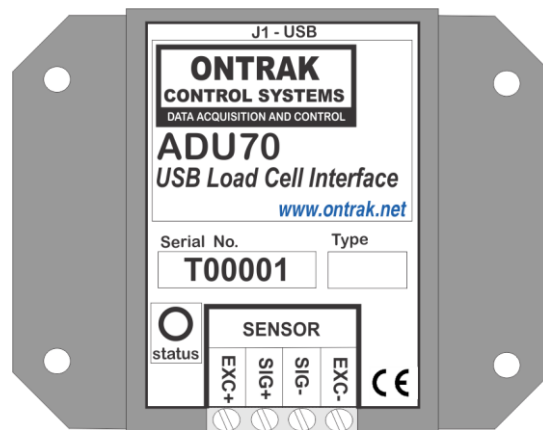# ADU70 USB to Load Cell Interface User Manual

Ver 1.0

EU Declaration of Conformity

We, the undersigned,

Manufacturer:	Ontrak Control Systems Inc.
Address, City	764 Notre Dame Avenue, Unit 1, Sudbury
Province, Country, Postal Code	Ontario CANADA P3A2T2
Phone and FAX	(705) 671-2652 (705) 671-6127 (FAX)
Email Address	tom@ontrak.net

certify and declare under our sole responsibility that the following Apparatus:

Model No: ADU70	SN: T00001 and higher.
Description:	USB to Load Cell Interface
Brand:	Ontrak Control Systems Inc.

Conforms with the essential requirements of the EMC Directive 2004/108/EC, via Annex II, based on the following specifications applied:

RF Emissions	*EN55011:2009/A1:2010 Class B*
ESD Immunity	*IEC 61000-4-2:2008 Level 2 Criterion B*
RF Immunity	*IEC 61000-4-3:2006 +A1:2007 +A2:2010 Level 2 Criterion B*

And therefore complies with the essential requirements and provisions of the EMC directive.

The technical documentation is kept at the following address:

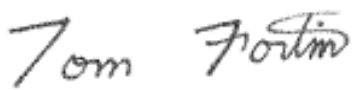| Company:	Ontrak Control Systems Inc.
Address, City	764 Notre Dame Ave, Unit 1, Sudbury
Country, Postal Code	Canada P3A 2T2
Phone Number	(705) 671-2652
Fax, Email	(705) 671-6127 tom@ontrak.net

Name of Person binding the manufacturer.	*Tom Fortin*
Tom Fortin- Director Ontrak Control Systems Inc	June 3, 2017 Sudbury , Ontario, CANADA

CE

Table Of Contents

1.   What is Included and Where to Start

The ADU70 ships complete with a 10' USB cable, and this User Manual.

A complete SDK including DLL, programming language examples, and AduHidtest software is available at:
http://www.ontrak.net/programming.htm

First time users should first review the ASCII command set for the ADU70 and then use AduHidTest USB test software to become familiar with the operation of the various features of the product.

Note: The AduHid DLL requires one of the following Windows operating systems, XP, Vista, Windows 7, Windows 8 or Windows 10.   The programming section of the web site also contains examples for use with various other operating systems and provides details that allow use of the ADU70 without using the Windows based AduHid DLL

2.   ADU70 Features

- USB load cell interface with precision bridge excitation source.
- Ratiometric configuration provides outstanding absolute (.02%) and relative (.003%) accuracy.
- 24-bit resolution
- Internal isolated bridge excitation supply derived from USB bus.
- Programmable gain from 1 to 128.
- Programmable sample rate up to 150Hz.
- Programmable buffer for high impedance sources.
- Programmable CHOP function to minimize offset and offset drift.
- 2500V Isolation
- Conformally coated sensing circuitry.
- High retention USB Connector
- CE Marked
- Bi-colour LED status indicator.
- High quality cage-clamp type terminal blocks.
- Uses standard HID drivers included with Windows 98SE,2000,XP,7,8,10 32-bit or 64-bit
- Mini-driver (DLL) provided for use with VB,VC, .NET, LabVIEW,MatLAB, TestPoint and others.
- Meets IEC61000-4-2 ESD protection for USB port.
- Available in flange (standard) or DIN rail mount.

3.   The ADU70 STATUS LED

The ADU70 STATUS LED is a bi-colour (Red/Green) led indicator used to identify the current status of the ADU70 USB connection.

