Genave ®

BETA/500*

ATC TRANSPONDER

MAINTENANCE MANUAL

CONTENTS

(Note: All Figures are printed on white within their appropriate sections)

Published by: **General Aviation Electronics, Inc.**
4141 Kingman Dr.
Indianapolis, Indiana 46226
(Area 317-546-1111)

*Patents Applied For

Price: Single Copy $20.00

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

This service manual contains all the information normally required to install, operate and maintain the Genave BETA/500 ATC Transponder.

1-2. DESCRIPTION

The BETA/500 is a self-contained ATC transponder complete with integral regulated power supply. It is a solid-state design utilizing 29 silicon transistors and 18 silicon integrated circuits. In addition the BETA/500 employs one vacuum tube in the transmitter output stage.

The receiver in the BETA/500 is a single frequency (1030 MHz) solid state design. The transmitter is a cavity stabilized design (1,090 MHz) that employs adequate frequency compensation to allow operation under conditions of high antenna VSWR. The unit features all 4,096 Mode A (Identity reporting) codes plus SPI, and in addition, Mode C (Altitude reporting) to 30,000 ft. in 100 ft. increments is available, utilizing a special interface circuit board to accommodate future digitizer designs.

The unit is a state of the art design that employs the latest types of transistors and integrated circuits in a high performance, economical design.

1-4. EQUIPMENT SUPPLIED

a. 1—BETA/500 ATC Transponder
b. 1—Mounting Tray with Hardware
c. 1—Power Connector (16 Pin)
d. 2—RF Connectors (UG-88A/U)
e. 1—LAMBDA/1000 Antenna

1-5. EQUIPMENT REQUIRED, BUT NOT SUPPLIED

a. Coaxial Cable, as required (RG-58A/U or equivalent)
b. Wire for Harness, as required

1-6. OPTIONAL EQUIPMENT

a. 1—250 ohm, 5 watt Dimmer Pot (see installation manual)
b. BETA/500 Mode C Adapter Board, if altitude reporting is desired
c. Altitude Digitizer

1-3. SPECIFICATIONS

GENERAL	
WEIGHT:	3 lbs.
FRONT PANEL:	6½" X 2"
DEPTH BEHIND PANEL:	9"
INPUT POWER: 1 Amps Min.; 1.5 Amps Max. @ 14 VDC* (*28 VDC adapter available)	
NUMBER OF TRANSISTORS:	29
NUMBER OF INTEGRATED CIRCUITS:	18
RECEIVER	
FREQUENCY:	1030 mHz
SENSITIVITY:	−72 dbm nominal
TRANSMITTER:	
FREQUENCY:	1090 mHz ± 3 mHz
POWER OUTPUT:	100 watts nom.
FEATURES:	
MODE A:	4096 codes plus SPI (Ident) pulse with automatic Ident hold circuits.
MODE C:	Full altitude reporting capability (ICAO Code) to 30,000' in 100' increments. It may be necessary to add a special interface circuit board to accommodate future digitizer designs.
SIDE LOBE SUPPRESSION:	3 pulse

GENERAL AVIATION ELECTRONICS, INC.
4141 KINGMAN DRIVE, INDIANAPOLIS, INDIANA 46226

INSTALLATION MANUAL

BETA/500 ATC Transponder

NOTE: THIS UNIT IS FOR 14VDC OPERATION ONLY-FOR 28VDC AIRCRAFT USE GENAVE PSI/1 CONVERTER.

Please Note:

THIS DEVICE MUST BE INSTALLED by a properly certificated and authorized person in accordance with the Federal Aviation Regulations, Part 43. No responsibility for improper installation of this unit is either implied or assumed by the manufacturer. Units shown to be installed in violation of the FARs will not be covered by the warranty and will remove any and all responsibility from the manufacturer for such equipment.

Patents Applied For.

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Warranty

Products bearing the trademark "GENAVE" or the trade name "GENERAL AVIATION ELECTRONICS, INC." have been fabricated by skillful technicians, under the strictest quality control conditions, using the finest materials and component parts available.

When properly adjusted and competently operated according to factory specifications and instructions, General Aviation Electronics Inc. unconditionally guarantees and warrants all parts and bench service labor for one (1) full year from the date of the original installation of the BETA/500 ATC Transponder.

This warranty shall not apply to malfunction, which in the opinion of General Aviation Electronics, Inc. is the result of abusive use, accident, willful destruction, improper or unauthorized repair or installation. All service under this warranty must be performed by an Authorized Genave Distributor, or by returning the unit or units, freight pre-paid, to the factory at Indianapolis, Indiana.

GENERAL AVIATION ELECTRONICS, INC.

By ______________________
Elmore W. Rice, III, President

The Company offers no other guarantees or warranties expressed or implied

Proper Installation Will Assure Quality

The BETA/500 ATC Transponder you are installing is a high quality, rugged, complex piece of electronic equipment. It has been manufactured under rigid quality control and has been fully aligned, tested, and operated at high temperatures to stabilize the component parts.

The proper installation of this unit into your customer's aircraft is essential to complete the quality assurance program under which the unit was manufactured.

It should be noted that the installation of the BETA/500 differs slightly from the majority of electronic equipment installed in the aircraft panel. The mounting of the unit has been designed to facilitate simple and rapid removal and reinstallation of the unit in the event that maintenance is required in the future.

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Specifications:

GENERAL

WEIGHT:	3 lbs.
FRONT PANEL:	6½″ X 2″
DEPTH BEHIND PANEL:	9″
INPUT POWER: 1 Amps Min.; 1.5 Amps Max. @ 14 VDC* (*28 VDC adapter available)	
NUMBER OF TRANSISTORS:	29
NUMBER OF INTEGRATED CIRCUITS:	18

RECEIVER

FREQUENCY:	1030 mHz
SENSITIVITY:	−72 dbm nominal

TRANSMITTER:

FREQUENCY:	1090 mHz ± 3 mHz
POWER OUTPUT:	100 watts nom.

FEATURES:

MODE A: 4096 codes plus SPI (Ident) pulse with automatic Ident hold circuits.

MODE C: Full altitude reporting capability (ICAO Code) to 30,000′ in 100′ increments. It may be necessary to add a special interface circuit board to accommodate future digitizer designs.

SIDE LOBE SUPPRESSION: 3 pulse

Unpacking

CAREFULLY REMOVE the BETA/500 and its mounting accessories from the shipping container by removing the staples from the top of the carton and lifting the contents straight out. The carton should be saved until the installation is complete in the event that damage is discovered or return of the unit is necessary for some reason. Any damage due to shipping should be reported and a claim filed as soon as possible with the shipping company. (If it is necessary to re-ship, use our container which is specifically designed for that purpose.)

Pre-Installation Check

VISUALLY INSPECT the unit for any obvious external damage, such as dents, broken knobs, loose wires, etc. Any damage not related to shipping should be reported to General Aviation Electronics, Inc., 4141 Kingman Drive, Indianapolis, Indiana (46226), (317)-546-1111, as soon as possible.

Damage due to shipping should be reported to and a claim should be promptly filed with the transportation company.

All BETA/500 units are shipped in perfect operating condition. However, a pre-installation electrical test may be performed to assure that the unit has suffered no internal damage during shipment. For a detailed test procedure, refer to the Maintenance Section of the BETA/500 Service Manual. DO NOT ATTEMPT to bench test the unit without proper equipment as specified in the Service Manual.

NOTE: It is not necessary to remove any screws from the unit for installation purposes.

Removing some screws from the unit may cause mechanical or electrical damage to the unit.

GENAVE WILL NOT HONOR any warranty claims based on damage of the unit resulting from improper servicing. SEE THE SERVICE MANUAL FOR PROPER SERVICING TECHNIQUES.

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Installation Planning

THE LOCATION of the BETA/500 in the aircraft should be carefully selected with due consideration to the following:

1. The BETA/500 generates only a very small amount of heat and, as such, does not require any forced air or ram air cooling. However, the unit must NOT be mounted directly above a vacuum tube device or any other equipments that generate large amounts of heat unless cooling is provided.

   MOUNTING THE BETA/500 DIRECTLY OVER UNCOOLED VACUUM TUBE EQUIPMENT OR IN THE HOT AIR BLAST OF ANY DEVICE INCLUDING CABIN HEATERS WILL AUTOMATICALLY VOID THE WARRANTY

2. The radio will extend about 12 3/8 inches behind the front surface of the aircraft panel. Therefore, at least 12 7/8 inches of clear space behind the panel must be available to mount the unit.

3. The placement of the unit should be such that all controls are easily accessible and all readouts are easily visible to the pilot.

4. Selection of the antenna location is very important to the proper functioning of the BETA/500 . A location on the bottom of the aircraft will generally provide the best service. The surface of the aircraft must be clear of protrusions for at least two feet in all directions. The location of the antenna must be at least six feet from a DME antenna or a strobe light. The mounting surface must be metal. The BETA/500 will not function correctly if the antenna is mounted on a fabric aircraft without a ground plane. A one-foot diameter ground plane of aluminum foil may be used on fabric aircraft.

5. The antenna cable length should be as short as possible. When using RG-58A/U do not use more than 12 feet of cable. If runs of more than 12 feet are required, use RG-8A/U.

Installation

1. The aircraft panel cutout for the BETA/500 is 6¼" wide X 1 13/16" high. Make this cutout in the selected location.

2. Insert the supplied mounting rack into the cutout. Mark the rack mounting holes on the panel support brackets on both sides of the cutout. If the location chosen does not provide the brackets, two angle brackets must be made and Installed. Drill out the marked mounting holes with a #27 drill.

3. The mounting rack alone will provide sufficient support for the radio in most cases. If further support is required or desired, a rack support bracket must be fabricated and installed. A mounting hole in the rack for a support bracket has been provided. (See mounting rack illustration). Other locations will generally cause mechanical interference when inserting the unit.

4. Install the rack in the aircraft panel, using the holes drilled in step 2, the #6-32 Binder head screws, washers, and nuts supplied, and the support bracket if used. All screws must have their heads inside the rack.

5. Fabricate the power and signal cable using the connector socket supplied.A wiring diagram is shown in this manual. The cable wires should be long enough to allow the connector to be passed through the panel cutout from the rear and extended to about 2" in front of the panel.

6. Fabricate the RF cable as illustrated using 50 ohm coax, RG-58A/U or RG-8A/U. The cable should be long enough to protrude 2" through the cutout.

7. Connect the cable just fabricated to the appropriate points in the aircraft's electronic system. Bring the connector ends through the cutout. Mechanically secure the cables at appropriate support points.

8. Attach the cables to the unit.

9. Insert the unit into the rack. Tighten the mounting bolt to secure the unit in the panel. Do not use excessive torque on the bolt.Tighten only until the unit is snugly secured against the front panel.

10. Install the antenna as shown in the illustration in this manual.

11. Connect the RF cable to the antenna.

12. Update the appropriate logs and papers of the aircraft.

13. Fill out the upper portion of the warranty card.

14. Give the Warranty card and the Pilots Information manual to your customer. The proper sections of the warranty card MUST be completed and returned to Genave by both the Distributor and the customer for the warranty to be in effect.

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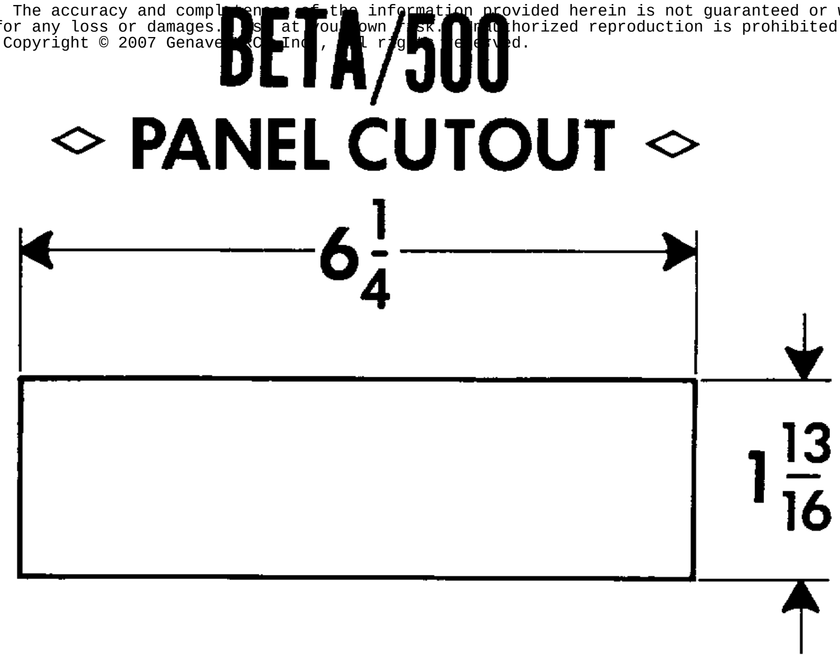
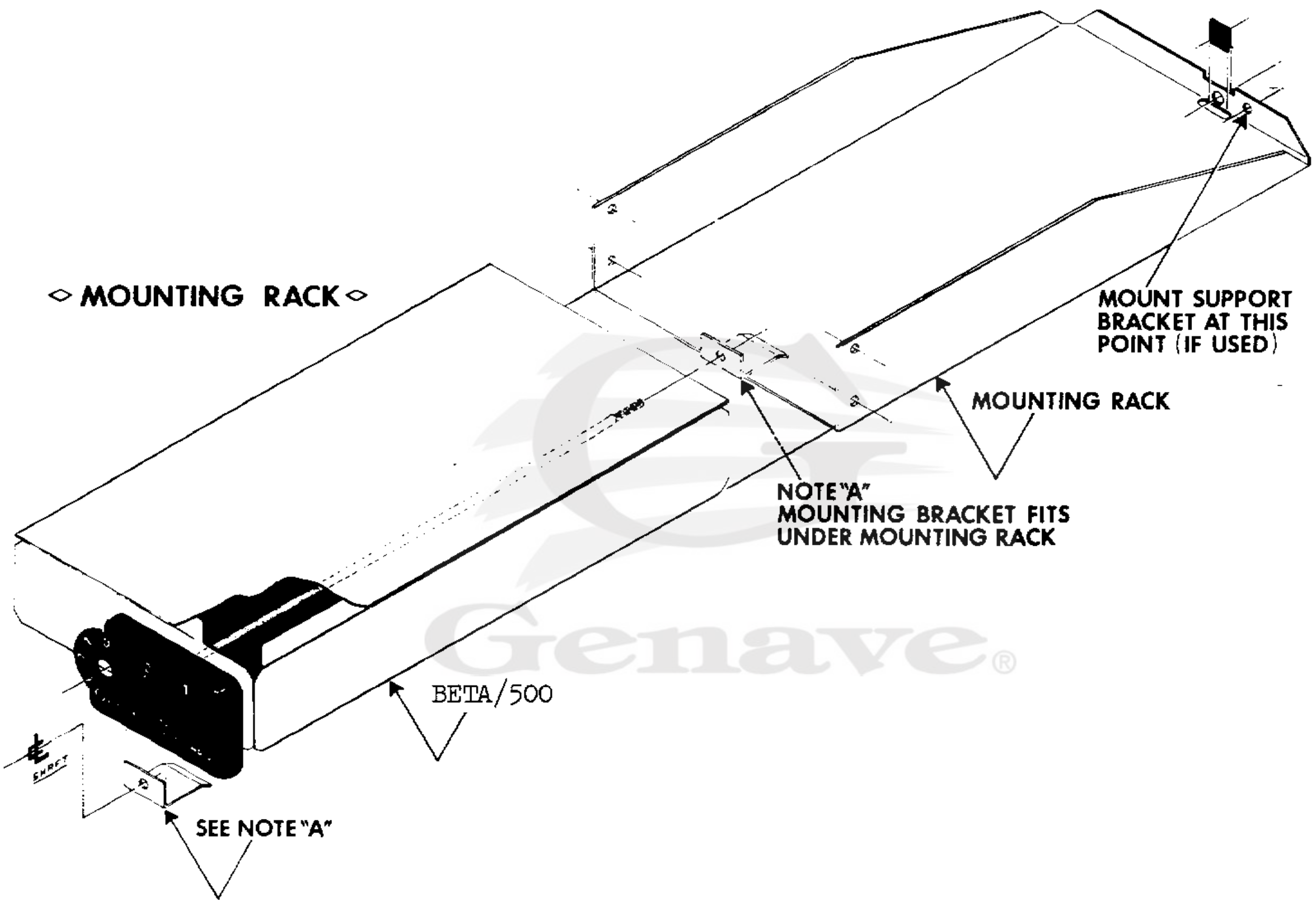
Panel Cutout



