812

MAXI Q
Equalizer

OPERATING INSTRUCTIONS

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1. GENERAL INFORMATION

1.1 DESCRIPTION

MAXI Q lives up to its name ... providing maximum equalization capability, while a host of innovative features distinguishes MAXI Q from other equalizer devices. Each of the three frequency bands features continuously variable frequency tuning over a very wide 7-octave range. The resulting 6-octave overlap allows a spectrum coverage previously requiring 4 or more EQ bands.

Each EQ band may be selected to either peaking or shelving curves, or individually de-selected to the bypass mode. In addition, each band has a "Q" control (Bandwidth Control) which is effective in either the peaking or shelving mode.

In a departure from most parametric equalizers, which commonly employ the "parallel filter" approach, MAXI Q uses a more elaborate (and more costly) "series filter" configuration. In addition, MAXI Q uses an "all feedforward" approach instead of the usual "feedforward/feedback" configuration. The advantages of both innovations are discussed in the section on Theory of Operation.

Finally, MAXI Q offers a front panel input gain control, and an overload display which monitors 13 specific circuit points for potential clipping caused by excessive EQ or level structure. In combination, these features assure freedom from distortion and noise in all uses (including semi-pro level structures), as well as allowing for truly meaningful A/B comparisons by eliminating the common level shift between EQ and non-EQ.

All in all, MAXI Q is indeed what the name implies.

1.2 MAXI Q SPECIFICATIONS

Tuning Ranges: 125Hz to 16kHz(hi); 62Hz to 8kHz(mid); 31Hz to 4kHz(lo).

EQ Range: $\geq$30dB of attenuation at "INF" cut to 14dB boost. Fully independent sections (no interaction).

Input: Balanced differential input, 60K ohms, +21dBv max input level.

Output: +21dBm @ 600 ohms max.

Clip Indicator: Monitors 13 critical circuit points for overload.

Input Gain Control: $\pm$20dB of range (center unity).

Tune Mode: Presents response of selected filter to output.

"Q" (Bandwidth): .3 to 3 octaves (peaking, boost), 4dB to 28dB/octave (shelving).

Power Requirements: $\pm$15v @ 60ma.

Note: The following measurements are performed with all sections "IN" and "-EQ+" controls at mid position. Main gain control is at unity (mid position).

Distortion: Less than .03% THD or IMD.

Output Noise: -86dBv (20kHz bandwidth).

Slew Rate: 13v/μsec.

Dimensions: 5½"H x 1½"W x 9½"D

Notes: .0dBv = .775v RMS.

All specifications subject to change without notice.

2. INSTALLATION

2.1 POWERING/HOUSING

The MAXI Q is designed to be housed in any of the Valley International "800" series powered or unpowered racks including: PR-10A; PR-2A; TR 804; TR 805; TR 806; or CM 801A.

2.2 SYSTEM INTERFACE CONSIDERATIONS

MAXI Q is designed to interface into essentially line level circuits, having a nominal signal level in the range of -20dBv to +8dBv, re .775v RMS.

The audio inputs into the device are electronically balanced differential inputs, exhibiting an impedance of 30K ohms on the inverting leg (low side) and 60K ohms on the non-inverting leg (high side). For situations requiring a phase reversal, the high and low (+ and -) input connections may be reversed without adverse ramifications. The inputs will handle, without clipping, signal levels up to +21dBv.

The output circuit is unbalanced, and has a voltage drive capability of +21dBv into 600 ohms or greater. The output impedance is 33 ohms.

2.3 CONNECTIONS IN UNBALANCED CIRCUITS

Often, in recording studio console installations, a patch point may be "unbalanced to unbalanced". In most such situations, the input and output circuits share a common power supply, and are integrally grounded together. In these cases, a beneficial scheme to avoid unwanted ground loops is to connect only the MAXI Q output ground (to the circuit which the device is feeding its output signal), while leaving the MAXI Q input ground(s) unconnected (connecting only the + and - inputs).

