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A-GAGE® EZ-ARRAY™ Instruction Manual

Two-piece sensing array with 2 analog and 2 discrete outputs, plus serial output

Features

- A cost-effective, two-piece measuring light curtain designed for quick and simple installations with the sophistication to handle the toughest sensing applications

- Excels at high-speed, precise process monitoring and inspection, profiling, and web-guiding applications

- A comprehensive combination of scanning options:
  – 14 measurement ("scan analysis") modes
  – 3 scanning methods
  – Selectable beam blanking
  – Selectable continuous or gated scan initiation
  – Selectable threshold setting for semi-transparent applications
  – 2 analog outputs, 2 discrete outputs, plus Modbus 485-RTU serial output

- Outstanding 4 meter range with 5 mm beam spacing

- Available in 12 lengths from 150 mm to 2400 mm

- Excellent 5 mm minimum object detection or 2.5 mm edge resolution, depending on scanning method

- Receiver user interface for quick, intuitive setup of many common applications:
  – 6-position DIP switch for setting scan mode, measurement mode, analog slope, discrete output 2 option (complementary measurement or alarm operation)
  – 2 push buttons for gain method selection and alignment/ blanking
  – 7 Zone LEDs for instant alignment and beam blockage information
  – 3-digit display for sensing information and diagnostics

- Software PC interface available for advanced configuration setup

- Remote teach wire option for alignment, gain settings, inverted display, and DIP switch disable

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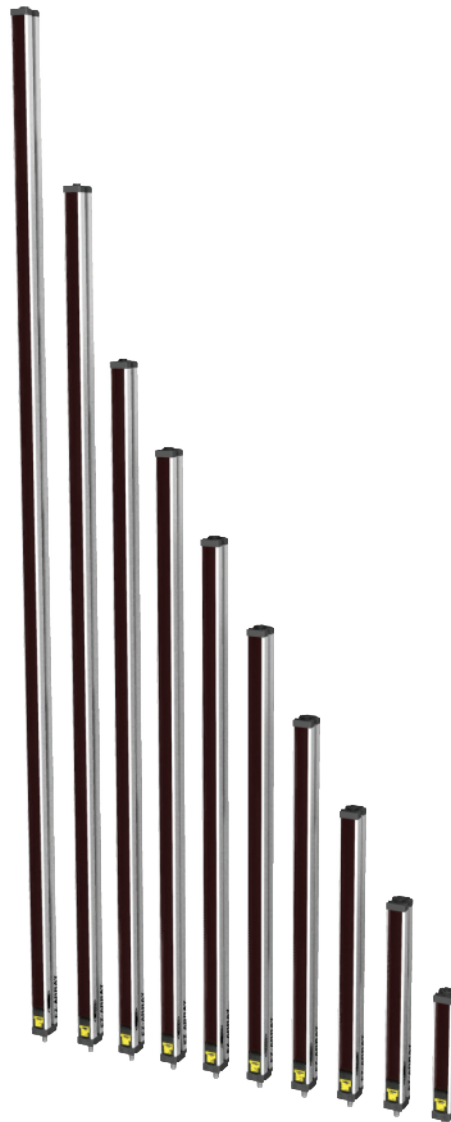
⚠ **WARNING . . . Not To Be Used for Personnel Protection**

Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death.

These sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.

Table of Contents

1. Overview

The A-GAGE™ EZ-ARRAY™ measuring light screen is ideal for such applications as on-the-fly product sizing and profiling, edge-guiding and center-guiding, loop tensioning control, hole detection, parts counting, and similar uses (see Figure 1-1).

Emitters and receivers are available with arrays from 150 to 2400 mm (5.9" to 94.5") long. The emitter has a column of infrared light emitting diodes (LEDs) spaced 5 mm apart; their light is collimated and directed toward the receiver, positioned opposite the emitter, which has photodiodes on the same 5 mm pitch. The light from each emitter LED is detected by the corresponding receiver photodiode.

This sophisticated light curtain is capable of detecting opaque cylindrical objects as small as 5 mm in diameter or measuring part edges within 2.5 mm, depending on the scanning method selected (see Section 1.6). The sensing range is 400 mm to 4 m (16" to 13').

The EZ-ARRAY's two-piece design makes it economical and easy to use. Controller functionality is built into the receiver housing. It can be configured for many straightforward applications simply by configuring the six-position DIP switch on the front of the receiver (the receiver user interface). For more advanced control, easy-to-use PC interface software is available on the included CD to configure the sensors using a PC.

Installation is easy, too. The emitter and receiver housings can be side-mounted or end-cap-mounted using the included end-cap brackets; longer models also include a center bracket (see Section 3.1).

Beam synchronization is achieved via the 8-conductor sensor cables. Individual LEDs and a 3-digit diagnostic display on the receiver provide ongoing visual sensing status and diagnostic information. Comprehensive data is available to a process controller via a combination of five outputs: two analog, two discrete, and one Modbus 485-RTU serial.

1.1 System Components

A typical A-GAGE EZ-ARRAY has four components: an emitter and a receiver, each with an integral quick-disconnect (QD) fitting, plus an 8-pin QD cordset for the emitter and for the receiver (see Figure 1-2). For applications that use the Modbus RTU-485 interface, an additional 5-wire cable is used to connect the receiver with a PC or process controller, via the Modbus 485-RTU connection. (A PC used with software version 1.1 for configuration must run on Windows® XP or 2000; software version 1.2, when available, will be compatible with Vista™.)

Figure 1-1. A typical A-GAGE EZ-ARRAY application

Emitter   Receiver

8-Pin Euro
Sensor Cordset

Optional PC for PC interface
software configuration

5-Pin Euro Communications
Cable for use with PC;
USB adapter not shown

Figure 1-2. A-GAGE EZ-ARRAY system components

1.2 Features

Built-in features in the EZ-ARRAY contribute to its ease of use. Many features are available using either the user-friendly receiver interface or the more advanced PC interface.

Built-in diagnostic programming and easy-to-see indicators on the receiver simplify physical alignment and troubleshooting (Figure 1-3); more advanced diagnostics are available via the PC interface.

The receiver has a bright LED that indicates overall sensing status (OK, marginal alignment, and hardware error). Two other LEDs indicate serial communication status. Seven Zone indicators each communicate the blocked / aligned status of one-seventh of the total array. A 3-digit diagnostic display provides further diagnostic information, including number of beams blocked, whether blanking is configured, and troubleshooting codes.

The emitter has a red LED that signals proper operation (ON when power is applied). See Section 1.4 for more information about indicators and Section 4.5 for display codes and troubleshooting.

The Alignment routine (Section 4.2 or Section 5.6) automatically equalizes the excess gain of each beam for reliable object detection throughout the array. This routine need not be performed again unless the sensing application changes, or if the emitter and/or receiver is moved.

Configurable beam blanking accommodates machine components and fixtures that must remain in or move through the light screen. Blanking may be set using the receiver interface, the teach wire, or the PC interface.

The EZ-ARRAY light screen provides a wide selection of sensing and output options, including measurement ("scan analysis") modes and scanning methods that can determine a target object's location, overall size, total height, or total width, or the number of objects. Scanning may be continuous or controlled by a gate sensor. Up to 15 systems may be networked, via Modbus; see Section 5 and Appendix A.

1.3 Configuration via DIP Switch or PC Interface

Commonly used configuration options can be set up easily via a six-position DIP switch located behind a hinged clear access panel on the front of the receiver.

Access to the DIP switch can be prevented by using the screw-on security plate to hold the clear access panel closed or by disabling them via the PC interface.

For more advanced, individualized applications, use the supplied PC interface software program (the "Banner Sensors GUI"; Section 5) to configure the receiver. The menu-driven program easily accesses the many scanning and output options. After the desired options are selected, the combination of selections can be saved in an .xml file, stored in the system configuration computer, and recalled as needed. Communication between the

Emitter   **Receiver**

Connection to 5-pin Communication Cable

Under Hinged Access Panel:

Zone Indicators

3-Digit Diagnostic Display

Alignment/Blanking Push Button

Gain (Sensitivity Adjust) Push Button

Status, Communication Active, and Communication Error LEDs

Beam #1 (Closest to Display)

6-Position Configuration DIP Switch

Power ON LED

Screw-on Security Plate limits access to DIP switch and push buttons
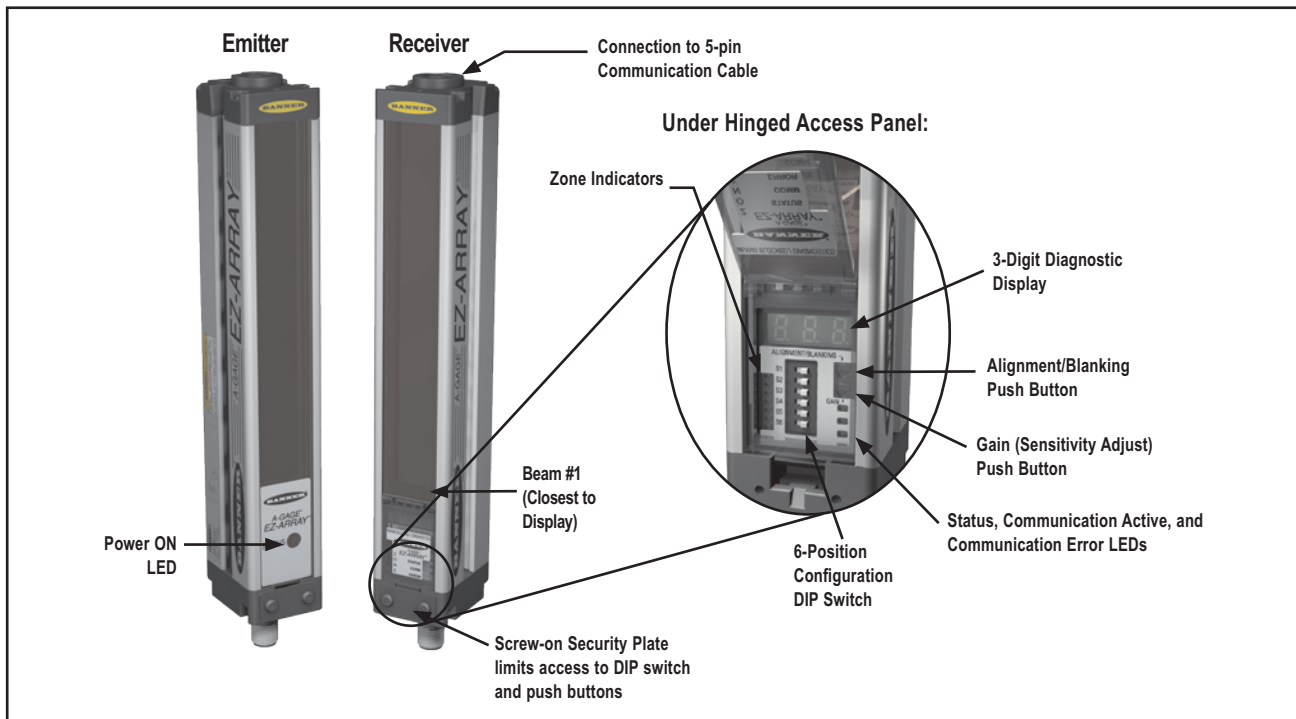
Figure 1-3. A-GAGE EZ-ARRAY features

sensors and a PC is accomplished via the serial output and Modbus RTU-485 interface.

The software also provides alignment and diagnostics routines. An Alignment screen displays the individual status of each beam in the light screen, as well as the total number of beams, and totals of beams blocked, made, and blanked. Built-in diagnostics can be used to assess emitter and receiver status.

Outputs
In addition to the serial output (see above), all models have two analog outputs and two discrete outputs.

The analog outputs are either 4–20 mA current or 0–10V voltage, depending on model (see Section 2-1). They may be configured (via DIP switch or PC interface) for either a positive or negative slope.

Discrete output 1 is always used for measurement; discrete output 2 may be used either for alarm or measurement operation (selectable via DIP switch or PC interface). When the receiver interface is used, discrete output 1 follows the operation of analog output 1 (it conducts when the analog output senses a target is present). When the PC interface is used for configuration, both discrete outputs have full configurability, including measurement mode, NPN or PNP polarity, and normally open or normally closed operation.

Display Invert
For applications where the sensors must be mounted with the display end at the top (so that the display is not right-reading), the receiver's diagnostic display can be inverted for easy reading, either by use of the receiver's remote wire (Section 1.5) or the PC interface.

1.4 Status Indicators

Both the emitter and receiver provide ongoing visual indication of operating and configuration status.

The emitter has a red LED that signals proper operation (ON when power is applied).

The receiver has a bright Status LED that indicates overall sensing status (OK, marginal alignment, and hardware error). Two other LEDs indicate whether serial communication is active or if there is a communication error. Seven Zone indicators each communicate the blocked/aligned status of one-seventh of the total array. A 3-digit diagnostic display provides further diagnostic information: number of beams blocked, whether blanking is configured, and troubleshooting codes. See Section 4.5 for display codes and troubleshooting.

Zone Indicators (Beams Blocked Segment)
Seven LEDs represent emitter/receiver alignment status. They provide a visual aid for sensor alignment and monitoring objects within the sensor's field of view. The sensor array is partitioned

into seven equal segments, each of which is represented by one of the seven LEDs. The LED closest to DIP switch S6 (see Figure 4-1) represents the group of optical channels closest to the receiver display (the "bottom" group). The LED closest to DIP switch 1 represents the far segment of channels.

These LEDs illuminate either green or red. When an LED is green, no unblanked beams are obstructed in that segment. When the LED is red, one or more beams in that segment is obstructed.

Three-Digit Display
The 3-digit display has slightly different functions during normal operation, alignment, and gain adjust modes. In normal operation the display indicates current numerical value of the measurement mode for analog output 1. The display also identifies the following activated sensor functions: blanking and locked-out user interface/electronic configuration, as shown in Figure 1-4. (For directions for inverting the display, see Section 1.5 or 5.8.)

During blanking mode, the display reads "**n**", followed by the number of blocked beams in the array. During alignment mode, it reads "**A**", followed by the number of blocked, unblanked beams; a period follows the A ("**A.**") if blanking is configured.

During gain adjust mode, the display reads "**L**" followed by "**1**" or "**2**" to indicate the gain level. (A "**1**" represents high excess gain, and a "**2**" represents low contrast.)

If a sensing error occurs, the display reads "**c**" followed by a number that corresponds to the recommended corrective action (see Section 4.5).

Blanking Indicator
The Blanking indicator will be visible (ON) when the blanking feature is enabled. It appears as a period following the first digit of the display.

Electronic Configuration Indicator
The Electronic Configuration indicator is ON when the sensor configuration is defined by the PC interface, and not the DIP switch and push buttons. When electronic configuration is enabled, the DIP switch and push button settings are ignored.
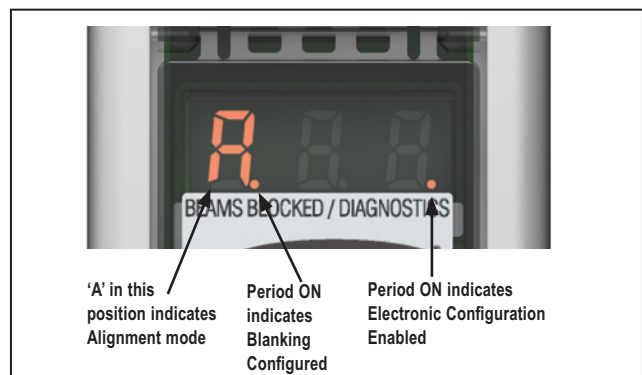

'A' in this position indicates Alignment mode

Period ON indicates Blanking Configured

Period ON indicates Electronic Configuration Enabled

Figure 1-4. Indications provided by the receiver's 3-digit display

Receiver Interface Status Indicators

The receiver has three status indicators: green/red System Status, yellow Modbus Activity, and red Modbus Error. The following table lists the indicator states.

Receiver Interface Status Indicators		
LED Indicator	**Color**	**Explanation**
System Status	Green	System is OK
	Red	Marginal Alignment or Hardware Error; check 3-digit display*
Modbus Activity	Yellow ON or Flashing	Activity detected on the Modbus communication channel
Modbus Error	Red	Communication Error: Check cabling or Modbus master controller

*Display shows "**c**": See Section 4.5.
 Display shows only numbers: Low Gain/Marginal Alignment condition. See Section 4.5.

1.5 Receiver Gray (Remote Teach) Wire

The receiver gray (remote teach) wire is used to electronically emulate the receiver push button functions (see Section 4.5) via a process controller, to disable the DIP switches for security, or to provide a gate input to initiate sensor scanning. Connect a normally open switch between the receiver's gray wire and dc common, or connect the gray wire to a digital input (PLC) and pulse the wire as indicated in Figure 1-5.

NOTE: A low level is 0 to 2 volts and a high level is 10 to 30 volts or circuit open. Input impedance is 22kΩ.

Remote TEACH/Gate in the System Config view of the PC interface Setup screen (Section 5.8) determines the functionality of the receiver gray wire, as follows.

• **Disabled: (**selected via the PC interface only) the remote wire has no function (regardless of whether it is low or high).
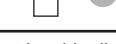
Process		Remote Wire Procedure 0.05 sec. ≤ T ≤ 0.8 sec.	Result
Alignment/Blanking	**Access Alignment Mode**	1x	"**A**" appears on 3-digit display
	Access Blanking Mode	From Alignment Mode: 2x	"**n**" appears on 3-digit display, along with number of blocked beams
	Exit Blanking Mode	1x	"**A.**" appears on 3-digit display (sensor returns to alignment mode with blanking enabled)
	Exit Alignment Mode	1x	Sensor returns to run mode
Gain Method	**Access Gain Mode**	From Run Mode: 2x	"**L**" appears on 3-digit display, along with number "**1**" or "**2**", to designate gain level
	Toggle Between Gain Settings	1x	Number changes from number "**1**" to "**2**", back to "**1**", etc.
	Save Gain Level and Exit	When correct level is displayed: 2x	Gain level is configured: "**1**" = <u>High-excess-gain setting</u> "**2**" = Low-contrast setting Sensor returns to run mode
Invert Display	**Invert Display**	3x	Display inverts from previous state; sensor continues in run mode
Receiver Interface Enable/Disable	**Receiver Interface Enable/Disable**	4x	The factory default is <u>Receiver Interface enabled</u>. Four-pulsing the remote line saves the current settings and disables the interface (the sensor continues to operate using the saved settings; changes made to the DIP switch will have no effect). Repeating the process enables the Receiver Interface so that settings can be changed.

Figure 1-5. Remote wire Teach procedures

When the gray wire is disabled, the receiver is in continuous scan mode; it begins a new scan immediately after updating the outputs from the previous scan. (Continuous scan is used in most analog output applications and whenever continuous updating of the outputs is acceptable.) The gray wire is always enabled when in DIP switch mode.

• **Remote Teach** — The gray wire provides the full Remote Teach functionality shown in Figure 1.5.

• **Alignment/Sensitivity** — This mode is an abbreviated version of Remote Teach. It can perform the alignment and sensitivity adjustment functions, but not the display inversion or DIP switch enable/disable functions.

Gate Mode options can be selected via the PC interface only. The gray wire provides a gate input pulse, typically from a dc device such as an NPN-output photoelectric sensor or a PLC discrete output. Refer to Section 5 for more information.

• **Gate – Active High** — The receiver scans whenever the gate is pulled high.

• **Gate – Active Low** — The receiver scans whenever the gate is pulled low.

• **Gate – Rising Edge** — The receiver scans once for each low-to-high gate transition. (Multiple transitions cannot be faster than the sensor's response for them to be reliably detected.)

