

PAW-TAW-JOHN SERVICES, INC.™

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## TECHNICAL REFERENCE AND OPERATIONS GUIDE

# TTU-2 TRANSDUCER TEST UNIT USERS GUIDE

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TECHNICAL REFERENCE  
AND  
OPERATIONS GUIDE



TRANSDUCER TEST UNIT  
TTU-2 USERS GUIDE



PAW-TAW-JOHN SERVICES, INC.™

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## Revision History

Sep 03	–	First release
Mar 04	–	Added SSI information
Dec 04	–	Added G-Series information
Apr 05	–	Added G-Series programming information

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## Product Warranty

Paw-Taw-John Services, Inc., (Seller) warrants product(s) of its manufacture to be free of defects in material and workmanship for a period of 90 days from date of shipment from Sellers facility. Sellers only obligation under this warranty is to furnish an equivalent product(s) by form fit and function, return shipping prepaid, for any product(s) returned, shipping prepaid, to Sellers facility and found to contain a liable defect within the warranty period.

Paw-Taw-John Services, Inc., shall accept liability only if the product(s):

- Are erected, tested, and operated in a manner approved by, or in accordance with instructions provided by seller,
- Have not been subjected to electrical or mechanical misuse or abuse or accident,
- Have been used for the purpose for which the goods were designed,
- Have not been altered or repaired by persons other than seller in any respect which in the judgment of seller affects the condition or operation of the product(s).

This warranty constitutes Paw-Taw-John Services, Inc., entire and only warranty. There are no other warranties, expressed or implied in law or in fact including implied warranties of fitness and merchantability. Paw-Taw-John Services, Inc., will not be liable for compensatory or incidental damages caused by defects and will not be responsible for costs or repairs done by others.

Returned goods must be carefully packed, preferably using the original shipping carton and packaging material. Product(s) should be returned prepaid to:

Paw-Taw-John Services, Inc.  
18125 N. Ramsey Road  
Rathdrum, ID 83858  
Phone: 208-687-1478  
Fax: 208-687-4148

# Important Rules for Safe Operation

The general safety information in this part of the manual is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary. Always follow basic safety procedures when using this equipment to reduce risk of injury from fire or shock

## READ AND RETAIN THESE RULES

- Read all of the instructions before you operate this equipment. Give particular attention to all safety precautions. Retain these instructions for future reference.
- Comply with all warning and caution statements in the instructions. Observe all warning and caution symbols that are affixed to this equipment.
- Comply with all instructions that accompany this equipment.

## ***Symbols Used in This Manual***



**WARNING STATEMENTS IDENTIFY CONDITIONS OR PRACTICES THAT COULD RESULT IN PERSONAL INJURY OR LOSS OF LIFE.**



**THE CAUTION SYMBOL IDENTIFIES CONDITIONS OR PRACTICES THAT COULD RESULT IN DAMAGE TO THE EQUIPMENT AND/OR OTHER PROPERTY.**



The information symbol is intended to alert you of the presence of important operating and maintenance (servicing) instructions in the literature accompanying this product.



## ***Safety Summary***

### **Power Source**

This product is intended to operate from a power source that will not apply more than 120 volts RMS (132 volts RMS maximum) between the power supply conductors or between either power supply conductors and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

### **Grounding the Product**

This equipment has a three-prong plug. This equipment is grounded through the grounding conductor in the power cord. Properly ground (earth) this equipment by inserting the plug into a grounded electrical, three-socket outlet. To avoid electrical shock, plug the power cord into a properly wired receptacle before making any connections to the equipment input and output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation. If you are unable to insert this plug fully into the outlet, contact an electrician to replace your obsolete outlet.

### **Danger Resulting From Loss of Ground**

Upon loss of protective-ground, all accessible conductive parts (including those controls and connectors that may appear to be insulated) may render an electric shock.

### **Use the Proper Power Cord**

Use only the factory-supplied power cord for this equipment. Use only a power cord that is in good condition. Do not use damaged power cord. Replace frayed, worn or damaged power cord immediately. If extension cords are required for proper operation, use only a suitable, grounded extension cord.

### **Power Cord Protection**

Arrange the power cord so that people cannot walk on the cords, place objects on the cords or place objects against the cords, which can damage the cords. Pay particular attention to cords that are at plugs, at electrical outlets, and at the places where the cords exit the equipment.

### **Overloading**

Do not overload electric outlets or extension cords as this can result in risk of fire or electric shock.

### **Use the Proper Fuse**

To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified in the parts list for your equipment.

### **Do Not Operate In Explosive Atmospheres**

To avoid explosion, do not operate this equipment in an explosive atmosphere.

## Lightning and Power Surges

Plug your equipment into a surge protector in order to reduce the risk of damage from lightning strikes and power surges. If you are unsure of the type of surge protector to use, contact your local electrician or electrical service provider.

## Servicing

Do not open the cover of this equipment. If you open the cover, your warranty will be void. Refer all servicing to qualified personnel only. Contact Paw-Taw-John Services, Inc., for instructions. To avoid personal injury, do not remove the equipment covers or panels. Do not operate the equipment without the covers and panels properly installed. **This equipment contains no user serviceable parts, components or adjustments inside.** Refer all servicing to qualified service personnel.

## Object and Liquid Entry

Never push objects of any kind into this product through openings as they may touch dangerous voltage points or short out parts that could result in a fire or electric shock. Do not expose this equipment to liquid or moisture. Do not place this equipment on a wet surface. Do not spill liquids on or near this equipment.

## Do Not Expose the Product to Moisture

TO PREVENT FIRE OR ELECTRIC SHOCK DO NOT EXPOSE THIS UNIT TO RAIN OR MOISTURE. To avoid the risk of electrical shock to yourself, do not use this equipment when you or the products are wet.

## Cleaning the Equipment

Before cleaning this equipment, unplug it from the electrical outlet. Use a slightly damp cloth to clean this equipment. Do not use a liquid cleaner or an aerosol cleaner. Do not use magnetic or static cleaning devices (dust remover) to clean this equipment.

## Placement

Place this equipment in a location that is close enough to an electrical outlet to accommodate the length of the power cord. Place this equipment on a stable surface. The surface must support the size and weight of this equipment. Place this equipment flat (horizontally).



TO AVOID PERSONAL INJURY AND DAMAGE TO THIS EQUIPMENT, PLACE THIS EQUIPMENT ON A STABLE SURFACE.

## Ventilation

This equipment uses convection for cooling that protects it from overheating. To ensure reliable operation, do not place other equipment, books, lights or any other object on top of the equipment.

## ***Damage that Requires Service***

For damage that requires service, unplug this equipment from the electrical outlet. Contact qualified service personnel when any of the following occurs:

- There is damage to the power cord or plug
- Liquid enters the equipment
- A heavy object falls on the equipment
- There is exposure to rain or water
- Operation is not normal (the instructions describe the normal operation)
- If you drop this equipment, or damage the case of this equipment
- If this equipment exhibits a distinct change in performance

Upon completion of any service or repairs to this equipment, the qualified service technician will perform safety checks to determine that the equipment is in proper operating condition.

# Shipping

## ***Unpacking the Product***

1. Inspect the shipping carton for shipping damage and exposure to moisture or unknown substances. Notify your commercial freight carrier of any visible signs of damage.
2. Unpack the contents from the shipping carton.
3. Verify the contents against the packing list. Notify Paw-Taw-John Services, Inc., of any discrepancy between the contents and the packing list.
4. Visually inspect the contents for shipping damage and exposure to moisture or unknown substances.
5. Open the product and verify the contents.

## ***Repackaging for Shipment***

It is recommended that the original carton and packaging material be saved in case the product needs to be reshipped using a commercial freight carrier. If the original packing materials are not available, use the following recommended guidelines:

1. Use a corrugated cardboard shipping carton with rated test strength of 250 pounds and inside dimensions at least 6 inches greater than the instrument dimensions.
2. Enclose the following information:
  - a. The owners name and address.
  - b. A name and phone number of a contact person.
  - c. The model type and serial number of the product.
  - d. The reason for returning.
  - e. A complete description of the repair or service to be performed.
3. Cushion the product on all sides using 3 inches of padding tightly packed between the carton and the product.
4. Seal the carton with an industrial stapler or strapping tape.
5. Mark the address of Paw-Taw-John Services, Inc., and the return address in two locations on the carton.

Paw-Taw-John Services, Inc.  
18125 N. Ramsey Road  
Rathdrum, ID 83858  
Phone: 208-687-1478  
Fax: 208-687-4148

# Specifications

## *Physical Specifications*

Dimensions	13.375L x 11.625W x 6.000H (33.97cm X 29.65cm x 15.24cm)
Weight	8.75 lbs (4 Kilos)

## *Electrical Specifications*

Power Requirements	115VAC
Fuse Specifications	1.5A/250V, 3AG, Fast Acting
Voltage Outputs At Connectors	+24VDC @ 2A +15VDC @ 150ma -15VDC @ 150ma +12VDC @150ma +5VDC @ 500ma

## *Environmental Specifications*

Temperature	Operating	50°F - 122°F (+10°C - +50°C)
	Nonoperating	-20°F - 140°F (-28.9°C - +60°C)
Cooling method	Convection	
Humidity	+104°F (+40°C) or below	≤90% relative humidity
	104°F - 122°F (+40°C - +50°C)	≤60% relative humidity
Altitude	Operating	10,000 ft. (3000 m)
	Nonoperating	40,000 ft. (15,000 m)

## *Shipping Specifications*

Item	Ships With	
TTU-2	3 (three) Connection Headers	
	1 (one) Power cord	
TTU-2 Accessory Kit	3 (three) Connection Headers	
	1 (one) MTS MT005P0 cable	
	1 (one) MTS D6005P0 Cable	
	1 (one) MTS Ring Magnet	

# INTRODUCTION

*The purpose of this chapter is to describe the basic features and use of this manual, and an introduction to MTS Temposonics Sensors.*

Congratulations on your purchase of the Transducer Test Unit (TTU-2), a powerful test instrument for MTS linear-position sensors. You can use the TTU-2 to test MTS sensors to verify operation prior to installing in systems, or troubleshoot sensors in existing systems.

## About This Manual

Paw-Taw-John Services, Inc., provides this operations manual and technical reference as an instructional aid for the operation of the Transducer Test Unit (TTU-2) in conjunction with Temposonics linear-position sensors.

The information included in this technical reference and operations manual is generic to Paw-Taw-John Services, Inc., and MTS products. Information that is specific to a particular product, such as mechanical and electrical drawings and schematics and parts lists, are provided in addition to this manual.

## Who We Are

Paw-Taw-John Services, Inc., is a designer and manufacturer of semi-custom servo controller systems and associated components. The company brings together individuals with decades of experience in systems and software design, custom electrical and electronic systems manufacturing and technical sales with expertise in system manufacturing. Paw-Taw-John Services, Inc., specializes in systems that provide greater user flexibility, lower maintenance, increased productivity, quicker payback and higher yield. Our systems are in use worldwide by companies wanting more intelligence with their controllers.

## MTS Temposonics Linear-Position Sensor Basics

It is not the intention of this manual to re-create the sensor information readily available from MTS. The information presented here is of a broad how-to nature, as it relates to the Transducer Test Unit. The MTS information is accurate at the writing of this manual. The specific sensors discussed in this manual relate to the most common models and outputs. For specific information on Temposonics linear-position sensors, contact MTS at:

MTS Systems Corporation  
Sensors Division  
3001 Sheldon Drive  
Cary, NC 27513  
Tel: 919-677-0100  
Fax: 919-677-0200

Web: <http://www.mtssensors.com/>

MTS has manufactured numerous models of Temposonics linear-position sensors to meet many different applications. New models employing improved technology have also added to the product mix. Many of these sensor configurations have very different operating parameters. It cannot be stressed enough that the

## INTRODUCTION

information on MTS linear-position sensors presented in this manual is generic in nature and may not apply to the specific sensor to be tested. Information presented here is based on the most common models and configurations.

### Sensor Types

Although transducers are available in many body styles, they can generally be categorized by the output, and can be reduced to the following types:

- **Neuter Sensors**

These sensors supply a raw signal output representative of the actual return pulse of the waveguide determined by the magnet position only. This signal is used by other external electronics to create a useable signal such as PWM, Start/Stop, and Analog outputs.

- **Digital Sensors**

Sensors that provide pulse width modulation (PWM) and Start/Stop (RPM) outputs are considered digital sensors. These have special modules/electronics installed inside the sensor cap that use the raw signal from the waveguide and converts it to a signal that a host controller/electronics can use.

- **Analog Sensors**

Sensors that supply a voltage or current output representative of the magnet position are considered analog sensors. They also have specialized modules/electronics inside the head of a sensor that convert the raw signal from the waveguide to a usable analog signal for host controllers/electronics.

- **Protocol Sensors**

Sensors that provide CANbus, Device-Net, PROFIBUS and SSI outputs are considered protocol sensors. These have special modules/electronics installed inside the sensor cap that use the raw signal from the waveguide and convert it to an information signal that a host controller can use.

- **Motion Controller Sensors**

The S-Series sensor, also referred to as the Servo Sensor, is a specialized sensor combining the measurement sensing capability with a motion controller and proportional valve drive electronics (on a second connector), all in the sensor head.

## INTRODUCTION

It should be noted that some sensors bridge the general definitions above. The following table shows the various models of Temposonics linear-position sensors and the outputs supported and testable by the TTU-2.

TEMPOSONICS LINEAR-POSITION SENSOR CONFIGURATIONS							
BASE MODEL / SERIES	MODEL# PREFIX	OUTPUT					
		NEUTER	PWM	START / STOP <sup>1</sup>	ANALOG		PROTOCOL
					VOLTAGE	CURRENT	
MTS I or Temposonics I **	Many	✓					
MTS II or Temposonics II **	TTS	✓	✓ <sup>2</sup>	✓	✓		
L Series **	LP LH	✓ <sup>3</sup>	✓	✓	✓	✓	
E Series	EP			✓	✓	✓	
R Series	RH RP RF				✓	✓	✓ <sup>4</sup>
S Series	SH SP SF						✓ <sup>5</sup>
G Series	GH GP GF	✓ <sup>3</sup>	✓	✓	✓	✓	

\*\* = These product lines are obsolete and are no longer supported by MTS.

**Table 1 - TTU-2 Testable MTS Sensor Models**

The following table shows the various models of Temposonics linear-position sensors and the operating voltages required.

Model	Nominal Operating Voltage
MTS I or Temposonics I	+15VDC @ 100mA - 15VDC @ 75mA +12VDC @ 50mA
MTS II or Temposonics II	±15VDC (±15 to ±12VDC) @ 140mA
LP Series	+15VDC to +24VDC, ±10% @ 100mA
LH Series	+13.5 to 26.4 VDC @ 100mA
E Series	+24VDC (+28.8 to 20.4 VDC) @ 110ma
R Series	+24VDC (+28.8 to 20.4 VDC) @ 110ma
S Series	+24VDC (+28.8 to 20.4 VDC) @ 110ma
G Series	+24VDC (+28.8 to 20.4 VDC) @ 110ma
	+15VDC (+23 to +9) Optional

**Table 2 - Sensor Operating Voltages**

<sup>1</sup> Also known as RPM

<sup>2</sup> PWM is referred to as DPM in the Temposonics II model series.

<sup>3</sup> Start/Stop output can be used to simulate a neuter sensor.

<sup>4</sup> Includes, but not limited to, CANbus, Device-Net, PROFIBUS and SSI.

<sup>5</sup> User selectable, factory set, voltage and current outputs are wired directly to a proportional valve.



## INTRODUCTION

### Sensor Connection Types

In order to connect the sensor to the TTU-2 the connection to the sensor falls into three broad classes:

- **Integral Connector**

The connection to the sensor is provided by a built in integral connector or connectors (located at the end of the sensor cover) and is usually mated with a matching cable.

- **Integral Cable to Pigtail**

The connection to the sensor is provided by a built in integral cable (located on the end of a cable coming from the end of the sensor cover) and is terminated in pigtail leads.

- **Integral Cable with Hanging Connector**

The connection to the sensor is provided by a built in integral cable (located on the end of a short cable coming from the end of the sensor cover) and terminates in a hanging connector (a connector on the end of a cable coming from the end of the sensor cover). This hanging connector may, or may not, be MTS standard, and often is system dependent. Care must be used in testing these types of sensors. Consult your engineering specifications for the particular hanging connector attached to the sensor cable.

MTS Sensors Division provides technical materials for the various sensor models. Material available includes:

- Datasheets
- Specification sheets
- Users guides
- Application notes

Contact Paw-Taw-John Services, Inc., or MTS directly or visit the MTS website to obtain sensor information.

