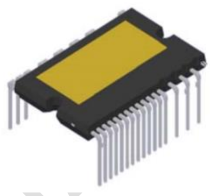
3 Phase 20A/600V intelligent Power Module

Super-Mini-DIP IPM Series

LAM3N2060

Overview

LAM3N2060 is a highly integrated and high reliability 3 phase intelligent power module designed for advanced BLDC motor drive applications such Air condition, wash machine etc. LAM3N2060 integrates 6 low power dissipation IGBTs and HVICs. The dedicated open-emitter pins from low side IGBTs are provided for current sensing. The input works with Schmitt-trigger and the logic voltage is compatible with 3.3V/5V/15V signal. The UVLO, deadtime, over current protection and thermal indication/thermal shutdown are also provided.



DIP25

Features

- 3 phase DC/AC inverter
- Built-in high-performance 20A/600V IGBT and >5us short circuit tolerance
- Built-in Bootstrap diode with current limiting resistor
- Low Side IGBT open emitter
- For High side: Drive circuit, HV high-speed level shifting, Control supply under-voltage (UV) protection
- For Low side: Drive circuit, Control supply under-voltage protection (UV), Short Circuit protection (SC), Over temperature protection
- Fault signaling: Corresponding to SC fault (low side IGBT), UV fault (Low side supply) and OT fault
- Temperature output: Output LVIC temperature by analog signal
- Input interface: 3.3, 5V, 15V line, Schmitt trigger receiver circuit (High Active)

Typical Application

- AC 100~240Vrms (DC voltage:400V or below) class low power motor control

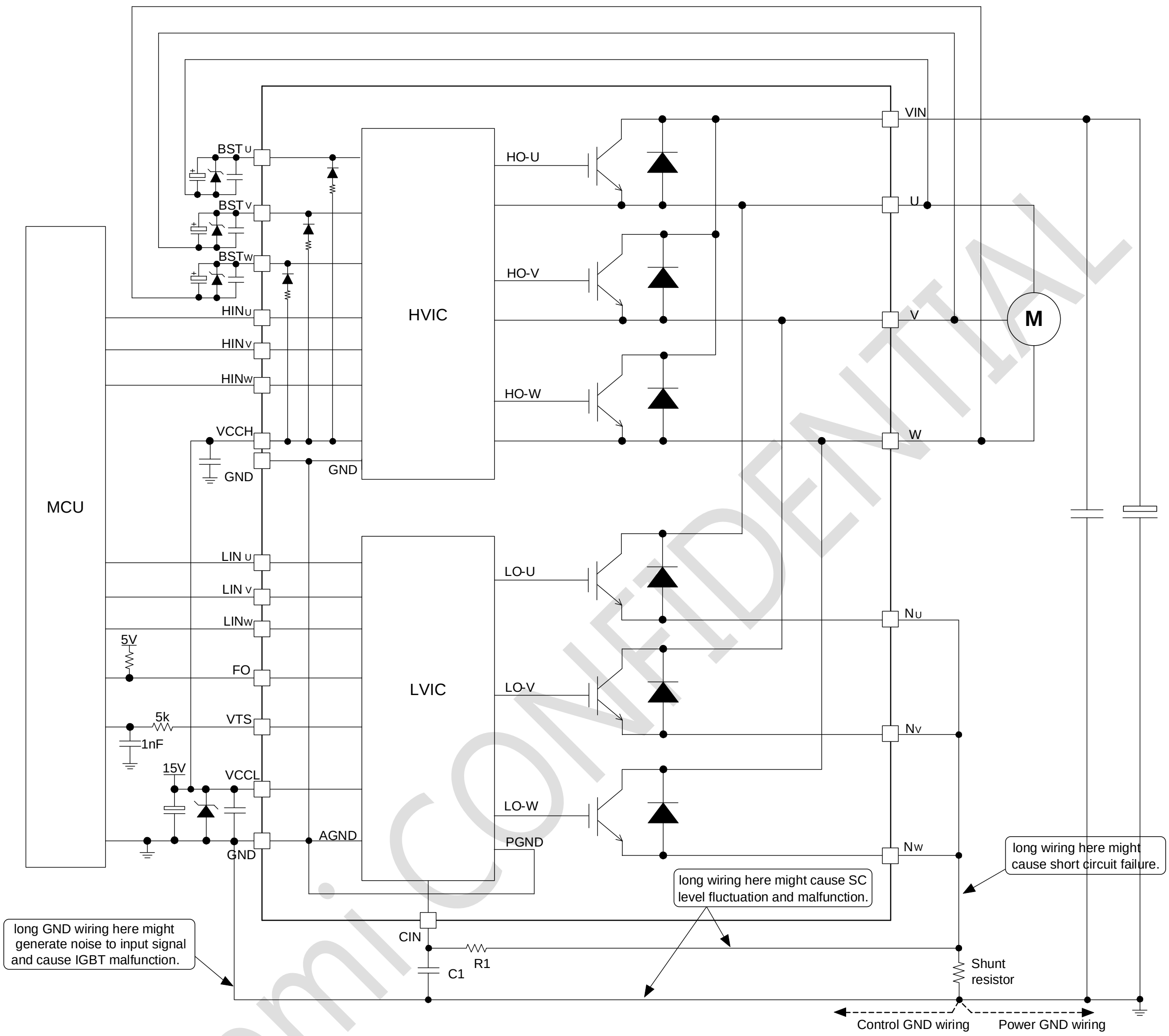
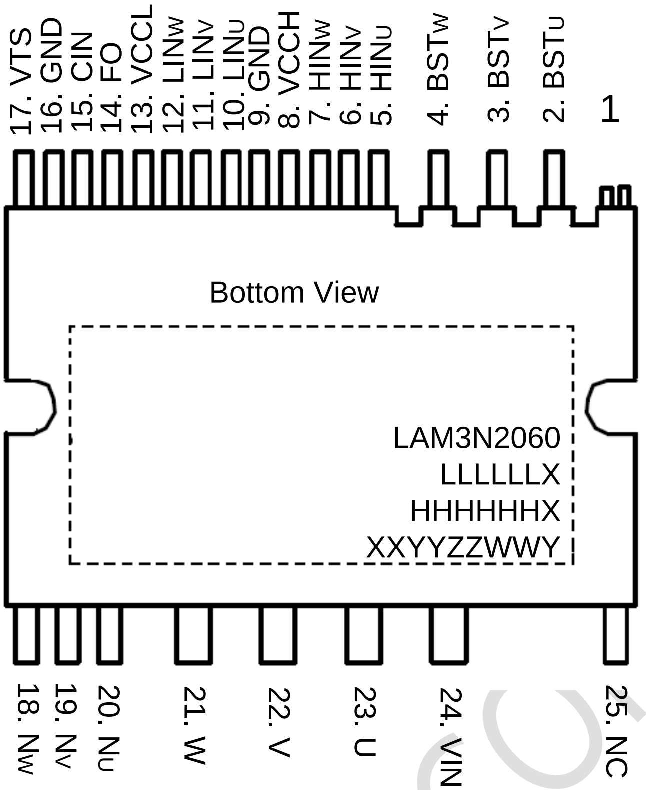