Mounting Rack



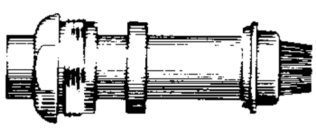
Post Installation Check

UPON COMPLETION of the installation, a flight test is desirable to insure that the BETA/500 is operating properly.

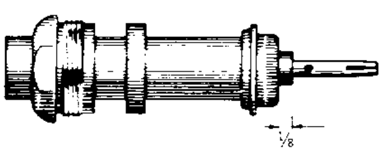
Antenna Connector Assembly

Place nut and gasket, with "V" groove toward clamp, over cable and cut jecket to dimension shown.

Comb out braid and fold out. Cut cable dielectric to dimension shown. Tin center conductor, using minimum amount of heat.

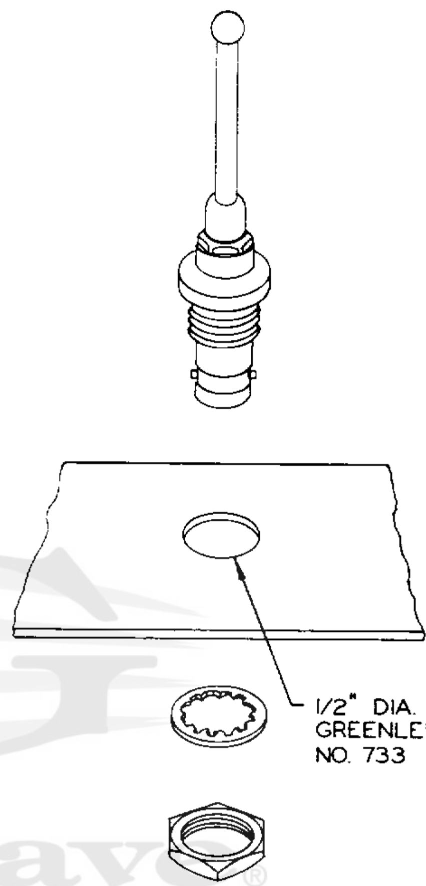


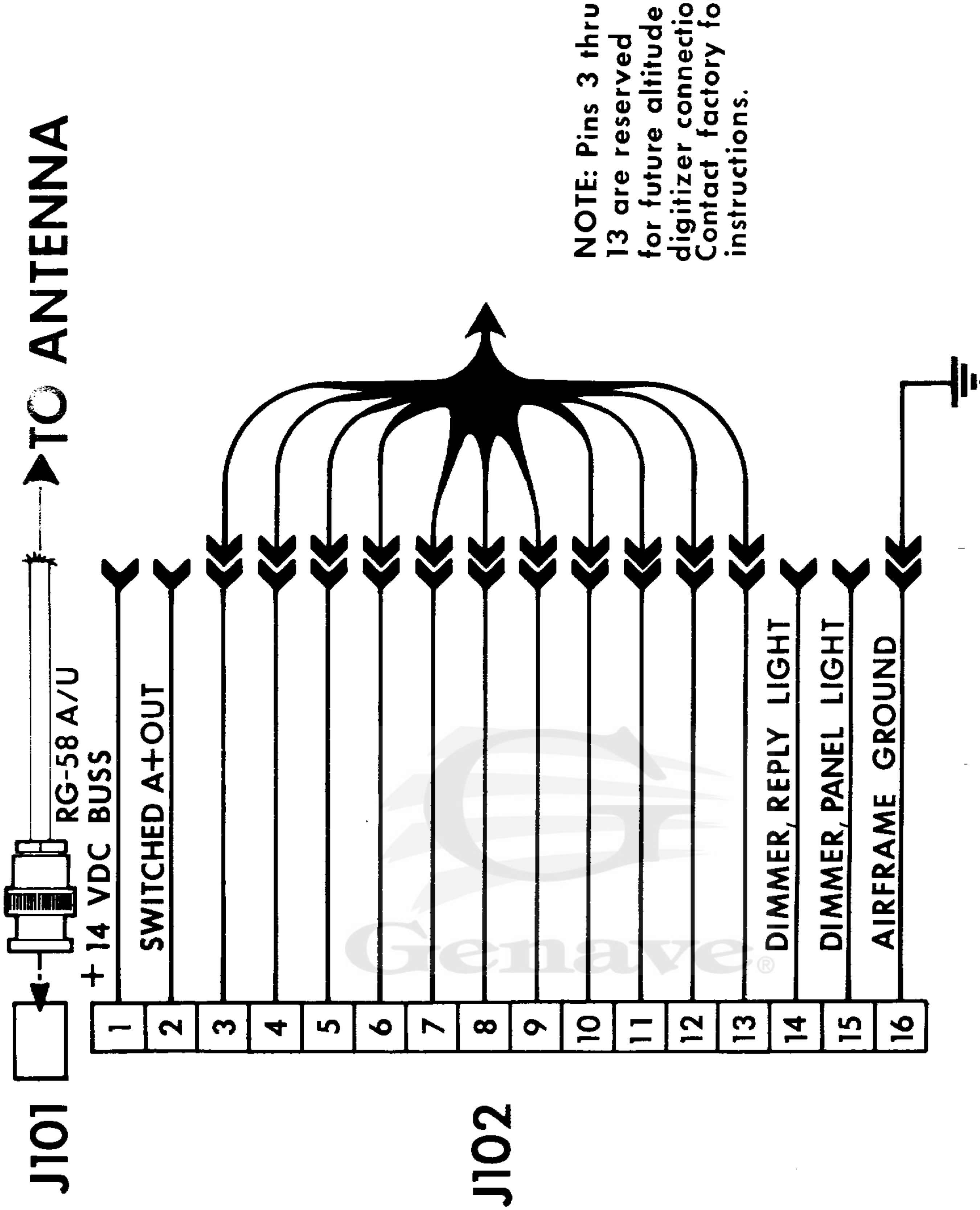
Pull braid wires forward and taper toward center conductor. Place clamp over braid and push back against cable jacket.



Fold back braid wires as shown, trim to proper length and form over clamp as shown.
Solder contact to center conductor, avoiding excessive heat which might swell cable dielectric.

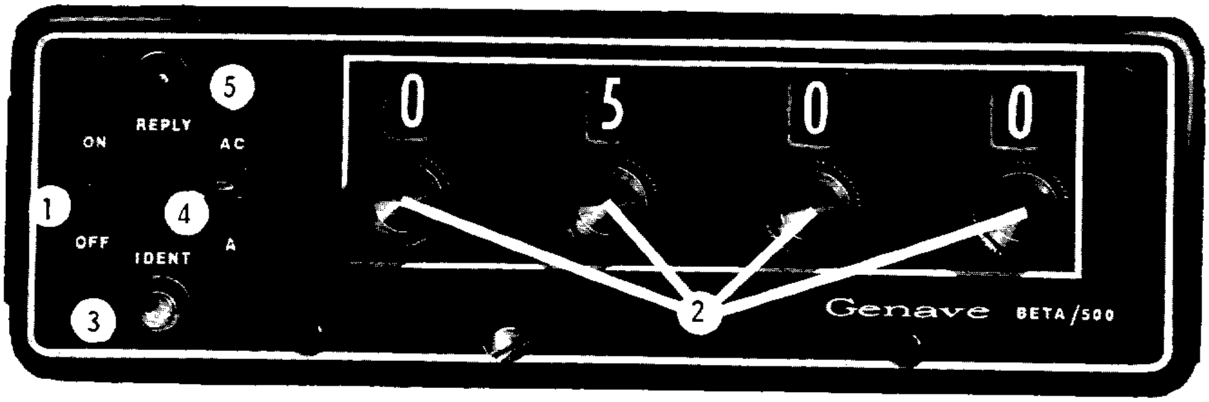
BETA/500 ANTENNA INSTALLATION




NOTE: Pins 3 thru 13 are reserved for future altitude digitizer connection. Contact factory for instructions.
TO ANTENNA
RG-58 A/U
+14 VDC BUSS
SWITCHED A+OUT
DIMMER, REPLY LIGHT
DIMMER, PANEL LIGHT
AIRFRAME GROUND
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
J101
J102

SECTION III

OPERATING MANUAL



3-1. OPERATING CONTROLS AND INDICATORS

The BETA/500 ATC Transponder has eight operating controls and indicators:

1. On/Off
2. Four Mode A Code Selector Switches with code read-out for each switch
3. SPI Enable Switch IDENT
4. Mode Selector
5. Reply and SPI Indicator Lamp, REPLY

To operate the BETA/500, turn the Unit on. Switch to A (Mode A) or AC (Mode C), as requested by ATC.

To activate SPI (IDENT) push the IDENT switch button (3). Your BETA/500 will automatically reply IDENT for 15 seconds after releasing the button.

The reply (REPLY) light will illuminate when your BETA/500 replies to a ground interrogation, Mode A or Mode C, or when the IDENT button (3) is activated.

The BETA/500 will reply automatically to a Mode A (Identity) interrogation with the selected code (2) when the Function Selector Switch (1) is in A or AC. It will reply automatically to a Mode C interrogation when the unit is in A or AC, but will provide altitude data only when in AC.

The reply to Mode C interrogation when the Mode Selector Switch (4) is in A will consist of framing pulses only. These pulses are used to provide position information on the ground ATC displays. It is necessary to connect an altitude digitizer to the BETA/500 to provide altitude data. Genave will make available special interface circunit boards to adapt new altitude digitizers to the BETA/500 as necessary.

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SECTION IV

MAINTENANCE MANUAL

4-1. INTRODUCTION

This section provides the basic information required to electronically test, align and repair the BETA/500 ATC Transponder. It is assumed that the person working on the unit is familiar with the principles of ATC transponders and has the necessary electronics background to understand the operation of the various circuits.

4-2. THEORY OF OPERATION

The BETA/500 employs 29 silicon transistors, 14 silicon diodes, and 18 silicon integrated circuits. The following is a breakdown of the functions and circuits within the unit.

A. Power Supply
B. Receiver
C. Decoder
D. Encoder
E. Transmitter

The preselector/local oscillator and IF amplifier sections of the receiver and the transmitter are contained within separate replaceable modules mounted on the lid of the unit. The remaining circuits are on the main circuit board. The power supply and the modulator circuitry are located within a shielded compartment at the rear of the main circuit board.

II. DETAILED THEORY

A. Power Supply

The power supply provides five basic voltages for operation of the various circuits:

1. +1080 volts DC
2. +14 volts DC
3. +10 volts DC
4. +5 volts
5. —9 volts

The +1080 volts DC powers the transmitter while the +14 volts DC supplies the filament and the modulator driver. All other circuits operate from one or more of the other voltages. The power supply consists of two parts: the first is a DC regulator and the second is a DC-DC inverter.

The DC regulator operates from the 14 volt DC input provided via pin 1 of P102, the power plug, and SW101 the On/Off switch. The incoming 14 volts DC is filtered by C106, C101, L101, and C102 and is fed to the regulator comprised of Q101, Q102, Q103, Q104 and associated circuitry. CR101 sets the reference voltage level of 5.6 volts on the base of Q102. R106 is used to adjust the regulator output to 10 volts. The differential amplifier formed by Q102 and Q103 are used to control Q101 and Q104 which in a complementary pair configuration form the regulating element. R105 supplies a portion of the load current and allows Q104 to operate well within its dissipation capabilities.

CR101 also sets the base bias on Q105, the voltage regulator. Q105 provides the regulated +5 volt DC output. C105 provides additional filtering of the +5 volt line. CR105 in the emitter circuit of Q102 and Q103 is used to insure shutdown of the 10 volt regulator if the +5 volt line becomes accidentally shorted.

The regulated +10 volts is fed to the DC-DC inverter and to the circuits requiring +10 volts. The DC-DC inverter operates at 25 KHz to produce the +1080 volts DC, and the —9 volts DC. When the inverter transistor, Q106, turns on, high voltage is induced on the high voltage secondary of T101. This high voltage is rectified to DC by CR104 and applied to the voltage divider consisting of R111, R114, and R115. The high voltage is filtered by means of C109. From the junction of R111 and R114, +1080 volts DC is fed to the transmitter via J502/P502. When the transformer field collapses a portion of the energy is delivered to CR103 and rectified to provide the negative voltage needed. The excess energy stored in the power transformer is dissipated back to the +10 volt line by means of the clamping diode CR102. The negative voltage from CR103 is filtered by the "pi" filter consisting of C108, R110, and C110. The output of this filter forms the —9 volt DC line.