## INTRODUCTION

The following table provides some of the documentation numbers for the user guides (which provide connection information). Paw-Taw-John Services, Inc., highly recommends that even experienced users of MTS products should acquire the appropriate technical literature for the sensor models in use from MTS. The user guides are obtainable from MTS directly or on the MTS website.

MTS Systems Corporation  
Sensors Division  
3001 Sheldon Drive  
Cary, NC 27513  
Tel: 919-677-0100  
Fax: 919-677-0200

Web: <http://www.mtssensors.com/>

SENSOR TYPE	OUTPUT	MTS DOCUMENTATION <sup>6</sup> NUMBER
MTS I or Temposonics I	NEUTER	550019
MTS II or Temposonics II	NEUTER DPM (PWM) RPM –START / STOP	550055 550033
	APM – VOLTAGE	550032
L Series	NEUTER PWM START / STOP	550602
	VOLTAGE CURRENT	
E Series	START / STOP	550741 550996
	VOLTAGE CURRENT	
R Series	SSI	550989
	VOLTAGE CURRENT	550992
G Series	PWM START / STOP	550966
	VOLTAGE CURRENT	
S Series	ALL	Contact Paw-Taw-John Services, Inc.

**Table 3 - MTS Sensor Documentation**

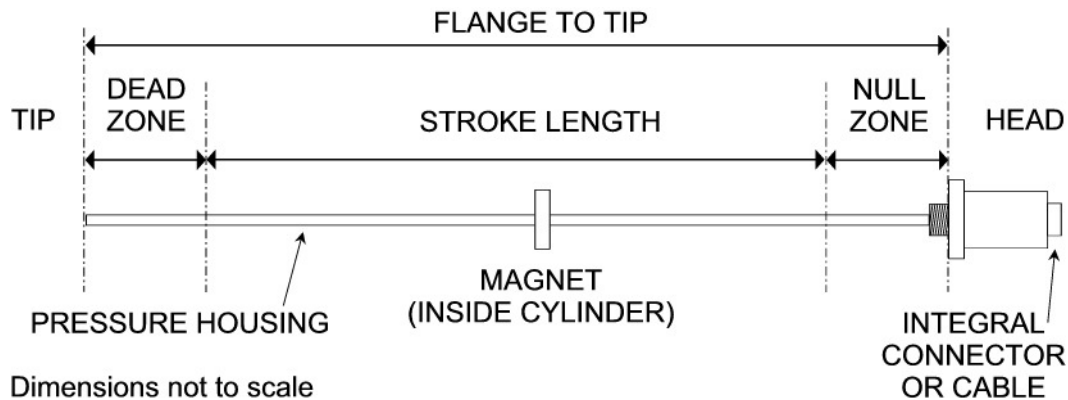
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<sup>6</sup> Users guides and datasheets are available from MTS. Availability and document numbers may change without notice.

### Basic Rod Style Orientation

The term sensor length refers to the stroke length of the sensor, not the physical length of the sensor. All sensors have a dead zone at the tip end, and a null zone at the head end.

The following figure provides a general orientation for all MTS Rod Style Sensor models.



**Figure 1 - Hydraulic Rod Sensor Orientation**

For most MTS sensors<sup>7</sup>, the dead zone at the tip end is 2.5 inches. For all DIGITAL sensor models tested, the TTU-2 uses a default null distance of 4.15" and a baseline gradient of 9.00000. Using default values, rather than actual values for null position and gradient, will vary the actual displayed output position by a small amount. For the purposes of testing a sensor, *this slight variance is operationally insignificant.*



Sensor Length refers to the stroke length of the sensor, not the physical length of the sensors pressure housing.

<sup>7</sup> Consult the factory concerning MTS II sensors with extension tips.

## Examples of MTS Model Numbers

It should be noted that the following tables contains only a small sample of the most common MTS model numbers for the various series of sensors. Contact MTS or Paw-Taw-John Services, Inc., for help in breaking down the model number of your sensor.

Model Number	Stroke Length	Output	Personality Module
TTSRBU0240	U0240 U=English 0240 = 24" stroke	Neuter	None
TTSRBU0180R	U0180 U=English 0180 = 18" stroke	R R = Start/Stop Always External Interrogation with 1 circulations	RPM
TTSRBU0360DI002	U0360 U=English 0360 = 36" stroke	DI002 D = DPM (Pulse Width Modulation) I = Internal Interrogation 002 = # of circulations	DPM (PWM)
TTSRBU0420DE004	U0420 U=English 0420 = 42" stroke	DE004 D = DPM (Pulse Width Modulation) E = External Interrogation 004 = # of circulations	DPM (PWM)
TTSRBU0720AS1B	U0720 U=English 0720 = 72" stroke	AS1B A = Analog Output S1 = 0-10V B = Balanced Mode	APM

**Table 4 - MTS II (Temposonics II) Model Numbers**

Model Number	Stroke Length	Output	Output Type
EPS0180UD601R0	0180U U=English 0180 = 18" stroke	R0 R = Start/Stop Always External Interrogation with 1 circulations	Start/Stop
EPS0520UD601V0	0520U U=English 0520 = 52" stroke	V0 V = Analog Voltage Output 0 = 0 -10V	Analog - Voltage
EPS0520UD601A0	0520U U=English 0520 = 52" stroke	A0 A = Analog Current Output 0 = 4-20MA 1 = 20-4MA	Analog - Current

**Table 5 - E-Series Model Numbers**

## INTRODUCTION

Model Number	Stroke Length	Output	Output Type
LHTRB00U024014 <u>NQ</u>	U0240 U=English 0240 = 24" stroke	4N0 4N0 = Neuter	Neuter
LHTRB00U01801 <u>RQ</u> LPSC <u>S</u> U01801	U0180 U=English 0180 = 18" stroke	<u>RQ</u> OR <u>S</u> R or S = Start/Stop Always External Interrogation with 1 circulations	Start/Stop
LHTRB00U03601 <u>DI02</u> LPSC <u>P</u> U0360100 <u>I02</u>	U0360 U=English 0360 = 36" stroke	<u>DI02</u> or <u>P</u> & <u>I02</u> D or P = Pulse Width Modulation I = Internal Interrogation 002 = # of circulations	PWM
LHTRB00U04201 <u>DE04</u> LPSC <u>P</u> U0420100 <u>E04</u>	U0420 U=English 0420 = 42" stroke	<u>DE04</u> or <u>P</u> & <u>E04</u> D or P = Pulse Width Modulation E = External Interrogation 004 = # of circulations	PWM
LHTRB00U07201 <u>VO</u> LPSC <u>V</u> U07201	U0720 U=English 0720 = 72" stroke	<u>VO</u> or <u>V</u> V = Analog Voltage Output 0 = 0 -10V	Analog - Voltage
LHTRB00U07201 <u>AQ</u> LPSC <u>A</u> U07201	U0720 U=English 0720 = 72" stroke	<u>AQ</u> or <u>A</u> A = Analog Current Output 0 = 4-20MA	Analog - Current

**Table 6 - L-Series Model Numbers**

Model Number	Stroke Length	Output	Output Type
RHT0180UD701S2B1100**	0180U U=English 0180 = 18" stroke	<u>S</u> <u>S</u> = SSI <u>2B1100</u> = SSI configuration	SSI
RHT0520UD701 <u>VQ</u>	0520U U=English 0520 = 52" stroke	<u>VQ</u> V = Analog Voltage Output 0 = 0 -10V	Analog - Voltage
RHT0360UD601 <u>AQ</u>	0360U U=English 0360 = 36" stroke	<u>AQ</u> A = Analog Current Output 0 = 4-20MA	Analog - Current

\*\* The R-Series supports a wide variety of protocols. Only SSI is supported by the TTU-2, therefore only the SSI model number is shown.

**Table 7 - R-Series Model Numbers**

## INTRODUCTION

Model Number	Stroke Length	Output	Output Type
GHT0240UD601N0 <sup>8</sup>	0240U U=English 0240 = 24" stroke	N0 N0 = Neuter <sup>8</sup>	Neuter
GHT0180UD601R0	0180U U=English 0180 = 18" stroke	R0 R0 = Start/Stop Always External Interrogation with 1 circulations	RPM
GHT0360UD601DI2	0360U U=English 0360 = 36" stroke	DI2 D = Pulse Width Modulation I = Internal Interrogation 2 = # of circulations	PWM
GHT0420UD601DE4	0420U U=English 0420 = 42" stroke	DE4 D = Pulse Width Modulation E = External Interrogation 4 = # of circulations	PWM
GHT0720UD601V0	0720U U=English 0720 = 72" stroke	V0 V = Analog Voltage Output 0 = 0 -10V	Analog - Voltage
GHT0720UD601A0	0720U U=English 0720 = 72" stroke	A0 A = Analog Current Output 0 = 4-20MA	Analog - Current

**Table 8 - G-Series Model Numbers**

Model Number	Stroke Length	Output	Output Type
SHT0180UD821V102	0180U U=English 0180 = 18" stroke	V10 V = Analog Voltage Output to Valve 0 = -10 to 10V	Analog - Voltage
SHT0240UD821A202	0240U U=English 0240 = 24" stroke	A20 A = Analog Current Output to Valve 0 = -20 to 20MA	Analog - Current

**Table 9 - S-Series Model Number**

NOTE: the S-Series supports three protocols; the sensor protocol is designated by the last number in the model number.

- 1 = Proprietary serial protocol<sup>9</sup>
- 2 = ASCII protocol for PC based systems
- 3 = ASCII protocol for PLC based systems

The TTU-2 will test and program only the ASCII protocols.

<sup>8</sup> A G-Series Sensor can be configured as a neuter. Contact MTS or Paw-Taw-John Services, Inc., for information.

<sup>9</sup> Contact Paw-Taw-John Services, Inc., for information and service on the proprietary protocol sensors.

### ***MTS Basics Summary***

The information provided in the tables and figures above are provided to the user for the purposes of determining the following:

- Sensor output (PWM, S/S, ect.): the test header, operating voltage connections and input and output connections to use.
- Type of connection: how to connect to the test header.

If there is no way of determining the model number from the sensor itself, it may be necessary to consult records of service or purchase, engineering drawings and documents, or system operating manuals and users guides to determine the model number. If unable to determine the model number or the operating characteristics, contact Paw-Taw-John Services, Inc., or MTS for help with this crucial step.

# TTU-2 OVERVIEW

*This chapter provides an overview of the Transducer Test Unit.*

## **General Introduction**

Paw-Taw-John Services, Inc., developed the Transducer Test Unit, (referred to as TTU-2), to provide a quick and accurate means of determining the operational status of MTS Temposonics linear-position transducers. The TTU-2 was designed to test the most common configurations of Temposonics linear-position sensors in a field or bench environment. The TTU-2 can aid service personnel in system troubleshooting by testing and eliminating the sensor as a possible fault.

Using microcontroller and PLD technology, the TTU-2 produces and monitors the signals to and from a sensor for integrity in a system application. The unit front panel is designed for quick connections of sensors under test. Tests are performed using a menu driven LCD display and keypad. The TTU-2 tests for the correct parameters required by the specific model of sensor being tested. Sensor selection and parameter value(s) are selected and entered via the keypad and position information is displayed on the TTU-2s LCD display.

The TTU-2 has a detachable three-wire power cord with a three contact plug for connection to both the power source and protective ground. The protective ground contact on the plug connects through the power cord protective grounding conductor to the accessible metal parts of the front panel. For electrical shock protection, insert the power cord plug into a power outlet that has a properly grounded protective-ground contact.



## Functional Diagram

The TTU-2 is a microprocessor controlled test instrument. Using the LCD Display and keypad allow for a menu driven selection of the type of sensor, its input and outputs, and in some cases, allow for programming of the sensor. Figure 2 shows the basic component layout of the TTU-2.

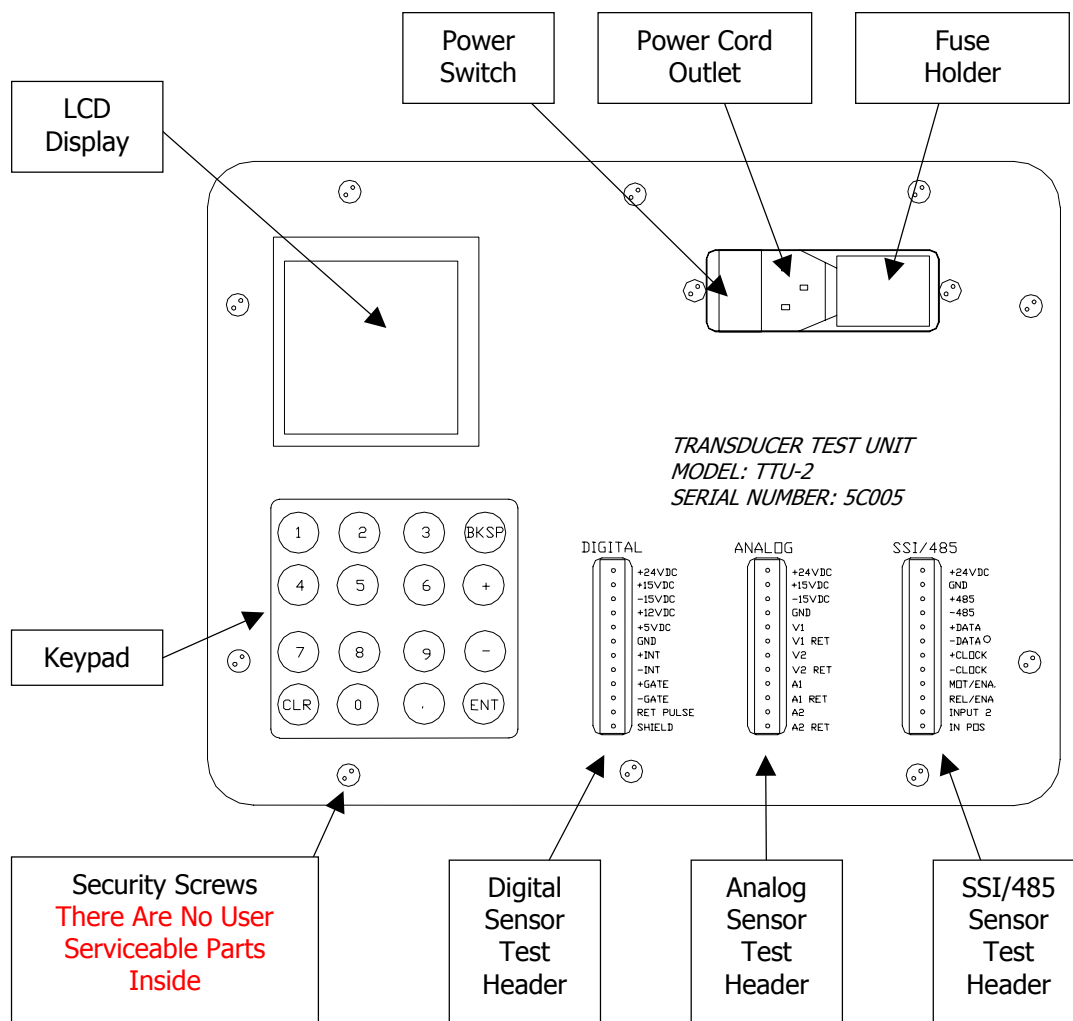


Figure 2 - TTU-2 Functional Layout



**THE TTU-2 CONTAINS NO USER SERVICEABLE PARTS OR INTERNAL ADJUSTMENTS. TAMPERING WITH OR REMOVING THE PANEL FROM THE CASE MAY EXPOSE THE USER TO LETHAL VOLTAGES AND THE RISK OF INJURY OR DEATH.**



**TAMPERING WITH OR REMOVING THE PANEL FROM THE CASE WILL VOID THE WARRANTY.**

## Functional Description

The principle sections are:

- **POWER BLOCK**
  - Provides a safe connection for power and ground and contains the On/Off switch and fuse.
- **LCD**
  - Displays menus and sensor information
- **KEYPAD**
  - Selects items from the various menus and enters data as needed
- **DIGITAL HEADER**
  - Connections for testing neuter, PWM, and Start/Stop sensors
- **ANALOG HEADER**
  - Connections for testing the various analog sensor models
- **SSI/485 HEADER**
  - Connections for R-Series SSI and S-Series model sensors, both operation and programming modes.
  - Connections for G-Series model sensor, programming mode only.

