MICHIGAN SCIENTIFIC
corporation

5/18/2021

Type 1, 2, and 3 PTO Telemetry Torque Transducer

THIS IS A TWO CHANNEL TELEMETRY & ENCODER SYSTEM DESIGNED TO SENSE TORQUE AND SPEED OF THE PTO

Operating Manual & Calibration Documentation

Type 1, 2, and 3 PTO Telemetry Torque Transducer
Transducer Model: MSC-PTO
Telemetry System Model: M540

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SBB 05/19/21

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Introduction

The PTO Telemetry Torque Transducer was designed to fit between male and female PTO splines. The transducer was strain gaged and calibrated to measure torque. The strain gage signals are transmitted through telemetry. There is also a 60 pulse/rev tone wheel installed on the rotating transducer. A stationary Hall Effect sensor detects the tone wheel and provides the speed signal.

A telemetry transmitter provides excitation to the strain gages and amplifies, digitizes, and transmits the torque signal via RF. A telemetry and induction housing is attached to the transducer and contains the telemetry transmitter, induction regulator, and secondary induction coil.

A non-rotating aluminum stator is held in place and aligned to the rotating transducer by a large sealed bearing. The stator contains the primary induction coil, receiving telemetry antennas, and Hall Effect sensor.

The PTO Telemetry Torque Transducer can be purchased with either the Type 1 (6 tooth 1⅜"), Type 2 (21 tooth 1⅜"), or Type 3 (20 tooth 1¾") agricultural splines. Both the male and female spline ends can be simply removed and replaced with different spline sizes. Other spline ends can be purchased from Michigan Scientific that can bolt directly to this PTO Telemetry Torque Transducer.

System Components

This section of the manual provides photographs and descriptions of the major components of the PTO Telemetry Torque Transducer system.

PTO Telemetry Torque Transducer

DESCRIPTION

The PTO Telemetry Torque Transducer is a strain gage based transducer that is gaged and wired to measure torque and speed. Integral to the transducer (Figure 1) is a secondary inductive coil that supplies power to the electronics mounted to the transducer. The electronics condition the inductive power and provide a regulated voltage to the transmitter that contains the strain-gauge-bridge driver. The transmitter provides bridge excitation and amplification. Gain and shunt calibration resistors are fixed. The data is anti-alias filtered, digitized, and transmitted via telemetry.

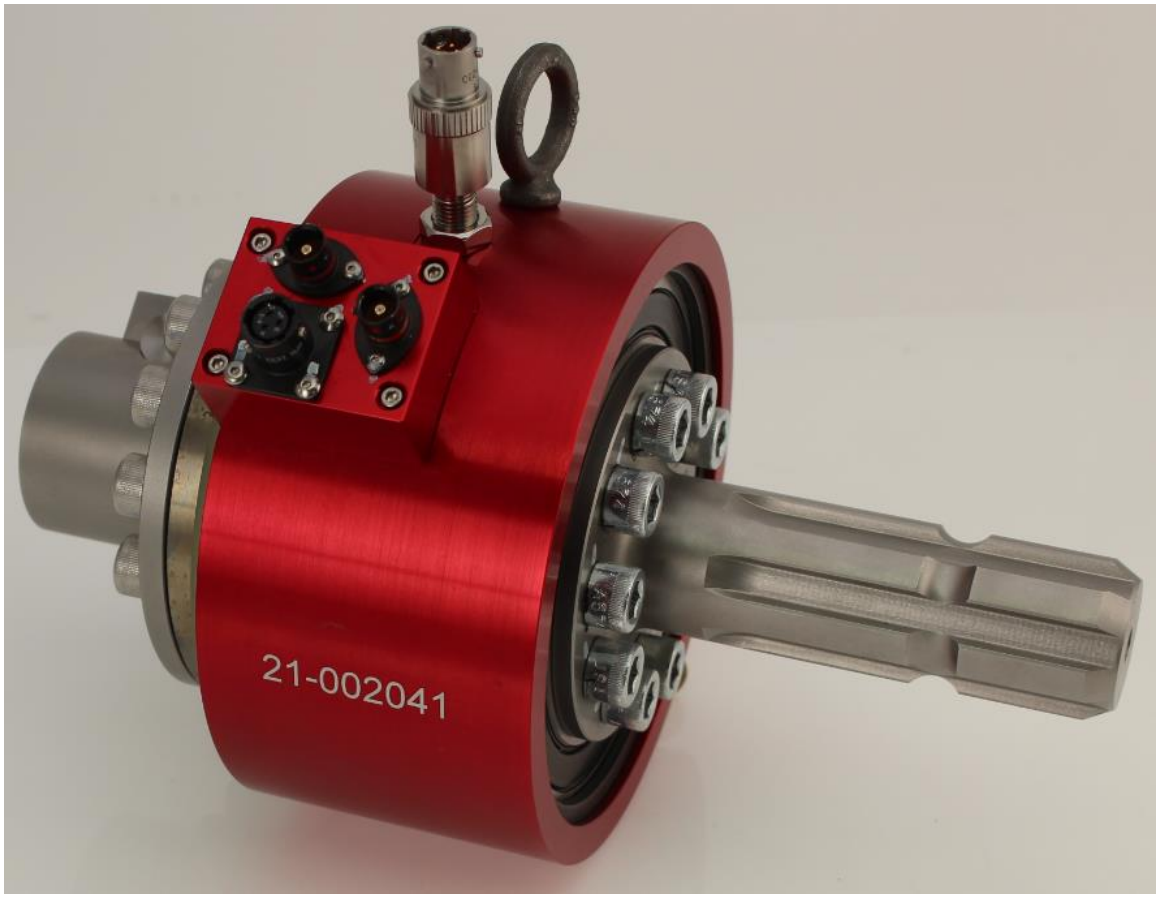


Figure 1: PTO Telemetry Torque Transducer

M540 Receiver/Induction Power Supply

DESCRIPTION

The M540 Receiver/Induction Power Supply provides the high frequency AC power to the primary coil. The primary coil inductively couples with the secondary coil. The telemetry receiver converts the RF signal from the telemetry transmitter, decodes the signal, and provides an analog signal that corresponds to the torque applied to the PTO Telemetry Torque Transducer.

