1SP0635D2S1R-CM1200HC-66X
SCALE™-2 Family

Peripheral Gate Driver for 3300 V IGBT modules

Product Highlights

Highly Integrated, Compact Footprint

- Ready-to-use gate driver solution for power modules up to 3300 V blocking voltage
- Applicable for paralleling of up to 3 power modules
- Optimized for Mitsubishi's Half-Bridge Power Modules CM-1200HC-66X
- -40 °C to +85 °C operating ambient temperature
- Optical status indicator

Protection / Safety Features

- Undervoltage lock-out (UVLO) protection
- Short circuit protection
- Dynamic Advanced Active Clamping (DA²C)
- Applied double sided conformal coating (by using ELPEGUARD SL 1307 FLZ/2 from Lackwerke Peters)

Applications

- Railway inverter
- Industrial drives
- Other industrial applications

Description

This datasheet describes the peripheral driver of the main driver 1SP0630xM1R gate driver family.

The peripheral driver is designed for operation of power modules with a blocking voltage of up to 3300 V.

It enables easy paralleling of up to three power modules (one main driver and two peripheral drivers) providing high flexibility and system scalability with minimum development effort.

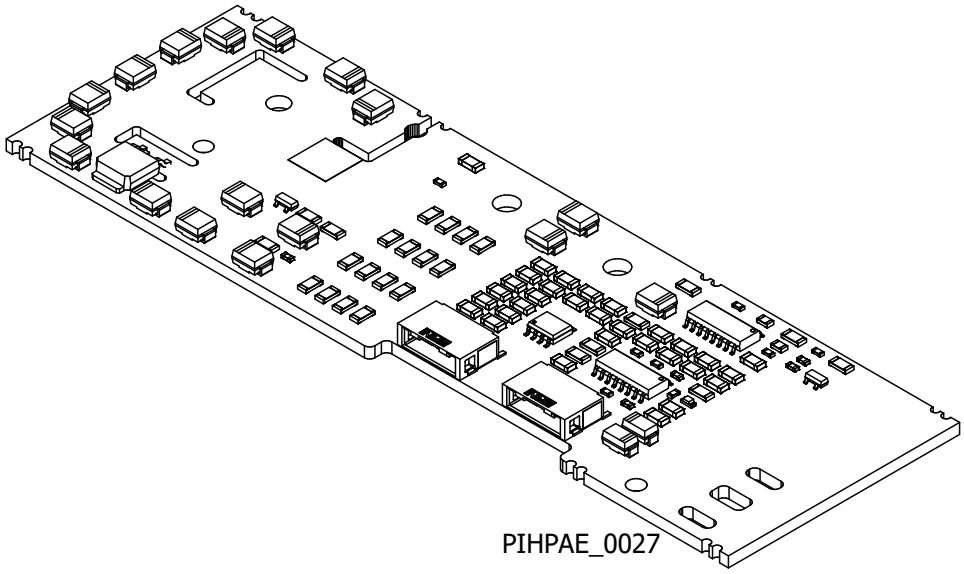

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Figure 1. 3D-Picture.