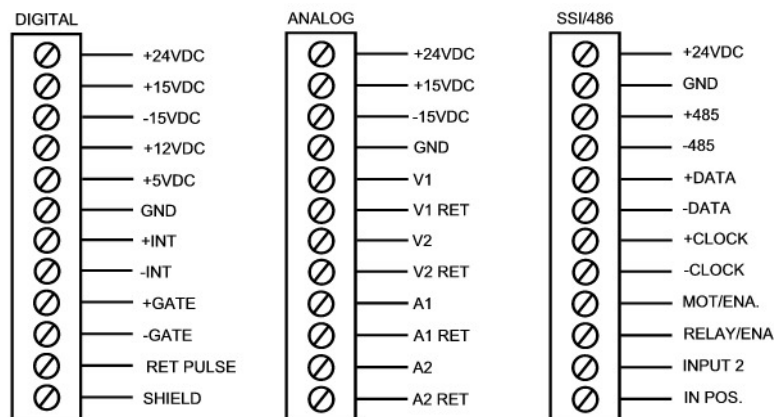


Figure 3 - TTU-2 Test Headers

Digital Header Signals	Meaning	Direction
+24VDC	Operating Voltages	
+15VDC		
-15VDC		
+12VDC		
+5VDC		
GND		
+ INT	Positive Interrogation	Output To Sensor
-INT	Negative Interrogation	Output To Sensor
+GATE	Positive Gate	Input From Sensor
-GATE	Negative Gate	Input From Sensor
RET PULSE	Raw Return	Input From Sensor
SHIELD	Cable Shield Connection	

Table 10 - DIGITAL Header Definitions

Analog Header Signals	Meaning	Direction
+24VDC	Operating Voltages	
+15VDC		
-15VDC		
GND		
V1	Voltage signal 1	Input From Sensor
V1 RET	Voltage signal 1 return	Input From Sensor
V2	Voltage signal 2	Input From Sensor
V2 RET	Voltage signal 2 return	Input From Sensor
A1	Current signal 1	Input From Sensor
A1 RET	Current signal 1 return	Input From Sensor
A2	Current signal 2	Input From Sensor
A2 RET	Current signal 2 return	Input From Sensor

Table 11 - ANALOG Header Definitions

SSI/485 Header Signals	Meaning	Direction
+24VDC	Operating Voltages	
GND		
+485	RS485 Half Duplex	
-485		
+DATA	RS422 - +Rx	Input From Sensor
-DATA	RS422 - -Rx	Input From Sensor
+CLOCK	RS422 - +Tx	Output To Sensor
-CLOCK	RS422 - -Tx	Output To Sensor
MOT/ENA.	Motion Enable (Discrete)	Output To Sensor
RELAY/ENA	Relay Enable (Discrete)	Output To Sensor
INPUT 2	Trigger (Discrete)	Output To Sensor
IN POS.	In Position (Discrete)	Input From Sensor

Table 12 - SSI/485 Header Definitions

## BASIC OPERATION

*This chapter describes the basic operation of the Transducer Test Unit.*

### **Tools and Parts Required**

1. TTU-2, Transducer Test Unit
2. Interface cable
  - a. For sensors with an integral connector, an interface cable appropriate to the sensor under test. These cables may be purchased from Paw-Taw-John Services, Inc., or MTS.
  - b. Sensors with an integral cable to pigtail connect directly to the appropriate TTU-2 connector.
  - c. Sensors with hanging connectors must have a connector-to-pigtail adapter cable made locally. These adapters may be purchased from Paw-Taw-John Services, Inc.
3. An appropriate MTS sensor magnet for the sensor model. These magnets may be purchased from Paw-Taw-John Services, Inc., or MTS.
4. Small slotted screwdriver, 1/8" blade width.

### **Before Using the Tester**

Before actual use of the tester, and perhaps the most important, is a visual inspection of the sensor. Look for the following:

- Oil on, or dripping, from the sensor body or cap. Clean when necessary.
- If the sensor head cap (containing the sensor electronics) is loose, dangling from the pressure housing, or is deformed or damaged the sensor should not be tested and returned for repair or replacement.
- If the integral connector is loose or can be moved, the sensor should be sent in for repair. Testing can be done to verify electronics but broken connections could prevent a good test.
- When an integral cable is installed on the sensor, check for wear, cracks, shields showing, splices, severe bends, and connector integrity. These observations indicate possible problems and repair/replacement may be required.
- The sensor tip is worn down enough that a black seal is partially showing. This indicates that oil may have entered the pressure housing and the unit should be replaced. Other mechanics should be checked if this occurs.
- Scoring of the body or pressure housing. This would indicate wear caused by external sources. These problems should be explored further to prevent compromising the ingress protection of the sensor.
- A small black weld spot, or spots, near the end of the sensor or anywhere along the sensor pressure housing. This usually indicates that welding was done near the sensor and the welder was improperly grounded. Typically, the electronics in the head of the sensor would be destroyed. A repair may be necessary.
- If there are bends greater than 2 degrees, the sensor's linearity is suspect. Although the sensor may work, the measurement quality is degraded. The unit should be sent in for repair.
- Bends or excessive wear spots along the pressure housing. If the sensor is used in a cylinder that is too short or too long, the pressure housing may show a distinct corkscrew effect. The sensor cannot be repaired and is not worth testing.

## Sensor Test Setup

MTS has manufactured numerous models of Temposonics linear-position sensors to meet many different applications. Many of these sensor configurations have very different operating connections. To effectively use the Transducer Test Unit, knowing the sensor model is essential. The required information can be obtained from the model number of the sensor.

To connect the sensor to the TTU-2, the following information is required:

- Operating voltage
- Sensor output (PWM, Start/Stop, Analog, ect.)
- Type of connection to the sensor

If there is no way of determining the model number from the sensor itself, it may be necessary to consult records of service or purchase, engineering drawings and documents, or system operating manuals and users guides to determine the model number. If unable to determine the model number, contact MTS or Paw-Taw-John Services, Inc., for help with this crucial step.

The following table shows the TTU-2 test headers for various sensor models outputs and operating voltages.

SENSOR TYPE	OUTPUT	TTU-2 HEADER	OPERATING VOLTAGE
MTS I or Temposonics I	NEUTER	<b>DIGITAL</b>	+15VDC - 15VDC +12VDC
MTS II or Temposonics II	NEUTER <sup>10</sup> <sup>11</sup> DPM (PWM) RPM (START / STOP) <sup>11</sup>	<b>DIGITAL</b>	+15VDC -15VDC
	APM – VOLTAGE	<b>ANALOG</b>	
L Series	NEUTER PWM START / STOP	<b>DIGITAL</b>	+24VDC +15VDC (Dependent on model number)
	VOLTAGE CURRENT	<b>ANALOG</b>	
E Series	START / STOP	<b>DIGITAL</b>	+24VDC
	VOLTAGE CURRENT	<b>ANALOG</b>	
R Series	SSI	<b>SSI/485</b>	+24VDC
	VOLTAGE CURRENT	<b>ANALOG</b>	
G Series	NEUTER PWM START / STOP	<b>DIGITAL</b>	+24VDC +15VDC (optional)
	VOLTAGE CURRENT	<b>ANALOG</b>	
	PROGRAMMING	<b>SSI/485</b>	
S Series	ALL	<b>SSI/485</b>	+24VDC

**Table 13 - TTU-2 Header and Operating Voltages**

<sup>10</sup> The unused interrogation wire MUST be tied to ground for proper operation.

<sup>11</sup> Neuter and RPM (Start/Stop) sensors are tested with external interrogation and a circulation of one (1).

### TTU-2 Power Up Sequence:

1. Insert the power cord into the power cord receptacle on the TTU-2 front panel.
2. Plug into a properly grounded outlet.
3. Turn the power switch from 0 (OFF) to 1 (ON). At this time, any sensors connected to the **DIGITAL** and **ANALOG** headers will have operational power applied.
4. A 3-second splash screen will appear. The screen shows program version and date at the bottom of the display. While the splash screen is displayed, the TTU-2 is performing self-test diagnostics and program initialization.
5. After the initialization and self-test, the TTU-2 Main Menu is displayed. The figure below shows a typical Main Menu screen.

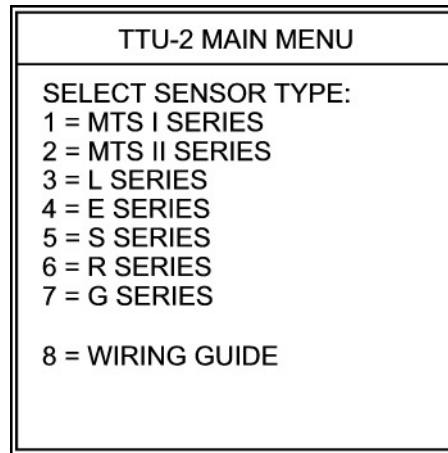


Figure 4 - Sample TTU-2 Main Menu



The last selection on the TTU-2 Main Menu is a wiring guide. The wiring guide contains only the most common MTS sensor wiring configurations for that sensor model. Users are cautioned that the wiring of the test sensor MAY NOT BE LISTED in the wiring guide. Users should double check the wiring of the sensor before performing a test.

# Basic Test Procedure for All Digital and Analog Sensors

The following is the basic procedure for all digital and analog sensor models.

1. Determine model of the sensor, operating voltage and its inputs and outputs.
2. Using the correct hookup drawings, connect the sensor to the header connector. Labeling is provided on the front of the panel next to each test header for easy signal orientation. Plug the connector to the appropriate test header on the TTU-2.
3. Verify correct connections to sensor power.
4. Verify connections:
  - a. **DIGITAL** connector: Verify Interrogation and Gate polarities are correct.
  - b. **ANALOG** connector: Verify the polarities of voltage and current connections and the associated returns are correct.
  - c. **SSI/485** connector: Verify 485, data and clock polarities are correct.
5. Plug in power to the TTU-2.
6. Turn on power to the TTU-2.

Note: R-Series SSI and S-Series Sensors require supply voltage (+24vdc) to be cycled for sensor programming. Sensors connected to the **SSI/485** header have operational voltage switched ON by the TTU-2 at test/programming time. Any sensors connected to the **DIGITAL** and **ANALOG** headers will have operational power applied as soon as power is turned on.
7. The TTU-2 LCD display will show a splash screen for 3 seconds. The screen shows program version and date at the bottom of the display.
6. After the initialization and self-test, the TTU-2 Main Menu is displayed, listing the sensor models that can be tested.
8. Enter the number associated with the sensor model you want to test via the keypad.
9. Follow the instructions shown on the display. The menus will guide you through the test setup.
10. Once you have configured the test options for the sensor under test, the test begins automatically.
11. Move a magnet along the housing. The display will show position relating to magnet position.

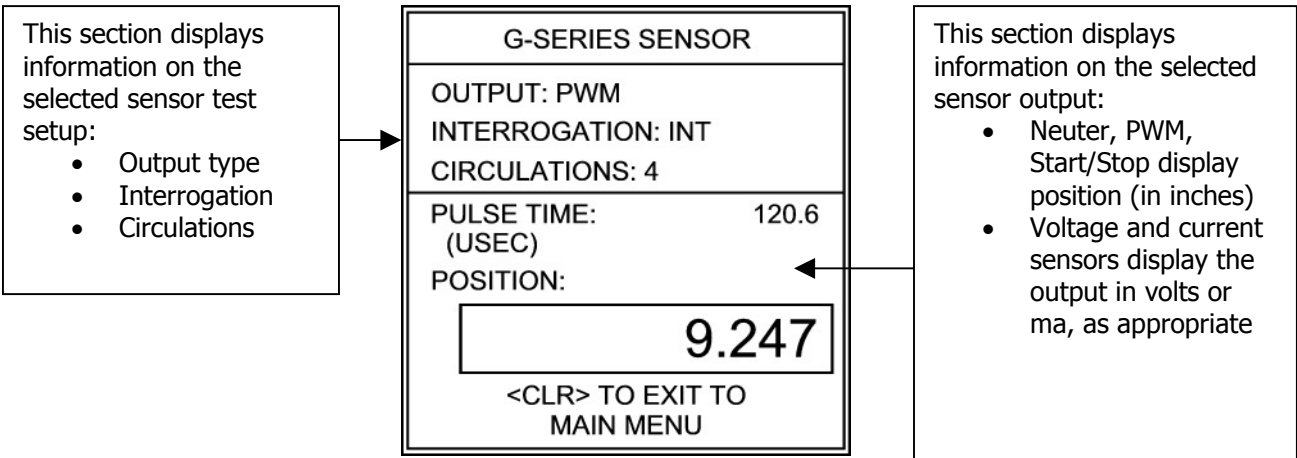
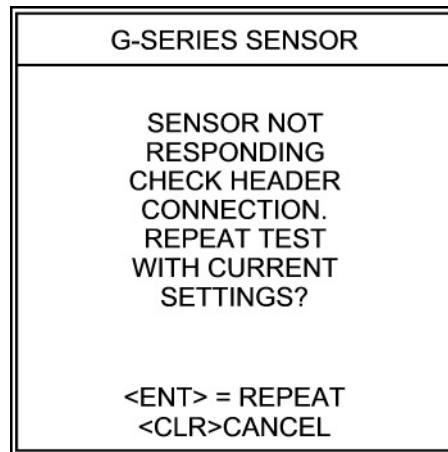


Figure 5 - Sample Run Screen

## BASIC OPERATION

12. If the sensor fails the test, or the connections are not correct, a **Sensor Not Responding Screen** appears.



**Figure 6 - Sample Sensor Not Responding Screen**

13. If the sensor fails, the user can check the connections to the TTU-2 and press **<ENT>** to repeat the test using the same test setup. Pressing the **<CLR>** key returns to the main menu.



## Display Interpretations for Troubleshooting

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 2.5" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 2.5" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
  - Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
  - While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.
- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing <ENT> to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

# DETAILED OPERATION

*This chapter describes the testing of specific sensor models.*

## Procedure for Testing MTS I (Temposonics I) Sensors

The Temposonics I sensor was the original magnetostrictive sensor offered first by the Temposonics company and then later by MTS® who bought Temposonics. For the purposes of this manual, Temposonics I sensors are referred to as MTS I sensors. They are considered neuter sensors and generally have small external electronic conversion boxes for converting the raw return signal to a useable signal for host controllers/electronics. The TTU-2 provides proper voltages for this unit.

Only two basic types of MTS I sensors were built:

- Short sensors, less than 12 inches<sup>12</sup>, usually use negative interrogation.
- Long sensors, 12 inches<sup>12</sup> and longer, usually use positive interrogation.
- In some cases the sensor serial number may end in 'P' or 'N', indicating 'P'ositive or 'N'egative interrogation.



CONNECTING THE SENSOR TO THE INCORRECT POLARITY OF THE INTERROGATION PULSE CAN DAMAGE OR DESTROY THE SENSOR ELECTRONICS.

## Connecting the MTS I Sensor to the TTU-2

Signal / Function	Wire Color Code
+15VDC	Green or Grey
-15VDC	Blue
+12VDC	Red
DC Ground	Black
Interrogation Pulse	White
Return Pulse	Orange or Brown

**Table 14 - MTS I Sensor Wiring Color Code**

<sup>12</sup> 12 inches refers to stroke length, not the physical length of the sensor. Refer to Figure 1.

## Header Connections for MTS I (Temposonics I) Sensors

- Once length has been determined, connect the cable to the TTU-2 header connector as shown in the figures below, whichever is appropriate.

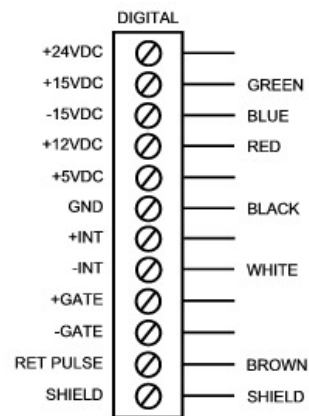


Figure 7 - MTS I Short Sensor Connection < 12" Using Negative Interrogation

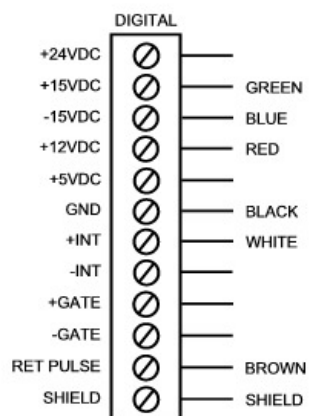


Figure 8 - MTS I Long Sensor Connection >= 12" Using Positive Interrogation

- Slide a MTS sensor magnet onto the shaft of the sensor pressure housing.
- Connect the header connector to the **DIGITAL** jack on the front panel of the TTU-2.

Testing the MTS I Sensor

- Plug the TTU-2 power cord into a properly grounded outlet and with the sensor properly wired to the **DIGITAL** test header turn the TTU-2 on. **Operating voltage is now applied to the sensor.**
- After a 3 second splash screen, the TTU-2 MAIN MENU appears.
- To select the MTS I SERIES sensor, press **1** on the TTU-2 keypad.

