2SILT1200T2A0C-33
SCALE-iFlex LT Family

Isolated Master Control (IMC) for Driving
Half-Bridge Power Modules with NTC Measurement
via Electrical Interface

Product Highlights

Highly Integrated, Compact Footprint

- Ready-to-use dual-channel gate driver solution for power modules up to 3300 V blocking voltage
- Optimized to be used with up to 4 Module Adapted Gate Driver 2SMLT0220D2C0C
- Flexible input supply voltage with 15 V_{DC} or 24 V_{DC}
- 5.6 W output power per channel at maximum ambient temperature
- Electrical interface
- -40 °C to 85 °C operating ambient temperature

Protection / Safety Features

- Supported protection features of 2SMLT0220D2C0C MAG:
  - Short circuit ($V_{CE(SAT)}$ monitoring)
  - Advanced Active Clamping (AAC)
  - Undervoltage lock-out (UVLO)
- UVLO for primary and secondary sides
- NTC measurement:
  - TPM sensing with a reinforced isolated output signal using duty cycle based pulse protocol repeated every second
- Conformal coating applied on both sides of PCB

Comprehensive Safety Assurance

- 100% production tests include both transformer partial discharge and HIPOT testing
- Creepage and clearance distances between primary and secondary sides meets IEC 61800-5-1 reinforced isolation requirements
- RoHS compliant

Applications

- Wind and photovoltaic power
- Industrial drives
- Traction inverters

Description

The SCALE-iFlex™ LT with NTC gate driver family consists of an Isolated Master Control (IMC) unit that supports up to four Module Adapted Gate Drivers (MAGs) together with a cable set. The IMC 2SILT1200T2A0C-33 operates power modules that have a rated blocking voltage of up to 3300 V. The MAGs are matched to the specific power modules from a variety of suppliers.

The IMC 2SILT1200T2A0C-33 driver currently supports 2SMLT0220D2C0C designed for XHP™2, HPnC and LV100 module packages.

SCALE-iFlex LT with NTC enables easy paralleling of power modules providing high flexibility and system scalability.

Figure 1. Board Photo of 2SILT1200T2A0C-33.

