# CL-449 Product Family Specification

PFS-CL449

2/8/2016

## 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

# INPUT STB or 4-20mA/STG/VTD/FREQ/PWM/ENCODER (PINS 1 – 4)

## Switch-to-Battery (STB) Mode

Input Resistance
- 1.4KΩ (typical)

Input Current
- 5.7mA at 8V (typical)
- 24.0mA at 32V (typical)

Positive Going Threshold
- > 6.5V

Negative Going Threshold
- < 3.5V

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

Series Resistance
- 220Ω (maximum)

**Internal to Module**

Application Switch | Input Capacitance | Pull-down Resistance | | Filtering

BAT+

10KΩ

Voltage Clamp

1KΩ

MCU

100pF | 1.5KΩ | 10KΩ

0.22µF
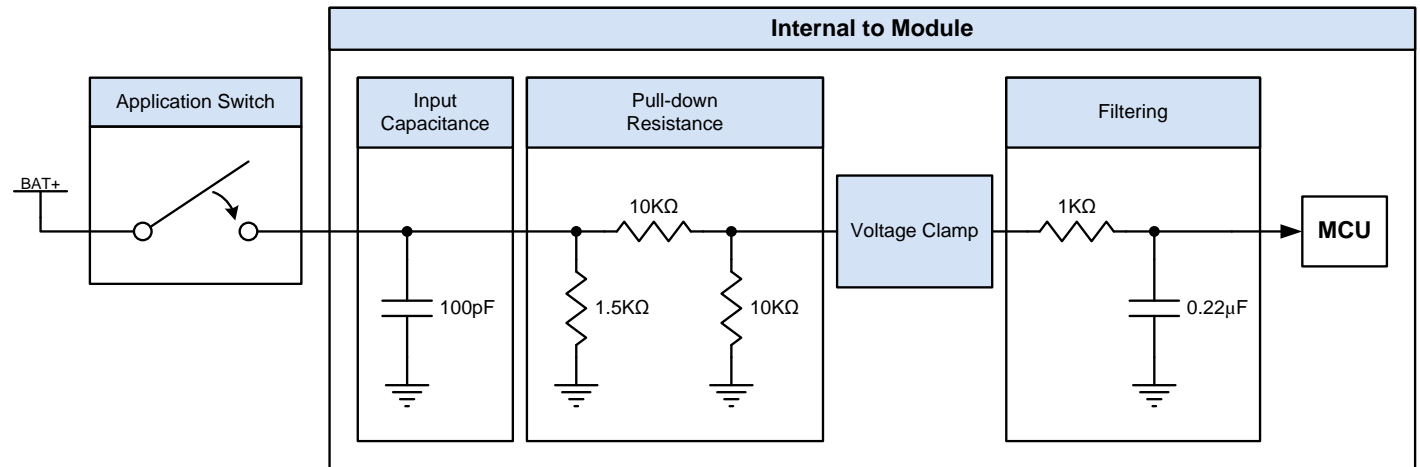
## Switch-to-Ground (STG) Mode

Pull-up Resistance
- 560Ω (typical)

Input Current
- 7.6mA at 0V (typical)

Positive Going Threshold
- > 3.25V

Negative Going Threshold
- < 1.75V

Parallel Resistance
- 2KΩ at 0V (minimum)

Series Resistance
- 220Ω (maximum)

**Internal to Module**

Application Switch | Input Capacitance | Pull-up Resistance | Filtering

+5V

560Ω

100pF

NOTE:
Resistor is pulled up to 5V through a rectifier diode.

