



Clamping Battery Telemetry

Model: CBT-MICRO & CBT-MICRO-3

User Manual





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Clamping Battery Telemetry-MICRO

- Clamps to any shaft 25 mm (1.00 inch) or larger
- Smallest weatherproof battery-powered telemetry package
- One strain gauge bridge input channel
- Up to 8 hours of battery life
- Lightweight rugged IP67 housing
- Digital 2.4 GHz RF link for reliable transmission without interference or spikes

Specifications

RF Frequency Range	2.4 GHz
Channel Type	Strain Gauge, Full Bridge, 350 Ω or higher
Input Channel Count	1
Output Channel Count	
CBT-MICRO	1
CBT-MICRO-3	3
Transmitter Power	Two 10440 rechargeable batteries
Receiver Power	9 Vdc to 36 Vdc, 1A max. each
Continuous Battery Life	8 h for CBT-MICRO 6 h for CBT-MICRO-3
Weight	90 g with batteries installed
Input Range	
CBT-MICRO	20 mV/V bridge input standard (other gains available)
CBT-MICRO-3	20 mV/V, 4 mV/V, & 2 mV/V bridge input standard (other gains available upon request)
Shunt Resistor	
CBT-MICRO	Fixed 49.9 k Ω standard, other shunt resistor values available
CBT-MICRO-3	Fixed 100 k Ω standard, other shunt resistor values available
Typical Broadcast Distance	3 m to 4 m, line of sight
Channel Sampling Rate	1 ksps (7 ksps upon request)
Signal Output	± 10 Volt Analog
System Resolution	14 Bit
Operating Temperature	-20 °C to 60 °C (-4 °F to 140 °F) (battery temperature limit)
Total System Delay	<200 μ s
RF Channels Available	16

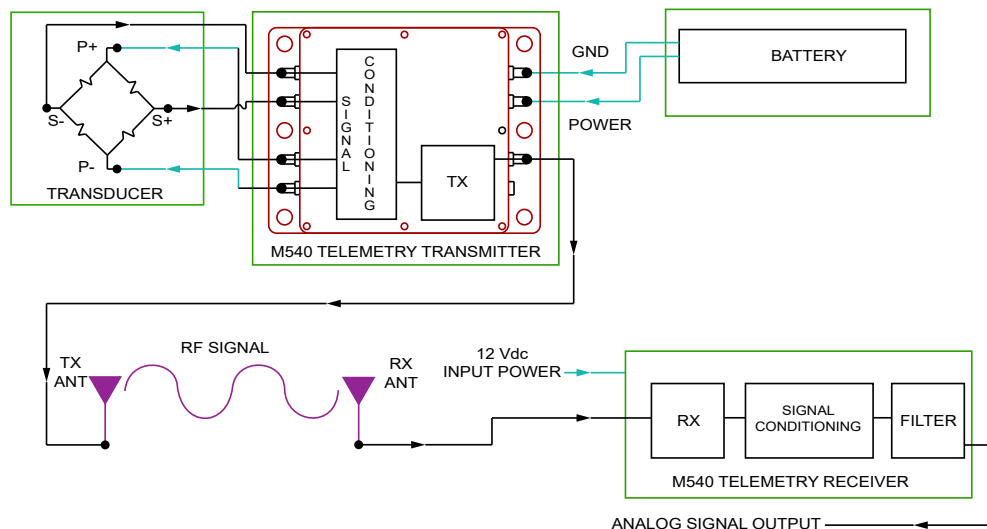
System Overview

The CBT-MICRO System is comprised of the following components: CBT-MICRO transmitting unit, M540 Receiver, two receiving antennas, receiver power cable, receiver signal output cable, and optional counterweight.

