# *Model 3955*

*Dual Channel, Low-Pass*
*170Hz to 25.6MHz, 24dB/Octave Slope*
*Tunable Active Filter*

KROHN-HITE CORPORATION

## *Operating Manual*

# *Service and Warranty*

*Krohn-Hite Instruments are designed and manufactured in accordance with sound engineering practices and should give long trouble-free service under normal operating conditions. If your instrument fails to provide satisfactory service and you are unable to locate the source of trouble, contact our Service Department at (508) 580-1660, giving all the information available concerning the failure.*

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# *Model 3955*

*Butterworth*
*4-Pole Dual Channel Filter*
*170Hz to 25.6MHz Cutoff Frequency Range*

Serial No. _____

# Operating Manual

KROHN-HITE CORPORATION

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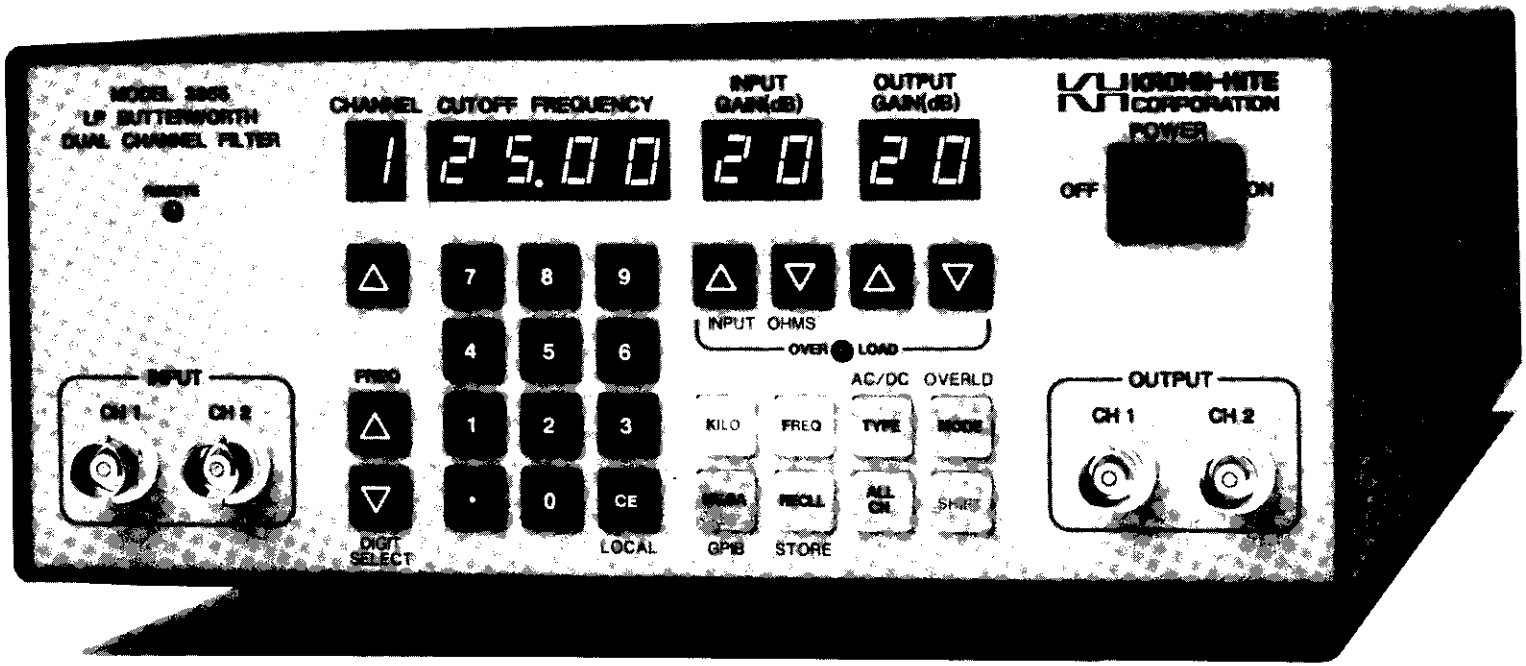
MODEL 3905
LP BUTTERWORTH
DUAL CHANNEL FILTER
CHANNEL
CUTOFF FREQUENCY
1
25.00
INPUT GAIN(dB)
20
OUTPUT GAIN(dB)
20
KRON-HITE CORPORATION
POWER
OFF
ON
INPUT OHMS
OVER LOAD
AC/DC
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.
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CE
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CH 1
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# SECTION 1

# GENERAL DESCRIPTION

## 1.1 INTRODUCTION

The Krohn-Hite Model 3955 programmable, dual channel, low-pass filter is the first dual low-pass programmable filter of its kind, covering the wide cutoff frequency range from 170Hz to 25.6MHz with 2½ digits of resolution. The 3955 is a 4-pole, maximally flat (Butterworth) filter, with an attenuation slope of 24dB/octave and a stopband attenuation of >100dB.

The filter has selectable ac or dc coupling and selectable 1M or 50 ohm input impedance. Programmable input gains to 20dB and output gains to 26dB are standard.

The Model 3955 also has the capability to be used in an "amplifier bypass" mode to operate as an amplifier, bypassing the filter. This gives the user the ability to amplify without filtering when so desired.

## 1.2 SPECIFICATIONS (each channel)

### 1.2.1 Function

Two independent, low-pass filter channels; amplified bypass.

### 1.2.2 Filter Mode

**Filter Type:** 4-Pole, Butterworth, low-pass.

**Attenuation Slope:** 24dB/Octave.

**Tunable Frequency Range:** 170Hz to 25.6MHz.

**Cutoff Frequency Resolution:** 10Hz, 170Hz to 2.56kHz; 100Hz, 2.6kHz to 25.6kHz; 1kHz, 26kHz to 256kHz; 10kHz, 260kHz to 2.56MHz; 100kHz, 2.6MHz to 25.6MHz.

**Frequency Control:** Keypad entry or increment, decrement keys.

**Cutoff Frequency Accuracy:** ±2% to 2.56MHz, ±5% to 25.6MHz.

**Passband Response:** ±0.2dB up to 2.56MHz, ±0.5dB to 25.6MHz.

**Stopband Attenuation:** 100dB to 1MHz; 80dB at 10MHz; 70dB at 30MHz; 60dB at 50MHz; 50dB to 100MHz.

**Input/Output Coupling:** AC or DC. AC coupling cutoff is approximately 16Hz at the input and 10Hz at the output with a 50W termination. Note that the internal 50 ohms input termination is before the AC coupling.

**Noise Spectral Density (10kHz to 100MHz referred to input):** Below –128dBm/Hz into 50 ohms. This translates into a wideband noise power or voltage for a 30MHz BW of below –53dBm or 500mVrms referred to input.

**Harmonic Distortion (1Vrms sinewave):** >–60dB below signal up to 100kHz (0.1%). All harmonics below 50dB to 1MHz; below 40dB above 1MHz.

**Spurious Signals:** Below –80dBm to 65MHz; below –75dBm to 100MHz. Referred to input represented in voltage form: 22mV and 40mV respectively.

**DC Stability:** ±0.5mV/°C referred to input.

### 1.2.3 Amplifier Mode (each channel)

**Bandwidth:** >50MHz.

**Rise and Fall Time:** <7ns with 0dB input gain 6dB output gain; <10ns with +20dB input or output gain. <5% ringing or overshoot.

**Input:**

Pre-Filter Gain: 0dB, +10dB, +20dB; ±0.1dB.

Impedance: Selectable 1M ohms or 50 ohms, ±2%, shunted by 65pF.

Maximum Signal: ±1.5V peak with 0dB input gain, reduced in proportion to input gain selected.

