DOUBLE BLANK ANALYZER
(Ethernet/IP Interface)

Installation and User's Manual
DBANXNE

Covering the following versions:
Single Channel and Dual Channel DBA's
DBAN1NE and DBAN2NE
Ferrous and Non-Ferrous

Drawing # 15832MN

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Chapter 1: System Description

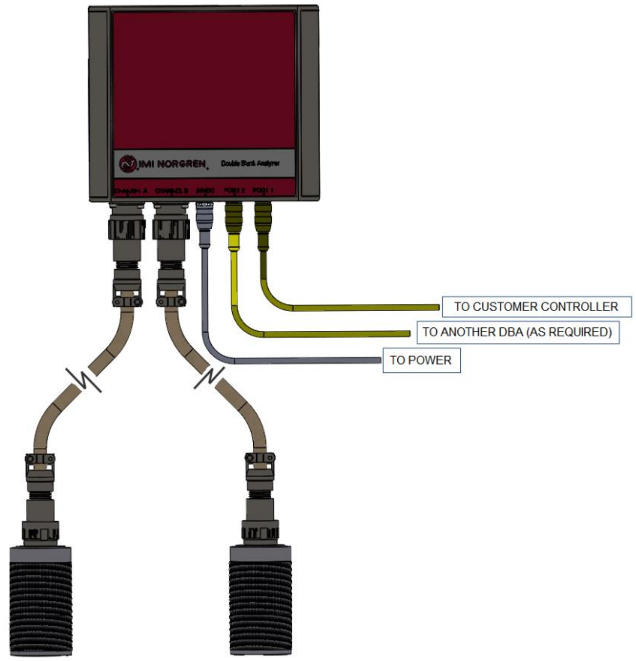
1.1 Introduction

The Norgren Automation Solutions (hereafter referred to as NAS) Series DBA Double Blank Analyzer is a device designed to verify that single sheets of metal are entering a manufacturing process. The thickness of each new sheet is compared to a Single Sheet Thickness Value that represents the correct thickness of a single sheet. The DBA software automatically develops a tolerance window around this thickness value to ensure that multiple sheets are reliably detected while eliminating nuisance faults caused by varying process or environmental conditions.

The DBA system uses contact type sensors that require direct contact with the sheet being processed. The sensor face is placed against the sheet while a thickness measurement is taken. The measured thickness is compared to the job's single sheet thickness value and implicit data bits turn on to indicate the number of sheets measured. The status of these outputs are used by a machines control logic to allow a process to continue if proper material thickness is measured or be stopped if an abnormal thickness is detected.

Typical applications include de-stacker systems feeding sheets of metal stock into stamping presses. The DBA will detect multiple sheets stuck together before they can be fed into the press causing damage to the press or die.

The DBA is available as a single (DBAN1NE) or dual channel (DBAN2NE) device. Each channel of the system has its own independent sensor "driver" board. Thickness readings and the output status of each channel are available through the provided Ethernet/IP interface.



Each sensor has its own cable assembly. Two M12 D Code Industrial Ethernet cable provides the Ethernet/IP interface to the PLC or machine control, only one is required. 24VDC system power is provided by a M12 4 Pin A code Micro connector. All wiring is through connectors on the bottom of the controller housing.

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1.2 Theory of Operation

A DBA controller can be supplied with up to two ferrous/non-ferrous input channels. The DIS10 sensors can operate in either ferrous or non-ferrous mode depending on how the channel is configured. All sensors are contact type and are selected based on the maximum Ferrous single sheet material thickness.

1.3 Ferrous Sensing

In ferrous mode, the sensor generates a magnetic field that magnetizes the ferrous sheet being measured. The ferrous sheet is driven to magnetic saturation by the sensor-generated magnetic field. The amount of flux used to reach magnetic saturation in the sheet increases as material thickness increases. The controller monitors the amount of flux used to reach magnetic saturation and calculates material thickness.

1.4 Non-Ferrous Sensing

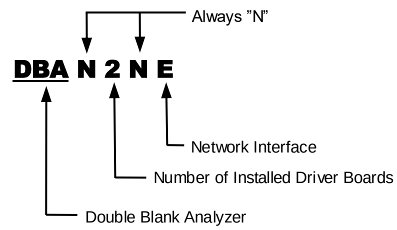
In non-ferrous operation, the sensor generates a low power sine wave which induces eddy currents in the material. The controller monitors the effects of these eddy currents and calculates a material thickness. Non-ferrous sensing is only supported by the DIS10 family of sensors.

1.5 Sensors

In ferrous mode, larger diameter sensors generate more magnetic energy and are required as material thickness increases. Sensor diameter must be selected based on the maximum thickness of the material being monitored. In non-ferrous mode the sensor diameter plays a much smaller role in thickness capability and in general the maximum capability of each sensor is the same. Refer to section 3.3.2 for sensor sizes and capabilities.

1.6 DBA Controller Part Numbers

The DBA controller is numbered as follows:



- **Number of Installed Driver Boards** – A multi-channel DBA controller can have up to 2 input channels. This digit specifies the number of input channels that have been factory installed.

1.7 Features:

1.7.1 Dual-Channel Operation

A dual-channel DBA can operate both input channels simultaneously. Each channel operates totally independent of the other channels. The Ethernet/IP interface provides simultaneous measurement, part present and number of parts detected information for each channel.

1.7.2 Ferrous and Non-ferrous Operation

The sensor has been designed to allow its use on both ferrous and non-ferrous material. The sensor functions differently during ferrous or non-ferrous operation. Each channel is configured by the PLC for the type of material during the job setup.

The selection of ferrous or non-ferrous operation is done through an explicit message at job setup.

1.7.3 Calibration

The calibration sequence provides the sensor's microprocessor with a sample measurement on a piece of material of a known thickness. The internal thickness conversion software uses this sample measurement to improve the accuracy of the material thickness measurements taken during production.

The magnetic flux technology used during ferrous measurements provides accurate thickness measurements over a wide range of ferrous alloys after one calibration sequence. Systems that are used on ferrous material typically do not require Calibration. In most cases the factory Calibration for ferrous material will be accurate within .1mm or (.004").

The eddy current technology used during non-ferrous operation requires calibration at every new job set up for accurate thickness measurements during production. Variations in non-ferrous alloys affect the eddy currents monitored by the sensor. Measurement accuracy is improved by performing a calibration sequence on a sample of the alloy used on each new job.

The calibration sequence is a series of explicit messages sent by the interface logic while material of a known thickness is present at the face of the sensor.

1.7.4 Measurement Mode

The DBA controller allows selection of two different measurement modes, Normal or Fast Mode for flexibility in the speed with which measurements are taken. Normal mode will allow the system to not only detect whether there is just a single sheet being detected, but the thickness of the measurement as well. Fast Mode behaves the same as Normal Mode except for when a double blank is detected. See section 2.6.2 for more information. Which mode of operation is used can be setup using an explicit message. Fast measure mode sacrifices a real double blank thickness measurement in exchange for measurement speed. When a predetermined threshold is met the measurement stops, and the double blank bit is set.

1.7.5 Part Present Indication

Each channel sensor will continuously report a "part present" status. This bit will be set if a part is detected by the sensor. This indicator provides the PLC with an extra layer of logic that can be used prior to initiating a thickness measurement.

1.7.6 Presets

Each channel sensor can be programmed with a preset thickness value that represents the single sheet thickness of the material being processed. The single sheet thickness value is programmed in the sensor using an explicit message during job setup. The sensor software will calculate a tolerance window around the programmed preset thickness and will compare each measurement during production to this tolerance window to determine whether one or two sheets are present. A zero, one, or two sheet conditions will be indicated by a bit in the response message after each thickness measurement.

1.7.7 Fault Indication

The DBA system monitors the sensors and the system and will provide a fault output specific to a channel if a problem occurs. The fault code (see Appendix B) can be accessed through explicit messaging (see Appendix A).

1.7.8 Sensor Recognition

All NAS sensors used with the DBA are electronically coded. This allows the DBA to determine the type of sensors connected to it.

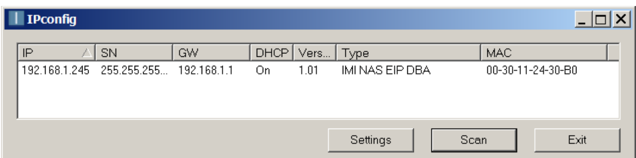
1.7.9 LED Indicators

The LEDs on the DBA can provide some visual indication as to the state of the device and the network connection. See section 2.8 for a description of the System Status LED (SysStat), and the Network Status LEDs (NetStat1 and NetStat2.)

Chapter 2: Using the DBA

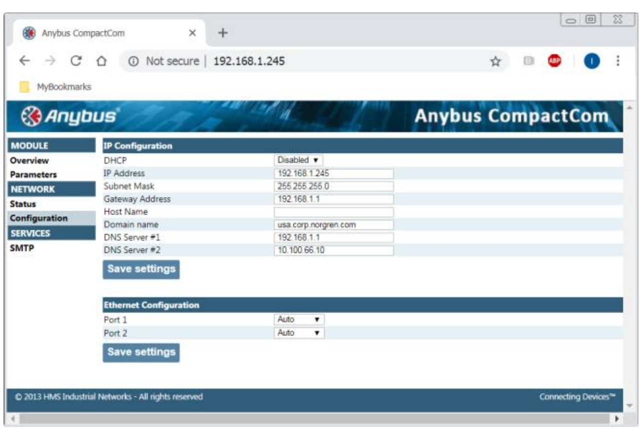
2.1.1 Connecting to the Device

To use the DBA, you'll need to locate the IP address of the device. By default, the DBA is configured to work with a DHCP server and can be assigned an IP address by your network. If this is the case, you can use your system router to locate the IP address of the device, or you can use a tool such as the IPconfig software from HMS to query the network for any Ethernet/IP devices. You can download the IPconfig tool directly from HMS at the following location: https://www.anybus.com/support/file-doc-downloads/anybus-support-tools?orderCode=tools



If you prefer to assign a static IP address to the device, you can use the IPconfig tool to do this as well or the IP address of the device can be typed into a browser window and the Configuration changed there. For example, if your DBA has an IP address of 192.168.1.245, Simply type that address into the address bar of your computer's browser (a computer connected to the same Local Area Network), and the Anybus CompactCom configuration screen should appear.

To set a static IP address, navigate to the "Configuration" screen. The DHCP option needs to be disabled and the device reset after the new IP address, subnet, and gateway are configured. Make sure to "Save Settings" before rebooting your DBA system.



2.1.2 Device/Job Setup

When first using the DBA system or configuring for a new job, there are a few settings that may need to be addressed. In addition to calibration (see section 2.3), you'll also need to verify a few conditions and define a few settings.