The LED modes are;

RED   -ADU70 powered but not enumerated.
GREEN   -ADU70 powered and enumerated by host computer.
OFF   -ADU70 disconnected from USB bus OR host computer has entered SLEEP/SUSPEND mode.

The ADU70 can be connected to the USB bus via the enclosed 10' A-B USB cable. The cable provides both power and communications connections to the ADU70. When first connected, the STATUS led will turn RED indicating power is applied. For Windows operating systems, a message may flash on the screen indicating;

New hardware Found
ADU70 USB Load Cell Interface

Depending on the version of Windows, the host may prompt to search for a driver.   Select,

Let Windows Search for a Driver

and click next.

After several seconds, the STATUS led will turn green indicating enumeration is complete.   The enumeration process is completely transparent to the application program as the ADU70 is a full-speed USB HID class device. Enumeration is completed by the Windows (or other) operating system standard USB HID drivers.

The ADU70 can be connected directly to the host hub or externally powered hubs.

Caution: (Use of System Sleep): If the Windows (or other) operating system allows the host computer to enter sleep mode, attached USB devices will be set to suspend mode. In this mode the power draw of the ADU70 drops to less than 2.5mA (USB2.0 Specification). In suspend mode the ADU70 Status LED is turned off.   Once the host computer is revived from sleep/suspend mode, the ADU70 status LED will turn on. Ensure system power settings are set such that the host computer does not enter sleep mode during normal operation.

4.   AduHidTest USB Device Test Program

AduHidTest is a Windows based USB device test program used to test the connection of ADU data acquisition devices to a USB port. The program is also a useful tool to allow programmers to become familiar with the ADU70 command set.   AduHidTest software can be downloaded from the Ontrak website at: http://www.ontrak.net/programming.htm   . Note that the program requires the AduHid.dll to operate and it should be copied to the same directory as the AduHidTest.exe file.

There are three steps in using a USB device in any application software. The three steps are;

1. Obtain a handle for the USB device.
2. Send commands to the USB device.
3. Receive data from the USB device.

STEP 1: Obtain a handle for the ADU70

A handle is a unique code that application software uses to identify a USB device for the purpose of reading and writing to the device.   A USB bus can have up to 128 devices connected to a single host and there are three criteria that can be used to open a handle. The three criteria are, Vendor ID, Product ID and Serial Number. If a single device is connected to the bus, any of the three criteria may be used.   If multiple devices are connected, we recommend using the Serial Number to open the handle.
(All ADU devices have their unique serial number printed on the top label)

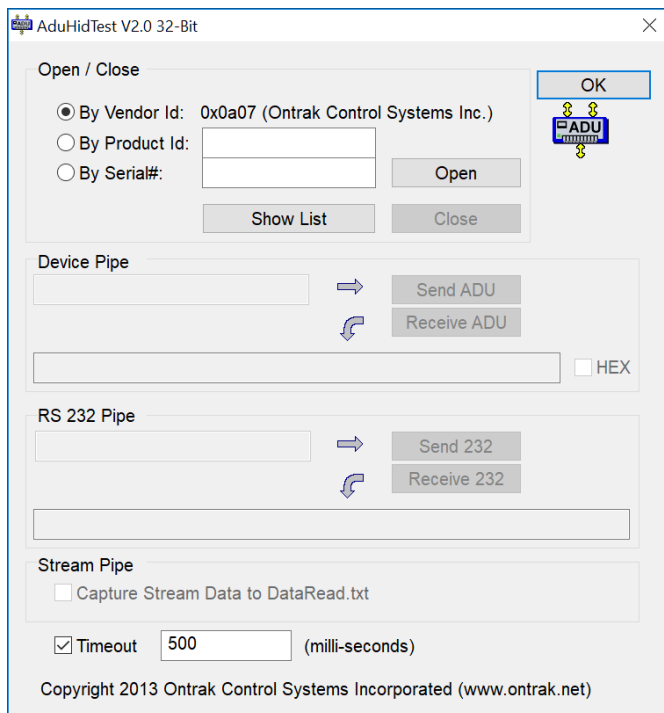When run, the AduHidtest Software will display the following window.

