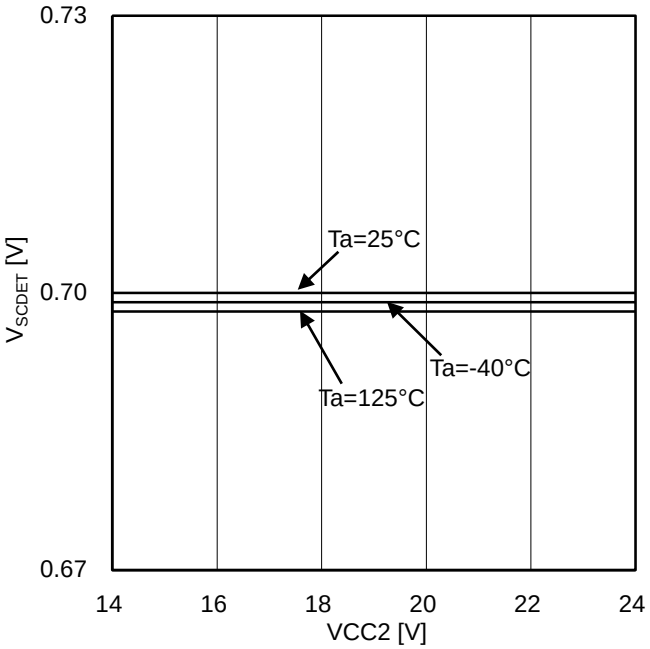


Figure 55. SCP threshold voltage vs. VCC2

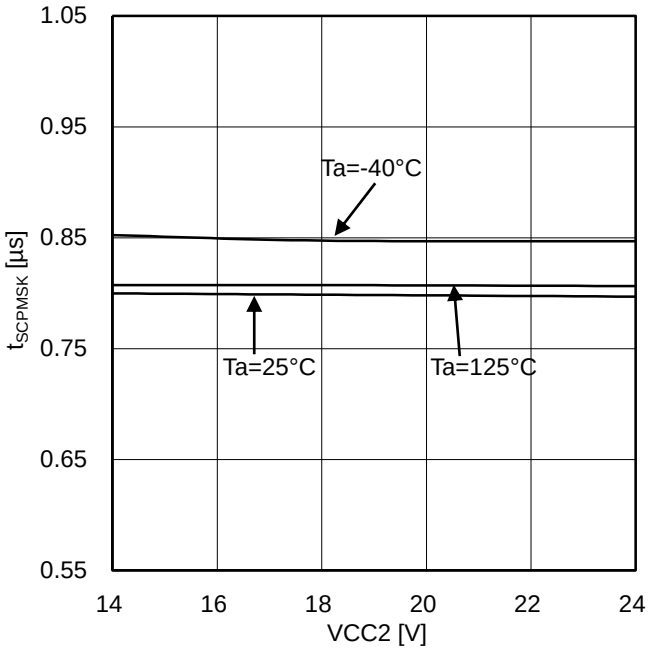


Figure 56. SCP detection mask time vs. VCC2

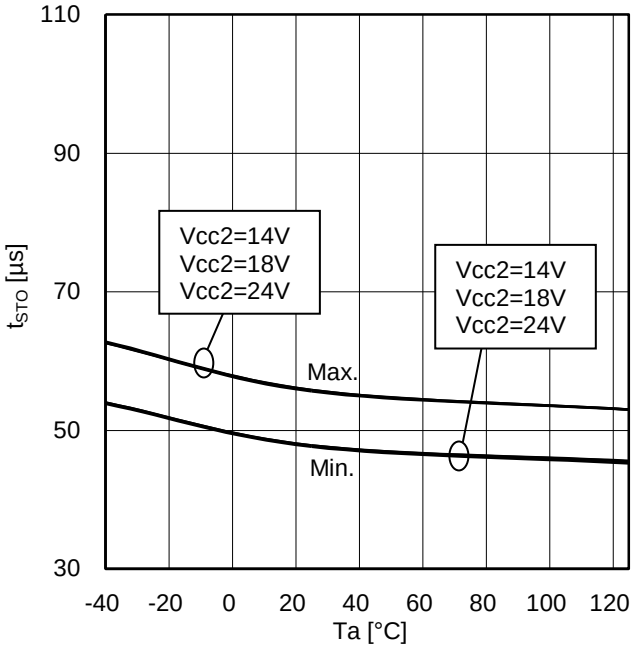


