Extech Electronics Co.

7006

Matrix Scanner

User Manual

ER 1.02

WARRANTY

EEC certifies that the instrument listed in this manual meets or exceeds published manufacturing specifications. This instrument was calibrated using standards that are traceable to Chinese National Laboratory Accreditation (CNLA).

Your new instrument is warranted to be free from defects in workmanship and material for a period of (2) year from date of shipment. During the warranty period, you must return the instrument to EEC or its branches or its authorized distributor for repair. EEC reserves the right to use its discretion on replacing the faulty parts or replacing the assembly or the whole unit.

Any non-authorized modifications, tampering or physical damage will void your warranty. Elimination of any connections in the earth grounding system or bypassing any safety systems will void this warranty. This warranty does not cover batteries or accessories not of EEC manufacture. Parts used must be parts that are recommended by EEC as an acceptable specified part. Use of non-authorized parts in the repair of this instrument will void the warranty.

This warranty does not cover accessories not of EEC manufacture.

Compliance Information

Conforms with the following product standards:

EMC Standard

EN 61326-1:2006 (EN 55011:1998 / A2:2002 Class A

EN 61000-3-3:1995 / A1:2001 / A2:2005

IEC 61000-4-2:1995 / A2:2000

IEC 61000-4-3:2002

IEC 61000-4-4:2004

IE 61000-4-5:1995 / A1:2000

IEC 61000-4-6:2003

IEC 61000-4-8:1993 / A1:2000

IE 61000-4-11:2004

1. The product is intended for use in non-residential/non-domestic environments. Use of the product in residential/domestic environments may cause electromagnetic interference.
2. Connection of the instrument to a test object may produce radiations beyond the specified limit.
3. Use high-performance shielded interface cable to ensure conformity with the EMC standards listed above.

1. Introduction

1.1 Safety Symbols

1.1.1 Product Marking Symbols

Product will be marked with this symbol when it is necessary to refer to the operation and service manual in order to prevent injury or equipment damage.

Product will be marked with this symbol when hazardous voltages may be present.

Product will be marked with this symbol at connections that require earth grounding.

1.2.2. Caution and Warning Symbols

WARNING Calls attention to a procedure, practice, or condition that could possibly cause bodily injury or death.

CAUTION Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data

1.2 Glossary of Terms (As used in this manual)

Alternating Current, AC: Current that reverses direction on a regular basis, commonly 60 per second or 50 times per second.

Breakdown: The failure of insulation to effectively prevent the flow of current sometimes evidenced by arcing. If voltage is gradually raised, breakdown will begin suddenly at a certain voltage level. Current flow is not directly proportional to voltage. Once breakdown current has flown, especially for a period of time, the next gradual application of voltage will often show breakdown beginning at a lower voltage than initially.

Conductive: Having a volume resistivity of no more than 10^3 ohm-cm or a surface resistivity of no more than 10^5 ohms per square.

Conductor: A solid or liquid material which has the ability to let current pass through it, and which has a volume resistivity of no more than 10^3 ohm-cm.

Current: The movement of electrons through a conductor. Current is measured in amperes, milliamperes, microamperes, nanoamperes, or picoamperes. Symbol = **I**

Dielectric: An insulating material that is positioned between two conductive materials in such a way that a charge or voltage may appear across the two conductive materials.

Direct Current, DC: Current that flows in one direction only. The source of direct current is said to be polarized and has one terminal that is always at a higher potential than the other.

Hipot Tester: Common term for dielectric-withstand test equipment.

Insulation: Gas, liquid or solid material which has a volume resistivity of at least 10^{12} ohm-cm and is used for the purpose of resisting current flow between conductors.

Insulation Resistance Tester: An instrument or a function of an instrument capable of measuring resistance's in excess of 200 megohms. Usually employs a higher voltage power supply than used in ohmmeters measuring up to 200 megohms.

Leakage: AC or DC current flow through insulation and over its surfaces, and AC current flow through a capacitance. Current flow is directly proportional to voltage. The insulation and/or capacitance are thought of as a constant impedance, unless breakdown occurs.

Resistance: That property of a substance that impedes current and results in the dissipation of power, in the form of heat. The practical unit of resistance is the *ohm.* Symbol = **R**

Trip Point: A minimum or maximum parameter set point that will cause an indication of unacceptable performance during a run test.

Voltage: Electrical pressure, the force which causes current through an electrical conductor. Symbol = **V**

1.3 Safety

This product and its related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).
Before applying power verify that the instrument is set to the correct line voltage (110 or 220) and the correct fuse is installed.

WARNING A Hipot produces voltages and currents that can cause **harmful or fatal electric shock.** To prevent accidental injury or death, these safety procedures must be strictly observed when handling and using the test instrument.

1.3.1 Service and Maintenance

User Service
To prevent electric shock do not remove the instrument cover. There are no user serviceable parts inside. Routine maintenance or cleaning of internal parts is not necessary. Avoid the use of cleaning agents or chemicals on the instrument, some chemicals may damage plastic parts or lettering. Any external cleaning should be done with a clean dry or slightly damp cloth. Schematics, when provided, are for reference only. Any replacement cables and high voltage components should be acquired directly from EEC. Refer servicing to an EEC authorized service center.

Service Interval
EEC will not be held liable for injuries suffered if the instrument is not properly maintained and safety checked annually.

User Modification
Unauthorized user modifications will void your warranty. EEC will not be responsible for any injuries sustained due to unauthorized equipment modifications or use of parts not specificated by EEC. Instruments returned to EEC with unsafe modifications will be returned to their orginal operation condition at the customer's expense.

1.3.2 Test Station

Location
Select an area away from the main stream of activity which employees do not walk through in performing their normal duties. If this is not practical because of production line flow, then the area should be roped off and marked for **HIGH VOLTAGE TESTING**. No employees other than the test operators should be allowed inside.

If benches are placed back-to-back, be especially careful about the use of the bench opposite the test station. Signs should be posted: **"DANGER - HIGH VOLTAGE TEST IN PROGRESS - UNAUTHORIZED PERSONNEL KEEP AWAY."**

Work Area
Perform the tests on a non-conducting table or workbench, if possible. If you cannot avoid using a conductive surface, be certain that it is connected to a good earth ground and the high voltage connection is insulated from the grounded surface.

There should not be any metal in the work area between the operator and the location where products being tested will be positioned. Any other metal in the work area should be connected to a good ground, never left "floating".

Position the tester so the operator does not have to reach over the product under test to activate or adjust the tester. If the product or component being tested is small, it may be possible to construct guards or an enclosure around the device to be tested. Construct the guards of a non-conducting material such as clear acrylic, so that the item being tested is within the guards or enclosure during the test. If possible, the guards or enclosure should also contain safety switches that will not allow the tester to operate unless the guards are in place or the enclosure closed.

Keep the area clean and uncluttered. All test equipment and test leads not necessary for the test should be removed from the test bench and put away. It should be apparent to both the operator and to any observers, the product that is being tested and the product that is waiting to be tested, or has already been tested.

Do not perform Hipot tests in a combustible atmosphere or in any area where combustible materials are present.

Power
Dielectric Voltage-Withstand Test Equipment must be connected to a good ground. Be certain that the power wiring to the test bench is properly polarized and that the proper low resistance bonding to ground is in place.

Power to the test station should be arranged so that it can be shut off by one prominently marked switch located at the entrance to the test area. In case of an emergency, anyone can cut off the power before entering the test area to offer assistance.

1.3.3 Test Operator

Qualifications
This instrument generates voltages and currents that can cause **harmful or fatal electric shock** and must only be operated by a skilled worker trained in its use.

The operator should understand the electrical fundamentals of voltage, current, and resistance. They should recognize that the test instrument is a variable high-voltage power supply with the return circuit directly connected to earth ground, therefore, current from the high-voltage output will flow through any available ground path.

Rules

Operators should be thoroughly trained to follow all of the aforementioned rules, in addition to any other applicable safety rules and procedures. Defeating any safety system should be considered a serious offense with severe penalties such as removal from the Hipot testing job. Allowing unauthorized personnel in the area during a test should also be dealt with as a serious offense.

Dress

Operators should not wear jewelry that could accidentally complete a circuit.

Medical Restrictions

Personnel with heart ailments or devices such as pacemakers should be informed that the voltages and currents generated by the instrument are very dangerous. If contacted it may cause heart-related problems that a person of good health may not experience. Please have the test operator consult their physician for recommendations.

1.3.4 Instrument Connections

WARNING Never perform a hipot test on energized circuitry or equipment.

⏚ The instrument is equipped with a safety ground connection, be sure that this is connected to a good earth ground.

Always connect the return lead first, regardless of whether the item under test is a sample of insulating material, a component tested with the high voltage test lead, or a cord-connected device with a two or three prong plug. The return lead should be connected first for any type of hipot testing.

Plug in the high voltage test lead only when it is being used. Handle its clip only by the insulator---**never touch the clip directly.** Be certain that the operator has control over any remote test switches connected to the Hipot. Double check the return and high voltage connections from the Hipot and the Line, Neutral, Ground and Case connections from the Line Leakage tester to be certain that they are proper and secure.

1.3.5 Device Under Test

WARNING Never touch the Device Under Test (DUT) or anything connected to it while high voltage is being applied by the hipot.

When testing with DC, always discharge the capacitance of the item under test and anything the high voltage may have contacted--such as test fixtures--before handling it or disconnecting the test leads.

HOT STICK probes can be used to discharge any capacitance in the device under test as a further safety precaution. A hot stick is a non-conducting rod about two feet long with a metal probe at the end that is connected to a wire. To discharge the device under test, two hot sticks are required. First, connect both probe wires to a good earth ground. Then touch one probe tip to the same place that the return lead was connected. While holding the first probe in place, touch the second probe tip to the same place where the high voltage lead was connected.

1.3.6 Key Safety Points to Remember

Keep unqualified and unauthorized personnel away from the test area.

- Arrange the test station in a safe and orderly manner.
- Never touch the product or connections during a test.
- In case of any problem, turn off the high voltage first.
- Properly discharge any item tested with DC before touching connections.