Figure 1: AduHidTest Software Window

The Open/Close section of the window is where the handle is determined. Click on the **Show List** button to view the devices connected to the USB bus. (Note: Only ADU devices will be listed) Figure 2 is the window that appears when the **Show List** Button is clicked.
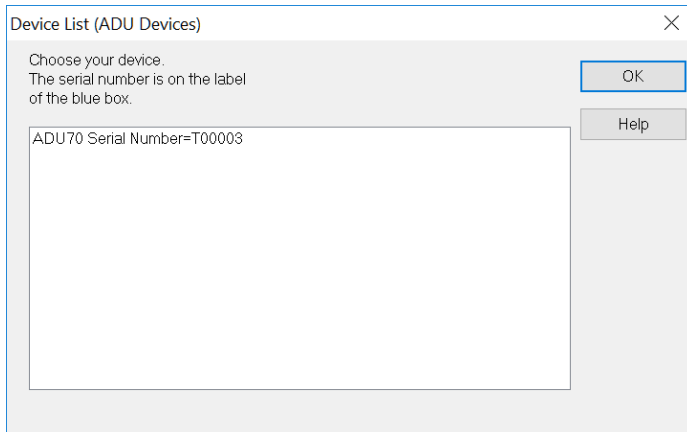

Figure 2: **ShowList** Window

The window indicates that there is one ADU70 connected with serial number T00003. Select the device by double clicking on the text **" ADU70 serial number = T00003**".   The AduHidTest main window will now display the product ID and Serial number. Click the **By Serial #** radio button and then click **Open** to open the handle to the selected ADU70.
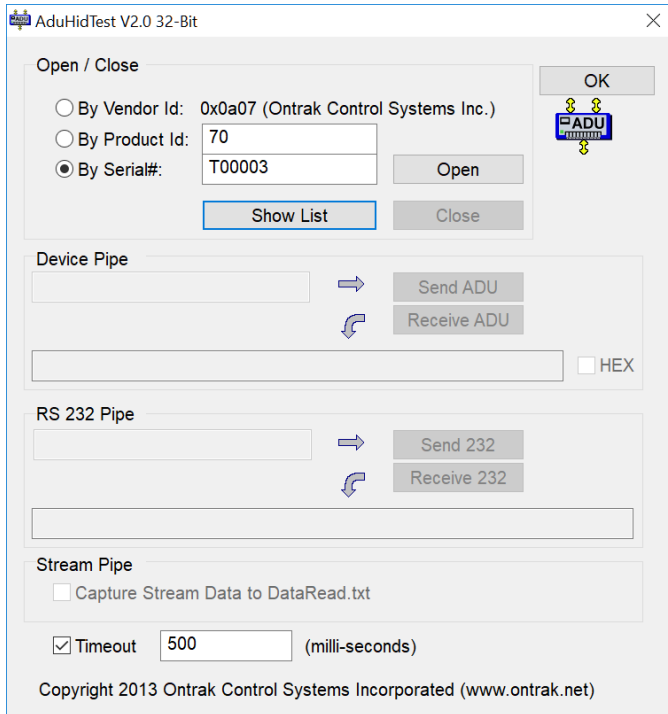

Figure 3: Handle Open to ADU70

STEP 2: Sending Commands to the ADU70

Once connected, you may now send commands to the available "pipes" on the ADU70 device. Pipes are the individual connections to functional sections of the ADU70 . The **Device Pipe** is used to send standard ASCII ADU commands to control the peripherals built into the ADU70 such as the configuration command or the read command.   The ADU70 does not use the **RS232** or **Stream** pipes.   Type "**WC6711**" (+/-39.06mV, 100Hz sample rate, buffers and chop enabled) into the device pipe send window and click **Send ADU** .   An **OK** will appear beside the **Send ADU** button if successful and the ADU70 configure, perform a calibration and then be ready for reading data. Note that ADU commands are not case sensitive.
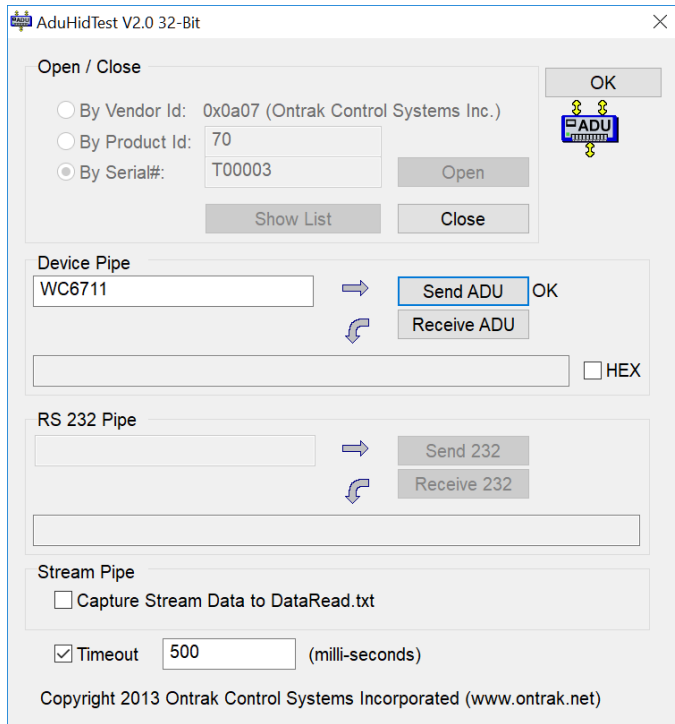

