

CL-446 Product Family Specification

PFS-CL446-A2

7/15/2015



INTELLIGENT VEHICLE CONTROLS



HED® Inc.

2120 Constitution Avenue

Hartford, WI 53027 USA

Telephone: (800) 398-2224

Fax: (262) 673-9455

Email: info@hedonline.com

Web: www.hedonline.com

Copyright 2014 © HED® Inc.

All rights reserved. This material may not be reproduced, published, displayed, modified, or distributed in any form or by any means, or stored in a database retrieval system, without the express prior written permission of HED® Inc.

USING THIS DOCUMENT

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

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.

INPUT STB/STG/VTD/RTD (PINS A01-A04)¹
INPUT STB/STG/VTD (PINS A09-A10, B01-B12)^{1,2}
INPUT STB/STG/VTD/FREQ/PWM/ENCODER (PINS A11-A12)¹

Switch-to-Battery (STB) Mode

Input Resistance³

- 1.4KΩ or 1.47KΩ (typical)

Input Current³

- 5.7mA or 5.4mA at 8V (typ)
- 24.0mA or 21.7mA at 32V (typ)

Positive Going Threshold

- > 7.0V

Negative Going Threshold

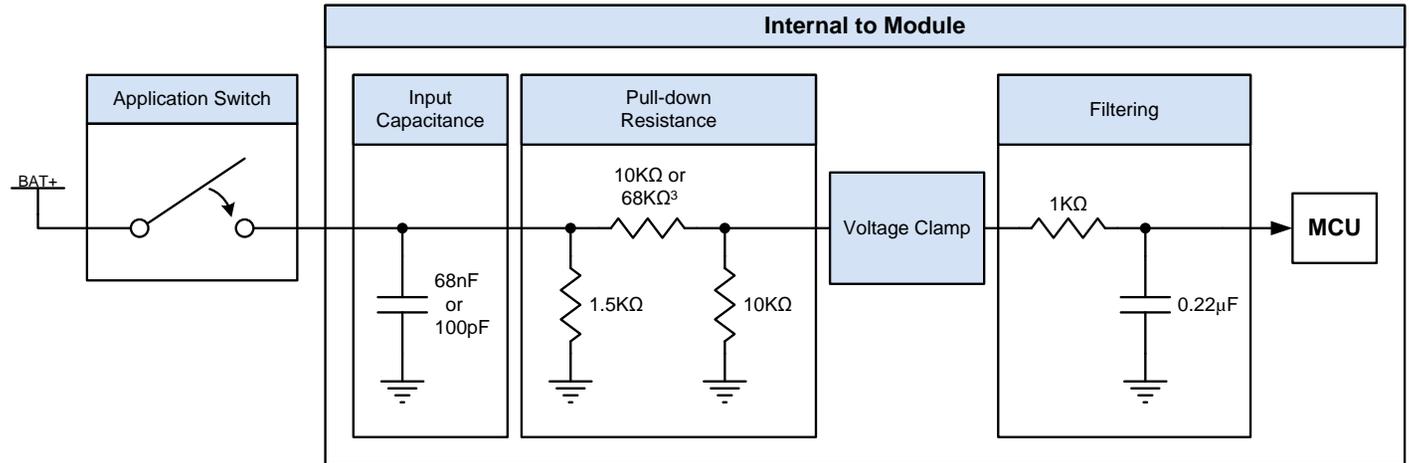
- < 3.0V

Parallel Resistance

- 2KΩ at 8V (minimum)
- 12KΩ at 32V (minimum)

Series Resistance

- 220Ω (maximum)



**Switch-to-Ground (STG) Mode
(also Harness ID Mode)**

Pull-up Resistance

- 560Ω (typical)

Input Current

- 7.6mA at 0V (typical)