Pin Functional Description

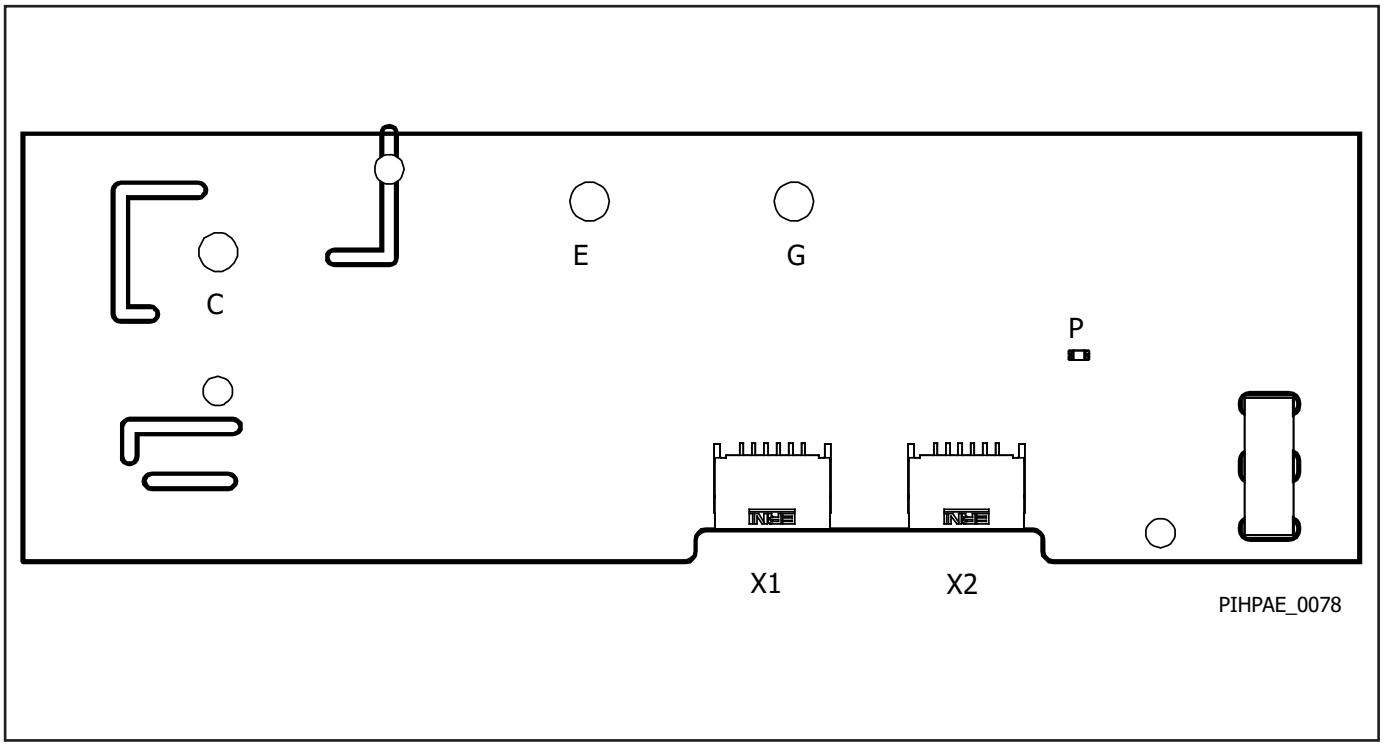

Figure 2. 1SP0635D2S1R-CM1200HC-66X interfaces.

Connection to Main or another Peripheral Driver (Connector X1 and X2)

ERNI interface to connect peripheral driver to main driver or to another peripheral driver.

Part number: Erni 505018, 6 pin, right angle.

VISO (Pin 1)

This pin provides secondary side positive supply voltage.

COM (Pin 2, 4)

This pin provides secondary side negative supply voltage.

Command signal (Pin 3)

This pin is the input for logic command signal.

NC (Pin 5)

This pin is not connected.

Gate Monitoring (Pin 6)

This pin is the output pin for gate monitoring.

Note: X1 and X2 are interchangeable.

Connection to Semiconductor

Terminal G

Gate contact of switch.

Terminal E

Auxiliary emitter contact of switch.

Terminal C

Auxiliary collector contact of switch.

Optical Indicator

P

Green LED for monitoring the status output. During fault state the indicator is turned off.

Functional Description

The basic topology of the 1SP0635D2S1R driver is shown in Figure 3. This driver can only be used together with main driver when parallel connection of IGBT modules is required. This driver can be connected via paralleling interface X1 and X2 to a main driver or to another peripheral driver. Up to two peripheral drivers (and a main driver) can be directly connected in parallel. The X1 and X2 interfaces are fully identical.

The driver is equipped with the following features:

- Power supply monitoring
- Dynamic Advanced Active Clamping DA²C (overvoltage protection at turn-off)
- Gate monitoring
- Paralleling interfaces X1, X2 for the main-peripheral connection or peripheral-peripheral

The power supply as well as the input signal are provided by the main driver. No fiber optics are present on this driver. Moreover, no desaturation protection is implemented, as it is already implemented on the main driver.

