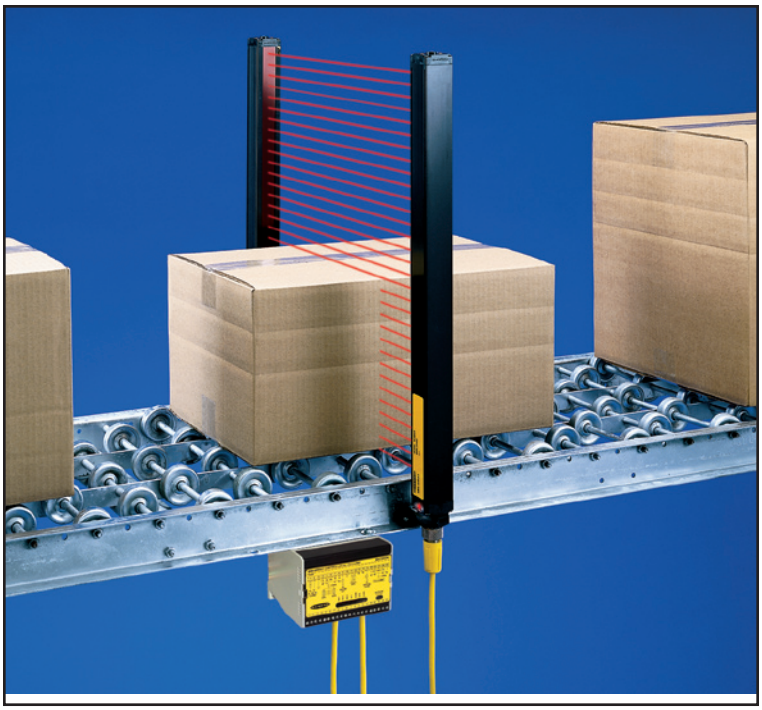
A-GAGE™ MINI-ARRAY® Instruction Manual

(Control Modules MACNXDN-1 and MACPXDN-1 with DeviceNet™ Interface)

A-GAGE MINI-ARRAY Features

- Measuring light screen system for profiling and inspection applications
- Compact control module and sensors
- Controller is programmable, using DeviceNet configuration software and supplied EDS files for:
  - 8 measurement ("Scan Analysis") modes
  - 4 scanning methods
  - Beam blanking
  - Selectable continuous, gated or host-controlled scan initiation
  - Programmable hysteresis for high and low limits
- Two Discrete outputs
- Separate Gate input allows external control of scan initiation, for example, by a presence sensor
- Low cost, compared with similar systems
- Working range up to 17 m (55'), depending on model
- Wide field of view, easily aligned



WARNING . . .
Not To Be Used for Personnel Protection

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 output condition. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.

the photoelectric specialist

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1. System Description

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

This system was designed specifically for use on DeviceNet™ Bus networks.

1.1 System Components

A typical A-GAGE MINI-ARRAY System has five components: an emitter/receiver pair, each sensor having quick-disconnect (QD) connectors; one of two compact control modules; and quick-disconnect cables to connect them.

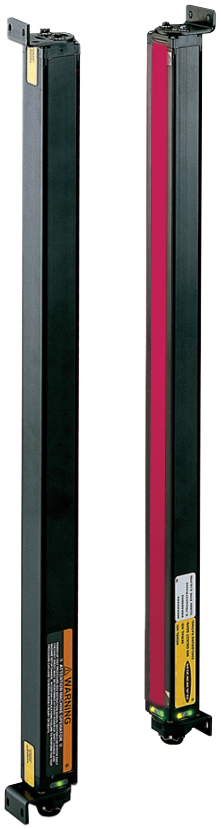
Sensors are available with array lengths from 133 mm to 1819 mm (5.25" to 71.6"), in 152 mm (6") increments (see the table on page 5). The emitter has a column of infrared LEDs spaced 9.5 or 19 mm (3/8" or 3/4") apart, which translates to 16 or 32 beams per foot. The receiver is configured opposite to the emitter, with the identical length and beam spacing. Sensor pairs with 16 beams/foot are capable of detecting a 38-mm diameter (1.5" dia.) cylindrical rod (held perpendicular to the sensor) and have a sensing range of up to 17 m (55'). Sensor pairs with 32 beams/foot are capable of detecting a 19.1-mm diameter (0.75" dia.) cylindrical rod (held perpendicular to the sensor) and have a sensing range of up to 6 m (20'). (In Interlaced mode, the specified object sensitivity increases; see Section 4.5.)The sensors have a wide field of view and are easily aligned.

The microcontroller-based control module is interfaced with, and controlled by, the DeviceNet network. EDS files are supplied to work with the user's DeviceNet configuration tool to interface and program the controller. Cables connecting the MINI-ARRAY System with the facility's Bus network are user-supplied. Contact your Banner sales engineer or interlinkBT for cable information.

Cables connecting the sensors with the control module are available in three lengths, and have quick-disconnect fittings at the sensor end. See Figure 1-1, page 5.

Emitter and Receiver Models

Housing Length	3/4" Beam Spacing (16 Beams/Ft)		3/8" Beam Spacing (32 Beams/Ft)	
	Models	Total Beams	Models	Total Beams
201 mm (7.9")	**BMEL616A** Emitter	8	**BMEL632A** Emitter	16
		8	**BMRL632A** Receiver	16
356 mm (14.0")	**BMEL1216A** Emitter	16	**BMEL1232A** Emitter	32
	BMRL1216A Receiver	16	**BMRL1232A** Receiver	32
505 mm (19.9")	**BMEL1816A** Emitter	24	**BMEL1832A** Emitter	48
	BMRL1816A Receiver	24	**BMRL1832A** Receiver	48
659 mm (26.0")	**BMEL2416A** Emitter	32	**BMEL2432A** Emitter	64
	BMRL2416A Receiver	32	**BMRL2432A** Receiver	64
810 mm (31.9")	**BMEL3016A** Emitter	40	**BMEL3032A** Emitter	80
	BMRL3016A Receiver	40	**BMRL3032A** Receiver	80
963 mm (37.9")	**BMEL3616A** Emitter	48	**BMEL3632A** Emitter	96
	BMRL3616A Receiver	48	**BMRL3632A** Receiver	96
1115 mm (43.9")	**BMEL4216A** Emitter	56	**BMEL4232A** Emitter	112
	BMRL4216A Receiver	56	**BMRL4232A** Receiver	112
1267 mm (49.9")	**BMEL4816A** Emitter	64	**BMEL4832A** Emitter	128
	BMRL4816A Receiver	64	**BMRL4832A** Receiver	128
1572 mm (61.9")	**BMEL6016A** Emitter	80	**BMEL6032A** Emitter	160
	BMRL6016A Receiver	80	**BMRL6032A** Receiver	160
1877 mm (73.9")	**BMEL7216A** Emitter	96	**BMEL7232A** Emitter	192
	BMRL7216A Receiver	96	**BMRL7232A** Receiver	192



Receiver

Emitter

Configure and monitor the System with the supplied EDS files and the user's DeviceNet configuration tool.

DIN-Rail Mountable Control Module

Quick-Disconnect Cables

Control Module Models (with DeviceNet interface)

Controller Model	Description
MACNXDN-1	Two discrete, solid-state NPN outputs
MACPXDN-1	Two discrete, solid-state PNP outputs

Cables

Cable Model	Description
QDC-515C	4.6 m (15') cable, straight QD connector
QDC-525C	7.6 m (25') cable, straight QD connector
QDC-550C	15.2 m (50') cable, straight QD connector

Figure 1-1. A-GAGE MINI-ARRAY System components

1.2 System Features

Built-in features simplify the operation of the A-GAGE MINI-ARRAY System. Emitters and receivers, available in a choice of two resolutions and 10 lengths, provide the right size and precision needed for many applications. Programmable beam blanking accommodates machine components or other fixtures that must remain in or move through the light screen. Blanking is set using the included EDS file and the user's DeviceNet configuration tool.

