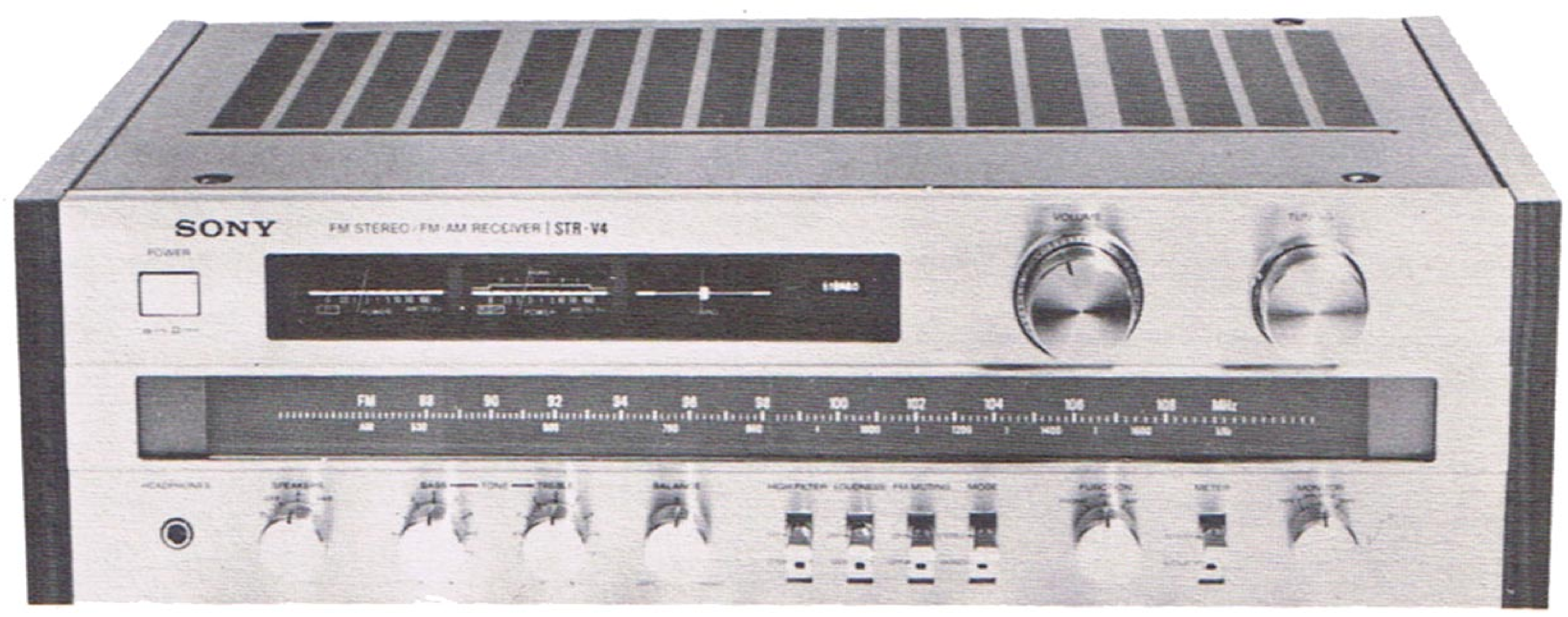
SONY

Receivers

STR-V2
STR-V3
STR-V4



servicing information

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PRINTED IN U.S.A.
2H990 1178 –1

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1. Introduction

The tuner sections of the STR-V series receivers use multipurpose ICs for the bulk of the signal processing at IF frequencies and below. In fact, the smaller receivers (STR-V2 to V4) use ICs for everything in the tuner except the FM front end. This makes conventional troubleshooting techniques near useless. More sophisticated techniques, such as signal injection for FM IF troubleshooting, proved unreliable. Signal tracing with a scope equipped with 10X probes turned out to be the simplest and most reliable method of determining whether or not the circuitry is working properly.

The circuitry in all STR-V series is similar. In fact, the tuner sections of the STR-V3 and V4 are almost identical. Even the top-of-the-line V7 uses the same FM, MPX, and AM ICs, though they are supplemented by many additional components. The power amplifier sections of the STR-V3 to V7 also reflect the same basic design (with due allowances for the power differences), a straightforward and reliable design that has appeared in previous SONY models. The little STR-V2 is the only model with a "different" audio design. As Fig. 1-1 shows, the tone control functions are performed in the power-amplifier section. The overall voltage gain is made quite high, so tuners and tape recorders can drive the power amplifier to rated output without the need for preamplification!

Audio is applied to the input stage through a low-pass filter consisting of resistor R554 and capacitor C554. This prevents RFI from reaching a sensitive junction. The input stage is a differential amplifier consisting of transistors Q551 and Q552. Output voltage appearing across collector load resistor R556 is directly coupled to the base of Q554, a class-A high-level voltage amplifier. Transistor Q553 is a constant-current source operated as an active load for Q554. This permits maximum possible voltage gain from Q554, and maximum peak-to-peak voltage swings. The voltage drop across diode D551, in series with the collectors of Q553 and Q554, provides operating bias for the output transistors (Q557 and Q558) and their drivers (Q555 and Q556).

The feedback path from the amplifier output point to the inverting input of the input stage (Q552's base) contains the tone controls. The frequency-selective voltage dividers formed by the tone-control components thus determine the amount of signal fed back to Q552, hence the overall amplifier AC gain. The AC signal path from the tone controls is through resistor R560 and capacitor C555. Resistor R558 forms the shunt arm of the feedback divider, since it is grounded (to AC) by capacitor C556. However, the DC path from the power-amplifier output point to Q552 is through resistors R559 and R558. Since there is no DC path from the base of Q552 to ground, the amplifier has a DC gain of 1, hence is highly stable. Capacitor C556 also filters AC signal from the DC path.

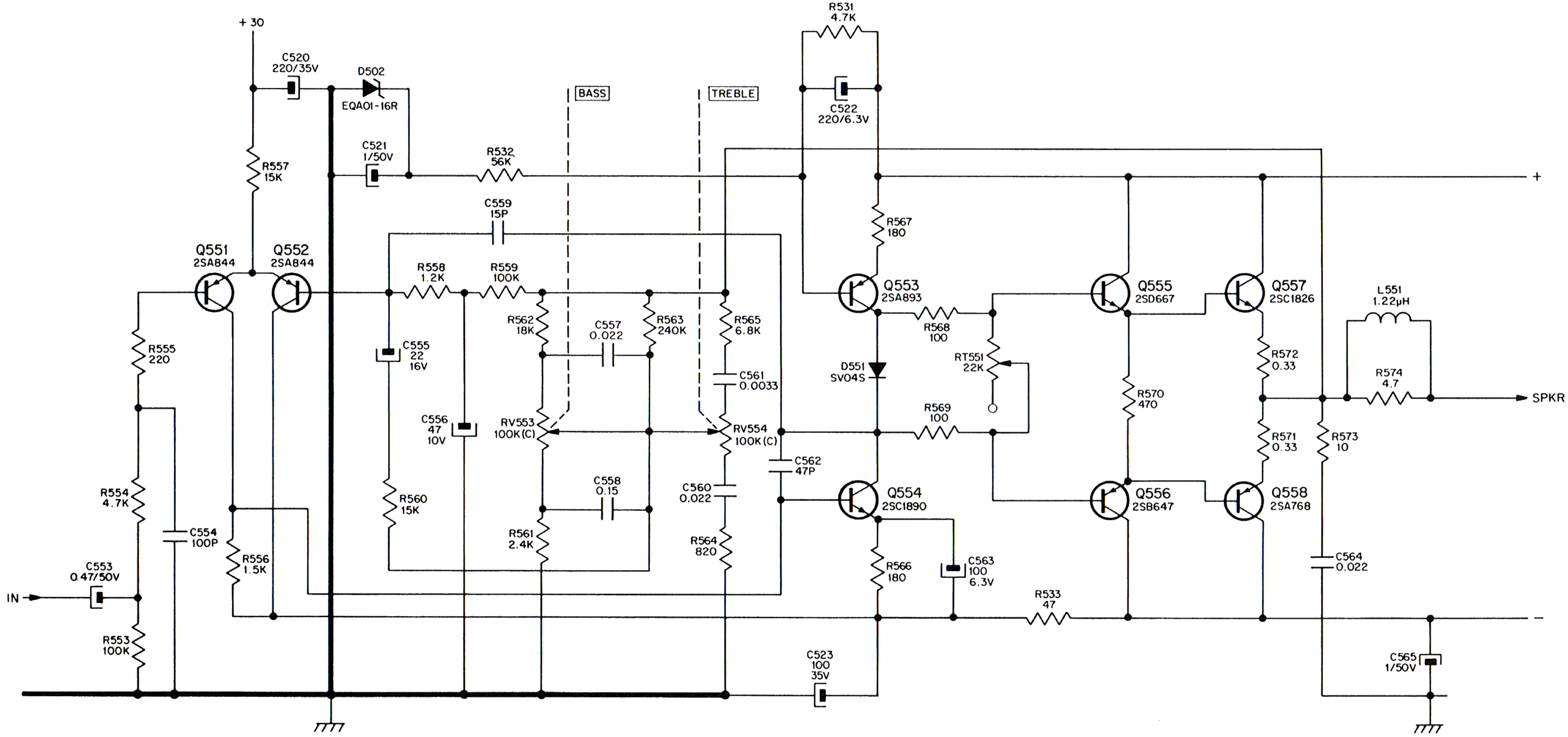


Fig. 1-1. STR-V2 Audio Amplifier

Muting. The STR-V3 and V4 use the muting circuit shown in Fig. 1-2 to prevent the power-supply transients that occur when the receiver is turned on and off from being heard or damaging speakers.

When the receiver is turned on, the ±20V supplies that operate the preamplifier circuitry quickly rise, so +20 volts is immediately available to resistor R805. However, the bias for the base of transistor Q803 is supplied through resistor R803. The long time constant of R803 and capacitor C802 results in a few seconds delay before the base-emitter voltage of Q803 rises high enough to cause Q803 to conduct. While Q803 remains cut off, transistor Q802 is also nonconducting, and the full current flow through resistor R805 goes to the base of muting transistor Q801. The resulting low collector-emitter impedance of this saturated transistor shorts the preamplifier output. During the time Q801 is saturated, the preamp is muted and operating voltages are stabilizing in the preamp and tuner sections of the receiver.

After a few seconds delay, the base-emitter voltage of Q803 will exceed 0.6 volt and this transistor will conduct and close the series circuit formed by itself, transistor Q802, and resistors R805 and R806 across the ±20 volt supplies. The junction of R805 and R806 (to which the bases of the muting transistors are connected) will now go negative, cutting off the muting transistors and allowing normal operation.

When the power switch is turned off, the +15 and ±20 volt lines begin to drop. However, capacitor C803 is charged to nearly the full difference between the +15 and -20 volt buses (less base-emitter drop of Q802 and saturation voltage of Q803). Since resistor R804 has such a high value, the charge on capacitor C803 will decay at a far slower rate than the power-supply voltage. Therefore as the power-supply voltage drops, the capacitor voltage will cut off transistor Q802 and current from R805 will turn on Q801. Q801 will remain on, muting the audio, until after the power-supply voltages have decayed too low to produce audible output. To allow for the possibility of the receiver being turned off and quickly turned on again, diode D801 quickly dumps the charge on C802, allowing Q803 to provide turn-on protection as previously described. Capacitor C801 aids in this action by making D801 conduct as soon as the supply voltages drop a little.

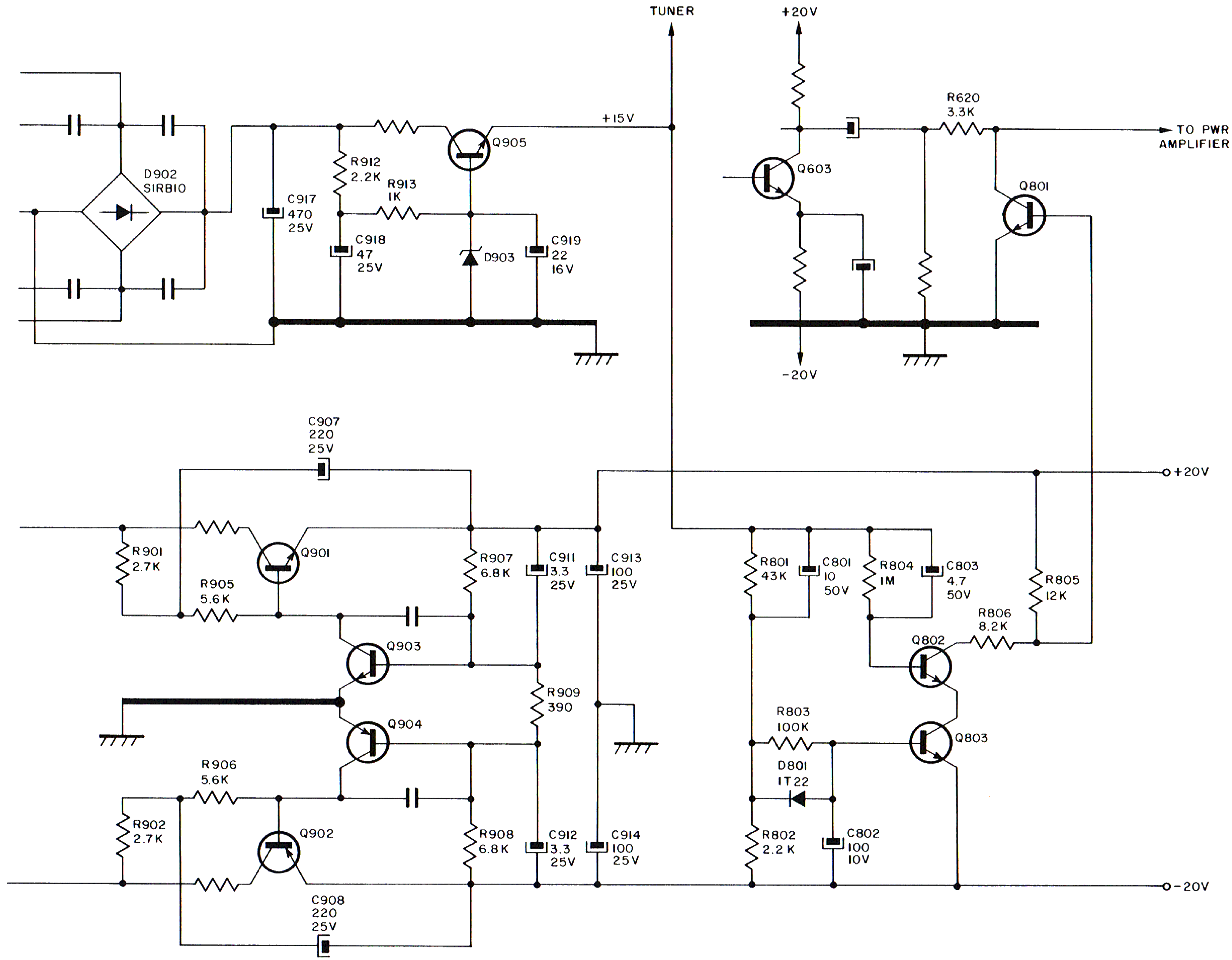


Fig. 1-2. STR-V3/V4 Muting Circuit

2. Signal Tracing the FM IF Strip

Signal tracing through an IF strip containing a multipurpose IC is one of the few reliable ways of troubleshooting. However, some of the waveforms the technician will encounter are unusual, and/or vary with the type of signal used. The waveform photographs in this section show what is present at each AC-active pin of the HA1137 IF IC with standard mono and stereo FM test signals. Each signal is 1000 microvolts RF, 400 Hz modulation, with a total deviation of ±75 kHz (100% modulation). The stereo signal modulation is 10% pilot carrier, 90% 400 Hz.

Except for Fig. 2-7b, the waveforms were made with an AC-coupled scope, and low-capacitance probe. Because of the frequencies involved, the scope must have a -3 dB response of at least 25 MHz, preferably 50 MHz. The lower trace in each photo is the 400 Hz generator-modulating signal. Always trigger your scope from this signal when signal tracing.

The FM IF strip is shown in Figs. 2-1 and 2-2. A discrete IF amplifier (Q201) is used to boost the front-end output signal (Fig. 2-3) before application to the IC. The small apparent voltage gain at the collector of Q201 (Fig. 2-4) is due to significant signal loss in the ceramic filter (CF201). The signal level at the base of Q201 was too low to measure with common equipment. The signal loss produced by ceramic filters is evident by comparing the Fig. 2-5 signal level to the Fig. 2-4 signal level. Ceramic filter CF202 is responsible for the voltage loss.

The IF amplifier output (Fig. 2-6) is rectified by the detector to produce recovered audio, and amplified by the audio amplifier to produce the pin 6 output shown in Fig. 2-7. The output is simply recovered audio when a mono test signal is processed (Fig. 2-7a), and multiplexed audio when a stereo test signal is processed (Fig. 2-7b).

Low-level demodulated audio riding on a DC level appears at pin 7 (Fig. 2-8a) when a mono test signal is processed, but only DC appears here with a stereo test signal (Fig. 2-8b). This is used to operate the center-channel tuning meter, so the DC voltage level at pin 7 equals that at pin 10 (around 5 volts) only when tuning is dead center. When mistuned the pin 7 voltage will be either higher or lower than pin 10, depending on direction of mistuning.

The signals at pin 13 (Fig. 2-9) are also very sensitive to tuning. The DC level on which they ride (about 4.5 volts) holds up over a fairly wide range of mistuning, but the AC component changes waveshape drastically with tuning. Keep this in mind, and your hand on the tuning knob, as you try to match your scope trace to these.

The signal at the input (pin 9) to the last auxiliary circuit (muting) in the HA1137 is still RF (Fig. 2-10).