1.4 Introduction to Product Safety Testing

1.4.1 The Importance of Safety Testing

Product Safety Tests are specified during the design and development stages of a product as well as in the production of the products to insure that it meets basic safety requirements. These tests are designed to verify the safety of the electrical products in that they do not jeopardize the safety of the people, domestic animals, and property of anyone who may come in contact with these products. In an era of soaring liability costs, original manufacturers of electrical and electronic products must make sure every item is as safe as possible. All products must be designed and built to prevent electric shock, even when users abuse the equipment or by-pass built in safety features.

To meet recognized safety standards, one common test is the "dielectric voltage-withstand test". Safety agencies which require compliance safety testing at both the initial product design stage and for routine production line testing include: Underwriters Laboratories, Inc. (UL), the Canadian Standards Association (CSA), the International Electrotechnical Commission (IEC), the British Standards Institution (BSI), the Association of German Electrical Engineers (VDE) and (TÜV), the Japanese Standards Association (JSI). These same agencies may also require that an insulation resistance test and high current ground bond test be performed.

1.5 The Different Types of Safety Tests

1.5.1 Dielectric Withstand Test

The principle behind a dielectric voltage - withstand test is simple. If a product will function when exposed to extremely adverse conditions, it can be assumed that the product will function in normal operating circumstances.

Common Applications of the Dielectric Withstand Test:

- Design (performance) testing: Determining design adequacy to meet service conditions.
- Production Line testing: Detecting defects in material or workmanship during processing.
- Acceptance testing: Proving minimum insulation requirements of purchased parts.
- Repair Service testing: Determine reliability and safety of equipment repairs.

The specific technique used to apply the dielectric voltage - withstand test to each product is different. During a dielectric voltage - withstand test, an electrical device is exposed to a voltage significantly higher than it normally encounters, for a specified duration of time.

During the test, all current flow from the high voltage output to the return is measured. If, during the time the component is tested, the current flow remains within specified limits, the device is assumed safe under normal conditions. The basic product design and use of the insulating material will protect the user against electrical shock.
The equipment used for this test, a dielectric-withstand tester, is often called a "hipot" (for high potential tester). The "rule of thumb" for testing is to subject the product to twice its normal operating voltage, plus 1,000 volts.

However, specific products may be tested at much higher voltages than 2X operating voltages + 1,000 volts. For example, a product designed to operate in the range between 100 to 240 volts can be tested between 1,000 to 4,000 volts or higher. Most "double insulated" products are tested at voltages much higher than the "rule of thumb".

Testing during development and prototype stages is more stringent than production run tests because the basic design of the product is being evaluated. Design tests usually are performed on only a few samples of the product. Production tests are performed on every item as it comes off the production line.

The hipot tester must also maintain an output voltage between 100% and 120% of specification. The output voltage of the hipot must have a sinusoidal waveform with a frequency between 40 to 70 Hz and has a peak waveform value that is not less than 1.3 and not more than 1.5 times the root-mean-square value.

Types of Failures only detectable with a Hipot test

- Weak Insulating Materials
- Pinholes in Insulation
- Inadequate Spacing of Components
- Pinched Insulation

Dielectric Withstand Test; AC verses DC

Please check with the Compliance Agency you are working with to see which of the two types of voltages you are authorized to use. In some cases, a Compliance Agency will allow either AC or DC testing to be done. However, in other cases the Compliance Agency only allows for an AC test. If you are unsure which specification you must comply with please contact our CUSTOMER SUPPORT.

Many safety agency specifications allow either AC or DC voltages to be used during the hipot test. When this is the case, the manufacturer must make the decision on which type of voltage to utilize. In order to do this it is important to understand the advantages and the disadvantages of both AC and DC testing.

AC testing characteristics

Most items that are hipot tested have some amount of distributed capacitance. An AC voltage cannot charge this capacitance so it continually reads the reactive current that flows when AC is applied to a capacitive load.

AC testing advantages

AC testing is generally much more accepted by safety agencies than DC testing. The main reason for this is that most items being hipot tested will operate on AC voltages. AC hipot testing offers the advantage of stressing the insulation alternately in both polarities, which more closely simulates stresses the product will see in real use.

Since AC testing cannot charge a capacitive load the current reading remains consistent from initial application of the voltage to the end of the test. Therefore, there is no need to gradually bring up the voltage since there is no stabilization required to monitor the current reading. This means that unless the product is sensitive to a sudden application of voltage the operator can immediately apply full voltage and read current without any wait time.

Another advantage of AC testing is that since AC voltage cannot charge a load there is no need to discharge the item under test after the test.

AC testing disadvantages

One disadvantage of AC testing surfaces when testing capacitive products. Again, since AC cannot charge the item under test, reactive current is constantly flowing. In many cases, the reactive component of the current can be much greater than the real component due to actual leakage. This can make it very difficult to detect products that have excessively high leakage current.

Another disadvantage of AC testing is that the hipot has to have the capability of supplying reactive and leakage current continuously. This may require a current output that is actually much higher than is really required to monitor leakage current and in most cases is usually much higher than would be needed with DC testing. This can present increased safety risks as operators are exposed to higher currents.

DC testing characteristics

During DC hipot testing the item under test is charged. The same test item capacitance that causes reactive current in AC testing results in initial charging current which exponentially drops to zero in DC testing.

DC testing advantages

Once the item under test is fully charged, the only current flowing is true leakage current. This allows a DC hipot tester to clearly display only the true leakage of the product under test.

Another advantage to DC testing is that the charging current only needs to be applied momentarily. This means that the output power requirements of the DC hipot tester can typically be much less than what would be required in an AC tester to test the same product.

DC testing disadvantages

Unless the item being tested has virtually no capacitance, it is necessary to raise the voltage gradually from zero to the full test voltage. The more capacitive the item the more slowly the voltage must be raised. This is important since most DC hipots have failure shut off circuitry which will indicate failure almost immediately if the total current reaches the leakage threshold during the initial charging of the product under test.
Since a DC hipot does charge the item under test, it becomes necessary to discharge the item after the test.

DC testing unlike AC testing only charges the insulation in one polarity. This becomes a concern when testing products that will actually be used at AC voltages. This is an important reason that some safety agencies do not accept DC testing as an alternative to AC.

When performing AC hipot tests the product under test is actually tested with peak voltages that the hipot meter does not display. This is not the case with DC testing since a sinewave is not generated when testing with direct current. In order to compensate for this most safety agencies require that the equivalent DC test be performed at higher voltages than the AC test. The multiplying factor is somewhat inconsistent between agencies which can cause confusion concerning exactly what equivalent DC test voltage is appropriate.

1.5.2 Insulation Resistance Test

Some "dielectric analyzers today come with a built in insulation resistance tester. Typically, the IR function provides test voltages from 500 to 1,000 volts DC and resistance ranges from kilohms to gigaohms. This function allows manufacturers to comply with special compliance regulations. BABT, TÜV and VDE are agencies that may under certain conditions, require an IR test on the product before a Hipot test is performed. This typically is not a production line test but a performance design test.

The insulation resistance test is very similar to the hipot test. Instead of the go/no go indication that you get with a hipot test the IR test gives you an insulation value usually in Megohms. Typically, the higher the insulation resistance value the better the condition of the insulation. The connections to perform the IR test are the same as the hipot test. The measured value represents the equivalent resistance of all the insulation which exists between the two points and any component resistance which might also be connected between the two points.
Although the IR test can be a predictor of insulation condition it does not replace the need to perform a dielectric withstand test.

1.5.3 Ground Bond Test

The Ground Bonding test determines whether the safety ground circuit of the product under test can adequately handle fault current if the product should ever become defective. A low impedance ground system is critical in ensuring that in case of a product failure, a circuit breaker on the input line will act quickly to protect the user from any serious electrical shock.

International compliance agencies such as CSA, IEC, TÜV, VDE, BABT and others, have requirements calling out this test. This test should not be confused with low current continuity tests that are also commonly called out in some safety agency specifications. A low current test merely indicates that there is a safety ground connection. It does not completely test the integrity of that connection.

Compliance agency requirements vary on how different products are to be tested. Most specifications call for test currents of between 10 and 30 amps. Test voltages at these currents are typically required to be less than 12 volts. Maximum allowable resistance readings of the safety ground circuit are normally between 100 and 200 milliohms.

If you are testing a product that is terminated in a three-prong plug, you are required to perform a continuity or ground bond test on the ground conductor to the chassis or dead metal of the product.

1.5.4 Run Test

All manufacturers of a product that runs on line power normally need to run the DUT (Device Under Test) after final safety testing so that they can verify the functionality of their products. In addition to running the DUT to test its basic functionality many customers also require some basic test data to be recorded while the DUT is powered up. A Run Test System allows the product to be powered up immediately after the safety tests are completed with a single connection to the DUT. Measurements that are commonly made while the DUT is running can include Amperage, Voltage, Watts and Power Factor.

1.5.5 Line Leakage Test

The Line Leakage test is one of many product safety tests that are normally specified for electrical products by safety testing agencies such as Underwriters Laboratories (UL) and the International Electrotechnical Committee (IEC). The line leakage specifications vary as well as the method in which the measurements are taken depending upon the application or function of a product and the standard to which the product is being tested.

Current Leakage or Line Leakage tests are general terms that actually describe three different types of tests. These tests are Earth Leakage Current, Enclosure Leakage Current, and Applied Part Leakage Current. The main differences in these tests are in the placement of the probe for the measuring device. The Earth Leakage Current is the leakage current that flows through the ground conductor in the line cord back to earth. The Enclosure Leakage Current is the current that flows from any enclosure part through a person back to ground if it were contacted by a person. The Applied Part Leakage Current or Patient Lead Leakage Current is any leakage that flows from an applied part, between applied parts or into an applied part. The Applied Part Leakage Current test is required only for medical equipment. All of these tests are used to determine if products can be safely operated or handled without posing a shock hazard to the user.

Line Leakage Testers provide the capability of meeting the line leakage test specified in the following standards; UL 544, IEC 950, UL 1950, IEC 601-1, UL 2601, UL 1563, UL 3101, IEC 1010 and others. The Line Leakage test, is a test which measures the leakage current of a product, through a circuit that is designed to simulate the impedance of the human body. The simulation circuit is called the Measuring Device (MD). The instrument has five different MD circuits, selectable through the menu, which are representative circuits designed to simulate the impedance of the human body under different conditions. The impedance of the human body will vary depending upon point of contact, the surface area of the contact and the path the current flows. For these reasons, the specifications of the Measuring Devices are different depending upon the type of test being performed as well as the maximum allowable leakage current. Leakage current measurements are performed on products under normal conditions and single fault conditions as well as reversed polarity. This simulates possible problems, which could occur if the product under test is faulted or misused while the product is operating under high line conditions (110% of the highest input voltage rating of the product).

