

A-GAGE® MINI-ARRAY®

Measuring Light Screen System (MAC Series Controllers)

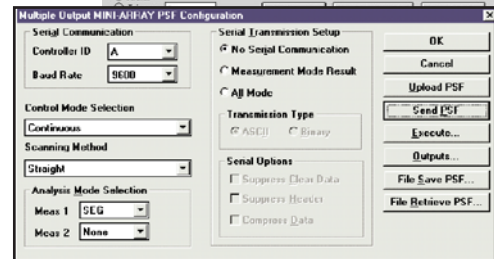
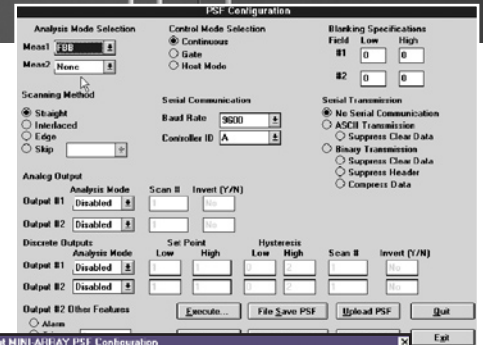
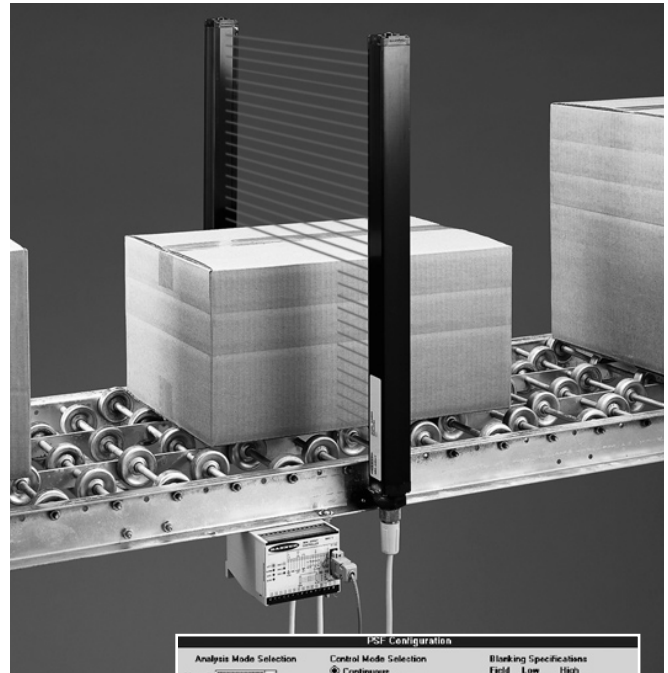
Instruction Manual

Features

**Controller Models MAC-1, MACN-1, MACP-1,
MACV-1, MACI-1, MAC16N-1, MAC16P-1**

(See Section 1.1 for additional, model-specific features)

- Measuring Light Screen system for inspection and profiling applications.
- Modular system with compact controller and a variety of BMEL/ BMRL series MINI-ARRAY emitters and receivers.
- Sensors available with either 9.5 mm (3/8") or 19.1 mm (3/4") beam spacing and with array lengths from 6" to 4' (in 6" increments), plus 5' and 6' models.
- Controller is programmable for any one or two of ten measurement modes (depending on model) and any one of four scanning modes, using a computer running Windows®.XP, Vista, or 7 and the Banner-supplied software
- Software is also supplied for display of error analysis (via controller self-diagnostics) and for sensor alignment.
- System status, including alignment, is displayed via LED indicators on the controller and on the receivers.
- Controller may be programmed for blanking to ignore activity in one or two fields along the length of the array.
- Programmable hysteresis at the high and/or low limit of each measurement area provides smoothing of output response; also programmable for number of consecutive scans before an output update.
- Separate gate input (e.g., from a presence sensor) allows control of scan initiation.
- Supports serial communication with a computer or PLC via RS-232C interface; enables a computer or PLC to process scan data and/or initiate scans; serial data may be either ASCII or binary.



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 which meet OSHA, ANSI and IEC standards for personnel protection.

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1. System Overview

The Banner A-GAGE® MINI-ARRAY measuring light screen is ideal for applications such as on-the-fly product sizing and profiling, edge-guiding and center-guiding, loop tensioning control, hole detection, parts counting, die ejection verification, and similar uses.

A typical MINI-ARRAY System consists of five components:

- a Controller module,
- an emitter and corresponding receiver, and
- two interconnecting cables.

Sensors are available in array lengths from 6" to 4' (in 6" increments), plus 5' and 6' array models, as listed on page 7. Sensors are available with either 9.5 mm (3/8") or 19.1 mm (3/4") beam spacing, which translates to either 32 or 16 beams per foot of array length. Sensors with 3/8" beam spacing have a sensing range of up to 6 m (20'). Sensors with 3/4" beam spacing have a sensing range of up to 17 m (55'); 5' and 6' arrays have shorter range (see Specifications).

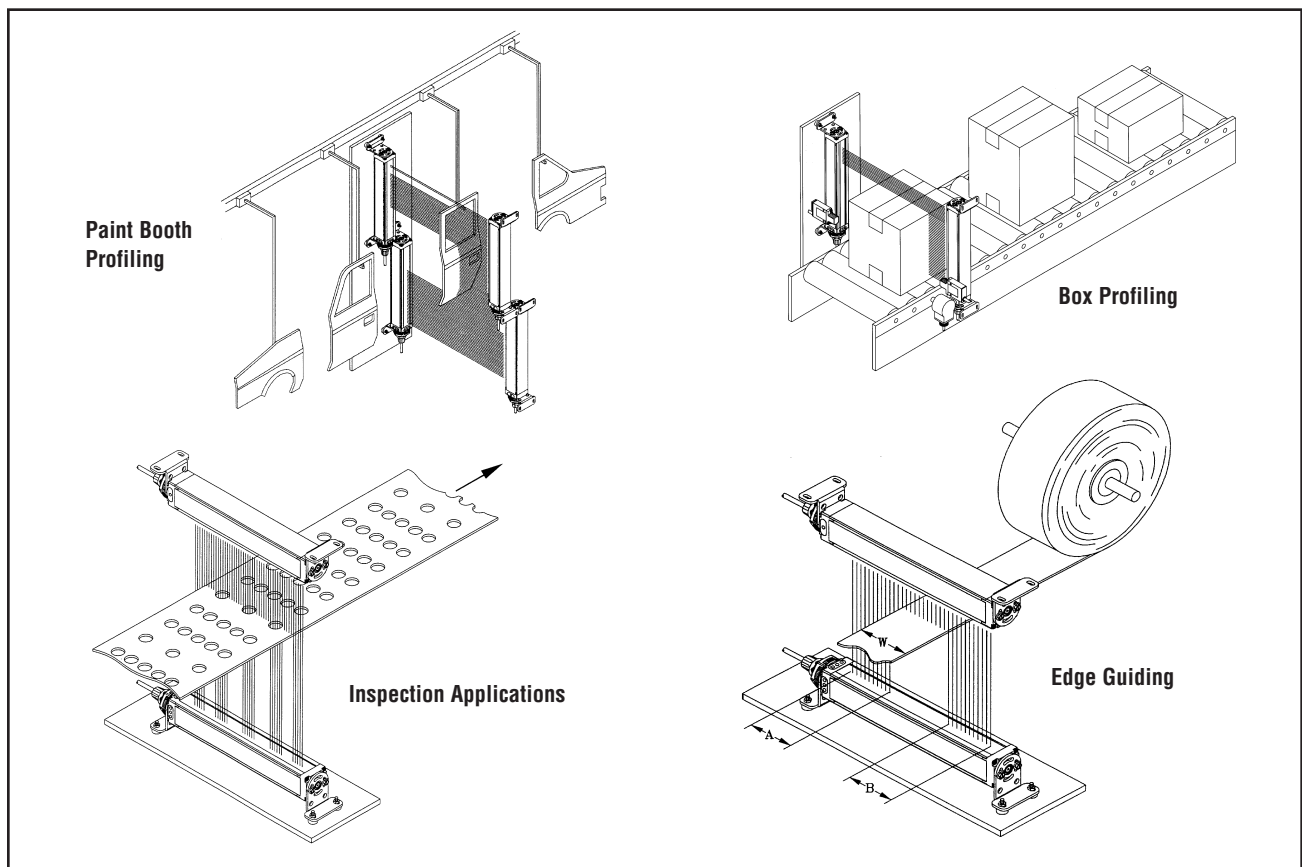


Figure 1-1. Typical MINI-ARRAY Applications

1.1 System Features

Built-in features simplify the operation of the A-GAGE MINI-ARRAY system. Programmable beam blanking accommodates machine components or other fixtures that must remain in or move through the light screen. Blanking is set by using the included configuration software. See Section 5.5.4 for more information.

Built-in diagnostic programming and easy-to-see indicators on the sensors and the control module make alignment and troubleshooting easy (Figure 1-2). The emitter has a red LED that signals proper operation. The receiver has three bright LEDs: green signals that the sensors are properly aligned; yellow signals marginal alignment; and red signals misalignment or a blocked condition. The control module has seven status indicators: 5 red LEDs signal when outputs are conducting (see Section 3 for more information), Alarm output conducting, and gate signal received; a green LED signals that the sensors are properly aligned. DIAG 1, 2, and 3 LEDs indicate system status. A key to the diagnostics codes is printed on the side of the control module for simplified troubleshooting (see Section 6.3).

The MINI-ARRAY System provides a wide selection of sensing and output options, including: measurement (“scan analysis”) modes and scanning methods that can determine the target object’s location, overall size, total height or total width. Scanning may be continuous or controlled by a host process controller or a gate sensor. Some models (MAC1, MACP, MACN) support RS-485, where up to 15 systems may be networked.

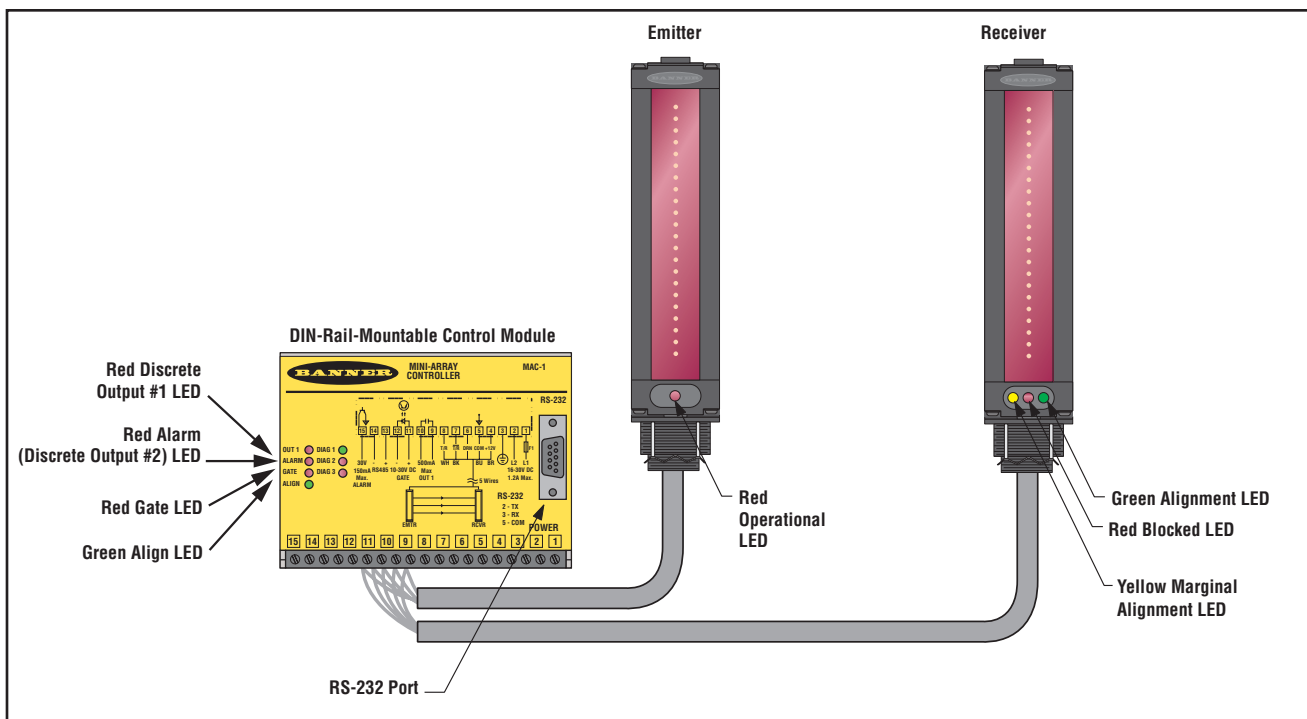


Figure 1-2. A-GAGE MINI-ARRAY System features

1.1.1 Model-Specific Features

Models MAC-1, MACN-1, and MACP-1

- Supports serial communication with a host computer or PLC via RS-232 or RS-485 interface; enables a computer or PLC to process scan data and/or initiate scans; serial data may be either ASCII or binary.
- Up to 15 controllers may be assigned separate IDs and placed on RS-485 party line.
- **MAC-1:** Two outputs: one reed relay and one NPN transistor output; either output may be inverted (i.e., programmed for normally open or normally closed).
- **MACN-1 and MACP-1:** Two discrete open-collector PNP (current sourcing) or NPN (current sinking) transistor outputs, depending on model.

Models MACV-1 and MACI-1

- Analog output null and span can be adjusted via PC interface and supplied software.
- Analog output signal can have either a rising or falling slope.
- Analog outputs will automatically adjust to sensor length.
- Discrete output is an open-collector NPN (current sinking) that can be used as an alarm, a trigger, or used with an Analysis Mode Selection (output capable of being inverted in Analysis Mode).
- **MACV-1:** Two linear sourcing analog voltage outputs (0 to 10 volts) and one NPN transistor output.
- **MACI-1:** Two linear sinking analog current outputs (4 to 20 mA) and one NPN transistor output.

Models MAC16N-1 and MAC16P-1

- Two additional measurement modes:
 - TRN mode counts the number of clear-to-blocked and blocked-to-clear transitions;
 - SEG mode partitions the array into up to 16 regions.
- Controller has flexible blanking capabilities with unlimited blanking conditions. Blanking may be set automatically (Auto Blanking) or specified using the supplied PC software.
- **MAC16N-1:** 16 discrete open-collector NPN (current sinking) transistor outputs.
- **MAC16P-1:** 16 discrete open-collector PNP (current sourcing) transistor outputs.

1.1.2 Sensing Response

Sensing response is a function of the number of beams interrogated (i.e., steps) per scan of the array. The time per step is 55 μ s (0.000055 seconds). As a result, dense arrays (i.e., 3/8" beam spacing) yield the highest sensing resolution, while arrays with wider (3/4") beam spacing offer faster sensing response.

1.1.4 Supplied System Software

The supplied software program, used to configure each System control module, may be run on any PC running Windows® XP, Vista, or 7. The menu-driven program walks the user through the many scanning and output options. After the desired options are selected, the user can save the combination of selections in a Parameter Setup File (PSF), and store it in the control module's non-volatile memory. Any number of PSFs may be stored in the computer and recalled as needed.

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 in the System, and totals of beams blocked, made, and blanked. Built-in system diagnostics can be used to assess emitter and receiver hardware errors.