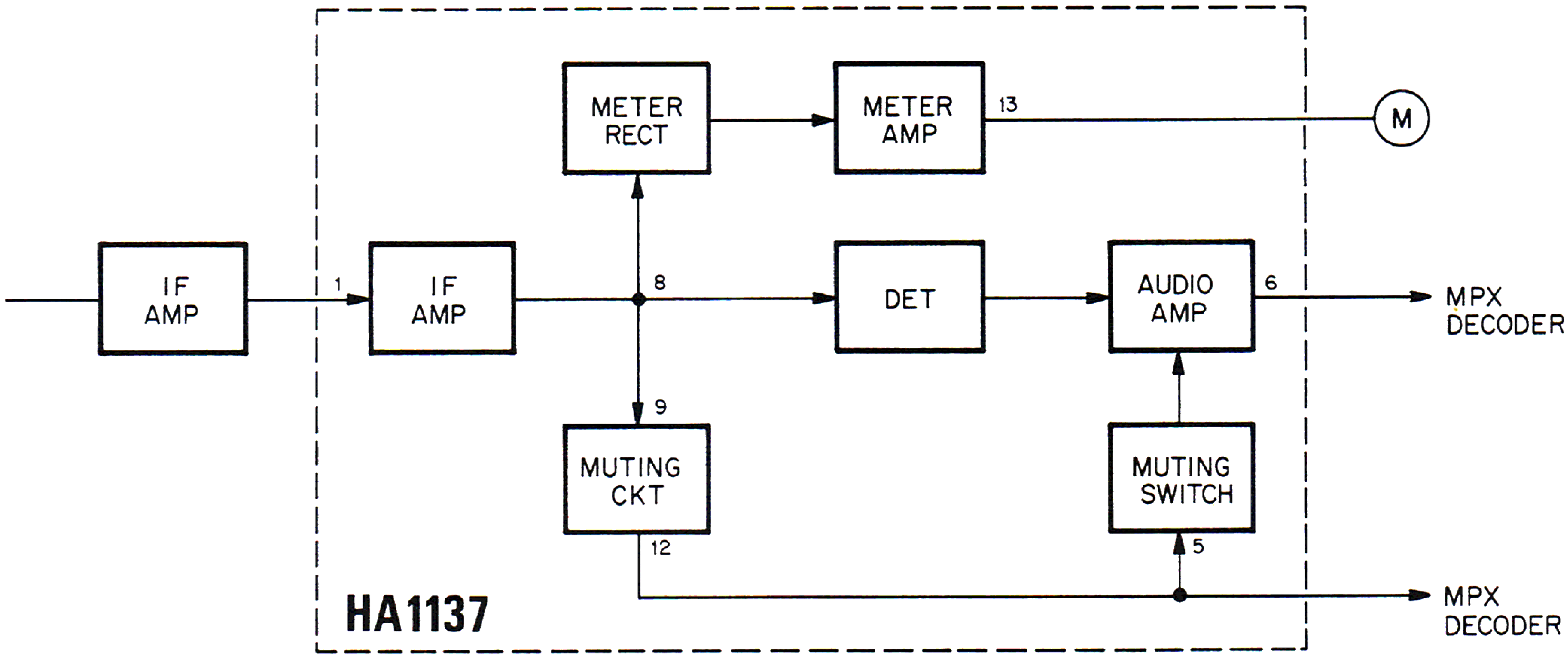


Fig. 2-1. STR-V4 IF Strip Block Diagram

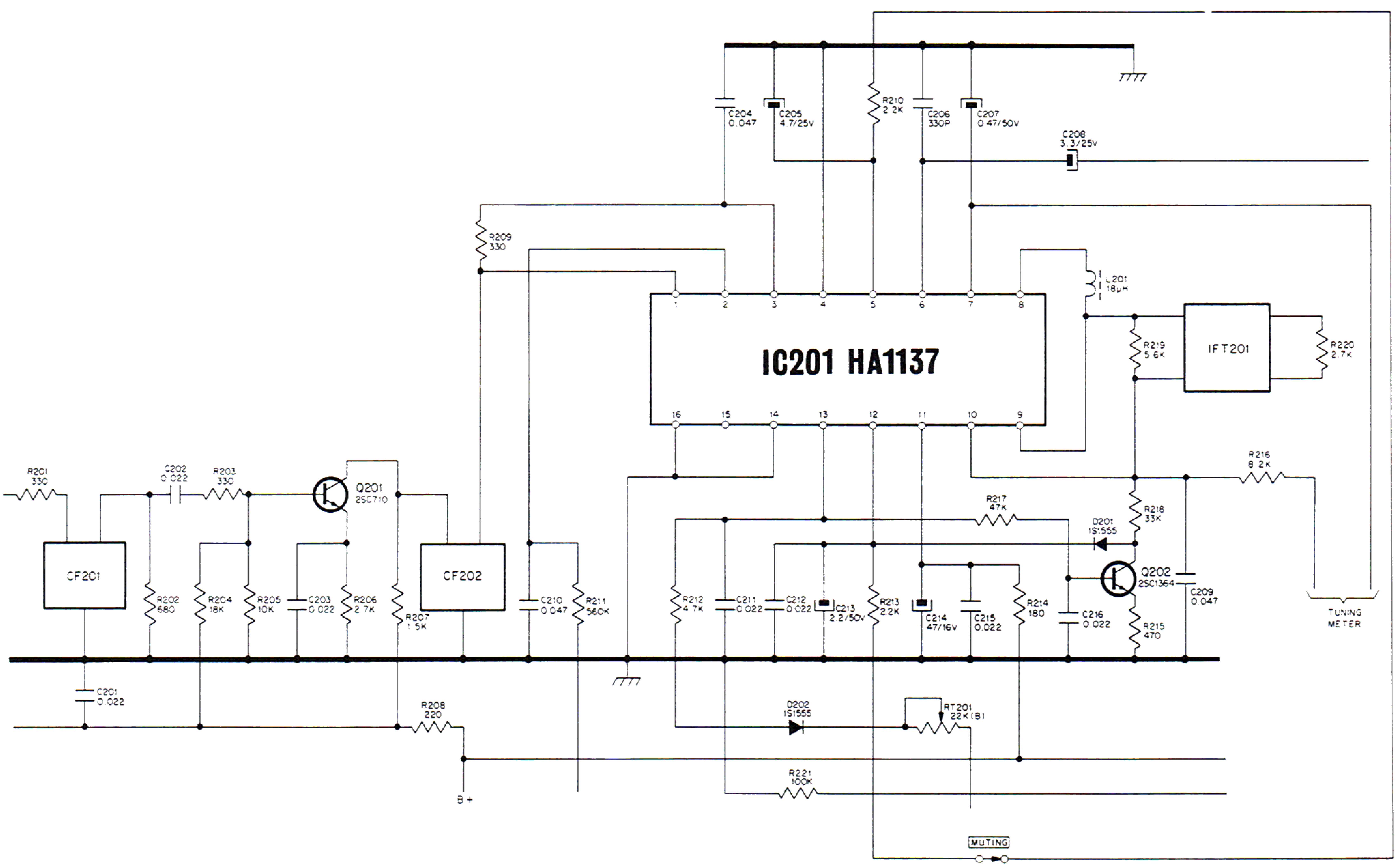
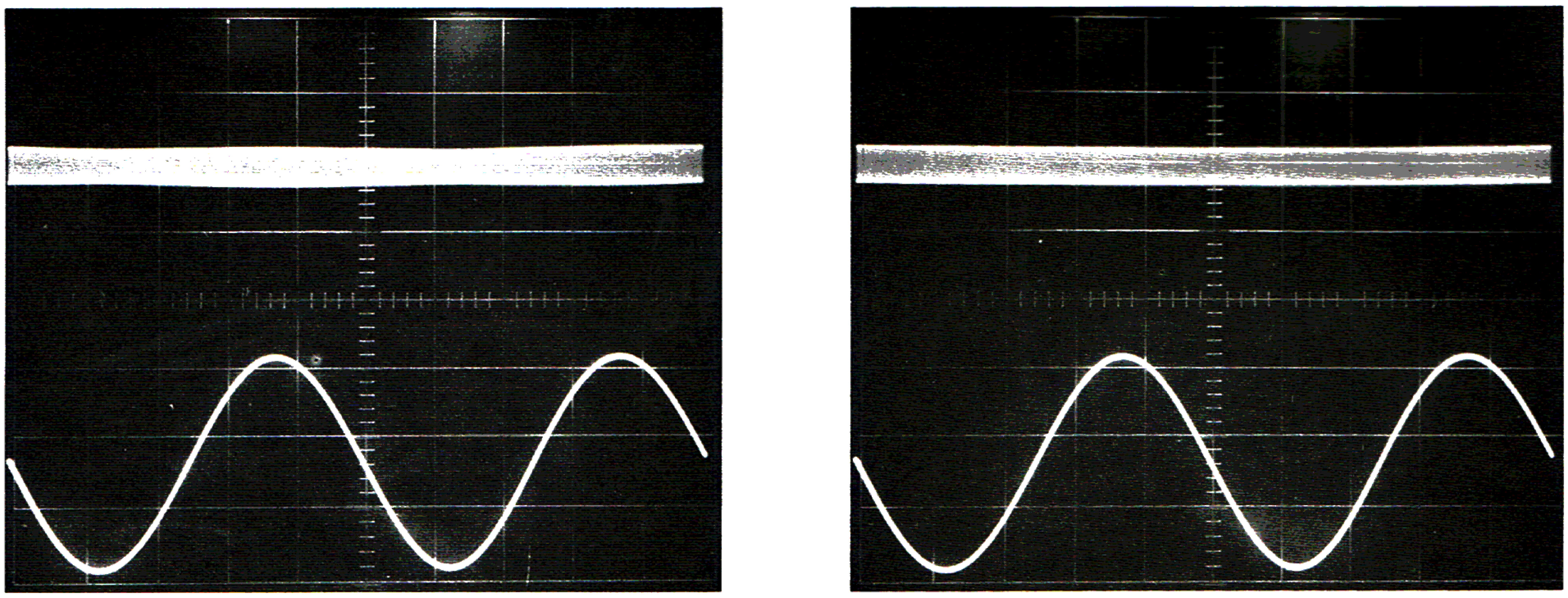
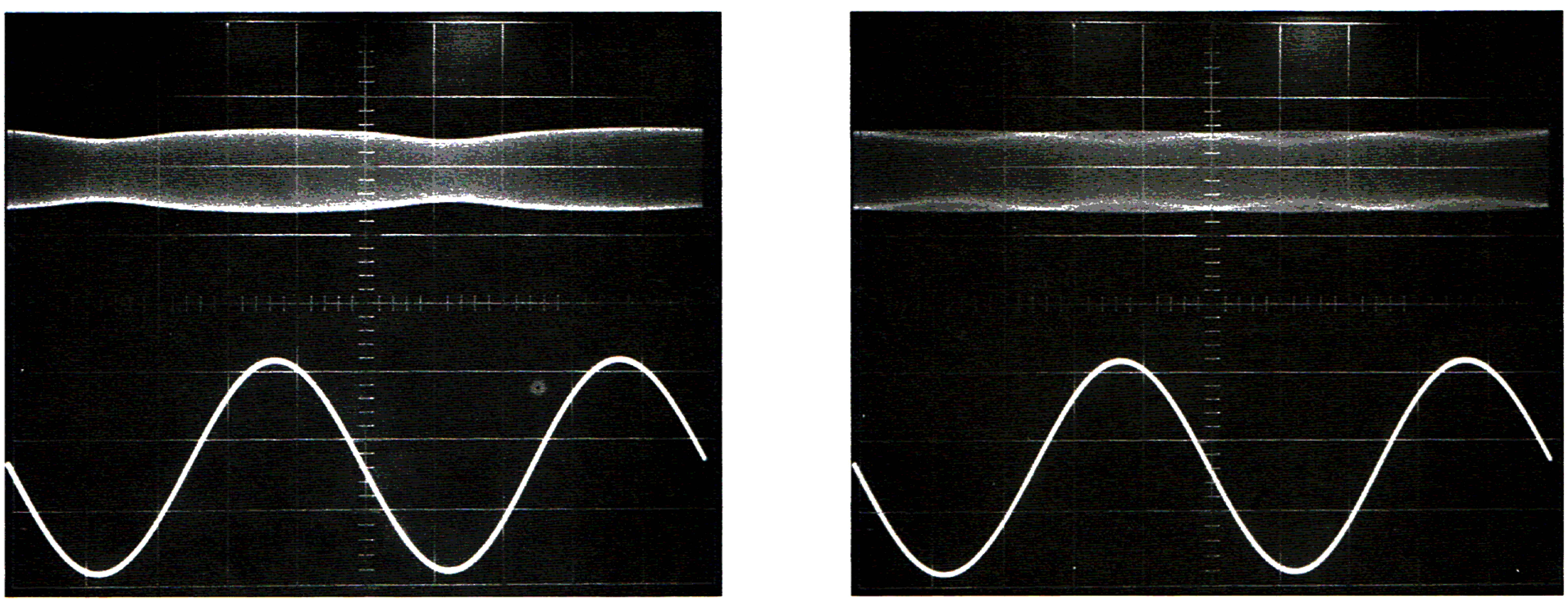


Fig. 2-2. STR-V4 IF Strip Schematic Diagram



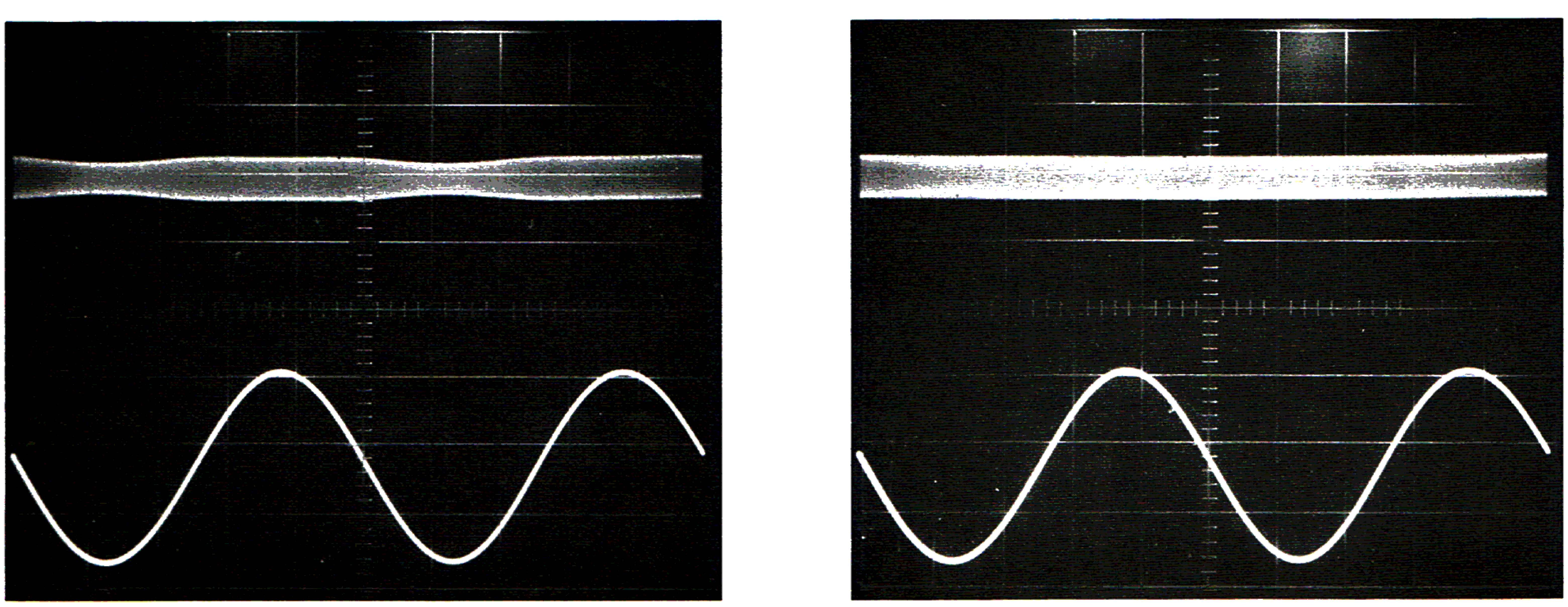
(a) Mono (b) Stereo

Fig. 2-3. Input to IF Strip (V=.1V/Div; H=.5 mS/Div)



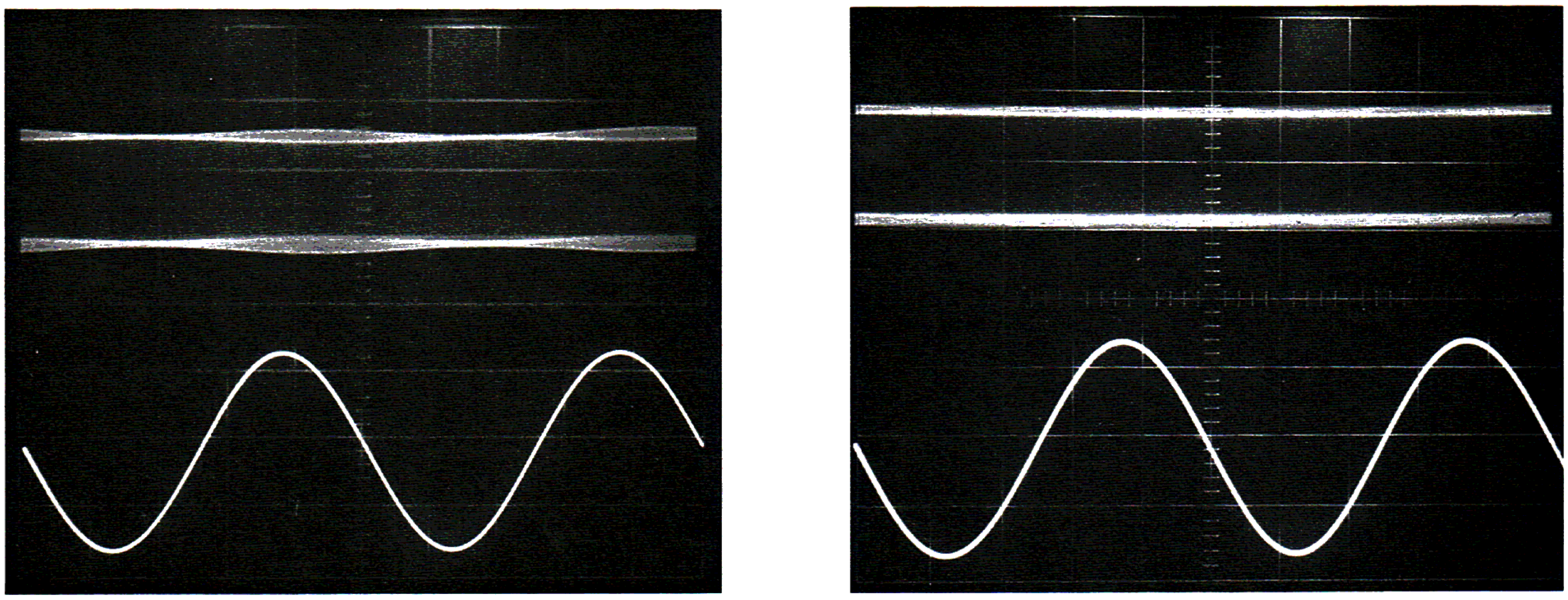
(a) Mono (b) Stereo

Fig. 2-4. Q201 Collector Signal (V=.1V/Div; H=.5 mS/Div)



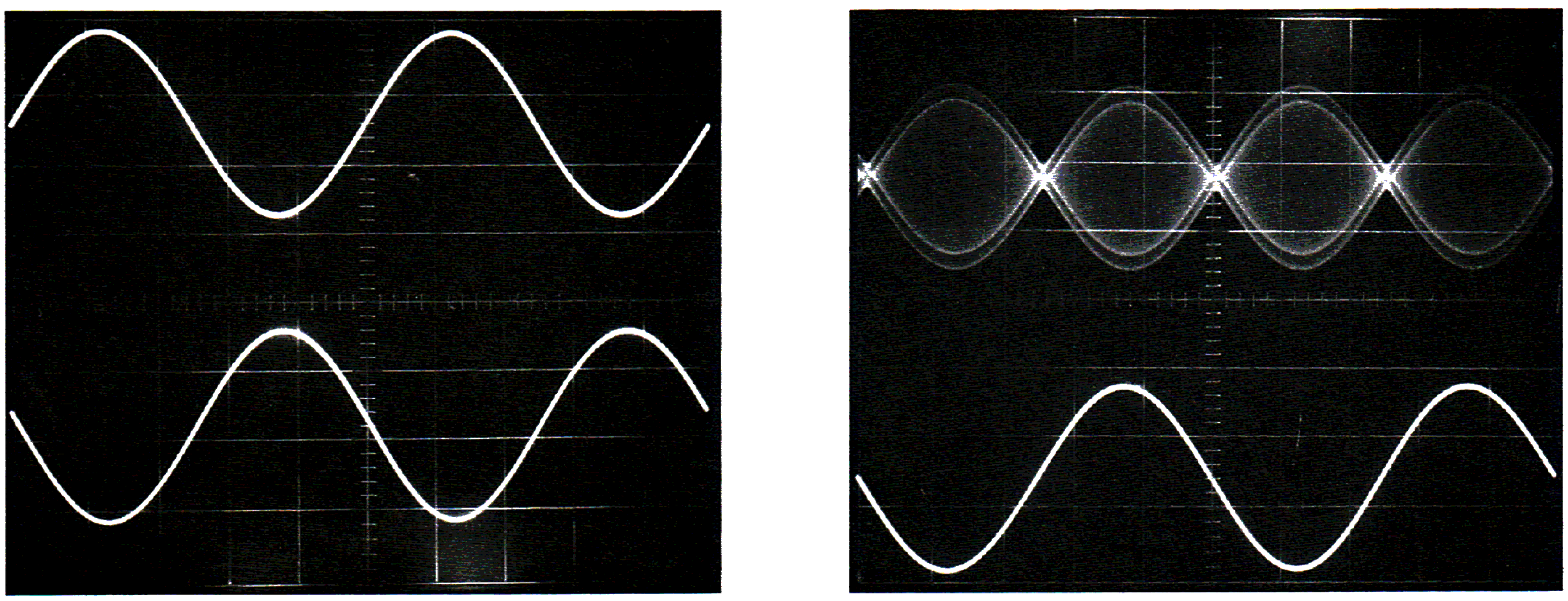
(a) Mono (b) Stereo

Fig. 2-5. IF Amplifier (Pin 1) Input Signal (V=.1V/Div; H=.5 mS/Div)



