OEM Vehicle Safety Controller

Rugged Vehicle Safety Controller with Dual Emergency Stop Inputs and Outputs, USB, RS232, and CAN Integration Interfaces

HRI's Safe Remote Control System is a medium to long-range wireless controller designed from the ground up to enable the safe operation of remote and automated systems. It provides a rugged, ergonomic, and easy to understand controller with a flexible receiver that both implement HRI's proprietary SafetySense™ technology to ensure both consistent and reliable control.

1. Applications

- Control of remote, tele-operated, semi- or fully autonomous robotic systems where safety and usability are critical.
- Monitoring of fixed or mobile industrial systems requiring sophisticated control and reliable wireless emergency stop capabilities.
- Pan & tilt controls for security and surveillance.

2. Key Features (Vehicle Safety Controller – VSC)

- SafetySense™ wireless communications with a range of 1000+ ft
  - Frequency bands include 900 MHz, 2.4 GHz (other bands available)
  - Encryption available upon request
- USB, RS-232 serial, and CAN bus support for flexible system integration options
- Hardware-based SafetySense™ implementation for high reliability, no single point of failure safety implementation
- Differential wired emergency stop input
- Master enable output for direct stop of motion control equipment
- 9 VDC to 32 VDC power input
- USB interface for programming and configuration
- -40°C to 85°C operation (depending on radio configuration)
- C drivers available to accelerate system software development

3. SafetySense™ Technology

SafetySense™ Technology consists of major system-level technologies that work together to provide the integrator the ability to design systems with consistent and reliable remote operations.

While the receiver is monitoring the health of both remote and user computer, it contains dedicated hardware that is monitoring its internal health. Both firmware-based and independent hardware based watchdog timers monitor the functionality of the receiver firmware. The communication link to the remote is also monitored directly in hardware (independent of the firmware-based monitoring). Finally, the reference clock source, used by this custom hardware block, is monitored by a third independent timer to ensure that is operating within its specifications. A failure in any of these components causes the system to indicate an emergency stop situation.

