Target Description and Application Manual

2BB0535T
Target Description & Application Manual

Base Board for 2SC0535T SCALE-2 driver for 1700V, 2500V and 3300V IGBT modules with a combined electrical/fiber-optic interface for 2-level, 3-level and multilevel converter topologies with paralleling capability

Abstract

The 2BB0535T is a dual-channel Base Board for CONCEPT's SCALE-2 driver core 2SC0535T, a cost-effective SCALE-2 dual-driver core for the reliable driving and safe operation of IGBTs.

The Base Board is suitable for driving almost all available IGBT modules up to 3300V, such as 130mm x 140mm or 190mm x 140mm IGBT modules and others. Its plug-and-play capability (only the gate resistors and the auxiliary gate capacitors are missing) makes it ready to operate immediately after mounting. The user needs invest almost no effort in designing or adjusting it to a specific application.

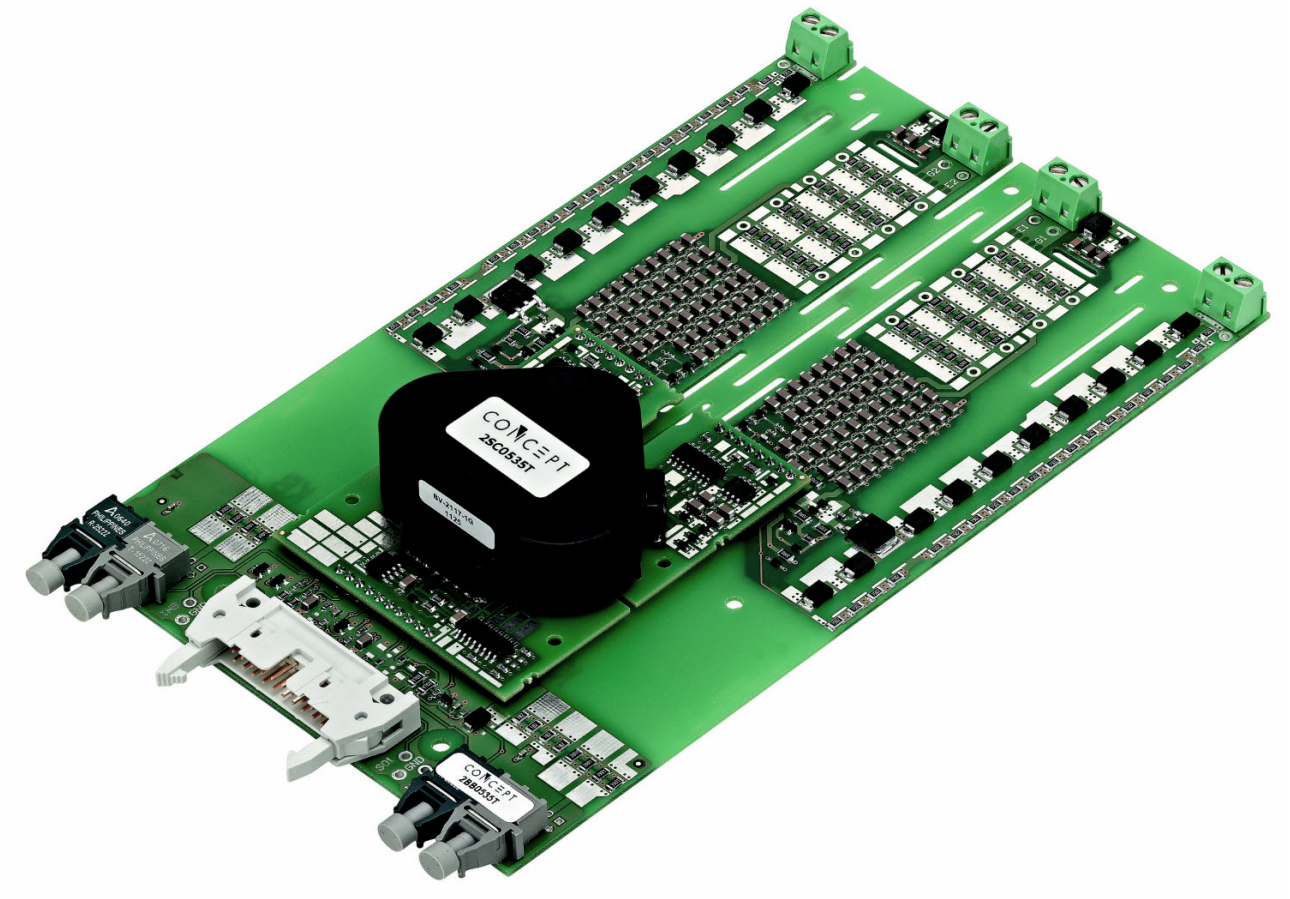

Fig. 1 2BB0535T Base Board with driver 2SC0535T

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System Overview

The 2BB0535T are Base Boards for the 2SC0535T driver. 2SC0535T are SCALE-2 driver cores based on the SCALE-2 technology developed by CONCEPT /1/. This set of application-specific integrated circuits (ASICs) covers 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 basic topology of the 2BB0535T Base Board is shown in Fig. 2.

