

*48501 Warm Springs Blvd
Suite 109
Fremont, CA 94539
(510) 623-9600
www.loadstarsensors.com*



DI-1000

High Precision Resistive Load Cell to USB Adapter

Users Guide

Notes

© Copyright 2008/2009 Loadstarsensors Inc. All Rights Reserved.

No part of this manual may be reproduced in any form or by any means (including electronic storage and retrieval, or translation into a foreign language) without prior agreement and written consent from Loadstarsensors, Inc. as governed by United States and international copyright laws.

Manual Part Number

033-01591

First Edition: November 2008

Fourth Edition: September 2011

Loadstar Sensors Inc.,
48501 Warm Springs Blvd., Suite 109
Fremont, CA 94539
(510) 623-9600 [Voice]
(510) 623-9602 [Fax]

WARRANTY

The material contained in this document is provided “as is,” and is subject to being changed without notice. Further, to the maximum extent permitted by applicable law, Loadstar Sensors disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including by not limited to the implied warranties of merchantability and fitness for a particular purpose. Loadstar Sensors shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Loadstar Sensors and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall override.

SAFETY INFORMATION**General**

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operating instructions.

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Loadstar Sensors office for any required service and repair to ensure that safety features are maintained.

Instrument Grounding

If your product is provided with a grounding type power plug, the instrument chassis and cover must be connected to an electrical ground to minimize shock hazard. The ground pin must be firmly connected to an electrical ground (safety ground) terminal at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Cleaning

Clean the outside of the instrument with a soft lint-free, slightly dampened cloth. Do not use detergent or chemical solvents. Doing so may void your warranty.

WARNING

1. *Do not use the DI-1000 with the cover, or part of the cover removed or loose, as a hazardous condition may result. Inspect the case for cracks or missing plastic. Do not use if the display is damaged.*
2. *Use only AC Adapter Charger(s), which conforms to the display required voltage and current ratings provided.*
3. *Do not operate the display in an explosive atmosphere, or in the presence of flammable gases or fumes.*
4. *Do not immerse the display in liquid, the housing is not fluid-tight. Humidity specifications are specified as non-condensing only.*
5. *Do not substitute parts or modify the display box to avoid the introduction of additional hazards. Return the display to Loadstar sensors office for service and repair to insure all safety features are maintained.*
6. *When the built in Li Ion Polymer battery option is present, take care not to:*
 - a. *Operate or store the display in temperatures beyond -20C to 60C. Battery failure may occur.*
 - b. *Excessive barometric pressure changes may also cause the battery to fail or outgas. This display is not to be used within a pressure vessel, for example.*
 - c. *Excessive physical damage, or severe product impact, may cause battery failure. Physically damaged units should be returned to the factory for service and repair.*

ROHS/WEEE COMPLIANCE STATEMENT**EUROPE**

Directive 2002/95/EC. Restriction of the Use of Certain Hazardous Substances in Electrical & Electronic Equipment, as amended by EU Commission Decision 2005/95/EC.

This product is RoHS Compliant 2005/95/EC.

“RoHS Compliant 2005/95/EC” means that the product or part (“Product”) does not contain any of the substances in excess of the maximum concentration values in EU Directive 2002/95/EC, as amended by Commission Decision 2005/618/EC, unless the substance is in an application that is exempt under EU RoHS. Unless otherwise stated by Loadstar sensors in writing, this information represents LoadStar Sensors best knowledge and belief based upon information provided by third party suppliers to LoadStar Sensors.

In the event any product is proven not to conform with LoadStar Sensors Regulatory Information Appendix, then LoadStar Sensors entire liability and Buyer’s exclusive remedy will be in accordance with the Warranty stated below.

WEEE Directive (2002/96/EC)

The Waste Electrical and Electronic Equipment Directive (WEEE) applies to companies that manufacture, sell, and distribute electrical and electronic equipment in the E.U. It covers a wide range of large and small household appliances, IT equipment, radio and audio equipment, electrical tools, telecommunications equipment, electrical toys, etc.

The Directive aims to reduce the waste arising from electrical and electronic equipment, and improve the environmental performance of everything involved in the life cycle of electrical and electronic equipment. This is translated into the following requirements:

- * Producers (manufacturers or importers) of electrical and electronic equipment will be required to register in their countries.
- * Private households will be able to return their WEEE to collection facilities free of charge and producers will be responsible for financing these facilities.
- * Producers will be required to achieve a series of demanding recycling and recovery targets.
- * Wheeled bin emblem Producers will be required to mark their products with the 'crossed out wheeled bin'. This symbol indicates that the equipment carrying this mark must NOT be thrown into general waste but should be collected separately and properly processed under local regulations.

The WEEE directive has been transposed into each EU member state's legislation and so the exact timing and details will vary slightly from country to country, but the above principles will apply. In particular, the arrangements for the separate collection of WEEE will vary in each country but might include for example: public collection points, retailers take back schemes, collection from households, etc. The Directive encourages reuse, recycling and other forms of recovery in order to prevent WEEE. Users of electrical and electronic equipment in the E.U. can therefore play an important role in reducing WEEE and helping the environment by separating out WEEE and disposing of it properly. Consumers can ask the supplier from whom they purchased the Electronic & Electrical equipment from about local arrangements for the disposal of WEEE.

Business users are advised to ensure that WEEE, which is not suitable for reuse or recycling, be disposed of properly via approved authorized treatment facilities. The Producer in your country may be able to assist you.

