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INSTRUCTION MANUAL

MODELS 751A, 752A AND 753A BRICKWALL FILTERS

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WAVETEK SAN DIEGO, INC.

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INSTRUCTION MANUAL

MODELS 751A, 752A AND 753A BRICKWALL FILTERS

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SAFETY

This instrument is wired for earth grounding via the facility power wiring. Do not bypass earth grounding with two wire extension cords, plug adapters, etc.

BEFORE PLUGGING IN the instrument, comply with installation instructions.

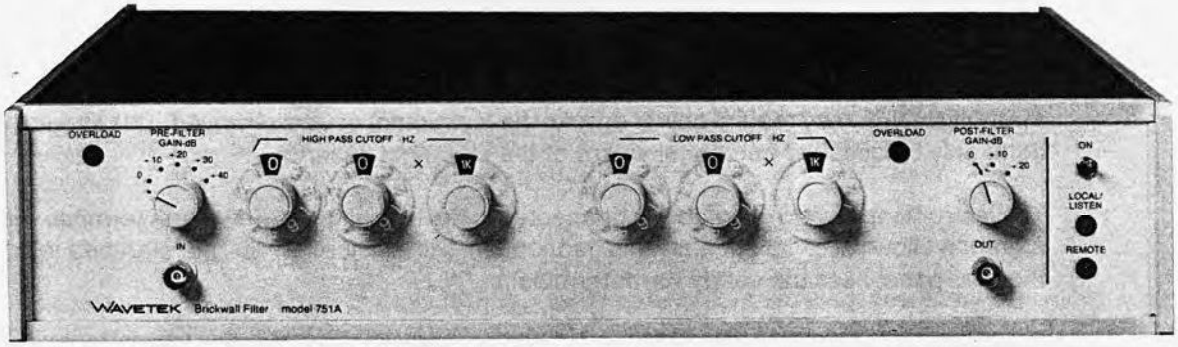
MAINTENANCE may require power on with the instrument covers removed. This should be done only by qualified personnel aware of the electrical hazards.

The instrument power receptacle is connected to the instrument safety earth terminal with a green/yellow wire. Do not alter this connection. (Reference: ⏚ or ⚠ stamped inside the rear panel near the safety earth terminal.)

WARNING notes call attention to possible injury or death hazards in subsequent operations.

CAUTION notes call attention to possible equipment damage in subsequent operations.

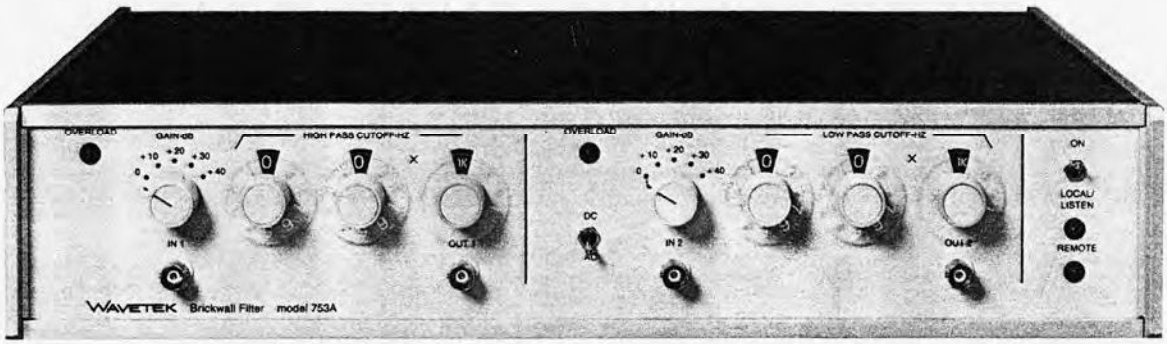
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Model 751A. Brickwall Filter



Model 752A. Brickwall Filter



Model 753A. Brickwall Filter

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SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The Models 751A, 752A and 753A are programmable Brickwall™ Filters offering near-ideal passband and stopband characteristics.

The instruments employ 7th-order (7 poles and 6 zeroes) Elliptic or Cauer filters with design values of 0.3 dB peak-to-peak passband ripple and 85 dB stopband attenuation. The transition from passband to stopband has a 115 dB/octave rolloff rate. For low pass response, the stopband is at 1.7 × cutoff frequency; high pass response, the stopband is 0.6 × cutoff for frequency.

The cutoff frequency may be programmed from 10 Hz to 99 kHz with 2-digit resolution and 1 Hz to 9 Hz with 1-digit resolution. Pre-filter, and (where available) post-filter gain may be programmed in 10 dB steps, up to the maximum available.

These instruments are extremely valuable in signal-processing applications for band-limiting prior to sampling to prevent aliasing, or for separating a narrow spectrum of interest from noise or other interfering signals. In addition to the extremely sharp filtering, they provide programmable low noise amplification for applications involving low-level signals and overload indicators to ensure operation within their linear dynamic range.