Inverter noise is filtered from the +10 volt line by R109 and C111. CR106 insures that the regulator will shut-down if the +10 volt line is accidentally shorted. This prevents damage to the +10 volt regulator.

Power for the filaments of the transmitter output tube and the modulator driver are derived from the +14 volt DC input line. R101 provides the 6.25 volt transmitter tube filament voltage.

CAUTION: Do not operate the transponder when the +10 volt DC supply is adjusted in excess of +10 volts. Failure to heed this warning could lead to the destruction of the high voltage power supply.

B. Receiver

The receiver of the BETA/500 consists of a preselector filter, a local oscillator, a mixer, and a 60 MHz IF strip. The preselector, local oscillator, and mixer are contained within a single enclosure secured to the lid of the unit. The 60 MHz IF strip is also enclosed in a separate shielded module and secured to the lid.

Preselector Filter, Local Oscillator, and Mixer—1030 MHz interrogation signals from the antenna are fed from the antenna jack (J501) through the diplexer to the preselector. The diplexer consists of two critically tuned coaxial lines which allow the transmitter to utilize the same antenna as the receiver. The preselector consists of a 3-pole Chebyshev filter which is coupled to the mixer diode, CR501. A fourth tuned circuit within this same enclosure is utilized as the tuned element in the common base local oscillator. Q501, the local oscillator transistor, is supplied bias voltage from the power supply through the two .001 MFd feed-through capacitors in the side of the metal enclosure. The voltage divider formed by R112 and R113 determine the bias voltage fed to the local oscillator. This voltage is approximately —7 volts DC. J504 connects the mixer output to the input of the 60 MHz IF amplifier.

60 MHz IF Amplifier—The IF amplifier is a four-stage common emitter transistor design that employs five single-tuned transformers—T401, T402, T403, T404, and T405. The first stage, consisting of Q401 and associated components, is gain controlled by the voltage developed by the AOC circuitry and adjusts the receiver sensitivity to provide overload protection.

Q402, Q403, and Q404; the second, third, and fourth stage respectively, function as conventional amplifier stages and provide approximately 20 db of gain each. The amplifier comprised of Q403 and associated circuitry also performs a portion of the "ditch digging." C416 is of sufficient value to reduce the gain of Q403 for a short duration following the application of a pulse to the amplifier input.

CR401 functions as a video detector. Interrogation pulses appear at the output of the detector with amplitudes between .05 volts and 5.0 volts depending upon input signal strength.

C. Decoder

The decoder of the BETA/500 can be divided into six subsections: video processor, decoder driver, SLS decoder, Mode A decoder, Mode C decoder, and rate integrator/suppression circuitry.

Video Processor—The video processor consists of Q601, Q602, Q603, Q604, Q606, and associated circuitry. The purpose of this block of circuitry is to compress the dynamic range of the interrogation pulse pairs produced at the output of the receiver IF amplifier in order to allow operation over the required 50 db dynamic range. In addition, the circuitry in conjunction with CR601 and CR606 form a compression amplifier.

Q601 is connected as an emitter follower and provides a positive interrogation pulse pair at its output. These pulse pairs are applied to CR601. CR601 is forward biased through R604 providing a dynamic load whose impedance varies with the level of applied pulse input. Q602 is connected as a conventional common emitter amplifier whose output provides negative interrogation pulse pairs to CR602. CR602 serves to further compress the dynamic range of the interrogation pulse pairs. Q603 and associated components form a variable gain common emitter amplifier. The gain of this stage is controlled by R610, which allows the overall decoding sensitivity to be adjusted. Q604 and associated components form a "ditch digging" circuit with gain a time varying function of the amplitude of the input pulses. The time constant of the gain is controlled by C607, R617, and R618. This time constant is adjusted to suppress SLS pulses when their amplitude is 9 db or more below the amplitude of the first interrogation pulse and allow SLS pulses to pass through the circuit when their amplitude is equal to or greater than the first interrogation pulse.

Q606 and associated components form a common emitter amplifier with offset bias to give noise immunity. The positive output pulses from Q606 are applied to CR603, a diode clamp that provides a rapid discharge path for C608 on the trailing edge of an output pulse and are then differentiated by C608. The negative trailing edge is clipped by CR604. The video output pulses produced are 300 nanosecond, high amplitude, fast rise time positive pulses.

NOTE: Up to this point in the circuit description of the BETA/500 ATC transponder, all of the circuit components have been conventional transistors. From this point on the circuit elements are a combination (Hybrid) of discrete transistors and DTL integrated circuits. Some basic rules of operation for DTL integrated circuitry may be stated:

1. **All output signals operate from +5 volts to ground or from ground to +5 volts.**
2. **All circuit elements are supplied from the +5 volt supply line. This connection and the ground connections are not shown on the schematics. Pin #7 is ground and Pin #14 is +5 volts in all cases.**
3. **In the absence of an input signal to any DTL integrated circuit element, the circuit input will float up to approximately +2.5 volts and the output will be at ground.**

In our description of DTL circuitry we will use the terms "up" and "down". "Up" means a high voltage level usually +5 volts DC. "Down" indicates a very low voltage level or more commonly 0 volts. For example, if we were to say, "The output of the IC goes up." We mean that the output becomes +5 volts.

Decoder Driver—Processed interrogation pulse pairs, including the SLS pulse (if it is of sufficient amplitude) appear at Pin #5 (input) of IC301B, a two input gate. Pin #4 (input) of IC301B is connected to the SLS suppression line. Under quiescent conditions, the SLS suppression line will be in the up condition and therefore upward video processor output pulses will cause a downward output from Pin #6 of IC301B.

The downward going output from IC301B is used to trigger a 1.5 microsecond multivibrator consisting of IC303C and IC302D. The 1.5 microsecond duration is determined by C301 and the input impedance of IC303C. Output from the multi is fed to the SLS, Mode A, and Mode C Decoders.

SLS Decoder—The 1.5 microsecond pulses from the decoder driver are squared without inversion by IC304B and applied to IC303D through C302. The downward going trailing edge of the 1.5 microsecond pulse causes an upward going output from IC303D. This output is the SLS acceptance gate.

The SLS acceptance gate is applied to Pin #12 of IC301D, a 2-input "nand" gate. The other input comes directly from the video processor output. If the initial pulse is followed 2 microseconds later by a second pulse, coincidence will occur between the second pulse and the SLS acceptance gate. When coincidence occurs a downward pulse will appear at the output of IC301D, the SLS decoder.

IC303B and IC303A form a one-shot multivibrator which generates a wide upward going pulse when an output is received from the SLS decoder. The wide output pulse generated is inverted by IC302C and applied to IC305C and C304. C304 and the input impedance of IC305C determine the duration of the output from IC305C. Upon a valid SLS interrogation IC305C will produce an upward going pulse of 35 microseconds ±5 microseconds duration. This pulse is enhanced and inverted by IC303F and IC303E. This downward going pulse is sent back to the 2-input "nand" gate of IC301B to inhibit further decoding following an SLS interrogation.

Mode A Decoder—When a valid mode A interrogation occurs, two 1.5 microsecond pulses spaced 8 microseconds apart will be sent down the line to the Mode A and Mode C decoders. When the first pulse reaches IC302B it will generate a downward output which discharges C305 and turns-off Q301. Q301 will remain turned-off until C305 recharges above +5.6 volts through R303 and R304. The upward going output pulse provided by Q301 when turned-off has a duration which is controlled by the setting of R304. CR302 is used to insure a fast fall time at the trailing edge of the output pluse.

The trailing edge of the output pulse from Q301 produces an upward output from IC306F. The output from IC306F is compared with the level of the decoder driver line at IC307D. When the initial pulse is followed by a second pulse 8 microseconds later, as in the case of a valid Mode A interrogation, coincidence occurs and IC307D will produce a downward output.

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The downward going output from IC307D is applied to IC306E and IC306D which form a 60 microsecond one-shot multivibrator. The 60 microsecond one-shot produces an upward going output pulse which is used as the Mode A Enable and is fed to the Mode A pulse summing circuitry. The Mode A Enable is used to signal the encoder to reply with Mode A information. The 60 microsecond downward going pulse produced at the output of IC306D is the Encoder Enable Gate and is fed to IC304A, a 2-input "or" gate.

Mode C Decoder—The operation of the Mode C decoder circuitry is identical to the Mode A decoder operation with the exception of coincidence gate delay timing. Upon valid interrogation an upward going 60 microsecond Mode C Enable pulse is sent to the Mode C pulse summing circuitry and to a 60 microsecond downward going Encoder Enable Gate is fed to IC304A.

Both the Mode A and the Mode C decoders are supplied an emitter referenced +5 volts from Q305 and associated circuitry. The reference level of Q305 is set by R315 and R317.

Rate Integrator/Suppression Circuitry — The output of IC304A will consist of an Encoder Enable Gate when either of the Mode A and C decoders receive a correctly spaced pulse pair. This Encoder Enable Gate is applied to a fixed delay circuit, a rate integrator, and an inverter which drives the suppression circuitry.

The fixed delay circuit consists of R314 and C312, which are used to produce a portion of the necessary delay time between received interrogation and transmitter reply. The delayed Encoder Enable Gate appears at the output of IC304C from which it is applied to the encoder circuits.

The Encoder Enable Gate is applied to the rate integrator circuitry via Q314, which functions as an emitter follower. The rate integration itself is accomplished by R308, C308, and IC304C. As the number of Encoder Enable Gates applied to R308 and C308 increases the voltage on C308 will decrease thus causing the output level of IC304C to decrease. The output of IC304C is applied to the AOC input to the IF. Therefore, as the output level of IC304C decreases the gain of the IF amplifier will be reduced.

The suppression circuitry is comprised of CR303, IC305A, CR305, and Q605 and associated circuitry located in the video processor. The downward output pulse from IC304A is applied to IC305A through CR303. IC305A inverts the output from IC304A and applies it to the base of Q605 via CR305. When the upward output from IC305A is applied to Q605 it turns-on Q605 thereby clamping the video processor output to ground. A provision for external suppression is provided via J601 and R616. A positive input to J601 will suppress the video processor output.

D. Encoder

The encoder consists of the following circuits: clock, sequential pulse generator, SPI timer, pulse summing, pulse shaper and reply lamp circuitry. When an Encoder Enable Gate is sent to the encoder it is applied to two circuits within the encoder. The two circuits to which the Encoder Enable Gate is applied are the clock circuit and the sequential pulse generator.

Clock Circuit—When the downward going Encoder Enable Gate is applied to IC308C it appears at the output as an upward going pulse. The output pulse from IC308C is applied to the clock's LC circuit and to IC308A. Under quiescent conditions the output of IC308C is clamped to nearly ground. When the output goes upward, as in the case of the Encoder Enable Gate, the LC circuit consisting of L301, C316, and C317 oscillators. The oscillating output is inverted by IC308B and a portion is fed back to the LC circuit via R316 in order to enhance the oscillations. When the output of IC308C is claimed back to ground the oscillation ceases.

As the clock oscillates the outputs from IC301A and IC308D, which operate inversely, will be switched at the clock frequency. These two outputs are fed to the sequential pulse generator where they are used to time the sequencing of reply pulses.

Sequential Pulse Generator — The sequential pulse generator is so named because it generates a series of positive pulses which can be used to develop a transponder reply code.

Inputs to the sequential pulse generator are applied from the Encoder Enable line and each phase of the clock output. The Encoder Enable Gate, when received, initiates sequencing while the clock outputs time the sequencing. Sequencing stops when the last possible reply pulse has been generated (SPI), however, the clock will continue to run until the Encoder Enable Gate runs out.

The basic circuit used in the sequential pulse generator consists of two inverters with appropriate input circuitry and DC coupled outputs. For the purpose of explanation an example of two of these circuits, complete with timing waveforms, are shown in figure 4-4-5.

When a downward input is applied to C1 the input to IC1 goes downward then returns to its quiescent level in the time determined by the value of C1 and the input impedance of IC1. When the input to IC1 goes downward the output of IC1 will go upward unless clamped down by the output of IC2. If the input to IC2 (first clock phase) goes downward at the same time as the input to IC1 the outputs of both IC's will go upward and remain upward until one of the inputs returns to its quiescent state. This action will generate a positive pulse at the IC outputs which will be used to trigger the reply pulse. When this output pulse falls, a downward input will be applied to IC3, the first IC in the second circuit, via C2. The second circuit functions in the same manner as the first circuit. The input of IC3 is forced down by the trailing edge of the output pulse of the first circuit. As the input to IC3 goes downward the second phase clock output will also go downward allowing the outputs of the second pair of IC's to go up.

In the BETA/500 fifteen of the circuits described are used in the sequential pulse generator. A similar circuit with an extra IC and requiring an additional downward input to provide an upward output is used in the SPI pulse sequencing circuit.

Following output from the F_2 sequencing circuit Q305 and associated circuitry generate an approximate 3.9 microseconds of delay before a downward input is applied to IC305E of the SPI sequencing circuit.

The output timing for the entire sequential pulse generator is shown in figure 4-4-6. In this illustration an entire pulse sequencing cycle can be readily seen.

SPI Timer—The SPI timer consisting of Q306, Q307, and associated circuitry operate as a triggered one-shot multivibrator which provides a downward pulse of approximately 20 seconds duration. When the SPI Switch, SW301, is depressed C335 is discharged turning off Q306 and Q307. When the switch is released C335 recharges through R335 turning Q306 and Q307 on. This action takes approximately 20 seconds after which the input of IC308 goes upward.

Summing Circuitry—Upon application of an Encoder Enable Gate the sequential pulse generator will provide a properly timed series of sequential output pulses which are applied to the summing diodes of EC314, IC315, IC316, and IC317. The front panel Mode A switches are used to select the desired Mode A sequential pulses and deliver them to the Mode A summing line.

In Mode C the altitude digitizer interface circuit is used to select the desired Mode C sequential pulses and apply them to the Mode C summing line. The F_1 and F_2 summing diodes are directly wired to the summing lines since these reply pulses are always required. No connections are made to IC311C & D since the "X" reply pulse is never used.

