



Steering Wheel Torque Measurement System

User Manual



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Steering

Wheel Torque Measurement System

- No modifications necessary
- Mounts to wheel or shaft spline
- Includes transducer, encoder, and mounting bracket
- Transducer mounted on either aftermarket steering wheel or custom spline adapter for OEM wheel
- Measures steering torque and angle

Specifications

Torque Range	100 N • m Nominal
Non-linearity	<0.5 % of full scale output
Torque Resolution	0.1 ft • lb
Angle Resolution	0.03 Degrees
Angle Sensitivity	37.895 Deg/V (0.5 V to 10 V over 360 Deg)
Angular Velocity	2000 Degrees per second
Temperature Range of Transducer	-40°F to 185°F (85°C to 85°C)
Input Power	9 to 36 Vdc

System Overview

The Michigan Scientific Corporation (MSC) Steering Wheel Torque Measurement System measures steering effort torque and rotational position of the steering wheel.

The system is comprised of a precision torque transducer, high resolution encoder, mounting assembly, and signal conditioner. Torque data is amplified and then transmitted from the rotating to stationary via an instrument quality Michigan Scientific slip ring assembly which connects to a stator bracket and stator cable. The stator bracket attaches to an adjustable bracket system with suction cup that should be secured to the windshield. The stator cable connects to the PS-DC-SW amplifier control unit.



There are two optional mounting arrangements available. In both cases the user will interact with an aftermarket steering wheel which is bolted to the top of the transducer.

With the first option 'Clamping Arms' attach the bottom side of the transducer to the OEM steering wheel.



With the second option, the OEM steering wheel is removed, and the bottom side of the transducer is bolted to a custom spline adapter which mounts directly to the steering wheel shaft.



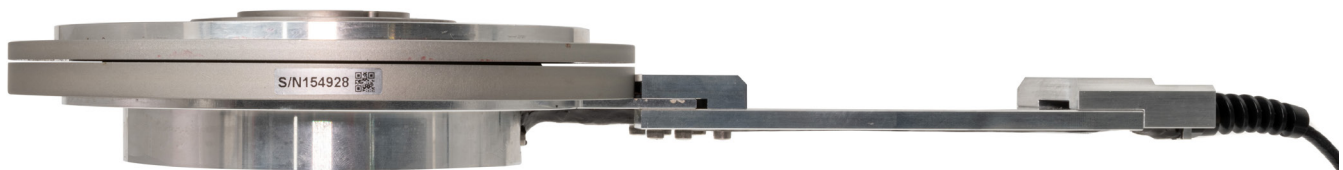
Transducer

The transducer is a single channel strain gauge based transducer that is gauged and wired to measure torque only. Mounted to the transducer (see Figures 2 and 3) is a Michigan Scientific 'M1' an amplifier that supplies excitation to the strain gauge bridge and amplifies the signal. The high level data is transmitted through the Slip Ring Assembly to the stator cable.



Encoder

A high resolution Zettlex encoder is mounted in the assembly and uses the bearing in the slip ring to rotate in plane. The rotating component is mounted to the transducer, and the stationary component is mounted to the slip ring stator. The assembly creates the necessary air gap between the two components of the encoder assembly.



PS-DC-SW Amplifier Control Unit

The PS-DC-SW Remote Amplifier Control Unit provides power to the strain gauge amplifier and encoder assembly, has user control switches, and provides Analog signal outputs for both Torque and Rotational Angle.

A power supply of 10 to 36V DC is required to operate the *PS-DC* which makes it ideal for automotive applications.

The PS-DC-SW has four switches which are POWER, BRIDGE EXCITATION, SHUNT CALIBRATION, and ENCODER ZERO SET.

Operating details of the PS-DC-SW are on page 11.



Installation Instructions

Precautions

- **WARNING !** - Remove airbag to prevent injury.
- To avoid damage use care when working with any part of the transducer system.

Clamping Arms Installation:

Remove airbag from vehicle. Then remove the steering wheel center bolt holding the OEM steering wheel to the steering shaft.

