

MCRT® 48200V NON-CONTACT DIGITAL TORQUEMETER INSTALLATION, OPERATION, AND TROUBLESHOOTING GUIDE

Revision B; December 11, 2013

Customer:
Model Number:
Serial Number:
Factory Reference Number:
Rated Torque (lbf-in):
Torque Overload Capacity (lbf-in):
Maximum Speed (rpm):
Performance Code:
Special Features:
.....
.....
.....
Speed Pickup Supplied: () None () Code A () Code Z

Optional Software Package Supplied: () Yes () No

Installed Scaling, Analog Output, Unit of Measure, and Filter Cutoff Frequency

Torque Range:
Torque Unit of Measure:
Analog Output Voltage:
Filter Cutoff Frequency:
Password Protection: () On () Off

Note: Unless specified differently when ordered, default values are as follows:

Sensor Full Scale ±10 Volts,
Torque Unit of Measure lbf-in,
Filter Cutoff Frequency 10 Hz,
Password Protection Off.

These selections can be changed with the included software.

The attached Calibration Certificate lists actual calibration data. The calibration was done in Himmelsteins' NVLAP Accredited Laboratory (NVLAP Lab Code 200487-0). For details, visit www.himmelstein.com or the 'laboratory accreditation' link @ www.nist.gov. Cal values are loaded on power up. Calibration data can be accessed using a PC and the supplied software.

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TABLE OF CONTENTS

	Page
I. Introduction	3
A. Mechanical Installation	
A.1 Applicability	3
A.2 Coupling Selection	3
A.3 Coupling Installation	4
A.4 End-to-End Orientation	4
B. Electrical Installation	
B.1 Applicability	4
B.2 Stator Connectors	4
B.2.1 Earth Ground Connection	4
B.2.2 Power Input	5
B.2.3 Analog Outputs, Cal Enable, Torque Zeroing	5
B.2.3.1 Analog Outputs	5
B.2.3.2 Cal Check Enable	5
B.2.3.3 Torque Zeroing	6
B.2.4 Speed Pickup Connector	6
B.2.4.1 Zero Velocity (Code Z) Pickup	6
B.2.4.2 Standard (Code A) Pickup	6
B.2.5 Com Port Connector	6
C. DT482 PC Interface Software	
C.1 DT482 PC Software Overview	6
C.2 Change Sensor/Test Setup	6
C.3 Display Torque Data	8
C.4 Test Control	8
C.5 Perform Dead Weight Calibration	8
C.6 Calibration Intervals	8
D. Operating and Safety Considerations	
D.1 Applicability	8
D.2 Allowable Torque Loads	8
D.2.1 Overload Considerations	8
D.2.2 Fatigue Considerations	8
D.2.3 Starting High Inertia Loads with Electric Motors	9
D.3 Allowable Bearing Loads	9
D.4 Allowable Extraneous Loads	9
D.4.1 Allowable Bending Loads	9
D.4.2 Allowable Thrust Loads	10
D.5 Operating Speeds	10
D.6 Contaminants	10
E. Troubleshooting	
E.1 Scope	10
E.2 Preliminary Inspection	10
E.2.1 Torquemeter	10
E.2.2 Cabling and Earth Grounding	10
E.2.3 Readout Instrument/Data Acquisition System/Controller ..	10
E.3 Torque Subsystem	10
E.3.1 No Output When Torque is Present	10
E.3.2 Constant Output Regardless of Shaft Torque	11
E.3.3 Apparent Zero Drift	11
E.3.4 Signal Instability	11
E.3.5 System Will Not Zero	11
E.4 Speed Pickup Replacement	11
E.4.1 Removing A Defective Pickup	11
E.4.2 Installing A Replacement Pickup	11
E.4.3 Replacement Part Numbers	11
Appendices	
I MCRT [®] 48200V Specification	12
II Belt and Chain Drive Considerations	13
III Mating Stator Connector Part Numbers	14
IV Serial Communication Commands	15

I. Introduction

MCRT® 48200V Torquemeters measure and output *shaft torque and speed*; speed is an option. Manual adjustments and noisy pots are eliminated. Null, scaling and unit of measure are stored in non-volatile memory. Ten common units of torque are supported. Bessel response signal filters avoid delay distortion and overshoot and assure optimal measurement response. You may choose from eleven (11) filter cutoff frequencies; 0.1 to 200 Hertz in 1-2-5 steps. Input power is a single, unregulated dc supply. The torquemeter has reverse polarity protection.

If you re-calibrate, previous calibration values are archived. Pin strapping and serial commands enable traceable* torque calibrations, and remote zeroing. Password protection may be invoked if needed.

* NIST traceable calibration performed in our accredited Cal Lab (NVLAP LAB Code 200487-0). For details visit www.himmelstein.com or www.nist.gov.

Included standard software operates on Windows-based PC's. Use it to:

- Display Current Torque with Unit of Measure on the PC screen
- Display Peak Torque with Unit of Measure on the PC screen
- Display Torque Minimum with Unit of Measure on the PC screen
- Display Torque Spread with Unit of Measure on the PC screen
- Select ± 5 Volt or ± 10 Volt analog output
- Select filter cutoff frequency
- Select from ten Units of Measure without recalibration
- Remotely invoke a CW or a CCW Cal Check
- Remotely Zero the Torque Signal
- Turn Password Protection On and Off
- Re-dead weight calibrate the torquemeter
- Torque vs time screen plot
- Set High and Low torque limits with on screen status indicator
- Save data to disk
- Store Test setup parameters

Torque is sensed by one or more metal foil strain gage bridges. The rotating bridges are excited, amplified and converted by proprietary circuitry which produces coded data unaffected by amplitude variations. That data is then transmitted to the stator as infrared (IR) energy where it is detected and output in industry standard analog and digital formats.

The IR transmission is inherently tolerant of electrical and magnetic noise. Because MCRT®48200V's are fully inclosed, they are immune to sunlight and virtually all airborne contaminants. Power is transferred to the rotor inductively, without contact. Elimination of slip rings, brushes, radio transmitters and other limited-life, noise-generating and noise susceptible elements provides long life and high data reliability.

A. Mechanical Installation

A.1 Applicability

This discussion is applicable to all MCRT® 48200V torquemeters, i.e, MCRT® 48201V, MCRT® 48202V, etc.

A.2 Coupling Selection

Your torquemeter installation method dictates the type of coupling needed. There are two installation methods, i.e., a floating shaft and a base (or foot) mount.

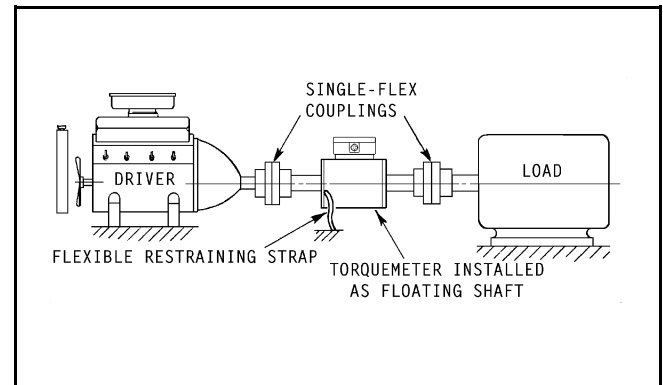


Figure 1. Floating Shaft Installation.

