Features

Standard module for SwitcherGear

Three half-bridge interfaces, each with

> *two 15 V driver channels*
>
> *one active-low TRIP channel*
>
> *20-way header*

15 V power supply output for external gate drivers

> *short circuit protected*

Optional output for gate driver operating mode

Applications

Half-bridge gate drivers from Power Integrations and Semikron

3-phase voltage source inverter

Half-bridge

Full-bridge

Multi-level converters

Novel converter topologies

General Description

The CON002 module provides line driver channels and fault inputs that allows SwitcherGear to be connected to the gate drivers of power converters.

The CON002 module can be connected to various half-bridge gate drivers from Power Integrations and Semikron using 20-way ribbon cable.

The CON002 module can also be connected to a Semikron SemiTeach IGBT using 20-way ribbon cable and adaptors.

Ordering Information

Order Code	Description
CON002	SwitcherGear module, 3-phase converter interface, 20-way header
CON001	SwitcherGear module, 3-phase converter interface, screw terminal
CBL002/1.0	20-way ribbon cable, 1 metre long
CBL002/2.0	20-way ribbon cable, 2 metres long
ADP002/3	SwitcherGear accessory, kit of 3 half-bridge adaptors and driver supply cables, Semikron SemiTeach IGBT.
ADP002/4	SwitcherGear accessory, kit of 4 half-bridge adaptors and driver supply cables, Semikron SemiTeach IGBT.

Module Quick Start

1. **Set the configurable features.**

    Determine the feature settings that are required for the system under control. If necessary, change the default solder jumper settings. Refer to the Configuration section.

2. **Review the allocation of the MCU interface signals.**

    Confirm that the MCU interface signals connect to appropriate pins on the host MCU. Refer to your SwitcherGear configuration document and Table 3.

3. **Insert into the base slot.**

    Refer to your SwitcherGear configuration document for the location of modules.

4. **Connect the external wiring to the system connector.**

    Refer to Table 1 for the pin-out of the system connector.
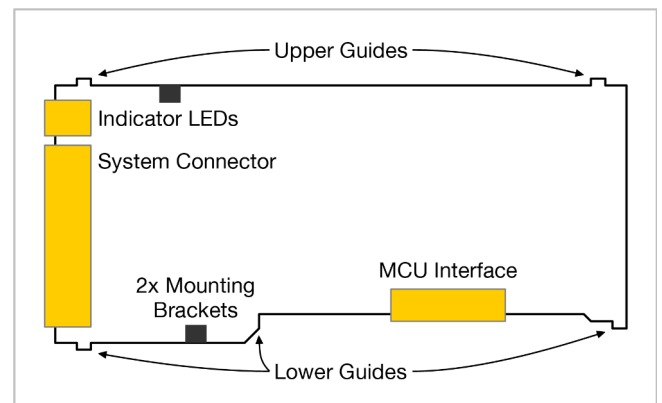
Standard Interfaces

Figure 1: Parts of a SwitcherGear module.

System Connector

The CON002 module has three 20-way headers that allow connections to be made to three half-bridges. The three header interfaces are designated HB1, HB2 and HB3. They are referred to generically as HBx.

Table 1 shows the pin-out of one 20-way header.

The connectors used for the headers are standard 2× 10-way pin headers with 2.54 mm pitch.

Indicator LEDs

Eight miniature indicator LEDs on the front panel show the status of the module. Refer to Table 2 for details.

Table 1: System connector, 20-way header HBx (x = 1, 2 or 3).

Pin	Signal	Description	Pin	Signal	Description
1	+15V	+15 VDC supply output.	2	COM	0 VDC supply output.
3	+15V	+15 VDC supply output.	4	COM	0 VDC supply output.
5	+15V	+15 VDC supply output.	6	COM	0 VDC supply output.
7	+15V	+15 VDC supply output.	8	COM	0 VDC supply output.
9	HBxTRIPn	Trip input from half-bridge.	10	COM	0 VDC supply output.
11	HBxCHB	Channel B driver output to half-bridge.	12	COM	0 VDC supply output.
13	HBxTRIPn	Trip input from half-bridge.	14	COM	0 VDC supply output.
15	HBxCHA	Channel A driver output to half-bridge.	16	COM	0 VDC supply output.
17	HBxMODE	Mode output.	18	COM	0 VDC supply output.
19	-	Not connected.	20	COM	0 VDC supply output.

