

Gate Driver Module 2DMB51507CC

■ Overview

Gate driver 2DMBxxxxCC is a dual channel gate driver designed for IGBT and SiC MOSFET.

The high breakdown voltage and low parasitic capacitance make it suitable for gate drives such as SiC MOSFET and IGBT.

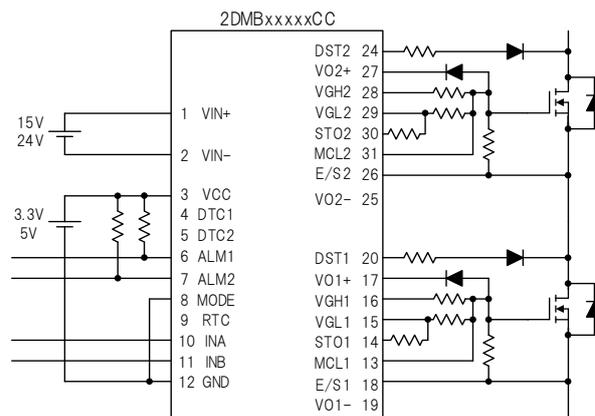
■ Features

- Ideal for drive of IGBT and SiC MOSFET
- Gate voltage : +15V/-15V
- ALL-IN-ONE (Built-in isolated DC / DC converter and gate drive circuit)
- Low parasitic capacitance (about 12pF) ; highly resistant to common-mode noise.
- Fast response : about 100nsec(typ)
- The isolation for primary-secondary signal used fast response isolator.
- Input-to-Output dielectric withstand voltage : AC5000V
- Output CH1-to-Output CH2 dielectric withstand voltage : AC4000V
- Input-to-Output insulation distance : 14mm (clearance·creepage)
- Output CH1-to-Output CH2 insulation distance : 7mm (clearance), 12mm(creepage)
- DC/DC converter input voltage : 13~28V
- Signal input voltage : 3.3V,5V
- Overload protection (DC/DC converter)
- Overheat protection (DC/DC converter)
- Half bridge mode (Gate drive circuit)
- Desaturation protection (Gate drive circuit)
- Soft turn-off function (Gate drive circuit)
- Fault signal output function (Gate drive circuit)
- Miller clamp function (Gate drive circuit)
- Under-voltage lockout(UVLO) (Gate drive circuit)
- Safety standards:UL508(file no.E243511) (DC/DC converter only)
- Reinforced isolation according to IEC 60664-1 (IEC61800-5-1, IEC62477-1, IEC62109-1, etc.)
- UL compliant (UL1741, UL508, etc.)

