

2SP0320x2Ax-17

Preliminary Data Sheet

Compact, high-performance, plug-and-play dual-channel IGBT driver based on SCALE-2 technology for individual and parallel-connected modules in 2-level, 3-level and multilevel converter topologies

Abstract

The SCALE-2 plug-and-play driver 2SP0320x2Ax-17 is a compact dual-channel intelligent gate driver designed for 1700V PrimePACK™ IGBT modules. The driver features an electrical interface (2SP0320T) or a fiber-optic interface (2SP0320V and 2SP0320S) with a built-in DC/DC power supply.

The turn-on and turn-off gate resistors of both channels are not assembled in order to provide maximum flexibility. They must be assembled by the user before start of operation. Please refer to the paragraph on "Gate Resistor Assembly" for the recommended gate resistors.

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

www.IGBT-Driver.com/go/plug-and-play

Features

- ✓ Plug-and-play solution
- ✓ Allows parallel connection of IGBT modules
- ✓ For 2-level, 3-level and multilevel topologies
- ✓ Shortens application development time
- ✓ Extremely reliable; long service life
- ✓ Built-in DC/DC power supply
- ✓ 20-pin flat cable interface (2SP0320T)
- ✓ Fiber-optic links (2SP0320V & 2SP0320S)
- ✓ Duty cycle 0... 100%
- ✓ Active clamping of V_{ce} at turn-off
- ✓ IGBT short-circuit protection
- ✓ Monitoring of supply voltage
- ✓ Safe isolation to EN 50178
- ✓ UL compliant
- ✓ Suitable for 1700V PrimePACK IGBT modules
- ✓ Gate resistors not assembled

Applications

- ✓ Wind-power converters
- ✓ Industrial drives
- ✓ UPS
- ✓ Power-factor correctors
- ✓ Traction
- ✓ Railroad power supplies
- ✓ Welding
- ✓ SMPS
- ✓ Radiology and laser technology
- ✓ Research
- ✓ 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 "Description & Application Manual for 2SP0320T SCALE-2 IGBT Drivers" (electrical interface) or "Description & Application Manual for 2SP0320V and 2SP0320S SCALE-2 IGBT Drivers" (fiber-optic interface) on www.IGBT-Driver.com/go/2SP0320.

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

Mechanical Dimensions

Dimensions: See the relevant "Description and Application Manual"

Mounting principle: Connected to IGBT module with screws

Fiber-Optic Interfaces

| Interface | Remarks | Part type # |
|--------------------|--|-------------|
| Drive signal input | 2SP0320V, fiber-optic receiver (Notes 21, 22) | HFBR-2522Z |
| Drive signal input | 2SP0320S, fiber-optic receiver (Notes 21, 22) | HFBR-2412Z |
| Status output | 2SP0320V, fiber-optic transmitter (Notes 21, 23) | HFBR-1522Z |
| Status output | 2SP0320S, fiber-optic transmitter (Notes 21, 23) | HFBR-1412Z |

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 (Note 1) | 0 | 16 | V |
| Logic input and output voltages | To GND | -0.5 | VCC+0.5 | V |
| SO _x current | Fault condition, total current | | 20 | mA |
| Gate peak current I_{out} | Note 2 | -20 | +20 | A |
| Average supply current I_{DC} | 2SP0320T (Note 24) | | 600 | mA |
| Average supply current I_{DC} | 2SP0320V and 2SP0320S (Note 24) | | 690 | mA |
| Output power per gate | Ambient temperature <70°C (Note 3) | | 3 | W |
| | Ambient temperature 85°C (Note 3) | | 2 | W |
| Turn-on gate resistance | Note 17 | 0.3 | | Ω |
| Turn-off gate resistance | Note 17 | 1 | | Ω |
| Switching frequency F | Note 29 | | n.d. | kHz |
| Test voltage (50Hz/1min.) | Primary to secondary (Note 19) | | 5000 | $V_{AC(eff)}$ |
| | Secondary to secondary (Note 19) | | 4000 | $V_{AC(eff)}$ |
| DC-link voltage | Note 4 | | 1200 | V |
| $ dV/dt $ | Rate of change of input to output voltage (Note 20) | | 50 | kV/μs |
| Operating voltage | Primary/secondary, secondary/secondary | | 1700 | V_{peak} |
| Operating temperature | | -40 | +85 | °C |
| Storage temperature | | -40 | +90 | °C |