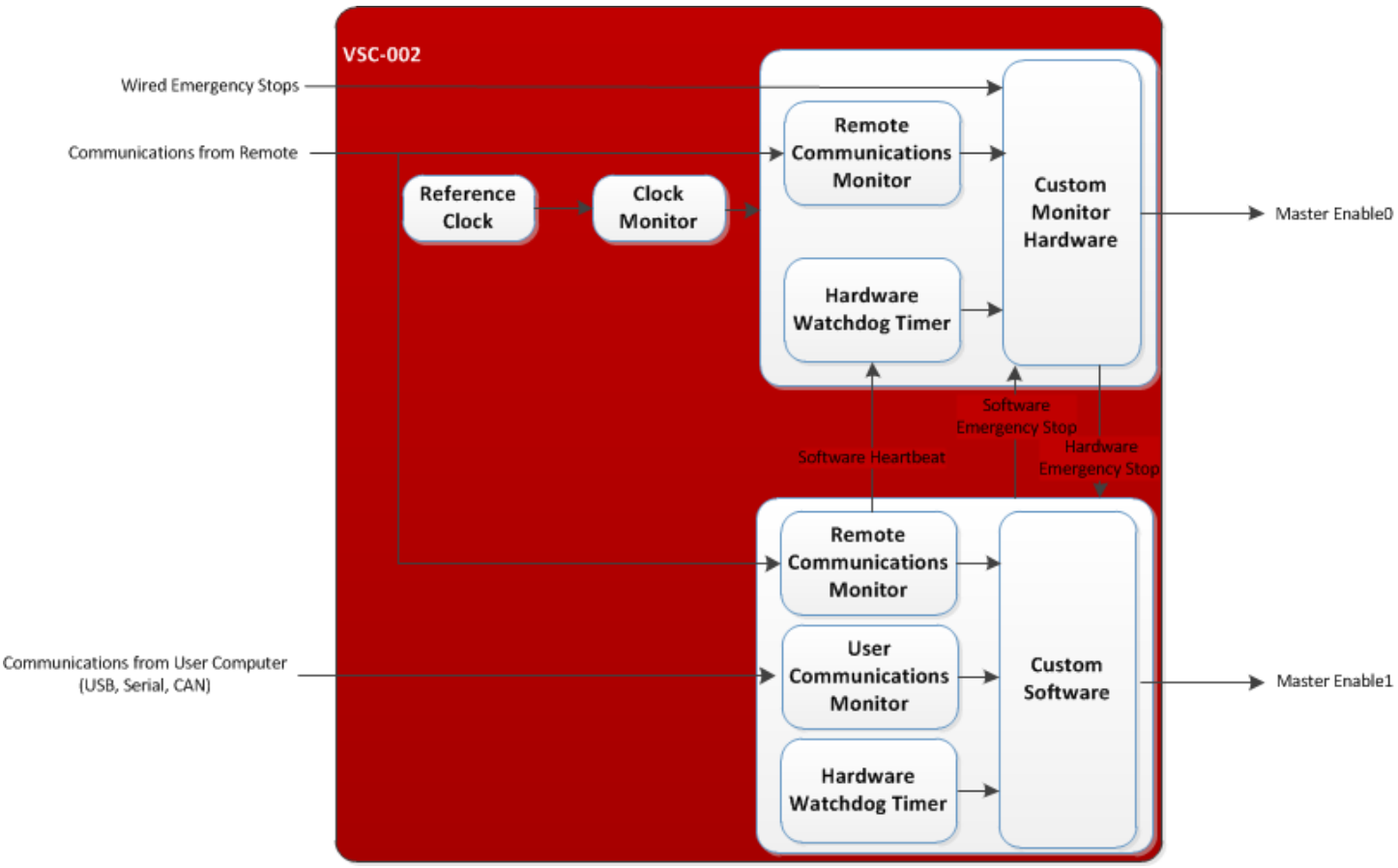

Figure 1 - Internal Hardware Monitors

The figure above illustrates the internal structure of the VSC. It is designed from the ground up to ensure that no single point of failure (hardware or software) exists that could cause an unsafe condition to not be caught and indicated by the Master Enable. It is important that system designers pay careful attention in the integration of the VSC with their drive system to ensure that motion will be prevented when the system de-asserts the Master Enable signals.

4. Specifications (Vehicle Safety Controller – VSC)

The Vehicle Safety Controller is an advanced receiver for several of HRI's wireless control and safety systems. It incorporates many of the SafetySense™ technologies described above.

4.1. Specifications

Parameter	Minimum	Typical	Maximum	Unit
PVin High Operating Voltage	9	12	32	V
RF Transmit Power – 900MHz		140	1000[1]	mW
RF Transmit Power – 2.4GHz		100	500[1]	mW
RF Receive Sensitivity	-101			dBm
RF Spread Spectrum		FHSS		
Data Security		AES 128		optional
Estop input voltage		PVin		V
Weight		1.0		lbs
Radio Connector		MMCX		
I/O Connector		30 pin Hirose DF-13 DF13A-30DP-1.25V		

1 – Maximum depends on local regulations. Inquire for details.

Table 1 - Vehicle Safety Controller Specifications

4.2. Data Interfaces

The VSC's integration interface is USB, RS232, or CAN. The communication specifications (data rates and protocol) are described in the system user's manual. The dual Master Enable outputs should be used to prevent any motion of the system under control when the VSC receives an emergency stop from either the remote or its wired emergency stop input. The Master Enable outputs are open drain type, designed to drive the coil of a pair of safety relays. The emergency stop inputs are relative to the PVin. A single ground reference should be maintained for all power and reverence voltages.

Parameter	Minimum	Typical	Maximum	Unit
Master Enable V_{ol}	GND	0.1	0.7	V
Master Enable I_o			150	mA
Estop V_{ih}			PVin/2 + 6%	V
Estop V_{il}	PVin/2 - 6%			V

Table 2 - VSC Data Interface Specifications

4.3. I/O Connector Pinout

All interfacing to the OEM VSC is through the 30 pin Hirose DF-13 connector. Its pin out is listed below.

