1SC2060P2Ax-17 Preliminary Datasheet

Single-Channel High-Power High-Frequency SCALE-2 Driver Core

Abstract

The 1SC2060P2Ax-17 is a 20W, 60A CONCEPT driver core. This high-performance SCALE-2 driver targets high-power single-channel IGBT and MOSFET applications such as induction heating, resonant and high-frequency power conversion as well as parallel gate driving of large modules.

It features newly developed planar transformer technology for a real leap forward in power density, noise immunity, and reliability.

Equipped with the latest SCALE-2 chipset, the gate driver supports switching up to 500kHz at best-in-class efficiency. The 1SC2060P2Ax-17 effectively comprises a complete single-channel IGBT driver core, fully equipped with an isolated DC/DC converter, short-circuit protection, advanced active clamping and supply-voltage monitoring.

With its extremely compact outline of 44mm x 74mm and a total height of typ. 6.5mm, it delivers high power density with an attractive form factor. Thanks to the highly integrated SCALE-2 chipset, the component count is reduced by 80% compared to conventional solutions. This results in significantly increased reliability and reduced costs.

Product Highlights

- 20W maximum output power
- Switching up to 500kHz
- New SCALE-2 platform
- Planar transformer
- Jitter less than ±1ns
- Signal delay < 80ns
- 3.3V...15V input logic
- 1700V isolation (signal + DC/DC)
- Safe isolation to EN 50178
- UL compliant
- Dedicated IGBT and MOSFET mode

Applications

- Induction heating
- High-frequency converters
- High-current switches
- Industrial drives
- Pulse power
- Resonant switching
- Wind power converters
- Single switch control
- Parallel connection of modules

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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 important information that apply to this product, please refer to "1SC2060P Description & Application Manual" on www.IGBT-Driver.com/go/1SC2060P

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 input and output voltages	Primary side, to GND	-0.5	VCC+0.5	V
SO current	Failure condition, total current		20	mA
Gate peak current I_{out}	Notes 1, 11	-60	+60	A
Average supply current I_{DC}	Notes 2, 3		2100	mA
Output power	Ambient temperature <70°C (Notes 4, 5)		23	W
	Ambient temperature 85°C (Note 4)		21	W
Switching frequency F			500	kHz
Test voltage (50Hz/1min.)	Primary to secondary side (Note 12)		5000	$V_{AC(eff)}$
Operating voltage	Primary to secondary side		1700	V_{peak}
|dV/dt|	Rate of change of input to output voltage (Note 17)		100	kV/µs
Operating temperature	Note 5	-40	+85	°C
Storage temperature		-40	+90	°C

Recommended Operating Conditions

Power Supply	Remarks	Min	Typ	Max	Unit
Supply voltage V_{DC}	VDC to GND, IGBT mode	14.5	15	15.5	V
Supply voltage V_{DC}	VDC to GND, MOSFET mode (Note 10)	6		12	V
Supply voltage V_{CC}	VCC to GND	14.5	15	15.5	V

Electrical Characteristics (IGBT mode)

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

Power supply	Remarks	Min	Typ	Max	Unit
Supply current I_{DC}	Without load		36	60	mA
Supply current I_{CC}	F = 0Hz		12	15	mA
Supply current I_{CC}	F = 360kHz		31		mA
Coupling capacitance C_{io}	Primary to output, total		40		pF

Power Supply Monitoring	Remarks	Min	Typ	Max	Unit
Supply threshold V_{CC}	Primary side, clear fault	11.9	12.6	13.3	V
	Primary side, set fault (Note 18)	11.3	12.0	12.7	V
Monitoring hysteresis	Primary side, set/clear fault	0.35			V
Supply threshold V_{ISO}-V_E	Secondary side, clear fault	12.1	12.6	13.1	V
	Secondary side, set fault (Note 18)	11.5	12.0	12.5	V
Monitoring hysteresis	Secondary side, set/clear fault	0.35			V
Supply threshold V_E-V_{COM}	Secondary side, clear fault	5	5.15	5.3	V
	Secondary side, set fault (Note 18)	4.7	4.85	5	V
Monitoring hysteresis	Secondary side, set/clear fault	0.15			V