Often also, in such installations, the shield wires should be connected only at one end, and left open at the other end, so as to not allow ground currents to flow through the shields.

2.4 POWER LINE GROUND

The PR-10 and PR-2 cases are connected to the ground prong of the line cord, and are thus grounded to the power line ground. In some installasions, an earth ground, separate from the power line ground, is employed to reduce ground noise. To properly separate the audio ground from the safety ground, please refer to the schematics provided with each individual powered rack.

3. THEORY OF OPERATION

As evidenced by the familiar front panel nomenclature, MAXI Q performs parametric equalization functions already understood by most users. There are, however, a number of departures from the norm in the design and capability of MAXI Q with respect to other equipment currently on the market. It is desireable that the user fully understand these differences in order to gain optimum benefit from the device.

3.1 SERIES STRUCTURE VS PARALLEL STRUCTURE

Most equalizers available today employ what is known as a parallel structure. In such a design, a number of filter networks are placed in parallel between an input amplifier and an output amplifier. While simple to implement, this structure has certain limitations which the user should understand. These limitations are associated with the interaction between filter sections which is inherent in the design, and are obvious when two or more filter sections are tuned to similar frequencies. If, for example, two sections were adjusted to boost 3kHz by 10dB, the result would not be the expected 20dB total boost. Rather, depending on the specific design, the actual total boost might be only 10 - 14dB. In the cut mode it is possible for multiple section "cut instructions" to cancel one another resulting in no attenuation, and even boost, at the selected frequencies. Unpredictable phase responses may also result.

In the MAXI Q a series structure is used. This results in a complete absence of section-to-section interaction, as well as dramatically increasing the range and amounts of equalization available. As an example, if all three sections of MAXI Q were tuned to the same frequency range and were adjusted to 14dB of boost, the total amount of boost to that frequency range would be 42dB ... exactly as indicated by the controls. The reverse would be true if the sections were all adjusted to cut. Thus, MAXI Q may be considered as an equalizer-followed-by-an-equalizer-followed-by-an-equalizer, as opposed to three equalizers summed together in parallel.

The obvious advantages of the series approach are somewhat offset by the requirement that the operator use more discretion in operation to avoid excessive overall equalization. This is somewhat alleviated by the overload indicator system, which alerts the user of potential circuit overload at 13 discrete circuit points, as well as by the inclusion of the input gain control, which may be used to increase headroom under high-boost conditions.

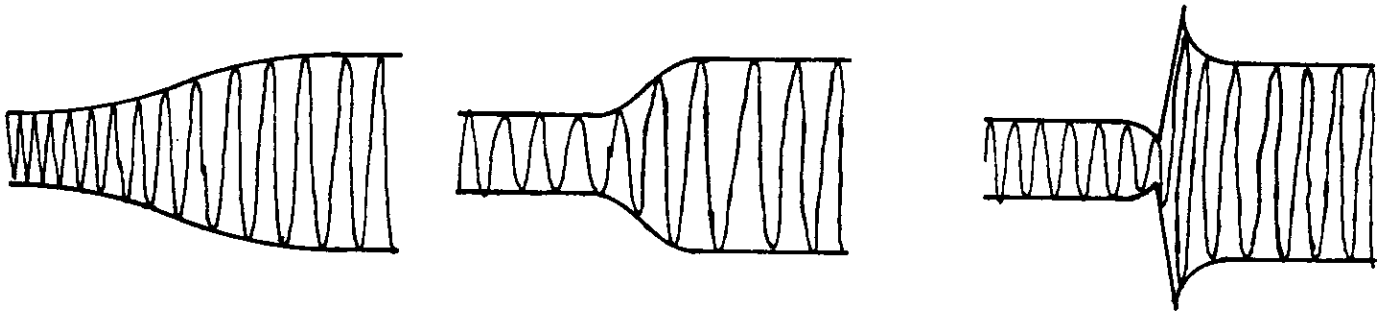
3.2 RECIPROCAL VS NON-RECIPROCAL EQ CURVES