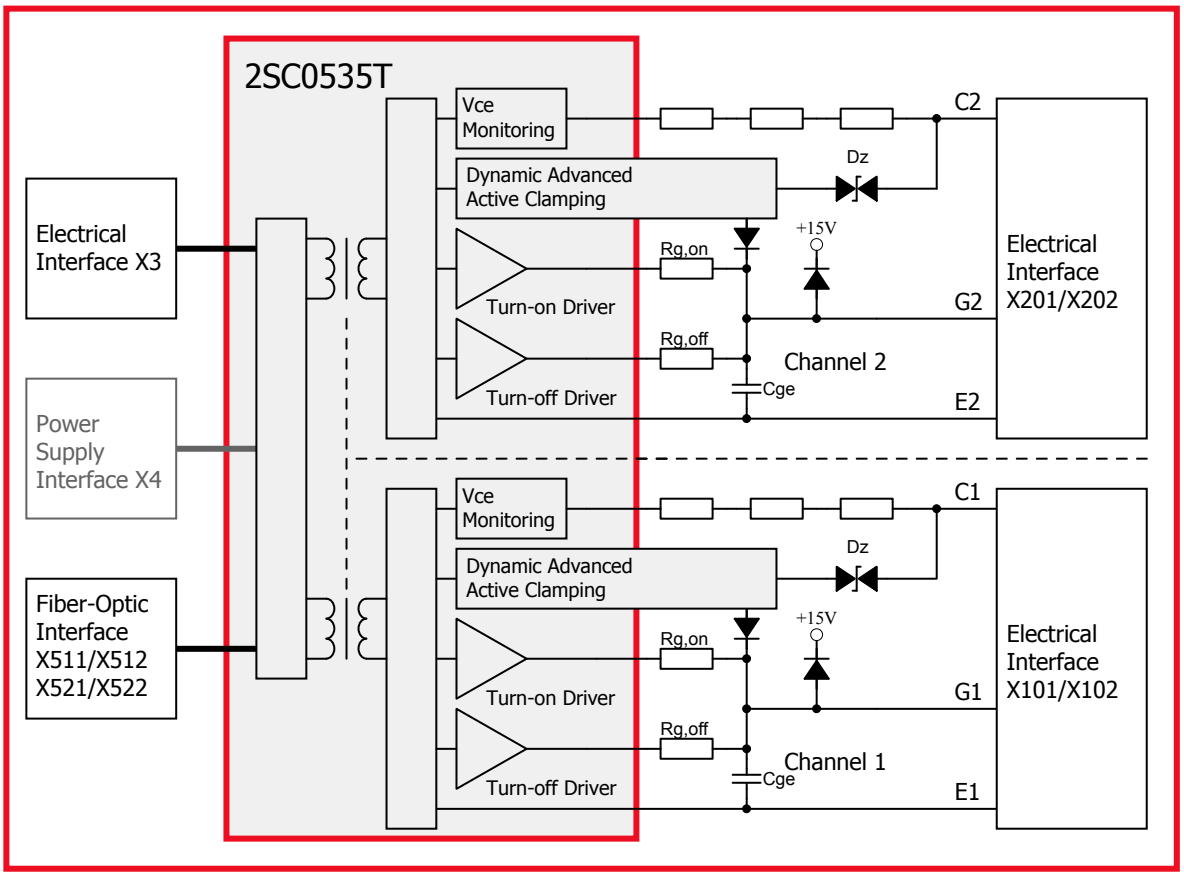

Fig. 2 Basic schematic of the 2BB0535T Base Board with 2SC0535T driver

The Base Board contains all necessary components for the optimal and safe driving of IGBT modules: gate clamping, active-clamping diodes (overvoltage protection at turn-off), Vce monitoring (short-circuit protection) as well as the electrical and fiber-optic input connector interfaces X3, X4 (X4 is not assembled on the delivered versions), X511, X512, X521, X522 and the output connectors X101, X102, X201 and X202 to connect the IGBT modules. Moreover, it includes components for setting the turn-off trip level, the response time and the dead time between both channels in half-bridge mode (this mode is only available with the input interface X3; it is not available with the fiber-optic and supply interface X4). Its plug-and-play capability means that it is ready to operate immediately after mounting. The user needs invest almost no effort in designing or adjusting the Base Board to a specific application. Only the gate resistors and the auxiliary gate capacitors are not assembled in order to provide full flexibility for the user.

The Base Board primary side supports two driving options:

1. Electrical interface with the 20-pin connector X3. For details see Section "3. Connect the Base Board to the control electronics".

2. Fiber-optic interfaces X511, X512, X521 and X522 and supply interface X3 or X4 (not assembled on the delivered version). For details, see Section "3. Connect the Base Board to the control electronics".

For a detailed description of 2SC0535T, please also refer to the "Description & Application Manual for 2SC0535T drivers" on www.IGBT-Driver.com/go/2SC0535T.

The Six Steps to Success

The following steps point out the easy way to use 2BB0535T Base Boards in power converters:

1. Choose a suitable Base Board/driver

When applying 2BB0535T Base Boards, you should note that the gate resistors and the auxiliary gate capacitors C_{ge} are not assembled. They must be assembled according to the IGBT module used before the start of operation.

The type designation of the Base Board also includes a number corresponding to the voltage class of the power device used (see "Ordering Information").

These Base Boards are not valid for IGBT modules of voltage classes other than those specified. Incorrect use may result in failure.

2. Connect the Base Board to the IGBT modules

Any handling of IGBT modules or drivers 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).

If these specifications are ignored, both IGBTs and drivers may be damaged.

The Base Board can be easily connected to an IGBT module by using the corresponding connectors X101, X102 (channel 1) and X201, X202 (channel 2).

3. Connect the Base Board to the control electronics

The Base Board supports an electrical interface as well as a fiber-optic interface to control the IGBT. The user can select its main preferred control principle.

In the standard configuration (delivered version), the Base Board is assembled with the 20-pin connector X3 and the fiber-optic interfaces X511, X512, X521 and X522. The Base Board supply voltages VDC and VCC must be connected independently on the interface used (electrical or fiber-optic interface). The use of the remaining pins of the connector X3 as well as of the fiber-optic interfaces X511, X512, X521, X522 depends on the user setup. The following table explains how the pins of the electrical interface X3 must be connected for both electrical and fiber-optic interfaces:

User-Specific Mode → Recommended Base Board Setup ↓		Electrical Interface	Fiber-Optic Interface
Electrical input signals X3	Pin 15 (INA)	Connected	Floating
	Pin 11 (INB)	Connected	Floating
Fiber-optic input signals X511 and X521	X511 (INA)	Unused[1]	Connected
	X521 (INB)	Unused[1]	Connected
Electrical status output signals X3	Pin 13 (SO1)	Connected	Floating
	Pin 9 (SO2)	Connected	Floating
Fiber-optic status output signals X512 and X522	X512 (SO1)	Unused[1]	Connected
	X522 (SO2)	Unused[1]	Connected
Mode setup X3	Pin 17	See paragraph "MOD (mode selection)"	See paragraph "MOD (mode selection)"
Blocking time setup X3	Pin 19	Resistor to GND or floating	Resistor to GND or floating

[1] Unused: No light must be applied to the fiber-optic receivers. They must be closed with adequate means.

4. Select the operating mode

The operating mode can be set with input MOD (interface X3: pin 17: see page 15 for details). Note that half-bridge mode is only available when using interface X3 (not available with power supply interface X4 and fiber-optic interfaces X511, X512, X521, X522).

5. Check the Base Board function

Check the gate voltage: For the off-state, the nominal gate voltage is specified in the relevant driver data sheet /3/. For the on-state, it is +15V. Also check the input current consumption of the Base Board without clock signals and at the desired switching frequency.

These tests should be performed before installation, as the gate terminals may otherwise not be accessible.

6. Set up and test the power stack

Before starting up the system, it is recommended that each IGBT module be checked separately under power-cycling conditions. It is usually sufficient to apply the single or double-pulse technique. CONCEPT specially recommends users to check that the IGBT modules switch inside the SOA in the worst case condition, as this depends strongly on the specific converter construction.

Even if only single IGBTs are tested, all the system's gate drivers must be supplied with energy. All the other IGBTs are then kept in the off state by applying negative gate voltages. This is particularly important when switching the IGBTs under test.

The short-circuit behavior can also be verified at this point.

The system is then ready to start under real-world load conditions. This allows the thermal behavior of the whole arrangement to be determined.

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The system must be re-qualified over the entire specified range of temperature and load conditions.

CAUTION: All handling with high voltages involves risk to life.

It is imperative to comply with the respective safety regulations!