Operating and adjustment details of the M540 Receiver/Induction Power Supply start on page 14.

Figure 2: M540 Receiver/Induction Power Supply

Transducer Wire Harness

DESCRIPTION

The Transducer Wire Harness contains the induction cable, two antenna cables, and the Hall Effect speed sensor cable.

Figure 3: Transducer Wire Harness

12 VDC Power Cable

DESCRIPTION

The 12 VDC Power Cable connects the M540 Receiver/Induction Power Supply to a power source.

Figure 4: 12 VDC Power Cable

Signal Cable

DESCRIPTION

The Signal Cable allows data to be transmitted to a data acquisition unit or multimeter. The CH1 cable carries analog transducer torque data. The Fault, Cal, and Low Power cables carry analog data regarding the receiver RF fault, shunt cal, and low power conditions respectively. If possible, these wires should be attached to your data acquisition in order to monitor the RF fault, low power, and shunt cal conditions.

Figure 5: Signal Cable

Spline Locking Blocks

DESCRIPTION

The Spline Locking Blocks get fastened to the female spline of the Type 3 PTO Telemetry Torque Transducer in order to prevent any axial movement of the mating male Type 3 PTO spline.

Figure 6: Spline Locking Blocks

PTO Telemetry Torque Transducer Installation

Installation of the PTO Telemetry Torque Transducer should be straight forward.

1. Mate the female spline of the PTO Telemetry Torque Transducer with the male PTO spline of the tractor.

Figure 7: Factory Male PTO Spline

2. The male spline of the PTO Telemetry Torque Transducer has a groove which can be used to restrain the axial movement of the PTO. For Type 1 and Type 2 splines, push in on the spring-loaded locking pin and engage it with the mating spline (see Figure 8). Once the pin is lined up with the groove in the male spline, release the locking pin to lock the male spine in place. Mate the male spline of the transducer with the female spline of the PTO accessory. For Type 3 splines, remove the eight #8-32 screws holding the two Spline Locking Blocks to the female spline of the PTO Telemetry Torque Transducer. Then engage the PTO transducer with the mating male spline. Once the groove in the mating male spline is aligned with the holes in the female spline of the PTO transducer, insert the Spline Locking Blocks and tighten the #8-32 screw to 32 in*lbf with blue Loctite threadlocker.

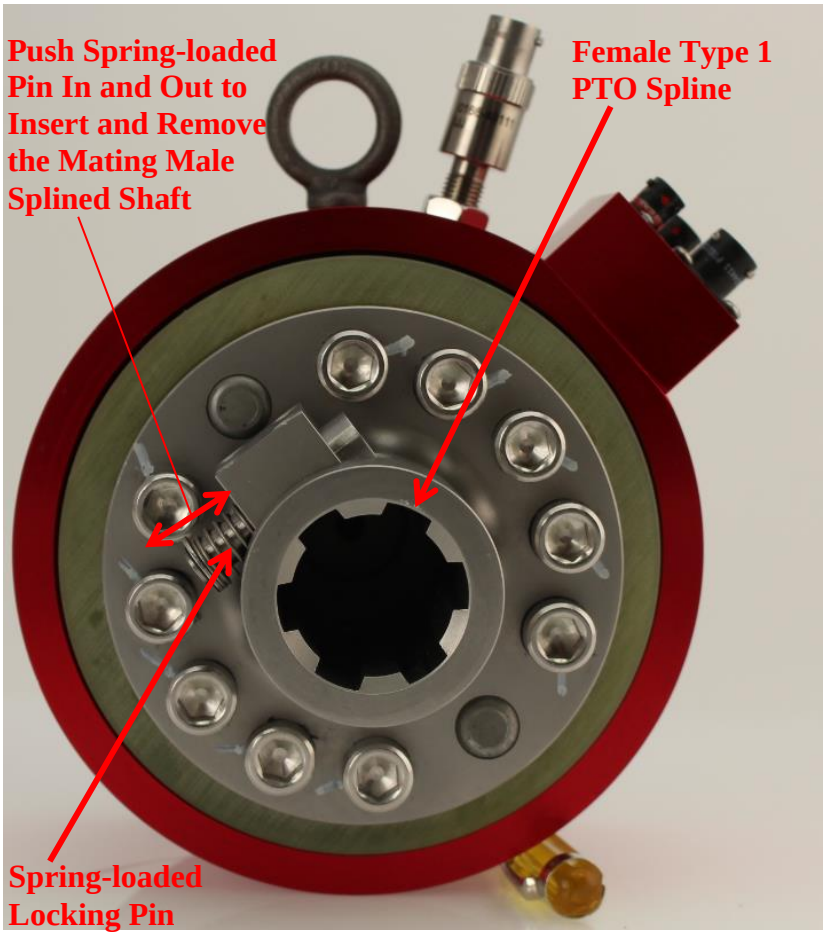


Figure 8: Spring Loaded Locking Pin on Type 1 and 2 PTO Telemetry Torque Transducers

Figure 9: Spline Locking Blocks Mounted to Type 3 Female PTO Spline

3. Use the eye bolt on the PTO Transducer Stator to restrict the rotational motion of the unit. It should be tethered to a stationary component of the tractor and securely fixed.