• **Gate – Falling Edge** — The receiver scans once for each high-to-low gate transition. (Multiple transitions cannot be faster than the sensor's response for them to be reliably detected.)

1.6 Scanning Method

One of three scanning methods may be configured:

• Straight scan
• Single-edge scan
• Double-edge scan (1, 2, 4, 8, 16, or 32 steps)

Sensor response time is a function of sensor length and scanning method. Maximum scan times are shown in Figure 1-6.

Straight Scan is the default mode, in which all beams are scanned in sequence, from the display end to the far end of the array. This scanning method provides the smallest object detection size. Straight scan is used when low-contrast sensitivity is selected or when single-edge and double-edge scan cannot be used. The edge resolution is 5 mm (0.2"). When low-contrast sensing is selected (used when measuring semi-transparent objects), the minimum object detection size is 5 mm (0.2") diameter. When high-excess-gain sensing is selected, the minimum object detection size is 10 mm (0.4"). See Figure 1-5.

Single-Edge Scan is used to measure the height of a single object. This scanning method is commonly used for box height measurement. For single-edge scan, the receiver always activates the first beam channel (or "bottom" beam, nearest the display). When the first beam is blocked, the sensor performs a binary search to hunt for the last beam blocked, as follows:

1. The receiver scans only the first beam until it is blocked (see Figure 1-7).

2. When the first beam is blocked, the sensor looks to see whether the middle beam is blocked or made (unblocked).

3. If the middle beam is made (unblocked), the sensor checks the bottom quarter beam; if the middle beam is blocked, the sensor checks the top quarter beam.

4. The routine continues to divide the number of beams in half until the edge is found.

Single-edge scan can be used only for single, solid objects that block the first beam (closest to the display). Because the receiver checks only the first beam until it is blocked, single-edge scan will not function when the item to be measured does not block the first beam. Single-edge scan is also ineffective if the object does not present a continuous blocked pattern.

Single-edge scan works only when the high-excess-gain setting is enabled. When single-edge scan is selected, the sensor object detection size is 10 mm and edge resolution is 2.5 mm.

Scanning Method	Straight Scan		Single-Edge Scan	Double-Edge Scan (per Edge)					
	Low-Contrast	High-Excess-Gain		Step Size (Number of Beams)					
				1	2	4	8	16	32
Minimum Object Detection Size*	5 mm (0.2")	10 mm (0.4")	10 mm (0.4")	10 mm (0.4")	20 mm (0.8")	30 mm (1.2")	50 mm (2")	90 mm (3.6")	170 mm (6.8")
Edge Resolution	5 mm (0.2")	5 mm (0.2")	2.5 mm (0.1")	2.5 mm (0.1")	2.5 mm (0.1")	2.5 mm (0.1")	2.5 mm (0.1")	2.5 mm (0.1")	2.5 mm (0.1")
*MODS determined using a rod target object									

Figure 1-6. The effect of scan mode and step size on minimum object detection size and edge resolution

Double-Edge Scan is used to detect two edges of a single object, for example, to determine box width measurements. Double-edge scan requires the selection of a step size: 1, 2, 4, 8, 16 or 32 beams. The sensor uses the steps to "skip" over beams, as follows:

1. The sensor activates beam 1 (closest to the sensor display end).

2. The sensor activates the next beam, determined by the step size. (For example, if the step size is 2, beam 3 is next; if the step size is 8, beam 9 is next.)

3. As long as the activated beam is made (unblocked), the sensor continues the stepping routine until a blocked beam is found.

4. When a blocked beam is found, a binary search is conducted to find the object's "bottom" edge.

5. When the bottom edge is found, the sensor continues to step through the array until it finds the next unblocked beam.

6. Another binary search is performed to find the second edge.

Similar to single-edge scan, double-edge scan has some restrictions: the object should provide a solid obstruction; the size of the object determines the maximum step size (Figure 1-6). Double-edge scan can be used to detect up to three objects. Like single-edge scan, double-edge scan works only when the high-excess-gain setting is selected. When double-edge scan is selected, the sensor object detection size varies, depending on the step size, but edge resolution is 2.5 mm.
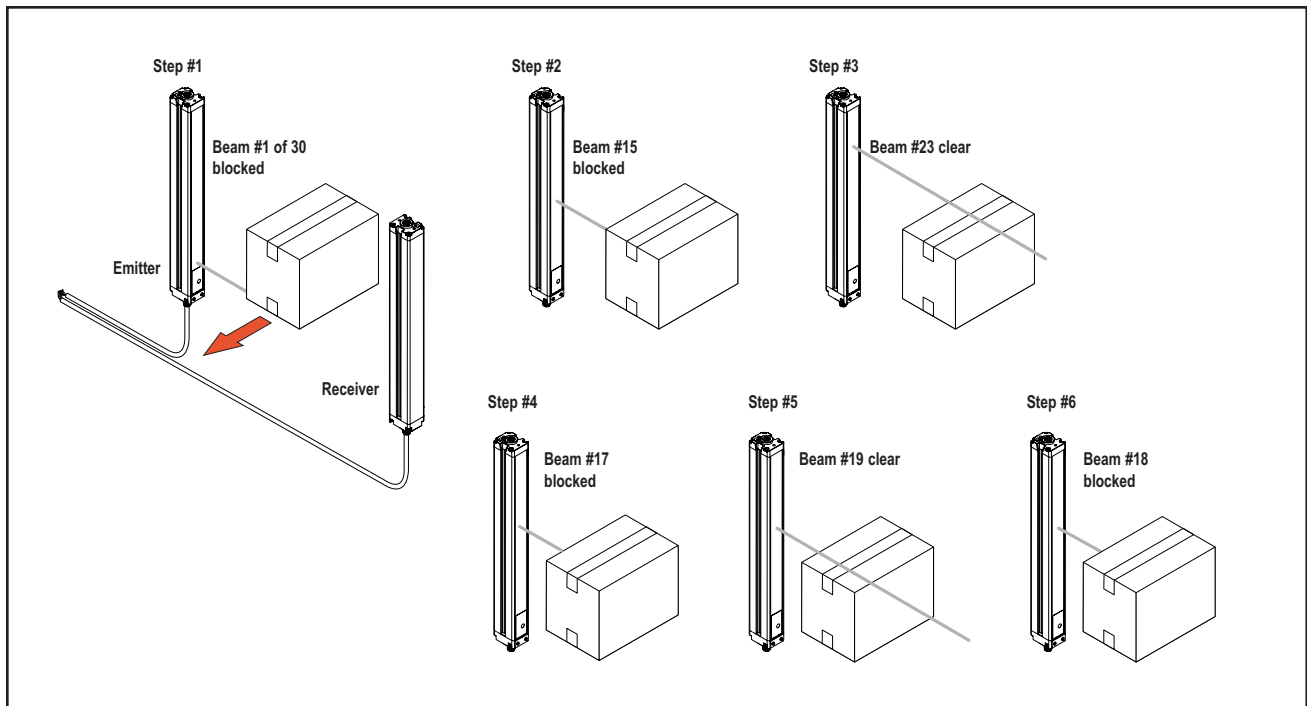
Figure 1-7. Finding an edge using a binary search (single-edge scan)

Maximum Scan Times (in milliseconds)								
Array Length	**Straight Scan**	**Single-Edge Scan**	**Double-Edge Scan**					
			Step 1 Beam	**Step 2 Beams**	**Step 4 Beams**	**Step 8 Beams**	**Step 16 Beams**	**Step 32 Beams**
150 mm (5.9")	2.8	1.5	3.4	2.8	2.5	2.4	1.9	N/A
300 mm (11.8")	5.0	1.5	5.9	4.1	3.2	2.8	2.3	2.1
450 mm (17.7")	7.1	1.6	8.5	5.5	4.2	4.0	3.2	2.5
600 mm (23.6")	9.3	1.6	11.0	6.8	4.9	4.2	4.0	2.8
750 mm (29.5")	11.4	1.7	13.5	8.1	5.7	4.6	4.5	4.5
900 mm (35.4")	13.6	1.7	16.0	9.5	6.1	4.7	4.6	4.6
1050 mm (41.3")	15.7	1.8	18.6	10.8	6.8	5.2	4.8	4.8
1200 mm (47.2")	17.9	1.8	21.1	12.2	7.4	5.5	4.9	4.9
1500 mm (59.1")	22.2	1.9	26.1	14.8	9.0	6.4	5.3	4.9
1800 mm (70.9")	26.5	2.0	31.2	17.5	10.5	7.3	6.0	5.6
2100 mm (82.7")	30.8	2.8	36.3	20.2	12.0	8.2	6.7	5.6
2400 mm (94.5")	35.1	2.8	41.4	22.9	13.5	9.1	7.4	5.9

NOTES: Scan times are exclusive of serial communication transmission times.
Scan times are also dependent on analog filter speed; see Section 5.8.

Figure 1-8. Maximum scan times for straight, single-edge and double-edge scanning

1.7 Gain Configuration

The EZ-ARRAY provides two gain options for straight scan applications: high excess gain and low contrast. The gain method can be selected using the receiver push button, the receiver remote teach wire, or the PC interface.

High (maximized) excess gain is suited for detecting opaque objects and for reliable sensing in dirtier environments where objects to be detected are 10 mm or larger. The high excess gain method is always used in single- and double-edge scan. The high excess gain option has a minimum blocked threshold level, which provides reliable sensing at higher excess gain levels.

The low-contrast setting is used for sensing semi-transparent materials and for detecting objects as small as 5 mm (straight scan only). In low-contrast operation, only a portion of a beam must be blocked for detection to occur. In low-contrast operation, the sensor sets an individual threshold for each optical channel during the alignment process; this process equalizes the signal strength to allow semi-transparent object detection.

When using the PC interface, low-contrast sensing provides a fine-tune sensitivity setting of 15% to 50%. When using the receiver interface, low-contrast sensitivity is always 30%.

Gain Setting	Scan Method	EZ-ARRAY MODS*	EZ-ARRAY Resolution
Low Contrast	Straight scan	5 mm	5 mm
	Single-edge scan	—	—
	Double-edge scan	—	—
High Excess Gain	Straight scan	10 mm	5 mm
	Single-edge scan	10 mm	2.5 mm
	Double-edge scan	Depends on step size	2.5 mm / edge 5 mm total (both edges)

* MODS: Minimum Object Detection Size

Figure 1-9. Effects of Gain selection on minimum object detection size and sensing resolution

1.8 Electronic Alignment Routine

The objective of the optical alignment process is to adjust the emitter light level to maximize sensor performance. Perform the alignment procedure at installation and again whenever the emitter and/or receiver is moved.

During the alignment procedure, the receiver polls each beam channel to measure excess gain and performs a gain adjustment for each beam. When the system exits the alignment procedure, each channel's signal strength is stored in non-volatile memory.

The procedure can be performed using the receiver remote wire, the receiver interface or the PC interface (see Section 1.5, 4.2, or 5.6). The receiver's Alignment push button may be disabled, using the PC interface.

1.9 Blanking

If a machine fixture or other equipment blocks one or more sensing beams, the affected beam channels may be blanked. The blanking option causes the receiver to ignore the status of blanked beams for measurement mode calculations. For example, if a machine fixture blocks one or more beams during sensing, the output data will be incorrect; if the beams blocked by the fixture are *blanked*, the output data will be correct. Blanking may be configured using the receiver's Alignment push button, the receiver remote wire, or the PC interface.

For total beam values (TBB and TBM analysis modes), selection of blanked beams affects the proportional analog outputs. Blanked beams are ignored both in the number of blocked or made beams and in the total number of beams. For example, if a 30-beam array has 10 blanked beams and 10 of the remaining 20 beams are blocked, the analog output values will be at mid-range.

1.10 Measurement Mode Selection

The outputs may be configured for any of fourteen measurement (scan analysis) modes, which refer to specific beam locations, quantities of beams, or edge transitions. Note that not all measurement mode options are available when the receiver interface is used for configuration. Selected modes are individually assigned to each output (see Section 4.1 or 5.9 and 5.10).

When using the PC interface for configuration, the discrete outputs can have NPN or PNP polarity (regardless of model), be normally open or normally closed, and be assigned to any of the measurement modes. When using the receiver interface, limited output configuration combinations may be selected (Section 4.1).

NOTE: Array beams are numbered in sequence (beam 1 located nearest the sensor display; see Figure 1-3). The "first beam" referenced in the following descriptions is the beam nearest the sensor display.

"Beam Location" Modes
• **First Beam Blocked (FBB):** The location of the first blocked beam.
• **First Beam Made (FBM):** The location of the first made (unblocked) beam.
• **Last Beam Blocked (LBB):** The location of the last blocked beam.
• **Last Beam Made (LBM):** The location of the last made beam.
• **Middle Beam Blocked (MBB):** The location of the beam midway between the first and last blocked beams.

"Beam Total" Modes
• **Total Beams Blocked (TBB):** The total number of blocked beams.
• **Total Beams Made (TBM):** The number of beams made.
• **Contiguous Beams Blocked (CBB):** The largest number of consecutively blocked beams.
• **Contiguous Beams Made (CBM):** The largest number of consecutively made beams.
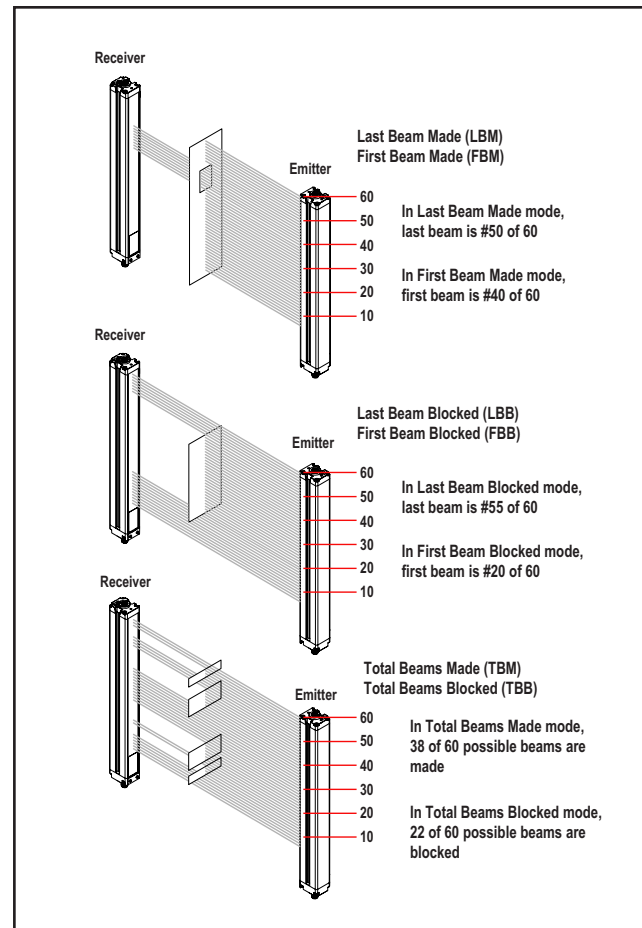
Figure 1-10. Measurement mode examples

- Transitions (TRN): The number of changes from blocked to clear status and from clear to blocked status. (If beams 6-34 are blocked, then there is a clear-to-blocked transition from beam 5 to beam 6, and a blocked-to-clear transition from beam 34 to beam 35.) Transition mode can be used to count objects within the array.

- **Outside Dimension (OD):** The inclusive distance (measured in beams) from the first blocked beam to the last blocked beam.

- **Inside Dimension (ID):** The number of made beams, between the first and last blocked beams.

- **Contiguous First Beam Blocked (CFBB):** The location of the first blocked beam in the largest group of adjacent blocked beams.

- **Contiguous Last Beam Blocked (CLBB):** The location of the last blocked beam in the largest group of adjacent blocked beams.

- **Carpet Nap and Carpet Edge:** These measurement modes are used to measure the location of carpet backing and tuft, and are selectable only via the PC interface, and only when the Scan Type "**Carpet Nap**" is selected. The modes can be measured from either end of the sensor, but at least 10 beams (2") must be blocked from one edge.

- **Special:** This mode is reserved for specialized applications; contact the factory for information.

1.11 Analog Output Configuration

Analog output configuration assigns analog outputs 1 and 2 to one of the measurement modes described in Section 1.10. When the selected measurement mode involves first or last beam blocked or made (unblocked), the assigned output will vary in proportion to the beam number identified during a scan. When the measurement mode involves total beams blocked or made, that assigned output will vary in proportion to the total beams counted during a scan.

Analog outputs may have Null and Span values set in the PC interface, in addition to a filter setting (to smooth the output) and Zero Value (to specify the output value when the measurement mode value is zero). See Section 5.8 for more information.

1.12 Discrete Output Configuration

Discrete Output 1; Receiver Interface
When the receiver interface is used for configuration, the measurement mode assigned to discrete output 1 is the same as that assigned to analog output 1. When the analog output detects a target present, discrete output 1 conducts (normally open).

Discrete Output 2; Receiver Interface
Discrete output 2 (only) has two options: alarm and complementary (measurement) operation.

Alarm: Output 2 energizes when the receiver detects a sensor error (such as a disconnected cable) or whenever the excess gain of one or more beams becomes marginal.

Complementary (Measurement): Discrete output 2 operation is complementary to discrete output 1 (when output 1 is ON, output 2 is OFF, and vice versa).

Discrete Output 1 and 2 Configuration; PC Interface
When the PC interface is used for configuration, the discrete outputs have more options: either discrete output can be assigned to any of the measurement modes, high and low set points can be added, the outputs can be inverted, and hysteresis values can be set, as well as a scan number to smooth output performance. Discrete output 2 can be assigned to alarm mode via the PC interface also. See Section 5.9 for more information.

1.13 Serial Communication

When the PC interface is used, the receiver communicates with a process controller via a Modbus RTU-485 interface. The PC interface software has a Communications Settings menu that includes the selected sensor communications port, options (either leave this field set at **DPB1**, or change it to **No Echo Suppression**), and a read-only window that provides current communications status. Advanced settings are also accessible, including baud rate, timeout (in milliseconds), message delay (in milliseconds), sensor address, parity, retry and byte delay. See Section 5.10 and the Appendix for more information.

