

# 2SC0108T2Dx-xx

## Description & Application Manual

Dual Channel Ultra-compact Low-cost SCALE-2 Driver Core

### Abstract

The new low-cost SCALE-2 dual-driver core 2SC0108T2Dx-xx combines unrivalled compactness with broad applicability. The driver was designed for universal applications requiring high reliability. The 2SC0108T2Dx-xx drives all usual IGBT modules up to 650V (2SC0108T2Dx-07) or 1200V (2SC0108T2Dx-12). The embedded paralleling capability allows easy inverter design covering higher power ratings. Multi-level topologies are also supported.

The 2SC0108T2Dx-xx is the most compact driver core available for industrial applications, with a footprint of only 45 x 34.3mm and an insertion height of max. 16mm. It allows even the most restricted insertion spaces to be efficiently used.

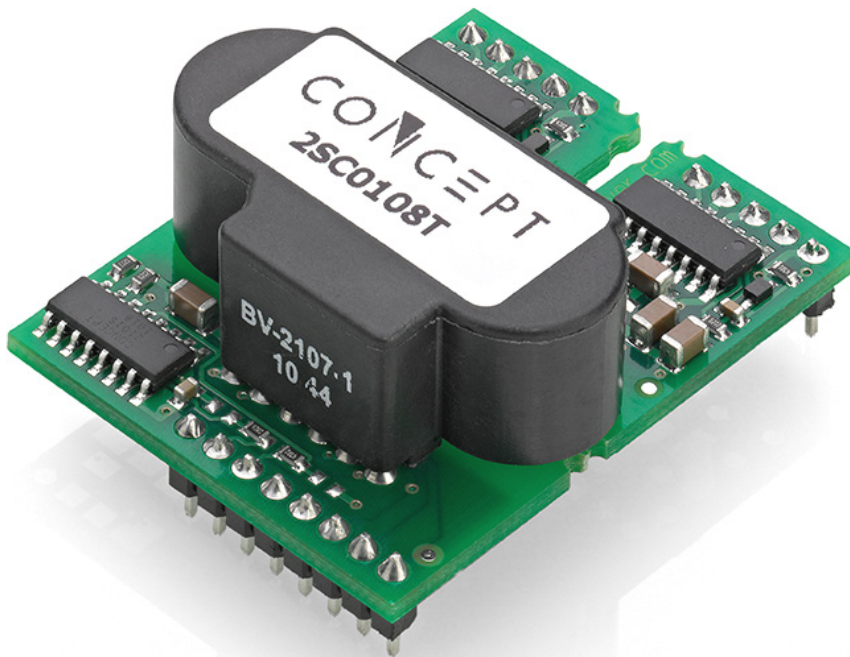


Fig. 1 2SC0108T2Dx-xx driver core

---

Description & Application Manual

|                 |
|-----------------|
| <b>Contents</b> |
|-----------------|

|  |           |
|--|-----------|
| <b>Abstract</b> .....  | <b>1</b>  |
| <b>Contents</b> .....  | <b>2</b>  |
| <b>Driver Overview</b> .....   | <b>4</b>  |
| <b>Mechanical Dimensions</b> .....   | <b>5</b>  |
| <b>Pin Designation</b> .....   | <b>6</b>  |
| <b>Recommended Interface Circuitry for the Primary Side Connector</b> .....    | <b>7</b>  |
| <b>Description of Primary Side Interface</b> .....                             | <b>7</b>  |
| General .....  | 7         |
| VCC terminal .....   | 7         |
| MOD (mode selection) .....   | 8         |
| INA, INB (channel drive inputs, e.g. PWM) .....                                | 9         |
| SO1, SO2 (status outputs).....   | 9         |
| TB (input for adjusting the blocking time $T_b$ ) .....                        | 9         |
| <b>Recommended Interface Circuitry for the Secondary Side Connectors</b> ..... | <b>10</b> |
| <b>Description of Secondary Side Interfaces</b> .....                          | <b>10</b> |
| General .....  | 10        |
| Emitter terminal (VEx).....  | 11        |
| Active clamping (ACLx) .....   | 11        |
| Collector sense (VCEx) with resistors .....                                    | 12        |
| Desaturation protection with sense diodes.....                                 | 13        |
| Disabling the $V_{ce,sat}$ detection .....                                     | 15        |
| Gate turn-on (GHx) and turn-off (GLx) terminals .....                          | 15        |
| <b>How Do 2SC0108T2Dx-xx SCALE-2 Drivers Work in Detail?</b> .....             | <b>15</b> |
| Power supply and electrical isolation .....                                    | 15        |
| Power-supply monitoring.....   | 16        |
| Parallel connection of 2SC0108T2Dx-xx.....                                     | 16        |
| 3-level or multilevel topologies .....   | 16        |
| Additional application support for 2SC0108T2Dx-xx .....                        | 16        |
| <b>Bibliography</b> .....  | <b>16</b> |
| <b>The Information Source: SCALE-2 Driver Data Sheets</b> .....                | <b>17</b> |
| <b>Quite Special: Customized SCALE-2 Drivers</b> .....                         | <b>17</b> |
| <b>Technical Support</b> .....   | <b>17</b> |
| <b>Quality</b> .....   | <b>17</b> |

Preliminary

**Legal Disclaimer..... 17**  
**Ordering Information..... 18**  
**Information about Other Products ..... 18**  
**Manufacturer..... 18**

Description & Application Manual

**Driver Overview**

The 2SC0108T2Dx-xx is a low cost driver core equipped with CONCEPT's latest SCALE-2 chipset /1/. The SCALE-2 chipset is a set of application-specific integrated circuits (ASICs) that cover the main range of functions needed to design intelligent gate drivers. The SCALE-2 driver chipset is a further development of the proven SCALE technology /2/.

The 2SC0108T2Dx-xx targets low- and medium-power, dual-channel IGBT applications such as general purpose drives, UPS, solar converters and automotive applications. The 2SC0108T2Dx-xx comprises a complete dual-channel IGBT driver core, fully equipped with an isolated DC/DC converter, short-circuit protection, advanced active clamping and supply-voltage monitoring.

