2SIS0400T2C0C-33
SCALE-iFlex-Single Family

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

Product Highlights

Highly Integrated, Compact Footprint
- Ready-to-use gate driver solution for power modules up to 3300 V blocking voltage
- Electrical 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 2SMS0220D2C0C
- -40 °C to 85 °C operating ambient temperature

Protection / Safety Features
- Supporting Short-Circuit Detection 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 datasheet 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 2SIS0400T2C0C-33 is designed for the operation of power modules with 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 2SIS0400T2C0C-33.

This Product is Covered by Patents and/or Pending Patent Applications.

Pin Functional Description

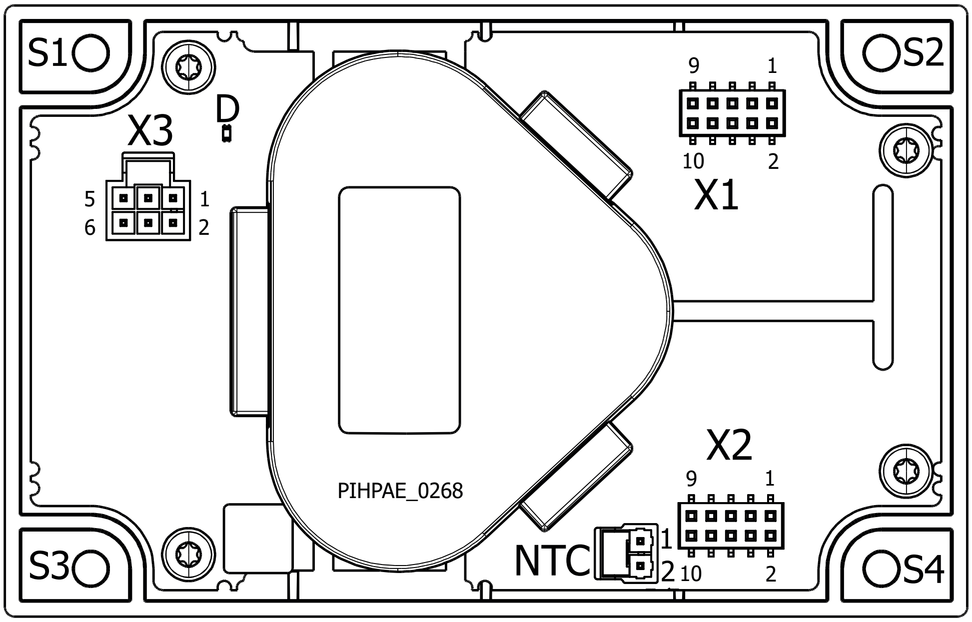

Figure 2. Pin Configuration.

Connector X3

MOLEX 105310-1106 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.

IN1 (Pin 6)
This pin is the command input for channel 1 (high-side switch).

IN2 (Pin 4)
This pin is the command input for channel 2 (low-side switch).

SO1 (Pin 5)
This pin is the status output for channel 1 (high-side switch).

SO2 (Pin 3)
This pin is the status output for channel 2 (low-side switch).

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.

NTC Connector

MOLEX 105309-1102 connector to module-internal NTC (directly routed to MAG).

Terminals S1 to S4

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

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 2SIS0400T2C0C-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.

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 switch(es) and, in conjunction as secondary failure, the attached MAG and/or IMC.

Power Supply (Primary-Side X3)
The 2SIS0400T2C0C-33 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_{VISO}, and the negative rail has the voltage level V_{COM}. 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. In case 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 of the IMC, the status signal of the respective channel will be set to GND and the corresponding power semiconductor(s) will be turned off.

Signal Inputs (Primary-Side X3)
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 gate of the MAG 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 X3)
The gate driver provides status feedbacks SO1 and SO2. The status feedback signals SO1 and SO2 stay at V_{VCC} under 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 or any MAG, 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.

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.