1.2 System Components

1.2.1 Emitter and Receiver Models

19.1 mm (3/4") beam spacing – 16 beams/foot		
Emitter / Receiver Models	Array Length	Total Beams
BMEL616A / BMRL616A	133 mm (5.25")	8
BMEL1216A / BMRL1216A	286 mm (11.25")	16
BMEL1816A / BMRL1816A	438 mm (17.25")	24
BMEL2416A / BMRL2416A	591 mm (23.25")	32
BMEL3016A / BMRL3016A	743 mm (29.25")	40
BMEL3616A / BMRL3616A	895 mm (35.25")	48
BMEL4216A / BMRL4216A	1048 mm (41.25")	56
BMEL4816A / BMRL4816A	1200 mm (47.25")	64
BMEL6016A / BMRL6016A	1505 mm (59.25")	80
BMEL7216A / BMRL7216A	1810 mm (71.25")	96
9.5 mm (3/8") beam spacing – 32 beams/foot		
BMEL632A / BMRL632A	143 mm (5.62")	16
BMEL1232A / BMRL1232A	295 mm (11.62")	32
BMEL1832A / BMRL1832A	448 mm (17.62")	48
BMEL2432A / BMRL2432A	600 mm (23.62")	64
BMEL3032A / BMRL3032A	752 mm (29.62")	80
BMEL3632A / BMRL3632A	905 mm (35.62")	96
BMEL4232A / BMRL4232A	1057 mm (41.62")	112
BMEL4832A / BMRL4832A	1210 mm (47.62")	128
BMEL6032A / BMRL6032A	1514 mm (59.62")	160
BMEL7232A / BMRL7232A	1819 mm (71.62")	192

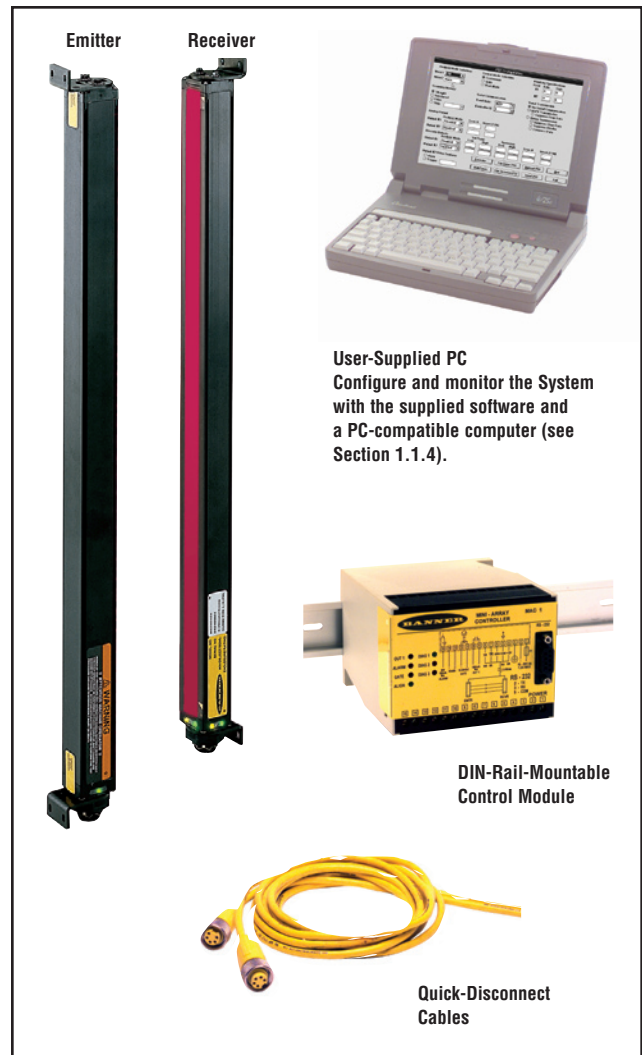


Figure 1-3. MINI-ARRAY system components

1.2.2 Controller-to-Sensor Cables

2 required per system

Model	Length	QD Connector
QDC-515C	4.6 m (15')	5-pin Mini-style straight
QDC-525C	7.6 m (25')	
QDC-550C	15.2 m (50')	
MAQDC-575C	22.7 m (75')	
MAQDC-5100C	30.3 m (100')	
MAQDC-5125C	37.9 m (125')	
MAQDC-5150C	45.5 m (150')	

1.2.3 MINI-ARRAY MAC Series Controller Models

Controller Model	Supply Voltage	Inputs	Output 1	Output 2	Scan Analysis Modes*	PSF Parameter Diskette	Serial Output		
MAC-1	16 to 30V dc	1 Sensor Pair 1 Gate	Discrete Reed Relay	Discrete NPN	8	43989	RS-232 and RS-485		
MACN-1			Discrete NPN						
MACP-1			Discrete PNP	Discrete PNP					
MACV-1			(2) Analog 0 to 10V dc Sourcing	Discrete NPN					
MACI-1			(2) Analog 4 to 20 mA Sinking						
MAC16N-1			16 Discrete NPN Outputs				10	59114	RS-232
MAC16P-1			16 Discrete PNP Outputs						

Dimensions for all MAC Series Controllers listed above are: 110 x 100 x 75 mm (4.3" x 3.9" x 3.0"); see Figure 2-2.

* See Section 5.5.3 for a detailed description of available scan analysis modes.

2. Specifications

2.1 Emitter and Receiver Specifications

Emitter/Receiver Range	9.5 mm (3/8") Beam Spacing 0.6 to 6.1 m (2 to 20') for sensors < 4' 0.6 to 4.6 m (2 to 15') for sensors > 4' NOTE: Maximum range is specified at the point where 3x excess gain remains.	19.1 mm (3/4") Beam Spacing 0.9 to 17 m (3 to 55') for sensors < 4' 0.9 to 14 m (3 to 45') for sensors > 4' NOTE: Maximum range is specified at the point where 3x excess gain remains.
Minimum Object Sensitivity	9.5 mm (3/8") Beam Spacing 19.1 mm (0.75") Interlaced Mode: 12.7 mm (0.5")* *NOTE: Assumes sensing is in middle one-third of scanning range.	19.1 mm (3/4") Beam Spacing 38.1 mm (1.5") Interlaced Mode: 25.4 mm (1.0")* *NOTE: Assumes sensing is in middle one-third of scanning range.
Sensor Scan Time	55 microseconds per beam, plus 1 millisecond processing time per scan. (Assumes straight scan, continuous scan, and TBB mode; see Section 5.5.5 Scanning Modes for further information.)	
Power Requirements	Emitter 0.10 amps @ 12V dc NOTE: Maximum current is for a 6' sensor.	Receiver 9.5 mm (3/8") beams: 0.75 amps @ 12V dc max. 19.1 mm (3/4") beams: 0.50 amps @ 12V dc max. NOTE: Maximum current is for a 6' sensor.
Connections	Emitter and receiver connect to controller using two 5-conductor quick-disconnect cables (one each for emitter and receiver), ordered separately. See Section 1 for available cable lengths. Cables measure 8.1 mm (0.32") dia., and are shielded and PVC-jacketed; conductors are 20-gauge. <ul style="list-style-type: none"> • Use only Banner cables, which incorporate a "twisted pair" for noise immunity on RS-485 data communication lines. • Emitter and receiver cables may not exceed 250' each. 	
Status Indicators (See Section 6.1 for more information)	Emitter Red LED lights for proper operation	Receiver Green: sensors aligned (> 3x excess gain) Yellow: marginal alignment (1x-3x excess gain) Red: sensors misaligned or beam(s) blocked
Environmental Rating	NEMA 4, 13 (IEC IP65)	
Construction	Aluminum housing with black anodized finish; acrylic lens cover	
Operating Conditions	Temperature: -20° to 70° C (-4° to 158° F) Max. rel. humidity: 95% (non-condensing)	

2.2 Emitter and Receiver Dimensions

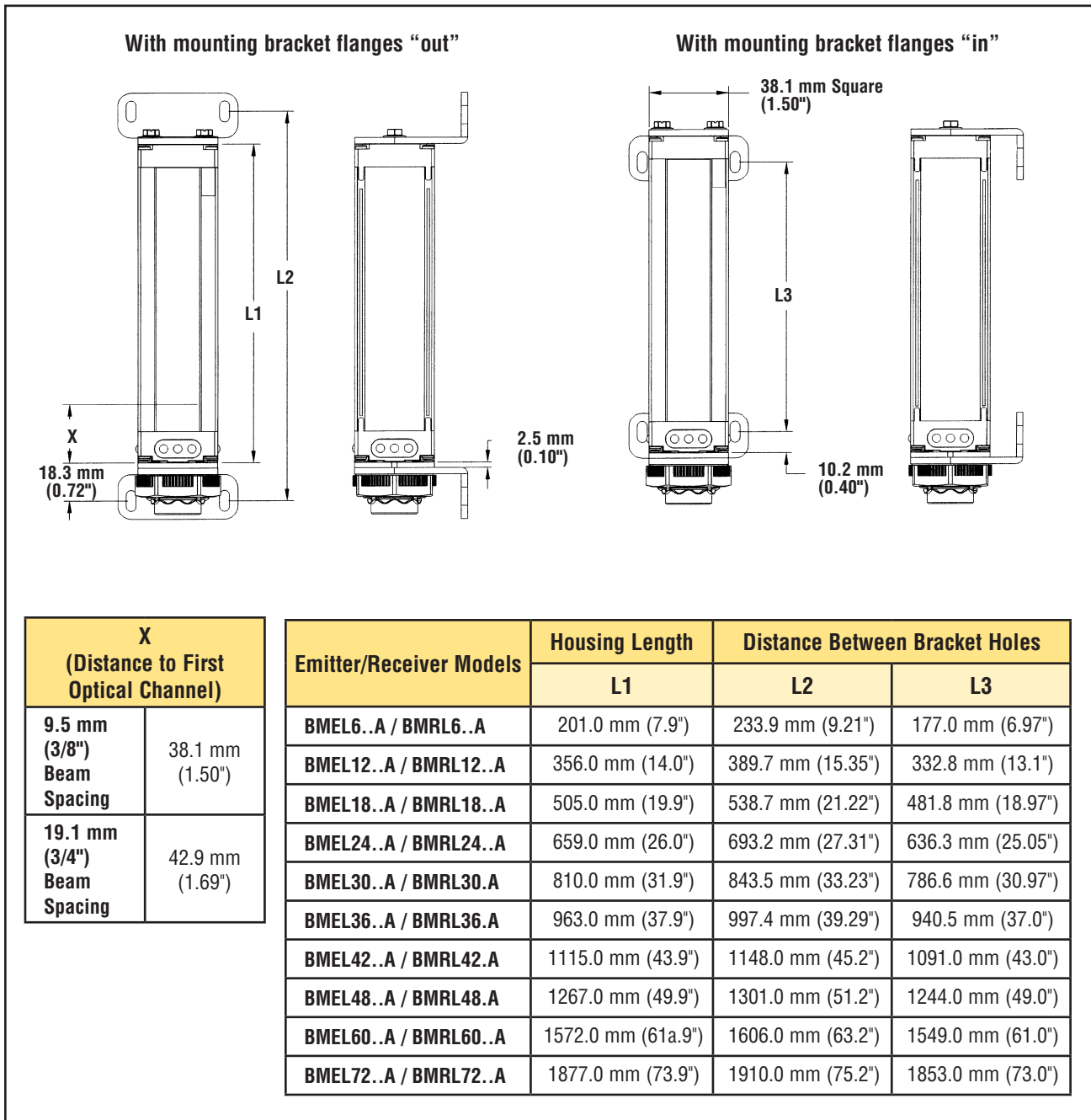


Figure 2-1. Emitter and receiver mounting dimensions and defined area location

2.3 Controller Specifications

Power Requirements	16 to 30V dc @ 1.25 amps max. (see current requirements for sensors); Controller alone (without sensors connected) requires 0.1 amp.
Inputs	MINI-ARRAY sensor input (5 connections); emitter and receiver wire in parallel to five terminals. GATE input: Optically-isolated, requires 10 to 30V dc (7.5K input impedance) for gate signal.
System Response Time	Outputs are not active for 5 seconds after system power up. Maximum response time for the discrete outputs is two scan cycles. A scan cycle includes a sensor scan plus any serial data transmission. Serial transmission (if activated) follows every sensor scan.
Discrete Outputs	<p>MAC-1: Output 1 (OUT 1): Reed relay contact rated 125V ac/dc max., 10 VA max. resistive load (non-inductive). Output 2 (ALARM): Open collector NPN transistor rated 30V dc max., 150 mA max, short-circuit protected (may be configured as a second data analysis output, system alarm output, or scan trigger output for a parallel array). OFF-STATE Leakage Current: <10µA @ 30V dc ON-STATE Saturation Voltage: <1 Volt @ 10 mA, <1.5 Volt @ 150 mA</p> <p>MACN-1: (2) Open collector NPN transistor outputs.</p> <p>MACP-1: (2) Open collector PNP transistor outputs. Transistor rated 30V dc max., 150 mA max, short circuit protected (may be configured as a second data analysis output, system alarm output, or scan trigger output for a parallel array). OFF-STATE Leakage Current <10µA @30V dc ON-STATE Saturation Voltage <1 Volt @10 mA, <1.5 Volt @150 mA</p> <p>MACV-1/MACI-1: Alarm: Open collector NPN transistor rated 30V dc max. 150 mA max, short circuit protected. (may be configured as a data analysis output, system alarm output, or scan trigger output for a parallel array) OFF-STATE Leakage Current: <10µA @30V dc ON-STATE Saturation Voltage: <1 Volt @10 mA, <1.5Volt @150 mA</p> <p>MAC16P-1: Sixteen open collector PNP transistor outputs.</p> <p>MAC16N-1: Sixteen open collector NPN transistor outputs. 30V dc max, 150 mA max., short circuit protected. OFF-STATE leakage current: <10 µA ON-STATE Saturation Voltage: <1 Volt @ 10 mA; <1.9V @ 150 mA</p>
Analog Outputs	<p>MACV-1: (2) 0-10 Volts sourcing adjustable Null and Span (20 mA current limit).</p> <p>MACI-1: (2) 4-20 mA current sinking adjustable Null and Span (16 to 30V input).</p> <p>Resolution: Span minus Null, divided by the number of sensor channels</p> <p>Linearity: 0.1% of Full Scale</p> <p>Temp. Var.: 0.01% of Full Scale/°C</p>
Serial Data Outputs	<p>All Models: RS-232, ASCII or binary data format. Baud rate: 9600, 19.2K, or 38.4K 8 data bits, 1 start bit, 1 stop bit, even parity. Clear data may be suppressed; header string may be suppressed in binary format.</p> <p>MAC-1, MACN-1, and MACP-1: Up to 15 Controllers may be given unique address for RS-485 party line.</p>
Controller Programming	Via RS-232 to PC-compatible computer running Windows®.XP, Vista, or 7 operating system and using Banner-supplied software (see user manual).