Pin	Signal Name	Type	Description
1	3V3_REF	O	Internally regulated 3.3V output. Can be used for referencing all I/O when an external source is not available or necessary.
2	Master Enable 0	O	Normally low system enable open-drain output (high-Z = active estop condition).
3	Master Enable 1	O	Normally low system enable open-drain output (high-Z = active estop condition).
4	Reserved	NA	Reserved. Do not connect.
5	Reserved	NA	Reserved. Do not connect.
6	ESTOP_IN_L	I	Normally low Estop input (low = active estop condition). Must be referenced to Vref voltage
7	Reserved	NA	Reserved. Do not connect.
8	ESTOP_IN_H	I	Normally High Estop input (high = active estop condition). Must be referenced to Vref voltage
9	Reserved	NA	Reserved. Do not connect.

Pin	Signal Name	Type	Description
10	GND		
11	Reserved	NA	Reserved. Do not connect.
12	CAN_H	I/O	CAN interface positive data signal.
13	Reserved	NA	Reserved. Do not connect.
14	CAN_L	I/O	CAN interface negative data signal.
15	Reserved	NA	Reserved. Do not connect.
16	Reserved	NA	Reserved. Do not connect.
17	Reserved	NA	Reserved. Do not connect.
18	Reserved	NA	Reserved. Do not connect.
19	Reserved	NA	Reserved. Do not connect.
20	Reserved	NA	Reserved. Do not connect.
21	Vin	I	Main power input
22	LED0	O	
23	Reserved	NA	Reserved. Do not connect.
24	LED1	O	
25	USB_DN	I/O	USB Data negative
26	GND		
27	USB_DP	I/O	USB Data positive
28	RS232_0_TX	O	RS-232 serial data transmit
29	Vin_USB	I	USB power input. Must be connected to the 5V power provided by the USB host.
30	RS232_0_RX	I	RS-232 serial data receive

