



**PLEASE CHECK FOR CHANGE INFORMATION  
AT THE REAR OF THIS MANUAL.**

**SI 5020**  
Switch  
Matrix

**INSTRUCTION MANUAL**

**Tektronix, Inc.**  
**P.O. Box 500**  
**Beaverton, Oregon 97077**

070-7753-00  
Product Group 75

Serial Number \_\_\_\_\_

First Printing OCT 1989

Copyright © 1989 Tektronix, Inc. All rights reserved.  
Contents of this publication may not be reproduced in any  
form without the written permission of Tektronix, Inc.

Products of Tektronix, Inc. and its subsidiaries are covered  
by U.S. and foreign patents and/or pending patents.

TEKTRONIX, TEK, SCOPE-MOBILE, and  are  
registered trademarks of Tektronix, Inc. TELEQUIPMENT  
is a registered trademark of Tektronix U.K. Limited.

Printed in U.S.A. Specification and price change privileges  
are reserved.

#### **INSTRUMENT SERIAL NUMBERS**

Each instrument manufactured by Tektronix has a serial  
number on a panel insert, tag, or stamped on the chassis. The  
letter at the beginning of the serial number designates the  
country of manufacture. The last five digits of the serial number  
are assigned sequentially and are unique to each instrument.  
Those manufactured in the United States have six unique  
digits. The country of manufacture is identified as follows:

B010000 — Tektronix, Inc. Beaverton, Oregon, USA  
G100000 — Tektronix Guernsey, Ltd., Channel Islands  
E200000 — Tektronix United Kingdom, Ltd., London  
J300000 — Sony/Tektronix, Japan  
H700000 — Tektronix Holland, NV, Heerenveen,  
The Netherlands

Instruments manufactured for Tektronix by external vendors  
outside the United States are assigned a two digit alpha code  
to identify the country of manufacture (e.g., JP for Japan, HK  
for Hong Kong, IL for Israel, etc.).

# CONTENTS

ILLUSTRATIONS .....	iii
TABLES .....	iv
OPERATORS SAFETY SUMMARY .....	v
SERVICING SAFETY SUMMARY .....	vi

## 1 Specification

SPECIFICATION .....	1-1
INTRODUCTION .....	1-1
STANDARD ACCESSORIES .....	1-1
IEEE-488 (GPIB) FUNCTION CAPABILITY .....	1-1
PERFORMANCE CONDITIONS .....	1-2

## 2 System Installation

SYSTEM INSTALLATION .....	2-1
PREPARATION FOR USE .....	2-1
FRONT PANEL CONTROLS AND CONNECTORS .....	2-4
REPACKAGING INFORMATION .....	2-5

## 3 Programming Information

PROGRAMMING INFORMATION .....	3-1
INTRODUCTION .....	3-1
OVERVIEW .....	3-1
COMMANDS AND MESSAGE FORMATS .....	3-1
MESSAGE PROCESSING .....	3-3
IEEE 488 INTERFACE MESSAGES .....	3-4
INTRODUCTION .....	3-4
GPIB CONTROLLER INTERFACE MESSAGES .....	3-4
COMMANDS .....	3-7
COMMAND SUMMARY .....	3-7
DETAILED COMMAND LIST .....	3-7
FRONT PANEL SWITCHES AND RELAY ACTIONS .....	3-12
HARDWARE AND SOFTWARE IMPLEMENTATION .....	3-13
HARDWARE DEFINITION .....	3-13
CONTROLLER SOFTWARE OVERVIEW .....	3-13
DIAGNOSTIC SOFTWARE .....	3-13
STATUS AND ERROR REPORTING .....	3-14
SERVICE REQUEST, STATUS BYTE, AND ERROR QUERY .....	3-14
STATUS BYTE ORGANIZATION .....	3-15



*The information in the remaining sections of this manual is for qualified service personnel only. Refer to the "Service Safety Summary" located later in this manual.*

## **4 Theory of Operation**

THEORY OF OPERATION .....	4-1
INTRODUCTION .....	4-1
MAIN BOARD .....	4-1
GPIB CONTROLLER BOARD .....	4-3
INTERNAL ADDRESS DECODE AND MPU BUFFERS .....	4-3
FRONT PANEL BOARD .....	4-4

## **5 Performance Check**

PERFORMANCE CHECK AND FUNCTIONAL VERIFICATION PROCEDURE .....	5-1
INTRODUCTION .....	5-1
PREPARATION .....	5-1
SI 5020A PROCEDURE .....	5-1
SI 5020B PROCEDURE .....	5-2
SI 5020C PROCEDURE .....	5-2

## **6 Maintenance**

MAINTENANCE AND DIAGNOSTICS .....	6-1
GENERAL MAINTENANCE .....	6-1
CIRCUIT BOARD REMOVAL AND INSTALLATION .....	6-4
SIDE COVERS .....	6-4
GPIB BOARD .....	6-4
MAIN BOARD .....	6-4
FRONT PANEL BOARD .....	6-4
TROUBLESHOOTING .....	6-4

## **7 Options**

## **8 Replaceable Electrical Parts**

## **9 Diagrams**

## **10 Replaceable Mechanical Parts**

# ILLUSTRATIONS

<i>Figure</i>		<i>Page</i>
1-1	Channel insertion loss vs. frequency .....	1-3
1-2	Channel isolation vs. frequency .....	1-3
1-3	VSWR vs. frequency .....	1-3
2-1	IEEE 488 bus address and message terminator switches .....	2-1
2-2	Installation and Removal .....	2-3
2-3	SI 5020A front panel controls and connectors .....	2-4
2-4	SI 5020B front panel controls and connectors .....	2-5
2-5	SI 5020C front panel controls and connectors .....	2-5
3-1	ASCII and IEEE 488 (GPIB) Code Chart .....	3-6
4-1	Block diagram for the Main Board .....	4-2
4-2	Block diagram for the GPIB Controller Board .....	4-5
6-1	Orientation and disassembly of multipin connectors .....	6-3

# TABLES

<i>Table</i>		<i>Page</i>
1-1	IEEE 488 Interface Function Subsets .....	1-1
1-2	Electrical Characteristics .....	1-2
1-3	Environmental Characteristics .....	1-4
1-4	Mechanical Characteristics .....	1-4
3-1	SI 5020 GPIB Command Summary .....	3-7
3-2	Status Byte Definitions .....	3-14
3-3	Event Classes .....	3-14
3-4	Status Byte & Event/Error Codes .....	3-16
4-1	Main Board Device Addresses .....	4-1
4-2	Internal Addressing .....	4-3
4-3	GPIB Module Address Selection .....	4-4
5-1	Test Equipment Required .....	5-1
6-1	Relative Susceptibility to Static Discharge Damage .....	6-1

# OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

## TERMS

### In This Manual

**CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property.

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

## TERMS

### As Marked on Equipment

**CAUTION** indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

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

## SYMBOLS

### In This Manual



This symbol indicates where applicable cautionary or other information is to be found.

### As Marked on Equipment



**DANGER** – High voltage.



Protective ground (earth) terminal.



**ATTENTION** – Refer to manual.

## Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

## Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before making any connections to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

## Danger Arising from Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulated) can render an electric shock.

## Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

## Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified in the parts list for your product.

## Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this instrument in an explosive atmosphere unless it has been specifically certified for such operation.

## Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the instrument without the covers and panels properly installed.

# SERVICING SAFETY SUMMARY

## FOR QUALIFIED SERVICE PERSONNEL ONLY

*Refer also to the preceding Operators Safety Summary.*

### **Do Not Service Alone**

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

### **Use Care When Servicing With Power On**

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections or components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

### **Power Source**

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

# SPECIFICATION

## INTRODUCTION

The SI 5020 is a device for switching two independent sets of six-position multiplex switches carrying signals of up to 18 GHz. Each of the two switch sets has a common connector (positioned in the center of the SMA connector circle in each switch set shown on the front panel), and operates in the normally open mode. The operation of each switch can be software driven via the GPIB or directly via front panel controls.

The SI 5020 High Frequency Multiplexer is a TM 5000 Series plug-in instrument. All functional electronics are included, but it requires insertion into a TM 5000 Series Power Module for interfacing to both basic power supplies and the system GPIB interconnection.

Each switch actuation can be accomplished in approximately 15 ms at the junction of the relay; however, bus acquisition and related software functions could add an additional 1 to 3 ms. In addition, when switch operation is via the front panel, the software is designed to add an additional 25 ms to allow for possible front panel switch contact bounce (software equivalent of debounce circuitry). Hence, a usable cable routing switchover can be accomplished in approximately 18 ms when initiated by the controller and 40 ms when initiated via the front panel.

## STANDARD ACCESSORIES

One Instruction Manual is shipped with the SI 5020.

## IEEE-488 (GPIB) FUNCTION CAPABILITY

The IEEE Standard 488-1978 identifies the interface function repertoire of a programmable instrument on the digital interface in terms of interface function subsets. The subsets are defined in the standard. The subsets that apply to the SI 5020 are listed in Table 1-1.

### NOTE

*Refer to IEEE Standard 488-1978 for more detailed information. The standard is published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, New York 10017.*

### NOTE

*The GPIB control bus driver is a tri-state device. The data bus driver operates in either a normal open-collector mode, or in a tri-state mode when parallel polled. The SI 5020 does not respond to a parallel poll.*

Table 1-1  
IEEE 488 Interface Function Subsets

Function	Subset	Capability
Source Handshake	SH1	Complete.
Acceptor Handshake	AH1	Complete.
Basic Talker	T6	Responds to Serial Poll. Untalked if My Listen Address (MLA) is received.
Basic Listener	L4	Unlistened if My Talk Address (MTA) is received.
Service Request	SR1	Complete.
Remote-Local	RL1	Complete.
Parallel Poll	PP0	Does not respond to Parallel Poll.
Device Trigger	DT0	No Capability.
Device Clear	DC1	Complete.
Controller	C0	No Controller functions.
Drive Electronics	E1	Tri-state.

**PERFORMANCE CONDITIONS**

The SI 5020 must be in an environment whose limits are described under Environmental Characteristics (Table 1-3).

The limits stated in the Performance Requirements column of Table 1-2 are valid only if the SI 5020 is operated in an ambient temperature between 0°C and +50°C unless otherwise stated.

**Table 1-2**  
**Electrical Characteristics**

Characteristics	Performance Requirements
<b>FRONT PANEL INPUT/OUTPUT</b>	
Insertion Loss (any port to common - see Figure 1-1)	< 0.2 dB at 0-3 GHz < 0.3 dB at 3-8 GHz < 0.4 dB at 8-12.4 GHz < 0.5 dB at 12.4-18 GHz.
Channel Isolation (any port to common - see Figure 1-2)	> 80 dB at 0-3 GHz > 70 dB at 3-8 GHz > 60 dB at 8-18 GHz.
Crosstalk Isolation (between any two ports with common and all unused ports terminated)	> 80 dB at 0-3 GHz > 70 dB at 3-12.4 GHz > 60 dB at 12.4-18 GHz.
VSWR (any port to common - see Figure 1-3)	< 1.21 at 0-3 GHz < 1.31 at 3-8 GHz < 1.41 at 8-12.4 GHz < 1.51 at 12.4-18 GHz.
Maximum Switched Current	50 mA dc or peak ac.
Maximum Switched Voltage	15 V dc or peak ac.
Maximum Carry Current	3.0 A.
Maximum Switchable Power	125 mW (RF into 50 Ω).
Maximum Carry Power	450 W to 100 MHz 200 W to 700 MHz 100 W to 3.5 GHz 50 W to 1.8 GHz (all into 50 Ω).
Dielectric Standoff	50 V dc or peak ac.
Switch Life	10 <sup>9</sup> operations.
Settling Time	41 ms.
<b>POWER SUPPLY</b>	
Output Voltage	+5 V ± 4% from no load to 1.5 A. +26 V ± 9%.
Current Limit Threshold	3.0 A.
Undervoltage Reset	RESET line goes to a TTL LO for a minimum of 0.2 second if voltage drops below 4.55 V ± 2% or longer.

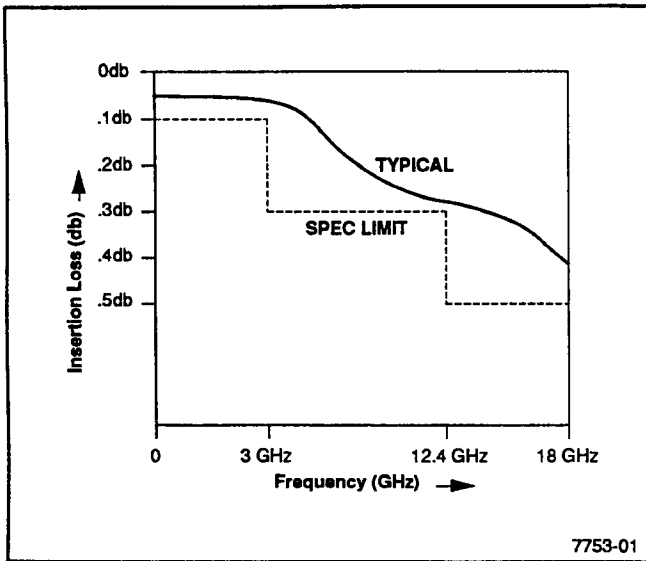


Figure 1-1. Channel Insertion loss vs. frequency.

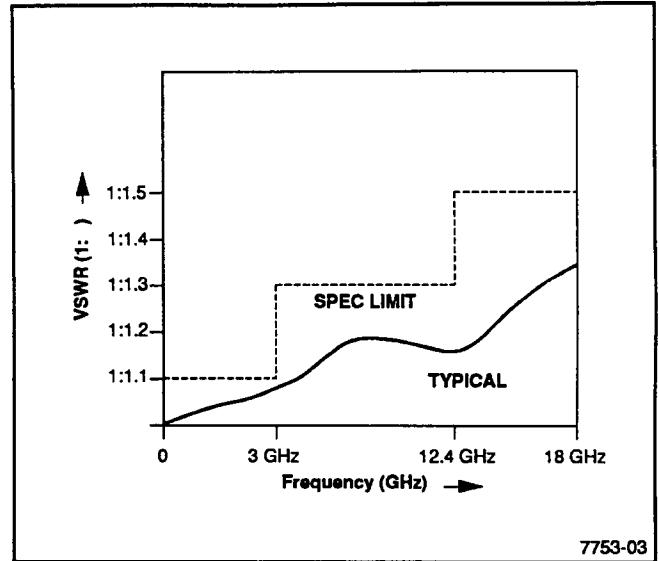


Figure 1-3. VSWR vs. frequency.

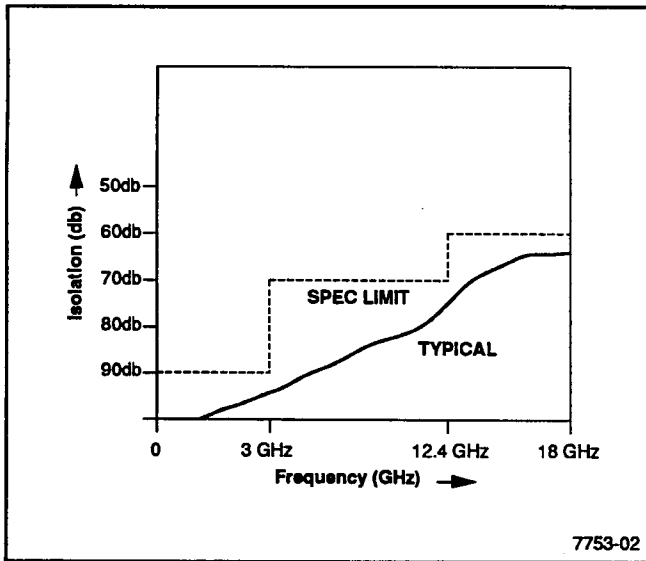


Figure 1-2. Channel Isolation vs. frequency.

**Table 1-3  
Environmental Characteristics<sup>a</sup>**

Characteristics	Description
Temperature	Meets MIL-T-28800B, class 5.
Operating	0°C to +50°C.
Non-operating	-55°C to +75°C.
Humidity	Meets MIL-T-28800B, class 5. 95% RH, 0°C to +30°C 75% RH, to 40°C 45% RH, to 50°C.
Altitude	Meets MIL-T-28800B, class 5.
Operating	4.6 km (15,000 ft).
Non-operating	15 km (50,000 ft).
Vibration <sup>b</sup>	Meets MIL-T-28800B, class 5, when installed in qualified power modules <sup>c</sup> . 0.38 mm (0.015 in) peak to peak, 5 Hz to 55 Hz, 75 minutes.
Shock	Meets MIL-T-28800B, class 5, when installed in qualified power modules <sup>c</sup> . 20 g's (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.
Bench Handling <sup>d</sup>	Meets MIL-T-28800B, class 5, when installed in qualified power modules <sup>c</sup> . 12 drops from 45°, 4 in or equilibrium, whichever occurs first.
Transportation	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1 and 1A-B-2.
EMC	Within limits of FCC Regulations, Part 15, Subpart J, Class A; VDE0871; and MIL-461A tests RE01, RE02, CE01, CE03, RS01, RS03, CS01, and CS02.
Electrical Discharge	20 kV maximum charge applied to instrument case.