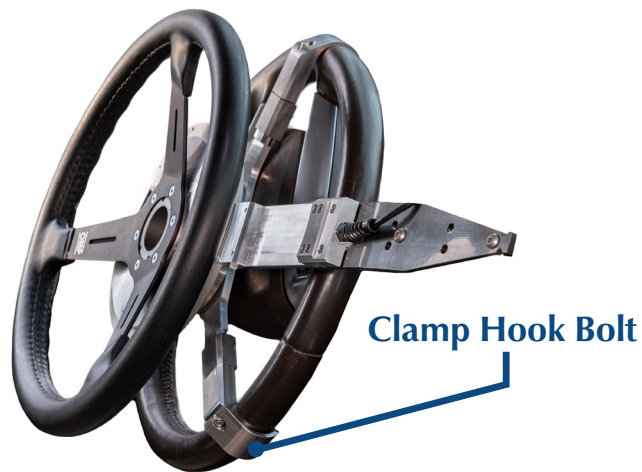
Next place the steering wheel center bolt into the provided Cylinder Alignment tool, re-install the steering wheel bolt into the steering shaft as shown below. The Cylinder Alignment tool is for installation only and is used to align the Steer Wheel Torque System on the steering wheel center of rotation.



The Steering Wheel Transducer System attaches to the production steering wheel with three Clamp Hooks. The Clamp Hooks bolt to the Y adapter with 1/2-20" SHCS bolts. Clamp Hook extenders and different size Y adapters are available to fit varying sized steering wheels. MSC offers three different size Y Adapters for fitting to different sized steering wheels. See the Appendix for Y Adapter sizing options. Clamp Hook extenders are also available for further adaptation options.



Place the Steering Wheel Transducer System with Clamping Hooks into place as shown below. The Clamping Hooks will grab the OEM steering wheel and the Cylinder Alignment Tool will pilot the Steering Wheel Transducer to the production steering wheel. Tighten the 1/4-20" Clamp Hook bolts incrementally until the SW-SR Steering Wheel can be fully turned without any slip between the OEM and SW-SR steering wheels (see note below). Finally remove the Cylinder Alignment tool and re-install the Steering Wheel center bolt.



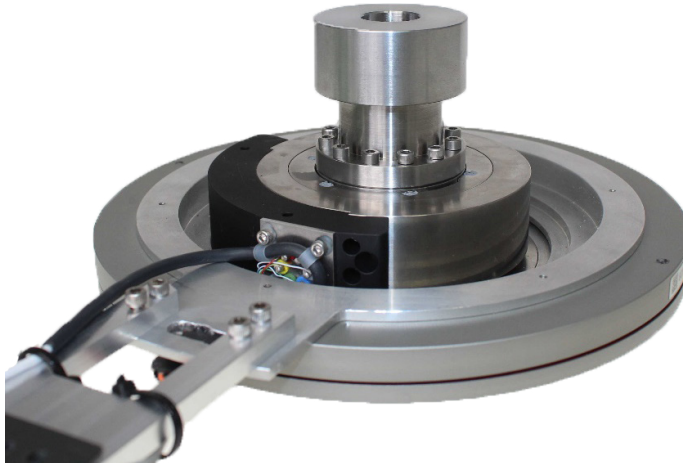
Notes

The amount of torque required to properly tighten Clamp Hook bolts to the steering wheel will vary based on the material and shape. If damage to the steering wheel is a concern, wrap tape around the wheel prior to mounting the Clamp Hooks.

Spline Adapter Installation:

The steering wheel transducer can be secured to the steering shaft spline when used with a spline adapter. The vehicle specific spline needs to be cut into the spline adapter by MSC or by the end user.

After the spline adapters has the appropriate spline for your vehicle steering shaft, bolt spline adapter to bottom of transducer with ten #6-32 bolts and tighten to 24 lbf·in (2.7 N·m).