Built-in diagnostic programming and easy-to-see indicators on the sensors and the control module simplify alignment and troubleshooting (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 System Status LEDs that indicate conditions such as output(s) conducting, Gate signal received, beam alignment and/or blocked beams. In addition, a bi-color (red/green) Network Status LED indicates whether the system is online with the DeviceNet network and whether there are problems.

The A-GAGE MINI-ARRAY System provides a wide selection of sensing and output options, including: measurement ("scan analysis") modes; scanning methods that can determine the target object's location, overall size, total height or total width; and numerous output options. Scanning may be continuous or controlled by a host process controller or a gate sensor.

Blanking feature allows the user to configure any number of beams to be "blanked." In effect, blanking causes the affected beams to be made "blind" to activity within the array.

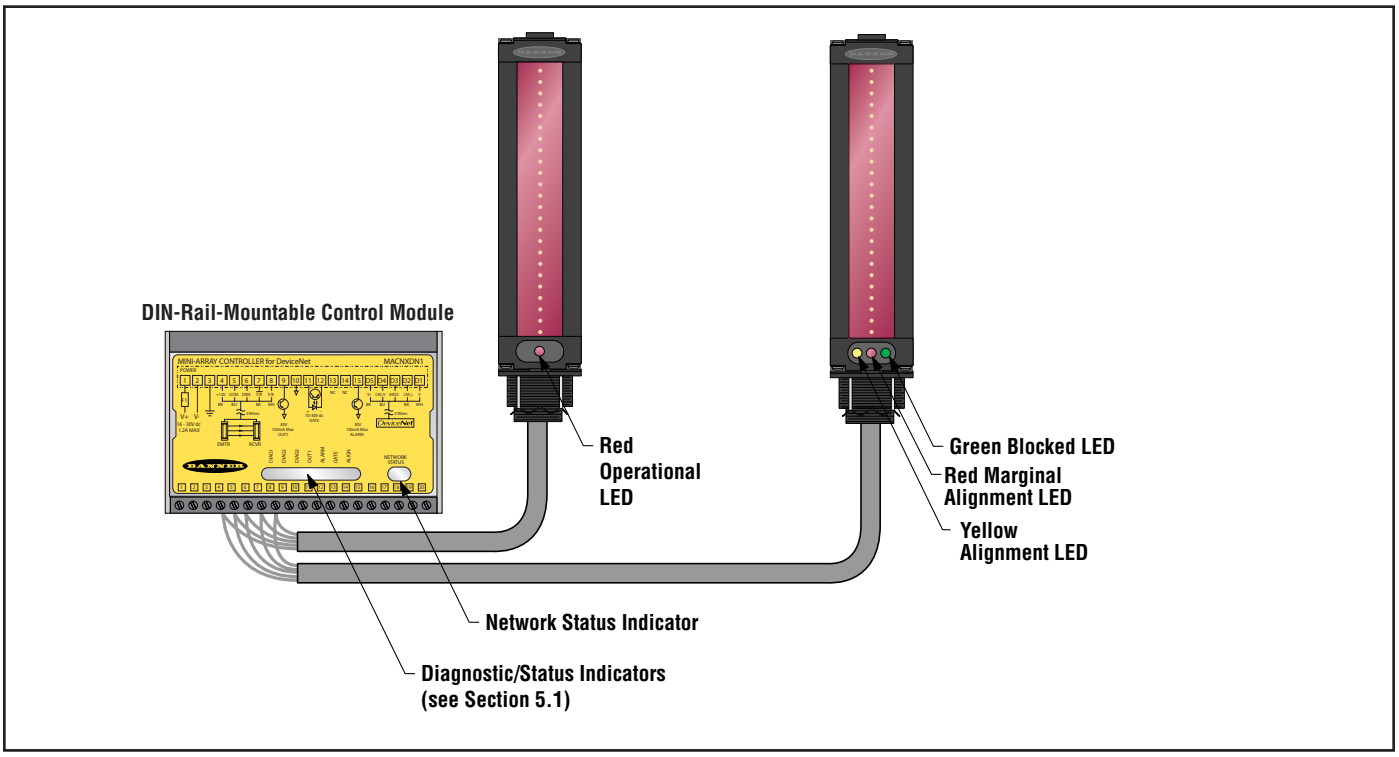


Figure 1-2. A-GAGE MINI-ARRAY with DeviceNet System features

1.3 DeviceNet Features

The A-GAGE MINI-ARRAY System connects to the DeviceNet Bus network using simple junction boxes or "T" connectors. An Electronic Data Sheet (EDS) is supplied with each controller to assist in device configuration. The MINI-ARRAY System may be configured by any of a number of DeviceNet configuration tools; for specific configuration information, refer to your DeviceNet documentation. The following MINI-ARRAY communications are available through DeviceNet:

Device Information: manufacturer, product name, device type, model and revision

Configuration: analysis mode selections, scan control selection, output settings (set point, hysteresis and invert), and blanking selections

Sensor Alignment Information: total number of sensor beams, beam status, and alignment status

Status Information: measurement modes result, alignment status, beam status, and blanked beam status

Diagnostic Information: number of emitter beams, number of receiver beams, and MINI-ARRAY System status

1.4 Typical Applications

The A-GAGE MINI-ARRAY is useful for many types of measurement and position-sensing applications, some of which are shown below.