10KΩ

Voltage Clamp

1KΩ

MCU

0.22µF
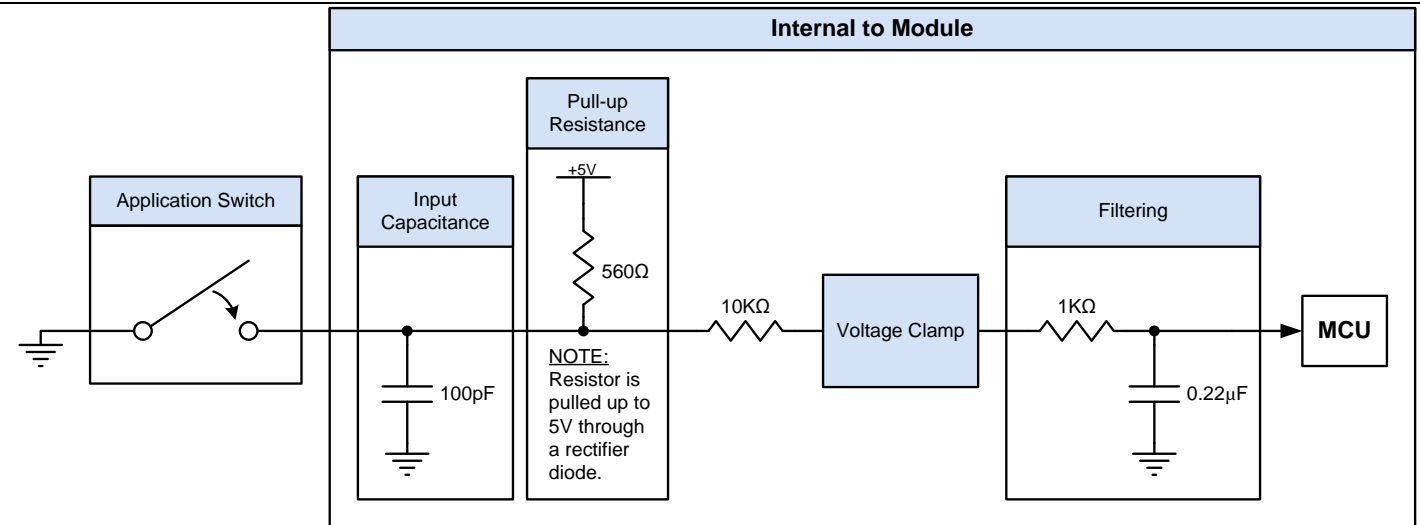
# INPUT STB or 4-20mA/STG/VTD/FREQ/PWM/ENCODER (PINS 1 – 4)

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

Input Voltage Range
- 0V to 5.5V (minimum)
- 0V to 5.65V (typical)

Input Resistance
- 57KΩ (typical)

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

Accuracy[1]
- ±1.0% and ±12mV ($T_A$ = 25°C)
- ±2.5% and ±18mV ($T_A$ = full)



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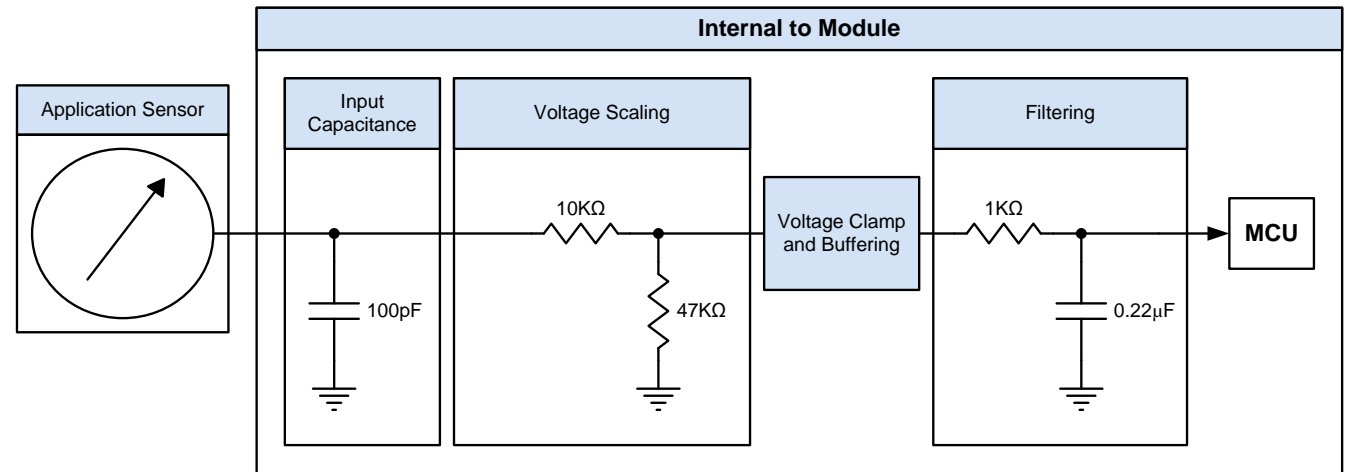
[1] VTD accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods. It is considered as a percentage of the input voltage combined with an additional offset.

