Typhoon HIL®

HIL Connect

Effortlessly Validate your Power Electronics Controllers, No Modifications Needed.

www.typhoon-hil.com

Interfacing Made Simple

Streamlining Controller Interfacing

Comprehensive signal conditioning integrated with Hardware-in-the-Loop (HIL) solutions, enable rapid and thorough validation of power electronics controllers. Utilizing HIL reduces delays, risks, and costs associated with traditional hardware testing. Typhoon HIL Connect acts as an essential intermediary between the HIL Simulator and controller, ensuring seamless compatibility and reliable performance.

HIL Connect is tailored to support a variety of controller interfaces, accommodating different signal types expected by the Device Under Test (DUT). With its modular architecture, HIL Connect enables rapid customization of I/O interfaces, ensuring seamless connection between the HIL Simulator and the DUT. All current, voltage, and optical I/O interfaces accurately mimic real power stage signals, allowing the DUT to operate as if it were part of an actual system.

Introducing the HIL Connect

HIL Connect is a card-based, 19-inch rack-mount signal-conditioning device capable of conditioning one row of HIL I/O (up to 32 x AO, 16 x AI, 32 x DO, 32 x DI). With eight card slots, it offers versatile configurations to meet various project requirements, with different cards providing different interfacing options. These cards are expansion modules that extend HIL capabilities through analog, digital, or communication I/O channels, adjusting voltage and current levels as required by the application.

HIL Connect ensures that the control signals and sensor measurements obtained from the simulation align with the DUT's expectations in real-world scenarios.

A true plug-and-play device

HIL Connect features a plug-and-play architecture with connector headers commonly used in real-world applications, including terminal blocks, BNC connectors, and custom connectors. This compatibility allows users to quickly connect the system to production-grade controllers, facilitating rapid testing and reducing certification risks.

Emulation capability

- Current sensors
- Voltage sensors
- Fiber optic transceivers
- Relays and contactors
- Temperature sensors
- Battery cells

Technical Specifications

HIL Connect offers a diverse array of inputs and outputs, encompassing analog voltage and current signals, digital signals, power, and optical signals. Its extensive range of voltage and current values ensures suitability for a wide spectrum of applications and products, from microgrids to electric vehicles. Additionally, all I/O ports feature short-circuit and overvoltage protection.

Analog current outputs	**Low current outputs**	**2A RMS current outputs**	**5A RMS current outputs**
Channels per slot	32	8	4
Output range	±20 mA	±2.82 A	±7.071 A
Compliance range	±10 V	±1.5 V	±1.5 V
Bandwidth	100 kHz	50 kHz	50 kHz

Analog voltage outputs	**Low voltage outputs**	**High voltage outputs**
Channels per slot	32	8
Output range	±10 V	±183.3 V
Compliance range	±40 mA	±1 mA
Bandwidth	100 kHz	10 kHz

Analog inputs	**Low current inputs**	**Mains current inputs**	**Mains voltage inputs**	**Low voltage inputs**
Channels per slot	16	8	8	16
Input range	±40 mA	±20 A	±600 V	±10 V
Input resistance	~16.5 Ω	~2 mΩ	1.2 MΩ	100 kΩ
Bandwidth	100 kHz	20 kHz	20 kHz	100 kHz

Analog I/O accuracy	**Low voltage inputs and outputs**	**Low current inputs and outputs**	**2A RMS current outputs**	**5A RMS current outputs**
	<1 mV ±0.1% FS	<0.1 mA ±0.1% FS	<10 mA ±0.5% FS	<20 mA ±0.8% FS

