

CL-T05/x6/x7 Product Family Specification

PFS-CLT05_x6_x7-B1

2/11/2020



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.

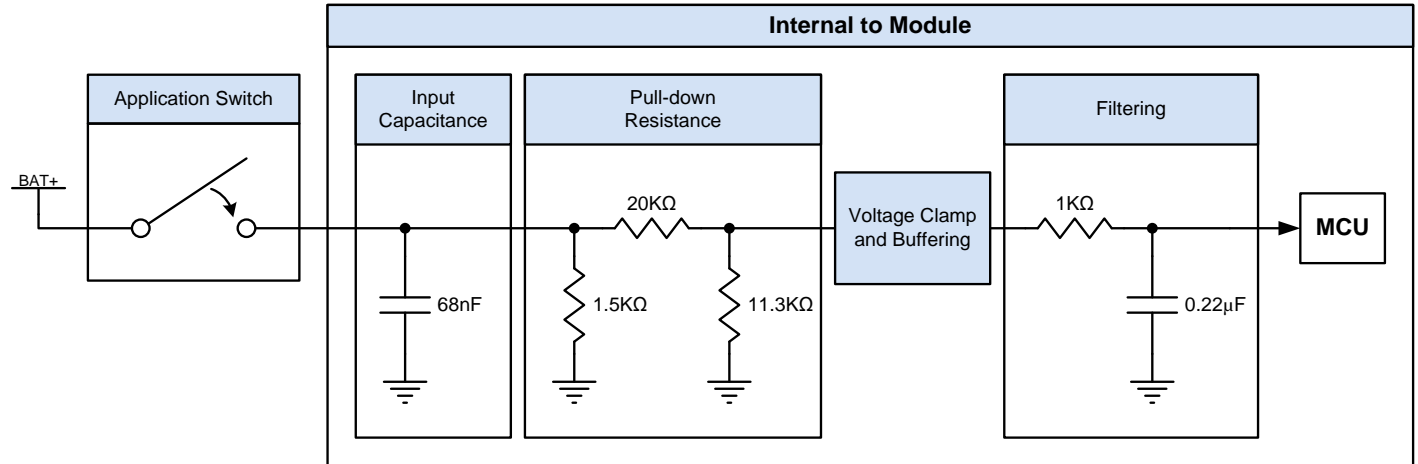
The OEM must analyze all aspects of their application and review the information concerning product or system in the current product documentation. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible 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/STG/VTD (PIN 12)

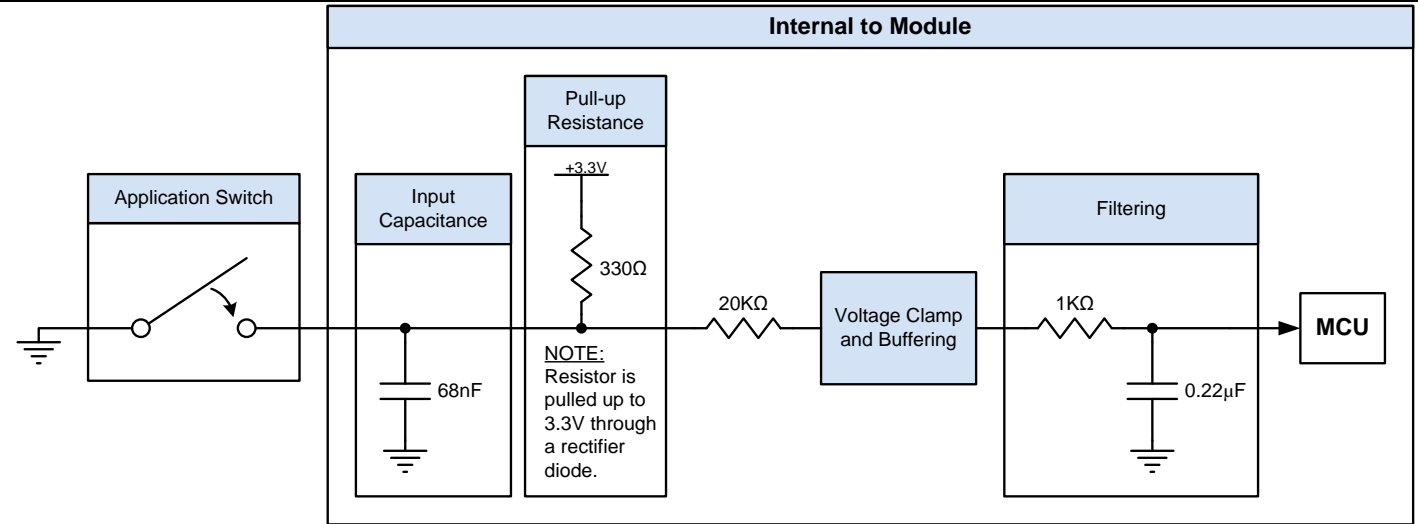
Switch-to-Battery (STB) Mode

- Input Resistance
- 1.4K Ω (typical)
- Input Current
- 5.5mA at 8V (typical)
 - 22.7mA at 32V (typical)
- Positive Going Threshold
- > 6.4V
- Negative Going Threshold
- < 2.7V
- Parallel Resistance
- 2.8K Ω at 8V (minimum)
 - 16K Ω at 32V (minimum)
- Series Resistance
- 220 Ω (maximum)