Maximum Input Without Damage: 12Vrms with input terminator OFF, 7Vrms with input terminator ON.

DC Blocking Voltage: 200V. Note that the internal input termination is before the AC coupling and can only tolerate 7Vrms when ON.

**Output:**

Post-Filter Gain: 0dB, +6dB, +20dB, +26dB; ±0.1dB.

Maximum Signal: ±3V peak open circuit; ±1.5V peak into 50 ohms.

Impedance: 50 ohms, ±2%.

DC Level: Adjustable to Zero.

### 1.2.4 General

**Memory:** 99 selectable groups; memory is non-volatile battery-backed CMOS.

**Overload Modes:** Three selectable modes; non-latching, that monitors all channels and displays the first channel to have an

overload; latching, that maintains the overload display until it is cleared; and no indications.

**Overload Indicators:** LEDs for input and output. Gain display flashes when overload occurs on displayed channel.

**Self-Test Diagnostics:** MPU checks unit upon power-up. Display indicates failure mode.

**Displays:** 7 segment, green, LED; 0.3" high.

**Remote Programming:** IEEE-488/1978 GPIB interface. Subsets: SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT0, C0, E1.

**Operating Temperature:** 0°C to 50°C.

**Isolation to Chassis:** ±200Vdc.

**Storage Temperature:** –20°C to 70°C.

**Input/Output Connectors:** BNC, front and rear.

**Power Requirements:** 90-132/180-264 volts ac, 50Hz-400Hz, 25 watts.

**Dimensions:** 3½" (9cm) high, 8½" (21.8cm) wide, 18" (46.2cm) deep.

**Weights:** 12 lbs (5.4kg) net; 14 lbs (6.3kg) shipping.

**Accessories:** 6 foot, 3 terminal line cord; operating and maintenance manual.

### 1.2.5 Options

**Rack Mount Kit:** Part No. RK-37, permits installation of the Model 3955 into a standard 19" rack spacing.

Specifications apply at 25°C ±10°C.

## 1.3 SHIPPING TO KROHN-HITE FOR REPAIR OR CALIBRATION

All shipments of Krohn-Hite Corporation instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original shipping carton; or if it not available, use any suitable container that is rigid and is of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least 4 inches of excelsior or similar shock-absorbing material.

## 1.4 CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing list unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the Krohn-Hite Service Department at (508) 580-1660.) Final claim and negotiations with the carrier must be completed by the customer.

## 1.5 EXTERNAL CLEANING

### NOTE

To avoid electrical shock or instrument damage, never get water inside the case. To avoid instrument damage, never apply solvents to the instrument.

Should the Model 3955 case need cleaning, wipe the instrument with a cloth that is lightly dampened with water or a mild detergent solution.

# SECTION 2

# OPERATION

## 2.1 INTRODUCTION

The Model 3955 is a dual, low-pass, Butterworth filter covering the frequency range from 170Hz to 25.6MHz. All filter parameters are programmable via the front panel keyboard controls or remotely over the IEEE-488 (GPIB) bus.

The filter has two modes of operation: filter mode and amplifier mode. Each mode will be explained in detail in this section.

## 2.2 TURN-ON PROCEDURE

The Model 3955 line voltage range has been preset for either 115V or 230V operation. To change this setting, remove the bottom cover to expose the line switch. Be sure to change the fuse to the proper rating for the line switch setting selected.

Make certain the POWER switch on the front panel is off.

Plug the line cord into the unit, then the ac outlet.

If the Model 3955 is to be programmed remotely, connect the bus cable to the rear panel connector of the 3955.

After reading the Self-Test feature, described next, turn on the Model 3955.

## 2.3 SELF TEST

When the Model 3955 is turned on, the microprocessor performs a self-test routine whereby the entire RAM and ROM operation is verified. During the test, the front panel LEDs and DISPLAYS will light sequentially. If there is a malfunction on the microprocessor board, such as a defective RAM or ROM, the sequence will stop and the word "bad" will appear in the DISPLAY followed by a number 1, 2 or 3. Refer to Section 6, Maintenance, to find which RAM or ROM is defective.

When the self-test program is complete, the Model 3955 will return to the last set-up prior to turning the unit off. The Model 3955 is now ready to operate.

## 2.4 FRONT PANEL CONTROLS AND DISPLAY

### 2.4.1 Data Keys And Display

Data entry keyboard controls [0] to [9] and [.] set the numeric value of any parameter selected. To enter 1.5kHz press the [1][.][5] keys and the paramter key [KILO] and [FREQ]. The cutoff frequency will be indicated in the DISPLAY. To enter 6dB of Output Gain, press [6] key and either the up [Δ] or down [∇] control key below the Output Gain display.

### 2.4.2 Parameter And Control Keys

**[KILO]** When pressed, multiplies the numeric value of the keyboard entry by $10^3$.

**[MEGA]** When pressed, multiplies the numeric value of the keyboard entry by $10^6$.

**[FREQ]** When pressed, enters and/or displays frequency in Hertz.

**[TYPE]** When pressed, DISPLAY indicates the filter type, "bu." (Butterworth).

**[MODE]** When pressed, DISPLAY indicates the mode of operation for the channel displayed. "GAin" for amplifier mode, "L.P - 1." for low-pass mode.

**[RECLL]** When preceeded by a number, it will recall the entire instrument set-up from the memory location selected.

When first pressed, the DISPLAY indicates the number of the memory location to be recalled. For example, the DISPLAY will indicate the following: "n=09". Pressing the [RCLL] key again will recall the entire instrument set-up from memory location "09".

When pressed to indicate the memory location to be recalled only, pressing the [CE] (clear entry key) will restore the DISPLAY to the cutoff frequency setting.

**[ALL CH]** When frequency, input/output gain, type, mode or coupling are entered or changed, and the LED in the [ALL CH] key is lit, the new setting will be entered in both channels of the filter.

**[SHIFT]** The [SHIFT] key in conjunction with other keys (keys with red lettering under them) provide additional filter characteristics, and permits front panel entry of the type of GPIB line termination and address.

Overload Detection — When [SHIFT][MODE] is first pressed, the DISPLAY will indicate the overload mode currently selected. Pressing a number from [1] to [3] then [SHIFT][MODE] will select the following overload conditions:

[1][SHIFT][MODE] will select no overload indication.

[2][SHIFT][MODE] will select the non-latching mode. The unit will monitor all channels and display the first channel to have an overload.

[3][SHIFT][MODE]will select the latching mode. In this mode, the unit will maintain the overload display until it is cleared.

Store — When [SHIFT] [RECLL] is first pressed, the DISPLAY indicates the number of the next memory location available. For example, the DISPLAY will indicate the following: "n=09". Pressing [RECLL] again will store the entire instrument set-up into that memory location. If another memory location is desired, enter that location on the keyboard and then press [SHIFT] [RECLL].

When [SHIFT] [RECLL] is preceded by a number (0-98), the filter will store the entire instrument set-up into the memory location selected. The maximum number of memory groups is 99.

When [SHIFT] [RECLL] is pressed to indicate the next memory location only, pressing the clear entry key [CE] will restore the DISPLAY to the cutoff frequency setting.

AC/DC Coupling — Pressing the [SHIFT] key followed by the [TYPE] key will display the input coupling, indicating "AC" or "dC", and will alternate between the two.

GPIB Address — When the [SHIFT] key followed by the [MEGA] key are pressed, the DISPLAY will indicate the existing GPIB address setting. To select a different address setting, enter the address number in the data keys from [0] to [30] and press the [SHIFT] followed by the [MEGA] key (see Section 3.2.1 for GPIB addressing information).