Pin Functional Description

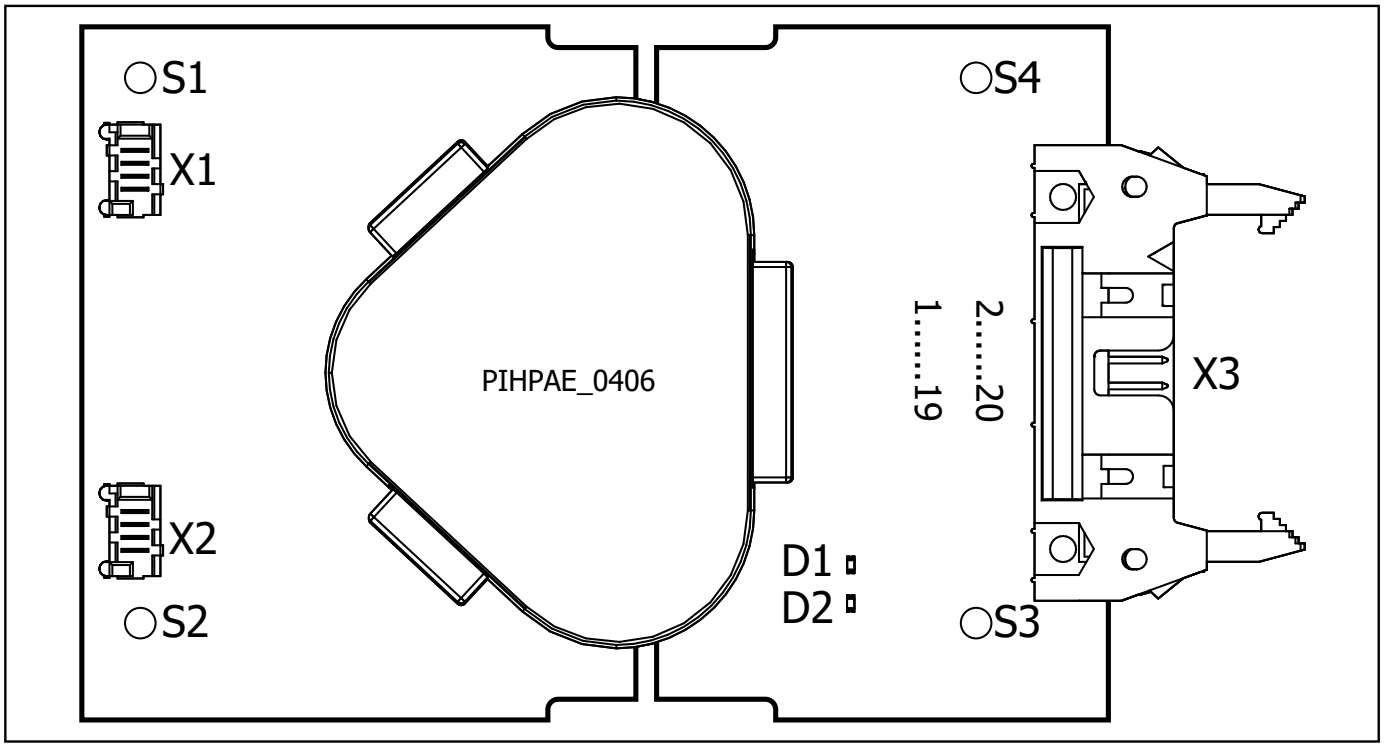

Figure 2. Pin Configuration.

Connector X3

AMPHENOL FCI 71922-120LF (or similar) Eject Latch Header Assembly at X3; Connection from IMC to superior controller.

VCC (Pins 1, 3)
This pin is the primary-side 24 V supply voltage connection.

V15 (Pin 5, 7)
This pin is the primary-side 15 V supply voltage connection.

Warning:
Either VCC or V15 has to be used for supplying the 2SILT1200T2A0C-33; any unsued supply connection must be left open.

IN1 (Pin 15)
This pin is the command input for channel 1.

SO1 (Pin 13)
This pin is the status output for channel 1.

IN2 (Pin 11)
This pin is the command input for channel 2.

SO2 (Pin 9)
This pin is the status output for channel 2.

TPM (Pin 17)
This is the measurement output for the NTC temperature sensing.

GND (Pins 2, 4, 6, 8, 10, 12, 14, 16, 18, 19, 20)
These pins are the connection for the primary-side ground potential. All primary-side signals refer to these pins

Connector X1

Connection from IMC to MAG for gate driver channel 1.

Connector X2

Connection from IMC to MAG for gate driver channel 2.

Warning: X1 and X2 connections must be connected to the correct channel on the MAGs (they are not interchangeable).

LED

D1

Red LED for monitoring the fault status.

The LED is turned on and keeps the light on upon a fault detected by the driver (i.e. short-circuit detection, undervoltage monitoring).

Notes:

- Red LED cannot report errors for the first three seconds after startup
- Power supply must rise faster than 200 ms (applies for V15 and V24) to avoid triggering the red LED

D2

Green for monitoring the power supply. The indicator is turned

on when the driver is supplied with voltage.

Note: Refer to further details in Optical Indicators Section.

