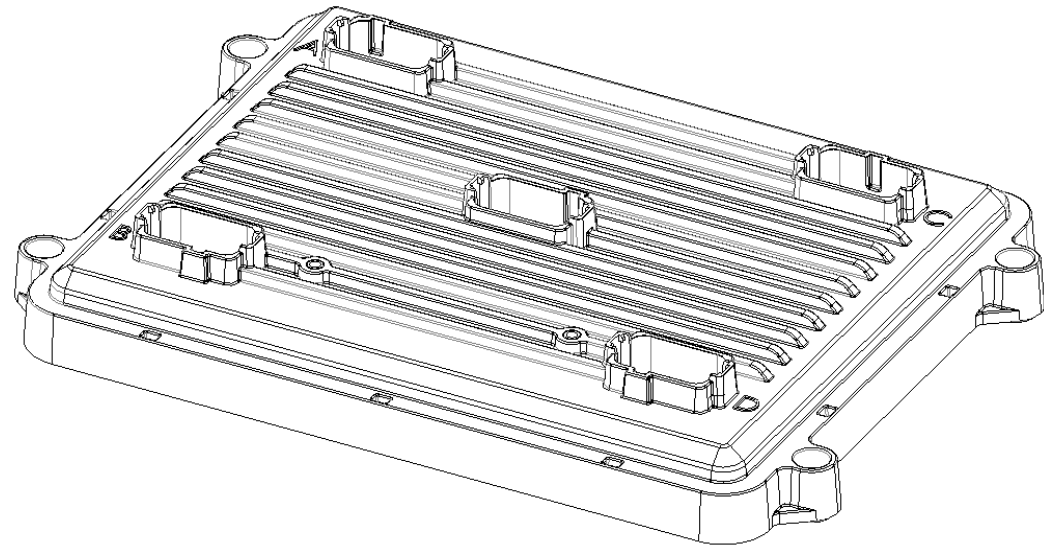


# CL-450 Product Family Specification

PFS-CL450-A1

7/23/2014



INTELLIGENT VEHICLE CONTROLS



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## 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 (PINS A15-A18, B11, B15-B18, C07-C08, C11, C15-C18, D08, D11, D15-D18, E07-E08)

### Input Resistance

- 2.6K $\Omega$  (typical)

### Input Current

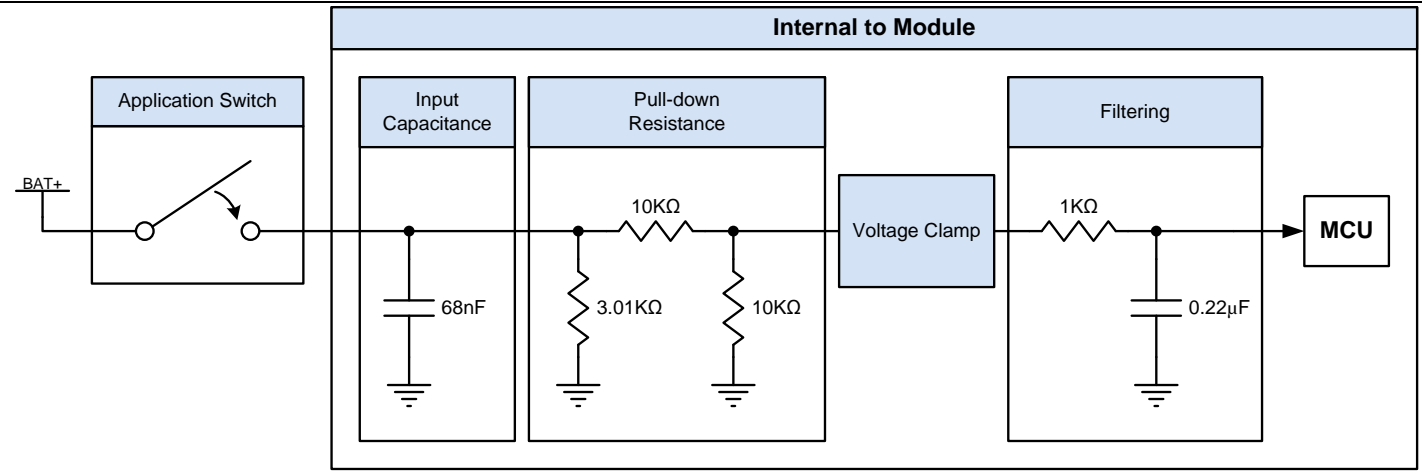
- 3.1mA at 8V (typical)
- 12.2mA at 32V (typical)

### Parallel Resistance

- 2K $\Omega$  at 8V (minimum)
- 16K $\Omega$  at 32V (minimum)

### Series Resistance

- 220 $\Omega$  (maximum)



## RETURN(-) OUTPUTS (PINS A12, B12, C12, D12)

### Current Sense Range

- 0A to 3.84A (minimum)
- 0A to 3.95A (typical)

### Resolution

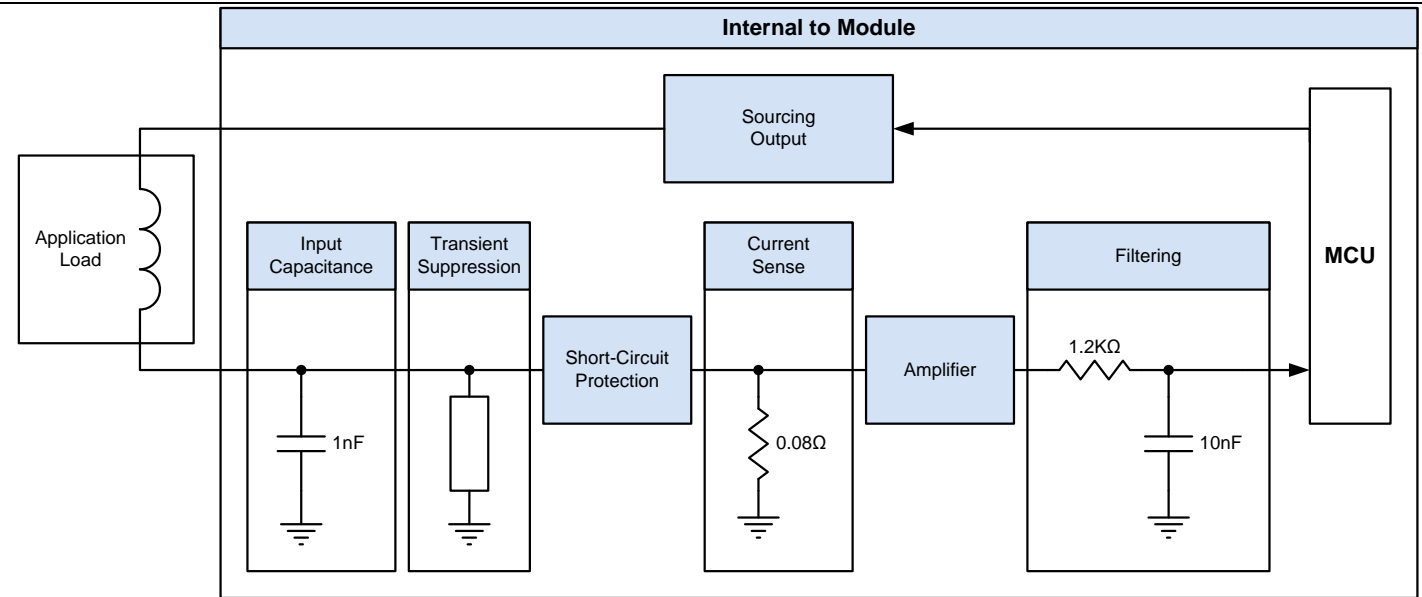
- 12 Bits
- 0.96mA / count (typical)

### Hardware Current Limit / Trip Point

- 4.40A (minimum)
- 5.18A (typical)
- 5.78A (maximum)

### Accuracy<sup>1</sup>

- $\pm 10\text{mA}$  at 0.7A ( $T_A = 25^\circ\text{C}$ )
- $\pm 20\text{mA}$  at 0.7A ( $T_A = \text{full range}$ )
- $\pm 20\text{mA}$  at 2A ( $T_A = 25^\circ\text{C}$ )
- $\pm 30\text{mA}$  at 2A ( $T_A = \text{full range}$ )



<sup>1</sup> Return(-) Output accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods.