<sup>a</sup>With power module.

<sup>b</sup>Requires retainer clip.

<sup>c</sup>Refer to TM 5000 power module specifications.

<sup>d</sup>Without power module.

**Table 1-4  
Mechanical Characteristics**

Characteristics	Description
Nominal Overall Dimensions	
Height	4.961 in (126.0mm).
Width	2.63 in (66.8 mm).
Length	11.493 in (291.9 mm).
Net Weight	2 lb (0.907 kg).
Finish (front panel)	Plastic/aluminum laminate.

# SYSTEM INSTALLATION

## PREPARATION FOR USE

### Operating Environment

The SI 5020 should be operated in a clean, controlled environment that does not exceed the environmental limitations listed in Section 1, Table 1-3.

**NOTE**

*Before installation, refer to the Operators Safety Summary in the front of this manual and to the Change Information section at the rear of this manual. Also refer to the power module instruction manual for line voltage requirements and power module operation.*

### Front Panel Controls

Each switch has a pushbutton on the SI 5020 front panel control. This pushbutton is also under program commands sent over the IEEE 488 (GPIB) digital interface. Refer to the above commands listed in the Programming Information section of this manual for more information.

### IEEE 488 Address and Message Terminator Switches

A bank of eight switches is located in a cut-out in the lower right-hand corner of the rear panel on the SI 5020 when looking from the rear. These switches are used before installation to set the IEEE 488 talk-listen address and message terminator for the operating system.

The upper five switches are set to select the primary address; secondary addressing is not implemented in the operating system. When the rocker is down on the OPEN side, it has a low binary weight for that bit. Adding the binary weights establishes the decimal address. For example, Figure 2-1 shows the switches set to decimal address 11 and message terminator to the EOI position.

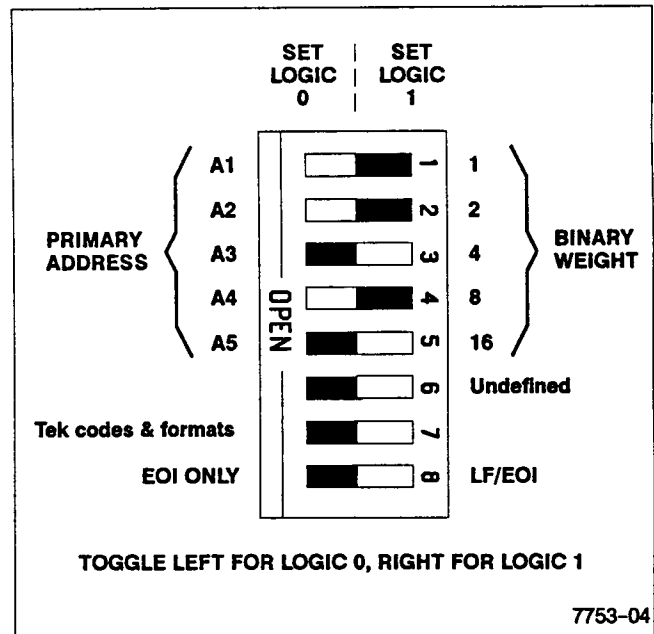
**NOTE**

*Do not set the SI 5020 to the same address as the controller being used.*

Valid addresses are from 1 to 30. Address 0 is reserved for maintenance and servicing the instrument. Address 31 is the IEEE 488 (Untalk) and UNL (Unlisten) interface address message; setting address 31 effectively prevents the SI 5020 from communicating over the IEEE 488 digital interface.

**NOTE**

*When shipped, the SI 5020 address is set to decimal 11 and message terminator set to EOI.*



IEEE 488 (GPIB) PRIMARY ADDRESSES											
Switches					Primary	Switches					Primary
A5	A4	A3	A2	A1	Address	A5	A4	A3	A2	A1	Address
0	0	0	0	0	0	1	0	0	0	0	16
0	0	0	0	1	1	1	0	0	0	1	17
0	0	0	1	0	2	1	0	0	1	0	18
0	0	0	1	1	3	1	0	0	1	1	19
0	0	1	0	0	4	1	0	1	0	0	20
0	0	1	0	1	5	1	0	1	0	1	21
0	0	1	1	0	6	1	0	1	1	0	22
0	0	1	1	1	7	1	0	1	1	1	23
0	1	0	0	0	8	1	1	0	0	0	24
0	1	0	0	1	9	1	1	0	0	1	25
0	1	0	1	0	10	1	1	0	1	0	26
0	1	0	1	1	11	1	1	0	1	1	27
0	1	1	0	0	12	1	1	1	0	0	28
0	1	1	0	1	13	1	1	1	0	1	29
0	1	1	1	0	14	1	1	1	1	0	30
0	1	1	1	1	15	1	1	1	1	1	31

**Figure 2-1. IEEE 488 bus address and message terminator switches.**

The number 8 switch sets the message terminator so that the operating system can respond to one of two possible message terminators controllers may send on the IEEE-488 digital interface, EOI only or LF/EOI. Message terminators are as follows:

#### Input message terminator:

EOI position - Only the EOI line on IEEE-488 digital interface asserted with last data byte as the message terminator.

LF/EOI position - <CR> <LF> and <EOI> are added to the end of the message being sent (EOI is asserted with the <LF> character). If the <LF> character without EOI, EOI with <LF>, or EOI is asserted with any data byte in the message string, the SI 5020 recognizes it as a message terminator.

#### Output message terminator:

EOI position - <;> with EOI asserted.

LF/EOI position - <;> <CR> then <LF> with EOI asserted.

### Installation and Removal



*To prevent damage to the SI 5020, turn off the power module before installation or removal. Do not use excessive force when installing or removing the SI 5020. Refer to the Operator Safety Summary at the front of this manual and check the change information at the back of this manual for additional safety notes.*

Before installation, set the IEEE-488 bus address, then check to see if the plastic barrier on the interconnecting jack of the selected power module compartments matches the cut-out in the circuit board edge connectors at the rear interface (see Figure 2-2).

Align the chassis of the plug-in unit with the upper and lower guide rails of the selected compartments. Push inward and press firmly to seat the circuit board edge connectors in the interconnecting jacks.

To remove the SI 5020, turn off the power module and pull on the release latch (front panel, lower left corner) until the interconnecting jacks disengage. Pull straight forward to remove the plug-in from the power module.

### Power-Up and Front Panel Indications

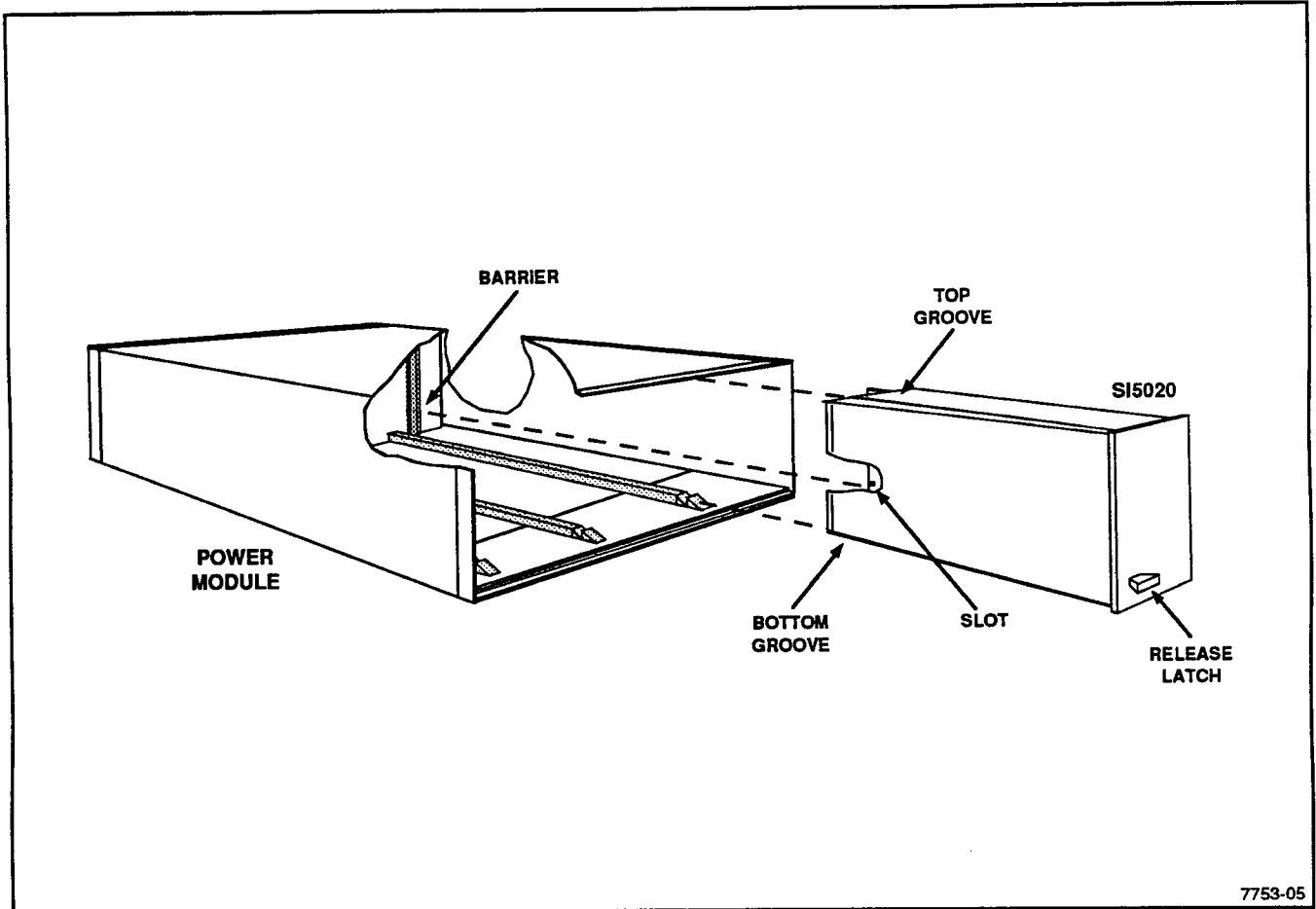
Apply power to the SI 5020 by activating the POWER switch on the TM 5000-Series power module.

There is no indication on the front panel that power is applied.

SRQ will be initiated at power-on.

The ADDRESSED light is illuminated every time the SI 5020 is programmed (addressed) to talk or listen over the IEEE-488 digital interface; it should not be illuminated at power-up (not under program control).

The power-on conditions for the SI 5020 are restored by the INIT command sent over the IEEE-488 digital interface. For more information on this command and a list of power-up parameters, refer to the Programming Information section of this manual.



7753-05

Figure 2-2. Installation and Removal.

## FRONT PANEL CONTROLS AND CONNECTORS

See Figures 2-3 through 2-5 for the three SI 5020 configurations front panel controls and connectors.

Connections to and from any of the front panel SMA connectors should be made using a high quality 50- $\Omega$  coaxial cable, such as RG 58A/U, or better.

For best vswr (voltage-standing wave ratio) and maximum power transfer conditions, the signal source output impedance should match the input load impedance of the signal receiving device. Unmatched source and load impedances degrade the vswr specifications.

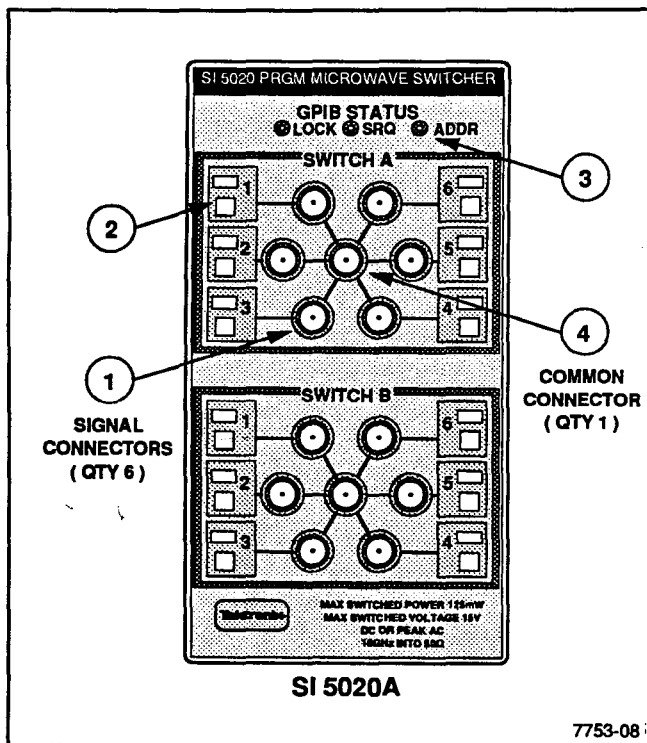


Figure 2-3. SI 5020A front panel controls and connectors.

### 1 Signal Connectors

SMA-type connectors for input and output signals.

### 2 Relay Switches and LEDs

These switches control the relays which determine which of the front-panel inputs are connected to each other. Only 4 relays can be closed at any one time. When a relay is

closed, its LED is on; otherwise, that relay is open and its LED is off.

### WARNING

*Do not have more than two relays closed per switch for extended periods or overheating will occur, and personal injury could result if the instrument is disassembled and the switch is touched.*

### 3 GPIB STATUS LEDs

These LEDs give an indication of GPIB activity. Look at these LEDs if a steady-state problem arises (such as dead front-panel controls). Each LED is described below.

**LOCK** - If this LED is lit, the AT 5010 will not respond to any front-panel control.

**SRQ** - If this LED is lit, the AT 5010 is asserting the SRQ GPIB hardware line to request service. When the controller performs a serial poll, this LED will go out.

**ADDR** - When this LED is lit, the AT 5010 is addressed to talk or listen.

### 4 Common Connector

SMA-type common connector which connects to all of the 6 signal connectors (either A or B). The three SI 5020 versions (A, B, and C) use this common connector as described below:

SI 5020A both A and B have a common connector.

SI 5020B only A has a common connector.

SI 5020C neither A nor B has a common connector.

### NOTE

*Switches with common connector should only use paths through the common for proper impedance matching. Connections across the switch, i.e. 4 to 1, will have impedance discontinuities caused by the common and equipment connected to it. Switches without common maintain 50  $\Omega$  impedance when connections between any two connectors are made.*

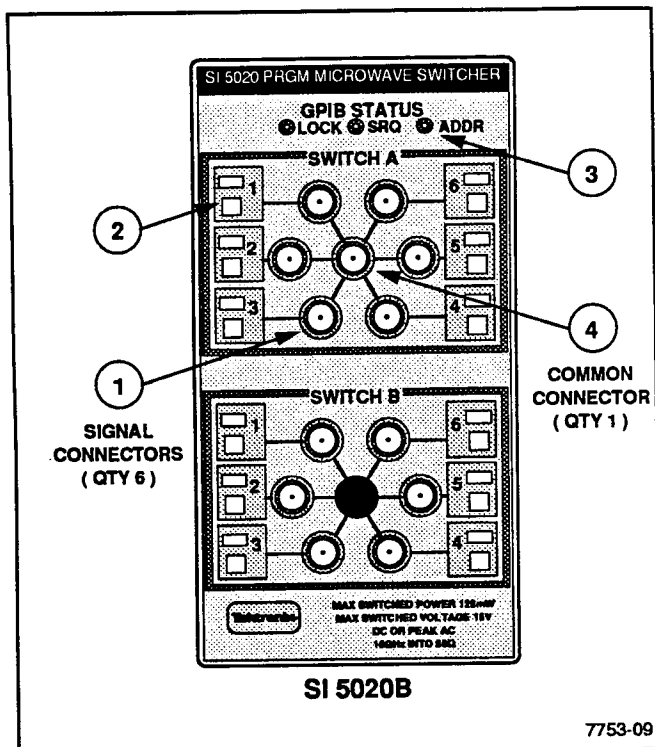


Figure 2-4. SI 5020B front panel controls and connectors.