2.1.3 Available Channels

The DBANXNE system is available in 1 and 2 channel configurations. When first communicating with the device, you can verify the number of available channels by querying the DBA Class (0x66).

2.1.4 Using the DBA Class Instance

Accessing the class instance (instance 0), attribute 3 will provide the total number of instances (channels) installed in the system. For example, sending a GET_ATTR_SINGLE request:

Table 1 Request total number of installed channels from the DBA Class

CLASS	0x66
INSTANCE	0x00
SERVICE	0x0E
ATTRIBUTE	0x03

Depending on your system, the result should either be a 1 or 2 based on the number of channels the system has detected.

2.1.5 Using the Channel Instances

In addition to the class instance, a query of each channel instance (instance 1 for channel 1, and instance 2 for channel 2) can be used to determine if the channel is installed. If a channel is not installed, any query of that instance will generate a NAK response from the system.

Table 2 Request Status attribute from Channel 2

CLASS	0x66
INSTANCE	0x02
SERVICE	0x0E
ATTRIBUTE	0x01

The explicit request shown in Table 2 above is requesting a single attribute ("Status") from the DBA Class (0x66), channel 2 (Instance 2). The result will be a single byte representing 8 different flags reported by the system. Bit 7 (the most significant bit) is the "Channel Installed Flag." If this bit is set, the channel is installed. In reality, if this command generates a NAK ("object does not exist" error), that is the first clue that the channel is not installed.

2.1.6 Using the IO Data

If you already have an implicit connection established, the IO data can be used to determine the number of channels installed. Regardless of whether your system is a 1 or 2 channel device, the IO data will always report the same number of bytes. The "Channel Installed" flag in Byte 0 (CH1 Status) and Byte 3 (CH2 Status) can be used to determine the number of installed channels. See Appendix A for more details.

2.1.7 Measuring Limit

Each sensor has a limit regarding maximum sensing thickness. Good practice is to query each installed channel for this measurement limit and compare it against the expected material for the job that's being setup. The result is returned as a 2-byte unsigned integer in little-endian format. Each LSb (least significant bit) represents 0.01mm.

Table 3 Request Measuring Limit for channel 2

CLASS	0x66
INSTANCE	0x02
SERVICE	0x0E
ATTRIBUTE	0x05

2.1.8 Material Type

Each channel can be configured to sense either ferrous or non-ferrous material (depending upon the installed sensor.) The system must be told which type of material is being sensed. Use INSTANCE Service 0x4F to set the material type. Setting a value of 1 will configure the channel for non-ferrous, and a value of 0 will configure the channel to sense ferrous material.

Table 4 Set material type for channel 1 to ferrous

CLASS	0x66
INSTANCE	0x01
SERVICE	0x4F
ATTRIBUTE	NA
ARG[0]	0x00

2.1.9 Sample Mode

The sample mode can be either "Fast Mode" or "Normal Mode." Use INSTANCE service 0x54 to set the mode, and service 0x55 to read the mode. See appendix A for details.

Table 5 Set channel 1 to "Normal Mode" sampling

CLASS	0x66
INSTANCE	0x01
SERVICE	0x54
ATTRIBUTE	NA
ARG[0]	0x00

2.1.10 Set Preset Thickness

Each channel must have a preset thickness value set. If no value is set, the "preset loaded" flag in the channel's status byte will be clear and sampling will not be permitted. If the preset thickness is set to a value exceeding the channel's measuring limit, a fault will be generated indicating this. Using INSTANCE service 0x4D, set the preset thickness using a 2-byte value such that each bit represents 0.01mm. The arguments must be presented in little-endian format (least significant byte first).

Example: Set the preset thickness for channel 2 to 0.15mm. 15mm → 15/0.01 = 15. 15 decimal = 0x000F.

Table 6 Set preset thickness for CH2 to 0.15mm

CLASS	0x66
INSTANCE	0x02
SERVICE	0x4D
ATTRIBUTE	NA
ARG[0]	0x0F
ARG[1]	0x00

2.1.11 Calibration

Calibration should only be performed when a system is initially installed or after the installation of replacement sensors or sensor cables. Replacing sensors or cables does not automatically mean that the system needs re-calibration. A thickness reading on a sheet of known thickness will confirm whether re-calibration is required. Calibration should be performed using a sample calibration sheet of a known thickness that represents the thickest material that is processed on that press line or a sheet that represents the thickest material that the sensor size is designed for. NAS offers precision calibration sheets for each sensor size. Contact the factory for details. A 6"x6" calibration sheet should be stored by the press line and used by <u>everyone</u> that calibrates the system. Calibration performed using a sheet at the high end of your press line capabilities will result in measurements that are within our ±0.1mm (.004”) accuracy specification for that size sheet and all thinner sheets. Calibration performed using a sheet at the low end of your thickness range can result in inaccurate measurements on thicker material. **For ferrous measurements, re-calibration is only required when new sensors or sensor cables are initially installed. Non-ferrous measurements may need re-calibration when different alloys are used.**

To calibrate each sensor, use the following steps:

1. Configure the channel being calibrated to the material type you’re calibrating for.
2. With the sensor not sitting on the metal sheet used for calibration (in-air), use the INSTANCE service 0x50 to start in-air calibration.
3. Poll the calibration status attribute (0x0B) for the instance/channel being calibrated. (Note: between EVERY read of attribute 0x0B, execute a “refresh calibration status” request using INSTANCE service 0x52.) Wait until the status response returns 0x02, “in-air measurement complete.”
4. Place the sensor on the metal sheet used for calibration (on-metal.)
5. Use the “Calibrate On-Metal” INSTANCE service (0x51) to begin the last phase of calibration. For this command, you must provide the actual thickness of the metal sheet being used to calibrate. The thickness is in 0.01mm increments and is a 2-byte value presented in little-endian format.

   Table 7 Start Cal-on-metal sequence using 0.7mm sheet for channel 2.

CLASS	0x66
INSTANCE	0x02
SERVICE	0x51
ATTRIBUTE	NA
ARG[0]	0x46
ARG[1]	0x00

6. Poll the calibration status attribute (0x0B) and wait until it returns 0x00 for a successful calibration, or 0xFF for a failure. Don’t forget to refresh the calibration status between reads of the status.

Table 8 Calibration Status

0x00	Calibration has not been started or calibration has completed successfully
0x01	In-air measurement is taking place
0x02	In-air measurement is complete
0x03	On-metal measurement is being performed
0xFF	Failure

2.2 Implicit Connections – Class 1 Connection

The Assembly Object (Class 0x04) for the DBA has been configured to provide 6 bytes of status and measurement data for 2 channels, regardless of whether the system you use is a single or double channel device. The DBA expects 2 bytes of data from the PLC. The provided EDS will help you configure your PLC for this connection and will provide some limitations regarding the bytes and bits, but will also provide a limit for the sample rate (the RPI.) For most applications, we don’t recommend a sample rate faster than 10ms.

In Appendix A, this data is described in terms of Originator and Target, or Scanner and Adapter.

(T)Target: this is the “Adapter” or the DBA System.
(O)Originator: this is the “Scanner” or the PLC.

So, a T→O connection is the DBA System sending data to the PLC.

An O→T connection is the PLC sending data to the DBA.

2.2.1 T→O Adapter to Scanner

Instance ID: 100 (0x64)
Data Size: 6 bytes

Table 9 T-->O Data Descriptions

Byte Index	Data
0	CH1 Status
1	CH1 Thickness (LSB)
2	CH1 Thickness (MSB)
3	CH2 Status
4	CH2 Thickness (LSB)
5	CH2 Thickness (MSB)

When valid and applicable (not in fast mode), the channel thickness is reported in increments of 0.01mm. Example: 15 = 0.15mm.

Table 10 Status Bit Descriptions

Bit	Flag
0	DONE bit. New Measurement available
1	FAULT bit. Fault detected
2	PRESET LOADED
3	PART PRESENT

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4	SheetCount_LSb
5	SheetCount_MSb
6	MEASURING
7	CHANNEL INSTALLED (1=installed)

Table 11 SheetCount Status Bits

SheetCount	MSb	LSb
0	0	0
1	0	1
2	1	0
NA	1	1

2.2.2 O→T Scanner to Adapter

Instance ID: 101 (0x65)
Data Size: 2 bytes

Table 12 O-->T Data Descriptions

Byte Index	Data
0	CH1 Control Flags
1	CH2 Control Flags

Table 13 Control Flag Bit Descriptions

Bit	Flag
0	START bit
1	CLEAR FAULT bit
2	NA
3	NA
4	NA
5	NA
6	NA
7	NA

2.3 Understanding the Signals

2.3.1 DONE bit

The DONE bit is a flag in the status byte of the channel which conveys that a measurement is complete, the thickness values are now updated and can be read. In "fast mode", if a double blank is detected, the only result that should be read is the sheet count bits since the actual thickness value will simply report 9.99mm. The measurement process will stop as soon as a double is confirmed. The DONE bit is a useful flag to incorporate as part of the logic which determines when another measurement can be started.

2.3.2 FAULT bit

If at any point there is a fault of some type, this bit will be set. The user can use explicit messaging to read the fault code if desired.

2.3.3 PRESET_LOADED bit

Prior to any samples being collected, a "preset" thickness value must be loaded into each installed channel. Once this is done, the PRESET_LOADED flag will be set indicating that measurements can be taken.

2.3.4 PART_PRESENT bit

In Ferrous mode, part presence is asserted whenever a ferrous target is detected within a fixed distance. The detection is independent of the targets thickness and therefore is not affected by the job's preset value.

Non-Ferrous sensors use their eddy current thickness sensing technology to see material as it approaches the sensor face. Because the presence of a part is affected by the thickness of it, the part presence indication uses the job's preset as a basis for determining part presence. Once the part is determined to be above a fixed negative offset from the job preset, the part present flag is set.

2.3.5 Sheet Count

When a measurement is complete and ready for reading by the user, the sheet count bits identify the number of sheets detected by the last sample. The sheet count is only reliable following a valid measurement (in either fast or normal modes) in which the DONE bit is set and the FAULT bit is clear.

2.3.6 MEASURING bit

When the user requests a measurement, the MEASURING bit will be set during the actual measurement taking place for the channel. When the MEASURING bit clears, this is not an indication that the measurement is valid, only that measuring has ceased. Do not read the thickness results until the DONE bit is set and the FAULT bit is clear.

2.3.7 CHANNEL_INSTALLED bit

In addition to the explicit methods to determine whether a channel is installed or not, the CHANNEL_INSTALLED flag in the Assembly Object can be read as part of the IO data stream to determine which of the two possible channels is installed in the user's system. If the bit is set, the channel is installed.

2.3.8 START bit

The PLC/Scanner software has control over the START bit. This bit is read by the DBA software and will begin a measurement on that channel if conditions are such that one can begin. This bit is used as part of the handshaking described in section 2.6 for taking a sample.