Figure 1 Example of Application Circuit

Package Mark and Order Information

Device	Package	Temperature range	Packaging Type	Purchase Contact
LAM3N2060	DIP25	-40 to 125^{0}C	11 pcs/Tube	sales@latticeart.com

Pin Diagram



LLLLLL: LVIC Lot number
HHHHHH: HVIC lot number
XXYYZZ: IGBT&FRD Code
WW: week number
Y: Year code

Pin Description

Pin No.	Symbol	Pin Description
1	NC	Not used, VCC1&GND signal
2	BST_U	U phase high side floating supply
3	BST_V	V phase high side floating supply
4	BST_W	W phase high side floating supply
5	HIN_U	U phase High Side gate driver input
6	HIN_V	V phase High Side gate driver input
7	HIN_W	W phase High Side gate driver input
8	VCCH	Power supply for HVIC's input circuit.
9	GND	Ground pin
10	LIN_U	U phase low side gate driver input
11	LIN_V	V phase low side gate driver input
12	LIN_W	W phase low side gate driver input
13	VCCL	Power supply for LVIC
14	FO	Fault Output indicator

15	CIN	Over current detection input
16	GND	Ground pin
17	VTS	Temperature sensing voltage
18	N_W	W phase low side IGBT open emitter output
19	N_V	V phase low side IGBT open emitter output
20	N_U	U phase low side IGBT open emitter output
21	W	W phase power output
22	V	V phase power output
23	U	U phase power output
24	VIN	High voltage power supply pin
25	NC	No Connect pin

Block Diagram

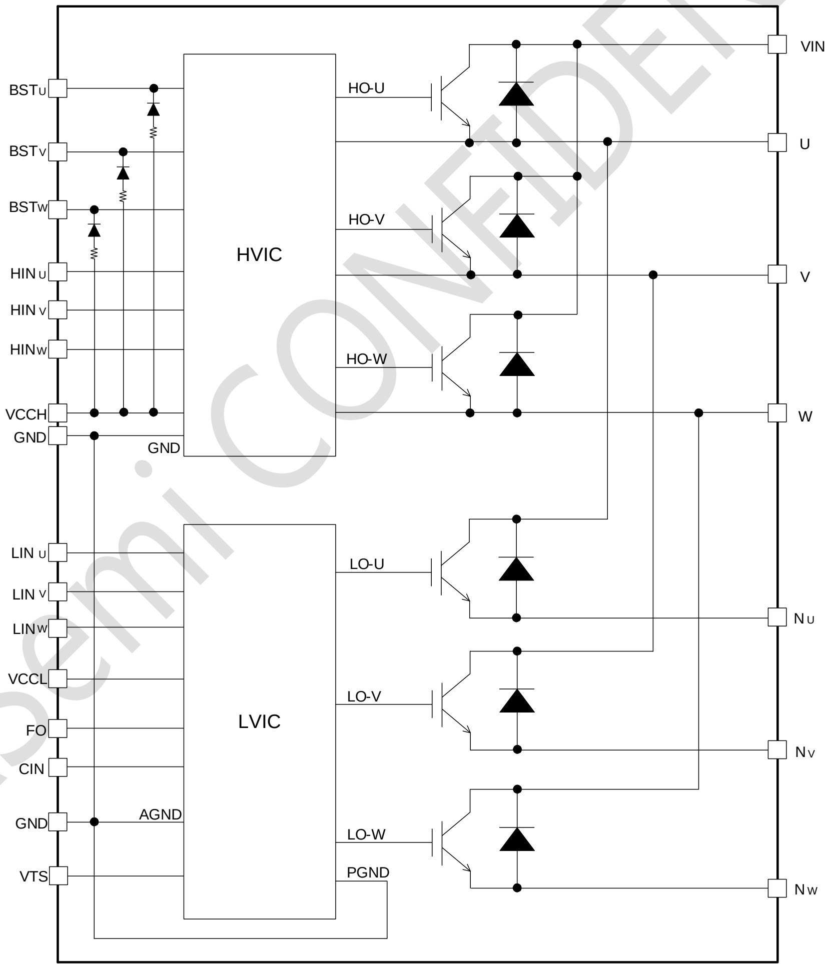


Figure 2 IPM block diagram

Absolute Maximum Ratings (note 1)

INVERTER PART

T_A=25^{0}C, unless otherwise specified.