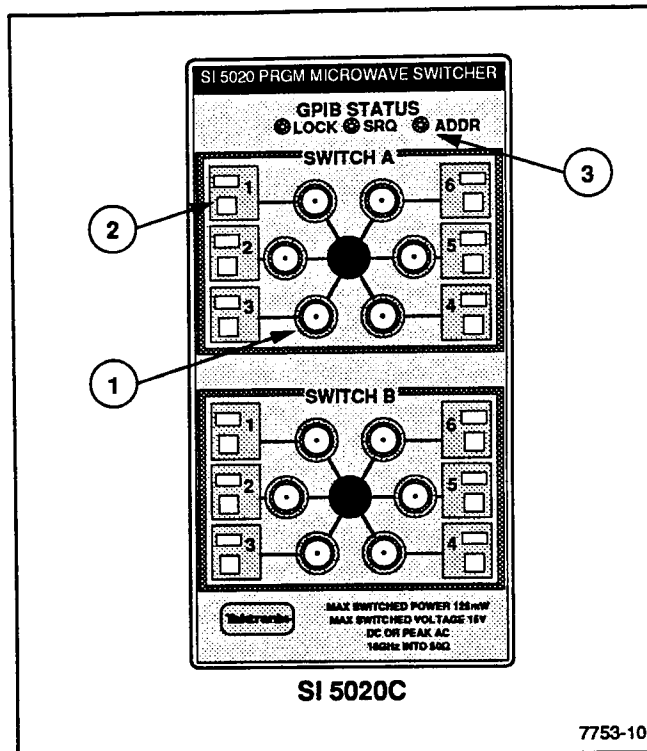


Figure 2-5. SI 5020C front panel controls and connectors.

## REPACKAGING INFORMATION

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing:

- Owner (with address) and the name of the individual at your firm that can be contacted.
- Complete instrument description and its serial number.
- A description of the service required.

If the original package is not fit to use or not available, repackage the instrument as follows:

- Surround the instrument with polyethylene sheeting, or other suitable material, to protect the exterior finish.
- Obtain a carton of corrugated cardboard of adequate strength that has inside dimensions no less than six inches more than the instrument dimensions.
- Cushion the instrument by tightly packing dunnage or urethane foam between the carton and the instrument, on all sides.
- Seal the carton with shipping tape or an industrial stapler.

The carton test strength for your instrument is 200 pounds.

# PROGRAMMING INFORMATION

## INTRODUCTION

### OVERVIEW

#### NOTE

*The SI 5020 connects to the IEEE-488 digital interface through a TM 5000-Series power module. Refer to Section 2 for information related to setting the primary address and message terminator switches before programming the SI 5020.*

This section of the manual provides information for programming the SI 5020 by remote control via the IEEE-488 digital interface. The digital interface is specified and described in the IEEE-488-1978 standard, "Standard Digital Interface for Programmable Instrumentation".

The following information assumes that the reader has some understanding of the communication process between instruments on the IEEE-488 digital interface and some experience with controller programs. In this manual, the IEEE-488 digital interface is called the General Purpose Interface Bus (GPIB).

#### NOTE

*The IEEE-488-1978 standard is published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, New York 10017.*

The SI 5020 is designed to communicate with any GPIB-compatible controller that sends ASCII characters (ISO 7-bit code representation) or messages over the digital interface. The messages are commands used to program the system or used to request information related to data, events, conditions, or status of the system.

The commands are designed for compatibility among instrument types within the TM 5000 family. The same command may be used for different instruments to control similar functions. In addition, commands are specified in mnemonics related to the functions they implement. For example, the INIT command initializes instrument settings to their power-up states.

The commands are presented in abbreviated summaries (see Table 3-1) and in a detailed description format. The Detailed

Command List further differentiates the commands into command types that define the commands based on the internal processing. These types are:

- operational commands, which cause a particular action
- settings commands, which control the instrument settings
- query or output commands, which ask for data or status

#### NOTE

*If the power-on self-test routine has been successfully completed, the SI 5020 starts with the SRQ (Service Request) line on the IEEE-488 digital interface asserted.*

## COMMANDS AND MESSAGE FORMATS

### Introduction

Each command begins with a header, a word that describes the function to be implemented. Many commands require an argument following the header which is a word or number that specifies the desired state of the implemented function.

The query commands have no arguments; the header contains the question mark character (?) to identify the header as a query command.

#### NOTE

*Command headers and arguments must contain, at a minimum, the exact characters shown in the abbreviated examples.*

### Command Separator

A complete message contains one command or a series of commands, followed by a message terminator. Messages consisting of multiple commands must have the commands separated (delimited) by semicolons. A semicolon at the end of a complete message is optional. For example, each line immediately following is a complete message:

INIT

TEST;INIT;RQS ON;ID?;CLOSE?

OPEN?;

## Programming Information

### Message Terminator

A complete message may be terminated with EOI or the ASCII line feed character <LF>. Some controllers assert the EOI line on the GPIB concurrently with the last data byte in the message, while others use only the <LF> character as a terminator. The SI 5020 can be set to accept either type of message terminator.

With EOI ONLY selected as the terminator, the SI 5020 interprets a data byte received with the EOI line asserted as the end of an input message. The SI 5020 also asserts the EOI line concurrently with the last data byte of an output message.

If LF/EOI is selected as the message terminator, the SI 5020 interprets the LF character without EOI asserted, or any data byte received with EOI asserted, as the end of an input message. At the end of an output message, the SI 5020 transmits carriage return <CR>, followed by line feed <LF> with EOI asserted.

Selecting one of the above mentioned termination schemes is done via switch SW1 on the GPIB controller PCB.

#### NOTE

*The SI 5020 is shipped with message terminator set to EOI only and IEEE-488 address switches set to decimal 11.*

### Formatting a Message

Commands must have the proper format (message syntax) to be understood. However, this format is flexible in that many variations are possible. The following material describes this format and the acceptable variations.

The system expects all commands to be encoded in ASCII and will accept both upper and lower case characters. All data output returned to the controller is in upper case.

A command consists of a header followed, if necessary, by an argument (or arguments). A command with an argument must have a header delimiter which is the space character <SP> between the header and the first argument. The space character <SP>, carriage return <CR>, and line <LF> are shown as subscripts in the following examples. If extra formatting characters are added between the header delimiter and the argument, they are ignored.

Example 1:

**RQS<sub>SP</sub>ON;**

Example 2:

**RQS<sub>SP</sub> <sub>SP</sub>ON;**

Example 3:

**RQS<sub>SP</sub> <sub>CR</sub> <sub>LF</sub>  
<sub>SP</sub> <sub>SP</sub>ON**

In general, these formatting characters are ignored after any delimiter and at the beginning and end of a message.

Example 4:

**<sub>SP</sub>RQS<sub>SP</sub>ON;<sub>CR</sub> <sub>LF</sub>**

#### NOTE

*All message commands must be delimited with a semicolon (;) or a message terminator. Space characters <SP> are not allowed between the last alpha or numeric character in any message unit and the message unit delimiter (;) or message terminator. Also, the <LF> character cannot be used for format if the LF/EOI message terminator mode is selected.*

In the command list, some headers and arguments are listed in two forms, a full-length command version and an abbreviated version. Any header or argument containing at least the characters listed in the abbreviated form will be accepted. Any characters added to the abbreviated version must be those given in the full-length version.

For documentation of programs, the user may add alpha characters to the abbreviated version. Alpha characters may also be added to a query header, provided that the question mark character <?> is added at the end of the alpha characters. For example:

**CL?**

**CLO?**

**CLOS?**

**CLOSE?**

Multiple arguments are separated by commas. However, a space <SP> or spaces will be accepted as a delimiter. For example:

**A2,A3**

**A2<sub>SP</sub>A3**

**A2<sub>SPSP</sub>A3**

**A2,<sub>SP</sub>A3**

#### NOTE

*In the last example, the space is treated as a format character because it follows the comma (the argument delimiter).*

## MESSAGE PROCESSING

### Introduction

When a message is received, it is stored in an input buffer, processed, and then executed. Processing a message consists of decoding commands, detecting delimiters, and checking the message syntax.

When commands are processed, the indicated changes are then stored in an execution buffer. If an error is detected during processing, the Service Request (SRQ) line is asserted, and the remainder of the message is ignored.

Executing a message consists of performing the actions specified by its command(s). This involves updating the instrument settings and recording these updates in a current settings buffer. Command execution occurs when the instrument processes the message unit terminator.

The query command is executed by retrieving the appropriate data and loading it in the output buffer; processing and execution then continues for the rest of the message. The data in the output buffer are sent to the controller when the SI 5020 is made a talker.

All commands are executed in the order received, so that the buffered mode of operation can be precisely defined.

### Multiple Messages

The input buffer has finite capacity, and to avoid having a single message long enough to fill it, each portion of the message is processed before additional input data are accepted. During command processing, additional data are held off (NRFD line on the GPIB is asserted) until space is available in the buffer.

After a query command in a message is executed, the response is held in the output buffer until the controller makes the instrument a talker. If a new message is received before all of the data in the output buffer are read, the output buffer is cleared before executing the new message. This prevents the controller from getting unwanted data from old messages.

One other situation may cause the data in the output buffer to be deleted. The execution of a long message might cause the output buffer to become full. This occurs when a large number of queries (greater than 30) are being retained for transmission. When the SI 5020 detects this condition (output buffer full), it generates an error message, asserts the SRQ line, and deletes the data in the output buffer. This action informs the controller that the message was executed and that the output was deleted.

### Status and Event/Error Reporting

The GPIB Service Request (SRQ) function may be used by the instrument to alert the controller that it needs service. The SRQ function is also a means of indicating that an event, status change, or error has occurred.

When the GPIB controller services the request, it performs a serial poll routine. In response, the instrument returns a status byte (STB), indicating whether it needs service or not. The status byte provides a limited amount of information about the SRQ.

### Talked With Nothing To Say

If the SI 5020 is addressed a talker without having received a message that specifies exactly what it should output, a single byte with all bits equal to 1 (FFh) with a message terminator will be returned, i.e., output buffer empty.

## IEEE 488 INTERFACE MESSAGES

### INTRODUCTION

All of the IEEE 488 interface messages listed below are sent with the ATN line on the digital interface asserted. See Figure 3-1 for bus interface control messages at the low level. Higher level commands are also available for the user. For the following commands, A = 32 plus instrument address and B = 64 plus instrument address.

#### Example:

for address 26:

$$A = 32 + 26 = 58$$

$$B = 64 + 26 = 90$$

#### NOTE

*For Tektronix controllers, the SPE (Serial Poll Enable) and SPD (Serial Poll Disable) interface messages are implemented in the POLL statement. The TCT (Take Control), GTL (Go To Local), LLO (Local Lockout), PPC (Parallel Poll Configure), PPE (Parallel Poll Enable), and PPU (Parallel Poll Unconfigure) interface messages are not implemented. The IFC (Interface Clear) unline message has the same effect as both the UNTalk UNListen interface messages. If illuminated, the front panel ADDRESSED light will turn off.*

### GPIB CONTROLLER INTERFACE MESSAGES

The SI 5020 responds to the following Interface Messages from the GPIB Controller:

Attention (ATN)  
 Interface Clear (IFC)  
 Device Clear (DCL)  
 Selected Device Clear (SDC)  
 Go To Local (GTL)  
 Remote Enable (REN)  
 Local Lockout (LLO)  
 My Listen Address (MLA)  
 My Talk Address (MTA)  
 Unlisten (UNL)  
 Untalk (UNT)  
 Group Execute Trigger (GET)  
 End of Message (END)  
 Serial Poll Enable (SPE)  
 Serial Poll Disable (SPD)

**Attention (ATN)** - tells the SI 5020 that the accompanying multiline message should be interpreted as an Interface Message.

**Interface Clear (IFC)** - causes the reset of the Talker and Listener interface conditions. Reception of this message will not terminate any operation.

**Device Clear (DCL)** - is sent to the SI 5020 by the controller to restart the communications process. None of the SI 5020's settings are changed but the SI 5020 will stop execution of any previously received command, clear both the input and output buffers, and clear SRQ and the status byte and any pending status.

**Selected Device Clear (SDC)** - is the same as DCL but is an addressed command sent to the listen addressed devices on the bus. The SI 5020 response is the same as to DCL.

**Go To Local (GTL)** - is an addressed command sent to the SI 5020 by the controller to cause it to go to Local mode from Remote mode.

**Remote Enable (REN)** - is the message sent to the SI 5020 from the controller indicating the REN interface signal line is being asserted. This message along with MLA causes the SI 5020 to enter Remote mode.

**Local Lockout (LLO)** - is the message sent by the controller to make the SI 5020 front panel switches completely inoperative. The only way to return to Local mode of operation is by receiving the GTL command from the controller or the unassertion of the REN line on the interface, neither of which the SI 5020 has control over.

**My Listen Address (MLA)** - controller telling SI 5020 to listen.

**My Talk Address (MTA)** - controller telling SI 5020 that it is okay to talk (transmit data to controller). If the SI 5020 has data to transmit, it does so after the reception of MTA. If the SI 5020 has no data to transmit, it sends the "talked with nothing to say" message (all data bits set to a "1", FF hex) and EOI.

**Unlisten (UNL)** - is the message to SI 5020 from controller telling it to stop listening. Being unlistened temporarily will not by itself cause loss of data. Reception of data will resume again when MLA is received.

**Untalk (UNT)** - is the Untalk message sent by the controller to the SI 5020. If the SI 5020 is talking when this message is received, transmission is interrupted but no data is lost. The SI 5020 will pick up where it left off when it receives MTA again.

**Group Execute Trigger (GET)** - it is an addressed command and is not implemented on the SI 5020.

**End of Message (END)** - is the End of Info message sent to the SI 5020 to indicate end of message. It is selectable via SW1 on GPIB Controller PCB to either EOI with last data byte or ASCII Line Feed character with or without EOI.

**Serial Poll Enable (SPE)** - is the message which enables the SI 5020 to output serial poll status bytes when it is talk addressed.

**Serial Poll Disable (SPD)** - puts the SI 5020 back in the normal mode outputting data bytes when talk addressed.

### Remote/Local Operation

When powered up, the SI 5020 is in the Local mode of operation and is ready to accept GPIB interface messages and/or device dependent commands via GPIB. The relays may be open and closed at this time only via the front panel switches. A transition from Local mode to Remote mode is caused by the reception of a command through the GPIB port, REN line asserted and My Listen Address (MLA). Any opening or closing of the relays in the switch matrices that the controller wishes to make must be done in the REMOTE mode. Therefore, the device dependent messages which the SI 5020 can receive can be divided into two distinct groups; Local/Remote commands and Remote Only commands.

At power-up, the SI 5020 is in Local mode and the reception of any Remote Only commands will result in an error indication being sent to the controller, SRQ asserted, and the commands being ignored. Any Local/Remote commands received in Local mode will be executed.

In Remote mode, the SI 5020 front panel switches are still completely functional (the relays may be opened either by GPIB commands or front panel switches). To disable the front panel switches, the controller needs to instruct the SI 5020 to go to Remote mode with Lockout. There are two ways to get to Remote mode with Lockout. The first is to place the SI 5020 in Remote mode as mentioned above; then the controller sends a Local Lockout (LLO) message. The second is if the SI 5020 is in Local mode and the controller sends LLO and MLA interface messages.

A transition from Remote mode to Local mode can occur one of two ways:

- the controller sends GTL (Go To Local) command
- the REN line becomes unasserted

The GPIB interface goes to Local mode almost immediately, but the SI 5020 may not (it will make the transition to Local mode when the end of the current message is processed).

There is no front panel method to make the SI 5020 go from Remote mode to Local mode.

BITS				CONTROL		NUMBERS		UPPER		LOWER		
B7	B6	B5	B4	B3	B2	B1	0	1	0	1	0	1
0	0	0	0	0	0	0	0	1	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0	1	1
0	0	0	1	0	0	0	0	1	0	0	1	1
0	0	0	1	1	0	0	0	1	0	0	1	1
0	1	0	0	0	0	0	0	1	0	0	1	1
0	1	0	0	1	0	0	0	1	0	0	1	1
0	1	0	1	0	0	0	0	1	0	0	1	1
0	1	0	1	1	0	0	0	1	0	0	1	1
0	1	1	0	0	0	0	0	1	0	0	1	1
0	1	1	0	1	0	0	0	1	0	0	1	1
0	1	1	1	0	0	0	0	1	0	0	1	1
0	1	1	1	1	0	0	0	1	0	0	1	1
1	0	0	0	0	0	0	0	1	0	0	1	1
1	0	0	0	1	0	0	0	1	0	0	1	1
1	0	0	1	0	0	0	0	1	0	0	1	1
1	0	0	1	1	0	0	0	1	0	0	1	1
1	0	1	0	0	0	0	0	1	0	0	1	1
1	0	1	0	1	0	0	0	1	0	0	1	1
1	0	1	1	0	0	0	0	1	0	0	1	1
1	0	1	1	1	0	0	0	1	0	0	1	1
1	1	0	0	0	0	0	0	1	0	0	1	1
1	1	0	0	1	0	0	0	1	0	0	1	1
1	1	0	1	0	0	0	0	1	0	0	1	1
1	1	0	1	1	0	0	0	1	0	0	1	1
1	1	1	0	0	0	0	0	1	0	0	1	1
1	1	1	0	1	0	0	0	1	0	0	1	1
1	1	1	1	0	0	0	0	1	0	0	1	1
1	1	1	1	1	0	0	0	1	0	0	1	1

ADDRESSED COMMANDS
LISTEN ADDRESSES
LISTEN ADDRESSES
SECONDARY ADDRESSES OR COMMANDS

**KEY**    octal 25 PPU    GPIB code  
           hex 15 NAK    ASCII character  
                       21    decimal

Figure 3-1. ASCII and IEEE 488 (GPIB) Code Chart.