Most equalizers produce what are known as "reciprocal EQ curves" ... that is to say the "cut" family of curves is a mirror image of the "boost" family in both the amount of equalization and "Q", or equalizing bandwidth. While this relationship has proven beneficial for "tone control" type circuits, an increasing percentage of studio engineers are showing a preference for the "non-reciprocal" format for curves, as exhibited by MAXI Q. Here, the bandwidths tend to be smaller (higher Q) when cutting, with respect to the boost bandwidths. This allows for more selective attenuation of unwanted frequencies with less loss of desired frequencies. Of particular interest is the "infinite cut" mode. Rather than the typical "14dB maximum cut", the design of MAXI Q allows for "infinite" attenuation of selected frequencies at the maximum cut position. (Due to component tolerances, a typical maximum cut of 30dB is specified). Thus, the equalizer can effectively become an adjustable "Q" notch filter when in the PEAKING position, or an adjustable slope cut-off filter when in the SHELVING position.

3.3 ADJUSTABLE "Q" IN SHELVING POSITIONS

In most parametric equalizers, the "Q", or "bandwidth" control, has effect only when PEAKING EQ shape is selected. The "Q" during SHELVING is generally fixed, resulting in a non-adjustable slope (usually around 6dB/octave). In MAXI Q, the "Q" control remains active in the SHELVING EQ shape, thus allowing the user to vary the slope dramatically. This parametric feature, while extremely useful should be well understood in order to avoid certain potentially undesireable effects. When in the SHELVING MODE each section of the MAXI Q exhibits a range of very gentle slopes (4dB/octave when the "Q" control is fully CCW) through moderate, critically damped slopes (8dB/octave as the "Q" control is advanced to mid-position.) Advancing the "Q" control beyond mid-position causes more extreme slopes, as well as causing a condition of under-damping, or pronounced peaks and dips appearing in the response curve around the frequency to which the filter is tuned. With the "Q" control at fully CW, the EQ slopes are approximately 28dB/ octave, and are accompanied by severe overshoot/undershoot around the equalizing frequencies, as depicted graphically in Figure 1. At the same time, rapidly changing phase responses occur. When properly and intentionally used, these radical responses are useful in causing coloration and exaggerated tonality to the signal source. On the other hand, the indiscriminate use of the high-Q shelving function can result in undesireable coloration. For most purposes, it is recommended that the "Q" control not be advanced beyond mid-position when standard shelving effects are desired. (Note the front panel graphics around the "Q" control, which show the relative slopes to be expected.)

FIGURE 1.



