2SMS0220D2C0C-CM1200DC-34X
SCALE-iFlex Single Family

Gate Driver for 1700 V Half-Bridge Power Modules

Advanced Information

PRELIMINARY

Product Highlights

Highly Integrated, Compact Footprint

- Ready-to-use gate driver solution for power modules up to 1700 V blocking voltage
- Optimized for Mitsubishi's Half-Bridge Power Modules CM1200DC-34X
- -40 °C to +85 °C operating ambient temperature

Protection / Safety Features

- Undervoltage lock-out (UVLO)
- Overvoltage protection by Advanced Active Clamping (AAC)
- Short circuit protection
- Applied double sided conformal coating

Full Safety and Regulatory Compliance

- 100% production partial discharge and HIPOT test of transformer
- Clearance and creepage distances between both secondary sides meet requirements for reinforced isolation

Green Package

- RoHS compliant

Applications

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

Description

This datasheet describes the Module Adapted Gate Driver (MAG) of the SCALE-iFlex™ Single gate driver family which consists furthermore of a central Isolated Master Control (IMC).

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

SCALE-iFlex Single enables compact and easy controlling power modules providing high flexibility and system scalability with minimum development effort.

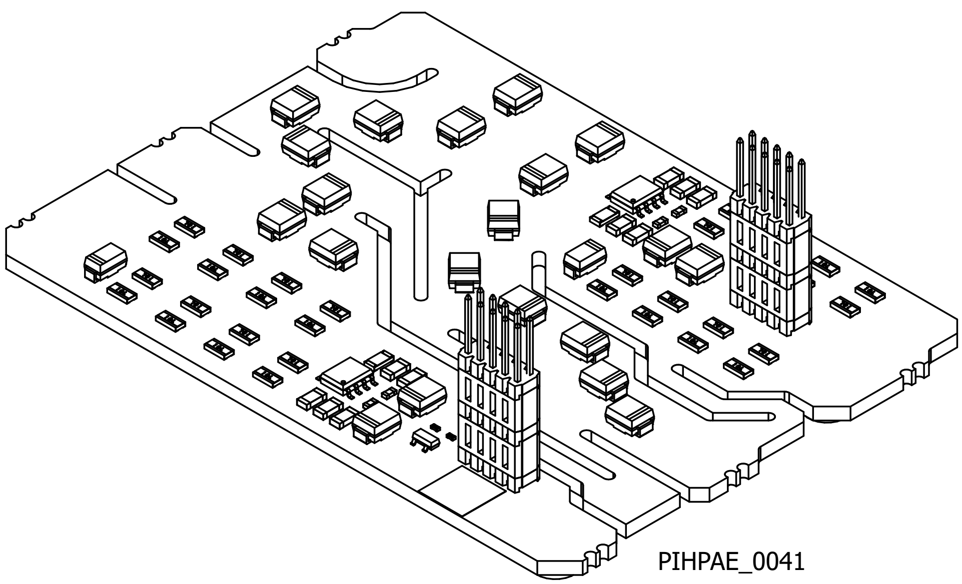

Figure 1. 3D-Picture.