Recommended Operating Conditions

| Power Supply | Remarks | Min | Typ | Max | Unit |
|---------------------------|---------------------------------------|------|-----|------|------|
| Supply voltage V_{DC} | To GND (Note 1) | 14.5 | 15 | 15.5 | V |
| Supply voltage V_{CC} | To GND (Note 1) | 14.5 | 15 | 15.5 | V |
| Resistance from TB to GND | 2SP0320T, blocking time≠0, ext. value | 128 | | ∞ | kΩ |
| SO _x current | Fault condition, 3.3V logic | | | 4 | mA |

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|-----------------------------------|
| Electrical Characteristics |
|-----------------------------------|

| Power Supply | Remarks | Min | Typ | Max | Unit |
|-------------------------------------|--|-----------------------|------|------|------------|
| Supply current I_{DC} | 2SP0320T, without load | | 37 | | mA |
| | 2SP0320V and 2SP0320S, without load | | 145 | | mA |
| Efficiency η | Internal DC/DC converter | | 85 | | % |
| Supply current I_{CC} | Without load | | 19 | | mA |
| Coupling capacitance C_{i0} | Primary side to secondary side, total, per channel | | | | |
| | | 2SP0320T | | 20 | pF |
| | | 2SP0320V and 2SP0320S | | 15 | 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 5) | 11.3 | 12.0 | 12.7 | V |
| Monitoring hysteresis | Primary side, set/clear fault | 0.35 | | | V |
| Supply threshold $V_{isox}-V_{eex}$ | Secondary side, clear fault | 12.1 | 12.6 | 13.1 | V |
| | Secondary side, set fault (Note 26) | 11.5 | 12.0 | 12.5 | V |
| Monitoring hysteresis | Secondary side, set/clear fault | 0.35 | | | V |
| Supply threshold $V_{eex}-V_{COMx}$ | Secondary side, clear fault | 5 | 5.15 | 5.3 | V |
| | Secondary side, set fault (Note 26) | 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 impedance | 2SP0320T, $V(INx) > 3V$ (Note 6) | 3.5 | 4.1 | 4.6 | k Ω |
| Turn-on threshold | 2SP0320T, $V(INx)$ (Note 7) | | 2.6 | | V |
| Turn-off threshold | 2SP0320T, $V(INx)$ (Note 7) | | 1.3 | | V |
| SOx output voltage | Fault condition, $I(SOx) < 8mA$ | | | 0.7 | V |
| Short-circuit Protection | Remarks | Min | Typ | Max | Unit |
| Vce-monitoring threshold | Between auxiliary terminals | | 10.2 | | V |
| Response time | DC-link voltage $> 550V$ (Note 8) | | 6.9 | | μs |
| Delay to IGBT turn-off | After the response time (Note 9) | | 1.4 | | μs |
| Blocking time | 2SP0320T, after fault (Note 10) | | 90 | | ms |