2. Components and Specifications

2.1 Sensor Models

Emitter/Receiver Model NPN Outputs	Emitter/Receiver Model PNP Outputs	Analog Output	Array Length Y*	Total Beams
EA5E150Q Emitter **EA5R150NIXMODQ** Receiver **EA5R150NUXMODQ** Receiver	**EA5E150Q** Emitter **EA5R150PIXMODQ** Receiver **EA5R150PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	150 mm (5.9")	30
EA5E300Q Emitter **EA5R300NIXMODQ** Receiver **EA5R300NUXMODQ** Receiver	**EA5E300Q** Emitter **EA5R300PIXMODQ** Receiver **EA5R300PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	300 mm (11.8")	60
EA5E450Q Emitter **EA5R450NIXMODQ** Receiver **EA5R450NUXMODQ** Receiver	**EA5E450Q** Emitter **EA5R450PIXMODQ** Receiver **EA5R450PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	450 mm (17.7")	90
EA5E600Q Emitter **EA5R600NIXMODQ** Receiver **EA5R600NUXMODQ** Receiver	**EA5E600Q** Emitter **EA5R600PIXMODQ** Receiver **EA5R600PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	600 mm (23.6")	120
EA5E750Q Emitter **EA5R750NIXMODQ** Receiver **EA5R750NUXMODQ** Receiver	**EA5E750Q** Emitter **EA5R750PIXMODQ** Receiver **EA5R750PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	750 mm (29.5")	150
EA5E900Q Emitter **EA5R900NIXMODQ** Receiver **EA5R900NUXMODQ** Receiver	**EA5E900Q** Emitter **EA5R900PIXMODQ** Receiver **EA5R900PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	900 mm (35.4")	180
EA5E1050Q Emitter **EA5R1050NIXMODQ** Receiver **EA5R1050NUXMODQ** Receiver	**EA5E1050Q** Emitter **EA5R1050PIXMODQ** Receiver **EA5R1050PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	1050 mm (41.3")*	210
EA5E1200Q Emitter **EA5R1200NIXMODQ** Receiver **EA5R1200NUXMODQ** Receiver	**EA5E1200Q** Emitter **EA5R1200PIXMODQ** Receiver **EA5R1200PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	1200 mm (47.2")*	240
EA5E1500Q Emitter **EA5R1500NIXMODQ** Receiver **EA5R1500NUXMODQ** Receiver	**EA5E1500Q** Emitter **EA5R1500PIXMODQ** Receiver **EA5R1500PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	1500 mm (59.1")*	300
EA5E1800Q Emitter **EA5R1800NIXMODQ** Receiver **EA5R1800NUXMODQ** Receiver	**EA5E1800Q** Emitter **EA5R1800PIXMODQ** Receiver **EA5R1800PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	1800 mm (70.9")*	360
EA5E2100Q Emitter **EA5R2100NIXMODQ** Receiver **EA5R2100NUXMODQ** Receiver	**EA5E2100Q** Emitter **EA5R2100PIXMODQ** Receiver **EA5R2100PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	2100 mm (82.7")*	420
EA5E2400Q Emitter **EA5R2400NIXMODQ** Receiver **EA5R2400NUXMODQ** Receiver	**EA5E2400Q** Emitter **EA5R2400PIXMODQ** Receiver **EA5R2400PUXMODQ** Receiver	– Current (4–20 mA) Voltage (0–10V)	2400 mm (94.5")*	480

* Models with array lengths 1050 mm and longer ship with a center bracket as well as two end-cap brackets.

Components and Specifications

2.2 Cordsets and Connections

Quick-Disconnect Sensor Cordsets

Model	Description			Pinout
MAQDC-815	Straight female connector, 8-pin Euro-style	5 m (15') long		**Female Connector Shown**
MAQDC-830		9 m (30') long		
MAQDC-850		15 m (50') long		

M12X1 · Ø15.0 mm (0.59") · 48.5 mm (1.91")

Brown, White, Blue, Pink, Green, Yellow, Gray, Red
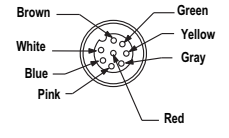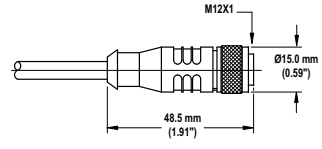
Communication Connections

Model	Description			Pinout
Communications Cables				
MQDMC-506	Straight male connector, 5-pin Euro-style	2 m (6.5') long		**Male Connector Shown**
MQDMC-515		5 m (15') long		
MQDMC-530		9 m (30') long		
MQDMC-506RA	Right-angle male connector, 5-pin Euro-style	2 m (6.5') long		
MQDMC-515RA		5 m (15') long		
MQDMC-530RA		9 m (30') long		

M12X1 · Ø14.5 mm (0.57") · 40.0 mm (1.57")

Blue, Black, White, Brown, Gray

31.8 mm (1.25") · 31 mm (1.22") · M12X1 · Ø13.5 mm (0.53")

USB Serial Adapter	**Dimensions**		
INTUSB485-1	For connection of 5-pin communications cable to computer USB port		

72.5 mm (2.85") · 77.5 mm (3.05") · 70.0 mm (2.75") · 82.0 mm (3.23") · 22.5 mm (0.88")

2.3 Alignment Aids

Model	Description
LAT-1-SS	Self-contained visible-beam laser tool for aligning any EZ-ARRAY emitter/receiver pair. Includes retroreflective target material and mounting clip.
EZA-LAT-SS	Replacement adaptor (clip) hardware for EZ-ARRAY models
EZA-LAT-2	Clip-on retroreflective LAT target
BRT-THG-2-100	2" retroreflective tape, 100'
BT-1	Beam Tracker

LAT-1-SS

Components and Specifications

2.4 Accessory Mounting Brackets and Stands

See Section 2.5 for standard brackets. Order one EZA-MBK-20 bracket per sensor, two per pair.

Model		Description
EZA-MBK-20		Universal adaptor bracket pair for mounting to engineered / slotted aluminum framing (e.g., 80/20™, Unistrut™).

EZA-MBK-20

MSA Series Stands (Base Included)*

Stand Model	Useable Stand Height	Overall Stand Height
MSA-S24-1	483 mm (19")	610 mm (24")
MSA-S42-1	940 mm (37")	1067 mm (42")
MSA-S66-1	1549 mm (61")	1676 mm (66")
MSA-S84-1	2007 mm (79")	2134 mm (84")

*Available without a base by adding suffix "**NB**" to the model number, e.g., **MSA-S24-1NB**.
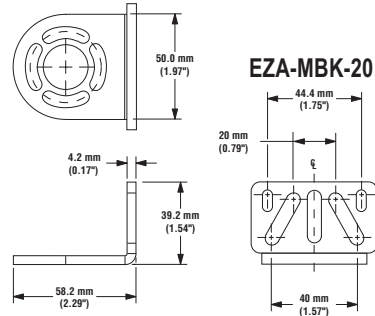
NOTE: Standard brackets shipped with sensors connect directly to MSA series stands, using hardware included with the stands.
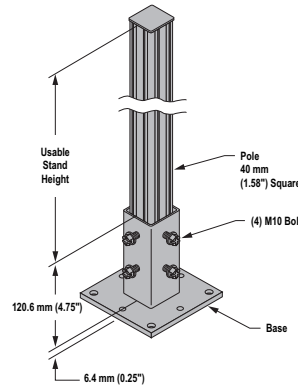
2.5 Replacement Parts

Description		Model
Access cover with label – receiver		EA5-ADR-1
Access cover security plate (includes 2 screws, wrench)		EZA-TP-1
Wrench, security		EZA-HK-1
Standard bracket kit with hardware (includes 2 end brackets and hardware to mount to MSA Series stands)	Black	EZA-MBK-11
	Stainless Steel	EZA-MBK-11N
Center bracket kit (includes 1 bracket and hardware to mount to MSA Series stands)		EZA-MBK-12

2.6 Specifications

Emitter/Receiver Range	400 mm to 4 m (16" to 13')
Field of View	Nominally ± 3°
Beam Spacing	5 mm (0.2")
Light Source	Infrared LED
Minimum Object Detection Size	**Straight Scan, Low-Contrast:** 5 mm (0.2") **Straight Scan, High-Excess-Gain:** 10 mm (0.4") See Figure 1-5 for other scan mode values; size is tested using a rod.
Sensor Positional Resolution	**Straight Scan:** 5 mm (0.2") **Double-Edge Scan:** 2.5 mm (0.1") **Single-Edge Scan:** 2.5 mm (0.1")

2.6 Specifications, continued

Supply Voltage (Limit Values)	**Emitter:** 12 to 30V dc **Receiver Analog Current Models:** 12 to 30V dc **Receiver Analog Voltage Models**: 15 to 30V dc
Supply Power Requirements	Emitter/Receiver Pair (Exclusive of Discrete Load): Less than 9 watts **Power-up delay**: 2 seconds
Teach Input (Receiver Gray Wire)	**Low:** 0 to 2 volts **High:** 6 to 30 volts or open (input impedance 22 K ohms)

Two Discrete Outputs	Solid-State NPN or PNP (current sinking or sourcing)
	Rating: 100 mA maximum each output
	OFF-State Leakage Current: NPN: less than 200 uA @ 30V dc
	                                    PNP: less than 10 uA @ 30V dc
	ON-State Saturation Voltage: NPN: less than 1.6V @ 100 mA
	                                          PNP: less than 2.0V @ 100 mA
	Protected against false pulse on power-up and continuous overload or short circuit.

Two Analog Outputs	**Voltage Sourcing:** 0 to 10V (maximum current load of 5 mA) **Current Sourcing:** 4 to 20 mA (maximum resistance load = $(V_{supply} - 3)/0.020$)
Serial Communication Interface (also see Appendix A)	EIA-485 Modbus RTU (up to 15 nodes per communication ring) RTU binary format **Baud Rate:** 9600, 19.2K or 38.4K 8 Data Bits, 1 Stop Bit, and Even, Odd, or 2 Stop Bits and No Parity
Scan Time	Scan times depend on scan mode and sensor length. Straight scan times range from 2.8 to 26.5 ms. See Figure 1-8 for all combinations.

**Status Indicators
(also see Section 1.4)**
	Emitter:
	Red Status LED
	  ON Red — Status OK
	  Flashing at 1 hz — Error **Receiver:**
	                                      7 Zone Indicators
	                                        Red — Blocked channels within zone
	                                        Green — All channels clear within zone
	                                3-digit 7-segment measurement mode / diagnostic indicator
	                                Sensor Status Bi-Color Indicator LED
	                                        Red — Hardware Error or Marginal Alignment
	                                        Green — OK
	                                Modbus Activity Indicator LED: Yellow
	                                Modbus Error Indicator LED: Red

System Configuration (Receiver Interface)	**6-position DIP switch:** Used to set scanning type, measurement modes, analog slope, and discrete output 2 function (see Section 4.1). **Push Buttons:** Two momentary push buttons for alignment and gain level selection.
System Configuration (PC interface)	Supplied software provides all configuration options of receiver interface, plus additional functionality; see Sections 1 and 5.
Connections	**Serial communication:** The receiver uses a PVC-jacketed, 5-conductor 22-gauge quick-disconnect cable, 5.4 mm diameter; see Sections 2.2 and 5.2. **Other Sensor connections:** 8-conductor quick-disconnect cables (one each for emitter and receiver), ordered separately; see Section 2.2 for available lengths (may not exceed 75 meters long), PVC-jacketed cables measure 5.8 mm diameter, have shield wire; 22-gauge conductors.
Construction	Aluminum housing with clear-anodized finish; acrylic lens cover
Environmental Rating	IEC IP65
Operating Conditions	**Temperature:** −40° to +70° C (−40° to 158° F) **Maximum relative humidity:** 95% at 50° C (non-condensing)
Certifications	$C \, \epsilon$

Components and Specifications

2.7 Emitter and Receiver Dimensions

With mounting bracket flanges "out"

With mounting bracket flanges "in"

45.2 mm (1.78")

36.0 mm (1.42")

12 mm (0.47")

Y

L1

L2

L3

56.0 mm (2.20")

4.2 mm (0.17")

65 mm (2.6")

R13 mm (0.5") minimum bend
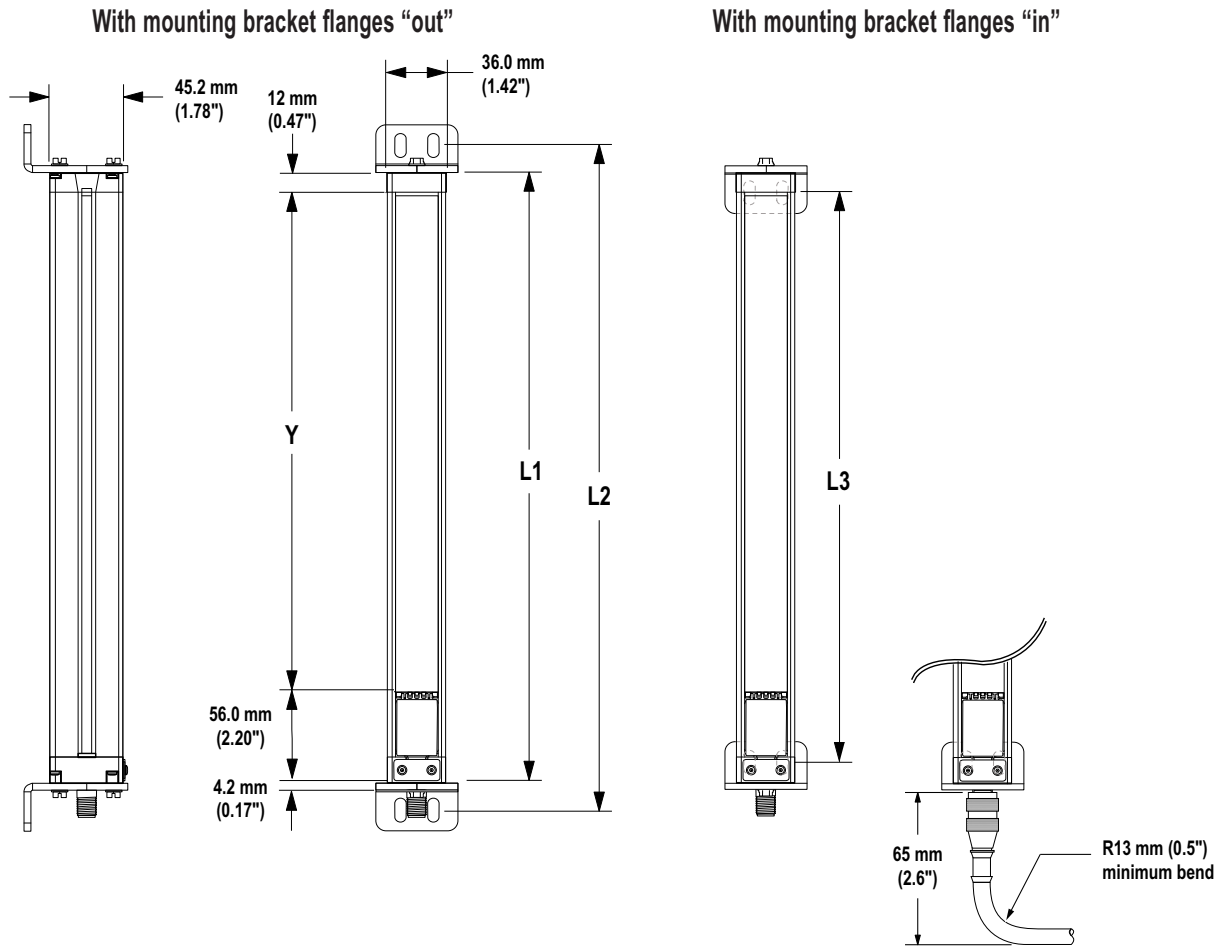
Emitter or Receiver Model	Housing Length L1	Distance Between Bracket Holes		Defined Area† Y
		L2	L3	
EA5..150..	227 mm (8.9")	260 mm (10.2")	199 mm (7.8")	150 mm (5.9")
EA5..300..	379 mm (14.9")	412 mm (16.2")	351 mm (13.8")	300 mm (11.8")
EA5..450..	529 mm (20.8")	562 mm (22.1")	501 mm (19.7")	450 mm (17.7")
EA5..600..	678 mm (26.7")	704 mm (27.7")	650 mm (25.6")	600 mm (23.6")
EA5..750..	828 mm (32.6")	861 mm (33.9")	800 mm (31.5")	750 mm (29.5")
EA5..900..	978 mm (38.5")	1011 mm (39.8")	950 mm (37.4")	900 mm (35.4")
EA5..1050..	1128 mm (44.4")	1161 mm (45.7")	1100 mm (43.3")	1050 mm (41.3")
EA5..1200..	1278 mm (50.3")	1311 mm (51.6")	1250 mm (49.2")	1200 mm (47.2")
EA5..1500..	1578 mm (62.1")	1611 mm (63.4")	1550 mm (61.0")	1500 mm (59.1")
EA5..1800..	1878 mm (73.9")	1911 mm (75.2")	1850 mm (72.8")	1800 mm (70.9")
EA5..2100..	2178 mm (85.7")	2211 mm (87.0")	2150 mm (84.6")	2100 mm (82.7")
EA5..2400..	2478 mm (97.6")	2511 mm (98.9")	2450 mm (96.4")	2400 mm (94.5")

†Nominal measurement

2.8 Standard Bracket Dimensions

End Cap Brackets
(model EZA-MBK-11*)

4 x R 19.4 mm (0.76")
4 x 45
4 x 5.8 mm (0.23") wide slots
Ø 21.5 mm (0.85")
Ø 33 mm (1.30")
38.2 mm (1.50")
50 mm (1.96")
111087

4.2 mm (0.17")
63.2 mm (2.49")
25 mm (0.98")

2 x 5 mm (0.20")
2 x 7 mm (0.28")
2 x R 5 mm (0.20")
2 x 15 mm (0.59")
20 mm (0.79")

***Dimensions are identical for model EZA-MBK-11N stainless steel brackets.**

Center Bracket
(model EZA-MBK-12)**

Ø 60 mm

20 mm (0.79")
20 mm (0.79")

**** Supplied with emitters and receivers over 1050 mm.**

20 mm (0.79")
55 mm (2.17")
50 mm (1.97")
17.5 mm (0.69")

55.6 mm (2.19")
4.2 mm (0.17")

9.5 mm (0.37")
10 mm (0.39")
Ø 8.3 mm (0.33")
36 mm (1.42")
Ø 7 mm (0.28")
15 mm (0.59")
20.0 mm (0.79")

3. Installation and Alignment

3.1 Mounting the Emitter and Receiver

Compact EZ-ARRAY emitters and receivers are easy to handle during mounting. When mounted to the sensor end caps, the supplied mounting brackets allow ±30° rotation. An emitter may be separated from 400 mm to 4 m (16" to 13') from its receiver.

From a common point of reference, make measurements to locate the emitter and receiver in the same plane, with their midpoints and display ends directly opposite each other. (If sensors are mounted with their display ends at the top, see Section 1.5 or 5.8 for directions on inverting the 3-digit display.) Mount the brackets to the emitter and receiver housings using the supplied M6 bolts and Keps nuts, or user-supplied hardware; see Figure 3-1.

Center mounting brackets must be used with longer sensors, if they are subject to shock or vibration. In such situations, the sensors are designed to be mounted with up to 900 mm unsupported distance (between brackets). Sensors 1050 mm and longer are supplied with a center bracket to be used as needed with the standard end-cap brackets.

1. Attach the center bracket to the mounting surface when mounting the end-cap brackets.

2. Attach the clamp to both slots of the housing, using the included M5 screws and T-nuts.

3. After the sensor is mounted to the end-cap brackets, attach the clamp to the center bracket using the supplied M5 screw.

EZ-ARRAY End-Cap Brackets
(supplied with each emitter and receiver)

Swivel Center Bracket
(supplied with emitters and receivers 1050 mm and longer)

End-Mounted

Side-Mounted
(two center brackets may be substituted)

Sensors are designed to be mounted with up to 900 mm unsupported distance between brackets.

Bracket

Clamp

NOTE: Sensor brackets are designed to mount directly to accessory MSA series stands (Section 2.3), using hardware supplied with the stands.

Figure 3-1.   A-GAGE EZ-ARRAY emitter and receiver mounting hardware

3.2 Mechanical Alignment

Mount the emitter and receiver in their brackets and position the windows of the two units directly facing each other. Measure from one or more reference planes (e.g., the building floor) to the same point(s) on the emitter and receiver to verify their mechanical alignment. Use a carpenter's level, a plumb bob, or the optional LAT-1-SS Laser Alignment Tool, or check the diagonal distances between the sensors, to achieve mechanical alignment.

When alignment is difficult, a LAT-1-SS tool is useful to assist or confirm alignment by providing a visible red dot along the sensor's optical axis (see Figure 3-3). Snap the LAT-1 clip onto the sensor housing, turn on its laser emitter, and use a strip of retroreflective tape at the opposite sensor to see the dot.