Switch-to-Ground (STG) Mode

- Pull-up Resistance
- 330 Ω (typical)
- Input Current
- 9.3mA at 0V (typical)
- Positive Going Threshold
- > 2.3V
- Negative Going Threshold
- < 1.0V
- Parallel Resistance
- 2K Ω at 0V (minimum)
- Series Resistance
- 150 Ω (maximum)



INPUT STB/STG/VTD (PIN 12)

Voltage-to-Digital (VTD) Mode (0 – 5.66VDC)

Input Voltage Range

- 0V to 5.30V (minimum)
- 0V to 5.66V (typical)

Input Resistance

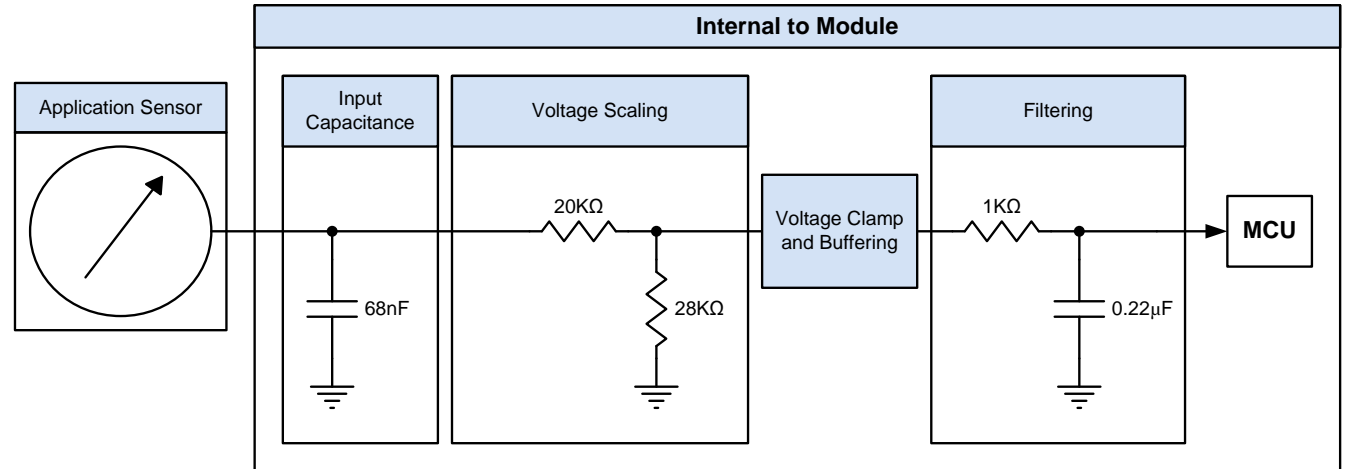
- 48K Ω (typical)

Resolution

- 12 Bits
- 1.38mV / count (typical)

Accuracy¹

- $\pm 1.0\%$ and $\pm 15\text{mV}$ ($T_A = 25^\circ\text{C}$)
- $\pm 3.0\%$ and $\pm 22\text{mV}$ ($T_A = \text{full}$)



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 range combined with an additional offset.

CAN COMMUNICATION (PINS 7/8, 9/10)

Baud Rate

- Up to 1Mbps

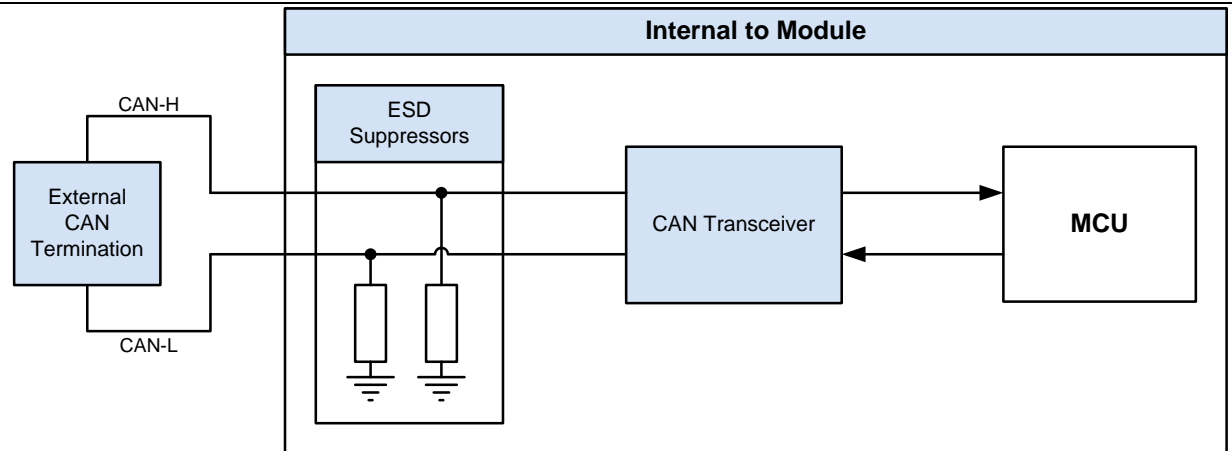
Maximum Allowable Voltage¹

- -58V to +58V

Input Capacitance (max)

- 26pF ($f = 1\text{MHz}$)

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.