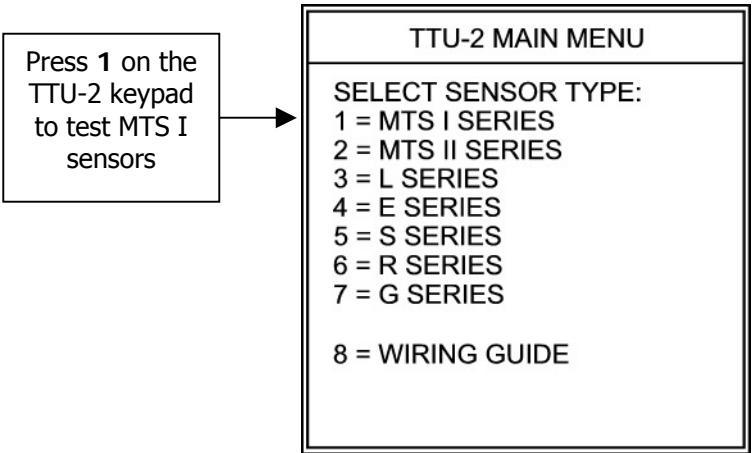


Figure 9 - Selecting MTS I Sensors from the Main Menu



All MTS I (Temposonics I) sensors use EXTERNAL interrogation with number of circulations determined by the controller. The TTU-2 tests all MTS I sensors with a circulation of 1.

- If the sensor is wired correctly to the **DIGITAL** test header and in a functional state, a **Run Screen** will appear showing position.

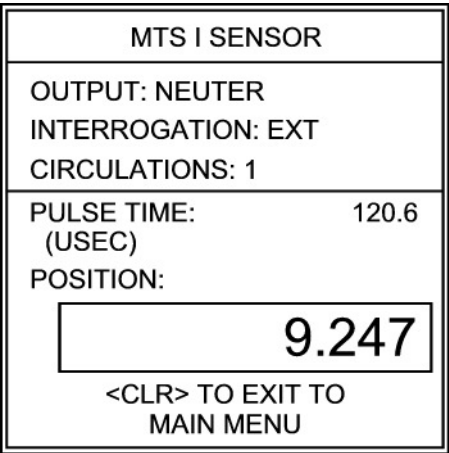


Figure 10 - MTS I Run Screen

## DETAILED OPERATION

- If, however, there is a test header wiring error, or the sensor is non-functional, then a **Sensor Not Responding Screen** will appear.

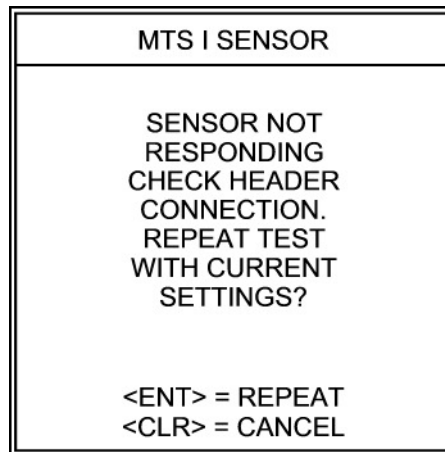


Figure 11 - MTS I Sensor Not Responding Screen

## Troubleshooting Using Test Results

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 5-7" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 5-7" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
  - Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
  - While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.
- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing <ENT> to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

## Procedure for Testing MTS II (Temposonics II) Sensors

The Temposonics II sensor was a magnetostrictive sensor offered first by the Temposonics Company and then later by MTS who bought Temposonics. For the purposes of this manual, Temposonics II sensors are referred to as MTS II sensors. The TTU-2 **DIGITAL** and **ANALOG** headers provide proper voltages for this unit.

**NOTE:** In reference to the term sensor length, the term refers to the stroke length of the sensor, not the physical length of the sensor. All sensors have a dead zone at the tip end, and a null zone at the head end. Refer to Figure 1.

### Connecting the MTS II Sensor to the TTU-2

Pin Number	Color Code (Striped Leads)	Color Code (Solid Leads)	Neuter	DPM Option (PWM)
1	White / Blue Stripe	White	DC Ground	DC Ground
2	Blue / White Stripe	Brown	Frame	Frame
3	White / Orange Stripe	Gray	Not Used	(-) Gate
4	Orange / White Stripe	Pink	Not Used	(+) Gate
5	White / Green Stripe	Red	VCC	VCC
6	Green / White Stripe	Blue	VEE	VEE
7	White / Brown Stripe	Black	Output Pulse Return	Not Used
8	Brown / White Stripe	Violet	Output Pulse	Not Used
9	White / Gray Stripe	Yellow	(+) Interrogation	(+) Interrogation
10	Gray / White Stripe	Green	(-) Interrogation	(-) Interrogation

Table 15 - MTS II Neuter and DPM (PWM) Color Code



UNDER NO CONDITION SHOULD BOTH THE POSITIVE (+) AND NEGATIVE (-) INTERROGATION LEADS BE CONNECTED AT THE SAME TIME WHEN TESTING THE **NEUTER** VERSION OF MTS II (TEMPOSONICS II) TRANSDUCERS. **THE UNUSED INTERROGATION LEAD MUST BE CONNECTED TO DC GROUND.**

Pin Number	Color Code (Striped Leads)	Color Code (Solid Leads)	RPM Option (Start/Stop)	APM Option (Analog)
1	White / Blue Stripe	White	DC Ground	DC Ground
2	Blue / White Stripe	Brown	Frame	Frame
3	White / Orange Stripe	Gray	(-) Start / Stop Pulse	Displacement Return
4	Orange / White Stripe	Pink	(+) Start / Stop Pulse	Displacement Out
5	White / Green Stripe	Red	VCC	VCC
6	Green / White Stripe	Blue	VEE	VEE
7	White / Brown Stripe	Black	Not Used	Not Used
8	Brown / White Stripe	Violet	Not Used	Not Used
9	White / Gray Stripe	Yellow	(+) Interrogation	Not Used
10	Gray / White Stripe	Green	(-) Interrogation	Not Used

Table 16 - MTS II RPM (Start/Stop) and APM (Analog -Voltage) Cable Color Code

Header Connections for Neuter MTS II Sensors

- Once length has been determined, connect the cable to the TTU-2 header connector as shown in the figures below, whichever is appropriate.

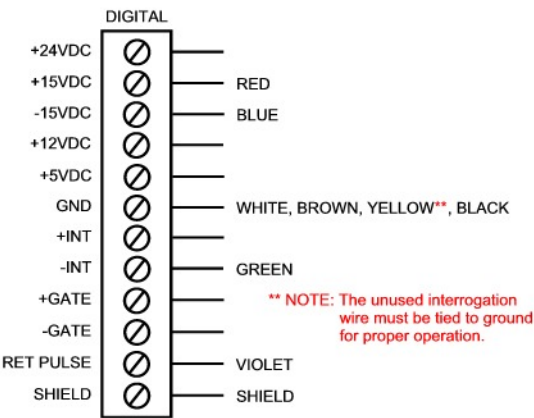


Figure 12 - MTS II or Temposonics II Neuter Sensor  
Using Negative Interrogation

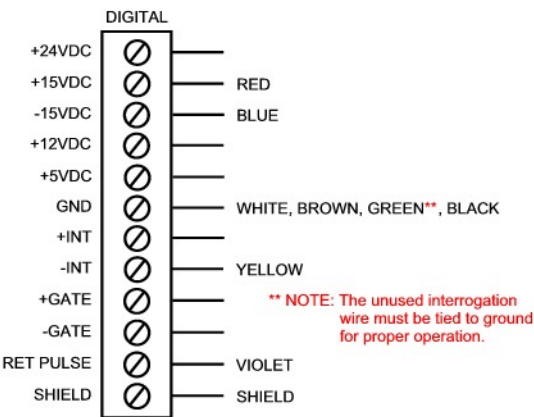


Figure 13 - MTS II or Temposonics II Neuter Sensor  
Using Positive Interrogation

Header Connections for DPM (PWM) and RPM (Start/Stop) MTS II Sensors

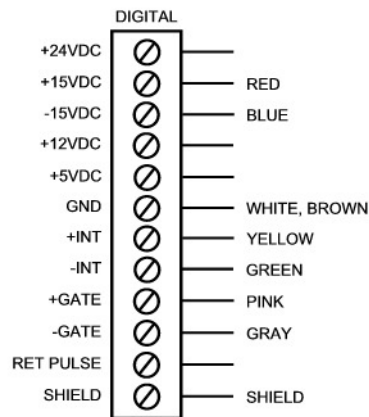


Figure 14 - MTS II or Temposonics II with DPM (PWM) and RPM (Start/Stop)



If the sensor is internally interrogated, and the user selects the external interrogation test sequence, the position readout will be erratic or erroneous.

Header Connections for Analog MTS II Sensors

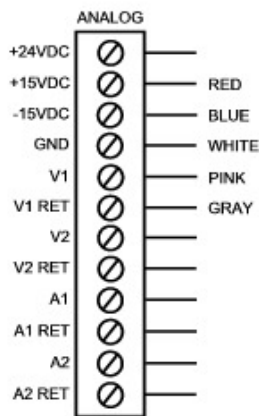


Figure 15 - MTS II or Temposonics II Analog (APM)



## Testing the MTS II Sensor

- Slide a MTS sensor magnet onto the shaft of the sensor.
- Connect the header connector to the **DIGITAL** header (for Neuter, RPM (Start/Stop) and DPM (PWM) sensors, or the **ANALOG** header (for Analog - Voltage sensors) on the front panel of the TTU-2.
- Plug the TTU-2 power cord into a properly grounded outlet and turn the TTU-2 on. Operating voltage is now applied to the sensor.
- After a 3 second splash screen, the TTU-2 MAIN MENU appears.

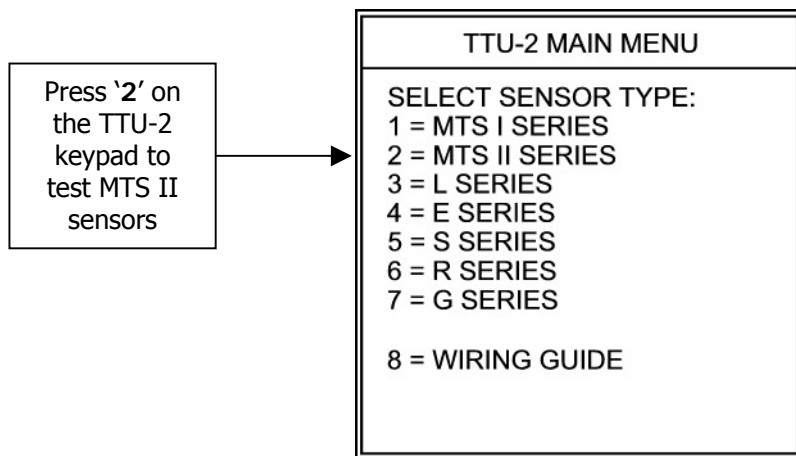


Figure 16 - MTS II Sensor Selection

**NOTE:** All MTS II (Temposonics II) neuter sensors use external interrogation with number of circulations determined by the controller. The TTU-2 tests all MTS II neuter sensors with a circulation of 1.

- With the sensor properly wired to the **DIGITAL** test header and the TTU-2 power turned on, press **2** on the TTU-2 keypad to select MTS II SERIES as shown below.
- The next menu selects the personality (output) module of the test sensor. Select the type of personality (output) module for the sensor under test as shown in the figure below.

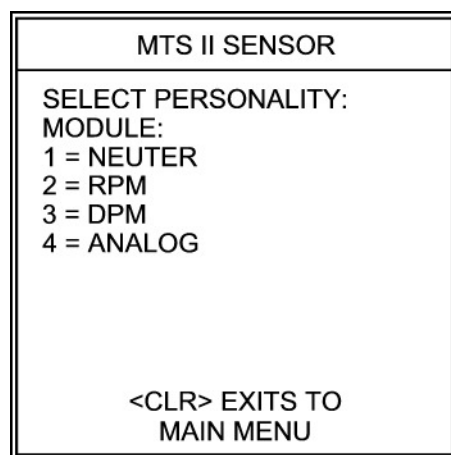


Figure 17 - MTS II Output Selection

- Neuter and RPM (Start/Stop) sensors default to external interrogation with a circulation of 1. Neuter and RPM (Start/Stop) show the **Run Screen**.

## DETAILED OPERATION

- DPM (PWM) sensors have two additional menus: Interrogation type (internal or external) and circulations (1-128) screens. Select the appropriate interrogation and enter the circulations obtained from the model number.

MTS II SENSOR
SELECT SENSOR INTERROGATION: 1 = INTERNAL 2 = EXTERNAL
<CLR> EXITS TO PREVIOUS MENU

Figure 18 - MTS II Interrogation Menu



If the sensor is internally interrogated, and the user selects the external interrogation test sequence, the position readout will be erratic or erroneous.

MTS II SENSOR
ENTER NUMBER OF CIRCULATIONS DEFAULT = 4
<input type="text"/>
<CLR> EXITS TO PREVIOUS MENU

Figure 19 - MTS II Circulations Menu

DETAILED OPERATION

- If the sensor is connected correctly and in a functional state, a **Run Screen** will appear showing position.

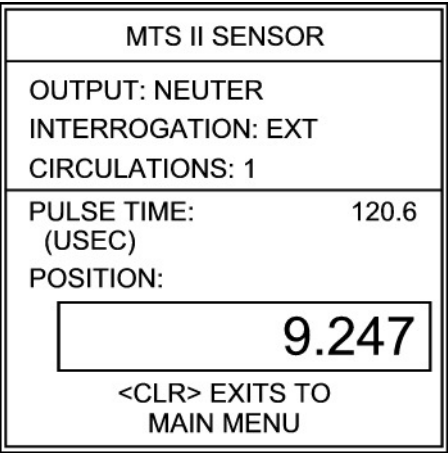


Figure 20 - MTS II Neuter, RPM (Start/Stop), and DPM (PWM) Run Screen

- The **Run Screen** for MTS II analog voltage sensors is functionally similar to the digital **Run Screens**, with one important difference. There is no way to determine if a sensor is actually connected to the **ANALOG** header. The user must use the <CLR> key on the keypad to exit this screen and return to the MAIN MENU.

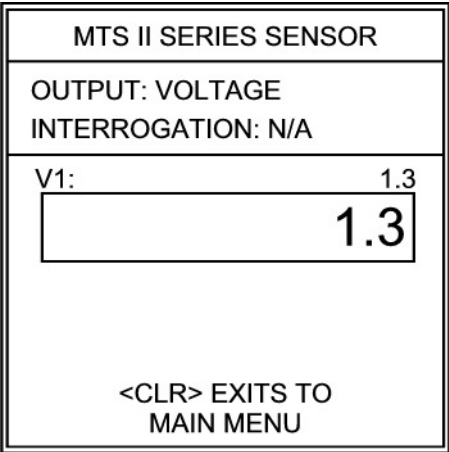
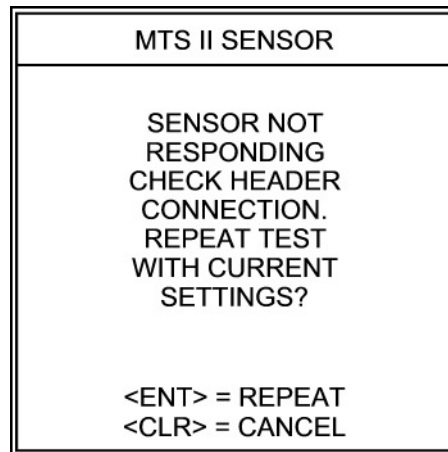


Figure 21 - MTS II Voltage Run Screen

- If, however, there is a test header wiring error, or the sensor is non-functional, then a **Sensor Not Responding Screen** will appear.



**Figure 22 - MTS II Sensor Not Responding Screen**

- Check the connections for the sensor under test and press **<ENT>** to repeat the test using the same settings, or **<CLR>** to return to the MAIN MENU.

## Troubleshooting MTS II Sensors with Test Results

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 2.5" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 2.5" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
  - Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
  - While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.
- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing **<ENT>** to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling

## DETAILED OPERATION

needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

## Procedure for Testing L-Series Sensors

The MTS L-Series sensor replaced the 'personality modules' of the MTS II (Temposonics II) sensors with dedicated output electronics, eliminating the ability to field-change the output configuration. Connector and integral cables were standardized beginning with this series.