Its Plug-and-Play capability means that it is ready to operate immediately after mounting. The user does not need to invest any effort in designing or adjusting the driver to a specific application.

Description of X1 and X2

The paralleling interfaces X1 and X2 are available on the gate driver. They allow the following to be connected:

- A peripheral driver to the main driver
- A peripheral driver to another peripheral driver

The following signals are available on this interface X1 and X2:

- Supply voltage from the main to the peripheral. (The main driver is connected to the DC/DC converter.)
- Drive signal from the main to the peripheral. The drivers are configured so that all paralleled IGBT modules switch on and off synchronously.
- Gate-monitoring signal from the peripherals to the main driver

Note that there is no galvanic isolation for the power supply is implemented on the driver. Therefore, it is recommended to use the external DC-DC converter ISO6125R-33 for the power supply connected to the main driver.

Screw Terminals

The peripheral driver is mounted on top of the power module and fixed by screws.

Connection cables for X1 and X2

For recommended cables, please read the datasheet RLC-IMS-61-050-0 and RLC-PSI-41-050-0.

It is important to note that the paralleling cables as well as the supply cables carry high potential. The user is fully responsible to apply sufficient isolation to the delivered cables.

Power Supplies and electrical isolation

The power supply of 1SP0635D2S1R is delivered from the main driver via the paralleling interfaces X1 or X2. The insulation is provided by the external DC-DC converter.

However, an insulation of 200 V_{peak} is provided on the peripheral drivers. This allows dynamic voltage differences between parallel-connected drivers to be withstood in case the switching operation is not fully symmetrical.

The signal insulation is realized with a planar transformer.

