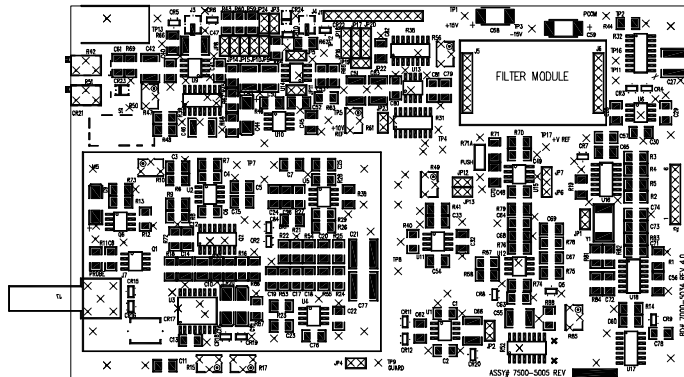


# User's Manual

## ACCUMEASURE™ SYSTEM 9000

*CAPACITANCE SENSOR AMPLIFIER  
SINGLE CHANNEL BOARD UNIT*



**MTI INSTRUMENTS, Inc.**

**DOCUMENT# 10A000492**

**Revision 1.0**

# ACCUMEASURE™ SYSTEM 9000

## WARRANTY

Seller warrants to the Purchaser that equipment to be delivered hereunder which is of Seller's own manufacture will be free from defects in material or workmanship and will be of the kind and quality designed or specified in the contract. Any parts of the equipment which have been purchased by Seller are warranted only to the extent of the original manufacturer's warranty.

This warranty shall apply only to defects appearing within 1 year from the date of shipment by Seller. If the equipment delivered hereunder does not meet the above warranty, and if the Purchaser promptly notifies Seller, Seller shall thereupon correct any defect, including nonconformance with the specifications, either, at its option, by repairing any defective or damaged parts of the equipment, or by making available at Seller's plant necessary repaired or replacement parts. No allowance will be made for repairs or alterations made by others without Seller's written consent or approval. Seller assumes no responsibility for damage caused by improper installation or by operation in violation of its rated operating condition, intentional or otherwise, or by improper handling or maintenance. The liability of Seller under this warranty (except as to title), or for any loss or damage to the equipment whether the claim is based on contract or negligence, shall not in any case exceed the cost of correcting defects in the equipment as herein provided and upon the expiration of the warranty period of all such a liability shall terminate. The foregoing shall constitute the exclusive remedy of the purchaser and the exclusive liability of the Seller.

The foregoing warranty is exclusive and in lieu of all warranties, whether written, oral, implied or statutory (except as to title). There are no warranties which extend beyond those expressly stated in this contract.

## FCC NOTICES

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the manufacturer's instruction manual, may cause interference with radio and television reception. This equipment has been designed as a Class A digital device of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference, which can be determined by turning the equipment off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Relocate the instrument with respect to the other device.
- Plug the instrument into a different outlet so that the instrument and the other device are on different branch circuits.

If necessary, consult a representative of MTI Instruments, Inc. You may find the following booklet helpful: *FCC Interference Handbook*, 1986, available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 004-000-00450-7.

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# Contents

<b>WARRANTY .....</b>	<b>2</b>
<b>FCC NOTICES .....</b>	<b>2</b>
<b>CONTENTS .....</b>	<b>3</b>
<b>1: INTRODUCTION .....</b>	<b>4</b>
<i>1.1 Accumeasure 9000 System Description .....</i>	<i>4</i>
<i>1.2 Probe Amplifier Specifications .....</i>	<i>6</i>
<i>1.3 Probe Specifications .....</i>	<i>7</i>
<i>1.4 Receiving Inspection Procedure .....</i>	<i>8</i>

# ACCUMEASURE™ SYSTEM 9000

1.5 Return Shipment Procedure .....	9
2: OPERATING PRINCIPLES .....	10
3: INSTALLATION INSTRUCTIONS .....	12
3.1 Power Requirements .....	12
3.2 Connections.....	14
3.3 Control Switches and Jumpers .....	15
3.4 Displays.....	16
3.5 Probe Mounting.....	17
3.6 Probe Cables .....	18
3.7 Target Grounding.....	18
4: OPERATING INSTRUCTIONS .....	20
4.1 Probe Amplifier Calibration Check.....	20
4.2 “Pushed” Amplifiers and Probes .....	22
4.3 Conductive Target Thickness Measurements.....	22
4.4. MASTER/SLAVE OPERATION .....	24
5: TROUBLESHOOTING .....	26

## 1: Introduction

### 1.1 Accumeasure 9000 System Description

The Accumeasure System 9000, single channel board unit is a high-precision capacitance probe amplifier that uses standard or custom MTI noncontact probes. Its analog output voltage is proportional to the gap between a probe and a measurement target. The output signal is provided on a coaxial cable that is connected to a miniature connector on the top surface of the amplifier board.

The probes measure displacement from the probe face to the target, and are connected to the amplifier with special low-noise coaxial cable. The cable outer shield is electrically driven to cancel cable parasitic capacitance and ensure the highest linearity. Gain and offset potentiometer controls permit minor adjustments of the probe calibration characteristics.

An internal 5-pole Butterworth low-pass filter removes unwanted high-frequency

## ACCUMEASURE™ SYSTEM 9000

noise for the best resolution possible. Optional filter cutoff frequencies of 10 Hz, 500 Hz, 1 kHz, 2 kHz and 5 kHz are available.

Two separate factory preset calibrations are offered. The primary calibration produces an analog output proportional to the probe range divided by 10 volts. For a probe with a 0.050-inch (1.27-mm) range and a 10V full-scale output, the analog output is 5 mils per volt (0.127 mm per volt).

The second type of calibration produces a normalized 1 micro-inch per millivolt (0.025 micron per millivolt) calibration slope when used with any MTI probe. With this type of calibration, a 0.050-inch (1.27-mm) range probe would have a range of 10 mils (254 microns), a 1 micro-inch per millivolt (0.025 micron per millivolt) sensitivity factor, and a standoff of 40 mils (1.016 mm). The advantage of this type of calibration is that any probe type will have the same sensitivity factor of 1 micro-inch per millivolt, regardless of its range.

