REV A1 PER ECO 294
REV A2 PER ECO 706
REV B PER ECO 947
QSC OCTAL INPUT ACCESSORIES

MODEL UF-1 UNIVERSAL ACTIVE FILTER

OWNER'S MANUAL

INTRODUCTION

The UF-1 is a multi-purpose active filter which plugs into the back of all QSC Series One and Series Three amplifiers. This product combines three variable filter sections:

1. An 18 dB/octave low frequency rolloff with selectable frequency and Q;
2. A 6 dB/octave high frequency rolloff with selectable frequency;
3. A 6 dB/octave high frequency shelving boost with selectable frequency and amount of boost.

These three functions may be combined to produce a wide range of complex frequency response curves. In order to assist in achieving the most suitable settings, we have divided this manual into four sections. The first explains the installation of the UF-1 in the amplifier; the second, operation of each of its three sections; the third section of the manual shows typical applications of the UF-1 with suggested settings; and the fourth has technical information.

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INSTALLATION

1.1 ADJUSTING AND INSTALLING THE UF-1.

The UF-1 plugs into the octal socket of the amplifier channel you wish to equalize. Both channels of the amplifier may be driven with one UF-1, in parallel or in bridged mono mode. Before installing the UF-1, read the following sections to insure it is set correctly for your application.

Internal Adjustments of the UF-1.

Before installing the module, read the appropriate sections of the manual, determine the desired frequency modifications desired, and then carefully remove the module cover which is held on by three screws. Gently withdraw the circuit board from the can, taking care not to break the wires to the octal base. You will also find a plastic bag of resistor networks.

The low frequency rolloff is set by plugging in one of the supplied resistor networks. Eight values are supplied with each unit, as shown in Section 2.1 below. The "Q", or sharpness of the rolloff, may also be set using the internal microswitch, as described in Section 2.2. **Caution:** the unit must have a network in place to function; it is shipped with the 16 Hz network in place for unaffected bass response over the audible range.

The high frequency rolloff is set using the internal bank of microswitches as shown in Section 2.3. The high frequency boost is also set with the microswitches, as shown in Sections 2.4 and 2.5.

After making the desired settings, re-wrap the resistor networks carefully, seal with tape, tuck behind the circuit board, and carefully refit the can to the base. It is now ready to install.

Plugging the UF-1 into the Amplifier.

BE SURE THE POWER IS OFF TO THE AMPLIFIER. Select the octal socket for the desired channel and remove the blue label, which is applied to the socket at the factory to prevent corrosion. Align the center post of the plug to the socket and insert carefully. To activate the octal socket, the input selector mini switches on the back of the amplifier must be set to send the input signal through the UF-1.

1.2 SETTING INPUT SWITCHES IN SERIES ONE AMPLIFIERS

Turn off (down) switches 7 and 8 to activate Channel One's octal socket. Turn off switches 1 and 2 to activate Channel Two's octal socket.

Parallel Channels in Series One.

Set the switches as described in the section above. If you wish to power both channels with the output of one UF-1, turn on (up) switches 3 and 4. The volume controls act normally to control each channel's level.

Bridged Mono in Series One.

To use the amplifier in bridged mono mode, install the UF-1 in Channel One's octal socket and set the bridging switch to the mono position. All switches should be off. Channel One's volume control then controls the output level.

1.3 SETTING INPUT SWITCHES IN SERIES THREE AMPLIFIERS

On Series Three amplifiers there are two eight position miniswitches, one for each channel. Switches 5,6,7, and 8 for both channels set the XLR input polarity and are not affected by this procedure. For the channel with the UF-1, installed turn off (down) switches 1 and 2 of that channel's switch to send the input signal through the module.

Parallel Channels in Series Three.

Set the switches as described in the section above. To power both channels with the output of one UF-1 turn on (up) switch 4 of both channels.

Bridged Mono in Series Three.

To use the amplifier in bridged mono mode, install the UF-1 in Channel One's octal socket and set switch 3 on and 1,2 and 4 off. On Channel Two, set switches 1,2, and 3 on and 4 off. Set both gain controls to equal values to adjust the level.