# COMMANDS

## COMMAND SUMMARY

Table 3-1 contains a command summary for the SI 5020.

Table 3-1  
SI 5020 GPIB Command Summary

Command	Action
CLose	Close relays in both matrices.
OPen	Open relays in both matrices.
HElp	List of available command headers.
ERror	Event/error status reporting.
EVent	Event/error status reporting.
ID	SI 5020 Identification.
INit	Return instrument to power up configuration.
MSgdlm	Message delimiter.
RQs	Service request.
SEttings	Query setup of SI 5020.
TEST	SI 5020 power up tests.

## DETAILED COMMAND LIST

The following material is a detailed description of each command.

### CLose (CL) Command

Type: Setting and Query

Modes: Settings - Remote Only  
Query - Local/Remote

Setting Syntax:

```
CLose <matrix> <relay_number>
[,<matrix> <relay_number> ...]
```

where:

<matrix> settings argument list

A (specifies matrix A)  
B (specifies matrix B)

<relay\_number> settings argument list

1 (closes relay labeled 1 in specified matrix)  
2 (closes relay labeled 2 in specified matrix)  
3 (closes relay labeled 3 in specified matrix)  
4 (closes relay labeled 4 in specified matrix)  
5 (closes relay labeled 5 in specified matrix)  
6 (closes relay labeled 6 in specified matrix)

Example: CL A1,A3,A5,B2,B4,B6

closes relays 1, 3, and 5 in matrix A and  
closes relays 2, 4, and 6 in matrix B  
(if relays were previously open)

Query Syntax: CLose?

Query Response:

```
CLOSE <matrix> <relay_number>
[,<matrix> <relay_number> ...];
```

where:

<matrix> and <relay\_number> argument  
lists are the same as settings list

Example Response: CLOSE A1,A2,A3,B4,B5,B6;

relays 1, 2, and 3 are closed in matrix A and  
relays 4, 5, and 6 are closed in matrix B

Discussion:

The CLOSE command closes the relays specified by the argument list. No more than four relays may be closed in matrix A or matrix B at one time. If there is an attempt to close more than four relays in a matrix, an error will be generated. Refer to "Status and Event Reporting" for more on error conditions.

**Programming Information****OPen (OP) Command****Type:** Setting and Query**Modes:** Settings - Remote Only  
Query - Local/Remote**Setting Syntax:**

OPen <matrix> <relay\_number>  
[, <matrix> <relay\_number> ...]

**where:**

&lt;matrix&gt; settings argument list

A (specifies matrix A)

B (specifies matrix B)

&lt;relay\_number&gt; argument list

1 (opens relay labeled 1 in specified matrix)

2 (opens relay labeled 2 in specified matrix)

3 (opens relay labeled 3 in specified matrix)

4 (opens relay labeled 4 in specified matrix)

5 (opens relay labeled 5 in specified matrix)

6 (opens relay labeled 6 in specified matrix)

ALL or all (opens all relays in both matrices)

**Example:** OP A1,A3,A6,B2,B4,B6

opens relays 1, 3, and 6 in matrix A and  
opens relays 2, 4, and 6 in matrix B  
(if relays were previously closed)

**Query Syntax:** OPen?**Query Response:**

OPEN <matrix> <relay\_number>  
[, <matrix> <relay\_number> ...];

**where:**

<matrix> <relay\_number> argument  
lists are the same as settings list

**Example Response:** OPEN A1,A2,A3,A5,B2,B3,B4,B6;

relays 1, 2, 3, and 5 are open in matrix A  
relays 2, 3, 4, and 6 are open in matrix B

**Discussion:**

The OPEN command opens the relays specified by the argument list. OPEN ALL will open all relays in both matrices.

**Help (HEIp?) Command****Type:** Query**Modes:** Local/Remote**Query Syntax:** HEIp?**Query Response:**

CLose;ERror;EVEnt;HEIp;ID;INit;MSgdIm;OPen;RQs;SEt;  
TEST;

**Discussion:**

This is a query command which will result in the SI 5020 sending a list of all the valid command headers.

**Event/Error (EVENT? or ERror?) Command****Type:** Query**Modes:** Local/Remote**Query Syntax:** EVENT? or ERror?**Query Response:**

EVENT &lt;event code&gt; or ERROR &lt;event code&gt;;

For codes for specific events, refer to "Status and Event Reporting."

**Discussion:**

EVENT is a query which can be sent to the SI 5020 by the controller to retrieve an event code. The SI 5020 response to this query is EVENT <event code>. The <event code> is a number corresponding to a certain condition in the SI 5020 caused by an SRQ. The <event code> returned by the SI 5020 depends on whether RQS is ON or OFF.

With RQS ON, the event query returns the event code for the most recent SRQ generated. When the event code is returned to the controller, that event is considered reported and will not be reported again. An event code of zero means that there are no events to report. With RQS OFF the SI 5020 returns the event code corresponding to the highest priority pending status (assuming a Serial Poll has been done before the first EVENT? to enable the SI 5020 to respond to the EVENT? query).

The event code and status byte are then removed from the pending status list. An error code of 0 is returned if there were no errors. If RQS is changed from OFF to ON, the SI 5020 begins sending the SRQ's that were stacked up while RQS was OFF.

ERR? is an alternate header for the EVENT? query. They are equivalent messages and result in the same response from the SI 5020 except for the different header, ERROR <event code>.

**Identify (ID?) Command****Type:** Query**Modes:** Local/Remote**Query Syntax:** ID?**Example:** ID?**Query Response:** ID TEK/SI 5020,V81.1,F1.1**Discussion:**

The ID query is the query sent by the controller when it wants the SI 5020 to identify itself. The SI 5020 returns the ID command header followed by the name of the instrument, Tektronix Codes & Format version, and firm-ware version.

**Programming Information****Message (MSgdlm) Delimiter****Initialize (IN) Command****Type:** Operational**Modes:** Remote Only**Setting Syntax:** INit**Example:** INit**Discussion:**

The INITIALIZE command returns the SI 5020 to the power up default values. Power-up defaults are RQS ON;OPEN A1,A2,A3,A4,A5,A6,B1,B2,B3,B4,B5,B6;CLOSE 0;. The default MSgdlm is semicolon. Internal diagnostics are not run, the power on SRQ is not sent, and the SI 5020 is not unlistened.

**Type:** Setting and Query**Modes:** Local/Remote**Setting Syntax:**

MSgdlm semicolon  
or  
MSgdlm lf

**Query Syntax:** MSgdlm?**Query Response:**

MSGDLM SEMICOLON;  
or  
MSGDLM LF;

**Discussion:**

The settings command controls the message unit delimiter sent by the SI 5020 for query commands. If LF is selected, then a line feed character will follow any query response. If SEMICOLON is selected, then a semicolon character will follow any query response.

**Request For Service (RQs) Command****Type:** Setting and Query**Modes:** Local/Remote**Setting Syntax:**

RQs ON  
or  
RQs OFF

**Query Syntax:** RQs?**Query Response:**

RQS ON;  
or  
RQS OFF;

**Discussion:**

When the SI 5020 needs service from the system controller, it generates a service request by asserting the GPIB SRQ interface line. This usually causes an interrupt to the controller, which then conducts a serial poll to find out which instrument on the bus caused the assertion of the SRQ line.

There are times when the controller would like to disable a device's ability to generate SRQs. The RQS command gives the controller this ability. With RQS OFF, the SI 5020 doesn't generate SRQs. If RQS is changed from OFF to ON, the SI 5020 begins sending the SRQs that stacked up during the time that RQS was OFF. While RQS is OFF, the controller can poll the SI 5020 for events which may be stacking up using the Serial Poll and EVENT? queries.

RQS? is the query sent by the controller to find out the current RQS mod the SI 5020 is programmed to (either ON or OFF).

**Setting (SE?) Command****Type:** Query**Modes:** Local/Remote**Query Syntax:** SETtings?**Query Response:** < current settings > ;**Example Response:**

```
RQS OFF; MSGDLM SEMICOLON;  
CLO A4,A5,A6,B1,B2,B3;OPE A1,A2,A3,B4,B5,B6;
```

**Discussion:**

The settings query returns the current RQS setting, current message Unit Delimiter setting, and which relays in the switch matrices are open and closed in the SI 5020. The response of the SET? query does not contain the SET header, but is a concatenation of the responses to the RQS?, MSGDLM?, CLOSE? queries in one message.

**Test (TEST) Command****Type:** Output**Modes:** Remote Only**Syntax:** TEST**Discussion:**

This command can be sent to the SI 5020 to execute power-up diagnostics. The SI 5020 performs three diagnostic tests on its circuitry. The first is a checksum on all locations in EPROM, the second is a check of functionality of RAM, and the third is a check for legal GPIB primary address. If all three tests are error free, the "test complete" SRQ is sent to the controller on completion. If one of the tests finds an error, it is reported via SRQ, internal error status byte, and an error code. This command will not be executed if RQS is OFF; an execution error indication will be returned instead. Refer to "Status and Event/Error Reporting" for specific codes for error conditions.

## FRONT PANEL SWITCHES AND RELAY ACTIONS

The opening and closing of relays in Matrixes A and B may also be accomplished via switches on the front panel of the SI 5020 HF Relay Switch Module. There are 12 switches, one associated with each relay in both matrices. To open or close a relay, press the switch associated with that relay. The action is that of a toggle (if the relay is closed, then it will open when the switch is pressed; if open, it will close when the switch is pressed).

If a relay is closed as the result of a GPIB command or its controlling front panel switch, then the front panel LED associated with that relay will be on; conversely, if the relay is open, its LED will be off.

### Front Panel Switch Interaction With GPIB Programmed Relays

If the controlling front panel switch of a relay is pushed, it will open if it was previously closed, or it will close if it was previously open. However, the GPIB controller still considers the relay to be in its previous state.

A possible solution to this problem is to have the user determine the status of the front panel switches via an event/error reporting mechanism. Whenever a front panel switch is pressed, the event for that switch is recorded. To determine if the relay is open or closed, one would have to query the instrument for relay status. The report will include those changed via the front panel as well as via GPIB.

### Power Up Default Conditions

When power is applied to the SI 5020, a diagnostic self test routine is performed to check the functionality of the memory (ROM and RAM), GPIB Controller, and selection of the GPIB Primary Address. If errors are found, front panel LEDs are blinked to inform the user of an error condition.

### SI 5020 Relay Switch Closure Limitations

#### **WARNING**

*Do not have more than two relays closed per switch for extended periods or overheating will occur, and personal injury could result if the instrument is disassembled and the switch is touched.*

There is a limit to the number of relays that can be closed at any one time in either matrix A or B via GPIB commands. This limit is set to four so as not to exceed manufacturer's recommendations for switch matrix closures. If the current number of closed relays is four in either matrix, and a command to close another relay in the matrix is received, an error will be generated. If a front panel switch tries to close more than four relays, it is ignored and no error is reported.

# HARDWARE AND SOFTWARE IMPLEMENTATION

## HARDWARE DEFINITION

The SI 5020 HF Relay Switch Matrix module consists of three circuit board assemblies, one containing the microprocessor, memory (ROM and RAM), address decoders, interface circuitry and GPIB controller.

A listing of the instrument hardware is:

CPU	Motorola 6809 @ 8 MHz (500 nsec cycle)
RAM	4464C 8k x 8 Static
ROM	27256 32k x 8 EPROM
GPIB Controller	Texas Instruments TMS9914A

The second circuit board assembly contains power supply circuitry, latches for processor input/output of data from front panel switches, and relay drivers for switch matrices.

## CONTROLLER SOFTWARE OVERVIEW

The base system consists of a Motorola 6809 microprocessor, 8K of RAM, 32K of ROM, the Texas Instruments TMS9914A GPIB Controller and various registers for controlling switch matrices and monitoring front panel switches. Processor instructions are fetched from system ROM and dynamic variables and buffers are stored in system RAM. All registers are mapped into system memory space for easy I/O manipulation.

At power-up, diagnostics are run on system ROM, RAM, and the GPIB Controller to determine system readiness. If there are no errors encountered, the system enters a monitor loop described below. If there are errors, a diagnostic loop is entered, flashing an LED on and off once every half second. The scheme by which the system software determines service information for the front panel switches or commands from the GPIB bus is a simple polling routine called the monitor loop.

If the SI 5020 is not in remote with local lockout, then the front panel switch registers are checked for a change in status. If a change in front panel switch status is found, then the switch is debounced (wait 25 ms, then reread to make sure switch is still depressed) and the appropriate action for that switch depression is performed.

A check is then made to determine if a command has been received via GPIB. If a command was received, it is processed for legal SI 5020 syntax.

If the SI 5020 is talk addressed, then whatever information is in its output buffer will be sent to the GPIB controller (possibly a response to a query command). If the buffer is empty, it simply answers with a single byte with all bits set to a 1 (FFh).

## DIAGNOSTIC SOFTWARE

Diagnostics that are run at power up or after receiving the TEST command from the GPIB controller perform four checks on system hardware. If any errors are found during these tests, the HF Relay Switch Matrix will not respond to GPIB commands or front panel switches.

- A checksum calculation on all bytes in system ROM starting at location 8002h through FFFFh. This calculation will be an 8 bit Exclusive OR (XOR) of all locations into a checksum value. All of the even bytes from 8002h thru FFFEh will be XORed, then compared with a known good value stored in ROM at location 8000. All of the odd bytes from E003h thru FFFFh will be XORed, then compared with a known good value previously stored in ROM at location 8001h. The LED associated with relay 1 in Matrix B is the error indicator for this test and will flash on and off every half second.
- A RAM test to check ability to read/write all locations from 0000h thru 1FFFh with a simple checker board pattern of 55h, then AAh. This gives a 10101010 then 01010101 then 10101010 etc. The LED associated with relay 2 in Matrix B is the error indicator for this test and will flash on and off every half second.
- The GPIB Controller register read/write is checked to see if it can respond to the CPU. The LED associated with relay 3 in Matrix B is the error indicator for this test and will flash on and off every half second.
- GPIB Primary Address selection is checked for a legal value (0 through 30). If a legal value is not found, then the LED associated with relay 4 in Matrix B on the front panel will flash on and off once every half second.

If any errors are found during these tests, then the HF Relay Switch Matrix will not respond to GPIB commands or front panel switches and an LED in Relay Switch Matrix B associated with each test will flash on and off once every half second.

## STATUS AND ERROR REPORTING

### SERVICE REQUEST, STATUS BYTE, AND ERROR QUERY

The IEEE 488 Service Request (SRQ) function may be used by the instrument to alert the controller that it needs service. The SRQ function is also a means of indicating that an event, status change, or error has occurred.

When the controller services the request, it performs a serial poll routine. In response, the instrument returns a status byte (STB), indicating whether it needs service or not. The status byte provides a limited amount of information about the SRQ (see Table 3-2).

If there is more than one event or error to be reported, the instrument continues to assert SRQ until it reports all events. Each event or error is automatically cleared when it is reported via the serial poll.

**NOTE**

*The DCL (Device Clear) interface message may be used to clear all events, except for the power-on SRQ.*

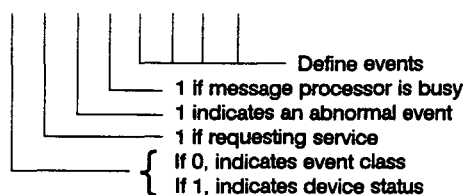
Commands are provided to control the reporting of some individual events and disable all service requests. The Request For Service (RQS) command controls whether the instrument reports any events by asserting SRQ. The RQS OFF command inhibits all SRQ's (except power-up event).

With RQS OFF the controller may find out about events without first performing a serial poll. The error query (ERR?) may be sent at any time and the instrument returns an error code waiting to be reported. The controller can clear all errors by sending the error query (ERR?) until a zero (0) code is returned, or the DCL message.

With RQS OFF the controller may perform a serial poll, but the status byte only contains device-dependent status information. With RQS ON, the status byte contains the class of the event and a subsequent query returns additional information about the previous event reported in the status byte.