## 1.2 Probe Amplifier Specifications

The following specifications are listed for the “Standard” configuration (MTI P/N: 8000-2562). Contact the factory for specifications of other versions.

### **Output Signal**

0 - 10 Vdc output (+/-5V offset adjustment range).  
Signal proportional to probe gap<sup>1,2</sup>  
Maximum range 0.5 inch (12.5 mm)

### **Linearity**<sup>1</sup>

±0.1% over 10% to 120% of full-scale range using a standard 8-ft probe cable.  
±0.05% over 10% to 100% of full-scale range available as special order<sup>4</sup>.

### **Repeatability**

± 0.01% of the full-scale range at constant temperature.

### **Frequency Response/Output Noise**

-3dB at 500 Hz/0.20 mV rms, 1 mV p-p  
-3dB at 1 kHz/0.28 mV rms, 1.4 mV p-p

### **Dynamic Resolution**<sup>3</sup>

1 nm RMS @ 10Hz -3db Frequency Response  
7 nm RMS @ 500Hz -3db Frequency Response

### **Temperature Stability (after a 30-minute warm-up)**

60° to 95°F, (15 to 35°C), drift less than ±0.1% of range.  
40° to 100°F, (4 to 38°C), drift less than ±0.25% of range.

### **Long-Term Stability**

Less than ±0.1% of range drift for 100 hours at constant temperature,  
±2°F (±1.1°C)

### **Storage Temperature**

0 to 150°F (-18 to 66°C)

### **Probe Voltage**

Proportional to gap, 8.5 V rms max

### **Output Signal Display**

No display on the board level, single channel unit

### **Power Requirements**

+15 Volt DC and -15 Volt DC power, with a ±0.5 Volt DC tolerance and a power supply noise of less than 0.010 Volts p-p for optimal operation. The Accumeasure 9000 single channel amplifier board unit requires a maximum of 0.075 Ampere DC from each power supply.

# ACCUMEASURE™ SYSTEM 9000

## **Output Voltage Stability**

0.002% full-scale output or less, change over the  $\pm 1$  Volt DC tolerance range around the nominal power supply voltages of +15 and -15 Volts DC.

## **Board Size**

0.75 inches (19 mm) high (board plus components)  
3.8 inches (97 mm) wide (board plus power cable)  
7.25 inches (184 mm) deep (board plus connector extensions)

## **Board Weight**

0.28 Pounds (0.125 kilograms)

<sup>1</sup>Output voltage sensitivity factor is 10 V divided by the probe range. A 10-mil (0.254 mm) probe is 10V/10 mil (10V/0.254 mm) or 1 volt/mil (1V/25.4  $\mu$ m).

<sup>2</sup>Output voltage sensitivity may be factory adjusted to 1 $\mu$  inch/mv (0.0254 $\mu$  m/mv), with any MTI probe at time of order.

<sup>3</sup>With ASP-10-CTA probe {10-mil (0.254 mm) range} @ 500-Hz frequency response, with 8-ft cable.

<sup>4</sup>Probe must be matched to amplifier

## 1.3 Probe Specifications

### **Temperature Rating**

Standard Probes: -200 to 400°F (-143 to 200°C)

Probe Connectors and Cable: -200 to 350°F (-143 to 176°C)

High-temperature probes available to 1300°F, contact the factory.

### **Accuracy**

$\pm 0.015\%$  of range when calibrated to a known standard

### **Probe Cable Interchangeability**

Accurate within  $\pm 0.5\%$  of range without recalibration

### **Pressure Rating**

Standard, 200 psig. Higher pressure probes available for special order

### **Cable Length**

8 feet, provided with probe

### **Construction**

304 stainless steel standard.

INVAR and INCONEL probes available -- contact the factory.

## 1.4 Receiving Inspection Procedure

The Accumeasure System 9000 single channel board unit is shipped from MTI fully assembled and packed in a cardboard carton with foam inserts to guard against shipping damage. Upon receipt, perform the following procedure before using the unit to perform dimensional measurements:

1. Inspect the exterior of the shipping carton. Note any obvious damage. If shipping damage is evident, file a claim with the carrier.
2. Remove the amplifier board from the shipping carton. Inspect the board for any signs of damage.
3. Apply  $\pm 15$  Volt DC power to the board in accordance the wiring information provided in the **Power Requirements** section on page 8).
4. With no probe cable attached to the probe BNC connector, the voltage on the Output Signal Cable BNC connector should be close to +12 Volts DC.
5. If any problems were found with the Output Signal Cable voltage, contact MTI at 1-518-218-2550.



## 1.5 Return Shipment Procedure

Contact MTI Instruments, Inc. at 1-518-218-2550 to receive return authorization prior to shipping the instrument. Reference the instrument's name, model and serial numbers on all correspondence. Be sure to include a brief description of the reason for the return. Place the instrument in the original shipping carton (if available) and forward prepaid to:

**MTI Instruments, Inc.  
Supervisor of Manufacturing  
325 Washington Avenue Extension  
Albany, NY 12205-5505**

Mark "RMA" and the RMA number (if a number is issued) on the outside of the box. If the original packing materials are not available:

1. Wrap the instrument in plastic or heavy paper.
2. Place packing material around all sides of the instrument and pack it in a cardboard carton.
3. Place instrument and inner container in a sturdy cardboard carton or wooden box.

