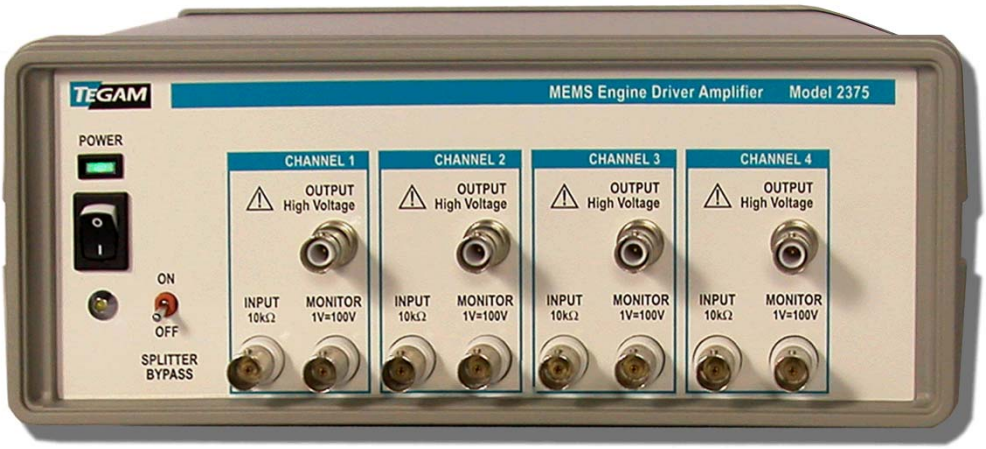


MODEL 2375

FOUR-CHANNEL HIGH VOLTAGE AMPLIFIER FOR MEMS ENGINES

Instruction Manual

PN# 810045-CD
Publication Date: September 2004
REV. A

NOTE: This user's manual was as current as possible at the time of manufacture. However, products are continuously being updated and improved. Because of this, some differences may occur between the descriptions in this manual and the product received. Please refer to www.tegam.com for future updates of this manual.

Unpacking & Inspection:

Each 2375 is put through a series of electrical and mechanical inspections before shipment to you. Upon receipt of your instrument unpack all of the items from the shipping carton and inspect for any damage that may have occurred during transit. Report any damaged items to the shipping agent. Retain and use the original packing material for reshipment if necessary.

Upon Receipt, inspect the carton for the following items:

1 - Model 2375 Four Channel MEMS Driver Amplifier
1 - Model 2375 User's Manual CD, P/N 810045-CD
4 - High Voltage BNC to BNC cables (3ft), TEGAM P/N 740949
1 - Power Cord, P/N 600014

Safety Information & Precautions:

The following safety information applies to both operation and service personnel. Safety precautions and warnings may be found throughout this instruction manual and the equipment. These warnings may be in the form of a symbol or a written statement. Below is a summary of these precautions.

Terms in This Manual:
CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements apply conditions or practices that could result in personal injury or loss of life.

Terms as Marked on Equipment:
CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Safety Information & Precautions Cont'd:

Symbols:

As Marked in This Manual:

	This symbol denotes where precautionary information may be found.

As Marked on Equipment:

	Attention – Please refer to the instruction manual.
	Danger – High or hazardous Voltage
	Earth Ground Terminal
I	On
O	Off
	Chassis Terminal
	Alternating Current

Grounding the Equipment
This product is grounded through the grounding conductor of the power cord.
WARNING: To avoid electrical shock or other potential safety hazards, plug the power cord into a properly wired receptacle before using this instrument. The proper grounding of this instrument is essential for safety and optimizing instrument operation.

Danger Arising from Loss of Ground
If the connection to ground is lost or compromised, a floating potential could develop in the instrument. Under these conditions all accessible parts, including insulating parts such as keypads and buttons could develop a hazardous voltage and put the user at risk.

⚠

Use the Proper Fuse
To avoid fire hazard, use only the correct fuse type as specified for the AC power supply in this manual. Please note that the fuse rating for 100/120-volt operation is different than the rating for 200/240-volt operation. Information about the proper fuse type is also printed on the rear panel of the instrument.

Refer fuse replacement to qualified service personnel.

Do Not Use in Explosive Environments
WARNING: The 2375 is not designed for operation in explosive environments.

Do not Operate Without Covers
WARNING: This device should be operated with all panels and covers in place.
Operation with missing panels or covers could result in personal injury.