## INPUT DUAL RANGE VTD (VTD1 = 0-6.06VDC / VTD2 = 0-14.13VDC) (PINS E01-E04)

**Dual Range (VTD) Mode  
(0 – 6.06VDC)**

Input Voltage Range

- 0V to 6.00V (minimum)
- 0V to 6.06V (typical)

Input Resistance

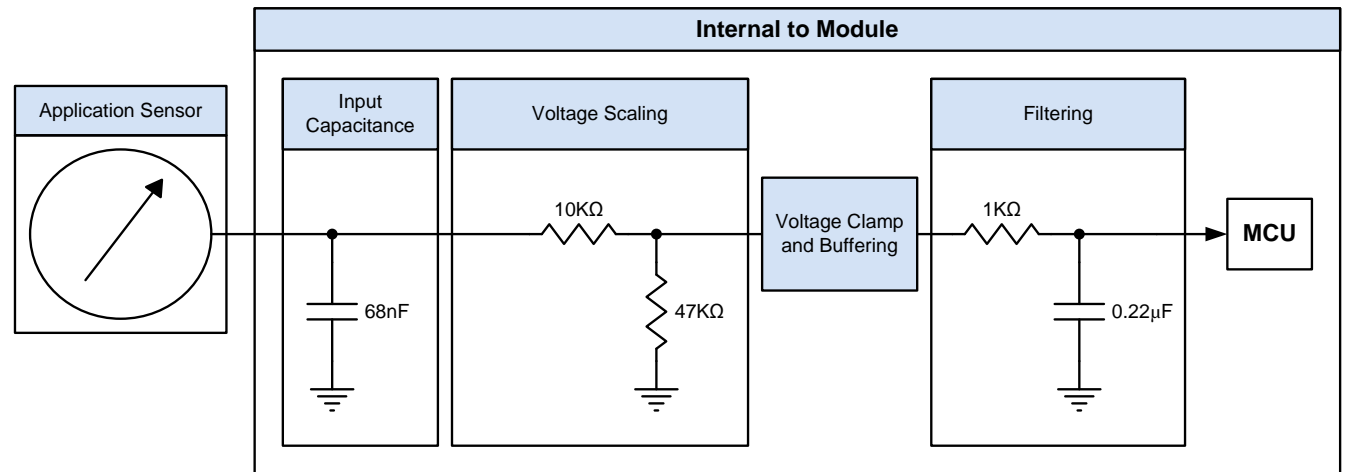
- 57K $\Omega$  (typical)

Resolution

- 12 Bits
- 1.48mV / count (typical)

Accuracy<sup>1</sup>

- $\pm 1.0\%$  ( $T_A = 25^\circ\text{C}$ )
- $\pm 2.0\%$  ( $T_A = \text{full range}$ )



**Dual Range (VTD) Mode  
(0 – 14.13VDC)**

Input Voltage Range

- 0V to 13.90V (minimum)
- 0V to 14.13V (typical)

Input Resistance

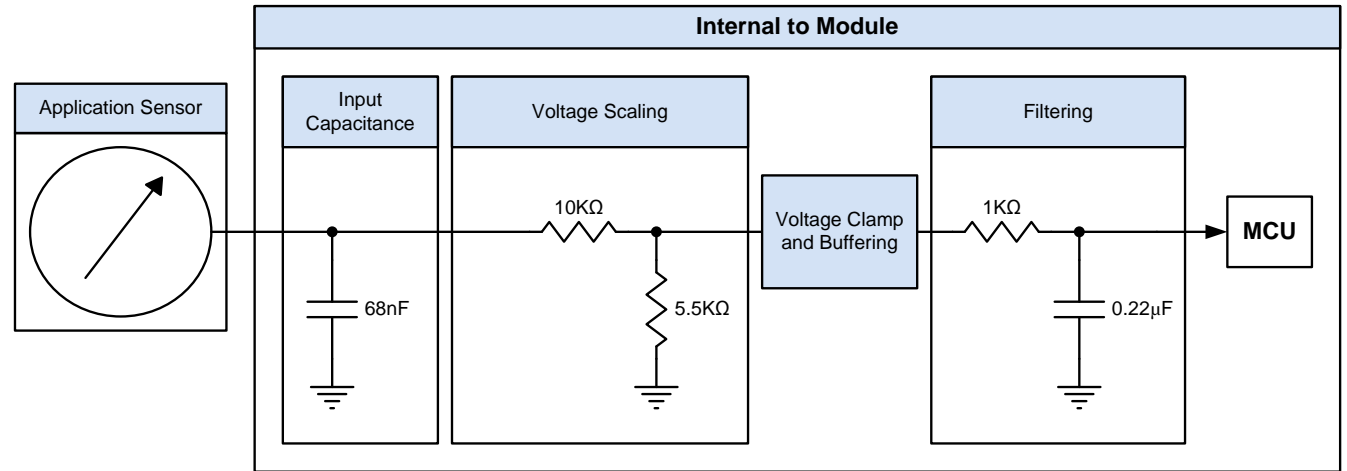
- 15.5K $\Omega$  (typical)

Resolution

- 12 Bits
- 3.45mV / count (typical)

Accuracy<sup>1</sup>

- $\pm 1.0\%$  ( $T_A = 25^\circ\text{C}$ )
- $\pm 2.0\%$  ( $T_A = \text{full range}$ )

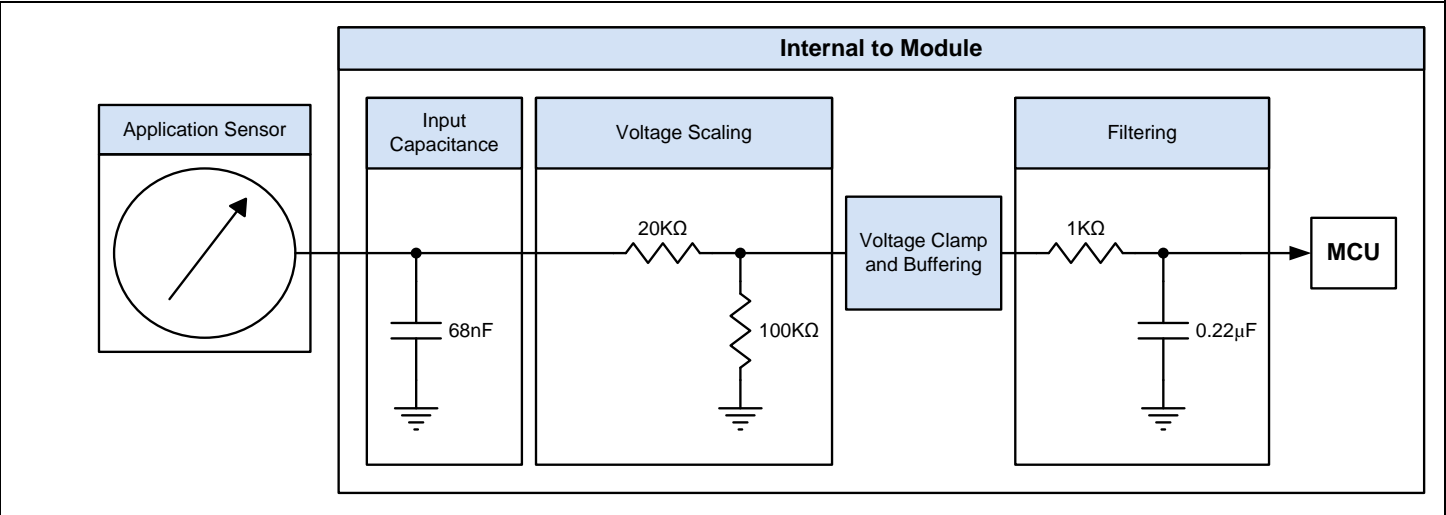


<sup>1</sup> VTD accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods. It is considered as a percentage of the full-scale input voltage range.

