E-OR“ 230 LASER Range Finder

User Manual

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E-OR“ 230 LASER Range Finder

User Manual

CHAPTER ONE: E-OR“ 230 Hardware

GENERAL DESCRIPTION

The E-OR“ 230 is a fully eye-safe laser range finder that uses a high-speed electro-optical technique to bounce a pulse of light off a target, measuring the time-of-flight to determine the target s distance. With repeated measurements, target velocity and acceleration can also be determined.

This device can be used in a variety of applications requiring distance, velocity, or acceleration measurements. Such applications include liquid and material level sensing, rolled material diameter measurement, object profiling, safety monitoring and collision avoidance, crash and impact testing, production line monitoring, and many, many others. And, because the E-OR 230 is virtually immune to most difficulties associated with industrial fumes and chemical emissions, it can be used in many applications that are inhospitable to ultrasonic devices.

The E-OR 230 comes in a small, functional package with an integrated view finder for easy alignment, and screw holes for solid mounting on a bracket or pistol-grip handle.

To communicate with other devices, the E-OR 230 is equipped with a serial RS-232 interface, as well as a 4-20 mA analog output (for chart recorders and data acquisition devices). The serial interface enables the user to set the E-OR 230 s acquisition parameters, such as its data rate and range gating features, as well as transfer acquired distance data.

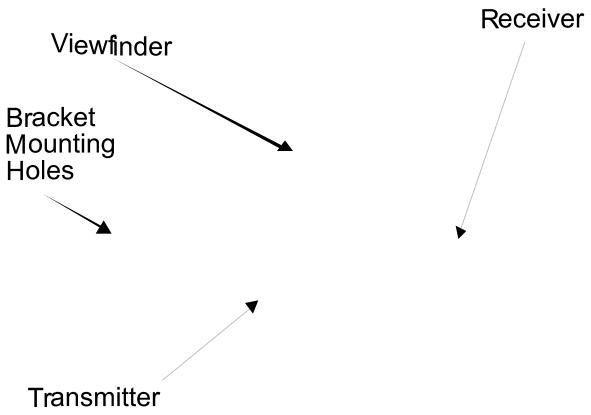
Included with the E-OR 230 is an application software package that runs under Microsoft Windows¤ (95/NT v4). With this software, the user can view distance and velocity data, in numerical and graphical formats, as well as log data to disk for permanent storage. The software also acts as a utility interface to the range finder, to set various parameters, such as the data rate, range gating, and analog output settings.

PACKAGE CONTENTS

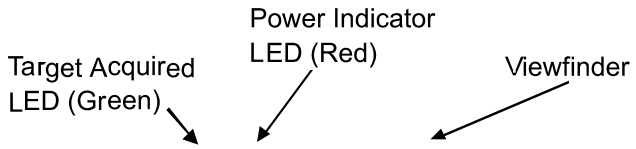
The following items are included with the E-OR 230:

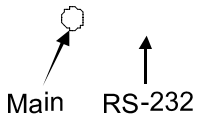
- E-OR 230 Laser Range Finder Unit
- Main Cable (Power and 4-20 mA Output)
- RS-232 Serial Cable
- AC Adapter
- 3.5 Installation Diskette
- Manual

If any of the above materials are not included with this package, please contact your local dealer or Power Spectra, Inc.



Front View of the E-OR 230





Rear View of the E-OR 230

Although the E-OR 230 is packaged for a rugged environment, it is important to note that the device is not water proof, and can be damaged by an impact, such as from being dropped. In consideration of this, please take special care in handling and placement of the unit.

HARDWARE DESCRIPTION

The E-OR 230 is a pulsed laser rangefinder that employs a variety of state-of-the-art electronic technologies. The device uses a fully eye-safe laser with a 5 nanosecond (ns) pulse of light that strikes a target, and is reflected back. The rangefinder measures the amount of time taken for the pulse to travel to the target and back, then converts the time-of-flight into distance.

The core of the time-of-flight technology is a system that performs digital time interval measurement. This is a wholly digital system, primarily implemented in a digital ASIC (Application Specific Integrated Circuit). The system uses digital time domain multiplexing, and digital resolution enhancement technology, bringing up to 0.1 inch resolution to the E-OR 230 (patent pending).