⚠ **Outputs 1~4 have the potential to deliver high voltage and the necessary precautions should be taken.**

FOR QUALIFIED SERVICE PERSONNEL ONLY

⚠ **Servicing Safety Summary:**

Do Not Service Alone
Do not perform service or adjustment on this product unless another person, capable of rendering first aid, is present.

Use Care When Servicing with Power On
Dangerous voltages may exist at several points in this product. To avoid personal injury or damage to this equipment, avoid touching exposed connections or components while the power is on. Assure that the power is off when removing panels, soldering, or replacing components.

Power Source
This product is intended to connect to a power source that will not apply more than 252V RMS between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Power & Fuse Settings

CAUTION: DO NOT POWER THIS INSTRUMENT before verifying that the proper supply voltage settings have been made. Be sure that the instrument is unplugged. There are two separate settings that need to be verified. Position the 2375 so that you are facing the rear panel and follow the instructions below:

1. Make sure that the supply voltage switch, on the rear panel, is set for either 110 or 220 V operation. Then verify that the fuse rating is the correct value. The proper fuse rating is posted next to the line voltage selection switch. First remove the power cord and then check the fuse by taking a small straight edged screwdriver and inserting it into the fuse holder slot located below the power cord socket. Use the screwdriver to gently pry the fuse drawer until it slides out. Reinstall the fuse by simply pushing the fuse drawer back into its original position. You will hear it snap into place.

2. Near the line voltage selection switch you will note another selection switch. This is the line voltage compensation switch. Adjust the position of this switch to the closest position that defines the actual line voltage. You may choose from LO line voltage (90-105/198-231V) or HI line voltage (108-126/216-252V). Once the proper settings have been verified, you may apply power to the unit.

Important Safety Information:

The chassis of the 2375 is grounded. The grounding shields of all the connectors are also grounded. This is for your safety.

WARNING: DO NOT MODIFIY any configurations or connections from their original state otherwise safe operation of this equipment may be compromised.

WARNING: Always remember to shut off the power and wait at least 5 minutes before disconnecting or connecting any cables or connections to or from the Model 2375. This warning also applies to any instruments having an electrical connection of any kind to the Model 2375. This includes the signal source, load, and all ground and shield connections. Ignoring this warning could result in electric shock.

WARNING: Replace damaged output cables immediately. Otherwise, severe injury or death could result from electric shock.

Model 2375 Specifications

Electrical	
Number of Channels	4
Input Impedance	10KΩ
Output Voltage Range	0 to +150 VDC (Splitter Mode) -7 to +150 VDC (Splitter Bypass Mode)
Maximum Output Current	20mA per channel
Output Impedance	< 0.2 Ω
Voltage Gain	+15 Fixed
Sine Wave Distortion (THD)	< 0.1% for DC to 5kHz. 150Vp-p sine wave with 75VDC offset
Output DC Offset Temperature Stability	
Full Power Bandwidth	5kHz / 150 Vp-p sine wave with 75VDC offset typical, (-0.1dB) (C_L<200pF)
Slew Rate	> 5V/µSec
Square Wave Response	< 25 µSec for 150 Volt Step (10-90%)
Aberrations	< 2%
Voltage Monitor Outputs	Source impedance 2KΩ (100:1 Ratio for 50Ω input)
Environmental	
Operating Temperature	32°F to 113°F, (0°C to +45°C) Ambient
Storage Temperature	-4°F to +122°F, (-20°C to +50°C)
Humidity Range	80% RH Non-Condensing
General	
Input Supply Voltage	110/220VAC @ 50/60 Hz – *Please specify voltage requirements when placing order.*
Power Rating	100VA; 80W
Dimensions: (H x W x L)	4.51”x10.14”x11.81” (11.5 x 25.8x30.0 cm)
Weight (approximate)	10lbs (4.5kg)
Warranty	1 year parts & labor
Standard Accessories	CD user’s manual, 4 - high voltage BNC cables PN 740949, power cord P/N 600014
Optional Accessories	Rack Mount Kit, 5 ¼” height, P/N 740532; standard BNC cable PN CBL-3102