# INPUT DUAL RANGE VTD (VTD1 = 0-6.00VDC / VTD2 = 0-39.33VDC) (PINS E01-E04)

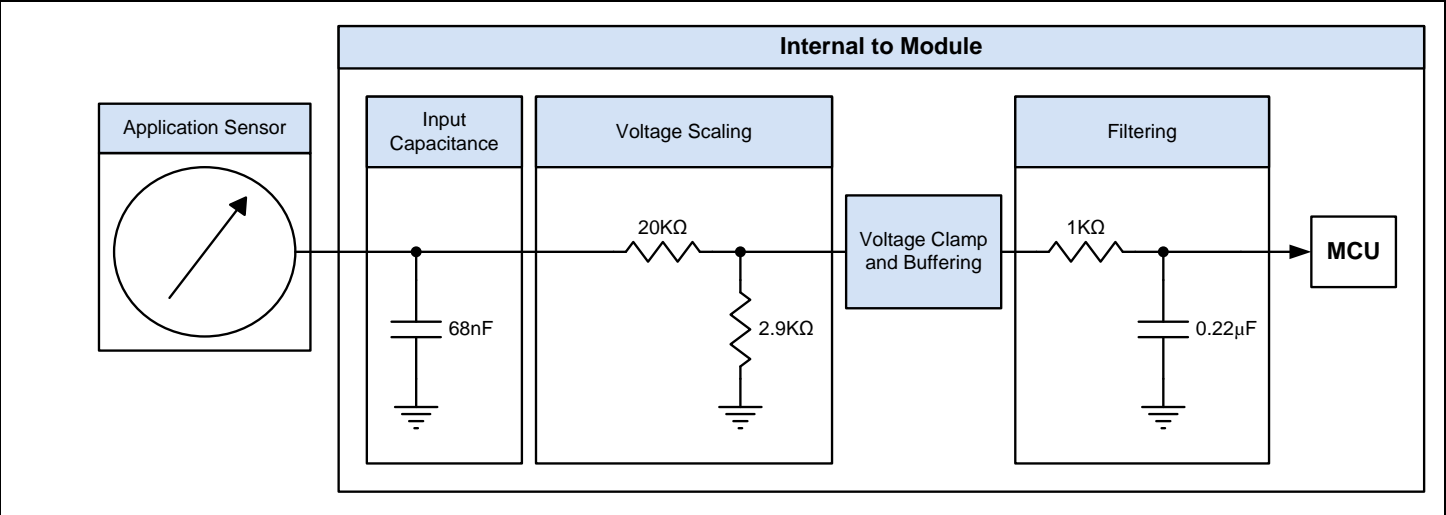
## Voltage-to-Digital (VTD) Mode (0 – 6.00VDC)

- Input Voltage Range
- 0V to 5.93V (minimum)
  - 0V to 6.00V (typical)
- Input Resistance
- 120K $\Omega$  (typical)
- Resolution
- 12 Bits
  - 1.46mV / count (typical)
- Accuracy<sup>1</sup>
- **$\pm 1.0\%$**  ( $T_A = 25^\circ\text{C}$ )
  - **$\pm 2.0\%$**  ( $T_A = \text{full range}$ )



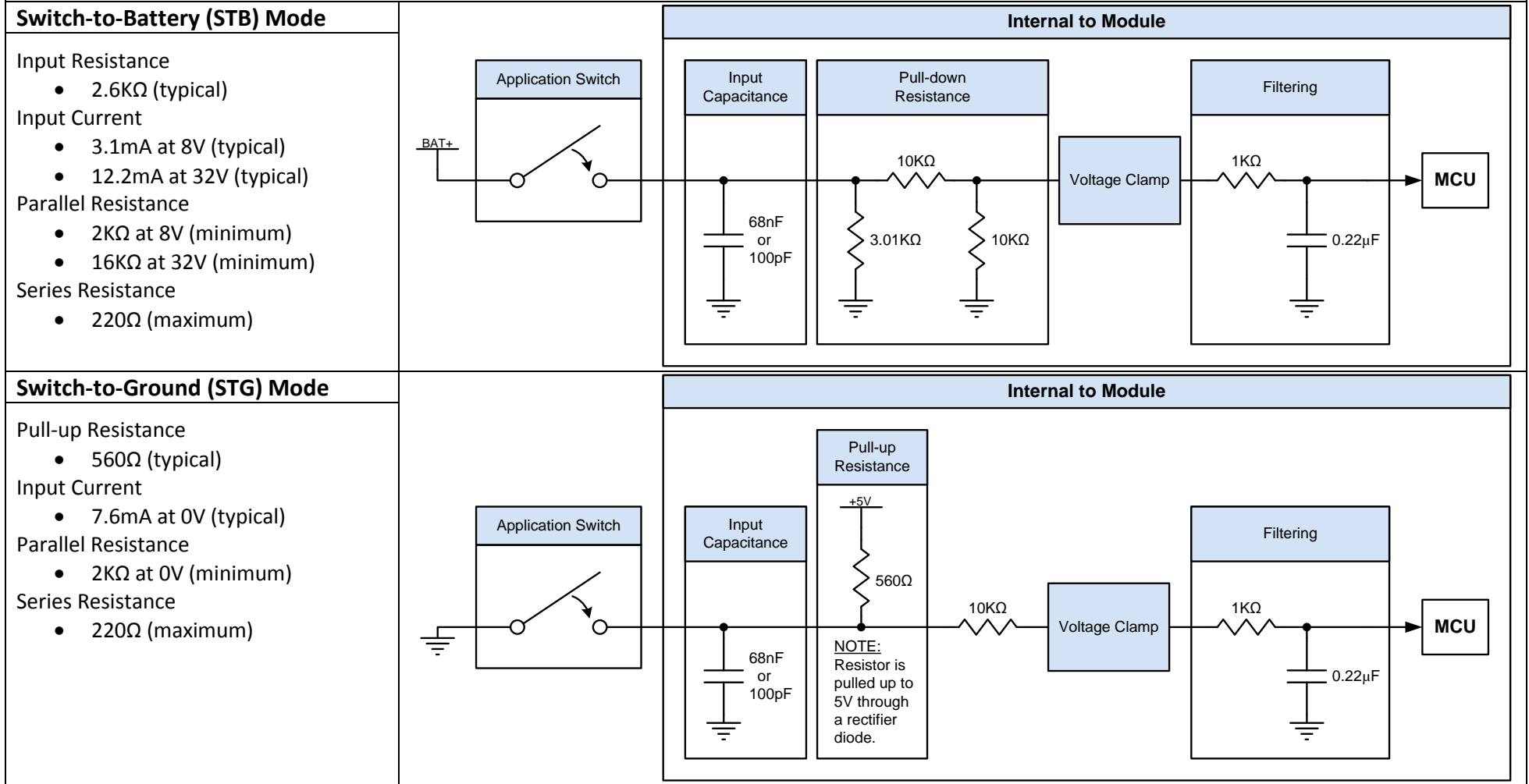
## Voltage-to-Digital (VTD) Mode (0 – 39.33VDC)

- Input Voltage Range
- 0V to 38.91V (minimum)
  - 0V to 39.33V (typical)
- Input Resistance
- 22.9K $\Omega$  (typical)
- Resolution
- 12 Bits
  - 9.60mV / count (typical)
- Accuracy<sup>1</sup>
- **$\pm 1.0\%$**  ( $T_A = 25^\circ\text{C}$ )
  - **$\pm 2.0\%$**  ( $T_A = \text{full range}$ )



<sup>1</sup> 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 full-scale input voltage range.

**INPUT STB/STG/VTD/RTD/4-20mA (PINS E09-E10, E13-E14, E16-E17)<sup>1</sup>**  
**INPUT STB or 4-20mA/STG/VTD/FREQ/PWM/ENCODER (PINS E11-E12, E15, E18)<sup>1</sup>**



<sup>1</sup> Pins E09-E10, E13-E14, and E16-E17 have input capacitance of 68nF. Pins E11-E12, E15, and E18 have input capacitance of 100pF.

# INPUT STB/STG/VTD/RTD/4-20mA (PINS E09-E10, E13-E14, E16-E17) <sup>1</sup>

## INPUT STB or 4-20mA/STG/VTD/FREQ/PWM/ENCODER (PINS E11-E12, E15, E18) <sup>1</sup>

### Voltage-to-Digital (VTD) Mode (0 – 6.06VDC)

#### Input Voltage Range

- 0V to 6.00V (minimum)
- 0V to 6.06V (typical)

#### Input Resistance

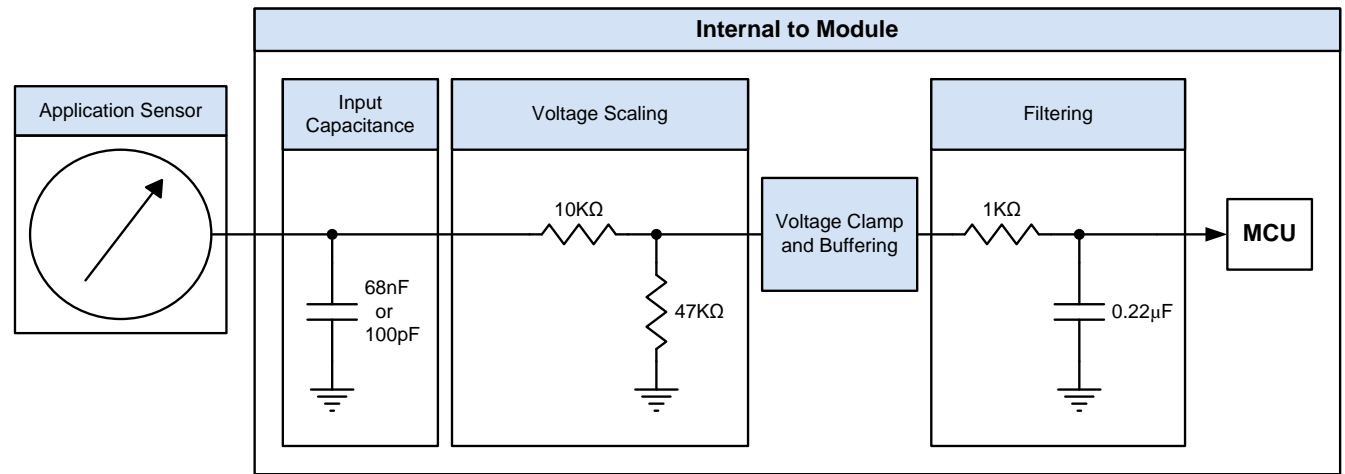
- 53.9K $\Omega$  (typical)

