

# Six-pack SCALE Driver 6SD106E

## for IGBTs and Power MOSFETs

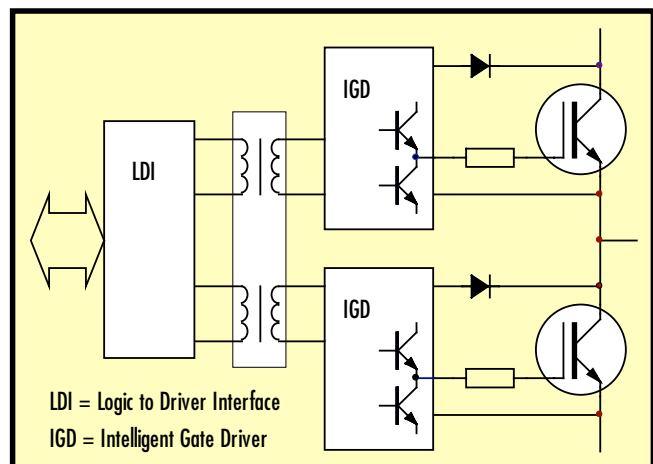
### Description

The **SCALE** drivers from **CONCEPT** are based on a chip set that was developed specifically for the reliable driving and safe operation of **IGBTs** and power **MOSFETs**.

The name "SCALE" is an acronym for the most outstanding properties of the SCALE series of drivers:

**SCALE** = Scaleable, Compact, All purpose, Low cost and Easy to use.

The SCALE driver is a winning project of the competition organized by "Technology Center Switzerland 1998". And ABB Switzerland AG honored the development of the SCALE driver by distinguishing it as the "best power electronics project in 1998".



### Product Highlights

- ✓ Suitable for IGBTs and power MOSFETs
- ✓ Short circuit and overcurrent protection
- ✓ Extremely reliable, long service life
- ✓ High gate current of  $\pm 6A$
- ✓ Electrical isolation of  $4000V_{AC}$
- ✓ Electrically isolated status acknowledgement
- ✓ Monitoring of power supply and self-monitoring
- ✓ Switching frequency DC to  $>100kHz$
- ✓ Duty cycle: 0... 100%
- ✓ High dv/dt immunity, guaranteed  $>100,000V/\mu s$
- ✓ Complete with DC/DC converter

### Applications

- ✓ Inverters
- ✓ Motor drive technology
- ✓ Traction
- ✓ Railroad power supplies
- ✓ Converters
- ✓ Power engineering
- ✓ Switched-mode power supplies
- ✓ Radiology and laser technology
- ✓ DC/DC converter
- ✓ Research
- ✓ RF generators and converters