The heart of the E-OR 230 s transmitter is a proprietary Pulsed Optical Source (POS“). The POS is a laser diode actuated by a gallium arsenide semi-conductor switch with a very fast, 1 ns rise time. The pulse of light generated by the POS has a peak power of 10-40 watts, and is fully eye-safe at the E-OR 230 s trigger rate of 10 kHz.

The E-OR 230 s receiver is composed of a photo diode (which detects the reflected light pulse), followed by a series of amplifiers and an analog-to-digital converter that transforms the diode s output to a suitable signal for the digital time interval measurement system.

The above subsystems (transmitter, receiver, timer) are all controlled and coordinated by a powerful micro-controller. This device also manages the user selectable features, such as range gating, the data transfer rate, etc., as well as the data flows, and I/O port activity.

The E-OR 230 has a variety of external connections that the user should be aware of. These are described below.

Main Cable

The main cable plugs into the rear of the E-OR 230, providing an interface to the power supply and a 4-20 mA output source.

Power. The E-OR 230 requires input power of 8-30 VDC, and uses a maximum of 6 Watts. The AC adapter that comes with the E-OR 230 (hard-wired to the main cable) is compatible with this requirement. If you wish to replace the AC adapter, or use another power source, be sure the source conforms to this requirement. **Failure to do so may result in damage to the E-OR 230, or worse, cause an electrical injury (perhaps severe or fatal) to the user.**

4-20 mA. The analog output of the E-OR 230 uses the factory control industry standard 4-20 mA. This standard is well suited for transmitting analog data over long distances and through noisy environments. Access to the 4-20 mA output is available on the main cable, via two floating leads (red is positive, black is negative).

RS-232

The serial port of the E-OR 230 is available for host communications, for both parameter settings input and data output. The E-OR 230 follows standard protocols for serial communication (detailed later in this manual); a pinout listing of the RS-232 port is shown below.

Pin	Description
1	Not used
2	TX transmit data
3	RX receive data
4	Not used
5	GND signal ground
6	Not used
7	CTS clear to send
8	RTS request to send
9	Not used

HARDWARE OPERATION

The E-OR 230 is extremely simple to operate, requiring only a few basic steps to begin acquiring data. Follow the steps below to get the E-OR 230 up and running.

1. Connect the main cable (included) to the rangefinder s main connector, located at the rear side of the unit.

2. Connect the included serial cable to the E-OR 230 and to a personal computer with a DB-9 serial port (be sure the power to the PC is switched off). The serial cable is mated, such that one end is designated for the E-OR 230 and the other for the PC.

3. Plug the AC adapter into a standard 120 VAC wall receptacle.

4. Switch on power to the PC.

The hardware is now set up to take distance measurements, and communicate with the connected PC. The only remaining task is to aim the device at a target. The integrated viewfinder greatly helps in this process, especially for objects that are far away and/or small in size.

CHAPTER TWO: E-OR 230 Windows Application Software

SOFTWARE INSTALLATION

Included with the E-OR 230 is a Windows application software package that is used to set up the range finder, and to display distance and velocity measurements. Following are installation and operation instructions.

1. Insert the 3.5 floppy disk included with E-OR 230; open the window for the floppy drive.

2. Double-click on the Install icon. The installation software will create a directory* named E-OR 230 and herein copy all files needed for the application software. This is all that the install program does; no existing files (such as SYSTEM.INI) are altered in any way.

* This directory is installed on the C: drive. If you wish to maintain the directory elsewhere, simply move it after installation.

SOFTWARE TUTORIAL

After installation, there will be a new directory on your hard disk, named PSI. This directory contains the application software, a configuration file, and two shortcuts, for a total of four file icons.

