



Installation and Operation Instructions

RETROFIT KIT RET-044

For OPTIMOD-AM Models 9000A and 9000A/1

Purpose: Adds NRSC Pre-emphasis and 10kHz Low-pass Filter

This kit modifies the Model 9000A or 9000A/1 OPTIMOD-AM® to provide the pre-emphasis and 10kHz low-pass filtering that is required by the National Radio Systems Committee (NRSC). 11kHz and 5kHz low-pass filtering are provided for stations that require them. The filters can be preset, or can be switched by OPTIMOD-AM's day/night logic. This kit also provides a means of de-emphasizing the NRSC pre-emphasized signal for monitoring.

Retrofit Kit RET-044 contains:

- 1 Capacitor, 1300pF $\pm 2\%$, mica
- 1 Resistor, 5.49K $\pm 1\%$, $\frac{1}{8}$ -watt, metal film (green-yellow-white-brown-brown)
- 2 Resistors, 8.66K $\pm 1\%$, $\frac{1}{8}$ -watt metal film (gray-blue-blue-brown-brown)
- 1 Resistor, 3.16K $\pm 1\%$, $\frac{1}{8}$ -watt metal film (orange-brown-blue-brown-brown)
- 1 Resistor, 49.9K $\pm 1\%$, $\frac{1}{8}$ -watt metal film (yellow-white-white-red-brown)
- 1 Resistor, 1.27meg $\pm 1\%$, $\frac{1}{8}$ -watt metal film (brown-red-violet-yellow-brown)
- 1 Resistor, 10.0K $\pm 1\%$, $\frac{1}{8}$ -watt metal film (brown-black-black-red-brown)
- 1 Opamp (TL072) IC
- 1 Capacitor, 0.1 μ F $\pm 10\%$ metallized polyester
- 1 28-gauge jumper wire
- 1 Resistor, 75.0K $\pm 1\%$, $\frac{1}{8}$ -watt metal film (violet-green-black-red-brown)
- 1 Pre-wired 22-pin card connector with mounting hardware
- 2 Card guides
- 1 #1F10 Card
- 1 Label, "Special Modification"
- 1 Resistor, 100 Ω $\pm 5\%$, $\frac{1}{4}$ -watt, carbon film
- 2 Resistors, 620 Ω $\pm 5\%$, $\frac{1}{4}$ -watt, carbon film
- 1 Capacitor, 0.18 μ F $\pm 5\%$, 100-volt, metallized polyester
- 1 Installation and Operation Instructions

These instructions first discuss the reasons behind the NRSC requirements (starting on the following page), then explain how to install the retrofit (on page 3).

Installation consists of replacing components on Cards #3 and #8, installing a new card edge connector, setting jumpers, and plugging in a new circuit card. A simple de-emphasis circuit can be installed for off-air monitoring.

New operation information and **technical notes** follow the installation instructions. Also included are **field alignment and performance verification instructions**, a **circuit description**, a **parts list**, a **schematic**, and an **assembly drawing** for Card #1F10.

Why the New NRSC Standard?

Over the years, as the North American air waves has become more crowded, interference from first and second adjacent stations has become more and more of a problem. Receiver manufacturers responded by producing receivers with decreased audio bandwidth, so that an adjacent station's modulation extremes would not be audible as interference. This cutting of the bandwidth had the effect of reducing the receiver's high-frequency response, but it was felt that lower fidelity would be less obnoxious than interference. As long ago as 1978, Orban proposed and implemented pre-emphasis and low-pass filtering for AM broadcast to provide brighter sound at the receiver while minimizing interference. This approach has become widely accepted. Now the NRSC has formalized a standard which is acceptable to all industry segments, and which can, if promptly implemented, result in a vast improvement in AM radio.

AM Stereo Introduces a Pre-emphasis Dilemma

Certain AM receivers manufactured since 1984 for sale in North America, particularly those designed for domestic AM stereo reception, have a frequency response that is substantially wider than that of the typical mono AM receiver. The frequency response was widened largely to enhance the sales potential of AM stereo by presenting a dramatic, audible improvement in fidelity in the showroom. As these new receivers became more prevalent, broadcasters had to choose whether the station's pre-emphasis would be optimized for the new AM stereo receivers or for the existing conventional receivers that form the vast majority of the market. If the choice was for conventional receivers (which implies a relatively extreme pre-emphasis), the newer receivers might sound strident or exceptionally bright. If the choice favored the newer receivers (less pre-emphasis and probably less processing), the majority of receivers would be deprived of much high-end energy and would sound both quieter and duller.

NRSC Standard Pre-emphasis and Low-pass Filtering

In response to this dilemma, the National Radio Systems Committee (NRSC) undertook the difficult task of defining a voluntary recommended pre-emphasis curve for AM radio that would be acceptable to broadcasters (who want the highest quality sound on the majority of their listeners' radios) and to receiver manufacturers (who are primarily concerned with interference from first- and second-adjacent stations).

After a year of deliberation, a 'modified 75-microsecond' pre-emphasis/de-emphasis standard was approved. This provides a moderate amount of improvement for existing narrowband radios, while optimizing the sound of wideband radios. Most importantly, it generates substantially less first-adjacent interference than do steeper pre-emphasis curves. The second part of the NRSC standard calls for a sharp upper limit of 10kHz for the audio presented to the transmitter. This essentially eliminates interference to second and higher adjacencies. While some have protested that this is inadequate and that 15kHz audio should be permitted, the unfortunate fact is that interference-free 15kHz audio could only be achieved by a complete re-allocation of the AM band! The *practical* effect of widespread implementation of the 10kHz standard is that 10kHz radios will then be feasible, and the bandwidth perceived by the average consumer (now limited by the receiver to 3kHz, typically) will be dramatically improved. On much mass-market consumer equipment, it will be difficult to tell AM from FM.

On April 27, 1989, The FCC (U.S.A.) released a Report and Order that amended section 73.44 of the FCC Rules by requiring all U.S. AM stations to comply with the occupied bandwidth specifications of the NRSC-2 standard by June 30, 1990. The NRSC-2 standard is an 'RF mask' that was derived from the NRSC-1 audio standard by the NRSC. The purpose of the NRSC-2 RF mask is to provide a transmitted RF occupied bandwidth standard that any station with a properly-operating transmitter will meet, *provided that NRSC-1 audio processing is used prior to the transmitter, and provided that the station is not over-modulating.*

The Report and Order provides for 'presumptive compliance' with the NRSC-2 occupied bandwidth standard: Prior to June 30, 1994, any station whose audio complies with the NRSC-1 standard (an *audio* standard) is presumed to comply with the NRSC-2 standard (an *RF occupied bandwidth* standard), unless the station receives an Official Notice of Violation or a Notice of Apparent Liability from the Commission alleging non-compliance with the NRSC-2 occupied bandwidth standard.

Orban welcomes the FCC's decision: The radio manufacturers participating in the NRSC stated emphatically that reduction in interference *must be demonstrated by broadcasters* before receiver manufacturers would be willing to release true wideband (10kHz audio bandwidth) receivers to the mass market. This is rational — the receiver manufacturers can lose millions of dollars if they produce receivers that are rejected as noisy or interference-prone by consumers. In contrast, broadcasters can easily change pre-emphasis and filtering with very little expense.

It would therefore be wise to strictly conform to the standard even if it were *not* required by the FCC. We are convinced that use of this more modest pre-emphasis and sharp 10kHz filtering by broadcasters is the only factor that will eventually induce the receiver manufacturers to build and mass-market the high-fidelity, wideband radios which would allow AM stations to compete with FM in audio quality. The commitment to do so was strongly expressed by the receiver manufacturers involved in the NRSC's deliberations.

Installation

In these instructions "OPTIMOD-AM" refers to either of Models 9000A or 9000A/1. For the purposes of this retrofit, your unit should be considered to be a "9000A/1" if there are DAY and NIGHT indicators and a XMTR EQ switch on the right side of the subpanel; if these are not present, you have a "9000A." (Use the presence or absence of the XMTR EQ switch and LEDs to determine your model number for this retrofit — some units labeled "9000A" have been upgraded to 9000A/1 units.)

You will need a set of tools suitable for printed circuit board repairs. Refer to the drawings in your OPTIMOD-AM Operating Manual for location of parts. All parts needed for this retrofit are supplied in this kit.

Allow about 2 hours for this retrofit.

CAUTION: The reliability of your unit can be compromised by poor workmanship. Refer to "Replacement of Components on Printed Circuit Cards" in Section 4 of your OPTIMOD-AM Operating Manual (page 4-4 in the 9000A Manual, page 4-13 in the 9000A/1 Manual) for instructions on how to rework the cards without damaging them or making them unreliable.

1) Open the front panel of OPTIMOD-AM, remove the subpanel.

- a) Disconnect OPTIMOD-AM, remove it from the rack, and place it on a work bench.
- b) Remove the three screws at the top of the front panel, then tilt the hinged front panel downward to reveal the interior.
- c) Set the AC POWER switch to OFF.
- d) Loosen the four DZUS fasteners on the subpanel by turning each 1/4-turn counterclockwise with a long 3/16-inch or 1/4-inch flat-blade screwdriver.
- e) Taking care not to stress the flat cables beneath it, tilt the top of the subpanel outward and to the left to clear the upper chassis lip and the door support rail at the right.