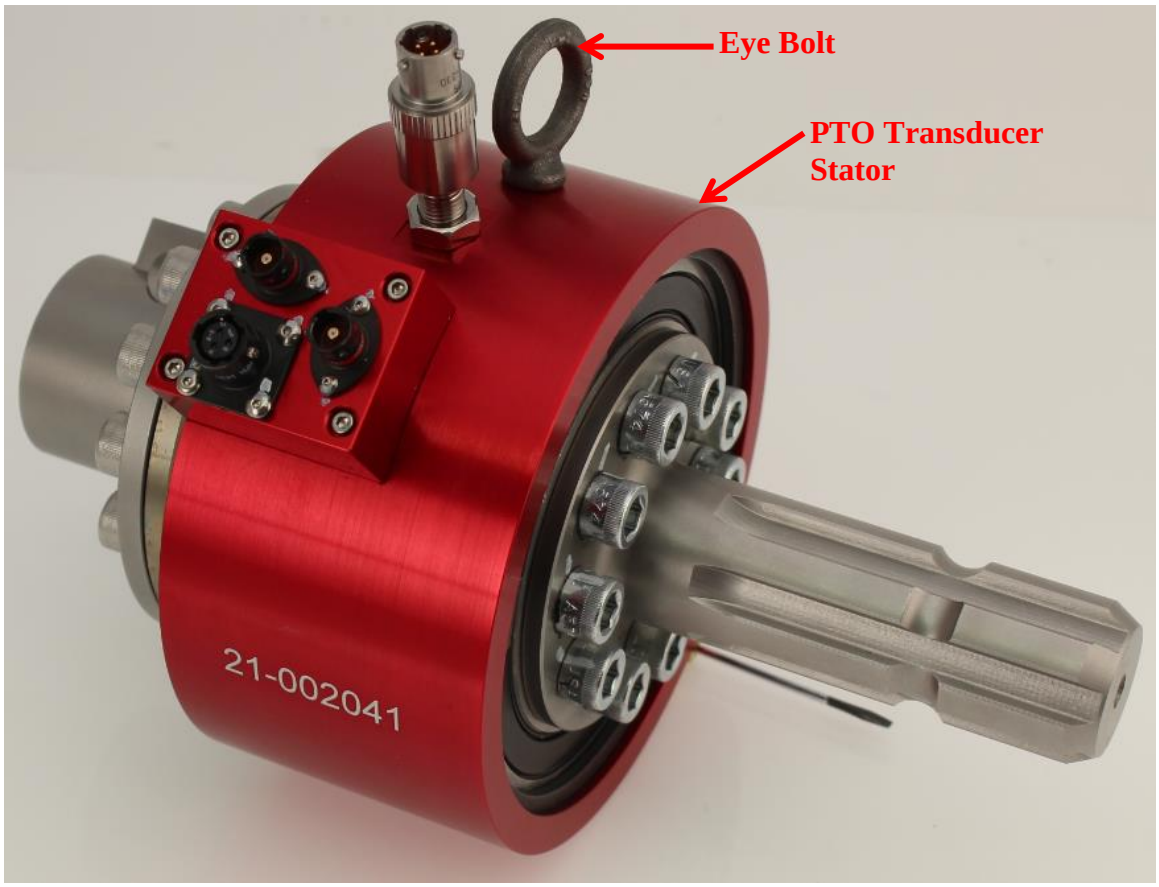


Figure 10: PTO Telemetry Torque Transducer Stator and Eye Bolt

4. Connect the induction power, Hall Effect sensor, and both antenna cables from the Transducer Wire Harness to the corresponding connectors found on the PTO Transducer Stator as shown in Figure 11.