OUTPUT DOUT(-) (PIN 18)

Output Current

- 150mA (maximum)

Output Protection

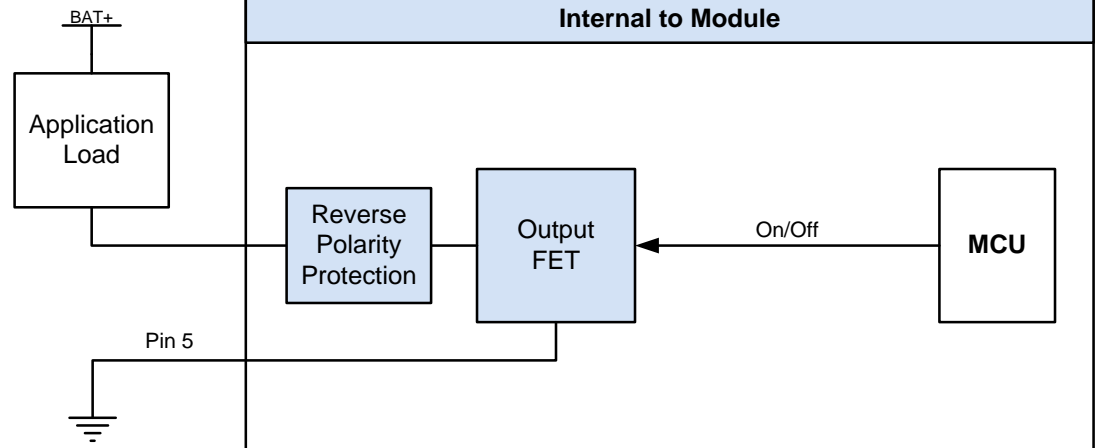
- Short Circuit
- Over Temperature
- Over-Voltage (Transient)¹

Output Diagnostics

- None

Hardware Current Limit

- 1.5A (typical)



¹ Transient over-voltage protection is limited to a single pulse inductive energy 550mJ (typical).

SWITCHED BATTERY (+) / KEYSWITCH (PIN 11)

Switched Battery (+)

Operating Voltage Range

- 6.5VDC – 32VDC

Maximum Continuous Voltage¹

- 36VDC

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 35.2V (minimum)
- 0V to 36.3V (typical)

Input Resistance

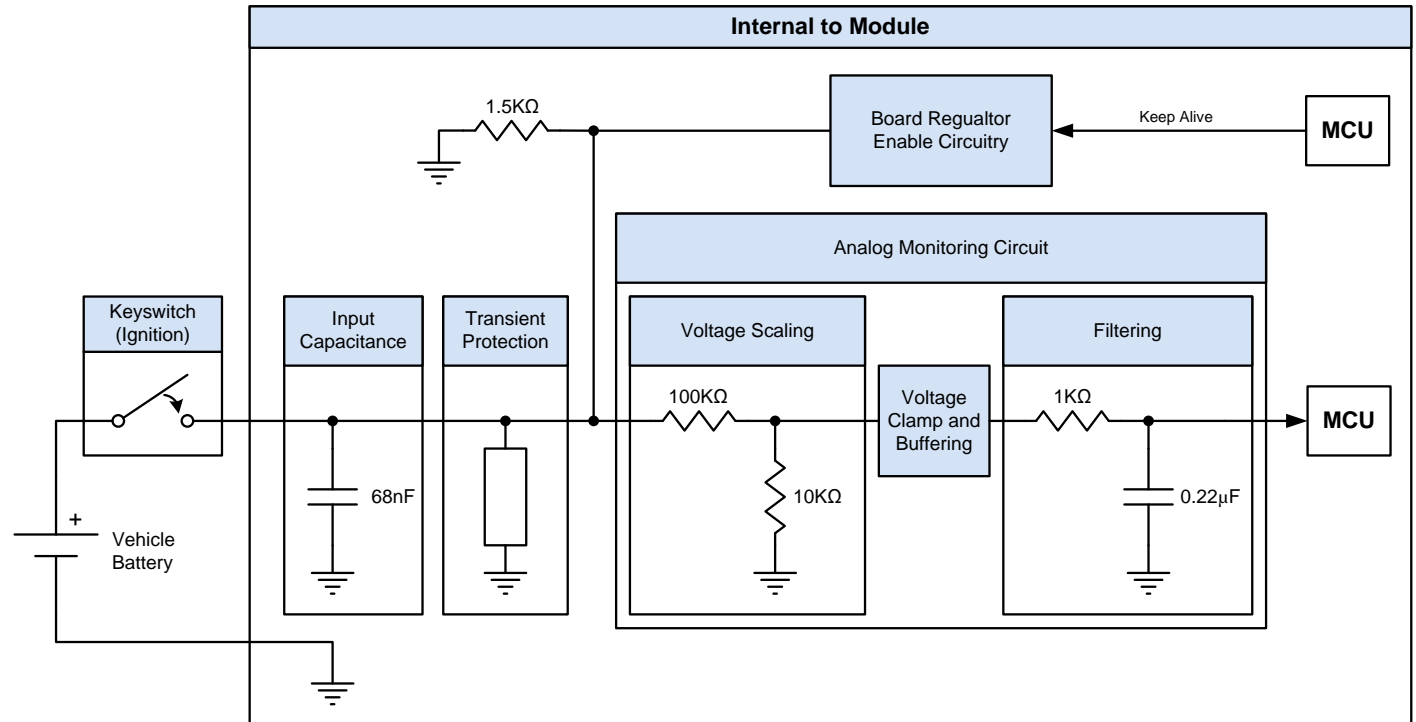
- 110KΩ (typical)