## 2: Operating Principles

Accumeasure System measurement technology is based on the principle of parallel plate capacitor measurement. The electrical capacitance formed between an Accumeasure probe and a target surface varies as a function of the distance (gap) between these two surfaces. This function can be stated as:

$$C = \frac{(\epsilon) (A)}{(D)}$$

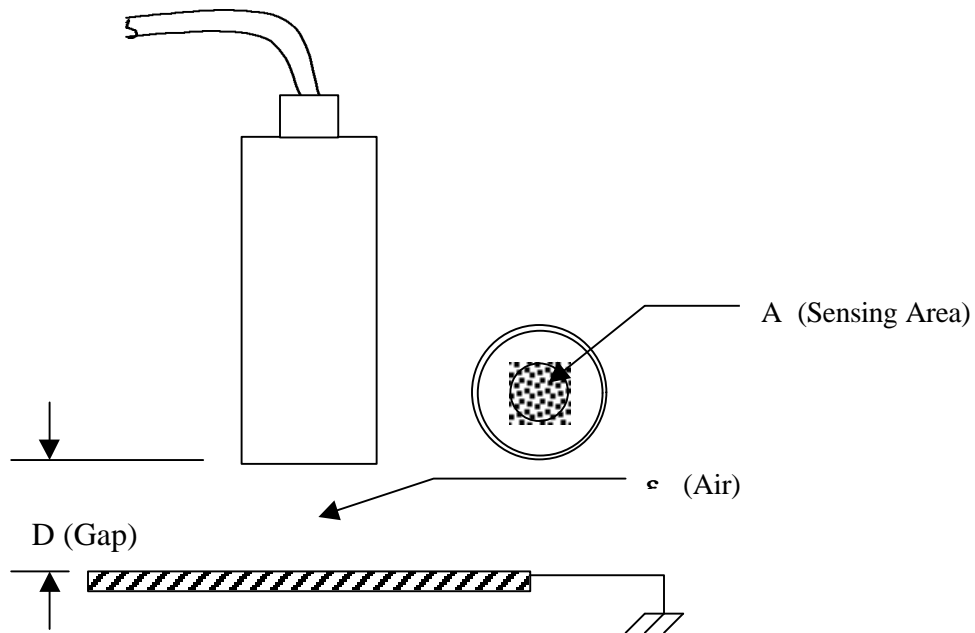
where:

C = capacitance.

$\epsilon$  = dielectric constant of the medium (Air) between the probe and target.

D = distance (Gap) between probe and target.

A = probe sensing electrode area.



## ACCUMEASURE™ SYSTEM 9000

The Accumeasure System measures the electrical impedance of the capacitance between a sensing electrode in the probe and a ground-referenced target. The magnitude of the impedance is proportional to the reciprocal of the capacitance value as defined by the equation below:

$$Z_c = \frac{1}{(\omega C)}$$

where:

$\omega$  is proportional to the frequency at which the capacitance measurement is performed.

Substituting the equation for capacitance into the impedance equation shows that the impedance is directly proportional to the gap value D, as shown in the following equation:

$$Z_c = \frac{(D)}{(\omega) (\epsilon) (A)}$$

The Accumeasure probe amplifier produces a DC voltage that is linearly proportional to the average value of the probe gap impedance, and an AC voltage variation from the DC voltage that is directly proportional to the amplitude of the target vibration. The amplifier electronic circuitry eliminates the effects of both the probe cable capacitance and the stray capacitance at the edge of the probe sensing area that could cause non-linearity of the gap and vibration measurements.

Probe coaxial cable lengths from one to fifty feet (0.3 to 15.2 meters) can be used with the Accumeasure probe amplifier, and probe with full scale gap values from 5 ten-thousandths of an inch to one half an inch (12.7 micron to 12.7mm) are available. A summing amplifier is present in the dual-channel model (System 9000-2) to produce the sum or difference of two gap proportional voltages. This function is ideal for target thickness measurements (see **Thickness Measurements**, page 18).

## 3: Installation Instructions

### 3.1 Power Requirements

The Accumeasure System 9000 single channel board unit requires a maximum of 0.075 Amperes DC from a +15 Volt DC and a -15 Volt DC power supply. A power connector is provided on the edge of the circuit board, and power cable with an un-terminated, labeled end is shipped with each board. Caution should be exercised when applying power to this board since there is no fuse protection, or reverse voltage protection provisions on the board. It is recommended that the power supply lines to this unit be current limit protected with 0.10 Ampere fuses, or be driven from a power supply with 0.1 Ampere maximum current capability. It is also recommended that the power supply voltages be tested for the correct voltage values and polarities on the power cable plug provided with the board before the plug is connected to the board for the first time in an installation. There is no power On/Off switch provided with the single channel board unit, so the probe amplifier will be operational whenever there is DC voltage on the power supply cable. Refer to Figure 3-1 for the location of the J1 power supply connector on the circuit board, and the location of J1, pin1. The power supply connections to the J1 connector pins are:

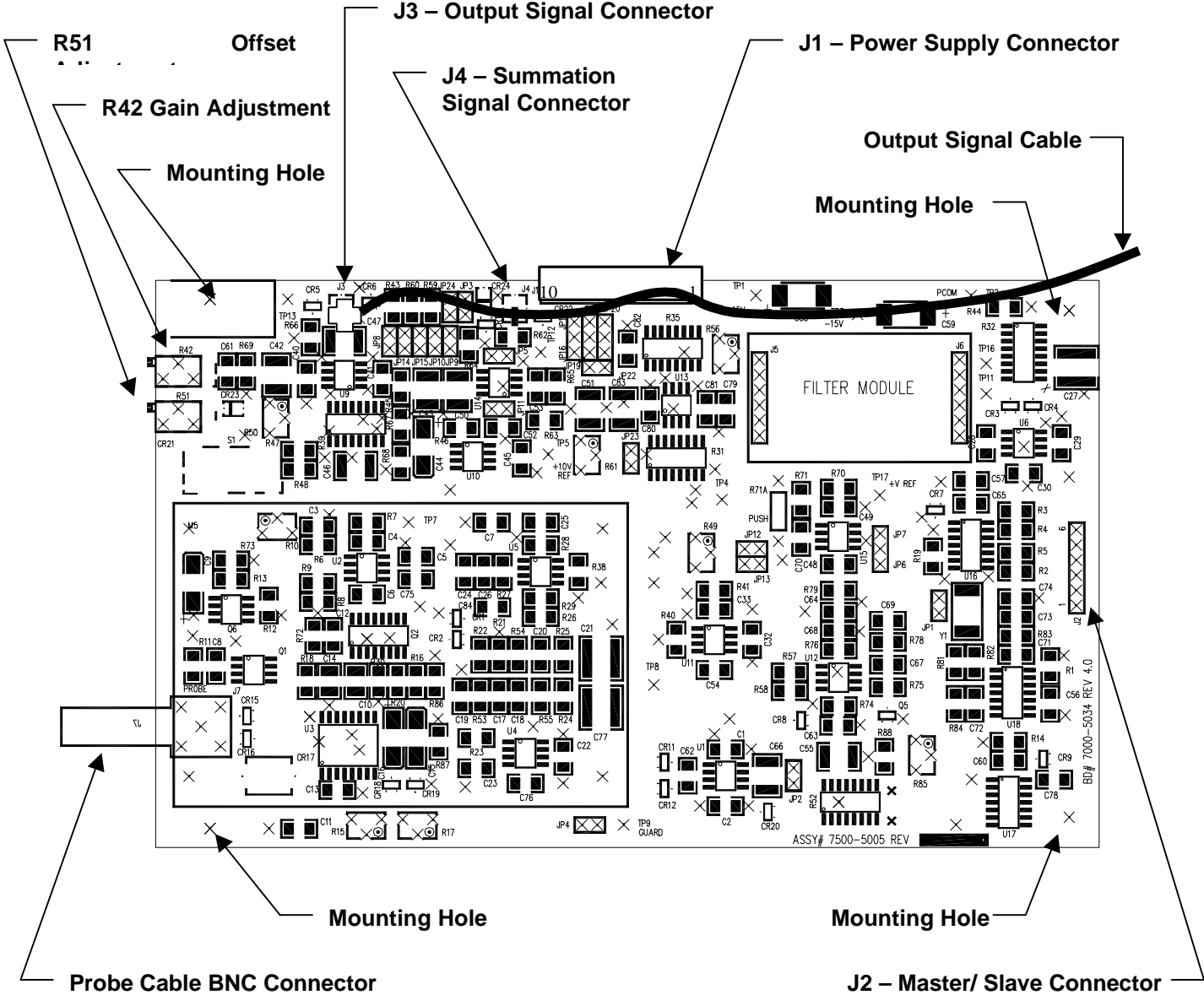
- Pin 1, +15 Volts DC
- Pin 2, Power Common (Ground)
- Pin 3, -15 Volts DC
- Pin 4, Analog Common (Ground )

