OPERATION
and
REFERENCE MANUAL

For Release: 2.1

IMCS MODEL 5000

AUTOMATED ESD TEST SYSTEM

 Sept., 1988

Welcome

The IMCS Model 5000 is a uniquely powerful ESD Test System designed to provide maximum test flexibility and high test throughput.

The IMCS 5000 is a simple system to use and understand. It is important that you review this manual carefully prior to operating the system. The explanations, examples and tables in this manual will help you take full advantage of the Model 5000's many features.

Should you not understand a particular section or feel that the program is not operating properly, call us and we will be happy to assist you.

About the Model 5000

The IMCS Model 5000 ESD Test System is designed to test all types of integrated circuits in all styles of packages. The system consists of the tester mainframe, the controller (computer with monitor and graphics printer) and the operating software.

The controller is an MS/DOS based PC system. Five additional boards are installed within the controller by IMCS to provide the interface between the controller and the mainframe tester. The controller and its peripherals can perform all of the functions and applications of a desk top computer. Its intended application is to control the operation of the Model 5000 tester mainframe.

This software includes all programs necessary to perform ESD testing as well as diagnostics and calibration of the system. The user can use the controller to run other MS/DOS based programs such as statistics and data reduction routines when not otherwise employed in testing devices. IMCS may periodically provide software updates to system users.

The tester mainframe is the heart of the Model 5000. It is the part of the system that low level digital signals from the controller are converted into precision high voltage pulses. The unit contains high voltage power supplies, sensitive digital and analog circuitry, pulse discharge networks and from 140 to 400 electro-mechanical high voltage switches.

The alignment of many components within the Model 5000 mainframe is critical and care should be taken when moving or transporting it. The user/operator should always be aware that the function of this test equipment is to generate high voltage discharges and that such discharges are not only destructive to the devices being tested, but can also be detrimental to the electronics within the tester unless proper test precautions are taken.

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SPECIFICATIONS

Introduction

The IMCS Corp. Model 5000 Automated ESD Sensitivity Test System is designed to simulate static discharge events in IC devices and hybrids with up to 192 pins. The system consists of a controller and a test console.

The controller (a micro computer with additional application interfaces installed in the mother board) system has 640k of internal ram memory, 12 bit D to A and 12 bit A to D signal conversion, a floppy disk drive, a 20Mb hard disk, a 12" monitor, and a high speed dot matrix printer with graphics capabilities. The test console contains input latches, high and low voltage power supplies, a programmable current driven leakage tester, additional operational logic, and the discharge circuit. The discharge circuit consists of a high voltage pulse relay, a manually changeable RC network module, a pulse distribution switching network, and the DUT socket board.

Standard software guides the user through test set-up with menus, commands and messages. Several levels of test complexity are possible, from automatic sequencing of each pin of a device relative to ground, to automatic testing that changes configuration as actual leakage results are obtained and to graphic engineering analysis of leakage characteristics. Once test programs have been written and stored to disk, unskilled operators are guided through testing procedures by a series of prompts, with almost no commands to remember. A self diagnostics test can be run at anytime to check current measurement accuracy, high voltage supplies, and the high voltage relay function.

Algorithms in software enable the appropriate high voltage switches to match the pin-out of each device when the number of leads are entered by the operator. Each of the interchangeable RC modules used for zap testing has an identity code which is checked by the test program to insure that the proper module is in place every time a particular test is run. Three standard socket boards accomodate all dual in line packages up to 64 pins. Custom sockets are available for any device up to 192 pins (may require optional HV switches). All interface boards have provision for connection of external power to any pin (for use during leakage measurement only).

General Data

High Voltage Capabilities:

- Power supply - 100 to 10,000 volts positive or negative polarity
- Recommended Pulse range - 250 volts to 10,000 volts.
- HV supply output within ± 5 % + 5 volts of keyboard input

Leakage Measurement Range (std):

- 0.5 µA to 50.0 µA
- Initial offset error: ≤ 5%
- Voltage compliance: 27 volts

Note: Under special order, higher forced current levels are available as follows: 100 µa; 200 µa; 500 µa; 1 ma; 2 ma; 5 ma; 10 ma. Use of a higher current supplies will result in a loss of minimum resolution.

Test Configuration:

Pin selection provided by a matrix of miniature HV relays.
Set-up time ~ 500 mSec.
Any combination of two or more pins, up to 192, can be zapped up to 99 times each test.
Delay between pulses vary from 1 to 99 seconds.
Leakage test can be done on the zapped pins or any other combination.
Up to 500 tests (zap and leakage) per test file in random test mode.
Any number of pins (up to 192) can be tested sequentially.
Standard RC module allows testing to Mil Std. 883C, Method 3015.6
2 other RC modules can be identified in software.

Standard Interface Boards:

28 pin 300/400 mil DIP
48 pin 600 mil DIP
64 pin 900 mil DIP

Software:

Forth language. The standard package includes programs to create test files, run random and sequential zap and leakage tests, perform immediate execution testing for engineering analysis, and to perform self-checks of hardware function.

Power Requirements:

1 amp nominal, 2 amps max. from 105-125 volts, 50/60 Hz
0.5 amp nominal, 1 amp max. from 205-235 volts, 50/60 Hz

Dimensions:

Test console - 24.5" W x 16.5" D x 6" H
Computer - 15" W x 18" D with drive and monitor 18" H
Printer - 16" W x 12" D x 4.5" H

Environmental:

Temperature - 50 to 85° F.
Humidity - 10 to 60% relative.
Location - Place the test console on a level surface.. Rear panel must be at least 2" from wall. Do not restrict air flow under the console.

SYSTEM DESCRIPTION

Figure 1 is a simplified line drawing of the 5000 test console. Smoked plexiglas safety cover, (2), covers the device under the test compartment (3). The RC module compartment (4) is located on the front panel. High voltage is not present in the test compartment, except instantaneously during pulsing. However, the RC module connections are "hot" all of the time. For added safety, any existing high voltage will be reduced to below 20 volts in less than one tenth of a second, when either of these covers is lifted. If either cover is lifted during a pulse sequence, the sequence will stop until both covers are closed again.

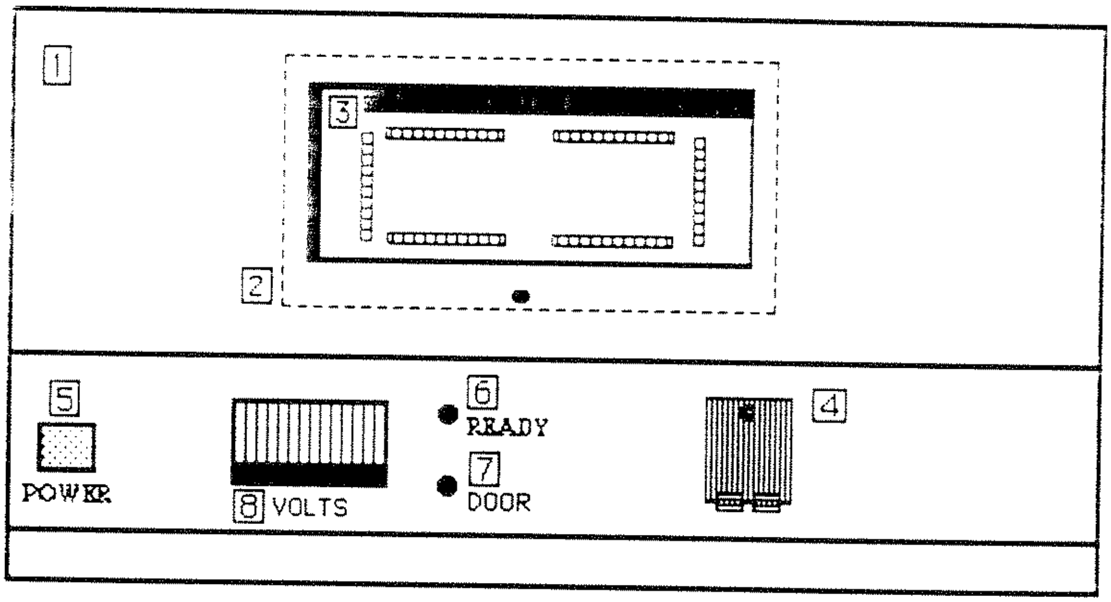
The power switch (5) must be pressed to energize all of the test console circuits. The switch will light up when the console is on. Voltmeter (8) will also come on only when the power switch is pressed on. Press the power switch again to turn off console power. Ready light (6) is on at all times except during a pulse sequence. The fault light (7) indicates that one of the doors has been opened, which interrupts any program that may be running at the time.

Inside the DUT compartment are six "zero insertion force" sockets. The DUT socket/interface boards fit into these sockets. Be certain that the "zero insertion force" sockets are open before attempting to install or remove an interface board. Be certain that all of the "zero insertion force" sockets are closed during all testing routines. Surrounding this compartment are the high voltage pulse distribution relays. Below this compartment are the computer interface and relay driver circuits. Power transformers are placed along the rear of the console on this level. The DC power supplies are mounted to the rear panel, with the voltage regulator "cans" protruding for more efficient heat transfer. The components for generating high voltage are: a HV control unit, a HV (step-up) transformer, and a HV (multiplier) module. These are located in the right front section of the console. The HV calibration adjust is also located here.

The R/C module supplied standard with the Model 5000 is designated "R/C-1". With values of 100 pf and 1500 ohms, this network is commonly known as the "human body" network. These two components are encapsulated in a high dielectric, low loss potting compound. This network has seven pins which plug into the pulse relay assembly located behind the front panel. There are two pins each for the resistor and the capacitor with the three remaining pins used for module identification. The Model 5000 is specifically designed for testing using the human body model. While it can be used to test utilizing R/C networks other than 100 pf/ 1500 ohms, the validity of any test results obtained are the sole responsibility of the user.

SYSTEM DESCRIPTION

Figure 1



1 Test console cabinet
2 DUT compartment safety cover
3 DUT compartment
4 RC module cover
5 Power switch
6 Ready LED
7 Open door LED
8 Voltmeter

When inserting a module, be certain that all of the pins line up with their respective sockets in the epoxy; also, push the module firmly into place so that no air gap exists.

The low voltage power supplies produce + 5V and - 5V for the logic circuits and + 12V and -12V for the relay drivers. These supplies are relatively simple and reliable and rarely need adjustment.

The high voltage supplies are controlled from a 12 bit D/A converter board placed within the computer. This signal drives a low voltage supply which in turn drives a pair of voltage mutipliers. These multipliers are encapsulated within a high dielectric epoxy resin and are current limited by their inherent design as well as a 10M ohm resistor. A feed back loop is used to monitor the HV output.

Incoporated in the Model 5000 is a precision current pump which can force up to 50 μa's with a 0.025 μa resolution. Through software and a 12 bit D/A converter, this current pump provides the function of a curve tracer. A current source was chosen over a voltage source due to its greater application over the different types of loads represented by inputs, outputs and various supply pins. The further advantages of a current pump are smaller offset errors and less drift. Also, by limiting the compliance voltage, any performance degradation to the DUT by the ESD pulse will not be enhanced by performing a leakage test. Finally, the accuracy and speed of our current pump allows us to provide an automated characterization mode whereby the leakage level at a preset current for each pin on a device can be quickly measured and stored for later comparison. We call this the 'self-learn' mode.

Finally, in the Model 5000, the pulse relay assembly has been placed behind the front panel and is shielded from all other componentry. New, more reliable HV switching relays are now used. Designed into this assembly is circuitry to prevent current overshoot and ringing of the pulse into low impedance loads. Earlier versions of ESD testers, those designed to be calibrated (matched) with a 1500 ohm resistor, would produce a basically oscillatory waveform with higher than expected current densities when pulsed into loads below 100 ohms. Current ESD testers designed to produce pulses into low impedance loads without current overshoots and minimal ringing bring a greater degree of accuracy and correlation to ESD sensitivity testing.

SOFTWARE

Test functions:

The Model 5000 performs two different testing functions under software control. These are the Zap test and the Leakage test.

The Zap test causes a specified combination of HV pin select relays to be connected to pins of the device under test. Each Zap test contains instructions for the pins to be pulsed and those to be grounded, high voltage polarity, initial pulse voltage, voltage increment, and maximum pulse voltage, as well as the number of pulses at each voltage, and the interval between pulses. Each Zap test also contains data about the number of pins on the device under test, and the RC module used.

The leakage test causes the high voltage source to be disconnected, while the selected combination of DUT pins is connected to a voltage-limited current supply under computer control. This leakage tester acts as a current pump, with a measurement range which varies from ± 0.1 µA to 50 µA. A maximum compliance voltage is internally set at 27 volts. This voltage was chosen to preclude overstressing the DUT and leading to a premature failure unrelated to the ESD test. In the "analysis" mode, this current pump will display leakage curves much like the familiar voltage curve tracer. Characterizing a part this way is slow and while not a primary design feature, can be a useful tool. The key feature of the current pump design is the ability for the operator to select a current to force and have the Model 5000 automatically measure and store in memory the resulting voltage of all pin combinations. In a matter of a minute or two, a device can be totally characterized. The operator has then only to input a 'delta' or percentage of allowable shift. Thus failure criteria can be set quickly with a minimum of operator interpretation.

The zap test and the leakage test, with their associated hardware control functions, create the basis for all of the test modes of the 5000.

Test Modes:

The **analysis mode** is a direct method of testing and the most visual way to "zero in" on the static charge sensitivity of a device. This program allows immediate execution of commands for independent zap or leakage tests. There is no limit to the number of tests because no test file is created. After each test (zap or leakage) the data is printed out and then cleared from memory. This is the least structured testing environment; it allows a trained engineer to quickly produce detailed sensitivity data, with all of the parameters of both the ESD test and the leakage test under immediate control.

The **sequential mode** of ESD testing is the most structured yet efficient environment. One Zap test is defined and is performed on each selected pin in sequence. Leakage measurements can be made before and/or after zapping or eliminated altogether. Flexible methods for selecting the pins provide quick development of such test structures as: zapping each pin in sequence with all other pins grounded, or zapping selected pins to ground/positive supplies/negative supplies or combinations of pins.

Each pin of the device can have unique leakage test parameters, and the Zap test voltage can be incremented each time that the program loops through all of the selected pins. Combined with the program's ability to change the test sequence or to stop testing based on leakage test results, this mode of operation can bring a high degree of automation to the process of device characterization. A special version of the sequential mode allows quick development of test files for Mil Std. format testing.

In the **random mode** of testing some structure is provided, but almost any combination of tests and subtests is possible (up to 500). A typical random test file would consist of a sequence of Zap tests, each with one or more leakage tests as subtests. Leakage tests can measure any combination of pins, independent of the Zap tests. In this mode of operation, any voltage incrementing is done each time that a leakage subtest loop is completed. Each test/subtest loop is repeated until the maximum voltage is reached, and then the next Zap test loop is begun. The sequence can be changed or stopped based on the results of any leakage test.

Diagnostics is a completely automated mode of operation. The diagnostics routines put the test console hardware through a series of self-tests to assure proper operation of all critical components. The following self-tests are completed automatically: the high voltage supply in both polarities; the leakage tester circuitry and; the selection and operation of the pin select relays.

Language:

The user portion of the Model 5000 software requires english language commands although many are either highly specialized or abbreviated. The sections of this manual covering individual testing modes discuss the use of these commands and show typical 'help' screens. The glossary in the back of this manual provides a definition of each command and shows the test mode in which each is used. The programming language is a version of Forth known as "PC FORTH". The source codes for our programs are available upon request to our customers. While not recommended by IMCS, customers wishing to modify the source code programming can obtain information and compiler software from:

LABORATORY MICROSYSTEMS INC., P.O. BOX 10430, 3007 WASHINGTON BLVD., SUITE 230, MARINA DEL REY, CA 90295

SYSTEM STARTUP

After unpacking the shipping boxes and after inspecting for any obvious shipping damage, the equipment should be setup on a work bench of approximately sixty by thirty inches in area. The Model 5000 will be placed in the right center of the bench with the computer and printer to its left. Room may be required to the right of or behind the Model 5000 for external bias supplies.

The computer to Model 5000 interface cable should be connected first. In the back of the operation manual are drawings showing: (a), the locations of the D/A, A/D and I/O boards as installed in the computer and, (b), the connection of the interface cable to these boards and the Model 5000. Of primary importance is the correct connection of the two large flat cables to the Model 5000. The cable labeled bottom must go to the lower connector on the Model 5000 and the cable labeled top must go to the upper connector. In both cases, the red stripe on both flat ribbon cables faces the rear of the unit. If any of these connections are made improperly, either the computer will not boot up or there will be no control of the Model 5000 and numerous error messages will be displayed.

Connecting the AC power cords should be completed next. Then the printer and monitor cables should be connected. When all this is complete, the following sequence of events can take place.

1.) Turn on power to computer.
2.) Computer will boot and execute its own internal diagnostics.
3.) Screen will prompt for current month/date/year. This is optional.
4.) Screen will prompt for current time. This is optional.
5.) Screen will then show title of operating system, version and copyright.
6.) Screen will then show a prompt: C> ('C' is the hard disk drive in use).
    NOTE: Items 7 thru 9 may not be necessary if IMCS has already installed the software on the hard disk drive.
7.) Type " A:" [Rtn].
8.) Prompt will change to "A>".
9.) Insert Model 5000 software disk in floppy drive and close latch.
10.) Type: DIR (for Directory) (hit the return key to enter).
11.) The screen will show the directory of Model 5000 programs.

Not all items shown in the directory are directly addressable by the user. The following files are addressable:

A.) ANALY21C = The command to load the analysis test program.

B.) SEQUE21C = The command to load the sequential test program.

C.) RANDO21C = The command to load the random test program.

D.) DIAG21C = The command to load the diagnostic test program.

Note: The number "21" stands for version "2.1" of the software . Should you receive a later version, these numbers will change accordingly.

Files are addressed by typing the file name as shown in the directory and depressing the return key. Files are closed by typing the command BYE and the return key.

After loading the applicable test program, the AC power to the Model 5000 can be turned on. To run any of the test programs, insure that the appropriate DUT load board is installed in the Model 5000 and type the program file name. At this point, you should refer to individual program sections in this manual for further instructions.

ANALYSIS TESTING

The analysis test mode is used when first characterizing a device. It is essentially a manual mode of testing and can be very time consuming. It is however ideal for observing minute changes in a junction's I/V curve as ESD voltage is incremented. This program will graphically plot any one or all the four quadrants of the device's I/V curve.

In the Model 5000, there is a precision current source (pump) rather than the more common voltage supply. This current pump has a range of 0.025 µA to 50.0 µA. To avoid the possibility of overstressing a device (or junction), the compliance voltage is limited to a maximum of 27 volts. There are a small number of devices on the market which may require greater currents or higher voltages. It is suggested that for these devices, a standard curve tracer will offer greater flexibility and range for high breakdown potentials. However, for the vast majority of devices, the range of the Model 5000 current pump is more than sufficient to measure changes in leakage current caused by ESD pulses.

The current pump will force either a positive or a negative current into the pins selected and measure the resulting feedback voltage. Using a current mode allows for the leakage test of most normal structures as well as some that cannot be measured using a voltage forcing source.

Program Structure

The analysis test is centered around four sub-sections, called screens. Two of these screens contain the parameters for the testing and the third displays the results of the test.

One screen, called the ZAP screen, defines the Zap structure. This includes a list of pins that will be zapped, the polarity of Zap voltage, the starting voltage of Zap, the incremental voltage, the end voltage, the number of pulses and the delay between pulses.

The second screen, call the LEAK screen, defines the leakage structure. This section of the program controls the curve tracer function of the Model 5000. Here are the parameters that include a list of pins that will be used to measure leakage, selection of the quadrant in which to plot the leakage curve and selection of the current and voltage scale used in the leakage plot.

The third screen, activated upon execution of the program, is the graphics screen. Here the I/V curve will be plotted.

Finally, there is the HELP screen. This section is not directly involved with testing, nor does it contain any test parameters. However, it does contain a complete list of commands available to the user in the analysis program.

The HELP Screen

The HELP screen is called up by the simple command, **HELP**. It contains all of the commands used in the analysis test mode. The screen will appear as follows:

NETWORK-# 1	n PIN-IC	PART#	=	SERIAL#=	
NETWORK-# *n*	*n* PIN-IC				
Z	L	G	HELP	DOIT	
Z.	L.	G.	HELP.		
GRID	DOLEAK	REPLOT	REPLOT-ALL	DATA?	CUR
CREATE-DIR	USE-DIR	SAVE-TEST	LOAD-TEST		
+V	-V	ONLY	CHANGE		
START-V *v*	INC-V *v*	END-V *v*			
#-PUL *n*	DLY *n*				
VBUS	GND	ON *n*	OFF *n*	& *n*	TO *n*
ZERO *n*	ZERO?				
X1	X2	X5	X10		
X1	X.5	X.2	X.1		
BIAS1 v	BIAS2 v				

An explanation of each of the above commands is contained in the Glossary. (If you are new to the Model 5000, you should review the Glossary prior to using any program.)

To make it easier for the operator to find a particular command, the HELP screen has been separated into sections. Above the dashed line at the top of the screen is information about the current configuration of the system. This information includes which R/C network is being used and the number of pins on the device being tested (Always starts in the default mode which is the maximum capability of pins). This header will also show the part number of the device and the serial number of the device.

Directly under the header are a list of general commands used in the analysis test. These include commands to select the screens, commands to store and recall test parameters from floppy disk and commands that affect the graphics screen.

The third section of the HELP screen contains commands that affect the Zap parameters. The fourth section contains commands that control selection of pins to be tested. And the fifth section affects the leakage screen parameters.

An important thing to mention here is that upon initial start-up of this program, the operator must first tell the computer the number of pins on the device. Next, the operator must tell the computer which R/C network is being used, if other than the default R/C network # 1. To tell the computer the number of pins being tested, type the command n **PIN-IC**, with # being a value beween 2 and the maximum number of pins your Model 5000 is configured for. If the R/C network is other than network# 1, 100pF/1500Ω, type **NETWORK-#** n, where n is the number you assign to the network.

The ZAP screen

After defining the number of pins on the device and the R/C network to be used, the operator will enter parameters for testing. To enter Zap parameters, first display the ZAP screen by typing Z . Note: All commands are followed by depressing the 'return' key which enters the command.

You should see the following screen:

VBUS ON

GND ON

------------------------------------ ZAP ------------------------------------

+V ONLY

START-V	Ø	INC-V	1	END-V	Ø
*-PUL	1	DLY	1		

The operator will first want to define the pins to Zap. Selecting pins to Zap is done through the command **VBUS ON** *n*, where *n* is one pin or several pins. The operator will also want to select pins to be grounded, this is done through the command **GND ON** *n*, where n is one pin or several pins. In any event, all the pin(s) defined on the VBUS will be Zapped with all the pin(s) defined on the GND. There are several ways of defining which pins will be tested. The format is identical for both the VBUS and GND. Here are some examples:

VBUS ON 1	Selects pin 1
GND ON 1 & 5 & 9	Selects pins 1 and 5 and 9
VBUS ON 1 TO 3	Selects pins 1 through 3

To deselect the pin, in other words to remove a pin, from either the VBUS or GND, the commands **VBUS OFF** and **GND OFF** are used. Here are some examples:

VBUS OFF 1	Deselects pin 1
GND OFF 1 & 5 & 9	Deselects pins 1 and 5 and 9
VBUS OFF 1 TO 3	Deselects pins 1 to 3

Again, whatever pins are defined on the VBUS will be held in common and voltage will be applied to all pins simultaneously. All pins defined on GND will be held in common as the return path to ground. In the analysis test mode, normally only one VBUS pin and one GND pin are selected at a time.

Once the pins are selected, the operator will wish to select the polarity of Zap. **+V** selects the polarity as being positive, **-V** selects the polarity as negative. The operator may also wish to have the polarity alternate before voltage incrementing. For example, the operator may wish to set up a situation where the selected pins are stressed at 500 volts positive, then after the leakage measurement is taken, have the same pins tested at 500 volts negative. This can be done automatically with the command **CHANGE.** If only one polarity is desired, the command **ONLY** is used.

DEFAULTS FOR POLARITY ARE **+V** and **ONLY.**

Finally, the operator will need to define starting Zap voltage, ending Zap voltage, voltage increment, the number of pulses at each voltage level and the delay (in seconds) between pulses. The Commands are as follows:

START-V *n*	***n*** being the voltage to start Zap. (***n*** is a value between 250 and the maximun voltage of your Model 5000)
INC-V *n*	***n*** being the voltage increment (***n*** is a value between 1 and maximum voltage of your Model 5000. However, the Model 5000 will never increment higher than the selected ending voltage parameter)
END-V *n*	***n*** being the ending voltage of Zap (***n*** is a value between the selected start voltage and the maximum voltage of your Model 5000. n can be equal to, but never less than, the start voltage)
#-PUL *n*	***n*** being the number of pulses at each voltage increment (***n*** is a value between 1 and 99)
DLY *n*	***n*** being the delay, in seconds, between each pulse. (***n*** is a value between 1 and 99)

NOTE: All values for voltage are absolute with the polarity determined by the polarity selection command **+V** and **-V**.

The LEAK screen

Next, the operator will wish to enter leakage parameters. These parameters will control the curve tracer function of the Model 5000. To enter leakage parameters, first display the LEAK screen by typing the command: **L** .

You will see the following screen:

VBUS ON

GND ON

ZERO 5

FEEDBACK:

X1	X2	X5	X10

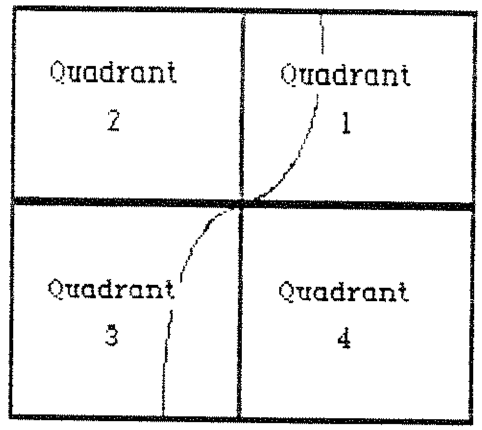
FORCING:

X1	X.5	X.2	X.1

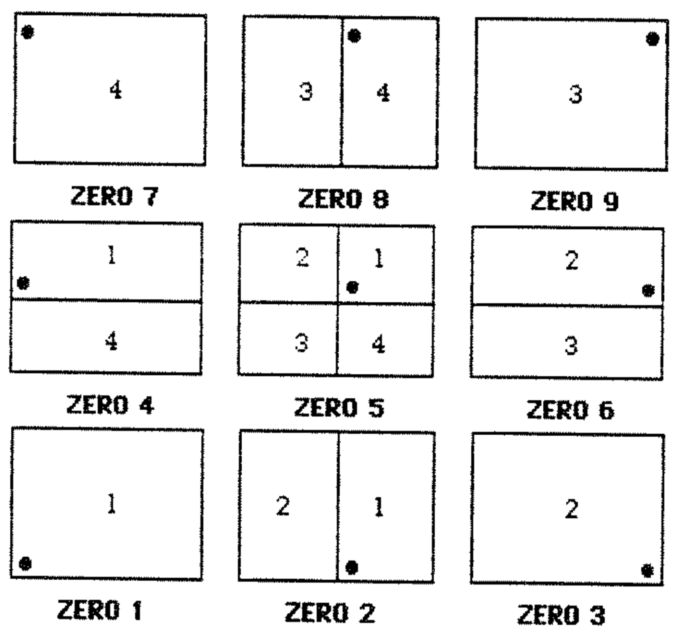
As when entering the Zap parameters, the LEAK screen will require the operator to select pins on which to measure the I/V curve. In the analysis test, the pins zapped can be different than the pins measured by the leakge test. In other words, the operator has the choice of selecting the pins to test in the LEAK screen independently from those pins in the ZAP screen.

The format for entering pins on the VBUS and GND is identical to the format used in the ZAP test.

One of the unique features of the analysis test is its ability for graphing the I/V curve. Consistant with conventional curve tracer operation, the Model 5000 will plot the standard four quadrants. In addition, if asked to, the Model 5000 can highlight specific quadrants for close evaluation. The four quadrants are oriented as follows:

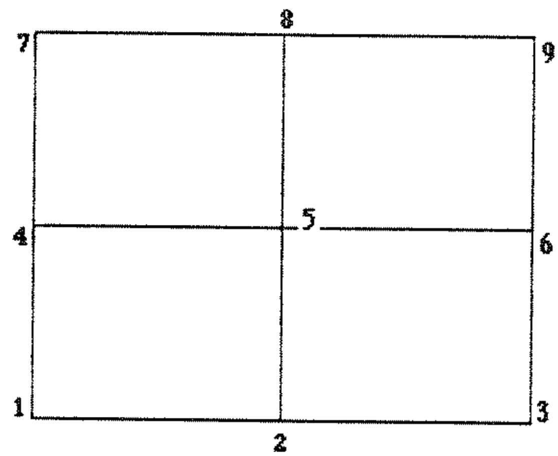


By using the command **ZERO *n***, where ***n*** is a value between 1 and 9, the zero of the curve can be moved on the screen. In the following drawing, the "•" character indicates the zero volt bias position of the I/V curve:



For example, if we typed the command **ZERO 1**, we will only plot quadrant 1 and the zero volt bias position will be in the lower left hand corner.

Rather than memorizing which graph each zero command produces, the operator need only remember that positions of the numeric keypad correspond to the position of the zero graphed. In the drawing below, the number indicates the position of the zero:



ZERO 5 is the default parameter.

To find out which ZERO position is currently selected, the command **ZERO ?** can be used. This will position an asterick to indicate the location of the zero on the graphic screen.

Finally, the operator can adjust the current and voltage scales for the graphic plot. At the bottom of the leak screen, there are four values listed for current and four listed for voltage. These values indicate the scale used per division of the graphic plot. This section of the screen looks as follows:

FEEDBACK:

X1	X2	X5	X10

FORCING:

X1	X.5	X.2	X.1

The default leakage parameters are ' X1' for both the current and feedback scales. The following table shows the available ranges:

RANGE	FEEDBACK VOLTS/DIVISION	FORCING µA/DIVISION
X1	3.00 x 2	5.00 x 2
X2	1.50 x 2	
X5	.60 x 2	
X10	.30 x 2	
X.5		2.50 x 2
X.2		1.00 x 2
X.1		.50 x 2

The Graphic Screen

The graphic screen displays the effects of simulation on the leakage characteristics of the junction selected. The graph will display one I/V plot for each increment of Zap voltage as well as an initial plot prior to Zap. Normally, the operation of the graphic screen is transparent to the operator as it will be selected automatically during test execution.

During automatic program execution, I/V information is stored in a portion of computer memory reserved for data. For each voltage increment, separate I/V data is accumulated. Simultaneously, this data is displayed on the graphic screen as I/V plots. In the automatic execution mode, a composite of all I/V plots are displayed on the same screen.

Some simulation may require the operator to review the graphic plots in a manner more selectively than provided during automatic execution. To allow further flexibility in the analysis mode, several direct access commands have been made available. By using the direct access commands, the operator can redisplay individual I/V plots for a particular Zap level or display combinations of several Zap levels.

Please note that the graphics screen can be erased without destroying the I/V data. Only during automatic execution will the I/V data be destroyed.

I/V data is stored with an associated identifier number. During automatic execution, this number will be the Zap voltage after which the I/V measurement was taken, including data at the 0 volt Zap level. Only during the **DOLEAK** will the operator be asked to input an identifier. This identifier, abbreviated **Ident.:**, can be any number between -32767 and +32767.

The operator may select the graphic screen directly by the command **G.** This command will recreate the screen exactly as it was last displayed.

The following are direct commands for the graphic Screen:

GRID	Erases the graphic screen and replots a fresh grid. Be sure the graphic screen is displayed, if not, preceed this command with **G.**
DOLEAK	Performs I/V plot without Zap. Followed by a prompt to select a new **Ident.:** to be associated with the data generated. This **Ident.:** can be a number between -32767 and + 32767, but should not be same as any **Ident.:** generated during automated execution.
REPLOT	Replots I/V curve of a particular **Ident.:** to be selected. by the operator. This **Ident.:** will normally be a the same number as the Zap voltage for the desired I/V curve.
REPLOT-ALL	Replots all I/V data stored in memory.
DATA?	A utility command numerically displaying I/V data.

Here is an example where the direct commands may come in useful. Lets assume that the operator has just finished execution of a test on a device. At the end of the test, a graphic screen remains with a composite of all I/V curves for each of the Zap increments. Rather than displaying all of the I/V curves at once, the operator may wish to highlight only the 0 volt curve and 300 volt curve. The operator would first erase the graphic screen with the command **GRID**. Next the operator would type **REPLOT 0** and **REPLOT 300.** The operator can at any time recreate all of the I/V plots by typing **REPLOT-ALL.**

In another example, the operator may only want to perform a leakage test on the device without Zapping the part. The operator should complete the leak screen. Because the graphic screen is not displayed, the command **G** should be issued. If there is previous information on the screen, it can be erased with the command **GRID**. Finally, the operator would type **DOLEAK**, and then responding to the **Ident.:** prompt with an indentifier number.

Test Execution

Once all parameters are input in the Zap screen and the leak screen, the test can be executed by typing the command **DOIT**. This command will be followed by:

PART# =(Part Number) **(Y,N)**	An optional field to name the part. Responding **(Y)** indicates that the existing field is acceptable. Responding **(N)** indicates that the operator wishes to change the field. Acceptable inputs are alphanumeric up to 8 characters long. The default is a blank part number.
SERIAL#=(Serial Number) **(Y,N)**	An optional field to assign a serial number. Responding **(Y)** indicates that the existing field is acceptable. Responding **(N)** indicates that the operator wishes to change the field. Acceptable inputs are alphanumeric up to 8 characters long. The default is a blank serial number.

After inputing the **SERIAL#=** field, the test begins.

The Model 5000 will first perform a leakage test prior to Zapping and will display the I/V plot on the graphic screen. Next, zapping will commence at the Start Voltage and will increment to the End voltage with additional I/V plots performed between each of the increments.

Addional Commands

PRINTING:	**Z.** **L.** **G.** **HELP.**	Typing the screen selection command followed by a period will output screen to the printer.
STORING AND RECALLING DATA:	**SAVE-TEST** **LOAD-TEST**	Followed by the prompt **Enter drive and Filename:.** Data includes all parameters of the Zap screen, leak screen and all I/V data. Drive and Filename should be in the format **x:** (filename), where **x** is the letter of the drive where data will be directed and a filename of no longer than eight characters. (" **A:** " for the floppy drive and " **C:** " for the hard disk.
DIRECTORY SELECTION:	**CREATE-DIR** **USE-DIR**	Followed by the prompt **Enter Drive and Directory Name:.** These commands allow the operator to store data and parameters under a common subdirectory and make use of the MS-DOS special directory facility. If a subdirectory is created, be sure to use the same directory when accessing parameters stored in that directory.
DIRECTORY LISTING:	**DIR**	Will display all files in the current directory.