**Table 3-2**  
Status Byte Definitions

STB Examples	Data Bits								Decimal	
	8	7	6	5	4	3	2	1	Not busy	Busy
Power-on Event	0	1	0	X	0	0	0	1	65	81
Card Event	1	1	1	X	0	0	0	1	225	241
Execution Error	0	1	1	X	0	0	1	0	98	114



Because the status byte conveys limited information about an event, the events are divided into classes; the status byte reports the class of event. The classes of events are defined in Table 3-3 as follows:

**Table 3-3**  
Event Classes

Class	Indicator
Command Error	Indicates the instrument has received a command that is invalid or it cannot understand.
Execution Error	Indicates that the instrument has received a command it cannot execute (argument value out of range, or settings conflict).
Internal Error	Indicates that the instrument has detected a hardware condition or firmware problem that prevents operation.
System Events	Events that are common to instruments in a system (Power On, User Request, etc.).
Execution Warning	Instrument is operating but the user should be aware of potential problems.
Internal Warning	Indicates that the instrument has detected an internal problem, but remains operational (e.g., out of adjustment).
Device Status	Device-dependent status.

The error query (ERR? or EVE?) may be used by the controller program to obtain additional information not provided by the status byte. After examining the status byte to determine whether the instrument requested service or not, the ERR? or EVE? command may be sent. In response, the instrument reports a number code that defines the error or event in more detail. Serial poll responses (status bytes) and error code numbers are listed in Table 3-4.

## STATUS BYTE ORGANIZATION

The status byte information is indicated below:

### DI01-DI04

are used to further specify system or device status; they are used in conjunction with DI08.

### DI05 is the busy bit

1 = SI 5020 is processing or executing a command  
0 = SI 5020 is ready

### DI06 is the error bit

1 = abnormal condition (error)  
0 = normal condition (non-error)

### DI07 is RQS

1 = SI 5020 is requesting service  
0 = SI 5020 is not requesting service

### DI08 is the Device/System status bit

1 = bits DI01 thru DI04 contain a code corresponding to a particular device status.

0 = bits DI01 thru DI04 contain a code corresponding to a particular system status.

System Status - DI08 = 0	8765 4321
Abnormal Conditions - DI06 = 1	
command error	011x 0001
execution error	011x 0010
internal error	011x 0011
execution error	011x 0101
internal error warning	011x 0110
Normal Conditions - DI06 = 0	
power on (online)	010x 0001
operation complete	010x 0010
Device Status - DI08 = 1	
Abnormal Conditions - DI06 = 1	8765 4321
this class of errors will be reported through response to event query( EVENT? ) and not encoded in this status byte	111x 0000
Normal Conditions - DI06 = 0	8765 4321
test complete	110x 1000
Matrix A Front Panel Switch pressed	110x 0001
Matrix B Front Panel Switch pressed	110x 0010
Normal Device Dependent Status - DI06, DI07 = 0	
No status to report	110x 0000

**Table 3-4**  
**Status Byte & Event/Error Codes**

Description	Event/Error Query Response (In decimal)	Serial Poll Response (In decimal)
No Errors or Events	0	0
Active, No Errors To Report	0	128
<b>Command Errors</b>		
Command header error	101	97
Header delimiter error	102	97
Command argument error	103	97
Argument delimiter error	104	97
Nonnumeric Argument (if numeric expected)	105	97
Missing Argument	106	97
Invalid message unit delimiter	107	97
Unrecognized argument type	150	97
Argument contains too many characters	151	97
<b>Execution Errors</b>		
Remote Only Command, while in local mode	201	98
I/O buffers full, output dumped (dead lock)	203	98
Integer Overflow, maximum 65520	253	98
Attempt to execute TEST command with RQS OFF	257	98
Output Buffer full (too many query commands)	271	98
Input Buffer full (command too long)	272	98
<b>Internal Errors</b>		
RAM error	350	99
ROM error	351	99
GPIB error	352	99
<b>System Events</b>		
Power on	401	65
<b>Device-Dependent Events</b>		
Attempt to close more than four relays in Matrix A, command ignored	258	98
Attempt to close more than four relays in Matrix B, command ignored	259	98
Matrix A Front Panel switch 1 was pressed	700	193
Matrix A Front Panel switch 2 was pressed	701	193
Matrix A Front Panel switch 3 was pressed	702	193
Matrix A Front Panel switch 4 was pressed	703	193
Matrix A Front Panel switch 5 was pressed	704	193
Matrix A Front Panel switch 6 was pressed	705	193
Matrix B Front Panel switch 1 was pressed	706	194
Matrix B Front Panel switch 2 was pressed	707	194
Matrix B Front Panel switch 3 was pressed	708	194
Matrix B Front Panel switch 4 was pressed	709	194
Matrix B Front Panel switch 5 was pressed	710	194
Matrix B Front Panel switch 6 was pressed	711	194
Operation complete, all is operational	799	66
<b>Device-Dependent Errors</b>		
Firmware Error - illegal event occurred	823	224

# THEORY OF OPERATION

## INTRODUCTION

The SI 5020 consists of two high frequency single-pole, six-throw or 6X6 microwave switches under front panel and remote programming control. Each of the switch elements are individually relay driven and are essentially independent, except that each switch (of six elements) has a common connection on one side of each element (the center connector, as viewed from the front panel).

Each switch element allows a signal transmission rate of 18 GHz and, acting in conjunction with another simultaneously opened or closed switch, can change an incoming signal path in 65 ms (15 ms actuation time plus 50 ms software allowance for debounce).

Up to four connections can be remotely closed at any one time per relay (this limit is set to keep within manufacturer's allowances for heat tolerance), and any programmed (or unprogrammed) switch element may be overridden manually. An override changes the open/closed mode that the switch is already in.

In the ensuing text, the two main circuits, supported on separate PC boards, are described individually. The first circuit containing principal functional elements is called the Main Board. The second board consisting of the GPIB remotely controlled (receiver) portion, is called the GPIB Controller Board. A third board called the Front Panel Board is also discussed. It forms a holder for the switches and display LEDs.

## MAIN BOARD

Figure 4-1 provides a block diagram for the Main Board. A detailed schematic is included in the Diagrams section at the back of this manual.

The board basically consists of a power supply and latches and drivers for the relay switches and various LEDs. In particular, a large part of the circuit is duplicated for the two separate but essentially identical relay switches whose inputs and outputs dominate the front panel. Both on the front panel and in the block diagram (as well as the Main Board and Controller discussions), the two sets of relays are referred to as forming part of the A matrix (Upper), and the B matrix (Lower).

The principal elements for the A relay are U43, U44, and U45. The equivalent elements for the B relay are U46, U47, and U48.

The U43 Buffer works in conjunction with R47; U43 reads the front panel switches while R47 provides a constant pull-up. A HI on any U43 input signifies an open switch. When a Numeric switch is closed, it pulls the input of U43 LO – which is read and the result sent to U44 to toggle the relay contact.

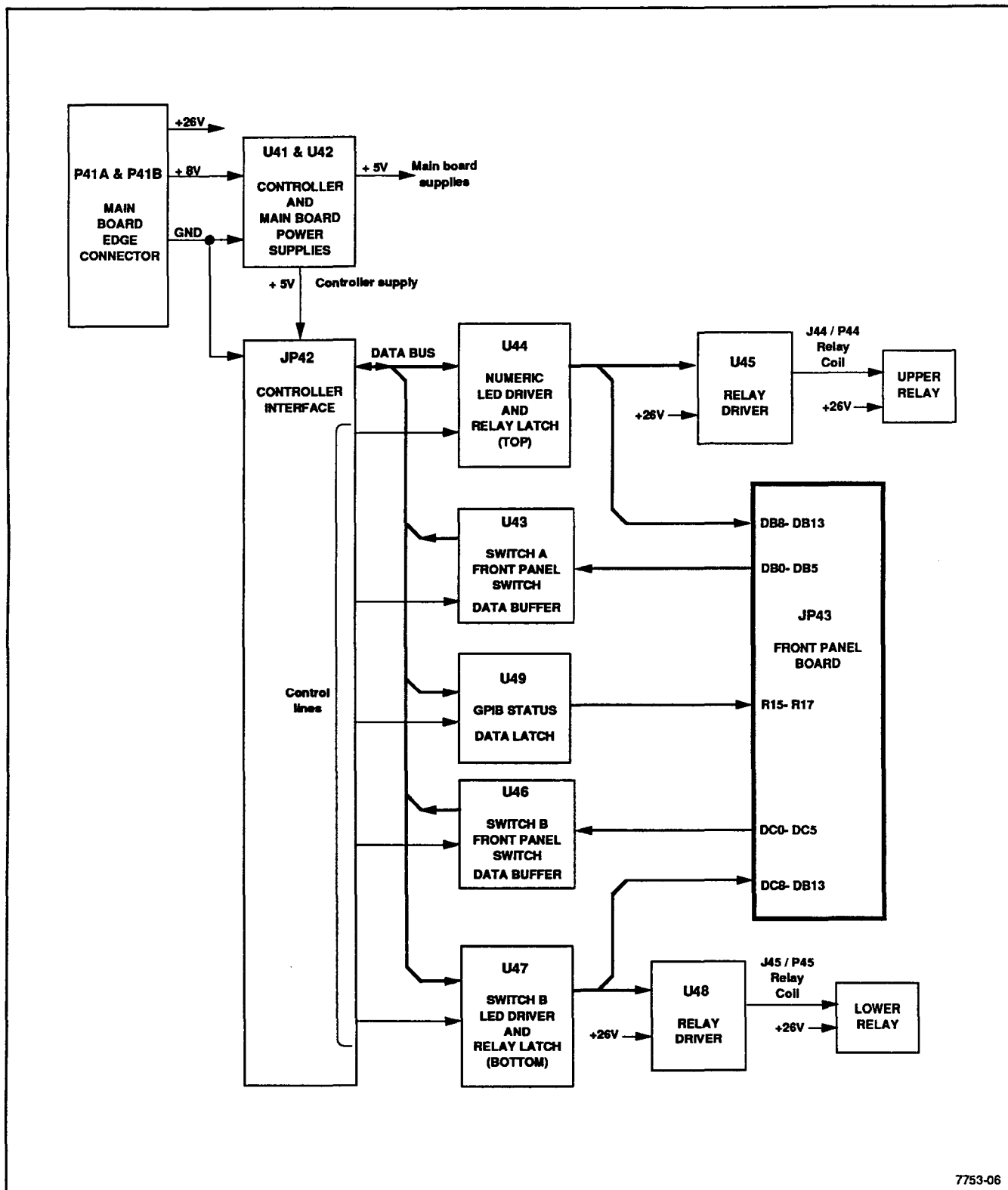
Both the front panel LEDs and the input to the relay driver U45 are driven by U44. When a HI is presented to the input of U45, the corresponding output goes LO, toggling the relay contact (note that the front panel port characters differ from the numbers painted on the relay).

The GPIB status LEDs on the front panel are driven by U49 via J46. Data lines and device select lines are provided from JP1 on the Controller Board to JP42 on the Main Board. The addresses used to select devices on the Main Board are shown in Table 4-1.

**Table 4-1**  
**Main Board Device Addresses**

Address	Device	Function
2000	U44	Drives 1-6 LEDs and Upper Relay.
2001	U43	Reads switches 1-6 on Relay A.
2002	U47	Drives 1-6 LEDs and Lower Relay.
2003	U46	Reads switches 1-6 on Relay B.
2004	U49	Drives GPIB status LEDs.

The Main Board interacts with the TM5000 Series Power Module via connectors P41A and P41B. The SI 5020 High Frequency Multiplexer uses +8 V, +26 V and ground. The +8 V is used by U41 and U42 to provide +5 V regulated supplies used by both the Main Board and the GPIB Controller Board. The +26 V is used to power the microwave switch relays.



7753-06

Figure 4-1. Block diagram for the Main Board.

## GPIB CONTROLLER BOARD

The Controller Board allows the SI 5020 Multiplexer to operate by remote commands over the GPIB backplane connection. It also has a provision for both front panel direct control (over switched connections), or exclusively using a front panel lockout feature.

As illustrated in Figure 4-2, this board contains the microprocessor (MPU), memory (ROM and RAM), GPIB control logic, interrupt timer, and address decoders as well as microprocessor buffer/latch circuitry. The following subsections describe the board circuitry as it most closely relates to the circuit groups mentioned.

### Microprocessor Operations

The controller is based on a Motorola 6809 Microprocessor Unit (MPU) running at 8 MHz (500-ns cycle). The microprocessor (U1) accesses 32k bytes of ROM and 8k bytes of RAM, and externally addresses up to 16 devices through JP1.

The power supplies are provided from the Main board via JP1. At power-up, U3 remains LO for 200 ms until these stabilize. After power supply settling, the microprocessor begins to search for ROM locations FFFEh and FFFFh to get the starting address for the operations program.

Related circuits involve U2 and U3; U2 provides the 8-MHz clock source, and U3 provides power protection. If at any time a voltage lower than 4.55 V is detected (as in a power-down), U3 will pull the reset line LO causing U1 to reset.

### ROM And RAM

The ROM (U11) contains the operating system code needed for control of the GPIB and Main Board. It also contains lookup tables and jump vectors.

The RAM (U10) contains uninitialized variables, system heap, and system stack.

### Main Board Device/Address Selection

Main board device selection is accomplished by U6 and U7. The device selection and buffered data lines interface with the Main board through JP1. Only one device on the Main board can be selected at any time.

The S0 to S7 outputs from U6 are selected by reading or writing to addresses 2000h through 2007h. The S8 through S15 outputs of U7 are selected by reading or writing to addresses 3000h through 3007h.

### Interrupt (1 ms) Timer

The Counter/Timer at U4 divides down the 'E' line from U1. After 1.024 ms, pin 1 of U4 goes HI, saturating Q1 and pulling the FIRQ line of U1 LO.

This interrupt can be counted by the software to create delays or timeouts. After each cycle, U4 is reset by U1.

### Internal Address Decode and MPU Buffers

Internal addressing of devices is provided by U5. Table 4-2 contains a list of this information. Pin 14 of U5 is a write enable output and pin 15 is a read enable. These outputs are used by U8 and U9.

Table 4-2  
Internal Addressing

U5 Pin Number	Device Addressed	U5 Output Address Range
18	U10	0000-1FFF
11	U6	2000-2007
12	U7	3000-3007
9	None	4000-4FFF
16	U12	5000-5FFF
17	U13	6000-6007
13	U4	7000-7FFF
19	U11	8000-FFFF

ICs U8 and U9 serve as buffers for the MPU; U8 is a read buffer, and U9 functions as both a write buffer and latch because of the short write time of U1.

### GPIB Control And Address Selection

As with other GPIB compatible plug-ins, the controller first identifies the complete module. The address for the SI 5020 is achieved through SW1 and is constituted by the sum of switches 1 through 5. The binary value of these switches is shown in Table 4-3.

The valid address range is 1 through 31 and is selected by pressing down the rocker switch on the right (closed) side. For instance, selecting positions 4, 2, and 1 would produce an address location of 11. Note that address 0 is reserved for service and maintenance and address 31 for Unlisten (see Figure 2-1 for related set-up notes).

