

WEATHERPROOF WHEEL TORQUE
TRANSDUCER SYSTEM

INSTALLATION AND OPERATION MANUAL

FOR ALL MODELS (TW*)



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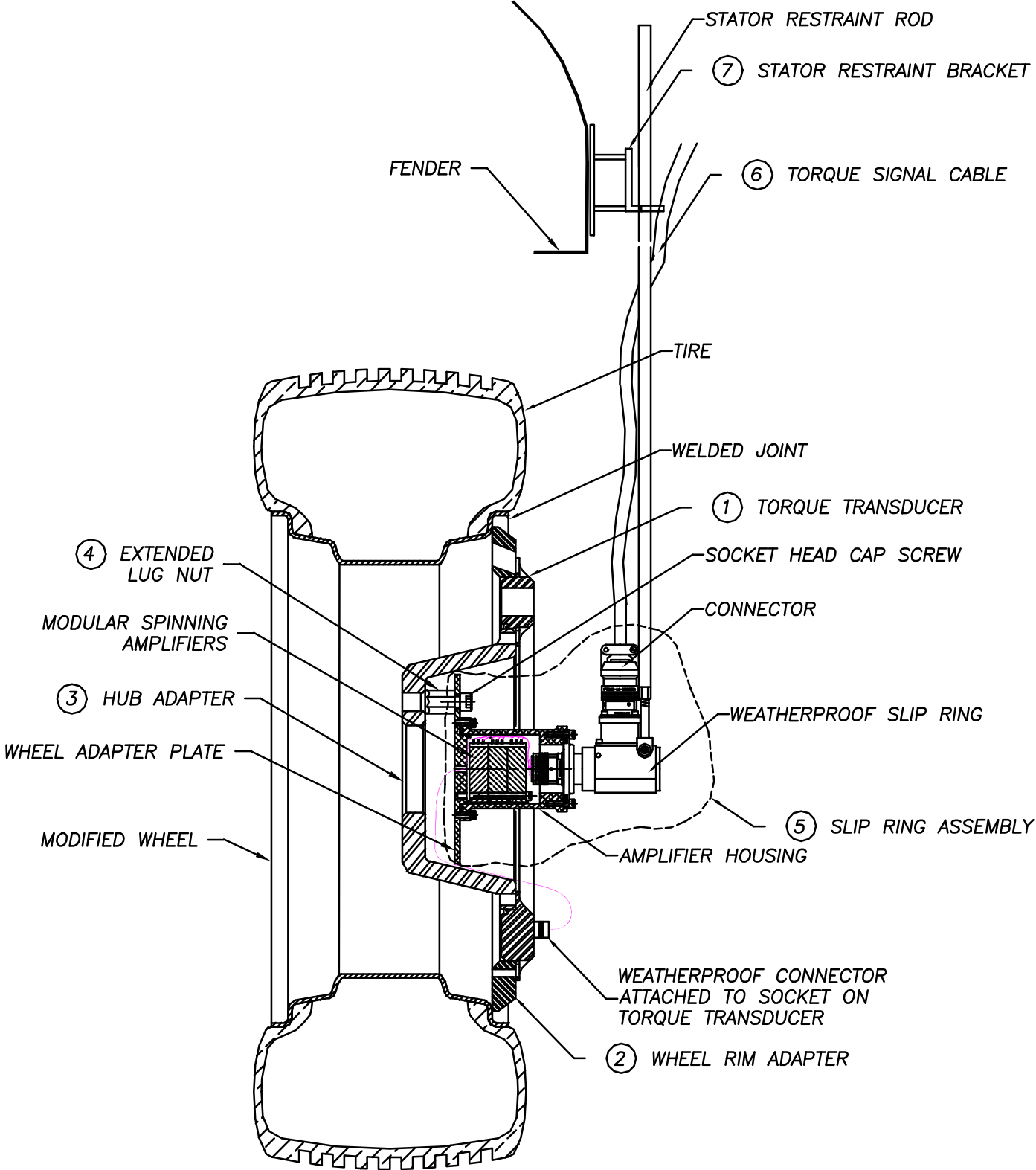
Table of Contents

<u>Parts List</u>	2
<u>Torque Wheel System Cross Sectional View</u>	3
<u>Parts List (cont.)/Installation</u>	4-5
<u>Setup</u>	5-7
<u>Operation</u>	7-10
<u>Appendix</u>	11-15

Parts List (Refer to Figure 1 – Cross Section View)