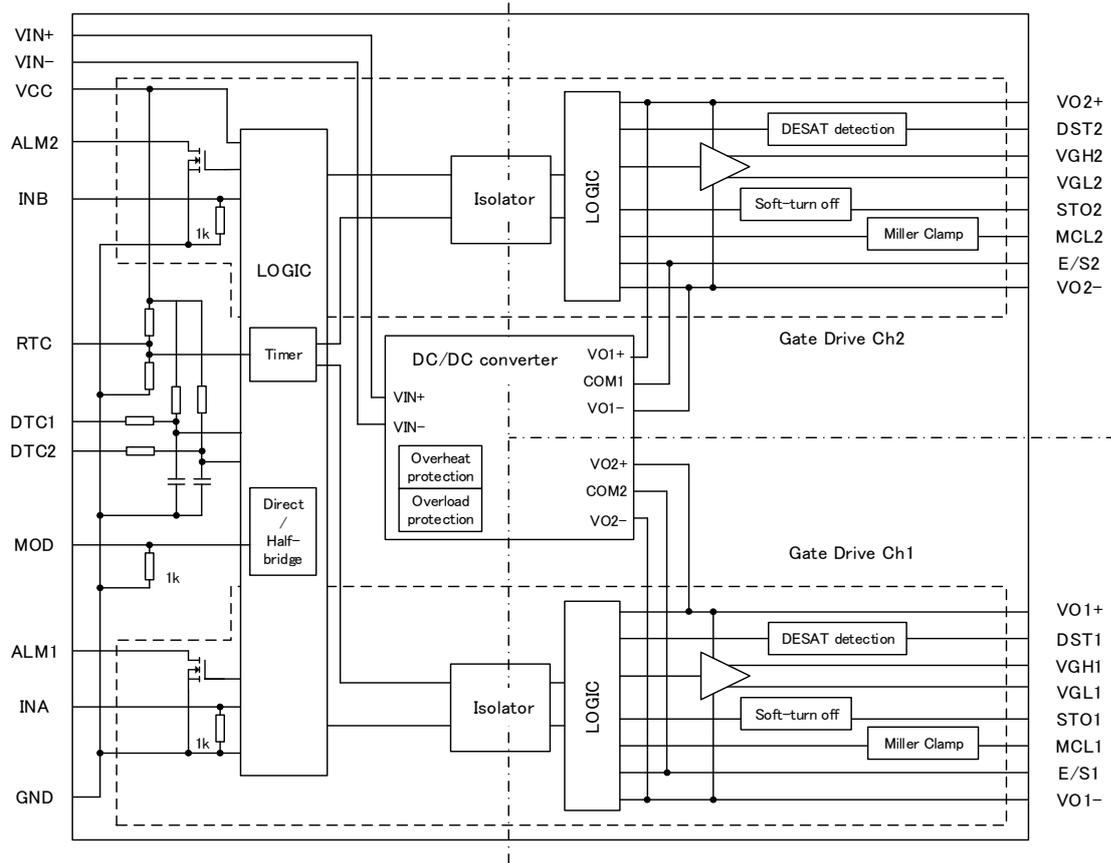
■ Application

Industrial inverter, power conditioner, etc ...

■ Circuit Image



Internal Block Diagram



Pin Connection

Input

Pin No.	Name	CH	Function
1	VIN+	Common	Power supply for DC/DC converter(+)
2	VIN-	Common	Power supply for DC/DC converter(-)
3	VCC	-	Power supply for drive circuit
4	DTC1	1	Dead time adjustment
5	DTC2	2	Dead time adjustment
6	ALM1	1	Alarm signal output
7	ALM2	2	Alarm signal output
8	MOD	-	Mode select
9	RTC	-	Recovery time of protection circuit cont
10	INA	1	Control input A
11	INB	2	Control input B
12	GND	-	Ground for drive circuit

Output

Pin No.	Name	CH	Function
13	MCL1	1	Miller clamp pin
14	STO1	1	Soft turn off pin
15	VGL1	1	Gate OFF side pin
16	VGH1	1	Gate ON side pin
17	VO1+	1	DC/DC converter output pin
18	E/S1	1	Emitter·source connection pin
19	VO1-	1	DC/DC converter output pin
20	DST1	1	Desaturation protection pin
21	NONE	-	None
22	NONE	-	None
23	NONE	-	None
24	DST2	2	Desaturation protection pin
25	VO2-	2	DC/DC converter output pin
26	E/S2	2	Emitter·source connection pin
27	VO2+	2	DC/DC converter output pin
28	VGH2	2	Gate ON side pin
29	VGL2	2	Gate OFF side pin
30	STO2	2	Soft turn off pin
31	MCL2	2	Miller clamp pin

■I/O Condition Table

No.	Status	Input						Output(CH2)					Output(CH1)				
		VO+	DST2	DST1	MOD	INB	INA	ALM2	VGH2	VGL2	STO2	MLC2	ALM1	VGH1	VGL1	STO1	MLC1
1	VOx+ UVLO	UVLO	X	X	X	X	X	L	Hi-Z	Hi-Z	L	L	L	Hi-Z	Hi-Z	L	L
4	Normal operation (Direct Mode)	○	X	L	L	X	L	X	X	X	X	X	Hi-Z	Hi-Z	L	L	L
5		○	X	L	L	X	H	X	X	X	X	Hi-Z	H	Hi-Z	Hi-Z	Hi-Z	
2		○	L	X	L	L	X	Hi-Z	Hi-Z	L	L	L	X	X	X	X	X
3		○	L	X	L	H	X	Hi-Z	H	Hi-Z	Hi-Z	Hi-Z	X	X	X	X	X
6	Normal operation (Half-bridge Mode)	○	L	L	H	L	X	Hi-Z	Hi-Z	L	L	L	Hi-Z	Hi-Z	L	L	L
7		○	L	L	H	H	L	Hi-Z	H	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Hi-Z	L	L	L
8		○	L	L	H	H	H	Hi-Z	Hi-Z	L	L	L	Hi-Z	H	Hi-Z	Hi-Z	Hi-Z
9	Desaturation protection1	○	L	Hi-Z	L	X	L	Hi-Z	X	X	X	X	Hi-Z	Hi-Z	L	L	L
10		○	L	Hi-Z	L	X	H	Hi-Z	X	X	X	X	L	Hi-Z	Hi-Z	L	L
11		○	L	Hi-Z	H	H	L	Hi-Z	H	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Hi-Z	L	L	L
12		○	L	Hi-Z	H	H	H	Hi-Z	Hi-Z	L	L	L	L	Hi-Z	Hi-Z	L	L
13	Desaturation protection2	○	Hi-Z	L	L	L	X	Hi-Z	Hi-Z	L	L	L	Hi-Z	X	X	X	X
14		○	Hi-Z	L	L	H	X	L	Hi-Z	Hi-Z	L	L	Hi-Z	X	X	X	X
15		○	Hi-Z	L	H	H	L	L	Hi-Z	Hi-Z	L	L	Hi-Z	Hi-Z	L	L	L
16		○	Hi-Z	L	H	H	H	Hi-Z	Hi-Z	L	L	L	Hi-Z	H	Hi-Z	Hi-Z	Hi-Z