GPIB Line Termination — When the [SHIFT] key followed by the [ALL CH] key are pressed, the DISPLAY will indicate the existing GPIB Line Termination Code sequence. To select a different one, enter a number from [0] to [4] and press [SHIFT] [ALL CH] keys (see Section 3.2.1 for line termination information).

Software Version — When the [SHIFT] key followed by the [KILO] key are pressed, the DISPLAY will indicate the software version installed (i.e. 3.7).

**[CE]** When entering a numeric value in the keyboard, but not specifying a parameter, pressing the clear entry key will function as an error correction procedure and restore DISPLAY to the current numeric setting.

When a numeric value and its parameter has been entered, pressing the [CE] key will restore DISPLAY to the previous value of that parameter.

When either the[SHIFT][STORE] or [RECALL] keys are pressed, the next memory location will be indicated on the DISPLAY. Pressing the [CE] key will restore DISPLAY to the current parameter setting.

If the Model 3955 is operating via the IEEE-488 bus (the front panel REMOTE LED is "on"), pressing the [CE] key will return unit to LOCAL operation.

Pressing [CE] will toggle between present parameter setting and the previous parameter setting.

### 2.4.3 Channel Selection

The up [Δ] or down [∇] control key below the CHANNEL display alternates the channel settings.

### 2.4.4 Cutoff Frequency

Data entry keyboard controls [0] to [9] and [.] set the numeric value of the cutoff frequency desired. To select 1.5kHz, press the [1][.][5] data keys and parameter keys [KILO] and [FREQ]. The cutoff frequency for the channel selected will be indicated in Hertz on the four digit DISPLAY (when [ALL CH] mode is selected, the frequency will be changed on both channels). The KILO and FREQ keys will be lit. Also see 2.4.7.

### 2.4.5 Input Gain (Pre-Filter)

Up [Δ] and down [∇] INPUT GAIN SET controls increase or decrease the input amplifier by 10dB. The two digit DISPLAY will indicate either 0dB, 10dB or 20dB.

### 2.4.6 Output Gain (Post Filter)

Up [Δ] and down [∇] OUTPUT GAIN SET controls increase or decrease the output amplifier. The two digit DISPLAY will indicate the following selection 0dB, 6dB, 20dB or 26dB.

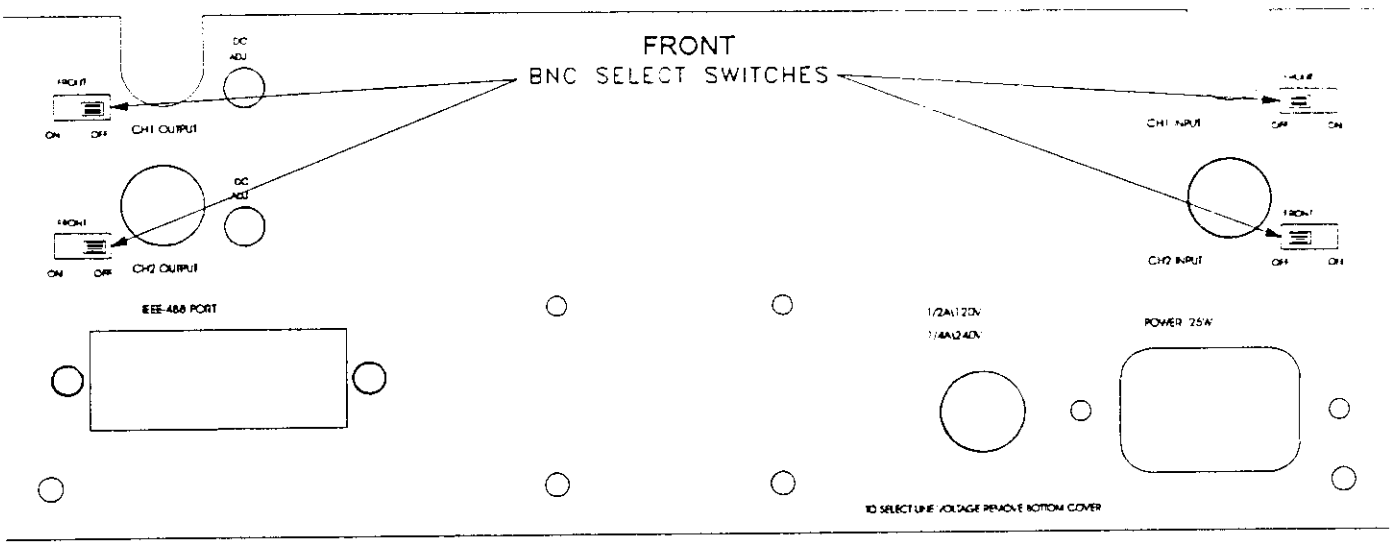


**Figure 2.1** Rear Panel of Model 3955

### 2.4.7 Digit Select/Increment and Decrement

When the [SHIFT] key is pressed, followed by the DIGIT SELECT [Δ] or [∇] keys, the DISPLAY will intensify the first or second digit. Pressing the [SHIFT] followed by the [Δ] or [∇] key again, will intensify the next digit or will turn the DIGIT SELECT off. Pressing the [Δ] or [∇] keys will then increment or decrement the intensified digit.

**NOTE:** *The intensified digit will only increment or decrement within the resolution in that band.*

### 2.4.8 Key Click Feature On/Off

When the [SHIFT] key is pressed, followed by the [Δ] key under the CHANNEL display, the key click feature will either toggle on or off.

## 2.5 REAR PANEL CONTROLS AND CONNECTORS

### 2.5.1 Introduction

Model 3955 rear panel consists of the following: two input and two output BNC connectors, front panel terminal selection switches and dc level adjustments, a fuse holder, GPIB bus connector and an ac receptacle.

#### 2.5.1.1 Front Terminal Selection Switches

The Model 3955 has an input and output front panel BNC connector selection switch for each channel. For optimum performance, this switch should be in the on position when using the front panel connectors, and off when using the rear BNC connectors.

### 2.5.2 BNC Connectors and Indicators

#### 2.5.2.1 Input Connectors

The Model 3955 has two input BNC connectors on both the front and rear panels. The inputs are labeled CH1 and CH2.

#### 2.5.2.2 Output Connectors

The Model 3955 has two output BNC connectors on both the front and rear panels.

### 2.5.3 DC Level Adj (Rear Panel)

Proper procedure for adjusting input and output dc levels can be found in the Calibration section of this manual.

There are two DC Adj potentiometers located on the rear panel of the Model 3955. They are for adjusting the DC level at the output BNC connector.

### 2.5.4 Power

**Receptacle:** Standard 3 pin.

Fuse: 1/2 amp slow-blow for 120V operation; 1/4 amp slow-blow for 230V operation. To change this setting, refer to Section 2.2.

### 2.5.5 GPIB Connector

Standard IEEE-488 interface. Subsets are SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT0, C0 and E1.

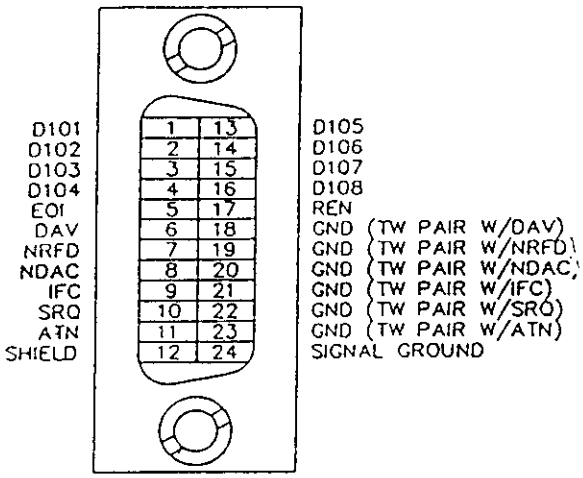


**Figure 2-2** GPIB Connector

## 2.6 FILTER OPERATION

### 2.6.1 Introduction

The Model 3955 is a filter with two identical channels that can function independently. Each channel is a low-pass filter with 24dB/octave rolloff or a voltage gain amplifier with up to 46dB of gain.