SEQUENTIAL TESTING

The sequential test mode will probably be the most used of all test modes provided. Once you understand how to write and save test files, it becomes a simple matter to recall, load and run files for each device.

A sequential test file contains a zap parameter test, a list of pins to be tested, and a list of leakage parameters for the pins tested. The pins to be zapped are programmed onto the VBUS list just as in the other modes, except they do not all connect to the VBUS at the same time. In the sequential testing mode, one pin at a time is automatically selected from the VBUS list, zapped, and may then be immediately checked for leakage. The zap test on each pin is limited to this one integrated leakage subtest. Once started, this process continues until each pin on the VBUS list has been stressed according to the parameters shown in the zap test menu, and the leakage has been compared to the maximum and minimum value(s) specified in the leakage parameter list. High voltage increments are made after each cycle through the list of pins, until all of the test instructions have been completed. At test completion, a report screen can be viewed or printed.

Developed for MS/DOS compatible systems is the HELP screen which is called up by the simple command, **HELP**. It contains all of the commands used in the sequential test mode. The screen will appear as follows:

NETWORK-# 1	64 PIN-IC	BIAS1= Ø	BIAS2= Ø		
NETWORK-# n	n PIN-IC	n BIAS1	n BIAS2	BIAS1?	BIAS2?
LOAD-PARAM	SAVE-PARAM	LOAD-REP	SAVE-REP		
Z	P	L	REP	DOIT	HELP
DISCARD	STOP	CONTINUE			
+V	-V	ONLY	CHANGE		
GALL	G1&G2	G1/G2	G1	G2	
ZONLY	LONLY	LEARN	ZL	LZL	Z/L
CRØ v	CR1 v	CR2 v	CR3 v	CR4 v	STØ v
ST1 v	ST2 v	ST3 v	#-PUL n	DLY n	
VBUS	GND1	GND2	ON n	OFF n	
& n	TO n				
#LEAKS	SETSEG,L,P	SETSEG,L	SET,L	SET,P	SET
LEAK,L,P	LEAK,L	LEAK,P	LEAK	CHECKW	
%,L,P	%,L	%,P	%		
DELTA,L,P	DELTA,L	DELTA,P	DELTA		
RESTORE,L,P	RESTORE,L	RESTORE,P	RESTORE		
<>LEAK,P	<>LEAK	BACKW,L,P	BACK,L		
IL,L	IL	COPY,L,P	COPY,L	COPY,P	COPY

The HELP screen is divided into five sections. First, the top heading above the dotted line is the default values for the network number and pin count of the IC to be tested (default is maximum machine size). If you will be performing Mil-Std-883 testing, then Network-# 1 is the correct network. If you intend to use a different R/C network, then you must enter its assigned number by typing **NETWORK-#** (space) and the actual number (represented by 'n' on the HELP list) of the network to be used. Likewise, the actual pin count of the device to be tested will most likely be different than that shown in the default mode. It must be changed by typing the number of pins followed by a space and the command **PIN-IC** so that the Model 5000 can setup the proper pin numbering sequence for the part to be tested. Example: **24 PIN-IC**. **Remember to always hit [Return] after each command.**

An explanation of each command is contained in the Glossary. If you are new to the Model 5000, you should review the Glossary prior to using any program.

The second section immediately below the dotted line are general commands used throughout the sequential test routine. It includes such commands as: Load and Save parameters and reports; and one stroke commands for displaying the various other screens used in the sequential test mode such as Z for Zap, P for Pins, and L for Leakage. These screens require additional inputs described further on in this chapter. The command n **BIAS1** allows for the setting of the optional bias power supply.

The sequential mode is unique in its print command. While the other modes use a command followed by a period to print, the sequential mode uses the command 'PRINT ___ , e.g., 'PRINT L' or 'PRINT REP'.

Writing test files consists of inputing a number of parameters. Creating these test files requires the greatest amount of labor and understanding on the part of the user. However, once a test file is completed, it can be saved to disk and recalled any time using the **SAVE-** and **LOAD- PARAM**eters commands. Likewise, after completing the testing of a device, the condensed test report can be saved and recalled.

The third section of the Help screen are commands and inputs for the HV pulse (zap) screen. The fourth section are commands and inputs for the pin screen. The fifth section are commands and inputs for the leakage screen.

ZAP SCREEN

The Zap screen contains all the parameters directly related to the ESD pulse. A typical screen might look as follows:

```
------------------------------ZAP------------------------------

DISCARD ON FAIL
                            /............................or: G2, G1&G2, GALL, G1/G2
+V    CHANGE    zap on: G1       mode: ZL
                                       \.................or: ZONLY, LONLY, LEARN, LZL, Z/L
CROSSOVER-0   250       STEP-0    50
CROSSOVER-1   500

#-PUL    1        DLY    1
-----------------------------------------------------------------------
```

The Zap screen consists of four lines. The first tells the program what to do in the event of a failure. The command **DISCARD ON FAIL** will eliminate individual pins from subsequent zap tests as they fail; the command **STOP** will terminate the entire test upon the first pin failure detected; and the command **CONTINUE** will cause the program to ignore all failures and continue on to test completion. Simply type these commands as shown, hit return and the screen will be updated.

In the second line, **+V** instructs the program to begin the test with a positive voltage polarity. Typing in the command **-V** will cause the program to always start with a negative polarity. The command **CHANGE** will instruct the V+ program to zap first positive and then again negative at each voltage step or negative and then positive if the starting polarity is -V. The command **ONLY** will instruct the program to test only +V or -V. The "**G**" commands inform the program that the zap pulse will be to a defined ground pin or pins. (See the Glossary for definitions of various ground options). The "mode" instructs the program as to the sequence of zap/leakage tests for each pin. One can do zap only (ZONLY), leak only (LONLY), zap then leak (ZL), leak then zap then leak (LZL). The mode Z/L is special in that at each HV step, all pins on the VBUS list will be zapped and at the end of the sequence, each pin will be tested for leakage in sequence. This mode can be used to determine the effect of multiple pin zaps on each pin's leakage characteristics.

Not mentioned above is the LEARN mode. This mode is new to users of our software and is only applicable to Model 5000's or older systems that have had the current pump installed in place of the original voltage driven curve tracer. The command **LEARN** is only temporarily used the first time a test file is written and is replaced by a leakage mode such as "ZL" prior to saving the test parameters to disk. The use of the learn mode is explained further below and again in a sample program at the end of this chapter.

The third group also contains instructions for the initial start voltage, the voltage increment value/ step voltage and the end or maximum voltage. The instruction **CRØ v** (CROSSOVER-Ø) is always the starting voltage. **STØ v** (STEP-Ø) is the incremental voltage to be added to the pulse voltage after the pulse sequence has completed its round of all pins listed to be zapped. In the screen example above, after completing +250V and -250V, the next round of voltage pulses would be at +300V and -300V. This would continue until the maximum voltage limit was reached or until all pins failed, whichever came first. The maximum or end voltage is always the voltage shown by the last crossover instruction, **CR1 v** (CROSSOVER-1), 500 in the example above. Should a single voltage (no steps) be desired, then the start voltage **(CRØ)** should be the same as the step voltage **(STØ)** with the end voltage set as: **CR1 Ø**.

Additional step voltage increments can be added as needed to speed threshold testing. For example, lets say that a test is desired that starts at 500 volts, increments at 100 volts per step until 1000 volts is reached, then increments at 500 volts per step until 5000 volts is reached and then increments at 1000 volts per step until 10,000 volts is reached. By using the commands (as shown in the HELP screen): **STØ 100**, **ST1 500**, and **ST2 1000**, these step voltages will be added to the screen. Also required of course will be additional crossover voltage values to instruct the program when to make the step changes. These commands would be: **CRØ 500**, **CR1 1000**, **CR2 5000**, and **CR3 10000**. The screen would then look as follows:

---------------------------ZAP---------------------------

DISCARD ON FAIL

+V CHANGE zap on: G1 mode: ZL

```
CROSSOVER-0    500    STEP-0   100
CROSSOVER-1   1000    STEP-1   500
CROSSOVER-2   5000    STEP-2  1000
CROSSOVER-3  10000
```

*-PUL 1 DLY 1

The fourth and final line in the Zap screen contains the commands for the number of pulses, **#-PUL**, and the delay time in seconds between pulses, **DLY**. Each of these commands will accept a value between 1 and 99.

Once a program is written to your satisfaction, it can be saved by typing the command, SAVE-PARAM. The program will then ask you to name this test file. Thereafter, this program can be recalled and loaded as desired. Of course, to perform the sequential test, additional programming of the pins to be tested and leakage parameters is required.

PIN SCREEN

The 'Pin Screen' will be displayed by typing the command, "**P**". The initial screen will look as follows:

VBUS ON

GND1 ON

GND2 ON

No pins are listed on the initial screen and must be programmed by the operator. As an example, let us say that you wish to program a list of pins for a 8 pin IC. In this example, we will assume that we wish to sequentially Zap all pins with respect to the ground pin with ground being pin #8. By typing **VBUS ON 1 & 2 & 3 & 4 & 5 & 6 & 7** [return], and then **GND1 ON 8** [return], the required pins would be programmed. A simpler method to use when numbers are in direct sequence is the command: **VBUS ON 1 TO 7**. The statement **TO** will automatically connect all numbers between the first and last number in the command. To see the updated screen, type the screen command **P**.

VBUS ON 1 2 3 4 5 6 7

GND1 ON 8

GND2 ON

Since this is a sequential test program, pin #1 will be zapped with reference to pin #8, then pin # 2 to pin #8, then pin # 3 to pin #8 and so on until pin # 7 to pin #8 at which time the voltage will be incremented (if so programmed) and the sequence will begin again. The test will continue in this manner until the max voltage limit is reached or all pins fail the leakage test.

To turn off pins, the commands **VBUS OFF** and **GND1 OFF** and/or **GND2 OFF** must be used. To turn off the above pins for instance, the commands would be: **VBUS OFF 1 TO 7** and **GND1 OFF 8**. This will clear the pin table.

Let us suppose that instead of pin #8 being ground, that pin #4 was the ground pin. The command would then be: **VBUS ON 1 TO 3 & 5 TO 8; GND1 ON 4**. The command uses the statement **TO** to connect the sequential numbers 1,2,and 3 and also 5,6,7, and 8 while the statement **&** connects the two individual sequences. Should you make a mistake and list the same pin number in both the VBUS and the GND lists, the computer will notify you of this error automatically.

On a growing number of larger pin count devices, there can be more than one ground pin. The program therefore allows as many ground connections as might be needed. For example, to connect pins 20,47 and 68 to the ground list, the command would be: **GND1 ON 20 & 47 & 68**. The pins will remain connected together throughout the sequential test.

There are also instances when a device has more than one ground, but the programmer does not want to tie these pins together. This is the reason for the GND1 and GND2 lists. For this example, let us assume that we wish to test a 68 pin PGA that has a ground on pin 21 and another on pin 68. Also, let us assume that we wish to sequentially zap each pin first in reference to pin 21 and then with reference to pin 68. The pin programming commands could be as follows:

VBUS ON 1 TO 20 & 22 TO 67
GND1 ON 21
GND2 ON 68

By typing **P**, the pin table would look as follows:

VBUS ON 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67

GND1 ON 21

GND2 ON 68

In the example above, pin 1 would be zapped with respect to pin 21, then pin 2 with respect to pin 21 and so on down the VBUS list until the completion of pin 67. Then pin 1 would again be zapped but this time with respect to pin 68, then pin 2, 3, 4, and so on with respect to pin 68 until the end of the VBUS list was reached. (The zapping includes the number of pulses, the delay time between pulses and any polarity changes as programmed previously in the ZAP screen.) If a STEP voltage was programmed, the voltage will be increased and the sequential test will begain again and continue until all instructions given in the ZAP screen are completed.

Not discussed so far is the 'GALL' mode (as mentioned in the ZAP screen). This mode holds all pins to ground except the zapped pin. (Many users will find that this capability allows for quick creation of tests for their devices). For example, typing **VBUS ON 3 & 7 & 10** and leaving the GND list blank, would result in pin 3, then 7, and then 10 being pulsed independently with the other two pins automatically connected to the ground bus. In other words, first pin 3 would be zapped with respect to pins 7 and 10, then pin 7 would be zapped with respect to pins 3 and 10 and finally pin 10 would be zapped with respect to pins 3 and 7. If any other pins were to be typed into the GND1 or GND2 lists, these would be continuously held at ground.

One last consideration is that when using multiple ground pins, it may become difficult to program leakage values or detect small changes in leakage.

LEAK SCREEN

The Leak screen is usually the last of the sequential test screens which must be programmed. In the Model 5000, there is a precision current pump controlled by a 12 bit D/A convertor installed in the computer. The standard current pump can force discrete currents, both positive or negative, in a range from 0.025 micro amp to 50.0 micro amps. After forcing the programmed current(s), the computer reads the feedback voltage of the pins being tested. In order to avoid damaging the device, the feedback voltage is limited to +27 and -27 volts. The user can then set either a percentage delta or absolute delta from the initial feedback voltage obtained prior to zapping and thus set the failure criteria. The programming allows for one to eight different points along a typical leakage curve to be set in this manner.

Using the learn mode, this programming is very efficient. The following example will explain the various programming alternatives.

Let us assume that we wish to zap the inputs of a device with respect to the ground pin and that the pin screen is programmed as below:

VBUS ON 5 6 7 9 10 11 12 13

GND1 ON 16

GND2 ON

Typing the command **LH** will bring up theleak header screen:

------------------------------------LEAK------------------------------------

Leak on: G1 #LEAKS: 8

This is the default screen. "Leak on: G1" is correct in this instance. However, for this example, we wish to perform a leakage test at one point only. We must therefore change the number of leak points to one. Typing **#LEAKS 1** (return) will change this value. Sometimes to see the updated screen, the screen command (LH in this instance) must be typed again. The screen will now look like:

---LEAK---

Leak on: G1 *LEAKS: 1

Typing the command **L** will display the leakage parameter screen for one segment. (Additional parameter sections will be shown on this screen for each segment up to the maximum of eight).

---LEAK---

Leak on: G1 *LEAKS: 1

PIN	5	6	7	9	10	11	12	13
LEAK1								
Forc	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0
MaxF	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0
MinF	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0

In this example, we will set a force current of one micro-amp. As we will set the same value for all pins and only one segment (point), we would type the command: **SET,P** . A prompt will appear on the screen asking for the value in micro-amps. Type: "1" . Typing the command **L** again will display the updated screen.

---LEAK---

Leak on: G1 *LEAKS: 1

PIN	5	6	7	9	10	11	12	13
LEAK1								
Forc	01.0	01.0	01.0	01.0	01.0	01.0	01.0	01.0
MaxF	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0
MinF	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0	*00.0

The updated screen now shows that one micro-amp will be forced on each of the pins. The asterisk (*) reminds the operator that 00.0 is not an acceptable value. At this point, we will have the computer automatically measure the voltage for each pin at this value of current.

Type the command Z to return to the zap screen. Type the command **LEARN** . The zap screen will change to the learn mode. Type L again to return to the leak screen. Type the command **DOIT** . A prompt will appear asking for a part number and a serial number. When this is completed, the computer will execute the learn mode and display the results on an updated leak screen which might look as follows:

---LEAK---

Leak on: G1 #LEAKS: 1

PIN	5	6	7	9	10	11	12	13
LEAK1								
Forc	01.0	01.0	01.0	01.0	01.0	01.0	01.0	01.0
MaxF	16.8	17.5	16.8	16.4	16.9	16.9	16.3	16.2
MinF	16.8	17.5	16.8	16.4	16.9	16.9	16.3	16.2

The computer will retain these original measured values in memory as long as the program is not exited. If after subsequent programming steps, the operator wishes to return to these original measured values, using the command "RESTORE" will return to this place in the programming.

Once having obtained the values in the above screen, the operator must set a minimum and a maximum 'delta' against which the original measured values will be compared after each zap step. Exceeding these min/max values will determine failure of the pin under test.

Deltas can be either a percentage of the original value or an absolute number difference. The command **%** can be any whole number between 1 and 100 (some 'rounding off' will occur). The absolute number can be a minimum of 0.2 (volts) up to any number that when added the original measured value does not exceed the maximum compliance voltage of 27 volts. In any case where the delta for either minimum or maximum feedback voltages equals 00.0 or exceeds 27.0, an asterisk will be displayed in front of the number. Values with an asterisk must be modified to be within the limits in order for the program to run properly.

Setting a percentage delta on a single leak segment, type the command: %,P . The screen prompt will ask for the segment number which in this case is #1. Type: 1 . The screen will then ask for the percentage number. For this example, we will type '25' for 25%. (Deltas do not have to be even. For example, you could choose +10% and -50%). After typing in the percentage, the screen will prompt if this is a positive/negative percentage or to be used for both positive and negative. As this example is to be both a positive and negative delta, you would type 'B'. Typing the command **L** will update the screen and show the now revised deltas.

------------------------------------LEAK------------------------------------

Leak on: G1 #LEAKS: 1

PIN	5	6	7	9	10	11	12	13
LEAK1								
Forc	01.0	01.0	01.0	01.0	01.0	01.0	01.0	01.0
MaxF	21.0	21.9	21.0	20.6	21.1	21.1	20.4	20.3
MinF	12.6	13.1	12.6	12.3	12.6	12.6	12.2	12.2

BEGINNING THE TEST SEQUENCE

To begin the test sequence, first we must return to the zap screen and exit the learn mode. Typing the command Z returns to the zap screen. Typing the command **ZL** will change the mode from learn to a zap-then-leak test mode. To initiate the complete test sequence, type the command **DOIT** .

The test sequence will begin shown by the screen automatically scrolling through each pin, incrementing the voltage, zapping the pins, measuring the leakage of the part and so on until the test is complete. At the end of the test sequence, a tone will sound.

To display the final test results, type the command **REP** . The screen might look as follows:

PART# = xxxx

SERIAL# = xxx

ZAP PIN	0	2000	-2000	3000	-3000	4000	-4000	5000	-5000	6000
5	16.9	16.9	17.0	16.3	16.6	13.8	14.6	1 06.2	.....	.....
6	17.7	16.4	16.6	16.3	16.7	13.4	14.3	1 12.9	.....	.....
7	16.8	16.9	16.1	16.2	16.3	13.7	14.4	1 06.5	.....	.....
9	16.7	16.7	16.8	15.9	15.3	13.6	14.6	13.7	14.3	15.1
10	15.1	15.1	15.2	15.2	15.2	14.5	15.2	14.9	15.2	15.0
11	17.1	15.9	16.0	15.9	16.0	14.5	15.2	15.9	16.0	14.6
12	16.5	16.6	16.7	14.4	15.1	12.9	14.1	14.6	15.4	15.3
13	16.4	16.4	16.3	15.8	16.3	13.3	14.3	13.4	14.5	13.3

ZAP PIN	-6000	7000	-7000
9	15.2	12.9	13.0
10	15.2	1 002	.....
11	14.8	1 06.2	.....
12	15.9	1 07.6	.....
13	14.2	12.4	12.9

In the above report, we can see that pins 5, 6 & 7 failed the minimum limit at 5000 volts. Pins 10, 11 &12 failed at 7000 volts. Pins 9 and 13 did not fail. Notice that because we programmed "DISCARD ON FAIL", the pins that failed were not zapped or tested at higher voltage steps. One benefit of this command is faster test times as pins are eliminated. In another chapter, we will discuss how this report can be converted into a ASCII format for later use away from the Model 5000. If a printed copy of this report is desired, type the command: **PRINT REP** .

ENDING THE SEQUENTIAL TEST MODE

It may be desired to save various portions of the test session. To save the report, type the command: SAVE-REP . To save the test parameters, type the command: SAVE-PARAM . In all cases when saving, the screen will ask for a file and drive name. The file name is any name you choose. The drive name must follow the convention used by the MS/DOS system in the computer. Usually if you have two floppy disk drives, they are " A: " and " B: " respectively. If you have a single floppy and a hard disk, they will be " A: " for the floppy and " C: " for the hard disk. If you use " B: " on a system with a single floppy and a hard disk, the computer will ask you to change disks in the floppy drive.

To exit the sequential mode to quit or to go to another test mode, you must type the command: **BYE** . At this point you can turn off the power first to the Model 5000 and then to the computer. If you wish to go to a new test mode, type the command **DIR** to review the menu.

OPTIONAL: BIAS SUPPLY

The Model 5000 can be ordered with up to two bias supplies. These are respectively named BIAS1 and BIAS2. Each supply can provide 0 to +/- 15 volts under computer control and are connected directly to the device via interconnect cables in the test bay. During the leakage test portion of the Sequential test, these supplies become active, allowing for leakage measurement under Bias conditions.

The supply voltage can be observed on the status line in the HELP menu. To select a supply level, the following commands should be used:

BIAS1 n or BIAS2 n

In this case, n is equal to the bias voltage desired. For example,

To select a 15 volt bias on BIAS1, type **BIAS1 15.00**

To select a -5 volt bias on BIAS2, type **BIAS2 5.00**

IMCS MODEL 5000 QUICK REFERENCE GUIDE/EXAMPLE

COMMAND INPUT/ RETURN	SYSTEM SCREEN RESPONSE	COMMENTS
1. Turn on computer		
2. Enter date		
3. Dir	Shows directory, files	
4. Sequenxc	Shows help/set up screen	
5. Turn on tester	------------	
6. 16 Pin-IC	Updates help screen	Sets system up for 16 pin IC
7. P	Shows Pin screen	Allows selection/ assignment of stimulus /grnd pins.
8. VBUS ON 5 to 7 & 9 & 13	OK	Selects pins 5,6,7,9 and 13 as stimulus.
9. GRND1 on 16	OK	Selects pin 16 as ground 1
10. P	Updated pin screen	Allows verification of pin assignments.
11. Z	Shows zap screen	Allows selection of ESD discharge parameters.
12. Change	Shows : +V CHANGE	Selects positive then negative pulses (zaps).
13. G1	Shows : zap on : G1	Selects G1 as zap grnd
14. CRØ 2000	Updates :CRØ 2000	Sets start voltage at 2KV.
15. STØ 1000	Updates :STØ 1000	Increments ESD pulse in 1KV steps.
16. CR1 7000	Updates : CR1 7000	Sets 7KV limit on ESD pulses.
17. #-PUL 3	Updates : #-PUL to 3	Selects 3 pulses per zap polarity
18. LEARN	mode : LEARN	Selects curve learn mode for leakage on each pin
19. LH	Shows leakage screen	

20. # LEAKS 3	Updates # LEAKS to 3	Selects 3 test points on leakage curves.
21. SETSEG, L,P	From [uA] = _	Steps 20, 21 & 22 set up checkpoints at -4uA, 0.5uA, 5uA for monitoring changes in leakage values
22. -4	to [uA] =	
23. 5	ok	
24. DOIT	Part # = , (y,n)_	Part# same as before?
25. Y	Serial # = , (y,n)_	Serial# same as before?
26. Y	Learning part, beeps OK	Learns voltage feedback value for each pin at each leakage point.
27. %, L, P	%=	Select desired guard-band tolerance.(25%).
28. 25	(+/-/B):_	Select +,-, or both
29. B	ok	Sets guardband at +/- 25%.
30. L	Leakage vs pin values	Shows "learned" parameters for each pin and leakage point.
31. Z	Shows zap screen	Return to zap screen.
32. ZL	mode : ZL	Goes from learn mode to zap & leak(other options are LZL or ZL)

We are now ready to run the sample test. There are three test modes:

Discard on Fail-------------Discontinues testing of failed pins.

Continue on Fail------------Continues testing of failed pins.

Stop on Fail----------------Stops test on failure of any pin.

Discard on fail comes up as a default mode. It is the most commonly used mode and will be used in this example.

33. DOIT	Part# =, (y/n)-	Part# same as before?
34. Y	Serial# =, (y/n)-	Serial# same as before?
35. Y	ok	Initiaties test.
36. Rep	Report screen	Shows report.
37. Rep.	ok	Prints report.
38. L.	ok	Prints leakage screen setup.

39. Z.	ok	Prints zap screen.
40. P.	ok	Prints pin assignments.

MILITARY TEST PROGRAM

Modified sequential test program per Method 3015.6

The MIL2C test program is a modified version of the "SEQUENTIAL TEST" program. You must read and understand the application of the sequential test program in the Model 5000 operators manual before attempting to write test programs using MIL21C. You must also have a complete understanding of Method 3015.6. Many of the commands used in the sequential test are duplicated in this addendum. Only those commands which differ will be explained here.

The MIL2C program is designed to perform voltage and pin combination testing strictly per MIL-STD-883C, Notice 7, Method 3015.6. The operator has fewer choices than the standard sequential test program. This program may not comply with future revisions of Method 3015.

The HELP screen of the MIL2C program should appear as follows:

NETWORK-# 1 192 PIN-IC

NETWORK-# n	n PIN-IC				
LOAD-PARAM	SAVE-PARAM	LOAD-REP	SAVE-REP	**PRINT**	
Z	P	L	REP	DOIT	HELP
STOP	CONTINUE	+V	-V	ZONLY	LONLY
LEARN	ZL	LZL	**NORMAL**	**G/ALL**	
CRØ v	CR1 v	CR2 v	CR3 v	CR4 v	STØ v
ST1 v	ST2 v	ST3 v	#-PUL n	DLY n	
I/O	**SØ1**	**SØ2**	**SØ3**	**SØ4**	**SØ5**
SØ6	**SØ7**	**SØ8**	**SØ9**	**S10**	**S11**
S12	**S13**	**S14**	**S15**	**GNDL**	
ON n	OFF n	& n	TO n	**?TOTAL**	**P/**
#LEAKS	SETSEG,L,P	SETSEG,L	SET,L	SET,P	SET
LEAK,L,P	LEAK,L	LEAK,P	LEAK	CHECKW	
%,L,P	%,L	%,P	%		
DELTA,L,P	DELTA,L	DELTA,P	DELTA		
RESTORE,L,P	RESTORE,L	RESTORE,P	RESTORE		
<>LEAK,P	<>LEAK	BACKW,L,P	BACK,L		
IL,L	IL	COPY,L,P	COPY,L	COPY,P	COPY

Having read the "SEQUENTIAL TEST" program, you will notice that many of the commands listed above are the same. Those commands which are new to the MIL2C program are shown in bold face. The MIL2C program operates in a similar manner to the SEQUENTIAL TEST program. The new commands function per the following explanations:

The command **PRINT** when used with most other commands will cause all information to be sent to the printer, ie: **PRINT** Z; **PRINT** P; **PRINT** REP; etc.

The commands **NORMAL** and **G/ALL** are interchangeable with **NORMAL** being the default as it refers to the "normal" operation of the leakage test portion of the sequential test program. Typing **G/ALL** will cause an additional grounding operation to be performed after zapping and prior to the leak test in order to provide a drain for any stray charges remaining on the DUT after zapping.

The command **I/O** replaces the command **VBUS** in the MIL2C program. Besides refering to input and output pins, **I/O** is the pin list for any and all pins which are not supply pins.

All commands from **S01** to **S15** are individual lists for those pins which are to be tied together and to ground. It is in these lists that you will type the common combination of like-named supply pins.

The command **GNDL** is the list for the particular pin(s) that will be used strictly for leakage testing. The pin(s) placed on this list may be also used on the ground lists "Sxx". For Method 3015.6 testing, we advise that DC parametric testing be used to determine ESD failure thresholds as the results from leakage testing may not always be conclusive.

The command **?TOTAL** is strictly for informational purposes. Once you have typed into the appropriate lists the pins of your device, this command will execute a formula which will calculate the total number of pin combinations which will be tested.

The command **P/** will cause to be listed all pins of the device which are not connected to any pin list. It will show any pins on your package which are normally "NC" (non-connects) or which you may have missed or forgotten to program. This is especially helpful with extremely high pin count devices.

ZAP SCREEN

The addition of new commands in the force some changes in the "zap" and "pin" screens (the "leak" screen remains unchanged). Lets look at these screens.

```
—————————————— ZAP ——————————————
STOP on fail
Start: +V      mode: ZONLY      NORMAL
CRØ   2000
*-PUL  3    DLY  1
```

The screen shown above is the default screen for the command Z .

When using the internal leakage tester to determine failure thresholds, the commands "**STOP** on fail" and "**CONTINUE** on fail" are used. The command "**DISCARD** on fail" cannot be used in the MIL2C program because most pins are used more than once for the required pin combination testing.

The start voltage can be either +V or -V . Single polarity voltages cannot be tested in the MIL2C due to the requirements of Method 3015.6 for dual polarity testing.

Modes for testing are similar to the sequential test. The only addition is to decide upon "normal" testing (zap/leak, zap/leak, etc.) or G/ALL (zap/ground all/leak, zap/ground all/leak, etc.).

On the "ZAP" screen above, notice that CRØ is preprogrammed at 2000 volts. To do a single voltage test, only CRØ need be programmed to the desired voltage. (No other commands are necessary). This will facilitate zapping at a single voltage (500, 1000, 2000, 4000) per

Method 3015.6 followed by DC parametric testing. You can however do step stress testing using crossover points and steps as previously explained in under sequential testing.

The default for number of zaps is three (positive and negative) and a delay between pulses of one second. The parameters may be changed as in the standard sequential test although any changes will deviate from Method 3015.6.

PIN SCREEN

The "PIN" screen will appear as follows:

I/O

SØ1

SØ2

I/O is where all pins (non-supply) are typed. Again, the standard conventions used in the sequential mode for typing pins to a pin list are used. **SØ1** and **SØ2** are lists for those pins which will be tied together and to ground. Additional SØ lists are available as needed. For example, once you have typed pins into **SØ1** and **SØ2** above and should you need a third list, type the command **SØ3** followed by the pin numbers to be placed on this list. Upon hitting "return" and the "P" command, the screen will be updated to show the additional list. You can continue to add lists up to a maximum of fifteen.

If you will be using the Model 5000 leakage tester to determine failure thresholds, you will need to type the command **GNDL** followed by the pin number(s) to this screen.

It may be helpful to examine a sample pin screen. Assume a fictitious 10 pin IC. This device has five I/O (non-supply) pins, two +V pins, one -V pin and two ground pins. Also assume that we wish to use the same ground pins as our ground reference for leakage testing. The screen might look as follows when programmed:

I/O 1 2 3 4 5

SØ1 6 7

SØ2 8

SØ3 9 10

GNDL 9 10

Upon typing the command **DOIT** , the sequence of testing is as follows: The pin list **SØ1** will be placed to ground and each individual pin on the **I/O** list will be zapped in reference to **SØ1** . Then the pin list **SØ2** will be placed to ground and each individual pin on the **I/O** list will be zapped in reference to **SØ2** . Then each individual pin on the **I/O** list will be zapped in reference to pin list **SØ3** . Then list **SØ1** will be zapped in reference to list **SØ2** . Then list **SØ1** will be zapped in reference to list **SØ3** . Then list **SØ2** will be zapped in reference to list **SØ3** . Finally pins on the **I/O** list will individually and in turn zapped to the remaining common and grounded combination of all the other pins on the **I/O** list. In tabular form, the sequence would look something as follows:

<u>ZAP</u> then	<u>ZAP</u> then	<u>ZAP</u> then	<u>ZAP</u>
1 to 6,7	1 to 8	1 to 9,10	1 to 2,3,4,5
2 to 6,7	2 to 8	2 to 9,10	2 to 1,3,4,5
3 to 6,7	3 to 8	3 to 9,10	3 to 1,2,4,5
4 to 6,7	4 to 8	4 to 9,10	4 to 1,2,3,5
5 to 6,7	5 to 8	5 to 9,10	5 to 1,2,3,4
8 to 6,7	6 to 8	6 to 9,10	
9 to 6,7	7 to 8	7 to 9,10	
10 to 6,7	9 to 8	8 to 9,10	
	10 to 8		

Once you have written the complete program, you may save and recall "parameter files" as in the sequential test program. "Reports" may be saved and recalled in a similar manner. Reviewing a report in the MIL2C program is a little more time consumming because of the large number of pin combinations. However the basic information is the same.

RANDOM TESTING

The random test mode is used to automatically step stress, and perform leakage measurements on numerous junctions of a device when greater flexibility is required than is provided by the sequential test. Through selective linking of independent TEST routines, this mode allows the operator considerable freedom in defining a test program. Unlike the sequential test which requires the operator follow a defined structure, the random test allows the operator to define their own structure. Because there is no defined sequence, entering test parameters takes somewhat longer than the sequential test.

Please note that the random test is considered an advanced mode. We strongly urge you to learn and fully understand the analysis test and sequential test prior to starting to test with this mode. This chapter will assume that you are familiar with the Model 5000 programming conventions.

Program Structure

The random test is actually a combination of several completely individual test routines. These individual routines, simply called TESTS, can either define a Zap TEST or a leakage TEST. The random test ties each of these TESTS together in a user selected order. Subroutine loops of these tests are supported along with branching on defined failures.

Unlike the analysis or sequential test modes which have only 2 or 3 screens, the random test has a separate screen for each (pin) of the individual TESTS. Each TEST is assigned a number for identification; up to 510 TESTS. A test number can be either a zap test or a leakage test, never both. NOTE: TEST 511 is a special test which may be used to emulate a sequential test mode with numerous leakage sub-tests. This test is neither a zap nor a leak test.

As with all of the Model 5000 software, a HELP screen is provided containing all commands needed to operate the random test.

The HELP Screen

Typing the command HELP will cause the following screen to be displayed.

NETWORK-# 1	64 PIN-IC	BIAS1= Ø	BIAS2= Ø		
NETWORK-# n	n PIN-IC	n BIAS1	n BIAS2	BIAS1?	BIAS2?
LOAD-PARAM	SAVE-PARAM	LOAD-REP	SAVE-REP		
DIR d:	CREATE-DIR	USE-DIR			
PIN-MATRIX	PARAM	REP	HELP (H)	DOIT	
PIN-MATRIX.	PARAM.	REP.	HELP.	DOIT.	
GET n	S	ZAP	LEAK	NEXT-TEST n	SUB-TEST n
END	RET	NONE	COPY		
+V	-V	ONLY	CHANGE		
START-V v	INC-V v	END-V v			
#-PUL n	DLY n				
CONT	STOP	JUMP	IL		

An explanation of each of the above commands is contained in the Glossary. (If you are new to the Model 5000, you should review the Glossary prior to using any program.)