Resolution

- 12 Bits
- 8.86mV / count (typical)

Accuracy²

- ±1.1% and ±90mV ($T_A = 25^\circ\text{C}$)
- ±3.2% and ±139mV ($T_A = \text{full}$)



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

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 range combined with an additional offset.

UNSWITCHED BATTERY (+) MODULE (PIN 6)¹

Operating Voltage Range

- 6.5VDC – 32VDC

Maximum Continuous Voltage²

- 36VDC

Maximum Transient Voltage

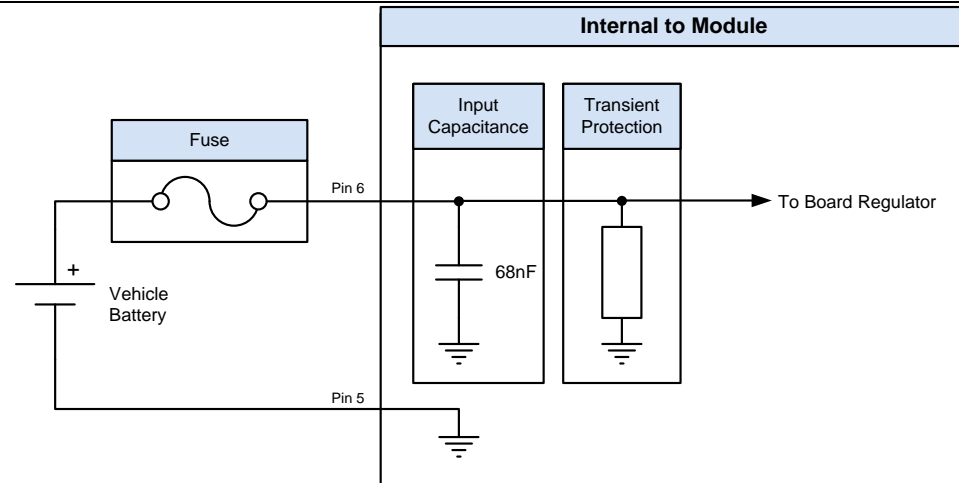
- See test section of datasheet

Module Fusing (Automotive, Fast Acting)

- Can be connected to an existing 10 Amp branch
- Minimum 2 Amps

Module Current Draw

- See table below



¹ It is strongly recommended that Pin 6 of the module be connected directly to the vehicle battery source and to utilize Pin 11 (keyswitch) for activating and deactivating, as well as allowing a safe shut-down sequence of, the module. Connecting Pin 6 to a switched battery source may result in memory corruption which, in its most severe case, may render the unit inoperable and require device reprogramming to recover.

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

MODULE CURRENT DRAW

Configuration	At 6.5VDC	At 13.8VDC	At 28VDC	At 32VDC
Maximum Theoretical Peak Current (peak current during GSM cellular transmission) ¹	3.17 Amps	1.50 Amps	0.74 Amps	0.64 Amps
Maximum Theoretical Average Current (average current during cellular transmission) ²	1.92 Amps	0.91 Amps	0.45 Amps	0.39 Amps
Typical Average Current Logging 110 Parameters at 500ms Rate and Transmitting 150 Parameters over WiFi at 5 second Rate	285 mA	141 mA	76 mA	68 mA
Typical Average Current Logging 110 Parameters at 500ms Rate and Transmitting 150 Parameters over Cellular (3G/4G) at 5 second Rate	377 mA	181 mA	96 mA	88 mA
Typical Average Current in Shutdown Mode (Keyswitch Disabled / Module Shutdown)	185 μ A	248 μ A	490 μ A	571 μ A

¹ Maximum theoretical peak current is a theoretical calculation assuming maximum current draw for each peripheral as specified in datasheets, 85% efficiency for step-down regulators, and peak cellular current during a 1-slot Tx burst at maximum power. Note the burst duration is typically 1 ms or less, thus not affecting recommended fuse ratings.

