

640u 650u 640e 650e

Requires a 32-bit version of Windows®



Windows 2000 SP4
Windows XP
Windows Vista (x86)

Ethernet models 640e and 650e
USB models 640u and 650u



***Dynamic Signal Analyzers for
Vibration Analysis and Monitoring***



372538E-01

1142-0901 rev 2.4

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Warranty Information

Your IOTech warranty is as stated on the *product warranty card*. You may contact IOTech by phone, fax machine, or e-mail in regard to warranty-related issues.
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Many IOTech products carry the CE marker indicating they comply with the safety and emissions standards of the European Community. When applicable these products have a Declaration of Conformity stating which specifications and operating conditions apply. You can view our Declarations of Conformity at www.iotech.com/CE

Warnings, Cautions, Notes, and Tips



Refer all service to qualified personnel. This caution symbol warns of possible personal injury or equipment damage under noted conditions. Follow all safety standards of professional practice and the recommendations in this manual. Using this equipment in ways other than described in this manual can present serious safety hazards or cause equipment damage.



This warning symbol is used in this manual or on the equipment to warn of possible injury or death from electrical shock under noted conditions.



This ESD caution symbol urges proper handling of equipment or components sensitive to damage from electrostatic discharge. Proper handling guidelines include the use of grounded anti-static mats and wrist straps, ESD-protective bags and cartons, and related procedures.



This symbol indicates the message is important, but is not of a Warning or Caution category. These notes can be of great benefit to the user, and should be read.



In this manual, the book symbol always precedes the words "Reference Note." This type of note identifies the location of additional information that may prove helpful. References may be made to other chapters or other documentation.



Tips provide advice that may save time during a procedure, or help to clarify an issue. Tips may include additional reference.

Specifications and Calibration

Specifications are subject to change without notice. Significant changes will be addressed in an addendum or revision to the manual. As applicable, IOTech calibrates its hardware to published specifications. Periodic hardware calibration is not covered under the warranty and must be performed by qualified personnel as specified in this manual. Improper calibration procedures may void the warranty.

CAUTION



Using this equipment in ways other than described in this manual can cause personal injury or equipment damage. Before setting up and using your equipment, you should read *all* documentation that covers your system. Pay special attention to Warnings and Cautions.

Note: During software installation, Adobe® PDF versions of user manuals will automatically install onto your hard drive as a part of product support. The default location is in the **Programs** group, which can be accessed from the *Windows Desktop*. Initial navigation is as follows:

Start [on Desktop] ⇒ **Programs** ⇒ **IOtech 600 Software**

You can also access the PDF documents directly from the data acquisition CD by using the <**View PDFs**> button located on the opening screen.

Refer to the PDF documentation for details regarding both hardware and software.

640_650 Users Manual.pdf

The user's manual includes chapters pertaining to configuration, connectors, analog signals, digital I/O, triggers, CE compliance, troubleshooting, specifications, and a brief look at related *out-of-the-box* software. The following PDFs are companion documents and should be referred to as applicable to your system.

640e_650e Quick Start.pdf Quick Start for Ethernet models 640e & 650e

640u_650u Quick Start.pdf Quick Start for USB2.0 models 640u & 650u

eZ-Analyst.pdf Real-Time Vibration & Acoustic Analysis Software

eZ-TOMAS.pdf Total Online Monitoring and Analysis Software

eZ-Balance.pdf Portable Machine Balancing Software

eZ-NDT.pdf Non-Destructive Testing Systems

About the Documentation

In addition to the user's manual there are several PDF documents of importance. During software installation, Adobe® PDF versions of documents are automatically installed onto your hard drive. The default location is in the **Programs** group, accessible through the *Windows Desktop*. The documents may also be viewed directly from the data acquisition CD via the <**View PDFs**> button located on the CD's opening screen.

Unless you have hardcopy equivalents, you should refer to the PDF version documents for details regarding both hardware and software.

The *IOtech 640 & 650 Series User's Manual* consists of the following chapters. The chapters contain references to other documents as applicable.

- Quick Start, IOtech 640e and 650e (324539C-01)
- Quick Start, IOtech 640u and 650u (324540C-01)
- Chapter 1 – What are IOtech 640 & 650 Series Devices?
- Chapter 2 – Block Diagram and General Comments
- Chapter 3 – Connectors, Indicators, and Cables
- Chapter 4 – Configuring Ethernet Models 640e and 650e
- Chapter 5 – Configuring USB Models 640u and 650u
- Chapter 6 – Analog Signals
- Chapter 7 – Digital I/O
- Chapter 8 – CE Compliance and Noise Considerations
- Chapter 9 – Troubleshooting and Customer Support
- Chapter 10 – Software Options
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Appendices

- Appendix A – Using the Daq Configuration Applet
- Appendix B – TCP/IP and Resource Tests
- Appendix C – Transducer Electronic Data Sheets (TEDS)

Glossary

CAUTION



Using the equipment in ways other than described in the documentation can cause personal injury or equipment damage. Pay attention to all Warnings and Cautions.



Reference Notes:

Information (not available at the time of publication), will be made available in **ReadMe** files, or in supplemental documentation.

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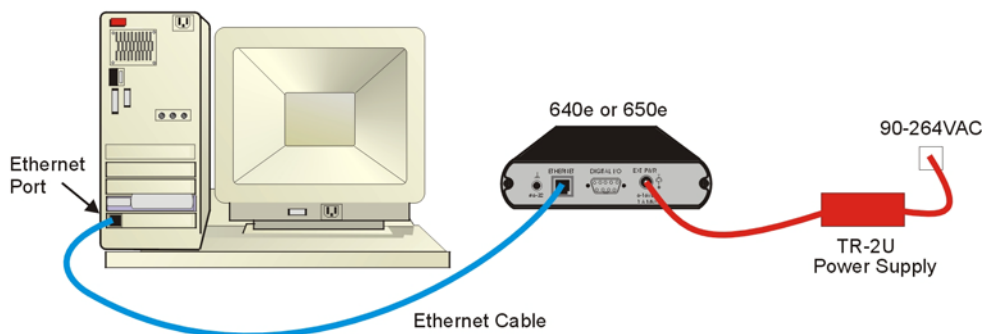
Ethernet Dynamic Signal Analyzers for Vibration Analysis & Monitoring

Before you get started verify that you have a 32-bit version of Windows, the following items, and meet or exceed the minimum requirements listed.

- 640e or 650e
- TR-2U Power Supply
- Ethernet Patch Cable
- Ethernet jack [on PC or on a hub connected to the Ethernet]
- *Dynamic Signal Analysis CD*
- License Keys for purchased software;
e.g., eZ-Analyst, eZ-TOMAS, eZ-Balance, eZ-NDT
- Monitor: SVGA, 1024 x 768 screen resolution
- Windows 2000 SP4 and Windows XP users:
Intel™ Pentium 4 or equivalent
1 GB memory; 10 GB disk space
- Windows Vista (x86) users:
PC must be *Windows Vista Premium Ready*

Step 1 - Install Software

1. Close all running applications on the host PC.
2. Insert the *Dynamic Signal Analysis CD* into your CD-ROM drive and wait for the CD to auto-run. An *Opening Screen* will appear. As an alternative, you can download software from: www.iotech.com/ftp.html
3. Click the <ENTER SETUP> button.
Note: If you are downloading software from our website, follow instructions provided there.
4. From the hardware selection screen [which follows a licensing agreement], select the **640, 650 product-line** from the drop-down list and follow the on-screen instructions.

Step 2 - Connect the 640e or 650e to the Ethernet

In this scenario a 640e or 650e is connected directly to an Ethernet port on a host computer. Please consult your user's manual (located in PDF format on the CD) should you need information regarding the other network types.

1. Connect the Ethernet cable to the Ethernet jack on the 640e [or 650e].
2. Connect the other end of the Ethernet cable to the Ethernet jack on the host computer or network hub.

Step 3 - Connect the 640e or 650e to Power

1. Connect the power supply cable from the TR-2U to the External Power connector of the 640e [or 650e].
2. Connect the TR-2U plug to a standard AC outlet. The 640e [or 650e] Power LED will light up.

Step 4 - Configure Computer Network Settings

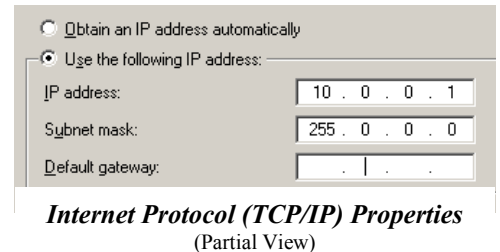
Applies to “dedicated networks” only. See user’s manual in regard to other network types.



We recommend that you discuss this procedure with your Network Administrator before proceeding. Note that the 640e and 650e Ethernet ports typically require 5 to 30 seconds after power-up to configure, depending on your network configuration. When the Active LED goes dark the unit is ready to be accessed over the network.



1. Open the Control Panel by navigating from the Windows Desktop: **Start Menu ⇒ Settings ⇒ Control Panel.**
2. Double-click the “Network Connections” icon.
3. Double-click the icon for the network that the 640e [or 650e] is connected to.
4. In the “Local Area Connection Status” box, click on the **<Properties>** button.
The “Local Area Connection Properties” box will appear.
5. Double-click the “Internet Protocol (TCP/IP)” component.
The “Internet Protocol (TCP/IP) Properties” box will appear.
6. Select the “Use the following IP Address” radio button. (See figure at left).
7. Set the IP address field to 10.0.0.x , where x is some number from 1 to 254.
Make sure that each computer and each device on the dedicated network has a unique IP address.
8. Set the Subnet mask to 255.0.0.0. Note that the remaining fields can be left as is.
9. Click **<OK>** on follow-up screens to exit.



Step 5 - Configure & Test the System with the Daq Configuration Applet

1. Open the Daq Configuration Applet.
 - a. Navigate from the Windows’ Desktop: **Start Menu ⇒ Settings ⇒ Control Panel**
 - b. From the Control Panel, double-click the **Daq Configuration** icon.
2. Add the 640e or 650e to the list of installed devices.
 - a. Click the **<Add Device>** button. The “Select Device Type” box will appear.
 - b. Select the **640e** or **650e** from the list of devices, as applicable.
 - c. Click the **<OK>** button. The “Properties” box will appear for the selected device.
 - d. Enter the **Serial Number** of the 640e [or 650e].
 - e. Select the **“Auto IP Setting”** radio button. The IP Address of the 640e [or 650e] will be calculated automatically and displayed in the IP Address field.
3. Test the System.
 - a. Click the **“Test Hardware”** tab.
 - b. Click the **<TCP/IP Test>** button. This tests the Transmission Control Protocol / Internet Protocol.
 - c. Upon completion of the TCP/IP test, click the **<Resource Test>** button.
When testing, if the unit does not respond within 30 seconds perform the following steps:
 - 1) reboot the system, 2) upon power-up, re-open the Daq Configuration applet,
 - 3) select another configuration setting, 4) reinitiate the test.



Step 6 - Connect Data Acquisition Signal Lines

Prior to making signal connections review the *Specifications* chapter of your user’s manual to ensure that your intended signal inputs do not exceed the specified limits. The manual is included in PDF format on your CD.



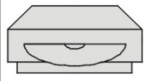
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USB2.0 Dynamic Signal Analyzers for Vibration Analysis & Monitoring

Requires a 32-bit version of Windows®



Windows 2000 SP4
Windows XP
Windows Vista (x86)

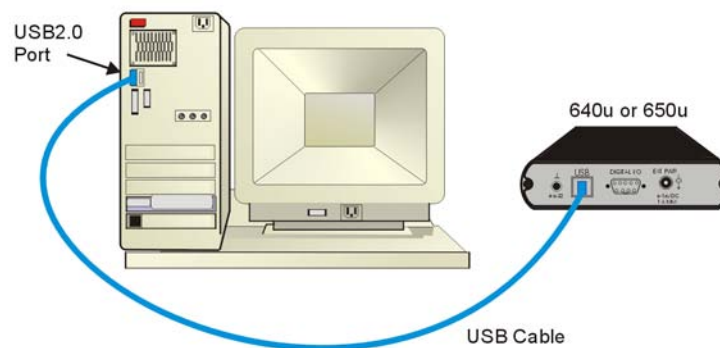


Before you get started verify that you have a 32-bit version of Windows, the following items, and meet or exceed the minimum requirements listed.

- 640u or 650u
- USB Cable
- USB2.0 port [on PC]
- *Dynamic Signal Analysis CD*
- License Keys for purchased software;
e.g., eZ-Analyst, eZ-TOMAS, eZ-Balance, eZ-NDT
- Monitor: SVGA, 1024 x 768 screen resolution
- Windows 2000 SP4 and Windows XP users:
Intel™ Pentium 4 or equivalent
1 GB memory; 10 GB disk space
- Windows Vista (x86) users:
PC must be *Windows Vista Premium Ready*

Step 1 - Install Software

1. Close all running applications on the host PC.
2. Insert the *Dynamic Signal Analysis CD* into your CD-ROM drive and wait for the CD to auto-run. An *Opening Screen* will appear. As an alternative, you can download software from: www.iotech.com/ftp.html
3. Click the <ENTER SETUP> button.
Note: If you are downloading software from our website, follow instructions provided there.
4. From the hardware selection screen [which follows a licensing agreement], select the **640, 650 product-line** from the drop-down list and follow the on-screen instructions.

Step 2 - Connect the 640u or 650u to the Computer

1. Using a USB cable, connect the 640u [or 650u] to a USB2.0 port on the computer. USB2.0 port is required.
2. Follow the computer screen prompts as directed to allow the computer to detect your new hardware.

Note:

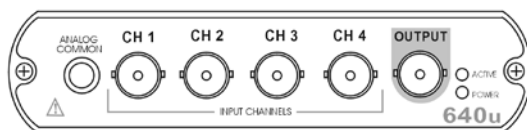
Power LED: The "Power" LED blinks during device detection and initialization; then remains on solid as long as the module has power. If there is insufficient power the LED will go off.

Active LED: This LED is on whenever active communication is taking place between the 640 [or 650] and the host PC. Note that the Active LED will be on solid during a data acquisition.

Step 3 - Connect Data Acquisition Signal Lines

Prior to making signal connections review the *Specifications* chapter of your user's manual to ensure that the input signals do not exceed the specified limits. The manual is included in PDF format on the CD.

The 640u

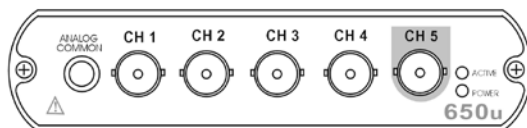


4 analog channel inputs (CH1 through CH4) via front panel BNC connectors.

1 analog output via the fifth front panel BNC connector.

8 digital I/O lines via rear panel DB9 connector, as discussed in Chapter 3 of the user's manual.

The 650u



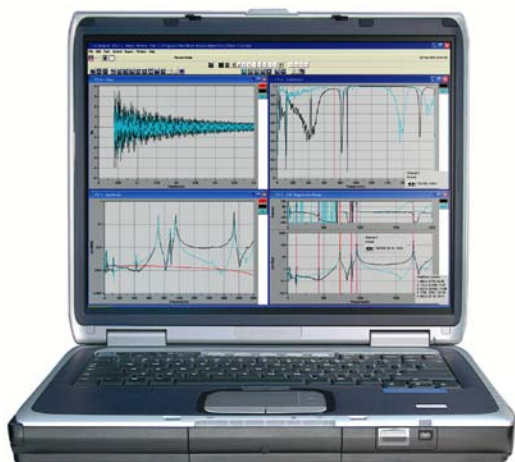
5 analog channel inputs (CH1 through CH5) via front panel BNC connectors.

8 digital I/O lines via rear panel DB9 connector, as discussed in Chapter 3 of the user's manual.



Reference Notes:

Adobe Acrobat PDF versions of documents pertaining to IOtech 640u and 650u are automatically installed onto your PC's hard-drive as a part of product support at the time of software installation. The default location is the **Programs** group. It can be accessed via the *Windows Desktop Start Menu*.



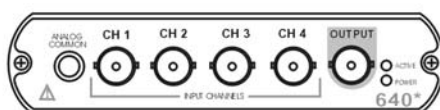
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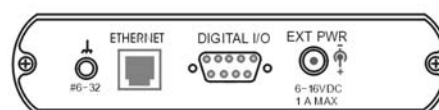
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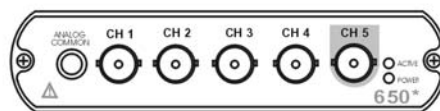
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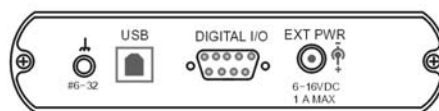
**4 Analog Input & 1 Output Channel
For 640e & 640u**



**Ethernet Back Panel
For 640e & 650e**



**5 Analog Input Channels
For 650e & 650u**



**USB Back Panel
For 640u & 650u**

* The actual model number includes an “e” or “u” to indicate Ethernet or USB version.

IOtech 640 and 650 Series Panels

IOtech 640 and 650 Series devices are dynamic signal analyzers used for monitoring and analyzing machinery and structures in regard to sound, vibration, and rotation. The device hardware is the signal conditioning and acquisition engine, while the software defines the specific analysis and monitoring features of the system. Since the software [in the host PC] determines which capabilities will be used, it is easy to upgrade the system and add more capabilities over time.

There are currently 4 models in the 640 and 650 product line. These are 640e, 640u, 650e, and 650u, where

“e” indicates Ethernet Interface and “u” indicates USB2.0 Interface. The following matrix compares model features.

Model	Interface	Analog Input Channels	High Pass Filter Cutoff	Analog Input Range	Analog Output Channels	Digital I/O Channels	External Power Connector
640e	Ethernet 10/100BaseT	4	1.0 Hz	±10 V	1	8	6 to 16 VDC 1 amp (max.)
640u	USB2.0						
650e	Ethernet 10/100BaseT	5	0.1 Hz	±40 V	0		
650u	USB2.0						

There are four end-user software application packages available for IOtech 640 and IOtech 650 systems. A brief description of each follows. For more information refer to Chapter 10, *Software Options*. For detailed information refer to the specific software user’s manual. The data acquisition CD includes PDF versions of the software documents.

eZ-Analyst Used to record and analyze time history data; as well as perform impact (resonance) testing.

eZ-TOMAS Used to acquire, monitor, and analyze rotating machinery data for steady-state and transient conditions.

eZ-Balance Used to field balance multi-plane rotating machinery.

eZ-NDT Used to determine the quality of production parts during the manufacturing process. eZ-NDT is a non-destructive, resonance-based, testing process.

The IOtech 640e and 650e include a high-speed Ethernet engine powered by a PowerPC processor. The 640u and 650u include a high-speed USB2.0 engine. These Ethernet and USB interfaces allow *all* acquired data to be transferred to the PC in real time at 630k samples/sec. This means that *every* acquired data point can reside on the host PC's hard drive, making re-creation and post acquisition analysis of acquired data as precise as possible. Many other analyzers simply store frequency-domain information, which results in play-back that is less precise than the original real-time measurement. In comparison, the 640 and 650 models transmit *all* time-domain measurements. This means there is no data loss when analyzing acquired waveforms. Since the data is already on the host PC's hard drive there is no time lost transferring data.

Another advantage of the 640/650 architecture is that there is virtually no limit to the length of time continuous data can be acquired. Many other systems do not offer continuous time-domain transfer to the PC, and as a result the waveform length is limited by the amount of built-in data storage. In regard to 640/650 units, the only limitation is the amount of available hard disk memory on the host PC, or that which can be accessed by a PC on a network.

- ***Features of the Dynamic Signal Inputs***

- a current source for transducer biasing (ICP)
- detection of a transducer fault
- AC coupling: 0.1 Hz for IOtech 650 models; 1.0 Hz for IOtech 640 models; or DC coupling
- ± 10 V range (IOtech 640 models)
- ± 40 V range (IOtech 650 models)
- anti-aliasing filters: 3-pole low pass filter in hardware; set appropriately for each analysis rate
- pseudo-differential inputs
- support for TEDS (Transducer Electronic Data Sheet) in eZ-Analyst
- any analog input channel can serve as a tach input
- channel-to-channel phase matching

- ***For 640u and 650u - Easy Connection to **USB2.0-ready** Notebooks, Desktop PCs, or USB2.0 Hubs.***
Note that the USB2.0 port allows a continuous stream of data to be collected and stored in the host PC.

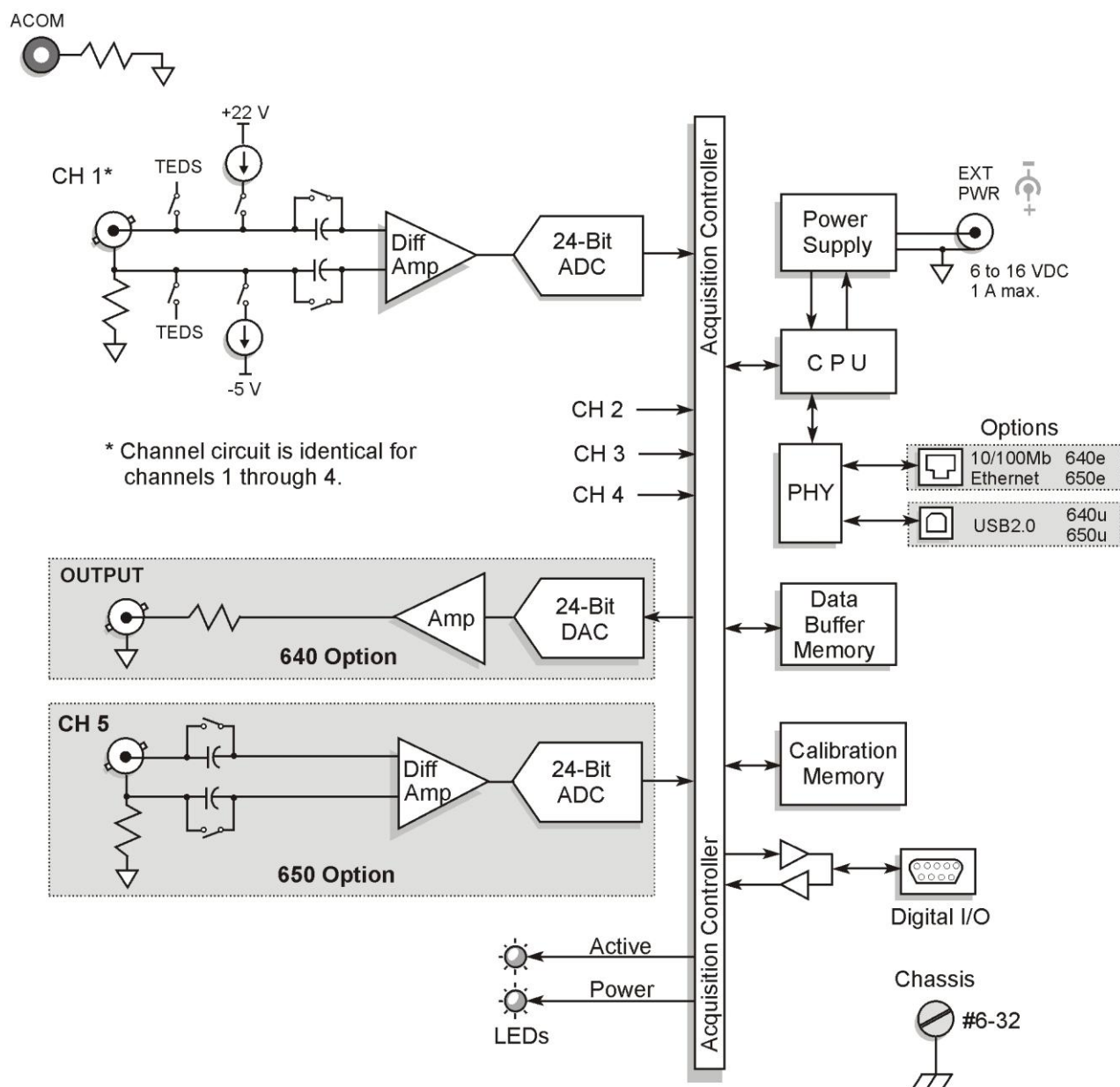
- ***For 640e and 650e - Easy Connection to **Ethernet-ready** Notebooks, Desktop PCs, or Ethernet Hubs.***
Note that the 10/100BaseT Ethernet port allows a continuous stream of data to be collected and stored in the host PC.

- ***Analog Input Channels:*** BNC connectors.

- ***8 Digital I/O Channels:*** DB9 connector for connection of Digital I/O signal lines.
Note: eZ-NDT or eZ-TOMAS software must be used to make use of the Digital I/O.

- ***Analog Channel Triggering***

- ***Pre- and Post-Trigger Readings***



Iotech 640/650 Series Block Diagram

General Comments

Ethernet Connection (640e and 650e models only)

IOtech 640e and 650e units transfer the acquired data to the PC via a 10/100BaseT Ethernet connection. The Ethernet connection allows for a continuous stream of data to be collected and stored.

The 10/100BaseT Ethernet interface can be used in a *point-to-point* application, such as when attached to a notebook PC and used in the field. In this case the 16 Mbytes of buffer storage built into the unit is adequate to ensure that continuous data transfers to the PC can occur without risk of data loss.

The 10/100BaseT Ethernet interface can also be used to connect the unit to a network, presuming the network has enough available bandwidth. The network bandwidth required is a function of the number of signals being measured, and the bandwidth of the signals.

USB Connection (640u and 650u models only)

IOtech 640u and 650u units transfer the acquired data to the PC via a USB2.0 connection. When a computer has a board with USB 2.0 ports, an “Enhanced” USB controller can be found in the Device Manager. The Device Manager will also show two other USB controllers. This is due to the fact that USB2.0 circuitry includes 3 chips [one for the actual USB2.0 capable devices and two for backward USB1.1 compatibility]. Thus a USB 2.0 motherboard can host any USB device (version 2.0 or lower), assuming there are no defects with the board, system, and/or device.

USB Notes:

- IOtech 640u and IOtech 650u require connection to USB2.0
- USB 1.1 (obsolete) hubs will work on USB 2.0 ports, but cannot utilize USB 2.0 capabilities.
- Hi-Speed and Full/Low-Speed USB devices can coexist on USB 2.0 hubs.
- USB 2.0 hubs can be used on computers with USB 1.1 ports, but will not exhibit USB 2.0 capabilities.
- Minimize hub use and keep USB cables as short as possible.
- Regardless of the USB hub or port used, if power to the 640u or 650u device is insufficient, connect a TR-2U power adapter to the unit's External Power jack.

Power

640e and 650e units can be powered directly from a 6 to 16 VDC source. They can also be powered from a 100 to 250 VAC source via its power adapter, which converts the AC to the required DC.

640u and 650u units can be powered solely from a USB2.0 bus, or optionally from a 6 to 16 VDC source via the external power connector.

LEDs

640/650 Series modules have 2 LEDs on the front panel. The LEDs function as follows:

Power LED: The “Power” LED blinks during device detection and initialization; then remains on solid as long as the module has power. If there is insufficient power the LED will go off.

Active LED: This LED is on whenever active communication is taking place between the 640/650 and the host PC. Note that the Active LED will be on solid during a data acquisition.

Digital I/O

To make use of the Digital I/O feature the 640 or 650 must be operating with eZ-TOMAS or eZ-NDT. The 8-bits of digital I/O are provided via a rear panel DB9 connector. Each bit is programmable as input or output.

Signal Conditioning

Every input to a 640 or 650 system is software programmable for AC/DC coupling, IEPE source [if AC coupling is selected], and is capable of reading sensor calibration information using Transducer Electronic Data Sheets (TEDS). eZ-Analyst software is required if the TEDS functionality is to be used.