Mechanical Dimensions

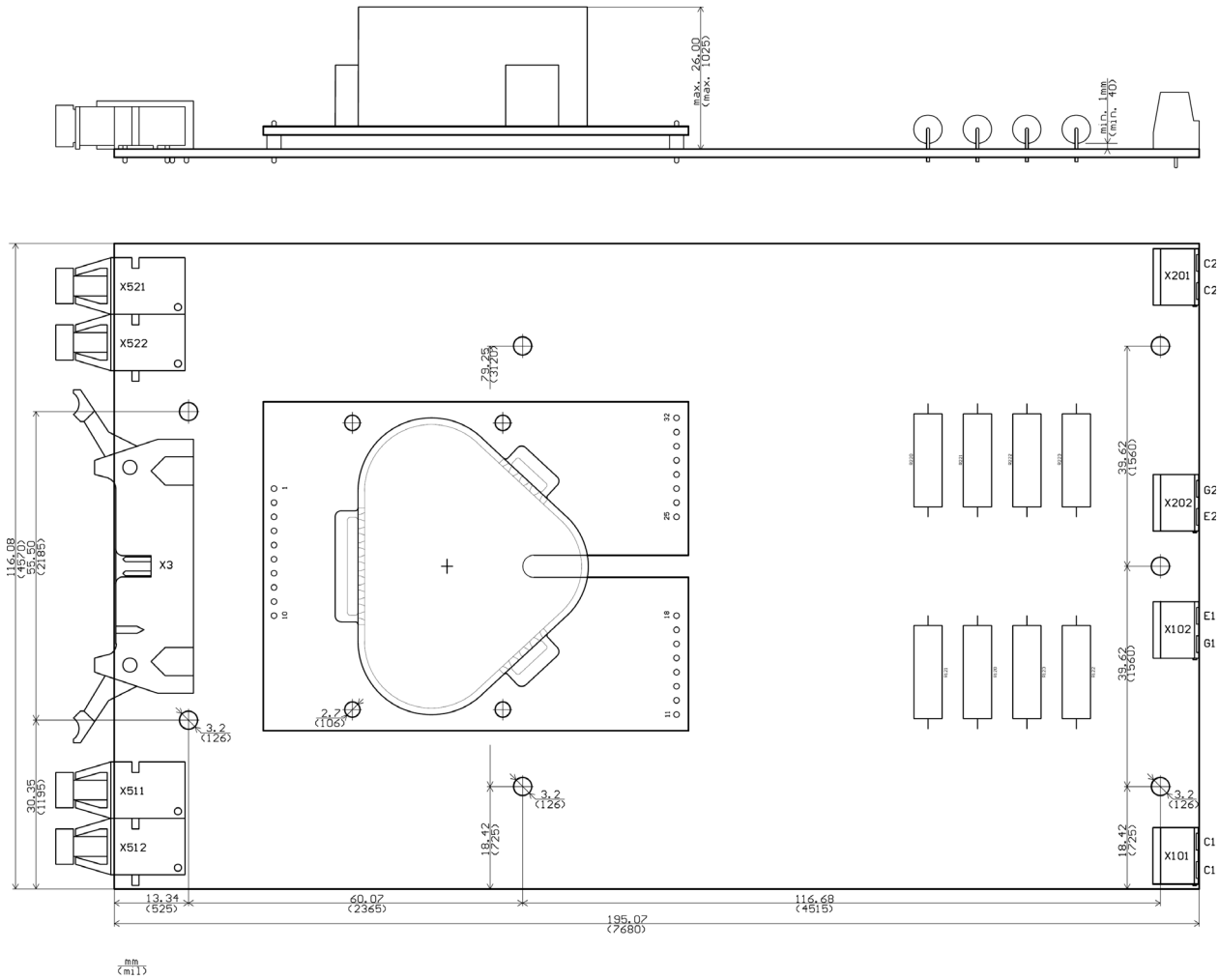

Fig. 3 Mechanical dimensions of 2BB0535T with 2SC0535T driver (top view)

Electrical connector X3 on the Base Board: 71922-120LF from FCI

Recommended cable connector for X3: 71600-020LF from FCI (matching with connector 71922-120LF)

Recommended twisted pair flat cable: 1700/20 or 2100/20 from 3M™

Recommended Assembly of Components (Primary Side)

Standard Assembly 2BB0535T2A0-xx (Delivered Driver Versions)

The standard assembly versions of 2BB0535T2A0-xx have both the electrical and the fiber-optic interfaces assembled:

- Electrical interface:
  - Input signals INA and INB
  - Status output signals SO1 and SO2
- Fiber-optic interface:
  - Fiber-optic input signal receivers: HFBR-2522Z (Versatile Link)
  - Fiber-optic status output transmitters: HFBR-1522Z (Versatile Link)

Electrical Interface

Several components can be saved in comparison to the delivered standard assembly of the 2BB0535T if only the electrical interface is required (e.g. customer-specific solution).

The recommended assembly is given in the BOM under the column: "Assembly Version", "Electrical".

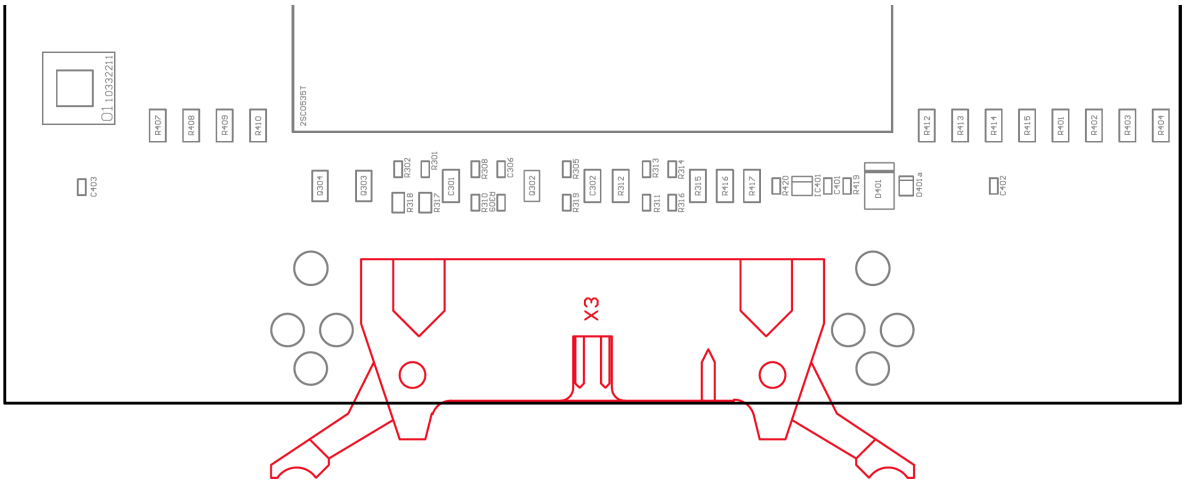

Fig. 4 Assembly drawing of primary side of the 2BB0535T with electrical interface X3

Fiber-optic Interface

Several components can be saved in comparison to the delivered standard assembly of the 2BB0535T if only the fiber-optic interface is required (e.g. customer-specific solution).

The following fiber-optic systems are supported within CONCEPT's Base Board:

- Versatile link receiver: HFBR-2522Z
- Versatile link transmitter: HFBR-1522Z

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- ST connector receiver: HFBR-2412Z (not assembled on the delivered versions)
- ST connector transmitter: HFBR-1412Z (not assembled on the delivered versions)

The recommended assembly is given in the BOM "Assembly Version: Versatile Fiber-Optic" and "Assembly Version: ST Fiber-Optic".

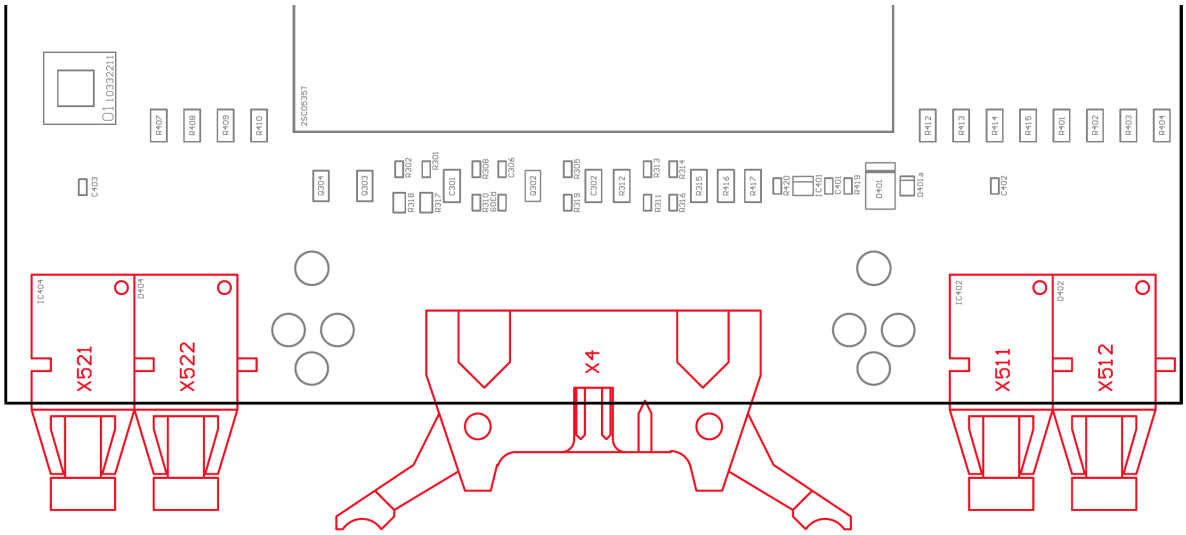

Fig. 5 Assembly drawing of primary side of the 2BB0535T with power supply connector X4 and versatile link interface X511, X512, X521 and X522 (assembly version: versatile fiber-optic)

