MCRT® TORQUE TRANSMITTER
INSTALLATION, OPERATION, AND TROUBLESHOOTING GUIDE

with

WARRANTY STATEMENT

REVISION A

PATENT NOTICE: Himmelstein torque measurement products are manufactured under one or more of the following U.S. Patents: RE26,501; 3,441,886; 3,531,748; 3,531,749; 3,717,029; 3,800,591; 3,961,526; 4,412,198; 4,555,956; 4,563,905; 4,616,512; 4,651,573; 4,790,175.

Model Number: . . . .

Customer: . . . .

Serial #: . . . . *Reference #:* . . . .

Torque Range (lbf-in): . . . .

Overload Capacity (lbf-in): . . . .

Maximum RPM: . . . . *Performance Code:* . . . .

Speed Pickup Code & Type: . . . .

Foot Mount: ( ) Yes ( ) No

Factory Settings (field changeable): *Filter Cutoff (Hz):* ( ) 1.5 ( ) 200

Operating Mode: *Uni-directional:* ( ) CCW ( ) CW
Bi-directional: ( ) CCW ( ) CW

Special Features: . . . .

. . . .

. . . .

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i. Introduction

When installed between a driver and load, MCRT® torque transmitters measure static and dynamic shaft torque. Torque sensing employs field proven, strain gage technology. A corrosion resistant, one piece shaft is gaged with one or more bridges. The bridge measures torque and cancels signals from bending and thrust loads. Careful temperature compensation eliminates zero, span and calibration drift.

Rotary transformers connect the rotating gages to stationary, 4-20 mA transmitter circuitry. They provide high quality non-contact signal coupling to the rotating gages. Rotary transformers don't generate noise or wear. They are immune to ambient noise, vibration, lubricants and other hostile environments.

Transmitter circuitry is shielded from RFI which fact, combined with the current loop output, yields extraordinary noise immunity, even close to large electric machines. Elimination of slip rings, brushes, radio transmitters and other limited-life, noise-generating elements further increases performance and reliability. Moreover, the *non-ferrite design* makes these transmitters suitable for diesel and other hostile applications. All models incorporate Option G which provides hardening to EMI from adjustable speed drives and enhanced magnetic field immunity.

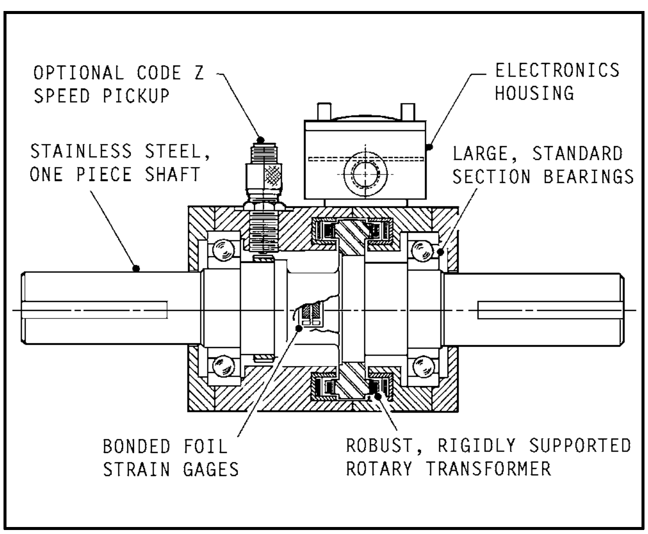

Figure 1. Typical Torque Transmitter Construction

ii. MCRT® Torque Transmitter Specifications

The tabulation lists condensed specifications applicable to standard products. See product literature for complete details.

Condensed Specifications*

	Performance	
	Code N Standard	**Code C Enhanced**
Non-linearity** (% of F.S.)	±0.10	±0.05
Hysteresis (% of F.S.)	±0.10	±0.05
Non-repeatability (% of F.S.)	±0.10	±0.05
Temperature Effects		
Zero (% of F.S./deg. F.)	±0.003	±0.002
Span (% of Rdg./deg. F.)	±0.003	±0.002
Compensated Range (deg. F.)		+75 to +175
Maximum Usable Range (deg. F.)		- 25 to +185
Storage Range (deg. F.)		- 65 to +225

Output: 4 switch selected ranges as follows:
- Clockwise (CW) Uni-directional . . . . 4-20 mA
- Counterclockwise (CCW) Uni-directional 4-20 mA
- CW Bi-directional . . . . 12±8 mA
- CCW Bi-directional . . . . 12±8 mA

Bandwidth . . . . dc to 200 Hz or dc to 1.5 Hz, switch selected.

Zero Control Minimum Range . . . . 5% of Scale
Span Control Minimum Range . . . . 5% of Scale
Power Supply (see Figure 6) . . . . . 10 to 28 Volts dc
Load Resistance (see Figure 6)
- Minimum . . . . 0 ohms
- Maximum . . . . 900 ohms @ 28V or [(50)(Supply Voltage) - 500] ohms.

* Subject to change without notice.
** End point method.
F.S. denotes "Full Scale".
Rdg. denotes "reading".
deg. F denotes "degree Fahrenheit".

A. Mechanical Installation

A.1 Applicability

This discussion is applicable to both MCRT® shaft, and flanged torque transmitters.

A.2 Coupling Selection

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

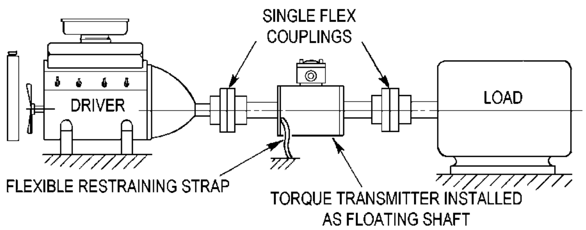

Figure 2. Floating Shaft Installation

Floating shaft installations are applicable to both shaft and flanged type transmmitters. A *single flex coupling* is installed at each shaft end. It takes out angular misalignment, and the transmitter "tilts" to take out parallel misalignment. Use a *flexible strap* to prevent housing rotation and to strain relieve the 2-wire cable. ***Caution: When torque loop wires are run in a short, rigid conduit, you must foot mount the transmitter. Alternately, use flexible conduit and single flex couplings.***

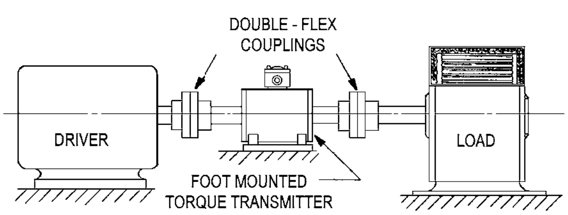

Figure 3. Foot Mounted Installation

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

Appendix I 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.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 transmitter shaft with an anti-seizing compound suitable for use at 400 deg. F. Next, heat the coupling hub, ***not the torque transmitter***, to approximately 400 deg. F. Then, install the coupling.

