

# 1SP0350V2A1-45

## Target Data Sheet

High-performance, plug-and-play single-channel IGBT driver based on SCALE™-2 technology for IGBT modules and Press-Packs in 2-level, 3-level and multilevel converter topologies

### Abstract

The SCALE™-2 plug-and-play driver 1SP0350V2A1-45 is a compact single-channel intelligent gate driver with a fiber-optic interface designed for 4500V Press-Packs, IGBT modules and IEGTs.

All components required for driving, such as an isolated DC/DC converter, short-circuit protection, Dynamic Advanced Active Clamping as well as supply voltage monitoring are included on the driver.

The driver's secondary side is electrically isolated from its primary side and meets the requirements of 4500V IGBT applications.

**The turn-on and turn-off gate resistors as well as the auxiliary gate capacitor are not assembled in order to provide maximum flexibility. They must be assembled by the user before start of operation.**

For drivers adapted to other types of high-power and high-voltage IGBT modules, refer to:

[www.power.com/igbt-driver/go/Plug-and-Play](http://www.power.com/igbt-driver/go/Plug-and-Play)

### Features

- ✓ Plug-and-play solution
- ✓ For 2-level, 3-level and multilevel topologies
- ✓ Fiber-optic links
- ✓ Duty cycle 0...100%
- ✓ Dynamic Advanced Active Clamping DA<sup>2</sup>C
- ✓ IGBT short-circuit protection
- ✓ Monitoring of supply voltage
- ✓ Extremely reliable; long service life
- ✓ Shortens application development time
- ✓ Lead-free
- ✓ No free floating metal
- ✓ Basic isolation to IEC 61800-5-1 and IEC 60664-1

### Applications

- ✓ HVDC
- ✓ Flexible AC transmission systems (FACTS)
- ✓ Railroad power supplies
- ✓ Light rail vehicles
- ✓ Traction
- ✓ Medium-voltage converters
- ✓ Industrial drives
- ✓ Wind-power converters
- ✓ Medical applications
- ✓ And many others

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### Safety Notice!

The data contained in this data sheet is intended exclusively for technically trained staff. Handling all high-voltage equipment involves risk to life. Strict compliance with the respective safety regulations is mandatory!

Any handling of electronic devices is subject to the general specifications for protecting electrostatic-sensitive devices according to international standard IEC 60747-1, Chapter IX or European standard EN 100015 (i.e. the workplace, tools, etc. must comply with these standards). Otherwise, this product may be damaged.

### Important Product Documentation

This data sheet contains only product-specific data. For a detailed description, must-read application notes and common data that apply to the whole series, please refer to the "Description & Application Manual for 1SP0350V SCALE-2 IGBT Drivers" on [www.power.com/igbt-driver/go/1SP0350V](http://www.power.com/igbt-driver/go/1SP0350V).

The gate resistors as well as the auxiliary gate capacitor on this gate driver are not assembled in order to provide maximum flexibility. For the values required for specific IGBT modules, refer to the paragraph on "Gate Resistor and Auxiliary Gate Capacitor Assembly". Use of gate resistors and gate auxiliary capacitors other than those specified may result in failure.

### Mechanical Dimensions

Dimensions: Refer to the relevant "Description and Application Manual"

Mounting principle: Electrical connection to IGBT module via cables

### Fiber-Optic Interfaces

Interface	Remarks	Part type #
Drive signal input	Fiber-optic receiver (Notes 1, 2)	HFBR-2522ETZ
Status output	Fiber-optic transmitter (Notes 1, 3)	AFBR-1529Z

### Electrical Connectors

Interface	Remarks	Part type #
Power supply connector X1	On-board connector (Note 4)	CIM039P5
IGBT module connectors		
X2GE	On-board connectors (Note 5)	71922-120LF
X2G, X2E and X2C	On-board connectors (Note 6)	PCB-1M4

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### Absolute Maximum Ratings

