2SIS0400V2D0C-33
SCALE-iFlex-Single Family

Isolated Master Control Gate Driver for Half-Bridge Power Modules in High-Voltage Package up to 3300 V Optical Interface

Product Highlights

Highly Integrated, Compact Footprint

- Ready-to-use gate driver solution for power modules up to 3300 V blocking voltage
- Optical interface
- Up to 3 W output power per channel at maximum ambient temperature
- ± 20 A maximum gate current
- Optimized for use with Module Adapted Gate Driver 2SMS0220D2D0C
- -40 °C to 85 °C operating ambient temperature

Protection / Safety Features

- Supporting Short-Circuit Dection and Advanced Active Clamping of the Module Adapted Gate Driver
- Undervoltage lock-out (UVLO)
- Applied double sided conformal coating

Full Safety and Regulatory Compliance

- 100% production partial discharge and HIPOT test of transformer
- Clearance and creepage distances between primary and secondary sides meet requirements for reinforced isolation according to IEC 61800-5-1 and EN 50124-1.
- RoHS compliant

Applications

- Wind and photovoltaic power
- Traction inverter
- Industrial drives
- Other industrial applications

Description

This data sheet describes the Isolated Master Control (IMC) of the SCALE-iFlex™-Single gate driver family which works conjointly with a Module Adapted Gate Driver (MAG).

The IMC is designed for the operation of power modules with a blocking voltage up to 3300 V, whereas the MAGs are available in different variants optimized for different power modules and chip technologies of different suppliers in the voltage classes up to 3300 V.

SCALE-iFlex-Single enables compact and easy control of the power modules providing high flexibility and system scalability with a minimum development effort. In addition, it allows compact mounting of adjacent modules due to the integrated isolation housing.

Figure 1. Product Photo of 2SIS0400V2D0C-33.