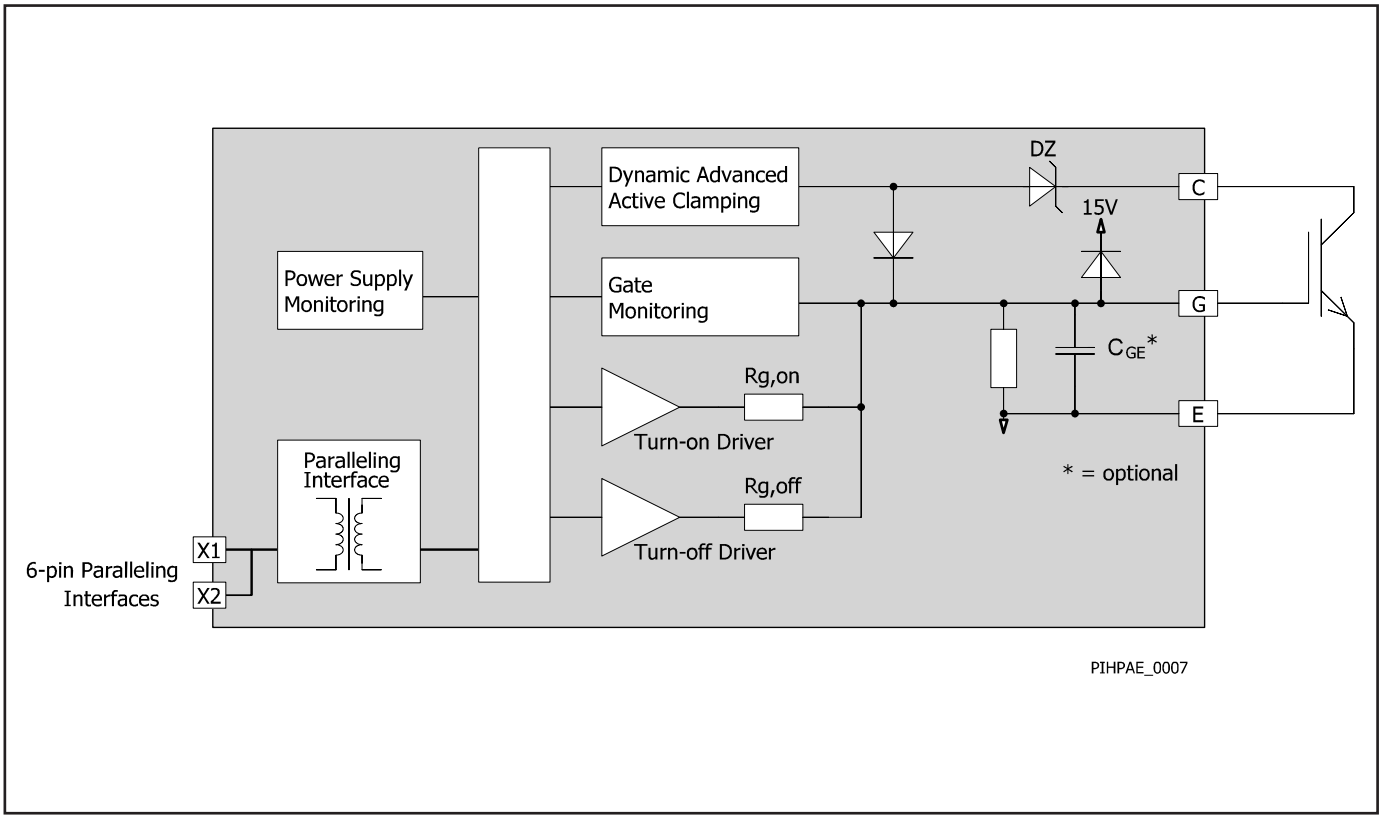

Figure 3. Functional Block Diagram.

Coreless common mode coils are placed in the supply conductors in order to limit the dynamic equalizing currents flowing from and to the main during not fully symmetrical switching operation. It is recommended to measure the resulting equalizing current flowing via the paralleling interface (see absolute maximum value).

Note that the peak value as well as the RMS value of the equalizing current can be reduced by inserting a ferrite core via the paralleling cables if required.

Short-Circuit detection

The main driver is detecting a SC and turns off the peripheral drivers synchronously. For more description, see data sheet of main driver.

Under Voltage detection

The peripheral drivers are equipped with a local undervoltage monitoring circuit. In case of a supply undervoltage, the corresponding IGBT is driven immediately with a negative gate voltage to keep it in the off-state (the channel is blocked). Only the corresponding IGBT is switched off immediately, and not all paralleled IGBTs. However, all other parallel connected IGBTs will be turned off by the gate monitoring function implemented on all drivers after the given delay (see Gate monitoring).

Gate monitoring fault

The peripheral driver is monitoring the gate voltage and reports it to the main driver. For more description, see data sheet of main driver.

Dynamic Advanced Active Clamping (DA^{2}C)

The peripheral driver is equipped with DA^{2}C . For more description, see data sheet of main driver.

Optical Indicators for Main and Peripheral

To facilitate verification, the drivers are each equipped with a green status LED. The LED light up under normal operation. A turned-off LED means that the respective driver is not supplied with voltage, the supply voltage is too low (main and peripheral drivers) or that the gate monitoring function has detected a fault condition (main driver). Moreover, in case of IGBT short-circuit, the LED on the main driver is switched off during the delay to clear the fault state (refer to timing information).

Parallel connection of Main Driver and Peripheral Driver

If parallel connection of two or three IGBT modules is required, one main as well as one to two peripherals must be used. The basic principle is illustrated in Figure 4. The electrical isolation of the power supply must be realized with a separate unit (e.g. DC-DC converter). The electrical isolation of the signals is realized on the main (fiber-optic interface for the input signal and the status feedback). The power supply of the peripheral as well as the input signal and gate monitoring feedback are transmitted to/from the peripheral and from/to the main via the interface bus connected to the paralleling interfaces X1 and/or X2 respectively. Both interfaces X1 and X2 are fully identical and interchangeable on the main as well as on the peripheral. The paralleling interface X1 or X2 makes sure that all paralleled drivers switch on and off synchronously.

Mechanical Considerations while using Main Driver and Peripheral Driver

It is important to ensure the symmetrical operation of the parallel connected IGBT modules.