## Block Diagram

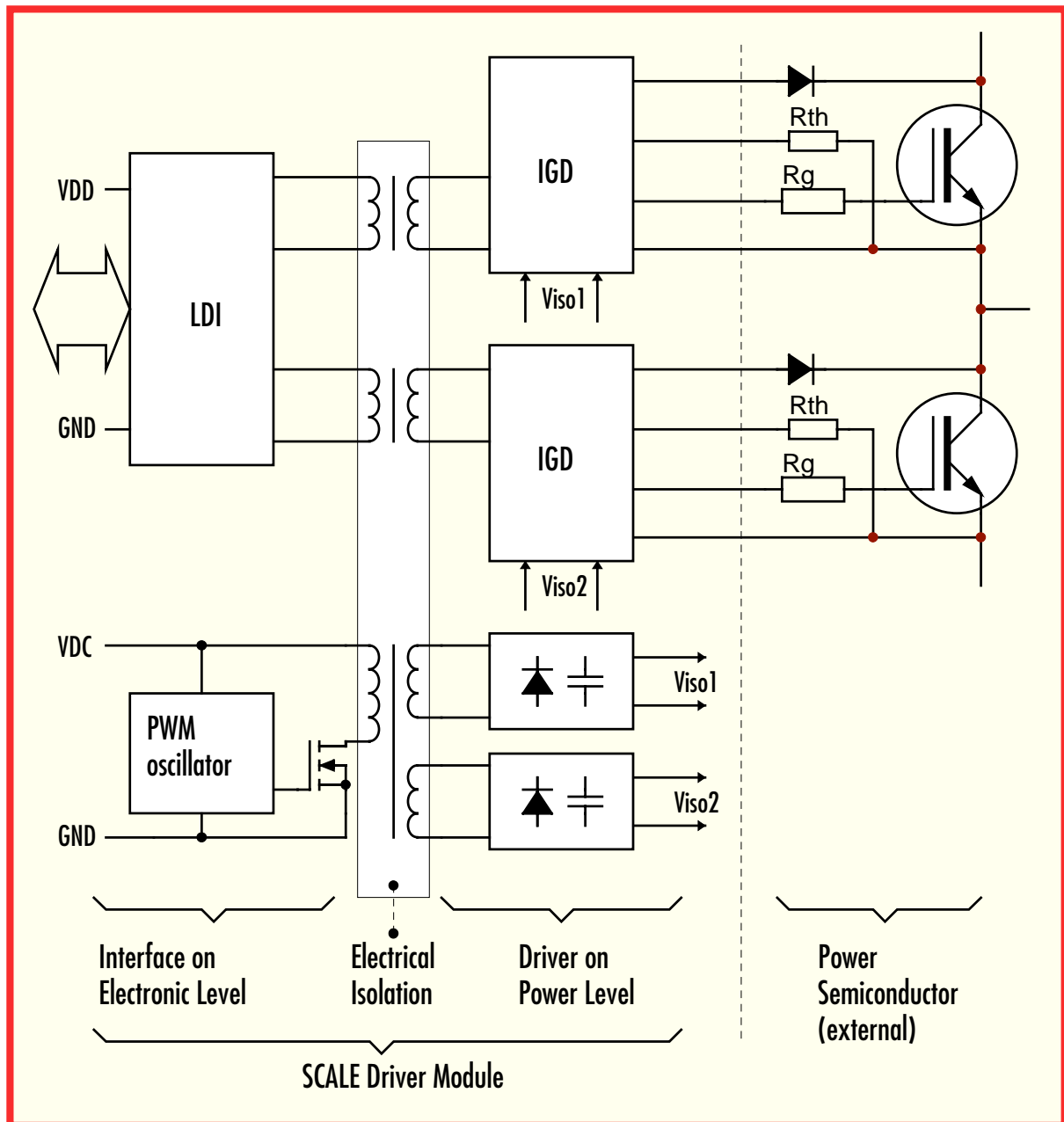


Fig. 1 Block diagram shows 2 channels (i.e. one third) of the 6SD106E

The block diagram shows two channels (i.e. one third) of the 6SD106E six-pack driver. There is only one PWM oscillator, whereas all other components are present in triplicate.