When IEPE sensors are attached, AC coupling with bias current is selected via software. AC coupling without bias is also possible for measuring any AC waveform. DC coupling, which is useful for proximity sensor applications, can also be selected via the software.

For IEPE sensors, indication of an open or shorted fault is available within the eZ-Analyst software application.

Source Output (640 units only)

640e and 640u each include one analog output channel capable of generating continuous waveforms. These waveforms are programmable in regard to amplitude and frequency per product specifications. They can be continuous sine, random, burst, or arbitrary.



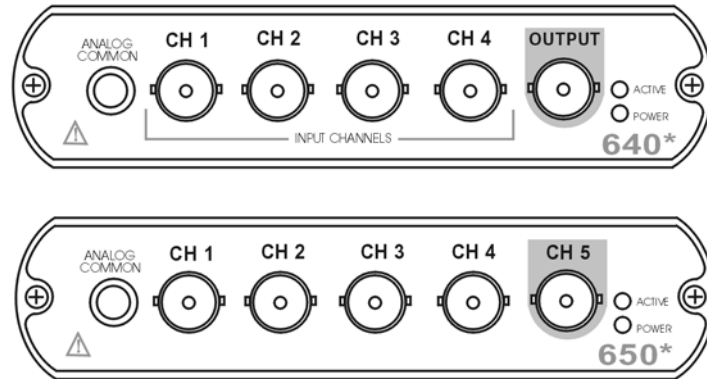
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Front Panel Connectors and Indicators



640 and 650 Front Panels

* The actual model number includes an “e” or “u” to indicate Ethernet or USB version.

The 640 and 650 Front Panels include the following connectors and LED indicators.

ANALOG COMMON: Common analog ground.

ANALOG SIGNAL INPUT CHANNELS: These BNC connectors are used for voltage input. The 640 models have 4 input channels. The 650 models have 5 input channels.

The BNC center-conductor is the signal HI and the BNC shell is the signal LO. Each BNC shell is connected to the chassis ground through its own channel-dedicated 1 k Ω resistor. Consequently, the shell is not meant to be driven with respect to earth ground more than $\pm 10V$.

An additional consideration pertains to input transducer setup. If the transducer case is effectively earth grounded through its connection to a device under test, *there exists the possibility for added measurement noise due to the ground loop that is created.* The pseudo-differential input rejects much of this noise. Electrically isolating the transducer from the test device minimizes noise.

OUTPUT (640 units only): The 640 units include a programmable voltage source that can be set in discrete amplitudes (see specifications). The output waveform parameters are controlled by software and can be sine, swept-sine, random, burst, or arbitrary. The output can be used as a test source for the input channels or as excitation for other system elements, such as the amplifier for a shaker table. Detailed information on the excitation source and its operation can be found in the applicable eZ software documentation, e.g., the *eZ-Analyst User’s Manual*.

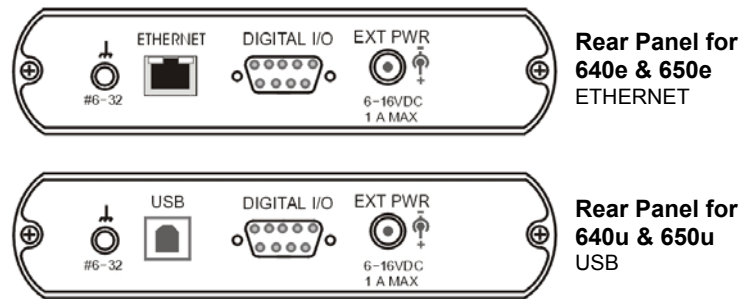
NOTE: The output value is not guaranteed unless the Power LED has lit.

Status LEDs 640 and 650 Series modules have 2 LEDs on the front panel. The LEDs function as follows:

Power LED: The “Power” LED blinks during device detection and initialization; then remains on solid as long as the module has power. If there is insufficient power the LED will go off.

Active LED: This LED is on whenever active communication is taking place between the 640 or 650 and the host PC. Note that the Active LED will be on solid during a data acquisition.

Rear Panel Connectors



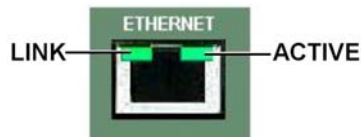
Iotech 640 [or 650] Rear Panels

Iotech 640 and 650 “e” and “u” version rear panels are identical aside from their interface ports, with the “e” versions being for Ethernet and the “u” versions being for USB. Both rear panels include a #6-32 chassis ground, a DB9-Digital I/O port, and an External Power connector.

#6-32: Provides a connection point for Chassis Ground via use of a #6-32 machine screw.

ETHERNET (Applies only to 640e and 650e): The 10/100BaseT Ethernet port can connect to the Ethernet port of the host PC, or to an Ethernet network. Either of two Ethernet patch cables may be used to make the connection. CA-242 is a 1.5 foot cable. CA-242-7 is a 7-foot cable. Note that the Ethernet connector has two built in LEDs that indicate Ethernet status. These are discussed below. Note that the Ethernet cable length must be <10m in order for the system to be CE Compliant.

Two rectangular ETHERNET Status LEDS (LINK and ACTIVE) are built into the frame of the Ethernet jack.

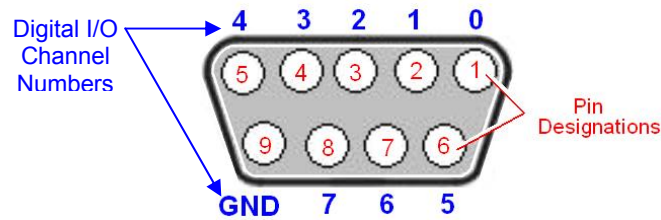


LINK – “ON” indicates that a link via Ethernet exists.

ACTIVE – “ON” indicates that the port is receiving or transmitting traffic.

USB2.0 (Applies only to 640u and 650u): The USB port for 640u and 650u is intended for USB2.0 high-speed (480Mbps). Chapter 2 includes information regarding USB2.0 and USB1.1. However, for these units connection to a USB2.0 port on the host PC is required.

DIGITAL I/O: The units include a female DB9 connector for up to 8 Digital I/O lines. The connections are designated as digital input or output via software. To make use of the Digital I/O feature, eZ-TOMAS or eZ-NDT must be used. Refer to Chapter 8, Digital I/O and to the applicable software document for details for additional information.



DB9 – As viewed from the rear panel

EXT POWER: +6 to +16 VDC, 1 amp maximum. Power is typically supplied from a TR-2U power adapter.

Unit Underside

MAC Address Label: Located on the bottom of the chassis, the Media Access Control (MAC) label shows the device serial number in barcode and base 10 formats. It also shows the Ethernet address (MAC Address) which is derived from the serial number in hexadecimal and is needed for 640e and 650e models. If prompted to enter a serial number in software, use the base 10 number. Conversion to a hexadecimal number for use in addressing will be automatic.

Note: If your network administrator asks you for a MAC number or MAC Address, provide the hexadecimal number that is located at the bottom of the label.

Accessories

CA-242 or CA-242-7 Ethernet Patch Cable

CA-242 is a 1.5 foot cable that can be used to connect an IOtech 640e or 650e to an Ethernet port on a PC or network. CA-242-7 is a 7-foot cable that can be used for the same purpose.

CA-179-1, -3, or -5 High-Speed USB Cable

CA-179-x cables can be used to connect an IOtech 640u or 650u to a USB port on a PC or USB hub. The -1, -3, and -5 cables are 1m, 3m, and 5m in length, respectively.

TR-2U Power Supply

TR-2U is an AC-to-DC conversion power supply. TR-2U plugs into the External Power connector of the IOtech 640 or 650 unit.

TR-2U Ratings:

- Input voltage to TR-2U: 90-264 VAC
- TR-2U voltage output (supply to device): 9VDC
- Max Current Output: 1.7 amp

System Requirements 4-1

Software Installation 4-2

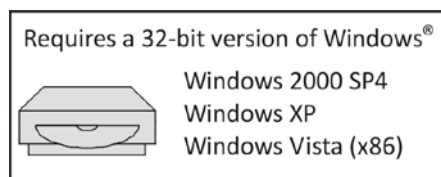
Ethernet Connection and System Power-up 4-3

Connecting Data Acquisition Signal Lines 4-14



Purchased software packages such as eZ-Analyst and eZ-TOMAS are shipped with a license key. Keep your key(s) in a safe place. You will need to enter them during the initial run of your purchased software.

System Requirements



Before setting up the hardware or installing the software, verify that you have a 32-bit version of Windows and the following:

- 640e or 650e
- TR-2U Power Supply
- Ethernet Patch Cable
- Ethernet jack [on PC or on a hub connected to the Ethernet]
- *Dynamic Signal Analysis CD*
- License Keys for purchased software;
e.g., eZ-Analyst, eZ-TOMAS, eZ-Balance, eZ-NDT
- Monitor: SVGA, 1024 x 768 screen resolution
- Windows 2000 SP4 and Windows XP users:
Intel™ Pentium 4 or equivalent
1 GB memory; 10 GB disk space
- Windows Vista (x86) users:
PC must be *Windows Vista Premium Ready*

Software Installation



Remove any previous-installed versions of your application software (eZ-Analyst, eZ-TOMAS, eZ-Balance, or eZ-NDT) before installing a new version.

1. Start Windows.
2. Close all running applications.
3. Insert the Data Acquisition CD into your CD-ROM drive and wait for the CD to auto-run.

If the CD does not start on its own:

- (a) click the desktop's <Start> button
- (b) choose the Run command
- (c) select the CD-ROM drive, then select the **setup.exe** file.
- (d) click <OK>

An *Opening Screen* will appear.

4. Click the <**ENTER SETUP**> button.
5. From the hardware selection screen [which follows a licensing agreement], select **640e** or **650e** from the drop-down list and follow the on-screen instructions.

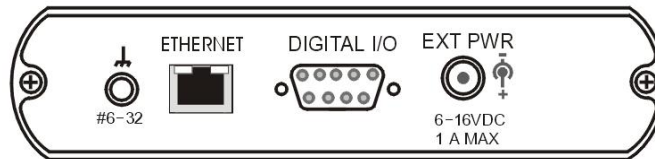


Reference Notes:

Adobe Acrobat PDF versions of documents pertaining to IOtech 640 and 650 are automatically installed onto your PC's hard-drive as a part of product support at the time of software installation. The default location is the **Programs** group, which can be accessed via the *Windows Desktop Start Menu*.

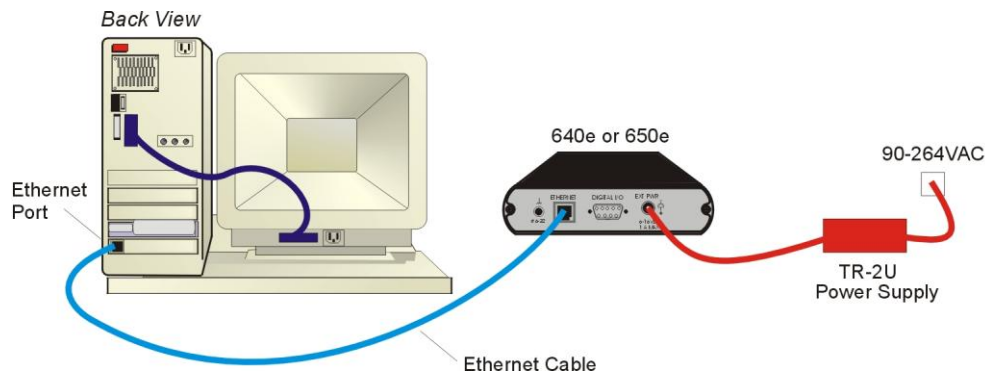
Ethernet Connection and System Power-up

Overview



640e or 650e, Rear Panel

IOtech 640e and 650e connect directly to an Ethernet port on a PC or network hub, via the unit's built-in 10/100BaseT Ethernet interface. An Ethernet patch cable CA-242 (1.5 foot) or CA-242-7 (7 foot) cable is used to make the connection. Note that either a straight-through or a cross-over cable may be used. The circuitry automatically adjusts for the cable type to ensure proper connection.



Connecting an IOtech 640e or 650e to the Ethernet

CAUTION



Turn off power to the system devices and externally connected equipment before connecting cables. Electric shock or damage to equipment can result even under low-voltage conditions.



Take ESD precautions (packaging, proper handling, grounded wrist strap, etc.)



Reference Note:

Adobe PDF versions of user manuals will automatically install onto your hard drive as a part of product support. The default location is in the **Programs** group, which can be accessed from the *Windows Desktop*. You can also access documents directly from the data acquisition CD via the <View PDFs> button located on the CD's opening screen.

STEP 1 – Install the Software

Install the software prior to connecting the 640e or 650e to the Ethernet. If you have not already installed the software, do so at this time. Refer to the section entitled *Software Installation*, page 4-2.

STEP 2 – Determine the type of Network Connection

To properly connect and configure a 640e or 650e, you must determine the type of network that the device will become part of. This is because the type of network used has a direct bearing on the IP address of the device.

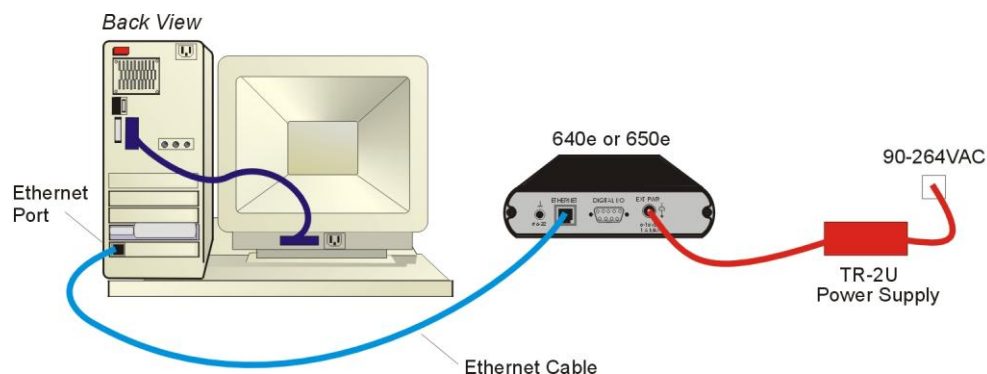
Briefly, the four network types are as follows:

- **Dedicated Network - with a direct cable connection from the PC to the device**
- **Dedicated Network - making use of a network hub or switch**
- **LAN with a DHCP server**
(Local Area Network with a Dynamic Host Configuration Protocol)
- **LAN without a DHCP server**
(Local Area Network with no Dynamic Host Configuration Protocol)

Brief descriptions and illustrations follow.

Dedicated Network - with a direct cable connection from the PC to the device

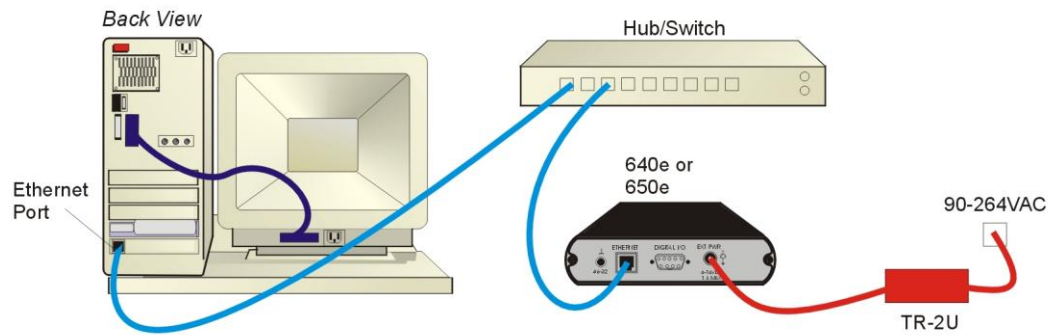
In this scenario a 640e or 650e is connected directly to an Ethernet port on a host computer.



Dedicated Network using a Direct Cable Connection

Dedicated Network - making use of a network hub or switch

In this scenario the 640e or 650e connects to the Ethernet through a network hub or switch. At least one computer is also connected to the hub.



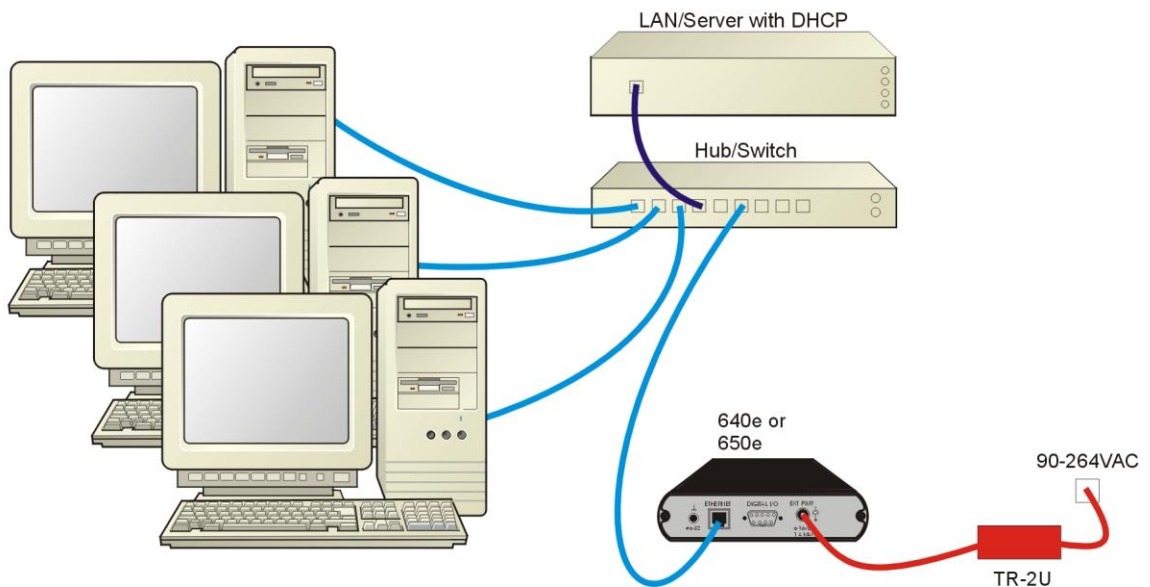
Dedicated Network using a Hub/Switch



Some network devices such as a *wireless access point* may act as a DHCP server. If this is the case, follow the instructions for the LAN with a DHCP server. For detailed information consult the documentation that is specific to your network device.

LAN with a DHCP Server (Local Area Network with a Dynamic Host Configuration Protocol server)

Many corporations use the LAN/Server with DHCP arrangement for their networks. In this type of setup several computers are typically connected to a network that makes use of a DHCP server. In addition, a 640e or 650e is connected to the network hub/switch.



LAN with a DHCP Server

Notes:

- Using a 640e or 650e on a typical LAN may affect the speed of the network and internet data transfer. Because of this we recommend adding a network card to the computer and using one of the two dedicated network configurations.
- Contact your network administrator before connecting a 640e or a 650e to a corporate network.

LAN with no DHCP Server

(Local Area Network with no Dynamic Host Configuration Protocol server)

This scenario looks the same as that shown in the previous illustration, except there is no Dynamic Host Configuration Protocol (DHCP). In this type of setup, one or more computers are connected to a network; and each computer has a static IP address.

STEP 3 – Connect the System Components

What you will need to connect a 640e or a 650e to the Ethernet:

- An available connection to the Ethernet. The connection can be either
 - an Ethernet jack on a computer or
 - an Ethernet jack on a hub that is connected to the Ethernet.
 - An Ethernet patch cable, e.g., a CA-242 (1.5 foot cable) or a CA-242-7 (7-foot cable).
1. Connect the Ethernet cable to the Ethernet jack on the 640e or the 650e.
 2. Connect the other end of the Ethernet cable to the Ethernet jack on the host computer or network hub.

STEP 4 – Power-up the System Components

What you will need:

A power supply with a range of 6 to 16 VDC. We recommend the TR-2U power supply.

How to make the connection:

1. Connect the power supply cable, e.g., from the TR-2U, to the External Power connector on the rear panel of the 640e or 650e.
2. Connect the power supply's plug to a standard AC outlet.
3. If you are using a power supply with a power switch, position it to "ON."

When the unit is initially powered on:

- Both the **Power LED** and **Active LED** will light up *solid*.
- If you have a DHCP server on your network or, if you have specified a user IP, after about 5 seconds the **Active LED** will begin *blinking*.
If you have no DHCP server on your network and not specified a user IP, after a period of about 25 seconds the **Active LED** will begin *blinking*.
- After 10 *rapid blinks* the **Active LED** will go out. The unit is now ready to be accessed over the network.

STEP 5 - Configure the Computer's Network Settings [Applies to “dedicated networks” only]



The 640e and 650e Ethernet ports typically require 30 seconds after power-up to configure, before the unit can be accessed via the network.

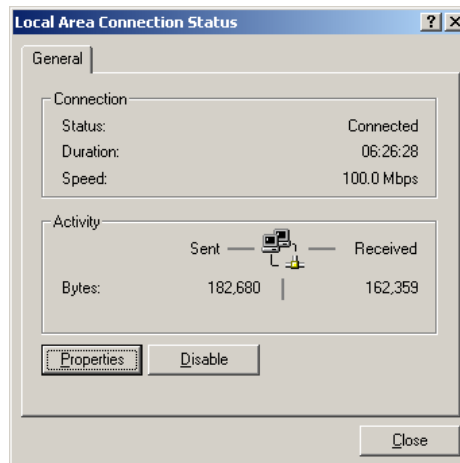


If using a LAN (Local Area Network), which has a DHCP server, skip this section and continue with *STEP 7 - Configure and Test the System using the Daq Configuration Applet* (page 4-11).



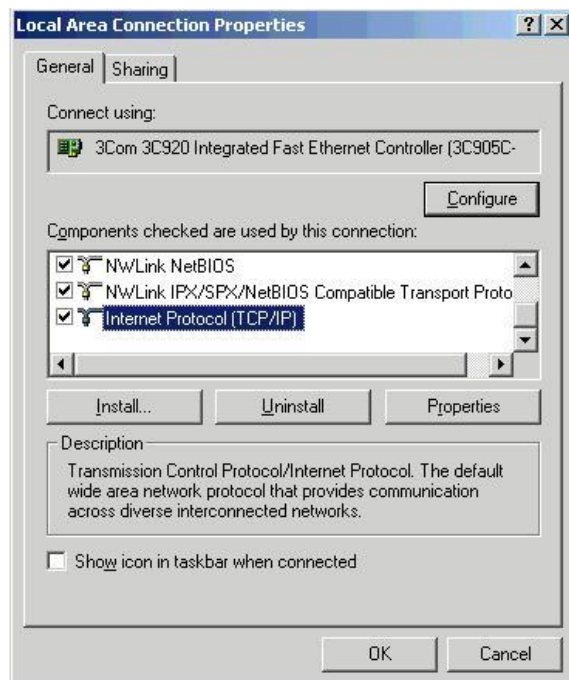
If using a LAN (Local Area Network), which has no DHCP server, skip this section and continue with *STEP 6 - Configure Device Network Settings using DaqIPConfig* (page 4-10).

1. Open the Control Panel by navigating from the Windows Desktop as follows:
Start Menu ⇒ Settings ⇒ Control Panel.
2. Double-click the “Network and Dial-up Connections” icon.
3. Double-click the “Network Connection” icon for the network that the 640e or 650e is connected to.



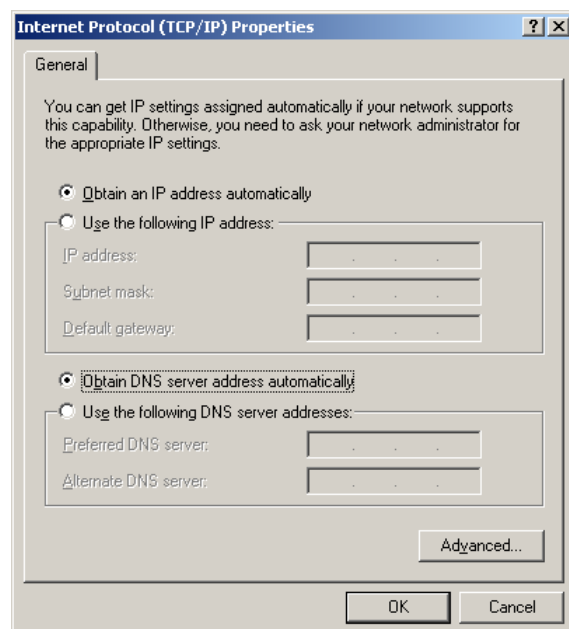
Local Area Connection Status

4. In the “Local Area Connection Status” box (previous figure), click on the <**Properties**> button. The “Local Area Connection Properties” box will appear (following figure).



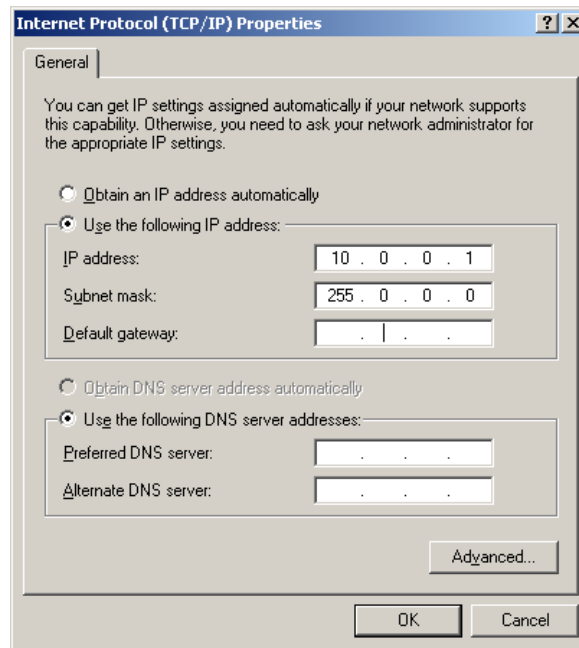
Local Area Connection Properties

5. Double-click the “Internet Protocol (TCP/IP)” component (previous figure). The “Internet Protocol (TCP/IP) Properties” box will appear (following figure).



Internet Protocol (TCP/IP) Properties

Configure the Computer's TCP/IP settings as follows.



Internet Protocol (TCP/IP) Properties

6. Select the "Use the following IP Address" radio button.
7. Set the IP address field to 10.0.0.x where x is some number from 1 to 254.
Make sure that each computer on the dedicated network has a unique IP address.
8. Set the Subnet mask to 255.0.0.0. Note that the remaining fields can be left unchanged.

STEP 6 - Configure Device Network Settings using DaqIPConfig

Applies only to a LAN (Local Area Network), which has a no DHCP server.



Never set the TCP/IP for the device to be the same as the host computer's IP address!
Each computer and each device on a dedicated network must have a unique IP address!

If using a LAN (Local Area Network), which has a DHCP server, skip this section and continue with *STEP 7 - Configure and Test the System using the Daq Configuration Applet* (page 4-11).

Multiple devices on a LAN are each identified by their unique (device-specific) serial number. Ensure that the serial number displayed for the unit [being configured] agrees with the serial number on the MAC label, located on the rear panel of the device.

The *DaqIPConfig* applet is designed for 32-bit Windows/2000/XP/Vista systems. You can use *DaqIPConfig* to change the IP address of the device to be compatible with networks that require fixed IP addresses. As a precaution, you should always consult with your IT administrator before using the applet to ensure that each device and host computer connected to the network maintains a unique IP address. The applet is located in the program group for the associated device and can be accessed from the Windows Desktop via the start menu.



Reference Note:

Appendix A contains general information regarding how to use the *Daq Configuration Applet*.