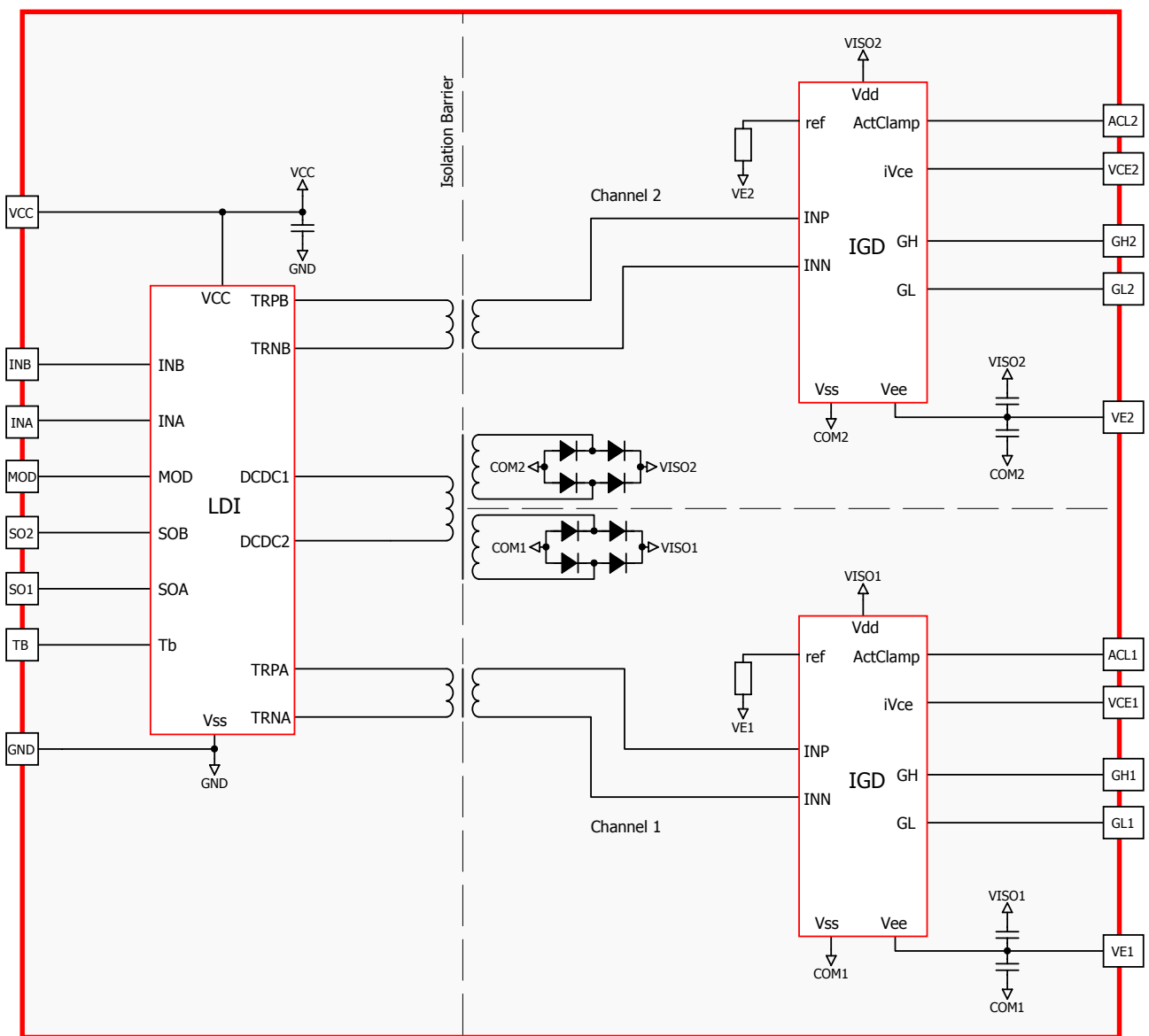
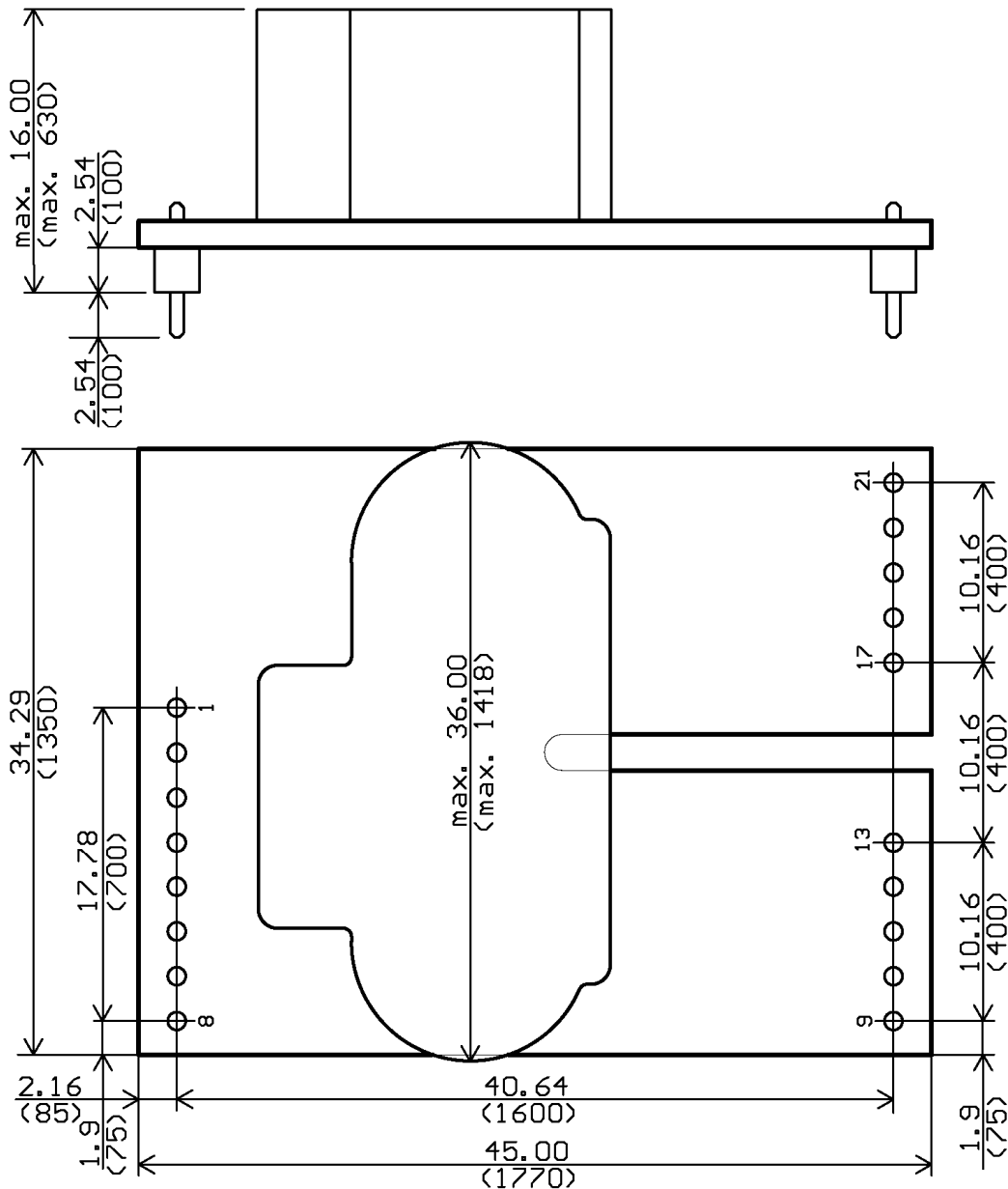


Fig. 2 Block diagram of the driver core 2SC0108T2Dx-xx

**Mechanical Dimensions**



mm  
(mil)

Fig. 3 Mechanical drawing of 2SC0108T2Dx-xx

The primary side and secondary side pin grid is 2.54mm (100mil) with a pin cross section of 0.64mmx0.64mm. Total outline dimensions of the board are 34.3mmx45mm. The total height of the driver is max. 16mm measured from the bottom of the pin bodies to the top of the populated PCB.