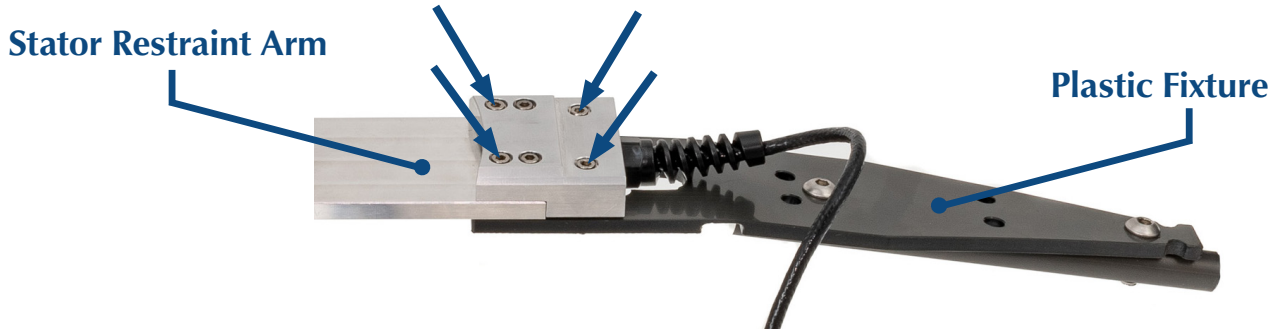
Remove the Original Vehicle Steering Wheel until steering shaft male spline is exposed.

Mate SW-SR with spline adapter onto the Steering shaft spline and install the Steering Wheel Center bolt to secure the SW-SR to the steering shaft with the OEM Steering Wheel Center Bolt.



Anti-Rotation Bracket Installation:

Use four 6-32 socket head cap screws and 6-32 nuts with lock washers to fasten the Plastic Fixture to the Stator Restraint Arm.



Secure the suction cup to the vehicle windshield out of the main view of the driver. It is recommended to clean the windshield before attaching the section cup assembly. Then tighten each of the ball pivot locks securely so that there is minimal play in the Anti-Rotation Bracket when turning the steering wheel.



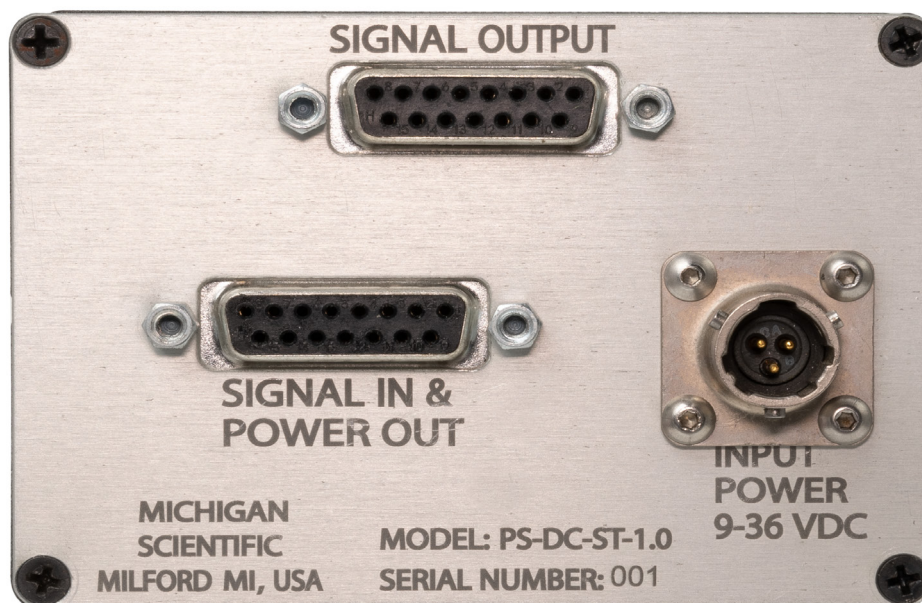
Cable Connections and Control Unit

Cable Connections

Connect the steering wheel transducer cable to the 'Signal In & Power Out' Connector on the back of the Steering Wheel Control Unit .