### 2.6.2 Amplitude Response

Each channel of the Model 3955 has a rolloff rate of 24dB/octave. The amplitude response characteristics of each channel are shown in Figure 2.3.

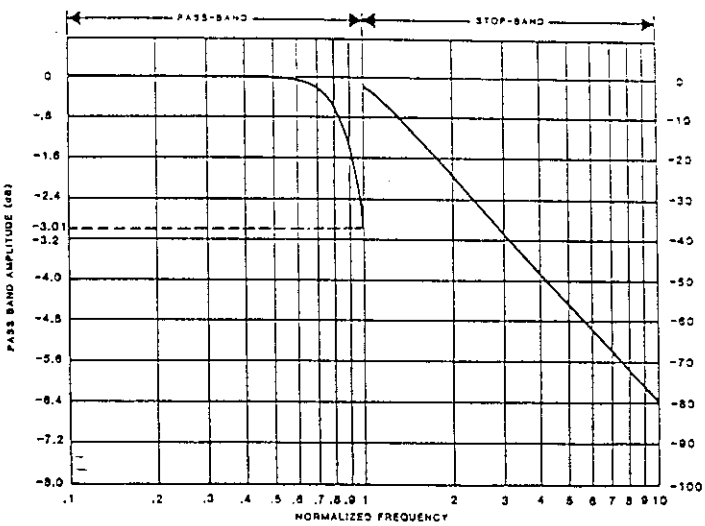


**Figure 2-3** Amplitude Response

### 2.6.3 Operating Procedure

Plug the Model 3955 into the power line. Connect the signal to be filtered to channel 1 or 2. Select the channel where the signal is connected. Set the filter to the desired MODE (gAin or L.P.). Enter the desired cutoff frequency. The output signal will be at the corresponding output channel.

### 2.6.4 Jumper Settings For Front And Rear Panel BNC Operation

To achieve clean high frequency signal performance from the rear input and output BNCs, it is neccessary to change each rear panel FRONT switch to OFF (shown in Figure 2.1). This will disconnect the front panel BNC input and output BNC connectors.

# SECTION 3

# IEEE-488 STD (GPIB) PROGRAMMING

## 3.1 INTRODUCTION

The Model 3955 remote programming interface accepts both ASCII data commands and IEEE-488 standard commands (ATN true) for control of the unit.

In presenting the information required to program the Model 3955 via the IEEE-488 STD bus, this manual presupposes a user knowledge of both ASCII data and IEEE-488 bus commands.

## 3.2 PRELIMINARY PROGRAMMING INFORMATION

### 3.2.1 GPIB Primary Bus Address

The GPIB primary address and software line-termination-character-sequence (LTCS) selection is set via the front panel keyboard as listed in Tables 3.1 and 3.2. These two parameters are stored in non-volatile memory and will be remembered indefinitely, even when the power to the unit is removed. They do not need to be reentered each time the unit is turned on.

The LTCS affects the GPIB in the TALKER mode only (data output from the 3955 to the GPIB). After the printable characters have been sent, non-printable characters, such as carriage return (CR) and line feed (LF), are often required to achieve the desired results in various computers. Table 3.2 lists the various key sequences with the LTCS it selects.

**SETTING AND DISPLAYING THE GPIB PRIMARY ADDRESS**

| | Function | Keyboard Entry |
|---|---|---|
| a. | To set a primary address from 0 to 30 | [x][SHIFT][MEGA] |
| b. | To display the primary address | [SHIFT][MEGA] |

**Table 3.1**

**LINE-TERMINATION-CHARACTER-SEQUENCE**

| | Line-Termination Character-Sequence | Keyboard Entry |
|---|---|---|
| a. | None (EOI only) | [0][SHIFT] [ALL CH] |
| b. | Carriage return (with EOI) | [1][SHIFT] [ALL CH] |
| c. | Line Feed (with EOI) | [2][SHIFT] [ALL CH] |
| d. | Carriage return followed by line feed (with EOI) | [3][SHIFT] [ALL CH] |
| e. | Line feed followed by carriage return (with EOI) | [4][SHIFT] [ALL CH] |
| f. | Display present LTCS | [SHIFT] [ALL CH] |

**Table 3.2**

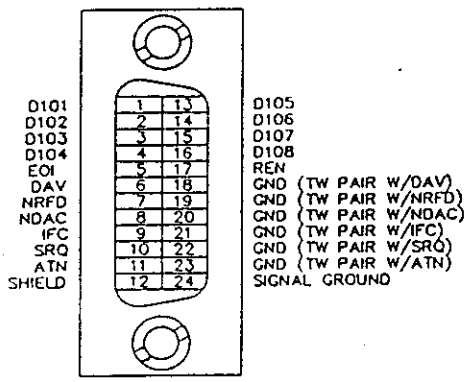


**Figure 3.1** Rear Panel GPIB Connector

### 3.2.2 IEEE-488 Bus Interface Programming Connector

The rear panel programming connector, labeled "IEEE-488 PORT" (Figure 3.1), is the standard bus interface connector as specified in the IEEE-488 STD.

## 3.3 ASCII DATA COMMANDS

### 3.3.1 Format

The Model 3955 employs free-format software commands, allowing the user to program a specific function in several different ways. See Section 3.3.3.

### 3.3.2 Types Of Data Commands

**a.** Commands fall into **two types** : Those involving numeric parameters and those that do not.
Commands which involve numeric data contain (3) types of fields:

**1.** Numeric: Numeric fields may be floating point or scientific notation.

| | | |
|---|---|---|
| 1 | = | 1.0 |
| 1.0 | = | 1.0 |
| 2.7E3 | = | $2.7 \times 10^3$ |
| –2E3 | = | $-2 \times 10^3$ |
| 2E–3 | = | $2 \times 10^{-3}$ |

**2.** Multiplier: "KILO", "MEGA".

**3.** Parameter: Parameter (frequency, gain, channel, etc.) is included in Section 3.3.3.

**b.** Delimiters which may separate commands are the following: (; : / \ .)

**c.** Two consecutive character strings (i.e. parameter and multiplier) must have a space between them or they will be treated as one string.

**d.** The Model 3955 uses an internal 32 character buffer for command processing. A line may be composed of multiple commands, separated by delimiters mentioned above. No commands are executed until the line is terminated with a line feed ASCII character (Hex 0A) or carriage return (Hex 0D) or by sending the end-or-identify (EOI) command with the last character.

### 3.3.3 Table Of ASCII Commands

In this Section there are characters that are underlined and characters that are **NOT** underlined. The characters that are underlined **MUST** be sent for the command to be recognized properly. Any additional characters may be sent once all the underlined letters are sent. Commands are case sensitive; upper case characters **MUST** be used.