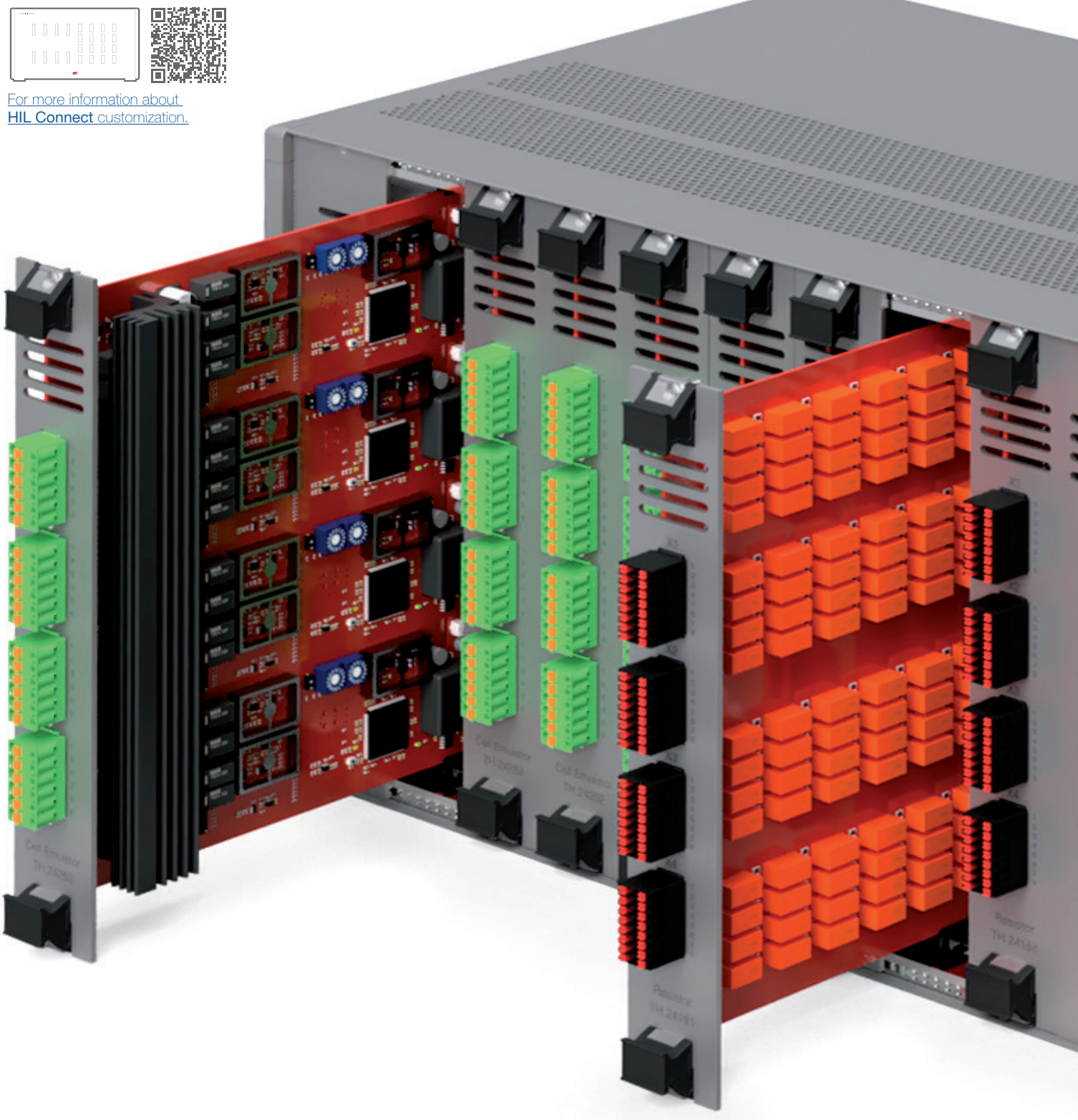
Digital voltage I/O	**Voltage digital inputs**	**Voltage digital outputs**
Channels per slot	32	32
Logic levels	3.3 V - 24 V (Universal Inputs)	3.3 V, 5 V, 15 V, 24 V (Selectable)
Resistance	100 kΩ (VI < 5.1 V), 1 kΩ (VI > 5.1 V)	~20 Ω

Optical I/O	**Optical inputs**	**Optical outputs**
Channels per slot	16	16
Coupling	1mm POF	1mm POF
Data rate	50 MBd/s Receiver	50 MBd/s Transmitter