Connect the power cable to the Steering Wheel control unit, and connect other end of the power cable to a DC voltage source in the range of 10 to 36 volts. The other end of the power cable has a Cigarette Lighter plug for connection to vehicle power.

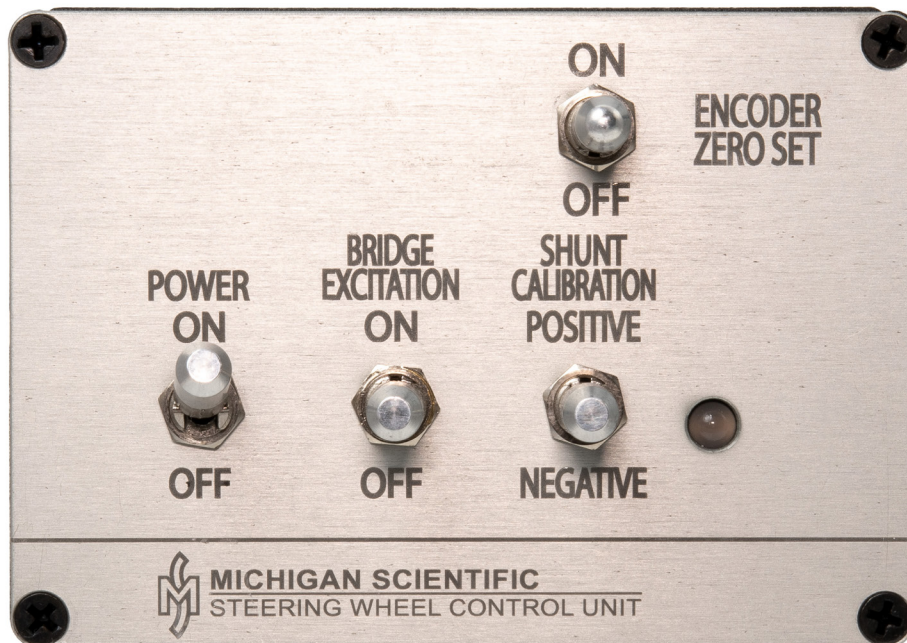
Connect the output cable to the 'Signal Output' connector and connect the other end to the data acquisition. Both the Torque and Encoder signals provide a ± 10 Volt DC signal output.



Control Switches

The Steering Wheel Control unit has four switches on the front panel. The Power Switch turns the power on and off. The LED located on the front panel will illuminate when the supply is operating properly, and the power switch is on.

The Bridge Excitation switch controls the bridge excitation voltage. When the switch is in the ON position, the amplifiers supply excitation voltage to the transducers strain gauge bridge. This is normal operating mode. When the switch is in the OFF position, the amplifiers do not provide excitation to the transducers strain gauge bridge but the amplifier is still operational. In this mode, any signal observed on the signal lines is background noise.



Angle Encoder Zeroing

The Encoder Zero Set switch sets the zero for the SW-SR angular encoder. The Encoder Zero Set switch should be set to OFF during normal operation.

In order to zero the angle position start with the wheels straight. Turn the Power Switch OFF. Following this, turn the Encoder Zero Set to ON. Next, turn the Power Switch to ON. After approximately five seconds, return the Encoder Zero Set Switch to OFF. The encoder zero has now been set.

Shunt Calibration

The Shunt Calibration Switch controls the shunt resistor located in the amplifier of the SW-SR. When the switch is in the center position the transducers operate normally. When the switch is in the POS position, a shunt resistor is placed between the P+ and S+ lines of the strain gauge bridge. This causes an electrical offset that corresponds to a calibrated output from the transducer. When the switch is in the NEG position, a shunt resistor is placed between the P+ and S- lines of the strain gauge bridge, providing a negative offset. More information is below.

The LED located on the front panel is green when the PS-DC-SW is in normal operation mode. If the LED is red, either the shunt switch is not in the center position or the bridge excitation is turned off. If the LED is not lit, the power supply is not powered up.