2.3.9 CLEAR_FAULTS bit

In addition to the channel instance service (0x4C) for clearing faults, this bit in the Assembly Object stream can be used by the PLC to request that faults be cleared. Toggle the bit from 0 to 1 to request that faults be cleared.

2.4 Taking a Sample

Requesting a measurement on a particular channel can be done implicitly using the Assembly IO data, or explicitly through the DBA object instances for the corresponding channel.

2.4.1 Normal Mode

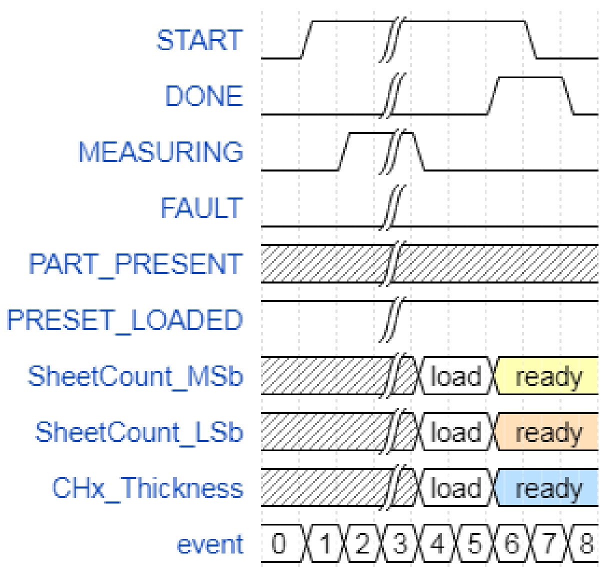

Figure 1 Normal Measurement Sequence

EVENT 0:
Preconditions are met. START not asserted, DONE not asserted, not MEASURING, no FAULT, PRESET_LOADED is set.

EVENT 1:
PLC asserts the START bit.

EVENT 2:
DBA indicates that MEASURING begins

EVENT 3:
Time passes while sample completes. Amount varies based on sensor type.

EVENT 4:
MEASURING flag clears, sheet count and thickness are loaded.

EVENT 5:
Sheet count and thickness still loading.

EVENT 6:
DONE bit asserts. Data is ready. No FAULT flag. PLC can now read the data.

EVENT 7:
PLC has read the data. PLC releases the START request by clearing the flag.

EVENT 8:
DBA recognizes that the START bit has been released so it clears the DONE bit. A new measurement sequence can now be requested.

2.4.2 Fast Mode

Fast Mode samples are taken in the same way as with Normal Mode, however, the measurement is completed faster in the event of a double blank being detected. The measurement is stopped as soon as a double blank can be guaranteed. The DBA does not have enough information to determine the thickness accurately and will report 9.99mm if a double blank is detected. If less than 2 sheets are detected, the thickness is valid and can be read.

2.5 Faults

Faults that are generated at any point in the process will be indicated by the FAULT bit in the status byte for the channel. The status byte is mirrored in the Assembly Object for the specific channel as well as in the DBA Class instance for the channel (attribute 1.) Once discovered, the user's system can access the fault code explicitly using the DBA instance for the channel and reading attribute 0x0C (Fault Code 1.) Fault Code 2 and Fault Code 3 are unused in this product. See appendix B for descriptions, causes, and possible actions that can be taken as a result.

2.6 LED Indicators

The DBA has 3 external bi-color LEDs that can provide some indication of the operation state.

2.7 System Status LED

The SysStat LED will typically flash green at a fixed rate when operation is normal. With no Class 1 connection established, the SysStat LED will flash green approximately once every 2 seconds. Once a Class 1 connection is made and IO data is flowing, the LED will transition to a faster rate of approximately once every 500ms. Any error state will change the SysStat LED from green to red.

2.7.1 Network Status LEDs

The 2 Network Status LEDs, NetStat1 and NetStat2, correspond to the two Ethernet/IP connections on the DBA. Similar to the SysStat LED, green is indicative of normal operation. With no Class 1 connection, the LEDs flash green at a rate of about once per second. Once a Class 1 connection has been established, the LEDs stays green all the time.

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Chapter 3: Specifications

3.1 Electrical Specifications

Input power – 24VDC

.5 amp base plus
.1 amp steady + 4.7 amp max transient per sensor input channel DIS1075 (Ferrous mode)
.1 amp steady + 3.4 amp max transient per sensor input channel DIS1054 (Ferrous mode)
.1 amp steady + 3.0 amp max transient per sensor input channel DIS1042 (Ferrous mode)
.15 amp steady (all sensors) (Non-Ferrous mode)

Note – The transient current draw specifications in Ferrous mode outlined above are worst case. Each sensor input channel draws the current noted for 250 milliseconds whenever a measurement is taken. Most systems do not trigger measurements at all sensors simultaneously.

Data Retention

- Flash memory stores data for 10 years

3.2 Operational Specifications:

- The press PLC Interface Logic must consider the following possible delay times when developing a program for the DBA.

  - Settling time for the sensor face to make good contact against the sheet, about 50mS.

  - Dwell time after a start command is given to calculate material thickness, compare calculation to the job's preset value and turn on appropriate 0, 1 or 2 sheet discrete output:

    Time for non-ferrous mode: 15mS on any target

    Time for 42mm ferrous mode: 135mS on 4mm target, 140mS on 8mm target (Double Blank)
    Time for 54mm ferrous mode: 180mS on 5mm target, 190mS on 10mm target (Double Blank)
    Time for 75mm ferrous mode: 255mS on 6mm target, 350mS on 12mm target (Double Blank)

  - Continuous Measurement mode cycle time (Part Present must be active):
    42mm ferrous mode: 3.0 Hz *, 4mm target thickness
    54mm ferrous mode: 2.7 Hz *, 5mm target thickness
    75mm ferrous mode: 1.8 Hz *, 6mm target thickness
    (* The rate drops to 1 Hz after 1 minute of continuous on target measurements)

    42mm, 54mm, 75mm Non-Ferrous mode: 5Hz, any target thickness
    (Rev 1.4 and older driver software)

    42mm, 54mm, 75mm Non-Ferrous mode: 22Hz, any target thickness
    (Rev 1.5 and newer driver software)

  - Time needed to extend the sensor if a pneumatically actuated sensor mount is used, about 50mS.

  - The DBA takes a thickness measurement when the start input is asserted. This gives the PLC control over when and where a measurement is taken in the machine cycle. Machine position data or external proximity switches are used to tell the PLC that material is properly positioned for a measurement and that a start input should be sent to the DBA. The PLC can immediately react to the 1 or 2 sheet output. The results of each measurement are latched until another measurement is initiated.

  - Thickness measurement resolution is 0.01mm.

  - Measurement accuracy is ±0.1mm. (If calibrated accurately)

  - Measurement repeatability ±0.1mm.

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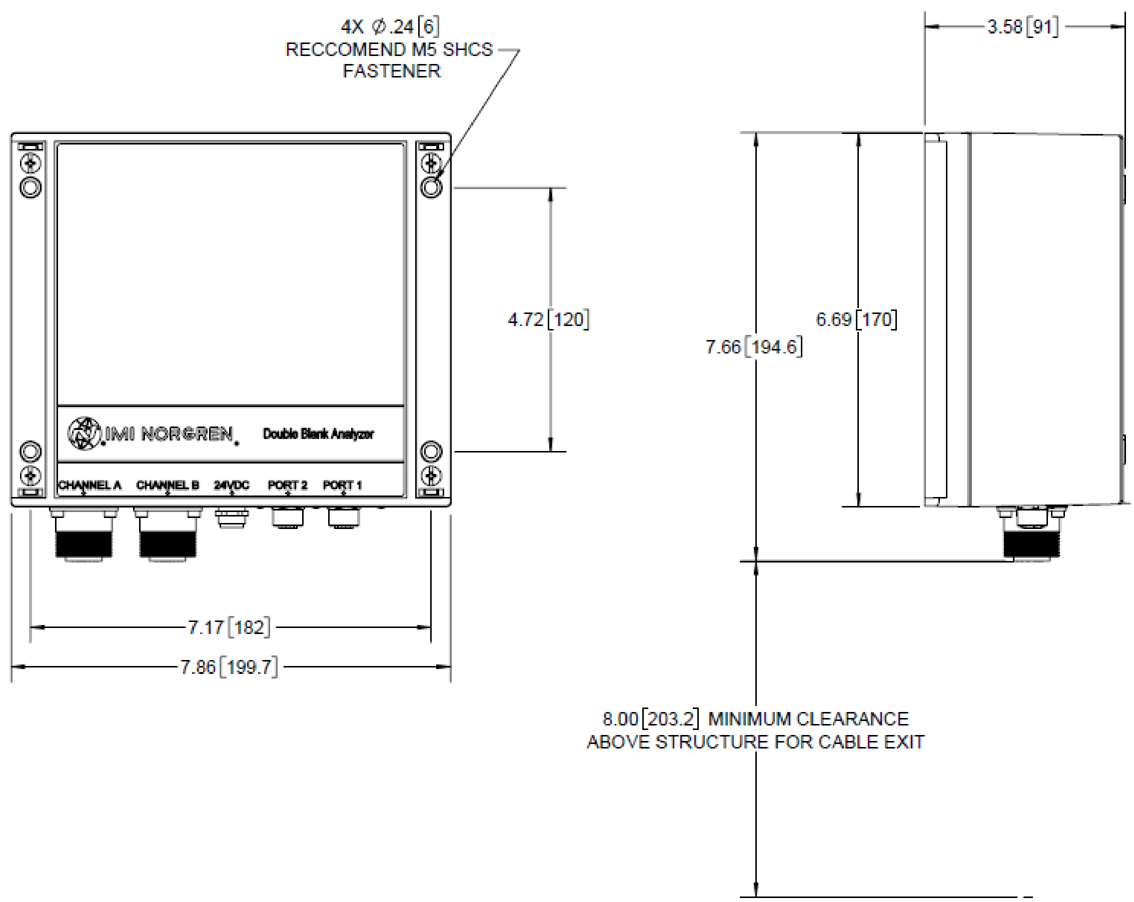
3.3 Mechanical Specifications

3.3.1 CONTROLLER

- Painted Aluminum enclosure with Overlay
- Oil tight rated – NEMA4 or IP67
- Vibration Proof to 4G
- Operating temperature 10°C to 50°C