Figure 4:   Sending "WC6711" Command

STEP 3: Receiving Data from the ADU70

Some commands will cause a response to be sent from the ADU70 back to the host computer. For example, if an **"RD"** (read output level) command is sent, the ADU70 will send back the 8 digit value of the present input level. To read responsive commands, simply click the ***Receive ADU*** button and the data will be displayed.
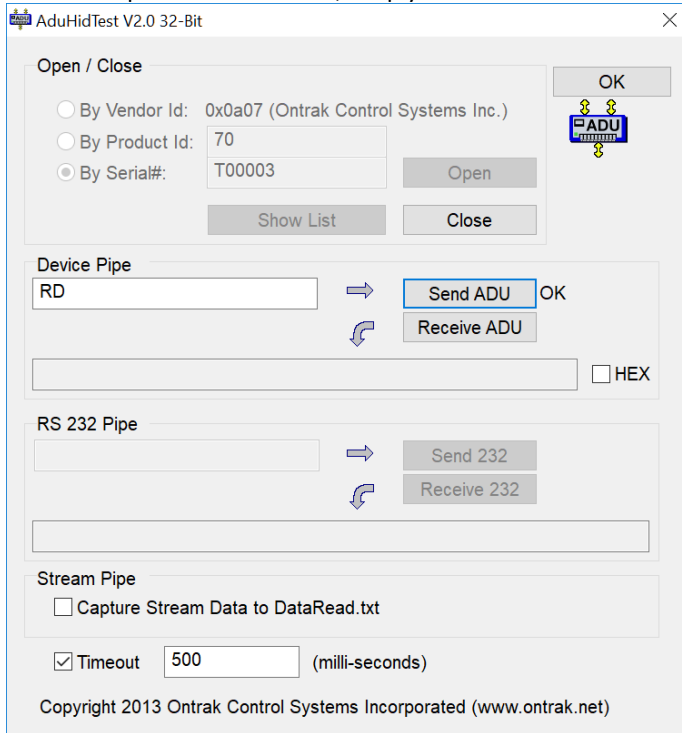

Figure 5: Sending "RD" Command
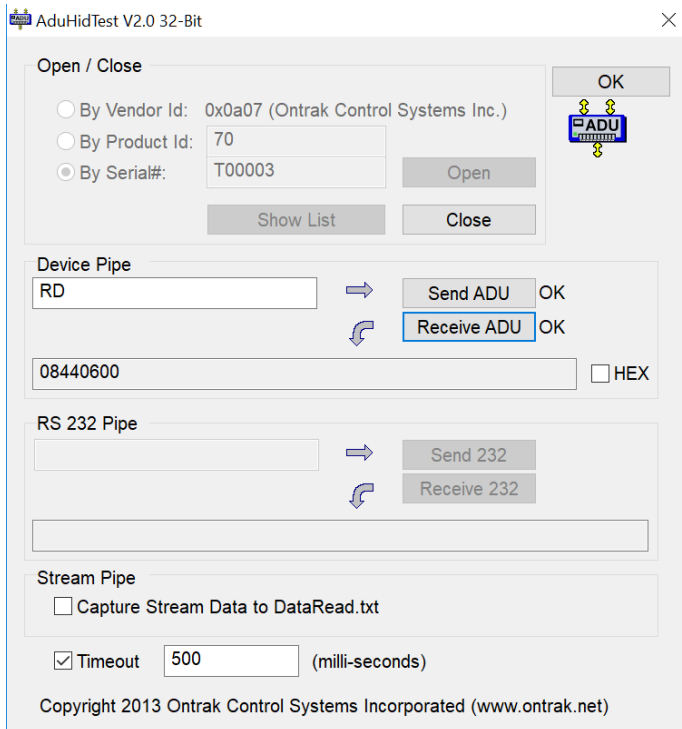
Figure 6: Receiving Data

