

**OPERATOR'S MANUAL
FOR
MOTORIZED
WAVEGUIDE SWITCHES

MODEL MWS-XX-XIGXX**

SEPTEMBER 2004

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MOTORIZED WAVEGUIDE SWITCHES TABLE OF CONTENTS

1.0	GENERAL INFORMATION	3
1.1	SCOPE AND ORGANIZATION OF THE MANUAL	3
1.2	INTRODUCTION	3
1.3	GENERAL DESCRIPTION	3
1.4	FUNCTIONAL DESCRIPTION	3
1.5	SPECIFICATIONS	3
1.6	INSTRUMENT IDENTIFICATION	3
1.7	SAFETY CONSIDERATIONS	4
1.8	Table 1-1: Waveguide Band Designations	4
1.9	Table 1-2: Electrical Specifications	5
1.10	Table 1-3: Instrument Identification	6
2.0	INSTALLATION	6
2.1	INTRODUCTION	6
2.2	UNPACKING AND INITIAL INSPECTION	6
2.3	INTERCONNECTION	8
2.4	PERFORMANCE VERIFICATION	8
3.0	OPERATION	11
3.1	INTRODUCTION	11
3.2	OPERATIONAL OVERVIEW	12
3.3	OPERATING INSTRUCTIONS	12
4.0	MAINTENANCE	17
4.1	INTRODUCTION	17
4.2	OPERATOR CHECKS	18
4.3	TROUBLESHOOTING GUIDE	18
5.0	APPENDIX	19

1.0 GENERAL INFORMATION

1.1 SCOPE AND ORGANIZATION OF THE MANUAL

This Manual contains information and procedures required to install, operate and maintain the Millitech series MWS-XX-XIGXX Motorized Waveguide Switches ("W/G Switches"). The Manual is divided into sections as follows:

Section 1.0:	General Information
Section 2.0:	Installation
Section 3.0:	Operation
Section 4.0:	Maintenance

1.2 INTRODUCTION

This section of the Manual contains a general description of the W/G Switches, including functional description, a list of equipment supplied, specifications and safety precautions.

1.3 GENERAL DESCRIPTION

The W/G Switches are designed to provide switching of two waveguide paths. These W/G Switches are easy to use and are extremely useful in laboratory and systems set-ups requiring combinations of more than one source, detector or thermistor for purposes of substitution or comparison. The W/G Switch has a built-in encoder and a separate controller.

1.4 FUNCTIONAL DESCRIPTION

The W/G Switches have a three-channel rotor accurately indexed to eight 45° switch positions with continuous clockwise rotation. The W/G Switch has four ports and four functional switch positions so that each port can be coupled to any other port or can be isolated. The W/G Switch is set to various positions with a stepper motor and controller.

1.5 SPECIFICATIONS

Mechanical specifications for the W/G Switch assemblies are shown in Table 1-1. Electrical specifications are shown in Table 1-2.

1.6 INSTRUMENT IDENTIFICATION

The model number structure of the W/G Switch series is identified in Table 1-3. For example, an MWS-28-IIG6W is a Ka band or 26.5 - 40 GHz, 110 VAC lab bench model with a six-foot cable and the IEEE-488 interface option without a waveguide switch stand.

1.7 SAFETY CONSIDERATIONS

The W/G Switch is a precision electro-mechanical device that should be protected from physical shock and any foreign objects entering the waveguide ports. When not in use, the waveguide ports should be kept covered to prevent inadvertent entry of foreign objects, dust or material. Never insert any object into the interior of the waveguide because accuracy and performance of the W/G Switch may be affected. It may be desirable to purchase a short waveguide extension for each port and attach them if the W/G Switch assembly is subjected to frequent attachment and detachment to other assemblies. This will reduce wear on the waveguide flanges that are permanently attached to the W/G Switch and allow easy replacement of a relatively inexpensive part. Worn waveguide flanges can cause poor VSWR performance or instability of power measurements.

