HITECSENSORS
A HUMANETICS COMPANY

OPERATING MANUAL

# IR TELEMETRY STEERING EFFECT SENSOR

## (MODEL 01184)

# CONTENTS

# INTRODUCTION

## SYSTEM OVERVIEW

HITEC Sensor Developments IR Telemetry Steering Effort Sensor (Model 01184) is designed to measure the amount of effort needed to turn the steering wheel and the angular position of the steering wheel.

This system provides:

- A 10 in. through-hole for uninhibited deployment of an air bag without the danger of the sensor being projected at the driver.
- A low mass-moment of inertia.
- Dual resolution for angular measurement (0.2° or 0.05°), and
- Non contacting torque signal transmission which permits unlimited wheel rotation

## SYSTEM COMPONENTS

The system consists of the following:

- A steering effort sensor with.
- An Infra-Red (IR) telemetry transmission system
- An angular position sensor, and
- An analog converter

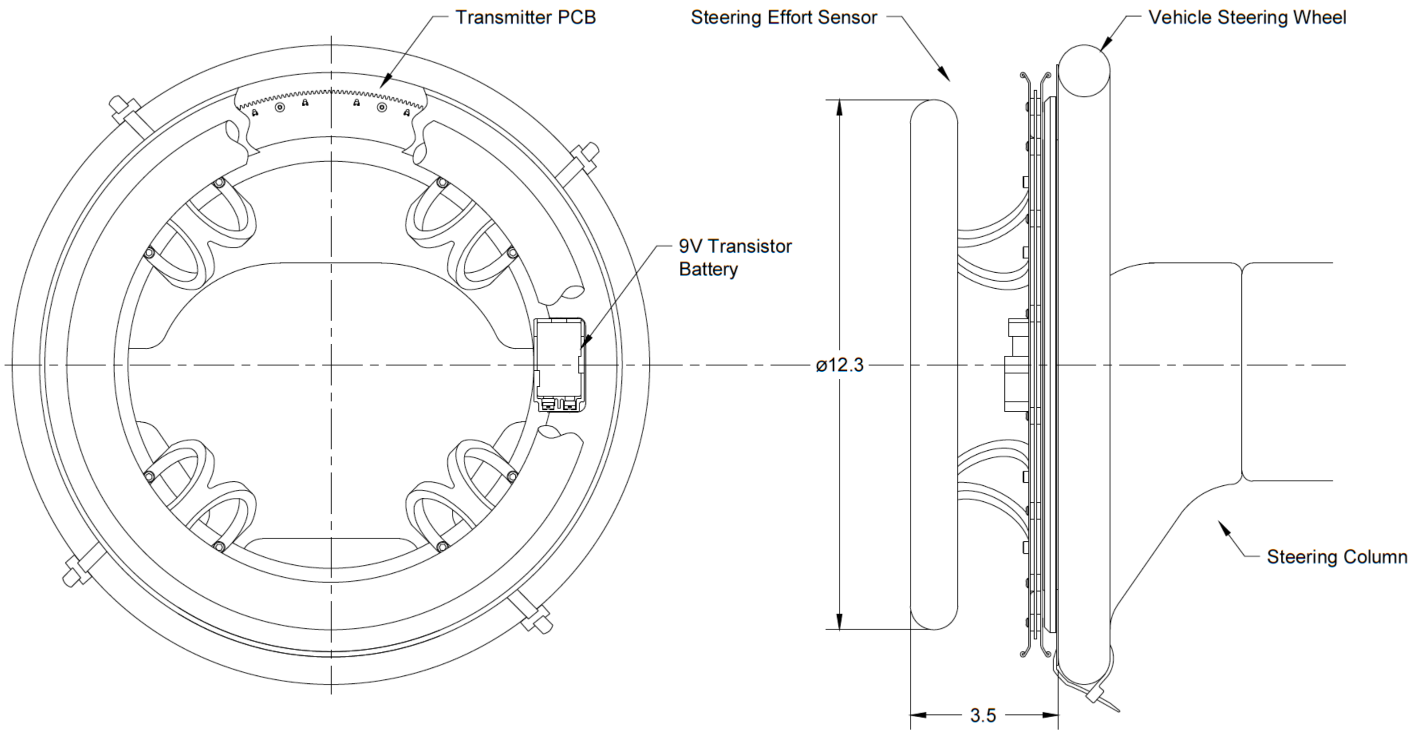
### The Steering Effort Sensor

The steering effort sensor is an auxiliary steering wheel with 12 in. OD. The sensor mounts to the vehicle's steering wheel with four cable ties. The sensor has four adjustable mounting plates to fit steering wheels from 14.5-16 in. OD. The sensor has a 2.6 in. offset from the steering wheel. (See illustration on next page.)