Recommended diameter of solder pads: Ø 2mm (79 mil)

Recommended diameter of drill holes: Ø 1mm (39 mil)

---

Description & Application Manual

**Pin Designation**

| Pin No. and Name       | Function  |
|------------------------|---|
| <b>Primary Side</b>    |   |
| 1 GND                  | Ground  |
| 2 INA                  | Signal input A; non-inverting input relative to GND                           |
| 3 INB                  | Signal input B; non-inverting input relative to GND                           |
| 4 VCC                  | Supply voltage; 15V supply for primary side                                   |
| 5 TB                   | Set blocking time   |
| 6 SO2                  | Status output channel 2; normally high-impedance, pulled down to low on fault |
| 7 SO1                  | Status output channel 1; normally high-impedance, pulled down to low on fault |
| 8 MOD                  | Mode selection (direct/half-bridge mode)                                      |
| <b>Secondary Sides</b> |   |
| 9 GH1                  | Gate high channel 1; pulls gate high through turn-on resistor                 |
| 10 VE1                 | Emitter channel 1; connect to (auxiliary) emitter of power switch             |
| 11 GL1                 | Gate low channel 1; pulls gate low through turn-off resistor                  |
| 12 ACL1                | Active clamping feedback channel 1; leave open if not used                    |
| 13 VCE1                | $V_{ce}$ sense channel 1; connect to IGBT collector through resistor network  |
| 14 Free                |   |
| 15 Free                |   |
| 16 Free                |   |
| 17 GH2                 | Gate high channel 2; pulls gate high through turn-on resistor                 |
| 18 VE2                 | Emitter channel 2; connect to (auxiliary) emitter of power switch             |
| 19 GL2                 | Gate low channel 2; pulls gate low through turn-off resistor                  |
| 20 ACL2                | Active clamping feedback channel 2; leave open if not used                    |
| 21 VCE2                | $V_{ce}$ sense channel 2; connect to IGBT collector through resistor network  |

Note: Pins with the designation "Free" are not physically present.

**Recommended Interface Circuitry for the Primary Side Connector**

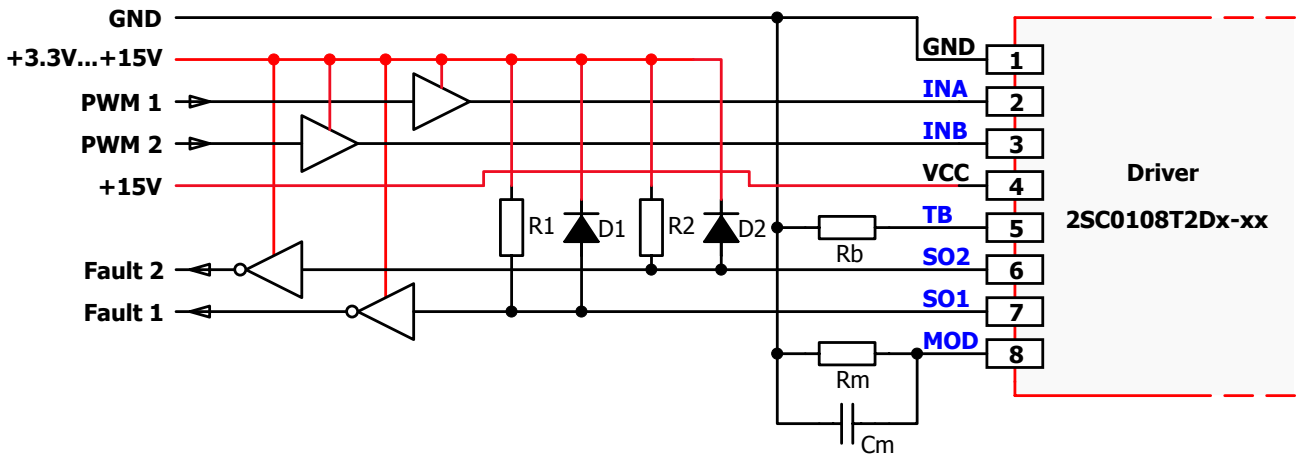


Fig. 4 Recommended user interface of 2SC0108T2Dx-xx (primary side)

**Description of Primary Side Interface**

**General**

The primary side interface of the driver 2SC0108T2Dx-xx is very simple and easy to use.

The driver primary side is equipped with an 8-pin interface connector with the following terminals:

- 1 x power-supply terminal
- 2 x drive signal inputs
- 2 x status outputs (fault returns)
- 1 x mode selection input (half-bridge mode / direct mode)
- 1 x input to set the blocking time

All inputs and outputs are ESD-protected. Moreover, all digital inputs have Schmitt-trigger characteristics.

**VCC terminal**

The driver has one VCC terminal on the interface connector. It supplies the primary side electronics as well as the DC-DC converter to supply the secondary sides with 15V.

The driver limits the inrush current at startup and no external current limitation of the voltage source for VCC is needed.

## Description & Application Manual

### MOD (mode selection)

The MOD input allows the operating mode to be selected with a resistor connected to GND.

#### Direct mode

If the MOD input is connected to GND, direct mode is selected. In this mode, there is no interdependence between the two channels. Input INA directly influences channel 1 while INB influences channel 2. High level at an input (INA or INB) always results in turn-on of the corresponding IGBT. In a half-bridge topology, this mode should be selected only when the dead times are generated by the control circuitry so that each IGBT receives its own drive signal.

**Caution:** Synchronous or overlapping timing of both switches of a half-bridge basically shorts the DC link.

#### Half-bridge mode

If the MOD input is connected to GND with a resistor  $71k < R_m < 181k$ , half-bridge mode is selected. In this mode, the inputs INA and INB have the following functions: INA is the drive signal input while INB acts as the enable input (see Fig. 5). It is recommended to place a capacitor  $C_m = 22nF$  in parallel to  $R_m$  in order to reduce the deviation between the dead times at the rising and falling edges of INA respectively.

