Intelligent Vehicle Controls

CL-4002

User Manual

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CL-4002

OVERVIEW

Designed for the Vocational, Construction and Military markets, HED's CL-4002 is a highly programmable small to-mid-size microcontroller that offers high speed processing and large memory capacity along with configurable I/O.

CORE FEATURES

- J1939 and CANopen communication
- CANopen Client standard offering
- Custom application development with C-Code
- (16) 5A Digital / PWM Outputs with Constant Current Control
- Optional Constant Current Control of Outputs
- Software configurable I/O (Inputs: Digital, Analog, Frequency; Output pins configurable as inputs)
- IP67 and IP6K9K seal rating
- -40C to +85C operating temperature

USER NOTICES

Typical Use

The specifications contained herein represent all possible configurations for this product family. The actual configurations available on each module may be a subset of this specification. Please refer to the module-specific datasheet for the connector pinout and configurations that are available.

User Liability

HED, along with any affiliated distributor or reseller, shall not be liable for any direct, indirect, incidental, special, or consequential damages arising from the use or inability to use this product, even if advised of the possibility of such damages. Users assume all risks associated with the product's use. Always follow provided instructions and generally accepted safety guidelines.

The OEM of a machine or vehicle in which HED® electronic controls are installed is fully responsible for all consequences that might occur. HED®, and any authorized distributor, has no responsibility for any consequences, direct or indirect, caused by failures or malfunctions. Failure or improper selection or improper use of HED® products can cause death, personal injury and property damage.

The OEM must analyze all aspects of their application and review the information concerning product or system in the current product documentation. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

The products described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by HED® at any time without notice.

PART NUMBERING

Standard I/O Configurations

Configuration[1]	Model Name	Total Inputs[2]	Digital Inputs	Analog Inputs	Frequency Inputs	RTD Inputs	20mA Inputs	Total Outputs[3]	Sourcing Outputs	Sinking Outputs	Analog Outputs
CL-4002-105	Plus	10x	10x	10x	4x	4x	4x	8x	8x	2x	2x
CL-4002-106	Base	10x	10x	6x	4x	0x	0x	8x	8x	0x	0x
CL-4002-101	Flex	4x	4x	4x	0x	0x	0x	4x	4x	0x	0x

[1] See full PINOUT configurations starting on page 30 for additional details

[2] Total Inputs shows the quantity possible if all I/O pins are software configured as Inputs. This would reduce total number of Outputs in that configuration.

[3] Total Outputs shows the quantity possible if all I/O pins are software configured as Outputs. This would reduce total number of Inputs in that configuration.

Standard CAN and Peripheral Configurations

Configuration[1]	Model Name	CAN Ports	QSPI Flash	Bluetooth®	Accelerometer	Daughterboard Connectors
CL-4002-105	Plus	2x	yes	no	no	yes
CL-4002-106	Base	2x	yes	no	no	yes
CL-4002-101	Flex	2x	yes	yes	yes	no

[1] See full PINOUT configurations starting on page 30 for additional details

Part Number Details

CL-4002-HHH-FF-IIOODD-CCCNNN	(HHH)	Firmware Options (FF)		(II)	(OO)	(DD)	Custom Suffix (CCCNNN)[3]	
	Hardware Configuration[1]	**CANopen Client**	**BSP Master**	**# Inputs[2]**	**# Sourcing Outputs**	**Reserved for Future Options**	**Customer**	**Number**
CL-4002-105-FF-020800-CCCNNN	105	50	B0	02	08	00	CCC	NNN
CL-4002-106-FF-020800-CCCNNN	106	50	B0	02	08	00	CCC	NNN
CL-4002-101-B0-020800-CCCNNN	101	n/a	B0	00	04	00	CCC	NNN

[1] See PINOUT configurations starting on page 30 for additional details

[2] Output pins can be configurable in software to a variety of input types, so total number of inputs can exceed input number listed

[3] Custom Suffix added if customer requests HED to pre-program their application into controller prior to shipment

Standard Part Numbers Available

	CANopen Client Part Numbers	**BSP Master Part Numbers**
Plus Model – Full Feature	CL-4002-105-50-020800	CL-4002-105-B0-020800
Base Model – Limited Outputs	CL-4002-106-50-020800	CL-4002-106-B0-020800
Flex Model - I/O with Bluetooth®	n/a	CL-4002-101-B0-000400

Example Part Number:
CL-4002-105-50-020800

This part number designates a Plus model with CANopen firmware, 2 Inputs, 8 Outputs, no Bluetooth®, no accelerometer.

Demo Kit Part Numbers Available

	Programming	**Included in Kit**
CL-4002-105-B0-020800-KIT-JTAG	BSP Master w/JTAG	Controller, A Key 18 PIN, Y-Connector, Terminating Resistor, Wire Harness, JTAG Cable (Access hole in controller for JTAG connection)
CL-4002-105-50-020800-KIT	CANopen	Controller, A Key 18 PIN, Y-Connector, Terminating Resistor, Wire Harness

RELATED DOCUMENTS for CL-4002

- Sales Support Collateral: https://hedcontrols.com/wp-content/uploads/2026/03/HED-CL-4002-GM.pdf
- J1939 Protocol (for interface with HED J1939 Keypads): https://hedcontrols.com/wp-content/uploads/2026/02/HED-J1939-Module-Keypad-Specifications.pdf
- STEP files: https://hedcontrols.com/wp-content/uploads/2026/02/CL-4002STEP.zip
- EDS file: https://hedcontrols.com/product-resources/cl-4002-eds/

COMPUTING CORE

DESCRIPTION	VALUE	NOTES
Overview	Arm™ Cortex-M7 Microcontroller running at 160 MHz	
MCU	S32K322	
Flash	2MB	
RAM	256KB	
Bootup Time	150msec (approximate)	

SOFTWARE FRAMEWORK & TOOLS

DESCRIPTION	VALUE	NOTES
Development	NXP Design Studio	
Programming	C / C++	

INTERFACES / PROTOCOLS

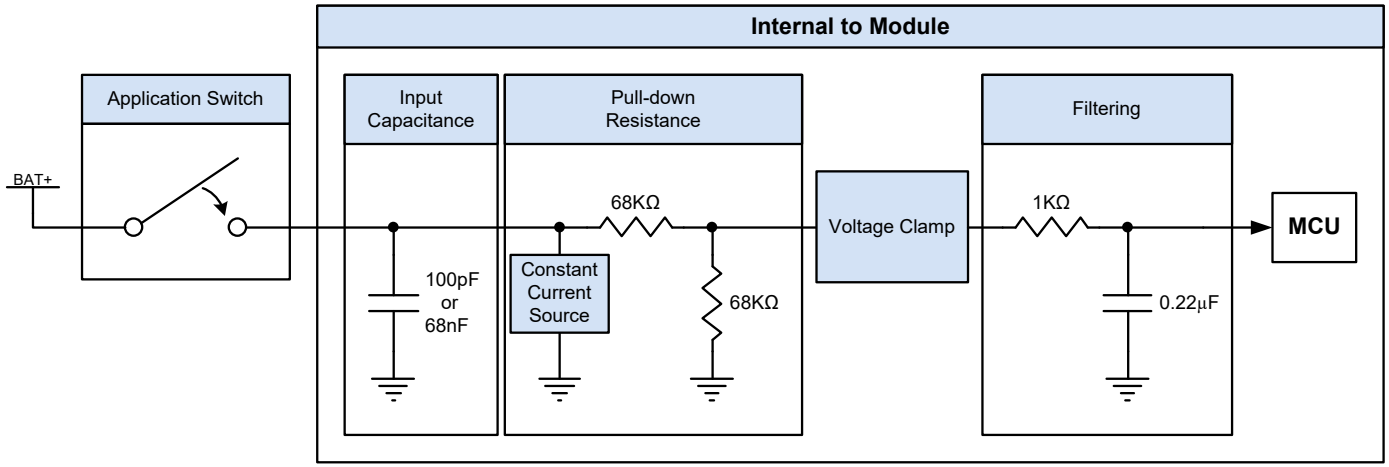
INTERFACE/PROTOCOL	DETAILS
CAN	2x CAN-FD
CAN Protocol	CANopen and J1939 networks (Capable of interfacing with J1939 devices but HED does not currently offer a standard J1939 Client)
LIN	2x LIN (optional)
Bluetooth®	5.1 Compliant (optional)
Accelerometer	3-axis (2g to 16g selectable range) (optional)
Real-Time Clock Calendar	Internal Battery Backup (15-year typical life)

INPUT / OUTPUT TYPES AND SPECIFICATIONS

INPUT TYPE	DETAILS
STB	Switch to Battery. Digital Input that is "ON" when pin has voltage above Positive Threshold, and "OFF" when pin is open (nothing connected to it) or has a voltage on pin below Negative Threshold. Typically, input is switched to +Battery level signal.
STG	Switch to Ground. Digital Input that is "ON" when pin has voltage below Negative Threshold, and "OFF" when pin is open (nothing connected to it) or has a voltage on pin above Positive Threshold. Typically, input is switched to Ground (-Battery) level signal.
TRI	Tri-State. Digital Input that has 3 states compared to just 2 states of the STB and STG input types. Three states are STB, STG and OPEN. STB and STG are "ON" same as defined for STB and STG, but the OPEN state (nothing connected to pin) is now a 3rd "ON" state.
VTD1	Voltage to Digital. Analog to Digital input with range of 0V to 5.5V (typical).
VTD2	Voltage to Digital. Analog to Digital input with range of 0V to 35V (typical).
FREQ	Frequency. Time based signal (typically a square wave or series of pulses) whose value in Hz is determined by specific time intervals between rising (or falling) edges of the signal.
PWM	Pulse Width Modulation. Time based signal (typically a square wave) whose value in duty cycle is determined by the ratio of On time vs Off time.
CNT	Pulse Counter. Time based signal (typically a square wave or series of pulses) whose value in whole numbers is determined by the number of times the signal has rose from low to high (or has fallen from high to low).
ENCODER	Encoder. Supports interface to Quadrature Encoder (aka A/B Encoder) that has two separate Frequency signals that are 90 degrees out of phase with each other. This allows for determination of the direction of rotation by analyzing which signal leads the other. Firmware reports Frequency (Hz) and direction to application software.
20MA	20mA. Analog input that converts current (0mA to 22mA) to voltage for processor to interpret and report to application.
RTD1	Resistive to Digital. Analog input that converts resistance range (0 to 500 Ohms) to voltage for processor to interpret and report to application.
RTD2	Resistive to Digital. Analog input that converts resistance range (0 to 2000 Ohms) to voltage for processor to interpret and report to application.
STB/STG	Configurable Switch to Battery or Switch to Ground input.