Symbol	Definition	Ratings	Unit
VIN	DC bus	450	V
VIN_{SURGE}	DC bus surge	500	V
V_{CES}	IGBT collector-emitter voltage	600	V
I_C	Each IGBT collector current, Tc=25^{o}C, Tj<150^{o}C	20	A
I_{CP}	Each IGBT pulse current<1ms, Tc=25^{o}C	40	A
P_C	Collector dissipation per 1 chip(Tj=125 ^{o}C)	33.3	W
T_j	Junction temperature (Note 2)	-40 to +150	^{o}C

Note 1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are not tested at manufacturing.

Note 2: The maximum junction temperature rating of built-in power chips is 150^{o}C (@Tc<100^{o}C). However, to ensure safe operation of LAM3N2060, the average junction temperature should be limited to $T_{j(Ave)}$<125^{o}C(@Tc<100^{o}C).

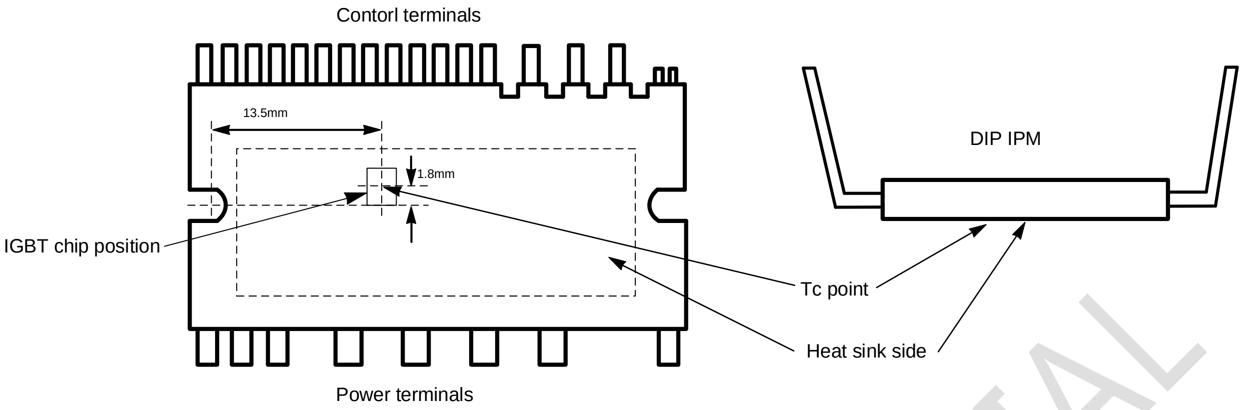
CONTROL PART

Symbol	Definition	Ratings	Unit
VCCH/VCCL	Control supply voltage	20	V
V_{BST-SW}	High side control supply voltage	20	V
V_{INPUT}	Input voltage	-0.5~20	V
V_{FO}	Fault output supply voltage	-0.5~20	V
I_{FO}	Fault output current, sink current at FO pin	10	mA
V_{VTS}	Temperature monitor output	-0.5~5	V
V_{CIN}	Current sensing input voltage	-1~20	V

TOTAL SYSTEM

Symbol	Definition	Ratings	Unit
VIN_{SC}	Self-protection supply voltage limit (short circuit protection capability); VCC=15V, Inverter part, Tj=125^{0}C, non-repetitive, less than 2us	400	V
T_C	Module case operation temperature	-30~+100	^{0}C
T_{STG}	Storage temperature	-40~+125	^{0}C
V_{ISO}	Isolation voltage, 60Hz, Sinusoidal AC 1min between connected all pins and heat sink plate	1500	V_{rms}

Tc MEASUREMENT POINT



THERMAL RESISTANCE

Symbol	Definition	Limits	Unit
$R_{th(j\text{-}c)\text{-}IGBT}$	Junction to case thermal resistance (note 3)	Max 3.0	k/W
$R_{th(j\text{-}c)\text{-}FRD}$		Max 3.9	k/W

*Note 3: Grease with good thermal conductivity and long-term endurance should be applied evenly with about +100um~+200um on the contacting surface of LAM3N2060 and heat sink. The contacting thermal resistance between case and heat sink $R_{th(c\text{-}f)}$ is determined by the thickness and the thermal conductivity of the applied grease. For reference, $R_{the(c\text{-}f)}$ is about 0.3k/W (per 1/6 module, grease thickness:20um, thermal conductivity:1.0W/m*k).*

Recommended Operation Conditions

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
VIN	Supply Voltage		0	300	400	V
VCCH/VCCL	Control supply voltage		13.5	15	18.5	V
$V_{BST\text{-}SW}$	High side control supply		13	15	18	V
ΔVCC, $\Delta V_{BST\text{-}SW}$	Control supply variation	V_{HIN}=5V	-1		1	V
t_{DT}	Arm shoot-through deadtime		2			us
f_{PWM}	PWM input frequency	Tc<100^{0}C, Tj<125^{0}C			20	kHz
I_O	Allowable r.m.s current	VIN=300V,Vcc=15V,P.F=0.8, Sinusoidal PWM, T_C≤100^{0}C, T_j≤125^{0}C, f_{PWM}=5kHz			10.0	Arms

		VIN=300V,Vcc=15V,P.F=0.8, Sinusoidal PWM, $T_C \leq 100^0$C, $T_j \leq 125^0$C, f_{PWM}=15kHz (Note 4)			6.0	Arms
PW_{IN_ON}	Minimum on input pulse		0.7			us
PW_{IN_OFF}	Minimum off input pulse		0.7			us
GND	GND variation	Between GND-$N_{U,V,W}$	-5.0		+5.0	V
Tj	Junction temperature		-30		+125	^{0}C

Note 4: Allowable r.m.s current depends on the actual application conditions.

