Procedure - Metrix Digital Proximity System (Includes Probes and Cables)

Troubleshooting Guide

1.0 PURPOSE

The purpose of this procedure is to outline the necessary steps to prove that a Metrix Digital Proximity System is working properly, from the probe through the extension cable to the output of the proximity driver or proximity transmitter.

2.0 SCOPE

This troubleshooting procedure applies to the Metrix proximity probes and extension cables, as well as the MX2033 Driver and MX2034 Transmitter.

3.0 REFERENCES

a. Metrix Digital Proximity System (DPS) Datasheet – Document Number 1087015
b. Metrix 1.35 Software Installation Manual - Document Number 100961
c. Metrix Digital Proximity System Installation Manual – Document Number 100545
d. Digital Proximity System Software – Download the most recent version from the Metrix Website.

4.0 SAFETY TERMS AND SYMBOLS

Terms that appear in this manual requiring special attention include:

- **WARNING:** Warning statements identify conditions or practices that could result in injury or loss of life.
- **CAUTION:** Caution statements identify conditions or practices that could result in damage to the product, loss or corruption of data, or damage to the environment or other property.
- **NOTE:** Notes identify material of special interest or importance to the user, not including cautions or warnings.

Symbols that may appear on the product and/or in this manual include:

HIGH VOLTAGE PRESENT

DANGER or CAUTION

PROTECTIVE EARTH

FUNCTIONAL GROUND

NOTE

5.0 GENERAL SAFETY SUMMARY

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

- **USE ONLY AS SPECIFIED**
  To avoid potential hazards, use this product only as specified. Only qualified personnel should perform installation and uninstallation procedures.

- **OBSERVE ALL TERMINAL RATINGS**
  To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the individual sections of this manual for further ratings information before making connections to the product.

- **AVOID EXPOSURE TO CIRCUITRY**
  Do not touch exposed electrical connections and components when power is present.

- **DO NOT OPERATE WITH SUSPECT FAILURES**
  If you suspect there is damage to this product, have it inspected by qualified personnel.

6.0 PROCEDURE

1. **Basic Troubleshooting Steps**

   a. Document what the problem is.

   b. Ensure the plant has bypassed the shutdown associated with the channel you are going to check.

   c. Check that the system is properly connected from the probe through the extension cable to the MX2033 Driver or MX2034 Transmitter. Ensure that the connector protector is on the probe to extension cable connector. Ensure to check that the probe, extension cable, and transmitter/driver are compatible for system length, probe type and material type.

   This procedure assumes that the proximity system is not working and you have already checked all the connections and the power to the DPS as well as compatibility between probe, cable, DPS and material type.

   d. Check the proximity probe for proper resistance. Disconnect the proximity probe from the extension cable, or proximity driver or transmitter. Measure the resistance of the proximity probe from the center pin to the casing of the connector. The resistance should read 8 to 12 ohms. If the resistance is less, that indicates a short, and if it's more than that, that indicates an open. In either case, the probe needs to be replaced.

   e. Check the extension cable for continuity. Check the resistance from one cable connector at one end to the other cable connector at the other, and they should be shorted (< 0.5 ohms in resistance). Check the center cable for continuity. Measure the resistance from the center pin at one end to the center pin at the other end. The center pin should be shorted (< 0.5 ohms in resistance). If the resistance is higher, either from the connector or from the pin continuity test, there may be an open circuit and the cable should be replaced.

   f. Check for grounds of both the probe and the extension cable by measuring the resistance of the connec-

tor casing to ground. The reading should measure infinite resistance or an open circuit. Also, check for grounds with the center pin of both the probe and the extension cable compared to ground. The reading should measure infinite resistance or an open circuit. If there is not an open circuit, then a ground exists, either with the probe or the extension cable. In either case, the component should be replaced.

g. Assuming the proximity probe checks out as above: connect the extension cable to the proximity probe. Ensure you place the rubber connector protectors over the probe to extension cable connection in order to prevent ground loops. At the extension cable end, measure the resistance from the center pin to the casing. The resistance should read 8 to 12 ohms. If the resistance is less, that indicates a short, and if it's more than that, that indicates an open. In either case, the extension cable needs to be replaced.