NOTE: Due to mechanical interference, Cards #3 and #5 must be removed before Cards #4 and #6 can be removed. (There is, however, no need to remove Card #4 or #6 for this retrofit.)

2) Remove and replace components on Card #3.

- a) Remove Card #3 from its slot.
- b) Remove and replace the following components on Card #3.

This step modifies OPTIMOD-AM's "input conditioning filter" on Card #3 to obtain "modified 75 μ s" pre-emphasis.

Remove:

- C305 (4700pF capacitor)
- C307 (160pF mica capacitor)
- R309 (35.7K resistor)
- R310 (28.0K resistor)
- R311 (28.0K resistor)
- R312 (4.53K resistor)

Replace with the supplied:

- (discard C305) —
- 1300pF \pm 2% mica capacitor
- 5.49K resistor (green-yellow-white-brown-brown)
- 8.66K resistor (gray-blue-blue-brown-brown)
- 8.66K resistor (gray-blue-blue-brown-brown)
- 3.16K resistor (orange-brown-blue-brown-brown)

- c) Remove and replace the following components on Card #3.

This step retunes the high-pass filter within the "input conditioning filter" from 100Hz to 50Hz. These changes are not required by the NRSC standard, but are strongly recommended by Orban to improve the audible bass quality of the processing.

Remove:

- R304 (24.9K resistor)
- R305 (634K resistor)
- R306 (4.99K resistor)
- IC302 (RC4558)

Replace with the supplied:

- 49.9K resistor (yellow-white-white-red-brown)
- 1.27meg resistor (brown-red-violet-yellow-brown)
- 10.0K resistor (brown-black-black-red-brown)
- TL072

Be sure that the IC chip is correctly oriented in its socket, with the notch or dot on the chip on the same side as the "tab" on the circuit board foil pattern.

- d) Connect the supplied 0.1 μ F polyester film capacitor in parallel with resistor R345 on Card #3.

This step makes the operation of the Broadband Compressor smoother by de-emphasizing its control sample (so that it sees a "flat" signal and does not produce unnatural gain reduction on program material rich in high frequencies). This modification is not required by the NRSC standard, but is recommended by Orban.

- e) Return Card #3 to its slot.

3) Cut jumper, install jumper and resistor on Card #8 (with XMTR EQ switch).

[Skip this step unless your OPTIMOD-AM has DAY and NIGHT indicators and a XMTR EQ switch on the right side of the subpanel and your Card #8 is Assembly Number 30381-000-02.]

There are three versions of Card #8: one with transmitter equalization, one without, and one with Assembly Number 30381-000-02 (The assembly number is located on the solder side of the card).

- Remove Card #8 from its slot.
- Verify that jumper 2 on Card #8 is in the "DAY ONLY" position (unless you have a NIGHT filter installed on Card #8, and you want to continue using it at night).

See Fig. 1 for jumper location.

- Cut and remove the jumper labeled "3" on the Card #8 assembly drawing in the 9000A/1 Operating Manual.

This jumper is located very close to finger 20 on the card's edge.

- On the solder side of the card, solder one end of the supplied jumper wire to pin 7 of IC804's socket (-2.0VDC clipper bias source).

- Solder the other end of that wire to finger L of the card edge connector.

Finger L is the tenth pin down from the top, counting finger A as the first finger. Note that G, I, O, and Q are skipped in the labeling sequence.

Use only a tiny amount of solder, and solder to the very inner edge of the finger to avoid contaminating the gold mating surface of the finger with solder. Clean away any flux residue with solvent.

- Solder the supplied 75.0K (violet-green-black-red-brown) resistor between pins 1 and 3 of R817, the large OUTPUT ATTENUATOR control.

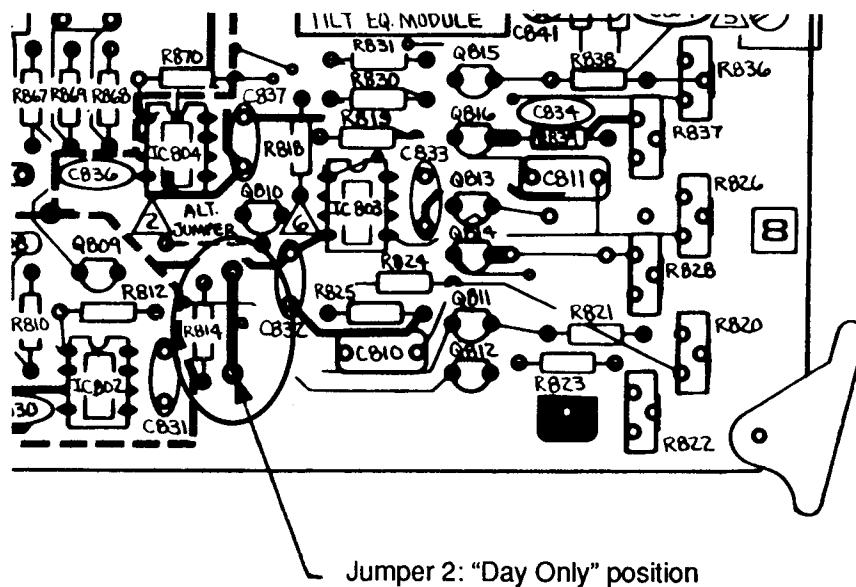


Fig. 1: Jumper Position, Card #8 (with transmitter equalization)

4) Cut jumper and install resistor on Card #8 (without XMTR switch).

[Skip this step if your OPTIMOD-AM has DAY and NIGHT indicators and a XMTR EQ switch on the right side of the subpanel, or if your Card #8 is Assembly Number 30381-000-02.]

There are three different versions of Card #8: one with transmitter equalization, one without, and one with Assembly Number 30381-000-02 (The assembly number is located on the solder side of the card).

- a) Remove Card #8 from its slot.
- b) Cut and remove the jumper labeled "STEREO OPTION JUMPER" on the Card #8 assembly drawing in the 9000A Operating Manual.

This jumper is located very close to pin 20 on the card edge connector.
- c) Solder the supplied 75.0K (violet-green-black-red-brown) resistor between pins 1 and 3 of R817, the large OUTPUT ATTENUATOR control.
- d) Return Card #8 to its slot.

5) Cut trace, and install resistor on Card #8 (with Assembly Number 30381-000-02).

[Skip this step if your Card #8 is not Assembly Number 30381-000-02.]

There are three versions of Card #8: one with transmitter equalization, one without, and one with Assembly Number 30381-000-02 (The assembly number is located on the solder side of the card).

- a) Remove Card #8 from its slot.
- b) Cut the trace between point 2 and the adjacent trim pot.
- c) Connect point 2 to edge connector pin 20.
- d) Connect the trim pot terminal disconnected in step 1 to edge connector pin 19.
- e) Return Card #8 to its slot.

6) Install edge connector and card guides for slot #1.

- a) Remove the 30 screws that attach the top cover to the chassis, then lift off the top cover.
- b) Remove the eight screws that attach the bottom cover to the rear panel.
- c) Set the unit on a padded surface with the rear panel facing you and the bottom cover down.

Leave about 6 inches (15cm) between the rear panel and the edge of the table. Be sure the AC power cord is unplugged.

- d) Remove the nine screws in three vertical groups on the rear panel.

One group of three is located at the left edge of the rear panel, one on the right edge. The third group is located about one-third of the way from the right edge.

- e) *Very carefully* pull the rear panel about $\frac{3}{4}$ -inch (2cm) toward you, and then tilt the top of the rear panel down until the rear panel is horizontal.

Careful! Watch for snags in the wiring or stress on the ceramic capacitors on the internal divider wall or RF box. These capacitors are very fragile and are difficult to replace.

- f) Attach the supplied edge connector to the circuit card cage at the rear of what will be slot #1 (to the left of Card #2) with the supplied screws and nuts.

Use the other edge connectors as models for installation.

- g) Working from the front of the unit, pop the two plastic card edge guides into their supports at the top and bottom of the card cage.

Again, use the existing guides as models.

- h) *If you have a OPTIMOD-AM with transmitter equalization*, connect the wires from the edge connector you just installed to the other edge connectors as follows.

[Skip to step i unless your OPTIMOD-AM has DAY and NIGHT indicators and a XMTR EQ switch on the right side of the subpanel.]

The 9000A/1 employs wire-wrap connections. To connect a wire, wrap it over and solder it near the end of the indicated wire-wrap pin.

The pins may be numbered on the connector body. If not, count down from the top. Alphabetic pins are those in the left row (the side furthest from the power supply). When counting alphabetic pins, skip G, I, O, and Q. To avoid errors, first mark the tip of every pin to be connected with a felt tip pen, then check the marks again before beginning work.

| Connect wire from: | To: | Function: |
|---|-------------------------|-------------------------|
| <input type="checkbox"/> slot #1, pin A | screw at top of slot #2 | chassis ground |
| <input type="checkbox"/> slot #1, pin B | slot #2, pin 2 | +15VDC |
| <input type="checkbox"/> slot #1, pin C | slot #2, pin 3 | circuit ground |
| <input type="checkbox"/> slot #1, pin E | slot #2, pin 5 | -15VDC |
| <input type="checkbox"/> slot #1, pin T | slot #8, pin J | NIGHT logic |
| <input type="checkbox"/> slot #1, pin U | slot #8, pin L | -2.0VDC clipper bias |
| <input type="checkbox"/> slot #1, pin V | slot #8, pin 7 | +2.0VDC clipper bias |
| <input type="checkbox"/> slot #1, pin X | slot #8, pin 19 | Card #1F10 audio output |
| <input type="checkbox"/> slot #1, pin Y | slot #8, pin 20 | Card #1F10 audio input |

- i) *If you have a OPTIMOD-AM without transmitter equalization, connect the wires from the edge connector you just installed to the other edge connectors as follows.*

[Skip to step j if your OPTIMOD-AM has DAY and NIGHT indicators and a XMTR EQ switch on the right side of the subpanel.]