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

Pin Functional Description

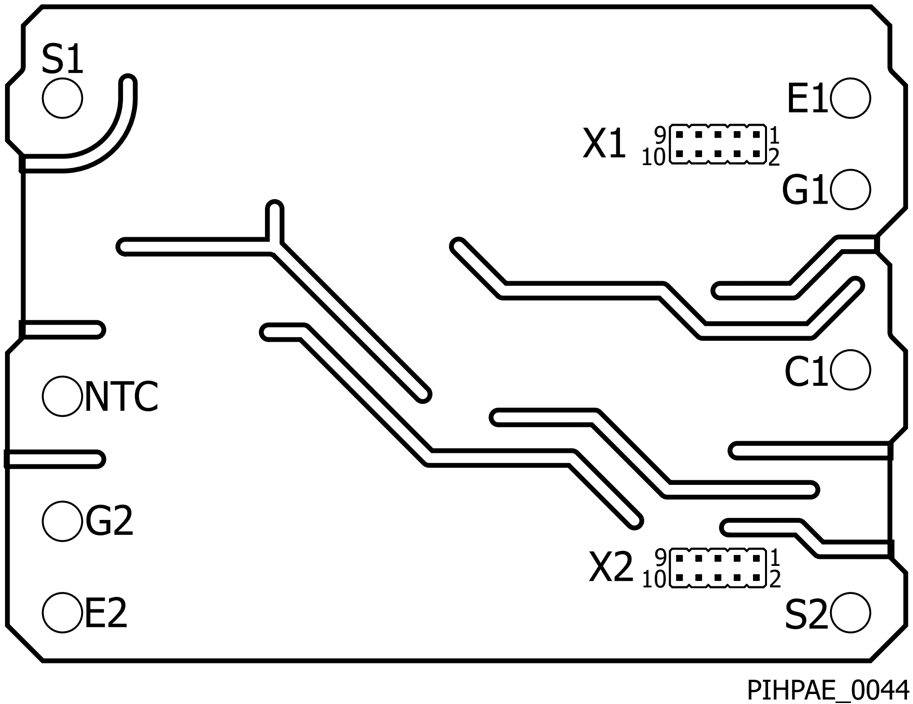

Figure 2. Pin Configuration.

Connection To Semiconductor

Terminal G1
Gate contact of channel 1 switch.

Terminal E1
Auxiliary emitter contact of channel 1 switch.

Terminal C1
Auxiliary collector contact of channel 1 switch.

Terminal G2
Gate contact of channel 2 switch.

Terminal E2
Auxiliary emitter contact of channel 2 switch.

Screw Holes S1 and S2
Dome positions for optional fixation of the MAG to the IMC housing.

NTC
Contact to module-internal NTC (directly routed to IMC).

Connection To IMC

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

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

Functional Description

Connector Terminals (X1 and X2)

The MAG has one connector terminals per channel.

The MAG needs to be connected to the secondary-side of the IMC. IMC and MAG have to be mounted in a piggyback like 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 with channel 2 of the MAG (X2).

Screw Terminals (S1, S2)
The MAG is mounted on top of the power module and fixed by screws.

Gate Voltage
SCALE-iFlex Single possesses a voltage regulator for the positive (turn-on) rail of the gate voltage. Internal current sources are regulating actively the positive gate-emitter voltage independently of actual load conditions within the maximum specified ratings. Therefore, the on-state gate-emitter voltage of the power semiconductor equals in steady state the positive supply voltage V_{VISO}.

The off-state gate-emitter voltage $V_{GE(OFF)}$ equals in steady state the voltage V_{COM}. This voltage is load dependent. It has its lowest value under no load conditions and is increasing slightly (i.e. getting less negative) with increasing load.

In the event of an under voltage lock-out condition the gate driver changes the control of the positive rail towards control of the negative rail V_{COM}. By this potential parasitic turn-on events of the power semiconductor are avoided.

Power Supplies
The isolated voltages for the gate driver channels of the MAG is generated by the integrated DC/DC converter of the IMC. The positive rail of the gate driver channels has the voltage level V_{VISOx} and the negative rail the voltage level V_{COMx}. Both are referenced to the emitter potential at terminal E1 or E2 of the driven power semiconductor.

Short-Circuit Protection
The SCALE-iFlex Single gate driver uses the semiconductor desaturation effect to detect short-circuits and protects the device against damage by turning off the power semiconductor in case of a short-circuit event.

The desaturation is monitored on the MAG 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 $V_{CE(STAT)}$, the driver detects a short-circuit condition. The monitored semiconductor is switched off immediately and a fault signal is transmitted to the customer interface by the IMC.

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 and increases at lower DC-link voltages. Please refer to the relevant data sheet section. An example waveform is shown in Figure 4.