Note: Power Common and Analog Common are connected together on the Accumeasure 9000 single channel board unit. However, separate wires should be connected from these pins to the  $\pm 15$  Volt power supply common.

#### CAUTION

The DC power supply voltage lines are not fused, and the power supply lines are not reverse voltage protected on the circuit board of the Accumeasure 9000 single channel board unit. Ensure the power supply connections and the supply voltages are correct before applying power to the board.

# ACCUMEASURE™ SYSTEM 9000



**Figure 3-1 Component locations**

# ACCUMEASURE™ SYSTEM 9000

## 3.2 Connections

The Accumeasure 9000, single channel probe amplifier board unit requires five external connections for operation:

- The probe cable.
- The target ground.
- The output signal
- The DC power cable.
- The master/slave signal cable.

These cables are available as cable set **P/N:7500-6080** with the exception of the “Target Ground”

The **probe cable** should be connected to the BNC connector attached to the bottom surface of the amplifier board unit. This connector is labeled PROBE CABLE BNC CONNECTOR on Figure 3-1.

### CAUTION

The shell of the probe cable input connector on the front panel is driven at the probe carrier voltage and cannot be grounded. Also, the shield integrity of the probe cable cannot be broken. If the probe cable is damaged, it is recommended that it be replaced rather than repaired.

The **target ground** wire should be connected to the DC ground of power supply that provides the DC voltages to the Accumeasure 9000 single channel probe amplifier board unit. This ground connection is returned to the board unit through the power supply ground connection wires attached to J1, pins 2 and 4 (see Figure 3-1).

The displacement voltage **output signal** is available from the BNC connector that is attached to the output signal cable from J3 on the top surface of the board unit (see Figures 3-1).

### CAUTION

The output impedance of the Signal Output BNC cable is 50 Ohms. Attachment of the Signal Output cable to any electronic instrument (meter, display, computer, or analog-to-digital converter) with an input impedance of less than 50k Ohms will result in a calibration error of greater than 0.1% of the full scale probe range. A total instrument load impedance on the Signal Output cable greater than 100k Ohm is recommended.

# ACCUMEASURE™ SYSTEM 9000

The output impedance of the amplifier that drives the output signal cable is 50 ohms. This impedance is included in the output signal circuit to ensure signal stability. The cable that is provided with the board unit is designed to be compatible with the miniature output connector, J3. This cable should be used for the best performance of the unit. Additional cable lengths can be added to the BNC connector at the end of this cable. Any good quality coaxial cable, up to a length of 100 feet (30 meters) can be used to connect to other equipment.

DC power is provided to the Accumeasure 9000 board unit through the **power cable** that is provided with the board. This power supply cable should be connected to the J1 receptacle on the edge of the board. See Figure 3-1 for the location of J1.

The **master/slave signal cable** provides the capability of synchronizing the sine wave carrier signal frequencies of multiple probe amplifier board units to minimize the output noise of the units. A square wave sync signal is transmitted from the master board unit to the slave board units to set the slave board unit carrier frequency to be in frequency and phase synchronization with the master. Jumpers are used to set each board to be either a master or a slave. For single channel units, no cable connection is required and the board set to a master condition. A “pigtail” harness is provided in cable set P/N: 7500-6080 so that the board can be synchronized with other boards. Contact MTI for additional jumper, and master/slave signal cable wiring information if more than one probe amplifier board unit is used in an installation.

## 3.3 Control Switches and Jumpers

There are no control switches on the Accumeasure 9000, single channel board unit. Jumpers are used on the board to set up the optional configurations of the board circuitry. The jumpers also used during the board calibration process. Jumpers should not removed from the board or moved to short two adjacent pins together without specific knowledge of the voltages and signals on the jumper pins. Random positioning of jumpers on the Accumeasure 9000 board could change the calibration of the unit, or could damage the board circuitry. Table 3-1 indicates the jumper states (OPEN or SHORTED) for normal operation of the single channel board unit.