# INPUT STB or 4-20mA/STG/VTD/FREQ/PWM/ENCODER (PINS 1 – 4)

## 4-20mA Current Input Mode

Input Current Range
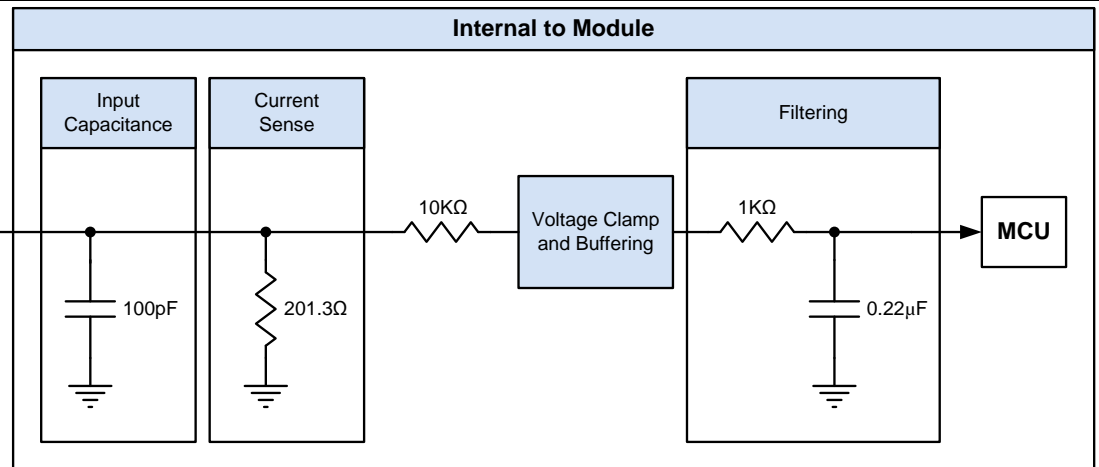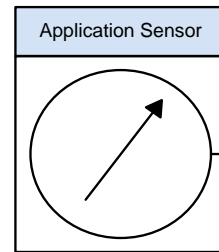- 0mA to 22.1mA (minimum)
- 0mA to 23.1mA (typical)

Input Resistance
- 201.3Ω (typical)

Resolution
- 12 Bits
- 5.65µA / count (typical)

Accuracy[1]
- ±2.0% and ±47µA ($T_A$ = 25°C)
- ±4.0% and ±74µA ($T_A$ = full)

**Internal to Module**

Application Sensor

Input Capacitance — 100pF

Current Sense — 201.3Ω

10KΩ

Voltage Clamp and Buffering

Filtering — 1KΩ — 0.22µF

MCU

## Frequency / PWM / Encoder Mode

Pull-up Resistance
- 4.7KΩ (typical)

Positive Going Threshold
- > 3.5V

Negative Going Threshold
- < 1.0V

Frequency Range
- 10KHz (maximum)[2]

Resolution
- < 5 Hz

Accuracy
- ±2.0% ($T_A$ = full range)

**Internal to Module**

Application Sensor

Input Capacitance — 100pF

Pull-up Resistance — +5V — 4.7KΩ

NOTE:
Resistor is pulled up to 5V through a rectifier diode.