Full System



Telemetry System Schematic



CBT-MICRO transmitting unit

The CBT-MICRO transmitting unit contains a Michigan Scientific M540 Series Digital Telemetry Transmitter, an On/Off switch, and a power indicating LED. The CBT-MICRO is powered by two removable 10440 rechargeable lithium ion batteries. The M540 Transmitter conditions low level strain gauge bridge signals, transmits signals wirelessly, and ultimately provides a high level analog voltage signal for recording. The two 10440 batteries, wired in series, provide power to the Telemetry Transmitter. The On/Off switch turns on the Transmitter, when the switch is depressed. The LED indicator turns on when the transmitter has power. The input cable is for connection to a full strain gauge bridge. CBT-MICRO has one bridge input and one output with a fixed gain (standard 20 mV/V bridge input range) CBT-MICRO-3 has one bridge input and three outputs each with a different fixed gain (standard is 2, 4, 20 mV/V bridge input range).



Batteries

Each CBT-MICRO transmitting unit is powered by two 10440 lithium ion batteries. MSC recommend JESSPOW brand batteries. CBT-MICRO with standard sample rate (1000 samples per second) has 8 hours of expected battery life. CBT-MICRO-3 with standard sample rate has 6 hours of expected battery life. CBT-MICRO-3 with high sample rate (7000 samples per second) has 4.5 hours of expected battery life.



M540 Transmitter

The M540 transmitter includes 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. Each time the power is switched on to the transmitter, a three-second-long shunt calibration sequence is initiated. This is the best way to set-up strain gauge bridge sensitivity. This will be explained in more detail on page 23.



M540 Receiver

After detection by a receiving antenna, the digital signal is converted to a high level analog signal by the Receiver. 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.



Power Cable

The Receiver must be powered by a DC power source between 10 V to 36 V. A cigarette plug power cable is provided.



Receiving Antennas

Two receiving Antennas are provided with the system. For best reception, use both antennas and place them on opposite sides of the shaft from each other.



Signal Output Cable

A signal output cable is provided which mates to the 15 pin D-sub connector on the back of the receiver. The Signal output cable has four BNC connectors.



CBT-MICRO

CH1: Strain gauge bridge connected to the CBT-MICRO. Nominal full scale 20 mV/V.

CBT-MICRO-3

CH1: Strain gauge bridge connected to the CBT-MICRO. Nominal full scale 2 mV/V.

CH2: Strain gauge bridge connected to the CBT-MICRO. Nominal full scale 4 mV/V.

CH3: Strain gauge bridge connected to the CBT-MICRO. Nominal full scale 20 mV/V.

The remaining 3 signals are diagnostic signals.

RF FAULT: RF Fault (loss of telemetry signal)

LOW BATTERY: Indicates low battery or insufficient power to transmitter

SHUNT CAL: Indicates an active Shunt Calibration Sequence

System Set-Up

Strain Gauge Bridge Connection

Wire your full 350 Ohm strain gauge bridge to the wire exiting the CBT-MICRO. Proper wiring to the strain gauge bridge is shown below.

CBT-MICRO Strain Gage Bridge Wiring		
Brown	→	P+
White	→	S+
Blue	→	S-
Black	→	P-



Install Batteries

Remove the Battery Lid (switch side) by removing the two M2.5x10 mm SHCS bolts holding the with a 2 mm Allen. Magnets are embedded in the Battery Lid for easy removal of the batteries. Install two charged batteries looking closely for positive and negative battery indicators engraved into the CBT-MICRO housing and Lid. Replace Battery Lid and install two M2.5x10mm SHCS bolts. Only tighten bolts until the gasket starts to splay outside the enclosure.



Notes

The transmitter lid (strain gauge input wire side) should not be removed.

CBT-MICRO Attachment Methods

CBT-MICRO can be installed with metal hose clamps, metal banding, load rated plastic tires, or even taped to the shaft. Attachment method depends on shaft speed and diameter. The chart below has calculations of safe attachment methods at various speed and shaft diameters. The force listed in the chart is the centripetal force of the CBT-MICRO + counterweight multiplied by a factor of safety of 2.5.

The green cells show when two 50 lb. rated cable ties can be used.

The yellow cells show when two 120 lb. rated cable ties can be used.

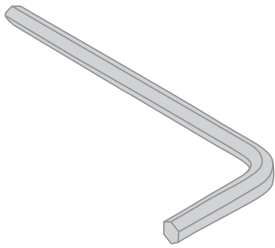
The blue cells show when two 675 lb. rated stainless steel bands can be used.