1. **MSCTW12.8 / MSCTW12.8ER** – Wheel Torque Transducer
2. **Wheel Rim Adapter** – Modified automotive wheel to which the torque transducer is attached.
3. **Hub Adapter** – Fabricated adapter that attaches to the torque transducer interior bolt circle and mounts to the vehicle wheel hub. The hub adapter, along with the wheel rim adapter, duplicate the critical dimensions of the production wheel. **Michigan Scientific Corporation suggests that the customer consult the factory before attempting to mount wheel rim and hub adapters onto vehicles they weren't intended for.**
4. **Quick Connect Collet Extension Lug-Nuts** – Lug-nut extensions used to mount the slip-ring assembly beyond the vehicle hub. Extensions mount onto “flats” of standard lug-nuts. A minimum of three are required per wheel, with four being necessary in four-bolt wheels. Optional lug-nut extension configurations are available for instances not suited for the Quick Connect Collet Extension Lug-Nuts.
5. **Signal-Conditioning Assembly** – Includes the following: weatherproof slip ring assembly with encoder (some slip-ring assemblies have the encoder electronics necessary for calculating speed and rotational direction and position built into the stator housing as well), AMP-SG-U2-10 modular strain gage amplifier that supplies 10 volts of bridge excitation and set with a specified gain (typically 500V/V) and shunt resistance (typically 100k ohms), a weatherproof amplifier housing, a slip-ring mounting wheel adapter plate and a wired connector that attaches to the torque transducer. Some signal-conditioning assemblies also include either a 2 or 3-channel thermocouple amplifier. When a thermocouple amplifier is included in the signal-conditioning assembly, miniature, blade-type thermocouple connectors exit the wire-seal grommet on the wheel side of the slip-ring mounting wheel adapter plate for making connections to the amplifier. Wiring diagrams can be found in appendix. *(The wiring and assembly for a typical slip ring assembly is provided in the appendix.)*
6. **Stator Cable Assembly** - A cable assembly which contains a power cable with a 6 pin connector to supply power to the amplifiers and encoders and a signal cable transferring the amplified torque and encoder signals from the slip ring assembly through Tygon tubing into the vehicle.
7. **Magnetic Stator Restraint Bracket** - A bracket that mounts to the fender of the vehicle to hold the torque signal cable stationary while the vehicle is in motion.

Torque Wheel System Cross Sectional View



8. **Remote Power and Calibration Supply, PS-DC-1.0V2** (not shown in CS view) - A DC powered unit and cigarette lighter plug power cable adapter. The unit supplies power to all amplifiers and encoders on the vehicle and provides controls needed to remotely shunt calibrate the transducers with positive and negative shunts.

Installation

1. Mount the torque transducer to the hub adapter through the inner bolt circle with 3 or 4 fasteners to hold the adapter in place loosely. Continue by mounting the torque transducer to the wheel rim adapter through the outer bolt circle using all fasteners and tighten to 49 ft-lbs. (All fasteners on the torque wheel should be Grade 8, 3/8-16 x 5/8"; **install using a medium-strength, removable thread-locking compound in order to prevent loosening**). Finish by installing the remaining fasteners in the hub adapter and tightening all fasteners to 49 ft-lbs. (*Note: Previously, stainless steel fasteners were used and tightened to 30 ft-lbs. Since the stainless steel fasteners have lower strength properties, we recommend using Grade 8 fasteners*) When complete Wheel Torque Transducer systems are shipped from the factory, this step is completed at the factory.
2. Mount a tire on the rim in the typical manner. Have the tire, transducer and rim and hub adapter assembly balanced to OEM specification.
3. Mount the magnetic slip-ring stator restraint to the fender directly above the wheel hub.
4. Mount the wheel onto the vehicle using one of the following procedures: 1) If **Threaded Extended Lug-Nuts** are being used, replace three (four in the case of a four bolt wheel) of the standard lug nuts with the extended lug nuts. Torque all lug-nuts to the recommended specification. 2) If **Quick Connect Collet Lug-Nut Extensions** are being used, fasten the wheel onto the vehicle using the standard lug nuts. Torque all lug-nuts to the recommended specification. Verify that you have the correct Quick Connect Collet Lug-Nut Extension size for the vehicle lug-nuts by placing one onto a lug-nut and tightening the 1/4-20 cap-screw until the collet clamps securely onto the lug-nut; remove

once the correct size is verified. If the collet will not open enough to fit onto the lug-nut or will not close enough to fasten securely onto the lug-nut, you have two options. First, you might need to replace production lug-nuts (many are over-sized for appearance purposes) with standard, tapered ones. If the collet will still not fit onto the lug-nut or doesn't clamp securely, contact the factory for alternate sizes.

