INSTALLATION, OPERATION AND TROUBLESHOOTING GUIDE FOR

ULTRA PRECISION DIGITAL TORQUEMETERS

Applies to Series MCRT® 48800V, MCRT® 49800V, MCRT® 59800V and MCRT® 79800V

Customer: _____

Model Number: _____

Serial Number: _____

Factory Reference Number: _____

Horsepower at Max Rated Torque and Speed: _____

Maximum Rated Torque (lbf-in): _____

Low Range (if present) Torque Rating (lbf-in): _____

Torque Overload Capacity (lbf-in): _____

Overrange Rating: 150% on all outputs. _____

Maximum Speed (rpm): _____ Performance Code: _____

Foot Mount: (   ) Yes   (   ) No

Speed/Horsepower: (   ) Yes   (   ) No

Special Features:_____

_____

_____

Scaling, Units of Measure and Pin Assignments if Different Than Default

Torque Range(s):_____

Speed Range: _____

Power Range: _____

Filter Cutoff Frequency (Hertz): _____

Password Protection: (   ) On   (   ) Off

Calibration Data is listed on the attached Calibration Certificate. It is loaded on power up and can be accessed using a PC and the supplied software.

S. Himmelstein and Company
Designing and Making the World's Best Torque Instruments since 1960

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TABLE OF CONTENTS

I. Introduction

These transducers measure and output *shaft torque, power and speed.* Speed and power are optional. *They have no pots, switches or manual adjustments.* Null, scaling and units of measure are stored in non-volatile memory. Digital computation of power is errorless. Thirty three (33) common units of measure are supported. You can select any supported unit of measure(s) without the need to re-calibrate. Thirteen (13) selectable Bessel filters *avoid delay distortion and overshoot* and assure optimal measurement response in your application(s). Input power is a single, unregulated dc supply. Reverse polarity protection is standard.

If you re-calibrate, previous calibration values are archived. Pin strapping and serial commands enable simultaneous, traceable* torque/power/speed calibrations, remote tare, tare clear, max/min reset and remote zeroing. Password protection may be invoked if needed. Included interface software operates on Windows-based PC's and displays and plots real time data. Use it to select ±5V or ±10V analog outputs, filter cutoff frequency, scaling, units of measure, zero, tare, clear tare, store data, etc. and/or to control measurements.

Strain gages sense torque on the rotor where it is digitized and transmitted to stator circuitry. That circuitry decodes and conditions the signals as scaled analog and digital outputs. Both signal and power transfer is done inductively, without brushes or any physical contact. The transmission system doesn't generate noise or wear and is immune to ambient noise, vibration, lubricants and other hostile environments.

Circuitry is shielded from RFI and external magnetic fields which fact, combined with the absence of low level cables, yields extraordinary noise immunity, even close to large electric machines. Elimination of slip rings, brushes, fragile ferrites, and other limited-life, noise-generating and noise susceptible elements further increases performance and reliability. Moreover, the *non-ferrite design* makes these transducers suitable for diesel and other hostile applications.

A. Mechanical Installation

A.1 Applicability

This discussion is applicable to all models.

A.2 References

MCRT® 48800V, 49800V, 59800V, and 79800V transducers are mechanically interchangeable with the MCRT® 48000V, 49000V, 59000V and 79000V, DC Operated Torquemeter models with the

same full scale ranges and overload ratings. That is, they share the same physical dimensions. However, unlike the analog torquemeters, they:

- Use advanced digital technology to measure torque and transfer it to the stator
- Have integral digital speed (an option) conditioning and output circuitry
- Calculate shaft power (an option)
- Have no manual adjustments
- Output three 5V or 10V analog signals (user selectable)
- Have thirteen selectable filter cutoff frequencies
- Have a full duplex RS232/422/485 port
- Come with PC interface software
- Have improved long term drift
- Support 33 mouse selectable units of measure.

These Torquemeters also have *improved temperature performance, overrange ratings, combined nonlinearity and hysteresis, long term stability, wider bandwidth and, when present, much faster power computations* than earlier models.

A.3 Coupling Selection

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

Floating shaft installations are applicable to both shaft and flanged type torquemeters. 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: If electrical connections are run in a short, rigid conduit, you must foot mount the torquemeter. Alternately, use flexible conduit and single flex couplings.*

Install a foot mounted torquemeter between double *flex*

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

Figure 1. Floating Shaft Installation

Driver — Single-Flex Couplings — Load — Flexible Restraining Strap — Torquemeter Installed as Floating Shaft

Figure 2. Foot Mounted Installation

Figure 2. Foot Mounted Installation

Figure 3. Preferred Thrust Path

Figure 3. Preferred Thrust Path
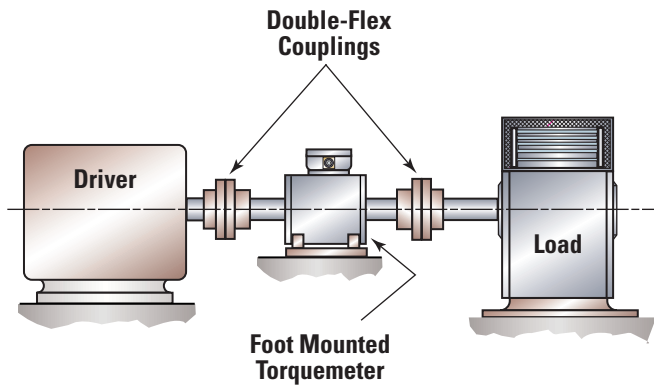
couplings as shown. The double flex couplings accommodate both parallel and angular misalignments.

Appendix IX discusses the choice of a foot mounted or a floating shaft installation. It also contains additional comments on coupling selection. *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.4 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 torquemeter shaft with an anti-seizing compound suitable for use at 400 deg. F. Next, heat the coupling hub, *not the torquemeter*, to approximately 400 deg. F. Then, install the coupling.

The heated coupling hub should "slip" on the torquemeter shaft without significant resistance. That is, coupling installation force shouldn't exceed 10% of the axial load tabulated in ¶ C.3. 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 torquemeter with anti-seizing compound. If cooling is speeded with water dampened rags, *orient the torquemeter 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 torquemeter stator, and
- The shaft-to-coupling fit is snug enough to prevent vibration induced coupling motion.
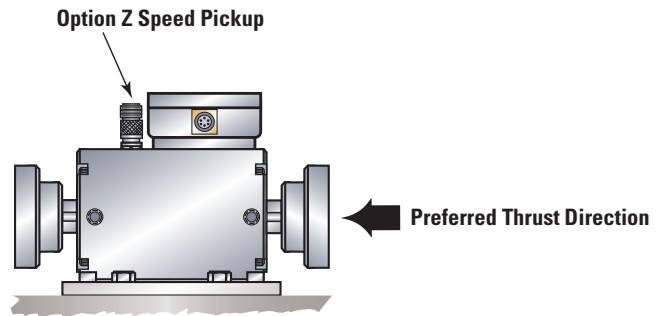
To Avoid Damage Or Injury

- ***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 torquemeter.***

A.5 End-to-End Orientation

A.5.1 Effect on Signal Polarity

MCRT® torquemeters 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 torquemeter end-for-end doesn't change the torque direction or magnitude. Therefore, it will have no effect on the torquemeter 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.

Torque signal polarity is fixed at the factory and is not field changeable.