OUTPUT TYPE	DETAILS
DOUT(+)	Digital Sourcing Output that switches +Battery voltage out connector pin. Can only be Full On (100%) or Full Off (0%).
DOUT(-)	Digital Sinking Output that switches -Battery (Ground) voltage out connector pin. Can only be Full On (100%) or Full Off (0%).
PWM(+)	PWM Sourcing Output that switches +Battery voltage out connector pin capable of PWM signal. Can vary between 0% and 100%, typically in 0.1% increments.
PWM(-)	PWM Sinking Output that switches -Battery (Ground) voltage out connector pin capable of PWM signal. Can vary between 0% and 100%, typically in 0.1% increments.

INPUT EQUIVALENT CIRCUITS

INPUT: Switch-to-Battery (STB)	
Switch-to-Battery (STB) Mode[1] Input Resistance • 1.2KΩ (typical) Input Current • 5.5mA (typical) Positive Going Threshold • > 6.5V Negative Going Threshold • < 3.5V	

Input Type	**STB**/STG/TRI/VTD1/Low Side Output	**Connector**	PIN A1, A2
Input Type	**STB**/STG/TRI/VTD1/VTD2/FREQ/20mA/RTD1	**Connector**	PIN A3, A4
Input Type	**STB**/STG/TRI/VTD1/VTD2/FREQ/20mA/RTD2	**Connector**	PIN A13, A14
Input Type	**STB**/STG/TRI/VTD1	**Connector**	PIN A15, A16, A17, A18
Notes	[1] If any of the outputs that share a battery input are used in a function where (if they fail) they could cause a safety issue, none of the shared battery outputs can be used as a STB input because (being connected to battery) they will prevent the ESTOP from functioning (output would stay on powered from the input).		

INPUT: Switch-to-Ground (STG)

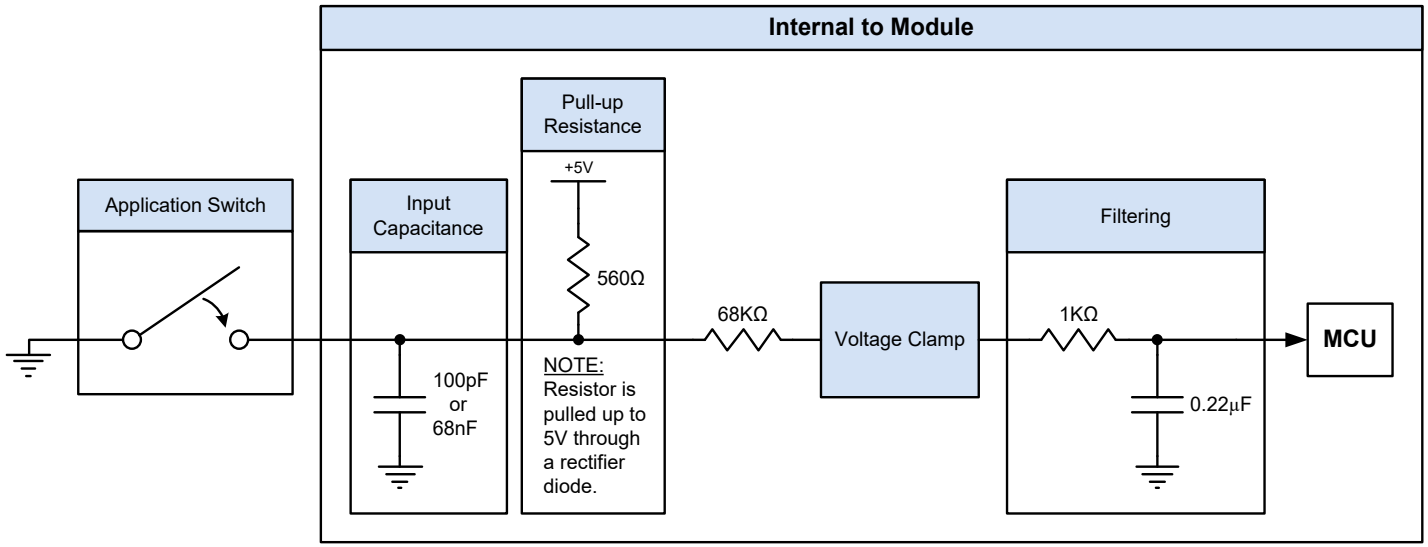
Switch-to-Ground (STG) Mode

Pull-up Resistance
- 560Ω (typical)

Input Current
- 8.4mA at 0V (typical)

Positive Going Threshold
- > 3.25V

Negative Going Threshold
- < 1.75V



Input Type	STB/**STG**/TRI/VTD1/Low Side Output	**Connector**	PIN A1, A2
Input Type	STB/**STG**/TRI/VTD1/VTD2/FREQ/20mA/RTD1	**Connector**	PIN A3, A4
Input Type	STB/**STG**/TRI/VTD1/VTD2/FREQ/20mA/RTD2	**Connector**	PIN A13, A14
Input Type	STB/**STG**/TRI/VTD1	**Connector**	PIN A15, A16, A17, A18

INPUT: Voltage-to-Digital (VTD1)

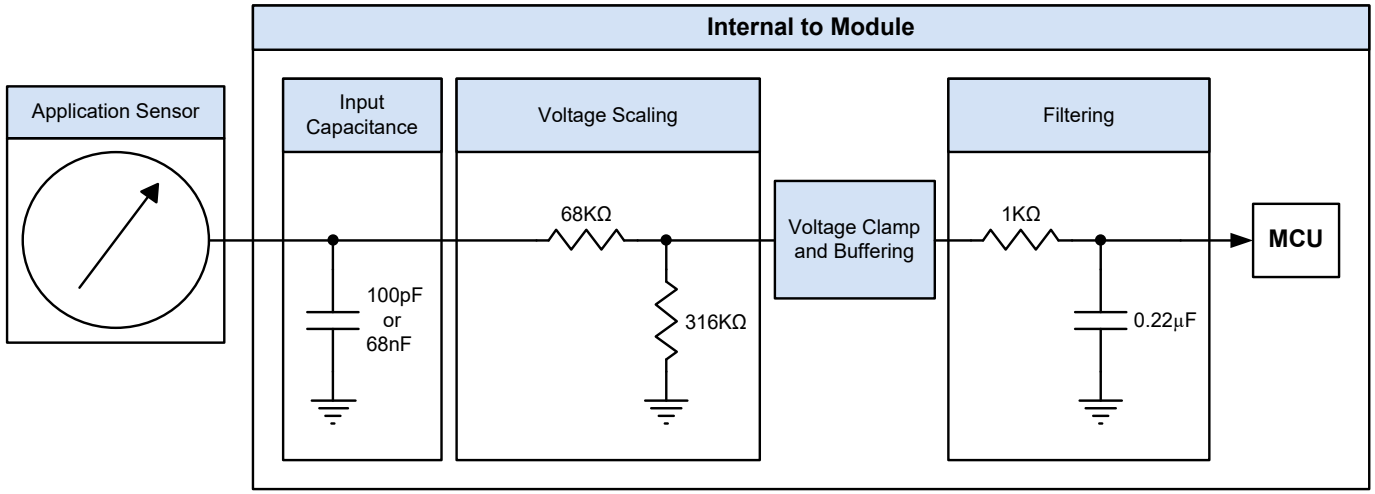
Voltage-to-Digital (VTD1) Mode (0 – 5.5VDC)

Input Voltage Range
- 0V to 5.30V (minimum)
- 0V to 5.61V (typical)

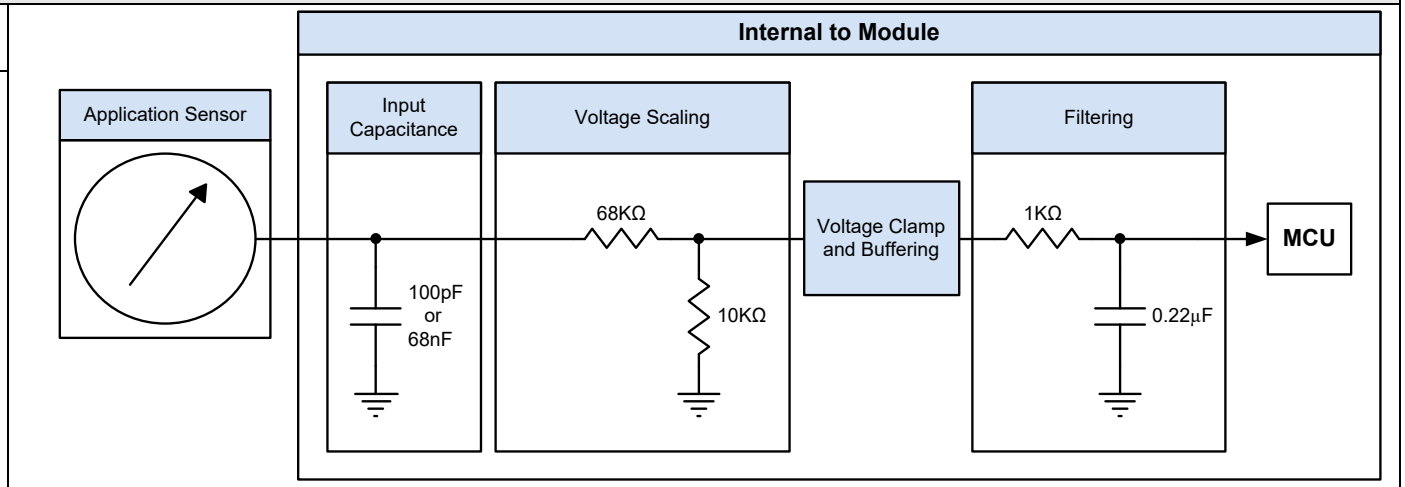
Input Resistance
- 384KΩ (typical)

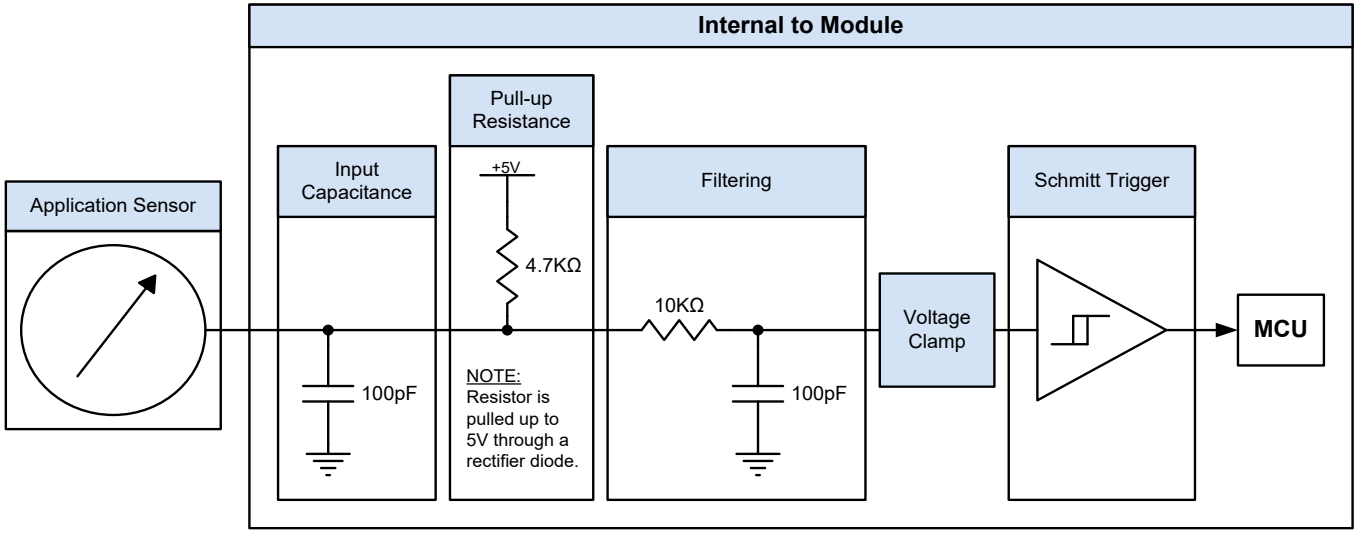
Resolution
- 12 Bits
- 1.37mV / count (typical)