5. Mount the slip-ring assembly to the vehicle using one of the following procedures: 1) If **Threaded Extended Lug-Nuts** are being used, mount the Wheel Adapter Plate to the extended lug-nuts using the ¼-20 cap-screws. 2) If **Quick Connect Collet Lug-Nut Extensions** are being used, unscrew the ¼-20 cap-screw from the top of the collet. Place the small washer onto the screw and insert the screw through the appropriate slot in the Wheel Adapter Plate. Place the large washer over the screw on the bottom side of the plate and thread the screw into the top of the collet. (Use of a medium-strength, removable thread-locking compound is recommended) Repeat this procedure in the appropriate slots for a minimum of three connections per wheel, using four on four bolt wheels. Now slide each collet onto the corresponding lug-nut, making sure each is fully seated on the lug-nut. Tighten the ¼-20 screws (8-10 lb-ft) to secure the slip-ring assembly to the lug-nuts. In both cases, mount the slip-ring assembly with the minimum amount of radial run-out.
6. Fasten the stator restraint rod to the slip-ring stator housing using the #8-32 x ½" socket-head cap screws and washers provided.
7. Connect the 22' torque signal cable to the slip ring assembly. Secure it to the stator restraint rod with cable ties.
8. Repeat this process for each wheel in the system.

Setup

After all components have been properly mounted onto the vehicle, perform the following steps to ensure proper operation:

1. Connect the 4-socket Bendix connector (PT06E-8-4S(SR)) wired to the base of the slip ring assembly to the 4-pin box-mount connector on the torque transducer. Restrain this signal cable to the lug-nut extensions using cable ties. **DO NOT restrain the signal cable to the Wheel Torque Transducer at any location.** This cable provides excitation to the transducer and transfers the torque signal back from the transducer. As indicated in the wiring diagram, the shielding in the cable is grounded at the amplifier and open at the transducer. The Bendix connector is a weatherproof model and will protect the contacts from prolonged outdoor use. It is suggested to completely wrap the connector with fusion tape to protect the outer shell from dirt. Excessive dirt can prevent the connector shell from rotating for removal and will result in damage to the wires inside the connector. If the optional thermocouple amplifiers are included in the slip-ring assembly, complete the connections to the thermocouples on the rotating components and wrap them with fusion tape as well.
2. The slip-ring stator cable containing the open cable ends and the power-supply connector should be extended into the vehicle through either the window or door. Care should be taken when routing the cables into the vehicle so that the wires are not pinched when the window or door is closed. To ensure proper weatherproofing, the cable should be routed such that the end of the protective tubing is inside the vehicle. Depending on the vehicle and setup, it may be necessary to fasten or tape the cable to the side of the vehicle in order to secure it and prevent excess strain.
3. Power is provided to the slip-ring encoders and the torque and thermocouple (optional) amplifiers by the Michigan Scientific *DC Remote Power and Calibration Supply, PS-DC-1.0V2*. The power supply draws power from the 12VDC vehicle system. To complete

this connection, fasten the 3-pin socket connector to the INPUT POWER connector on the back panel of the power-supply. The opposite end of the cable plugs into the cigarette lighter or accessory plug of the vehicle.

4. The *PS-DC-1.0V2* power supply has two OUTPUT connectors on the back panel. If two *Wheel Torque Transducer Systems* are installed on the vehicle, connect each of the 6-pin Bendix connectors (PT06A-10-6P) on the slip-ring stator cables to one of these OUTPUT connectors. When three or four *Wheel Torque Transducer Systems* are installed on the vehicle, a *Power Supply Y-Cable, PSCABLE*, will need to be used to adapt two 6-pin Bendix connectors (PT06A-10-6P) on the slip-ring stator cables to one OUTPUT connector on the rear panel of the power supply.
5. The torque, encoder and thermocouple (optional) signal leads can be connected to the desired instrumentation or data collection device. Each slip-ring stator cable will have a separate wire for torque signal high, torque signal common, encoder signal high and encoder signal low. If thermocouple amplifiers are included in the slip-ring assemblies, either two or three channels of thermocouple signal high and thermocouple signal low leads will be labeled as well. The wire color and its associated signal will be indicated in the wiring documentation for the system and be labeled on the wire. The shield for the signal cable is open at the slip-ring end of the cable and should be grounded at the data-acquisition system.