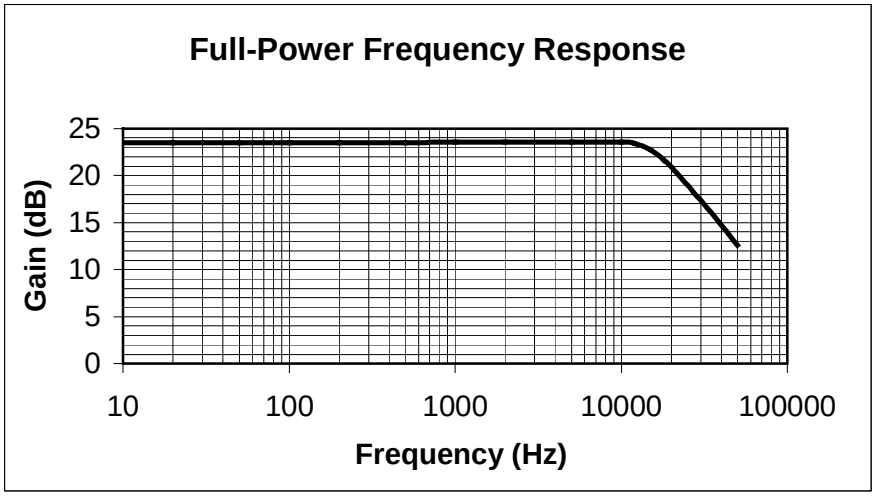


Figure 1: Full Power Frequency Response (Typical)
150V @ 20mA load. Sine Wave with 75VDC Offset
Typical (-0.1dB) (C_L<200pF)

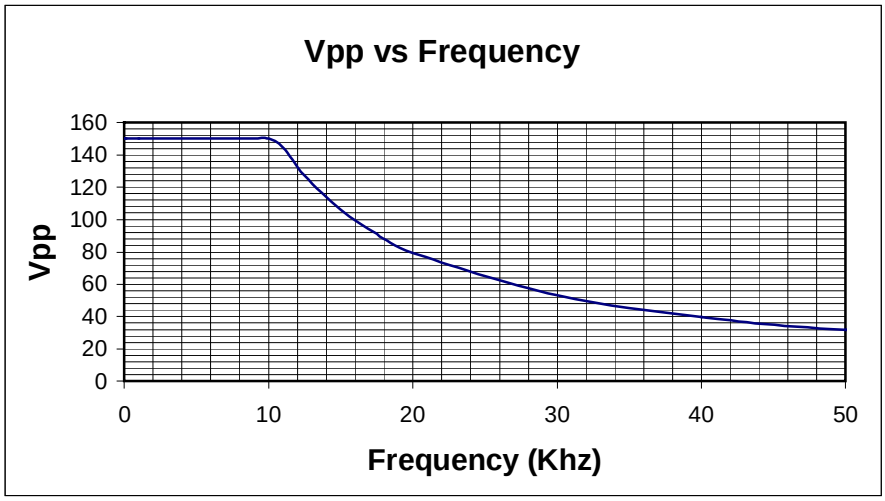
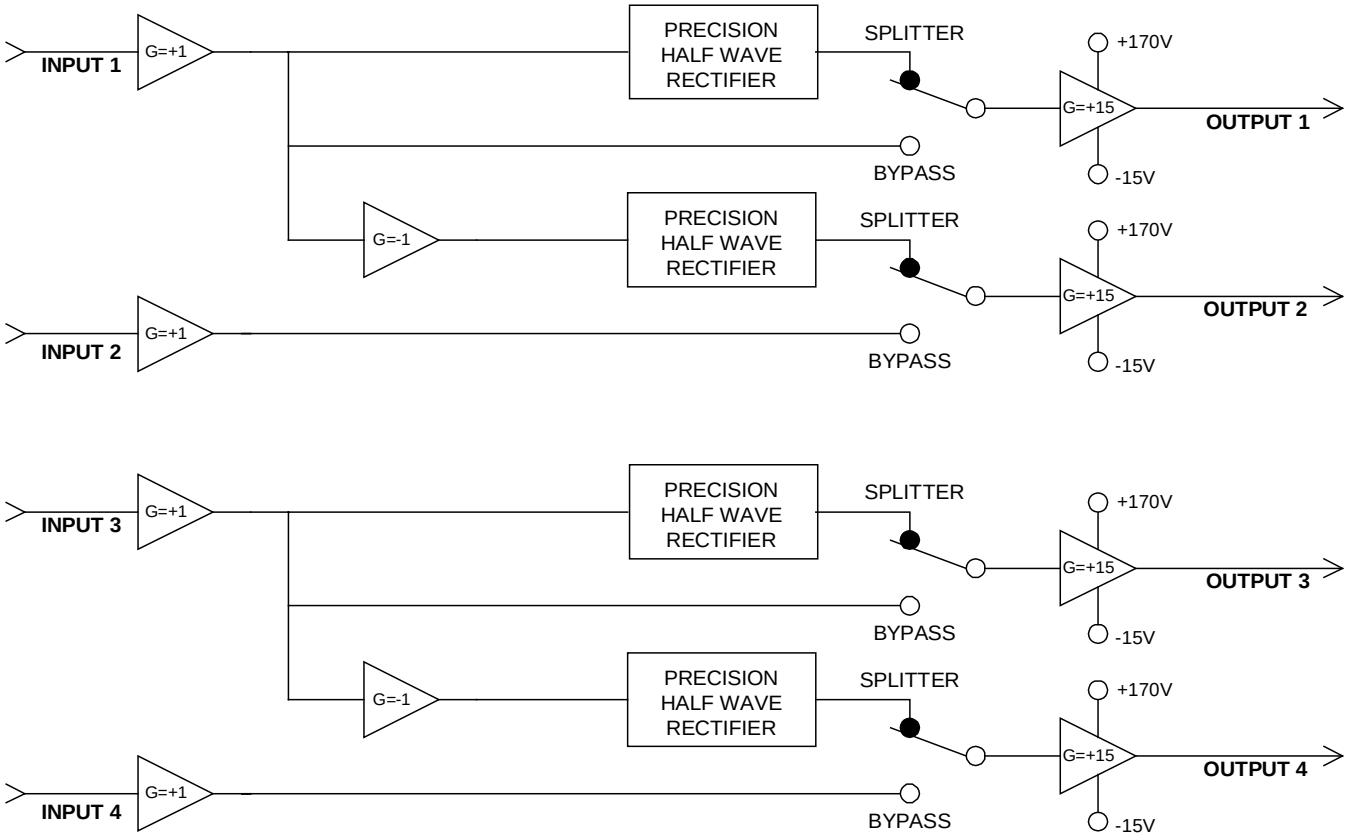