To make it easier for the operator to find a particular command, the HELP screen has been separated into sections. Above the dashed line at the top of the screen is information about the current configuration of the system. This information includes which R/C network is being used and the number of pins there are on the device being tested. This header will also show the bias supply parameters if this is a previously written and saved program.

Directly under the header is a list of general commands used in the random test. These include commands to save and recall TEST parameters on disk, commands that summarize TEST parameters as well as the results of testing and commands to execute testing.

The third section contains commands that select TESTS and control the branching of TESTS. The fourth section contains commands to input a TEST'S Zap parameters. And the fifth section contains commands that initiate branching and commands to input a TEST'S leakage parameters.

Overview of Commands

Before we go further, let us review those commands which have not been explained in previous chapters.

EDITING TESTS

TEST-# n — Selects a TEST to be edited. Valid values for 'n' are 1 to 510. Once a TEST is selected, it will be considered the active screen to be edited until a new TEST number is defined. The default for 'n' is 1 when first running the program.

S — The Show command. Displays the screen of the current TEST selected by the command **TEST-#**.

ZAP/ LEAK — Each TEST can be either a **ZAP** or a **LEAK** TEST. These define the function of the TEST. To change the function of a TEST, first select a TEST by the command **TEST-#** or show the current TEST by the command **S**. Then type either **ZAP** or **LEAK**. The default for TEST-# 1 is always a ZAP TEST, and all other defaults are LEAK TESTS.

NEXT-TEST n — This is used to define an execution order for each TEST. Along with the command **SUB-TEST, NEXT TEST** controls the path between each of the individual TEST routines. **NEXT-TEST** is most accurately defined as being the same as a GOTO command in the language BASIC. Valid values for n are 1 to 510 or the command **END**. For more detail, see the example given in this chapter.

SUB-TEST n — This is used to define an execution order for each TEST. Along with the command **NEXT-TEST, SUB-TEST** controls the path between each of the individual TEST routines. **SUB-TEST** is most accurately defined as being the same as a GOSUB command in the language BASIC to create a TEST loop. Valid values for n are 1 to 510 or the commands **RET** and **NONE**. For more detail, see the examples given in this chapter.

END — Used with the command **NEXT-TEST** in the form

NEXT-TEST END	Will terminate the entire test program.
RET NONE	Used with the command **SUB-TEST** in the form **SUB-TEST RET** and **SUB-TEST NONE. RET** is best defined as a RETURN statement in the language BASIC and will close a **SUB-TEST** loop. **None**, the default, is used when no subroutine is desired.
COPY n m	Will copy all but the pin parameters of one TEST number n to another TEST m.

PARAMETER INPUT COMMANDS FOR A LEAK TEST

CONT STOP JUMP	As in the sequential test, when a fail is detected in the leakage test, several options are available. Choosing **CONT**inue on fail will execute the next TEST regardless of any changes in the leakage curve. Choosing **STOP** on fail will terminate the entire test program when excess leakage is measured. **JUMP** will immediately leave any loop and go to the next ZAP test defined by the command **NEXT-TEST.**
IL	A command used to set forcing current levels and expected minimum and maximum voltages against which subsequent measurements will be compared.

Learning the Random Test

Because the random test is so adaptable to a user's needs, any explanation of the test can be quite lengthy and at times confusing. Besides description of the individual screens, flow charts are included to give a pictorial view of how tests are linked together.

There are a few points which should be explained to the reader. There are two similar yet different modes ("ModeA" and "Mode B") which can be performed. In Mode A, the first pin in a list will be tested completely before advancing to the second pin in the list. That is, the first pin will be zapped at the start voltage, then go to the leakage sub-test(s), increment the voltage and zap at next voltage, then go through the sub-test(s) again, increment the voltage and repeat until the pin fails or the maximum voltage is reached. When this pin test ends, the same procedure is repeated on the second pin on the list and so on until all pins are tested.

Mode B acts more like a sequential test except the ability to link sub-tests is retained. In Mode B, each pin in turn will be zapped at the same voltage and each will go to their respective sub-tests. When all pins have been tested, the voltage will increment and testing will proceed again down the list of pins. This will continue until all pins fail or the maximum programmed voltage is reached.

MODE A

The random test will sequence through a series of TESTS each containing a list of pin combinations. In each of these TESTS, the pins are defined exactly as they would be in the analysis test and are held in common with each other on either the **VBUS** or **GND**. These TESTS can be either involved with Zapping or measuring leakage to see if a junction has failed.

Next, in creating a random test, we assign a unique number to each TEST. By defining the **NEXT-TEST** or **SUB-TEST**, the program will know which TEST number to execute next. It is not necessary to define a random test with ascending TEST numbers. A number is simply an identifier for a TEST.

The feature of 'looping' makes the random test quite powerful. A loop is best defined as a series of individual TEST numbers, such as TESTS 1-2-10-11, repeating themselves until a specified condition is met. In most cases, the first TEST in the loop will be a Zap test, followed by leakage test(s). For example:

* TEST 1, Zap, performed at the start voltage,
* TEST 2, Leak, any pin combination
* TEST 10, Leak, any pin combination
* TEST 11, Leak, any pin combination
* TEST 1, Zap, performed at the next voltage increment
* TEST 2, Leak
* TEST 10, Leak
* TEST 11, Leak
* TEST 1, Zap, performed at the next voltage increment

.... And so on until one of the following conditions is met

1) The Zap voltage reaches its defined END voltage

2) The leakage in any of TEST 2-10-11 exceeded the defined threshold

TEST 1, defined its **SUB-TEST** to be TEST 2. TEST 2 defined its **SUB-TEST** to be TEST 10. TEST 10 defined its **SUB-TEST** to be TEST 11. And TEST 11 defined its **SUB-TEST** to be the command **RET**, indicating that the sequence will return to the first TEST in the loop, namely TEST 1.

If leakage exceeded the threshold defined in any of the leakage tests (2-10-11), one of three things could happen. If the user entered **CONT**inue on fail, the loop will continue until the Zap TEST reaches its final voltage. If the user entered **JUMP** on fail, the loop will immediately terminate and the next Zap TEST will be executed (if so programmed). Finally, if the user entered **STOP** on fail, the entire random test will end.

The elegance of looping is apparent when one loop is called up separately for a number of other TESTS. For example, if it was felt that a leakage loop of TESTS 10-11-12 would define the most critical path in a given IC, we would be able to call it up for several independent Zap TESTS. We might see an order like the following:

	1-10-11-12
Jumping to ...	2-10-11-12
Jumping to ...	3-10-11-12

And for even further flexibility, each of the **SUB-TESTs**, can call up other **SUB-TESTs**. As you can imagine, the number of possible combinations can be enormous.

So what is the difference between using the command **NEXT-TEST** and the command **SUB-TEST**? Whenever a loop is desired, **SUB-TEST** should be used. If no loop is desired or a new loop is to be started, then the **NEXT-TEST** command should be used. Remember, when a **JUMP** is performed from a leakage TEST, it will be to the first **NEXT-TEST** out of the loop.

Finally, a word about summaries and reports. As you will see in looking over the next example, there are three types. The first is the **PARAM** summary. It condenses all of the programmed TESTS into a very readable table, separating Zap TESTS and Leak TESTS. This summary is very handy in determining program flow. The default or initial screen looks as follows:

TEST	START	INC	END	POL	CHG	PUL	DLY	NEXT	SUB
511	Ø	1	Ø	+	*	1	1	END	NONE

TEST	Forc [µA]	MaxF [V]	MinF [V]	FAIL	NEXT	SUB

In this screen, the Zap parameters on the top line are programmed the same as you learned in previous chapters. The bottom line will fill in automatically once you make the appropriate inputs to other screens.

The next is the **PIN-MATRIX** summary. For three pins we might see something like this:

TEST-# / PIN	1-Z	2-Z	5-L	50-L
3	V	—	G	G
4	G	V	—	G
5	G	G	V	G

The assigned numbers for each of the **NEXT** or **SUB-TESTs** are listed along the top creating columns. These test numbers are further defined as ZAP tests (Z) or leak tests (L). The pin numbers are listed vertically along the left side. Within the summary, V indicates that a pin is used on the VBUS of a certain TEST and G indicates that a pin is usd on the GND of a certain TEST.

The last is the **REPort**. This is where the results of testing are compiled. The report will be printed at the end of the test if the command **DOIT.** is used. If **DOIT.** was not used, **REP** can be used to display the report on the screen and/or **REP.** can be used to print the report.

WRITING TEST PARAMETERS

The best way to explain how to write a random test is to give an example. Our example will be relatively simple to avoid confusion. Let us assume that we wish to do a random test on four pins of an IC (I/O pins 4,5,6 and ground pin 8). We will start at 2000 volts, increment the voltage by 1000 volt steps and the maximum voltage is to be 4000 volts. Let us also assume that the leakage of a typical pin to ground at 15 volts is less than one microamp. We want to know if zapping any given pin will affect the leakage of other surrounding pins so we will incorporate sub-tests to check the leakage not only of the pin being zapped but also of the surrounding pins. To keep our test numbering from becoming confusing, we will number the zap tests as 1,2,3 and the leakage tests as 10,20,30.

You have loaded the Model 5000 program disk, and called up the 'RANDOM5C' test program. The help screen is shown and you type in the total number of device pins as in previous chapters. You are now ready to begin writing the test parameter for a random test.

You type the command: **GET** 1 . **Get** is the command to bring up a fresh parameter screen. The number "1" could be any number between 1 and 510 but as this is the first test, it may be convenient to start with the number one. The following screen will be shown:

VBUS ON

GND ON

TEST-# 1

NEXT-TEST (NT) **END**

SUB-TEST (ST) **NONE**

ON FAIL **CONT**

————————————————LEAK————————————————

Forc [µA] =

MaxF [V] = *00.0

MinF [V] = *00.0

The default mode is the leak screen. To change to a zap screen, type the command: **ZAP** . The screen changes to :

VBUS ON

GND ON

TEST-# 1

NEXT-TEST (NT) **END**

SUB-TEST (ST) **NONE**

----------------------------------ZAP----------------------------------

+V CHANGE

START-V (SV) Ø INC-V (IV) 1 END-V (EV) Ø

#-PUL (#P) 1 DLY 1

To write the ZAP test program, you might type:

VBUS ON 1

GND ON 8

SV 2000

IV 1000

EV 4000

#P 3

This is similar to previous chapters. To complete this screen, you would type:

NEXT-TEST 2

SUB-TEST 10

This completes test #1. Type the command **GET** 2 . Do the same as for test #1 except VBUS will be pin number 2 and the NEXT-TEST will be #3. Type the command **GET** 3 . Do the same as before only VBUS will be pin #3 and NEXT-TEST will be "**END**".

Now you will write the leak sub-test screens. Type: **GET** 10. As before, a new leak screen will appear. Type the commands:

VBUS ON 1

GND ON 10

NT 11

Now that we have told this leak screen what pins are to be tested and which test is next, we must fill in the leakage parameters. For now the screen shows zeros. Type the command: **IL** . The screen will prompt: Force @ ______ . We will type the number 1 for one microamp. (Any number between 0.10 and 50.0 will be recognized as microamps). Once we have typed in the force current, the screen will prompt: MaxF ______ . As we already established that the typical voltage at one microamp is 15 volts, we should pick a higher voltage in case the pin failure mode is an open. We type 18. The screen now prompts: MinF ______ . We will type 12 to set the minimum limit to 12 volts. This screen is now complete. We would now type **GET** 11 and complete this screen in the same way. When we type **GET** 12, all commands will be the same except for NEXT-TEST where we will type the command: RET . This stands for 'return' to last Zap test where the computer will receive instructions as the the NEXT-TEST.

This would normally complete the parameters and we could begin testing. However, there are some instances where we might wish to do an initial leak test before we begin zapping. In this case we must create a special test that does not zap the pins but has the leakage test as sub-tests. Lets call this test number 50. We type GET 50 . A new leak screen appears. We put all pins to the ground bus, type NEXT-TEST as #1 and the SUB-TEST as #10. When we begin to test and type the command DOIT , the program will ask for the beginning test number and we would type '50'. The flowchart called "RANDOM TEST EXAMPLE, MODE A" is a pictorial representation of what we have just completed.

MODE B TESTING

Mode B testing is almost identical to Mode A. The screens and commands are the same. The differences are as follows:

1. On zap screens, the start voltage, increment voltage and end voltage are not completed (left blank).
2. A special test block called '511' is used to set the start, increment and end voltages.
3. Test block '511' is either the first test or is inserted between an initial leak screen and the first zap screen. In other words, the initial leak screen's NEXT-TEST will be 511 and test 511's NEXT-TEST will be whichever number is assigned to the first zap test.
4. The final zap test in the program will have test 511 as its NEXT-TEST.

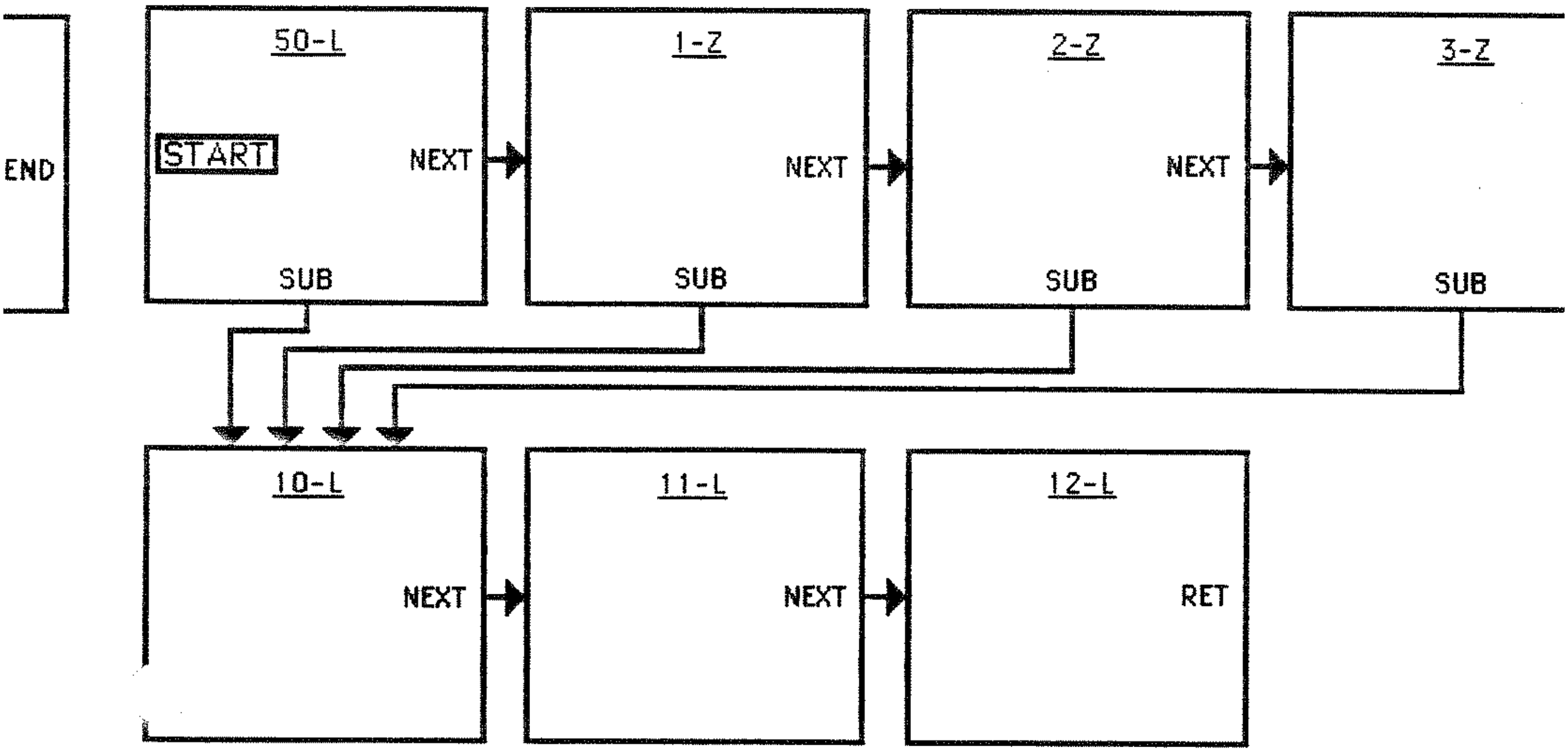
Test block 511 will set the starting voltage. All pins to be zapped will use this voltage (although the number of pulses and delay between pulses is still independently set on each zap screen). Once all pins have been tested at this voltage, test block 511 will increment the voltage. This will continue until the part fails or until the end voltage is reached. See the flow chart called " RANDOM TEST EXAMPLE, MODE B " for a pictorial overview.

SPECIAL NOTE

This program will become rather lengthly. We strongly suggest that all random test programs be designed on paper in a flow chart configuration **BEFORE** attempting to write the program on disk. Besides being easier to see inter-relationships between tests and sub-tests you will have a handy reference guide when some months later you see the program in the directory but no longer recall how the test is structured.

RANDOM TEST EXAMPLE

MODE : A



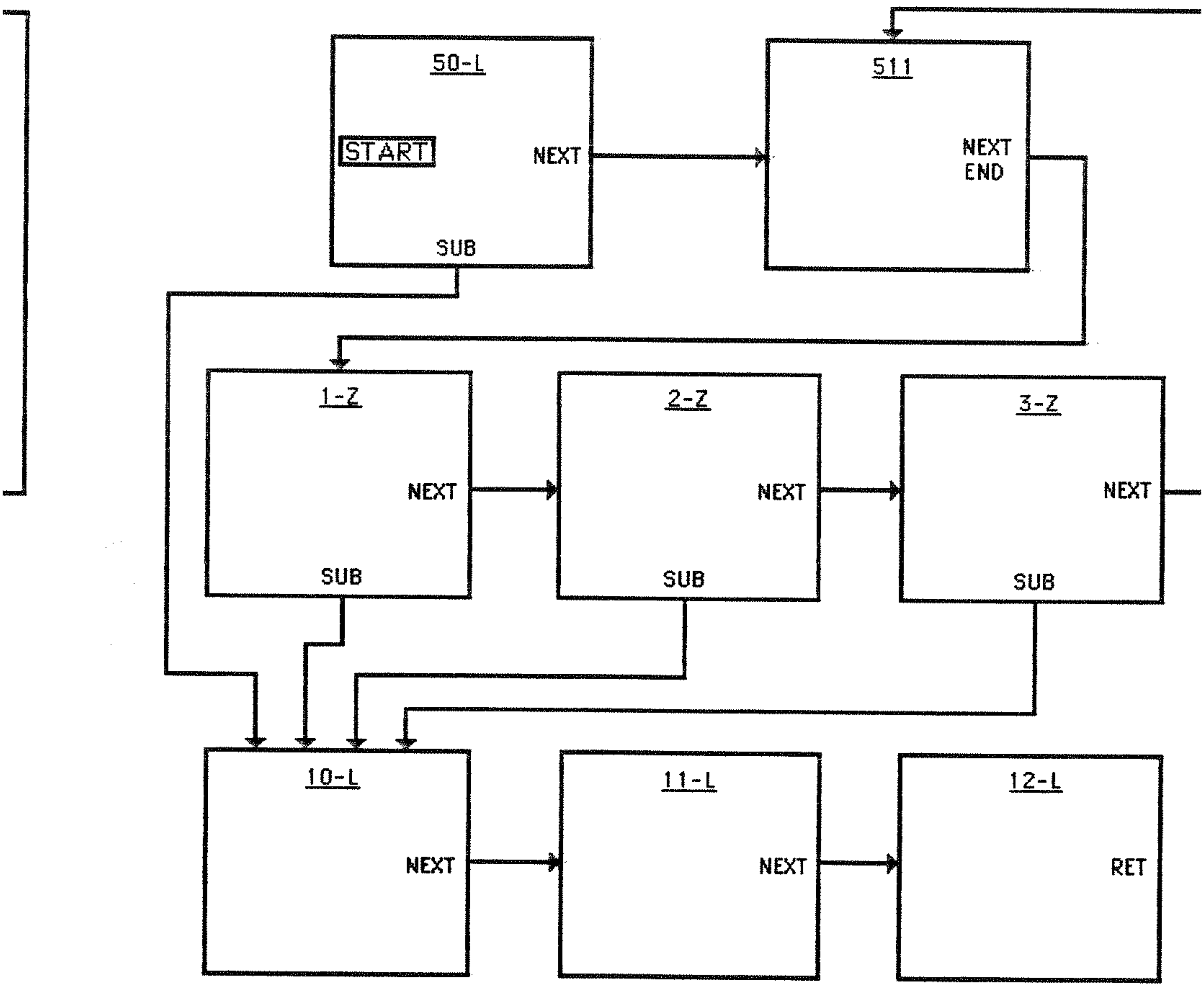
Program Flow

Start test 50 (leak sub-test optional)
Next to 1-Z, loop to sub-tests
Return to 1-Z Next
Goto 2-Z, Loop to sub-tests
Return to 2-Z Next
Goto 3-Z, loop to sub-tests
Return to 3-Z, END

Note: In Mode A, each Zap test will execute Zap from initial voltage through maximum programmed voltage while loops to sub-tests between voltage steps. When complete, the next pin will begin again at the initial voltage and so on until all pins are tested.

RANDOM TEST EXAMPLE

MODE : B



PROGRAM FLOW

Start test 50 (leak sub-test optional)
Next test:511 (initial start voltage)
Goto 1-Z; loop to sub-tests
Rtn to 1-Z, Next
Goto 2-Z; loop to sub-tests
Rtn to 2-Z, Next
Goto 3-Z; loop to sub-tests
Rtn to 3-Z, Next
Goto 511 (step voltage)
Repeat till end.

DIAGNOSTIC MODE

The diagnostic mode is a comprehensive program that verifies the integrity of the Model 5000 hardware. This mode will inspect the leakage current supply, both the positive and negative high voltage supplies and each of the high voltage selection relays for proper operation. In addition, provisions have been provided to allow the operator manual control of Zap discharge in order to perform waveform measurements. Used each day, the diagnostic mode will ensure the accuracy of results obtained with the Model 5000.

Program Structure

The diagnostic mode performs two functions. The first is the evaluation of operation of the Model 5000. The second, manual control of Zap discharging for calibration of waveform. The manual control of Zap discharge requires that the operator input certain Zap parameters prior to discharging. For future reference, diagnostic results can be printed if desired.

Because of the simplicity of the diagnostic mode, the extensive use of screens is not required. Yet, as with each of the other programs, there is a HELP screen. Though the HELP screen is not directly involved with testing, it does contain a complete list of commands available to the user in the diagnostic mode.

The HELP Screen

The HELP screen is called up by the simple command **HELP**. It contains all of the commands used in the diagnostic mode. The screen looks as follows:

NETWORK-# 1 192 PIN-IC

CUR-TEST	PIN-TEST	HV-TEST	NET-TEST	DIAG	CEFF-TEST
DIAG.	CEFF-TEST.	REP	REP.		
n PIN-IC	VBUS	GND	ON n	OFF n	
& n	TO n	P	PINS	ALLOFF	SHORTBUS
+V	-V	n HV	HV@	FORCE	FEED?
#-PUL n	DLY n	`	REST		
BIAS1 .00	BIAS2 .00				

An explanation of each of the above commands is contained in the Glossary. (If you are new to the Model 5000, you should review the Glossary prior to using any program.)

To make it easier for the operator to find a particular command, the HELP screen has been separated into sections. Above the dashed line at the top of the screen is information about the configuration of the system. This information includes which R/C network is being used and the number of pins the system will consider for diagnostics; it will automatically default for the maximum pin configuration of your Model 5000.

Directly under this header are a list of commands that inspect the integrity of the Model 5000. These include commands that will test for calibration accuracy of the current supply, calibration of both positive and negative high voltage power supplies, and includes commands that will inspect each of the high voltage selection relays for proper operation.

The third section of the HELP screen contains commands used in selecting pin combinations for manual control of Zap discharge. The fifth section contains commands affecting the High voltage and pulse parameters used during manual control of ZAP discharge.

Testing the calibration and operation of the Model 5000

The most often used command is **DIAG**. This command is a combination of three commands. It will automatically execute the commands **CUR-TEST**, **HV-TEST** and **PIN-TEST** in order. Under most conditions, **DIAG** will be sufficient to test the integrity of the Model 5000.

To better explain the functions of the diagnostic mode, we will look at **CUR-TEST**, **HV-TEST** and **PIN-TEST** separately.

CUR-TEST will inspect the leakage function in ten ranges starting with the micro-amp range through the nano-amp range. Each current is forced through a 400k ohm resistor mounted on the diagnostic test board and the imposed voltage is readback and listed in the report. The report consists of (1), the forced current, (2) the feedback voltage and (3), the difference between expected and read voltage. This report will appear as follows:

Forc. [µA]	Feed [V]	Err.* [V]	Forc [µA]	Feed [V]	Err.* [V]
50.00	20.00	.60	-50.00	-20.00	.60
25.00	10.00	.30	-25.00	-10.00	.30
10.00	4.00	.20	-10.00	- 4.00	.20
5.00	2.00	.15	- 5.00	- 2.00	.15
2.50	1.00	.08	- 2.50	- 1.00	.08
1.00	.40	.06	- 1.00	- .40	.06
.50	.20	.05	- .50	- .20	.05
.25	.10	.04	- .25	- .10	.04

* Maximum allowed; minimun error will be from 0.00 to 0.04 volts.

The maximum expected error voltage tolerance is as shown above. The error voltages of your Model 5000 should be the same of less and may be either positive or negative. Some rounding does occur as shown above. If during a diagnostic test run it is noted that the error voltages exceed the tolerances, the unit should be scheduled for re-calibration as explained in the calibration section.

HV-TEST will inspect both the positive high voltage supply and negative high voltage supply at 300, 1000, 3000, 6000 and 10,000 volts. The computer will send an analog signal from the D/A converter to drive the HV control circuitry after which a HV output signal from a divider network is sent back through a A/D converter. The test report might look as follows although the ranges for the feedback voltage tolerances are inserted for comparison purposes.

NETWORK-# 1

POSITIVE POLARITY TESTING HIGH V. P.S.				TOLERANCE
AT	300	OK	300	270 - 330
AT	1000	OK	1000	975 - 1025
AT	3000	OK	3000	2965 - 3045
AT	6000	OK	6000	5940 - 6060
AT	10000	OK	10000	9950 - 10050
AT	300	OK	300	270 - 330

NEGATIVE POLARITY TESTING HIGH V. P.S.				
AT	300	OK	300	Same as above
AT	1000	OK	1000	
AT	3000	OK	3000	
AT	6000	OK	6000	
AT	10000	OK	10000	
AT	300	OK	300	

PIN-TEST will inspect each of the high voltages selection relays for proper closing and opening of the contact. Because there are two relays for each pin of the IC, the **PIN-TEST** will examine both the VBUS relays as well as the GND relays. Here are examples of a normal condition:

```
TESTING VBUS

PIN  1  OK to CLOSE                OK to OPEN
PIN  2  OK to CLOSE                OK to OPEN
PIN  3  OK to CLOSE                OK to OPEN
•                                  •
•                                  •
•                                  •
PIN  n  OK to CLOSE                OK to OPEN

TESTING GND

PIN  1  OK to CLOSE                OK to OPEN
PIN  2  OK to CLOSE                OK to OPEN
PIN  3  OK to CLOSE                OK to OPEN
•                                  •
•                                  •
•                                  •
PIN  n  OK to CLOSE                OK to OPEN
```

Should the pin select relay being tested fail to close or open, the comment will be "Fail to CLOSE" or "Fail to Open". The pin number should then be noted. By refering to the appropriate schematic in this manual, the pin select relay card can be identified and replaced. Another possible error message could be "Pin n Some Opposite Side Closed". This indicates a shorted relay other than the one being tested. Call the factory for assistance in determining the appropriate relay card to replace.

To print the results of the Diagnostic test, type the following two commands as shown (with the period). The test(s) will run with results sent to the printer rather than the screen. For example:

DIAG. (ALL TESTS IN SEQUENCE)

CEFF-TEST.

REP. (SHORT FORM REPORT OF PIN TEST)

Manual control of Zap Discharge for Waveform Measurement

Detailed here are the commands that prepare the Model 5000 to produce a discharge for waveform measurement purposes. Please refer to the chapter on waveform verification for equipment recommendations and setup.

Prior to waveform measurement, the Model 5000 will have to be configured for a combination of pins to test, a polarity for Zap, a voltage for Zap, the number of pulses to Zap and the delay between pulses. Once these parameters are defined, the operator can then connect measurement equipment and begin evaluation of the waveform.

To assure proper pin correlation, it is strongly suggested that the operator define to the computer the number of pins as EXACTLY the number of pins on the interface board selected to do waveform measurement. To select the number of pins, type the command n **PIN-IC**. n being the number of pins on the selected interface board and socket.

Next, the operator will select the two pins across which the waveform measurement will be performed. In most cases, the operator will only need to select one VBUS pin and one ground pin.

COMMAND	RESULT
VBUS ON 1	Selects pin 1 to the VBUS
VBUS ON 14	Selects pin 14 to the VBUS
VBUS OFF 14	Deselects (floats) pin 14
GND ON 15	Puts pin 15 to ground
GND OFF 15	Floats pin 15
ALLOFF	Floats all pins (to quick clear)
P	Displays selected pins

The operator will then select the polarity of voltage using the command **+V** or **-V**, select the voltage by the command n **HV**, select the number of pulses by the command **#-PUL** n, and the delay between pulses **DLY** n. Acceptable values for n are from 1 to 99 seconds.

With all parameters configured, waveform measurement can be performed. When ready to Zap, the operator need only type the command (`) followed by a return and pulsing will commence.

Additional Commands

NET-TEST Will display the current network number.

HV● Will display the current High Voltage setting.

REST Will deselect all pins from both the VBUS and GND, will place the HV supply at 0 Volts and will reduce the leakage supply to 0 Volts.

PINS This command will energize selected relays.

CONT/BREAK Used to stop (end) a test sequence at any point.

BYE Exits program.

REMEMBER: All commands must be followed by [RTN] or [ENTER].

WAVEFORM VERIFICATION

NOTE: WHEN PERFORMING WAVEFORM CALIBRATION PER THE MIL-STD, REFER TO THE INSTRUCTIONS AND CONDITIONS CONTAINED IN METHOD 3015.6.

1. Insert program disk, turn on computer, load diagnostic program. Turn on Model 5000 console.

2. Insert a program board with a socket that will accept the leads of the CT-1 current probe, being certain to close all of the connectors afterwards.

3. Identify the size of the socket selected by typing in the number of pins on the socket using the format **nn PIN-IC**. (nn is the socket size.)

4. Select a pin to pulse and a pin to connect to ground. For example: **VBUS ON 1**, and **GND ON 28**, may be chosen on a 28 pin test socket. It is good practice to always type **ALLOFF** before choosing the pin pair, to be certain that the buses are cleared of any previous commands, especially when starting up for the first time.

5. Override the DUT bay door interlock by placing a magnet next to the switch located at the right rear of the compartment (if necessary).

6. Be certain that the R/C-1 module is in place (1500 ohm, 100pF).

7. Place a short length of solid copper wire through the CT-1 and connect across the DUT socket in the pins chosen in Step 4 above. Remember to observe the polaity as indicated on the CT-1.

8. Per Method 3015.6, the calibration voltage is +4000 and -4000 volts. The command to set the high voltage would in this case be " **4000 HV** ". The " **+V** " and " **-V** " commands will set the polarity. As almost all oscilloscopes use preamp ranges of " .1; .2; .5; 1; 2; 5 " volts, the required 4000 volt calibration points will not give five full divisions with a CT-1 current probe. These five divisions are needed to measure risetime and decay time. As an alternative (not a substitute) for this problem, we suggest the use of 1500 and/or 3000 volts which will allow a pulse covering five full divisions.

9. The pulse can be initiated by typing " **** " or " **`** " (depends on type of computer) plus hitting the return key. To obtain more than one pulse (makes adjustments easier), use the standard command " ***-PUL** n " where 'n' is the number of pulses desired. The delay between pulses will be one second unless changed with the command " **DLY** n " where 'n' is the time in seconds.

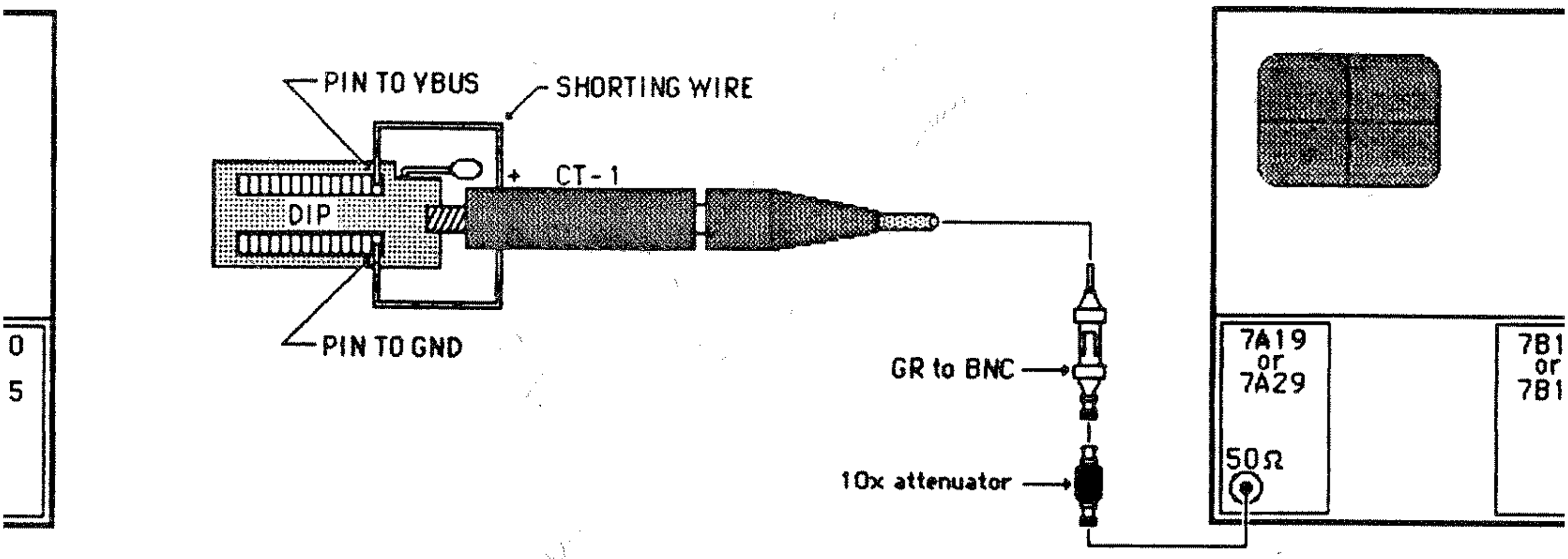
10. When testing at negative polarities, it is some times easier to invert the polarity on the preamp using the switch (usually) provided for this purpose. This method eliminates the need to readjust trigger polarity, sensitivity levels and trace position.

