



Procedure - Metrix Speed Measurement System - Cryogenic Applications

Installation Manual

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1.0 PURPOSE

The purpose of this procedure is to describe how the Metrix Speed Measurement System works with, how it is set up and how it is tested with a Turbo Cryogenic Expander.

2.0 SCOPE

This procedure applies to the Metrix Digital Proximity System MX2033 Driver and more particularly the MX2034 Transmitter.

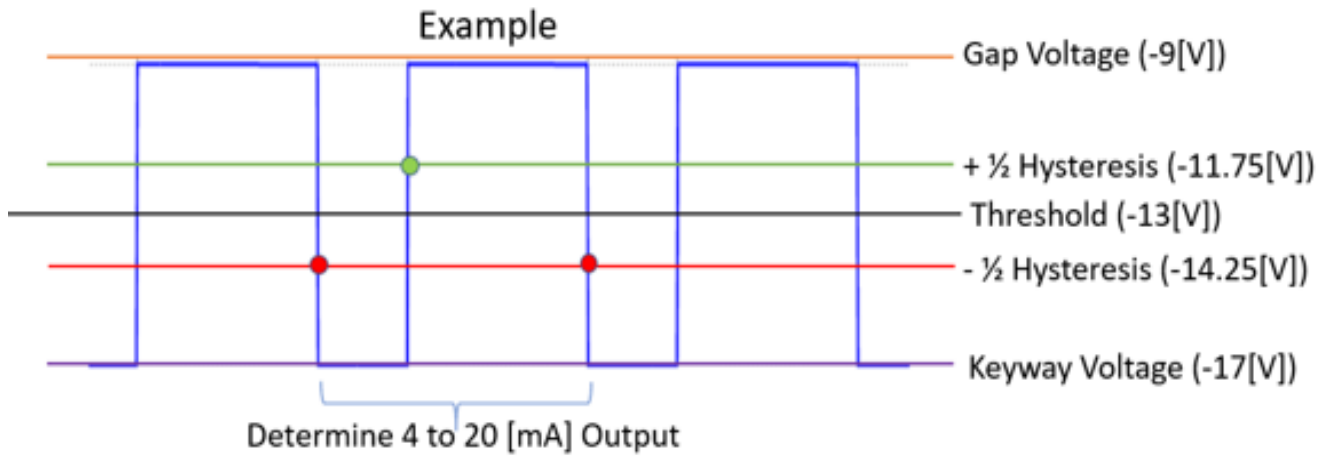
3.0 REFERENCES

- a) Metrix Digital Proximity System (DPS) Datasheet – Document Number 1087015
- b) Metrix Digital Proximity System Manual – Document Number 1005435
- c) Digital Proximity System Software – Download the most recent version from the Metrix Website.

4.0 GENERAL

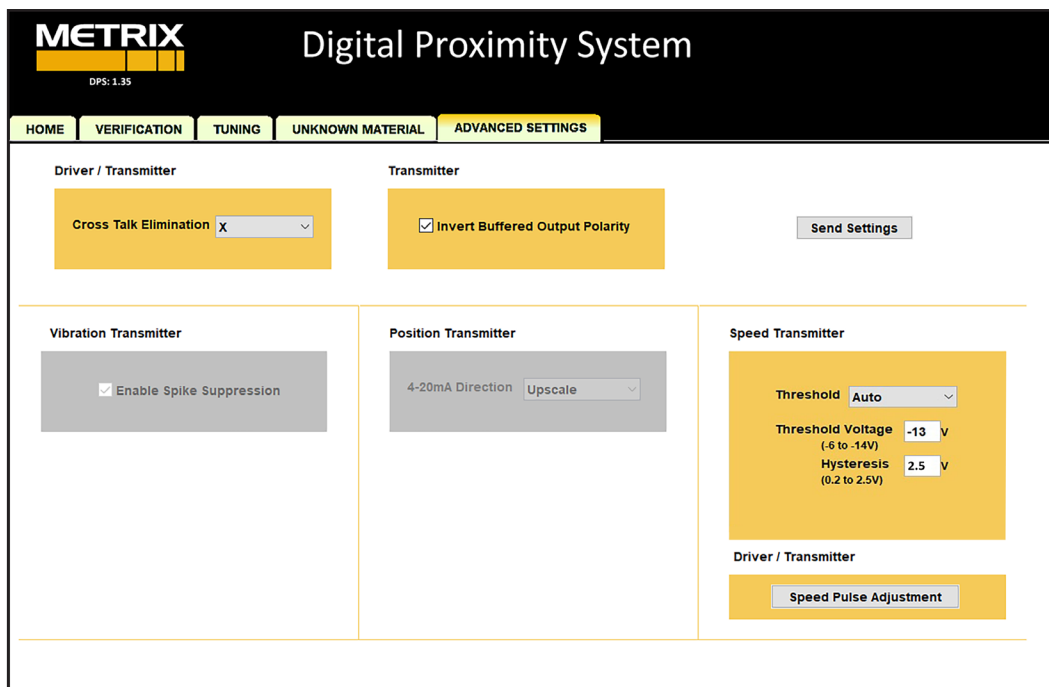
This procedure is used when installing, operating or troubleshooting a Metrix Speed Measurement System meant for Cryogenic Applications. Whether the system is a 10-meter, 12-meter or 18-meter system the same steps are followed. From the factory Metrix has done several things to help ensure the speed system is easy to install and provides excellent data:

1. To prevent Cross Talk between the probes and long cables Metrix sets each of the Oscillator Demodulator Frequencies to different Frequencies 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 marked W, X, Y and Z depending upon the number of probe cables in the set. If the parts are purchased separately, then each System will need to be configured for different Frequencies and tuned in the field.
2. 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 as required in the field for W, X, Y or Z frequencies for the 10-meter, 12-meter or 18-meter system lengths.
3. Increased the Auto Speed setting hysteresis 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, and due to the noise 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.
4. The diagram below shows the voltage of a keyway and how the Threshold and Hysteresis values work.
Note: half the peak to peak voltage is -13 Vdc ($(-9 \text{ Vdc} + -17 \text{ Vdc}) / 2 = -13 \text{ Vdc}$).



The Hysteresis feature is used to improve the performance of the speed measuring system. Threshold is used with a 'Speed' selected transmitter, this feature allows one to use an Auto Threshold setting (Auto is set at the Factory), which will trigger the DPS when the voltage passes through half (½) the peak to peak amplitude with a dead band of 2.5 volts, or Manual Threshold setting where the user can select the 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.

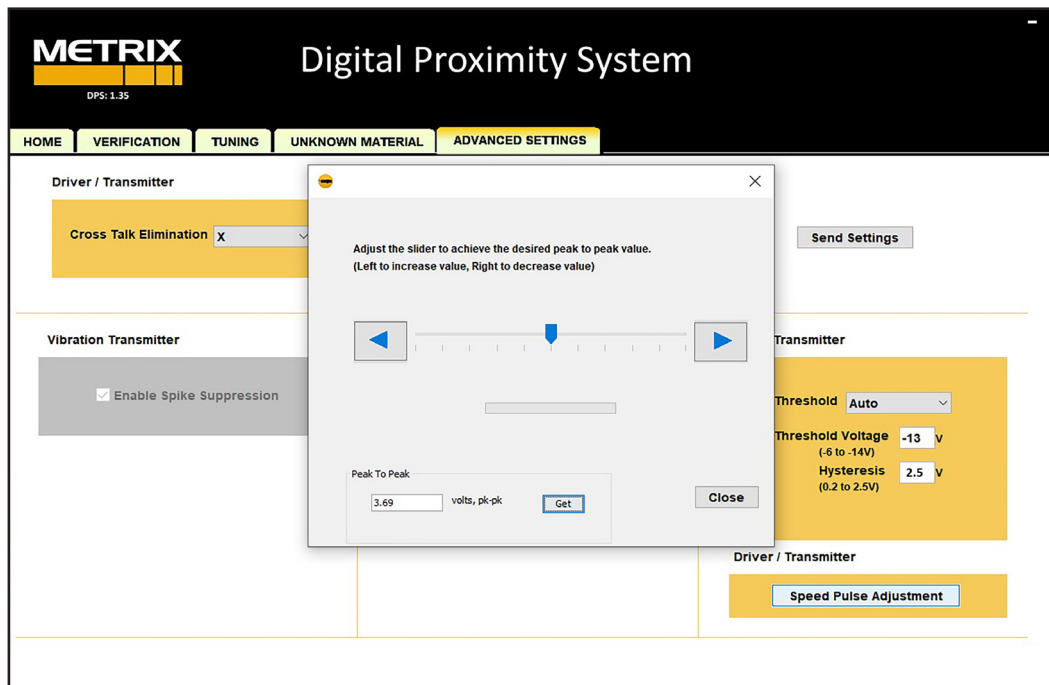
- If the pulse height from the MX2033 Driver is not large enough for the Monitoring System to provide a reliable speed indication, or the MX2034 Transmitter is not providing a large enough pulse to have a reliable 4-20 mA speed output, then take advantage of the “Speed Pulse Adjustment” in the DPS Software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

5.0 PROCEDURE

1. Installation

- a) Prior to installation of the Metrix Speed Measurement System 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 2 “MX2033 and MX2034 Tuning and Verification Steps” below.
- b) After a satisfactory linearity check, if possible, test the system with a speed wheel to ensure one obtains the proper speed pulses 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 50 to 60 mils (1250 to 1500 μm). This will result in a gap voltage of -8 to -11 Vdc.
- d) 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, -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.