These procedures can be repeated using the various commands available on the ADU70. The AduHidTest software is an invaluable tool to allow programmers to become familiar with any ADU product.

5. ADU70 Command Summary

WCnnnn   Configures input range, sample rate, buffer and chop mode and performs a self-calibration. (nnnn= configuration word)

RC   Returns present configuration number. (4 bytes)

RD   Returns present reading (8 bytes, 00000000-16777215)

6. ADU70 Command Descriptions

6a) Determine and Send Configuration Word

The ADU70 features a simple command set where all configuration data is sent to the ADU70 using a single configuration word consisting of 4 bytes. The configuration word sets the input range, sample rate, buffer configuration, and chopper configuration. Table 1 outlines the available settings.

Table 1: ADU70 Configuration Word Worksheet

Input Range:

1	±5.000 V (Gain=1)
2	±625mV (Gain=8)
3	±312.5mV (Gain=16)
4	±156.2mV (Gain=32)
5	±78.125mV (Gain=64)
6	±39.06mV (Gain=128)

Vref = EXC+ = 5.000V
Inputs are fully differential.
Readings return 8 digits.
00000000 to 16777215

+V = 16777215
0V = 08388608
-V = 00000000

Sample Rate:

	With Chop Disabled	With Chop Enabled
1	4.7Hz (213ms)	1.56Hz (641ms)
2	7.5Hz (133ms)	2.5Hz (400ms)
3	10Hz (100ms)	3.33Hz (300ms)
4	50Hz (20ms)	16.6Hz (60.2ms)
5	60Hz (16.6ms)	20Hz (50ms)
6	120Hz (8.44ms)	40Hz (25ms)
7	150Hz (6.66ms)	100Hz (10ms)

Buffer:

0	Buffers Disabled
1	Buffers Enabled

When input buffers are disabled the min/max voltage on input pins is -50mV to +5.05V.
(50mV beyond rails)

When input buffers are enabled the min/max voltage on input pins is +250mV to 4.750V .
(250mV less than rails)

Input buffer should be enabled for low impedance loads such as load cells.

Chop:

0	Chop Disabled
1	Chop Enabled

With Chop enabled, the ADC offset and offset drift are greatly reduced. This is achieved by continuously swapping the input pins on each conversion. With chop enabled, sample rates are reduced.

Chop should be enabled for higher gains (32-128).

The effective resolution is determined by the selected sample rate.   As the sample rate increases, noise increases, which reduces the effective resolution of the ADU70. Table 2 shows the effective resolution at the available gain and sample rate settings.

		Sample Rate						
		1	2	3	4	5	6	7
Input Range	1 ±5.000 V (Gain=1)	24(24)	24(24)	24(24)	22.5(23)	22.5(23)	22.5(23)	22(23)
	2 ±625mV (Gain=8)	24(24)	24(24)	24(23.5)	22.5(23)	22.5(22)	22(21.5)	22(21.5)
	3 ±312.5mV (Gain=16)	24(24)	24(24)	24(23.5)	22.5(22)	22.5(22)	22(21.5)	21.5(21.5)
	4 ±156.2mV (Gain=32)	24(24)	24(23.5)	24(23.5)	22.5(22)	22(21.5)	22(21.5)	21.5(21.5)
	5 ±78.125mV (Gain=64)	23.5(23)	23.5(23)	23(22.5)	22(21.5)	22(21.5)	21.5(21)	21(21)
	6 ±39.06mV (Gain=128)	23(22.5)	22.5(22)	22.5(22)	21.5(22)	21(20.5)	20.5(20)	20(19.5)

Table 2: ADU70 Effective Resolution in Bits - Chop Enabled (Chop Disabled)

Once the configuration word is determined, it can be sent using the **WCnnnn** command.
For example, **WC6711** sets the range at +/-39.06mV, sample rate at 100Hz, buffer and chop enabled.