2.3 Controller Specifications (continued)

Status Indicators (See Section 6.2 for more information)	<p>The following status LEDs are located on the front panel:</p> <p>OUTPUT 1 (red) (name and function vary depending on model): Indicates active output</p> <p>ALARM (red): Indicates that Output 2 or 16 is active (depending on model)</p> <p>GATE (red): Indicates voltage is applied to GATE input</p> <p>ALIGN (green): Indicates sensor aligned (excess gain >1x)</p> <p>Plus three diagnostic LEDs:</p> <p>DIAG1 (green): Indicates power is applied to the module</p> <p>DIAG2 (red): Indicates receiver failure</p> <p>DIAG3 (red): Indicates emitter failure</p>
Sensor Scan Time	<p>For all models: 55 microseconds per beam plus processing time. The processing time is dependent on the scan analysis and the number of active outputs. This timing assumes a straight scan, continuous, and TBB mode.</p> <p>MAC-1, MACN-1 & MACP-1: 1 millisecond processing time.</p> <p>MACV-1 & MACI-1: 1.5 milliseconds processing time.</p> <p>MAC16N-1 & MAC16P-1: 2.3 to 7 milliseconds processing time.</p>
Construction	Polycarbonate
Environmental Rating	NEMA 1 (IP20)
Operating Conditions	<p>Temperature: -20° to +70°C (-4° to +158°F)</p> <p>Maximum Relative Humidity: 95% (non-condensing)</p>

2.4 Controller Dimensions

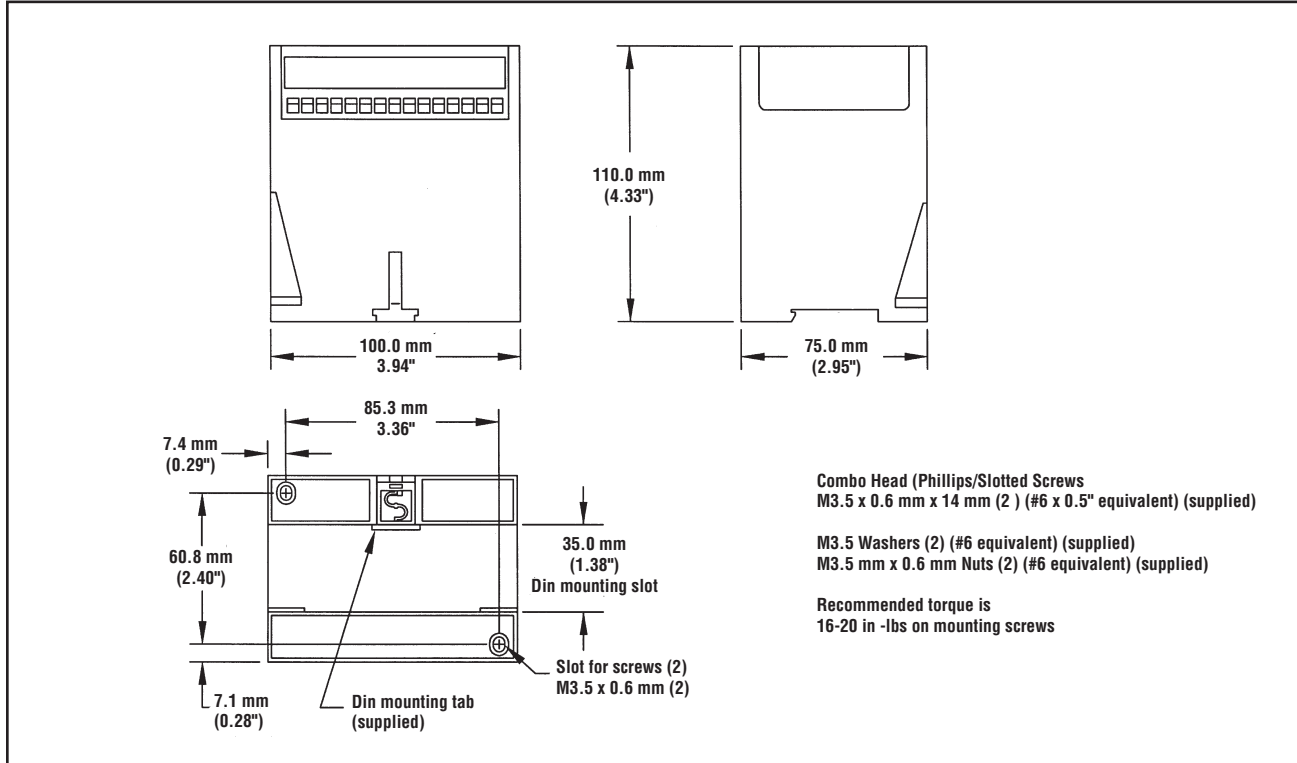


Figure 2-2. Control module dimensions and mounting hole locations

3. Installation and Mechanical Alignment

3.1 Emitter and Receiver Mounting

Banner MINI-ARRAY emitters and receivers are small, lightweight, and easy to mount; the mounting brackets (supplied) allow ± 30 degrees rotation.

From a common point of reference, make measurements to position the emitter and receiver in the same plane with their midpoints directly opposite each other. Mount the emitter and receiver brackets using the M4 x 0.7 x 14 mm bolts and associated mounting hardware (all supplied). See Figure 3-1.

Although the internal circuitry of the emitter and receiver can withstand heavy impulse forces, vibration isolators can be used instead of the M4 bolts to dampen impulse forces and prevent possible damage from resonant vibration of the emitter or receiver assembly. Two different Anti-Vibration Mounting Kits are available from Banner as accessories.

P/N 48955 consists of 4 anti-vibration mounts (M4 x 0.7 x 9.5 mm) and 8 M4 Keps nuts. These mounts are made from BUNA-N rubber and are more resistant to chemicals and oils.

P/N 12847 consists of 4 anti-vibration mounts (M4 x 0.7 x 9.5 mm) and 8 M4 Keps nuts. These mounts are made from natural rubber, which are less chemically resistant than the 48955 mounts, but have a greater shear force spec at higher temperature.

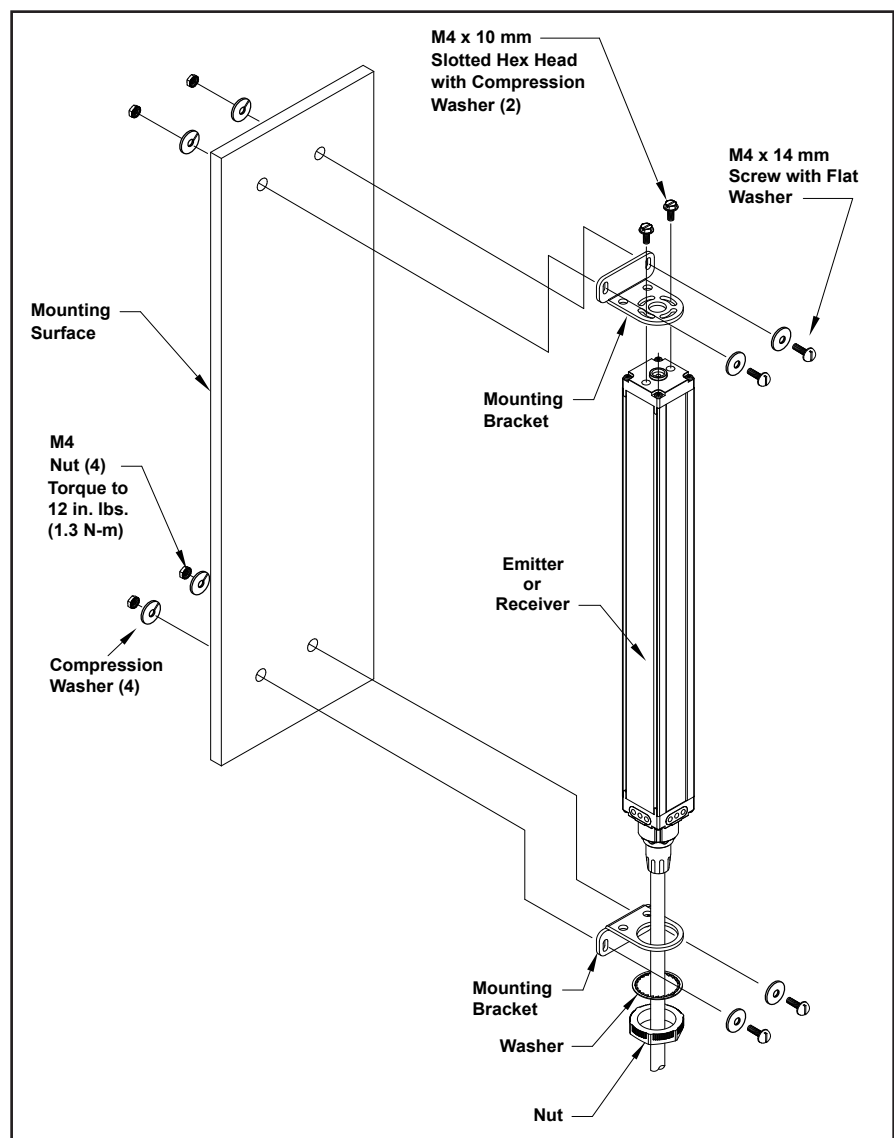


Figure 3-1. MINI-ARRAY emitter and receiver mounting hardware

Mount the emitter and receiver in their mounting brackets (shown in Figure 3-1), and position the red lenses of the two units directly facing each other. The connector ends of both sensors must point in the same direction. Measure from one or more reference planes (i.e., the floor) to the same points on the emitter and receiver to verify their mechanical alignment. If the sensors are positioned exactly vertical or exactly horizontal, a carpenter's level may be useful for checking alignment. Extending a straight-edge or a string between the sensors may help with positioning. Also check by eye for line-of-sight alignment. Make any necessary final mechanical adjustments, and hand-tighten the bracket hardware. See Section 5 for information on alignment indicators and the use of the alignment software supplied with the controller.

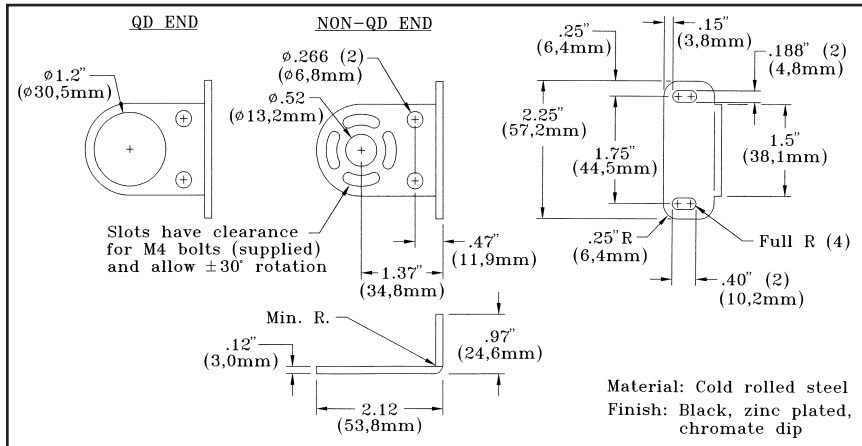


Figure 3-2. MINI-ARRAY emitter and receiver mounting bracket dimensions

Connect the shielded cables to the emitter and receiver, and route them to the controller location. Follow the local wiring code for low-voltage dc control cables. The same cable type is used for both emitter and receiver (two cables required per system). Cut the cables to length after making sure they are routed properly. Remove cable braid at the controller connection points (see Figure 3-4).

3.2 Controller Mounting

The controller must be installed inside an enclosure with a NEMA (or IEC) rating suitable for the operating environment.

Mounting dimensions for the controller are shown in Figure 2-2. The controller is supplied with M3.5 x 0.6 hardware for direct mounting to a surface, or it can be mounted onto standard 35 mm DIN rail.

3.3 Emitter and Receiver Hookups

Emitter and receiver cables connect in parallel to controller terminals #4 through #8. Connect the wires from both sensor cables, as follows:

Terminal 4	Brown
Terminal 5	Blue
Terminal 6	Bare
Terminal 7	Black
Terminal 8	White

Trim off the foil shield and the braided shield at the point where the wires exit the cable (see Figure 3-4).

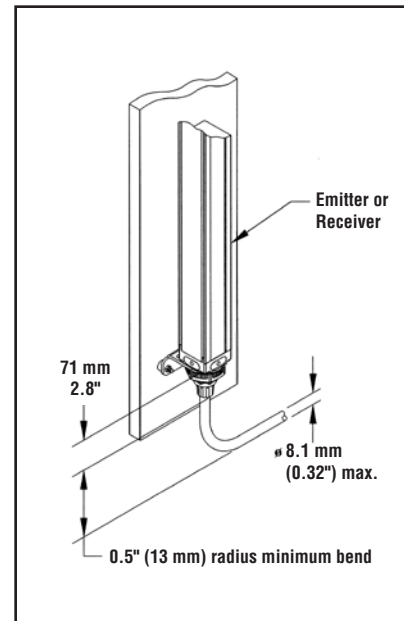


Figure 3-3. Quick-disconnect cable clearances

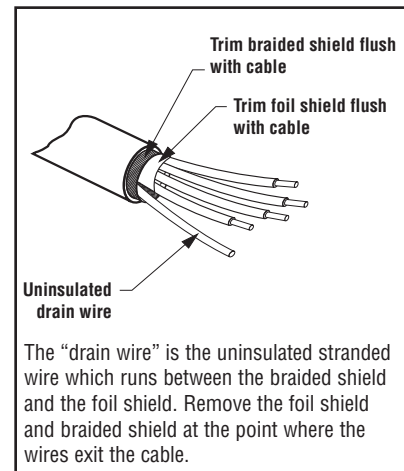


Figure 3-4. Emitter/receiver cable preparation

3.4 Controller Wiring and Output Hookups

Cable clearance dimensions for the arrays are shown in Figure 3-3.

Controller connections are made via the wiring terminals along the front surface of each module. Emitter and receiver hookups and controller outputs are shown in Figures 3-5 through 3-11.

3.4.1 Model MAC-1 Controller Hookup

Output 1: Controller terminals #9 and #10 (OUT1) are reed relay contacts rated at 125V ac/dc max., 10 VA max. resistive (i.e., non-inductive) load. It may be programmed as either normally open or normally closed.

Alarm: Controller terminal #15 (Alarm) is an open-collector NPN transistor switch rated at 30V dc max., 150 mA max. It is protected against overload and short circuits.

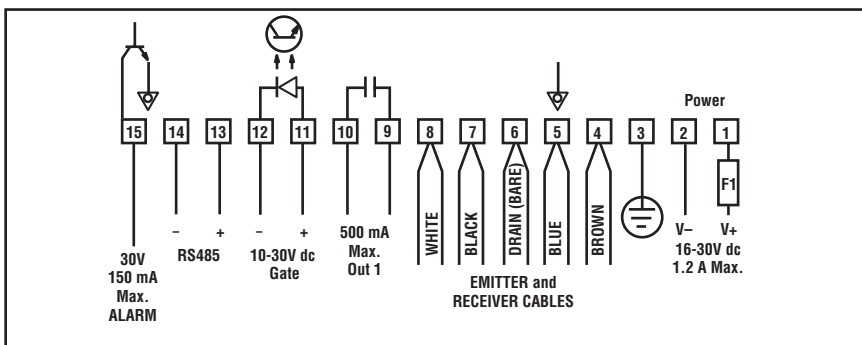


Figure 3-5. Model MAC-1 hookup

3.4.2 Model MACP-1 Controller Hookup

Output 1: Controller terminal #9 (OUT1) is an open-collector PNP transistor switch rated at 30V dc max., 150 mA max. It is protected against overload and short circuits.

