2SIXT0112T2A0
SCALE™-2 Family

Plug-and-Play Gate Driver for 1200 V and 1700 V Half-Bridge Power Modules via Electrical Interface

Product Highlights

Highly Integrated, Compact Footprint

- Ready-to-use dual-channel gate driver solution optimized for XHP™2, HPnC and LV100 power modules
- 1 W output power per channel at maximum ambient temperature
- +15 / -8 A maximum gate current
- Isolated digital NTC readout signal
- Operation altitude up to 2000 m
- - 40 °C to 85 °C operating ambient temperature

Protection / Safety Features

- Short circuit protection ($V_{CE,SAT}$ monitoring)
- Undervoltage lock-out (UVLO) for primary and secondary sides

Comprehensive Safety Assurance

- 100 % production tests include both transformer partial discharge and HIPOT testing
- Creepage on PCB and transformer material and clearance distances between primary and secondary sides meets IEC 61800-5-1 reinforced for two-level applications with 1700 V power modules and basic isolation for three-level-applications with 1200 V power modules
- RoHS compliant

Application

- PV inverters
- Energy storage systems
- Wind converters

Description

The SCALE™-2 plug-and-play driver 2SIXT0112T2A0 is a compact dual-channel gate driver designed for the operation of XHP™2, HPnC and LV100 power modules in two and three-level PV application. The driver features an electrical interface, NTC read-out, and a built-in DC-DC power supply.

Figure 1. Exemplary Board Photo of 2SIXT0112T2A0.