Figure 57. Soft turn OFF release time vs. Temperature

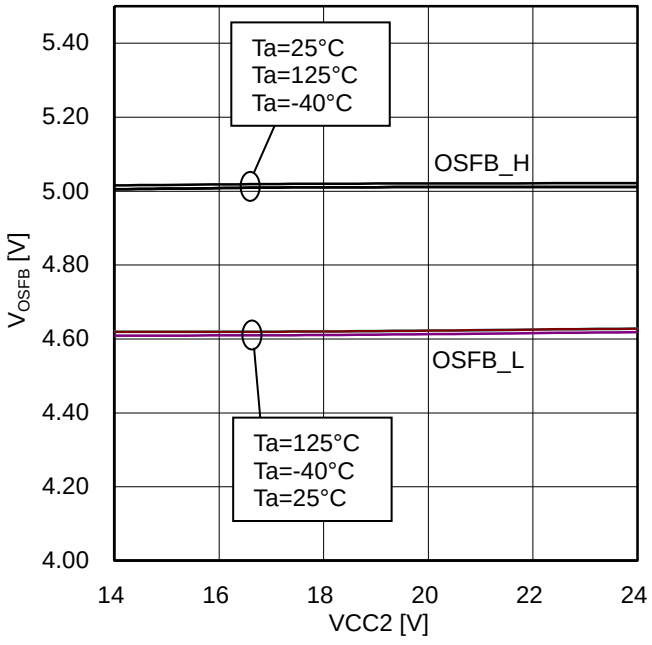


Figure 58. OSFB threshold voltage H/L vs. VCC2

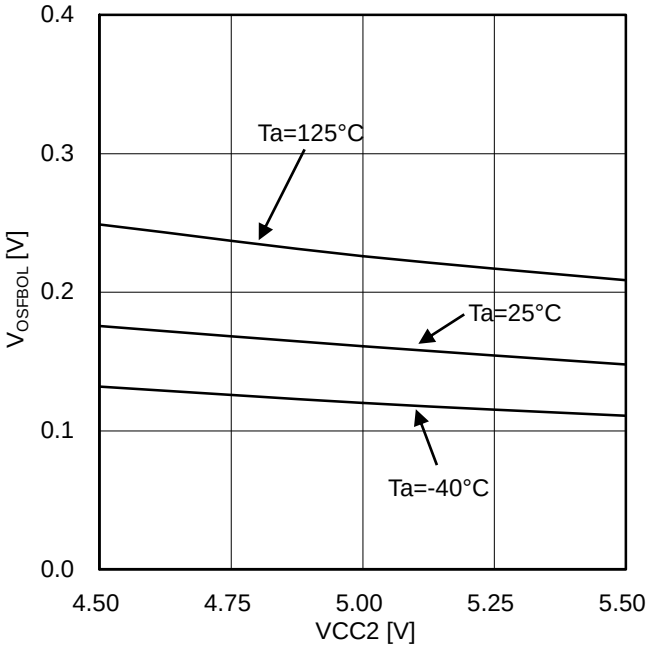


Figure 59. OSFB output low voltage vs. VCC2 (IOSFB=5mA)