#### Resolution

- 12 Bits
- 1.48mV / count (typical)

#### Accuracy<sup>2</sup>

- $\pm 1.0\%$  ( $T_A = 25^\circ\text{C}$ )
- $\pm 2.0\%$  ( $T_A = \text{full range}$ )

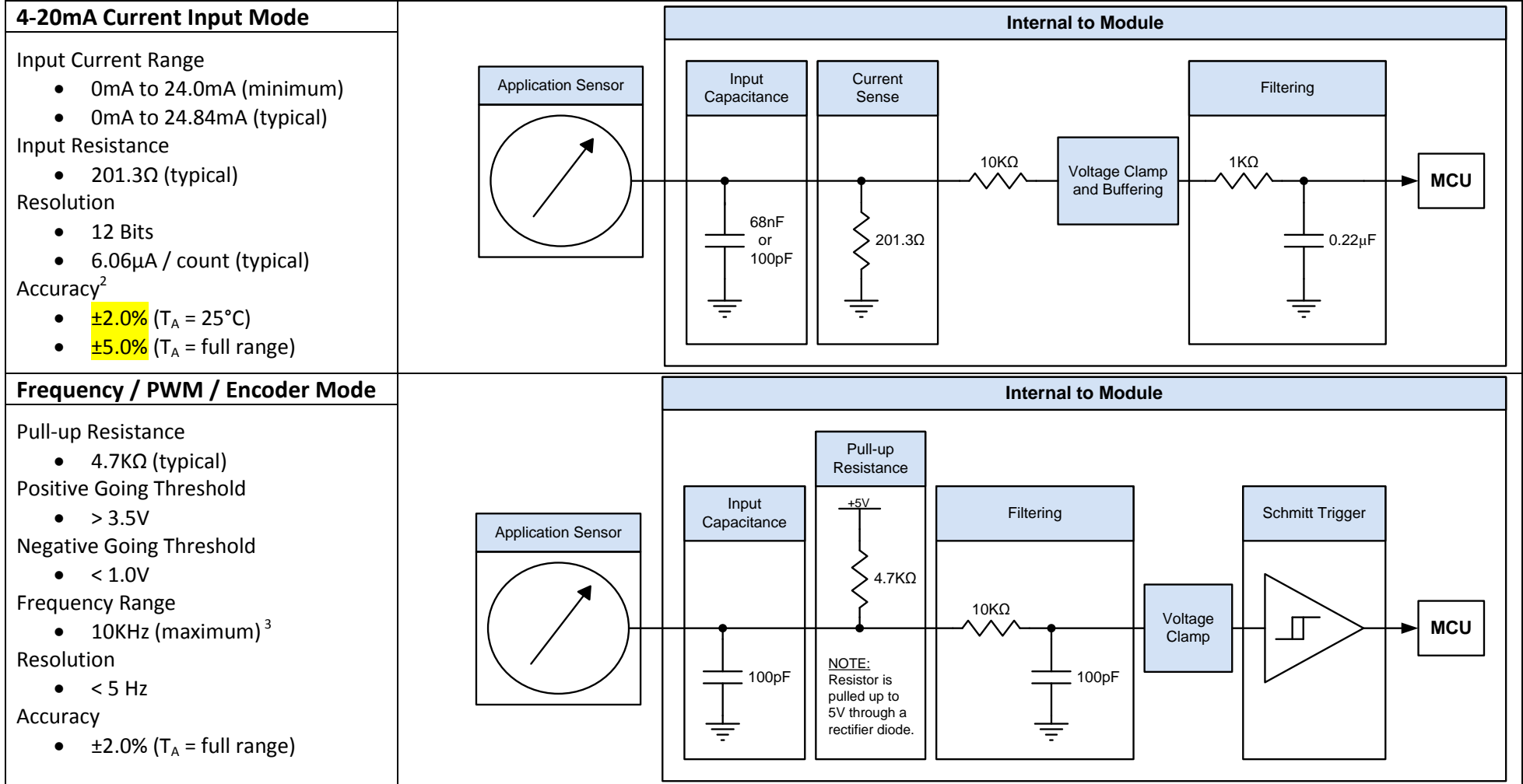


<sup>1</sup> Pins E09-E10, E13-E14, and E16-E17 have input capacitance of 68nF. Pins E11-E12, E15, and E18 have input capacitance of 100pF.

<sup>2</sup> 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 full-scale input voltage range.

# INPUT STB/STG/VTD/RTD/4-20mA (PINS E09-E10, E13-E14, E16-E17)<sup>1</sup>

## INPUT STB or 4-20mA/STG/VTD/FREQ/PWM/ENCODER (PINS E11-E12, E15, E18)<sup>1</sup>



<sup>1</sup> Pins E09-E10, E13-E14, and E16-E17 have input capacitance of 68nF. Pins E11-E12, E15, and E18 have input capacitance of 100pF.

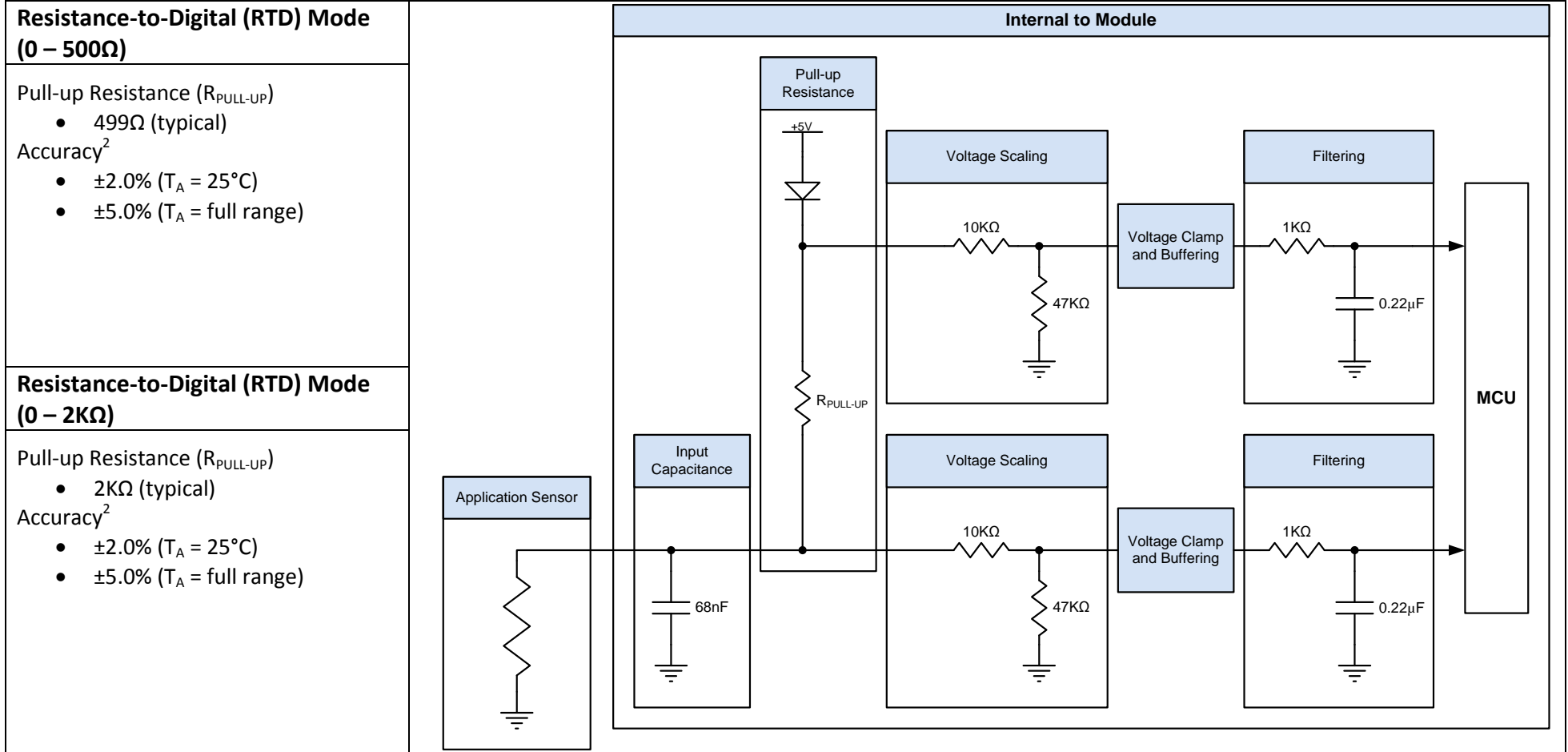
<sup>2</sup> 4-20mA input accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods. It is considered as a percentage of the full-scale input current range.