Loadstar sensors is dedicated to minimizing the impact our products have on the environment and to comply with the WEEE Directive.

ROHS in China



Electronic Industry Standard of the People's Republic of China, SJ/T11363-2006. Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products.

This symbol, per Marking for the Control of Pollution Caused by Electronic Information Products SJ/T11364-2006, means that the product or part **does not** contain any of the following substances in excess of the following maximum concentration values in any homogenous material: (a) 0.1% (by weight) for cadmium. Unless otherwise stated by LoadStar Sensors in writing, this information represents LoadStar Sensors best knowledge and belief based upon information provided by third party suppliers to LoadStar Sensors.

In the event any product is proven not to conform with LoadStar Sensors Regulatory Information, as provided herein, then LoadStar Sensors entire liability and Buyer's exclusive remedy will be in accordance with the Warranty stated below.

China RoHS is a two-step process that identifies concentration limits of certain hazardous substances in electronic information products that are sold into China. Per the deadline set by the Chinese government, March 1, 2007, LoadStar Sensors has implemented step one of China RoHS, self declaration of hazardous materials and marking of the product. LoadStar Sensors display modules that are sold into the China market have the required marking on the product designating that the product meets the China RoHS requirements.

The second step involving a testing obligation is currently under development. Full compliance will follow once it has been finalized.

Table of contents:

1	INTRODUCTION.....	8
1.1	External DI-1000 Connections.....	9
1.2	DI-1000 Mechanical Dimensions.....	10
2	STEP BY STEP OPERATING GUIDE.....	11
2.1	Plug in the AC power adapter to your DI-1000.....	11
2.2	Attach your load cell to the DI-1000.....	11
2.3	Special sensor grounding considerations.....	13
2.4	Install Virtual COM port drivers.....	14
2.5	Connect the USB Host (e.g., your PC) to the DI-1000.....	14
	Terminal command line operation.....	14
2.6	14	
2.7	Initial set up of the DI-1000.....	14
3	CALIBRATING THE DI-1000.....	16
3.1	Setting the calibration mode.....	16
3.2	Millivolt Calibration.....	16
3.3	2-Point Calibration.....	16
4	ADDITIONAL CONSIDERATIONS.....	18
4.1	Effect of Improper Grounding on typical resolution.....	18
4.2	Noise (nV) vs Amplifier Gain.....	18
4.3	Effect of Sample Rate on typical resolution (bits).....	18
5	DI-1000 COMMAND SUMMARY.....	19
5.1.1	. UNIT ↵.....	19
5.1.2	LC ↵.....	19
5.1.3	ID ↵.....	19
5.1.4	TARE.....	20
5.1.5	GAIN ↵.....	20
5.1.6	SPS ↵.....	20
5.1.7	CAL ↵.....	20
5.1.8	mVOLT ↵.....	21
5.1.9	2PCAL ↵.....	21
5.1.10	W ↵.....	21
5.1.11	WC ↵.....	21
5.1.12	WU ↵.....	22
5.1.13	R ↵.....	22
5.1.14	SETTINGS ↵.....	22
5.1.15	? ↵.....	22
6	ZIGBEE WIRELESS VERSION.....	23
6.1	Before We Get Started.....	23
6.2	Installing Host USB Drivers.....	23
6.3	Selecting the Virtual COM port and communicating.....	23
6.4	Continuation of the Quick Start.....	25
7	DI-1000 TECHNICAL SPECIFICATIONS.....	26

List of figures:

Figure 1: Load cell Wiring Block Connections	9
Figure 2: Power and Host connections	9
Figure 3: DI-1000 Mechanical Top View	10
Figure 4: Mechanical Long Side View (shows battery switch)	10
Figure 5: Mechanical End View (Power adapter and host connector)	10
Figure 6: Removable Wiring Connector End (Load cell connection)	10
Figure 7: Four Wire Load Cell Wiring Schematic	11
Figure 8: Six Wire Load cell Wiring Schematic	12
Figure 9: Typical RMS noise Values (nV) vs. sample rate	18
Figure 10: Typical noise free equivalent resolution (bits)	18

1 INTRODUCTION

The Basic Loadstar Sensors DI-1000U High Precision Load Cell Interface module provides a convenient method to convert nearly any existing millivolt output load cell into a PC friendly USB load cell! Just attach your 4 or 6 wire strain gauge load cell to the convenient 8-pin wiring connector, plug the USB host connector to your PC, and voila! you've got a complete Windows PC ready load cell measurement system. The unit can be powered entirely by the PC's USB port. The included AC power adapter is needed only for wireless capable DI-1000ZP units with battery backup.

The DI-1000ZP offers the following additional features:

- 1) Internal ZigBee wireless networking. With the advanced power saving features can run for long periods of time without any cable connections.
- 2) Extended input voltage 6 – 32V input, compatible with industrial process control
- 3) Included Li-Polymer battery, for true cable free operation, for up to 5 hours.
- 4) This unit can also be used in wired USB mode for faster throughput.

Either DI-1000 device version offers the same high precision load cell to PC interface. With consistent remote programming, built in LoadVUE software compatibility, and low power operation, either DI-1000 device is sure to play a key role in your high performance measurement system.