Both the Mode A and the Mode C summing lines are fed to their respective summing emitter followers. Q308 and Q309 serve as Mode A and Mode C summing emitter followers respectively. The emitter follower outputs are each applied to a capacitor and then to an inverter. The trailing edge of the sequential output pulses generate a downward going pulse at the input of the inverters IC305D & F. The upward going pulse reply trains from the inverter outputs are each applied to a 2-input "nand" gate.

When a Mode A decode occurs the Mode $\bar{A}$ Enable, which is sent from the decoder circuitry as previously described, enables the Mode A pulse train and allows the Mode A pulse reply train to be fed to the pulse shaper circuitry. When a Mode C Enable is received the Mode C reply train is sent to the pulse shaper circuitry.

Pulse Shaper—The pulse shaper consists of a monostable multivibrator which is triggered by the reply pulse train from either of the summing amplifiers. The monostable multivibrator itself consists of R344, R345, C339, Q310 and IC305B. The output pulse width of the multi is controlled by varying the RC time constant R344, R345, and C339 thus allowing the transmitter output pulses to be set to the prescribed width. The upward reply pulse train from the pulse shaper is sent to the reply lamp circuit and the transmitter modulator.

Reply Lamp Circuit—In the reply lamp circuit the upward reply pulse train from the pulse shaper is inverted to downward going pulses by IC318D. This downward going reply pulse train is then applied to IC318A through C340. IC318A is

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also fed the downward going output of the SPI timer through IC317E & F. IC318E provides positive feedback to enhance the downward input to IC318A. C340 and R346 provide the necessary time constant to maintain a continuous downward input for the full duration of the reply pulse train.

The upward going output from IC318A is applied to IC318B which drives IC318C. R347 and C341 are used to sustain operation between reply pulse trains. When the downward level is applied to IC318C the output comes up, turning-on Q311. Q311, when on, completes the circuit through DS301 and therefore the lamp illuminates.

E. Transmitter

Transmitter Modulator—The transmitter modulator consists of an inverter followed by two stages of current gain which are used to control the transmitter. When a reply pulse train is applied to IC318F it is inverted and used to turn-off Q312. Q312 drives Q313 which, when a reply pulse is applied, turns-on, grounding the transmitter cathode through the current limiting resistor, R351.

Transmitter Oscillator—The transmitter oscillator consists of an RCA 4058 pencil triode mounted in a high Q cavity. The oscillator operates in a grounded grid configuration using tuned lines in both the plate and cathode circuits with enough capacitive feedback from plate to cathode to assure oscillation under pulse modulated conditions. Major frequency adjustments are made by physically adjusting the length of the plate line while minor adjustments are made by the capacitive adjustment screw mounted in the cavity wall. The transmitter operates with a plate supply voltage of +1080 VDC which is applied to the tube through R501 and Z501, the radio suppression circuit.

Under quiescent conditions the cathode is allowed to rise to approximately +55 volts biasing the tube to cutoff. During modulation the cathode is clamped to ground through R351 allowing the tube to conduct and oscillate at a frequency of 1090 MHz. The modulation characteristics are such that the RF output is a train of pulses coded to the specifications of the Federal Aviation Administration (See figure 4-4-4). The individual pulses are 0.45 micro-seconds in duration and approximately 100 watts in peak power. The RF power is coupled to the output connector, J501, by an inductive pick-up link adjacent to the plate tuning line.

4-3. TEST EQUIPMENT REQUIRED

a) Oscilloscope (high frequency 8 MHz min.) DC coupled (Heath I0-14 or equivalent)
b) VTVM (any accurate instrument)
c) Bench Power Source (14 VDC, 3 Amps, well filtered)
d) Signal Generator 1030 MHz capable of ATC modulation
e) ATC Simulator (to modulate signal generator)
f) RF Power Meter (HP430C or equivalent)
   Note: This unit is to measure transmitter Power output. Other means are acceptable, i.e. calibrated diode detector, etc.
g) Frequency Meter for 1090 MHz pulses
h) Detector for 1090 MHz pulses (Microlab/FXR XA 2404 or equivalent)
i) Dummy Load (50 ohms, 5 watts, 1090 MHz, VSWR 1.1 to 1 or less)
j) Directional Coupler 30 db or equal (Microlab/FXR CB49N, Narda 3002-30, or equivalent)
k) Attenuators: 50 ohm precision (adequate to make power output and sensitivity measurements)
l) Time Mark Generator capable of producing 1 microsecond and 1.45 microsecond markers for scope calibration.

The following pieces of equipment will serve as suitable replacements for various combinations of the above equipment.

m) UPM/6A or B modified and calibrated by Genave (this piece of equipment is an acceptable alternate for lines d, f, g and i)
n) Genave NU/5 Transponder Test Set (This piece of equipment is an acceptable alternate for line 1)

4-4. ALIGNMENT PROCEDURES

A. *General*

Connect the transponder to the Test and Alignment Setup shown in Figure 4-4-1.

B. *Power Supply Adjustment*

1. Connect an accurate VOM or VTVM from ground to TP-1, the +10 volt line. Disconnect P502.
2. Adjust R106 for a voltage reading of +10 volts.
3. Measure the voltage on TP-2, the +5 volt line, with respect to ground. The voltage should be between +4.5 and +5.5 VDC. If voltage is out of tolerance check CR101.

4. Measure the voltage on the +1080 volt line with respect to ground at TP-3. The voltage should read between +1000 and +1100 volts with the transmitter disconnected.

C. *60 MHz IF Alignment*

1. Disconnect P504 from the preselector/local oscillator.
2. Apply an accurate 60 MHz —70 dbm signal to P504.
3. Connect a high gain oscilloscope to the emitter of Q601, TP-4.
4. Adjust T401, T402, T403, T404, and T405 for greatest output amplitude as indicated on the oscilloscope.
5. Disconnect signal generator from P504 and reconnect P504 to the preselector/local oscillator.
6. Apply a —69 dbm 1030 MHz signal to the antenna jack, J501.
7. Readjust T401 for greatest output amplitude as indicated on the oscilloscope.

NOTE: Unless component parts have been damaged or replaced the preselector/local oscillator alignment below should never be necessary during the normal service life of this equipment. If, however, this alignment is to be performed the final three steps of the 60 MHz IF alignment should also be performed following preselector/local oscillator alignment.

D. *Preselector/Local Oscillator Alignment*

1. Connect the high gain oscilloscope to the emitter of Q601, TP-4.
2. Apply a —69 dbm 1030 MHz signal to the antenna jack, J501.
3. Loosen the locking nuts on the three steel preselector adjustment screws one at a time and rotate the adjustment screws to obtain maximum output amplitude as indicated on the oscilloscope.

CAUTION: Never turn any of these adjustments more than half a turn in either direction.

4. Loosen the locking nut on the brass oscillator adjustment screw and rock the adjusting screw slightly to obtain maximum output amplitude on the oscilloscope.

E. *Decoder Alignment*

1. Set the test equipment for Mode A interrogation and a repetition rate of 500 replies/second.
2. Connect the scope to the junction of CR603 and C608, TP-5.
3. Adjust the signal generator level to obtain a noise free interrogation pulse.
4. Connect the oscilloscope or frequency counter to the junction of R314 and C312, TP-6.*
5. Adjust R304, A Coinc. to center the reply on 8 micro-seconds.
6. Observe reply and adjust R304 for 100% reply.
7. Check decoding selectivity by moving P_3 spacing from 7 to 9 microseconds. By adjustment of R304, set the reply selectivity equally either side of 8 micro-seconds. No reply should be observed at less than 7 and greater than 9 microseconds.
8. Set the generator for Mode C interrogation and adjust R310, C Coinc. to center the reply on 21 micro-seconds.
9. Final adjustment for R310 is made similar to step 7 using 21 microsecond spacing. Center the reply equally either side of 21 microseconds and check for no reply at 20 and 22 microseconds.

*An alternate method for determining the no-reply points is to watch the reply lamp. When the lamp goes out the no reply point has been reached.

F. *Video Processor Alignment*

1. Set the test equipment for Mode A interrogation, repetition rate of 500 and output at —72 dbm.
2. Connect the scope or frequency counter to the junction of R314 and C312, TP-6.
3. Adjust the sensitivity control, R610, for 90% triggering.
4. Readjust the generator and check to insure proper triggering at levels from —72 dbm to —20 dbm.
5. Readjust the generator to —69 dbm and check for proper response with pulse spacings either side of 8 microseconds.
6. Readjust the generator and check Mode C triggering at —69 dbm for equal spacing either side of 21 microseconds.
7. Check Mode C triggering at levels from —72 dbm to —20 dbm.

G. *SLS Adjustment*

1. Adjust the generator for Mode A interrogation with the SLS pulse at proper spacing.
2. Adjust the generator for output level of 3 db above MTL (MTL = −72 dbm) and SLS pulse amplitude to 0 db.
3. Connect scope or frequency counter to junction of R314 and C312, TP-6, and observe number of Encoder Enable Gates. The BETA/500 should be suppressed at least 99%.
4. Slowly advance signal generator attenuator to 50 db above MTL and observe Encoder Enable Gates. The BETA/500 should be suppressed at least 99%.
5. Reduce the SLS pulse amplitude to −9 db and observe the number of Encoder Enable Gates. The transponder should reply at least 90%.
6. If reply, in above step, is less than 90% adjust the SLS pot, R617, until at least 90% reply is obtained.
7. Reduce signal generator amplitude slowly to 3 db above MTL while observing Encoder Enable Gates. The transponder should reply at least 90%.
8. After adjusting SLS pot recheck MTL as set in Part E above.

H. *AOC Adjustment*

1. Set generator for a normal Mode A interrogation.
2. Connect vertical input of scope to junction of R314 and C312, TP-6, and set sweep for 0.1 milliseconds per centimeter.
3. Adjust repetition rate to 1200 interrogations per second (0.833 millisecond gate spacing).
4. With signal generator set at 3 db above minimum triggering level adjust R318, AOC Adjust, until the base line just starts to show during gate time.
5. Adjust repetition rate to 2400 and scope time base to display one gate waveform. Reply should be 50% as seen on scope.
6. Return the pulse repetition frequency to 1200 and increase the RF level 33 db above MTL. The number of replies should remain constant and never reach 100%.

I. *Transmitter Alignment*

1. Connect the BETA/500 to power supply and test equipment using the directional coupler and pads as necessary to protect the signal generator.
2. Connect the +1080 volt line to the plate terminal using the shielded jumper shown in figure 4-5-1.
3. Connect one vertical input of the scope to the wavemeter output.
4. Connect the other vertical input to a 1.45 microsecond marker generator or use a calibrated sweep.
5. Set the front panel code selectors to 7777 and turn the transponder on.
6. When pulses appear, adjust the scope delay and time base to display one reply train.
7. By comparison of the markers and transmitter pulses, adjust capacitor C317 for proper pulse spacing of F_1 and F_2 (Tolerance ± 0.1 microsecond).
8. Check the code pulses for proper spacing (Tolerance ± 0.1 microsecond from F_1 and ± 0.15 between any adjacent pair of pulses.
9. Check the spacing of the SPI pulse (Tolerance ±0.1 microseconds from F_2). No adjustment is provided for SPI.
10. Adjust scope to present one pulse and adjust R344, Pulse Width, for proper pulse width (0.45 microseconds).
11. Check all pulses in reply train for proper width.
12. Check transmitter frequency using wavemeter and adjust if necessary with the tuning screw in cavity wall. If a major frequency change is necessary loosen the four plate line mounting screws and slide the plate line assembly in the direction necessary to obtain the proper frequency range adjustment for the frequency adjustment screw.

    CAUTION: Turn the transponder OFF and allow 5 seconds for the bleeder resistor to discharge the +1080 VDC to ground before loosening the plate line mounting screws.

13. Check power output on meter; less than 50 watts indicates end of tube life. Transmitter module should be replaced and old module returned to factory for tube replacement.