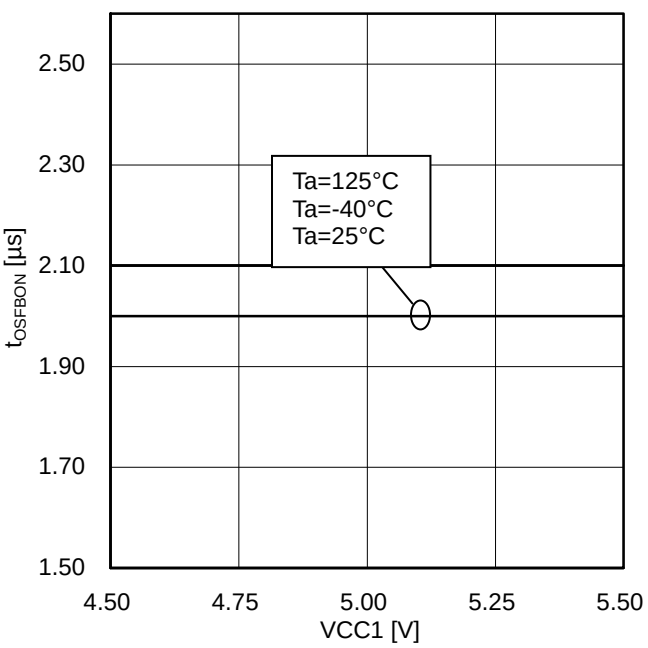


Figure 60. OSFB filter time vs. VCC1

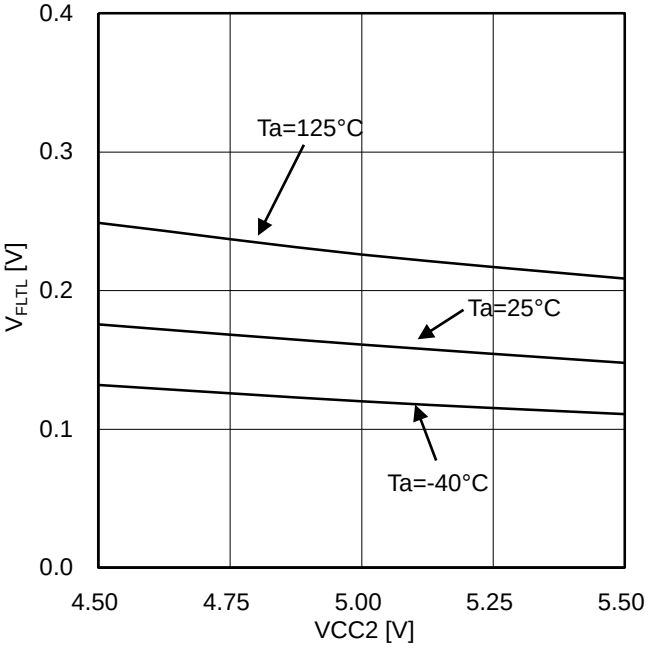


Figure 61. FLT output low voltage vs. VCC2 (IFLT=5mA)