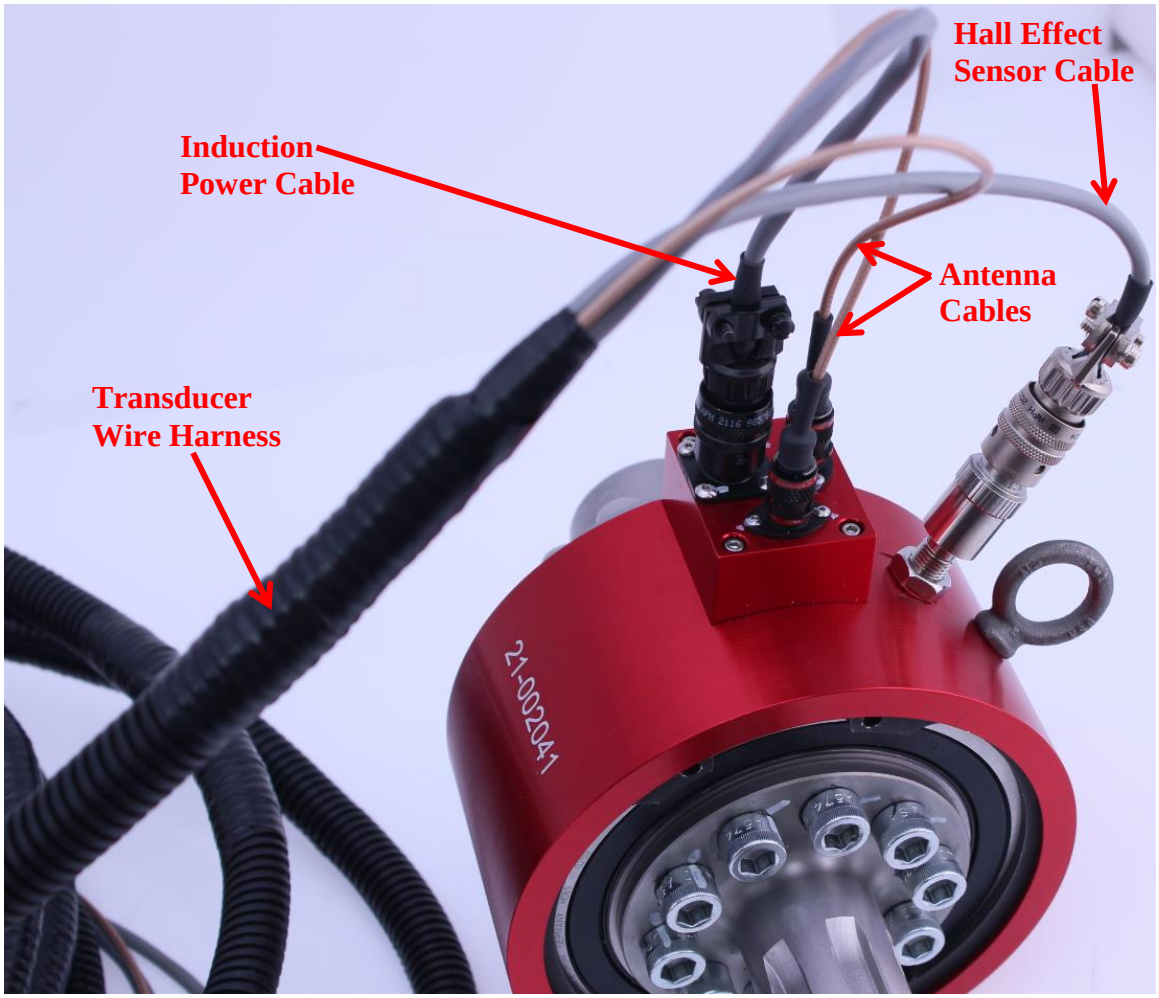


Figure 11: Attaching the Wire Harness to the PTO Telemetry Torque Transducer

5. Route the Transducer Wire Harness back to the cab. Avoid making sharp bends in any of the cables, especially the receiving antenna cables.

Setting Up Electronics

M540 Receiver/Induction Power Supply Control and Connector Descriptions

Figure 12: M540 Receiver/Induction Power Supply Front and Rear

POWER CONNECTOR (INPUT)		INDUCTION POWER (OUTPUT)[1]	
Terminal	Function	Terminal	Function
A	Input power	A	Primary out
B	Input ground	B	Primary out
C	Chassis ground	C	Chassis ground

[1] CAUTION: HIGH VOLTAGE!!! Primary out pins generate high voltages under normal operating conditions.

M540 Receiver/Induction Power Supply Setup

1. Connect the induction power cable and the female ends of the receiving antenna cables from the Transducer Wire Harness to the back of the M540 Receiver/Induction Power Supply as shown in Figure 13.

Figure 13: Attaching Cables to the M540 Receiver/Induction Power Supply

2. One four conductor cable was provided for the Hall Effect speed sensor. The red wire should be connected to + DC voltage 4.0 to 27 Volts at ≤ 30mA (or 4.0 to 30 + DC voltage at ≤ 18 mA). The black wire is for signal & power ground. The white wire is the + signal. See pages 24-25 for more info about the Hall Effect speed sensor.

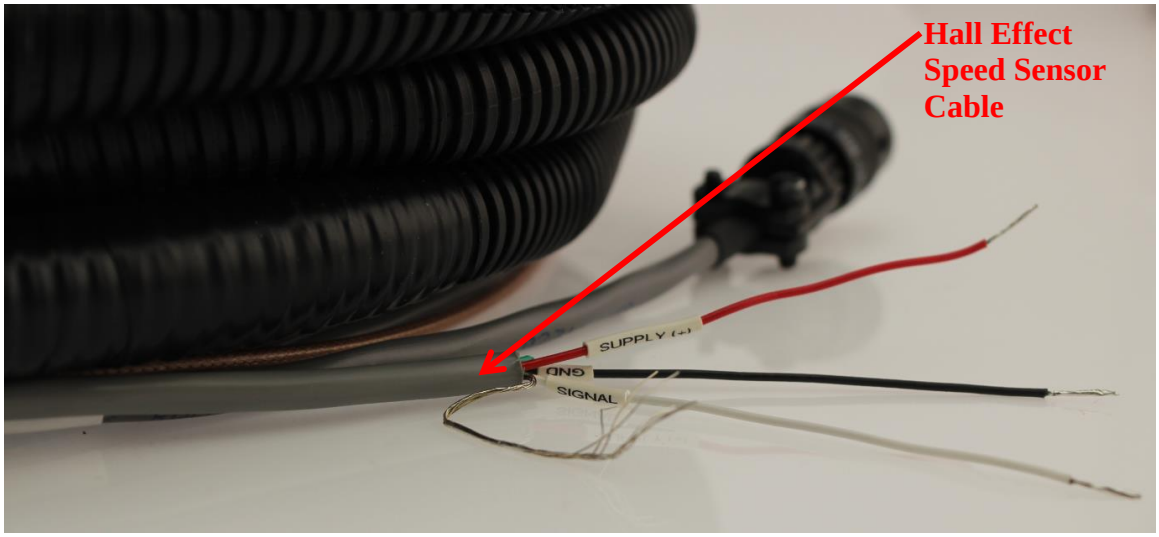


Figure 14: Hall Effect Speed Sensor Cable

3. Connect the M540 Receiver/Induction Power Supply to 12VDC power using the supplied 12 VDC Power Cable as shown in Figure 15.

Figure 15: 12 VDC Power Cable Attached to M540 Receiver/Induction Power Supply

4. The system is now ready to be tested. Turn on the power switch to the M540 Receiver/Induction Power Supply.

5. **If the RF Fault Indicator light does not turn off** either the system is not getting power or the signal is not getting to the receiver. Proceed to the Induction Power Operating/Adjustment Instructions section for more details on Tuning the Induction Power Supply.

6. **If the RF Fault Indicator light turns off**, the system is operating and will start the Shunt Calibration Sequence.

7. Rotate the PTO Telemetry Transducer to check for any RF faults as you rotate.

8. Proceed to the Shunt Calibration Sequence section on page 21.

Induction Power Operating/Adjustment Instructions

NOTE: The M540 Receiver/Induction Power Supply is equipped with a fan to cool the internal electronics. Be sure to leave at least 0.5" air gap to the side and rear panel vents. Failure to do this may damage the electronics or not allow it to operate effectively.

Before turning on power, make sure all cables are connected. First turn on the power switch. The RUN and CAL receiver status lights and all three induction power status lights should turn on indicating that the receiver is powered. At power up, the transmitter and receiver should perform an automatic calibration sequence. The user may observe the calibration sequence on the receiver signal output, and it should look similar to the example shown in Figure 17 on page 21. The calibration sequence lasts about 2 seconds.

The drive level and frequency of the induction power system is adjusted at the factory but may need to be field adjusted if the M540 transmitter does not power-up and perform the automatic calibration sequence.