Functional Description of 2SILT1200T2A0C-33

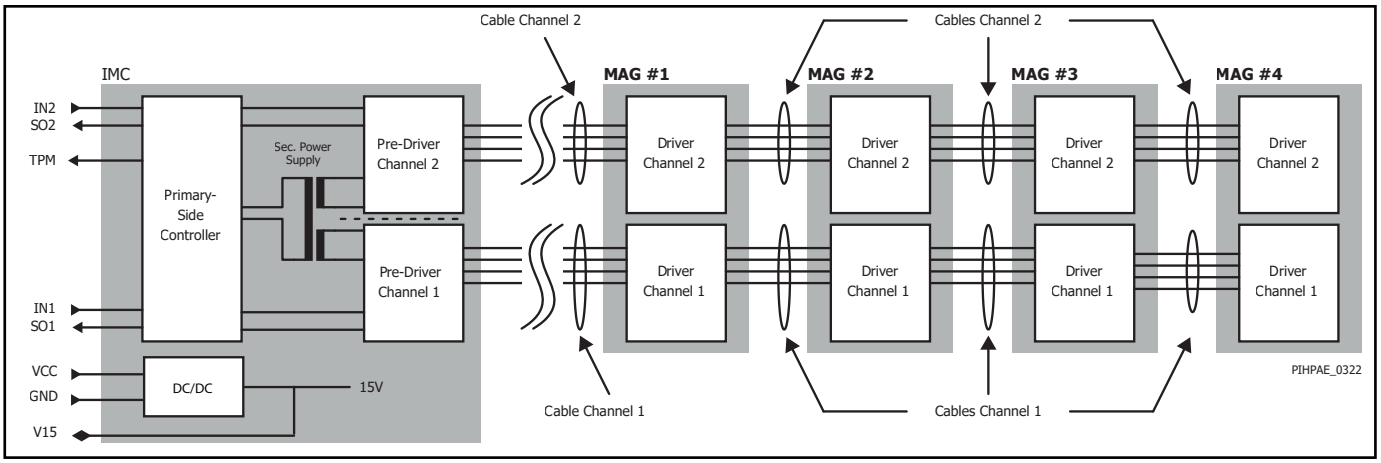

Figure 3. Functional Block Diagram.

The SCALE-iFlex LT with NTC is a dual-channel gate driver, comprising three components (Figure 3):

- Isolated Master Control (IMC): The IMC 2SILT1200T2A0C-33 is independent of the actual target power module voltage class. It operates with various power modules up to a blocking voltage of 3300 V and provides reinforced isolation between primary and either secondary sides as well as basic isolation between both secondary sides.
- Module Adapted Gate Drivers (MAG): MAGs are particularly designed to operate with specific power modules such as XHP™2, HPnC and LV100 type. Their characteristics match the requirements of the individual power modules.
- Cables: The interconnection between the external system controller and the IMC, from the IMC to the first MAG as well as between the MAGs is established with cables to allow a large degree of mechanical flexibility for the positioning of the devices.

The gate driver offer flexibility, operating single or up to four power modules in parallel based on application conditions and selected MAGs.

The operation of channel 1 and channel 2 of the gate driver is independent of each other. Dead-time insertion is required to avoid synchronous or overlapping switching. It has to be generated by the external system controller.

Note: Synchronous or overlapping switching within a half-bridge leg may damage the driven power switch(es), MAG and/or IMC.

Power Supplies (Primary-Side X3)
The 2SILT1200T2A0C-33 offers two independent power supply inputs. The first input, VCC, accepts a non-isolated fixed supply voltage V_{VCC}, while the second input, V15, accepts a non-isolated fixed supply voltage V_{V15}.

Only one supply input can be used at a time. When the supply voltage at terminal VCC is used, a regulated voltage of 15 V (typical value) is present at terminal V15. This serves as the internal reference voltage for all primary-side functions and can be used as a 15 V output. If VCC is used as a supply, an external load is permitted at V15, provided, along with the gate output loads, it does not raise the component temperature as well as the supply current above the defined limits in the absolute maximum ratings.

It should be mentioned that when input supply V15 is used, the VCC terminal must be left floating.

Undervoltage Monitoring
The supply voltages are closely monitored. In case of an under voltage condition (UVLO), a fault 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_{V15}, both status output signals will be set to GND and all gate driver channels will be synchronously turned off.

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.

Note: An UVLO event on a MAG will only turn off the affected MAG immediately. All other paralleled power semiconductors of the related channel are turned off after the delay $t_{OFF(MAG)}$.