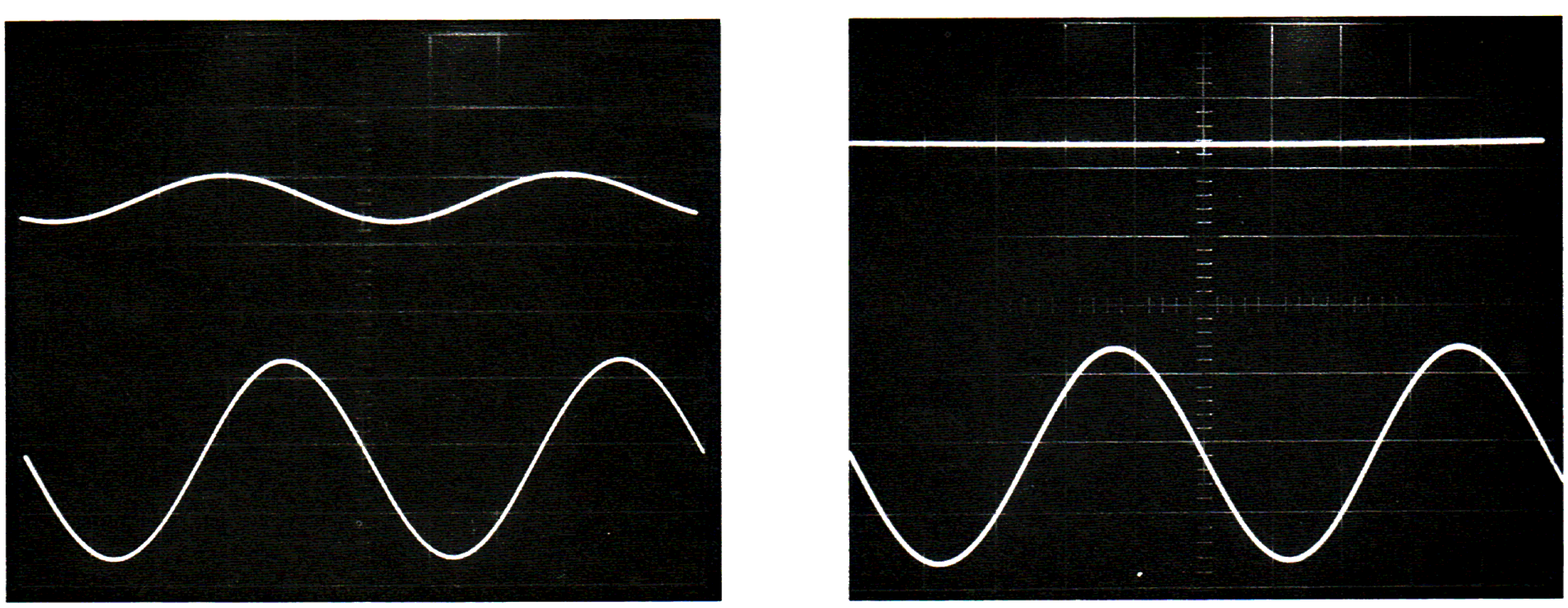
(a) Mono (b) Stereo

Fig. 2-6. IF Amplifier (Pin 8) Output Signal (V=.1V/Div; H=.5 mS/Div)



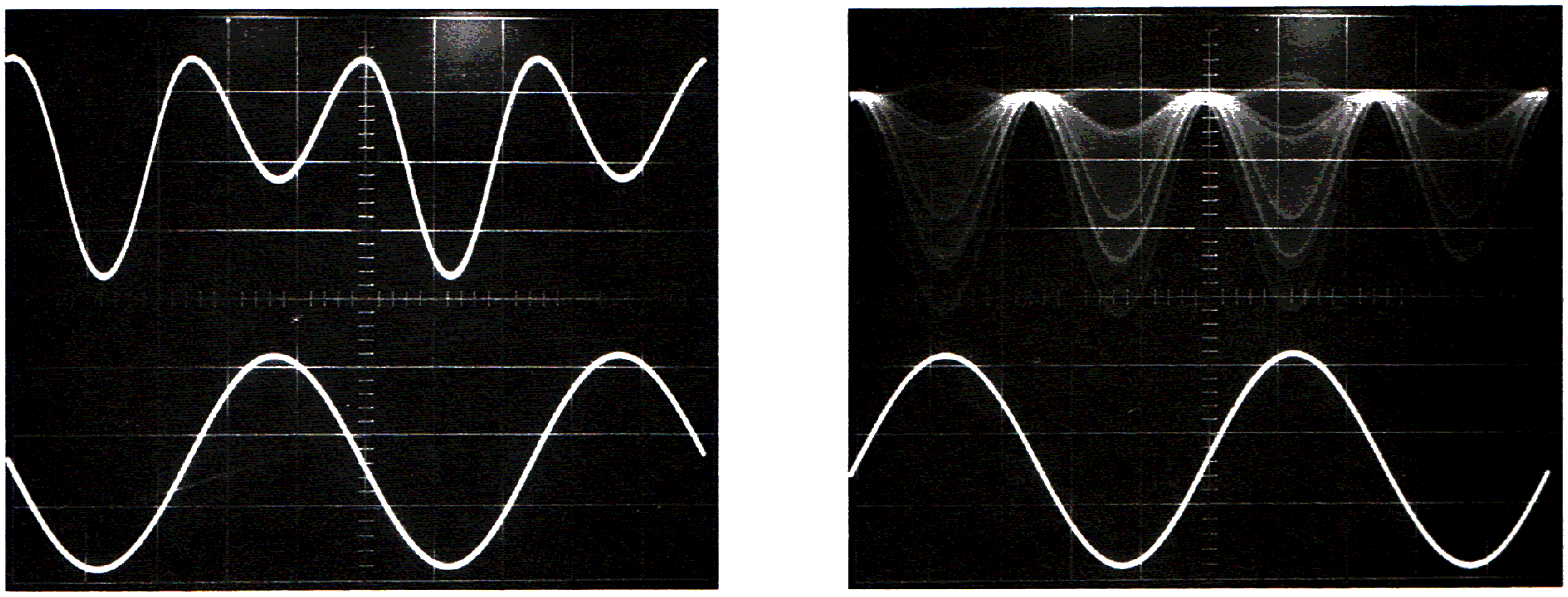
(a) Mono (b) Stereo

Fig. 2-7. AF Amplifier (Pin 6) Signal (V=.2V/Div; H=.5 mS/Div)



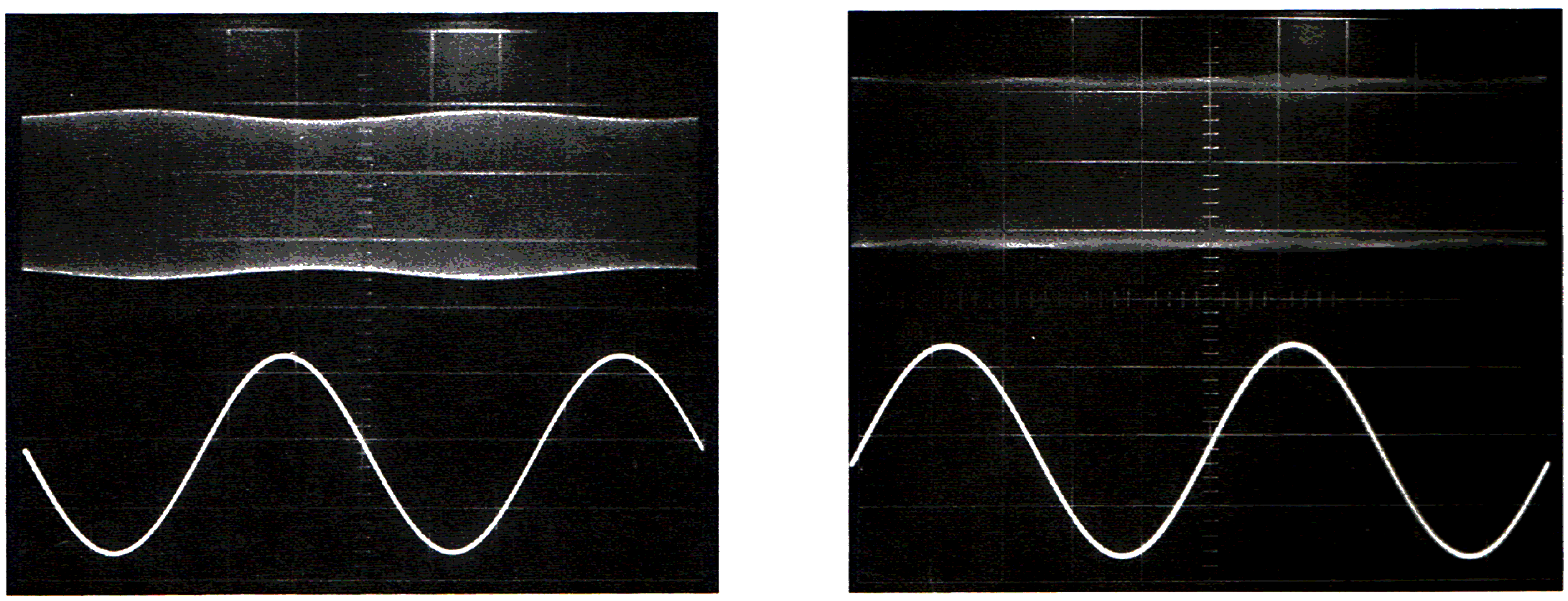
(a) Mono (V=.1V/Div) (b) Stereo (V=2V/Div DC)

Fig. 2-8. Detector (Pin 7) Output Signal (H=.5 mS/Div)



(a) Mono *(b) Stereo*

Fig. 2-9. Meter-Amplifier Output (Pin 13) Signal (V=.1V/Div; H=.5 mS/Div)



(a) Mono *(b) Stereo*

Fig. 2-10. Muting Circuit Input (Pin 9) Signal (V=.1V/Div; H=.5 mS/Div)

3. Signal Tracing the Multiplex Decoder

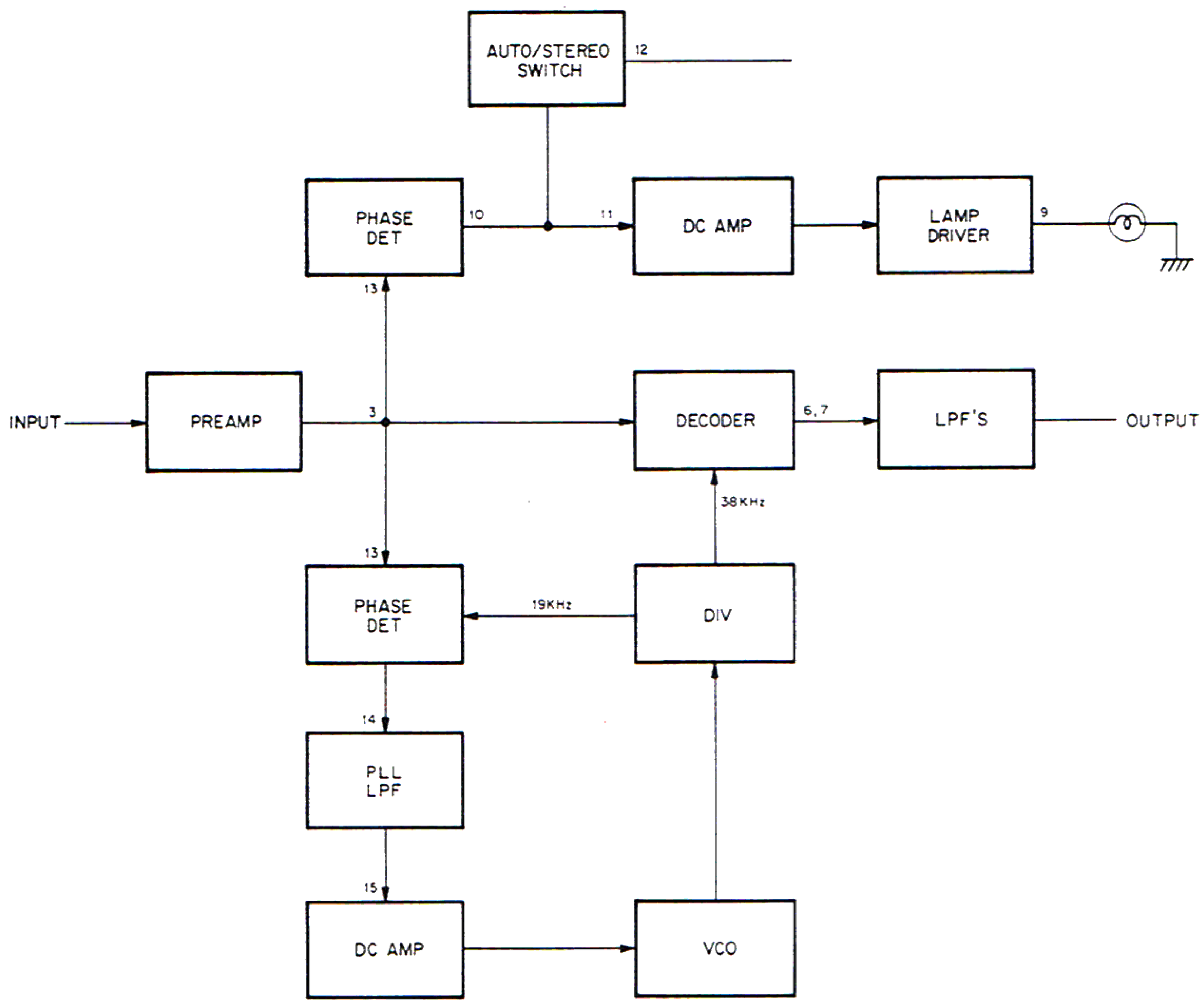
Signal tracing a multiplex decoder with a scope is complicated by the variety of waveforms present in a functioning decoder. Some of these waveforms are rather bizarre, so the technician may be uncertain of whether the waveform he is observing is correct or not. The waveform photographs in this section show what is present at each AC-active pin of the HA1196 MPX decoder IC with a standard FM stereo test signal (1000 microvolts RF, 10% pilot carrier, 90% 400 Hz modulation, ±75 kHz total deviation). The circuit shown in Fig. 3-1 is used in the STR-V3 and V4. However, the STR-V2, V5, V6, and V7 decoders are so similar that these waveforms will aid in troubleshooting these models also.

Except for Fig. 3-3, the lower trace in <u>each</u> photo is a reference from the signal generator, either the 400 Hz modulating signal or the 19 kHz pilot carrier. These reference signals are included for greater understanding of the waveforms being discussed (upper traces).

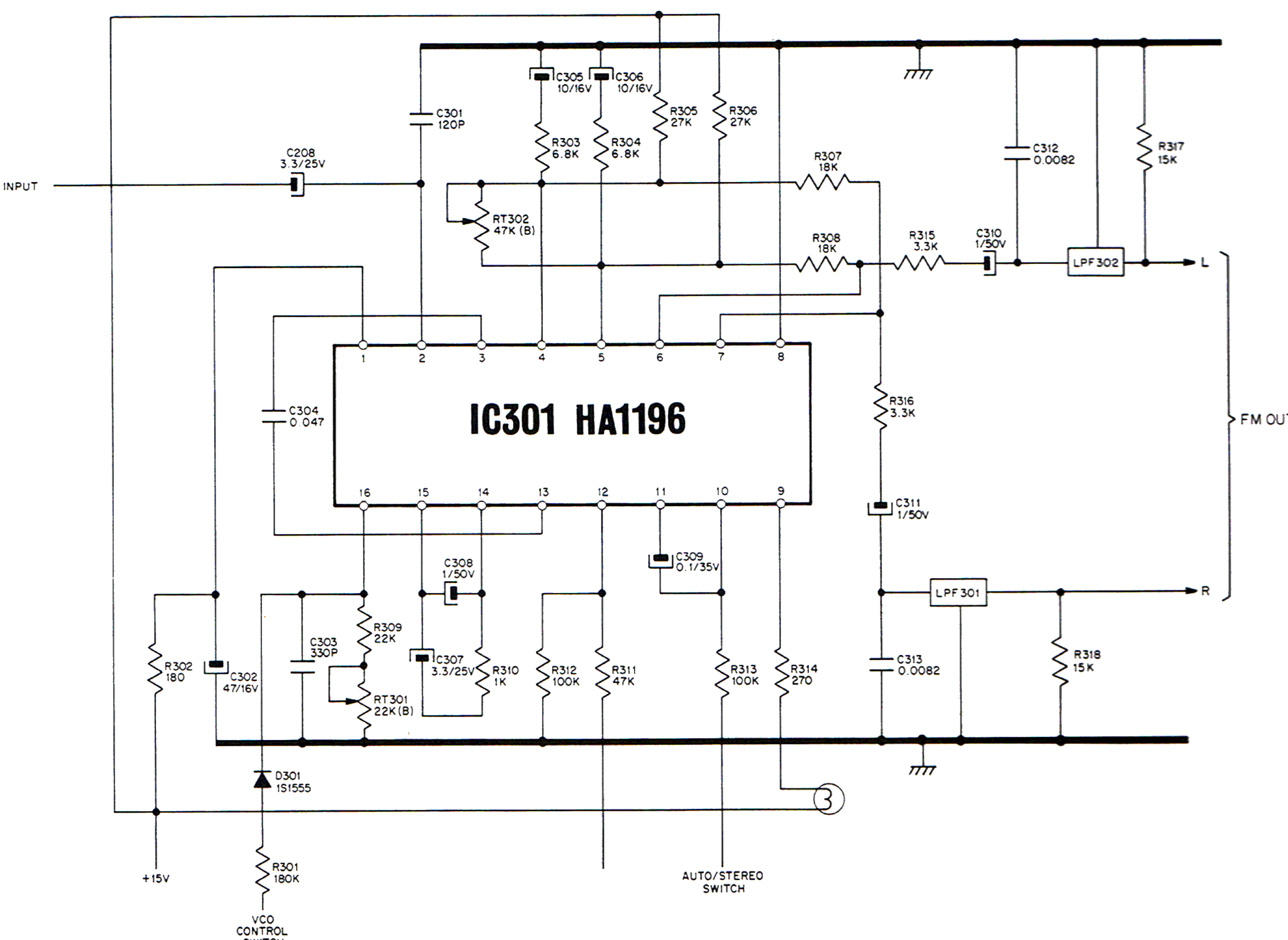
The preamplifier in the HA1196 simply increases the FM detector output signal (Fig. 3-2) to the level needed to operate the decoder and phase detectors (Fig. 3-4).