EFFECT OF "Q" CONTROL ON SHELVING MODE RESPONSE

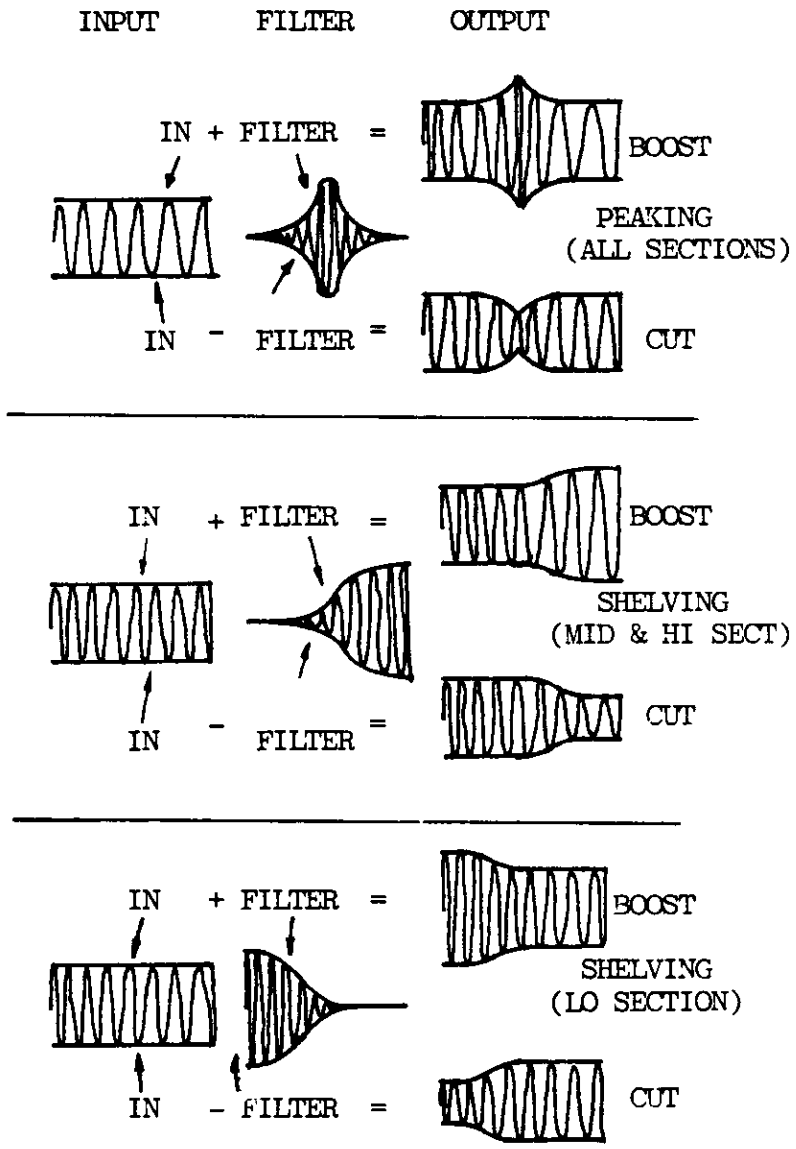
3.4 TUNE MODE

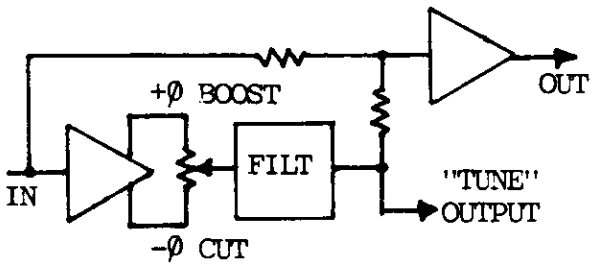
The MAXI Q has an exclusive feature known as TUNE MODE. The purpose of this feature is to allow the user a method of easily making critical frequency and "Q" adjustments by ear. In a sense, TUNE MODE is likened to a solo system. In order to fully understand the operation of TUNE MODE, the user should be aware of how the EQ curves are generated within MAXI Q. In each of the three EQ sections the input signal is passed through a filter network either Hi Pass, Lo Pass, or Band Pass, depending on whether PEAK or SHELF is selected. (See Figure 2.) The selected filter output is then summed in phase with (added to) the input signal for "boost", or is summed out of phase with (subtracted from) the input for "cut". Thus, as seen again in Figure 2, the actual filter output always has maximum response at the fre-

quency of interest whether boost or cut is selected. When 0dB of EQ is selected, no signal is allowed to pass from the filter to the summing mode, thus the input signal passes unmodified to the output.

FIGURE 2.