In order to drive parallel connected IGBT modules, it is important – like in every parallel connection of IGBT modules – to ensure their symmetrical operation. The following points must especially be considered:

- The converter should be constructed as symmetrically as possible with respect to the paralleled IGBT modules in order to ensure symmetrical operation. The DC-link stray inductance of each paralleled IGBT module in particular should be similar ($L_{s1x} \approx L_{s2x}$, $L_{s5} \approx L_{s6}$ in Figure 5).
- It is important – except for the load terminals (L_{s5} and L_{s6}) to have a low-inductance connection between all paralleled IGBT modules. This avoids large voltage differences between these modules.
- Generally speaking, it is advantageous to keep the DC-link stray inductance of the converter low.
- Increasing the output inductances L_{s5} and L_{s6} helps to reduce the dynamic current imbalance during commutation.

Some power semiconductor manufacturers offer selected IGBT modules for parallel connection. If available, it is strongly recommended to use selected IGBT modules in order to avoid current imbalances during operation.

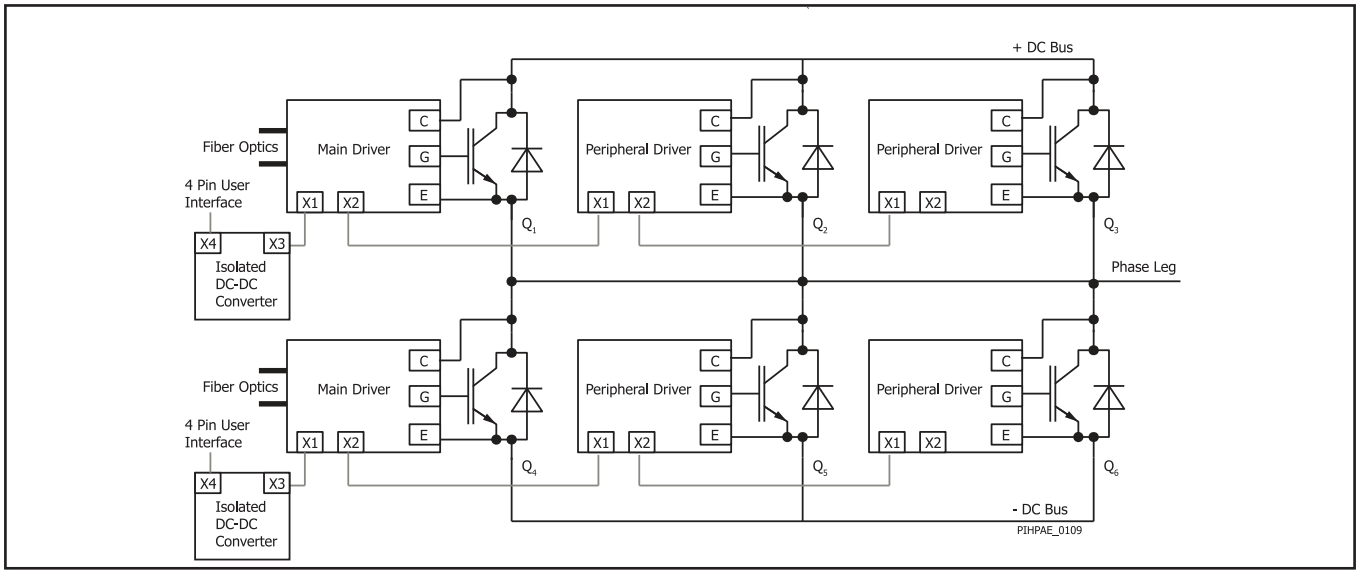

Figure 4. Principle of parallel connection of one main and two peripheral driver in half bridge configuration