Pin Functional Description

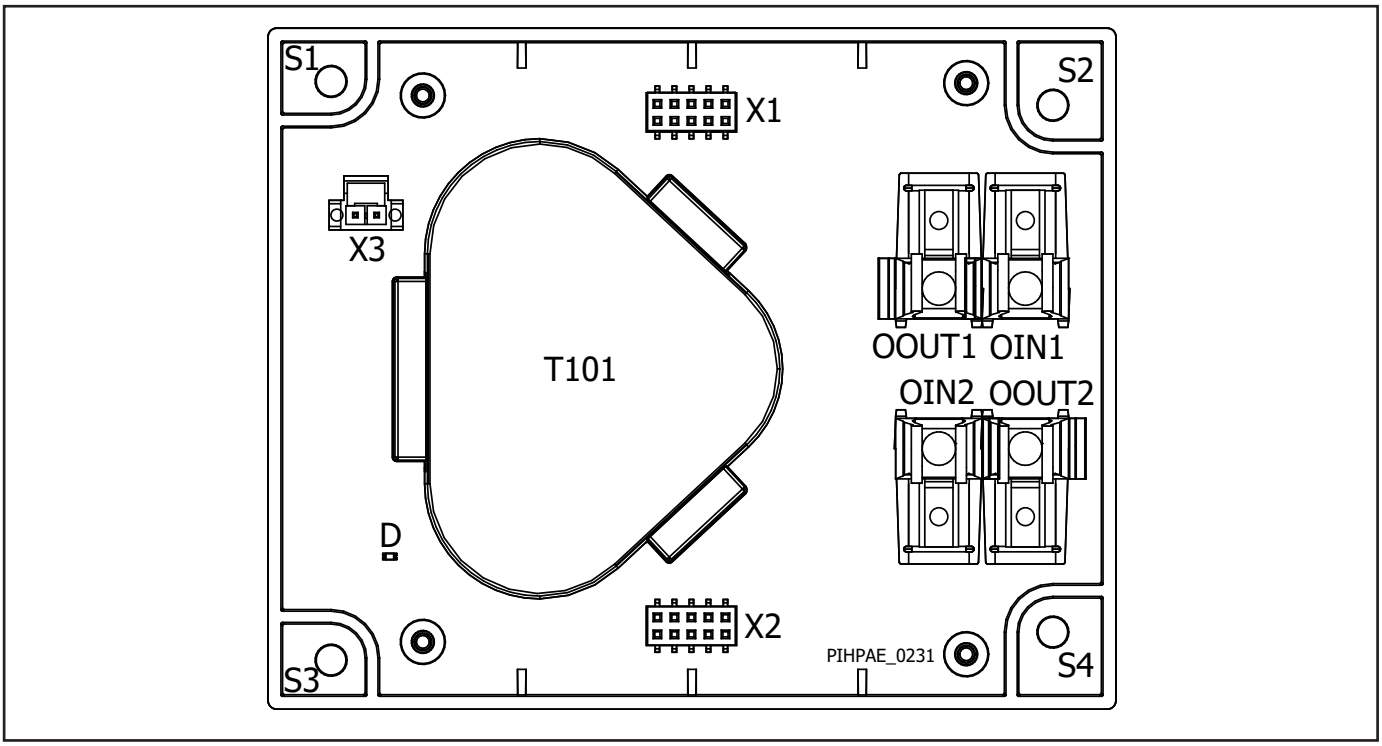

Figure 2. Pin Configuration.

Connector X3

MOLEX 105311-1202 Supply connector for external power supply.

GND (Pin 1)
This pin is the connection for the primary-side ground potential.

VCC (Pin 2)
This pin is the primary-side supply voltage connection and it has to be used for supplying the SCALE-iFlex-Single gate driver.

Fiber Optic Interface

IMC to external controller (Fiber optic receivers and transmitters).

OIN1 (Receiver)
This fiber optic receiver is the command input for channel 1.
Part number: HFBR-2532ETZ from Broadcom

OIN2 (Receiver)
This fiber optic receiver is the command input for channel 2.
Part number: HFBR-2532ETZ from Broadcom

OOUT1 (Transmitter)
This fiber optic transmitter is the status output for channel 1.
Part number: AFBR-1539Z from Broadcom

OOUT2 (Transmitter)
This fiber optic transmitter is the status output for channel 2.
Part number: AFBR-1539Z from Broadcom

Connection To MAG

Connector X1
Pin-header connector to MAG for gate driver channel 1.

Connector X2
Pin-header connector to MAG for gate driver channel 2.

Terminals S1 to S4

Dome positions for mechanical fixation of the IMC to the MAG.

LED

D
Optical indicator for monitoring the voltage V_{VCC}. During absence of V_{VCC} the indicator is OFF.

Functional Description

The SCALE-iFlex-Single is a dual channel gate driver, which consists of two parts:

- Isolated Master Control (IMC)
- Module Adapted Gate Driver (MAG)

The IMC 2SIS0400V2D0C-33 is independent of the actual target power module voltage class. It provides reinforced isolation of the power supply up to a voltage class of 3300 V.

In contrast, the MAGs are particularly designed to operate with specific power modules. Their characteristics match the requirements of the individual power modules.

The interconnection between the external system controller to the IMC is established with a cable connected to X3 and fiber optic connections.

The SCALE-iFlex-Single gate driver provides the highest flexibility and is able to operate a single power module depending on actual application conditions.

The operation of channel 1 and channel 2 of the gate driver is independent of each other. Any dead time insertion, to avoid synchronous or overlapping switching of the driven power switches, has to be generated in the external system controller.

Note: Synchronous or overlapping switching of top and bottom switches within a half-bridge leg may damage or destroy the driven power switche(s) and, in conjunction as secondary failure, the attached MAG and/or IMC.

Connector Terminals (X1 and X2)
The IMC has one connector terminal per channel. The IMC needs to be connected to the secondary-side of the MAG. The IMC and MAG have to be mounted in a piggyback which is depicted in Figure 3, i.e. direct connection to the pin header. The channel assignment is mechanically determined. Channel 1 from the IMC shall be connected to channel 1 of the MAG (X1). Accordingly, channel 2 of the IMC is with channel 2 of the MAG (X2).