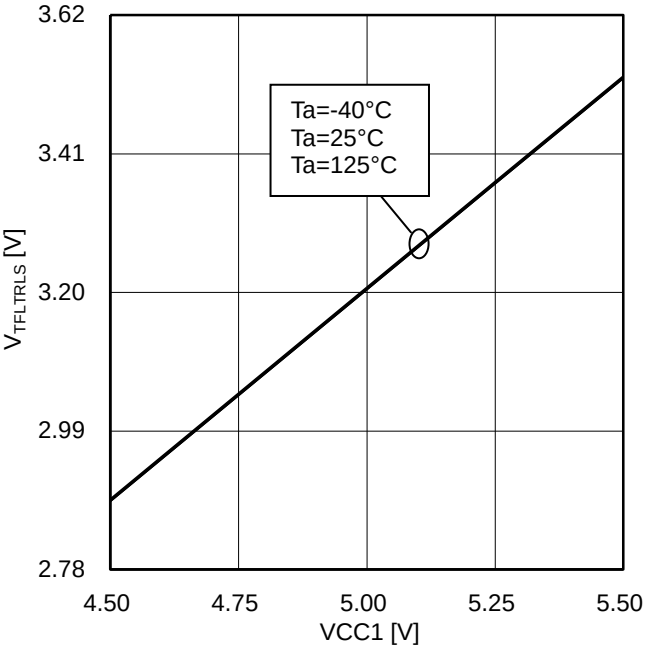


Figure 62. FLTRLS threshold vs. VCC1

Selection of Components Externally Connected

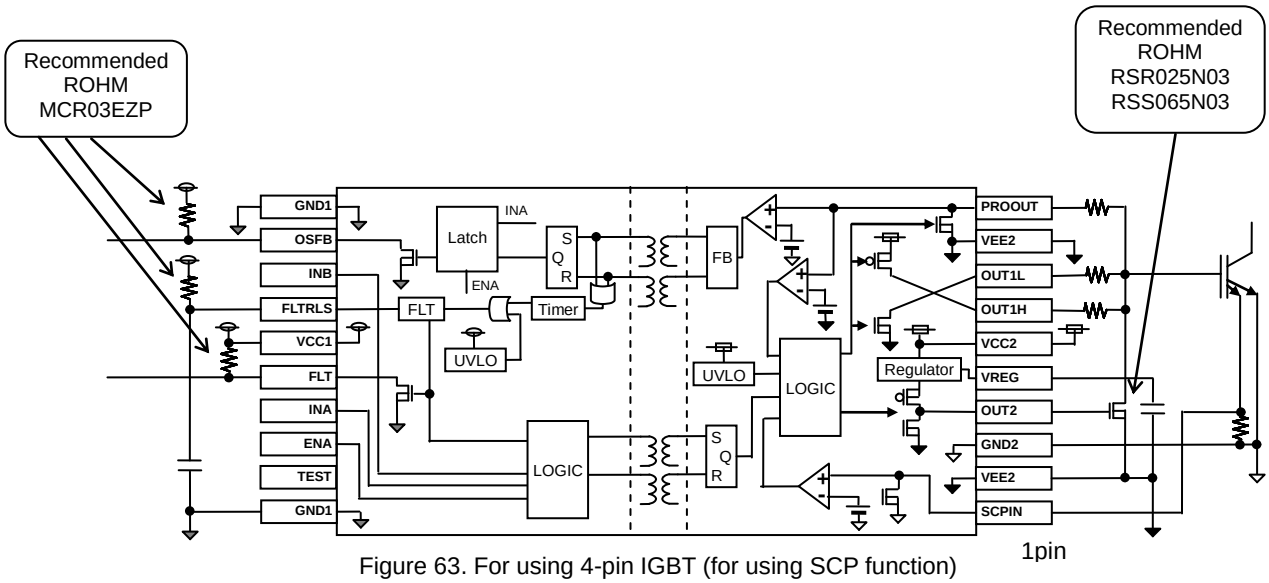


Figure 63. For using 4-pin IGBT (for using SCP function)

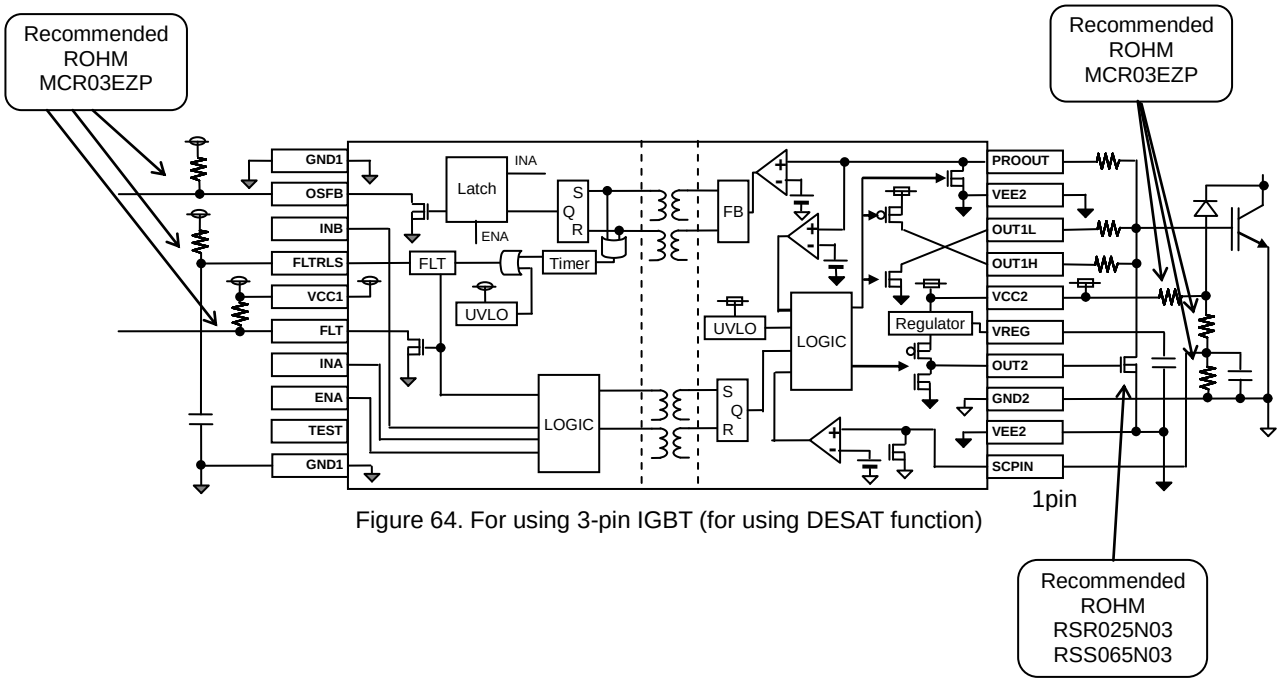


Figure 64. For using 3-pin IGBT (for using DESAT function)