## FRONT PANEL BOARD

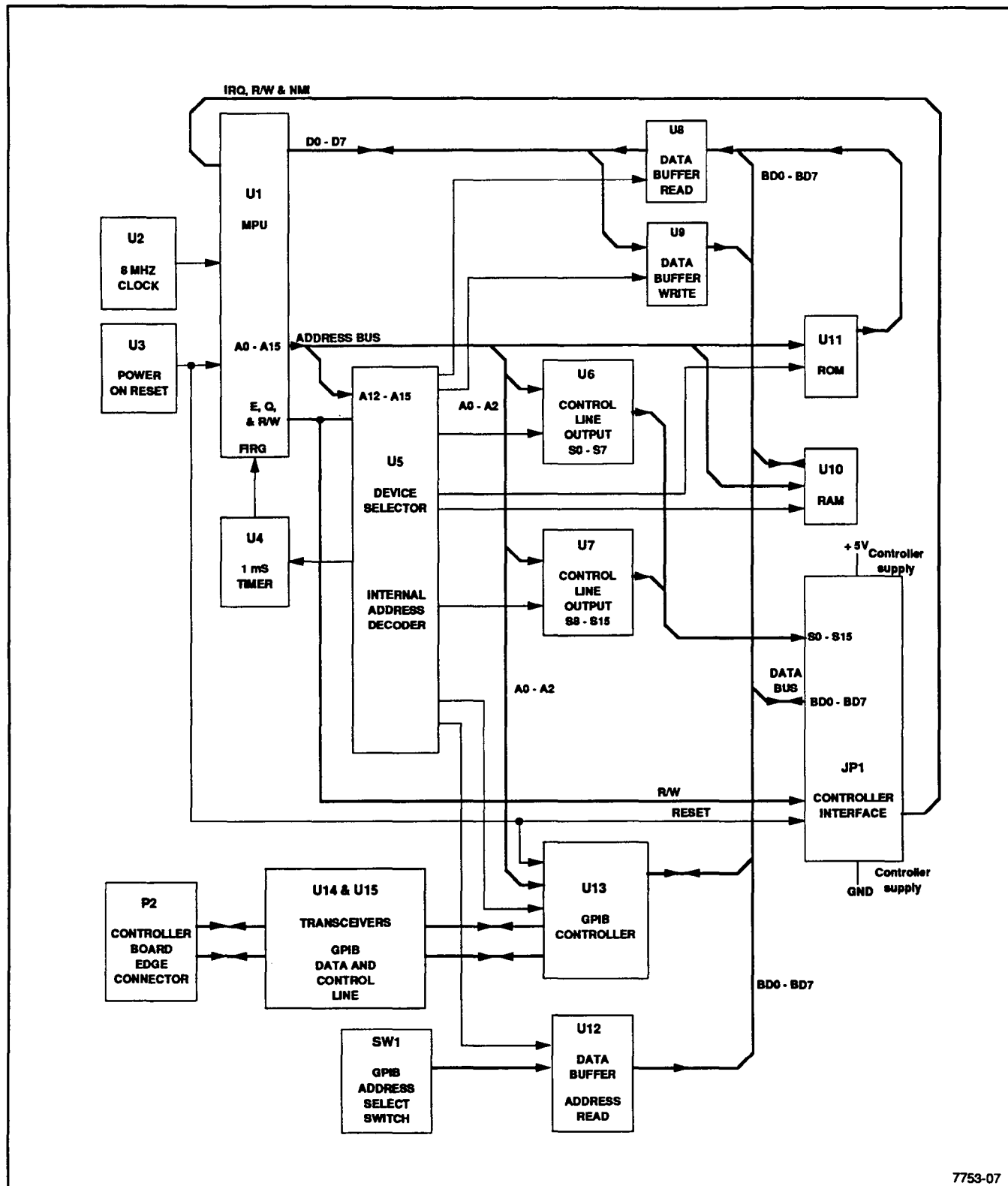
The Front Panel board is used to mount the twelve switches and LEDs associated with both sets of relay switches. Also mounted is the interface plug (JP43A and J46A) for the relays and LEDs, and three LEDs for GPIB status.

The LED for each switch, e.g. D77 for SW77, will illuminate in the relay switch 'closed' position only. Also, when software programmed front panel lockout is not present, the adjacent switch will toggle the switch to the alternate condition, e.g., if the relay switch was off, the front panel switch will turn it on, and vice versa. This will occur independent of what the controller has programmed it for. For this reason, switch conditions should always be reset to a known condition if connections are changed during interruption of an ongoing program.

Note that the software is programmed to generate an error if more than four relays are closed at any one time. This is done to hold internal heat limits within the microwave switch manufacturer's recommendations.

**Table 4-3**  
**GPIB Module Address Selection**

Switch Number	Binary Value
1	1
2	2
3	4
4	8
5	16



7753-07

Figure 4-2. Block diagram for the GPIB Controller Board.

# PERFORMANCE CHECK AND FUNCTIONAL VERIFICATION PROCEDURE

## INTRODUCTION

This procedure is used to verify proper operation of the instrument and its controls. These checks may also be used as an acceptance test and as a preliminary troubleshooting aid.

There is a separate procedure for each SI 5020 version (A, B, and C) since they differ in relay-matrix configurations.

## PREPARATION

Test equipment items listed in Table 5-1 are required to perform this procedure.

**Table 5-1**  
**Test Equipment Required**

Item and Description	Use	Examples of Applicable Test Equipment
1. Power Module	Power for SI 5020.	TEKTRONIX TM500/5000 Series Power Module.
2. Ohmmeter	Relay check.	DM 5010 Digital Multimeter.

## SI 5020A PROCEDURE

1. Connect one lead of the ohmmeter to the inner conductor of the A Matrix common SMA connector.
2. Verify that all of the A Matrix LEDs are off.
3. Push the number 1 Matrix A switch. Its associated LED should turn on.
4. Connect the other ohmmeter lead to the inner conductor of the number 1 Matrix A SMA connector.
5. CHECK - That the ohmmeter shows continuity between the two connectors.
6. Disconnect the ohmmeter lead from the number 1 A Matrix SMA connector. Connect it in turn to each of the other five SMA connectors and CHECK that the ohmmeter shows no continuity between the two connectors.
7. Push the number 1 Matrix A switch. Its associated LED should turn off.
8. Repeat Steps 3 through 7 for Matrix A switches numbers 2 through 6. In these steps, substitute the current switch number being tested for the number 1 switch.
9. Repeat Steps 1 through 8 for the Matrix B switches. In these steps, substitute the B matrix for the A matrix.

**SI 5020B PROCEDURE**

1. Connect one lead of the ohmmeter to the inner conductor of the A Matrix common SMA connector.
2. Verify that all of the A Matrix LEDs are off
3. Push the number 1 Matrix A switch. Its associated LED should turn on.
4. Connect the other ohmmeter lead to the inner conductor of the number 1 Matrix A SMA connector.
5. CHECK - That the ohmmeter shows continuity between the two connectors.
6. Disconnect the ohmmeter lead from the number 1 A Matrix SMA connector. Connect it in turn to each of the other five SMA connectors and CHECK that the ohmmeter shows no continuity between the two connectors.
7. Push the number 1 Matrix A switch. Its associated LED should turn off.
8. Repeat Steps 3 through 7 for Matrix A switches numbers 2 through 6. In these steps, substitute the current switch number being tested for the number 1 switch.
9. Disconnect the ohmmeter lead from the common A Matrix SMA connector.
10. Connect one ohmmeter lead to the number 1 Matrix B SMA connector and the other lead to the number 2 Matrix B SMA connector.
11. Push both the number 1 and number 2 switches for Matrix B.
12. CHECK - That the ohmmeter shows continuity between the two connectors and that both of their LEDs are turned on.
13. Push both the number 1 and number 2 switches for Matrix B. Both of their LEDs should turn off.
14. Disconnect the ohmmeter leads from the B Matrix SMA connectors.
15. Repeat Steps 10 through 14 for the following Matrix B switch pairs (2 and 3, 3 and 4, 4 and 5, and 6 and 1).

**SI 5020C PROCEDURE**

1. Connect one ohmmeter lead to the number 1 Matrix A SMA connector and the other lead to the number 2 Matrix A SMA connector.
2. Push both the number 1 and number 2 switches for Matrix A.
3. CHECK - That the ohmmeter shows continuity between the two connectors and that both of their LEDs are turned on.
4. Push both the number 1 and number 2 switches for Matrix A. Both of their LEDs should turn off.
5. Disconnect the ohmmeter leads from the A Matrix SMA connectors.
6. Repeat Steps 1 through 5 for the following Matrix A switch pairs (2 and 3, 3 and 4, 4 and 5, and 6 and 1).
7. Repeat Steps 1 through 6 for the Matrix B switches. In these steps, substitute the B matrix for the A matrix.

# MAINTENANCE AND DIAGNOSTICS

## GENERAL MAINTENANCE

### Static-Sensitive Components



*Static discharge can damage any semiconductor component in this instrument.*

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 6-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

- minimize handling of static-sensitive components.
- transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam.
- label any package that contains static-sensitive assemblies or components.
- discharge the static voltage from your body by wearing a wrist strap while handling these components.
- service static-sensitive assemblies or components only at static-free workstations by qualified service personnel.
- nothing capable of generating or holding a static charge should be allowed on the work station surface.
- keep the component leads shorted together whenever possible.
- pick up components by the body, never by the leads.
- do not slide the components over any surface.

- avoid handling components in areas that have a floor or work surface covering capable of generating a static charge.
- use a soldering iron that is connected to earth ground.
- use only special antistatic suction type or wick type desoldering tools.

**Table 6-1**  
**Relative Susceptibility to Static Discharge Damage**

Semiconductor Classes	Relative Susceptibility Levels <sup>a</sup>
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

<sup>a</sup>Voltage equivalent for levels:

1 = 100 to 500 V	4 = 500 V	7 = 400 to 1000 V (est)
2 = 200 to 500 V	5 = 400 to 600 V	8 = 900 V
3 = 250 V	6 = 600 to 800 V	9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 ohms.)

## Cleaning

This instrument should be cleaned as often as operating conditions require. Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small brush. Remove dirt that remains with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.



*To clean the front panel use freon, isopropyl alcohol, or denatured ethyl alcohol. Do not use petroleum-based cleansing agents. Before using any other type of cleaner, consult you Tektronix Service Center or representative.*

The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (approximately 5 lb/in<sup>2</sup>) or use a soft brush or cloth dampened with a mild detergent and water solution.

Hold the board so the cleaning residue runs away from the connectors. Do not scrape or use an eraser to clean the edge connector contacts. Abrasive cleaning can remove the gold plating.



*Circuit boards and components must be dry before applying power.*

## Obtaining Replacement Parts

Electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, it may be possible to obtain many of the standard electronic components from a local commercial source. Before purchasing or ordering a part from a source other than Tektronix, Inc., check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

### NOTE

*When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the instrument.*

Some parts are manufactured or selected by Tektronix, Inc., to satisfy particular requirements or are manufactured for Tektronix, Inc., to our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. To determine the manufacturer, refer to the Replaceable Parts List and the Cross Reference Index, Mfr. Code Number to Manufacturer.

When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type and option number.
2. Instrument serial number.
3. A description of the part (if electrical, include complete circuit number).
4. Tektronix part number.

## Soldering Techniques

### WARNING

*To avoid electric-shock hazard, disconnect the instrument from the power source before soldering.*

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core, electronic grade solder. The choice of soldering iron is determined by the repair to be made.



*All circuit boards in the instrument are multilayer-type boards with a conductive path laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connections to this conductive path. Only experienced maintenance personnel should attempt to repair these boards.*

When soldering on circuit boards or small wiring, use only a 15-watt, pencil type soldering iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material and melt the insulation from small wiring. Always keep the soldering iron tip properly tinned to ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder removing wick to remove excess solder from connections or to clean circuit board pads.

### Integrated Circuits

To remove in-line integrated circuits use an extracting tool. This tool is available from Tektronix, Inc.: order Tektronix Part Number 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated circuit. Try to avoid disengaging one end before the other end.

### Multipin Connectors

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the wires. To replace damaged multipin connectors, remove the old pin connector from the holder. Do this by inserting a scribe between the connector and the holder and prying the connector from the holder. Clamp the replacement connector to the wire. Reinstall the connector in the holder.

If the individual end lead pin connectors are removed from the plastic holder, note the order of the individual wires for correct replacement in the holder. For proper replacement, see Figure 6-1.

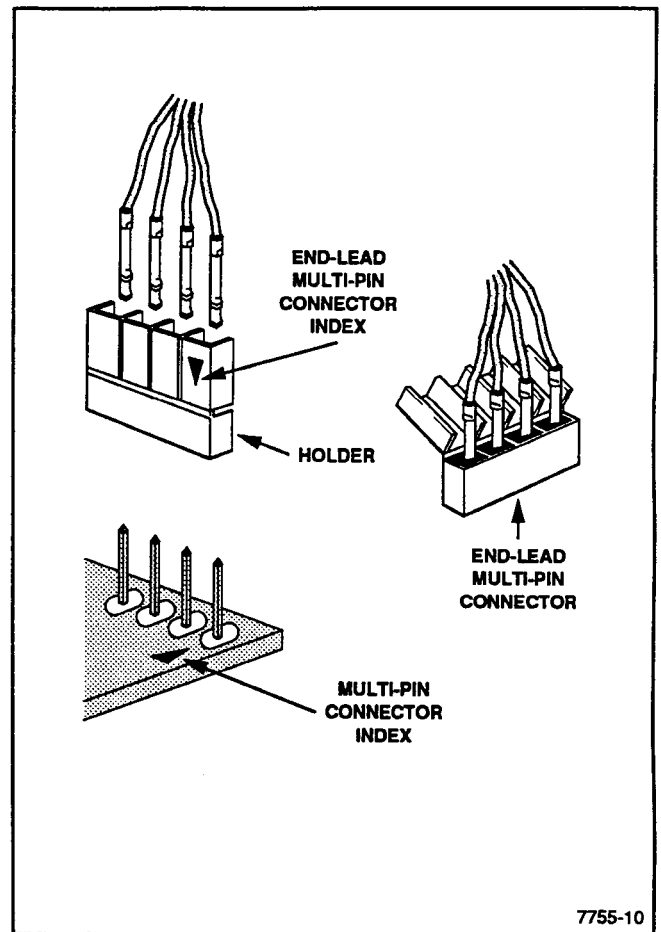


Figure 6-1. Orientation and disassembly of multipin connectors.

7755-10

# CIRCUIT BOARD REMOVAL AND INSTALLATION

## SIDE COVERS

Before any circuit boards can be removed, the side covers must first be removed from the sides of the instrument chassis. Turn the side cover fasteners a quarter turn clockwise, then lift the covers slightly and separate them from the notch at the rear of the instrument.

## GPIB BOARD

To remove the GPIB board from the instrument, perform the following steps:

1. Disconnect the connector from near the front of the GPIB board.
2. Remove 2 screws connecting the GPIB board to the spacers to the Main board.
3. Remove 1 screw connecting the GPIB board to the nut block on the back of the instrument chassis.
4. Lift the GPIB board forward and out of the instrument chassis.

To reinsert the GPIB board into the chassis, perform the reverse of the preceding steps.

## MAIN BOARD

To remove the Main board from the instrument, perform the following steps:

1. Remove the GPIB board as described above.
2. Disconnect the 4 connectors from near the front of the Main board which connects it to the matrix switches and the Front Panel board.

3. Remove 2 screws connecting the front of the Main board to the instrument chassis.
4. Remove 2 screws connecting the rear of the Main board to the instrument chassis.
5. Slide the Main board forward until the regulators clear the mounting tabs, then lift out of the instrument chassis. (Do not bend the regulators up too high, or their legs could break.)

To reinsert the Main board into the chassis, perform the reverse of the preceding steps. When the Main board is reinstalled, perform the GPIB installation procedure.

## FRONT PANEL BOARD

To remove the Front Panel board from the instrument, perform the following steps:

1. Disconnect the 4 connectors from near the front of the Main board which connect it to the matrix switches and the Front Panel board.
2. Remove 4 screws connecting the Front Panel to the chassis. Remove the latch knob from the latch assembly and slide the Front Panel module forward.
3. Remove 6 screws connecting the Front Panel board to the front of the instrument chassis.
4. Lift the Front Panel board backwards and out of the instrument chassis.

To reinsert the Front Panel board into the chassis, perform the reverse of the preceding steps. Be sure that the pushbuttons are aligned with the Front Panel holes. Install washer-less screw in mounting hole above latch. Align the board so pushbuttons don't bind before tightening mounting screws.

# TROUBLESHOOTING

Troubleshooting the circuit boards is straightforward. Review *Theory of Operation* for an understanding of the circuit operation. Also see "Hardware and Software Implementation" in Section 3, *Programming Information*.

# OPTIONS

No options are available.



# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

### LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

### CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

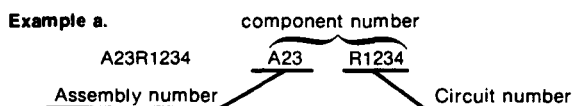
The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

### ABBREVIATIONS

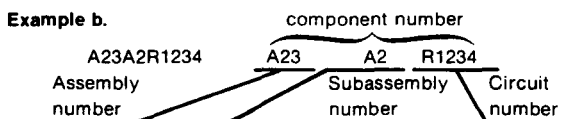
Abbreviations conform to American National Standard Y1.1.