The 9000A employs wire-wrap connections. To connect a wire, wrap it over and solder it near the end of the indicated wire-wrap pin.

The pins may be numbered on the connector body. If not, count down from the top. Alphabetic pins are those in the left row (the side furthest from the power supply). When counting alphabetic pins, skip G, I, O, and Q. To avoid errors, first mark the tip of every pin to be connected with a felt tip pen, then check the marks again before beginning work.

| Connect wire from: | To: | Function: |
|---|-------------------------|-------------------------|
| <input type="checkbox"/> slot #1, pin A | screw at top of slot #2 | chassis ground |
| <input type="checkbox"/> slot #1, pin B | slot #2, pin 2 | +15VDC |
| <input type="checkbox"/> slot #1, pin C | slot #2, pin 3 | circuit ground |
| <input type="checkbox"/> slot #1, pin E | slot #2, pin 5 | -15VDC |
| <input type="checkbox"/> slot #1, pin T | slot #8, pin 3 | circuit ground |
| <input type="checkbox"/> slot #1, pin U | slot #8, pin 6 | -2.0VDC clipper bias |
| <input type="checkbox"/> slot #1, pin V | slot #8, pin 7 | +2.0VDC clipper bias |
| <input type="checkbox"/> slot #1, pin X | slot #8, pin 19 | Card #1F10 audio output |
| <input type="checkbox"/> slot #1, pin Y | slot #8, pin 20 | Card #1F10 audio input |

- j) Check all your work very carefully by retracing all steps. Look for solder bridges.
- k) *Very carefully* tilt the rear panel up to the vertical position, and then push the rear panel forward into place.

Take care that no wires are pinched between the panel and the chassis.

- l) Replace the 9 rear-panel screws removed above.
Do not tighten screws until all screws are loosely in place, and the flanges of the rear panel are aligned with those of the side panels.
- m) Replace the top cover and the 30 screws that hold it in place.
Replace all screws loosely before tightening them. For best RFI protection, replace and firmly tighten *all* screws.
- n) Replace the eight screws that attach the bottom cover to the rear panel.

7) Install Card #1F10.

NOTE: The "12kHz" positions of Card #1F10 in fact bypass all filters on the card. Since the nominal bandwidth of the 9000A or 9000A/1 is 11kHz without further filtering, read "11kHz" whenever you see "12kHz" in the following text.

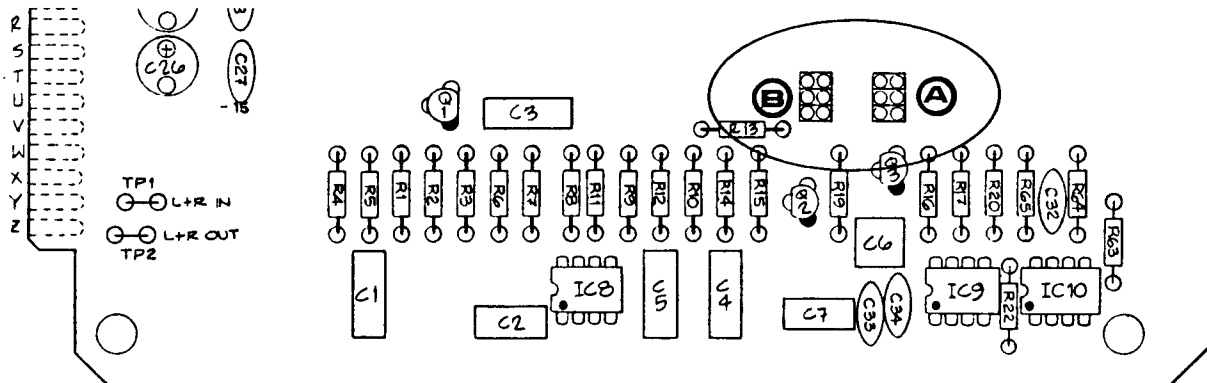
Card #1F10 contains the sharp 10kHz low-pass filter necessary to restrict the output spectrum of the processor within NRSC standards. It also contains a 5kHz 30dB/octave low-pass filter (for international use). When jumpers A and B are in the "12kHz" position, the 5kHz and 10kHz filters are bypassed (and OPTIMOD-AM's built-in 11kHz band limiting remains in effect). In the 9000A/1 (but *not* in the 9000A), Card #1F10 follows the DAY/NIGHT logic on Card #8.

a) Position jumper A (day) on Card #1F10 to select the low-pass filter (see Fig. 2).

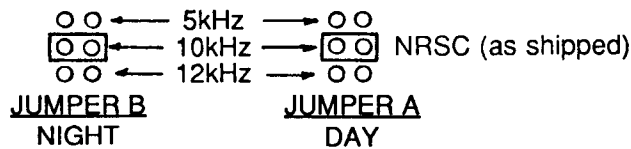
You may select 5kHz, 10kHz, or 12kHz low-pass filtering in any combination for day and night operation. The NRSC standard specifies 10kHz low-pass filtering for both day and night.

IMPORTANT: The 9000A is always in the DAY mode. Select low-pass filtering with jumper A (jumper B has no effect).

b) Insert Card #1F10 into slot #1.



#1F10



(inactive on 9000A)

Fig. 2: Low-pass Filter Jumper Positions, Card #1F10

8) Replace subpanel and close the front panel.

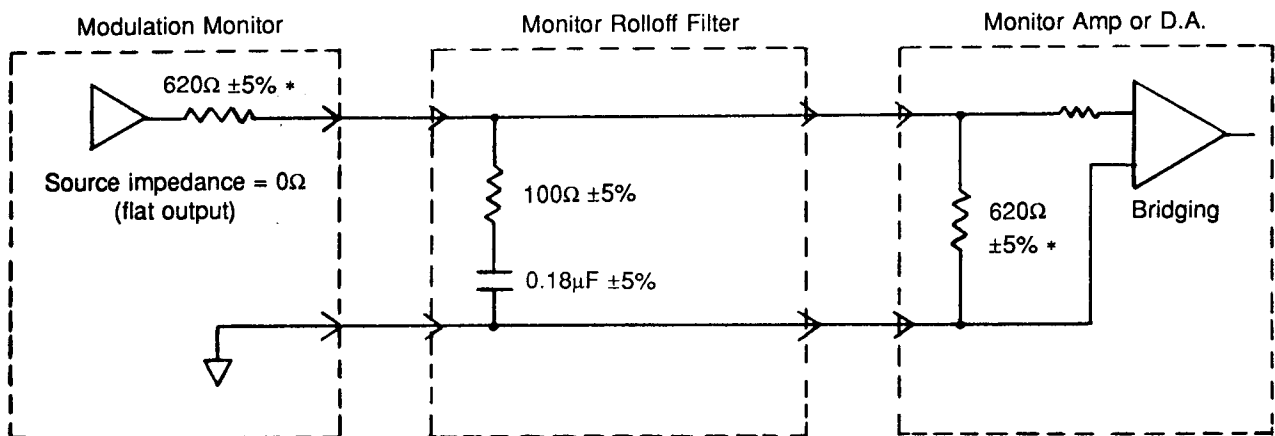
The subpanel should always be replaced, since it is an integral part of the chassis RFI protection.

- a) Taking care not to stress the flat cables beneath it, tilt the top of the subpanel inward and to the left to clear the upper chassis lip and the door support at the right.
- b) Turn the DZUS fasteners $\frac{1}{4}$ -turn clockwise.
The DZUS fasteners turn only $\frac{1}{4}$ -turn. Don't force them, lest they be damaged in a way that is very time consuming to repair.
- c) Set the internal AC POWER switch to ON.
- d) Raise the front panel and fasten the three screws that secure it in place.
- e) Return OPTIMOD-AM to its rack, connect and ground unit.

9) Attach the supplied "Special Modification" label to the rear panel.**10) Install NRSC de-emphasis circuit.**

A simple de-emphasis circuit can be placed between the audio output of the modulation monitor and the input of the monitor amplifier to provide complementary $75\mu\text{s}$ de-emphasis. For a more precise simulation of a "standard" NRSC receiver (including a 10kHz notch filter to reduce any audible artifacts that might result from ringing introduced by the very sharp 10kHz low-pass filter, and to eliminate 10kHz whistles encountered in off-air monitoring), we recommend our ACC-023 NRSC Monitor Rolloff Filter.

See Fig. 3 for a schematic of the simplified rolloff filter and information about installing it (the parts needed are included in this kit). Note that the frequency response of this filter is correct only when *both* its source and load impedances are 600 ohms, and that resistors or pads may have to added to achieve this.



* Add resistance as required to present approx. 600-ohm impedance to filter.

