TMS Manual

Section 1.0 Introduction

1.1 General

Congratulations! You have purchased the TMS-5000 Thickness Measuring System, the most accurate air-coupled, ultrasonic thickness measurement system available. It is engineered for use in industrial environments, and, with proper maintenance, should provide accurate measurements for many years.

The TMS-5000 can be used as a stand-alone system or interfaced to other control devices such as programmable controllers, personal computers, or microcomputers. It is accurate to ± 0.0002″. Almost any surface – liquid or solid – can be used as a measurement target. Since there is no physical contact or loading, a true measurement is obtained. You will find the system software permits a variety of total system solutions to measurement and control application problems.

1.2 First Look at the TMS-5000

The TMS-5000 is composed of two transducers, transducer cables, mounting hardware, installation hardware, and the controller, which is housed in a NEMA 13 electrical enclosure.

Transducers are shipped with environmental filters installed to protect the gold foil face. An air hood is provided for each to protect the transducer and reference bars during operation.

The five-digit display on the controller is visible with the enclosure door either open or closed. The door can be opened by rotating the door latch screw 90° counter-clockwise with a flat blade screwdriver. The two buttons on the main board are used to program the unit for individual applications. A second set of buttons located on the outside of the door perform the same functions and may be locked out by using the key switch on the enclosure door.

1.3 Operating Environment

The TMS-5000 is designed to be used in factory and mill environments. Each unit self-calibrates to automatically correct for the effects of changes in temperature, wind, or humidity. The unit will operate within specification in normal factory environments; however it will provide optimum accuracy under the following conditions.

- Clean line power is supplied to the controller.
- The transducers and cables are protected and are as far away from radiated electromagnetic noise as possible.
- Air hoods are used to minimize random air temperature gradients between the target and the transducer. If there is radiated heat from the target or from objects near the sound path, be sure to use the UAI air flow system.

The TMS-5000 will operate through smoke, fog, vapors, chips, or other airborne particles. It will not operate if materials are allowed to collect on the surface of the transducer. The transducer should never be mounted pointing up if there is any chance of material being deposited on its face. Accessories are available fro UAI to handle special installation needs. (See Section ???)

Section 2.0 Technical Discussion of the TMS-5000

2.1 Principles of Operation

The TMS-5000 is a highly accurate, non-contact thickness measurement system. The system propagates a high frequency sound pulse, measures the time elapsed for the pulse to travel from the transducer to the target and back, and converts this time into a measurement of distance. It then adds the distance measurements from the upper and lower transducers and subtracts the sum from the known distance between the two transducers, which results in a thickness measurement.

The accuracy specification of the device is ± 0.0002″ or ± 0.02% of the sum of the distances from the transducers to the target surfaces for distances up to 1.5″, ± 0.033% for distances from 1.5″ to 4″, and ± 0.05% for distances greater than 4″. Accuracies of up to ± 0.0002″ or ± 0.02% can be achieved with high average counts.

A complete breakdown of the TMS-5000's specifications can be found in Appendix B of this document.

2.2 Beam Pattern

The half angular beam width is approximately 1.6°. Due to the frequencies used, virtually all of the sound energy is specularly reflected from any target surface (angle of incidence equals the angle of reflection); therefore the spot size from a flat target is 0.85″ at any range (the actual size of the transducer aperture).

2.3 Reference Bars

The purpose of the reference bars is to provide automatic recalibration to overcome the effects of temperature fluctuation. All measurements are taken from the outer surface of the reference bar.

Special care is taken to precisely machine and assemble each transducer; however, the position of the reference bar in relation to the transducer face is varies from transducer to transducer. This variation is reflected by the calibration code marked on each transducer. Calibration values are precisely determined at the factory prior to shipment.

2.4 Environmental Compensation

The velocity of sound waves in air is affected by temperature. The TMS-5000 utilizes two external reference bars and signal processing techniques to normalize for the environmental effects from the measurement data.

Each time the system takes a sample, it measures the distance between the external reference bars and compares this measurement to the factory calibrated distance. If this distance varies from the standard, it can be assumed that the speed of sound has changed. The system corrects the target distance based on the reference error.

This calibration method works on the principle that the environmental influence is the same at the reference bar as it is over the path length to the target. If the ambient atmosphere is different at the reference bar when compared to the path to the target,

measurement accuracy will be affected. Air flow through the air hoods effectively breaks up these temperature gradients.

2.5 Contamination

Many industrial environments have airborne contaminants such as oil, smoke, fog, or chips. One of the major advantages of using high frequency ultrasound over other non-contact measurement systems is the ability to “punch” through these contaminants due to the relationship of particle size to wavelength. Ultrasonic wavelengths are much larger compared to particle size than optical wavelengths, resulting in less absorption and the ability to penetrate contaminated atmospheres.

2.6 Computer Controlled Gain Settings

The TMS automatically calibrates signal amplitude to enhance accuracy over time. The TMS measures the signal amplitude from the outer reference bar, compares it to a standard value. If the current amplitude varies significantly from the standard, a gain setting is automatically selected to obtain the standard. The cALr value is the calibrated second reference amplitude for each transducer. The right hand three digits are the digitized amplitude value.

2.7 Frequently Asked Questions

Is the TMS-5000 affected by other sources of acoustic noise?

Generally, no. The operating frequency is so high that it is virtually impossible to generate sound waves in a frequency range that could be picked up by the receiver. The unit can pick up high frequency air noise from discharges of high pressure air. Do not point the transducer toward these discharges. If a problem exists, use mechanical shields.

Does the unit work only with flat surfaces?

No, the TMS-5000 can see targets of all shapes, including cylinders, spheres, edges, and other irregular shapes. A small target generally must have the transducer closer to the surface to be measured.

Does the target have to be perpendicular?

Yes, this is the most important parameter in developing a successful application. The target surface should be within $\pm$ 2.5° of perpendicular with respect to the transducer.

What materials can be measured with the TMS-5000?

Essentially, any material may be measured; however, the rougher the surface, the more energy will be scattered. Thus, the operating range may be reduced with a poor reflector such as foam. Such a problem may be resolved by increasing the gain setting (the three right hand digits of cALr), making the unit more sensitive.

Will the TMS-5000 work in areas where there is dirty line power?

To a point; there is substantial line filtering within the unit, but if the lines are extremely dirty, use an external line filter together with a dedicated power line free from external noise.

Will the TMS-5000 work in high temperature applications?

The speed of sound is directly affected by air temperature. If the air temperature is constant, the external reference will normalize for non-standard temperatures and provide correct data. We do not recommend transducer operating temperatures above specification. If a target is warmer than ambient, the external reference on the transducer will not completely bring the data into specification unless transducer enclosures with purging air are used to break up these temperature gradients.

Will the reference bars compensate for hot targets?

No. A target surface that is much warmer than the environment and/or the transducer will have significant temperature gradients at the target surface. These gradients will change the time of flight of the sound wave and cause irregular sound path lengths, leading to gross measurement inaccuracy. UAI's transducer enclosures with purging air effectively break up these temperature gradients.

Is the zero point measured from the foil surface or from the reference bar?

Zero is measured from the second or outside reference bar. There is a deadband or ignore zone for 0.2″ from the reference bar.

Is the TMS-5000 linear over its full measurement range?

Yes; this linearity can be verified by checking it against a known and accurate mechanical standard such as an accurate cross slide on a machine tool. If the unit is not linear, then the wrong calibration code has been used for one or both of the transducers.

2.8 Response Time

Response time or time per measurement will vary depending on the number of samples taken per measurement. The following chart shows actual response time versus sample size with baud rate at 19.2k and a 4″ standoff. Measurements will be slower at lower baud settings and greater standoff. For example, add 11 msec to the approximate times shown below for 9600 baud.

Note: If no baud is selected or the serial output is disabled, subtract 11 msec from the values below.

Number of Samples	Time per Measurement	Measurements per Minute
1	29 msec	2,069
2	40 msec	1,500
4	54 msec	1,111
8	86 msec	698
16	146 msec	411
32	268 msec	224
64	511 msec	117
128	1 sec	60

Section 3 Installation

3.1 Installation

This section provides general installation instructions as well as a specific applications guide to serve as a check list during installation.

NOTE: Proper installation and careful attention to all of the guidelines and practices included in this section are the key to obtaining the highest accuracy possible with the TMS-5000.

3.2 TMS-5000 Parts List

When unpacking your TMS-5000 thickness measurement system, use the following check list to verify receipt of all required components.

TMS-5000 with Industrial Air Hoods

	Qty	Description
_____	1	TMS-5000 Controller Housed in NEMA 13 Enclosure
_____	2	Double Reference Bar Transducer
_____	2	Transducer Cable
_____	2	Industrial Air Hood with Transducer Mounting Gimbals Installed
_____	1	600 CFM Air Fan
_____	1	25′ Air Hose
_____	2	Package of 10 Environmental Filters
_____	Lot	Adjustment Wrenches

TMS-5000 with Non-Industrial Air Hoods

	Qty	Description
_____	1	TMS-5000 Controller Housed in NEMA 13 Enclosure
_____	2	Double Reference Bar Transducer
_____	2	Transducer Cable
_____	2	Non-Industrial Air Hood with Transducer Mounting Gimbals Installed and Internal Fan
_____	1	Power Supply
_____	2	Package of 10 Environmental Filters
_____	Lot	Adjustment Wrenches

TMS-5000 without Air Hoods

	Qty	Description
_____	1	TMS-5000 Controller Housed in NEMA 13 Enclosure
_____	2	Double Reference Bar Transducer
_____	2	Transducer Cable
	2	Insulating Washers

_____ 4 Lock Nuts

_____ 2 Package of 10 Environmental Filters

3.3 Mounting the Controller

Mount the controller securely in a location free of severe vibration and sufficiently close to the object to be measured so that the transducer cables reach from the points of measurement to the controller without putting strain on the connectors. Power (115 volts AC) must be supplied to the controller and connected to the barrier strip terminals on the display bracket. RS-232C or RS-422A input and output, relay, aux input, and external trigger input connections to desired devices are made at TB1 as required by the application. For ease of wiring, remove TB1 from its socket. Connections to the 16 bit parallel binary output port are made at connector J2 on the main board.

3.4 Mounting the Air Hoods

Mount both air hoods in appropriate locations to make the measurement and as close to the target surface as practical. The mounting means must be rigid to prevent movement of the transducer relative to the target area. The transducer enclosures must be aligned so that they are perpendicular to the surface of the object to within ± 2.5° to allow the maximum adjustment of the transducer. See Figure 3.1????

3.5 Transducer Wiring

NOTE: For accurate measurements, the transducers must be electrically isolated from chassis ground or any other ground.

Run each transducer cable in its own conduit. The transducer cable can pick up electrical noise from motors and solenoids if not properly isolated. Since the transducer cable carries approximately 300 volts, encase the cable in a protective sheath to prevent damage to the cable and potential injury to personnel.

Run the cable through the conduit, leaving enough slack cable inside the air hood to connect the transducer after it is installed in the gimbal.

The transducer cables should be installed in the TMS-5000 housing with a 360° service loop between the enclosure's cable entry and the plug-in jack. Route each transducer cable in a loop 6″ or larger along the side of the controller enclosure so that no strain is applied to the connector end of the transducer cable.

Signal ground is Ultrasonic Arrays' system ground, which must be isolated from earth ground. The signal ground test point is TB5, which is next to J4 on the main board.

3.6 Installing the Transducer into the Air Hood

CAUTION: Review the cautions and warnings on Page ?? prior to installing and connecting the transducers. Improper installation procedures may void your warranty.

If the transducer has a clean environmental filter installed, leave it in place. If not, see Section ???, Maintenance, for instructions on installing the environmental filter

Remove the air hood door by unscrewing the spring-loaded, straight slot screws at each corner. Loosen the gimbal yoke by turning the bolt on the lower right face of the yoke. Carefully insert the transducer into the gimbal yoke. While holding the transducer flush against the yoke, tighten the bolt until the transducer is held securely in place. To ensure proper operation, there should be no movement of the transducer in the yoke.

After the transducer is firmly installed in the gimbal, connect the transducer cable, taking care that the small “fingers” surrounding the center pin are properly aligned. Improper alignment can damage the connector Screw the cable down. The connector should turn at least three full turns; if it does not, check connector alignment and try again.

3.7 Connecting the Transducer Cable to the Printed Circuit Board

The transducer cables have a Molex connector attached to the controller end for rapid connection to the controller. Plug the cable for Transducer 1 (usually the upper transducer) into the three-pronged J1 in the upper left corner of the main (bottom) board. Plug the cable for Transducer 2 into the three-pronged J2 in the upper right corner of the daughter (top) board.

3.8 Ground Isolation Check

At this time, check the electrical isolation between signal ground and chassis ground. Using an ohmmeter, measure the electrical resistance between chassis ground, which is the GND connection on the power terminal block, and signal ground, which is the test point adjacent to the barrier strip (TB1). If properly isolated, the measurement is open, or at least 20 megaohms. If the measurement is less than 20 megaohms, check wiring and grounding practices. If necessary, provide electrical insulation on the transducer mounting bracket. If isolation between chassis ground and signal ground is less than 20 megaohms, erratic measurements will occur.

3.9 Additional Tips on Mechanical Fixturing

The presentation of the target to the gauges is the most important factor in determining the success of an application. The gauges must be held perpendicular to the axis of the gauges, it must be prevented from vibrating, and if the target material is deformable, it must be supported in the vicinity of the gauges so that there is no sag. Here are tips for some typical applications.