A.5.2 Effect on Torquemeter Thrust Capacity

*Orienting a **foot mounted** torquemeter per Figure 3 will provide increased uni-directional thrust capacity.* Because dynamic thrust loading is usually bi-directional, it's safest to limit bearing axial (thrust) loads per ¶ C.3. ***Orientation does not affect the thrust capacity of torquemeters installed as floating shafts.***

When axial bearing loads are *uni-directional,* the orientation illustrated in Figure 3 increases the unidirectional thrust rating by a factor of four (4). Remember, the *increased uni-directional rating applies only to optimum orientation of foot mounted torquemeters.*

A.6 Vertical Installations & Belt/Chain Drives

Vertical installations frequently require special mounting and coupling selection considerations. See Appendix X for vertical installations and Appendix XIV for belt/chain drives.

B. Electrical Installation

B.1 Applicability

This section is applicable to all MCRT® 48800V, 49800V, 59800V and 79800V Ultra Precision Digital Torquemeters.

B.2 Stator Connectors

Four connectors as follows: one 10 pin, one 8 pin, and twin (2) 6 pin connectors. If ordered without readouts, one each 10, 8 and 6 pin mating connector is supplied. A connector terminated, RS422 twenty foot Com Port to PC cable is also furnished. The following tables list pinouts for the 4 user connectors.

Note: to invoke a command, ground the control pin or drive it with a logic zero. Output flags are Low (0V) when within rating and High (3V) if outside rating; see Appendix V if you wish to drive an external optical relay.

B.3 Wiring Cautions and Tips

Reverse polarity protection is standard. Although any wire may be used, shielded cable performs best in noisy environments and is

10 Pin Connector Pinout

Pin A	Invoke Clockwise Calibration
Pin B	Tare Data
Pin C	Clear Tare
Pin D	Ground Return
Pin E	+ Power Input (10 to 26 VDC)
Pin F	Resest Max/Min's
Pin G	Temperature Status. See Appendix V of you wish to drive an optical relay.
Pin H	Torque Status. See Appendix V if you wish to drive an optical relay.
Pin J	Speed Status. See appendix V if you wish to drive an external optical relay.
Pin K	Invoke Counterclockwise Calibration.

Twin 6 Pin Connector Pinouts

Pin A	+ TXD
Pin B	Ground for RS422/485, Open for RS232
Pin C	Ground
Pin D	- RXD or TXD
Pin E	+ RXD or RXD
Pin F	- TXD

Both identical connectors are wired in parallel to facilitate RS485 connections to multiple Torquemeters. Either connector may be used for RS232 or RS422 service.
The terms TXD and RXD apply to RS232 applications. The terms ±TXD and .±RXD apply to RS422 and RS485 applications.

8 Pin Connector Pinout

Pin A	Speed Analog Out (±10V)
Pin B	Power Analog Out (±10V)
Pin C	Analog Signal Ground
Pin D	+ Power Input (10 to 26VDC)
Pin E	Invoke Clockwise Calibration
Pin F	Invoke Counterclockwise Calibration
Pin G	Torque Analog Out (±10V)
Pin H	Digital Ground/Power Return

Default pinout is shown; it assumes Option Z is present. **Default without Option Z is:** Pins A and B are +5V and -5V Torque analogs thus, they provide a differential ±10V torque output. Pin G remains a ground referenced ±10V torque signal.

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strongly recommended. The shield should float at the Transducer, tie the other end to earth ground.

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

Connect the transducer 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 and the test stand components as shown in the sketch. **Don't "daisy chain" the connections; see Figures 4 and 5.**

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, as well as reading errors from excessive noise. VFD's should have shielded power and motor cables. Belden Types 29500 thru 29507cable are designed for VFD use. See "Cable Alternatives for PWM AC Drive Applications" at www.belden.com. Use the connections shown in Figure 20 of that document. For best results in noisy environments, use a differential input amplifier and the differential output configuration.

B.4 As Delivered Pin Connections

Unless specified in the customers' order, Torquemeters are delivered with the default pin connections defined in ¶ B.2 and expanded in ¶ B.5. If specified differently, the connections are defined on the manual front page or in an equivalent document.

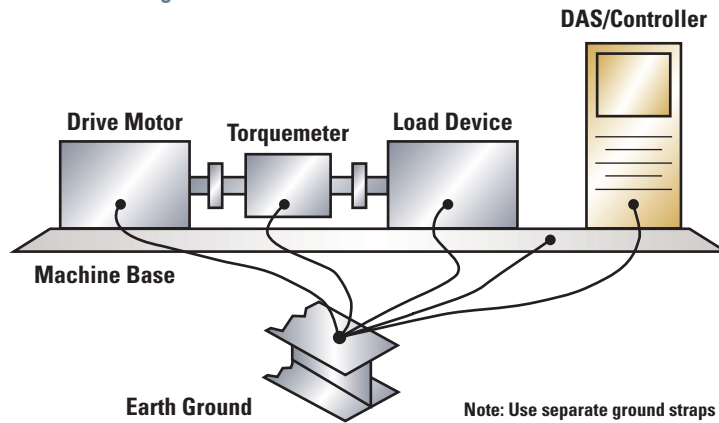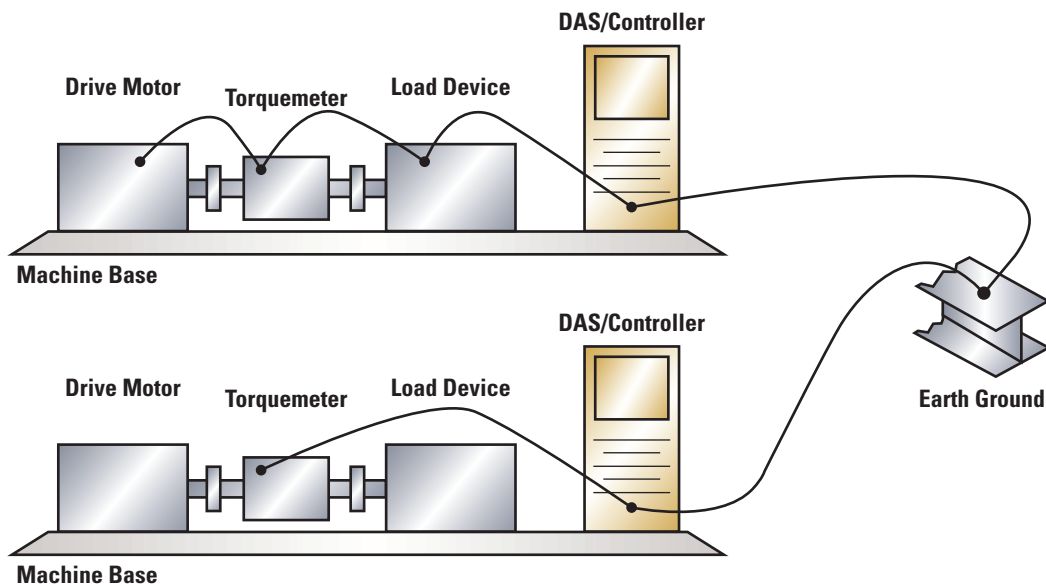## Figure 4. Correct System Earth Grounding

Figure 5. Examples of Incorrect Earth Grounding

B.5 Analog Output Default Pin Assignments Summarized

Unless requested differently, units are shipped with the default pin assignments listed below. The user may re-assign any three analog output signals present in any combination. For example, using the supplied software, if Torque, Speed and Power outputs are present (Code Z Option), you can output Two Torque Signals and Power, etc.