Fig. 3: NRSC Simplified $75\mu\text{s}$ Monitor Rolloff Filter Schematic

Operation

No alignment or adjustment of OPTIMOD-AM following this retrofit is required. However, if the NRSC pre-emphasis has significantly reduced the amount of pre-emphasis that you are using, you may find that it is possible to get greater loudness by advancing the setting of the CLIPPING and/or SMART CLIPPER DRIVE controls without increasing distortion objectionably.

Note that all OPTIMOD-AM controls may be set as they were prior to installation of the modification, except for the 5kHz EQ and 10kHz EQ controls (which must both be set to "0"), and the INPUT FILTER switch (which must be set to IN).

Technical Notes

Fig. 4 shows the normal input-to-output swept frequency response of an OPTIMOD-AM in PROOF mode with Retrofit Kit RET-044 properly installed. You may wish to check the operation of your unit against this figure.

Fig. 5 shows the normal response of Card #3 from the processor input terminals to finger 6 of Card #3. Fig. 5 is a useful reference against which to check the success of your Card #3 modifications.

Fig. 12 shows the typical output power spectrum of OPTIMOD-AM when the NRSC modification has been successfully installed. This is a 0–20kHz linear measurement using an FFT spectrum analyzer in its "peak hold" mode over a 20-minute period with bright program material.

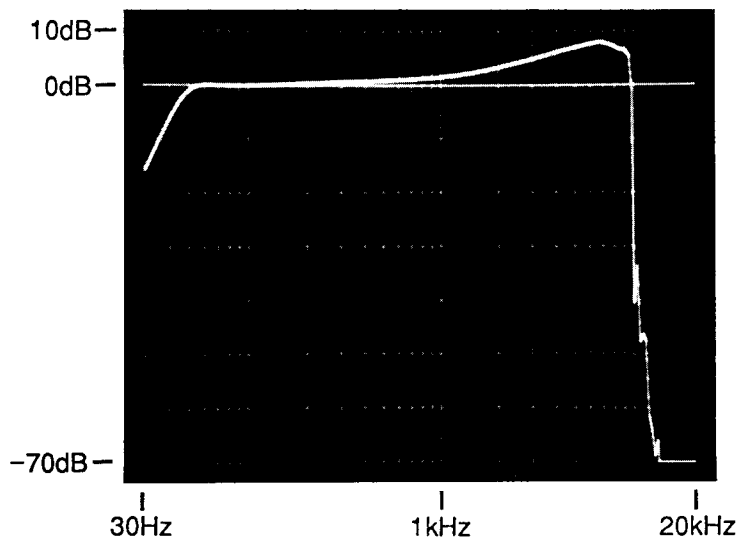


Fig. 4: Swept Frequency Response, Input-to-Output, 30-20,000Hz

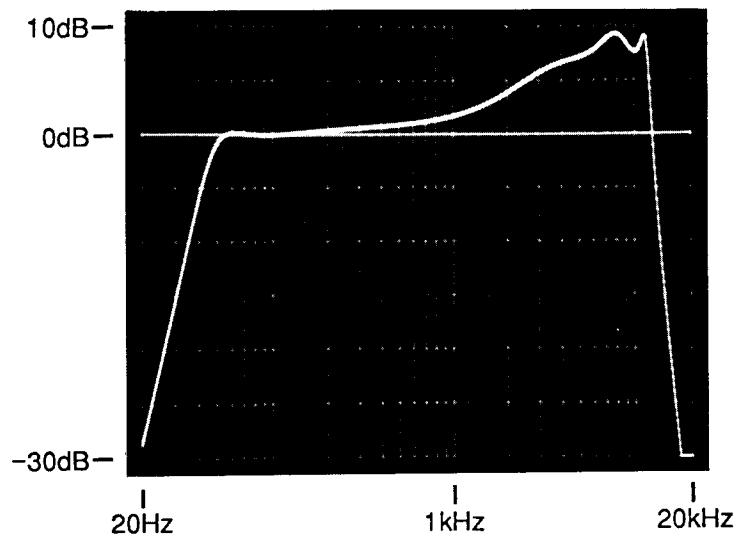


Fig. 5: Card #3 Frequency Response, 20-20,000Hz

Field Alignment and Performance Verification — Card #1F10

Use the following procedure to align and verify performance of Card #1F10 after the card has been repaired.

This procedure is not required for routine maintenance or Proof of Performance.

Record all current control settings before beginning, so these settings can be restored when this procedure is completed.

Record jumper positions when directed to reposition a jumper, so the jumpers can be returned to these positions when you are finished.

Jumper and component locations are shown in the Card #1F10 assembly drawing at the end of these instructions.

In a mono OPTIMOD-AM, all connections are to the *left* input or output.

Always turn off the power to OPTIMOD-AM when removing circuit cards to move jumpers.

The alignment and verification procedure consists of:

- checking the accuracy of the DC reference voltage
- verifying the performance of the 5kHz and 10kHz low-pass filters
- checking DC servo operation
- adjusting the gain of the 10kHz low-pass filter
- adjusting the notch frequency of the 10kHz low-pass filter
- verifying distortion and noise performance

Follow instructions in the order given, without skipping steps.

NOTE: The “12kHz” positions of Card #1F10 in fact bypass all filters on the card. Since the nominal bandwidth of the 9000A or 9000A/1 is 11kHz without further filtering, read “11kHz” whenever you see “12kHz” in the following text.

Equipment required:**Low-frequency spectrum analyzer with tracking generator**

Tektronix 5L4N plug-in with 5111 bistable storage mainframe, or equivalent. Alternatively, a sweep generator with 20–20,000Hz logarithmic sweep can be used (with the oscilloscope in X/Y mode).

Oscilloscope

With DC-coupling, dual trace, triggered sweep, and 5MHz or greater vertical bandwidth. $\times 10$ probe.

Audio oscillator

Residual distortion less than 0.0015%.

Frequency counter

Accurate to $\pm 0.05\%$

Total harmonic distortion (THD) analyzer

Residual distortion less than 0.0015%.

Audio voltmeter

Accurate to $\pm 2\%$. (Sound Technology 1700 A/B or 1710, for example.)

Pink noise generator**Digital voltmeter**

Accurate to $\pm 0.1\%$.

It is assumed that the technician is thoroughly familiar with the operation of this equipment.

1) Open the front panel of the OPTIMOD-AM, remove the subpanel.

It is not necessary to remove the unit from the rack, as long as you have access to the input terminals on the rear panel. The OPTIMOD-AM must, however, be off the air during this procedure.

- a) Remove the three screws at the top of the front panel, then tilt the hinged front panel downward to reveal the interior.
- b) Loosen the four DZUS fasteners on the subpanel by turning each $\frac{1}{4}$ -turn counterclockwise with a long $\frac{3}{16}$ -inch or $\frac{1}{4}$ -inch flat-blade screwdriver.
- c) Taking care not to stress the flat cables beneath it, tilt the top of the subpanel outward and to the left to clear the upper chassis lip and the door support rail at the right.

2) Extend Card #1F10.

Remove Card #1F10, insert a card extender into slot #1 of OPTIMOD-AM's card cage, and then plug Card #1F10 into the extender card.

3) Set controls.

- a) Record the current settings of your OPTIMOD-AM.
- b) Set the controls as follows:

| | |
|-----------------------|---------|
| EQUALIZER | OUT |
| CLIPPING | 5 |
| SMART CLIPPER DRIVE | 5 |
| MODE | OPERATE |
| 9100A/1 only: XTMR EQ | OUT |

Don't change the positions of the other controls.

4) Verify DC voltages.

Measure voltages against circuit ground (available at pin C of the edge connector on Card #1F10.).

- a) Set the MODE switch to OPERATE.
- b) Turn the POS PEAK THRESH control fully counterclockwise.
- c) Measure the voltage at the anode of diode CR2 on Card #1F10 to verify that it is -2.0 volts DC, $\pm 0.2V$.
- d) Measure the voltage at the cathode of diode CR1 on Card #1F10 to verify that it is +2.0 volts DC, $\pm 0.2V$.
- e) Set the MODE switch to PROOF.
- f) Measure the voltage at the anode of diode CR2 on Card #1F10 to verify that it is approximately -14 volts DC.
- g) Measure the voltage at the cathode of diode CR1 on Card #1F10 to verify that it is approximately +14 volts DC.

NOTE: In the following, ignore instructions to move jumper B (night) if your OPTIMOD-AM does not have DAY and NIGHT indicators and a XMTR EQ switch on the right side of the subpanel. If it does not, only jumper A (day) is active in your unit.

5) Verify performance of the 5kHz low-pass filter, and of "bypass."

In "bypass", 11kHz low-pass filtering is provided by other OPTIMOD-AM cards.

- a) Connect the output of a sweep or tracking generator to OPTIMOD-AM's input.
- b) Connect the input of a spectrum analyzer or oscilloscope to TP2 on Card #1F10.
- c) Place jumpers A (day) and B (night) on Card #1F10 in the "12kHz" position.