Alarm: Controller terminal #15 (ALARM) is an open-collector PNP transistor switch rated at 30V dc max., 150 mA max. It is protected against overload and short circuits.

Both outputs are current sourcing.

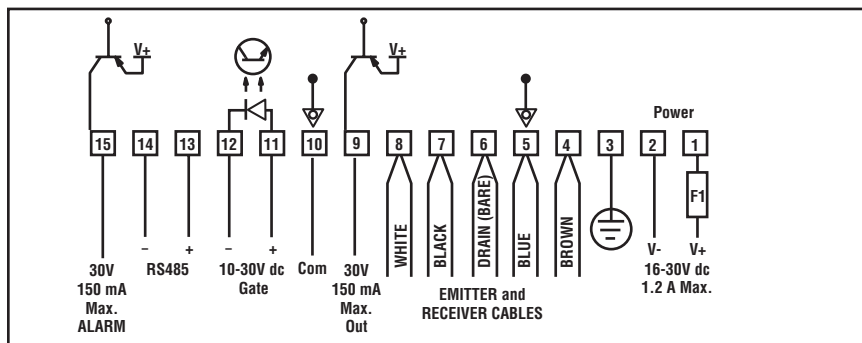


Figure 3-6. Model MACP-1 hookup

3.4.3 Model MACN-1 Controller Hookup

Output 1: Controller terminal #9 (OUT1) is an open-collector NPN transistor switch rated at 30V dc max., 150 mA max. It is protected against overload and short circuits.

Alarm: Controller terminal #15 (ALARM) is an open-collector NPN transistor switch rated at 30V dc max., 150 mA max. It is protected against overload and short circuits.

Both outputs are current sinking.

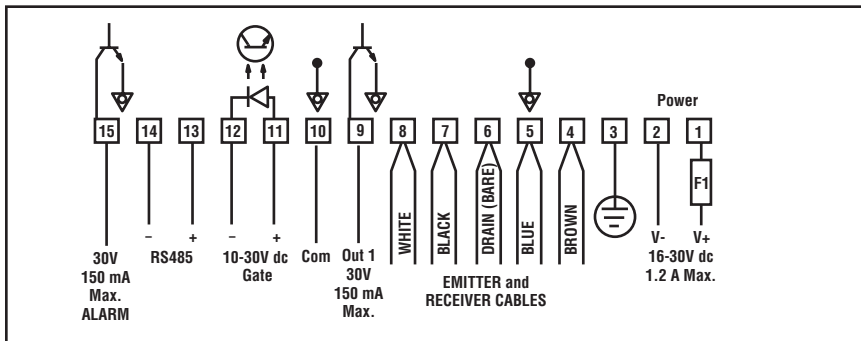


Figure 3-7. Model MACN-1 hookup

3.4.4 Model MACV-1 Controller Hookup

Voltage outputs 1 and 2: Controller terminals #9 (V out 1) and #13 (V out 2) are analog voltage outputs. The load for analog voltage Output #1 should be tied across terminals #9 and #10. The load for analog voltage Output #2 should be tied across terminals 13 and 14. Both switches are rated at 10V dc max., 10 mA max. Both outputs are voltage sourcing.

Alarm: Controller terminal #15 (ALARM) is an open-collector NPN transistor rated at 30V dc max., 150 mA max., current sinking.

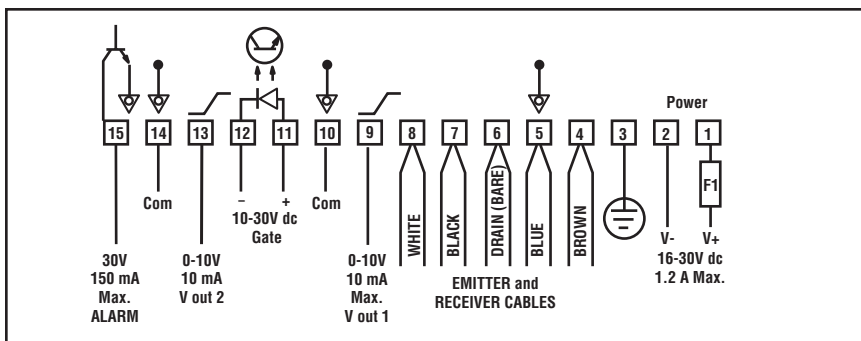


Figure 3-8. Model MACV-1 hookup

3.4.5 Model MACI-1 Controller Hookup

Current outputs 1 and 2: Controller terminal #9 (I out 1) and #13 (I out 2) are analog current outputs. The load for analog current Output #1 should be connected between an external 16 to 30V dc power supply and terminal #9. The load for analog current Output #2 should be connected between an external 16 to 30V dc power supply and terminal 13. The load external power supply return should be common with the controller power supply return. Both outputs are current sinking.

Alarm: Controller terminal #15 (ALARM) is an open-collector NPN transistor rated at 30V dc max., 150 mA max. It is protected against overload and short circuits.

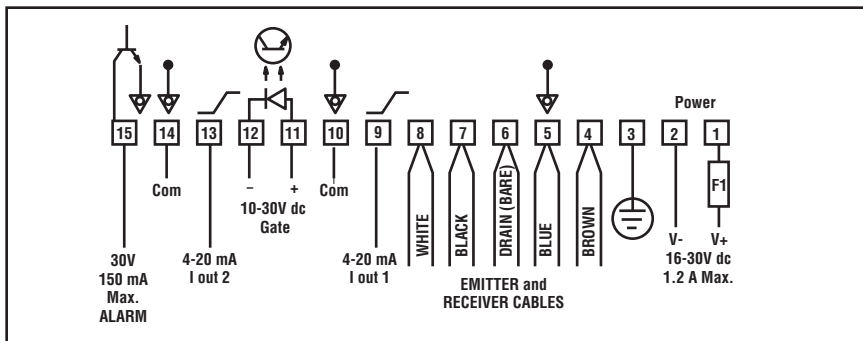


Figure 3-9. Model MACI-1 hookup

3.4.6 Model MAC16P-1 Controller Hookup

Terminals #15 through #30 are open-collector PNP transistor outputs rated at 30V dc max., 150 mA max. They are protected against overload and short circuits. The isolated gate input is at pins 11 and 12.

Controller terminal #15 (output #16) may be used as an output or as an alarm. Whenever this output is active, the red Alarm LED is ON.

All outputs are current sourcing.

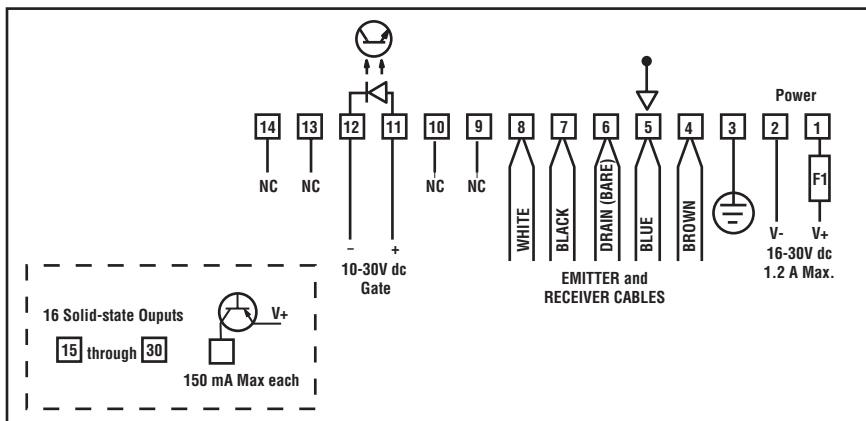


Figure 3-10. Model MAC16P-1 hookup

3.4.7 Model MAC16N-1 Controller Hookup

Terminals #15 through #30 are open-collector NPN transistor outputs rated at 30V dc max., 150 mA max. They are protected against overload and short circuits. All outputs are current sinking.

Controller terminal #15 (output #16) may be used as an output or as an alarm. Whenever this output is active, the red Alarm LED is ON.

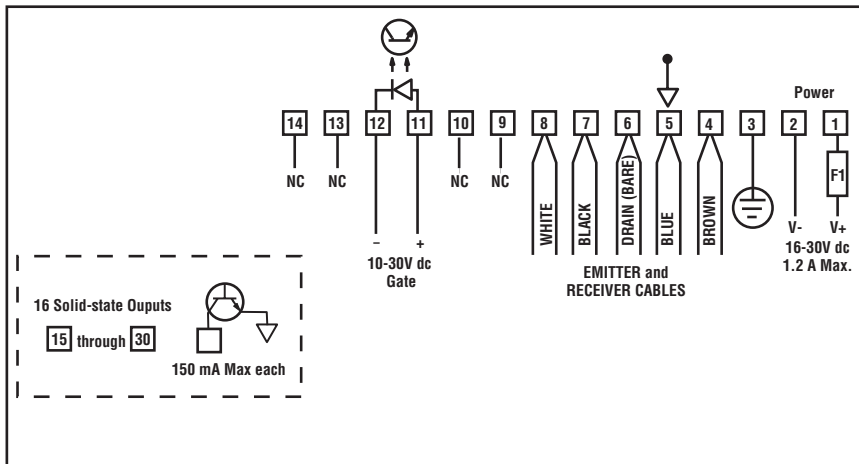


Figure 3-11. Model MAC16N-1 hookup

3.5 System Power

Connect a 16 to 30V dc source to controller terminals #1 (V+) and #2 (V-). Connect a good earth ground to terminal #3. A good earth ground is important for providing electrical and RF noise immunity to the MINI-ARRAY System. The dc power source must supply 1.25 amps (worst case) when using the longest (6') sensors. See Specifications (Section 2) for more information.

3.6 Gate

Connect a switched 10 to 30V dc source as a gating input (if required) between controller terminal #11 (+) and #12 (-). Voltage is typically switched by the open-collector output transistor of a dc sensing device.

3.7 Serial Communication

RS-485 (Models MAC-1, MACP-1, and MACN-1 only)

Connect RS-485 lines (if used) to terminals #13 (+) and #14 (-).

RS-232

Prepare an RS-232 cable using a DB-9 male connector with the connections shown in Figure 3-12.

NOTE: DO NOT use a “null modem” RS-232 cable.

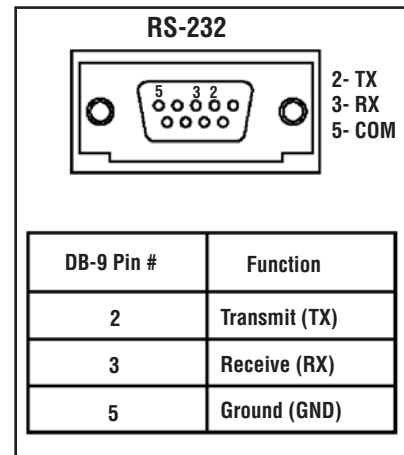


Figure 3-12. DB9 serial connector

4. Software Installation

The Parameter Setup Software CD includes an installation program that quickly and easily loads the MINI-ARRAY configuration program into the computer. The MINI-ARRAY configuration program requires approximately 50 MB of hard disk space. Install as follows:

1. Use the Parameter Setup Software CD included with the controller, or download (www.bannerengineering.com) per the following:
Models MAC-1, MACI-1, MACN-1, MACP-1, MACV-1: CD P/N 75877
Models MAC16N-1, MAC16P-1: CD P/N 75878
2. Insert the Software CD into the CD drive.
 If the program does not auto-start, browse to your CD drive, click **Setup.exe**, then select **START**, then select **RUN**.
2. The **Welcome** dialog box will appear. Select **Next**, and follow the prompts in the dialog boxes as they appear.
4. The installation program then decompresses the files. A status dialog box monitors the progress of the installation.
5. An **Installation Completed** dialog box appears. Select **OK**. Reboot your computer for the changes to take effect.

After the software is installed, a **MINI-ARRAY shortcut icon** is placed on your desktop. Double-click on the **MINI-ARRAY icon** to launch the program, then follow the configuration and setup procedures described in Section 5 of the primary manual.

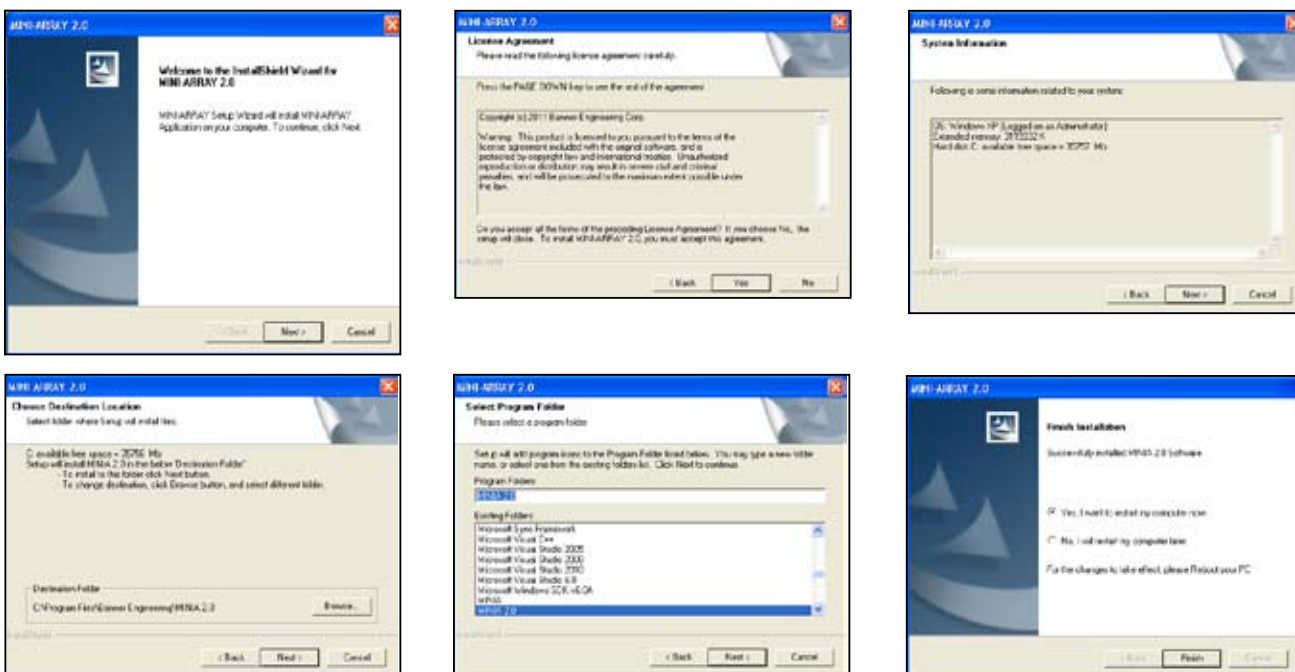


Figure 4-1. MINI-ARRAY software installation: dialog boxes

5. Controller Configuration

Configuration of the MINI-ARRAY controller is accomplished with a Windows® menu-style procedure, using the Banner-supplied software and a PC-compatible computer running Windows® XP, Vista, or 7. A serial data connection is made between the computer and the DB9 connector on the controller (see Figure 3-12).