○ : VOx+ UVLO > UVLO, X : Don't care

■ Absolute Maximum Ratings

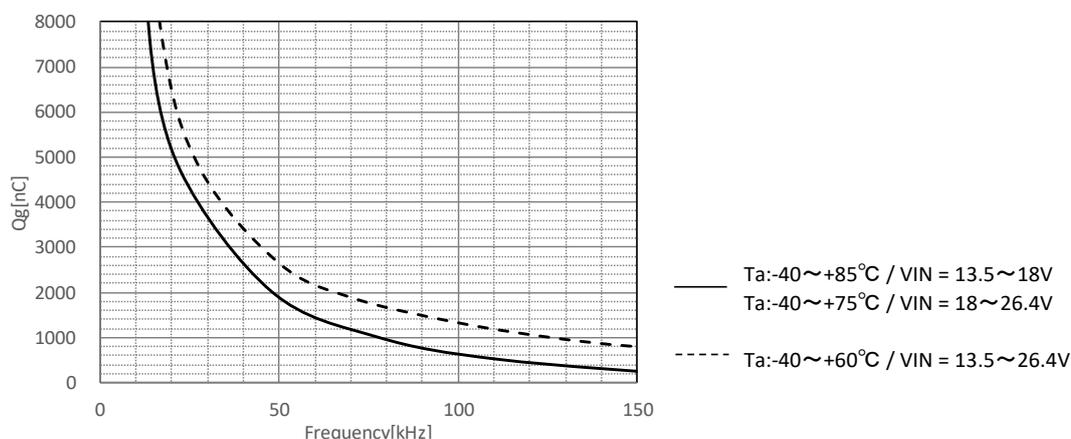
Item	Symbol	Min	Max	Unit	Conditions·Note	
Input voltage for DC/DC converter	V_{IN}	-0.3	28	Vdc	Between VIN+ to VIN-	
Input-side signal voltage	V_{CC}, V_{SG}	-0.3	5.5	V	VCC, RTC, MOD, INA, INB	
	V_{ALM}	-0.3	28	V	ALM1, ALM2	
Input-side signal maximum current	I_{ALM}	-	5	mA	ALM1, ALM2	
DESAT pin input voltage	V_{DESAT}	-0.3	$V_{GH}+0.3$	V		
Miller clamp pin input voltage	V_{CLAMP}	$V_{GL}-0.3$	$V_{GH}+0.3$	V		
Maximum gate current	I_{GPEAK}	-	43	A		
DC/DC converter output power	P_{OUT}	-	3.3	W	Per output circuit	
Switching frequency	F_{SW}	-	150	kHz	See the permissible frequency curve	
Operating temperature range	$V_{IN}=13.5\sim18V$	T_{OP}	-40	85	°C	See the permissible frequency curve
	$V_{IN}=18\sim26.4V$	T_{OP}	-40	75	°C	
Operating humidity	RH_{OP}	20	95	%RH	No condensation	
Storage temperature range	T_{STG}	-40	90	°C		
Storage humidity	RH_{STG}	5	95	%RH	No condensation	