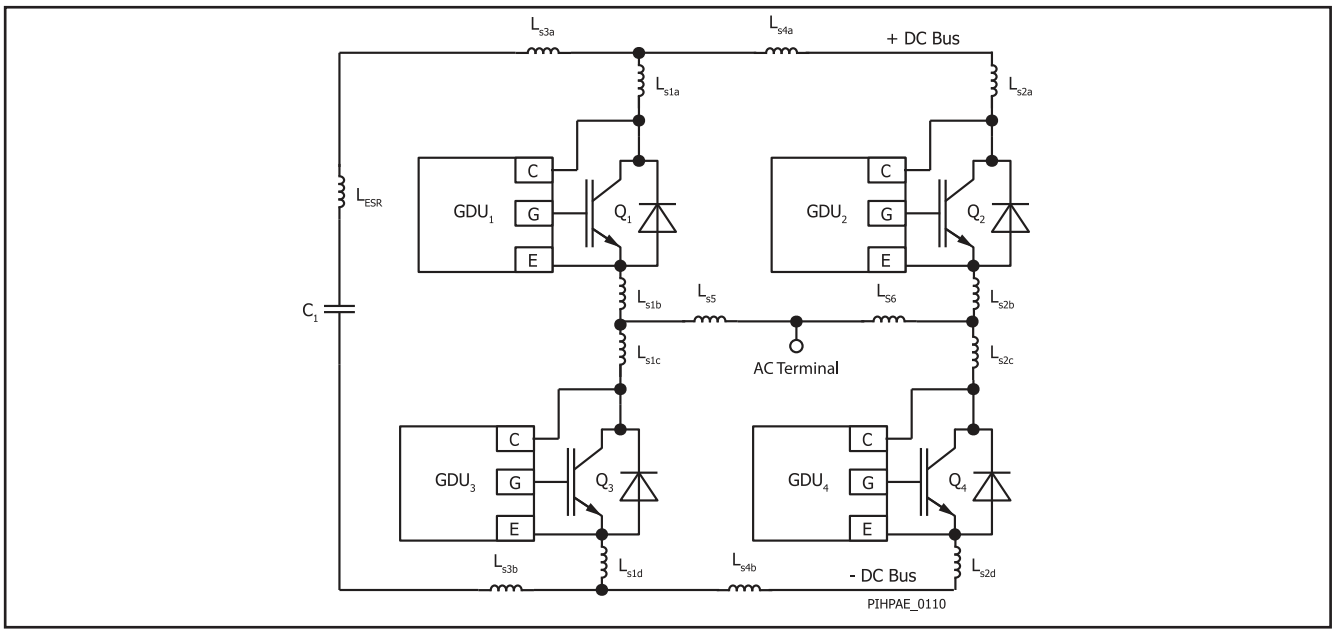

Figure 5. Half bridge topology with stray inductance.

Dynamic behavior of IGBT

The dynamic behavior of IGBT modules depends on their type and manufacturer due to the specific behavior of the included IGBT and diode chips, the particular module construction and the distribution of the internal gate resistances and inductances. Note that different module types from the same manufacturer may also require a specific gate-driver adaptation.

Power Integrations therefore supplies specific versions of SCALE-2 plug-and-play drivers adapted to the particular IGBT module. These drivers must not be used with IGBT modules other than those for which they were specified.

Turn-on of the IGBT / commutation of the diode current

When a driver input goes high (light on), the gate driver turns on the corresponding IGBT. The driver already includes the gate resistors, which are matched to the relevant IGBT module.

The driver is optimized to achieve minimum switching losses for the case of relatively low inductances within the power stack. It is recommended to check the commutation behavior within the final system assembly.

Turn-off of the IGBT

The IGBT is turned off when the corresponding input turns low (light off). The gate resistors are determined by Power Integrations and must not be altered.

Fast turn-off of the IGBT may cause overvoltage, which increases with DC-link voltage or load current. The turn-off overvoltage can be approximated by:

$V_{tr}=L_S \times di_C/dt$

where V_{tr} is the turn-off overvoltage, i_c the collector current and L_s the stray inductance.

Overvoltage limitation at turn-off is essential for high-power or high-voltage IGBTs. To solve this problem, SCALE-2 plug-and-play drivers provide a Dynamic Advanced Active Clamping function DA^{2}C.

3-level and multilevel topologies

If 1SP0635D2S1R drivers are to be used in 3-level or multilevel topologies, please refer to application note AN-0901.