- Hard Materials, such as particleboard, gypsum board, plywood, glass, metal, acrylic sheet, etc.: Adjust the conveyor system so that the product is held flat and at right angles to the gauges. If there is much vibration of the product, install hold downs or pinch rollers.
- Soft Materials, such as foam rubber, extruded rubber, paper products, thin veneer, etc.: The major problem here is removing sag from the target in the area of the gauges. This is usually accomplished by fabricating a structure that supports the product as it passes between the two transducers. Increasing the tension of the takeup rollers can often improve things.

When checking perpendicularity and flatness, a carpenter’s square and a high quality bubble level are very useful tools that are easily obtained at any hardware store.

3.10 Controller Wiring

3.10.1 AC Power

Connect 115 VAC, 60 Hz power to the controller as shown in Figure 3.2. An internal fuse is provided in the controller on the primary side of the power supply but no power disconnect switch is provided.

Route the 110 VAC in separate conduit. This will help prevent induced noise in the controller and communication wiring. Make sure that the 110 VAC line is at least 100 volts and not greater than 130 volts. If voltage spikes or power fluctuations commonly occur, UAI recommends that line filtering and surge protection be installed. If you wish to install a switch to disconnect the 110 volts, locate the switch in a separate box outside the unit. The power lines should be as short as possible once inside the electronics enclosure, as they can radiate electrical noise into the printed circuit boards.

3.10.2 External Trigger Wiring

The external trigger function can be connected if required by the application. Two terminals are provided on the controller barrier strip and are marked “EXT. TRIG.” ad “EXT. TRIG. GND.” respectively. A switch, relay contact, or transistor can provide an open connection between these terminals during the time that measurements are not desired. When connection is made such as by the jumper supplied from the factory in the initial configuration (EXT. TRIG. to EXT. TRIG. GND.) or by an external contact, the controller free funs and makes measurements continuously. Upon closure of the contacts between the external trigger and the external trigger ground the unit takes as many samples as possible before the external trigger opens. It does not take just one set of samples upon closure unless it is programmed to do so. (See Section ???). When the connection is open, measurements stop. See Figure 3.3 for reference.

NOTE: If a transistor brings the external trigger input to the same potential as the external trigger ground, the current rating for that transistor should be able to handle at least 50 mA. The external trigger input ground is isolated from the system’s signal ground. The external trigger input should never be more than 10 volts DC greater than, or two volts less than, the EXT. TRIG. GND. input. See Figure 3.4 for a schematic of external trigger circuitry. There is no need for a “pull up” resistor on the EXT. TRIG. input.

FIGURE ?? Inserted Here

3.10.3 Set Point Relay Wiring

Three terminals are provided on the controller barrier strip labeled “K1 COM,” “K1 NC,” and “K1 NO.” These are common, normally closed and normally open contacts respectively of an electro-mechanical relay mounted on the main board. These contacts are rated for a maximum 2 amp resistive load. They can be wired to any external alarm, ejection device or other controller as desired by the user. Controller software allows changing the relay coil energization from “in-limits” to “out of limits” which, with the NO and NC contacts provided, allows maximum flexibility in wiring.

Do *not* use relay (K1) to directly control or switch voltages (AC or DC) greater than 100 volts, in order to avoid compromising the noise suppression capabilities

of the TMS-1000. If it is absolutely necessary to switch 110 AC, use a line filter between the TMS-1000 and the connected device. UAI recommends line filters manufactured by Shape, Topaz, or the “Isafil” by Converter Concepts Corporation. Tranzorbs or metal oxide varistors should be placed across the relay common and the normally open or normally closed terminal(s), whichever is used. UAI will furnish appropriate tranzorbs if requested. The tranzorbs are transient suppressers that schematically resemble diodes. If it is necessary to switch 110 VAC through the common to the normally open relay terminal, tranzorbs should be installed as in Figure 3.4.

FIGURE ?? Inserted Here

3.10.4 RS-232 Wiring

To use the RS-232 communications feature, connect the “RS-232 GND” (pin 7 of a standard DB-25 connector), “RS-232 in” (pin 2), and “RS-232 out” (pin 3) terminals to the host processor or other compatible asynchronous communication device. If you use shielded cable, terminate the shield to earth (chassis) ground at the host or terminal end only. There is a jumper adjacent to the relay on the main board that must be configured between the two pins that are closest to the barrier strip. (See Figure 3.5) If the jumper is not placed properly, the TMS will not receive any data from the host.

NOTE: The RS-232 lines (including ground) are optically isolated from the TMS for better noise rejection.

FIGURE ?? Inserted Here

3.10.5 RS-422 Wiring

There are five terminals on the barrier strip (TB1) for the RS-422A connection, two each for receive and transmit, and one for signal ground. The receiver is terminated with a shunt resistor of 240 ohms. The TMS can be connected in a “multi-drop” configuration with special software. Contact the factory for information. RS-422 is useful for long distance communication needs between the host and the TMS controller. Figure 3.6 shows how the RS-422A set of twisted pairs should be wired to the host. The jumper (JP1) should be between the two pins farthest from the barrier strip (TB1) or the TMS will not receive from the host. (See Figure 3.5)

FIGURE ?? Inserted Here

3.10.6 16 Bit Parallel Port Binary Output Wiring

This output is provided on connector J2 located on the main board. Wiring to this port requires a 20 pin female mating connector. The pin out diagram is shown below:

PIN	FUNCTION	PIN	FUNCTION
8	SIGNAL GND	11	BIT 8
6	BIT 0	13	BIT 9
4	BIT 1	15	BIT 10
2	BIT 2	17	BIT 11
1	BIT 3	19	BIT 12
3	BIT 4	20	BIT 13
5	BIT T	18	BIT 14

7	BIT 6	16	BIT 14
9	BIT 7	14	LOW WHEN SAMPLING

Bit 0 is the least significant bit. The output lines will source up to 5 mA to or sink 20 mA from the host. Pin 14 is the only open collector output. The switching time is 20 to 40 nanoseconds under standard TTL load. Data out depends on the resolution and type of units (inches or millimeters) for which the application is set. The following chart indicates the output.

Type of Units and Resolution	Binary Output
Hundredths of inches (00.00)	Number of hundredths
Thousandths of inches (00.000)	Number of thousandths
Tenths of millimeters (0000.0)	Number of tenths
Hundredths of millimeters (0000.00)	Number of hundredths
Thousandths of millimeters (0000.000)	Number of thousandths

NOTE: Tenths of thousandths of inches (0.0000) is not available on 16 bit parallel output.

The data is valid when the sampling line is not low with respect to pin 8. It will not change while that line is high. The low voltage will never be above 1 volt with respect to pin 8.

NOTE: The outputs are referenced to the system's signal ground, which is the same ground to which the transducer's signal is referenced. If there is any possibility that the cable from the 16 bit port will be run in a noisy electrical environment, proper precautions must be taken or degradation in accuracy will occur. In this instance, use a shielded cable between the TMS controller and the host computer end only and let the cable "float" electrically on the TMS end. Run the cable in conduit to provide additional noise protection.

3.11 Analog Output Option

The input to the analog output option is a 12 bit binary number transformed into an analog voltage or current by a 12 bit D/A converter. The analog option is implemented using a separate printed circuit board, which is connected to the main board by two cables, one for digital signals (J2 on the main board) and one for the analog board power supply (J6 on the main board). The analog output signals are available at the four terminal barrier strip on the analog board, TB1. Two of the terminals are for analog voltage and two terminals are for analog current.

To use the analog outputs, the size of the analog span, the positioning of the span, and the polarity must be selected using added menu items available on the display. Follow the conventional unit configuration to "AnStr," which is the starting or zero point of the analog output span. Configuring the zero point, analog span, analog polarity, and 10 VDC/4-20 mA output at the zero point or at the top of the span is discussed later in this section.

The analog voltage or current, changes in incremental steps (2.44 mV/increment for 0-10 VDC output and 3.9 mA/increment for 4-20 mA output) as the range differential offset changes.

3.12 Analog Output Installation and Wiring

3.12.1 Operation

The input to the analog output option is a 16 bit binary number transformed into an analog voltage current by a 12 bit D/A converter. The analog option is implemented using a separate printed circuit board which is connected to the main board.

To use the analog outputs, the size, position and polarity of the analog span must be selected by using the menu items available on the display.

3.12.2 Installation

Analog units shipped from the factory have the analog output board installed. No additional installation is required.

3.12.3 Analog Signal Wiring

Four terminals are provided on the right side of the analog board barrier strip for analog wiring. Terminals 1 and 2 are for the 4-20 mA output and terminals 3 and 4 are for the 0-10 VDC output. Following is a simplified schematic of these outputs. Pin 1 of the terminal strip is the closest terminal to the main board terminal strip (TB1). See Figure 3.6.

FIGURE ?? Inserted Here

3.12.4 Configuring the Analog Output Option Via RS-232C or RS-422A

See Section 4 for the proper communications protocol to configure the span, starting point, and polarity of the analog output.

Section 4.0 Configuring the TMS-5000

4.1 Introduction

NOTE: The TMS-5000 Thickness Measuring Gauge must be installed and aligned according to the procedures outlined in Section 3.0 of this manual prior to proceeding.

The TMS-5000 hardware permits the user to configure the system to a given application for optimum performance. Once configured the unit can free fun, continuously make measurements, or sample on command. Many programmable options are available for customizing the unit to the user's application requirements. This section describes how to use the configuration menu to program the gauge for optimum performance.

See Appendix for a listing of factory default settings for each parameter.

4.2 Using the Configuration Menu

See Appendix C for a listing of menu items and sequence for various TMS-5000 models

4.2.1 Activating the Menu

Simultaneously pressing and releasing both switches on the display board activates menu mode with the first menu item, cALd1.

4.2.2 Advancing to the Next Menu Item

While in menu mode, pressing the left switch (SW1) advances the unit to the next menu item.

4.2.3 Accessing Configuration Mode

While in menu mode, pressing the right switch (SW2) accesses the configuration mode for the menu item on display.

4.2.4 Modifying Parameters

Unless otherwise noted, pressing SW2 will *increase* the value displayed. Holding the switch down for more than two seconds will increase the rate at which the value increments.

Unless otherwise noted, pressing SW1 will *decrease* the value displayed. Holding the switch down for more than two seconds will increase the rate at which the value decreases.

When the value displayed reaches either the highest or lowest value possible for the parameter, the value will roll over.

4.2.5 Saving Changes

The last value displayed prior to exiting configuration mode will automatically be saved upon exit.

4.2.6 Exiting Configuration Mode

Pressing both switches simultaneously causes the TMS to exit configuration mode and advance to the next menu item.

4.2.7 Returning to Measurement Mode

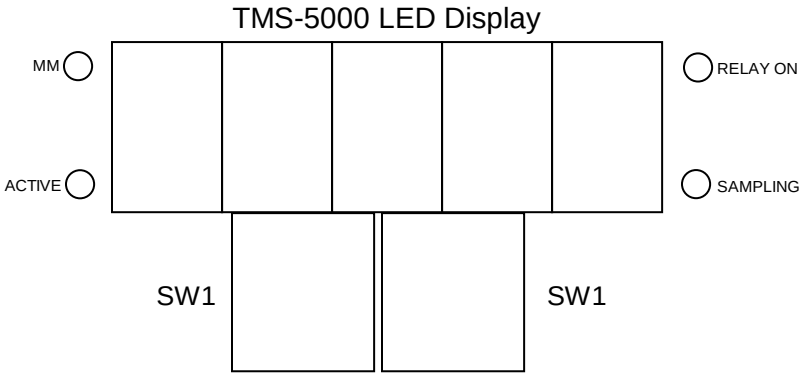
Pressing SW1 while the last menu item is displayed causes the unit to return to measurement mode.

4.3 Initial Power Up of the TMS-5000

After all wiring connections are made and the transducers are installed, apply power to the controller. Upon power up, the following conditions should occur:

- There are two LED indicators at each end of the digital display. Upon power up of a factory-configured unit, these LED's will be on, off or flashing as indicated in Figure ???.

FIGURE 4.??



MM	OFF	Indicates readout is in inches
ACTIVE	FLASHING	Indicates computer is working
RELAY ON	OFF	Target within limits or no limits specified
SAMPLING	FLASHING	Indicates measurements are being taken

- When power is first applied, the unit goes through a short diagnostic routine and self calibration procedure. The display has five dashes during this sequence. This procedure may take as long as 30 seconds. If error code 1, 2, 3, 4, or 5 appears, contact Ultrasonic Arrays' Technical Support.
- An indication of thickness measurement will be displayed on the readout providing a suitable target is between the two transducers. If no target is present, the display will read zero. If the two transducers are misaligned, all decimal points will be lit on the display.

After initial powerup, proceed to Para. 4.4. If problems are experienced on power up, see Section ??, Troubleshooting, or contact Ultrasonic Arrays' Technical Support for assistance.

4.4 Initial InS Configuration

Following the instructions in Paras. 4.2.1 and 4.2.2, advance through the menu to the install prompt, InS. Adjusting InS fine tunes the alignment of the transducer to the target. Following the instructions found in Para. ???, adjust InS, then proceed to Para. 4.5.

4.5 Verify Default Settings

After initial InS configuration, step through and verify the menu items found in Table ??? to prepare the unit for initial operation following the instruction found in Paras. 4/2/1 through 4.2.6. Application specific programming of menu items can be done after proper operation is confirmed.