Screw Terminals S1 to S4
The IMC is mechanically connected to the MAG and fixed by screws.

Power Supply
The 2SIS0400V2D0C is equipped with a power supply connector X3. A stabilized voltage of V_{VCC} = 15 V is required. The input VCC supplies the primary-side electronic 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_{VISOx}, and the negative rail has the voltage level V_{COMx}. Both rails are referenced to the emitter potential at terminal E1 or E2 of the driven power semiconductor.

UnderVoltage Monitoring
The supply voltages are closely monitored on the secondary side of the IMC. In case of an UVLO on the secondary-side of the IMC or MAG, the fiber-optic signal of the respective channel is set to light off and the corresponding power semiconductor is turned off. During fault conditions, no gate signals are transmitted to the respective gate driver channel.

Fiber Optic Receivers OINx
The input signals of OIN1 and OIN2 are received by a "Versatile" fiber optic link receiver directly connected to the secondary sides of the gate driver. Both inputs have positive logic (light on implies turn-on) and are edge-triggered.

The gate driver signals are transferred from the OIN1 and OIN2 receivers to the gate of the attached MAG with a propagation delay of $t_{P(LH)}$ for the turn-on and $t_{P(HL)}$ for the turn-off commands.

Fiber Optic Transmitters OOUTx
The IMC provides the status feedback signals OOUT1 and OOUT2. All output signals are directly connected to the secondary sides of the gate drive by "Versatile" fiber optic link transmitters.

During normal operation (i.e. the driver is supplied with power at nominal voltage, and there is no fault on the corresponding channel), the status feedback is given by a "light on" at the optical link. A fault condition is signaled by a "light off".