The decoder circuitry combines the 38 kHz carrier reconstituted by the PLL circuit with the amplified FM detector signal to produce L- and R-channel signals. Pot RT202 is connected across pins 4 and 5 (an intermediate point in the decoder) to permit separation adjustment. Note also that the 20 µS/Div traces of decoder pins 4-7 (Figs 3-5 to 3-8) show the 38 kHz subcarrier component in the resultant output signals. Most of this ripple component, as well as traces of the 19 kHz pilot carrier, will be removed by the low-pass filters (LPF301 and LPF302). The filter output is therefore a pair of low-ripple signals (Fig. 3-3) that are identical to the generator's modulating signal (lower trace of Fig. 3-2).

The PLL oscillator (Fig. 3-9) operates at 76 kHz, four times the pilot-carrier frequency. This is divided once to make 38 kHz carrier for the decoder, and twice to make 19 kHz carrier for the phase detectors. Most of the classic phase-locked loop circuitry (VCO, frequency divider, phase detector (or comparator), DC error amplifier) is in the HA1196; only some the low-pass filter components (C307, C308, R310) and the VCO frequency components (C303, R309, and RT301) are external to the IC.

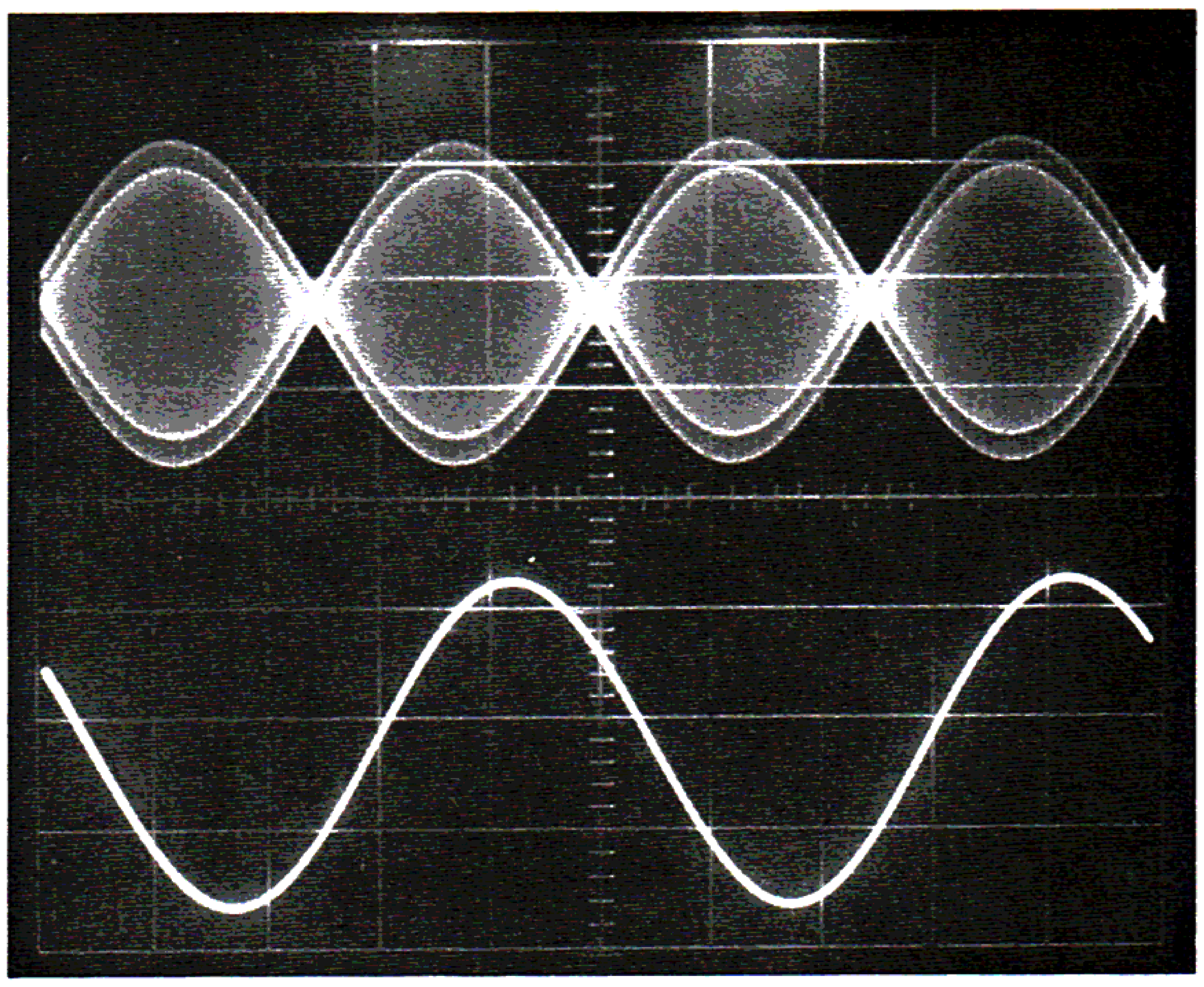


(a) Block diagram



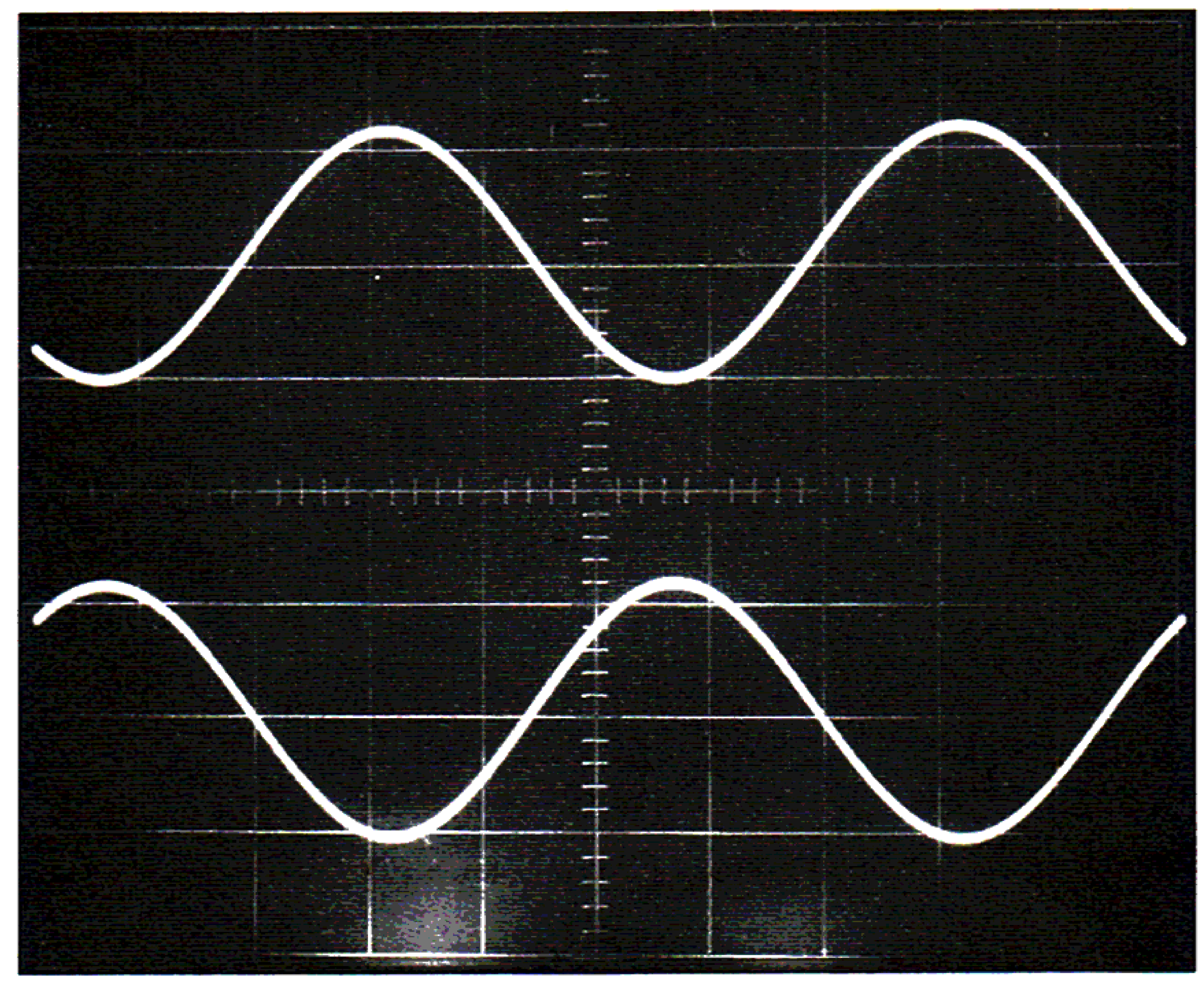
(b) Schematic diagram

Fig. 3-1. STR-V4 Multiplex Decoder



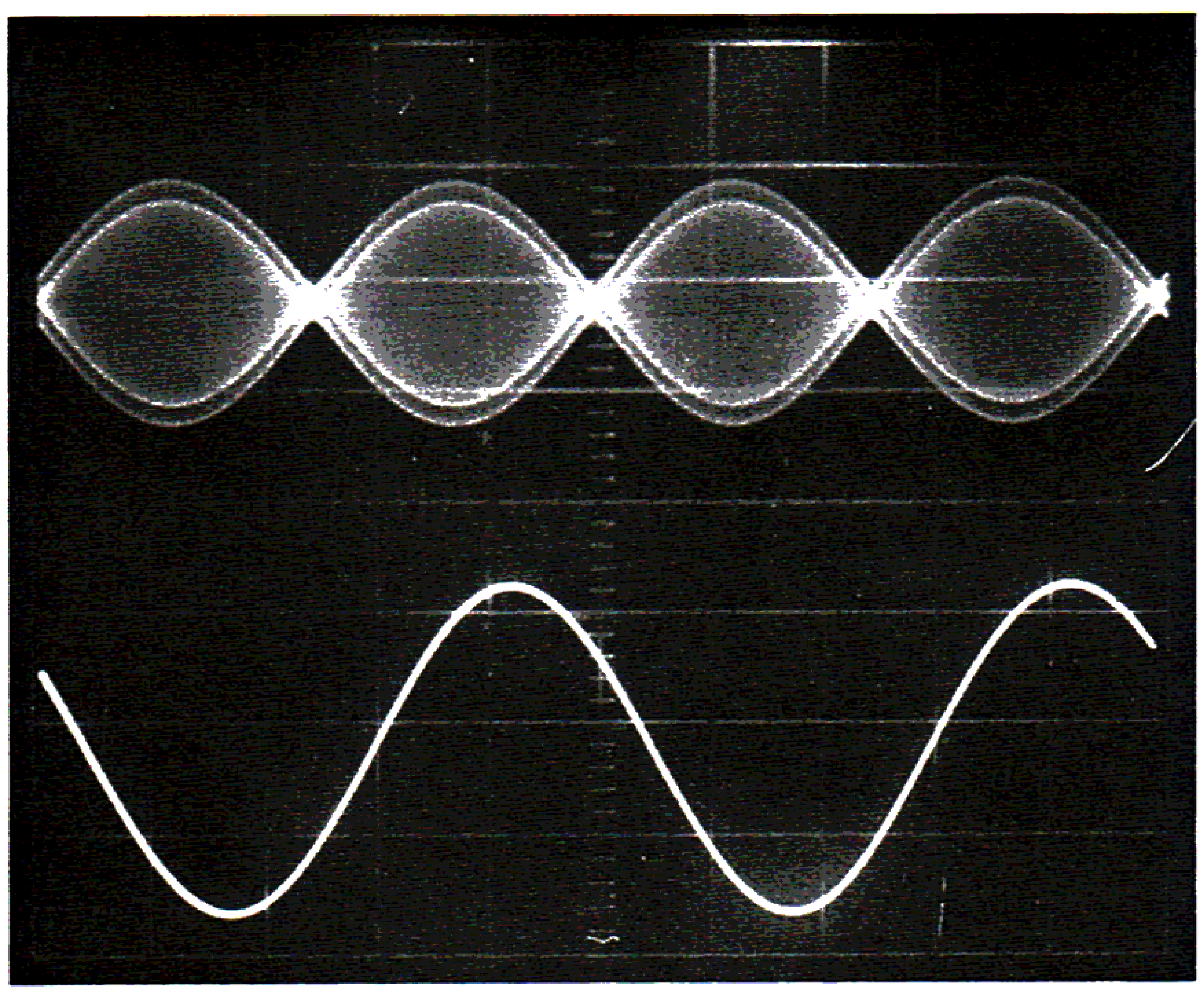
V = .2V/Div; H=.5 mS/Div

Fig. 3-2. Preamp Input (Pin 2) Signal

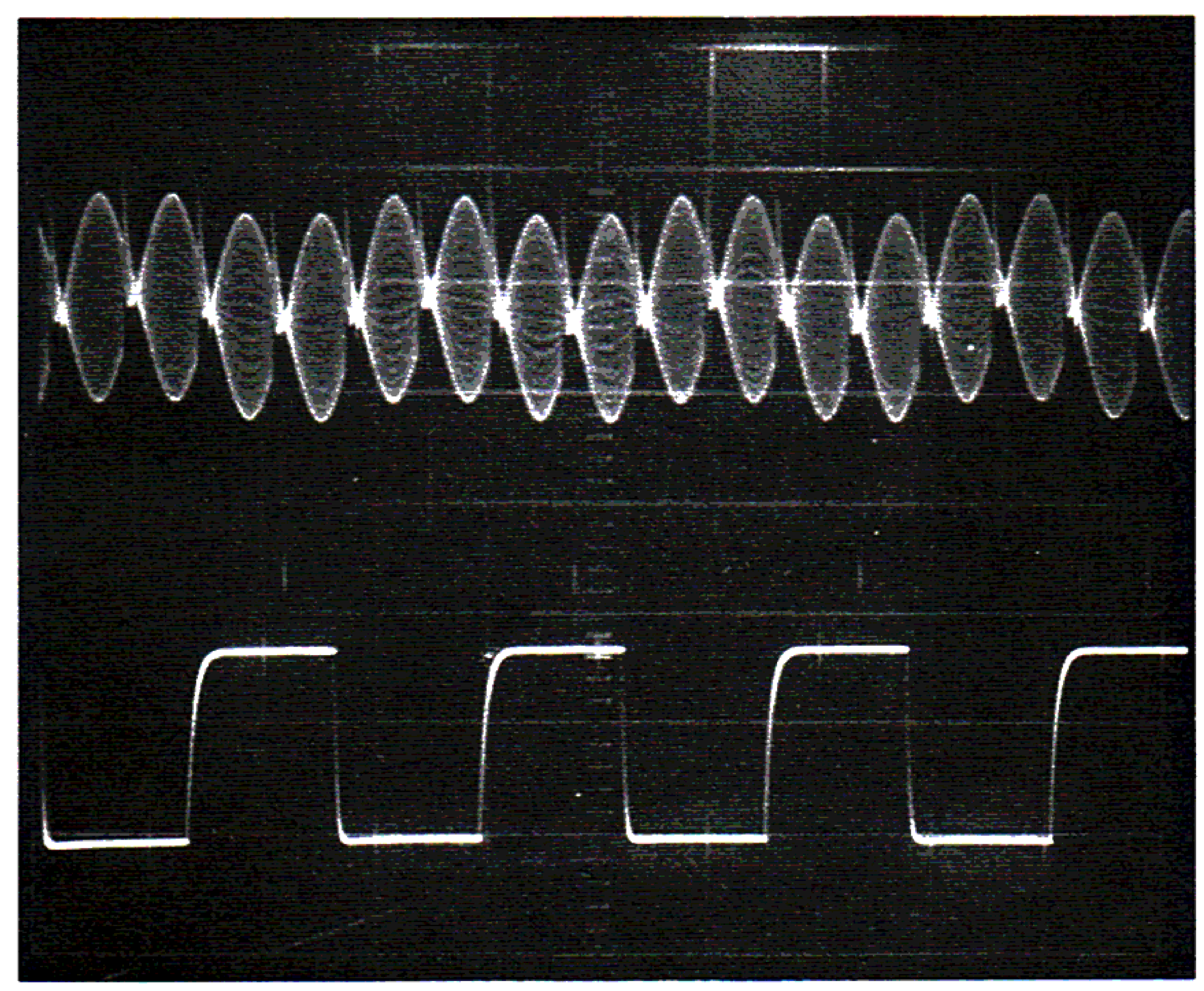


V = .5/Div; H=.5 mS/Div

Fig. 3-3. MPX Decoder Block Output Signals

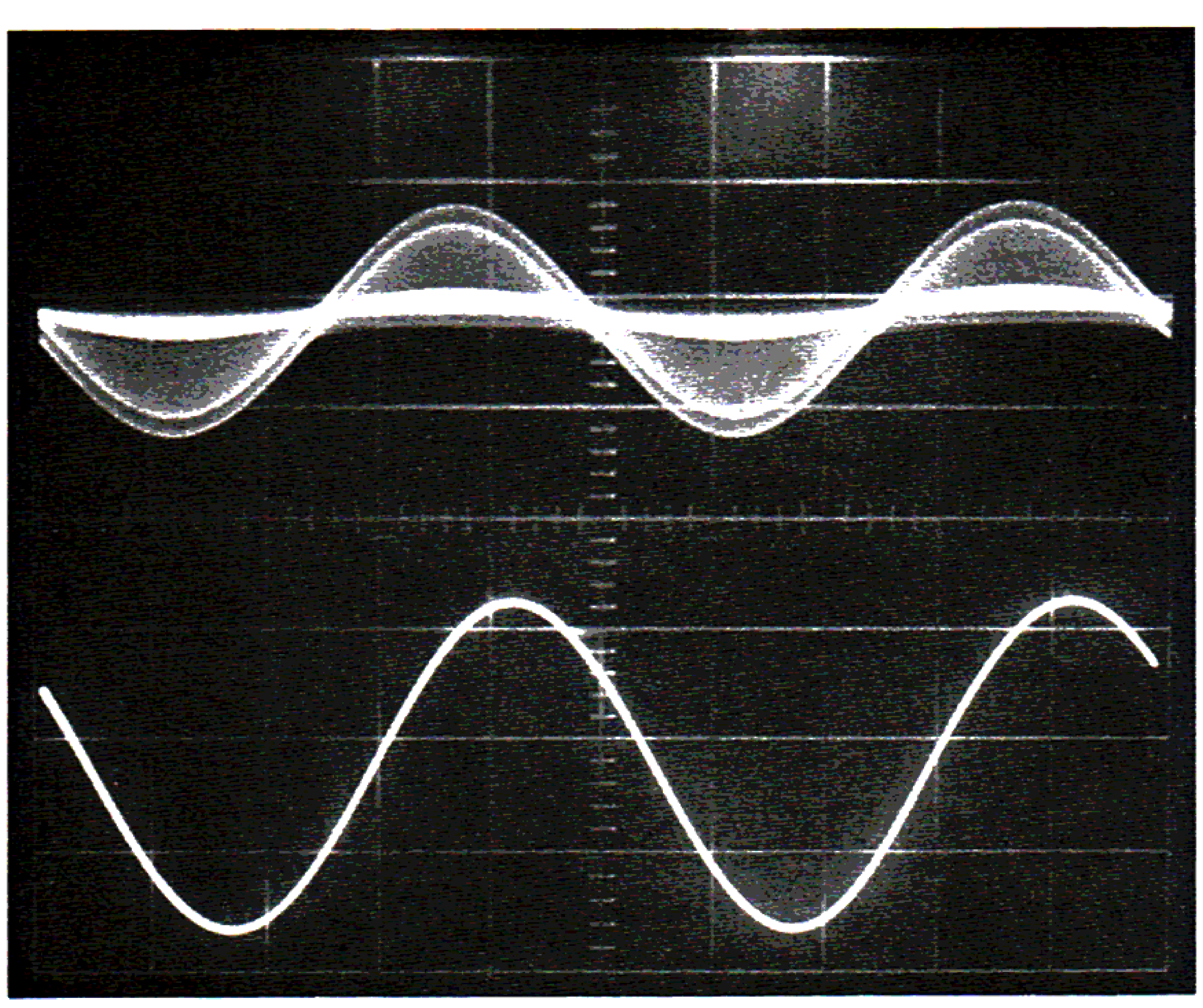


(a) V=1V/Div; H=.5 mS/Div

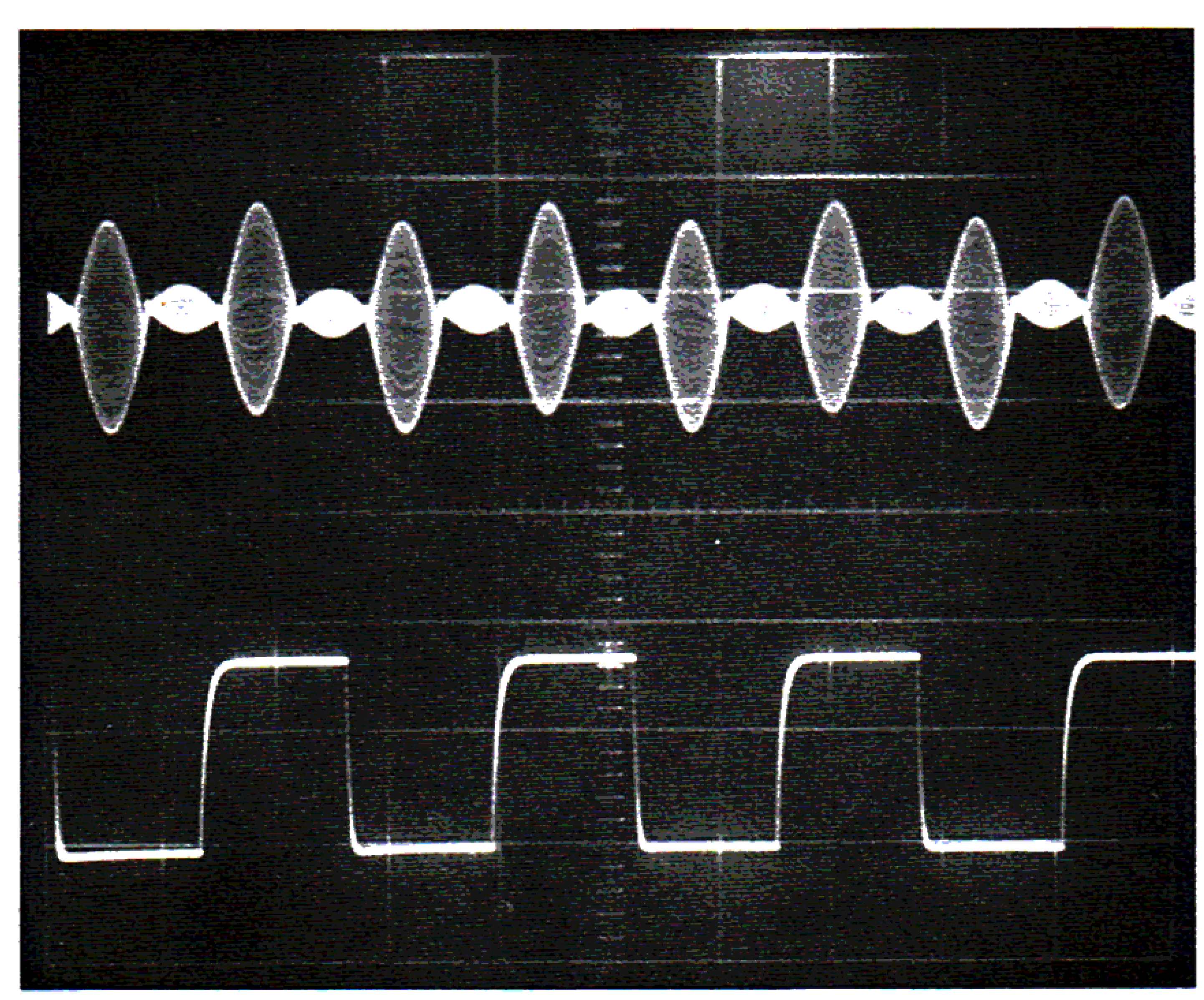


(b) V=1V/Div; H=20 μS/Div

Fig. 3-4. Preamp Output (Pin 3) And Phase Detector Input (Pin 13) Signals

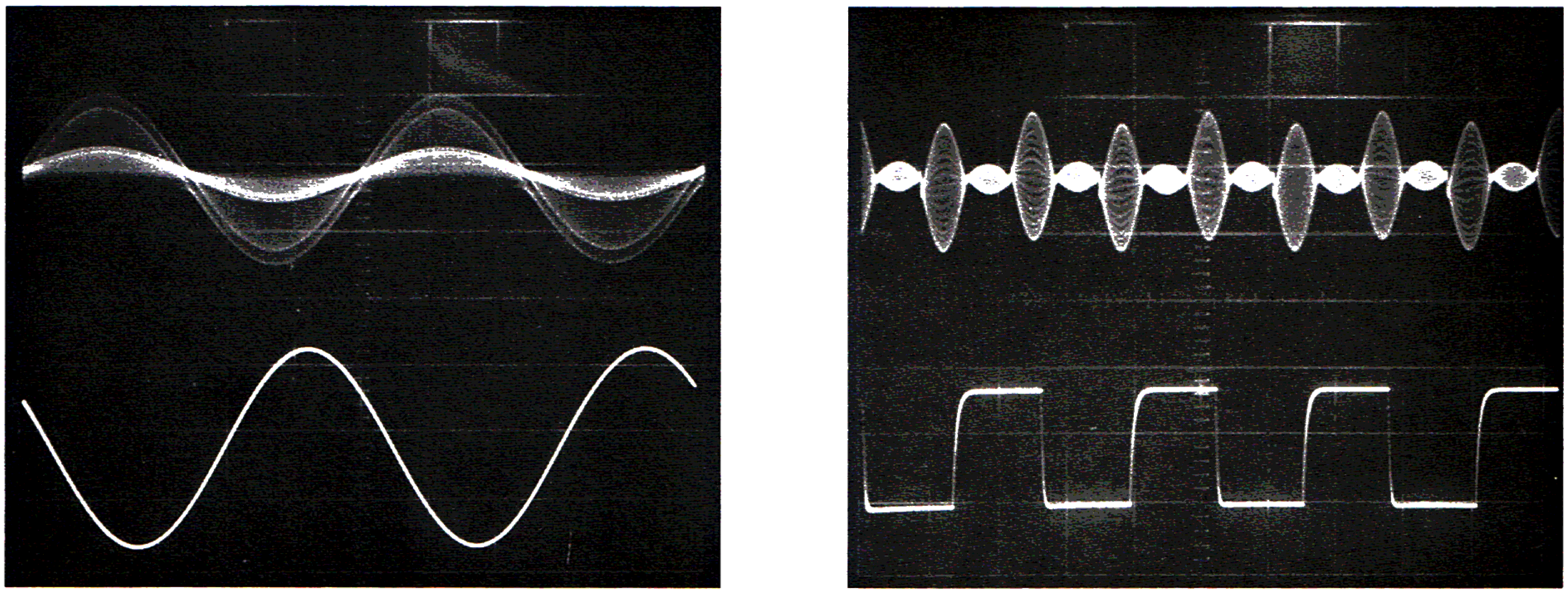


(a) V = .5V/Div; H=.5 mS/Div



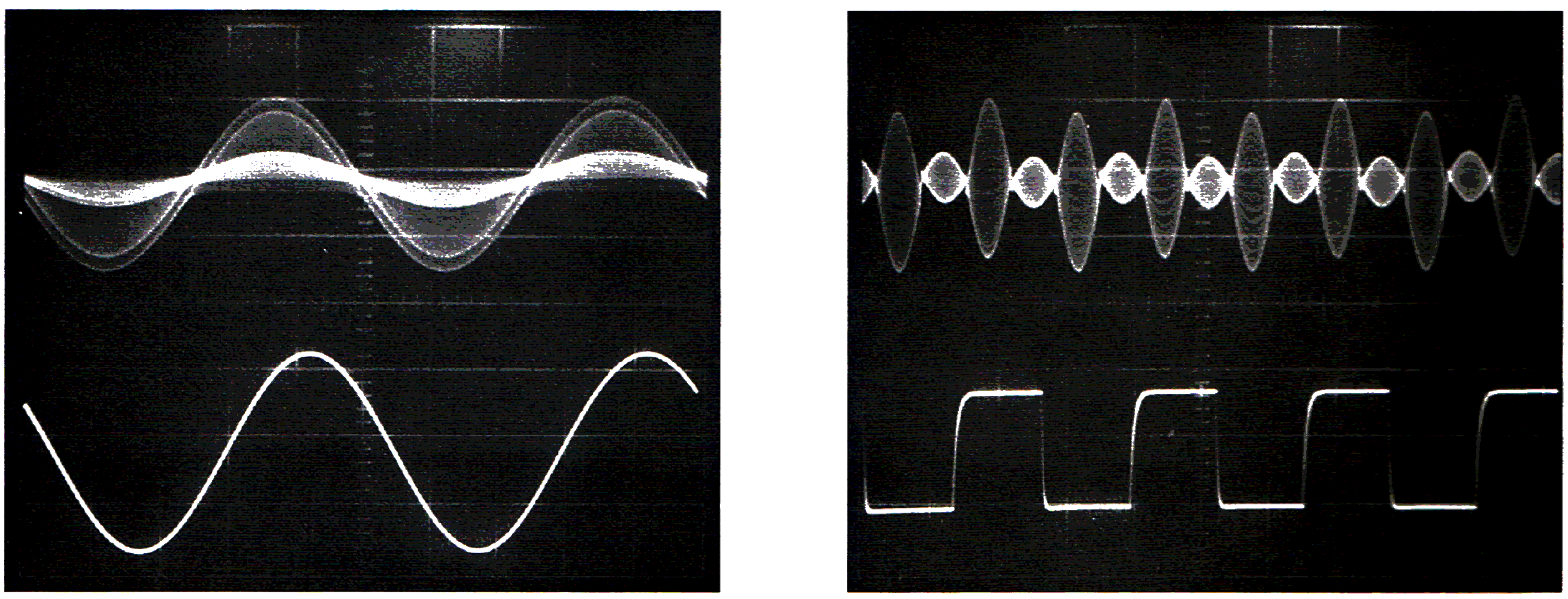
(b) V = .5V/Div; H=20 μS/Div

Fig. 3-5. Decoder Internal (Pin 4) Signal



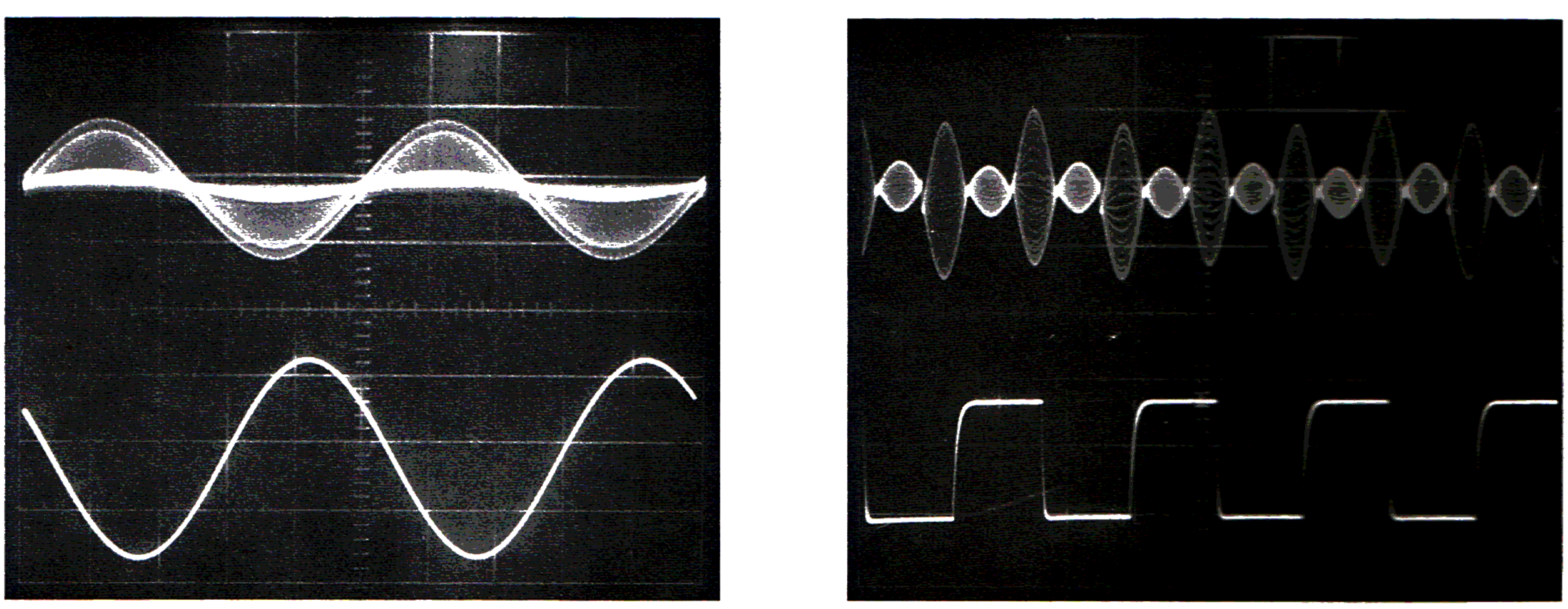
(a) V=.5V/Div; H=.5 mS/Div *(b) V=.5V/Div; H=20 µS/Div*

Fig. 3-6. Decoder Internal (Pin 5) Signal



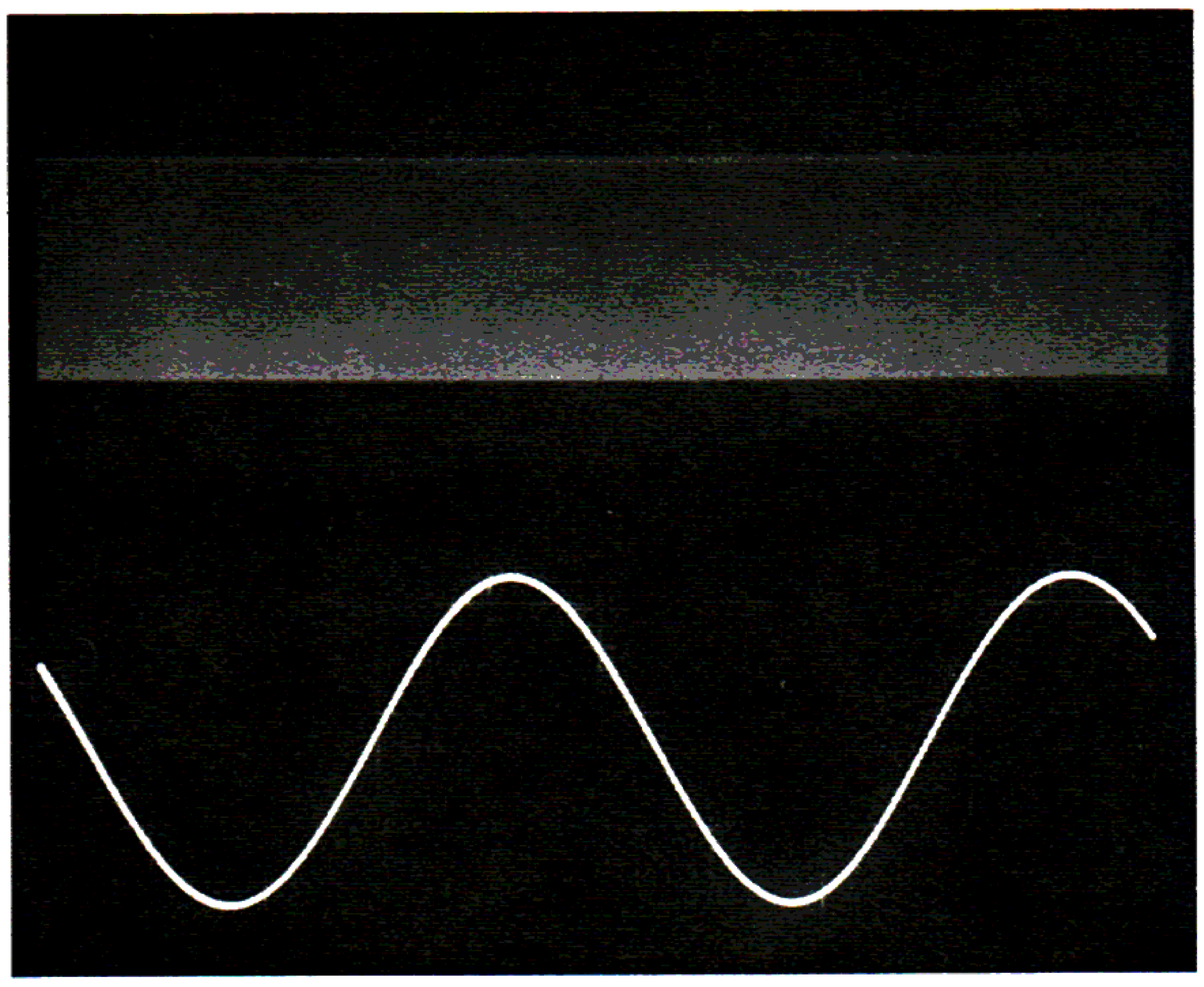
(a) V=2V/Div; H=.5 mS/Div *(b) V=2V/Div; H=20 µS/Div*