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

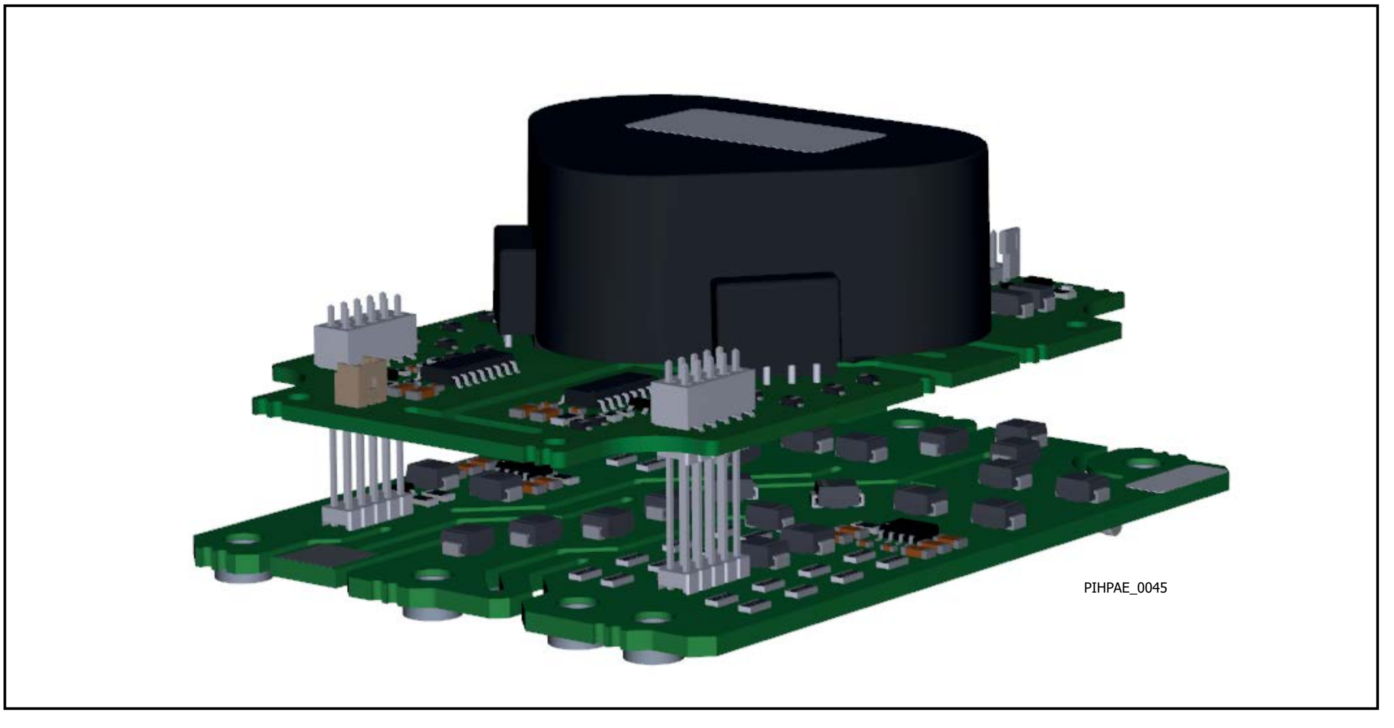

Figure 3. Assembly (Actual product may differ from illustration.).

the transconductance of the power semiconductor. To ensure that the gate-emitter voltage stays close to the nominal turn-on voltage each MAG features a gate-clamping circuitry. The gate clamping provides a voltage similar to V_{VISO} to the gate, i.e. 15 V. As the effective short-circuit current is a function of the gate-emitter voltage the short-circuit current is limited. As consequence the energy dissipated in the power semiconductor during the short-circuit event is reduced, leading to a junction temperature within the short-circuit safe operating area (SCSOA) limits and enables a safe turn-off of the device.

Advanced Active Clamping (AAC)
Active clamping is a technique designed to partially turn on the IGBT in case the collector-emitter voltage exceeds a predefined threshold. The IGBT is then kept in linear operation. Figure 5 illustrates the general behavior of active clamping and its voltage thresholds. Basic active clamping topologies implement a single feedback path from the IGBT's collector through transient voltage suppressor (TVS) diodes to the IGBT gate. The gate driver contains Power Integrations' Advanced Active Clamping (AAC) based on this principle: When active clamping is activated, the turn-off MOSFET of the gate driver is switched off in order to improve the effectiveness of the active clamping and to reduce the losses in the TVS diodes. This feature is mainly integrated in the secondary-side ASIC of the gate driver.