When input INB is low level, both channels are blocked. If it goes high, both channels are enabled and follow the signal on the input INA. At the transition of INA from low to high, channel 2 turns off immediately and channel 1 turns on after a dead time  $T_d$ .

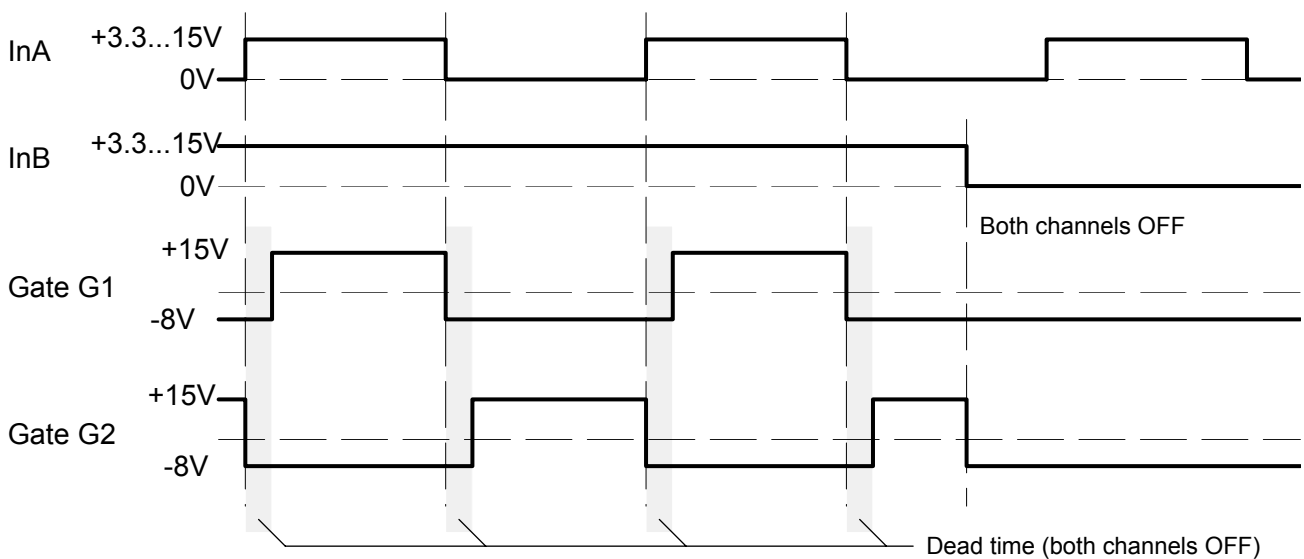


Fig. 5 Signals in half-bridge mode

The value of the dead time  $T_d$  is determined by the value of the resistor  $R_m$  according to the following formula (typical value):

$$R_m [k\Omega] = 33 \cdot T_d [\mu s] + 56.4 \quad \text{where } 0.5\mu s < T_d < 3.8\mu s \text{ and } 73k\Omega < R_m < 182k\Omega$$



### INA, INB (channel drive inputs, e.g. PWM)

INA and INB are basically drive inputs, but their function depends on the MOD input (see above). They safely recognize signals in the whole logic-level range between 3.3V and 15V. Both input terminals feature Schmitt-trigger characteristics (refer to the driver data sheet /3/). An input transition is triggered at any edge of an incoming signal at INA or INB.

### SO1, SO2 (status outputs)

The outputs SOx have open-drain transistors. When no fault condition is detected, the outputs have high impedance. An internal current source of 500µA pulls the SOx outputs to a voltage of about 4V when leaved open. When a fault condition (primary side supply undervoltage, secondary side supply undervoltage, IGBT short circuit) is detected, the corresponding status output SOx goes to low (connected to GND).

The diodes D<sub>1</sub> and D<sub>2</sub> must be Schottky diodes and must only be used when using 3.3V logic. For 5V...15V logic, they can be omitted.

The maximum SOx current in a fault condition must not exceed the value specified in the driver data sheet /3/.

Both SOx outputs can be connected together to provide a common fault signal (e.g. for one phase). However, it is recommended to evaluate the status signals individually to allow fast and precise fault diagnosis.

### How the status information is processed

- a) A fault on the secondary side (detection of short circuit of IGBT module or supply undervoltage) is transmitted to the corresponding SOx output immediately. The SOx output is automatically reset (returning to a high impedance state) after a blocking time T<sub>b</sub> has elapsed (refer to "TB (input for adjusting the blocking time T<sub>b</sub>)" for timing information).
- b) A supply undervoltage on the primary side is indicated to both SOx outputs at the same time. Both SOx outputs are automatically reset (returning to a high impedance state) when the undervoltage on the primary side disappears.

### TB (input for adjusting the blocking time T<sub>b</sub>)

The terminal TB allows the blocking time T<sub>b</sub> to be set by connecting a resistor R<sub>b</sub> to GND (see Fig. 4). The following equation calculates the value of R<sub>b</sub> connected between pins TB and GND in order to program the desired blocking time T<sub>b</sub> (typical value):

$$R_b [k\Omega] = 1.0 \cdot T_b [ms] + 51 \quad \text{where } 20ms < T_b < 130ms \text{ and } 71k\Omega < R_b < 181k\Omega$$

The blocking time can also be set to a minimum of 9µs (typical) by selecting R<sub>b</sub>=0Ω. The terminal TB must not be left floating.

Note: It is also possible to apply a stabilized voltage at TB. The following equation is used to calculate the voltage V<sub>b</sub> between TB and GND in order to program the desired blocking time T<sub>b</sub> (typical value):

$$V_b [V] = 0.02 \cdot T_b [ms] + 1.02 \quad \text{where } 20ms < T_b < 130ms \text{ and } 1.42 < V_b < 3.62V$$