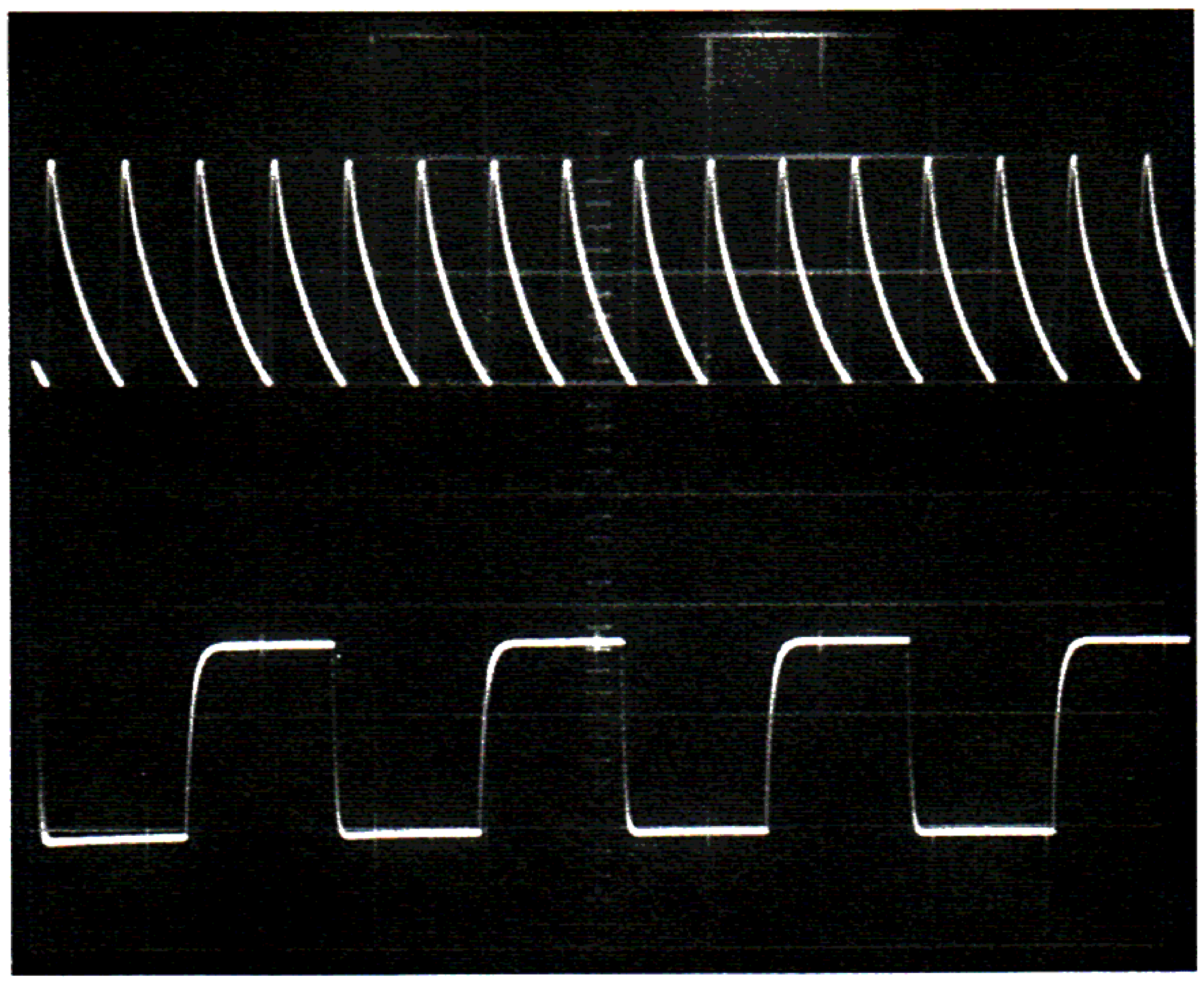
Fig. 3-7. Decoder Output (Pin 6) Signal



(a) V=2V/Div; H=.5 mS/Div *(b) V=2/Div; H=20 µS/Div*

Fig. 3-8. Decoder Output (Pin 7) Signal

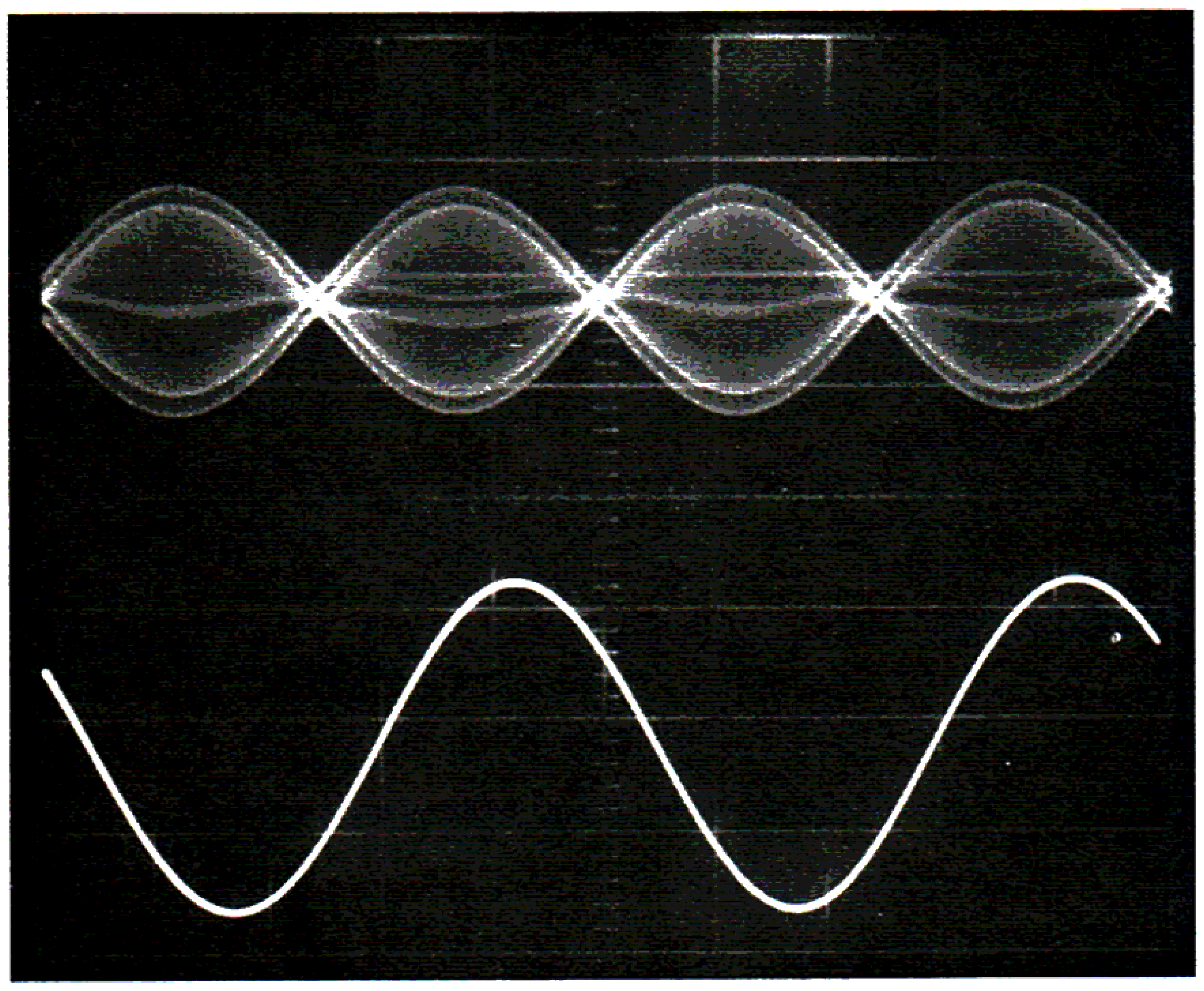


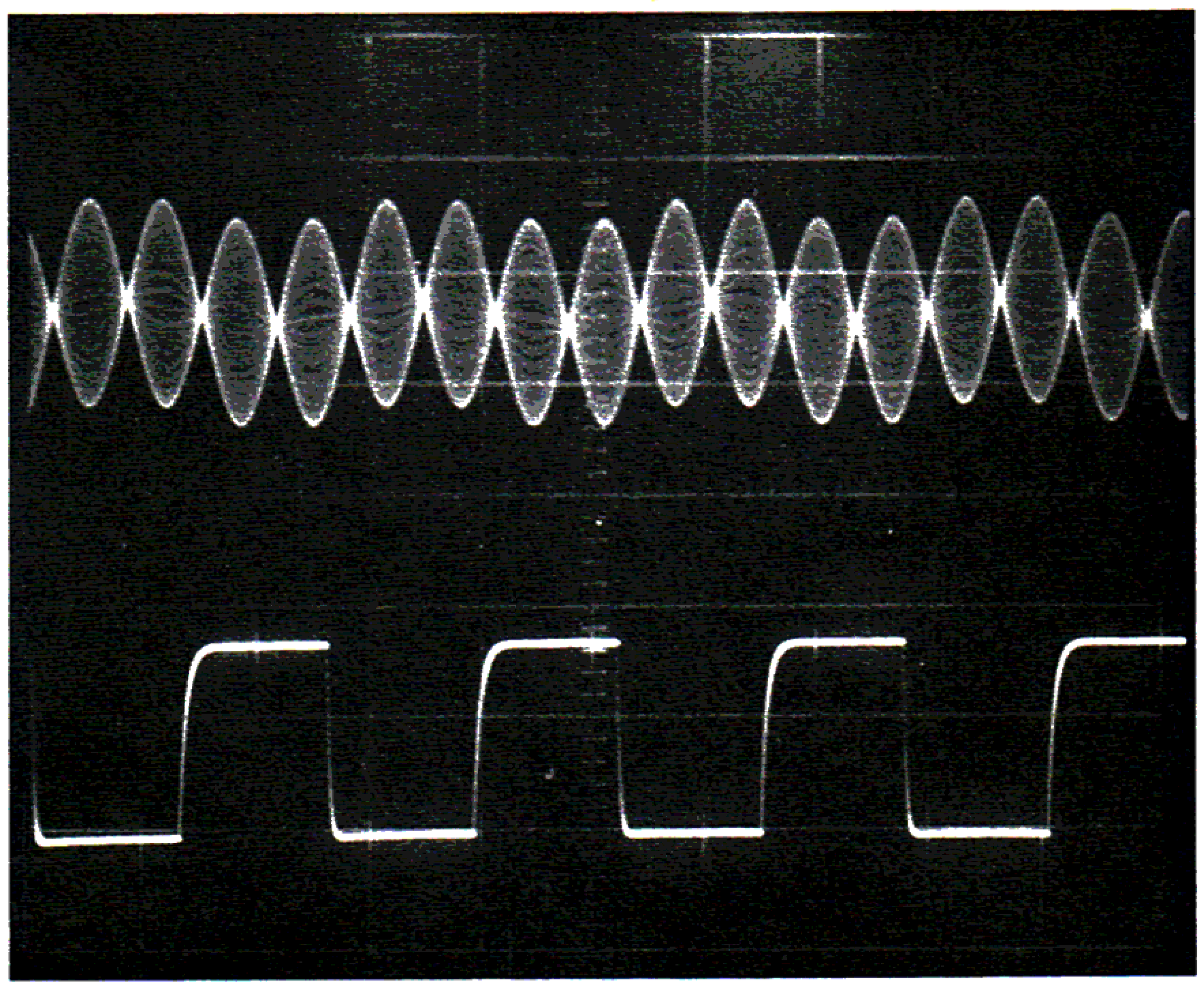


(a) V=2V/Div; H=.5 mS/Div

(b) V=2V/Div; H=20 µS/Div

Fig. 3-9. VCO Output (Pin 16) Signal

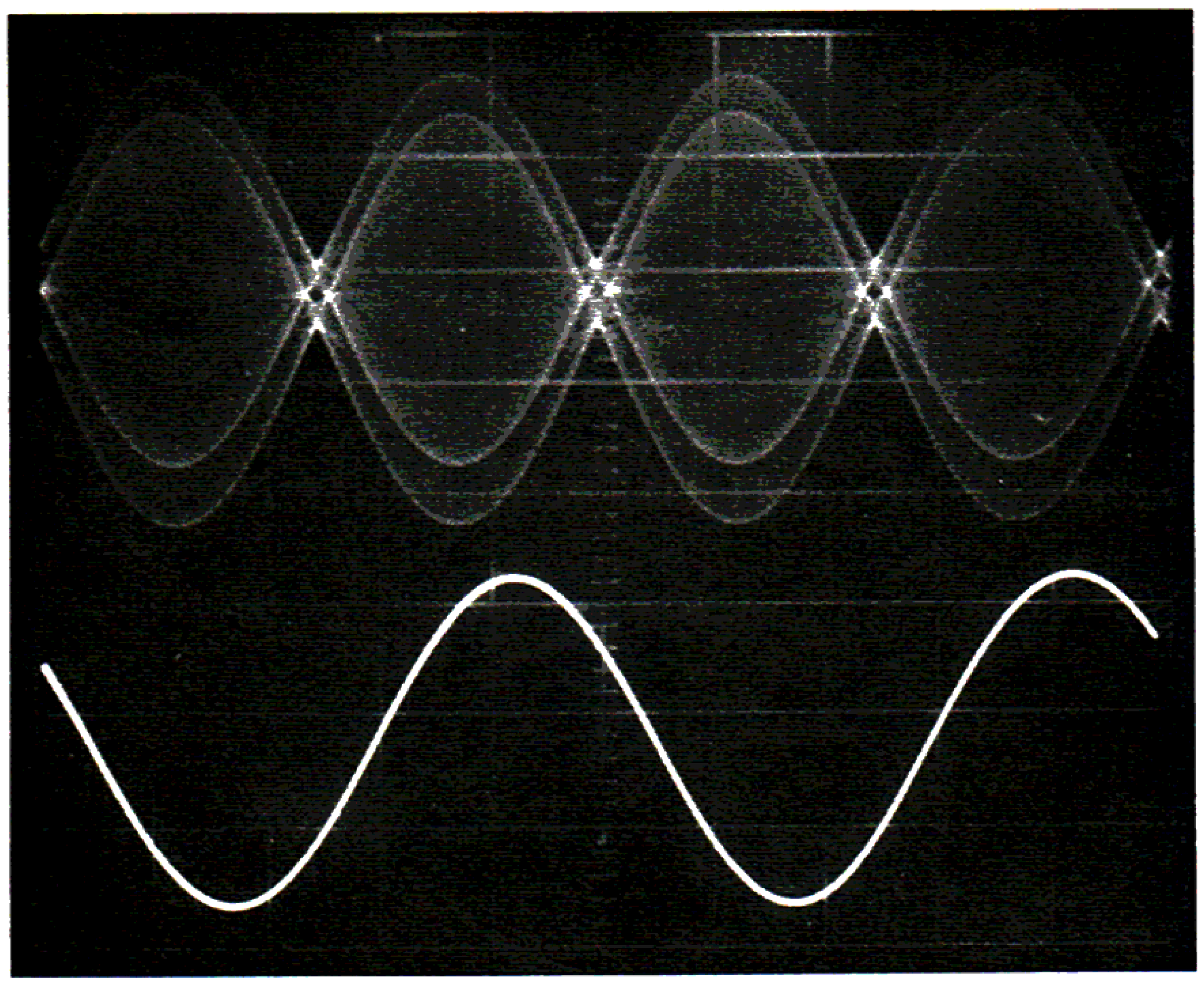


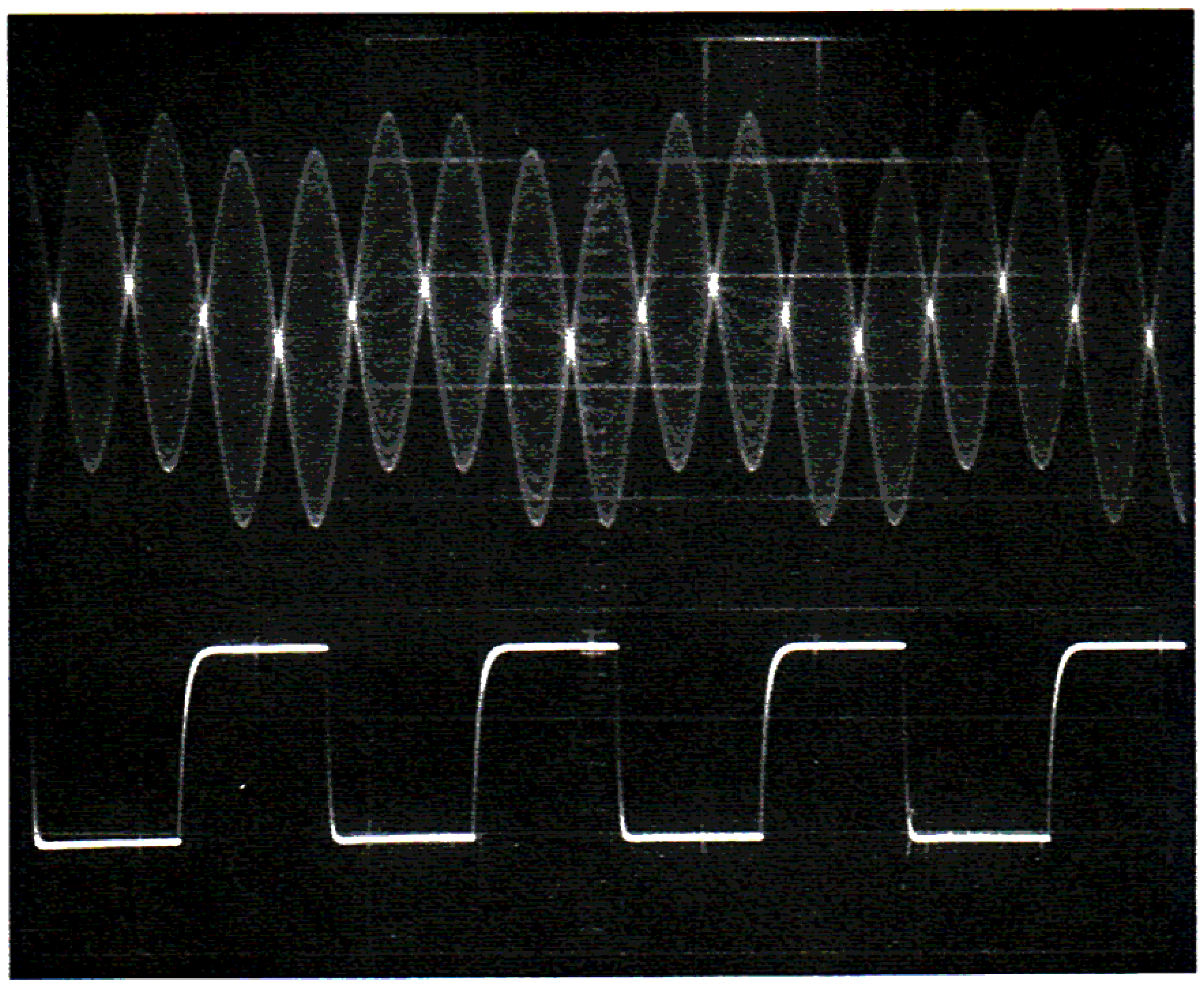


(a) V=.1V/Div; H=.5 mS/Div

(b) V=.1V/Div; H=20 µS/Div

Fig. 3-10. PLL Phase-Detector Output (Pins 14 and 15) signal





(a) V=.2V/Div; H=.5 mS/Div

(b) V=.2V/Div; H=20 µS/Div

Fig. 3-11. Auxiliary-Circuit Phase-Detector Output (Pins 10 and 11) Signal

4. Troubleshooting the AM Block by Signal Tracing and Injection

Signal tracing through the AM section of the STR-V4 is relatively easy. The waveforms are familiar to even the least-informed graduate of the radio/TV repair shops, and the frequencies involved are so low that even a 5 MHz scope is sufficient. All of the waveforms in this section were made with an AC-coupled scope equipped with a low-capacitance probe. The lower trace in all photos (where present) is the 400 Hz generator modulating signal. Always trigger your scope from this signal source when signal tracing.