Accuracy
- ±1.0% and ±50mV (T_A = 25°C)
- ±3.0% and ±75mV (T_A = full))



Input Type	STB/STG/TRI/**VTD1**/Low Side Output	**Connector**	PIN A1, A2
Input Type	STB/STG/TRI/**VTD1**/VTD2/FREQ/20mA/RTD1	**Connector**	PIN A3, A4
Input Type	STB/STG/TRI/**VTD1**/VTD2/FREQ/20mA/RTD2	**Connector**	PIN A13, A14
Input Type	STB/STG/TRI/**VTD1**	**Connector**	PIN A15, A16, A17, A18

INPUT: Voltage-to-Digital (VTD2)			
Voltage-to-Digital (VTD2) Mode (0 – 35.0VDC) Input Voltage Range • 0V to 33.5V (minimum) • 0V to 35.0V (typical) Input Resistance • 78KΩ (typical) Resolution • 12 Bits • 8.65mV / count (typical) Accuracy • ±1.0% and ±70mV (T_A = 25°C) • ±3.0% and ±100mV (T_A = full range)			
Input Type	STB/STG/TRI/VTD1/**VTD2**/FREQ/20mA/RTD1	**Connector**	PIN A3, A4
Input Type	STB/STG/TRI/VTD1/**VTD2**/FREQ/20mA/RTD2	**Connector**	PIN A13, A14

INPUT: Frequency / PWM / Encoder Mode			
Frequency / PWM / Encoder Mode Pull-up Resistance • 4.7KΩ (typical) Positive Going Threshold • > 3.25V Negative Going Threshold • < 1.75V Frequency Range • 10KHz (maximum) Accuracy • ±2.0% (T_A = full range)			
Input Type	STB/STG/TRI/VTD1/VTD2/**FREQ**/20mA/RTD1	**Connector**	PIN A3, A4
Input Type	STB/STG/TRI/VTD1/VTD2/**FREQ**/20mA/RTD2	**Connector**	PIN A13, A14

INPUT: 4-20mA Current

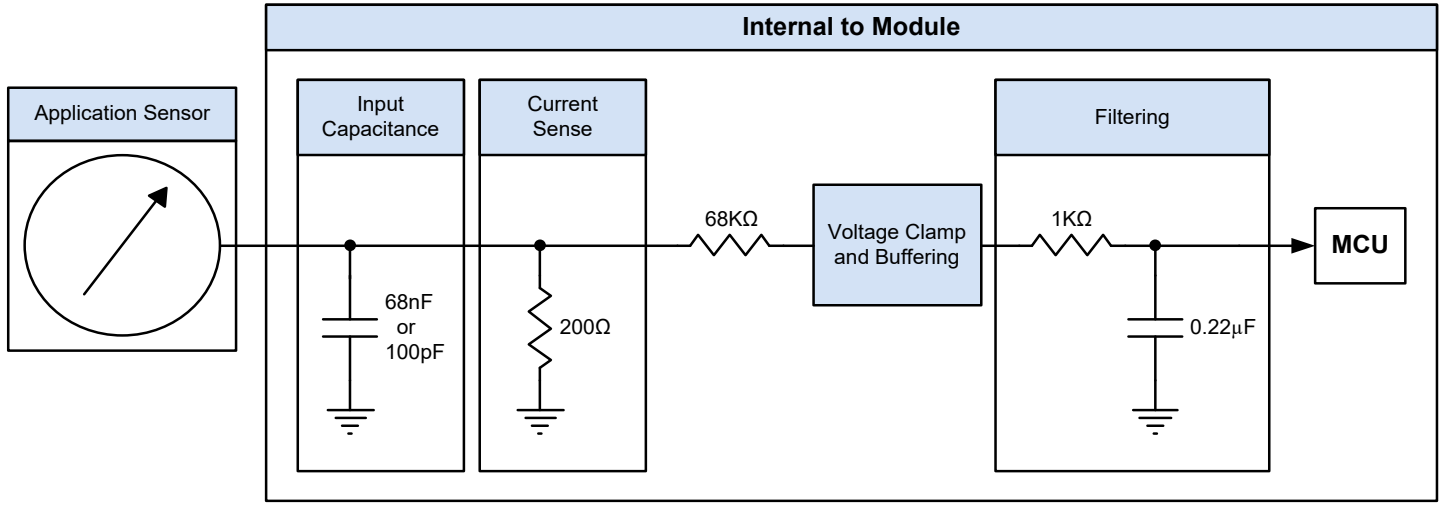
4-20mA Current Input Mode

Input Current Range
- 0mA to 21.32mA (minimum)
- 0mA to 23.57mA (typical)

Input Resistance
- 201Ω (typical)

Resolution
- 12 Bits
- 5.75µA / count (typical)

Accuracy
- ±2.0% (T_A = 25°C)
- ±5.0% (T_A = full range)



Input Type	STB/STG/TRI/VTD1/VTD2/FREQ/**20mA**/RTD1	**Connector**	PIN A3, A4
Input Type	STB/STG/TRI/VTD1/VTD2/FREQ/**20mA**/RTD2	**Connector**	PIN A13, A14

INPUT: Resistance-to-Digital (RTD1) / (RTD2)

Resistance-to-Digital (RTD1) Mode (0 – 500Ω)

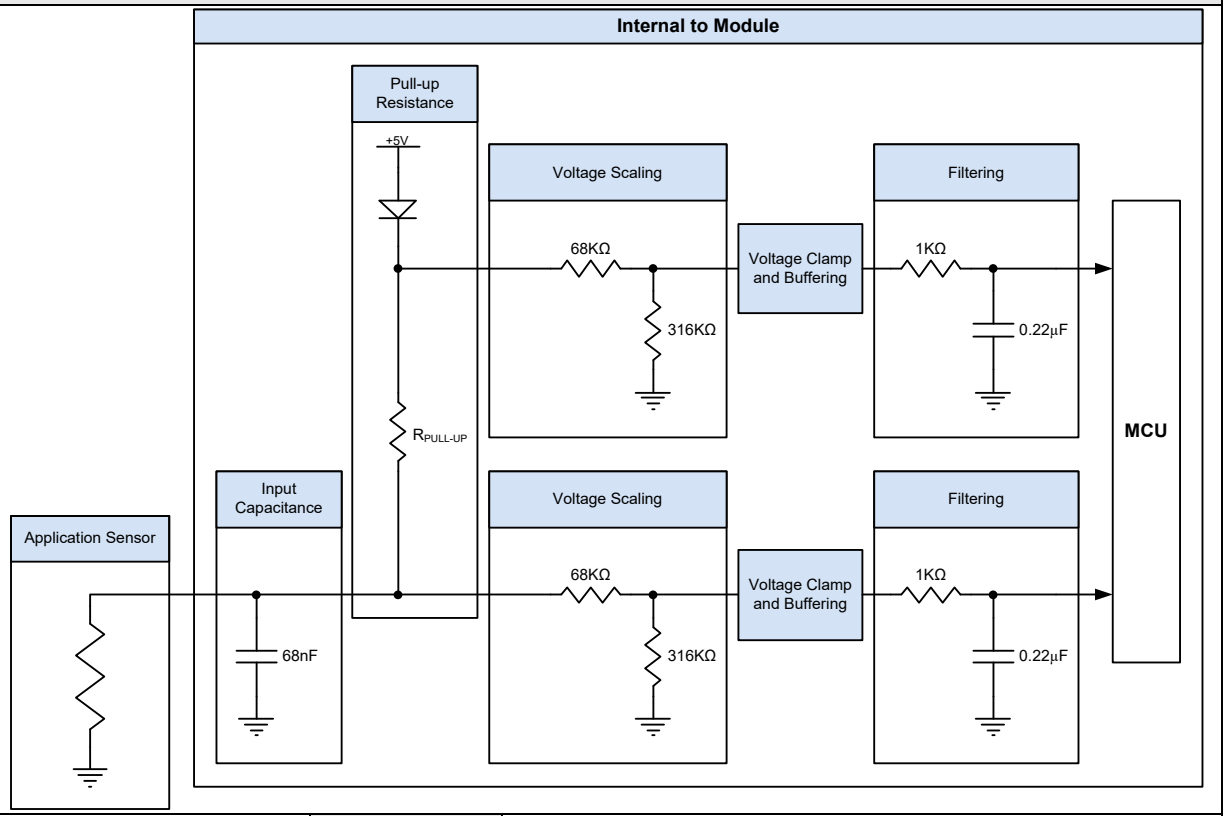
Pull-up Resistance ($R_{PULL-UP}$)
- 499Ω (typical)

Accuracy
- ±2.0% (T_A = 25°C)
- ±5.0% (T_A = full range)

Resistance-to-Digital (RTD2) Mode (0 – 2KΩ)

Pull-up Resistance ($R_{PULL-UP}$)
- 2KΩ (typical)

Accuracy
- ±2.0% (T_A = 25°C)
- ±5.0% (T_A = full range)



Input Type	STB/STG/TRI/VTD1/VTD2/FREQ/20mA/**RTD1**	**Connector**	PIN A3, A4
Input Type	STB/STG/TRI/VTD1/VTD2/FREQ/20mA/**RTD2**	**Connector**	PIN A13, A14

INPUT: 5VDC Sensor

5VDC Sensor Supply Mode

Voltage Range
- 5V ± 4%

Current Rating
- 500mA

Current Limit
- 500mA (Typical)
- 525mA (Max)
-

Analog Monitoring Circuit

Resolution
- 12 Bits
- 1.38mV / count (typical)

Accuracy
- See Section Input – VTD Mode (0-5.65V Range)