RPM	Calculated Force (lbf) x 2.5 Factor of Safety					
1000	14	28	43	57	71	85
1500	32	64	96	128	160	192
2000	57	114	170	227	284	341
2500	89	177	266	355	443	532
3000	128	255	383	511	639	766
3500	174	348	521	695	869	1043
4000	227	454	681	908	1135	1362
4500	287	575	862	1149	1437	1724
5000	355	710	1064	1419	1774	2129
5500	429	859	1288	1717	2146	2576
6000	511	1022	1533	2043	2554	3065
6500	600	1199	1799	2398	2998	3597
7000	695	1391	2086	2781	3477	4172
	1.00	2.00	3.00	4.00	5.00	6.00
	Shaft Diameter (in)					

Rated Strength x 2 Total Ties			F.O.S.
Plastic Cable Ties	50	100	2.50
	120	240	
430 Stainless Steel Clamps	675	1350	
Too Fast			

CBT-MICRO Installation

Required Tools



Allen Wrench



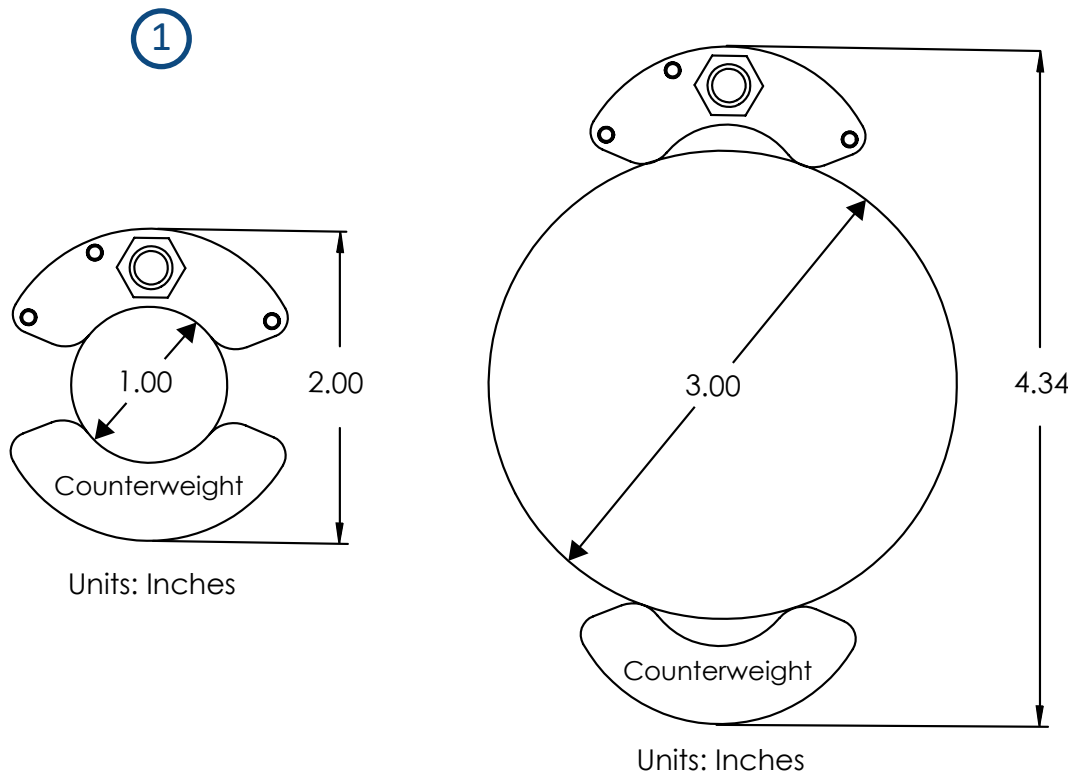
Cable Ties or Hose Clamps



Cable Tie Tool

Mounting Location

1. Ensure the gauge location leaves enough clearance and space to comfortably fit the CBT-MICRO.
2. Include space to take the lid off and slide the batteries out.
3. Mark desired gauge location



Mounting

Apply fusion tape to prevent slip during rotation.