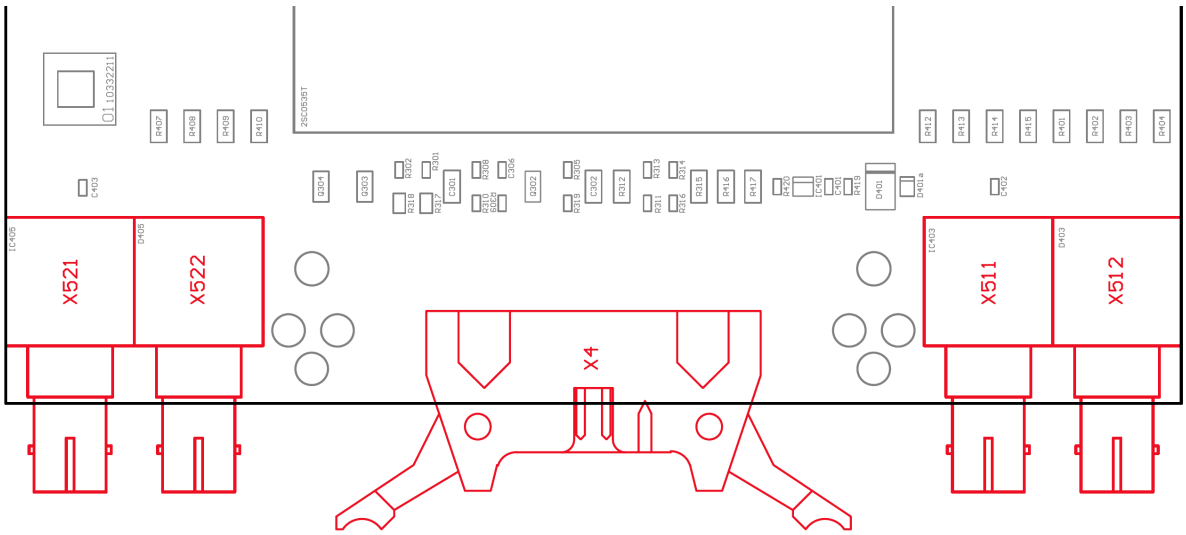

Fig. 6 Assembly drawing of primary side of the 2BB0535T with X4 and ST interface X511, X512, X521 and X522 (assembly version: ST fiber-optic)

Recommended Assembly of Components (Secondary Side)

Recommended components and component values are given in the bill of material included in the production documentation for the Base Boards. However, some components which depend on the voltage class of the power semiconductor used are marked with *** in the schematics and the bill of material. They are given below. If the Base Boards are ordered by CONCEPT, these components are already assembled.

Note that gate resistor and auxiliary gate capacitor values are not explicitly given as they depend on the power semiconductor used and on the application. The gate resistors as well as the auxiliary gate capacitors must be determined and assembled by the user.

2BB0535T2A0-17

The following components marked with *** in the bill of material are recommended:

D120…D121, D220…D221,	
D127...D128, D227…D228:	SMBJ150A (Fairchild) or SMBJ150A (General Semiconductor)
D122…D126, D222…D226:	SMBJ130A-E3 (Vishay) or SMBJ130A-TR (ST)
D129, D229:	SMBJ150CA (Fairchild) or SMBJ150CA (General Semiconductor)
R124…R143, R224…R243:	100k (CRCW1206 / 0.25W)
R101, R201:	68k (0603 / 1%)
R103, R203:	120k (0603 / 1%)
R105, R205	Not assembled
C104, C204:	33p (0603 / NP0, C0G / 50V / 5%)

2BB0535T2A0-25

The following components marked with *** in the bill of material are recommended:

D120…D121, D220…D221,	
D126…D128, D226…D228:	P6SMB250A (Diotec)
D122…D125, D222…D225:	P6SMB220A (Diotec) or SMBJ188A-E3 (Vishay)
D129, D229:	P6SMB250CA (Diotec)
R124…R143, R224…R243:	180k (CRCW1206 / 0.25W)
R101, R201:	68k (0603 / 1%)
R103, R203:	62k (0603 / 1%)
R105, R205	2200k (0603 / 1%)
C104, C204:	62p (0603 / NP0, C0G / 50V / 5%)

2BB0535T2A0-33

The following components marked with *** in the bill of material are recommended:

D120…D128, D220…D228:	P6SMB300A (Diotec)
D129, D229:	P6SMB300CA (Diotec)
R124...R143, R224...R243:	220k (CRCW1206 / 0.25W)
R101, R201:	22k (0603 / 1%)
R103, R203:	68k (0603 / 1%)
R105, R205	1000k (0603 / 1%)
C104, C204:	130p (0603 / NP0, C0G / 50V / 5%)

Assembly Drawing of Gate Resistors and Auxiliary Gate Capacitors

The turn-on and turn-off gate resistors of 2BB0535T Base Boards are not assembled. They must be assembled by the user.
Recommended gate resistors are CRCW1206 / 0.25W / 1% (SMD) from Vishay or PR03 / 3W / 5% (THT).

Recommended auxiliary gate capacitors are MLCC 1206 / X7R / 25V / 5% / -40°C…125°C

The component position (SMD) can be found in Fig. 7:

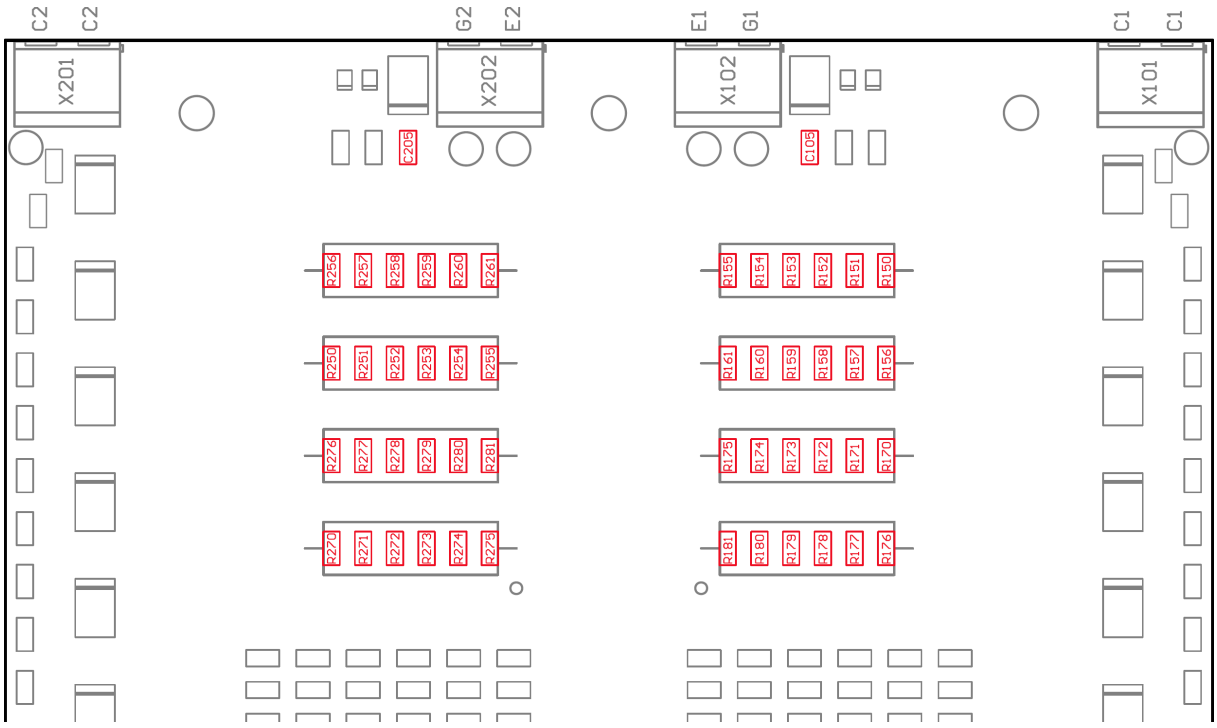

Fig. 7 Assembly drawing of the 2BB0535T with highlighted SMD gate resistors and auxiliary gate capacitors
Turn-on gate resistors: R170…R181, R270…R281
Turn-off gate resistors: R150…R161, R250…R261
Auxiliary gate capacitors: C105, C205 (SMD)

The component position (THT) can be found in Fig. 8:

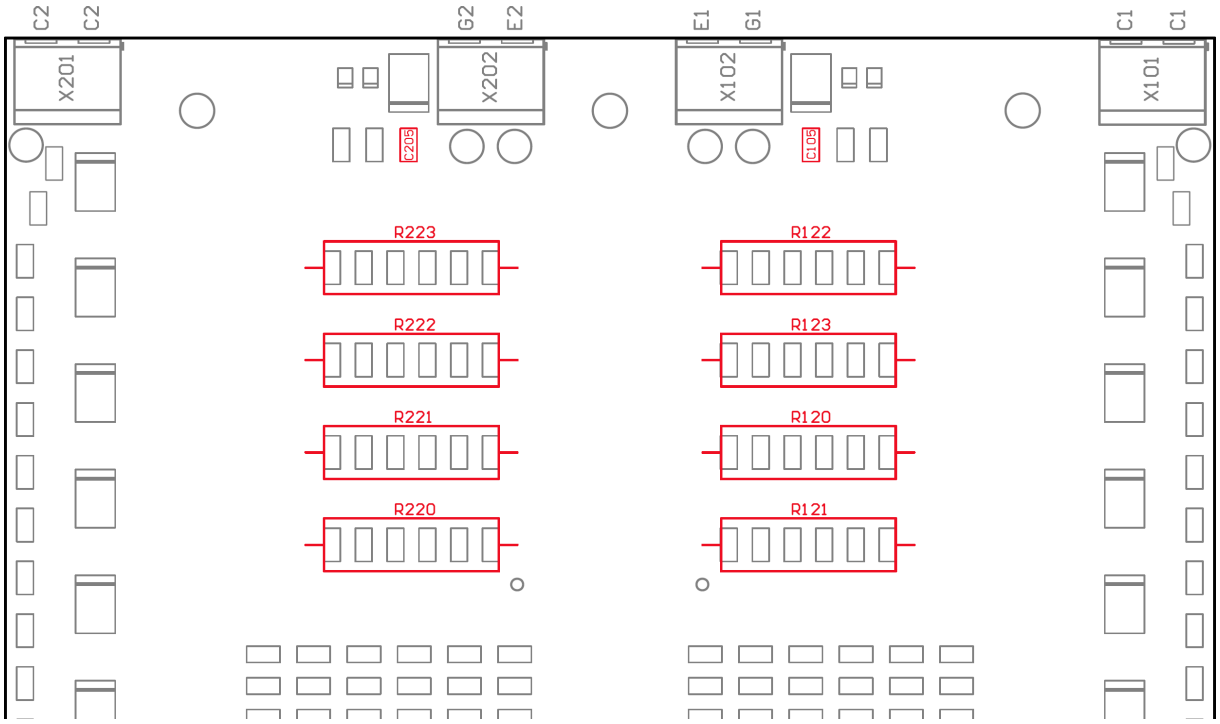

Fig. 8 Assembly drawing of the 2BB0535T with highlighted THT gate resistors and auxiliary gate capacitors
Turn-on gate resistors: R120…R121, R220…R221
Turn-off gate resistors: R122…R123, R222…R223
Auxiliary gate capacitors: C105, C205 (SMD)

A minimum distance of 1mm must be maintained between the gate resistor body and the PCB (see Fig. 9).

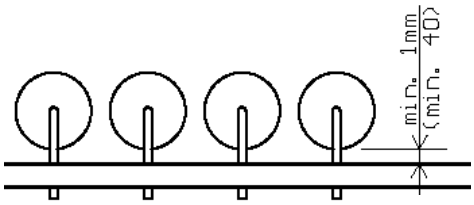

Fig. 9 Minimum distances when soldering THT gate resistors (in mm/mil)

Description and Pin Designation of Connectors X101, X102, X201 and X202

X101, X102, X201 and X201 are the output connectors used to connect the IGBT modules to Channel 1 (X101, X102) and Channel 2 (X201, X202) respectively.

Connector reference	Pin	Des.	Function
X101	1	C1	Collector of Channel 1
X101	2	C1	Collector of Channel 1
X102	1	G1	Gate of Channel 1
X102	2	E1	Emitter of Channel 1
X201	1	C2	Collector of Channel 2
X201	2	C2	Collector of Channel 2
X202	1	E2	Emitter of Channel 2
X202	2	G2	Gate of Channel 2

Pin Designation of Connector X3

Pin	Des.	Function	Pin	Des.	Function
1	VDC	+15V for DC/DC converter	2	GND	Ground
3	VDC	+15V for DC/DC converter	4	GND	Ground
5	VCC	+15V for primary side electronics	6	GND	Ground
7	VCC	+15V for primary side electronics	8	GND	Ground
9	SO2	Status output Channel 2	10	GND	Ground
11	INB	Signal input B (Channel 2)	12	GND	Ground
13	SO1	Status output Channel 1	14	GND	Ground
15	INA	Signal input A (Channel 1)	16	GND	Ground
17	MOD	Mode selection (direct/half-bridge)	18	GND	Ground
19	TB	Blocking time	20	GND	Ground