The software can be launched in one of three modes: 1) as demonstration software, 2) as application software using COM 1, or 3) as application software using COM 2 (COM 3 or COM 4 can also be used; this will be explained later in the manual). The mode depends on which icon is used to launch the software:

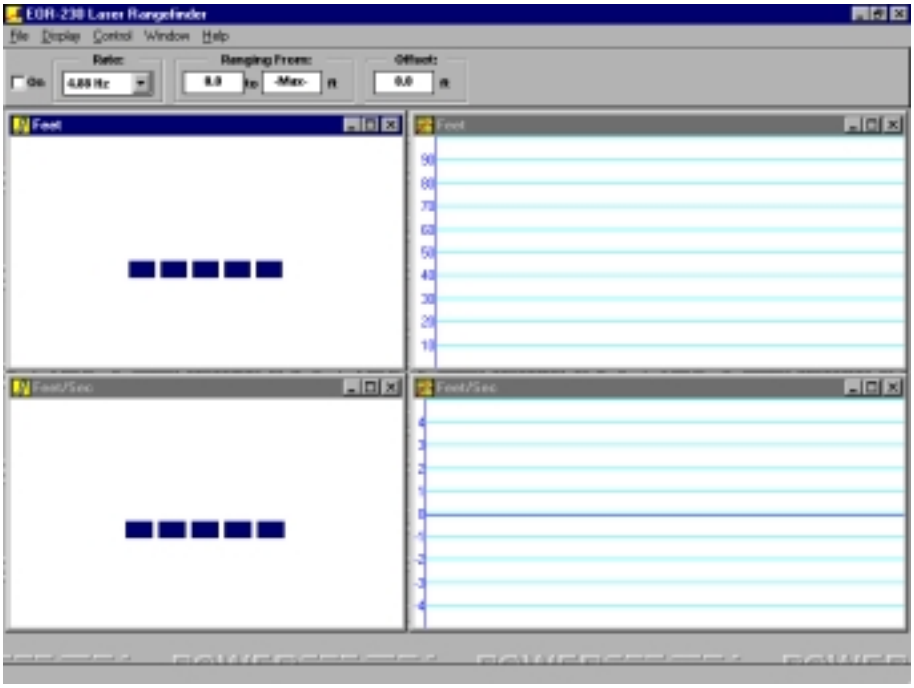
- To launch a demonstration version of the software, double-click on the E-OR Demo icon.

- To launch the application software, using COM 1 as the serial port for the range finder, double-click on the App-COM 1 icon.

- To launch the application software, using COM 2 as the serial port for the range finder, double-click on the App-COM 2 icon.

The remainder of this tutorial applies to all modes. The wording of the instructions, however, assume the software is in application mode.

1. After the program has been launched, maximize its window. All windows in the application software comply with Microsoft s windowing standard, which means all window operations, such as minimizing, closing, etc., will be immediately familiar to the user. The picture below shows what now appears on the screen.



2. To invoke range finder operation, simply click the On box in the upper left corner of the screen. The box will show a check mark, and after a few seconds, both hardware and software will begin operating. As shown in the picture below, the screen now displays distance and velocity data in their respective windows (both numerically and graphically).

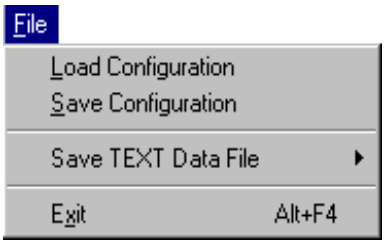
You ve successfully installed and used the E-OR 230 for a distance and velocity application! The next section further details this software.

SOFTWARE OPERATION

The range finder s application software can be customized to suit specific requirements; it can also be used to set various parameters in the range finder hardware. The following describes these features in detail.

File Menu

The File Menu is used to manage configuration files, invoke data logging, and to exit the program. An image of the File Menu is shown below.



Configuration files are used to save parameters set in the range finder software. For example, if two applications require different window displays, each can be saved to a separate configuration file. Or, if multiple E-OR 230s require identical hardware settings, a configuration file can be created to streamline the hardware setup process.

Select the Save Configuration command to save the current software configuration. Select the Load Configuration command to open a different configuration.

The Save TEXT Data File command (disabled in the initial state) is used to store a permanent record of range finder measurements. When this command is invoked, all data points in the E-OR 230 s data buffer are written to a user-named ASCII text file.

To create a data storage file:

1. Activate the range finder by clicking the On box in the upper left corner of the screen. Let the range finder run until data storage is required.

   The maximum number of data points that can be stored in the E-OR 230 s data buffer is 5,000. This means that after this many data points are stored, data is overwritten, point by point on a first-in first-out basis. The time interval for overwriting can be determined by dividing the maximum number of data points (5,000) by the data rate (described later). The result of this computation is the number of seconds between buffer loops.