h. If Step g above is okay, then measure the resistance from the extension probe connector casing to ground. It should measure infinite resistance or an open circuit. Measure the resistance from the center pin of the extension cable to ground. It should measure infinite resistance or an open circuit. If either of these checks show resistance, then there is a ground loop and the extenson cable needs to be replaced.

i. If Steps a-h prove to be satisfactory, then the probe and cable system are okay. Connect the proximity probe and extension cable to the MX2033 Driver or MX2034 Transmitter.

j. Check that there is power to the Digital Proximity System (nominal 24 Vdc). If there is not adequate power, fix this problem. Check to ensure the MX2033 and MX2034 has adequate voltage (MX2033 Driver pwr to com voltage should be between -20 to -28 Vdc, MX2034 Transmitter loop power should be between +20 to +28 Vdc). Note: MX2034 Transmitter loop power can also be negative, -20 to -28 Vdc.

CAUTION: Do not apply a voltage to the BNC of the MX2034 with a portable data collector, this could lead to malfunction. By default, portable data collectors supply a bias voltage to the connected sensor (or device); this option needs to be turned off when connecting to the BNC of the MX2034, or damage to the MX2034 may result.

k. If possible, deenergize the MX2033 or MX2034, remove it from service, and then connect it to a like probe system and check the linearity using a static calibrator with the proper target material. If using an MX2034 Transmitter, also check the linearity of the 4-20 mA output.

l. If using an MX2034: If a position MX2034, the linearity and 4-20 mA should match. If a vibration MX2034, check linearity and that the "no vibration" 4-20 mA output, it should be 4 mA (+/- 5%). If a speed MX2034, check linearity and that the "no speed" 4-20 mA output, it should be 4 mA (+/- 5%). At no time should you see spiking in the 4-20 mA output, or if the output is stuck, you may have a defective unit. If you observe spiking with an MX2033 or MX2034 unit, please refer to the troubleshooting spiking Section 8.0 toward the end of this guide.

Note: The accuracy values noted in this procedure, are using API 670 for a 5 meter system length and a 4140 target material using MX8030 or MX2030 probes. For specific accuracies of various Metrix proximity probes and cables, please go to the DPS datasheet (doc# 108715) page 5. Be sure to read the notes on page 2 and page 5 of the datasheet.

If you see spiking behavior, either on the MX2033 or MX2034, please check the following:

- Ground Loops: Is the probe and cable properly connected to the Transmitter/Driver? Spiking behavior may be from a ground loop, the normal problem is the connector protectors for the probe to cable con-

nection are not covering the connection and the connector is contacting the metal junction box creating a ground loop. Also, the connector protectors need to be free of moisture or oil, the dirty water or oil can conduct electricity and cause a ground loop.

- Loose Connections: Are there any loose or questionable connections from the Transmitter to the Control System. Make sure the wires are tight and connections are clean.
- Portable Data Collectors: Has a Portable Data Collector been connected to the BNC? This is normally not a problem as long as the bias voltage for the Collector is turned off, if the bias voltage is applied at the BNC it could damage the MX2034 transmitter, resulting in intermittent behavior.
- Power Supplies: Is spiking isolated to one Transmitter, or do you see spiking on several transmitters on the machine? If several transmitters are effected concurrently, examine the power supply voltage for spiking issues.
- Operational Issues: Operational issues may have patterns associated with them. For example, spikes occur every day at 4 pm. Is there a possibility of a valve line up issue, or other operational issue, that causes actual vibration spikes (e.g. check valve slamming, check valve chatter, adjacent work, etc.)?
- Swap Units: Is the spiking behavior above 1 mil pp (25 µm pp)? If it is less, than it may be noise in the measurement loop. If possible, place the channel in bypass and replace the spiking unit with a known good unit. If the spiking behavior follows the unit, the unit should be replaced.