### The IR Telemetry Transmission System

The non-contact data coupling system consists of the IR transmitter (built into the steering sensor), a near-by IR detector (mounted on the encoder housing), and the receiver. Power to the transmitter is supplied by a 9 Volt battery. The receiver is powered by 11-16VDC vehicle power.

Note: HITEC Sensor Developments recommends replacing the transmitter battery at the beginning of each test day.




### The Angular Position Sensor

The angular position sensor is an optical encoder mounted on the inside of the front windshield. A drive train assembly rotates the drive shaft attached to the encoder as the steering wheel sensor is turned. When the chain is installed, and both gears are properly aligned, the IR emitters in the sensor are also properly aligned with the IR detector mounted to the encoder housing.

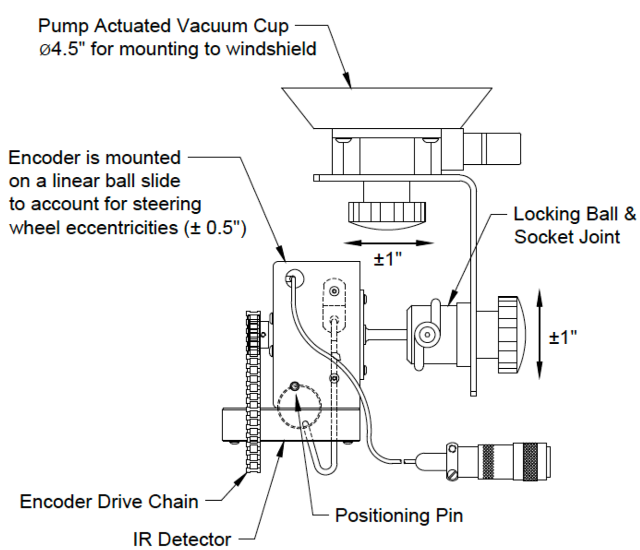



Figure 2: Angular Position Sensor

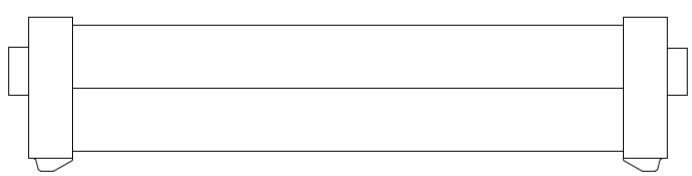


Figure 3: The IR Receiver/Encoder to Analog Converter

The receiver (Figure 3) produces analog outputs from both the torque sensor and the encoder.

# INSTALLATION

## INSTALLING THE SYSTEM

To install the system:

**Step 1: Mount the steering effort sensor to the vehicle's steering wheel.**

**A.** Position the sensor so that it rests firmly against the front of the steering wheel.

**B.** Adjust all four mounting brackets for the proper fit. Make certain to adjust all four brackets symmetrically.

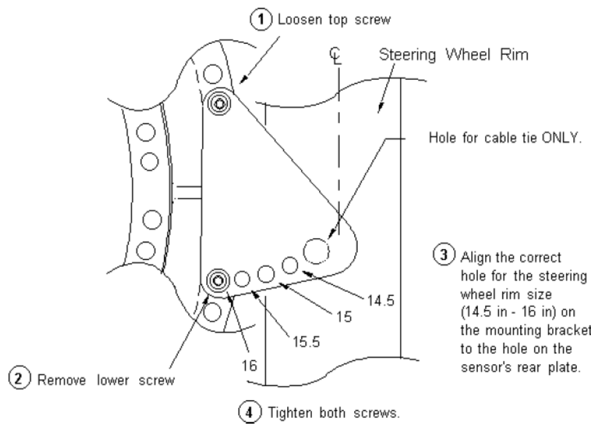



Figure 4: Step 1B - Mounting brackets

**C.** Tie the steering effort sensor to the steering wheel using one cable tie for each of the four mounting brackets.

**D.** Pull the cable ties firmly to tighten, and then trim the ties. (If not trimmed the ties may interfere with the drive train.)

**Step 2: Mount the angular position sensor to the inside of the windshield.**

**A.** Push the gear all the way up the linear ball slide, and place the positioning pin through the holes in the front and rear of the optical encoder to limit its travel to the midpoint.