Positive Going Threshold

- > 3.5V

Negative Going Threshold

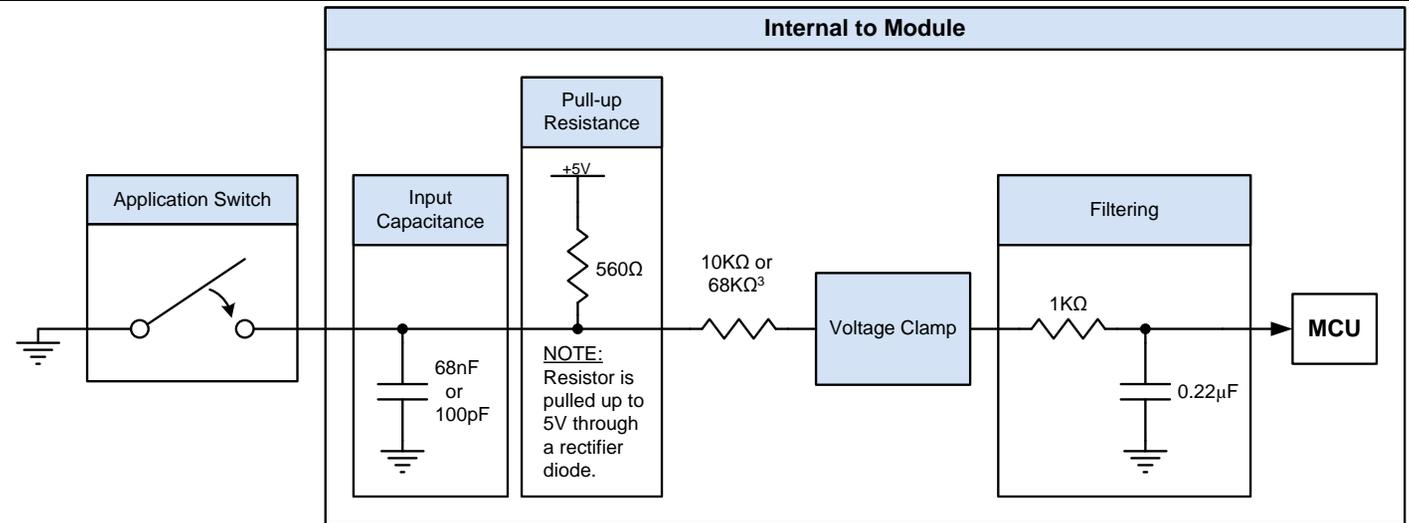
- < 1.5V

Parallel Resistance

- 2KΩ at 0V (minimum)

Series Resistance

- 220Ω (maximum)



¹ Pins A01-A04, A09-A10, and B01-B12 have input capacitance of 68nF. Pins A11-A12 have input capacitance of 100pF.

² Pins B09-B12 may be capable of use as harness IDs (HID). Please see module-specific datasheet for pinout.

³ The first value (before 'or') is for pins whose VTD mode is 0-5.5V. The second value (after 'or') is for pins whose VTD mode is 0-11V.

INPUT STB/STG/VTD/RTD (PINS A01-A04)¹
INPUT STB/STG/VTD (PINS A09-A10, B01-B12)¹
INPUT STB/STG/VTD/FREQ/PWM/ENCODER (PINS A11-A12)¹

**Voltage-to-Digital (VTD) Mode
(0 – 5.65VDC)**

Input Voltage Range

- 0V to 5.5V (minimum)
- 0V to 5.65V (typical)

Input Resistance

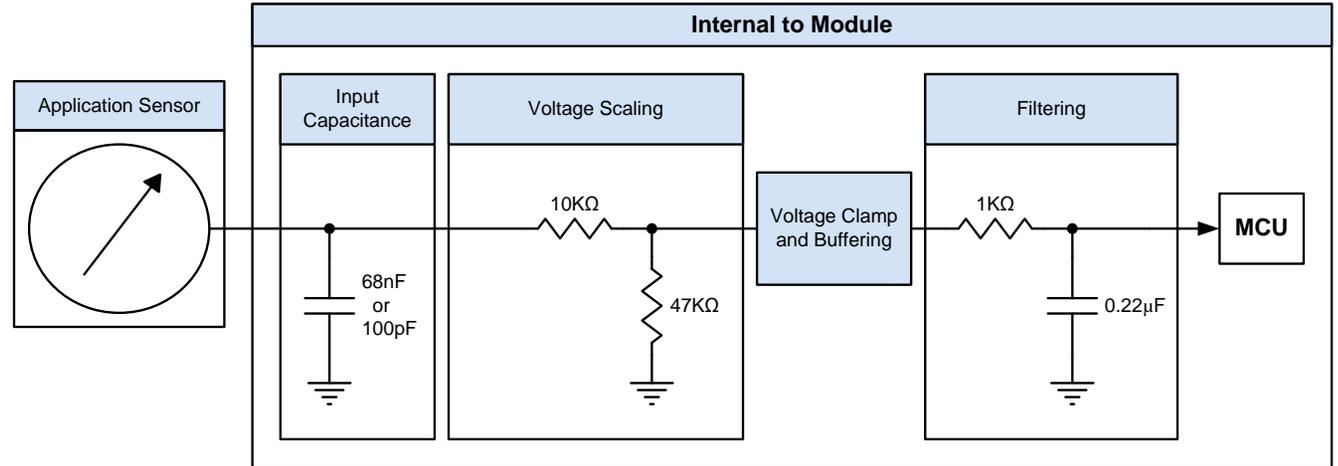
- 57K Ω (typical)

Resolution

- 12 Bits
- 1.38mV / count (typical)

Accuracy²

- $\pm 1.0\%$ and $\pm 12\text{mV}$ ($T_A = 25^\circ\text{C}$)
- $\pm 2.5\%$ and $\pm 18\text{mV}$ ($T_A = \text{Full}$)



**Voltage-to-Digital (VTD) Mode
(0 – 11.40VDC)**

Input Voltage Range

- 0V to 11.13V (minimum)
- 0V to 11.40V (typical)