Basic Module Features:

- *May be powered from USB Host (if connected). No need for AC adapter for most load cells.*
- *Standards Compliant 5.00V load cell excitation*
- *Supports 200(optional)/300/330/350 Ohm (or higher) Load cells*
- *Supports 4-wire and 6-wire load cell connections for improved accuracy*
- *All user input program parameters stored in non-volatile memory.*
- *Convenient small industrial case, for convenient mounting options in your equipment*
- *Power On/Off switch, allows manual control.*

Extended Module Features:

(including the features above, the extended DI-1000ZP also includes:)

- *Extended input voltage range (6V – 32V), compatible with nearly all process controllers.*
- *Internal Lithium-Ion Polymer cell, for true cable free operation. Internal battery is automatically recharged when sufficient external power is available (either AC adapter, or USB). Battery charging will always occur regardless of the power switch setting.*
- *ZigBee wireless networking. No wires!*

Advanced power saving features, allow extended run time during cord free operating conditions.

The following pictures of the DI-1000 show the external connections.

1.1 External DI-1000 Connections

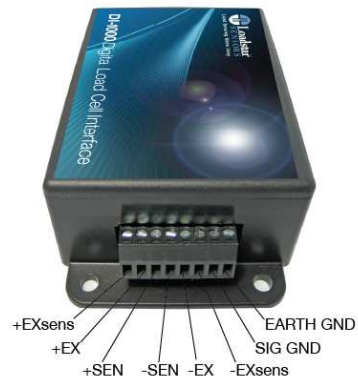


Figure 1: Load cell Wiring Block Connections



Figure 2: Power and Host connections

1.2 DI-1000 Mechanical Dimensions

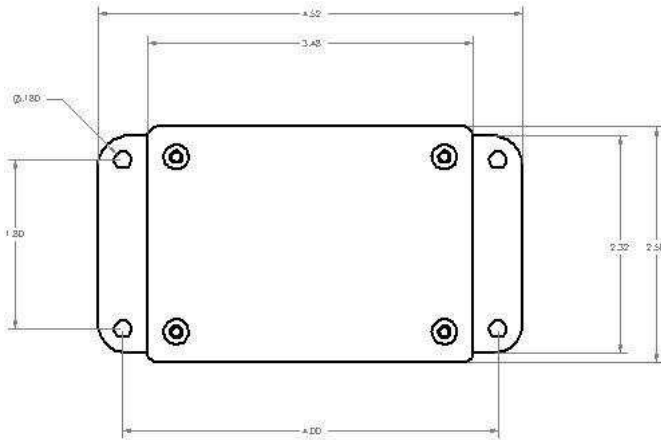


Figure 3: DI-1000 Mechanical Top View

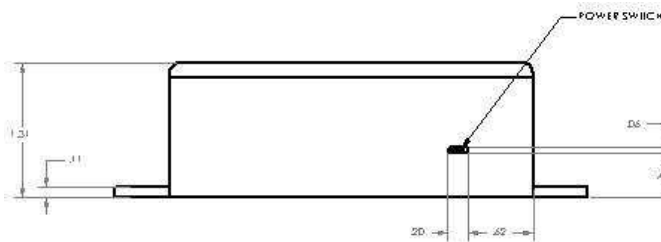


Figure 4: Mechanical Long Side View (shows battery switch)

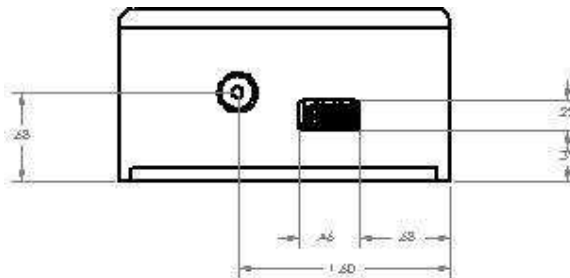


Figure 5: Mechanical End View (Power adapter and host connector)

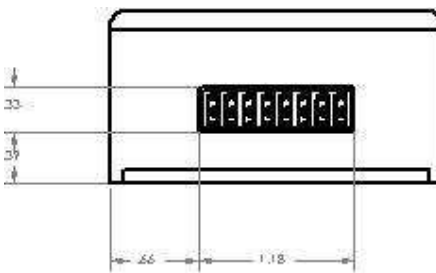


Figure 6: Removable Wiring Connector End (Load cell connection)

2 STEP BY STEP OPERATING GUIDE

Designed for ease of use, the DI-1000 is easy to bring up. The following steps should get you up and running quickly.

2.1 Plug in the AC power adapter to your DI-1000

2.2 Attach your load cell to the DI-1000

Both 4-wire and 6-wire load cell wiring diagrams for the DI-1000 are shown in the following figures:

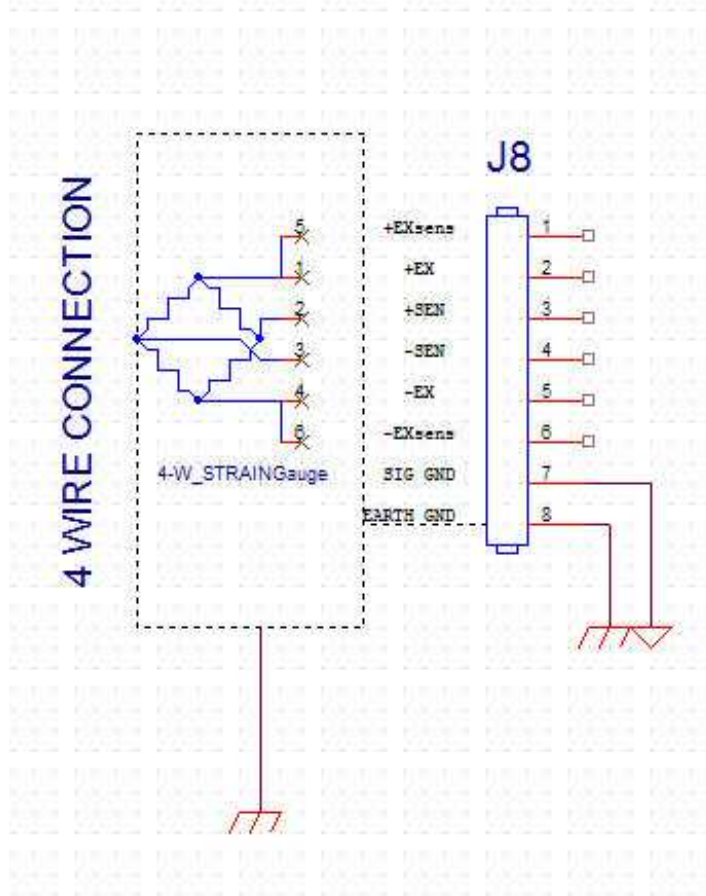


Figure 7: Four Wire Load Cell Wiring Schematic



Note that, as shown in the following picture, for a 4-wire load cell, you will need to add an external jumper between pins 1 and 2 (+EXsens and +EX) as well as between pins 5 and 6 (-EXsens and -EX).



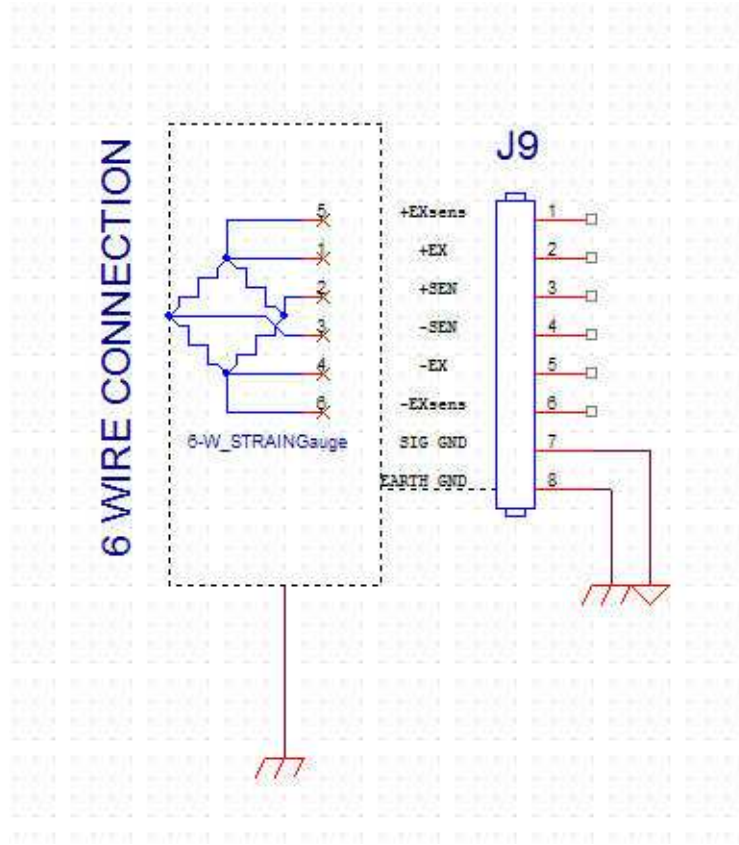


Figure 8: Six Wire Load cell Wiring Schematic

We've included a handy reference chart below that you can use to help determine how to correctly wire your load cell to the DI-1000 wiring connector.

Table 1: Typical Load Cell Wiring Color Table

	+Excitation (+EX)	-Excitation (-EX)	+Signal (+SEN)	-Signal (-SEN)	Shield (Earth)	+Sense (+EXSENS)	-Sense (-EXSENS)
A&D Engineering	Red	White	Green	Blue	Yellow	(Tie to +EX)	(Tie to -EX)
Allegany	Green	Black	White	Red	Bare	(Tie to +EX)	(Tie to -EX)
Beowulf	Green	Black	White	Red	Bare	(Tie to +EX)	(Tie to -EX)
BLH	Green	Black	White	Red	Yellow	(Tie to +EX)	(Tie to -EX)
Cardinal	Green	Black	Red	White	Bare/Yellow	(Tie to +EX)	(Tie to -EX)
Digi Matex	Red	White	Green	Yellow	Silver	(Tie to +EX)	(Tie to -EX)
Electroscale	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
Evergreen	Green	Black	White	Red	Bare	(Tie to +EX)	(Tie to -EX)
General Sensor	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
HBM	Green	Black	White	Red	Yellow	(Tie to +EX)	(Tie to -EX)
HBM (PLC/SBE)	Red	Black	Green	White	Yellow	(Tie to +EX)	(Tie to -EX)
Interface	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
Kubota	Red	White	Green	Blue	Yellow	(Tie to +EX)	(Tie to -EX)
LeBow	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
Mettler Toledo	White	Blue	Green	Black	Orange	Yellow	Red
National Scale	Green	Black	White	Red	Yellow	(Tie to +EX)	(Tie to -EX)
NCI	Red	Black	White	Green	Bare	Yellow	Blue
Nikkei	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
Presage Promotion	Blue	White	Red	Black	Yellow	(Tie to +EX)	(Tie to -EX)
Philips	Red	Blue	Green	Gray	Bare	(Tie to +EX)	(Tie to -EX)
Revere	Green	Black	White	Red	Orange	(Tie to +EX)	(Tie to -EX)
Sensortronics	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
Sensortronics 60007	Green	Black	White	Red	Yellow	(Tie to +EX)	(Tie to -EX)
Strainsert	Red	Black	Green	white	Bare	(Tie to +EX)	(Tie to -EX)
T-Hydronics	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
Tedea/Huntleigh	Green	Black	Red	White	Bare	Blue	Brown
Thames Side	Red	Blue	Green	Yellow	Bare	(Tie to +EX)	(Tie to -EX)
Toledo	Green	Black	White	Red	Yellow	(Tie to +EX)	(Tie to -EX)
Totalcomp	Red	Black	Green	White	Bare	(Tie to +EX)	(Tie to -EX)
Transducers	Red	Black	Green	White	Orange	(Tie to +EX)	(Tie to -EX)