Menu Item	Desired Setting
cALoF	0.0000
AC	1
dELAy	0.000
OSHot	0.000
bAud	No
AF1	0.00
AF2	0.00

4.6 AutoZ-Cal

AutoZ-Cal is a powerful feature available exclusively with Ultrasonic Arrays' TMS thickness gauge. This feature automates the manual calibration that would otherwise have to be performed on a regular basis.

The need for frequent calibration arises from the fact that it is virtually impossible to design a perfectly stable mechanical fixture to hold the two opposing transducers that comprise the TMS. Over even short periods of time, the structures that hold the transducers will drift due to temperature variations, vibration, and settling. Although the absolute magnitude of the motion may only be on the order of 0.001″ to 0.005″, this can represent an appreciable percentage of the readings, particularly for thin targets. Without AutoZ-Cal, this drift error would add directly to the gauge reading. AutoZ-Cal functions as follows:

When there is no target present between the two transducers, each transducer receives a sonic pulse from its opposing transducer. The thickness measuring algorithm perceives this as representing a target of about zero thickness. Whenever the gauge reading is less than the value programmed for cbAnd, the AutoZ-Cal function recognizes that there is no target and proceeds to recalibrate. An offset will be added or subtracted to the reading until it reads exactly zero, thus compensating for any distance variation between the transducers.

NOTE: AutoZ-Cal will not function unless there are periodic breaks in the product flow through the gauge. For panel based products, the gauge should be placed in a location where there is a minimum 0.25 second gap. For continuous sheet fed products, the gauge must periodically be brought off the product. Ultrasonic Arrays manufactures scanning frames designed to perform this function.

The TMS gauge is shipped with the AutoZ-Cal function enabled. If for any reason it becomes disabled, it can be enabled by following the procedure outlined in Section ???. Perform the following steps to initialize AutoZ-Cal.

4.6.1 Set unIts

Choose the desired “unItS”, inches or millimeters.

4.6.2 Set cbAnd

Set “cbAnd” to one half the thickness of the thinnest target that is anticipated, or 0.020″ (0.5 mm), whichever is smaller.

4.6.3 Remove Target

Remove any target in the gauge.

4.6.4 Set cAL

Access cAL and set the display to exactly “00000.”

4.6.5 Return the Gauge to Thickness Measurement Mode

Return the display to thickness measurement. The display will show “88888.” This indicates that the gauge is taking 5,000 samples of the zero point. This measurement will take about ten seconds. *Do not disturb the gauge during the course of this measurement*. The result of this measurement is recorded in the non-volatile memory for all future calculations.

When the measurement is completed, the display will return to “00000.” Whenever “00000” is displayed, the gauge is automatically recalibrating itself to compensate for fixture motion.

4.6.8 Setting cALoF

After performing correlation testing with real products (HOW????), it may be necessary to enter a value for cALoF in order to compensate for elevated product temperature or rough surface texture. See Para. ??? for instructions on setting cALoF.

4.7 Delta AutoZ-Cal

This is an optional feature of AutoZ-Cal that further refines measurement accuracy. When performing the initial system setup, a “gold standard” reference target of know thickness is placed in the gauge and that thickness entered as the value for the menu item cAL. When the reference target is removed, the gauge will perform a calculation and record certain constants. These constants will be used for enhancing the precision of subsequent measurements.

The TMS gauge will function quite well without the optional Delta function, but it is recommended that this function be used to obtain the best system accuracy. It is often convenient at first to omit the Delta Cal in order to get quickly “up and running” upon initial installation, then return later to fine tune the gauge with Delta Cal.

The gold standard reference target should be made from a hard, dimensionally stable material such as acrylic sheet, glass, or milled metal such as steel or aluminum and

have a smooth surface and uniform thickness. It should also be large enough so that when placed in the gauge it is presented in the same attitude as the product and rests correctly on the rollers or conveyor. Measure the thickness of the target exactly in the spot that will be placed in the gauge. It might be necessary to cut a hole in the target in order to allow access for the micrometer.

NOTE: The above method of choosing a precise, standard material assumes that the user wishes to calibrate the TMS to be able to accurately measure a similar, hard material. However, there are many cases when the intended target material is soft and/or textured, such as foam rubber, acoustic tiles, or rough cut lumber. If so, the user may wish to calibrate the TMS to measure that particular material so as to agree with a customary method of manual measurement. If this is the case, then the reference target should be chosen to be exactly the same material as the intended product. Measure the reference in the customary manner, keeping in mind that measurement of soft or textured material can be very subjective.

The following steps must be performed to initialize AutoZ-Cal with Delta Option

4.7.1 Set unIts and cbAnd

Perform the steps outlined in Paragraphs 4.6.1 through 4.6.3.

4.7.2 Obtain a Reference

Obtain a gold standard reference target as described above.

4.7.3 Enter the Reference

Place the reference target in the gauge. Access the cAL menu item and enter the known target thickness.

4.7.4 Return to Thickness Measurement Mode

While the target is still in the gauge, exit the menu and return to the standard thickness display. The display will show “88888.” This indicates that the gauge is ready to start taking 5,000 samples of the zero point. Remove the reference target. This measurement will take about ten seconds. *It is essential that the gauge is not disturbed during the course of this measurement*. The result of this measurement, along with the number measured in Para. ???, is recorded in the non-volatile memory for all future calculations.

When the measurement is completed, the display will return to “00000.” Whenever “00000” is displayed, the gauge is automatically recalibrating itself to compensate for fixture motion.

4.7.6 Verify Calibration

In order to recheck the calibration, return the reference target to its former position. The measurement should agree with the known thickness within the specified tolerance of the gauge.

4.7.7 Setting cALoF

After performing correlation testing with real products, it may be necessary to enter a number for cALoF in order to compensate for elevated product temperature or rough surface texture.

NOTE: Even though a value has been entered for cALoF, the gauge will still read "00000" when no target is present. The cALoF number is only added to the measurement when a target is present.

4.7.8 Store the Reference Target

Store the reference target in a clean environment, free from large temperature and humidity variations. Calibration should be verified as a part of the regular maintenance schedule.

4.8 Configuring cALd1

cALd1 corresponds to the actual distance in inches from the transducer face to the reference bar for the transducer connected to the main board.

The TMS-5000 is shipped with the transducers calibrated to the gauge so that the transducer that has been calibrated to the main board must be installed on the main board. Likewise, the transducer that has been calibrated to the differential board, must be installed on the differential board.

When transducers are replaced, cALd must be determined according to an approved calibration procedure and the appropriate cALd parameter modified. See Section ??? for more information on determining cALd.

NOTE: .9000 is a reserved number. See Para. 4.9.4.

4.8.1 Accessing cALd1

Follow the instructions of Para. 4.2, to access cALd1 configuration mode. The display reads ".9xxx," where xxx is a number between from 000 to 999.

4.8.2 Modifying cALd1

Follow the instruction of Para. 4.2 to modify the cALd1 parameter. While modifying cALd1, if the displayed number reaches .9999, it will roll over to .9000.

4.8.3 Determing the Correct Value for cALd1

See Appendix ??? for instructions on determining cALd

NOTE: .9000 is a reserved number. See Para. 4.9.4.

4.8.3 Exiting cALd1

Follow the instructions of Para. 4.2 to exit cALd1 configuration mode and return to menu mode. The prompt will then read "cALr1".

4.9.4 Exception

Pressing both switches simultaneously while .9000 is displayed will access the unit configuration sequence for selecting or disabling the Special Feature described in Section ???

4.9 Configuring cALr1

Over time, the sensitivity of the transducer varies. For better accuracy and repeatability, the TMS automatically adjusts the electronic amplifier (receiver) to keep the sensitivity

constant. The lower the right-hand three digits, the lower the requirements for sensitivity. UAI sets the required sensitivity to 120. If it is felt that greater sensitivity is required, for small or distant targets, for example, this value can be modified; keep in mind, however, that increasing sensitivity will cause the system to be less immune to electrical noise.

If the sensitivity is increased, the TMS would then raise the gain setting (left two digits) to maintain the operation at the increased level. The gain setting will vary with operation. The number will be low after applying power to the unit (0 to 12). With time, the gain setting may increase to compensate for a drop in transducer sensitivity. If the gain setting rises above 20 for aparticular transducer, an error message will be displayed; for the main board transducer, the message will read “1-OFF;” for the differential board transducer, the message will read “2-OFF.”

4.9.1 Accessing cALr1

With “cALr1” displayed, press the right switch to advance the unit into the configuration level. The display will read “GGxxx,” where xxx is a number between 000 and 255 which corresponds to the sensitivity of the transducer connected to the main board. “GG” represents the gain setting the unit is presently utilizing to maintain xxx sensitivity. The operator controls the last three digits, letting the unit control the gain settings, or first two digits.

4.9.2 Modifying cALr1

Holding down the right switch for more than two seconds increases the right, three-digit number by tens. If the displayed number reaches 255, it will roll to 000.

Holding down the left switch for more than two seconds decreases the number by tens. If the displayed number reaches 000, it will roll to 255.

4.9.3 Exiting cALr1

Once the desired cALr1 value is displayed, exit configuration mode by pressing both switches simultaneously. The last number displayed is saved as the new cALr1 value. The display then reads “cALd2.”

4.10 Configuring cALd2

4.10.1 Modifying cALd2

Repeat the procedures detailed in Paras. 4.9.1 and 4.9.3 for the transducer that is connected to the differential board.

4.10.2 Exiting cALd2

After entering the correct value, exit this configuration sequence by pressing both switches simultaneously. The number last displayed is saved as the calibration number to the reference bar. The prompt will then be “cALr2” for configuration of the sensitivity of the transducer connected to the differential board.

4.11 Configuring cALr2

4.11.1 Modifying cALr2

Repeat the procedures detailed in Paras. 4.10.1 and 4.10.3 for the transducer that is connected to the differential board.

4.11.3 Exiting cALr2

Once the desired cALr2 value is displayed, exit configuration mode by pressing both switches simultaneously. The last number displayed is saved as the new cALr2 value. The display then reads “InS.”

4.12 Configuring InS

To use the install feature, the TMS unit must be sampling The external trigger input on the barrier strip (TB1) should be connected to the external trigger ground terminal. Place a target between the transducers to simulate the same orientation as normal operating conditions.

4.12.1 Accessing InS; Transducer 1

Press the right switch to access the install mode. This sequence is used to aid in the proper installation of the transducer. The right three digits on the display correspond to the strength or amplitude of the return echo from the target. The number will range from 0 to 255. the stronger the echo, the larger the number will be. The left two digits display “1-,” denoting the main board transducer.

4.12.2 Modifying InS; Transducer 1

As the transducer is operating, align the transducer to obtain the maximum value on the display. Loosen the clamp screw(s) (See Figure 4.?) for the axis to be aligned. Adjust that axis for the for the maximum value, then tighten the clamp screw(s). As the number increases, note that the frequency of samples increases (like a Geiger counter). Repeat this process for the other axis. Check each axis again to ensure that the maximum number has been obtained on the display. A flat, smooth, perpendicular target such as steel, about 6″ away (FROM THE TRANSDUCERS????) would normally have an InS value between 150 and 250.

FIGURE ?? Inserted Here

4.12.3 Exiting InS; Transducer 1

After the transducer is properly aligned, exit the configuration mode for Transducer 1 by pressing the left switch. The display will now read “2-xxx” for configuration of the InS value for the transducer connected to the differential board.

4.12.2 Modifying InS; Transducer 2

Repeat Para. 4.12.2 for the transducer connected to the differential board.

4.12.3 Exiting InS; Transducer 2

After Transducer 2 is properly aligned, press the left switch to exit the InS configuration mode and advance the menu to the next item.

4.13 Configuring unItS

4.13.1 Accessing unItS

Press the right switch to access configuration mode. The display and output options are inches or millimeters. (WHAT DOES THE DISPLAY LOOK LIKE FOR EACH?)

4.13.2 Modifying unItS

Pressing and releasing the right switch toggles between the two options. The option last displayed upon leaving the sequence is the format under which the unit will operate.

4.13.3 Exiting unItS

Press the left switch to exit the configuration mode and advance the menu to the next item.

4.14 Configuring rES

The TMS is able to operate in three different resolutions for each type of unit (inches or millimeters). Refer to the table below for the resolutions available each.

	Resolution	Display Prompt
English (inches)	.01″ .001″ .0001″	0.01_ _ 0.001_ 0.0001
Metric (millimeters)	.1 mm .01 mm .001 mm	--.1-- -.01-- -.001-

The five digit display, serial data output stream, and the 16 bit parallel port are affected by the resolution selected (See Section ???).

4.14.1 Accessing rES

Press the right switch to access configuration mode. The display and output options are inches or millimeters.

4.14.2 Modifying rES

Pressing and releasing the right switch toggles between the two options. The option last displayed upon leaving the sequence is the format under which the unit will operate.

4.14.3 Exiting rES

When the desired resolution is displayed, press the left switch to exit the rES configuration mode and advance to the next menu item.

4.15 Configuring cAL

When configuring cAL, a target of known thickness must be present between the two transducers, and the unit must be sampling. The present measured thickness is displayed as if in the measurement mode. The TMS adds the two distance measurements plus the entered thickness for the total distance between the two transducers. This value is retained as the standard to calculate any further thickness readings. After Every set of samples, the TMS takes the standard distance between the transducers and subtracts the sum of the two distance samples for the thickness of the target.

NOTE: If AutoZ-Cal is enabled, only perform cAL using targets with thicknesses greater than the calibration bandwidth (cbAnd). The TMS-5000 will improperly zero on any target thickness that is less than cbAnd. For more information on how to correctly set cbAnd, refer to ?????