2. When it is time to invoke logging, click the On box again.

3. Click on the Save TEXT Data File command in the File Menu, then choose either the As Raw Data or Formatted option. The program will then prompt the user to name the data file.

4. Name the data file, then click the OK button in the dialog box.

Once a data file has been saved, it can be viewed/edited with any software that reads text only files (word processors, spreadsheets, etc.). Below is a sample data file.

"Power Spectra Data Buffer"
Feet:
50.1
50.3
Err:128
50.5
50.8

The first two lines of the data file are for identification only. Data points start on the third line.

Note that the above sample file contains an error message. Error message codes are listed in the chapter on the range finder s serial interface. To preserve as much data as possible, the software will resume data logging after any error that is recoverable (as evidenced by data points that follow an error message).

The data file has only one column of data, regardless of the number of windows displayed in the application software. This is because raw data is used to derive all display data. For example, velocity data is created by first converting raw data into distance data, then using two distance points, and the known data rate, velocity is computed.

If the As Raw Data option is selected, each number must be transformed into a meaningful number. To do this, input the raw number (X) to one of the following formulas:

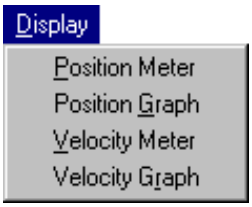
X * 0.002135 = distance in feet
X * 0.007005 = distance in meters

The last item in the File Menu is the Exit command. Select this command to close the program. A shortcut for this command is shown to the right of the command. Invoke this key sequence to close the program more quickly, or, if keyboard usage is preferred over mouse

usage. (Several other shortcuts are available in this program; any menu command with a named key sequence operates similarly. Also, the underlined letter in each command provides a keyboard shortcut.)

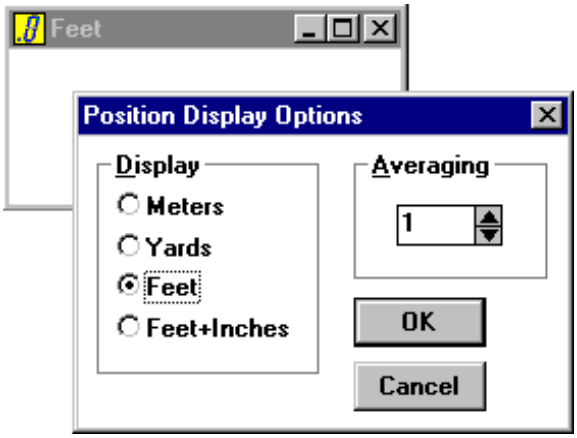
Display Menu

The Display Menu is used to create new display windows. An image of the Display Menu is shown below.



To create a new window, simply select one of the four commands above. After selecting a display, a new window will appear. Each display window has a display options dialog box, which is accessed by double-clicking anywhere in the display area of the window. Following is a picture and description of each of these dialog boxes. Any window parameter not shown in the display options dialog box is set automatically by the software.