10KΩ

Filtering — 100pF

Voltage Clamp

Schmitt Trigger

MCU

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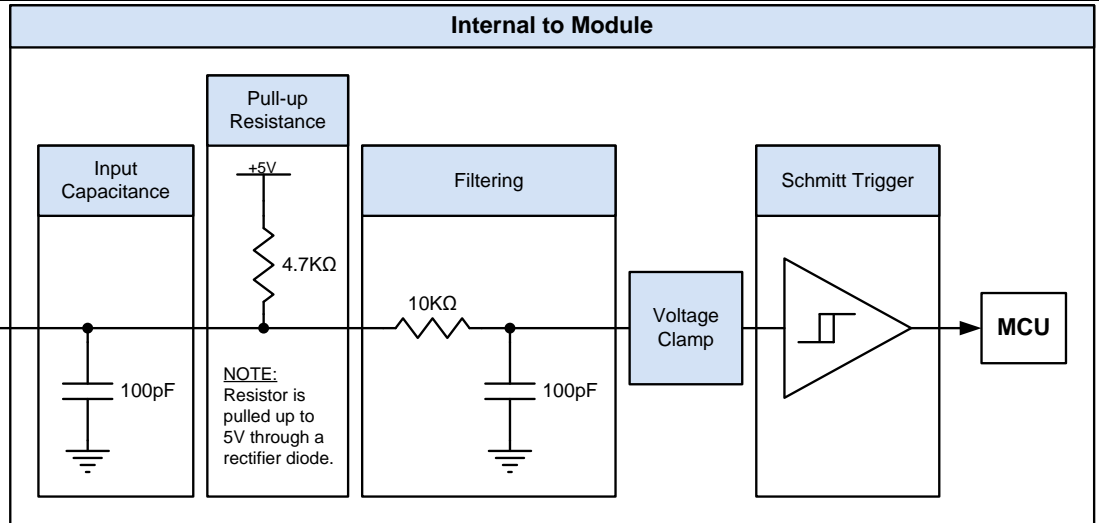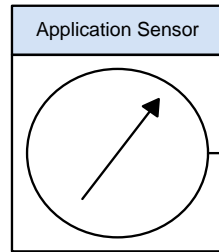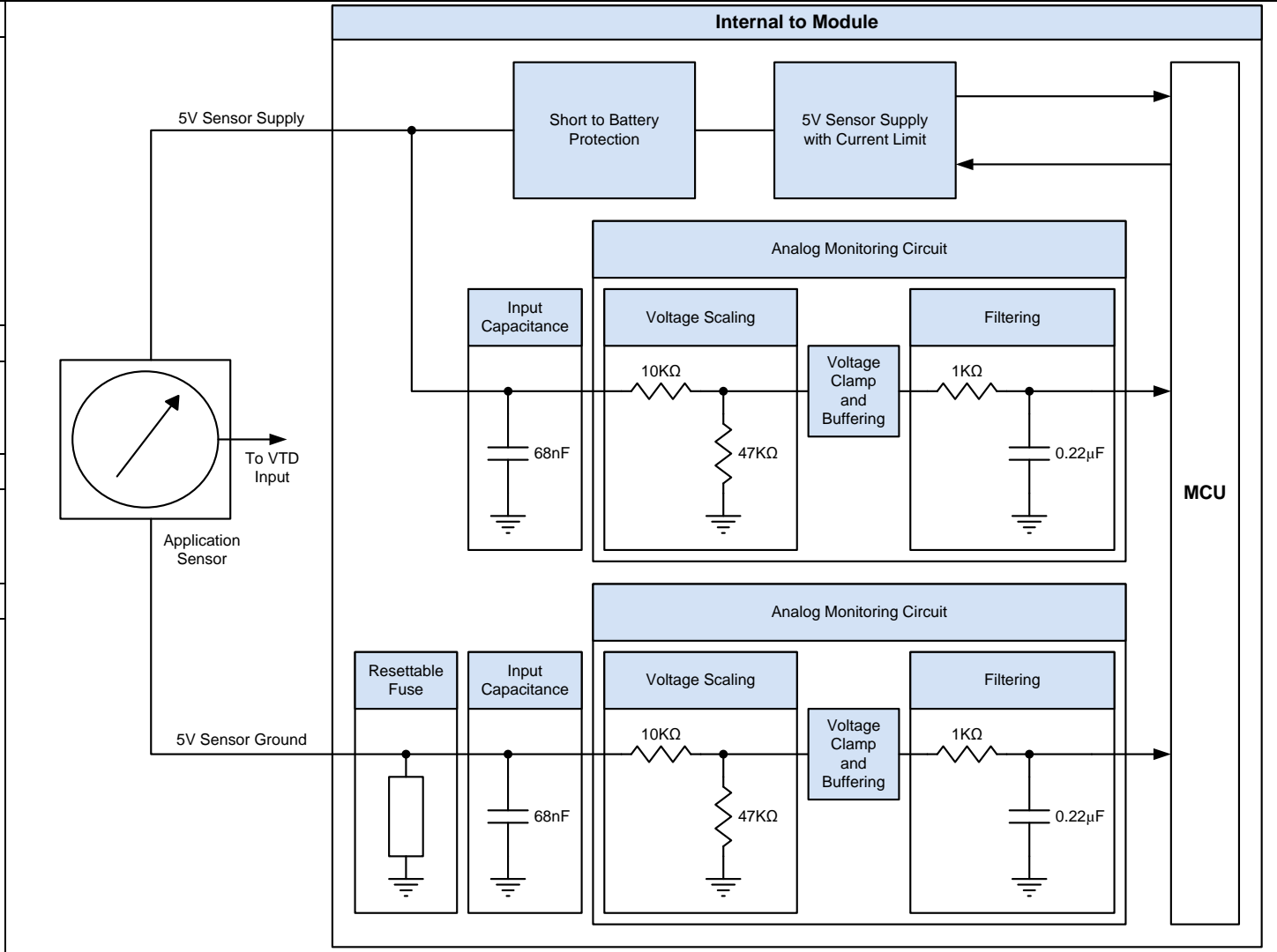
[1] 4-20mA input accuracy is estimated using datasheet maximums and a weighted average of worst-case and root-sum-square (RSS) methods. It is considered as a percentage of the input current combined with an additional offset.