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| Timing Characteristics | Remarks | Min | Typ | Max | Unit |
|-------------------------------------|---------------------------------------|----------------|---------------|------|------------|
| Turn-on delay $t_{d(on)}$ | 2SP0320T (Note 11) | | 90 | | ns |
| Turn-off delay $t_{d(off)}$ | 2SP0320T (Note 11) | | 90 | | ns |
| Jitter of turn-on delay | 2SP0320T (Note 28) | | ±2 | | ns |
| Jitter of turn-off delay | 2SP0320T (Note 28) | | ±2 | | ns |
| Turn-on delay $t_{d(on)}$ | 2SP0320V and 2SP0320S (Note 12) | | 120 | | ns |
| Turn-off delay $t_{d(off)}$ | 2SP0320V and 2SP0320S (Note 12) | | 100 | | ns |
| Output rise time $t_{r(out)}$ | G_x to E_x (Note 13) | | 7 | | ns |
| Output fall time $t_{f(out)}$ | G_x to E_x (Note 13) | | 25 | | ns |
| Dead time between outputs | 2SP0320T, half-bridge mode | | 3 | | µs |
| Jitter of dead time | 2SP0320T, half-bridge mode | | ±100 | | ns |
| Transmission delay of fault state | 2SP0320T (Note 14) | | 450 | | ns |
| Transmission delay of fault state | 2SP0320V and 2SP0320S (Note 25) | | 90 | | ns |
| Delay to clear fault state | 2SP0320V and 2SP0320S (Note 15) | | 11 | | µs |
| Acknowledge delay time | 2SP0320V and 2SP0320S (Note 16) | | 220 | | ns |
| Acknowledge pulse width | 2SP0320V and 2SP0320S (on host side) | | 700 | 1050 | ns |
| Outputs | Remarks | Min | Typ | Max | Unit |
| Turn-on gate resistor $R_{g(on)}$ | Note 17 | | not assembled | | Ω |
| Turn-off gate resistor $R_{g(off)}$ | Note 17 | | not assembled | | Ω |
| Gate voltage at turn-on | | | 15 | | V |
| Gate-voltage at turn-off | 2SP0320T / (2SP0320V & 2SP0320S) | | | | |
| | P = 0W | | -10.4/-9.9 | | V |
| | P = 0.3W | | -10.2/-9.8 | | V |
| | P = 2.1W | | -9.7/-9.5 | | V |
| | P = 3W | | -9.6/-9.4 | | V |
| Gate resistance to COMx | | | 4.7 | | kΩ |
| dV/dt Feedback | Remarks | Implementation | | | |
| dV/dt feedback | Note 18 | | No | | |
| Electrical Isolation | Remarks | Min | Typ | Max | Unit |
| Test voltage (50Hz/1s) | Primary to secondary side (Note 19) | 5000 | 5050 | 5100 | V_{eff} |
| | Secondary to secondary side (Note 19) | 4000 | 4050 | 4100 | V_{eff} |
| Partial discharge extinction volt. | Primary to secondary side (Note 27) | 1768 | | | V_{peak} |
| | Secondary to secondary side (Note 27) | 1700 | | | V_{peak} |
| Creepage distance | Primary to secondary side | 20 | | | mm |
| | Secondary to secondary side | 17 | | | mm |

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

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Footnotes to the Key Data

- 1) Both supply voltages V_{DC} and V_{CC} should be applied in parallel.
- 2) The gate current is limited by the gate resistors located on the driver.
- 3) If the specified value is exceeded, this indicates a driver overload. It should be noted that the driver is not protected against overload. From 70°C to 85°C, the maximum permissible output power can be linearly interpolated from the given data.
- 4) This limit is due to active clamping. Refer to "Description & Application Manual for 2SP0320T SCALE-2 IGBT Drivers" (electrical interface) or "Description & Application Manual for 2SP0320V and 2SP0320S SCALE-2 IGBT Drivers" (fiber-optic interface).
- 5) Undervoltage monitoring of the primary-side supply voltage (V_{CC} to GND). If the voltage drops below this limit, a fault is transmitted to the corresponding output(s) (2SP0320T/2SP0320V/2SP0320S) and the IGBTs are switched off (only 2SP0320T).
- 6) The input impedance can be modified to values $< 18\text{ k}\Omega$ (customer-specific solution).
- 7) Turn-on and turn-off threshold values can be increased (customer-specific solution).
- 8) 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 response time plus delay to IGBT turn-off.
- 9) The turn-off event of the IGBT is delayed by the specified time after the response time.
- 10) Factory set value. The blocking time can be reduced with an external resistor. Refer to "Description & Application Manual for 2SP0320T SCALE-2 IGBT Drivers".
- 11) Measured from the transition of the turn-on or turn-off command at the driver input to direct output of the gate drive unit (excluding the delay of the gate resistors).
- 12) Including the delay of the external fiber-optic links. 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).
- 13) Refers to the direct output of the gate drive unit (excluding the delay of the gate resistors).
- 14) Transmission delay of the fault state from the secondary side to the primary status outputs.
- 15) Measured on the host side. The fault status on the secondary side is automatically reset after the specified time.
- 16) Including the delay of the external fiber-optic links. 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.
- 17) 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 Assembly".
- 18) A dV/dt feedback can optionally be implemented in order to reduce the rate of rise of the collector emitter voltage of the IGBTs at turn-off (customer-specific solution).
- 19) 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 the given value for 1s.
- 20) This specification guarantees that the drive information will be transferred reliably even at a high DC-link voltage and with ultra-fast switching operations.
- 21) 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.IGBT-Driver.com/go/fiberoptics
- 22) The recommended transmitter current at the host controller is 20mA. A higher current may increase jitter or delay at turn-off.
- 23) The typical transmitter current at the gate driver is 18mA. In case of supply undervoltage, the minimum transmitter current at the gate driver is 12mA: this is suitable for adequate plastic optical fibers with a length of more than 10 meters.
- 24) If the specified value is exceeded, this indicates a driver overload. It should be noted that the driver is not protected against overload.