Power	*Dependent on card selection, see table on page 7

Selecting the best cards for your application

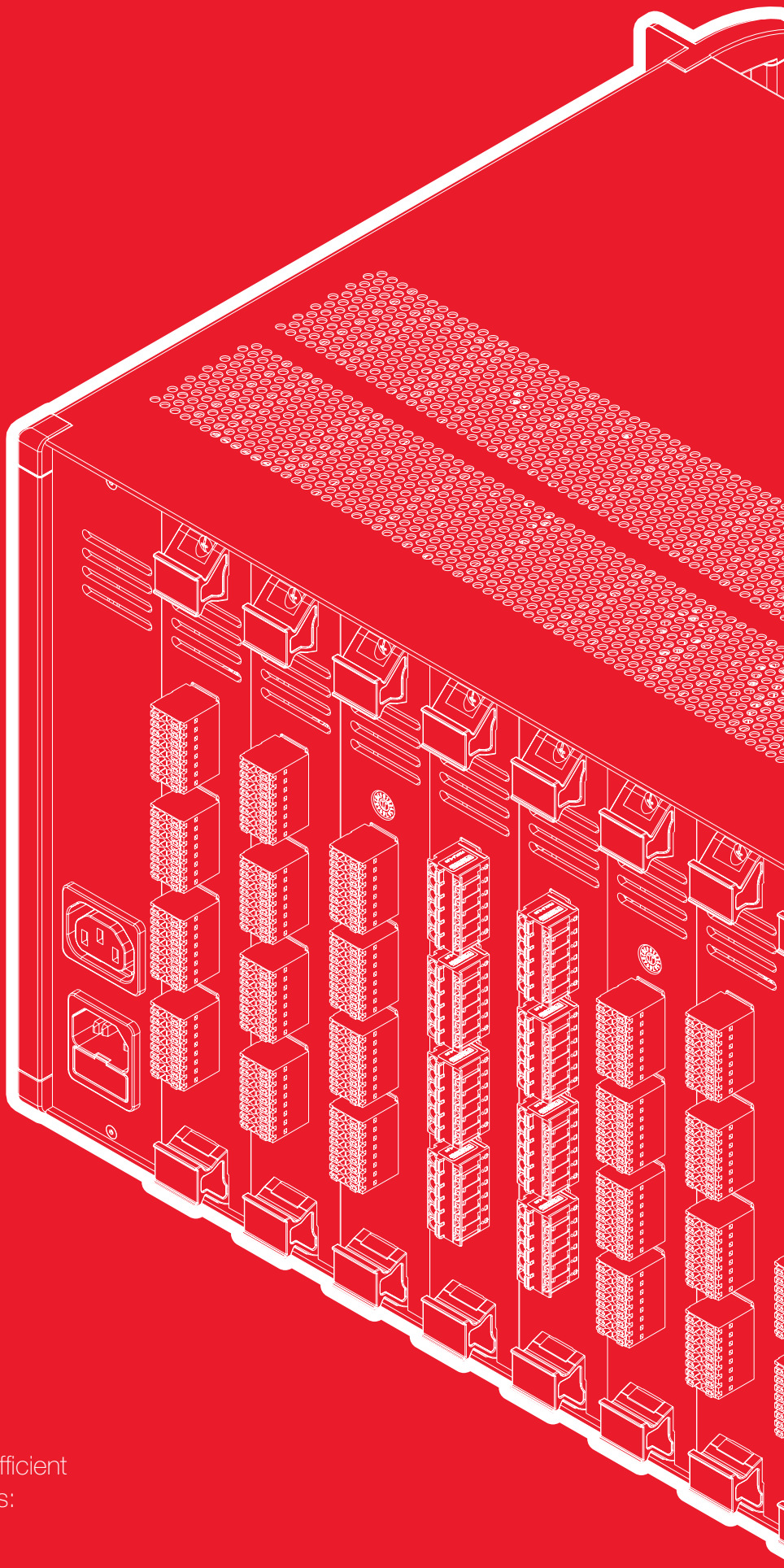
When designing the interface between your DUT and the HIL Simulator, Typhoon HIL provides a variety of off-the-shelf cards. Our highly experienced engineers are available to assist you in selecting the optimal interface cards for your HIL Connect configuration, tailored to your application's needs. You can ensure comprehensive coverage based on the system requirements, such as analog and digital I/O, signal types, voltage and current levels, connectors, and power supplies. Subsequently, your HIL Connect will be equipped with the necessary cards, connector headers, and cables to align with your device's I/O specifications.