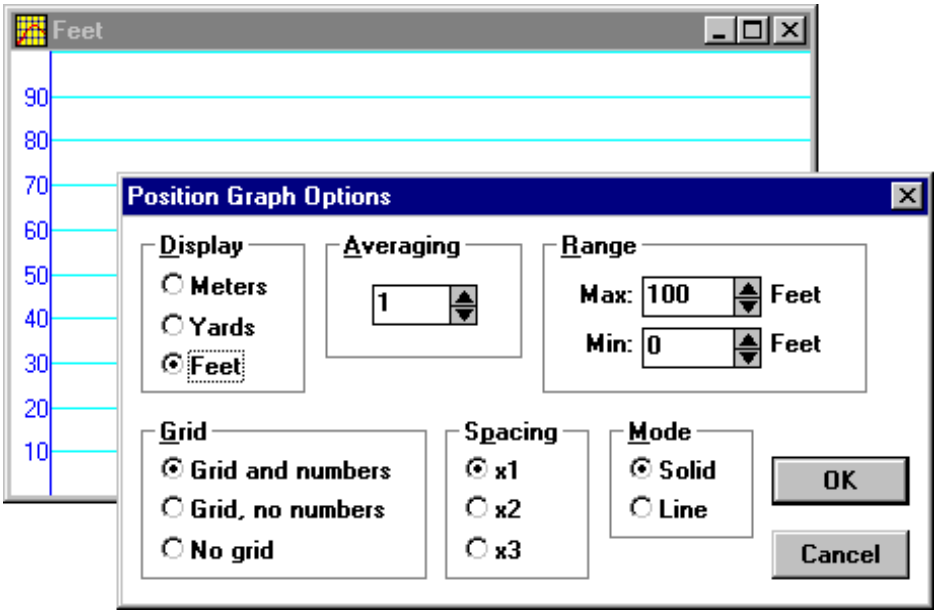
Position Meter



The Position Meter displays distance in numerical format. Distance units are changed by clicking the button next to the desired unit of measurement.

The Averaging option lets the user specify the number of samples used for a moving average. The default setting of 1 results in no averaging. To change to a different number, simply click the up or down arrow until the desired number is displayed. Alternatively, the number can be selected with the mouse, by pressing the Tab key, or by pressing the Alt + A key sequence, or it can be changed via keyboard input. Up to 40 samples can be used for averaging.

Position Graph



The Position Graph displays distance in graphical format, as a function of time. Distance units can be changed by clicking in the Display area, on the button next to the desired unit of measurement.

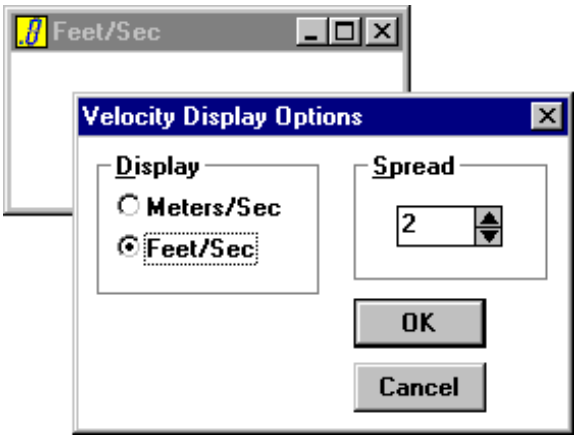
The number of averaging samples can be changed by clicking the up or down arrow in the Averaging area, or by highlighting the number and changing it with keyboard input.

Set the minimum and maximum values for the Y-axis by clicking the respective up and down arrows in the Range area. The Y-axis grid settings are changed in the Grid area.

The Mode area is for specifying the line style of the graph. The Line option sets the graph to display a plain line; the Solid option sets the graph to display a filled line.

The Spacing area is for setting one of the variables that specify the length of the X-axis. The other two variables are the data rate and the width of the graph window. Essentially, the graph displays data by drawing one, two, or three pixels (depending on the Spacing setting), for each data point taken by the range finder. The time taken for one sweep of the X-axis depends on all of the above variables. For example, to set the X-axis to take as long as possible for one sweep, the window must be as wide as the computer screen will allow, the data rate must be at the lowest setting (1.22 Hz), and the Spacing must be set at x1. The x2 and x3 settings reduce the time of one X-axis sweep by 50% and 67%, respectively.