### Pin Designation

| Pin | Des.  | Function                         | Pin | Des.   | Function                          |
|-----|-------|----------------------------------|-----|--------|-----------------------------------|
| 1   | GND   | Ground of the power supply       | 68  | U_C2   | Phase U, Collector sense ch. 2    |
| 2   | U_SO2 | Phase U, Status output channel 2 | 67  | U_Rth2 | Phase U, Reference resistor ch. 2 |
| 3   | U_Mod | Phase U, Mode input              | 66  | U_E2   | Phase U, Emitter channel 2        |
| 4   | U_RC2 | Phase U, RC network channel 2    | 65  | U_G2   | Phase U, Gate channel 2           |
| 5   | U_InB | Phase U, Input B                 | 64  |        | Free                              |
| 6   | U_InA | Phase U, Input A                 | 63  |        | Free                              |
| 7   | U_RC1 | Phase U, RC network channel 1    | 62  | U_C1   | Phase U, Collector sense ch. 1    |
| 8   | U_VL  | Phase U, Logic level/Reset       | 61  | U_Rth1 | Phase U, Reference resistor ch. 1 |
| 9   | U_SO1 | Phase U, Status output channel 1 | 60  | U_E1   | Phase U, Emitter channel 1        |
| 10  | GND   | Ground of DC/DC converter        | 59  | U_G1   | Phase U, Gate channel 1           |
| 11  | GND   | Ground of DC/DC converter        | 58  |        | Free                              |
| 12  | VDC   | +15V for DC/DC converter         | 57  |        | Free                              |
| 13  | VDC   | +15V for DC/DC converter         | 56  | V_C2   | Phase V, Collector sense ch. 2    |
| 14  | V_SO2 | Phase V, Status output channel 2 | 55  | V_Rth2 | Phase V, Reference resistor ch. 2 |
| 15  | V_Mod | Phase V, Mode input              | 54  | V_E2   | Phase V, Emitter channel 2        |
| 16  | V_RC2 | Phase V, RC network channel 1    | 53  | V_G2   | Phase V, Gate channel 2           |
| 17  | V_InB | Phase V, Input B                 | 52  |        | Free                              |
| 18  | V_InA | Phase V, Input A                 | 51  |        | Free                              |
| 19  | V_RC1 | Phase V, RC network channel 1    | 50  | V_C1   | Phase V, Collector sense ch. 1    |
| 20  | V_VL  | Phase V, Logic level/Reset       | 49  | V_Rth1 | Phase V, Reference resistor ch. 1 |
| 21  | V_SO1 | Phase V, Status output channel 1 | 48  | V_E1   | Phase V, Emitter channel 1        |
| 22  | GND   | Ground of the power supply       | 47  | V_G1   | Phase V, Gate channel 1           |
| 23  | GND   | Ground of the power supply       | 46  |        | Free                              |
| 24  | VDD   | +15V for electronic input side   | 45  |        | Free                              |
| 25  | VDD   | +15V for electronic input side   | 44  | W_C2   | Phase W, Collector sense ch. 2    |
| 26  | W_SO2 | Phase W, Status output channel 2 | 43  | W_Rth2 | Phase W, Reference resistor ch. 2 |
| 27  | W_Mod | Phase W, Mode input              | 42  | W_E2   | Phase W, Emitter channel 2        |
| 28  | W_RC2 | Phase W, RC network channel 2    | 41  | W_G2   | Phase W, Gate channel 2           |
| 29  | W_InB | Phase W, Input B                 | 40  |        | Free                              |
| 30  | W_InA | Phase W, Input A                 | 39  |        | Free                              |
| 31  | W_RC1 | Phase W, RC network channel 1    | 38  | W_C1   | Phase W, Collector sense ch. 1    |
| 32  | W_VL  | Phase W, Logic level/Reset       | 37  | W_Rth1 | Phase W, Reference resistor ch. 1 |
| 33  | W_SO1 | Phase W, Status output channel 1 | 36  | W_E1   | Phase W, Emitter channel 1        |
| 34  | GND   | Ground of the power supply       | 35  | W_G1   | Phase W, Gate channel 1           |