4.15.1 Accessing cAL

Press the right switch to access configuration mode.

4.15.2 Modifying cAL

Place a target of known thickness between the two transducers. Subsequent depressions of the right switch increase the number displayed. Holding the switch down for more than two seconds increases the number by tenths. If the displayed number reaches 99.999 (999.99 mm), it will roll over to 00.000 (000.00 mm).

Subsequent depressions of the left switch decrease the number displayed. Holding the switch down for more than 2 seconds decreases the number by tenths. If the displayed number reaches 00.000 (000.00 mm), it will roll to 99.999 (999.99 mm).

4.15.3 Troubleshooting cAL Problems

If the numbers displayed are changing erratically, the target is not properly aligned to either one or both of the transducers. Improper alignment of the transducers to the target will make accurate thickness readings impossible. Be sure to use the InS sequence to properly align the transducers. The number on the display should not vary more than 0.1% of the total distance between the transducers while the TMS is sampling.

4.15.4 Exiting cAL

Press both switches simultaneously to exit the cAL configuration mode and advance to the next menu item. If AutoZ-Cal is enabled, the next item will be cbAnd; if not, it will be Ac.

4.16 Configuring cbAnd

The calibration bandwidth, cbAnd, defines the span positive and negative within which the TMS-5000 will automatically calibrate itself. This feature is only available when AutoZ-Cal is enabled. (See Section ???) All thickness measurements are compared to the bandwidth. If the thickness is less than the bandwidth, the gauge is programmed to assume no target is present and will begin adjusting itself to zero thickness. If the thickness is greater than the bandwidth, no such action is taken.

4.16.1 Accessing cbAnd

Press the right switch to access the configuration mode.

4.16.2 Modifying cbAnd

Pressing the right switch increases the value displayed. Pressing the left switch decreases the value. cbAnd range is 0.000″ (00.0 mm) to 0.255″ (25.5 mm).

NOTE: If cbAnd is set to 0.000″ (00.0 mm) AutoZ-Cal is disabled. UAI recommends setting cbAnd at about 50% of the thickness of the thinnest product to be measured.

4.16.3 Exiting cbAnd

Press both switches simultaneously to exit cbAnd configuration mode and advance the menu to the next item.

4.17 Configuring cALoF

4.17.1 Accessing cALoF

Press the right switch to access the cALoF configuration mode. This sequence is used to add or subtract an offset to the thickness measurement. This feature is only used with AutoZ-Cal enabled. With AutoZ-Cal enabled, the TMS will measure the distance between the transducers when no target is present. The unit then uses that calibrated distance to subtract the ensuing distance measurements and calculate the thickness of the target. Due to the difficulty in aligning the two transducers colinearly and still maintaining perpendicularity to the target, it may be necessary to add or subtract an offset, cALoF, to the measured target thickness to match the reading to the actual thickness.

Set cALoF to zero while aligning the transducers to the target using the install mode, InS. Place the TMS in the thickness measuring state. Ensure the TMS is continually sampling. Remove the target to activate AutoZ-Cal. AutoZ-Cal is filtered, so allow 30 seconds for the TMS to complete the sequence. The time required may be much longer if average count, Ac, is set to a high value. For this procedure, it is best to set Ac to a value of 1.

NOTE: If the transducers have just been aligned, the reference value may be greater than the cbAnd value. If this occurs, AutoZ-Cal will not function. Enter the cAL mode and set the displayed value to 0.000″

Replace the target between the transducers and not if there is a discrepancy between the indicated thickness and the actual thickness of the target. If, for example, the target measures too thin by 0.010″, enter +0.10″ in cALoF to adjust the thickness measurement. If the target measures too thick, by 0.010″, enter - 0.010″ for cALoF.

4.17.2 Modifying cALoF

Pressing the right switch increases the value displayed. Holding the switch down for more than two seconds increases the number by tenths. If the value displayed reached .999 (99.99 mm), it will roll to -.998 (-99.99 MM).

Pressing the left switch decreases the value displayed. Holding the switch down for more than two seconds decreases the number by tenths. If the value displayed reached -.999 (-99.99 mm), it will roll to .999 (99.99 MM).

4.17.3 Exiting cALoF

Pressing both switches simultaneously exits the cALoF configuration mode and advances the menu to the next item.

NOTE: Even though a value has been entered for cALoF, the gauge will still read zero when no target is present.

4.18 Configuring Ac

4.18.1 Accessing Ac

With “Ac ,“ press the right switch to advance the unit to the Ac configuration mode. The display will read “Axxxx,” where xxxx is a number from 1 to 4095. This number corresponds to the set size of samples taken before averaging.

For example, if the unit is programmed to take ten samples and the TMS does not see a target on one of the ten samples, whether due to insufficient signal strength or the absence of a target, only nine samples will be averaged. If all ten samples do not see a target, the unit will output that there is no target present. If only one sample out of ten is valid, that measurement will be displayed.

4.18.2 Modifying Ac

Pressing the right switch increases the number displayed. Holding the switch down for more than two seconds increases the number by hundreds. If the displayed value reaches 4095, it will roll to 1

Pressing the left switch decreases the number displayed. Holding the switch down for more than two seconds decreases the number by hundreds. If the displayed value reaches 1, if will roll to 4095??????????????????????

4.18.3 Exiting Ac

When the desired value is displayed, exit Ac mode by press both switches simultaneously to exit Ac configuration mode and advance to the next menu item. The last number displayed is saved as the new Ac value.

If Gated Sampling is enabled, the next menu item is ES; otherwise it is AF1.

4.19 Configuring ES

ES, or enable sampling, is a special feature which is enabled by the user. See Section ??? the procedure for enabling or disabling this function.

In some applications, it is required that only one set of samples (based on the setting of Ac) be taken for each closure of the external trigger to external trigger ground. This is called sample gating. The standard TMS, as configured at the factory, samples in the free run mode. This means that if the external trigger input is the same potential as the external ground on the barrier strip, the unit samples continuously until the external

trigger point is ungrounded. The ES feature provides the option of running in either mode.

4.19.1 Bypassing ES

Pressing the left switch advances to the next menu item.

4.19.2 Accessing ES Configuration Mode

Press the right switch to advance to the ES configuration mode. The display will read either “FrEE” for free run mode or “gAtEd” for gated sampling mode.

4.19.3 Modifying ES

Pressing and releasing the right switch toggles between the two mode.

4.19.4 Exiting ES Configuration Mode

Press the left switch to exit the ES configuration mode and advance to the next menu item. The unit is configured to the last mode displayed prior to exit.

4.20 Configuring AF1

AF1, or amplitude filter for the main board transducer, ignores target echoes that are not strong enough because of poor transducer alignment or vibration. When a target is perpendicular to the transducer, the amplitude or strength of the return echo is maximized. If a target is moving on an assembly line, for example, and the TMS is measuring thickness, the part may be vibrating such that it is not always perpendicular to the transducer. The TMS can be programmed to ignore measurements that are not above the value of the amplitude filter. If the unit is averaging one sample per set and the target measurement is below the amplitude filter number, the TMS will output as if no target were present.

4.20.1 Determining the Correct Amplitude Filter Value

To determine the amplitude filter number, place a target of the coarsest, thinnest product to be measured in front of the transducer with the transducer sampling. Enter the install mode, InS, for Transducer 1 (main board transducer) and note the maximum value displayed while the target is perpendicular to the transducer head. The amplitude filter number should be 60 to 75% of the InS value. Once the system is running, the amplitude value may be lowered if the TMS consistently reads no target.

4.20.2 Accessing AF1 Configuration Mode

Press the right switch to access the AF1 configuration mode. The display will read “1-xxx” where xxx is a number from 000 to 255.

4.20.3 Modifying AF1

Press the right switch to increase the amplitude filter value. Holding the switch down for more than two seconds increases the number by tens.

Press SW1 to decrease the amplitude filter value. Holding the switch down for more than two seconds causes the value to decrease by tens.

4.20.4 Exiting AF1 Configuration Mode

Press SW1 and SW2 simultaneously to exit AF1 configuration mode.

4.21 Configuring AF2

Repeats the steps in Paras. 4.20.1 through 4.20. 4 for Transducer 2.

4.22 Configuring HI

The HI item is used to modify the high and low relay limits. This is a selection sequence only. If the high and low limits are not to be noted or changed, pressing SW1 advances the TMS to the next menu item.

THERE IS NOTHING HERE TO LET THE USER KNOW WHAT IS AN APPROPRIATE VALUE FOR THIS PARAMETER.

4.22.1 Accessing HI Configuration Mode

Press SW2 to access the HI configuration mode. The current HI limit will be displayed.

4.22.2 Modifying HI

The range limits are 00.000″ (000.00 mm) to 99.999″ (999.99 mm).

4.22.3 Disabling HI

Setting the high value to zero disables the limit.

4.22.4 Exiting HI Configuration Mode

Press SW1 and SW2 simultaneously to exit the HI configuration mode and advance the menu.

4.22 Configuring Lo

The Lo item is used to modify the high and low relay limits. This is a selection sequence only. If the high and low limits are not to be noted or changed, pressing SW1 advances the TMS to the next menu item. (Doesn't it work that way for all of the menu items? Won't pressing the left switch advance the menu no matter what? WHAT IS THIS SUPPOSED TO MEAN?!?!?!?!?!?!?!)

THERE IS NOTHING HERE TO LET THE USER KNOW WHAT IS AN APPROPRIATE VALUE FOR THIS PARAMETER.

4.22.1 Accessing Lo Configuration Mode

Press SW2 to access the Lo configuration mode. The current Lo limit will be displayed.

4.22.2 Modifying Lo

The range limits for Lo are 00.000″ (000.00 mm) to 99.999″ (999.99 mm).

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths or ten mm. If the value displayed reaches 99.999″ or 999.99 mm, it will roll to zero.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths or 10 mm. If the value displayed reaches zero, it will roll to 99.999″ or 999.99 mm.

4.22.3 Disabling Lo

Setting the Lo value to zero disables the limit.

4.22.4 Exiting Lo Configuration Mode

Press SW1 and SW2 simultaneously to exit the Lo configuration mode and advance the menu.

4.23 Configuring rS

(I FIND THIS WHOLE SECTION TO BE EXCEPTIONALLY MEANINGLESS!!!)

Relay state, rS, allows the configuration of the relay to be in its normal state when the measurement is within the programmed limits, or “in,” or in its normal state when the measurement is outside the programmed limits, or “out.” The relay is in its normal state when the normally open contact is open and the normally closed contact is closed. Thus, if the relay is configured to normally in, the relay changes state (energizes) after a measurement which is out of the programmed high and low limits. Conversely, if the relay is configured to normally out, the relay changes state (energizes) after a measurement which falls within the programmed high and low limits.

The relay will go to its within limits state (as controlled by in and out) when no target is present. This condition is defined as a measurement that is less than cbAnd. This feature can be enabled even if AutoZ-Cal is not. This is achieved as follows:

- Enable AutoZ-Cal as described in section ????
- The cbAnd menu item will not be available. Enter the desired value for this item as described in Para. ????.
- Turn off the AutoZ-Cal feature as described in Section ????

NOTE: Both the normally open and normally closed contacts of the relay are accessible on the terminal strip TB1.

4.23.1 Accessing rS Configuration Mode

Press SW2 to access the rS configuration mode.

4.23.2 Modifying rS

The relay output options are “in” and “out.” Pressing SW2 toggles between the options.

4.23.3 Exiting rS Configuration Mode.

Press both switches simultaneously to exit rS configuration mode and advance the menu.

4.23.4 Example

Measurement	Lo Limit	Hi Limit	Relay State (rS)	Normally Open	Normally Closed
3	4	6	In	Closed	Open
3	4	6	Out	Open	Closed
5	4	6	In	Open	Closed
5	4	6	Out	Closed	Open

4.24 Configuring dELAy

(THIS SECTION IS KIND OF WORTHLESS, TOO. HOW IS A PERSON SUPPOSED TO KNOW HOW TO SELECT THE PROPER VALUE OR WHEN TO MODIFY THE PARAMETER?)

This parameter delays the relay output based on whether the last sample is in or out of limits and the configuration of the relay's normal state. The delay parameter does not control the length of time the relay is energized. It is the amount of time between the measurement and the state change. The delay time can be up to 65.634 seconds with 0.002 second resolution. If the external trigger is tied to external ground, or if another sample is requested, the delay time plus the relay's one shot time is the total time elapsed before another sample can be taken.

4.24.1 Accessing dELAy Configuration Mode

Press SW2 to access the dELAy configuration Mode. The current delay time to one-shot is now displayed.

4.24.2 Modifying dELAy

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths of a second. If the displayed value reaches 65.535, it will roll to 0.000.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths of a second. If the displayed value reaches 0.000, it will roll to 65.535.

4.24.3 Exiting dELAy Configuration Mode

Press SW1 and SW2 simultaneously to exit dELAy configuration mode and advance the menu.

4.25 Configuring oSHot

The one shot parameter controls the amount of time the relay stays energized after each sample. The relay state changes based on whether the last sample is in or out of limits and the configuration of the relay's normal state. If the one-shot time is zero, the relay will never change state, regardless of what limits are entered or how the relay is configured. The time allowed is up to 65.534 seconds with 0.002 second resolution. If the external trigger is tied to external trigger ground, or if another sample is requested, the delay plus the relay's one-shot time is the total time elapsed before another sample can be taken.

4.25.1 Accessing oSHot Configuration Mode

Press SW2 to access oSHot configuration mode and display the current value for this parameter.