Line Leakage tests are normally specified as “Type Tests” or “Design Tests” which are performed during the development of the product. This helps verify that the design is safe but it does not guarantee the safety of the products being produced on the production line. The only way to be sure you are shipping safe products is to test each product at the end of the production line. The user may perform a Leakage Current test along with other common safety test such as Dielectric Withstand, Insulation Resistance, and Ground Bond on the production line with a single connection to the device under test.

1.6 Key Features and Benefits: 7006

▪ **Configurable Scanning matrix**	The 7006 includes a configurable power module that allows the 7006 to be configured as a "master" scanning matrix with its own power source or as a "slave" scanning matrix controlled through an automated EEC instrument. Master configurations can control up-to four additional slave scanners allowing a total of 80 test points from a single power source.
▪ **Up to 16 high voltage switching outputs**	High voltage outputs are rating for up to 5KV AC and 6KV DC providing the ability to handle full hipot capabilities for testing to a wide range of safety agency specifications.
▪ **Up to 16 high current switching outputs**	This allows ground bond testing to be incorporated into automated testing applications. Outputs are rated for up to 40 Amps.
▪ **Automated multi-point or multi-product testing capabilities**	When used in tandem with 77 series and 74 series, the 7006 reduces test setup time and eliminates operator error to ensure consistent test results with the use of full automatics control of the outputs.
▪ **Configurable power module**	The 7006 includes a configurable power module that allows the 7006 to be configured as a "master" scanning matrix with its own power source or as a "slave" scanning matrix controlled through an automated EEC instrument. Master configurations can control up-to four additional slave scanners allowing a total of 80 test points from a single power source.
▪ **Automation interfaces for software control**	The 7006, when configured as a master scanner, comes with both RS-232 and GPIB automation interfaces or control by our Autoware software.
▪ **Front panel indicators**	This indicates the status of each output. The operator can clearly see which output is active and if the instrument is set to High, Low or off.
▪ **Point to point continuity tests**	This high voltage channels can also be used to automate point-to- point continuity test. This allows test connections to be automatically made by the scanning matrix eliminating an operator's exposure to high voltage.
▪ **Compact 2U rack mount design**	This space saving design allows the 7006 to be quickly and easily installed into a rack mount system.

2. Getting Started

This section contains information for the unpacking, inspection, preparation for use and storage of EEC product.

2.1 Unpacking and Inspection

2.1.1 Packaging

Your instrument was shipped in a custom foam insulated container that complies with ASTM D4169-92a Assurance Level II Distribution Cycle 13 Performance Test Sequence.
If the shipping carton is damaged, inspect the contents for visible damage such as dents, scratches or broken display. If the instrument is damaged, notify the carrier and EEC's customer support department. Please save the shipping carton and packing material for the carriers inspection. Our customer support department will assist you in the repair or replacement of your instrument. Please do not return your product without first notifying us .

· Please retain all of the original packaging materials.

Returning the Instrument

When it is necessary to return the instrument for servicing or calibration, repackage the instrument in its original container, please include all accessories and test leads. Indicate the nature of the problem or type of service needed. Also, please mark the container "FRAGILE" to insure proper handling. Please refer to this number in all correspondence.

If you do not have the original packaging materials, please follow these guidelines:

- Wrap the instrument in a bubble pack or similar foam. Enclose the same information as above.
- Use a strong double-wall container that is made for shipping instrumentation. 350 lb. test material is adequate.
- Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inch) thick around all sides of the instrument. Protect the control panel with cardboard.
- Seal the container securely.
- Mark the container "FRAGILE" to insure proper handling.

2.1.2. Contents of the Carton

Inside the carton should be the following:

DESCRIPTION	PART NUMBER
7006 (Standard)	
7006 Scanner	7006
25-Pin External Scanner Bus Cable	W-C2506-RS-C
High Voltage Cable	1105
8 High Voltage Output Cable	1109
4 Hook-Style Crimp Lugs	3-TM-5-8-S
w/ Master Module	
Line Cord	WC-10
Fuse (2A, 20mm, Fast-Blow)	F2A-2F
RS232 Cable	W-RS232-9P2F-2M
w/ High Voltage Module*	
8 High Voltage Output Cable	1109
w/ Ground Bond Module*	
20 Hook-Style Crimp Lugs	3-TM-5-8-S

* The items listed are per module. If two of a particular module have been purchased, then double the amounts listed will be supplied.

2.2 Installation

2.2.1 Work Area

Locate a suitable testing area and be sure you have read all safety instructions for the operation of the instrument and suggestions on the test area set-up in the Safety section. Make sure the

WARNING

work area you choose has a three-prong grounded outlet. Be sure the outlet has been tested for proper wiring before connecting the instrument to it.

2.2.2 Power Requirements

This instrument requires a power source of either 115 volts AC ± 15%, 50/60 Hz single phase or 230 volts AC ±15%, 50/60 Hz single phase. For operation at 115 and 230 Volts AC, use a A, 250VAC fast-blow fuse.

2.2.3 Basic Connections

Power Cable

WARNING

Before connecting power to this instrument, the protective ground (Earth) terminals of this instrument must be connected to the protective conductor of the line (mains) power cord. The main plug shall only be inserted in a socket outlet (receptacle) provided with a protective ground (earth) contact. This protective ground (earth) **must not be defeated** by the use of an extension cord without a protective conductor (grounding).

The instrument is shipped with a three-wire power cable. When the cable is connected to an appropriate AC power source, the cable will connect the chassis to earth ground. The type of power cable shipped with each instrument depends on the country of destination.

Return Connection

CAUTION The output power supplies of this instrument are referenced directly to earth ground. Any conductor that completes a path between the high voltage and earth ground will form a completed circuit.

When the instrument Return is grounded, any internal and external stray leakage will be monitored due to currents that flow from High Voltage to earth ground (such as from HV to the chassis of the instrument). This current is inherent and will cause errors when trying to monitor very low leakage currents in the microampere range.

It is important to note that grounding the return lead will disable the smart GFI function. Smart GFI allows the user to automatically configure the instruments return configuration. When the return lead is earth grounded, the GFI circuit is disabled and the instrument operates in a grounded return mode of operation.

2.3 Environmental Conditions

Operating Environment

This instrument may be operated in temperatures from 0° - 40° C (32° - 104° F) and relative humidity of 20 to 80%, altitude 2000 meters (6560 feet).

Storage and Shipping Environment

This instrument may be stored or shipped in environments with the following limits:

Temperature......................... -40° to 75°C

Altitude........................... 7,620 meters (25,000 feet)

The instrument should also be protected against temperature extremes that may cause condensation within the instrument.

3. SPECIFICATIONS AND CONTROLS

3.1 Specifications

MODEL	7006
High Voltage Rating (H.V.)	5KVAC / 6KVDC
High Current Rating (H.A.)	40A AC
Standard module	1 module (8 H.V. channels)
Optional module (See below for detail)	1 module can be mounted in addition to the standard module Either 8 H.V. or 8 H.A. modules can be selected from option items
Maximum modules per scanner	Maximum 2 models can be mounted
GENERAL	
Input Voltage AC	N / C
Environment	0 - 40ºC, 20 - 80%RH
Dimension (W x H x D), mm	430 x 89 x 300
Net Weight	Max. 9.5Kg
Option:	1. 8 H.V. channels in one module
	2. 8 H.A. channels in one module
	3. Master module : Include GPIB or USB & RS232 Interface and Power module (Input Power 115V / 230Vac ± 15%, 50Hz / 60Hz ± 5%, max. current 2A)
	7006 + Master module acts as master to control slave units (Max 4 units) This makes this system total 80 channels. (16ch / unit x 5 units = 80 ch)
STANDARD ACCESSORIES	
Hipot Link Lead, 1.5m (1105)	x 1
Hipot Output Link Lead, 1.5m (1109)	x 8
External Scanner Cable, 70cm (1111)	x 1

*product specifications are subject to change without notice.

【Ordering Information】

7006 Matrix Scanner (8 H.V. scanner inclusive as standard)

Opt.743 8 H.V. channels module for 5kV ACW / 6kV DCW or IR testing

Opt.744 8 H.A. channels module for 40A Ground Bond testing

Opt.791 Master module with GPIB Interface

Opt.792 Master module with USB & RS232 Interface

Opt.7032 8 H.V. channels module for 7kV ACW / 8kV DCW or IR testing

- One mainframe can only insert one Opt.7032 module.

3.2 Instrument Controls

3.2.1 Front Panel Controls

1. POWER INDICATOR： For a 7006 Master, this lights when the power switch on the rear panel of the unit is turned ON. For a 7006 Slave, this lights when the power switch on the host instrument is turned ON.

2. MODULE TYPE INDICATOR: These LED s indicate the type of module that is installed for the corresponding module slot. If the red LED lights, it indicates that the installed module is a High Voltage / Continuity module. If the green LED lights, it indicates that the installed module is a Ground Bond module.

3. MODULE B CHANNEL STATUS INDICATORS: These LED s indicate the status of each individual channel on Module B. If the red LED lights it indicates a High Voltage/Continuity Current/Ground Bond Channel. If the green LED lights it indicates a Return channel.

4. MODULE A CHANNEL STATUS INDICATORS: These LED s indicate the status of each individual channel on Module A. If the red LED lights it indicates a High Voltage/Continuity Current/Ground Bond Channel. If the green LED lights it indicates a Return channel.