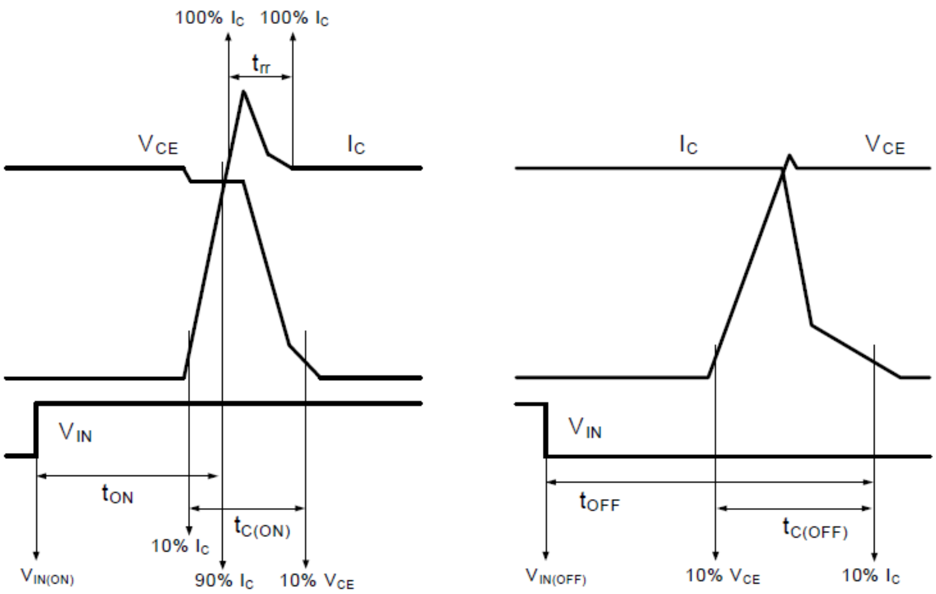
Electrical Characteristics

$T_A=25^0C$, unless otherwise specified.

INVERTER PART

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
$V_{CE(SAT)}$	IGBT CE saturation voltage	VCC=15V, V_{IN}=5V, I_C=20A, $T_j=25^0C$		1.70	1.90	V
		VCC=15V, V_{IN}=5V, I_C=20A, $T_j=100^0C$		1.90		V
		VCC=15V, V_{IN}=5V, I_C=2.0A, $T_j=25^0C$		0.90		V
V_{EC}	FRD forward voltage	V_{IN}=0V, I_C=-20A		1.5	1.7	V
t_{ON}	Switching times	VIN=300V, VCC1=VCC2=15V, I_C=20A, $T_j=125^0C$, V_{IN}=0→5V, inductive Load (Upper-lower arm) (Note 5)	0.5	0.6	0.8	us
$t_{C(ON)}$				0.56	0.65	us
t_{OFF}				0.9	1.3	us
$t_{C(OFF)}$				0.2	0.35	us
t_{rr}				0.20		us
I_{CES}	Collector-emitter cut-off current	V_{IN}=0V, V_{CE}=600V			4	uA
$V_{(BR)CES}$	Collector-emitter Breakdown Voltage	V_{IN}=0V, I_{CE}=1mA	600			V

Note 5: t_{ON} and t_{OFF} include the propagation delay time of the internal drive IC. $t_{C(ON)}$ and $t_{C(OFF)}$ are the switching time of IGBT itself under given gate driving condition internally . For detailed information, please see Figure 3.



(a) Turn-On (b) Turn-Off

Figure 3. Switching Time Definition

LVIC PART

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I_{VCCL}	supply current	VCC2=15, V_{IN}=0V		0.3		mA
		VCC2=15, V_{IN}=5V		0.3		mA
$VCCL_{ON}$	VCCL turn on voltage		10	11	12	V
$VCCL_{OFF}$	VCCL turn off voltage		8	10	11	V
V_{CIN}	Short circuit trip level		0.45	0.5	0.55	V
V_{VTS}	(Note 6	LVIC Temp=90^{0}C	2.63	2.77	2.91	V
		LVIC Temp=25^{0}C	0.88	1.13	1.39	V
T_{OTP}	Over temperature protection	VCC2=15V. Detect LVIC temperature	120	130	140	^{0}C
T_{HYS}	Hysteresis of trip-reset			20		^{0}C
V_{FOH}	Fault output voltage	V_{CIN}=0V, FO pin pulled up to 5V by 10kohm	4.8			V
V_{FOL}	Fault output voltage	V_{CIN}=1V, I_{FO}=5mA			0.5	V
t_{FO}	Fault output pulse width		20	65		us
I_{LIN}	Input current	V_{LIN}=5V		16		uA
V_{LIN_ON}	On threshold voltage		2.6			
V_{LIN_OFF}	On threshold voltage				0.8	V

HVIC PART

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I_{VCCH}	High side supply current	VCC1=15,U,V,W=0V, V_{IN}=0V		50		uA
		VCC1=15, U,V,W=0V, V_{IN}=5V		50		uA
V_{BST_ON}	BST-SW turn on voltage		9	10	11	V
V_{BST_OFF}	BST-SW turn off voltage		8	9	10	V
V_{HIN_ON}	On threshold voltage		2.6			V
V_{HIN_OFF}	OFF threshold voltage				0.8	V
V_F	Bootstrap Diode forward voltage	I_F=10mA (note 7)	1.1	1.7	2.3	V
R_{BST}	Built-in limiting Resistance		80	90	100	Ω

Note 6: Temperature of LVIC vs. VTS output characteristics is described in Fig.6 and Fig.7.