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

# 5VDC SENSOR SUPPLY (PIN 3) AND SENSOR GROUND (PIN 4)

## 5VDC Sensor Supply Mode (Pin 3)

Voltage Range
- 5V ± 5%

Current Rating
- 250mA

Current Limit
- 255mA (minimum)
- 292mA (typical)
- 355mA (maximum)

## Analog Monitoring Circuit

See Section INPUT (PINS 1-4) VTD Mode (0-5.65V Range)

## 5VDC Sensor Ground Mode (Pin 4)

Current Rating
- 250mA

## Analog Monitoring Circuit

See Section INPUT (PINS 1-4) VTD Mode (0-5.65V Range)

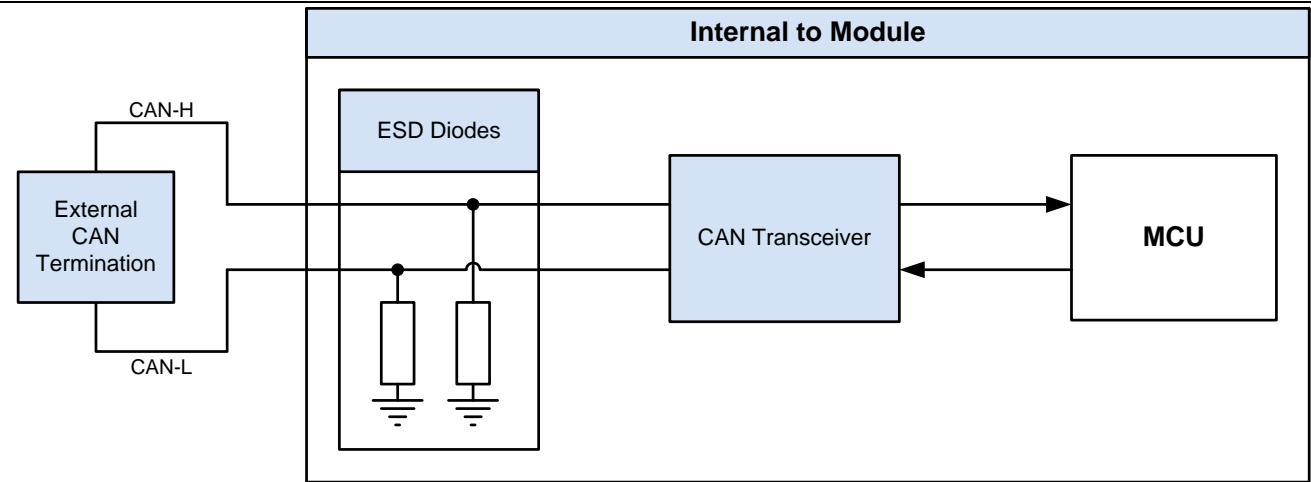# CAN COMMUNICATION (PINS 5, 6)