Pin Functional Description

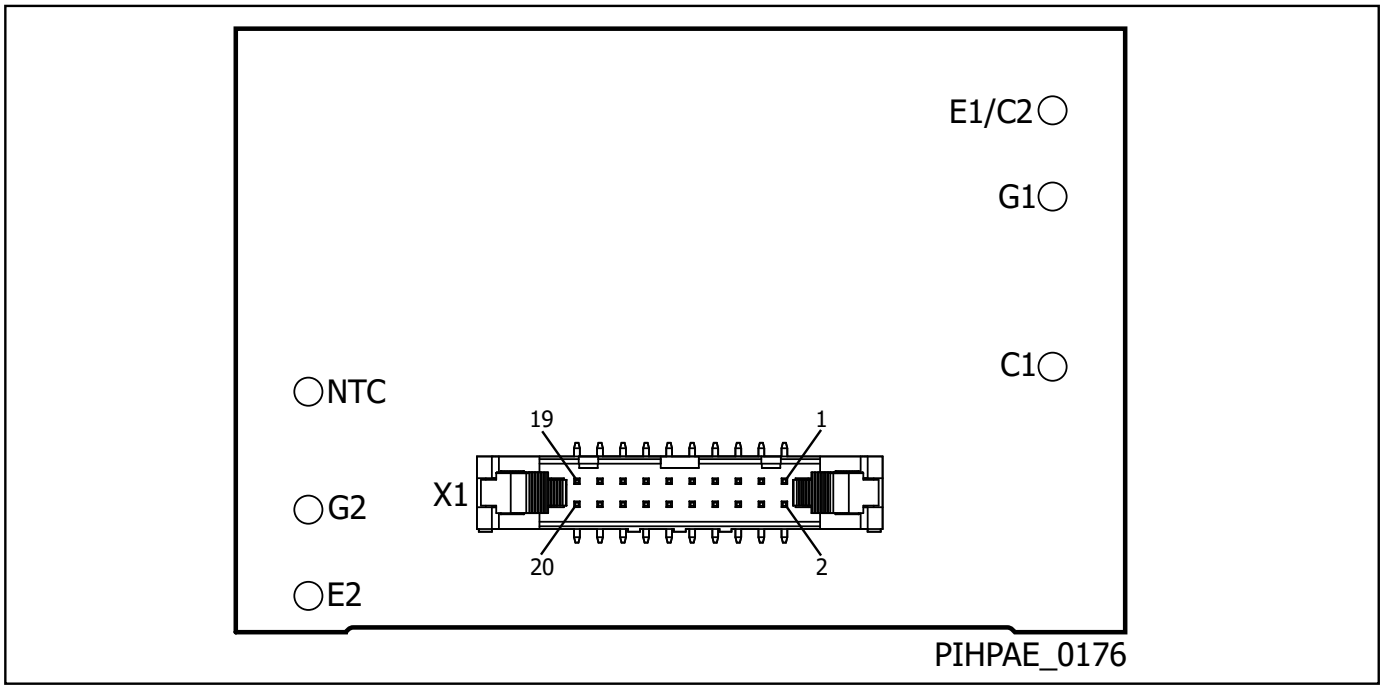

Figure 2. Pin Configuration.

Connector X1

CNC TECH 3010-20-003-13-00 Eject Latch Header Assembly (or similar) at X1; Connection from 2SIXT0112T2A0 to superior controller.

VCC (Pins 1, 3, 5, 7)
This pin is the primary-side 15 V supply voltage connection for the primary-side electronic and the integrated DC/DC converter.

IN1 (Pin 11)
This pin is the command input for channel 1 (high-side switch).

SO1 (Pin 9)
This pin is the status output for channel 1 (high-side switch).

IN2 (Pin 15)
This pin is the command input for channel 2 (low-side switch).

SO2 (Pin 13)
This pin is the status output for channel 2 (low-side switch).

NC (Pin 17)
This pin is not connected.

TPM (Pin 19)
This is the measurement output for the NTC temperature sensing.

GND (Pins 2, 4, 6, 8, 10, 12, 14, 16, 18, 20)
These pins are the connection for the primary-side ground potential. All primary-side signals refer to these pins.

Connections to Power Module

2SIXT0112T2A0 gate driver is are directly mounted to power modules using screws.

G1
This is the screw connection to the gate of the high-side IGBT.

C1
This is the screw connection to the collector of the high-side IGBT.

E1/C2
This is the screw connection to the emitter of the high-side IGBT and to the collector of the low-side IGBT.

G2
This is the screw connection to the gate of the low-side IGBT.

E2
This is the screw connection to the emitter of the low-side IGBT.

NTC
This is the screw connection to the NTC of the IGBT module.

Functional Description

The 2SIXT0112T2A0 is a dual channel Plug-and-Play gate driver for 1200 V and 1700 V half-bridge power modules that use XHP™2, HPnC and LV100 packages. The driver provides reinforced isolation between primary and secondary sides for 1700 V in 2-level application and basic isolation for 1200 V in 3-level applications. As plug-and-play gate driver, the 2SIXT0112T2A0 characteristics match the requirements of the individual power module.

Power Supplies (Primary-Side X1)

The 2SIXT0112T2A0 provides a power supply input. A typical supply voltage level of 15 V is required. The input VCC supplies the primary-side electronics of the gate driver and the integrated DC/DC converter, which generates the isolated voltage for the secondary-side gate driver channels. The positive rail of the gate driver channels has the voltage level V_{ISO}, while the negative rail is at V_{COM}. Both are referenced to the emitter potential at terminal E1 or E2 of the driven power semiconductor.

Undervoltage Monitoring

The supply voltages are closely monitored. In the event of an under voltage condition (UVLO), a failure signal will be provided on the status output SO1/SO2 of the gate driver. If the UVLO is present on the primary-side supply V_{VCC}, both status output signals will be set to GND and all gate driver channels will be turned off synchronously.

In case of an UVLO on the secondary-side, the status signal of the respective channel will be set to GND and the corresponding power semiconductor(s) will be turned off after the delay $t_{PD(SOx)}$.

Signal Inputs (Primary-Side X1)

The input logic of IN1 and IN2 is designed to work with 15 V logic levels to provide a sufficient signal/noise ratio. Both inputs have positive logic and are edge-triggered.

Gate driver signals are transferred from the IN1 and IN2 pins to the corresponding gate with a propagation delay of $t_{P(LH)}$ for the turn-on and $t_{P(HL)}$ for the turn-off commands.