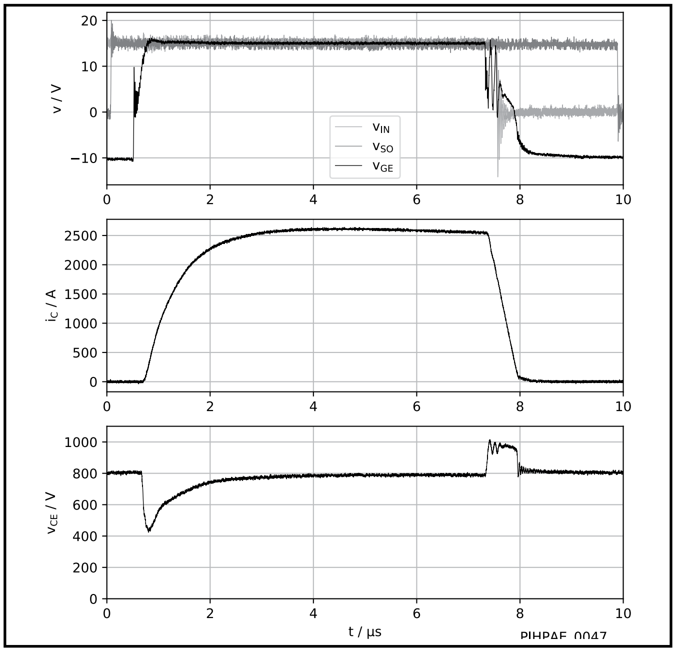

Figure 4. Short-Circuit Turn-Off.

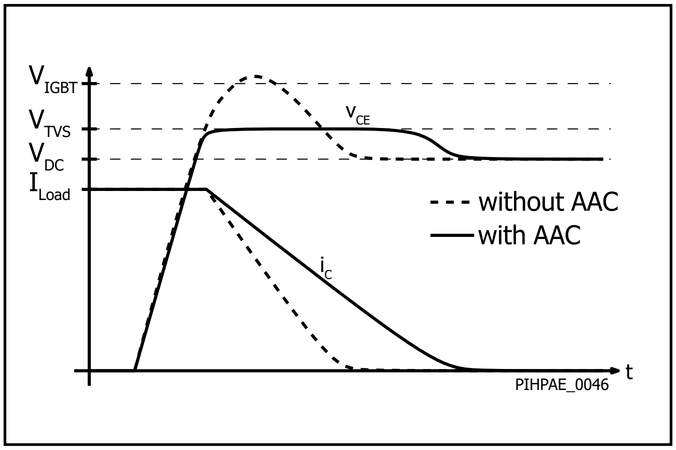

Figure 5. Advanced Active Clamping.

PRELIMINARY

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Maximum Ratings

Parameter	Symbol	Conditions T_A = -40 °C to 85 °C	Min	Max	Units
Absolute Maximum Ratings[1] - 2SMS0220D2C0C-CM1200DC-34X					
Gate Output Power Per Channel[5]	$P_{Gx,max}$			3.0	W
Gate Output Current Per Channel	I_G			20	A
DC-Link Voltage	$V_{DC-Link}$	Switching operation		1200	V_{DC}
Storage Temperature[2]	T_{st}		-40	50	°C
Operating Ambient Temperature	T_A		-40	85	°C
Surface Temperature[3]	T			125	°C
Relative Humidity	H_r	No condensation		93	%
Altitude of Operation[4]	A_{op}			2000	m

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Parameter	Symbol	Conditions $T_A = +25\ °C$		Min	Typ	Max	Units
Electrical Characteristics - 2SMS0220D2C0C-CM1200DC-34X							
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 peration)	11.0	12.0	13.0	
			Hysteresis	0.35			
	$UVLO_{COMx}$		Clear fault (resume operation)		-5.15		V
			Set fault (suspend peration)		-4.85		
			Hysteresis		0.3		
Gate Turn-On Voltage	$V_{GE(on)}$	IMC supplied with 15 V, without load, referenced to respective terminal Ex			15		V
		IMC supplied with 15 V, $P_{Gx} = P_{G,max}$ referenced to respective terminal Ex			15		
Gate Turn-Off Voltage	$V_{GE(off)}$	IMC supplied with 15 V, without load, referenced to respective terminal Ex			9.5		V
		IMC supplied with 15 V, P_{Gx} = 1.5 W, referenced to respective terminal Ex			9.1		
Static V_{CE}-Monitoring Threshold	$V_{CE(stat)}$				46		V
Response Time	t_{res}	DC-link voltage = 600 V			6.1		µs
		DC-link voltage = 900 V			5.3		
		DC-link voltage = 1200 V			5.2		
Delay to Power Semi-conductor Turn-Off After short-Circuit Detection	$t_{pd,SC}$				0.2		µs
Creepage Distance	CPG_{S-S}	Secondary-side to secondary-side		22			mm
Clearance Distance	CLR_{S-S}	Secondary-side to secondary-side		8			mm
Mounting Holes	d_{hole}	Diameter of screw holes			3		mm
Screw Header/Washer Diameter	d_{M3}	Terminals G1, E1, C1, G2, E2, S1 and S2				8.0	mm
Terminal Connection Torque	M_{MAG}	Screw M3				0.6	Nm
Bending	I_{bend}	According to IPC				0.75	%
Turn-On Gate Resistor	$R_{G(on)}$				1.14		Ω
Turn-Off Gate Resistor	$R_{G(off)}$				7.0		Ω
Auxiliary Gate Capacitor	C_{GE}				33		nF