B.5.1 Eight (8) Pin Connector: MCRT® 48800V, 49800V, 59800V with Speed/Power Option

Pin A ±10V Speed Output

Pin B ±10V Power Output

Pin G ±10V Torque Output

Pin C Analog Ground

B.5.2 Eight (8) Pin Connector: MCRT® 48800V, 49800V, 59800V without Speed/Power Option

Pin A ±5V Torque Output

Pin B ±5V Torque Output

Pin G ±10V Torque Output

Pin C Analog Ground

B.5.3 Eight (8) Pin Connector: MCRT® 79800V with Speed/Power Option

Pin A ±10V Speed Output

Pin B ±10V Low Range Torque Output

Pin G +10V High Range Torque Output

Pin C Analog Ground

B.5.4 MCRT® 79800V without Speed Option - Default Pin Assignments

Pin A ±10V Low Range Torque Output

Pin B ±5V High Range Torque Output

Pin G ±10V High Range Torque Output

Pin C Analog Ground

B.6 Cables

Shielded cables should be used to avoid noise pickup. The shields should float at the Torquemeter end and all should be terminated at a single earth ground. Don't run transducer cables in close proximity to power lines.

Figure 6 illustrates cable connections for multiple Torquemeters with Option Z, conditioned Speed and Power Outputs, to a host computer with an RS232 port. If the computer has an RS422 port, a converter isn't needed. For computers with USB ports see Appendix VI.

B.7 Calibration Function

These Torquemeters have rotor side, bi-polar shunt calibration. That is, a stable, precision resistor is shunted across the torque bridge in response to a user initiated command. The resultant Cal signal is referenced to the factory dead weight torque calibration and, is NIST traceable. Thus, when invoked, it permits calibration of the users' data acquisition system, traceable to NIST. Further-more, it permits verification of the entire data chain in both the CW and CCW directions.

Figure 6. Cable Connections for Multiple Torquemeters Connected to a Single Host Computer
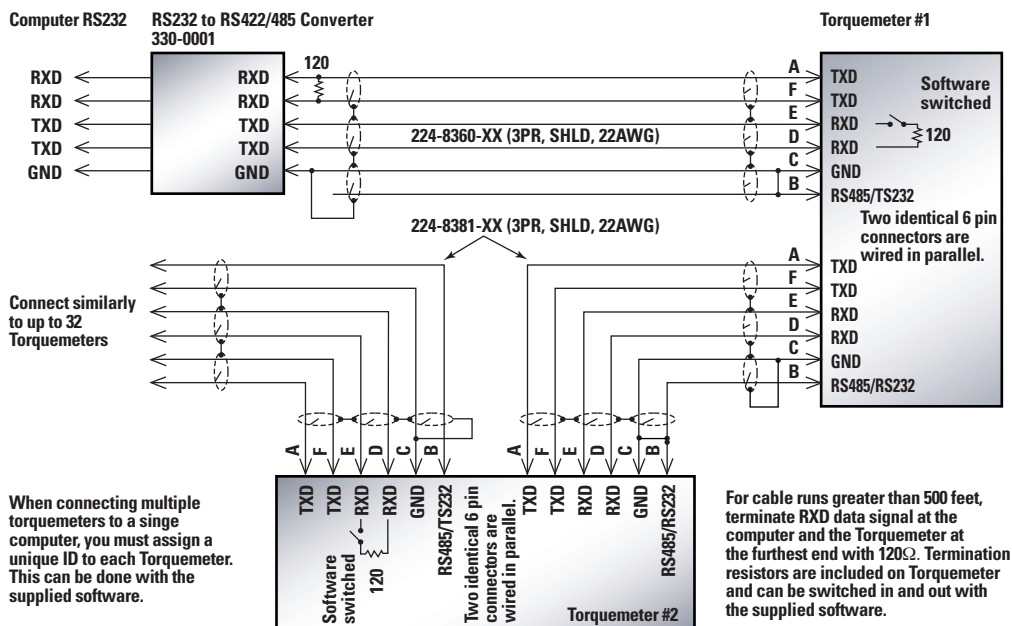
Calibration may be invoked from your PC using the supplied interface software. Alternately you can invoke calibration by grounding pins as follows:

CW Calibration: ground Pin A on the 10 pin connector, or ground Pin E on the 8 pin connector.

CCW Calibration: ground Pin K on the 10 pin connector, or ground Pin F on the 8 pin connector.

Invoking a Cal Check produces simultaneous calibration signals for all outputs, i.e, Torque and, with Option Z present, Speed and Power. 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.**

Always remove the Cal Check command before running a test.

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

B.8 Clockwise (CW) and Counterclockwise (CCW) Definition

CW Torque causes the shaft to turn CW when viewed from the driven end. CCW Torque causes the opposite rotation. Power polarity tracks the torque. Himmelstein uses the following polarity definitions:

CW Torque produces a positive output signal.

CCW Torque produces a negative output signal.

When the Torque is CW, the Output Power is positive.

When the Torque is CCW, the Output Power is negative.

Speed Output is always positive.

B.9 Tare Function

The Tare function is intended to cancel or "zero" a residual value that is not due to a permanent shift in the Torquemeter itself. For example, if you are interested in seeing the result of a transmission shift, you can Tare the running Torque before the shift and then see the resultant shift torque.

Caution: Unless you remove the Tare Value, by using the Clear Tare function, subsequent readings will be in error due to the residual Tare. Tare values are deleted when power is turned off. The Tare and Clear Tare functions can be invoked from a remote PC with the software furnished. They can also be invoked by driving control pins, as follows:

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

Invoke Tare by grounding Pin B of the 10 pin connector.

Clear Tare by grounding Pin C of the 10 pin connector.

B.10 Torque Zeroing

The Zero function is intended to correct a minor long term drift or slight yield in the torquemeter itself. ***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 before attempting to Zero the Torquemeter. Should the Torquemeter Zero shift by more than 1% of the Torquemeter Full Scale Rating, return the Torquemeter to the factory for re-calibration and/or service, if indicated. Zero adjustments are retained during power off and automatically accessed when power is re-applied.

The Zero function can only be accessed using the supplied software.

C. Operating & Safety Considerations

C.1 Applicability

The following paragraphs apply to all MCRT® products.

C.2 Allowable Torque Loads

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

C.2.1 Overload Considerations

The overload rating of an MCRT® Torquemeter is usually 2 times (Series 48800V), 4 times (Series 49800V) or 10 times (Series 59800V) full scale, but can be lower. This torquemeter's overload rating is listed on the cover sheet. A Himmelstein 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 ¶ C.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 Technical Memorandum 8150 for further information. The Figure 7 waveform is typical of what occurs in the real world.

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.

C.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. Refer to Appendix XI for additional details.

C.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 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.

To avoid damage when starting high inertia loads, use a torque meter *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

C.3 Allowable Bearing Loads

MCRT® Torquemeter bearing design provides long life, smooth running, and avoids bearing torque measurement errors. These results are achieved, in part, by providing optimum bearing pre-load. A lower pre-load would degrade high speed performance. A higher preload would increase bearing friction torque, increase measurement error, and reduce bearing life.

In a floating shaft installation, the stator must be *flexibly restrained* so total loads, including the stator restraint and shaft run-out, 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 torquemeters in belt/chain drives, pillow blocks are usually needed to isolate them from radial bearing and bending loads (see ¶ C.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.