### Legend:

Pins with the designation "Free" are not physically present

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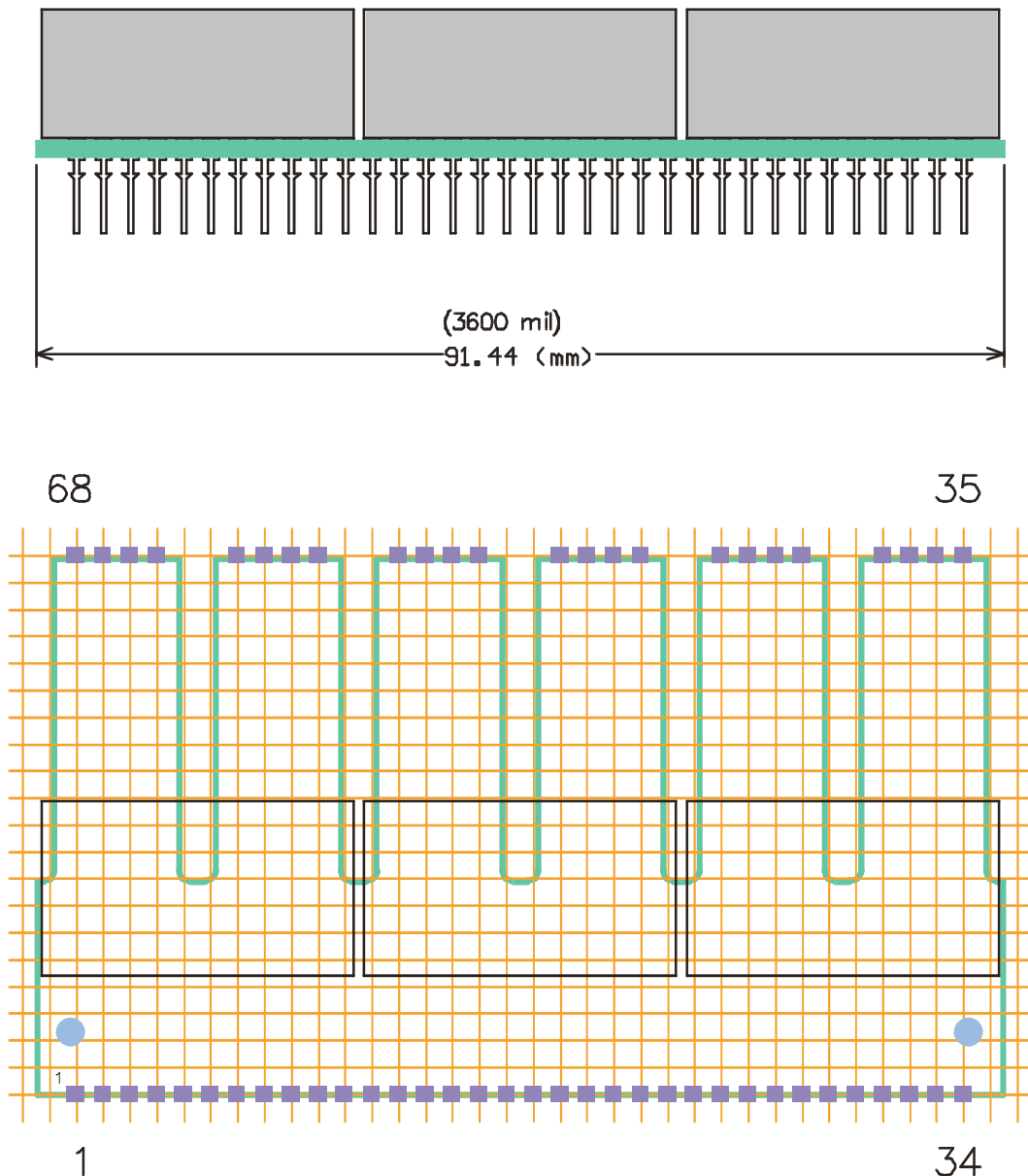
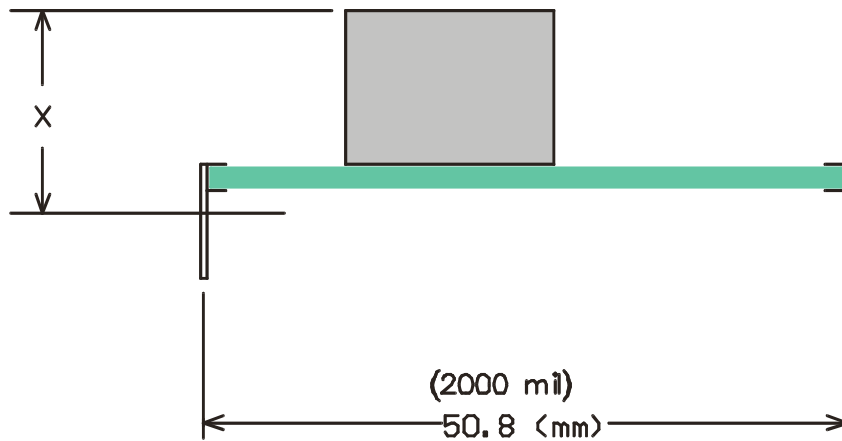
**Mechanical Dimensions**

Fig. 2 Front view (top) / Layout overview component side (bottom) 6SD106E

Grid of the aspect drawing on page 4 below: 2.54mm (100mil)

Recommended diameter of solder pad:  $\varnothing$  1.6mm; diameter of drill holes:  $\varnothing$  1.0mm