<sup>3</sup> Frequency range maximum assumes square wave, open-drain, sinking sensor at 50% duty cycle.



# INPUT STB/STG/VTD/RTD/4-20mA (PINS E09-E10, E13-E14, E16-E17)<sup>1</sup>

## INPUT STB or 4-20mA/STG/VTD/FREQ/PWM/ENCODER (PINS E11-E12, E15, E18)<sup>1</sup>

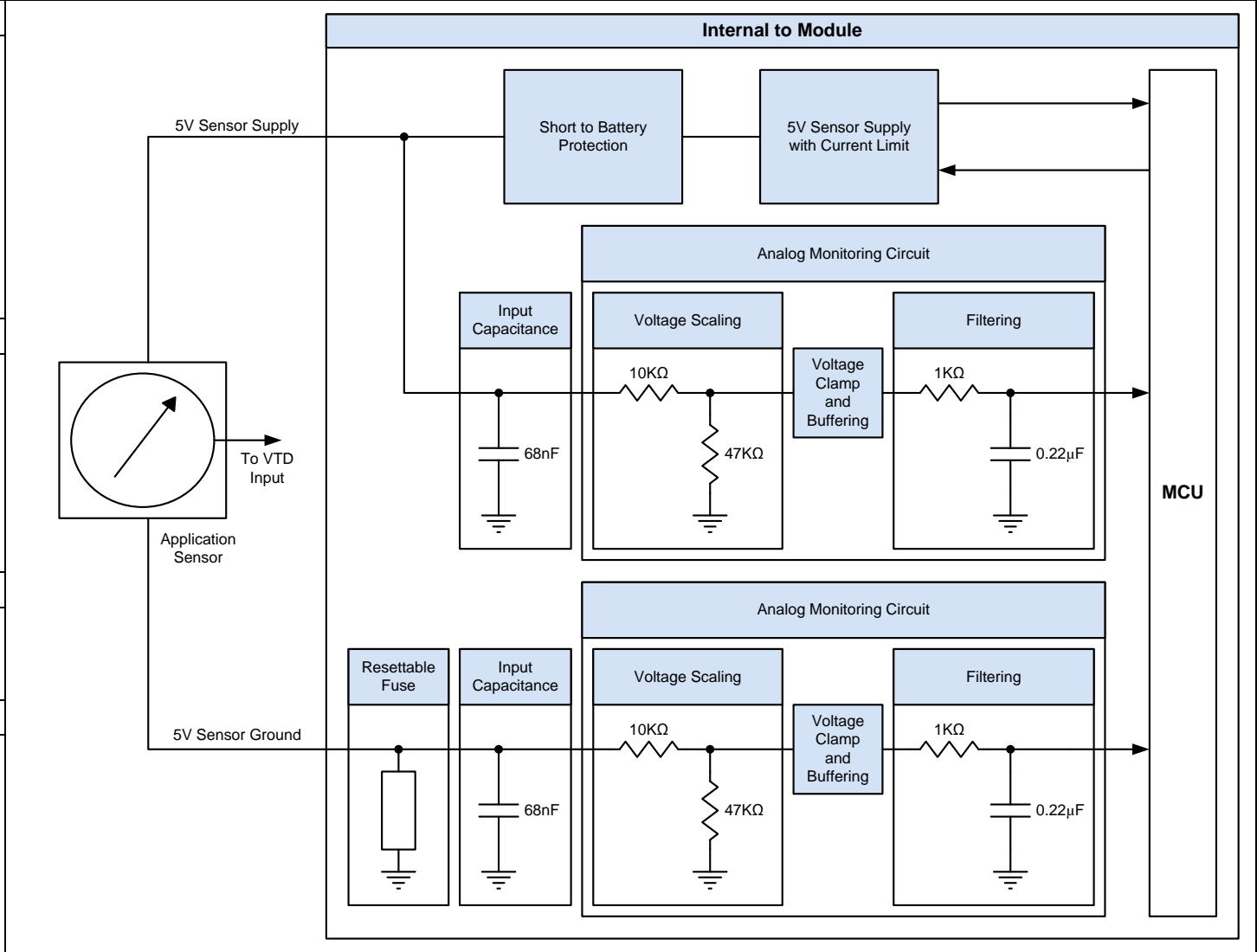


<sup>1</sup> Pins E09-E10, E13-E14, and E16-E17 have input capacitance of 68nF. Pins E11-E12, E15, and E18 have input capacitance of 100pF.

<sup>2</sup> 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 full-scale input resistance range.

# 5VDC SENSOR SUPPLY (PIN E05) AND SENSOR GROUND (PIN E06)

<b>5VDC Sensor Supply Mode</b>
Voltage Range <ul style="list-style-type: none"> <li>• 5V ± 4%</li> </ul> Current Rating <ul style="list-style-type: none"> <li>• 250mA</li> </ul> Current Limit <ul style="list-style-type: none"> <li>• 255mA (minimum)</li> <li>• 292mA (typical)</li> <li>• 355mA (maximum)</li> </ul>
<b>Analog Monitoring Circuit</b>
Resolution <ul style="list-style-type: none"> <li>• 12 Bits</li> <li>• 1.48mV / count (typical)</li> </ul> Accuracy <ul style="list-style-type: none"> <li>• See Section Input – VTD Mode (0-6.06V Range)</li> </ul>
<b>5VDC Sensor Ground Mode</b>
Current Rating <ul style="list-style-type: none"> <li>• 250mA</li> </ul>
<b>Analog Monitoring Circuit</b>
Resolution <ul style="list-style-type: none"> <li>• 12 Bits</li> <li>• 1.48mV / count (typical)</li> </ul> Accuracy <ul style="list-style-type: none"> <li>• See Section Input – VTD Mode (0-6.06V Range)</li> </ul>



## CAN COMMUNICATION (PINS A07/A08, B07/B08, C07/C08)

### Baud Rate

- 40kbps to 500kbps

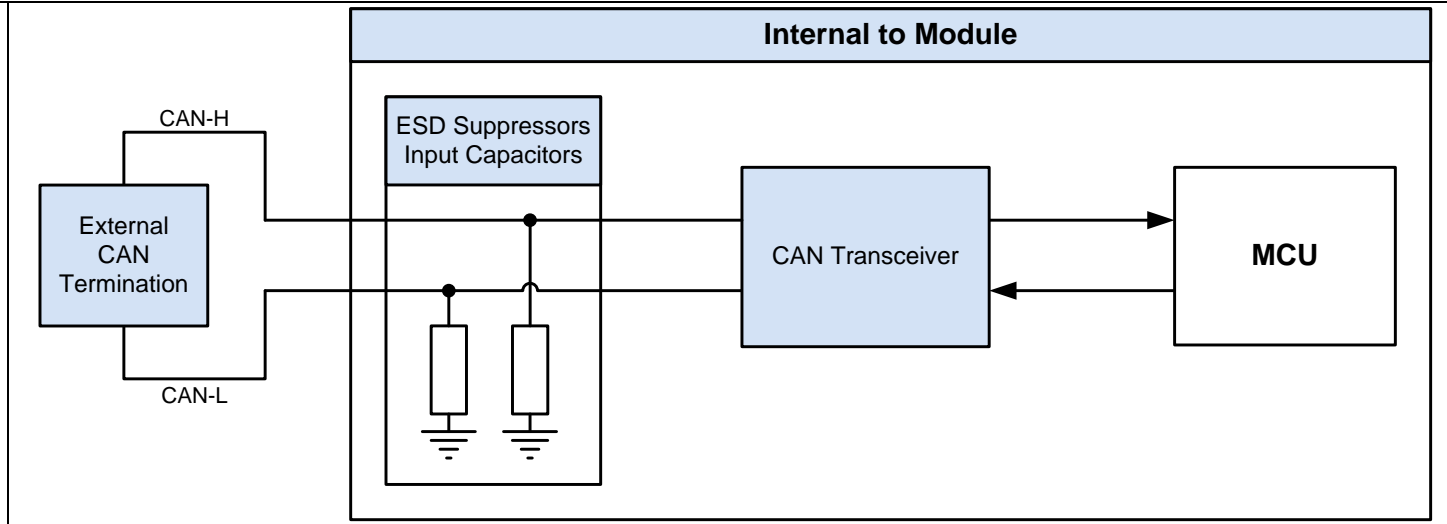
### Maximum Allowable Voltage<sup>1</sup>