Note 7: The characteristics bootstrap diode is described in Fig.5.

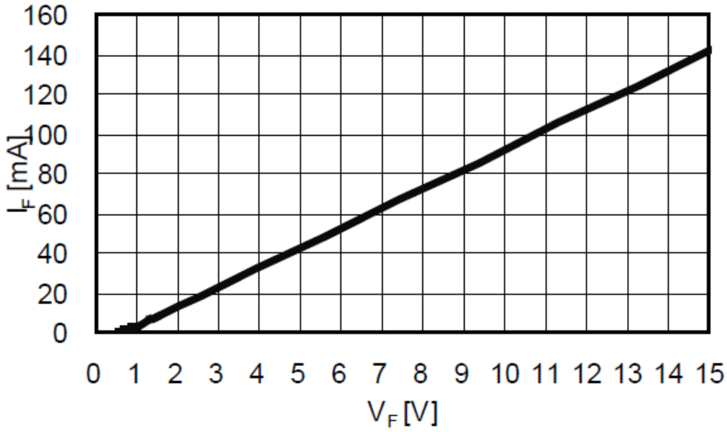


Figure 5 Built-In Bootstrap Diode Characteristic

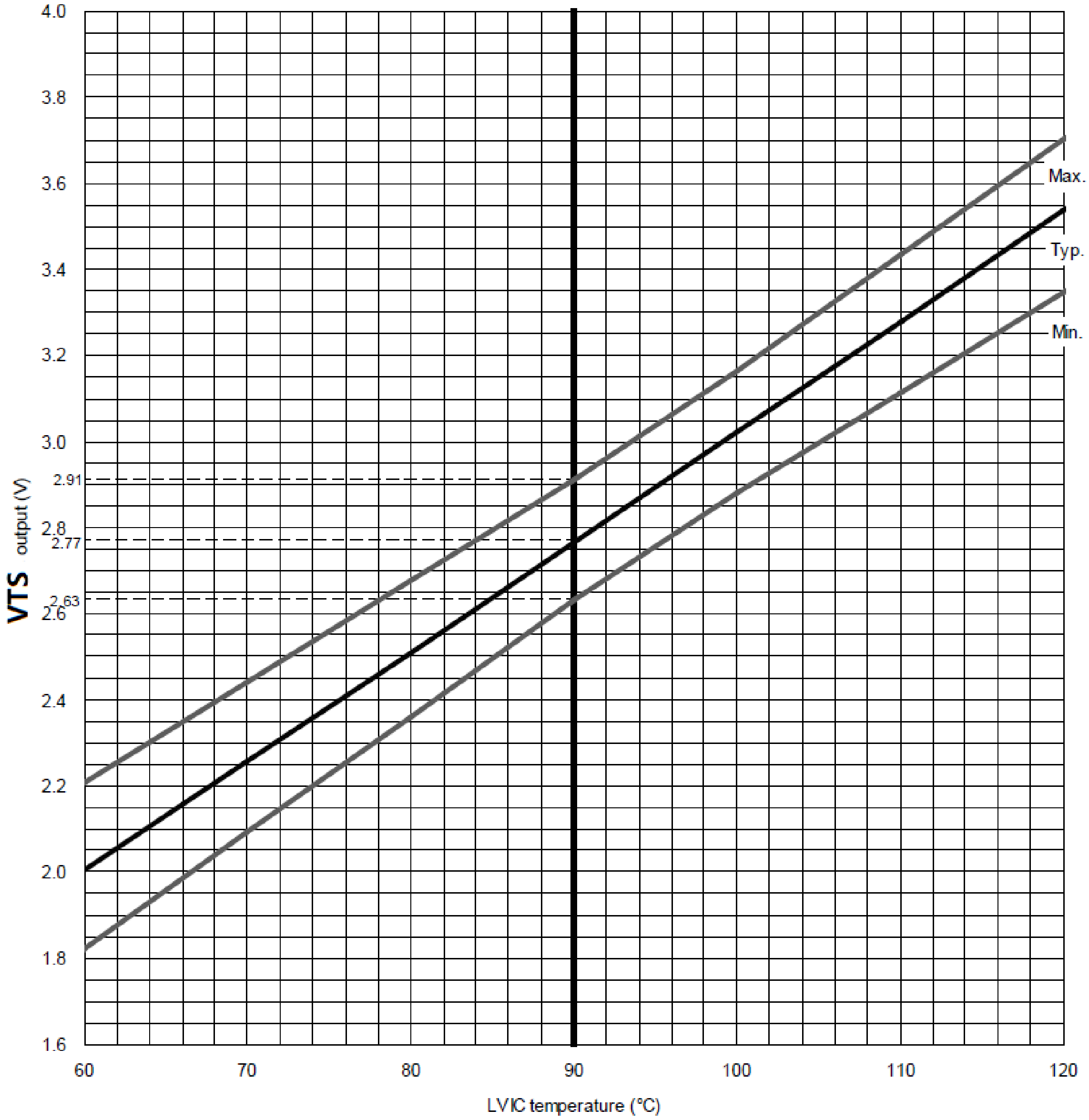


Figure 6 Temperature of LVIC vs. VTS output characteristics

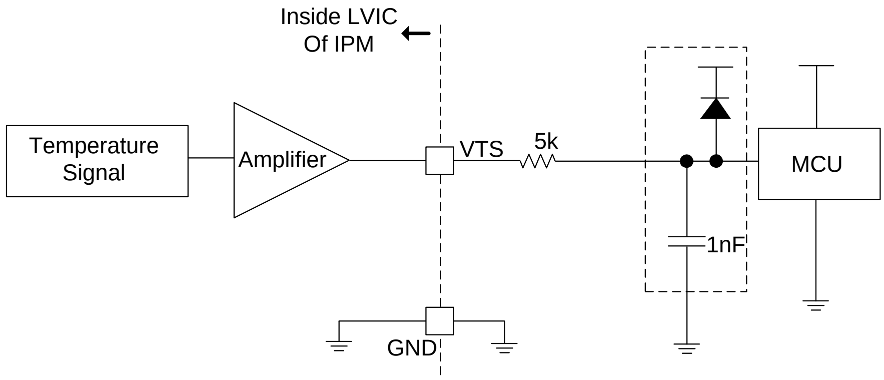


Figure 7 VTS output circuit

(1) It is recommended to insert RC(5kΩ+1nF) between VTS and MCU and the capacitor is placed to be close to MCU. This can make sure MCU detect a clean analog voltage signal.

(2) In the case of using VTS with low voltage controller like 3.3V MCU, VTS output might exceed control supply voltage 3.3V when the temperature rises excessively. If system uses low voltage MCU, it is recommended to insert a clamp Diode between control supply of the MCU and the VTS input signal to MCU.

(3) In the case of not using VTS, leave VTS output no connection.