If the Transmitter Does Not Power Up

If the transmitter does not power up and the receiver RF Fault light is ON, press the induction tune button. While tuning, the induction blue tuning status light will be ON. Once the induction is tuned, the induction blue tuning status light turns OFF and the induction green tuned status light turns ON. If the receiver red RF Fault light is ON, manually increase the induction power slightly by pressing the UP amplitude adjustment once and then press the SHUNT CAL button to reattempt the automatic calibration sequence. Once SHUNT CAL is pressed, the three induction status lights (IND. ERROR, TUNED, and TUNING) will be ON for 2 seconds and the primary coil power strength indicator will decrease to zero. After 2 seconds, the three Induction status lights will turn OFF and power will be restored to the primary coil. If successful, the receiver CAL status light should be ON indicating the automatic calibration sequence started. If the calibration has not started and the red RF Fault light is ON, repeat the process of increasing the amplitude and pressing the SHUNT CAL button. If the RF Fault light does not turn off after a few attempts of increasing the amplitude, see the troubleshooting guide on pages 22 and 23.

NOTE: Cycling the power switch or pressing the CAL button will reset the Induction green Tuned light on the induction power supply. The frequency of the supply will not change.

Transducer Zero

Before recording data with the telemetry system, as typical with transducers, it is necessary to null out or zero any voltage offsets in the signal under no-load condition. This establishes a *zero output at zero load* reference. First ensure that there is zero torque on the PTO Telemetry Torque Transducer. There is one offset adjustment potentiometer per channel on the M540 Receiver/Induction Power Supply. The offset adjustment potentiometer is labeled for the channel it affects. To adjust the zero offset, turn the screw potentiometer, with a small flat head screwdriver, until the signal is zeroed.

Transducer Sensitivity and Shunt Calibration

The conversion from transducer telemetry output signal (volts) to engineering units (lb-ft or Nm) can be obtained using either the transducer sensitivity (engineering units/volt) or shunt calibration method. Cycling the power on induction power supply will initiate a shunt calibration sequence. It will produce a voltage offset (delta shift) equivalent to a certain magnitude of force or moment as determined during the factory calibration. This magnitude is referred to as "shunt cal equivalent." The telemetry calibration sequence is explained further on page 21. See page 19 for a list of the PTO Telemetry Torque Transducer specifications.

Specifications

TORQUE RANGE	+/-1850 LB.-FT. (2508 Nm) -Nominal
SPEED RANGE	0 to 2850 RPM (bearing limiting speed)
SPEED SENSOR	SPECTEC Hall Effect Speed Sensor Part # 0166-43111 set to a 1/16" height above the tone wheel
BRIDGE RESISTANCE	Torque: 700 Ohm
DATA BANDWIDTH	
Low-pass 2-pole Bessel	
High Bandwidth Output	1000 Hz @ -3dB (factory setting)
Low Bandwidth Output	100 Hz @ -3dB
TEMPERATURE	
Transmitter	-40 to 125˚C
Receiver	-40 to 70˚C
POWER REQUIREMENT	
Induction Power And Receiver	9 to 36VDC (12V Nominal) Input, 40W

See calibration data sheet for details specific to your PTO Telemetry Torque Transducer.

Telemetry Overview

The M540 Series Digital Telemetry Measurement System conditions low level strain gage bridge signals, transmits signals wirelessly, and ultimately provides a high level analog voltage signal for recording.

The M540 is comprised of three components: transmitter, receiver, and power source. These components are shown schematically in Figure 16.

The transmitter incorporates a strain gauge driver, amplifier, and anti-alias filter within the signal conditioning block. It sends the bridge output signal (measured across S+ to S-) via radio frequency (RF). The RF carrier transmits the digital data. After detection by a receiving antenna, the digital signal is then converted to an analog force or moment signal. A jumper selectable low-pass filter in the receiver provides data output bandwidths of either 100 Hz or 1000 Hz. The system shipped to you has been set at the factory for a bandwidth of 1000 Hz.

Each time the power is switched on to the transmitter, a shunt calibration sequence is initiated and transmitted. This lasts for approximately 2 seconds. This will be explained in more detail on page 21.

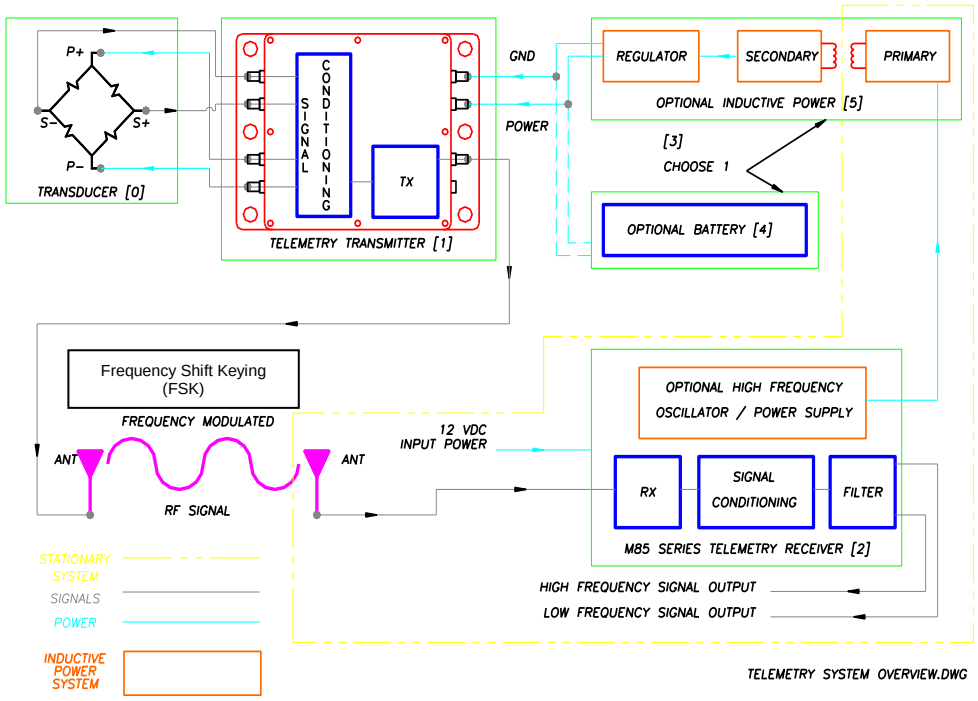


Figure 16: General Overview of Telemetry System

Shunt Calibration Sequence

A power-up calibration sequence is generated to provide the user a means to relate output voltage (the voltage recorded) to engineering units. This sequence also allows for background noise checking. The calibration sequence can also help the user monitor bridge-offset or gain changes, which may indicate a problem.