Logic Inputs and Outputs	Remarks	Min	Typ	Max	Unit
Input bias current	V(IN) > 3V		190		µA
Turn-on threshold	V(IN)		2.6		V
Turn-off threshold	V(IN)		1.3		V
SO output voltage	Failure condition, I(SO)<20mA			0.7	V

Short-Circuit Protection	Remarks	Min	Typ	Max	Unit
Current through pin REF	R(REF, VE)<70kΩ		150		µA
Minimum response time	Note 15		1.2		µs
Minimum blocking time	Note 16		9		µs

Timing Characteristics	Remarks	Min	Typ	Max	Unit
Turn-on delay $t_{d(on)}$	Note 6		75		ns
Turn-off delay $t_{d(off)}$	Note 6		70		ns
Jitter of turn-on delay	Note 20		±1		ns
Jitter of turn-off delay	Note 20		±1		ns
Output rise time $t_{r(out)}$	Note 7		10		ns
Output fall time $t_{f(out)}$	Note 7		15		ns
Transmission delay of fault state	Note 19		400		ns

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Electrical Isolation	Remarks	Min	Typ	Max	Unit
Test voltage (50Hz/1s)	Primary to secondary side (Note 12)	5000	5050	5100	$V_{AC(eff)}$
Partial discharge extinction volt.	Note 13	1768			V_{peak}
Creepage distance	Primary to secondary side	15			mm
Clearance distance	Primary to secondary side	15			mm

Output	Remarks	Min	Typ	Max	Unit
Blocking capacitance VISO to VE	Note 14		9.4		µF
Blocking capacitance VE to COM	Note 14		9.4		µF
External gate resistor loop	F ≤ 250kHz (Note 8)	2.0			Ω
Turn-on gate resistor $R_{g(on)}$	F ≤ 250kHz (Note 9)	1.0			Ω
Turn-off gate resistor $R_{g(off)}$	F ≤ 250kHz (Note 9)	1.0			Ω
External gate resistor loop	F ≤ 310kHz (Note 8)	3.2			Ω
Turn-on gate resistor $R_{g(on)}$	F ≤ 310kHz (Note 9)	1.6			Ω
Turn-off gate resistor $R_{g(off)}$	F ≤ 310kHz (Note 9)	1.6			Ω
External gate resistor loop	F ≤ 360kHz (Note 8)	4.8			Ω
Turn-on gate resistor $R_{g(on)}$	F ≤ 360kHz (Note 9)	2.4			Ω
Turn-off gate resistor $R_{g(off)}$	F ≤ 360kHz (Note 9)	2.4			Ω

Output power

The permissible drive power at the output of the driver card is given versus switching frequency for different total gate resistance values. Linear interpolation is permissible for gate resistance values other than those shown. However, no extrapolation beyond the given data range is allowed.