2.3 Special sensor grounding considerations

The DI-1000 has two ground pins, EARTH ground, and SIGNAL ground. Connection to both pins should be carefully considered for each application. The very high accuracy possible using the DI-1000 can easily be compromised with an incorrect connection to EITHER of these two pins!

Firstly, make sure you know how your load cell is wired! If your load cell has 4 wires and one shield, that shield may be attached to the body of the load cell. Verify this with an ohm-meter or continuity test! If your load cell has 6 wires, and two shield wires, one is the sensor body, the other is the signal shield.

The DI-1000 connects signal ground to the adapter power ground, and also connects to the USB signal power ground. Ideally this ground should be connected to any cable shield, but not the load cell body. Many load cell assemblies connect the cable shield to the load cell body. This creates a problem, since any ground connection between the load cell and your system ground will induce a current in this combined ground system. In this case, you'll need to connect the load cell shield to the DI-1000 earth ground terminal, so a ground loop is not formed with the load cell within your system. Make sure your earth ground is electrically clean, to avoid introducing excessive common mode noise into your load cell signal wiring.

The DI-1000 earth ground is isolated from signal ground, which is connected to the USB host shield ground. Keep in mind that EMI performance and ESD protection depend on the earth ground connection, so this shield terminal should ALWAYS be connected to a suitable earth ground in your system. That connection in some cases may be adequately made by the USB cable itself to your PC. It is your responsibility to verify this is the case.

The simplest approach is to simply connect all system grounds to the DI-1000 earth ground terminals. If performance isn't adequate in this case, then experimenting with system grounding, can often improve system performance.

2.4 Install Virtual COM port drivers

The DI-1000 may be accessed on your host PC using either using a simple virtual COM port mechanism, or by using the LoadVUE application. For information on LoadVUE, please refer to the manual which ships with that software CD for more details.

This document will focus on the virtual serial interface. This approach may be easily adapted to user programs, and is very flexible.

Please install the drivers for the DI-1000 using the included iLoad Digital USB Driver disc or, if you have purchased LoadVUE software, from the LoadVUE disc. Instructions are included with the documentation that comes with your driver disc or LoadVUE.

Once you have connected the DI-1000U physically to your PC, you can use the steps outlined in the document entitled "Driver Installation and Hyperterminal Operation of iLoad Digital USB Sensors and Interface Devices" to determine the COM port assigned and to connect to HyperTerminal.

Please note that the instructions in the booklet above are written primarily for Loadstar Sensors' iLoad series of Digital USB sensors, but will work with the DI-1000 as well with the one change that the Baud rate for communication should be set at 9600 (or 230400 for DI-1000U-HS high speed models)..

2.5 Connect the USB Host (e.g., your PC) to the DI-1000

2.6 Terminal command line operation

Once you are connected to the DI-1000 via HyperTerminal or another terminal emulator, press <ENTER> several times. You should get an "A" returned onscreen for every <ENTER> pressed. You may now type ASCII commands to the DI-1000, to remotely monitor and control the attached sensors.

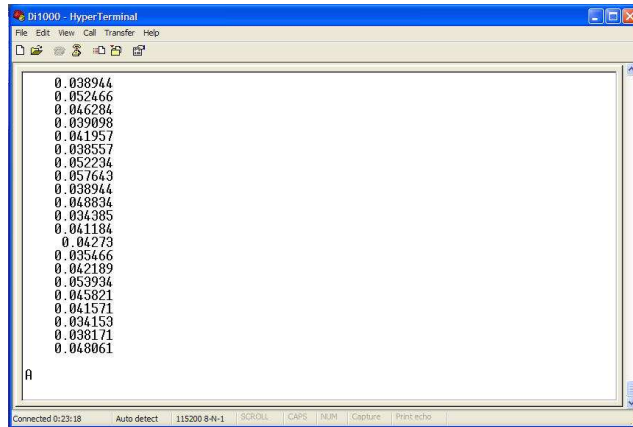
You may press "?" at any time to see the available command list. The available commands will be described in detail in the next chapter.