2. Installation Steps

a. Prior to installation of the Metrix DPS, put the probe, cable and MX2033 Driver or MX2034 Transmitter together and test the system for linearity using the DPS Software and a static calibrator. See Procedure Step 3 “MX2033 and MX2034 Tuning and Verification Steps” below.

b. After a satisfactory linearity check, if possible, test the system with a static calibrator, shaker, or with a speed wheel to ensure one obtains the proper output from the MX2033 Driver and MX2034 Transmitter. Check the 4-20 mA output of the MX2034 Transmitter and ensure the output is correct.

c. Install the probe, cable and DPS per the design. Gap the probes to the specification, usually 45 to 55 mils (1125 to 1375 µm). This will result in a gap voltage of approximately -8 to -10 Vdc.

d. For certain speed systems, ensure the o-rings are installed on each side of the feed throughs to ensure no foreign particles get into the connection.

e. Ensure all connections are tight, and the rubber connector protectors are installed over the probe to cable connector. Failure to install the rubber connector protectors properly could result in a ground loop and poor system performance.

f. Power the DPS with -24 Vdc (for Transmitter it could be +24Vdc). If the power to the DPS is not between -22 Vdc and -26 Vdc something is wrong with the input power, and it should be corrected. If the power to the DPS is correct, move to step g.

g. Record the gap voltage. For Vibration and Speed, the gap should be between -8 to -10 Vdc. For Position, it depends upon the Thrust Position, but should be within the measurement range of 10 to 90 mils (250-2,250 µm), -1 to -17 Vdc. If the gap voltage is not within specification, and is no longer in specification, go to the Proximity Trouble Shooting Guide in this Procedure.

3. MX2033 and MX2034 Tuning and Verification Steps

The Metrix 1.35 DPS Software allows System Tuning, Verification and Custom Calibration if necessary. After a

verification is complete a Report specific to the DPS unit can be generated.

a. Tuning Steps

Download the DPS Software for free from the Metrix Vibration website. From the home page, select the “Tuning” tab. Follow the steps as instructed.

i. The “Offset” is the first step and it is done with the Proximity Probe in open air, this sets the top end of the Proximity System characteristic configured for the probe type, system length, and target material. In a static calibrator, the open air measurement can be considered with a 0.5 inch (12.5 mm) gap.

ii. The second step is done with the Proximity Probe gapped at 10 mils (250 µm). Select “1 Volt”. This sets the bottom of the Proximity Probe range and ensures the System is oscillating properly. This “1 Volt” feature is also very useful in thrust applications to ensure the physical gap actually matches the electrical gap.

With the Tuning Steps complete, go to the Verification steps.

b. Verification

This step is completed using a Proximity Probe static calibrator (dial micrometer) and incrementally changing the gap and recording the corresponding voltages. The DPS Software is set up to take voltages every 10 mils (250 µm) or 20 mils (500 µm), depending on the scale factor of the DPS unit. When the proper gap is set between the probe and appropriate target material, use the “Get” button for the DPS to gather the voltage information. Please note that this process takes between 5 and 10 seconds, and cannot be filled in manually. It must be the voltage measured by the Metrix Digital Proximity System. As the gaps are changed and voltages recorded the system draws the line between points, calculates the Incremental Scale Factor (IFS – slope between points), the Average Scale Factor (ASF) and the Deviation from Straight Line (DSL = +/– 1 mil or 25 µm). Acceptable IFS for a 200 mV/mil Proximity Probe is from 190 to 210 mV/mil or 7.48 to 8.26 mV/µm (200mV/mil + 5% or 7.87mV/µm + 5%, per API 670).

c. Probes buried in a machine (inaccessible for Verification)

If the systems you are verifying have probes buried within a machine, use an identical probe connected to the extension cable to check out the proximity probe system. Using the appropriate shaft target material in the static calibrator, with the identical probe to complete the system, should provide accurate results.

d. Custom Calibration

If the Verification is satisfactory, then one can generate a report. If the Verification is unsatisfactory, then the user can select “Perform a Custom Calibration – Yes”. This will use the voltages measured in the Verification Step to create a Custom Calibration for the DPS unit connected. To ensure the Custom Calibration was

effective perform the Verification step again. If the Verification after the Custom Calibration is not satisfactory, you may have a defective unit, do not do another Custom Calibration. It could also be a problem with the system set up, please verify the configuration in the DPS software, noting probe type, material type and system length. The system configuration should be the same as what's connected to the DPS. Please note that last point (100 mils or 2500 µm) is not required, Metrix put this in because we normally can meet this distance. The requirement is 80 mils (2250 µm) of linearity.