Recommended Interface Circuitry for Connector X3

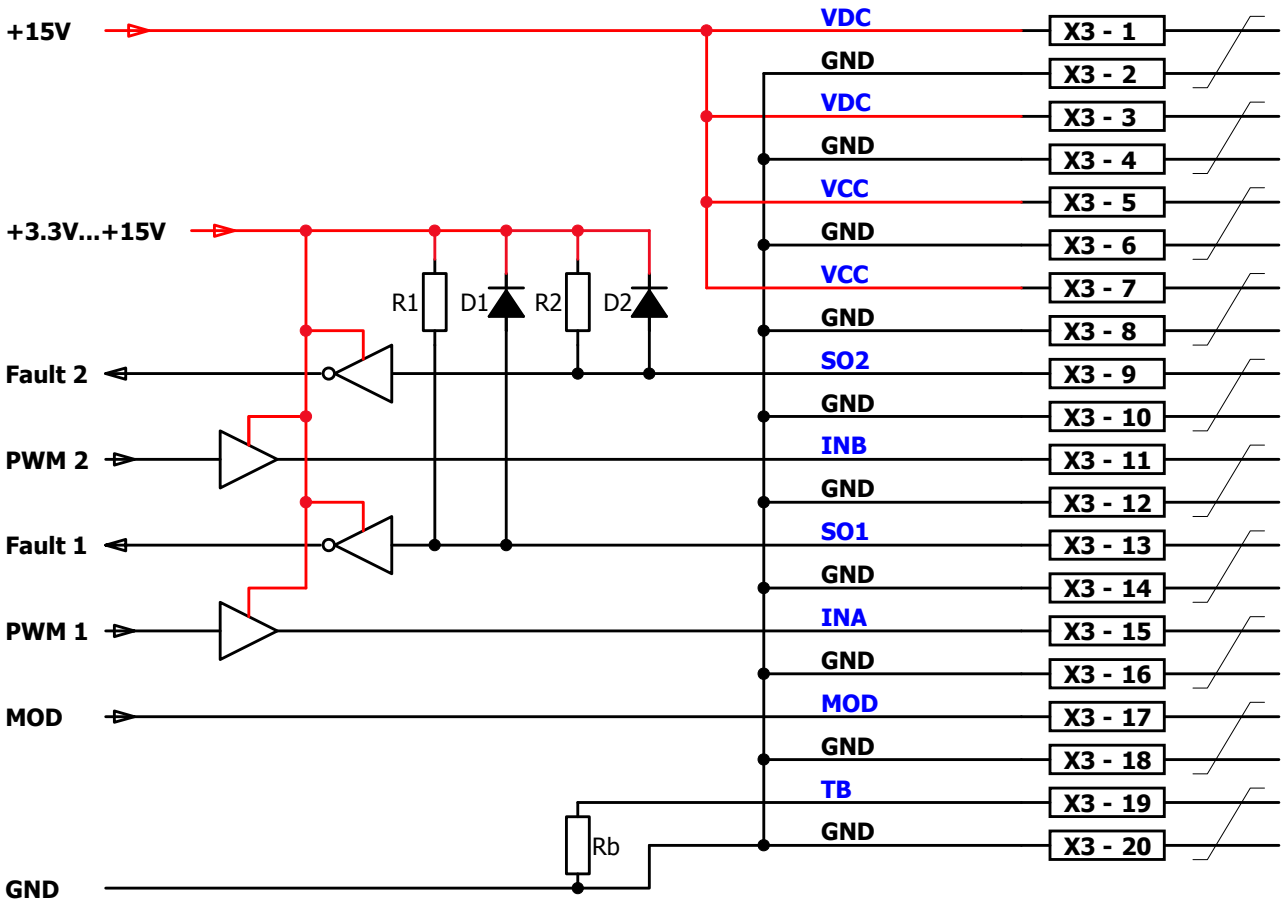

Fig. 10 Recommended user interface circuitry of the 2BB0535T with electrical interface

Description of Interface X3

General

The standard DIC20 interface X3 of the 2BB0535T Base Board is very simple and easy to use. It has the following terminals:

- 4 x power-supply terminals (but only one 15V power supply is needed)
- 2 x drive signal inputs
- 2 x status outputs (fault returns)
- 1 x mode selection (half-bridge mode / direct mode)
- 1 x input to set the blocking time

The Base Board is equipped with a 20-pin interface connector. All even-numbered pins are used as GND connections. The odd-numbered pins are used as inputs or status outputs. It is recommended to use a 20-pin twisted flat cable. Each input and output signal is then twisted with its own GND wire. All GND pins are connected together on the 2BB0535T Base Board and should also be connected on the control-board side. This arrangement produces a very low-inductance connection with high immunity against interferences.

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

VCC terminal

The driver has two VCC terminals on the interface connector to supply the primary side electronics.

VDC terminal

The driver has two VDC terminals on the interface connector to supply the DC-DC converters for the secondary sides.

All VCC and VDC terminals must be connected to a single +15V power supply. The driver limits the inrush current at startup, and no external current limitation of the voltage source for VDC is needed. The VDC and VCC terminals are split into separate pins only for testing.

MOD (mode selection)

The MOD input allows the operating mode to be selected.

Direct mode

If the MOD input is not connected (floating), or connected to VCC, direct mode is selected.

Half-bridge mode

If the MOD input is low level (connected to GND), half-bridge mode is selected. The dead time is set by a resistor on the 2BB0535T.

TB (input for adjusting the blocking time)

The terminal TB allows the factory-set blocking time to be reduced by connecting an external resistor to GND (see Fig. 10). The following equation calculates the resistor R_b connected between pins TB and GND in order to define the desired blocking time T_b (typical value):

$$R_b[k\Omega] = \frac{7650 + 150 \cdot Tb[ms]}{99 - Tb[ms]} - 6.8 \quad \text{where } 20\text{ms} < T_b < 90\text{ms}$$

The blocking time can also be set to a minimum of 9µs by selecting R_b=0Ω.

If not used, the input TB can be left open.

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

INA (Channel 1) and INB (Channel 2) are basically drive inputs, but their function depends on the MOD input. For details, see the section "MOD (mode selection)". They safely recognize signals in the whole logic-level range between 3.3V and 15V. They have built-in 4k7 pull-down resistors and Schmitt-trigger characteristics (see Base Board datasheets /4/ and driver core datasheet /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 and an internal pull-up resistor of 100kΩ. When no fault condition is detected, the outputs have Vcc level. When a fault condition (primary side supply undervoltage, secondary side supply undervoltage or IGBT short-circuit) is detected, the corresponding status output SOx goes to low (connected to GND).

The diodes D_1 and D_2 must be Schottky diodes and are mandatory when using 3.3V or 5V logic. They can be omitted for 15V logic.

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 accurate 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_b has elapsed (refer to "TB (input for adjusting the blocking time) and Base Board datasheet /4/ 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.

Pin Designation of Connector X4 (not available on the delivered driver versions)

Pin	Des.	Function	Pin	Des.	Function
1	VDC	+15V for DC/DC converter	2	GND	Ground
3	VDC	+15V for DC/DC converter	4	GND	Ground
5	SO	Status output (power supply)	6	GND	Ground
7	VCC	+15V for primary side electronics	8	GND	Ground
9	VCC	+15V for primary side electronics	10	GND	Ground

Recommended Interface Circuitry for Connector X4

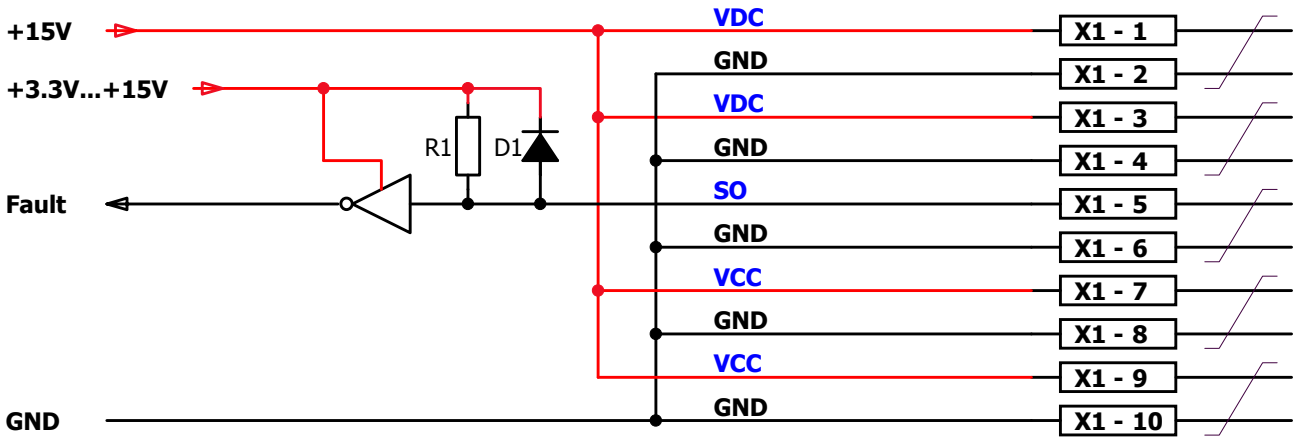

Fig. 11 Recommended user interface circuitry of the 2BB0535T with fiber-optic interface