1. Locate the DaqIPConfig Applet.

Locate the *DaqIPConfig* applet by navigating from the Windows' Desktop as follows:

Start Menu

- ⇒ Programs
- ⇒ **IOtech Application Software**; for example:
IOtech eZ-Analyst Software, IOtech eZ-TOMAS Software, etc.
- ⇒ **DaqIPConfig**

2. Open the DaqIPConfig Applet.

Click on the *DaqIPConfig* selection to open the applet.

3. Select the Device Type that is to have the address change.

Note: In the figure to the right 650e is selected.

4. Set the internet protocol (TCP/IP) settings to be compatible with host computer.

- (a) Select the radio button labeled "Use the following IP address."
- (b) Enter the new internet protocol settings. If needed, consult your network administrator for acceptable numbers.

Do not set the TCP/IP to the computer's IP address!

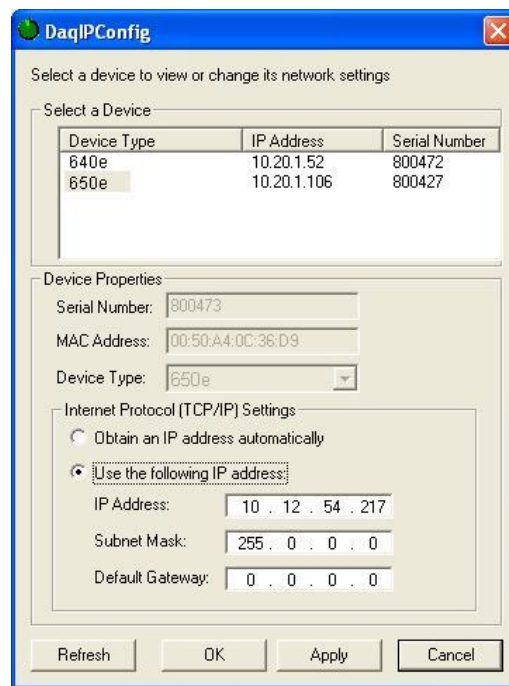
- (c) Click the <OK> button.

5. Reboot the device.

The new IP address will not take effect until the device has been powered-off, then powered back on.

6. Repeat steps 3, 4, and 5 for other devices in the system.

After configuring the network settings for all devices, proceed to Step 7.



DaqIPConfig

STEP 7 - Configure and test the System using the Daq* Configuration Applet

The *Daq* Configuration* applet, designed for 32-bit systems, is located in the Windows *Control Panel*. It allows you to add or remove a device and change configuration settings. The included test utility provides feedback on the validity of current configuration settings, as well as performance summaries.

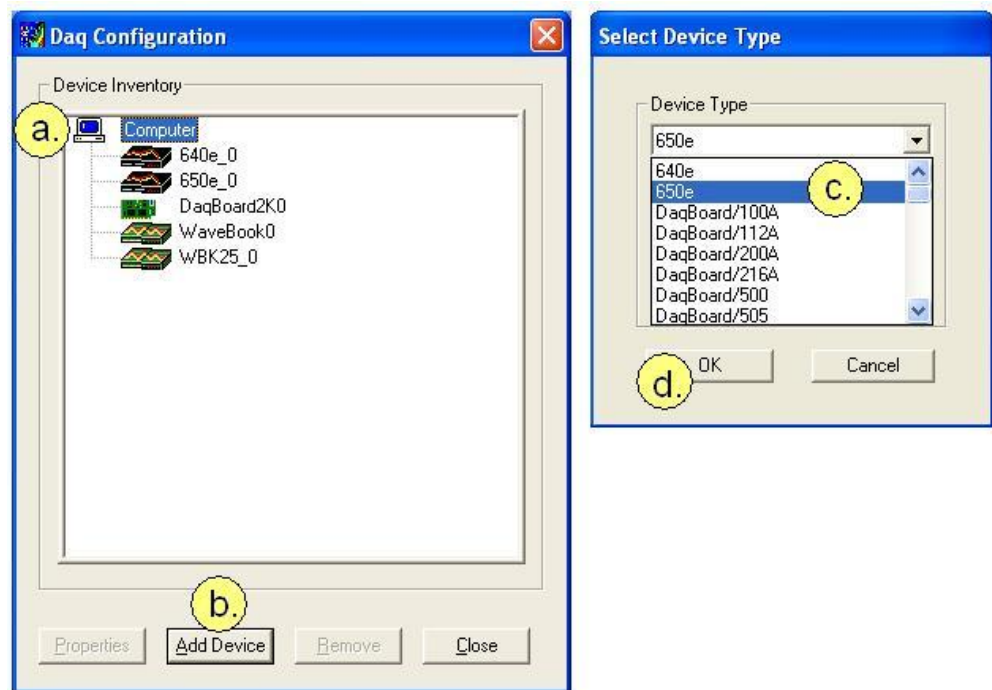
1. Open the Daq* Configuration Applet.

- a. Open the Control Panel by navigating from the Windows' Desktop as follows:
Start Menu ⇒ Settings ⇒ Control Panel
- b. From the Control Panel, double-click the *Daq* Configuration* icon.

2. Add the first-level device to the list of installed devices.

The first-level device is the device that will be connected directly to the Ethernet, via a host computer's Ethernet jack or a jack on a network hub. The 640e and 650e are first-level devices.

- a. Select the Computer image in the Device Inventory configuration tree (following figure).
- b. Click the <Add Device> button. The "Select Device Type" box will appear.
- c. Select the **640e** or **650e** from the list of devices, as applicable.
- d. Click the <OK> button. The "Properties" box will appear for the selected device.



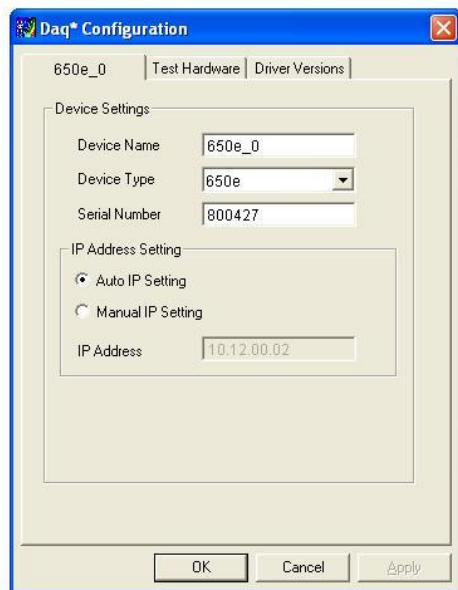
Using Daq Configuration Device Inventory & Select Device Type to Add a Device

3. Set the properties of the first-level device.

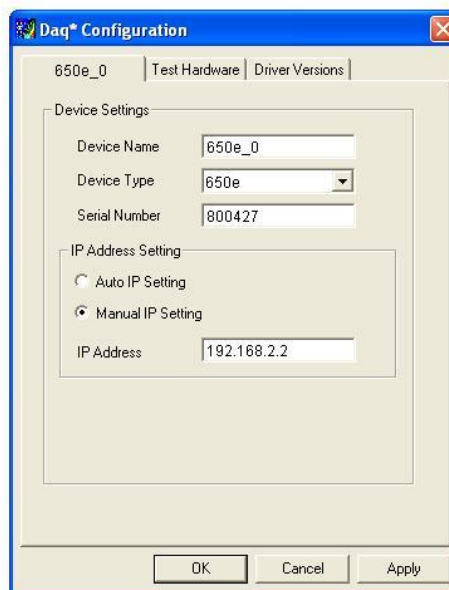
In this step you will set the device properties according to one of the following two methods, depending on whether you have a “Dedicated Network” or a “LAN with DHCP Server Network.”

Users of Dedicated Networks follow these 2 steps.

- Enter the **Serial Number** of the 640e or 650e. In the following screen shots the Serial Number is 800427.
- Select the “**Auto IP Setting**” radio button. Note that the IP Address of the 640e or 650e will be calculated automatically and displayed in the IP Address field as indicated in the following left-hand figure.
- Click the <OK> button.



For **DEDICATED** Networks



For **LAN with DHCP** Server Networks

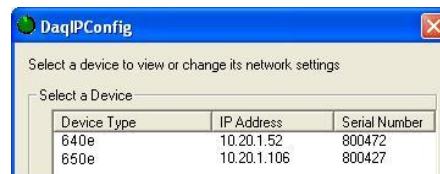
Daq Configuration, Properties Dialog Boxes*

Users of LAN with DHCP Server Networks follow these 3 steps.

The *DaqIPConfig* applet provides the Serial Number and the IP Address of the device. Users of LAN with DHCP Server Networks will need to enter both numbers in the *Daq* Configuration, Properties* dialog boxes (previous right-hand figure). Page 4-10 includes instructions for accessing *DaqIPConfig*.

If needed, refer to the upper right-hand figure in regard to radio-button and data entry locations.

- Enter the base 10 version of the **Serial Number** of the 640e or 650e.
- Select the “**Manual IP Setting**” radio button.
- In the **IP Address** field, enter the IP address.
- Click the <OK> button.



Partial View of DaqIP Config
Showing IP Address & Serial Number



Provide your network administrator with the information on the device’s MAC label. Also, find out from the administrator if the IP Address will be changing. If so, see if you can obtain a permanent IP Address dedicated specifically to your device.

4. Test the system connections.

- a. Make sure the device has been properly installed and is powered-on.
- b. Make sure all cables are properly and securely connected.
- c. Click the “**Test Hardware**” tab.
- d. Click the <**TCP/IP Test**> button. This tests the Transmission Control Protocol / Internet Protocol.

The TCP/IP test results have two components: *Pinging Device and TCP Connection*. *Appendix B, TCP/IP and Resource Tests*, includes a brief explanation of each.

- e. Upon completion of the TCP/IP test, click the <**Resource Test**> button.
The Resource Test consists of two components: *Resource Tests* and *Performance Tests*. *Appendix B, TCP/IP and Resource Tests*, includes a brief explanation of each.



When testing a 640e or a 650e, if the unit does not respond after 30 seconds perform the following steps:

- 1) reboot the system
- 2) upon power-up, re-open the *Daq* Configuration* applet
- 3) select another configuration setting
- 4) reinitiate the test

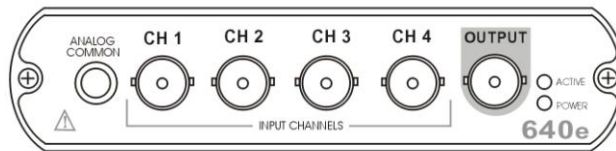
This completes the procedure for connecting an IOTech 640e or 650e to the Ethernet. At this point you should refer to the following section regarding signal lines.

Note: You can access PDF documents directly from the opening screen of the data acquisition CD via the <**View PDFs**> button.

Connecting Data Acquisition Signal Lines

Prior to making signal connections review the *Specifications* chapter to ensure that signal inputs do not exceed the specified limits.

The 640e

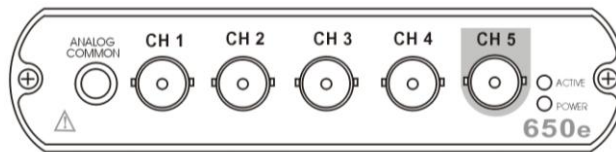


4 analog channel inputs (CH1 through CH4) via front panel BNC connectors.

1 analog output via a front panel BNC connector.

8 digital I/O lines via rear panel DB9 connector, as discussed in Chapter 3, *Connectors, Indicators, and Cables*.

The 650e



5 analog channel inputs (CH1 through CH5) via front panel BNC connectors.

8 digital I/O lines via rear panel DB9 connector, as discussed in Chapter 3, *Connectors, Indicators, and Cables*.

System Requirements 5-1

Software Installation 5-2

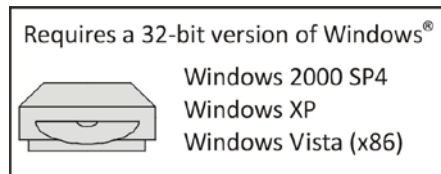
USB Connection and System Power-up 5-3

Connecting Data Acquisition Signal Lines 5-6



Purchased software packages such as eZ-Analyst and eZ-TOMAS are shipped with a license key. Keep your key(s) in a safe place. You will need to enter them during the initial run of your purchased software.

System Requirements



Before setting up the hardware or installing the software, verify that you have a 32-bit version of Windows and the following:

- 640u or 650u
- USB Cable
- USB2.0 port [on PC]
- *Dynamic Signal Analysis CD*
- License Keys for purchased software;
e.g., eZ-Analyst, eZ-TOMAS, eZ-Balance, eZ-NDT
- Monitor: SVGA, 1024 x 768 screen resolution
- Windows 2000 and Windows XP users:
Intel™ Pentium 4 or equivalent;
1 GB memory; 10 GB disk space
- Windows Vista users:
PC must be *Windows Vista Premium Ready*

Software Installation



Remove any previous-installed versions of your application software (eZ-Analyst, eZ-TOMAS, eZ-Balance, or eZ-NDT) before installing a new version.

1. Start Windows.
2. Close all running applications.
3. Insert the Data Acquisition CD into your CD-ROM drive and wait for the CD to auto-run.

If the CD does not start on its own:

- (a) click the desktop's <Start> button
- (b) choose the Run command
- (c) select the CD-ROM drive, then select the **setup.exe** file.
- (d) click <OK>

An *Opening Screen* will appear.

4. Click the <ENTER SETUP> button.
5. From the hardware selection screen [which follows a licensing agreement], select **640u** or **650u** from the drop-down list and follow the on-screen instructions.



Reference Notes:

Adobe Acrobat PDF versions of documents pertaining to IOtech 640 and 650 are automatically installed onto your PC's hard-drive as a part of product support at the time of software installation. The default location is the **Programs** group, which can be accessed via the *Windows Desktop Start Menu*.

USB Connection and System Power-up



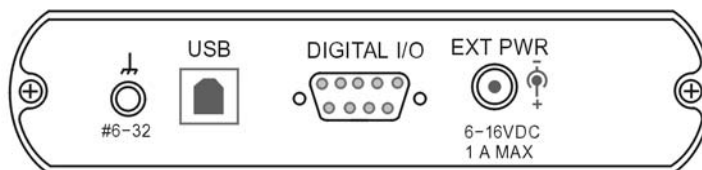
As this document goes to print, USB connectivity can only be used with Windows 2000 or Windows XP operating systems.

Overview

IOtech 640u and 650u units transfer the acquired data to the PC via a USB2.0 connection. When a computer has a board with USB 2.0 ports, an “Enhanced” USB controller can be found in the Device Manager. The Device Manager will also show two other USB controllers. This is due to the fact that USB2.0 circuitry includes 3 chips [one for the actual USB2.0 capable devices and two for backward USB1.1 compatibility]. Thus a USB 2.0 motherboard can host any USB device (version 2.0 or lower), assuming there are no defects with the board, system, and/or device.

USB Notes:

- IOtech 640u and IOtech 650u require connection to USB2.0
- USB 1.1 (obsolete) hubs will work on USB 2.0 ports, but cannot utilize USB 2.0 capabilities.
- Hi-Speed and Full/Low-Speed USB devices can coexist on USB 2.0 hubs.
- USB 2.0 hubs can be used on computers with USB 1.1 ports, but will not exhibit USB 2.0 capabilities.
- Minimize hub use and keep USB cables as short as possible.
- If you do not want to power the 640u or 650u from a USB2.0 port, connect a TR-2U power adapter to the unit's External Power jack.



640u or 650u, Rear Panel

IOtech 640u and 650u connect directly to a USB port on the PC [or USB2.0 hub] via the unit's built in USB2.0 interface. A CA-179-1 (or -3, or -5) USB cable is used to make the connection.

CAUTION



Turn off power to the system devices and externally connected equipment before connecting cables. Electric shock or damage to equipment can result even under low-voltage conditions.



Take ESD precautions (packaging, proper handling, grounded wrist strap, etc.)

**Reference Note:**

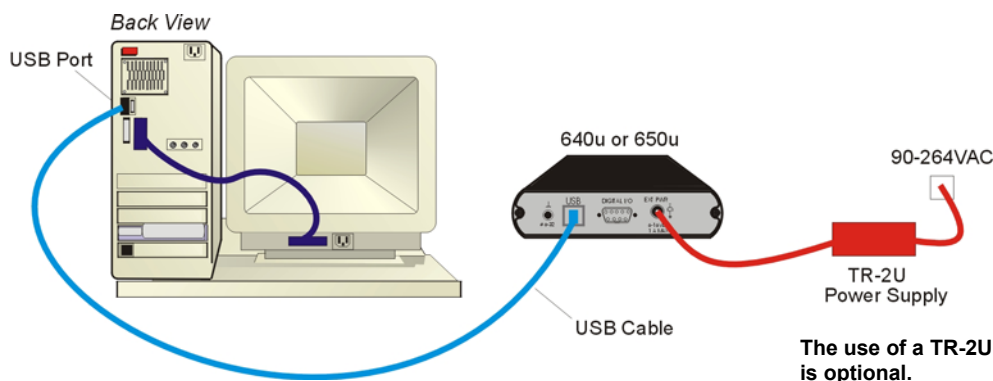
Adobe PDF versions of user manuals will automatically install onto your hard drive as a part of product support. The default location is in the **Programs** group, which can be accessed from the *Windows Desktop*. You can also access documents directly from the data acquisition CD via the <View PDFs> button located on the CD's opening screen.



Contact the factory or your service representative in regard to USB connectivity if your operating system is other than Windows 2000 or Windows XP.

Making Power and USB Connections

1. If using an *optional* TR-2U power supply, connect it to the 640 or 650 unit's External Power (EXT PWR) connector; then plug the TR-2U into an outlet which supplies 90 to 264 VAC.



Do not connect the CA-179-x USB cable until after the Power Supply is supplying power to the 640u or 650u. (See following note.)



The use of a TR-2U is optional. If using one, be sure to supply power from the TR-2U to the 640u or 650u before connecting the USB cable to the computer. This allows the 640u [or 650u] to inform the host computer (upon connection of the USB cable) that the unit requires minimal power from the computer's USB port. **When removing the unit from the PC, the TR-2U power cable must be removed after the USB cable is unplugged.**

2. Use a CA-179-1 (or -3, or -5) USB cable to connect the 640u or 650u device to a USB2.0 port on the computer. USB2.0 port is required.
3. Follow the screen prompts as directed.

LED Note: 640 and 650 Series modules each have 2 LEDs on their front panel. The LEDs function as follows:

Power LED: The "Power" LED blinks during device detection and initialization; then remains on solid as long as the module has power. If there is insufficient power the LED will go off.

Active LED: This LED is on whenever active communication is taking place between the 640 [or 650] and the host PC. Note that the Active LED will be on solid during a data acquisition.



If you need to find the name of your device for any reason, you can do so by navigating from the Windows Desktop to the Device Manager. The navigation path is:

**Start⇒Settings⇒Control Panel⇒System⇒Hardware(Tab) ⇒Device Manager
⇒DaqX PnP Devices**

You will see the device listed in the format of **640u** or **650u** (see first figure, below).

You can change the name of the device by doing a *right-click* on the device name to open its properties dialog box, then clicking on the Properties tab (see second figure). You can then change the “FriendlyName” of the device.



Locating DaqXPnP Devices

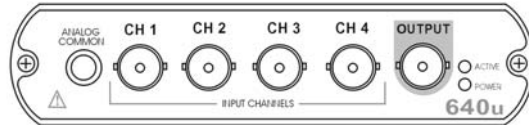


Properties Dialog Box

Connecting Data Acquisition Signal Lines

Prior to making signal connections review the *Specifications* chapter to ensure that signal inputs do not exceed the specified limits.

The 640u

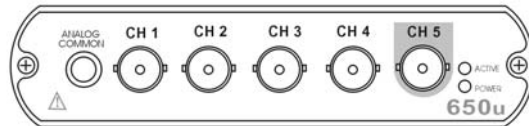


4 analog channel inputs (CH1 through CH4) via front panel BNC connectors.

1 analog output via the fifth front panel BNC connector.

8 digital I/O lines via rear panel DB9 connector, as discussed in Chapter 3, *Connectors, Indicators, and Cables*.

The 650u



5 analog channel inputs (CH1 through CH5) via front panel BNC connectors.

8 digital I/O lines via rear panel DB9 connector, as discussed in Chapter 3, *Connectors, Indicators, and Cables*.

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Introduction

IOtech 640 and 650 units include circuitry for dynamic analog signal conditioning. The circuitry provides a way for the units to interface with piezoelectric transducers that include, but are not limited to: accelerometers, microphones, tachometers, and force/pressure transducers.

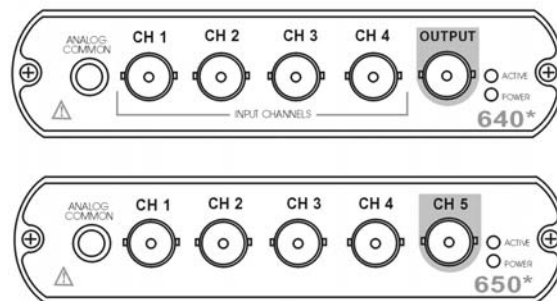
The analog input signal lines, which connect to the dynamic signal conditioning circuit, do so via the front panel BNCs labeled CH1 through CH4 for 640 models and CH1 through CH5 for 650 models. The center conductor of these Input Channel BNCs is the signal HI (High). Each BNC shell is connected to the chassis ground through its own channel-dedicated 1 k Ω resistor. The Output BNC [applicable to 640 units only] is discussed later in this section.

Depending on your application, you will need to set several software parameters. Proper settings will allow the software to organize data to best meet your acquisition needs.



Reference Note:

For detailed information, refer to the applicable software document, e.g., eZ-TOMAS, eZ-Analyst, eZ-NDT, or eZ-Balance. PDF versions of the document can be accessed from the data acquisition CD via the <View PDFs> button on the CD's opening screen.



* The actual model number includes an "e" or "u" to indicate Ethernet or USB version.

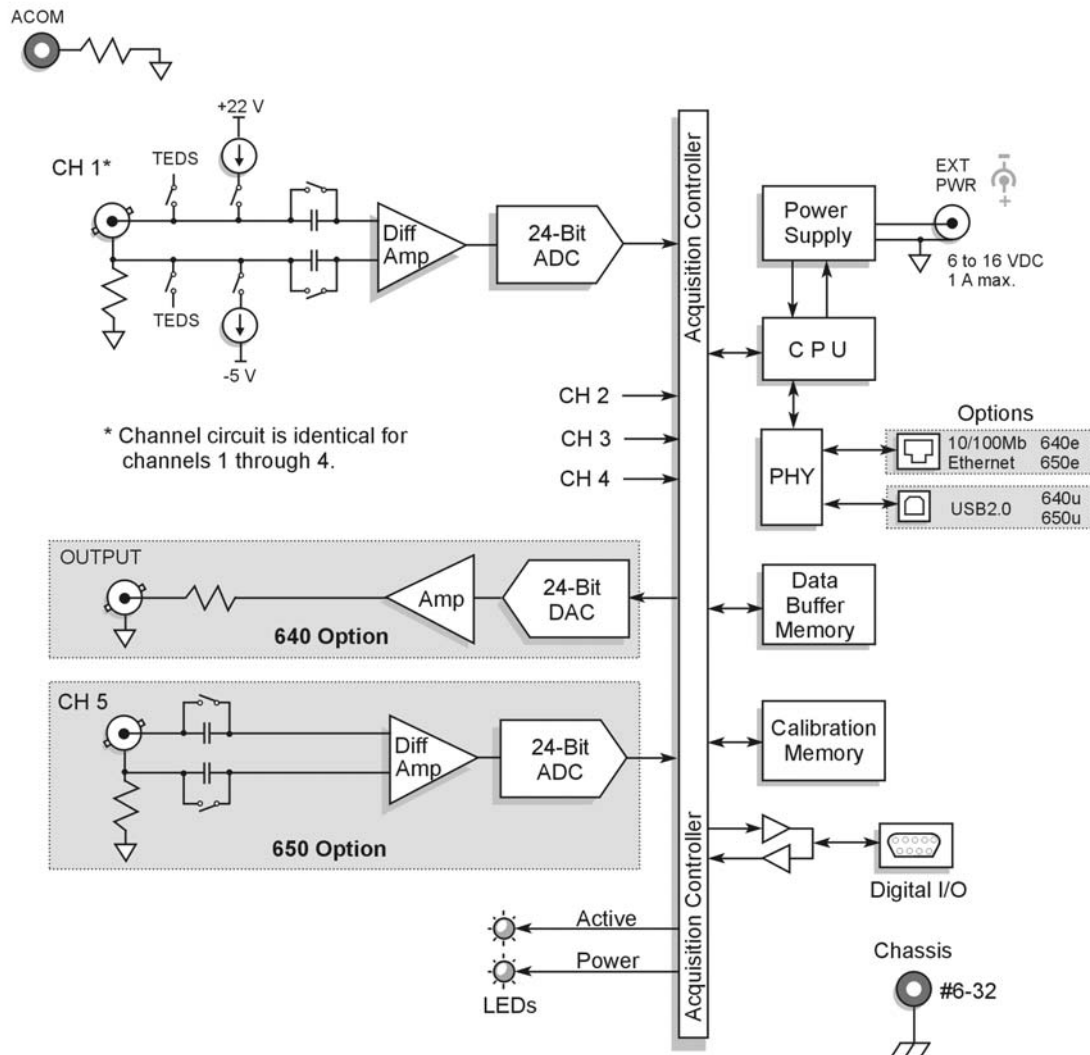
IOtech 640 and 650 Front Panels

Features of the dynamic signal conditioning circuit:

- current source for transducer biasing (IEPE)
- detection of a transducer fault
- AC or DC coupling
- ± 10 V range (IOtech 640 models)
- ± 40 V range (IOtech 650 models)
- anti-aliasing filters: 3-pole low pass filter in hardware; programmable digital filtering via software
- pseudo-differential inputs
- support for TEDS (Transducer Electronic Data Sheet), requires eZ-Analyst
- any analog input channel can serve as a tach input
- channel-to-channel phase matching

Signal parameters are independently controlled in software on a per channel basis.

For 640e and 640u, the conditioning circuit includes a built-in programmable voltage excitation source. This source can be used to stimulate dynamic systems for transfer function measurements or serve as a test signal for the input channels.



IOtech 640 and 650 Series Block Diagram

Comments pertaining to the diagram are included in Chapter 2.

Analog Common

The BNC shells for the analog input channels have a 1k ohm resistance from the BNC shell to earth ground [computer chassis ground]. If a transducer is effectively earth grounded through its connection to a device under test, there exists the possibility of added measurement noise due to the ground loop that is created. This issue is minimized by electrically isolating the transducer from the test device.

If the host computer is a desktop PC, then the computer ground will likely connect to the AC power line ground.

*If the host computer is a notebook PC, then the computer ground could be: (a) *floating*, for example, when operating on batteries, or (b) *connected to a vehicle ground*, for example, when using an automotive cigarette lighter adapter in conjunction with the vehicle's battery.*



TIP: Additional measurement noise may be present when using earth grounded transducers. For best results electrically isolate the input transducers from earth ground.

Current Source (IEPE) with Transducer Fault Detection

If IEPE is selected in software, a constant current is supplied to bias IEPE transducers. The bias current is sourced through the center conductor of the input channel BNC connector and returns to the conditioning circuit by the outer conductor. The current source features a voltage operating compliance and is short-circuit and over-voltage protected as stated in the specifications. Operating compliance refers to the highest voltage that can be sourced without change of the current source value. In the absence of a transducer, the current source will output a higher open circuit voltage. For applications that do not require bias, the current source can be disabled from the input via software control on a per channel basis.

When the current source is enabled, the input voltage is continuously monitored with level detection circuitry for indicating an open transducer (high voltage) or a transducer short (low voltage). Existence of either condition triggers a transducer fault for the associated channel. This error is communicated to the user on the monitor via software and is also available through a software status request at the end of an acquisition. Faults are detected and communicated when present. Detection of a fault does not alter the acquisition process or its data.