3.2.2. Rear Panel Controls

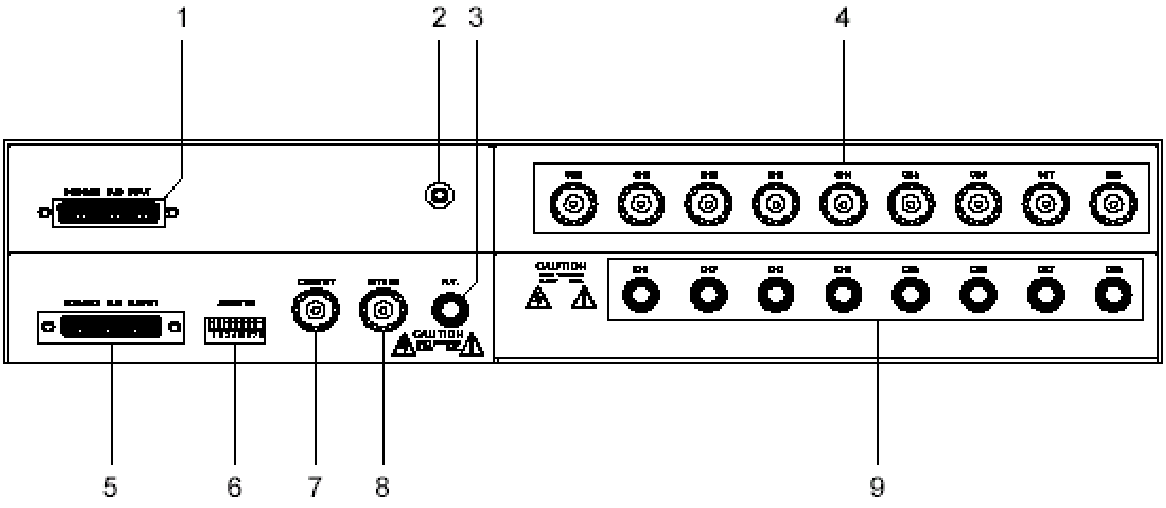


Fig. 1 Slave Configuration

1. SCANNER BUS INPUT: Interconnect port for connecting the control cable between the 7006 slave and an automated EEC safety tester or 7006 master.

2. SAFETY GROUND CONNECTOR: Must be connected to a known good ground system to ensure operator safety.

3. HIGH VOLTAGE INPUT: Connector for input of high voltage output from the host instrument.

4. GROUND BOND OUTPUTS: Output channels for application of high current for Ground Bond tests. These outputs are only available on 7006 scanners that are configured with a Ground Bond Module.

5. SCANNER BUS OUTPUT: Interconnect port for connecting the control cable to another 7006 in a multiple 7006 system.

6. ADDRESS SWITCHES: 8-pin DIP switch used to configure the modules in a 7006 slave or used to configure the address of a 7006 master.

7. CURRENT INPUT JACK: Connector used to attach the high current input lead or continuity current input lead from the host instrument.

8. RETURN INPUT: Connector for interconnecting the return of the host instrument with the 7006. This connection provides the return current path for the high voltage, ground bond current, and continuity current.

9. HIGH VOLTAGE OUTPUTS: Eight individual output channels for high voltage tests and continuity tests. These outputs are only available on 7006 scanners that are configured with a High Voltage Module.

Master Module

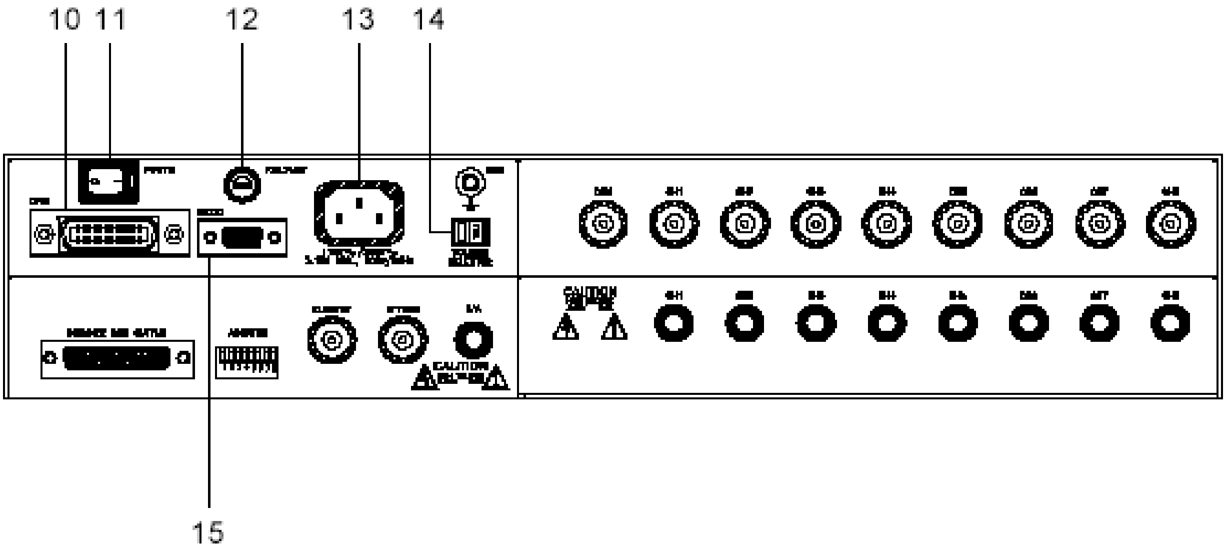


Fig. 2 Master Configuration

10. GPIB CONNECTOR: Standard connector for interconnection to IEEE 488 interface.

11. POWER SWITCH: Switch with international ON (|) and OFF (O) markings.

12. FUSE RECEPTACLE: To change the fuse, unplug the power (mains) cord and turn the fuse receptacle counter-clockwise. The fuse compartment will be exposed. Please replace the fuse with one of the proper rating.

13. INPUT POWER RECEPTACLE: Standard IEC 320 connector for connection to a standard NEMA style line power (mains) cord.

14. INPUT VOLTAGE SWITCH: Line voltage selection is set by the position of the switch. In the left position it is set for 110 120 volt operation, in the right position it is set for 220 240 volt operation.

15. RS-232 CONNECTOR: Standard 9 pin D-Subminiature connector for interconnection to the RS-232 Bus interface.

4. OPERATION

The 7006 is built off of two basic configurations; these are either a master scanning matrix or a slave scanning matrix. The master scanning matrix includes its own power module and is controlled directly through automation software, by using the standard RS-232 or GPIB interfaces. In addition, a master scanning matrix can control up to 4 slave scanning matrices which provides a total of 80 testing channels from a single power source. The slave is configured without a power module and can only be controlled by EEC automated electrical safety tester or a master scanning matrix. EEC automated electrical safety tester can control up to 16 scanner channels at any time. For scanner channel configurations of greater than 16, automation software must be used. For more information on controlling scanners with the EEC safety tester that you have, please consult the tester s manual. The following configurations are available for either the 7006 master or slave scanning matrix.

8 High Voltage/Continuity Testing Channels
16 High Voltage/Continuity Testing Channels
8 High Voltage/Continuity & 8 High Current Testing Channels
8 High Current Testing Channels
16 High Current Testing Channels

4.1. Operation of the 7006 with ESA Series

4.1.1. Description

The 7006 Scanning system can be easily interconnected to any ESA series tester to enhance it s testing capabilities. In order to fully understand this option you should also refer to the manual for ESA series. This switching matrix allows ESA to direct high voltage or continuity current to any of the High Voltage channels or high current to to any Ground Bond channel. The amount of channels available for each type of test depends on the type of scanning system configuration the user has. This accessory is ideal for applications where multiple points of the same item need to be tested quickly and accurately. The Scanner is also applicable when high volume manufacturing calls for multiple item testing to save setup time.

4.1.2. Interconnect Cables

When the 7006 scanner is to be used with an ESA series tester, the 7006 comes with a number of hardware and interconnect cables depending on the modules that are a part of the system.

The 25-pin control cable connects between the rear panel SCANNER 1 or SCANNER 2 connector of ESA and the rear panel connector of the 7006. The High Voltage Cable is then connected from the high voltage rear output connector of the ESA to the rear high voltage input of the 7006. The rear panel return of 7006 is connected to the rear panel return input of the 7006 with the black return cable. The rear panel current output of ESA is connected to the rear panel input of the 7006 with the red ground bond output cable. Eight high voltage connectors are provided as well as a reel of cable and assembly instructions so that each user can assemble the lengths of High Voltage Cable to meet their specific needs. 20 hook-style crimp lugs are provided so that the user can connect their ground bonding cables to the scanner. Refer to section 4.2.3 of this manual for more information on connecting ESA and 7006.

WARNING Under certain conditions high voltage can appear on the cabinet of the 7006. The ground terminal on the rear panel of the 7006 must be connected to a good earth ground to ensure operator safety.

The rear panel of the 7006 can include up to sixteen output terminals for Ground Bond testing if this configuration was selected at the time of purchase. We recommend using standard 12 gauge wire for operation at 30 amps and 10 gauge wire for 40 amps. The wires should be attached using the hook-style crimp lugs provided, to minimize connection resistance. The Kelvin connection of an EEC ground bond tester will end at the ground bond input terminals of the 7006 scanner. For this reason, the wire lengths going from the 7006 high current outputs and the high current return should be kept as short as possible to limit the effect of test lead resistance.

7006 slave scanning matrix configuration does not have it s own power switch or any other user configurable switches. Power is provided through the ESA or a 7006 master scanning matrix and setup of the 7006 is done through the ESA control menu or automation software.