Shunt Calibration Explanation

This Shunt Calibration operation provides the method to relate the output torque voltage to the corresponding measurement.

Each SW-SR has been calibrated statically in a torque calibration rig. The recorded data has been entered into a least-squares transducer calibration program to compute a best fit ratio between applied torque (lbf·ft or N·m) and bridge output. The “100K Shunt” reported on the transducer calibration sheet, is the torque equivalent to bridge output when one arm of the bridge is shunted with a 100 k Ω resistance, which is installed in the amplifier.

To perform a shunt calibration, ensure no torque is applied to the SW-SR. Monitor the signal outputs from the transducer with either a multi-meter or the data acquisition system.

Invoke the shunt calibration by moving the Shunt switch to the POS position. The delta voltage (voltage change from Shunt Off to POS Shunt) corresponds to the 100 k Ω shunt value recorded on the calibration sheet. A relationship between the signal output voltage and torque can be made to set-up the data acquisition.

See the calibration sheets that were shipped with your equipment. Be sure to return the shunt switch to the center before recording data.

Transducer Calibration Sensitivity

The data acquisition can be set-up using the Transducer Calibration Sensitivity listed on the Calibration Sheet of Each Transducer. This value gives the amount of torque equivalent to 1 volt of output from the Wheel Torque Transducer System.

It is recommended to perform a Shunt Calibration to verify that the data acquisition is set-up properly. Check that the Shunt Calibration in N·m (or lbf·ft) matches the Delta change in torque data acquisition.

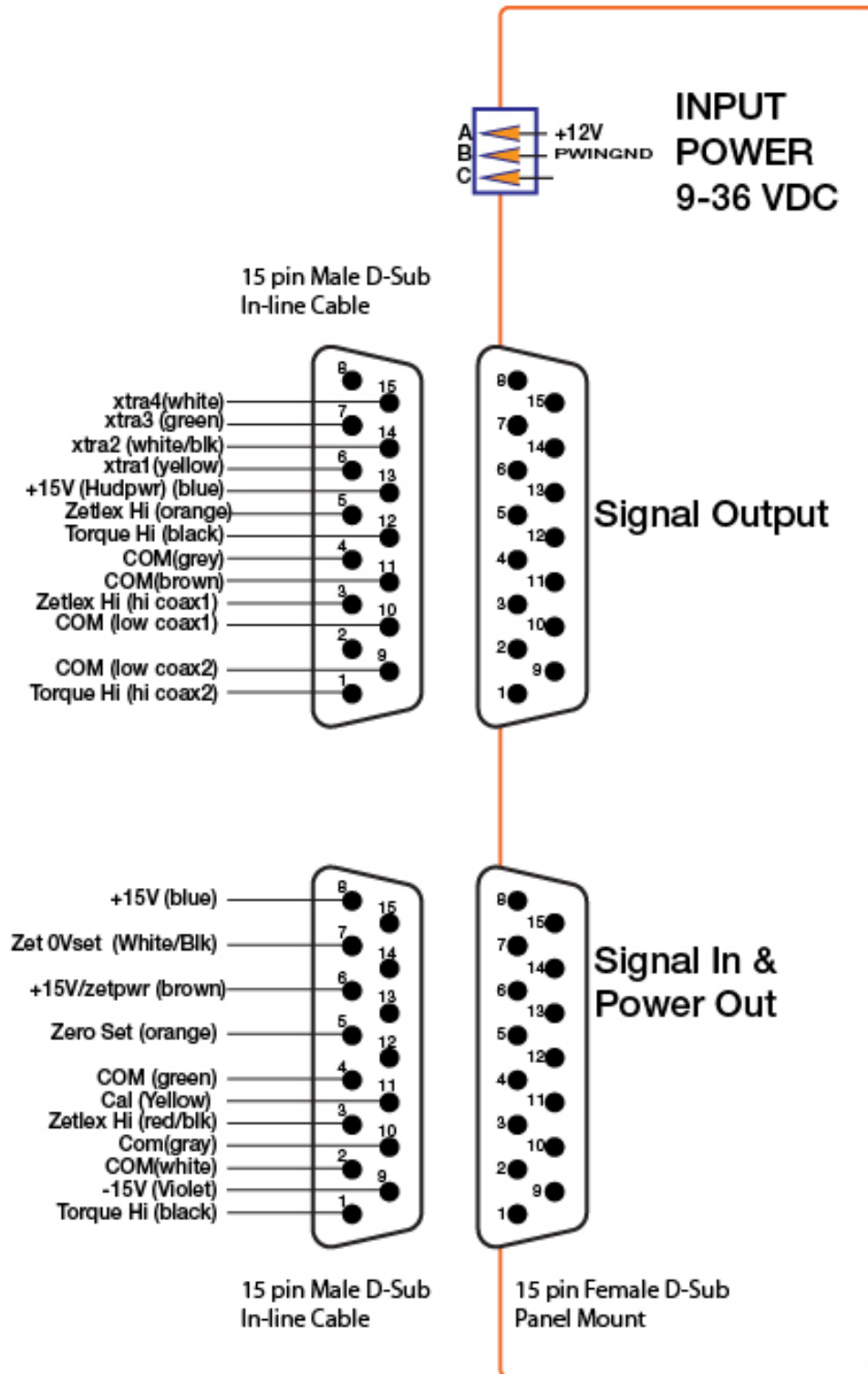
Optional Heads Up Display (HUD)