Status Outputs (Primary-Side X1)

The status feedback signals SO1 and SO2 must be connected to VCC with external pull-up resistors. They remain at V_{VCC} under normal (no-fault) conditions. In case of a fault (e.g. detected short-circuit of the driven power module or an under voltage lock-out (UVLO) condition on the secondary-side), the status feedback is set to GND potential for a duration of t_{BLK}. In the case of a primary-side UVLO condition, both status feedback signals remain at GND during the UVLO and are extended by t_{BLK}. During this time, no gate signals will be transmitted to the respective gate driver channel.

Short-Circuit Protection

The 2SIXT0112T2A0 gate driver variant uses the semiconductor's desaturation effect to detect short-circuits.

The desaturation is monitored on the driver by using a resistor sensing network. The collector-emitter voltage is checked after the response time t_{RES} at turn-on to detect a short-circuit. If the voltage is higher than the programmed threshold voltage $V_{CE(SAT)}$, the driver detects a short-circuit condition. The monitored power semiconductor is switched off immediately and a fault signal is transmitted primary-side status.

It should be noted that the response time t_{RES} is dependent on the DC-link voltage. It remains constant between about 50 % to 100 % of the maximum DC-link voltage but increases at lower DC-link voltages. Please refer to the relevant data sheet section.
Note: The desaturation function is for short-circuit detection only and cannot provide over-current protection. However, over-current detection has a lower time priority and can be easily provided by the application.

Gate Clamping

In the event of a short-circuit condition, the gate voltage is increased due to the high dV_{CE}/dt between the collector and emitter terminals of the driven power semiconductor. This dV_{CE}/dt drives a current through the Miller-capacitance (capacitance between the gate and collector) and charges the gate capacitance, which eventually leads to a gate-emitter voltage larger than the nominal gate-emitter turn-on voltage. In consequence, the short-circuit current is increased due to the transconductance of the power semiconductor.

NTC Temperature Measurement

The driver senses the NTC temperature of the attached power module. This signal can be accessed at TPM on X1 interface connector. The temperature signal at terminal TPM is a duty cycle based protocol with a repeatable pulse of F_{TPM}.

Note: The NTC temperature does not represent the junction temperature of any of the semiconductor dies within the power module. Instead, it is a good indication of the baseplate temperature of the power module.

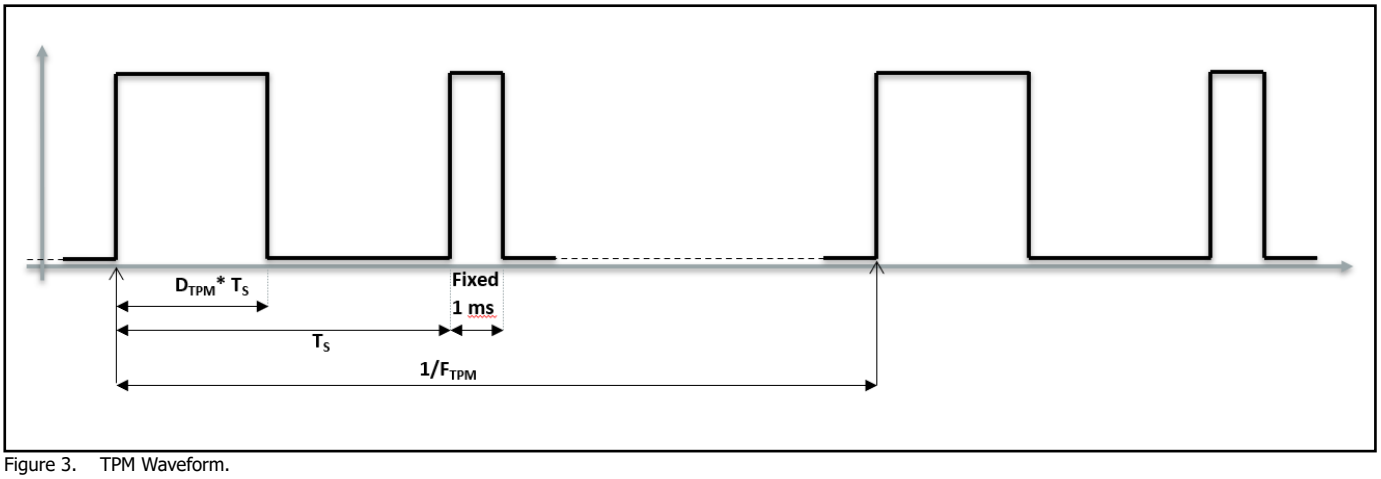

Figure 3. TPM Waveform.