Figure 7. Reciprocating Machine Torque Profile
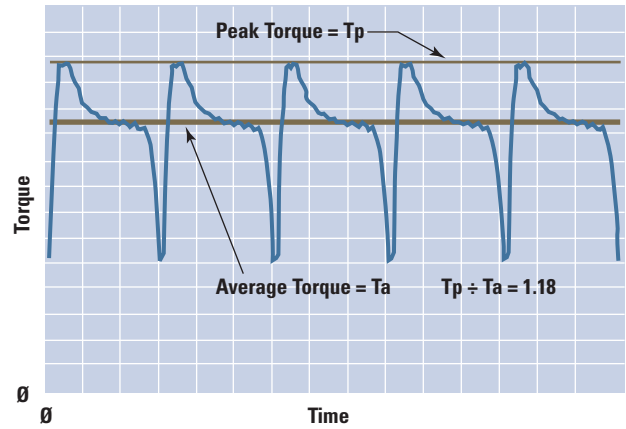
Figure 8. Motor Start Torque Profile

J1 & J2 Are Rotating Inertias
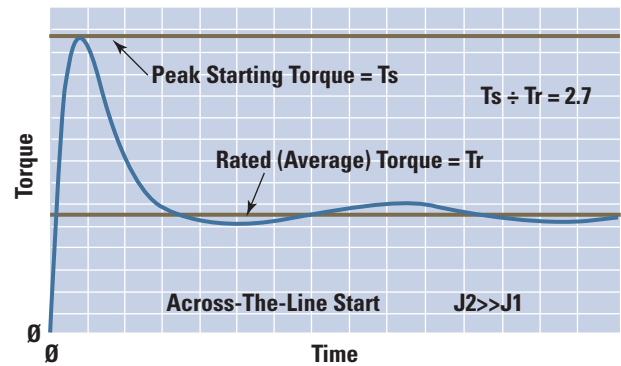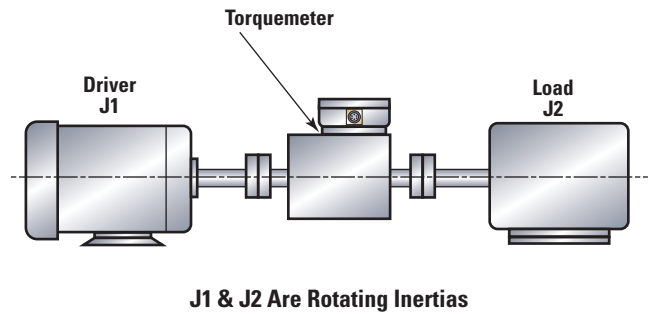
Shaft Type Digital Torquemeters	Bi-directional Bearing Load	
	Axial (lbs)	Radial (lbs)
MCRT® 48801/49801/59801/79801V	15	30
MCRT® 48802/49802/59802/79802V	30	80
MCRT® 48803/49803/59803/79803V	35	100
MCRT® 48804/49804/59804/79804V	35	100
MCRT® 48806/49806/59806/79806V	55	150
MCRT® 48807/49807/59807/79807V	70	200
MCRT® 48808/49808/59808/79808V	80	220

C.4 Allowable Extraneous Loads

Any moment or force the 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.

C.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.

The allowable bending input to a foot mounted torquemeter (Fig. 9) is dictated by its bearing radial load ratings (see ¶ C.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 IX for explicit details.

C.4.2 Allowable Thrust Loads

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 10), 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 ¶ C.3 and ¶ A.5.

C.5 Operating Speeds

Operate MCRT® 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.

C.6 High Speed Operation

Refer to Appendix XII for information on high speed torquemeter operation.

C.7 Lubrication

C.7.1 Standard MCRT® Torquemeters

The following data applies to all MCRT® Torquemeters except oil-mist lubricated high speed units. Standard torquemeters are permanently lubricated. Nonetheless, they should be re-lubricated every six months. Nye Lubricants (nyelubricants.com) synthetic oil 181RA (or equal) is recommended. Salient characteristics of 181RA oil are:

To re-lubricate, remove the threaded closures at either end of the MCRT® device; See Figure 11. Add lubricant per the table, then close the ports.

Density (lbs/gallon @ 77°F.)	6.926
Viscosity (cSt @ 104°F)	49.9
(cSt @ 212°F.)	8.6
Viscosity Index	150
Pour Point (°F.)	-69
Flash Point (°F.)	464

Caution

Do not over lubricate. Too much lubricant will cause viscous losses and excessive heating at high speeds.

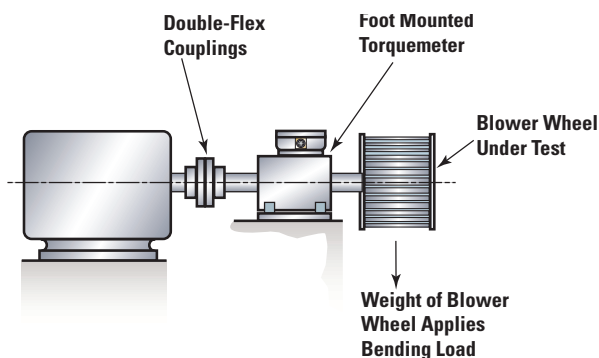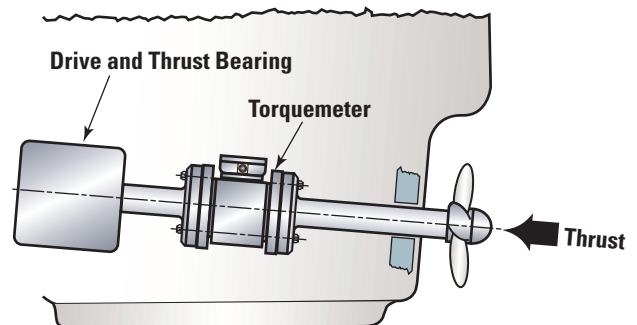## Figure 9. Torquemeter with Bending Load

Double-Flex Couplings
Foot Mounted Torquemeter
Blower Wheel Under Test
Weight of Blower Wheel Applies Bending Load

Figure 10. Torquemeter with Thrust Load

Drive and Thrust Bearing
Torquemeter
Thrust

	Permanent Lubrication Limit*	Lubrication Per Bearing
MCRT®48800/49800V	25,000RPM	permanent
MCRT®48/49/59/79801V	15,000RPM	10 drops
MCRT®48/49/59/79802V	15,000RPM	10 drops
MCRT®48803/48804V	8,500RPM	15 drops
MCRT®49/59/79803V & 49/59/79804V	10,000RPM	15 drops
MCRT®48/49/59/79806V	8,000RPM	4cc
MCRT®48/49/59/79807V	6,000RPM	5cc
MCRT®48/49/59/79808V	3,600RPM	7cc
*For maximum life, re-lubricate on a six month schedule.		

C.8 Contaminants

Don't *flood* a torquemeter with liquids. At high operating speeds, excessive viscous losses will occur and can cause heating that could damage the torquemeter.

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 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. See Appendix XIII for additional information on air purging.

C.9 Hazardous Environments

Refer to Appendix XIII when operating in hazardous environments.

D. PC Interface Software

D. 1 PC Interface Software Description

Sensors are shipped with Windows-based PC interface software. That software provides for several functions as follows:

- Change Setup; Units of Measure, Filter Cutoff Frequency, etc.
- Display Measured and Computed Data
- Control Test Functions

Figure 11. Torquemeter Lube Ports

(2) Lube Ports at Each End.
(Usually 1/8 NPT Plugs)
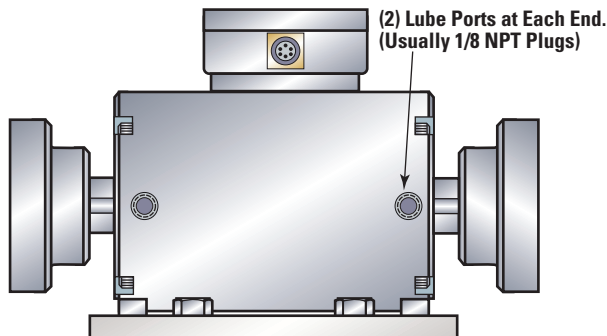
- Perform Dead Weight Calibration and Archive Cal Data

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.