Note that IEPE current source can only be enabled when AC Coupling is selected.

Input Coupling

The analog input channels can be independently set in software to AC Coupling or to DC Coupling. When AC Coupling is selected, the input signal passes through a high pass filter. When DC Coupling is selected the high-pass filter is bypassed.

Low-Pass Anti-Aliasing Filter

Each of the analog input channels has its own low-pass filter to provide alias protection and to allow for the removal of undesired frequencies from the measured response.

What is Aliasing?

Aliasing is a phenomenon of sampled data systems wherein a high frequency signal is misrepresented as a low frequency signal when the A/D converter sampling rate being used is too slow. This misrepresentation can result in severe data corruption and incorrect FFT results. Aliasing is a well-documented data acquisition effect, and interested users are encouraged to research detailed information that is available on-line from companies such as Analog Devices and Texas Instruments. This text aims to not supplant those resources, but to provide most users with sufficient knowledge to avoid most aliasing problems through proper filter and sampling rate configuration.

For a given sampling rate, F_s , input signals of frequency up to $F_s/2$ will be processed correctly. However, input signals above $F_s/2$ are subject to aliasing. For example, a sampling rate of 100 kHz can process signals up to 50 kHz without aliasing. An input signal of 90 kHz, however, will be aliased. Specifically, it will appear in the sampled data as a signal of frequency $F_s - F_{IN}$, which in this case is $100 \text{ kHz} - 90 \text{ kHz} = 10 \text{ kHz}$.

Aliasing, and its prevention, should be a consideration in all sampled data systems. This is especially important in mechanical vibration measurements, because most mechanical systems exhibit a resonance apart from their fundamental frequency. That is, there may be signal energy present that has the potential to be aliased that is unknown to the user. And the worst part of aliasing is that its effects are indistinguishable from real input signals. That is, in the given example, it is not apparent to the user whether the 10 kHz energy is real or an alias.

Aliasing Protection

The 640 and 650 series analyzers have 24 bit sigma/delta analog to digital converters (ADCs). These ADCs actually sample at rates of between 13.5 million samples per second (Msps) to 27 Msps depending on the analysis frequency chosen in the eZ software. This high sample rate eases the requirements of the anti-aliasing filter since the Nyquist frequency is now between 6.75MHz and 13.5MHz.

The 640 and 650 series analyzers have three pole anti-aliasing filters. Refer to the specifications chapter for details, including a response chart.

Transducers seldom have any significant energy at these high frequencies, if there is such energy, then this filter will ensure it is attenuated.

Transducer Electronic Data Sheet (TEDS) Support eZ-Analyst Only

The TEDS feature provides a 640 or 650 series device with access to the calibration information stored within TEDS-compatible sensors. The 640 or 650 can read sensor calibration information directly from a sensor; and can then automatically scale the readings.

TEDS is further discussed in *Appendix C* and in separate software documentation, when applicable.

Output BNC (640 units only) eZ-Analyst Only

WARNING



When the Signal Generator is started [in eZ-Analyst] the device that is connected to Source Output will receive excitation and could possibly cause injury to personnel. Be aware of which device is receiving excitation and post adequate notice to keep individuals and physical objects clear of the device.

IOtech 640e and 640u have a voltage source, which can be set in frequency and in discrete amplitudes [see specs].

The Output can be used as a test source for the input channels or as excitation for other system elements, such as the amplifier for a shaker table. All source output parameters are software controlled and the actual output signal leaves the device through the 640's output BNC connector.

Detailed information on the excitation source and its operation can be found in the *eZ-Analyst* manual. With respect to *eZ-Analyst*, the "Output Channel Setup" tab [under the Edit pull-down menu] is used to set the SOURCE OUTPUT channel to "Active" and the Control pull-down menu can be used to turn the Signal Generator "On."

Do not confuse *excitation source* with *source level*, as the latter term refers to transducer bias current.

Analog Triggers

IOtech 640 and 650 signal analyzers can be triggered per software configuration. The 650 models can be triggered in regard to their 5 analog input channels. The 640 models can be triggered in regard to their 4 analog input channels. In addition, the 640 models can be triggered for analog waveform output.

Since all 640 and 650 triggers are dictated by software, refer to your associated software documentation for detailed information regarding triggers and how to set them.

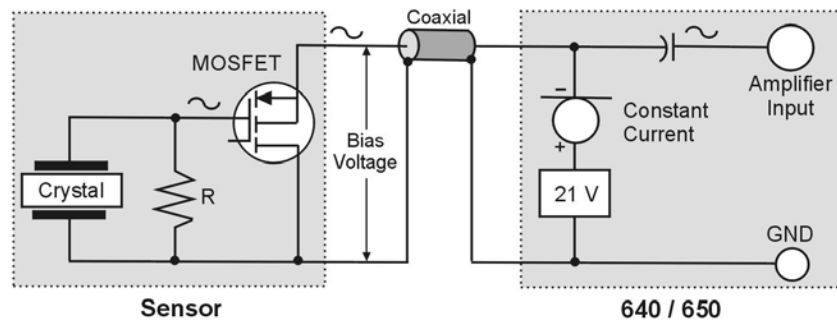
Using Accelerometers

Overview

A low-impedance piezoelectric accelerometer consists of a piezoelectric crystal and an electronic amplifier. When stretched or compressed, the two crystal surfaces develop a charge variation that is related to the amount of stress, shock, or vibration on the crystal. The amplifier outputs a corresponding signal and transforms the sensor's high impedance to a lower output impedance of a few hundred ohms. Note that, in addition to acceleration, these sensors can also measure pressure and force.

The circuit requires only two wires (coax or twisted pair) to transmit both power and signal. At low impedance, the system is insensitive to external or "triboelectric" cable noise. Cable length does not affect sensitivity.

The following figure shows a simple sensor-to-640 [or 650] connection. The voltage developed across R is applied to the gate of the MOSFET. The MOSFET is powered from a constant current source.



Using a Sensor with a 640 or 650

The MOSFET circuit will bias at approximately 12 V in the quiet state. As the system is excited, voltage is developed across the crystal and applied to the gate of the MOSFET. This voltage will cause linear variation in the impedance of the MOSFET and a proportional change in bias voltage. This voltage change will be coupled to the 640 [or 650] input amplifier through the capacitor. The value of R and the internal capacitance of the piezoelectric crystal control the low frequency corner. Units weighing only a few grams can provide high-level outputs up to 1 V/g with response to frequencies below 1 Hz.

Accelerometer Specification Parameters

Noise in Accelerometers

The noise floor or resolution specifies the lowest discernible amplitude (minimum "g") that can be measured. There are two main sources of noise as follows:

- **Noise from the crystal and microcircuit inside the accelerometer.** Some types of crystals, such as quartz, are inherently noisier than others. A good noise floor is 10 to 20 μV .
- **Noise from electrical activity on the mounting surface.** Since the signal from the accelerometer is a voltage, 60 Hz or other voltages (ground loop, etc) can interfere with the signal. The best protection is to electrically isolate the accelerometer.

Sensitivity

The sensitivity of an accelerometer is defined as its output voltage per unit input of acceleration. The unit used is "g." One "g" is equal to the gravitational acceleration at the Earth's surface, which is 32.2 ft/sec per sec or 981 cm/sec per sec. The output is usually specified in millivolts per "g" (mV/g).

Sensitivity is usually specified under defined conditions such as frequency, testing levels, and temperature. An example: 100 mV/g at a frequency of 100 Hz, level +1 g, at 72°F. Note that, although a sensor may have a "typical" sensitivity of 100 mV/g, its actual sensitivity could range from 95 to 105 mV/g (when checked under stated conditions). Manufacturers usually provide sensor calibration values.

Transverse Sensitivity - An accelerometer is designed to have one major axis of sensitivity, usually perpendicular to the base and co-linear with its major cylindrical axis. The output caused by the motion perpendicular to the sensing axis is called *transverse sensitivity*. This value varies with angle and frequency and typically is less than 5% of the basic sensitivity.

Base-Strain Sensitivity - An accelerometer's *base-strain sensitivity* is the output caused by a deformation of the base, due to bending in the mounting structure. In measurements on large structures with low natural frequencies, significant bending may occur. Units with low *base-strain sensitivity* should be selected. Inserting a washer (smaller in diameter than the accelerometer base) under the base reduces contact surface area; and can substantially reduce the effects of base-strain. Note that this technique lowers the usable upper frequency range.

Acoustic Sensitivity - High-level acoustic noise can induce outputs unrelated to vibration input. In general, the effect diminishes as the accelerometer mass increases. Use of a light, foam-rubber boot may reduce this effect.

Frequency Response

An accelerometer's frequency response is the ratio of the sensitivity measured at frequency (f) to the basic sensitivity measured at 100 Hz. This response is usually obtained at a constant acceleration level, typically 1 g or 10 g. Convention defines the usable range of an accelerometer as the frequency band in which the sensitivity remains within 5% of the basic sensitivity. Measurements can be made outside these limits if corrections are applied. Care should be taken at higher frequencies because mounting conditions greatly affect the frequency range.

Dynamic Range

The dynamic measurement range is the ratio of the maximum signal (for a given distortion level) to the minimum detectable signal (for a given signal-to-noise ratio). The dynamic range is determined by several factors such as sensitivity, bias voltage level, power supply voltage, and noise floor.

Bias Level

Under normal operation, a bias voltage appears from the output signal lead to ground. There are two basic MOSFET configurations commonly used. One exhibits a 6 to 8 V bias and the second a 9 to 12 V bias. Operation of the two circuits is identical except for the available signal swing.

Thermal Shock - Temperature Transients

Piezoelectric accelerometers exhibit a transient output that is a function of a temperature's "rate-of-change." This "thermal shock" is usually expressed in g/°C and is related to:

- Non-uniform mechanical stresses set up in the accelerometer structure.
- A pyroelectric effect in piezoelectric materials, in which an electrical charge is produced by the temperature gradient across the crystal.

This quasi-static effect produces a low-frequency voltage input to the MOSFET amplifier. This voltage is usually well below the low-frequency corner, but the effect can reduce the peak clipping level and cause loss of data. This effect does not affect the accelerometer's basic sensitivity or the data unless the thermal shift in the operation bias level results in clipping. Where drastic thermal shifts are expected, use 12 V bias models. The effect's severity is related to the mass of the accelerometer. In 100 mV/g industrial units, the effect is usually negligible. Using rubber thermal boots can reduce the effect significantly.

Overload Recovery

Recovery time from clipping due to over-ranging is typically less than 1 ms. Recoveries from quasi-static overloads that generate high DC bias shifts are controlled by the accelerometer input RC time constant that is fixed during manufacture.

Connector

This parameter specifies the connector type and size (4-48, 6-40, 10-32 coaxial etc.) and the location on the sensor, that is, top or side (usually on the hex base). Where there is no connector on the sensor, an integral cable is specified with the length and the connector, that is, integral 6-ft to 10-32.

Electrical Grounding

Case-Grounded Design

In case-grounded designs, the common lead on the internal impedance matching electronics is tied to the accelerometer case. The accelerometer base/stud assembly forms the signal common and electrically connects to the shell of the output connector. Case-grounded accelerometers are connected electrically to any conductive surface on which they are mounted. When these units are used, take care to avoid errors due to ground noise. The pseudo-differential input of the 640 [or 650] will help ignore many of these sources of noise.

Isolated-Base Design

To prevent ground noise error many accelerometers have base-isolated design. The outer case/base of the accelerometer is isolated electrically off ground by means of an isolation stud insert. The proprietary material used to form the isolation provides strength and stiffness to preserve high-frequency performance.

Cable Driving

Operation over long cables is a concern with all types of sensors. Concerns involve cost, frequency response, noise, ground loops, and distortion caused by insufficient current available to drive the cable capacitance.

The cost of long cables can be reduced by coupling a short (1 m) adapter cable from the accelerometer to a long low-cost cable like RG-58U or RG-62U with BNC connectors. Since cable failure tends to occur at the accelerometer connection where the vibration is the greatest, only the short adapter cable would need replacement.

Capacitive loading in long cables acts like a low-pass, second-order filter and can attenuate or amplify high-frequency signals depending on the output impedance of the accelerometer electronics. Generally this is not a problem with low-frequency vibration (10 Hz to 2000 Hz). For measurements above 2000 Hz and cables longer than 100 ft, the possibility of high-frequency amplification or attenuation should be considered.

The maximum frequency that can be transmitted over a given length of cable is a function of both the cable capacitance and the ratio of the maximum peak signal voltage to the current available from the constant current source:

Drive Current	Cable Length @30 pF/ft	Frequency Response to 5% of Maximum Output Signal Amplitude	
		± 1 V	± 5 V
2 mA	10 ft	275 kHz	55 kHz
2 mA	100 ft	27.5 kHz	5.5 kHz
2 mA	1000 ft	2.75 kHz	550 Hz

Where:

f = Maximum frequency in Hz

$K = 3.45 \times 10^9$. K is the scale factor to convert Farads to picoFarads and Amperes to milliAmperes and a factor to allow cable capacitance to charge to 95% of the final charge.

C = Cable capacitance in picoFarads

V = Maximum peak measured voltage from sensor in volts

I_{cc} = Constant current from current source in mA

I_b = Current required to bias the internal electronics, typically 1 mA

$$f = \frac{K}{2\pi C \left(\frac{V}{I_{cc} - I_b} \right)}$$

Sound & Vibration Sensors – Supplemental Information

A system with an extremely high Q excited near its resonant frequency produces large oscillations which can mask the true acceleration signal, produce inaccurate measurements, and damage the sensor. Consequently oil, or a similar material, is frequently added to control the damping.

Figures 1 and 2 show the frequency response of harmonic resonators with $Q = 1$ and 100,000. For $Q = 100,000$, the accelerometer is accurate within 10% to 1/3 of its resonant frequency. In contrast, for $Q = 1$, the accelerometer is accurate within 10% to half of its resonant frequency.

Most strain gages in accelerometers are wired in Wheatstone bridge circuits. Signal conditioners for a common strain-gage bridge also apply to this type of transducer since it resembles a strain-gage circuit in a load cell.

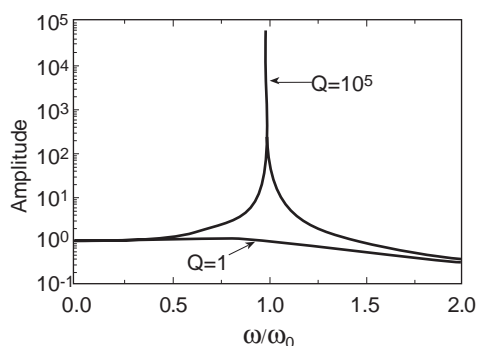


Fig. 1. An undamped accelerometer can have a high Q at its resonant frequency, which produces large oscillations and completely overrides the acceleration signal. Also, if large enough, resonant oscillations can destroy the accelerometer.

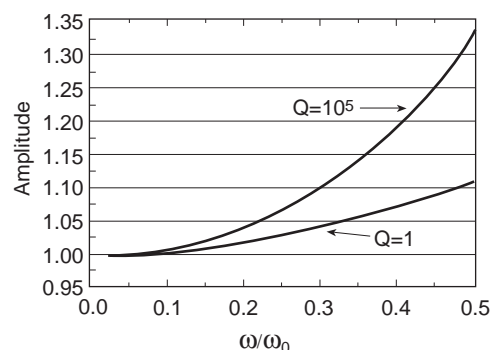


Fig. 2. This figure shows the low frequency portion of Figure 1 magnified.

Low-Impedance Transducers

Most modern piezoelectric transducers contain integrated signal conditioning amplifiers. Also known as integrated-circuit piezoelectric transducers, these units have a low impedance output and require an external power supply. The manufacturer usually specifies their sensitivity and frequency range. Users need only connect a supply to the power terminals and the output to a voltmeter circuit. The voltage is then scaled to the measured engineering units.

The most common application for piezoelectric-type accelerometers is in measuring a wide range of accelerations and mechanical vibrations. They monitor automobile deceleration (and deploy the air bag at the correct millisecond) in safety systems, lift-off acceleration and motion during space-shuttle missions, and mechanical vibration in numerous machines. Piezoelectric sensors, however, cannot measure constant acceleration as do strain-gage sensors.

Low-impedance piezoelectric transducers also measure pressure or force. The accelerometer circuit requires only two wires to handle both power and signals.

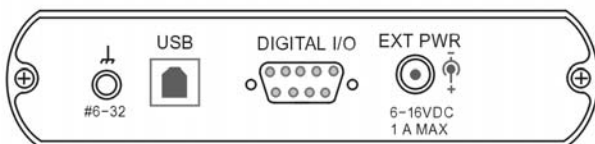
Piezoelectric sensors have resonant frequencies as high as 120 kHz giving them a usable frequency range of <1 Hz to >40 kHz.

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Applies only to eZ-TOMAS and eZ-NDT

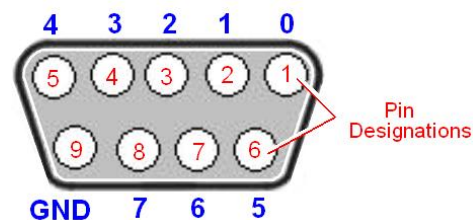
Digital Inputs and Outputs

Eight digital I/O lines are included in each of the 600 series modules, accessible via a 9-pin, female DSub connector. Each bit of digital I/O can be programmed individually to be either an input or an output. By hardware default, the digital I/O port boots up as an input. This is to prevent any output of the 600 series device from damaging external customer hardware.



640u Rear Panel with DB9 Connector for Digital I/O

All 640/650 Series units have a DB9 connector centrally located on their rear panel.



DB9 – As viewed from the rear panel

Outer numbers are digital channels.
Inner numbers are pin designations.

The digital I/O can be read synchronously or asynchronously. It can also be read asynchronously while being in a synchronous acquisition. Synchronously, the digital I/O will be read at the same rate as the analog channels, and thus can be read as fast as 105.469 kHz. Since all of the analog signals are read simultaneously along with the digital I/O channel in synchronous mode, there is no delay between any analog signal and the digital I/O channel. Asynchronously, the digital I/O can be either read or written to, as opposed to the synchronous mode, which is read-only.



640/650 Digital I/O is only applicable to eZ-TOMAS and eZ-NDT.

Points to note:

- To use 640/650 Series device Digital I/O, either eZ-TOMAS or eZ-NDT software must be used.
- All configurations pertaining to digital I/O are controlled by software and can be updated by the software at any time.
- All 8 digital inputs can be read back as part of the scan group of an acquisition.



Reference Note:

For detailed documentation regarding software and Digital I/O you will need to refer to one or more of the following, as applicable. A PDF version of each is included on the installation CD.

- *eZ-TOMAS User's Manual*
- *eZ-NDT User's Manual*

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CE Rules of Thumb for 640/650 Series Devices 8-3

Noise Considerations 8-4

Overview



CE compliant products bear the “CE” mark and include a *Declaration of Conformity* stating the particular specifications and conditions that apply. The test records and supporting documentation that validate the compliance are kept on file at the factory.

This product meets the essential requirements of applicable European directives, as amended for CE markings in accordance with the product family standard for:

- electrical equipment for measurement, control, and laboratory use
- immunity requirements for equipment used in controlled EM environments

Refer to this product’s Declaration of Conformity (DoC) for any additional regulatory compliance information. To obtain the DoC for this product, visit iotech.com/CE

CE Standards and Directives

The electromagnetic compatibility (EMC) directives specify two basic requirements:

1. The device must not interfere with radio or telecommunications.
2. The device must be immune from electromagnetic interference from RF transmitters, etc.

The standards are published in the *Official Journal of European Union* under direction of CENELEC (European Committee for Electrotechnical Standardization). The specific standards relevant to data acquisition equipment are listed on the product’s *Declaration of Conformity*.

The safety standard that applies to data acquisition products is EN 61010-1 : 1993 (*Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements*). Environmental conditions include the following:

- indoor use
- altitude up to 2000 m
- temperature 5°C to 40°C (41°F to 104°F)
- maximum relative humidity 80% for temperatures up to 31°C (87.8°F) decreasing linearly to 50% relative humidity at 40°C (104°F)
- mains supply voltage fluctuations not to exceed $\pm 10\%$ of the nominal voltage
- other supply voltage fluctuations as stated by the manufacturer
- transient overvoltage according to installation categories (overvoltage categories) I, II and III
For mains supply, the minimum and normal category is II
- pollution degree I or II in accordance with IEC 664

For clarification, terms used in some Declarations of Conformity include:

- **pollution degree:** any addition of foreign matter, solid, liquid or gaseous (ionized gases) that may produce a reduction of dielectric strength or surface resistivity. **Pollution Degree I** has no influence on safety and implies: the equipment is at operating temperature with non-condensing humidity conditions; no conductive particles are permitted in the atmosphere; warm-up time is sufficient to avert any condensation or frost; no hazardous voltages are applied until completion of the warm-up period. **Pollution Degree II** implies the expectation of occasional condensation.
- **overvoltage (installation) category:** classification with limits for transient overvoltage, dependent on the nominal line voltage to earth. **Category I** implies signals without high transient values. **Category II** applies to typical mains power lines with some transients.

Safety Conditions

Users must comply with all relevant safety conditions as stated in the user's manual and in the pertinent *Declarations of Conformity*. Both the documentation and the associated hardware make use of the following Warning and Caution symbols. If you see any of these symbols on a product or in a document, carefully read the related information and be alert to the possibility of personal injury and/or equipment damage.



This WARNING symbol is used in documentation and/or on hardware to warn of possible injury or death from electrical shock under noted conditions.



This WARNING/CAUTION symbol is used to warn of possible personal injury or equipment damage under noted conditions.



This CAUTION symbol warns of possible equipment damage due to electrostatic discharge. The discharge of static electricity can damage some electronic components. Semiconductor devices are especially susceptible to ESD damage. You should always handle components carefully, and you should never touch connector pins or circuit components unless you are following ESD guidelines in an appropriate ESD-controlled area. Such guidelines include the use of properly grounded mats and wrist straps, ESD bags and cartons, and related procedures.



Unless otherwise stated our data acquisition products contain no user-serviceable parts. Only qualified personnel are to provide service to the devices.

The specific safety conditions for CE compliance vary by product; but general safety conditions include the following bulleted items:

- The operator must observe all safety cautions and operating conditions specified in the documentation for all hardware used.
- The host computer and all connected equipment must be CE compliant.
- All power must be off to the device and externally connected equipment before internal access to the device is permitted.
- Isolation voltage ratings: do not exceed documented voltage limits for power and signal inputs. All wire insulation and terminal blocks in the system must be rated for the isolation voltage in use. Voltages above 30 Vrms or ± 60 VDC must not be applied if any condensation has formed on the device.
- Current and power use must not exceed specifications. Do not defeat fuses or other over-current protection.

Emissions/Immunity Conditions

The specific immunity conditions for CE compliance vary by product; but general immunity conditions include:

- Cables must be shielded, braid-type with metal-shelled connectors. Input terminal connections are to be made with shielded wire. The shield should be connected to the chassis ground with the hardware provided.
- The host computer must be properly grounded.
- In low-level analog applications some inaccuracy is to be expected when I/O leads are exposed to RF fields or transients over 3 or 10 V/m as noted on the Declaration of Conformity.

CE Rules of Thumb for 640 and 650 Series Devices

IOtech 640/650 Series units are CE Compliant at the time they leave the factory. They will remain in compliance providing that the conditions stated on their associated *Declaration of Conformity* continue to be met.

A few general rules of thumb regarding 640/650 Series and CE compliance:

- Use short cables.
- When possible use shielded cables.
- When assembling or disassembling components, take ESD precautions, including the use of grounded wrist straps.
- Ensure that the host computer is CE Compliant.
- Review the most recent *Declaration of Conformity* for each device.
- Ensure all system components are properly grounded.

Noise Considerations

Controlling electrical noise is imperative because it can present problems even with the best measurement equipment. Most laboratory and industrial environments suffer from multiple sources of electrical noise. For example, AC power lines, heavy equipment (particularly if turned on and off frequently), local radio stations, and electronic equipment can create noise in a multitude of frequency ranges.

Local radio stations are a source of high frequency noise, while computers and other electronic equipment can create noise in all frequency ranges. Creating a completely noise-free environment for test and measurement is seldom practical. Fortunately, simple techniques such as using shielded/twisted pair wires, filtering, and differential voltage measurement are available for controlling the noise in our measurements. Some techniques prevent noise from entering the system; other techniques remove noise from the signal.

While many techniques for controlling noise in signals provide a means of removing the noise that is already present, the preferred solution is to prevent the occurrence of noise in the signal in the first place.

The following practices, some of which are required for CE compliance, should be employed to minimize noise.

- **Make a solid earth ground connection.** Ensure that the chassis of the primary data acquisition device, e.g., 640/650 Series device is connected to earth ground. This practice:
 - (a) keeps radiated emissions low by keeping the chassis electrically quiet,
 - (b) keeps potential common-mode voltages low,
 - (c) improves user safety, and
 - (d) provides a safe path for Electrostatic Discharge energy back to earth ground.
- **Use short Ethernet cables (for 640e and 650e).** The use of short Ethernet cables will reduce noise. The shorter the cable the better.
- **Use short USB cables (for 640u and 650u).** The use of short USB cables will reduce noise. The shorter the cable the better.
- **Use shielded cables.** Loose wires are effective antennae for radio frequency pickup and can form loops for inductive pickup. The use of properly connected shields will greatly reduce such noise.
- **Minimize ambient EMI.** The lower the ambient EMI, the better. Sources of electromagnetic interference include solenoids, motors, computer equipment, high power distribution wiring, etc.
- **Distance cables.** Power supply switch transients can vary in strength and frequency. Ethernet cables can radiate digital switching noise. For these reasons route the power supply and Ethernet cables such that they are as far as possible from analog input channel lines.

<i>Electrostatic Discharge (ESD), Handling Notice.....</i>	<i>9-1</i>
<i>Product Care</i>	<i>9-1</i>
<i>ReadMe Files, the Install CD-ROM, and Interim Releases</i>	<i>9-2</i>
<i>Ethernet Problems (640e and 650e only)</i>	<i>9-2</i>
General	9-2
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Electrostatic Discharge (ESD), Handling Notice



The discharge of static electricity can damage some electronic components. Semiconductor devices are especially susceptible to ESD damage. You should always handle components carefully, and you should never touch connector pins or circuit components unless you are following ESD guidelines in an appropriate ESD-controlled area. Such guidelines include the use of properly grounded mats and wrist straps, ESD bags and cartons, and related procedures.

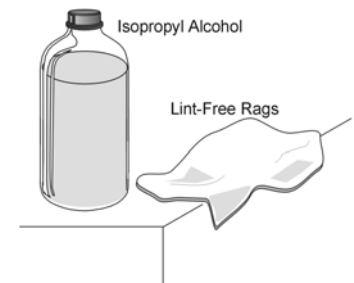
Product Care

IOtech 640 and 650 Series devices are essentially maintenance free and require a minimal amount of care. They should be treated much like other high-tech equipment. In general:

- The units should be operated in ventilated and relatively dust-free environments.
- Keep the units clear of harsh chemicals and abrasive elements.
- Avoid exposing the products to extreme heat, for example, avoid setting the units near boilers and furnaces.
- Avoid extreme shock and vibration.
- Avoid subjecting the units to liquids and extremely fine air particulate, such as silica dust.
- Never touch circuit boards without proper ESD (Electrostatic Discharge) measures in place.

A “common-sense” approach to handling acquisition components will go a long way in protecting them from inadvertent damage.

Note that you can use lint-free rags and Isopropyl Alcohol (Rubbing Alcohol) to clean the outer surfaces of the IOtech 640 or 650 Series device.