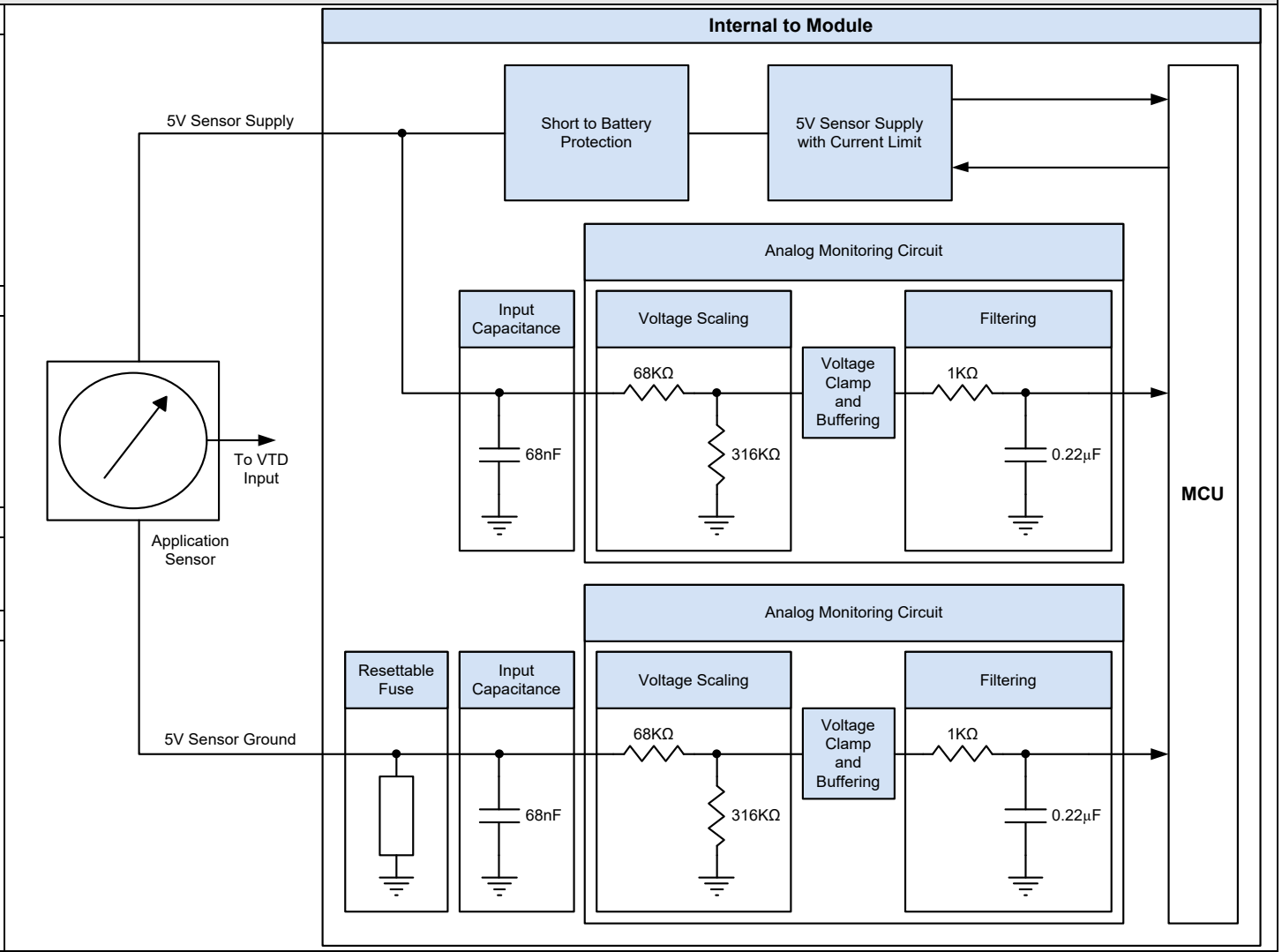
5VDC Sensor Ground Mode

Current Rating
- 500mA

Analog Monitoring Circuit

Resolution
- 12 Bits
- 1.38mV / count (typical)

Accuracy
- See Section Input – VTD Mode (0-5.65V Range)



Input Type	5V Sensor Supply	**Connector**	PIN A13
Input Type	5V Sensor Ground	**Connector**	PIN A14

OUTPUT EQUIVALENT CIRCUITS

OUTPUT: High Side Switch

HIGH SIDE SWITCH OUTPUT ECC(+)

Individual Output Current
- Digital Mode = 5A (maximum)
- PWM Mode = 3.5A (maximum)

Combined Output Current
- Digital Mode = 15A (maximum)
- PWM Mode = 10A (maximum)

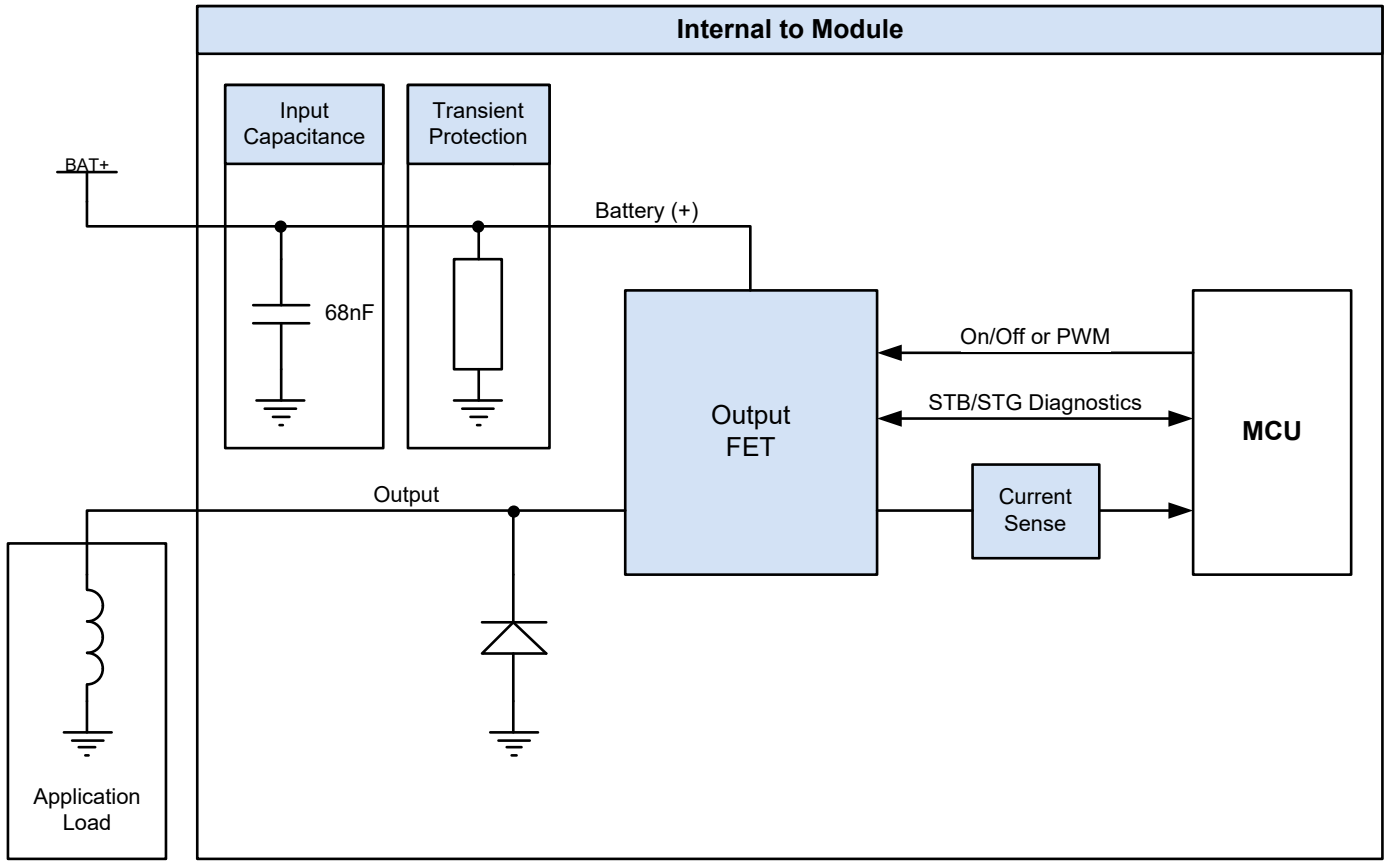
PWM Frequency
- < 100 Hz (typical)
- < 300Hz (maximum)

Output Diagnostics
- Short to Battery
- Short to Ground
- Overcurrent
- Open Circuit

Current Sense Range
- Up to 6.0A (typical)

Current Sense Resolution
- 12 bits
- 1.2mA / count (typical)

Current Sense Accuracy (typical)
- ±125 mA at 5A, T_A = 25°C
- Internal Flyback Diodes



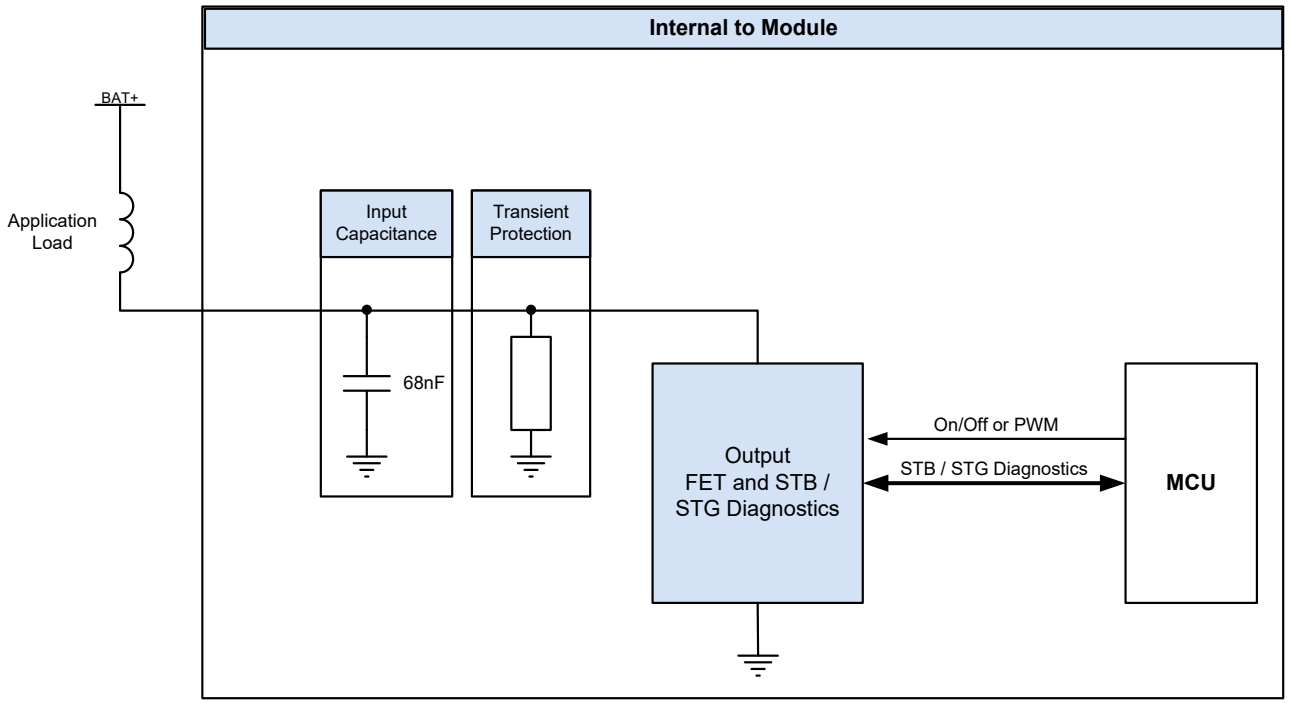
Output Type	High Side Output **DOUT/PWM/ECC(+)(5A)**	**Connector**	PIN A1, A2, A3, A4, A15, A16, A17, A18