When powered up, the transmitter generates a calibration sequence that lasts approximately 2 seconds. An example of this sequence is depicted in Figure 17.

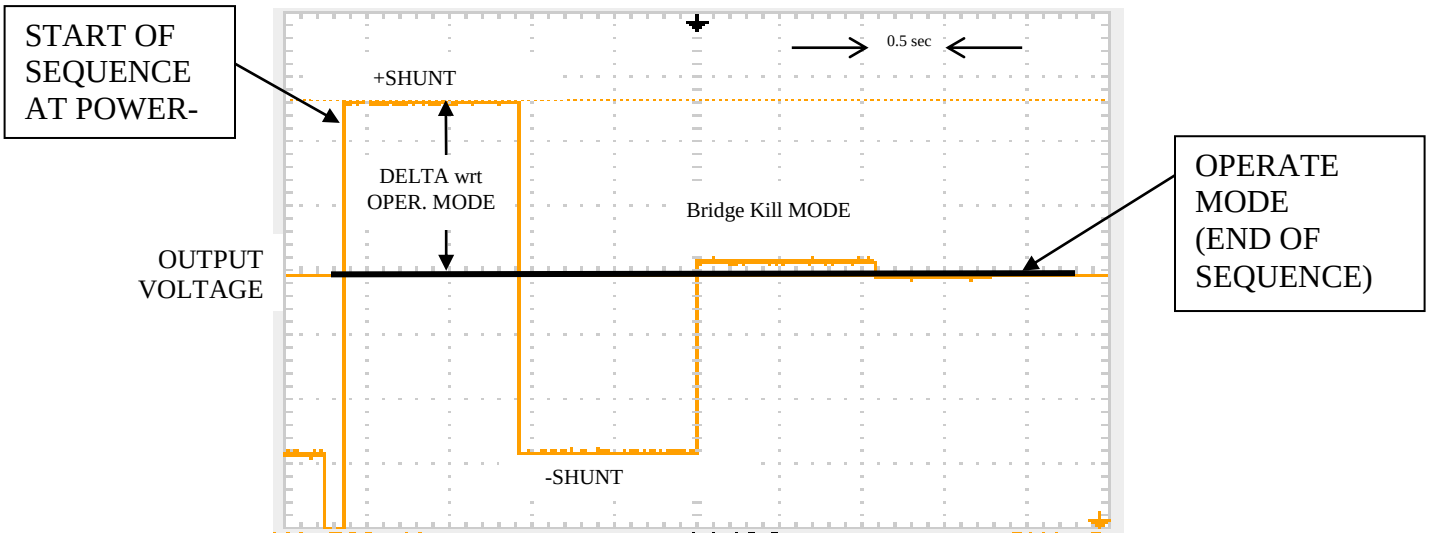


Figure 17: Typical Power-Up Shunt Calibration and Noise Check Sequence

The sequence begins with a shunt calibration resistor applied across the positive excitation (P+) and positive signal (S+) of each strain gage bridge. This is referred to as the **+SHUNT MODE**. This shunting produces an electrical unbalance of the bridge that produces a positive voltage shift as shown. The amount of voltage shift (or delta) is equivalent to a corresponding voltage shift that would result from a physical force or moment applied to the transducer as determined by the factory calibration of the transducer. ***IMPORTANT: The shift or delta to use must be with respect to the OPERATE MODE voltage level (OPERATE MODE ends the sequence as shown in Figure 17)***.

The next part of the sequence directly following the +SHUNT mode is the **-SHUNT MODE**. As with the +SHUNT mode this likewise electrically offsets the bridge but now in the negative direction due to placement of the shunt resistor across the positive excitation (P+) and negative signal (S-) leads of the transducer bridge.

The next sequence mode is **BRIDGE KILL MODE**. During this mode the bridge excitation is removed but the signal amplifiers remain active. This provides an opportunity to check for background noise (for example due to EMI). The tractor PTO should be running (PTO spinning) to best evaluate the level of background noise. Any dynamic signal that is present during bridge kill mode is noise. The end of the sequence is noted by **OPERATE MODE**. This is the normal "measurement-taking" mode.

Troubleshooting Guide

Shown below are guidelines to help in determining the cause of problems you may experience with the PTO Telemetry Torque Transducer system. These guidelines are arranged in categories of failure symptoms. Areas to check for problems are listed for each specific symptom.

Step	Action	Yes	No
1	**START** - Turn ON the power switch Is the power switch light ON?	Go to step 3	Go to step 2
2	1. Turn OFF the power switch 2. Verify all connections are good (open/shorts) a. 12 VDC Power Cable b. Induction Cable 3. Verify the power source is ON a. Voltage Input is in the 9-36V range b. Receiver requires about 40W of power 4. Turn ON the power switch Is the power switch light ON?	Go to step 3	Contact MSC
3	Verify the calibration process has started. Is the yellow CAL light ON?	Go to step 18	Go to step 4
4	Verify the induction power is working. Is the red RF Fault light ON?	Go to step 6	Go to step 5
5	Verify the receiver is working. Is the green RUN light ON?	Go to step 6	Go to step 2
6	Once power is ON for at least 5 seconds: Press the Induction Tune button (hold ~ ½ sec). Did the blue Tuning light turn ON?	Go to step 7	Go to step 2
7	Verify Induction power is tuned. Note: Tuning process takes about 1 minute Did the green Tuned status light turn ON?	Go to step 8	Go to step 11
8	Verify the transmitter is getting power Is the red RF Fault light ON?	Go to step 9	Go to step 3
9	Is the Primary coil power strength indicator at a maximum level on the bar graph?	Go to step 17	Go to step 10
10	Increase the Induction Power to the Primary Coil 1. Press UP amplitude button 2x 2. Press the CAL button 3. Wait 2 seconds Is the red RF Fault light ON?	Go to step 9	Go to step 3
11	Is the Induction Error status light blinking? Is the error flashing 1x every 2 seconds? Is the error flashing 2x every 2 seconds? Is the error flashing 3x every 2 seconds? Is the error flashing 4x every 2 seconds?	Go to step 12 Go to step 13 Go to step 14 Go to step 15	
12	Induction error flashing 1x every 2 seconds: The Induction Power supply did not Tune properly to a normal operating frequency. Contact MSC.	Contact MSC	Contact MSC
13	Induction error flashing 2x every 2 seconds: The Induction Power Supply sensed an over-current condition. Is this the first time this fault occurred?	Go to step 2	Go to step 16