Baud Rate
- 40kbps to 500kbps

Maximum Allowable Voltage[1]
- -27V to +40V

ESD Diode Capacitance (maximum)
- 33pF ($V_R$ = 0V, f = 1MHz)

No Internal Termination

**Internal to Module**

CAN-H

ESD Diodes

CAN Transceiver

MCU

External CAN Termination

CAN-L

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[1] 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 (PINS 7 – 10)

Input Resistance
- 1.4KΩ (typical)

Input Current
- 5.7mA at 8V (typical)
- 24.5mA at 32V (typical)

Positive Going Threshold
- > 6.5V

Negative Going Threshold
- < 3.5V

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

Series Resistance
- 220Ω (maximum)

**Internal to Module**

Application Switch

Input Capacitance

Pull-down Resistance

Filtering

BAT+

10KΩ

1KΩ

Voltage Clamp

MCU

68nF

1.5KΩ

10KΩ

0.22µF
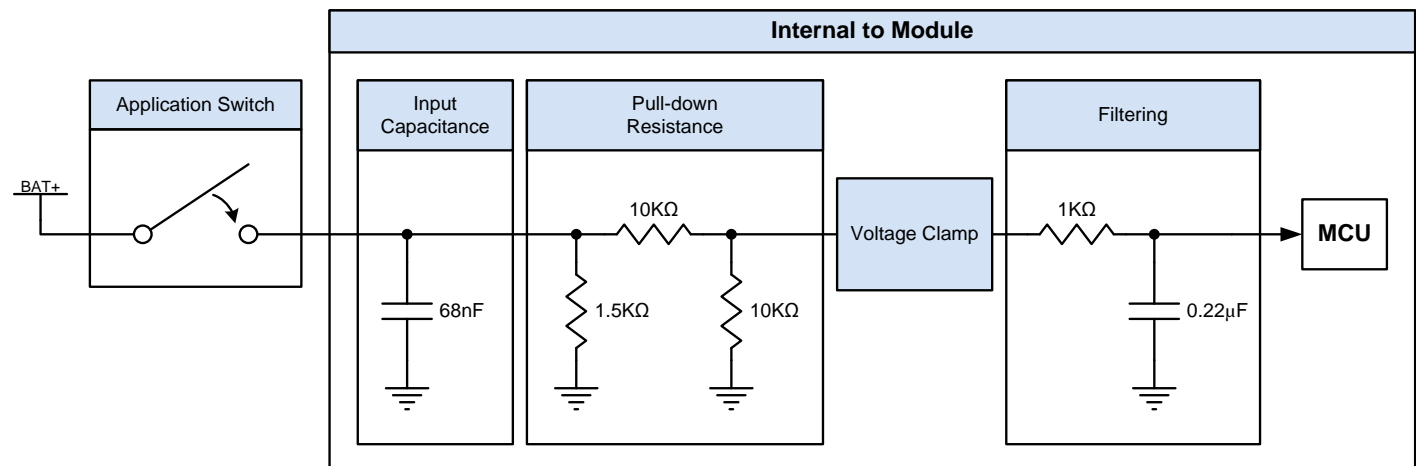
**IMPORTANT NOTE:** On modules where Input STB and Output modes are software configurable and Input STB mode is chosen, the input voltage must remain at or below the main battery voltage on Pin 12 of the module. Otherwise, the input voltage can back feed through the output FET and may source current to the outputs from the STB input instead of Pin 12, potentially causing damage to the application switch and/or module.

# OUTPUT DOUT(+)/PWM(+)/ECC(+) (PINS 7 – 10)

Individual Output Current[1]
- Digital Mode = 3.0A (maximum)
- PWM Mode = 3.0A (maximum)

Grouped Output Current[2,3]
- Digital Mode = 2.5A (maximum)
- PWM Mode = 2.0A (maximum)

PWM Frequency[4]
- < 300 Hz (typical)
- < 1 KHz (maximum)

Output Diagnostics
- Short to Battery
- Short to Ground
- Overcurrent
- Open Circuit[5]