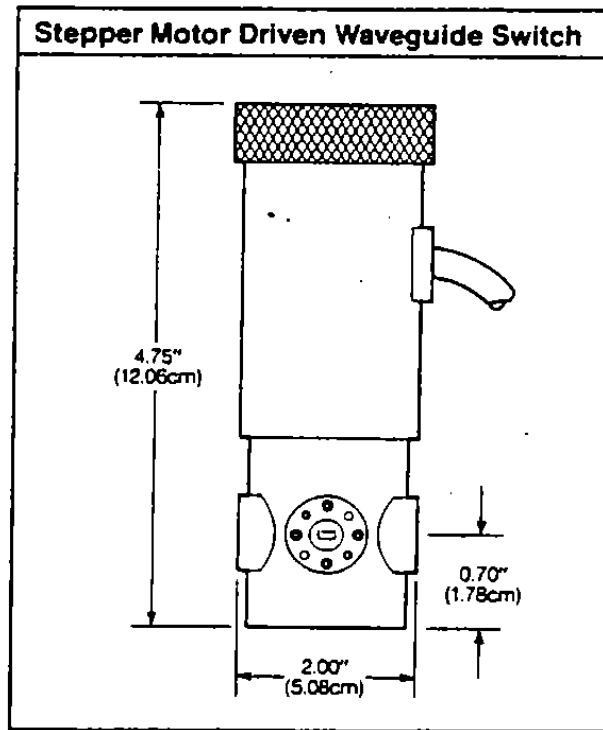
The W/G Switch assembly should always be properly supported to avoid stress on the waveguide flanges, either by use of a lab jack, optional waveguide switch stand or proper mounting using the holes provided.

The controller assembly contains Electro-statically Sensitive Devices (ESD) and the proper precautions should be observed when operating the unit. The controller should not be disconnected from the W/G Switch assembly with the power on.

1.8 Table 1-1: Waveguide Band Designations

Frequency Band (GHz)	K (18 – 26.5)	Ka (26.5 – 40)	Q (33 – 50)	U (40 – 60)	V (50 – 75)
Waveguide Size	WR – 42	WR – 28	WR – 22	WR – 19	WR – 15
Waveguide Flange	UG 595/U*	UG – 599/U* UG – 381/U†	UG – 383/U	UG – 383/U	UG – 385/U
Frequency Band (GHz)	E (60 – 90)	W (75 – 110)	F (90 – 140)	D (110 – 170)	G (140 – 220)
Waveguide Size	WR – 12	WR – 10	WR – 8	WR – 6	WR – 5
Waveguide Flange	UG – 387/U	UG – 387/U (mod)	UG – 387/U (mod)	UG – 387/U (mod)	UG – 387/U (mod)
* Square Flange † Round Flange					

OUTLINE DRAWINGS (Ka- through G-band)



1.9 Table 1-2: Electrical Specifications

Model No.	WSM-42	WSM-28	WSM-22	WSM-19	WSM-15	WSM-12	WSM-10	WSM-08	WSM-06	WSM-05
Frequency Band and Range, GHz	K 18-26.5	Ka 26.5-40	Q 33-50	U 40-60	V 50-75	E 60-90	W 75-110	F 90-140	D 110-170	G 140-220
Isolation, dB (Min.)	60	60	60	60	60	50	50	50	50	50
Insertion Loss, dB (Max.)	0.4	0.4	0.4	0.5	0.6	0.8	1.0	1.5	1.5	2.0
Repeatability, dB (Typ.)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.1	0.1
VSWR (Max.)	1.25:1	1.25:1	1.15:1	1.15:1	1.15:1	1.15:1	1.15:1	1.15:1	1.15:1	1.15:1

NOTE: Repeatability Guaranteed For Insertion Loss Only

1.10 Table 1-3: Instrument Identification

MWS-	XX	A	B	C	D	E
<u>Series Model</u>	<u>Waveguide Band</u>	<u>Line Voltage</u>	<u>Configuration Options</u>	<u>Interface Options</u>	<u>Length of Cable In Feet</u>	<u>Other Options</u>
	See Table 1-1: Standard Values:	0 =+28V at 2.3 Amp (Max.) 1 =100-120 VAC 2 =200-220 V AC	B = Basic Model I = Instrumentation Model R = Single Rack Model D = 19"Dual Rack Model V = VME Card Format (External Power Supply Required)	G = GPIB Interface P = Parallel Interface S = Serial Interface	3 = 3 Feet 6 = 6 Feet A = 12 Feet N = Nonstandard Length (please Specify)	M = With Switch Stand W = Without Switch Stand
	42 =18-26.5 GHz 28 =26.5-40 GHz 22 =33-50 GHz 19 =40-60 GHz 15 =50-75 GHz 12 =60-90 GHz 10 =75-110 GHz 08 =90-140 GHz 06 =110-170 GHz					

2.0 INSTALLATION

2.1 INTRODUCTION

This section provides instructions for installing the W/G Switch, as well as information about initial inspection, damage claims, preparation for use and guidance for storing, shipping, and repacking.