Absolute Maximum Ratings

Parameter	Symbol	Conditions T_A = -40 °C to 85 °C	Min	Max	Units
Absolute Maximum Ratings[1]					
Primary-Side Supply Voltage	V_{VCC}	VCC to GND	0	16	V
Primary-Side Supply Current	I_{VCC}	Average supply current		330	mA
Logic Input Voltage (Command Signal)	V_{INx}	INx to GND	0	V_{VCC} + 0.5	V
Logic Output Voltage (Status Signal)	V_{SOx}	SOx to GND	0	V_{VCC} + 0.5	V
Temperature Output Voltage (NTC Measurement)	V_{TPM}	V_{TPM} to GND		V_{VCC} + 0.5	V
Status Output Current[2]	I_{SOx}	SOx to GND, fault condition, total current	0	20	mA
Temperature Measurement Output Current	I_{TPM}	TPM to GND, total current	0	20	mA
Gate Output Power Per Channel[3]	P_{Gx}			1	W
Switching Frequency	f_{SW}			25	kHz
Operating Voltage Primary-Side to Secondary-Side	$V_{OP(P-S)}$	Transient only		2050	V
		Permanently applied		1600	
Operating Voltage Secondary-Side to Secondary-Side[4]	$V_{OP(S-S)}$	Transient only		1700	V
		Switching operation		1200	V
Test Voltage Primary-Side to Secondary-Side	$V_{ISO(PS)}$	50 Hz, 60 s		6813	V_{RMS}
Test Voltage Secondary-Side to Secondary-Side[5]	$V_{ISO(SS)}$	50 Hz, 60 s		4050	V_{RMS}
Common-Mode Transient Immunity	|dv/dt|			50	kV/µs
Storage Temperature[6]	T_{ST}		-40	50	°C
Operating Ambient Temperature	T_A		-40	85	°C
Surface Temperature[7]	T			125	°C
Relative Humidity	H_R	No condensation	20	95	%
Altitude of Operation[8]	A_{OP}			2000	m

Recommended Operating Conditions

Parameter	Symbol	Conditions T_A = -40 °C to 85 °C	Min	Typ	Max	Units
Power Supply						
Primary-Side Supply Voltage	V_{VCC}	VCC to GND	14.5	15	15.5	V