3.3.1.1 Control Dimensions:



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3.3.2 SENSORS

- Zinc plated steel body with stainless steel face

Catalog #	Ratchet Connector	Material Type	Dia.	Weight	Single Sheet Thickness Range	Single Sheet Thickness Range
					Ferrous	**Non-Ferrous**
DIS0242-01	Straight	FE only	42mm	1.35 lbs / 611 gm	0.5 - 2.3mm	NA
DIS0254-01	Straight	FE only	54mm	2.46 lbs / 1117 gm	0.5 - 3.0mm	NA
DIS0354-01	Right Angle	FE only	54mm	2.79 lbs / 1265 gm	0.5 - 3.0mm	NA
DIS0275-01	Straight	FE only	75mm	6.52 lbs / 2959 gm	0.5 - 4.6mm	NA
DIS1036S	Straight	FE/NF	36mm	0.9 lbs / 408 gm	0.5 – 3.6mm	0.5 - 4.0mm
DIS1042S	Straight	FE/NF	42mm	1.2 lbs / 541 gm	0.5 - 4.3mm	0.5 - 4.0mm
DIS1054S	Straight	FE/NF	54mm	2.46 lbs / 1114 gm	0.5 - 5.7mm	0.5 - 4.0mm
DIS1054R	Right Angle	FE/NF	54mm	2.78 lbs / 1260 gm	0.5 - 5.7mm	0.5 - 4.0mm
DIS1075S	Straight	FE/NF	75mm	5.34 lbs / 2422 gm	0.5 - 8.0mm	0.5 - 4.0mm
DIS1075R	Right Angle	FE/NF	75mm	5.72 lbs / 2594 gm	0.5 - 8.0mm	0.5 - 4.0mm

- Maximum Sensor Cable Length – **30 meters** (Electrical noise and voltage drop at the sensor become possible issues beyond 30 meters)

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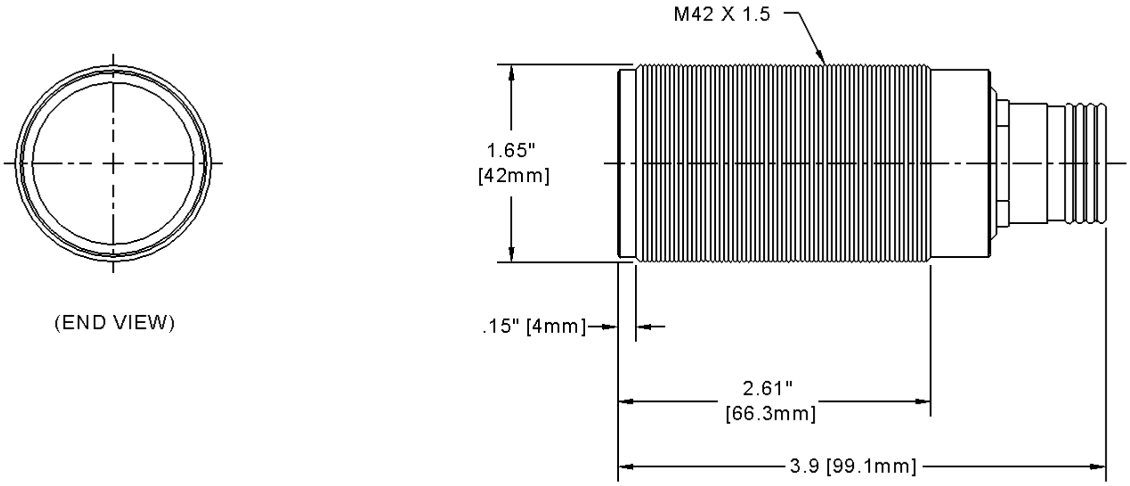
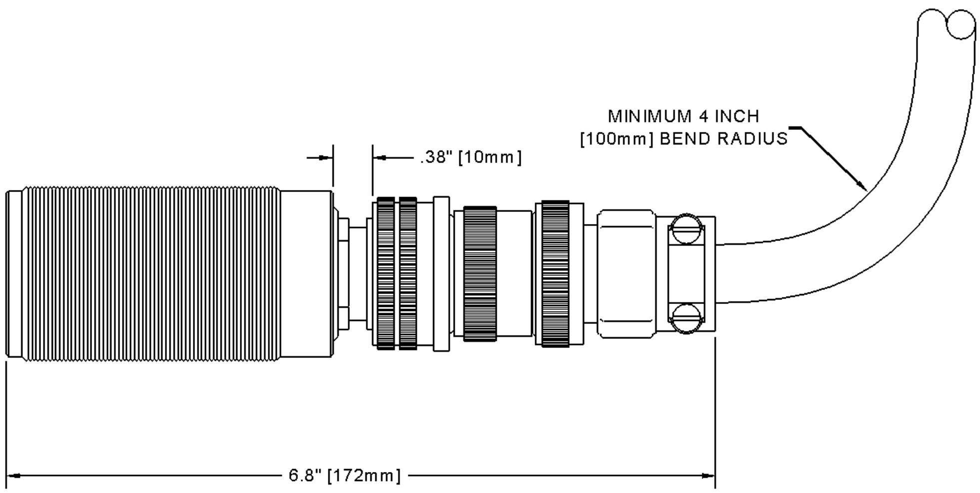
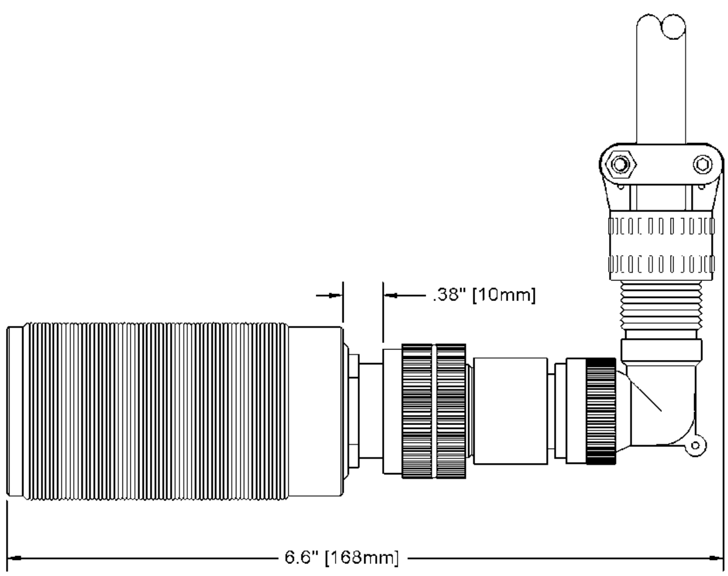
3.3.2.1 Sensor Dimensions:

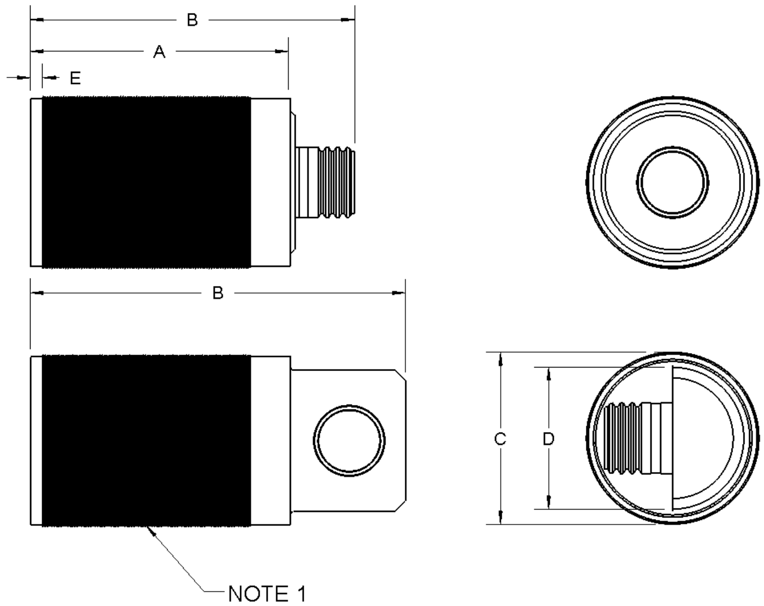
3.3.2.1.1 42mm Ferrous/Non-Ferrous Sensor





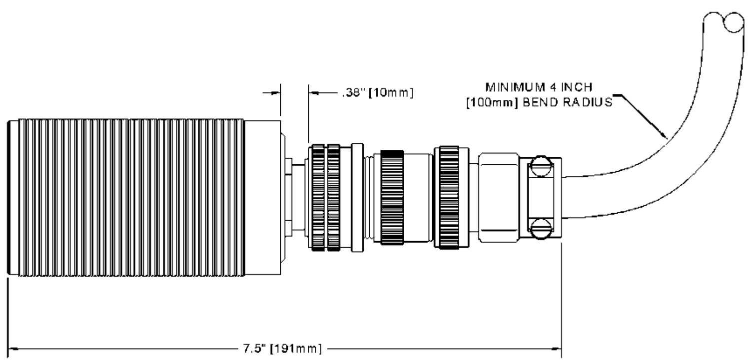


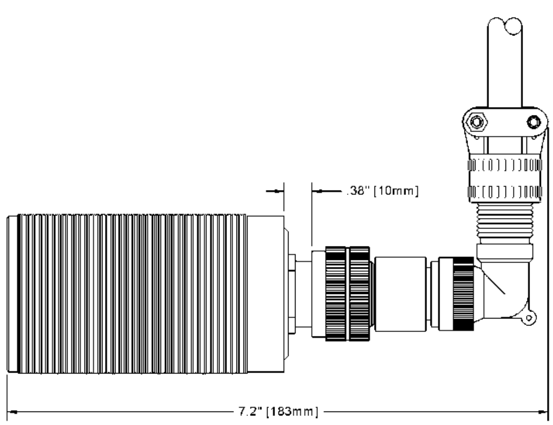
3.3.2.1.2 54mm Ferrous/Non-Ferrous Sensor



DIM	DIS1054S		DIS1054R	
	MM	INCHES	MM	INCHES
A	80.5	3.17	80.5	3.17
B	113.3	4.46	129	5.08
C	54.1	2.12	54.1	2.12
D	-	-	44.5	1.75
E	3.8	0.15	3.8	0.15