In floating shaft installations, a *single flex coupling* is installed at each shaft end. It takes out angular misalignment, and the torquemeter "tilts" to take out parallel misalignment. Use a *flexible strap* to prevent housing rotation and to strain relieve the torquemeter electrical cable. **Caution: when conduit is required for electrical connections, the conduit must be flexible. If rigid conduit must be used, then use a foot mounted installation as described below.**

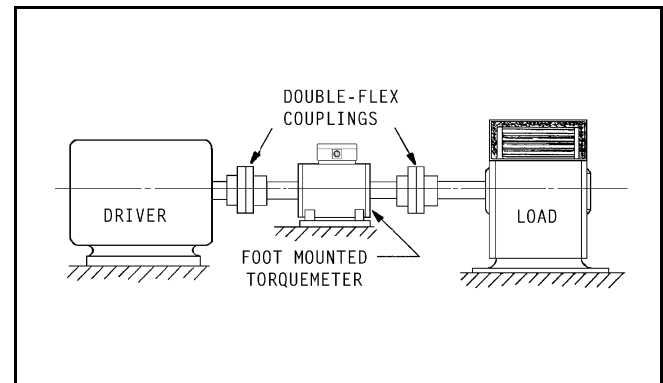


Figure 2. Foot Mounted Installation.

Install a foot mounted Torquemeter between *double flex couplings* as shown. The double flex couplings accommodate both parallel and angular misalignments.

For either installation method, choose couplings that will handle the:

- Expected shaft end float
- Parallel and angular misalignments
- Maximum expected shaft speed
- Maximum expected shaft torque
- Expected extraneous loading

A.3 Coupling Installation

Use a slight interference fit (0.0005 inches per inch of shaft diameter) and follow the coupling manufacturers' instructions. Before installation, lightly coat the torque-meter shaft with an anti-seizing compound suitable for use at 400 deg. F. Next, heat the coupling hub, *not the torque-meter*, to approximately 400 deg. F. Then, install the coupling.

The heated coupling hub should "slip" on the torque-meter shaft without significant resistance. That is, coupling installation force shouldn't exceed a few pounds of axial force. Next, allow the assembly to cool to room temperature. Then, repeat the process for the second coupling.

If desired, use forced air to accelerate cooling. Air cooling avoids contaminating the torque-meter with anti-seizing compound. If cooling is speeded with water dampened rags, *orient the torque-meter to prevent entry of water mixed with anti-seizing compound*. Otherwise, internal damage can occur.

After coupling installation, verify that:

- Clearance exists between the coupling and the torque-meter stator, and
- The shaft-to-coupling fit is snug enough to prevent vibration induced coupling motion.

To Avoid Damage Or Injury

- *Use fixturing to support the hot shaft.*
- *Use insulated gloves when handling hot parts.*
- *Stop the hub installation if the pressing force exceeds a few pounds. Remove the coupling. Cool all parts, and then inspect for burrs on the coupling bore, shaft, keys and keyways. If the parts are burr free, check the bore size and verify the coupling keyway squareness.*
- *Don't allow fluids to enter the torque-meter.*

A.4 End-to-End Orientation

MCRT® torque-meters are bi-directional. Their output signal polarity reverses when the direction of transmitted torque reverses. Himmelstein uses the following convention for defining torque direction.

CW Torque: the shaft turns CW, when viewed from the driven end

CCW Torque: the shaft turns CCW, when viewed from the driven end

Reversing a torque-meter end-for-end doesn't change the torque direction or magnitude. Therefore, it will have no effect on the torque-meter output signal. When in doubt about shaft torque direction, observe the output signals during normal machine operation. A positive signal output indicates CW torque per the above definition. A negative output signal signifies a CCW torque.

B. Electrical Installation

B.1 Applicability

This section applies to all MCRT® 48200V Torque-meters.

B.2 Stator Connectors

Three stator connectors are used, as follows:

- Input Power (2 Pins)
- Analog Output/Cal Enable/Zero (4 Pins)
- Com Port (3 Pins)

If an optional speed pickup is furnished, it will have an integral 2 pin (Code A) or 3 pin (Code Z) connector. *The Code Z Zero Velocity Pickup is recommended for use at low operating speed and for electrically noisy environments.* Mating connectors are supplied except if a complete cable is furnished for the Com Port.

Before wiring mating connectors, refer to Figure 5 for the connector pin number identification(s). That Figure shows the stator connector looking down at the torque-meter. Matling connector pin sequence is their mirror image.

B.2.1 Earth Ground Connection

Connect the Torque-meter stator directly to earth ground, a buildings' structural steel or a floor rod. If neither is available, drive a six foot copper rod into the floor. Then run separate ground straps between it, the drive motor frame, the machine base, the torque-meter housing, the load device and the data acquisition/computer system ground. Don't "daisy chain" the connections. See Figures 3 and 4.

If an IGBT-based variable frequency drive (VFD) is used, follow its installation manual. Improperly installed VFD's can cause premature motor and cable failures, and reading errors from excessive noise. VFD's should have shielded power and motor cables. Belden Types 29500 thru 29507 cable are designed for VFD use. See "Cable Alternatives for PWM AC Drive Applications" available at www.belden.com. Himmelstein recommends the connection in Figure 20. For best results, use a differential input amplifier in these electrically noisy environments.

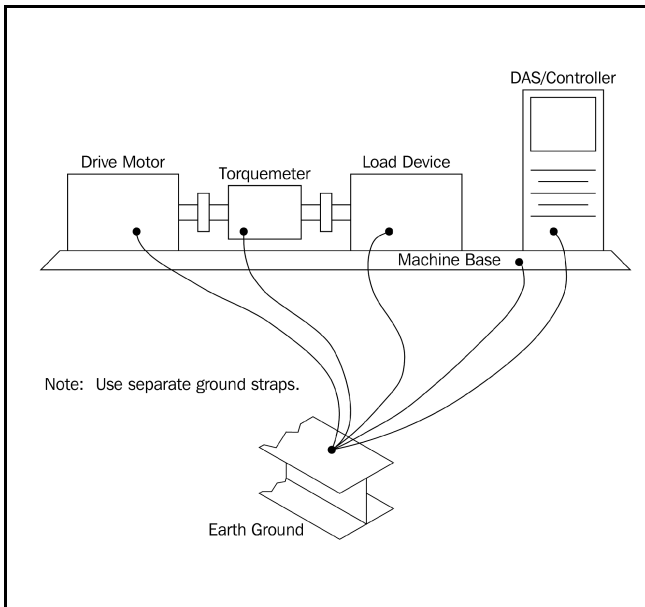


Figure 3. Correct System Earth Grounding

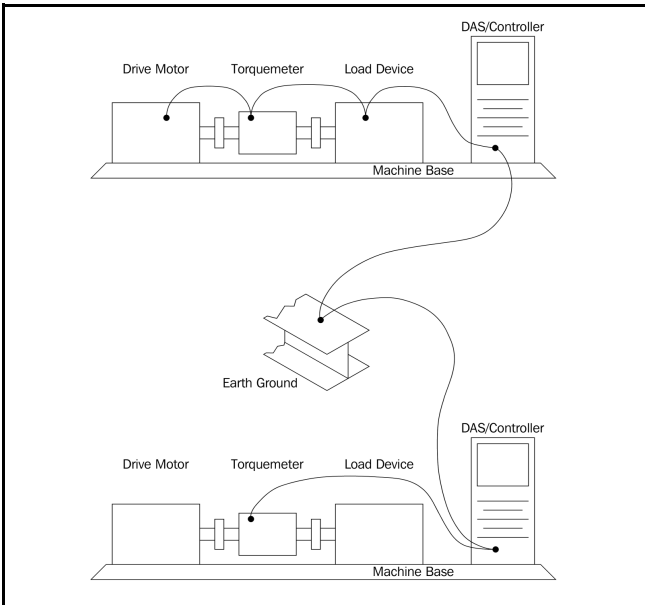


Figure 4. Examples of Incorrect Earth Grounding

B.2.2 Power Input; 2 Pin Connector

The power connector has two pins with pinout as follows:

Pin 1	Power Return
Pin 2	+ Power In (10 to 15 VDC)

Spare mating connectors can be ordered from the factory; P/N: 320-1285.