■ Recommended Operating Conditions

Item	Symbol	Min	Max	Unit	Conditions·Note
Input voltage range for DC/DC converter	V_{IN}	13.5	26.4	Vdc	
Input-side signal voltage range	V_{CC}, V_{SG}	3	5.5	Vdc	
Driver circuit number	N	-	2	-	
Logic high level input voltage	V_{SGH}	$V_{CC} \times 0.7$	-	V	MOD, INA, INB
Logic low level input voltage	V_{SGL}	-	$V_{CC} \times 0.3$	V	MOD, INA, INB
Source current of control signal	I_{SG}	5	-	mA	MOD, INA, INB $V_{SG}=5V$
Maximum gate drive capability (150 kHz)	Q_{MAX}	-	210	nC	Gate current (ave) = 31mA Reference value
Maximum gate drive capability (30 kHz)	Q_{MAX}	-	5000	nC	Gate current (ave) = 150mA Reference value
Maximum gate charge amount	Q_G	-	8000	nC	
Minimum input pulse width	t_{INMSK}	80	-	ns	

■ Permissible frequency curve

Total gate charge (Qg) vs permissible frequency curve



Electrical Specification (Vin=24V, Vcc=5V, Ta=25°C, Unless otherwise specified)

Item	Symbol	Min	Typ	Max	Unit	Conditions·Note	
DC/DC converter							
Start-up voltage	V _{START}	-	-	13	V		
Input current	I _{IN}	-	0.4	-	A	F _{sw} =12kHz / Test load: 280nF	
Standby power	P _{STBY}	-	1.4	-	W	No load	
Logic inputs							
Logic high level input voltage	V _{SGH}	V _{CC} × 0.7	-	-	V	MOD, INA, INB / Guaranteed by design	
Logic low level input voltage	V _{SGL}	-	-	V _{CC} × 0.3	V	MOD, INA, INB / Guaranteed by design	
Logic pull-down resistance	R _{SGD}	-	1000	-	Ω	MOD, INA, INB	
Gate driver output							
Gate ON side pin / output voltage(+)	V _{GH} , V _{O+}	14	15	16	V	No load	
Gate OFF side pin / output voltage(-)	V _{GL} , V _{O-}	-16	-15	-14	V	No load	
Miller clamp voltage	V _{CLAMP}	-	1.2	-	V	I _{CLAMP} =500mA, Guaranteed by design	
Miller clamp ON threshold voltage	V _{CLPON}	-	V _{GL} +2	-	V		
Delay time	Turn ON time	t _{PON}	-	100	-	ns	
	Turn OFF time	t _{POFF}	-	100	-	ns	
Dead time	t _{DEAD}	-	4.1	-	us	Half bridge mode	

Protection

Item	Symbol	Min	Typ	Max	Unit	Conditions·Note
DC/DC converter						
Overload protection	-	8.8	-	-	W	Auto recovery
Overheat protection	-	120	-	150	°C	Auto recovery, Internal temperature
Gate driver						
Output voltage(H) UVLO OFF voltage	V _{UVLOGHH}	13.2	13.5	13.8	V	Guaranteed by design
Output voltage(H) UVLO ON voltage	V _{UVLOGHL}	12.2	12.5	12.8	V	Guaranteed by design
DESAT charge current	I _{DESAT}	200	240	280	uA	Guaranteed by design
DESAT detection voltage	V _{DESAT}	6.0	6.35	7.0	V	Guaranteed by design
DESAT detection filter time	t _{DSTFIL}	-	300	-	ns	
DESAT detection time	t _{DSTOUT}	-	350	-	ns	
Alarm signal output L voltage	V _{ALML}	-	-	0.5	V	I _{ALM} =5mA
Alarm signal output time	t _{ALM}	-	550	-	ns	
Restart time	t _{RESTART}	-	110	-	ms	
Soft turn off duration	t _{STO}	-	4	-	us	

■ Insulation

Item	Specification	Conditions·Note
Between Input-Output		
Dielectric withstand voltage	AC5000V	1min, Cutoff 2mA
Insulation resistance	100M Ω or more	DC500V
Partial discharge extinction volt.	1768V _{peak} or more	According to EN50178/IEC 60270
Common-mode transient immunity (CMTI)	70kV/us	
Minimum clearance distances	14mm	
Minimum creepage distances	14mm	
Between CH1-CH2		
Dielectric withstand voltage	AC4000V	1min, Cutoff 2mA
Insulation resistance	100M Ω or more	DC500V
Partial discharge extinction volt.	1700V _{peak} or more	According to EN50178/IEC 60270
Minimum clearance distances	7mm	
Minimum creepage distances	12mm	