Parameter Setup Files (PSF) are programmed configurations that can be stored in the control module's non-volatile memory. The Banner software can store various PSFs in computer files for instant call-up of a particular configuration.

The Banner software also provides two additional features: An Alignment screen and a Diagnostics screen

5.1 Communications Setup

The MINI-ARRAY software permits serial communication via RS-232 between the MAC controller and the PC. The minimum connections to the DB-9 connector on the MINI-ARRAY Controllers are as follows:

Pin Number of DB-9	Function
2	Transmit (TX)
3	Receive (RX)
5	Ground (GND)

NOTE: DO NOT use a “null modem” RS-232 cable.

Configure the COM port of the PC by first selecting the **Options** menu (see Figure 5-1). The program supports serial communication via the COM1-COM20 port of the computer. Select **Options**, then select **Serial Port** (or **Enter**). Select either **COM1** or **COM2**. Check **Save Settings on Exit** (if it is not already checked) to store the COM port selection.

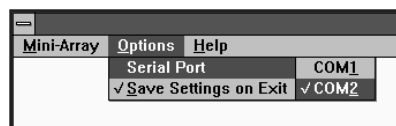


Figure 5-1. MINI-ARRAY software Option menu

5.2 Alignment Analysis

Alignment status is continuously displayed by the green LED indicator on the Receiver and the controller. When all unblanked beams are clear, and excess gain of all beams is more than 3x, the green alignment indicators will be ON. When the excess gain of one or more beams drops to between 3x and 1x, the green ALIGN LED on the controller will remain ON, but the yellow LED on the receiver will come ON to indicate a warning of marginal alignment. See Section 6 for more information about sensor alignment.

One feature of the MINI-ARRAY software is a program that displays the status of each beam in the array. This routine can be very helpful for final alignment or when analyzing how the MINI-ARRAY is viewing objects in the sensing array. To launch this program, select **Alignment...** under the **MINI-ARRAY** menu (see Figure 5-2), or press the F3 key.

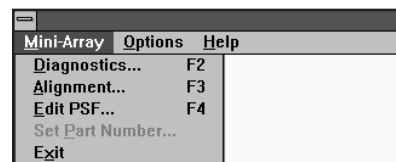


Figure 5-2. MINI-ARRAY software Main menu

5.3 Alignment

The Alignment screen (Figures 5-3 and 5-4), identifies the location of the first and last beams made (clear) and broken (blocked), plus the total number of beams made and broken. The beams are numbered in sequence from the cable end of the sensors to the top end. This is valuable during setup, for analyzing exactly what is being seen by the light screen. (The **Diagnostics screen** indicates any problems with the emitter or the receiver; see Section 6.3 for more information.)

Models MAC-1, MACP-1, MACN-1, MACV-1, and MACI-1

To display current information, select the desired Channel Status Option (Broken, Made or Both) and select **Run**. The chart on the right side of the screen shows the status (broken or made) of each beam in the array. Beam status is continuously updated to allow accurate positioning of the array, and/or analysis of sensing response. To exit the Alignment screen, first select **Stop**, then select **Exit**.

Models MAC16P-1 and MAC16N-1

The Alignment screen (Figure 5-4) displays the status of each beam along the entire length of the light screen.

The information displayed includes the total number of optical channels (labeled as Beams), the number of blocked, made, and blanked beams. Each channel state is indicated as either 1-made, 0-blocked, or B-blanked. Other alignment functions allow the user to scan on a step command and to adjust the blanking fields. Each channel can be individually blanked. When a channel is blanked, the controller ignores the state of the channel and does not consider the channel when calculating measurement mode data. See Section 5.5.4 for more information about blanking.

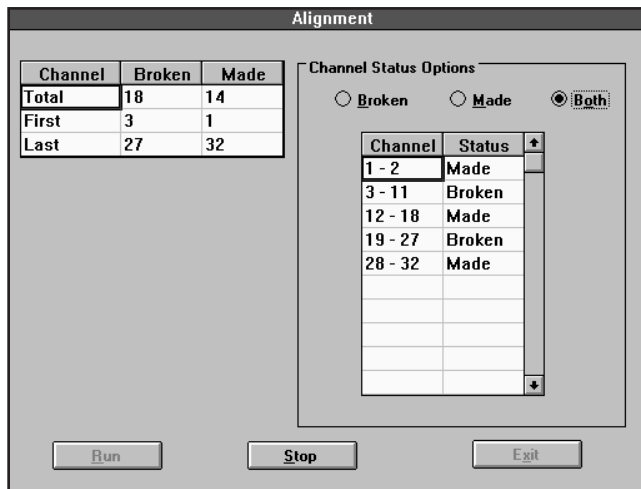


Figure 5-3. MINI-ARRAY software Alignment screen (models MAC-1, MACP-1, MACN-1, MACV-1, and MACI-1)

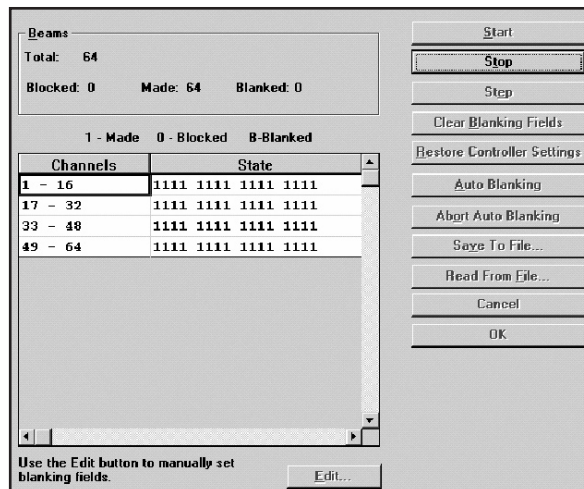


Figure 5-4. Alignment screen (models MAC16P-1 and MAC16N-1)

5.4 Parameter Setup Files (PSFs)

The input and output response of the MAC controller is programmed using the PSF Configuration screen shown in Figure 5-5 (models MAC-1, MACN-1, MACP-1, MACV-1, and MACI-1) and Figure 5-6 (models MAC16N-1 and MAC16P-1).

To access the PSF Configuration screen, select Edit PSF under the MINI-ARRAY Main menu (Figure 5-2), or press the F4 key. The chart on page 24 lists the programmable functions. Section 5.5 describes them in detail.

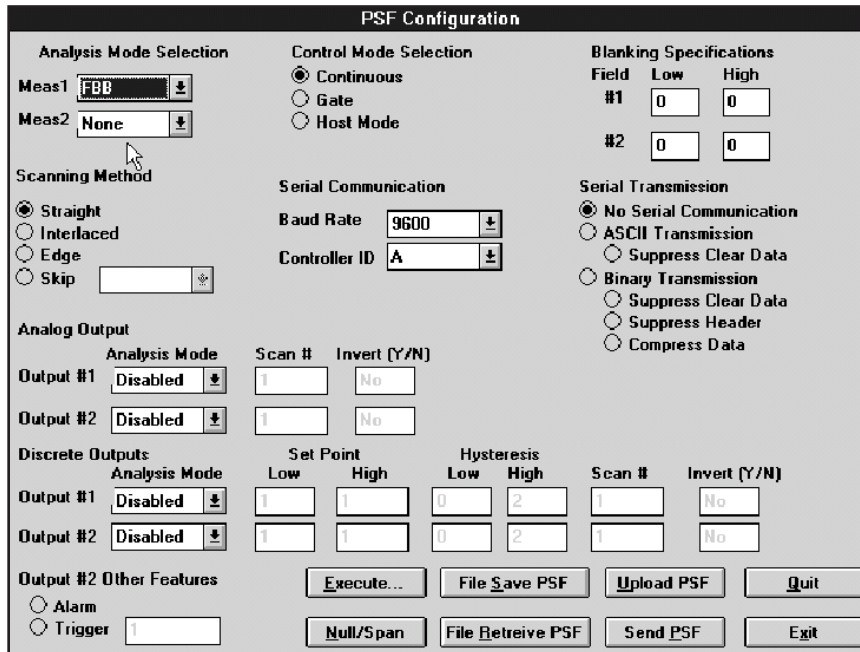


Figure 5-5. MINI-ARRAY software PSF Configuration (models MAC-1, MACP-1, MACN-1, MACV-1, and MACI-1)

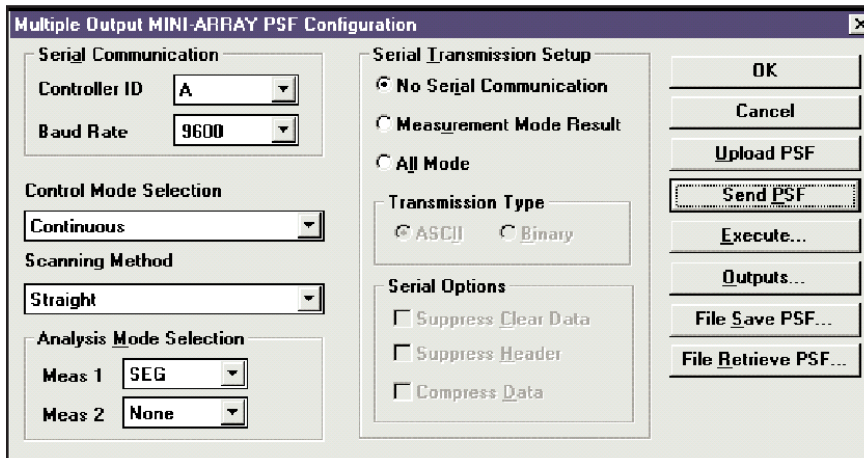


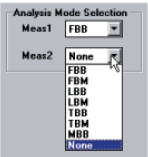
Figure 5-6. MINI-ARRAY software PSF Configuration (models MAC16N-1 and MAC16P-1)

Many options, yet easy to program

The software included with the control module makes it easy to configure the **MINI-ARRAY** using your PC-compatible computer*. Simply load the software, access the program, and access the Edit PSF Configuration screen, shown below. Each option is easily selectable, using your mouse and the pop-up menu-styles selections.


*Running Windows® 95, 98, NT, ME, XP or 2000

Analysis (Measurement) Mode Selection
Choose the measurement option that best tells you the size and/or position of objects as they relate to the array.



Control Mode Selection
Continuous Mode: The control module constantly polls the array for status.
Gate Mode: The control module polls the array for status when prompted by an input from a Gate sensor.
Host Mode: The control module polls the array for status when prompted by a host controller.

Serial Communication
Changes the identification and baud rate of the controller being configured.



Blanking
Allows either 1 or 2 areas of the array to be blind to the activity of the area specified.

Serial Transmission
Choose ASCII, binary or no serial communication

Invert
Allows output to be normally open (No) or normally closed (Yes)

Scan #: (1-9) Analog outputs are updated with an average value of the data received during the selected number of scans; discrete outputs respond only if the received data is identical for all of the selected number of consecutive scans.

Set Point and Hysteresis Selection
Assigns the set point to determine where within the array the output(s) will respond and hysteresis values to smooth output response.

Set Point		Hysteresis	
Low	High	Low	High
1	0	0	2
1	0	0	2

Scanning Method
 Straight
 Interlaced
 Edge
 Skip

Interlaced alternates a straight scan with a slanted beam scan to improve optical resolution in the center one third of the sensing range.

Edge activates only the beams located near the top edge of the object in the light screen to reduce sensing response time.

Skip - one to seven beams skipped reduces response time. Minimum object detection size increases proportionally to the number of beams skipped

Analog and Discrete Output Assignment
Assigns an analysis (measurement) mode to each output.

Alarm/Trigger
Output 2 may instead be programmed to serve as a trigger input for another MINI-ARRAY or ALARM for the self-diagnostic circuitry.

Downloadable Software
To test and verify software, download MINI-ARRAY version 1.3 (43989.exe) or Multiple (16) Output version 1.0 (59114_10.exe) at www.bannerengineering.com.

Figure 5-7. Use the PSF Configuration screen to program each control module individually (see Figure 5-10 for 16-output models)

Parameter Setup Files Available for Each Controller Model

		MAC-1 MACP-1 MACN-1	MACV-1 MACI-1	MAC16N-1 MAC16P-1
Analysis Mode Selection (See Section 5.5.3 for descriptions of these Analysis Modes.)	ALL: All data passed to host	x	x	x
	FBB: First Beam Blocked	x	x	x
	LBB: Last Beam Blocked	x	x	x
	TBB: Total Beams Blocked	x	x	x
	CBB: Contiguous Beams Blocked	x	x	x
	FBM: First Beam Made	x	x	x
	LBM: Last Beam Made	x	x	x
	TBM: Total Beams Made	x	x	x
	CBM: Contiguous Beams Made	x	x	x
	SEG: Segments			x
	TRN: Transitions			x
	VHS: Vehicle Separation	x		
Blanking Options	One or two fields may be blanked	x	x	
	Blanking conditions are unlimited			x
Output Assignments	2 to 16 outputs, depending on model			
Scanning Methods	Straight Scan Interlaced Scan Edge Scan Skip Scan			
Control Mode Selection	Continuous scanning Gate Mode: scanning controlled by applying 10-30V dc to GATE input Host Mode: scanning controlled by host computer or PLC			
Serial Communication	Defines baud rate and controller I.D.			
Serial Transmission	Activates serial data transmission and specifies data format.			

After a PSF is configured, it may be sent to the controller. The PSF may also be saved for call-up at a later time. Many PSFs may be saved within PC files for quick controller configuration whenever a setup change is required.

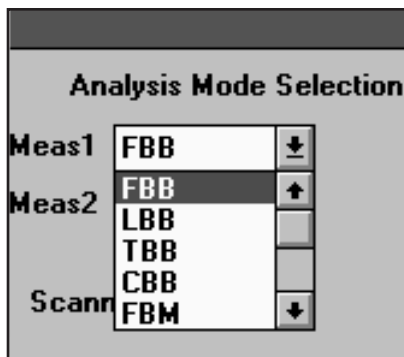


Figure 5-8. MINI-ARRAY Software Analysis Mode Selection

5.5 Creating New Parameter Setup Files (PSFs)

5.5.1 Analysis Mode Assignment

One or two Measurement Analysis modes may be programmed. Meas1 or Meas2 may be assigned to one or both outputs (Figure 5-8). If **ALL** is selected in either Analysis mode, all of the scanning information is sent via the serial connection to a host computer or PLC. The selection of **ALL** does not allow output assignments to be made to that measurement mode.

The available Analysis Modes are listed on page 24 and described on page 28.

5.5.2 Output Programming

The controller offers 2, 3, or 16 outputs, depending on the model. One scan analysis mode may be assigned to Output #1 and a second, different, analysis mode may be assigned to Output #2. Programmable output response criteria are described in the following sections.

All models except the 16-output models have an output labeled **Alarm**. This output can be programmed to function as the alarm output for the controller's self-diagnostic circuitry, whenever a scan analysis mode is not assigned to it. The output may instead be programmed to serve as a trigger input to begin the scan sequence of another MINI-ARRAY System.

Models MAC-1, MACP-1, MACN-1, MACV-1, and MACI-1 — Discrete Outputs

The Output Assignments portion of the PSF Configuration screen, shown in Figure 5-9, allows complete customization of response of the selected Analysis Mode(s). With the exceptions noted, either Meas1 or Meas2 can be assigned to Output #1 or Output #2.