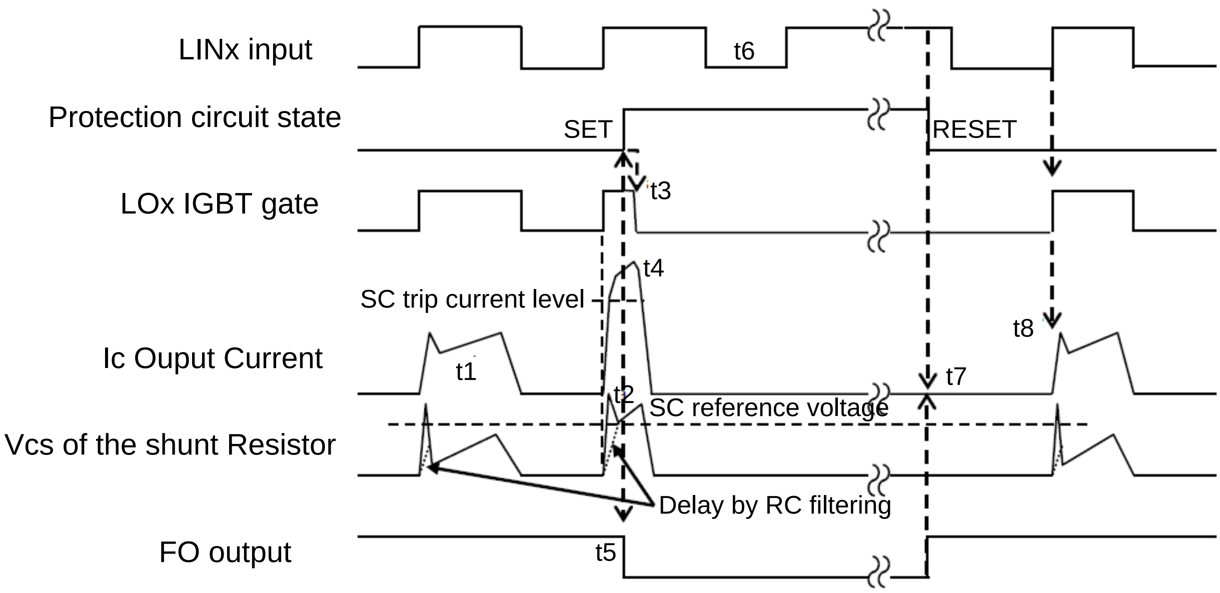
MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Condition		Min.	Typ.	Max.	Unit
Mounting torque	Mounting screw: M3	Recommended 0.69N*m (Note 8)	0.59	0.69	0.78	N*m
Weight				8.5		g
Heat-sink flatness			-50		100	um

Note 8: Do not make over torque when mounting screws. Much mounting torque may cause package crack, as well as bolts and Al heat-sink destruction.

Function Descriptions

1. Timing Chart of Short-Circuit Protection (Low side Only with external shunt resistor and RC filter)



t1: Normal operation: IGBT ON and outputs current.

t2: Short circuit current detection (SC trigger)

(It is recommended to set RC time constant 1.5~2.0us so that IGBT shut down within 2.0us when SC.)

t3: All low side IGBT's gates are hard shutdown.

t4: All low side IGBTs turn OFF.