The heated coupling hub should "slip" on the torque transmitter 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 torque transmitter with anti-seizing compound. If cooling is speeded with water dampened rags, **orient the torque transmitter 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 transmitter 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 transmitter.***

A.4 End-to-End Orientation

A.4.1 Effect on Signal Polarity

MCRT® transmitters 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 transmitter end-for-end doesn't change the torque direction or magnitude. Therefore, it will have no effect on the torque transmitter output signal. Select, per ¶B.2.2, the appropriate operating mode (one of 4) for valid transmitter operation; see Figure 7. If in doubt about torque polarity, select either *bi-directional mode* and observe the output signals during normal machine operation. Then, change the mode as needed.

A.4.2 Effect on Torque Transmitter Thrust Capacity

*Orienting a **foot mounted** torque transmitter per Figure 4 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 torque transmitters installed as floating shafts.***

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

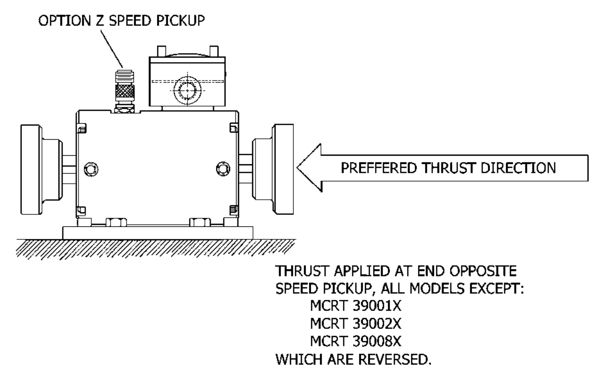

Figure 4. Preferred Thrust Path

A.5 Vertical Installations & Belt/Chain Drives

Vertical installations frequently require special mounting and coupling selection considerations. Refer to Appendix II when making a vertical installation.

B. Electrical Installation

B.1 Applicability

This section is applicable to all MCRT® torque transmitters.

B.2 Torque Signal

B.2.1 Torque Loop Connections

Connect the loop power to the screw terminals provided; see figure 5. Reverse polarity protection is standard. Observe the load resistance limits specified and plotted in Figure 6. ***The transmitter case should be connected directly to earth ground when conduit isn't used or, if its' not reliably grounded.*** Although any wire may be used for loop connections, *a shielded twisted pair will perform best in noisy environments.*

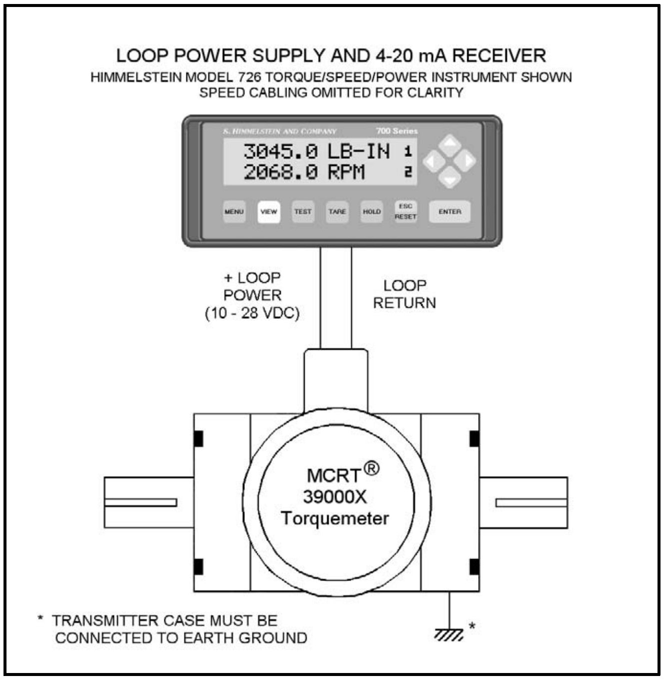

Figure 5. Torque Loop Connections

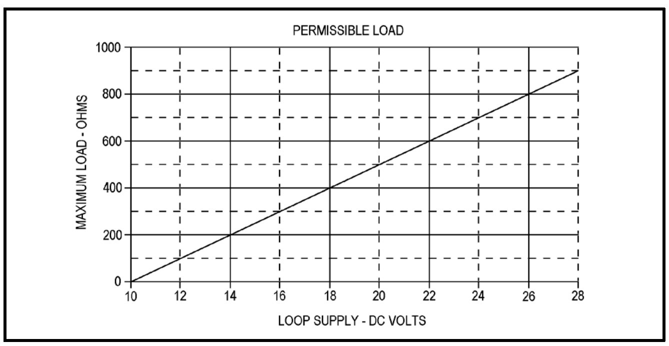

Figure 6. Permissible Loop Load

B.2.2 Operating Mode and Filter Selection

Factory settings for this transmitter are listed on the cover. Unless ordered otherwise, MCRT® torque transmitters are shipped with the CW bi-directional mode and 1.5 hertz filter cutoff selected. That mode selection permits measurements in bi-directional and/or reversing shaft systems. You may also use it to experimentally determine the torque direction. Then, after it is known, the transmitter mode may be changed as needed.

Each transmitter is factory calibrated on *dead weight stands traceable to NIST*. CW and CCW equivalent *calibration torques are referenced to that dead weight calibration.* That calibration data and a compliance certification are appended to this document. Appendix VIII contains a specimen Calibration Certification.

Figure 7 defines the transmitter operating modes. To change from one mode to another, proceed as follows:

1. Unscrew the electronic housing cover.

2. Switch to either ***CW or the CCW mode,*** as desired.

3. Then, switch to either the ***bi-directional*** *or* ***uni-directional mode,*** as desired.

4. Next select either the 1.5 hertz (Hz) or 200 Hz filter position as needed. The 1.5 Hz cutoff is usually preferred because it filters out most machinery vibration torques and provides stable, accurate readings of average torque. The 200 Hz filter is most useful for wideband studies and very fast control systems.

5. Finally, re-adjust the ***zero*** *and* ***span controls*** in accordance with the instructions of ¶B.2.3.

B.2.3 Zero and Span Adjustment

These adjustments must be made with zero torque on the driveline. To achieve zero torque in installations that can "lock-in" friction torques (between gear drives, on pump and other sealed shafts, etc.), break or disconnect one of the shaft couplings. Then,

1. Adjust the ***zero control*** for zero torque outptut, i.e.,

   4 mA (@ 0 lbf-in) in either uni-directional mode.

   12 mA (@ 0 lbf-in) in either bi-directional mode.