The basic differences of the three models are summarized here.

1.1.1 Model 751A is a single-channel band pass filter which consists of a high-pass section followed by a low-pass section. Low-pass and high-pass cutoff frequencies may be independently programmed. Prefilter gain, up to 40 dB, may be programmed, as well as postfilter gain, up to 20 dB. In addition, there are individual input and output overload indicators.

1.1.2 Model 752A is a dual-channel, low-pass filter. The two channels are amplitude-and phase-matched. They may be used independently, or cascaded for a rolloff rate of 230 dB/octave. Each channel has prefilter gain of up to 40 dB, input overload indicators and selectable ac/dc input coupling.

1.1.3 Model 753A is a dual-channel instrument which consists of independent high-pass and low-pass sections. The two sections may be used independently, cascaded for band pass response, or paralleled for band reject response. Each section has prefilter gain of up to 40 dB and input overload indicators. The low-pass section has selectable ac/dc input coupling.

1.2 OPTIONS

Option 001 allows remote control of the filter using 35 lines of parallel BCD programming. Programming delay is 500 μs plus filter settling time, which is a function of the programmed cutoff frequency.

Option 002 allows remote control of the filter using the IEEE 488-1978 (GPIB) interface. The interface includes the following functions: AH1 (Acceptor Handshake), L1 (Basic Listener with listen only), and DT1 (Device Trigger).

1.3 DEFINITIONS

The important low-pass characteristic of an Elliptic Filter is illustrated in Figure 1-1. The high-pass characteristic is the "mirror image" of the low-pass curve shown.

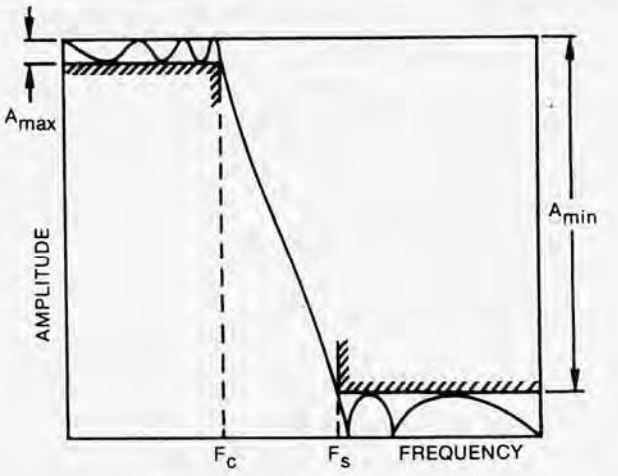


Figure1-1. Elliptic Filter Response

The Cutoff Frequency, F_c, is the frequency at which the response of the filter drops below the specified passband

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ripple, A_{max}. The conventional −3 dB frequency criterion has no significance in an elliptic filter.

For the low-pass section, F_s is the lowest frequency for which the specified stop-band attenuation (A_{min}) applies. For the high-pass section, it is the highest frequency.

It should be noted that the low-pass and high-pass cutoff frequency tolerances of these instruments are intentionally "skewed" to slightly beyond their nominal values. That is, the high-pass cutoff frequency is slightly lower and the low-pass cutoff frequency is slightly higher than its nominal value. This ensures no data loss up to the F_c setting in the case of the 752A, or in the case of the 751A or 753A, when the two sections are set to identical cutoffs (minimum bandwidth) the slopes of the resulting response will not overlap and cause a passband amplitude loss.

1.4 SPECIFICATIONS

The following specifications apply to all models, except as noted.

1.4.1 Cutoff Frequency (F_c)

Range
1 Hz to 99 kHz with front panel and GPIB, 1 Hz to 100 kHz with remote control (BCD only).

Control (each channel)
Two 10-position switches, one 4-position multiplier switch; remotely by 12-bit code.

Resolution

Multiplier	Frequency (Hz)		Resolution of Setting (Hz)
	Local	Remote	
× 1	1-99	1-100	1
× 10	100-990	100-1k	10
× 100	1k-9.9k	1k-10k	100
× 1K	10k-99k	10k-100k	1k

Accuracy
−0.3 ± 0.1 dB at F_c.

Stability
± 200 ppm/°C.

1.4.2 Gain (Prefilter)

Control (each channel)
One 5-position switch, or 3-bit code.

Steps
0, +10, +20, +30, +40 dB.

Accuracy
± 0.2 dB.

Gain (Postfilter)
Model 751A only

Control
One 3-position switch, or 3-bit code.

Steps
0, +10, +20 dB.

Accuracy
± 0.2 dB.

1.4.3 Filter Characteristics

Type
7-pole, 6 zero elliptic (Cauer).

Rolloff
115 dB/octave.

Passband Response
Low-pass channel: 0.3 dB p-p; High-pass channel: 0.3 dB p-p (−3 dB at approximately 400 kHz).