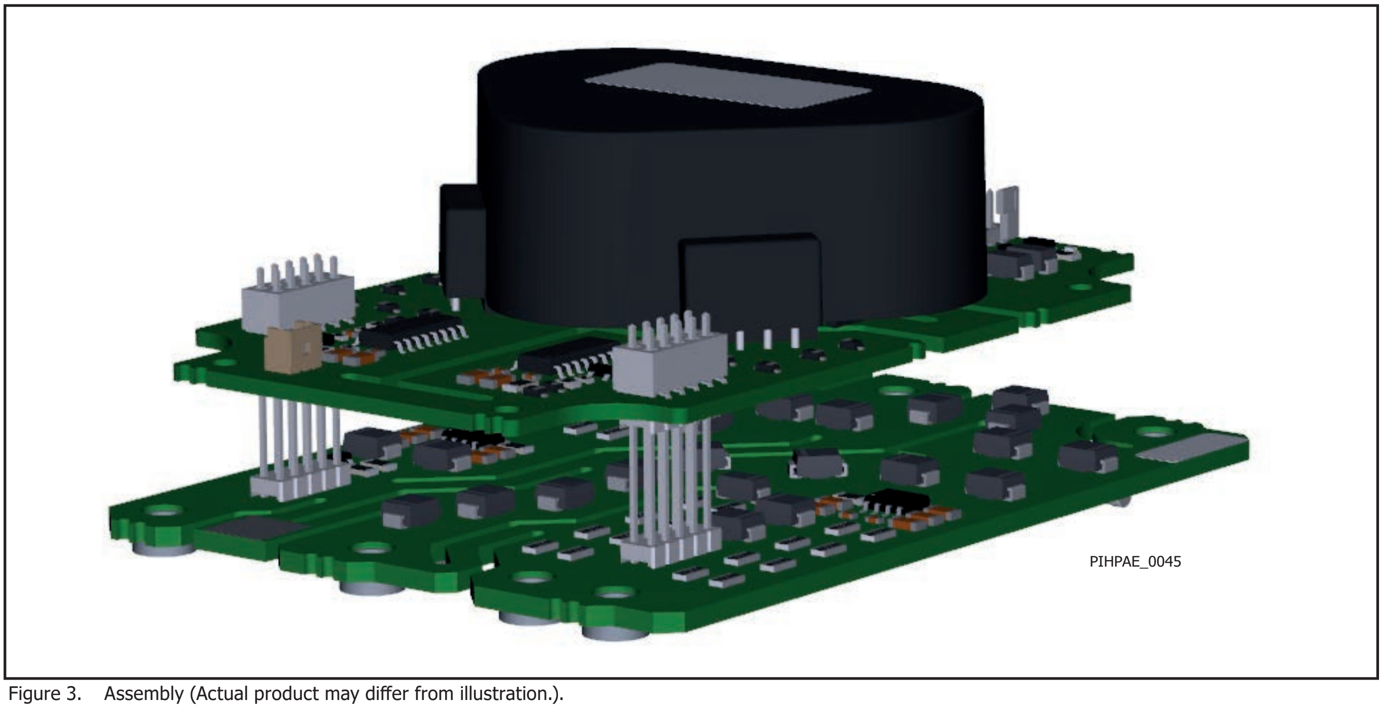

Figure 3. Assembly (Actual product may differ from illustration.).

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
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
Status Output Current[2]	I_{SOx}	SOx to GND		20	mA
Gate Output Power Per Channel[3]	P_{Gx}			3	W
Switching Frequency[4]	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}
Common Mode Transient Immunity	|dv/dt|			50	kV/µs
Storage Temperature[5]	T_{ST}		-40	50	°C
Operating Ambient Temperature	T_A		-40	85	°C
Surface Temperature[6]	T			125	°C
Relative Humidity	H_R	No condensation		93	%
Altitude of Operation[7]	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. 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. 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.
5. 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.
6. 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.
7. Operation above this level requires a voltage derating to ensure long-term reliability of the product.