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- 25) Delay of external fiber-optic links. Measured from the driver secondary side (ASIC output) to the optical receiver on the host controller.
- 26) Undervoltage monitoring of the secondary-side supply voltage (Visox to Veex and Veex to COMx which correspond with the approximate turn-on and turn-off gate-emitter voltages). If the corresponding voltage drops below this limit, the IGBT is switched off and a fault is transmitted to the corresponding output.
- 27) Partial discharge measurement is performed in accordance with IEC 60270 and isolation coordination specified in EN 50178. The partial discharge extinction voltage between primary and either secondary side is coordinated for safe isolation to EN 50178.
- 28) Jitter measurements are performed with input signals INx switching between 0V and 15V referred to GND, with a corresponding rise time and fall time of 8ns.
- 29) The maximum switching frequency is not defined, as it depends on the IGBT module used. Please consult the corresponding driver data sheet for more information.

Gate Resistor Assembly

The turn-on and turn-off gate resistors of 2SP0320x2Ax drivers are adapted to their respective IGBT modules. Recommended gate resistors are: PR02 / 2W / 5% from Vishay.

The following versions exist:

| 1700V IGBT Type | R120/R121/ R220/R221 | R122/R123 / R222/R223 | Resulting Rg,on | Resulting Rg,off |
|---------------------|-------------------------|--------------------------|--------------------|---------------------|
| FF450R17IE4 | 5.6Ω | 10Ω | 2.8Ω | 5Ω |
| 2MBI650VXA-170E-50 | 3.6Ω | 6.8Ω | 1.8Ω | 3.4Ω |
| FF650R17IE4 | 3.6Ω | 6.8Ω | 1.8Ω | 3.4Ω |
| FF650R17IE4D_B2 | 2Ω | 6.8Ω | 1Ω | 3.4Ω |
| 2MBI1000VXB-170E-50 | 3.6Ω | 5.1Ω | 1.8Ω | 2.55Ω |
| DP1000B1700T103715 | 2.2Ω | 5.6Ω | 1.1Ω | 2.8Ω |
| FF1000R17IE4 | 2.4Ω | 6.8Ω | 1.2Ω | 3.4Ω |
| FF1000R17IE4D_B2 | 0.68Ω | 4.7Ω | 0.34Ω | 2.35Ω |
| 2MBI1400VXB-170E-50 | 1Ω | 1.8Ω | 0.5Ω | 0.9Ω |
| 2MBI1400VXB-170P-50 | 1Ω | 2Ω | 0.5Ω | 1.0Ω |
| FF1400R17IP4 | 1Ω | 3.3Ω | 0.5Ω | 1.65Ω |

For the component position, refer to Fig. 1.