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min	Max	Units
Absolute Maximum Ratings[1]					
Switching frequency[2]	f_{SW}	T_a < = 70 °C		10	kHz
Gate output power	P_G	T_a < = 85 °C		1.6	W
		T_a < = 70 °C		2.2	
Gate peak output current	I_G	Limited by the gate resistors	-35	35	A
DC-link voltage	$V_{DC\text{-}Link}$	Switching operation[3]		2200	V_{DC}
		Off State[4]		2700	
Operating voltage	V_{CE}			3300	V_{peak}
Emitter to emitter voltage[3]	$V_{E1\text{-}E2}$	Between parallel connected drivers		200	V_{peak}
Common-mode transient immunity	|dv/dt|	Between parallel connected drivers		50	kV/µs
Interface current (main driver to peripheral driver)	$I_{Interface}$	RMS value		4	A_{RMS}
		Peak value		20	A_{Peak}
Storage temperature[4]	T_{st}		-40	50	°C
Operating ambient temperature	T_A		-40	85	°C
Component surface temperature[5]	T			125	°C
Relative humidity	H_r	No condensation		93	%
Altitude of operation[6]	A_{op}			2000	m

Recommended Operating Condition

Parameter	Symbol	Conditions T_A = -40 °C to 85 °C	Min	Typ	Max	Units
Power Supply						
Supply voltage	$V_{VISO-COM}$	VISO-COM to GND	23.5	25	26.5	V

Characteristics

Parameter	Symbol	Conditions T_A = +25 °C, $V_{VISO-COM}$ = 25 V	Min	Typ	Max	Units
Power Supply						
Supply current	I_{VISO}	Peripheral driver only, without load		20		mA
		Peripheral driver only, 1.6 W, fsw=1.63 kHz, 50% duty cycle		90		
Mounting						
Mounting torque	$M_{Peripheral}$	Screw M4, as per IGBT datasheet	1		2	Nm
Bending	I_{bend}	According to IPC			0.75	%
Gate Output						
Turn-on gate resistor	$R_{G(on)}$	The gate resistors are determined to optimally match the power device characteristics		2.25		Ω
Turn-off gate resistor	$R_{G(off)}$			18.75		Ω
Auxiliary gate capacitor	C_{GE}			N.A.		nF

NOTES:

1. Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device.
2. Actually achievable maximum switching frequency has to be validated in final system as it is limited by maximum gate output power in conjunction with maximum allowed surface temperature.
3. Dynamic voltages between auxiliary emitters of parallel connected drivers at turn on and turn off lead to currents over the interface. The peak and RMS values of the resulting current must be limited to the given value.
4. The storage temperature inside the original package or in case the coating material of coated products may touch external parts must be limited to the given value. Otherwise, it is limited to 85°C
5. The component surface temperature, which may strongly vary depending on the operating condition, must be limited to the given value for coated driver versions to ensure long-term reliability of the coating material.
6. Operation above this level requires a voltage derating to ensure proper isolation coordination.