Reverse polarity protection is standard. Although any wire may be used for connections, *shielded cable will perform best in noisy environments and is recommended.* Note: the shield should float at the Torquemeter end; the other end should be tied to earth ground; see Figure 5.

Caution: Don't connect a Torquemeter to a Power Supply that also drives inductors or solenoids. Induced switching transients may cause damage or noise.

B.2.3 Analog Outputs, Cal Enable, Torque Zeroing; 4 Pin Connector

Shielded cable is recommended for these connections. The shield should float at the Torquemeter end and tied to earth ground at the other end; See Figure 5. Spare mating connectors can be ordered from the factory; P/N: 320-1287.

B.2.3.1 Analog Outputs

An analog of Torque is output on the four pin connector. Pin connections are as follows:

- Pin 1 Analog Output
- Pin 2 Analog Ground

The analog signal may have full scale values as follows:

Torque CW = +10V, CCW = -10V, or
CW = +5V, CCW = -5V

The default value is 10 Volts. The user may reassign the output voltage selection with the use of a PC and supplied software. CW torque causes the shaft to turn CW when viewed from the driven end. CCW torque causes the opposite rotation.

B.2.3.2 Cal Check Enable

Internal Calibration Check Circuitry may be remotely enabled by pin strapping and/or via the com port using furnished software. Pin strapping is accomplished by shorting the designated pin on the four pin connector, to Analog Ground (Pin 2).

- CW Cal: Short Pin 3 to Pin 2
- CCW Cal: Short Pin 4 to Pin 2

The calibration signal will remain on until the short is released. For that reason it should be invoked while the driveline torque is at zero; if locked-in torque is present, break one of the shaft couplings. When the driveline torque isn't zero, the calibration signal will add algebraically with the driveline torque.

Calibration can also be invoked from a remote computer using the furnished software.

Equivalent calibration values, in engineering unit of measure, are listed on the Calibration Certificate which documents NIST traceability. Calibration values were determined in S. Himmelstein and Company's accredited* (NVLAP Lab Code 200487-0) calibration laboratory. They can also be accessed using the furnished software. The user may perform a dead weight calibration and store the results in memory, using furnished software. The original cal data is archived.

*For details visit www.himmelstein.com or follow the accreditation link at www.nist.gov.

B.2.3.3 Torque Zeroing

TORQUE ZEROING SHOULD ONLY BE DONE WHEN THE DRIVELINE TORQUE IS ZERO. If locked-in torque is present, break one of the shaft couplings to remove it.

The Torquemeter can be remotely zeroed by simultaneously strapping the CW and CCW Cal enable lines (Pins 3 & 4) to Pin 2, **and holding that condition for five (5) seconds**. When this is done, any residual system offsets will be removed.

Torque Zeroing can also be invoked from a remote computer using the furnished software.

B.2.4 Speed Signal Connector

B.2.4.1 Zero Velocity (Code Z) Pickup

Code Z Zero Velocity Speed Pickups have three pin connectors. They require external power (6 to 15VDC). Connections are as follows:

Pin A	+Power In (6 to 15VDC)
Pin B	Output Signal (60 pulses/rev)
Pin C	Common

Zero Velocity Speed Pickups produce 60 pulses/revolution. The pulse amplitude is independent of speed and is approximately equal to the external supply voltage. Code Z pickups are **recommended for low speed service and for electrically noisy environments.**

Replacement Code Z Pickups can be ordered from the factory; P/N: 900-1007. Spare mating connectors can also be ordered; P/N: 224-5361.

B.2.4.2 Standard (Code A) Pickup

Code A Standard Speed Pickups have two pin connectors. They are self generating, i.e., they do not require external power. Connections are as follows:

Pin A	Signal
Pin B	Signal

Standard Speed Pickups produce 60 pulses/revolution. The pulse amplitude is approximately proportional to shaft speed. Therefore, outputs are low at low speeds. **If you must measure speeds below 100 rpm or, if you are in an electrically noisy environment, you should use a Code Z Pickup.**

Replacement Code A Pickups can be ordered from the factory; P/N: 900-1001. Spare mating connectors can also be ordered; P/N: 224-3897.

B.2.5 Com Port Connector; 3 Pins

Torquemeters are shipped with a 20' Sensor to PC cable. The cable is made per Figure 5. If required, we can supply a 50 foot cable. RS232 runs greater than 50 feet require a repeater.

The Baud rate is fixed at 115,200. Eight data bits are used without parity. Neither handshaking or an ID is employed. If you wish to write your own software, see Appendix IV for serial communication commands. Spare mating connectors can be ordered; P/N: 320-1286. Call the factory should you need a spare cable assembly.

C. DT482 PC Interface Software

C. 1 DT482 PC Software Overview

Sensors are shipped with standard Windows-based PC interface software (Titled: DT482). That software provides for several valuable functions as follows:

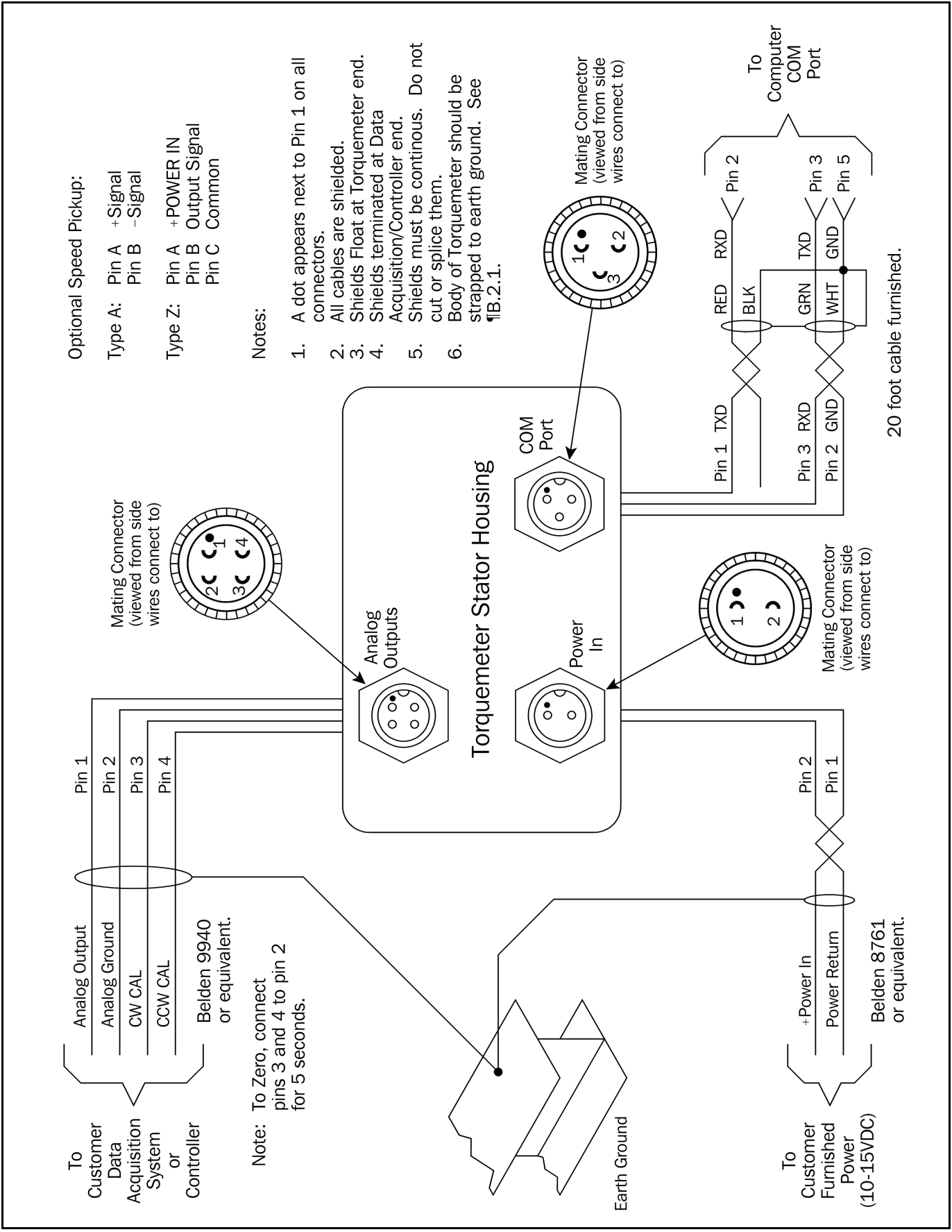
- Change Setup; Units of Measure, etc.
- Display Current Measured Torque
- Display Peak Torque
- Display Minimum Torque
- Display Torque Spread
- Make Real-time Torque Plots
- Store Data
- Store Test Setup
- Control Test Functions
- Perform dead weight calibration and archive cal data