EQUIVALENT CIRCUIT & GENERATION OF EQ CURVES FROM BAND PASS, HI PASS & LO PASS FILTERS





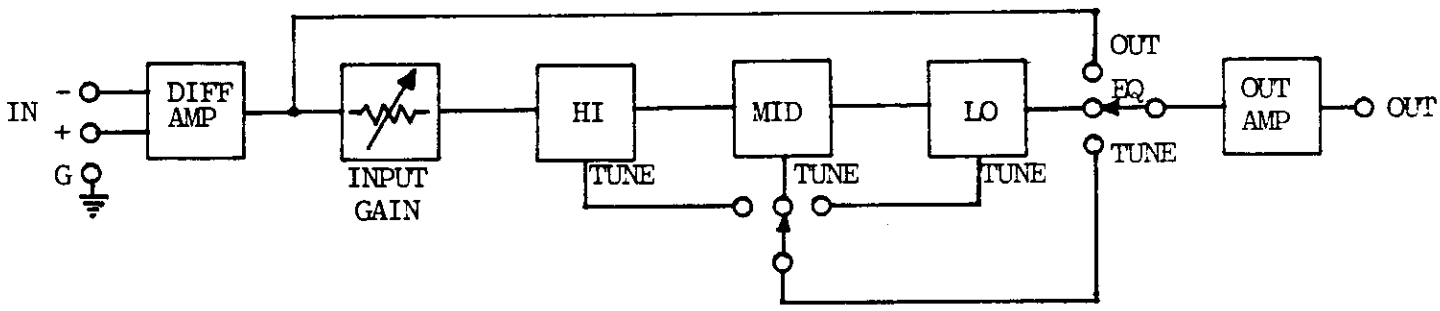
EQUIVALENT EQ SECTION DIAGRAM

If one monitors the selected filter section output, only that signal which is used to modify the input signal is heard, and all other frequencies are absent. Thus, the operator is able to "solo" what is being added to or subtracted from the actual signal prior to effecting equalization.

In referring to Figure 3, it is seen that in the TUNE MODE the main signal path is shut off, and only the direct filter output of the selected section is audible.

FIGURE 3.

EQUIVALENT OVERALL BLOCK DIAGRAM



Consider a case in which an instrument resonance is to be boosted or attenuated. By first selecting the TUNE MODE, the operator may tune each filter section, making critical "Q" and frequency adjustments while listening only to those frequencies to be dealt with. Then, by switching to the EQ MODE, he can cut or boost the previewed frequencies as desired. In short, TUNE MODE simply offers an extremely accurate means of fine tuning the filters.

Please note that, due to the series nature and order of the EQ sections, as shown in Figure 3, equalization established by the Mid and Lo EQ sections will not be heard in the output when the Hi EQ section is selected to TUNE MODE, but the equalization established in the Hi and Mid EQ sections will be heard when tuning the Lo section and Mid section. Although this is normally unimportant, should a situation arise where it is necessary to fully ignore the effect of previous EQ sections while tuning, the preceding sections can simply be switched to the OUT position.

3.5 USE OF THE INPUT GAIN CONTROL

The input gain control has two basic purposes:

To allow accurate A/B comparisons (EQ in/EQ out) and;
To accomodate a wide range of input signal levels and/or large amounts of EQ.

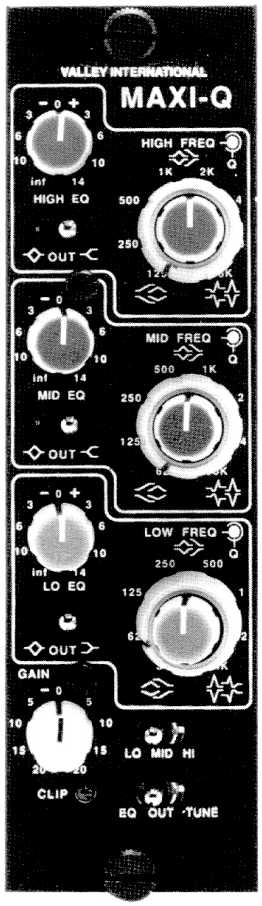
With many equalizers, when making comparisons the user often believes that the added EQ is beneficial simply because the EQ'ed version is louder. It is quite possible that the selected EQ settings have actually detracted from the aesthetic value of the program, and that better program content might be attained by simply

raising the volume of the unequalized music. The only accurate way to make EQ comparisons is to present both programs to the listener at the same apparent loudness. Since the input gain control of the MAXI Q is active only in the EQ IN position, it may be adjusted to compensate for the inherent gain change incurred by EQ'ing. By switching between EQ IN and EQ OUT, A/B comparisons may be made without the deceiving level change which normally occurs.