The test signal is 5000 microvolts RF at approximately 1000 kHz, with 50% 400 Hz modulation.

The LA1240 AM IC (Fig. 4-1a) contains all of the active (and many of the passive) components needed to convert modulated RF to audio. As Fig. 4-1b shows, most of the external components in the STR-V4 AM section are frequency selective. To reduce the chance of oscillation caused by the long connecting leads to the outboard components, yet maintain high sensitivity and S/N ratio, the RF stage has an untuned RC-output circuit, much like a video amplifier. The oscillator voltage (pin 6) generated by the converter appears as a near-perfect sine wave (Fig. 4-4) even when a high-frequency scope is used. This spectral purity minimizes spurious responses.

Figures 4-5 and 4-6 show the input and output waveforms of the 1st IF amplifier. Because of the high signal level involved, this stage is operating at greatly reduced gain, so no difference in amplitude is noticeable. In fact, because of the voltage loss in the interstage coupling network (IFT301), the signal level at the input to the 2nd amplifier (Fig. 4-7) is lower than that at the input to the 1st (Fig. 4-5).

The amplitude at the output of transistor Q401 is almost the same as that shown for the detector output in Fig. 4-8, since Q401 is an emitter follower with close to unity gain. However, the waveform at Q401 will be an even closer match to the 400 Hz reference signal (bottom of all photos) because of the RF filtering action of R406, C417, R410, and C418.

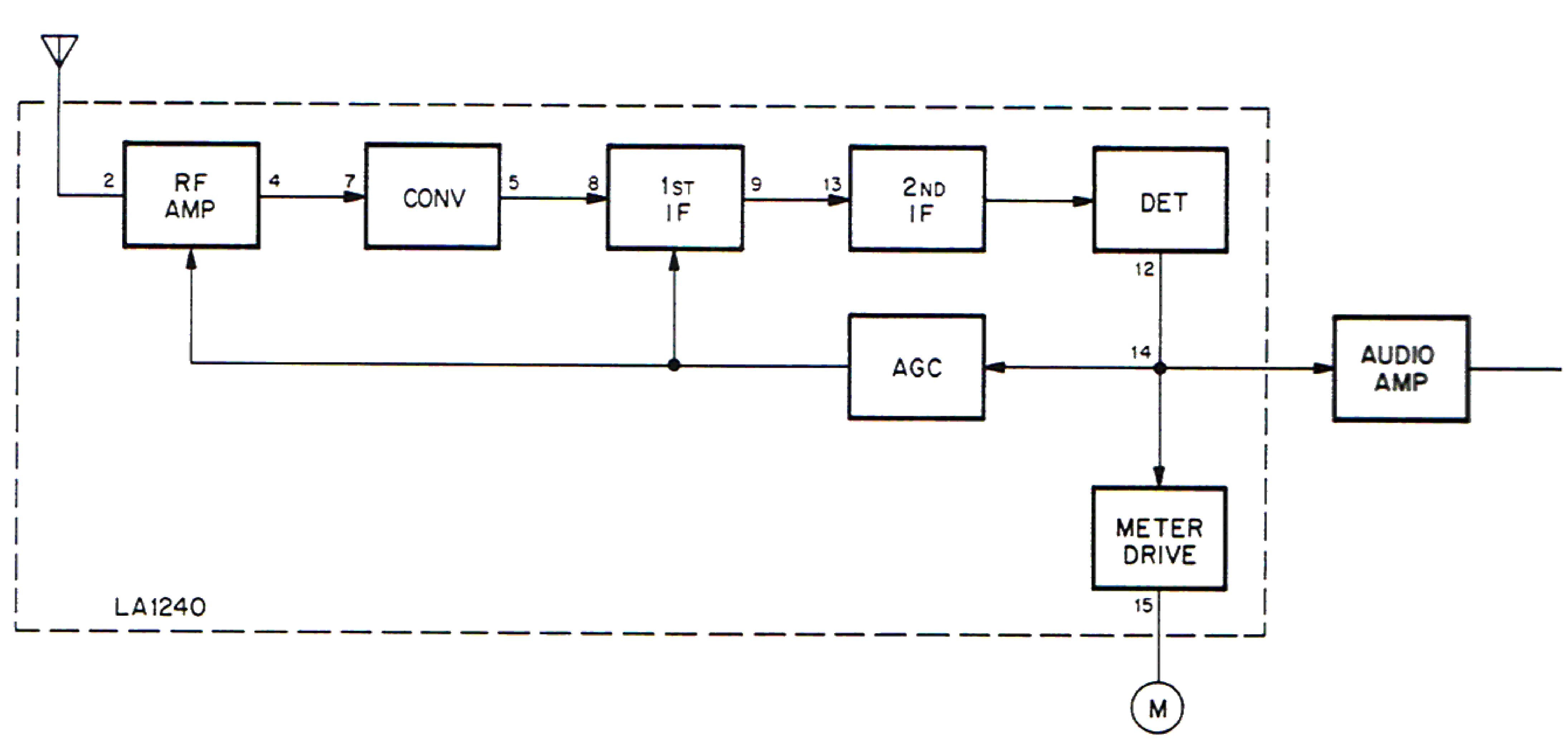
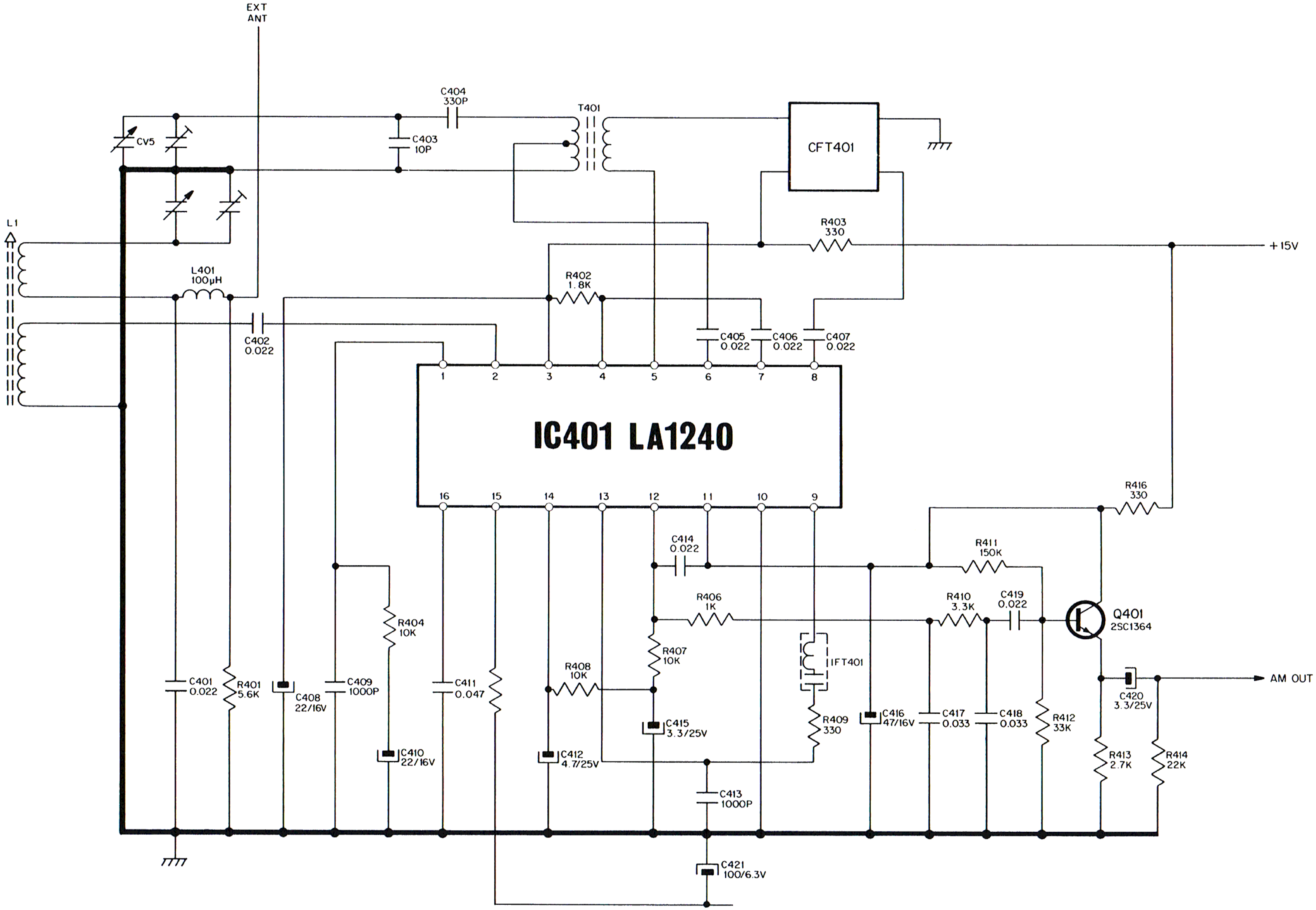
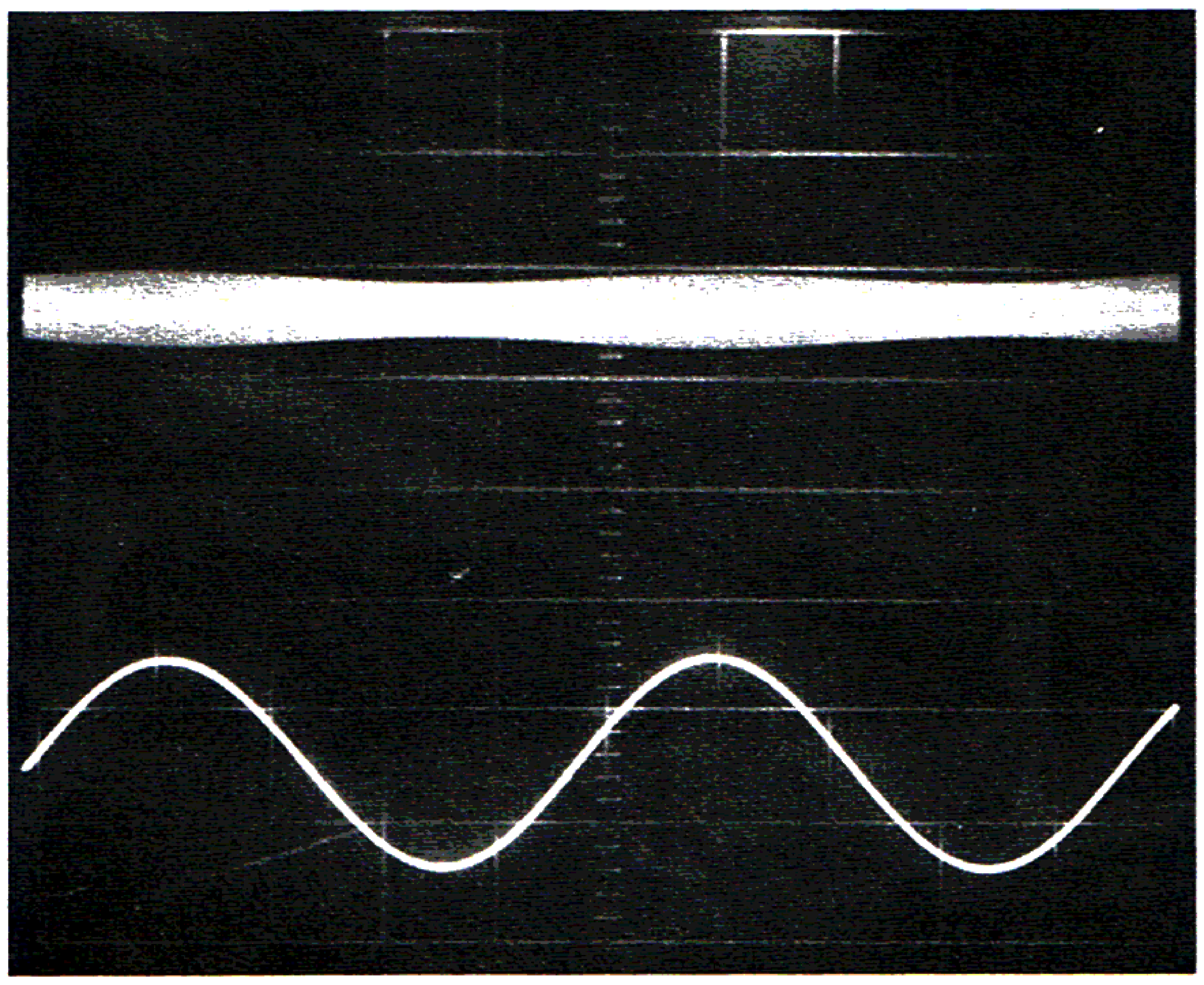