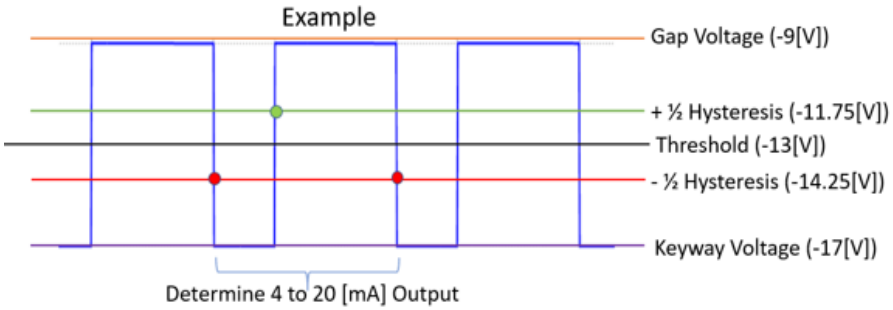
e. If you're working with the MX2034 Transmitter, you must also check linearity of the voltage range and the linearity of the milliamp output. This is done by inserting an amp meter in the current loop, and monitoring the milliamp output with changes in scale range parameters. Depending on the scale range chosen, it is useful to check the 4-20 mA output. The 4-20 mA output of an MX2034 (Vibration Transmitter) can only be fully tested using a shaker table. However, there are a couple of other simple checks that can be done: 1) with the probe in the static calibrator (no vibration condition) and gapped at -9 Vdc (for example), the DPS should read 4 mA +/- 5%. You can also use a handheld shaker to see vibration, however, this device may not be calibrated, but it will show movement in the 4-20 mA output, up and down as you increase or decrease the vibration. The 4-20 mA of an MX2034 speed sensor can only be verified using a rotor kit, or other rotating mechanical device. However, you can check the "no speed" condition at 4 mA +/- 5%, by placing the probe in the static calibrator and gapping the static calibrator to -9 Vdc (for example). Be sure to check the output at 0, half scale and full scale to ensure the 4-20 lines up with 4, 12 and 20 mA +/-5% respectively. For displacement or thrust, one can use the static callibrator to look at the 4, 12 and 20 mA ranges to ensure they are within +/- 5% of the micrometer reading.

f. Generate Verification Reports

After the System Verification is complete a Report can be generated by selecting "Generate Report". The system will prompt the user to input appropriate information for the test. None of the fields are required, but are usually necessary for proper documentation. The data from the DPS Configuration is automatically uploaded into the report. After the report fields are filled in, or not, the user selects "OK" and then the user is prompted to input a file name and file location. The file generated is a Microsoft Excel file. The data in the Excel file is protected. Only the header and the footer can be changed. If you wish to add other calculations or verifications, copy the verifications into a common Excel workbook. Other verifications can be added, using the Excel copy and paste feature, to create a complete report.

4. Speed Pulse Adjustments - Applies to an MX2034 Speed Transmitter

Whether you are using an MX2033 Driver or MX2034 Transmitter for a speed measurement, a healthy voltage pulse (> 5 Vdc) is usually necessary. Ensure a proper voltage pulse is happening, > 5 Vdc change from gap to pulse. See Section 4.d for setting Manual Threshold and Hysteresis parameters, and possibly Section 4.e for Speed Pulse Adjustment.



This procedure is used when installing, operating or troubleshooting a Metrix Digital Proximity System (DPS). Whether the system is a 5-meter, 7-meter or 9-meter system the same steps are followed. From the factory Metrix has done several things to help ensure the Proximity System is easy to install and provides excellent data:

a. To prevent Cross Talk between probes, or systems with feedthroughs, or systems with long cables, Metrix can alter the Oscillator Demodulator Frequency of one of the probes so the systems don't electrically talk to each other. From the factory, the DPS units, whether MX2033 Driver's or MX2034 Transmitter's, are shipped with the X frequency chosen. Most MX2030 and MX8030 probe types have two possible frequencies (X and Y) selectable from the advanced features of the DPS software. If a different frequency is chosen in the field, one will need to tune the system and possibly perform a custom calibration using the DPS software.