### COMPONENT NUMBER (column one of the Electrical Parts List)

A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:



Read: Resistor 1234 of Assembly 23



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

### TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

### SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

### NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

### MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

### MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

## CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPY PO BOX 655012	DALLAS TX 75265
01537	MOTOROLA COMMUNICATIONS AND ELECTRONICS INC	2553 N EDGINGTON ST	FRANKLIN PARK IL 60131-3401
02735	RCA CORP SOLID STATE DIVISION	ROUTE 202	SOMERVILLE NJ 08876
04713	MOTOROLA INC SEMICONDUCTOR PRODUCTS SECTOR	5005 E MCDOWELL RD	PHOENIX AZ 85008-4229
05397	UNION CARBIDE CORP MATERIALS SYSTEMS DIV	11901 MADISON AVE	CLEVELAND OH 44101
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507-2114
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	370 W TRIMBLE RD	SAN JOSE CA 95131
53387	MINNESOTA MINING MFG CO	PO BOX 2963	AUSTIN TX 78769-2963
54583	TDK ELECTRONICS CORP	12 HARBOR PARK DR	PORT WASHINGTON NY 11550
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195-4526
56289	SPRAGUE ELECTRIC CO WORLD HEADQUARTERS	92 HAYDEN AVE	LEXINGTON MA 02173-7929
57668	ROHM CORP	8 WHATNEY PO BOX 19515	IRVINE CA 92713
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
81073	GRAYHILL INC	561 HILLGROVE AVE PO BOX 10373	LA GRANGE IL 60525-5914
TK0961	NEC ELECTRONICS USA INC ELECTRON DIV	401 ELLIS ST PO BOX 7241	MOUNTAIN VIEW CA 94039
TK1483	TEKA PRODUCTS INC	45 SALEM ST	PROVIDENCE RI 02907

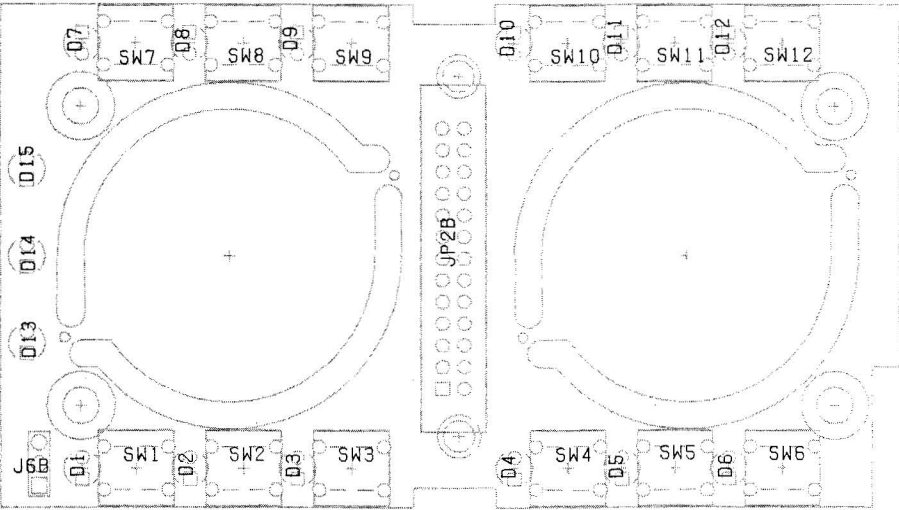
Component No.	Tektronix Part No.	Serial/Assembly No.		Name & Description	Mfr. Code	Mfr. Part No.	
		Effective	Dscmt				
A1	671-1310-00			CIRCUIT BD ASSY:GPIB AT5010	80009	671-1310-00	
A4	671-1192-00			CIRCUIT BD ASSY:HF MUX	80009	671-1192-00	
A5	671-1311-00			CIRCUIT BD ASSY:FRONT PANEL	80009	671-1311-00	
A1	671-1310-00			CIRCUIT BD ASSY:GPIB AT5010	80009	671-1310-00	
A1C1	290-0722-00			CAP, FXD, ELCTLT:100 UF, 20%, 10V	56289	196D107X0010PE3	
A1C2	290-0527-03			CAP, FXD, ELCTLT:15UF, 20%, 20VDC	05397	T361 (ADVISE)	
A1C3	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C4	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C5	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C6	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C7	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C8	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C9	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C10	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C11	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C12	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C13	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C14	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C15	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C16	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C17	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C18	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1C19	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A1JP1	131-3364-00			CONN, RCPT, ELEC:HEADER, STRAIGHT, 34 PIN	53387	3594-6002	
A1Q1	151-0736-00			TRANSISTOR:NPN, SI, TO-92	80009	151-0736-00	
A1R1	322-3289-00			RES, FXD, FILM:10K OHM, 1%, 0.2W, TC=TO	57668	CRB20 FXE 10K0	
A1R2	322-3289-00			RES, FXD, FILM:10K OHM, 1%, 0.2W, TC=TO	57668	CRB20 FXE 10K0	
A1R3	322-3289-00			RES, FXD, FILM:10K OHM, 1%, 0.2W, TC=TO	57668	CRB20 FXE 10K0	
A1R4	322-3289-00			RES, FXD, FILM:10K OHM, 1%, 0.2W, TC=TO	57668	CRB20 FXE 10K0	
A1R5	322-3289-00			RES, FXD, FILM:10K OHM, 1%, 0.2W, TC=TO	57668	CRB20 FXE 10K0	
A1R6	322-3289-00			RES, FXD, FILM:10K OHM, 1%, 0.2W, TC=TO	57668	CRB20 FXE 10K0	
A1R7	322-3289-00			RES, FXD, FILM:10K OHM, 1%, 0.2W, TC=TO	57668	CRB20 FXE 10K0	
A1R8	307-0445-00			RES NTWK, FXD, FI:4.7K OHM, 20%, (9)RES	32997	4310R-101-472	
A1SW1	260-1721-00			SWITCH,ROCKER:8, SPST, 125MA, 30VDC	81073	76SB08S	
A1U1	156-1494-01			MICROCKT, DGTL:NMOS, 8 BIT MICROPRC, SCRNM	04713	MC68809	
A1U2	119-1897-00			OSCILLATOR, RF:XTAL CONTROLLED, 8.00MHZ, 0.01%	01537	RASCO-1-8.00 MHZ	
A1U3	156-2396-00			MICROCKT, LINEAR:BIPOLAR, MPU RESET GENERATOR	01295	TL7705 ACP	
A1U4	156-2355-00			MICROCKT, DGTL:CMOS, 14 STAGE BIN RIPPLE CNTR	02735	CD74HCT4020EX	
A1U5	160-6479-00			MICROCKT, DGTL:E2CMOS, LOGIC ARRAY, PRGM	80009	160-6479-00	
A1U6	156-0469-00			MICROCKT, DGTL:3-LINE TO 8-LINE DECODER	01295	SN74LS138N	
A1U7	156-0469-00			MICROCKT, DGTL:3-LINE TO 8-LINE DECODER	01295	SN74LS138N	
A1U8	156-1111-00			MICROCKT, DGTL:OCTAL BUS TRANSCEIVERS	01295	SN74LS245N	
A1U9	156-1858-00			MICROCKT, DGTL:TRANSPARENT D-TYPE LATCHES	80009	156-1858-00	
A1U10	156-2473-00			IC, MEMORY:CMOS, SRAM;8K X 8, 200NS, 10UA	TK0961	uPD4464C-20	
A1U11	160-6580-00			MICROCKT, DGTL:NMOS, 32768 X 8 EPROM, PRGM	80009	160-6580-00	
A1U11	160-6758-00			MICROCKT, DGTL:32768 X 8 EPROM W/3 ST OUT	80009	160-6758-00	
A1U12	156-1111-00			MICROCKT, DGTL:OCTAL BUS TRANSCEIVERS	01295	SN74LS245N	
A1U13	156-1444-01			MICROCKT, DGTL:NMOS, GPIB INTFC CONTROLLER	01295	TMS9914A (NL)	
A1U14	156-1415-00			MICROCKT, DGTL:TTL, OCTAL GPIB XCVR MGT BUS	01295	SN75161A N	
A1U15	156-1414-00			MICROCKT, DGTL:TTL, OCTAL GPIB XCVR DATA BUS	01295	SN75160 (N OR J)	
A1XU11	136-0755-00			SKT, PL-IN ELEK:MICROCIRCUIT, 28 DIP	09922	D1LB28P-108	
A4	671-1192-00			CIRCUIT BD ASSY:HF MUX	80009	671-1192-00	
A4C1	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T	
A4C2	290-0974-01			CAP, FXD, ELCTLT:10UF, 20%, 50V	55680	UVX1H100MAA1TA	

Component No.	Tektronix	Serial/Assembly No.		Name & Description	Mfr.	Mfr. Part No.
	Part No.	Effective	Discont		Code	
A4C3	290-0944-01			CAP, FXD, ELCTLT:220UF, 20%, 10V	55680	UVX1C221MPA1TA
A4C4	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C5	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C6	290-0974-01			CAP, FXD, ELCTLT:10UF, 20%, 50V	55680	UVX1H100MAA1TA
A4C7	290-0944-01			CAP, FXD, ELCTLT:220UF, 20%, 10V	55680	UVX1C221MPA1TA
A4C8	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C9	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C10	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C11	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C12	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C13	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C14	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C15	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C16	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C17	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C18	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4C19	281-0909-00			CAP, FXD, CER DI:0.022UF, 20%, 50V	54583	MA12X7R1H223M-T
A4F1	156-0159-00			MICROCKT, DGTL:NON-INVERTING 1-OF-8 DCDR	04713	MC4048P
A4F2	156-0159-00			MICROCKT, DGTL:NON-INVERTING 1-OF-8 DCDR	04713	MC4048P
A4J4	131-1857-00			TERM SET, PIN:36/0.025 SQ PIN, ON 0.1 CTRS (7 LOCATIONS)	TK1483	082-3643-SS10
A4J5	131-1857-00			TERM SET, PIN:36/0.025 SQ PIN, ON 0.1 CTRS (7 LOCATIONS)	TK1483	082-3643-SS10
A4J6	131-1857-00			TERM SET, PIN:36/0.025 SQ PIN, ON 0.1 CTRS (3 LOCATIONS)	TK1483	082-3643-SS10
A4JP1	131-3364-00			CONN, RCPT, ELEC:HEADER, STRAIGHT, 34 PIN	53387	3594-6002
A4JP2	131-3362-00			CONN, RCPT, ELEC:HEADER, STR, 26 PIN	53387	3593-6002
A4R1	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R2	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R3	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R4	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R5	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R6	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R7	307-0445-00			RES NTWK, FXD, FI:4.7K OHM, 20%, (9)RES	32997	4310R-101-472
A4R8	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R9	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R10	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R11	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R12	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R13	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R14	307-0445-00			RES NTWK, FXD, FI:4.7K OHM, 20%, (9)RES	32997	4310R-101-472
A4R15	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R16	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4R17	322-3114-00			RES, FXD, FILM:150 OHM, 1%, 0.2W, TC=TO	57668	CRB20FX150EAXIAL
A4U1	156-0277-00			MICROCKT, LINEAR:VOLTAGE REGULATOR	04713	LM340T-5.0
A4U2	156-0277-00			MICROCKT, LINEAR:VOLTAGE REGULATOR	04713	LM340T-5.0
A4U3	156-1111-00			MICROCKT, DGTL:OCTAL BUS TRANSCEIVERS	01295	SN74LS245N
A4U4	156-2357-00			MICROCKT, DGTL:OCT LATCH, NONINV, D TYPE FF	01295	SN74HCT574N3
A4U5	156-1245-00			MICROCKT, LINEAR:7 XSTR, NPN, SI, HV/HIGH CUR	01295	ULN2003AN-P3
A4U6	156-1111-00			MICROCKT, DGTL:OCTAL BUS TRANSCEIVERS	01295	SN74LS245N
A4U7	156-2357-00			MICROCKT, DGTL:OCT LATCH, NONINV, D TYPE FF	01295	SN74HCT574N3
A4U8	156-1245-00			MICROCKT, LINEAR:7 XSTR, NPN, SI, HV/HIGH CUR	01295	ULN2003AN-P3
A4U9	156-2357-00			MICROCKT, DGTL:OCT LATCH, NONINV, D TYPE FF	01295	SN74HCT574N3
A5	671-1311-00			CIRCUIT BD ASSY:FRONT PANEL	80009	671-1311-00
A5D1	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D2	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487

Component No.	Tektronix	Serial/Assembly No.		Name & Description	Mfr.	Mfr. Part No.
	Part No.	Effective	Discont		Code	
A5D3	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D4	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D5	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D6	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D7	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D8	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D9	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D10	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D11	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D12	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D13	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D14	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5D15	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A5J6	131-4671-00			CONN,RCPT,ELEC:1 X 3,0.1 SPACING	80009	131-4671-00
A5JP2	131-4950-00			CONN,RCPT,ELEC:2 X 13,PIN STRIP,GOLD,VERT	80009	131-4950-00
A5SW1	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW2	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW3	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW4	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW5	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW6	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW7	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW8	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW9	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW10	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW11	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00
A5SW12	260-2280-00			SW,PUSH BUTTON:MINI MOM,SPST,NORM OPEN	80009	260-2280-00