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. Additionally the input signal IN1 and IN2 are filtered.

Gate driver signals are transferred from the IN1 and IN2 pins to the gate of the attached MAG(s) 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 status feedback signals SO1 and SO2 are open-drain outputs connected to V15 over pull-up resistors on the IMC. They stay at V_{V15} 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 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.

IMC Output (Secondary-Side X1, X2)
The IMC provides per channel an output connector towards the first MAG. Details on recommended routing and general mounting are given in the section "Mounting Instruction".

Screw Terminals
The 2SILT1200T2A0C-33 can be mounted within the system using screws at locations S1 to S4.

Short-Circuit Detection
In case of a detected short-circuit of the driven power module, the monitored semiconductor is immediately switched off and a fault signal is transmitted to the status output SOx after a delay t_{SOx}.

The fault feedback is automatically reset after the blocking time t_{BLK}. The semiconductor is turned-on again as soon as the next turn-on command signal is applied to the respective inputs after the fault status has disappeared.

NTC Temperature Measurement
Each MAG senses the NTC temperature of the attached power module. This signal is forwarded to the IMC and can be accessed at TPM on X3 interface connector. If more than one MAG is used, only the signal of the highest NTC temperature is considered. The temperature signal at terminal TPM is a duty cycle based pulse protocol with a repeatable pulse of F_{TPM} as shown in Figure 4.

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. Beyond the maximum detectable temperature of approx. 140°C, the provided TPM value will remain at 200 Ω even for higher temperatures. Repetition rate frequency changes by more than 20% tolerance (repetition from 0.8 Hz to 1.2 Hz) is acceptable. Missing duty cycle signal indicates an issue with the NTC circuit.

Optical Indicators (D1 and D2)
The IMC includes two optical indicators: a green LED (D2) and a red LED (D1). These LEDs provide visual status of the driver's operation state and any fault conditions.

LED Functionality:
- **No LED ON:** The board is not powered.
- **D2 ON:** The board is powered and operating normally.
- **D1 ON:** A fault has been detected. This could be due to undervoltage and desaturation faults.

To reset the fault condition indicated by D1:
1. Remove power from the driver.
2. Wait for 10 seconds to ensure complete discharge.
3. Reapply power to the driver.

Note: D1 starts reporting errors 3 seconds after start up.

Mounting Instruction
The IMC can be mounted at a suitable location within the target application using four M3 screw holes S1 to S4. It is recommended to place the IMC out of any hot-spot area (e.g. heat sinks). Cable length between IMC and MAG of up to 0.5 m allows a high level of design freedom. Alternatively, the IMC and MAG can be also mounted on a piggyback.

Note that the isolation coordination must be respected, e.g. plastic screws and/or spacers may be used if the support is electrically conducting (S1 and S2 are located close to secondary-side potentials while S3 and S4 are located close to primary-side potential).

Parallel connected modules shall have the same distances between each other to ensure a symmetrical switching behaviour.

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

Cables
SCALE-iFlex LT with NTC gate driver requires a set of cables to establish the electrical connection between the IMC and the first MAG as well as between paralleled MAGs. The usage of cables allows for a flexible positioning of the IMC within the application. Furthermore, it allows adapting to various pitches between paralleled power modules. Several cable connections have to be established for proper system operation. These are:

- Cable from the system level controller to the primary-side IMC interface X3.
- Cables from the secondary-side IMC interface to the first MAG (one per channel).
- In case of paralleling of power modules, the cables from one MAG to another MAG (one per channel).

The cables for IMC to MAG and MAG to MAG connection are standard cable assemblies Micro-MaTch from TE Connectivity and can be bought on the open market.