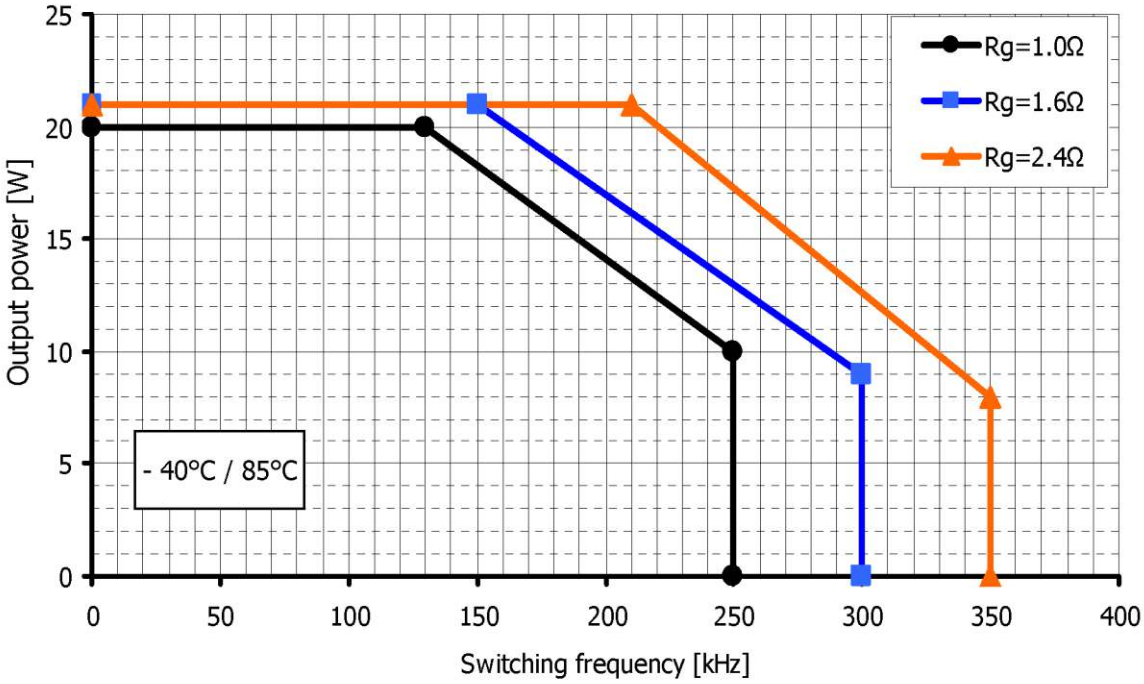

*Fig. 1 Output power vs. switching frequency at ambient temperature range – 40°C through **85°C***

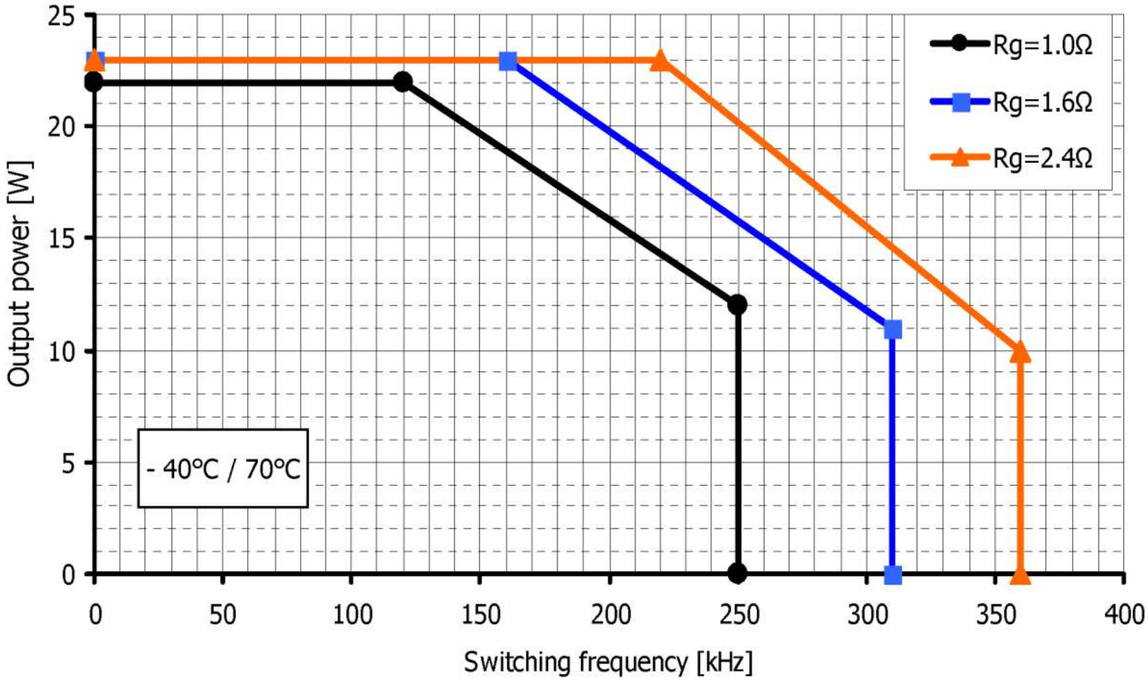

*Fig. 2 Output power vs. switching frequency at ambient temperature range – 40°C through **70°C***

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To check if the driver output power is in accordance with the data given in Figs. 1 and 2, proceed as follows:

- determine the actual gate charge of the power switch
- check with note 14
- determine the output voltage swing of the driver at the required switching frequency
- calculate the output power as gate charge x voltage swing x frequency
- check the calculated power at the relevant switching frequency against the diagram "Output power vs. switching frequency" at the appropriate max. temperature (70°C / 85°C)

The actual value of the driver's output voltage swing should be taken to determine the output power drawn from the driver. If the nominal (no-load) value is taken, the driver will not be operated up to its full capacity. See the section "Output voltage swing" for output voltage swing vs. output power.