Characteristics

Parameter	Symbol	Conditions V_{VCC} = 15 V, T_A = 25 °C		Min	Typ	Max	Units
Power Supply							
Supply Current	I_{VCC}	Without load			57		mA
		$P_{Gx} = P_{Gx,max}$, f_{SW} = 3 kHz, 50 % duty cycle			204		mA
Power Supply Monitoring Threshold (Primary-Side)	$UVLO_{VCC}$	Referenced to GND	Clear fault (resume operation)	11.6	12.6	13.6	V
			Set fault (suspend operation)	11.0	12.0	13.0	
			Hysteresis	0.35			
Power Supply Monitoring Threshold (Secondary-Side)	$UVLO_{VISOx}$	Referenced to respective terminal E1 or E2	Clear fault (resume operation)	11.6	12.6	13.6	V
			Set fault (suspend operation)	11.0	12.0	13.0	
			Hysteresis	0.35			
	$UVLO_{COMx}$		Clear fault (resume operation)		-5.15		V
			Set fault (suspend operation)		-4.85		
			Hysteresis		0.3		
Output Voltage (Secondary-Side)	V_{VISOx}	Without load			25.2		V
		Referenced to V_{COMx}, $P_{Gx} = P_{Gx,max}$, f_{SW} = 3 kHz, 50 % duty cycle			24.7		
Coupling Capacitance	C_{IO}	Primary-side to secondary-side, total per channel			19		pF
Gate Output							
Turn-on Gate Voltage	$V_{GE(ON)}$	Without load			15		V
		f_{SW} = 3 kHz, $P_{Gx} = P_{Gx,max}$, 50 % duty cycle			15		V
Turn-Off Gate Voltage	$V_{GE(OFF)}$	Without load			-10.2		V
		f_{SW} = 3 kHz, $P_{Gx} = P_{Gx,max}$, 50 % duty cycle			-9.7		V
Logic Inputs and Status Outputs							
Input Impedance	R_{INx}	INx to GND			4.5		kΩ
Turn-On Threshold	$V_{TH-ON(INx)}$	INx to GND			10.5		V
Turn-Off Threshold	$V_{TH-OFF(INx)}$	INx to GND			5.1		V
Timing Characteristics							
Turn-On Delay	$t_{P(LH)}$	50 % INx to 10 % of $V_{GE(ON)}$			77		ns
Turn-Off Delay	$t_{P(HL)}$	50 % INx to 90 % of $V_{GE(ON)}$			59		ns
Transmission Delay of Fault State	t_{SOx}	After secondary-side fault detection			1300		ns
Blocking Time	t_{BLK}	After secondary-side fault detection			21		ms
TPM Output							
Signal Repetion	F_{TPM}				1		Hz
Signal Length[9]	T_S	Duration from rising edge of first duty-cycle variable pulse to the rising edge of second pulse			13.2		ms
TPM Measurement		At 25 °C excluding NTC tolerance			3.5		K
Signal Characteristics		5 % ≤ D_{TPM} ≤ 95 %		R_{NTC} = 10*(23983+ 1080*D_{TPM} [%]/ (1205-10*D_{TPM}[%])			Ω

Characteristics (cont.)

Parameter	Symbol	Conditions V_{CC} = 15 V, T_A = 25 °C	Min	Typ	Max	Units
Short Circuit Protection						
Static V_{CE}-Monitoring Threshold	$V_{CE(SAT)}$	1.7 kV driver version		59		V
Response Time (10 % V_{GE} to 90 % V_{GE})	t_{RES}	1.7 kV driver version DC-link voltage = 1200 V		7		µs
Turn-off Delay after Short-Circuit Detection	$t_{PD(SOx)}$			100		ns
Electrical Isolation						
Test Voltage[10]	$V_{ISO(PS)}$	Primary-side to secondary-side	6813			V_{RMS}
	$V_{ISO(SS)}$	Secondary-side to secondary-side	4050			V_{RMS}
Partial Discharge Extinction Voltage[11]	$P_{D(PS)}$	Primary-side to secondary-side	2201			V_{RMS}
	$P_{D(SS)}$	Secondary-side to secondary-side	1442			V_{RMS}
Creepage Distance[12]	CPG_{P-S}	Primary-side to secondary-side, on PCB	16			mm
	CPG_{S-S}	Secondary-side to secondary-side, on PCB	6.4			mm
Clearance Distance	CLR_{P-S}	Primary-side to secondary-side	12.2			mm
	CLR_{S-S}	Secondary-side to secondary-side	6.4			mm
Mounting						
Mounting Holes	D_{HOLE}	Diameter of screw hole S1 - S4		3.2		mm
Mounting Torque[13]	M	Screw M3				Nm
Bending	I_{BEND}	According to IPC			0.75	%

NOTES:
1. Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device.
2. The status output current must be limited by external pull-up resistors located on the host board.
3. Actually achievable maximum power depends on several parameters and may be lower than the given value. It has to be validated in the final system. It is mainly limited by the maximum allowed surface temperature.
4. Overvoltages during turn-off in normal operation and in short circuit condition must be monitored carefully as no active clamping function is provided.
5. This value applies to the transformer for 2SIXT0112T2A0. The test voltage cannot be applied to the product itself due to the desaturation protection circuits.
6. The storage temperature inside the original package must be limited to the given value. Otherwise, it is limited to 85° C.
7. The component surface temperature, which may strongly vary depending on the actual operating conditions, must be limited to the given value to ensure long-term reliability of the product.
8. Operation above this level requires a voltage derating to ensure long-term reliability of the product.
9. Refer to figure 3 for details.
10. The transformer of every production sample has undergone 100 % testing at the given value for 1 s.
11. Partial discharge measurement is performed on each transformer.
12. CTI ≥ 600 PCB material.
13. Refer to data sheet of the IGBT module.