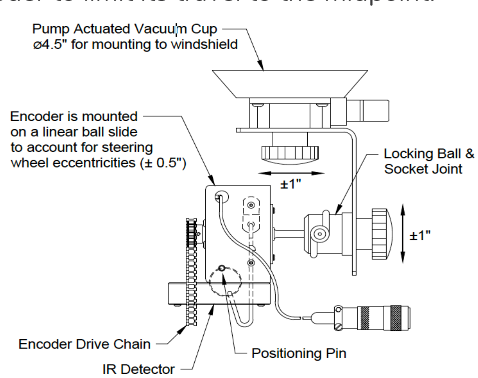



Figure 5: Step 2A - Optical encoder

**B.** Place the drive chain around the gear of the steering effort sensor.

**C.** Position the angular position sensor on the windshield so that:

- The angle encoder is NOT in the drivers direct line of vision
- The drive chain is taut
- The encoder gear is in the same plane as the gear on the steering wheel

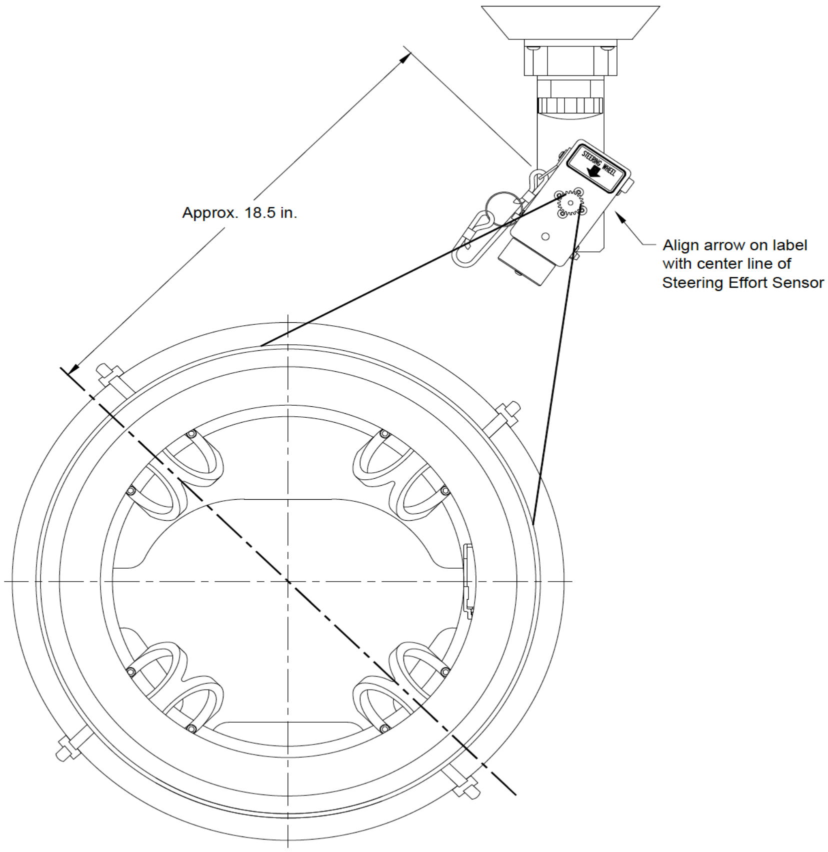



Figure 6: Step 2C - Positioning the angular position sensor

**D.** Attach the angular position sensor to the windshield by pumping the suction cup's plunger. Pump it until the red stripe is no longer visible.

**E.** If necessary, adjust its position by loosening the knobs and sliding the bracket to the correct position (see figure 2).

**F.** Adjust the angle of the encoder so the arrow on its label is pointing directly toward the center of the steering wheel by loosening and the tightening the ball and socket joint.

**G.** Remove the positioning pin from the front and rear holes of the angular position sensor, and place it through the side holes.

**H.** Rotate the steering wheel to ensure that the encoder (on the angle position sensor) can travel along the linear ball slide without restriction.
The IR telemetry emitters and detector are now properly aligned as well.

Step 3: **Connect the angular position sensor (encoder) to the receiver. The IR detector's power and digital data signals are also carried through this cable/connector.**

Step 4: **Connect the encoder signal outputs of the receiver to the data acquisition system.**

Step 5: **Connect the torque sensor signal outputs of the receiver to the data acquisition system.**

Step 6: **Connect a 9V alkaline battery to the sensing element. Use the power switch to control power to the transmitter.**

Note: HITEC Sensor Developments recommends installing a new battery at the beginning of each test day.