Figure 2: Maximum Vp-p vs. Frequency
Amplifier's maximum peak to peak output roll off with frequency.
Slew rate >5 V/µSec

Figure 3: Operational Diagram of Model 2375, High-Voltage Driver Amplifier for MEMS Engines



Intended use

The Model 2375 Amplifier is a four-channel, high voltage amplifier designed specifically for use in the TEGAM 9070, MEMS Driver System. The 9070 system is used for the accurate electrostatic control of actuator-driven micro engines.

The 2375 amplifier is compatible with all standard signal and function generators but is best used with the TEGAM Model 2414A-GS Arbitrary Waveform Generator (AWG) or equivalent signal source. To take full advantage of the amplifier's operation, Sandia's Super µDriver software is also recommended.

The output voltage range of the 2375 ranges from –7 to +150V. Model 2375 is capable of sourcing and sinking current for a variety resistive and reactive loads. The 2375 is a current limited device. However, to protect your MEMS devices against possible over current damage, it is recommended that a resistor be placed in series with each of the individual MEMS devices.

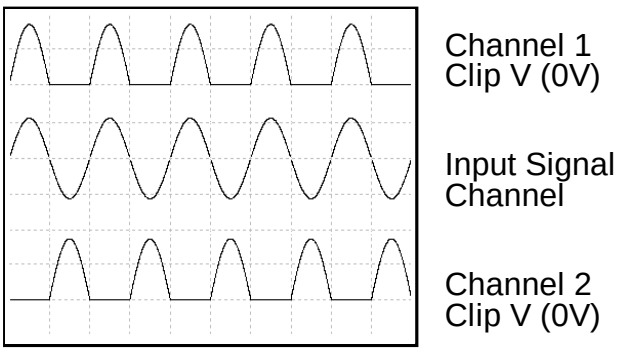
Two Modes of Operation

The 2375 has two modes of operation. These are normal (splitter bypass) mode and splitter mode. Normal mode of operation will amplify each of the inputs (1 through 4) with a gain of +15. A resulting signal will appear at each of the corresponding outputs from 0 to +150V. Due to the 0 to +150V power supply, negative going inputs signals will be clipped at approximately –7V.