2.2 UNPACKING AND INITIAL INSPECTION

The equipment is inspected and packed to meet normal shipping environments. If damage to the shipping container is evident, request that a representative of the freight carrier be present when the container is opened. Unpack and verify the contents of the container against the packing sheet. Retain the container and the packing material until acceptance is completed.

2.2.1 Mechanical Check

Check the equipment and all the accessories for mechanical damage, such as broken or bent connectors and knobs, loose external or internal parts and for scratches or dents on the panel surfaces. If damage of any kind is found, retain the shipping container and packing material for inspection.

2.2.2 Electrical Check

Prepare the equipment for electrical check in the following sequence:

1. Section 2.3: Interconnection
2. Section 3.3: Operating Instructions
3. Section 2.4: Performance Verification

A complete test data package is shipped with each W/G Switch assembly for reference. Complete the performance tests in Section 2.4 as soon as possible after satisfactory completion of the mechanical check.

If the equipment fails the performance test and, therefore, does not meet the specifications, refer to Section 2.2.3, Claim for Damage.

2.2.3 Claim for Damage

If physical damage is evident or if the instrument does not meet specifications when received, notify the freight carrier and Millitech Corporation, Sales Department, to arrange for repair or replacement. Refer to Section 2.2.4, Packaging for Shipment, and 2.2.5, Communicating With The Company.

2.2.4 Packaging for Shipment

Packaging for Equipment: When using original packaging materials or other packing materials, make sure that all items are individually wrapped in protective wrapping before they are packed in the shipping carton.

1. Enclose copy of packing list, listing model number and serial number of each item being shipped. If an item does not have a model number (*i.e.*: cable assembly), list item by description.
2. To assist problem diagnosis and repair, enclose a brief description of problem or malfunction encountered.
3. Enclose equipment return-to-address and bill-to address.
4. Reference original purchase order number for repair under warranty.
5. Mark or label outside of shipping carton "FRAGILE".

Original Packaging: Cartons and packaging materials identical to that in which the instrument was originally shipped are available upon request.

1. Use a double-wall carton made of at least 350-pound test materials.
2. Use enough shock absorbing packing materials on all sides to provide a firm cushion and to prevent the instrument from sliding. Protect control panel exposed parts and connectors with cardboard.
3. Protect pre-wrapped cables and accessories with cardboard separators.

2.2.5 Communicating with the Company

Telephone numbers for Sales/Marketing and Engineering Inquires:

Voice phone: (413)-582-9620 FAX: (413)-582-9622

Shipping Hardware to Company:

Millitech, Inc.
29 Industrial Drive East
Northampton, MA 01060 U.S.A.

Mailing address for Sales/Marketing and Engineering Inquiries:

Millitech, Inc.
29 Industrial Drive East
Northampton, MA 01060 U.S.A.

2.2.6 Storage and Shipping Environment

These instruments may be stored or shipped in environments within the following limits:

Temperature: -40°C to +75°C
Humidity: 5% to 95% relative at 0°C
Altitude: Up to 15,240 meters (approximately 50,000 feet)

These instruments should also be protected from temperature extremes, which may cause condensation in the instrument.

2.3 INTERCONNECTION

The following are the installation instructions for the W/G Switches:

1. Connect the male end of the 9-pin "D" connector cable to the rear panel female "D" connector labeled **"MOTOR OUTPUT"** on the controller assembly.
2. Connect the female end of the 9-pin "D" connector cable to the male 9 pin "D" connector on the W/G Switch assembly.
3. Connect the AC cord to the rear panel IEC connector labeled **"AC POWER"**.
4. Plug the other end of the AC cord into a wall socket with the appropriate AC voltage.

2.4 PERFORMANCE VERIFICATION

Once the steps in Section 2.3 are completed, perform the following procedures to verify the proper operation of the W/G Switch. These steps should be performed when the equipment is first received and when problems are suspected.