MODEL 3955 GPIB COMMANDS

| Command Desired | Allowable Character String | |
|---|---|---|
| Input Gain | IG | set input gain |
| | IU | increase input gain (up) |
| | ID | decrease input gain (down) |
| Frequency | F | frequency |
| | H | frequency (Hz) |
| | K | kilo ($10^3$ multiplier) |
| | ME | Mega ($10^6$ multiplier) |
| Channel | CH | set channel |
| | CU | next channel (up) |
| | CD | previous channel (down) |
| Output Gain | OG | set output gain |
| | OU | increase output gain (up) |
| | OD | decrease output gain (down) |
| Type | TY1 | Butterworth |
| Mode | M1 | Low-Pass |
| | M2 | Gain |
| Coupling | AC | ac coupled |
| | D | dc coupled |
| Store | ST | store |
| Recall | R | recall |
| All Channel | AL | all channel mode |
| | B | NOT all channel mode |
| Misc. | CE | clear entry |
| | OV | overflow (1, 2, 3) |
| | Q | reports board model number(s) (see Section 3.5.4) |
| | SRQON | GPIB service request on |
| | SRQOF | GPIB service request off |
| | V | report model number and software version (see Section 3.5.3) |
| | U | Input unterminate (1M ohm Ch. 2.1 only) |
| | TE | Input terminate (50 ohms Ch. 2.1 only) |

**Alphabetical Listing of Model 3955 GPIB Commands**

| Character String | Command |
|---|---|
| AC | ac coupled |
| AL | all channel mode |
| B | NOT all channel mode |
| CD | channel down |
| CE | clear entry |
| CH | channel # n |
| CU | channel up |
| D | dc coupled |
| F | frequency |
| H | frequency (Hz) |
| ID | input gain down |
| IG | input gain |
| IU | input gain up |
| K | kilo |
| M1 | Low-Pass mode |
| M2 | Gain mode |
| ME | Mega ($10^6$ multiplier) |
| OD | output gain down |
| OG | output gain |
| OU | output gain up |
| OV | overflow mode |
| Q | report board model number(s) (see Section 3.5.4) |
| R | recall |
| SRQON | GPIB service request on |
| SRQOF | GPIB service request off |
| ST | store |
| T1Butterworth Type | Butterworth Type |
| V | report model number and software version (see Section 3.5.3) |
| U | Input unterminate (1M ohm Ch. 2.1 only) |
| TE | Input terminate (50 ohms Ch. 2.1 only) |

### 3.3.4 Examples

#### 3.3.4.1 Example 1

To set channel 1 to 10dB input gain, 2kHz, 0dB output gain: CH1; 10IG;2K;0OG <LF>

*NOTE: It is only necessary to send those parameters that change, all others remain unaffected.*

#### 3.3.4.2 Example 2

To change frequency to 150Hz:

**150H** or 150bHZ
or 150F
or .15K
or F150
or H150
or HZ150
or K0.15
or 1.5E2HZ
or F1.5E2

#### 3.3.4.3 Example 3

To read back the settings of channel 1 (see Section 3.5.1):

Data sent to filter: CH1

Data received from filter: 10b150.0E+0b01.1b00bAC†

Interpretation: 10dB input gain
150Hz cutoff frequency
channel #1
0dB output gain
ac coupled

† *b represents a space*

## 3.4 IEEE-488 STANDARD COMMANDS

These commands are sent with ATN true as described in the standard.

### 3.4.1 Multi-Line Messages

| IEEE-488 Command | Mnemonic | Result |
|---|---|---|
| My listen address | MLA | Enables unit to recieve data. |
| Unlisten | UNL | Disables unit from recieving data. |
| My talk Address | MTA | Designates unit to send data. |
| Untalk | UNT | Disables unit from sending data. |
| Local lockout | LLO | Disables return-to-local key (CE key) on front panel such that when in remote mode, keyboard cannot be activated by pressing a front panel key. |
| Go to local | GTL | Puts unit into local control mode such that front panel keyboard is activated. |
| Device clear | DCL | When the device clear command is sent, the following parameters are changed regardless of their existing settings: Input Gain = 0dB; Output Gain = 0dB; Response = Butterworth; Mode = low-pass; Cutoff Frequency = 1MHz; Coupling = ac; All Channel = off; Overload Mode = 2.. Clears current settings for both channels. It does not clear set-ups stored with [STORE] key. It does not change interface bus parameters and flags, such as: addresses, SRQ ON/OFF, parallel poll bit selected, etc. |
| Selected device clear | SDC | Performs same functions as device clear (DCL) except only if unit is addressed. |

DISCUSSION: (See Section 2.8 and Figure 10 of the IEEE-488 Interface Standard). Note that there are (4) possible states; local, remote, local-with-lockout, and remote-with-lockout. Front panel control is considered to be local while control from the system controller is considered to be remote. Selection of local or local-with-lockout and remote or remote-with-lockout is done several ways. When the unit is addressed to talk (MTA) or listen (MLA), it will enter into remote. When GO-TO-LOCAL (GTL) is sent, it enters into local mode or local-with-lockout mode.

Also, if lockout mode is not invoked by the controller (local lockout command LLO), pressing the [CE] key when the remote LED is on will return control to the keyboard.

NOTE: The lockout mode is not related to whether control is local or remote, only whether control can be returned to local by the [CE] key.

Lockout mode (local-with-lockout and remote-with-lockout versus local and remote) is controlled by the controller. Sending the local lockout command (LLO) selects the local-with-lockout and remote-with-lockout pair versus remote and local without lockout out. Lockout can only be canceled by the controller placing the remote enable line false.

### 3.4.2 Polling Commands

The IEEE standard provides two methods of determining the status of the devices in the system; namely serial poll and parallel poll. The parallel poll produces up to 8 bits of status from up to 8 different units simultaneously. A parallel poll is very fast but provides limited information. The serial poll provides 7 bits of status from one unit at a time.

#### 3.4.2.1 Parallel Polling

The Model 3955 provides for software configuring of which bit and with which polarity the unit should respond. This bit is "true" when an error condition exists. ("ERR" displayed on the panel). Configuring needs to be done only once or anytime the software desires to change the configuration. The commands related to parallel poll are as follows:

For sample sequences, see section 6.5.4 of the IEEE-488 standard.

| IEEE-488 Command | Mnemonic | Result |
|---|---|---|
| Configure | PPC | Places unit into a state where it expects parallel poll enable and disable commands to establish which bits should be set or selected in response to a parallel poll. |
| Unconfigure | PPU | Removes unit from PPC state (UNL does the same, but also unlistens device). |
| Enable | PPE | When unit is in PPC state, it indicates which bit and which polarity the device should respond. Hex codes 60-67 selects bits 0-7 respectively to be set to 0 for a true error response. Since logic 0 is HI on open collector lines, this provides a logical "OR" of all units designated to respond with a given line. Hex codes 68-6F selects bits 0-7 respectively to be set to 1 for a true (error) response. This can provide logical NAND of all units designated to respond with a given line. |
| Disable | PPD | Clears any configuration previously entered. This is valid only when unit is in PPC state. |

**Example**: If the Model 3955 to be configured is unit #5, and we want it to respond with a "1" when an error exists:

| IEEE-488 Command | Result |
|---|---|
| MLA 5 | Addresses unit to be configured. |
| PPC | Places unit into parallel poll configured mode. |
| PPE 8 | Configures bit #0 (Lo 3 bits of command) to respond with a "1" (8's bit) when an error exists. |
| UNL | Unlistens unit. |

For additional sample sequences, see Section 6.5.4 of the Standard.

### 3.4.2.2 Service Request And Serial Polling

The IEEE-488 standard provides serial polling as a method of determining which unit caused a service request. When serial poll enable (SPE) is sent, the system enters into serial poll state. When a unit is addressed to talk, a single status byte will be sent. The hex 40 bit in this byte is true if that unit is requesting service. The remaining bits are used to provide status information. The Model 3955 service request capability is enabled or disabled with the SRQON and SRQOFF commands (see Section 3.3.3). The unit turns on with service request disabled. This is an extension of the standard.

| IEEE-488 Command | Mnemonic | Result |
|---|---|---|
| Enable | SPE | Unit enters serial poll when a unit is addressed to talk. It will send one status byte in which the hex 40 bit is true if the unit is requesting service. |
| Disable | SPD | Unit exists serial poll state. |

### 3.4.2.3 Serial Responses

The chart below lists the error numbers, in decimal notation, resulting a command error either from the bus or not from the bus.