A typical MEMS engine requires four independent signals for basic operation. The splitter mode reduces this requirement by precision rectifying channels 1 & 3 and allowing the negative going cycles of these channels be inverted and appear at outputs 2 & 4 as positive going (0 to +150V) signals. The AC drive signal is created by using Sandia's Super µDriver software and 2 to 4 TEGAM model 2414A-GS arbitrary waveform generators.

See Figure 4 for a detailed operational diagram.

Figure 4: Splitter Operation for Channels 1 & 2.
Channels 3 & 4 duplicate this operation.



Monitor Outputs

Each main output is accompanied by a monitor output. The monitor output is designed to provide an accurate, low-voltage representation of the amplifier output at a scale of 100:1 when feeding into a >1MΩ input. The basic 2375 amplifier gain is fixed at +15 with no inversion unless the splitter mode is used.

Voltage & Current Limitations
The input circuitry is designed to withstand voltages up to ±10V peak. Voltages exceeding this limit could cause excessive heating, distortion and could damage the amplifier's circuitry. The amplifier is protected in all operating modes with current limiting in either positive or negative directions. The maximum operating current of each output is rated for 20mA continuous current per channel.

Frequency Characteristics
The 2375 has a full signal bandwidth from DC to 5kHz. As signal amplification is increased beyond the 5kHz limit the sine wave distortion begins to increase beyond the .1% specification. This is due to slew rate limitations (>5V/µs) of the amplifier. There are figures in the specification section of this manual that illustrate the full power frequency response and output voltage versus frequency. Because the 2375 is a unipolar device, bandwidth characteristics are obtained by DC biasing the input signal at 5V. This allows the 150 Vp-p AC signal to float at the outputs midpoint voltage (75VDC).

Protection Circuits
The 2375 has a current limit function to protect the outputs against short circuits etc.

Connections
The amplifier's inputs require standard BNC connections and have an impedance of 10kΩ. This makes it compatible with all TEGAM or other conventional signal generators. The output is specified at less than .2Ω. Four output cables are supplied with the 2375. These are special cables (P/N 740949), which have high-voltage BNC connectors on one end and standard BNC connectors on the other. The cables are designed for use with the high voltage output connectors on the front panel. There is a binding post available on the instrument's front panel to be used as a direct connection to the instrument's chassis. The monitor outputs may be connected using any standard type BNC to BNC cables to an oscilloscope, A/D card or other compatible monitoring device.

Warranty:

TEGAM, Inc. warrants this product to be free from defects in material and workmanship for a period of one year from the date of shipment. During this warranty period, if a product proves to be defective, TEGAM Inc., at its option, will either repair the defective product without charge for parts and labor, or exchange any product that proves to be defective.

TEGAM, Inc. warrants the calibration of this product for a period of 6 months from date of shipment. During this period, TEGAM, Inc. will recalibrate any product, which does not conform to the published accuracy specifications.

In order to exercise this warranty, TEGAM, Inc., must be notified of the defective product before the expiration of the warranty period. The customer shall be responsible for packaging and shipping the product to the designated TEGAM service center with shipping charges prepaid. TEGAM Inc. shall pay for the return of the product to the customer if the shipment is to a location within the country in which the TEGAM service center is located. The customer shall be responsible for paying all shipping, duties, taxes, and additional costs if the product is transported to any other locations. Repaired products are warranted for the remaining balance of the original warranty, or 90 days, whichever period is longer.

Warranty Limitations:

The TEGAM, Inc. warranty does not apply to defects resulting from unauthorized modification or misuse of the product or any part. This warranty does not apply to fuses, batteries, or damage to the instrument caused by battery leakage.

Statement of Calibration:

This instrument has been inspected and tested in accordance with specifications published by TEGAM Inc. The accuracy and calibration of this instrument are traceable to the National Institute of Standards and Technology through equipment, which is calibrated at planned intervals by comparison to certified standards maintained in the laboratories of TEGAM Inc.

Contact Information:

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GENEVA, OHIO 44041
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Equipment Maintenance

The cooling fan is designed for continuous operation. Periodically check the fan to make sure that airflow is not impeded and that there is adequate ventilation to keep the instrument cool.

TEGAM recommends that the 2375 be calibrated and routine functional checks be performed on a regular basis. The recommended interval is every twelve months after the initial 6 month calibration. The actual interval is dependent upon the application and is determined by your company's Quality Assurance policy.

Repair Parts

The Model 2375 has no user replaceable parts.