Notes for use of WCnnnn command

1. Power on default word is WC6711. Configures range to
+/-39.06mV, 100Hz sample rate, buffers and chop enabled, for an effective resolution of 20 bits.

2. All digits must be specified, and valid, or entire WCnnnn command is ignored.

3. When WCnnnn command is sent, A/D is reset, configured, and a zero scale, and full scale internal calibration is performed. Data not available for up to 6 sample times.

4. Configuration word can be changed on the fly.

5. When data is read at or below sample rate, every reading contains new data. Reading faster than the sample rate results in duplicate readings.

6. WCnnnn command can be used at any time to initiate calibration sequence.

The configuration word can be read back using the **RC** command. When sent, the ADU70 returns the present configuration word as a 4 byte number. For example;

RC
Returns
5410

(Range = +/- 78.125mV, sample rate = 50Hz, Input Buffer Enabled, Chop Disabled)

6b) Reading Input Level

The ADU70 is read using the **RD** command.   This command returns the present input level in a 24-bit decimal value of from 00000000 to 16777215. The **RD** command returns 8 bytes, including leading zeros.

IMPORTANT: Ensure receiving software is configured to receive 8 bytes from ReadAduDevice function call.

The ADU70 is a differential input device which returns the differential reading between the **SIG-** and **SIG+** inputs. When both inputs are at the same level, the ADU70 returns the midpoint reading of 08388608 which is half of the full 24-bit decimal maximum reading. As SIG+ becomes more positive than SIG- , the reading increases from this value up to the maximum of 16777215. As SIG- becomes more positive than SIG+, the reading decreases towards the minimum value of 00000000.

To calculate the mV output, the following formula is used;

mV Output = ((Reading / 16777215) X (Input Range X 2)) – (Input Range)

For example, if the configuration word was set to WC5300 (Input Range +/- 78.125mV, 10Hz Sample Rate, Buffer Disabled, Chop Disabled) and an RD command returned 09625141, the mV input could be calculated as;

mV Output = ((Reading / 16777215) X (Input Range X 2)) – (Input Range)

mV Output = ((09625141 / 16777215) X (78.125 X 2)) – (78.125)

mV Output = ((.573703144) X 156.25) – (78.125)

mV Output = 11.51612mV (SIG+ is 11.51612mV more positive than SIG-)

6b) Reading Load Cells

The ADU70 was designed to be interfaced to wheatstone bridge type load cells. Converting the mV output of the ADU70 to a load cell weight can be done if the load cell sensitivity is known. Load cell sensitivity is generally given as a **mV/V** specification. This specification can be used to determine the full scale output for a given load cell by multiplying by the excitation voltage. The excitation voltage provided by the ADU70 is 5.000V.

For example a Tedea-Huntleigh Model 1042, 30Kg load cell specifies its sensitivity of 2mV/V giving a full scale sensitivity of 2 X 5.000 = 10mV. Figure 7 shows the proper connections to the ADU70 for the load cell and the calculations to determine the weight.
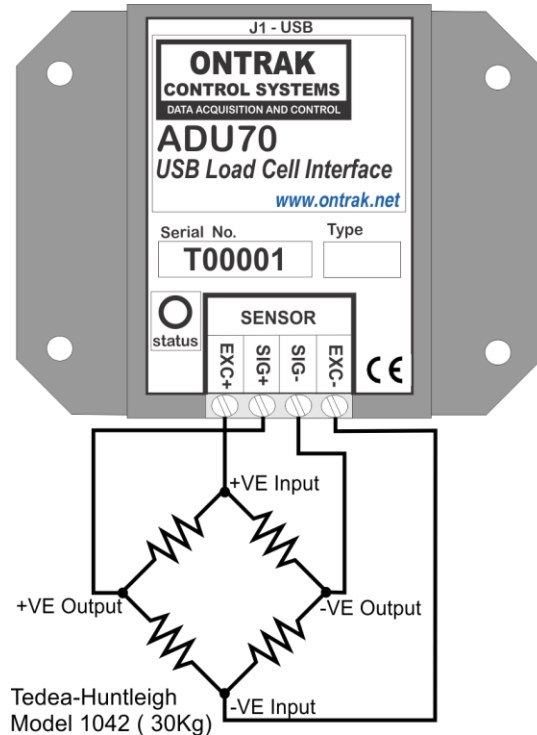
1. **WC6711** configures Range to +/-39.06mV, 100Hz sample rate, buffers and chop enabled, for an effective resolution of 20 bits. This is an ideal setting for 350 ohm wheatstone bridge type sensors.