Input Resistance

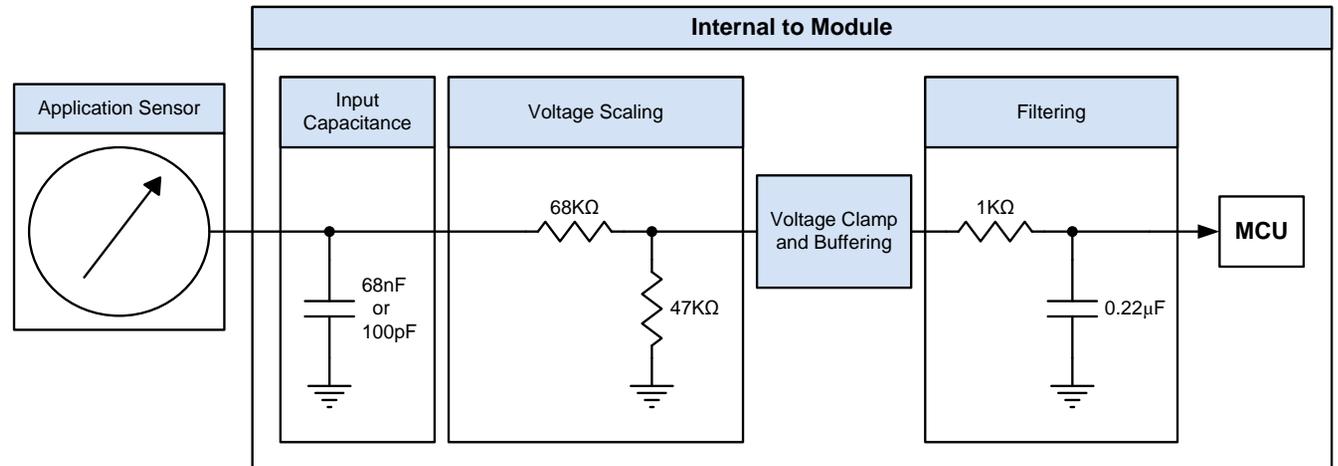
- 115K Ω (typical)

Resolution

- 12 Bits
- 2.78mV / count (typical)

Accuracy²

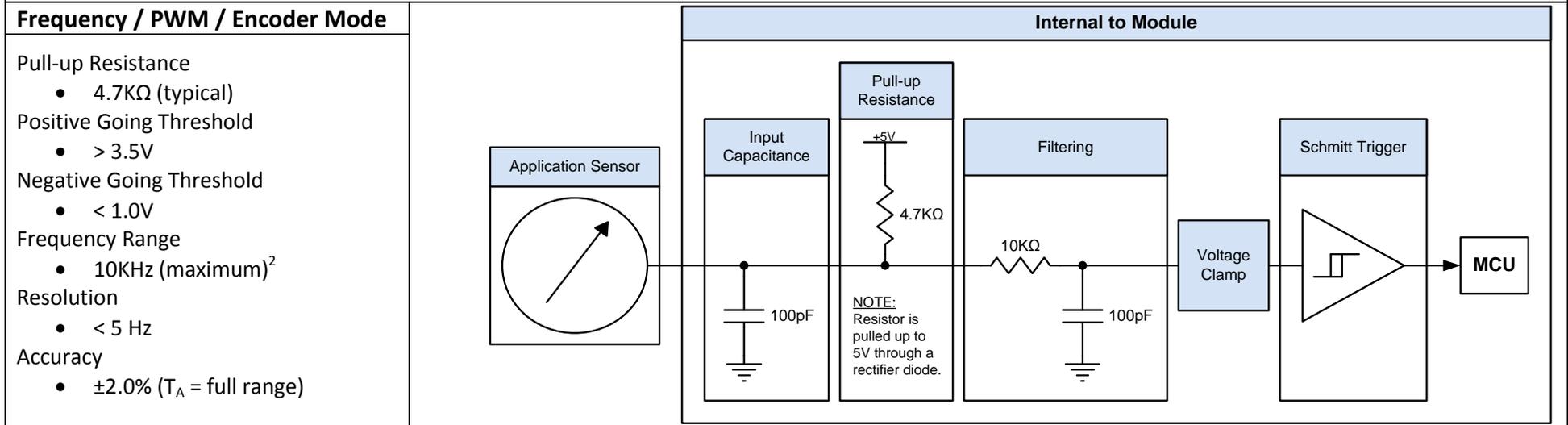
- $\pm 1.0\%$ and $\pm 24\text{mV}$ ($T_A = 25^\circ\text{C}$)
- $\pm 2.5\%$ and $\pm 37\text{mV}$ ($T_A = \text{Full}$)



¹ Pins A01-A04, A09-A10, and B01-B12 have input capacitance of 68nF. Pins A11-A12 have input capacitance of 100pF.

² VTD accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods. It is considered as a percentage of the input voltage combined with an additional offset.

INPUT STB/STG/VTD/RTD (PINS A01-A04)¹
INPUT STB/STG/VTD (PINS A09-A10, B01-B12)¹
INPUT STB/STG/VTD/FREQ/PWM/ENCODER (PINS A11-A12)¹

