1SC0450E2A0-45 and 1SC0450E2A0-65 Preliminary Data Sheet

Single-Channel Cost-Effective SCALE™-2 IGBT Driver Core with Customer-Specific Gate Drive Input for 4500V and 6500V IGBTs

Abstract

The 1SC0450E2A0-xx supports maximum design flexibility to drive all usual high-power IGBT modules up to 4500V or 6500V, as no fiber-optic links are assembled on the driver board. Gate driving input and output signals are provided over an electrical interface connector. Thanks to its high output power capability, a single 1SC0450E2A0-xx driver can drive up to four parallel-connected 4500V or 6500V IGBT modules and consequently provides easy inverter design covering higher power ratings. Multi-level topologies involving 3300V or 4500V IGBTs with higher isolation requirements can also be easily supported by 1SC0450E2A0-xx.

The 1SC0450E2A0-xx combines a complete single-channel driver core with all components required for driving, such as an isolated DC/DC converter, short-circuit protection, Advanced Active Clamping as well as supply voltage monitoring. Enhanced features such as gate boosting or power supply short-circuit protection are also implemented and provide further driving benefits.

The driver's secondary side is electrically isolated from its primary side. The 1SC0450E2A0-45 meets the requirements of 4500V IGBT applications while the 1SC0450E2A0-65 covers the requirements of 6500V IGBT applications.

An output current of 50A and 6W drive power is available, making the 1SC0450E2A0-xx an ideal driver platform for universal use in medium- and high-power applications. The driver provides a gate voltage swing of 15V/-10V. The turn-on voltage is regulated to maintain a stable 15V regardless of the output power level.

Its outstanding EMC allows safe and reliable operation even in harsh industrial applications.

Product Highlights

- ✓ Ultra-compact single-channel driver
- ✓ Highly integrated SCALE™-2 chipset
- ✓ Gate current ±50A, 6W output power
- ✓ 15V/-10V gate driving
- ✓ Blocking voltages up to 4500V or 6500V
- ✓ Basic isolation to IEC 61800-5-1 and IEC 60664-1
- ✓ UL-compliant
- ✓ Lead-free

Applications

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

Preliminary Datasheet

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 important information that apply to this product, please refer to "1SC0450E Description & Application Manual" on www.power.com/igbt-driver/go/1SC0450.

Mechanical Dimensions

Dimensions: Refer to the "1SC0450E Description & Application Manual"

Absolute Maximum Ratings

Parameter	Remarks	Min	Max	Unit
Supply voltage V_{DC}	VDC to GND	0	16	V
Supply voltage V_{CC}	VCC to GND	0	16	V
Logic output voltage V_{SO}	SO to GND	-0.5	VCC+0.5	V
SO current	Failure condition, total current (Note 26)		20	mA
Logic input voltage V_{IN}	IN to COM	-0.5	VISO+0.5	V
Logic input/output voltage V_{OUT}	OUT to COM	-0.5	VISO+0.5	V
Load current OUT			25	mA
Maximum external capacitance	OUT to VISO, VE, COM		50	pF
Gate peak current $\hat{I}_G$	Note 1	-50	+50	A
External gate resistance	Turn-on and turn-off (Notes 1, 2)	0.3		Ω
Average supply current I_{DC}	Notes 3, 4		860	mA
Output power	Ambient temperature ≤70°C (Notes 5, 6)		8	W
	Ambient temperature ≤85°C (Note 5)		6	W
Gate boosting output power	Notes 5, 7		4	W
Gate charge Q_{GBS}	GBS to GH		15	nC
Bias current I_{GBS}	On-state		20	µA
Switching frequency f			10	kHz
Power supply short-circuit time	Non-repetitive (Note 21)		1	s
Test voltage (50Hz/1min.)	Primary to secondary (Note 15)		10.2	kV_{eff}
|dV/dt|	Rate of change of input to output voltage		35	kV/µs
Operating voltage	Primary/secondary, 1SC0450E2A0-45		4500	V_{peak}
	Primary/secondary, 1SC0450E2A0-65		6500	V_{peak}
Operating temperature	Notes 6	-40	+85	°C
Storage temperature		-40	+85	°C

Recommended Operating Conditions

Power Supply	Remarks	Min	Typ	Max	Unit
Supply voltage V_{DC}	VDC to GND	14.5	15	15.5	V
Supply voltage V_{CC}	VCC to GND	14.5	15	15.5	V
IN voltage V_{IN}	IN to COM, high-level		15		V
OUT voltage V_{OUT}	OUT to COM, high-level	3.5			V

Electrical Characteristics

All data refer to +25°C and V_{CC} = V_{DC} = 15V unless otherwise specified.

Electrical characteristics apply for the recommended fiber-optic link according to "1SC0450E Description & Application Manual" if not otherwise specified.