- d) Verify that response is approximately flat to 11kHz.
Be sure that the sweep level is low enough to avoid clipping by OPTIMOD-AM circuitry.
- e) Place jumpers A (day) and B (night) on Card #1F10 in the "5kHz" position.
- f) Verify that response is flat ± 1 dB to 5.0kHz, and rolls off with a slope of greater than 30dB/octave above 5kHz.
It is normal to see a slight "glitch" at 10kHz about -30dB.
- g) *If you have a 9000A OPTIMOD-AM*, skip to step 6.
If you have a 9000A/1, continue.
- h) Place jumper A (day) on Card #1F10 in the "12kHz" position.
- i) Verify that the 5kHz low-pass filter is activated when the TX EQ DAY/NIGHT switch is moved to the NIGHT position.
If the filter is operating, you will see a steep rolloff of frequencies higher than 5kHz, as above.
- j) Verify that the 5kHz low-pass filter is deactivated when the TX EQ DAY/NIGHT switch is moved to the DAY position.
If the filter is inactive, you will not see a steep rolloff above 5kHz.
- k) On Card #1F10, place jumper B (night) in the "12kHz" position, and jumper A (day) in the "5kHz" position.
- l) Verify that the 5kHz low-pass filter is activated when the TX EQ DAY/NIGHT switch is moved to the DAY position.
- m) Verify that the 5kHz low-pass filter is deactivated when the TX EQ DAY/NIGHT switch is moved to the NIGHT position.
- n) Disconnect the sweep or tracking generator and spectrum analyzer or oscilloscope from OPTIMOD-AM.

6) Check DC servo operation.

- a) Place jumper A (day) and B (night) on Card #1F10 in the "10kHz" position.
- b) With a digital voltmeter, verify that the DC offset is less than 15mV at TP2.

7) Adjust 10kHz low-pass filter gain.

- a) On Card #1F10, place jumper A (day) in the "12kHz" position.
- b) Connect an audio oscillator to OPTIMOD-AM's input.
- c) Set OPTIMOD-AM's VU meter selector to SMART CLIPPER.
- d) Set the audio oscillator to 1kHz, and adjust its output level until OPTIMOD-AM's VU meter reads approximately "-6VU."
- e) *If you have a 9000A/1*, set OPTIMOD-AM's TX EQ DAY/NIGHT switch to DAY.
Skip to step f if your OPTIMOD-AM is a 9000A.

- f) Observe the level at TP2. Make a note of it.
- g) On Card #1F10, place jumper A (day) in the "10kHz" position.
- h) Adjust trimmer R62 until the level at TP2 is the same ($\pm 0.1\text{dB}$) as that observed in step f, above.

8) Adjust frequency of the first 10kHz low-pass filter's notch.

- a) Set the audio oscillator for $10,100\text{Hz} \pm 10\text{Hz}$, and check the frequency with a counter.
The audio oscillator should still be connected to OPTIMOD-AM's input.
Do not change the audio oscillator's output level.
- b) While observing TP2 with an audio voltmeter, adjust trimmer R17 to null the signal.
The null should be more than 45dB below the "flat" (below 9kHz) level observed in step 7f.
- c) Disconnect the audio oscillator and voltmeter from OPTIMOD-AM.

9) Verify 10kHz low-pass filter performance.

- a) Connect the output of the sweep or tracking generator to OPTIMOD-AM's input.
- b) Connect the input of the spectrum analyzer or oscilloscope to TP2.
- c) Verify that response is flat +1.0dB, -2.0dB to 9600Hz, and rolls off with a slope of greater than 60dB/octave above 10kHz.
Be sure that the sweep level is low enough to avoid clipping by OPTIMOD-AM circuitry.
- d) *If you have a 9000A OPTIMOD-AM*, skip to step 10.
If you have a 9000A/1, continue.
- e) Place jumper A (day) on Card #1F10 in the "12kHz" position.
- f) Verify that the 10kHz low-pass filter is activated when the TX EQ DAY/NIGHT switch is moved to the NIGHT position.
If the filter is operating, you will see a very steep rolloff of frequencies higher than 10kHz.
- g) Verify that the 10kHz low-pass filter is deactivated when the TX EQ DAY/NIGHT switch is moved to the DAY position.
If the filter is inactive, you will not see a steep rolloff above 10kHz.
- h) On Card #1F10, place jumper B (night) in the "12kHz" position, and jumper A (day) in the "10kHz" position.
- i) Verify that the 10kHz low-pass filter is activated when the TX EQ DAY/NIGHT switch is moved to the DAY position.
- j) Verify that the 10kHz low-pass filter is deactivated when the TX EQ DAY/NIGHT switch is moved to the NIGHT position.
- k) Disconnect the sweep or tracking generator and spectrum analyzer or oscilloscope from OPTIMOD-AM.

10) Restore all jumpers to the positions they were in at the beginning of this alignment and performance verification procedure.

11) Remove the card extender and return Card #1F10 to slot #1.

12) Replace subpanel, close front panel.

The subpanel should always be replaced, since it is an integral part of the chassis RFI protection.

a) Disconnect all test instruments from OPTIMOD-AM.

b) Taking care not to stress the flat cables beneath it, tilt the top of the subpanel inward and to the left to clear the upper chassis lip and the door support at the right.

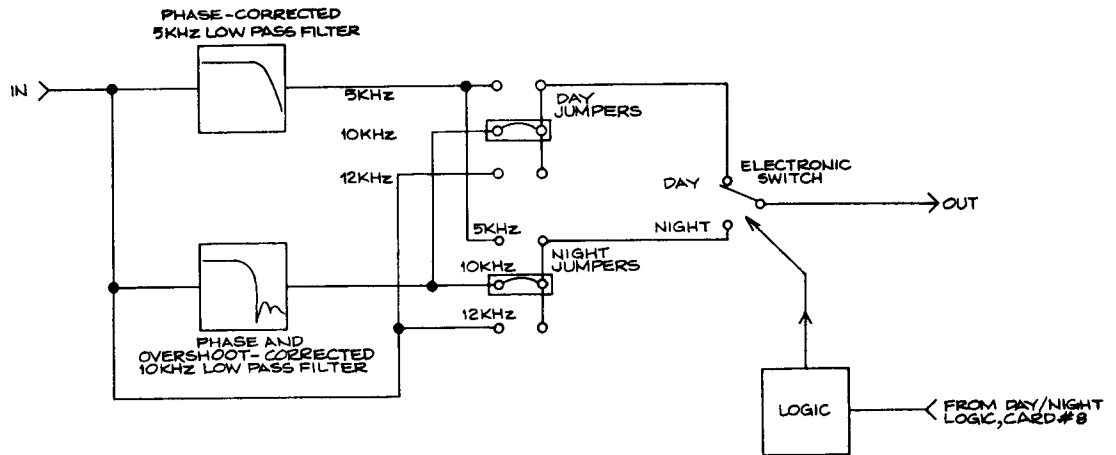
c) Turn the DZUS fasteners $\frac{1}{4}$ -turn clockwise.

The DZUS fasteners turn only $\frac{1}{4}$ -turn. Don't force them, lest they be damaged in a way that is very time consuming to repair.

d) Set the internal AC POWER switch to ON.

e) Raise the front panel and fasten the three screws that secure it in place.

13) Restore all controls to their settings prior to beginning this alignment and performance verification procedure.



REPLACES CARD#1 IN MAIN BLOCK DIAGRAM.

Fig. 6: Block Diagram, Card #1F10

Circuit Description — Card #1F10

Card #1F10 is divided into two “subsystems”, which are described below in order of signal flow. The block diagram in Fig. 6 illustrates this description.

1) 5kHz Low-Pass Filter

This is a unity-gain, phase-corrected, 5th-order Chebychev filter with 0.1dB frequency response irregularity and a -0.1dB bandwidth of 5.0kHz.

IC8a and associated components form a third-order non-inverting filter with a gently rolled-off frequency response. The 5th-order filter's frequency response shaping is completed by IC9a and associated components, which form a 2nd-order inverting filter when the circuit path is completed by strapping jumper A (DAY) or B (NIGHT) to the “5kHz” position. IC8b and associated components form a phase corrector, which is an all-pass filter with flat magnitude response and frequency-dependent phase response. This filter adds delay as necessary to make the delay of the entire filter approximately constant with frequency, thereby minimizing overshoot.

DAY/NIGHT switching is effected by very simple logic. Pin T on the card is low (-15V) when OPTIMOD-AM is in NIGHT mode, and high (ground) when it is in DAY mode. The logic level at pin T drives JFET Q2 directly. Q1 inverts the logic and drives Q3. Q2 and Q3 are on when their gates are at ground, and off when their gates are at -15V. Thus Q3 turns on in NIGHT mode and connects jumper B into the circuit path, while Q2 turns on in DAY mode, and connects jumper A into the circuit path.

2) 10kHz (NRSC) Low-Pass Filter

The signal can be routed to a 10kHz overshoot-compensated low-pass filter, consisting of a first and second filter in series, with embedded clippers.

The signal enters the filter system and encounters clipper CR1, CR2, which provides main peak control for the signal. After buffering by IC1a, the clipped signal is applied to the first 10kHz filter IC2, IC3, IC4 (and associated components). This filter is very steep, and removes the harmonics introduced by the clipping in CR1, CR2, as well as any significant program energy above 10kHz.

The first filter is an active-RC analog of a passive LC ladder filter. It is realized by resistors, capacitors, and frequency-dependent negative resistors (FDNRs). An FDNR is realized with a dual opamp, three resistors, and two capacitors. When the passive LC filter is transformed into an active RC filter, inductors become resistors, resistors become capacitors, and capacitors become FDNRs.