ReadMe Files, the Install CD-ROM, and Interim Releases

The Install CD-ROM includes ReadMe Files. These files often contain late-breaking information that may not appear in the user documentation. During installation you should review the ReadMe files when prompted to by the program.

The Install CD-ROM includes:

- Windows 2000/XP driver
- eZ-Analyst*
- eZ-TOMAS*
- eZ-Balance*
- eZ-NDT*
- Daq Configuration Control Panel Applet
- User documentation in Adobe® PDF format

*Each eZ software package requires an authorization code for installation. Authorization codes are supplied with the purchase of the associated software.

For 640e and 650e units, upon installation, the user needs to run the *Daq Configuration Control Panel* applet. The applet is used to configure IOtech 640e and 650e devices for Ethernet connection. This must be performed in order for the application to access the unit through the Windows 2000/XP driver.

Ethernet Problems (640e and 650e only)

General

- Make sure the Ethernet network is not experiencing technical problems. Check with your Network Administrator.
- Ensure that your system is properly configured in the Daq Configuration Applet [located in the Windows' Control Panel]. If a device is not configured correctly it will not be accessible from an application.
- Verify that the correct MAC (Media Access Control) number is reflected by the software.
- If communications cannot be established with the 640e or 650e, or if trying to connect causes the system to hang or crash, try the following:
 - Verify device power is on; verify the POWER LED is lit.
 - Ensure that all physical device interface connections are correct. This includes Ethernet connections from the 640e or 650e to the host PC's Ethernet jack or Ethernet Network hub.
 - Run the *Daq Configuration* applet from the Windows Control Panel. Make sure the device is configured to the appropriate Ethernet port with the appropriate protocol. Run the device test and if it fails try other protocols for the device. Be sure to click on **<Apply>** to apply the settings, before re-running the test.
- Try the following "ping" method (next section) to check the device connection.
- If problems persist, notify your Network Administrator. If he or she can't solve the problem, contact the factory.

Troubleshooting the Ethernet Connection using the “Ping” Method

1. Find the IP Address of the 640e or 650e, as applicable.

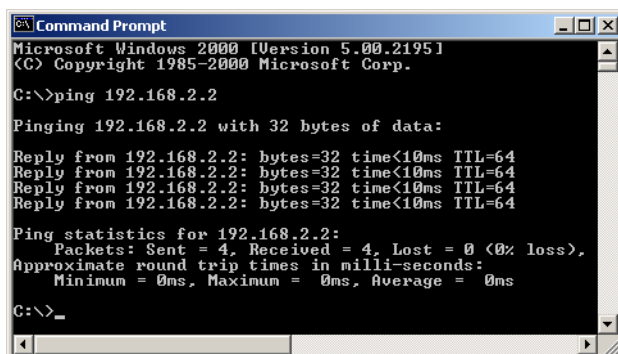
- Open the Control Panel by navigating as follows from the Windows Desktop:
Start Menu ⇒ Settings ⇒ Control Panel
- Double-click the Daq Configuration icon.
- Select the 640 or 650 device from the device tree.
- Click the Properties button.
- Make note of the IP Address displayed in the IP Address field.

2. Test the connection with the ping command.

- Open the Command Prompt by navigating as follows from the Windows Desktop:
Start Menu ⇒ Programs ⇒ Accessories ⇒ Command Prompt.
- Run **'ping x.x.x.x'** where x.x.x.x is the IP Address of the 640e or 650e.

If the ping command does not time out, the computer and device are communicating.

- Verify that your computer is running Windows NT, 2000, or XP.
- Verify the name of the device that your software is trying to open matches the device name that is configured in the Daq Configuration Applet.



```
Microsoft Windows 2000 [Version 5.00.2195]
(C) Copyright 1985-2000 Microsoft Corp.

C:\>ping 192.168.2.2

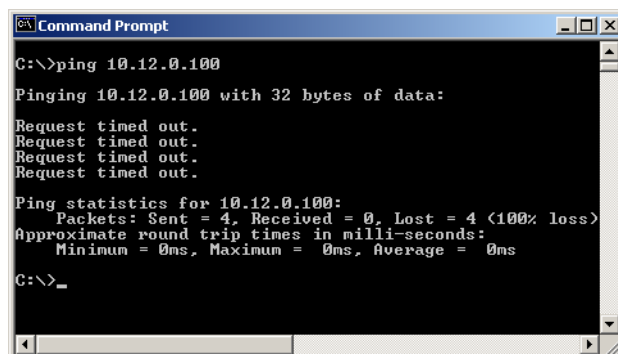
Pinging 192.168.2.2 with 32 bytes of data:

Reply from 192.168.2.2: bytes=32 time<10ms TTL=64
Reply from 192.168.2.2: bytes=32 time<10ms TTL=64
Reply from 192.168.2.2: bytes=32 time<10ms TTL=64
Reply from 192.168.2.2: bytes=32 time<10ms TTL=64

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>_
```

Did Not Time Out



```
C:\>ping 10.12.0.100

Pinging 10.12.0.100 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.12.0.100:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>_
```

Timed Out

Command Prompt, Ping Examples

If the ping command timed out and you are on a Dedicated Network, check the following:

- Verify that the 6-digit serial number of the 640e or 650e is correct in the Serial Number field of the Device Properties page. The device serial number is located on the bottom of the unit.
- Verify that the “Auto IP Setting” radio button is selected on the Device Properties page.
- Verify the IP settings of the computer using the **ipconfig** command (discussed shortly). The IP address should be 10.x.x.x with a subnet mask of 255.0.0.0.
- Verify that there is no DHCP server on the network (see the following “if” statement.)

If the ping command timed out and you are on a LAN with a DHCP Server, check the following:

1. Verify that the Manual IP Setting radio button is selected on the device properties page.
2. Verify the IP Address of the 640e or 650e with your system administrator. Verify the IP Address is entered correctly in the IP Address field of the device properties page.
3. Have your network administrator verify that your computer is configured properly to use the DHCP server. Your computer should be configured to automatically get an IP address from the DHCP server or configured with a static IP address that is compatible with other computers and devices on the network.
4. Verify the IP settings of the computer using the **ipconfig** command (see below).

Using the **ipconfig** Command to find the computer's TCP/IP Settings

You can use the ipconfig command to find the computer's TCP/IP Settings. This is done as follows:

1. Open the Command Prompt by navigating as follows from the Windows Desktop.
Start Menu ⇒ Programs ⇒ Accessories ⇒ Command Prompt.
2. Run '**ipconfig /all**' at the command prompt.
3. Make note of the IP address, subnet mask and DHCP enabled setting.

How to check for the existence of a DHCP Server

1. Open the Control Panel by navigating from the Windows Desktop as follows:
Start Menu ⇒ Settings ⇒ Control Panel.
2. Double-click Network and Dial-up Connections icon.
3. Double-click the Network Connection icon for the network that the 640e or 650e is connected to.
4. In the Local Area Connection Status box, click on the <Properties> button.
The Local Area Connection Properties box will appear.
5. Double-click the "Internet Protocol (TCP/IP)" component.
The Internet Protocol (TCP/IP) Properties box will appear.
6. Verify that the "Obtain an IP address automatically" radio button is selected.
7. Get the computer IP configuration settings using the **ipconfig** command.
8. Verify the DHCP Enabled value in the **ipconfig** output is set to "yes."
9. Check the output of the **ipconfig** command for **Lease Obtained** and **Lease Expired** lines. The presence of these lines indicates that there is a DHCP server on the network. If this is the case, notify your network administrator and follow the instructions in your network device documentation. The instructions should have a heading to the effect of: **Configuring a Device on a LAN with a DHCP Server.**

Customer Support

If you need to report problems or request product support . . .

Note: Please do not return any equipment to the factory unless it has an RMA number (Return Merchandise Authorization number). RMA numbers are issued by the factory.

To report problems or request support, contact our Applications Department. Contact information follows shortly. When you contact us, please have the following information available, as applicable:

- Hardware model numbers and software version numbers.
- Operating system, type of computer, and device information in the Windows control panel, such as interrupts and address settings for our hardware and others.
- Results of tests, such as the Daq Configuration control panel.
- Hardware setup and software configuration.
- Information on input signals, including voltage ranges, signal impedance ranges, noise content, and common mode voltages.
- The name of a contact person from your company who can discuss the problems encountered.
- Instructions for return shipping.
- All troubleshooting notes and comments on tests performed, and all problem-related conditions.

Note: Before calling for assistance, take a few minutes to read all parts of the manual that may be relevant to the problem. Also, please review the troubleshooting material.

You can reach IOtech by one of the following means:

Phone: **(440) 439-4091**

Fax: **(440) 439-4093**

E-mail Product Information/Sales: **sales@iotech.com**

E-mail Technical Support/Applications Department: **productsupport@iotech.com**

Internet: **<http://www.iotech.com>**

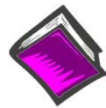
Mail: **IOtech, Inc. • 25971 Cannon Road • Cleveland, Ohio 44146-1833**

All equipment returned to the manufacturer must have an RMA (Return Material Authorization) number. You can obtain an RMA number from our Applications Department. When returning the equipment, use the original shipping container (or equivalent) to prevent damage. Put the RMA number on your shipping label to ensure that your shipment will be handled properly. After receiving your equipment, we will fax a confirmation form that summarizes the charges (if applicable) and expected return date.



eZ-Analyst	Real- Time Vibration & Acoustic Analysis Software 10-2
eZ-TOMAS	On-line Rotating Machine Monitoring and Analysis Software 10-3
eZ-TOMAS Remote*	Remote monitor and control application 10-3
eZ- Balance	Rotating Machine, Field Balancing Software 10-4
eZ-NDT **	Non-Destructive Test Software 10-5

This chapter offers a glimpse of the eZ software packages that can be used with an IOtech 600 series device, with exceptions as noted. The software is usually purchased when the hardware is ordered; but should your acquisition needs change, additional software packages can be ordered at a later time.



Reference Notes:

For detailed information regarding software, refer to one or more of the following as applicable.

- *eZ-Analyst User's Manual*
- *eZ-TOMAS and eZ-TOMAS Remote User's Manual*
- *eZ-Balance User's Manual*
- *eZ-NDT User's Manual***

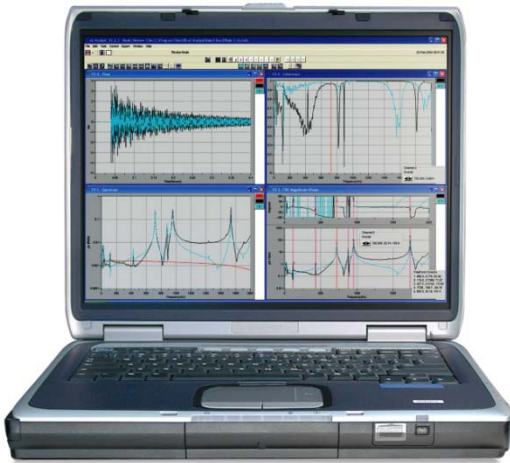
A PDF version of each is included on the installation CD and on our website.

* *eZ-TOMAS Remote* requires use of a licensed copy of *eZ-TOMAS*. For *eZ-TOMAS Remote* to operate, the version numbers of the two applications (*eZ-TOMAS* and *eZ-TOMAS Remote*) must match.

** *eZ-NDT* does not support IOtech 652u, 655u, or 672u.

eZ-Analyst

Real-Time Vibration & Acoustic Analysis Software



eZ-Analyst is the result of more than ten years of software development and customer input. This software adds real-time continuous and transient data acquisition to an IOtech 600 series system. Analysis can be in the time, frequency, or order domain.

eZ-Analyst is operated through a series of setup windows that display only the information deemed important to your test. Acquisition configuration involves selecting desired acquisition parameters from user-friendly menus.

Features

- Real-time FFT analysis
- Easy-to-use graphical user interface provides fast setup
- Large number of display options: Time Waveform, Spectrum, Auto Spectrum, FRF, Cross, PSD, Transfer Function, Coherence, Octave, and Waterfall
- Order Normalization and Order Tracked Plots
- Multiple Plot Overlays using exported data files
- Export to Excel, ME Scope, SMS Star, or UFF Type 58 ASCII or Binary
- Save/Recall display setups with multiple display windows and overlays
- Wide selection of real-time analysis features, including integration/differentiation averaging, and much more

eZ-TOMAS (On-Line Rotating Machine Monitoring & Analysis Software) and

eZ-TOMAS Remote (Remote monitor and control application)



eZ-TOMAS provides an economical means of continuously monitoring and analyzing rotating machinery. eZ-TOMAS records the change in vibration condition, and quickly provides information for making important operational decisions regarding the machine. You can display and analyze historical data while eZ-TOMAS continues to collect, monitor, and store data.

An IOtech 600 series system running with eZ-TOMAS can be easily moved from machine to machine with very short setup times. You can use the system to reduce downtime, improve data collection, troubleshoot, and recondition the machine.

eZ-TOMAS Remote is a software application that allows you to remotely monitor and/or control eZ-TOMAS applications through client/server architecture. The server, an eZ-TOMAS application, interacts with the hardware; and can be in a remote location. Each client (*eZ-TOMAS Remote*) communicates with eZ-TOMAS via TCP/IP.

Features

- Transient and Steady State rotating machinery analysis
- Easy-to-use graphical user interface and multiple project configurations provide fast setup
- Overall, spectral amplitude, and phase gauges with peak hold indicators
- Publish gauge data as OPC tags
- Spectral limit checking, with output relays and alarm event logging
- Limit sets for specific RPM ranges
- Event data storage based on user defined triggers, with automatic backup
- Rotating Machinery Analysis: Time Waveform, Orbit, Spectrum, Waterfall, Polar, Bode, Shaft Center Line, and Trend displays
- Machine and Bearing Fault analysis and limit checking
- Save/Recall display setups with multiple display windows and overlays
- Integration and differentiation for acceleration, velocity, and displacement inputs
- Harmonic, Sideband, and Peak cursors for time waveform and spectrum displays
- Statistical analysis report with automatic limit generation
- Generate production test cell reports
- Export data to Excel, UFF Type 58 Binary, or ASCII format
- Copy/Paste graphs and data into Microsoft applications
- Remotely monitor and/or control eZ-TOMAS with purchase of *eZ-TOMAS Remote*

eZ-Balance

Rotating Machine Balancing



An IOTech 600 series system using eZ-Balance provides a solution for multi-plane field balance applications of rotating machinery. eZ-Balance computes the optimal balance weights and their locations, based on vibration data collected from the analyzer. The data is displayed in a convenient Polar plot that indicates the magnitude and phase of the unbalance as well as time and spectrum data.

eZ-Balance determines a balance solution by calculating the change in vibration condition based on adding trial weights. The balance process is a series of well defined steps.

Accelerometers, velocity probes, or displacement probes may be used to measure the vibration level at each balance plane. A tachometer measures the rotation speed and provides a phase reference.

Features

- **Single, Multi-plane, and trim balancing**
- **Polar, time, and spectral displays**
- **Computes and stores influence coefficients for future trim balancing**
- **Vibration data can be acquired from the analyzer or entered manually**
- **Balancing toolkit**
 - Trial weight calculations
 - Weight splitting
 - Centrifugal force
 - Stock weights
 - Weight removed
 - Unbalance tolerance
- **Balance solution can be based on multiple response points**

eZ-NDT

Non-Destructive Test Software

Does not support 652u, 655u, or 672u



eZ-NDT (non-destructive test) uses resonance to identify part variations caused by process inconsistencies and defects. Using eZ-NDT with an IOTech 600 series device is a fast and inexpensive method for performing 100% inspection of production parts. Inspection parts include, but are not limited to: powder metal, ceramics, and composites.

An eZ-NDT system applies energy to target parts and analyzes the resonant frequencies. The system compares the results to the acoustic signature of a known-good part.

Testing a part takes less than one second and requires no special tooling, dyes, chemicals, cleaning, magnetization, or expensive and time consuming visual inspection equipment.

Features

- Provides inspection of metal, ceramic, and hard plastic parts
- Removes the ambiguity that is common in other inspection systems
- Requires no parts preparation, making the test fast and inexpensive
- Tests parts in less than 1 second
- Quantifies and documents the first natural frequency for end user comparison to final assembly resonant frequencies
- Time and Spectrum Display
- Easy-to-use graphical user interface provides fast setup
- Overlay good and bad baselines
- Investigation and Inspection Modes

Section 11.b, *Specifications, Data Plots*, contains a great deal of information in the form of plotted data. References to the plots appear throughout this section [11.a], as applicable.

General Specifications

Environment:

Operating Temperature
 640u and 650u: -40° to 60°C
 640e and 650e: 0° to 50°C
 Humidity: 0° to 95% RH, non-condensing
 Vibration: IEC 60068-2-64
 Shock: IEC 60068-2-27
 Emissions: EN61326, 89/366EEC
 Safety: EN61010
 Ingress: IP 40

Power Supply:

Maximum Power Draw:
 640e; 650e: 4.2W
 640u; 650u: 2.5W
 Required Supply Voltage:
 640e, 650e: 6.5 to 16 VDC
 640u, 650u: 6.0 to 16 VDC
 Supply Current:
 1 amp max
 Power Jack:
 Barrel Type: 5.5 mm O.D.; 2.5 mm I.D.



PC Communication:

640e; 650e: 10/100BaseT Ethernet
 640u; 650u: USB2.0

Dimensions: 5.6" W x 7.1" D x 1.5"H
 (142.2mm W x 180.3mm D x 38.1mm H)

Weight: 1.5 lbs. (675 g)

Warm-up: 10 minutes to rated specifications

Analog Specifications

Analog Measurements

ADC converter resolution: 24 bits
ADC converter type: Delta-sigma
Sample rates: up to 105,468 samples per second
Sample rate accuracy: ±50ppm
Channels:
 640e; 640u: 4 input channels
 650e; 650u: 5 input channels
Input connector: 1 BNC per channel

Input impedance from	640e / 640u	650e / 650u
High to ground	200kΩ 130 pF	800kΩ 120 pF
Low to ground	1kΩ	1kΩ
High to low	201kΩ	801kΩ

Input coupling: DC, AC, or AC + IEPE; software programmable per channel basis

High-pass filter (AC coupling cutoff):

640e; 640u: 1.0Hz

650e; 650u: 0.1Hz

[Figure II. Measurement High Pass Filter Response](#)

Input ranges:

640e; 640u: $\pm 10\text{V}$ peak

650e; 650u: $\pm 40\text{V}$ peak

Input protection: BNC Shell to BNC Center: $\pm 60\text{V}$ Max without damage
BNC Shell to Earth Ground: $\pm 5\text{V}$ Max without damage

Over-range indication: Software

Low-pass filter (software programmable per channel)

[Figure III. 640 Measurement Delay vs. Frequency DC Coupled](#)

[Figure IV. 640 Measurement Delay vs. Frequency AC Coupled](#)

[Figure V. 650 Measurement Delay vs. Frequency DC Coupled](#)

[Figure VI. 650 Measurement Delay vs. Frequency AC Coupled](#)

Type: Anti-Aliasing hardware 3-pole 360kHz, Software selectable FIR filter

[Figure VII. Measurement Antialiasing Filter Performance](#)

Any unwanted signals above 27MHz is lost in the noise floor of a 64k FFT.

Amplitude accuracy:

	640e / 640u	650e / 650u
AC at 1kHz	$\pm 0.07\text{dB}$ typ $\pm 0.12\text{dB}$ max	$\pm 0.1\text{dB}$ typ $\pm 0.15\text{dB}$ max
DC	$\pm (0.05\% \text{ of reading} + 2\text{mV})$	$\pm (0.2\% \text{ of reading} + 15\text{mV})$

Amplitude -3dB: $0.49 \times \text{sample rate}$

Amplitude flatness: $\pm 0.05 \text{ dB}$ typ $\pm 0.10\text{dB}$ max DC to 20kHz

[Figure X. Analog Measurement Flatness](#)

Total harmonic distortion: -100dB typical 1kHz, -97dB typical 10kHz

[Figure IX. Measurement THD+N](#)

SFDR including harmonics: 108dB typical DC to 50kHz

SFDR (@-60dB): 128dB typical DC to 50kHz

[Figure XI. 640 SFDR Full-Scale is +20dBV; Input is -40dBV](#)

[Figure XII. 650 SFDR Full-Scale is +29dBV; Input is -30dBV](#)

Channel-to-channel crosstalk: $< -100\text{dB}$ at 1kHz

[Figure XIII. 640 Channel-to-Channel Cross Talk](#)

[Figure XIV. 650 Channel-to-Channel Cross Talk](#)

Channel-to-channel phase matching:

640e; 640u: $< 0.04^\circ / \text{kHz} + 0.08^\circ$

650e; 650u: $< 0.06^\circ / \text{kHz} + 0.1^\circ$

[Figure XV. 640 Phase-Matching vs. Frequency, AC-Coupled](#)

[Figure XVI. 650 Phase-Matching vs. Frequency, AC-Coupled](#)

Common mode rejection ratio:

640e; 640u: -70dB typ; -55dB max, at 1kHz

650e; 650u: -56dB typ; -41dB max, at 1kHz

[Figure XVII. 640 CMRR](#)[Figure XVIII. 650 CMRR](#)**Wideband noise:**

Analysis Frequency (Hz)	Typical Noise ($\mu\text{V rms}$)	
	640e, 640u ¹	650e, 650u ²
20	2.4	11
50	3.5	15
100	4.6	20
200	6.2	26
500	9.0	37
1000	12.0	48
2000	16.0	62
5000	23.3	89
10000	31.1	116
20000	41.4	151
40000	55.1	197

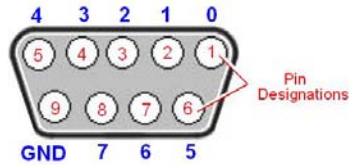
¹640e, 640u: maximum noise @ $\leq 50^\circ\text{C}$ = 1.4x; @ $> 50^\circ\text{C}$ = 1.6x (where x is the typical value given in the above table).²650e, 650u: maximum noise @ $\leq 50^\circ\text{C}$ = 1.4x; @ $> 50^\circ\text{C}$ = 2.1x (where x is the typical value given in the above table).**IEPE bias source (640e, 640u, 650e, 650u channels 1 to 4):**

Current: 2.1mA, 22V compliance (on/off software programmable per channel)

Impedance: $>255\text{k}\Omega$ **IEPE fault detection thresholds:** $<1\text{V}$ (short), $>20\text{V}$ (open)**IEPE fault indication:** Software indicator, per channel**Analog Output (640e / 640u only)****Channels:** 1**Signal connection:** BNC**Frequency range:** DC to 45kHz (-3.0dB)**Frequency accuracy:** $\pm 50\text{ppm}$ **DAC resolution:** 24 bit**DAC Update Rate:** 93.75 KSps**DAC type:** Delta-sigma**Total Harmonic Distortion:** 1kHz; -96dB typical**Total Harmonic Distortion + Noise:** 1kHz; -87dB typical**Initial Powered Up Value:** 0.0V for 640e; not guaranteed for 640u**Amplitude settings:** 0 to 7Vp-p**Amplitude flatness (DC to 20kHz):** $\pm 0.02\text{dB}$ typ $\pm 0.1\text{dB}$ max[Figure XIX. 640 Analog Out Flatness vs. Frequency](#)**Amplitude accuracy at 1kHz:** $\pm 0.05\text{dB}$ typ $\pm 0.12\text{dB}$ max[Figure XX. 640 Analog Output Distortion](#)**SNR (DC to 20kHz):** 100dB typ 90dB max**Maximum load:** 1k Ω (50 Ω with external power)**Waveform modes:** Sine; Swept sine; Random; Burst; and Arbitrary**Output impedance:** 50 Ω **Tachometer Inputs**

Any analog input channel may be used as a tachometer input.

Digital I/O Lines **Note:** To make use of Digital I/O, eZ-TOMAS or eZ-NDT software must be running in the host PC.



DB9 – As viewed from the rear panel. Outer numbers are digital channels. Inner numbers are pin designations.

Channels: 8 Digital I/O, programmable as inputs or outputs on a line by line basis

Ports: 1 x 8-bit, Each bit is programmable as input or output

Power-up mode: Inputs pulled low

Connector: DB-9 female (*figure*)

Input Scanning Modes: 2 programmable scanning modes Asynchronous, under program control at any time relative to Analog scanning; Synchronous with Analog scanning

Input Protection: -0.6V and +5.6V

Input Levels:

Low: 0 to +0.8V

High: +2.0V to +5.0V

Input pull-down resistor: 10k Ω

Output voltage range: 0 to +3.3V, may be pulled up to +5V

Output resistance: 100 Ω

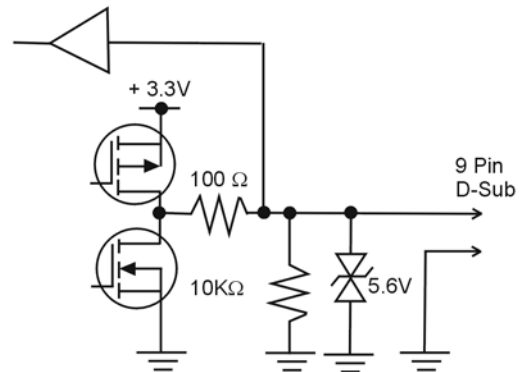
Output Levels:

Low: < 0.8V

High: >3.0V with no load

Sampling:

105,468Hz, maximum



Input / Output Circuit

Note: A Digital I/O example is located in section 11.b.

See [Figure XXI. Digital I/O I-V Curve](#)

Output timing: Outputs are always written asynchronously.