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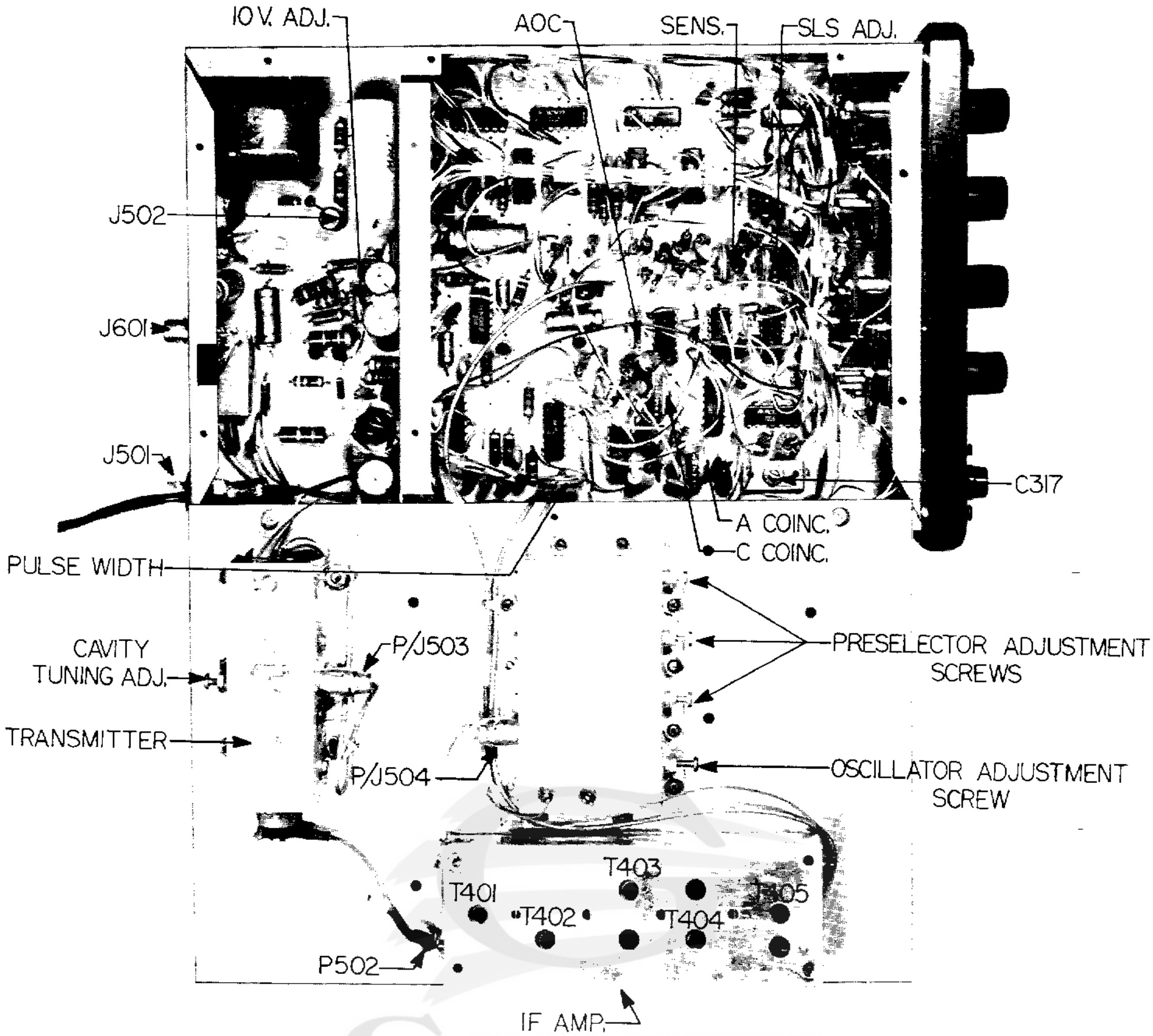
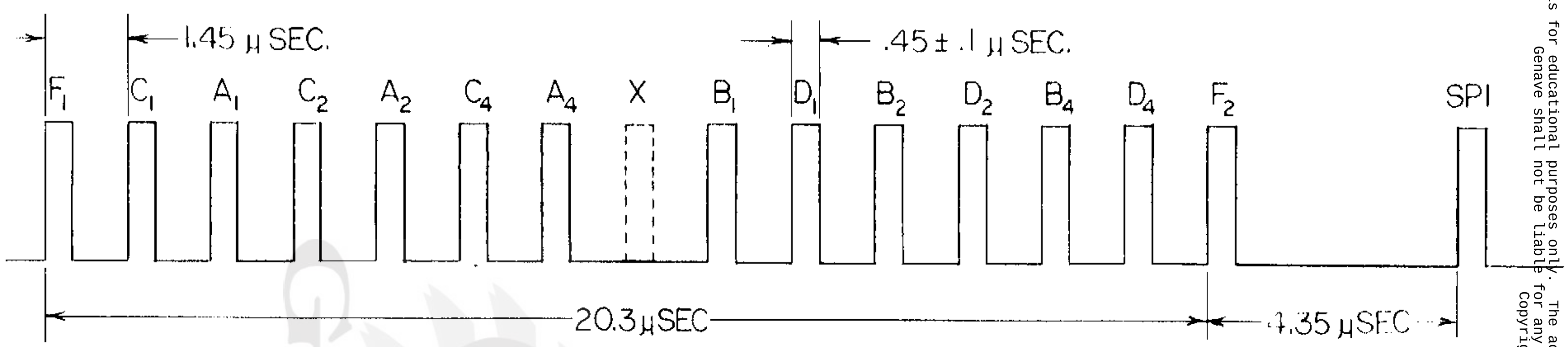


Model BETA/500

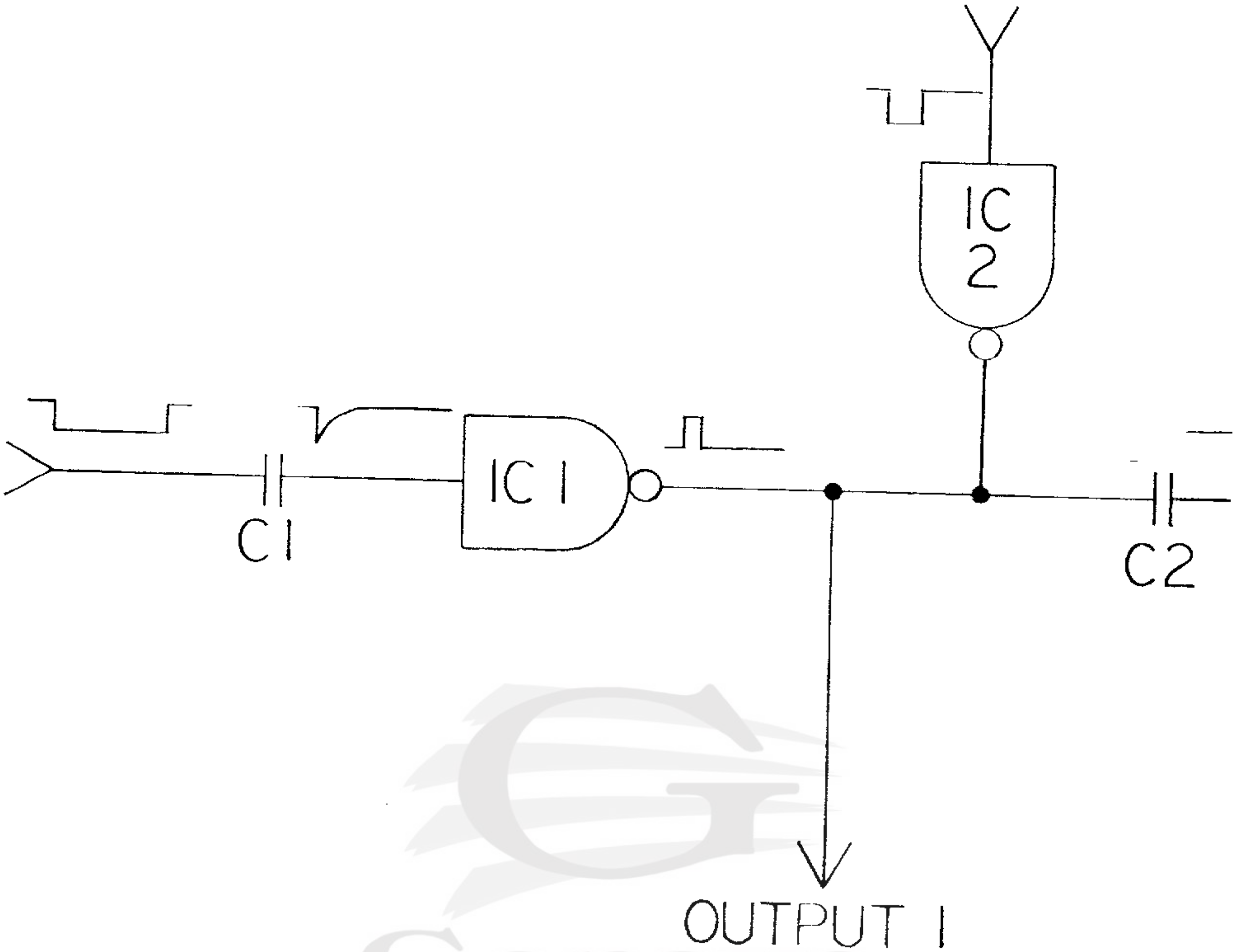
Figure 4-4-3
TRANSPONDER INTERNAL VIEW



NOTE:

1. ALL PULSE SPACINGS ARE 1.45 μSEC. OR MULTIPLES OF 1.45 μSEC.
2. ALL PULSE WIDTHS ARE .45±.1 μSEC.
3. F_1 AND F_2 ARE PRESENT IN ALL REPLYS
4. "X" PULSES ARE NOT USED
5. SPI IS USED ONLY IN MODE A (IDENT)
6. THERE ARE 4096 POSSIBLE COMBINATIONS OF A, B, C, & D PULSES IN A REPLY