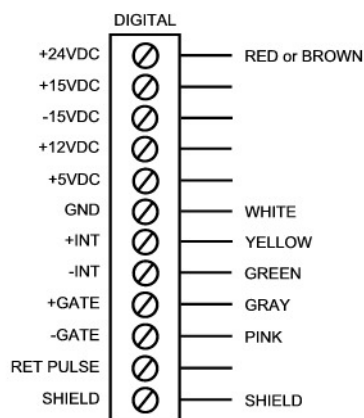
### Connecting the L-Series Sensor to the TTU-2

Pin #	Cable	Voltage	Current	Digital PWM	Digital Start / Stop
1	Grey	0-10VDC	4 to 20ma, 0 to 20ma	(+) Gate	(-) Stop
2	Pink	Return for pin 1	Return for pin 1	(-) Gate	(+) Stop
3	Yellow	10-0VDC	20 to 4 ma, 20 to 0ma	(+) Interrogation	(-) Start
4	Green	Return for pin 3	Return for pin 3	(-) Interrogation	(+) Start
5	Red or Brown	+24VDC	+24VDC	+24VDC	+24VDC
6	White	DC ground	DC ground	DC ground	DC ground
	Shield	Connector housing	Connector housing	Connector housing	Connector housing

Note: supply voltage for LH models with a stroke length <= 60" ranges from 13.5 to 26.4

**Figure 23 - L-Series Cable Color Code**

### Header Connections for PWM and Start/Stop Sensors



**Figure 24 - L-Series PWM and Start/Stop Connections**

Header Connections for Analog Sensors

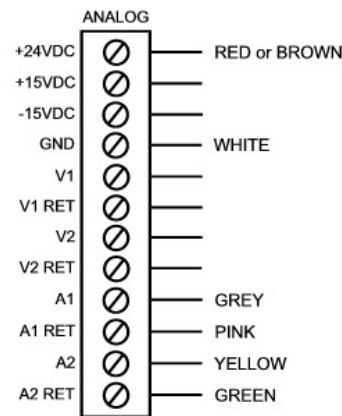


Figure 25 - L-Series Analog Current Output

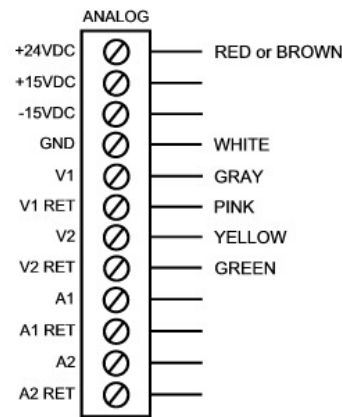


Figure 26 - L-Series Analog Voltage Output

Testing the L-Series Sensor with the TTU-2

- With the sensor properly wired to the **DIGITAL** test header and the TTU-2 power turned on, press **3** on the TTU-2 keypad to select L-Series as shown in the figure below.

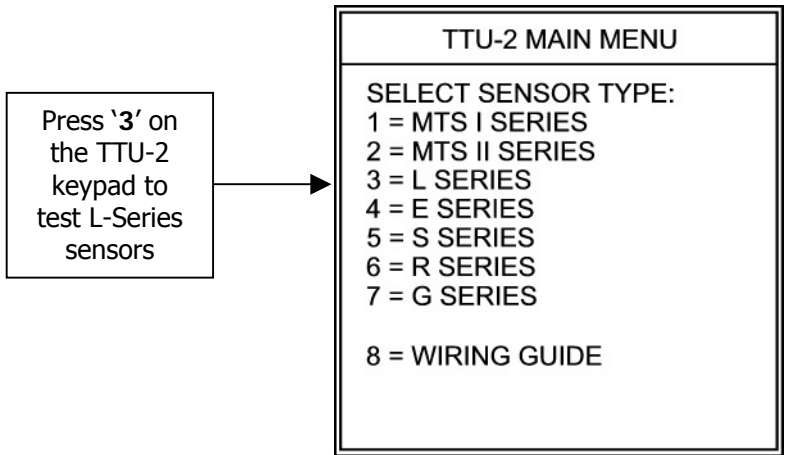


Figure 27 - L-Series Sensor Selection

- Select the type of output type module for the sensor under test.

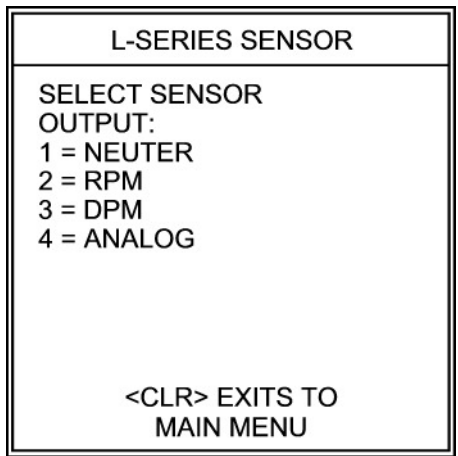


Figure 28 - L-Series Output Selection

- Neuter and Start/Stop sensors default to external interrogation with a circulation of 1. Neuter and Start/Stop show the **Run Screen**.



## DETAILED OPERATION

- PWM sensors have two additional menus: Interrogation type (internal or external) and circulations (1-128) screens. Select the appropriate interrogation and enter the circulations obtained from the model number.

L-SERIES SENSOR
SELECT SENSOR INTERROGATION: 1 = INTERNAL 2 = EXTERNAL
<CLR> EXITS TO PREVIOUS MENU

Figure 29 - L-Series Interrogation Menu

L-SERIES SENSOR
ENTER NUMBER OF CIRCULATIONS DEFAULT = 4
<input type="text"/>
<CLR> EXITS TO PREVIOUS MENU

Figure 30 - L-Series Circulations Menu

## DETAILED OPERATION

- If the sensor is connected correctly and in a functional state, a **Run Screen** will appear showing position.

L-SERIES SENSOR	
OUTPUT: START/STOP INTERROGATION: EXT CIRCULATIONS: 1	
PULSE TIME: (USEC)	120.6
POSITION:	
<div style="border: 1px solid black; padding: 5px; display: inline-block;">9.247</div>	
<CLR> EXITS TO MAIN MENU	

Figure 31 - L-Series Neuter, Start/Stop, and PWM Run Screen

- If, however, there is a test header wiring error, or the sensor is non-functional, then a **Sensor Not Responding Screen** will appear.

L-SERIES SENSOR
<p>SENSOR NOT RESPONDING CHECK HEADER CONNECTION. REPEAT TEST WITH CURRENT SETTINGS?</p> <p>&lt;ENT&gt; = REPEAT &lt;CLR&gt; = CANCEL</p>

Figure 32 - L-Series Sensor Not Responding Screen

## DETAILED OPERATION

- The **Run Screen** for L-Series analog voltage sensors is functionally similar to the digital **Run Screens**, with one important difference. There is no way to determine if a sensor is actually connected to the **ANALOG** header. The user must use the **<CLR>** key on the keypad to exit this screen and return to the MAIN MENU.

L-SERIES SENSOR	
OUTPUT: CURRENT INTERROGATION: N/A	
A1:	5.5
<div>5.5</div>	
A2:	4.5
<div>4.5</div>	
<CLR> EXITS TO MAIN MENU	

Figure 33 - L-Series Current Run Screen

L-SERIES SENSOR	
OUTPUT: VOLTAGE INTERROGATION: N/A	
V1:	1.3
<div>1.3</div>	
V2:	8.7
<div>8.7</div>	
<CLR> EXITS TO MAIN MENU	

Figure 34 - - L-Series Voltage Run Screen

## Troubleshooting L-Series Sensors with Test Results

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 2.5" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 2.5" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.

- If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
- Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
- While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.
- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing <ENT> to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

## ***Procedure for Testing E-Series Sensors***

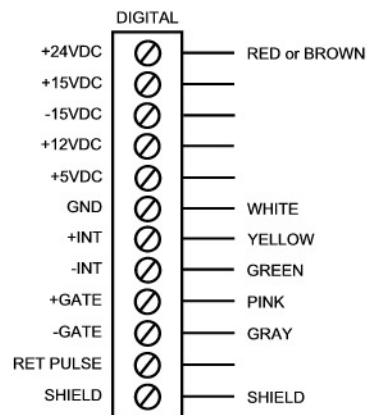
The Temposonics EP is a precise, durable and cost effective alternative to linear potentiometers. They offer all of the advantages of a non-contact position sensor suitable for a wide range of machines and automation applications.

### Connecting the E-Series Sensor to the TTU-2 headers

Pin Number	Cable	Function	Digital Start / Stop
1	Grey	0-10VDC	(-) Stop
2	Pink	Return for pin 1	(+) Stop
3	Yellow	10-0VDC	(-) Start
4	Green	Return for pin 3	(+) Start
5	Brown	+24VDC	+24VDC
6	White	DC ground	DC ground
	Shield	Connector housing	Connector housing

**Table 17 - E-Series Cable Color Code**

### Header Connections for Start/Stop E-Series Sensors



**Figure 35- E-Series Start/Stop Connections**

Header Connections for Analog E-Series Sensors

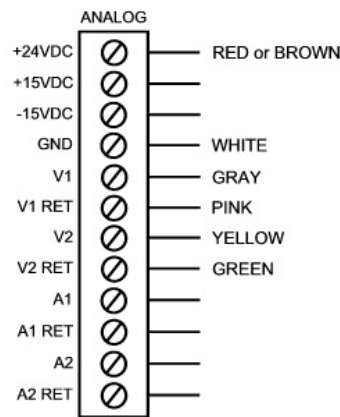


Figure 36 - E-Series Analog Voltage Output

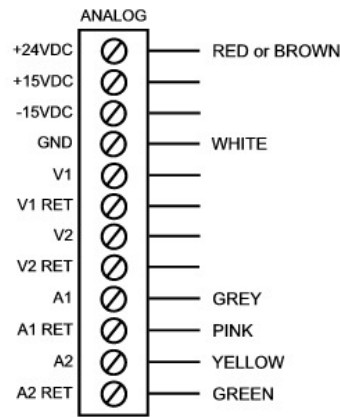


Figure 37 - E-Series Analog Current Output

## Testing the E-Series Sensor with the TTU-2

- With the sensor properly wired to the **DIGITAL** test header and the TTU-2 power turned on, press **4** on the TTU-2 keypad to select E-Series as shown below.

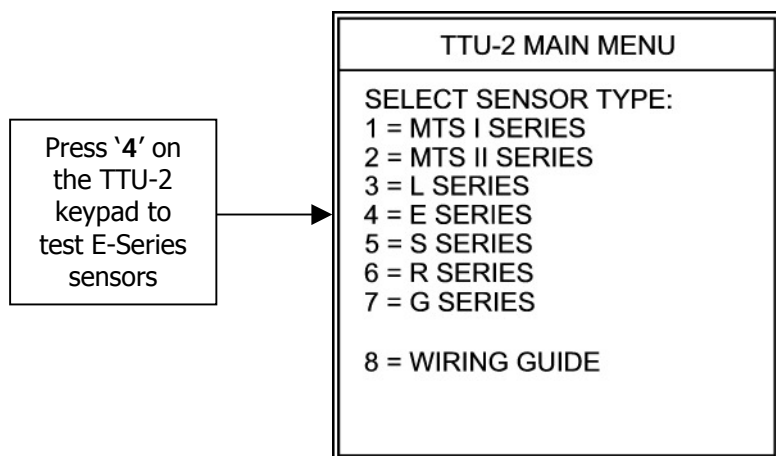


Figure 38 - E-Series Sensor Selection

DETAILED OPERATION

- Select the type of output type for the sensor under test.

E-SERIES SENSOR
SELECT SENSOR OUTPUT: 1 = START/STOP 2 = VOLTAGE 3 = CURRENT
<CLR> EXITS TO MAIN MENU

Figure 39 - E-Series Output Selection

- Start/Stop sensors default to external interrogation with a circulation of 1.
- If the sensor is connected correctly and in a functional state, a **Run Screen** will appear showing position.

E-SERIES SENSOR	
OUTPUT: START/STOP INTERROGATION: EXT CIRCULATIONS: 1	
PULSE TIME: (USEC)	120.6
POSITION:	
<div>9.247</div>	
<CLR> EXITS TO MAIN MENU	

Figure 40 - E-Series Start/Stop Run Screen



## DETAILED OPERATION

- If, however, there is a test header wiring error, or the sensor is non-functional, then a **Sensor Not Responding Screen** will appear.

E-SERIES SENSOR
SENSOR NOT RESPONDING CHECK HEADER CONNECTION. REPEAT TEST WITH CURRENT SETTINGS?
<ENT> = REPEAT <CLR> = CANCEL

Figure 41 - Sensor Not Responding Screen

- The **Run Screen** for E-Series analog voltage sensors is functionally similar to the digital **Run Screens**, with one important difference. There is no way to determine if a sensor is actually connected to the **ANALOG** header. The user must use the <CLR> key on the keypad to exit this screen and return to the MAIN MENU.

E-SERIES SENSOR	
OUTPUT: VOLTAGE INTERROGATION: N/A	
V1:	1.3
<div>1.3</div>	
V2:	8.7
<div>8.7</div>	
<CLR> EXITS TO MAIN MENU	

Figure 42 - E-Series Voltage Run Screen

E-SERIES SENSOR	
OUTPUT: CURRENT INTERROGATION: N/A	
A1:	5.5
	5.5
A2:	4.5
	4.5
<CLR> EXITS TO MAIN MENU	

Figure 43 - E-Series Current Run Screen

### Troubleshooting E-Series Sensors with Test Results

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 2.5" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 2.5" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
  - Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
  - While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.
- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing <ENT> to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

## ***Procedure for Testing S-Series Sensors***

The S-Series Servo Sensor was co-developed by Paw-Taw-John Services, Inc. and MTS Sensors Division. Manufactured by Paw-Taw-John Services, Inc. the platform for the unique design is an MTS R-Series linear position sensor. By combining a proven MTS linear position sensor with an embedded systems servo controller and discrete I/O for PLC interfacing, Paw-Taw-John Services, Inc. has produced the versatile S-Series Servo Sensor.

The S-Series Servo Sensor is a complete servo controller installed and interfaced inside an MTS Temposonics R-Series sensor consisting of the pressure housing containing a magnetostrictive waveguide, and a sensor cartridge.

S-Series Servo Sensor systems are used to control one or more axes. Several of these may be interactive in multi-axis systems such as moving multiple axes simultaneously while still allowing individual axis adjustment. A simple S-Series Servo Sensor control system may consist of a S-Series Servo Sensor, a hydraulic or pneumatic cylinder, a servo valve and an interface device that allows commands to be given to the S-Series Servo Sensor.

A control module, containing a microcontroller, communications, output driver, and discrete I/O interfaces inside the sensor head body. MTS proprietary technology is integrated directly to the control module. This integration in the control module provides the S-Series Servo Sensor with very fast displacement measurements and servo control outputs. Hydraulic cylinders can typically be positioned to .001".

### **Connecting the S-Series sensor to the TTU-2**

<b>Pin Number</b>		<b>Cable</b>	<b>Function</b>
<b>Paw-Taw-John</b>	<b>MTS</b>		
P2-1	P2-6	Red (22AWG)	Set/Motion Enable Input
P2-2	P2-1	Green (22AWG)	Relay Enable Input
P2-3	P2-4	Black (28AWG)	- 485/Comm
P2-4	P2-2	White (28AWG)	+ 485/Comm
P2-5	P2-5	Yellow (22AWG)	Trigger Input or Input 2
P2-6	P2-3	Black (18awg)	DC Ground
P2-7	P2-7	Orange (18awg)	+24VDC
P2-8	P2-8	Blue (22awg)	In Position Output
		Shield	Connector housing

**Table 18- S-Series Cable Color Code**

Header Connections for S-Series Sensors

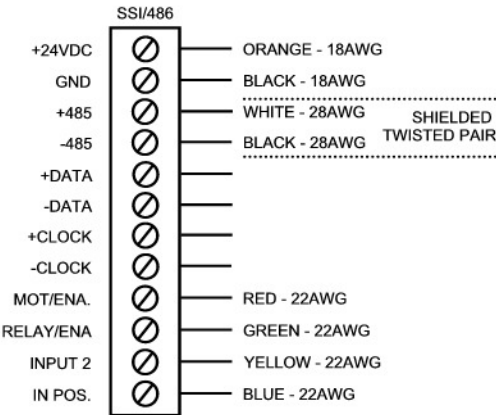
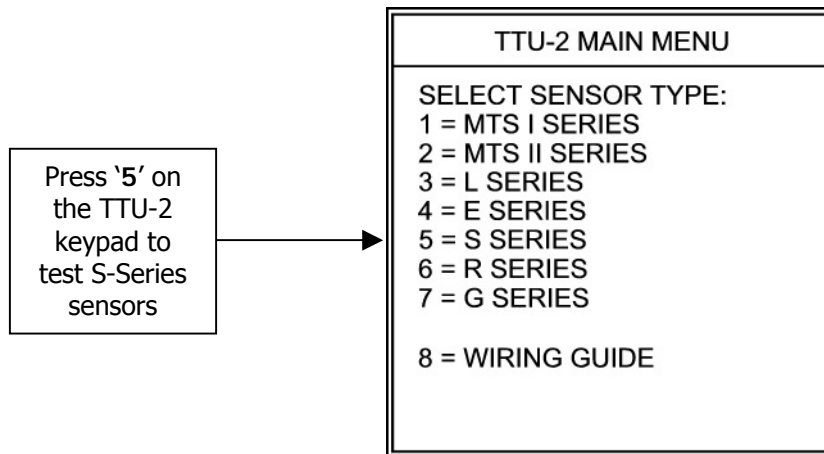


Figure 44 - S-Series Header Connections

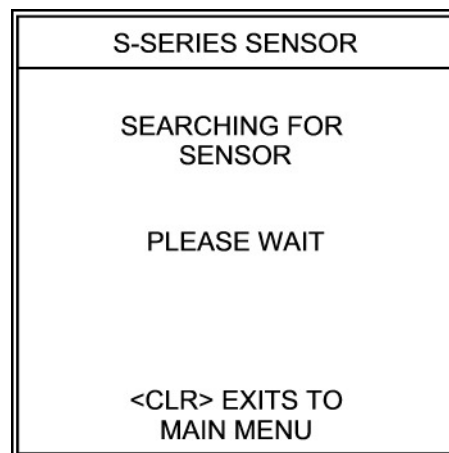
## Testing the S-Series Sensor with the TTU-2

- With the sensor properly wired to the **SSI/485** header and the TTU-2 power turned on, press **5** on the TTU-2 keypad to select R-Series as shown below.