2. Depress and ***hold*** the ***cal switch***, then adjust the ***span control*** for the tabulated output current.

CW Operation:
Output Current* ____________ mA

Equivalent Cal Torque* ____________ lbf-in
** Transcribe values from calibration printout following this booklet.*

CCW Operation:
Output Current* ____________ mA

Equivalent Cal Torque* ____________ lbf-in
** Transcribe values from calibration printout following this booklet.*

3. Release the ***cal switch***, repeat steps 1 and 2, as needed. Then replace the cover.

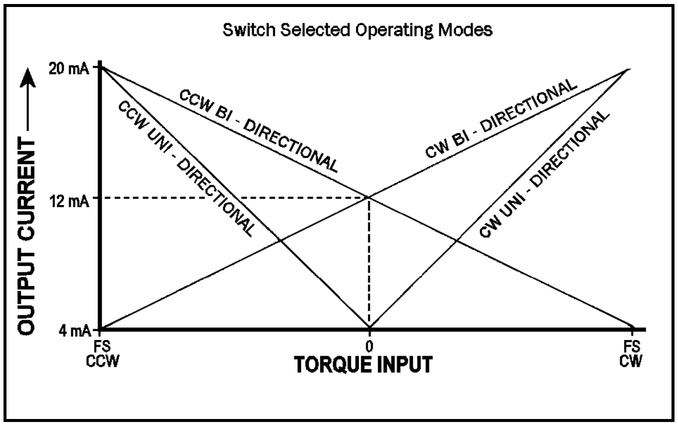

Figure 7. Transmitter Operating Modes

B.2.4 Calibration Intervals

For continuous service usage, make monthly calibration and zero checks per ¶B.2.3, above. When used intermittently, perform those checks before each test series. In applications requiring high accuracy, perform an annual transmitter *dead weight calibration.* If the torque transmitter is overloaded or operates abnormally, then calibrate/inspect it at once.

Himmelstein offers dead weight calibration service, traceable to NIST, for all its products. Two levels of precision are available; 0.02% and 0.002%. If you purchased a transmitter with readout, return both for a *system calibration.* A system calibration will provide the highest measurement accuracy as well as assurance that all system components are functioning properly.

B.3 Speed Signal

Both *explosion proof passive (Code P) and zero velocity speed pickups (Code Z)* are options for MCRT® torque transmitters. A speed pickup *Code N* is used when the speed pickup is omitted. Both pickup types produce exactly 60 pulses per shaft revolution. Hence, their output *frequency* in hertz equals the *shaft speed* in rpm.

A *passive speed (Code P) pickup* requires no external power. Its output voltage is approximately proportional to speed. Thus, below 25 to 100 rpm, a *Code P passive pickups' output voltage* may be too small to be useful. However, the *output voltage* of a *Code Z zero velocity pickup* is independent of speed. Therefore, they are the choice for low speed measurements. *Zero velocity pickups are* also preferred in noisy electrical environments, i.e., where SCR and Triac Motor Controllers and similar devices are present.

B.3.1 Code P Passive Speed Pickup Connections

Lead Color	Function
White	Signal
Red	Signal
Green	Case Ground*

Note: Signal wires are isolated from the connector shell.
* May be omitted on some units.

B.3.2 Code P Passive Speed Pickup Cabling

Refer to the manufacturers' manual for speed signal conditioner/readout connections. Use a stranded and shielded twisted pair wire. Belden Type 8761 (or equal) is recommended.

Cable Diagram for SHC Speed Signal Conditioners

Figure 8 shows connections for SHC Models CTUA, UDCA and 700 Series Instruments. When using another readout, substitute its plug designations for those shown.

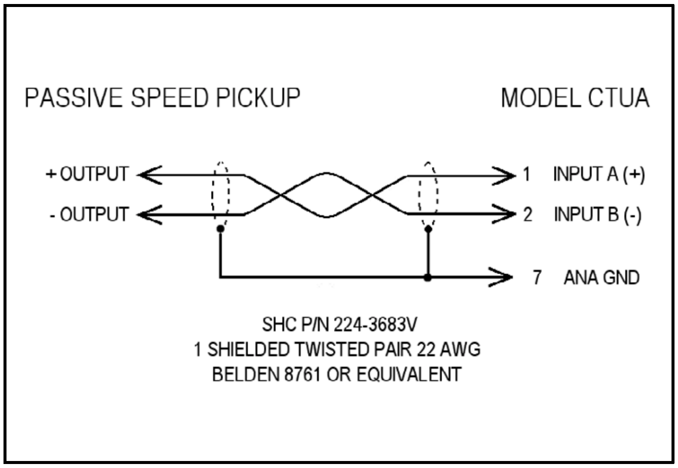

Figure 8. Code P Passive Speed Pickup Cable

B.3.3 Code Z Speed Pickup Pinout

Pin	Function
A	+ Supply (8 to 28 Volts DC)
B	Output Signal
C	Common

Notes: All pins are isolated from the connector shell. Incorrect connections can damage the pickup.

Mating Connector: MS 3106A-10SL-3S (SHC P/N 224-5361; includes cable clamp and boot)

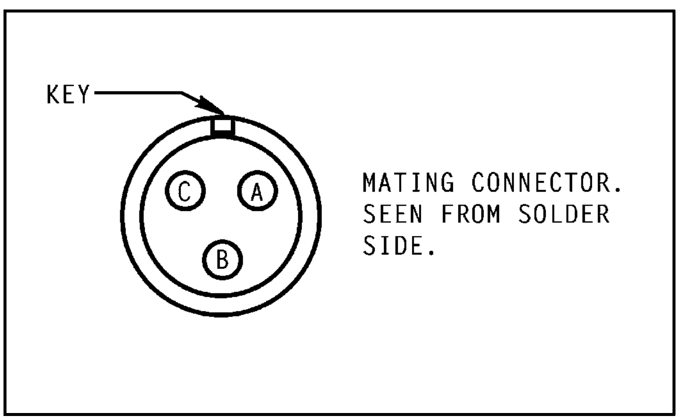

Figure 9. Code Z Speed Pickup Connector

B.3.4 Zero Velocity Speed Pickup Cabling

Refer to the manufacturers' manual for speed signal conditioner/readout connections. Use stranded and shielded three conductor cable. Belden Type 8723 (or equal) is recommended.

Cable Diagram for SHC Speed Signal Conditioners
Figure 10 connections are for SHC Models CTUA, UDCA and 700 Series Instruments.