OPERATION

2.1 LOW FREQUENCY ROLLOFF--SETTING THE FREQUENCY.

The 18 dB/octave low frequency rolloff in the UF-1 is adjusted for different cutoff frequencies by plugging in the appropriate resistor network. Table 1 below shows the values supplied with every UF-1. If you need a cutoff frequency other than those provided, you may calculate the value needed from the formula below and insert a resistor network of this value or, if necessary, 4 discrete 1% resistors of the same value into the socket. For discrete resistors, insert them so that the first resistor goes between pins 1 and 2 of the socket, the second resistor between pins 3 and 4, etc.

Formula: $R = 1{,}590{,}000/F$

TABLE 1: LOW FREQUENCY ROLLOFF RESISTOR VALUES

-3dB Cutoff Frequency (Hz)	Resistor Network: Value (Ohms)	Network Code
16	100k	104
30	47k	473
40	39k	393
60	27k	273
80	20k	203
125	12k	123
250	6.8k	682
330	4.7k	472

The UF-1 comes from the factory with the 100 Kohm resistor network installed for a subsonic cutoff frequency of 16 Hz. If you need a different cutoff frequency, select the appropriate value from the chart above and install as described in section 2.1.

2.2 LOW FREQUENCY ROLLOFF--SETTING THE "Q".

Standard Rolloff.

The standard type of bass rolloff has flat frequency response down to the rolloff frequency. This is called "Butterworth" response, and has a "Q" of 0.7. This response is the factory pre-set, and is obtained by setting micro-switch position 6 OFF (down).

Boost Before Rolloff.

In some cases, such as explained in Section 3.2 below, you may want the response to be boosted somewhat just before rolloff. For instance, this can help get the maximum low-frequency response from a speaker whose response is beginning to fall off while protecting it from unwanted frequencies well below its range. This corresponds to a higher "Q". For a 6dB peak at the rolloff frequency, with a steep rolloff below this point ("Q" of 2), set switch number 6 ON (up).

2.3 HIGH FREQUENCY ROLLOFF--SETTING THE FREQUENCY.

The UF-1 has a 6 dB/octave high frequency rolloff. The -3dB cutoff frequency of this filter may be adjusted using the internal microswitches to the values shown in Table 2 below.

TABLE 2: HIGH FREQUENCY ROLLOFF SWITCH SETTINGS

SWITCH NUMBER 7	8	-3 dB CUTOFF FREQUENCY
OFF	OFF	6 KHz
OFF	ON	15 KHz
ON	OFF	33 KHz
ON	ON	42 KHz

ON is up, OFF is down.

The UF-1 comes from the factory with switches 7 and 8 ON (up) for a cutoff frequency of 42 KHz. This ensures that the response at 20 KHz is less than 1 dB down. To select a new cutoff frequency, find the desired value in the chart above and set the switches accordingly.

2.4 HIGH FREQUENCY BOOST--SETTING THE FREQUENCY

The UF-1 high frequency boost network is adjustable for 28 different combinations of boost frequency and amount (not including the no boost position). Adjustments are made via the internal microswitches, as shown in Table 3 below.

TABLE 3: HIGH FREQUENCY BOOST: FREQUENCY SETTINGS

SWITCH NUMBER 5	4	3	+3 DB BOOST FREQUENCY
OFF	OFF	OFF	NO BOOST
OFF	OFF	ON	9 KHz
OFF	ON	OFF	6 KHz
OFF	ON	ON	3.6 KHz
ON	OFF	OFF	2.8 KHz
ON	OFF	ON	2.1 KHz
ON	ON	OFF	1.9 KHz
ON	ON	ON	1.5 KHz

ON is UP, OFF is DOWN.

The UF-1 comes from the factory with switches 3, 4, and 5 OFF (down) for no boost. To set a new boost frequency, simply set the switches as shown above.

2.5 HIGH FREQUENCY BOOST--SETTING THE BOOST AMOUNT

The UF-1 comes from the factory with switches 1 and 2 ON (up) for maximum (15 dB) boost. **No boost is actually engaged until a frequency is selected from Table 3 above, since the frequency switches are factory pre-set OFF.** Different amounts of boost can be selected from Table 4 below.

TABLE 4: HIGH FREQUENCY BOOST AMOUNT

SWITCH NUMBER 1	2	MAXIMUM AMOUNT OF BOOST
ON	ON	15 dB
ON	OFF	12 dB
OFF	ON	9 dB
OFF	OFF	6 dB

ON is UP, OFF is DOWN.