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		-10.5		V
Turn-off voltage, V_{GL}	1W output power		-9.2		V
Turn-off voltage, V_{GL}	20W output power		-7.5		V

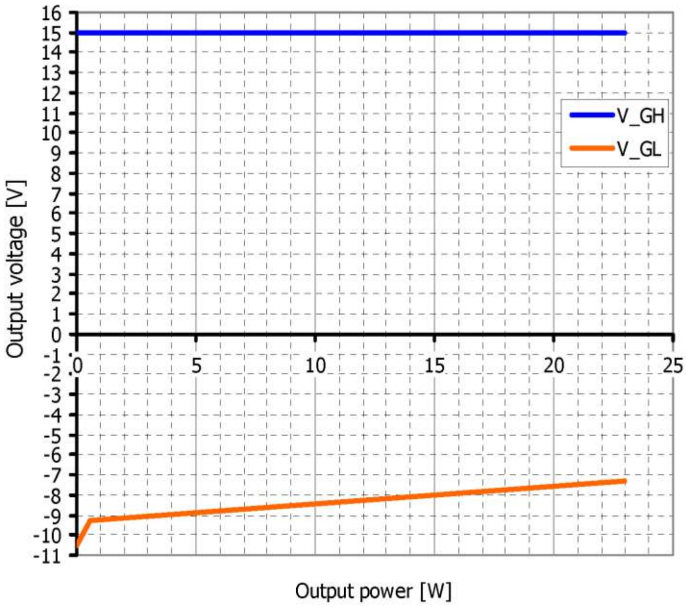

Fig. 3 Output voltage swing (typ.) vs. output power

Electrical Characteristics (MOSFET Mode)

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

Power supply	Remarks	Min	Typ	Max	Unit
Supply current I_{DC}	V_{DC}=9.2V, without load		25		mA
Supply current I_{CC}	F = 0Hz		12		mA
Supply current I_{CC}	F = 500kHz		39		mA
Coupling capacitance C_{io}	Primary to output, total		40		pF

Power Supply Monitoring	Remarks	Min	Typ	Max	Unit
Supply threshold V_{CC}	Primary side, clear fault	11.9	12.6	13.3	V
	Primary side, set fault (Note 18)	11.3	12.0	12.7	V
Monitoring hysteresis	Primary side, set/clear fault	0.35			V
Supply threshold V_{ISO}-V_{VE}	Secondary side, clear fault	8.3	8.75	9.2	V
	Secondary side, set fault (Note 18)	7.9	8.2	8.6	V
Monitoring hysteresis	Secondary side, set/clear fault	0.23	0.5		V

Logic Inputs and Outputs	Remarks	Min	Typ	Max	Unit
Input bias current	V(IN) > 3V		160		µA
Turn-on threshold	V(IN)		2.6		V
Turn-off threshold	V(IN)		1.3		V
SO output voltage	Failure condition, I(SO)<20mA			0.7	V

Short-circuit Protection	Remarks	Min	Typ	Max	Unit
Current through pin REF	R(REF, VE)<70kΩ		150		µA
Minimum response time	Note 15		1.2		µs
Minimum blocking time	Note 16		9		µs

Timing Characteristics	Remarks	Min	Typ	Max	Unit
Turn-on delay $t_{d(on)}$	Note 6		75		ns
Turn-off delay $t_{d(off)}$	Note 6		70		ns
Jitter of turn-on delay	Note 20		±1		ns
Jitter of turn-off delay	Note 20		±1		ns
Output rise time $t_{r(out)}$	Note 7		10		ns
Output fall time $t_{f(out)}$	Note 7		15		ns
Transmission delay of fault state	Note 19		400		ns

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Electrical Isolation	Remarks	Min	Typ	Max	Unit
Test voltage (50Hz/1s)	Primary to secondary side (Note 12)	5000	5050	5100	$V_{AC(eff)}$
Partial discharge extinction volt.	Note 13	1768			V_{peak}
Creepage distance	Primary to secondary side	15			mm
Clearance distance	Primary to secondary side	15			mm