Reliability and EMC Qualification Items

Test Item	Test Methods and Conditions
Environmental Tests	
Dry heat	IEC 60068-2-2, 85 °C, 96 h, DUT operated
Cold	IEC 60068-2-1, -40 °C, 96 h, DUT operated
Thermal cycling	IEC 60068-2-14, -40 °C and 85 °C, ramp: 5 °C/min, dwell: 30 min, DUT operated, 10 cycles
Endurance Tests	
High temperature operating lifetime	IEC 60068-2-2, 85 °C, test duration 1000 h, DUT operated
Damp heat	IEC 60068-2-78, 85 °C, 85 % R.H., 56 d, DUT operated
Thermal cycling	IEC 60068-2-14, -40 °C, 125 °C (5 K/min, 200 cycles, DUT unpowered)
EMC Tests	
Electrostatic discharge	IEC 61000-4-2, ±2 kV charge voltage, Class A, 10 pulses each, contact and air discharge.
Fast Transient/Burst Immunity	IEC 61000-4-4, 5 kHz, Power ports: ±2 kV, 5 kHz, 300 ms, Signal/control ports: ±1 kV, 5 kHz, 300 ms, duration per test: 60 s
Conducted noise immunity	IEC 61000-4-6, frequency range 0.15 – 80 MHz, 3 V_{RMS}, log 1 %
Mechanical Tests	
Mechanical vibrations (sinusoidal)	IEC 60068-2-6, frequency range 200 - 500 Hz (± 3.3 mm displacement, 15 m/s², 1 sweep cycles)
Mechanical shock	IEC 61373, Class 1B, acceleration 30 m/S², duration 30 ms, vertical and transversal, half sine, ±100 shocks per axis