All PC operated functions are accomplished by selecting options shown on the screen. The following paragraphs summarize the functions available. Page 1 lists the installed setup, when shipped. If desired, a user may write his own communication software; see Appendix IV for information on the serial command structure.

C.2 Change Sensor/Test Setup

- Select any of 10 units of measure. Default units are: lbf-in. See Appendix I for a complete listing.
- Select any of 11 data filter cutoff frequencies; 0.1 to 200 Hz in 1-2-5 steps. Data filters have neither delay distortion or overshoot errors.
- Select $\pm 5V$ or $\pm 10V$ full scale analog output.
- Set High and Low Torque Limits and display their status on PC screen.
- Save data to disk.
- Store test setup.
- Adjust the value of the analog output voltage. This is factory set at $\pm 5.000V$ and $\pm 10.000V$ and should not be re-adjusted without accurate measuring equipment.
- Invoke or disable password protection and enter a new password. Default condition is password protection disabled. The default password is **SHC**. You can change the password to any string but, **record the new one in a secure place.**

Setup changes made with the Interface Software don't require recalibration. Any change will automatically re-configure dependent parameters. For example, if units are changed from lbf-in to Nm, torque data and Cal Checks will be correct without further adjustments.



Optional Speed Pickup:

Type A: Pin A +Signal
Pin B -Signal

Type Z: Pin A +POWER IN
Pin B Output Signal
Pin C Common

Notes:

1. A dot appears next to Pin 1 on all connectors.
2. All cables are shielded.
3. Shields Float at Torquemeter end.
4. Shields terminated at Data Acquisition/Controller end.
5. Shields must be continuous. Do not cut or splice them.
6. Body of Torquemeter should be strapped to earth ground. See 1B.2.1.

Figure 5. Torquemeter Cable Connections

C.3 Display Torque Data

- Displays Current Torque numeric data with unit of measure.
- Displays Torque Peak and Valley numeric data with unit of measure.
- Displays Torque Spread numeric data with unit of measure.
- Classifies status of user set High and Low Torque Limits.
- Displays real time plots of Torque.

C.4 Test Control

You can initiate the following actions from a PC:

- Invoke CW and CCW Cal Checks.
- Invoke Torque Zeroing.
- Save current setup parameters.
- Save Data to disk.

C.5 Perform Dead Weight Calibration

Units are shipped with an NIST traceable dead weight calibration performed in our accredited laboratory; a Calibration Certificate is shipped with the sensor. The results of that calibration are stored in non-volatile memory and automatically loaded on power up. Remote, initiated either via PC (per ¶C.4) or by strapping (per ¶B.2.3.2), Calibration Checks are referenced to it.

The user can perform a dead weight calibration and store it in memory. The interface program prompts you through the process. If done, the original factory calibration will be archived as will subsequent dead weight calibrations.

However, *unless you have accurate, accredited calibration facilities, you should not substitute a field calibration for the factory calibration.* Rather, you can perform a field calibration for use as a rough check of operation. If an inaccurate or erroneous calibration is inadvertently stored, the factory calibration(s) may be recovered.

C.6 Calibration Intervals

For continuous or intermittent service, make periodic Calibration Checks per ¶B.2.3.2 or ¶C.4, above.

In applications requiring high accuracy, perform a *dead weight calibration in a accredited torque calibration laboratory at intervals specified by your QC Procedures.* If you do not have an established QC procedure, then we recommend an initial one year interval.

If the MCRT® Torquemeter is overloaded or operates abnormally, then calibrate/inspect it at once.

Himmelstein offers certified dead weight calibration service, traceable to NIST, for all its products. Its calibration laboratory is accredited (Laboratory Code 200487-0) by NVLAP, an arm of the NIST. For further information visit our website at www.himmelstein.com or, follow the accreditation link at www.nist.gov

D. Operating & Safety Considerations

D.1 Applicability

The following paragraphs apply to all MCRT® products.

D.2 Allowable Torque Loads

Operate an MCRT® torquemeter within its' full scale; see booklet cover for rating of this device.

D.2.1 Overload Considerations

The overload rating of an MCRT® Compact Digital Torquemeter is 2 times full scale. This torquemeters' overload is listed on the cover sheet. The torquemeter will not yield (evidenced by a non-return to zero) or fail if subjected to an *instantaneous peak torque* up to its' overload value.

Both the full scale and overload ratings are based on the peak stress seen by the transducer. They are independent of stress duration, except for cyclical (or fatigue) loading considerations; see ¶D.2.2. Virtually all rotary power producing and absorbing devices produce pulsating rather than smooth torque and power.

Thus, in addition to its' average torque and speed values, the driveline torque usually includes a fundamental (driving) frequency and superimposed harmonics. Torsional vibration magnitudes can be amplified by the driveline. See Bulletin 705 for further information. The Figure 6 waveform is typical of what occurs in the real world.

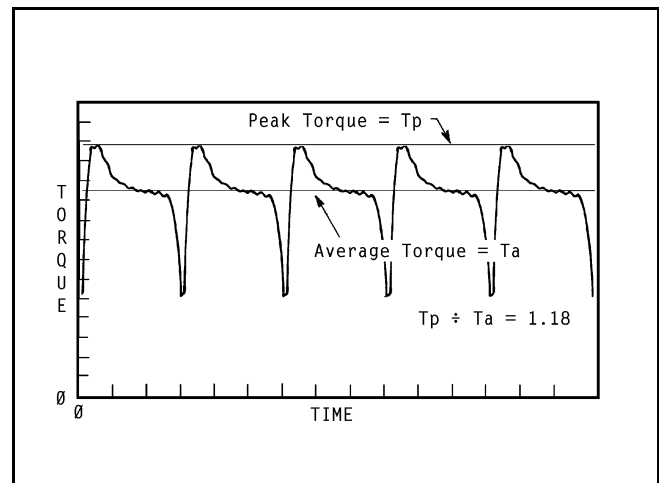


Figure 6. Reciprocating Machine Torque Profile.