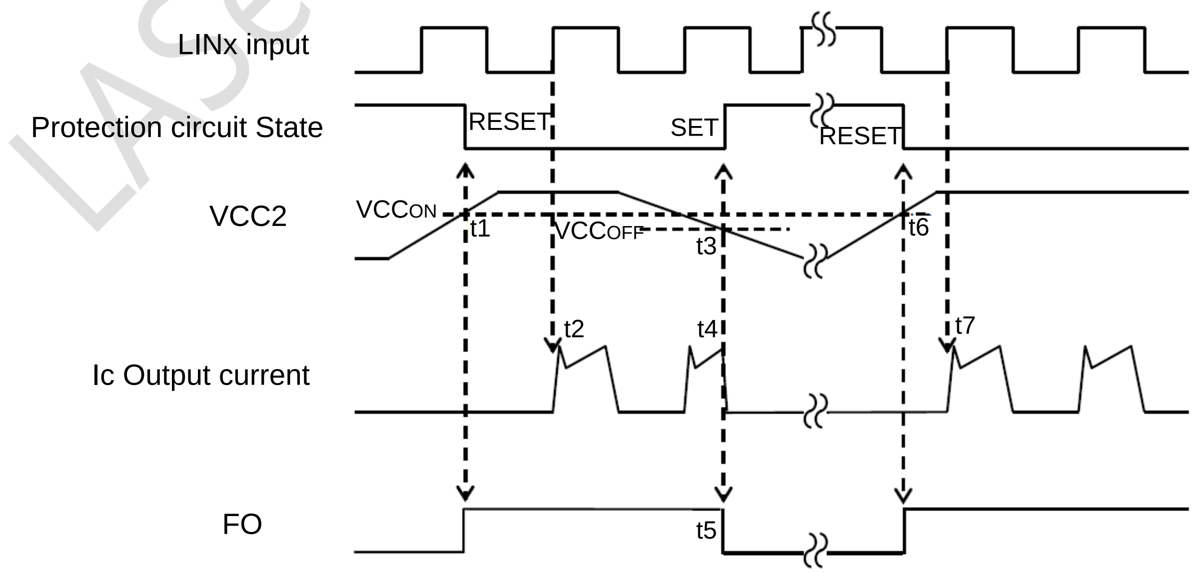
t5: FO outputs for t_{FO}=minimum 20us, typical 65us.

t6: Input=Low: IGBT OFF.

t7: FO finishes output, but IGBTs don't turn on until inputting next ON signal(L→H).

t8: Normal operation: IGBT ON and outputs current.

2. Timing Chart of Under-Voltage Protection (Low side, VCC2_UVLO)



t1: VCC2 exceeds under voltage reset level (VCC_{ON}), but IGBT turns ON by next ON signal (L→H). (IGBT of each phase can return to normal state by inputting ON signal to each phase.)

t2: Normal operation: IGBT ON and outputs current.

t3: VCC level drops to under voltage trip level. (VCC_{OFF})

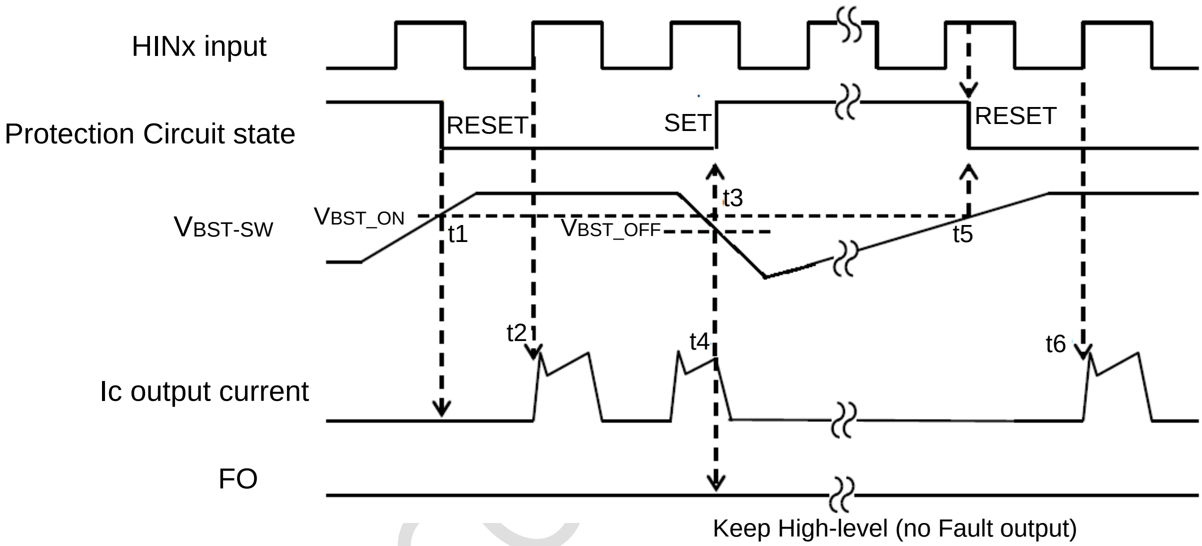
t4: All low side IGBTs turn OFF in spite of LINx condition.

t5: FO outputs for t_{FO}=minimum 20us, typical 65us, but FO output is extended during VCC keeps below VCC_{ON}.

t6: VCC level reaches VCC_{ON}.

t7: Normal operation: IGBT ON and outputs current.

3. Timing Chart of Under-Voltage Protection (High side, $V_{BST\text{-}SW}$_UVLO)



t1: $V_{BST\text{-}SW}$ rises. After the voltage reaches under voltage reset level V_{BST_ON}, IGBT turns on by next ON signal (L→H).

t2: Normal operation: IGBT ON and outputs current.