Parameter	Remarks	Min	Max	Unit
Supply voltage $V_{DC}$	VDC to GND	0	16	V
Logic output voltage $V_{SO}$	SO to GND	-0.5	VDC+0.5	V
Average supply current $I_{DC}$	Note 7		400	mA
SO current	Failure condition, total current (Note 8)		20	mA
Gate output power	$T_a \leq 70^\circ\text{C}$		2.5	W
	$T_a \leq 85^\circ\text{C}$		1.8	W
Switching frequency $f$	Note 9		5	kHz
Gate peak current $I_{out}$	Note 10	-50	+50	A
External gate resistance	Turn-on and turn-off (Note 11)	0.3		$\Omega$
DC-link voltage	Switching operation (Note 12)		3400	V
	Off state (Note 13)		4000	V
Test voltage (50Hz/1min.)  dV/dt	Primary to secondary (Note 14)		10.2	kV <sub>eff</sub>
	Rate of change of input to output voltage		35	kV/ $\mu\text{s}$
Operating voltage	Primary to secondary side		4500	V <sub>peak</sub>
Operating temperature		-40	+85	$^\circ\text{C}$
Storage temperature		-40	+85	$^\circ\text{C}$

### Recommended Operating Conditions

Power Supply	Remarks	Min	Typ	Max	Unit
Supply voltage $V_{DC}$	VDC to GND	14.5	15	15.5	V

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<b>Electrical Characteristics</b>
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All data refer to +25°C and  $V_{DC} = 15V$  unless otherwise specified

<b>Power Supply</b>	<b>Remarks</b>	<b>Min</b>	<b>Typ</b>	<b>Max</b>	<b>Unit</b>
Supply current $I_{DC}$	Without load		108		mA
<b>Power Supply Monitoring</b>	<b>Remarks</b>	<b>Min</b>	<b>Typ</b>	<b>Max</b>	<b>Unit</b>
Supply threshold $V_{DC}$	Primary side, clear fault	11.6	12.6	13.6	V
	Primary side, set fault (Note 15)	11.0	12.0	13.0	V
Monitoring hysteresis	Primary side, set/clear fault	0.35			V
Supply threshold $V_{iso}-V_{ee}$	Clear fault	11.6	12.6	13.6	V
	Set fault (Note 16)	11.0	12.0	13.0	V
Monitoring hysteresis	Set/clear fault	0.35			V
Supply threshold $V_{ee}-V_{COM}$	Clear fault		5.15		V
	Set fault (Note 16)		4.85		V
Monitoring hysteresis	Set/clear fault		0.3		V
<b>IGBT Short-circuit Protection</b>	<b>Remarks</b>	<b>Min</b>	<b>Typ</b>	<b>Max</b>	<b>Unit</b>
Static $V_{CE}$ -monitoring threshold	Between auxiliary terminals (Note 17)		550		V
Response time	DC-link voltage = 3400V (Note 18)		9.1		μs
	DC-link voltage = 2800V (Note 18)		9.4		μs
	DC-link voltage = 1800V (Note 18)		10.6		μs
Delay to IGBT turn-off $t_{CSHD}$	After the response time (Note 19)		0.2		μs
<b>Timing Characteristics</b>	<b>Remarks</b>	<b>Min</b>	<b>Typ</b>	<b>Max</b>	<b>Unit</b>
Turn-on delay $t_{d(on)}$	Note 20		140		ns
Turn-off delay $t_{d(off)}$	Note 20		110		ns
Output rise time $t_{r(out)}$	G to E (Note 21)		10		ns
Output fall time $t_{f(out)}$	G to E (Note 21)		18		ns
Transmission delay of fault state	Note 22		90		ns
Delay to clear fault state $t_{(block)}$	After IGBT short circuit (Note 23)		9		μs
Acknowledge delay time $t_{d(ack)}$	Note 24		200		ns
Acknowledge pulse width $t_{(ack)}$	On host side	400	700	1050	ns

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Gate Output	Remarks	Min	Typ	Max	Unit
Turn-on gate resistor $R_{g(on)}$	Note 25			not assembled	$\Omega$
Turn-off gate resistor $R_{g(off)}$	Note 25			not assembled	$\Omega$
Auxiliary gate capacitor $C_{ge}$	Note 25			not assembled	nF
Gate voltage at turn-on	Note 26		15		V
Gate-voltage at turn-off	Without load (Note 26)		-9.4		V
	$P_{DC/DC} = 1.8W$ (Note 26)		-9.1		V
	$P_{DC/DC} = 2.5W$ (Note 26)		-9.0		V