For these reasons, a conservative design approach dictates the *torquemeters' overload => twice the probable peak torque. Reserve the region between the peak instantaneous torque and the torquemeters' overload rating as a safety margin for unexpected loads. Do not knowingly operate in the overload region.* If you expect torques in the overload region, then change to a torquemeter with a higher overload rating.

D.2.2 Fatigue Considerations

If the peak torque seen by an MCRT® torquemeter is less than half its *overload rating*, it can handle full torque reversals with infinite fatigue life. When peak torques are cyclical, and exceed 50% of the overload rating, then fatigue failure can occur.

D.2.3 Starting High Inertias with Electric Motors

When started across the line, *during the start*, a motors' developed torque can be several times its' rated torque. Thus, a Digital Torquemeter sized to handle the motors' rated load torque, can be overloaded during starting. Drivelines are particularly vulnerable when oversized motors drive light duty, high inertia loads.

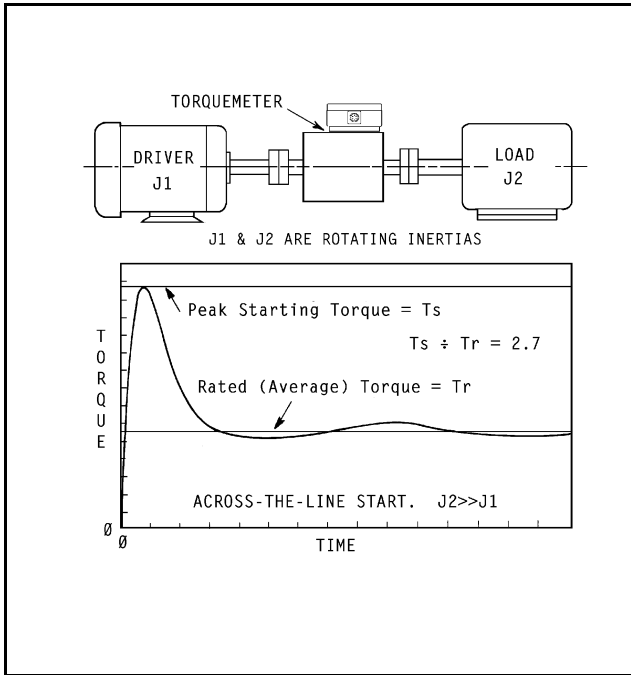


Figure 7. Motor Start Torque Profile.

To avoid damage when starting high inertia loads, use a torquemeter *rated for the starting torque or, limit the starting torque to a safe value.* Techniques to limit electric motor starting torques include:

- Use reduced voltage starting.
- Electronically limit the maximum motor current.
- Add inertia to the input side of the torquemeter. *Before operating, verify the motor can safely start the increased load inertia.*
- Use "shock absorbing" couplings. Careful coupling selection and thorough analysis is essential. Under some conditions, such couplings can aggravate rather than improve the situation.

D.3 Allowable Bearing Loads

MCRT[®] torquemeter bearing design provides long life, smooth running, and avoids bearing torque measurement errors. In a floating shaft installation, the stator must be *flexibly restrained* so total loads, including the stator restraint and shaft runout, don't exceed its bearing rating. A *stranded wire or braided cable* will provide this flexible restraint and strain relieve the electric cable.

When the stator is foot mounted, the coupling *end float must be sufficient to take up axial shaft motions and hold the bearing loads within the limits specified in the following table.*

When using shaft torquemeters in belt/chain drives, pillow blocks are usually needed to isolate them from radial bearing and bending loads (see ¶D.4). Consider pulley or wheel type torque sensors for such service. Their bearings are isolated from the belt loads, and they accept large radial and bending loads without damage or measurement errors.

Model	Bidirectional Bearing Load (lbs)	
	Radial	Axial
MCRT [®] 48201V	50	20
MCRT [®] 48202V	50	20
MCRT [®] 48203V	75	30
MCRT [®] 48204V	75	30

D.4 Allowable Extraneous Loads

Any moment or force a Torquemeter sees, other than the transmitted torque, is an extraneous load. Depending on the installation, these could include bending moments and axial thrust. Crosstalk errors from such loads, expressed in pound-inches, are typically 1% of the applied pound-inches of bending or, 1% of the applied pounds of thrust.

D.4.1 Allowable Bending Loads

When it is applied without thrust, a standard MCRT[®] Torquemeter, *mounted as a floating shaft*, can handle a shaft bending moment equal to one half its' torque rating. Such bending may be applied simultaneously with rated torque.

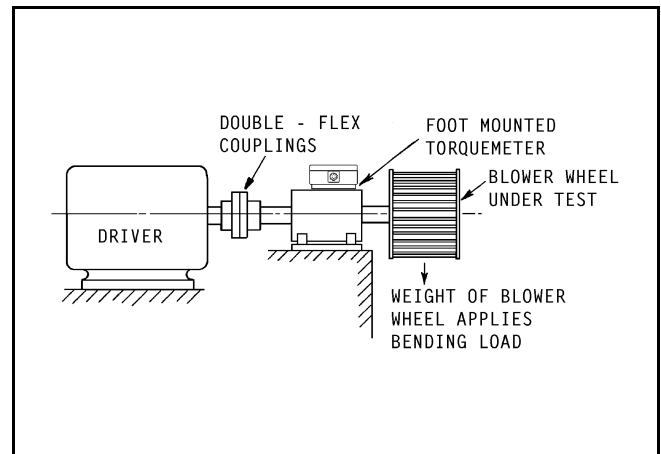


Figure 8. Torquemeter With Bending Load

The allowable bending input to a foot mounted torquemeter (Fig. 8) is dictated by its' bearing radial load ratings (see ¶D.3), and by the need to prevent coupling "lock-up". When a coupling locks-up, it no longer provides one or more needed degrees of freedom and, *ultimately causes a driveline failure.*

Caution

Use pillow blocks to isolate a foot mounted torquemeter from excessive bending and radial loads. When applying such loads, don't exceed a torquemeters' bearing load ratings; see Appendix II for explicit details.

D.4.2 Allowable Thrust Loads

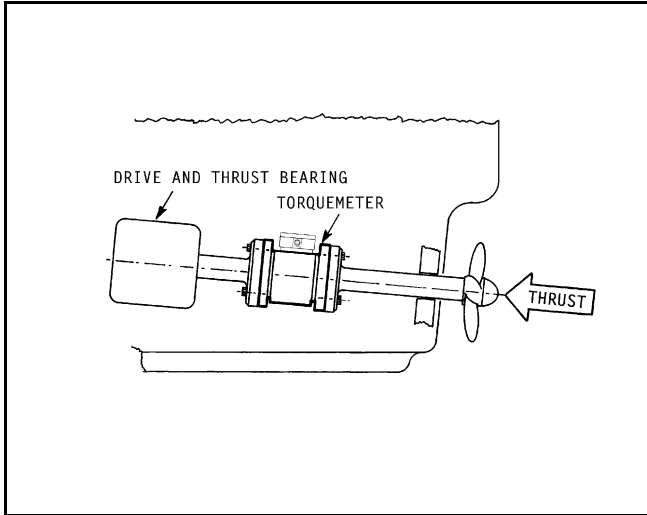


Figure 9. Torquemeter With Thrust Load

When applied without bending, most MCRT® Torquemeters, *when mounted as a floating shaft*, can handle a thrust load (tension or compression) in pounds, applied to its' shaft (see Figure 9), equal to its' torque rating in pound-inches. Some units may have different thrust capacities; refer to the applicable Specification or Descriptive Bulletin. Such thrust may be applied simultaneously with rated torque.