D.2 Change Sensor Setup

- Select any of 33 units of measure. Default units are: *hp, lbf-in.* rpm, See Appendix II for a complete listing.
- Select any of 13 data filter cutoff frequencies from 0.1 to 1,000 Hz in 1-2-5 steps. The default is 10 Hz. The Torque and Speed channel filters are set to the selected cutoff frequency; they have no delay distortion or overshoot. Power is computed 7,800 times per second. Torque is sampled every 128 µs.
- Select 5V or 10V full scale for any of the three analog outputs. The defaults are listed in ¶ B.5, Both are zero based; differential outputs are available, see note on 8 pin connector tabulation ¶ B.2.
- Reassign any or all of the analog outputs. The defaults are listed in ¶ B.5 for all standard Torquemeter configurations.
- Adjust the value of the analog output voltage. These are factory set at 5.000V and 10.000V and should not be readjusted without accurate measuring equipment.
- Change the full scale range of any or all parameters. Except for torque, range changing will alter the increment of measurement. If the torque range is changed, the 5V/10V analog output will be reset to the new range; but, the torque increment of measurement will not change. See the first page of this document for factory range settings.
- 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 an alphanumeric string but, record the new one in a secure place.

Setup changes made using the PC Interface Software, do not require recalibration of the Digital MCRT® Transducer. Any change will automatically re-configure dependent parameters. For example, if only the torque unit of measure is changed from *lbf-in* to *N-m*, power readings will output/display correctly *without further user adjustments* and all parameter Cal Checks will be correct.

D.3 Display Measured and Computed Data

- Displays Current, Max, Min and Spread Torque, Power (an Option) and Speed (an Option) numeric data with units of measure
- Displays real time plots of Torque, Power (an Option) and Speed (an Option)

D.4 Test Control

You can initiate the following actions from a PC :

- Invoke CW Cal Check
- Invoke CCW Cal Check
- Zero Torque
- Invoke Tare (all parameters)
- Clear Tare (all parameters)
- Reset Max/Mins
- Change Units of Measure
- Select a Different Filter Cutoff Frequency

D.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 via PC or by pin strapping, 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, don't 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 original calibration may be recovered.

D.6 Calibration Intervals

For continuous or intermittent service, make periodic Calibration Checks per ¶ B.7.

In applications requiring high accuracy, perform *a dead weight calibration in a* <u>accredited torque calibration laboratory</u> *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® Transducer is overloaded or operates abnormally, then calibrate/inspect it at once.

Himmelstein offers accredited dead weight calibration service, traceable to NIST, for all its products. Its calibration laboratory is accredited (Laboratory Code 200487-0) by NVLAP and arm of the NIST. Accredited calibrations are available for torques from 10 ozf-in (0.071 N-m) thru 4,000,000 lbf-in (452 kN-m). For further information visit our website at www.himmelstein.com or, follow the accreditation link at www.nist.gov.

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.

Potential faults include the installation, the Transducer, the cabling and the terminal device. 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 Transducer

Inspect the sensor for physical damage. If the shaft is locked or a rub exists, remove the speed pickup 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 cable continuity and shorts; see ¶ B.2 and B.5 for connections. *Verify that 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 <u>good earth ground</u> to the motor, machine base and transducer housing per ¶ B.3 and the Cable Connection Diagram.* 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 26 VDC appears at the Transducer terminals. Finally, verify the load is within the specified maximums. Concerning digital communication, the Torquemeter operates at 115.2 kBaud, and uses eight data bits without parity. Neither handshaking or an ID is employed.

Operate the Cal Check. If the correct calibration value appears on the PC display but not at the analog output, make sure the torque analog is assigned to that pin. If necessary, reassign it. If the analog output has the correct Cal Signal but the PC does not, then check the PC cable connections and verify the transducer port and PC port match, i.e, both are RS232, RS422 or RS485. Also verify the PC will accept data per the preceding paragraph. 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 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.**

  Transducers 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 Transducer 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 Application Note 221101D- Dynamic Torque Measurement). Use the Transducer's 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; however, you should use *a high frequency signal filter and the analog output* during 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. They can be identified with the Transducer's signal filters.

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 or the Transducer. Verify cable integrity, configuration and connections and check the Transducer per ¶ E.2.1.
- **Verify A Good Installation Earth Ground,** per ¶ B.3 is present.

E.4 Speed Subsystem

Speed measurement problems can originate in several components. They include the speed pickup, the readout device, and the inter-connect cable. The best procedure is to isolate the defective element and then correct or replace that element.

E.4.1 No Signal Output When Shaft is Rotating

- **Examine the Speed Cable and Pickup.** Verify the speed cable pickup are undamaged and the speed pickup is plugged into the Torquemeter housing and securely held in place with lock nuts. If the cable or pickup are damaged, return the Torquemeter for factory service.

E.4.2 Erratic Output

- **Examine the Speed Cable and Pickup** per ¶ E.4.
- **Verify Your Drive Speed is Stable.** Some drives have significant speed variations caused by control system instability, torsional vibrations, etc. To eliminate this possibility, use another drive source – preferably a direct drive motor running between 600 and 3000 rpm. Alternately, observe the torque variations at the analog output using an oscilloscope. If they track the speed variations and both signals are stable with the shaft stationary, then the drive is probably unstable and the instruments are reporting real speed variations.
- **Verify A Good Installation Earth Ground,** per ¶ B.3, is present.

E.4.3 Speed Pickup Replacement

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

To remove the defective pickup, *with shaft motion stopped*, proceed as follows:

- Disengage the electrical connector.
- Loosen the jam nut.
- Back out the defective speed pickup.

To install the replacement pickup, proceed as follows:

- *With shaft motion stopped*, turn the new pickup in 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.
- Plug the connector into the 6 pin stator connector.

E.5 Power Subsystem

When the torque and speed subsystems operate properly and the power subsystem does not, make certain the power scaling is property set. That is, if the power channel is properly set, then the problem must be in the onboard processor. That is because Power is digitally computed from the Speed and Torque signals. Under those highly unlikely circumstances, return the Transducer for factory service.

APPENDIX I

DETAILED SPECIFICATIONS

Specifications for **MCRT® 48800V** and **49800V** are contained in Bulletin 7409

Specifications for **MCRT® 59800V** are contained in Bulletin 7511

Specifications for **MCRT® 79800V** are contained in Bulletin 7509

APPENDIX II

INSTALLED UNITS OF MEASURE

Supported Units of Measure (the first unit in each category is default)	
Power	hp, hp (metric), kW, W, ft-lbf/min, ft-lbf/s, Btu/h, Btu/min, Btu/s, ton, cal/h, cal/min, cal/s
Torque	lbf-in, lbf-ft, ozf-in, ozf-ft, N-m, kN-m, N-cm, kgf-m, kgf-cm, gf-cm
Speed	rpm, rps, rph, rad/s, rad/min, rad/h, degree/min, degree/s, degree/h, grad/s

APPENDIX III

MATING STATOR CONNECTOR PART NUMBERS

Transducers are furnished with mating connectors or, when a readout is supplied interconnecting cables if ordered. When a Transducer(s) is delivered without readout(s) the following mating connectors are supplied: one 10 pin, one 8 pin one 6 pin. A Com Port-to-PC cable with installed connectors is also provided. When Option Z is ordered, the Speed pickup and associated cable are an integral part of the Torquemeter.