Product Dimensions

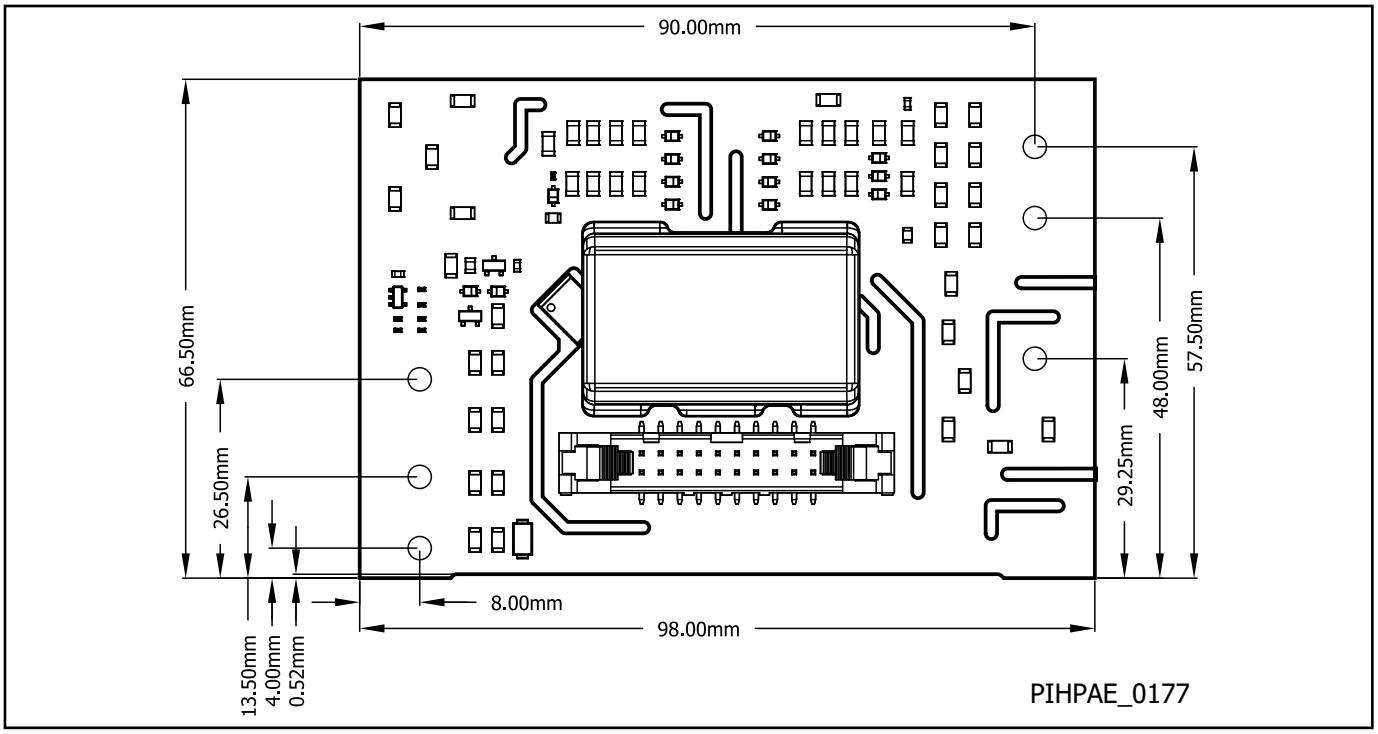

Figure 4. Top View

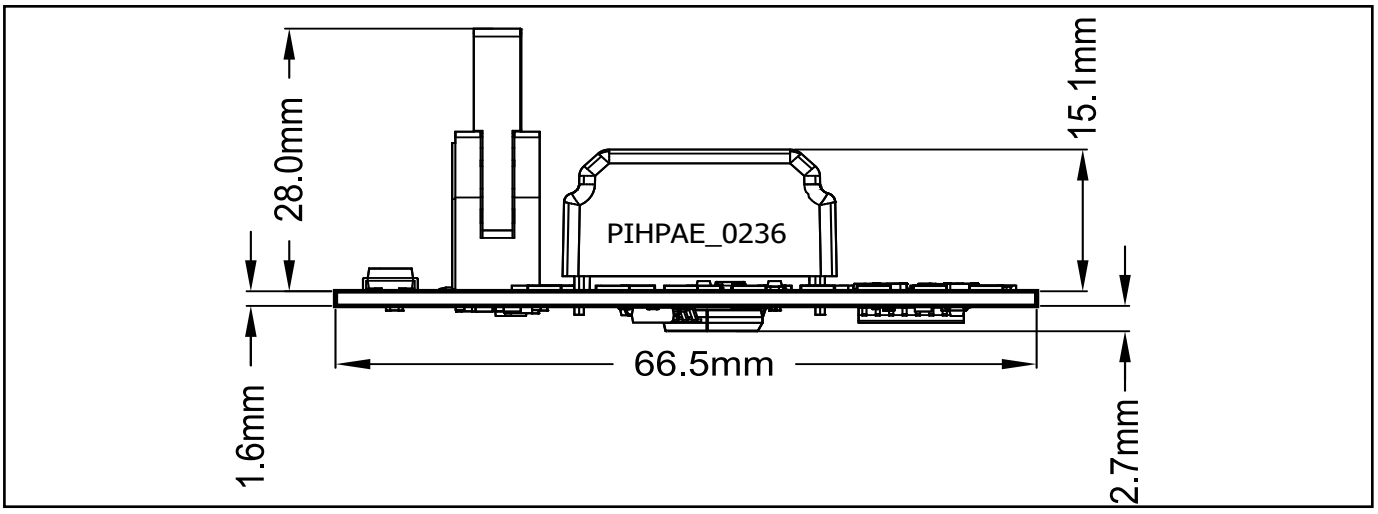

Figure 5. Side View.

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 described in 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.