Preparation for Repair or Calibration Service:

Once you have verified that the cause for 2375 malfunction cannot be solved in the field and the need for repair and calibration service arises, contact TEGAM customer service to obtain an RMA, (Returned Material Authorization), number. You can contact TEGAM customer service via the TEGAM website, www.tegam.com or by calling 440.466.6100 (*All Locations*) OR 800.666.1010 (*United States Only*).

The RMA number is unique to your instrument and will help us identify your instrument and to address the particular service request by you which is assigned to that RMA number. Of even greater importance is a detailed written description of the problem that should be attached to the instrument. Many times repair turnaround is unnecessarily delayed due to a lack of repair instructions or of a detailed description of the problem.

This description should include information such as is the problem intermittent?, when is the problem most frequent?, has anything changed since the last time the instrument was used?, etc. Any detailed information provided to our technicians will assist them in identifying and correcting the problem in the quickest possible manner. Use the form provided on the next page.

Once this information is prepared and sent with the instrument and RMA number to our service department, we will do our part in making sure that you receive the best possible customer serviced and turnaround time possible.

Expedite Repair & Calibration Form

Use this form to provide additional repair information and service instructions. The Completion of this form and including it with your instrument will expedite the processing and repair process.

RMA#:		Instrument Model #:	
Serial Number:		Company:	
Technical Contact:		Phone Number:	
Additional Contact Info:			

Repair Instructions:

☐ Evaluation ☐ Calibration Only ☐ Repair Only ☐ Repair & Calibration ☐ Z540 (Extra Charge)

Detailed Symptoms:

I*nclude information such as measurement range, instrument settings, type of components being tested, is the problem intermittent? When is the problem most frequent?, Has anything changed with the application since the last time the instrument was used?, etc.*

Power Amplifier Gain Calibration Procedure

Required Equipment:

1. Fluke 5101A Precision Calibrator or equivalent
2. Fluke 8842A – 5½ digit Digital Multimeter or equivalent

WARNING: Qualified service personnel must do servicing and calibration.

WARNING: When disassembling the Amplifier for calibration, turn power OFF and disconnect the power cord from the AC power source.

1. Remove the Amplifier's front and back bezels by pulling out on the left or right side to release the plastic from the metal sub panel. Rotate the released edge away from the panel 1 to 2 inches and move the bezel toward unreleased side and remove.
2. Remove the 2 top and 2 bottom sheet metal screws from the 4 corners of the rear panel.
3. Remove the 2 sheet metal screws from the 2 top corners of the front panel.
4. Carefully slide the rear panel out far enough so that the top cover can be grasped. Then slide the top cover back 8 to 10 inches so the gain potentiometers are visible. Refer to Figure 5
5. Before connecting the power cord to the amplifier, verify that all wiring is routed away from metal surfaces.

Figure 5: – Power Amplifier Gain / Offset Adjustments

Power Amplifier Gain Calibration Procedure cont'd:

6. Turn the 2375 power ON and allow for the 2375 to warm up for at least 15 minutes.
7. Set the 5101A Precision Calibrator for +10.0000 VDC.

CAUTION

HIGH VOLTAGE MAY BE GENERATED BY THE 5101A IF NOT SET CORRECTLY. USE A MULTIMETER TO VERIFY 10 VDC AT THE OUTPUT BEFORE APPLYING TO THE UUT

8. Place the Splitter Bypass Switch to the **ON** position.
9. Connect the output of the 5101A to Channel 1 INPUT
10. Connect the DVM to Channel 1 OUTPUT and adjust gain potentiometer R9A for 150V ± 0.02 VDC.
11. Connect the output of the 5101A to Channel 2 INPUT
12. Connect the DVM to Channel 2 OUTPUT and adjust gain potentiometer R18A for 150V ± 0.02 VDC.
13. Connect the output of the 5101A to Channel 3 INPUT
14. Connect the DVM to Channel 3 OUTPUT and adjust gain potentiometer R27A for 150V ± 0.02 VDC.
15. Connect the output of the 5101A to Channel 4 INPUT
16. Connect the DVM to Channel 4 OUTPUT and adjust gain potentiometer R36A for 150V ± 0.02 VDC.
17. Turn power OFF and disconnect the power cord from the AC power source. Assemble the unit in the reverse order of disassembly.

Appendix

There is no supplementary information contained in the appendix at this time.