Velocity Meter



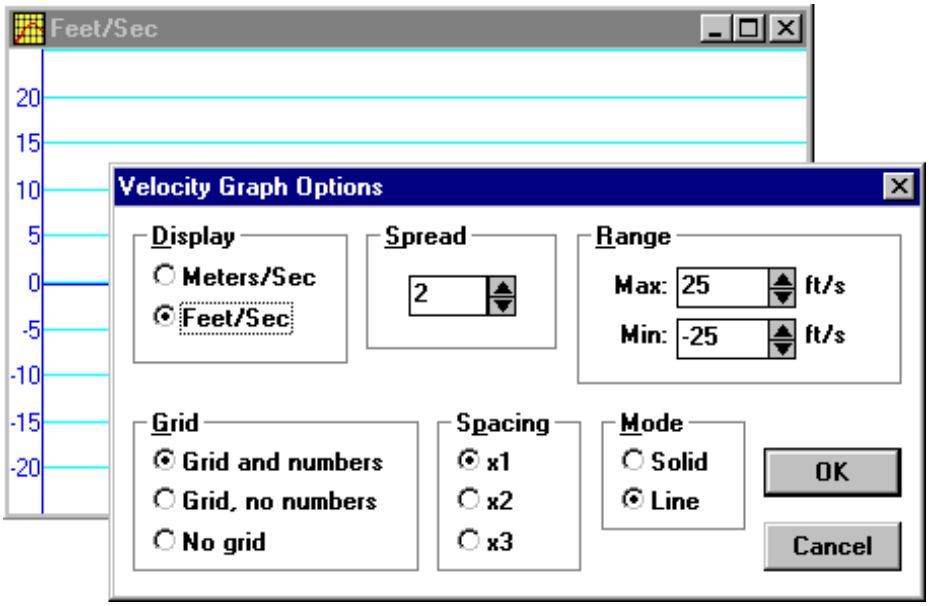
The Velocity Meter displays velocity in numerical format. Note that this reportage of velocity is not necessarily the velocity of the target being measured. This is because the target may not be moving at the same angle, relative to the range finder, that the pulsed light is moving (which is perpendicular within 3… to the face of the range finder).

To ensure that velocity is reported correctly, place the range-finder directly in line with the angle of motion of the target object.

Velocity units can be changed by clicking the button next to the desired unit of measurement.

The Spread option lets the user specify the sensitivity of velocity calculations. The spread value specifies the number of points between velocity calculations. For example, a spread of 2 means that the current point and the immediately preceding point are used to compute velocity; a spread of 40 uses the current point and the 39th preceding point. Use a small spread in applications where a brief change in velocity is important; use a large spread in applications where brief changes in velocity are unimportant. To change to a different number, simply click the up or down arrow until the desired number is displayed. The spread can be between 2 and 40 samples.

Velocity Graph

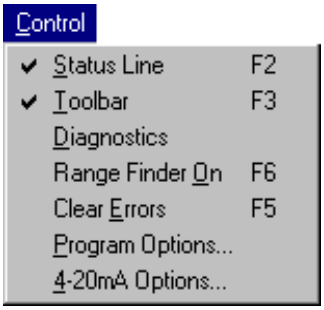


The Velocity Graph displays velocity in graphical format, as a function of time. Velocity units can be changed by clicking in the Display area, on the button next to the desired unit of measurement.

The Spread option works identically to that in the Velocity Meter. The Range, Grid, Spacing, and Mode options work identically to those in the Position Graph.

Control Menu

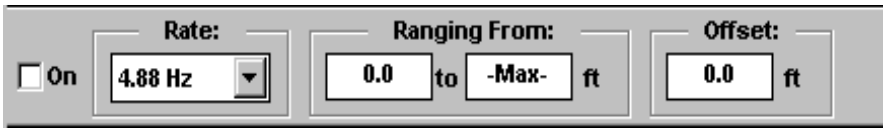
The Control Menu is used to manage a variety of general program settings. An image of the Control Menu is shown below.



The Status Line command toggles the display of the Status Line, which, when checked, appears at the bottom of the screen, and gives brief explanations of all menus and menu commands when the mouse is positioned over the respective menu or command.

The Toolbar command toggles the display of the Toolbar, which, when checked, appears below the menu bar, and displays various control parameters. These are described below.

The Toolbar



- The On box toggles the operating state of the range finder, and acts as a shortcut to the Range Finder On command in the Control Menu.

- The Rate field, which is actually a pop-up menu, is used to enter the data rate for the range finder. Simply click in the box to see the available data rates, then select the desired rate.

- The Ranging From field is used to enter the minimum and maximum range that the range finder should measure. This is especially useful if the range finder is ranging through a window, which may reflect light back, thereby causing erroneous data collection.

- The Offset field is used to enter a distance to be subtracted from the actual range finder reading. This is useful in applications where the range finder is placed perpendicular to a target s movement direction, and a mirror is used to direct the range finder s laser to correct the angle.