Each FDNR resonates with a series resistor to create a notch in the frequency response of the filter. (This is analogous to a series LC circuit to ground.) The notches are located in the “stopband” (beyond approximately 10.05kHz). The circuit associated with IC2 produces a notch at 10.65kHz $\pm 4\%$. The circuit associated with IC3 produces a notch at 12.00kHz $\pm 4\%$. The circuit associated with IC4 is tuned by R39 to produce a notch at precisely 10.10kHz to ensure that the filter's response falls accurately above 10kHz, and that NRSC specifications are met.

Measuring the frequency of these notches and their depth is the best way of diagnosing problems with such filters, since problems with a given notch can be associated with a given FDNR in most cases.

Because all parts of the filter interact, failures which cannot be cured merely by replacing opamps are best left to factory service, since special tight-tolerance, tight-temperature-coefficient parts are used in certain places. (The circuitry has been designed to be insensitive to normal unit-to-unit variations in opamps.) See Section 4 in the 9000A or 9000A/1 Operating Manuals for information on how to obtain factory service.

To avoid possible clipping, the signal is attenuated 5dB with voltage divider R24, R25 before being applied to the filter. This gain is made up by IC5a to restore unity gain at low frequencies.

All-pass delay corrector IC5b adds frequency-dependent delay to the first filter as necessary to make its time delay more constant with frequency, thereby minimizing overshoot.

Any residual overshoot is then clipped in IC6a, and then the signal is applied to second 10kHz filter IC6b, IC7a. The primary purpose of this second filter is to remove harmonics caused by clipping in IC6a.

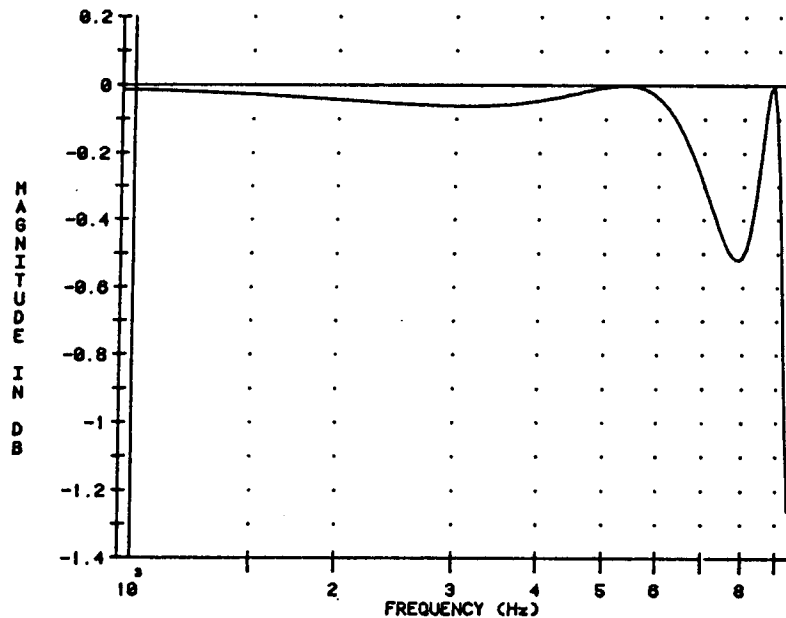


Fig. 7: Response of the First 10kHz Low-Pass Filter in the Passband

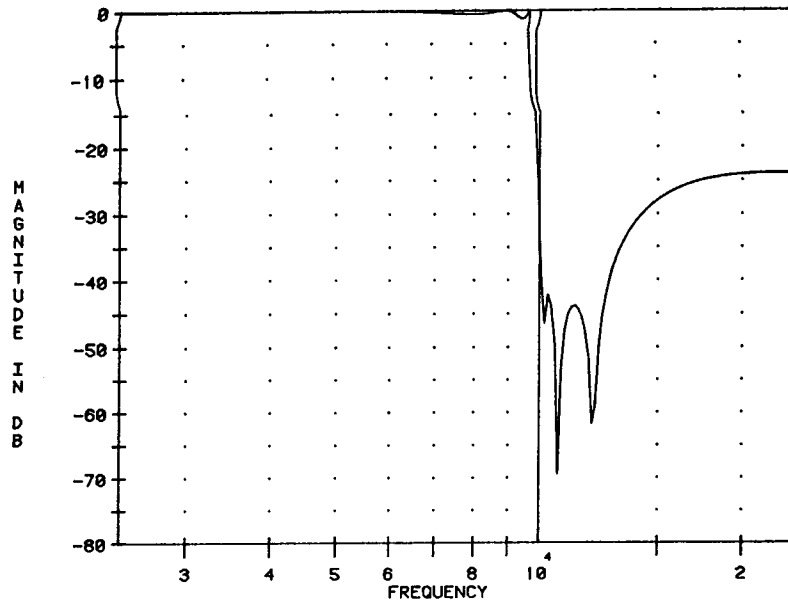


Fig. 8: Response of the First 10kHz Low-Pass Filter in the Passband and Stopband

Finally, all-pass delay corrector IC7b adds delay as necessary to make the delay of the second filter more constant with frequency.

Fig. 9 shows the normal frequency response of the part of the second filter associated with IC6b, while Fig. 10 shows the normal frequency response of the part of the second filter associated with IC7a. Fig. 11 shows the overall frequency response of the second filter.

The normal frequency response of each all-pass delay corrector (IC5b and IC7b) is flat, although each has a frequency-dependent phase shift. IC10b and associated components act as a servo to eliminate DC offset at the output of IC9b.

Fig. 12 shows the normal power spectrum measured at OPTIMOD-AM's output with the 10kHz filter strapped in and bright program material applied to OPTIMOD-AM's input. The measurement (made with an 801-line FFT spectrum analyzer operated in "peak hold" mode over a 20-minute observation period with OPTIMOD-AM controls at the normal recommended settings) verifies that NRSC power bandwidth specifications are met by the system.

The 10kHz filters can be strapped into the circuit with jumpers A and B. These jumpers can also be configured to bypass all filters on Card #1F10, retaining only the built-in 12kHz filtering provided elsewhere in OPTIMOD-AM.

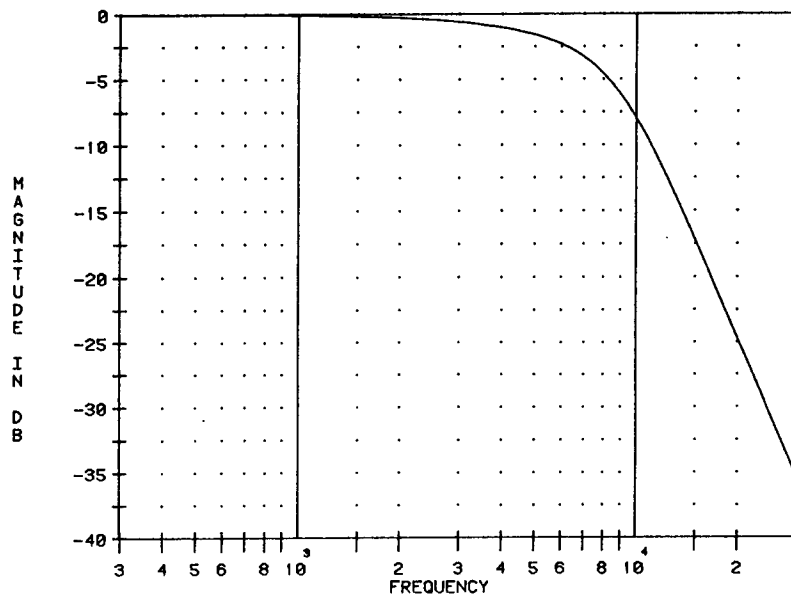


Fig. 9: Normal Frequency Response of that part of the Second 10kHz Filter associated with IC6b

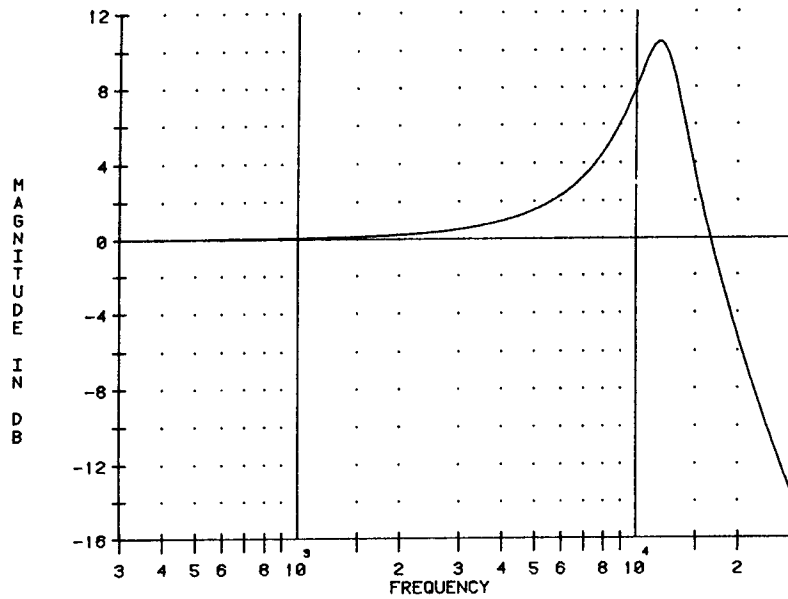


Fig. 10: Normal Frequency Response of that part of the Second 10kHz Filter associated with IC7a