Power Dissipation

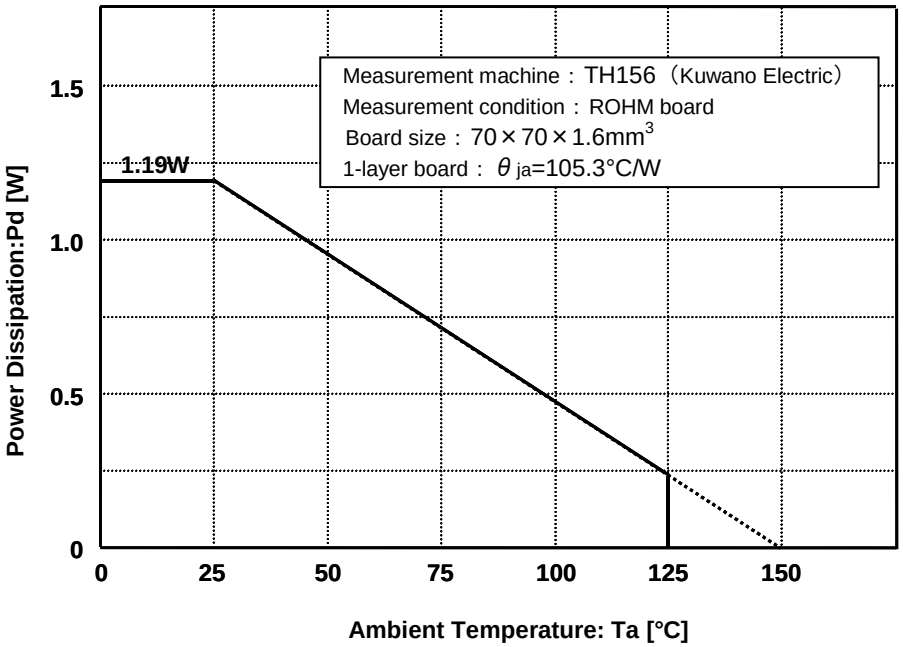
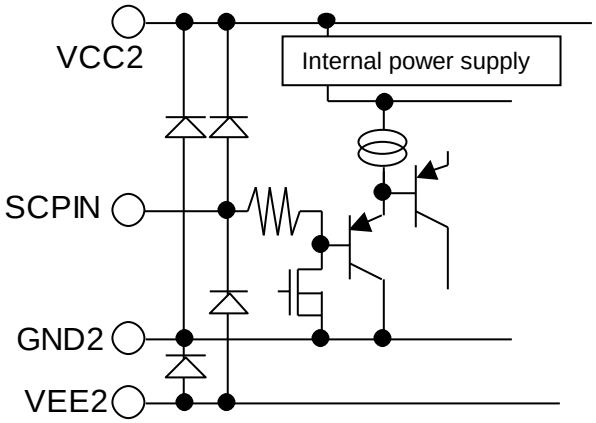
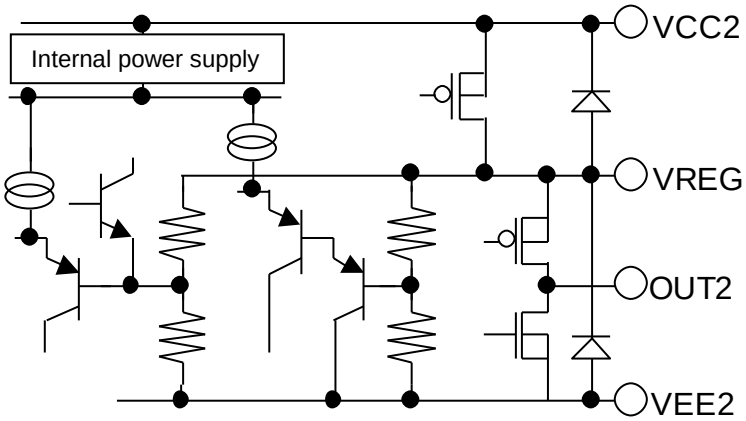
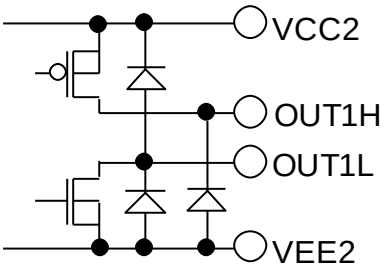
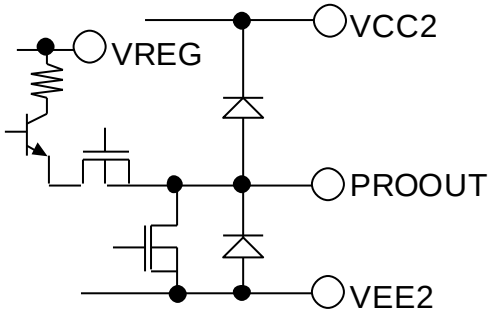