OUTPUT: Low Side

Individual Output Current
- Digital Mode = 2A (maximum)
- PWM Mode = 2A (maximum)

PWM Frequency
- < 100 Hz (typical)
- < 300Hz (maximum)

Output Diagnostics
- Short to Battery
- Short to Ground
- Overcurrent

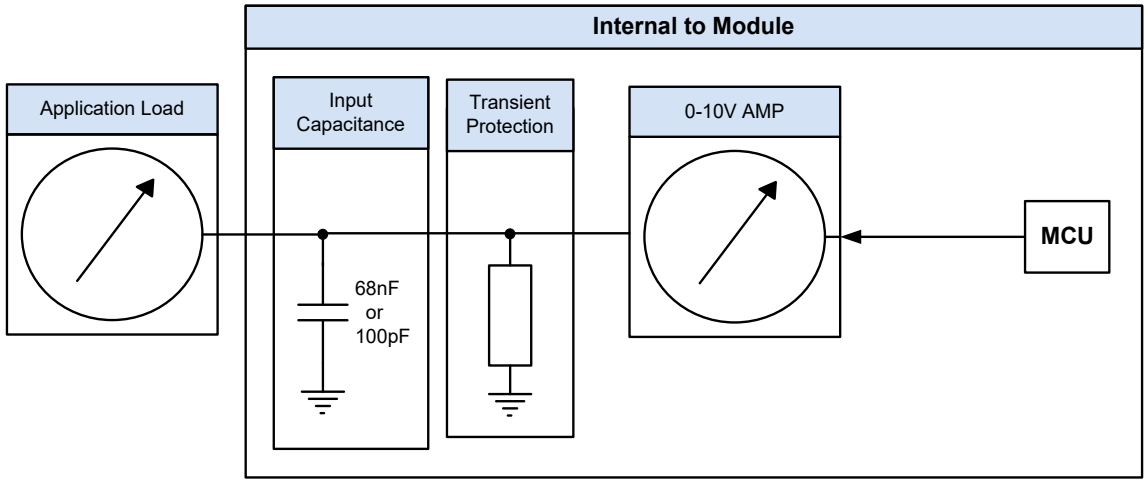


Output Type	Low Side Output **(2A)**	**Connector**	PIN A1, A2

OUTPUT: 0-10V Analog

0-10V Analog Output

- 0-12VDC max range
- 25mA TYP
- 0.3A Maximum Output Current (DC)
- Voltage Output Accuracy +/- 2%[1]
- Closed Loop Feedback



Output Type	Output **Analog (0-10V)**	**Connector**	PIN A13, A14

OUTPUT: Battery (+)

Battery (+) (Pins 1,8)[1]

Operating Voltage Range

- 8VDC – 32VDC

Maximum Continuous Voltage[2]

- 36VDC

Module Current Draw – Running

Battery Voltage	No I/O or CAN active[3]	Only Bluetooth® active
8V	154 mA	155 mA
13.8V	113 mA	129 mA
28.0V	94 mA	116 mA
32.0V	93 mA	117 mA

Module Current Draw – Shutdown[4]

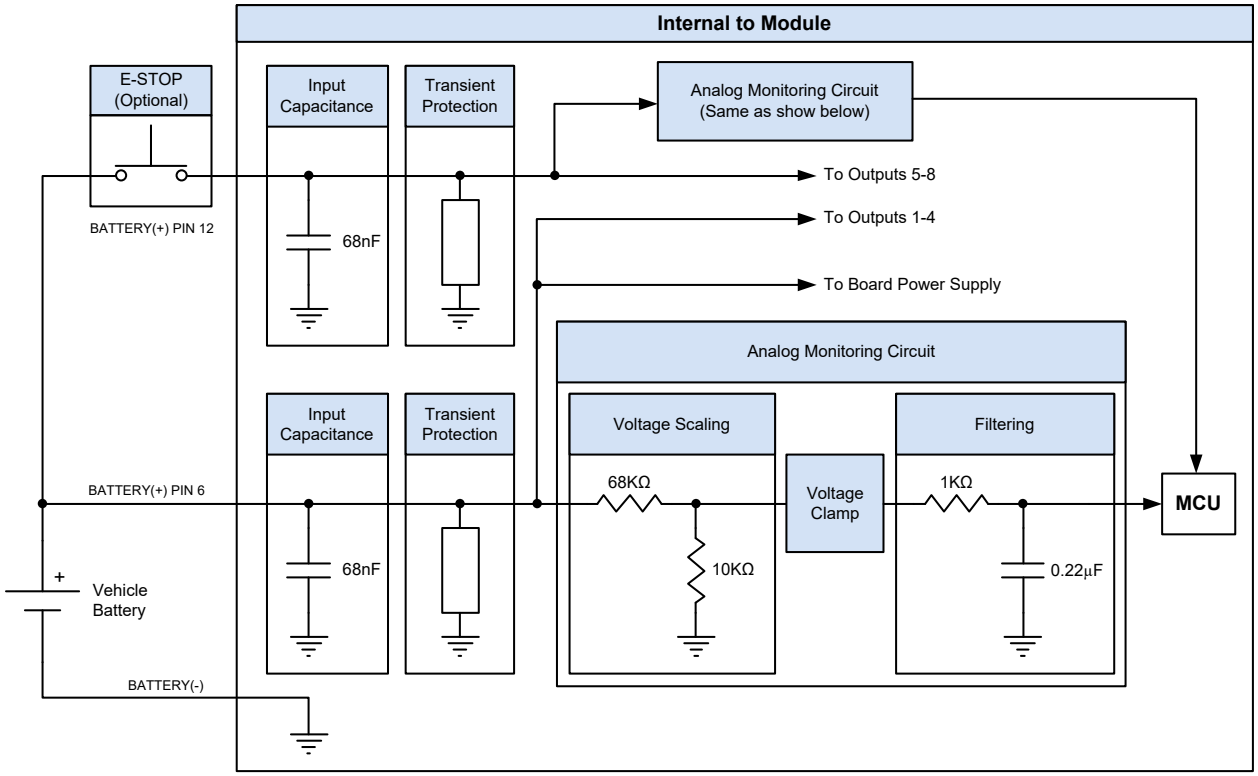
- 0.3mA at 6.5V (typical)
- 0.6mA at 13.8V (typical)
- 1.7mA at 28.0V (typical)
- 2.5mA at 32.0V (typical)

Maximum Total Output Current

- See Output Section for output current constraints

Analog Monitoring Circuit

See Section Input – VTD Mode (0-35V Range)



Notes	[1] If any of the outputs that share a battery input are used in a function where if they fail on could cause a safety issue, none of the shared battery outputs can be used as a STB input because being connected to battery will prevent the ESTOP from functioning (output would stay on powered from the input). [2] Exposure to maximum voltages for extended periods may affect device reliability. [3] Module current draw was measured on a CL-4002 with I/O inactive, no CAN communication, 5V sensor supply disabled, Key Switch asserted, and simple application to monitor I/O. Actual values will vary based on I/O configuration, CAN traffic, and application. [4] Module current draw is measured with inputs inactive and Key Switch de-asserted. Actual values may vary.		
Output Type	Battery (+) Module / **Outputs 1-4**	**Connector**	Deutsch PIN 6
Output Type	Battery (+) **Outputs 15-18**	**Connector**	Deutsch PIN 12

OTHER EQUIVALENT CIRCUITS

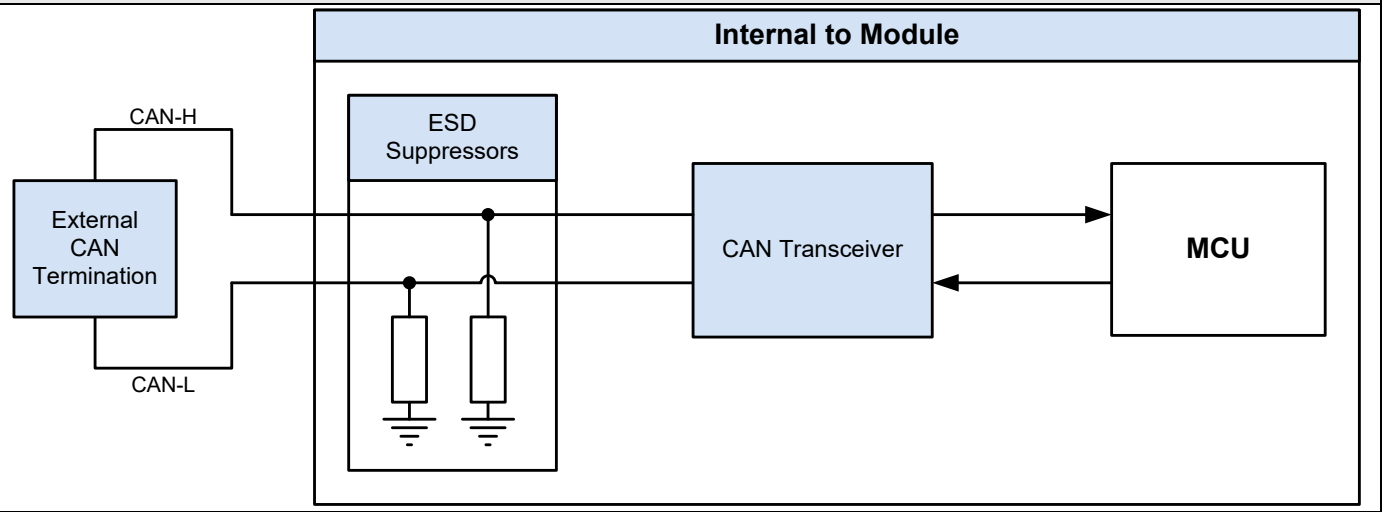
OTHER: CAN FD Communication

Baud Rate
- CAN Up to 1Mbps
- CAN FD up to 5Mbps

Maximum Allowable Voltage
- -70V to +70V

Input Capacitance (max)
- 30pF

No Internal Termination



Output Type	CAN FD Communication	**Connectors**	PIN 7/8, 9/10
Notes	Maximum allowable voltage defines the voltage extremes that the transceiver can tolerate. Exposure to these voltages for extended periods may affect device reliability.		