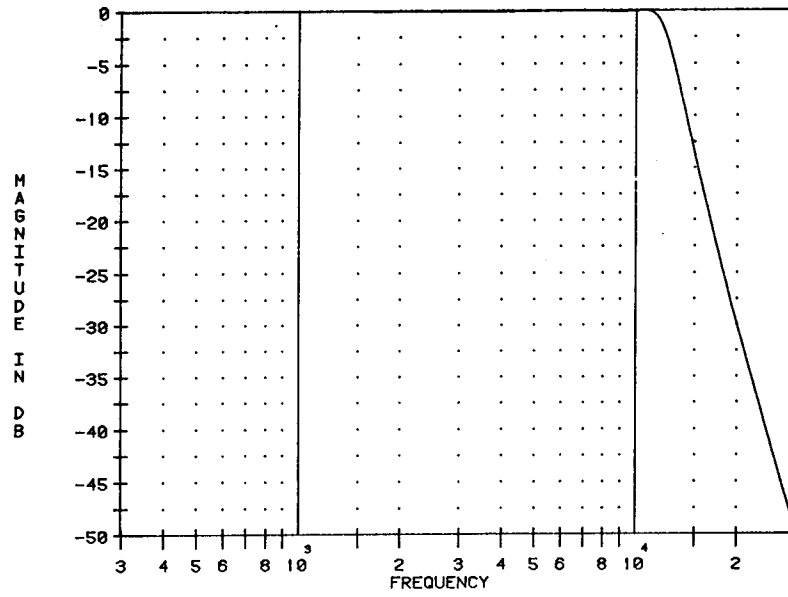


Fig. 11: Overall Frequency Response of the Second 10kHz Filter

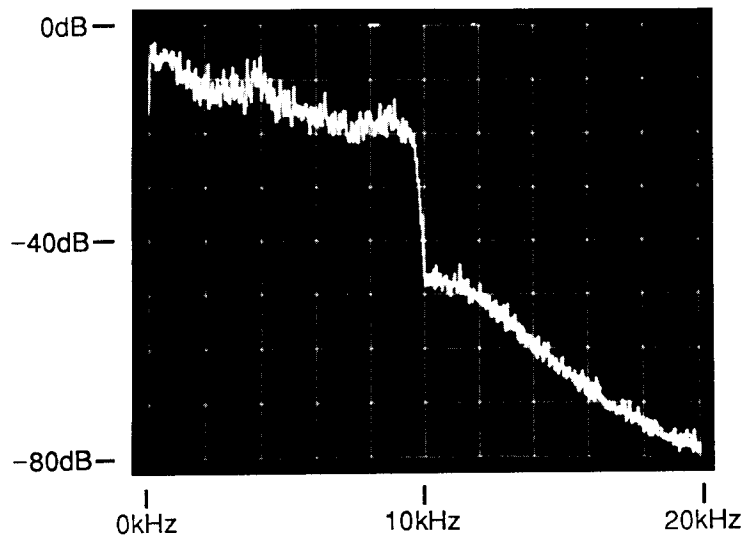


Fig. 12: Normal Output Power Spectrum of a Mono OPTIMOD-AM with 10kHz Filter

Parts List — Card # 1F10

See Section 4 of the 9000A or 9000A/1 Operating Manuals for information on ordering parts.

| REF DES | DESCRIPTION | ORAN P/N | VEN (1) | VENDOR P/N | ALTERNATE VENDORS (1) | NOTES |
|-------------------|-------------------------------------|-----------|------------|------------------|--------------------------|-------|
| <u>CARD #1F10</u> | | | | | | |
| <u>Capacitors</u> | | | | | | |
| C1 | Mica, 500V, 1%; 1000pF | 21022-210 | CD | CD19-FD102F03 | SAN | |
| C2 | Mica, 500V, 1%; 150pF | 21018-115 | CD | CD15-FD151F03 | SAN | |
| C3-5 | Mica, 500V, 1%; 1000pF | 21022-210 | CD | CD19-FD102F03 | SAN | |
| C6 | Polypropylene, 50V, 1%; 0.01uF | 21701-310 | NOB | CQ15PLH103FPP | WES | |
| C7 | Mica, 500V, 1%; 100pF | 21018-110 | CD | CD15-FD101F03 | SAN | |
| C8-15 | Polypropylene, 50V, 1%; 4700pF | 21701-247 | NOB | CQ15PLH472FPP | WES | |
| C16,17 | Mica, 500V, 1%; 1000pF | 21022-210 | CD | CD19-FD102F03 | SAN | |
| C18,19 | Polypropylene, 50V, 1%; 4700pF | 21701-247 | NOB | CQ15PLH472FPP | WES | |
| C20 | Mica, 500V, 1%; 680pF | 21022-168 | CD | CD19-FD681F03 | SAN | |
| C21 | Polypropylene, 50V, 1%; 0.01uF | 21701-310 | NOB | CQ15PLH103FPP | WES | |
| C22 | Mica, 500V, 1%; 220pF | 21018-122 | CD | CD15-FD221F03 | SAN | |
| C23,24 | Mica, 500V, 1%; 1000pF | 21022-210 | CD | CD19-FD102F03 | SAN | |
| C25,26 | Alum., Radial, 25V; 100uF | 21206-710 | PAN | ECE-ALEV101S | | |
| C27-31 | Monolythic Ceramic, 50V, 20%; 0.1uF | 21123-410 | SPR | 1C25 Z5U104M050B | KEM | |
| C32 | Polypropylene, 50V, 1%; 0.01uF | 21701-310 | NOB | CQ15PLH103FPP | WES | |
| C33,34 | Monolythic Ceramic, 50V, 20%; 0.1uF | 21123-410 | SPR | 1C25 Z5U104M050B | KEM | |
| <u>Diodes</u> | | | | | | |
| CRI-4 | Diode, Signal, Hot Carrier | 22102-001 | HP | HP5082-2800 | | |

FOOTNOTES:

- (1) See last page for abbreviations
 (2) No Alternate Vendors known at publication
 (3) Actual part is specially selected from part listed, consult Factory
 (4) Realignment may be required if replaced, see Circuit Description and/or Alignment Instructions

**SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS**

OPTIMOD-AM Model 9100B
 Card #1F10 - Capacitors

| REF DES | DESCRIPTION | ORBAN P/N | VEN (1) | VENDOR P/N | ALTERNATE VENDORS (1) | NOTES |
|------------|-------------|-----------|------------|------------|--------------------------|-------|
|------------|-------------|-----------|------------|------------|--------------------------|-------|

Integrated Circuits

| | | | | | | |
|-------|--------------------|-----------|-----|---------|--------|--|
| IC1-5 | Linear, Dual Opamp | 24206-202 | TI | TL072CP | MOT | |
| IC6-9 | Linear, Dual Opamp | 24207-202 | SIG | NE5532N | TI,EXR | |
| IC10 | Linear, Dual Opamp | 24209-202 | NAT | LF412CN | | |

Resistors

| | | | | | | |
|-----|----------------------------------|-----------|-----|---------|-----|---|
| R28 | Resistor Set, MF, 2.00K | 28520-002 | ORB | | | 3 |
| R32 | Resistor Set, MF, 2.00K | 28520-002 | ORB | | | 3 |
| R37 | Resistor Set, MF, 2.00K | 28520-002 | ORB | | | 3 |
| R39 | Trimpot, Cermet, 1 Turn; 200 OHM | 20510-120 | BEK | 72PR200 | BRN | |
| R43 | Resistor Set, MF, 20.0K | 28521-001 | ORB | | | 3 |
| R58 | Resistor Set, MF, 20.0K | 28521-001 | ORB | | | 3 |
| R62 | Trimpot, Cermet, 1 Turn; 1K | 20510-210 | BEK | 72PR1K | BRN | |

Transistors

| | | | | | | |
|------|-------------------------|-----------|-----|--------|-----|--|
| Q1 | Transistor, Signal, NPN | 23202-101 | MOT | 2N4400 | FSC | |
| Q2,3 | Transistor, JFET/N | 23406-101 | NAT | J113 | SIL | |