2.7 Initial set up of the DI-1000

1. Enter desired units: UNIT LB← (← stands for the Enter key)
2. Enter total load capacity of the attached load cell (e.g., 100 lb): LC 100.0 ←
3. Enter your desired load cell name: ID SENSOR_1

4. Enter the desired amplifier gain: GAIN 64 ←
5. Enter the desired samples/sec: SPS 60←
6. Reset the zero value of the sensor: TARE ←
7. Set the calibration mode to be used for load measurements. You can set mV/V calibration by entering CAL m←. Two point calibration mode is selected by typing CAL 2←.

Assuming you have already entered a calibration (see the next section) for the selected mode, you may now monitor the load on the load cell: type WC ← at the terminal window.



```
DI1000 - HyperTerminal
File Edit View Call Transfer Help
0.038944
0.052466
0.046284
0.039098
0.041957
0.038557
0.052234
0.057643
0.038944
0.046834
0.034385
0.041184
0.04273
0.035466
0.042189
0.053934
0.043821
0.041571
0.034153
0.038171
0.048061
^
```

Continuous weight output updates end when a carriage return (←) is pressed.

3 CALIBRATING THE DI-1000

Two calibration modes are currently supported by the DI-1000 firmware:

1. Millivolt calibration
2. 2-point linear calibration

You may perform the calibration for either mode at any time and independently select the actual calibration mode to be used. **Please ensure** that the load capacity of your load cell is entered correctly using the LC command before any calibration is performed.

3.1 Setting the calibration mode

The CAL command is used to select the calibration mode:

CAL m← selects the mV/V mode.

CAL 2← selects the 2 point calibration mode

3.2 Millivolt Calibration

Millivolt calibration is in some respects the easiest user calibration to perform. For every resistive load cell sensor shipped, either a calibration report, or a label on the sensor itself should have the mV/V calibration number present. This number is the best fit mV/V value determined during the factory calibration procedure.

To enter the mVolt calibration type the following in your terminal window:

mvolt x.xxxx← (where x.xxxx represents the known mV/V calibration number for the load cell)

The DI-1000 echoed the value of the mV/V number you typed in to confirm that it has been accepted.

The calibration value is retained until it is again changed by the user, even through DI-1000 power cycles.

3.3 2-Point Calibration

Two point calibration can be used if you have the ability to load and unload your load cell with known weights or forces. Two-point is the simplest form of curve fitting: a simple best fit linear relationship between no-load, and a known load value. Accuracy will improve as the known load moves closer to the full scale value for the attached load cell.

To begin this calibration procedure, remove any loading from the load cell. Then type the command:

2pcal X← (where X represents the value of the load to be used for the second point in the units set)

The DI-1000 prompts back with

Apply Point 1 Load of 0, LB Press C when ready or Q to quit

Ensure that there is no load applied to the load cell and press the "C" key. After a couple of seconds, the DI-1000 prompts with:

Apply Point 2 Load of X, LB Press C when ready or Q to quit

Again, the "X" above represents the value of your calibration load to be applied in the units set on the DI-1000. Apply the calibration load to the load cell and press the "C" key.

The DI-1000 responds with a number and "Calibration complete!" Your two point calibration has been stored. The number reported represents the mV/V of the load cell as computed by the DI-1000.

4 ADDITIONAL CONSIDERATIONS

4.1 Effect of Improper Grounding on typical resolution

4.2 Noise (nV) vs Amplifier Gain

Output Word Rate (Sps)	-3 dB Filter Frequency (Hz)	Instrumentation Amplifier Gain						
		x64	x32	x16	x8	x4	x2	x1
7.5	1.94	17	17	19	26	42	79	155
15	3.88	24	25	27	36	59	111	218
30	7.75	34	35	39	51	84	157	308
60	15.5	48	49	54	72	118	222	436
120	31	68	70	77	102	167	314	616
240	62	115	160	276	527	1040	2070	4150
480	122	163	230	392	748	1480	2950	5890
960	230	229	321	554	1060	2090	4170	8340
1,920	390	344	523	946	1840	3650	7290	14600
3,840	780	1390	2710	5390	10800	21500	43000	86100

- Notes: 11. Wideband noise aliased into the baseband. Referred to the input. Typical values shown for 25 °C.
 12. For peak-to-peak noise multiply by 6.6 for all ranges and output rates.
 13. Word rates and -3dB points with FRS = 0. When FRS = 1, word rates and -3dB points scale by 5/6.

Figure 9: Typical RMS noise Values (nV) vs. sample rate

4.3 Effect of Sample Rate on typical resolution (bits)

Output Word Rate (Sps)	-3 dB Filter Frequency (Hz)	Instrumentation Amplifier Gain						
		x64	x32	x16	x8	x4	x2	x1
7.5	1.94	19	20	21	22	22	22	22
15	3.88	19	20	21	21	21	22	22
30	7.75	18	19	20	21	21	21	21
60	15.5	18	19	20	20	20	21	21
120	31	17	18	19	20	20	20	20
240	62	16	17	17	17	17	17	17
480	122	16	17	17	17	17	17	17
960	230	15	16	16	16	16	16	16
1,920	390	15	15	15	15	15	15	15
3,840	780	13	13	13	13	13	13	13

14. Noise-free resolution listed is for bipolar operation, and is calculated as $\text{LOG}((\text{Input Span})/(6.6 \times \text{RMS Noise}))/\text{LOG}(2)$ rounded to the nearest bit. For unipolar operation, the input span is 1/2 as large, so one bit is lost. The input span is calculated in the analog input span section of the data sheet. The noise-free resolution table is computed with a value of 1.0 in the gain register. Values other than 1.0 will scale the noise, and change the noise-free resolution accordingly.
15. "Noise-free resolution" is not the same as "effective resolution". Effective resolution is based on the RMS noise value, while noise-free resolution is based on a peak-to-peak noise value specified as 6.6 times the RMS noise value. Effective resolution is calculated as $\text{LOG}((\text{Input Span})/(\text{RMS Noise}))/\text{LOG}(2)$.