Output #2 may be assigned as an Alarm output for the module's self-diagnostic circuitry whenever a scan analysis mode is not assigned to it. Output #2 can also be programmed to serve as a Trigger input to begin the scan sequence of another MINI-ARRAY System. The Trigger value is the beam location along the array at which the Trigger output (during a scan) occurs.

Set Point (Low and High) determines where within the array the output(s) will respond. In the case of total or contiguous beams made or broken, these settings determine the minimum and maximum number of beams required for an output.

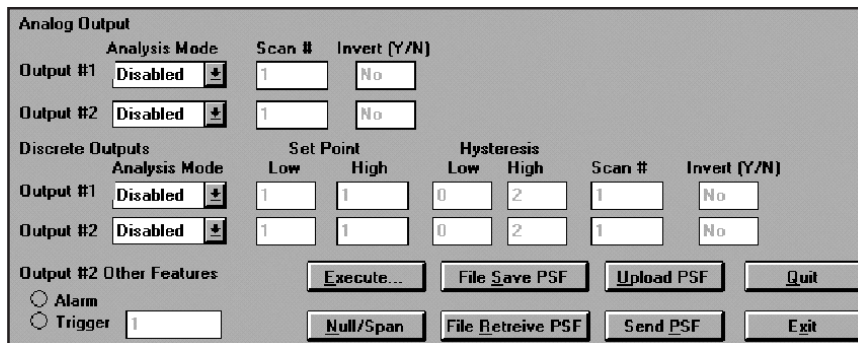


Figure 5-9. Output assignments portion of PSF Configuration screen

Hysteresis (Low and High) determines how much change must occur at each set point to cause the associated output to change state. Hysteresis avoids unstable output conditions (e.g., chattering of the output) when the scanning condition exactly matches one of the set points. The default setting for hysteresis is one beam less than the Low Set Point and one beam more than the High Set Point.

Scan # is the number of consecutive scans of the array required before the associated output is updated. The controller can be programmed for from one to nine consecutive scans. The scan data **MUST BE THE SAME** for all consecutive scans for the outputs to be updated.

Invert (Y/N) allows the output to be normally open (No) or normally closed (Yes).

Models MAC16P-1, MAC16N-1 — Discrete Outputs

The sixteen discrete outputs are programmed using the **Outputs** button on the Multiple Output MINI-ARRAY PSF Configuration screen (Figure 5-10).

The **Outputs** Button launches the Edit Discrete Outputs screen (Figure 5-11, which allows the Set Points and Hysteresis levels to be defined for each output. Set Point and Hysteresis values may be configured individually for each output and assigned to either Meas1 or Meas2. Set Point level defines the condition where the output is in the “true condition”. For a typical application, the output will be active when the Measurement mode result is between the set point limits. If the inverted option is specified, the output will be inactive when the Measurement mode result is between the set point limits (i.e., the true condition). The Hysteresis Low and High levels determine when the output will change back to the false condition.

The SEG measurement mode uses the Set Point Low and High levels to define segmentation of the light screen. As an example, Output #1 Set Point Low is 5 and the Set Point High is 20. These two values define beams 5 through 20 as a segment. Whenever any of these beams are blocked, this segment of the light screen is considered blocked, and Output #1 will be active (or inactive, if “Inverted” is selected). For the SEG measurement mode, the Hysteresis specification is inactive. The Scan Number may be used to change the number of consecutive scans necessary to change the output. When the Scan Number is set to one, the output will change after only one scan. If the Scan Number is set to five, the outputs will not change unless the condition is true for five consecutive scans.

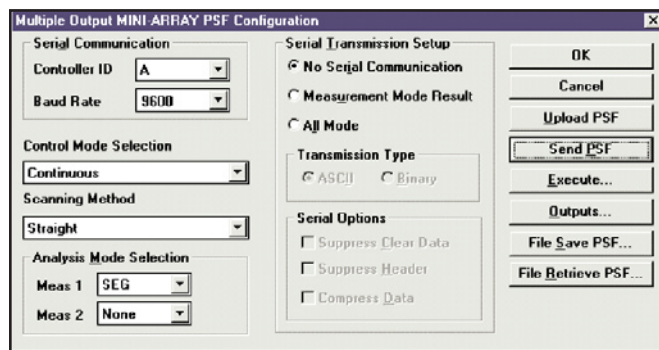


Figure 5-10. PSF Configuration screen (models MAC16P-1 and MAC16N-1)

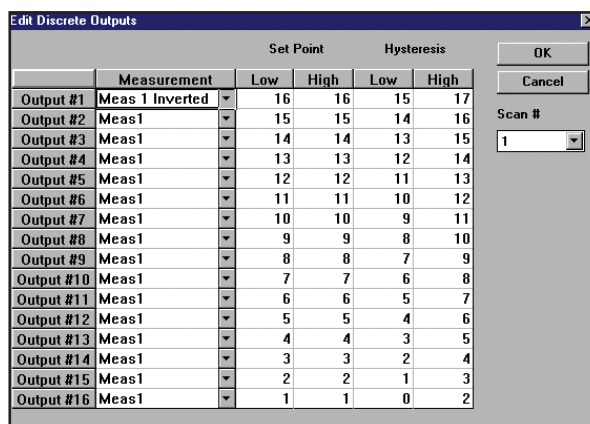


Figure 5-11. Edit Discrete Outputs screen

MACV-1 and MACI-1 — Analog Outputs

The MACV-1 and MACI-1 Controllers offer two independent analog outputs. See Figure 5-9.

For Analog Output #1 and Analog Output #2, each output is assigned to one of six analysis modes, which are selected via the Edit PSF Screen of the supplied software. Once the Analysis Mode Selection is specified for Meas1 and Meas2, the Analog Output can be specified via the Analog Output choices. The analysis mode is selected as Meas1, Meas2, or Disabled. The Disabled option means the output is not utilized. Meas1 and Meas2 reflect the choices provided with the Analysis Mode Selection. The Scan # provides a means to average from 1 to 9 scans before the analog output gets updated. The Invert option changes the output from a rising signal to a falling signal.

Null/Span Adjustment

The user can adjust both the zero and full-scale reading for both analog outputs of MACV-1 and MACI-1 Controllers. This adjustment is implemented via the Edit PSF screen **Null/Span** button, which activates the Null/Span menu (Figure 5-12).

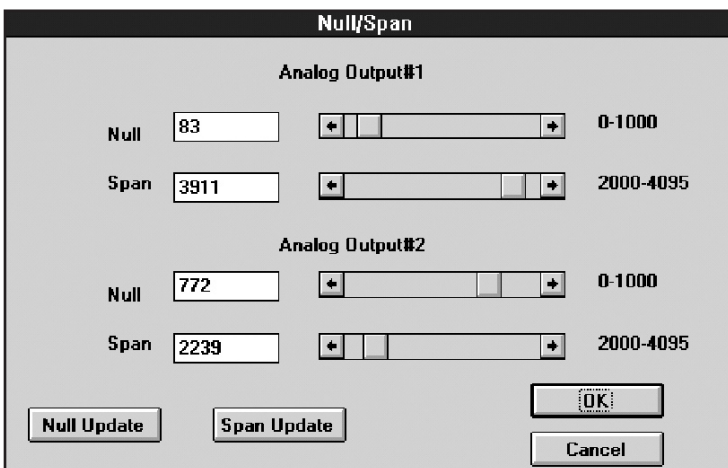


Figure 5-12. Null/Span Menu

The Null/Span menu causes the controller to temporarily respond to scaling adjustments. The Null and Span ranges can be adjusted as follows:

Model	Null		Span	
	Min	Max	Min	Max
MACV-1	10 mV	2.3 V	4.8 V	10.1 V
MACI-1	3.9 mA	7.8 mA	11.9 mA	20.2 mA

Each output's Null and Span is independently adjusted via the separate sliding bars. When the adjustments are made, the new values can be temporarily monitored by selecting either the **Null Update** or **Span Update** button. The **OK** button saves the new settings and instructs the controller to resume normal operation. Clicking the **Cancel** button disregards any Null/Span adjustments and causes the controller to resume normal operation with the the previously saved null and span settings.

The MAC controller has a four-minute Null/Span time-out feature that causes the controller to leave the Null/Span adjustment procedure when neither the Null Update nor the Span Update functions are accessed. When this time-out condition occurs, the MAC controller automatically cancels the Null/Span adjustment procedure and returns to the previously saved settings.

5.5.3 Analysis Mode Selection

The MINI-ARRAY controller is a versatile microcontroller-based module that may be configured using a PC-compatible computer running Windows® XP, Vista, or 7 and the Banner-supplied software via the built-in RS-232 or RS-485 interface. The Banner MINI-ARRAY System can be programmed for any one or two of the following Scan Analysis Modes (see Figure 5-13 for examples):

All Data (ALL): The controller passes all beam condition data for every scan to the serial interface for analysis by a host computer or controller.

First Beam Blocked (FBB): The controller identifies the location of the first beam blocked. Beams are numbered, beginning with the cabled end of the sensor, and continuing in sequence to the top end of the sensor.

Last Beam Blocked (LBB): The controller identifies the location of the last beam blocked.

Total Beams Blocked (TBB): The controller totals the number of blocked beams.

Contiguous Beams Blocked (CBB): The controller totals the number of contiguous beams blocked in each group of blocked beams along the length of the light screen and registers the maximum value.

First Beam Made (FBM): The controller identifies the location of the first clear beam.

Last Beam Made (LBM): The controller identifies the location of the last clear beam.

Total Beams Made (TBM): The controller totals the number of clear beams.

Contiguous Beams Made (CBM): The controller totals the number of contiguous clear beams in each group of clear beams along the length of the light screen and registers the maximum value.

Vehicle Separation (VHS) (discrete output models only): Controller output #1 is energized when six or more continuous inches of light screen length are blocked (i.e., contiguous beams blocked), and de-energizes when all beams are clear. This mode is typically used for vehicle sensing in toll booth applications.

Segment (SEG) (controller models MAC16N-1 and MAC16P-1 only): The controller segments the array into regions and allows the user to partition the array. The user defines contiguous segments. Once the segments are defined, the Controller monitors each segment for blocked beams within each segment. If one or more beams are blocked within any segment, the output corresponding to that segment will respond.

Transition (TRN) (controller models MAC16N-1 and MAC16P-1 only): The controller counts transitions, which are used to count objects. This mode counts both clear-to-blocked and blocked-to-clear transitions. For example, if an object blocks beams 20 through 30, the TRN mode will count two transitions. If an additional object blocks beams 35 through 40, then the TRN mode will count four transitions.

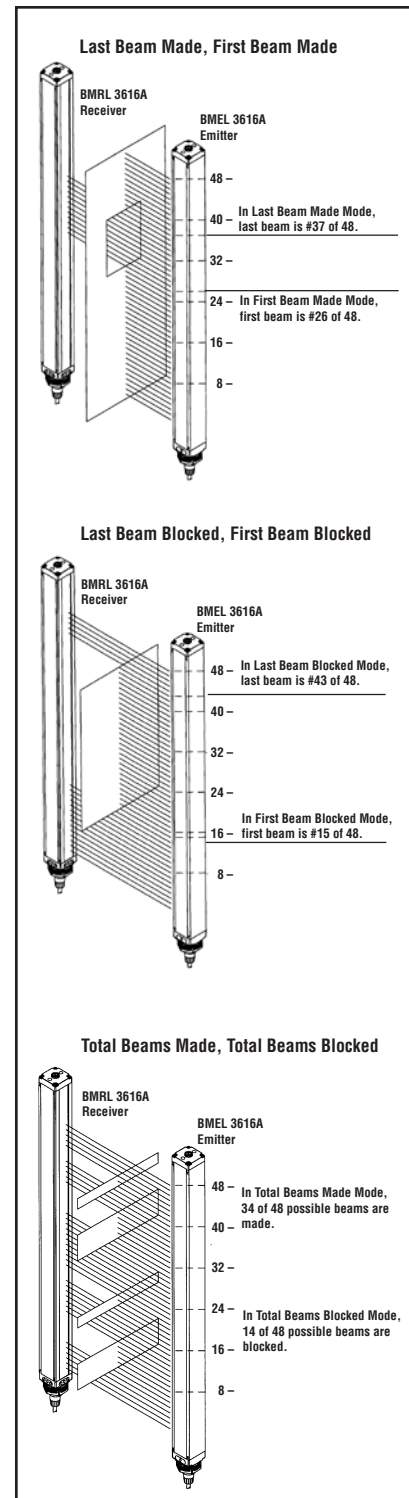


Figure 5-13. Examples of MINI-ARRAY scan analysis modes

5.5.4 Blanking Specifications

A **Blanking** feature allows areas of the array to be blanked (made blind to activity within an area).

Models MAC-1, MACP-1, MACN-1, MACV-1, and MACI-1

Blanking specifications allow either one or two areas of the array to be blanked (made blind to activity within that area). Beams are numbered from the bottom (cable end) of the sensors to the top of the sensors. The Low beam number and the High beam number can be designated to define a Field to be blanked (see Figure 5-14). Zeros are used as default settings to signify no blanking.

The screenshot shows the PSF Configuration software interface. A pop-up window titled "Blanking Specifications" is centered on the screen. The pop-up window contains a table with the following data:

Field	Low	High
#1	0	0
#2	0	0

The background interface includes the following sections:

- Analysis Mode Selection:** Meas1 (FEB), Meas2 (None).
- Control Mode Selection:** Continuous (selected), Gate, Host Mode.
- Scanning Method:** Straight (selected), Interlaced, Edge, Skip.
- Serial Communication:** Baud Rate (9600), Controller ID (A).
- Serial Transmission:** No Serial Communication (selected), ASCII Transmission, Binary Transmission, Suppress Clear Data, Suppress Header, Compress Data.
- Analog Output:** Output #1 (Disabled), Output #2 (Disabled).
- Discrete Outputs:** Output #1 (Disabled), Output #2 (Disabled).
- Output #2 Other Features:** Alarm, Trigger (1).
- Buttons:** Execute..., File Save PSF, Upload PSF, Quit, Null/Span, File Retrieve PSF, Send PSF, Exit.

Figure 5-14. MINI-ARRAY software blanking specifications (models MAC-1, MACP-1, MACN-1, MACV-1, and MACI-1)

Models MAC16P-1 and MAC16N-1

The controller can specify blanking of any light channel and save these specifications in static memory. Blanking options are changed using the supplied software. Under the MINI-ARRAY tasks, select the Alignment function to access the Alignment screen (Figure 5-4).

The **Start** button causes the system to scan and update the Alignment screen.

Blanking commands include: Clear Blanking Fields, Restore Controller Settings, Auto Blanking, Abort Auto Blanking, Save to File, Read From File, Cancel, OK, and Edit.

Clear Blanking Fields removes all blanking specifications.

Restore Controller Settings reads the previously saved blanking specifications from the MINI-ARRAY controller.

Auto Blanking selects all blocked channels for blanking. When the Auto Blanking feature is selected, the settings may be accepted or aborted.

Abort Auto Blanking cancels Auto Blanking.

File Save and File Retrieve allow the user to save and retrieve blanking data to a file.

The **OK** button saves the new blanking configuration to the controller. After the **OK** button is selected, Restore Controller Settings will reflect the new blanking configuration.

The **Cancel** button prevents the new blanking configuration from being saved.

The **Edit** function allows individual beams to be blanked.