Pre-attach zip ties / metal bands.



Mount CBT-MICRO on fusion tape, lid slightly overhanging.



Partially tighten retention bands.

Adjust counterweight to be 180 degrees from CBT-MICRO.



Tighten both retention bands.



Zip tie tool for zip ties or 30 lb-in for hose clamp



Connect CBT-MICRO to strain gauge.



Internal magnets used to remove / guide batteries.



Secure strain gauge wires with tape or adhesive.



Power Switch and Shunt Sequence

Depress the power switch to turn on power to the Telemetry Transmitter. Immediately upon power up a 3 second Shunt Sequence is initiated. The Shunt Sequence can be used to set-up sensitivity of your strain gauge bridge.



Transmitter Full Scale and Shunt

The Telemetry Transmitter Gain and Shunt are fixed in the transmitter. The nominal bridge input full scale and Shunt calibration resistor value for your system can be found on the Receiver label, like the one below.



Receiver Box Set-up

The receiver box should be placed in an area protected from the weather. The power cable and the antenna cables need to connect to the rear panel.

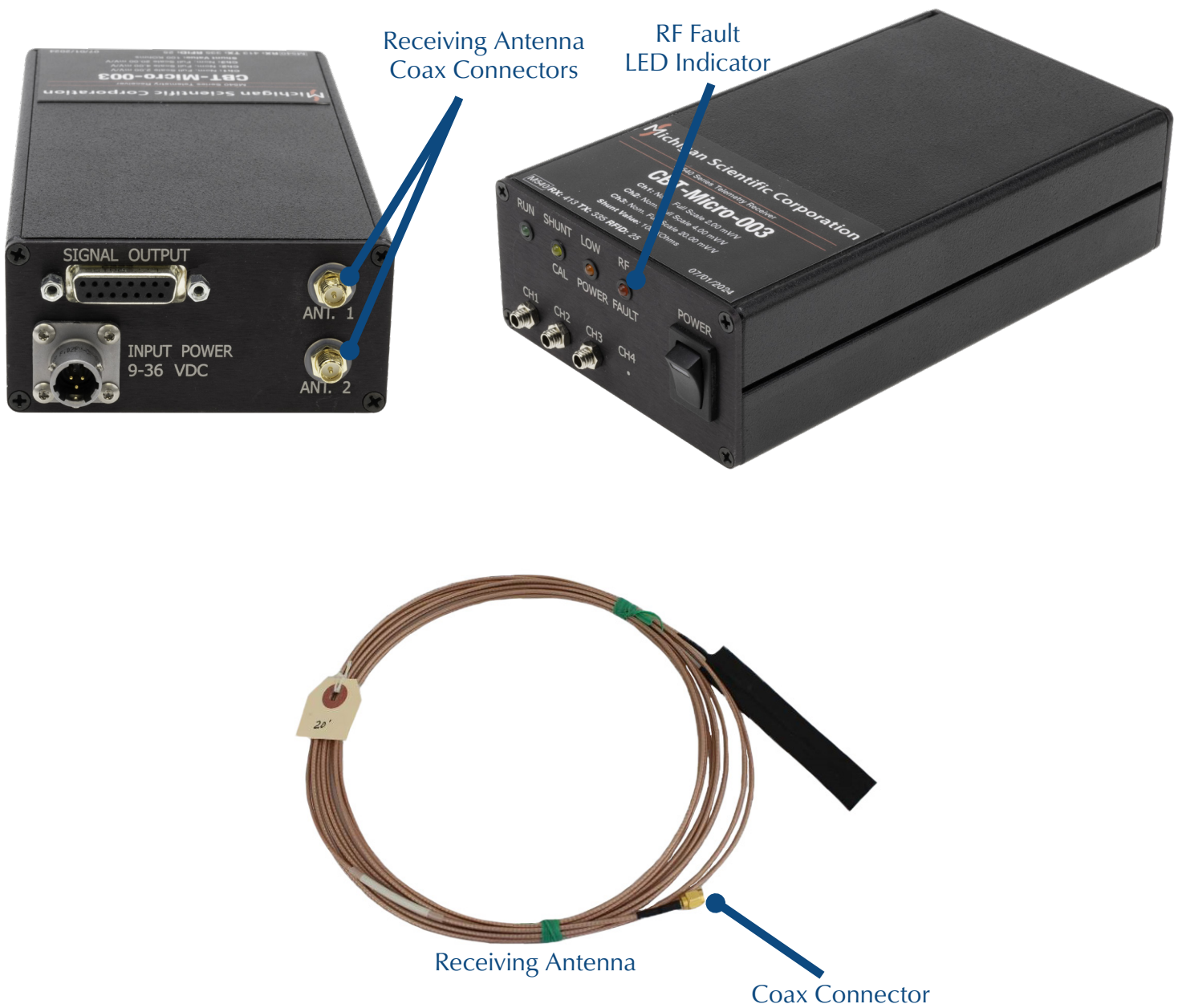
Plug the two antenna coax connectors into the appropriate connector on the back panel of the receiver box and route them close to the CBT-MICRO. With the CBT-MICRO switch off, power-on the receiver. The front panel RF FAULT LED should be lit. Now turn on the switch of the CBT-MICRO. Mount the antenna as close to the CBT-MICRO as practical. The RF FAULT LED on the front panel of the receiver box will help determine the best antenna position and orientation during installation. RF FAULT LED on is bad, off is good. Some experimentation with antenna location and orientation will be needed to obtain the best signal as indicated by the RF FAULT LED. It is usually better to position the antennas away from large bodies of metal that will weaken or block the transmitted and received RF signals. The receiving radio listens to both inputs and selects the input with the best reception. Receiving antennas should be in different locations, ideally 180 degrees apart.