4.25.2 Modifying oSHot

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths of a second. If the displayed value reaches 65.535, it will roll to 0.000.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths of a second. If the displayed value reaches 0.000, it will roll to 65.535.

4.25.3 Exiting oSHot Configuration Mode

Press SW1 and SW2 simultaneously to exit oSHot configuration mode and advance the menu.

4.26 Configuring End-L

End-L configures the unit to mark the serial output stream's end of line with a carriage return character (ASCII 13) or a carriage return followed by a line feed (ASCII 10).

The TMS-5000 ignores a line feed character (ASCII 10) from the host computer or terminal and looks for carriage returns (ASCII 13) as the marker for the end of a message.

4.26.1 Accessing End-L Configuration Mode

Press SW2 to access End-L configuration mode and display the current value for this parameter.

4.26.2 Modifying End-L

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths of a second. If the displayed value reaches 65.535, it will roll to 0.000.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths of a second. If the displayed value reaches 0.000, it will roll to 65.535.

4.26.3 Exiting End-L Configuration Mode

Press SW1 and SW2 simultaneously to exit End-L configuration mode and advance the menu.

4.27 Configuring bAud

This parameter sets the speed at which characters are received and transmitted via the serial port (RS-232C or -422A). The optional baud settings are "no", 300, 600, 1200, 2400, 4800, 9600 or 19,200 bits per second. If serial communications are not being used, set the baud to none to disable serial output. This results in higher sample rates. Set the baud to the highest possible setting (BASED ON WHAT???) to minimize the

time between samples. The TMS does not initiate another set of samples until the serial data has been transmitted.

For any baud setting entered, with the exception of “no,” the serial output of the data is re-enabled. The serial output of data can be re-disabled by sending <ctrl>S (ASCII 19) via the RS-232C/422A port from the host computer/terminal. The serial output of data can be re-enabled by sending <ctrl>Q (ASCII 17) from the host computer/terminal

4.27.1 Accessing the bAud Configuration Mode

Press SW2 to access bAud configuration mode. The display will read “bxxxx,” where “xxxx” is the current value of this parameter.

4.27.2 Modifying bAud

Press and release SW2 to advance the value one setting. If the value displayed reaches 19.2, it will roll to “no.”

4.27.3 Exiting the bAud Configuration Mode

Press SW1 to exit bAud configuration mode and advance to the next menu item. The baud parameter is the final parameter to be set for units with digital output.

4.28 Configuring AnStr

The Analog Starting Point, AnStr, is used for the 0-10VDC or 4-20MA output configuration. The number entered sets the minimum thickness for the analog span to begin, or is at the top or bottom in output voltage or current, depending on the polarity setting. For example, if the span desired is 2″ and the lowest thickness that the span is to be started at is 1″, enter “01.000.” The polarity sequence will set the 1″ distance to be either 0 volts (4mA) or 10 volts (20mA).

NOTE: The analog output may be used in other unit and resolution modes.

4.28.1 Accessing AnStr Configuration Mode

Press SW2 to access the AnStr configuration mode and display the current setting.

4.28.2 Modifying AnStr

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by hundredths. If the value displayed reaches 99.999″ (999.99 mm), it will roll over to 00.000″ (000.00 mm).

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by hundredths. If the value displayed reaches 00.000″ (000.00 mm), it will roll over to 99.999″ (999.99 mm).

4.28.3 Exiting AnStr Configuration Mode

Press SW1 and SW2 simultaneously to exit AnStr configuration mode and advance the menu to the next item.

4.29 Configuring AnSPn

Analog span, AnSPn, sets the range of thickness readings the analog output is to span. For example, if the span desired is 2″, with the lowest range being 1″, enter “02.000.” The polarity sequence sets the 1″ distance to be either 0 volts (4 mA) or 10 volts (20 mA).

4.29.1 Accessing AnSPn Configuration Mode

Press SW2 to access AnSPn configuration mode and display the current value.

4.29.2 Modifying AnSPn

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by hundredths. If the value displayed reaches 47.999″ (609.59 mm), it will roll over to 00.000″ (000.00 mm).

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by hundredths. If the value displayed reaches 00.000″ (000.00 mm), it will roll over to 47.999″ (609.59 mm).

4.29.3 Exiting AnSPn Configuration Mode

Press SW1 and SW2 simultaneously to exit AnSPn configuration mode and advance the menu to the next item.

4.30 Configuring AnPoL

AnPoL configures the analog’s (what is an analog? I thought analog was an adjective.) output polarity. The TMS can output 0 VDC (4 mA) or 10 VDC (20 mA) when the thickness of the target is below the analog zero point. The voltage varies linearly over the entire span, based on the difference in the distance from the zero point.

4.30.1 Accessing AnPoL Configuration Mode

Press SW2 to access AnPoL configuration mode and display the current setting.

4.30.2 Modifying AnPoL

The display outputs are P0-10 for zero volts or P10-0 for 10 volts at the analog starting point. Pressing SW2 toggles between the two options.

4.30.3 Exiting AnPoL Configuration Mode

Press SW1 to exit AnPoL configuration mode. The TMS will now display the current thickness measurement.

4.31 Configuring the TMS-5000 via RS-232C or RS-422A

See Appendix D for a discussion of configuring the TMS-5000 via the RS-232C or RS-422A communication interface.

Section 5.0 Technical Specification for Interfacing

5.1 Introduction

The TMS-5000 includes an ASCII RS-232C or RS422A full duplex serial communications interface as well as a 16 bit parallel binary output port (J2).

5.2 RS-232C/422A Specifications

The TMS-5000 provides a full duplex asynchronous RS-232C, 3-wire communications interface (4-wire for RS-422A). See Section 3.0 for proper wiring practices.

Parameter	RS-232C/422A Data Format
Baud	300 - 1,9200
Word length	8 bit
Parity	7 bit ASCII data; no parity
Start bit	1 start bit
Stop bit	1 stop bit
Line status	disable

5.3 RS-232C/422A Serial Interface

The RS-232C/422A interface permits the data on the LED display to be remotely displayed on a dumb terminal or sent to a host computer. The keyboard on the remote terminal can be used to change most parameters in the menu as it is a full duplex interface. The only parameters that must be entered locally via SW1 and SW2 on the main board are the bAud and the End-L settings of the serial output. See Section 4.0 to configure the unit serially. See Section 3.0 to wire the RS-232C/422A interface to the host or terminal.

During the time data is transmitted to the controller, the controller continues to make measurements. Data format is an alpha character which tells the controller which parameter is to be changed, followed by either numbers or characters which tell the controller what change is to be made to that parameter. There must be no spaces between characters, and the character group must be ended with a carriage return. A minimum of 25 milliseconds must be allowed between transmission of parameters to allow updating of the non-volatile memory.

The control unit will echo back the characters sent, unless the TMS buffer is full. If the buffer is full, the TMS returns a beep (ASCII 07) until it receives a carriage return. If the format is not a valid parameter or configuration, a question mark will be sent to the host, followed by a “cr” or “cr-lf,” depending on the TMS configuration. (See Section 4.??, End-L.)

The actual data string for different configurations of thickness measurements and conditions is stated below.

5.4 RS-232C/422A Serial Port Data Output

NOTE: <cr>=carriage return (ASCII 13) also can be <cr>-<lf> output: (<lf> is line feed ASCII 010). Bad reference means that there is a fault condition. The TMS is unable to

“find” the echo from either transducer reference bar. The accuracy drops appreciably if the unit is unable to get an echo from the reference bar. See Section??? to rectify the problem.

The tables below show the actual data string sent by the controller for different units, resolution, output modes or fault conditions.

5.4.1 Thickness Mode

Units = Inches, Good Reference

Resolution	Serial Output
.01	XX.XX<cr>
.001	XX.XXX<cr>
.0001	XX.XXXX<cr>

Units = Inches, Bad Reference

Resolution	Serial Output
.01	XX.X?<cr>
.001	XX.X??<cr>
.0001	XX.X???<cr>

Units = mm, Good Reference

Resolution	Serial Output
1	XXX.<cr>
.1	XXX.X<cr>
.01	XXX.XX<cr>

Units = mm, Bad Reference

Resolution	Serial Output
1	XXX?<cr>
.1	XXX.?<cr>
.01	XXX.??<cr>

5.4.2 Thickness and Distance Mode

NOTE: Y is a number from 0 to 9 and represents the distance from the transducer connected to the main board to the target. Z is a number from 0 to 9 and represents the distance the distance from the transducer connected to the differential board to the target. X is a number from 0 to 9 and represents the thickness of the target.

Units = Inches, Good References

Resolution	Serial Output		
.01	YY.YY	ZZ.ZZ	XX.XX<cr>
.001	YY.YYY	ZZ.ZZZ	XX.XXX<cr>
.0001	YY.YYYY	ZZ.ZZZZ	XX.XXXX<cr>

Units = Inches, Bad Reference on the Main Board Transducer

Resolution	Serial Output		
.01	YY.Y?	ZZ.ZZ	XX.X?<cr>

.001	YY.Y??	ZZ.ZZZ	XX.X??<cr>
.0001	YY.Y???	ZZ.ZZZZ	XX.X???<cr>

Units = Inches, Bad Reference on the Differential Board Transducer

Resolution	Serial Output		
.01	YY.YY	ZZ.Z?	XX.X?<cr>
.001	YY.YYY	ZZ.Z??	XX.X??<cr>
.0001	YY.YYYY	ZZ.Z???	XX.X???<cr>

Units = Inches, Bad Reference on Both Transducer

Resolution	Serial Output		
.01	YY.YY?	ZZ.Z?	XX.X?<cr>
.001	YY.Y??	ZZ.Z??	XX.X??<cr>
.0001	YY.Y???	ZZ.Z???	XX.X???<cr>

Units = mm, Good References

Resolution	Serial Output		
1	YYY	ZZZ	XXX<cr>
.1	YYY.Y	ZZZ.Z	XXX.X<cr>
.01	YYY.YY	ZZZ.ZZ	XXX.XX<cr>
.001	YYY.YYY	ZZZ.ZZZ	XXX.XXX<cr>

Units = mm, Bad Reference on the Main Board Transducer

Resolution	Serial Output		
1	YYY?	ZZZ	XXX?<cr>
.1	YYY.?	ZZZ.Z	XXX.?<cr>
.01	YYY.??	ZZZ.ZZ	XXX.??<cr>
.001	YYY.???	ZZZ.ZZZ	XXX.???<cr>

Units = mm, Bad Reference on the Differential Board Transducer

Resolution	Serial Output		
1	YYY	ZZZ?	XXX?<cr>
.1	YYY.Y	ZZZ.?	XXX.?<cr>
.01	YYY.YY	ZZZ.??	XXX.??<cr>
.001	YYY.YYY	ZZZ.???	XXX.???<cr>

Units = mm, Bad Reference on Both Transducer

Resolution	Serial Output		
1	YYY?	ZZZ?	XXX?<cr>
.1	YYY.?	ZZZ.?	XXX.?<cr>
.01	YYY.??	ZZZ.??	XXX.??<cr>
.001	YYY.???	ZZZ.???	XXX.???<cr>

5.5 16 Bit Parallel Port Binary Output Wiring

THIS IS INCLUDED IN SECTION 3; DO WE NEED IT HERE AS WELL???????????

This output is provided on connector J2 located on the main board. Wiring to this port requires a 20 pin female mating connector. The pin out diagram is shown below, where bit 0 is the least significant bit.

This output is provided on connector J2 located on the main board. Wiring to this port requires a 20 pin female mating connector. The pin out diagram is shown below:

PIN	FUNCTION	PIN	FUNCTION
8	SIGNAL GND	11	BIT 8
6	BIT 0	13	BIT 9
4	BIT 1	15	BIT 10
2	BIT 2	17	BIT 11
1	BIT 3	19	BIT 12
3	BIT 4	20	BIT 13
5	BIT T	18	BIT 14
7	BIT 6	16	BIT 14
9	BIT 7	14	LOW WHEN SAMPLING

NOTE: When the unit is sampling, pin 14 will be "LOW." It is brought "high" or "open" immediately after the new data is present on the port.

Pin 14 is driven by an open collector transistor. It will sink 60 milliamperes, but not source any current. The bit pins are totem pole outputs that will source 5 mA and sink up to 20 mA. The bit pattern depends on the resolution and type of units (inches or millimeters) selected. The following chart indicates output.

Type of Units and Resolution	Binary Output
Hundredths of inches (00.00)	Number of hundredths
Thousandths of inches (00.000)	Number of thousandths
Tenths of millimeters (0000.0)	Number of tenths
Hundredths of millimeters (0000.00)	Number of hundredths
Thousandths of millimeters (0000.000)	Number of thousandths

NOTE: Tenths of thousandths of inches (0.0000) is not available on 16 bit parallel output.

5.6 Five Digit Display

The table below shows the five digit display format readout when the TMS is in the thickness measurement mode. Pressing SW1 only displays the distance to the target from the main board transducer. Pressing SW2 only displays the distance to the target from the differential board transducer.

Bad reference means there is a fault. The TMS will not sample accurately if it does not receive an echo from the reference bar. See the Section ??? if this occurs.

5.6.1 Measurement Mode

Units = Inches, Good Reference - what is the difference between the third and fourth
lines???

Resolution	Serial Output

Units = Inches, Bad Reference

Resolution	Serial Output

Units = mm, Good Reference

Resolution	Serial Output

Units = mm, Bad Reference

Resolution	Serial Output

5.6.2 Lamp Test

Pressing either switch while out of configuration mode will light all segments and decimal points on the five-digit seven-segment display.