Stopband Attenuation

Low-Pass Channel	High-Pass Channel
−0.3 dB (dc to F_c)	−0.3 dB at F_c
−40 dB at 1.34 F_c	−40 dB at 0.75 F_c
−60 dB at 1.53 F_c	−60 dB at 0.65 F_c
−80 dB at 1.7 F_c	−80 dB at 0.6 F_c

Maximum Stopband Attenuation
Low-pass channel: 85 dB (typical); 80 dB (minimum) to 10 MHz. High-pass channel: 85 dB (typical); 80 dB (minimum).

Model 752A only

Amplitude Match*
± 0.1 dB, dc to 0.8 F_c. ± 0.2 dB, 0.8 F_c to F_c.

Phase Match*
± 1/2° (typical). ± 1° (maximum), dc to 0.8 F_c. ± 1° (typical), ± 2° (maximum), 0.8 F_c to F_c.

1.4.4 Input Characteristics

Coupling
Low-pass channel: dc or ac with 0.3 Hz cutoff (nominal). High-pass channel: dc.

Impedance
1 MΩ 50 pF nominal.

Full Scale Signal
± 10V at 0dB gain; ± 100V absolute maximum.

Equivalent Input Noise
-150 dBV/$\sqrt{\text{Hz}}$ at + 40 dB gain.

1.4.5 Output Characteristics

Impedance
50Ω nominal.

Full Scale Signal
± 10V into $R_L > 5k\Omega$.

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Noise (1 MHz detector BW)
<80 dB below full-scale referred to output at any prefilter gain. (0 dB postfilter gain, 751A).
<10 μV referred to input at 40 dB prefilter gain.

Harmonic Components
>80 dB below full-scale for 1kHz input frequency.

Spurious Components
>80 dB below full-scale (includes line-related spurious).

Intermodulation Products
>70 dB below full-scale for 90 kHz and 70 kHz input frequencies.

DC Offset
Adjustable to 0 Vdc; < ± 10 mV

Drift
± 50 mV (maximum), +15°C to +40°C at 0 dB gain setting.

1.4.6 General

Configuration
Bench-top, convertible to rack-mounting.

Input/Output Connectors
Front and rear panel BNCs.

Accessories Supplied
Instruction Manual, Rack-mounting kit.

Temperature
0°C to +40°C for operation; −20°C to +70°C for storage.

Dimensions
43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.

Weight
8.2 kg (18 lb) net; 10.5 kg (23 lb) shipping.

Power
115/230 Vac ± 10%, 50 to 60 Hz, 25W.

1.4.7 Options

001 Parallel BCD Interface
002 GPIB Interface — (IEEE 488-1978)

*Specifications apply when most significant cutoff digit is used; derate by a factor of 2 when both digits are used.

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SECTION 2
INITIAL PREPARATION

2.1 INSPECTION

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

2.2 MECHANICAL INSTALLATION

The Models 751A, 752A, and 753A are designed for bench top operation or standard 19-inch RETMA rack mounting. Ambient temperature within the rack must not exceed + 40°C while the instrument is operating. The rear panel switches should be set before installing the filter in the rack.

2.3 ELECTRICAL INSTALLATION

2.3.1 Power Connection

The instrument will operate from either 115 or 230 Vac ± 10%, 50 to 60 Hz. The unit is shipped with the rear panel line voltage selector set for 115 V and a 1A SB fuse (see figure 2-1). To change the setting, insert a small-blade screwdriver in the switch slot and move switch to expose 115 for 115 Vac operation, or 230 for 230 Vac operation. For 230 Vac operation, change to a ½A SB fuse.

WARNING

In keeping with standard safety practice, the case of the instrument is grounded through the power cord. If the instrument must be connected to a two wire receptacle, use a parallel ground adapter and connect the short lead to ground.

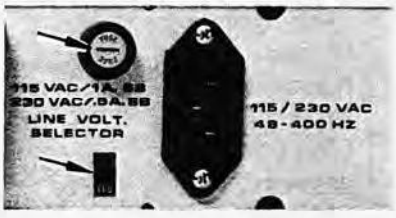


Figure 2-1. Voltage Selector and Fuse

2.3.2 Signal Connection

Use RG58U 50Ω coaxial cables equipped with BNC connectors to distribute signals when connecting this instrument to associated equipment.

2.3.3 GPIB Option

2.3.3.1 GPIB Connection

The GPIB I/O rear panel connection is shown in figure 2-2; pin connections and signal names are given in table 2-1. The panel connector is an Amphenol 57-10240 or equivalent and connects to a GPIB bus cable connector (available from Wavetek in 1 and 2 meter lengths).