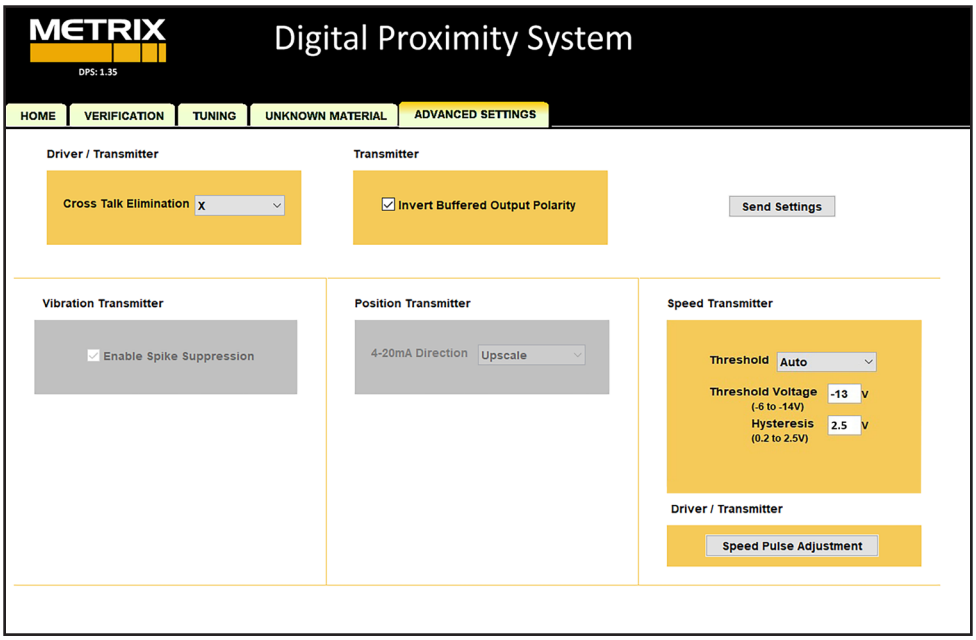
b. The ability to change the frequency of the Oscillator Demodulator is enabled in the DPS Software. This allows one to purchase a new DPS Unit and adjust the frequency to Y as required. For longer systems, usually speed systems, other frequencies are available. For the 10-meter, 12-meter or 18-meter system lengths, one can select the W, X, Y or Z frequencies associated with speed systems.

c. The Auto Speed setting hysteresis is set to 2.5 volts to prevent low level noise from being counted as speed. As the speed pulse is increased to greater than 190,000 pulses per minute the Auto Speed setting hysteresis decreases to 1 volt. The Auto Threshold is set at half the peak to peak value of the voltage sensed. At zero speed, or even at high speed, if there is low level noise it is possible for the counter to detect the changes in voltage, due to the noise, and give erroneous speed readings even when the unit is not rotating. To prevent this, the Auto Threshold has to see a pulse greater than 2.5 volts to be counted, or, at very high pulse counts, 1 volt to be counted, to minimize the effect of noise on the speed readings. The diagram above shows the voltage of a keyway and how the Threshold and Hysteresis values work.

   Note: half the peak to peak voltage is -13 Vdc ((-9 Vdc + -17 Vdc) / 2 = -13 Vdc).

d. The Hysteresis feature is used to improve the performance of the speed measuring system. Threshold is used with a 'Speed' selected MX2034 transmitter, using the voltage passing through half (½) the peak to peak amplitude with a dead band of 2.5 volts. In the example above, the user can set the Manual Threshold setting to a Threshold Value (usually -13 Vdc) and a hysteresis band of up to 2.5 Vdc for a negative going pulse. One must ensure the negative going pulse will produce a more negative voltage than the Hysteresis dead band. Hysteresis creates a dead band around the Threshold Value. For example, if the Threshold was set at -13Vdc, and the Hysteresis was set at 2.5 Vdc, the negative going pulse would have to pass -14.25Vdc (-14.25Vdc = -13Vdc-1.25Vdc) to have the counter within the transmitter see the pulse, and then the counter would not reset until it saw the voltage pass through -11.75Vdc (11.75Vdc = -13Vdc+1.25Vdc) on its way back to the original gap voltage. Using Threshold and Hysteresis are ways to help reduce noise and increase accuracy in a speed measurement system. The same or similar adjustment can be made in a Monitoring System.