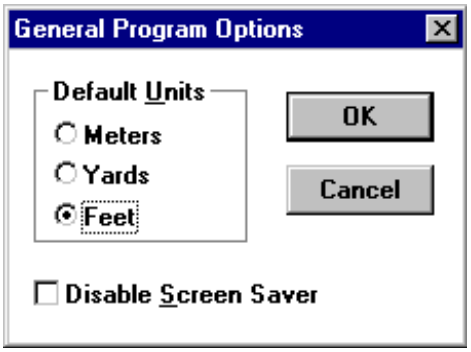
- The right side of the Toolbar displays various messages during rangefinder operation.

The Diagnostics command in the Control Menu toggles display of the Diagnostic window, which, when checked, appears as a moveable window, and displays range finder identification information (or Emulation Mode when launched as demonstration software), and the occurrence of any errors. Errors are listed in Appendix 1.

The Range Finder On command toggles the operating state of the range finder (identical to the On box in the Toolbar).

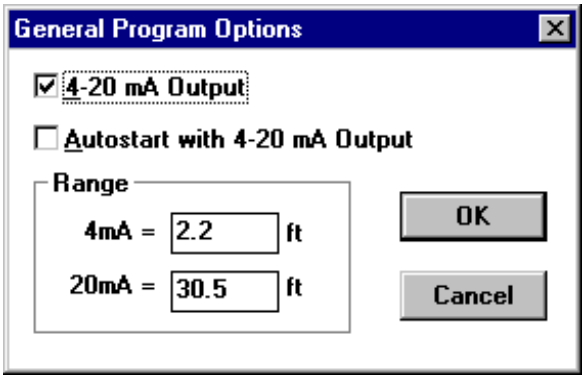
The Clear Errors command clears all errors, and restarts software operation if any error caused the software to stop running.

Selecting the Program Options command causes a dialog box to open. In this dialog box, the default measurement units can be selected. The default unit is immediately changed in the Toolbar, and new windows will be initialized with the new default unit.



Also in the Program Options dialog box is a box to disable the screen saver. Checking this box will disable the Windows standard screen saver, as well as most third party screen savers. This feature is helpful if the program is running constantly with no mouse or keyboard action, and a user needs to periodically view range finder data.

The last command in the Control menu is 4-20 mA Options
When this command is selected a dialog box opens. This dialog box is shown below.

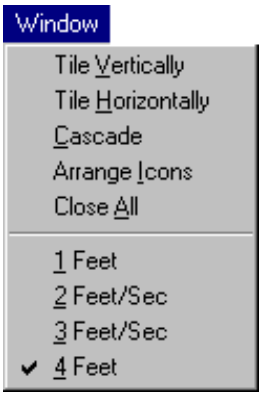


To enable 4-20 mA output, click on the top box. The Autostart with 4-20 mA Output box will set the range finder to always enable the 4-20 mA port upon power-up. This feature enables range finder operation without the need for a computer to be connected.

The Range area of the dialog box is for entering 4-20 mA endpoints. In these boxes, enter the minimum and maximum ranges to be measured. The output of the 4-20 mA port will reflect the entered endpoints, with intermediate current levels representing linear data between the endpoints.

Window Menu

The Window Menu is used to manage open windows in the range finder software. This menu operates according to the Microsoft standard; refer to Microsoft documentation for further information. An image of the Window Menu is shown below.



Help Menu

Under the Help Menu is the About command. The window that pops up upon choosing this command is the same window that is displayed when the program is launched. The window contains, among other pieces of program information, the version number of the program in use. Having the version number handy is helpful, if technical support is required for the software and/or hardware.

USING COM 3 OR COM 4

The two App icons that launch for COM 1 and COM 2 are actually Windows Shortcut icons. Each of the two shortcut icons are set up to launch the software, using special switches to choose the COM port. To use COM 3 or 4, follow the instructions below.

1. Create a copy of one of the App shortcut icons.

2. Change the name of the new icon to reflect which COM port will be used.

3. In the Properties dialog box for the new shortcut, select the Shortcut tab, and change the last character in the Target field to reflect the new COM port number.

4. Launch the software with the new shortcut icon.

CHAPTER THREE: RS-232 Interface

GENERAL DESCRIPTION

The E-OR 230 has a built-in RS-232 interface for communicating with other serial devices. With this interface, a program can be written to acquire range finder distance measurements, and to change operational settings for the device. Following is a description of the serial interface, which is intended for use by experienced programmers. In the absence of RS-232 programming experience, a general purpose communications package, such as HyperTerminal, can be used to communicate with the range finder.