Figures Included in this Section

Figure	Description
I.	-- removed --
II.	Measurement High Pass Filter Response 2
III.	640 Measurement Delay vs. Frequency, DC-Coupled 3
IV.	640 Measurement Delay vs. Frequency, AC-Coupled 3
V.	650 Measurement Delay vs. Frequency, DC-Coupled 4
VI.	650 Measurement Delay vs. Frequency, AC-Coupled 4
VII.	Measurement Antialiasing Filter Performance 5
VIII.	640u High Frequency Artifacts 5
IX.	Measurement THD+N 6
X.	Analog Measurement Flatness 6
XI.	640 SFDR Full-Scale is +20dBV; Input is -40dBV 7
XII.	650 SFDR Full-Scale is +29dBV; Input is -30dBV 7
XIII.	640 Channel-to-Channel Crosstalk 8
XIV.	650 Channel-to-Channel Crosstalk 8
XV.	640 Phase-Matching vs. Frequency, AC-Coupled 9
XVI.	650 Phase-Matching vs. Frequency, AC-Coupled 9
XVII.	640 CMRR 10
XVIII.	650 CMRR 10
XIX.	640 Analog Out Flatness vs. Frequency 11
XX.	640 Analog Output Distortion 11
XXI.	Digital I/O I-V Curve 12