To order spare mating connectors, use the following part numbers (P/N)	
	P/N
10 Pin Connector:	320-1255
8 Pin Connector:	320-1295
6 Pin Connector:	320-1271

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AVAILABLE INTERCONNECT CABLES

Standard Lengths	Lengths (XX) are 20, 50 and 100 feet. RS232 cables are limited to 50 feet. Except for RS232, other lengths can be furnished up to 2,000 feet.
Torquemeter to Model 703 **P/N 224-8722-XX**	Powers Torquemeter, displays torque, implements Model 703 functions including Cal, Tare, Analog Output, Zero, etc.
Torquemeter to Model 733 **P/N 224-8800-XX**	Powers Torquemeter, displays Torque and Speed, accesses Model 733 functions including Remote Cal, Tare, Zero, Analog Output, Cross Channel Calculations, etc.
Torquemeter to RS422/485 Host **P/N 224-8360-XX**	Connects Torquemeter to Host Computer and implements all Torquemeter functions. Requires external power (10-26VDC). Cable is unterminated at host end.
RS485 Torquemeter to Torquemeter **P/N 224-8361-XX**	Provides Torquemeter interconnect when using RS485 protocol to interface multiple Torquemeters to a single computer.
Torquemeter to RS232 PC Port **P/N 224-8359-XX**	Connects Torquemeter to RS232 host; 50 foot maximum length. Implements all Torquemeter functions. Use RS422/485 for noisy locations or long runs.

DRIVING EXTERNAL OPTICAL RELAYS WITH STATUS FLAGS

<div align="center">
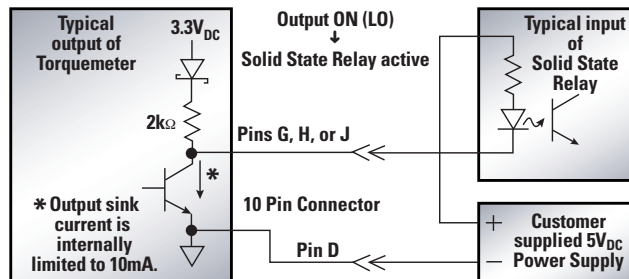
APPENDIX VI

AVAILABLE COMPUTER PORT ADAPTERS

</div>

If your computer doesn't have an RS232 port, we can furnish the following adapters which will allow use of the standard intercon-nect cables listed in Appendix IV. These adapters don't require external power.

Your Computer Port	Adapter Part Number	Converts Port To
RS232	330-0001	RS422/485
USB	330-0002	RS232
USB	330-0003	RS422/485

<div align="center">

APPENDIX VII

TORQUEMETER TO RS232 COMPUTER PORT CABLING

</div>

<div align="center">
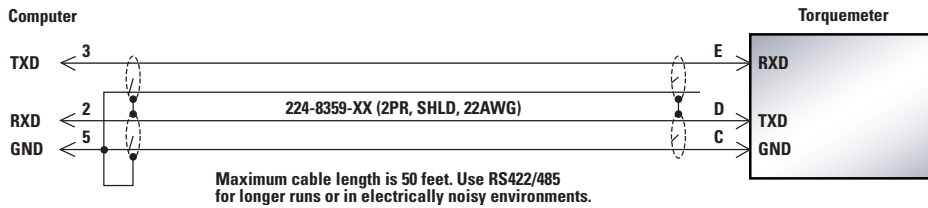
APPENDIX VIII

TORQUEMETER TO RS422 COMPUTER PORT CABLING

</div>

APPENDIX IX

FOOT MOUNTED VERSUS FLOATING SHAFT INSTALLATIONS

Floating shaft installations have two principal disadvantages. First, if the driving or driven machine is frequently changed, and the torquemeter is unsupported during the changeover, then pillow blocks must be added to handle this situation. Second, the *critical speed* of a foot mounted torquemeter is usually much higher than a floating shaft torquemeter.

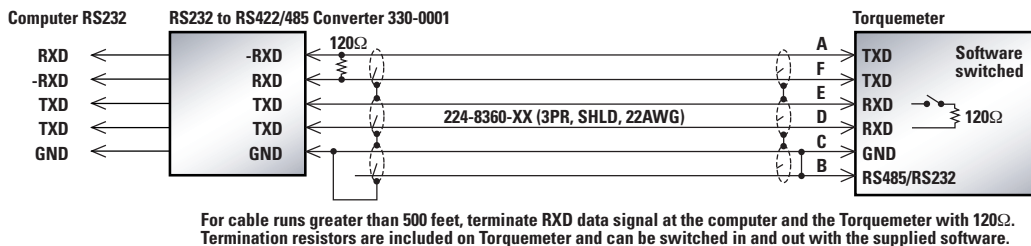If neither of these concerns are important, consider a floating shaft installation. They are less critical to align. Furthermore, because they don't directly transfer thrust and bending loads to the torquemeter bearings, *floating shaft installations can usually handle much greater thrust and bending loads than the foot mounted alternative.*

Very high speed applications should employ foot mountings; see Appendix XII for additional information.

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

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

Where dynamic, once per revolution torque measurements are important, *use constant velocity, zero backlash, torsionally rigid couplings.* If operated at high speed, dynamically balance the torquemeter and coupling assembly *after coupling installation.* Install the couplings in accordance with the manufacturers' instructions and ¶ A.4.

Technical Memorandum 7850 has detailed installation discussions. Use only installations recommended in that memorandum. If in doubt, consult the factory. Addendum 7850-1 lists commercial coupling types. However, *coupling selection and mounting is the users' responsibility.*

APPENDIX X

VERTICAL INSTALLATIONS

In vertical installations, the torquemeter and couplings often carry the weight of suspended devices and frequently carry the live thrust of a pump impeller, mixer blade, etc. Even when those dynamic loads are absent, the upper shaft coupling must carry the weight of the torquemeter and coupling.

A flanged torquemeter with properly attached couplings can support substantial thrust loads. It is well suited for vertical drives. On the other hand, neither axial keys nor interference fits will carry significant thrust. Special order shaft torquemeters can be supplied with radial keyways to carry thrust loads.

Vertical floating shaft installations don't transfer thrust to the torquemeter bearings. Thus, **floating shaft installations are simpler and usually safer than foot mounted installations.** See ¶ C.4.2 for data on shaft thrust ratings.

Vertical, foot mounted installations must limit torquemeter bearing loads to those of ¶ C.3.

Vertical Torquemeter Installation

Drive Motor with Thrust Bearing

Torquemeter

Radial Keyway in Each Shaft in Addition to Axial Keyway

www.himmelstein.com ••••••••••••••••••••••••••• 17
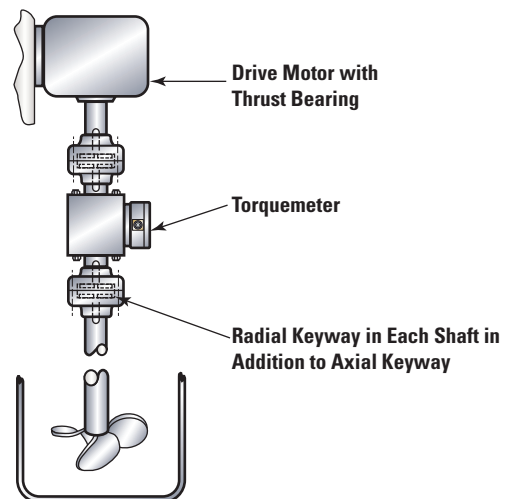
APPENDIX XI

FATIGUE CONSIDERATIONS

MCRT® torquemeters can handle full torque reversals whose instantaneous magnitude is equal to or less than half the overload rating. Under those conditions, fatigue life is infinite. When peak torques exceed 50% of overload rating, then fatigue failure can occur.