Figure 10: Typical noise free equivalent resolution (bits)

5 DI-1000 COMMAND SUMMARY

The commands for the DI-1000 can all be entered without parameters to have the DI-1000 report the value of the appropriate parameters in memory. For example, entering `UNIT KG←` sets the DI-1000 units to KG. Now entering `UNIT←` gets the DI-1000 to respond with the currently set units, i.e. KG.

5.1.1 .UNIT ↵

Function:	Set (returns) currently selected units
Summary:	Sets or returns one of the 3 unit types: LB (pounds), Kg (kilograms) or N (Newtons) both for internal and output usage..
Example:	UNIT LB ← (to set units TO POUNDS) UNIT ← (to display currently set units)

5.1.2 .LC ↵

Function:	Sets (returns) the load capacity of the attached load-cell
Summary:	Sets or returns the total load capacity of the load-cell as a floating point number. Should be entered in the currently selected value of UNIT.
Example:	UNIT KG ← (example sets units to KILOGRAMS) LC 500 ← (sets total load capacity to 500 Kg) LC← displays currently set load capacity

5.1.3 ID ↵

Function:	Sets (Returns) a unique identification string for this device
Summary:	Sets or returns a unique identification string for this device. The total string should not exceed 12 characters. The string value is retained between power cycles.
Example:	ID Sensor_12 (Note that we typically enter the unit serial number as the ID at the factory)

5.1.4 . TARE

Function: *Tares, or sets the display ZERO value.*

Summary: When this command is issued, the current ADC value, is retained as the currently defined ZERO output value. All output values are referenced to this value.

Example: TARE ←

5.1.5 . GAIN ↵

Function: *Sets (returns) input amplifier gain*

Summary: Sets (returns) the input amplifier gain. This is used to compensate for different load cell impedances, and re-scaling of device input gain. Valid gains are 1, 2, 4, 8, 16, 32 and 64. Factory default is 64.

Example: GAIN 32 ←

5.1.6 . SPS ↵

Function: *Sets (returns) ADC sample rate*

Summary: Sets (returns) the currently selected number of ADC samples/second. Remember! Accuracy increases with fewer samples/second, so always choose the slowest rate your application can tolerate. Valid samples rates/second are: 7.5, 15, 30, 60, 120, 240, 480, 960, 1920, 3840. Factory default is 120

5.1.7 . CAL ↵

Function: *Sets (returns) calibration type*

Summary: Sets or returns the currently selected calibration type. Acceptable values are:

1. m for milliVolt calibration
2. 2 for 2 point calibration

Example: CAL m ← (sets mV calibration mode)

5.1.8 mVOLT ↵

Function: Sets (returns) the current mV calibration parameter

Summary: Sets (returns) the current sensor mV calibration parameter. This may be the parameter listed on the sensor, the manufacturers data sheet, or may have been derived through the calibration procedure.

Example: MVOLT 2.123 ↵

5.1.9 2PCAL ↵

Function: Runs the 2 point calibration procedure

Summary: Begins the 2 point calibration procedure. Follow the prompts from the DI-1000 to complete the calibration as described in the section on calibration above.

Example: 2PCAL 250↵

5.1.10 W ↵

Function: Displays the current weight

Summary: Displays the current measured weight in the currently active units

Example: W ↵
-277.162536
A

5.1.11 WC ↵

Function: Continuously outputs current weight

Summary: Produces a continuous stream of output. Each line of the output represents the load in the currently set units. You may stop the streaming load readings by pressing the Enter key.

Example: WC ↵

5.1.12 WU ↵

Function: *Displays current weight & units***Summary:** This is similar to the W command except that the unit is also reported by the DI-1000.**Example** WU ←
-0.363733 LB

5.1.13 R ↵

Function: *Return RAW ADC value***Summary:****Example** R ←

5.1.14 SETTINGS ↵

Function: *Returns all current setting values***Summary:****Example** SETTINGS ←

5.1.15 ? ↵

Function: *Returns the command summary***Summary:****Example** ? ←

6 ZIGBEE WIRELESS VERSION

The DI-1000 also ships as a “wireless” version, with an internal battery for true cable free operation. A separate USB “dongle” is provided to plug into the PC, which wirelessly communicates with the remote DI-1000 and attached loadcell device.

The wireless link between the DI-1000 and the PC uses a point to point variant of the ZigBee 802.15.4 protocol which provides wireless end-point connectivity for fast wireless networking between the provided host dongle, and the DI-1000 device. Features include:

1. Power Output: 1mW (+0 dBm) North American & International version
2. Indoor/Urban range up to 100 feet (30 meters)
3. Outdoor line of sight up to 300 feet (90 meters)
4. RF Data Rate 250 kbps
5. Interface data rate: 9600/230400 baud
6. Operating Frequency 2.4 Ghz
7. Receiver Sensitivity up to -92 dBm
8. Direct Sequence Spread Spectrum for improved interference immunity
9. Automatic link error handling, with transparent retries and data acknowledgement
10. Up to 16 channels available (Channel is currently set at the factory only)

The internal LiPolymer battery run-time typically falls between 10 and 20 hours depending on the attached loadcell impedance, and the frequency of host data queries. For longer periods of time, an external battery (for example a 12V Gel Battery) can easily be used to extend the operational life to any desired length. For those applications that can support a physical AC power adapter connection, no additional restrictions on runtime, query rate, or loadcell impedance apply.