2.4.1 Local Operation


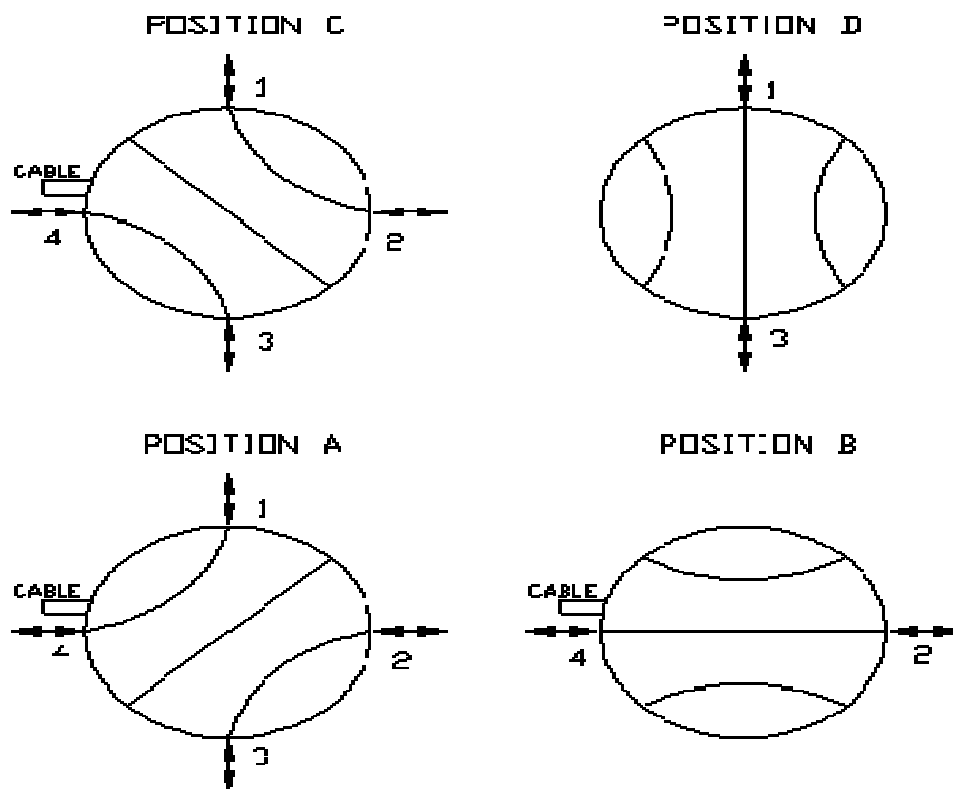
1. Set the front panel "**REMOTE/LOCAL**" switch to the "**LOCAL**" position.
2. Turn on the switch marked "**POWER**".
3. The LED's on the front panel should indicate the ports that are currently connected and the W/G Switch will drive to Position "A".
4. Press the button marked . The W/G Switch will move to the next position. Reset will return the W/G Switch to Position "A".

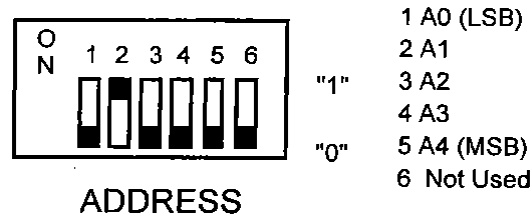
Figure 1: Waveguide Switch Position (Top View)



2.4.2 Remote Operation

1. On the rear panel, set the dipswitch marked "**ADDRESS**" to a valid IEEE-488 address. The unit is shipped from Millitech with the address set at "2". Addresses are formed by the addition of the binary weight of the switches in the "**ON**" position. The "**ON**" position is a logical "1" and the opposite is a logical "0". The least significant bit is the switch position marked by a "1". The example shown below is as the switch should look when shipped from Millitech (Address "2").

The "ADDRESS" switch is read only once, on power up of the instrument, so if a change in address is needed, the power must be cycled as well.



2. Connect an appropriate IEEE-488 connector and controller to the rear panel connector labeled "GPIB".
3. Switch the front panel "REMOTE/LOCAL" switch to the "REMOTE" position.
4. Send a command from the controller that sets the W/G Switch position to Position "A" (refer to the programming command list below). If the W/G Switch is already in Position "A", no action will occur. Otherwise, the W/G Switch will rotate to the correct position and the front panel LED display will indicate the connected ports.