Figure 4-4-4
TRANSPONDER REPLY


IC 2
IC 1
C1
C2
OUTPUT 1

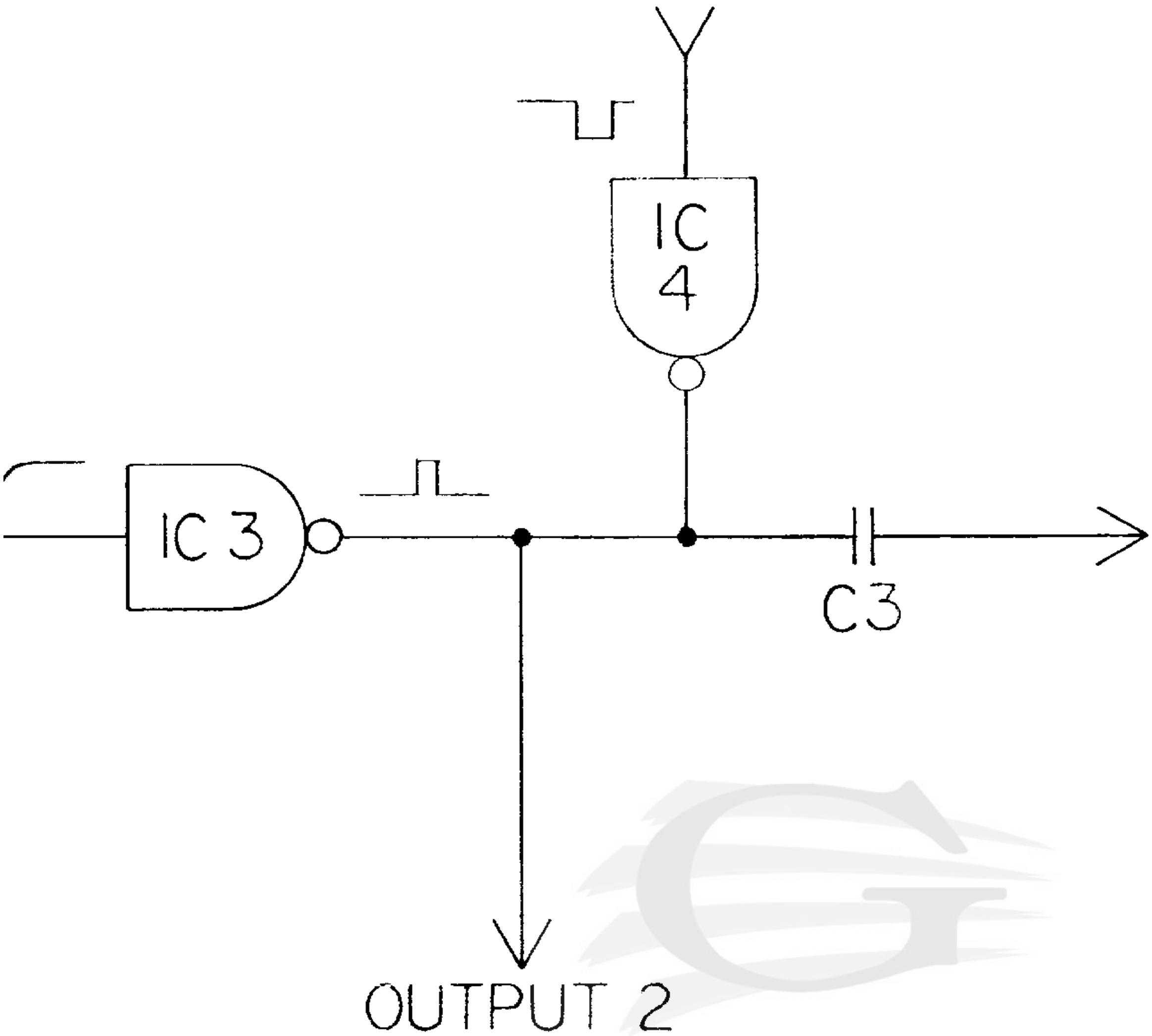


Figure 4-4-5
SEQUENCING CIRCUIT TIMING

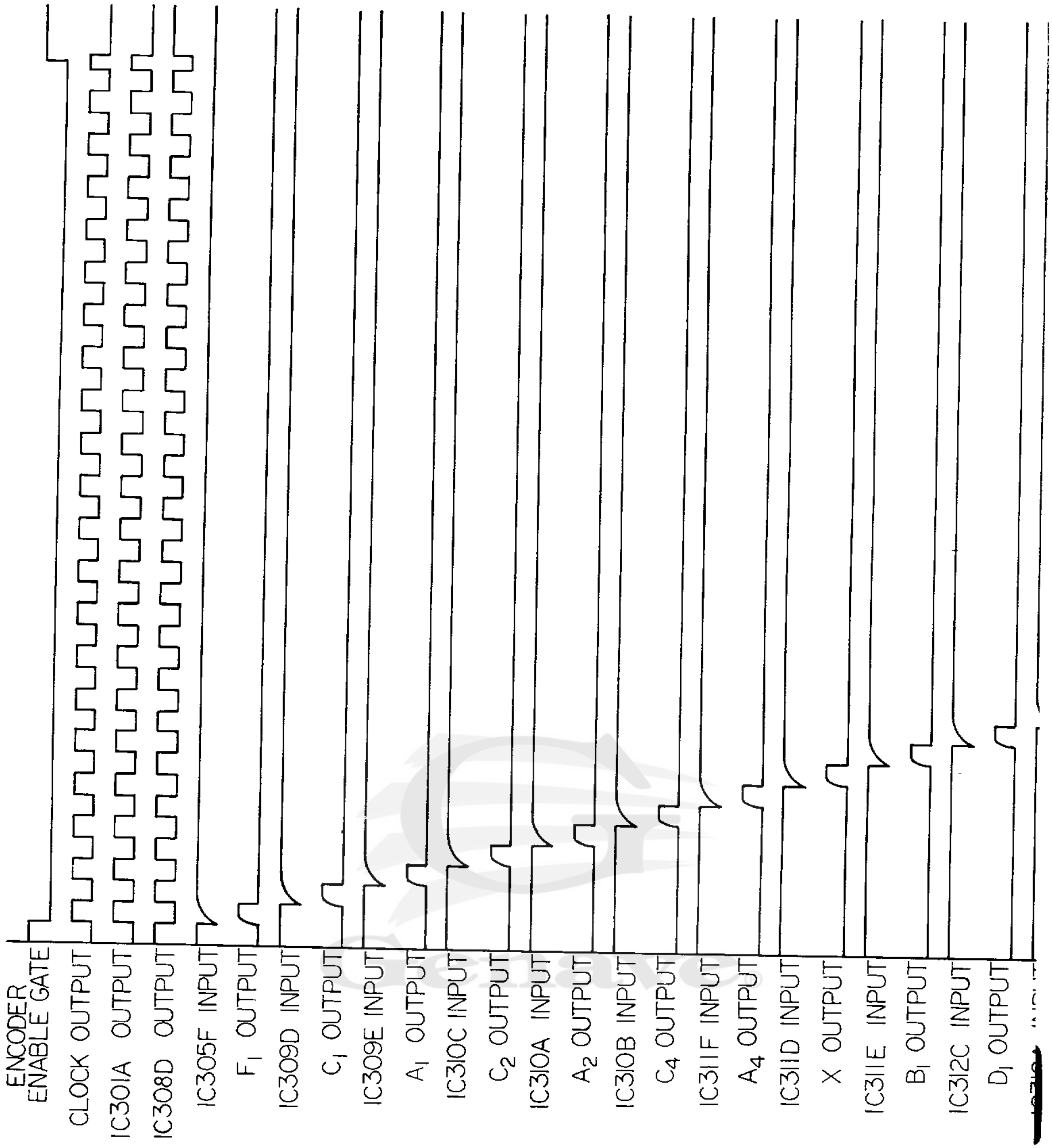
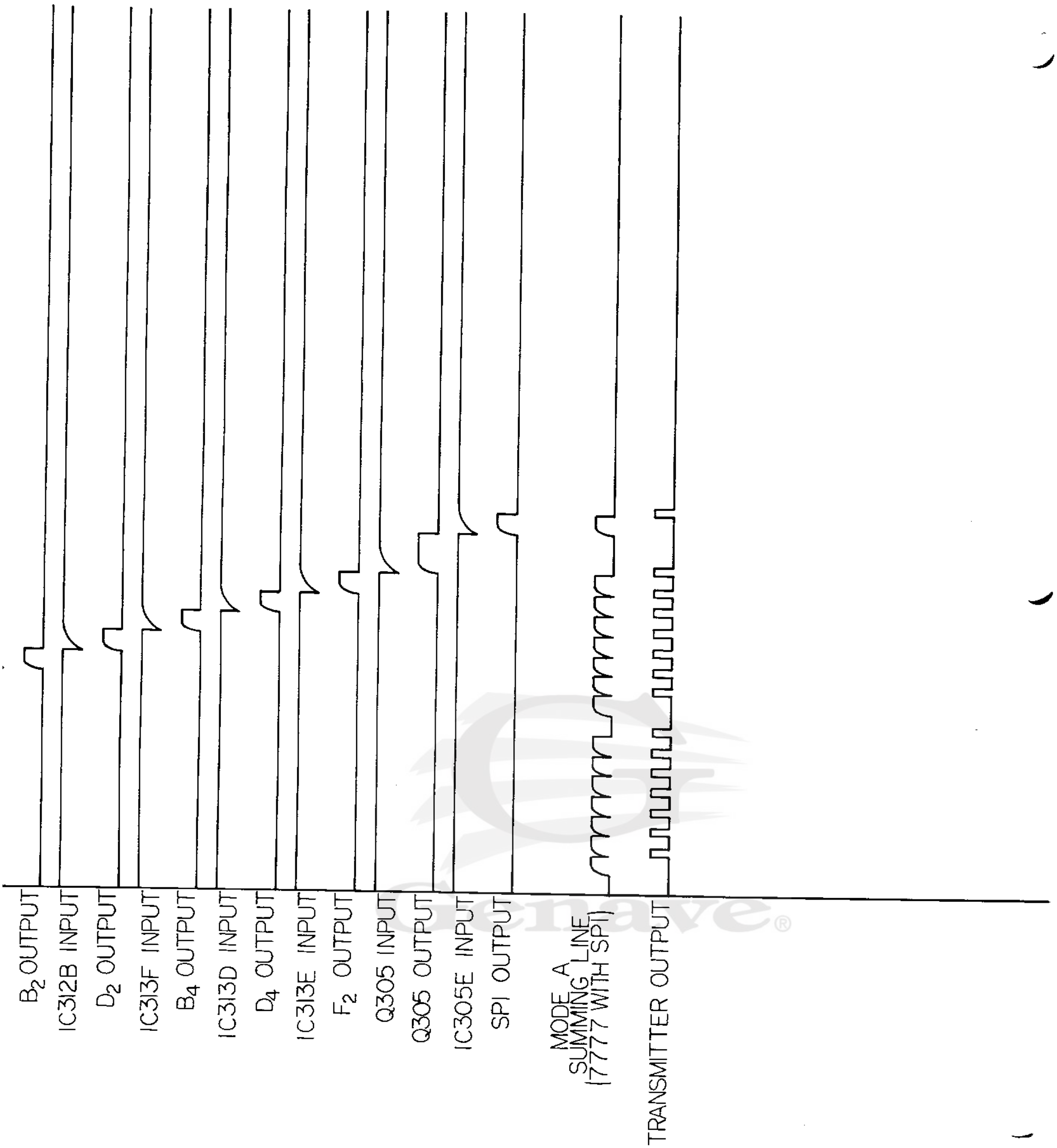


Figure 4-4-6
ENCODER TIMING


B_2 OUTPUT
IC312B INPUT
D_2 OUTPUT
IC313F INPUT
B_4 OUTPUT
IC313D INPUT
D_4 OUTPUT
IC313E INPUT
F_2 OUTPUT
Q305 INPUT
Q305 OUTPUT
IC305E INPUT
SPI OUTPUT
MODE A
SUMMING LINE
(7777 WITH SPI)
TRANSMITTER OUTPUT