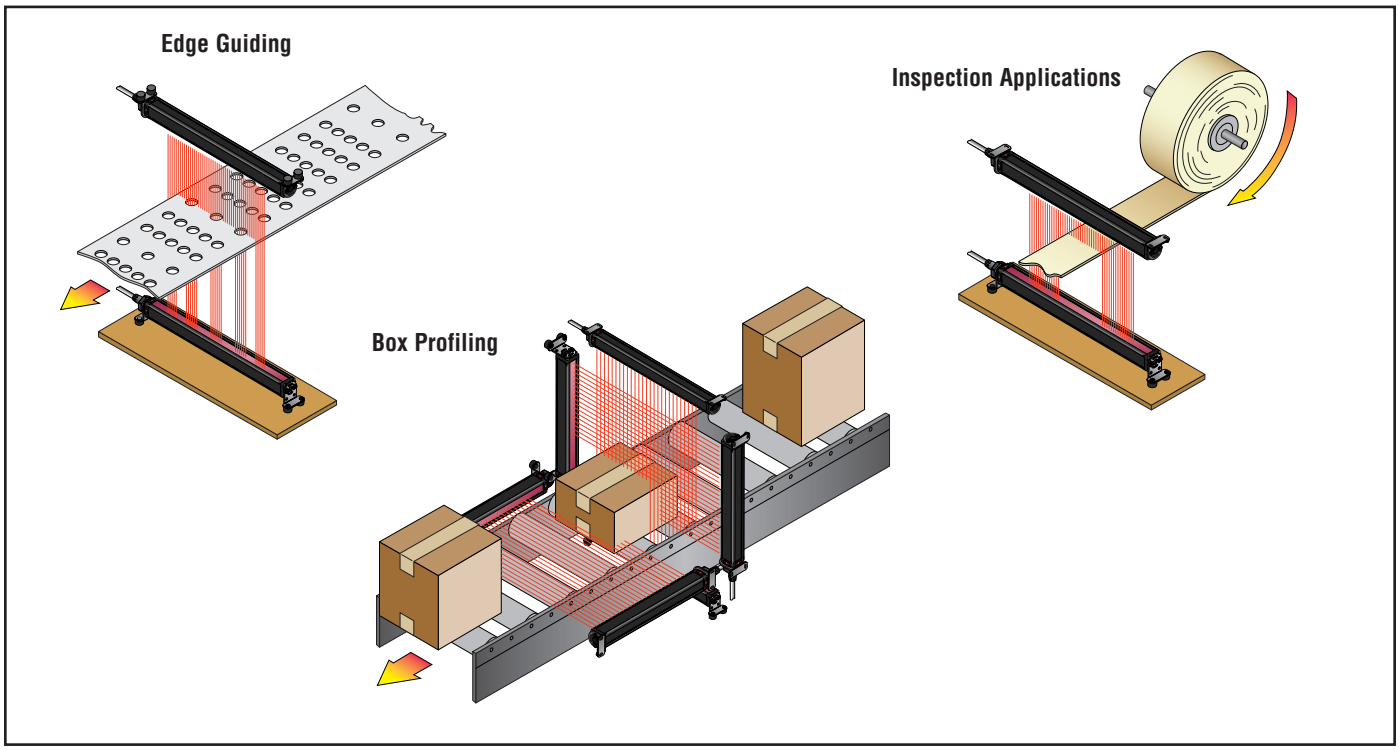


Figure 1-3. Typical applications for the A-GAGE MINI-ARRAY System

2. Specifications

2.1 Emitter and Receiver Specifications

Emitter/Receiver Range Specified at the point where 3x excess gain remains.	**3/8" beam spacing**	**3/4" beam spacing**
	Sensors < 4': 0.6 to 6.1 m (2' to 20') **Sensors > 4':** 0.6 to 4.6 m (2' to 15')	**Sensors < 4':** 0.9 to 17 m (3' to 55') **Sensors > 4':** 0.9 to 14 m (3' to 45')
Minimum Object Sensitivity	**3/8" beam spacing**	**3/4" beam spacing**
	Straight, Edge Modes: 19.1 mm (0.75") **Skip Mode:** Multiply the above by the number of skipped beams, plus 1 **Interlaced Mode:** 12.7 mm (0.5")*	**Straight, Edge Modes:** 38.1 mm (1.5") **Skip Mode:** Multiply the above by the number of skipped beams, plus 1 **Interlaced Mode:** 25.4 mm (1.0")*
	*Assumes sensing is in the middle 1/3 of sensing range.	
Sensor Scan Time	55 microseconds per beam, plus post process time per scan. Post process time will vary, based on the number of channels interrogated during each scan. See page 20 for a description of scan time for each scanning method and the formula for calculating post process time.	
Power Requirements †Maximum current is for a 6' sensor.	**3/8" beam spacing**	**3/4" beam spacing**
	12V dc ±2%, supplied by controller **Emitter:** 0.10 A @ 12V dc **Receiver beam spacing:** 0.75 A @ 12V dc†	12V dc ±2%, supplied by controller **Emitter:** 0.10 A @ 12V dc **Receiver beam spacing:** 0.50 A @ 12V dc†
Connections	Sensors connect to controller using 5-conductor quick-disconnect cables (one each for emitter and receiver), ordered separately; see page 5 for available lengths. Use only Banner cables, which incorporate a "twisted pair" for noise immunity. Cables measure 8.1 mm (0.32") dia. and are shielded and PVC-jacketed. Conductors are 20 gauge (0.9 mm). Emitter and receiver cables may not exceed 75 m (250') long, each.	
Status Indicators	**Emitter:** Red LED lights to indicate proper emitter operation **Receiver:** Green indicates sensors aligned (> 3x excess gain) Yellow indicates marginal alignment of one or more beams Red indicates sensors misaligned or one or more beam(s) blocked	
Construction	Aluminum, with black anodized finish; acrylic lens cover	
Environmental Rating	NEMA 4, 13 (IP65)	
Operating Conditions	**Temperature:** -20° to +70°C (-4° to +158°F) **Maximum relative humidity:** 95% at 50°C (non-condensing)	