Ordering codes:
2205060-1
- Micro-MaTch 4 pin cable; 75 mm

2205060-2
- Micro-MaTch 4 pin cable; 150 mm

2205060-3
- Micro-MaTch 4 pin cable; 200 mm

Furthermore, cable assemblies can be self-made in individual lengths by using TE MicroMaTch connectors and 4-wire flat ribbon cables, AWG 28.
Ordering code: **7-215083-4**

- Micro-MaTch 4 pin IDC connector

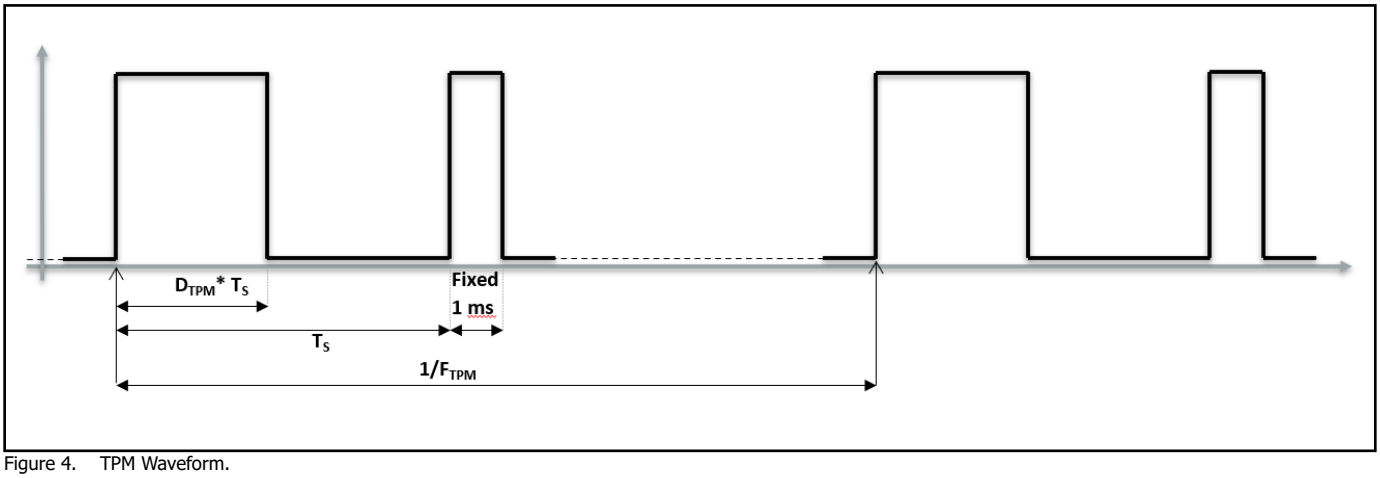

Figure 4. TPM Waveform.

All connections shall be assembled in non-powered status of the system only. The cable from IMC (connector X3) to the system level controller is not part of the SCALE-iFlex LT NTC gate driver and has to be provided by the designer of the system. It is recommended to route the cable with minimum parasitic coupling from the controller to the IMC. Parasitic coupling in particular to any potential of the secondary-side of the IMC has to be avoided. Otherwise, increased common-mode currents may circulate, which may cause interferences with command, measurement and/or status feedback signals.

The cables should not touch the PCB area to avoid contact with hot surfaces. The cable from the IMC (connectors X1/X2) to the first MAG has to be isolated from surrounding potentials including the frame of the inverter system. The minimum required distance to such potentials is 30 mm. A larger distance might be required depending on actual application conditions and applied isolation standards. The maximum length of the cable is 0.5 m. Beyond this length, degradation or timing variations of the command and/or status feedback signals may occur. The isolation can be established for instance with spacers or isolation sleeves.

Note: Partial discharge may occur within the cable and/or isolation sleeve depending on actual application conditions, which might lead to a degradation of the isolation. Proper routing of the cable and selection of the isolation sleeve are mandatory.

The cable connection from one MAG to another MAG should be kept as small as technically feasible. By this, typically no particular requirements concerning the isolation are given. In case the cable is in close proximity to other potentials (e.g. corresponding opposite channel, system frame), additional measures to ensure proper isolation distances have to be established. In any case, a minimum distance of 30 mm is required for such potentials. A larger distance might be required depending on actual application conditions and applied isolation standards. Using an isolation sleeve at reduced distances is not allowed due to parasitic cross-coupling effects.