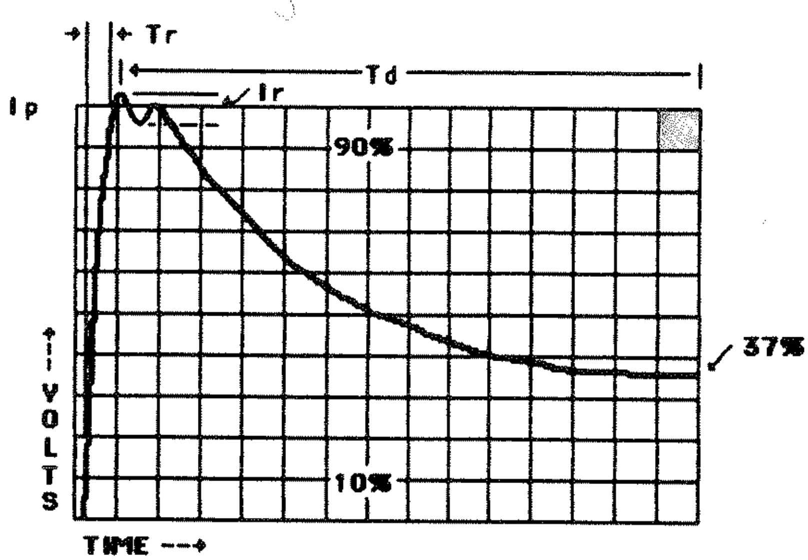
10. The pulse waveshape should be as specified in Method 3015.6. See the suggested apparatus and test setup illustration on the next page. If adjustments appear to be needed, see the calibration section.

WAVEFORM VERIFICATION per METHOD 3015.6

MIL-STD-883C

* Scope mainframe: Tektronix /7934/7104/2467
* Scope probes: Tek. CT-1 current probe (1GHz BW)
* Attenuator: Tek. P/N 011-0059-02, 10x, 50Ω, 2W or equiv.
* Scope preamps: Tek. 7A19 (50Ω, 600MHz BW) with CT-1 current probe or Tek. 7A29 (50Ω, 1GHz BW) with CT-1 current probe
* Scope timebase: Tek 7B10 or 7B15
* Misc: GR to BNC Male adaptor for CT-1





WAVEFORM SPECIFICATIO

RL = 0 Ω
Tri: 10 ns max.
Tdi: 150 ns +/- 20 ns
Ip: +/- 10 % of expected pe
Ir: < 15 % of Ip

effective Capacitance

Ceff. VERIFICATION

NOTE: This test procedure is required when engaged in testing to MIL-STD-883C, Method 3015.6. Refer to the instructions and conditions contained in Method 3015.6. This procedure applicable to all 5000 systems past ECO #2013.

TEST EQUIPMENT:

Electrometer/Coulombmeter, Kiethley 610C or equiv.
1 Gohm resistor

SEQUENCE:

1. With the 28 pin DIP I/F board installed and the R/C-1 (100pf/1500Ω) module in place, power up the Model 5000 as per normal procedure. Invoke the diagnostic routine by typing the command: **DIAGCX** (Rtn)

2. Cage (short) the electrometer input and connect to the appropriate DUT board terminals with a series limiting resistor, typically 1 Gohm minimum.

3. Set the electrometer controls for: positive polarity, fast response, and a scale of 3 X 10E-7. Adjust zero balance as necessary.

4. From the primary HELP screen invoke the Ceff mode by typing the command: **CEFF-TEST** (Rtn).

   The screen will display:

   Default values: 2 PIN-IC VBUS ON 1 GND ON 2 2000 HV

STEP	FUNCTION	ENTRY FORMAT
1)	To activate test with default values - then go to step 6. To change test values, go to step 2	**F1** (Rtn)
2)	Change default pin configuration?	n **PINIC** (Rtn)
3)	Change default VBUS pin?	**VBUS ON** n (Rtn)
4)	Change default GND pin?	**GND ON** n (Rtn)
5)	Change default high voltage?	n **HV** (Rtn)
6)	Connect Coulombmeter path	**F2** (Rtn)
7)	Reset Coulombmeter to zero (manually)	
8)	Transfer charge	**F3** (Rtn)
9)	Read Coulombmeter (manually)	
10)	To repeat the test, go to step 6	
11)	To end test	**F4** (Rtn)

5. Follow the screen prompts to perform measurement and verify an electrometer reading of between 1.80 and 2.20 for a standard R/C-1 module with the default values. Divide reading by 2 and multiply by 100 to obtain the effective capacitance value in picofarads (90pf to 110pf).

6. After exiting the test using F4, cage the electrometer input and disconnect from the Model 5000.

CALIBRATION ADJUSTMENTS

EQUIPMENT REQUIRED

4-digit DMM with a current measuring range of 200 µA with a minimum resolution of 0.1 µA and an input impedance of 10MΩ.

Hewlett Packard High Voltage Probe, Model 34111A.

350 MHz minimum bandwidth oscilloscope. (See 'WAVEFORM VERIFICATION' for scope recomendations).

Tektronix Model CT-1 current probe and 10x attenuator.

Small screwdriver.

A 400K ohm resistor, 1%. (Soldering four 100 k ohm resistors in series is acceptable)

General Notes:

Allow thirty minutes of warmup at normal room temperature before making any final adjustments. Calibration technicians should be aware that the high voltage and waveform requirements of MIL-STD-883C, Method 3015.6 have in some cases, tighter specifications and tolerances than the high voltage probes and scopes used to make adjustments to the Model 5000. Any tolerance variations of the measurement equipment can and will affect the observed performance of the Model 5000. It is therefore important for the calibration technician to know the actual accuracy limits of the measurement equipment before making any adjustments.

HIGH VOLTAGE SUPPLY ADJUSTMENT

The Model 5000 incorporates high voltage power supplies. These supplies are internally current limited through a ten Megohm resistor which is potted within the H.V. supply. It is difficult to measure this voltage directly without some loading of the supply. We suggest a 1000 Megohm, high voltage probe if this measurement is desired. However as mentioned above, these kind of probes generally have an accuracy of no better than +/- 4%. Appropriate precautions should be taken when working inside the Model 5000 due to the high voltage potentials as well as the 110/220 volt AC power.

Procedure: With the system up and in the diagnostic mode, type the command: **Ø HV**. Open the R/C module compartment door and remove the R/C module. Close the compartment door. Type the command: **2000 HV** and verify that the front panel meter reads 2000 volts. Connect the HP high voltage probe to a suitable DVM. Set DVM to the 20 volt DC full scale range. Connect the HV probe ground wire to Model 5000 chassis ground. Open the R/C module door (note that the HV is disabled with the door open). Place a small magnet next to the upper right hand side of the door opening. When in the proper place, the meter should again indicate HV is on. Holding the magnet in place, position the HV probe tip against the upper right hand female pin connector (supplies charging voltage to capacitor in R/C network). The DVM should read 2 volts ± 5% (1000:1 probe division) or 1.90 volts to 2.10 volts. Should the High voltage exceed this range, refer to figure "CAL. ADJ. 1" which shows the location of the HV adjustment potentiometer. The same procedure can be performed at other voltages but the Model 5000 should not be run at voltages greater than 5000 without the R/C module connected and the door closed (possible arc-over and ionization).

HIGH VOLTAGE PULSE ADJUSTMENT

This adjustment can be used in conjunction with the HV supply adjustment above and is used to fine adjust the pulse amplitude as necessary due to differences in DUT load boards. The pulse amplitude should be ±10 % of expected current peak. To make adjustments in the output amplitude of the pulse waveshape, the following steps should be completed in sequence:

1.) Refer to the "Waveform Verification" section of this manual and initiate a series of pulses. (It may simplify matters to program 25 pulses with the command: ***-PUL 25** .

2.) Remove the four top and three side screws holding the right hand side panel and detach and set aside the side panel.

3.) Refering to Figure "Cal. Adj. 1", locate the ten turn pot labeled " HV ADJ. " . (Pg. 79)

4.) Using a small screwdriver, adjust pot one half turn at a time until voltage peak is within specification.

CURRENT SUPPLY ADJUSTMENTS

In the diagnostic program, complete the following steps in sequence:

1.) Insert the 28 PIN DIP board.

2.) Type the command, "**28 PIN-IC** ".

3.) Type the command, "**VBUS ON 1** ".

4.) Type the command, "**GND ON 28** ".

5.) Type the command, "**PINS** ".

6.) Place a 400 k ohm, 1% resistor across pins 1 and 28.

7.) Connect a current meter set on the 200µA range in series with the resistor and the socket.

8.) Type the command, "FORCE ". Screen will prompt: [ua]. Type the command "Ø".

9.) Adjust Pot #1 on the current supply board for zero current as noted on the current meter. This pot is the zero offset adjustment. (See page 65 for pot location)

10.) Type the command, "FORCE ". Type the command, "25".

11.) Adjust Pot #2 for 25.0 µA.

12.) Type the command, "FORCE ". Type the command, "49". The reading should be 49.0 µA. Some offset of Pot #2 may be necessary to correct for slight linearity differences. (See DIAGNOSTIC MODE for normal toloerances expected).

The following adjustments are generally not necessary but are included herein for informational purposes.

HV CONTROL REGULATED SUPPLIES

Adjust potentiometers R55 and R60 to set the internal bias supplies to +14V and -14V, respectively. These voltages can be measured across C14 and C15 (see layout).

OSCILLATOR FREQUENCY

Observe the output of U3 (pin 7) on a scope and adjust R31 until the frequency of the square wave is approximately 2kHz.

DIGITAL PANEL METER CALIBRATION

This adjustment assumes that the waveform of the Model 5000 has been verified as being correct or adjusted as per the procedure above. This calibration step is only to adjust the digital panel meter reading only and has no effect on the actual output of the Model 5000.

Type the command, "5000 HV". Remove the flat red lens of the panel meter. This will expose a small ten turn pot. Adjust this pot to make the panel meter read 5000.

MAIN SUPPLY

Adjust R1 to set the logic supply at +5V (+/- .1V) with respect to chassis. Adjust the remaining regulators to +12V (+/- .2V) by means of potentiometers R3, R5, and R7.

SUPPLEMENTARY CALIBRATION PROCEDURE

Equipment - Tektronix 7104, 7834, 7934, 2467 Oscilloscope or equivalent [1].
Tektronix CT-1 current probe with a 10x attenuator.
Three inch length of copper bus wire, #20.
HP High Voltage Probe, Model 34111A or equivalent [2].

General Considerations:

To properly display the current pulse, an oscilloscope with a bandwidth of at least 350 MHz must be used. For risetime measurements, sufficient writing speed must be available (4 divisions per nanosecond), or the leading edge may not be visible. If a "reduced scan" mode is available, it should be used. The Tektronix CT-1 probe must be used with a scope preamplifier having a 50 Ω input. Make sure that the scope used is properly calibrated, following the manufacturers' instructions. Special attention should be paid to the scope's high frequency calibration. Digitizing scopes, while appearing to have a wide bandwidth, may not be suitable to properly display single-shot waveforms.

The Model 5000 has been designed to produce the proper current waveform into Ø Ω (shorted load) as per Method 3015.6. Our testing has shown that the Model 5000 will operate properly into loads from Ø to 100 ohms. Above this range, the current and voltage performance begins to drop off sharply. This is an expected occurance due to the RF nature of the ESD pulse in conjunction with the unavoidable wiring parasitics of the tester. As very few, if any, IC structures have ESD dynamic impedances above this range, it is expected that the Model 5000 will produce accurate ESD data.

CAUTION: THE CALIBRATION OF THIS EQUIPMENT WILL INVOLVE THE MEASUREMENT AND POSSIBLE ADJUSTMENT OF THE HIGH VOLTAGE SUPPLIES. THESE PROCEDURES SHOULD BE ATTEMPTED ONLY BY THOSE INDIVIDUALS AUTHORIZED WITHIN YOUR COMPANY TO PERFORM SUCH TASKS.

Calibration Interval:

When involved in testing to Mil-Std-883, Method 3015, follow the current revision's requirements for waveform verification which shall take precedence over this specification.

It is recommended that the Model 5000 be placed on a maximum six week calibration interval. For maximum accuracy and to comply with certain military specifications, the voltage waveform should be verified prior to testing.

HV Adjustments

Due to limitations of all voltage probes currently available, MIL-STD-883C, Method 3015.6 no longer requires the measurement of ESD voltage waveforms. However, it is deemed necessary to set the high voltage supply to within certain limits. Therefore a procedure is recommended whereby the charging voltage applied to the 100 pf capacitor is verified. The actual voltage applied to the DUT (IC) is allowed to vary with the dynamic impedance of the junction(s) under test.

Verification and/or adjustment of the high voltage may be necessary when performing testing per Method 3015.6. Using a H.V. probe such as the HP 34111A in conjunction with a matching DVM, the actual H.V. supply charging voltage may be measured directly at a point prior to the R/C network. The procedure is as follows:

In the diagnostic mode, type the command: **Ø HV**. Remove the R/C network. Looking inside the R/C module compartment, note that there are seven female pin jacks which accept the pins of the R/C module. The upper right hand pin jack is the output of the H.V. supply. **CAUTION: HIGH VOLTAGE IS PRESENT AT THIS PIN.** Set the DVM to the 20 volts full scale position. Type the command: **4000 HV**. Place a small magnet against the upper right-hand side of the

R/C module opening (*this defeats the safety interlock*). The front panel meter should now display 4000 volts. After grounding the ground clip of the probe to the chassis of the Model 5000, place the tip of the probe against this pin. The DVM should read 4.00 volts ± 3%. If there is a greater than 3% difference, an adjustment will be required. Refering to the figure, CAL. ADJ. 1, adjust the "H.V. Cal. Pot" as needed. Type the command, **Ø HV** and replace the R/C network.

Current Amplitude Check (Ipk):

Replacing the older voltage waveform check of Method 3015.1/2/3 is the current (I) waveform measurement. This change was precipitated by various published findings that early ESD testers were over-stressing components and data was not correlatable between ESD testers from various manufacturers. The reason generally given was that while each tester may have produced the same voltage waveform across a 1500 Ω resistor, these testers did not produce proper or similar waveforms into low impedance loads as represented by most IC's. Also recognized was the failing of voltage probes to accurately capture and display the voltage waveform. Thus, the most recent revisions of Method 3015.6 have eliminated the voltage measurement and adopted a current (I) measurememt. That procedure is as follows:

Place the three inch length of bus wire through the CT-1. The ends of this wire should be bent down. With a socket/load board installed on the tester, choose two pins to test. Connect the two ends of the shorting wire to the chosen pins. Notice that the CT-1 is polarized and must be connected positive to positive and negative to negative. Use the jumper cable and programming pegs to connect the appropriate pins of the socket to the tester.

A calculation needs to be performed to determine the expected current amplitude at the probe and the voltage amplitude at the scope. The following formula will yield the expected current amplitude across the short: (Vs / Rs) = A.

Where Vs is the HV supply setting, and Rs as always, is the series resistance of the HBM R/C network: 1500 Ω. 3000 volts is our prefered calibration voltage because the resultant current is an even amount which can easily be displayed over five full divisions on an oscilloscope. (However, 4000 volts is listed as the voltage in Method 3015.6 and this voltage should be used for waveform verification).

If the front panel meter were to be set to 3000 volts, the resultant current would be calculated as 3000 volts divided by 1500 ohms yielding 2 amps. (4000 volts/1500 ohms = 2.67 amps for Method 3015.6). As the Tektronix CT-1 current probe's conversion factor is 5 mv per milliamp, we will expect an output of 10 volts at Vs = 3000. (13.33 volts @ Vs =4000 volts).

Choosing a vertical amplifier setting of 2 volt/division will yield a waveform of five divisions amplitude at Vs = 3000 volts. (If the preamplifier of your scope does not have a 2 V/div. setting, a 10x attenuator can be inserted in line and use the 200 mV setting). We recommend that the risetime measurement be made with the time base set at 5 ns/div. and that the decay time measurement be made at 20 ns/div. Risetime and decay time are a function of system and R/C network performance. Minor adjustments of Ipk can be accomplished using the "HV OUTPUT ADJ. POT" shown in the figure "CAL. ADJ. 1" refered to earlier in this section.

Waveform Specifications:

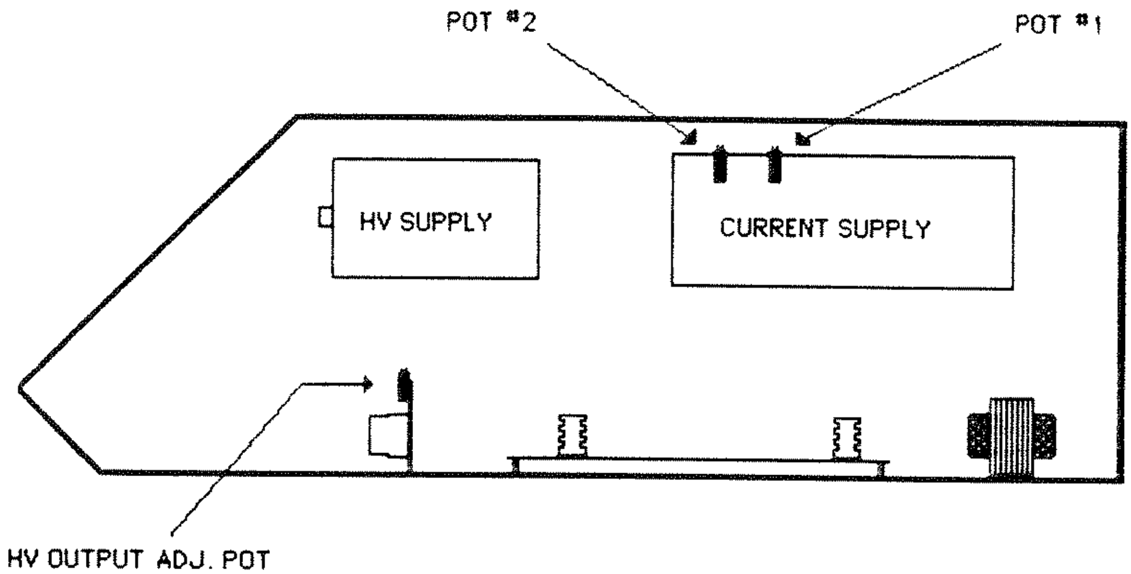
Special Note: The IMCS Model 5000 ESD test system is designed to be used in testing IC's to Mil-Std-883C, Method 3015. We strive to provide test instrumentation to the most current revisions of applicable specifications. Units delivered after March, 1988 should comply to Notice 7, Method 3015.6 dated February 12, 1988. Future changes to this specification are beyond our control and IMCS can make no representation or guarantee to meet such changes. ESD test systems built to different ESD test specifications or different revisions of the same ESD test specification can be expected to produce different and possibly un-correlatable test data.

After proper calibration using the procedures outlined above and those encompassed in Mil-Std-883C, Method 3015.6, waveforms produced should meet the following limits:

Current Waveform:	Tri (rise time)	10 nanoseconds max. (10% - 90%)
	Tdi (decay time)	150 ±20 nanoseconds
	Ipk (peakcurrent)	Within ±10% of calculated Ipk
	Ir (ringing)	15% of Ipk maximum

[1] NOTE: Most oscilloscopes, unless designed specifically for single-shot, nanosecond risetime pulses, may not be suitable for this type of measurement. IMCS cannot guarantee the ability of any scope/probe combination to accurately capture and display the output waveform of our equipment.

[2] NOTE: This HV probe is designed to be used with a DVM that has a 10 MΩ input. It has a 1000:1 divider with a 1 GΩ input impedance. The division accuracy is specified as ± 4%. This accuracy varies with the actual input impedance of the DVM.



CAL. ADJ. 1

GLOSSARY OF COMMANDS AND TERMS

The list below includes most words, phrases, and commands that are normally seen on, or that are typed onto the screen of the IMCS 5000 Automated ESD Test System. The letters immediately following the subject tell which modes of operation they apply to:

A for Analysis, D for Diagnostics, S for Sequential, R for Random and M for Military.

ALLOFF (D)	An instruction that resets all of the relay latches, in order to assure that no unwanted connections to either bus exist before running diagnostics.
BACK,L (S,M)	Reverses the order of all leak points of one specific pin; ie, 1,2,3 to 3,2,1.
BACKW,L,P (S,M)	Reverses the order of all leak points on all pins.
BIAS1 (all)	OPTIONAL- A command to set the #1 Bias power supply voltage level.
BIAS2 (all)	OPTIONAL - A command to set the #2 Bias power supply voltage level.
BIAS1? (R,S,A)	OPTIONAL- A command to display the Voltage level of the #1 Bias power supply.
BIAS2? (R,S,A)	OPTIONAL- A command to display the Voltage level of the #2 Bias power supply.
BIAS1= (R,S,A)	A message telling the voltage level of the #1 Bias power supply.
BIAS2= (R,S,A)	A message telling the voltage level of the #2 Bias power supply.
BYE (all)	A command to exit any mode. Must be used when going from one mode to another or to go to the directory.
CEFF-TEST (D)	A command to enter the C- Effective test mode. Directions for test will appear on the screen.
CHANGE (A,S,R)	A command which programs alternate polarities of the HV discharge.
CHECKW (S,M)	Checks for a minimum window of 0.04 volts. Useful when using deltas to insure that limits are greater than 0.00 volts and less than the maximum compliance voltage.
CONTINUE (S,R,M) or **CONT**	An instruction referred to by the program when a MAX current failure is or detected. This instruction will cause the program to continue with out change.
[CONTROL- ALT-DEL] (all)	(All three keys are held down together). A DOS command which causes the computer to reboot. RAM is erased and the system menu will be displayed.

COPY (S,R,M) — A command which in the sequencial mode copies one single leak point to another single leak point. On the Random mode, copies one test to another.

COPY,L (S,M) — Copies all leak points from one single pin to another single pin.

COPY,L,P (S,M) — Copies all leak points from one single pin to all other pins.

COPY,P (S,M) — Copies one leak point to all other pins.

E-DIR (A,R) — Allows the creation and use of the MS-DOS special directory facility. This command along with the USE-DIR command will store data and parameters under a common sub-directory. This sub-directory must be used to recall this stored information.

CRØ (S) — An abbreviation for the variable CROSSOVER-0 used in sequential testing. The numerical value can range from 0 to 4 (i.e., CRØ, CR1, CR2, CR3, CR4).

CUR (A) — A command which causes a circular cursor to overlay the leakage plot in the Analysis mode grid. This cursor can be moved via the arrow keys on the keyboard. The portion of the leakage plot within the cursor will be displayed in absolute values for voltage and current.

CUR-TEST (D) — A command which causes the inspection of the various current ranges of the leakage tester. Individual currents are forced into the resistors on the diagnostic test board and measures the feedback voltage.

DATA? (A) — A command which displays the plotted values.

DELTA (S,M) — After a current is forced in the "learn mode" and the resulting feedback voltage is measured, this command allows the user to set a absolute voltage difference for both minimum and maximum limits. Should changes occur after zapping which causes the leakage to exceed these limits, a failure decision will be made. This command affects one leak point on one pin.

DELTA,L (S,M) — Same as 'DELTA' above, except effects all the leak points on one pin.

DELTA,L,P (S,M) — Same as 'DELTA' above, except effects all leak points and all pins.

DELTA,P (S,M) — Same as 'DELTA' above.

DIAG (D) — A command that initiates the complete diagnostics routine.

DIAG. (D) — A command that prints the results of the diagnostic routine in full.

DIR (all) — A command used to display the contents of the directory of the Current Drive.

DIR d: {R}	A command used to display the contents of the directory of Drive X.
DISCARD {S}	An instruction referred to when a leakage current failure is detected. This instruction will cause the program to skip the failed pin for subsequent zap tests.
DLY {all}	A variable used in all zap tests to determine the number of seconds between each pulse in a series. Has a range of 1 to 99 seconds.
DOIT {A,S,R,M}	A command used to initiate the test sequence.
DOIT. {A,R}	A command used to initiate the test sequence and print results.
DOLEAK {A}	A command which initiates a leakage current plot.
END {R}	Is used in the Random test to indicate the last test block.
END-V {A,R}	A variable used in zap tests to define the upper limit of high voltage used during a test sequence. Has a normal range of 0 to 10,000 volts.
FEED? {D}	Will read the feedback voltage (compliance voltage).
FORCE {D}	A command used to set the current supply to a specific current value: 00.0 to 50.0 µA.
G {A}	A command to display the graphics screen.
G. {A}	A command to print the current graphics screen.
GALL {S}	Zap or leak VBUS against GND1 and GND2 and VBUS.
G/ALL {M}	A command which will automatically cause all pins to be grounded after each Zap. The intention is to provide a discharge of device capacitances which may retain a charge after the Zap. See NORMAL.
GET {R}	A command used in conjunction with a number (1 through 510) which recalls and displays that particular programming block from memory.
GND {A,R,D}	A command used to connect or to disconnect pins to GND.
GNDL {M}	A command which is followed by a pin number(s) which will be used as a ground reference when performing a leakage test after Zap in the Military mode.
GND1 {S}	A command used to connect or to disconnect pins to GND1.
GND2 {S}	A command used to connect or to disconnect pins to GND2.
GND OFF {A,S,R}	A command used to remove pins from the list of pins connected to the ground bus of the discharge circuit.

GND ON (A,S,R)	A command used to add pins to the list of pins connected to the ground bus of the discharge circuit.
GRID (A)	A command to clear the screen and draw a new grid.
G1 (S)	Zap or leak VBUS against GND1.
G2 (S)	Zap or leak VBUS against GND2.
G1 & G2 (S)	Zap or leak VBUS against the pins in these lists tied together and to ground.
G1/G2 (S)	Used on 'ZAP only' and will zap VBUS against GND1 first and then to GND2.
H (R)	A command used to display the HELP SCREEN.
HELP (all)	A command used to display the HELP SCREEN which lists all of the commands used within a test program.
HELP. (A,R,D)	A command that will print the HELP SCREEN commands.
n **HV** (D)	A command used in the Diagnostic mode to program a single high voltage level to be used when measuring the output waveform (as in Mil-Std-883, Method 3015).
HV-TEST (D)	A command which initiates only the HV test routine portion of the diagnostic test.
HV@. (D)	A command which will display the current high voltage setting.
IL (S,R,M)	A command used in sequential testing to initiate the displays of pins under test for GND1 so that the leakage test parameters can be defined for each pin.
IL,L (S,M)	A command used to input leak parameters to all points on one pin.
IL2 (S)	A command used in sequential testing to initiate the displays of pins under test for GND2 so that the leakage test parameters can be defined for each pin.
INC-V (A,R)	A variable used in all zap tests to define the increment by which the high voltage is increased after each series of pulses.
I/O (M)	Pin list for all input and output pins which are to be zapped versus ground (SØ) lists.
JUMP (R)	An instruction referred to when a MAX current failure is detected. This instruction will cause the program to jump to the next zap test immediately, without completing any further voltage increment loops in the current zap test.
L (A,S,M)	A command used to display the leakage screen.
L. (A)	A command that will print the leakage test paramters.

LEAK (R) — It is used only in random testing as a command. When a new test number is typed, (see TEST-# "N"), a leakage menu is displayed by default. If the operator wants to make a leak test, "LEAK" is typed to change the screen to the leak menu.

LEAK (S,M) — A command used to show the leak parameters for one point on one pin.

LEAK,L (S,M) — A command used to show the leak parameters for all points on one pin.

LEAK,L,P (S,M) — A command to show the leak parameters for all points on all pins.

LEAK,P (S,M) — A command to show the leak parameters for one point on all pins.

LEARN (S) — A command which selects the 'LEARN' mode enabling computer aided characterization of leakage values.

LH (S,M) — A command to cause the screen to show the "Leak Header" display. This command is followed by the command "#LEAKS" n where n equals the number of different points (1 to 8) along the I/V curve where the leakage is to be measured. The program default is two leak points unless instructed otherwise.

LOAD-PARAM (S,R,M) — Loads a previously prepared and saved test file from disk to memory.

LOAD-REP (S,R,M) — Loads from disk to memory a previously saved test report.

LOAD-TEST (A) — Loads a previously prepared and saved test file from disk to memory.

LONLY (S,M) — Will measure leak on all VBUS or I/O pins to the ground specified on the leak screen and then stop.

LZL (S,M) — Same as **ZL** but measures leak before and after the zap.

NET-TEST (D) — A command that initiates a check of the RC module identity.

NETWORK OK (A,S,R) — A message which confirms the presence of the network called for in the program.

NETWORK-# (all) — A variable in all zap tests, used to define the RC network to be used during the zap tests. Has a range of 0 to 3, with 1 reserved for the standard 1500Ω, 100pF network.

NEXT-TEST (R) — Directs the flow from one programming block to another.

NONE (R) — Could be used when programming sub-tests exits meaning there are no other sub-tests related to this block.

NORMAL (M) — A command in the Military program which is the opposite of **G/ALL** in that the pins will not be grounded between zaps.

OFF (all)	A command to remove pins from a previously programmed list.
ON (all)	A command to include pins in a certain program list.
ONLY (A,R,S)	A command directing the program to remain at a single HV polarity.
OUT OF RANGE (A,S,R)	An error message displayed when the operator attempts to connect a pin to either bus, if the pin number is larger than the previously defined IC count. (See PIN-IC).
P (D,S,M)	A command used to display the pin lists. That is, the list of pins to be connected to the VBUS and GND bus during subsequent testing.
P/ (M)	In the Military program only, this command will cause to be displayed on the screen a list of all pins not programmed into the I/O and SØ lists. This list of pins should show not only the expected N/C's of a device but also any pins missed during programming.
PARAM (R)	Shows the parameters for each test.
PARAM. (R)	Prints the parameters for each test.
PART* (A,S,R)	A message requesting approval of a displayed part number (default: all spaces).
PINS (D)	Transfers complete current pin selection data from computer memory tables to tester hardware latches and relay drivers thus affecting (closing or opening) all pin selection relays.
PIN-IC (all)	A command preceded by the number of pins on the device to be tested which the program uses to determine the appropriate pin select relays.
PIN-MATRIX (R)	A command to display the pin configuration used in a particular test.
PIN-MATRIX. (R)	A command to print the pin configuration used in a particular test.
PIN-TEST (D)	A command that initiates a diagnostic routine that tests all pin select relays for proper opening and closing and displays pass or fail indications.
PLEASE CLOSE THE DOOR (ALL)	An error message displayed when the DUT compartment lid or R/C network door is open. Also may indicate that the interface cable between the computer and Model 5000 is not connected or seated properly.
PLEASE INSERT THE NETWORK (all)	An error message displayed when no network, or the wrong network is in place, and a zap test is attempted.
PRINT (S,M)	A command to print which is always used in conjunction with another term such as: **PRINT REP** or **PRINT PARAM** .

RE-ENTER (A,S,R)	An error message displayed when the computer does not recognize the keyboard input. The operator has most likely forgotten to type a command before hitting return. The message will be repeated until the correct response is given.
REP (S,R,M,D)	A command that displays the tabulated results (report) of a previously run test.
REP. (R,D)	A command that prints the tabulated results (report) of a previously run test.
REPLOT (A) ident.	Replots the I/V curve stored under a particular identification number. This number will be the Zap voltage for the desired curve.
REPLOT-ALL (A)	Replots all I/V data stored in RAM (maximum of 16 curves).
REST (D)	A command which opens all pin relays to both the VBUS and GND, places the HV supply at 0 volts and reduces the leakage test supply to 0 volts. Also clears all selection tables in memory.
RESTORE (S,M)	Reverts back to the last (original) learned value for one leak point for one pin.
RESTORE.L (S,M)	Same as above except for all leak points for one pin.
RESTORE.L.P (S,M)	Same as above except for all leak points on all pins.
RESTORE.P (S,M)	Same as above except for one leak point on all pins.
RET (R)	A command to return to the last zap test for instructions as to the next test.
[RETURN] (all)	A key on the keyboard. It must be pressed each time information is to be sent to the computer. It is assumed to be at the end of every command listed here.
SAVE-REP (S,R,M)	A command used to save the parameters for pin configuration, zap screen values, leak values, and data report. (Save data report only in the Random mode).
SAVE-PARAM (S,R,M)	A command used to save the parameters for pin configuration, zap screen values, and leak values.
SAVE-TEST (A)	A command to save the values in an Analysis test.
SET (S,M)	Sets a forcing current for one leak point on one pin.
SET.L (S,M)	Sets a forcing current for all leak points on one pin.
SET.P (S,M)	Sets a forcing current for one leak point on all pins.

SETSEG,L (S,M)	A command to set the leakage range (lowest to highest) (negative numbers are considered to be lower than positive numbers) for a single leakage point.
SETSEG,L,P (S,M)	A command to set the leakage range automatically for all leak tests and all pin tests.
SERIAL# (A,S,R,M)	A message requesting approval of a displayed serial number for the device to be tested . (Default: all spaces).
SHORTBUS (D)	To make a short between VBUS and GND (selects five pins at random to VBUS and five to GND).
S or **SHOW** (R)	A command used only in the random mode. It causes the display of the test currently in memory, whether it is a zap or a leakage test. When first creating a random test file, the first time SHOW is typed, the default zap test menu will be displayed.
START-V (A,R)	A variable used in all zap menus to define the voltage at which the zap test begins.
STØ (1,2,3) (S,M)	An abbreviation for the STEP variable used in sequential testing. The numerical value can range from 0 to 3 (i.e., STØ, ST1, ST2, ST3).
STOP (S,R,M)	Option that if chosen will stop the test when a leakge test failure is detected.
SUB-TEST (R)	A variable in the zap/leak test menus, used to define the number of the first leakage test to be performed after the given zap test.
SØ1 to **SØ15** (M)	Supply pin lists for the Military program only. Each individual supply pin (Vcc, Vss, V+, V-, Vref, Gnd, etc.) shall be allocated to a seperate supply pin list as indicated in test Method 3015.6.
TO (A,S,D,M)	A connector used in creating lists of pins to be connected to the VBUS or the GND bus. Example: 1 TO 4 includes all pins from 1 to 4 (1,2,3,4).
TEST-# n (R)	Selects a test to be edited. Valid numbers for n are 1 to 510. Once a test number is selected, it will be considered the active screen to be edited until a new test number is selected.
UA or **UA/** (A,S,R)	A current unit used in defining leakage test parameters. It is an abbreviation for microamperes.
UNDEFINED (A,S,R)	An error message displayed when an unknown command has been issued by the operator. Most likely the word is misspelled or a hyphen or space has been forgotten.
USE-DIR (A,R)	See the command; CREATE-DIR.
V or **V/** (A,S,R)	The abbreviation for "volt" used when defining both high voltage for zap tests, and low voltage for leakage tests.