Table 2-1. GPIB Data In/Out

Pin	Signal	
1	DIO1	True When Low
2	DIO2	
3	DIO3	
4	DIO4	
5	EOI	
6	DAV	
7	NRFD	True When High
8	NDAC	
9	IFC	True When Low
10	SRQ	
11	ATN	
12	Chassis Ground (⏚)	
13	DIO5	True When Low
14	DIO6	
15	DIO7	
16	DIO8	
17	REN	
18		Signal Ground (⏚)
19		
20		
21		
22		
23		
24		

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2.3.3.2 GPIB Address

For instruments on the General Purpose Interface Bus (GPIB), ensure that the GPIB address is correct. The GPIB address can be changed by the switch on the rear of the instrument (see figure 2-2) by simply setting the multiple section switch according to table 2-2. The switch sections are labeled from 1 through 5 and their open position noted (OPEN = Binary "0" in table 2-2).

Table 2-2. GPIB Address Codes

	ASCII		Switch Position					
Device	Listen	Talk	16	8	4	2	1	Listen (Hexa-decimal)
1	(space)	@	0	0	0	0	0	20
1	!	A	0	0	0	0	1	21
2	"	B	0	0	0	1	0	22
3	#	C	0	0	0	1	1	23
4	$	D	0	0	1	0	0	24
5	%	E	0	0	1	0	1	25
6	&	F	0	0	1	1	0	26
7	'	G	0	0	1	1	1	27
8	(	H	0	1	0	0	0	28
9	)	I	0	1	0	0	1	29
10	*	J	0	1	0	1	0	2A
11	+	K	0	1	0	1	1	2B
12	,	L	0	1	1	0	0	2C
13	—	M	0	1	1	0	1	2D
14	•	N	0	1	1	1	0	2E
15	/	O	0	1	1	1	1	2F
16	0	P	1	0	0	0	0	30
17	1	Q	1	0	0	0	1	31
18	2	R	1	0	0	1	0	32
19	3	S	1	0	0	1	1	33
20	4	T	1	0	1	0	0	34
21	5	U	1	0	1	0	1	35
22	6	V	1	0	1	1	0	36
23	7	W	1	0	1	1	1	37
24	8	X	1	1	0	0	0	38
25	9	Y	1	1	0	0	1	39
26	:	Z	1	1	0	1	0	3A
27	;	[	1	1	0	1	1	3B
28	<	\	1	1	1	0	0	3C
29	=	]	1	1	1	0	1	3D
30	>	↑	1	1	1	1	0	3E

NOTE

Address 31 is not allowed.

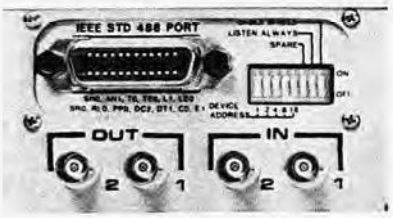


Figure 2-2. GPIB Address Selector Switch

2.3.4 BCD Option

The BCD I/O connector is a 50 pin connector; pin connections and functions are listed in table 2-3.

Table 2-3. BCD Interface Programming Connector All Models(1)

Pin	Function	
1	×1 Cutoff-Frequency Multiplier	True When Low Channel 1
2	×10 Cutoff-Frequency Multiplier	
3	×100 Cutoff-Frequency Multiplier	
4	×1k Cutoff-Frequency Multiplier	
5	Cutoff-Frequency 1	
6	Cutoff-Frequency 2	
7	Cutoff-Frequency 4	
8	Cutoff-Frequency 8	
9	Cutoff-Frequency 10	
10	Cutoff-Frequency 20	
11	Cutoff-Frequency 40	
12	Cutoff-Frequency 80	
13	Gain 1	
14	Gain 2	
15	Gain 4	
16	Overload	
17-22	Ground	
23	Load Command	
24	Ground	
25-26	Remote Enable	True When Low Channel 2
27	Ground	
28	Load Command	
29-34	Ground	
35	Overload	
36	Gain 4 (Not used in Model 751A).	

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Table 2-3. BCD Interface Programming Connector All Models[1] (Continued)

Pin	Function	
37	Gain 2	True When Low Channel 2
38	Gain 1	
39	Cutoff-Frequency 80	
40	Cutoff-Frequency 40	
41	Cutoff-Frequency 20	
42	Cutoff-Frequency 10	
43	Cutoff-Frequency 8	
44	Cutoff-Frequency 4	
45	Cutoff-Frequency 2	
46	Cutoff-Frequency 1	
47	× 1k Cutoff-Frequency Multiplier	
48	× 100 Cutoff-Frequency Multiplier	
49	× 10 Cutoff-Frequency Multiplier	
50	× 1 Cutoff-Frequency Multiplier	

[1] For Models 751A/753A, Channel 1 = High pass filter section; Channel 2 = Low pass filter section.

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SECTION 3
OPERATION

3.1 INTRODUCTION

This section describes how to operate the Models 751A, 752A, and 753A. Each model's controls and indicators are described. This is followed by typical operating procedures and response characteristics. Finally, the two interface options, BCD and GPIB, are discussed.

3.2 CONTROLS AND INDICATORS

The front panel controls and indicators are shown in the following figures and described in the following tables.

Model	Figure	Table
751A	3-1	3-1
752A	3-2	3-2
753A	3-3	3-3

Rear panel controls for all three models are shown in figure 3-4 and described in table 3-4.