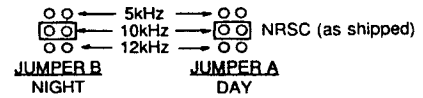
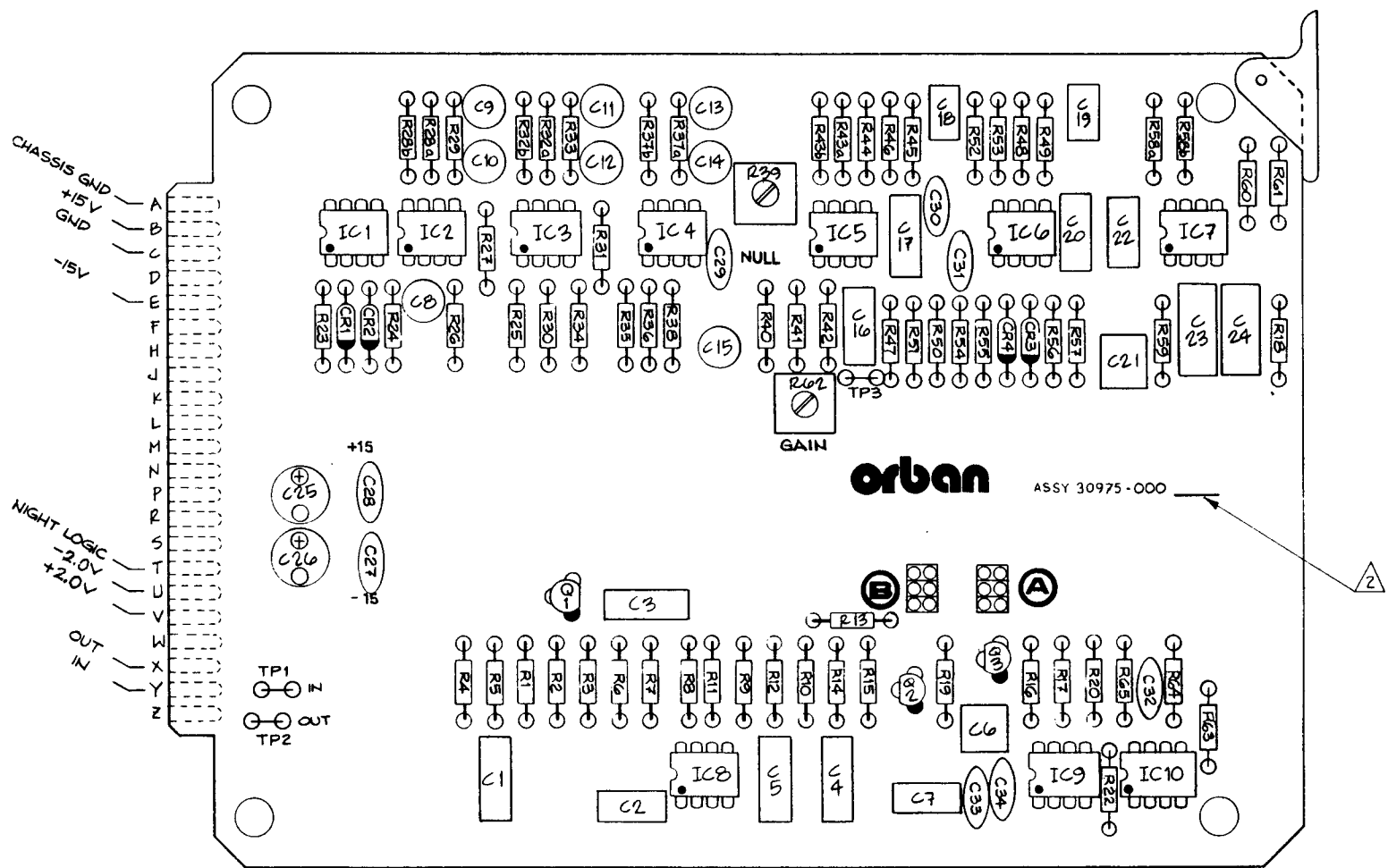
FOOTNOTES:

- | | |
|---|--|
| (1) See last page for abbreviations | (4) Realignment may be required if replaced, see Circuit Description and/or Alignment Instructions |
| (2) No Alternate Vendors known at publication | |
| (3) Actual part is specially selected from part listed, consult Factory | |

SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS

OPTIMOD-AM Model 9100B
Card #1F10 - Diodes, IC's,
Resistors, Transistors

Schematics, Assembly Drawings — Card #1F10

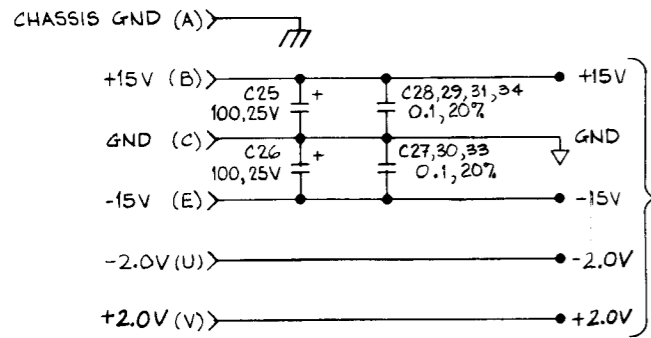
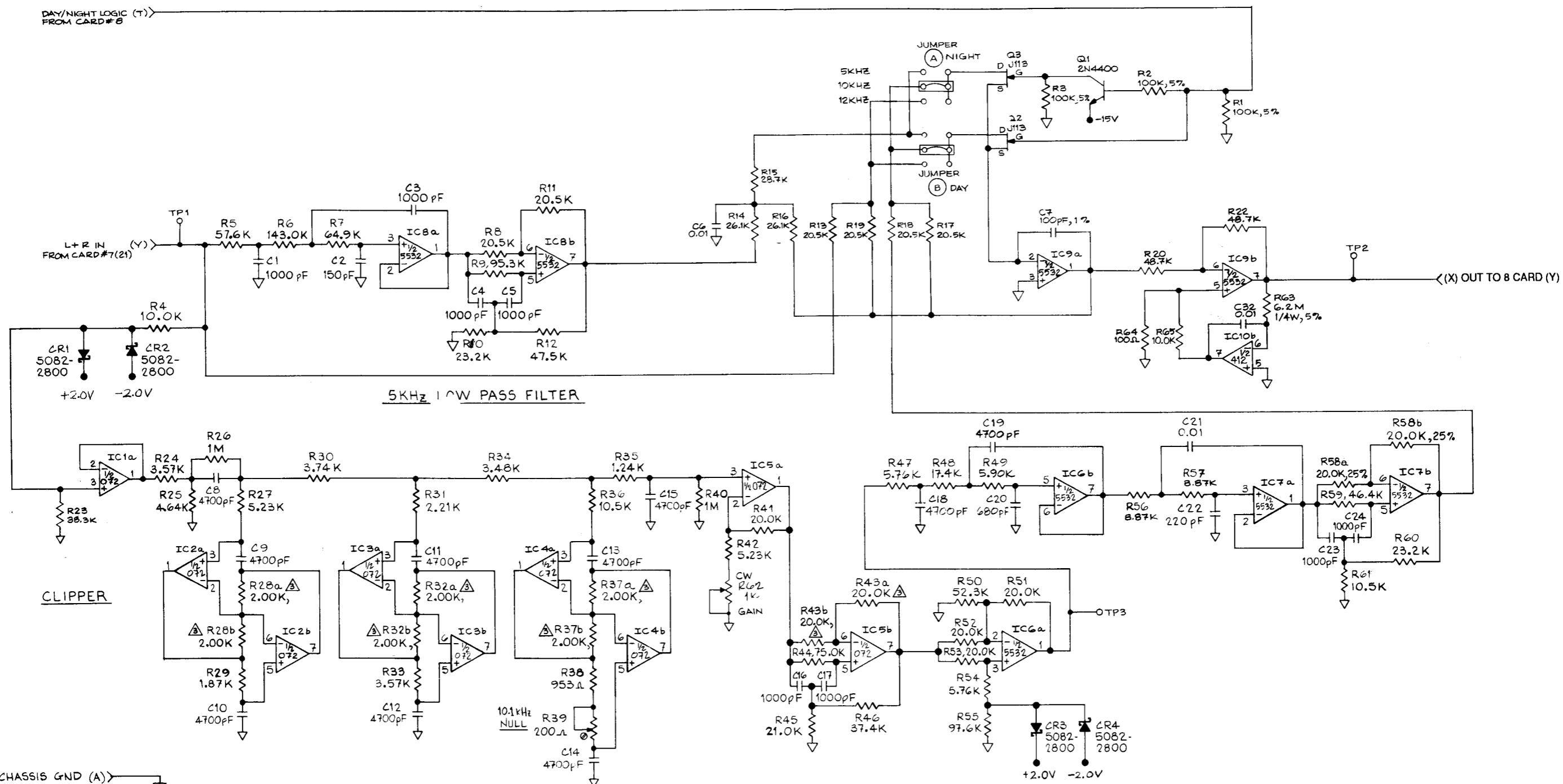


(inactive on 9000A)

- 3. REFERENCE SCHEMATIC 61012-000
 - △ MARK ASSY REV LEVEL IN SPACE PROVIDED.
 - TIC MARK INDICATES PIN 1 OF IC'S, CATHODE OF DIODE, POS. SIDE OF CAPS, EMITTERS OF TRANSISTORS.
- NOTES: (UNLESS OTHERWISE SPECIFIED)

orban a division of AKG Acoustics, Inc.

TITLE:
**ASSEMBLY DRAWING
 CARD #1F10
 30975-000-01**



10 KHZ LOW PASS FILTER

△ MATCHED PAIR

2 ALL CAPS ARE IN μF, 1%.

1 ALL RESISTORS ±1%, 1/8W MF.

NOTES (UNLESS OTHERWISE SPECIFIED)

| REF | DES | ITEM | LAST | NOT USED |
|-----|-----|-------|------|----------|
| C | 34 | | | |
| CR | 4 | | | |
| IC | 10 | 1b10a | | |
| Q | 3 | | | |
| R | 65 | 21 | | |
| TP | 3 | | | |

| IC | PWR | GND | PIN |
|---------|-----|-----|-----|
| TL072 | B | 4 | |
| 5532 | B | 4 | |
| LF412CN | B | 4 | |

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TITLE: SCHEMATIC CARD #1F10 61012-000-01