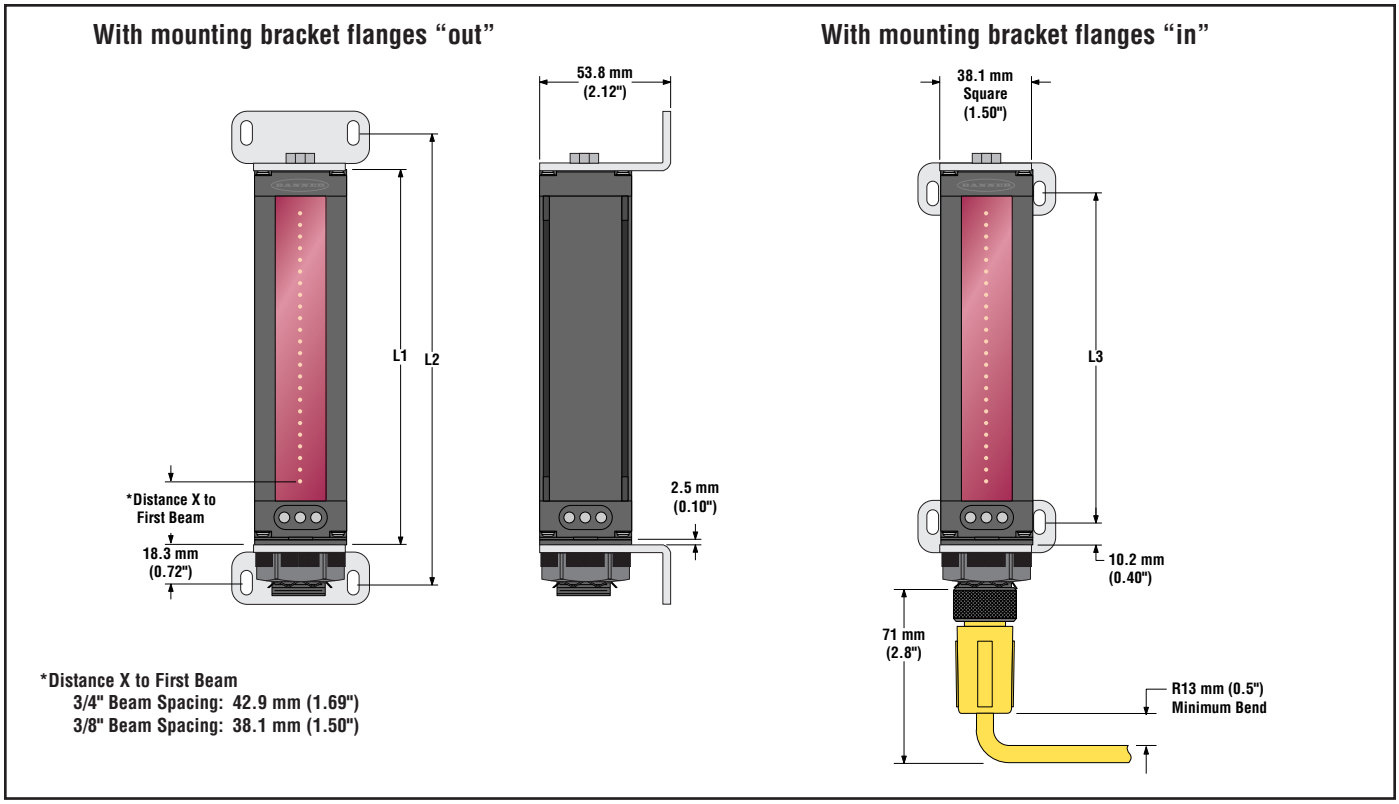


Figure 2-1. Emitter and receiver dimensions

3/4" Beam Spacing (16 Beams/Foot) Distance X: 42.9 mm (1.69")		3/8" Beam Spacing (32 Beams/Foot) Distance X: 38.1 mm (1.50")		Housing Length	Distance Between Bracket Holes	
Models	**Beams**	**Models**	**Beams**	**L1**	**L2**	**L3**
BMEL616A Emitter **BMRL616A** Receiver	8 8	**BMEL632A** Emitter **BMRL632A** Receiver	16 16	201 mm (7.9")	234 mm (9.2")	177 mm (7.0")
BMEL1216A Emitter **BMRL1216A** Receiver	16 16	**BMEL1232A** Emitter **BMRL1232A** Receiver	32 32	356 mm (14.0")	390 mm (15.4")	333 mm (13.1")
BMEL1816A Emitter **BMRL1816A** Receiver	24 24	**BMEL1832A** Emitter **BMRL1832A** Receiver	48 48	505 mm (19.9")	539 mm (21.2")	482 mm (19.0")
BMEL2416A Emitter **BMRL2416A** Receiver	32 32	**BMEL2432A** Emitter **BMRL2432A** Receiver	64 64	659 mm (26.0")	693 mm (27.3")	636 mm (25.1")
BMEL3016A Emitter **BMRL3016A** Receiver	40 40	**BMEL3032A** Emitter **BMRL3032A** Receiver	80 80	810 mm (31.9")	844 mm (33.2")	787 mm (31.0")
BMEL3616A Emitter **BMRL3616A** Receiver	48 48	**BMEL3632A** Emitter **BMRL3632A** Receiver	96 96	963 mm (37.9")	997 mm (39.3")	941 mm (37.0")
BMEL4216A Emitter **BMRL4216A** Receiver	56 56	**BMEL4232A** Emitter **BMRL4232A** Receiver	112 112	1115 mm (43.9")	1148 mm (45.2")	1091 mm (43.0")
BMEL4816A Emitter **BMRL4816A** Receiver	64 64	**BMEL4832A** Emitter **BMRL4832A** Receiver	128 128	1267 mm (49.9")	1301 mm (51.2")	1244 mm (49.0")
BMEL6016A Emitter **BMRL6016A** Receiver	80 80	**BMEL6032A** Emitter **BMRL6032A** Receiver	160 160	1572 mm (61.9")	1606 mm (63.2")	1549 mm (61.0")
BMEL7216A Emitter **BMRL7216A** Receiver	96 96	**BMEL7232A** Emitter **BMRL7232A** Receiver	192 192	1877 mm (73.9")	1910 mm (75.2")	1853 mm (73.0")

2.2 Control Module with DeviceNet Specifications

DeviceNet Configurations	**Vendor code:** 12 (Banner Corp.) **Device type:** 110 **Product code:** 1 (MACNXDN-1) 2 (MACPXDN-1) **Connection types supported:** Explicit Message, Poll, COS **Network address:** 0-63 (network configured) **Baud rate supported:** 125K, 250K, 500K (network configured)
Output Configurations	**MACNXDN-1:** Two PNP discrete (switched) **MACPXDN-1:** Two NPN discrete (switched)
Power Requirements*	**Controller, emitter and receiver:** 16 to 30V dc @ 1.2 A max. (typical: 0.5 A @ 16V dc)
DeviceNet Power*	11 to 25V dc - supplied by DeviceNet BUS Network
Inputs	**Sensor input:** Emitter and receiver wire in parallel to five terminals. **Gate input:** Optically isolated, requires 10 to 30V dc (7.5kΩ impedance) for gate signal
Discrete (Switched) Outputs	**NPN outputs:** Open collector NPN transistor rated at 30V dc max., 150 mA max. **PNP outputs:** Open collector PNP transistor rated at 30V dc max., 150 mA max. **All discrete outputs:** **OFF-state leakage current:** < 10 µA @ 30V dc **ON-state saturation voltage:** < 1V @ 10 mA and < 1.5V @ 150 mA
System Programming	Via DeviceNet interface and supplied EDS files.
System Status Indicators	**Output (steady red):** Output #1 energized. **Alarm (flashing red):** Output #2 energized. **Gate (steady red):** Gate input status. **Alignment (steady green):** Proper emitter/receiver alignment and a clear, unblocked light screen (ON when green or green/yellow receiver LEDs are ON. **Diag 1 (green), Diag 2 (red), Diag 3 (red):** Used in combination to display System status; see Chapter 5, System Diagnostics for more information.
Network Status Indicator	Bi-colored (red/green) LED visible on the control module front panel indicates network status: **Steady Green:** On-line, connected to master **Flashing Green:** On-line, address and baud rate OK **Steady Red:** Critical network fault or duplicate node address detected **Flashing Red:** Connection timeout **OFF:** No network power or off-line
Construction	Polycarbonate housing; mounts to flat surface or directly onto 35-mm DIN rail
Environmental Rating	NEMA 1 (IP20)
Operating Conditions	**Temperature:** -20° to +70°C (-4° to 158°F) **Maximum relative humidity:** 95% @ 50°C (non-condensing)
***Application Note**	The controller must be powered up before the DeviceNet connection in every power-up situation for proper operation