Table 3-1. Model 751A Controls and Indicators

Location in Figure 3-1	Function
1	OVERLOAD LED — When lit, indicates an input signal level of greater than ± 10V (including pre-filter gain).
2	PRE-FILTER GAIN — Sets the gain from 0 to 40 dB in 10 dB steps.
3	Most Significant Digit — Sets the MSD of the cutoff frequency of the high pass filter, positions 0 to 9 with continuous rotation.
4	Least Significant Digit — Sets the LSD of the cutoff frequency of the high pass filter, positions 0 to 9 with continuous rotation.
5	Decimal Multiplier — Sets the cutoff frequency range of high pass filter, positions 1, 10, 100, and 1k.
6	Most Significant Digit — Sets the MSD of the cutoff frequency of the low pass filter; positions 0 to 9 with continuous rotation.
7	Least Significant Digit — Sets the LSD of the low pass filter cutoff frequency, positions 0 to 9 with continuous rotation.
8	Decimal Multiplier — Sets the low pass filter cutoff frequency range, positions 1, 10, 100, and 1k.
9	OVERLOAD LED — When lit, indicates an output signal of greater than ± 10V (including all filter gain).
10	POST-FILTER GAIN — Sets the gain from 0 to 20 dB in 10 dB steps.
11	ON switch — Turns the 751A on.
12	LOCAL/LISTEN — A lit LED indicates active front panel controls (LOCAL) or remote GPIB control (LISTEN). With the BCD interface, the LED does not light in remote.

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Table 3-1. Model 751A Controls and Indicators (Continued)

Location in Figure 3-1	Function
13	REMOTE LED — When lit, indicates the 751A is in the remote mode.
14	Output BNC connector.
15	Input BNC connector.

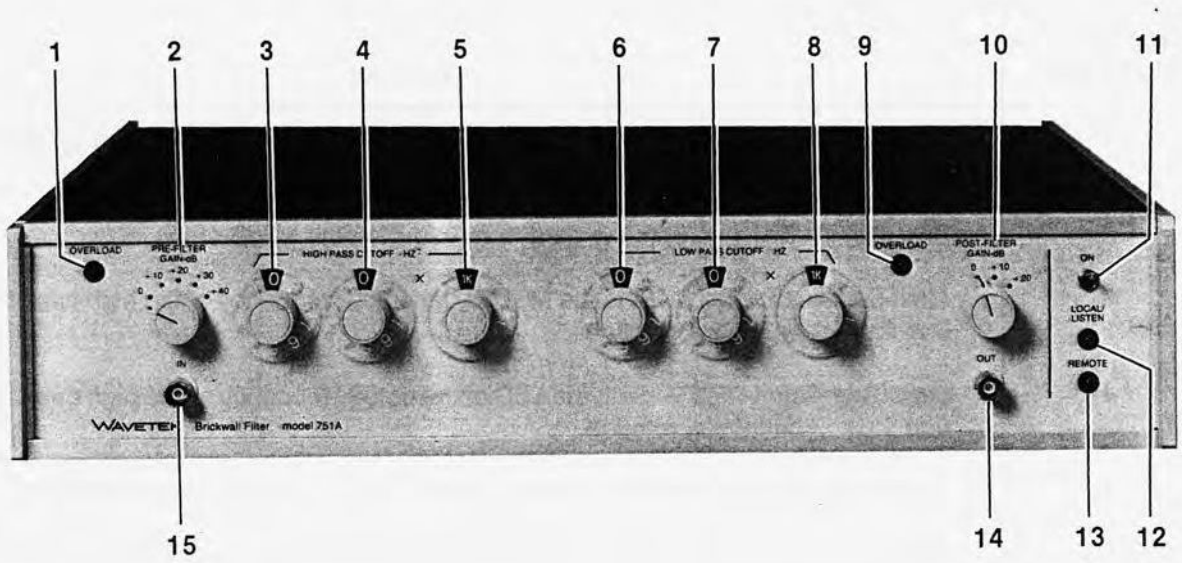


Figure 3-1. Model 751A Controls and Indicators

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Table 3-2. Model 752A Controls and Indicators