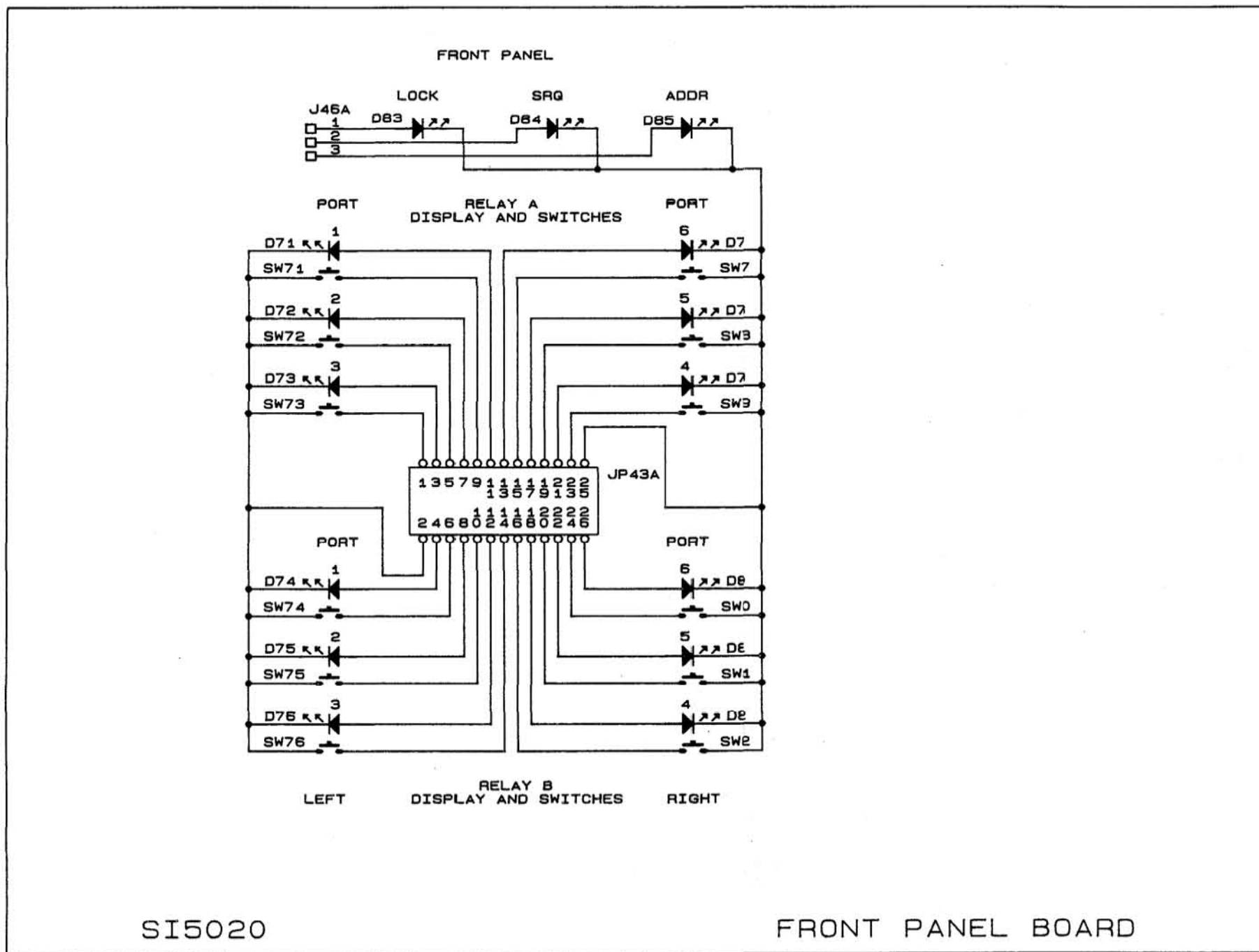


# DIAGRAMS

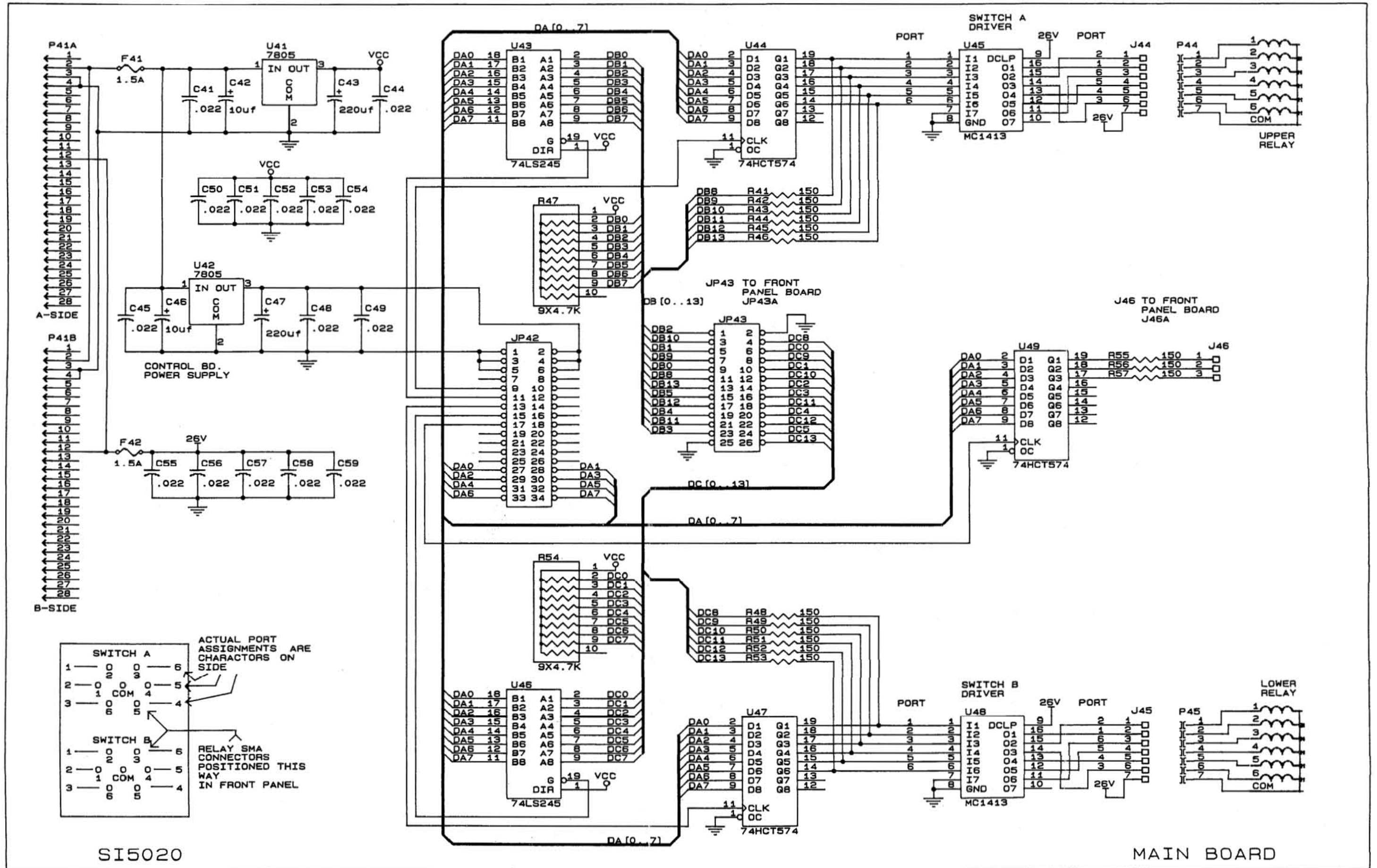


Front panel board.

7753-08

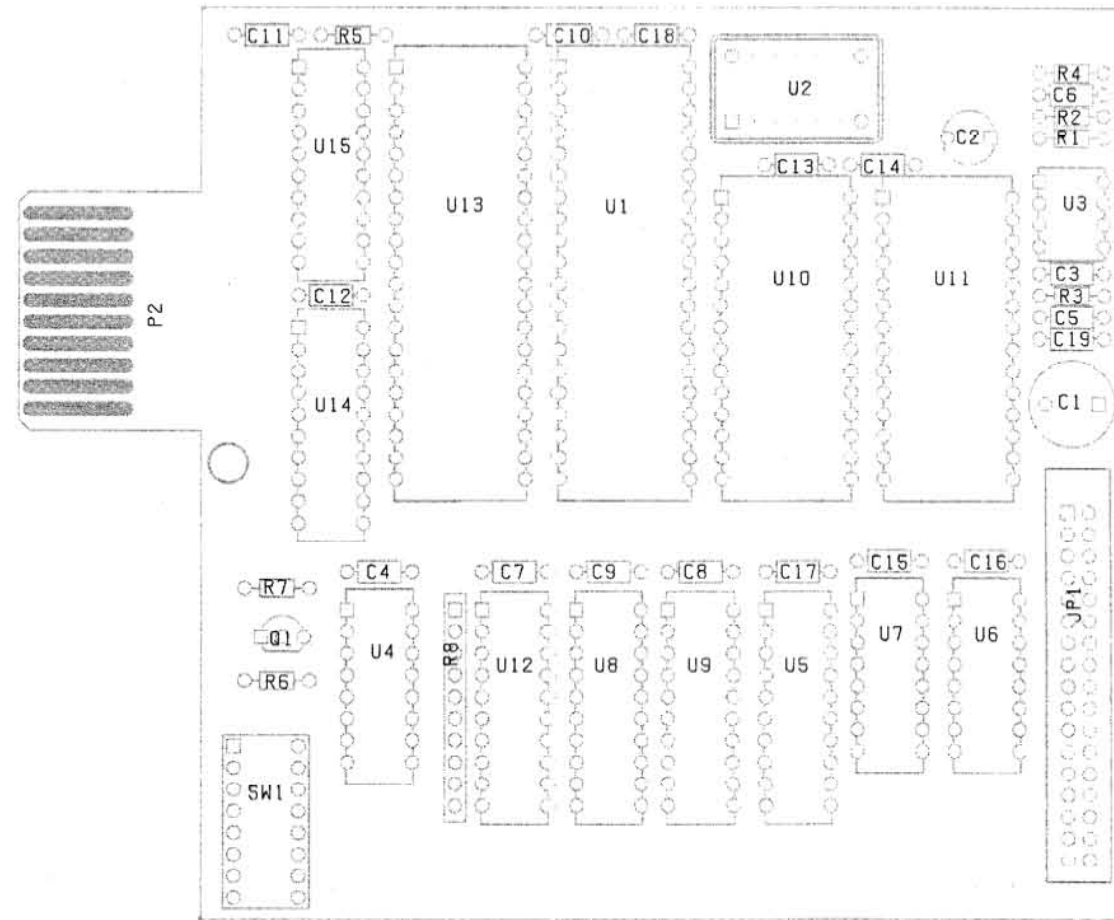






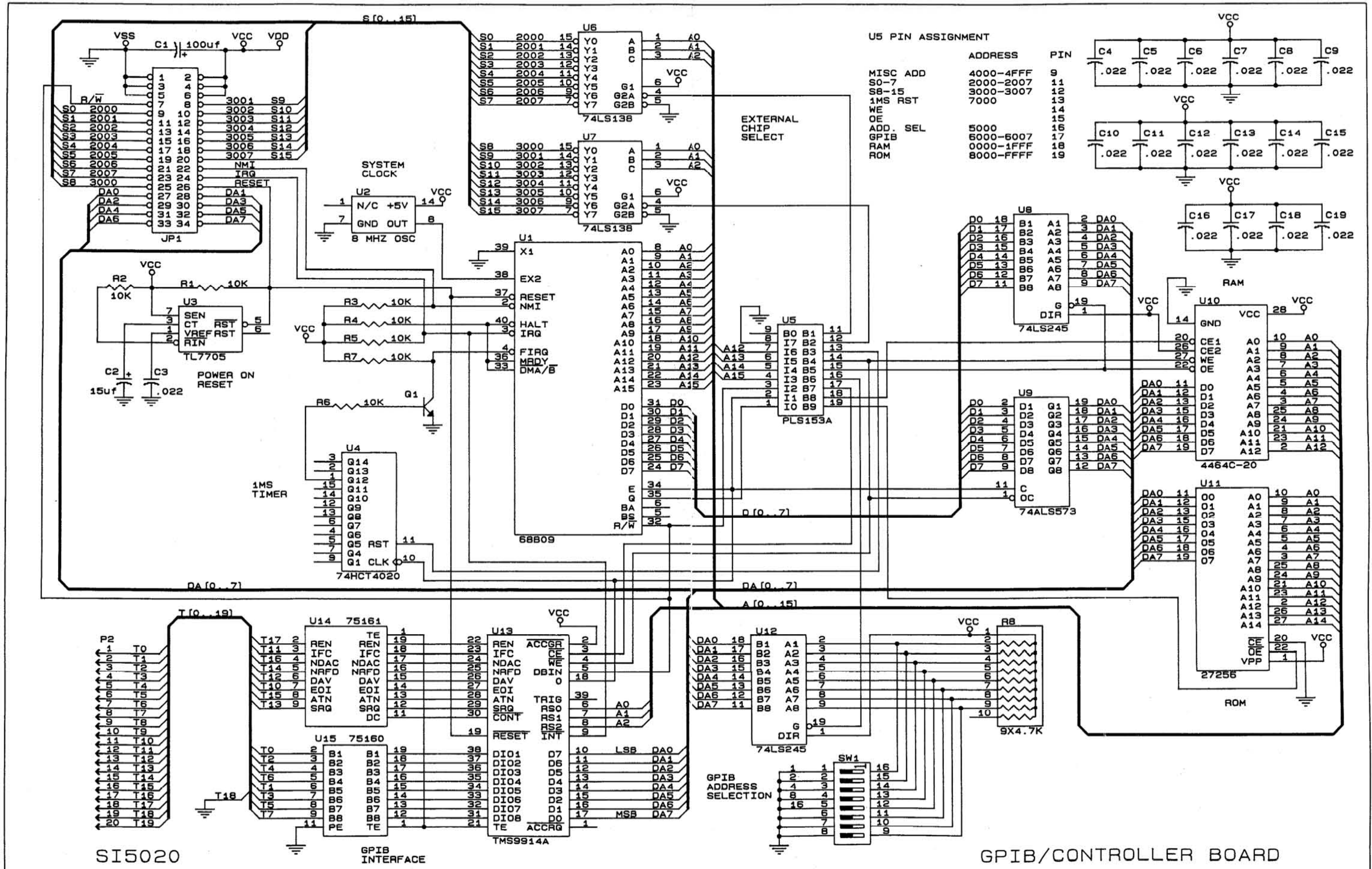
SI5020

MAIN BOARD



7753-12

GPIB/Controller board.



U5 PIN ASSIGNMENT

MISC ADD	ADDRESS	PIN
S0-7	4000-4FFF	9
S8-15	2000-2007	11
1MS RST	3000-3007	12
WE	7000	13
OE		14
ADD. SEL	5000	15
GPIB	6000-6007	17
RAM	0000-1FFF	18
ROM	8000-FFFF	19

SI5020

GPIB INTERFACE

GPIB/CONTROLLER BOARD

# REPLACEABLE MECHANICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## ITEM NAME

In the Parts List, an item Name is separated from the description by a colon(:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5                      *Name & Description*

*Assembly and/or Component*

*Attaching parts for Assembly and/or Component*

**END ATTACHING PARTS**

*Detail Part of Assembly and/or Component*

*Attaching parts for Detail Part*

**END ATTACHING PARTS**

*Parts of Detail Part*

*Attaching parts for Parts of Detail Part*

**END ATTACHING PARTS**

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

**Attaching parts must be purchased separately, unless otherwise specified.**

## ABBREVIATIONS

Abbreviations conform to American National Standards Institute Y1.1

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
01536	TEXTRON INC CAMCAR DIV SEMS PRODUCTS UNIT	1818 CHRISTINA ST	ROCKFORD IL 61108
28979	FREQUENCY SOURCES INC WAVECOM DIV SUB OF LORAL CORP	9036 WINNETKA AVE	NORTHRIDGE CA 91324-3235
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIV	ST CHARLES ROAD	ELGIN IL 60120
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
83385	MICRODOT MFG INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
83486	ELCO INDUSTRIES INC	1101 SAMUELSON RD	ROCKFORD IL 61101
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61108-5181
TK0858	STAUFFER SUPPLY CO (DIST)	810 SE SHERMAN	PORTLAND OR 97214
TK1326	NORTHWEST FOURSLIDE INC	18224 SW 100TH CT	TUALATIN OR 97062
TK2278	COMTEK MANUFACTURING OF OREGON (METALS)	PO BOX 4200	BEAVERTON OR 97076-4200

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No.		Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.	
		Effective	Discort					
1-	105-0865-00			4	BAR, LATCH RLSE:	80009	105-0865-00	
	105-0866-00			4	LATCH, RETAINING: SAFETY	80009	105-0866-00	
	105-0932-00			8	LATCH, PANEL: SIDE	80009	105-0932-00	
	148-0240-00			3	RELAY, SWITCH RF: COAXIAL, CONN SMA, FEMALE	28979		
	148-0241-00			5	RELAY, ARMATURE: RF COAX, 18GHZ, 24VDC, SP6T	28979		
	174-1981-00			4	CA ASSY, DP, ELEC: 26, 28 AWG, 4.0 L, 8-N, RIBBON	80009	174-1981-00	
	174-1982-00			4	CA ASSY, DP, ELEC: 34, 28 AWG, 4.0 L, 8-N, RIBBON	80009	174-1982-00	
	175-8156-00			8	CA ASSY, SP, ELEC: 7, 26 AWG, 3.25 L, RIBBON	80009	175-8156-00	
	175-9555-00			4	CA ASSY, SP, ELEC: 3, 26 AWG, 4.0 L, RIBBON	80009	175-9555-00	
	210-0457-00			16	NUT, PL, ASSEM WA: 6-32 X 0.312, STL CD PL	78189	511-061800-00	
	210-0586-00			32	NUT, PL, ASSEM WA: 4-40 X 0.25, STL CD PL	78189	211-041800-00	
	211-0101-00			36	SCREW, MACHINE: 4-40 X 0.25, FLH, 100 DEG, STL	93907	ORDER BY DESCR	
	211-0114-00			4	SCREW, MACHINE: 4-40 X 0.438, FLH, 100 DEG, STL	83385	ORDER BY DESCR	
	211-0121-00			8	SCR, ASSEM WSHR: 4-40 X 0.438, PNH, BRS	93907	ORDER BY DESCR	
	211-0244-00			16	SCR, ASSEM WSHR: 4-40 X 0.312, PNH STL	TK0858	211-0244-00	
	211-0711-00			28	SCR, ASSEM WSHR: 6-32 X 0.25, PNH, STL, TORX, T15	01536	ORDER BY DESCR	
	211-0722-00			4	SCREW, MACHINE: 6-32 X 0.25, PNH, STL	80009	211-0722-00	
	213-0146-00			8	SCREW, TPG, TF: 6-20 X 0.312, TYPE B, PNH, STL	83385	ORDER BY DESCR	
	213-0793-00			8	SCREW, TPG, TF: 6-32 X 0.4375, TAPTITE, FILH	83486	239-006-406043	
	214-3143-00			4	SPRING, HLEXT: 0.125 OD X 0.545 L, XLOOP	80009	214-3143-00	
	214-3364-00			8	FASTENER, LATCH: ACETAL, SIL GRAY	80009	214-3364-00	
	214-3406-00			4	SPRING, FLAT: 1.48 L X 0.125 W, CU BE	TK1326	ORDER BY DESCR	
	220-0729-00			4	NUT BLOCK: 4-40 X 0.188, BRS NP	80009	220-0729-00	
	333-3762-00			4	PANEL, FRONT:	80009	333-3762-00	
	337-3039-00			8	SHIELD, ELEC: SIDE	TK2278	ORDER BY DESCR	
	337-3626-00			4	SHIELD, ELEC: SUBPANEL, SI5020	80009	337-3626-00	
	361-0041-00			16	SPACER, POST: 0.375 L W/4-40 THRU, AL, 0.25 HEX	80009	361-0041-00	
	366-1516-00			48	PUSH BUTTON: IVORY GRAY, 0.3 X 0.665 H, SQ	80009	366-1516-00	
	366-1851-00			4	KNOB, LATCH: SIL GY, 0.625 X 0.25 X 1.09	80009	366-1851-00	
	378-2057-00			4	LENS, LIGHT: CLEAR, PLASTIC, PIPE	80009	378-2057-00	
	385-0122-00			8	SPACER, POST: 0.937 L W/6-32 THD EA END, AL	80009	385-0122-00	
	386-3657-01			8	SUPPORT, PLUG-IN:	93907	ORDER BY DESCR	
	386-4910-00			4	SUPPORT, FRAME: REAR	80009	386-4910-00	
	386-5984-00			4	SUBPANEL, FRONT:	80009	386-5984-00	
	426-0724-25			4	FR SECT, PLUG-IN: BOTTOM	80009	426-0724-25	
	426-0725-24			4	FR SECT, PLUG-IN: TOP	80009	426-0725-24	