OTHER: Key Switch (Switched +Battery) with VTD

Switched Battery (+)

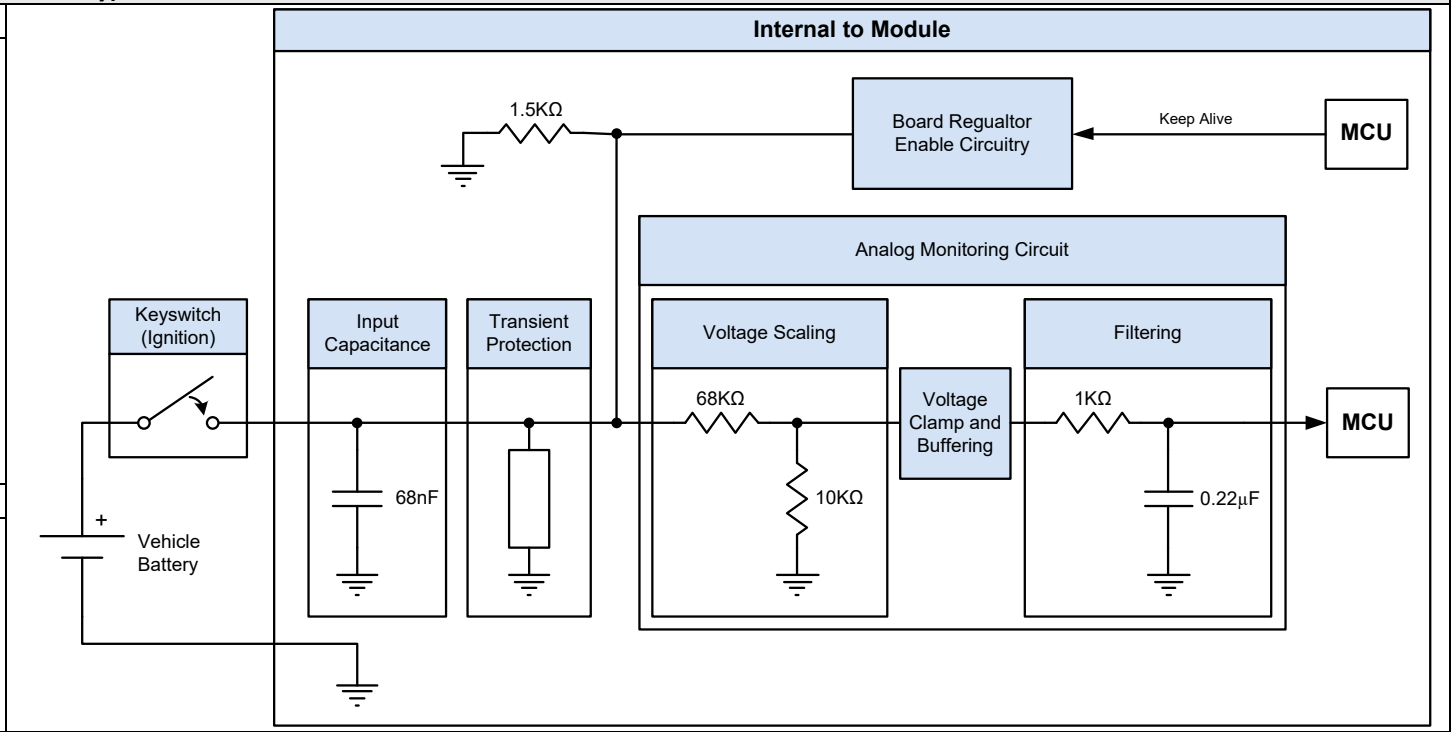
Operating Voltage Range
- 8VDC – 32VDC

Maximum Continuous Voltage
- 36VDC

Key Switch Function
- Input transition from inactive to active will activate module
- Input transition from active to inactive will begin controlled shutdown sequence (if applicable) and de-activate module

Analog Monitoring Circuit

See Section Input – VTD Mode (0-35V Range)



Type	Key Switch (Switched +Battery) with VTD	**Connectors**	PIN 11

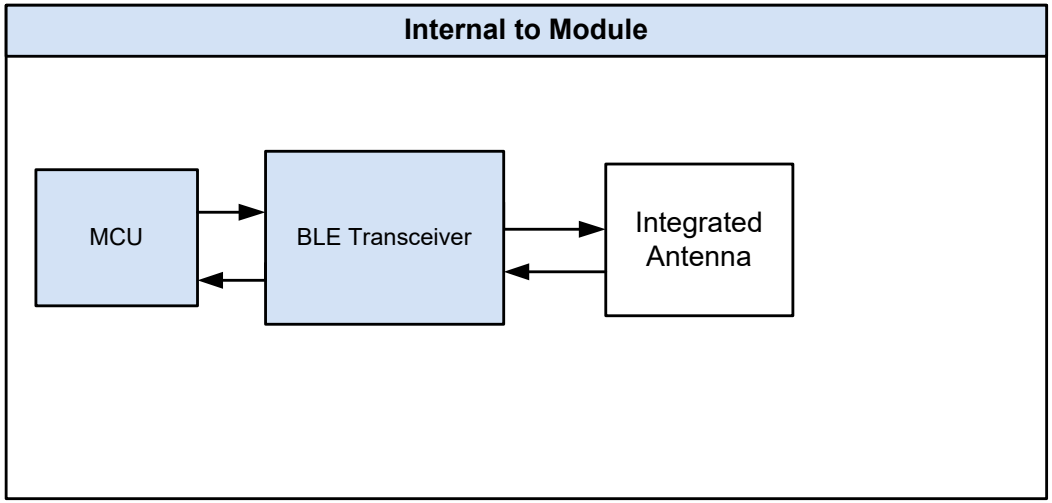
OTHER: Bluetooth® Low Energy

Features

- Bluetooth® 5.1 Low Energy
- IEEE 802.15.4 PHY and MAC

Security

- AES 128-bit cryptographic accelerator



ADDITIONAL NOTES

Important: Module configurations that contain sourcing outputs with internal flyback diodes may continue to operate in the event of a loss of module ground. This event can result in a ground shift to the internal board reference (ground). The ground shift is a result of a remaining current path from internal board reference (ground), through internal flyback diode(s), and terminating through an external load to ground (assuming the load is of relatively low resistance). Depending on system configuration and load resistances, analog input accuracy can be affected, especially if the analog sensor is not referenced to the module sensor ground. Be sure to include this condition when conducting a system-level FMEA.

PRODUCT RATINGS

GENERAL

DESCRIPTION	DETAILS	NOTES
Voltage	8-32 VDC	
Temperature Range	Operating: -40C to +85C Storage: -40C to +85C	Output current limits may require moderate derating for temperatures above +70C
Current Draw (No I/O active)	115mA (13.8VDC) (typ) 95mA (28VDC) (typ)	
Standby Current	<0.6mA (12VDC), <1.7mA (24VDC)	*Key Switch off, Unswitched Battery connected to Battery*
Total Maximum Output Current	15A per +Battery pin feeding bank of outputs (see pinout)	

COMPLIANCE MATRIXES

The CL-4002 controllers are compliant to all standards listed in the matrixes below, unless otherwise stated, to the noted class as applicable.

MECHANICAL COMPLIANCE

Requirement Area	ISO 20653: Aug 2023	ISO 16750-3: Dec 2012	ISO 16750-4: 2023	ISO 16750-5: 2023	IEC 60068: Date Below	SAE J400: Aug 22	Class / Notes
IPx9K Waterjet	Sec 8.4						*Class C*
Random Vibration		Sec 4.1.2.7					*Class C*
Sine Vibration		Sec 4.1.2.6					*Class C*
Mechanical Shock (Body/Frame and Doors/Flaps)		Sec 4.2.2			Part 2-27: (2008-02)		*Class C*
Thermal Shock					Part 2-14: (2023-07)		*Class C*
Gravel Bombardment						Sec 5	*Class C*
IP6K Dust	Sec 8.3						*Class C*
Salt Mist, Cyclic					Part 2-52: (2017-11)		*Class C*
Solar Weathering			Sec 5.10 (ISO 4982-2)				*Class C*
Combined Environment Thermal Stability					2-1 (2007-03) 2-2 (2007-03) 2-30 (2005-08) 2-38 (2017-11))		*Class C.*
Vertical Impact (Drop Test)					Part 2-31: (2008)		*Class C*
IPX7 Immersion	Sec 8.4						*Class C*
Chemical resistance				Sec 4.8			*See Note 1*

Note 1: Brake fluid, brake cleaner, and battery acid caused cosmetic damage but no structural damage within the 30 minutes of exposure defined in ISO 16750.

ELECTRICAL COMPLIANCE

Requirement Area	ISO 16750-2:2023	Class	Comments / Notes
Short Circuit Protection	Sec 4.10.2	*Class C*	
Open Circuit Protection	Sec 4.9.1		**See note 1*
Reverse Voltage Protection	Sec 4.7, Case 2	*Class C*	
Momentary Drop in Supply Voltage Protection	Sec 4.6.1	*Class C*	
Reset Behavior from Voltage Drop	Sec. 4.6.2	*Class C*	
Starting Profile	Sec 4.6.3	*Class A*	
Jump Start Protection	Sec 4.3.1.2	*Class B*	

Note 1: While the Device is disconnected from BAT(-), an alternate ground path can exist through the CAN Bus. This does not damage the device but results in current draw from the device that powers the “Power LED.”

EMC COMPLIANCE

Requirement Area	EN ISO 13766-1:2018 (Construction)	EN ISO 14982:2009 (Ag/Forestry)	EN ISO 13766-2:2018 (HED Preferred)	ISO 10605	UNECE Reg 10.06 (Vehicle/Tractor)	IEC 61000-4-2	EN 13309: 2010	EN 50498: 10	CISPR 25 (HED Additional)	ISO 7637-2	Comments / Notes
Emissions Radiated from ESA	Sec 4.5 and 4.6	Sec 6.4 and 6.5	➞ Refers to 13766-1:2018 Sec 4.5 and 4.6		Sec 6.5 and 6.6		Sec 4.5 and 4.6	Sec 7.1 and 7.2	Sec 6 (ALC test setup)		*Pass*
Conducted Transients	Sec 4.9.4	Sec 6.8	➞ Refers to 13766-1:2018 Sec 4.9		Sec 6.9		Sec 4.9.4	Sec 7.4		Sec 5.6	*See Note 1 for 7637-2 details*
Immunity of ESA to Electromagnetic Radiation (Absorber Chamber)	Sec 4.7	Sec 6.6			Sec 6.8		Sec 4.7		Sec 3 (150Ω method)		*Class A*
Immunity of ESA to Electromagnetic Radiation (BCI)	Sec 4.7	Sec 6.6	Sec 5.3.1		Sec 6.8		Sec. 4.7				*Class A*
Electrostatic Discharge (ESD)	Sec 4.8	Sec 6.7	Sec 5.3	Sec 9	Sec 4.8	Sec 8.3	Sec. 4.7				*Class A at all levels*
Conducted Transients Emissions on Supply Lines	Sec 4.9.3				Sec 6.7		Sec 4.9.3	Sec 7.3		Sec 4.3	*Severity III*
Conducted Emissions from Components – Voltage Method									Sec. 6.3		*Class 2/3. See Note 2*
Radiated Emissions from Components – ALSE Method									Sec. 6.5		*Class 3. See Note 3*

Note 1: Meets Status III for pulse 1; Meets Status III for pulse 2a; Meets Status III for pulse 2b; Meets Status I for pulse 3a; Meets Status I for pulse 3b. All pulses performed at severity Level III.