Operation

1. Power Supply - The *DC Remote Power and Calibration Supply, PS-DC-1.0V2* has three switches that provide the necessary controls to power all the amplifiers and encoders for the vehicle, check for noise on the cable to the transducer and remotely invoke a positive and negative shunt for calibration.

- a. The POWER switch on the front panel of the power supply turns the power on and off to the supply. The LED on the front panel will illuminate when the supply is properly powered and the power switch is “ON.”

- b. The BRIDGE EXCITATION switch controls the bridge excitation voltage from the amplifiers to the transducers. With the switch in the ON position, the excitation voltage is supplied to the transducers and the system will operate as expected with voltage readings from the transducers when torque is applied. When the bridge excitation switch is in the OFF position, the excitation voltage to the transducers is removed even though the amplifier is still powered and operational. This feature has been incorporated to check for externally induced noise caused by magnetic or thermoelectric effects.

Note: The *DC Remote Power and Calibration Supply, PS-DC-1.0V2* has been designed such that when the bridge excitation switch is in the ON position, the voltage at pin A of the output connector is +15 volts and pin C is -15 volts (normal operation). When the excitation switch is turned OFF, the voltage at pin A is -15 volts and on pin C is +15 volts. This will also cause the encoder to produce a signal only when the bridge excitation is in the ON position.

- c. The SHUNT CALIBRATION switch provides the control to invoke both a positive and negative shunt on all transducers. A shunt involves placing a specified resistance across one arm of the bridge in the transducer. The output voltage created by doing this corresponds to the calibrated output for the transducer. With the switch in the center position, the transducers operate normally. When the switch is in the POS position, +15 volts is supplied on pin F of the output connector. This voltage, when wired to the calibration control pin on the strain gage amplifier, will invoke a positive shunt (internal to the amplifier) on the transducer. When the switch is in the NEG position, -15 volts will be on pin F and this will invoke a negative shunt on the transducer. The shunt resistance for each transducer is selectable on the amplifier (set at the factory) and is typically 100k Ω for a Wheel Torque Transducer.

- d. The *DC Remote Power and Calibration Supply, PS-DC-1.0V2* has an LED on the front panel that indicates the operation mode. If the LED is not lit, the power supply is not supplying power to the amplifiers; the power switch will be OFF or the input power plug is not connected correctly. If the LED is red, the system is being checked; either the bridge excitation switch is OFF or the shunt calibration switch is in either the POS or NEG position. A green LED indicates the system is operational and providing power to the transducers.
 - e. Refer to the *DC Remote Power and Calibration Supply Operator's Manual* for more detailed information.
2. Shunt Calibration - This operation provides the functions needed to relate the output torque voltage to the corresponding torque measurement.
 - a. Each *Wheel Torque Transducer* has been calibrated by using a least-squares transducer calibration program to compute a best fit ratio between applied torque (in foot-pounds or Newton-meters) and bridge output. The "All Points 100k Shunt Calibration Value," reported on the transducer calibration sheet, is the torque equivalent to bridge output when one arm of the bridge is shunted with a 100k Ω resistance. (Typically, the "100k Shunt Calibration Value" is about 1,800 ft-lbs for a model *MSCTW12.8 Wheel Torque Transducer*)
 - b. A shunt calibration check of each torque transducer relating output voltage to the equivalent torque can be achieved remotely by using the *DC Remote Power and Calibration Supply* and monitoring the output torque signal from the slip-ring assembly. Each transducer can be shunt calibrated separately or as a set if all torque signals can be monitored at once and all slip-ring assemblies are attached to the same power supply.
 - c. The vehicle should be positioned such that there is no torque on any of the wheels. With the system set up properly, the power supply operating correctly (indicated by a green LED) and a multi-meter or data-acquisition system available to monitor the

- output torque signal, note the initial output voltage. This value, the zero offset voltage, should be minimal but needs to be factored out manually or through software so that the transducer output is zero in the no torque condition. (It is recommended to periodically check the transducer unbalance in the no torque condition. A significant change in the unbalance may indicate that the transducer has been damaged).
- d. Move the Shunt Calibration switch on the power supply to the POS position and note each torque signal output voltage. This voltage , when added to the zero offset voltage, corresponds to the positive 100k Shunt Voltage and in turn, the 100k Shunt Calibration Value calculated during calibration. A direct relationship between the signal output voltage and torque (conversion factor) can be made.
 - e. Move the Shunt Calibration switch to the NEG position and note the voltage. This voltage, when added to the zero offset voltage, should be the same value but opposite in sign to the positive shunt voltage and corresponds to the negative 100k Shunt Voltage.
 - f. An example of the voltage output for a typical *Wheel Torque Transducer* system during shunt calibration is shown:

Note: These are approximations and are not to be used for actual measurements. Each torque transducer will have a different conversion factor depending on the “100k Shunt Calibration Value” for the transducer and the measured shunt calibration voltage.