4.1.3. Connection Diagrams

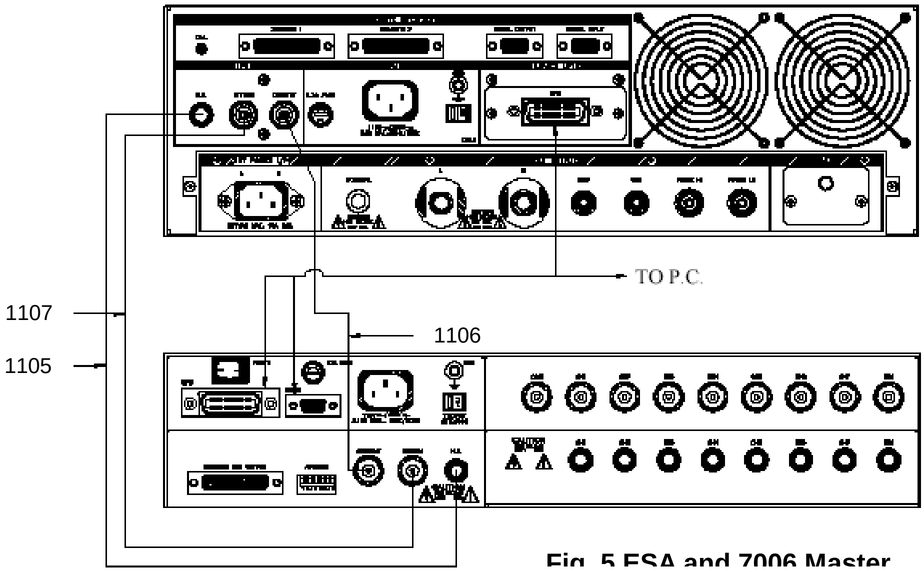


Fig. 5 ESA and 7006 Master

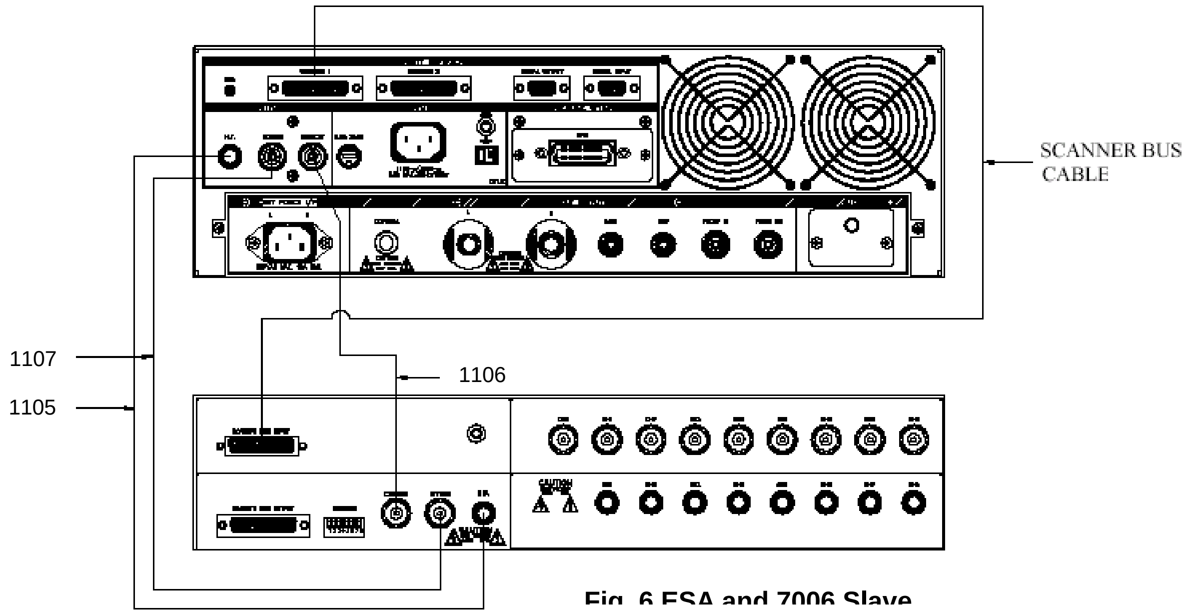


Fig. 6 ESA and 7006 Slave

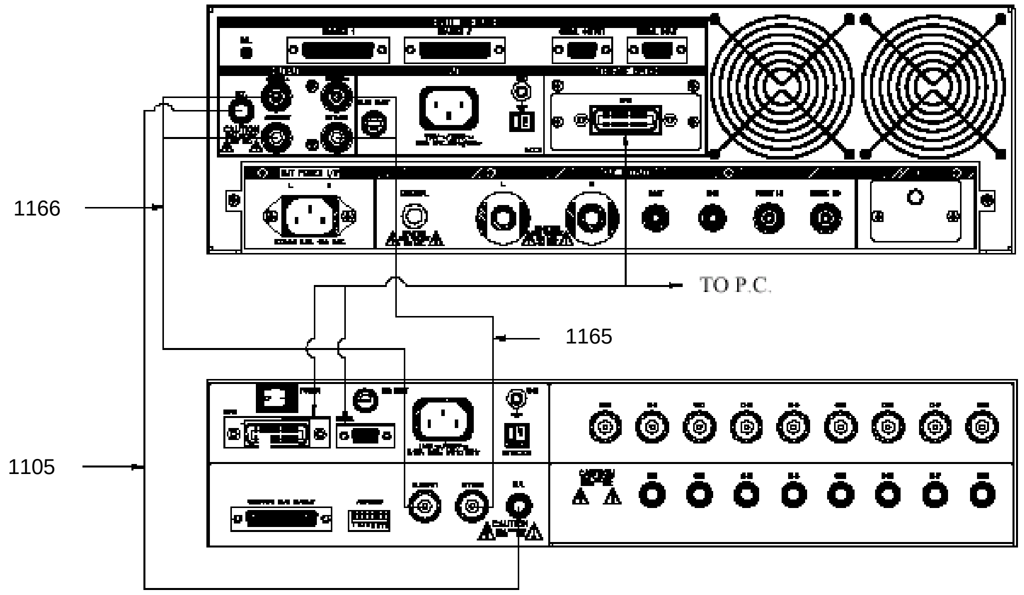


Fig. 7 ESA and 7006 Master

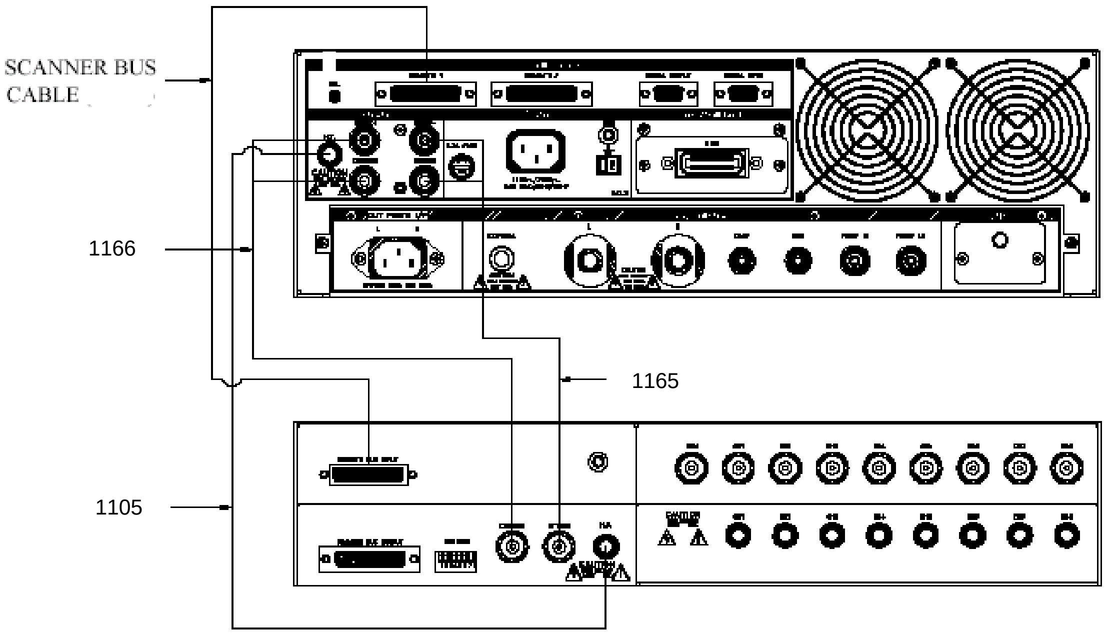


Fig. 8 ESA and 7006 Slave

4.1.4. Setup

High Voltage and Ground Bond scanner channels on the 7006 can be set as High (High Voltage, Ground Bond Current Output, Continuity Current Output), Low (Return) or Open. Parameter setup is done through the ESA setup menu or with automation software. For information on 7006 setup through EEC's Autoware Automation Software, consult the Autoware Manual. The following setup procedure will refer to setup through the ESA setup menu.

If you are in the ACW Withstand, DCW Withstand, Insulation Resistance, Ground Bond or Continuity test Test Setup menu you will find the Scanner settings. Below is an example of the ACW Withstand Test Setup Menu.

The above menu shows an ESA connected in a 16-channel configuration. This configuration can be one internal 8-channel scanner combined with an external 8-channel scanner or two external 8-channel scanners. With a two external 8-channel scanner configuration, one scanner should be connected to the Scanner 1 connector on the rear panel of ESA and the second scanner should be connected to the Scanner 2 connector on the rear panel of ESA. Each scanner port on the rear panel of ESA can only control 8 channels at a time, which makes a maximum total of 16 possible external scanner channels controllable by ESA. To control more than 16 external channels, automation software must be used along with a 7006 Master and a P.C.

Navigate the Test Setup screen using the arrow keys located on ESA keypad until you reach the

Scanner Setup portion of the menu. The channels of the scanner can be set using the Scanner Select softkey located to the right of the ESA. The channels of the scanner can be set to three different states:

H (High) - High voltage output channel for a high voltage test or current output for a ground bond or continuity test.
L (Low) - High voltage return channel for a high voltage test or a current return for a ground bond or continuity test.
O (Open) - Channel is neither an output nor a return.

4.1.5. Operation

Once the 7006 slave is interconnected to ESA, the power on LED will light as soon as the power switch of the ESA is turned on. The 7006 master is powered on by turning the switch on the rear panel of the unit to the ON position. The two leftmost LEDs for Module A and Module B indicate the type of module that has been installed. If the Red LED is illuminated there is a High Voltage module present. If the Green LED is illuminated there is a Ground Bond module present. The 7006 scanner channels will activate when the TEST switch of ESA is pressed. Individual LED indicators for each output provide an indication of whether the output is set as High, Low or Open. If the channel is set as a High Voltage Output, Ground Bound Output or Continuity Current Output, the red LED will light. If the channel is set as a Return the green LED will light. If the is set to Open then no LED will light.

When the Stop on Fail feature has been turned ON and a failure is detected, the test will stop, the output will be deactivated and the ESA will give a visual and audible indication of failure. If steps were connected to sequence through the outputs, then the test will stop and ESA will indicate failure once it reaches the output that was connected to the defective device. The 7006 will not continue on to test the other outputs until the RESET switch is pressed, the defective item is removed, and the TEST switch is pressed once again. The 7006 will then begin to test from the first setup in the program.

CAUTION

Multiple high voltage outputs or continuity current outputs can be set to activate simultaneously. However, when configured this way the 7006 cannot provide an indication of which output detected failure. Therefore, each item or test point would again have to be re-tested individually if the operator needs to determine the exact point of failure.