The serial responses are:

1. No error: 0.
2. Error (error numbers in decimal notation); See the chart below.

**Note:** that if SRQ is "**ON**" and the command which caused the error came from the bus, not the front panel, then the 64 bit will be set in the serial poll response, indicating that this unit requires service.

| Error # | Description |
|---|---|
| 1 | Input gain too high or too low. |
| 2 | Frequency too high. |
| 3 | Frequency too low. |
| 4 | Channel # too high. |
| 5 | Channel # too low |
| 6 | Output gain too high or too low. |
| 7 | Store page # too high. |
| 8 | Recall page # too high. |
| 9 | Type # invalid. |
| 10 | Mode # invalid. |

### 3.4.3 Uniline Messages

| IEEE-488 Command | Mnemonic | Result |
|---|---|---|
| End | END | Sent with last byte of data. A line of data may either be terminated by a line feed character or by this command. |
| Identify | IDY | This command, issued by the controller, causes a parallel response which was previously configured by the PPC, PPD, PPE and PPU commands. |
| Request service | RQS | Generated in response to an error when a command came from the bus, and service request is enabled by the SRQON command. |
| Remote enable | REN | When true, allows the 3955 to respond to remote messages. When this line goes false, the unit will go to local-with-lockout state, activating the front panel. |
| Interface clear | IFC | Un-addresses all units and clears all special states. |

## 3.5 TALKER FORMAT

The Talker Software allows an IEEE-488 (GPIB) controller to interrogate the Model 3955 and read back over the bus it's settings (gain, frequency, etc.)

Four different types of data can be sent over the bus: Normally parameter information is returned unless an "OS", "Q" or "V" command is sent to the unit.

### 3.5.1 Parameter Information Format

1. Two (2) digits of input gain.

1a. space

2. Four (4) digits including decimal for frequency or other alpha.

3. If frequency is displayed:

   E+0 if both kilo and mega LEDs are off
   E+3 if kilo LED is on
   E+6 if mega LED is on
   otherwise 3 spaces

3a. space

4. Two (2) digits, a decimal and one digit for channel #

4a. space

5. Two (2) digits for output gain

5a. space

6. "AC" if ac coupled

   "DC" if dc coupled

7. "*" if all channel mode, otherwise a space
   (See Section 3.3.4.3 for example)

### 3.5.2 Model Number and Software Version Format

After sending the "V" command, the next line of data read from the Model 3955 will be as follows:

KROHN-HITE 3955, V3.5

The version number will reflect the revision level of the firmware in the instrument.

This data is returned only once per command; after that it returns to talking what the front panel display is showing.

## 3.6 PROGRAMMING EXAMPLES

The following are programming examples in Microsoft® Quick Basic™, Borland Turbo C and National Instruments IBIC.

### 3.6.1 Example 1 – Microsoft Quick Basic

```
' Microsoft (R) Quick Basic (tm) program for the Krohn-Hite Model 3955
'
'   * Enter this program from DOS by typing: QB 3955 /LQBIB.QLB
'       (the /L switch means tells Quick Basic to load a library)
'
'   * Set the instrument to GPIB address 1:
'       Press 1 [SECOND FUNCTION] [MEGA]
'
'   * Set the instrument for no carriage return or line feed (EOI only):
'       Press 0 [SECOND FUNCTION] [ALL CHAN]
'
'————————— Initialize National Instruments Interface Board ————————
'
'$INCLUDE: 'QBDECL.BAS'
 CLS
 CALL IBFIND("GPIB0", BRD0%): 'initialize access to the board
 CALL IBFIND("DEV1", D3955%): 'init access to the instrument, assumes addr 1!
 CALL IBTMO(D3955%, 10): ' set timeout to 300mS
'
'————————————————— ———— Send/receive the data ———————————————— ————
'
' Set to 500 Hz (500HZ), 0dB input gain (0IG), 0db output gain (0OG),
' Re-display the frequency (F) so it will be read over the bus.
'
 CALL IBWRT(D3955%, "500HZ;0IG;0OG;F"): IF IBSTA% <0 THEN GOTO gpiberr

 ' allocate a buffer (define a string long enough to hold the response)
 ' and read the meter
 Buf$ = SPACE$(40): CALL IBRD(D3955%, Buf$): IF IBSTA% <0 THEN GOTO gpiberr

 'Shorten the buffer to the # of characters actually received and print it
 Buf$ = LEFT$(Buf$, IBCNT%)
 PRINT "Read: "; Buf$

 ' Send UNLISTEN(?), UNTALK(_) so the bus will be in an idle state
 CALL IBCMD(BRD0%, "?_"): IF IBSTA% <0 THEN GOTO gpiberr

'
' Set to 333 Hz, 20dB input gain (20IG), 20dB output gain (20OG),
' and again display frequency in the main display window.
'
 CALL IBWRT(D3955%, "333HZ;20IG;20OG;F"): IF IBSTA% <0 THEN GOTO gpiberr
 Buf$ = SPACE$(40): CALL IBRD(D3955%, Buf$): IF IBSTA% <0 THEN GOTO gpiberr
 Buf$ = LEFT$(Buf$, IBCNT%)
 PRINT "Read: "; Buf$
 CALL IBCMD(BRD0%, "?_"): IF IBSTA% <0 THEN GOTO gpiberr
'
'————————————————————————Cleanup and End————————————————————————
```

```
cleanup:
  CALL IBONL(BRD0%, 0): 'Release the board file handle
  CALL IBONL(D3955%, 0): 'Release the instrument file handle
END

gpiberr:
  PRINT "IBSTA%="; HEX$(IBSTA%); ", IBERR%="; IBERR%: GOTO cleanup
```