Characteristics

Parameter	Symbol	Conditions V_{VCC} = 15 V, T_A = 25 °C		Min	Typ	Max	Units
Power Supply							
Supply Current	I_{VCC}	Without load			89		mA
		P_{Gx} = 1.5 W, f_{SW} = 8 kHz, 50% duty cycle			341		mA
Power Supply Monitoring Threshold (Primary-Side)	$UVLO_{VCC}$		Clear fault (resume operation)	11.6	12.6	13.6	V
			Set fault (suspend operation)	11.0	12.0	13.0	V
			Hysteresis	0.35			V
Power Supply Monitoring Threshold (Secondary-Side)	$UVLO_{VISO}$	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	V
			Hysteresis	0.35			V
	$UVLO_{COM}$		Clear fault (resume operation)		-5.15		V
			Set fault (suspend operation)		-4.85		V
			Hysteresis		0.3		V
Output Voltage (Secondary-Side)	V_{VISO}	Referenced to COM without load			24.5		V
		Referenced to COM, P_{Gx} = 1.5 W, f_{SW} = 8 kHz, 50% duty cycle			24.1		V
Coupling Capacitance	C_{IO}	Primary-side to secondary-side, total per channel			19		pF
Logic Inputs and Status Outputs							
Input Impedance	R_{INx}				4.5		kΩ
Turn-On Threshold	$V_{TH\text{-}ON(INx)}$	INx to GND			10.4		V
Turn-Off Threshold	$V_{TH\text{-}OFF(INx)}$	INx to GND			4.9		V
Status Output Voltage	V_{SOx}	Fault condition, SOx current ≤ 5 mA				0.7	V
SOx Pull-Up Resistor to VCC	R_{SOx}	On the driver board			4.7		kΩ
Timing Characteristics							
Turn-On Delay	$t_{P(LH)}$	50% of INx to 100% of $V_{GE(ON)}$			89		ns
Turn-Off Delay	$t_{P(HL)}$	50% of INx to 90% of $V_{GE(ON)}$			77		ns
Transmission Delay of Fault State	t_{SOx}	From IMC short-circuit detection to SOx			400		ns
Blocking Time	t_{BLK}	After secondary-side fault detection			21		ms

Characteristics (cont.)

Parameter	Symbol	Conditions VCC = 15 V, T_A = 25 °C	Min	Typ	Max	Units
Electrical Isolation						
Test Voltage (50 Hz, 1s)[8]	$V_{ISO(PS)}$	Primary-side to secondary-side	9100			V_{RMS}
	$V_{ISO(SS)}$	Secondary-side to secondary-side	6700			V_{RMS}
Partial Discharge Extinction Voltage[9]	$P_{D(PS)}$	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		mm
Mounting Torque	T			0.3		Nm
Bending	I_{BEND}	According to IPC			0.75	%

Mounting Instruction

The PCB of the IMC is pre-mounted to the housing. The MAG has to be mounted first on the power module. Four jack-screws (e.g. 94518233 from WE WÜRTH ELEKTRONIK) need to be placed on terminal screws E1, E2, S6 and S7 of the MAG 2SMS0220D2C0C. The IMC with the housing is fixed over the MAG through the jack-screws with 12 mm M3 screws (S1, S2, S3 and S4 of IMC).

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 2SIS0400T2C0C-33 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.

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

Reliability and EMC Qualifications Items

Test Item	Test Methods and Conditions
Environmental Tests	
Dry heat	IEC 60068-2-2, 85 °C, 240 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, 100 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 5 - 200 Hz (± 3.5 mm displacement, 20 m/s², 20 sweep cycles, 1.0 Oct/min. sweep rate), according to EN 60721-3-5, Cat. 5M2
Mechanical shock	IEC 60068-2-27, acceleration 300 m/s², half sine, 3 axis, ±100 shocks per axis, according to EN 60721-3-5, Cat. 5M2
	IEC 61373, Class 1B, acceleration 50 m/s², duration 30 ms, longitudinal, half sine, ±100 shocks per axis
Mechanical vibration (random)	IEC 61373, Class 1B, 5 Hz - 150 Hz, 10 min per axis, 3 axis
Mechanical vibrations (long-life)	IEC 61373, Class 1B, 5 Hz - 150 Hz, 5 h per axis, 3 axis