# OPERATING THE SYSTEM

## CALIBRATION

This unit was calibrated at the factory. Calibration sheets have been provided with the unit specifying what each output will provide for a given input. The calibration on the torque output can be measured very accurately using the shunt cal. Refer to Figure 7 for location of the shunt button. When the shunt button is pressed, a resistor is placed across a leg of the bridge, which produces a very repeatable simulated torque on the sensor. The shunt button is a momentary type button and will release the shunt when the button is released.

To calibrate the torque sensor to the data acquisition system:

**Step 1**: Place the steering effort sensor at the desired neutral position.

**Step 2:** Adjust the "zero" potentiometer until the output voltage is 0 volts.

**Step 3:** Zero/tare the data acquisition system.

**Step 4:** Press the shunt calibration button on the sensing element and measure the simulated output produced. The output should reflect the number on the data sheet provided by the manufacturer.

**Step 5:** Input the simulated torque value to the data acquisition system.

**Step 6:** Alternate… use the capacity and full scale output numbers provided on the data sheet for the values entered into the data acquisition system. Use the shunt to verify cal.

The angle outputs do not have a simple method of verifying calibration, and if more than a "ballpark" verification is needed, an angle fixture will be required.

To calibrate the angle outputs to the data acquisition system:

**Step 1:** Place the steering effort sensor at the desired zero position.

**Step 2:** Momentarily press the encoder zero button on the receiver. See Figure 9 for location of this button.

**Step 3:** Zero/tare the data acquisition system on each encoder channel.

**Step 4:** Enter into the data acquisition system the range and output values from the data sheet provided with the sensor.

## COLLECTING DATA

Torque and position data are transmitted automatically and continuously when the system is powered up.

# OVERVIEW OF SYSTEM ELECTRONICS

## INFRA-RED (IR) TRANSMITTER

The transmitter consists of a strain gage amplifier, a 4 pole low pass butterworth filter, analog to digital converter, control electronics, and an array of IR LED's. The basic operation is that, when powered up, the transmitter amplifies the signal from the torque sensor, filters it, digitizes it and sends it out by pulsing the IR emitters to transmit the code.

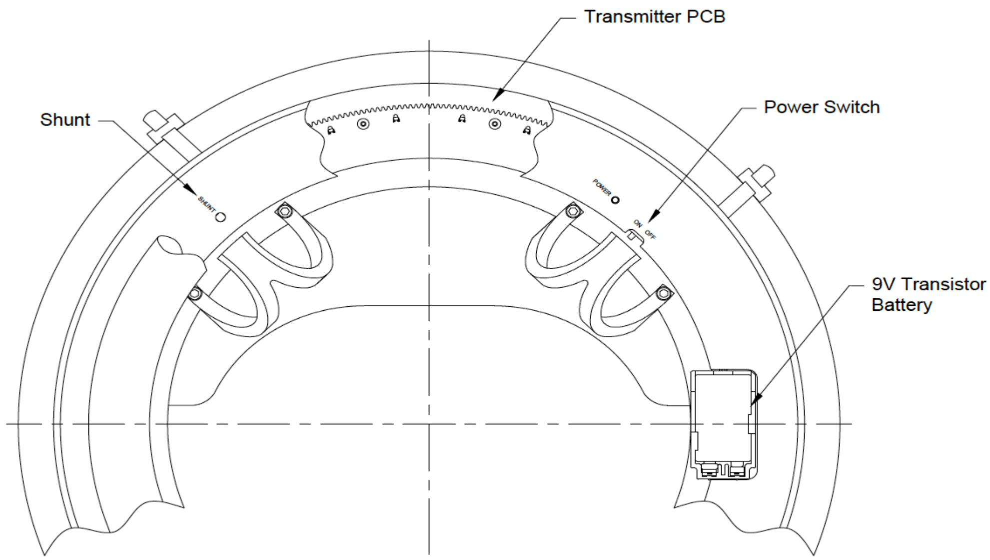



Figure 7: Infra-Red (IR) Transmitter

Under normal operation, the power indicator (see Figure 7) will blink indicating that the unit is powered up and transmitting normally. The power switch (Figure 7) controls power to the unit.

The shunt button is used to verify calibration of both this sensor, and any subsequent data acquisition system. It is a momentary switch that, when pressed, applies a shunt resistor to the sensor bridge. This has the effect of producing a simulated output from the sensor, and likewise, a signal will be produced at the receiver's output. The shunt is very repeatable and calibration information for its effect is documented in the calibration data provided with the sensor.