Model : MSCTW12.800 S/N : XXX
Bridge Excitation : 10 volts Shunt Resistance : 100k Ohms
100k Calibration Value : 1800 ft-lbs

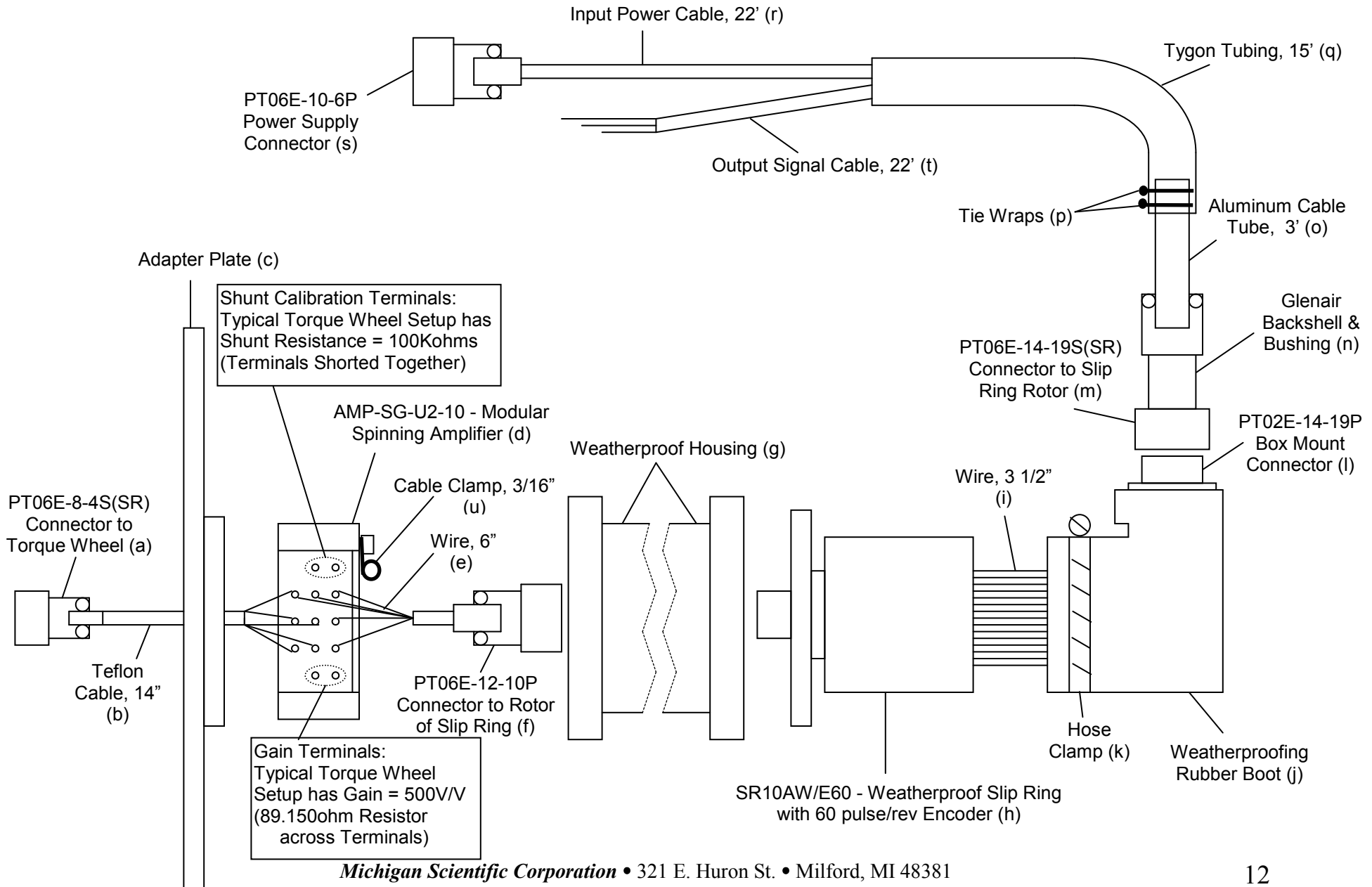
	<u>Transducer Unbalance</u>	<u>Positive Shunt</u>	<u>Negative Shunt</u>
Voltage Output	-6.8 mVolts	1.184 Volts	-1.198 Volts
Adjusted Output	0.0 mVolts	1.191 Volts	-1.191 Volts