Below are the IEEE-488 commands that the controller recognizes as implemented in HP Basic v 2.0 and above:

FUNCTION	HP BASIC COMMAND	DATA RETURNED
1. Set W/G Switch Position	<p>OUTPUT 702;"A"</p> <p>Set W/G Switch position at device located at GPIB Address "2" to Position "A".</p>	<p>None</p> <p>Controller accepts 1 character of the form "c" followed by a CR/LF terminator combination. The controller does not look at EOL. There is error checking of the ASCII data. Too few characters (followed by a CR/LF combination) will be ignored (as long as the string is terminated somewhere by a CR/LF). The GPIB data handshake is held off on the 'LF' byte to allow the controller to process the incoming data and send it on to the W/G Switch hardware. When all of the required processing is completed, the handshake is completed.</p>
2. Version/Date string read back command	<p>OUTPUT 702;"V"</p> <p>Send 'V' (upper case ASCII V) to W/G Switch at GPIB Address "2" so that next status read will produce controller's software Version and Date string.</p>	<p>None</p> <p>The controller will accept the letter "V", followed by a CR/LF combination. If this is received, then the next ENTER 7xx;a\$ command will receive a version string including the software rev level and date.</p>
3. Read back last command and	<p>ENTER 702;a\$</p>	<p>Data returned in string variable a\$ As shown in</p>

status	Return status from device at GPIB Address "2".	<p>the example above, a\$ would look like "A" assuming no errors were returned.</p> <p>Controller echoes back the last valid GPIB WIG Switch command and status, returning exactly 1 ASCII character ("c"), followed by an ASCII digit representing the status, followed by a CR/LF terminator combination. The returned status digit may be:</p> <p>'0' - all OK '1' - error in reaching position '2' - last data sent was bad '3' - failed to find home sensor when expected</p> <p>No EOI is sent with the last byte. As noted above, if the "V" command was sent to the W/G Switch, the next status read-back will receive a software version date string. Please delay 100 milliseconds between a W/G Switch setting command and a subsequent status read. If the previous command sent was the 'V' command, the Version/Date string is returned, which consists of 13 ASCII bytes followed by a CR/LF combination of the form "1.20_09/17/93".</p>
4. Status Poll Enable (SPE)	<p>SPOLL (702)</p> <p>Do a serial status poll of GPIB Address "2".</p>	<p>Controller reads and returns the status with 1 ASCII digit representing the status, followed by a CR/LF terminator combination. The returned status digit may be:</p> <p>'0' - all OK '1' - error in reaching position '2' - last data sent was bad '3' - failed to find home sensor when expected</p>
5. Device Clear (DCL)	<p>CLEAR 702</p> <p>Clear the device at GPIB Address "2".</p>	Controller causes the W/G Switch to go to Position "A".
6. Group Execute Trigger (GET)	<p>TRIGGER 702</p> <p>Trigger the device at GPIB Address "2".</p>	Controller recognizes this GPIB command but takes no action.

NOTE: "d" = Digit; "c" = ASCII Character

More detailed information and a low level description of the commands are located in Section 3.3.2:
Remote Operation


3.0 OPERATION

3.1 INTRODUCTION

This section contains information and procedures required to operate the W/G Switches.

3.2 OPERATIONAL OVERVIEW

The W/G Switch has been derived from Millitech's highly successful series of manually operated precision waveguide switches. Each W/G Switch consists of a rotary precision switch connected mechanically to a precision stepping motor. The position of the W/G Switch is determined by an indexing sensor attached to the motor body.


At power up or when the RESET button is pushed, the controller commands the W/G Switch to find Position "A". Successive positions can be obtained from pushing the front panel switch marked .

3.3 OPERATING INSTRUCTIONS

Two means of operating the W/G Switch are provided:

1. Local operation via the controller's front panel pushbutton switches.
2. Remote operation via the controller's rear panel "GPIB" connector.

3.3.1 Local Operation

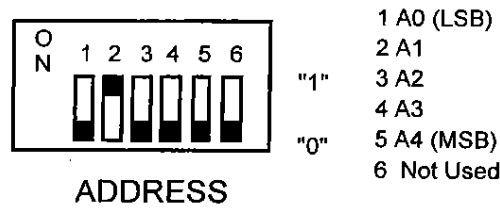
Local operation can be accomplished by pushing the button marked  on the front panel. Each time the button is pushed, the W/G Switch will advance clockwise and the front panel LED's will indicate which ports are connected.