68

35

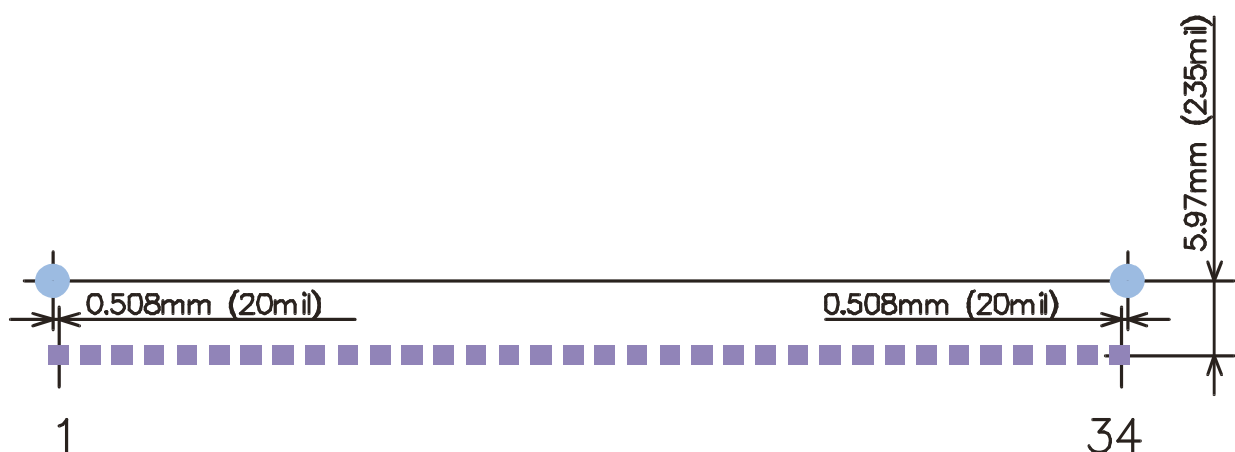


Fig. 3 Side view (top) / Mechanical fixing (bottom) 6SD106E

Height X: typ. 25mm in first series (1998); typ. 16mm from 1999

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### Mechanical fixing

The 6SD106E driver has two holes each 2.7mm in diameter. They allow additional fixing of the driver for applications requiring very high resistance to shaking/vibration (railways, traction systems, electrically-driven vehicles, etc.). See Fig. 3 (bottom).

### Absolute Maximum Ratings

| Parameter                                | Test conditions         | min | max        | unit                  |
|--|-------------------------|-----|------------|-----------------------|
| Supply voltage <i>VDC</i>                |                         | 0   | 16         | Vdc                   |
| Supply voltage <i>VDD</i>                |                         | 0   | 16         | Vdc                   |
| Logic input voltage                      | to GND                  | 0   | <i>VDD</i> | Vdc                   |
| Gate peak current <i>I<sub>out</sub></i> | Gx to Ex                | -6  | +6         | A                     |
| Output power DC/DC converter             | total for 6 channels    |     | 6          | W                     |
| Operating voltage                        | continuous (see Note 8) |     | 800        | Vdc                   |
| Test voltage (50Hz/1 min)                | inputs to outputs       |     | 4000       | V <sub>AC</sub> (eff) |
| Operating temperature                    | 6SD106EN (see Note 10)  | 0   | +70        | °C                    |
|  | 6SD106E I (see Note 10) | -40 | +85        | °C                    |
| Storage temperature                      | all types               | -40 | +90        | °C                    |

All data refer to +25°C and *VDD* = *VDC* = 15V unless otherwise specified

### Electrical Characteristics

| Power supply                      | Test conditions              | min | typ | max | unit |
|-----------------------------------|------------------------------|-----|-----|-----|------|
| Nominal supply voltage <i>VDC</i> | to GND (see Note 1)          | 15  |     |     | Vdc  |
| Supply current <i>IDC</i>         | without load                 | 70  |     |     | mA   |
| Max. supply current <i>IDC</i>    | (see Note 2)                 |     |     | 460 | mA   |
| Output power DC/DC converter      | (see Note 3)                 |     |     | 6   | W    |
| Efficiency $\eta$                 | internal DC/DC converter     | 85  |     |     | %    |
| Nominal supply voltage <i>VDD</i> | to GND                       | 15  |     |     | Vdc  |
| Supply current <i>IDD</i>         | without load                 | 35  |     |     | mA   |
| Supply current <i>IDD</i>         | at 25kHz switching frequency | 44  |     |     | mA   |