Figure I. *Not applicable. Figure I has been removed.*

Figure II. Measurement High Pass Filter Response

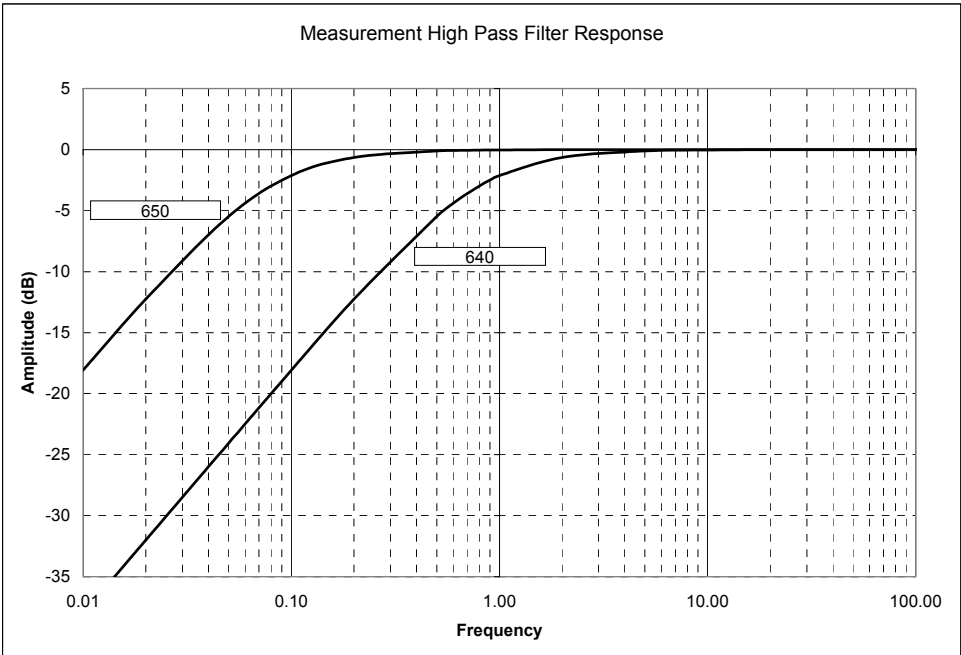


Figure III. 640 Measurement Delay vs. Frequency, DC-Coupled

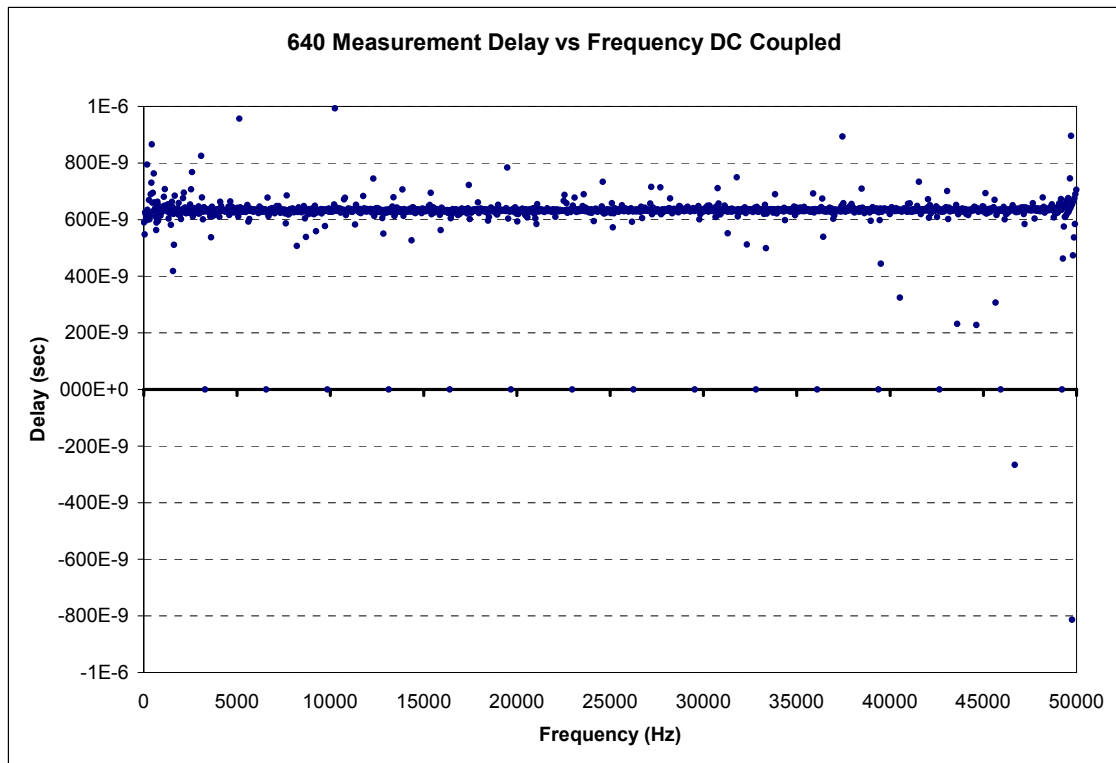


Figure IV. 640 Measurement Delay vs. Frequency, AC-Coupled

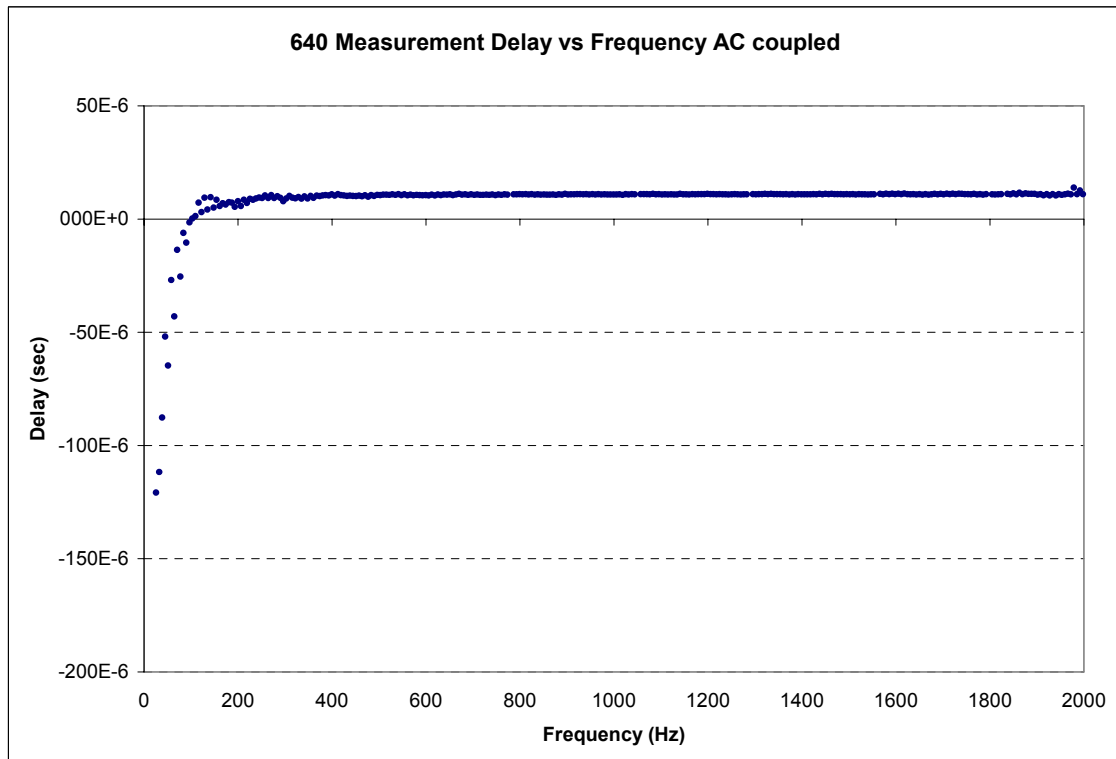


Figure V. 650 Measurement Delay vs. Frequency, DC-Coupled

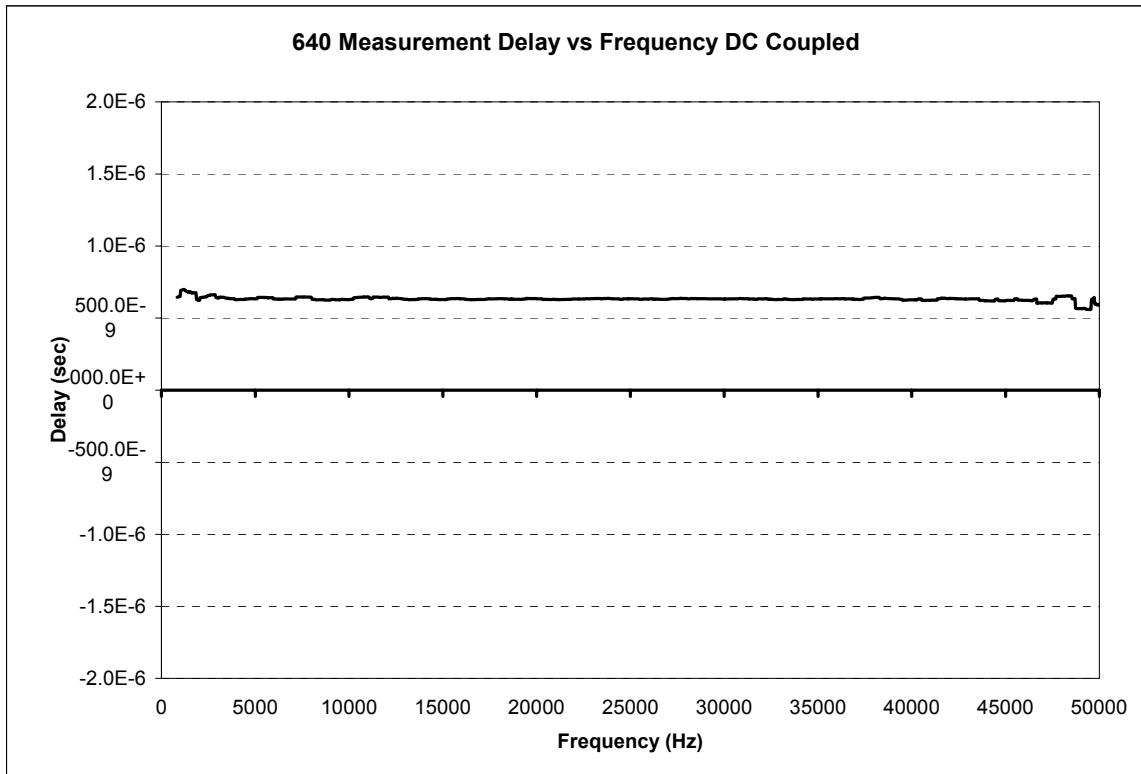


Figure VI. 650 Measurement Delay vs. Frequency, AC-Coupled

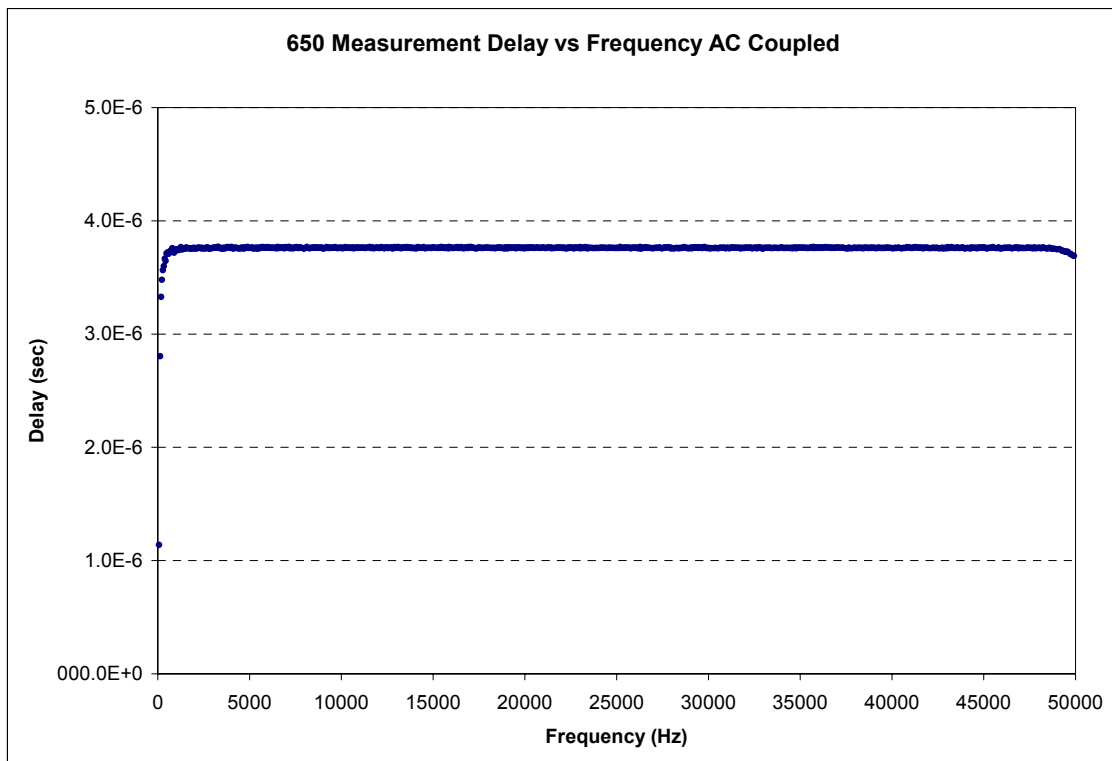


Figure VII. Measurement Antialiasing Filter Performance

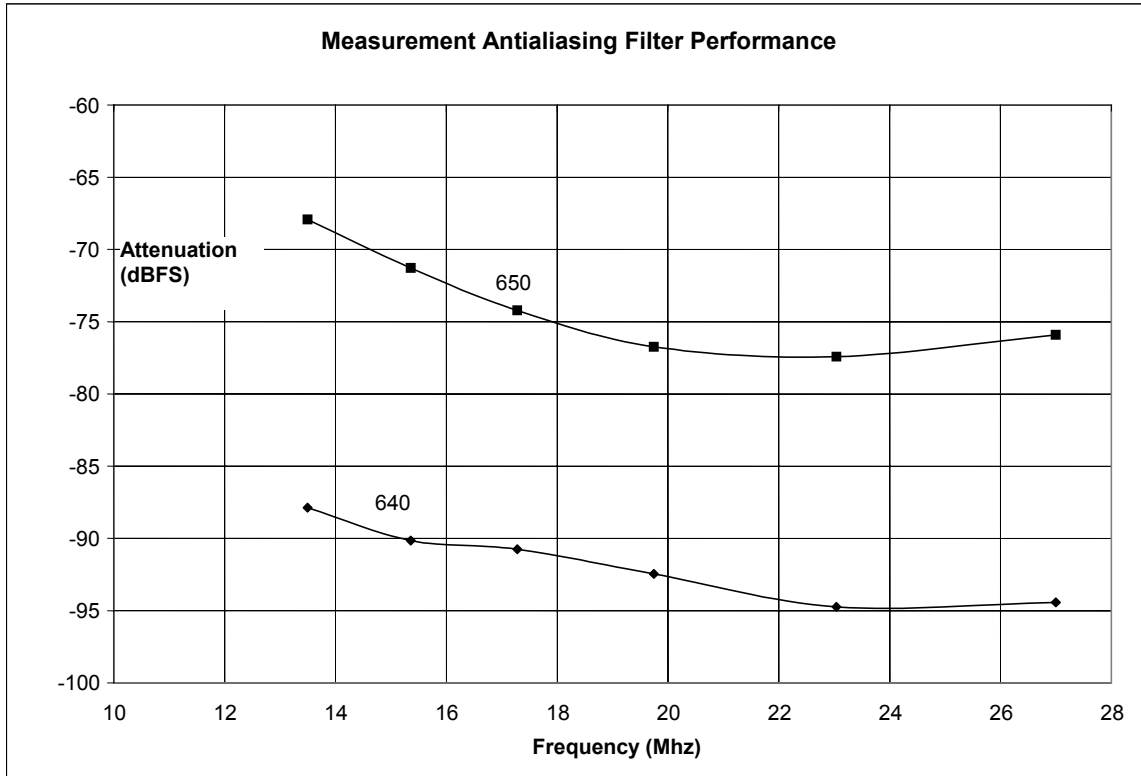


Figure VIII. 640u High Frequency Artifacts

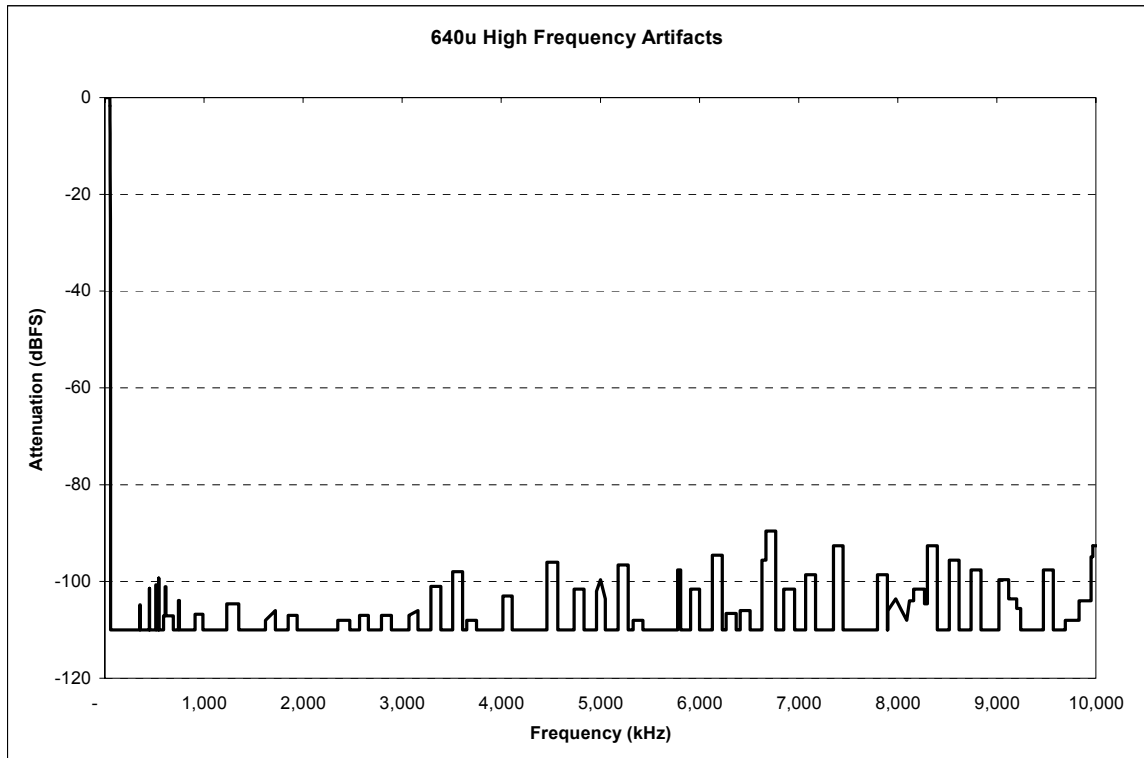


Figure IX. Measurement THD+N

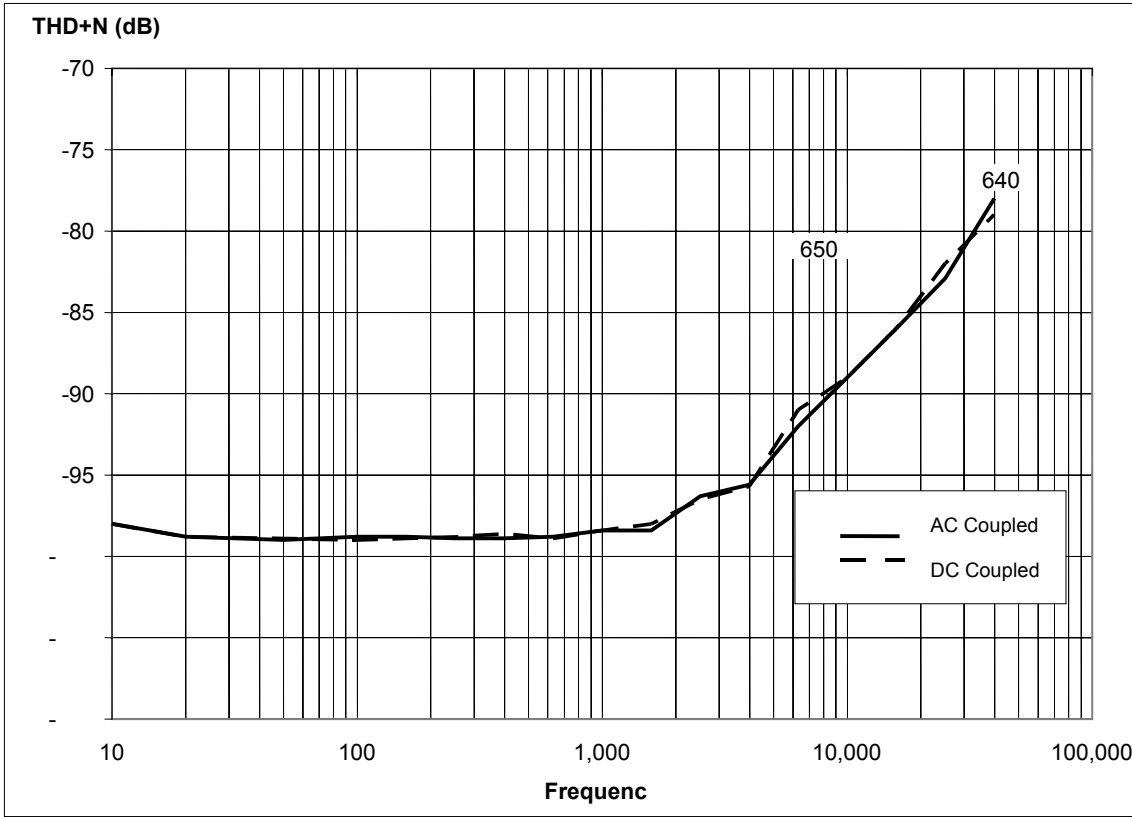


Figure X. Analog Measurement Flatness

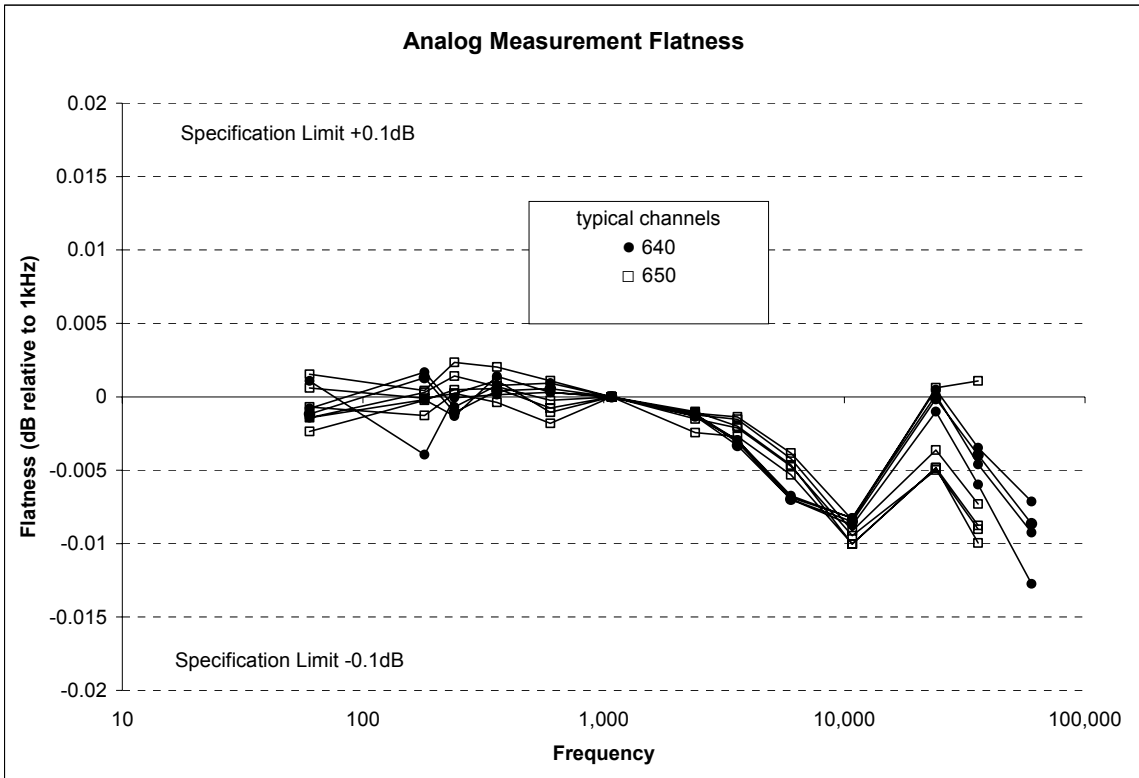


Figure XI. 640 SFDR Full-Scale is +20dBV; Input is -40dBV

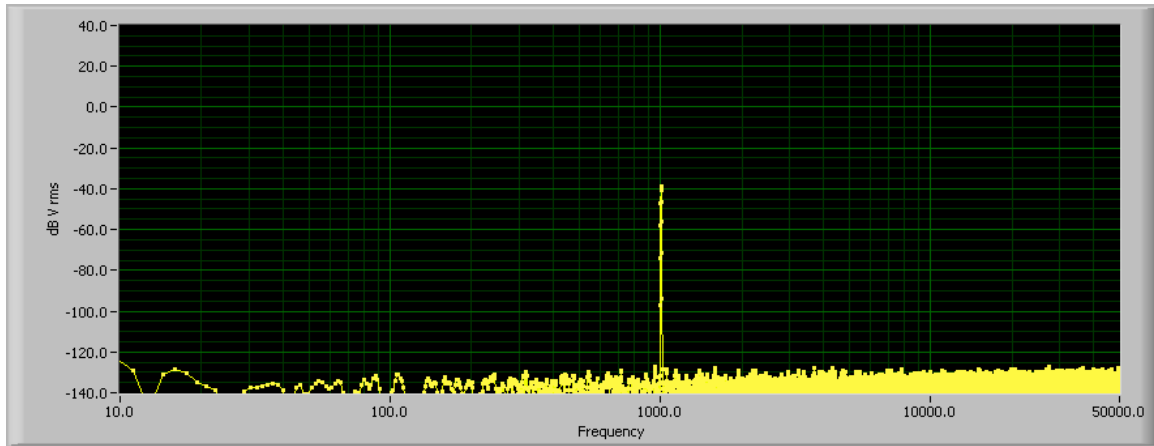


Figure XII. 650 SFDR Full-Scale is +29dBV; Input is -30dBV

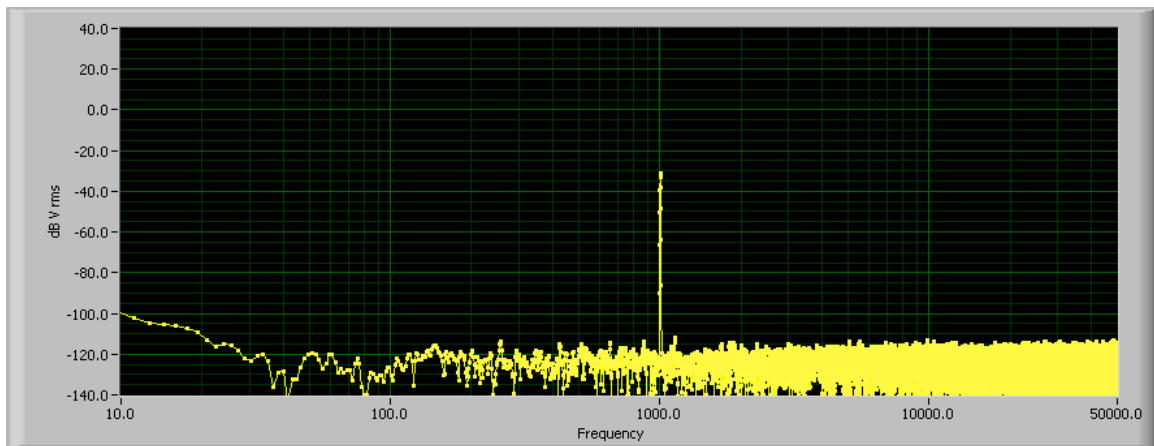


Figure XIII. 640 Channel-to-Channel Crosstalk

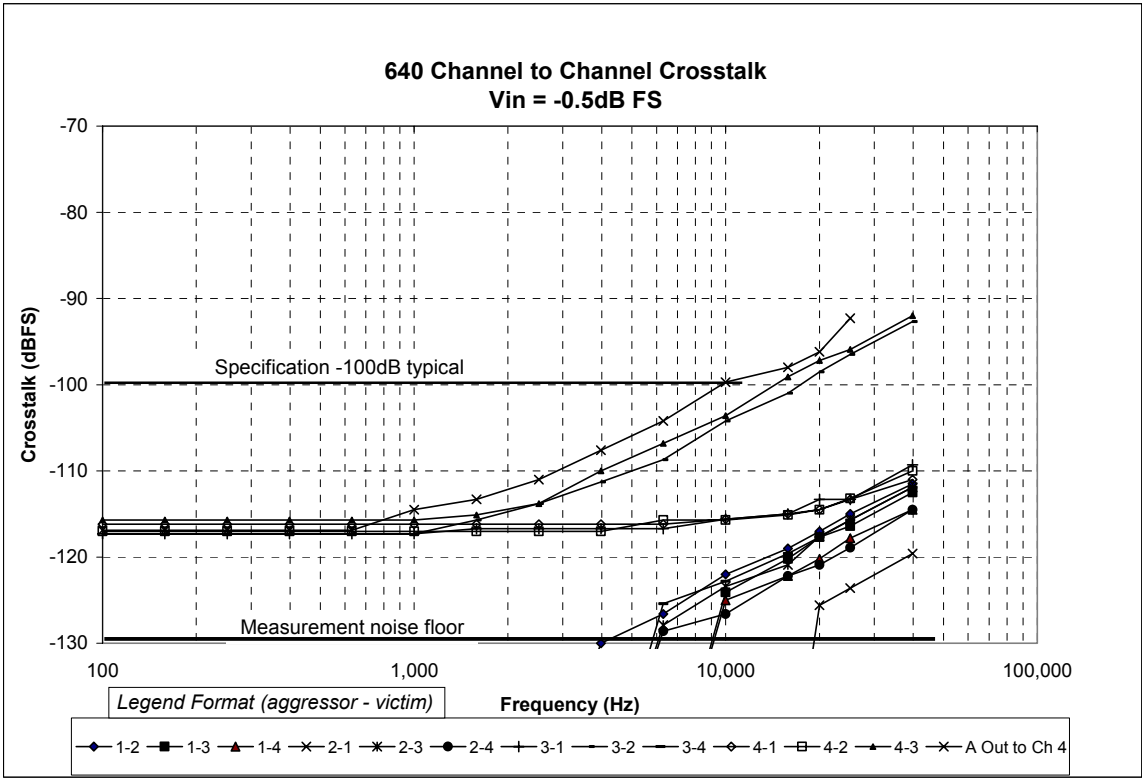


Figure XIV. 650 Channel-to-Channel Crosstalk

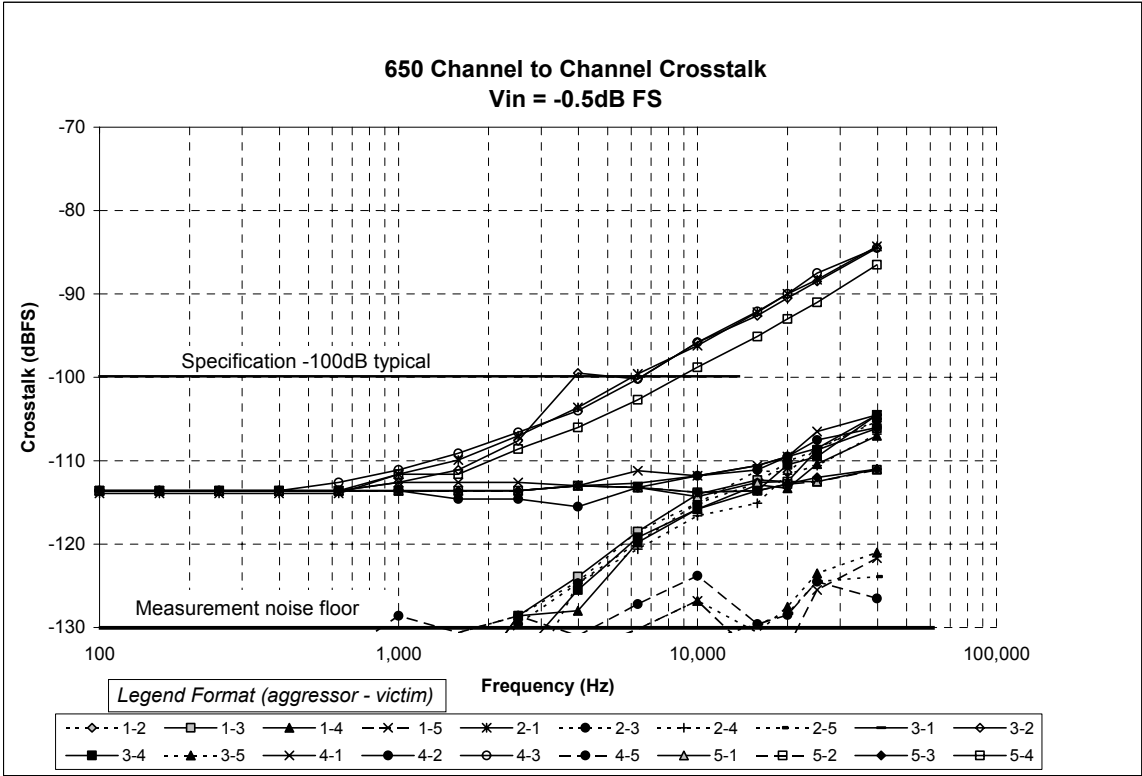


Figure XV. 640 Phase-Matching vs. Frequency, AC-Coupled

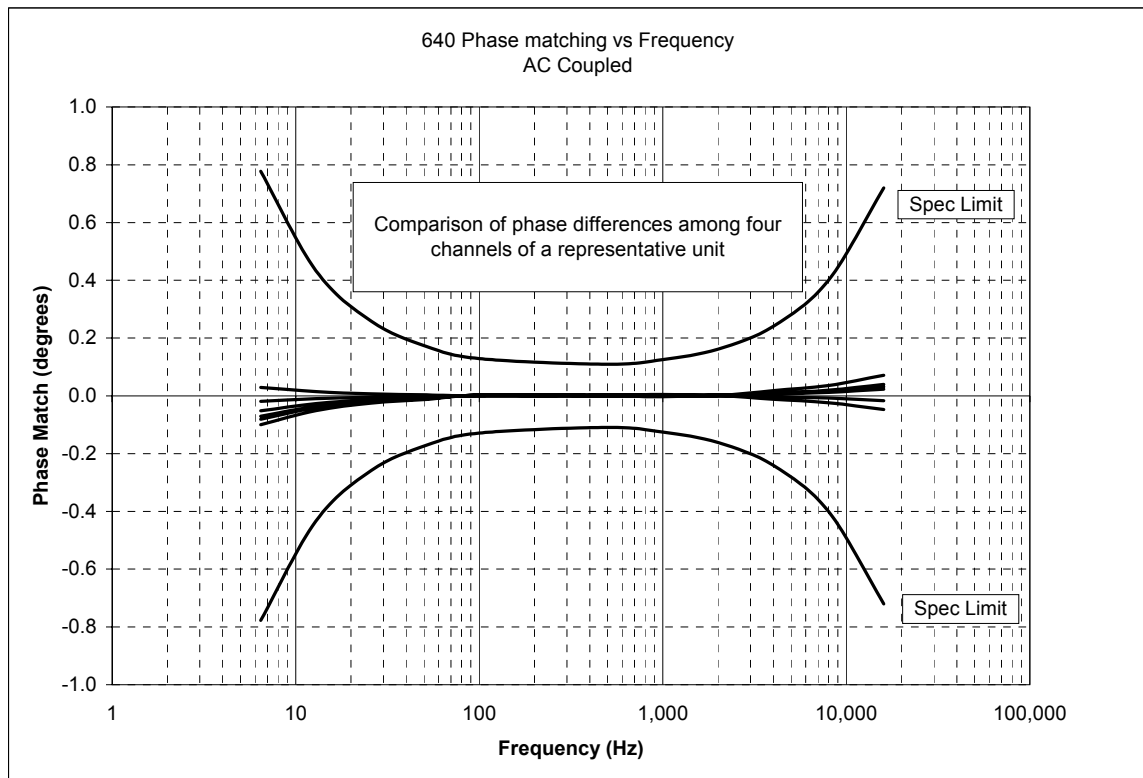


Figure XVI. 650 Phase-Matching vs. Frequency, AC-Coupled

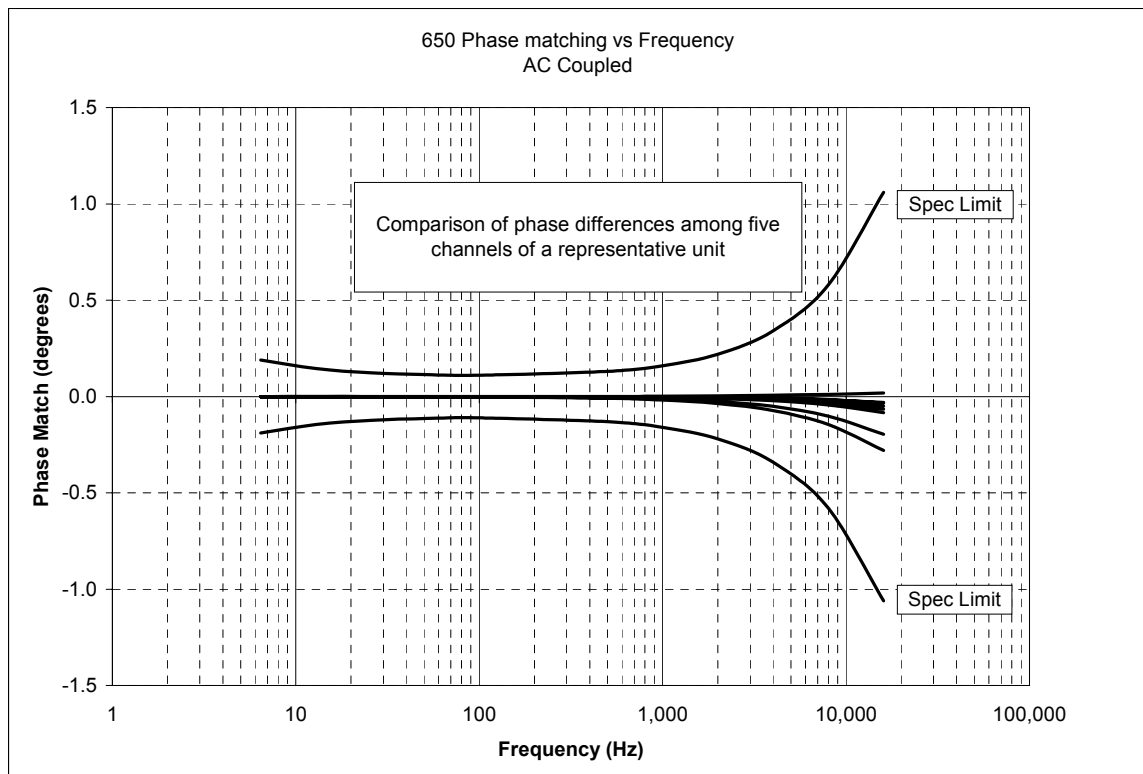


Figure XVII. 640 CMRR

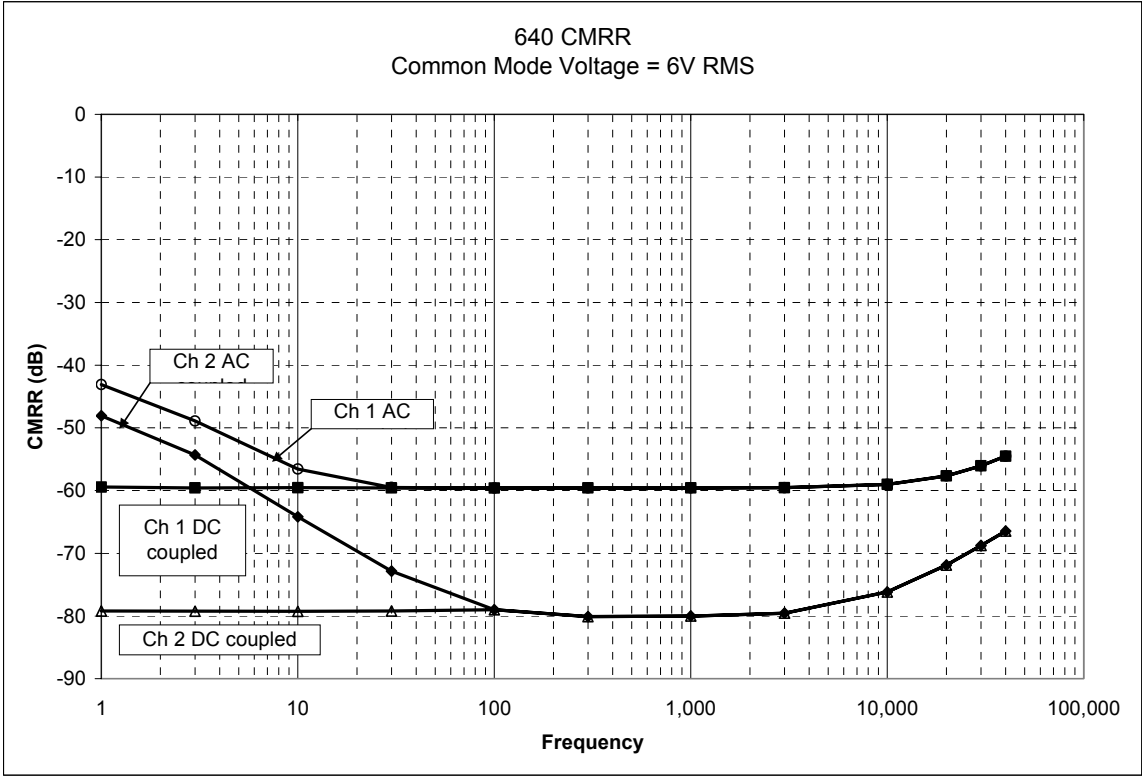


Figure XVIII. 650 CMRR

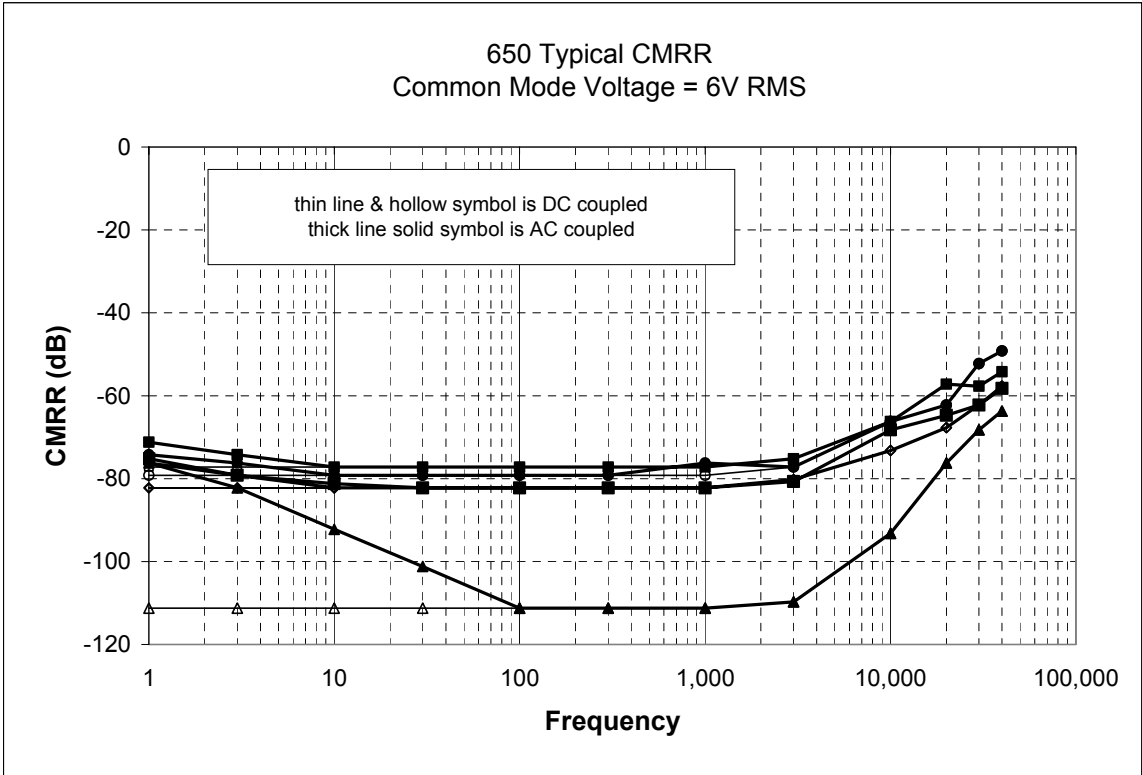


Figure XIX. 640 Analog Out Flatness vs. Frequency

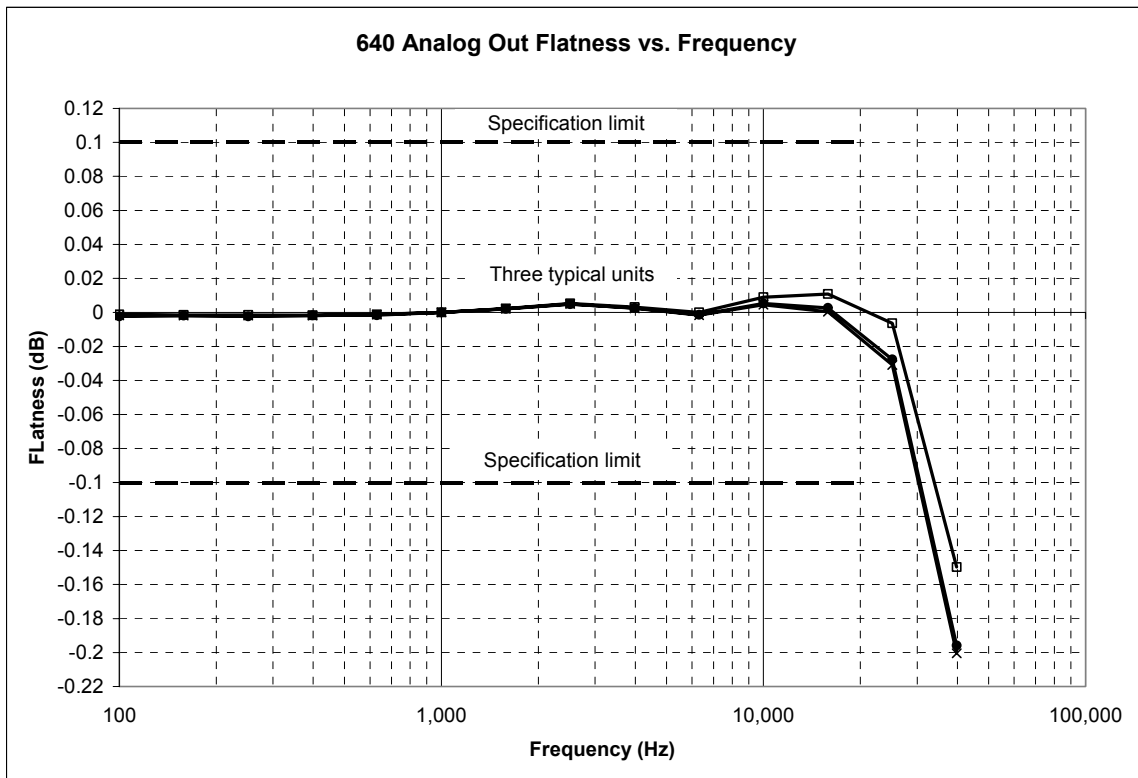


Figure XX. 640 Analog Output Distortion

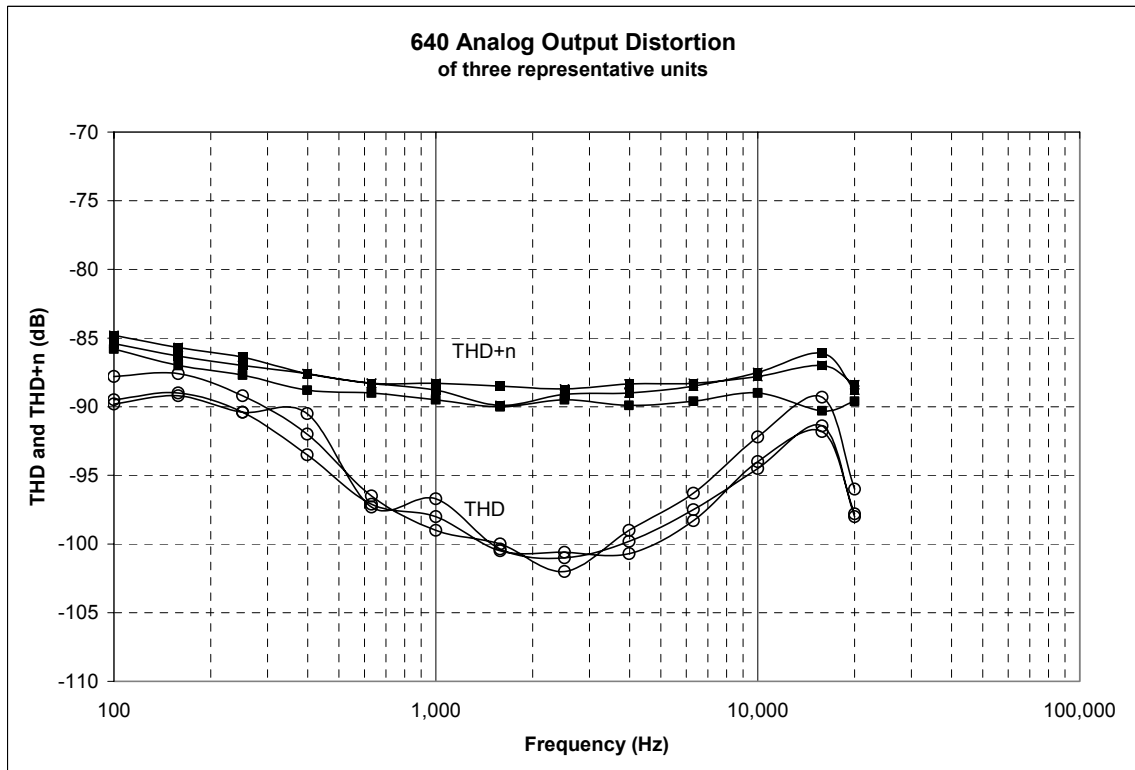
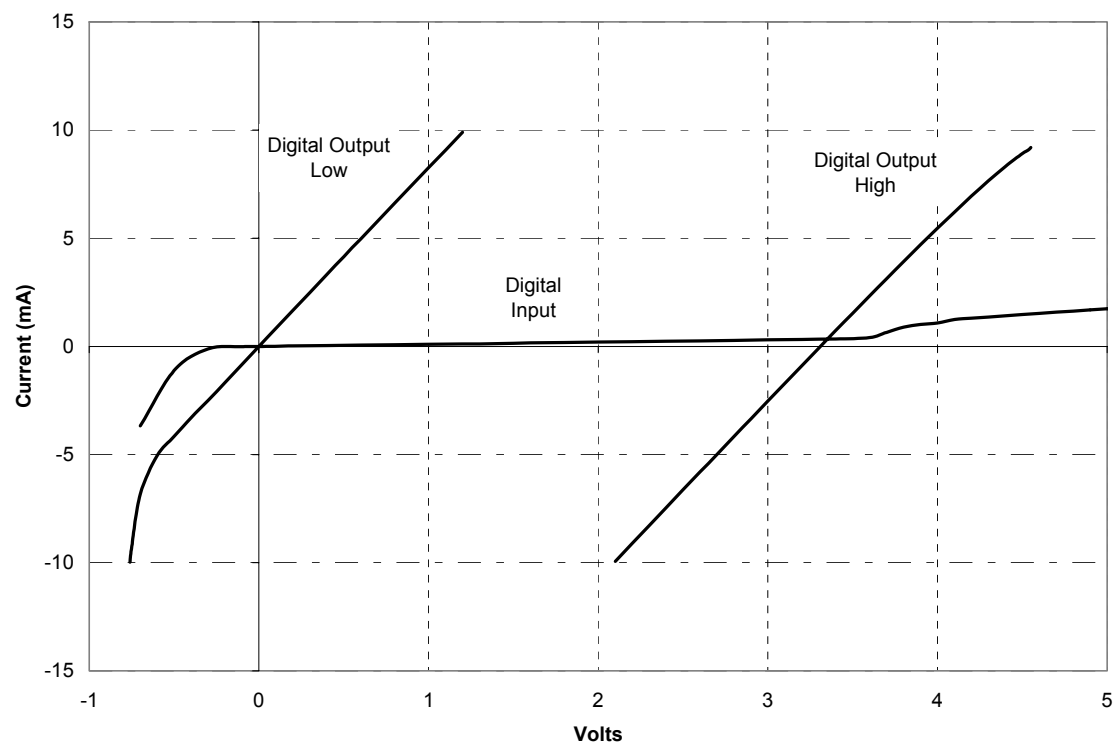


Figure XXI. Digital I/O I-V Curve



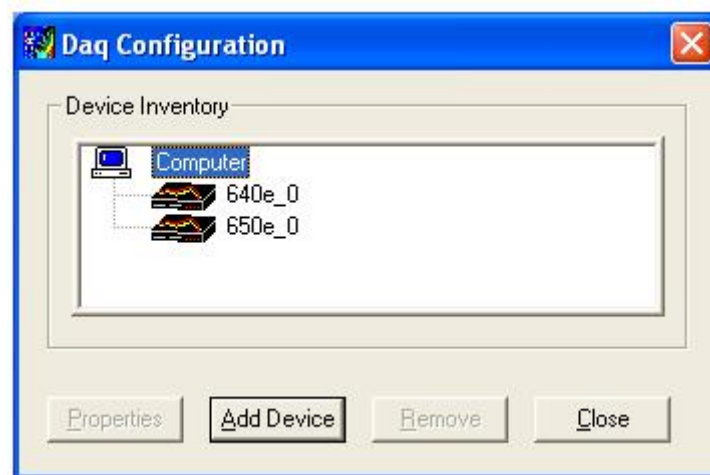
The *Daq Configuration* applet, designed for 32-bit Windows NT/2000/XP systems, is located in the Windows *Control Panel*. It allows you to add or remove a device and change configuration settings. The included test utility provides feedback on the validity of current configuration settings, as well as performance summaries.

To open the Daq Configuration Applet, navigate from the Windows' Desktop as follows:
Start Menu ⇒ Settings ⇒ Control Panel; then, from the Control Panel, double-click the *Daq Configuration* icon.

Device Inventory Dialog Box

After double-clicking on the *Daq Configuration* icon in the Windows *Control Panel*, the *Device Inventory* dialog box will open. The box displays all currently configured devices. Displayed devices show their name and an associated device icon, which identifies the device type.

Note: If no devices are configured, no devices will appear in the Device Inventory field.



Daq Configuration - Device Inventory Dialog Box

The four buttons across the bottom of the dialog box are used as follows:

- **Properties:** Current configuration settings for a device can be changed by first bringing up the corresponding *Properties* dialog box. Open the *Properties* dialog box by double-clicking on the device icon or selecting the device and then clicking on the <Properties> button.
- **Add Device:** The <Add Device> button is used to add a device configuration whenever a new device is added to the system. Failure to perform this step will prevent applications from properly accessing the device. Clicking on the <Add Device> button will open the *Select Device Type* dialog box.
- **Remove:** The <Remove> button is used to remove a device from the configuration. A device may be removed if it is no longer installed, or if the device configuration no longer applies.