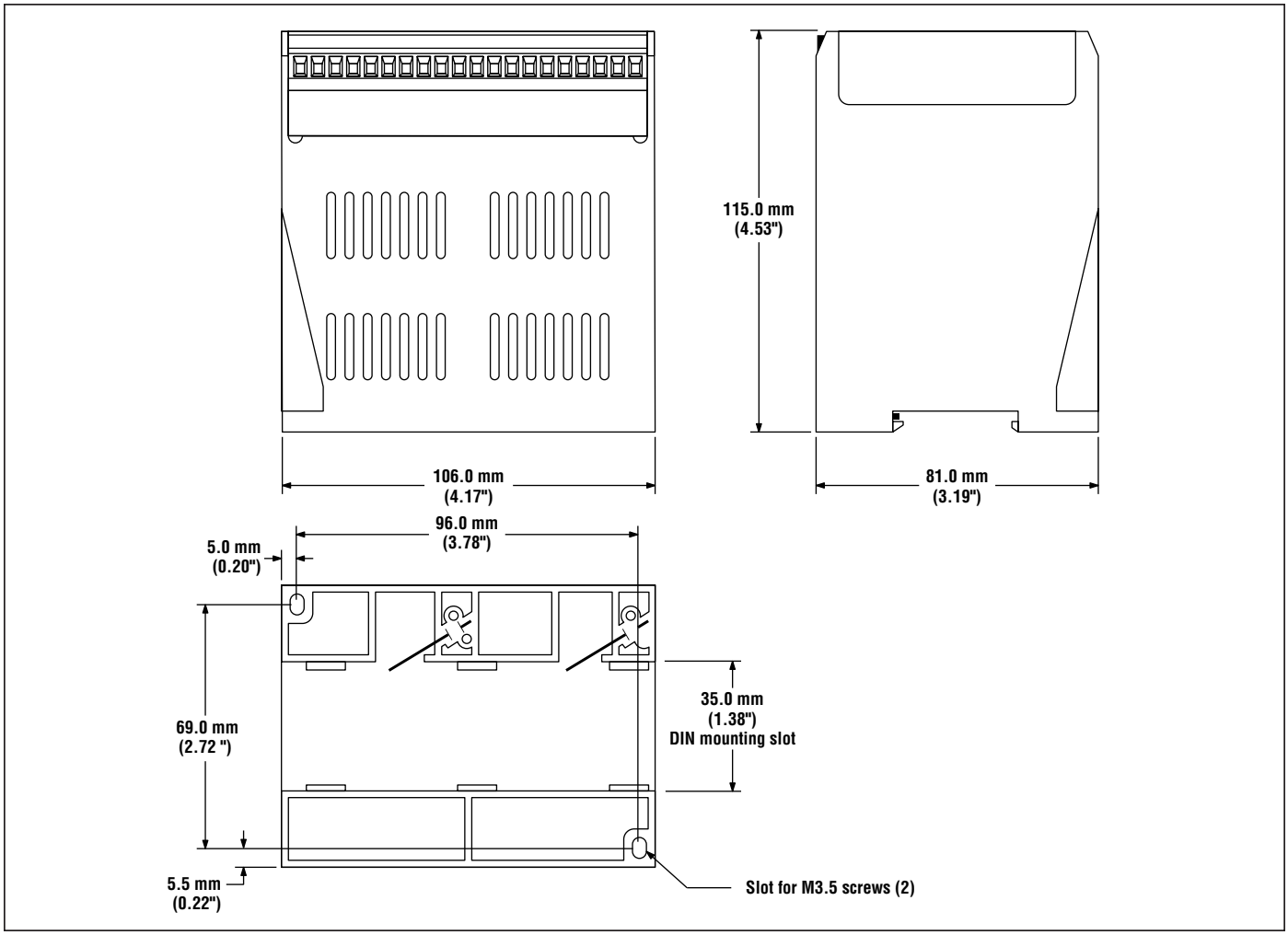


Figure 2-2. Control module dimensions

2.3 DeviceNet Attribute Information

I/O Data Mapping

I/O Message Types	Polled	COS
Produced Data Size	8 bytes	8 bytes
Consumed Data Size	0 bytes	0 bytes

I/O Data Attribute Format, Poll and COS

BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	X	System Status Bit 2	System Status Bit 1	System Status Bit 0	X	X	Alignment Blocked	Alignment OK
1	LSB – Measurement Mode 1*							
2	MSB – Measurement Mode 1*							
3	LSB – Measurement Mode 2*							
4	MSB – Measurement Mode 2*							
5	Reserved (always 0)							

*Measurement mode results:
Beam number if measurement mode is FBB, FBM, LBB, or LBM
Number of beams if measurement mode is TBB, TBM, CBB, or CBM

SYSTEM STATUS: (BYTE 0, NIBBLE 2):	
1	EEPROM error
2	Controller error
3	ROM error
4	Normal
5	Emitter error
6	Receiver error
7	Emitter/receiver mismatch

(Items in parentheses are Factory Default Settings)

Analysis Mode 1 (FBB)
FBB: First Beam Blocked
FBM: First Beam Made
LBB: Last Beam Made
LBM: Last Beam Made
TBB: Total Beams Blocked
TBM: Total Beams Made
CBB: Contiguous Beams Blocked
CBM: Contiguous Beams Made
Disabled

Analysis Mode 2 (Disabled)
FBB: First Beam Blocked
FBM: First Beam Made
LBB: Last Beam Made
LBM: Last Beam Made
TBB: Total Beams Blocked
TBM: Total Beams Made
CBB: Contiguous Beams Blocked
CBM: Contiguous Beams Made
Disabled

Scan Control Modes (Continuous)
Continuous Scanning
Gate Mode
Host Mode

Scanning Methods (Straight)
Straight Scan
Skip Scan 1
Skip Scan 2
Skip Scan 3
Skip Scan 4
Skip Scan 5
Skip Scan 6
Skip Scan 7
Interlaced (Dither) Scan
Edge Scan

Output 1 Analysis Mode (Disabled)
Disabled
Analysis Mode 1
Analysis Mode 2

Output 1 Set Point – Low (1)
1-384

Output 1 Set Point – High (1)
1-384

Output 1 Hysteresis – Low (0)
0-385

Output 1 Hysteresis – High (2)
0-385

Output 1 Invert (No)
No
Yes

Output 2 Analysis Mode (Disabled)
Trigger
Alarm
Disabled
Analysis Mode 1
Analysis Mode 2

Single Scan (No)
No
Yes

Output 2 Set Point – Low (1)
1-384

Output 2 Set Point – High (1)
1-384

Output 2 Hysteresis – Low (0)
0-385

Output 2 Hysteresis – High (2)
0-385

Output 2 Invert (No)
No
Yes

Measurement Mode 1 Result (0)

Measurement Mode 2 Result (0)

Output 1 & 2 Scan Number (1)
1-9

Alignment Status (Unknown)
0: Made
1: Broken

Number of Beams (0)
0-384

Beam Status (0)
0: Broken or not used
1: Made

Blanking Beams (0)
0: Not blanked
1: Blanked

Number of Emitter Beams (0)
0-192

Number of Receiver Beams (0)
0-192

Status of Controller (Unknown)
Unknown
EEPROM error
Controller error
ROM error
Normal
Emitter error
Receiver error
Emitter/receiver mismatch

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.

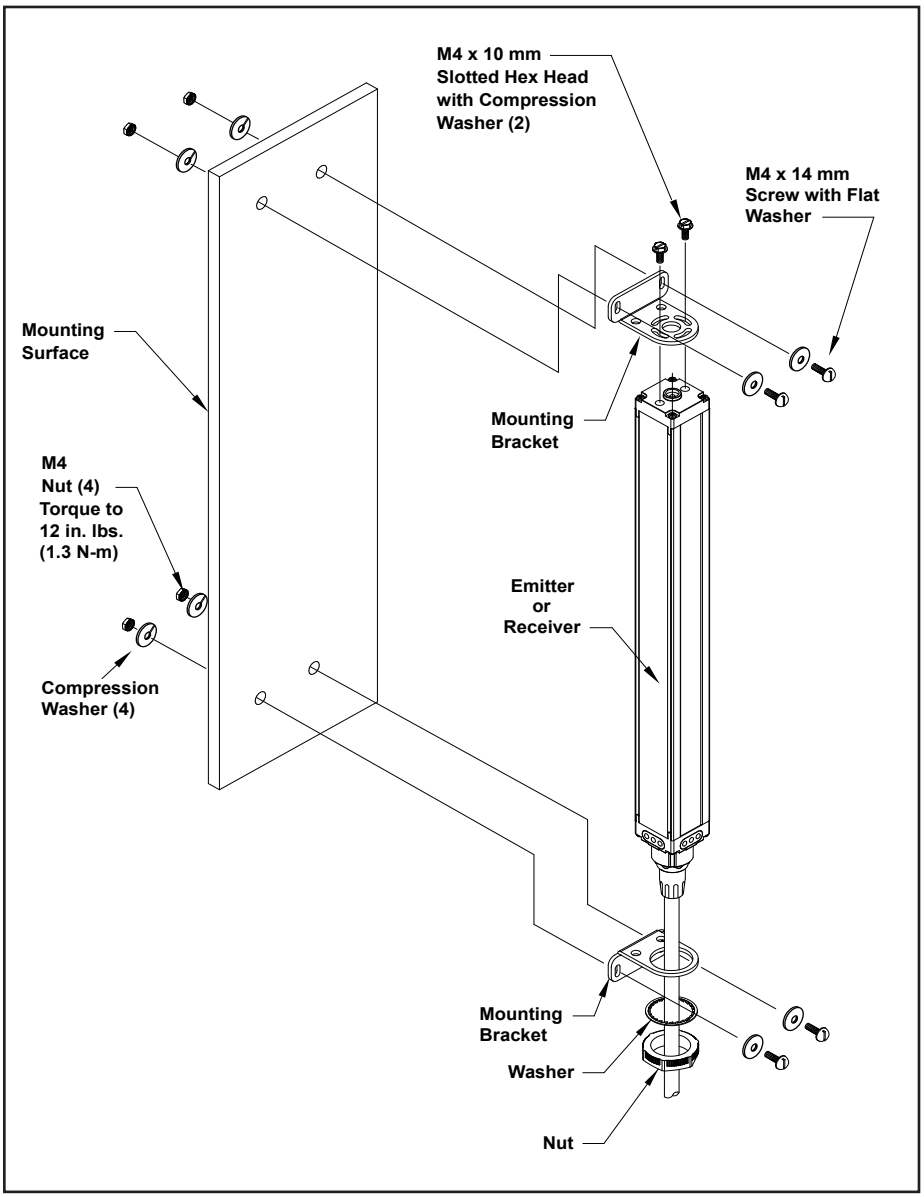


Figure 3-1. A-GAGE MINI-ARRAY emitter and receiver mounting hardware

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 sheer force spec at higher temperature.