NOTE 1
M54 X 0.75





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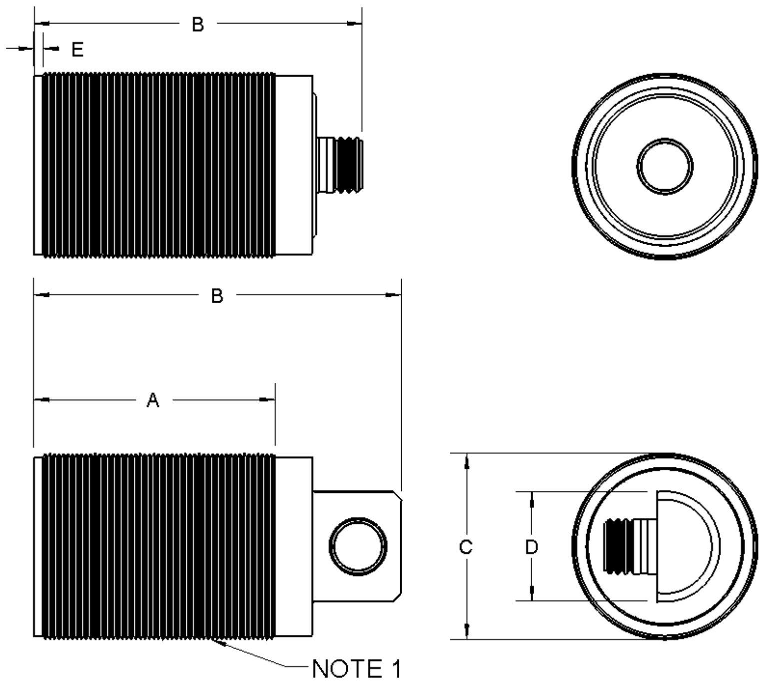
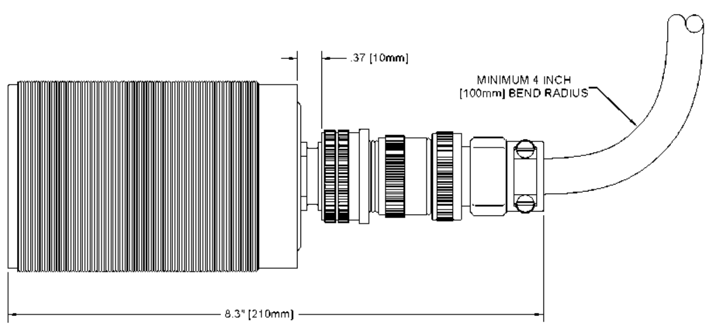
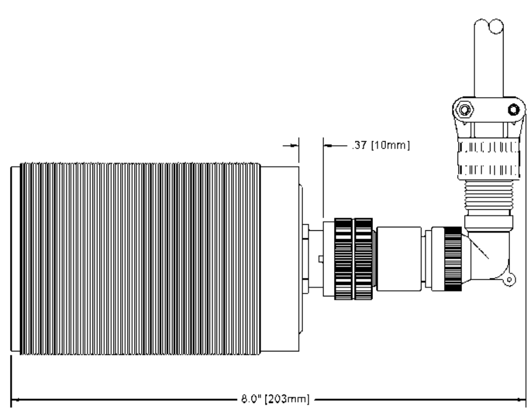
3.3.2.1.3 75mm Ferrous/Non-Ferrous Sensor



DIM	DIS1075S		DIS1075R	
	MM	INCHES	MM	INCHES
A	97.5	3.84	97.5	3.84
B	132.6	5.22	148.6	5.85
C	75	2.95	75	2.95
D	-	-	44.5	1.75
E	3.8	0.15	3.8	0.15

NOTE 1
M75 X 1.5





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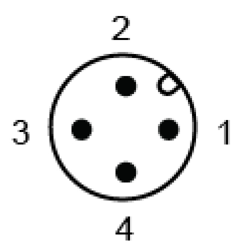
Chapter 4: Wiring

4.1 Power:

- The installer must ensure that all wires are used, a single pair of conductors from an M12 cable does not supply enough current to adequately supply the DBA.

Pin 1	+24V
Pin 2	+24V
Pin 3	0V
Pin 4	0V
Pin 5	N/C

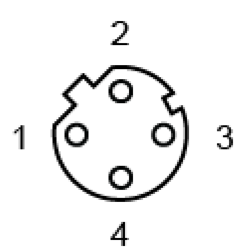


(Front View)

4.2 I/O Connections:

- For Star Topology use Port 1 first, followed by Port 2.
- For linear and Device Level Ring (DLR) the order does not matter.

Pin 1	TX+
Pin 2	RX+
Pin 3	TX-
Pin 4	RX-



(Front View)

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Chapter 5: Installation and Startup

This section provides typical installation and startup procedures that should be followed whenever a new system is installed or components are changed on an existing installed system.

The programming portion of this section covers all possible features that may or may not have been used by the systems integrator that developed the interface logic to the machine control PLC.

Integrator Note – It is extremely important that you document the DBA features used and the programmed values that you selected for proper interface to the machine logic that you developed. Plant level maintenance and NAS factory service will need these details for long term maintenance of the overall system. Several steps in this section cover multiple setup choices for a specific feature.

5.1 Mechanical and Electrical:

1. The DBA controller housing is oil tight (Nema 12) and is designed for use in an industrial environment. As with any piece of electronic equipment, it should be protected from excessive temperature, vibration and electrical noise generated by welders, drives, servos, etc. The electrical connectors that exit from the bottom of the controller housing require 18 inches of clearance to accommodate the installation of the connectors, the cabling and their minimum bending radius.
2. The DBA sensor must be installed in a spring mount assembly as shown on page 19. The spring mount should be adjusted for 4mm to 6mm of spring compression when the system performs a thickness measurement. This ensures that the sensor can set flat against the sheet during measurements. A consistent flat relationship of the sensor face on the sheet is critical for reliable operation of the DBA system
3. Sensor cables should be routed away from electrical noise generating devices and should not be run in conduit or cable tray that contains high voltage signals. Maximum sensor cable length should be 30 meters or less (consult factory if longer lengths are required). If the sensors are mounted on a moving structure, the sensor cables should be mechanically anchored to the structure to prevent side loading from the cable pulling at the sensor connector.
4. Sensor mounted bumpers and vacuum cups are not recommended unless absolutely necessary. See section **5.2** for details. If either of these accessories are used, they must be installed and adjusted as outlined on our installation instruction sheet. Failure to consistently follow these instructions can result in double sheets not being detected.
5. The control cable is a 4 pin M12 D code cable. See section 4.1 for connections.
6. Verify that your input power to the DBA controller is 24V DC +-10%.

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5.2 Sensor Selection, Mounting and Adjustment

Sensor selection must be based on the maximum single sheet thickness that will be processed. Refer to section **3.2.2** for sensor specifications and catalog numbers.

5.2.1 Effects of Material Properties:

The ferrous sensors utilize pulsed, electromagnetic fields in making their measurements. The older sensors will only measure ferrous materials. The carbon content of steels may affect the accuracy of a measurement. The higher the carbon content, in steel alloy, the less magnetic they appear to the sensor. This limits the ability of the sensor to magnetically saturate high carbon steels, resulting in readings that are lower than the actual thickness of the blanks. Magnetic stainless steel alloys will behave in a similar manner.

Materials such as aluminum, copper, and brass cannot be measured with the older ferrous-only sensors. The DIS10 family sensors can measure ferrous and non-ferrous material.

Different non-ferrous alloys often require calibration when a different alloy is used. For driver boards with software Rev 1.9 or newer, non-ferrous calibration data is stored in the sensor. If sensors are changed with each job, they may need no recalibration, but if a sensor is used with a different DBA controller, recalibration will be needed.

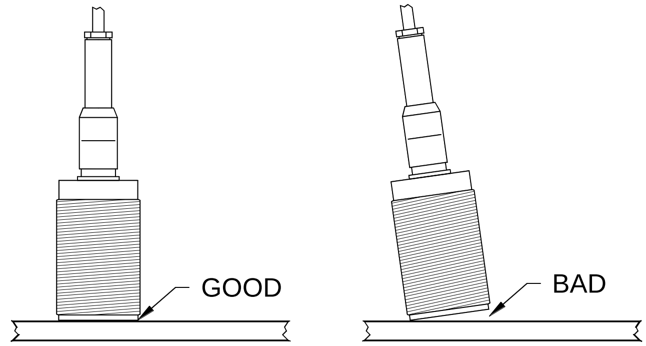
Questions regarding the measurement of high carbon, magnetic stainless steel or other materials with the DBA should be referred to Norgren Automation Solutions .

5.2.2 Sensor Mounting:

All DBA sensors used with these controllers are contact type sensors designed for direct contact with the material surface.

The sensors have a stainless steel face designed for continuous impact. Some care should be taken to control extreme impact forces by isolating the sensor from the mass of the mechanism through spring sensor mounts. Flow restrictors in pneumatic sensor mounts help prevent extreme impact forces.

All sensors must be mounted in such a way that the entire sensing face is able to seat **FLAT** on the surface of the material to be measured. Any variable air gap or imperfect contact between the sensor and the material will result in improper thickness readings. In extreme cases, poor sensor seating may result in failure to properly detect a multiple part (double blank) condition. The following drawing shows some examples of good and bad sensor seating.

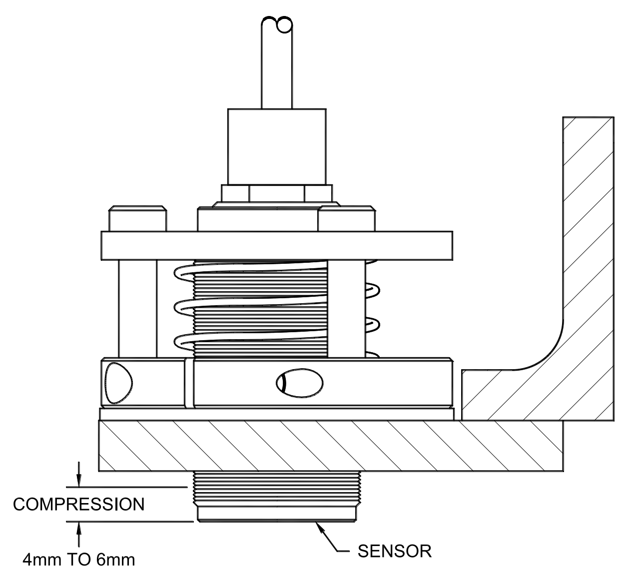


Sensor Seating

5.2.2.1 <u>Sensor Mount Adjustment</u>

The best approach is a resilient mounting scheme in which the sensor is suspended by springs as shown in the diagram below. This isolates the mass of the sensor from the mass of the support structure and allows the sensor to adjust itself to the surface of the material it is measuring.

NAS has developed a series of resilient mounts based on this principle. These resilient mounts employ a spring flex that allows the sensor to sit flat on the surface of the material and absorb shock.



Typical NAS Spring Mount

The sensor needs to be compressed between 4mm and 6mm (.16” and .24”) for optimal compensation for blank distortion and flex.

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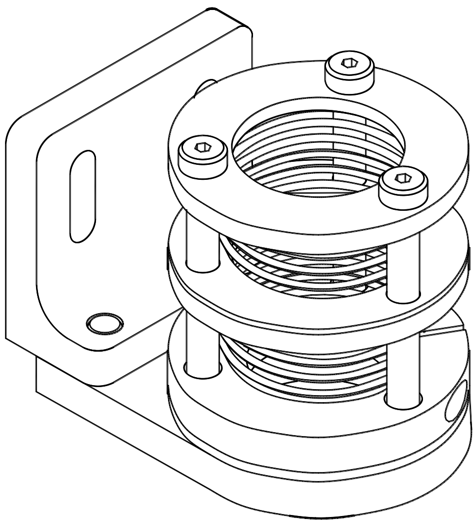
NOTE: NAS warrants the proper function of the DBA only when original NAS sensor mounting fixtures are used.