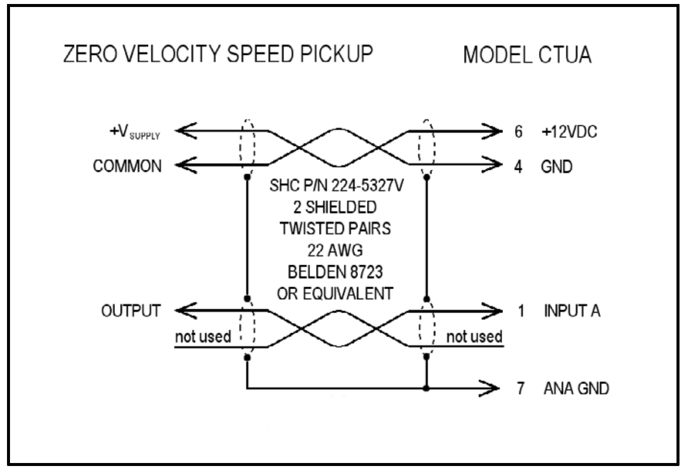

Figure 10. Code Z Speed Pickup Cable

C. Operating & Safety Considerations

C.1 Applicability

The following paragraphs apply to all MCRT® products.

C.2 Allowable Torque Loads

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

C.2.1 Overload Considerations

The overload rating of an MCRT© transmitter is usually 4 times full scale; but can be 2.5 or 3 times full scale. This transmitters' overload rating is listed on the cover sheet. A Himmelstein torque transmitter 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; refer to ¶C.2.2.

Virtually all rotary power producing and absorbing devices produce pulsating rather than smooth torque and power. Furthermore, starting and stopping generates torque transients.

Thus, in addition to its average torque and speed values, the driveline torque usually includes a fundamental (driving) frequency and superimposed harmonics. It may also have transient torque pulses. The Figure 11 waveform is typical of what occurs in the real world. Torsional vibration magnitudes are difficult to estimate and can be amplified by the driveline. See ¶E.4 for further information.

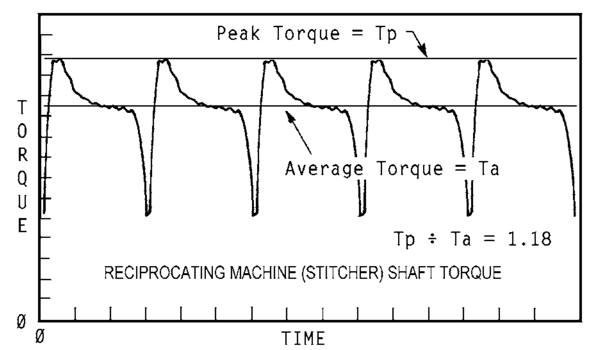

Figure 11. Reciprocating Machine Torque Profile

For these reasons, a conservative design approach dictates the *torque transmitter overload region be used 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 torque transmitter with a higher rating.

C.2.2 Fatigue Considerations

If an MCRT® torque transmitter sees peak-to-peak torques within its full scale rating, it can handle full torque reversals with infinite fatigue life. When peak torques are cyclical, and exceed the full scale rating, then fatigue failure can occur. Refer to Appendix III 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 torque transmitter 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.

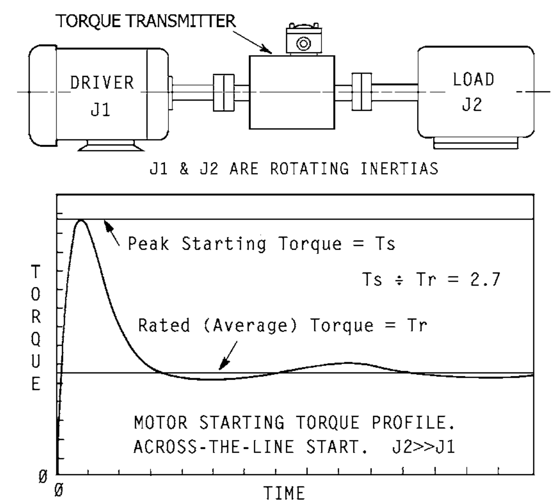

Figure 12. Motor Start Torque Profile

To avoid damage when starting high inertia loads, either use a torque transmitter *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 torque transmitter. Before operating, verify the motor can safely start the increased load inertia.
- Use compliant, “shock absorbing” shaft couplings. Careful coupling selection and thorough analysis of the resultant driveline is essential. Under some conditions, such couplings can aggravate rather than improve the situation.

C.3 Allowable Bearing Loads

MCRT® torque transmitter 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 pre-load 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 runout, don't exceed its bearing rating. ***Use flexible conduit*** to satisfy this requirement.

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 and flanged torque transmitters 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.

Shaft Type Torque Transmitters	**Bi-directional** Bearing Load** **Axial** (lbs)	**Radial** (lbs)
MCRT® 39001X	15	35
MCRT® 39002X	30	80
MCRT® 39003X	35	100
MCRT® 39004X	35	110
MCRT® 39006X	55	150
MCRT® 39007X	70	200
MCRT® 39008X	80	220
MCRT® 39009X	300	1,000
MCRT® 39010X	1,000	3,000

** See ¶A.4.2 for increased uni-directional axial load ratings.

Flange Type Torque Transmitters	**Bi-directional Bearing Load** **Axial** (lbs)	**Radial** (lbs)
MCRT® 39060X	25	75
MCRT® 39061X	25	75
MCRT® 39070X	50	150
MCRT® 39080X	80	220
MCRT® 39090X	300	1,000
MCRT® 39091X	1,000	3,000

Flanged models must be mounted as floating shafts. If they are used without flexible couplings, alignment must limit bearing loads to indicated values. Observe bending and thrust limits specified in ¶C.4.

C.4 Allowable Extraneous Loads

Any moment or force the torque transmitter 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® torque transmitter, ***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.

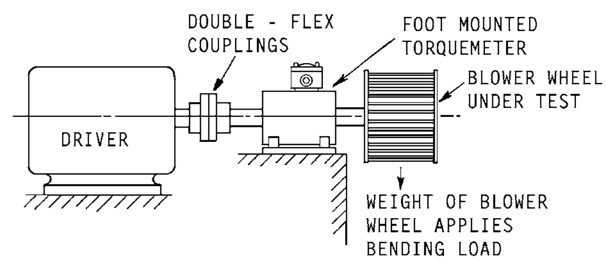

Figure 13. Torque Transmitter With Bending Load

The allowable bending input to a foot mounted torque transmitter (Figure 13) 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 transmitter from excessive bending and radial loads. When applying such loads, don't exceed a transmitters' bearing load ratings; see Appendix VII for explicit details.

C.4.2 Allowable Thrust Loads

When applied without bending, most MCRT® torque transmitters, ***when mounted as a floating shaft***, can handle a thrust load (tension or compression) in pounds, applied to its shaft (see Figure 14), 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.

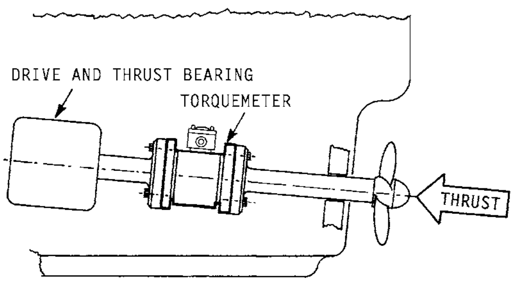

Figure 14. Torque Transmitter With Thrust Load

Caution

Significant thrust loads are only allowable in floating shaft installations. Bearing axial loads limit the thrust capacity of foot mounted torque transmitters; see ¶ C.3 and ¶A.5.