Mount the emitter and receiver in their brackets and position the red lenses of the two units so they directly face each other. The connector ends of both sensors must point in the same direction. 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. If the sensors are positioned exactly vertical or horizontal to the floor, a carpenter's level is useful for checking alignment. A straightedge or a string extended between the sensors also helps 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 4.2 for further information on alignment.

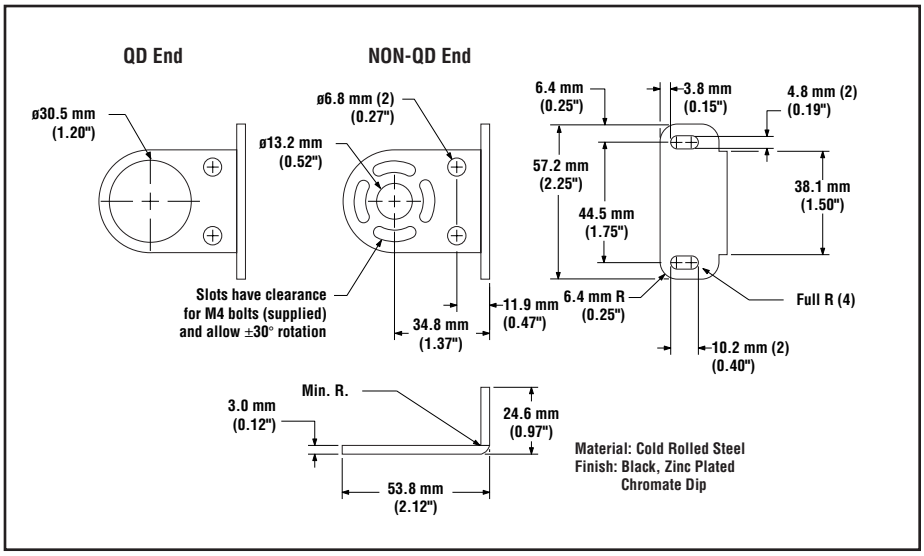


Figure 3-2. A-GAGE MINI-ARRAY emitter and receiver mounting bracket dimensions

3.2 Control Module Mounting

The control module must be installed inside an enclosure which has a NEMA (or IEC) rating suitable for the operating environment.

Mounting dimensions for the controller are shown in Figure 2-2, on page 11. The control module is supplied with M3.5 hardware for direct mounting to a surface, or it may mount directly onto standard 35 mm DIN rail.

3.3 Hookups

Connections are made to the MACNXDN-1 and MACPXDN-1 control modules via 20 wiring terminals located along the front surface of the module. Refer to Figures 3-3 and 3-4 for the appropriate hookup information.

NOTE: The controller must be powered up before the DeviceNet connection in every power-up situation, for proper operation.

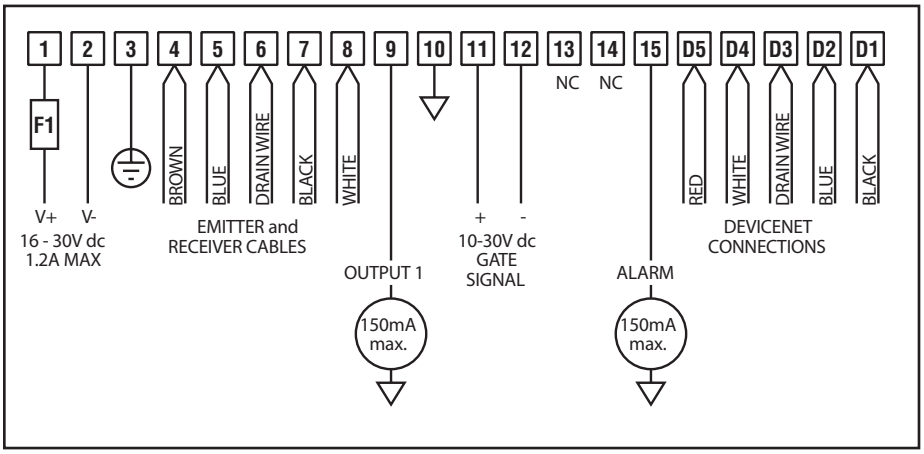


Figure 3-3. MACNXDN-1 hookup (2 NPN discrete outputs)

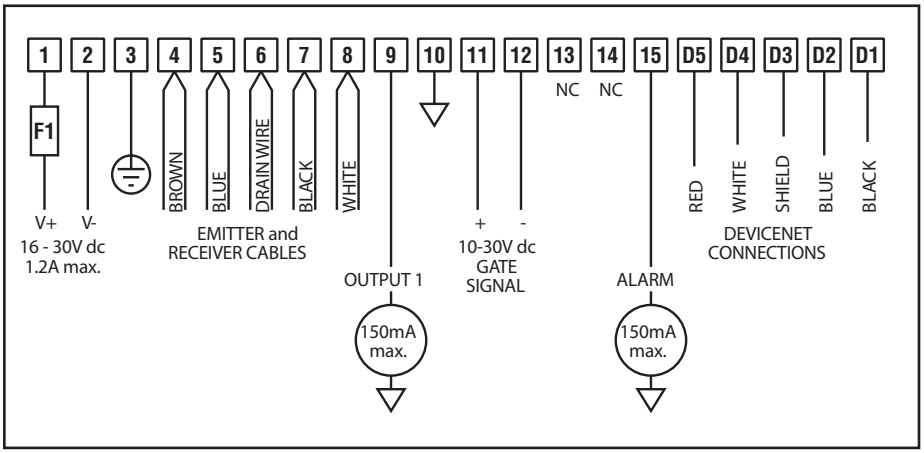
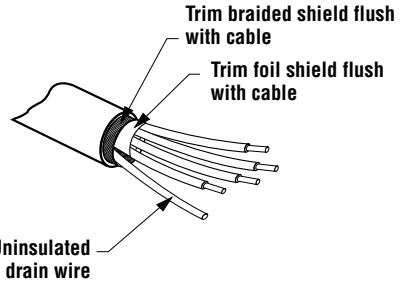


Figure 3-4. MACPXDN-1 hookup (2 PNP discrete outputs)



NOTE: The "drain wire" is the uninsulated stranded wire which runs between the braided shield and the foil shield. The foil shield and the braided shield should be removed at the point where the wires exit the cable.

Figure 3-5. Emitter and receiver cable preparation

3.3.1 Emitter and Receiver Hookups

Emitters and receivers connect together in parallel to terminals #4 through #8 of the control module (identical for both control module models). See Figures 3-3 and 3-4 for wire color information.