Caution

Large thrust loads are only allowable in floating shaft installations. Bearing axial loads limit the thrust capacity of foot mounted torquemeters; see ¶ D.3.

D.5 Operating Speeds

Operate MCRT® Digital Torquemeters within the maximum speed rating published in the pertinent specification and appearing on the cover of this booklet. The ratings are bi-directional. Standard torquemeters do not require external lubrication.

Caution

If a driveline part fails, dynamic balance is lost and the resultant forces can cause other part failures. Therefore, it is an essential safety requirement that guard covers, substantial enough to contain any separated mass, be installed.

D.6 Contaminants

Don't *flood* a torquemeter with liquids—they can interfere with IR signals and cause heat buildup from viscous losses at high speeds.

MCRT® devices are immune to spray from mineral based oils and natural, hydrocarbon hydraulic fluids. When using synthetic fluids, verify they are compatible with plastic, electronic components, and electrical insulation. Protect the Torquemeter from contact with fluids that attack insulation or plastics. Warranties are void for damage caused by such materials.

Airborne abrasive can cause premature bearing failure. When they are present, consider using an air purge to prevent invasion of such materials.

E. Troubleshooting

E.1 Scope

These discussions suggest procedures for identifying a defective system component. They are an aid for operating personnel. Special training and adequate inspection, test and assembly fixtures are needed for extensive service.

The installation, the Torquemeter, the cabling and the terminal device are all potential faults. The best procedure is to isolate the problem part, then correct or replace it. Otherwise, return the defective part to the factory.

E.2 Preliminary Inspection

E.2.1 Torquemeter

Inspect the sensor for physical damage. If the shaft is locked or a rub exists, remove the speed pickup, if present, per instructions contained in ¶E.4.3. If the fault clears, reinstall the pickup following ¶E.4.3 instructions. Otherwise return the unit to the factory.

E.2.2 Cabling and Earth Grounding

Make electrical checks for continuity and shorts; see Paragraph B.2 and Figures 3, 4 and 5 for connections. *Verify that the mating connectors are installed and secured.* Erratic connections, omission of shields and poor grounds can produce noise. If noise is a problem, then replace the cable with one that is shielded and *provide a good earth ground to the motor, machine base and Torquemeter housing per ¶ B.2.1.* Examine all cables for damage. Replace damaged cables. Clean connectors with an approved contact cleaner.

E.2.3 Readout Instrument/Data Acquisition System/Controller

Examine for physical damage, blown fuses and/or loose parts. Correct any defects; refer to the manufacturers' manual, as necessary.

E.3 Torque Subsystem

E.3.1 No Output When Torque is Present

Verify input power is present, its' polarity is correct, and the cable is intact, i.e., between 10 and 15 VDC appears at the Torquemeter terminals. Finally, verify the power supply is properly sized. That is rated for 10 to 15 VDC output and will handle at least 250 mA and preferably 500 mA.

Operate the Cal Check. If the analog output has the correct Cal Signal but the PC does not, then check the PC cable connections and verify the port is set per ¶B.2.5. If all checks are negative, the problem is in the sensor. Return it for factory service.

E.3.2 Constant Output Regardless of Shaft Torque

If the ¶E.3.1 above Cal Checks are performed and found normal, then the problem is the sensor. Return it for factory service.

E.3.3 Apparent Zero Drift

- **Check the Cabling.** See ¶E.2.2.
- **Check for Driveline Torque Offsets.** Torquemeters installed in a drive which has hysteresis or friction torques, may *appear* to have long term drift when there is none. For example, when installed between a pump and a gear drive, the torque reading may not return to zero after a test because of locked-in friction torque. The sensor sees and reads that locked-in torque. Always zero the Torquemeter with no torque on the driveline – in the case cited, with a coupling disassembled. At the end of the test, the shaft should be mechanically "shaken" or a coupling broken, to return to zero torque. Otherwise, the sensor will read locked-in torque. A rub between any rotating and stationary part is a common cause of friction. Verify the shaft couplings and other rotating parts have adequate clearance.

E.3.4 Signal Instability

- **Check the Cabling.** See ¶E.2.2 above.
- **Check For Driveline Torque Variations.** The driveline may have a low frequency oscillation which the sensor reads (see Tech Memo 8150). Use the Torquemeters' low frequency filter to suppress signals above 1 Hertz. If the readings become steady, then you may wish to identify the physical cause of the shaft torque variation or, remove it with mechanical filtering techniques. Oscillographic signal analysis is often helpful under these conditions. Use the 200 Hertz filter for this analysis. If very large, high inertia machines are used, or large machines are used in a control loop, torque and speed oscillations can be present below 1 hertz.

E.3.5 System Will Not Zero

- **Check the Cabling.** See ¶E.2.2 above.
- **Verify the Torque Input is Zero.** If the sensor is installed in a driveline, break or remove one of the couplings. If the system still can't be zeroed, then the problem is either the cable, system grounding or the Torquemeter. Verify cable integrity, configuration and connections and check the Torquemeter per ¶E.2.1.
- **Verify A Good Earth Ground,** per ¶B.2.1, is present.

E.4 Speed Pickup Replacement Speed pickups are threaded into the sensor stator housing and locked with a jam nut.

E.4.1 Removing A Defective Pickup

- Disconnect the mating cable.
- ***With shaft motion stopped,*** loosen the jam nut.
- Back out the defective speed pickup.

E.4.2 Installing A Replacement Pickup

- ***With shaft motion stopped,*** screw in the new pickup until it makes contact with the rotor assembly.
- Back off the pickup one quarter of a turn.
- Tighten the jam nut.
- Slowly rotate the shaft to verify no rub occurs. If you detect a rub, re-adjust the pickup.
- Reconnect the mating cable.

E.4.3 Replacement Part Numbers

- Standard (Code A) Speed Pickup P/N: 900-1001
- Zero Velocity (Code Z) Speed Pickup P/N: 900-1007