Note: Missing cable connections especially between MAGs will not lead to a fault signal at the IMC terminal X3 and will therefore not be detected by the gate driver. During mating, the connectors should make an audible clicking noise when fully mated.

Conformal Coating

The electronic components of the gate driver 2SILT1200T2A0C-33 are protected by a layer of acrylic conformal coating with a typical thickness of 40µm using ELPEGUARD SL 1307 FLZ/2 from Lackwerke Peters on both sides of the PCB. This coating layer increases the product reliability when exposed to contaminated environments.

Note: The accumulation of standing water (e.g. through condensation) on top of the coating layer must be prevented. Standing water will diffuse through the coating over time and will eventually form a thin film between the PCB surface and coating layer, causing leakage currents to increase. Such currents will interfere with the performance of the gate driver.

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.

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}	Either VCC or V15 must be connected	0	26	V
	V_{V15}		0	16	
Primary-Side Supply Current	I_{VCC}	Average supply current at full load		750	mA
	I_{V15}			1	A
Logic Input Voltage (Command Signal)	V_{INx}	INx to GND	0	V_{V15} + 0.5	V
Logic Output Voltage (Status Signal)	V_{SOx}	SOx to GND	0	V_{V15} + 0.5	V
Status Output Current[2]	I_{SOx}	SOx to GND, fault condition, total current	0	20	mA
Temperature Output Current (NTC Measurement)	I_{TMP}	TPM to GND, total current	0	20	mA
Output Power Per Channel[3]	P_x			5.6	W
Switching Frequency	f_{SW}			25	kHz
Operating Voltage Primary-Side to Secondary-Side	V_{OP}	Transient only		3300	V
		Limited to 60 s		2500	
		Permanently applied		2200	
Test Voltage Primary-Side to Secondary-Side	$V_{ISO(PS)}$	50 Hz, 60 s		9100	V
Test Voltage Secondary-Side to Secondary-Side	$V_{ISO(SS)}$	50 Hz, 60 s		6700	V
Common-Mode Transient Immunity	|dv/dt|			50	kV/µs
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		95	%
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						
Primary-Side Supply Voltage	V_{VCC}	VCC to GND	22.8	24	25.2	V
	V_{V15}	V15 to GND	14.5	15	15.5	

Characteristics

Parameter	Symbol	Conditions T_A = 25 °C		Min	Typ	Max	Units
Power Supply							
Supply Current	I_{VCC}	V_{VCC} = 24 V, P_x = 250 mW, non-switching			70		mA
		V_{VCC} = 24 V, P_x = 5.6 W			570		
	I_{V15}	V_{V15} = 15 V, P_x = 250 mW, non-switching			100		
		V_{V15} = 15 V, P_x = 5.6 W			860		
Power Supply Monitoring Threshold (Primary-Side)	$UVLO_{V15}$	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)[7]	$UVLO_{VISOx}$	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}	P_x = 250 mW, non-switching			24.5		V
		P_x = 5.6 W			23.8		
Coupling Capacitance	C_{IO}	Primary-side to secondary-side, channel 1 (low-side)			14		pF
		Primary-side to secondary-side, channel 2 (high-side)			18		
Logic Inputs and Status Outputs							
Input Impedance	R_{INx}	INx to GND			7.8		kΩ
Turn-On Threshold	$V_{TH-ON(INx)}$	INx to GND			10.3		V
Turn-Off Threshold	$V_{TH-OFF(INx)}$	INx to GND			5.3		V
SOx Pull-Up Resistor to V_{V15}[8]	R_{SOx}				10		kΩ
TPM Measurements							
Signal Repetion Frequency	F_{TPM}				1		Hz
Signal Length	T_S	Duration from the rising edge of the first duty-cycle variable pulse to the rising edge of the second pulse (Figure 4)			13.2		ms
TPM Measurement Tolerance		At 25 °C excluding NTC tolerance			3.5		K
Signal Characterisitics		5 % ≤ DUT_{TPM} ≤ 95%		$R_{NTC} = 10 \cdot (24157 + (1215 \cdot D_{TPM})) / (1227 - (10 \cdot D_{TPM}))$			Ω

Characteristics (cont.)