Also check "by eye" for line-of-sight alignment. Make any necessary final mechanical adjustments, and hand-tighten the bracket hardware. See Sections 3.4 and 4.2 for further alignment information.
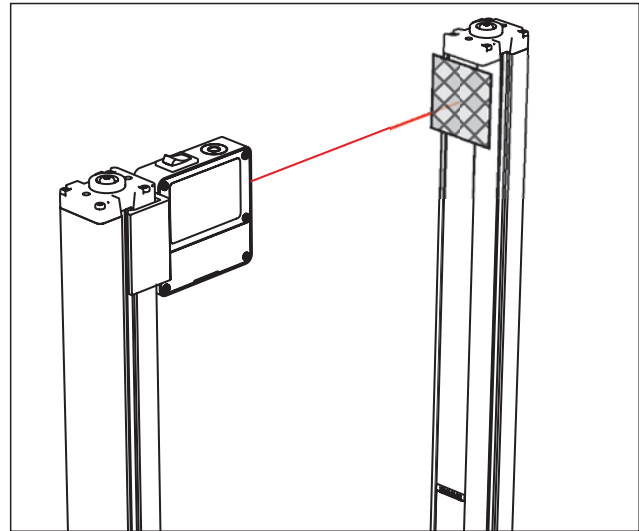
Figure 3-3. Optical alignment using the LAT-1-SS

Verify that:
- The emitter and receiver are directly opposite each other, and nothing is interrupting the beams.
- The sensing area is the same distance from a common reference plane for each sensor.
- The emitter and receiver are in the same plane and are **level/plumb and square to each other** (vertical, horizontal, or inclined at the same angle, and not tilted front-to-back or side-to-side).
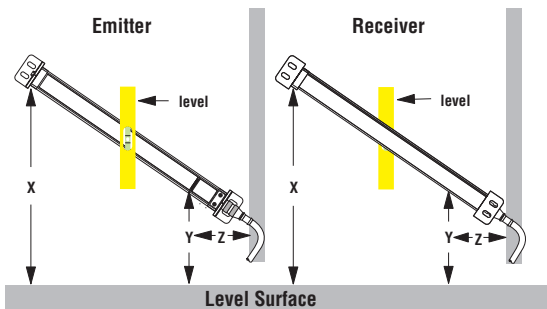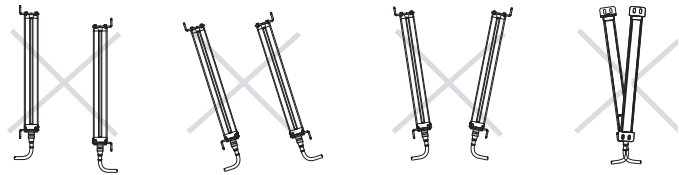
Angled or Horizontal Installations – verify that:
- Distance X at the emitter and receiver are equal.
- Distance Y at the emitter and receiver are equal.
- Distance Z at the emitter and receiver are equal from parallel surfaces.
- Vertical face (i.e., the lens) is level/plumb.
- Sensing area is square. Check diagonal measurements if possible; see Vertical Installations, at right.
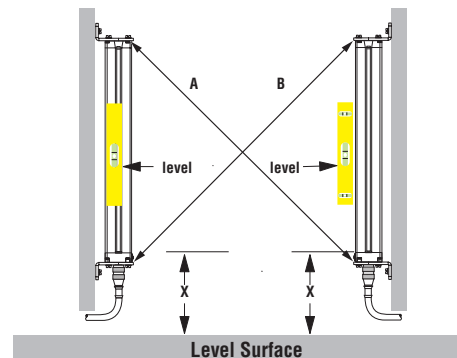
Vertical Installations – verify that:
- Distance X at the emitter and receiver are equal.
- Both sensors are level/plumb (check both the side and face).
- Sensing area is square. Verify diagonal measurements if possible (Diagonal A = Diagonal B).

Figure 3-2. Sensor mounting, mechanical alignment

3.3 Hookups

Refer to Figures 3-4, 3-5, and 3-6 for the appropriate hookup information.

Serial Connection

This connection is used only when the PC interface is also used. The receiver has a Modbus RTU-485 serial interface. A separate 5-pin Euro-style connection is provided at the end opposite from the power cable connection to electrically connect the serial communication cable to an external PC or PLC. Refer to Figure 3-4; the white wire is connected to the Modbus D1/B/+ terminal and the black wire is connected to the D0/A/− terminal.

Inputs

Refer to Figures 3-5 and 3-6 for standard hookup information.

Receiver gray wire: The receiver has an input that can be used as a gate input or for remote teach. To initiate remote teach, alignment, and gating functions, tie the wire through a switch to sensor common. See Sections 1.7 and 5.7 for more information.

Outputs

Refer to Figures 3-5 and 3-6 for standard hookup information and Section 2.6 Sensor Specifications for further electrical requirements.

Analog white and yellow wires: The receiver has two analog outputs. Depending on receiver model, both outputs are either voltage or current. The white wire is referenced as analog output 1; the yellow wire is referenced as analog output 2. Both analog current and voltage will source current through an external load to sensor common.

Discrete Outputs: The receiver has two discrete outputs; the green wire is referenced as discrete #1, and the red wire, discrete #2. Depending on model, both outputs are either NPN or PNP, unless the polarity is altered via the PC interface. Refer to Section 2.6 Specifications for further electrical requirements.

Sync (Pink) Wire

The emitter and receiver are electrically synchronized via the pink wire. The emitter and receiver pink wires must only be electrically connected together.
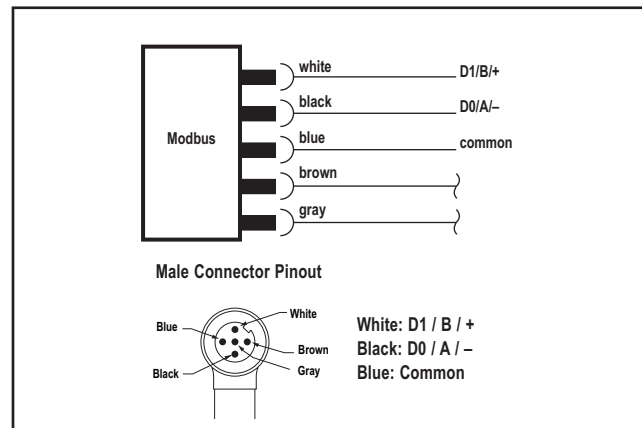
Figure 3-4. Serial communication hookup
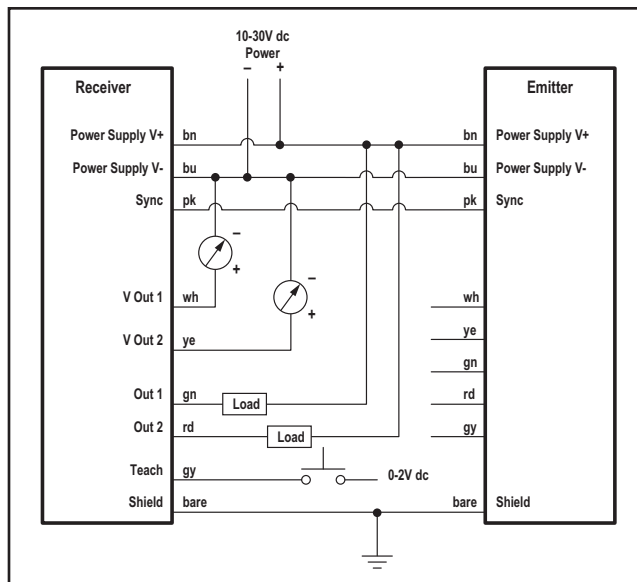
Figure 3-5. NPN hookup
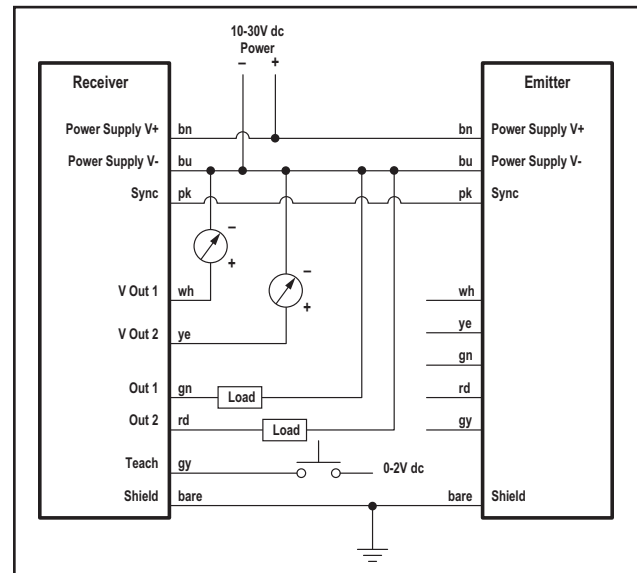
Figure 3-6. PNP hookup

3.4 Optical Alignment

After the electrical connections are made, power up the emitter and receiver. Verify that input power is present to both emitter and receiver; the emitter Status indicator and the receiver Status LED should be ON green. If the receiver Status LED is on red (and a "**c**" appears on the 3-digit display), refer to Section 4.5.

NOTE: At power-up, all Zone indicators are tested (flash red), then the number of blocked beams is displayed.

Observe the receiver indicators (see table below).

Optimize Alignment and Maximize Excess Gain
Verify that the emitter and receiver are pointed squarely at each other. A straightedge (e.g., a level) can help determine the direction the sensor is facing (see Figure 3-7).

Slightly loosen the sensor mounting screws and rotate one sensor to the left and right, noting the positions where the receiver Zone indicators turn from green to red; repeat with the other sensor. Center each sensor between the noted positions and tighten the end cap mounting screws, making sure to maintain the positioning. The sensor windows should directly face each other.

Once optimum optical alignment is verified, proceed to configuration, via the remote teach wire, the receiver interface, or the PC interface (Section 1.5, 4.2, or 5.3) and complete the electronic alignment. This further alignment step adjusts the emitted light level of each beam for the application, to maximize sensing performance.

a) 0 beams blocked; all Zone indicators ON Green

b) 60 beams blocked; all Zone indicators ON Red

c) 30 beams blocked; 4 Zone indicators ON Green, 3 ON Red

d) 0 beams blocked; all Zone indicators ON Green
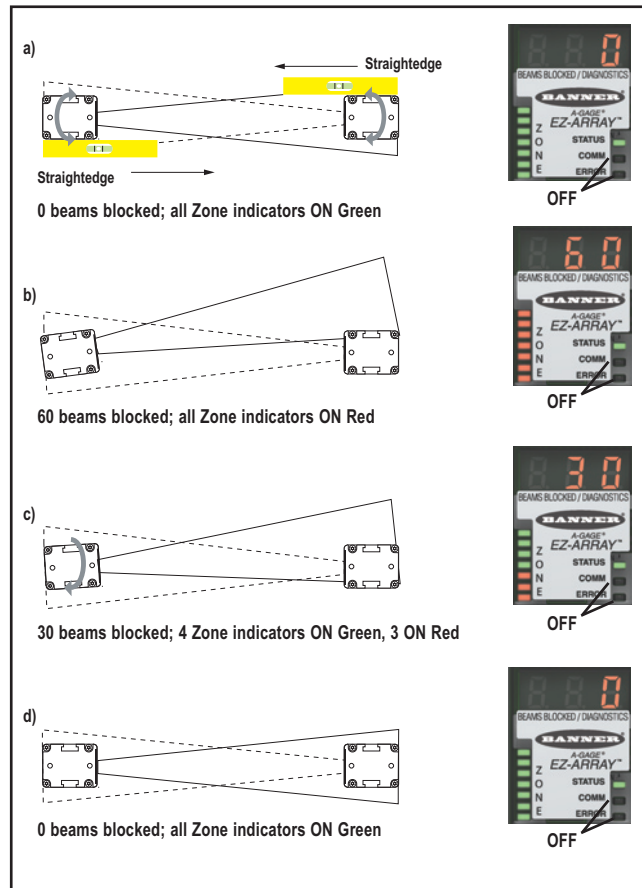
Figure 3-7. Optimizing optical alignment; 300 mm model shown

Possible Indicator Combinations

	All Beams Either Clear or Blanked	**Some Beams Blocked or Mis-Aligned**	**Out of Alignment**
Zone Indicators	All ON Green	Some ON Red (zones with blocked beams) Some ON Green (zones with all clear beams)	All ON Red (Some beams blocked in each zone)
Receiver Status Indicator	ON Green	ON Green	ON Green
3-Digit Display	0 (Number of blocked beams)	Number of blocked beams	Total number of beams in the array

4. Using the Receiver User Interface

The receiver user interface comprises the six-position DIP switch, two push buttons, 3-digit display, and other indicators present on the receiver (see Section 1.4 for more complete status indicator information). The receiver interface enables configuration of standardized combinations of the EZ-ARRAY sensing options (output configuration, scanning methods and modes); for more advanced setup, refer to Section 5 for PC interface configuration instructions.

4.1 Configuration DIP Switch

The DIP switch can be used to configure the sensor. Access the switch by removing the screw-on security plate and lifting the clear hinged access cover. The access cover may be removed entirely (pull straight out to remove, press back in to replace) for easier access during configuration.

Some of the switches are assigned their own functions, others work together in combination (see table). Switches S1 and S2 in combination select one of four scanning modes. Switches S3 and S4 in combination select one of four measurement mode pairs (one for each analog output). Switch S5 defines the analog slope setting for both analog outputs and S6 defines whether discrete output 2 is complementary to discrete 1, or functions as an alarm (when configuration is accomplished via DIP switch, discrete output 1 conducts when analog output 1 senses the presence of a target).
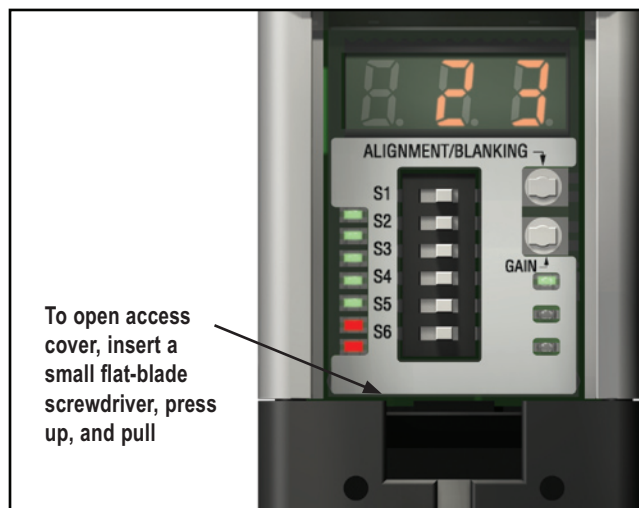
EZ-ARRAY Receiver User Interface DIP Switch Settings

Switch Settings*		Result	
S1	**S2**	**Scan Mode**	
<u>ON</u>	<u>ON</u>	<u>Straight Scan</u>	
ON	OFF	Double-Edge, Step 1	
OFF	ON	Double-Edge, Step 4	
OFF	OFF	Single-Edge	
S3	**S4**	**Analog 1** (Value reads on 3-digit display)	**Analog 2**
<u>ON</u>	<u>ON</u>	<u>TBB</u>	<u>FBB</u>
ON	OFF	LBB	MBB
OFF	ON	OD	ID
OFF	OFF	CBB	CFBB
S5 ON		<u>Positive Analog Slope</u>	
S5 OFF		Negative Analog Slope	
S6 ON		<u>Discrete 2 Complementary</u>	
S6 OFF		Discrete 2 Alarm	
*<u>Underlined</u> settings are factory defaults			

Scanning Modes (S1 and S2)
Straight Scan (S1 ON, S2 ON) is the most versatile scanning mode and can be used without the exceptions noted in the other scanning modes. Use this scanning mode when using the low-contrast sensitivity setting to measure semi-transparent materials.

Double-Edge Step 1 (S1 ON, S2 OFF) can be used when three or fewer opaque objects are presented to the light curtain at one time. The advantage of this mode is improved sensor edge resolution (2.5 mm). The minimum object detection size is 10 mm.

Double-Edge Step 4 (S1 OFF, S2 ON) can be used when three or fewer opaque objects are presented to the light curtain and the minimum size object to be detected is 30 mm. This scanning mode ignores objects smaller than 30 mm. Like Double-Edge Step 1, the sensor edge resolution is 2.5 mm. See Figure 1-8 for sensor scan times.

Single-Edge Scan (S1 OFF, S2 OFF) can be used when a single opaque object is presented to the light curtain at one time. The object must block the "bottom" channel (the channel closest to the receiver display). Like the double-edge scans, the sensor edge resolution is 2.5 mm. The minimum object detection size is 10 mm. See Figure 1-8 for sensor scan times.

To open access cover, insert a small flat-blade screwdriver, press up, and pull

Figure 4-1. Receiver user interface. NOTE: All DIP switch positions are shown in the ON condition.

Because single-edge scan is capable only of measuring the height of an opaque object that blocks the bottom channel and all channels up to the height of the object, the pertinent measurement modes are LBB (last beam blocked) or TBB (total beams blocked). When single-edge scan is selected, the selected measurement mode will be applied to both analog outputs. Selection of OD/ID with single-edge scan will result in an error code.

Measurement Modes (S3 and S4)

The measurement modes, determined by switches S3 and S4 in combination, define what information is calculated by the sensor and sent via the analog outputs. **See Section 1.10 for measurement mode definitions**. Discrete output 1 will conduct when analog output 1 detects a target. (If single-edge scan is selected, select measurement mode LBB or TBB.)

During normal operation, the 3-digit diagnostic display reads out the numerical value of the specified measuring mode for analog output 1.

Analog Slope (S5)

Switch S5 defines the analog output slope. As the measurement mode values increase, the analog output voltage can either increase (positive slope, S5 ON) or decrease (negative slope, S5 OFF). Switch S5 applies the same slope to both analog outputs.

Complementary/Alarm (S6)

Switch S6 defines the operation of discrete output 2. When the receiver user interface is used, discrete output 1 is active when an object is detected by the sensor (normally open operation). In complementary mode (S6 ON), output 2 will always be in the opposite state of output 1. In alarm mode (S6 OFF), discrete output 2 will be active when the sensor detects a system fault. System faults include a failed emitter, mis-wiring of the emitter/receiver communication wire (the pink wire), and low excess gain (if the sensor is configured for high-contrast sensitivity).

4.2 Alignment/Blanking Button (Electronic Alignment)

The Alignment/Blanking push button is used both to maximize the alignment and to access the blanking feature. The electronic alignment routine adjusts the emitted light level to maximize sensor performance. Perform the procedure at installation and again when the emitter and/or receiver is moved. For PC interface software alignment instructions, see Section 5.5.

Blanking is used to maintain sensing accuracy in applications where a fixed object (for instance a permanently mounted bracket) will block one or more beams. The sensor will ignore the blanked channels when calculating outputs from the selected measurement modes.

Electronic Alignment and Blanking — Receiver Interface

To initiate the electronic alignment procedure, use a small screwdriver to press the Alignment/Blanking button for two or more seconds. The left-hand digit of the 3-digit display will read "**A**" (representing alignment); the right two digits will show the number of beams blocked. The receiver is learning the clear condition. Rotate the sensors as required (but do not change the distance between them). When the receiver's 3-digit display shows 0 beams blocked, the sensors are adequately aligned.

Tighten the sensor mounts, then press the Alignment/Blanking button again for two seconds to exit alignment mode. If all sensor light channels are clear, the EZ-ARRAY stores each channel's signal strength in non-volatile memory and reads " **- - -** " on the 3-digit display. Re-alignment is not required again, unless the emitter or receiver is moved.