Selecting the Edit function launches the Channel Blanking Edit Screen, shown in Figure 5-15.

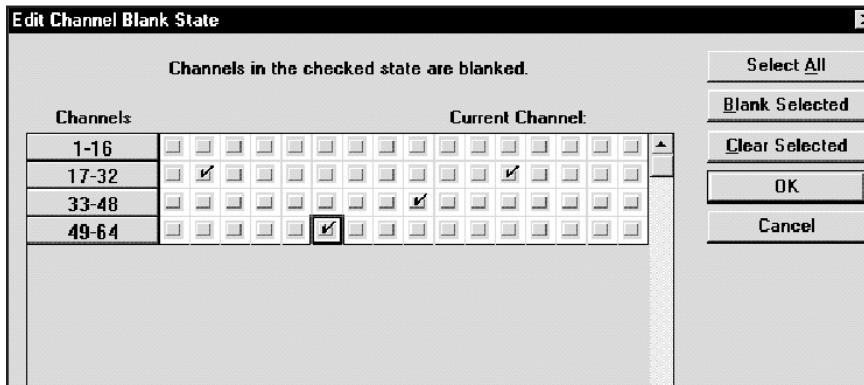


Figure 5-15. Channel Blanking Edit screen (models MAC16P-1 and MAC16N-1)

The Channel Blanking Edit Screen groups the beams into rows with a check box for each beam. For instance, the first row is labeled **1-16**. The first check box represents the blanking state of channel 1. The user can move the cursor over any check box and click the left mouse button to select blanking for that channel. A check mark indicates that the channel has been selected for blanking.

The **Blank Selected/Clear Selected** feature allows the user to select/clear rows of channels.

The **OK** button adds the new blanking additions to the Alignment screen.

The **Cancel** button voids the Edit changes.

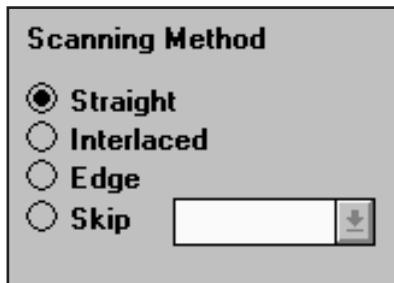


Figure 5-16. MINI-ARRAY software: scanning method selection

5.5.5 Scanning Methods

The control module may be configured for one of four available scanning methods (see Figure 5-16):

Straight Scan is the default mode in which all beams are scanned in sequence from the bottom end (cable end) to the top end of the sensors.

Interlaced Scan alternates a straight scan with a slanted-beam scan. A slanted-beam scan begins with a beam established between the emitter's second channel and the receiver's first channel, and between the emitter's third channel and receiver's second channel, continuing up the array to the last emitter channel and next-to-last receiver channel. The last emitter channel is then reactivated to establish a beam to the last receiver channel to complete the scan. Alternating this slanted-beam scan with a straight scan improves optical resolution within the middle one-third of the scanning range. See Figure 5-17.

Edge Scan activates only the beams located near the top edge of an object in the light screen. "Top edge" refers to the edge of the object passing nearest the top end of the sensors (i.e., the top of the light screen, farthest from the sensor's cabled end). Each scan begins six beams prior to the last beam blocked during the previous scan. The scan continues from this point and moves upward to the first unblocked beam, where the scan is completed. When the array is clear, the system will execute straight scans. Edge Scan begins again when a blocked channel is detected. This scanning mode is designed to reduce sensing response time when measuring or locating only one edge of an object. Use of the Edge Scan mode limits the scan analysis mode selection to Last Beam Blocked (LBB).

Skip Scan reduces response time at the expense of decreased sensing resolution. Skip Scan mode allows from one to seven beams to be skipped during each scan. For example, with one beam skipped, only beams #1, 3, 5, 7, etc. will be interrogated. With two beams skipped, only #1, 4, 7, 10, etc. will be interrogated, and so on.

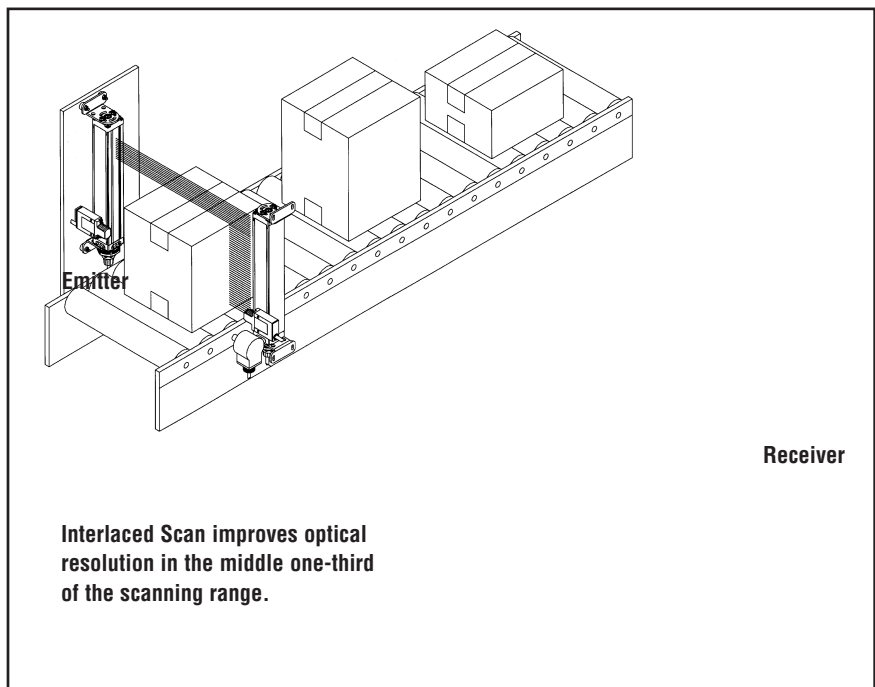


Figure 5-17. Interlaced Scan

5.5.6 Control Mode Selection

The controller can be programmed for Continuous scanning, Gated scanning, or for Host mode. The module offers an optically-isolated Gate input, which is energized by application of 10 to 30V dc. Gating is typically accomplished using a dc presence sensing device. Host mode allows the array to be gated by a host computer or programmable logic controller (PLC).

Host Control

All MINI-ARRAY Systems can communicate with a host computer or controller via RS-232 serial protocol. In addition, controller models MAC-1, MACN-1, and MACP-1 also can communicate via RS-485. The host can direct the MINI-ARRAY System to scan on demand and/or receive the scan data directly from the MINI-ARRAY System in binary or ASCII form. Selectable communication baud rates are 9600, 19200, and 38400.

5.6 Serial Communication

The MINI-ARRAY System can communicate with its host computer or controller via either RS-232 (all models) or RS-485 (MAC-1, MACN-1, MACP-1) serial protocol. The host can direct the MINI-ARRAY to scan on demand, and/or receive the scan data directly from the MINI-ARRAY System in Binary or ASCII form, Selectable communication baud rates are 9600, 12000, and 38400 (Figure 5-19). Protocol is one start bit, one stop bit, 8 data bits, and even parity. See the Appendix for more information on data formats.

When RS-485 communication is used, each controller module may be assigned a controller ID. Select letter A through O for individual identification of up to 15 Controllers on a RS-485 “party line.”

5.6.1 Serial Transmission

Serial Transmission activates the serial port, specifies the data format, and provides data suppression options. If **No Serial Communication** is selected (default), the serial port does not transmit sensing data. See Figure 5-20.

ASCII Transmission specifies that the scan data will use the ASCII format. ASCII Transmission has one suppression option called **Suppress Clear Data**, which means that data is sent one time when the array is completely clear (i.e., when no beams are blocked) and no further data is sent until one or more beams are blocked.

Binary Transmission specifies that the scan data will use the binary format. The binary format has three suppression options. The first option is **Suppress Clear Data**, which means that data is sent once when the array is completely clear (i.e., when no beams are blocked), and no further data is sent until one or more beams are blocked. The **Suppress Header** option reduces the size of the controller serial message by three bytes. Header bytes consist of the two byte start string plus the termination byte. The **Compress Data** option, in many cases, reduces the number of data bytes sent for each analysis mode from two to one byte.

See the Appendix for additional information.

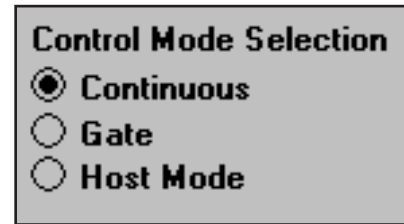


Figure 5-18. MINI-ARRAY software: control mode selection

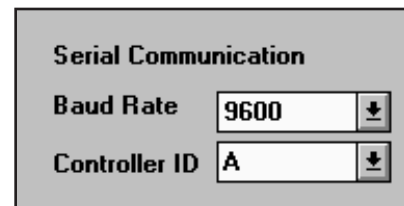


Figure 5-19. MINI-ARRAY software: Serial Communication Parameter selection

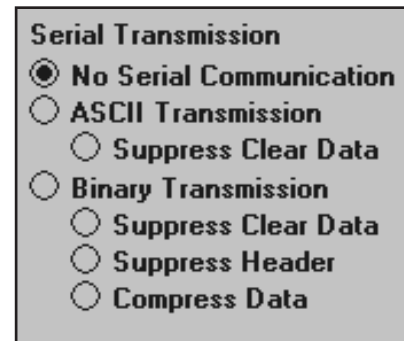


Figure 5-20. Serial communication options

5.7 PSF Assignment and Storage

The screens shown in Figures 5-20 through 5-22 are for MAC-1, MACP-1, MACN-1, MACV-1, and MACI-1 Controllers. The screen layouts for MAC16N-1 and MAC16P-1 are functionally the same and do not need to be shown separately.

PSF commands are located in the lower right corner of the PSF Configuration screen.

Sending a PSF to the Controller

After a PSF is configured by the selections made (above), the PSF is sent to the MINI-ARRAY controller by selecting **Send PSF**. This command loads the PSF into the controller's non-volatile memory and automatically overwrites any existing PSF. The program will confirm that the PSF was accepted, or it will prompt for changes that are still required.

Retrieving a PSF from the Controller

To check the PSF that is currently loaded into the controller, select **Upload PSF**. The current PSF will be displayed on the PSF Configuration screen.

Saving a PSF to Disk

To place the displayed PSF into a file that can be retrieved at any time, select **File Save PSF**. When prompted whether to save the PSF to a file, select **Yes**. A sub-screen titled **FileSave** will appear (Figure 5-20). Overtyping *.psf in the **File Name** entry box by entering the name of the file to be stored (up to 8 characters), plus the .psf extension, and then select **OK** or press the Enter key.

For example, type the name **Inspect1.psf**, and select **OK**. The PSF is stored on the selected drive (default is C:), and the program automatically returns to the PSF Configuration screen.

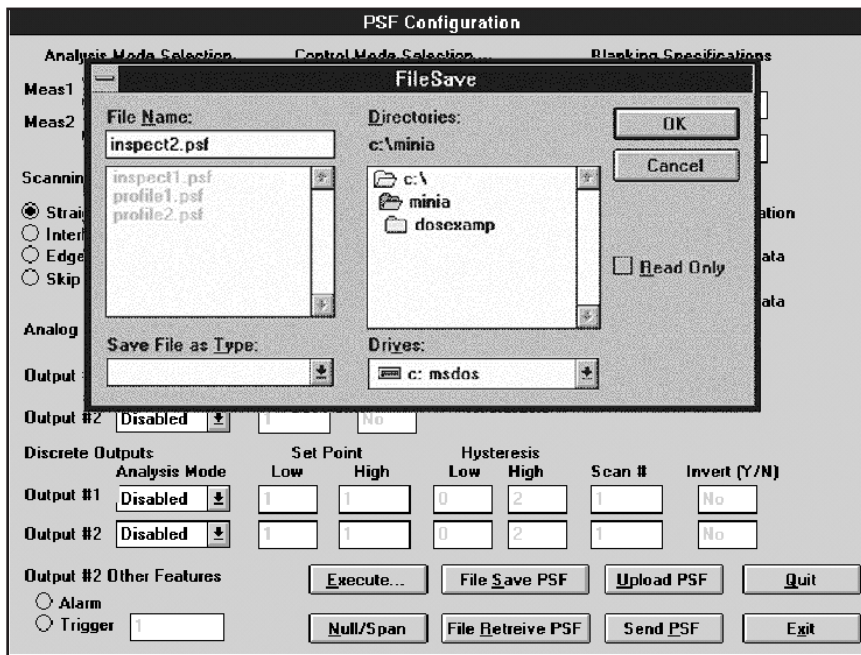


Figure 5-21. MINI-ARRAY software: Save PSF screen

Retrieving a PSF from Disk

To retrieve a filed PSF, select **File Retrieve PSF**. The **FileBox** subscreen will appear (Figure 5-22). Select the desired PSF from the **File Name** list and then select **OK** or press the Enter key. The selected PSF will load to the PSF Configuration screen and can be loaded into the controller using the **Send PSF** command.

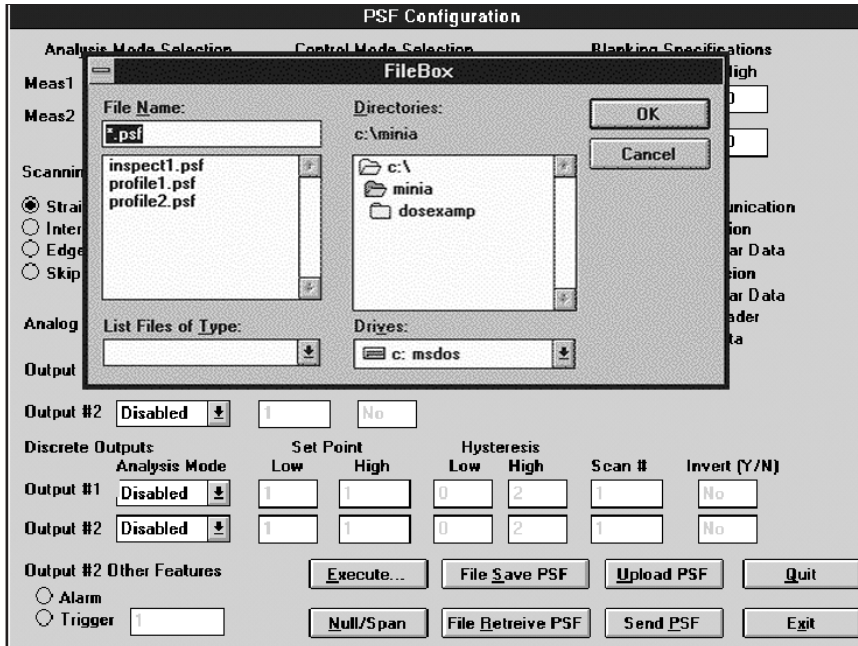


Figure 5-22. MINI-ARRAY software: Retrieve PSF screen

PSF Output Analysis

To view activity in the array in response to the currently loaded PSF, select **Execute**. The Measurement Output screen will appear (Figure 5-23). Select **Run**. The table will display the status for the selected measurement mode(s), including the Present value, and the High and Low values for the Run period.

Select **Stop** to freeze the data. Select **Step** to initiate a single scan of the array. This simulates a “snapshot” of what is viewed by the array when **Step** is selected.