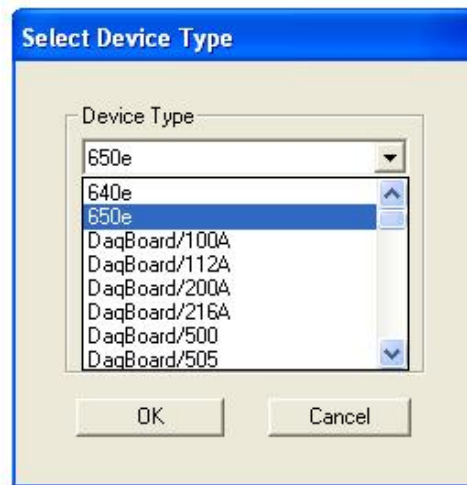
Note: If a device is removed, applications may no longer access the device. However, the device can be re-configured at any time using the *Add Device* function described above.

- **Close:** The <Close> button may be used at any time to exit the *Daq Configuration* applet.

The “Select Device Type” Dialog Box

This dialog box opens when the <Add Device> button of the *Device Inventory* dialog box is clicked. The box contains a pull-down list.

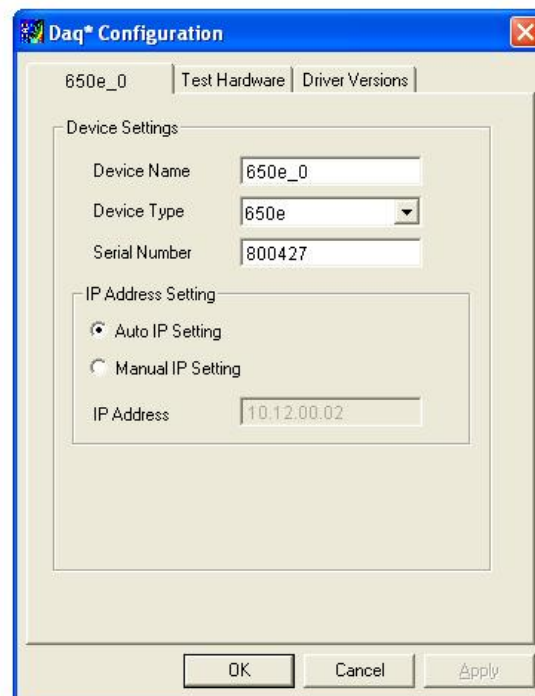
The device type you select for configuring will appear in the main edit box. Clicking on the <OK> button will then open the *Properties Dialog Box*.



*Daq Configuration
Select Device Type Dialog Box*

Properties Dialog Box

This dialog box opens when the <Properties> button of the *Device Inventory* dialog box is clicked, or when the <OK> button of the *Select Device Type* dialog box is selected. It displays the properties for the 640/650 device with the default configuration settings.



Daq Configuration - Properties Dialog Box

The following descriptions apply to the preceding figure.

- **Device Name:** The *Device Name* field is displayed with the default device name. The field can be changed to any descriptive name. This device name is the name to be used with the **daqOpen** function to open the device.
- **Device Type:** The *Device Type* field indicates the device type that was initially selected. However, it can be changed here if necessary.
- **Serial Number:** The device serial number is used in the Auto IP Address Setting process.
- **IP Address Setting Panel:** From this panel the user can select one of two radio buttons. The first is **Auto IP Setting**. If selected, the software will automatically derive the Internet Protocol Address. To do so, the serial number of the device must be entered in the Serial Number field. The resulting IP address will appear in the IP Address text box.

The second radio button is labeled **Manual IP Setting**. This feature can be used when the IP address is already known. When the “manual” radio button is selected the desired address can be entered into the text field.

- **OK:** Click on the <OK> button to store the configuration and exit the current dialog box.
- **Cancel:** Click on the <Cancel> button to exit the current dialog box without storing any changes.
- **Apply:** Click on the <Apply> button to store the configuration. Or you can click on the *Test Hardware* tab.

Quick Guide to Using the Daq Configuration Applet

To Open the Daq Configuration Applet:

- a. Open the Control Panel by navigating from the Windows Desktop as follows:
Start Menu ⇒ Settings ⇒ Control Panel
- b. Double-click the Daq Configuration icon.

To Add a 640/650 unit to the list of installed devices:

- a. Select the Computer in the device tree.
- b. Click the <Add Device> button.
- c. Select the **640** or **650** from the list of devices, as applicable.
- d. Click the <OK> button.

Note: The following pertains to 640e or 650e configuration. Before starting, be aware that the devices will have default names, for example, 640e_0. If desired, you can change the device name.

To set the properties of a 640e or 650e connected to a dedicated network:

- a. Enter the serial number of the 640e/650e.
- b. Select the Auto IP Setting Radio button. The IP address of the 640e or 650e will be calculated automatically and be displayed in the IP Address field.

To set the properties of a 640e or 650e on a LAN with DHCP server:

- a. Enter the base 10 version of the serial number of the 640e or 650e. The number is located on the MAC label on the bottom of the unit.
- b. Get the IP address of the device from your network administrator. The network administrator will need the unit powered-on and connected to the network. The administrator will also need the MAC address label's hexadecimal number (the label's bottom number).
- c. Select the "Manual IP Setting" radio button.
- d. In the IP Address field, enter the IP address obtained from your network administrator.

To test the connection:

- a. Click the "Test Hardware" tab.
- b. Click the <**Resource Test**> button.
- c. Perform a TCP/IP test per Appendix B.

Before you run a test

Before testing the system, make sure the device has been properly installed and powered-on. Make sure all cables are properly and securely connected.



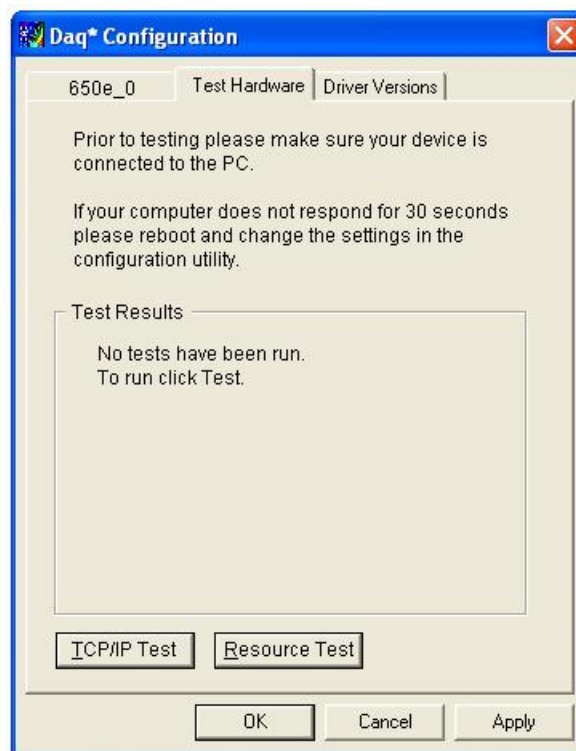
When testing a 640 or 650 Series device, if the unit does not respond within 30 seconds perform the following steps:

- 1) reboot the system
- 2) upon power-up, re-open the *Daq* Configuration* applet
- 3) select another configuration setting
- 4) reinitiate the test

How to run the TCP/IP Test (The TCP/IP test is for Ethernet devices only)

The TCP/IP (Transmission Control Protocol/Internet Protocol) test is for Ethernet devices only. The test is accessed and initiated as follows.

- a. Open the Control Panel by navigating from the Windows' Desktop as follows:
Start Menu ⇒ Settings ⇒ Control Panel
- b. From the Control Panel, double-click the *Daq Configuration* icon.
- c. Double-click on the 640e or 650e from the Device Inventory configuration tree.
- d. Click the “**Test Hardware**” tab.
- e. Click the <**TCP/IP Test**> button.



The Test Hardware Tab

What does the TCP/IP test tell me?

The TCP/IP test provides test results for “Pinging Device” and “TCP Connection Test.”

Pinging Device. The Pinging Device test is an ICMP (Internet Control Message Protocol) ping test. In addition to indicating either “Passed” or “Failed,” the test displays;

- (a) The round-trip time of the ping, for example, <10 ms.
- (b) Packet Loss expressed as a percent of data lost.

A long ping round trip time, for example, >50 ms and/or any packet loss indicates a slow network that is not optimized.

If the Pinging Device Test *fails* a <Details> button will appear just above the <Resource Test> button. If this is the case, click the <Details> button to obtain possible causes and possible solutions.

TCP (Transmission Control Protocol) Connection Test. The result of the TCP test will be either *passed* or *failed*. If the TCP test *failed* a <Details> button will appear just above the <Resource Test> button. If this is the case, click the <Details> button to obtain possible causes and possible solutions.

How to run the Resource Tests

For Ethernet devices, such as 640e and 650e, you can run the Resource Test after a successful completion of the TCP/IP test with a simple click of the <Resource Test> button.

What does the Resource Test tell me?

The Resource Test includes two categories of test, *Resource Tests* and *Performance Tests*.

Resource Tests. The resource tests are intended to test system capability for the current device configuration. Resource tests are *pass/fail*. Test failure may indicate a lack of availability of the resource, or a possible resource conflict.

Base Address Test – This resource test checks the base address for the selected port. Failure of this test may indicate that the port is not properly configured within the system. See relevant operating system and computer manufacturer’s documentation to correct the problem.

Interrupt Level Test – Tests the ability of an Ethernet port to generate interrupts. Failure of this test may indicate that the Ethernet port may be currently unable to generate the necessary hardware interrupt, while other Ethernet devices may work OK in this mode. Some devices (such as printers) do not require interrupts to work properly. See relevant operating system and computer manufacturer’s documentation to correct the problem.

Performance Tests. These types of tests are intended to check various device functions, using the current device configuration. Performance tests provide quantitative results for each supported functional group.

Test results represent maximum rates the various operations can be performed and vary according to port hardware capabilities.

The ADC FIFO Input Speed part of the test results in a display of the maximum rate at which data can be transferred from the tested device’s internal ADC FIFO to computer memory through the Ethernet. Results are given in samples/second, where a sample (3 bytes in length) represents a single A/D value.



Reference Notes:

- If you experience difficulties, please consult additional user documentation, as applicable, before calling technical support. User documentation is included on your data acquisition CD, and is installed automatically as a part of product support when your software is installed. The default location is the Programs Group.
- Documents can be read directly from the data acquisition CD via the <View PDFs> button located on the CD’s opening screen.

Smart Sensors

Certain types of transducers are classified as smart sensors. They contain a Smart Transducer Interface Module (STIM), which in turn, contains an onboard EEPROM memory IC, called TEDS, Transducer Electronic Data Sheet. (See Figure C.01.) The TEDS electronically stores information regarding the transducer's characteristics and parameters such as type of device, manufacturer, model number, serial number, calibration date, sensitivity, reference frequency, and other data. The TEDS also stores the calibration coefficients and frequency response for a transducer in terms of a table or an algorithm.

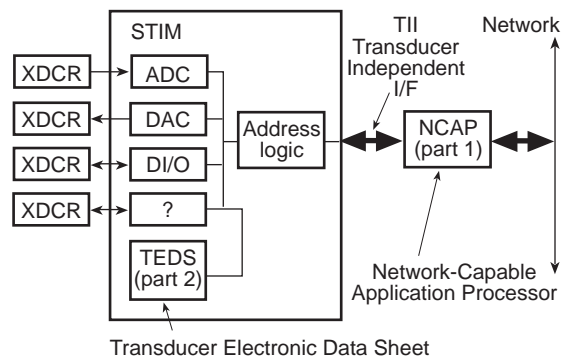


Fig. C.01. Three principal parts comprise smart sensor systems: the Smart Transducer Interface Module STIM, the Transducer Electronic Data Sheet TEDS, and the Network-Capable Application Processor NCAP.

Not all sensor manufacturers provide this feature, but those that do are encouraged to follow an evolving standard, IEEE 1451.0. One part of the standard, 1451.4, defines the TEDS format, channel identification formats, electrical interface, and read and write functions for accessing the TEDS and transducer data. The specification also defines the data set, that is, the number of samples acquired for one command that varies from 0 to 65,535 samples per set.

The standard does not specify requirements for signal conditioning, signal conversion, or how applications can use the TEDS data. However, the signal conditioners and other interface hardware used with these smart sensors must provide for an option or include circuits for TEDS communications under the direction of a software module specifically intended for this purpose. Another special module that works with TEDS is usually part of the data acquisition system's application software package that collects, stores, and displays the measured variables. The hardware automatically scales the readings and sets the range according to the data stored in the sensor. This is typically done for each TEDS-associated channel.

TEDS capability was originally intended for piezoelectric sensors such as accelerometers and pressure sensors, but it now includes all common analog sensors and actuators, such as MEMS (micro-electromechanical sensors), accelerometers, pressure transducers, and temperature sensors with two-wire and mixed-mode (analog and digital) input/output.

For two-wire analog sensors and actuators (called Class 1), the output signal is generally coupled to the signal conditioner or driver while the TEDS data are enabled and read out with a dc bias voltage applied to the same two wires. (See Figure C.02.) The transducers with mixed-mode capability (called Class 2) also communicate digitally with the TEDS memory. (See Figure C.03.) The analog part is the signal representing the measured variable, and the digital interface communicates with the embedded EEPROM. The TEDS architecture contains standard templates for common transducers, and custom sub-templates that manufacturers can use for defining special parameters and custom requirements.

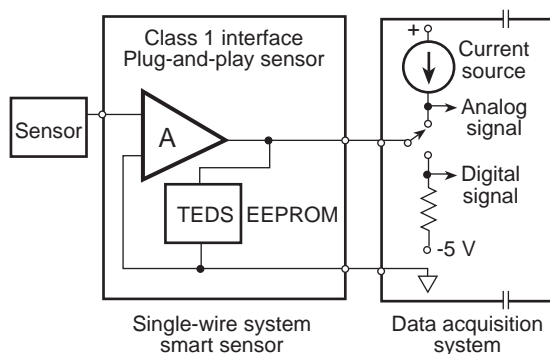


Fig. C.02. Class 1 sensors have only two leads that connect to the input of the STIM. The analog signal voltage and any required biasing voltage share the same pair of leads.

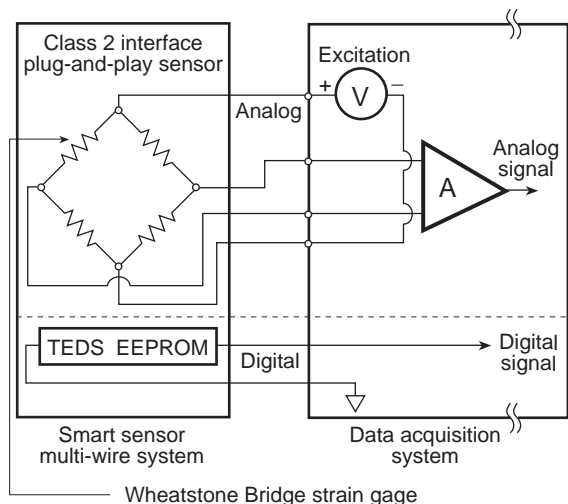


Fig. C.03. Class 2 sensors use multiple leads to connect between the sensor and STIM. In the case of a Wheatstone Bridge circuit, for example, four leads connect the sensor and the other pair connects to the onboard TEDS EEPROM, which illustrates the mixed-mode application.

The TEDS file may be contained onboard the sensor in the EEPROM, or off board in a reserved file in the data acquisition system. A number of transducer manufacturers plan to launch an Internet-accessible site where they list sensors that presently do not contain a TEDS memory IC. Users may enter the serial number of their sensor and obtain an equivalent TEDS specification to download. This lets application software programs work with both older sensors and newer TEDS-equipped sensors.

Networks

The original intent of the TEDS concept is to handle arrays of smart sensors and actuators over various types of networks. Different types of control networks now exist for both analog and digital communications, but most are intrinsically incompatible with one another. And not all transducer manufacturers are either able or willing to provide a unique sensor for each kind of network bus. As a consequence, they are increasingly turning to digital networks controlled with microprocessors to develop a universally accepted interface that is more economical for them to interconnect systems, networks, and instruments. The guiding document is the evolving IEEE 1451 standard, which also allows the new devices to be compatible with older and existing systems.

System Architecture

The IEEE has partitioned the P1451 standard into five major parts. Each part addresses a different facet or interface of the project that enables sensor manufacturers to design and build new sensors compatible with all networks. Each part is defined as follows:

Part 1. Network-Capable Application Processor (NCAP) Information Model

The purpose of this part is to define an object model for smart transducers that connect to a network, and specify a software interface to work with the transducer's components. The major components of this model include the NCAP block, function block, and transducer block. The NCAP processor connects the network to the transducer modules, and each different network requires a different NCAP physical interface. The smart transducer object model interfaces to the NCAP processor and to the transducer block. The interface to the transducer block contains details of the transducer hardware in a program model, and the interface to the NCAP block contains details describing the network protocols.

The NCAP's primary purpose is to communicate between the STIM and a particular network. The NCAP also computes calibration corrections and converts between values in metric units and values coming from the STIM's DACs or going to the ADCs.

Part 2. Transducer to Microprocessor Communications Protocols and TEDS Format

Part 2 defines the details of a TEDS, including the format for storing data in a small (256-bit to 4 kb) EEPROM and the interface between the NCAP processor and the transducers. The TEDS contains the information needed by the software to convert the sensor values such as volts or resistance to physical units, such as force in pounds or acceleration in gs. TEDS is also part of the Smart Transducer Interface Module. STIM includes the ADCs, DACs, digital I/O, and triggers that connect to the transducers.

Part 3. Digital Communications and TEDS Formats for Distributed Multi-drop Systems

This part is intended to define the TEDS format and the standard for the interface between multiple transducers in a multi-drop network. Some of the issues dealing with a multi-drop system include automatically identifying the transducer when it connects to the bus, and how quickly the system recovers after a short power dropout.

Part 4. Mixed-Mode Communication Protocols and TEDS Formats

Mixed-mode communications deals with the issue of using two-wire I/O, which shares both signal and digital interfaces vs. a multi-wire system where signal and digital communications are handled on separate wires or ports. Small analog sensors contain TEDS that let the sensors interface on the network through the same two wires they use for signals. The digital TEDS data uses the same two wires.

Part 5. Wireless Communication Protocols and TEDS Formats

At the time of this writing, the IEEE P1451 standards committee study group had defined the details of the interfaces for wireless communications, but not the modules. The intent of the standard is to separate the physical layers from the upper layers of the protocol stack. Significant progress on the specification is expected in 2004.

TEDS Composition

The data structure for the TEDS works well with a variety of sensor types. Regardless of the sensor's principle of operation, the structure contains three major subdivisions; the Basic TEDS; the Standard TEDS (sub-template), and the User Area. (See Figure C.04, Tables 1, 2, and 3.)

TEDS Table	
Meta-TEDS	Provides operational parameters for the transducer
Transducer-channel TEDS	Provides operational parameters for the transducer
Calibration TEDS	Provides calibration coefficients for the transducer
Text-based TEDS	Provides a description of the device for the operator, human readable in XML
Frequency-response TEDS	Provides frequency response for a transducer and associated electronics in a table
Transfer-function TEDS	Provides frequency response for a transducer and associated electronics in algorithm form
End-user, application-specific TEDS	User writeable block of non-volatile memory. Contents defined by user.
Commissioning TEDS	User writeable block of non-volatile memory. Intended to provide an identifier for the transducer.
Manufacturer-defined TEDS	Format defined by the manufacturer
Physical TEDS	Defined for the particular physical layer, not included in P1451.0. How to access it is defined by IEEE P1451.0.

Fig. C.04. Table 1. Basic TEDS Table.

The Basic TEDS contains the manufacturer's identification, model identification, version letter, and the serial number, which are common to all types of sensors. The Standard TEDS, however, contains data unique to the sensor's principle of operation. For instance, a piezoelectric accelerometer differs from a strain gage load cell, so the Standard TEDS EEPROM contains some common and some unique information. Both sensor TEDS list Calibration Date, Measurement Range, and Electrical Output, but they differ in as many as 12 other parameters. The accelerometer has 6 parameters that the strain gage lacks, and the strain gage has 6 parameters the accelerometer lacks. The User Area contains information such as Sensor Location, Calibration Due Date, and Calibration Table.

TEDS Configuration: Accelerometer		
Basic TEDS	Manufacturer ID	25
	Model ID	5226
	Version Letter	A
	Serial Number	11521S
Standard TEDS (Subtemplate)	Calibration Date	Jan. 6, 2004
	Sensitivity @ Reference	1.12E+03 mV/g
	Reference Frequency	110.0 Hz
	Reference Temperature	25 °C
	Measurement Range	±50 g
	Electrical Output	±5 V
	Quality Factor	
	Temperature Coefficient	-0.27%/°C
User Area	Direction (X, Y, Z)	X
	Sensor Location	Matrix A: B-3
	Calibration Due Date	Jun. 15, 2004

Fig. C.04. Table 2. *Example for an Accelerometer.*

TEDS Configuration: Strain-Gage Load Cell		
Basic TEDS	Manufacturer ID	56
	Model ID	350A
	Version Letter	E
	Serial Number	150-00878T
Standard TEDS	Calibration Date	Mar. 15, 2004
	Measurement Range	±250 lb
	Electrical Output	±5 mV/V
	Bridge Impedance	500 Ω
	Measurement Range	±75 g
	Excitation, Nominal	24 Vdc
	Excitation, Minimum	10 Vdc
	Excitation, Maximum	
Calibration TEDS	Response Time	
	Calibration Table	-2.06 mV/V, -150 lb
		-1.02 mV/V, -75 lb
		0.03 mV/V, 0 lb
		0.95 mV/V, 75 lb
User Area		1.89 mV/V, 150 lb
	Sensor Location	L23-3
	Calibration Due Date	Jun. 15, 2004

Fig. C.04. Table 3. *Example for a Strain-Gage Load Cell.*

Glossary

Acquisition	A collection of scans acquired at a specified rate as controlled by the sequencer.
Analog	A signal of varying voltage or current that communicates data.
Analog-to-Digital Converter (ADC)	A circuit or device that converts analog values into digital values, such as binary bits, for use in digital computer processing.
Bipolar	A range of analog signals with positive and negative values (e.g., -5 to +5 V); see <i>unipolar</i> .
Buffer	<p><i>Buffer</i> refers to a circuit or device that allows a signal to pass through it, while providing isolation, or another function, without altering the signal. <i>Buffer</i> usually refers to:</p> <ul style="list-style-type: none">(a) A device or circuit that allows for the temporary storage of data during data transfers. Such storage can compensate for differences in data flow rates. In a FIFO (First In - First Out) buffer, the data that is stored first is also the first data to leave the buffer.(b) A follower stage used to drive a number of gates without overloading the preceding stage.(c) An amplifier which accepts high source impedance input and results in low source impedance output (effectively, an impedance buffer).
Buffer Amplifier	An amplifier used primarily to match two different impedance points, and isolate one stage from a succeeding stage in order to prevent an undesirable interaction between the two stages. (Also see, <i>Buffer</i>).
Channel	<p>In reference to data acquisition, <i>channel</i> simply refers to a single <i>input</i>, or <i>output</i> entity.</p> <p>In a broader sense, an <i>input channel</i> is a signal path between the transducer at the point of measurement and the data acquisition system. A channel can go through various stages (buffers, multiplexers, or signal conditioning amplifiers and filters). Input channels are periodically sampled for readings.</p> <p>An <i>output channel</i> from a device can be digital or analog. Outputs can vary in a programmed way in response to an input channel signal.</p>
Common mode	Common mode pertains to signals that are identical in amplitude and duration; also can be used in reference to signal components.
Common mode voltage	Common mode voltage refers to a voltage magnitude (referenced to a common point) that is shared by 2 or more signals. Example: referenced to common, Signal 1 is +5 VDC and Signal 2 is +6 VDC. The common mode voltage for the two signals is +5.5 VDC $[(5 + 6)/2]$.
Crosstalk	An undesired transfer of signals between systems or system components. Crosstalk causes signal interference, more commonly referred to as <i>noise</i> .
Digital	A digital signal is one of discrete value, in contrast to a varying signal. Combinations of binary digits (0s and 1s) represent digital data.
Digital-to-Analog Converter (DAC)	A circuit or device that converts digital values (binary bits), into analog signals.

Differential mode	A differential mode measures a voltage between 2 signal lines for a single channel. (Also see <i>single-ended mode</i>).
Differential mode voltage	<p>Differential mode voltage refers to a voltage difference between two signals that are referenced to a common point. Example: Signal 1 is +5 VDC referenced to common. Signal 2 is +6 VDC referenced to common.</p> <p>If the +5 VDC signal is used as the reference, the differential mode voltage is +1 VDC (+ 6 VDC - +5 VDC = +1 VDC).</p> <p>If the +6 VDC signal is used as the reference, the differential mode voltage is -1 VDC (+ 5 VDC - +6 VDC = -1 VDC).</p>
ESD	Electrostatic discharge (ESD) is the transfer of an electrostatic charge between bodies having different electrostatic potentials. This transfer occurs during direct contact of the bodies, or when induced by an electrostatic field. ESD energy can damage an integrated circuit (IC); thus safe handling is required.
Excitation	A voltage or current supplied to a transducer. Some transducers [e.g. strain gages, thermistors, and resistance temperature detectors (RTDs)] require a specific voltage or current. Typically, the variation of this signal through the transducer corresponds to the condition measured.
Gain	The degree to which an input signal is amplified (or attenuated) to allow greater accuracy and resolution; can be expressed as $\times n$ or $\pm \text{dB}$.
Isolation	<p>The arrangement or operation of a circuit, such that signals from another circuit or device do not affect the <i>isolated</i> circuit.</p> <p>In reference to data acquisition, <i>isolation</i> usually refers to a separation of the direct link between the signal source and the analog-to-digital converter (ADC). Isolation is necessary when measuring high common-mode voltage.</p>
Linearization	Some transducers produce a voltage in linear proportion to the condition measured. Other transducers (e.g., thermocouples) have a nonlinear response. To convert nonlinear signals into accurate readings requires software to calibrate several points in the range used and then interpolate values between these points.
Multiplexer (MUX)	A device that collects signals from several inputs and outputs them on a single channel.
Sample (reading)	The value of a signal on a channel at an instant in time. When triggered, the ADC reads the channel and converts the sampled value into a 24-bit value.
Scan	The term “scan” typically refers to an acquisition that consists of one sample for each configured channel (see scan list). Note that all samples in a scan are acquired using the same clock stimuli.
Scan List	A list of channels that have been selected for sampling. A list of enabled (active) channels.
Sequencer	A programmable device that manages channels and channel-specific settings.
Simultaneous Sample-and-Hold	An operation that gathers samples from multiple channels at the same instant and holds these values until all are sequentially converted to digital values.
Single-ended mode	The single-ended mode measures a voltage between a signal line and a common reference that may be shared with other channels. (Also see <i>differential mode</i>).
Start of Scan	“Start of Scan” refers to a signal that is internal to the unit. It signals the start of a scan group and therefore pulses once every scan period.

Trigger	For IOtech 640 and 650 Series devices, “trigger” refers to a software event that starts a scan or marks an instant during an acquisition.
TTL	Transistor-Transistor Logic (TTL) is a circuit in which a multiple-emitter transistor has replaced the multiple diode cluster (of the diode-transistor logic circuit); typically used to communicate logic signals at 5 V.
Unipolar	A range of analog signals that is always zero or positive (e.g., 0 to 10 V). Evaluating a signal in the right range (unipolar or bipolar) allows greater resolution by using the full-range of the corresponding digital value. See <i>bipolar</i> .

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