All data sent from the transmitter are encoded with a CRC. This is an error detection scheme that is used by the receiver to tell if the received data was good. When the transmitter's battery gets low, the transmitter will intentionally corrupt the CRC before sending it. The receiver will continually see the transmission as in error. In addition, the transmitter's power indicator will stop flashing, turning solid red. Replace the transmitter's battery when this occurs.

# IR RECEIVER/ENCODER TO ANALOG CONVERTER

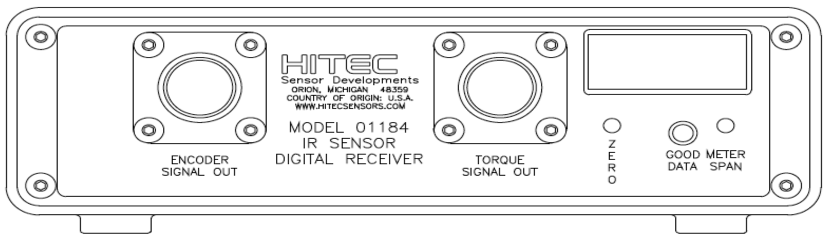
The receiver consists of an Infra-Red detector unit (mounted at the encoder), control electronics, digital to analog (D/A) converters and buffer/filters. Basic operation is:

**Step 1:** Connect to the required signal outputs as shown in Figure 8a or 8b.

**Step 2:** Connect the encoder as shown in Figure 9.

**Step 3:** Connect power to the power input pins as shown in Figure 9 and turn on the power switch.

ENCODER SIGNAL OUT
A High Resolution Sig
B High Resolution Gnd
C Low Resolution Sig
D Low Resolution Gnd
E Rate Sig
F Rate Gnd




SIGNAL OUT
A Sig
B Gnd
C N/C
D N/C
E N/C
F N/C

Figure 8a: IR Receiver PT Style Connections, Side 1

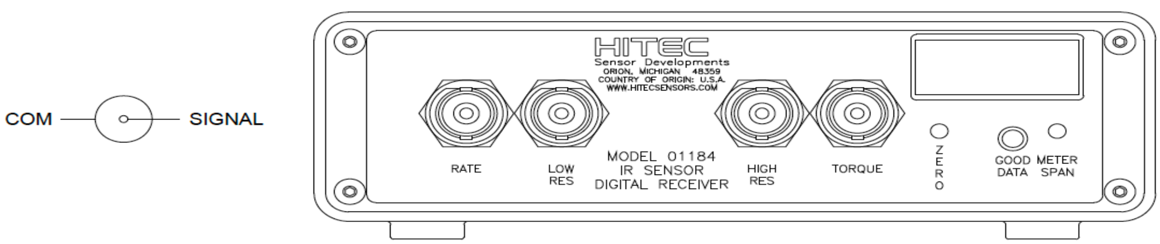
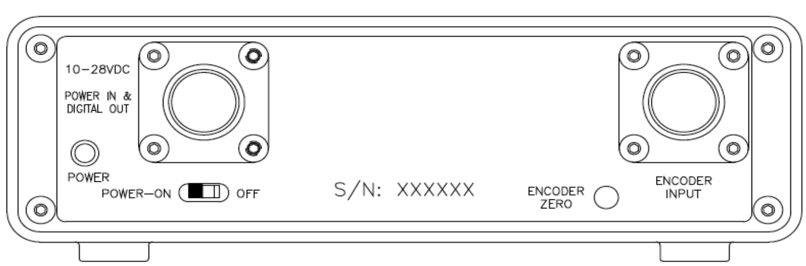



Figure 8b: IR Receiver Optional BNC Style Connections, Side 1

POWER IN & DIGITAL OUT
A +10V to 28VDC
B Gnd
C Good Data Relay-N/O
D Good Data Relay-Common
E N/C
F N/C




ENCODER INPUT
A +5V
B Ch A
C Ch B
D Gnd
E Data A
F Data B

Figure 9: IR Receiver Connections, Side 2

The unit will receive a digital signal from a near-by transmitter. When this happens, the green “good data” indicator will light showing that the digital data was recovered without error. The good data is then fed to the Digital to Analog converter, and on to the analog output. The analog output is buffered and filtered. The filter is there to smooth the steps that are inherent in the output of the D/A converter. In the event that the data is found to be in error, the good data light will go out, a beeper will sound a short tone and the good data relay contacts will open. In the event that the unit loses power, the relay contacts will rest in the open position, indicating an error. The contacts are available at the power connector as shown in Figure 9. Note that the beeper can be disabled by opening the enclosure and moving the jumper next to the beeper to the “disabled” location.