Step	Action	Yes	No
14	Induction error flashing 3x every 2 seconds: The Induction Power supply could not reload the previous successful tuning parameters Is this the first time this fault occurred?	**Go to step 2**	**Contact MSC**
15	Induction error flashing 4x every 2 seconds: The Induction Power supply could not adjust the amplitude automatically. Is this the first time this fault occurred?	**Go to step 2**	**Contact MSC**
16	Check cables and connections for open/short **Note: 20 Mega Ohm or less = BAD!!!** 1. Turn OFF the power switch 2. Disconnect the Induction Cable 3. Verify the Induction Cable connector pins A-B are NOT connected 4. Verify Induction Power Primary coil leadwire connector pin A is electrically isolated from pin C and vehicle ground 5. Verify Induction Power Primary coil leadwire connector pin B is electrically isolated from pin C and vehicle ground 6. Repair as necessary Was a repair made?	**Go to step 2**	**Contact MSC**
17	Verify that the transmitter and receiving antennas are not damaged. 1. Verify the receiver antenna is connected Is this the first time inspecting the antennas?	**Go to step 2**	**Contact MSC**
18	Automatic calibration in process, wait 2 seconds to complete and the yellow CAL light turns OFF Did the calibration complete?	**Go to step 23**	**Contact MSC**
19	Did the receiver output the correct readings during the calibration sequence? Note: Verify with the calibration report provided	**Go to step 23**	**Go to step 20**
20	Has the receiver offset pot been adjusted already to compensate for the problem?	**Go to step 21**	**Go to step 22**
21	Verify the PTO Transducer is installed properly. Was an issue with the PTO Transducer fixed?	**Go to step 2**	**Go to step 22**
22	The receiver amplitude may be offset up to +/- 1.00V, separately for each channel, as described on page 17. Adjust as necessary. Did this fix the problem?	**Go to step 23**	**Contact MSC**
23	**END** - Calibration is complete and the induction powered telemetry system is working properly.		

Speed Sensor Specifications

SPECTEC
THUNDERBIRD INTERNATIONAL CORPORATION
P.O. Box 360, Emigrant, MT 59027 USA
(406) 333-4967 FAX: (406) 333-4259
www.spectecsensors.com

0166 • 0167
DIGISPEC PROXIMITY/ZERO SPEED HF SENSOR
SIGNLE OUTPUT, FERROUS TARGET/GEAR ACTUATED
3/8, M10

PRODUCT DESCRIPTION

SPECTEC's Zero Speed sensors are designed to switch in the presence of ferrous targets such as gear teeth, blade tips, ect. Gear teeth as small as module 0.5 or 48 DP can be sensed.

The standard output is NPN Supply Tracking 0-Vs, provided from a 3k Ohm internal pull-up resistor to a collector, which can sink 25 mA. The output is normally high with no target present. Other output signal options are available; please see Page 2 for details.

For intrinsically safe versions refer to bulletin: IS170 & IS171.

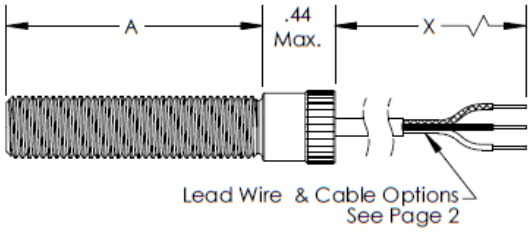
SPECIFICATIONS

Orientation:	Single: No orientation required. Differential: The alignment mark must be in line with the rotation of the gear.
Vs, Supply Voltage:	4.0 to 30 Vdc @ ≤ 18 mA 4.0 to 27 Vdc @ ≤ 30 mA 4.0 to 24 Vdc @ ≤ 24 mA (Differential) Reverse Polarity Protected
Vo, Signal Out:	Output signal is typically 'Normally High' except for PNP output which is 'Normally Low'
Operating Freq.:	0 to ~20 kHz (Standard) ~15 Hz to ~30 kHZ (Differential)
Air Gap:	24 DP / Module 1: .050" (1.3mm) 12 DP / Module 2: .080" (2.0mm) 5 DP / Module 5: .160" (4.0mm)
Magnetization:	Standard: ~1500 Gauss Low Mag: ~500 Gauss
Rise/Fall Time:	0.10 µs to 2 µs *Dependent on Configuration
Temperature Range:	2TE: -40° to 221°F (-40° to 105°C) *May be reduced based on options selected 3TE: -40° to 300°F (-40° to 150°C) *May be reduced based on options selected
Construction:	300 Series S.S. Housing & Face Solid Epoxy Encapsulation
Connectors & Pin Assignments:	See Page 2 All have Gold Plated Pin Contacts
Lead Wires & Assignments:	2TE: PVC 22-24 AWG (105°C) 3TE: TFE 22 AWG (150°C) Red: Supply (+) Black: Common (-) White/Green: Signal Bare: Cable Shielding
CE-Compliance:	**EN55011, EN50082-2**

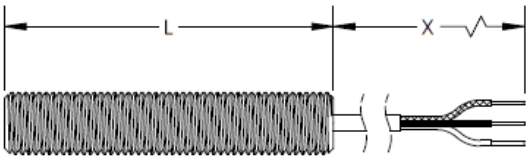
OPTIONS

Custom configurations, thread sizes including metric, special, materials of construction, special output circuits including short circuit protection, and temperature probe (NT10, RTD100, or others). Please contact sales.