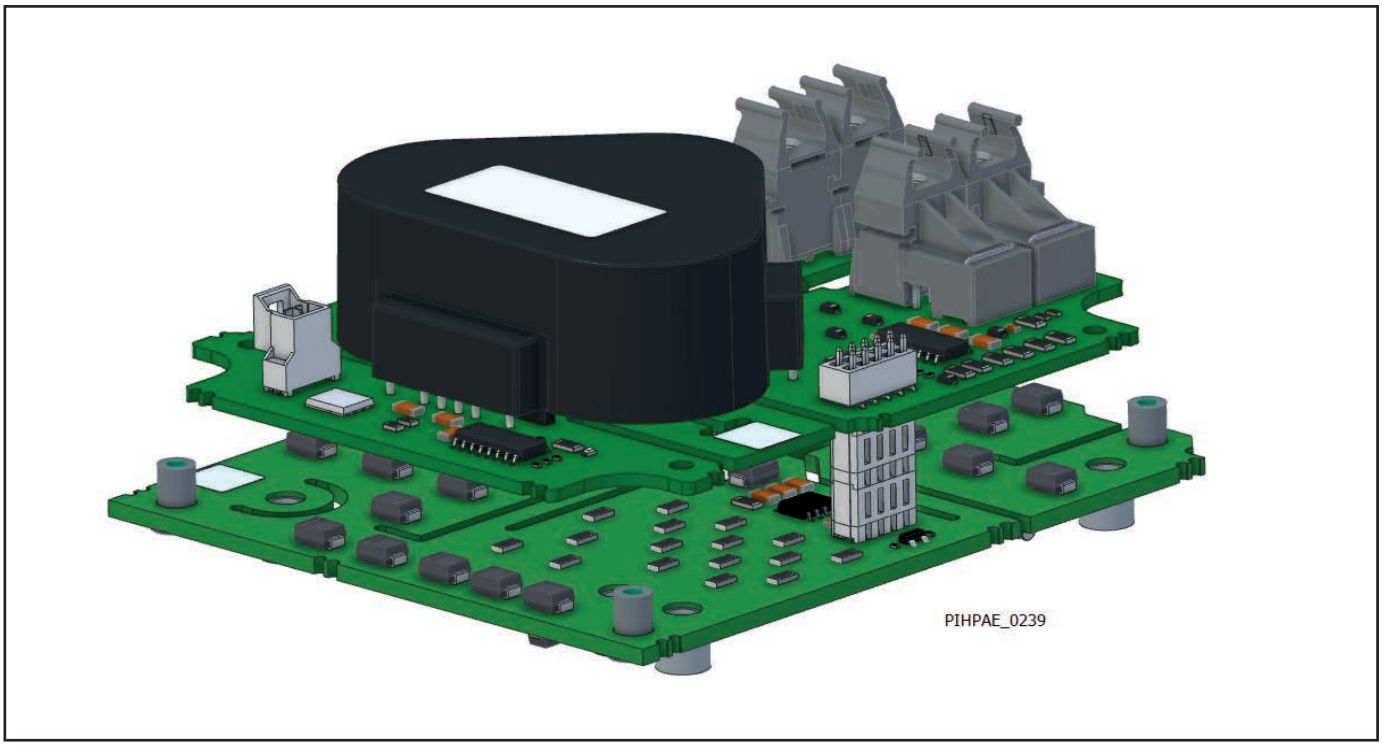

Figure 3. Assembly (Actual product may differ from illustration.).

The status outputs provide acknowledge information for every switching command by turning off the light for a duration of t_{ACK} after a delay of $t_{D(ACK)}$ referred to the edge of the received light signal on OINx. Figure 4 illustrates the timing of the fiber optic interface under normal operating conditions.

Short-Circuit detection

In case of a detected short-circuit of the driven power module, the monitored semiconductor is switched off immediately and a fault signal is transmitted to the status output feedback OOUTx. The light goes OFF after a delay of $t_{D(Fault)}$.

The fault feedback is automatically reset after the blocking time t_{BLK}. The semiconductor is turned on again as soon as the next on-signal is applied to the corresponding fiber optic input OINx after the fault status has disappeared.

Figure 5 illustrates the timing of the fiber optic interface in a short-circuit condition.

Optical Indicators

To facilitate verification, the driver is equipped with a green status LED. The LED lights up as soon as the supply voltage VCC is high enough. A turned-off LED means that the driver is not supplied with voltage or that the supply voltage is too low.

Mounting Instruction

The PCB of the IMC is pre-mounted to the housing. The MAG has to be mounted first on the power module. Round spacer (e.g. 05.54.053 from ETTINGER or 963050174 from WE WÜRTH ELEKTRONIK) need to be placed on the terminal screws S1, S2, S4 and S5 of the MAG 2SMS0220D2D0C. The IMC with the housing is fixed over the MAG through the spacers with 16 mm M3 screws.

To avoid mechanical stress on the IMC during and after the mounting process, any bending or warping force imposed on the IMC must not lead to vaulting or twisting of the housing of 0.75 % per axis.

Due to the integrated housing, the SCALE-iflex-Single product allows compact mounting of adjacent modules without violating the isolation coordination.

Conformal Coating

The electronic components in the gate driver 2SIS0400V2D0C are protected by a layer of acrylic conformal coating on both sides of the PCB with a typical thickness of 50 µm using ELPEGUARD SL 1307 FLZ/2 from Lackwerke Peters. This coating layer increases product reliability when exposed to contaminated environments.

Note: Standing water (e.g. condensate water) on top of the coating layer must be prevented. This water will diffuse through the layer over time. If allowed to remain, it will eventually form a thin film between the PCB surface and coating layer, which will cause leakage currents to increase. Such currents will interfere with the performance of the gate driver.