Electrical Isolation	Remarks	Min	Typ	Max	Unit
Test voltage (50Hz/1s)	Primary to secondary side (Note 14)	10.2			$kV_{eff}$
Partial discharge extinction volt.	Primary to secondary side (Note 27)	5400			$V_{peak}$
Creepage distance					
On the PCB	Primary to secondary side (Material group IIIa)	45			mm
On the transformer	Primary to secondary side (Material group I)	36			mm
Clearance distance	Primary to secondary side	25			mm

### Footnotes to the Key Data

- 1) The transceivers required on the host controller side are not supplied with the gate driver. It is recommended to use the same types as used in the gate driver. For product information refer to [www.power.com/igbt-driver/go/fiberoptics](http://www.power.com/igbt-driver/go/fiberoptics).
- 2) The recommended transmitter current at the host controller is 6mA. A higher current may increase jitter or delay at turn-off.
- 3) The typical transmitter current at the gate driver is 6mA. In case of supply undervoltage, the minimum transmitter current at the gate driver is 4.4mA: this is suitable for adequate plastic optical fibers with a length of more than 10 meters.
- 4) This refers to the manufacturer ordering number, see [www.power.com/igbt-driver/go/sauro](http://www.power.com/igbt-driver/go/sauro). Refer to the "Description & Application Manual for 1SP0350V SCALE-2 IGBT Drivers" for more information.
- 5) This refers to the manufacturer ordering number, see [www.power.com/igbt-driver/go/fci](http://www.power.com/igbt-driver/go/fci). X2GE can be used with X2C to connect 1SP0350V to the IGBT module.
- 6) This refers to the manufacturer ordering number, see [www.power.com/igbt-driver/go/ninigi](http://www.power.com/igbt-driver/go/ninigi). X2G, X2E and X2C can be used to connect 1SP0350V to the IGBT module.
- 7) If the specified value is exceeded, this indicates a driver overload. It should be noted that the driver is not protected against overload.
- 8) Including current flowing into the on-board pull-up resistor of 10k $\Omega$ .
- 9) The maximum switching frequency must additionally be limited by the maximum allowed gate output power.
- 10) The gate current must be limited to the given values by the gate resistors on the driver and the load.
- 11) The gate resistors are not assembled on this IGBT gate driver. They must be assembled by the user according to the paragraph on "Gate Resistor and Auxiliary Gate Capacitor Assembly".
- 12) This limit is due to active clamping under switching conditions. Refer to the "Description & Application Manual for 1SP0350V SCALE-2 IGBT Drivers".
- 13) Due to the Dynamic Active Advanced Clamping Function (DA<sup>2</sup>C) implemented on the driver, the DC-link voltage can be increased in the off-state condition (e.g. after emergency shut-down). This value is only valid when the IGBTs are in the off state (not switching). The time during which the voltage can be applied should be limited to short periods (< 60 seconds). Refer to the "Description & Application Manual for 1SP0350V SCALE-2 IGBT Drivers".