- -58V to +58V

### Input Capacitance (maximum)

- 62pF (f = 1MHz)

No Internal Termination

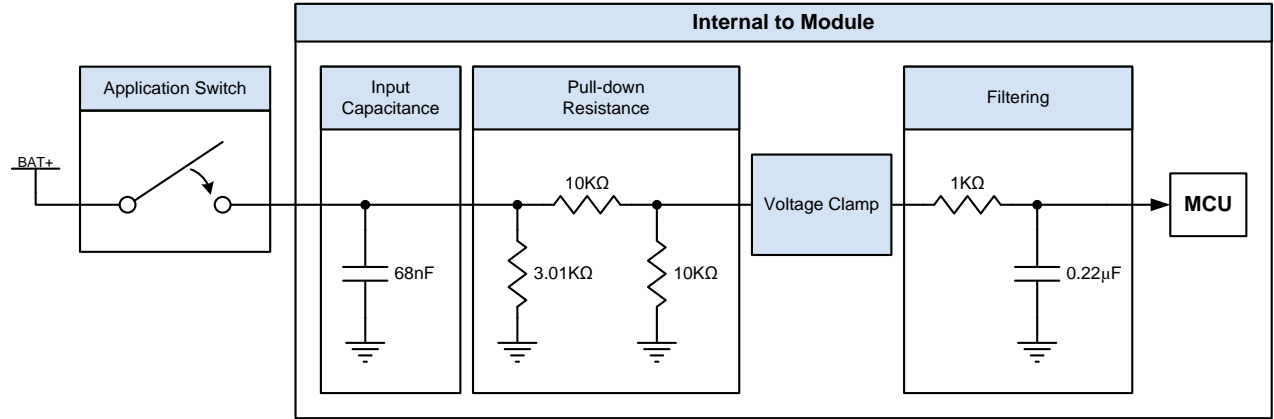


<sup>1</sup> Maximum allowable voltage defines the voltage extremes that the transceiver can tolerate. Exposure to these voltages for extended periods may affect device reliability.

# INPUT STB/STG (PINS A01-A04, A09-A10, A13-A14, B01-B04, B09-B10, B13-B14, C01-C04, C09-C10, C13-C14, D01-D04, D07, D09-D10, D13-D14)

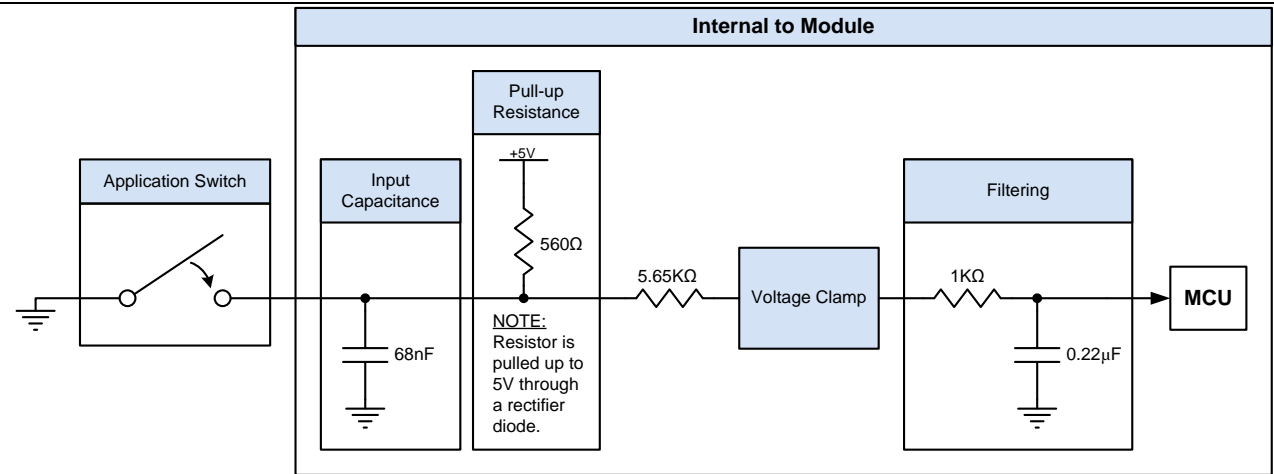
## Switch-to-Battery (STB) Mode

- Input Resistance
- 2.6K $\Omega$  (typical)
- Input Current
- 3.1mA at 8V (typical)
  - 12.2mA at 32V (typical)
- Parallel Resistance
- 2K $\Omega$  at 8V (minimum)
  - 16K $\Omega$  at 32V (minimum)
- Series Resistance
- 220 $\Omega$  (maximum)



## Switch-to-Ground (STG) Mode

- Pull-up Resistance
- 560 $\Omega$  (typical)
- Input Current
- 7.6mA at 0V (typical)
- Parallel Resistance
- 2K $\Omega$  at 0V (minimum)
- Series Resistance
- 220 $\Omega$  (maximum)



### IMPORTANT NOTES:

- 1) On modules where Input STB and Output modes are software configurable and Input STB mode is chosen, the input voltage must remain at or below the main battery voltage on Pin A06 (for Connector A inputs), Pin B06 (for Connector B inputs), Pin C06 (for Connector C inputs), and Pin D06 (for Connector D inputs) of the module. Otherwise, the input voltage can back feed through the output FET and may source current to the outputs from the STB input instead of Pin A06/B06/C06/D06, potentially causing damage to the application switch and/or module.
- 2) Pins A01/A02/A13/A14, B01/B02/B13/B14, C01/C02/C13/C14, and D01/D02/D13/D14 can be software configured in banks of four pins as outputs, STB inputs, or STG inputs; however, all pins within each bank must have the same I/O type chosen as 4 outputs, 4 STB inputs, or 4 STG inputs.
- 3) Pins A03/A04/A09/A10/B03/B04/B09/B10/C03/C04/C09/C10/D03/D04/D07/D09/D10 can be software configured in a bank of 17 pins as outputs, STB inputs, or STG inputs; however, all 17 pins must have the same I/O type chosen as 17 outputs, 17 STB inputs, or 17 STG inputs.

## OUTPUT DOUT(+)/PWM(+)/ECC(+)

(PINS A01-A04, A09-A10, A13-A14, B01-B04, B09-B10, B13-B14, C01-C04, C09-C10, C13-C14)

### Individual Output Current<sup>1</sup>

- Digital Mode = 3.0A (maximum)
- PWM Mode = 3.0A (maximum)

### Grouped Output Current<sup>2,3,4</sup>

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

### PWM Frequency<sup>5</sup>

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

### Output Diagnostics

- Short to Battery
- Short to Ground
- Overcurrent
- Open Circuit<sup>6</sup>

### Current Sense Range

- Up to 4.0A (minimum)
- Up to 4.8A (typical)