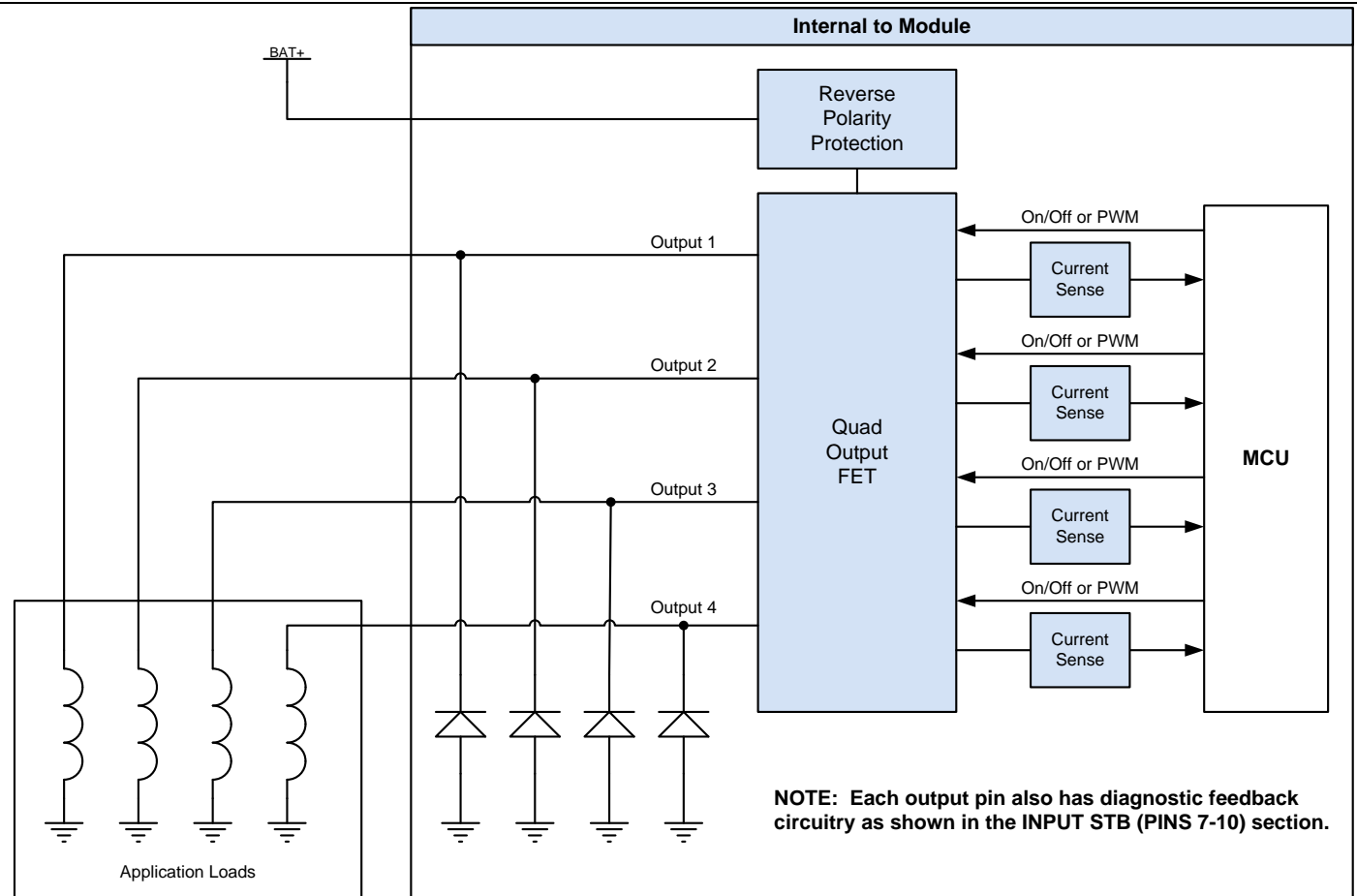Current Sense Range
- Up to 4.1A (minimum)
- Up to 5.0A (typical)

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

Current Sense Accuracy (typical)
- < 50mA at 2A, $T_A$ = 25°C

Internal Flyback Diodes



NOTE: Each output pin also has diagnostic feedback circuitry as shown in the INPUT STB (PINS 7-10) section.

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[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 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.