+V or -V (all) — The two variables used to define the polarity of the voltage in all zap tests.

VBUS OFF (A,S,R,D) — A command used to remove pins from the list of pins to be connected to the VBUS of the discharge circuit.

X1 (A) — The default leakage test range in the Analysis mode. X1 equals both 6V/div. on the horizontal scale and 10 µA/div. on the vertical scale of the leakage grid.

X2 (A) — A leakage test range in the Analysis mode which will change the horizontal scale to 3 V/div.

X5 (A) — A leakage test range in the Analysis mode which will change the horizontal scale to 1.2 V/div.

X10 (A) — A leakage test range in the Analysis mode which will change the horizontal scale to 0.6 V/div.

X.5 (A) — A leakage test range in the Analysis mode which will change the vertical scale to 5 µA/div.

X.2 (A) — A leakage test range in the Analysis mode which will change the vertical scale to 2 µA/div.

X.1 (A) — A leakage test range in the Analysis mode which will change the vertical scale to 1 µA/div.

VBUS ON (all) — A command used to add pins to the list of pins to be connected to the VBUS of the discharge circuit.

Z (A,S,R,M) — A command used to show the contents of the zap screen.

Z. (A,R) — A command used to print the contents of the zap screen.

ZAP (A,S,R,M) — Seen as a message on all zap tests, right above the zap parameters. It is also used only in random testing as a command.

ZERO n (A) — A command used to place the Zero on the screen.

ZERO? (A) — A command used to draw the Zero.

ZONLY (S,M) — Will zap all VBUS pins to the ground specified on the zap screen. To zap at one voltage only, for example: 2000 V. Set: CRØ 2000; STØ 1; CRØ Ø.

ZL (S,M) — Will zap VBUS pins to the ground specified on the zap screen and measure leakage to the ground specified on the leak screen.

Z/L (S,M) — Will zap sequentially all VBUS pins first; then measure leak sequentially on all pins.

& (A,S,D,M) — A connector used in creating lists of pins for connection to VBUS or GND. Serves the same function as a logic "and" statement.

#-PUL (all) — A variable used in all zap tests. It defines the number of pulses to be delivered at each voltage step.

#-LEAKS (S,M) — A programming command always followed by a number from 1 to 8. Defines the number of leakage test points along a leakage curve.

`\` (D) — When ready to Zap during calibration in the Diagnostics mode, the command `\` followed by hitting the "Return" key will cause pulsing to commence.

% (S,M) — Same as DELTA except uses a percentage instead of an absolute number. (1 to 100).

%.L (S,M) — Same as above and DELTA.L.

%.P (S,M) — Same as above and DELTA.P.

%.L.P (S,M) — Same as above and DELTA.L.P.

<>LEAK (S,M) — A command to exchange leak points to one pin.

<>LEAK.P (S,M) — A command to exchange leak points to all pins.

?TOTAL (M) — Will calculate the total number of pin combinations which will be zapped for one voltage step and one polarity. Double the number for two polarities and multiply by the number of voltage steps. This calculation can only per performed after all pin lists are completed.

TEST CONSOLE CIRCUIT DESCRIPTIONS

WARNING: HAZARDOUS POTENTIALS! USE CAUTION WHEN PROBING INSIDE THE TEST CONSOLE WHEN POWER IS APPLIED. READ AND UNDERSTAND THE OPERATION OF CIRCUITS BEFORE MAKING MEASUREMENTS OR WHILE CALIBRATING.

SYSTEM BLOCK DIAGRAM

The block diagram in Appendix A represents a comprehensive arrangement of the major functions contained within the 5000 console. A fully programmable high voltage (low current) supply is under direct computer control and requires a pre-scaled analog input signal between 0 and +10 volts. This control signal is derived from a latched 12-bit D/A converter located in one of the I/O ports inside the computer terminal. The corresponding high voltage output (HV) varies in direct proportion to the input and has a nominal operating range of 0 to 10,000 volts with respect to the GROUND BUS. Polarity of the programmed high voltage test signal is digitally controlled (latched TTL level): logic "0" for positive, logic "1" for negative potentials.

A specially designed mechanical switch is activated (PULSE TEST) for approximately 100 milliseconds to allow the stored charge on capacitor C to be discharged through R. Just prior to this event the leak test function is disabled (both GROUND BUS and VOLTAGE BUS), completing the high voltage discharge path through the programmed test socket. Following the HV pulse (approximately 50ms later) the leakage test function is restored (default mode).

As shown, a pair of independently operated solenoids is connected to each DUT pin. The status of each solenoid is determined by a dedicated latch, which is addressed by the computer through a serial/parallel port. Under direct computer control the device pins can be randomly connected to the GROUND BUS or to the VOLTAGE BUS, with the possibility of selecting multiple pins to be connected to either bus.

In the default mode (leakage test mode) a programmable (voltage limited) low current supply is connected to the programmed pin(s). The output of this supply varies +/- 0.1 to 50 µA for a corresponding input of -5 to +5 volts form a latched 12-bit D/A converter. To avoid damage to the device under test the drive voltage is limited to about 27 volts maximum.

HV CONTROL UNIT

The analog control input level is derived from D/A#2 through interface connector J4. This control voltage is internally scaled to a range of 0 to +5 volts at the non-inverting input of U1-C, which performs as an operational comparator within the overall feedback loop. The high voltage is sampled outside this circuit through a 2000:1 divider and enters into the loop at U1-A. U1-A and U1-B form an absolute value circuit to insure that the feedback signal into U1-C is positive at all times, even though the derived high voltage sample is bipolar in nature. In order to stabilize the loop a lead/lag network is placed between U1-C and U1-D as defined by R9, C4, and C5. The resulting DC potential at the emitter of Q1 is proportional to the desired high voltage and it controls the amplitude of the HV drive signal applied to the HV transformer through push-pull stage Q3/Q4. A fraction of the HV sample from the output of U1-A is used for the front panel meter display; with the DPM input ranging between -1 and +1 volts for an equivalent high voltage potential of -10kV to +10kV, the corresponding digital display will range between -10000 to +10000. The absolute value of the HV sample (see J4, A/D#2) is strictly used for computer diagnostics to ascertain proper system operation.

Referring to interface connector J7, a number of important control signals are derived from the LOGIC INTERFACE board located in the test console. This board is the primary interface between the computer and the DUT pin selection matrix and it also serves as an interface for signals that determine the various operating modes. The eight control lines (one spare) are obtained from an octal latch set by the computer (2-byte format) and the stored information is primarily used for such functions as:

POLARITY CONTROL (See J7-POL): This TTL level is first converted through a series of transistor stages into a drive signal for relay K1 to determine which of the op-amp outputs (U1-A or U1-B) to select from in order to obtain the absolute value of the HV sample signal. The HV supply produces a positive potential when the line is at logic "0", which is the default mode. The resulting HV output ranges between 0kV and -10kV when it is latched at a logic "1" level. The transition from positive to negative or from negative to positive, is used to generate a momentary impulse in the HV INHIBIT circuit for the purpose of suppressing the HV transformer drive signal (see KILL). Immediately following the KILL pulse, the polarity reversing relay in the HV head is switched to the opposite state through driver Q10. This sequence is necessary to avoid voltage stress in the HV head while switching from one multiplier stack to the other. During the KILL mode the active multiplier is allowed to "bleed" its potential before the other multiplier is "pumped" in the opposite direction; this is the same potential across capacitor C in the block diagram.

KILL (See J7-KILL): The computer can issue such a command while performing specific tasks independent from the mandatory KILL signal during polarity reversal. This procedure is used to quickly switch from a high potential to a lower voltage by first forcing the supply to approximately zero volts and then allowing the loop to re-stabilize at a different operating point. When powering down under feedback control the normal time decay is substantially longer as compared to the time it takes to reach a stable potential from a zero volt start. This occurs because of the very high resistance discharge path at the output of the HV supply.

PULSE TEST (See J7-PULSE): The computer must issue a positive TTL signal of no less than 10 milliseconds in order to invoke a pulse discharge. Only the positive transition is recognized after pulse shaping has been performed by U3-A and U3-B in conjunction with Q9. On the schematic is the timing sequence, which determines the duration of the pulse as seen at the output of U4-A, before it is applied to driver stage Q11. Also displayed is a longer negative pulse which starts at approximately 100 milliseconds after the pulse relay is opened. This signal is primarily used to energize the LEAKAGE TEST relay through Q8 (see J11) and to disable the leakage during high voltage pulsing.

DOOR INTERLOCK (See J5-DOORS): An unconditonal and indefinite KILL command is initiated when door covers are left open causing the high voltage to be immediately terminated. It is primarily intended for protection against electrical shock when the operator is exchanging pulse networks or removing a device that is under test. This function is recognized by the computer and the operator receives the message to correct the condition before testing can be resumed.

STATUS INDICATORS (See J6 and J13): There are two LED lights located on the front panel of the console: a FAULT indicator that indicates an open door and a READY light that indicates the occurrence of a pulse discharge event.

BIAS SUPPLIES: Two independent regulators provide -14 volts and +14 volts for internal and external use. R60 sets the -14V supply and R55 controls the +14V bias. Reference zeners, D13 and D14, are biased for near-zero temperature drift. AC power is derived through J14 from a 28VAC/2A center-tapped transformer.

MISCELLANEOUS CONNECTORS : A number of strip connectors are located near the edge of the PC assembly in order to provide an efficient interface between the LOGIC INTERFACE UNIT and the LEAKAGE TEST UNIT (see J8 through J11).

MAIN SYSTEM SUPPLY

Four independent voltage regulators are used to power the majority of the circuits in the 5000 test console. Three regulators, IC2 through IC4, are used primarily to supply +12V to all of the solenoids in the PIN SELECTION MATRIX UNIT. IC1 is a dedicated +5V supply for the LOGIC INTERFACE UNIT. Individual adjustments (1K multi-turn potentiometers) are located at the edge of the PC assembly for convenient access.

HV SWITCHING MODULE

The drive signal into this unit is received from an intermediate high voltage transformer which is switched to either a positive or a negative multiplier stack under polarity control (see HV CONTROL). Synchronous with the input, only the output of a selected stack is switched into the normally closed contact of the pulse discharge relay. Two high voltage resistors (200 megohms each) are series connected from the output to an external variable resistance to form a 2000:1 divider. The resultant signal is hereafter labeled as HV SAMPLE in the feedback loop (explained under HV CONTROL).

Because of the extreme voltages that are generated within this module, complete encapsulation is necessary to prevent arcing and other side effects that could interface with the normal operation of sensitive electronic components. No calibration or service can be performed on this assembly outside of the factory.

HV TRANSFORMER MODULE

A fully encapsulated toroidal transformer interfaces directly with the HV SWITCHING MODULE through a shielded cable. The shield is connected to chassis ground near the transformer. Connection to the HV CONTROL UNIT is completed through two short flat ribbon cables.

RELAY MODULE

This module contains six specially designed solenoids used in the PIN SELECTION MATRIX UNIT. Top contacts alternatingly connect to VBUS and GROUND BUS. Therefore, a multitude of such modules located around the perimeter of the device interface socket allows each pin to be terminated to either VBUS or GROUND BUS under digital control. An eight inch flat ribbon cable is used to connect each module to the LOGIC INTERFACE UNIT below.

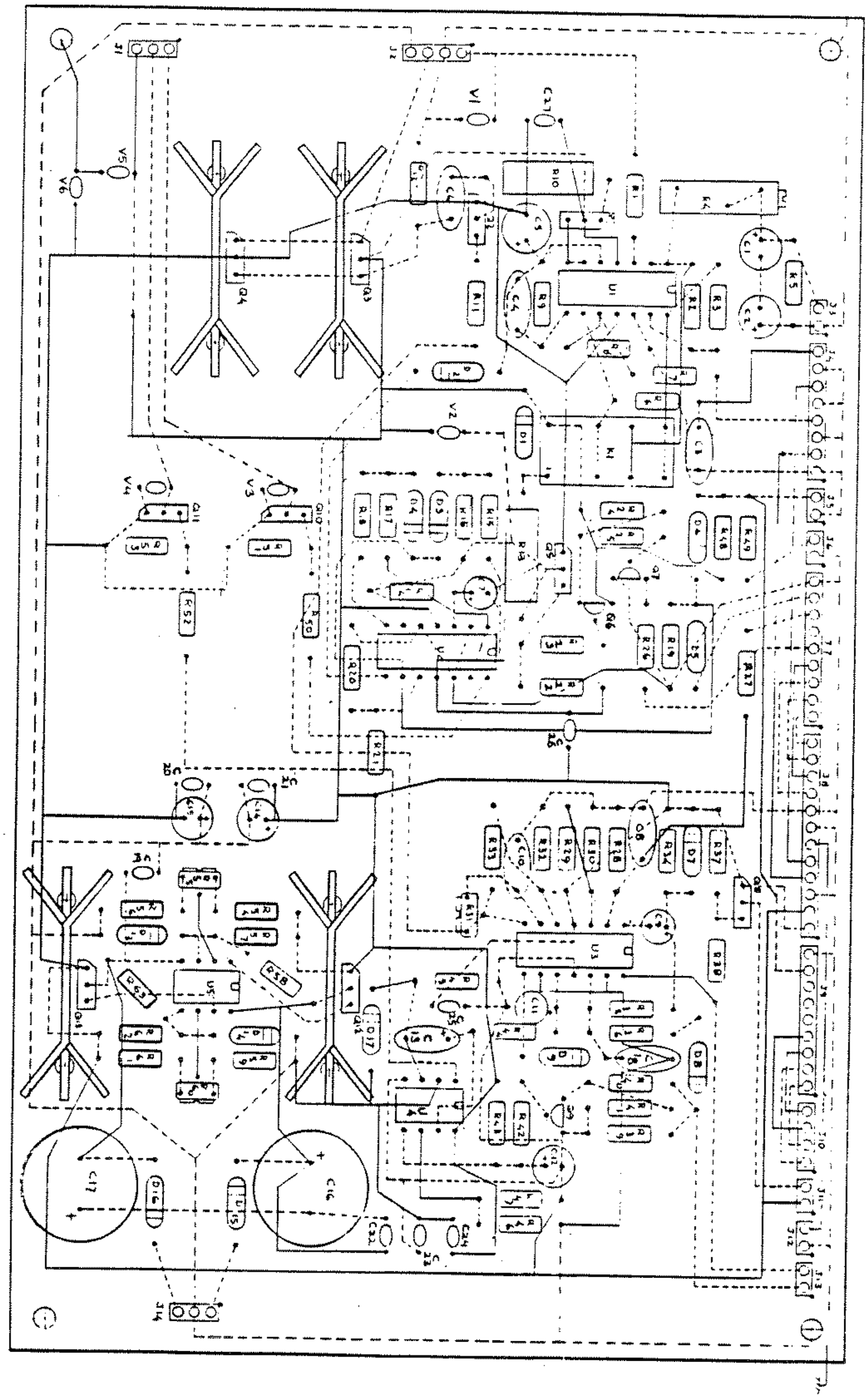
LOGIC INTERFACE UNIT

A total of 48 octal latches can be loaded onto the board. This corresponds to a maximum of 192 programmable device pins. Each latch is identified by a number (0-47) in accordance with the hexadecimal code structure stored in configuration arrays during program execution. Latch outputs directly interface with the relay modules in the PIN SELECTION MATRIX UNIT. All latch inputs are connected to the common data bus (D0-D7). Each latch is individually addressed by the secondary address decoder (B2-B7), at which time a specific data word is copied and stored. Latch address 48 (location A8) is reserved for operational commands as described under HV CONTROL UNIT. Because of the multitude of latches, additional data bus drivers (B1 and B8) are needed. Primary address decoders, A4 and A5, determine the input status of the secondary decoder chain during the I/O select cycle. During power up all of the latches are initialized (reset) by a 555 timer circuit in location A1. Under computer control, a software reset command can be issued to instantly de-energize all relays.

WARRANTY

IMCS Corp. warrants this equipment to be free from defects in materials and workmanship for a period of one year from the date of purchase. Units returned to IMCS Corp. will be repaired or replaced at the option of IMCS Corp. Damage as a result of misuse or abuse is not covered by this warranty.

Seller shall not be held liable for any special or consequential damages of any nature with respect to any merchandise os services sold, delivered, or rendered. The warranties stated herein are in lieu of all other warranties expressed or implied and all other obligations or liabilities on the part of the seller.

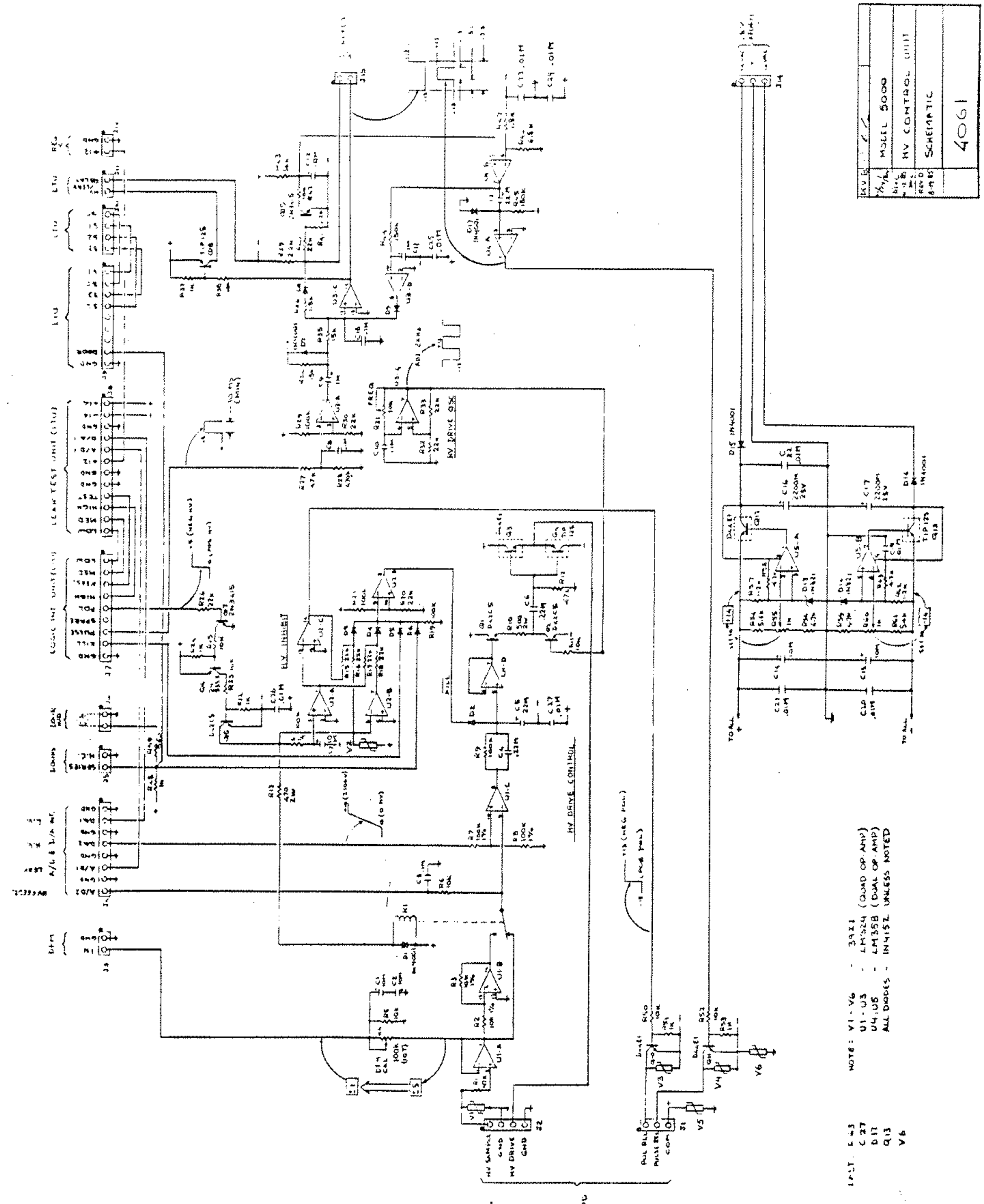


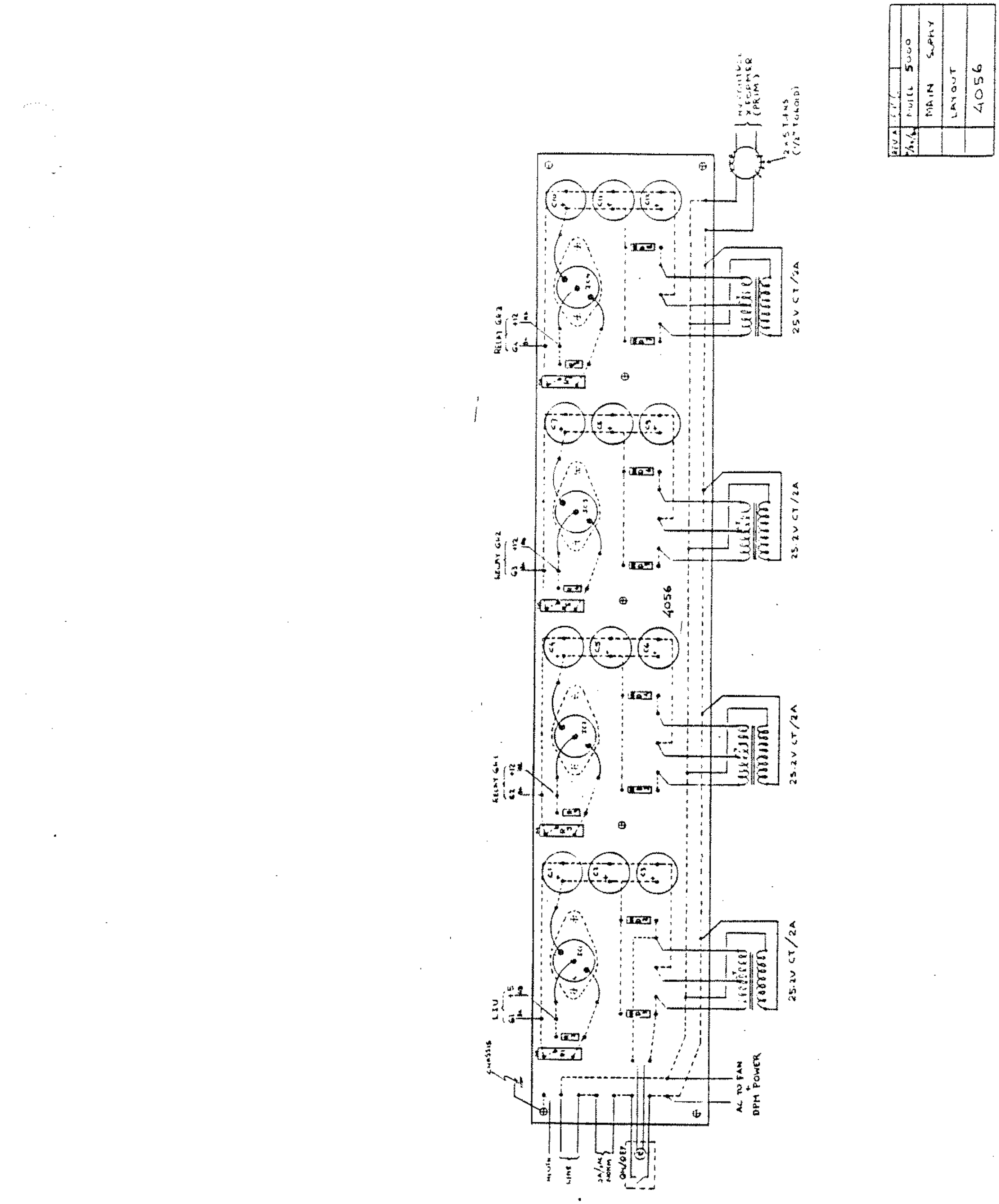
MODEL 5000

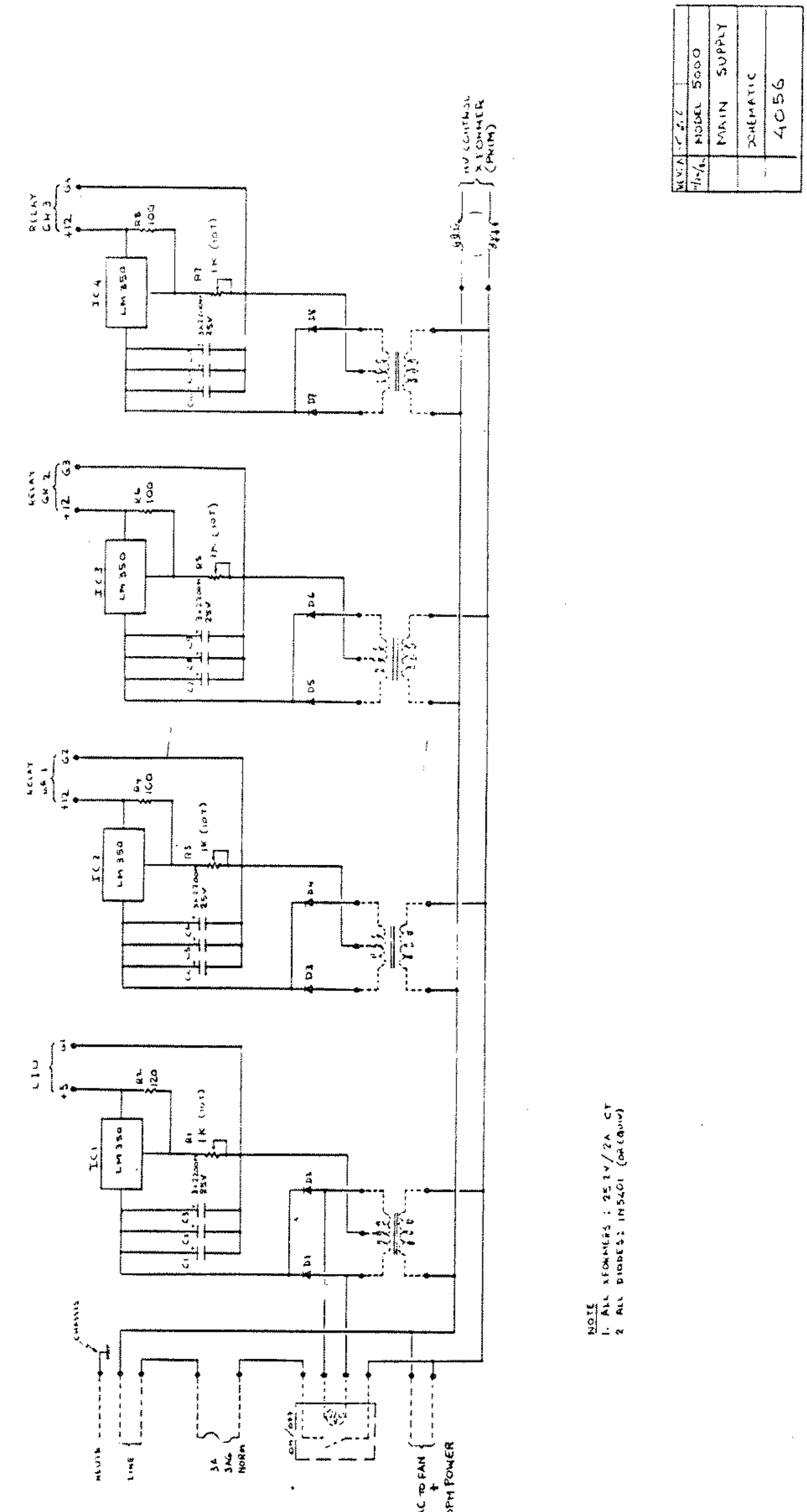
HV CONTROL UNIT

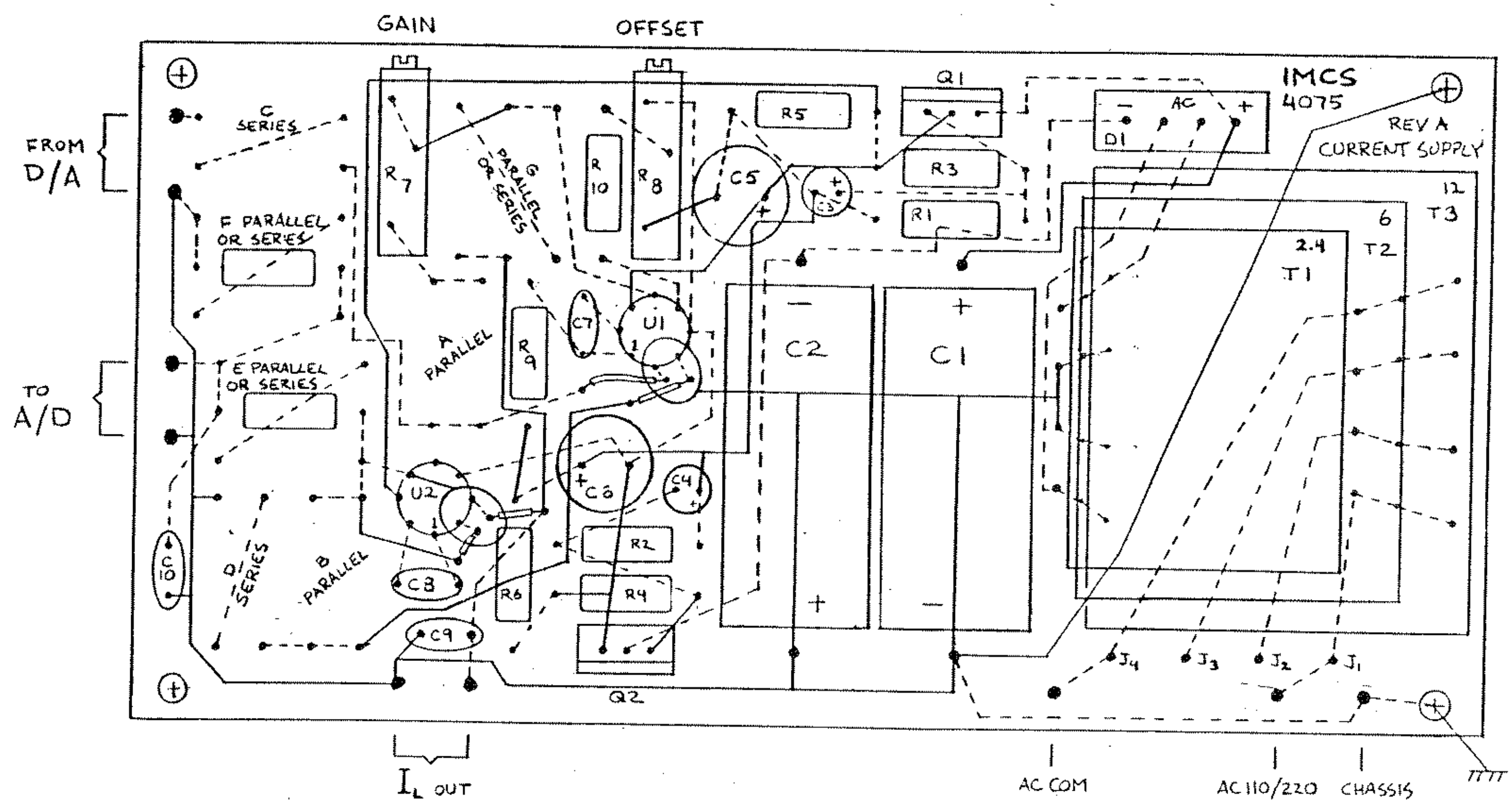
LAYOUT

4061

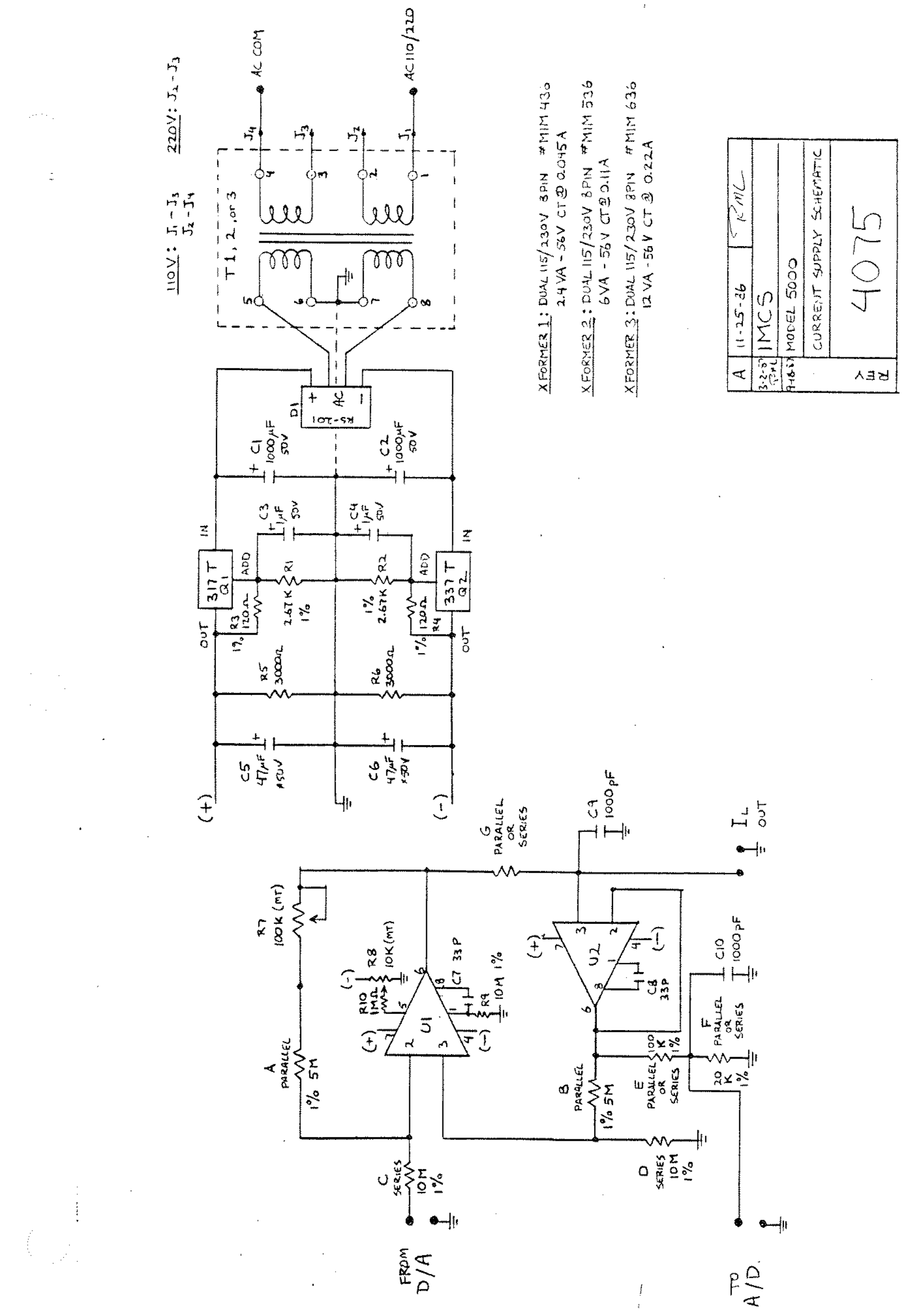

MODEL 5000
HV CONTROL UNIT
SCHEMATIC
4061
HV DRIVE CONTROL
HV INHIBIT
HV DRIVE OSC
LEAK TEST UNIT
NOTE: V1 - V6 - 3921
U1 - U3 - LM324 (QUAD OP AMP)
U4, U5 - LM358 (DUAL OP AMP)
ALL DIODES - 1N4152 UNLESS NOTED