Location in Figure 3-2	Function
1	OVERLOAD LED — When lit, indicates an input signal level to channel 1 of greater than ± 10V (including gain).
2	GAIN Channel 1 — Sets the input gain from 0 to 40 dB in 10 dB steps.
3	Most Significant Digit — Sets the MSD of the Channel 1 cutoff frequency, positions 0 to 9 with continuous rotation.
4	Least Significant Digit — Sets the LSD of the Channel 1 cutoff frequency, positions 0 to 9 with continuous rotation.
5	Decimal Multiplier — Sets the Channel 1 cutoff frequency range, positions 1, 10, 100, and 1k.
6	OVERLOAD LED — When lit, indicates an input signal level to channel 2 of greater than ± 10V (including gain).
7	GAIN Channel 2 — Sets the input gain from 0 to 40 dB in 10 dB steps.
8	Most Significant Digit — Sets the MSD of the Channel 2 cutoff frequency, positions 0 to 9 with continuous rotation.
9	Least Significant Digit — Sets the LSD of the Channel 2 cutoff frequency, positions 0 to 9 with continuous rotation.
10	Decimal Multiplier — Sets the Channel 2 cutoff frequency range, positions 1, 10, 100, and 1k.
11	ON Switch — Turns the 752A on.
12	LOCAL/LISTEN — A lit LED indicates active front panel controls (LOCAL) or remote GPIB control (LISTEN). With the BCD interface, the LED does not light in remote.
13	REMOTE LED — When lit, indicates the 752A is in the remote mode.
14	Channel 2 Output BNC connector.
15	Channel 2 Input BNC connector.
16	DC/AC Switch — Selects input coupling for Channel 2.
17	Channel 1 Output BNC connector.
18	Channel 1 Input BNC connector.
19	DC/AC Switch — Selects input coupling for Channel 1.

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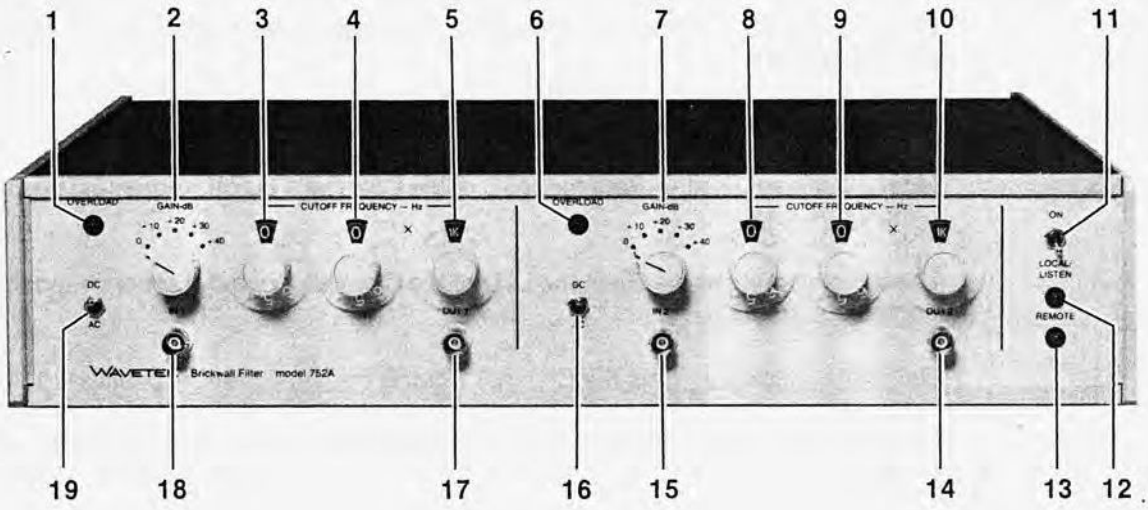


Figure 3-2. Model 752A Controls and Indicators

Table 3-3. Model 753A Controls and Indicators

Location in Figure 3-3	Function
1	OVERLOAD LED — When lit, indicates an input signal level to high pass filter of greater than ± 10V (including gain).
2	High Pass GAIN — Sets the input gain from 0 to 40 dB in 10 dB steps.
3	Most Significant Digit — Sets the MSD of the high pass filter's cutoff frequency, positions 0 to 9 with continuous rotation.
4	Least Significant Digit — Sets the LSD of the high pass filter's cutoff frequency, positions 0 to 9 with continuous rotation.
5	Decimal Multiplier — Sets the high pass filter's cutoff frequency range, positions 1, 10, 100, and 1k.
6	OVERLOAD LED — When lit, indicates an input signal level to low pass filter of greater than ± 10V (including gain).
7	Low Pass GAIN — Sets the input gain from 0 to 40 dB in 10 dB steps.
8	Most Significant Digit — Sets the MSD of the low pass filter's cutoff frequency, positions 0 to 9, continuous rotation.

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Table 3-3. Model 753A Controls and Indicators (Continued)

Location in Figure 3-3	Function
9	Least Significant Digit — Sets the LSD of the low pass filter cutoff frequency, positions 0 to 9 with continuous rotation.
10	Decimal Multiplier — Sets the high pass filter cutoff frequency range, positions 1, 10, 100, and 1k.
11	ON Switch — Turns the 753A on.
12	LOCAL/LISTEN — A lit LED indicates active front panel controls (LOCAL) or remote GPIB control (LISTEN). With the BCD interface, the LED does not light in remote.
13	REMOTE LED — When lit, indicates the 753A is in the remote mode.
14	Low pass channel output BNC.
15	Low pass channel input BNC.
16	DC/AC Switch — Selects input coupling for the low pass channel.
17	High pass channel output BNC.
18	High pass channel input BNC.