The unit can be reset and the W/G Switch returned to Position "A" by pushing the "RESET" button.

3.3.2 Remote Operation

Remote operation means that the controller will accept commands through the "GPIB" connector on the rear panel of the controller. The interface conforms to IEEE-488 1978 standards and will accept commands to set the W/G Switch's position or read back the last command and current status of the W/G Switch or the software version and date. The controller CANNOT function independently or communicate on the IEEE-488 bus without being connected to the W/G Switch assembly.

1. On the rear panel, set the dipswitch marked "**ADDRESS**" to a valid IEEE-488 address. The unit is shipped from Millitech with the address set at "2". Addresses are formed by the addition of the binary weight of the switches in the "**ON**" position. The "**ON**" position is a logical "1" and the opposite is a logical "0". The least significant bit is the switch position marked by a "1". The example shown below is as the W/G Switch should look when shipped from Millitech (Address "2"). The "**ADDRESS**" switch is read only once, on power up of the instrument, so if a change in address is needed, the power must be cycled as well.



2. Connect an appropriate IEEE-488 connector and controller to the rear panel connector labeled "GPIB".
3. Switch the front panel "**REMOTE/LOCAL**" switch to the "**REMOTE**" position.

Send a command from the controller that sets the W/G Switch position to Position "A". If the W/G Switch is already in Position "A", no action will occur. Otherwise, the W/G Switch will rotate to the correct position and the front panel LED display will indicate the connected ports.

3.3.2.1 Remote Operation Programming Commands

The GPIB interface is designed to be easy to use and simple to program. The controller monitors the GPIB bus in remote mode and looks for a sequence of three command bytes as listed below:

UNL/UNT	The unlisten or untalk command
MTA/MLA	The bus controller's W/G Switch's listen or talk address

If the MTA/MLA matches the W/G Switch's GPIB address, then the W/G Switch controller will respond, depending on whether it is the listener or talker.

If the W/G Switch controller is the listener, it will expect one of two commands listed below:

1. One ASCII character of the form "c", followed by an ASCII carriage return/line feed combination (CR/LF), where "c" are valid ASCII characters "A", "B", "C" or "D". The CR/LF combination is hexadecimal 0d,0A. Therefore, a properly encoded string sent to the W/G Switch controller for a setting of Position "B" at GPIB Address "2" would look like the following string of characters (shown as 0xDD, where 0x indicates base 16 or hexadecimal and DD are any valid hexadecimal digits):

ATN= Command	ATN= Command	ATN= Command	ATN= Data	ATN= Data	ATN= Data
0x3F	0x55	0x22	0x42	0x0d	0x0A
UNL	MTA	MLA	"B"	CR	LF

Normally, the first three characters sent in this string are handled by the bus controller software and are only shown here for clarity.

The W/G Switch controller does not look at the IEEE-488 EOI line. There is error checking performed on the ASCII data. Too few characters (followed by a CR/LF) will be ignored.

Characters beyond the required "c" will be ignored (as long as the string is terminated somewhere by a CR/LF). The GPIB handshake is held off on the LF byte to allow the software to process the incoming data and send it to the W/G Switch hardware. When all the required processing is completed, the handshake is completed.

2. The second command that the W/G Switch controller recognizes is the "**VERSION**" command.

When this command is received, the next valid status read (see Section 3.3.2.2) will contain the software version and date of the W/G Switch controller. This command consists of the ASCII letter "V" (this **MUST** be upper case), followed by a CR/LF combination.

3.3.2.2 Remote Operation Status Read Back

Two status strings are available for readback, depending on what was the command just prior to the read.

1. When the GPIB bus controller addresses the W/G Switch controller as a talker, the W/G Switch controller will respond with two ASCII characters of the form "cd", representing the last command sent to the W/G Switch, followed by one more ASCII digit, representing the status, followed by a CR/LF combination. The returned status digit may be:

"0"	No errors
"1"	Error in reaching position
"2"	Last data sent was bad (out of range or not ASCII)
"3"	Failed to find sensor when expected

No EOI is sent with the last character.