² Maximum theoretical average current is a theoretical calculation assuming maximum current draw for each peripheral as specified in datasheets, 85% efficiency for step-down regulators, and average cellular current of an HSDPA transmission (Tx/Rx) over a 10-second period.

REAL-TIME CLOCK - BATTERY BACKUP

Battery Chemistry

- High-Temperature Lithium Primary (Non-Rechargeable)

Nominal Capacity

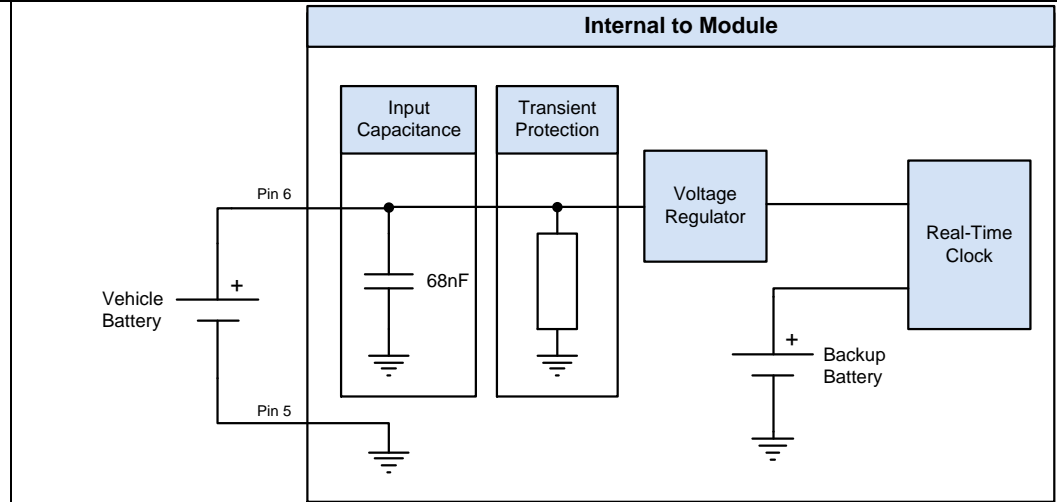
- 255mAh at > 25°C
- 120mAh at -10°C (estimate)

Function

- Switchover to backup battery occurs when Pin 6 of the module is disconnected or unpowered

Estimated Battery Life¹

- 10 years



¹ Battery life is estimated with the following assumptions: one year of storage prior to vehicle install at 25°C, nine years of usage with 3 months disconnection from Pin 6 per year at -10°C, and 30% self-discharge during a 10 year period.

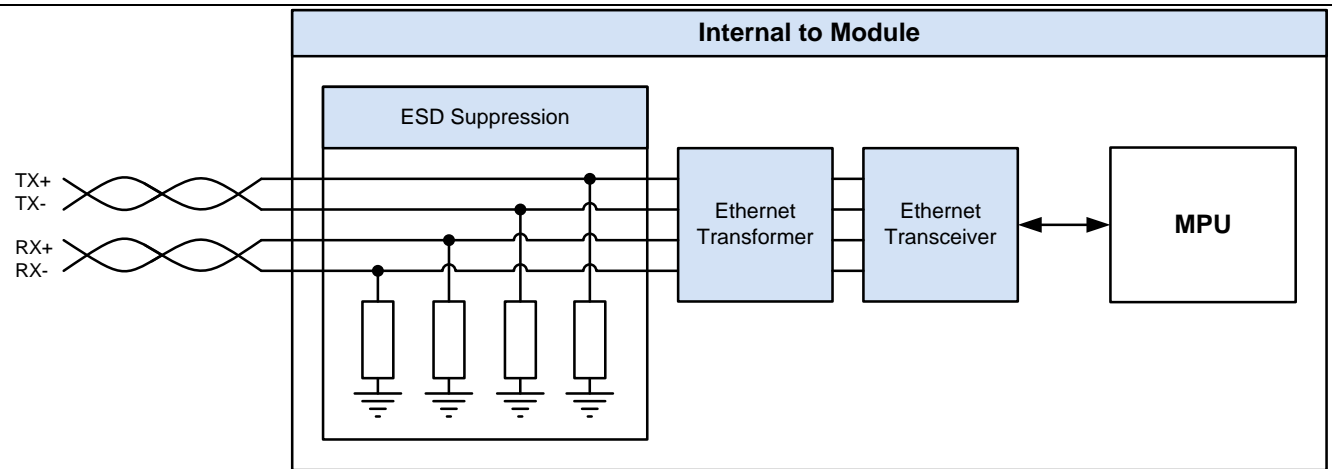
ETHERNET (PINS 1/2, 3/4)

Supported Modes

- 10Base-T
- 100Base-TX

ESD Suppression Capacitance (typ)

- 0.25pF



USB HOST / CLIENT (PINS 13/14/15/16/17)¹

USB Standard

- USB 2.0

Connection Speeds

- Full – 12Mbps (maximum)
- High – 480Mbps (maximum)

V_{BUS} Output Voltage Range

- 5V ± 5%

V_{BUS} Input Capacitance (typical)

- 134μF (Host)
- 2μF (Client)