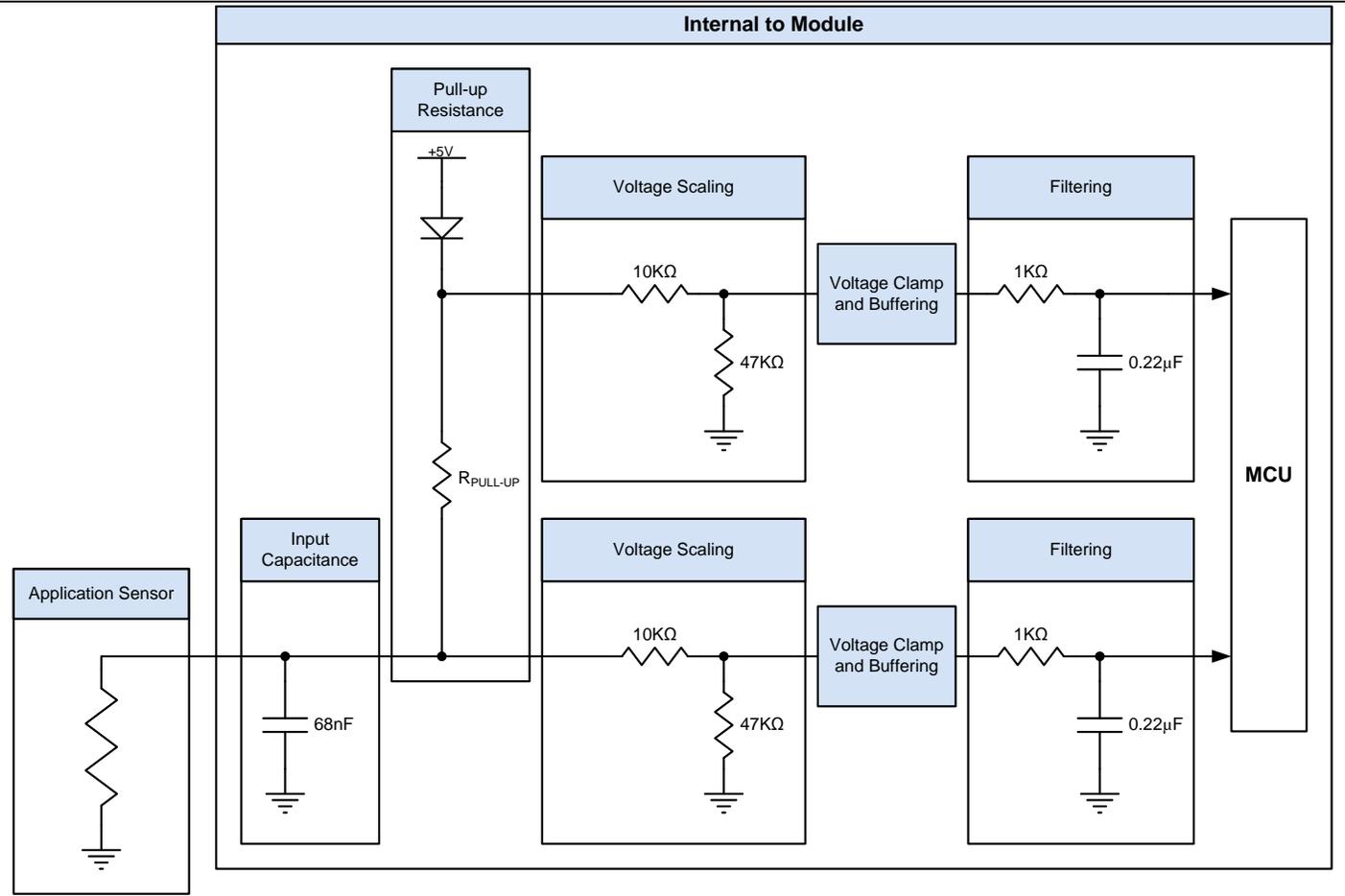


¹ Pins A01-A04, A09-A10, and B01-B12 have input capacitance of 68nF. Pins A11-A12 have input capacitance of 100pF.

² Frequency range maximum assumes square wave, open-drain, sinking sensor at 50% duty cycle.

INPUT STB/STG/VTD/RTD (PINS A01-A04)¹
INPUT STB/STG/VTD (PINS A09-A10, B01-B12)¹
INPUT STB/STG/VTD/FREQ/PWM/ENCODER (PINS A11-A12)¹

Resistance-to-Digital (RTD) Mode (0 – 200Ω)
Pull-up Resistance ($R_{PULL-UP}$) <ul style="list-style-type: none"> • 200Ω (typical) Accuracy ² <ul style="list-style-type: none"> • ±1.0% and ±1.5% ($T_A = 25^\circ\text{C}$) • ±2.5% and ±2.0% ($T_A = \text{Full}$)
Resistance-to-Digital (RTD) Mode (0 – 1KΩ)
Pull-up Resistance ($R_{PULL-UP}$) <ul style="list-style-type: none"> • 1KΩ (typical) Accuracy ² <ul style="list-style-type: none"> • ±1.0% and ±7.0% ($T_A = 25^\circ\text{C}$) • ±2.5% and ±10.0% ($T_A = \text{Full}$)