As for the accomodation of a wide range of input levels, it is known that boosting various frequencies tends to decrease headroom ... both within the equalizer itself, and in subsequent audio stages. Thus, the input gain control serves as a mechanism to offset the increased levels caused by equalization, in order to prevent clipping and other distortion. Of course, the gain control may also be used to elevate excessively low level signals to improve signal to noise ratio, or to attenuate excessively large input signals to prevent overload. By visually monitoring the multi-point clip indicator on the MAXI Q, the operator may easily adjust the input gain control to the optimum position for the particular signal source and EQ combination.

FIGURE 4.

THE CONTROLS



EQ control [-inf. (infinite attenuation) to +14 dB (boost)]. Determines the amount of "boost" or "cut" exhibited by each filter section.

FREQ control. Determines the frequency at which each filter section "boosts" or "cuts"; also determines the frequency at which shelving responses begin to occur. Adjustable over 7 octaves.

out
out
(filter mode switch.)

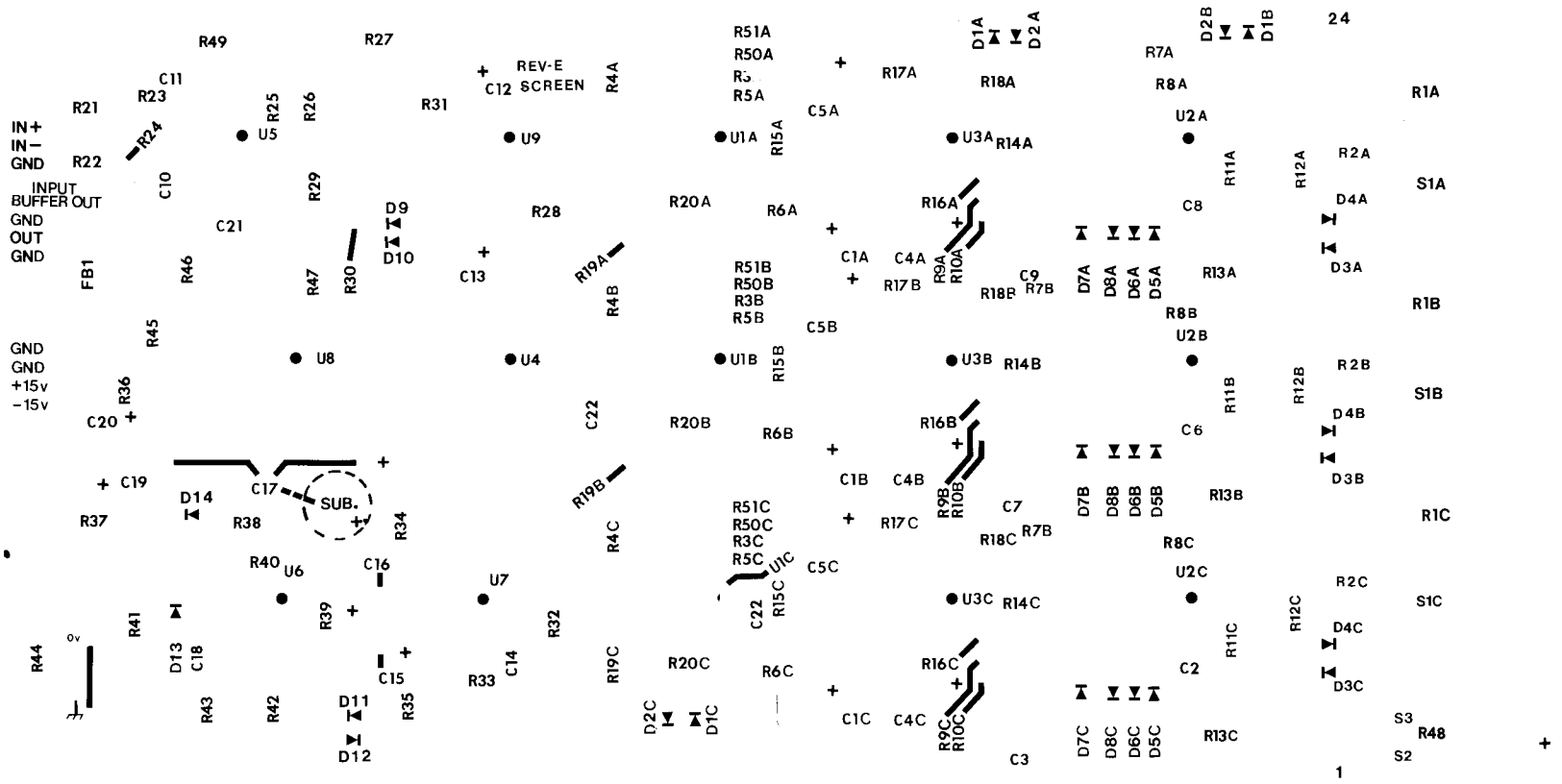
Selects the filter characteristic of, or bypasses each filter section. In the position, the bandpass output of the filter section is selected, and in conjunction with the **EQ** control either the (bandpass) or the (band reject or "notching") function is performed. The or position yields high frequency or low frequency "boost" or "cut" respectively in conjunction with the **EQ** control.