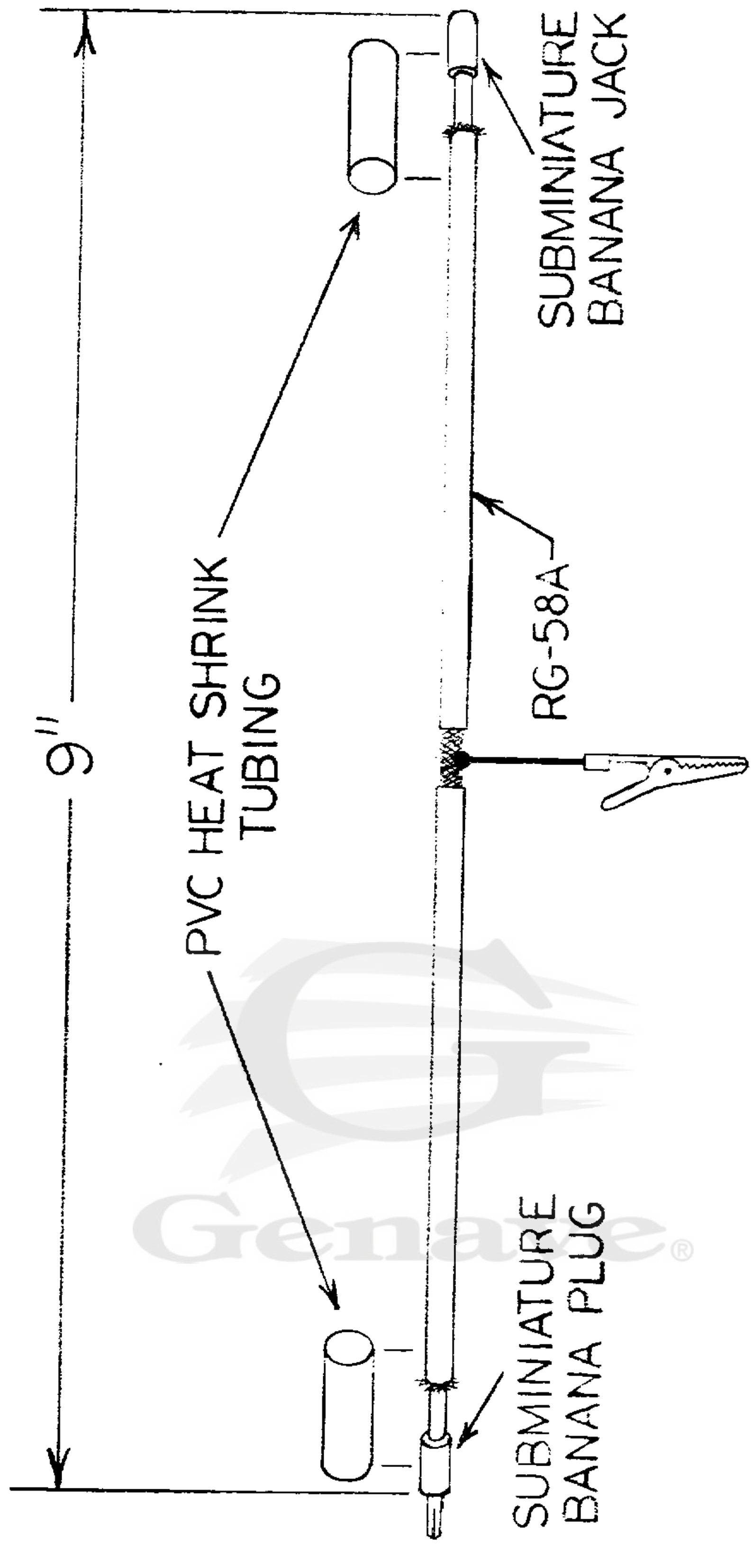


Figure 4-5-1
SHIELDED HV JUMPER

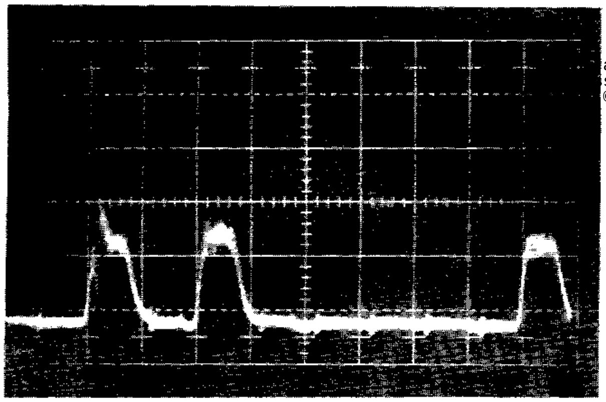


Figure 4-5-2
DETECTED IF OUTPUT

Figure 4-5-3
DITCH DIGGER

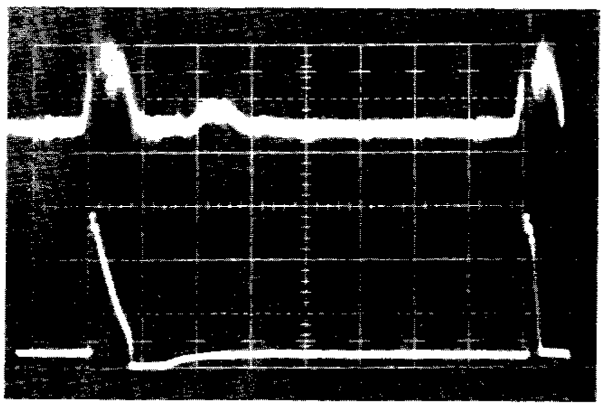


Figure 4-5-4
DITCH DIGGER

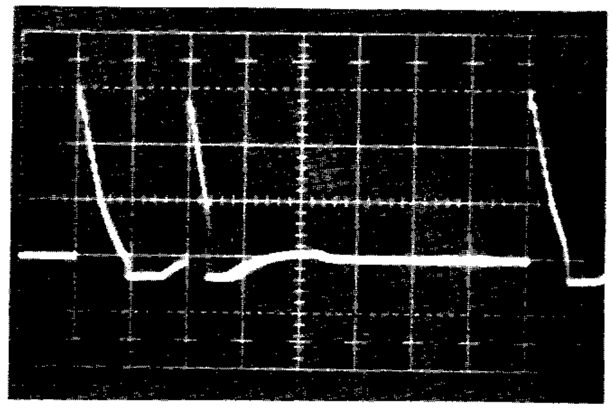


Figure 4-5-5
VIDEO PROCESSOR OUTPUT

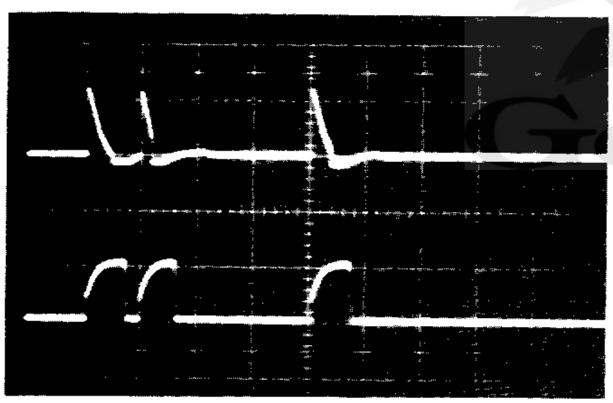


Figure 4-5-6
DECODER DRIVER OUTPUT

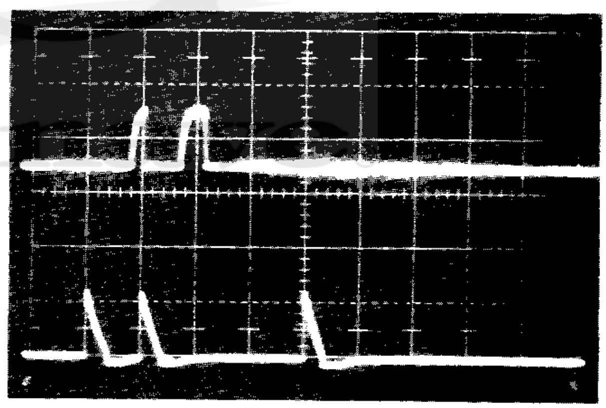


Figure 4-5-7
SLS DECODER INPUTS

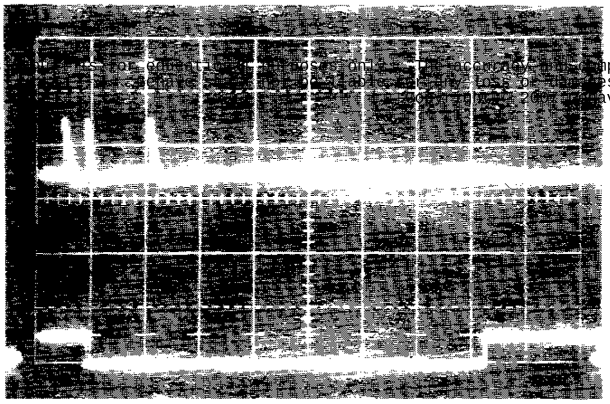


Figure 4-5-8
SLS SUPPRESSION

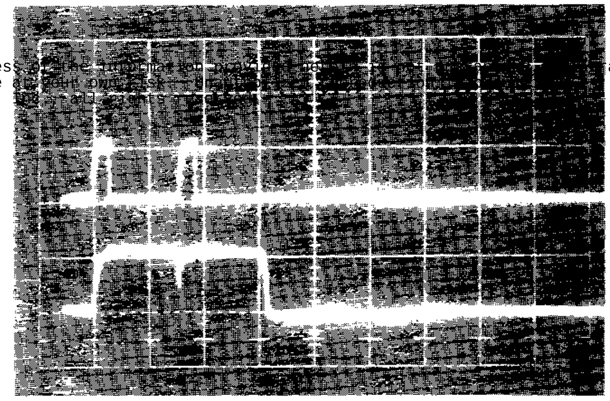


Figure 4-5-9
MODE A MULTI INPUT & OUTPUT

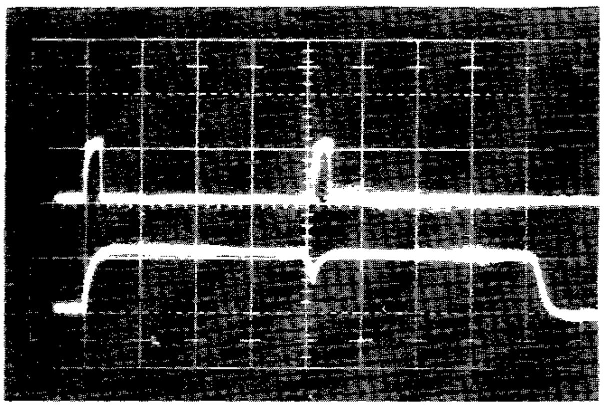


Figure 4-5-10
MODE C MULTI INPUT & OUTPUT

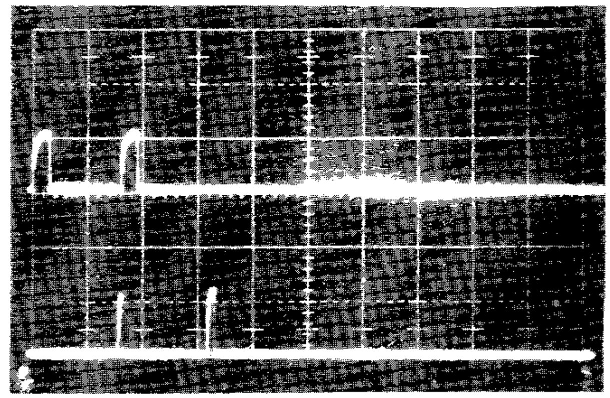


Figure 4-5-11
MODE A DECODER GATE INPUTS

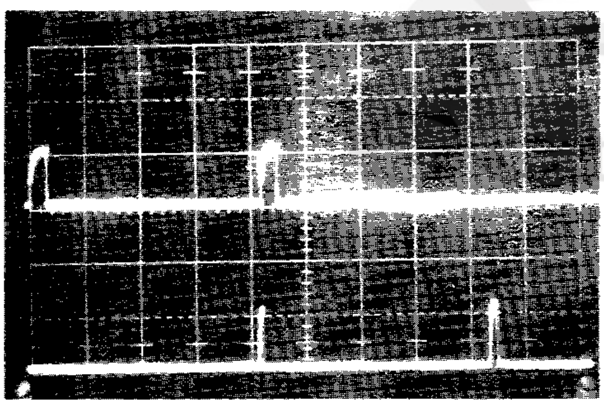


Figure 4-5-12
MODE C DECODER GATE INPUTS

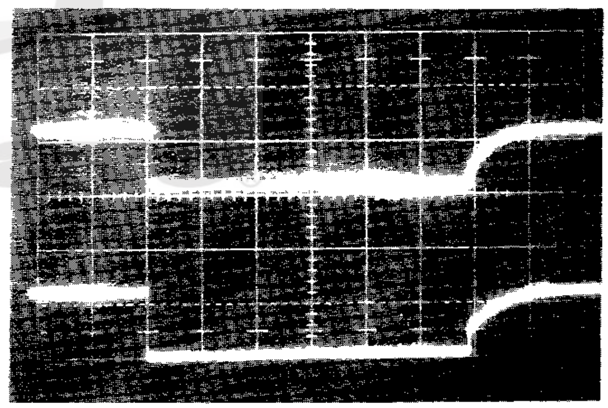


Figure 4-5-13
ENCODER ENABLE & ENABLE GATE

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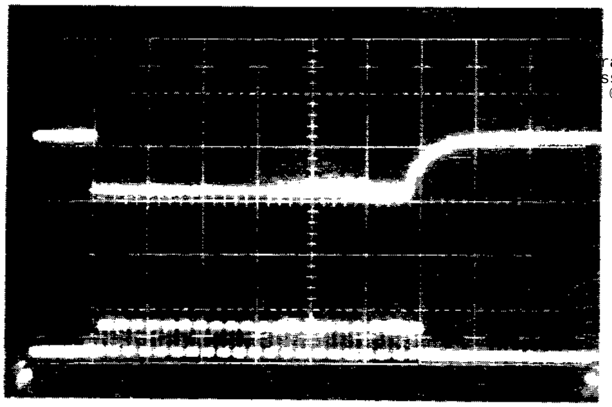


Figure 4-5-14
CLOCK OUTPUT

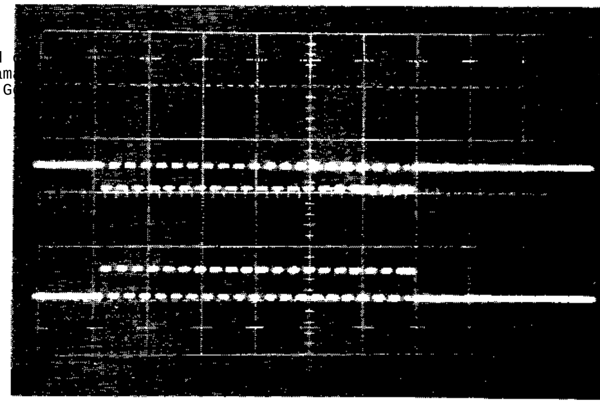


Figure 4-5-15
PHASED CLOCK OUTPUT LINES

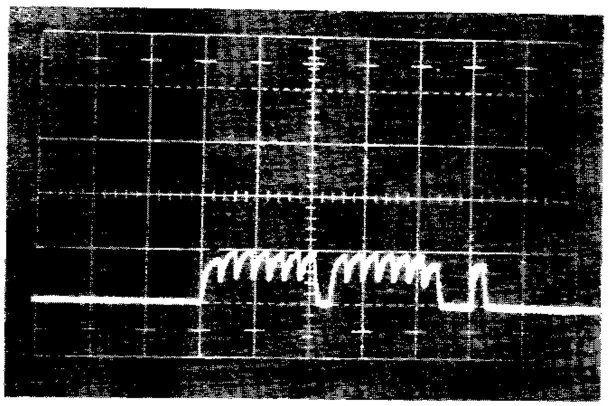


Figure 4-5-16
MODE A OR C SUMMING LINE

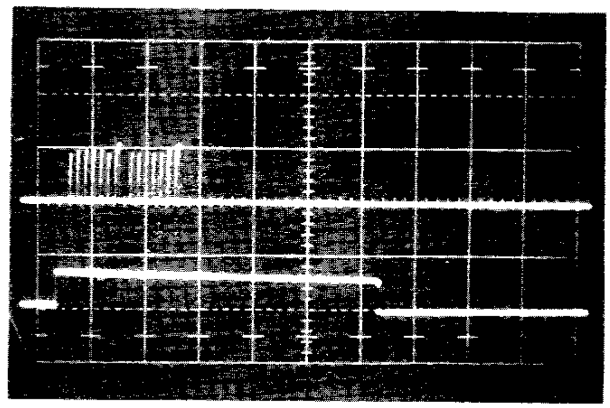


Figure 4-5-17
MODE A OR C SUMMING CIRCUIT OUTPUT
MODE A OR C ENABLE

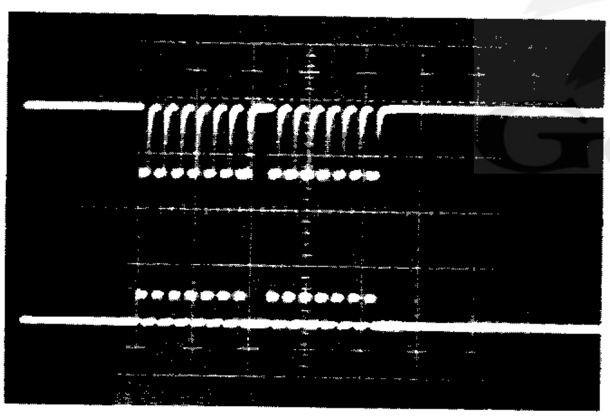


Figure 4-5-18
PULSE SHAPER INPUT, OUTPUT

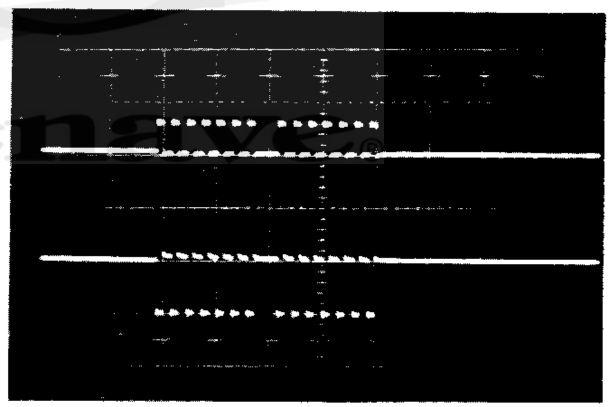


Figure 4-5-19
MODULATOR PULSES, COLLECTOR Q312,
V501 GRID

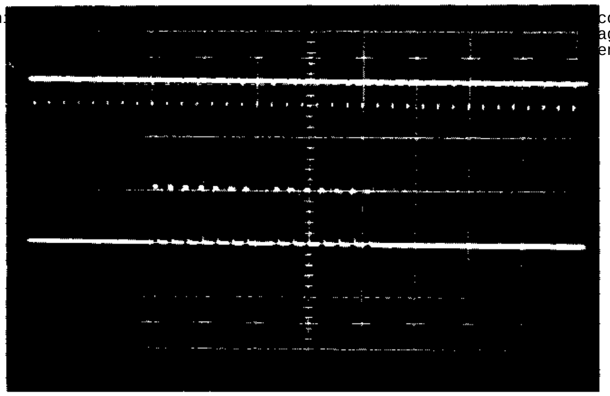


Figure 4-5-20
TRANSMITTER RF TRAIN

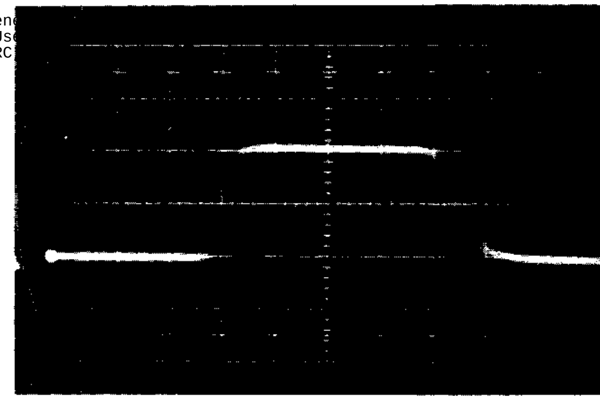


Figure 4-5-21
SINGLE RF PULSE

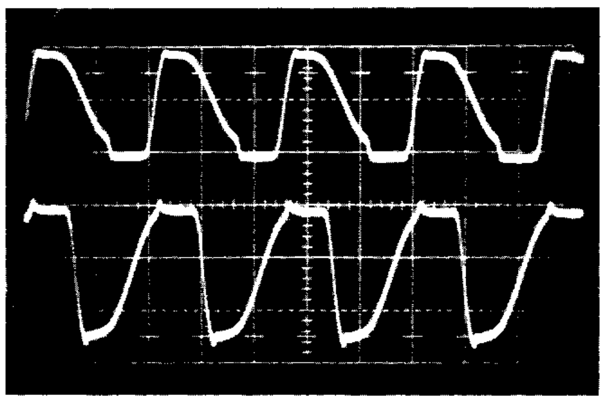


Figure 4-5-22
POWER SUPPLY, COLLECTOR Q106, BASE Q106

BRIEF WAVEFORM EXPLANATION

(All waveform photos taken with —70 dbm input signal.)

4-5-2 Detected IF Output Pulses on base of Q601 with Mode A, SLS interrogation, Vert. = .05 V/cm, Horiz. = 1 usec/cm.

4-5-3 Ditch Digger Operation—Upper: IF output on base Q601 with Mode A, SLS interrogation, $P_2 = P_1$. Lower: Video processor output at collector of Q605. Vert. = 2 V/cm, Horiz. = 1 usec/cm.

4-5-4 Ditch Digger Operation—Upper: IF output on base Q601 with Mode A, SLS interrogation, P_2 = 9 db down. Lower: Video processor output at collector of Q605. Vert. = 2 V/cm, Horiz. = 1 usec/cm.

4-5-5 Video Processor Output Pulses, Vert. = 2 V/cm, Horiz. = 1 usec/cm.

4-5-6 Decoder Driver Output—Upper: Decoder input at pin 5, IC301B, Mode A interrogation. Lower: Decoder driver output pulses at pin 6 of IC303C. Vert. = 5 V/cm, Horiz. = 2 usec/cm.

4-5-7 SLS Decoder Inputs—Upper: SLS acceptance gate at pin 12, IC301D, Mode A, SLS interrogation with $P_2 = P_1$. Lower: Output of video processor as seen at pin 13, IC301D. Vert. = 5 V/CM, Horiz. = 2 usec/cm.

4-5-8 SLS Suppression—Upper: Input to decoder at pin 5, IC301B, Mode A, SLS interrogation, $P_2 = P_1$. Lower: SLS inhibit pulse as seen on pin 4 IC301B. Vert. = 5 V/cm, Horiz. = 5 usec/cm.