NAS's standard sensor spring mount allows 15mm (.60") of overall spring travel. Some end effector installations mount the DBA sensor next to vacuum cups that have 25mm to 50mm (1.0" to 2.0") of spring travel.
NAS offers extended travel spring mounts that allow 30mm (1.2") of overall spring travel. The extended travel mount allows the sensor to compress over the longer travel of the spring mounted cups while maintaining the required 4mm to 6mm of sensor spring compression after the sheet has been lifted off the stack.

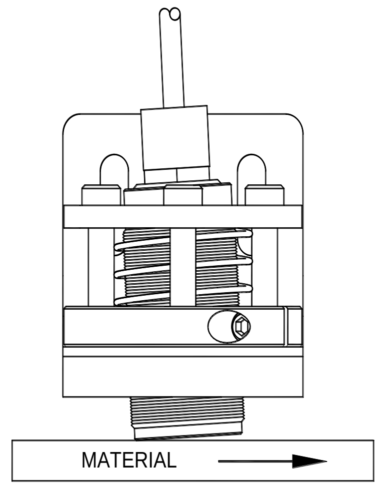


Extended Travel Mount

In all cases, sensor spring mount compression should not exceed 4mm to 6mm when the sheet has been lifted from the stack and thickness measurements are taken.

Due to the type of measurement the sensor performs, these sensors must remain stationary relative to the material for the duration of the measurement. During a measurement cycle, the sensor creates a magnetic field in the material directly in front of the sensor face. The sensor must remain in contact with that particular spot on the material for the entire measuring cycle for an accurate measurement.

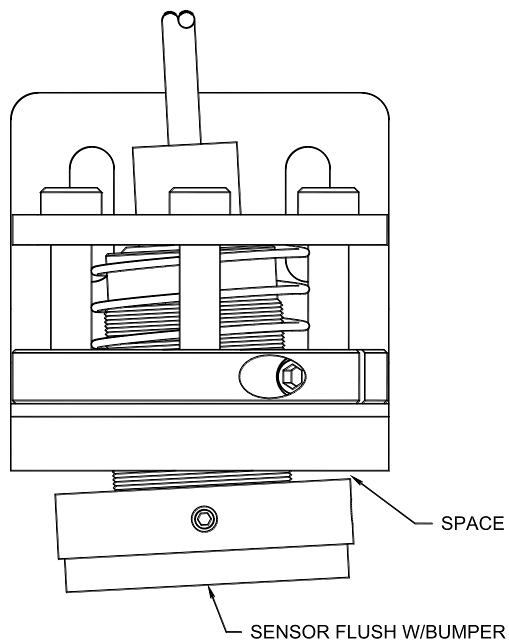
Movement can also create air gaps, scratch the material surface and cause sensor wear.



Sensor on Moving Material

5.2.2.2 Sensor Bumper Adjustment

A ring shaped bumper can be mounted on the end of the sensor to reduce material scratching. Bumpers should only be use when processing "Class A" surfaces (outer body panels). The bumper will also protect the face of the sensor from hammering under certain conditions.



Sensor with Bumper

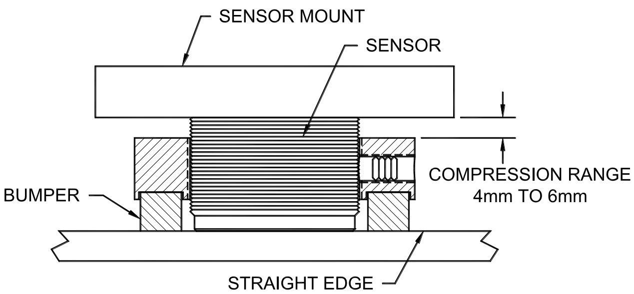
The bumper is mounted on the sensor as shown above. Care must be taken to accurately adjust the bumper-face to the face of the sensor. A straight edge is used to align the bumper face with the sensor face.

This aligned adjustment will provide material protection while maintaining the full thickness measurement capabilities of the sensor.

The sensor face can be recessed slightly behind the bumper face for additional material surface protection and to protect the sensor face from weld splatter or other material surface imperfections. The air gap adjustment procedures shown on the bumper installation instructions must be followed by all personnel that install or adjust bumpers. These instructions will result in a .003” to .005” air gap that will still provide accurate measurements. Sensor sensitivity is decreased by this air gap so the maximum thickness measurement rating of the sensor will be decreased by 15%.

Air gaps larger than .003” to .005” will drastically reduce measurement capacity and will eventually prevent the detection of double blank conditions.

Bumpers should not be used unless absolutely necessary. If they are required, they must be installed and adjusted exactly as stated on the installation instructions.



Bumper-Sensor Settings

Care must be taken to ensure that the sensor bumper does not interfere with the spring compression of the sensor spring mount. Verify that the bumper-mounting ring does not come in contact with the sensor spring mount bracket during spring compression.

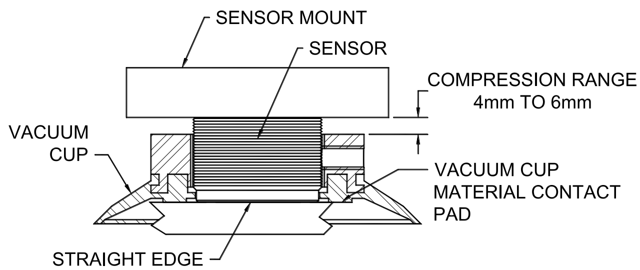
5.2.2.3 Sensor Vacuum Cup Adjustment

A vacuum cup can be mounted on the sensor to hold the material against the sensor face.

The vacuum cup is mounted on the sensor as shown below. Care must be taken to accurately adjust the sensor face to the cup material contact pads. A straight edge is used to align the sensor face with the cup contact pads. This aligned adjustment will pull the material against the sensor face for good thickness measurements.

The sensor face can be recessed slightly behind the cup contact pads for material surface protection and to protect the sensor face from weld splatter or other material surface imperfections. The air gap adjustment procedures shown on the vacuum cup installation instructions must be followed by all personnel that install or adjust the cup. These instructions will result in a .003” to .005” air gap that will still provide accurate measurement. Sensor sensitivity is decreased by this air gap so the maximum thickness measurement rating of the sensor will be decreased by 15%. Air gaps larger than .003” to .005” will drastically reduce measurement capacity and will eventually prevent the detection of double blank conditions.

Sensor mounted vacuum cups can interfere with the proper operation of the DBA system. If cups are used, they must be installed and adjusted exactly as stated on the installation instructions.



Vacuum Cup – Sensor Settings

Care must be taken to ensure that the sensor cup does not interfere with the spring compression of the sensor spring mount. Verify that the cup mounting ring does not come in contact with the sensor spring mount bracket during spring compression.

5.2.2.4 Recommended Sensor Mount

This concept drawing shows a sensor mounting arrangement that will provide reliable trouble free operation. Standard vacuum cups are mounted directly adjacent to the sensor spring mount to hold the sheet flat and stationary against the face of the sensor. This flat and stationary presentation of the sheet against the sensor face typically eliminates the need for bumpers to prevent surface marring.

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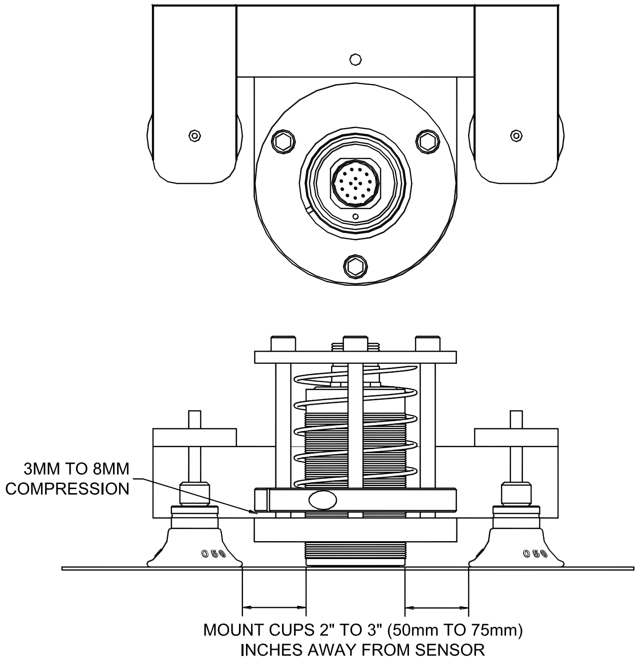
The unobstructed view of the sensor face against the material allows visual verification that the sensor is held flat against the material during thickness measurements.

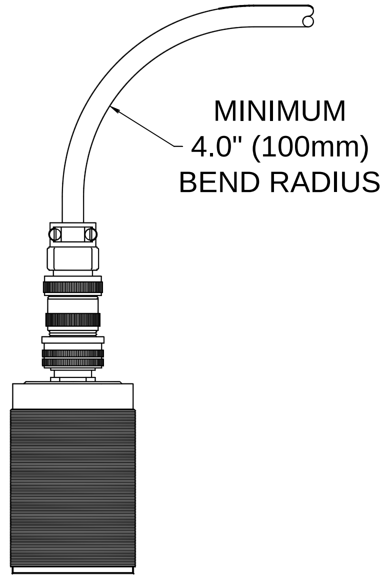


Sensor Mount Concept Drawing

Sensor Cable Installation

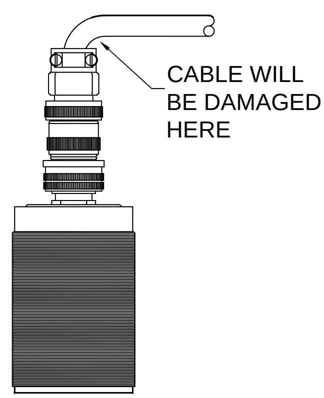
NAS uses a special high flex cable in all sensor cable assemblies.

All cable manufactures have a minimum bend radius specification that is typically about 10 times cable diameter. Our sensor cable has been tested to over 10 million cycles with a 4 inch (100mm) bend radius.



GOOD

A bend radius of less than 4” (100mm) will shorten the service life of high flex cable.