C.5 Operating Speeds

Operate MCRT® torque transmitters within the maximum speed rating published in the pertinent specification and appearing on the cover of this booklet. The ratings are bi-directional. Standard transmitters 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 IV for information on high speed torque transmitter operation.

C.7 Lubrication

C.7.1 Standard MCRT® Torque Transmitters

The following data applies to all MCRT® transmitters except oil-mist lubricated high speed units. Standard transmitters are permanently lubricated. Nonetheless, they should be re-lubricated every six months. Exxon Oil Company Nuto H-68 (or equal) is recommended. Salient characteristics of H-68 oil are:

Specific Gravity @ 60 deg. F.	0.882
Density (lbs/gallon)	7.344
Viscosity (cSt @ 104 deg. F.)	68
(cSt @ 212 deg. F.)	8.5
Pour Point (deg. F.)	-0.4
Flash Point (deg. F.)	453
ASTM D 1500 Protection	
Distilled Water	No Rust
Sea Water	No Rust

To re-lubricate, remove the threaded closures at either end of the MCRT® device; See Figure 15. Add lubricant per the table, then close the ports.

Caution

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

	Permanent Lubrication Limit*	Lubrication Per Bearing
MCRT® 39001X	15,000 RPM	10 drops
MCRT® 39002X	15,000 RPM	13 drops
MCRT® 39003X	10,000 RPM	16 drops
MCRT® 39004X	10,000 RPM	16 drops
MCRT® 39006X	8,000 RPM	4 cc
MCRT® 39007X	6,000 RPM	5 cc
MCRT® 39008X	3,600 RPM	7 cc
MCRT® 39009X	1,800 RPM	13 cc
MCRT® 39010X	1,200 RPM	26 cc
MCRT® 39060X	8,000 RPM	8 drops
MCRT® 39061X	8,000 RPM	8 drops
MCRT® 39070X	5,500 RPM	20 drops
MCRT® 39080X	3,600 RPM	7 cc
MCRT® 39090X	1,800 RPM	13 cc
MCRT® 39091X	1,200 RPM	26 cc

*For maximum life, re-lubricate on a six month schedule.

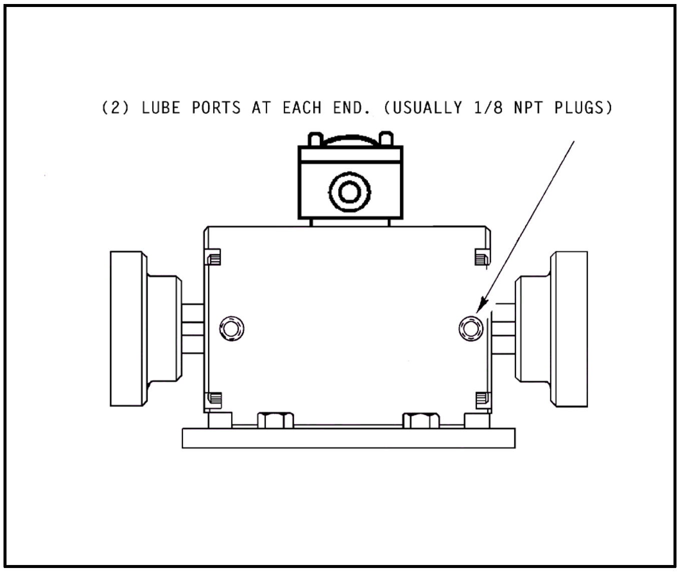

Figure 15. Torque Transmitter Lube Ports

C.7.2 Oil Mist For High Speed MCRT® Products
Special order, suffix "H", high speed devices must be oil mist lubricated. Refer to Appendix V for lubrication instructions.

C.8 Contaminants
Don't flood a torque transmitters' internal volume with liquids. At higher operating speeds, viscous losses can cause excessive heating and possible damage.

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 torque transmitter from contact with fluids that attack insulation or plastics. Warranties are void for damage caused by such materials.

Airborne abrasives can cause premature bearing failure. When they are present, consider using an air purge to prevent invasion of such materials. See Appendix VI for additional information on air purging.

C.9 Hazardous Environments
Refer to Appendix VI when operating in hazardous environments.

D. Troubleshooting

D.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 repair work.

Possible trouble sources include the installation, the torque transmitter, the cabling and the readout device. The best procedure is to isolate the problem part, then correct or replace it. Otherwise return the defective part to the factory.

D.2 Preliminary Inspection

D.2.1 Torque Transmitter
Inspect the torque transmitter for physical damage. If the shaft is locked or a rub exists then, remove the speed pickup, if present, per instructions contained in ¶D.4.4. If the fault clears, reinstall the pickup following ¶D.4.4 instructions. Otherwise return the unit to the factory.

D.2.2 Cabling
Make electrical checks for continuity and shorts; see ¶B.2 and ¶B.3 for connections. ***Verify that the torque loop connections are tight and overall loop resistance is within that allowed per ¶B.2.1 and Figure 6.*** Erratic connections causing loop resistance to violate the permissible envelope can cause signal noise. If noise is still a problem, replace the loop cable with a twisted pair. Similarly, replace unshielded speed cables with cable configured per ¶B.3. Examine the torque and, where present, speed cables for obvious damage. Replace damaged cables. Clean connectors with an approved contact cleaner.

D.2.3 Readout Instrument
Examine for physical damage, blown fuses and/or loose parts. Correct any defects; refer to the manufacturers' manual, as necessary.

D.3 Torque Subsystem Problems

D.3.1 No Output When Torque is Present
Check the transmitter circuitry for a blown fuse and replace it if necessary. The fuse is located on the upper circuit board and must be soldered in place. Verify that loop power is present, its polarity is correct, and the loop cable is intact, i.e., loop voltage appears at the transmitter terminals and that it is within specifications per Figure 5. Finally, verify that the loop load is within the specified maximum for the voltage supply. If all checks are negative, the problem is in the torque transmitter. Return it for factory service.

D.3.2 Constant Output Regardless of Shaft Torque

If the cable is checked per ¶D.3.1 above and found normal, then the problem is the torque transmitters. Return it for factory service.

D.3.3 Apparent Zero Drift

- **Check the Cabling.** See ¶D.2.2.

- **Check for a Drifting Amplifier/Receiver.** Without changing its span control setting, re-connect it to a known good 2-wire transmitter. If the drift remains, the torque transmitter is ok. Clean the input connections with an approved cleaner. If that does not clear the problem, the amplifier/readout is drifting. Analyze and correct it or, return it to the manufacturer for service.