When operated at peak torques above half the overload, fatigue life is a function of several factors. They include the torque magnitude, the magnitude and type of extraneous loads simultaneously applied, the total number of loading cycles, the torquemeter configuration, etc.

When large torsionals are present, the following steps will reduce the risk of fatigue failure:

- Reduce the magnitude of torsional inputs by using mechanical filtering (torsional dampers).
- Avoid torque magnification by eliminating torsional resonant frequencies in the operating range; see Technical Memorandum 8150.
- Size the torquemeter so peak instantaneous torques are < (overload rating)/2.
- Check peak torque values, *over the range of operating conditions,*

Typical Fatigue Life Characteristics

by observing the torque on an oscilloscope *at the high frequency output.*

If these guidelines are violated, shut down immediately or risk component damage.

APPENDIX XII

HIGH SPEED OPERATION

On special order, torquemeters can be supplied that operate at higher speeds than their standard counterparts. They are identified by an "H" suffix. The cover sheet of this document lists the speed rating of your torquemeter. "H" suffix devices have strengthened rotor assemblies, revised bearings and provision for oil mist lubrication.

A successful high speed installation requires:

- Adequate bearing lubrication. Too little will result in bearing failure. Too much, produces excessive heating from viscous losses and can cause damage.

- A stable, usually foot mounted, vibration-free installation operating either well below or well above the first shaft system torsional resonant frequency (see Technical Memorandum 8150). The operating speed should be below the first shaft critical (Technical Memorandum 7551).
- A dynamically balanced torquemeter and coupling assembly. All other driveline components must also be balanced.
- Taking all reasonable safety precautions including the installation of safety guards around rotating components.

APPENDIX XIII

HAZARDOUS ENVIRONMENTS

When they are used in hazardous locations, purge MCRT® torquemeters with air (or inert gas). Properly used, an air purge will prevent explosive, flammable or corrosive fluid, or airborne abrasive, from entering the torquemeter. The user must interlock and monitor the purge supply in compliance with safety codes.

On special order, Torquemeters can be modified for air purge operation. Introduce the gas purge through the special purge fitting installed on the electronic housing. Purge air will be ported to the torquemeter interior and will prevent hazardous gases from entering both the torquemeter and electronic housing. Assuming you feed the connecting wires through approved safety barriers and suitable interlocks are used, the torquemeter can be operated in a hazardous environment.

A special Code P explosion proof speed pickup should be used in hazardous locations. Run the speed wires through an approved conduit. If its necessary to use a zero velocity (Code Z) pickup, then make connections via suitable safety barriers.

Safety barriers are sealed, passive networks installed in each wire that connects the hazardous and safe locations. They limit electrical energy passing between the two locations to a safe value.

Special Code P, Explosion Proof Speed Pickup Wiring Color Code	
Function	Color
Signal	White
Signal	Red
Case Ground	Green**
** May be omitted on some units.	

APPENDIX XIV

BELT AND CHAIN DRIVE CONSIDERATIONS

Caution. Don't install a pulley or sprocket on the torquemeter shaft unless the torquemeters' radial bearing load rating, from ¶C.3, is :

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

and,

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

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

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 example. Alternatively, consider a pulley or wheel type torquemeter. Their bearings are isolated from the belt loads, and they can accept large radial and bending loads without damage or measurement errors.

Installation Definitions
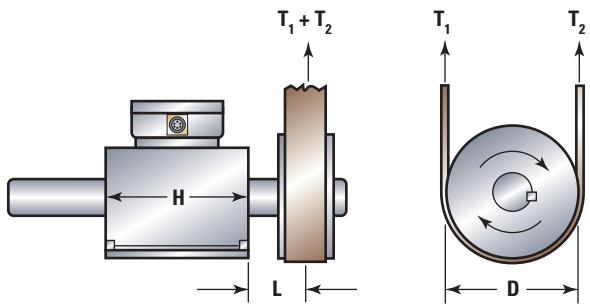
Torque = $(T_1 - T_2)*(D/2)$
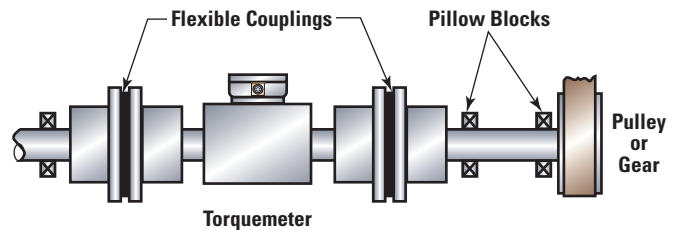
SERIAL COMMUNICATIONS FOR THE NEXT GENERATION TORQUEMETER

This specification of the serial communications for the NextGen Torquemeter is subject to change at *any* time *without* notice.

Communication Port Settings
- 8 data bits
- No parity
- No hardware / handshaking
- 1 start bit
- 1 stop bit
- 115200 baud

General conventions used in this document
- OK stands for the string "OK"
- index is an alphanumeric character (A-Z or 0-9)
- chnnum is either a "1", "2", or "3"
- 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 an integer number string (e.g. "1234")
- long is a long integer number string (e.g. "1234567")
- float is a floating point number string (e.g. "1234.57")
- string is a string (e.g. "LB-IN")
- hexNUM is a hexadecimal *string* that is NUM characters long (e.g. hex4 could be "8FC4")

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

In response to any command, the NextGen Torquemeter returns one of the following:
- "string" where string is the data requested.
- "OK" operation was successful
- Some error messages starting with a "!" character.
  Some common error messages include:
  — "!BadArg" command has a bad argument
  — "!BadIndex" The given index is out of range for the given command.
  — "!PasswordProtected" The parameter is password protected from change.
  — "!Unknown" an unknown error occurred.
  — "!xx" Command "xx" is unrecognized

EXAMPLES

 ALL messages to the NextGen Torquemeter series start with the torquemeter's ID (or "*" for RS232) and end with a CR or a LF.

- **Retrieve torque data:**
  Send "*DE1" to the NextGen Torquemeter. The return message should look something like "1234.56".
- **Retrieve engineering data for all channels:**
  Send "*DE*" to the NextGen Torquemeter. The return message should look something like "1234.56, 23.445, 0.4592478". The values are the torque, speed and power in engineering units respectively.

- **Retrieve filtered 32-bit torque data:**
  Send "*DC1" to the NextGen Torquemeter. The return message should look something like "1234567". To convert this to engineering units multiply the return value by Full-Scale-Torque/655,360,000.0
- **Retrieve the torque filter setting:**
  Send "*FL1" to the NextGen Torquemeter. The return message should be something like "6" which implies (referring to the

appropriate list under the "*FL" message) that torque has a filter of 10 Hz.