Note 2: The device complies with Class 2 limits across the tested frequency range and meets Class 3 limits for both Peak and Average detectors.
A minor Quasi-Peak exceedance was observed in the 30–108 MHz band under standalone laboratory test conditions, resulting in a Class 3 non-compliance for the QP detector only. Conducted emission performance in the 30–108 MHz range is influenced by installation variables including cable routing, harness length, grounding strategy, shielding practices, and the number and configuration of connected inputs and outputs. Final system-level compliance to CISPR 25 Class 3 limits should be verified in the intended vehicle or equipment installation.

Note 3: The product meets Class 4 limits across the applicable frequency bands with the following exception. Emissions in the 2.4 GHz Wi-Fi/Bluetooth® band are attributed to the module's intentional transmitter (FCC ID: XPYANNAB4) and are excluded from CISPR 25 compliance determination per the test report.

INSTALLATION

MECHANICAL

DESCRIPTION	DETAILS	NOTES
Dimensions	158.51 x 110.52 x 56.50 (mm)	
Housing material	Nylon 6/6 15% glass filled	
Installation	Panel mount (see dimensional drawings)	
Mating Connector	TE Deutsch: DT16-18SA-K004 Amphenol: AT16-18SA-K004	*Additional options available.* *Review at TE and Amphenol website*
Connector Sockets	TE Deutsch: 16-18 AWG: 0462-201-16141 14-16 AWG: 0462-209-16141 Amphenol: 16-18 AWG: AT62-201-16141 14-16 AWG: AT62-209-16141	*Additional options available.* *Review at TE and Amphenol website*
Sealing Plugs	TE Deutsch: Non-locking: 114017 Locking: 0413-217-1605 Amphenol: Non-locking: A114017 Locking: AT13-217-1605	*Additional options available.* *Review at TE and Amphenol website*
Weight	0.70 lbs	
Mounting fasteners & Torque	Fastener: 1/4-20 Bolt or M6 (Qty: 4) Torque: 50-55 in-lbs	*All mechanical standards testing was performed with fasteners that had thread locking patch*

BEST PRACTICES

DESCRIPTION	DETAILS	NOTES
Grounding	An electronic control system should have all devices in the system connected to a common ground for proper operation. A dedicated ground wire, appropriately sized, run directly to the machine battery is recommended.	
Interface	**CAN Terminating Resistor:** To ensure reliable communication on the CAN network, install a 120-ohm terminating resistor at each end of the CAN bus backbone (two resistors total). This helps minimize signal reflections and maintain signal integrity. Avoid placing terminating resistors at intermediate nodes or devices along the bus, as this can disrupt network performance. Confirm proper placement with the vehicle's wiring diagram.	
Shielding	**CAN Shielding Best Practices** To ensure reliable CAN communication and minimize susceptibility to electromagnetic interference (EMI), follow these shielding guidelines: • Connect the CAN cable shield to vehicle chassis ground at a single point only, ideally near the battery negative terminal or a designated ground stud. • Do not connect the shield to signal grounds of any devices on the network. • At the keypad end, the CAN shield should remain unconnected (floating). • If your system uses a connector with a CAN Shield pin, only use this pin to connect to vehicle chassis ground. Do not connect it to the Keypad ground pin. • Avoid grounding the shield at multiple locations to prevent ground loops, which can cause communication errors or system instability.	
Wiring guidelines	**Live Battery Connect / Disconnect:** Machine power should be off when connecting or disconnecting that mating connector. **Machine Welding Guidelines:** Disconnect all connectors from the HED device before performing any welding on a machine. The following steps are recommended when welding: • Turn engine off • Remove electronic devices from machine before any arc welding • Disconnect the negative battery cable from the battery • Clamp the ground cable for welder to the item that will be welded as close as possible to the weld. Do not use any electrical device to ground the welder. **General Wiring Best Practices:** • Protect wires from potential mechanical damage. Run wires in durable sheathing, or flexible metal or plastic conduits. • Use wire size appropriate for device connectors • Run wires for high current loads such as solenoids, lights, motors, pumps separate from sensors and other noise/interference sensitive signal wires.	

	• Run wires close to metal surfaces of machine when possible to aid in shielding to help minimize potential effects of EMI/RFI interference. • Do not run wires near sharp corners or through holes unless utilizing a grommet for protection. • Do not run wires near hot components that could cause damage. • Use appropriate temperature rated wires for application. • Use wires with abrasion resistant insulation. • Provide strain relief for all wires. • Do not run wires near moving or vibrating components. • Avoid running wires over long and unsupported spans.	
Fusing	The Battery pin should be protected with a fuse according to the maximum current calculated in Current section of User Manual.	
Orientation	Do not mount with connectors pointed up where moisture/water could pool, as this could allow entry into enclosure.	

PINOUT – Plus Configuration (CL-4002-105)

PIN	DESCRIPTION	VTD RANGE	RTD RANGE
Pin 1	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 / Output DOUT/PWM(-) (2A) (Bank 1)	0-5.5V	
Pin 2	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 / Output DOUT/PWM(-) (2A) (Bank 1)	0-5.5V	
Pin 3	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1/VTD2/FREQ/20mA/RTD1 (BanK 1)	0-5.5V / 0-35V	0-500 ohms
Pin 4	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1/VTD2/FREQ/20mA/RTD1 (Bank 1)	0-5.5V / 0-35V	0-500 ohms
Pin 5	Battery(-)		
Pin 6	Battery (+) CPU - Unswitched and Output Pins 1-4 (Max 15A) with VTD2	0-35V	
Pin 7	CAN1-L / Wake-up from Suspend		
Pin 8	CAN1-H / Wake-up from Suspend		
Pin 9	CAN2-L		
Pin 10	CAN2-H		
Pin 11	Key switch STB with VTD2 / Controlled Shutdown	0-35V	
Pin 12	Battery (+) Outputs Pins 15-18 (Max 15A) with VTD2	0-35V	
Pin 13	Input STB/STG/TRI/VTD1/VTD2/FREQ/20mA/RTD2 / 5V Sensor Supply / Output Analog (0-10V)	0-5.5V / 0-35V	0-2K ohms
Pin 14	Input STB/STG/TRI/VTD1/VTD2/FREQ/20mA/RTD2 / 5V Sensor Ground / Output Analog (0-10V)	0-5.5V / 0-35V	0-2K ohms
Pin 15	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Pin 16	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Pin 17	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Pin 18	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Bank 1	Each pin within bank can be independently configured as Output or any Input type.		
Bank 2	Each pin within bank can be independently configured as Output or any Input type.		

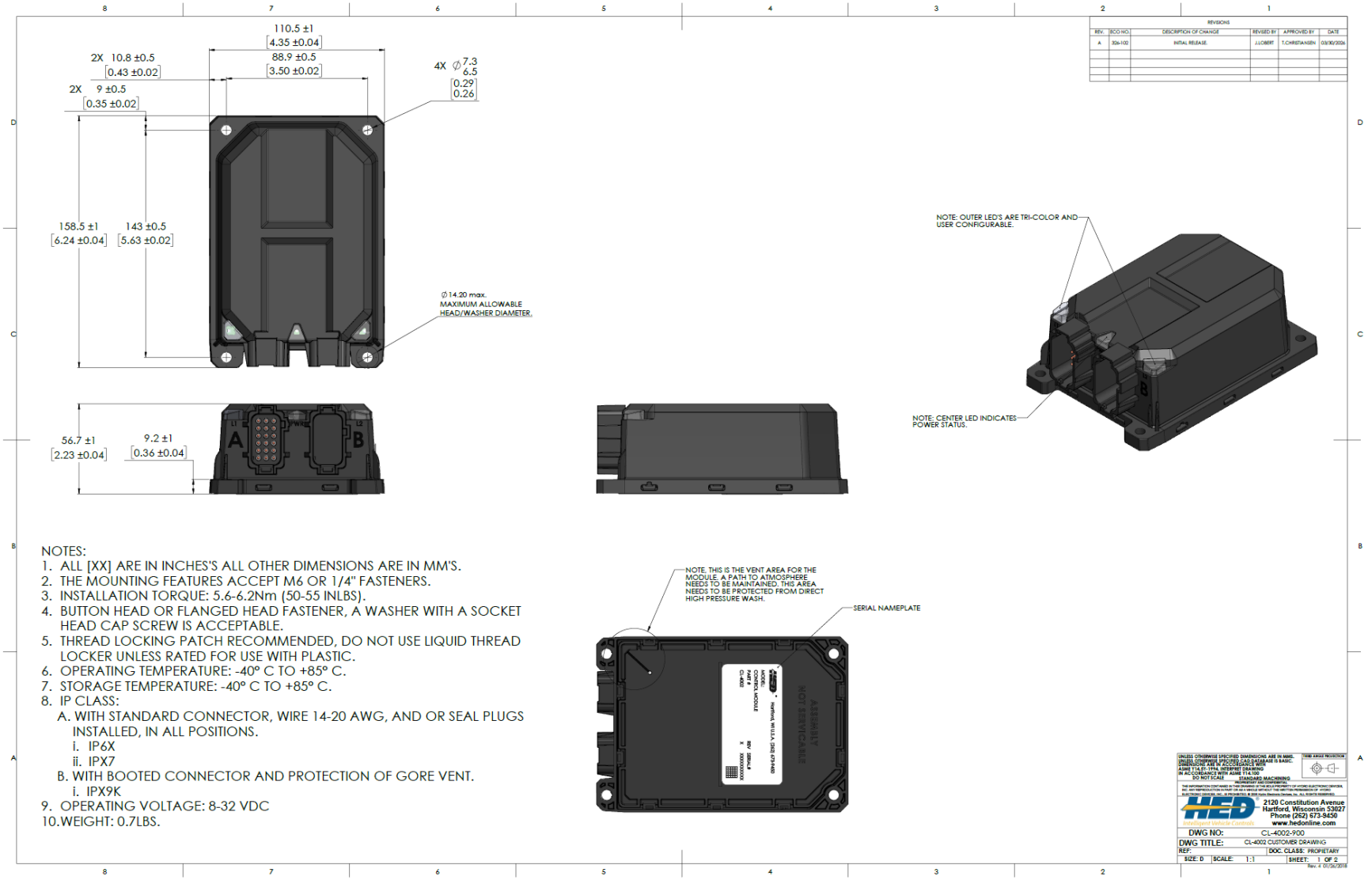
PINOUT – Base Configuration (CL-4002-106)

PIN	DESCRIPTION	VTD RANGE	RTD RANGE
Pin 1	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 1)	0-5.5V	
Pin 2	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 1)	0-5.5V	
Pin 3	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/FREQ (Bank 1)		
Pin 4	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/FREQ (Bank 1)		
Pin 5	Battery(-)		
Pin 6	Battery (+) CPU - Unswitched and Output Pins 1-4 (Max 15A) with VTD2	0-35V	
Pin 7	CAN1-L / Wake-up from Suspend		
Pin 8	CAN1-H / Wake-up from Suspend		
Pin 9	CAN2-L		
Pin 10	CAN2-H		
Pin 11	Key switch STB with VTD2 / Controlled Shutdown	0-35V	
Pin 12	Battery (+) Outputs Pins 15-18 (Max 15A) with VTD2	0-35V	
Pin 13	Input STB/STG/TRI/VTD1/VTD2/FREQ	0-5.5V / 0-35V	
Pin 14	Input STB/STG/TRI/VTD1/VTD2/FREQ	0-5.5V / 0-35V	
Pin 15	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI (Bank 2)		
Pin 16	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI (Bank 2)		
Pin 17	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI (Bank 2)		
Pin 18	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI (Bank 2)		
Bank 1	Each pin within bank can be independently configured as Output or any Input type.		
Bank 2	Each pin within bank can be independently configured as Output or any Input type.		