The encoder’s position and rate of change are available at the encoder output connector. As with the sensor output, the encoder outputs are buffered and filtered. Since the encoder input is compatible with incremental encoders only, the position output must be zeroed. To do this, position the encoder to the desired zero position, and press the “zero encoder” button. See Figure 9. The zero value will be lost if power is removed. The encoder’s output connector provides 2 position signals, thus providing 2 available resolutions. Refer to pages 13 & 14 of this document for specifications on resolution and rate.

This unit comes with adjustments for zero, along with a span adjustment for the meter. The signal output span adjustments have been set at the factory and are not user adjustable. The meter is simply a voltmeter connected to the sensor output signal. The meter has a span adjustment range that covers 0 to 2000 counts with a decimal point that is factory set. With 5 volts at the sensor output, units that have the meter configured for voltage will be adjusted to show 5.00 counts. Units that have the meter configured for engineering units will show those units in a unit that best fits the display. For example, if the sensor capacity was 7000 pounds, the meter would display 7.00 and the units would be understood to be in 1000’s of pounds.

When measuring the signal outputs, note that the signal ground is isolated from the power supply ground to prevent ground loops. Measurements must be taken with respect to the signal ground and not the power ground. The signal ground is common for all output signals. The signal ground may be connected to the power supply ground without damaging the unit. Some applications may require that they be connected. For example, when using a DAQ system with differential inputs to read these signals, it is important to ground the negative signal input on the DAQ system to provide an absolute point of reference for the input. Without such a connection, erroneous data may be collected. For DAQ systems with grounded single-ended inputs, this is not an issue.

# CAN OUTPUT (OPTIONAL)

HITEC Sensors provides the 01184 Steering Effort sensor with an optional CAN output. See Figure 10.

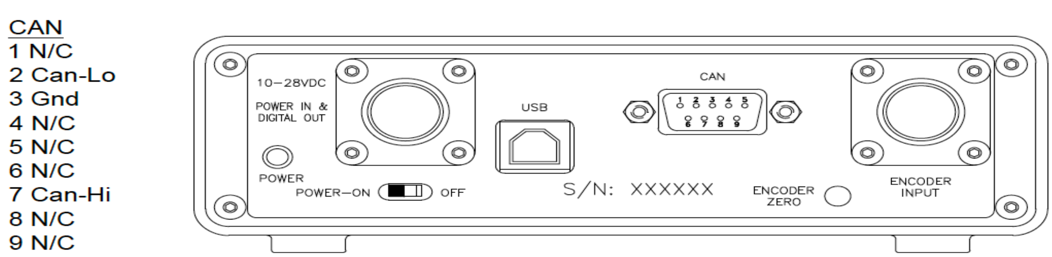



Figure 10: Steering Effort

The CAN output is designed to connect directly to a differential CAN bus, and supports the CAN 2.0B standard. The 01184 allows the user to select, via a USB Setup program (install from supplied CDROM), which items will be placed onto the CAN bus. See Figure 11.