Use of the **Execute** command is especially beneficial for testing the response of a gated system. **Run** simulates the **Continuous** scanning mode, and **Step** simulates a gate input command.

To close the PSF Configuration screen, select either **Quit** or **Exit**.

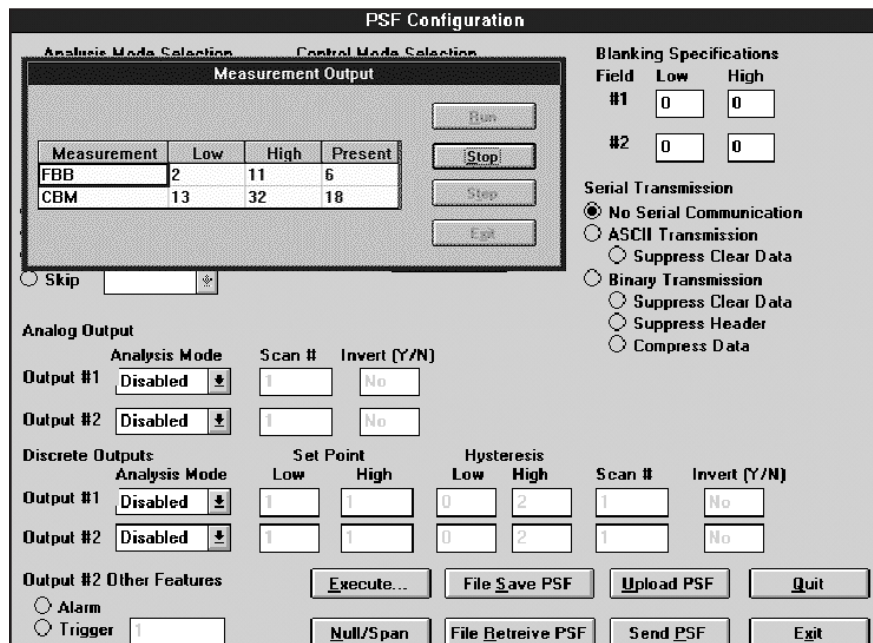


Figure 5-23. MINI-ARRAY software: PSF Output Analysis

6. System Operation

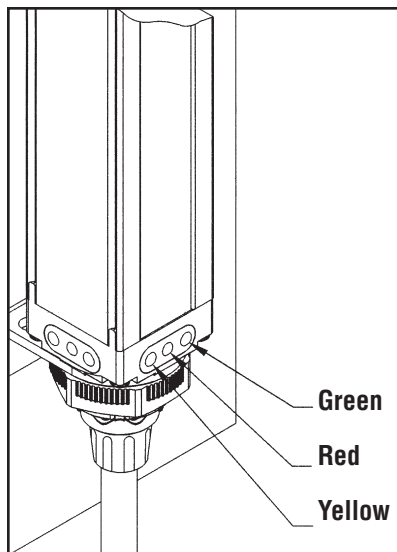


Figure 6-1. MINI-ARRAY sensor status indicator LEDs

6.1 Sensor Operating Status Indicators

NOTE: Status indicators appear to “freeze” if the controller has been configured for the Gate or the Host Mode (see Section 5.5.6), and there is no signal to cause a scan update.

Emitter (Figure 6-1)

The red LED ON indicates that the emitter has power applied and is functioning properly. If the red LED is OFF, there has been an emitter failure. The red DIAG 3 indicator on the controller should come ON whenever the red LED on the emitter goes OFF. Run the Diagnostics software (see Section 6.3) to determine the cause of the emitter failure.

A flashing red emitter LED indicates that the emitter has momentarily lost and then regained power, and is waiting for activity from the controller. This can occur in Gate or Host Mode after the emitter has been temporarily unplugged and then reconnected, but before the emitter receives its next gating command.

Receiver (Figure 6-1)

The **green LED ON** (only) indicates proper alignment, and no beams broken.

A **flashing green** (only) indicator has the same meaning as a flashing red emitter indicator, as described above.

Green and yellow ON together indicates marginal alignment. The MINI-ARRAY System will continue to operate normally, but the yellow comes ON as an early warning of possible signal loss due to gradual sensor misalignment and/or dirt buildup on the lenses, etc.

The **red LED ON** (only) indicates either one or more beams blocked or sensor misalignment (if the screen is clear of objects).

All three LEDs (yellow, red and green) ON at the same time indicates a receiver failure. Run the Diagnostics software (see Section 6.3) to determine the cause of the receiver failure.

6.2 Controller Operating Status Indicators

Output 1 (labeled OUT1, V out, I out, OUT or OUT 1 depending on model)	Red	Models MAC-1, MACP-1, MACN-1, MACV-1, MACI-1:	displays the status of Output #1					
		Models MAC16N-1 MAC16P-1:	displays the status that at least one output is active					
Alarm	Red	Models MAC-1, MACP-1, MACN-1, MACV-1, MACI-1:	displays the status of Output #2. Output #2 may be assigned to an Analysis Mode or may be used as a system diagnostics Alarm, or as a Trigger alarm for gating another MINI-ARRAY System					
		Models MAC16N-1 MAC16P-1:	displays the status of Output #16					
Gate	Red	All Models	displays the status of the Gate input					
Align	Green	All Models	indicates proper sensor alignment and a clear light screen. This indicator is ON when the green or green and yellow LEDs of the receiver are ON					
Diag 1,2,3		All Models	used in combination to indicate system status as shown below:					
			Normal Condition	Receiver Error	Emitter Error	Emitter/Receiver Mismatch	Controller Error	EEPROM Error
Diag 1	Green	ON	ON	ON	ON	OFF	OFF	OFF
Diag 2	Red	OFF	ON	OFF	ON	ON	OFF	ON
Diag 3	Red	OFF	OFF	ON	ON	OFF	ON	ON

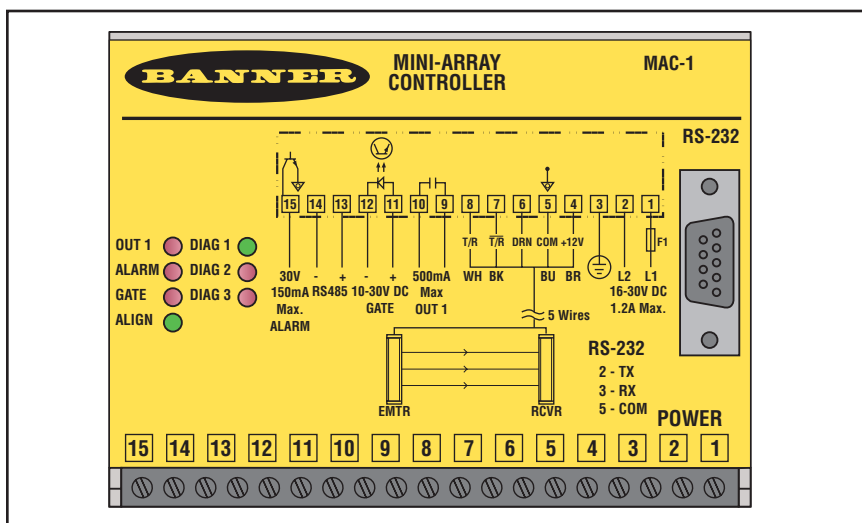


Figure 6-2. Controller front panel

6.3 Diagnostics Program

Emitter or receiver problems may be further diagnosed using the diagnostics routine, which is included with the MINI-ARRAY software. Launch the program by selecting **Diagnostics...** under the **MINI-ARRAY** menu (see Figure 6-3), or press the **F2** key.

The **Diagnostics** screen (Figure 6-4) displays the type of each emitter and receiver module (Board) and its functional status (State). If an error has occurred, the specific problem beam (Channel) will be identified. Additionally, If there is a problem with an emitter or receiver cable connection, a "No Response" message will be displayed.

The Diagnostics routine also displays the part number and date code of the controller, which may be useful information if factory-assisted troubleshooting by telephone is required.



Figure 6-3. MINI-ARRAY software: Main Menu

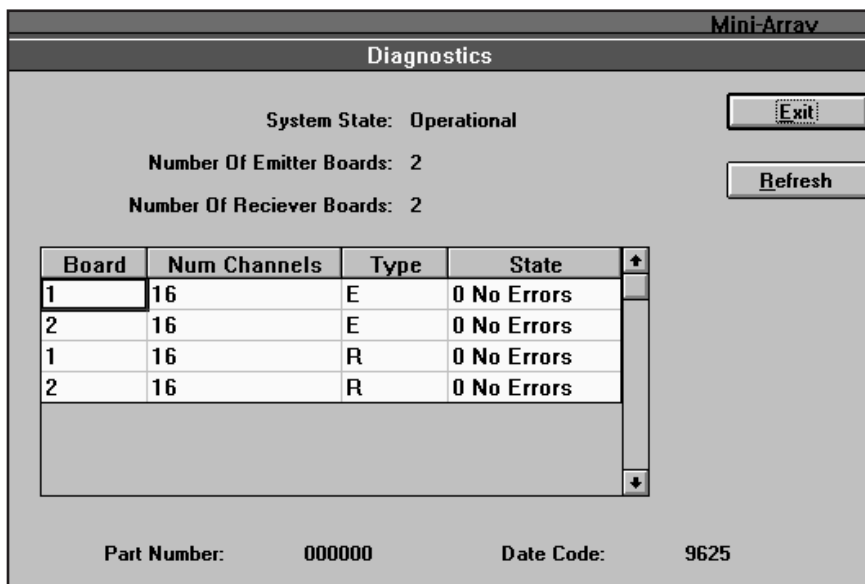


Figure 6-4. MINI-ARRAY software: Diagnostics screen

Appendix. Host Mode Command and Serial Data Format

Host Mode Command

The MINI-ARRAY controller can communicate with a computer or PLC via either an RS-232 connection (all models) or RS-485 connection (discrete-output models). See hookup information in Section 3.4. The host can respond to output from the controller when the controller is programmed for either the Continuous or Gate control mode (see Section 5.5.6).

Alternately, the host can control sensor scanning. When the Host control mode is selected, the host computer or controller initiates scans using a command string. The command string is a three-byte message, consisting of:

Control byte with decimal value 248

Controller ID (one of 16 ASCII letters A through O, as specified in the PSF)

Scan initiation byte (ASCII letter S)

The command string is further defined, as follows:

```
unsigned char msg[3]; /*declare three byte unsigned character array using C language*/
```

```
msg[0]=248; /*control byte*/
```

```
msg[1]=65; /*assume the controller ID is the letter A*/
```

```
msg[2]=83; /*scan initiation byte which is the ASCII letter S*/
```

The host transmits this three-byte message at the defined baud rate. The format is one start bit, one stop bit, even parity, and eight data bits. When this message is received by the MINI-ARRAY controller, the controller initiates a scan, and then updates its outputs as required. The MINI-ARRAY controller then waits for the next command string.

Serial Data Format

The programmed measurement mode or modes determine the type of information that is transmitted. For example, if Meas1 is set for FBB and Meas2 is set for LBB, then the data transmitted to the host contains the values of the first and last beam blocked.

The ALL measurement mode provides the status of all beams to the host. The VHS mode does not provide serial output data.

In addition to measurement mode information, the data transmission also contains a start string and a termination byte. The start string consists of two unsigned character bytes:

Hex value 1C

The controller ID value

The termination byte is the ASCII character for a linefeed (hex value 0A). These three bytes are collectively called the Header.

ASCII Format Data Transmission

There are two ASCII formats. The one used depends upon which measurement modes are selected. For the **ALL** measurement mode, each data byte is presented in an eight bit ASCII format which conveys the status of four consecutive channels (four consecutive beams). Each subsequent byte conveys the status of the next four channels, until the status of all channels is reported.

The allowable data values are the ASCII numbers 0 to 9 and the ASCII letters A to F. In the table shown in Figure A-1, the **0** represents a clear channel, and the **1** represents a blocked channel.

The other measurement modes use three ASCII bytes to represent their values. For example, if **Meas1** is **FBB** and **Meas2** is **LBB**, and the measured values are 6 and 120, and the controller ID is A, then the data string is as follows:

0x1c A 0 0 6 1 2 0 0x0a

The controller allows suppression of clear data. This means that data is sent one time when the array is completely clear (i.e., when no beams are blocked), and no further data is sent until one or more beams is blocked.

Binary Format Data Transmission

There are two binary formats. The one used depends upon which measurement modes are selected. For the ALL measurement mode, each data byte conveys the status of eight consecutive beams. Each bit of the byte is directly related to the status of an individual channel.

As an example, if the first eight beams are as follows...

Channel	Status	Binary Code
1	Blocked	1
2	Clear	0
3	Blocked	1
4	Blocked	1
5	Clear	0
6	Blocked	1
7	Clear	0
8	Clear	0

...then the data byte has the hex value of **0x2d** or **45** decimal. If the array has 32 optical channels, then there would be 4 data bytes representing the status of all 32 optical channels. The other measurement modes use two bytes to represent the measured value. The first of the two bytes is the most significant. As an example, the value of 262 for the **FBB** measurement mode is coded by the two-byte number: **0x01 0x06**.

Definitions for ASCII Data Values				
For the ALL measurement mode				
Character	Ch 4	Ch3	Ch2	Ch1
F	1	1	1	1
E	1	1	1	0
D	1	1	0	1
C	1	1	0	0
B	1	0	1	1
A	1	0	1	0
9	1	0	0	1
8	1	0	0	0
7	0	1	1	1
6	0	1	1	0
5	0	1	0	1
4	0	1	0	0
3	0	0	1	1
2	0	0	1	0
1	0	0	0	1
0	0	0	0	0

Figure A-1. ASCII Data Values

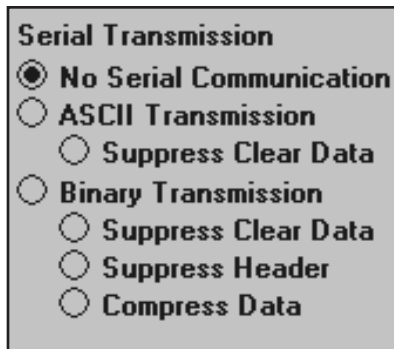


Figure A-2. Serial Communication Options

Figure A-2 shows that the binary transmission has three independent options. These options are independently selected and are used to custom-configure the serial data format. The **Suppress Clear Data** option is applicable when the sensor is unobstructed. While the sensor is blocked, serial data is transmitted; once the sensor is unobstructed, the “clear” data is transmitted once, and then no further data transmission occurs until the sensor is again blocked. The **Suppress Header** option will serially transmit the array data bytes. The three header bytes are not transmitted. The **Compress Data** option affects the data bytes for the measurement modes excluding the **ALL** mode. Except for the **ALL** mode, the analysis modes use two bytes to transmit the appropriate information. For cases where the sensor cannot provide a result greater than 255, the **Compress Data** option will provide this data in one byte.

As an example, assume that you have a 48-channel sensor with a last beam blocked of 35 and a controller ID of “B.” Assume two binary format options. The first option is the standard **Binary Transmission** format. The second format will use the **Suppress Header** and **Compress Data** options. The two strings would be as follows:

Option 1: **Binary Transmission**

0x1c B 0x00 0x23 0x0a (a total of 5 bytes per scan)

Option 2: **Binary Transmission, Suppress Header, Compress Data**

0x23 (1 byte per scan)

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