# ACCUMEASURE™ SYSTEM 9000

Jumper	Jumper State For Normal Operation
JP1	OPEN
JP2	OPEN
JP3	OPEN
JP4	SHORTED
JP5	SHORTED
JP6	SHORTED
JP7	OPEN
JP8	OPEN
JP9	OPEN
JP10	SHORTED
JP11	OPEN
JP12	OPEN
JP13	OPEN
JP14	SHORTED
JP15	OPEN
JP16	OPEN
JP17	OPEN
JP18	OPEN
JP19	SHORTED
JP20	OPEN
JP21	OPEN
JP22	SHORTED
JP23	OPEN
JP24	OPEN

**Table 3-1 Normal Jumper States**

## 3.4 Displays

There are no displays included on the Accumeasure 9000, single channel board



# ACCUMEASURE™ SYSTEM 9000

unit. Display of the output signal is achieved by connecting a DC voltage display instrument, such as a digital voltmeter to the coaxial output signal cable.

## 3.5 Probe Mounting

The Accumeasure System 9000 measures probe-to-target gap, so the probe fixture must have good mechanical stability and alignment. The fixture must hold the probe securely and keep the probe face parallel to the target surface. Probe tilt causes measurement errors, so a tilt of less than 5% of range is recommended. That would mean that for a .020" range sensor, the edge of the sensor should tilt no more than .001" on a side.

### CAUTION

The probe connector and the probe body on ASP-1, ASP-2, ASP-5, and ASP-10 probes carry a 3 to 5 V rms electrical guard voltage for the cable shield and the probe. These must not be shorted to ground by the fixture or the system will be inoperative.

It is recommended that the probe fixture be connected to the same ground return as the target. The target or structure under test should provide a noise-free, low-impedance return path to the DC supply ground of the power supply that provides the DC voltages to the Accumeasure 9000 single channel probe amplifier board unit. Values of up to 1 kilo-ohm resistance may be tolerated under certain conditions, such as when maximum system linearity and resolution are not required.

If a direct ground connection is not possible, a capacitive-coupled connection can be used. Be aware that a 350 pF value in the return path will introduce a 0.1% full-scale measurement error. Larger capacitances will introduce correspondingly smaller errors (1000 pF or larger is recommended). In practice, the ground return path may be provided automatically if the target is at ground potential and is connected back to the amplifier ground connector through the ground terminal on the AC supply line. To verify that a proper return path is present, connect a ground lead directly from the target to the ground connector on the probe amplifier module.

The probe should be mounted to meet two important conditions:

# ACCUMEASURE™ SYSTEM 9000

1. At a minimum excursion, the probe-to-target gap should be no less than 5% of the probe range.
2. At maximum excursion, the target gap must not exceed 120% of the full-scale probe range.

Before performing a measurement, ensure that the probe and target under test are clean and free from debris.

## 3.6 Probe Cables

MTI capacitance probes are equipped with special, low-noise coaxial cables. Standard coaxial cables are not acceptable for connecting the probes to probe amplifier. Cables are available in either 50-ohm or 95-ohm sizes. Specifications:

	Diameter	Operating Temperature
50-Ω Cable	0.064 inch (1.626 mm)	-100 to +200°C
95-Ω Cable	0.144 inch (3.658 mm)	-100 to +200°C

Most probes are shipped with 95-Ω cables. If cable size is important, please contact the factory.

Cables may be spliced only if the junction is 100% shielded. Routing the cable through relays and other switching devices will interfere with the measurement system. Cylindrical feed-through assemblies may be used, however, when transitioning through a panel. They must be fully shielded and insulated from the panel since the shield is **not** at ground potential. Contact the factory for information on MTI-manufactured feed-through assemblies.

## 3.7 Target Grounding

The target should be returned to the DC supply ground of the power supply that provides the DC voltages to the Accumeasure 9000 single channel probe amplifier board unit, using a wire or a clip lead. Often a direct probe-to-target ground connection is not possible, due to target configuration or other mechanical constraints.

### CAUTION

Poor ground return and connecting the rear panel output connectors to equipment such as oscilloscopes, chart recorders, or data loggers, can create ground loops, which will cause errors in excess of 60 Hz in the output and carrier signals.

## ACCUMEASURE™ SYSTEM 9000

In general, it is recommended that grounding practices for sensitive equipment be applied when using the Accumeasure amplifier. For additional information on grounding practices refer to H.W. Ott's *Noise Reduction Techniques in Electronic Systems* (John Wiley and Sons, 1976) or to Chapter 24 of the *Analog Devices Applications Reference Manual* (1993).

## 4: Operating Instructions

### 4.1 Probe Amplifier Calibration Check

Do not attempt to make adjustments, other than the probe amplifier gain (R42) and offset (R51) controls that are located on the edge of the board. The board unit has been calibrated at the factory to perform within published specifications. If this performance is not attained in the field, check for damaged cables, poor grounding, fixturing problems, or a damaged probe before attempting an adjustment of the calibration. Proper operation of the amplifier can be verified by using a MTI AS-1070-AC probe simulator. If the problem cannot be located, contact the factory for further instructions.

However, it may be necessary to check and adjust the amplifier calibration for applications which require maximum accuracy or when the probe and amplifier have been ordered separately. The best results are obtained when a calibrated micrometer is used as the probe-positioning device. If this is not available, a stand-alone micrometer such as the MTI KD-CH-III A calibration stand may be used.

The gain and offset controls on the Accumeasure front panel can be used to calibrate the probe. A slight tilt of the probe in a fixture also may introduce a gain or offset error that may be eliminated through calibration.

#### **CAUTION**

Only potentiometers R42 and R51 on the edge of the board should be adjusted. Under no circumstances should the settings of any of the other potentiometers on the board be changed. The other potentiometer settings control amplifier parameters and should only be adjusted at the MTI factory.

# ACCUMEASURE™ SYSTEM 9000

## RECOMMENDED EQUIPMENT

1. A **Voltmeter** with a minimum resolution of .0001V dc and accuracy of  $\pm 0.001$  V dc.
2. A **Micrometer** with a minimum resolution of 0.05% of the probe range (if available) and accuracy of  $\pm 0.1\%$  of the probe range. (An MTI KD-CH-III A Calibration Fixture may be used for this purpose; refer to the KD-CH-III A Operating Instruction Manual to compare the fixture resolution to the calibration requirements.)