- **Check for Driveline Torque Offsets.** Torque transmitters 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 torque transmitter sees and reads that locked in torque. Always zero a torque transmitter 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 reduce the driveline torque to zero. Otherwise, the torque transmitter 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 clearance to the stator.

D.3.4 Signal Instability

- **Check for Amplifier/Receiver Instability.** Perform a transmitter substitution per ¶D.3.3. If the amplifier/receiver output is stable, then the problem is in the torque transmitter or cabling.

- **Check the Cabling**. See ¶D.2.2 above.

- **Check For Driveline Torque Variations.** The driveline may have a low frequency oscillation which the torque transmitter reads (see ¶C.2.1). Engage the transmitters' 1.5 hertz filter. That action will remove torque signals above 1.5 hertz. If the readings steady, then you may wish to identify the physical cause of the shaft torque variation or, remove it with mechanical filtering techniques; see ¶E.4. Oscillographic signal analysis is often helpful under these conditions; however, *use the **high frequency signal 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 1.5 hertz. They can be identified with an external (to the transmitter) low pass filter.

D.3.5 System Will Not Zero

- **Check the Cabling.** See ¶D.2.2 above.

- **Check the Transmitter.** Substitute a known working 2-wire transmitter for the one in question. If it can be zeroed and operation is normal, then the problem is in the torque transmitter. Otherwise the readout/amplifier is at fault. Repair it or return it to the manufacturer.

- **Verify the Torque Input is Zero.** If the torque transmitter 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 torque transmitter. Verify cable integrity, configuration and connections and check the torque transmitter per ¶D.2.1.

D.4 Speed Subsystem Problems

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

D.4.1 No Signal Output When Shaft is Rotating

- **Verify the Shaft Speed is Within the Measurement Range.** Code P passive speed pickups have a practical lower operating speed range of 25 to 100 rpm, depending on the torque transmitter and speed readout models. Run the shaft at a higher speed and verify the problem still exists. Zero velocity pickups will work down to zero speed. However, most Himmelstein speed readouts have a lower operating limit of 5 to 10 rpm.

- **Verify the Speed Pickup Signal is Normal.** Measure peak output voltage at a constant speed. If no output exists, verify the cable is intact; replace defective cables. See ¶D.4.4 for pickup output data. If the signal is too low, then re-adjust the pickup location per ¶D.4.4. Misadjustment can cause marginal output.

- **Verify the Speed Readout is Operational.** Connect a known frequency to the readout input. It should be between 200 and 5,000 hertz, and operate at an input level of 0.1 volts, rms. If no output is present, the readout is defective and must be corrected or replaced. Otherwise the problem is in the cable, or the pickup, or the operating speed is beyond the system measurement range.

D.4.2 Erratic Output at Constant Speed

- **Check for Cable Faults.** In addition to the usual checks, make certain the shield is in place and only grounded at the amplifier. Verify there is no connection between either signal and shield.

- **Check the Pickup for a Ground Fault.** There should be no connection between the signal wires and the pickup shell.

- **Check the Speed Readout Operation.** Using the techniques described in ¶D.4.1, verify the amplifier output is stable.

- **Verify Pickup Operation.** Verify the pickup output is both normal and stable while the shaft is rotating at a constant speed above 600 rpm.

- **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 3,000 rpm. Alternately, observe the torque variations on 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 correct.

D.4.3 Output When the Shaft is Stationary

- **Check the Cable, Speed Pickup and Speed Readout Operation** per ¶D.4.2 above. If a defect is found, correct it. Otherwise proceed to the next step.

- **Check for High Ambient Electrical Noise.** If the torque transmitter is installed adjacent to large electrical machines, or the machinery is powered by Solid State Phase or Frequency Speed Controllers, significant noise interference can be present. Remove power from the machines and controls or, turn power to an adjacent machine on and off. If the readout stabilizes when power is off, use the techniques described below.

1. **Isolate the instrument from the machine power** by powering it from a separate line transformer.

2. **Reduce the noise** by providing one cable tray or conduit for the speed instrument cable and a separate tray for the machine power and control cables. If possible, use twisted and shielded wire pairs for the motor control cables.

3. **Increase the speed signal level** by replacing the Code P passive speed pickup with a Code Z zero velocity pickup (and cable). Then, adjust the speed amplifier to optimize the signal-to-noise ratio. Instructions for optimal adjustment of Himmelstein speed amplifiers can be obtained from the factory.

D.4.4 Speed Pickup Adjustment/Replacement

Standard speed pickups are field changeable. They thread into the stator housing and are secured with a jam nut. Loosen the jam nut to remove or adjust the pickup. Both the passive (Code P) and zero velocity (Code Z) types require radial location adjustment. These adjustments are described below.

D.4.4.1 Code P Passive Speed Pickup

The nominal outputs of Code P passive pickups are tabulated below. Use an oscilloscope to measure open circuit voltages, while the shaft rotates at the reference speed. The waveform is a distorted sine wave. Make the adjustment using the following procedure:

- Back out the pickup by turning it counterclockwise. Then re-insert it with one thread engaged.
- With the torque transmitter shaft rotating at the reference speed, slowly turn the pickup clockwise until the output is within 15% of the tabulated value. ***If a rub occurs, stop! Back off the pickup until the rub clears.***
- Stop the shaft and tighten the jam nut.
- Rotate the shaft by hand to verify no rub exists.
- Finally, verify the output is correct at the reference speed. Re-adjust if necessary.

The adjustments described take time and require test facilities. If neither is available, you may use the following *less satisfactory* procedure.

- ***With shaft motion stopped,*** turn the pickup in until it contacts the rotor assembly.
- Back off the pickup a quarter of a turn.
- Tighten the jam nut.
- Slowly rotate the shaft to verify no rub exists. If a rub exists, re-adjust the pickup.

MCRT® Transmitter Model Number	Open Circuit Output (Volts pk-pk)	Reference Speed (rpm)
39001X	3.0	5,000
39002X	3.0	5,000
39003X	2.0	1,000
39004X	2.0	1,000
39006X	1.5	1,000
39007X	1.5	1,000
39008X	2.0	1,000
39009X	1.5	500
39010X	1.7	500
39060X	2.0	1,000
39061X	2.0	1,000
39070X	2.0	1,000
39080X	2.0	1,000
39090X	1.5	500
39091X	1.7	500

D.4.4.2 Code Z Zero Velocity Pickup

The output of a Code Z Zero Velocity Speed Pickup swings between approximately + 0.3 Volts and the supply voltage. When used with a Himmelstein readout, the output will swing from +0.3 to about +11.7 volts. Certain specialized units have TTL (+0.3 to +5 Volt) outputs. To adjust the pickup, proceed as follows:

- ***With shaft motion stopped,*** turn the pickup in (clockwise) until it makes contact with the rotor assembly.
- Back off the pickup (counterclockwise) a quarter of a turn.
- Tighten the jam nut.
- Slowly rotate the shaft to verify no rub exists. If a rub exists, re-adjust the pickup until it is eliminated.