Control Interaction.

It is important to realize that the high frequency boost and high frequency rolloff switches overlap and interact with each other. For instance, if you set the boost frequency for 6 KHz, the boost amount 15 dB, and the high frequency rolloff for 15 KHz the actual response is going to be a 4 dB rise centered on the 10 KHz region instead of a +15 dB boost. The output of the filter should be measured to determine the actual response if the frequencies are separated by less than an octave.

The settings for boost amount and frequency also interact with each other. In general, the higher the amount of boost the higher the +3 dB frequency. The values in Table 3 are for +9 dB boost amount. To convert the boost frequency to other boost amounts see Table 5. The maximum error from the Table 3 values is only 2 dB and can usually be ignored.

TABLE 5: BOOST FREQUENCY CONVERSION

BOOST AMOUNT	MULTIPLY FREQUENCY IN TABLE 3 BY THIS AMOUNT
6 dB	.79
12 dB	1.15
15 dB	1.22

APPLICATIONS

3.1 SUBSONIC AND LOW FREQUENCY FILTERING.

The adjustable low frequency rolloff can solve several common problems in sound reinforcement. Most common is the need to prevent frequencies below the loudspeaker system's range from reaching the speaker's amplifier. The driver will be unloaded at these frequencies and subject to large excursions that may cause distortion or damage. A properly selected low frequency rolloff can ensure that the driver is power limited only by its thermal power capacity and not its excursion capability.

EXAMPLE: VENTED WOOFER CABINETS

A typical vented speaker system may have a frequency response specification of -3 dB at 40 Hz. The system resonance is also 40 Hz (typically). Consulting Table 1, we see a 39K ohm resistor network is required for a 40 Hz -3 dB low frequency rolloff. This value will give the most protection from subsonic frequencies, but the response of the speaker and the low frequency rolloff together will be -6 dB at 40 Hz. To preserve the system output at the lowest frequencies a somewhat lower frequency should be selected for the UF-1. Table 1 shows that the 47K ohm resistor network provided will give a -3 dB frequency of 30 Hz. Using this value will give good subsonic protection and have negligible effect on the speaker system response at 40 Hz.

3.2 THIELE-SMALL LOW FREQUENCY EQUALIZATION.

Keele (1) describes a method for extending the bass response of a vented loudspeaker system. It may be described briefly as follows. The frequency to which the box is currently tuned is determined by looking for the frequency at which the impedance and cone motion is minimum. The box is then retuned one half octave lower and a +6 dB boost applied electronically at this new lower frequency. This effectively extends the low frequency response one half octave. The steep rolloff of the electronic filter below this frequency protects the driver from subsonic signals which could drive it into nonlinearity.

The subsonic filter is factory set for a Q of 0.7, which corresponds to the classic Butterworth maximally flat response. If desired, A Q of 2 can be selected which gives a 6 dB peak at the filter's cutoff frequency. In this case the "-3 dB cutoff frequency" referred to in the tables and elsewhere becomes the "+6 dB peak frequency". The response decreases at an 18 dB/octave rate below the peak frequency, and reaches -3dB at a frequency of 0.79 Fc. When in the 6 dB boost mode, the overall gain through the UF-1 also increases 3 dB. This is easily compensated for with the volume control of the amplifier channel. See Section 2.2 for how to set the Q.

3.3 ULTRASONIC AND HIGH FREQUENCY FILTERING.

Power applied at frequencies above the useful range of a speaker add little to its total acoustic output and is turned into waste heat. Power handling is improved by limiting the signal applied to a speaker to the range that speaker operates most efficiently in.

The upper part of a speaker's useful range is often ragged with many peaks and dips in its response. These peaks can cause feedback.

The high frequency rolloff filter in the UF-1 has a gentle 6 dB per octave slope. It can alleviate the problems above without adversely affecting the overall sound of the speaker. Table 2 in section 2.3 shows the -3 dB frequencies available.

3.4 SPEECH-RANGE FILTERING AND PRESENCE PEAKING.

A system that is used primarily to reproduce speech, such as a paging or announcement system, should have the frequency response of the signal applied to the amplifier shaped to match the spectral distribution of speech and the loudspeaker's response. This maximizes intelligibility and power handling.