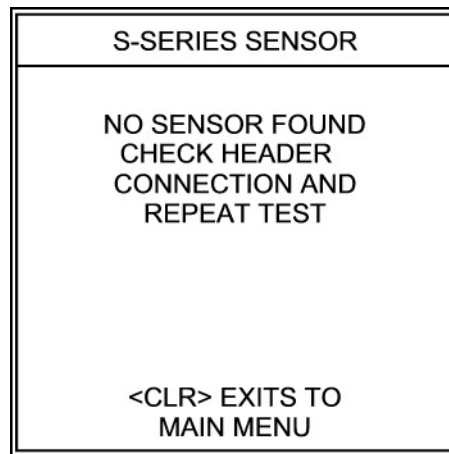
**Figure 45 - Selecting S-Series Sensor**

- The TTU-2 will search all 26 addresses and all baud rates for a sensor, and will respond to the first sensor found, in numeric order.



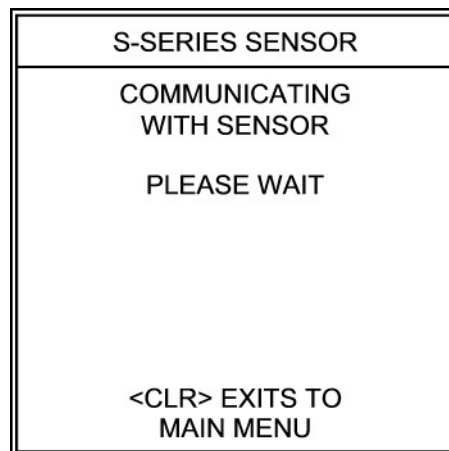
**Figure 46 - S-Series Sensor Search Screen**

- If there is a test header wiring error, the TTU-2 cannot establish communications, or the sensor is non-functional, then a **Sensor Not Responding Screen** will appear.



**Figure 47 - S-Series Sensor  
Sensor Not Found Screen**

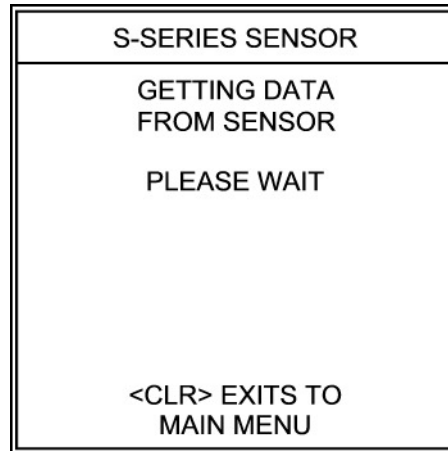
- If an S-Series sensor responds, the TTU-2 will initialize communications with the sensor.



**Figure 48 - S-Series Sensor Communicating  
With Sensor Screen**

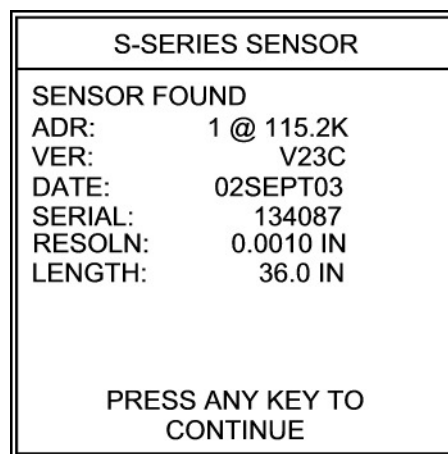
## DETAILED OPERATION

- Once the TTU-2 has initialized communications, it downloads all settings from the sensor.



**Figure 49 - S-Series Sensor  
Getting Data Screen**

- Once the S-Series sensor settings are downloaded to the TTU-2, the SENSOR FOUND screen is displayed.



**Figure 50 - S-Series Sensor  
Sensor Found Screen**

- Sensor Found Screen display definitions:
  - ADR: sensor network address and communications baud rate
  - Ver: firmware version
  - Date: firmware date
  - Serial: sensor serial number (last 6 digits)
  - Resoln: resolution (in inches)
  - Length: sensor length (in inches)

- Press any key to display the S-Series Mode screen.

S-SERIES SENSOR
SELECT SENSOR MODE: 1 = RUN MODE 2 = PROGRAM MODE 3 = SETPOINTS MENU 4 = RESET TO DEFAULTS
<CLR> EXITS TO MAIN MENU

Figure 51 - S-Series Sensor Mode Select Menu

- When the mode select screen appears the choices available to the user are:
  1. **RUN MODE**  
This selection will put the S-Series sensor into run mode, and the S-Series sensor **Run Screen** will be displayed.
  2. **PROGRAM MODE**  
This selection puts the S-Series sensor into program mode, and the S-Series sensor Programming Menu will be displayed.
  3. **SETPOINTS MENU**  
This menu allows the user to change the setpoints (1 to 60) stored internally in the S-Series sensor. The user can alter Target, Velocity and Dwell for all 60 setpoints.
  4. **RESET TO DEFAULTS**  
This setting allows the user to re-initialize all settings in the S-Series sensor to the factory default settings. The user will be asked to confirm re-initializing the S-Series sensor to factory defaults.  
**THE USER IS CAUTIONED THAT CONFIRMING THE RE-INITIALIZATION OF THE S-SERIES SENSOR, THE CHANGES WILL TAKE EFFECT IMMEDIATELY.**



## Programming S-Series Sensors

S-SERIES SENSOR
<p>SELECT SECTION TO PROGRAM:</p> <p>1 = COMMUNICATIONS</p> <p>2 = OPERATIONS MENU</p> <p>3 = DYNAMICS MENU</p> <p>4 = LIMITS</p> <p>5 = JOG SETTINGS</p>
<p>&lt;CLR&gt; EXITS TO PREVIOUS MENU</p>

- The S-Series program menu is divided into 5 sections:
  1. **COMMUNICATIONS** – Sets the sensor address and baud rate
  2. **OPERATIONS** – configures the operational characteristics for the sensor.
  3. **DYNAMICS** - configures the drive output characteristics for the sensor.
  4. **LIMITS** – configures the stroke limits used by the sensor.
  5. **JOG SETTINGS** – configures the jog functions

**NOTE:** Due to the complexity and multiplicity of sub-menus displayed in the PROGRAM MENU, they will not be duplicated here. Refer to the S-Series Sensor Manual for detailed information on programming the S-Series sensor.

## Troubleshooting S-Series Sensors with Test Results

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 2.5" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 2.5" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
  - Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
  - While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.

## DETAILED OPERATION

- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing <ENT> to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

**Procedure for Testing R-Series Sensors**

Many of the R-Series sensors provide CANbus, Device-Net, PROFIBUS and SSI protocol outputs. These have special modules installed inside the sensor cap that use the raw signal from the waveguide and convert it to an information signal that a host controller can use. Voltage and current outputs are available as well.

**Connecting the R-Series Sensor to the TTU-2**

Pin Number	Cable	SSI	Voltage	Current
1	Grey	(-) Data	Output voltage (V1)	Output current (A1)
2	Pink	(+) Data	Return for pin 1	Return for pin 1
3	Yellow	(+) Clock	Output voltage (V2)	Output current (A2)
4	Green	(-) Clock	Return for pin 3	Return for pin 3
5	Brown	+24VDC	+24VDC	+24VDC
6	White	DC ground	DC ground	DC ground
7	Blue	No connection	No connection	No connection
	Shield	Connector housing	Connector housing	Connector housing

Table 19 - R-Series Cable Color Code

**Header Connections for SSI Sensors**

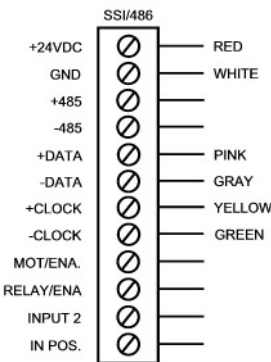


Figure 52 - R-Series SSI Output Both Programming and Operation

Header Connections for R-Series Analog Sensors

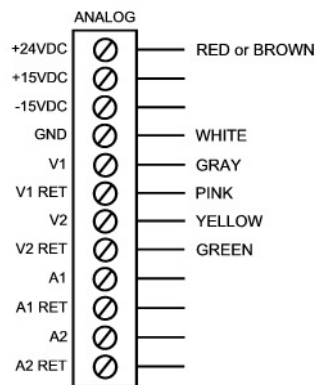


Figure 53 - R-Series Analog Voltage Output

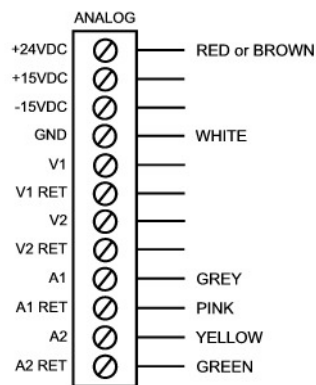


Figure 54 - R-Series Analog Current Output

Testing the R-Series Sensor with the TTU-2

- With the sensor properly wired to the **SSI/485** or **ANALOG** test header and the TTU-2 power turned on, press **6** on the TTU-2 keypad to select R-Series as shown in the figure below.

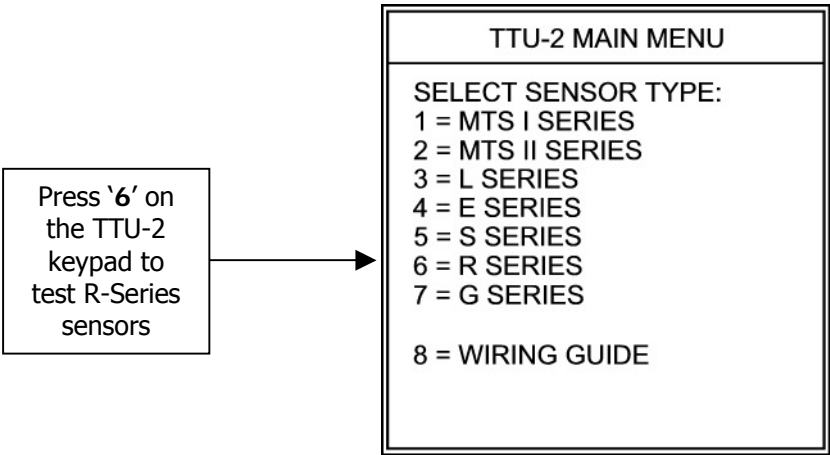


Figure 55 - Selecting R-Series Sensor

- Select the type of output type for the sensor under test

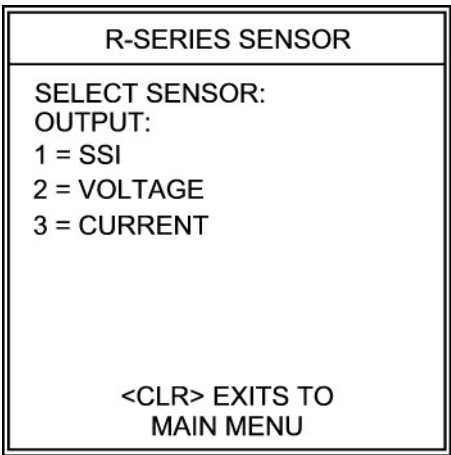
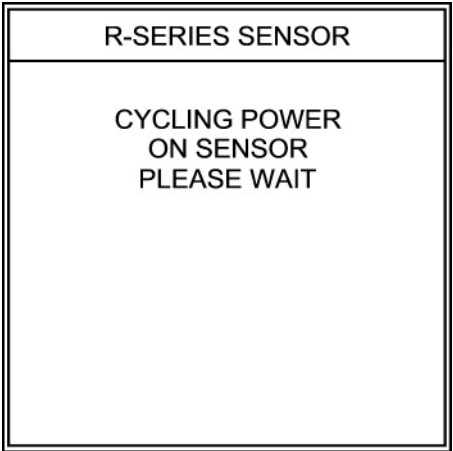


Figure 56 - R-Series Output Menu

**Testing the R-Series SSI Sensor with the TTU-2**

- When Selecting the R-Series SSI sensor for testing, the TTU-2 will first cycle power to put the SSI sensor into programming mode. This will allow the TTU-2 to read the internal sensor data.



**Figure 57 - R-Series SSI Cycling Power Screen**



**Figure 58 - R-Series SSI Getting Data Screen**

- If there is a test header wiring error, the TTU-2 cannot establish communications, or the sensor is non-functional, then a **Sensor Not Responding Screen** will appear.

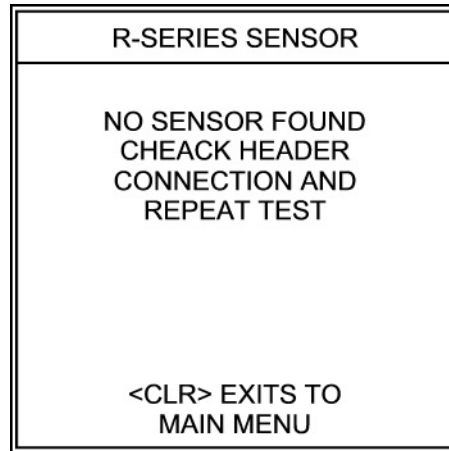


Figure 59 - R-Series SSI Sensor Not Responding Screen

- Once the TTU-2 establishes communications with the R-Series SSI sensor, the SSI Mode Select Menu is displayed.

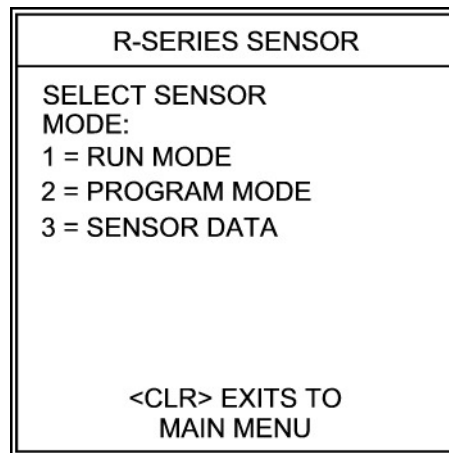


Figure 60 - R-Series SSI Mode Select Menu

- When the mode select screen appears three choices are available to the user.
  1. **RUN MODE**  
This selection will put the SSI sensor into run mode, and the SSI **Run Screen** will be displayed.
  2. **PROGRAM MODE**  
This selection puts the SSI sensor into program mode. The user can change the following settings:
    - a. Data format (24/25 bits, Binary/Gray)
    - b. Readout direction (Normal Or Reversed)
    - c.  $\pm$  Zero Offset Increment (in inches)
  3. **SENSOR DATA**  
This selection displays the information from the SSI sensor retrieved during the get data phase of initialization.

## DETAILED OPERATION

- When Run Mode is selected, the SSI **Run Screen** is displayed, as shown below.