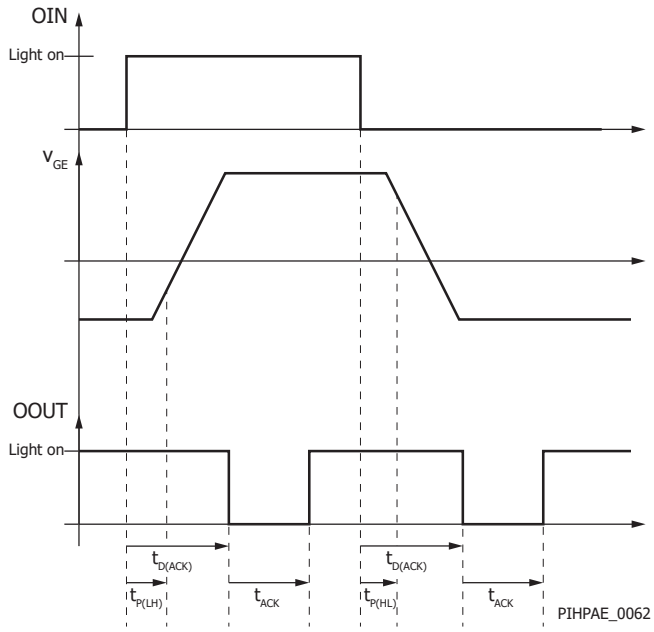

Figure 4. Fiber Optic Feedback in normal operation mode.

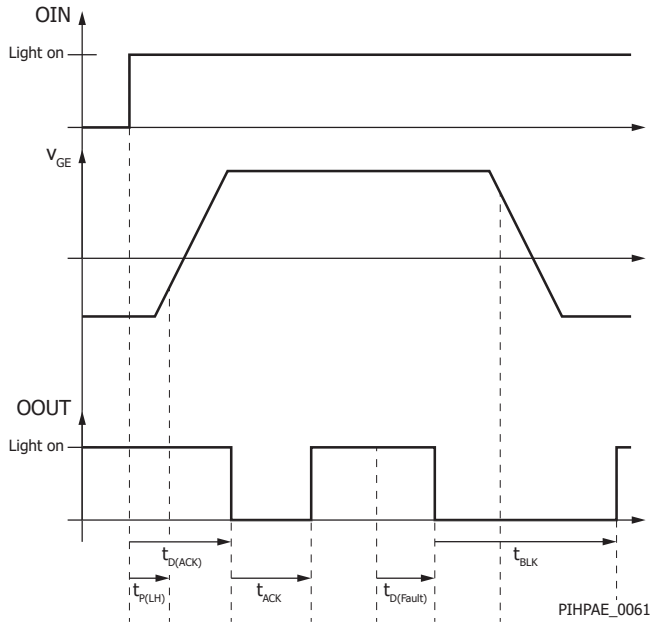

Figure 5. Fiber Optic Feedback in fault (short-circuit) operation mode.

Absolute Maximum Ratings

Parameter	Symbol	Conditions T_A = -40 °C to 85 °C	Min	Max	Units
Absolute Maximum Ratings[1]					
Supply Voltage	V_{VCC}	VCC to GND	0	16	V
Average Supply Current	I_{VCC}	Average supply current at full load		700	mA
Gate Output Power Per Channel[2]	P_{Gx}			3	W
Switching Frequency[3]	f_{SW}			25	kHz
Operating Voltage Primary-Side to Secondary-Side and Secondary-Side to Secondary-Side	V_{OP}	Transient only		3300	V
		Limited to 60s		2500	
		Permanently applied		2200	
Test Voltage Primary-Side to Secondary-Side	$V_{ISO(PS)}$	50 Hz, 60 s		9100	V_{RMS}
Test Voltage Secondary-Side to Secondary-Side	$V_{ISO(SS)}$	50 Hz, 60 s		6700	V_{RMS}
Storage Temperature[4]	T_{ST}		-40	50	°C
Operating Ambient Temperature	T_A		-40	85	°C
Surface Temperature[5]	T			125	°C
Relative Humidity	H_R	No condensation		93	%
Altitude of Operation[6]	A_{OP}			2000	m

Recommended Operating Conditions

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

NOTES:
1. Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device.
2. 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.
3. This limit applies to the whole product family. The actual achievable switching frequency may be lower for specific gate driver variants and has to be validated in the final system as it is additionally limited by the maximum gate output power in conjunction with the maximum allowed surface temperature.
4. The storage temperature inside the original package or in case the coating material 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 actual operating conditions, must be limited to the given value to ensure long-term reliability of the product.
6. Operation above this level requires a voltage derating to ensure proper isolation coordination.