Description & Application Manual

**Recommended Interface Circuitry for the Secondary Side Connectors**

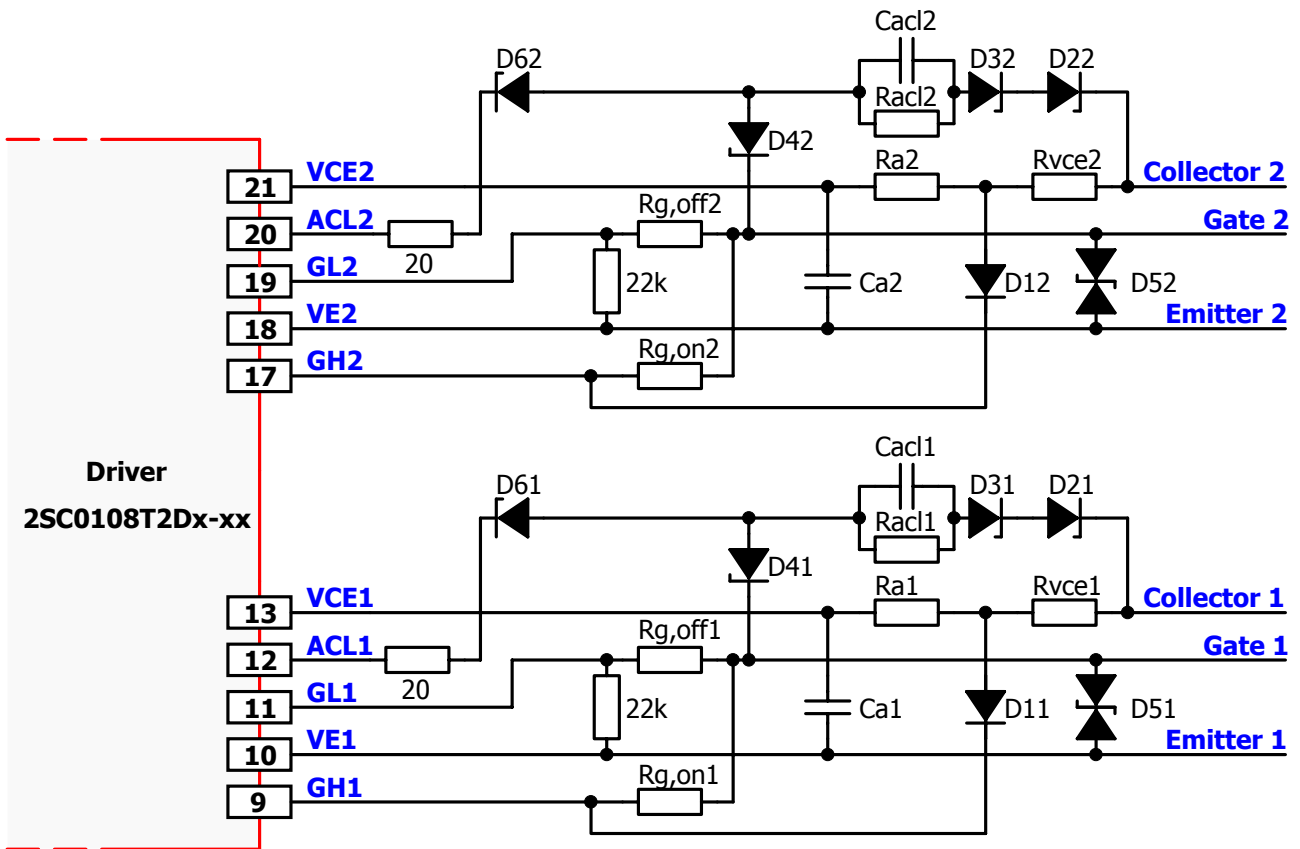


Fig. 6 Recommended user interface of 2SC0108T2Dx-xx (secondary sides).

**Description of Secondary Side Interfaces**

**General**

Each driver’s secondary side (driver channel) is equipped with a 5-pin interface connector with the following terminals (x stands for the number of the drive channel 1 or 2):

- 1 x emitter terminal VEx
- 1 x active clamping terminal ACLx
- 1 x collector sense terminal VCEx
- 1 x turn-on gate terminal GHx
- 1 x turn-off gate terminal GLx

All inputs and outputs are ESD-protected.

---

## Emitter terminal (VEx)

---

The emitter terminal must be connected to the IGBT auxiliary emitter with the circuit shown in Fig. 6.

---

## Active clamping (ACLx)

---

Active clamping is a technique designed to partially turn on the power semiconductor as soon as the collector-emitter (drain-source) voltage exceeds a predefined threshold. The power semiconductor is then kept in linear operation.

Basic active clamping topologies implement a single feedback path from the IGBT's collector through transient voltage suppressor devices (TVS) to the IGBT gate. The 2SC0108T2Dx-xx supports CONCEPT's advanced active clamping, where the feedback is also provided to the driver's secondary side at pin ACLx: as soon as the voltage on the right side of the 20Ω resistor (see Fig. 6) exceeds about 1.3V, the turn-off MOSFET is progressively switched off in order to improve the effectiveness of the active clamping and to reduce the losses in the TVS. The turn-off MOSFET is completely off when the voltage on the right side of the 20Ω resistors (see Fig. 6) approaches 20V (measured to COMx).

It is recommended to use the circuit shown in Fig. 6. The following parameters must be adapted to the application:

- TVS D<sub>2x</sub>, D<sub>3x</sub>. It is recommended to use:
  - Six 80V TVS with 600V IGBTs with DC link voltages up to 430V. Good clamping results can be obtained with six unidirectional TVS P6SMBJ70A from Semikron or with six unidirectional TVS SMBJ70A-E3 from Vishay.
  - Six 150V TVS with 1200V IGBTs with DC link voltages up to 800V. Good clamping results can be obtained with six unidirectional TVS SMBJ130A-E3 from Vishay or six unidirectional TVS SMBJ130A-TR from ST. Note that 1200V IGBTs can only be driven with the 2SC0108T2Dx-12 or the 2SC0108T2Dx-07 if the maximum operating voltage under absolute maximum ratings (see driver data sheet /3/) is not exceeded (e.g. specific 3-level topologies such as NPC2).

The use of bidirectional TVS is not required.

Note that it is possible to modify the number of TVS in a chain. The active clamping efficiency can be improved by increasing the number of TVS used in a chain if the total threshold voltage remains at the same value. Note also that the active clamping efficiency is highly dependent on the type of TVS used (e.g. manufacturer).

- R<sub>aclx</sub> and C<sub>aclx</sub>: These parameters allow the effectiveness of the active clamping as well as the losses in the TVS and the IGBT to be optimized. It is recommended to determine the value with measurements in the application. Typical values are: R<sub>aclx</sub>=0...150Ω and R<sub>aclx</sub>\*C<sub>aclx</sub>=100ns...500ns. R<sub>aclx</sub>=0Ω is recommended to improve the effectiveness of active clamping.
- D<sub>4x</sub>: it is recommended to use TVS diodes with a stand-off voltage of 33V (peak current >15A depending on the application) as SMBJ33A from Vishay, ST, Fairchild or P6SMBJ33A from Diotec.
- D<sub>6x</sub>: it is recommended to use TVS diodes with stand-off voltages >60V (peak current >1A) as SMAJ70A from Vishay, ST, Fairchild or P4SMAJ70A from Diotec.

Please note that the 20Ω resistor as well as diodes D<sub>4x</sub> and D<sub>6x</sub> must not be omitted if advanced active clamping is used. If advanced active clamping is not used, the 20Ω resistor as well as diodes D<sub>4x</sub> and D<sub>6x</sub> can be omitted.

Description & Application Manual

**Collector sense (VCE<sub>x</sub>) with resistors**

The collector sense of each channel of the 2SC0108T2Dx-xx must be connected to the IGBT collector or MOSFET drain with the circuit shown in Figs. 6 or 7 in order to detect an IGBT or MOSFET short circuit.