The LOW POWER LED on the front panel will light when the Voltage from the batteries is too low. When this LED is lit, replace the batteries in the CBT-MICRO.

The SHUNT CAL LED will be lit when the transmitter is in the start-up calibration sequence. This calibration sequence lasts for approximately three seconds immediately after the transmitter is powered. Additional information on the calibration sequence can be found below.

The front panel has a zero adjustment potentiometer. This potentiometer can be used to adjust for minor zero offset at zero load. To use, first insure that there is zero torque applied to the strain gauge bridge or transducer. With a voltmeter connected to the CH 1 output connector, adjust the voltage output level to zero by turning the potentiometer. You may also monitor your data acquisition system, and after putting the transducer in a zero torque condition, Zero your data acquisition equipment.

During operation, it is not uncommon to observe some flickering of the RF Fault LED. If the receiver detects a fault, the output D/A converter in the receiver holds the last valid sample. The sample rate for each transmitter is approximately 1000 samples per second.



Notes

There is NO provision for zeroing the transducer bridge at the transmitter. If the bridge unbalance is too high (above about 5% of full scale), the strain gauge bridge can be padded with a resistor across one arm.

Signal Output Range

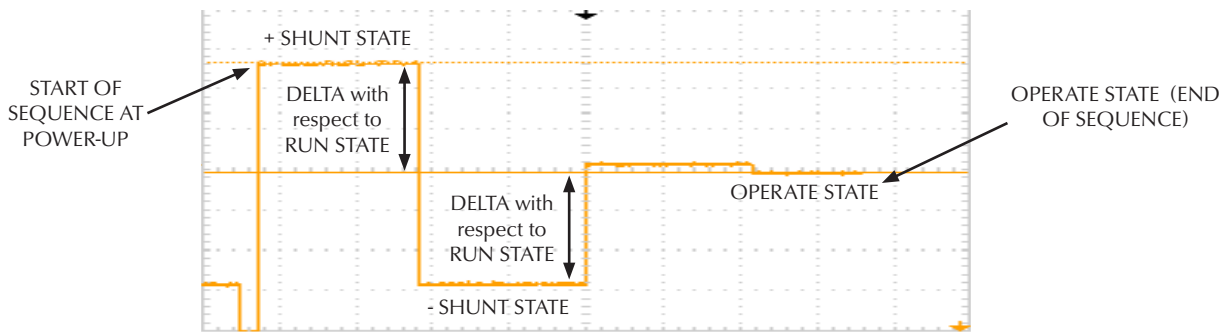
The Default Output Range for Michigan Scientific Telemetry Receivers is ± 10 Vdc. Upon request, this can be customized to other ranges, less the 10V, like 0 Vdc to 5 Vdc. The outputs for the diagnostic channels are listed below.