### Electrical Characteristics (Continuation)

| Power supply monitoring                           | Test conditions             | min | typ      | max      | unit          |
|---|-----------------------------|-----|----------|----------|---------------|
| Turn-on threshold $V_{th}$                        | (see Note 4)                |     | 11.5     |          | Vdc           |
| Hysteresis on-/off                                | (see Note 4)                |     | 0.7      |          | Vdc           |
| Logic inputs                                      | Test conditions             | min | typ      | max      | unit          |
| Input voltage                                     | all inputs (see Note 5)     | 0   | $V_{DD}$ |          | Vdc           |
| Timing characteristics                            | Test conditions             | min | typ      | max      | unit          |
| Delay time input to output                        | turn-on $t_{pd(on)}$        |     | 300      |          | ns            |
|   | turn-off $t_{pd(off)}$      |     | 350      |          | ns            |
| Blocking time                                     | after failure (see Note 14) |     | 1        |          | s             |
| Outputs   | Test conditions             | min | typ      | max      | unit          |
| Output current $I_G$                              | Gx to Ex (see Note 6)       | -6  |          | +6       | Adc           |
| Output rise time $t_{r(out)}$                     | Gx to Ex (see Note 7)       |     | 100      |          | ns            |
| Output fall time $t_{f(out)}$                     | Gx to Ex (see Note 7)       |     | 80       |          | ns            |
| Output current SOx                                |                             | 1.5 |          |          | mA            |
| Output voltage rating SOx                         | SOx to GND                  |     |          | $V_{DD}$ | V             |
| Vce-Monitoring                                    | Test conditions             | min | typ      | max      | unit          |
| Inputs Cx   | to Ex                       | 0   |          | $V_{DD}$ | Vdc           |
| Electrical isolation                              | Test conditions             | min | typ      | max      | unit          |
| Operating voltage                                 | continuous (see Note 8)     |     |          | 800      | Vdc           |
| Test voltage                                      | (50Hz/1min) (see Note 12)   |     |          | 4000     | $V_{AC}(eff)$ |
| Partial discharge extinction volt.                | IEC270 (see Note 11)        |     | >1200    |          | $V_{AC}(pk)$  |
| Creep path input-output                           |                             |     | 12.7     |          | mm            |
| Creep path output-output                          | (see Note 13)               |     | 7.0/12.7 |          | mm            |
| Maximum $\Delta V/\Delta t$ at $\Delta V = 1000V$ | (see Note 9)                | 100 |          |          | kV/ $\mu s$   |

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

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### Operating conditions

| Operating conditions  | Test conditions         | min | max | unit |
|-----------------------|-------------------------|-----|-----|------|
| Operating temperature | 6SD106EN (see Note 10)  | 0   | +70 | °C   |
|                       | 6SD106E I (see Note 10) | -40 | +85 | °C   |
| Storage temperature   | all types               | -40 | +90 | °C   |

### Footnotes to the key data

- 1) The drivers have a zener diode on each channel for over-voltage protection. When the feed voltage exceeds 16V, this protection can be subject to thermal overload.
- 2) If the specified power consumption is exceeded, this indicates an overload of the DC/DC converter. It should be noted that these DC/DC converters are not protected against overload.
- 3) This should be considered as a recommended value. Please consult the section: "Output power and self-heating".
- 4) Under-voltage monitoring for protecting the power semiconductors. The voltage refers to the local supply voltage of each individual drive channel. However, this corresponds approximately to the voltage at VDC with respect to GND.
- 5) The input levels must never exceed the limits of the supply voltage (i.e. between GND and VDD), otherwise latch-up of the integrated circuits LDI 00I can occur. Particular care must be taken when driving via cables or longer leads.
- 6) The gate current must be limited to its maximum value by a gate resistor.
- 7) At a load of 39nF in series with 5.6 Ω (typical load of a 1200V/100A IGBT).
- 8) Maximum continuous or repeatedly-applied DC voltage or peak value of the repeatedly-applied AC voltage between all inputs and all outputs. However, types that have been measured and selected for higher partial-discharge voltages (e.g. for 1700V IGBT modules) are also available (see Note 11).
- 9) This specification guarantees that the drive information will be transferred reliably even at a high DC-link voltage and fastest switching operations.
- 10) The application-specific self-heating of the drivers - specially at high load - must be taken into account.
- 11) The partial discharge is not measured for the standard types. Tested and selected types with guaranteed partial-discharge immunity can be supplied for applications with maximum requirements and higher operating voltages (such as railroad applications).
- 12) The test voltage of 4000 Vac(rms)/50Hz may be applied only once during a minute. It should be noted that with this (strictly speaking obsolete) test method, some (minor) damage occurs to the isolation layers due to the partial discharge. Consequently, this test is not performed at CONCEPT as a series test. In the case of repeated isolation tests (e.g. module test, equipment test, system test) the subsequent tests should be performed with a lower test voltage: the test voltage is reduced by 400V for each additional test. The more modern if more elaborate partial-discharge measurement is better suited than such test methods as it is almost entirely non-destructive.
- 13) The first series (1988) has a creep path of 7.0mm between adjacent channels. A creep path of 12.7mm will be implemented (with 100% mechanical compatibility) in later series.
- 14) The typical blocking time after an error is 1 second. If required, versions with other blocking times may also be supplied.