Table 3 - I/O Connector Pinout

4.4. Mechanical Specification

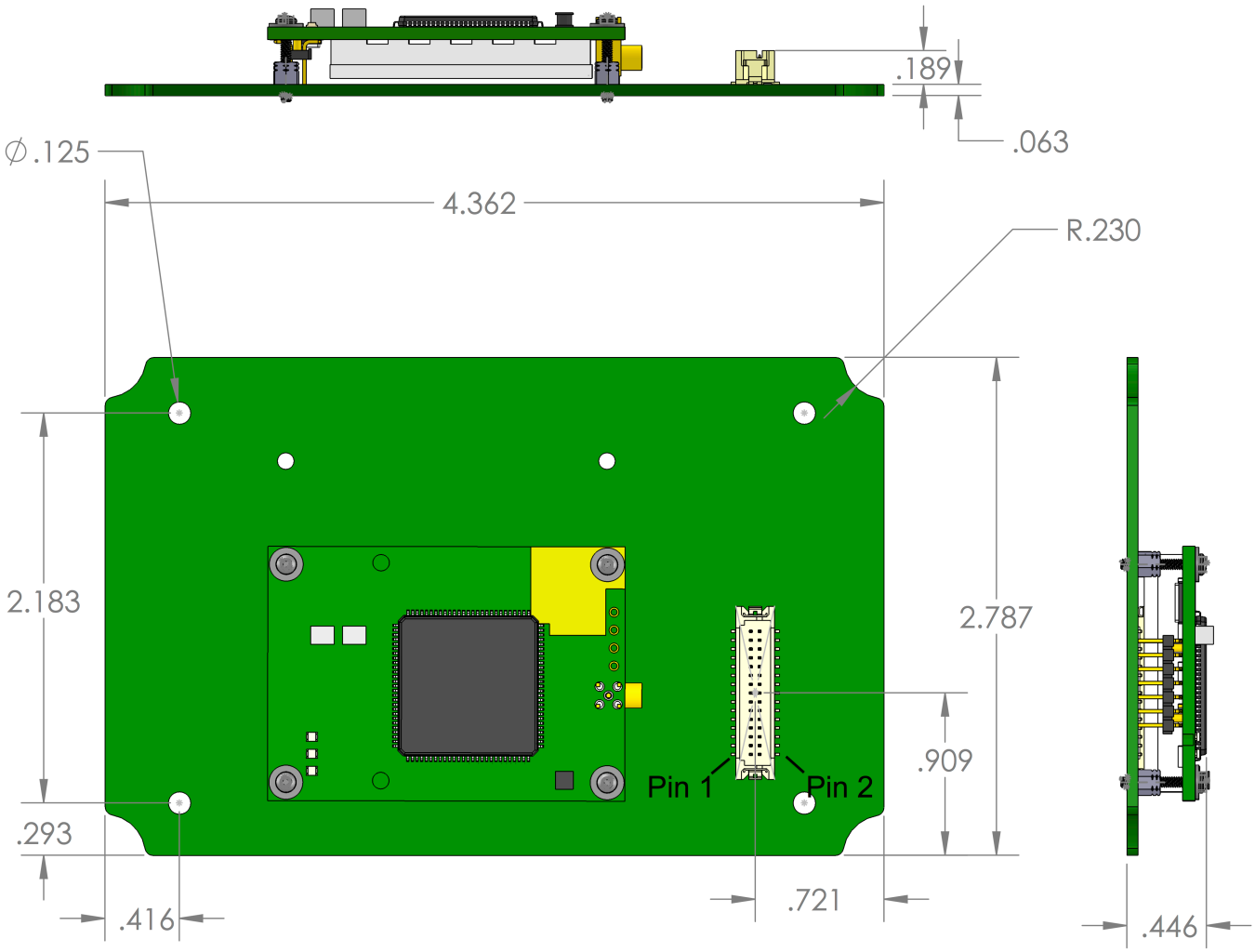

Figure 2: VSC Mechanical Drawing

5. Installation

5.1. Hardware Integration

A typical installation of the VSC will use the supplied VIC-001 integration cable. This cable provides the connections required for most integration into systems with a user computer, wired emergency stops, and utilizing the Master Enable. The figure below illustrates the connections in a typical system.