EXAMPLE: PAGING HORN

For a typical small reentrant horn the frequency response of the signal applied to the amplifier should be approximately 250 to 6 KHz with a rise in the 4 to 5 KHz range to improve intelligibility and compensate for falling speaker response. To get this response from the UF-1, first install the 6.8 Kohm resistor network for a low frequency rolloff of 250 Hz. Then set switches 7 and 8 on (up) for a nominal 6 KHz high frequency rolloff. The proper amount of "presence" should be determined empirically. Since the high frequency curves are fairly gradual, a boost starting at least one, or preferably two octaves lower, such as 1.5 KHz, with fairly high boost amount value, will be needed to create much of an actual peak before the high frequency rolloff. With maximum boost amount (switches 1 and 2 ON) and minimum boost frequency (switches 3,4 and 5 ON) the response curve will be gradually rising from +1 db at 1KHz to +7 dB at 7 KHz. Response falls off at 6 Db per octave above 6 KHz. With minimum boost amount (switches 1 and 2 off), the response peaks at 4 KHz +4 dB.

3.5 HIGH FREQUENCY EQ FOR TWEETERS AND CONSTANT COVERAGE HORNS.

Most tweeters do not have flat response to the highest audible frequencies. They need equalization to balance the overall sound. This equalization can be applied actively or passively.

Passive crossovers bypass the series resistor of the speaker's attenuator pad with a capacitor to provide a rising characteristic to the voltage supplied to the speaker.

The UF-1 accomplishes the same thing using active circuitry. Additionally it can roll off the boost applied when the signal is above the useful range of the speaker (see Section 3.3). This increases the power handling capability of the amp/speaker system in its passband.

EXAMPLE: TWEETER EQUALIZATION

Direct radiator tweeters and conventional horns usually need only a moderate amount of equalization, just at the highest frequencies. A typical setting of the UF-1 for this application would be a +3 dB boost frequency of 9 KHz (switches 4 and 5 OFF, 3 ON), a boost amount of 6 dB (switch 1 and 2 OFF), and a high frequency rolloff of 33 KHz (switch 7 ON and 8 OFF). For more effect, try a lower boost frequency.

Constant coverage horns require more high frequency equalization than conventional horns. To see why this is so, the compression driver's frequency response must be considered. All compression drivers exhibit a falling response characteristic with increasing frequency above 1 or 2 KHz. Conventional horns compensate for this falling response by increasing their directivity with frequency. This results in a fairly flat on axis response. On the other hand, constant coverage horns do not increase their directivity with frequency. Uncompensated, they have rapidly decreasing output with increasing frequency.

Figure 1 shows the family of curves of the UF-1 set for 15 dB boost, 42 KHz high frequency rolloff, for all possible boost frequencies.

EXAMPLE: CONSTANT COVERAGE HORN EQUALIZATION

A typical constant coverage horn would use the maximum boost amount (switches 1 and 2 ON), a boost frequency of 2.1 KHz (switches 3 and 5 ON) and a 42 KHz high frequency rolloff (switches 7 and 8 ON). To increase or decrease the effect, try changing the boost frequency. The proper amount of boost is a function of horn type, driver type, type of program material, and the acoustic environment. See Section 3.6.

3.6 RECOMMENDED INSTRUMENTATION

A pink noise generator and spectrum analyzer can be a great asset when setting equalization. Good results can be obtained by listening to typical program material and experimenting. All the switches may be operated while the unit is playing without dangerous transients being generated. However, the resistor networks **should only be replaced with the amplifier off. The UF-1 should only be plugged in and out of the amp while it is off.**

REFERENCES

1) D.B. Keele Jr., "A New Set of Sixth-Order Vented-Box Loudspeaker system Alignments" Journal of the Audio Engineering Society, Vol 23, Number 5 pp.354-360 (June 1975).