2. The second format of readback will occur if the command just prior to the read was the "V" or "**VERSION**" command. The readback string after the "V" command will be the W/G Switch controller's software version/date string. This string is currently 13 characters long, plus a CR/LF combination, for a total of 15 characters of the form "1.20_09/17/93". This, however, is not guaranteed to be the same for different controllers, since Millitech reserves the right to improve and modify the controller software when necessary.

The programmer should delay approximately 100 milliseconds between sending a command and a subsequent status read.

The W/G Switch Controller also recognizes several other GPIB control line commands:

Serial Poll Enable (SPE)	Status character is returned to the bus controller
Device Clear (DCL)	W/G Switch is homed and set to position "A"
Group Execute Trigger (GET)	W/G Switch recognizes the command but does nothing with it.

3.3.2.3 Table 3-1: IEEE-488 Command Summary Reference

The following assumes the controller address to be "20₁₀" and the WIG Switch address to be "2₁₀".

The proper format for sending W/G Switch position:

ATN= Command	ATN= Command	ATN= Command	ATN= Data	ATN= Data	ATN= Data
0x3F	0x55	0x22	0x42	0x0d	0x0A
UNL	MTA	MLA	"V"	CR	LF

Proper format for sending "VERSION" command:

ATN= Command	ATN= Command	ATN= Command	ATN= Data	ATN= Data	ATN= Data
0x3F	0x55	0x22	0x56	0x0d	0x0A
UNL	MTA	MLA	"V"	CR	LF

When combined with a subsequent Status Read, "VERSION" will return software version/date string.

Proper format for status readback:

ATN= Command	ATN= Command	ATN= Command
0x3F	0x35	0x42
UNL	MLA	MTA

W/G Switch Becomes Talker	ATN= Data	ATN= Data	ATN= Data	ATN= Data
	0x42	0x30	0x0d	0x0A
	"B"	"0"	CR	LF

Proper format for version/date string:

ATN= Command	ATN= Command	ATN= Command
0x3F	0x35	0x42
UNL	MLA	MTA

W/G Switch Becomes Talker	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN =Data	ATN= Data	ATN =Data
	0x31	0x2E	0x32	0x30	0x5F	0x30	0x39	0x2F	0x31	0x37	0x2F	0x39	0x33	0x0d	0x0A
	"1"	","	"2"	"0"	"_"	"0"	"9"	"/"	"1"	"7"	"7"	"9"	"3"	CR	LF

Below are the IEEE-488 commands that the controller recognizes as implemented in HP Basic v 2.0 and above:

FUNCTION	HP BASIC COMMAND	DATA RETURNED
1. Set W/G Switch	OUTPUT 702;"B" Set W/G Switch at device located at GPIB Address "2" to Position "B".	None Controller accepts I character of the form "c" followed by a CR/LF terminator combination. The controller does not look at Ear. There is error checking of the ASCII data. Too few characters (followed by a CR/LF combination) will be ignored (as long as the string is terminated somewhere by a CR/LF). The GPIB data handshake is held off on the 'LF' byte to allow the controller to process the incoming data and send it on to the W/G Switch hardware. When all of the required processing is completed, the handshake is completed.
2. Version/Date String Read Back Command	OUTPUT 702;"V" Send 'V' (upper case ASCII V) to W/G Switch at GPIB Address "2" so that next status read will produce controller's software Version and Date string.	None The controller will accept the letter "V", followed by a CR/LF combination. If this is received, then the next ENTER 7xx;a\$ command will receive a version string including the software revision level and date.
3. Read back last command and status	ENTER 702;a\$ Return status from device at GPIB Address "2".	Data returned in string variable a\$. As shown in the example above, a\$ would look like "B" assuming no errors were returned. Controller echoes back the last valid GPIB W/G Switch command and status, returning exactly 1