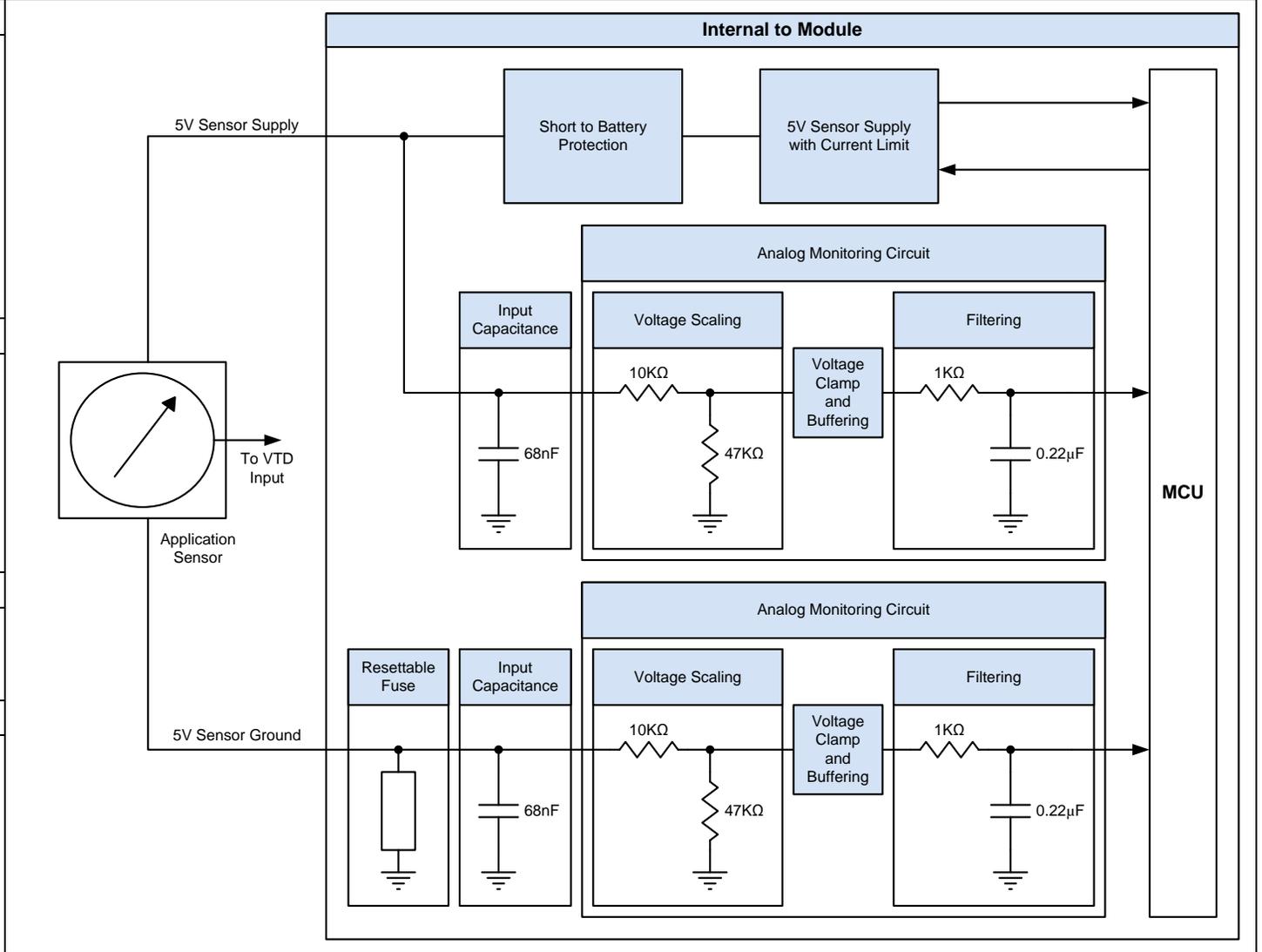


¹ Pins A01-A04, A09-A10, and B01-B12 have input capacitance of 68nF. Pins A11-A12 have input capacitance of 100pF.

² RTD accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods. It is considered as a percentage of the application sensor resistance combined with an additional offset. Offset is estimated at an application sensor resistance of $\frac{1}{2}(R_{PULL-UP})$.

5VDC SENSOR SUPPLY (PIN C06) AND SENSOR GROUND (PIN C07)

5VDC Sensor Supply Mode
Voltage Range <ul style="list-style-type: none"> • 5V ± 5% Current Rating <ul style="list-style-type: none"> • 500mA Current Limit <ul style="list-style-type: none"> • 503mA (minimum) • 522mA (typical) • 633mA (maximum)
Analog Monitoring Circuit
Resolution <ul style="list-style-type: none"> • 12 Bits • 1.38mV / count (typical) Accuracy <ul style="list-style-type: none"> • See Section Input – VTD Mode (0-5.65V Range)
5VDC Sensor Ground Mode
Current Rating <ul style="list-style-type: none"> • 500mA
Analog Monitoring Circuit
Resolution <ul style="list-style-type: none"> • 12 Bits • 1.38mV / count (typical) Accuracy <ul style="list-style-type: none"> • See Section Input – VTD Mode (0-5.65V Range)



CAN COMMUNICATION (PINS A07/A08, D01/D02)