If any beams are blocked by objects other than the sensing target to be measured during run mode, those beams can be blanked in alignment mode for more accurate measurement. The blocked beams must be either blanked or cleared during alignment mode for alignment to proceed (see below). While the "**A**" is visible on the receiver display, momentarily (about 0.5 seconds max.) press the Alignment/Blanking button again. The "**A**" will change to "**n**" to indicate the sensor is ready to "learn" the blanking pattern; momentarily press the button again to exit the blanking routine. The sensor blanks the blocked beams and the display changes to "**A.**"; the period following the lefthand digit signifies blanking is active. Press the Alignment/Blanking button for two seconds to exit alignment mode. The EZ-ARRAY stores each channel's signal strength in non-volatile memory and reads " **-. - -** " on the 3-digit display to denote blanking is in use.

Flashing "000" on the 3-Digit Display

When returning to run mode, the receiver determines whether any unblanked beam channels are obstructed. If any channels are obstructed, the new alignment settings are not saved; the receiver flashes zeroes on the display three times and sensing will continue, using the previously set alignment settings. If this occurs, either clear the blocked beams and repeat the alignment routine or repeat the alignment routine and blank the blocked beams.

4.3 Gain (Sensitivity Adjust) Button

To change the sensitivity (Gain setting), press and hold the button for two seconds. The left-hand digit of the 3-digit display will read "L"; the right-hand digit will read "**1**" (high excess-gain) or "**2**" (low-contrast. The sensitivity level can then be toggled between the values 1 and 2. When the desired sensitivity level is displayed, hold the Gain push button for 2 seconds and the sensor will return to run mode.

4.4 Inverting the 3-Digit Display

For instances where the sensors must be mounted in an inverted position, the 3-digit display can be can be inverted for readability. See the remote teach procedure (Section 1.5). The 3-digit display can then be switched back to "normal" by repeating the procedure.

NOTE: The periods on the three seven-segment indicators do not move when the display is inverted.

4.5 Troubleshooting and Error Codes

If the receiver Status LED is red and the 3-digit display reads "**c**" followed by a number from **1** to **10**, a corrective action is needed (see table below).

"Dirty" Channel Indicator
If the Status LED is red, but no "**c**" is visible on the 3-digit display (the scan measurement mode result is displayed), the sensor alignment is marginal. Clean the sensor windows and perform the alignment procedure as necessary.

For all corrective actions, first verify proper supply voltages and wiring connectivity. Disconnect and re-connect the sensor cable connectors to verify proper connector installation.

Error Code	Problem	Corrective Action
1	Receiver EEPROM Hard Failure	This problem is caused by a receiver failure that cannot be corrected by the user. Replace the receiver.
2	Receiver Alignment/Blanking Configuration Error	Remove and re-apply sensor supply voltage. If the error code 2 is removed, electrically re-align the sensor (Section 4.2). If the error code persists, contact Banner for further problem-solving techniques.
3	Reserved for Factory	Replace the receiver.
4	Emitter or Wiring Problem	1. Verify that emitter and receiver wiring is correct (see Figures 3-5 and 3-6). 2. Check the status of the emitter Status LED. • **Emitter LED OFF:** Check the voltage across the emitter brown and blue wires. If the voltage across the emitter brown and blue wire is OK, then replace the emitter. • **Emitter Status LED flashing (approx. every 2 seconds):** Verify that the emitter/receiver synch (pink) wires are correctly installed. 3. Verify that the Synch wires are correctly installed. Check the synch wire dc voltage. If the voltage is below 1 volt or above 3 volts, then again check the synch wire for possible mis-wiring. Unplug first the receiver and then the emitter to determine the problem source.
5	Emitter Channel Error	The emitter has identified a nonfunctional optical channel. **Temporary fix:** Blank the channel (Section 4.2) to ignore the problem. **Permanent fix:** Replace the emitter.
6	Reserved for Factory	Replace the receiver.
7	Reserved for Factory	Replace the emitter.
8	Reserved for Factory	Replace the receiver.
9	Reserved for Factory	Replace the receiver.
10	Incompatible Scan and Measurement Mode	Some measurement modes are incompatible with some scanning modes. **Single-Edge Scan; do not use the following measurement modes:** OD, ID, FBM, LBM, TBM, CBM, Nap Detection **Double-Edge Scan; do not use the following measurement modes:** FBM, LBM, TBM, CBM, Nap Detection

5. Using the PC Interface (Banner Sensors GUI)

The full functionality of the EZ-ARRAY is available by making use of the PC interface (the graphic user interface, or "Banner Sensors GUI"). Refer to Section 1 for a full description of the available sensing modes and other features.

The sensor is easily configured using a Windows® menu-style program via the Banner Sensors GUI software and a PC-compatible computer (running Windows XP or 2000; GUI software version 1.2 will also be compatible with Vista®).

5.1 Supplied Software

The PC interface software for configuring the EZ-ARRAY is included on the CD packed with the receiver, entitled Banner Sensors GUI (p/n 76978).

For the most recent software version, visit www. BannerEngineering.com and enter "Banner Sensors GUI" in the search field. Install the software (version 1.1 at this writing) onto your hard drive; the installer will automatically load the software into a folder titled "Banner Engineering\Banner Sensors GUI" onto your computer. If the CD is used, inserting it into your CD drive will auto-launch the GUI installation and place the icon onto your desktop.

Double-click on the **Banner Sensors GUI** icon [GUI] to launch the program. The main menu screen appears. Verify that **A-GAGE® EZ-ARRAY** is displayed in the **Select a Sensor** field of the screen.
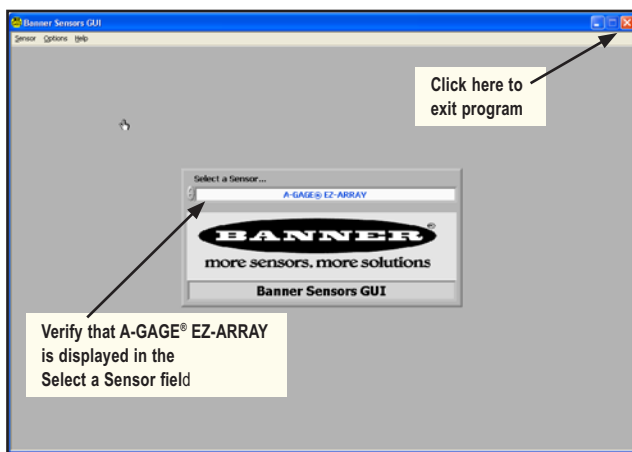
Figure 5-1. Banner Sensors GUI (PC Interface) main menu screen

5.2 Communications Connections

Connect the serial cable from your receiver to your PC, using an RS485-to-RS232 adapter, such as the model INTUSB485-1 USB serial adapter listed in Section 2.2. (Instructions for configuring the adapter are included with the packaging for the adapter.)

An operating EZ-ARRAY system must be connected before the software displays will open.

5.3 Accessing the GUI

With the sensor pair powered up and connected to your PC (as described in Section 5.2), go to **Sensor > Connect** (Ctrl + N).

The Alignment/Status screen appears, providing a snapshot of the current sensing alignment status, including the status of each array beam, total numbers of blanked, made and blocked beams, the selected measurements and their values (see Figure 5-2).

The Alignment/Status screen has three pull-down menus: **Sensor**, **Options**, and **Help**.

Sensor Menu (Alignment/Status screen)
When the Alignment/Status screen is active, the **Sensor** menu provides the options **Setup** (Ctrl + S), which is used to modify or view a sensor configuration, **Connect/Disconnect** (Ctrl + N), which connects (or disconnects) the PC to the sensor, and **Exit** (Ctrl + Q). When a setup screen view is active, the Sensor menu has other options (see Figures 5-3 and 5-5).

NOTE: **Most GUI Setup options are not available until the Connect function has linked the PC to a sensor pair.**
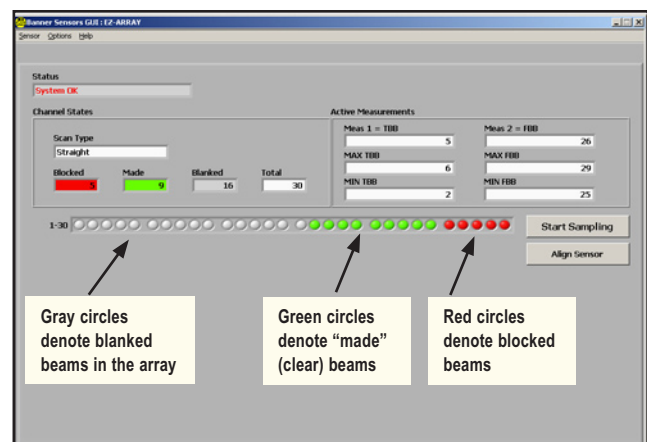
Figure 5-2. EZ-ARRAY Alignment/Status screen

Setup

Select **Sensor > Setup** (Ctrl + S) to modify or view the configuration of the connected sensor pair. Refer to Figure 5-12 for an overview of available configuration options and Sections 5.6–5.13 for more information.
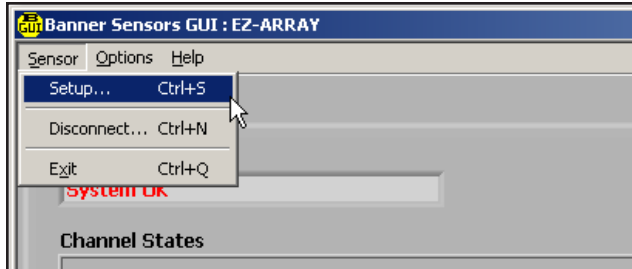
Figure 5-3. Sensor menu, Alignment/Status screen

Connect / Disconnect

To disconnect from a pair of sensors, select **Disconnect** (Ctrl + N) from the Sensor menu.

Exit

To quit the program, select **Exit** (Ctrl + Q) from the Sensor menu or click on the ⊠ in the upper right-hand corner of the screen (see Figure 5-1).

Sensor Menu (Setup Screen)

When a setup screen view is active, the sensor menu includes the read, write and save configuration options, plus Close (see Figure 5-5).

Reading, Writing, and Saving Configurations

When a configuration is complete, it can be written to the sensors and it can also be saved in an .xml file on your computer. The following commands can be accessed in several ways, including buttons on individual Setup screen views and in the Sensor menu while a Setup screen is active.

If changes will be made via the GUI, it is recommended to first save a copy of the sensor's original configuration.
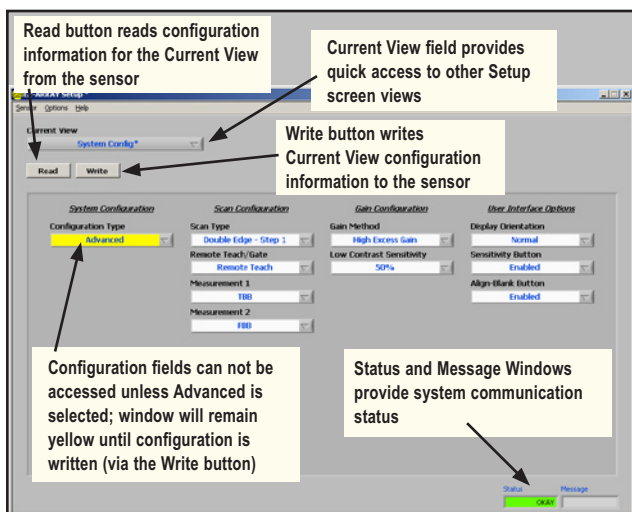
Figure 5-4. Setup screen, System Config view
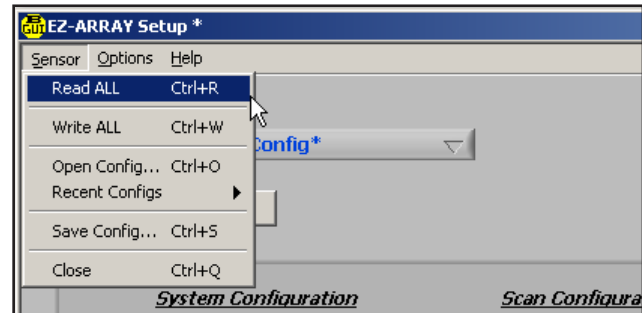
Figure 5-5. Sensor menu, System Config view

Use the **Read** button to read the current configuration for the displayed Setup view from the sensor. If a change is made to any configuration field, it remains highlighted in yellow on the PC screen until it is written to the sensor via the **Write** button. The **Write** button writes configuration changes for the selected Setup view only.

The **Read ALL** and **Write ALL** menu items read or write configuration parameters between the GUI and sensor for *ALL* setup view fields, regardless of the view selected—including the factory-calibrated Null and Span settings. Alignment and Blanking configuration information can be accessed only via the Alignment/Status screen.

The **Save Config** menu item is used to save a configuration file to your PC for later retrieval. Use the **Open Config** menu item to retrieve a file from the PC in order to write it to a sensor. The **Recent Configs** menu item provides a shortcut to recently used configuration files.

Close

To return to the Alignment/Status screen from any Setup screen view, click **Close** (Ctrl + Q) or click on the ⊠.

Options Menu

The **Options** menu (Figure 5-6) provides the pull-down menu options **Communication Settings** (Ctrl + M), where the COM port may be selected, and **Debug** (Ctrl + D), which may be helpful during troubleshooting. **Power Cycle** and **10 Click** are not used for the EZ-ARRAY.

The first time the system is used, or when changes need to be made to the communications configuration, select **Options** > **Communication Settings** (Ctrl + M) from the menu screen (see Figure 5-6) to configure the PC serial communications port.

The resulting Communication Settings window has an **Advanced** or **Basic** option; when Basic is selected, only the fields **Select a Product**, **COM Port**, and **Echo Suppression Options** are listed. To access the Advanced menu, select **Options** > **Advanced Settings** (Ctrl + U) from the Communication Settings menu.

- **COM Port** selects the computer port used for serial communication with the sensor (**COM1**, **COM2**, . . . **COM20**).

- **Baud Rate** is the data communication rate between the sensor and the computer used for configuration. Choose from three options: **9600**, **19200**, and **38400**.
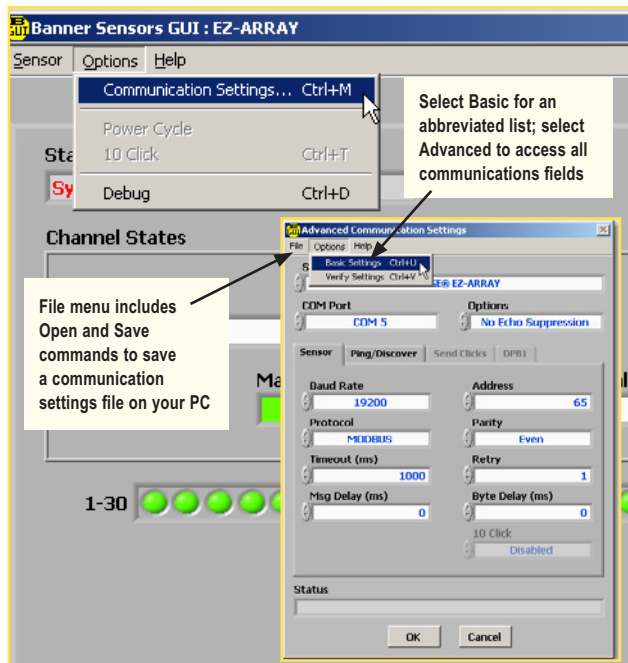
Figure 5-6. Options menu, Alignment/Status screen and resulting Communication Settings screen

- **Address** determines the sensor address (from **1** to **247**; factory default is **65**) on the Modbus network.

- **Timeout** determines how long (in ms) the PC will wait for a response from the sensor. Default is **1000 ms**.

- **Msg Delay** — Injects a delay (pause) between messages between the GUI and a sensor (in ms).

- **Protocol** (**Modbus**). Do not select Bannerbus.

- **Parity:** Select **Odd**, **Even**, or **None**.

- **Retry** — Number of times the GUI will attempt communication with the sensor.

- **Options** (**DPB1**, **No Echo Suppression**, or **Echo Suppression**). EZ-ARRAY requires either **DPB1** or **No Echo Suppression** for communication.

Help Menu

Help (Ctrl + A) provides system version information for reference in the event of a Factory applications help call; see Figure 5-7.
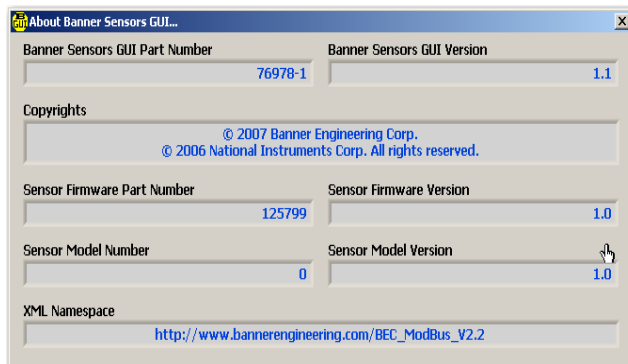
Figure 5-7. Help menu results in About Banner Sensors GUI screen

5.4 Factory Defaults

Factory default selections in this section are designated with an underline. To reconfigure a sensor to the factory default optons, access the .xml default file from the folder **Banner Engineering > Banner Sensors GUI > Configs > Defaults** (see Section 5.1).

This changes all the setup fields in the GUI to the default values, which can then be reviewed and/or written to the sensor.

NOTE: If reverting a configuration to the default values, first record the sensor's factory-calibrated Null and Span values, so they can later be written to the sensor.

5.5 Alignment and Blanking

When the Alignment/Status screen is first displayed (see Section 5.3 and Figure 5-2), two functions can be performed: Start Sampling and Align Sensor.

The System Alignment screen Channel States display can be used to see an ongoing, realtime display of sensing status. Click on **Start Sampling**; the Status window will read **Sampling in Progress** until **Stop Sampling** is selected. When sampling is not active, the Channel States displays are not updated.

The Channel States status fields in the screen provide a color-coded, visual status of the number of blocked (red), made (green), and blanked (gray) channels. The selected sensor scan type is displayed in the Scan Type text field. The "blanked" value is a count of the beam channels that are ignored when the sensor applies the current blanking configuration to the selected measurement mode (see Section 1.10). The "blocked" value is a count of blocked beams, excluding any blanked beams. The "made" value is a count of unblocked and unblanked beams. The total number of beams blocked, made, and blanked will always equal the total number of sensor beam channels. Below this row of text boxes is a graphic display that depicts the status of each individual beam, color-coded to the totals boxes above it. This graphic display may be used both to view which beams are blocked or blanked and also to blank individual beams.

The Active Measurements status fields depict the active (selected) measurement modes (up to two), with the present value for each, plus a history of the minimum and maximum values recorded during the sampling of a target, held until a new target is presented. This **sampling tool** is useful for setting the sensor discrete output levels, for verifying sensor operation, and for proving out an application.

Perform electronic alignment when the sensor is first installed, and repeat whenever the emitter or receiver (or both) is moved. Electronic alignment also can be initiated using the remote TEACH line or the Alignment switch on the receiver's front panel (see Sections 1.5 and 4.2).

The electronic alignment routine adjusts the emitted light level to maximize sensor perfomance. When the system exits alignment, the sensor records and stores channel signal strength and blanking information in non-volatile memory until electronic alignment is performed again. Perform the procedure at installation and again whenever the emitter and/or receiver is moved. (For Receiver interface software alignment instructions, see Section 4.2.)