Characteristics

Parameter	Symbol	Conditions VCC = 15 V, T_A = 25 °C		Min	Typ	Max	Units
Power Supply							
Supply Current	I_{VCC}	Without load			140		mA
		P_{Gx} = 2 W, f_{SW} = 10.6 kHz, 50% duty cycle			445		mA
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}	Referenced to V_{COMx}, without load			24.3		V
		Referenced to COMx, P_{Gx} = 2 W, f_{SW} = 10.6 kHz, 50% duty cycle			23.9		
Coupling Capacitance	C_{IO}	Primary-side to secondary-side, total per channel			5		pF

Characteristics (cont.)

Parameter	Symbol	Conditions VCC = 15 V, T_A = 25 °C	Min	Typ	Max	Units
Timing Characteristics						
Turn-On Delay	$t_{P(LH)}$	OINx-Light ON to 10% of V_{Gx} on MAG, no load attached (1m FO cable to external control)		140		ns
Turn-Off Delay	$t_{P(HL)}$	OINx-Light OFF to 90% of VGx on MAG, no load attached (1m FO cable to external control)		130		ns
Duration of Acknowledge Pulse	t_{ACK}	Measured on host board with 1m FO cable	400	700	1050	ns
Delay of Acknowledgment Pulse	$t_{D(ACK)}$	Measured on host board with 1m FO cable		180		ns
Propagation Delay of Fault State Condition	$t_{D(Fault)}$	From fault detection to host board with 1m FO cable		80		ns
Blocking Time	t_{BLK}			9		µs
Electrical Isolation						
Test Voltage (50 Hz, 1s)[7]	$V_{ISO(PS)}$	Primary-side to secondary-side	9100			V_{RMS}
	$V_{ISO(SS)}$	Secondary-side to secondary-side	6700			V_{RMS}
Partial Discharge Extinction Voltage[8]	$P_{D(PS)}$	Primary-side to secondary-side	4125			V_{PK}
	$P_{D(SS)}$	Secondary-side to secondary-side	3677			V_{PK}
Creepage Distance	$CPG_{P-S(PCB)}$	Primary-side to secondary-side, on PCB (Material category IIIa)	44			mm
	$CPG_{P-S(TRF)}$	Primary-side to secondary-side, on transformer (Material category I)	29			mm
	$CPG_{S-S(PCB)}$	Secondary-side to secondary-side, on PCB (Material category IIIa)	22			mm
	$CPG_{S-S(TRF)}$	Secondary-side to secondary-side, on transformer (Material category I)	25			mm
Clearance Distance	CLR_{P-S}	Primary-side to secondary-side	22			mm
	CLR_{S-S}	Secondary-side to secondary-side	8			mm
Mounting						
Mounting Holes	D_{HOLE}	Diameter of screw hole S1 – S4		3.5		mm
Bending	I_{BEND}	According to IPC			0.75	%

NOTES:
7. The transformer of every production sample has undergone 100% testing at the given value for 1s.
8. Partial discharge measurement is performed on each transformer.