Power Supply	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Supply current I_{DC}	Without load		110		mA
Supply current I_{CC}			20		mA
Coupling capacitance C_{io}	Primary to output, total		8		pF
Supply voltage VGB	VGB to VISO (Note 22)		25		V
VGB charge	VGB to VISO (Note 23)		540		nC
Power Supply Monitoring	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Supply threshold V_{CC}	Primary side, clear fault	11.6	12.6	13.6	V
	Primary side, set fault (Note 13)	11.0	12.0	13.0	V
Monitoring hysteresis	Primary side, set/clear fault	0.35			V
Supply threshold V_{ISO}-V_E	Secondary side, clear fault	11.8	12.6	13.4	V
	Secondary side, set fault (Note 14)	11.2	12.0	12.8	V
Monitoring hysteresis	Secondary side, set/clear fault	0.35			V
Supply threshold V_E-V_{COM}	Secondary side, clear fault		5.2		V
	Secondary side, set fault (Note 14)		4.9		V
Monitoring hysteresis	Secondary side, set/clear fault		0.3		V
Power Supply Protection	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Overload power threshold	Output, set fault (Note 19)		17		W
Fault feedback pulse	OUT to COM (Note 20)	500			µs
Logic Inputs	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Turn-on threshold	IN to COM (Note 28)		1.20		V
Turn-off threshold	IN to COM (Note 28)		2.60		V
No load voltage V_{IN}	Pin IN floating		4.0		V
External fault input V_{OUT}-V_{COM}	Set external fault		1.20		V
	Clear external fault		2.70		V
Hold time	Set external fault (V_{OUT} = low)	2			µs
Delay	Clear external fault (V_{OUT} = high)		0.1		µs

Logic Outputs	Remarks	Min	Typ	Max	Unit
SO pull-up resistor to VCC	On board		10		kΩ
SO output voltage V_{SO}	Failure condition, I(SO)<6.5mA			0.7	V
GBS voltage	GBS to GH, on-state (Note 22)		9		V
	GBS to GH, off-state (Note 22)		0		V
Low-level voltage V_{OUT}	OUT to COM at I_{OUT}=16.5mA			0.7	V
Short-Circuit Protection	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
V_{CE}-monitoring threshold	Factory set value (Note 17)		10.2		V
Minimum response time	Note 11		5.1		µs
Delay to clear fault state $T_{d(cfs)}$	After IGBT short circuit (Note 12)		8		µs
Delay in IGBT turn-off T_{cshd}	Factory-set value (Note 18)		0.2		µs
Timing Characteristics	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Turn-on delay $T_{d(on)}$	Note 8		80		ns
Turn-off delay $T_{d(off)}$	Note 8		35		ns
Output rise time $T_{r(GH)}$	Note 9		30		ns
Output fall time $T_{f(GL)}$	Note 9		25		ns
Acknowledge delay time $T_{d(ack)}$	Notes 24, 25		40		ns
Acknowledge pulse width $T_{(ack)}$	At pin OUT	400	700	1050	ns
Electrical Isolation	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Test voltage (50Hz/1s)	Primary to secondary side (Note 15)	10.2			kV_{eff}
Partial discharge extinction volt.	Primary to secondary side				
	1SC0450E2A0-45 (Note 16)	5400			V_{peak}
	1SC0450E2A0-65 (Note 16)	7800			V_{peak}
Creepage distance (Note 27)					
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
Output	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Blocking capacitance	VISO to VE (Note 10)		18.8		µF
	VE to COM (Note 10)		9.4		µF

Output Voltage Swing

The output voltage swing consists of two distinct segments. First, there is the turn-on voltage V_{GH} between pins GH and VE. V_{GH} is regulated and maintained at a constant level for all output power values and frequencies.

The second segment of the output voltage swing is the turn-off voltage V_{GL}. V_{GL} is measured between pins GL and VE. It is a negative voltage. It changes with the output power to accommodate the inevitable voltage drop across the internal DC/DC converter.

Output Voltage	Remarks	Min	Typ	Max	Unit
Turn-on voltage, V_{GH}	Any load condition		15.0		V
Turn-off voltage, V_{GL}	No load		-9.5		V
Turn-off voltage, V_{GL}	6W output power		-9.0		V
Turn-off voltage, V_{GL}	8W output power		-8.8		V