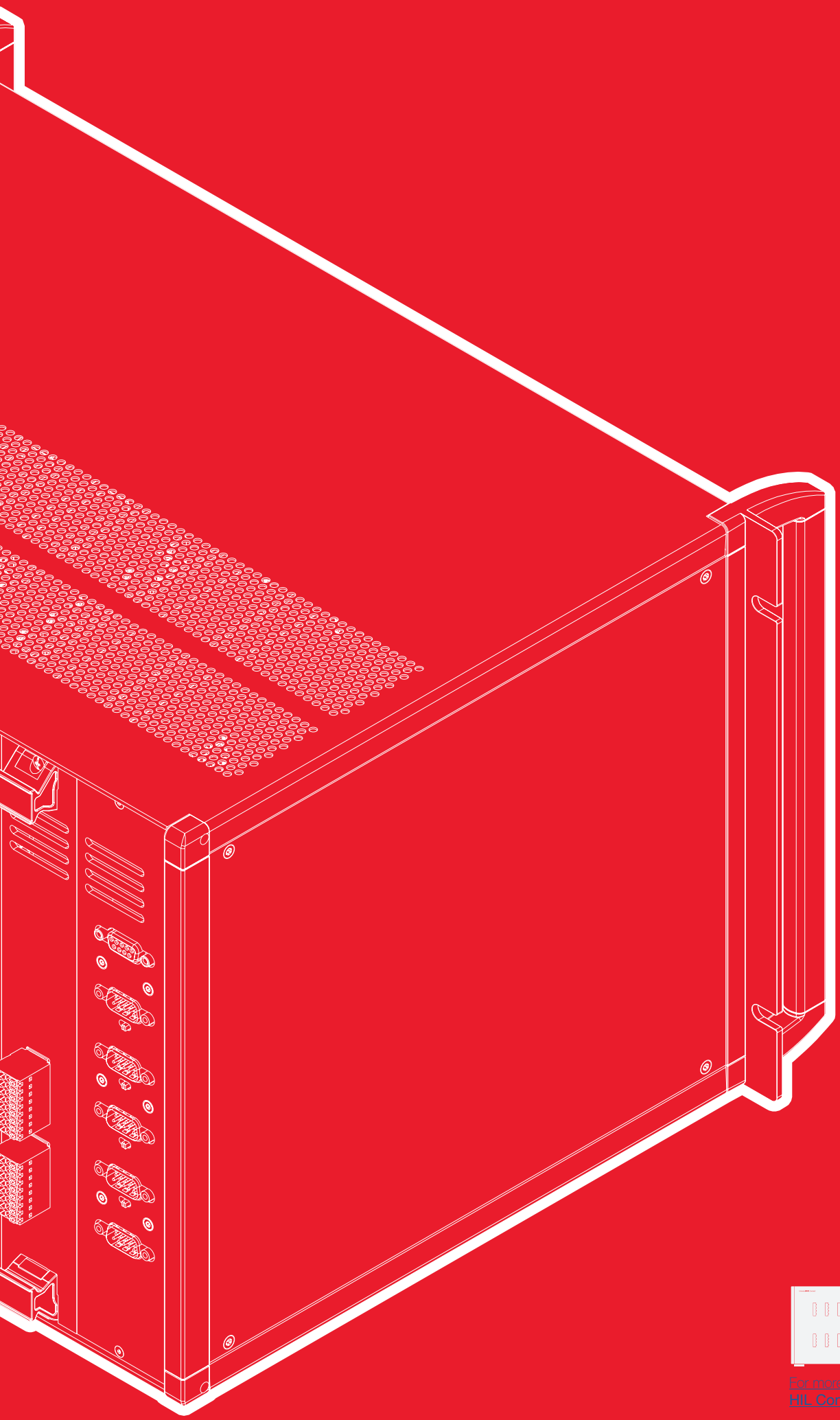
For more information about **HIL Connect** customization.

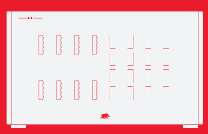
HIL Connect

Typhoon HIL standard HIL Connect card portfolio includes cards suitable for **industrial, grid, e-Mobility,** and **BMS** applications.



BMS Interface configuration enables efficient testing of all key BMS functions, such as: accuracy of cell voltage measurements, balancing algorithm verification, and cell temperature and battery current measurement. All these are key parameters for accurate estimation of battery SOC, SOP, and SOH.





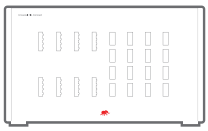
For more information on available
HIL Connect interface cards.

Interface Cards

A variety of HIL Connect cards are at your fingertips

The HIL Connect device features eight slots that allow you to integrate cards with specific interface capabilities. Each HIL Connect card has a corresponding Typhoon HIL Control Center (THCC) software component that simplifies the configuration process, ensuring seamless operation with your model. Moreover, some cards can be configured at the hardware level by toggling internal DIP switches.

Our standard HIL Connect card portfolio includes cards suitable for **industrial, grid, e-Mobility, and BMS applications.**



For more information on available HIL Connect interface cards.