4.2. Interfacing Multiple 7006

7006 was designed to allow the capability of interfacing multiple scanning matrixes with one EEC automated electrical safety testers into an integrated test system. One 7006 master configuration has the ability to control up to four 7006 slaves through the manipulation of the scanner bus interface and the address switches located on the rear panel of the 7006 scanners.

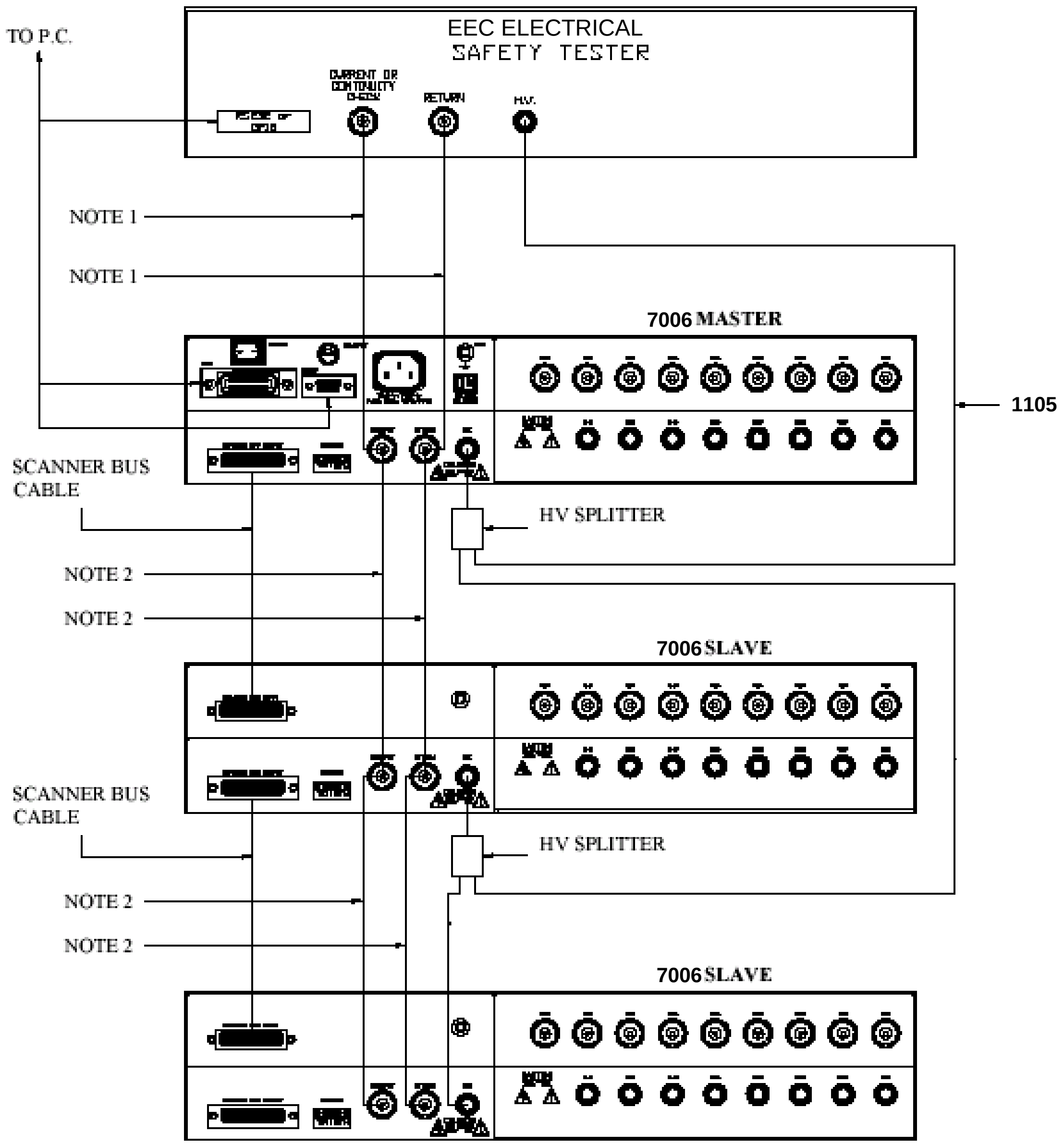
4.2.1. Scanner Interconnection

A 7006 master scanning matrix can be controlled by either a GPIB or RS232 interface. Both connectors come standard on the rear panel of the instrument. To connect a 7006 slave to a 7006 master, simply connect the master s Scanner Bus Output connector to the slave s Scanner Bus Input connector with the 25-pin External Scanner Bus Cable that is included with the 7006 slave. For systems that contain more than one slave, connect the Scanner Bus Output connector on the first slave to the Scanner Bus Input connector on the second slave with a second 25-pin External Scanner Bus Cable that is included with the second slave. This procedure should be followed with each additional slave that is added to the system.

The high voltage splitter should be connected to the high voltage input terminal on the rear panel of the 7006 master. This allows for a high voltage input cable from the host instrument and an output terminal for connection of high voltage to the next scanner in the system. If more than one 7006 slave is used, then an additional splitter is needed. All 7006 scanners in the system should be configured with a high voltage splitter except for the last one in the sequence (Amount of Splitters Needed = Total # of 7006s—1). The High Voltage Cable is used to connect from the splitter to the next 7006 scanner. Four hook-style crimp lugs are supplied for tying the Current and Return terminals from one scanner to the Current and Return terminals on the next scanner in the system. The lugs should be attached to user-supplied wire. Two terminals are supplied per binding post (Current and Return). One terminal is for the connection coming from the previous scanner in the system (if applicable) and one is for the connection to the next scanner in the system (if applicable), creating a daisy chain configuration. See Fig. 9 for an example on interconnecting scanners.

For Ground Bond applications we recommend using 10AWG wire for 40A testing and 12AWG for 30A testing.

4.2.2. Connection Diagram



NOTE 1 – Refer to the connection diagram for the applicable safety tester for the required cabling.
NOTE 2 – Use supplied Hook-Style Crimp Lugs and user specified wire for scanner-to-scanner interconnection.

Fig. 9 7006 Scanner Interconnection Example with 1 Master and 2 Slaves

4.2.3. Scanner Addressing

Addressing Master Units

The scanner bus connection alone will not allow for complete communication with the 7006 master or the EEC automated electrical safety tester. The address switches located on the rear of the instrument must also be configured. The 8 pin DIP switch on the 7006 master should be configured to the GPIB address (if applicable) you wish to use for the scanner. This will allow the computer to communicate with the master scanners connected to the bus so it can control the correct output when it receives a software command. The 8 pin DIP switch uses pins 1-5 to set the

GPIB address. Pins 6 through 8 on the master scanner are not used. The DIP switch is set in the up position for ON and in the down position for OFF. This is opposite to what the ON position is shown on the actual DIP switch on the rear of the panel of the unit. The DIP switch is arranged from pin 1 to pin 5 according to the following Binary Code.

PIN 1 = 1
PIN 2 = 2
PIN 3 = 4
PIN 4 = 8
PIN 5 = 16

The GPIB address number is the sum of the total binary code on the DIP switch. The GPIB address must be selected before turning ON the unit. Example: If you wish to set the address number on the master scanner to 9, you must turn ON (UP) DIP switch pin 1 and 4 and turn OFF (DOWN) pin 2, 3 and 5. If you wish to set the address number to 8, you must turn ON DIP switch 4 and turn OFF pin 1, 2, 3, and 5. A default address number of 9 is set at the factory. For more information on GPIB or RS232, consult section 5 Bus Remote Interface GPIB/RS232.

Addressing Slave Units

Each of the 7006 slave units also have an 8 pin DIP address switch which must be configured based upon the type of scanner installed (HV or High Current) and the total number of points controlled by each master for each function. The first 4 switches are for setting the address for the A position scanner, (the lower scanner), and the last four switches are for setting the address for the B position scanner, (the upper scanner) installed in each slave unit. The DIP switches in the slave scanners are arranged with the following Binary Code for setting the circuit address (not the GPIB address):

PIN 1 = 1
PIN 2 = 2
PIN 3 = 4
PIN 4 = 8
PIN 5 = 1
PIN 6 = 2
PIN 7 = 4
PIN 8 = 8

<u>Channel Assignment</u>

Each scanner unit can accept up to two 8 channel modules to be configured with up to 16 channels whether the unit is set up as a slave or master. Each module is physically marked on the front and rear panel with channel numbers of 1 through 8. But when using multiple modules you actually can have up to 80 individual channels to control. To direct the control signals to the correct channel and for the operator to know what channel numbers have been assigned to multiple scanners the address setting function must be used. Each High Voltage module must have its own unique address setting to operate correctly. This is also the same for each individual Ground Bond module. However, since Ground Bond and High Voltage modules are for different test functions a common address setting can be shared between two modules of different types. By setting the address you are configuring a set of virtual channel numbers for each of the modules. The following grid shows the set of channel numbers that are assigned for each unique address setting.

Address Setting	Virtual Channel Numbers
0	1-8
1	9-16
2	17-24
3	25-32
4	33-40
5	41-48
6	49-56
7	57-64
8	65-72
9	73-80

Setting the DIP switches;
Example 1; Setting up a test with either 80 HV test points or 80 High Current test points. The DIP switches on the master scanner must be set to the correct GPIB address (if applicable). See above. Note, fifteen devices can be controlled over a single GPIB bus.

A circuit address must also be assigned for each bank of 8 channel scanners. The master scanner automatically assigns a circuit address for the two 8 channel scanners installed in the master. The circuit address will be automatically set to 0 for position A and B if both of the scanners are of different types (1 HV and 1 High Current).