5.7 LEDs

HOW DO WE KNOW WHICH LED IS WHICH??????????????????????????????

Sampling LED will be lit while transducers are sampling.

Metric LED will be lit when units = mm and off when units = inches.

Relay LED will be lit when relay is energized into the abnormal state.

Active LED will blink every second (50% duty cycle) when unit is on.

Section 6.0 Maintenance

The transducer face may be cleaned by blowing off the surface with canned, clean, dry air. If you have any questions regarding cleaning the transducer, contact Technical Support at Ultrasonic Arrays.

The environmental filter covering the head of the transducer is a nylon mesh screen which filters out dust from the transducer face, ensuring proper operation. Ultrasound goes through the filter, but dust and grit are prevented from entering. Refer to Section ??, Maintenance for instructions on changing the environmental filter. Cut the filter in half, then install it by pulling the filter onto the transducer as far as it will go, ensuring that it makes snug contact with the reference bar.

Hold it in place with an elastic band or tie wraps. Install each transducer in its enclosure so that the shoulder of the transducer is against the shoulder of the plastic bushing.

The measured value to a static target is unstable; what is wrong? (WOULDN'T THIS GO BETTER IN THE TROUBLESHOOTING SECTION?)

There are several possible causes for measurement instability.

- One or both of the transducers are not perpendicular to the target. To correct, enter the install more, InS, and maximize the InS value in both the x and y axes.
- The environmental filter is dirty, preventing the acoustic signal from going through it. To correct, go into the cALr mode and note the reference bar amplitude, which should be 120, then into the InS mode and note the value. If the InS value to a flat, smooth target at a range of less than 6″ is less than 120, the filter is dirty and should be changed.

Noise could be coming through on the power line or could be radiating and being picked up by the transducer coaxial cable. To correct, see the Installation Guide.

The left hand two digits are the gain setting used to obtain this amplitude. A higher amplitude can be obtained by incrementing the keypad in the cALr1 or cALr2 mode in order to obtain more signal from a weak reflector. Contact UAI for assistance.

In general, the lowest gain setting that provides a stable signal should be used to prevent noise interference. The install mode, InS, can be used to check the target signal level. An InS value above 060 is usable. When changing gain settings in the cALr1 or cALr2 mode, the gain setting values do not repeat. Hysteresis is built in to prevent hopping between gain settings.Evidence of an incorrect calibration code is non-linearity over range. This calibration can be done by measuring a gauge block or other known thickness and re-entering the cAL value, or by allowing the unit to automatically recalibrate. (See Section ???)

The environmental filters supplied with the unit should always be used. If contaminants build up on the surface of the transducer, the unit will eventually fail. Proper cleaning procedures are detailed in Section ???.

UAI also offers several accessories — air hoods, fans, and filters — which are essential to protect the transducer in badly contaminated environments. See Section ??? or contact UAI for assistance.

6.1 Maintenance Schedule

6.1.1 Maintaining the TMS-5000 in Dirty Environments

Dirty environments include those found in particle board plants or saw mills, where airborne contaminants are particularly dense.

Every Seven Days: Change air fan filters, check environmental filters and replace as needed.

Every 30 days: Change environmental filters, check cALr (Section ???)

Every 6 months: Check alignment (see InS) and gauge accuracy using a standard.

6.1.2 Maintaining the TMS-5000 in ??? Environments

6.2 Maintenance Procedures

6.2.1 Changing the Air Fan Filter

IS THERE A PROCEDURE FOR THIS?????????????

The transducers are supplied in air hoods (NOT ALWAYS!!!!!!) that have a port for the incoming clean air required to break up temperature gradients and produce steady measurements.

6.2.2 Removing the Transducer from the Air Hood

CAUTION: Never touch the gold foil face of the transducer; permanent damage can occur. Never install or remove a transducer with power applied to the unit; permanent damage to the controller may result.

The transducer must be removed from the air hood for periodic changing of the environmental filter or when factory service is required.

6.2.2.1 If the transducer is being removed for factory service, record the current InS and cALr values.

6.2.2.2 Turn off power to the unit.

6.2.2.3 Remove the four straight-slot, spring-loaded screws from the front of the air hood door.

6.2.2.4 Carefully disconnect the transducer cable by ??????????????????

6.2.2.5 Loosen the gimbal yoke which holds the transducer in place. While loosening the gimbal yoke, hold the transducer to prevent it from falling.

6.2.2.6 Carefully remove the transducer from the air hood.

6.2.3 Changing the Environmental Filter

CAUTION: Never touch the gold foil face of the transducer; permanent damage can occur. Never operate the TMS-5000 if environmental filters are damaged or missing

The environmental filter which covers the head of the transducer is a nylon mesh screen which keeps dirt and dust off the face of the transducer, ensuring proper operation.

6.2.3.1 Remove the transducer from the air hood following the procedure in Para. 6.2.2.

6.2.3.2 Carefully pull the existing tie wrap (or other fastener) off of the transducer, taking care not to damage the transducer in any way.

6.2.3.3 Trim the new filter of excess length by cutting it approximately in half.

6.2.3.4 Slide the filter over the transducer, keeping the fold of the filter parallel with the reference bar.

6.2.3.5 Pull the filter so that the crease fits snugly against the reference bar.

6.2.3.6 Secure the filter on the transducer by holding the filter in place and attaching tie wraps. If tie wraps are not available, an elastic band can be used.

6.2.4 Installing the Transducer into the Air Hood

CAUTION: Never touch the gold foil face of the transducer; permanent damage can occur. Never install or remove a transducer with power applied to the unit; permanent damage to the controller may result.

6.2.4.1 Insert the transducer into the gimbal yoke and tighten the bolts until the transducer is secure and unable to move.

6.2.4.2 Check transducer alignment following the procedure found in Para. ????????????? (IS THIS THE SAME PROCEDURE FOUND IN THE InS SECTION?).

6.2.4.3 Connect the transducer cable by ??????????????????????

6.2.4.4 Replace the air hood door.

6.2.4.5 Replace the four spring-loaded screws into the front of the air hood and tighten.

6.2.4.6 Apply power to the unit and confirm proper operation.

SHOULD WE REFER BACK TO SECTION 4 FOR THE NEXT THREE OR REPEAT THE PROCEDURES?

6.2.5 Checking cALr

6.2.6 Checking Alignment

6.2.7 Checking Gauge Accuracy

6.2.8 Calibration Procedure using the Calibration Kit

6.2.8.1 Following the procedures in Para. 6.2.2, remove the transducer for which cALd is to be determined. Remove only one transducer at a time to ensure that each transducer is returned to its original station.

6.2.8.2 Place the calibration kit in a stable, level surface near the controller from which the transducer was removed. The kit is used while standing on end, with the cable slot facing up.

6.2.8.3 Verify that the 0.250″ gauge block is clean and dry, then place it over the pin at the bottom of the calibration frame. Set the 3″ gauge block aside.

6.2.8.4 Attach the 10′ transducer cable to either the measurement or differential cable connector of the controller, depending on which transducer is being calibrated.

6.2.8.5 Place the transducer as high as possible in the threaded seat of the calibration frame and snap the retaining clip over the body of the transducer. Attach the transducer cable to the fitting on the top of the transducer.

6.2.8.6 Close the calibration kit and allow 30 seconds for the air temperature in the kit to equalize.

6.2.8.7 Turn on the controller and ensure that the gauge is active and sampling.

6.2.8.8 Access the gauge menu, following the procedures outlined in Para.???. Set a cALd number of .9999 for the transducer being

calibrated. Set Gain POT (R20 for controller, R27 for differential board) for a cALr of 02120. The calibration procedure is performed with units of inches and a resolution of .xxxx.

6.2.8.9 Press push-button (ON WHAT???) 1 for controller distance and push-button 2 for differential distance. Record the distance between the transducer and the top of the 0.250″ gauge block (*d1*).

6.2.8.10 Verify that the 3.000″ gauge block is clean and dry; dirt between the gauge blocks will reduce the accuracy of this procedure. Open the calibration kit and slide the 3.000″ gauge block over the top of the 0.250″ gauge block.

6.2.8.11 Close the calibration kit and allow 30 seconds for the air temperature to equalize.

6.2.8.12 Press push-button (ON WHAT???) 1 for controller distance and push-button 2 for differential distance. Record the distance between the transducer and the top of the 3.00″ gauge block (*d2*).

6.2.8.13 Perform the following calculations to determine cALd:

$$cALd = \frac{1}{d1 - d2/3}$$

Subtract *d2* (determined in Para. 6.2.8.12) from *d1* (determined in Para. 6.2.8.9. Divide this number by 3, then invert (or divide by one).

6.2.8.14 Access the controller menu and replace the .9999 cALd value for the transducer being calibrated with the cALd calculated in Para. 6.2.8.13.

6.2.8.15 Remove the 3.000″ gauge block from the calibration kit. Close the calibration kit and allow 30 seconds for the temperature inside the kit to equalize.

6.2.8.16 Record the distance to the top of the 0.250″ gauge block.

6.2.8.17 Open the calibration kit and slide the 3.000″ gauge block over the top of the 0.250″ gauge block.

6.2.8.18 Close the calibration kit and allow 30 seconds for the temperature inside the kit to equalize.

6.2.8.19 Record the distance to the top of the 3.000″ gauge block.

6.2.8.20 Subtract the small recorded distance from the large recorded distance. If this number is 3.000 ± 0.001″, the gauge has been calibrated correctly.

7.0 Troubleshooting

8.0 Special Features

8.1 Introduction

Additional features are available for some applications and are described below.

8.2 Descriptions

8.2.1 Gated Sampling (ES)

Some applications require only one sample for each closure of the external trigger input on TB2 (barrier strip) to external trigger ground. This is called “gating” the samples. The standard TMS from the factory samples in the free run mode. If the external trigger input is the same potential as the external trigger ground point on the barrier strip, the unit will sample continuously, or free run, until the external trigger point is disconnected. The ES feature allows the operator the option of running in either mode. If the gated sampling feature is not required, there is no need to change the factory setting on the unit.

This feature is useful when needed to look at discrete parts on an assembly line, for example, where a gating device (optical or proximity switch) drives the external trigger to ground. Upon each closure of the external trigger input (EXT> TRIG.) to ground (EXT TRIG. GND.), the TMS will perform only one set of samples. The relay might be used to reject a bad part on an assembly line. The relay must return to the normal state before the next part comes through. The TMS programmed to sample on closure will then wait until the next part is in the field of view of the transducer by waiting for the next closure of the external trigger to ground. The gating logic prevents the TMS from sampling when there is no part present.

8.2.2 AutoZ-Cal

This special feature is designed to compensate for changes in the physical separation between transducers. The TMS-5000 monitors the distance between the transducers when there is no target between them. It can adjust for changes in transducer separation of up to 0.008″ over the last 128 samples for which no target was present. This ensures that the calibrated distance between the transducers will be adjusted for small amounts of fixture movement or drift.

For AutoZ-Cal to function properly, the TMS must be sampling when no target is present. It is essential that the transducers be colinear or mounted facing each other. See Para. 4.???

8.3 Activating Special Features

8.3.1 Access the Configuration Menu

Press SW1 and SW2 simultaneously to access the configuration menu. The display will read “cALd1.” Press SW2 to access the cALd1 configuration mode.

8.3.2 Activate the Combination Lock

Set cALd1 to 9000, then press SW1 and SW2 simultaneously. The display will read “cL000.” cL stands for combination lock, a safety feature which prevents inadvertent changes to the configuration of the unit. Using SW1 or SW2, increase or decrease the number until “123” is displayed.

8.3.3 Access Unit Configuration Mode

Press SW1 and SW2 simultaneously to advance the TMS into the unit configuration mode. If the switches are presses when any number other than 123 is displayed, the sequence is aborted and no changes are saved other than the cALd1 value.

8.3.4 Activate the Special Feature

Use SW1 and SW2 to enter a number from 0 through 9 corresponding to the special feature to be activated. (See Table ????)

NOTE: To enable more than one special feature, it is necessary to go through this sequence more than once to achieve the desired configuration.

Number Displayed	Analog Output Software	External Trigger Configuration (Gated Sampling)	AutoZ-Cal
uc 0	D	D	D
uc 1	E		
uc 2		E	
uc 3			E
uc 4		Unassigned	
uc 5		Unassigned	
uc 6		Unassigned	
uc 7		Unassigned	
uc 8		Unassigned	
uc 9		Unassigned	

D = Disable
E = Enable

8.3.5 Save Unit Configuration Changes

When the number corresponding to the desired special feature is displayed, press SW1 and SW2 simultaneously to save the change. If power is removed from the unit prior to pressing both switches, the changes will not be saved.

8.3.6 Configure cALd1

Following the procedures in Paras. ????, return the cALd1 menu item to the correct value.

9.0 Ordering Parts and Accessories

9.1 General Information

Contact Ultrasonic Arrays' Customer Service Department at (206) 481-6611 or by fax at (206) 481-4455 to obtain parts and accessories for your TMS-5000.