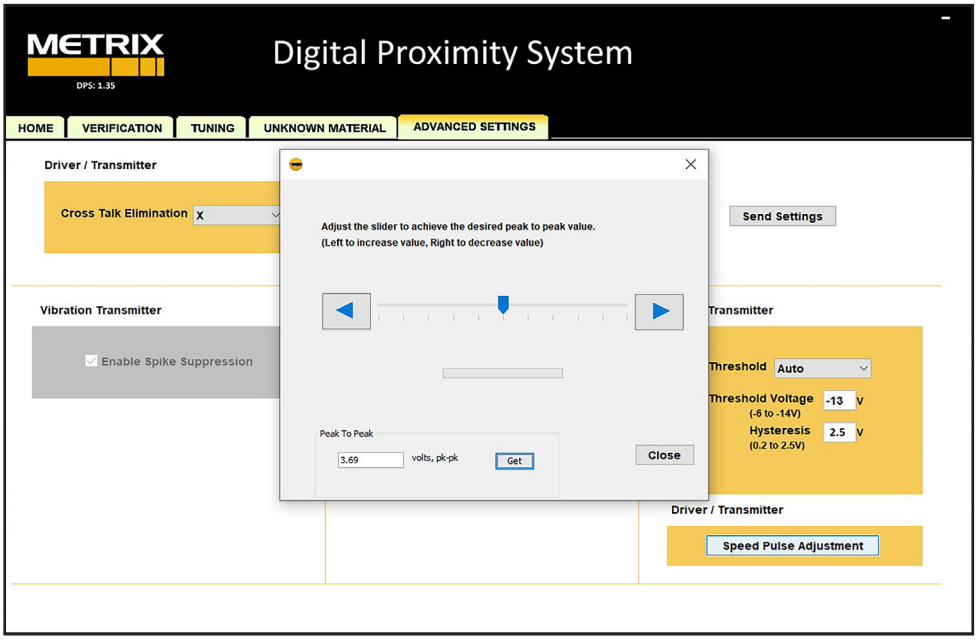
e. If the pulse height from the MX2033 Driver is not large enough for the Monitoring System to provide a reliable speed indication, or the MX2034 Transmitter is not providing a large enough pulse to have a reliable 4-20 mA speed output, then take advantage of the "Speed Pulse Adjustment" in the DPS Software "Advanced Features" tab:



Caution: This process is done with the machine running. Take necessary precautions to ensure safe work and prevent an unnecessary shutdown.

Export the current configuration of the DPS Unit to the computer. This is done in order to restore the configuration to the DPS Unit if necessary.

Go to the “Advanced Settings” tab. Select the button “Speed Pulse Adjustment”, you will see the following screen:



In order to change the pulse height, one must use the Speed Pulse Adjustment tool in the DPS software. With the machine running, select “Get” to get the current pulse height. Move the slide bar one division in the left direction, select “Get”, and observe the impact on speed pulse height. If the move is favorable, continue to move the slider bar, and select “Get”, in the same direction until the pulse height is greater than 5 V pp. If the move is unfavorable, move in the opposite direction until the pulse height is greater than 5 V pp. This control changes the scale factor of the DPS Unit to optimize the speed pulse, to provide an adequate pulse for a reliable speed reading. It is used only as necessary.

7.0 MEASURES AND MANAGEMENT

The Metrix Digital Proximity System should meet the accuracy requirements as stated on the DPS Datasheet page 5. When using MX8030 and MX2030, probes and cables, the system meets the requirements of API 670. For Speed Measurement systems, they should be accurate to +/-1% of actual rotor speed, and should agree within +/-1% from other speed sensors in the system. This troubleshooting guide should help you achieve the specifications found in the DPS Datasheet.

Note: Metrix is continuously improving our products. Please refer to our website to download the latest version of this document.