## BASIC CALIBRATION

Perform calibration by adjusting the R42 GAIN and the R51 OFFSET controls. Offset is adjusted while the probe is at 10% of range. Gain is adjusted at 100% of range. Use the following procedure:

1. Set the voltmeter to monitor the output signal voltage from the amplifier board unit.
2. With the power supply to the board unit turned off, adjust the probe so it is lightly touching the target.
3. Zero the micrometer and then move it back to 10% of the intended range. Turn the power supply for the board unit on.
4. Adjust the R51, OFFSET potentiometer until the output voltage reads 1.000 Vdc.
5. Move the micrometer to 100% of range, and adjust the R42, GAIN potentiometer until the output voltage reads 10.000 Vdc.
6. Readjust the micrometer to 10% of range and recheck the 10% point (1.000 V). Readjust R51 if necessary, and recheck the 100% limit.
7. Repeat steps 5 and 6 until the voltage at 10% of range is  $1.000 \pm 0.001$  Vdc and the voltage at 100% of range is  $10.000 \pm 0.001$  Vdc.
8. Verify several points between the minimum and maximum limits.

If this procedure does not produce the desired system accuracy, more elaborate calibrations such as linearizing the output may be accomplished by readjusting the potentiometers on top surface of the board unit. These adjustments must be made at the MTI factory or by a qualified MTI representative.

## 4.2 “Pushed” Amplifiers and Probes

Some applications require probes with smaller diameters to achieve the sensing ranges of larger-diameter probes. For example, a 20-mil (0.508-mm) range would normally require an ASP-20-CTA probe with a diameter of 0.437 inch (11.099 mm) for use with a standard amplifier. If a smaller probe diameter is required, the amplifier may be “pushed” by a factor of 2. This would allow smaller sized probes, such as an ASP-10-CTA, with a diameter of 0.250 inch (6.25 mm) to be operated over a 20-mil (0.508-mm) range.

Similar effects can be achieved with other combinations of probe range and amplifier push. The maximum push recommended is 40X.

When employing “pushed” amplifier and probe combinations, the output versus distance must be individually calibrated in order to obtain maximum accuracy and linearity. The level of output noise generated by the “pushed” amplifier also increases in amount equal to the push factor.

For example, a standard probe amplifier with an ASP-10 probe and an 8-foot (2.4 meter) cable has an output noise level of  $1.0 \pm 0.2$  millivolt peak-to-peak at a 10 mil (254 microns) probe-to-target air gap. A 5X pushed amplifier working with the same probe and cable will have a  $5.0 \pm 1.0$  millivolts peak-to-peak output noise at the same gap. The linearity of pushed probe amplifiers also may be degraded by  $\pm 0.15\%$  for push values between 10X and 40X using long probe cables.

It is recommended that you contact an MTI representative or factory applications personnel for more information on pushed probe and amplifier combinations.

## 4.3 Conductive Target Thickness Measurements

Two Accumeasure System 9000 single channel board units can be used to perform thickness measurements. A probe amplifier signal summation circuit located on the 9000 board unit can be set to produce a [Channel 1 + Channel 2] summation for the correct addition of two probe signals (contact MTI if there is a question about the exact configuration of the summation circuit). One of the terminals on the P1 power supply voltage connector provides a path for connecting the output signal from a second Accumeasure 9000 single channel board unit. This path allows the signal to be added directly to the output signal of the first amplifier to perform the thickness measurement summation. A summation output signal connector, J4, is also available to provide the thickness signal to an external

# ACCUMEASURE™ SYSTEM 9000

display or data acquisition instrumentation. A special summation signal output cable that attaches to the J4 connector is provided with probe amplifier board units that are to be used to perform thickness measurements.

To perform the thickness measurement, the Accumeasure 9000 single channel boards are provided with a wide voltage range offset adjustment that allows the summation signal value to be set to zero volts at a nominal target thickness value (refer to the measurement procedure below). With the 9000 board unit set up to perform the thickness measurement, the J4 Summation Signal Output connector produces an output that has an *increasingly* positive magnitude as the target thickness *decreases*.

## MEASUREMENT PROCEDURE

1. Fixture the probes on opposite sides of the target with the center-line of the two probe sensing faces directly in line with each other. Remove the target and set the air gap between the probe sensing faces so it is equal to the mean thickness of the target plus the sensing range of probes. For example, if the target thickness is 0.250 inch (6.35 mm) and probes with a range of 0.050 inch (1.27 mm) are being used, the total gap between the probe faces would be set at approximately 0.300 inch (7.62 mm). Make sure the probe-to-target air gap for Probe 1 and Probe 2 does not exceed the measuring range of the probes.
2. Connect the probes to two Accumeasure System 9000 single channel board units.
3. Place a target with known thickness midway between the probes. This test target should be the same thickness as the object that will be gauged.
4. Ground the target.
5. Connect a digital voltmeter (DVM) or oscilloscope (whichever is used) to the Channel 1 board output signal cable.
6. Adjust the probe gap until the output voltage is between 0 and +10V (+5 to +7 volts is ideal). Keep in mind the maximum excursion of targets to be gauged. The output voltage (gap) should not exceed the linear range of the probe.
7. Vary the wide range offset control, R56 to produce an output of zero volts.
8. Connect the DVM or oscilloscope to the Channel 2 board output signal cable and repeat steps 6 and 7 for Channel 2 output signal, varying R56 on the Channel 2 board to produce an output voltage of zero volts.
9. Connect the DVM or oscilloscope to the summation signal output cable from the Channel 1 board unit. The voltage display should read zero volts,

# ACCUMEASURE™ SYSTEM 9000

corresponding to the test target thickness. Thicker targets will read as positive numbers on the meter display. Thinner targets will read as negative displacement values.

NOTE: The Channel 2 board unit J1, pin 10 output signal has to be connected to the J1, pin 10 of the Channel 1 board unit and the jumpers on both boards installed per MTI instructions for the signal summation to function. Contact MTI for the specific jumper settings for thickness measurement.

10. To determine thickness, multiply the voltage change by the probe sensitivity factor. For example, 50-mil (1.27-mm) range probes have a sensitivity factor of 5 micro-inches (0.127  $\mu\text{m}$ ) per millivolt. If the output signal increases by +20 millivolts, then the target is increasing in thickness by 100 microinches (2.54  $\mu\text{m}$ ).