**Application Hints**

**IMPORTANT INFORMATION**

This data sheet contains only product-specific data. All data that apply to the whole type series of SCALE drivers is given in the document entitled: "Description and Application Manual for SCALE Drivers". In particular, this manual contains a detailed description of the concept of the SCALE drivers, a description of the function of all terminal pins as well as other important application hints.

**Overview and application**

The SCALE driver 6SD106E is a six-pack driver for power MOSFETs and IGBTs. The terminal pins of the 6SD106E driver are arranged so that the layout can be kept very simple and the logic signal flow (input signal  $\Rightarrow$  drive circuit  $\Rightarrow$  power transistors) is maintained. A distance of 12.7mm is observed between the drive signal and the power potential!

**Collector sense and dimensioning of Rth**

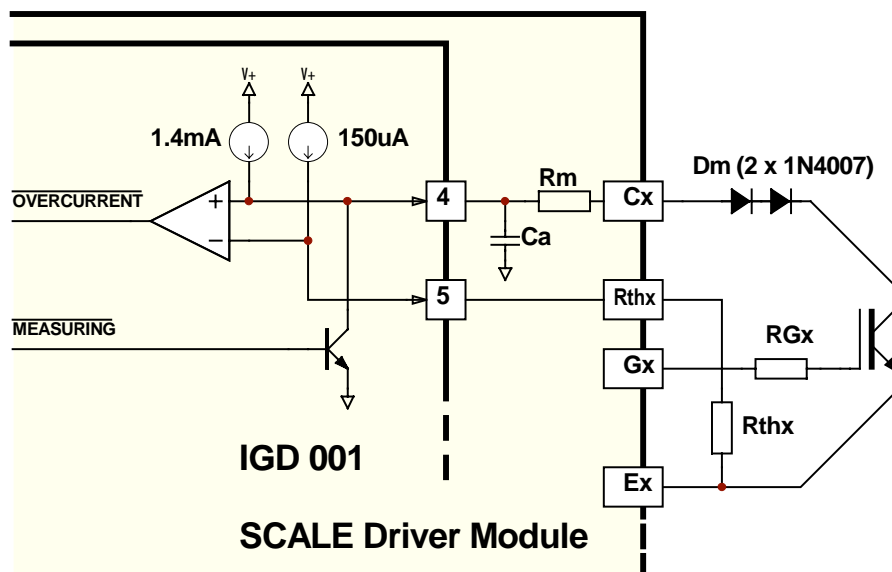


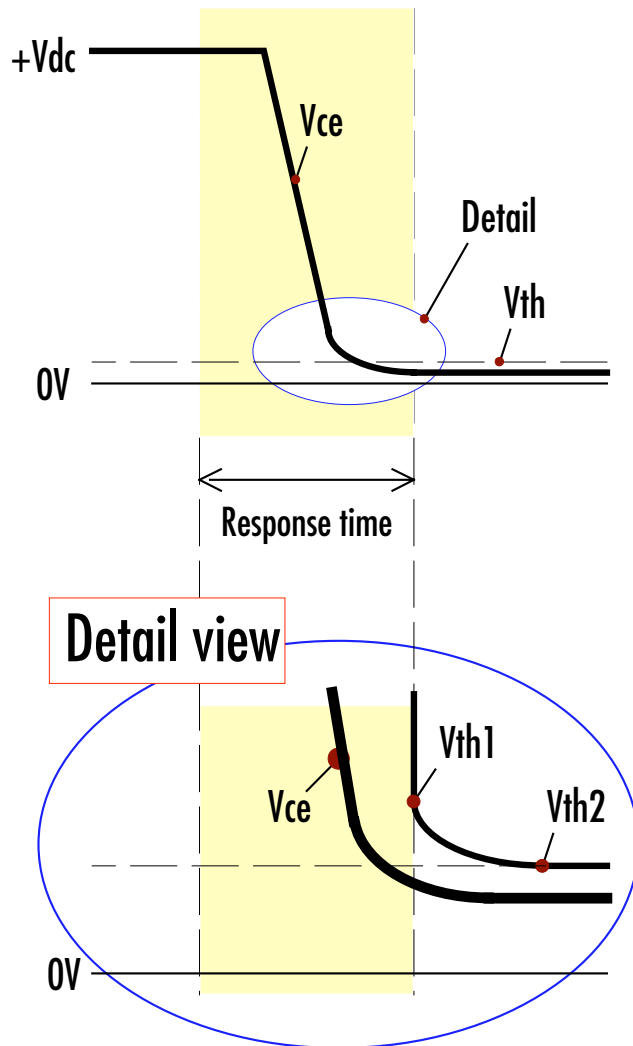
Fig. 4 Collector-sense circuit principle

The 6SD106E six-path driver has a collector-sense circuit to protect the power semiconductors. It is shown in Fig. 4

Its basic operating mode can be obtained from the brochure entitled: "Description and Application Manual for Scale Drivers".