<p>4. Status Poll Enable (SPE)</p>	<p>SPOLL(702)</p> <p>Do a serial status poll of GPIB Address "2".</p>	<p>ASCII character ("c"), followed by an ASCII digit representing the status, followed by a CR/LF terminator combination. The returned status digit may be: '0' - all OK.</p> <p>'1' - error in reaching position</p> <p>'2' - last data sent was bad</p> <p>'3' - failed to find home sensor when expected</p> <p>No EOI is sent with the last byte. As noted above, if the "V" command was sent to the W/G Switch, the next status readback will receive a software version date string. Please delay 100 milliseconds between a W/G Switch setting command and a subsequent status read. If the previous command sent was the 'V' command, the Version/Date string is returned, which consists of 13 ASCII bytes followed by a CR/LF combination of the form "1.20_09/17/93".</p> <p>Controller reads and returns the status with one ASCII digit representing the status, followed by a CR/LF terminator combination. The returned status digit may be:</p> <p>'0' - all OK</p> <p>'1' - error in reaching position</p> <p>'2' - last data sent was bad</p> <p>'3' - failed to find home sensor when expected.</p>
<p>5. Device Clear (DCL)</p>	<p>CLEAR 702</p> <p>Clear the device at GPIB Address "2".</p>	<p>Controller causes the W/G Switch to reset at Position "A".</p>
<p>6. Group Execute Trigger (GET)</p>	<p>TRIGGER 702</p> <p>Trigger the device at GPIB. Address "2".</p>	<p>Controller recognizes this GPIB Command, but takes no action.</p>

4.0 MAINTENANCE

4.1 INTRODUCTION

This section contains maintenance instructions for the W/G Switch and controller. Minimum performance verification checks included in Section 2.4 should be performed whenever any doubt about the W/G Switch performance arises.

4.2 OPERATOR CHECKS

Operator checks are procedures designed to verify that there are no initial functional problems with the W/G Switch. These checks can be used as incoming inspection criteria or as a quick check prior to installation into the system.

4.2.1 Functional Checks

Make the interconnection between the W/G Switch assembly and the controller assembly as discussed in Section 2.0. Verify that the W/G Switch functions according to Section 2.4.

4.3 TROUBLESHOOTING GUIDE

This guide contains information for troubleshooting the W/G Switch assembly and the controller assembly. In the event of a malfunction, check first for obvious causes:

1. Operator error
2. Incorrect AC power or fuse blown
3. Loose cable connections
4. Obvious physical damage

If the cause of the problem cannot be isolated, then contact Millitech Inc.'s Sales Department, as discussed in Section 2.0 for repairs. The W/G Switch has no field replaceable parts.

5.0 APPENDIX

Below are several program segments for HP Basic.

```

10 !THIS PROGRAM RUNS ON HP 9816 COMPUTER. FILE:SW_REV1
20 !SET SWITCH ADDRESS TO 2.
30 !*****
40 !*
50 !THE FOLLOWING LINES SHOW HOW TO COMMUNICATE WITH THE
60 !CONTROLLER USING GPIB LANGUAGE
70 !NOTE THE USE OF THE Unlisten, My Talk Address, AND
80 !My Listen Address GPIB COMMANDS
90 !
100 INPUT "INPUT SWITCH POSITION A, B, C, D", P$           !P$ HOLDS NEW POSITION
110 SEND 7;CMD UNL MTA LISTEN 2 DATA P$, 13, 10        !VALUE SENT TO SWITCH
120                                                       !13=CR, 10=LF.S
130 WAIT.1
140 SEND 7;UNL MTA TALK 2                                !VALUE READ BACK FROM SWITCH
150 ENTER 7;D$
160 PRINT "SWITCH IS AT POSITION",D$
170 PRINT
180 !
190 ! *****
200 ! *****
210 !*
220 !THE FOLLOWING LINES DO THE SAME THING AS THE PREVIOUS PROGRAMMING
230 !LINES BY USING THE NUMERIC VALUES FRO THE GPIB COMMANDS.
240 !I
250 INPUT "INPUT SWITCH POSITION A, B, C, D",P$
260 SEND 7;CMD 63, 85, 34 DATA P$, 13, 10
270 WAIT.1
280 SEND 7;CMD 63, 53, 66
290 ENTER 7;D$
300 PRINT "SWITCH IS AT POSITION",D$
310 PRINT
320 !
330 ! *****
340 ! *****
350 !*
360 !THE FOLLOWING LINES DO THE SAME THING AS THE PREVIOUS PROGRAMMING
370 !SEGMENTS BY USING THE HP 9816 BASIC LANGUAGE.
380 !
390 ASSIGN @Dev TO 702
400 INPUT "INPUT SWITCH POSITION A, B, C, D",P$
410 OUTPUT @Dev;P$
420 WAIT.1
430 ENTER @Dev;D@
440 PRINT "SWITCH IS AT POSITION",D$
450 PRINT
460 GOTO 100
470 END

```