9.2 Commonly Required Parts and Accessories

Description	Part Number
30 mm Transducer	102903
18 mm Transducer	101346
10′ Transducer Cable	100345
15′ Transducer Cable	100614
20′ Transducer Cable	100616
25′ Transducer Cable	100617
30′ Transducer Cable	100615
Calibration Kit for 30 mm Transducers	101872
Environmental Filters for 30 mm Transducers	100390
Environmental Filters for 18 mm Transducers	100391
Industrial Air Hood, Upper	100813
Industrial Air Hood, Lower	100814
Non-Industrial Air Hood with Internal Fan	101078
Power Supply for Non-Industrial Air Hood	101077
Air Hood for 30 mm Transducer with Sonic Concentrator, Upper	101400
Air Hood for 30 mm Transducer with Sonic Concentrator, Lower	101401
Air Hood Filter	100811
Air Manifold	100939
Air Hose, 2″	100733
Air Hose, 3″	100729
600 CFM Air Fan (Sufficient for up to three transducers)	100994
1,000 CFM Air Fan (Sufficient for up to six transducers)	101076
Line Conditioner	101366
Sonic Concentrator for 30 mm Transducer, 2″ Focal Length	100713
Remote Display for System Setup and Configuration	100702

C

R

T

4.8 Configuring cALd1

4.8.1 Accessing cALd1

In menu mode, with cALd1 displayed, press the right switch to advance the unit into the configuration level. The display reads ".9xxx," where xxx is a number between from 000 to 999. This number corresponds to the actual distance in inches to the reference bar for the transducer connected to the main board.

4.8.2 Modifying cALd1

After releasing the right switch, subsequent depressions of the right switch increment the displayed value, while depressions of the left switch decrement the number. Holding the switch down for more than two seconds decreases the number by hundredths. If the displayed number reaches number displayed. Holding the switch down for more than two seconds increases the number by hundredths. If the displayed number reaches .9999, it will roll over to .9000.

NOTE: .9000 is a reserved number. See Para. 4.9.4.

4.8.3 Exiting cALd1

After entering the correct value (how do you know the correct value??????????), exit this configuration sequence by pressing both switches simultaneously. The number last displayed is saved as the calibration number to the reference bar. The prompt will then read "cALr1" for configuration of the sensitivity of the transducer connected to the main board.

4.9.4 Exception

Pressing both switches simultaneously while .9000 is displayed will access the unit configuration sequence for selecting or disabling the special feature (WHAT SPECIAL FEATURE???). See Section ???.

4.9 Configuring cALr1

Over time, the sensitivity of the transducer varies. For better accuracy and repeatability, the TMS automatically adjusts the electronic amplifier (receiver) to keep the sensitivity constant. The lower the right-hand number, the lower the requirements for sensitivity. UAI sets the required sensitivity to 120. If it is felt that greater sensitivity is required, for small or distant targets, for example, this value can be modified; keep in mind, however, that increasing sensitivity will cause the system to be less immune to electrical noise.

If the sensitivity is increased, the TMS would then raise the gain setting (left two digits) to maintain the operation at the increased level. The gain setting will vary with operation. The number will be low after applying power to the unit (0 to 12). With time, the gain setting may increase to compensate for a drop in transducer sensitivity. There are 40 gain settings, numbered 0 to 39. If the gain setting is above 30 or "--" is displayed, contact UAI.

4.9.1 Accessing cALr1

With "cALr1" displayed, press the right switch to advance the unit into the configuration level. The display will read "Ggxxx," where xxx is a number between

000 and 255 which corresponds to the sensitivity of the transducer connected to the main board. “GG” represents the gain setting the unit is presently utilizing to maintain xxx sensitivity. The operator controls the last three digits, letting the unit control the gain settings, or first two digits.

4.9.2 Modifying cALr1

Holding down the right switch for more than two seconds increases the right, three-digit number by tens. If the displayed number reaches 255, it will roll to 000.

Holding down the left switch for more than two seconds decreases the number by tens. If the displayed number reaches 000, it will roll to 255.

4.9.3 Exiting cALr1

Once the desired cALr1 value is displayed, exit configuration mode by pressing both switches simultaneously. The last number displayed is saved as the new cALr1 value. The display then reads “cALd2.”

4.10 Configuring cALd2

4.10.1 Modifying cALd2

Repeat the procedures detailed in Paras. 4.9.1 and 4.9.3 for the transducer that is connected to the differential board.

4.10.2 Exiting cALd2

After entering the correct value, exit this configuration sequence by pressing both switches simultaneously. The number last displayed is saved as the calibration number to the reference bar. The prompt will then be “cALr2” for configuration of the sensitivity of the transducer connected to the differential board.

4.11 Configuring cALr2

4.11.1 Modifying cALr2

Repeat the procedures detailed in Paras. 4.10.1 and 4.10.3 for the transducer that is connected to the differential board.

4.11.3 Exiting cALr2

Once the desired cALr2 value is displayed, exit configuration mode by pressing both switches simultaneously. The last number displayed is saved as the new cALr2 value. The display then reads “InS.”

4.12 Configuring InS

To use the install feature, the TMS unit must be sampling The external trigger input on the barrier strip (TB1) should be connected to the external trigger ground terminal. Place a target between the transducers to simulate the same orientation as normal operating conditions.

4.12.1 Accessing InS; Transducer 1

Press the right switch to access the install mode. This sequence is used to aid in the proper installation of the transducer. The right three digits on the display correspond to the strength or amplitude of the return echo from the target. The number will range from 0 to 255. the stronger the echo, the larger the number will be. The left two digits display “1-,” denoting the main board transducer.

4.12.2 Modifying InS; Transducer 1

As the transducer is operating, align the transducer to obtain the maximum value on the display. Loosen the clamp screw(s) (See Figure 4.?) for the axis to be aligned. Adjust that axis for the for the maximum value, then tighten the clamp screw(s). As the number increases, note that the frequency of samples increases (like a Geiger counter). Repeat this process for the other axis. Check each axis again to ensure that the maximum number has been obtained on the display. A flat, smooth, perpendicular target such as steel, about 6″ away (FROM THE TRANSDUCERS????) would normally have an InS value between 150 and 250.

FIGURE ?? Inserted Here

4.12.3 Exiting InS; Transducer 1

After the transducer is properly aligned, exit the configuration mode for Transducer 1 by pressing the left switch. The display will now read “2-xxx” for configuration of the InS value for the transducer connected to the differential board.

4.12.2 Modifying InS; Transducer 2

Repeat Para. 4.12.2 for the transducer connected to the differential board.

4.12.3 Exiting InS; Transducer 2

After Transducer 2 is properly aligned, press the left switch to exit the InS configuration mode and advance the menu to the next item.

4.13 Configuring unItS

4.13.1 Accessing unItS

Press the right switch to access configuration mode. The display and output options are inches or millimeters. (WHAT DOES THE DISPLAY LOOK LIKE FOR EACH?)

4.13.2 Modifying unItS

Pressing and releasing the right switch toggles between the two options. The option last displayed upon leaving the sequence is the format under which the unit will operate.

4.13.3 Exiting unItS

Press the left switch to exit the configuration mode and advance the menu to the next item.

4.14 Configuring rES

The TMS is able to operate in three different resolutions for each type of unit (inches or millimeters). Refer to the table below for the resolutions available each.

	Resolution	Display Prompt
English (inches)	.01″ .001″ .0001″	0.01_ _ 0.001_ 0.0001
Metric (millimeters)	.1 mm .01 mm .001 mm	--.1-- -.01-- -.001-

The five digit display, serial data output stream, and the 16 bit parallel port are affected by the resolution selected (See Section ???).

4.14.1 Accessing rES

Press the right switch to access configuration mode. The display and output options are inches or millimeters.

4.14.2 Modifying rES

Pressing and releasing the right switch toggles between the two options. The option last displayed upon leaving the sequence is the format under which the unit will operate.

4.14.3 Exiting rES

When the desired resolution is displayed, press the left switch to exit the rES configuration mode and advance to the next menu item.

4.15 Configuring cAL

When configuring cAL, a target of known thickness must be present between the two transducers, and the unit must be sampling. The present measured thickness is displayed as if in the measurement mode. The TMS adds the two distance measurements plus the entered thickness for the total distance between the two transducers. This value is retained as the standard to calculate any further thickness readings. After Every set of samples, the TMS takes the standard distance between the transducers and subtracts the sum of the two distance samples for the thickness of the target.

NOTE: If AutoZ-Cal is enabled, only perform cAL using targets with thicknesses greater than the calibration bandwidth (cbAnd). The TMS-5000 will improperly zero on any target thickness that is less than cbAnd. For more information on how to correctly set cbAnd, refer to ?????

4.15.1 Accessing cAL

Press the right switch to access configuration mode.

4.15.2 Modifying cAL

Place a target of known thickness between the two transducers. Subsequent depressions of the right switch increase the number displayed. Holding the switch down for more than two seconds increases the number by tenths. If the displayed number reaches 99.999 (999.99 mm), it will roll over to 00.000 (000.00 mm).

Subsequent depressions of the left switch decrease the number displayed. Holding the switch down for more than 2 seconds decreases the number by tenths. If the displayed number reaches 00.000 (000.00 mm), it will roll to 99.999 (999.99 mm).

4.15.3 Troubleshooting cAL Problems

If the numbers displayed are changing erratically, the target is not properly aligned to either one or both of the transducers. Improper alignment of the transducers to the target will make accurate thickness readings impossible. Be sure to use the InS sequence to properly align the transducers. The number on the display should not vary more than 0.1% of the total distance between the transducers while the TMS is sampling.

4.15.4 Exiting cAL

Press both switches simultaneously to exit the cAL configuration mode and advance to the next menu item. If AutoZ-Cal is enabled, the next item will be cbAnd; if not, it will be Ac.

4.16 Configuring cbAnd

The calibration bandwidth, cbAnd, defines the span positive and negative within which the TMS-5000 will automatically calibrate itself. This feature is only available when AutoZ-Cal is enabled. (See Section ???) All thickness measurements are compared to the bandwidth. If the thickness is less than the bandwidth, the gauge is programmed to assume no target is present and will begin adjusting itself to zero thickness. If the thickness is greater than the bandwidth, no such action is taken.

4.16.1 Accessing cbAnd

Press the right switch to access the configuration mode.

4.16.2 Modifying cbAnd

Pressing the right switch increases the value displayed. Pressing the left switch decreases the value. cbAnd range is 0.000″ (00.0 mm) to 0.255″ (25.5 mm).

NOTE: If cbAnd is set to 0.000″ (00.0 mm) AutoZ-Cal is disabled. UAI recommends setting cbAnd at about 50% of the thickness of the thinnest product to be measured.

4.16.3 Exiting cbAnd

Press both switches simultaneously to exit cbAnd configuration mode and advance the menu to the next item.

4.17 Configuring cALoF

4.17.1 Accessing cALoF

Press the right switch to access the cALoF configuration mode. This sequence is used to add or subtract an offset to the thickness measurement. This feature is only used with AutoZ-Cal enabled. With AutoZ-Cal enabled, the TMS will measure the distance between the transducers when no target is present. The unit then uses that calibrated distance to subtract the ensuing distance measurements and calculate the thickness of the target. Due to the difficulty in aligning the two transducers colinearly and still maintaining perpendicularity to the target, it may be necessary to add or subtract an offset, cALoF, to the measured target thickness to match the reading to the actual thickness.

Set cALoF to zero while aligning the transducers to the target using the install mode, InS. Place the TMS in the thickness measuring state. Ensure the TMS is continually sampling. Remove the target to activate AutoZ-Cal. AutoZ-Cal is filtered, so allow 30 seconds for the TMS to complete the sequence. The time required may be much longer if average count, Ac, is set to a high value. For this procedure, it is best to set Ac to a value of 1.

NOTE: If the transducers have just been aligned, the reference value may be greater than the cbAnd value. If this occurs, AutoZ-Cal will not function. Enter the cAL mode and set the displayed value to 0.000″

Replace the target between the transducers and not if there is a discrepancy between the indicated thickness and the actual thickness of the target. If, for example, the target measures too thin by 0.010″, enter +0.10″ in cALoF to adjust the thickness measurement. If the target measures too thick, by 0.010″, enter - 0.010″ for cALoF.

4.17.2 Modifying cALoF

Pressing the right switch increases the value displayed. Holding the switch down for more than two seconds increases the number by tenths. If the value displayed reached .999 (99.99 mm), it will roll to -.998 (-99.99 MM).

Pressing the left switch decreases the value displayed. Holding the switch down for more than two seconds decreases the number by tenths. If the value displayed reached -.999 (-99.99 mm), it will roll to .999 (99.99 MM).

4.17.3 Exiting cALoF

Pressing both switches simultaneously exits the cALoF configuration mode and advances the menu to the next item.

NOTE: Even though a value has been entered for cALoF, the gauge will still read zero when no target is present.

4.18 Configuring Ac

4.18.1 Accessing Ac

With “Ac ,“ press the right switch to advance the unit to the Ac configuration mode. The display will read “Axxxx,” where xxxx is a number from 1 to 4095. This number corresponds to the set size of samples taken before averaging.

For example, if the unit is programmed to take ten samples and the TMS does not see a target on one of the ten samples, whether due to insufficient signal strength or the absence of a target, only nine samples will be averaged. If all ten samples do not see a target, the unit will output that there is no target present. If only one sample out of ten is valid, that measurement will be displayed.

4.18.2 Modifying Ac

Pressing the right switch increases the number displayed. Holding the switch down for more than two seconds increases the number by hundreds. If the displayed value reaches 4095, it will roll to 1

Pressing the left switch decreases the number displayed. Holding the switch down for more than two seconds decreases the number by hundreds. If the displayed value reaches 1, if will roll to 4095??????????????????????

4.18.3 Exiting Ac

When the desired value is displayed, exit Ac mode by press both switches simultaneously to exit Ac configuration mode and advance to the next menu item. The last number displayed is saved as the new Ac value.