An Optional Heads Up Display (HUD) can be purchased with the SW-SR. The HUD is provided with a suction cup assembly to attach it to the windshield. The HUD gives a live read-out Torque and Steering Wheel Angle. The output cable of the PS-DC-SW directly connects to the HUD, as shown below.



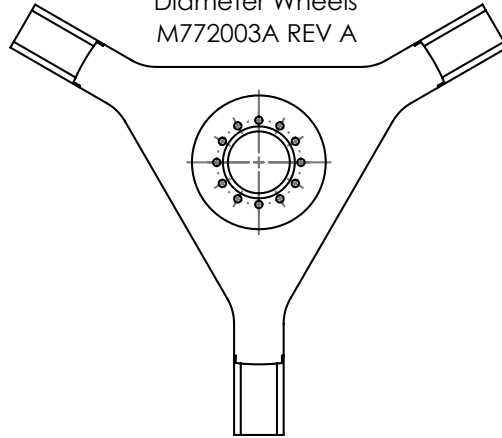
Appendix

Cable Wiring Diagram

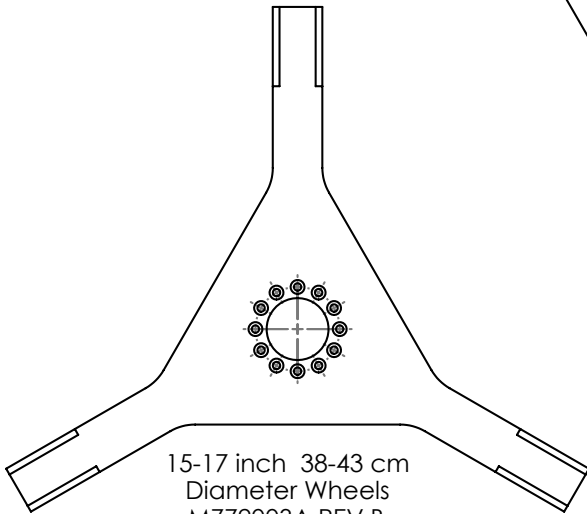