### 3.6.2 Example 2 – Borland Turbo C

```
/*
 * Borland Turbo C Example Program for the Krohn-Hite Model 3955 multichannel
 *   filter using the NI-488
 * Should work with Microsoft C also.
 */
*/=============================================== ====================
 *
 * This sample program sends and receives data from a Krohn-Hite model 3955
 *
 *   * In the Borland IDE, place "MCIB.OBJ" in your project list
 *
 *   * Set the instrument to GPIB address 1:
 *       Press [1] [SECOND FUNCTION] [MEGA]
 *
 *   * Set the instrument for no carriage return or line feed (EOI only):
 *       Press [0] [SECOND FUNCTION] [ALL CHAN]
 *
 * This program assumes the name of the device at address 1 hasn't been
 *  changed in IBCONFIG (it's still called DEV1, which is the default.)
 *
 * The status variables IBSTA, IBERR, and IBCNT are defined in DECL.H.
 * Each bit of IBSTA and each value of IBERR are defined in DECL.H as
 * a mnemonic constant for easy recognition in application programs. In
 * this example, these mnemonic definitions are logically ANDed with the
 * variable IBSTA to determine if a particular bit has been set. The mnemonic
 * definitions are equated with the variable IBERR to determine the error
 * code.
 *
 * The function GPIBERR is called when a NI-488 function fails. The
 * error message is printed along with the status variables IBSTA, IBERR,
 * and IBCNT.
 *
 * The NI-488 function IBONL is called from the main body of the program or
 * from the function GPIBERR.  When the second parameter of the function
 * IBONL is zero, the software and hardware are disabled.
 * Execution of this program is terminated after the call to the function
 * IBONL to disable the software and hardware.
 *
 * The function EXIT is used to terminate this program within the function
 * GPIBERR. The exit status is set to 1 to indicate an error has occurred.
 *
*/=============================================== ====================
 */

#include <stdio.h>
#include   <stdib.h>
#include <string.h>

/* DECL.H contains constants, declarations, and function prototypes. */
```

```
#include "decl.h"
#define DEVNUM "dev1"  /* Set instrument to GPIB address 1 */

/* GPIBERR is an error function that is called when a NI-488 function fails. */
void gpiberr(char *msg);

char    rd[255];                /* read data buffer */
int     GpibDev,GpibBoard;      /* device handles */


void main() {

   printf("\nSending data to the Krohn-Hite model 3955...\n");
   printf("\n");

/*
 * Assign a unique identifier (a 'handle') to the K-H 3955 and store it in the
 * variable GpibDev. If GpibDev is less than zero, call GPIBERR with an error
 * message.
 */
   GpibDev = ibfind (DEVNUM);
   if (GpibDev <0) gpiberr("ibfind Error");

/*
 * Assign a handle to the GPIB board so we can use ibcmd to send board
 * level commands such as UNL and UNT.
 */
   GpibBoard = ibfind ("gpib0");
   if (GpibBoard <0) gpiberr("ibfind Error");

/*
 * Clear the K-H 3955 to its default state. The settings vary depending on the
 * type of board in each channel.
 * If the error bit ERR is set in IBSTA, call GPIBERR with an error message.
 */
   ibclr (GpibDev);
   if (ibsta & ERR) gpiberr("ibclr Error");

/*
 * Write a string out to the K-H 3955.
 * If the error bit ERR is set in IBSTA, call GPIBERR with an error message.
 */
   ibwrt (GpibDev,"500HZ;0IG;0OG;F",18L);  /* the 'F' displays the frequency so when*/
   if (ibsta & ERR) gpiberr("ibwrt Error"); /* we read the unit we'll see the freq */

 /*
  * Read the K-H 3955. If the error bit ERR is set in IBSTA, call GPIBERR with
  * an error message.
  */
   ibrd (GpibDev,rd,30L);
   if (ibsta & ERR) gpiberr("ibrd Error");

   /* Append the null character to mark the end of the data */
   rd[ibcnt] = '\0'; /* do this BEFORE calling ibcmd because ibcnt will be */
   printf("Read:  %s\n", rd);      /* changed by any 'ib' calls. */

   ibcmd(GpibBoard,"?_",2L);     /* send unt, unl */
   if (ibsta & ERR) gpiberr("ibcmd Error");

/*
 * Change the K-H 3955 setting
 */
   ibwrt (GpibDev,"333HZ;20IG;20OG;F", 20L); /* the 'F' displays the frequency so when*/
  if (ibsta & ERR) gpiberr("ibwrt Error"); /* we read the unit we'll see the freq */
```

```
/*
 * Read the K-H 3955 again like before.
 */
  ibrd (GpibDev,rd,30L);
  if (ibsta & ERR) gpiberr("ibrd Error");

  rd[ibcnt] = '\0';
  printf("Read:  %s\n", rd);

  ibcmd(GpibBoard,"?_",2L); /* send unt, unl */
  if (ibsta & ERR) gpiberr("ibcmd Error");

 /*  Call the ibonl function to disable the hardware and software. */
  ibonl (GpibDev,0); /* Release the device handle */
  ibonl (GpibBoard,0); /* Release the board handle */

  exit(0);  /* exit with no error */

} /* main */


/*============================================================ ====================
 *                  Function GPIBERR
 * This function will notify you that a NI-488 function failed by
 * printing an error message.  The status variable IBSTA will also be
 * printed in hexadecimal along with the mnemonic meaning of the bit position.
 * The status variable IBERR will be printed in decimal along with the
 * mnemonic meaning of the decimal value.  The status variable IBCNT will
* be printed in decimal.
*
* The NI-488 function IBONL is called to disable the hardware and software.
*
* The EXIT function will terminate this program.
*============================================================ ====================
 */

void gpiberr(char *msg) {
 unsigned int i;

 /* Table of ibsta (interface board status word) bit positions and
    corresponding messages */
 static struct { int bit; char *msg;} ibstaMsg[16]=
  { {ERR, " ERR"},
    {TIMO, " TIMO"},
    {END, " END"},
    {SRQI, " SRQI"},
    {RQS, " RQS"},
    {SPOLL," SPOLL"},
    {EVENT," EVENT"},
    {CMPL, " CMPL"},
    {LOK, " LOK"},
    {REM, " REM"},
    {CIC, " CIC"},
    {ATN, " ATN"},
    {TACS, " TACS"},
    {LACS, " LACS"},
    {DTAS, " DTAS"},
    {DCAS, " DCAS"}};

 /* Table of iberr error messages */
 static struct { int val; char *msg;} iberrMsg[15]=

  { { EDVR," EDVR <DOS Error>\n"},
    { ECIC," ECIC <Not CIC>\n"},
    { ENOL," ENOL <No Listener>\n"},
```

```
    { EADR," EADR <Address error>\n"},
    { EARG," EARG <Invalid argument>\n"},
    { ESAC," ESAC <Not Sys Ctrlr>\n"},
    { EABO," EABO <Op. aborted>\n"},
    { ENEB," ENEB <No GPIB board>\n"},
    { EOIP," EOIP <Async I/O in prg>\n"},
    { ECAP," ECAP <No capability>\n"},
    { EFSO," EFSO <File sys. error>\n"},
    { EBUS," EBUS <Command error>\n"},
    { ESTB," ESTB <Status byte lost>\n"},
    { ESRQ," ESRQ <SRQ stuck on>\n"},
    { ETAB," ETAB <Table Overflow>\n"}};


  printf ("%s\n", msg); /* Print the application supplied context message. */

  /*
   * The ibsta variable provides the primary information about the cause of
   * the error: print it's value and mnemonic for each bit set.
   */
  printf ("ibsta = &H%x  <", ibsta);
  for (i=0; i<=15; i++)
    { if (ibsta & ibstaMsg[i].bit)  printf ("%s",ibstaMsg[i].msg); };
  printf (" >\n");

  /*
   * Print the iberr value and interpertation
   */
  printf ("iberr = %d", iberr);
  for (i=0; i<=14; i++)
    { if (iberr==iberrMsg[i].val)  printf ("%s",iberrMsg[i].msg); };

  /*
   * Print ibcnt in decimal
   */
  printf ("ibcnt = %d\n", ibcnt);
  printf ("\n");

  /* put the board and device offline */
  ibonl (GpibDev,0); /* Release the device handle */
  ibonl (GpibBoard,0); /* Release the board handle */

  exit(1); /* exit with status=1 to indicate error */
}
```

### 3.6.3 Example 3 – National Instruments IBIC

**Preparation:**

Your c:\config.sys file must have the following line in it:

**device=c:\488\gpib.com**

After you add this line, you must re-boot (reset) your computer for the driver to be loaded.
For purposes of this demo, set the Krohn-Hite Model 3955 to GPIB address 1:

**Press 1[SECOND FUNCTION][MEGA]**

Set the talker to only send EOI:

**Press 1[SECOND FUNCTION][ALL CHAN]**

| Prompt | Command You Type | Comments |
|---|---|---|
| C:\488> | IBIC | From the DOS command line, enter the IBIC program. |
| : | ibfind gpib0 | Initialize the program to access the board. |
| gpib0: | ibfind dev1 | Initialize the program to access the device at GPIB address 1. |
| dev1: | ibwrt "CH1;5.1K" | Set channel 1 to 5.1kHz. |
| dev1: | ibrd 50 | Read the unit (50 characters is adequate). |
| dev1: | set gpib0 | The *ibrd* command does not unaddress the unit; it must be done manually: select the board so you can do a board level command. |
| gpib0: | ibcmd "?_" | Send "unlisten (UNL)" which is "?" and "untalk (UNT)" which is "_" (underscore). |
| dev1: | ibwrt "AL;0IG;0OG" | Set both channels: 0dB input gain (0IG), 0dB output gain (0OG). |
| dev1: | ibwrt "CH1;1K;CH2;2K" | Set: channel 1 to 1kHz cutoff, channel 2 to 2kHz cutoff. |
| dev1: | e | Exit IBIC |
| c:\488> | | |

# SECTION 4
# INCOMING ACCEPTANCE

## 4.1 INTRODUCTION

The following procedure should be used to verify that the Model 3955 filter is operating within specifications. These checks may be used for incoming acceptance and periodic performance checks. Tests must be made with all covers in place and operating for a minimum of 30 minutes to reach operating temperature. If the unit is not operating within specifications, refer to Section 5, Calibration, in the Operating and Maintenance Manual before attempting any detailed maintenance. Before testing, follow the initial set-up and operating procedure in Section 2.