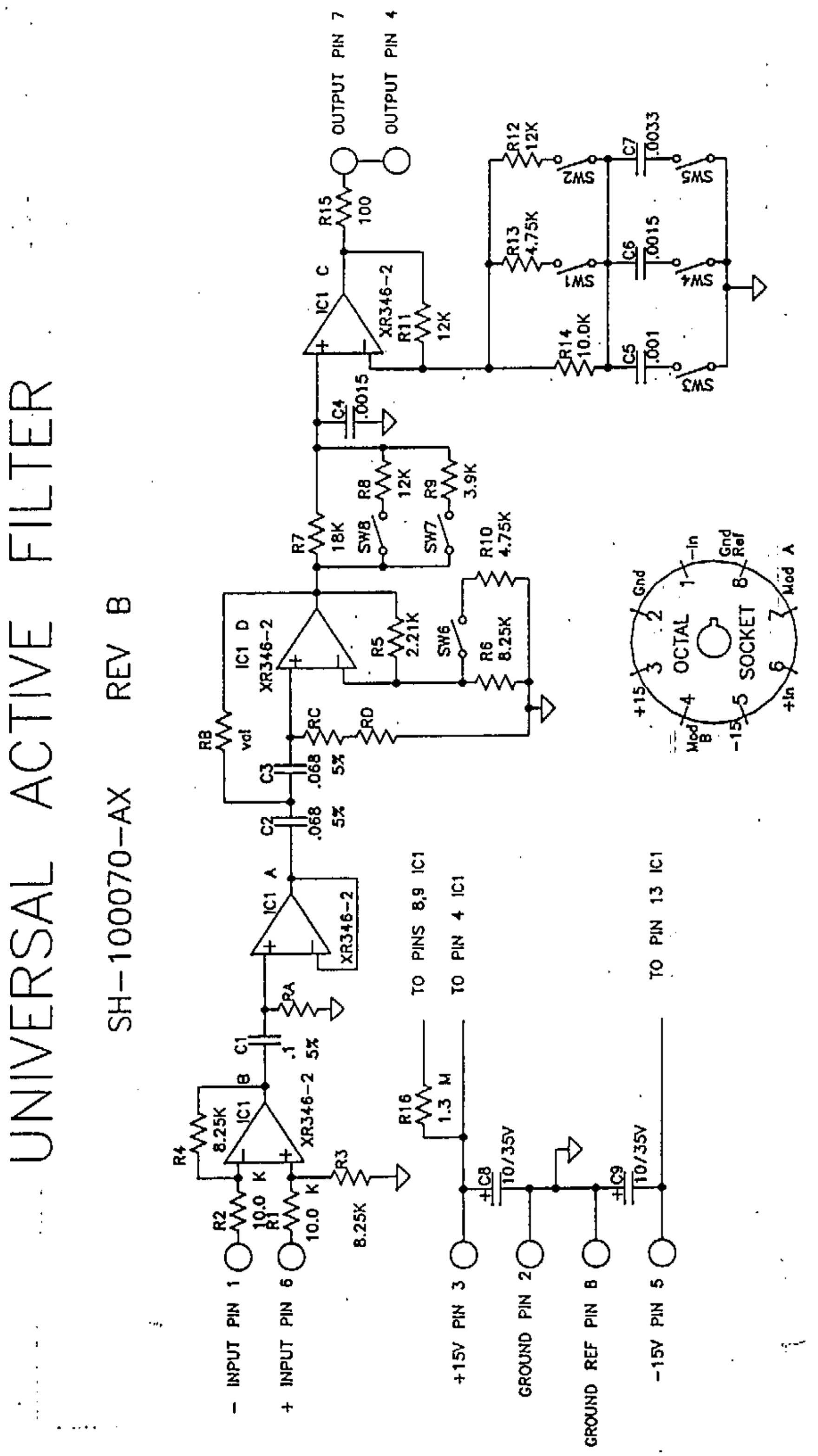
TECHNICAL AND WARRANTY INFORMATION

4.1 PRODUCT SPECIFICATIONS

LOW-FREQUENCY FILTER	18dB/octave
SELECTABLE ROLLOFF Q:	0.7 (Butterworth) or 2 (peaking).
-3dB LOW-FREQUENCY VALUES	16, 30, 40, 60, 80, 125, 250, 330 Hz
HIGH-FREQUENCY FILTER	6dB/octave high frequency rolloff.
-3dB HIGH-FREQUENCY VALUES	6K, 15K, 33K, 42KHz
HIGH-FREQUENCY BOOST	6dB/octave shelving type boost.
+3dB HIGH-FREQUENCY VALUES	1.5K, 1.9K, 2.1K, 2.8K, 3.6K, 6K, 9KHz
MAXIMUM BOOST	+6, +9, +12, +15 dB shelving level
MAXIMUM INPUT/OUTPUT LEVEL	+18dBv
DISTORTION (FLAT RESPONSE):	Less than 0.05%, 20-20KHz, +8dBv output.
NOISE:	-96 dB (A Weighted)