D.4.4.3 Replacement Part Numbers

Transmitter Type	Code P Passive Pickup	Zero Velocity Pickup
MCRT® 39001X	900-1009	900-1007
MCRT® 39002X	900-1009	900-1007
MCRT® 39003X	900-1009	900-1007
MCRT® 39004X	900-1009	900-1007
MCRT® 39006X	900-1009	900-1007
MCRT® 39007X	900-1009	900-1007
MCRT® 39008X	900-1009	900-1007
MCRT® 39009X	900-1009	900-1007
MCRT® 39010X	900-1022	900-1023
MCRT® 39060X	900-1009	900-1007
MCRT® 39061X	900-1009	900-1007
MCRT® 39070X	900-1009	900-1007
MCRT® 39080X	900-1009	900-1007
MCRT® 39090X	900-1009	900-1007
MCRT® 39091X	900-1022	900-1023

E. Summary of References

The following paragraphs summarize references pertinent to torque transmitter operation, installation and troubleshooting. Those references are too detailed and technical to be made a part of this document. The referenced material is available from the factory. Some of it may be found in the rear of the torque measurement section of Himmelstein Product Catalogs.

E.1 Torque Transmitter Loads and Specifications

The cover sheet of this document contains device explicit specifications for the serial number in use. Any special design modifications are identified. Page 3 contains an abbreviated specification. The Models' Technical Bulletin contains complete specifications, and outline information; please see Bulletin 7300 for further data.

E.2 Coupling Selection and Torque Transmitter Installation

Technical Memorandum 7850 contains useful information on coupling selection, mounting, measurement and operating considerations. It includes sketches of acceptable and unacceptable mounting arrangements. Addendum #1 to Technical Memorandum 7850 lists commercial sources of flexible couplings.

E.3 High Speed Operation

Technical Memorandum 7551 discusses the critical speed of installed torque transmitters (and torquemeters). It contains procedures for estimating shaft critical speeds, and related material.

E.4 Minimizing the Effects of Torsionals

Technical Memorandum 8150 discusses the estimation of torsional resonant frequencies, and describes how to avoid their destructive effects. It includes theoretical as well as practical help on the subject.

E.5 Selecting the Right Torque Transmitter

Bulletin 705 provides criteria for properly sizing a transmitter. In addition to average drive torque and/or power requirements, the effect of the load and driver characteristics are explained. The bulletin provides a simple, easy to follow selection procedure and contains many useful examples.

Appendix I

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 torque transmitter is unsupported during the change-over, then pillow blocks must be added to handle this situation. Second, the *critical speed* of a foot mounted torque transmitter is usually much higher than a floating shaft torque transmitter.

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 torque transmitter 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 IV 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 torque transmitter and coupling assembly *after coupling installation.* Install the couplings in accordance with the manufacturers' instructions and ¶A.3.

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 II

Vertical Installations

In vertical installations, the torque transmitter 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 torque transmitter and coupling.

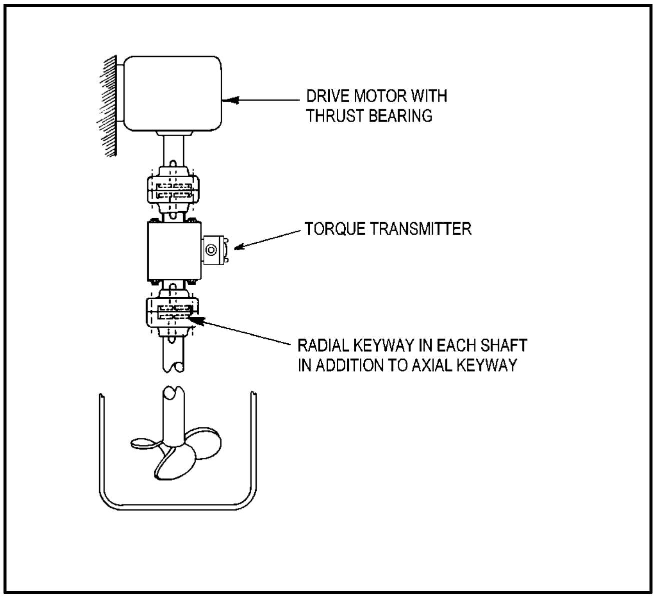

Figure 16. Vertical Torque Transmitter Installation

A flanged torque transmitter with properly attached couplings can support substantial thrust loads. It is well suited for vertical drives. On the other hand, neither axial keys nor the friction of interference fits will carry significant thrust. Special order shaft torque transmitters can be supplied with radial keyways to carry thrust and/or weight loads.

Vertical floating shaft installations don't transfer thrust to the torque transmitter 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 torque transmitter bearing loads to those of ¶C.3.

Appendix III

Fatigue Considerations

MCRT® torque transmitters can handle full scale torque reversals with infinite fatigue life. When peak torques are cyclical, and exceed the full scale rating, then fatigue failure can occur.

When operated at peak torques beyond its' full scale torque rating, a torque transmitters' 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 torque transmitter configuration, etc.

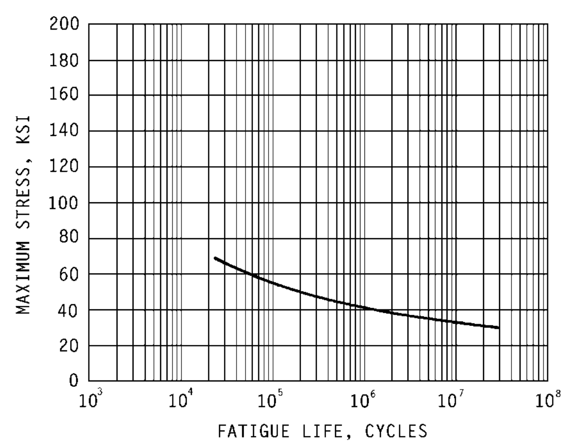

Figure 17. Typical Fatigue Life Characteristics

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 ¶E.4.

- Size the torque transmitter so peak instantaneous torques are within its' full scale rating.
- Check peak torque values, *over the range of operating conditions,* by observing the torque on an oscilloscope while the transmitter filter bandwidth is set to 200 hertz.