Electronic Alignment Procedure

Note that electronic alignment, once initiated, can not be exited without completing the entire routine (there is no "exit without save" option). To align the sensor from the PC, press the **Align Sensor** button on the System Alignment screen.

While the sampling is taking place, the Status field of the System Alignment screen will read **Alignment Sampling in Progress**.

When the sensor is aligned and all unobstructed beams are detected as made beams, press **Stop Sampling**. The Status window will read **Alignment in Progress**. When the alignment sampling stops, additional options become enabled on the Alignment screen: Save and Exit Alignment, Auto Blanking, Clear Blanking Fields, Undo Edits (if any blanking changes were made), Save Config, and Open Config.

If necessary, physically adjust the emitter and/or receiver until the diagnostic display of the Alignment screen indicates that all unblocked beams are made (no red circles).

If any beams are blocked, they must either be cleared or blanked to save the alignment settings (see Figure 5-2).

Click **Save & Exit Alignment** to save the gain adjustment settings. The sensor will verify that all non-blanked optical channels are clear. If some channels are not clear (fail), the sensor will not perform the electronic alignment process and will retain the previously saved alignment parameters. If all the non-blanked optical channels are clear (succeed), the sensor will save the new electronic alignment parameters. A message will appear that alignment either succeeded or failed.
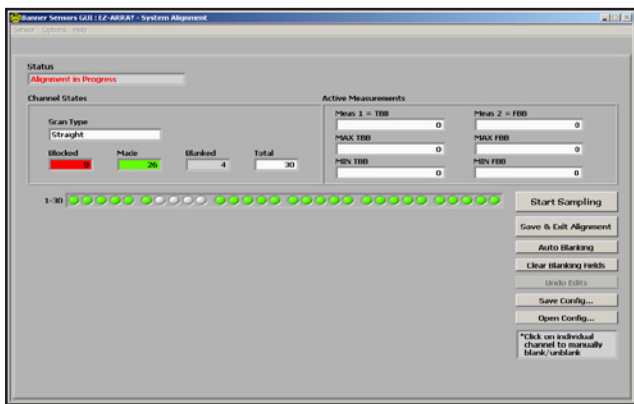
Figure 5-8. Alignment/Status screen, alignment in progress

If the alignment failed, check for objects that may be blocking one or more beams, or physically adjust the sensors until all beams on the Alignment screen's diagnostic display are green, then repeat the electronic alignment.

To blank individual channels, position the cursor on any of the depicted channels (either red or green circles) and click on it. To unblank any channel, click on a gray circle.

Click on **Auto Blanking** to automatically blank all blocked channels and remove blanking from unblocked channels. Click on **Clear Blanking Fields** to unblank all blanked channels. Click on **Undo Edits** to remove unsaved channel blanking edits.

Save Config

Click on **Save Config** to save the current set of configuration and blanking settings in an .xml file on your computer that can then be later retrieved and written to the sensor. In the pop-up box, select a storage destination and name the configuration file as desired.

Open Config

Click on **Open Config** to retrieve a previously saved configuration file. A screen will pop up, allowing you to browse in your computer for the file. When you select a new configuration, the blanking configuration automatically populates the Channel States status fields in the PC interface screens. This applies to blanking configuration information only, not to any other settings.

5.6 Configuration Setup

Configuration selections other than blanking and alignment adjustment are made to the sensor via the Setup screen. The Setup option becomes accessible after a connection is established between the PC and the sensor, using the Connect option. Refer to Figure 5-12 for an overview of Setup options.

Setup Screen

Selecting **Setup** (Ctrl + S) from the Sensor menu launches the Setup screen, which has six views: System Config, Analog Output Config, Discrete Output Config, Comm Config, Part Number and Version Info, and System Diagnostics. The **Current View** field displays the name of the currently selected view and allows quick switching between views; simply click on the arrow at the right side of the field to display a drop-down menu of alternate views (see Figure 5-9).

When any Setup view is displayed, the options in the Sensor menu become:

    READ All (Ctrl + R)
    WRITE All (Ctrl + W)
    Open Config (Ctrl + O)
    Recent Configs (if any exist)
    Save Config (Ctrl + S)
    Close (Ctrl + Q)
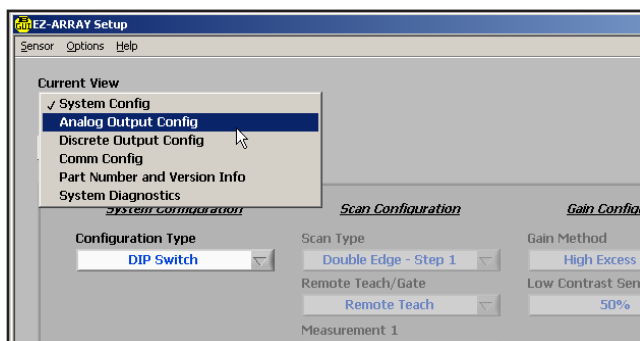
Figure 5-9. Setup screen view selection

Status and Message Windows

On the lower righthand corner of each of the Setup views (Figure 5-10) are two windows, labeled **Status** and **Message**. These two windows provide ongoing indication of system status, e.g., Okay, Busy, or Error. In the event of a communication error, a message will appear in the second window, providing further detail about the error.

Verify that the sensor is ON, that cables are connected, and perform a thorough check of the Comm Config and Options > Communications settings. (The most common communication errors are COM port selection or Timeout.) If this does not correct the problem, refer to Section 5.13 Communications Troubleshooting.

5.7 System Config View

Setup screen, System Config view selections are grouped into four categories: System Configuration, Scan Configuration, Gain Configuration, and User Interface Options. Each category has one or more pull-down boxes of options. Underlined options are the Factory default options. Settings can be changed only when the configuration type is set to **Advanced**.

Configuration Type determines whether the Receiver interface or the PC interface will control the sensing parameters.

• **DIP Switch:** Receiver interface is in control.

• **Advanced:** PC interface is in control. Select **Advanced** to override the receiver DIP switch settings and access configuration settings. (Settings can not be changed unless **Advanced** is selected.)

Scan Configuration

• **Scan Type.** Choose between **Straight**, **Single Edge**, or **Double Edge Step 1, 2, 4, 8, 16, or 32,** or **Carpet Nap**; see Section 1.6 for descriptions and scan rates for these scan types. **Carpet Nap** can be selected only via the advanced configuration and has its own set of parameter options that will appear if it is selected.

• **Remote Teach/Gate.** This field defines the functionality of the receiver's gray wire (see Section 1.5).

• **Measurement 1 and Measurement 2.** These pull-down boxes each select a measurement mode. The measurement mode values will be mapped individually to the analog and/or discrete outputs. The sensor will apply the blocked and clear optical channel status data from each scan to the selected measurement mode(s) to calculate the measurement mode value(s). See Section 1.10.

Gain Configuration

This section is used to define the sensing sensitivity parameters (see Section 1.7).

• **Gain Method: Low-Contrast** or **High-Excess-Gain** operation.

• **Low-Contrast Sensitivity** is selectable (via the PC interface only), from **15 percent** to **50 percent**, when Low-Contrast operation is selected. A 15 percent threshold is used for target objects that attenuate the sensing beam light only slightly. The default low-contrast setting is **30%**.
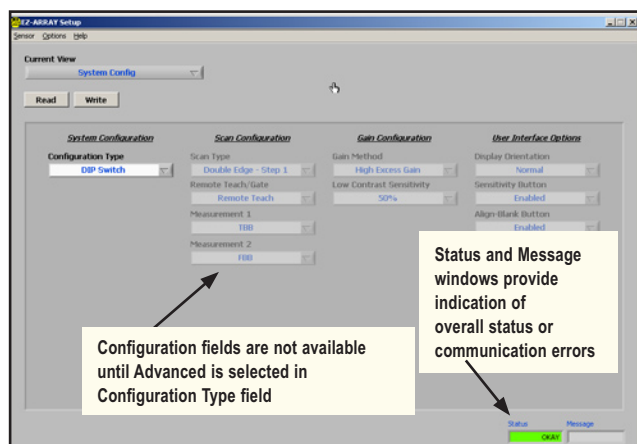
Figure 5-10. Setup view — DIP Switch selected
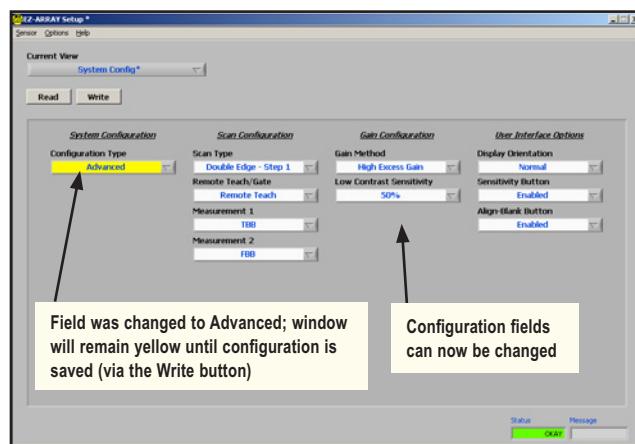
Figure 5-11. Setup view — Advanced selected, but not saved

User Interface Options

The user interface options control the Receiver user interface display and push buttons.

• **Display Orientation** (**Normal** or **Inverted**) is used to invert the display to right-reading when sensors are mounted "upside down." Note that the periods on the three seven-segment indicators do not move when the display is inverted.

• **Sensitivity Button** field (**Enabled** or **Disabled**) is used to enable or disable the Sensitivity button for security.

• **Align-Blank Button** field (**Enabled** or **Disabled**) is used to enable or disable the Alignment-Blanking button for security.

5.8 Analog Output Config View

This view is used to individually set the parameters for each of the analog outputs. Settings can be changed only when the configuration type (in the System Config view) is set to **Advanced**.

• **Status** determines whether that output is enabled or disabled. When the analog output is disabled, the analog output will source either 0 milliamps or 0 volts.

• **Slope** selects between positive and negative analog output slope. The slope option allows the analog output to increase as the measurement value increases, or to decrease as the measurement value increases.

• **Measurement** assigns the desired measurement mode (Meas1 and Meas2, as configured in the System Config view) to each output. (Select a negative slope to invert an output.)

• **Zero Value** is used to specify the analog output value when the array goes clear. The options for Zero Value are **hold** (output holds the last value before the light screen became clear), **minimum** (provides the null or minimum value), or **maximum** (provides the span or maximum value).

• **Analog Filter Speed** (**fast**, **medium**, or **slow**) allows averaging of the analog output response to slow, and therefore smooth, the response. The analog filter speed is defined as the number of scans necessary for a step response to reach 95% of the final value. These values are as follows:

Response Speed	95% Step Response (sensor scans)
Fast	1 scan
Medium	6 scans
Slow	24 scans

• **Peak Detect** (**disabled**, **minimum** or **maximum**) configures the sensor to capture a minimum or maximum value and latch this analog value until a reset has occurred (see Peak Detect Reset).

• **Peak Detect Reset** (**auto** or **external communication**) specifies the method by which the analog output peak-detect is re-triggered.
  Auto: the analog output remains latched until the sensor array goes clear and then detects another object.
  External communication: By serially reading the analog latch values (see Appendix A, Example A-8 for an example of peak detect reset using external communication).

Null and Span values can be adjusted to vary the analog signal levels. *These values are factory-calibrated to represent 0 volts (4 mA) and 10 volts (20 mA).* The values represent a 12 bit number that ranges from **0 to 4095**.

NOTE: If reverting a configuration to the default values, first record these factory-calibrated values, so they can later be written to the sensor.

• **NULL Output** determines the minimum analog output value (must be less than the Span value).

• **SPAN Output** determines the maximum analog output value (must be higher than the Null value).

5.9 Discrete Output Config View

This view is used to individually set the parameters for each of the discrete outputs. Settings can be changed only when the configuration type (in the System Config view) is set to **Advanced**.

• **Status** is used to **enable** or **disable** that discrete output.

• **Polarity:** The discrete outputs are independent and can be set to either **NPN** (sinking current) or **PNP** (sourcing current), regardless of the sensor model.

• **Mode** selects between normally closed and normally open for each output, in effect, "inverting" the output. When **Normally Closed** is selected, the output conducts when the sensor scan value is outside of the selected limits. When **Normally Open** is selected, the output conducts when the sensor scan value is within the selected limits.
  NOTE: If discrete output 2 Type is selected for Alarm/Health Status, the options in the Mode field become **Health** or **Alarm**; see "**Type**" below.

• **Measurement** ties the discrete output to one of the two selected measurement modes (Meas1 or Meas2, as configured in the System Config view).

• **Type** (discrete output 2 only) selects between measurement or alarm functions. (Output 1 always is tied to a measurement mode.) If **Alarm/Health Status** is selected, Output 2 will change state whenever the System detects a sensor error (such as a disconnected cable) or whenever the excess gain of one or more beams becomes marginal, as follows:

Health: Output is normally active, becomes inactive when an error occurs.
Alarm: Output is normally inactive, becomes active when an error occurs.

• **Demodulation** is used to smooth the discrete output response. Each discrete output can respond after each sensor scan, or the response time can be increased by increasing the demodulation. Increasing the demodulation increases the required number of consecutive qualifying scans (that have a measurement mode value within the prescribed window and hysteresis values) to change the discrete output state. The maximum demodulation value is 250 scans and is selected independently for each output.

• **Threshold Low and Threshold High Values** are used to "window" the measurement values that control a discrete output. The values each identify a beam in the array (beam 1 being closest to the sensor display). At each scan, the sensor processes the status of the optical channels and determines values for the selected measurement modes. For the Discrete Output analysis, the measurement values are compared to the low and high threshold. If the selected measurement value is between the low and high threshold values (including the low and high limit), then the sensor will register a valid condition. After the specified number of consecutive scan response values (see "**Demodulation**"), the sensor will recognize that the conditions specifying the discrete output are met and the output will change state.

Hysteresis prevents unstable output conditions when the scan analysis value exactly matches the threshold.

• **Hysteresis Low** value determines the amount of change that must occur beyond the low threshold to cause that output to change state. The default **Hysteresis Low** setting is one beam less than the **Threshold Low** setting.

• **Hysteresis High** value determines the amount of change that must occur beyond the high threshold to cause that output to change state. The default **Hysteresis High** setting is one beam more than the **Threshold High** setting.

5.10 Comm Config View

This view is used to define the serial communication parameters that the sensor uses for communication with the GUI or the process controller. If any changes are made to fields in this view, update the fields accordingly in **Options > Communications Settings** (Ctrl + M**)** to enable further communication.

• **Address** determines the sensor location (from **1** to **247**; default is **65**) on the process controller network. Adjust by highlighting the existing number and overtype a new value, or

use the up/down arrows to the left of the field. If a new sensor address is selected, update the GUI address via **Options > Communications Settings** (Ctrl + M) to enable further communication.

• **Parity:** Select **Odd**, **Even**, or **None**.

• **Baud Rate** is the data communication rate between the sensor and the computer used for configuration or the process controller. Choose from three values: **9600**, **19200**, and **38400**.

• **Modbus Timeout** can be used to relax communication timing. The Modbus standard (**Compliant** setting) defines spacing between words within a message to be no longer than the time required to transmit 1.5 bytes of information. However, the time between successive bytes within a serial message can be extended (**Extended** setting) to allow communication with a slower device.

5.11 Part Number and Version Info View

This view provides basic read-only reference information about the connected emitter and receiver. Information includes the receiver part number, firmware version numbers, and hardware date codes.

5.12 System Diagnostics View

This view provides read-only information about the connected emitter and receiver, for diagnostic purposes. This information may be useful if factory-assisted troubleshooting is required. Refer to Section 4.6 for possible error codes and corrective action.

• **Channel Status fields** display the number of emitter and receiver channels (which should be identical), the location of the first bad emitter channel, if any, and the level of optical power being delivered by the emitter.

• **Operational Status fields** display the overall Error Code (or System Status), plus the status of each receiver DIP switch position, regardless of whether they are enabled.

• **Output Status fields** display the status of each output individually.

• **Service Status** displays the sensor time of service, updated every two hours.

5.13 Communications Troubleshooting

The two most common communication errors are listed in the
table below. For other errors, contact the factory.

Error Code	Error Message	Description	Corrective Action
6101	Modbus Timeout	Timeout reached while communicating with sensor	1. Check sensor power. 2. Check communication cable connections. 3. Check Communication Settings in GUI. 4. Use Advanced Communication Settings to ping/discover sensor.
-1073807343	VISA: Insufficient location . . .	Selected COM port does not exist on PC	1. Verify COM port number on PC. 2. Choose correct COM port in Communication Settings screen.

NOTE: Underlined options designate <u>default</u> settings.

System Config View *Go to* **A**

Analog Output Config View *Go to* **B**

Discrete Output Config View *Go to* **C**

Comm Config View *Go to* **D**

Part Number and Version Info View *Go to* **E**

System Diagnostics View *Go to* **F**

Setup (Ctrl + S)
(not active until Connect is performed)
Creates or alters sensor configuration

Sensor

Connect (Ctrl + N)
Connects to a specific sensor pair
(If sensors will not connect, verify that
Communications Options are correct; e.g.
COM port agrees with computer COM port

Sensor > Disconnect (Ctrl + N)
Disconnects from current sensor pair so that other
sensors on the network can be connected

Exit (Ctrl + Q)
Ends connection and configuration between
software and sensors

Select a Sensor
Verify that **EZ-ARRAY** *is selected*

COM Port Selection *(COM 1 – 20)*

Select a Sensor

EZ-ARRAY®

Do not select:
Color Mark Sensors
D10 Series Sensors
L-GAGE® Light Gauging Sensors
T-GAGE® Temperature Sensors
U-GAGE® Ultrasonic Sensors
WORLD-BEAM® QS30 Sensors
WORLD-BEAM® QS30RX

Communication Settings (Ctrl + M)

Power Cycle
(not used for EZ-ARRAY)

Options

10 Click
(not used for EZ-ARRAY)

Options
<u>DPB1</u>
No Echo Suppression*
Echo Suppression

** If **DPB1** is de-selected, it can not be reselected.*
*Verify that this option box is set to either **DPB1** or*
***No Echo Suppression**.*

Status
Read-only indication of current sensor
communication status

Debug (Ctrl + D)
Read-only debug messages for
troubleshooting use

Help

About Banner Sensors GUI (Ctrl + A)
Part number and software version
information

Figure 5-12. PC Interface configuration overview, part 1 of 7

A **Sensor > Setup (Ctrl + S) > System Config View***
(Not available until Connect is performed)

NOTE: Underlined options
designate <u>default</u> settings.

A
System Configuration

**System Configuration –
Configuration Type**
- <u>DIP Switch</u>
- **Advanced**
  Verify that Advanced is selected in order to access other configuration fields

Scan Configuration

Scan Type
- <u>Straight</u>
- Single Edge
- Double Edge – Step 1
- Double Edge – Step 2
- Double Edge – Step 4
- Double Edge – Step 8
- Double Edge – Step 16
- Double Edge – Step 32
- Carpet Nap

Remote Teach / Gate
Determines the function of the Teach wire
- **Disabled**
  Teach wire has no function; continuous scan is automatically selected
- <u>Remote Teach</u>
  Teach functions can be input via Teach wire; see Section 1.5
- **Alignment/Sensitivity**
- **Gate – Active High**
- **Gate – Active Low**
- **Gate – Rising Edge**
- **Gate – Falling Edge**

Measurement 1
The measurement mode mapped to discrete output 1; can be any of those at right

Measurement 2
The measurement mode mapped to discrete output 2; can be any of those at right

Disabled	TBM
<u>FBB</u> *Meas 1 default*	CBM
LBB	MBB
<u>TBB</u> *Meas 2 default*	OD
TRN	ID
CBB	CFBB
FBM	CLBB
LBM	**Special** *(Reserved; contact Factory)*
TBM	

Carpet Nap scan type selected:
- Disabled
- Carpet Nap
- Carpet Edge

Gain Configuration

Gain Method
- <u>High Excess Gain</u>
- Low Contrast

Low Contrast Sensitivity
*Available only when **Low Contrast** is selected*

15%	35%
20%	40%
25%	45%
<u>30%</u>	50%

User Interface Options

Display Orientation
- <u>Normal</u>
- Inverted

Sensitivity Button
- <u>Enabled</u>
- Disabled

Align / Blanking Button
- <u>Enabled</u>
- Disabled

* Use drop-down arrow at right-hand side of the **Current View** field to quickly move to another view.