3.3.2 Inputs

System Power: Connect a source of 16 to 30V dc, rated at 1 amp or greater, to control module terminals #1 (+) and #2 (-). Connect a good earth ground to terminal #3 to provide electrical and RF noise immunity to the System.

NOTE: Remove power before making other connections to the controller.

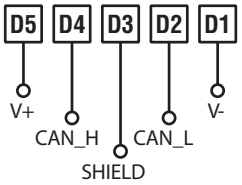
Gate Signal: Connect a switched source of 10 to 30V dc to terminals #11(+) and #12(-) to provide a gating input (if required). The gating voltage typically is switched by the open-collector output transistor of a dc sensing device. The gate signal controls scanning when the Gate option is selected (see Section 4.4).

3.3.3 Outputs

Each control module has two solid-state discrete outputs, labeled Output #1 and Alarm. Both are rated at 30V dc max., 150 mA max. They are either both NPN or both

Control Module	Output #1 (Terminal #9)	Output #2 ("Alarm") (Terminal #15)
MACNXDN-1 Figure 3-3	NPN open-collector 30V dc max. 150 mA max.	NPN open-collector 30V dc max. 150 mA max.
MACPXDN-1 Figure 3-4	PNP open-collector 150 mA max.	PNP open-collector 150 mA max.

PNP, depending on the model.



DEVICENET CONNECTIONS

Terminal	Wire Color	Function
D3	–	Shield
D5	Red	Bus Power (+V)
D1	Black	Bus Power (-V)
D4	White	Communications +
D2	Blue	Communications -

3.3.4 DeviceNet Communication Hookups

4. Control Module Configuration

The A-GAGE MINI-ARRAY control module is easily configured using the supplied EDS file and the user's DeviceNet configuration tool.

4.1 Communications Setup

See Section 3.3.4, page 17 for information on connecting the MINI-ARRAY control module to the DeviceNet network.

4.2 System Alignment

The emitter/receiver pairs have a wide field of view and are easy to align. The recommended distance between the emitter and receiver ranges from 15" to 72". (Shorter sensor separation can be achieved; please consult factory for details.) The Alignment process should be performed at System installation and repeated every time one or both of the sensors is moved.

Alignment status is continuously displayed by the green LED indicators on the receiver and the controller. When all unblanked beams are clear, and excess gain of all beams is at least 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 will remain ON, but the yellow LED also will come ON to indicate a warning of marginal alignment. See section 3.1 for more information about sensor alignment.

Make sure the sensors have been wired as shown in Section 3.3. Apply power to the control module via terminals #1 and #2 (16 to 30V dc).

4.3 Blanking

If a machine fixture or other equipment will continuously block one or more beams, the affected beam channels may be blanked. The Blanking option causes the control module to ignore the status of blanked beams for measurement mode calculations. For example, if a machine fixture blocks one or more beams during System operation, the output data will be incorrect; if beams blocked by the fixture are blanked, the output data will be correct. Blanking cannot be used with Edge Scan mode.

4.4 Control Mode Selection

The control mode determines the method used to control scanning of the light screen array. Choose from three scan control modes:

- Continuous Scan mode (the Factory default setting),
- Host Command mode, and
- Gate mode

In Continuous Scan Mode, the control module begins a new scan as soon as it updates the outputs from the previous scan. This is the fastest scan control method; it is used when continuous updating of the outputs is acceptable.

Host Mode allows the user, with a DeviceNet connection, to direct the MINI-ARRAY System to scan on command.

Gate Mode activates an optically isolated external Gate input between terminals 11 (+) and 12 (-) of the control module. The Gate input has impedance of 7.5 kΩ and accepts a 10 to 30V dc signal. A dc device such as a photoelectric sensor or optical encoder typically supplies the Gate input. Gate input signals must be greater than 100 microseconds in duration; the time between successive Gate inputs must be greater than the minimum scan time for the light screen array (see section 4.5 for scan time information).

4.5 Scanning Methods

The control module offers the choice of one of four scanning methods:

- Straight scan
- Interlaced scan
- Edge scan
- Skip scan

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 array. This scanning method requires the longest scan times and provides the smallest object detection size.

To calculate scan time for Straight Scan, multiply the number of beams by 55 microseconds, and add post process time.

Interlaced Scan alternates a straight scan with a slanted-beam scan to improve optical resolution within the middle one-third of the scanning range (see Figure 4-1). A slanted-beam scan begins with a beam between emitter channel 1 and receiver channel 2, then between emitter channel 2 and receiver channel 3, and so on. The last emitter channel beams to the last receiver channel to complete the scan. After this sequence, the emitter/receiver pair performs a standard straight-across scan (emitter channel 1 – receiver channel 1, and so on).

To calculate scan time for Interlaced Scan, double the number of beams in the array, multiply by 55 microseconds, and add post process time.

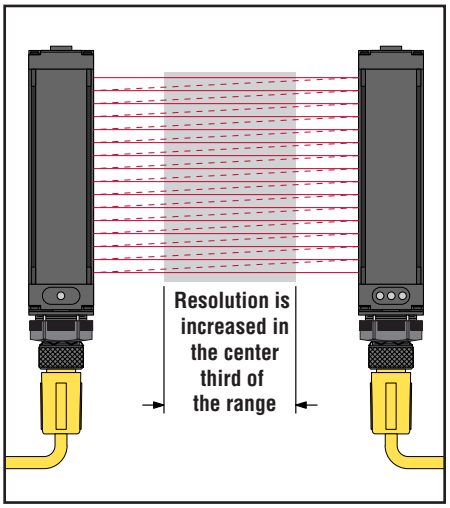


Figure 4-1. Interlaced Scan Mode improves optical resolution in the middle third of the scanning range.

Edge Scan is designed to speed sensing response time, by measuring or locating only one edge of an object. Edge scan activates only the beams located near the top edge of an object in the light screen. (NOTE: "Top edge" refers to the edge of the object passing farthest from the cabled end of the sensors.) When the array is clear, the system will execute straight scans. Edge scan begins when a blocked channel is detected. 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. Use of Edge Scan mode limits the Scan Analysis mode selection to only LBB (Last Beam Blocked). Edge Scan requires the following configuration: Analysis Mode 1 – LLB; Anaylsis Mode 2 – None; and all beams active (no blanking).

Scan time for Edge Scan mode will vary, depending on what size objects are in the array at a given time.

Skip Scan speeds sensing 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 beams 1, 4, 7, 10, etc. will be interrogated. Skip Scan also has some restrictions: the object should provide a solid obstruction, and the size of the object will determine the maximum step size (the target object cannot be smaller than the distance between two consecutive beams).

To calculate scan time for Skip Scan, first determine how many beams are being used. (For example, if the array has 16 beams, and it is configured to skip 1 beam, then half the beams – 8 – are in use. If the array is configured to skip 3 beams, then every fourth beam – a total of 4 for this array – is in use.) Multiply the number of beams by 55 microseconds, and add post process time.