Parameter	Symbol	Conditions V_{CC} = 24 V, T_A = 25 °C	Min	Typ	Max	Units
Timing Characteristics						
Turn-On Delay	$t_{P(LH)}$	50% INx to 10% V_{GE}		1000		ns
Turn-Off Delay	$t_{P(HL)}$	50% INx to 90% V_{GE}		850		ns
Turn-On Pulse Suppression[9]	$t_{PULSE(ON)(Inx)}$	INx to GND		820		ns
	$t_{PULSE(OFF)(Inx)}$	INx to GND		680		
Turn-Off Delay After MAG Fault	$t_{OFF(MAG)}$	Delay from any MAG fault detection until turn-off of all other MAGs		4		us
Transmission Delay of Fault State	t_{SOX}	From IMC error detection to SOx		6		us
Blocking Time	t_{BLK}	After secondary-side fault detection		20		ms
Electrical Isolation						
Test Voltage[10]	$V_{ISO(PS)}$	Primary-side to secondary-side	9100			V_{RMS}
	$V_{ISO(SS)}$	Secondary-side to secondary-side	6700			V_{RMS}
Partial Discharge Extinction Voltage[11]	$P_{D(PS)}$	Primary-side to secondary-side	4125			V_{PK}
	$P_{D(SS)}$	Secondary-side to secondary-side	3670			V_{PK}
Creepage Distance	CPG_{P-S}	Primary-side to secondary-side	44			mm
	CPG_{S-S}	Secondary-side to secondary-side	22			mm
Clearance Distance	CLR_{P-S}	Primary-side to secondary-side	22			mm
	CLR_{S-S}	Secondary-side to secondary-side	8.7			mm
Mounting						
Mounting Holes	D_{HOLE}	Diameter of screw hole S1 – S4		3.2		mm
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. 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 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 long-term reliability of the product.
7. Local emitter terminals are not routed outside of the IMC.
8. A pull-up resistor connects SOx to V15 on the driver board.
9. Pulse width shorter than the given values are suppressed (not processed up to the gate-emitter terminals).
10. The transformer of every production sample has undergone 100% testing at the given value for 1s.
11. Partial discharge measurement is performed on each transformer.