Conversion Factor : 1800 ft-lbs = 1.191 Volts; hence, 1511 ft-lbs/V or 1.511 ft-lbs/mV

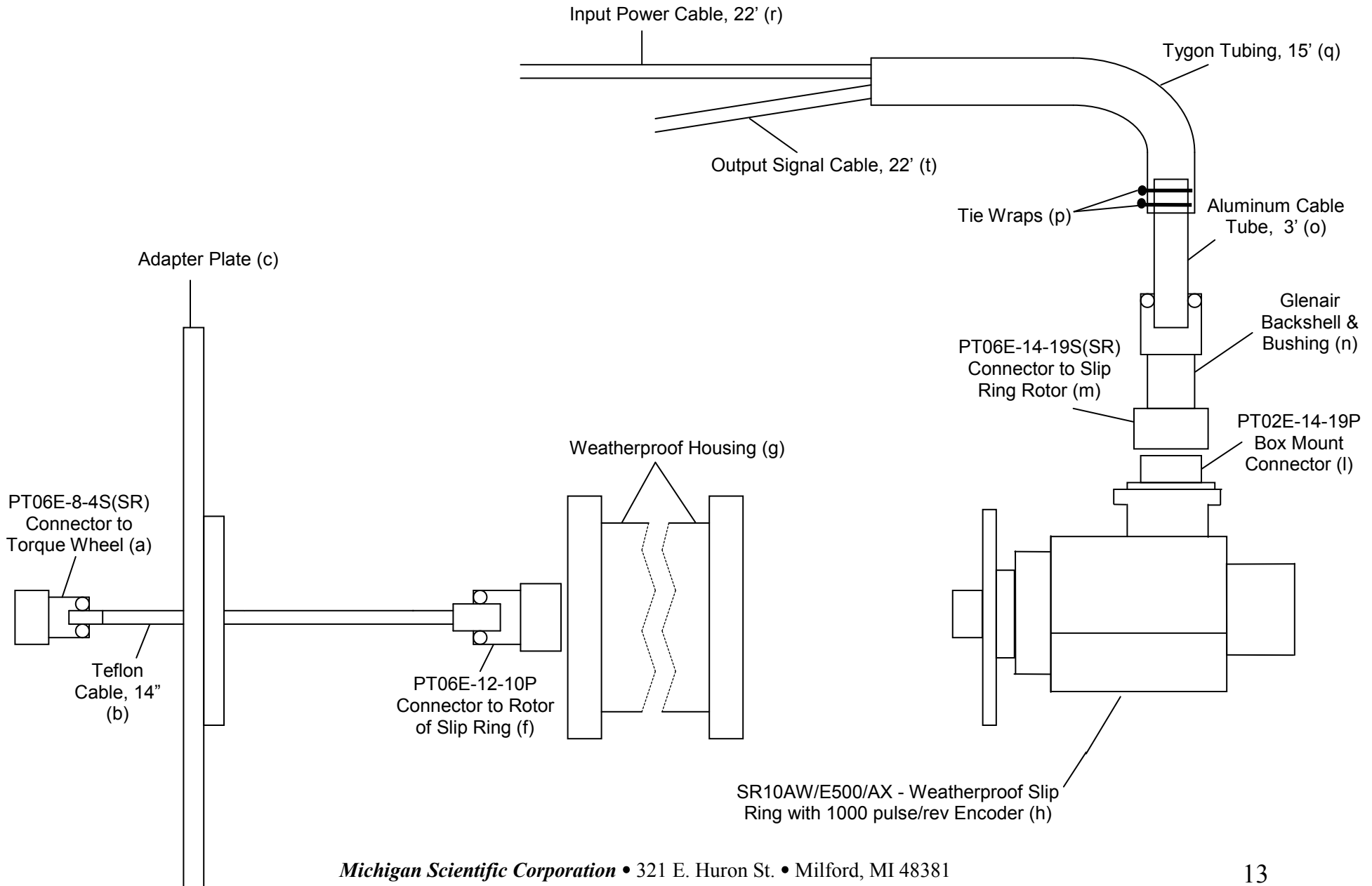
- g. Be sure to return the Shunt Calibration switch to the center position before recording torque measurements (the green LED on the power supply will verify an operational system).