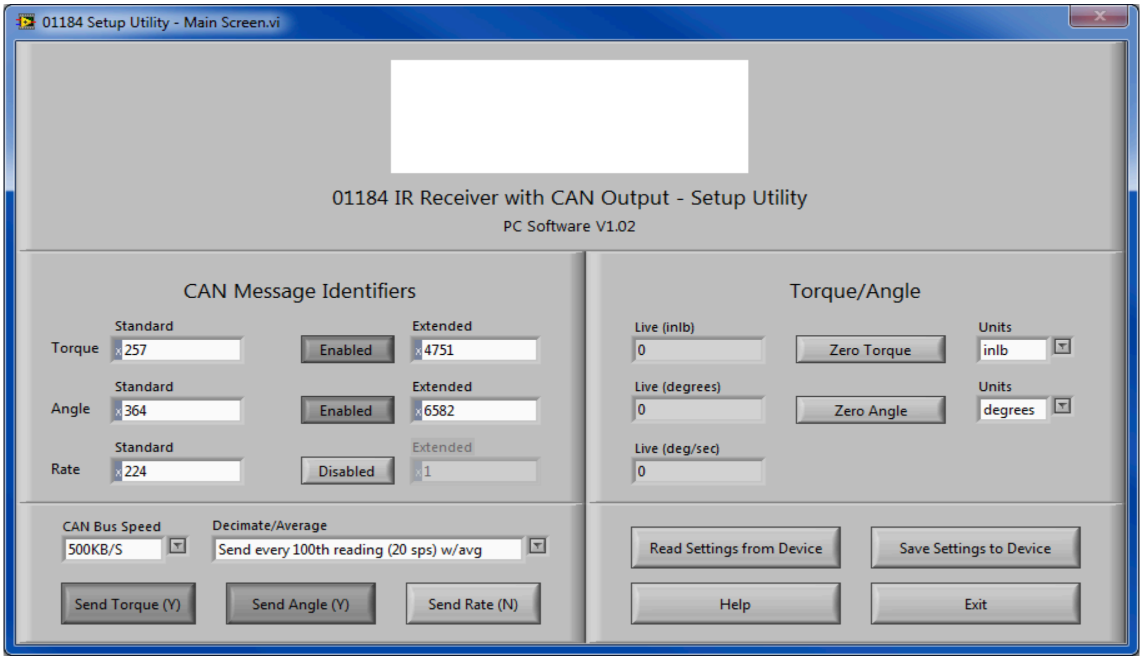



Figure 11: USB Setup program

The three items measured by the 01184 are Torque, Angle and Rate. Each item may be placed on the CAN bus as an individual message. Each message is made up of eight bytes. The first four bytes (bytes 0-3) are the 32 bit IEEE single precision floating point representation of the item being measured. They are stored little endian, with the low byte of the significand, or mantissa, in the first byte (D0). The remaining 4 bytes (bytes 4-7) are ASCII characters that contain engineering units. Units that use less than 4 bytes will be completed with ASCII space characters. For example, consider a data packet received, from D0-D7, that contains 0x27A00341696E6C62. The first four bytes, 0x27A00341, are the floating point portion. 0x27 is the lowest byte and 0x41 is the highest byte. A conversion, or re-typing, of these bytes from binary to floating, point reveals that the value is 8.2266. The next four bytes, 0x696E6C62 are ASCII codes for 'i', 'n', 'l' and 'b' respectively, or "inlb."

Each item measured can be specified with a Standard Identifier and an optional Extended Identifier. The Extended Identifier may be enabled or disabled by clicking the button next to it. It's worth noting that the lower the value of the Identifier, the higher the priority of the CAN message. Also, in the special case of two messages that share the same Standard Identifier, but one message is standard and the other is extended, the standard message will have priority. Standard Identifier values 0x7F0-0x7FF are reserved. Please do not use them.

The speed of the CAN bus can be selected, with values from 125k to 1Mbaud supported. In order to lower the amount of bus traffic, the user may opt to send less than the full amount of data that the IR Receiver has collected. This is done using the Decimate/Average selection. Note that if an 'average' selection is chosen, only Torque is averaged. Angle and Rate are not averaged to further reduce bus traffic, the user may opt to turn unwanted outputs off. This is done by clicking the Send Torque, Send Angle and Send Rate buttons, to enable/disable them.

The user may zero the Torque and/or the Angle using the Zero Torque and Zero Angle buttons. These values are recorded/saved immediately when the button is pressed. There is no Zero Rate, as Rate is inherently zero when the sensor is not in motion.

The Live update on the screen shows real time data in the engineering units shown above the Live display.

The Engineering Units may be changed by using the selections to the right of the Zero buttons, but these selections will not take effect until they are saved to the device. Engineering Units for Rate correspond to those of Angle. For example, if Angle is degrees, Rate is Degrees/Second.

Unsaved changes may be discarded by clicking 'Read Settings from Device'.

When all selections have been made, click 'Save Settings to Device'.

The 'Help' button launches this manual.

When setup is complete, click 'Exit' to close the program.

CAN bus termination is available by opening the receiver and turning on the dip switches labeled S2. Both switches must be turn on to enable termination. Likewise, both switches must be off to disable termination.

# APPENDIX

## SPECIFICATIONS

| TORQUE TRANSDUCER DATA | |
|---|---|
| Capacities (in-lbs) | 200, 500, 1000 |
| Output at Full Scale (nominal) (V) | ±5 |
| Optional Output at Full Scale (nominal) (V) | ±10 |
| Optional Output at Full Scale (nominal) (V) | +2.5 ±2.5 |
| Overload Capacity (%) | 150 of FS |
| Hysteresis (%) | 0.25 of FS |
| Non-linearity (%) | 0.25 of FS |
| Mass moment of inertia (calculated) (in-lbs) | 0.20 sec2 |
| Resolution (bits) | 16 (15 + sign) |
| Sample rate (second) | 2000 samples |
| Low pass anti-aliasing filter | 4 pole @600Hz |
| Power supply input (VDC) | 6.5 - 15 |
| Power supply current (mA) | 30 |
| Recommended battery (V) | 9 Alkaline |
| Approximate battery life with recommended battery | 8 Hours |