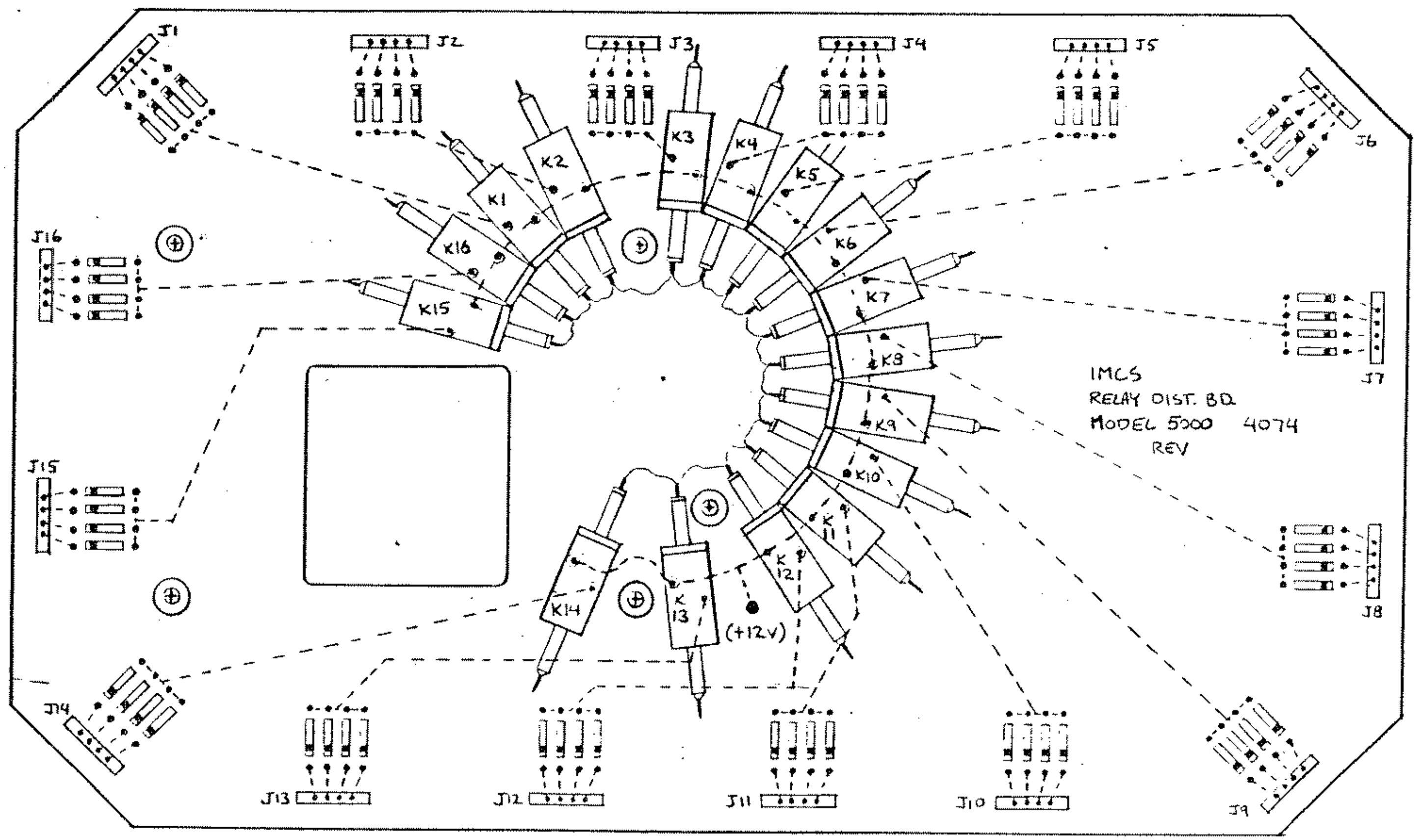

MODEL 5000
MAIN SUPPLY
LAYOUT
4056
25V CT/2A
25.2V CT/2A
25.2V CT/2A
25.2V CT/2A
4056
AC TO FAN
+
DPM POWER


MODEL 5000
MAIN SUPPLY
SCHEMATIC
4056
LM 350
NOTE
1. ALL XFORMERS : 25.2V/2A CT
2. ALL DIODES : 1N5401 (OR EQUIV)
NEUTR
LINE
ON/OFF
AC TO FAN + DPM POWER



A	11-22-86	[illegible]
3-2-87 RmL 9-16-87	IMCS	
	MODEL 5000	
	CURRENT SUPPLY LAYOUT	
REV	4075	


110V: J1 - J3
J2 - J4
220V: J2 - J3
AC COM
AC110/220
T 1, 2, or 3
D1
RS-201
C1 1000µF 50V
C2 1000µF 50V
C3 1µF 50V
C4 1µF 50V
317 T Q1
337 T Q2
R1 2.67K 1%
R2 2.67K 1%
R3 120Ω 1%
R4 120Ω 1%
R5 3000Ω
R6 3000Ω
C5 47µF 50V
C6 47µF 50V
(+)
(−)
IN
OUT
ADD
XFORMER 1: DUAL 115/230V 8PIN #MIM 430
2.4VA - 56V CT @ 0.045A
XFORMER 2: DUAL 115/230V 8PIN #MIM 536
6VA - 56V CT @ 0.11A
XFORMER 3: DUAL 115/230V 8PIN #MIM 636
12 VA - 56V CT @ 0.22A
A
11-25-86
IMCS
MODEL 5000
CURRENT SUPPLY SCHEMATIC
4075
REV
R7 100K (MT)
A PARALLEL 1% 5M
C SERIES 10M 1%
R8 10K (MT)
R10 1MΩ
C7 33P
R9 10M 1%
U1
U2
C8 33P
G PARALLEL OR SERIES
C9 1000pF
C10 1000pF
IL OUT
B PARALLEL 1% 5M
D SERIES 10M 1%
E PARALLEL OR SERIES
100 K 1%
F PARALLEL OR SERIES
20 K 1%
FROM D/A
TO A/D

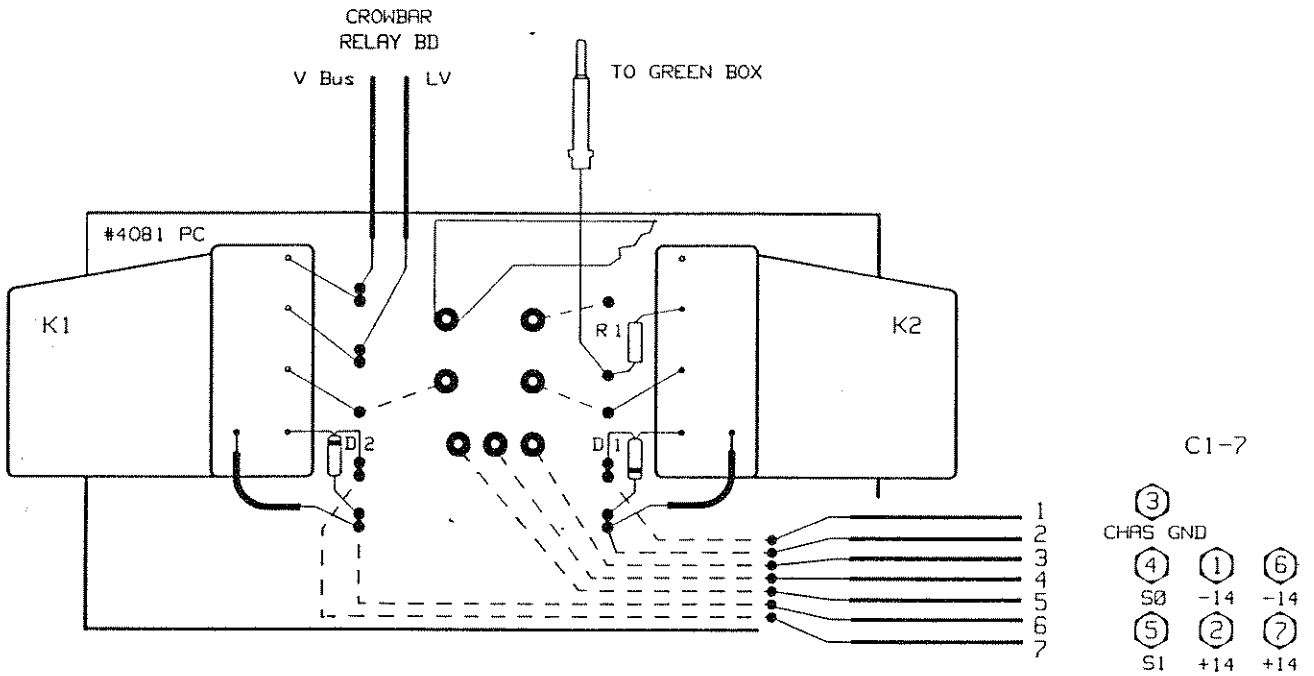


ALL DIODES : DIODE RECT. IN4001

J1 - J16 : HEADER ASSY. 22-10-2251

K1 - K16 : IMCS RELAYS

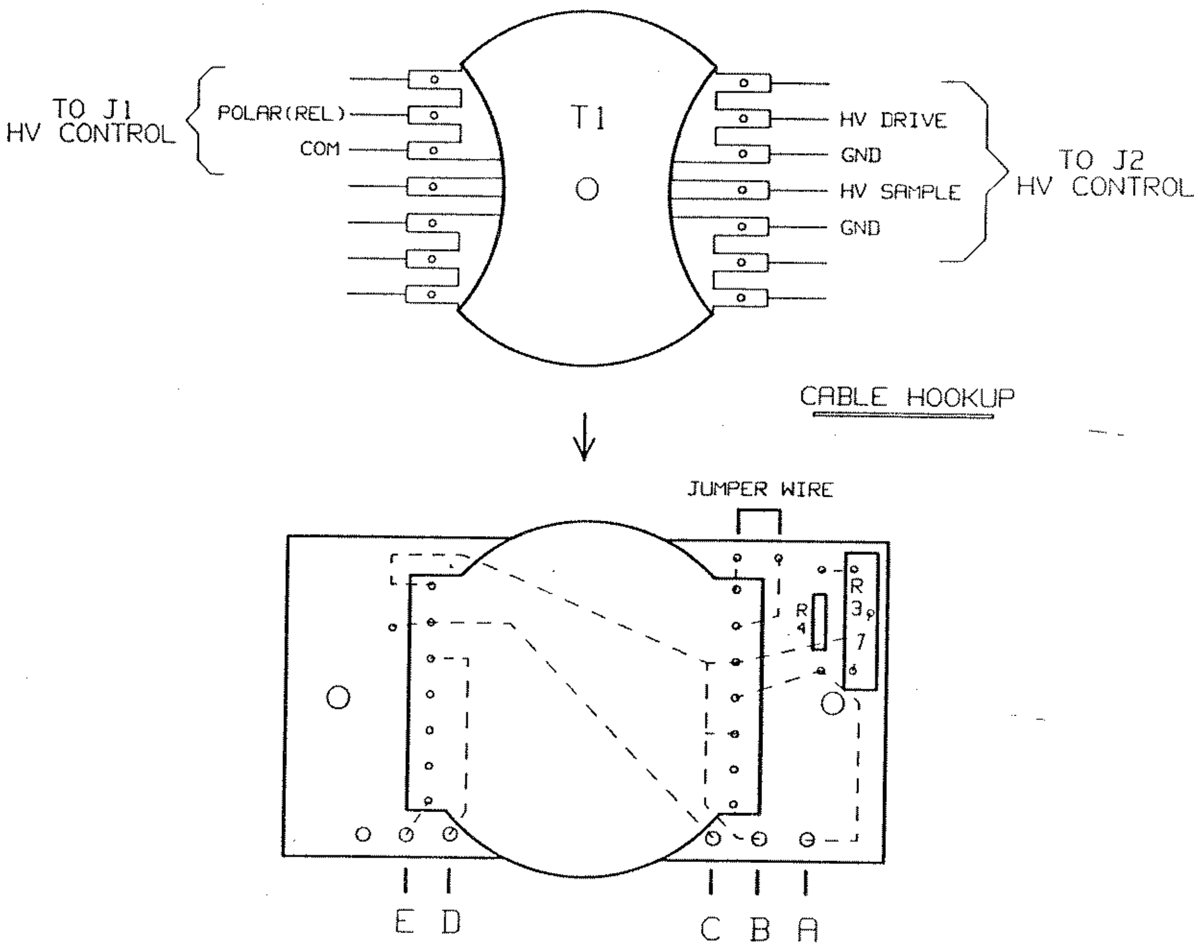
	2-9-87	TKMC
	IMCS	
	MODEL 5000	
	RELAY DIST. BD. LAYOUT	
REV	4074	



NOTE:

1. R1- 10M 1/2w 5%
2. D1,D2- RECT 1N4001
3. C1-C7- FEED THRU 1000P
4. K1,K2- 2B RELAY

IMCS AN INTEK DIVERSIFIED COMPANY	MODEL 5000
	PULSE MODULE BOX
LEA:4081bd	SIZE / FSCM NO. / DWG NO. 4081 / REV
	SCALE / 1/18/88 / SHEET



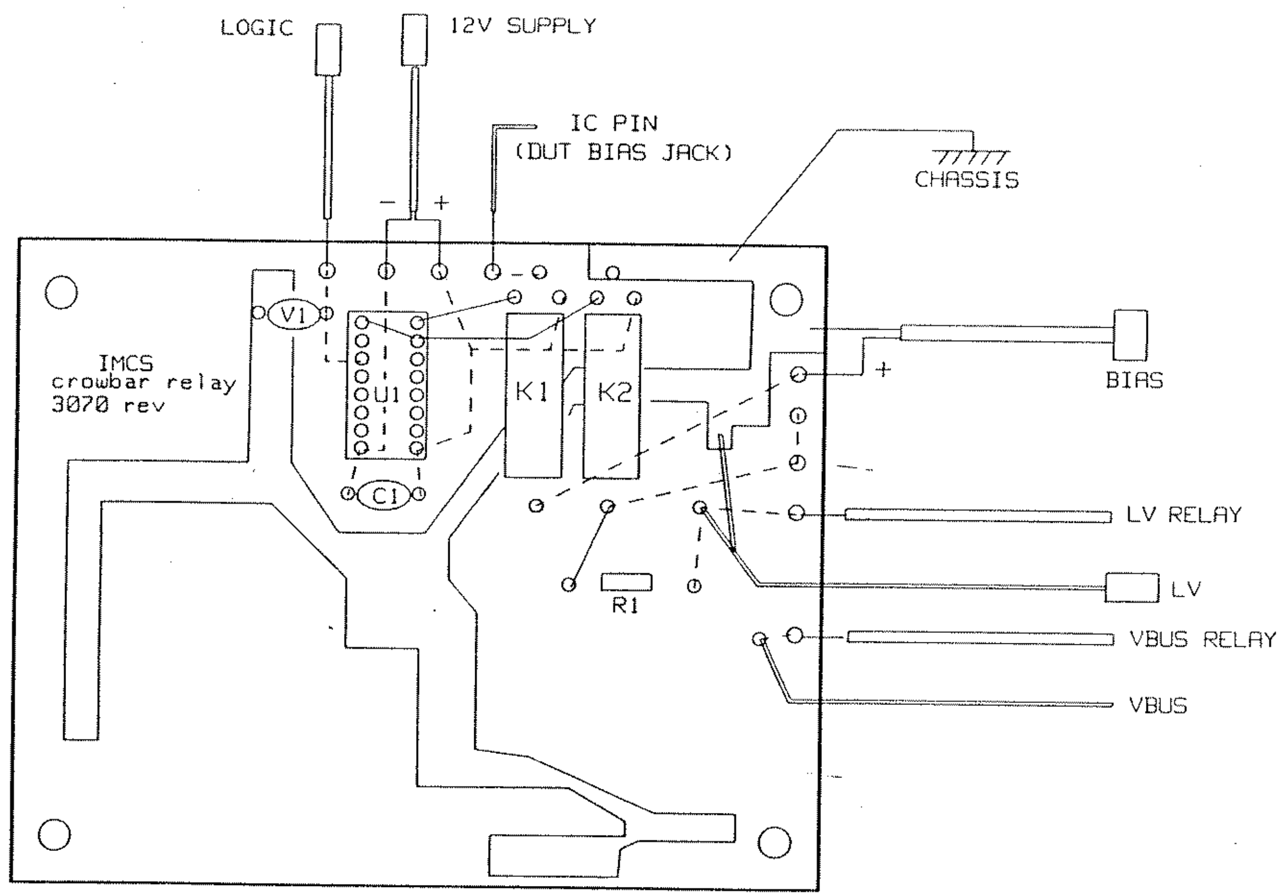
IMCS
AN INTEK DIVERSIFIED COMPANY

MODEL 5000

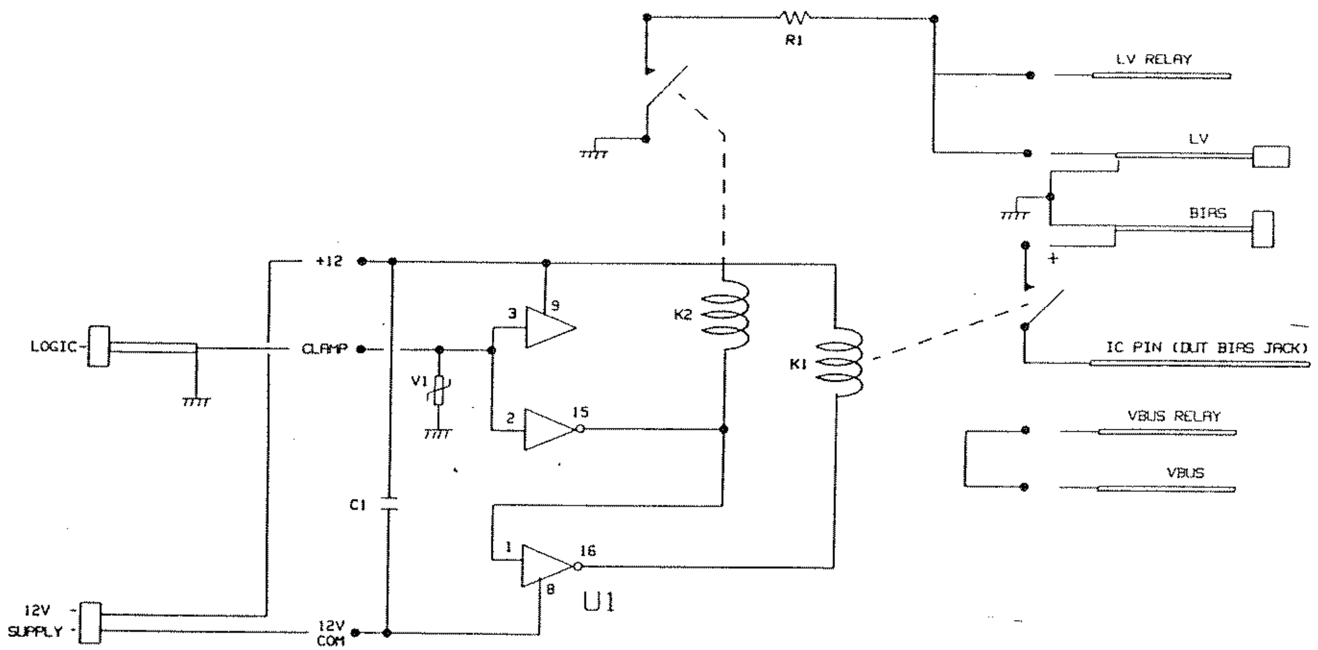
HV INTERFACE BD

SIZE B | FSCM NO. | DWG NO. 4046 L | REV

SCALE | DATE: 1/21/88 | SHEET



IMCS AN INTEX DIVERSIFIED COMPANY	MODEL 5000			
	CROWBAR RELAY BD			
	SIZE B	FSCM NO.	DWG NO. 3070 L	REV
	SCALE	1/20/88	SHEET	



NOTE :

1. R1- 1K 1/4w 5%
2. C1- .01M 10% CER
3. V1- GE 03TV392A1
4. K1,K2- REED RELAY
5. U1- ULN2003

iMCS — AN INTEX DIVERSIFIED COMPANY

MODEL 5000

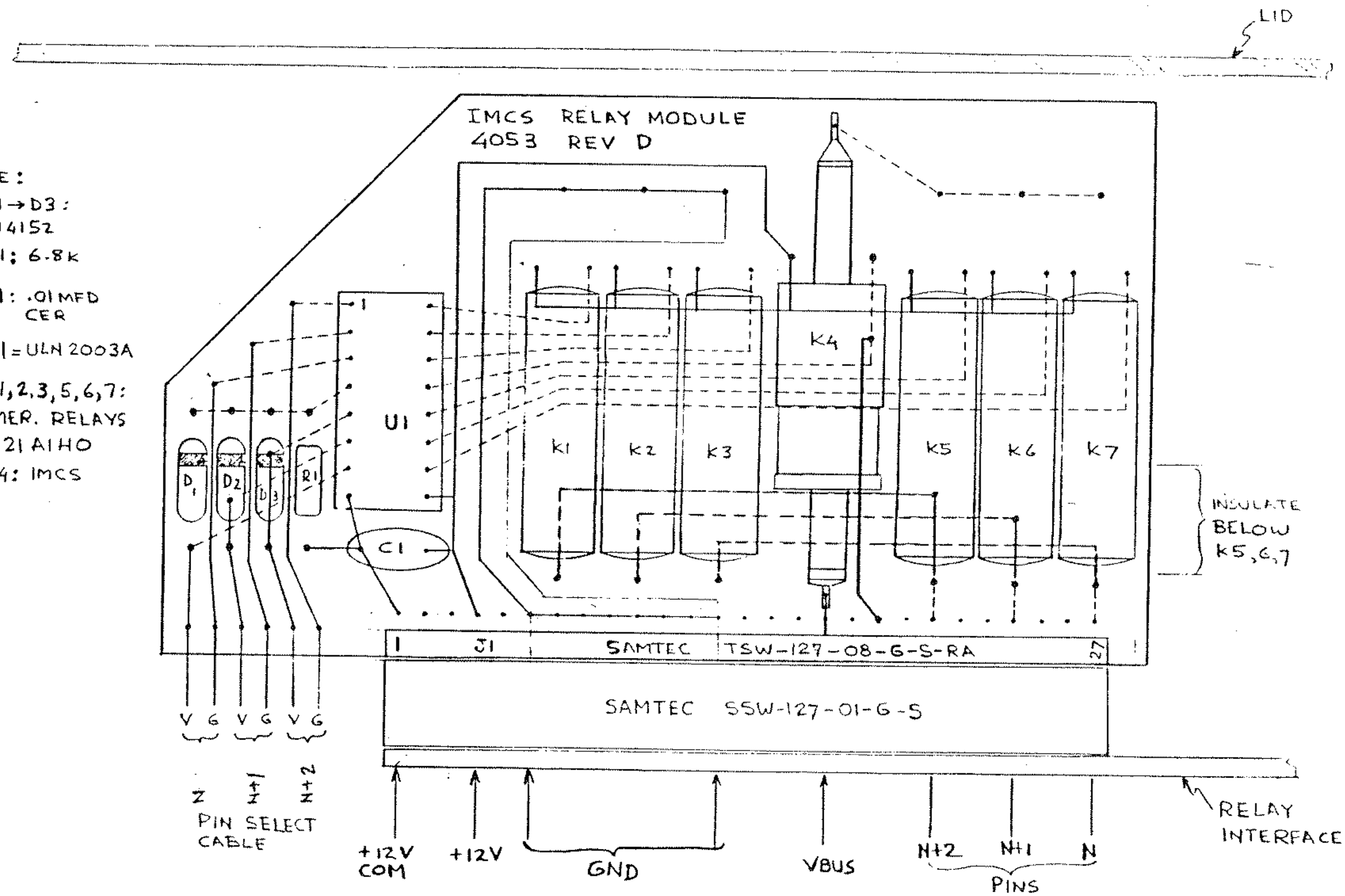
CROWBAR RELAY BD

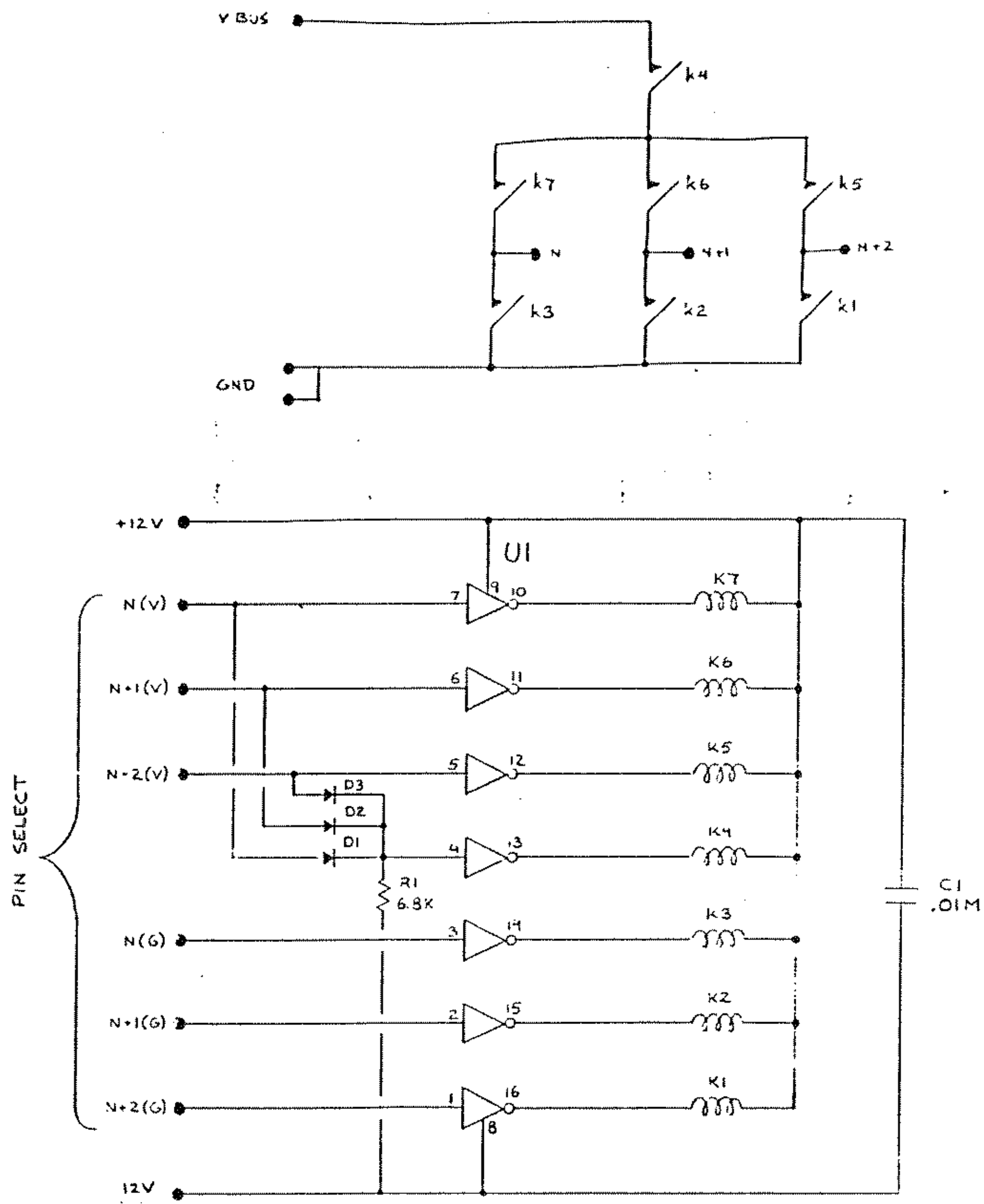
SIZE	FSCM NO.	DWG NO.	REV
B		3070 S	
SCALE	1/21/88	SHEET	

IMCS, INC 5/30/86 EBL

MODEL 5000 - RELAY MODULE (REV D)

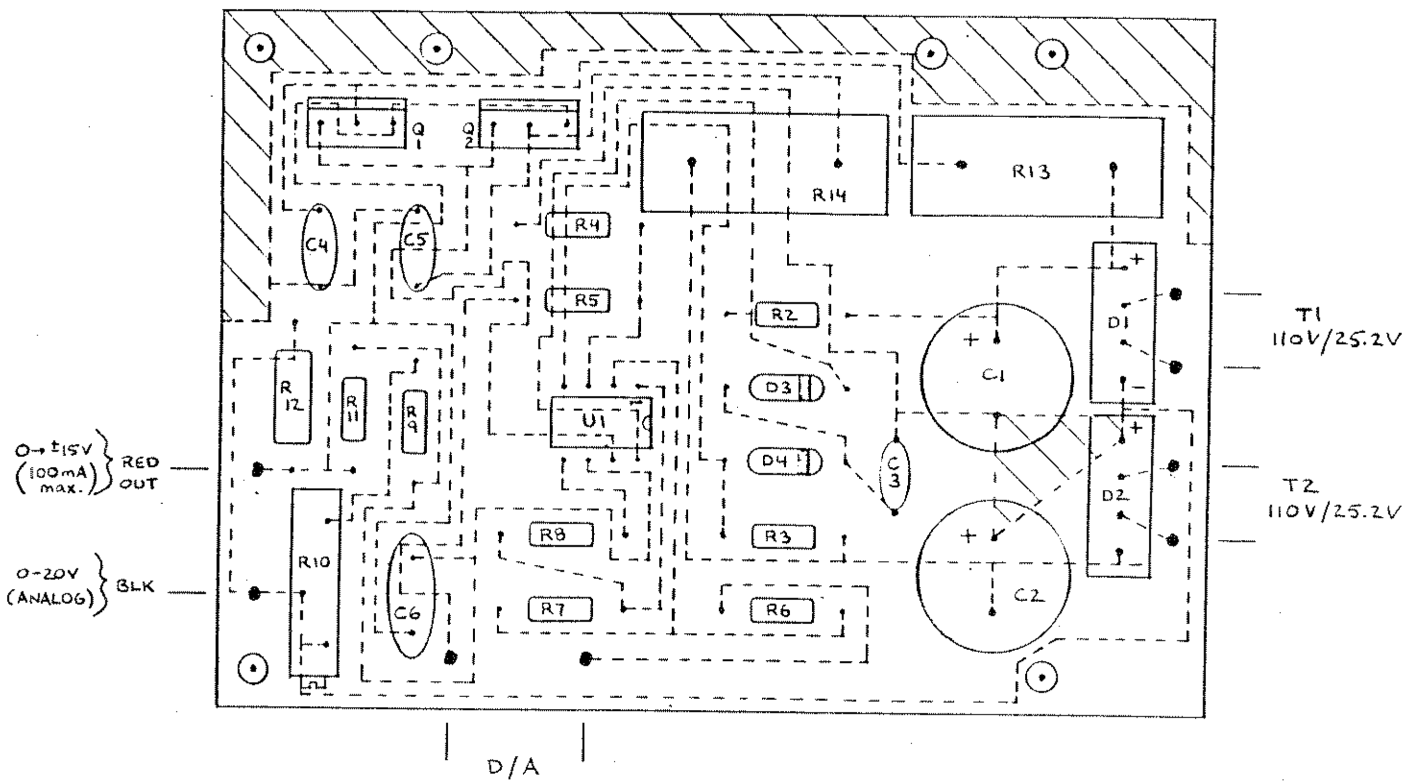
NOTE:
1. D1→D3: IN4152
2. R1; 6.8k
3. C1: .01MFD CER
4. U1 = ULN 2003A
5. K1,2,3,5,6,7: AMER. RELAYS # 0121 A1HO
   K4: IMCS