Product Details

Part Number	Power Module	Voltage Class	Current Class	Package	IGBT Supplier	$R_{G(on)}$	$R_{G(off)}$	C_{GE}
2SIXT0112T2A0-FF1800XTR17T2P5	FF1800XTR17T2P5	1700 V	1800 A	XHP2	Infineon	0.5 Ω	4.5 Ω	not assembled
2SIXT0112T2A0-CM1200DW-34T	CM1200DW-34T	1700 V	1200 A	LV100	Mitsubishi	TBD	TBD	TBD

Revision	Notes	Date
A	Final Datasheet.	12/24

For the latest updates, visit our website: www.power.com
Power Integrations reserves the right to make changes to its products at any time to improve reliability or manufacturability. Power Integrations does not assume any liability arising from the use of any device or circuit described herein. POWER INTEGRATIONS MAKES NO WARRANTY HEREIN AND SPECIFICALLY DISCLAIMS ALL WARRANTIES INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS.

Patent Information
The products and applications illustrated herein (including transformer construction and circuits external to the products) may be covered by one or more U.S. and foreign patents, or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations patents may be found at www.power.com. Power Integrations grants its customers a license under certain patent rights as set forth at www.power.com/ip.htm.

Life Support Policy
POWER INTEGRATIONS PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF POWER INTEGRATIONS. As used herein:

1. A Life support device or system is one which, (i) is intended for surgical implant into the body, or (ii) supports or sustains life, and (iii) whose failure to perform, when properly used in accordance with instructions for use, can be reasonably expected to result in significant injury or death to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

Power Integrations Worldwide Sales Support Locations

World Headquarters
5245 Hellyer Avenue
San Jose, CA 95138, USA
Main: +1-408-414-9200
Customer Service:
Worldwide: +1-65-635-64480
Americas: +1-408-414-9621
e-mail: usasales@power.com

China (Shanghai)
Rm 2410, Charity Plaza, No. 88
North Caoxi Road
Shanghai, PRC 200030
Phone: +86-21-6354-6323
e-mail: chinasales@power.com

China (Shenzhen)
17/F, Hivac Building, No. 2, Keji Nan
8th Road, Nanshan District,
Shenzhen, China, 518057
Phone: +86-755-8672-8689
e-mail: chinasales@power.com

Germany (AC-DC/LED Sales)
Einsteinring 24
85609 Dornach/Aschheim
Germany
Tel: +49-89-5527-39100
e-mail: eurosales@power.com

Germany (Gate Driver Sales)
HellwegForum 3
59469 Ense
Germany
Tel: +49-2938-64-39990
e-mail: igbt-driver.sales@power.com

India
#1, 14th Main Road
Vasanthanagar
Bangalore-560052 India
Phone: +91-80-4113-8020
e-mail: indiasales@power.com

Italy
Via Milanese 20, 3rd. Fl.
20099 Sesto San Giovanni (MI) Italy
Phone: +39-024-550-8701
e-mail: eurosales@power.com

Japan
Yusen Shin-Yokohama 1-chome Bldg.
1-7-9, Shin-Yokohama, Kohoku-ku
Yokohama-shi,
Kanagawa 222-0033 Japan
Phone: +81-45-471-1021
e-mail: japansales@power.com

Korea
RM 602, 6FL
Korea City Air Terminal B/D, 159-6
Samsung-Dong, Kangnam-Gu,
Seoul, 135-728, Korea
Phone: +82-2-2016-6610
e-mail: koreasales@power.com

Singapore
51 Newton Road
#19-01/05 Goldhill Plaza
Singapore, 308900
Phone: +65-6358-2160
e-mail: singaporesales@power.com

Taiwan
5F, No. 318, Nei Hu Rd., Sec. 1
Nei Hu Dist.
Taipei 11493, Taiwan R.O.C.
Phone: +886-2-2659-4570
e-mail: taiwansales@power.com

UK
Building 5, Suite 21
The Westbrook Centre
Milton Road
Cambridge
CB4 1YG
Phone: +44 (0) 7823-557484
e-mail: eurosales@power.com