BAD

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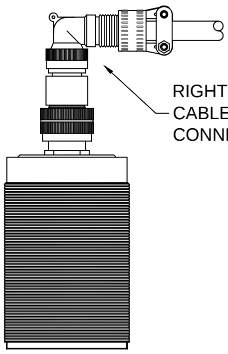
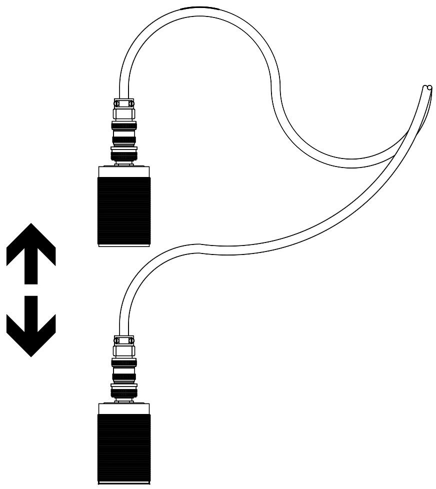


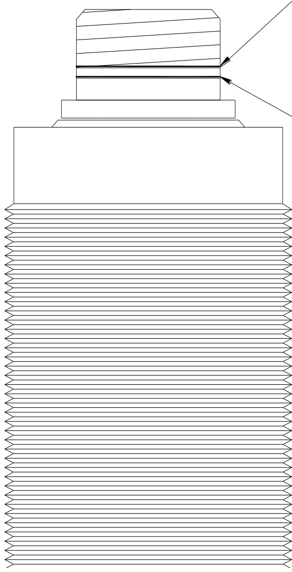
Use a right angle connector if overheard space limitations require a right angle cable exit.



Install with a loop in the cable that prevents side loading on the connector as the sensor moves through a machine cycle.

IMPORTANT:

Sensors with the ratchet style connector have a red and blue line on the connector. The cable mounted mating connector must be threaded all of the way down to the top edge of the blue line. The red line must not be visible. The connector pins will be damaged if the connectors are not completely tightened.



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Chapter 6: Trouble Shooting and Fault Messages

6.1 Operational Troubleshooting:

Operational troubleshooting covers problems with the system's ability to measure thickness accurately, detect a double sheet condition or reoccurring false 2 sheet outputs.

Operational troubleshooting should start with a visual review of the DBA Fault bits and Status bits. A review during job change is an easy preventative measure to ensure proper operation of the DBA system.

Operational problems are typically caused by the sensor not setting on the sheet properly or by incorrect job set-up in the controller. Incorrect job set-up in the controller is typically caused by operators reprogramming the controller to compensate for the sensor not setting on the sheet properly. Therefore, the sensor mount, its adjustment to the sheet and the sensor face to sheet interface is the first area that should be checked when problems occur.

1. Sensor Mounting and Adjustment

Contact type sensors are designed to be in contact with the sheet during the complete thickness measurement cycle. The sensor induces a magnetic or eddy current field in the sheet and then monitors the amount of the field that was stored in the sheet. The sensors ability to transmit energy into the sheet and read stored energy back changes dramatically when there are changes in the sensor face to sheet interface.

a. The sensor must be mounted in a NAS spring mount. The sensor must be compressed 4-6mm in the spring mount when the thickness measurement is being taken. Sensors mounted in the destack mechanism should be inspected for proper spring compression after the sheet has been lifted off the stack. This is the position where thickness measurements are taken and 1 or 2 sheet conditions calculated. See section **5.2.2**.

b. Destack vacuum cups must be located close to the sensor to ensure that the sheet is held tightly against the sensor face with 4-6mm of spring mount compression during the measurement. See page **5.2.1** for sensor mount concept drawing.

c. Sensor mounted bumpers or vacuum cups should not be used unless absolutely necessary. These items change the way the sensor sets on the sheet and every operator and maintenance person will install and adjust these items differently. See section **5.2.2**.

d. Sensors that monitor blank thickness in the centering station are often extended upwards by an air cylinder to take a thickness measurement. This approach often depends on the weight of the sheet to provide spring compression in the sensor mount. The sensor should be mounted as close to the center of the sheet as possible for a flat presentation of the sheet across the sensor face and maximum weight on the springs. We often see sensors mounted out near the edge of the sheet. The cylinder extends the sensor and the sheet lifts up with the sensor because there is not enough weight to cause spring compression. The sheet rests on the inside edge of the sensor face and is cantilevered across the sensor face with a large air gap that changes from cycle to cycle. It is questionable whether this sensor can reliably detect a 2-sheet condition.

e. Sensors are often mounted on tooling next to spring mounted vacuum cups. The spring travel of the cup can be 1-2 inches (25-50mm). The standard sensor spring mount only provides .6" (16mm) maximum spring compression. This makes it difficult to adjust the sensor to follow the spring compression of the cups while still providing sensor spring compression against the sheet when cup spring compression is released. NAS offers extended travel sensor spring mounts with 1.2" (30mm) of spring travel for use in these applications.

f. Thickness measurements taken with the sensor positioned over a hole or partially off the edge of a sheet will always read thinner than reality. The sensor should be moved to a position where the sensor face is totally covered by the sheet.

The system can be re-calibrated to read the correct thickness when the sensor face is not fully covered. However, future measurements on sheets that totally cover the sensor face will now read thicker than reality. Systems that must work on jobs that cover the sensor face and other jobs that do not cover the face should be calibrated with the sensor face fully covered. Next, take thickness measurements on the sheet that does not cover the sensor face and record the measured thickness. This thickness will be thinner than the actual thickness of the sheet. The preset value selected in the DBA should be this thinner value whenever this job is running. Double sheets will be reliably detected and potential problems with continuous calibration and re-calibration will be eliminated. The press line operators should be trained to understand that the measured thickness on these jobs will not match the actual sheet thickness.

2. Sensor Size

Review section **3.3.2** and note that the sensor diameter must be sized based on the maximum single blank thickness that the system will process. The maximum single sheet thickness values shown are for sensors that do not have sensor mounted bumpers or vacuum cups. The maximum thickness rating for a sensor should be reduced by 15% if bumpers or vacuum cups are mounted and adjusted properly.

Many de-stacker interface screens allow the selection of single sheet thicknesses that are beyond the capability of the sensor supplied with the de-stacker. The de-stacker designer may not have understood this sensor size/maximum thickness relationship and the reduction in maximum thickness when bumpers or sensor mounted cups are used. The system will not detect a double sheet condition if the sensor is not sized properly.

3. Job Set-Up

The preset value selected in the DBA should match the thickness of the single blank being processed. The thickness measured by the DBA should match the selected preset thickness and the actual thickness of the sheet being measured. We often find that these values do not match the reality of the job in process.

Most measurement problems are caused by sensor adjustment issues as outlined under item 1 above. However, operators often reprogram the DBA to mask the real problem being caused by improper sensor adjustment.

The DBA considers any thickness measurement that is 20% greater than the selected preset as a 2-sheet condition. The 1.1mm preset will require a thickness measurement of 1.4mm or greater to signal a 2-sheet condition.

4. System Calibration

For ferrous measurements, re-calibration is only required when new sensors or sensor cables are initially installed. Non-ferrous measurements may need re-calibration when different alloys are used. Calibration at other times is probably masking some other problem and can lead to unreliable double sheet detection:

a. Every ferrous calibration must be performed using a sample calibration sheet at the high end of the thickness range processed on that press line or a sheet at the high end of the sensors' capacity. The sheet should be clearly marked with its thickness in millimeters. Consistency is the key to an accurate calibration that does not need future re-calibration.

b. Thickness measurements that appear inaccurate should prompt the following checks before a re-calibration is performed:

   i. Mechanically measure the metal thickness to ensure that sheet thickness has not changed.

   ii. The sensor face must consistently set flat on the sheet with the sensor face fully covered and the sensor spring mount adjusted for 4-6mm of spring compression. Verify that the sensor is properly adjusted before re-calibrating. (see section **5.2.2** for details)

   iii. Sensor mounted vacuum cups and bumpers can change the way the sensor face sets on the sheet. Remove these accessories unless absolutely necessary. (see section **5.2.2** for details) If required, these accessories must consistently be installed and adjusted exactly the same by everyone.

   iv. Do you run jobs where the sensor is positioned over a hole or slightly off of the edge of the sheet? Move the sensor to a position that allows full sensor face coverage on all jobs. If this isn't possible, a measurement should be taken before re-calibration. The measurement will be thinner than reality because the sensor face is not fully covered. You are better off selecting a DBA preset value that corresponds to the thinner actual measurement than re-calibrating to compensate on this one job. Re-calibration to make this job read the proper thickness will require re-calibration again for the next job that fully covers the sensor face.

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6.1.1 Reoccurring Sensor or Sensor Cable Failures

DBA sensors and sensor cables have been tested to over 6 million cycles. Check the following if these items are failing on a regular basis:

a. All sensor cables must be installed with a minimum 4-inch (100mm) bend radius. Cabling that connects to a moving sensor must provide a loop of excess cable that spreads cable movement over the minimum bend radius. See section **5.2.2.4** for details. All cable manufactures have a minimum bend radius specification. NAS uses the best high-flex cable available and we have tested it to over 6 million cycles with a 4-inch bend radius. A smaller bend radius will reduce the cycle life of the cable.

b. Pneumatic cylinders that extend the sensor for a measurement must be installed with flow restrictors adjusted to minimize end-of-stroke impact. Cylinders that are supplied unrestricted air will generate extreme impact when the cylinder reaches the end of its stoke. This impact can destroy the sensor spring mount, snap mounting bolts and damage the sensor or cylinder. NAS cylinder mounted sensors are supplied with flow restrictors that are factory adjusted to eliminate extreme end stroke impact. Do not adjust or remove the flow restrictors on NAS cylinder mounted spring mounts and ensure that pneumatic actuators not supplied by NAS have flow restrictors properly adjusted.

6.1.2 Strange Behavior other than Faults

1. If the DBA powers up and successfully connects to the network but is not showing up in RS Linx on the host PC. Make sure the firewall is not blocking the ports used by the DBA.

6.1.3 Trouble Shooting Wiring Problems

The Ethernet DBA uses now uses standard power and I/O cables, Check the following if you are experiencing issues powering on or communicating with the DBA

2. The DBA uses all four wires in a standard M12 A code connector for power. The unit will not reliably operate with just the Brown and Blue wires connected. Ensure all wires are connected before powering on the DBA.
3. The Status LED's will describe any issues with power or Ethernet see sections **2.8.1** and **2.8.1** for more information.

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Chapter 7: Maintenance

The DBA requires very little maintenance, if any. Should something go wrong with the DBA, parts can be replaced quickly. This section will discuss how to replace the component parts of the DBA.

7.1 Replacing Sensor Cables

1. Disconnect the M12 A code cable from the DBA. Wait 30 seconds for power to dissipate from the system.

2. Disconnect the sensor cable from the DBA and the sensor.

3. Connect the new cable.

4. Turn the power to the DBA on.

5. Take a thickness measurement on a sample sheet of a known thickness. Recalibrate DBA if the measurement is inaccurate.