Available HIL Connect interface cards

Analog input and output cards

In the analog input card, each input can be configured for voltage or current mode, with an input signal range of ±10 V or ±40 mA and an output signal level of ±10 V, with an input resistance of 100 kΩ / ~16.5 Ω. Meanwhile, in the analog output card, each output can be configured for voltage or current mode, showing an input range of ±10 V and an output range of ±10 V or ±20 mA, with a load range of >500 Ω to voltage mode or <500 Ω to current mode. Additionally, they have an accuracy of 1 mV ± 0.1% FS in voltage mode or 0.1 mA ± 0.1% FS in current mode and bandwidth (-3 dB) ranging from DC signals to 100 kHz.

Digital input and output cards

The digital input card is versatile and can support high and low-bandwidth applications. It has an input range of 3.3 V to 24 V and an output range of 5 V. On the other hand, the digital output card has an input range of 5 V and an output range of 3.3 V, 5 V, 15 V, or 24 V. Which can be selected using switches on board in groups of 8 channels.

Resistor emulator card

Emulates varying resistance in a system using a ladder resistor networks. It has eight isolated channels. The resistors are controlled from a HIL device via CAN, with the update rate down to 1 ms.

Fault insertion card

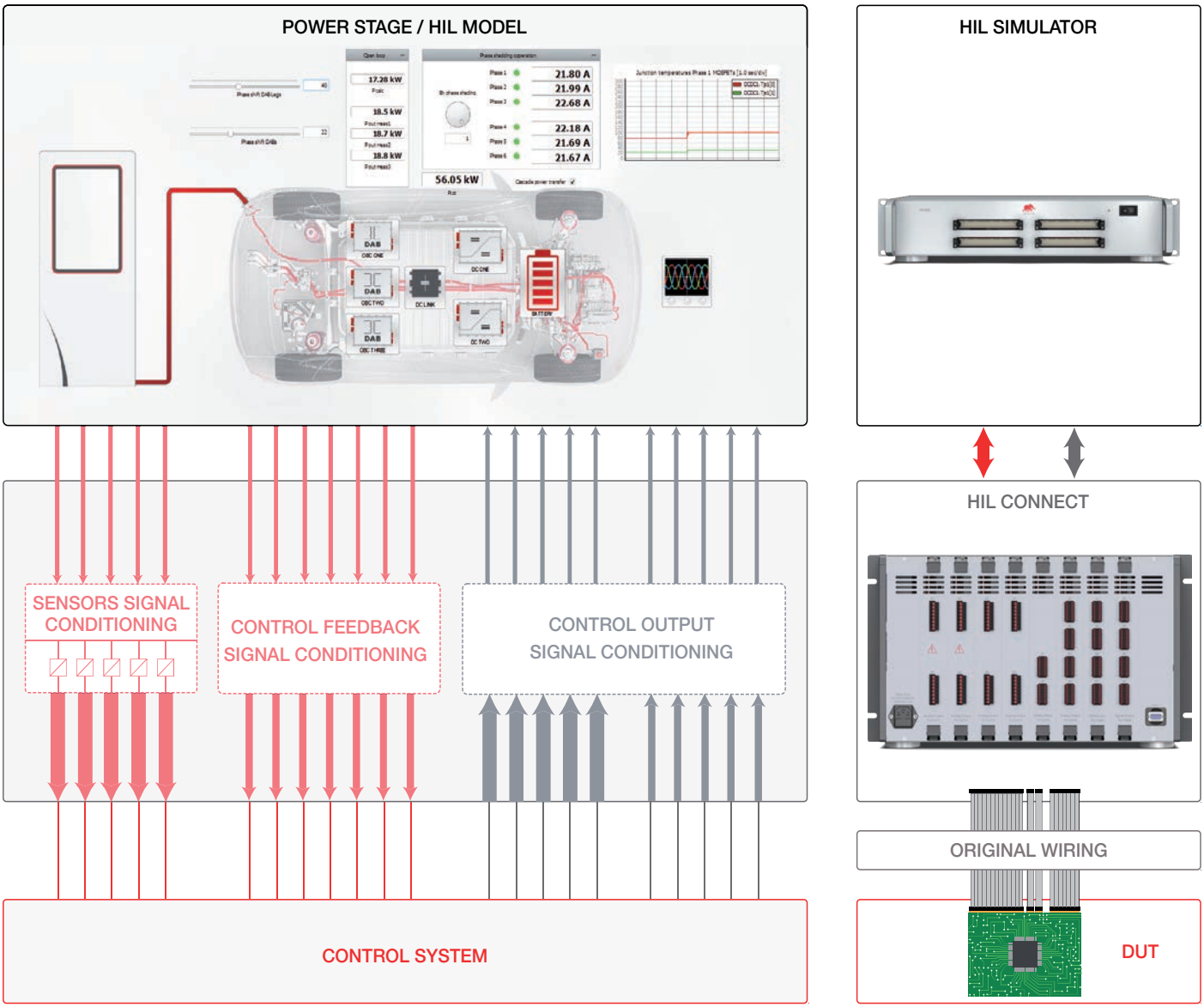
This card simulates fault conditions in a system through a relay network. It features 12 channels, each with four signal terminals and one fault terminal. Each channel can handle up to 100V and 5 A and simulates a range of faults, including open circuits, short circuits between in terminals or out terminals, and short circuits to an external signal fed to the fault terminal. The relays can be controlled from a HIL device via CAN, with the update rate down to 1 ms.