Output	Remarks	Min	Typ	Max	Unit
Blocking capacitance VISO to VE	Note 14		9.4		µF
Blocking capacitance VE to COM	VE is short-circuited to COM		Not applicable		
External gate resistor loop	F ≤ 500kHz (Note 8)	2.0			Ω
Turn-on gate resistor $R_{g(on)}$	F ≤ 500kHz (Note 9)	1.0			Ω
Turn-off gate resistor $R_{g(off)}$	F ≤ 500kHz (Note 9)	1.0			Ω

Output power

The permissible drive power at the output of the driver card is given versus the switching frequency for an output voltage swing of 10V and 15V. No extrapolation is allowed beyond the given data range towards higher frequency values.

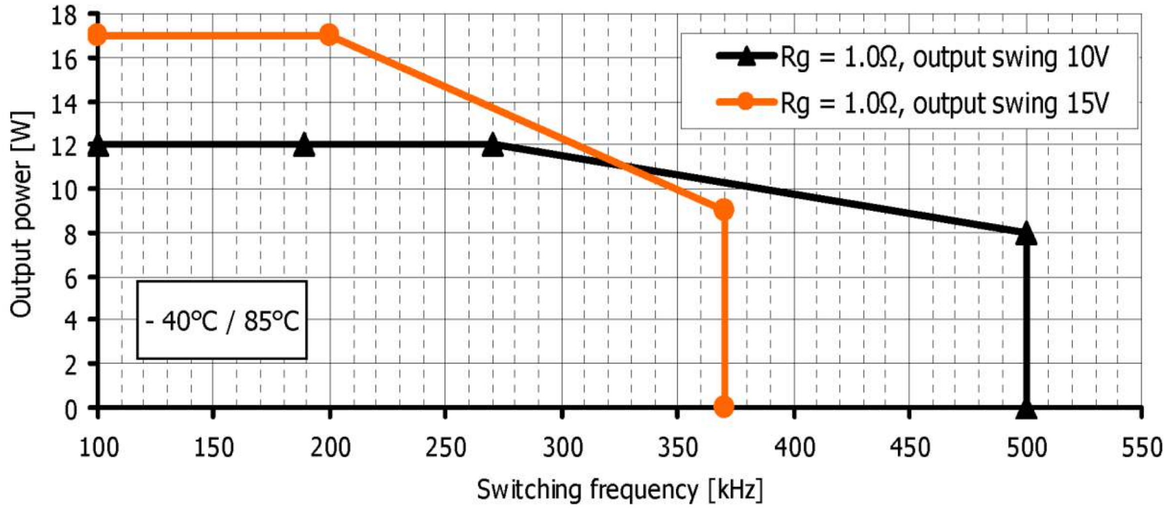

*Fig. 4 Output power vs. switching frequency for ambient temperature range – 40°C through **85°C***

To check if the driver output power is in accordance with the data given in Fig. 4, proceed as follows:

- determine the actual gate charge of the power switch
- check with note 14
- determine the output voltage swing of the driver at the required switching frequency
- calculate the output power as gate charge x voltage swing x frequency

- check the calculated power at the relevant switching frequency against the diagram “Output power vs. switching frequency” at the appropriate max. temperature (85°C)

The actual value of the driver’s output voltage swing should be taken to determine the output power drawn from the driver. If the nominal (no-load) value is taken, the driver will not be operated up to its full capacity. See the section “Output voltage swing” for output voltage swing vs. output power.

Output voltage swing

The output voltage swing in MOSFET mode directly follows the primary-side input voltage V_{DC}. The following table gives exemplary input voltages V_{DC} for a set of output voltages under various load conditions.