In an IGBT off-state, the driver’s internal MOSFET connects pin VCE<sub>x</sub> to pin COM<sub>x</sub>. The capacitor C<sub>ax</sub> is then precharged/discharged to the negative supply voltage, which is about -8V referred to VEx (red circle in Fig. 7 left). During this time, a current flows from the collector (blue circle in Fig. 7) via the resistor network and the diode BAS416 to GH<sub>x</sub>. The current is limited by the resistor chain.

It is recommended to dimension the resistor value of R<sub>VCE<sub>x</sub></sub> in order to obtain a current of about I<sub>R<sub>VCE<sub>x</sub></sub></sub>=0.6-1mA flowing through R<sub>VCE<sub>x</sub></sub> (e.g. 400-650kΩ for V<sub>DC-LINK</sub>=400V). The current through R<sub>VCE<sub>x</sub></sub> must not exceed 1mA. A high-voltage resistor as well as series-connected resistors may be used. In any case, the minimum creepage distance required for the application must be considered.

The reference threshold is internally set to 9.3V. The driver safely protects the IGBT against short circuit, but not necessarily against overcurrent. Overcurrent protection has a lower timing priority and is recommended to be realized within the host controller.

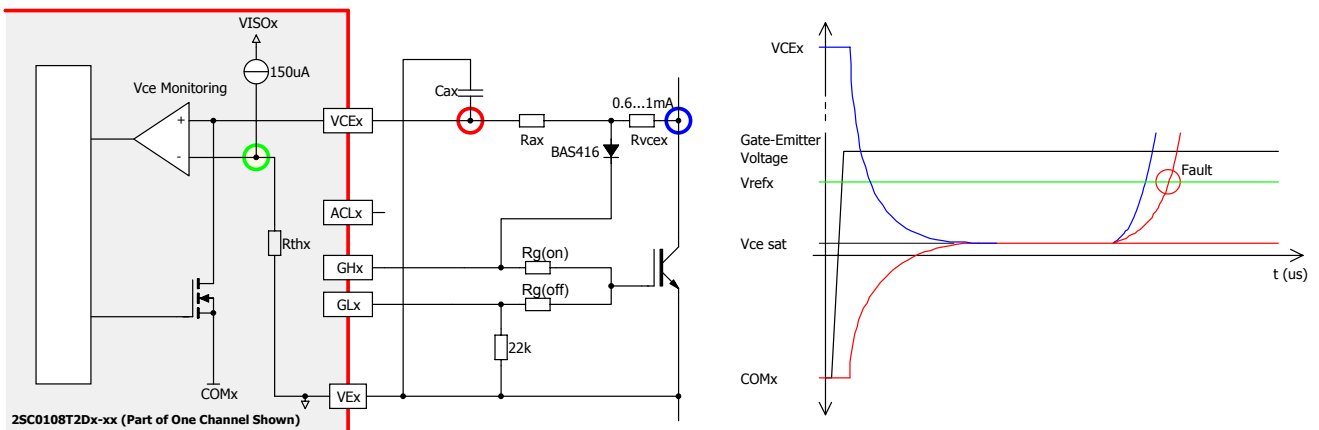


Fig. 7 V<sub>ce</sub> desaturation protection with resistors

At IGBT turn-on and in the on-state, the driver’s internal MOSFET turns off. While V<sub>ce</sub> decreases (blue curve in Fig. 7), C<sub>ax</sub> is charged from the COM<sub>x</sub> potential to the IGBT saturation voltage (red curve in Fig. 7). The time required to charge C<sub>ax</sub> depends on the DC bus voltage, the value of the resistor R<sub>ax</sub> and the capacitor C<sub>ax</sub>. During the response time, the V<sub>ce</sub> monitoring circuit is inactive. The response time is the time that elapses after turn-on of the power semiconductor until the collector voltage is measured. It corresponds to the short-circuit duration.

For 600V and 650V IGBTs, it is recommended to set R<sub>ax</sub>=62kΩ. If the current through the resistor R<sub>VCE<sub>x</sub></sub> is in the range of I<sub>R<sub>VCE<sub>x</sub></sub></sub>=0.6-1mA, the resulting response time is given in Table 1 for several values of C<sub>ax</sub>:

| C <sub>ax</sub> [pF] | Response time (typical value) [μs] |
|----------------------|------------------------------------|
| 0                    | 1.0                                |
| 15                   | 2.3                                |
| 22                   | 2.9                                |
| 27                   | 3.4                                |
| 33                   | 3.9                                |
| 39                   | 4.5                                |

Table 1 Response time as a function of C<sub>ax</sub> for 600V and 650V IGBTs (R<sub>ax</sub>=62kΩ)

For 1200V IGBTs – which can only be used with the 2SC0108T2Dx-12 or the 2SC0108T2Dx-07 if the maximum operating voltage under absolute maximum ratings (see driver data sheet /3/) is not exceeded (e.g. specific 3-level topologies such as NPC2) – it is recommended to set  $R_{ax}=120k\Omega$ . The resulting response time (typical value) is given in Table 2 for  $R_{vcex}=1.8M\Omega$  and several values of  $C_{ax}$ :

| $C_{ax}$ [pF] | Response time (typical value) [ $\mu$ s] |
|---------------|--|
| 0             | 1.4                                      |
| 15            | 4.5                                      |
| 22            | 5.9                                      |
| 33            | 8.2                                      |
| 47            | 11.2                                     |

Table 2 Response time as a function of  $C_{ax}$  for 1200V IGBTs ( $R_{ax}=120k\Omega$ ,  $R_{vcex}=1.8M\Omega$ ,  $V_{DC-LINK}>550V$ )

As the parasitic capacitances on the host PCB may influence the response time, it is recommended to measure it in the final design. It is important to define a response time which is shorter than the maximum permitted short-circuit duration of the power semiconductor used.

Note that the response time typically increases at lower values of the DC-link voltage.

The diode  $D_{1x}$  in Fig. 6 must have a very low leakage current and a blocking voltage  $>40V$  (e.g. BAS416). Schottky diodes must be explicitly avoided.

The components  $C_{ax}$ ,  $R_{ax}$  and  $D_{1x}$  must be placed as close as possible to the driver. A large collector-emitter loop must also be avoided.

When a short-circuit fault is detected, the driver switches off the corresponding power semiconductor. The fault status is immediately transferred to the corresponding SOx output of the affected channel. The power semiconductor is kept in the off state (non-conducting) and the fault is shown at pin SOx as long as the blocking time  $T_b$  is active.

The blocking time  $T_b$  is applied independently to each channel.  $T_b$  starts as soon as a fault has been detected.