Card name	I/O type	# of channels	Input rating	Output rating	User-available hardware settings
High Voltage	Analog output	8	±10 V	±183.3 V	Drive channel selection, in groups of 8
Current Output	Current output	8	±10 V	±2.82 A	Drive channel selection, in groups of 8
Analog Input	Analog input	16	±10 V or ±40 mA	±10 V	Voltage or current mode selection
Analog Output	Analog output	32	±10 V	±10 V / ±20 mA	Voltage or current mode selection
Digital Input	Digital input	32	universal 3.3 V to 24 V	5 V	-
Digital Output	Digital output	32	5 V	3.3 V, 5 V, 15 V, or 24 V	Output voltage selection (Revision 2.6 and up)
Smart Cell Emulator	Cell emulator	4	CAN FD Message	0 - 8 V, ±1 A	CAN ID selection
Thermistor Emulator	Resistor Emulator	6	CAN Message	0 - 655 kΩ	CAN ID selection
Isolation Resistance Emulator	Resistor Emulator	2	CAN Message	0 - 65 MΩ	CAN ID selection
Shunt Emulator	Analog Output	2	±10 V	±250 mV	Drive channel selection in groups of 2
BMS Digital	Digital I/O	16x optically isolated voltage input, 16x relay output	3 - 100 V	5 A relay contact	-
BMS Analog Output	Analog output, PSU	16 x AO, 2 x PSU	±10 V	±10 V analog output; 24 V and 5 V PSU	-
CAN Resistor Emulator	Resistor emulator	8	CAN message	0 - 655 kΩ	CAN ID selection
CAN Relay DO	Digital output	32	CAN message	0 - 100V	CAN ID selection

Standard Configuration

Specific resistances must be used to calculate the motor's temperature so that the electric vehicle can receive appropriate signals. Moreover, it is essential to ensure that the DUT is properly powered and receiving all connections and that fortified communication is established.

Empowering e-Mobility testing



Standard e-Mobility configurations for your solutions

e-Drive

The e-Drive HIL Connect configuration covers a diversity of signal types and ranges. Beyond adding ancillary signal type support, this configuration offers broader voltage level support and configurable logic level digital IO cards.

- **Slot A |** Analog Input Card (16ch, ±24V)
- **Slot B |** Analog Output Card (32ch, ±24V)
- **Slot C |** Digital Input Card (32ch, universal 3.3 V to 24 V)
- **Slot D |** Digital Output Card (32ch, 3.3 V, 5 V, 15 V, or 24 V)
- **Slot E |** Resistor Emulator Card (8ch, 0 - 655 kΩ)
- **Slot F |** CAN Relay DO Card (32ch, 100 V)
- **Slot G |** ACE Card (CAN, LIN, SPI, SENT, FlexRay)

BMS Interface

The BMS Interface Configuration consists of the essential cards required as the building blocks of a BMS HIL Testbed.

- **Slot A-F |** Smart Cell Emulator Card (4ch each, 0 - 8 V, ±1 A)
- **Slot G |** Thermistor Emulator Card (6ch, 10 kΩ NTC Thermistor)
- **Slot H |** Shunt Emulator Card (2ch, ±250 mV)

This configuration enables efficient testing of all key BMS functions, such as: accuracy of cell voltage measurements, balancing algorithm verification, and cell temperature and battery current measurement. All these are key parameters for accurate estimation of battery SOC, SOP, and SOH.