R-SERIES SENSOR	
RESOLN:	0.00500 IN
OFFSET:	-2.5 IN
RAW	
DATA:	3771
POSITION (IN):	
<div style="border: 1px solid black; padding: 5px; display: inline-block;">0.742</div>	
<CLR> EXITS TO PREVIOUS MENU	

**Figure 61 - R-Series SSI Run Mode Screen**

- When Program Mode is selected, the SSI Program Mode menu is displayed, as shown below.

R-SERIES SENSOR
SELECT SENSOR DATA TO CHANGE:
1 = DATA FORMAT
2 = READOUT DIR.
3 = OFFSET
<CLR> EXITS TO PREVIOUS MENU

**Figure 62 - R-Series SSI Program Mode Screen**

- The SSI Program Mode menu allows the user can alter the following SSI Sensor settings:
  - Data format
    - Binary 24 bits
    - Binary 25 bits
    - Gray Code 24 bits
    - Gray Code 25 bits
  - Readout Direction
    - Normal – Retract to 0
    - Reverse – Extend to 0
  - Offset
    - Enter an zero offset increment (in inches)



## DETAILED OPERATION

- When Sensor Data Mode is selected, two SSI Data screens are displayed, as shown below.

R-SERIES SENSOR	
VER:	3C6D28
SERIAL:	90008123
MODE:	ASYNCHRONOUS
DATA:	25 BITS
FORMAT:	GRAY
LENGTH:	6.0 IN
DIR:	NORMAL
PRESS ANY KEY TO CONTINUE	

**Figure 63 - R-Series SSI Data Screen 1**

- Data screen 1 display definitions:
  - Ver: Firmware version (Hexadecimal)
  - Serial: Sensor serial number
  - Mode: Operational Mode
    - Synchronous
    - Asynchronous
  - Data: Position data word length\*\*
    - 24 bits
    - 25 bits
  - Format: position data word format\*\*
    - Gray
    - Binary
  - Length: sensor length
  - Dir: position read direction\*\*
    - Normal
    - Reversed

\*\* Note: These values are changeable in the program menu. All other values are read only.

R-SERIES SENSOR	
RESOLN:	0.00500 IN
OFFSET:	-2.5 IN
SCALE:	0455F6 H
SPEED:	9.15345U/IN
TIMING:	5A0
MEASUR:	32 H
PRESS ANY KEY TO CONTINUE	

**Figure 64 - R-Series SSI Data Screen 2**

- Data screen 2 display definitions:
  - Resoln: resolution (in inches)
  - Offset: zero offset (in inches)  
Note: Offset is usually a negative number
  - Scale: resolution adjustment value
  - Speed: sensor gradient ( $\mu\text{Sec}/\text{inch}$ )
  - Timing: asynchronous timing value
  - Measur: Jitter window, where 32H = 50 $\mu\text{Sec}$

## Testing the R-Series Analog Sensor with the TTU-2

- The **Run Screen** for R-Series analog voltage sensors is functionally similar to the digital **Run Screens**, with one important difference. There is no way to determine if a sensor is actually connected to the **ANALOG** header. The user must use the **<CLR>** key on the keypad to exit this screen and return to the MAIN MENU. Dual output sensors shown.

R-SERIES SENSOR	
OUTPUT: VOLTAGE INTERROGATION: N/A	
V1:	1.3
	1.3
V2:	8.7
	8.7
<CLR> EXITS TO MAIN MENU	

Figure 65 - R-Series Analog Voltage Screen

R-SERIES SENSOR	
OUTPUT: CURRENT INTERROGATION: N/A	
A1:	5.5
	5.5
A2:	4.5
	4.5
<CLR> EXITS TO MAIN MENU	

Figure 66 R-Series Analog Current Screen

## Troubleshooting R-Series Sensors with Test Results

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 2.5" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 2.5" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.

- If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
- Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
- While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.
- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing <ENT> to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

## Procedure for Testing G-Series Sensors

THE G-Series is one of MTS's newest sensors. Utilizing an RS422 interface for digital sensors and an RS485 interface for analog sensors, the G-Series sensors are completely programmable. At the writing of this manual, the TTU-2 does not program analog G-Series sensors, although they can be tested using the **ANALOG** header.

- To perform an operational test of the G-Series digital sensors (PWM, Start/Stop, Neuter), use the **DIGITAL** header.
- To perform an operational test of the G-Series analog sensors, use the **ANALOG** header.
- To program the G-Series digital and analog sensors, use the **SSI/485** header.

## Connecting the G-Series Sensor to the TTU-2

Pin Number	Cable	Outputs			
		DPM	Start/Stop	Voltage	Current
1	Grey	(-) Gate	(-) Stop	Output voltage (V1)	Output current (A1)
2	Pink	(+) Gate	(+) Stop	Return for pin 1	Return for pin 1
3	Yellow	(+) Interrogation	(-) Start	No connection	No connection
4	Green	(-) Interrogation	(+) Start	No connection	No connection
5	Red or Brown	+24 or +15 VDC	+24 or +15 VDC	+24 or +15 VDC	+24 or +15 VDC
6	White	DC ground	DC ground	DC ground	DC ground
	Shield	Connector housing	Connector housing	Connector housing	Connector housing
TTU-2 HEADER		DIGITAL		ANALOG	

Table 20 - G-Series Cable Color Code

Pin Number	Cable	Neuter Using Positive Interrogation	Neuter Using Negative Interrogation
1	Grey	No connection	No connection
2	Pink	Output pulse	Output pulse
3	Yellow	(+) Interrogation	**
4	Green	**	(-) Interrogation
5	Red or Brown	+24 or +15 VDC	+24 or +15 VDC
6	White	DC ground	DC ground
	Shield	Connector housing	Connector housing
** Connect To DC Ground			
TTU-2 HEADER		DIGITAL	

Table 21 - G-Series Neuter Cable Connections



The standard G-Series sensor operates with a +24vdc supply voltage. A +15vdc supply power option is available at order time to maintain compatibility with older  $\pm 15$  sensors.

## Header Connections for Neuter Sensors

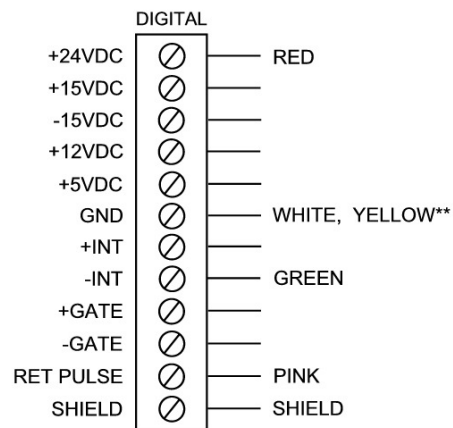
The G-Series square wave neuter output is provided for backwards compatibility to replace Temposonics I, Temposonics II, and L-Series sensors. These sensors have the neuter output option for connection to the analog output module (AOM), digital interface box (DIB), or to custom interfaces/controllers.

## DETAILED OPERATION

Notes on configuring the G-Series sensor for neuter operation:

1. The (+) Stop output is used for a compatible square wave neuter signal.
2. The G-Series output signal (-) Stop is not used when providing the backwards-compatible neuter type connection. However, this signal wire/connector pin is used for RS-422 Tx- during serial programming of the sensor. When the sensor output is active, not in programming mode, this signal must be left unconnected to allow the proper neuter type output.
3. When connecting to an analog output module (AOM), or to a digital interface box (DIB), or to a custom interface/controller that requires single-ended interrogation, always connect the unused interrogation lead, (+) start or (-) start, to ground at the AOM / DIB /controller.
4. For improved noise rejection when using external interrogation, use the positive and negative interrogation signals, (+) Start and (-) Start, to provide differential inputs to the sensor.
5. If pin 7 was originally used as DC ground for the Temposonics II and L-Series sensors being replaced then the DC ground connection at the controller must be changed to use pin 1.

- The figures below show the TTU-2 header connection for g-series neuter sensors.



**\*\* NOTE:** The unused interrogation wire must be tied to ground for proper operation.  
**NOTE:** The unused Gray wire must not be connected (OPEN) for proper operation.

**Figure 67 - G-Series Neuter Header Connections Using Negative Interrogation**

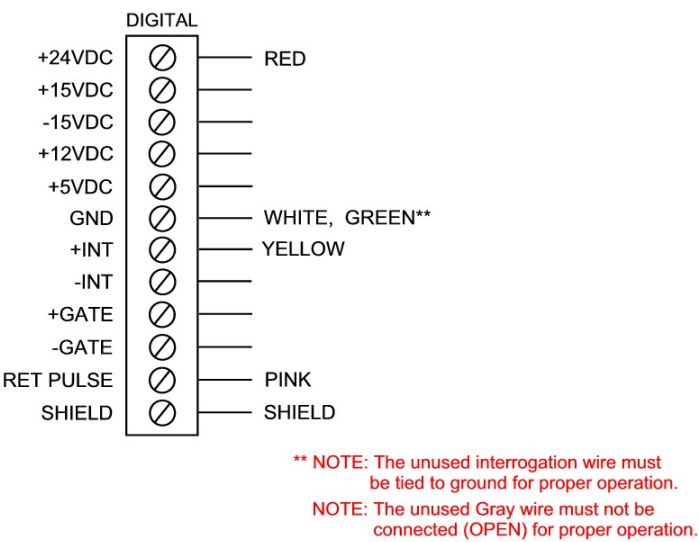


Figure 68 - G-Series Neuter Header Connections Using Positive Interrogation

Header Connections for PWM and Start/Stop Sensors

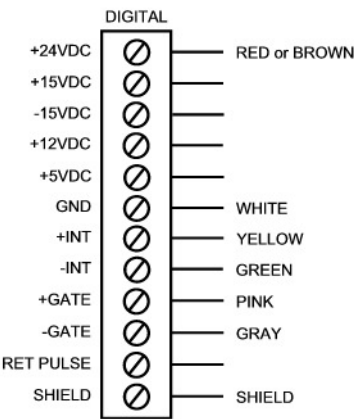


Figure 69 - G-Series PWM and Start/Stop Header Connections

Header Connections for Analog Sensors

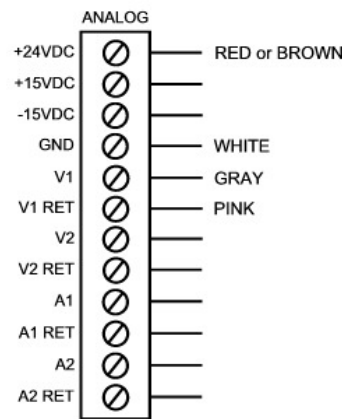


Figure 70 - G-Series Analog Voltage Header Connections

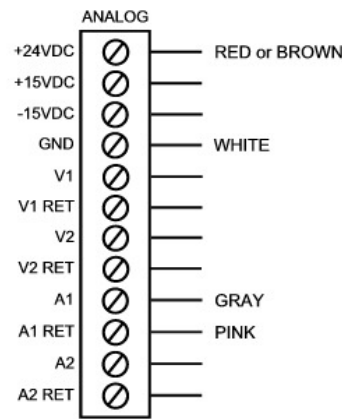


Figure 71 - G-Series Analog Current Header Connections





Testing G-Series sensors

- With the sensor properly wired to the **DIGITAL** test header and the TTU-2 power turned on, press 7 on the TTU-2 keypad to select G-Series as shown below.

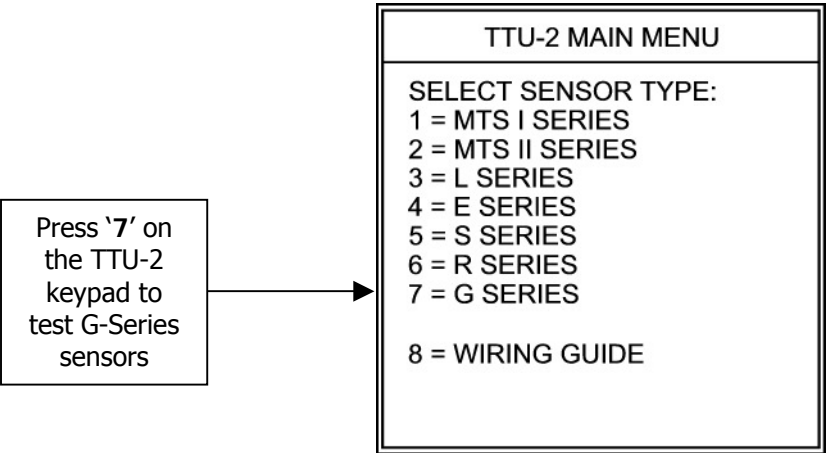


Figure 72 - Selecting the G-Series Sensor

- Select the type of output type for the sensor under test.

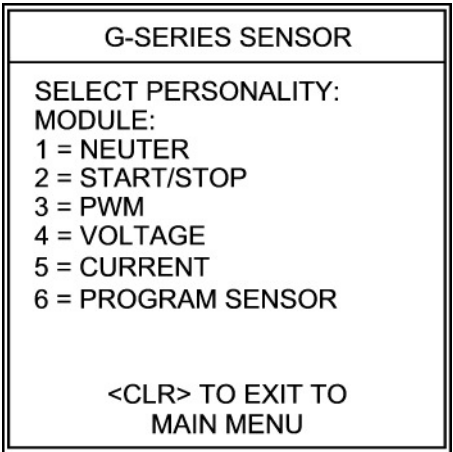


Figure 73 - Selecting G-Series Sensor Output

- Neuter and Start/Stop sensors default to external interrogation with a circulation of 1. Neuter and Start/Stop show the **Run Screen**.

## DETAILED OPERATION

- PWM sensors have two additional menus: Interrogation type (internal or external) and circulations (1-128) screens. Select the appropriate interrogation and enter the circulations obtained from the model number.

G-SERIES SENSOR
SELECT SENSOR INTERROGATION: 1 = INTERNAL 2 = EXTERNAL
<CLR> EXITS TO PREVIOUS MENU

Figure 74 - G-Series Interrogation Menu

G-SERIES SENSOR
ENTER NUMBER OF CIRCULATIONS DEFAULT = 4
<input type="text"/>
<CLR> EXITS TO PREVIOUS MENU

Figure 75 - G-Series Circulations Menu

DETAILED OPERATION

- If the sensor is connected correctly and in a functional state, a **Run Screen** will appear showing position.

G-SERIES SENSOR	
OUTPUT: PWM INTERROGATION: INT CIRCULATIONS: 4	
PULSE TIME: (USEC)	120.6
POSITION: <div style="border: 1px solid black; padding: 5px; display: inline-block;">9.247</div>	
<CLR> TO EXIT TO MAIN MENU	

Figure 76 - G-Series Neuter, Start/Stop, and PWM Output Run Screen

- If there is a test header wiring error, or the sensor is non-functional, then a **Sensor Not Responding Screen** will appear.

G-SERIES SENSOR
SENSOR NOT RESPONDING CHECK HEADER CONNECTION. REPEAT TEST WITH CURRENT SETTINGS?
<ENT> = REPEAT <CLR> CANCEL

Figure 77 - G-Series Sensor Not Responding Screen

Testing Analog Sensors

- The **Run Screen** for G-Series analog voltage sensors is functionally similar to the digital **Run Screens**, with one important difference. There is no way to determine if a sensor is actually connected to the **ANALOG** header. The user must use the <CLR> key on the keypad to exit this screen and return to the MAIN MENU.