- **Set the torque filter to 100 Hz:**
  Refer to the list under the "*FL" (filter) command to find that a 100 Hz filter corresponds to the value 3. Therefore, send "*FL13" to the NextGen Torquemeter. The NextGen Torquemeter should respond with "OK" if the operation was successful. To save this setting so that the next time you power up the torque filter is set to 100 Hz, send the command "@@" to write non-volatile memory.

- **Apply the positive shunt calibration signal:**
  Send "*ASB" to the NextGen Torquemeter. To remove this signal send "*ASA".

IMPORTANT MESSAGES

Message	Reply	Meaning
VR	string **Read Only.**	Version string. Return a string of the format "sNUM1rNUM2" where NUM1 is the firmware version of the stator, and NUM2 is the firmware version of the rotor.
MXchnnumindex	Comma separated list of Max/Min of the given channel	index: *: reset the Max/Mins of the given channel. E: return Max/Mins in engineering units C: return 32-bit Max/Mins X: return 32-bit hexadecimal Max/Mins Y: return 16-bit hexadecimal Max/Mins R: return raw A/D Max/Mins
DEchnnum	float	Current Engineering unit data. **Read only.** If chnnum is "*", then return a comma separated list for all channels.
DCchnnum	long	Current 32-bit data. **Read only**. If chnnum is "*", then return a comma separated list for all channels. To convert this value to engineering units, multiply the return value by the appropriate Full-Scale/655,360,000.0
DPchnnum	long	Current unfiltered 32-bit data. **Read only**. If chnnum is "*", then return a comma separated list for all channels.
DXchnnum	hex8	Current hexadecimal 32-bit data. **Read only**. If chnnum is "*", then return a comma separated list for all channels.
DYchnnum	hex4	Current hexadecimal 16-bit data. **Read only**. If chnnum is "*", then return a comma separated list for all channels.
DRchnnum	long	Current Raw A/D data. **Read only**. If chnnum is "*", then return a comma separated list for all channels.
DTchnnum	long	Current engineering tare data. **Read only**. If chnnum is "*", then return a comma separated list for all channels.
@UIindex	string	User Information index: A: Model Name B: Serial Number C: Customer Name D: Shaft Number (Continued)

SHUNT MESSAGES (continued)

Message	Reply	Meaning
TRchnnum0	OK	Clear Tare of the given channel
TRchnnum	OK	Tare the given channel with current data
ADchnnum	OK	Calibrate the chnnum internal A/D
ASA	OK	Apply no shunt to all channels
ASB	OK	Apply +CAL shunt to all channels
ASC	OK	Apply -CAL shunt to all channels
TC	float	Current temperature, in degF. **Read only.**
DSchnnum	float	Display scaling The native units (lbf-in) for the channel's data are multiplied by this number before being sent to the user. Do not change t his without a corresponding change in the unit name (UN). **Only torquemeter data retrieved via the DE command is subject to this scaling.**

FLchnnum	int	Filter (0-10((4-bits)
		int:
		  0: No digital filter (only hardware filter)
		  1: 500Hz 3db cutoff
		  2: 200Hz 3db cutoff
		  3: 100Hz 3db cutoff
		  4: 50Hz 3db cutoff
		  5: 20Hz 3db cutoff
		  6: 10Hz 3db cutoff
		  7: 5Hz 3db cutoff
		  8: 2Hz 3db cutoff
		  9: 1Hz 3db cutoff
		  10: 0.5Hz 3db cutoff
		  11: 0.2Hz 3db cutoff
		  12: 0.1Hz 3db cutoff

PS	int	Get the password protection state
		int:
		  0: Off
		  1: On

PCXstring1 Xstring2 Xstring3	OK	Change password The "X" represents any character not in any of the strings. string1: current password string2: new password string 3: new password Password is changed if and only if string1 equals the current password **AND** string2 and string3 are equal.
@@	OK	Write non-volatile flash The command writes the changes in torquemeters' configuration to the flash memory, so that if the power is cycled on the torquemeter the values are remembered. Use this command sparingly, as there are a limited number of times flash (<10,000) can be written.

ANALOG OUTPUT MESSAGES

Message	Reply	Meaning
IOindex	int	Input Pin definition index: A: Pin G action B: Pin H action C: Pin B action D: Pin J action E: Pin F action F: Pin C action G: Pin A action H: Pin K action I: Invert Mask 0x0001: Pin G Active High 0x0002: Pin H Active High 0x0004: Pin B Active High 0x0008: Pin J Active High 0x0010: Pin F Active High 0x0020: Pin C Active High 0x0040: Pin A Active High 0x0080: Pin K Active High int: 1: Positive Cal 2: Negative Cal 3: Tare 4: Clear Tare 5: Reset Max/Min 6: Max Data output 7: Min Data output 8: Hold Data 9: Hold Data output 16: Torque OK 17: Speed OK 18: Power OK 19: Temperature OK
ILindex	float	I/O limits: Limits for any IO pins outputting a signal stored as a fraction of full scale of the driving channel index: A: High limit for pin G B: Low limit for pin G C: High limit for pin H D: Low limit for pin H E: High limit for pin B F: Low limit for pin B G: High limit for pin J H: Low limit for pin J I: High limit for pin F J: Low limit for pin F K: High limit for pin C L: Low limit for pin C *(Continued)*

ANALOG OUTPUT MESSAGES (continued)

Message	Reply	Meaning
		M: High limit for pin A N: Low limit for pin A O: High limit for pin K P: Low limit for pin K

AOindex	float	Analog Output Setup
		index:
		  A: Drive Analog Output 1 with 0=Torque, 1=Speed, or 2=Power
		  B: Output on Analog Output 1 at 0 engineering units (Volts)
		  C: Output on Analog Output 1 Full Scale engineering units (Volts)
		  D: Target Output on Analog Output 1 when Shunt is applied (Volts)
		  E: Drive Analog Output 2 with 0=Torque, 1=Speed, or 2=Power
		  F: Output on Analog Output 2 at 0 engineering units (Volts)
		  G: Output on Analog Output 2 at Full Scale engineering units (Volts)
		  H: Target Output on Analog Output 2 when Shunt is applied (Volts)
		  I: Drive Analog Output 3 with 0=Torque, 1=Speed, or 2=Power
		  J: Output on Analog Output 3 at 0 engineering units (Volts)
		  K: Output on Analog Output 3 at Full Scale engineering units (Volts)
		  L: Target Output on Analog Output 3 when Shunt is applied (Volts)

CHANNEL SPECIFIC MESSAGES

Message	Reply	Meaning
TA	int	The number of adjustment points for the torque channel The valid possibilities are: 2,3,4, or 5

CFchnnumindex	float	Calibration Readings in Rotor-A/D-counts
		index:
		  A: Zero Offset value (units: rotor-A/D-counts)
		  B: Adjustment Point 1 Calibration Span (units: rotor-A/D-counts)
		  C: Adjustment Point 2 Calibration Span (units: rotor-A/D-counts)
		    Valid only for Torque channel
		  D: Adjustment Point 3 Calibration Span (units: rotor-A/D-counts)
		    Valid only for Torque channel
		  E: Adjustment Point 4 Calibration Span (units: rotor-A/D-counts)
		    Valid only for Torque channel

CEchnnumindex	float	Calibration Readings in lbf-in
		index:
		  A: Full Scale
		  B: Adjustment Point 1 Calibrations Span
		  C: Adjustment Point 2 Calibration Span Valid only for Torque channel
		  D: Adjustment Point 3 Calibration Span Valid only for Torque channel
		  E: Adjustment Point 4 Calibration Span Valid only for Torque channel