V_{BUS} Output Current Rating

- 200mA

V_{BUS} Output Current Limit²

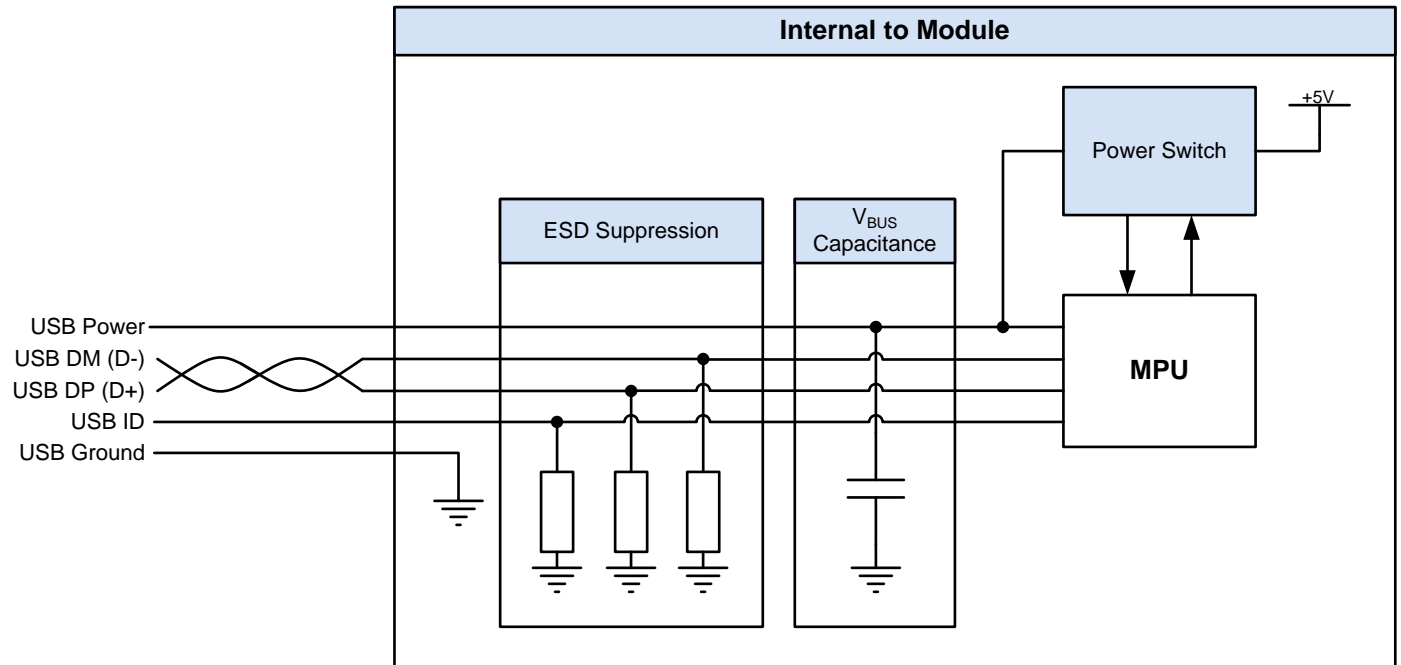
- 254mA (minimum)
- 292mA (typical)
- 336mA (maximum)

ID Pin Connection and Mode

- Connect to USB Ground = Host
- Leave Unconnected = Client

ESD Suppression Capacitance

- USB DP / DM: 0.25pF (typ)
- USB ID: 68nF (typ)



¹ USB power, ground, and signal pins are not protected against shorts to vehicle battery or other signals above typical USB voltage levels. The USB transceiver, per USB 2.0 standards, is required to withstand continuous short circuit of D+ and/or D- to GND, other data line, or cable shield for 24 hours (does not include shorts to USB power). Care must be taken to ensure wiring errors and shorts to higher voltage levels do not occur in the application.

² In host mode, USB bus voltage (VBUS) is used to power an external device as well as the MPU. MPU current draw can be up to 50mA; therefore, output current limit for the external device could reduce by up to 50mA from the values listed.



Warning: When in USB host mode, USB ID (Pin 16) must be connected only to the module USB Ground (Pin 17). Connecting to vehicle ground or other signals may result in damage to the module.

ADDITIONAL NOTES

Please refer to the module-specific technical datasheet for additional parametric data regarding internal peripherals such as flash memory, RAM memory, accelerometer, real-time clock, WiFi, Cellular, and GNSS.

Please refer to the appendix of this document for antenna gain requirements, recommended antennas, and installation guidance to be in compliance applicable regulations.

REVISION HISTORY

Revision	Date	EC #	Changes
A1	1/22/19	319-034	Initial Release based on PFS-CLT05/06/07, adding a warning to USB section and adding CL-T1x-1yy and CL-T1x-2yy to the Appendix for FCC/IC and antenna information
B1	2/10/20	320-037	Added RTC backup battery information. Added CL-T17-3xx / CL-T16-3xx to the appendix for antenna requirements.