RS-232 PROTOCOL

To enable serial communication with the E-OR 230, the first task is to set the communication s protocol in the host machine to match that of the range finder. These settings are listed below.

Baud Rate: 19,200 bps
Parity: None
Data Bits: 8
Stop Bits: 1
Handshaking: None

After communications have been established, interactions with the range finder take the form of host commands (described below) and returned data. As part of the protocol, all commands must have no blank spaces between the initial character and the termination character. The termination character must be either a carriage return <CR>, a carriage return and a line feed <CR><LF>, or a null character <0>.

Any response from the range finder, evoked by a host command, will include a carriage return <CR> at the end. Also, each data point sent during ASCII data streaming is followed by a carriage return <CR>.

HOST COMMANDS

Below is a list and description of the serial commands available with the E-OR 230. Some commands require an input parameter; this is denoted at the end of the command with a <n> . In all cases, n is an integer.

ID	Get instrument ID; returns name and firmware version number
SX	Sets all parameters to default values
SA<n>	Sets the number of 10kHz raw data points to average for each reading (1 255); the default is 16
SR<n>	Sets the rate, as a divisor of 10kHz, at which to stream data; the default is 1000
SF<n>	Sets the data format: 0=ASCII, 1=Binary, 2=Binary with sync tags; the default is 0
SL<n>	Sets the low limit for range (range gating), in counts (3.28 inches per count); the default is 30 set n to 0 to turn off range gating

Note: The SL (and SX) command writes <n> to the range finder s EEPROM. This parameter stays in force through range finder power cycles; it is removed only upon execution of the XX command, and can be changed by executing subsequent SL or SX commands. This is especially important to remember if there are multiple users of the range finder (i.e., if another user issues an XX command, the range gate reset may go unnoticed by the original user).

SZ<n>	Enables 4-20 mA output during data streaming: 1=enable, 0=disable; the default is 0
Q<c>	Queries the state of above S commands (c = A, R, F, L, or Z); returns the <n> value of the respective command
QQ	Queries error condition; returns all errors since last QQ command

The QQ command can return any of the below listed errors:

Error: Syntax Error
Error: Bad Parameter
Error: Inconsistent Parameters
Error: Command(s) Ignored
Error: EEPROM Error

EO<n>	Stores the offset to subtract from each reading into the EEPROM, in counts (0.0256 inches per count);
VO	Verifies offset; returns the <n> value of the EO command
EX<n>	Sets lower value for 4-20 mA output, in counts (3.28 inches per count)
EY<n>	Sets upper value for 4-20 mA output, in counts (3.28 inches per count)
EZ<n>	Enables 4-20 mA output at power-on: 1=enable, 0=disable
VX, VY, VZ	Verifies the 4-20 mA parameters; each returns the respective <n> value
DD	Acquires an individual data point, as an ASCII character or as a 3-byte binary number

Note on error reporting: when an error occurs in the range finder, it is reported upon receipt of a DD command. In ASCII format, the error is reported as Err: followed by a decimal error byte. In binary format, the error is reported as FF in the most significant byte. The error number (presented as a hex number in the least significant byte in binary format) is the sum of one or more of the numbers below, indicating which error(s) occurred:

1: ERR_WILDPT wild point error bit
(generated by make_data_point())

8: ERR_SETTLE AGC hasn't settled after attenuater switch
(not from FPGA)

64: ERR_MISFIRE misfire error bit, set by the FPGA

128: ERR_OVERRNG over range error bit, set by the FPGA

Example: Err:136 (FF0088 in binary) means that both the 2nd and 4th errors occurred.

DS	Starts data streaming, as ASCII characters or as 3-byte binary numbers
XX	Stops data streaming

APPENDIX 1: Diagnostic Window Errors

Below are the Communications Errors that can occur:

OH	overrun in hardware
OV	overrun of buffer
PA	parity
FR	framing
BR	break detect
TO	timeout

Below are the Hardware Errors that can occur:

MIS	start error (laser misfire)
RAN	overrange
WIL	wild points
SET	agc settling
SYN	data stream out of synch

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