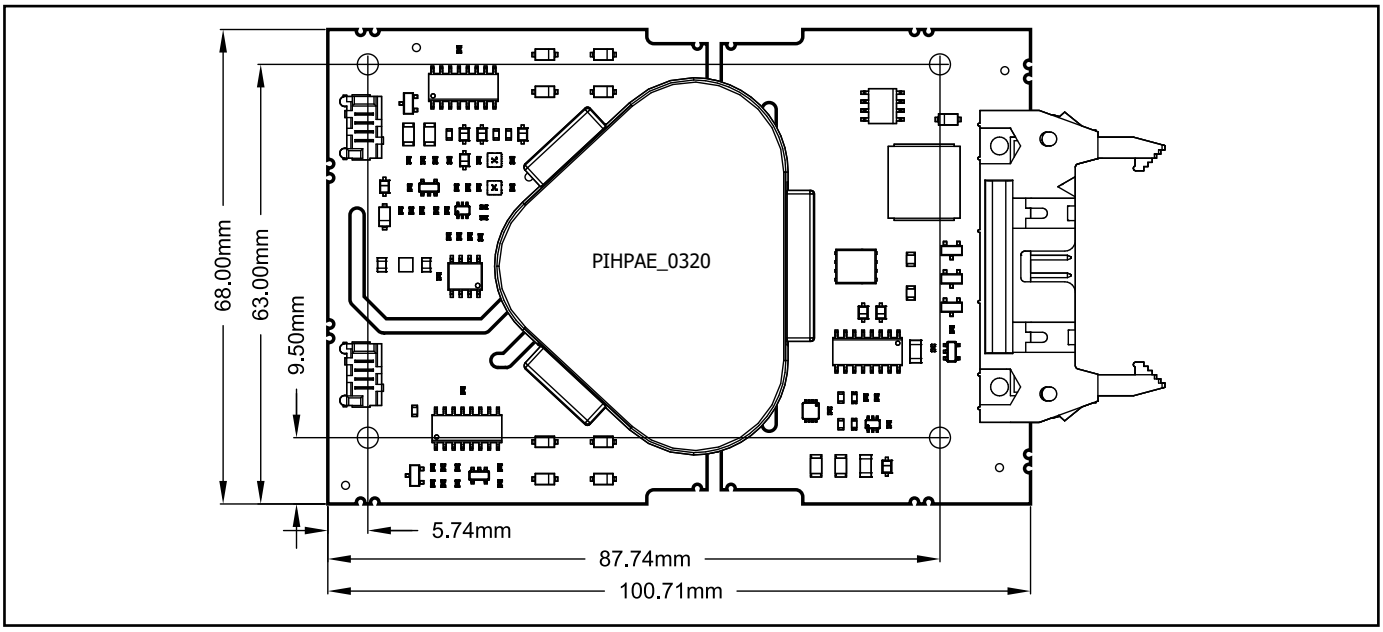

Figure 5. Top View

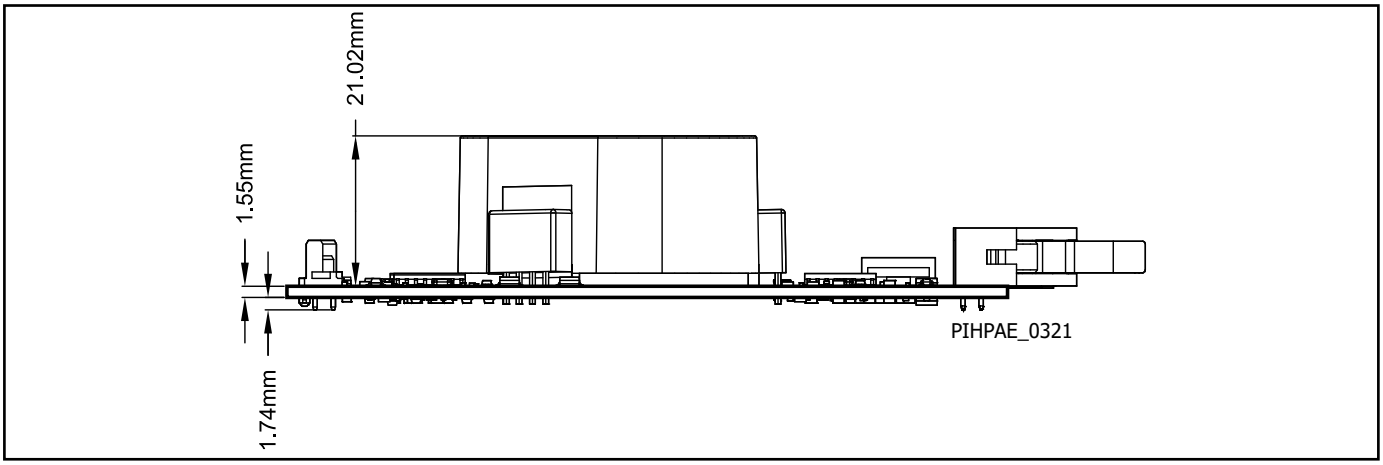

Figure 6. Side View.

Product Details		
Part Number	**Voltage Class**	**Coating**
2SILT1200T2A0C-33	3300 V	Coated

Revision	Notes	Date
A	Final Datasheet.	12/24

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