If a 7006 master is configured with either two High Current scanners or two High Voltage scanners, position A will be assigned a 0 address for channels 1-8 and position B will be assigned a 1 address for channels 9-16. A system requiring 80 test points would require 4 slave scanners each set up with two 8 channel scanners, one in position A and one in position B. Please refer to the following chart for circuit address set up instructions:

Scanner Type	Position	Circuit Address	Channels
Master	A	Automatically assigned 0	1-8
Master	B	Automatically assigned 1	9-16
Slave 1	A	2	17-24
Slave 1	B	3	25-32
Slave 2	A	4	33-40
Slave 2	B	5	41-48
Slave 3	A	6	49-56
Slave 3	B	7	57-64
Slave 4	A	8	65-72
Slave 4	B	9	73-80

For the above configuration the DIP switches would be set as follows:

Master	The DIP switch would be set for the GPIB address.	
Slave 1	Position A	PIN 1 = OFF
	Address 2	PIN 2 = ON
		PIN 3 = OFF
		PIN 4 = OFF
Slave 1	Position B	PIN 5 = ON
	Address 3	PIN 6 = ON
		PIN 7 = OFF
		PIN 8 = OFF
Slave 2	Position A	PIN 1 = OFF
	Address 4	PIN 2 = OFF
		PIN 3 = ON
		PIN 4 = OFF
	Position B	PIN 5 = ON
	Address 5	PIN 6 = OFF
		PIN 7 = ON
		PIN 8 = OFF
Slave 3	Position A	PIN 1 = OFF
	Address 6	PIN 2 = ON
		PIN 3 = ON
		PIN 4 = OFF
	Position B	PIN 5 = ON
	Address 7	PIN 6 = ON
		PIN 7 = ON
		PIN 8 = OFF
Slave 4	Position A	PIN 1 = OFF
	Address 8	PIN 2 = OFF
		PIN 3 = OFF
		PIN 4 = ON
	Position B	PIN 5 = ON
	Address 9	PIN 6 = OFF
		PIN 7 = OFF
		PIN 8 = ON

Example 2; A system requiring both 40 High Current and 40 High Voltage test points can be set up in either of the following configurations. The GPIB address would have to be set up on the master scanner and the master scanner would automatically assign the circuit address for the type of scanners installed in it. If a High Current Scanner is installed into position A and a High Voltage scanner is installed in position B a circuit address of 0 will be assigned to both positions because they represent test points 1-8 for both test functions.

Scanner Type	Position	Circuit Address	Channels
Master HC	A	Automatically assigned 0	1-8
Master HV	B	Automatically assigned 0	1-8
Slave 1 HC	A	1	9-16
Slave 1 HV	B	1	9-16
Slave 2 HC	A	2	17-24
Slave 2 HV	B	2	17-24
Slave 3 HC	A	3	25-32
Slave 3 HV	B	3	25-32
Slave 4 HC	A	4	33-40
Slave 4 HV	B	4	33-40

Example 3; The last example shows a test system requiring 40 HV and 40 HC points set up in a different configuration. The master and the first slave are set up with HV scanners in position A and B with the second slave is set up with one HV scanner and one HC scanner. The remaining slave scanners are set up with all HC scanners.

Scanner Type	Position	Circuit Address	Channels
Master HV	A	Automatically assigned 0	1-8
Master HV	B	Automatically assigned 1	9-16
Slave 1 HV	A	2	17-24
Slave 1 HV	B	3	25-32
Slave 2 HV	A	4	33-40
Slave 2 HC	B	0	1-8
Slave 3 HC	A	1	9-16
Slave 3 HC	B	2	17-24
Slave 4 HC	A	3	25-32
Slave 4 HC	B	4	33-40

5. Bus Remote Interface GPIB/RS-232

This section provides information on the proper use and configuration of bus remote interface. The RS-232 remote interface and GPIB (IEEE-488) remote interface are both standard on the 7006 Master configuration. Please refer to the Option section of this manual for details on the 7006 options. The RS-232 interface also uses the same command set as the GPIB interface for setting of scanner configurations. However, many functions of the GPIB 488.2 interface are not available through RS-232. The IEEE-488 interface included with 7006 conforms to the requirements of the IEEE-488.2 standard.

5.1. Description

Some test applications require more outputs for testing multiple points than the Automated Electrical Safety Instrument can control by itself. Additionally, in a production environment, time and money constraints require that multiple products be tested at the same time.

The 7006 accommodates both of these requirements. The 7006 allows for multiple scanners to be controlled independently with either the ESA. The 7006 is connected directly to a computer via a GPIB cable. The ESA would be setup as a separate device on the same bus. The output of the testers must be directly connected to the inputs of the 7006 scanner(s). Standard GPIB commands are used to activate the selected outputs of the scanner(s). Since a GPIB bus will allow connection of up to 15 devices, a total of up to thirteen 7006 Masters and either a ESA could be connected to a single GPIB card. Total system capability on a single bus could accommodate 13 7006 Master scanners, which would allow 1040 points be tested.

5.2. A Brief History of IEEE-488....

Hewlett-Packard designed in 1965 the Hewlett-Packard Interface Bus (HP-IB) to connect their line of programmable instruments to computers. This bus had high transfer rates (nominally 1 Mbytes/s), and thus quickly gained acceptance. Later, it was accepted as the IEEE Standard 488-1975 and has then evolved into ANSI/IEEE Standard 488.1-1987. An enhancement to this standard was the IEEE standard 728-1982 and evolved into IEEE Std 488.2-1887. The new standard 488.2 was created and intended to be used with the existing 488.1 standard. The 488.2 standard defines issues related to standard codes, formats, protocols, and common commands.

IEEE-488 has expanded over the years and is used with many more types of computers and instruments than just HP. Because of this, it is usually referred to as the General Purpose Interface Bus, (GPIB).

5.3. GPIB Messages

There are typically two types of messages that GPIB devices use to communicate with other interconnected GPIB devices;

Interface messages: often called commands or command messages and Device dependent messages often called data or data messages.

Data Messages: contain information such as programming instructions or measurement results. Command Messages perform functions such as initializing the bus and addressing and unaddressing devices.

5.4. Functions

A GPIB device can be a Listener, Talker and/or Controller. A Talker sends data messages to one or more Listeners, which receive data. A Controller manages the information flow on the GPIB by sending commands to all devices. The GPIB bus is much like a computer bus except a computer has circuit cards connected via a backplane and the GPIB has stand alone devices connected via a cable.

5.5. Signals and Lines

The GPIB consists of 16 signal lines and 8 ground-return or shield drain lines. The 16 signal lines are grouped into 8 data lines, 3 handshake lines and 5 interface management lines.

Data Lines: The eight data lines, DI01 through DI08 carry data and command messages. The 7-bit ASCII or ISO code set is used and the eighth bit DI08 is unused. Handshake Lines: The transfer of message bytes between devices is done via three asynchronously control lines. Referred to as three-wire interlocked handshake. This guarantees that message bytes on the data lines are sent and received without transmission error.

NRFD (not ready for data) indicates when a device is ready or not ready to receive a message byte.

NDAC (not data accepted) indicates when a device has or has not accepted a message byte.

DAV (data valid) tells when the signals on the data lines are stable (valid) and can be accepted safely by devices.

Interface Management Lines: Five lines are used to manage the flow of information across the interface.

ATN (attention) ATN is driven true by the controller when it uses the data lines to send commands, and drivers ATN false when a Talker can send data messages.

IFC (interface clear) IFC is driven by the system controller to initialize the bus and become CIC.

REN (remote enable) The REN line is driven by the controller which is used to place devices in remote or local program mode.

SRQ (service request) The SRQ line can be driven by any device to asynchronously request service from the Controller.

EOI (end or identify) This line has two purposes- the Talker uses this line to mark the end of a message string, and the Controller uses it to tell devices to identify their response in a parallel poll.

5.6. GPIB Connector

Connection is usually accomplished with a 24-conductor cable with a plug on one end and a connector at the other end. Devices may be connected in a linear, star or a combination configuration.

The standard connector is the Amphenol or Cinch Series 57 Microribbon or AMP CHAMP type.
The GPIB uses negative logic with standard transistor-transistor logic (TTL) levels. When DAV is true, for example, it is a TTL low level (0/8 V), and when DAV is false, it is a TTL high level (2.0 V).

Restrictions and Limitations on the GPIB
A maximum separation of 4 m between any two devices and an average separation of 2 m over the entire bus.

A maximum total cable length of 20 m.

No more than 15 device loads connected to each bus, with no less than two-thirds powered on.
Note: A bus extender which is available from numerous manufacturers is available to overcome these limitations.

5.7. GPIB Address Setup

This is an 8-pin DIP switch. Pins 1 through 5 are used to set the GPIB address. Pins 6 through 8 are not used. The DIP switch is set in the up position for ON and in the down position for OFF. This is opposite to what the On position is shown on the actual DIP switch on the rear panel of the unit. The DIP switch is arranged from pin 1 to pin 5 according to the following Binary Code:

PIN 1 = 1
PIN 2 = 2
PIN 3 = 4
PIN 4 = 8
PIN 5 = 16

The GPIB address number is the sum of the total binary code on the DIP switch. The GPIB address must be selected before turning ON the unit. The GPIB address must be set before the unit is turned on.

EXAMPLES: If you wish to set the address number to 9, you must turn ON (UP) DIP switch pin 1 and pin 4 and turn OFF (DOWN) pin 2, pin 3 and pin 5. If you wish to set the address number to 8, you must turn ON DIP switch pin 4 and turn OFF pin 1, pin 2, pin 3 and pin 5. A default address number of 9 is set at the factory.

5.8. Interface Functions

The capability of a device connected to the bus is specified by its interface functions. These functions provide the means for a device to receive, process, and send messages over the bus. The interface functions are listed in the chart below.

GPIB 488.1 INTERFACE FUNCTIONS

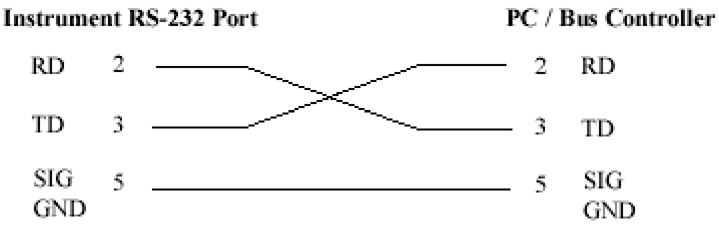
Interface Function	Subset	Description
Source Handshake	SH1	Complete Source handshake capability
Acceptor Handshake	AH1	Complete Acceptor handshake capability
Talker	T6	Talker functions (unaddress if MLA)
Listener	L4	Listener functions (unaddress if MTA)
Service Request	SR1	Complete Service request capability
Remote Local	RL0	No remote/local capability
Parallel Poll	PP0	No parallel poll capability
Device Clear	DC1	Complete Device clear capability
Device Trigger	DT0	No device trigger capability
Controller	C0	No controller capability
Electrical Interface	E2	Three-state drivers

Controllable Items	Test and Reset control. Setting of test parameters for tests. Reading of instrument status and test results.
Data Codes	ASCII
Delimiter	NL (+ EOI)

5.9. RS-232 Interface

This interface is also standard on a 7006 master. This interface provides all of the control commands and parameter setting commands of the GPIB interface with the exception of some of the 488.2 Common Commands and SRQ capability. All commands can be found in the command list, section 5.9.1 to 5.9.6 of this manual. The identification command *IDN and the Status Reporting commands are also available through RS-232.