## NOTES OF CAUTION FOR THICKNESS MEASUREMENTS

- Keep low-noise coaxial cables away from each other to prevent crosstalk. A very large guard signal in close proximity to a very low signal can easily cause a 1% thickness error.
- The probe fixture must be extremely rigid.
- If one or both probes are mounted in recessed wells, the probes may need to be re-calibrated, as the linearity may change when the probes are recessed. It is also recommended that the well diameter be 50% greater than the probe outer diameter to ensure linear operation at large gaps.
- Avoid target tilt errors. Range-extended probes (“pushed probes”) are less susceptible to target tilt error. However, noise increases with push. Target tilt warps the capacitance field, starting at the point of the target’s closest approach. Using smaller probe sensing areas with large air gaps will minimize the tilt effect.
- For thickness measurement of non-conductive, dielectric materials contact MTI to obtain application notes that describe the use of the Accumeasure System with this type of target.

## 4.4. MASTER/SLAVE OPERATION

When operating multiple probes close to each other, it is necessary to synchronize the carrier signals of the respective amplifiers. This will eliminate “beat-frequency” effects between



## ACCUMEASURE™ SYSTEM 9000

adjacent probe/amplifier pairs. Normally the amplifiers are configured as “Masters” with nothing connected to J2. See the table below for the relevant signals:

Connector: J2		Harness 7500-6080 wire color
Pin-1	SYNC OUT	RED
Pin-2	INPUT (SYNC IN)	GRN
Pin-3	MASTER/*SLAVE SELECT	WHT
	OPEN = MASTER	
	GND=SLAVE	
Pin-4	GND	BLK
Pin-5	N/C	
Pin-6	N/C	

Cut the **WHITE** and **BLACK** wires short (2”) and connect them together to configure an amplifier as a “SLAVE”. Connect **RED** from the connector on the **MASTER** to the **GREEN** wire on the **SLAVE** unit.

### Unused signals:

MASTER:	“SYNC IN”, GRN
	“*SLAVE”, WHT
	“GND”, BLK
SLAVE:	“SYNC OUT”, RED

## 5: Troubleshooting

**CAUTION**

Observe all electrical safety precautions when performing maintenance.

Accumeasure System 9000 single channel board units require specialized servicing techniques and should not be serviced in the field. The troubleshooting table in this section should help you determine if the problem exists in the Accumeasure equipment or in your auxiliary equipment. If the trouble is on the Accumeasure System 9000 board, it should be returned to the factory for servicing.

Before following the troubleshooting procedure:

1. Set up a probe and grounded target so that probe-to-target gap is within the probe full scale range,
2. Connect the probe to the Accumeasure 9000 Probe Amplifier board with an MTI probe cable,
3. Apply DC power within the specified operating range to the Probe Amplifier (refer to the **Power Requirements** section, pg. 8),
4. Refer to the table on the following page to determine the course of action that should be taken to solve a problem with the application of the Accumeasure System 9000 board unit.

# ACCUMEASURE™ SYSTEM 9000

PROBLEM	CORRECTIVE ACTION	REFERENCE
Output signal voltage is zero.	<ol style="list-style-type: none"> <li>1. Ensure that the DC power supply for the Accumeasure 9000 board is producing <math>\pm 15</math> Volts DC.</li> <li>2. Ensure the P1 power supply connector is securely attached to the Accumeasure 9000 board.</li> <li>3. Check the power supply voltages on TP1, TP2, and TP3 of the Accumeasure 9000 board.</li> <li>4. If the power supply voltages are correct, follow the next procedure below.</li> </ol>	<ol style="list-style-type: none"> <li>1. INSTALLATION INSTRUCTIONS manual section for component locations</li> <li>2. Figure 5-1 of this manual section for component locations.</li> <li>3. POWER REQUIREMENTS manual section for the power supply requirements of the board.</li> </ol>
Output signal voltage is zero and the power voltages are correct on the Accumeasure 9000 board test points.	<ol style="list-style-type: none"> <li>1. Disconnect the coaxial probe cable from the front panel receptacle. If the output signal voltage goes to a non-zero value, check cable for shield to center short circuit, and the probe for interelectrode short circuits.</li> <li>2. Check the voltage at the output signal test point TP13 on the Accumeasure 9000 board with DC voltmeter. If the TP13 voltage is a non-zero value, check the output signal cable for a short circuit between the center lead and the shield, and check for an open center lead.</li> </ol>	<ol style="list-style-type: none"> <li>1. INSTALLATION INSTRUCTIONS manual section for component locations</li> <li>2. Figure 5-1 of this manual section for component locations.</li> </ol>
Output voltage is zero; the power voltages are correct on the Accumeasure 9000 board test points for the channel under test; and the probe cable, probe, and output signal cable are not shorted and do not have open leads .	<ol style="list-style-type: none"> <li>1. If jumper changes on the probe amplifier board have been performed since the unit has been received from MTI, contact MTI to review jumper selection.</li> <li>2. If no jumper changes have been made or if the proper jumpers are installed, return the board to MTI for testing.</li> </ol>	<ol style="list-style-type: none"> <li>1. INSTALLATION INSTRUCTIONS manual section for component locations.</li> <li>2. Figure 5-1 of this manual section for component locations.</li> <li>3. See Table 5-1 for the jumper states for the normal operation of the probe amplifier board.</li> </ol>