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- 14) HiPot testing (= dielectric testing) must generally be restricted to suitable components. This gate driver is suited for HiPot testing. Nevertheless, it is strongly recommended to limit the testing time to 1s slots. Excessive HiPot testing at voltages much higher than  $3182V_{AC,rms}$  may lead to insulation degradation. No degradation has been observed over 1min. testing at  $10.2kV_{eff}$ . The transformer of every production sample shipped to customers has undergone 100% testing at the given value for 1s.
- 15) Undervoltage monitoring of the primary-side supply voltage (VDC to GND). If the voltage drops below this limit, a fault is transmitted to the power connector's SO output.
- 16) Undervoltage monitoring of the secondary-side supply voltage (Viso to Vee and Vee to COM which correspond with the approximate turn-on and turn-off gate-emitter voltages). If the corresponding voltage drops below this limit on 1SP0350V the IGBT is switched off (only valid if jumper J1 is set at the position "2-level") and a fault is transmitted to the status output.
- 17) A dynamic  $V_{CE}$  protection is implemented on the driver. The maximum allowed  $V_{CE}$  voltage at turn-on is dynamically adjusted in order to better fit to the IGBT characteristics at turn-on. At the end of the turn-on process the given static value applies.
- 18) The resulting pulse width of the direct output of the gate drive unit for short-circuit type I (excluding the delay of the gate resistors) is the sum of the response time plus the delay to IGBT turn-off (only valid if jumper J1 is set at the position "2-level").
- 19) The turn-off event of the IGBT is delayed by the specified time after the response time if the jumper J1 is set at the position "2-level". The position "3-level" should not be used in this driver version.
- 20) Including the delay of the external fiber-optic links (cable length: 1m). Measured from the transition of the turn-on or turn-off command at the optical transmitter on the host controller side to the direct output of the gate drive unit (excluding the delay of the gate resistors).
- 21) Output rise and fall times are measured between 10% and 90% of the nominal output swing. The values are given for the driver side of the gate resistors with  $4.7\Omega/270nF$  load. The time constant of the output load in conjunction with the present gate resistors leads to an additional delay at their load side.
- 22) Delay of external fiber-optic links. Measured from the driver secondary side (ASIC output) to the optical receiver on the host controller with a 1m cable.
- 23) Measured on the host side. The fault status is stretched by the given value after the IGBT short-circuit has been turned off.
- 24) Including the delay of the external fiber-optic links (cable length: 1m). Measured from the transition of the turn-on or turn-off command at the optical transmitter on the host controller side to the transition of the acknowledge signal at the optical receiver on the host controller side.
- 25) The gate resistors and the auxiliary gate capacitor are not assembled on this IGBT gate driver. They must be assembled by the user according to the paragraph on "Gate Resistor and Auxiliary Gate Capacitor Assembly".
- 26) The driver secondary-side voltage is split into two distinct voltages on the driver. The first one is the turn-on voltage which is regulated at about 15V. The difference between the total secondary-side voltage and the turn-on voltage is the turn-off voltage which is not regulated and mainly dependent on the driver input voltage VDC and the DC/DC converter power.
- 27) Partial discharge measurements are performed in accordance with IEC 60270 and IEC 60664-1 for basic insulation requirements.

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**Gate Resistor and Auxiliary Gate Capacitor Assembly**

The turn-on and turn-off gate resistors as well as the auxiliary gate capacitor of 1SP0350V drivers are adapted to their respective IGBT modules.

Recommended gate resistors (R148, R149, R138 and R139): PR02 / 2W / 5% from Vishay

Recommended auxiliary gate capacitor (C106): 1206 / X7R / 25V / 5%

The following versions exist:

4500V IGBT Type	R148/ R149	R138/ R139	Resulting Rg,on	Resulting Rg,off	C106
5SNA3000K452300	2Ω	15Ω	1Ω	7.5Ω	330n

For the component position, refer to Figs. 1 and 2.