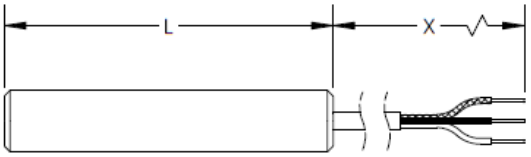
0167 3/8-24 UNF



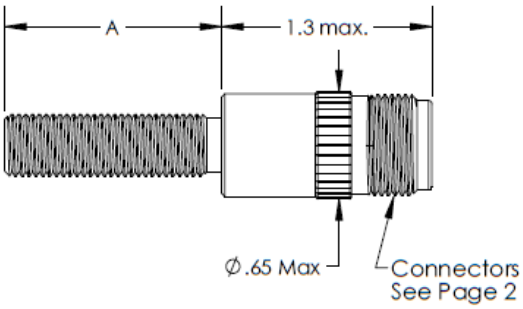
0167A 3/8-24 UNF
0167M M10 x 1.25
0167M1 M10 x 1



0167S Ø3/8" (9.5 mm) Smooth Shell



0166 3/8-24 UNF
0166M M10 x 1.25



4/28/17, REV. 9

ORDER INFORMATION

STYLE:		OPTIONS:					THREADS/DIA.:
0167	-	☐	☐	☐	☐	☐	3/8-24 UNF

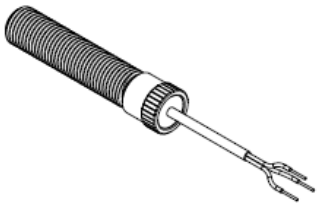
Thread Length(A):
1 - 0.8" (20mm)
A - 1.3" (33mm)
2 - 2.0" (51mm)
3 - 2.5" (63mm)
4 - 3.0" (76mm)
6 - 4.0" (102mm)

Temperature Range:
1 - 2TE: -40° to +221°F (-40° to +105°C)
6 - 3TE: -40° to +302°F (-40° to +150°C)

Vo, Signal Out:
1 - 0 – Vs, NPN w/3.1 k Ohm pull-up [Normally High]
2 - 0 – Vs, NPN, OC(Open Collector) [Normally High]
3 - 0 – Vs, PNP, OC [Normally Low]
5 - 0 – 5V, NPN [TTL] [Normally High]

Sensor Type:
3 - Standard Type Single Sensor (HF)
4 - Differential Type (HFd)

Lead Wire(X):
1 - 1' (.3m) Single Leads
7 - 3' (1m) Shielded Cable
9 - 10' (3m) Shielded Cable
(Shield is not connected to sensors shell; shield is intended to be connected to instrument panel ground.)

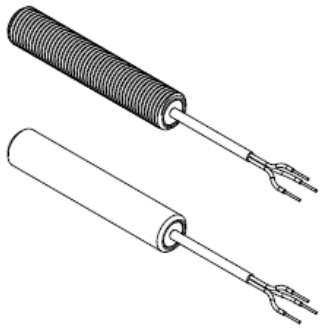


All Type 1-3 PTO Telemetry Torque Transducers come with the SPECTEC 0166-43111 Hall Effect Speed Sensors.

0167A	-	☐	☐	☐	☐	☐	3/8-24 UNF
0167M	-						M10 x 1.25
0167M1	-						M10 x 1.0
0167S	-	☐	☐	☐	☐	☐	Ø3/8" (10mm) Smooth Shell

Length(L):
2 - 1.0" (25mm)
3 - 1.25" (32mm)
4 - 1.5" (38mm)
5 - 2.0" (51mm)
6 - 2.5" (63mm)
7 - 3.0" (78mm)
8 - 4.0" (106mm)
9 - 5.0" (135mm)
A - 6.0" (152mm)

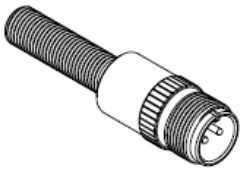
SAME AS ABOVE



0166	-	☐	☐	☐	☐	☐	3/8-24 UNF
0166M	-	☐	☐	☐	☐	☐	M10 x 1.25

Thread Length(A):
1 - 1.3" (33mm)
2 - 2.0" (51mm)
3 - 3.0" (76mm)

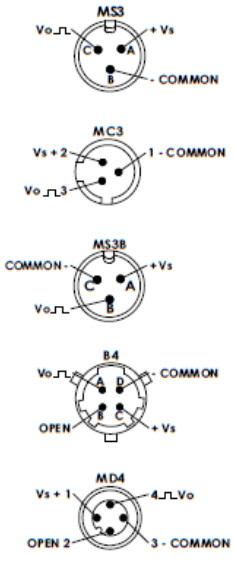
SAME AS ABOVE



Connector:

1 - MS3:	3 Pin	MS3106-10SL-3P (see Bulletin 3000)
2 - MC3:	3 Pin	Micro-C (see Bulletin 3004)
3 - MS3B:	3 Pin	MS3102-10SL-3P (see Bulletin 3000)
4 - B4:	4 Pin	Bayonet, MS3113-H8A4P (see Bulletin 3001)
6 - MD4:	4 Pin	Micro DIN (see Bulletin 3005)

Connector Pinout



Note: The magnetization level for special or low mag. Sensors is designated as a suffix to the P/N. i.e.: 0167-11111-500G designating a gauss level of 500(±50). (Standard mag. Level will not have a suffix)

A Normally Low output signal is available for the NPN output signal option (TTL, Supply Tracking and Open Collector) by adding '–NL' to the end of the part number.

Similarly, a Normally High output signal is available for the PNP output signal option by adding '–NH' to the end of the part number.

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