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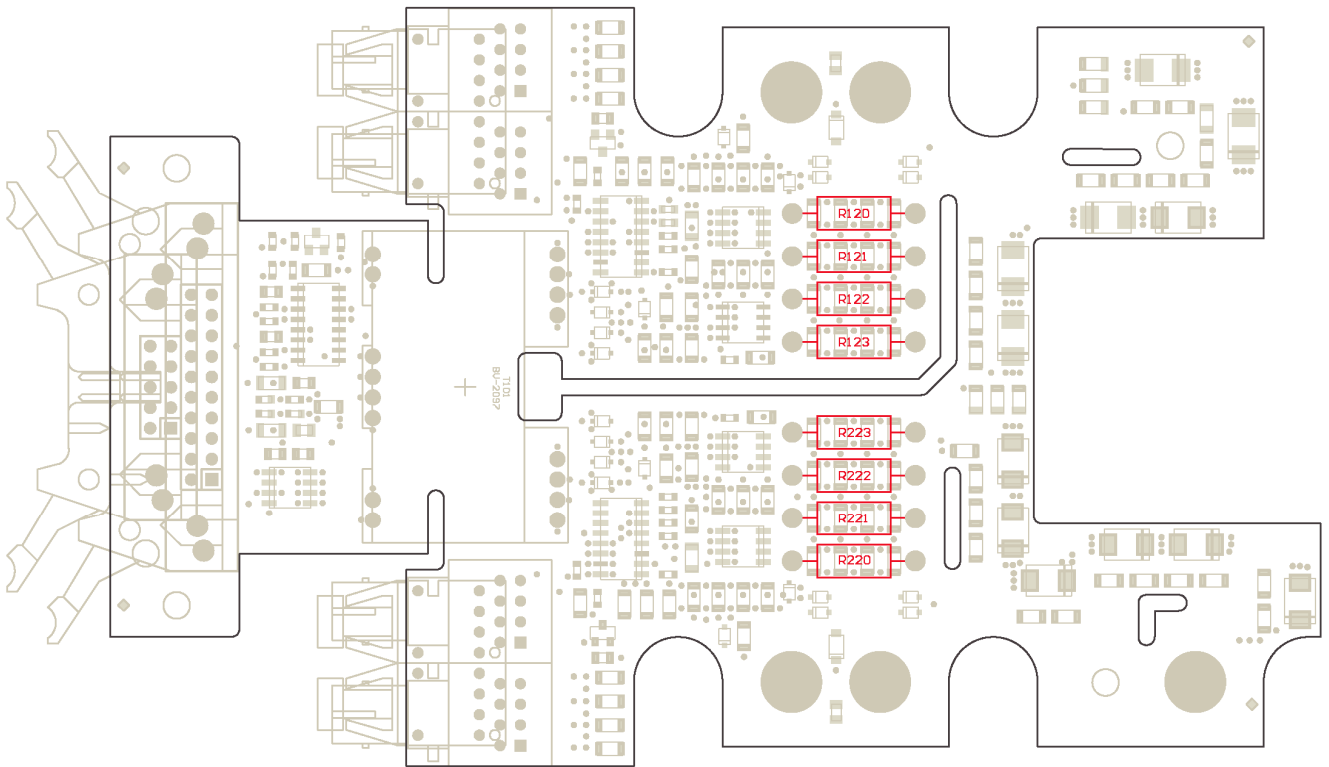
Assembly Drawing

Fig. 1: Assembly drawing of 2SP0320 with highlighted gate resistors

Note that the wires of the gate resistors should not project more than 1.6mm after soldering (excess length at bottom side). Furthermore, a minimum distance of 1mm must be maintained between the gate resistor body and the PCB.

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Ordering Information

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| Interface | CONCEPT Driver Type # | Related IGBT |
|-------------------------------------|-----------------------|--------------------|
| Electrical Interface | 2SP0320T2A0-17 | 1700V IGBT modules |
| Fiber-Optic Interface ¹⁾ | 2SP0320V2A0-17 | 1700V IGBT modules |
| Fiber-Optic Interface ²⁾ | 2SP0320S2A0-17 | 1700V IGBT modules |

- 1) Fiber-optic interface with versatile link (HFBR-2522Z and HFBR-1522Z)
- 2) Fiber-optic interface with ST (HFBR-2412Z and HFBR-1412Z)
See "Description & Application Manual for 2SP0320V and 2SP0320S SCALE-2 IGBT Drivers"

Product home page: www.IGBT-Driver.com/go/2SP0320

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

Information about Other Products

For other drivers, evaluation systems product documentation and application support

Please click: www.IGBT-Driver.com

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