■ Pin Function

- VIN+, VIN- (Power supply pin for DC/DC converter)
- VCC(Power supply pin for drive circuit)
- GND(Ground pin for drive circuit)

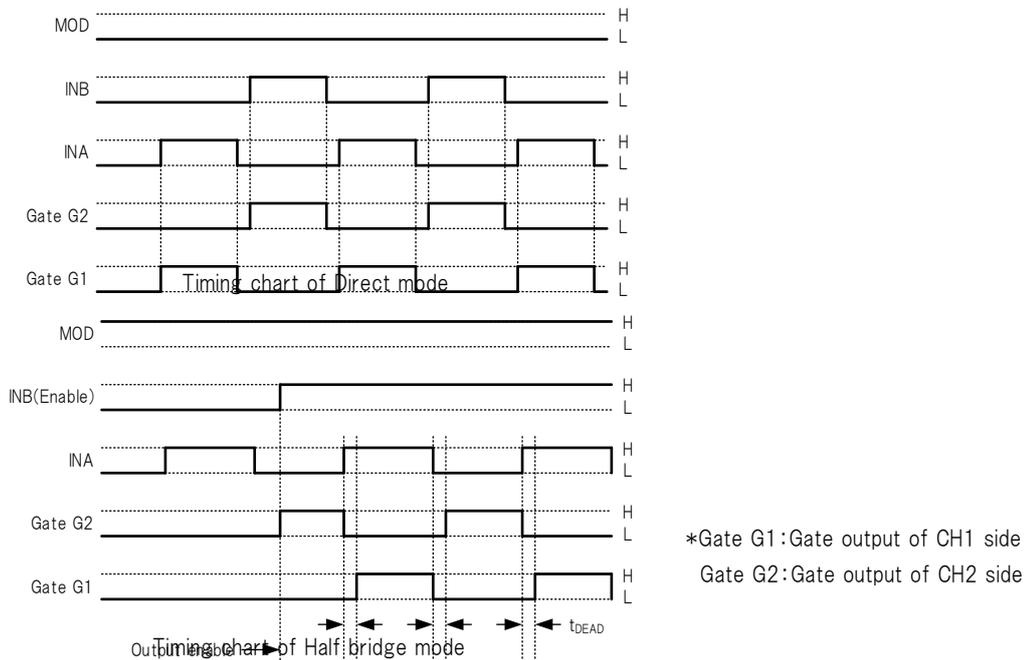
- MOD, INA, INB(Mode switching pin, Control input pin)

The INA, INB and MOD pin is a pin used to determine output logic.

Direct mode / Half bridge mode can be switched by MOD pin.

In Half bridge mode, it functions as INA: gate signal, INB: enable signal.

MOD	INB	INA	Gate G2 *	Gate G1 *	Mode
L	X	L	X	L	Direct mode
L	X	H	X	H	
L	L	X	L	X	
L	H	X	H	X	
H	L	X	L	L	Half bridge mode
H	H	L	H	L	
H	H	H	L	H	



- DTC1,2(Dead time adjustment pin)

When half-bridge mode, this pin is adjust the dead time of gate output G1,G2

- RTC(Recovery time of protection circuit control pin)

When abnormality occurs (UVLO, short circuit detected),this pin is used to adjust the recovery time.

·ALM1,2(Alarm signal output pin)

When abnormality occurs (UVLO, short circuit detected),This pin outputs an alarm signal. (Open drain)

Status	ALM1,2
While in normal operation	Hi-Z
UVLO, When detecting short circuit	L

·MCL1,2(Miller clamp pin)

The MCL pin is a pin for preventing increase in gate voltage due to the miller current of the power device connected to Gate pin.

·STO1,2(Soft turn off pin)

The STO pin is a pin for gradually decrease gate voltage in operating desaturation protection.

STO pin connect to the gate pin though a resistance value higher than the resistance value connected to VGL 1 and 2.

·VGL1,2(Gate OFF side pin)

The VGL pin is a pin for gate drive of low signal. VGL pin connect to the gate pin through gate resistor of OFF side.