Appendix

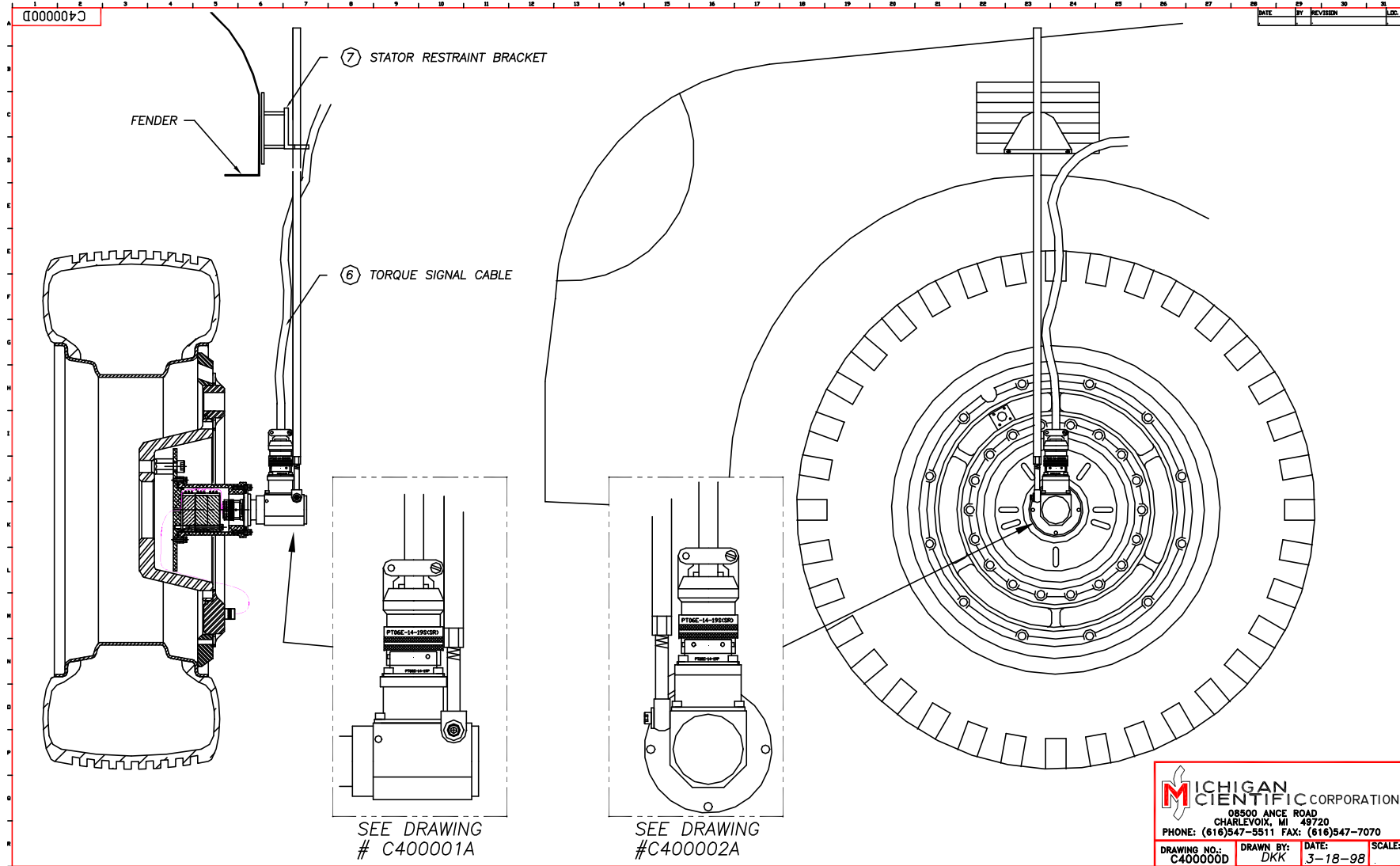
Wiring Diagram for Typical Torque Wheel Slip Ring Assembly