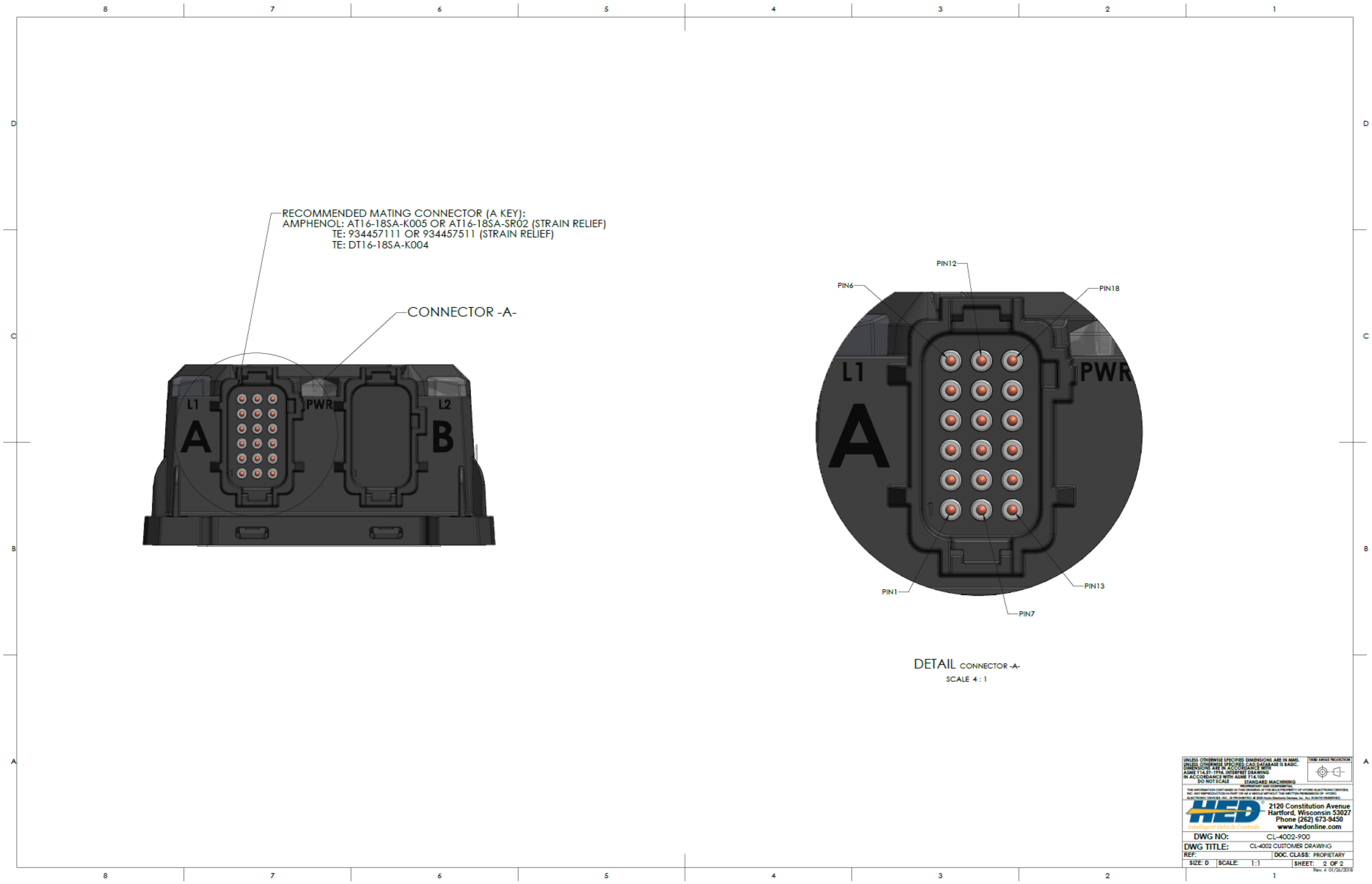
PINOUT – Flex Configuration (CL-4002-101)

PIN	DESCRIPTION	VTD RANGE	RTD RANGE
Pin 1	Unused		
Pin 2	Unused		
Pin 3	Unused		
Pin 4	Unused		
Pin 5	Battery(-)		
Pin 6	Battery (+) CPU - Unswitched with VTD2	0-35V	
Pin 7	CAN1-L / Wake-up from Suspend		
Pin 8	CAN1-H / Wake-up from Suspend		
Pin 9	CAN2-L		
Pin 10	CAN2-H		
Pin 11	Key switch STB with VTD2 / Controlled Shutdown	0-35V	
Pin 12	Battery (+) Outputs Pins 15-18 (Max 15A) with VTD2	0-35V	
Pin 13	Unused		
Pin 14	Unused		
Pin 15	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Pin 16	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Pin 17	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Pin 18	Output DOUT/PWM/ECC(+)(5A) / Input STB/STG/TRI/VTD1 (Bank 2)	0-5.5V	
Bank 1	Each pin within bank can be independently configured as Output or any Input type.		
Bank 2	Each pin within bank can be independently configured as Output or any Input type.		

CL-4002 Series DRAWINGS



NOTES:
1. ALL [XX] ARE IN INCHES'S ALL OTHER DIMENSIONS ARE IN MM'S.
2. THE MOUNTING FEATURES ACCEPT M6 OR 1/4" FASTENERS.
3. INSTALLATION TORQUE: 5.6-6.2Nm (50-55 INLBS).
4. BUTTON HEAD OR FLANGED HEAD FASTENER, A WASHER WITH A SOCKET HEAD CAP SCREW IS ACCEPTABLE.
5. THREAD LOCKING PATCH RECOMMENDED, DO NOT USE LIQUID THREAD LOCKER UNLESS RATED FOR USE WITH PLASTIC.
6. OPERATING TEMPERATURE: -40° C TO +85° C.
7. STORAGE TEMPERATURE: -40° C TO +85° C.
8. IP CLASS:
   A. WITH STANDARD CONNECTOR, WIRE 14-20 AWG, AND OR SEAL PLUGS INSTALLED, IN ALL POSITIONS.
      i. IP6X
      ii. IPX7
   B. WITH BOOTED CONNECTOR AND PROTECTION OF GORE VENT.
      i. IPX9K
9. OPERATING VOLTAGE: 8-32 VDC
10. WEIGHT: 0.7LBS.



RECOMMENDED MATING CONNECTOR (A KEY):
AMPHENOL: AT16-18SA-K005 OR AT16-18SA-SR02 (STRAIN RELIEF)
TE: 934457111 OR 934457511 (STRAIN RELIEF)
TE: DT16-18SA-K004
CONNECTOR -A-
L1
PWR
L2
A
B
PIN12
PIN6
PIN18
PIN1
PIN13
PIN7
DETAIL CONNECTOR -A-
SCALE 4 : 1
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MMS.
UNLESS OTHERWISE SPECIFIED CAD DATABASE IS BASIC.
DIMENSIONS ARE IN ACCORDANCE WITH
ASME Y14.5Y-1994. INTERPRET DRAWING
IN ACCORDANCE WITH ASME Y14.100
DO NOT SCALE
STANDARD MACHINING
PROPRIETARY AND CONFIDENTIAL
2120 Constitution Avenue
Hartford, Wisconsin 53027
Phone (262) 673-9450
www.hedonline.com
DWG NO: CL-4002-900
DWG TITLE: CL-4002 CUSTOMER DRAWING
REF:
DOC. CLASS: PROPIETARY
SIZE: D
SCALE: 1:1
SHEET: 2 OF 2
Rev. 4 01/26/2018

GENERAL GUIDELINES AND COMPLIANCE

FCC COMPLIANCE

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by HED could void the user's authority to operate the equipment. The device (when using internal antenna version) or external antenna(s) used with this device must provide a separation distance of at least 20cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with multi-transmitter policies.

This device contains the following FCC compliant module(s):

Device	Specification	ID
CL-4002_MC2-BLE	Part 15C + MPE FCC RF Exposure (Bluetooth®)	Bluetooth® LE FCC ID Contains: XPYANNAB4
	Part 15C + MPE FCC RF Exposure (802.15.4)	

ISED COMPLIANCE (Formally IC Compliance)

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Any changes or modifications not expressly approved by HED could void the user's authority to operate the equipment. The device (when using internal antenna version) or external antenna(s) used with this device must provide a separation distance of at least 20cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with multi-transmitter policies.

This device contains the following IC compliant module(s):

Device	Specification	ID
CL-4002_MC2-BLE	Part 15C + MPE FCC RF Exposure (Bluetooth®)	Bluetooth® LE FCC ID Contains: XPYANNAB4
	Part 15C + MPE FCC RF Exposure (802.15.4)	

EU / CE COMPLIANCE

Directives	Harmonized Standards
2014/30/EU (Electromagnetic Compatibility)	• EN 14982:2009 Agriculture and forestry machines – Electromagnetic compatibility – Test methods and acceptance criteria • EN 13309:2010 Construction machinery Electromagnetic compatibility of machines with internal electrical power supply • EN 50498:2010 Electromagnetic compatibility (EMC) — Product family standard for aftermarket electronic equipment in vehicles • ISO 13766:2006 Earth-moving machinery – Electromagnetic compatibility.
2011/65/EU (RoHS)	EN 50581:2012 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substance.

OTHER INFORMATION

Standard Warranty

Please see HED, Inc.'s standard warranty on our website at: https://hedcontrols.com/standard-warranty/