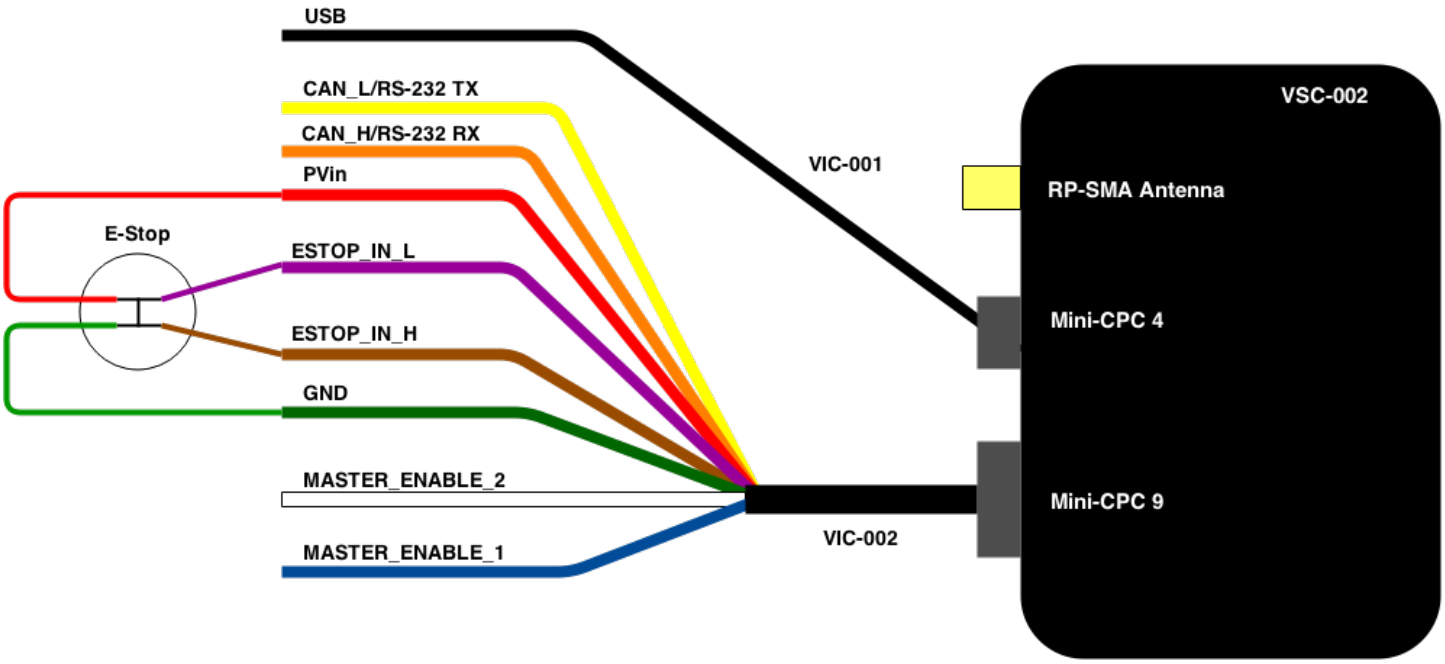

Figure 3 - Typical VSC Connections

Estop_In_H and Estop_In_L are intended to be connected as shown through a standard emergency stop switch. These signals are internally biased to their fault state, so it is necessary to select a normally closed emergency stop button to short them as shown above in the system's normally operating condition. It is critical that the Estop_In_H and Estop_In_L signals are treated properly. If one or both of these signals are treated improperly or left unconnected; the VSC will treat this as a fault condition and de-assert the Master Enable signals.

The Master Enable signals are open drain signals designed to drive either a digital enable inputs to the users drive system or a pair of safety relays to control the vehicle drive system. Examples of these two configurations are shown below. It is important to note that a back-EMF diode is necessary to install as shown when driving an inductive load (i.e. a relay coil).