Footnotes to the Key Data

1) The maximum peak gate current refers to the highest current level occurring during the product lifetime. It is an absolute value and also applies to short pulses.
2) Twice the given minimum resistance value must be inserted between the interface connectors GH and GL. Moreover, the given minimal resistance value must be used in the full gate turn-on (interface connector GH to gate) and turn-off (interface connector GL to gate) path.
3) The average supply input current is limited for thermal reasons. Higher values than specified by the absolute maximum rating are permissible (e.g. during power supply start up) if the average remains below the given value, provided this average is taken over a time period which is shorter than the thermal time constants of the driver in the application.
4) There is no protection against light overload of the power supply. In the case of start-up with very high blocking capacitor values, or of short circuit/heavy overload at the output, the supply input current is limited internally. The time during which the driver output is shorted/overloaded must be limited externally and must be within the absolute maximum rating.
5) The maximum output power must not be exceeded at any time during operation. It must also be observed for time periods shorter than the thermal time constants of the driver in the application.
6) An extended output power range is specified in the output power section for ambient temperatures limited from -40°C to 70°C.
7) The gate-boosting output power can be calculated according to "1SC0450E Description & Application Manual" and is specified as a part of the gate driver's total output power, which is the sum of the turn-on power over the output GH plus the gate boosting power over the output VGB. The turn-on power approximately equals the turn-off power of the output GL. The gate boosting is not active at turn-off.
8) Measured from the transition of the turn-on or turn-off command at pin IN with logic levels of 0V/5V to the direct output of the gate drive unit (excluding the delay of the gate resistors). The delay time is measured between 50% of the input signal IN and the 10% voltage swing of the corresponding output. The delay time is independent of the output loading.
9) Output rise and fall times are measured between 10% and 90% of the nominal output swing with an output load of 4.7Ω and 270nF. These values are given for the driver side of the gate resistors. The time constant of the output load in conjunction with the present gate resistors leads to an additional delay at the load side of the gate resistors.
10) External blocking capacitors should be placed between the VISO and VE as well as the VE and COM terminals. Refer to "1SC0450E Description & Application Manual" (paragraph "DC/DC output (VISO), emitter (VE) and COM terminals)" for recommendations. Ceramic capacitors are recommended.
11) The minimum response time is valid for the circuit given in the description and application manual with the values of the corresponding tables.
12) Measured on the host side. The fault status on the secondary side is extended by the "delay in IGBT turn-off" and automatically reset after the specified time. Refer to "1SC0450E Description & Application Manual" for more details.
13) Undervoltage monitoring of the primary-side supply voltage (VCC to GND). If the voltage drops below this limit, a fault is transmitted to the SO output.

14) Undervoltage monitoring of the secondary-side supply voltage (VISO to VE and VE to COM, which correspond to the approximate turn-on and turn-off gate-emitter voltages). If the corresponding voltage drops below this limit, a fault is transmitted to the OUT output and the IGBT is switched off after the corresponding delay. Refer to "1SC0450E Description & Application Manual" for more details.
15) 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 $3182V_{AC,rms}$ with 1SC0450E2A0-45 and $4596V_{AC,rms}$ with 1SC0450E2A0-65 may lead to insulation degradation. No degradation has been observed over 1min. testing at $10.2kV_{AC,rms}$. Every production sample (transformer only) shipped to customers has undergone 100% testing at the given value for 1s.
16) Partial discharge measurements are performed in accordance with IEC 60270 and IEC 60664-1 for basic insulation requirements.
17) The V_{CE}–monitoring threshold value can be reduced with an external resistor. Refer to "1SC0450E Description & Application Manual".
18) The turn-off event of the IGBT after a secondary-side fault (IGBT short circuit, undervoltage monitoring or power-supply short circuit/overload) can be additionally delayed with an external capacitor. Refer to "1SC0450E Description & Application Manual".
19) Gate turn-on and turn-off current pulses in normal operation do not affect the power supply protection. This protection is only triggered by a corresponding power-supply overload or short circuit (which would also occur in case of gate-emitter short circuit/overload).
20) The fault feedback pulse length/pattern depends on the power supply short-circuit/overload. The minimum value applies for any power-supply overload.
21) Maximum short-circuit duration of the driver output. The driver's power supply VDC must be switched off externally within the given time. The power supply protection prevents the driver's components from being damaged within the given time frame. For details refer to the driver's "1SC0450E Description & Application Manual".
22) The voltage values of the pins VGB resp. GBS are correspondingly about 50V and 34V respectively referred to COM. This must be considered for the design of the creepage and clearance distances.
23) The given value applies for a full discharge of VGB to VISO at turn-on, when no external capacitor is used. It can be increased by using additional external capacitors.
24) Measured from the transition of the turn-on or turn-off command at pin IN to the transition of the acknowledge signal at pin OUT.
25) Measured with a pull-up resistor of 10kΩ from pin OUT to VISO.
26) Including current flowing out of the on-board pull-up resistor of 10kΩ.
27) Creepage distances over additional components (e. g. fiber-optic wires, fixation screws, …) which are not part of the driver must be taken into account by the user.
28) The gate drive input signal IN is inverted to the gate output. Refer to "1SC0450E Description & Application Manual" for more information.

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.

Ordering Information

The general terms and conditions of delivery of Power Integrations Switzerland GmbH apply.

Type Designation	Description
1SC0450E2A0-45	Single-channel SCALE-2 driver core for 4500V IGBTs
1SC0450E2A0-65	Single-channel SCALE-2 driver core for 6500V IGBTs

Product home page: www.power.com/igbt-driver/go/1SC0450

Refer to www.power.com/igbt-driver/go/nomenclature for information on driver nomenclature.

Information about Other Products

For other drivers, product documentation, and application support:

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