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

Appendix IV
High Speed Operation

On special order, torque transmitters can be supplied that operate at higher speeds than their standard counterparts. The cover sheet of this document lists the speed rating of your transmitter. High speed 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 ¶E.4). The operating speed should be below the first shaft critical (see ¶E.3).
- A dynamically balanced torque transmitter 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 V

Oil Mist Lubrication For High Speed Products

Use oil mist lubrication for special high speed transmitters. These products contain structural modifications and oil mist ports that permit operation at higher speeds than their standard counterparts. See the cover sheet for the maximum speed rating of the torque transmitter supplied. Typically, each end has two 1/8" NPT tapped lubrication ports. Use either port for *Inlet* and the other port for *Drain.* Make the port selection on the basis of installation convenience.

Available options include NPT body fittings, manifolding between bearings, and a lubricator with manifolding. When manifolding is furnished, the torque transmitter has a single *Inlet* and a single *Drain.*

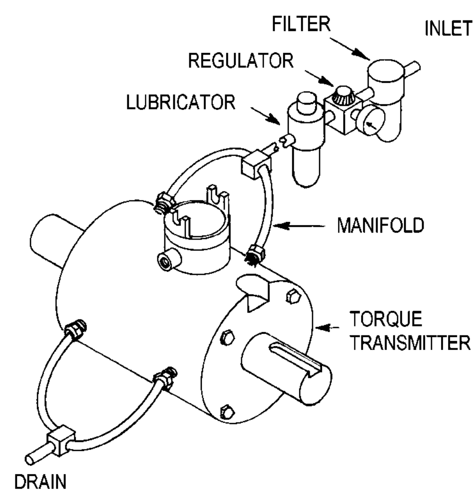

Figure 18. Typical Oil Mist Piping

Certain high speed torque transmitters have multiple *Inlet* and *Drain* ports to enhance lubrication. When so furnished, the device manual will include special manifold information.

Before operating an externally lubricated torque transmitter, verify the lube path is clear by ***confirming oil is recovered from all drains. Loss of lubrication will cause bearing failure. A blocked drain port will trap excess oil, cause overheating from viscous losses, and possible device damage.***

Recommended Lubricator: Norgren Lubro-Control Assembly Consisting Of:

Filter:	P/N F11-200-M3PA
Regulator:	P/N R11-200-RGLA
Lubricator:	P/N L11-200-MPNA

SHC P/N 944-1006 is a complete assembly including filter, regulator, lubricator and oil reservoir.

Recommended Lubricant: MIL-L-6085A. Salient characteristics of this lubricant are:

Viscosity (cSt @ 130 deg. F.)	9.0
(cSt @ -65 deg. F.)	11,740
Flash Point (deg.F.)	455
Pour Point (deg.F.)	-80
Rust/Corrosion Inhibited	Yes
Antiwear Properties	Yes

Recommended Lubricator Adjustments

MCRT® Model Number	Oil Rate* (Drops/Min)	Air Flow* (CFM)
39001XH	3	1.5
39002XH	3	1.5
39003XH	4	4
39004XH	4	4
39006XH	5	5
39007XH	6	6
39008XH	6	6
39060XH	4	3
39061XH	4	3
39070XH	5	6
39080XH	6	6

* Values are total for both device bearings.

Appendix VI

Hazardous Environments

When they are used in hazardous locations, ***purge MCRT® torque transmitters with air (or inert gas).*** Properly used, an air purge will prevent explosive, flammable or corrosive fluid, or airborne abrasive, from entering the torque transmitter. The user must interlock and monitor the purge supply in compliance with applicable safety codes. Introduce the gas purge through the torque conduit fitting. Then, assuming the loop wires are fed through an approved conduit, and suitable interlocks are used, the transmitter 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.

Appendix VII

Belt and Chain Drive Considerations

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

$\geq$ **[Torque Rating] / [4*L]**

and,

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

These criteria assure safe torque transmitter bending and bearing loads. To simplify your analysis, assume $T_2 = 0$ and calculate T_1 = [Torque Rating*2/D]. Then, make [T_1 + T2] = 1.1 times the calculated value of T_1.

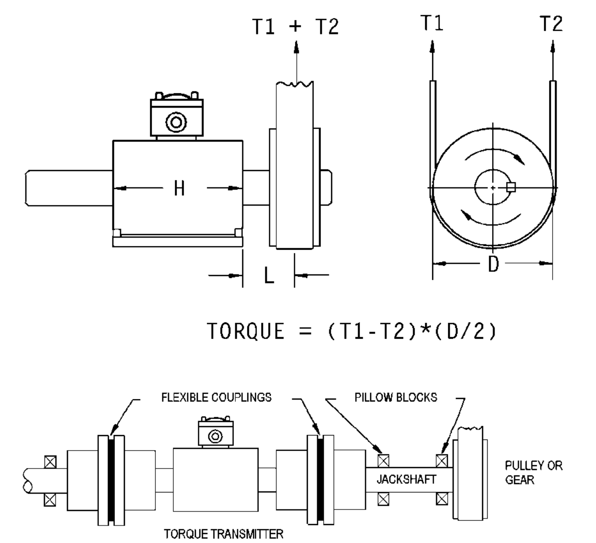

Figure 19. Installation Definitions

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 19 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.

Appendix VIII

WARRANTY STATEMENT AND SPECIMEN CALIBRATION AND COMPLIANCE CERTIFICATION

WARRANTY

Himmelstein hereby warrants, to their original purchaser, all its torque measurement products to be free of defects in materials and workmanship and to conform to the published specifications in effect at the time of order. The warranty period begins at the date of original shipment and extends for a period of one year thereafter.

Our liability under this warranty is limited to the obligation to repair or, at Himmelstein's option, replace without charge, F.O.B. our plant in Hoffman Estates, IL, any part found to be defective under normal use and service, provided:

1. The defect occurs within the warranty period.
2. Himmelstein is promptly notified in writing upon discovery of such defects.
3. The original parts are returned to Himmelstein, Hoffman Estates, IL, transportation charges prepaid.
4. Himmelsteins' examination shall disclose to its satisfaction that such defects have not been caused by abuse, accident, negligence or misuse after delivery.
5. No unauthorized modification has been made.

Equipment or merchandise not manufactured by Himmelstein is not warranted by Himmelstein but carries its manufacturers' warranty. Our performance warranties are stated in printed specifications for each standard product and in a written description included in system quotations. Himmelstein specifically disclaims any other performance warranties or implied warranties of fitness for a particular purpose. This warranty is expressly in lieu of all other warranties expressed or implied (except as to title) and constitutes all of Himmelsteins' liability in respect to equipment or merchandise sold by it.

CALIBRATION AND COMPLIANCE CERTIFICATION *(Specimen only. An executed document is attached.)*

Himmelstein certifies that, before shipment from its factory, this torque transmitter was thoroughly tested and inspected and was found to meet or exceed its published specifications. The listed calibration values were obtained during this process.

It further certifies that its calibration measurements are traceable to the NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST).

Calibrated by: . . . . . . ***Date:*** . . . .

Certified by: . . . . ***Date:*** . . . .

S. HIMMELSTEIN AND COMPANY

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