The RS-232 cabling should be configured as follows for a 9-pin serial port interface:



The COM port should have the following configuration. 9600baud, 8 data bits, 1 stop bit, no parity. This interface does not support XON/XOFF protocol or any hardware handshaking. The controller should be configured to ignore the handshaking lines DTR (pin 4), DSR (pin 6) CTS (pin 8) and RTS (pin 7). If the port cannot be configured through software to ignore the lines then the handshake lines should be jumpered together at the controller end of the cable.

When sending command over the RS232 bus the instrument will send a response string of 06 hex or 6 decimal, the Acknowledge (ACK) ASCII control code if the transfer was recognized and completed by the instrument. If there is an error with the command string that is sent, the instrument will respond with 15 hex or 21 decimal, the Not Acknowledge (NAK) ASCII control code. The ACK or NAK response strings, until it has been read by the controller.

5.10. GPIB / RS-232 Interface Command List

A GPIB read command must be sent after the command strings, to retrieve any data from a query command (?). The 7730 GPIB bus will not send any data to the controller without being queried. The RS-232 bus will automatically send any response back to the controller's input buffer. Each command string should be terminated by the ASCII control code, New Line <NL>, OAh or the end of line EOL message for GPIB. The following conventions are used to describe the commands syntax for the 7006. Braces ({ })enclose each parameter for a command string. Triangle brackets (< >) indicate that you must substitute a value for the enclosed parameter. The Pipe (|) is used to separate different parameter options for a command. The command and the parameter data must be separated with a space.
All commands that end with a question mark (?) are query commands and required an IEEE-488 read command to retrieve the data from the device's output buffer.

5.10.1. Scanner Channel Configuration Commands

The following commands are used to create or modify Test Setup Files.

Command	Description	Value
HV <channel configuration>	High Voltage channel set	H, L, O
CONT <channel configuration>	Continuity channel set	H, L, O
GND <channel number>	Ground Bond channel set	channel number = 1 - 80
CH:HV <channel numbers>	High Voltage channel set	channel number = 1 - 80
CH:CONT <channel numbers>	Continuity channel set	channel number = 1 - 80
CH:RTN <channel numbers>	Return channel set	channel number = 1 - 80
CH <channel numbers>?	Read channel set	channel number = 1 - 80

(1) "Valid ASCII" is the character set that is available from the front panel LCD user interface. Consisting of upper case alphabet (A-Z), numbers (0-9) and decimal point (.), asterisk (*), dash (-), under bar (_), tilde (~) and space (SP).

HV <channel configuration>

Set High Voltage channels in sequential order with values H (High), L(Return), O(Open). All channels that are not assigned a value (H,L or O) with be automatically set to O(Open). For example, HV HOHL will set channels 1 and 3 High, channel 2 Open, and channel 4 Low. All other channels will be set to Open.

CONT <channel configuration>
Set Continuity channels in sequential order with values H(High), L(Return), O(Open). All channels that are not assigned a value (H,L or O) with be automatically set to O(Open). For example, CONT HOHL will set channels 1 and 3 High, channel 2 Open, and channel 4 Low. All other channels will be set to Open.

GND <channel number>
Set an individual channel for a High Current Ground Bond test. For example, GND 1 will set channel 1 as a Ground Bond output and all other channels will remain unchanged.

CH:HV <channel numbers>
Set individual channels as H(High) for a High Voltage test. Channels must be separated with a comma. For example, CH:HV 1,2 will set channels 1 and 2 High and all other channels will remain unchanged.

CH:CONT <channel numbers>
Set individual channels as High for a Continuity Test. Channels must be separated with a comma. For example, CH:CONT 1,2 will set channels 1 and 2 High and all other channels will remain unchanged.

CH:RTN <channel numbers>
Set individual channels as Low (Return). Channels must be separated with a comma. For example, CH:RTN 1,2 will set channels 1 and 2 as Return and all other channels will remain unchanged.

5.10.2. Query Commands

These query commands will retrieve data from the instrument. The GPIB bus application requires an IEEE-488 read command to be sent after the query command. These commands include functions for retrieving test data, test results and remote hardware status as well as setup file information.

5.10.3. IEEE 488.2 Common Commands

These commands are required by the IEEE-488.2 standard with the exception of *PSC, *PSC?. Most of these commands are not available over the RS-232 bus except for the *IDN? command which can be used to retrieve the instrument identification information, and the four status reporting commands *ESR?, *ESE, *ESE? and *STB?

Command	Name	Description
*IDN?	Identification Query	ARI, Model Number, Serial Number, Firmware Revision
*RST	Reset Command	Resets SC6540
*TST?	Self-Test Query	00H=OK 01H=TEST EEPROM ERROR
*CLS	Clear Status Command	Clear Standard Event Status Register Clear Service Request Register
*OPC	Operation Complete Command	When TEST command ok setting ESR BIT0 =1
*OPC?	Operation Complete Query	
*WAI	Wait-to-Continue Command	
*PSC {1|0}	Power-on Status Clear Command	1 = Power-on clear enable registers 0 = Power-on load previous enable registers
*PSC?	Power-on Status Clear Query	
*ESR?	Standard Event Status Register Query	0 - 255
*ESE <*value*>	Standard Event Status Enable Command	*value* = 0 - 255
*ESE?	Standard Event Status Enable Query	0 - 255

Command	Name	Description
*STB?	Read Status Byte Query	Read Status Byte
*SRE <*value*>	Service Request Enable Command	*value* = 0 - 255
*SRE?	Service Request Enable Query	0 - 255

***IDN?**
Read the instrument identification string. Company =ARI.

***RST**
Reset the instrument to original power on configuration. Does not clear Enable register for Standard Summary Status or Standard Event Registers. Does not clear the output queue. Does not clear the power-on-status-clear flag.

***TST?**
Performs a self-test of the instrument data memory. Returns 0 if it is successful or 1 if the test fails.

***CLS**
Clears the Status Byte summary register and event registers. Does not clear the Enable registers.

***OPC**
Sets the operation complete bit (bit 0) in the Standard Event register after a command is completed successfully.

***OPC?**
Returns an ASCII "1" after the command is executed.

***WAI**
After the command is executed, it prevents the instrument from executing any further query or commands until the no-operation-pending flag is TRUE.

***PSC {1|0}**
Sets the power-on status clear bit. When set to 1 the Standard Event Enable register and Status Byte Enable registers will be cleared when power is turned ON. 0 setting indicates the Enable registers will be loaded with Enable register masks from non-volatile memory at power ON.

***PSC?**
Queries the power-on status clear setting. Returns 0 or 1.

***ESR?**
Queries the Standard Event register. Returns the decimal value of the binary-weighted sum of bits.

***ESE <*value*>**
Standard Event enable register controls which bits will be logically OR d together to generate the Event Summary bit 5 (ESB) within the Status Byte.

***ESE?**
Queries the Standard Event enable register. Returns the decimal value of the binaryweighted sum of bits.

***STB?**
Read the Status Byte. Returns the decimal value of the binary-weighted sum of bits.

***SRE <*value*>**
Service Request enable register controls which bits from the Status Byte should be use to generate a service request when the bit value = 1.

***SRE?**
Queries the Service Request enable register. Returns the decimal value of binary-weighted sum of bits.

5.10.4. Status Reporting
Status reporting system is configured using two types of registers. An Event Register and a Summary register. The summary register is known as the Status Byte register and records high-level summary information acquired by the event registers.

An Event register report defined conditions or messages at each bit. The bits are latched and remain at an active state until the register is either Read or Cleared. Reading the event register automatically clears the register and sets all bits to inactive state or 0. When querying an event register the information is returned as a decimal number representing the binary-weighted sum of all bits within the register.
The Enable registers bits represent the selection of bits that will be logically-ORed together to

form the summary bit in the status byte. The *CLS command will not clear the enable registers and if you wish to clear the register you must set it to a value of 0. Like the event register, the enable register is represented as a decimal number that equals the binaryweighted sum of all bits. The enable register will clear to value of 0 at power up unless the *PSC 0 command had been executed before power-off. The *PSC command tells the device whether or not it should clear the enable registers at power-on. Using this command will allow SQRs to function immediately after power-on.

		Standard Event Register		Status Byte Register	
Bit	Binary weight	Event Register	Enable Register	Summary Register	Enable Register
0	1	Operation Complete		not used	
1	2	not used		not used	
2	4	Query Error		not used	
3	8	not used		not used	
4	16	Execution Error		Message Available (MAV)	
5	32	Command Error		Event Summary Bit (ESB)	
6	64	not used		Request Service (RQS) or Master Summary Status (MSS)	
7	128	not used		not used	
		*ESR?	*ESE *ESE?	*STB? | SPOLL	*SRE *SRE?

5.10.5. GPIB Service Request

The service request capability is not available with the RS-232 interface. The SRQ line will be activated only after one or more of the service request functions have been enabled using the Status Byte Enable Register command *SRE.

The status byte bit assignments are as described in the previous section for status reporting. When the instrument has requested service, the enabled bit or bits and the RQS bit 6 will be active or 1. Bit 4, 5, and 7 are not used and will be set to false, or 0 for all status byte reads.

After the serial poll (SPOLL) is executed the RQS bit will be cleared to 0, and the remaining bits will remain unchanged. The status byte will not change value until the event register is read and cleared for the corresponding status byte bit.

For example after the All Pass SRQ has been enabled, when the test(s) have finished with pass indications the instrument will set the hardware SRQ line and output the status byte of 41 hex. This means that bit 6 and bit 0 are set to a value of 1. After reading the status byte the status byte value will change to 01 hex.