Table 2: Indicator LEDs

Appearance	Left Column		Right Column	
	Colour	Description	Colour	Description
🟢 ⚪	Green	+15 V supply	-	-
🟢 🔴	Green	Half-bridge 1 driver channel A or B active	Red	Half-bridge 1 trip active
🟢 🔴	Green	Half-bridge 2 driver channel A or B active	Red	Half-bridge 2 trip active
🟢 🔴	Green	Half-bridge 3 driver channel A or B active	Red	Half-bridge 3 trip active

Table 3: MCU interface

Pin	Signal	Description
D0	HB1CHA	Channel A driver input for half-bridge 1. Active-high.
D1	HB1CHB	Channel B driver input for half-bridge 1. Active-high.
D2	HB1TRIPn	Trip output for half-bridge 1. Active-low.
D3	HB2CHA	Channel A driver input for half-bridge 2. Active-high.
D4	HB2CHB	Channel B driver input for half-bridge 2. Active-high.
D5	HB2TRIPn	Trip output for half-bridge 2. Active-low.
D6	HB3CHA	Channel A driver input for half-bridge 3. Active-high.
D7	HB3CHB	Channel B driver input for half-bridge 3. Active-high.
D8	HB3TRIPn	Trip output for half-bridge 3. Active-low.
D9	HB123TRIPn	Combined trip output for all half-bridges. This is the logical AND of the individual trip signals. Active-low.
D10	-	-
D11	-	-
A0	-	-
A1	-	-
A2	-	-
A3	-	-

MCU Interface

The MCU interface connects analogue and digital signals between the modules and the host MCU.

Refer to Table 3 for details of the digital and analogue signals provided by the MCU interface of this module.

Refer to the SwitcherGear Configuration Document for your specific SwitcherGear unit for information on the routing of signals between the installed modules and the host MCU.

Configuration

Mode

Each half-bridge interface of the CON002 module features a Mode output on pin 17. This output is used as a mode control input by some half-bridge gate drivers. The output can be configured using the MDx solder jumper for each HBx as shown in Table 4.

Table 4: Configuration of MODE outputs

Mode Output		MDx Jumper
Logic State	**Voltage**	
1 (default)	+15V	Open
0	COM	Short

By default the Mode outputs are pulled to the +15VOUT supply voltage by a 10 kΩ resistor.

Functional Description

Protection

The driver channel outputs and fault inputs are not galvanically isolated from the SwitcherGear. However, filtering and protection devices prevent external interference from affecting performance or damaging the module.

Unused driver channel outputs and fault inputs should be left open circuit.

Drive Channels

The CON002 module has six non-inverting driver channels. The outputs drive 0/15 V high-speed gate control signals along cables up to a few metres long.

The drive channels operate independently from each other and have no predetermined function regarding the converter topology being driven. The user is free to use them in any way that suits the application.

For example, in a typical application with a 3-phase voltage source inverter, the HB1CHA driver channel would conventionally be used to control the lower IGBT of the first half-bridge in the inverter. However, this driver channel could equally be used to drive any other IGBT in the converter, so long as the correct control signal is wired to the driver.

Alternatively, the function of the drive channels may be set by the external gate driver.

The CON002 provides no logic to detect or prevent simultaneous activation of drive channels A and B.

The driver channels are intended to be used with gate drivers that are active high, i.e. a logic high signal turns ON the IGBT. The CON002 module ensures that the driver outputs are low (inactive) during power up and power fail states.

FAULT SIGNALS

The CON002 module has three trip inputs. The inputs are designed to be connected to the open-collector fault outputs of a gate driver. Each input has a pull-up resistor, though the gate driver's fault output may already have one.

Some half-bridge gate drivers may have two fault outputs – one for each of the lower and upper IGBTs. In this case (and in general), multiple open-collector outputs can be connected in parallel and connected to one fault input on the CON002 module.

External Power Supply

The CON002 module has a 15 V supply than can be used to power external gate drivers. The supply on each half-bridge interface is independently protected against short-circuit and over-current faults by a resettable fuse.

Applications Information

External Wiring

Ribbon cable (known as IDC – insulation displacement cable) should be used to connect from the CON002 module headers to the converter gate drivers. Consult ordering information for suitable cables.

Alternatively, the cables are relatively simple to make yourself:

- Use standard 2× 10-way receptacles with 2.54 mm pitch.
- Use ribbon cable with 1.27 mm pitch.
- The coloured stripe on the ribbon cable should align with the pin 1 marking on the receptacle. This marking is typically a line or arrow.
- The header and receptacle pairing is polarised. Ensure that the cable leads away from the connector is the correct direction.
- Use a strain relief to protect the cable/connector connection. Note that using a strain relief inverts the cable direction.
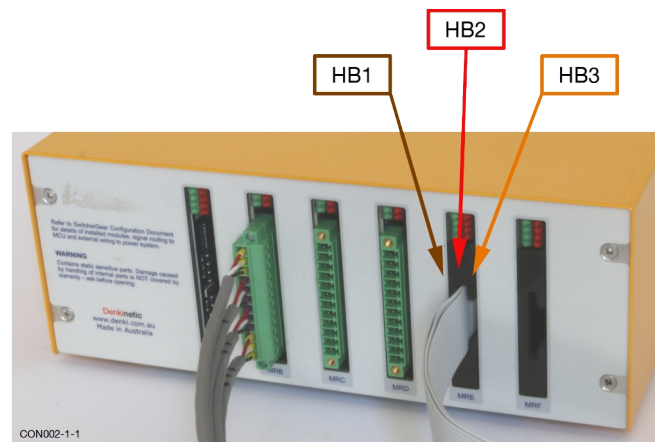
Figure 2: Identification of ribbon cables from CON002 module.

IGBT Gate Drivers from Power Integrations

The HBx headers are the same as those used on various half-bridge gate drivers and target boards from Power Integrations. A simple 20-way ribbon cable can be used to connect between the CON002 module and the gate driver.