## ACCUMEASURE™ SYSTEM 9000

<b>PROBLEM</b>	<b>CORRECTIVE ACTION</b>	<b>REFERENCE</b>
The output signal voltage is not +10.00 Vdc at the full-scale probe gap or +1.00 Vdc at 10% of full-scale probe gap.	<ol style="list-style-type: none"> <li>1. Check that the range of the probe under test is correct.</li> <li>2. Verify that the probe and target are touching when the probe gap should be zero.</li> <li>3. Check the calibration of the front panel GAIN adjustment.</li> <li>4. Ensure that the ground return connection from the target to the unit is intact.</li> </ol>	<ol style="list-style-type: none"> <li>1. PROBE AMPLIFIER CALIBRATION CHECK for gain adjustment.</li> <li>2. PROBE MOUNTING manual section.</li> </ol>
The output signal voltage is higher than +12 Volt DC at all probe-to-target gap settings.	<ol style="list-style-type: none"> <li>1. Check the probe cable connection to the probe BNC connector; ensure that the cable is securely attached to the connector.</li> <li>2. Check for an open circuit in the center wire of the probe cable.</li> <li>3. Check for open circuit in the probe between the connector and the sensing element on the probe face.</li> <li>4. Ensure that the ground return connection from the target to the unit is intact.</li> </ol>	<ol style="list-style-type: none"> <li>1. TARGET GROUNDING manual section.</li> <li>2. PROBE MOUNTING manual section.</li> </ol>
The noise on the rear-panel output voltage is abnormally high.	<ol style="list-style-type: none"> <li>1. Check the probe and probe cable for loose or high resistance connections.</li> <li>2. Check along the length of the probe cable for cuts or defects.</li> </ol>	<ol style="list-style-type: none"> <li>1. TARGET GROUNDING manual section.</li> <li>2. PROBE MOUNTING manual section.</li> </ol>
Excessive 60-Hz noise on the output signal.	<ol style="list-style-type: none"> <li>1. Check for a good AC power line ground on the power supply providing the DC voltages to the Accumeasure 9000 board.</li> <li>2. Ensure that there is a low resistance ground return connection between the target and the power supply providing DC voltages to the Accumeasure 9000 board.</li> </ol>	<ol style="list-style-type: none"> <li>1. TARGET GROUNDING manual section.</li> <li>2. PROBE MOUNTING manual section</li> </ol>

# ACCUMEASURE™ SYSTEM 9000

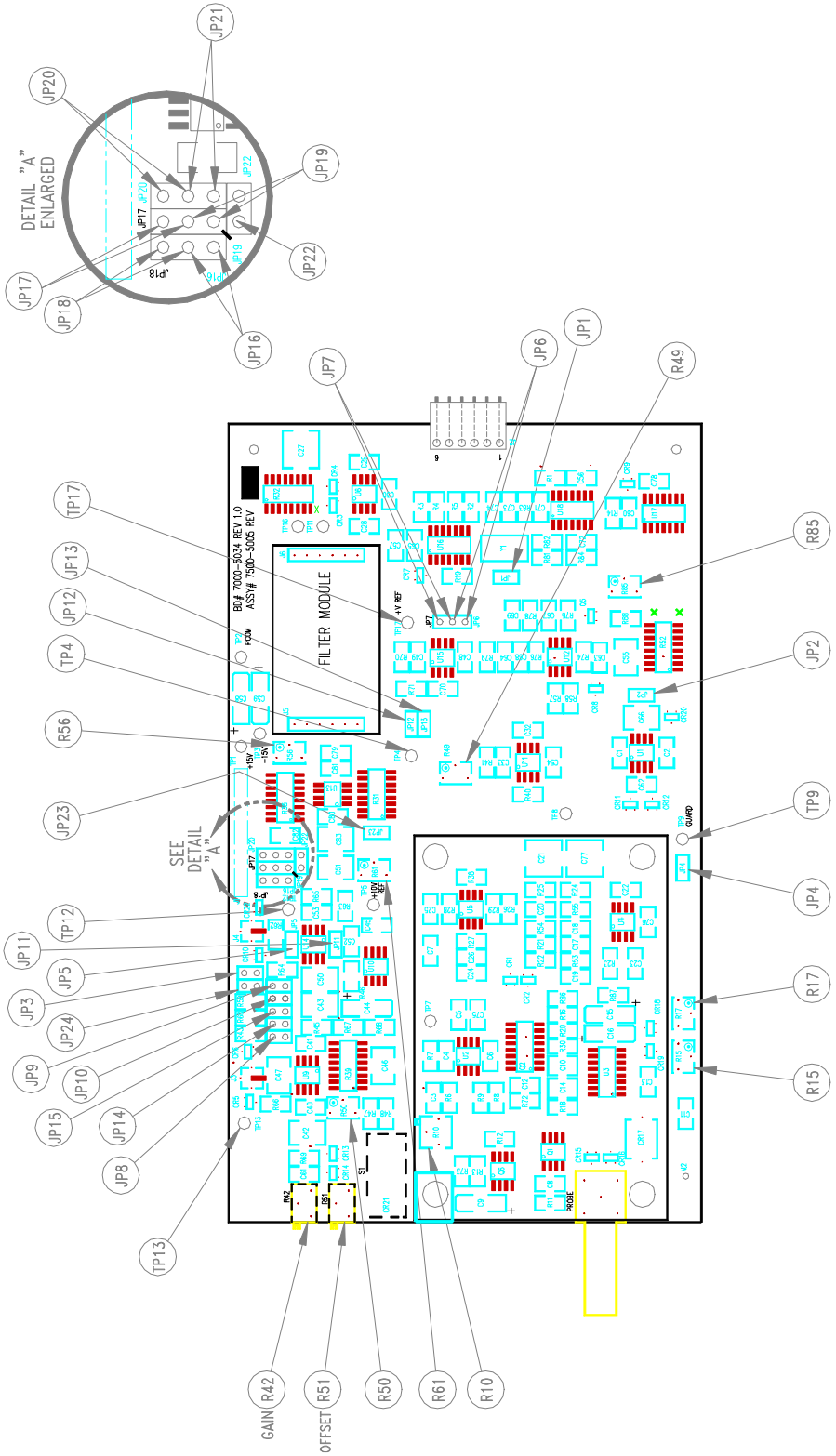


Figure 5-1

# ACCUMEASURE™ SYSTEM 9000

Jumper	Jumper State For Normal Operation
JP1	OPEN
JP2	OPEN
JP3	OPEN
JP4	SHORTED
JP5	SHORTED
JP6	SHORTED
JP7	OPEN
JP8	OPEN
JP9	OPEN
JP10	SHORTED
JP11	OPEN
JP12	OPEN
JP13	OPEN
JP14	SHORTED
JP15	OPEN
JP16	OPEN
JP17	OPEN
JP18	OPEN
JP19	SHORTED
JP20	OPEN
JP21	OPEN
JP22	SHORTED
JP23	OPEN
JP24	OPEN

**Table 5-1 Normal Jumper States**