Y Adapter Options

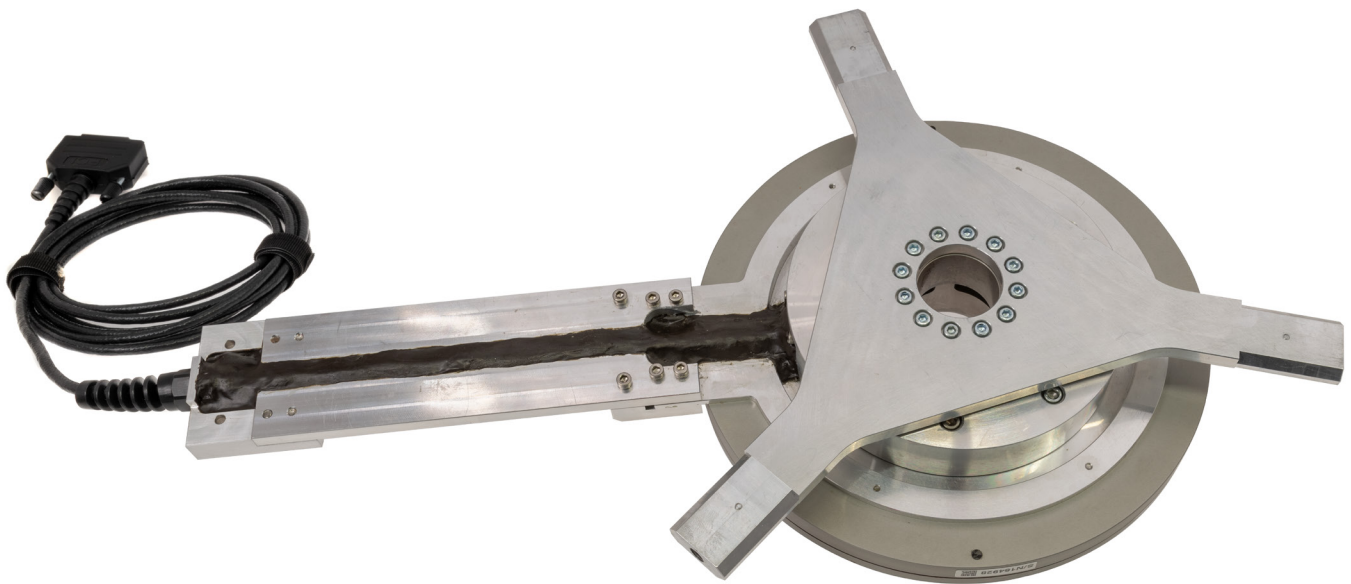
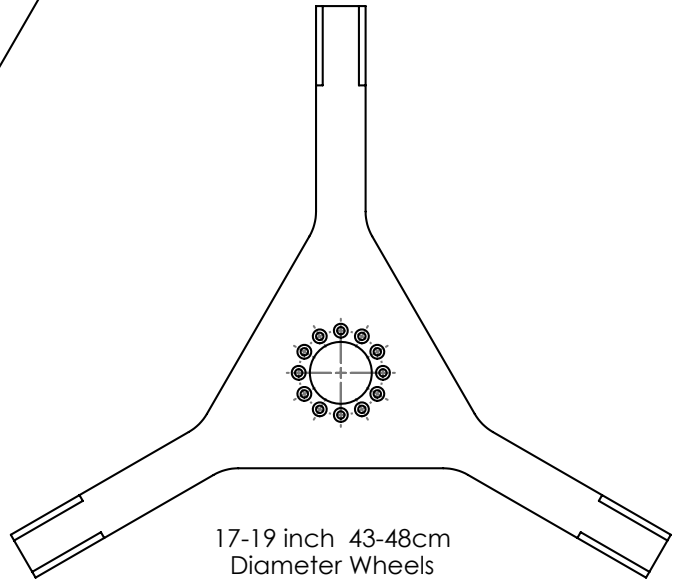
13-15 inch 33-38 cm
Diameter Wheels
M772003A REV A



15-17 inch 38-43 cm
Diameter Wheels
M772003A REV B



17-19 inch 43-48cm
Diameter Wheels
M772046B



Optional Clamping Hook Extenders

The Optional Clamping Hook Extenders extend the diameter range of the Y Adapters by approximately 3.5 inches.