If Gated Sampling is enabled, the next menu item is ES; otherwise it is AF1.

4.19 Configuring ES

ES, or enable sampling, is a special feature which is enabled by the user. See Section ??? the procedure for enabling or disabling this function.

In some applications, it is required that only one set of samples (based on the setting of Ac) be taken for each closure of the external trigger to external trigger ground. This is called sample gating. The standard TMS, as configured at the factory, samples in the free run mode. This means that if the external trigger input is the same potential as the external ground on the barrier strip, the unit samples continuously until the external trigger point is ungrounded. The ES feature provides the option of running in either mode.

4.19.1 Bypassing ES

Pressing the left switch advances to the next menu item.

4.19.2 Accessing ES Configuration Mode

Press the right switch to advance to the ES configuration mode. The display will read either “FrEE” for free run mode or “gAtEd” for gated sampling mode.

4.19.3 Modifying ES

Pressing and releasing the right switch toggles between the two mode.

4.19.4 Exiting ES Configuration Mode

Press the left switch to exit the ES configuration mode and advance to the next menu item. The unit is configured to the last mode displayed prior to exit.

4.20 Configuring AF1

AF1, or amplitude filter for the main board transducer, ignores target echoes that are not strong enough because of poor transducer alignment or vibration. When a target is perpendicular to the transducer, the amplitude or strength of the return echo is maximized. If a target is moving on an assembly line, for example, and the TMS is measuring thickness, the part may be vibrating such that it is not always perpendicular to the transducer. The TMS can be programmed to ignore measurements that are not above the value of the amplitude filter. If the unit is averaging one sample per set and the target measurement is below the amplitude filter number, the TMS will output as if no target were present.

4.20.1 Determining the Correct Amplitude Filter Value

To determine the amplitude filter number, place a target of the coarsest, thinnest product to be measured in front of the transducer with the transducer sampling. Enter the install mode, InS, for Transducer 1 (main board transducer) and note the maximum value displayed while the target is perpendicular to the transducer head. The amplitude filter number should be 60 to 75% of the InS value. Once the system is running, the amplitude value may be lowered if the TMS consistently reads no target.

4.20.2 Accessing AF1 Configuration Mode

Press the right switch to access the AF1 configuration mode. The display will read “1-xxx” where xxx is a number from 000 to 255.

4.20.3 Modifying AF1

Press the right switch to increase the amplitude filter value. Holding the switch down for more than two seconds increases the number by tens.

Press SW1 to decrease the amplitude filter value. Holding the switch down for more than two seconds causes the value to decrease by tens.

4.20.4 Exiting AF1 Configuration Mode

Press SW1 and SW2 simultaneously to exit AF1 configuration mode.

4.21 Configuring AF2

Repeats the steps in Paras. 4.20.1 through 4.20. 4 for Transducer 2.

4.22 Configuring HI

The HI item is used to modify the high and low relay limits. This is a selection sequence only. If the high and low limits are not to be noted or changed, pressing SW1 advances the TMS to the next menu item.

THERE IS NOTHING HERE TO LET THE USER KNOW WHAT IS AN APPROPRIATE VALUE FOR THIS PARAMETER.

4.22.1 Accessing HI Configuration Mode

Press SW2 to access the HI configuration mode. The current HI limit will be displayed.

4.22.2 Modifying HI

The range limits are 00.000″ (000.00 mm) to 99.999″ (999.99 mm).

4.22.3 Disabling HI

Setting the high value to zero disables the limit.

4.22.4 Exiting HI Configuration Mode

Press SW1 and SW2 simultaneously to exit the HI configuration mode and advance the menu.

4.22 Configuring Lo

The Lo item is used to modify the high and low relay limits. This is a selection sequence only. If the high and low limits are not to be noted or changed, pressing SW1 advances the TMS to the next menu item. (Doesn't it work that way for all of the menu items? Won't pressing the left switch advance the menu no matter what? WHAT IS THIS SUPPOSED TO MEAN?!?!?!?!?!?!?!)

THERE IS NOTHING HERE TO LET THE USER KNOW WHAT IS AN APPROPRIATE VALUE FOR THIS PARAMETER.

4.22.1 Accessing Lo Configuration Mode

Press SW2 to access the Lo configuration mode. The current Lo limit will be displayed.

4.22.2 Modifying Lo

The range limits for Lo are 00.000″ (000.00 mm) to 99.999″ (999.99 mm).

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths or ten mm. If the value displayed reaches 99.999″ or 999.99 mm, it will roll to zero.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths or 10 mm. If the value displayed reaches zero, it will roll to 99.999″ or 999.99 mm.

4.22.3 Disabling Lo

Setting the Lo value to zero disables the limit.

4.22.4 Exiting Lo Configuration Mode

Press SW1 and SW2 simultaneously to exit the Lo configuration mode and advance the menu.

4.23 Configuring rS

(I FIND THIS WHOLE SECTION TO BE EXCEPTIONALLY MEANINGLESS!!!)

Relay state, rS, allows the configuration of the relay to be in its normal state when the measurement is within the programmed limits, or “in,” or in its normal state when the measurement is outside the programmed limits, or “out.” The relay is in its normal state when the normally open contact is open and the normally closed contact is closed. Thus, if the relay is configured to normally in, the relay changes state (energizes) after a measurement which is out of the programmed high and low limits. Conversely, if the relay is configured to normally out, the relay changes state (energizes) after a measurement which falls within the programmed high and low limits.

The relay will go to its within limits state (as controlled by in and out) when no target is present. This condition is defined as a measurement that is less than cbAnd. This feature can be enabled even if AutoZ-Cal is not. This is achieved as follows:

- Enable AutoZ-Cal as described in section ????
- The cbAnd menu item will not be available. Enter the desired value for this item as described in Para. ????.
- Turn off the AutoZ-Cal feature as described in Section ????

NOTE: Both the normally open and normally closed contacts of the relay are accessible on the terminal strip TB1.

4.23.1 Accessing rS Configuration Mode

Press SW2 to access the rS configuration mode.

4.23.2 Modifying rS

The relay output options are “in” and “out.” Pressing SW2 toggles between the options.

4.23.3 Exiting rS Configuration Mode.

Press both switches simultaneously to exit rS configuration mode and advance the menu.

4.23.4 Example

Measurement	Lo Limit	Hi Limit	Relay State (rS)	Normally Open	Normally Closed
3	4	6	In	Closed	Open
3	4	6	Out	Open	Closed
5	4	6	In	Open	Closed
5	4	6	Out	Closed	Open

4.24 Configuring dELAy

(THIS SECTION IS KIND OF WORTHLESS, TOO. HOW IS A PERSON SUPPOSED TO KNOW HOW TO SELECT THE PROPER VALUE OR WHEN TO MODIFY THE PARAMETER?)

This parameter delays the relay output based on whether the last sample is in or out of limits and the configuration of the relay's normal state. The delay parameter does not control the length of time the relay is energized. It is the amount of time between the measurement and the state change. The delay time can be up to 65.634 seconds with 0.002 second resolution. If the external trigger is tied to external ground, or if another sample is requested, the delay time plus the relay's one shot time is the total time elapsed before another sample can be taken.

4.24.1 Accessing dELAy Configuration Mode

Press SW2 to access the dELAy configuration Mode. The current delay time to one-shot is now displayed.

4.24.2 Modifying dELAy

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths of a second. If the displayed value reaches 65.535, it will roll to 0.000.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths of a second. If the displayed value reaches 0.000, it will roll to 65.535.

4.24.3 Exiting dELAy Configuration Mode

Press SW1 and SW2 simultaneously to exit dELAy configuration mode and advance the menu.

4.25 Configuring oSHot

The one shot parameter controls the amount of time the relay stays energized after each sample. The relay state changes based on whether the last sample is in or out of limits and the configuration of the relay's normal state. If the one-shot time is zero, the relay will never change state, regardless of what limits are entered or how the relay is configured. The time allowed is up to 65.534 seconds with 0.002 second resolution. If the external trigger is tied to external trigger ground, or if another sample is requested, the delay plus the relay's one-shot time is the total time elapsed before another sample can be taken.

4.25.1 Accessing oSHot Configuration Mode

Press SW2 to access oSHot configuration mode and display the current value for this parameter.

4.25.2 Modifying oSHot

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths of a second. If the displayed value reaches 65.535, it will roll to 0.000.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths of a second. If the displayed value reaches 0.000, it will roll to 65.535.

4.25.3 Exiting oSHot Configuration Mode

Press SW1 and SW2 simultaneously to exit oSHot configuration mode and advance the menu.

4.26 Configuring End-L

End-L configures the unit to mark the serial output stream's end of line with a carriage return character (ASCII 13) or a carriage return followed by a line feed (ASCII 10).

The TMS-5000 ignores a line feed character (ASCII 10) from the host computer or terminal and looks for carriage returns (ASCII 13) as the marker for the end of a message.

4.26.1 Accessing End-L Configuration Mode

Press SW2 to access End-L configuration mode and display the current value for this parameter.

4.26.2 Modifying End-L

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by tenths of a second. If the displayed value reaches 65.535, it will roll to 0.000.

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by tenths of a second. If the displayed value reaches 0.000, it will roll to 65.535.

4.26.3 Exiting End-L Configuration Mode

Press SW1 and SW2 simultaneously to exit End-L configuration mode and advance the menu.

4.27 Configuring bAud

This parameter sets the speed at which characters are received and transmitted via the serial port (RS-232C or -422A). The optional baud settings are "no", 300, 600, 1200, 2400, 4800, 9600 or 19,200 bits per second. If serial communications are not being used, set the baud to none to disable serial output. This results in higher sample rates. Set the baud to the highest possible setting (BASED ON WHAT???) to minimize the time between samples. The TMS does not initiate another set of samples until the serial data has been transmitted.

For any baud setting entered, with the exception of "no," the serial output of the data is re-enabled. The serial output of data can be re-disabled by sending <ctrl>S (ASCII 19) via the RS-232C/422A port from the host computer/terminal. The serial output of data can be re-enabled by sending <ctrl>Q (ASCII 17) from the host computer/terminal

4.27.1 Accessing the bAud Configuration Mode

Press SW2 to access bAud configuration mode. The display will read "bxxxx," where "xxxx" is the current value of this parameter.

4.27.2 Modifying bAud

Press and release SW2 to advance the value one setting. If the value displayed reaches 19.2, it will roll to “no.”

4.27.3 Exiting the bAud Configuration Mode

Press SW1 to exit bAud configuration mode and advance to the next menu item. The baud parameter is the final parameter to be set for units with digital output.

4.28 Configuring AnStr

The Analog Starting Point, AnStr, is used for the 0-10VDC or 4-20MA output configuration. The number entered sets the minimum thickness for the analog span to begin, or is at the top or bottom in output voltage or current, depending on the polarity setting. For example, if the span desired is 2″ and the lowest thickness that the span is to be started at is 1″, enter “01.000.” The polarity sequence will set the 1″ distance to be either 0 volts (4mA) or 10 volts (20mA).

NOTE: The analog output may be used in other unit and resolution modes.

4.28.1 Accessing AnStr Configuration Mode

Press SW2 to access the AnStr configuration mode and display the current setting.

4.28.2 Modifying AnStr

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by hundredths. If the value displayed reaches 99.999″ (999.99 mm), it will roll over to 00.000″ (000.00 mm).

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by hundredths. If the value displayed reaches 00.000″ (000.00 mm), it will roll over to 99.999″ (999.99 mm).

4.28.3 Exiting AnStr Configuration Mode

Press SW1 and SW2 simultaneously to exit AnStr configuration mode and advance the menu to the next item.

4.29 Configuring AnSPn

Analog span, AnSPn, sets the range of thickness readings the analog output is to span. For example, if the span desired is 2″, with the lowest range being 1″, enter “02.000.” The polarity sequence sets the 1″ distance to be either 0 volts (4 mA) or 10 volts (20 mA).

4.29.1 Accessing AnSPn Configuration Mode

Press SW2 to access AnSPn configuration mode and display the current value.

4.29.2 Modifying AnSPn

Pressing SW2 increases the value displayed. Holding the switch down for more than two seconds increases the value by hundredths. If the value displayed reaches 47.999″ (609.59 mm), it will roll over to 00.000″ (000.00 mm).

Pressing SW1 decreases the value displayed. Holding the switch down for more than two seconds decreases the value by hundredths. If the value displayed reaches 00.000″ (000.00 mm), it will roll over to 47.999″ (609.59 mm).

4.29.3 Exiting AnSPn Configuration Mode

Press SW1 and SW2 simultaneously to exit AnSPn configuration mode and advance the menu to the next item.

4.30 Configuring AnPoL

AnPoL configures the analog's (what is an analog? I thought analog was an adjective.) output polarity. The TMS can output 0 VDC (4 mA) or 10 VDC (20 mA) when the thickness of the target is below the analog zero point. The voltage varies linearly over the entire span, based on the difference in the distance from the zero point.

4.30.1 Accessing AnPoL Configuration Mode

Press SW2 to access AnPoL configuration mode and display the current setting.

4.30.2 Modifying AnPoL

The display outputs are P0-10 for zero volts or P10-0 for 10 volts at the analog starting point. Pressing SW2 toggles between the two options.

4.30.3 Exiting AnPoL Configuration Mode

Press SW1 to exit AnPoL configuration mode. The TMS will now display the current thickness measurement.

4.31 Configuring the TMS-5000 via RS-232C or RS-422A

See Appendix D for a discussion of configuring the TMS-5000 via the RS-232C or RS-422A communication interface.