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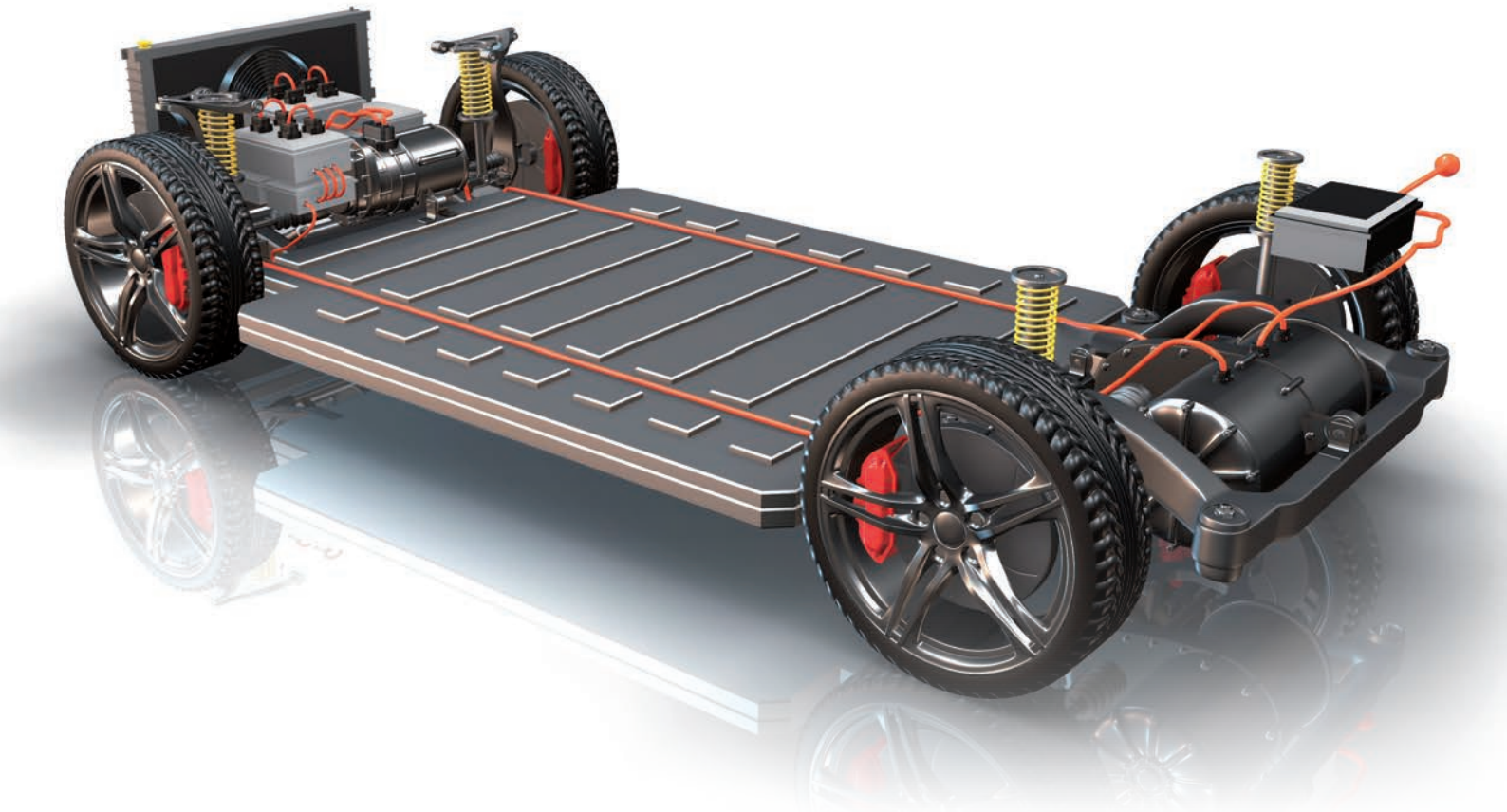
AVL list validates their e-storage test equipment with HIL.

Owing to the ability to port the controller algorithm early to the real target hardware, a large number of issues—especially in control hardware configuration—can be resolved prior to system integration. This results in significant development time and cost savings.

Read more:

Dr. Roland Greul
Head of Department at AVL

Typhoon HIL®



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