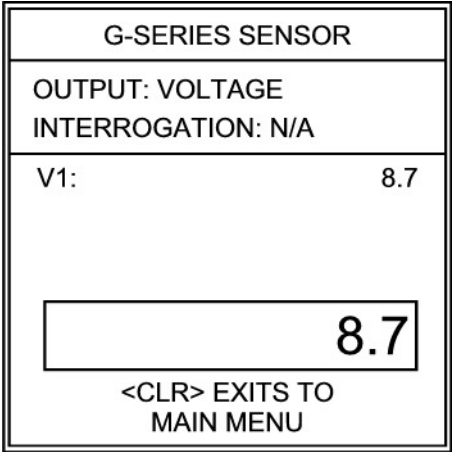


Figure 78 G-Series Voltage Output Run Screen

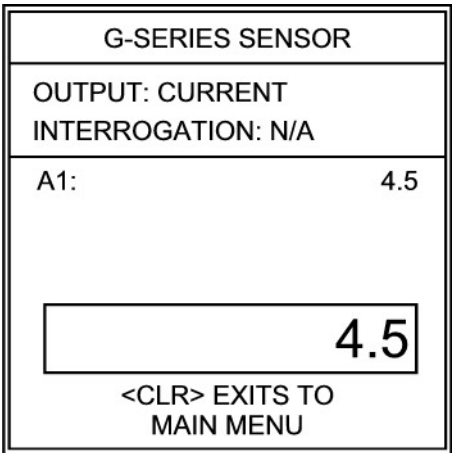


Figure 79 - G-Series Current Output Run Screen

## Troubleshooting G-Series Sensors with Test Results

- If the TTU-2 is displaying a position on a **Run Screen**:
  - Slowly move the magnet through the full stroke length of the sensor. Observe the display as the magnet is moved.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed
  - Sensors have a 2.5" dead band at the tip end of the pressure housing. Observe the display as the magnet is moved toward the tip end of the sensor, but before the 2.5" dead band is reached.
    - If the displayed position stops changing but continues to show a steady position, repair or replacement is needed.
    - If the **Sensor Not Responding Screen** appears, the sensor has a dead spot, and repair or replacement is needed. Pay particular attention to the magnet position while testing the sensor at the tip end. The **Sensor Not Responding Screen** will appear when you hit the dead band.
  - Gently move the connector and/or cable connection to the head cap while observing the displayed position. If the position freezes or a **Sensor Not Responding Screen** is shown, the sensor needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.
  - While holding the magnet steady, lightly tap the housing and observe the position on the display. (Use a small screwdriver, and tap no harder than you would tap on the back of your hand). If the position jumps significantly or a **Sensor Not Responding Screen** appears, the sensor has problems with the waveguide or sensor pickup and needs repair.
- If the **Sensor Not Responding Screen** appears (no **Run Screen** is displayed):
  - Check the connections to the TTU-2 headers. If the connections are correct then sensor repair or replacement is needed.
  - Gently move the connector and/or cable connection to the head cap while pressing <ENT> to repeat the test with current settings. If a **Run Screen** is displayed, the sensor connector/cabling needs repair. Please note: the object is to confirm a solid connection to the sensor, so exert little or no force while testing the connector and/or cabling.

## Programming G-Series Sensors

The G-Series sensor output can be changed programmatically. However only within the G-Series classes: i.e., digital sensors cannot be programming for analog output and analog sensors cannot be programmed for digital output. Digital sensors can be programmed for PWM or Start/Stop, as well as interrogation type and circulation counts, if applicable. Analog sensors can be programmed for voltage or current output with a wide number of ranges. The table below shows the MTS cable connections to program the G-Series digital and analog sensors.

Pin Number	Cable	Programming Digital Sensors (RS-422)	Programming Analog Sensors (RS-485)
1	Grey	(-) Tx	
2	Pink	(+) Tx	
3	Yellow	(+) Rx	(+) RS-485
4	Green	(-) Rx	(-) RS-485
5	Red or Brown	+24 or +15vdc	+24 or +15vdc
6	White	DC ground	DC ground
	Shield	Connector housing	Connector housing
<b>TTU-2 HEADER</b>		<b>SSI/485</b>	<b>SSI/485</b>

**Table 22 - G-Series Programming Cable Color Code**

Programming G-Series Digital Sensors  
Header Connections for Programming G-Series Sensors

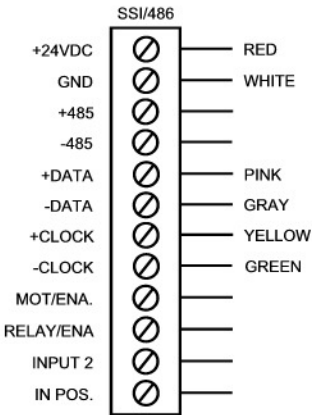


Figure 80 - +24VDC G-Series Digital Sensor Programming Header Connections

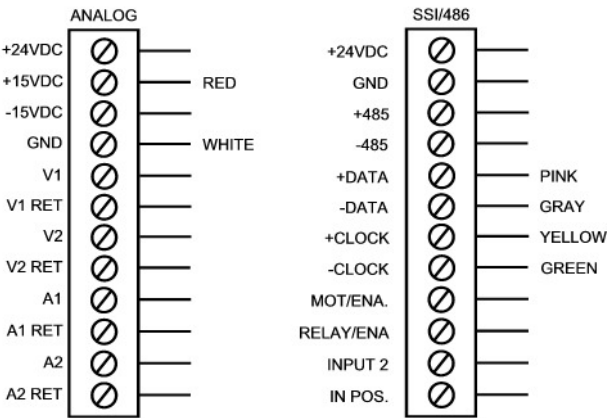


Figure 81 - +15VDC G-Series Digital Sensor Programming Header Connections



## DETAILED OPERATION

- Select which sensor class to program, Digital or Analog.

G-SERIES SENSOR
SELECT SENSOR TYPE: 1 = DIGITAL 2 = ANALOG
<CLR> EXITS TO MAIN MENU

Figure 82 - G-Series Programming Sensor Select Screen

- Programming g-series digital sensors
- After selecting digital as the sensor type the following screen appears:

G-SERIES SENSOR
SELECT ITEM TO CHANGE 1 = OUTPUT PWM 2 = INTERROGATION EXT 3 = RECIRCULATION COUNTS COUNT = 4
<CLR> EXITS TO PREVIOUS MENU

Figure 83 - G-Series Digital Programming Screen

- The current setting is shown underneath each selection. Enter the number of the item to change and select options from the menus that follow. The configurable items for a G-Series digital sensor are:
  1. **Output:**
    - PWM
    - Start/Stop
  2. **Interrogation**
    - External
    - Internal
  3. **Recirculation counts**
    - (1-15)

## **Programming G-Series Analog Sensors**

Programming for G-Series analog sensors is currently unavailable. Check Paw-Taw-John Services, Inc., website for updates to TTU-2 programming and updates to this manual.

# APPENDICES

# APPENDIX A

## APPENDIX

## A

## *L, R, G AND S SERIES SENSOR REPLACEMENT INSTRUCTIONS*

Recommended sensor removal and installation procedures are very important to minimize downtime and prevent further system damage. This appendix covers the steps for replacing L, R, G and S sensors used with hydraulic cylinders.

Some cylinders have sensor guards attached to the end of the cylinder to prevent sensor damage. Other cylinders have the sensor cap and cable completely enclosed. Use the appropriate wrenches necessary to remove and reinstall the guards.

The sensors have various connector/cable ensembles located at the head electronics, which gives the user quick-disconnect ability. The L, R, G and S series utilize high-pressure tube assemblies that remain in the cylinder. Removal and installation is much easier.



**POWERED HYDRAULIC EQUIPMENT AND CONTROL SYSTEMS CAN INJURE PERSONNEL OR DAMAGE EQUIPMENT. LOCK OUT ALL APPROPRIATE HYDRAULIC POWER AND CONTROL SYSTEMS IN ACCORDANCE WITH LOCAL SAFETY REQUIREMENTS.**

Paw-Taw-John Services, Inc. highly recommends that during the removal and installation of a sensor that all power to the system (hydraulics, control system and any other associated equipment) be turned off, tagged and locked out.

## ***Removal of L, R, G and S Series Sensors***



**AVOID INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT. OBSERVE ALL LOCAL LOCKOUT AND SAFETY PROCEDURES!**

1. Turn off motion control system power and control power to hydraulics. **Lock Out!**
2. Have replacement sensor ready and in clean and safe area.
3. Insure area around the sensor is clean and free of dirt, sawdust, and any other foreign material.
4. Survey the area behind the cylinder to make sure there is sufficient room to withdraw the sensor without encountering obstructions.
5. Remove all protective covers from the back of the sensor and cable.
6. Disconnect cable/s from sensor and secure away from work area.
7. Loosen two hex head screws at head electronics.
8. Slide the sensing element/electronics assembly out of the high-pressure tube.
9. Wipe the cables clean of any exposure to hydraulic oil.  
**Note:** Hydraulic oil can cause deterioration of the cable casing.
10. Proceed with sensor replacement immediately.

## ***Installation of L, R, G and S Series Sensors***



**AVOID INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT. OBSERVE ALL LOCAL LOCKOUT AND SAFETY PROCEDURES!**

1. Verify the replacement sensor is compatible with the faulty sensor.
2. Maneuver the sensor element tip into the hole of the high-pressure tube.
3. Tighten the sensor securely with the two hex head screws used during removal.
4. Clean and reconnect the cables to the sensor.
5. Reinstall guard or protective sensor and cable cover.  
**Note:** This step may be required prior to reconnecting cable.
6. Power may now be re-applied to the motion system.
7. Verify the sensor is working with the motion system electronics.
8. It is possible the sensor will need an address change when on a multiple axis system. Consult addressing procedures.
9. Turn on hydraulics power.
10. Proceed with operation of the machine.
11. If problems are still present, consult Troubleshooting chapter of the manual for other possible solutions.

# APPENDIX B

## TEMPOSONICS I & II SERIES SENSOR REPLACEMENT INSTRUCTIONS

## APPENDIX

## B

Recommended sensor removal and installation procedures are very important to minimize downtime and prevent further system damage. This appendix covers the steps for replacing of a MTS I or MTS II sensors used with hydraulic cylinders.

Some cylinders have sensor guards attached to the end of the cylinder to prevent sensor damage. Other cylinders have the sensor cap and cable completely enclosed. Use the appropriate wrenches necessary to remove and reinstall the guards.

The sensors have various connector/cable ensembles located at the head electronics, which gives the user quick-disconnect ability.



**POWERED HYDRAULIC EQUIPMENT AND CONTROL SYSTEMS CAN INJURE PERSONNEL OR DAMAGE EQUIPMENT. LOCK OUT ALL APPROPRIATE HYDRAULIC POWER AND CONTROL SYSTEMS IN ACCORDANCE WITH LOCAL SAFETY REQUIREMENTS.**

Paw-Taw-John Services, Inc. highly recommends that during the removal and installation of a sensor that all power to the system (hydraulics, control system and any other associated equipment) be turned off, tagged and locked out.

### ***Removal of Temposonics I & II Series Sensors***



**AVOID INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT. OBSERVE ALL LOCAL LOCKOUT AND SAFETY PROCEDURES!**

1. Retract the cylinder as far back as possible. This makes it easier to install the sensor.
2. Turn off motion system power and control power to hydraulics. **Lock Out!**
3. Have replacement sensor ready and in clean and safe area.
4. Have a bucket for oil spillage and a clean rag available.
5. Insure area around the sensor is clean and free of dirt, sawdust, and any other foreign material.
6. Survey the area behind the cylinder to make sure there is sufficient room to withdraw the sensor without encountering obstructions.
7. Remove all protective covers from the back of the sensor and cable.
8. Disconnect cable/s from sensor and secure away from work area.
9. Using a 1-3/4 inch, wrench or socket, unscrew the sensor from the cylinder.



**DO NOT ATTEMPT TO USE THE HEAD ELECTRONICS CAP TO UNSCREW THE SENSOR FROM THE CYLINDER. DAMAGE TO THE HEAD ELECTRONICS AND CAP CAN OCCUR.**

10. Slide the sensor out of the cylinder while holding the clean rag at the entry hole to the cylinder.
11. Proceed with sensor replacement immediately.

## ***Installation of Temposonics I & II Series Sensors***



**AVOID INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT. OBSERVE ALL LOCAL LOCKOUT AND SAFETY PROCEDURES!**

1. Verify the replacement sensor is compatible with the faulty sensor.
2. While keeping the clean rag at the entry hole to prevent oil from leaving the cylinder, maneuver the sensor tip into the hole of the sensor.
3. Screw the sensor into the cylinder with wrench or socket while not using the cap/head electronics for leverage.
4. Clean and reconnect the cables to the sensor.
5. Reinstall guard or protective sensor and cable cover. (Note: this step may be required prior to reconnecting cable.)
6. Power may now be re-applied to the motion system.
7. Verify the sensor is working with the motion system electronics.
8. Turn on hydraulics power.
9. Proceed with operation of the machine.
10. If problems are still present, consult Troubleshooting chapter of the manual for other possible solutions.

# APPENDIX C

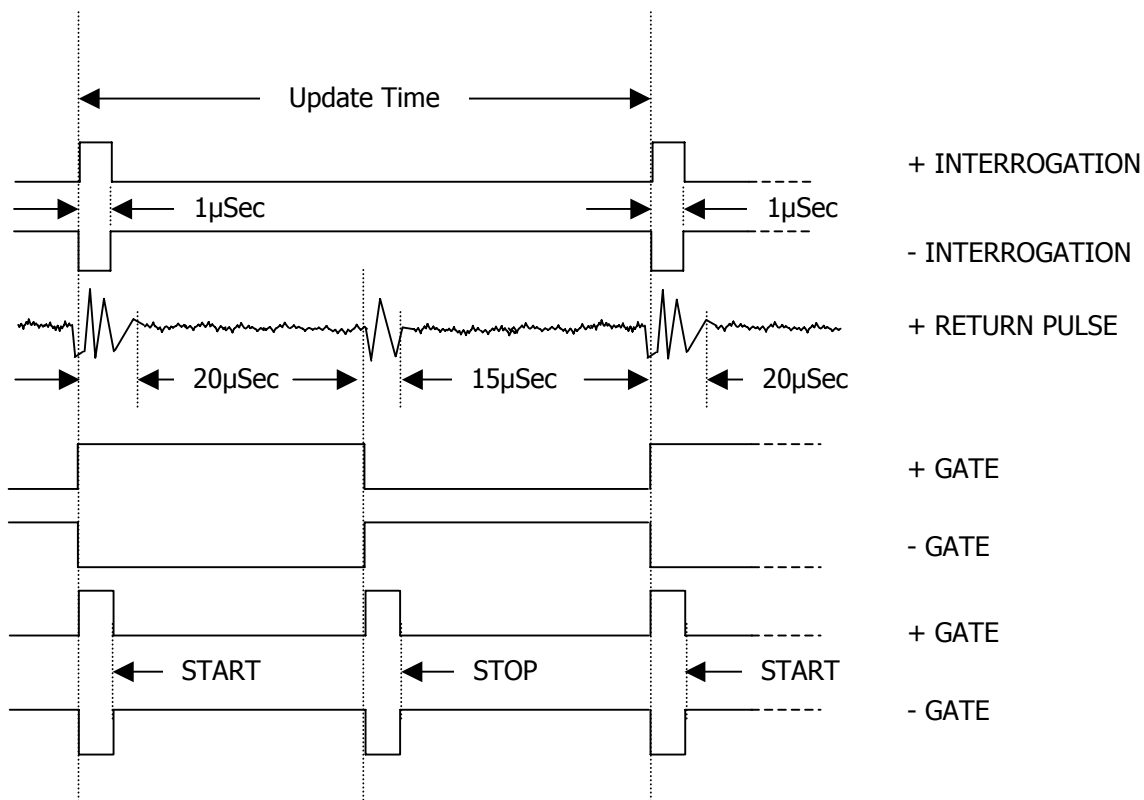
## C

*Calculating Position for Pulse Width Modulation (PWM) Outputs*

### **Determining Position of Pulse Width Modulation (PWM) Sensors**

- PWM output modes may use internal or external interrogation.
  - If external interrogation is used then the interrogation inputs to the sensor are used. These inputs are supplied by the controller/electronics.
- Start/Stop outputs always use external interrogation, and a circulation of 1.
- Internal interrogation uses a built-in clock that determines timing for pulsing the waveguide.
- External interrogation is provided by external controllers/electronics and is used primarily for synchronizing received Gate or Start/Stop data.
- Some applications require one interrogation input line to be grounded.

Those sensors using internal interrogation provide an output PWM pulse. Those sensors using external interrogation provide an output of a RET PULSE (for neuter sensors), Start/Stop or a PWM pulse. The TTU-2 **DIGITAL** header supplies external interrogation pulses of  $\approx 1\mu\text{sec}$  duration.





## APPENDICES

Upon receipt of the gate pulse, the pulse duration is determined, and the following formula is applied to determine position:

$$\text{POSITION in inches} = ((\text{PW (in } \mu\text{sec)}) \div \text{circulations (1-128)}) \div \text{gradient} - \text{null (inches)}$$

Where:

Gradient<sup>13</sup> = 9.0000 (the median gradient of MTS sensors)  
Null<sup>14</sup> = 4.15 inches (the median null distance for most of MTS sensors)  
Circulations = User selectable at test time (1-128)

Example: A Temposonics I using external interrogation with 1 circulation returning a 120.6μsec pulse.

$$\begin{aligned}\text{POSITION} &= ((\text{PW } (\mu\text{sec}) \div \text{circulations}) \div 9.0000) - 4.15 \\ &= ((120.6 \div 1) \div 9) - 4.15 \\ &= (120.6 \div 9) - 4.15 \\ &= 13.4 - 4.15 \\ \text{POSITION} &= 9.25 \text{ inches}\end{aligned}$$

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<sup>13</sup> The TTU-2 uses a fixed gradient of 9.00000 for all sensors.

<sup>14</sup> The TTU-2 uses a fixed null distance of 4.15" for all sensors.

## APPENDIX D

APPENDIX

D