## Desaturation protection with sense diodes

2SC0108T2Dx-xx also provides desaturation protection with high-voltage diodes as shown in Fig. 8. However, the use of high-voltage diodes has some disadvantages compared to the use of resistors:

- Common-mode current relating to the rate of change  $dv_{ce}/dt$  of the collector-emitter voltage: High-voltage diodes have large junction capacitances  $C_j$ . These capacitances in combination with the  $dv_{ce}/dt$  generate a common-mode current  $I_{com}$  flowing in and out of the measurement circuit.

$$I_{com} = C_j \cdot \frac{dv_{ce}}{dt}$$

- Price: High-voltage diodes are more expensive than standard 0805/150V or 1206/200V SMD resistors.
- Availability: Standard thick-film resistors are comparatively easier to source on the market.
- Limited ruggedness: The reaction time does not increase at lower  $V_{ce}$  levels. Consequently, false triggering may occur at higher IGBT temperatures, higher collector currents, resonant switching or phase-shift PWM. This may lead to limited IGBT utilization: the collector current may be limited to values smaller than twice the nominal current, or the short-circuit withstand capability may be reduced.

During the IGBT off-state,  $D_{4x}$  (and  $R_{ax}$ ) sets the VCEx pin to COMx potential, thereby precharging/discharging the capacitor  $C_{ax}$  to the negative supply voltage, which is about -8V referred to VEx. At IGBT turn-on, the

## Description & Application Manual

capacitor  $C_{ax}$  is charged via  $R_{ax}$ . When the IGBT collector-emitter voltage drops below that limit, the voltage of  $C_{ax}$  is limited via the high-voltage diodes  $D_{1x}$  and  $D_{2x}$ . The voltage across  $C_{ax}$  can be calculated by:

$$V_{C_{ax}} = V_{CEsat} + V_{F(D1x)} + V_{F(D2x)} + (330\Omega \cdot \frac{(15V - V_{CEsat} - V_{F(D1x)} - V_{F(D2x)})}{(R_{ax} + 330\Omega)})$$

The reference voltage  $V_{refx}$  which is internally set to 9.3V must be higher than  $V_{cax}$ .

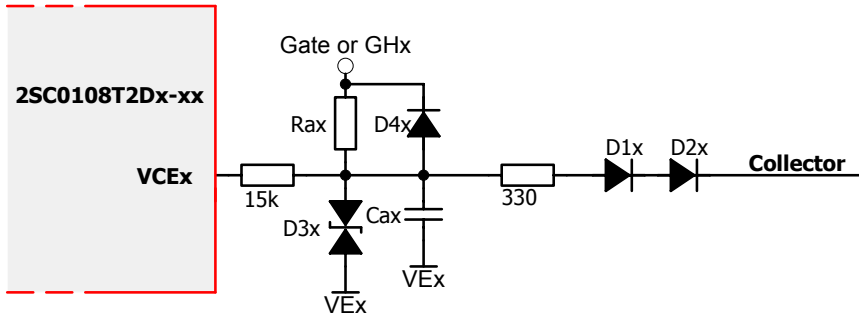


Fig. 8 Recommended circuit for desaturation protection with sense diodes (one channel shown)

The value of the resistance  $R_{ax}$  can be calculated with the following equation in order to program the desired response time  $T_{ax}$  at turn-on:

$$R_{ax} [k\Omega] \approx \frac{1000 \cdot T_{ax} [\mu s]}{C_{ax} [pF] \cdot \ln\left(\frac{15V + |V_{GLx}|}{5.7V}\right)}$$

$V_{GLx}$  is the absolute value of the turn-off voltage at the driver output. It depends on the driver load and can be found in the driver data sheet /3/.

Recommended components  $D_{1x}/D_{2x}/D_{3x}/D_{4x}$  and values for  $R_{ax}$  and  $C_{ax}$  are:

- High-voltage diodes  $D_{1x}/D_{2x}$ : 1x 1N4007 for 600V and 650V IGBT  
2x 1N4007 for 1200V IGBT
- $D_{3x}$ : Transient voltage suppressor of the voltage class 12V...15V with small junction capacitance as CDDFN2-12C from Bourns.
- $D_{4x}$ : High-speed diode as BAS316. Schottky diodes must be avoided.
- $R_{ax}=24k\Omega...62k\Omega$
- $C_{ax}=100pF...560pF$

Note that  $C_{ax}$  must include the parasitic capacitance of the transient voltage suppressor  $D_{3x}$  and the PCB.

Note also that the instantaneous  $V_{ce}$  threshold voltage is determined by the internally set reference voltage of 9.3V minus the voltage across the 330Ω resistor as well as the forward voltages across  $D_{1x}$  and  $D_{2x}$ .

The minimum off-state duration should not be shorter than about 1μs in order not to significantly reduce the response time for the next turn-on pulse.

Example: A resistor of  $R_{ax}\approx 33k\Omega$  must be used to define a response time of 4.7μs with  $C_{ax}=100pF$  and  $V_{GLx}=9V$ .

### Disabling the $V_{ce,sat}$ detection

To disable the  $V_{ce,sat}$  measurement of 2SC0108T2Dx-xx, a resistor with a minimum value of  $33k\Omega$  must be placed between VCEx and VEx according to Fig. 9.

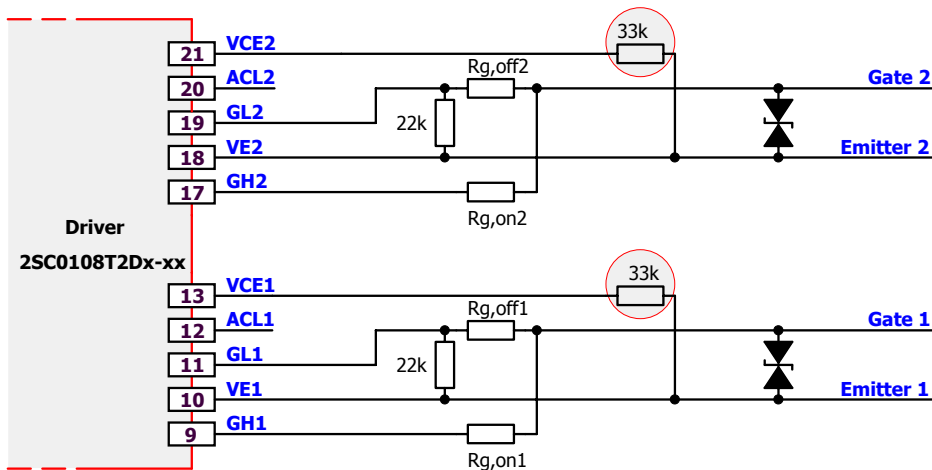


Fig. 9 Disabling the  $V_{ce,sat}$  detection

### Gate turn-on (GHx) and turn-off (GLx) terminals

These terminals allow the turn-on (GHx) and turn-off (GLx) gate resistors to be connected to the gate of the power semiconductor. The GHx and GLx pins are available as separated terminals in order to set the turn-on and turn-off resistors independently without the use of an additional diode. Please refer to the driver data sheet /3/ for the limit values of the gate resistors used.