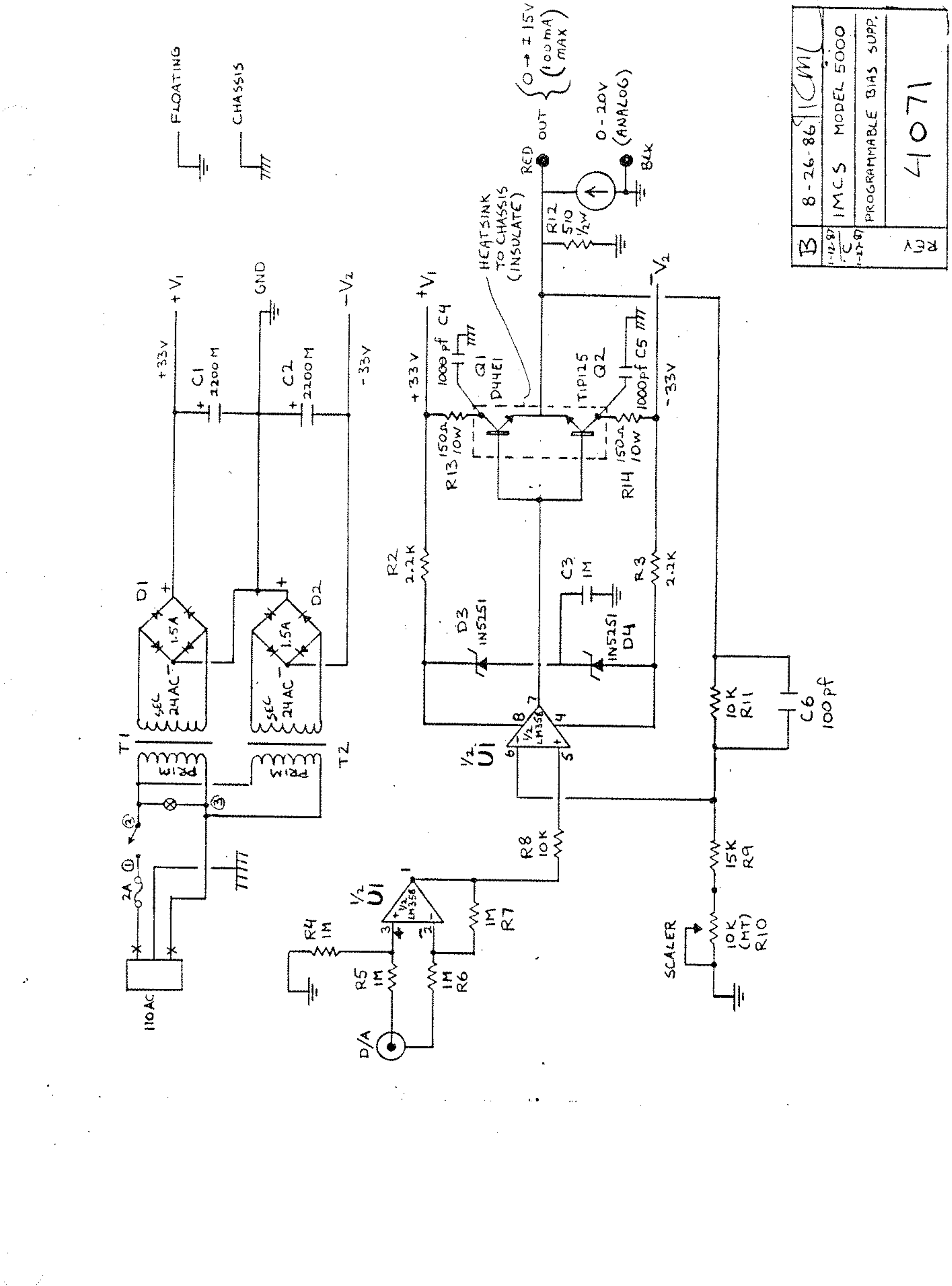


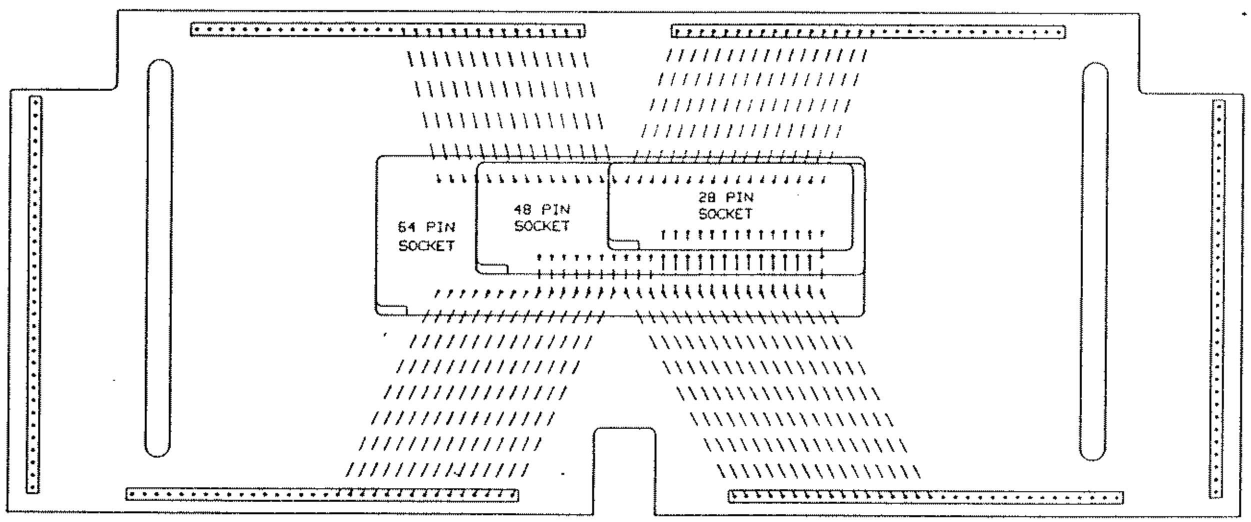
D1, 2, 3 - IN4152
U1 - ULN 2003A
K1, 2, 3, 5, 6, 7 - AMERICAN RELAY # O121A1HO
K4 - IMCS

D	6-13-86	
	RELAY MODULE SCHEMATIC	
	MODEL 5000	4053



C	1-27-87	RWL
REV	IMCS	
	MODEL 5000	
	PROG. BIAS SUPPLY	
	4071	

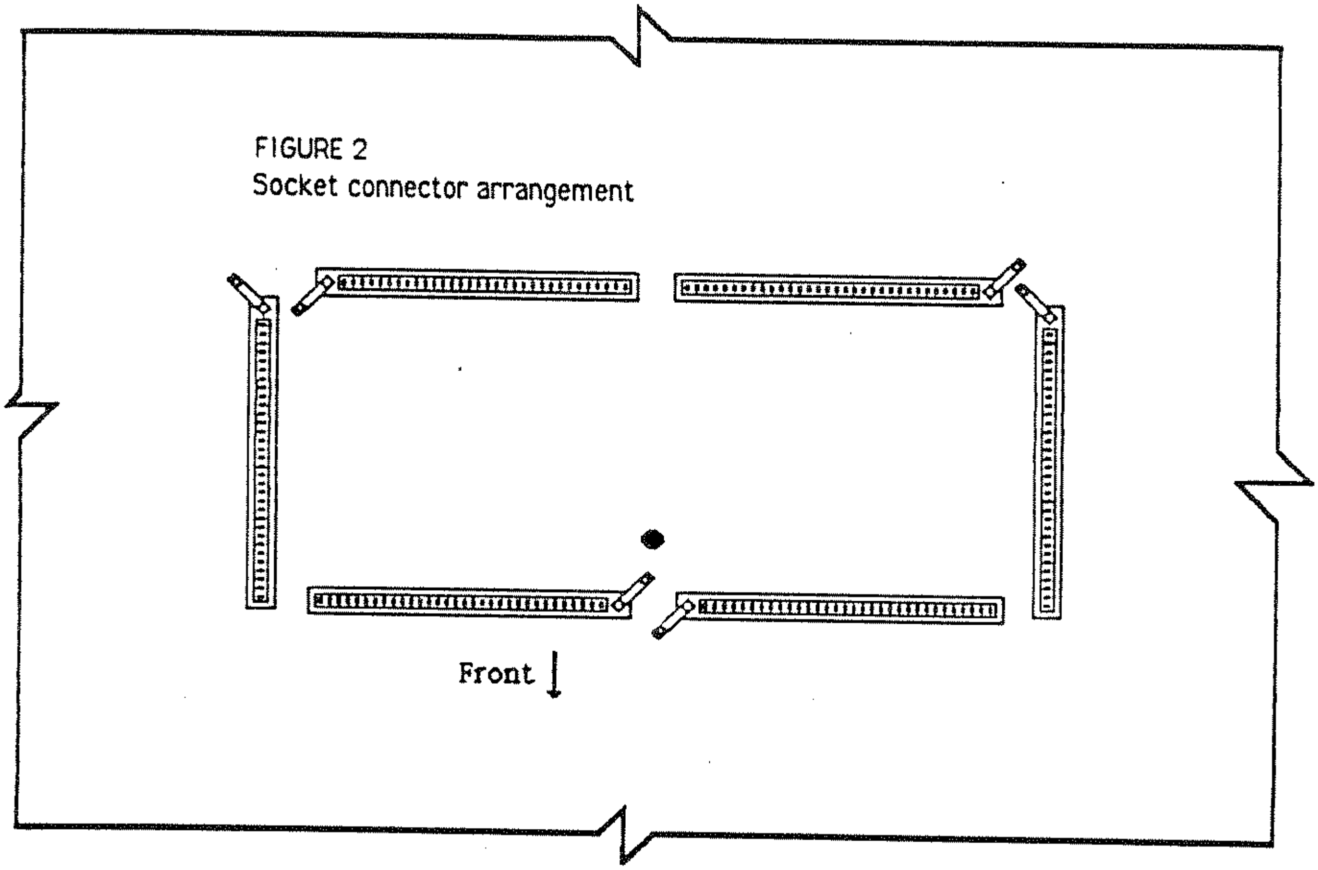

8-26-86
ICM
IMCS MODEL 5000
PROGRAMMABLE BIAS SUPP.
4071
B
C
REV
FLOATING
CHASSIS
OUT
RED
BLK
0 → ±15V (100mA MAX)
0-20V (ANALOG)
R12 510 1/2W
HEATSINK TO CHASSIS (INSULATE)
+V1
GND
-V2
+33V
-33V
C1 2200M
C2 2200M
C4 1000pf
C5 1000pf
Q1 D44E1
Q2 TIP115
R13 150Ω 10W
R14 150Ω 10W
R2 2.2K
R3 2.2K
C3 1M
D3 1N5251
D4 1N5251
D1
D2
1.5A
SEC 24AC
PRIM
T1
T2
2A
110AC
1/2 U1
1/2 LM358
R11 10K
C6 100pf
R9 15K
R10 10K (MT)
SCALER
R8 10K
R7 1M
R4 1M
R5 1M
R6 1M
D/A



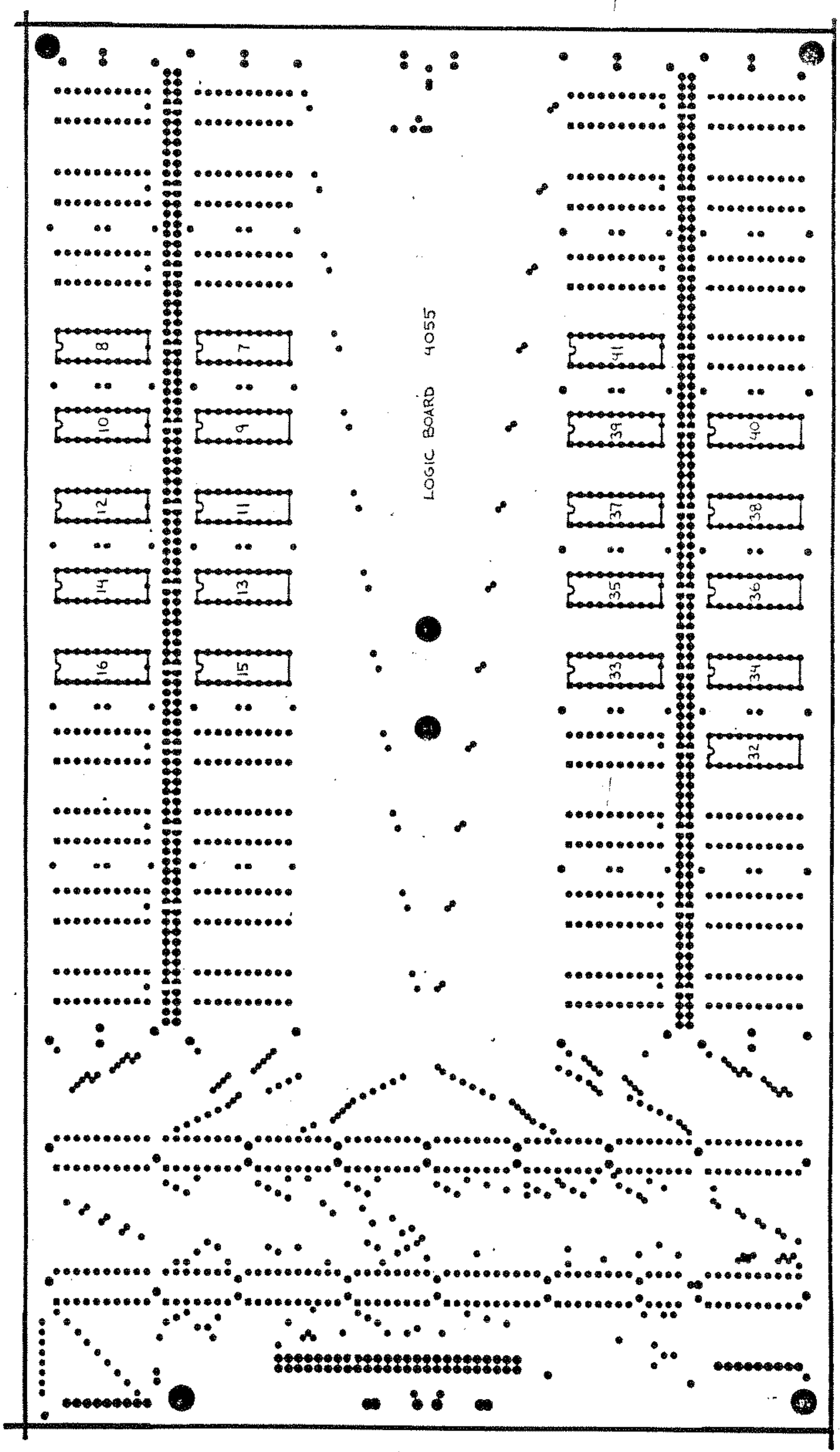
64 PIN SOCKET
48 PIN SOCKET
28 PIN SOCKET

IMCS
AN INTEX DIVERSIFIED COMPANY
MODEL 5000
DIP INTERFACE BD
SIZE B
FSCM NO.
DWG NO. 3058 L
REV
SCALE
1/21/88
SHEET

FIGURE 2
Socket connector arrangement



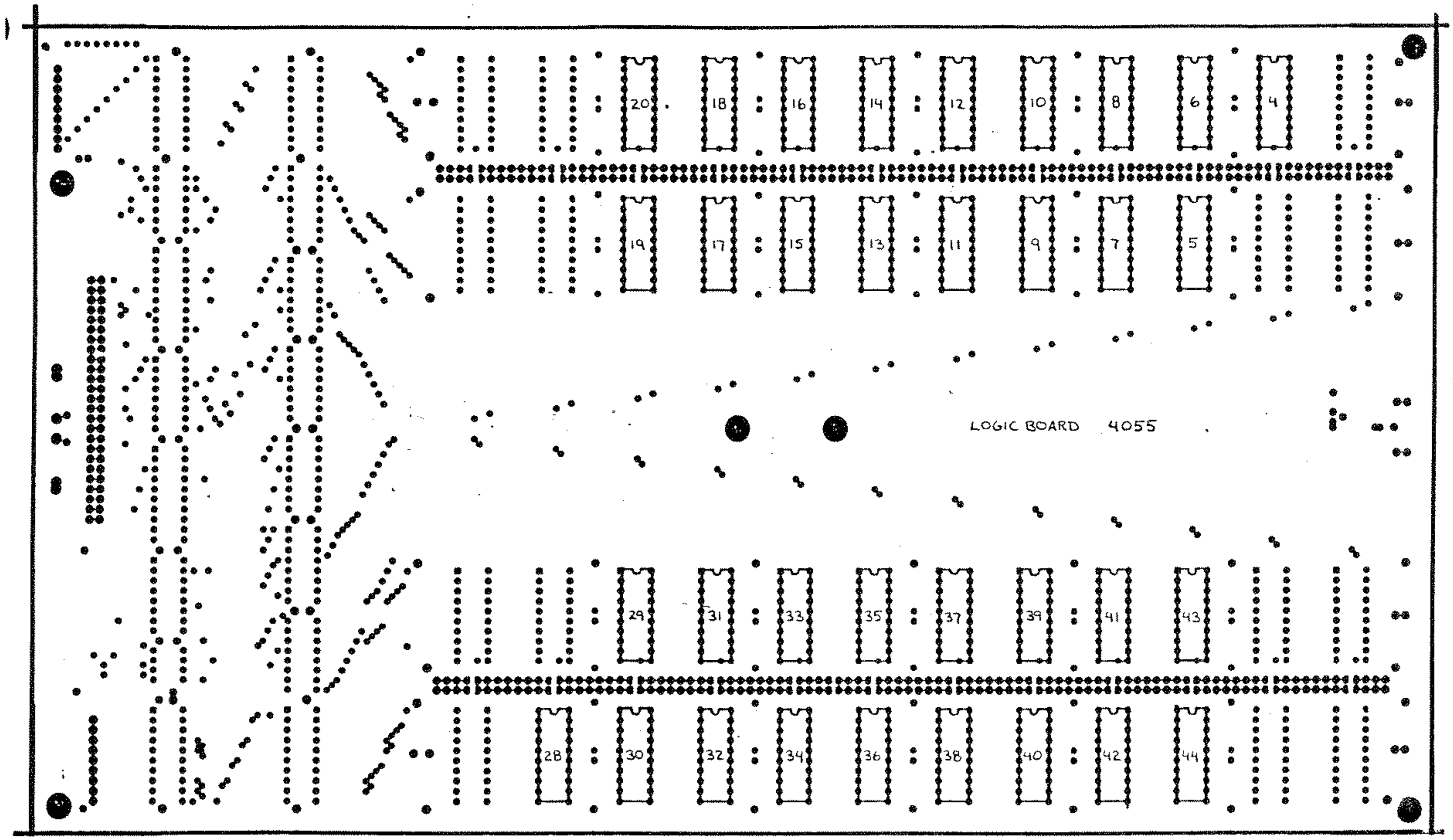
For 64 and 128 pin machines, do not use connectors at the left and right ends.



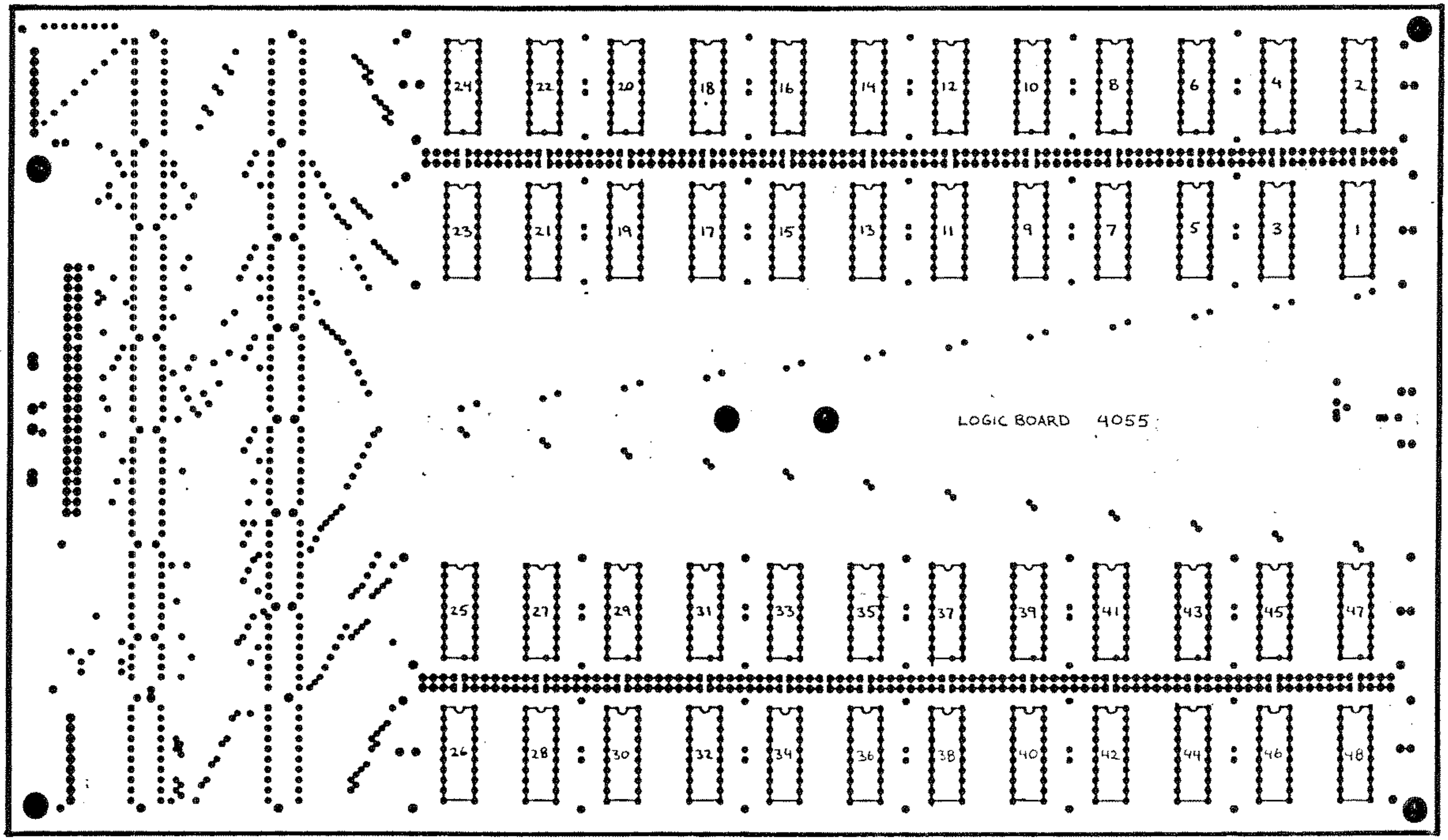
I.C. PLACEMENT FOR 64 PIN

U7-U16, U32-U41 : 74LS273

MODEL 5000



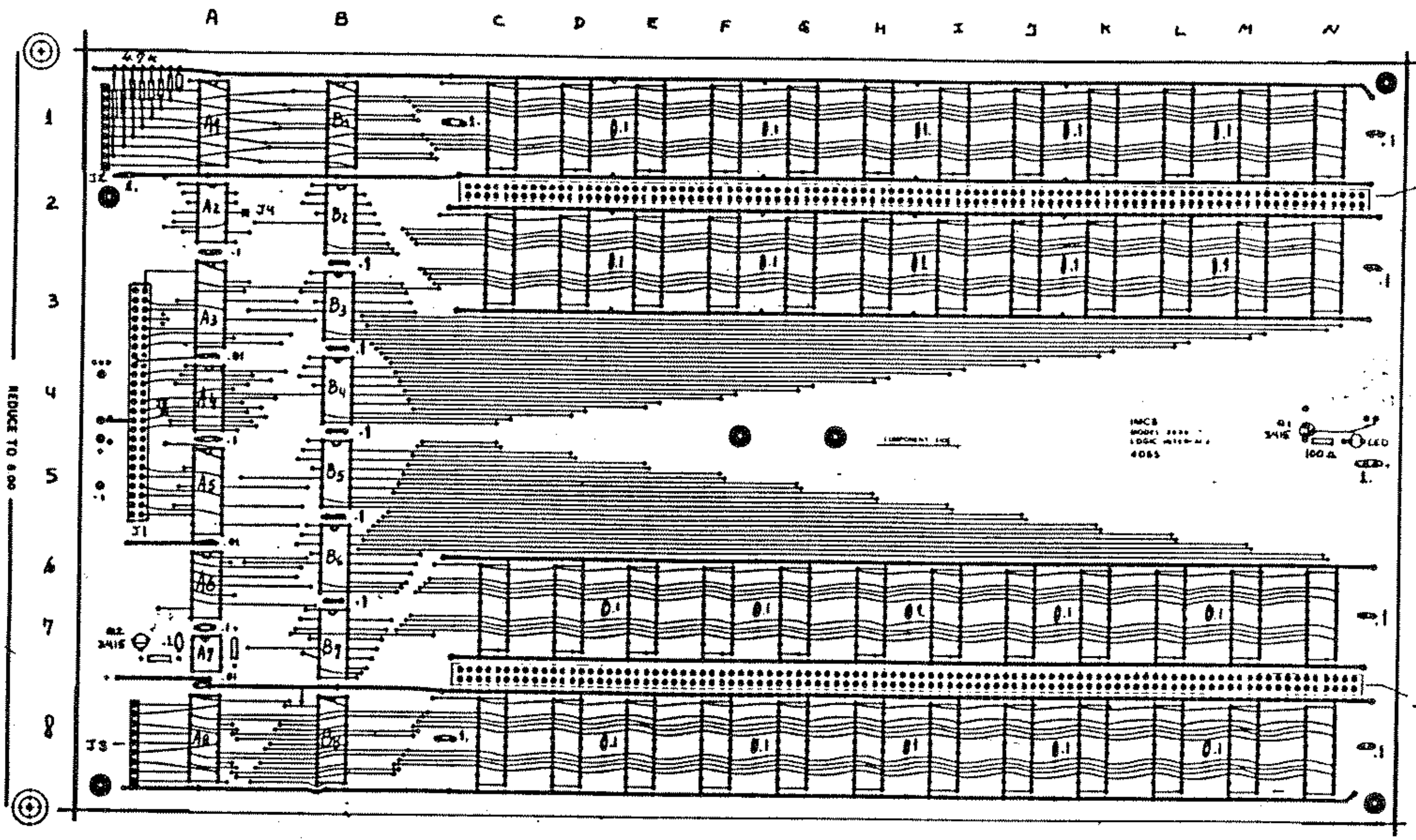
MODEL 5000 U4-U20, U28-U44: 74LS273 I.C. PLACEMENT FOR 128 PIN



MODEL 5000 U1-U48 : 74LS273 I.C. PLACEMENT FOR 192 PIN

A8: 74LS273
J1: IDH50S CONNECTOR
J2-J7: HEADER ASSY. 22-10-2251

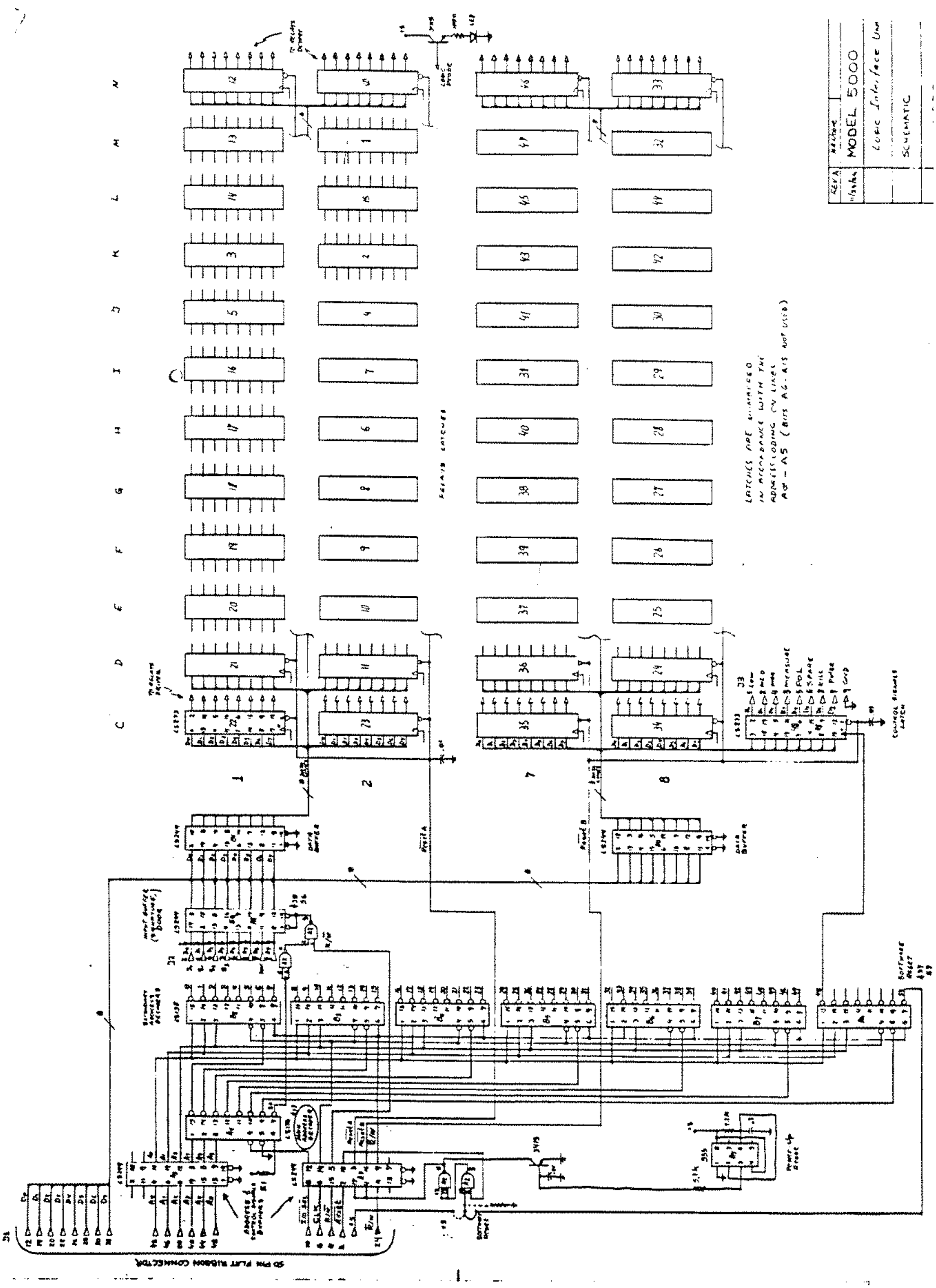
2-11-87	Logic Interface Unit
	COMPONENT LOCATION



COMPONENT SIDE

NOTES: A1, A5, A3, B1, B8: 74LS244
A4, A6, B2, B3, B4, B5, B6, B7: 74LS138
A2: 74LS00
A7: LM555

A	R. G. Hoare	2 of 2
4/87	MODEL 5000	


MODEL 5000
Logic Interface Unit
SCHEMATIC
LATCHES ARE NUMBERED IN ACCORDANCE WITH THE ADDRESS DECODING ON LINES A0 - A5 (BITS A6 - A15 NOT USED)
50 PIN FLAT RIBBON CONNECTOR

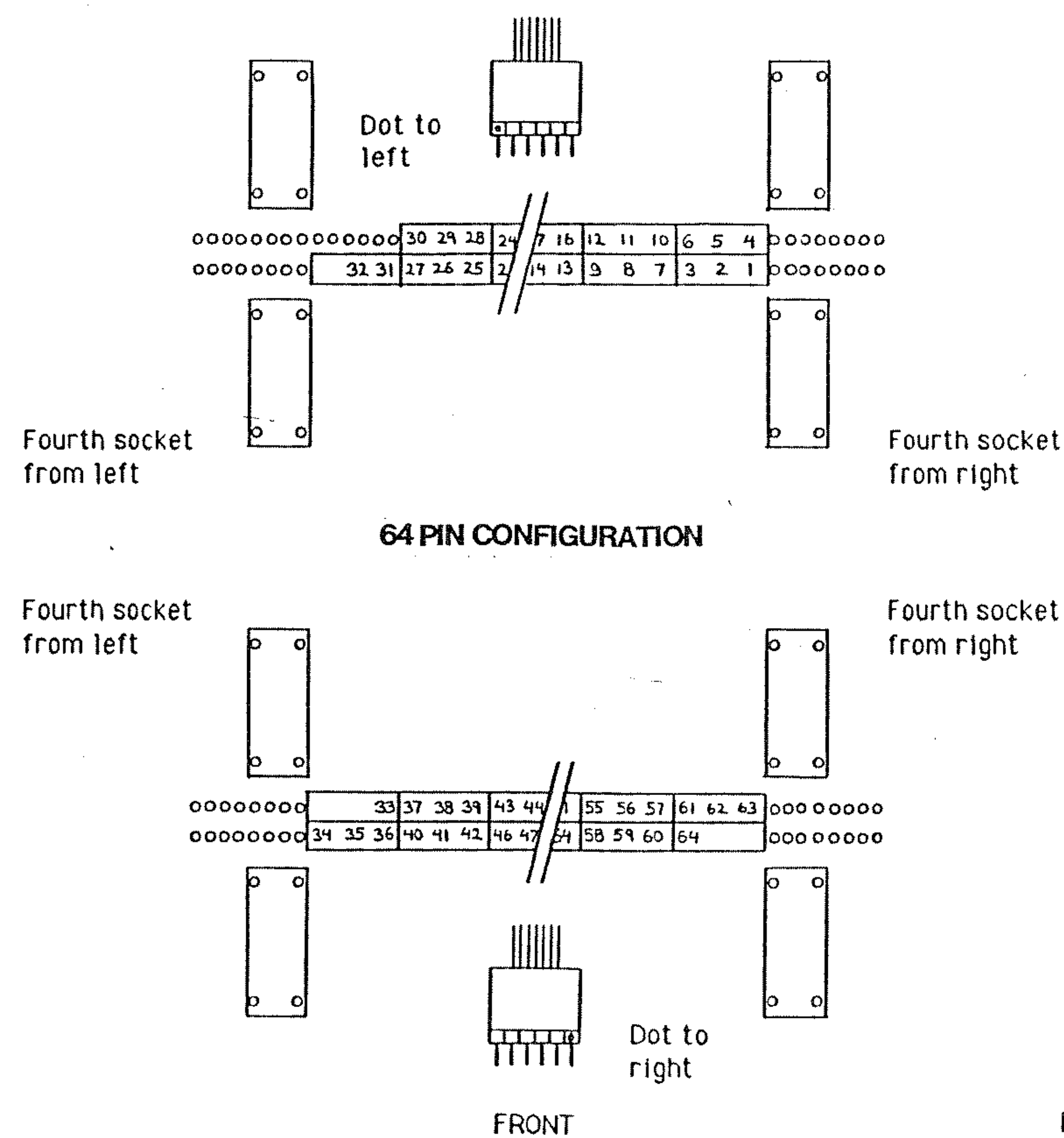

Dot to left
Fourth socket from left
Fourth socket from right
64 PIN CONFIGURATION
Fourth socket from left
Fourth socket from right
Dot to right
FRONT