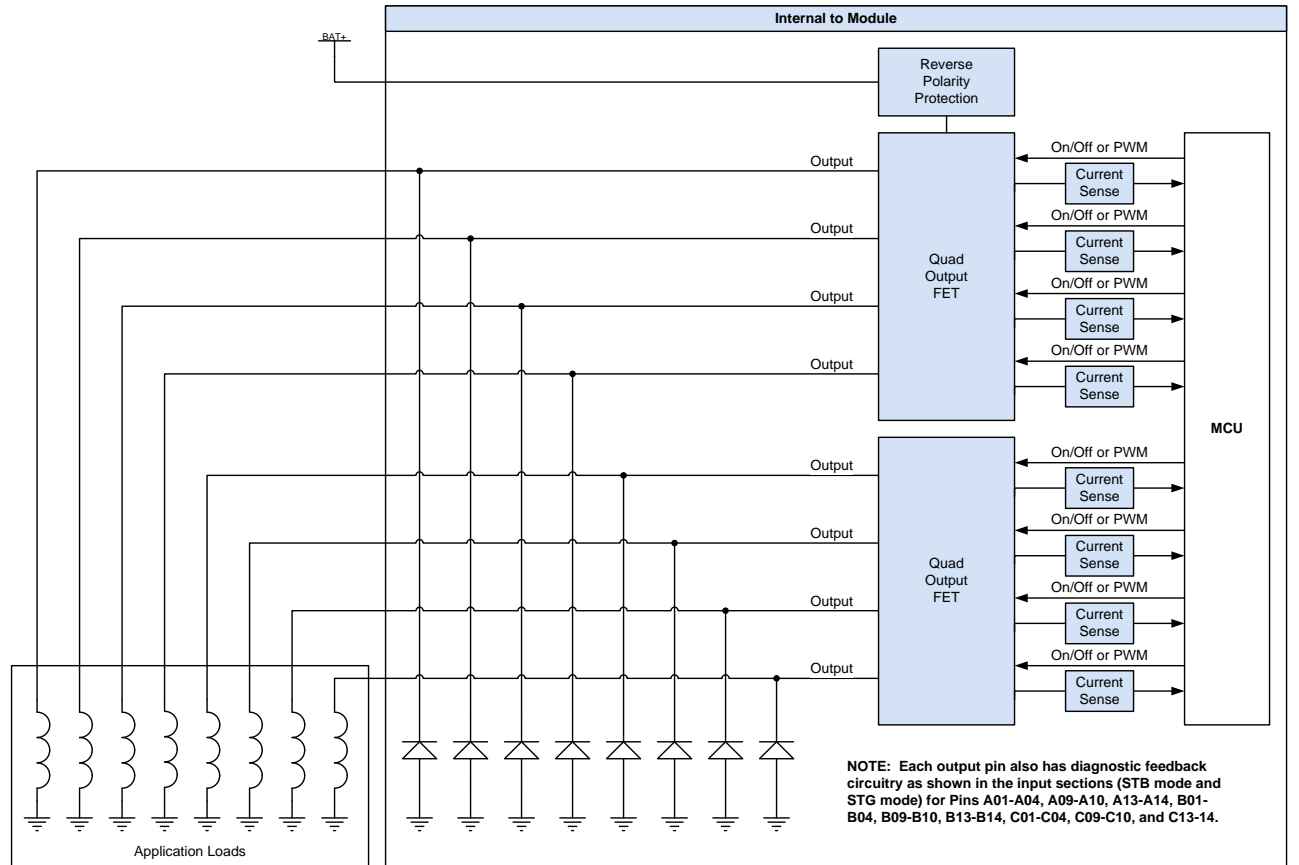
### Current Sense Resolution

- 10 bits
- 4.7mA / count (typical)

### Calibrated Current Sense Accuracy (typ)

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

### Internal Flyback Diodes



<sup>1</sup> 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.

<sup>2</sup> Output current is constrained in groups of four pins (quad output FET). Pin groups are A01/A02/A13/A14, A03/A04/A09/A10, B01/B02/B13/B14, B03/B04/B09/B10, C01/C02/C13/C14, and C03/C04/C09/C10. It is strongly recommended to level the total output current across each of the groups for best thermal performance.

<sup>3</sup> Output current maximums assume all four channels in the group 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.

<sup>4</sup> Maximum total output current for Connector A, Connector B, and Connector C outputs is 12.5 Amps per connector.

<sup>5</sup> 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.

<sup>6</sup> 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).

## OUTPUT DOUT(+)/PWM(+)/ECC(+) (PINS D01-D04, D07, D09-D10, D13-D14)

### Individual Output Current<sup>1</sup>

- Digital Mode = 3.0A (maximum)
- PWM Mode = 3.0A (maximum)

### Grouped Output Current<sup>2,3,4</sup>

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

### PWM Frequency<sup>5</sup>

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

### Output Diagnostics

- Short to Battery
- Short to Ground
- Overcurrent
- Open Circuit<sup>6</sup>

### Current Sense Range

- Up to 4.0A (minimum)
- Up to 4.8A (typical)

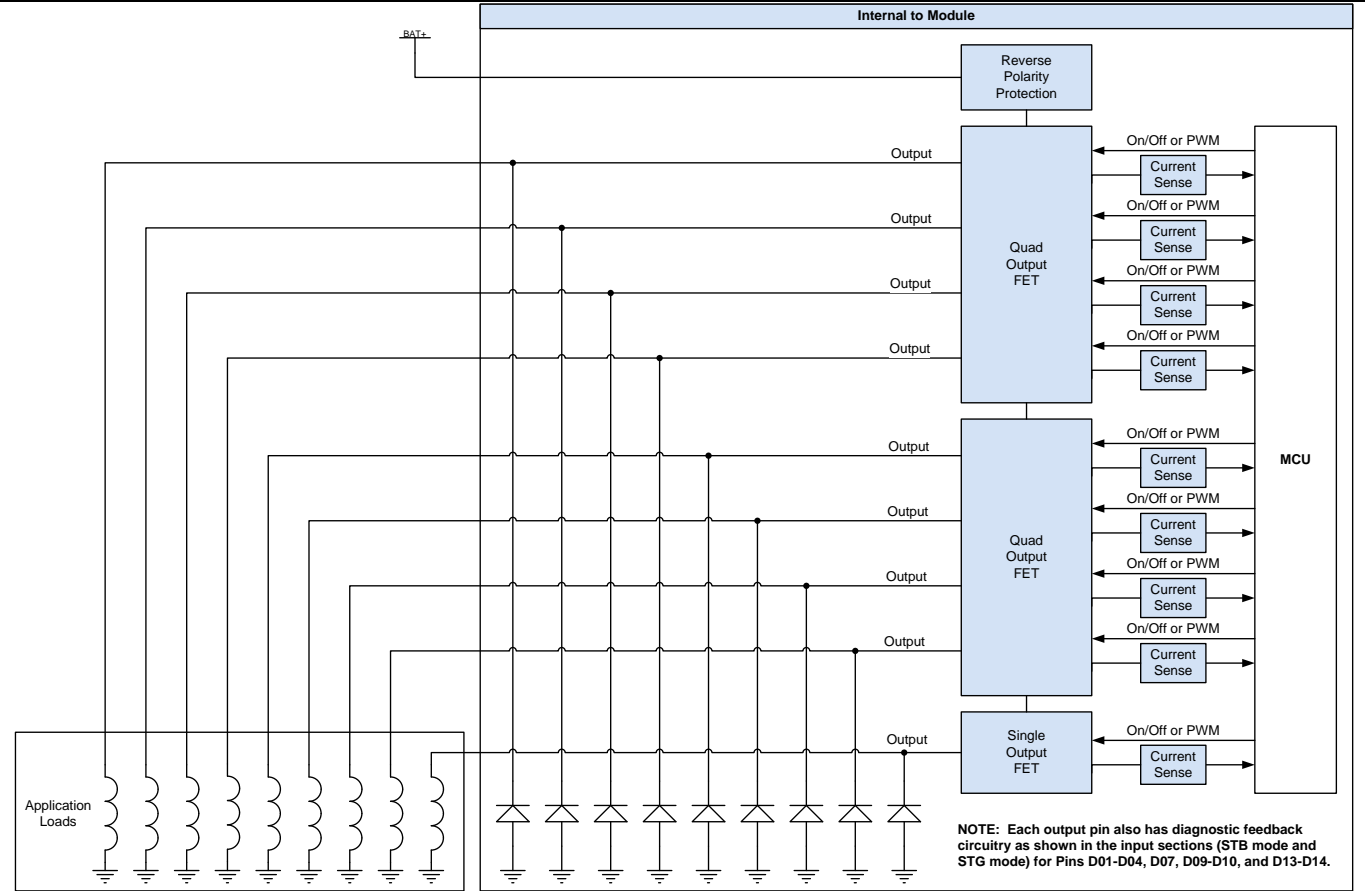
### Current Sense Resolution

- 10 bits
- 4.7mA / count (typical)

### Calibrated Current Sense Accuracy (typ)

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

### Internal Flyback Diodes



<sup>1</sup> 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.

<sup>2</sup> Output current is constrained in groups of four pins (quad output FET). Pin groups are D01/D02/D13/D14 and D03/D04/D09/D10. It is strongly recommended to level the total output current across each of the groups for best thermal performance. Pin D07 is sourced by a single output FET which can support up to the individual output current limits.

<sup>3</sup> Output current maximums assume all four channels in the group 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.

<sup>4</sup> Maximum total output current for Connector D outputs is 12.5 Amps.

<sup>5</sup> 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.

<sup>6</sup> 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).