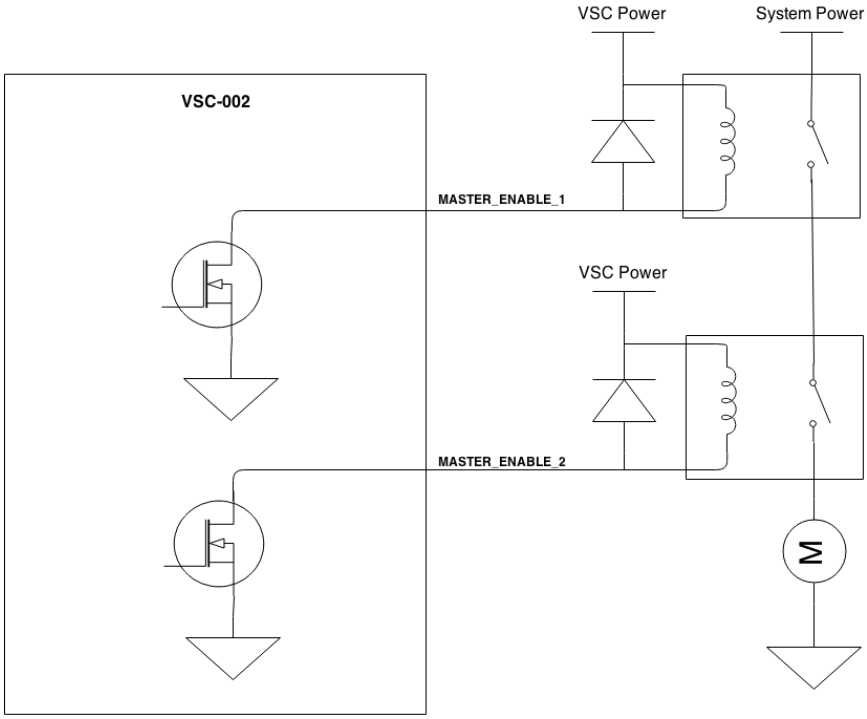

Figure 4 - Master Enable Relay Connection

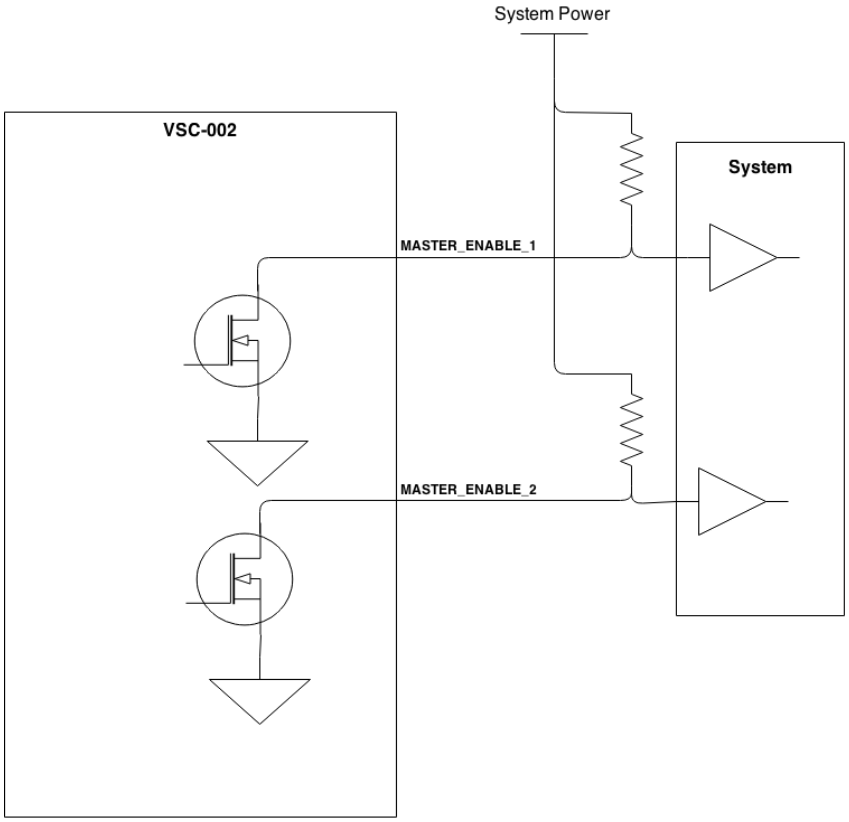

Figure 5 - Master Enable Digital Connection

5.2. Interfacing (RS232 / USB)

When using an RS232 or USB version of the VSC, all command and control communication is in the HRI Packet Protocol. The VSC USB interface is implemented as a CDC device and on most operating systems it will show up as a serial port (*/dev/tty.usbserial*, */dev/ttyACM0*, COM1, etc). There are no differences in software integration when using the RS232 connection or the USB connection. An example C application is provided that uses the HRI Packet Protocol to communicate with the VSC over a serial device. The example shows to how provide heartbeat and feedback messages to the VSC while receiving joystick, heartbeat and GPS messages from the VSC. Detailed integration information is described in the user manual. Up to date documentation and sample code can be found at http://docs.hri.io.

5.3. Interfacing (CAN-J1939)

When using the CAN version of the VSC, all command and control communication is over the CAN Bus interface using J1939 Protocol. The VSC uses the SAE J1939 basic joystick messages and extended joystick messages to transfer information about the measured status of the X, Y and Z-axis of the joysticks, and the state of buttons. The SRCS uses custom SAE J1939 messages to transfer the heartbeat and key-value pair information. Detailed integration information is described in the user manual. Up to date documentation and sample code can be found at http://docs.hri.io.