Baud Rate

- 40kbps to 500kbps

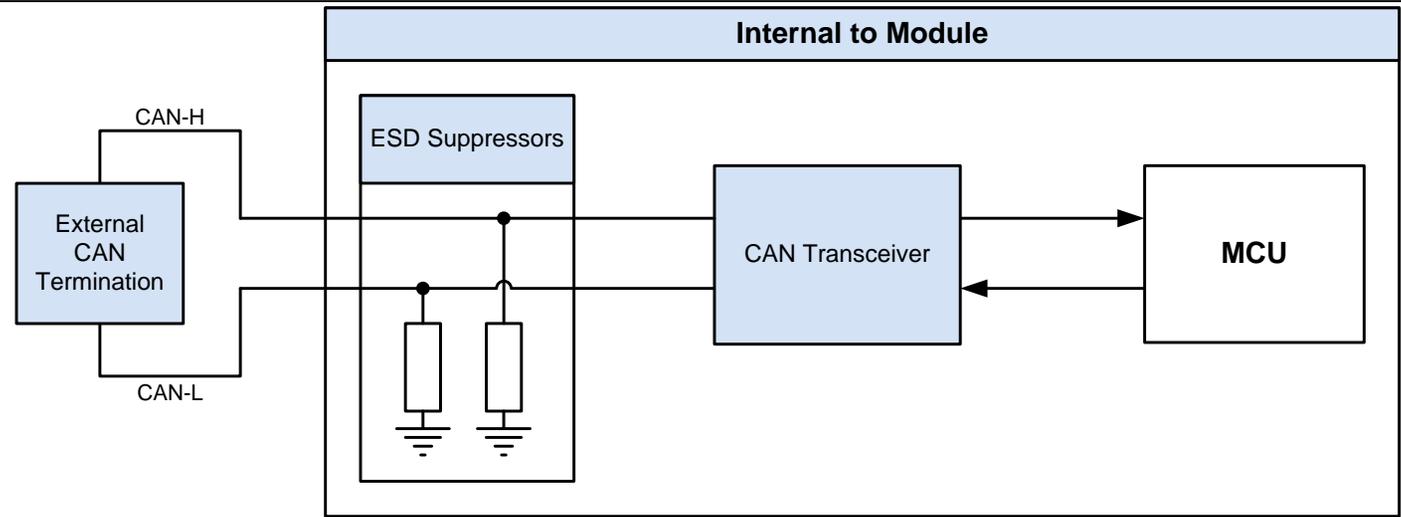
Maximum Allowable Voltage¹

- -27V to +40V

Input Capacitance (maximum)

- 26pF (f = 1MHz)

No Internal Termination



¹ Maximum allowable voltage defines the voltage extremes that the transceiver can tolerate. Exposure to these voltages for extended periods may affect device reliability.

USB-TO-UART SERIAL COMMUNICATION (PINS D05/D06/D07/D08)¹

USB Standard

- USB 2.0

Serial Baud Rate

- Up to 115.2 Kbps

V_{BUS} Input Voltage Range

- 4.00V < V_{BUS} < 5.25V

V_{BUS} Input Capacitance (typical)

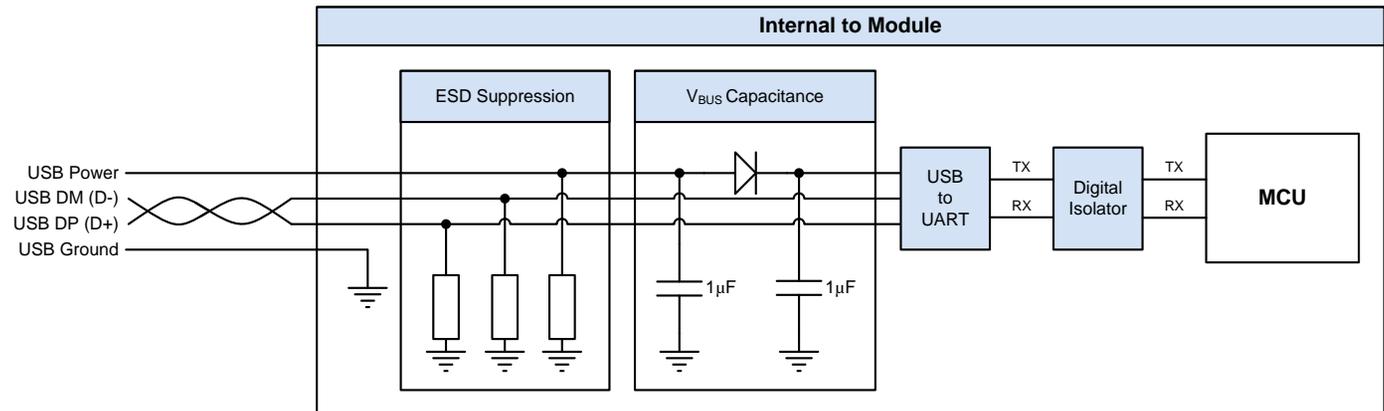
- 2.0μF

ESD Suppression Capacitance (typ)

- 12pF

Maximum Working Insulation Voltage

- 560V_{PK}



¹ USB power and signal pins are not protected against shorts to vehicle battery or other signals above USB V_{BUS} voltage levels. Care must be taken to ensure wiring errors and shorts to higher voltage levels do not occur in the application.