APPENDIX

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	Module(s)
CL-T05-1xx	ORR-HEDW131
CL-T06-1xx	XPYLISAU230
CL-T07-1xx	ORR-HEDW131 XPYLISAU230
CL-T16-1xx	XPY1EHM44NN
CL-T17-1xx	ORR-HEDW131 XPY1EHM44NN
CL-T16-2xx	XPY1EIQN2NN
CL-T17-2xx	ORR-HEDW131 XPY1EIQN2NN

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	Module(s)
CL-T05-1xx	21708-HEDW131
CL-T06-1xx	8595A-LISAU230
CL-T07-1xx	21708-HEDW131 8595A-LISAU230
CL-T16-1xx	8595A-1EHM44NN
CL-T17-1xx	21708-HEDW131 8595A-1EHM44NN
CL-T16-2xx	8595A-1EIQN2NN
CL-T17-2xx	21708-HEDW131 8595A-1EIQN2NN

ANTENNA REQUIREMENTS

WiFi Antenna Requirements

Parameter	Specification	Comments
Antenna Type	Dipole or PIFA	Additional testing and regulatory approval may be required for antenna types other than those listed.
Peak Gain	≤ 2.2 dBi	Additional testing and regulatory approval may be required for peak gains exceeding this requirement. Peak gain includes cable loss and can be affected by mounting method, location, and cable length.

GNSS

Parameter	Specification	Comments
Antenna Type	Active	
Gain	15 dB ≤ Gain ≤ 50dB	Minimum 15dB helps compensate for RF cable signal loss
Noise Figure	≤ 3 dB	Lower noise figures can result in better performance and tracking capability
Isolation	≥ 20 dB	Recommended isolation from other active transmitters or antennas
Input Voltage Rating	3.3V	If powered by CL-Txx module
Maximum Input Current	≤ 50 mA	If powered by CL-Txx module

Cellular (CL-T07-1xx/CL-T06-1xx)

Cellular Antenna Requirements:

Parameter	Specification	Comments
Peak Gain	3G / 2G ≤ 2.77 dBi in 850MHz Band ≤ 4.01 dBi in PCS 1900MHz Band ≤ 5.0 dBi in AWS 1700MHz Band	Additional testing and regulatory approval may be required for peak gains exceeding this requirement. Peak gain includes cable loss and can be affected by mounting method, location, and cable length. See note below.
Receive Diversity	No	Receive diversity is not supported on CL-T07/CL-T06 module

NOTE: Higher cellular antenna gains than those listed may be allowed without additional regulatory approval, provided the antenna-to-person distance is increased above 20cm and the ERP / EIRP and/or power density limits are maintained as specified in the associated FCC, ISED, and/ or EN/IEC standards. For further details, contact HED.

ANTENNA REQUIREMENTS (CONTINUED)

Cellular (CL-T17-1xx/CL-T16-1xx)

Parameter	Specification	Comments
Peak Gain	<p>2G ≤ 0.4 dBi in GSM850 band ≤ 2.2 dBi in GSM1900 band</p> <p>3G ≤ 8.3 dBi in FDD2 band ≤ 6.4 dBi in FDD5 band</p> <p>4G ≤ 9.3 dBi in eFDD2 band ≤ 7.7 dBi in eFDD4 band ≤ 6.9 dBi in eFDD5 band ≤ 6.4 dBi in eFDD12 band</p>	<p>Additional testing and regulatory approval may be required for peak gains exceeding this requirement. Peak gain includes cable loss and can be affected by mounting method, location, and cable length. See note below.</p> <p>For regions that support multiple cellular technologies (i.e. 4G/3G/2G) in similar frequency ranges, the most restrictive gain (i.e. minimum) must be used for that frequency range to ensure compliance.</p>
Receive Diversity	Yes	Receive diversity is supported on the CL-T17/CL-T16 module and should be used for best performance unless a waiver is approved by the carrier.
Isolation	≥ 20 dB	Recommended isolation between main and diversity antennas for best performance

Cellular (CL-T17-2xx/CL-T16-2xx)

Parameter	Specification	Comments
Peak Gain	<p>4G Only ≤ 7.5 dBi in eFDD4 band ≤ 6.7 dBi in eFDD13 band</p>	Additional testing and regulatory approval may be required for peak gains exceeding this requirement. Peak gain includes cable loss and can be affected by mounting method, location, and cable length. See note below.
Receive Diversity	Yes	Receive diversity is supported on the CL-T17/CL-T16 module and should be used for best performance unless a waiver is approved by the carrier.
Isolation	≥ 20 dB	Recommended isolation between main and diversity antennas for best performance

NOTE: Higher cellular antenna gains than those listed may be allowed without additional regulatory approval, provided the antenna-to-person distance is increased above 20cm and the ERP / EIRP and/or power density limits are maintained as specified in the associated FCC, ISED, and/ or EN/IEC standards. For further details, contact HED.