6. Regulatory Information

6.1. Power Output

The VSC-002-900 is capable of transmitting at up to 1W. It is recommended that the transmit antenna be kept at least 23cm away from nearby persons to satisfy FCC RF exposure requirements.

The VSC-002-240 is capable of transmitting at up to 500mW. The antenna used must provide a separation distance of at least 20cm from all persons and must no be co-located or operate in conjunction with any other antenna or transmitter.

6.2. FCC Notifications

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.

6.3. IC Notifications

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device many not cause interference, and (2) this device must accept any interference, including interference that many cause undesired operation of the device.

6.4. Ce dispositif est conforme aux norms permis-exemptes du Canada RSS d'industrie. L'opération est sujette aux deux conditions suivates: (1) ce dispositive peut ne pas l'interférence, et (2) ce dispositif doit accepter n'importe quelle interference, y compris l'interférence qui peut causer le fonctionnement peu desire du dispositif.

7. Ordering Information

Part Number	Description
VSC-003-(F)-(I)	Vehicle Safety Controller implementation kit with USB cable and 36-inch pigtail I/O connector (F) = Radio Selection 900: 900MHz FHSS 140mW (inquire for higher power) 240: 2.4GHz FHSS 100mW (inquire for higher power) ** Inquire about other frequency bands (I) = Interface Selection USB: USB CDC interface 232: RS-232 interface CAN: J1939 CANbus interface
VIC-001	USB interface cable for VSC
VIC-002	36 inch pigtail I/O connector for VSC
VIC-003	DF-13 30 pin to 4 and 9 pin CPC connectors (for use with OEM VSC)

Table 4 - VSC Orderable Part Numbers

8. Limited Warranty

All products sold by Humanistic Robotics, Inc are subject to the warranty provisions of the Humanistic Robotics Order Confirmation terms and conditions and are warranted against defects in material and workmanship for a period of one (1) year from the date of shipment. If you believe any Humanistic Robotics, Inc product you have purchased has a defect in material or workmanship or has failed during normal use within the warranty period, please contact Humanistic Robotics, Inc for assistance. If product repair or replacement is necessary, the Customer will be solely responsible for all shipping charges, freight, insurance and proper packaging to prevent breakage in transit, whether or not the product is covered by this warranty.

This warranty does not apply to defects resulting from any Customer actions, such as mishandling, improper interfacing, operation outside of design limits, misapplication, improper repair, or unauthorized modification. No other warranties are expressed or implied. Humanistic Robotics, Inc specifically disclaims any implied warranties of merchantability or fitness for a specific purpose and all warranties arising from course of dealing and/or trade usage. Humanistic Robotics, Inc.'s liability shall be limited to the actual purchase price of any defective unit or units of equipment to which a claim is made, and shall in no event include the Customer's manufacturing costs, lost profits or goodwill, or any other direct, indirect, special, incidental, consequential or punitive damages whether based on contract, tort or other legal theory. Humanistic Robotics, Inc shall not be liable for normal manufacturing defects or customary variances from specifications.

Products sold by Humanistic Robotics, Inc are not designed, intended or authorized for use in applications intended to sustain or support life, in any nuclear facilities or any other application where the failure of the product could create a situation where catastrophic property damage, personal injury or death may occur. In the event that the Customer purchases or uses any Humanistic Robotics, Inc products for any such unintended or unauthorized application, the Customer shall indemnify and hold harmless Humanistic Robotics, Inc and its officers, directors, employees, agents, affiliates, successors and assigns against all claims, costs, damages and expenses (including reasonable attorneys' and expert witness' fees) arising out of or in connection with, directly or indirectly, any claim for property damage, personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Humanistic Robotics, Inc was negligent regarding the design or manufacture of the subject product.

9. Revision History

Version	Date	Changes
-01	4/10/14	Initial Release
-02	4/14/15	Fixed error in estop input descriptions Updated figure 3 Updated ordering information Updated regulatory information

Humanistic Robotics, Inc.
111 South Independence Mall East
Suite 1010
Philadelphia, PA 19106
1-267-515-5880
www.humanisticrobotics.com