0dBv = 0.775V

4.2 SCHEMATIC



4.3 PRODUCT WARRANTY

QSC Audio Products guarantees the UF-1 to be free from defective material and/or workmanship for a period of three years from date of sale, and will replace defective parts and repair malfunctioning products under this warranty when the defect occurs under normal installation and use: provided the unit is returned to our factory via prepaid transportation with proof of purchase (sales receipt). This warranty provides that examination of the returned product must disclose, in our judgement, a manufacturing defect. This warranty does not extend to any product which has been subject to misuse, neglect, accident, improper installation, or where the date code has been removed or defaced.

WARRANTY AND SERVICE REPAIR INSTRUCTIONS:

1. Pack the product safely making sure to include a copy of the sales receipt, your name, return address, and phone number. Mark the package: Attention Service Dept.

2. Ship the product prepaid to QSC Audio Products. We recommend UPS.

3. We will determine if the product is under warranty:
   a. If it is we will repair and ship it back to you at no charge.
   b. If it is not we will contact you and inform you of the charges. Upon your approval, we will repair the product and ship it back freight and service charges collect (COD).

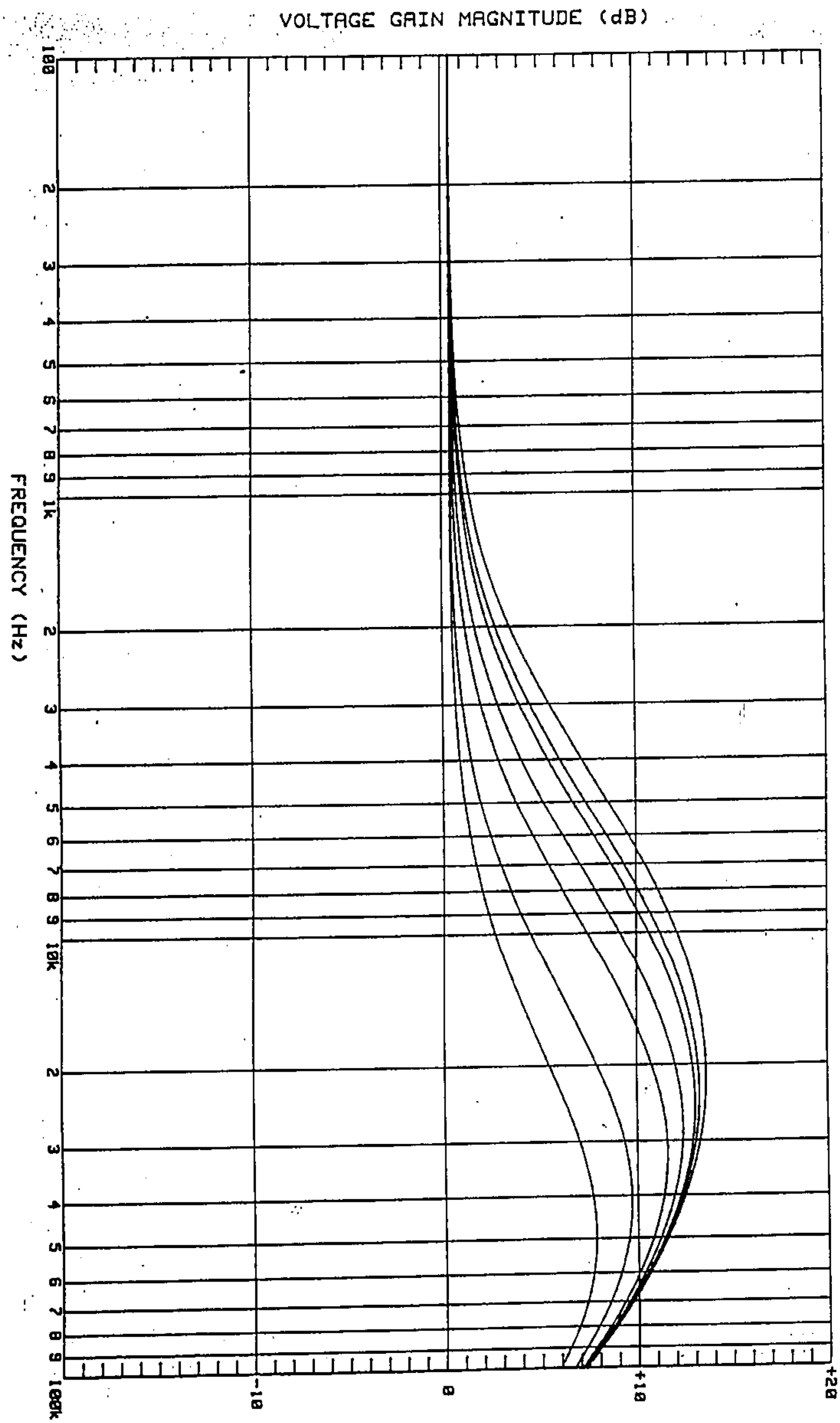

VOLTAGE GAIN MAGNITUDE (dB)
FREQUENCY (Hz)
100
1k
10k
100k