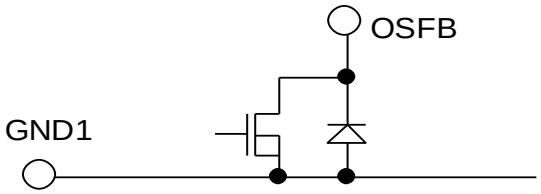
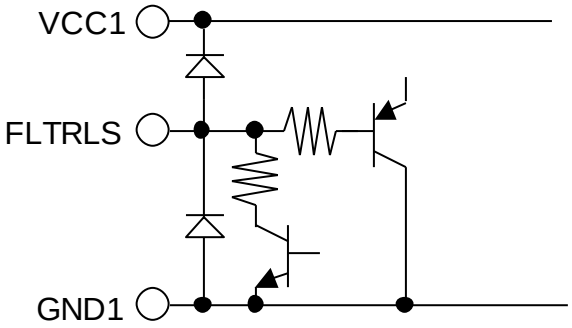
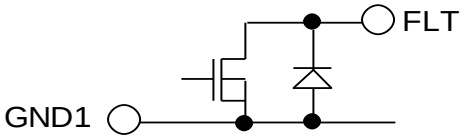
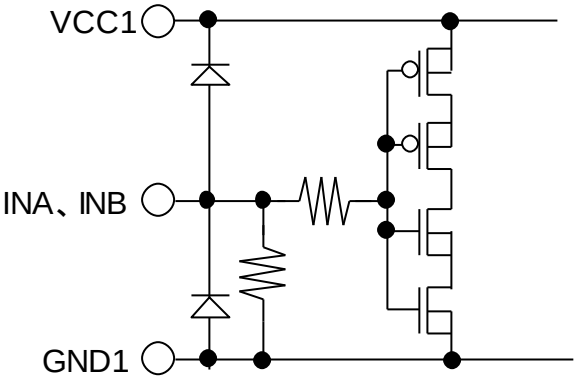
Figure 65. SSOP-B20W Derating Curve

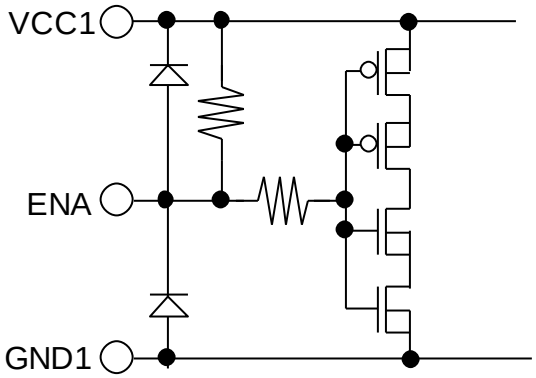
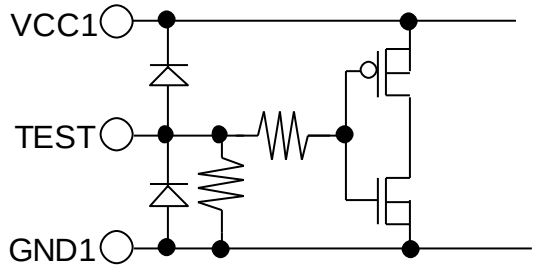
Thermal Design

Please confirm that the IC's chip temperature Tj is not over 150°C, while considering the IC's power consumption (W), package power (Pd) and ambient temperature (Ta). When Tj=150°C is exceeded, the functions as a semiconductor do not operate and some problems (ex. Abnormal operation of various parasitic elements and increasing of leak current) occur. Constant use under these circumstances leads to deterioration and eventually IC may destruct. Tjmax=150°C must be strictly followed under all circumstances.