Product Dimensions

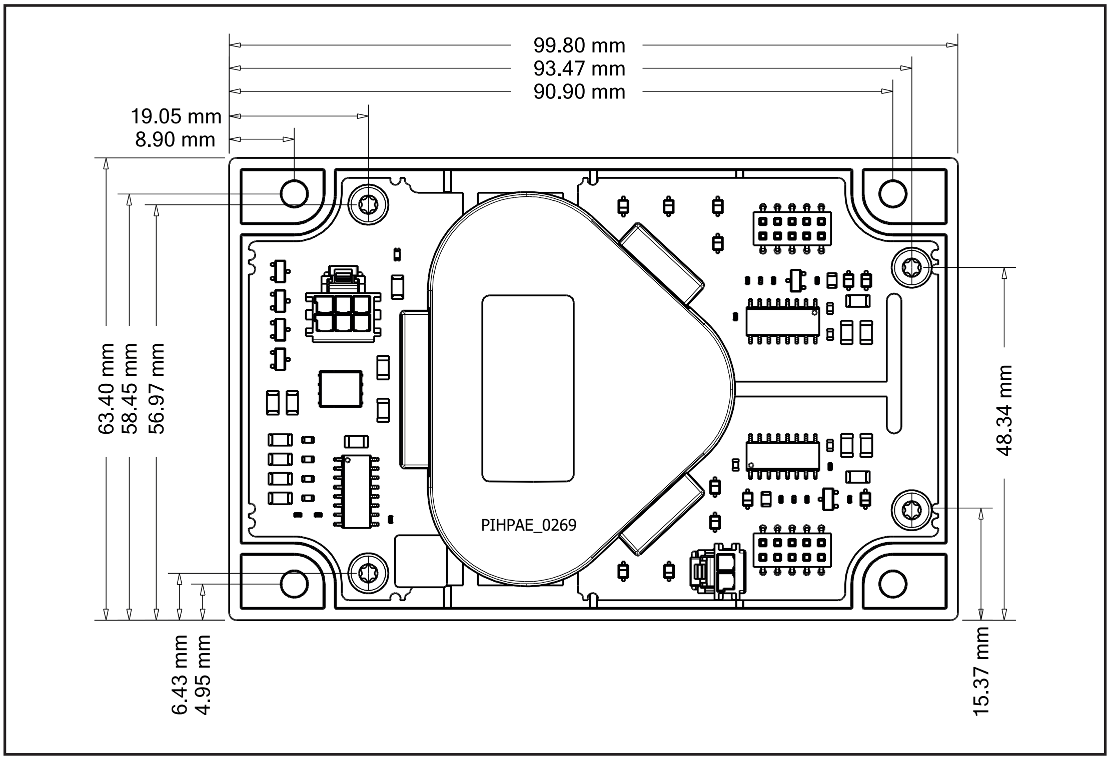

Figure 4. Top View of 2SIS0400T2C0C.

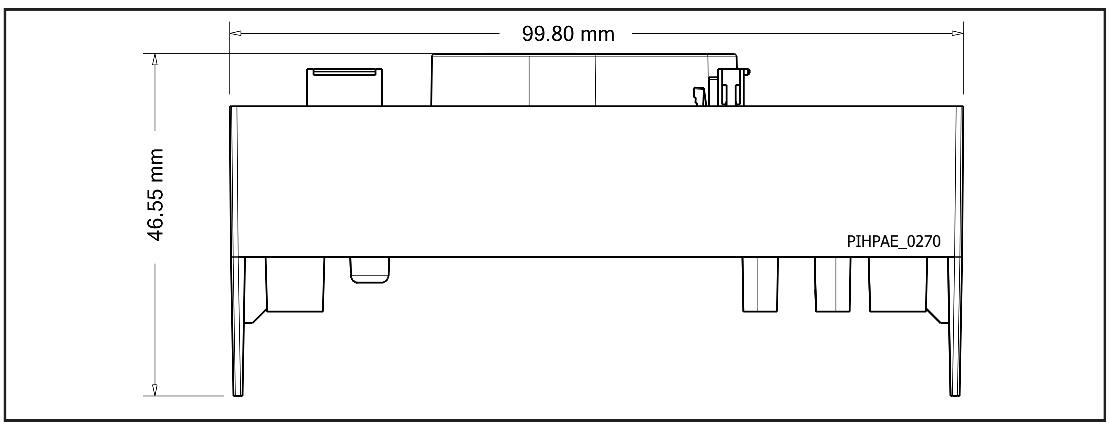

Figure 5. Side View of 2SIS0400T2C0C.

Product Details

Part Number	Power Module	Voltage Class	Current Class	Package	Power Device Supplier
2SIS0400T2C0C-33	N.A.	3300 V	N.A.	XHP2/LV100	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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