- SHUNT CAL: On (~ 3.3 V) during start up calibration sequence. Off (0 V) otherwise.
- LOW POWER: Low battery indicator. When the batteries reach the end of it's useful life and the voltage level to the transmitter drops, this indicator will come on. LOW POWER off (0 V) is good. LOW POWER on (~ 3.3 V) indicates that the battery needs to be replaced.
- RF FAULT: RF FAULT indicator. 0 V is good, no faults. ~ 3.3 V indicates RF faults. Check antenna connections and make sure that the transmitter is powered.

Sensitivity (Shunt Calibration)

A power-up calibration sequence is generated to provide the user a means to relate output voltage (the voltage recorded) to engineering units of torque. 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 3 seconds. An example of this sequence is shown below.



The sequence begins with a shunt calibration resistor applied across the positive excitation (P+) and positive signal (S+). 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 strain applied to the transducer as determined by the factory calibration of the transducers.

The next part of the sequence directly following the +SHUNT mode is the -SHUNT MODE. As for 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 end of the sequence is noted by OPERATE MODE. This is the normal "measurement-taking" mode.

Notes

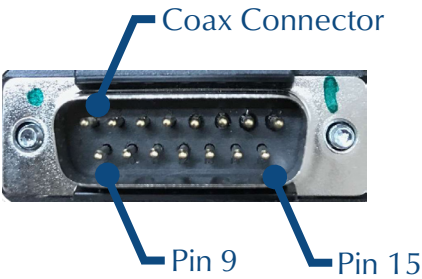
The calibration sequence may show a negative voltage shift, then a positive shift, if the receiver internal polarity jumper has been changed. A polarity change will not affect the system calibration or channel sensitivity (other than changing the sign of the output).

System Troubleshooting

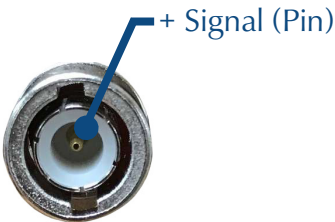
The following are guidelines to help in determining the cause of problems you may experience with the telemetry torque measurement system. These guidelines are arranged in categories of failure symptoms. Areas to check for problems are listed for each specific symptom.

1. Receiver Power Indicator Light Does Not Come On
 - a) Check if the green LED is illuminated on the CBT-MICRO transmitting unit. If so, move to step b. If not, replace the existing batteries with fully charged batteries.
 - b) Check that the Receiving Antennas are both connected to the Receiver, then move them both close to the CBT-MICRO transmitting unit.
2. Fault/Signal strength LED is always ON
 - a) Try a different antenna location or orientation.
 - b) Check the battery voltage level. Replace batteries as required.
3. Calibration sequence generated differs from expected
 - a) Check if LOW POWER LED is illuminated on the receiver. If so, replace the existing batteries with fully charged batteries.
 - b) Check the transducer bridge zero balance offset. Zero balance of the transducer bridge should be within 5 % of the rated full-scale value. If the bridge balance exceeds 5%, balancing resistors can be installed on the transducer to correct for this offset.

M540 Telemetry Pin-Out



15 Pin D-sub	
Pin Number	Function
1	Channel 1
2	Channel 2
3	Channel 3
6	CAL
7	RF Fault
8	Low Batt
9	Channel 1 Common
10	Channel 2 Common
11	Channel 3 Common
14	(CAL) Common
15	RF Fault, Low Bat Common



Power Cable	
Pin	
A	+12 Vdc
B	Ground
C	N/C