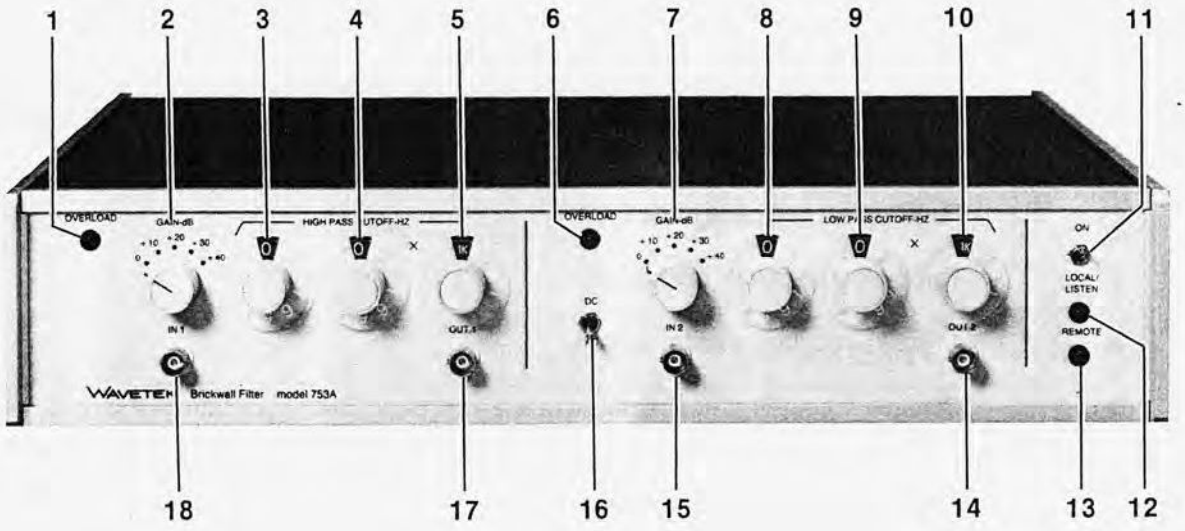


Figure 3-3. Model 753A Controls and Indicators

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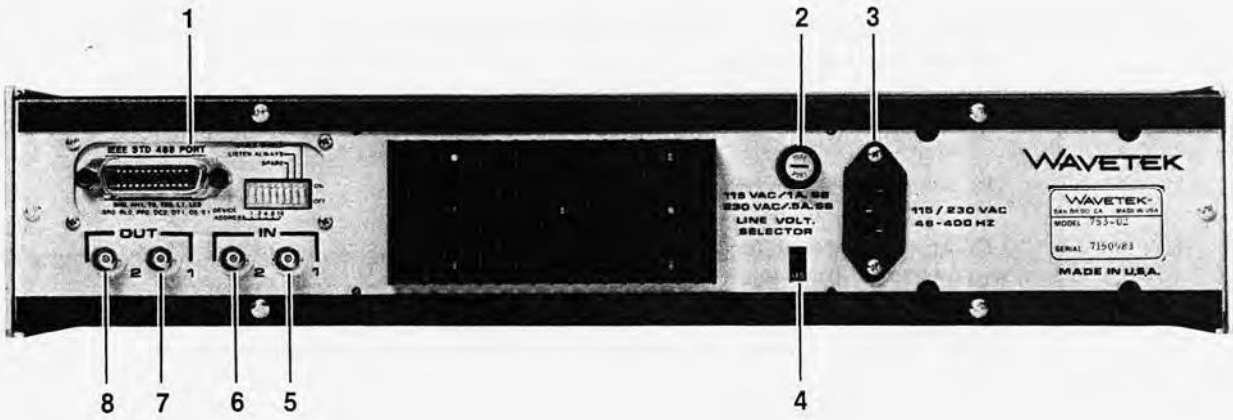


Figure 3-4. Models 751A, 752A, and 753A Rear Panel Controls

Table 3-4. Models 751A, 752A, and 753A Rear Panel Controls

Location in Figure 3-4	Function
1	Optional rear panel programming connector. Option 01: BCD interface 50 pin connector (not shown), see table 3-5 and paragraph 3.4. Option 02: GPIB interface connector, see table 2-1 and paragraph 3.5; GPIB address switch, see table 2-2 and paragraph 2.3.3.2.
2	Fuseholder, see paragraph 2.3.1.
3	Three-wire ac power connector.
4	115/230 Vac line selector switch.
5	Channel 1 input BNC connector parallels front panel BNC. Duplicate of item 6 for input on Model 751A.
6	Channel 2 input BNC connector.
7	Channel 1 Output BNC connector parallels front panel BNC. Duplicate of item 8 for output BNC on Model 751A.
8	Channel 2 Output BNC connector. Parallels front panel BNC.

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3.3 TYPICAL OPERATING PROCEDURES

Always select the minimum decimal multiplier setting. For example, a cutoff frequency of 90 Hz can be set as 09 × 10 or 90 × 1. The proper choice is 90 × 1. In other words, the most significant digit of the cutoff frequency dials should not be set to 0, unless the cutoff frequency is less than 10 Hz. The minimum valid setting of Cutoff Frequency dials is 01. The setting 00 is not valid.