2. **RD** command returns reading from 00000000-16777215

mV output (Gain=128) = ((reading/16777215) X 78.12) -39.06

Model 1042 sensitivity is 2mV/V and with a 5.000V excitation from the ADU70, results in a range of +/-10mV.

At 10mV output, load cell is at full scale of 30KG

weight in grams = (**mV output** /10mV) X 30,000

Figure 7: Tedea-Huntleigh Model 1042 Connections to the ADU70

Notes:

1. Either 4-wire or 6-wire load cells can be connected to the ADU70. For 6 wire cells, the sense lines can either be left open, or paired with their respective +VE and -VE output wires.

2. As the ADU70 is fully isolated, shield wires may be connected to the **EXC-** terminal. (optional)

8.   Specifications and Dimensions

Supply Voltage	NONE (Bus Powered)
USB Supply Current	70mA Typical 100mA Max
Operating Temperature	-25C Min to 85C Max
Isolation	2500V
Load Cell Input **(Ratiometric Bridge Measurement)**	
Resolution	24 Bits
Total Absolute Unadjusted error	+/- .02% FSR Max.
Relative Error	+/- .003% FSR max.
Temperature Stability	+/3ppm FSR/Degree C
Bridge Resistance	200 ohms or greater
Programmable Input Ranges	+/- 5V, 625mV,312.5mV,78.125mV,39.06mV
Differential Voltage Input **(Absolute Voltage Measurement)**	
Resolution	24 Bits
Total Absolute Unadjusted error	+/-.05% FSR Max.
Temperature Stability	10ppm/degree C
Programmable Input Ranges	+/- 5V, 625mV,312.5mV,78.125mV,39.06mV
Input Current	Buffered +/-3nA, Un-Buffered +/- 8uA (Varies with Voltage when GAIN=1)
Special Functions	
Internal Bridge Excitation	5.000V @ 30mA max.
Mounting Options	Flange Mount (STANDARD) , DIN Rail
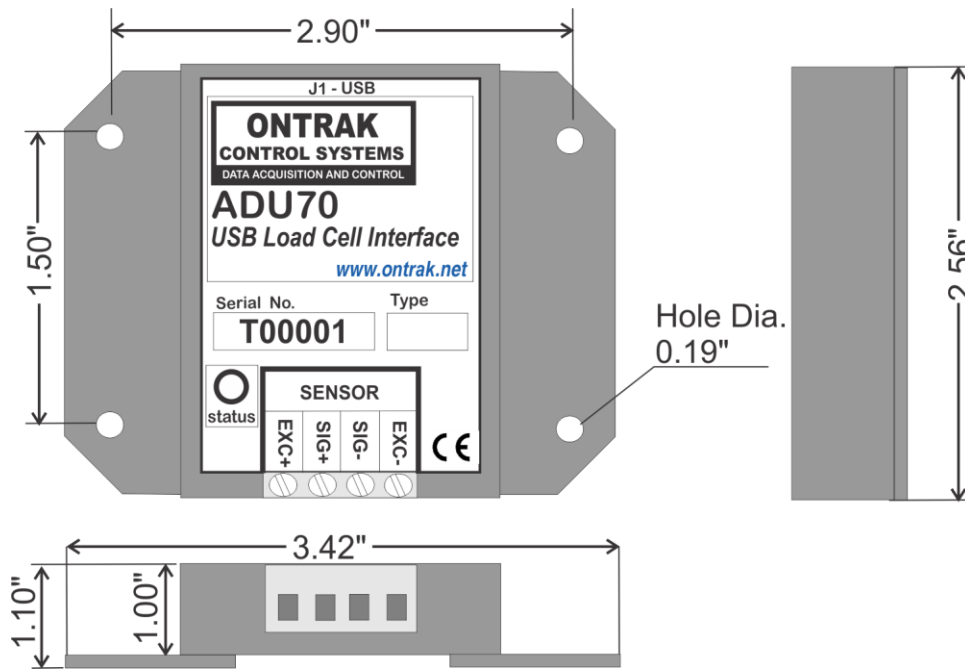
Notes:

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