Fig. 4-1. (a) Block diagram



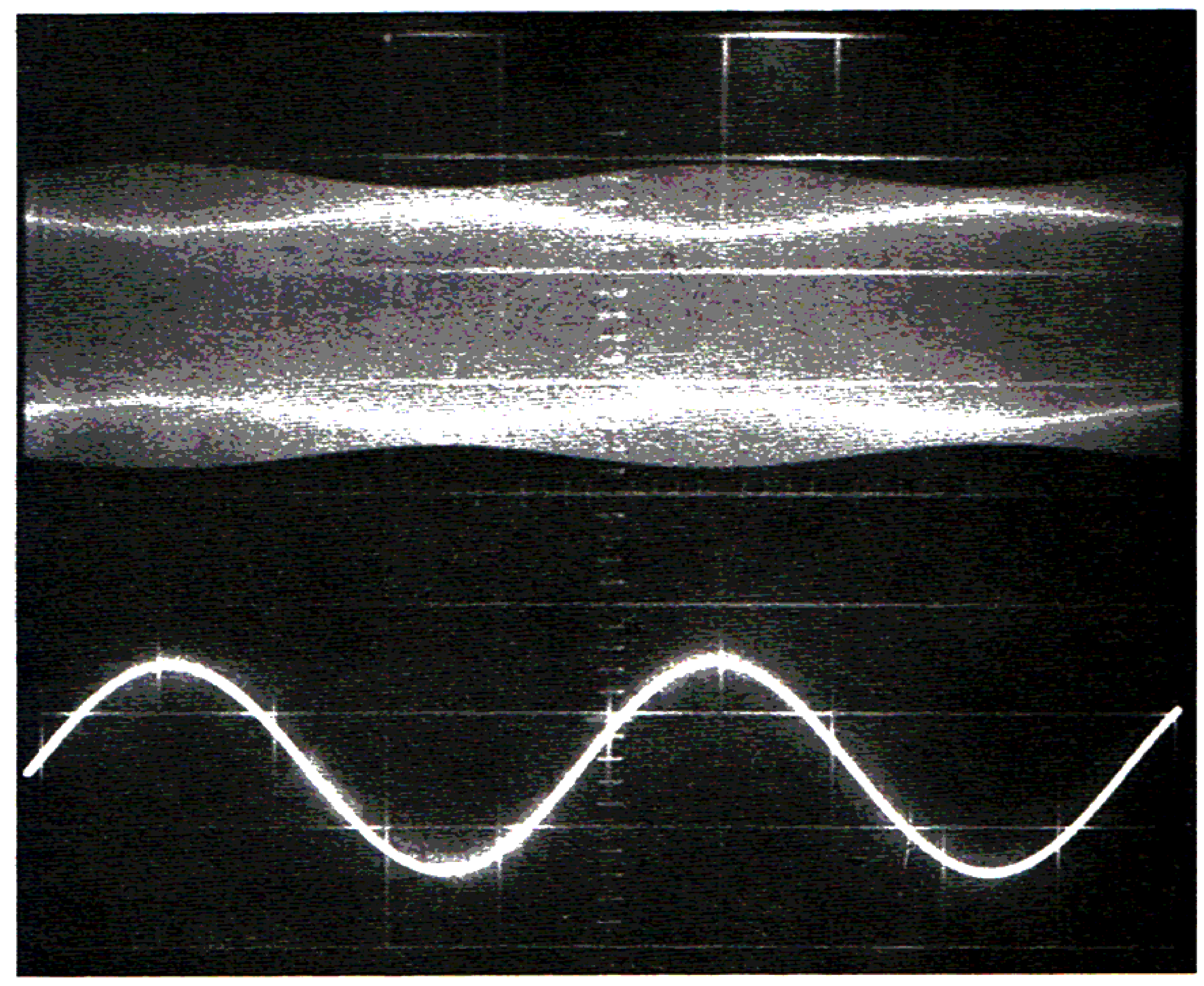
(b) Schematic diagram

Fig. 4-1. STR-V4 AM Block



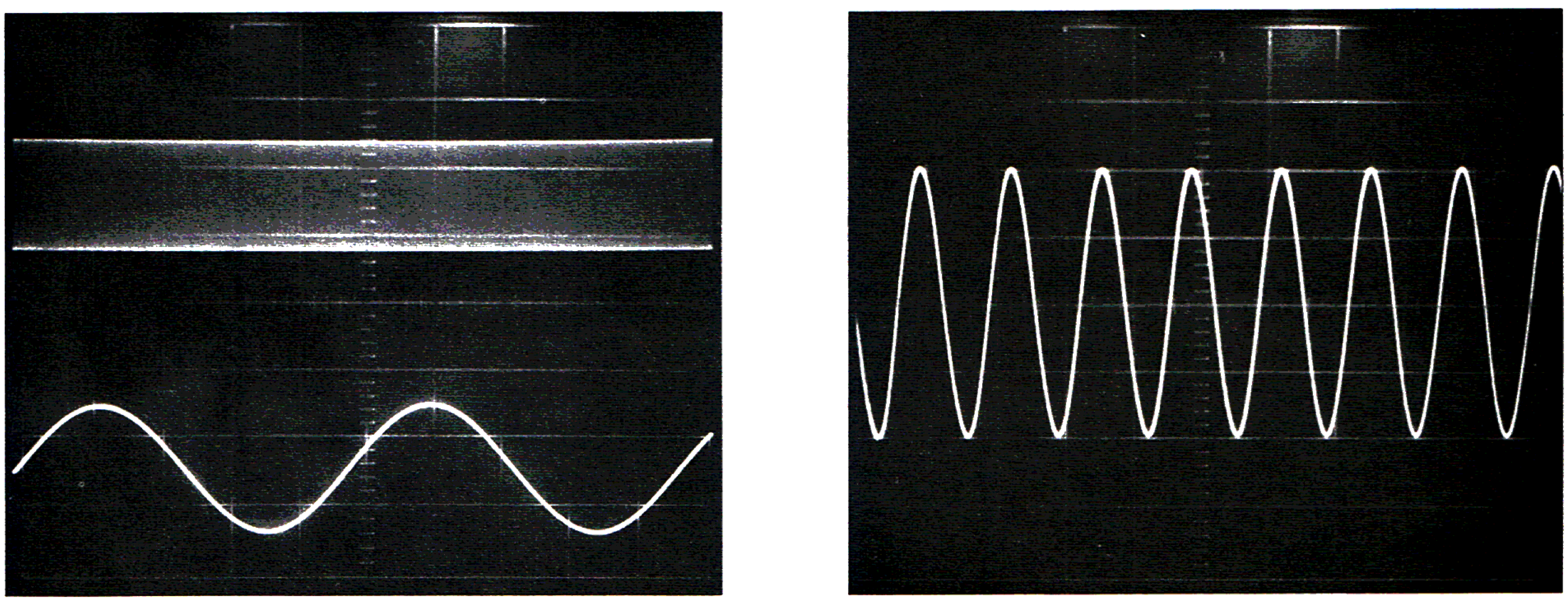
V=.1V/Div; H = .5 mS/Div

Fig. 4-2. RF Amplifier (Pin 4) Output, Mixer (Pin 7) Input Signal



V=1V/Div; H=.5 mS/Div

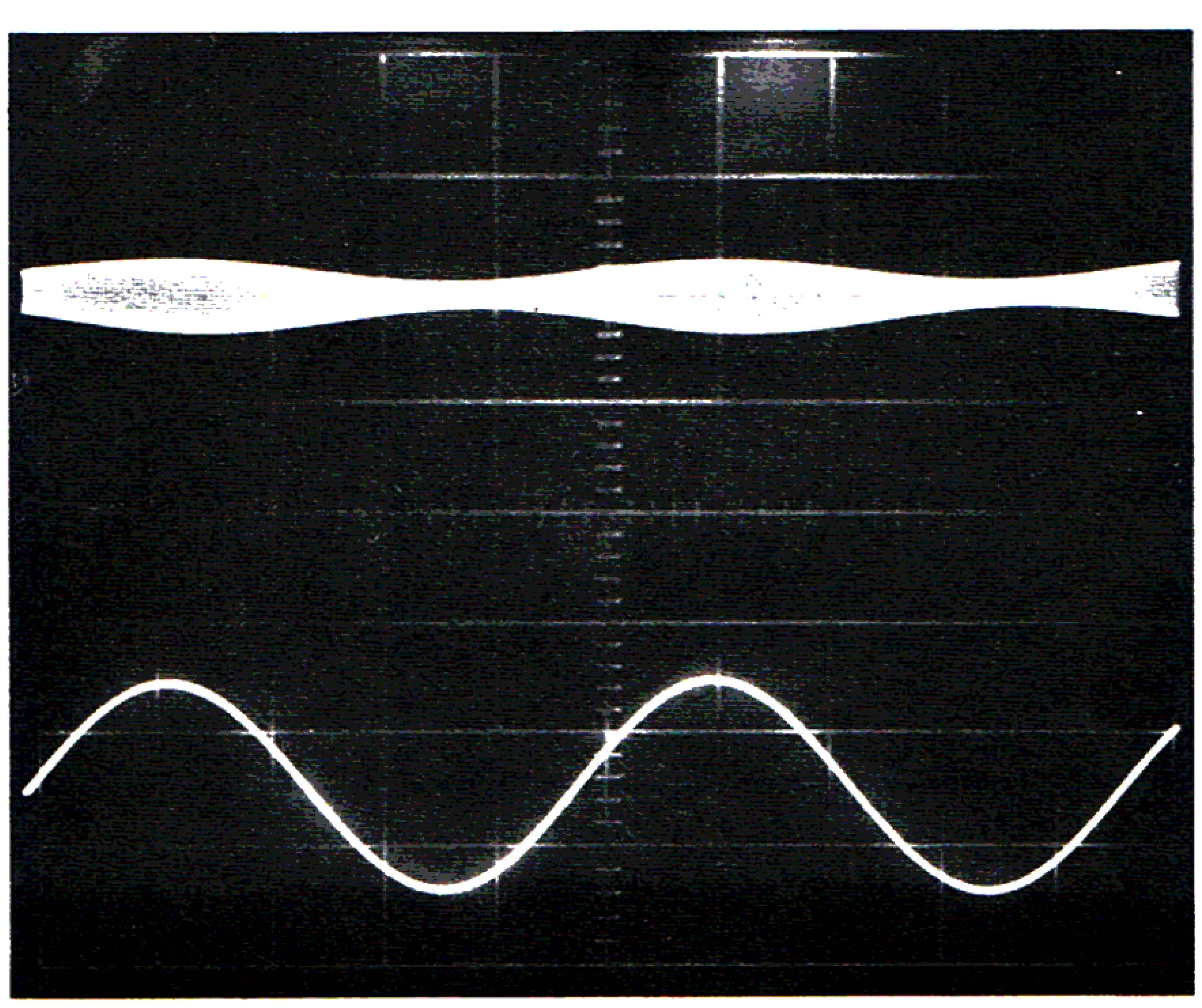
Fig. 4-3. Mixer (Pin 5) Output Signal



(a) V=.5V/Div; H=.5 mS/Div

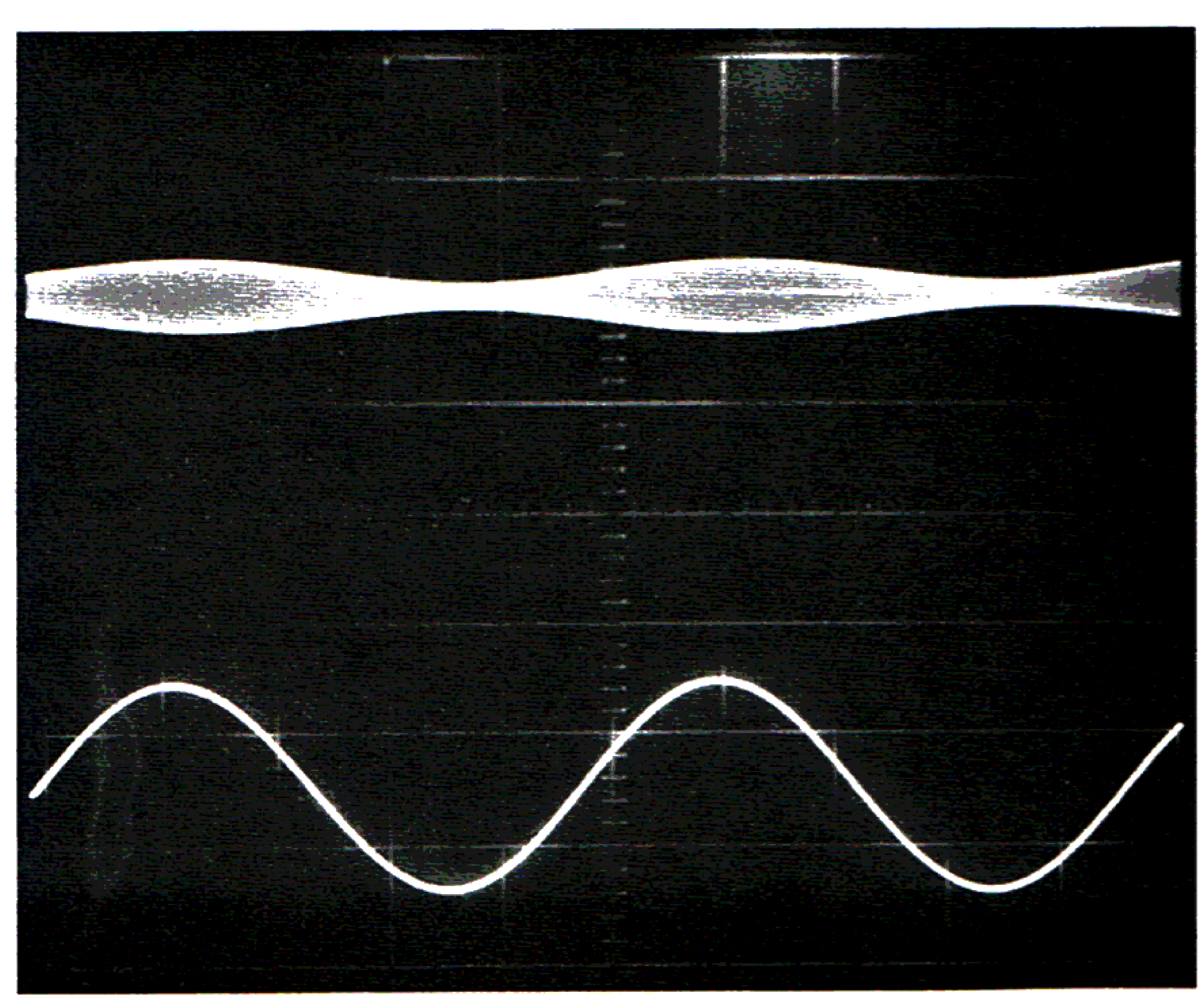
(b) V=.2V/Div; H=.5 µS/Div

Fig. 4-4. AM Oscillator (Pin 6) Signal



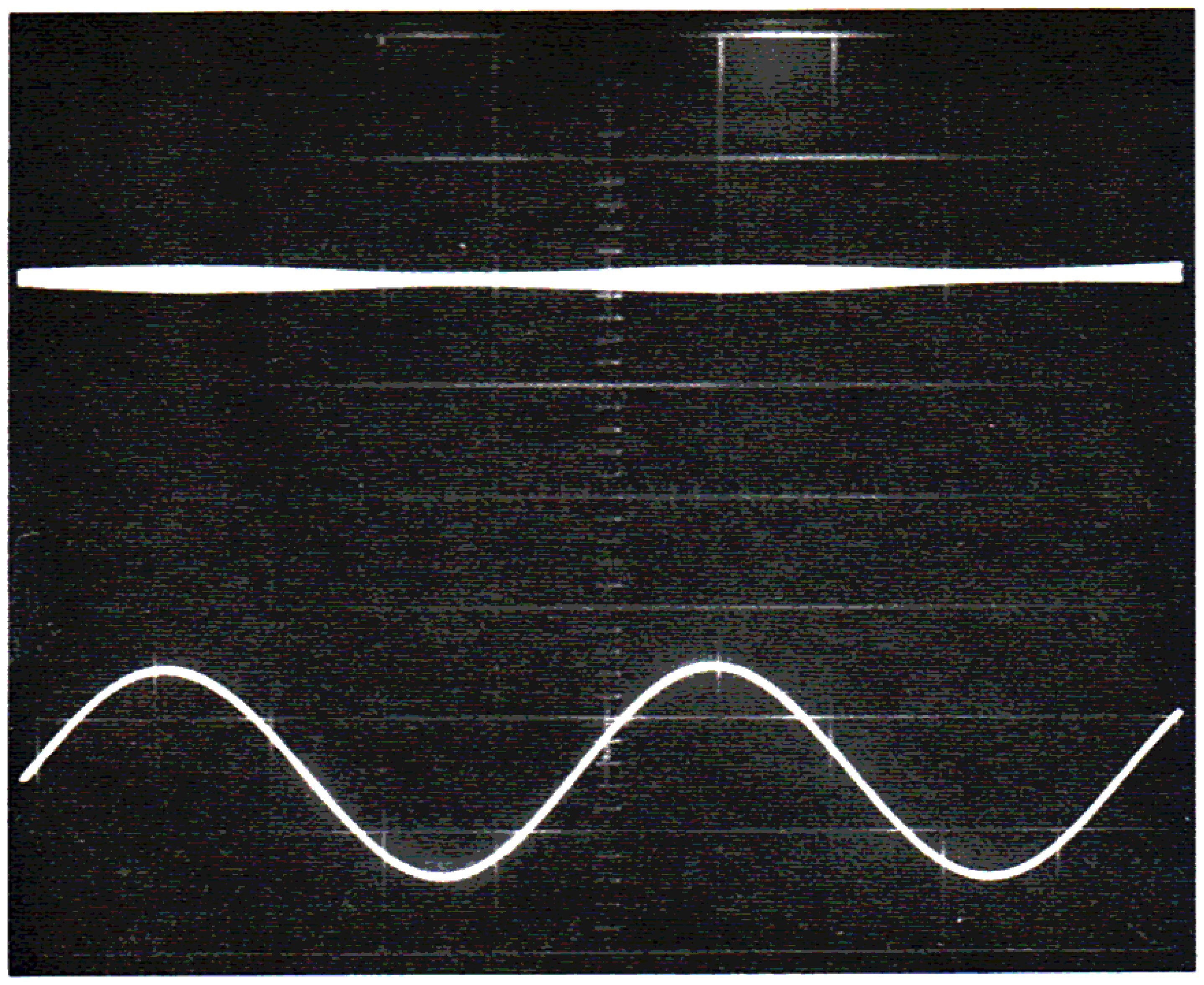
V=.1V/Div; H=.5 mS/Div

Fig. 4-5. 1st IF Amplifier (Pin 8) Input Signal



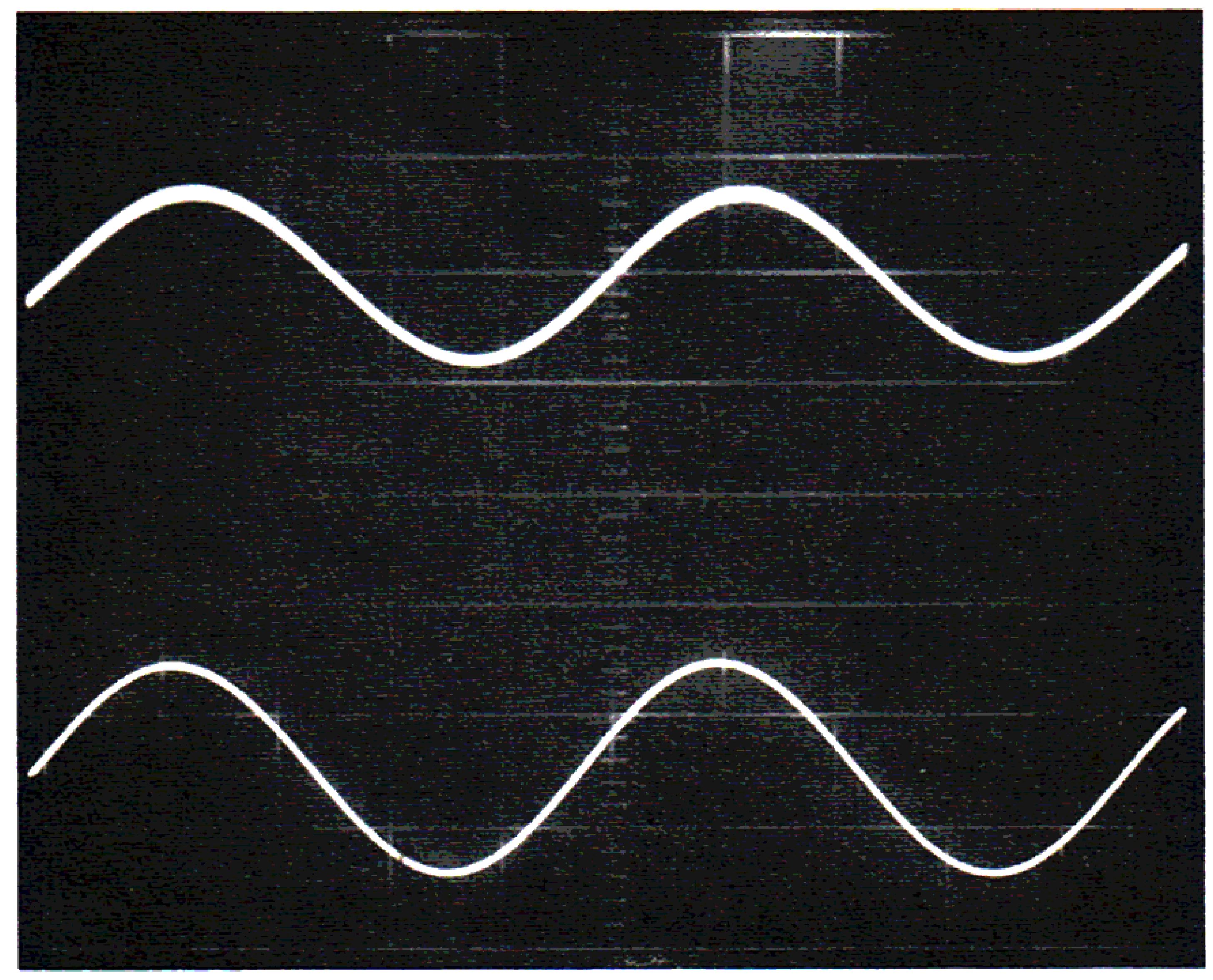
V=.1V/Div; H=.5 mS/Div

Fig. 4-6. 1st IF Amplifier (Pin 9) Output Signal



V=.1V/Div; H=.5 mS/Div

Fig. 4-7. 2nd IF Amplifier (Pin 13) Input Signal



V=.5V/Div; H=.5 mS/Div

Fig. 4-8. Detector (Pin 12) Output Signal

Signal injection works quite well for the LA1240. In this technique, signal is injected at the last IF stage, and is adjusted to produce 100 mV RMS 400 Hz output at the REC OUT jacks. The signal-injection point is then moved forward and the generator output level is readjusted to produce the same output condition. This is repeated until a point is reached where you get no (or insufficient) output, or very low stage gain. Between that point and the last "OK" test point is the defective stage. Since the LA1240 contains the active devices for all stages in the AM IF strip, this technique actually pinpoints the external (or outboard) components to check before replacing the IC.

The signal generator requirements are as follows: 455 and 1000 kHz output over the level range of 10 microvolts to 20,000 microvolts, with 50% 400 Hz modulation. Nearly any AC voltmeter will do, but one with a scope output is preferred. Prepare the receiver under test and test equipment as follows:

1. Remove the receiver bottom plate to gain access to the foil side of the board.

2. Allow the receiver and test equipment to warm up for about 10 minutes.

3. Connect the signal generator to the <u>input</u> of the IF strip. Make the connection via a 50Ω feed-thru termination and .01µF disc-ceramic capacitor (see Fig. 4-9).

4. Connect the AC voltmeter to the REC OUT jacks.

5. Set the signal generator modulation level at 50%, and its carrier frequency at 455 kHz. Then carefully adjust its frequency for maximum output from the receiver.

6. Set the receiver dial pointer near 1000. Be sure to pick a clear spot if you are <u>not</u> working in a shield room.

When performing this procedure, keep in mind that there are big unit-to-unit variations. So look for an outright failure or gross insufficiency in gain (say 1/10th of normal or less), rather than a 20-50% difference. With this in mind, proceed to check point-to-point gain as follows:

1. Connect the generator cable to pin 13 and adjust the generator output level to produce 100 mV RMS 400 Hz output at the receiver REC OUT jacks.

2. Note the injection (generator output) level, and compare it to the "typical" voltage shown on the following chart for that pin. A match ±30% is on the nose; a match within 2:1 is acceptable. A large difference is indicative of a problem.

3. Move the generator cable to the next pin listed on the chart.

4. Adjust the generator output level to produce reference output from the receiver, and record the generator output level. Rock the generator tuning to assure maximum possible output.

5. Divide the previous pin's injection level by the present injection level to find the voltage gain between the two pins. Compare this measured gain with the gain indicated in the chart. A match within ±30 is on the nose. A difference of over 3:1 is indicative of a problem.

6. Repeat Steps 3-5, determining the stage gains as you work your way toward the front end. Always rock the generator tuning at each new pin to assure maximum output. Also, note the change of frequency at pin 7. The defective stage is the first place where you get no output or the stage gain is far less than specified.

Level and Gain Chart

PIN	FUNCTION	FREQ	SIGNAL LEVEL REQUIRED	GAIN
13	2nd IF amplifier input	455	3,200 μV	
				.2X
9	1st IF amplifier output	455	16,000	
				19X
8	1st IF amplifier input	455	850	
				.1X
5	Converter output	455	8,600	
				33X
7	Converter input	455	260	
				.57X*
7	Converter input	1000	460	
				0X
4	RF amplifier output	1000	460	
				22X
2	RF amplifier input	1000	21	
				.07X
-	Antenna terminal	1000	310	

* Conversion loss from frequency change