Post Process Time

Post process time is determined by the number of beams "fired" in a given scan, and measured in milliseconds. To compute post process time, use the following formula:

$$\text{PPT* (in milliseconds)} = \left(\frac{\text{Beam Channels Fired}}{8} + 10\right) \times 0.12 \text{ ms} + 1 \text{ ms}$$

* Approximate Value

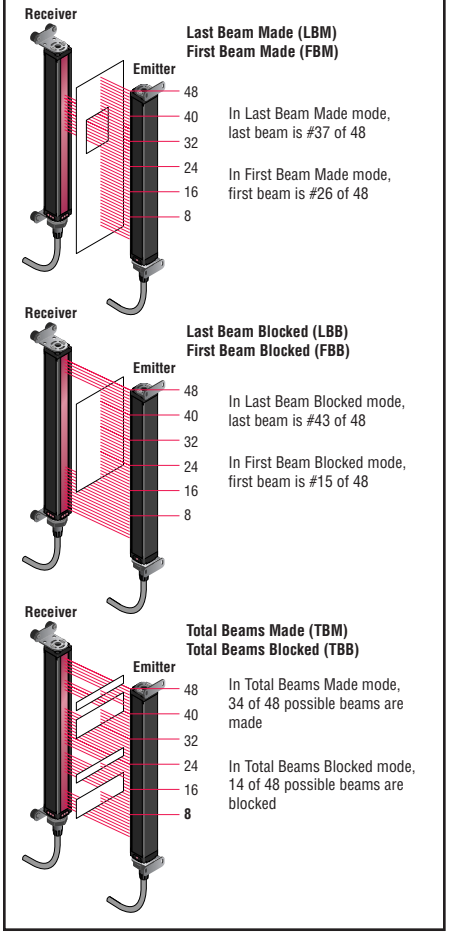


Figure 4-2. Examples of MINI-ARRAY scan analysis modes

4.6 Scan Analysis Mode Selection

The control module may be programmed, if desired, for any one or two of eight Scan Analysis (measurement) Modes. Each selected mode may be assigned individually to an output. The beams in the array are numbered in sequence, with beam #1 located at the cabled end of the emitter and the receiver. Factory Default Scan Analysis Mode is Disabled for both outputs #1 and #2; at least one output must be changed to another option before System will operate.

"Beam Location" Modes

- **First Beam Blocked (FBB):** The control module identifies the location of the First Beam Blocked.
- **First Beam Made (FBM):** The control module identifies the location of the First Beam Made (unblocked).
- **Last Beam Blocked (LBB):** The control module identifies the location of the Last Beam Blocked.
- **Last Beam Made (LBM):** The control module identifies the location of the Last Beam Made (unblocked).

"Beam Total" Modes

- **Total Beams Blocked (TBB):** The control module totals the number of blocked beams.
- **Total Beams Made (TBM):** The control module totals the number of made (unblocked) beams.
- **Contiguous Beams Blocked (CBB):** The control module identifies the largest number of consecutively blocked beams.
- **Contiguous Beams Made (CBM):** The control module identifies the largest number of consecutively made beams.

The Analysis Mode(s) selected may be assigned to either or both of the available outputs. Each output can be set for **MEAS1, MEAS2, MEAS1 Inverted** or **MEAS2 Inverted**. (The Invert option is selected separately from the MEAS1/MEAS 2 selection.)

4.7 Output Configuration (Analysis Mode Assignment)

Both outputs #1 and #2 ("Alarm") individually may be assigned to one of the Scan Analysis Modes selected for **Meas 1** or **Meas 2** or they may be **Disabled**. Either output may be disabled, but not both at the same time.

Each output has **Low** and **High Set Point** options. The number selected for each option identifies a beam in the array (beam #1 being closest to the cabled end of the emitter and the receiver). When the selected Scan Analysis Mode involves first or last beam blocked or made (unblocked), the assigned output will energize when the beam identified during a scan falls within the range of the set points. When the Scan Analysis Mode involves total beams blocked or made, that assigned output will energize when the value of total beams counted during a scan falls within the range of the set points.

Invert is an option (choose Yes or No) that may be applied to either or both of the selected outputs. When **Inverted (Yes)** is selected for an output, that output will de-energize (turn OFF), rather than energize, whenever the scan analysis value falls within the range of the set points.

Hysteresis values for each end of the set point range may also be set. Hysteresis determines the amount of change that must occur at each set point (**High** and **Low**) to cause the associated output to change state. Hysteresis prevents unstable output conditions when the scan analysis value exactly matches one of the set points. The default hysteresis setting is one beam less than the Low Set Point and one beam more than the High Set Point.

Alarm and Trigger
Output #2 (only) has two additional options: Alarm and Trigger.

Alarm: Output #2 energizes whenever the System detects a sensor error (such as a disconnected cable).

Trigger: can be used to gate a second control module. The Trigger output is a 100 microsecond (0.0001 sec.) pulse. If the control module is set for edge scan, the **Trigger** pulse will come at the end of the scan (**Trigger Channel Number** will be ignored).

5. System Diagnostics

System diagnostics may be performed using the status and diagnostics indicators on the control module and sensors.

5.1 Diagnostics/Status Indicators

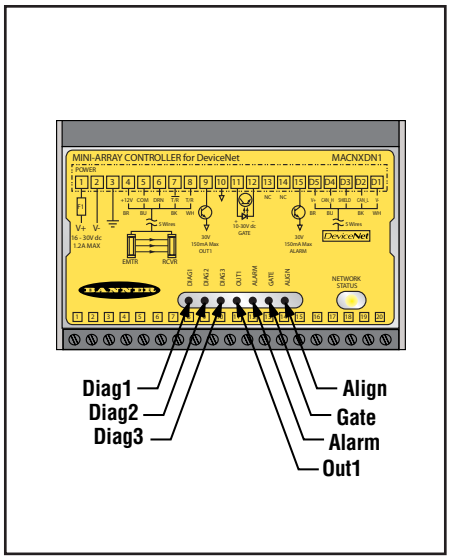


Figure 5-1. A-GAGE MINI-ARRAY with DeviceNet System diagnostics and status indicators

NOTE: Status indicators appear to "freeze" if the controller is configured for Gate or Host mode (Section 4.4), and no signal is present to cause a scan update.

Bright, easy-to-see LED indicators on both sensors and on the front panel of the control module provide an ongoing display of the system's operating status.

Control Module:
Output (steady red) indicates Output #1 energized.

Alarm (flashing red) indicates Output #2 energized. This output may be assigned to an analysis mode, or it may be used as a System Diagnostics alarm or as a Trigger alarm to gate another A-GAGE MINI-ARRAY System.

Gate (steady red) displays the status of the Gate input.

Alignment: (steady green) indicates proper emitter/receiver alignment and a clear, unblocked light screen. This indicator is ON when either the green or both the green and yellow LEDs of the receiver are ON.

Diag 1, Diag 2, Diag 3: These three Diagnostics indicators are used in combination to determine System status, as shown in the following table.

Diag 1 (Green)	Diag 2 (Red)	Diag 3 (Red)	Condition
ON	OFF	OFF	Normal operation
ON	ON	OFF	Receiver error
ON	OFF	ON	Emitter error
ON	ON	ON	Emitter/receiver mismatch
OFF	ON	OFF	Controller error
OFF	OFF	ON	EEPROM error
OFF	ON	ON	ROM/RAM error

Network Status Indicator: Bi-colored (red/green) LED indicates network status.

Steady Green	Online, connected to Master.
Flashing Green	On-line, address and baud rate OK
Steady Red	Critical network fault or duplicate node address detected
Flashing Red	Connection timeout
OFF	No network power, or offline

Emitter:
Operational (steady red) LED indicates power to the emitter is ON.

Receiver:
Blocked (steady red) LED indicates some of the array beams are blocked.

Marginal (steady yellow) LED indicates that array alignment is marginal.

Alignment: (steady green) LED indicates that array alignment is satisfactory.

Appendix A: Glossary

Blanked Beam: A beam that is "ignored" by the receiver, as the 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 MINI-ARRAY emitters and receivers automatically perform an Alignment procedure to equalize the amount of excess gain at each element along the array.

Host: A DeviceNet application that controls and receives input from the MINI-ARRAY System.

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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