·VGH1,2(Gate ON side pin)

The VGH pin is a pin for gate drive of high signal. VGH pin connect to the gate pin through gate resistor of ON side.

·E/S1,2(Emitter/source pin)

E/S pin connect to the emitter / source of the power device.

·VO1+,VO2+,VO1-,VO2-(DC/DC converter output pin)

The VO+,VO2+,VO1-,VO2- pin is a output pin of built-in DC/DC converter. If necessary, connect a capacitor.

·DST1,2(Desaturation protection pin)

The DESAT pin is a pin used to detect desaturation. When the DESAT pin voltage exceeds V_{DESAT} , the DESAT function will be activated. This may cause the IC to malfunction in an open state. To avoid such trouble, short-circuit the DESAT pin to the E/S pin if the desaturation protection is not used. In order to prevent the wrong detection due to noise, the noise mask time $t_{DESATFIL}$ is set.

■Description

1. Gate voltage rise prevention function (Miller clamp function)

If gate output $Gx=L$ and the Miller clamp pin voltage $< V_{CLPON}$, the internal MOSFET of the miller clamp pin turns on.

Gate Gx	MCL	Internal MOSFET of the MCL pin
L	Less than V_{CLPON}	ON
L	Not less than V_{CLPON}	OFF
H	X	OFF

2. Undervoltage Lockout (UVLO) function

The control circuit incorporates the undervoltage lockout (UVLO) function on the output voltage + sides.

When the output voltage+ drops to the UVLO ON voltage, the gate ON/OFF side pin and the ALM pin both will output the “L” signal.

When the output voltage+ rises to the UVLO OFF voltage, these pins will be reset.

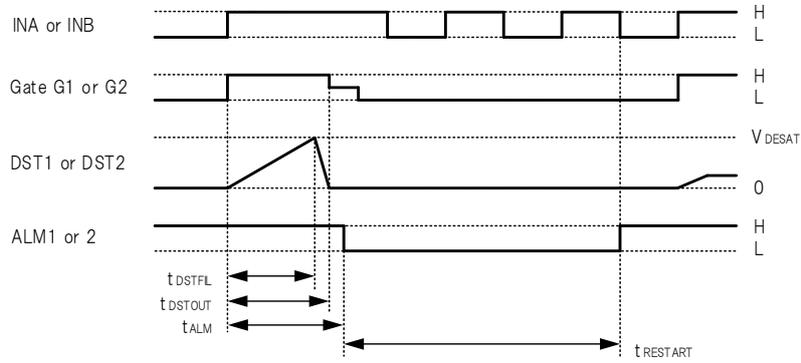
3. Short circuit protection function, Soft turn-off function

When the DESAT pin voltage exceeds V_{DESAT} , the short circuit protection function will be activated.

When the short circuit protection function is activated, the gate ON/OFF side pin will be set to the “Hi-Z” level, and then the ALM pin voltage to the “L” level.

Also, soft turn-off function works to reduce collector/drain voltage surge due to short circuit current.

Short-circuit protection is canceled automatically after an abnormal condition restart time and when the input signal is “L” level.