6.1 Before We Get Started

1. Verify the power switch is set to “ON.” Please note, the unit should not be left unpowered for long periods of time, as the internal battery can become discharged and it’s lifetime compromised.
2. Make sure the internal battery is fully charged before any extended “wireless” run is attempted. Plug the provided AC adapter into the DI-1000, for 6 to 8 hours minimum, to insure the internal Li battery is fully charged.

6.2 Installing Host USB Drivers

Please refer to section 3.4 for installing the drivers. The drivers used by the DI-1000 in direct wired connection and through the wireless dongle are the same.

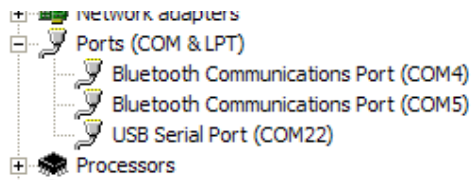
6.3 Selecting the Virtual COM port and communicating

Hyperterminal is the most popular terminal program available on Windows PC’s, since a basic version comes preloaded with Windows XP.

Unplug the Wireless DI-1000 dongle, and plug it back in. When you do so, the Windows Device Manager will help to determine which port corresponds to the connected DI-1000 dongle.



After connecting the DI-1000 a new port should appear:



In the above figure, COM22 corresponds to the virtual COM port of the DI-1000 Dongle.

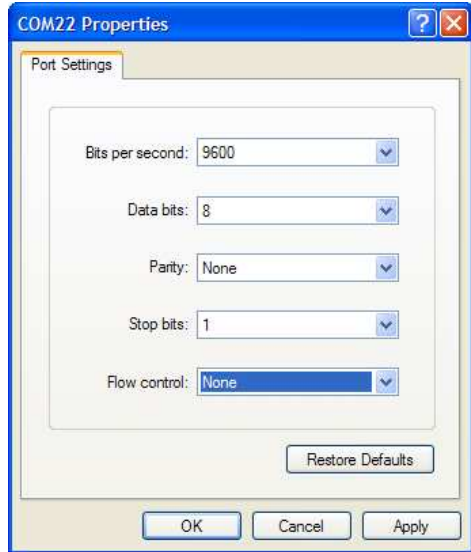
Next, open Hyperterminal, and create a new connection corresponding to your attached DI-1000 device:



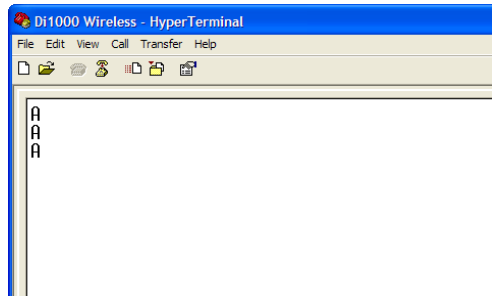
Select the COM port previously determined to correspond to the DI-1000:



Set the Baud Rate, parity, data bits, and number of stop Bits, as 9600-N-8-1. If you have a DI-1000U-HS (high speed) modem, set the baud rate to 230400



Click Apply, OK and <ENTER> several times. You should get an “A” returned onscreen for every <ENTER> pressed. You may now type ASCII commands to the DI-1000, to remotely monitor and control the attached sensors.



You may press “?” at any time to see the available command list. Please continue at section

6.4 Continuation of the Quick Start

The quick start process continues the same as in section 3.7 above with the wired version. Please continue there.

7 DI-1000 TECHNICAL SPECIFICATIONS

Performance

Resolution	See Figure 10: Typical noise free equivalent resolution (bits)
Output Resolution	Dynamic, Sensor Dependent
Update Speed	Programmable, 7.5 – 3840 Samples/Second
Output Sensitivity	Sensor dependent
Software Filter	None
Temp Coefficient	None

Environment

Operating Temperature	-10 to 55C (15 to 131F) (no battery)
	-10 to 45C (15 to 113F) (with internal battery)
Storage Temperature	-20 to 85C (-5 to 185F) (no battery)
	-20 to 60C (-5 to 140F) (with internal battery)

Warning: NEVER EXCEED 60C when internal battery is installed

Humidity	5 to 85% RH Non Condensing
Voltage	6 to 12 VDC [Basic Edition], 6 to 32 VDC [Battery Edition]
Power	1 W
Vibration	Not to exceed 4 mm displacement at 16.7 Hz, for > 60 mins.
Shock	Not greater than a 20 cm drop onto a hard wooden surface

Enclosure

Construction Material	ABS Plastic
Dimensions	approx. 3.2" x 1.6"

Maximum Remote Load Cell Cable Length

Cable Length	100 feet, 20 Gauge wire (6 wire sensor)
Cable Length	20 feet, 20 Gauge wire (4-wire sensor)

Special Interfaces

Host Interface	USB (virtual COM)
Sensor Interface	USB host