2. 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

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 from the DPS Software Home page (the DPS Software can be downloaded for free from the Metrix Vibration website). Follow the steps as instructed.

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). 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. 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, do not do another Custom Calibration. It is recommended to change parameters like System Length, or Material Type as appropriate. It could also be a problem with the system set up, please refer to helpful hints at the back of this manual. 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) 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. Upon opening the Excel file the header and footer can be changed, and the file can be supplemented with other verifications. Other verifications can be added, using the Excel copy and paste feature, to create a complete report.

f) Verify Proper Speed Pulse Height

Ensure a proper voltage pulse is happening, > 5 Vdc change from gap to pulse. See Section 4.4 for setting Manual Threshold and Hysteresis parameters, and possibly Section 4.5 for Speed Pulse Adjustment.

6.0 EXCEPTIONS

None

7.0 PROXIMITY TROUBLESHOOTING GUIDE

Assumptions: The below guide assumes a 200 mV/mil scale factor. Adjust values as necessary for a 100 mV/mil scale factor.

1. For transducers that are onsite, before doing any troubleshooting have the channel placed in bypass so no spurious alarms will take place.
2. What is the voltage to the DPS MX2033 Driver or MX2034 Transmitter?
3. Is the power to the DPS -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 4.
4. What is the current 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, -1 to -17 Vdc). If the gap voltage is not within specification, or it is no longer in specification, move to step 5.
5. If the gap voltage is not in the expected range, disconnect the extension cable from the Driver or Transmitter.
6. With the extension cable connected to the probe, check the resistance of the probe / cable system at the cable end that would be connected to the Driver or Transmitter (should be from 7 to 11 ohms measured from center pin to connector casing). If this is true, then the Probe and Cable are probably okay, go to step 14. If not, go to step 7.
7. Check the extension cable connector to ground, the resistance should be infinite (very large, >3 Megaohms). If they are the same, 0 to little resistance, the signal is grounded and the system will not work.

The below steps cannot be accomplished with the probes and the cables in the Cryogenic fluid. If the probes and cables are in the Cryogenic Fluid, skip to step 15 below.

8. Leave the extension cable removed from the Driver or Transmitter. Remove the probe to cable junction box cover and check to see if the rubber connector protectors are installed. Install the rubber connector protectors if necessary. It is okay to have the cryogenic fluid in and around the connectors, the fluid is nonconductive.
9. Disconnect the probe from the extension cable. If fluid is present, remove it using plant air using proper safety precautions, blow out the connectors so they are free of fluid.
10. Check the resistance of the probe in ohms (should be from 7 to 10 ohms). If the resistance is within these limits, it is unlikely the probe(s) is faulty. If the resistance is outside these limits the probe could be faulty.
11. Check continuity of the extension cable, both center conductor at each end of the cable, and from connector casing to connector casing at each end. Check to ensure there is an open circuit between the center conductor and the connector casing at both ends of the extension cable. Is the extension cable working within these limits? If no, replace cable, if yes, go to step 11.

12. Connect the probe to the extension cable and install the rubber connector protectors.
13. With the extension cable connected to the probe, check the resistance of the probe / cable system at the cable end that would be connected to the Driver or Transmitter (should be from 7 to 11 ohms).
14. Connect the extension cable to the Driver or Transmitter. Go to Step 6 and check the gap voltage.
15. Connect a good known MX8030 probe and MX8031 cable, matched to the Driver or Transmitter (10, 12 or 18-meter system) and the Target Material. Gap the probe in a static calibrator at 50 mils (1250 um), measure the gap voltage. If gap voltage is good (approximately 8 to 10 volts), check the response of the Driver or Transmitter using the DPS Software and a Static Calibrator. Confirm linearity. If the system is non-linear, and the target material is 4140, perform the Tuning and Verification Steps. If necessary, perform a Custom Calibration. If the shaft material is not 4140, a Shaft Calibration check will be necessary. For the DPS units for the Cryogenic Application, do not "Restore to Factory" using the DPS Software without Technical Support from Metrix. You could possibly end up with a Cross Talk problem.
16. For the MX2034 Transmitter ensure the 4-20 mA output tracks with the raw voltage output, be sure to adjust the raw voltage output when looking at vibration from RMS to Peak to Peak.
17. If the system fails at any point in the above checklist, that component or components should be replaced. If the above is all working, one must turn to the Monitoring system to identify the fault.
18. In the Transducer case, ensure a proper voltage pulse is happening, > -6 Vdc change from gap to pulse. See Section 4.4 for setting Manual Threshold and Hysteresis parameters, and possibly Section 4.5 for Speed Pulse Adjustment.

8.0 MEASURES AND MANAGEMENT

The Metrix Speed Measurement system should be accurate to +/-1% of actual rotor speed, and should agree within +/-1% from other speed sensors in the system.