Timing chart of short circuit protection function

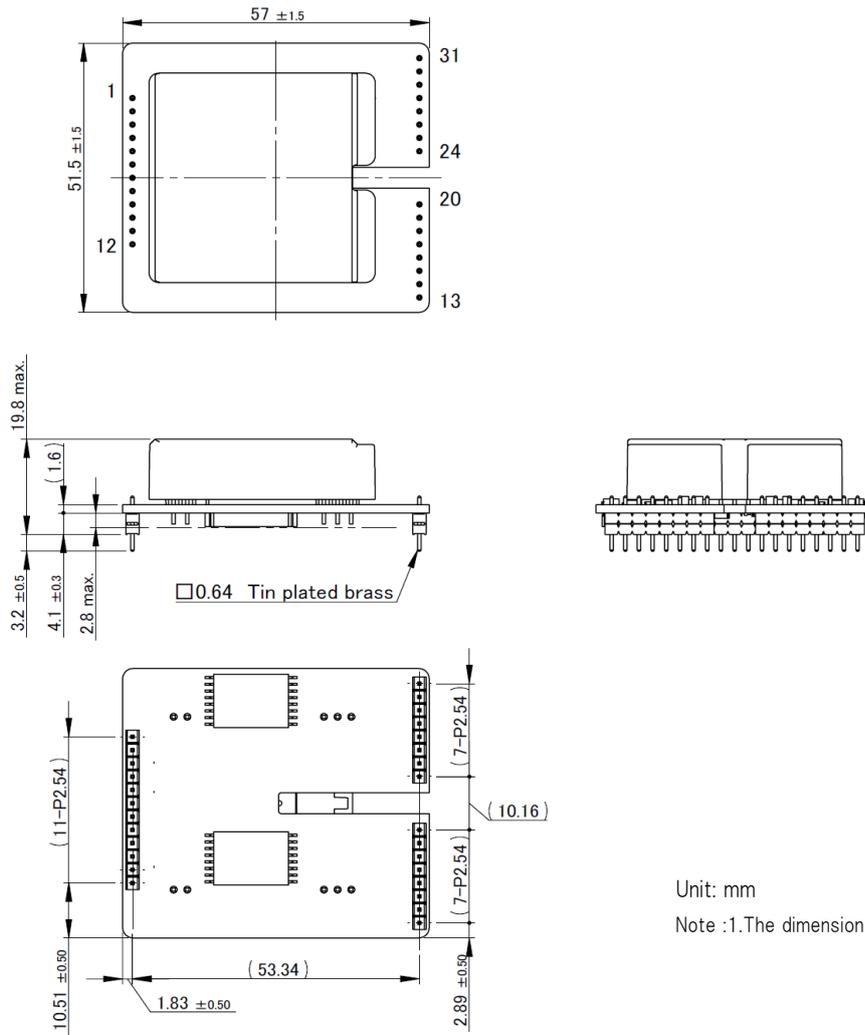
■ Reliability

Item	Test condition and acceptance criterion
Exposure in high temperature	IEC60068-2-2:2007: Test: Bb, 90°C, 240H, ※
Exposure in low temperature	IEC60068-2-1:2007: Test: Ab, -40°C, 240H, ※
Exposure in high temperature and high humidity	IEC60068-2-78:2012-10, 60°C, 90~95%RH, 240H, ※
Thermal shock	IEC60068-2-14:2009-01: Test: Na, -40°C/30min to 100°C/30min, 500cycles, ※
Low temperature operation	IEC60068-2-1:2007: Test: Ae, Input voltage: DC24V, Output current: Rated Load -40°C, 240H, ※
High temperature operation	IEC60068-2-2:2007: Test: Be, Input voltage: DC24V, Output current: Rated Load 85°C, 240H, ※
high temperature and high humidity operation	IEC60068-2-78:2012-10, Input voltage: DC24V, Output current: Rated Load 85°C, 85%RH, 240H, ※
Vibration	IEC 60068-2-6:2007-12, Frequency range: 10 to 55Hz, Sweep rate: 1.0oct/min, Displacement amplitude: ±0.75mm, Test duration: 120min, Axis: X,Y and Z, ※
	IEC 60068-2-6:2007-12, Frequency range: 5 to 200Hz, Sweep rate: 1.0oct/min, Cross-over frequency: 8.4Hz, , Displacement amplitude(5 to 8,4Hz): ±3.5mm, Acceleration amplitude(8.4 to 200Hz):1G, Test duration: 20sweeps, Axis: X, Y and Z, ※
Impact	IEC 60068-2-27:2008-02, Pulse shape: Half-sine, Corresponding duration: 11ms, Peak acceleration: 50G, Number of shocks:3, Axis: ±X, Y and Z, ※
	IEC 60068-2-27:2008-02, Pulse shape: Half-sine, Corresponding duration: 6ms, Peak acceleration: 15G, Number of shocks:100, Axis: ±X, Y and Z, ※
Solderability	Sample shall be dipped into the solution of Methanol and Rosin (having 75% Methanol and having 25% Rosin by weight measuring) and shall be dipped into the solder bath having the solder Sn-3Ag-0.5Cu of 250±5°C to the position to 3mm from the end of terminal for 3.0±0.5 seconds, and pulled up. After above treatment, the sample shall be covered by solder uniformly at more than 75% of circumference and shall not show any unusual appearance.
Resistance to soldering heat	Sample shall be dipped into the solution of Methanol and Rosin (having 75% Methanol and having 25% Rosin by weight measuring) and shall be dipped into the solder bath having the solder Sn-3Ag-0.5Cu of 260±5°C to the position to 3mm from the end of terminal for 10.0±0.5 seconds, and pulled up. After that sample shall be replace in normal ambient for 1~2 hours and shall not show any unusual appearance.