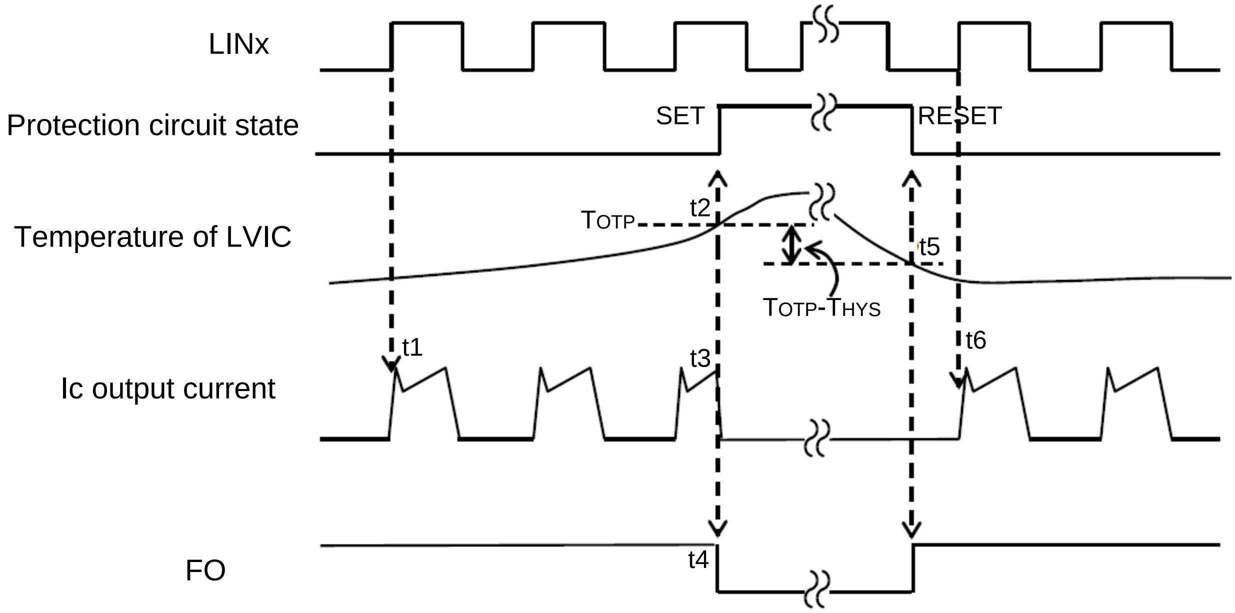
t3: $V_{BST\text{-}SW}$ level drops to under voltage trip level V_{BST_OFF}.

t4: IGBT of the correspond phase only turns OFF in spite of HINx input signal, but there is no FO signal output.

t5: $V_{BST\text{-}SW}$ level reaches V_{BST_ON}.

t6: Normal operation: IGBT ON and outputs current.

4. Timing Chart of Over Temperature Protection (low side, Detecting LVIC temperature)



t1: Normal operation: IGBT ON and outputs current.

t2: LVIC temperature exceeds over temperature trip level (T_{OTP}).

t3: All low side IGBTs turn OFF in spite of LINx input condition.

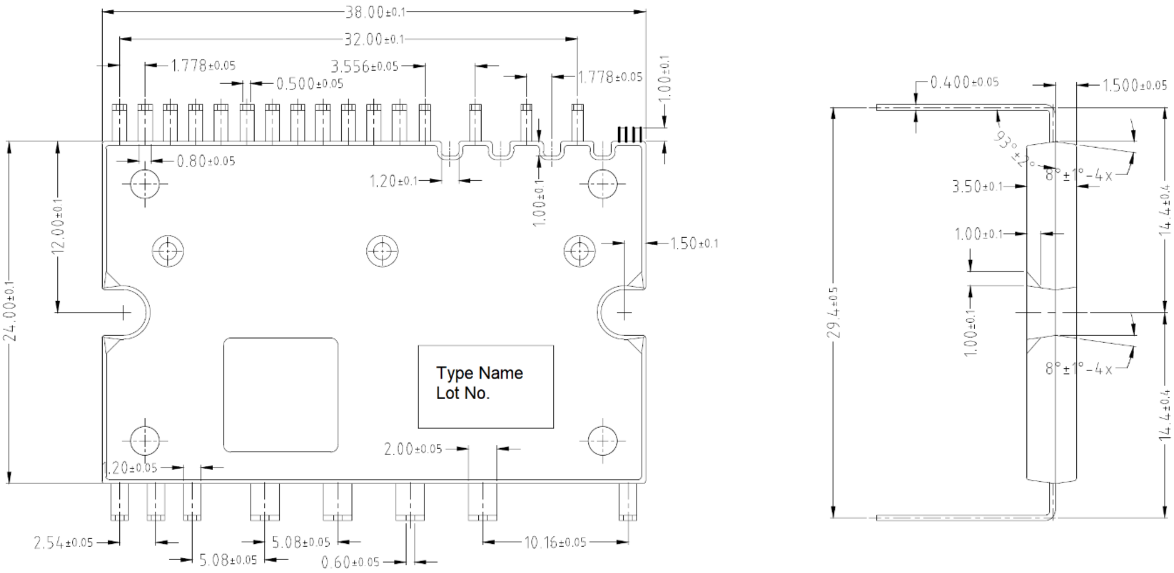
t4: FO outputs for t_{FO}=65us typ, but output is extended during LVIC temperature keeps over T_{OTP}-T_{HYS}.

t5: LVIC temperature drops to over temperature reset level.

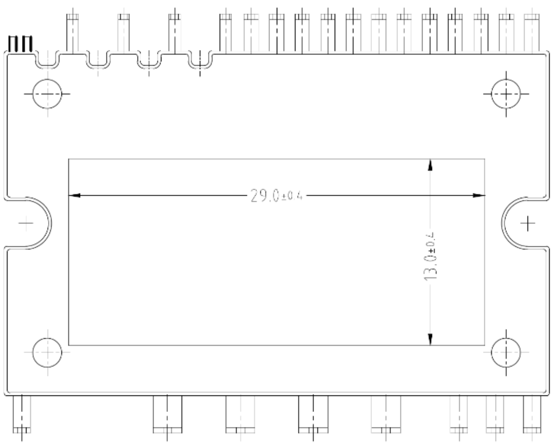
t6: Normal operation: IGBT turns on by next ON signal (L→H). (IGBT of each phase can return to normal state by inputting ON signal to each phase.)

Detail Package Outline Drawing

Package type: DIP25



Bottom View



Top View