Appendix I

MCRT® 48200V Torquemeter Specification

General Specifications		Code N Performance	Code C Performance
Accuracy (combined nonlinearity, hysteresis and nonrepeatability, % of Range)		<= ±0.20	<= ±0.10
Remote Calibration Accuracy* (% of Range @ 75 °F/23.9 °C, traceable to NIST)		<= ±0.10	<= ±0.05
Temperature Effects	Zero Drift (% of Range/°F)/(%) of Range/°C)	<= ±0.004/<= ±0.007	<= ±0.0017/<= ±0.003
	Span Drift (% of Reading/°F)/(%) of Range/°C)	<= ±0.004/<= ±0.007	<= ±0.0017/<= ±0.003
	Compensated Range (°F)/(°C)	+75 to +150/+23.9 to +66	
	Useable Range (°F)/(°C)	+32 to +175/0 to 79.4	
Analog Output <small>(Resolution: 0.02% on ±10V & 0.04% on ±5V output) (Source Impedance: < 1Ω)</small>	CW/CCW Output at Full Scale	+10V/-10V or +5V/-5V, user selectable. Default is +10V/-10V.	
	Bandwidth (Hz.); has Bessel Response Data Filter(s)	DC to 0.1 thru 200 in 1-2-5 steps	
	Noise and Ripple (rms, % of Range)	<= 0.1	
	Overrange (% of Full Range)	30	
	Maximum Allowable Resistive and Capacitive Loads	10kΩ Minimum and 0.05uF Maximum	
Rotational Effect on Zero (% of Range)	<= ±0.05	<= ±0.025	
RS232C Port (115,200 Baud)	Outputs Torque in Engineering Units. Inputs units of measure, scaling, signal filter selection(option), zero, span, cal data and commands.		
Supply Voltage	10 to 15 VDC @ 200 mA, nominal. Has reverse polarity and 25 Volt overvoltage protection.		
Available Options	Enhanced Performance - Code C, Code N is standard performance. 60 PPR Speed Pickup Options: Code A is standard type, Code Z is Zero Velocity type, Code N denotes no pickup. A Type Z pickup is recommended for low speeds and/or operation in electrically noisy environments.		
Supported Units of Measure	lbf-in, lbf-ft, ozf-in, ozf-ft, N-m, kN-m, N-cm, kgf-m, kgf-cm, gf-cm		

MCRT® MODEL	TORQUE RANGE		TORQUE OVERLOAD		SPEED RATING* (RPM)		SHAFT STIFFNESS**	ROTATING INERTIA	MAX WT.
	[lbf-in]	[n-m]	[lbf-in]	[n-m]	Code N	Code C			
48201V(25-0)	25	2.82	50	5.65	0 to ±8,000	0 to ±15,000	1,800	0.031	10
48201V(5-1)	50	5.65	100	11.3	0 to ±8,000	0 to ±15,000	5,000	0.031	10
48201V(1-2)	100	11.3	200	22.6	0 to ±8,000	0 to ±15,000	12,000	0.031	10
48201V(2-2)	200	22.6	400	45.2	0 to ±8,000	0 to ±15,000	26,000	0.031	10
48202V(5-2)	500	56.5	1,000	113	0 to ±7,000	0 to ±12,000	66,000	0.032	10
48202V(1-3)	1,000	113	2,000	226	0 to ±7,000	0 to ±12,000	85,000	0.032	10
48203V(2-3)	2,000	226	4,000	452	0 to ±6,500	0 to ±8,500	288,000	0.080	10
48204V(5-3)	5,000	565	10,000	1,130	0 to ±6,000	0 to ±8,500	545,000	0.100	11
48204V(1-4)	10,000	1,130	20,000	2,260	0 to ±6,000	0 to ±8,500	684,000	0.100	12

*Ratings are for continuous operation without external lubrication. **Stiffness is conservatively rated and includes the torsion section and shaft ends.

Appendix II

Belt and Chain Drive Considerations

Caution. Don't install a pulley or sprocket on the torque meter shaft unless the torque meters' radial bearing load rating, from ¶D.3, is :

$$\geq [\text{Torque Rating}] / [4 * L]$$

and,

$$\geq [T_1 + T_2] * [1 + L/H]$$

These criteria assure safe torque meter bending and bearing loads. To simplify your analysis, assume $T_2 = 0$ and calculate $T_1 = [\text{Torque Rating} * 2 / D]$. Then, make $[T_1 + T_2] = 1.1$ times the calculated value of T_1 .

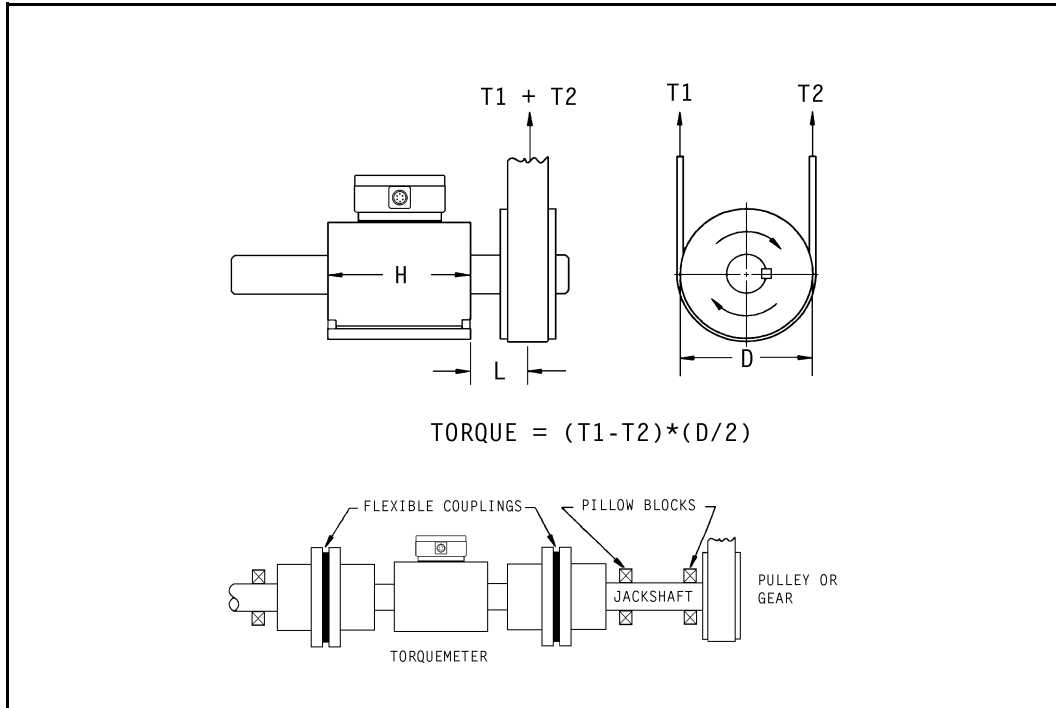


Figure 10. Installation Definitions

When the bearing load ratings don't meet the above criteria, use pillow blocks and a jack shaft to isolate the pulley/belt loads; see Figure 10 example. Alternatively, consider a pulley or wheel type torque meter. Their bearings are isolated from the belt loads, and they can accept large radial and bending loads without damage or measurement errors.

Appendix III, Mating Stator Connector Part Numbers

MCRT® 48200V Torquemeters are furnished with mating connectors and cable. Mating Connectors are supplied for Power (2 Pins) and for Analog Outputs and Cal Enable (4 Pins). Additionally, a Com Port-to-PC cable is also provided. That cable has connectors at each end. When a speed pickup option is ordered, the appropriate mating connector is supplied; 2 pins for a Type A pickup and 3 pins for a Type Z pickup.

To order spare connectors, use the following part numbers (P/N).

Function	Number of Pins	Part Number
Power Connector	2	320-1285
Analog Output/Cal Enable/Zero	4	320-1287
Com Port Connector	3	320-1286
Type A Speed Pickup	2	224-3897
Type Z Speed Pickup	3	224-5361

Appendix IV

Serial Communications for the MCRT[®] Compact Digital Torquemeter

This specification of the serial communications for the MCRT[®] 48200V is subject to change at any time without notice.