Figure 5a

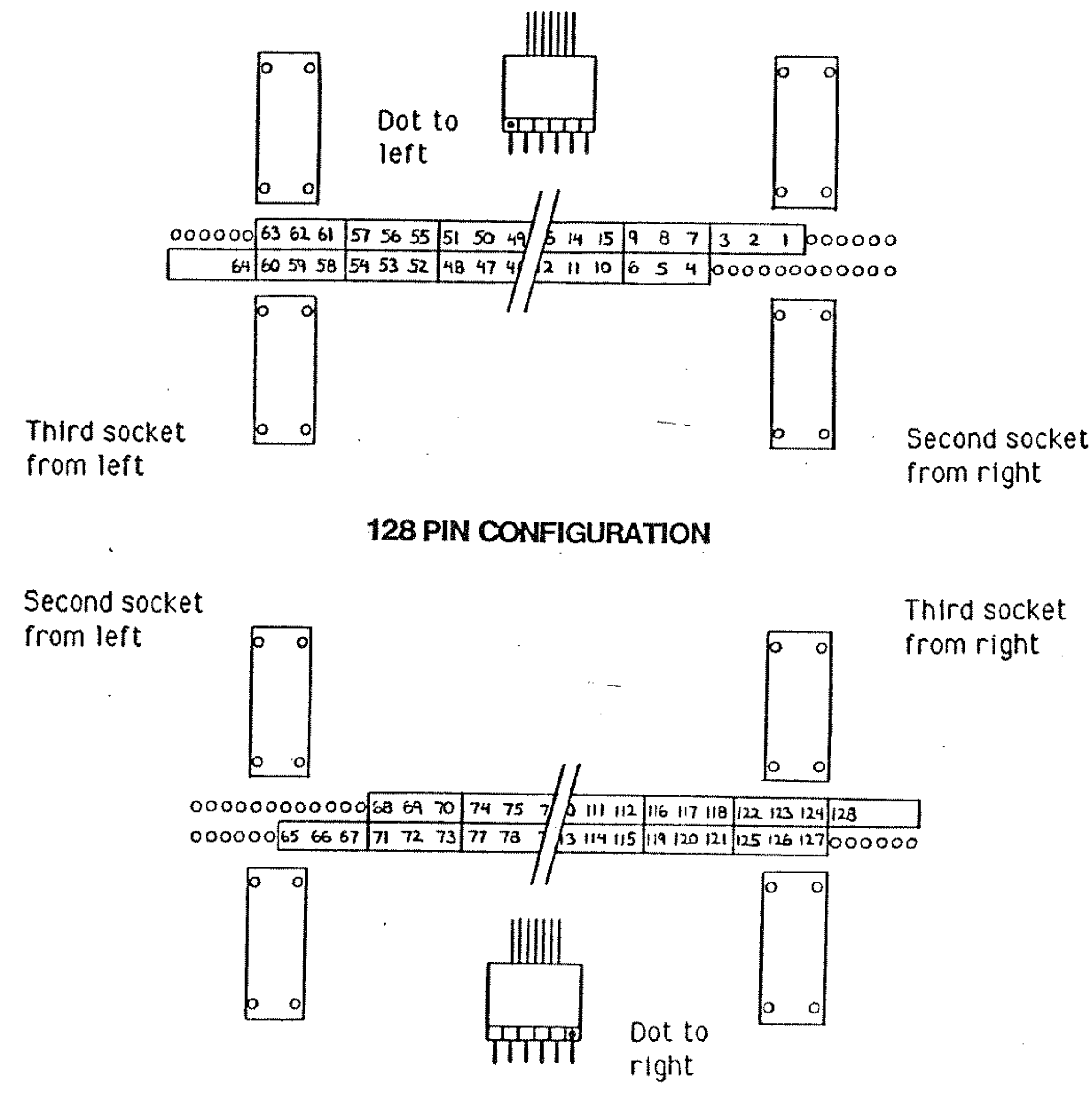

Dot to
left
Third socket
from left
Second socket
from right
128 PIN CONFIGURATION
Second socket
from left
Third socket
from right
Dot to
right
FRONT

Figure 5b

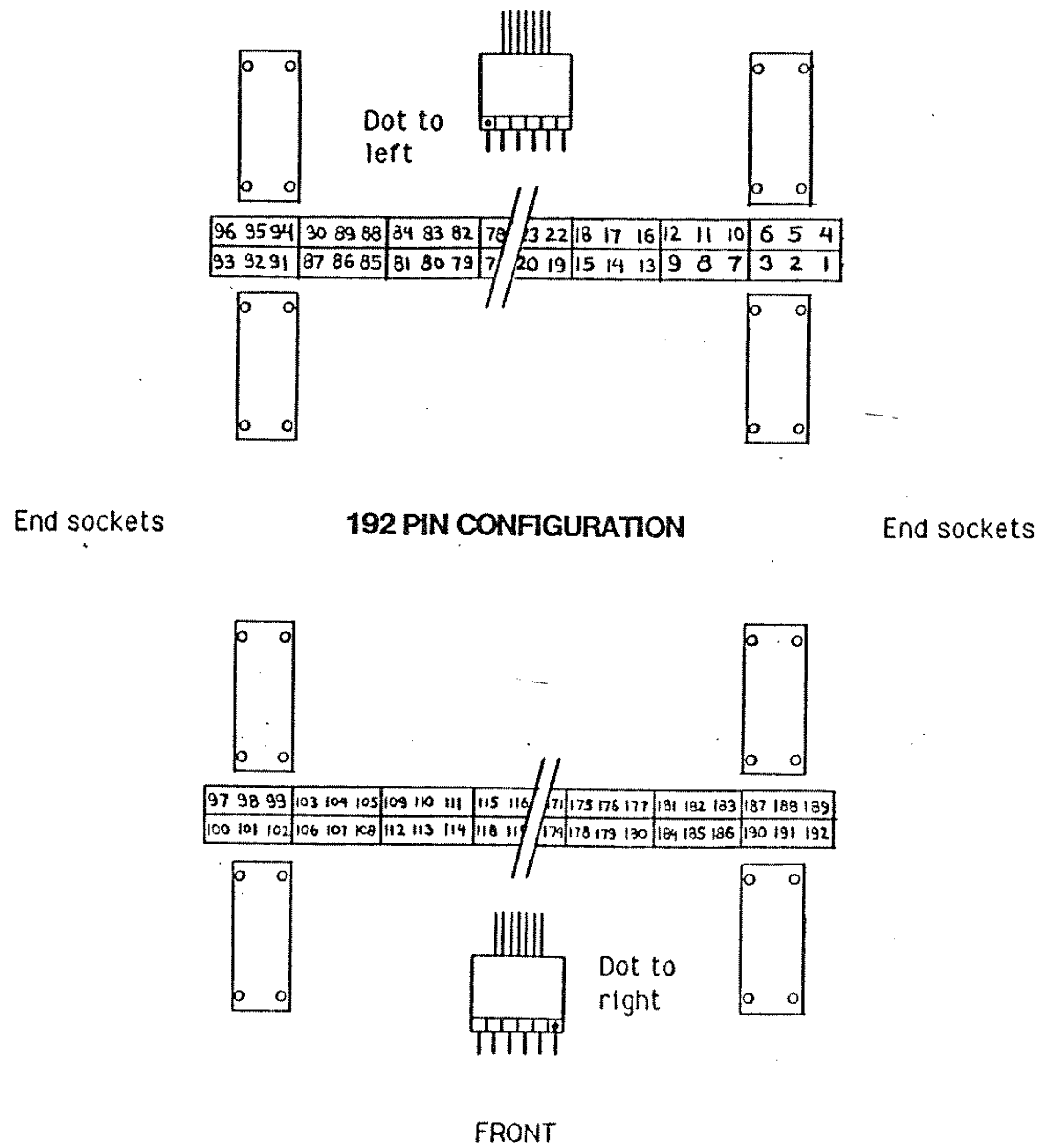
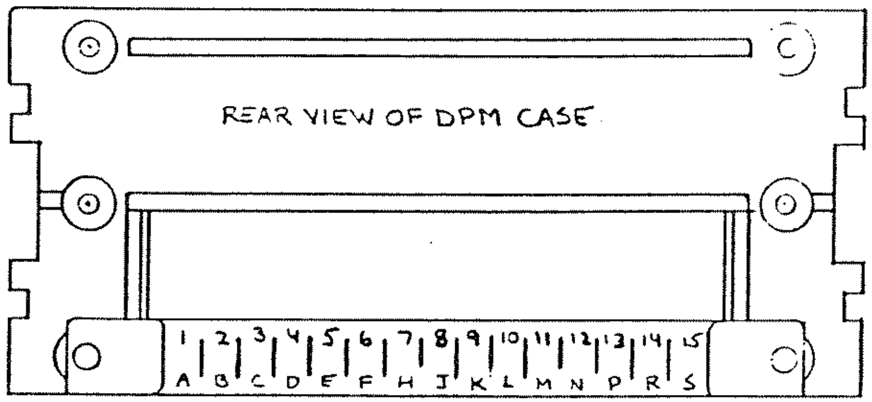
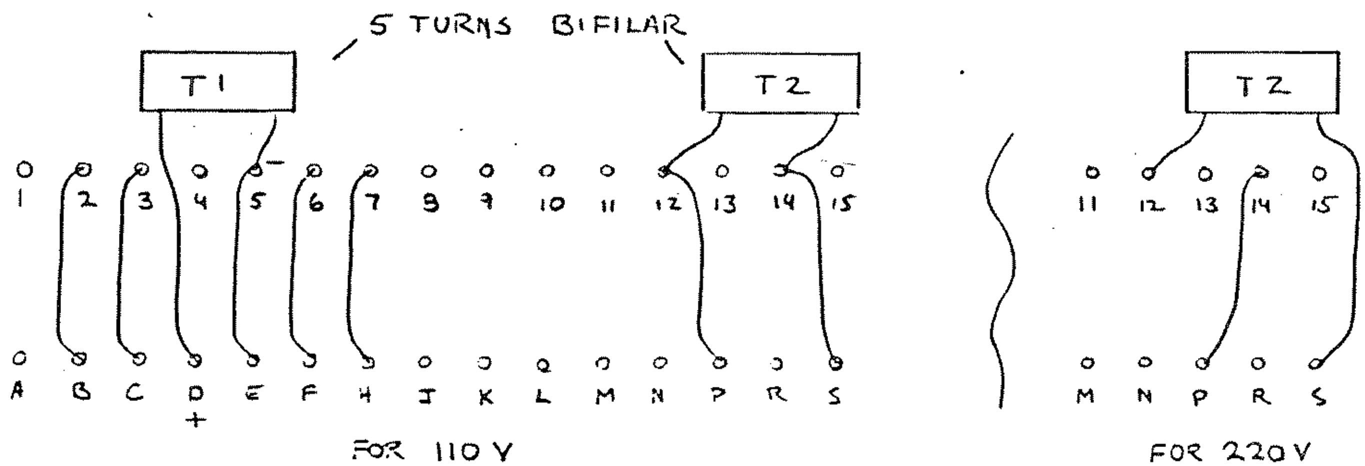
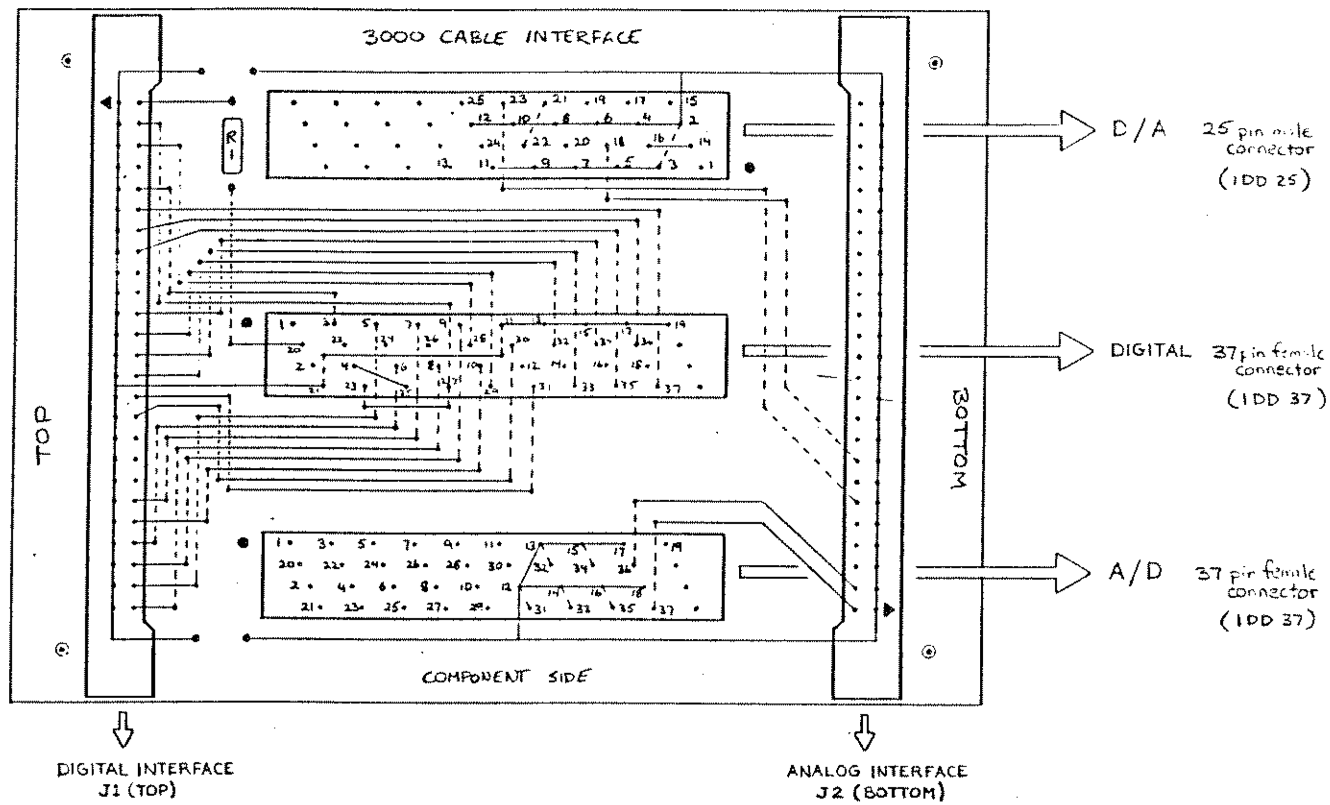

Dot to
left
End sockets
192 PIN CONFIGURATION
End sockets
Dot to
right
FRONT

Figure 5c

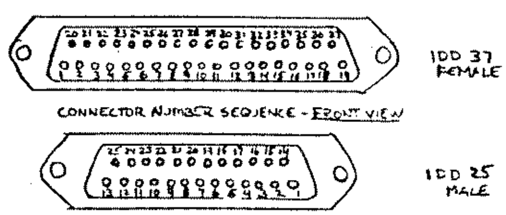




DPM CONNECTIONS FOR
2400 & 3000 & 5000

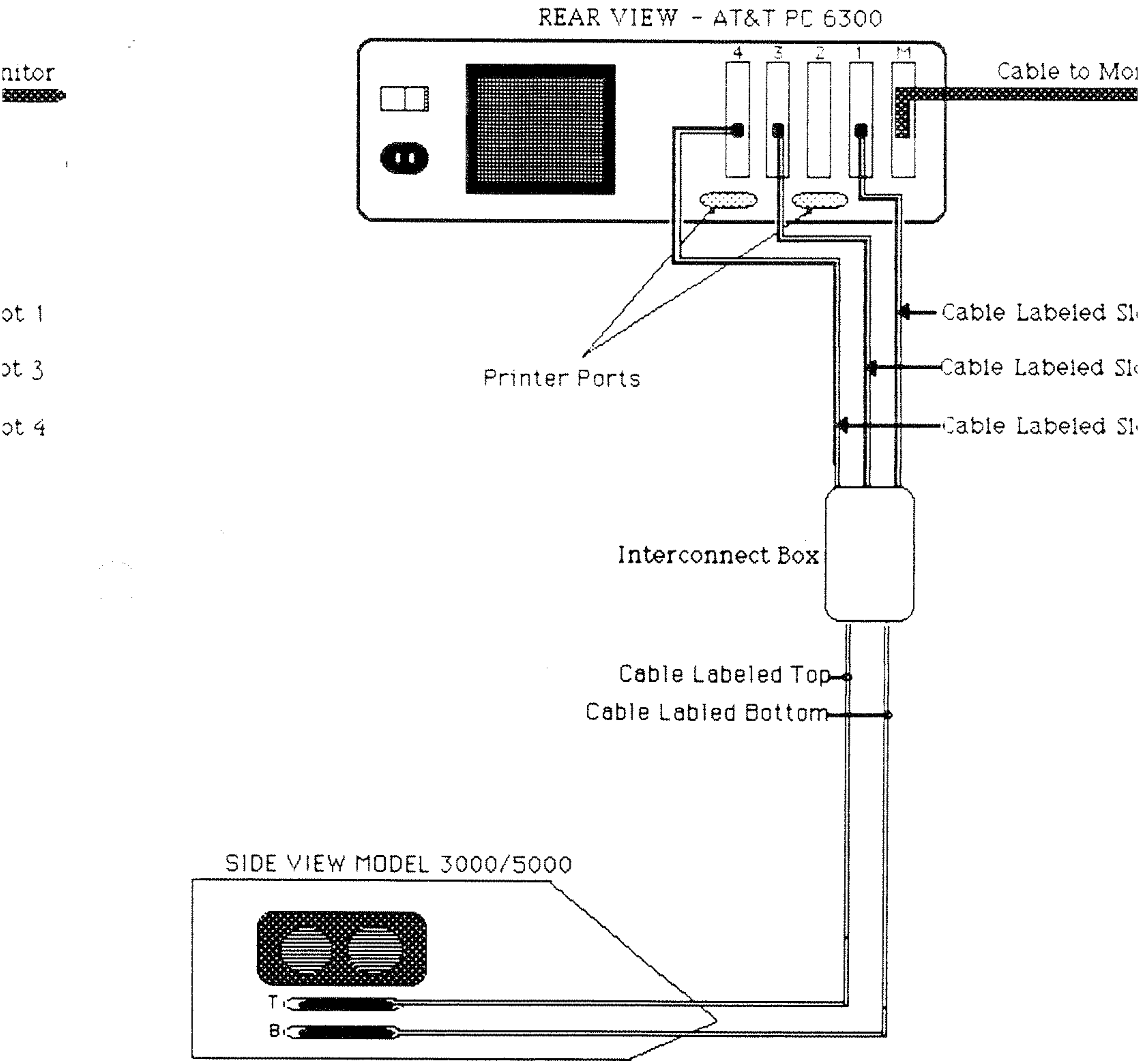


*NOTE: R1 - 4.7K



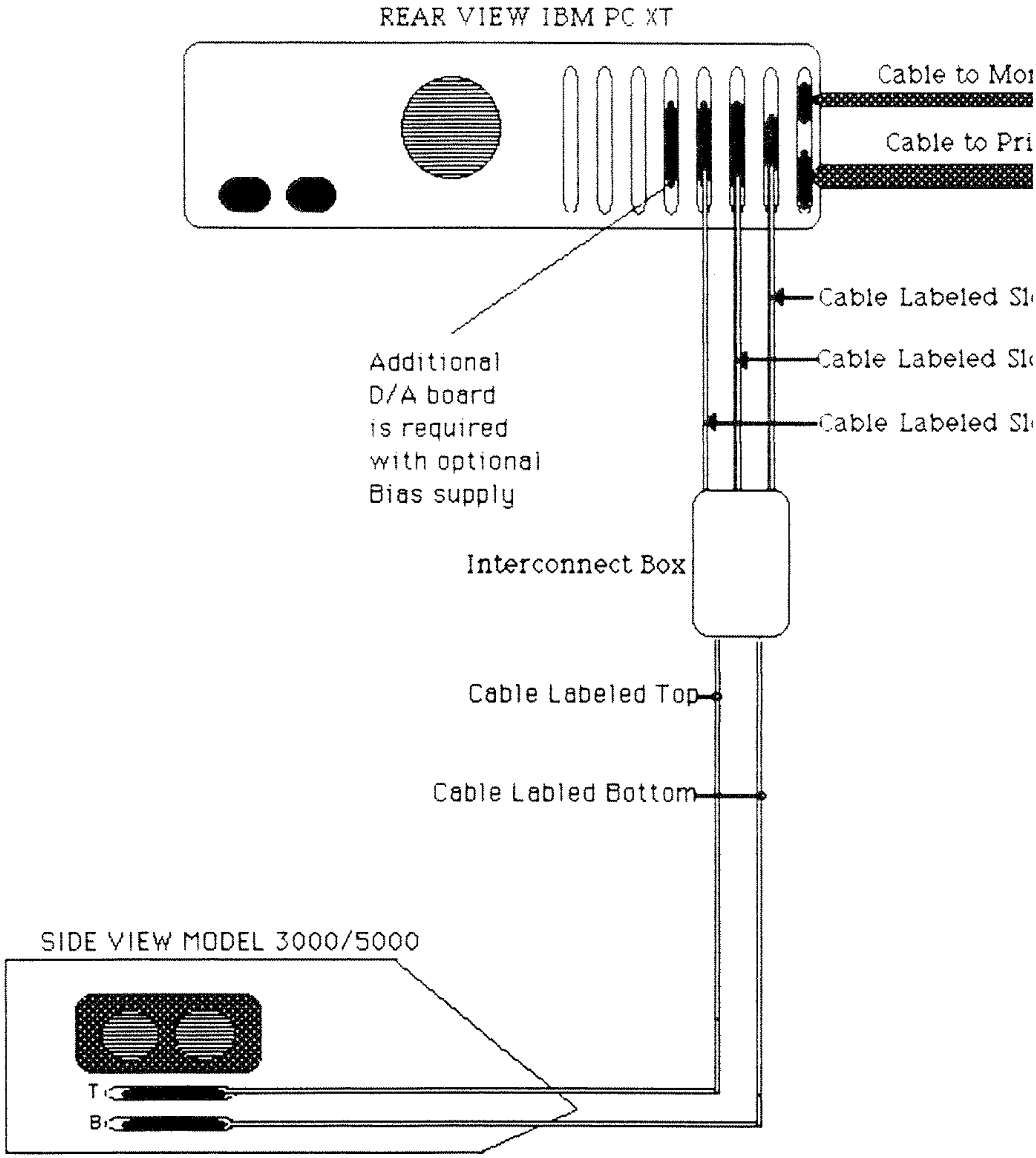
REV	1-29-86	[illegible]
	IMCS	
	MODEL 3000/5000	
	CABLE INTERFACE BD. LAYOUT	
	4068	

Cable Interconnect Diagram



NOTE: ATTACH CABLES WITH RED WIRE TO REAR
OF MODEL 3000/5000

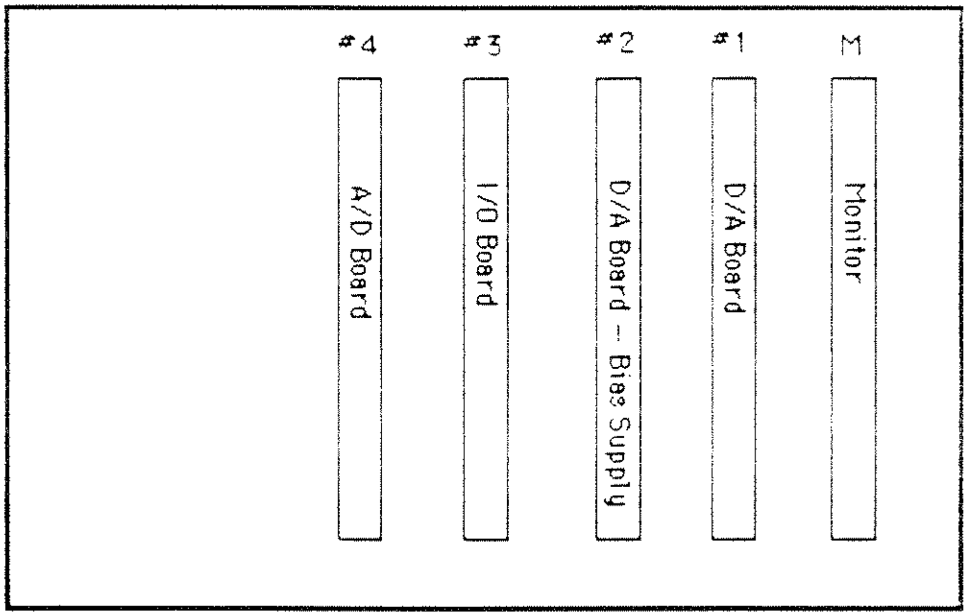
Cable Interconnect Diagram



NOTE: ATTACH CABLES WITH RED WIRE TO REAR
OF MODEL 3000/5000

Computer modifications/setup

AT&T PC 6300 REAR VIEW

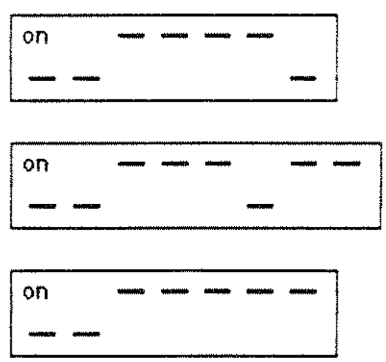


Aux. board locations in AT&T mother board

A/D (DASH-8) ....

I/O (PIO12) ....

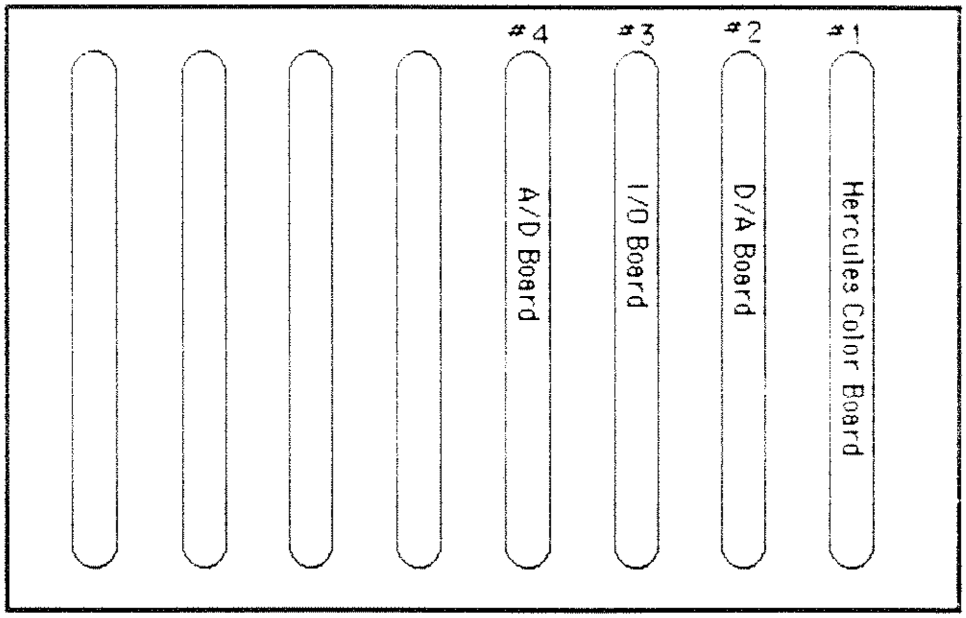
D/A (DAC-02) ....



Aux. board DIP switch positions

Computer modifications/setup

IBM PC XT REAR VIEW

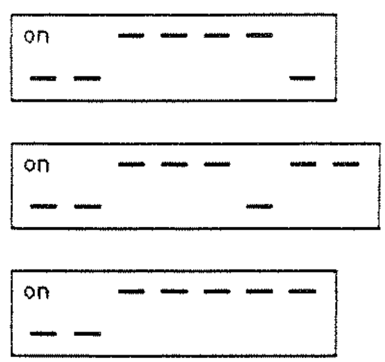


Aux. board locations in IBM mother board

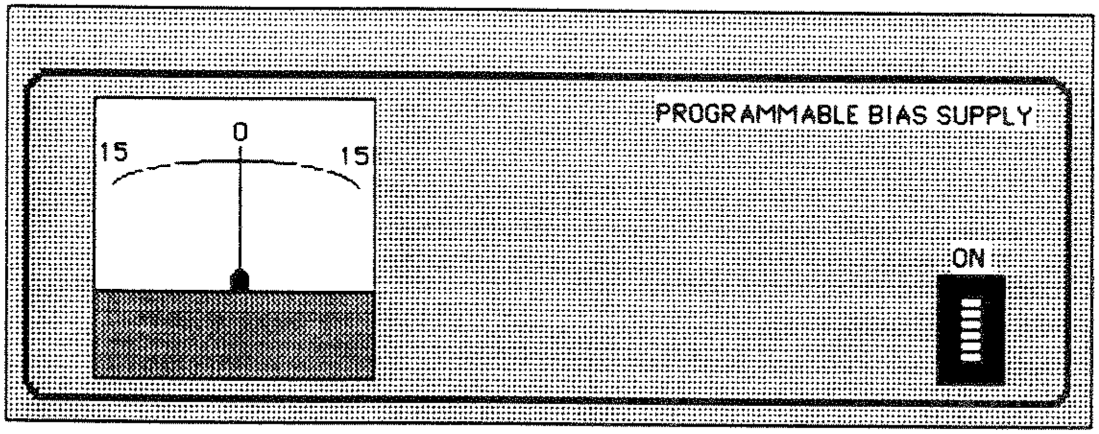
A/D (DASH-8) ....

I/O (PIO12) ....

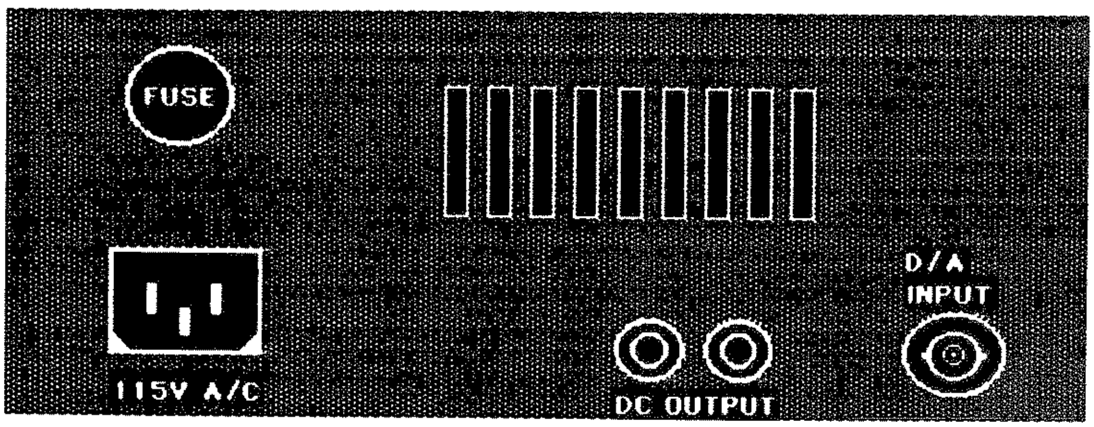
D/A (DAC-02) ....



Aux. board DIP switch positions



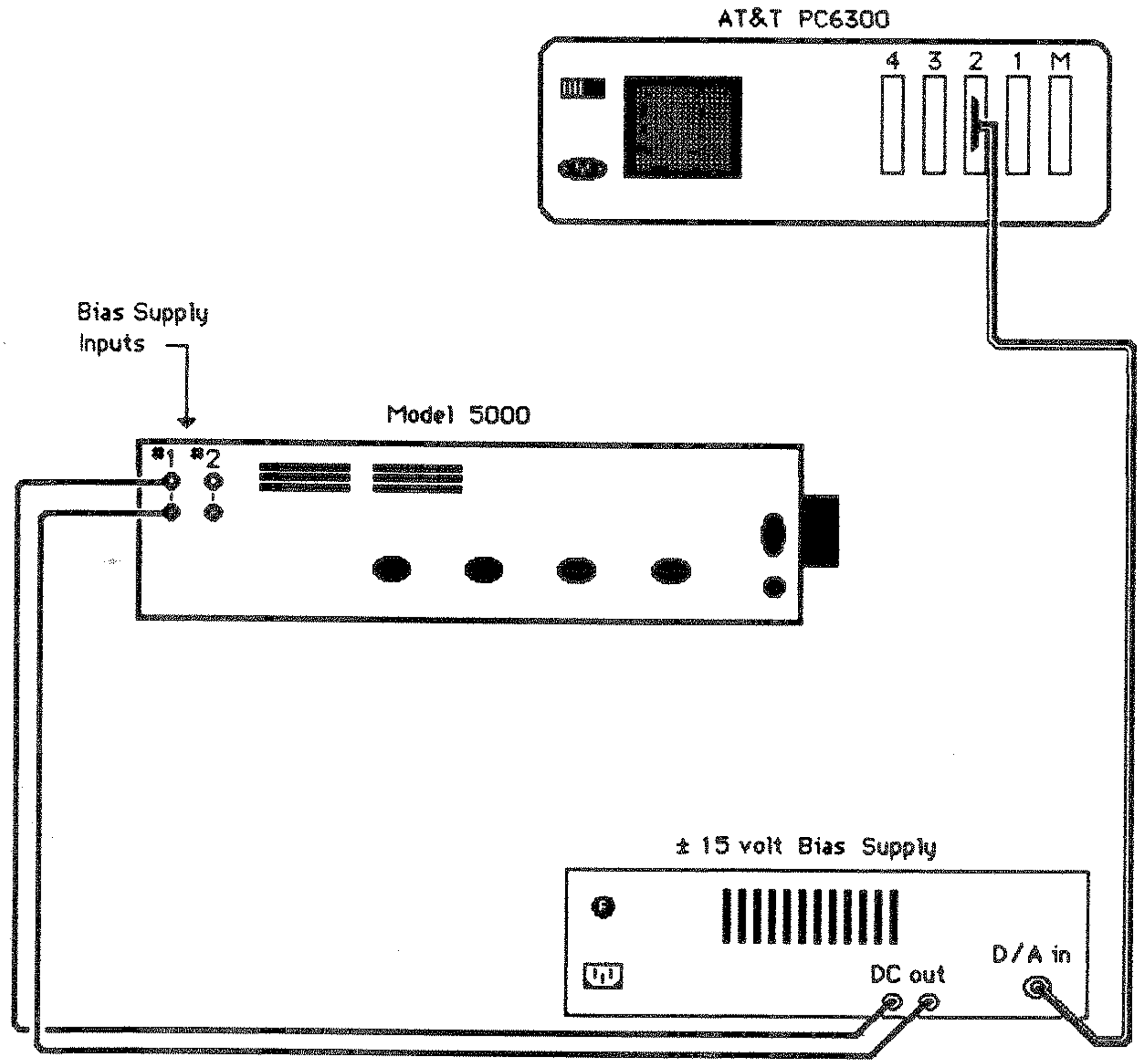
FRONT VIEW



BACK PANEL

EXTERNAL BIAS SUPPLY

Front and Rear views



Bias Supply Connections