GAIN control (—20 dB to +20 dB). Determines nominal gain of the composite channel. Not active in the **OUT** (bypass) mode.

EQ OUT TUNE (mode) switch. Determines the operating mode of the composite channel. When in **EQ,** passes the signal through the filter sections. When in **TUNE,** allows any filter section to be monitored at the audio output. When placed in the **OUT** position, all of the filter sections of the MAXI-Q are bypassed.

LO M (MID) HI (tune select) switch. Selects the filter section to be monitored in the **TUNE** mode.

CLIP warning indicator. Monitors 13 points in the circuit.


IN+
IN−
GND
INPUT BUFFER
OUT
GND
OUT
GND
GND
GND
+15v
−15v
REV-E SCREEN
SUB.
24
S1A
S1B
S1C
S2
S3
R1A
R1B
R1C
R48
U1A
U1B
U1C
U2A
U2B
U2C
U3A
U3B
U3C
U4
U5
U6
U7
U8
U9
D1A
D2A
D1B
D2B
D1C
D2C
D3A
D3B
D3C
D4A
D4B
D4C
C1A
C1B
C1C
C2
C3
C4A
C4B
C4C
C5A
C5B
C5C
C6
C7
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C13
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C15
C16
C17
C18
C19
C20
C21
C22
FB1
R2A
R2B
R2C
R3B
R3C
R4A
R4B
R4C
R5A
R5B
R5C
R6A
R6B
R6C
R7A
R7B
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R8C
R9A
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R50A
R50B
R50C
R51A
R51B
R51C
D5A
D5B
D5C
D6A
D6B
D6C
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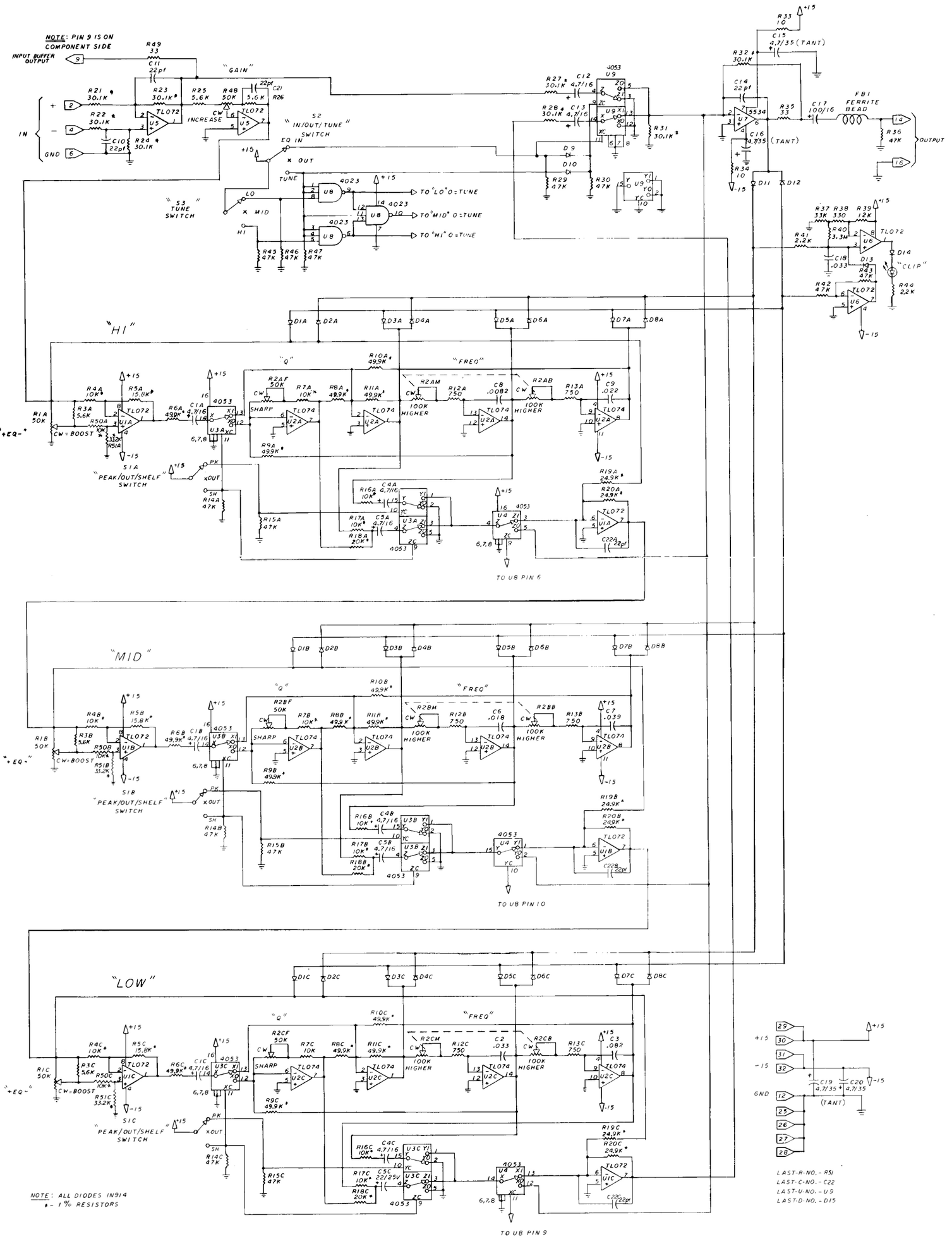
NOTE: PIN 9 IS ON COMPONENT SIDE
INPUT BUFFER OUTPUT
"GAIN"
INCREASE
IN
GND
S2 "IN/OUT/TUNE" SWITCH
EQ IN
X OUT
TUNE
LO
X MID
HI
S3 "TUNE SWITCH
TO "LO" O=TUNE
TO "MID" O=TUNE
TO "HI" O=TUNE
FB1 FERRITE BEAD
OUTPUT
"CLIP"
"HI"
"MID"
"LOW"
"Q"
"FREQ"
CW=BOOST
"+EQ-"
S1A "PEAK/OUT/SHELF SWITCH
S1B "PEAK/OUT/SHELF SWITCH
S1C "PEAK/OUT/SHELF SWITCH
SHARP
100K HIGHER
TO U8 PIN 6
TO U8 PIN 10
TO U8 PIN 9
NOTE: ALL DIODES IN914
* - 1% RESISTORS
LAST-R-NO. - R51
LAST-C-NO. - C22
LAST-U-NO. - U9
LAST-D-NO. - D15