For these gate drivers, the function of driver channels A and B is set by the Mode signal on pin 17 of the header and the MDx solder jumpers, as shown in Table 5.

Table 5: Configuration of MODE for Power Integrations gate drivers.

Operating Mode	MDx Jumper
Direct (default)	Open
Half-bridge	Short

In the direct operating mode, the HBxCHA and HBxCHB signals control the channel 1 and 2 gate drivers, respectively, as shown in Table 6.

Table 6: Function of driver channels for Direct Mode for Power Integrations gate drivers.

HBx Channel	Channel Function	Gate Driver State with channel logic...	
		0	**1**
A	Gate driver 1	Driver 1 OFF	Driver 1 ON
B	Gate driver 2	Driver 2 OFF	Driver 2 ON

In the half-bridge operating mode, the HBxCHA signal is a PWM input and the HBxCHB signal is an enable signal, as shown in Table 7.

Table 7: Function of driver channels for Half-Bridge Mode for Power Integrations gate drivers.

HBx Channel	Channel Function	Function State with channel logic...	
		0	**1**
A	PWM input	Driver 1 OFF Driver 2 ON	Driver 1 ON Driver 2 OFF
B	Enable input	Driver 1 OFF Driver 2 OFF	Enable PWM input

Consult manufacturer manuals for individual gate drivers and target boards for more detailed information.

IGBT Gate Drivers from Semikron

The HBx headers are compatible with "Skyper 12 press-fit C" gate drivers from Semikron. A simple 20-way ribbon cable can be used to connect between the CON002 module and the gate driver.

The Semikron gate driver does not use the MODE signal and the two driver channels are intended to rive two power devices in the half-bridge configuration. The gate driver prevents both power devices from being ON at the same time and enforces a dead-time between the driver channels.

Consult the Semikron datasheet for detailed information.

Host MCU

Texas Instruments C2000

The signals for the driver channels A and B will typically be generated by the ePWM peripherals.

For IGBTs that are operated in pairs in a half-bridge configuration, channels A and B should be mapped to the EPWMxA and EPWMxB peripheral I/O signals of a single ePWMx module. The dead-band generator sub-module of the ePWMx should be used to generate the required complementary gate drive signals with dead-time.

The TRIPn output signals of the CON002 module should be mapped to one of the $\overline{TZy}$ peripheral I/O signals. The trip-zone sub-module of ePWMx should be configured to enable one-shot trips on a $\overline{TZy}$ event and force to low each PWM output (i.e. turn off each associated IGBT). Note that multiple ePWM modules can be configured to be tripped by a single $\overline{TZy}$ input. Also, each ePWM module can be configured to be tripped by multiple $\overline{TZy}$ inputs.

Consult documentation for the host microcontroller for detailed information about how to configure the PWM resources.

Warnings

⚠ The length of cables connected to the module front panel connector must not be longer than 3 m.

⚠ The user is responsible to ensure that the cables and connectors used for external wiring have insulation and/or separation distances that provide isolation from live parts and from earth.

⚠ The user is responsible to ensure that cables and connectors used for external wiring that carry live voltages have insulation and/or separation distances that provide protection against indirect contact.

⚠ The user is responsible to ensure that the installation provides protection against direct contact.

⚠ This module provides no interlock mechanism to prevent simultaneous turn-on of the lower and upper IGBTs in a half-bridge.
The user is responsible to ensure that PWM peripherals are configured to generate complementary gate signals with appropriate dead-time.

⚠ This Module does not provide galvanic isolation between SwitcherGear and the power system under control. An appropriate isolated IGBT driver must be used to drive the IGBTs.

Electrical Characteristics

The following specifications apply for V_{DC} = 24 V, T_A = 25 °C.

Parameter	Conditions	Min	Typ	Max	Unit
DRIVER CHANNELS					
Logic 0 Output Voltage	No load			0.025	V
Logic 1 Output Voltage	No load	V_{DD} – 0.025			V
Output Resistance	I_{OUT} = 10 mA		110	115	Ω
Delay Time, Rising	C_L = 1 nF		40	60	ns
Delay Time, Falling	C_L = 1 nF		40	60	ns
FAULT CHANNELS					
Low-Level Input Voltage		0		1.6	V
High-Level Input Voltage		4.0		V_{DD}	V
Open-Circuit Voltage			10		V
Input Resistance			6.7		kΩ
Delay time, falling	Open-collector drive to 0 V			500	ns
EXTERNAL SUPPLY					
Output voltage, V_{DD}		14.6	15.0	15.4	V
Source Resistance	Per half-bridge			1.0	Ω
Output Current	Up to 60 °C, per half-bridge	0.3			A
Short-Circuit Current	Protection active, per half-bridge			0.04	A

Release History

Release	Date	Changes From Previous Release
1	16 Apr 2014	▪ Original release.
2	17 Oct 2014	▪ Updated naming and format.
3	20 Sep 2017	▪ Updated to SwitcherGear.
4	10 Mar 2021	▪ Updated references to 3rd party gate drivers. ▪ Added image to identify ribbon cables.