3.3.1 Model 751A

Passband

The passband of the filter extends from the high-pass cutoff frequency setting to the low-pass cutoff frequency setting. These, in turn, are detemined by the two cutoff frequency dials and the corresponding multiplier switches.

The narrowest passband is obtained by setting high-pass and low-pass cutoff frequencies to the same value f_o. In this case, the insertion loss is nominally 0 dB; the 3dB bandwidth extends from approximately 0.95 f_o to approximately 1.05 f_o and it is equal to 0.1 f_o. This corresponds to a Q of 10. In this mode of operation, the instrument operates as a constant – Q (or constant % – Bandwidth) filter.

Pre-Filter Gain

Pre-Filter gain may be selected to be 0, 10, 20, 30 or 40 dB. To maximize the useful dynamic range, the maximum gain should be used without causing the corresponding overload LED to light. Overload "On" indicates that an input signal has exceeded the maximum safe desirable amplitude. If the signal exceeds this range and its frequency is within the passband of the filter, a ± 10 Volt A/D converter connected to the output of the 751A will overflow; however, no distortion occurs in the instrument until the signal exceeds full-scale by 10%.

The maximum desirable full-scale signal is ± 10V (7.1 Vrms) for 0 dB gain. When pre-filter gain is employed, the maximum input signal decreases in direct proportion to the increase in gain. For example, with 20 dB gain, the maximum desirable input amplitude is ± 1.0 V (0.71 Vrms).

Post-Filter Gain

Post-Filter gain may be selected to be 0, 10 or 20 dB. This control should be set such that it does not cause the corresponding overload LED to light. Overload "On" indicates that the output signal has exceeded the maximum safe desirable amplitude and a ± 10 Volt A/D converter connected to the output of the 751A will overflow; however, no distortion occurs in the instrument until the signal exceeds full-scale by 10%.

When Post-filter gain other than 0 dB is used, the dynamic range of the instrument is reduced by the amount of gain employed.

The primary use of Post-filter gain is when the instrument is being used with small (narrow) passbands; gain may be used to increase the amplitude of a small signal which was buried in broadband noise; or, it may be be used to amplify noise, when the objective is to generate band-limited noise from a broadband noise source.

Response Characteristics

The following figures show examples of Model 751A typical response characteristics.

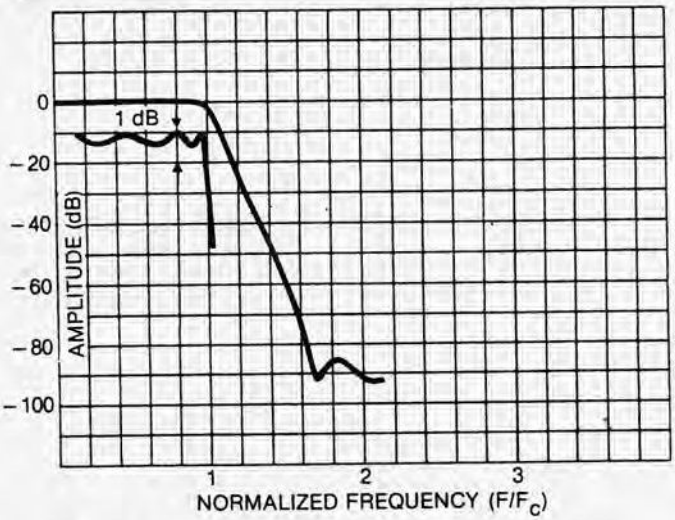


Figure 3-5. Model 751A Low-Pass Frequency Response

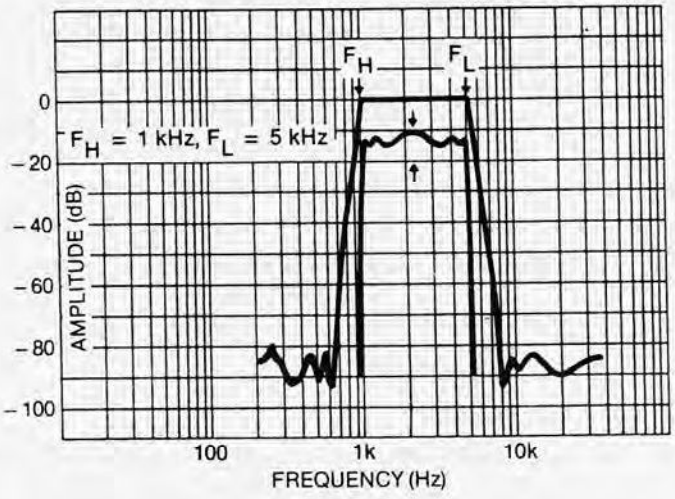


Figure 3-6. Model 751A Typical Bandpass Response

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