OUTPUT DOUT(+)/PWM(+)/ECC(+) (PINS C02-C05, C08-C11)

Individual Output Current¹

- Digital Mode = 2.5A (maximum)
- PWM Mode = 2.5A (maximum)

Grouped Output Current^{2,3,4}

- Digital Mode = 2.5A (maximum)
- PWM Mode = 2.0A (maximum)

PWM Frequency⁵

- < 300 Hz (typical)
- < 1 KHz (maximum)

Output Diagnostics

- Short to Battery
- Short to Ground
- Overcurrent
- Open Circuit⁶

Current Sense Range

- Up to 3.2A (minimum)
- Up to 4.0A (typical)

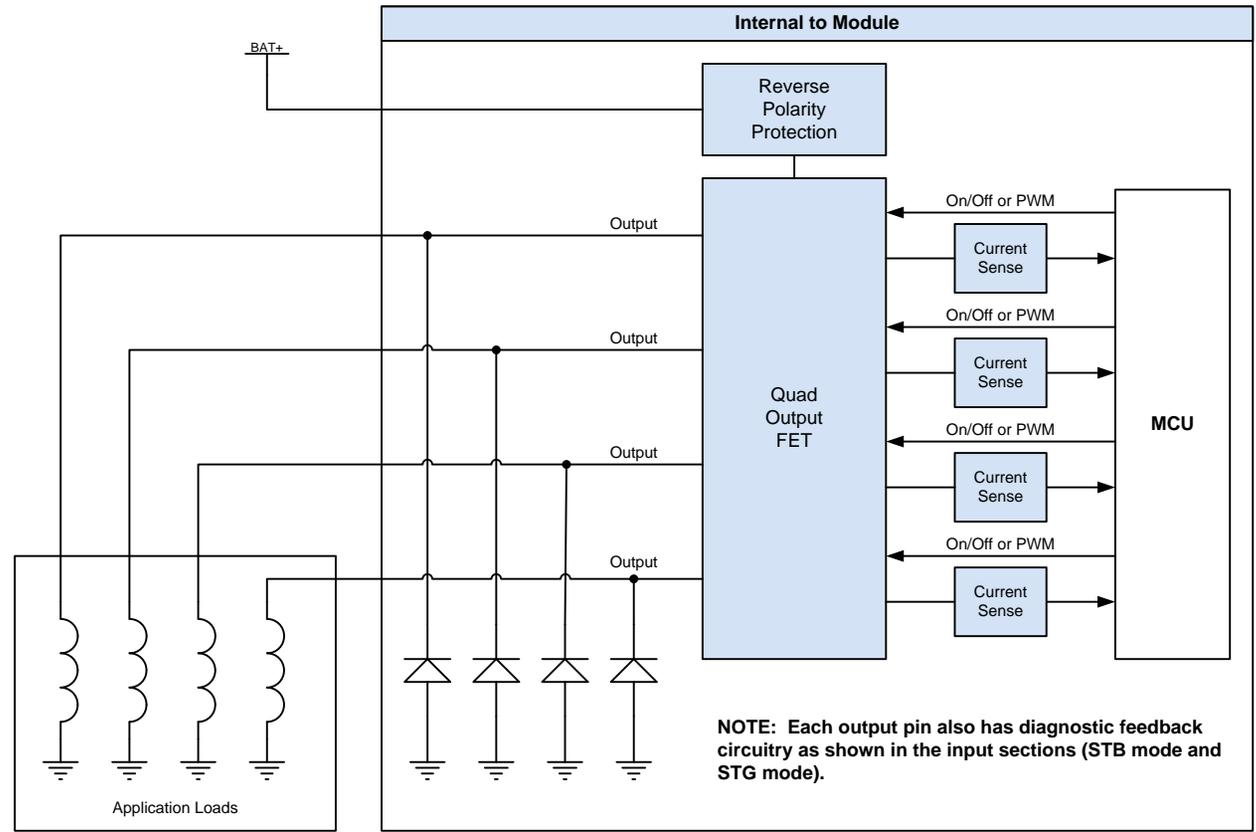
Current Sense Resolution

- 12 bits
- 1.0mA / count (typical)

Current Sense Accuracy (typical)

- $\pm 50\text{mA}$ at 2A, $T_A = 25^\circ\text{C}$

Internal Flyback Diodes



¹ Individual Output Current specifies the maximum current for an individual output channel. Additional restrictions regarding total output current, number of active channels, etc. will apply and are specified in the Grouped Output Current parameter. PWM outputs assume 250Hz frequency.

² Output current is constrained in groups of four pins (quad output FET). Pin groups are C02-C05 and C08-C11. It is strongly recommended to level the total output current across each of the groups as much as possible for best thermal performance.

³ Output current maximums assume all four channels are active simultaneously and the module is at maximum ambient temperature. PWM outputs assume 250Hz frequency. Output current may be increased per channel (up to the individual output current maximum) if not all channels are active simultaneously or other channels are at a reduced load current. Please contact HED® for further information.