Product Dimensions

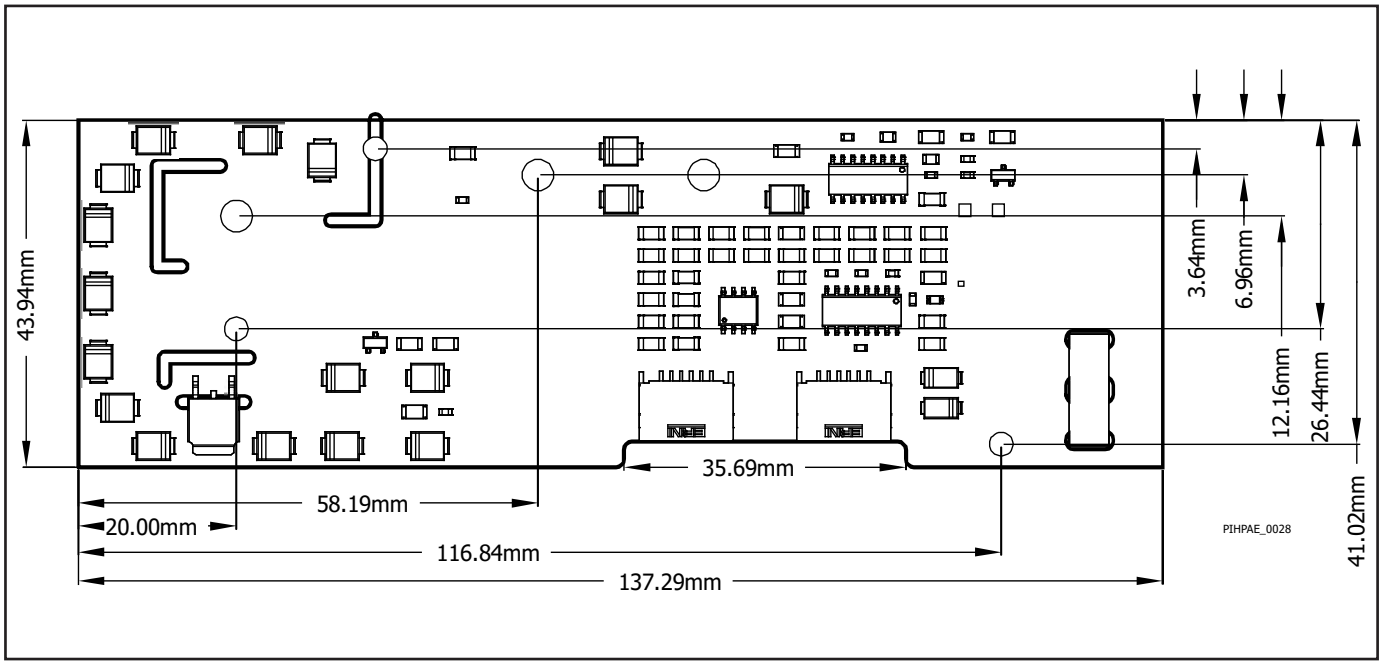

Figure 6. Top View.

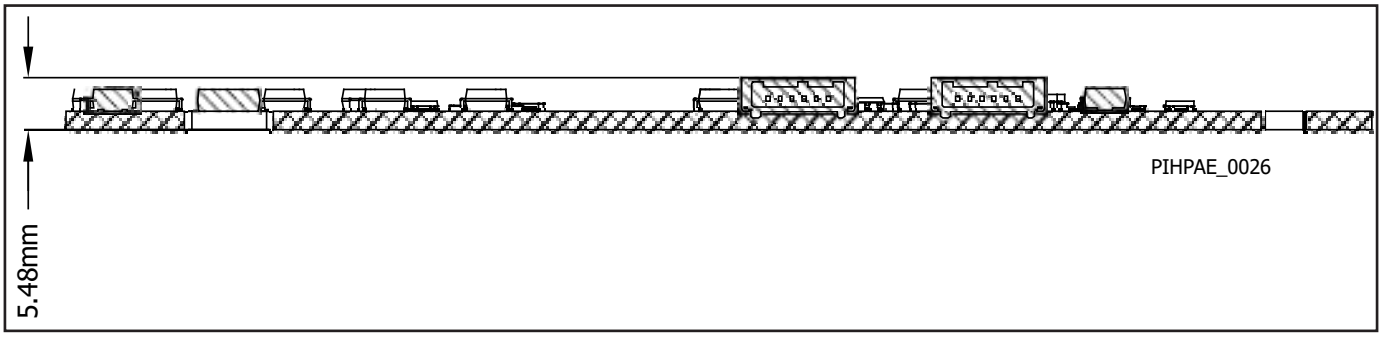

Figure 7. Side View.

Transportation and Storage Conditions

For transportation and storage conditions refer to Power Integrations' Application Note AN-1501.

RoHS Statement

We hereby confirm that the product supplied does not contain any of the restricted substances according Article 4 of the RoHS Directive 2011/65/EU in excess of the maximum concentration values tolerated by weight in any of their homogeneous materials.

Additionally, the product complies with RoHS Directive 2015/863/EU (known as RoHS 3) from 31 March 2015, which amends Annex II of Directive 2011/65/EU.

Notes

Revision	Notes	Date
A	Final Datasheet	06/21

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