NOTES:
1. Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device.
2. 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.
3. The component surface temperature, which may strongly vary depending on the actual operating conditions, must be limited to the given value for coated gate driver versions to ensure long-term reliability of the coating material.
4. Operation above this level requires a voltage derating to ensure proper isolation coordination.
5. Actually achievable maximum power depends on several parameters and has to be validated in the final system. It is mainly limited by the maximum allowed surface temperature.

Product Dimensions

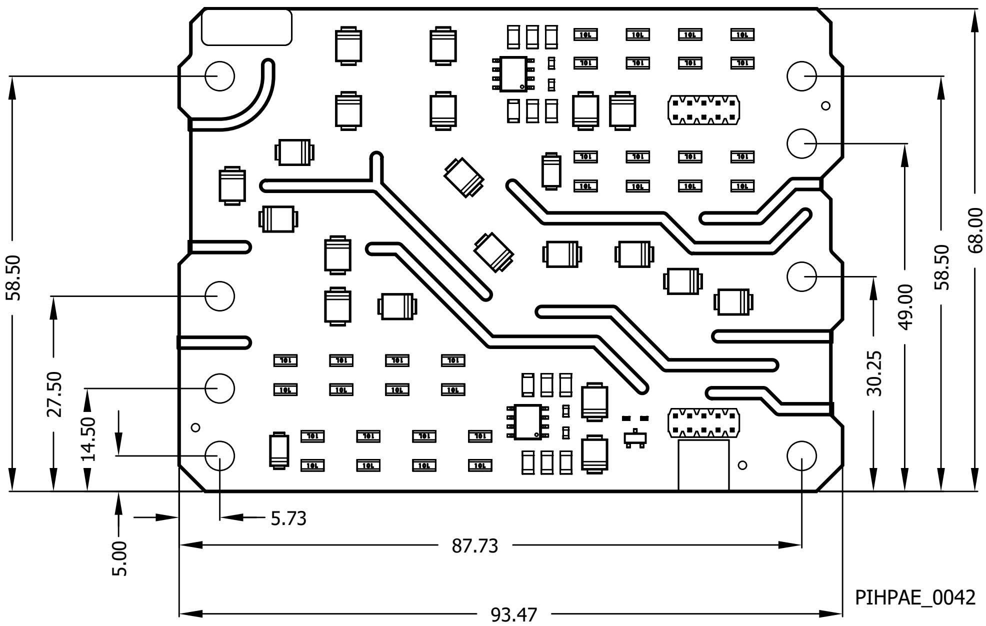

Figure 6. Top View.

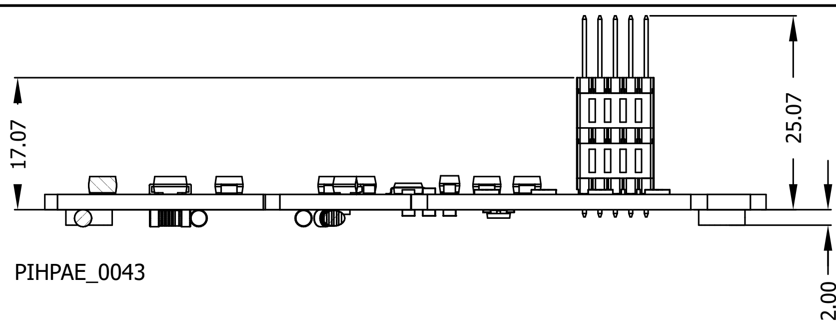

Figure 7. Side View.

Product Details

Part Number	Power Module	Voltage Class	Current Class	Package	Power Device Supplier
2SMS0220D2C0C-CM1200DC-34X	CM1200DC-34X	1700 V	1200 A	LV100	Mitsubishi

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.

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Revision	Notes	Date
A	Preliminary.	09/21

For the latest updates, visit our website: www.power.com

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