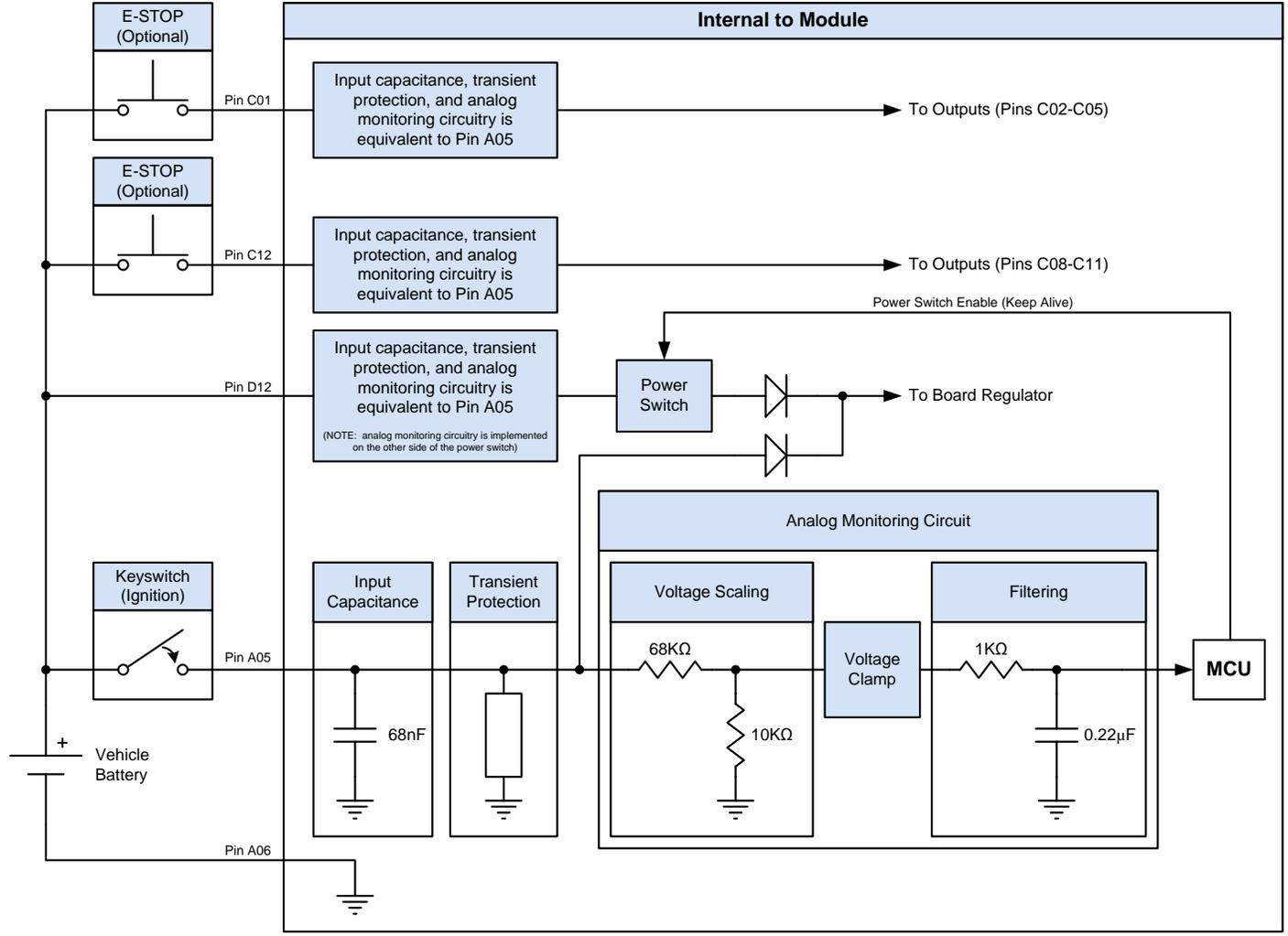
⁴ Maximum total output current for Pins C02-C05 is 10 Amps. Maximum total output current for Pins C08-C11 is 10 Amps.

⁵ The output driver is best suited for PWM frequencies of 300 Hz or less. PWM frequencies of up to 1 KHz are possible, but at reduced output current and duty cycle range.

⁶ Open circuit can be detected when the output is active using current sense feedback for load currents of at least 250mA and duty cycle of 100%. Open circuit can be detected when the output is inactive using the pull-up resistor for loads that are not influenced by the associated pull-up current (see Input STG mode circuit diagram and parameters).

BATTERY (+) MODULE (PIN A05) AND BATTERY (+) OUTPUTS (PINS C01, C12)¹

<p>Battery (+)</p> <p>Operating Voltage Range</p> <ul style="list-style-type: none"> • 8VDC – 32VDC <p>Maximum Continuous Voltage²</p> <ul style="list-style-type: none"> • 36VDC <p>Module Current Draw³</p> <ul style="list-style-type: none"> • 89mA at 8.0V (typ) • 60mA at 13.8V (typ) • 47mA at 28.0V (typ) • 45mA at 32.0V (typ) <p>Maximum Total Output Current</p> <ul style="list-style-type: none"> • See Output Section for output current constraints
<p>Analog Monitoring Circuit</p> <p>Input Voltage Range</p> <ul style="list-style-type: none"> • 0V to 35.54V (minimum) • 0V to 36.33V (typical) <p>Input Resistance</p> <ul style="list-style-type: none"> • 78KΩ (typical) <p>Resolution</p> <ul style="list-style-type: none"> • 12 Bits • 8.87mV / count (typical) <p>Accuracy⁴</p> <ul style="list-style-type: none"> • ±1.0% and ±75mV (T_A = 25°C) • ±2.5% and ±117mV (T_A = Full)



¹ The block diagram shown represents one possible implementation in the system. Other implementations may be used based on system requirements.

² Exposure to maximum voltages for extended periods may affect device reliability.

³ Module current draw is measured with I/O inactive, no CAN communication, and 5V sensor supply disabled.

⁴ VTD accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods. It is considered as a percentage of the input voltage combined with an additional offset.

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.

REVISION HISTORY

Revision	Date	EC #	Changes
A1	12/16/14	314-542	Initial Release
A2	7/15/15	315-246	Added switching thresholds to STB and STG inputs. Added note regarding loss of ground event.