Figure 5-12. PC Interface configuration overview, part 2 of 7

B Sensor > Setup (Ctrl + S) > Analog Output Config View*
(Not available until Connect is performed)

NOTE: Underlined options designate **default** settings.

B — Analog Output 1 / Analog Output 2
(Settings are nearly identical for output 2, with only minor variation)

Field	Options
A01 Status	**Enabled** / Disabled
A01 Slope	**Positive** / Negative
A01 Measurement	**Meas 1 selection** *(Default for output 1)* / **Meas 2 selection** *(Default for output 2)*
A01 Zero Value	Hold / **Minimum** / Maximum
A01 Filter Speed	**Fast** / Medium / Slow
A01 Peak Detect	**Disabled** / Minimum / Maximum
A01 Peak Reset	**Auto** / External Comm
A01 Null Output — *If restoring back to factory defaults, record this value first*	Factory-calibrated numeric value from 0 to 4095
A01 Span Output — *If restoring back to factory defaults, record this value first*	Factory-calibrated numeric value from 0 to 4095

* Use drop-down arrow at right-hand side of the **Current View** field to quickly move to another view.

Figure 5-12. PC Interface configuration overview, part 3 of 7

C Sensor > Setup (Ctrl + S) > Discrete Output Config View*
(Not available until Connect is performed)

NOTE: Underlined options designate **default** settings.

C — Discrete Output 1 / Discrete Output 2
(Settings are nearly identical for output 2, with only minor variation)

Field	Options
D01 Status	**Enabled** / Disabled
D01 Polarity *(Default polarity depends on model, but can be switched; reverting to factory default will result in a PNP setting, regardless of model)*	NPN / **PNP**
D01 Mode *(Default setting is for complementary outputs)*	**Measurement Model Selected** *(Either discrete output)* — **Normally Open** *(Default for output 1)* / **Normally Closed** *(Default for output 2)*; **Alarm/Health Status Mode Selected** *(Discrete output 2 only)* — **Health** / Alarm
D01 Measurement	Meas 1 selection / Meas 2 selection
D01 Demodulation	Numeric value from 1 to 250
D01 Hysteresis Low	Numeric value from 0 to 479
D01 Threshold Low	Numeric value from 1 to 480
D01 Threshold High	Numeric value from 1 to 480
D01 Hysteresis High	Numeric value from 2 to 481
D02 Type *Available for output 2 only*	**Measurement** / Alarm/Health Status

* Use drop-down arrow at right-hand side of the **Current View** field to quickly move to another view.

Figure 5-12. PC Interface configuration overview, part 4 of 7

D Sensor > Setup (Ctrl + S) > Comm Config View*
(Not available until Connect is performed)

NOTE: Underlined options designate **default** settings.

D — Comm Configuration

Field	Options
Address (1-247)	Numeric value from 1 to 247 *(Factory default 65)*
Parity	None / **Even** / Odd
Baud Rate	9600 / **19200** / 38400
Modbus Timeouts *(Relaxes timing requirement to permit communication with slower devices)*	Compliant / **Extended**

* Use drop-down arrow at right-hand side of the **Current View** field to quickly move to another view.

Figure 5-12. PC Interface configuration overview, part 5 of 7

E Sensor > Setup (Ctrl + S) > Part Number and Version Info View*
(Not available until Connect is performed)

NOTE: Underlined options designate **default** settings.

E — System Info

- **Receiver Info**
  - Receiver Part Number — *Read-only indication*
  - Receiver Firmware Part Number — *Read-only indication*
  - Receiver Firmware Version — *Read-only indication*
  - Receiver Datecode — *Read-only indication*
- **Emitter Info**
  - Emitter Firmware Part Number — *Read-only indication*
  - Emitter Firmware Version — *Read-only indication*
  - Emitter Datecode — *Read-only indication*
- **Comm Info**
  - Comm Firmware Part Number — *Read-only indication*
  - Comm Firmware Version — *Read-only indication*

* Use drop-down arrow at right-hand side of the **Current View** field to quickly move to another view.

Figure 5-12. PC Interface configuration overview, part 6 of 7

F   **Sensor > Setup (Ctrl + S) > System Diagnostics View***
(Not available until Connect is performed)

NOTE: Underlined options
designate <u>default</u> settings.

	Number of Receiver Channels *Read-only indication*
	Number of Emitter Channels *Read-only indication*
Channel Status	
	First Bad Emitter Channel *Read-only indication*
	Emitter Power *Read-only indication*

	Error Code *Read-only indication*
	DIP Switch S1 *Read-only indication*
	DIP Switch S2 *Read-only indication*
Operational Status	**DIP Switch S3** *Read-only indication*
	DIP Switch S4 *Read-only indication*
	DIP Switch S5 *Read-only indication*
	DIP Switch S6 *Read-only indication*

F

Diagnostics

	Discrete Output 1 *Read-only indication*
	Discrete Output 2 *Read-only indication*
Output Status	**Analog Output 1 DAC** *Read-only indication*
	Analog Output 2 DAC *Read-only indication*
Service Status	**Time of Service (Hours)** *Read-only indication*

* Use drop-down arrow at right-hand side of the **Current View** field to quickly move to another view.

Figure 5-12. PC Interface configuration overview, part 7 of 7

Appendix A. Modbus Reference

A.1 Modbus Specifications and Message Formats

For the latest Modbus protocol and specifications, please visit http://www.modbus.org

The EZ-ARRAY is compliant with Modbus v1.1a. EZ-ARRAY utilizes the RTU transmission Mode. The RTU message frame is depicted below.

Table A–1. RTU Message Frame

Slave Address	Function Code	Data	Cyclic Redundancy Check (CRC)
1 byte	1 byte	0 up to 252 bytes(s) (High Byte, Low Byte)	2 bytes (CRC Low, CRC Hi)

The slave address can be assigned a value in the range 1-247. Three function codes are supported:

(0x03) Read Holding Registers
(0x04) Read Input Registers
(0x10) Write Multiple Holding Registers

The data in the registers is transmitted in big endian order (HIGH byte, LOW byte).

A.1.1 Read Holding Registers (0x03)

This function code is used to read the contents of a contiguous block of EZ-ARRAY holding registers. The command specifies the starting address and the number of registers. The EZ-ARRAY employs a direct addressing scheme. For example, the holding register at address 40001 is accessed by reading address 40001 (0x9C41) directly (i.e. the starting address is not an offset). The register data in the response message are packed as two bytes per register. For each register, the data is returned in a big endian order (HIGH byte, LOW byte).

Request

Function Code	1 byte	0x03
Starting Address	2 bytes	0x0000 to 0xFFFF
Quantity of Holding Registers	2 bytes	0x0001 to 0x007D

Response

Function Code	1 byte	0x03
Byte Count	1 byte	2 X N*
Holding Registers	N X 2 Bytes	

* "N" is the number of holding registers
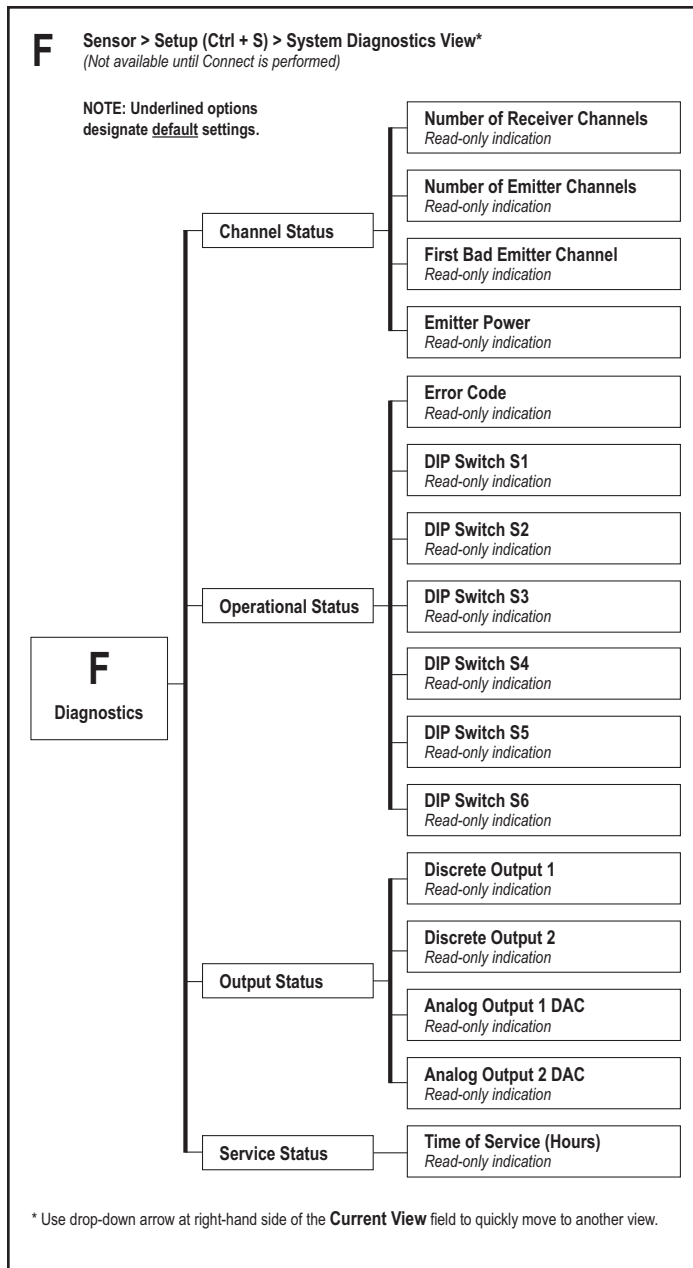
Error

Error Code	1 byte	0x83
Exception Code	1 byte	1 to 4

Example A–1. Reading Holding Registers

Request		Response	
Field Name	(Hex)	Field Name	(Hex)
Slave Address	41	Slave Address	41
Function	03	Function	03
Starting Address (HIGH Byte)	9C	Byte Count	06
Starting Address (LOW Byte)	41	Register 40001 (HIGH Byte)	02
Quantity of Registers (HIGH Byte)	00	Register 40001 (LOW Byte)	2B
Quantity of Registers (LOW Byte)	03	Register 40002 (HIGH Byte)	00
CRC (LOW Byte)	75	Register 40002 (LOW Byte)	00
CRC (HIGH Byte)	4F	Register 40003 (HIGH Byte)	00
		Register 40003 (LOW Byte)	64
		CRC (LOW Byte)	34
		CRC (HIGH Byte)	B9

The contents of addresses 40001, 40002, and 40003 are the two-byte values 0x022B (555 decimal), 0x0000 (0 decimal), and 0x0064 (100 decimal), respectively.

A.1.2 Read Input Registers (0x04)

This function code is used to read from 1 to 125 contiguous EZ-ARRAY input registers. The command specifies the starting address and the number of registers. The EZ-ARRAY employs a direct addressing scheme. For example, the input register at address 30001 is accessed by reading address 30001 (0x7531) directly (i.e. the starting address is not an offset). The register data in the response message are packed as two bytes per register. For each register, the data is returned in big endian order (HIGH byte, LOW byte).

Request

Function Code	1 byte	0x04
Starting Address	2 bytes	0x0000 to 0xFFFF
Quantity of Input Registers	2 bytes	0x0001 to 0x007D

Response

Function Code	1 byte	0x04
Byte Count	1 byte	2 X N*
Input Registers	N X 2 Bytes	

* "N" is the number of holding registers

Error

Error Code	1 byte	0x84
Exception Code	1 byte	1 to 4

Example A–2. Reading Input Registers

Request		Response	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Slave Address	41	Slave Address	41
Function	04	Function	04
Starting Address (HIGH Byte)	75	Byte Count	02
Starting Address (LOW Byte)	31	Register8 (HIGH Byte)	00
Quantity of Registers (HIGH Byte)	00	Register8 (LOW Byte)	2B
Quantity of Registers (LOW Byte)	01	CRC (LOW Byte)	38
CRC (LOW Byte)	74	CRC (HIGH Byte)	F8
CRC (HIGH Byte)	C9		

The contents of address 30001 are shown as the two-byte values of 0x000A (10 decimal).

A.1.3 Write Multiple Holding Registers (0x10)

This function code is used to write a block of contiguous registers into the EZ-ARRAY. The requested written values are specified in the request data field. The EZ-ARRAY employs a direct addressing scheme. For example, the holding register at address 40001 is accessed by writing address 40001 (0x9C41) directly (i.e. the starting address is not an offset). Data is packed as two bytes per register. For each register, the data is sent in big endian order (HIGH byte, LOW byte). The normal response returns the function code, starting address, and quantity of registers written.

Request

Function Code	1 byte	0x10
Starting Address	2 bytes	0x0000 to 0xFFFF
Quantity of Holding Registers	2 bytes	0x0001 to 0x007B
Byte Count	1 byte	2 X N*
Register Value		

* "N" is the number of holding registers

Response

Function Code	1 byte	0x03
Starting Address	2 bytes	0x0000 to 0xFFFF
Holding Registers	N X 2 Bytes	1 to 0x7B

Error

Error Code	1 byte	0x90
Exception Code	1 byte	1 to 4

Example A–3. Writing Holding Registers

Request		Response	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Slave Address	41	Slave Address	41
Function	10	Function	10
Starting Address (HIGH Byte)	9C	Starting Address (HIGH Byte)	9C
Starting Address (LOW Byte)	41	Starting Address (LOW Byte)	41
Quantity of Registers (HIGH Byte)	00	Quantity of Registers (HIGH Byte)	00
Quantity of Registers (LOW Byte)	02	Quantity of Registers (LOW Byte)	02
Byte Count	04	CRC (LOW Byte)	31
Register 1 (HIGH Byte)	00	CRC (HIGH Byte)	4C
Register 1 (LOW Byte)	01		
Register 2 (HIGH Byte)	0A		
Register 2 (LOW Byte)	02		
CRC (LOW Byte)	3A		
CRC (HIGH Byte)	C7		

The holding registers at addresses 40001 and 40002, were written to the two-byte values of 0x000A (10 decimal) and 0x0102 (258 decimal), respectively.

A.2 Modbus Tables

EZ-ARRAY uses the Holding Registers table for providing read-write access to configuration data. The Holding Registers are defined in the 40000-49999 address range. The Input Registers table is used for providing read-only access to system status and measurement data. The Input Registers are defined in the 30000-39999 address range. EZ-ARRAY employs a direct addressing scheme. For example, the input register at address 30000 is accessed by reading address 30000 (0x7530) directly (i.e., the starting address is not an offset).

A.2.1 Holding Registers

Scan Configuration
The Scan Configuration contains the settings for the scan type and receiver's remote teach wire (gray wire) function.

Table A–1. Scan Configuration

Holding Register Address	MASK	Member Name
40000	LOW BYTE	Scan Type
40000	HIGH BYTE	Remote Teach/Gate

Table A–2. Scan Type

Value	Type	Description
0	Disabled	Scanning is Disabled
1	Straight	Straight Scanning
2	Single Edge	Scanning for Single Edge
3	Double Edge – Step 1	Scanning for Edges of up to 3 objects (fires every channel)
4	Double Edge – Step 2	Scanning for Edges of up to 3 objects (fires channels 1,3,5,…)
5	Double Edge – Step 4	Scanning for Edges of up to 3 objects (fires channels 1,5,9,…)
6	Double Edge – Step 8	Scanning for Edges of up to 3 objects (fires channels 1,9,17,…)
7	Double Edge – Step 16	Scanning for Edges of up to 3 objects (fires channels 1,17,33,…)
8	Double Edge – Step 32	Scanning for Edges of up to 3 objects (fires channels 1,33,65,…)
10	Carpet Nap	Scanning for Carpet Nap Detection Applications

Table A–3. Remote Teach/Gate

Value	Function	Description
0	Disabled	Disabled
1	Remote Teach	Enabled with All Functionality
2	Alignment/ Sensitivity	Only Alignment, Blanking, & Sensitivity Adjustments can be performed
3	Gate – Active High	Setting the gray wire in the high state enables scanning
4	Gate – Active Low	Setting the gray wire in the low state enables scanning
5	Gate – Rising Edge	A single scan will occur after the gray wire goes from a low-to-high state
6	Gate – Falling Edge	A single scan will occur after the gray wire goes from a high-to-low state

Blanking Configuration
The blanking configuration contains the blanking bit-mask for the EZ-ARRAY channels. Each register represents 16 channels.

Table A–4. Blanking Configuration

Model	Holding Register Address	MASK	Member Name
150–1800 mm	40003	LOW BYTE	Blanking 1–8
	40003	HIGH BYTE	Blanking 9–16
	…	…	…
	40025	LOW BYTE	Blanking 353–360
	40025	HIGH BYTE	(Pad byte)
2100–2400 mm	40250	LOW BYTE	Blanking 1–8
	40250	HIGH BYTE	Blanking 9–16
	…	…	…
	40279	LOW BYTE	Blanking 349–464
	40279	HIGH BYTE	Blanking 465–480

Table A–5. Blanking Bit-Mask

Value	Status	Description
0	Non-Blanked	The channel will be used during scanning
1	Blanked	The channel will be skipped during scanning

Example A–4. Writing Blanking Configuration to Blank the First 2 Channels

Request		Response	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Slave Address	41	Slave Address	41
Function	10	Function	10
Starting Address (HIGH Byte)	9C	Starting Address (HIGH Byte)	9C
Starting Address (LOW Byte)	43	Starting Address (LOW Byte)	43
Quantity of Registers (HIGH Byte)	00	Quantity of Registers (HIGH Byte)	00
Quantity of Registers (LOW Byte)	17	Quantity of Registers (LOW Byte)	17
Quantity of Bytes	2E	CRC (LOW Byte)	51
Register 40003 (HIGH Byte)	00	CRC (HIGH Byte)	43
Register 40003 (LOW Byte)	03		
Register 40004 (HIGH Byte)	00		
Register 40004 (LOW Byte)	00		
…	…		
…	…		
Register 40025 (HIGH Byte)	00		
Register 40025(LOW Byte)	00		
CRC (LOW Byte)	3A		
CRC (HIGH Byte)	96		

To Blank the first 2 channels, the Blanking 1-16 register (address 40003) is set to the two-byte value of 0x0003 (3 decimal).

General Configuration

The General Configuration contains the general settings for the EZ-ARRAY.