I/O Equivalence Circuits

Pin No.	Name / Function	I/O equivalence circuits
1	SCPIN Short current detection pin	
4	OUT2 MOSFET control pin for Miller Clamp	
5	VREG Power supply pin for driving MOSFET for Miller Clamp	
7	OUT1H Source side output pin	
8	OUT1L Sink side output pin	
10	PROOUT Soft turn-off pin	

Pin No.	Name / Function	I/O equivalence circuits
12	OSFB Output state feedback pin	
14	FLTRLS Fault output holding time setting pin	
16	FLT Fault output pin	
13 17	INB Control input pin B INA Control input pin A	

Pin No.	Name Function	I/O equivalence circuits
18	ENA Input enabling signal input pin	
19	TEST Test mode setting pin	

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 terminals.

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.

11. Unused Input Terminals

Input terminals 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 terminals should be connected to the power supply or ground line.

12. Regarding Input Pins 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.

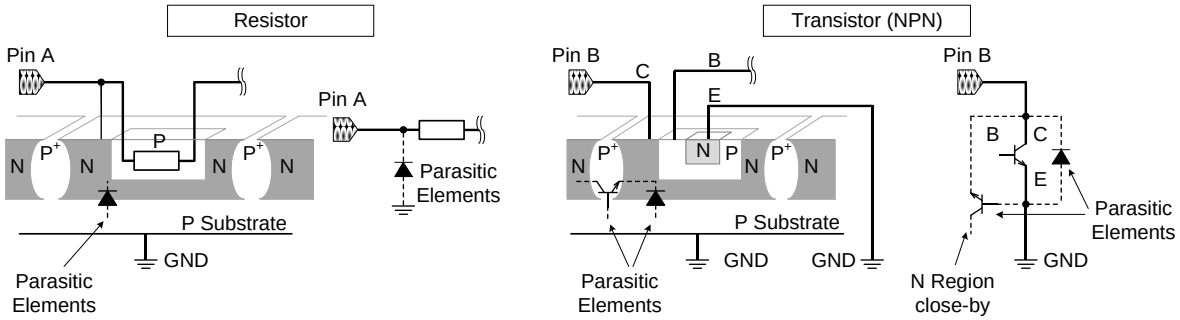


Figure 66. Example of monolithic IC structure

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 1 0 4 F V - CE 2

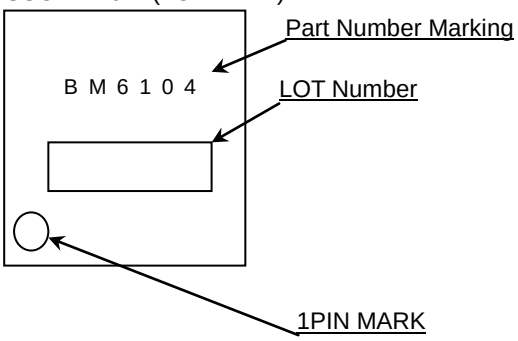
Part Number

Package
FV:SSOP-B20W

Rank
C:Automotive
Packaging and forming specification
E2: Embossed tape and reel

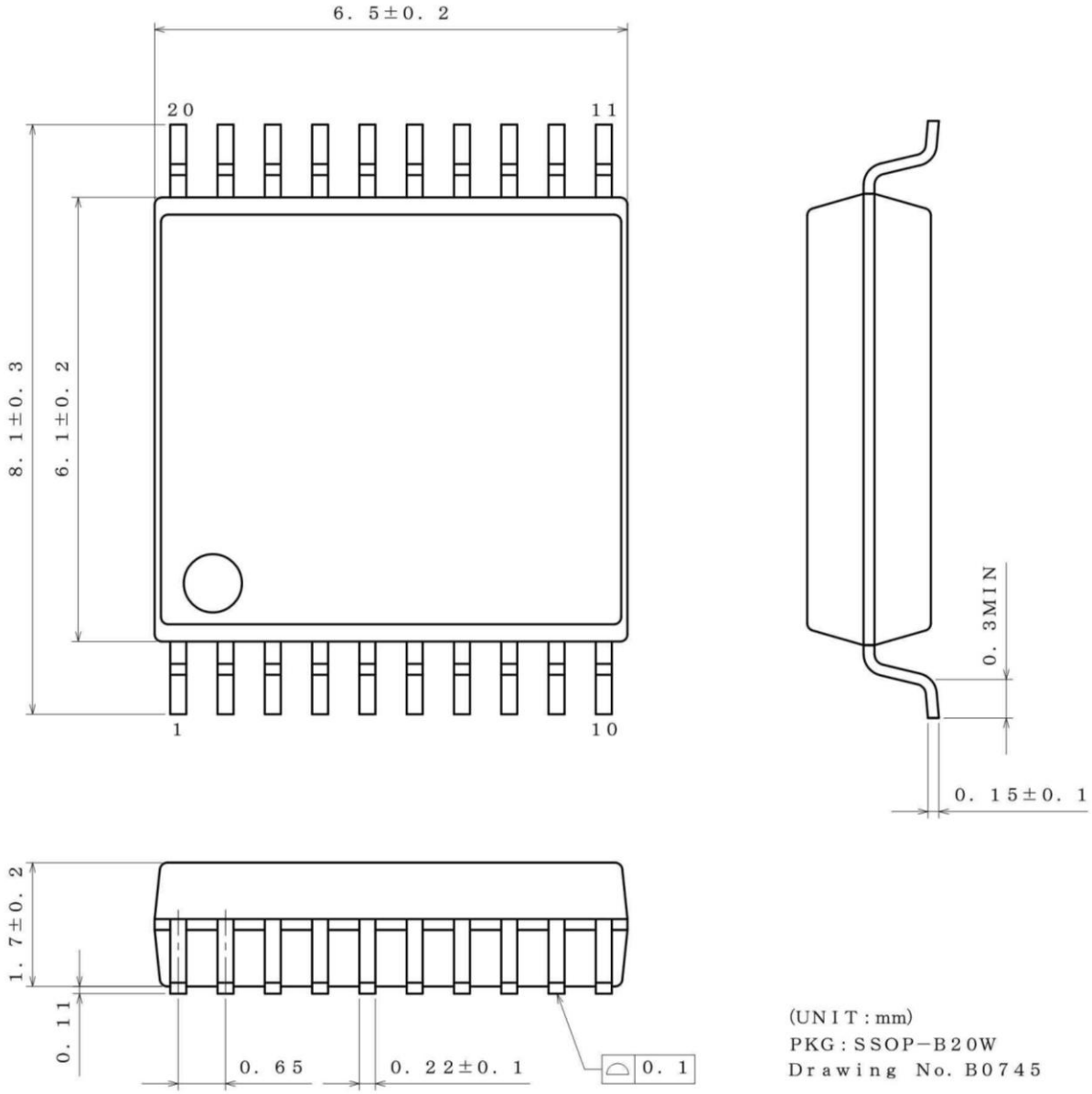
Marking Diagram

SSOP-B20W (TOP VIEW)