**Assembly Drawing**

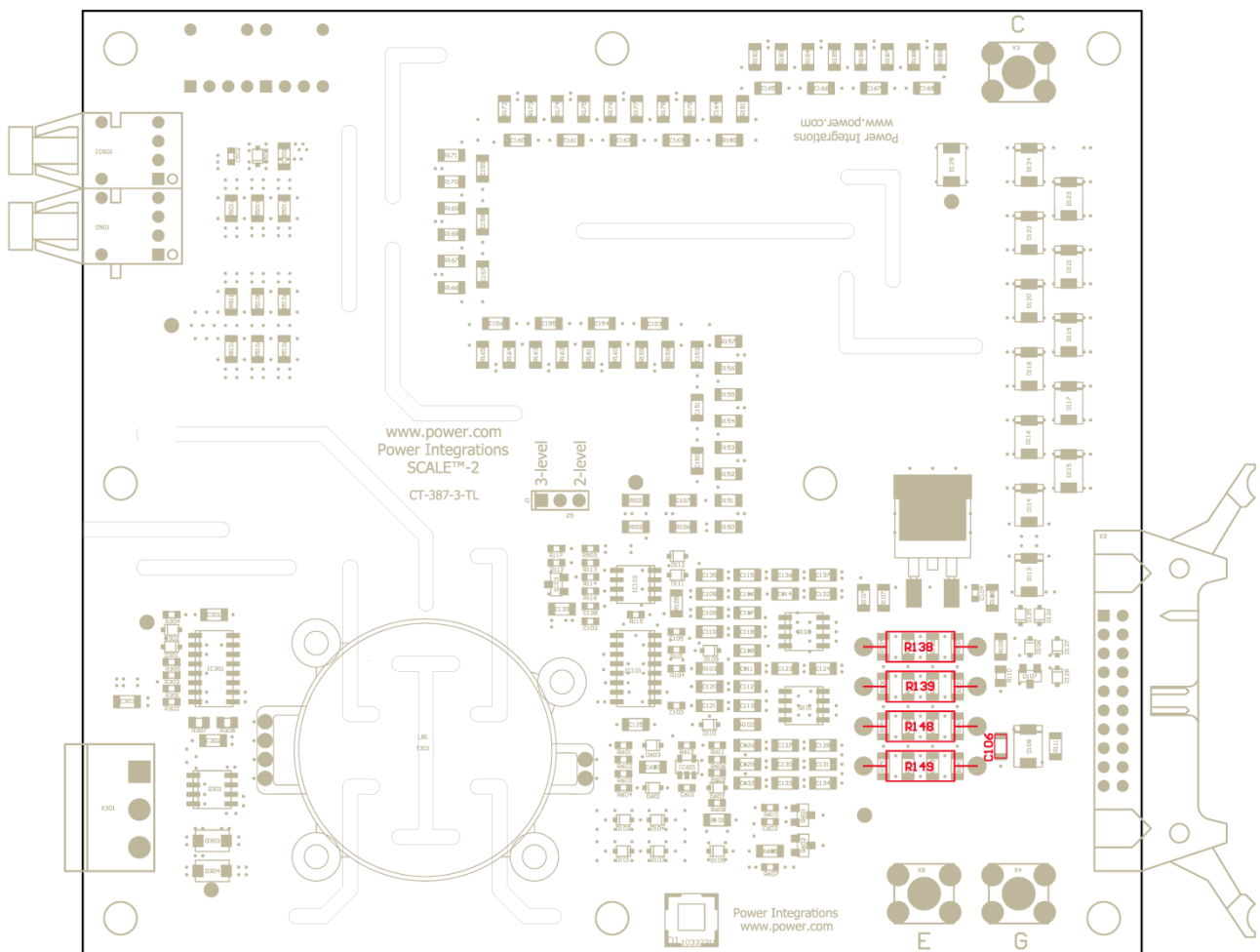


Fig. 1 Assembly drawing of 1SP0350V with highlighted gate resistors and auxiliary gate capacitor

Furthermore, a minimum distance of 1mm must be maintained between the gate resistor body and the PCB.

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### **RoHS Statement**

On the basis of Annexes II and III of European Directive 2011/65/EC of 08 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), we hereby state that the products described in this datasheet do not contain lead (Pb), mercury (Hg), hexavalent chromium (Cr VI), cadmium (Cd), polibrometo of biphenyl (PBB) or polibrometo diphenyl ether (PBDE) in concentrations exceeding the restrictions set forth in Annex II of 2011/65/EC with due consideration of the applicable exemptions as listed in Annex III of 2011/65/EC.

### **Legal Disclaimer**

The statements, technical information and recommendations contained herein are believed to be accurate as of the date hereof. All parameters, numbers, values and other technical data included in the technical information were calculated and determined to our best knowledge in accordance with the relevant technical norms (if any). They may base on assumptions or operational conditions that do not necessarily apply in general. We exclude any representation or warranty, express or implied, in relation to the accuracy or completeness of the statements, technical information and recommendations contained herein. No responsibility is accepted for the accuracy or sufficiency of any of the statements, technical information, recommendations or opinions communicated and any liability for any direct, indirect or consequential loss or damage suffered by any person arising therefrom is expressly disclaimed.



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## Target Datasheet

### Ordering Information

Our international terms and conditions of sale apply.

Interface	Power Integrations Driver Type #	Related IGBT
Fiber-Optic Interface	1SP0350V2A1-45	4500V IGBT modules

Product home page: [www.power.com/igbt-driver/go/1SP0350V](http://www.power.com/igbt-driver/go/1SP0350V)

Refer to [www.power.com/igbt-driver/go/nomenclature](http://www.power.com/igbt-driver/go/nomenclature) for information on driver nomenclature.

### Information about Other Products

**For other drivers, product documentation, and application support:**

Please click: [www.power.com](http://www.power.com)

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