| SECONDARY STEERING WHEEL | |
|---|---|
| OD (in) | 12 |
| Offset (in) | 3.5 |

| IR TRANSMISSION SYSTEM | |
|---|---|
| Analog Output (nominal) (V) | ±5 |
| Optional Analog Output (nominal) (V) | ±10 |
| Optional Analog Output (nominal) (V) | +2.5 ±2.5 |
| Output low pass filter | 2 pole @ 1000Hz |
| Resolution (%) | 0.005 of FS |
| Transmitter (V) | 9 battery |
| Receiver (VDC) | 10 - 28 |
| Transmitting range (in) | 2 - 10 |

| POSITION/VELOCITY SYSTEM | |
|---|---|
| Encoder (ppr) | 7,200 |
| **Low resolution Output** | |
| Resolution (degrees) | 0.20 |
| Maximum Range (degrees) | ±1638.4 |
| Output at maximum range (VDC) | ±5 |
| Optional Output at maximum range (VDC) | ±10 |
| Optional Output at maximum range | +2.5V ±2.5VDC |
| Update rate (second) | 2000 updates |
| Low pass filter | 2 pole @1000Hz |
| **High Resolution Output** | |
| Resolution (degrees) | 0.05 |
| Maximum Range (degrees) | ±409.6 |
| Output at maximum range (VDC) | ±5 |
| Optional Output at maximum range (VDC) | ±10 |
| Optional Output at maximum range | + 2.5 V ± 2.5VDC |
| Update rate (second) | 2000 updates |
| Low pass filter | 2 pole @1000Hz |

| Rate Output | |
|---|---|
| Resolution (degrees) | 0.20 |
| Maximum Range (degrees) | ± 1638.4 |
| Signal Output at maximum range (VDC) | ±5 |
| Optional Signal Output at maximum range (VDC) | ±10 |
| Optional Output at maximum range | +2.5V ±2.5VDC |
| Update rate (second) | 2000 updates |
| Low pass filter | 2 pole @1000Hz |

| POWER REQUIREMENTS FOR IR RECEIVER | |
|---|---|
| Voltage range (VDC) | 10 - 28 |
| Voltage range (mA) | 300 max. |

# SERVICE WARRANTY

HITEC Sensor Developments warrants its products to be free from defects in material and workmanship for a period of one year from shipment from our factory. In that period we will, at our option, repair or replace a defective component or entire product which has been submitted for our examination. This is our sole obligation. We are not responsible for any costs or liabilities arising from but not limited to de-installing, consequent or collateral damage, delays, loss of use, re-installing, or any others. The warranty is in effect provided the component or product is properly used in the application for which it is intended. Products which have been modified without HITEC Sensor Developments approval, on which repairs have been attempted by non-qualified persons, which have been subjected to physical or electrical stress beyond our ratings, or which have had their identifying marks removed or altered are not covered by this warranty.

In cases of incorporation of a product by the user in a larger system provided by a third party or sold on to a third party, we make no warranties except those above. We assume no responsibility for fitness for purpose in these circumstances.

Warranty returns must be authorized by us and shipped prepaid to us. Our return authorization number must appear on the packaging and any correspondence. We will return the goods prepaid. Products, which have been exposed to hazardous materials, will not be accepted unless they have been properly decontaminated. HITEC Sensor Developments reserves the right to refuse any shipment which it believes may create a physical or health hazard to our employees. Products returned out of warranty for repair are subject to a minimum inspection fee. The fee is waived if the repair is authorized. It is also waived if the product is un-repairable and/or a replacement is purchased.

# REPAIR SERVICES

HITEC Sensor Developments products requiring repair should be returned freight prepaid to:
Attention - Service Department.

Information should be included stating what is wrong with the item(s) returned and name of contact.

No item shall be returned for repair which has been exposed to hazardous materials without suitable decontamination. Hazardous materials include, but are not limited to: poisons, materials capable of producing toxic fumes, radioactive waste materials which can spread viral or other diseases and materials which pose hazards by airborne ingestion, such as asbestos. HITEC Sensor Developments reserves the right to refuse and/or return any shipment which it believes poses any health risk to its employees. Unless the repair is covered under the terms of HITEC Sensor Developments warranty, there will be a minimum inspection and evaluation fee for each item returned. This fee may be waived if the item proves non-repairable, and a comparable replacement is ordered.

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