ANTENNA REQUIREMENTS (CONTINUED)

Cellular (CL-T17-3xx/CL-T16-3xx)

Parameter	Specification	Comments
Peak Gain	<p>2G ≤ 2.8 dBi in GSM900 band ≤ 8.7 dBi in GSM1800 band</p> <p>4G ≤ 12.2 dBi in eFDD3 band ≤ 12.8 dBi in eFDD7 band ≤ 9.0 dBi in eFDD20 band</p>	<p>Additional testing and regulatory approval may be required for peak gains exceeding this requirement. Peak gain includes cable loss and can be affected by mounting method, location, and cable length. See note below.</p> <p>For regions that support multiple cellular technologies (i.e. 4G/2G) in similar frequency ranges, the most restrictive gain (i.e. minimum) must be used for that frequency range to ensure compliance.</p>
Receive Diversity	Yes	Receive diversity is supported on the CL-T17/CL-T16 module and should be used for best performance unless a waiver is approved by the carrier.
Isolation	≥ 20 dB	Recommended isolation between main and diversity antennas for best performance

NOTE: Higher cellular antenna gains than those listed may be allowed without additional regulatory approval, provided the antenna-to-person distance is increased above 20cm and the power density limits are maintained as specified in the associated EN/IEC standards. For further details, contact HED.

EXAMPLE ANTENNAS (SINGLE)

The following antennas are examples that meet the regulatory requirements for use with the CANect products. Actual performance may be affected by mounting method, location, available service, etc. and should be verified by the system integrator. Antennas other than those listed below may be used, provided they meet the antenna requirements as listed earlier in this document.

Manufacturer	Manufacturer P/N	Mounting	Comments	WiFi		GNSS ¹				Cellular ²	
				2.4G	5G ³	GPS	GLO	GAL	BEI	4G	3G 2G
Linx Technologies	ANT-2.4-CW-RCT-RP	Direct		X							
L-com	HG2402RDR-RSP	Direct or Magnetic	Optional magnetic mount available	X							
Taoglas	AA.162.301111	Magnetic				X	X	X			
Taoglas	AA.107.301111	Adhesive				X	X	X			
Taoglas	A.41.A.301111	Roof Mount				X	X	X	X		
Taoglas	GSA.8827.A.101111	Adhesive	<u>Cell:</u> Cable length may need to be ≥ 3m if using 2G on CL-T1x products.								X

¹ GLO = GLONASS; GAL = Galileo; BEI = Beidou

² 'X' denotes single antenna. Separate main and diversity antennas are required for 4G LTE operation.

³ 5GHz band of WiFi not supported by current hardware

EXAMPLE ANTENNAS (MULTI)

Manufacturer	Manufacturer P/N or Series ⁴	Mounting	Comments	WiFi ⁵		GNSS ⁶				Cellular ⁷	
				2.4G	5G ⁸	GPS	GLO	GAL	BEI	4G	3G 2G
Taoglas	MA240 Series	Adhesive	<u>Cell</u> : Cable length may need to be ≥ 3m if using 2G on CL-T1x products.			X	X	X			2X
Taoglas	MA250 Series	Adhesive	<u>Cell</u> : Cable length may need to be ≥ 5m if using 2G on CL-T1x products.			X	X	X	X		2X
Taoglas	MA411 Series	Roof Mount	<u>Cell</u> : Do not use if deploying on a 2G network.			X	X	X	X		2X
Taoglas	MA245 Series	Adhesive	<u>Cell</u> : Do not use if deploying on a 2G network. <u>WiFi</u> : Cable length may need to be ≥ 5m to meet WiFi gain requirements.	X		X	X				2X
Taoglas	MA950 Series	Adhesive	<u>Cell</u> : Do not use if deploying on a 2G network. <u>WiFi</u> : Contact antenna manufacturer for assistance selecting cabling.	2X		X	X	X	X		2X
Taoglas	MA600.A.ABC.007	Roof Mount		X		X	X	X			X
Taoglas	MA760.A.ABIC.003	Roof Mount		X		X	X	X			2X
Taoglas	MA450 Series	Roof Mount	<u>Cell</u> : Do not use if deploying on a 2G network. <u>WiFi</u> : Contact antenna manufacturer for assistance selecting cabling.	2X		X	X	X	X		2X
Taoglas	MA850 Series	Roof Mount	<u>Cell</u> : Cable length may need to be ≥ 3m if using 2G on CL-T1x products. <u>WiFi</u> : Cable length may need to be ≥ 2m to meet WiFi gain requirements.	2X		X	X	X	X		2X

⁴ Manufacturer series are given when the stock part number does not meet all regulatory requirements, but a change to cable type or cable length (due to attenuation) would meet requirements. Please contact the antenna manufacturer for assistance. Cellular gain requirements vary based on technology (4G/3G/2G) with 2G being most restrictive.

⁵ 'X' denotes single antenna. '2X' denotes a MIMO (dual antenna) interface. MIMO is not supported by current hardware, single antenna only.

⁶ GLO = GLONASS; GAL = Galileo; BEI = Beidou

⁷ 'X' denotes single antenna. '2X' denotes a MIMO (dual antenna) interface for main and diversity antennas. Main and diversity antennas are required for 4G LTE operation.

⁸ 5GHz band of WiFi not supported by current hardware