7.2 Replacing Sensors

1. Disconnect the M12 A code cable from the DBA. Wait 30 seconds for power to dissipate from the system.

2. Disconnect the sensor from its cable.

3. Adjust sensor spring mount for 4mm to 6mm of spring compression when positioned for thickness measurements.

4. Connect the new sensor to the cable.

5. Turn on the power to the DBA.

6. Take a thickness measurement on a sample sheet of a known thickness. Recalibrate DBA if the measurement is inaccurate.

   Note: Non-Ferrous measurements always require calibration when a sensor is changed.

It is important to turn the power to the DBA off, primarily to prevent system damage.

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Chapter 8: Appendix A:

8.1 Ethernet/IP Data Objects

8.1.1 Object Notes

```
T: Target  (Adapter/DBA)
O: Origin  (Scanner/PLC/HMI)

Class 1 connection used to establish the FWD_OPEN request to periodically TX/RX
data as part of the Assembly Object.

RPI: Typical RPI as set forth in the electronic data sheet (EDS) as 10ms.
     Minimum RPI is defined as 1ms.
     Most applications shouldn't need RPI rates faster than 10ms.

Number Representation:
Example: 32-bit number
Byte Index: 00 01 02 03 = MSB .. .. LSB (00=MSB)
Little-Endian = 03 02 01 00 (LSB comes first)
Big-Endian    = 00 01 02 03 (MSB comes first)

32-bit number = 0x784283AB
Little-Endian = AB 83 42 78
Big-Endian    = 78 42 83 AB
```

8.1.2 Identity Object (Class 0x01) Instance Data

```
    INSTANCES
    1: Instance 1 identifies the whole device

    INSTANCE 1 ATTRIBUTES
    - (01) Vendor ID
      - uint16_t (UINT)LITTLE-ENDIAN
    - (02) Device Type
      - uint16_t (UINT) LITTLE-ENDIAN
    - (03) Product Code
      - uint16_t (UINT) in LITTLE-ENDIAN format
    - (04) Revision
      - 2 uint8_t (USINT) bytes, or 1 uint16_t in BIG_ENDIAN format
      - Order is MAJOR: MINOR
    - (05) Status
      - uint16_t (UINT) in LITTLE-ENDIAN format
      - Thickness in units of 0.01mm. Ex: 15 = 0.15mm
    - (06) Serial Number
      - uint32_t (UDINT) in LITTLE-ENDIAN format
    - (07) Product Name
      - string (SHORT_STRING) *
      - Human readable name of the product (MAX 255 8-bit characters)

* SHORT_STRING: In CIP world, this is a string no longer than 255 characters,
                where each character is only 1-byte long, and the number of
                characters are represented by a single "length" byte at the
                beginning of the byte array.
   Example: the string "01234" would be represented by the byte array:
            {05 30 31 32 33 34}

    INSTANCE SERVICES SUPPORTED (Use INSTANCE 1)
```

```
- (01) GET_ATTR_ALL
  - Returns all Instance Attributes in order as an array of bytes, each in
    little-endian format (or as defined above).
- (0E) GET_ATTR_SINGLE
  - Returns the selected attribute
- (05) Reset the system

CLASS (Instance 0) SERVICES SUPPORTED
- (01) GET_ATTR_ALL
  - Returns all Class Attributes in order as an array of bytes, each in
    little-endian format.
- (0E) GET_ATTR_SINGLE
  - Returns the selected attribute
```

8.1.3 Assembly Object (Class 0x04) Instance Data

```
------------------------------------------------------
Instance 100 (T->O Adapter to Scanner)
------------------------------------------------------

IDX: 00 01 02 03 04 05
      \  \  \  \  \  \_ CH2 Thickness (MSB)
       \  \  \  \  \___ CH2 Thickness (LSB)
        \  \  \  \_____ CH2 Status
         \  \  \_______ CH1 Thickness (MSB)
          \  \_________ CH1 Thickness (LSB)
           \___________ CH1 Status

6-byte data array combining multiple parameters into a single "glob" of data.

1. Status: Contains a number of 1-bit indicators defining the status of the
           DBA channel.
   BIT: 07 06 05 04 03 02 01 00
         \  \  \  \  \  \  \  \_ (DONE) New Measurement available
          \  \  \  \  \  \  \___ (FAULT) Fault Detected
           \  \  \  \  \  \_____ (PRESET_LOADED)
            \  \  \  \  \_______ (PART_PRESENT)
             \  \  \  \_________ SheetCount_LSB
              \  \  \___________ SheetCount_MSB
               \  \_____________ Measuring
                \_______________ Channel Installed Flag (1=Installed)




  SheetCount | MSB LSB
  --------------------
           0 |  0   0
           1 |  0   1
           2 |  1   0
          NA |  1   1


2. Thickness: Measured thickness of the material analyzed
   (Little-Endian Format)

------------------------------------------------------
```


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```
Instance 101 (O->T Scanner to Adapter)
------------------------------------------------------

IDX: 00 01
      \  \_ CH2 Flags
       \___ CH1 Flags

1. Flags: Contains 1-bit request indicators
   BIT: 7 6 5 4 3 2 1 0
         \ \ \ \ \ \ \ \_ (0) START BIT
          \ \ \ \ \ \ \__ (1) CLEAR FAULT
           \ \ \ \ \ \___ (2) NOT USED
            \ \ \ \ \____ (3) NOT USED
             \ \ \ \_____ (4) NOT USED
              \ \ \______ (5) NOT USED
               \ \_______ (6) NOT USED
                \________ (7) NOT_USED
```


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8.1.4 DBA Class (Custom Class 0x66) Instance Data

```
INSTANCES
1: Driver Channel 1
2: Driver Channel 2 *
   * if channel installed

CLASS ATTRIBUTES
- (01) Revision
       - uint16_t
       - revision of the object
- (02) Max Instance
       - uint16_t
       - largest instance # of a created object of this class
- (03) Number of Instances
       - uint16_t
       - # of object instances of the class
- (06) Maximum Class Attribute
       - uint16_t
       - Largest Class attribute ID
- (07) Maximum Instance Attributes
       - uint16_t
       - ID of largest Instance attribute

INSTANCE ATTRIBUTES
- (01) Status
  - uint8_t (USINT)
  - 07 06 05 04 03 02 01 00
     \  \  \  \  \  \  \  \_ New Measurement available
      \  \  \  \  \  \  \___ Fault Detected
       \  \  \  \  \  \_____ Preset Loaded
        \  \  \  \  \_______ Sheet Present
         \  \  \  \_________ SheetCount_LSB
          \  \  \___________ SheetCount_MSB
           \  \_____________ Measuring
            \_______________ Channel Installed Flag (1=Installed)
- (02) Status Counter
  - uint16_t (UINT) LITTLE-ENDIAN
  - incremented every time the attribute has been updated
- (03) Material Thickness
  - uint16_t (UINT) in LITTLE ENDIAN format
  - Thickness in units of 0.01mm. Ex: 15 = 0.15mm
- (04) Material Thickness Counter
  - uint16_t (UINT) LITTLE-ENDIAN
  - incremented every time the attribute has been updated
- (05) Measuring Limit
  - uint16_t (UINT) in LITTLE ENDIAN format
  - Thickness in units of 0.01mm. Ex: 15 = 0.15mm
- (06) System Voltage
  - uint8_t (USINT)
  - 1 for 120VAC, 2 for 24VDC
- (07) Driver PN
  - uint16_t (UINT) in LITTLE ENDIAN format
  - Driver Part Number
- (08) Driver FW Version
  - 2 uint8_t (USINT) bytes, or 1 uint16_t in BIG_ENDIAN format
  - Order is MAJOR:MINOR
- (09) Sensor Code
  - 2 uint8_t (USINT) bytes, or 1 uint16_t in BIG_ENDIAN format
```

```
  - Order is HEADCODE:SUB-HEADCODE
- (0A) Sensor Temperature
  - uint16_t (UINT) in LITTLE ENDIAN format
  - temperature is in units of 0.5C, Ex. if temp=51, 51/2=25.5C
- (0B) Calibration Status
  - uint8_t (USINT)
  - 0 = calibration has not been started or has completed successfully
    1 = if in-air measurement is taking place
    2 = if in-air measurement is complete
    3 = if on-metal measurement is being performed
    255 = if any steps have failed
- (0C) Fault Code 1
  - uint8_t (USINT)
- (0D) Fault Code 2
  - uint8_t (USINT)
- (0E) Fault Code 3 (one-wire errors)
  - uint8_t (USINT)
- (0F) Fault Code Counter
  - uint16_t (UINT) LITTLE-ENDIAN
  - incremented every time the faults have been updated

NOTE: Any attempt to access an Instance for a channel that is not installed
      will be rejected (error returned.)

INSTANCE SERVICES SUPPORTED
- (01) GET_ATTR_ALL
  - Returns all Instance Attributes in order as an array of bytes, each in
    little-endian format.
- (0E) GET_ATTR_SINGLE
  - Returns the selected attribute
- (4B) Start Measurement
- (4C) Clear Faults
- (4D) Set Preset Thickness
  - Argument: 2-byte preset thickness in LITTLE-ENDIAN format (16-bit)
- (4E) Refresh Status
  - Will request that the STATUS bits be updated
- (4F) Set Material Type
  - Argument: 1-byte type: 0=FE, 1=NF
- (50) Calibrate In-Air
- (51) Calibrate On-Metal
  - Argument: 2-byte thickness in LITTLE-ENDIAN format
- (52) Refresh Calibration Status
- (53) Refresh Faults
- (54) Enable Fast Mode
  - Argument: 1-byte: 1=enable, 0=disable
- (55) Get Fast Mode Status
  - Returns a single byte: 1==enabled, 0==disabled

CLASS SERVICES SUPPORTED
- (01) GET_ATTR_ALL
  - Returns all Class Attributes in order as an array of bytes, each in
    little-endian format.
- (0E) GET_ATTR_SINGLE
  - Returns the selected attribute
```


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Chapter 9: Appendix B:

9.1 Fault Conditions

CODE(HEX)	Condition	Troubleshooting
0x01	Sensor head code not detected	Check sensor connection
0x02	Sensor head code not valid	Check sensor connection
0x06	Bad sensor connection	Check sensor connection
0x07	Preset is set too large for this sensor	Lower the preset value
0x0A	Sensor over temperature	Try sampling at a slower rate
0x11	Bad sensor connection	Check sensor connection
0x14	Ferrous only sensor. Cannot measure in non-ferrous mode	Change channel mode to ferrous or use non-ferrous capable sensor
0x1D	Non-ferrous sensor uncalibrated	Calibrate the sensor
0x20	Sensor not compatible with system	Sensor not compatible with this version of DBA. Must be changed out with compatible version.
All others	Internal error	Possible Remedies: a. Clear Faults (explicit command) and retry b. Restart system and retry c. Contact NAS if fault continues

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