To correspond more effectively to the turn-on characteristic of the IGBTs, the SCALE

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drivers do not use a static reference voltage to compare the voltage at the collector. Instead, the reference is used as shown in Fig. 5.

### Notes on Table 1

The values for “Vth1” and “Vth2” are listed in **Table 1** as a function of the reference resistance Rth.

The value in the “Vth1” column corresponds to the voltage threshold after the response time has elapsed.

The value in the “Vth2” column corresponds to the voltage which is set up statically across the resistor Rth. This static value is typically reached after between 10 and 15  $\mu$ s.

The value in the “V<sub>CE(off)</sub>” column corresponds to the collector-emitter voltage value at which the protection function is activated when the external circuit is used as shown in Fig. 4 with one or two Dm diodes of type 1N4007 connected in series.

Fig. 5 Collector-sense voltage curve

| Value Rth | Reaction time | Vth1   | Vth2   | V <sub>CE(off)</sub> |
|-----------|---------------|--------|--------|----------------------|
| 22k       | ≈ 4.9 $\mu$ s | ≈ 4.8V | ≈ 3.2V | 2.35V (1 Diode)      |
| 27k       | ≈ 5.7 $\mu$ s | ≈ 5.6V | ≈ 3.9V | 3.05V (1 Diode)      |
| 33k       | ≈ 6.8 $\mu$ s | ≈ 6.5V | ≈ 4.7V | 3.25V (2 Diodes)     |
| 39k       | ≈ 7.6 $\mu$ s | ≈ 7.3V | ≈ 5.6V | 4.15V (2 Diodes)     |
| 47k       | ≈ 9 $\mu$ s   | ≈ 8.4V | ≈ 6.8V | 5.35V (2 Diodes)     |

Table 1 Reference resistor, reaction time and turn-off threshold

## Output power and self-heating

The specified output power of the driver totals 6W (1W per channel). This typically suffices to drive a 100A/1200V six-pack IGBT module with 25kHz. In the case of a drive power of 6W, the typical input power of the driver is about 7W; the losses due to the driver total about 1 W. Because CONCEPT cannot predict how the drivers will be incorporated in the user's application, no binding recommended value for self-heating and thus for the maximum useful output power at high ambient temperatures can be made. It is consequently recommended to check the self-heating of the system, especially when it is used at higher temperatures.

For the calculation of the exact output power, reference should be made to Application Note AN-9701 "IGBT drivers correctly calculated" from CONCEPT.

### If you need any help, simply call our technical support

CONCEPT offers you expert help for your questions and problems:

E-Mail: [support@ct-concept.com](mailto:support@ct-concept.com) or on the Internet: [www.CT-CONCEPT.com](http://www.CT-CONCEPT.com)

Fax international ++41 32 / 322 22 51 (in Switzerland: 032 / 322 22 51)

Tel international ++41 32 / 322 42 36 (in Switzerland: 032 / 322 42 36)

### Quite special: customized SCALE drivers

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

CONCEPT engineers have more than 15 years experience in the development and manufacture of intelligent drivers for power MOSFETs and IGBTs and have already implemented a large number of customized solutions.

### Exclusion Clause

CONCEPT 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 Technology Ltd. apply.

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**Ordering Information****Six-pack SCALE driver with  $\pm 6A$  gate current /  $\pm 15V$  gate voltage**

|                                |          |
|--------------------------------|----------|
| Standard version (0...70°C)    | 6SD106EN |
| Industry version (-40...+85°C) | 6SD106EI |

**Additional Products and Information****Drivers for high isolation voltages (i.e. railroad applications)**

Please request further information

**Other intelligent drivers (i.e. half-bridge drivers etc.)**

Please ask for following overviews from CONCEPT (also to be found on the Internet):  
"Overview of Intelligent Drivers Standard Program"  
"Overview of SCALE Drivers"

**Evaluation boards**

Please ask for following overview from CONCEPT (also to be found on the Internet):  
"Overview and Price List of Evaluation-Boards"

**Manufacturer****Your Distribution Partner**

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