[3] Maximum total output current for Pins 7-10 is 10 Amps.

[4] 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.

[5] Open circuit can be detected when the output is active using current sense feedback for load currents of at least 250mA and duty cycles greater than 0%.

# BATTERY (+) MODULE AND OUTPUTS (PIN 12)

## Battery (+) (Pin 12)

Operating Voltage Range
- 8VDC – 32VDC

Maximum Continuous Voltage[1]
- 36VDC

Module Current Draw[2]
- 36mA at 8.0V (typ)
- 23mA at 13.8V (typ)
- 13mA at 28.0V (typ)
- 12mA at 32.0V (typ)

Maximum Total Output Current
- See Output Section for output current constraints

## Analog Monitoring Circuit

Input Voltage Range
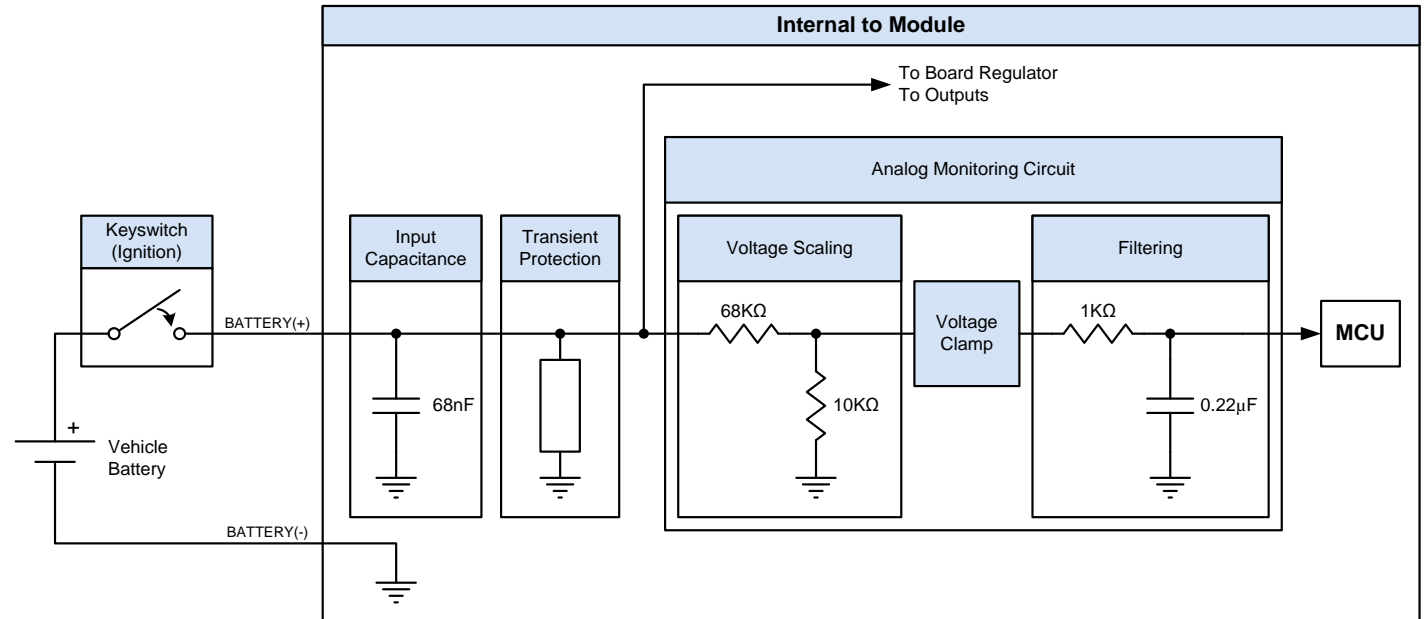- 0V to 35.54V (minimum)
- 0V to 36.33V (typical)

Input Resistance
- 78KΩ (typical)

Resolution
- 12 Bits
- 8.87mV / count (typical)

Accuracy[3]
- ±1.0% and ±38mV  ($T_A$ = 25°C)
- ±2.5% and ±458mV  ($T_A$ = Full)



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[1] Exposure to maximum voltages for extended periods may affect device reliability.

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

[3] 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 | 2/8/16 | 316-003 | Initial Release |
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