- Lines that end in " =a.b" apply only to version a.b
- Lines that end in " >c.d" apply only to versions >c.d
- Lines that end in " <e.f" apply only to versions <e.f

General conventions used in this document

- <OK> stands for the string "OK"
- <index> is an alphanumeric character (A-Z or 0-9)
- <CR> is a carriage return (^M / 13 decimal / 0D hexadecimal / 15 octal)
- <LF> is a line feed (^J / 10 decimal / 0A hexadecimal / 12 octal)
- <int> is a integer (e.g. "1234")
- <float> is a floating point number string (e.g. "1234.57")
- <string> is a string (e.g. "LB-IN")
- <hex> is a hexadecimal *string* (e.g. hex could be "8FC4")
- <base64> is a base-64 *string* with "0-9A-Za-z@_"
- <Bool> is either a '0' which means false, or '1' which means true.
- <HF> is an 8 character hexadecimal string that represents a IEEE-float. (A 1-bit sign, 8-bit exponent biased by 126, and a 23-bit mantissa with an implied MSB of 1)
 - 0x80000000 : Sign (0 = positive, 1 = negative)
 - 0x7F800000 : Exponent
 - 0x007FFFFFFF : Mantissa
 - if (sign = 0) then value = $(2 ^ (\text{Exponent} - 24)) * (\text{Mantissa} + 0x800000)$
 - else value = $-(2 ^ (\text{Exponent} - 24)) * (\text{Mantissa} + 0x800000)$

General information

- All messages to and from the MCRT48200V are terminated with a <CR> or <LF>.
 - The default termination character is <CR>.
- To set a value on the MCRT48200V, find the message that retrieves the data you want to change. Then append to that message the desired value of the parameter. The MCRT48200V should respond with "OK".
- All hexadecimal/binary data from the MCRT48200V is in big-endian (MSB first) format.

In response to any command, the MCRT48200V returns one of the following:

- "string" where string is the data requested.
- "OK" operation was successful.
- "!Command:xx" command "xx" is not recognized.
- "!Channel" command is inappropriate for the given channel.
- "!Arg" parameter is malformed.
- "!Index" an index <index> is bad (see "CC" for example)
- "!Invalid" there is some other error.
- "!Unknown Error" an unknown error occurred.
- "!Signal Too Small" calibration signal is too small in magnitude.
- "!Signal Too Large" calibration signal is too large in magnitude.
- "!Signal has wrong sign" calibration signal is of the wrong sign for the requested calibration.

Examples:

Remember ***ALL*** messages to and from the MCRT48200V series end with a <CR> or a <LF>.

- Retrieve data for channel 1:
Send "DC1" to the MCRT48200V. The "DC" is the data current command, and the "1" is for channel 1. The return message should look something like "1234.56".
- Retrieve data for channel all channels:
Send "DC0" to the MCRT48200V. The "DC" is the data current command, and the "0" designates all channels. The return message should look something like "1234.56,987.654,11.2233".
- Retrieve the filter on channel 2:
Send "FL2" to the MCRT48200V. The return message should be something like "07" which implies (referring to the appropriate list under the "FL" message) that channel 2 has a filter of 20 Hz.
- Set the filter of channel 2 to 100 Hz:
Refer to the list under the "FL" (filter) command to find that a 100 Hz filter corresponds to the value 09. Therefore, send "FL209" to the MCRT48200V. The MCRT48200V should respond with "OK" if the operation was successful.
- Change the unit name of channel 1 to "LBF-IN":
Send "UN1LBF-IN" to the MCRT48200V. The MCRT48200V should respond with "OK" if the operation was successful.
- Retrieve the version number of the MCRT48200V:
Send "VR" to the MCRT48200V. The return message should be something like "Model MCRT48200V v1.2".

Informational Only Messages:

- These messages can only retrieve information from the MCRT48200V -- they can not change any data on the MCRT48200V.
- The time returned is the number of 10kHz clock ticks since the MCRT48200V was powered on.

MESSAGE	REPLY	MEANING
DC	float	Current engineering data for the torque.
XC	hex	Current hexadecimal data for the torque.
YC	hex, hex	Time and Current hexadecimal data for torque
64	base64	Current base-64 data for the given channel.
65	hex, base64	Hexadecimal time and Current base-64 data for the given channel.
MX	int, int	The max and min of the torque. Multiply by the scaling constants (SC command) to get lbf-in.
SN	string	Serial number of the MCRT48200V.
SP	string	Scratch pad of the MCRT48200V.
MD	string	Model number of the MCRT48200V.
PP	Bool	Is flash password protected?
VR	string	Version number of firmware.
AD	A/D readings	int, int, int <ul style="list-style-type: none"> ○ 1st number: temperature sensor ○ 2nd number: F-coil voltage ○ 3rd number: Input voltage
SC	hexfloat, hexfloat	Positive/Negative Scaling Constants

Analog Output Messages:

MESSAGE	REPLY	MEANING
AI index	OK	Analog output user tweak values <ul style="list-style-type: none"> ○ index: <ul style="list-style-type: none"> ▪ A: +10V value ▪ B: +5V value ▪ C: +0V value ▪ D: -5V value ▪ E: -10V value

Miscellaneous Messages:

MESSAGE	REPLY	MEANING
@@	OK	Write data in RAM to non-volatile flash
PS index string	OK	Change Flash password protection <ul style="list-style-type: none"> ○ string must match the current flash password ○ index: <ul style="list-style-type: none"> ▪ A: Disable flash password protection. ▪ B: Enable flash password protection, but still allow taring of the torque. ▪ C: Enable flash password protection.
PC string: string: string	OK	Change flash protection password. <ul style="list-style-type: none"> ○ If the first string equals the current password, and the second and third strings are equal, then change the flash protection password to the second string.

Torque Specific Messages:

MESSAGE	REPLY	MEANING
UN	string	Unit name of torque
TV	int	Current Tare Value (16 bits) <ul style="list-style-type: none"> ○ Chars 1- 4: Current Tare Value In A/D Units
TT	OK	Tare Torque
SC	HF HF	Scaling Constants positive, negative <ul style="list-style-type: none"> ○ Chars 1- 8: Positive scaling constant (IEEE-float) ○ Chars 9-16: Negative scaling constant (IEEE-float)
AS index	OK	Apply Shunt to AC-Carrier channel <ul style="list-style-type: none"> ○ index: <ul style="list-style-type: none"> ▪ A: no-shunt applied ▪ B: Apply Positive Cal Signal ▪ C: Apply Negative Cal Signal

Torque Specific Messages (cont.):

MESSAGE	REPLY	MEANING
DS	HF	<p>Display Scaling</p> <ul style="list-style-type: none"> ○ 0xFFFFFFFF : Display Scaling (IEEE-float) <ul style="list-style-type: none"> ▪ The native units (lbf-in) for the channel's data are multiplied by this number before being sent to the user. ▪ Only data from the DC command is subject to this scaling
FL	int	<p>Filter (0-10) (4 bits)</p> <ul style="list-style-type: none"> ○ 0: No Filter ○ 1: 500 Hz ○ 2: 200 Hz ○ 3: 100 Hz ○ 4: 50 Hz ○ 5: 20 Hz ○ 6: 10 Hz ○ 7: 5 Hz ○ 8: 2 Hz ○ 9: 1 Hz ○ 10: 0.5 Hz ○ 11: 0.2 Hz ○ 12: 0.1 Hz
MX0	OK	Set the max and min data to the current torque data.
CL index	long	<p>Do a calibration. This message takes at least 1 second to finish!</p> <ul style="list-style-type: none"> ○ index <ul style="list-style-type: none"> ▪ A: Do a Zero Calibration ▪ B: Do a Positive Load Calibration ▪ C: Do a Negative Load Calibration

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