Table A–6. General Configuration

Holding Register Address	MASK	Member Name
40046	LOW BYTE	Emitter Power
40046	HIGH BYTE	Gain Method
40047	LOW BYTE	Low Contrast Sensitivity
40047	HIGH BYTE	HW Interface Flags
40048	LOW BYTE	Measurement 1
40048	HIGH BYTE	Measurement 2
40049		RESERVED
40050		Number of Dirty Channels
40051		Time of Service
40052		

Table A–7. Emitter Power

Value	Function	Description
0	Disabled	Disabled
1	Level 1	Power Setting 1 (Lowest)
2	Level 2	Power Setting 2
3	Level 3	Power Setting 3
4	Level 4	Power Setting 4
5	Level 5	Power Setting 5
6	Level 6	Power Setting 6
7	Level 7	Power Setting 7
8	Level 8	Power Setting 8
9	Level 9	Power Setting 9
10	Level 10	Power Setting 10
11	Level 11	Power Setting 11 (Highest)

Table A–8. Gain Method

Value	Status	Description
1	High-Excess Gain	Fixed thresholds for maximum excess gain
2	Low Contrast	Adjustable percentage-based thresholds (Straight Scan only)

Table A–9. Low-Contrast Sensitivity

Value	Function	Blocked Threshold Set
0	10%	10% below aligned signal
1	15%	15% below aligned signal
2	20%	20% below aligned signal
3	25%	25% below aligned signal
4	30%	30% below aligned signal
5	25%	35% below aligned signal
6	40%	40% below aligned signal
7	45%	45% below aligned signal
8	50%	50% below aligned signal

Table A–10. HW Interface Flags

Bit	Flag	Description
0	Display Orientation	0 = Normal, 1 = Inverted
1	DIP Switch Interface	0 = Enabled, 1 = Disabled
2	Sensitivity Button	0 = Enabled, 1 = Disabled
3	Align/Blank Button	0 = Enabled, 1 = Disabled

Table A–11. Measurement 1 and Measurement 2

Value	Function	Description
0	Disabled	Disabled
1	FBB	First Beam Blocked
2	LBB	Last Beam Blocked
3	TBB	Total Beams Blocked
4	TRN	Transitions
5	CBB	Contiguous Beams Blocked
6	FBM	First Beam Made
7	LBM	Last Beam Made
8	TBM	Total Beams Made
9	CBM	Contiguous Beams Made
10	MBB	Middle Beam Blocked
11	OD	Outer Diameter
12	ID	Inner Diameter
13	CFBB	Contiguous First Beam Blocked
14	CLBB	Contiguous Last Beam Blocked
15	O1 FBB	Object 1 First Beam Blocked
16	O1 LBB	Object 1 Last Beam Blocked
17	O2 FBB	Object 2 First Beam Blocked
18	O2 LBB	Object 2 Last Beam Blocked
19	O3 FBB	Object 3 First Beam Blocked
20	O3 LBB	Object 3 Last Beam Blocked
21	CARPET NAP	Carpet Nap
24	CARPET EDGE	Carpet Edge
25	SPECIAL	Reserved for Specials

Table A–12. Number of Dirty Channels

Range	Description
1-480	Number of channels that need to be dirty before indicator is lit

Table A–13. Time of Service

Range	Description
$2^{32}-1$	Number of hours EZ-ARRAY has been in operation

Communications Configuration

The Communications Configuration contains the settings for the Modbus/RS-485 communications.

Table A–14. Communications Configuration

Holding Register Address	MASK	Member Name
41000	LOW BYTE	Address
41000	HIGH BYTE	Parity
41001	LOW BYTE	Baud Rate
41001	HIGH BYTE	Modbus Timeouts
41002		Cache Mode

Table A–15. Modbus Address

Range	Description
1-247	Modbus address for EZ-ARRAY

Table A–16. Parity

Value	Type	Description
0	Even	Even parity bit is used
1	Odd	Odd parity bit is used
2	None	No parity is used (stop bits MUST be set to 2)

Table A–17. Baud Rate

Value	Baud Rate	Description
0	19200	EZ-ARRAY communicates at 19.2 Kb/s
1	9600	EZ-ARRAY communicates at 9.6 Kb/s
2	38400	EZ-ARRAY communicates at 38.4 Kb/s)

Table A–18. Modbus Timeouts

Value	Type	Description
0	Compliant	EZ-ARRAY adheres to strict Modbus timing
1	Extended	EZ-ARRAY relaxes PC timing to 2x the Modbus timing specifications

Table A–19. Cache Mode

Value	Type	Description
0	Standard	Active measurements are cached
1	Extended	Active measurements and channel states are cached (decreases MAX scan rate)

Analog Output 1 Configuration

The Analog Output 1 Configuration contains the settings for the first analog output.

Table A–20. Analog Output 1 Configuration

Holding Register Address	MASK	Member Name
40026	LOW BYTE	Config Flags
40026	HIGH BYTE	RESERVED
40027	LOW BYTE	Filter Speed
40027	HIGH BYTE	RESERVED
40028	NULL Output	
40028	SPAN Output	

Table A–21. Config Flags (Analog Outputs 1 and 2)

Bit	Flag	Description
0	Slope	0 = Negative, 1 = Positive
1	Measurement	0 = Measurement 2, 1 = Measurement 1
2	ZERO Value	00 = Hold, 01 = Minimum, 10 = Maximum
3		
4	Peak Detect	0 = Disabled, 1 = Enabled
5	Peak Detect Direction	0 = Maximum, 1 = Minimum
6	Status	0 = Disabled, 1 = Enabled
7	Peak Detect Reset	0 = Auto, 1 = External Communications

Table A–22. Filter Speed (Analog Outputs 1 and 2)

Value	Filter Speed	Description
0	Fast	No filtering
1	Medium	Filter step response is 6 scans for 98% of signal
3	Slow	Filter step response is 24 scans for 98% of signal

Table A–23. NULL Output (Analog Outputs 1 and 2)

Range	Description
0-4095	Minimum DAC value of Analog Output (MUST be < SPAN Output)

Table A–24. SPAN Output (Analog Outputs 1 and 2)

Range	Description
0-4095	Maximum DAC value of Analog Output (MUST be > NULL Output)

Analog Output 2 Configuration

The Analog Output 2 Configuration contains the settings for the second analog output.

Table A–25. Analog Output 2 Configuration

Holding Register Address	MASK	Member Name
40030	LOW BYTE	Config Flags
40030	HIGH BYTE	RESERVED
40031	LOW BYTE	Filter Speed
40031	HIGH BYTE	RESERVED
40032		NULL Output
40033		SPAN Output

Discrete Output 1 Configuration

The Discrete Output 1 Configuration contains the settings for the first discrete output.

Table A–26. Discrete Output 1 Configuration

Holding Register Address	MASK	Member Name
40034	LOW BYTE	Config Flags
40034	HIGH BYTE	RESERVED
40035		Scan Response
40036		Hysteresis LOW
40037		Hysteresis HIGH
40038		Threshold LOW
40039		Threshold HIGH

Table A–27. Config Flags (Discrete Outputs 1 and 2)

Bit	Flag	Description
0	Status	0 = Disabled, 1 = Enabled
1	Type	0 = Measurement, 1 = Alarm/Health (Discrete Output 1 can ONLY be of type Measurement)
2	Polarity	0 = PNP, 1 = NPN
3	Mode*	0 = Normally Closed (Health) 1 = Normally Open (Alarm)
4	Measurement	0 = Measurement 2 1 = Measurement 1
*For Alarm/Health Type, Mode setting corresponds to 0=Health, 1=Alarm		

Table A–28. Scan Response (Discrete Outputs 1 and 2)

Range	Description
1-250	Number of consecutive measurements before changing state

Table A–29. Hysteresis LOW (Discrete Outputs 1 and 2)

Range	Description
0-479	Lower hysteresis threshold for discrete output (MUST be < Threshold LOW)

Table A–30. Hysteresis HIGH (Discrete Outputs 1 and 2)

Range	Description
2-481	Upper hysteresis threshold for discrete output (MUST be > Threshold HIGH)

Table A–31. Threshold LOW (Discrete Outputs 1 and 2)

Range	Description
1-480	Lower threshold for discrete output (MUST be <= Threshold HIGH)

Table A–32. Threshold HIGH (Discrete Outputs 1 and 2)

Range	Description
1-480	Upper threshold for discrete output (MUST be >= Threshold LOW)

Discrete Output 2 Configuration

The Discrete Output 2 Configuration contains the settings for the second discrete output.

Table A–33. Discrete Output 2 Configuration

Holding Register Address	MASK	Member Name
40040	LOW BYTE	Config
40040	HIGH BYTE	RESERVED
40041		Demodulation Count
40042		Hysteresis LOW
40043		Hysteresis HIGH
40044		Threshold LOW
40045		Threshold HIGH

A.3 Input Registers

A.3.1 Active Measurements

The Active Measurements section contains the current values of the two measurements that were configured in the General Configuration. The Active Measurements data can be read after each scan.

Table A–34. Active Measurements

Input Register Address	MASK	Member Name
30001		Measurement 1
30002		Measurement 2

Table A–35. Measurement 1 and Measurement 2

Range	Description
0-1920	Measurements are represented in 4x channel resolution

Example A–5. Reading Active Measurements

Request		Response	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Slave Address	41	Slave Address	41
Function	04	Function	04
Starting Address (HIGH Byte)	75	Byte Count	04
Starting Address (LOW Byte)	31	Register 30001 (HIGH Byte)	00
Quantity of Registers (HIGH Byte)	00	Register 30001 (LOW Byte)	20
Quantity of Registers (LOW Byte)	02	Register 30002 (HIGH Byte)	00
CRC (LOW Byte)	34	Register 30002 (LOW Byte)	90
CRC (HIGH Byte)	C8	CRC (LOW Byte)	BB
		CRC (HIGH Byte)	E6

To read the Active Measurements, a read input registers request is sent starting at address 30001, requesting 2 registers.

A.3.2 ALL Measurements

The ALL Measurements section contains the current values of all the available measurements. The ALL Measurements data can be read after every third scan.

Table A–36. ALL Measurements

Input Registers	Member Name
30500	FBB
30501	LBB
30502	TBB
30503	TRN
30504	CBB
30505	FBM
30506	LBM
30507	TBM
30508	CBM
30509	MBB
30510	OD
30511	ID
30512	CFBB
30513	CLBB
30514	O1 FBB
30515	O1 LBB
30516	O2 FBB
30517	O2 LBB
30518	O3 FBB
30519	O3 LBB
30520	CARPET NAP
30521	AO1 PEAK
30522	AO2 PEAK
30523	CARPET EDGE
30524	SPECIAL

Table A–37. Measurements (ALL)

Range	Description
0-1920	Measurements are represented in 4x channel resolution

Example A–6. Reading ALL Measurements

Request		Response	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Slave Address	41	Slave Address	41
Function	04	Function	04
Starting Address (HIGH Byte)	77	Byte Count	32
Starting Address (LOW Byte)	24	Register 30500 (HIGH Byte)	00
Quantity of Registers (HIGH Byte)	00	Register 30500 (LOW Byte)	00
Quantity of Registers (LOW Byte)	19	Register 30501 (HIGH Byte)	00
CRC (LOW Byte)	64	Register 30501 (LOW Byte)	00
CRC (HIGH Byte)	BF	…	…
		…	…
		Register 30524 (HIGH Byte)	00
		Register 30524 (LOW Byte)	00
		CRC (LOW Byte)	28
		CRC (HIGH Byte)	C0

To read ALL Measurements, a read input registers request is sent starting at address 30500, and requesting 25 registers.

AO1 PEAK and AO2 PEAK Measurements

The AO1 PEAK and AO2 PEAK measurements store the minimum/maximum values of Analog Output 1 and Analog Output 2 respectively. When the EZ-ARRAY's Analog Outputs are configured to have Peak Detect = Enabled and Peak Detect Reset = External Communications, then reading these measurements will reset the Analog Output Peak Detect value. To enable this mode of operation, the Analog Output's Config Flags register (address 40026 – AO1, address 40030 – AO2) must be configured as shown in Example A–7.

Example A–7. Analog Output Config Flags for Peak Detection with External Comm Reset

Bit	Flag	Description	Value
0	Slope	0 = Negative 1 = Positive	X*
1	Measurement	0 = Measurement 2 1 = Measurement 1	X
2	ZERO Value	00 = Hold 01 = Minimum 10 = Maximum	XX
3			
4	Peak Detect	0 = Disabled, 1 = Enabled	1
5	Peak Detect Direction	0 = Maximum 1 = Minimum	X
6	Status	0 = Disabled 1 = Enabled	1
7	Peak Detect Reset	0 = Auto 1 = External Communications	1

* "X" denotes a "don't care" value.

Example A–8. Reading A01 PEAK Measurement

Request		Response	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Slave Address	41	Slave Address	41
Function	04	Function	04
Starting Address (HIGH Byte)	77	Byte Count	02
Starting Address (LOW Byte)	39	Register 30521 (HIGH Byte)	00
Quantity of Registers (HIGH Byte)	00	Register 30521 (LOW Byte)	A0
Quantity of Registers (LOW Byte)	01	CRC (LOW Byte)	B8
CRC (LOW Byte)	F4	CRC (HIGH Byte)	87
CRC (HIGH Byte)	B3		

This input register request will read the current Peak value of Analog Output 1, and will reset the value all in one action.

A.3.3 Channel States

The Channel States section contains the state of all the channels in the EZ-ARRAY. Each register represents 16 channels.

Table A–38. Channel States

Model	Input Register Address	MASK	Member Name
150–1800 mm	30003	LOW BYTE	Channel 1-8
	30003	HIGH BYTE	Channel 9-16
	…	…	…
	30025	LOW BYTE	Channel 353-360
	30025	HIGH BYTE	(pad byte)
2100–2400 mm	30003	LOW BYTE	Channel 1-8
	30003	HIGH BYTE	Channel 9-16
	…	…	…
	30025	LOW BYTE	Channel 349-364
	30025	HIGH BYTE	Channel 365-380

Table A–39. Channel States Bit-Mask

Value	State	Description
0	Made	The channel is made (clear)
1	Blocked	The channel is blocked

For example, if the first and third beams of the EZ-ARRAY are blocked, input register 30003 would contain the value 0x0005.

Example A–9. Reading ALL Channel States

Request			Response		
Field Name		**(Hex)**	**Field Name**		**(Hex)**
Slave Address		41	Slave Address		41
Function		04	Function		04
Starting Address (HIGH Byte)		75	Byte Count		32
Starting Address (LOW Byte)		33	Register 30003 (HIGH Byte)		00
Quantity of Registers (HIGH Byte)		00	Register 30003 (LOW Byte)		00
Quantity of Registers (LOW Byte)		17	Register 30004 (HIGH Byte)		00
CRC (LOW Byte)		54			00
CRC (HIGH Byte)		C7	…		…
			…		…
			Register 30025 (HIGH Byte)		00
			Register 30025 (LOW Byte)		00
			CRC (LOW Byte)		43
			CRC (HIGH Byte)		B6

To read ALL Channel States, a read input registers request is sent starting at address 30003, and requesting 23 registers.

The channel states can be accessed after each scan, if Cache Mode is set to Extended in the Communications Configuration.

Example continued from previous page

Otherwise, the Channel States data can be accessed after every third scan (default). To set the EZ-ARRAY in Extended Cache Mode, the register at address 41002 must be set to a value of 1. This is a configuration register (Communications Configuration), so this register only needs to be set once. To exit Extended Cache Mode, the register must be set to a value of 0.

Example A–10. Writing Communications Configuration to Enable Extended Cache Mode

Request		Response	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Slave Address	41	Slave Address	41
Function	10	Function	10
Starting Address (HIGH Byte)	A0	Starting Address (HIGH Byte)	A0
Starting Address (LOW Byte)	2A	Starting Address (LOW Byte)	2A
Quantity of Registers (HIGH Byte)	00	Quantity of Registers (HIGH Byte)	00
Quantity of Registers (LOW Byte)	01	Quantity of Registers (LOW Byte)	01
Quantity of Bytes	02	CRC (LOW Byte)	32
Register 41002 (HIGH Byte)	00	CRC (HIGH Byte)	65
Register 41002 (LOW Byte)	01		
CRC (LOW Byte)	F1		
CRC (HIGH Byte)	93		

A.3.4 System Info and Status

The System Info and Status section contains the current status of the EZ-ARRAY.

Table A–40. System Info and Status

Input Register Address	MASK	Member Name
30026		Number of Emitter Channels
30027		Emitter First Bad Channel
30028		Number of Receiver Channels
30029		RESERVED
30030	LOW BYTE	DIP Switch
30030	HIGH BYTE	ERROR Code
30031	LOW BYTE	RESERVED
30031	HIGH BYTE	Discrete Outputs
30032		Analog Output 1 DAC
30033		Analog Output 2 DAC
30034		RESERVED

Table A–41. Number of Emitter Channels

Range	Description
30-480	Number of channels the emitter has (multiples of 30)

Table A–42. Emitter First Bad Channel

Range	Description
0-480	First channel that emitter is unable to fire (0 = no bad channels)

Table A–43. Number of Receiver Channels

Range	Description
30-480	Number of Receiver channels (multiples of 30)

Table A–44. DIP Switch

Bit	Function	Description
0	DIP Switch 6	0 = ON, 1 = OFF
1	DIP Switch 5	0 = ON, 1 = OFF
2	DIP Switch 4	0 = ON, 1 = OFF
3	DIP Switch 3	0 = ON, 1 = OFF
4	DIP Switch 2	0 = ON, 1 = OFF
5	DIP Switch 1	0 = ON, 1 = OFF

Table A–45. ERROR Code

Value	Status
0	System OK
1	Receiver EEPROM Hard Failure
2	Receiver Alignment/Blanking Configuration Error
3	Reserved for Factory 3
4	Emitter or Wiring Problem
5	Emitter Channel Error
6	Reserved For Factory 6
7	Reserved For Factory 7
8	Reserved For Factory 8
9	Reserved For Factory 9
10	Incompatible Scan and Measurement Mode

Table A–46. Discrete Outputs

Bit	Function	Description
0	Discrete Output 1	0 = OFF, 1 = ON
1	Discrete Output 2	0 = OFF, 1 = ON

Table A–47. Analog Output 1 DAC and Analog Output 2 DAC

Range	Description
0-4095	Current DAC value of analog output

A.5 Receiver and Emitter Version Info

The Receiver and Emitter Version Info section contains the part numbers and versions of the receiver and emitter firmware.

Table A–48. Receiver and Emitter Version Info

Input Register Address	MASK	Member Name
31000		Receiver Part Number
31001		
31002	LOW BYTE	Receiver Version
31002	HIGH BYTE	RESERVED
31003		Emitter Part Number
31004		
31005	LOW BYTE	Emitter Version
31005	HIGH BYTE	RESERVED

A.6 Communications Version Info

The Communications Version Info section contains the part number and version of the communications firmware.

Table A–49. Communications Version Info

Input Registers	MASK	Member Name
32000		Part Number
32001		
32002	LOW BYTE	Version
32002	HIGH BYTE	RESERVED

Glossary

Blanked Beam: A beam that is "ignored" by the receiver, as a result of a blanking program being applied to it. Beams (or groups of beams) are blanked when a component or fixture will remain in or move through the light screen array; blanking the affected beams prevents the component or fixture from causing false outputs.

Blocked Beam: A beam that is obstructed between the emitter and the receiver, and is not blanked.

Clear Beam: A beam that runs unobstructed from the emitter to the receiver (same as a made or unblocked beam).

Excess Gain: A measurement of the amount of light falling on the receiver from the emitter over and above the minimum amount required for operation. A-GAGE EZ-ARRAY emitters and receivers can perform an electronic Alignment procedure to equalize the amount of excess gain at each element along the array.

Host: A computer or process controller that controls and receives input from the High-Resolution MINI-ARRAY System, and/or other equipment and systems within a factory.

Made Beam: A beam that runs unobstructed from the emitter to the receiver (same as an unblocked or clear beam).

Unblocked Beam: A beam that runs unobstructed from the emitter to the receiver (same as a made or clear beam).

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