V_{DC} for V_{GH}= 10V	Remarks	Min	Typ	Max	Unit
Primary side input, V_{DC}	No load		6.3		V
Primary side input, V_{DC}	12W output power		7.8		V

V_{DC} for V_{GH}= 15V	Remarks	Min	Typ	Max	Unit
Primary side input, V_{DC}	No load		9.2		V
Primary side input, V_{DC}	17W output power		10.5		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 does also apply for short pulses.
2) 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 the average is taken over a time period which is shorter than the thermal time constants of the driver in the application.
3) There is no means of actively controlling or limiting the input current in the driver. In the case of start-up with very high blocking capacitor values, or in case of short circuit at the output, the supply input current has to be limited externally.
4) The maximum output power must not be exceeded at any time during operation. The absolute maximum rating must also be observed for time periods shorter than the thermal time constants of the driver in the application.
5) An extended output power range is specified in the output power section for maximum ambient temperatures of 70°C. In that case, the absolute maximum rating for the operating temperature changes to (–40°C - 70°C) and the absolute maximum output power rating changes to 23W.
6) The delay time is measured between 50% of the input signal and 20% voltage swing of the corresponding output. The delay time is independent of the output loading.
7) 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. 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.
8) The external gate resistor loop comprises all resistors located between the driver gate and the driver emitter. The internal resistance of any output load (e.g. an IGBT module) makes no contribution.
   Example:
   Total turn-on gate resistance: 1.0Ω
   Total turn-off gate resistance: 1.5Ω
   IGBT module internal gate resistance: 0.25Ω
   Leads to:

External turn-on gate resistance: 0.75Ω
External turn-off gate resistance: 1.25Ω
External gate resistor loop: 2.0Ω

9) The values given refer to the total gate resistance, including both external resistors and the internal resistance of the power module / transistor.
10) The secondary side output voltage swing must not exceed 20V.
11) The maximum current given is the short circuit value of the output stage. Continuous operation is limited by thermal constraints. The surface temperature of the output stage must not exceed 125°C.
12) 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 as stipulated by EN 50178. Excessive HiPot testing at voltages much higher than $1200V_{AC(eff)}$ may lead to insulation degradation. No degradation has been observed over 1min. testing at $5000V_{AC(eff)}$. Every production sample shipped to customers has undergone 100% testing at $5000V_{AC(eff)}$ (typical) for 1s.
13) Partial discharge measurement is performed in accordance with IEC 60270 and isolation coordination specified in EN 50178. The minimum value given is designed to include appropriate safety margins for long-term ageing. Accelerated ageing tests show virtually no insulation deterioration. Minimum partial discharge extinction voltages remain >2100V even after 2600 slow thermal cycles between –40°C and 125°C and also after 500 thermal shock cycles between –55°C and 150°C. The partial discharge extinction voltage is coordinated for safe isolation to EN 50178.
14) External blocking capacitors are to be placed between VISO and VE as well as VE and COM for gate charges exceeding 3µC. Ceramic capacitors are recommended. A minimum external blocking capacitance of 3µF is recommended for every 1µC of gate charge beyond 3µC. Insufficient external blocking can lead to reduced driver efficiency and thus to thermal overload.
15) The minimum response time given is valid for the circuit given in the description and application manual (Figs. 5 and 6) with the values of table 1 (C_a=0pF, R_{th}=43kΩ).
16) The blocking time sets a minimum time span between the end of any fault state and the start of normal operation (remove fault from pin SO). The value of the blocking time can be adjusted at pin TB. The specified blocking time is valid if TB is connected to GND.
17) This specification guarantees that the drive information will be transferred reliably even at a high DC-link voltage and with ultra-fast switching operations.
18) Undervoltage monitoring of the corresponding supply voltage (VCC to GND as well as VISO to VE and VE to COM which correspond with the approximate turn-on and turn-off gate-emitter voltages). If the corresponding voltage drops below this limit, the power semiconductor is switched off and a fault is transmitted to SO.
19) Transmission delay of fault state from the secondary side to the primary status output.
20) Jitter measurements are performed with input signal IN switching between 0V and 5V referred to GND, with a corresponding rise time and fall time of 5ns.

Legal Disclaimer

Ordering Information

The general terms and conditions of delivery of CT-Concept Technologie AG apply.

Type Designation	Description
1SC2060P2A0-17	Single-channel SCALE-2 driver core

Product home page: www.IGBT-Driver.com/go/1SC2060P

Refer to www.IGBT-Driver.com/go/nomenclature for information on driver nomenclature

Information about Other Products

For other drivers, product documentation, and application support

Please click: www.IGBT-Driver.com

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