Description of Interface X4

General

The driver can optionally be equipped with a 10-pin interface connector. All even-numbered pins are used as GND connections. The odd-numbered pins 1, 3, 7 and 9 are used for the +15V voltage supply. Pin 5 is used as a status output to monitor the supply voltage VCC.

It is recommended to use a 10-pin twisted flat cable. Pin 5 is then twisted with its own GND wire. All GND pins are connected together on the 2BB0535T Base Board and should be also connected on the control-board side. This arrangement produces a very low-inductance connection with high immunity against interference.

VCC terminal

The driver has two VCC terminals on the interface connector to supply the primary side electronics.

VDC terminal

The driver has two VDC terminals on the interface connector to supply the DC-DC converters for the secondary sides.

All VCC and VDC terminals must be connected to a single +15V power supply. The driver limits the inrush current at startup, and no external current limitation of the voltage source for VDC is needed. The VDC and VCC terminals are split into separate pins only for testing.

SO (status output power supply)

It is not recommended to use the SO status output additionally to the fiber-optic status outputs, as the primary side undervoltage (VCC) is already signalized to the fiber-optic status outputs. When a primary side undervoltage occurs, the lights of both fiber-optic status outputs immediately switch off.

It is recommended to keep the pin unconnected (floating).

However, if the SO status output is used, the following points have to be observed:

- When no power supply undervoltage of VCC is detected, the output SO has VCC level. An internal pull-up resistor of 100kΩ is connected to VCC. When a power supply undervoltage of VCC is detected, the status output SO goes to low (connected to GND).
- The diode D_1 must be a Schottky diode and is mandatory when using 3.3V or 5V logic. It can be omitted for 15V logic.
- The maximum SO current in a fault condition should not exceed the value specified in the driver data sheets /3/.

Note that the SO output is automatically reset about 90ms after the supply undervoltage fault disappears.

Description of Fiber-Optic Inputs

The fiber-optic connectors X511 (Channel 1) and X521 (Channel 2) are drive inputs. Half-bridge mode is supported if connector X3 is used.

Description of Fiber-Optic Outputs (status feedback)

The fiber-optic connectors X512 (Channel 1) and X522 (Channel 2) are status feedback outputs.

During normal operation (i.e. the driver is supplied with power at nominal voltage, and there is no fault anywhere), the status feedback is "light on" at the optical link. A malfunction is signaled by "light off".

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 fiber-optic output immediately and the light is switched off. The output is automatically reset (the light is turned on again) after a blocking time T_b has elapsed (refer to "TB (input for adjusting the blocking time)" and Base Board datasheet /4/ for timing information).

b) A supply undervoltage on the primary side is indicated to both fiber-optic outputs at the same time. Both outputs are automatically reset (the light is turned on again) when the undervoltage on the primary side disappears.

N.B. During power up, the status feedback will also show a fault condition until the supply undervoltage disappears.

How Do 2BB0535T Base Boards Work in Detail?

Overview

All drivers of the SCALE-2 driver family with an electrical interface are equipped with the usual protection functions such as V_{ce} monitoring for short-circuit protection, operation inhibit after fault, supply-undervoltage shutdown and status feedback.

Outstanding features of 2BB0535T Base Boards are:

- Possible use of both electrical and fiber-optic interface within one board
- Simple mounting - directly to the IGBT module via the interfaces X101/X102/X201/X202
- Very low propagation delay time (electrical interface)
- Blocking capacitance included for gate charges up to 47µC
- Dynamic Advanced Active Clamping (DA^2C) function

Active clamping describes an active scheme designed to protect the IGBTs against overvoltage during turn-off. It is particularly relevant when turning an IGBT off in cases of high DC-link voltage and collector current or short circuit. The 2BB0535T Base Boards also allow parallel operation of IGBT modules in order to increase the system power (see "Parallel connection of 2BB0535T" on page 21). This feature is however only possible with an electrical interface.

V_{ce} monitoring / short-circuit protection

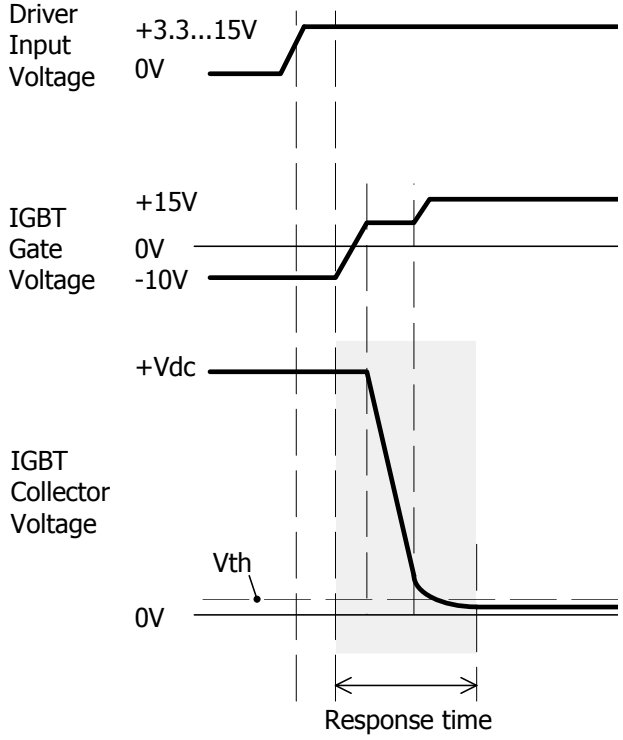

Fig. 12 *Turn-on characteristic of an IGBT*

The basic V_{ce} monitoring circuit implemented in 2BB0535T SCALE-2 Base Boards is illustrated in Fig. 2. Both IGBT collector-emitter voltages are measured with a resistor network. Vce is checked after the response time (see Fig. 12) at turn-on to detect a short circuit. If this voltage is higher than the programmed threshold Vth, the driver detects a short circuit at the IGBT and signals it immediately to the corresponding SOx output. The corresponding IGBT is immediately switched off. The IGBT is kept off (non-conducting) and the fault is shown at pin SOx as long as the blocking time is active.

The blocking time is applied independently to each channel. It starts when V_{ce} exceeds the threshold of the V_{ce} monitoring circuit.

It should be noted that the response time increases at DC-link voltages lower than about 1400V (2BB0535T2Ax-33), 1300V (2BB0535T2Ax-25) and 500V (2BB0535T2Ax-17) respectively. Please read the Base Board data sheet for timing information /4/.

Note: The desaturation function is designed for short-circuit detection only and cannot provide overcurrent protection. However, overcurrent detection has a lower time priority and can be easily provided by the application.