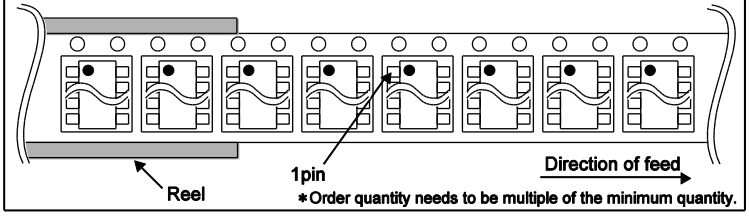
Physical Dimension, Tape and Reel Information

Package Name	SSOP-B20W



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	E2 (The direction is the 1pin 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)



*Order quantity needs to be multiple of the minimum quantity.

Revision History

Date	Revision	Changes
06.Nov.2013	001	New Release
23.Jan.2014	002	Page 13 : Change Electrical Characteristics ' VCC2 UVLO OFF Voltage ' Page 13 : Change Electrical Characteristics ' VCC2 UVLO ON Voltage ' Page 26 : Change Selection of Components Externally Connected
20.May.2015	003	P.1 Features Adding item (UL1577 Recognized) P.4 Description of Pins Adding TEST pin P.7 Description of functions Correcting mistake of Figure 10

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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   [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 (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient 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

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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.

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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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Тел: +7 (812) 336 43 04 (многоканальный)
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