# SWITCHED BATTERY (+) / KEYSWITCH (PIN A11)

## Switched Battery (+) (Pin A11)

Operating Voltage Range

- 8VDC – 32VDC

Maximum Continuous Voltage<sup>1</sup>

- 36VDC

Maximum Transient Voltage

- See test section of datasheet

Keyswitch 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

Input Voltage Range

- 0V to 38.4V (minimum)
- 0V to 39.0V (typical)

Input Resistance

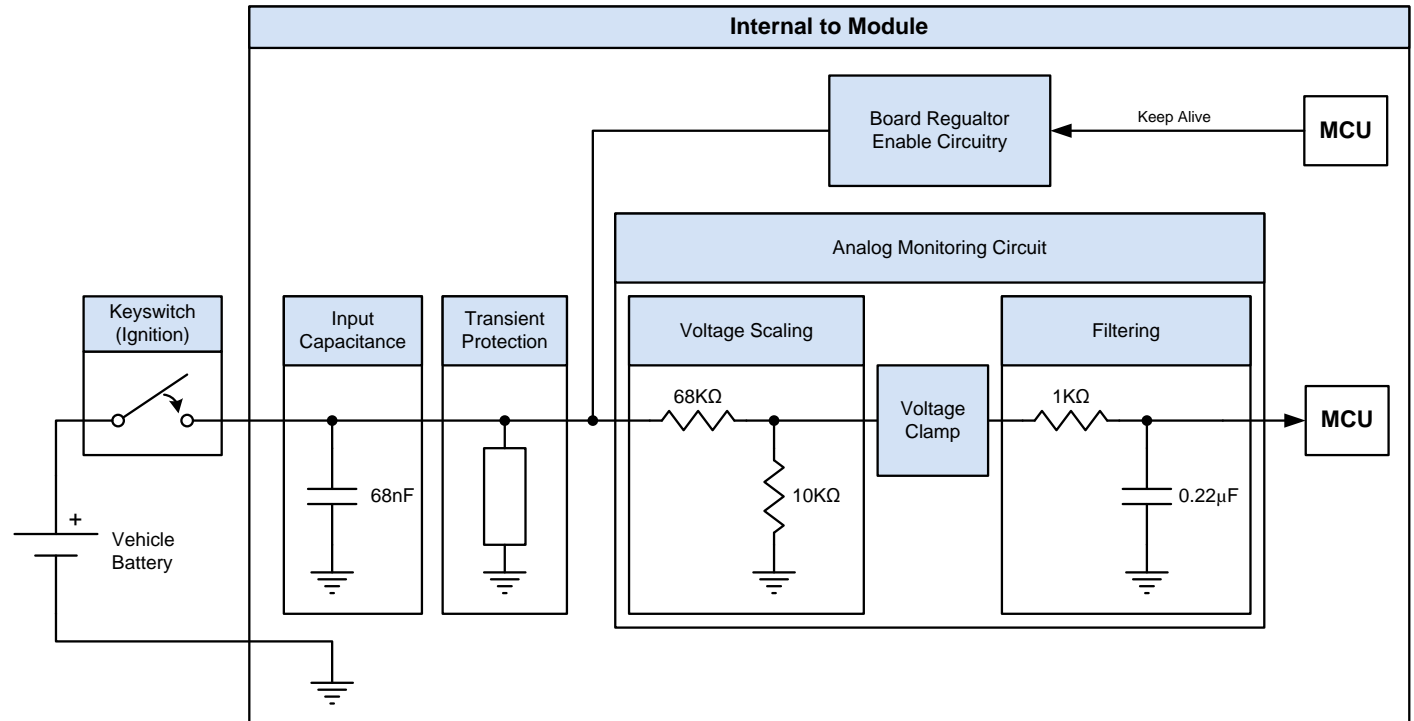
- 72.4K $\Omega$  (typical)

Resolution

- 12 Bits
- 9.52mV / count (typical)

Accuracy<sup>1</sup>

- $\pm 1.0\%$  ( $T_A = 25^\circ\text{C}$ )
- $\pm 2.0\%$  ( $T_A = \text{full range}$ )



<sup>1</sup> Exposure to maximum voltages for extended periods may affect device reliability.

## BATTERY (+) MODULE AND OUTPUTS (PINS A06, B06, C06, D06)<sup>1,2</sup>

### Operating Voltage Range

- 8VDC – 32VDC

### Maximum Continuous Voltage<sup>3</sup>

- 36VDC

### Maximum Transient Voltage

- See test section of datasheet

### Module Current Draw – Running<sup>4</sup>

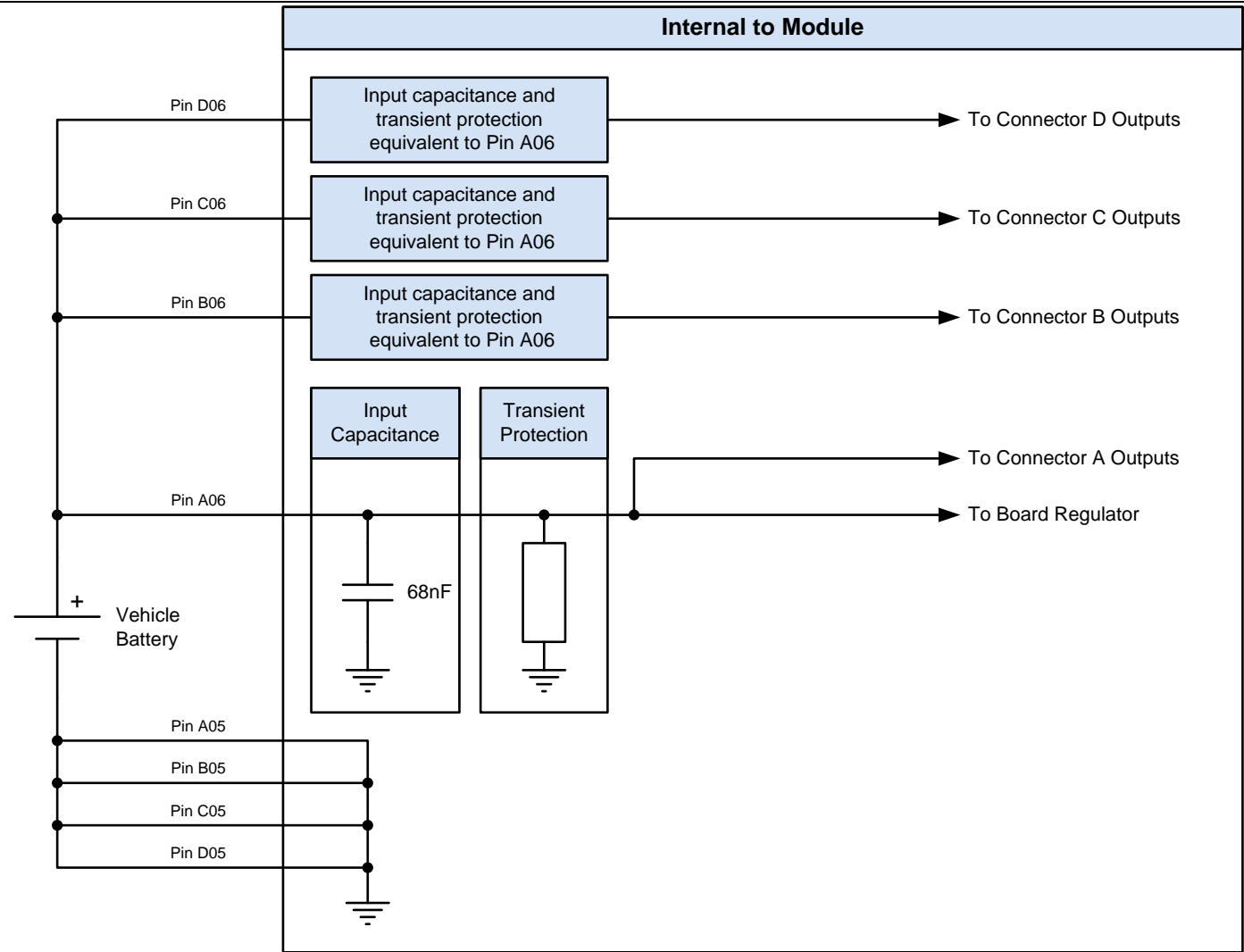
- 180mA at 8V (typ)
- 88mA at 32V (typ)

### Module Current Draw – Low Power Mode<sup>5</sup>

- TBD  $\mu$ A at 8V (typ)
- TBD  $\mu$ A at 32V (typ)

### Maximum Total Output Current

- See Output Section for output current constraints



<sup>1</sup> Pin A06 provides power to module and Connector A outputs. Pin B06 provides power to Connector B outputs only. Pin C06 provides power to Connector C outputs only. Pin D06 provides power to Connector D outputs only.

<sup>2</sup> Pins A05, B05, C05, and D05 must be connected at a single point to Battery (-).

<sup>3</sup> Exposure to maximum voltages for extended periods may affect device reliability.

<sup>4</sup> Module current draw is measured with I/O inactive, no CAN communication, 5V sensor supply inactive, and keyswitch (Pin A11) active.

<sup>5</sup> Module current draw is measured with I/O inactive, no CAN communication, 5V sensor supply inactive, and keyswitch (Pin A11) inactive.



## REVISION HISTORY

Revision	Date	EC #	Changes
A1	7/23/14	314-307	Initial Release. Items in yellow identify general market design targets requiring specific board configuration or firmware feature support to complete remaining verification testing.