※After each test, exposure at room temperature and humidity condition for 24 hours.

There shall be no abnormality on the electrical specification and appearance.

■ Outline Dimensional Drawing



Unit: mm

Note :1.The dimensional tolerance without directions is ± 0.5 mm.

■ Product Weight

45g(TYP)

■Recommended Soldering Condition

- Flow soldering condition : 255±3°C Less than 3sec
Temperature of preheating 110°C~130°C
End temperature of preheating 110°C±10°C
- Soldering condition of hand work : 360°C(MAX) Less than 3sec

■Storage Conditions

Item	Min	Max	Unit	Conditions·Note
Storage temperature	-25	60	°C	A packing state

※If you want to use past the long period there is a concern that the solder non-wetting by terminal oxidation to occur.

Therefore, please use from taking enough tests.

■Usage Cautions

- Always mount fuse on the plus side of input for ensuring safety because the fuse is not built-in the product.
Please select the fuse considering conditions such as steady current, inrush current, and ambient temperature.
When using a fuse having large rated current or high capacity input electrolytic condenser, by combining another converter and input line and input electrolytic condenser, fuse may not blow off in the case of abnormality.
Do not combine high voltage line and fuse.
- Make sure the rise/fall time of the input signal is 500ns or less.
- This product has DESAT protection for arm short circuit and load short circuit protection.
However, even if this protection works, the IGBT may be damaged if abnormally high current occurs due to IGBT's characteristics variations or the load short-circuit mode during parallel operation.
To ensure safety, be sure to check the short-circuit current at the unit in which this product is integrated, and evaluate whether it can protect under the condition that there is no damage to the IGBT.

■ Important Notice

- This information and product are subject to change without prior notice for the purpose of improvements, etc.
Ensure that you are in possession of the most up-to-date information when using this product.
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- The circuit examples and part constants listed in this document are provided as reference for the verification of characteristics. You are to perform design, verification, and judgment at your own responsibility, taking into account the various conditions.
- TAMURA has evaluated the efficiency and performance of this product in a usage environment determined by us.
Depending on your usage environment or usage method, there is the possibility that this product will not perform sufficiently as shown in the specifications, or may malfunction.
When applying this product to your devices or systems, please ensure that you conduct evaluations of their state when integrated with this product. You are responsible for judging its applicability.
TAMURA bears no responsibility whatsoever for any problems with your devices, systems or this product which are caused by your usage environment or usage method.
- TAMURA Corporation constantly strives to improve quality and reliability, but malfunction or failures are bound to occur with some probability in power products. To ensure that failures do not cause accidents resulting in injury or death, fire accidents, social damage, and so on, you are to thoroughly verify the safety of their designs in devices and/or systems, at your own responsibility.
- This product is intended for use in consumer electronics (electric home appliances, business equipment, Information equipment, communication terminal equipment, measuring devices, and so on.) If considering use of this product in equipment or devices that require high reliability (medical devices, transportation equipment, traffic signal control equipment, fire and crime prevention equipment, aeronautics and space devices, nuclear power control, fuel control, in-vehicle equipment, safety devices, and so on), please consult a TAMURA sales representative in advance. Do not use this product for such applications without written permission from TAMURA Corporation.
- This product is intended for use in environments where consumer electronics are commonly used.
It is not designed for use in special environments such as listed below, and if such use is considered, you are to perform thorough safety and reliability checks at your own responsibility.
 - Use in liquids such as water, oil, chemical solutions, or organic solvents, and use in locations where the product will be exposed to such liquids.
 - Use that involves exposure to direct sunlight, outdoor exposure, or dusty conditions.
 - Use in locations where corrosive gases such as salt air, C12, H2S, NH3, SO2, or NO2, are present.
 - Use in environments with strong static electricity or electromagnetic radiation.
 - Use that involves placing inflammable material next to the product.
 - Use of this product either sealed with a resin filling or coated with resin.
 - Use of water or a water soluble detergent for flux cleaning.
 - Use in locations where condensation is liable to occur.
- This product is not designed to resist radiation.
- This product is not designed to be connected in series or parallel.
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