-10
0
+10
+20

FIG.1

DRAFTED BY: [signature]	DATE 1/9/91	PRIORITY 1 ■	QSC AUDIO PRODUCTS, INC. 1926 PLACENTIA AVE. COSTA MESA, CA. 92627	ACCEPTED: ___ REJECTED: ___	DATE: 12/10/90	ECO NO. 947
IMPLEMENTED BY: GRANT	DATE 1/15/91	2 ☐ 3 ☐	OTHER IMPACT: UL/CSA: ____ SALES: ____ OTHER: ____	PARTS DISPOSITION: A= USE AS IS B= REWORK PER INST: ____ C= SCRAP D= PARTS CONFORM E= SEE REMARKS	ORIGINATOR: R. BECKER	ECR NO. 592
CHECKED BY: GRANT	DATE 1-15-91	4 ☐			CLASS OF CHANGE: ☐ NON-INTERCHANG ☐ INTERCHANGABLE DOC ONLY	PAGE 1 OF 3 COORDINATE WITH: ECO #899

REMARKS:

REASON FOR CHANGE: CHANGE RESISTOR VALUES ON BELOW DOCUMENT AND DRAWINGS.

DOCUMENT #	DESCRIPTION	CUR REV	NEW REV	LAR	ON ORDER P/O #	ON ORDER DONE	ON ORDER OPEN	STOCK	WIP	BACK ORDER	FINIS GOODS	MATERIALS EFFECTIVITY DATE
SH-100070-ΔX	UF-1 UNIV. FILTER SCHEMATIC (DWG)	A	B	ok								1-28-91
SH-100050-00	CROSSOVER XH-1, XL-1 SCHEM. (DWG)	B	C	ok								1-28-91
TD-100918-ΔX	UNIV. FILTER OWNER'S MANUAL (DOCU.)	Δ2	B	ok	—	—	—	—	—	—	—	1-28-91

DESCRIPTION OF CHANGE:

SEE PAGE 2 FOR CHANGES

PRODUCT ENGINEER APPROVAL: R. Becker
DATE: 1-22-91

CCB APPROVALS	DATE	CCB DISTRIBUTION	DATE
MATERIALS [signature]	1/28/91	MATERIALS	DATE
QUALITY [signature]	1-28-91	QUALITY	DATE
SERVICE/MRKT BLF	1-28-91	SERVICE/MRKT	DATE
R & D ENG BRO	1-28-91	R & D ENG	DATE
MFG ENG [signature]	1/28/91	MFG ENG	DATE

REASON FOR REJECTION:

PRODUCTS: ☐ BOM CHANGE: ☐ DATE: __________ MIS UPDATED:

ECO NO. 947
PAGE 2 OF 3

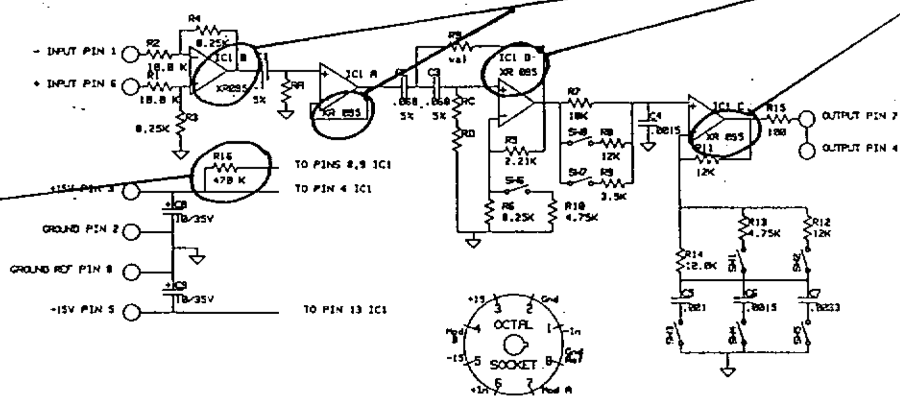
1. SH-100070-ΔX, TD-100918-ΔX (IS: P.10 IN OWNER'S MANUAL) (S/B: P. 12)
   a. CHANGE PART NUMBER ON IC1A-D FROM XR095 TO XR346-2,
   b. CHANGE VALUE ON R16 FROM 470K TO 1.3MΩ AS SHOWN BELOW.

IS:

UNIVERSAL ACTIVE FILTER

SH-100070-AX

SEE 1a

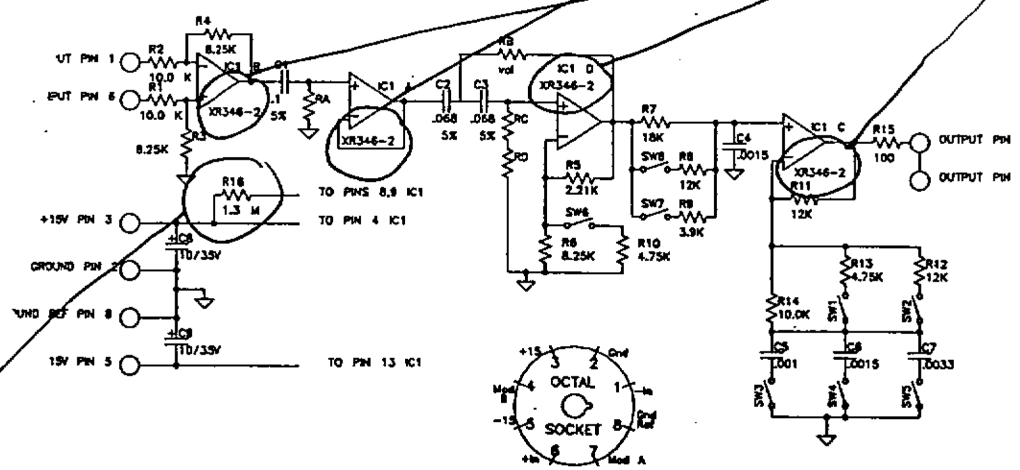


SEE 1b

S/B:

SH-100070-AX

SEE 1a



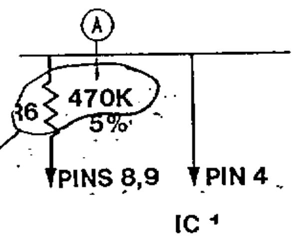
SEE 1b

2. SH-100050-00 (DWG.)

a. CHANGE VALUE ON R6 FROM 470K TO 1.3MΩ AND,

b. CHANGE PART NUMBER OF IC1 (IN NOTES) FROM XR095 TO XR346-2 AS SHOWN BELOW.

IS:



SEE 2a

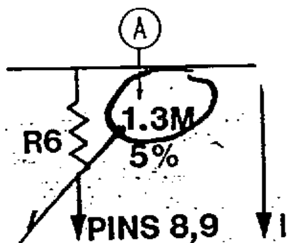
NOTES:

(1) IC1= XR 095
IC2= LF 442

(2) $F_c = \frac{1}{2\pi RC}$

SEE 2b

S/B:



SEE 2a

NOTES:

(1) IC1= XR 346–2
IC2= LF 442

SEE 2b