A resistor between GLx and VEx of 22k (higher values are also possible) may be used in order to provide a low-impedance path from the IGBT gate to the emitter even if the driver is not supplied with power. Lower resistance values are not allowed.

A transient voltage suppressor device ( $D_{5x}$ ) may be used between gate and emitter (e.g. SMBJ13CA) if the gate-emitter voltage becomes too high in the IGBT short-circuit condition, thus leading to excessive short-circuit currents.

Note however that it is not advisable to operate the power semiconductors within a half-bridge with a driver in the event of a low supply voltage. Otherwise, a high rate of increase of  $V_{ce}$  may cause partial turn-on of these IGBTs.

### How Do 2SC0108T2Dx-xx SCALE-2 Drivers Work in Detail?

### Power supply and electrical isolation

The driver is equipped with a DC/DC converter to provide an electrically insulated power supply to the gate driver circuitry. All transformers (DC/DC and signal transformers) feature safe isolation to EN 50178, protection class II between primary side and either secondary side.

Note that the driver requires a stabilized supply voltage.

---

## Description & Application Manual

---

### Power-supply monitoring

---

The driver's primary side as well as both secondary-side driver channels are equipped with a local undervoltage monitoring circuit.

In the event of a primary-side supply undervoltage, the power semiconductors are driven with a negative gate voltage to keep them in the off-state (the driver is blocked) and the fault is transmitted to both outputs SO1 and SO2 until the fault disappears.

In case of a secondary-side supply undervoltage, the corresponding power semiconductor is driven with a negative gate voltage to keep it in the off-state (the channel is blocked) and a fault condition is transmitted to the corresponding SOx output. The SOx output is automatically reset (returning to a high impedance state) after the blocking time.

**Within a half-bridge, it is advised not to operate the IGBTs with an IGBT driver in the event of a low supply voltage. Otherwise, a high rate of increase of  $V_{ce}$  may cause partial turn-on of these IGBTs.**

---

### Parallel connection of 2SC0108T2Dx-xx

---

If parallel connection of 2SC0108T2Dx-xx drivers is required, please refer to the application note AN-0904 /5/ on [www.IGBT-Driver.com/go/app-note](http://www.IGBT-Driver.com/go/app-note).

---

### 3-level or multilevel topologies

---

If 2SC0108T2Dx-xx drivers are to be used in 3-level or multilevel topologies, please refer to the application note AN-0901 /6/ on [www.IGBT-Driver.com/go/app-note](http://www.IGBT-Driver.com/go/app-note).

---

### Additional application support for 2SC0108T2Dx-xx

---

For additional application support using 2SC0108T2Dx-xx drivers, please refer to the application note AN-1101 /4/ on [www.IGBT-Driver.com/go/app-note](http://www.IGBT-Driver.com/go/app-note).

---

### Bibliography

- /1/ "Smart Power Chip Tuning", Bodo's Power Systems, May 2007
- /2/ "Description and Application Manual for SCALE Drivers", CONCEPT
- /3/ Data sheet SCALE-2 driver core 2SC0108T2Dx-07 and 2SC0108T2Dx-12, CONCEPT
- /4/ Application note AN-1101: Application with SCALE-2 Gate Driver Cores, CONCEPT
- /5/ Application note AN-0904: Direct Paralleling of SCALE-2 Gate Driver Cores, CONCEPT
- /6/ Application note AN-0901: Methodology for Controlling Multi-Level Converter Topologies with SCALE-2 IGBT Drivers, CONCEPT

**Note:** These papers are available on the Internet at [www.IGBT-Driver.com/go/papers](http://www.IGBT-Driver.com/go/papers)



**The Information Source: SCALE-2 Driver Data Sheets**

CONCEPT offers the widest selection of gate drivers for power MOSFETs and IGBTs for almost any application requirements. The largest website on gate-drive circuitry anywhere contains all data sheets, application notes and manuals, technical information and support sections: [www.IGBT-Driver.com](http://www.IGBT-Driver.com)

**Quite Special: Customized SCALE-2 Drivers**

If you need an IGBT driver that is not included in the delivery range, please don't hesitate to contact CONCEPT or your CONCEPT sales partner.

CONCEPT has more than 25 years experience in the development and manufacture of intelligent gate drivers for power MOSFETs and IGBTs and has already implemented a large number of customized solutions.

**Technical Support**

CONCEPT provides expert help with your questions and problems:

[www.IGBT-Driver.com/go/support](http://www.IGBT-Driver.com/go/support)

**Quality**

The obligation to high quality is one of the central features laid down in the mission statement of CT-Concept Technologie AG. The quality management system covers all stages of product development and production up to delivery. The drivers of the SCALE-2 series are manufactured to the ISO9001:2000 quality standard.

**Legal Disclaimer**

This data sheet specifies devices but cannot promise to deliver any specific characteristics. No warranty or guarantee is given – either expressly or implicitly – regarding delivery, performance or suitability.

CT-Concept Technologie AG reserves the right to make modifications to its technical data and product specifications at any time without prior notice. The general terms and conditions of delivery of CT-Concept Technologie AG apply.

## Description & Application Manual

### Ordering Information

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

| Type Designation | Description  |
|------------------|--|
| 2SC0108T2D0-07   | Dual-channel SCALE-2 driver core for IGBTs up to 650V  |
| 2SC0108T2D0-12   | Dual-channel SCALE-2 driver core for IGBTs up to 1200V |

Product home page: [www.IGBT-Driver.com/go/2SC0108T](http://www.IGBT-Driver.com/go/2SC0108T)

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

### Information about Other Products

#### For other driver cores:

Direct link: [www.IGBT-Driver.com/go/cores](http://www.IGBT-Driver.com/go/cores)

#### For other drivers, product documentation, evaluation systems and application support

Please click onto: [www.IGBT-Driver.com](http://www.IGBT-Driver.com)

### Manufacturer

CT-Concept Technologie AG  
Intelligent Power Electronics  
Renferstrasse 15  
CH-2504 Biel-Bienne  
Switzerland

Tel. +41 - 32 - 344 47 47

Fax +41 - 32 - 344 47 40

E-mail [Info@IGBT-Driver.com](mailto:Info@IGBT-Driver.com)

Internet [www.IGBT-Driver.com](http://www.IGBT-Driver.com)

© 2011...2012 CT-Concept Technologie AG - Switzerland.

We reserve the right to make any technical modifications without prior notice.

All rights reserved.

Version of 2012-05-03