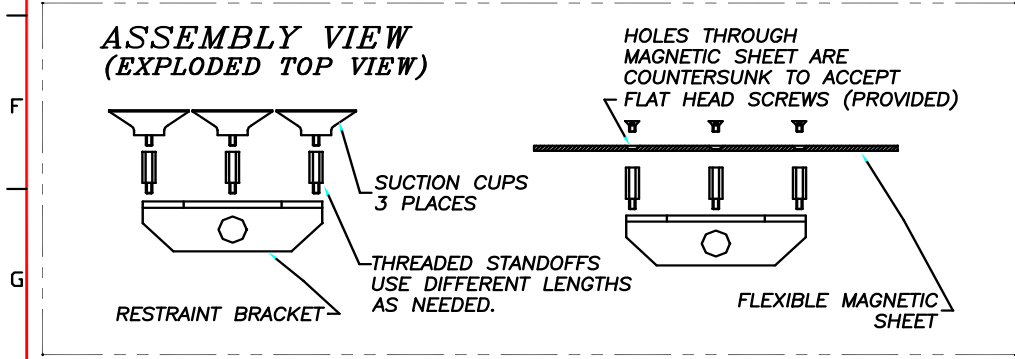
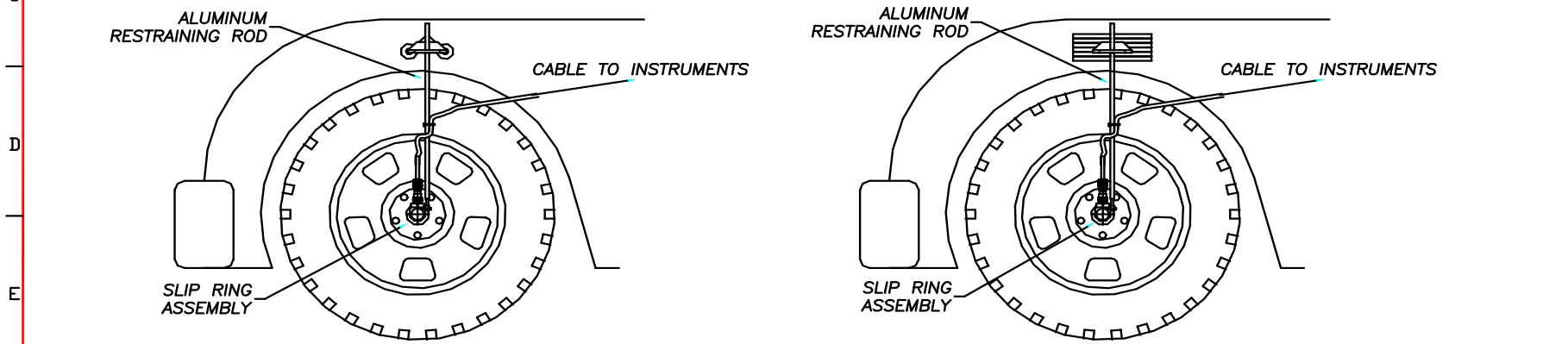
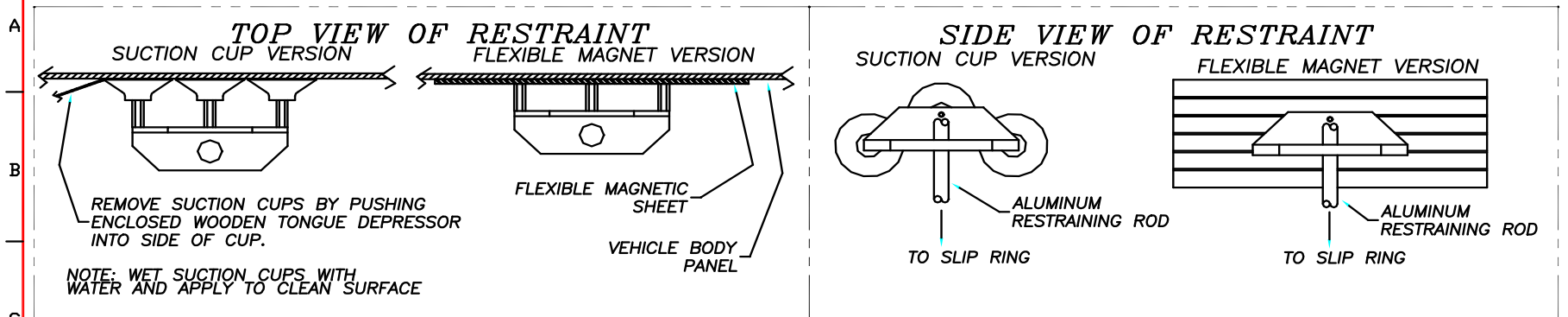
Wiring Diagram for Typical Torque Wheel Slip Ring Assembly



SLIP RING RESTRAINT SYSTEM FOR WHEEL APPLICATIONS



MAG-CUP VEHICLE STATOR RESTRAINT



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