Dynamic Advanced Active Clamping DA^{2}C

Active clamping is a technique designed to partially turn on the IGBT in the event that the collector-emitter voltage exceeds a predefined threshold. The IGBT is then kept in linear operation. The basic circuit for active clamping can be found in /5/.

Basic active-clamping topologies implement a single feedback path from the IGBT collector through transient voltage suppressor devices (TVS) to the IGBT gate. 2BB0535T SCALE-2 Base Boards assembled with SCALE-2 driver core 2SC0535T support CONCEPT's Dynamic Advanced Active Clamping (DA^{2}C) based on this principle:

- When active clamping is activated, the turn-off MOSFET of the driver is switched off in order to improve the effectiveness of the active clamping and to reduce the losses in the TVS. This feature – called Advanced Active Clamping – is mainly integrated in the secondary-side ASIC.
- Additional transient voltage suppressors (TVS) have been added in series to the TVS required to withstand the maximum DC-link voltage under switching operation. These TVS are short-circuited during the IGBT on state as well as during about 15-20µs after the turn-off command to guarantee efficient active clamping. After this delay, these additional TVS are activated and allow the DC-link voltage to be increased to a higher value during the IGBT off-state (e.g. after emergency shut-down). This feature – together with Advanced Active Clamping – is called Dynamic Advanced Active

Clamping DA^{2}C. Note that the time during which the voltage can be applied above the value for switching operation should be limited to short periods (< 60 seconds).

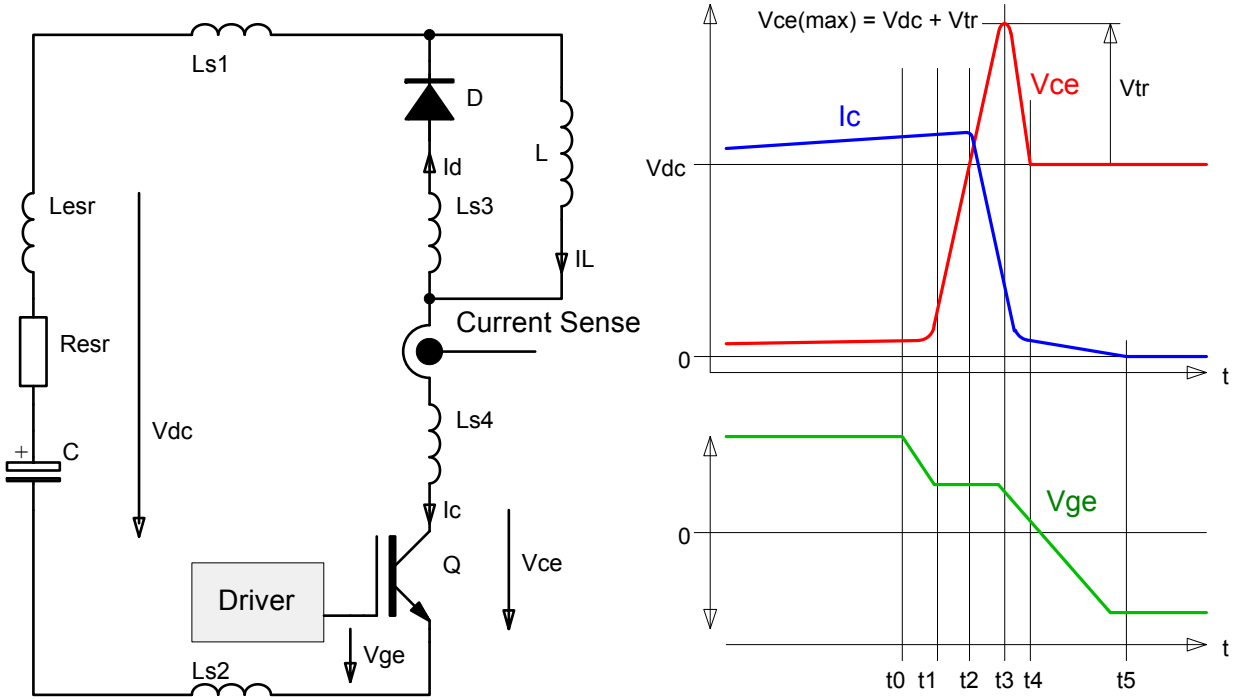

Fig. 13 Test circuit (left) and typical switching behavior (right)

Legend to Fig. 13

t0 = Initiation of the turn-off process

t1 = Start of turn-off time

t2 = Start of collector current fall time

t3 = Maximum collector voltage

t4 = IGBT is blocking, start of tail current

t5 = End of tail current

In comparison with other driving methods, active clamping allows enhanced utilization of the IGBT modules during normal operation by increasing the switching speed and therefore reducing switching losses. The overvoltage at fault-current turn-off is also managed by active clamping.

The value of the maximum DC-link voltage under switching operation and in the IGBT off state can be found in the Base Board data sheets /4/.

Parallel connection of 2BB0535T

If parallel connection of 2BB0535T Base Boards is required (only possible with electrical interface), please refer to application note AN-0904 /7/ on www.IGBT-Driver.com/go/app-note and to /6/.

3-level and multilevel topologies

If 2BB0535T Base Boards are to be used in 3-level or multilevel topologies, please refer to application note AN-0901 /8/ on www.IGBT-Driver.com/go/app-note.

Low-inductance layout

The active-clamping function should not lead users to forget about the inductances of the power stack. For several reasons, it is recommended to reduce the DC-link stray inductance to about 30nH…120nH depending on the IGBT modules used with 2BB0535T Base Boards.

Bibliography

/1/ "Smart Power Chip Tuning", Bodo's Power Systems, May 2007

/2/ "Description and Application Manual for SCALE Drivers", CONCEPT

/3/ Data sheets SCALE-2 driver core 2SC0535T, CONCEPT

/4/ Data sheets for 2BB0535T Base Board, CONCEPT

/5/ "Advantages of Advanced Active Clamping", Power Electronics Europe, November/December 2009

/6/ "Intelligent Paralleling", Bodo's Power Systems, March 2009

/7/ Application note AN-0904: Direct Paralleling of SCALE-2 Gate Driver Cores, CONCEPT

/8/ Application note AN-0901: Methodology for Controlling Multi-Level Converter Topologies with SCALE-2 IGBT Drivers, CONCEPT

Note: These documents are available on the Internet at www.IGBT-Driver.com

The Information Source: SCALE-2 Driver Data Sheets

CONCEPT offers the widest selection of gate drivers for power MOSFETs and IGBTs for almost all application needs. 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

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

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 application manual 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.

Target Description and Application Manual

Ordering Information

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

CONCEPT Base Board Type #	Related IGBTs
2BB0535T2A0-17	1700V IGBT modules
2BB0535T2A0-25	2500V IGBT modules
2BB0535T2A0-33	3300V IGBT modules

Note that the 2BB0535T2A0-xx Base Boards are delivered without a 2SC0535T driver, without gate resistors and without auxiliary gate capacitors.

For orders of 1000 items or more (per delivery), the Base Board can be assembled in a customer-specific version: assembly of the 2SC0535T driver and the required gate resistors and auxiliary gate capacitors as well as with user-specific input and status output control functionality (X4 instead of X3 assembly; X3 or X4 in vertical PCB assembly version; only electrical control unit components assembled; only fiber-optic control unit components assembled, …).

Product home page: www.IGBT-Driver.com/go/2BB0535T
Refer to www.IGBT-Driver.com/go/nomenclature for information on driver nomenclature

Information about Other Products

For drivers adapted to high-voltage or high-power IGBT modules

Direct link: www.IGBT-Driver.com/go/plug-and-play

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

Please click onto: www.IGBT-Driver.com

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