## 4.2 TEST EQUIPMENT REQUIRED

The test equipment below is required to perform the following tests:

a. Low Distortion Sinewave: <0.05% distortion to 100kHz, 0.1% to 1MHz, Krohn-Hite Model 4200B or equivalent.

b. Sinewave Source: covering the frequency range from 1MHz to 100MHz, Tektronix Model 191 or equivalent.

c. RC Oscillator: 10Hz to 10MHz, frequency response of æ0.025dB from 10Hz to 500kHz. Krohn-Hite Model 4300B or equivalent.

d. AC RMS Voltmeter: capable of measuring 100mV to 10Vrms, 10MHz bandwidth, Fluke Model 8920A or equivalent.

e. DC Voltmeter: capable of measuring 1mV to 20V, Fluke 8000 or equivalent.

f. Squarewave Source: 2Vp-p squarewave with rise and fall times <5ns with 5% overshoot or ring. HP8012B or equivalent.

g. Frequency Counter.

h. Distortion Analyzer: capable of measuring distortion to 1MHz, Krohn-Hite Model 6900B or equivalent.

i. Spectrum Analyzer: HP Model 141T with RF section 8553B and IF section 8552B or equivalent.

## 4.3 INITIAL SETTINGS

**Note:** *Good "high frequency techniques" should be used at all times, which includes the use of good quality 50 ohm cabling for signal connections to and from the filter.*

Input Ohms: 50

Input Gain: 0dB

Input Coupling: DC

Cutoff Frequency: 10MHz

Output Gain: 6dB

Overload Mode: 2

Filter Mode: LP

## 4.4 DC OUTPUT LEVEL CHECKS

Conenct the DVM set for DC operation to the filter Output.

Measure DC level for all Input and Output gain settings.

The Output DC level should be adjustable to 0V using the DC level adjust located on the rear panel for each channel if necessary.

## 4.5 GAIN ACCURACY CHECK

Disconnect the DVM and connect the Fluke 8920A to the filter Output.

Connect a 0.1Vrms, 1kHz signal to the filter input (note that the filter input is set for 50 ohms and will terminate with a 50 ohm source producing a factor of less than 2 in amplitude).

Set the filter Output Gain to 0dB.

Set the Fluke 8920A for AC relative dB measurements, then zero reference the Fluke.

Check each Input and Output gain setting by switching each one up from 0dB independently.

All dB readings should be within 0.1dB of the filter gain setting.

## 4.6 DISTORTION CHECK

Disconnect the Fluke 8920A from the filter Output.

Set the filter for 0dB Input gain and 6dB Output gain.

Set the signal source for 1Vrms, 1kHz, sinewave and connect to the filter Input.

Connect the Distortion Analyzer to the filter Output through a 50 ohm cable terminated at the analyzer end.

Measure the distortion at the following frequencies:

| Frequency | Tolerance |
|---|---|
| 1kHz | 0.1% |
| 100kHz | 0.1% |
| 1MHz | 0.3% |

If necessary, verify that the signal source's distortion is below the above readings by measuring it separately.

## 4.7 SQUAREWAVE RISE AND FALL TIME CHECK

Disconnect the Distortion Analyzer and Signal Source from the filter.

Set the filter to Gain Mode.

The filter Input and Output gain should be set to 0dB and 6dB respectively, and Input Ohms set to 50.

Set the filter coupling to AC.

Connect the filter Input using a 50 ohm cable to the Squarewave Source set for 2Vp-p, 2.5MHz, squarewave.

Connect the filter Output to an Oscilloscope with a 50 ohm cable terminated at the oscilloscope end.

Observe on the scope that overshoot and ringing is <5%.

Measure the ise and fall time from the 10% and 90% waveform points.

Reading should be <7ns.

Set the Squarewave Source for 0.2Vp-p.

Check the Output waveform first with 20dB Input gain, then with 26dB Output gain for <5% overshoot and ringing., and <10ns rise and fall time.

## 4.8 FREQUENCY CALIBRATION CHECK

Set the filter for the initial setting at the beginning of this section.

Connect the filter Input via a 50 ohm cable to a 1Vrms, 1kHz, sinewave signal source.

Connect the Fluke 8920A to the filter Output with a 50 ohm cable.

Set the Fluke for relative dB operation.

Set the filter for a cutoff frequency of 1kHz and Gain Mode.

Zero reference the Fluke.

Set the filter for Low-Pass (LP) mode and measure the drop in dB at the Output.

It should be within -2.67dB to -3.37dB for a 2% calibration range.

Set the Sinewave Generator and filter cutoff to the following frequencies in the filter Gain Mode, and zero reference the Fluke 8920A.

Measure the drop in gain on the Output of the filter when switching the filter to the LP mode.

| Frequency | dB at Cutoff Range | % Error Spec |
|---|---|---|
| 1kHz | -2.67 to -3.37 | ±2 |
| 10kHz | -2.67 to -3.37 | ±2 |
| 100kHz | -2.67 to -3.37 | ±2 |
| 1MHz | -2.67 to -3.37 | ±2 |
| 10MHz | -2.21 to -3.94 | ±5 |

## 4.9 WIDEBAND NOISE CHECK

Set the filter for 25.6MHz, LP mode, 0dB Input and 26dB Output gain.

Disconnect the sinewave signal from the filter Input.

With the Fluke 8920A connected to the Output via a 50 ohm terminated cable, measure the wideband noise voltage present.

Wideband noise should be <5mV which translates to 500µV referenced to the Input, since the net gain from the filter Input to the meter is 20dB.

## 4.10 STOPBAND ATTENUTATION CHECK

**NOTE:** *This test uses a spectrum analyzer to detect the rejected signal. Most spectrum analyzers have a maximum signal amplitude without damage limit. Care should be taken that this signal level limit is not exceeded. A simple precaution would be to use a 50 ohm inline 20dB attenuator at the analyzer input. It is also advisable to set all the equipment before connecting the analyzer.*

Set the filter to the initial settings stated at the beginning of this section.

Set the filter coupling to AC, cutoff frequency to 10kHz, and mode to Gain.

Set the Tektronix 191 Signal Generator for 1MHz, 3Vp-p into 50 ohms.

Connect the Tektronix 191 to the filter Input.

Set the spectrum analyzer to measure the 3Vp-p, 1MHz signal into a 50 ohm termination at the filter Output and connect the filter Output to the analyzer.

Adjust the analyzer for 0dB, referencing level at the 1MHz signal.

Set the filter to the LP mode.

The measured amount of 1MHz signal should be down -100dB.

Set the signal generator for 10MHz.

The measured amount of 10MHz signal should be down -75dB.

Set the signal generator for 30MHz.

The measured amount of 30MHz signal should be down -55dB.

**NOTE:** *Zero referencing the spectrum analyzer at 100MHz must be done by connecting the signal generator to the spectrum analyzer Input.*

Set the signal generator to 100MHz.

The measured amount of 100MHz signal should be down -40dB.