Product Dimensions

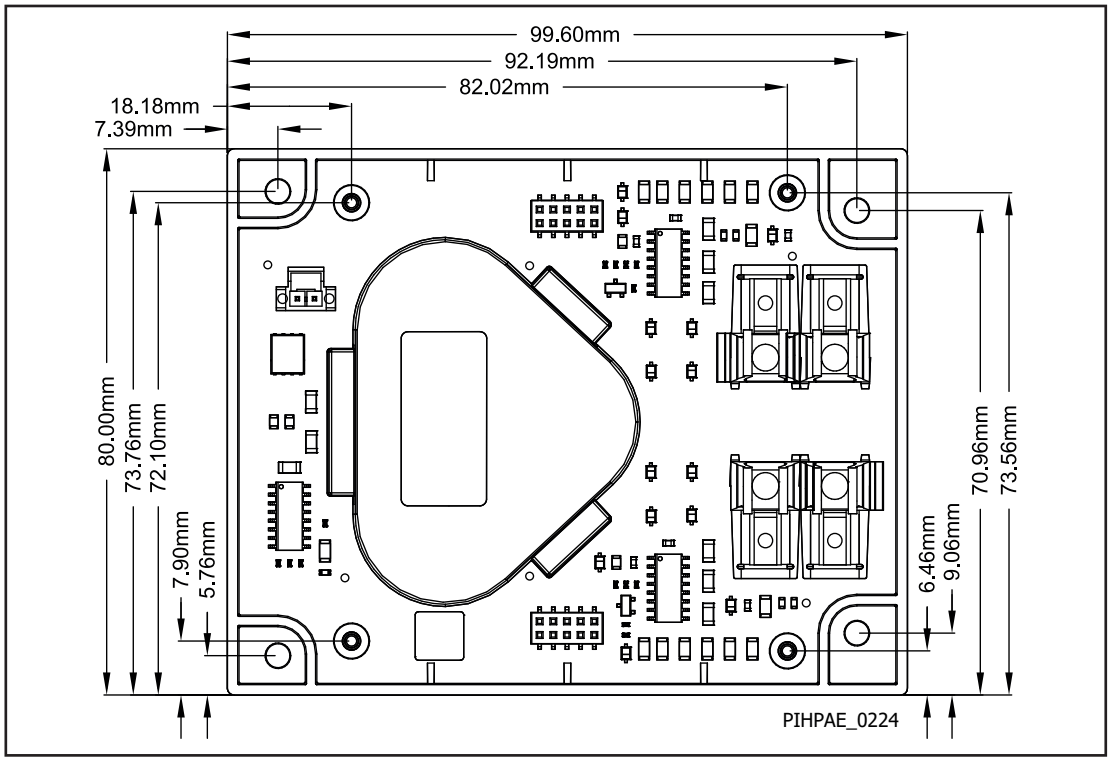

Figure 6. Top View of 2SIS0400V2D0C-33.

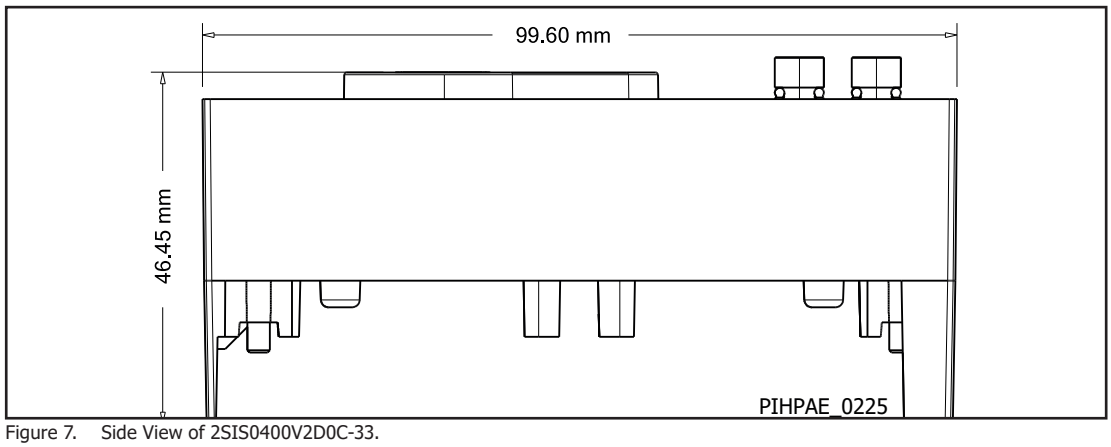

Figure 7. Side View of 2SIS0400V2D0C-33.

Product Details

Part Number	Power Module	Voltage Class	Current Class	Package	Power Device Supplier
2SIS0400V2D0C-33	N.A.	3300 V	N.A.	XHP3, HV100	N.A.

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.

Revision	Notes	Date
A	Final Datasheet.	11/22

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