4-5-9 Mode A Multi Input & Output—Upper: Mode A multi input at pin 5, IC302B, Mode A interrogation. Lower: Multi output seen at collector of Q301. Vert. = 5 V/cm, Horiz. = 5 usec/cm.

4-5-10 Mode C Multi Input & Output—Upper: Mode C multi input at pin 1, IC302A, Mode C interrogation. Lower: Multi output seen at collector Q303. Vert. = 5 V/cm, Horiz. = 5 usec/cm.

4-5-11 Mode A Decoder Gate Inputs—Upper: Input to pin 12, IC307D, Mode A interrogation. Lower: Input to pin 13, IC307D. Vert. = 5 V/cm, Horiz. = 5 usec/cm.

4-5-12 Mode C Decoder Gate Inputs—Upper: Input to pin 10, IC307C, Mode C interrogation. Lower: Input to pin 9, IC307C. Vert. = 5 V/cm, Horiz. = 5 usec/cm.

4-5-13 Encoder Enable & Enable Gate—Upper: Encoder enable as seen at pin 11, IC304D. Lower: Enable gate seen at pin 3, IC304A. Note slight delay of encoder enable. Vert. = 5 V/cm, Horiz. = 10 usec/cm.

4-5-14 Clock Output—Upper: Encoder enable as seen at pin 5, IC308C. Lower: Clock output pulses as seen at pin 12 IC308F. Vert. = 5 V/cm, Horiz. = 10 usec/cm.

4-5-15 Phased Clock Output Lines—Upper: Output IC308A, pin 3. Lower: Output IC301A, pin 3. Vert. = 5 V/cm, Horiz. = 10 usec/cm.

4-5-16 Mode A or C Summing Line, base Q308 Mode A reply with SPI. Mode C summing line appears identical without SPI pulse. Vert. = 5 V/cm, Horiz. = 5 usec/cm.

4-5-17 Mode A or C Summing Circuit Output. Mode A or C Enable—Upper: Pin 4, IC307B or pin 1, IC307A. Lower: Pin 5, IC307B or pin 2, IC307A. Vert. = 5 V/cm, Horiz. = 10 usec/cm.

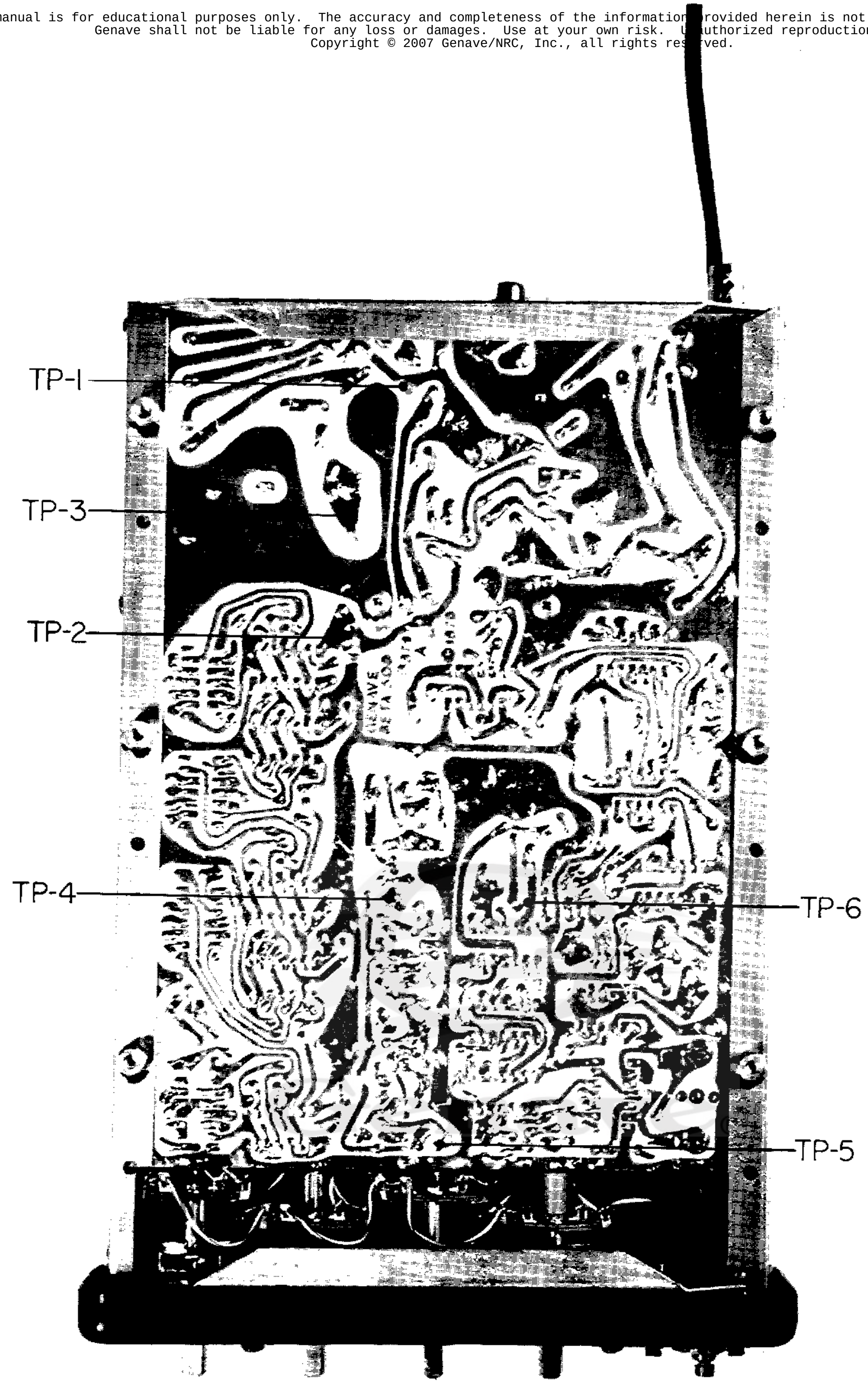
4-5-18 Pulse Shaper Input, Output—Upper: Input as seen at pin 4, IC305B. Lower: Output at collector of Q310. Vert. = 5 V/cm, Horiz. = 5 usec/cm.

4-5-19 Modulator Pulses, Collector Q312, V501 Grid—Upper: Collector Q312, Vert. = 1 V/cm. Lower: Grid V501, Vert. = 50 V/cm. Horiz. = 5 usec/cm.

4-5-20 Transmitter RF Train—Upper: 1.45 usec markers. Lower: Transmitter detected output, Horiz. = 5 usec/cm.

4-5-21 Single RF Pulse—Detected RF output, Horiz. = 5 usec/cm.

4-5-22 Power Supply—Upper: Collector Q106, Vert. = 10 V/cm. Lower: Base Q106, Vert. = 2 V/cm. Horiz. = 20 usec/cm.



Model BETA/500

Figure 4-5-23
TEST POINTS

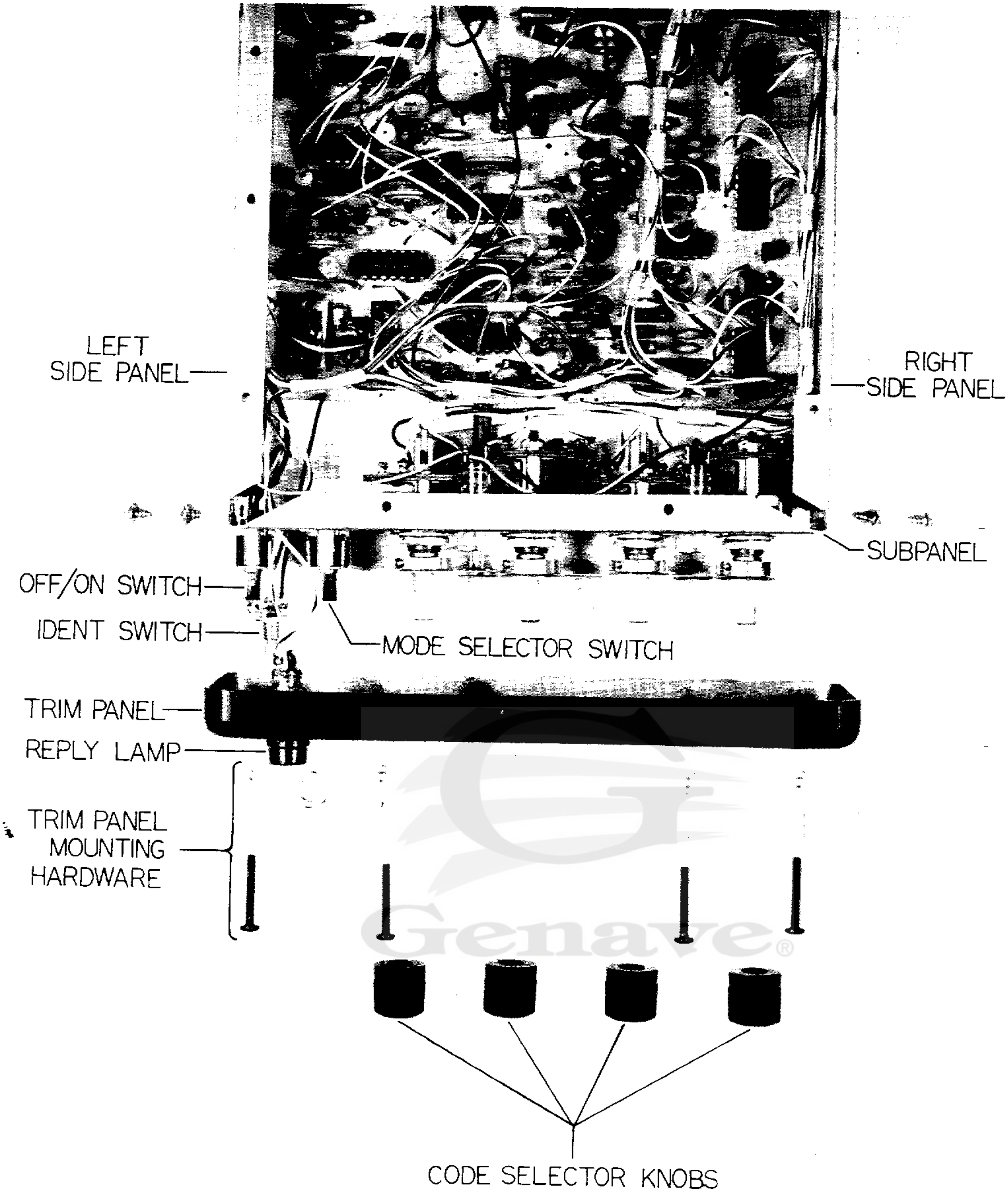
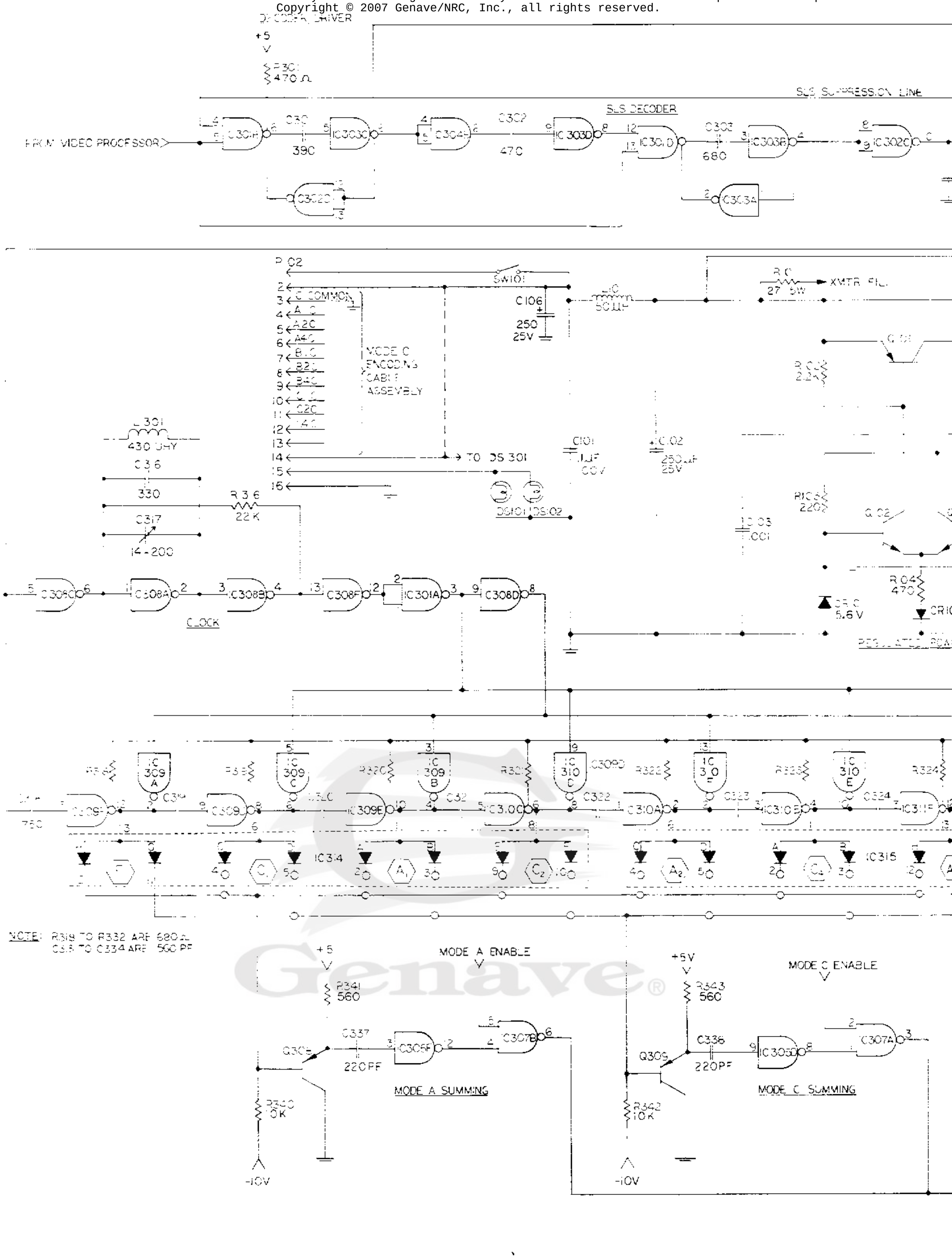
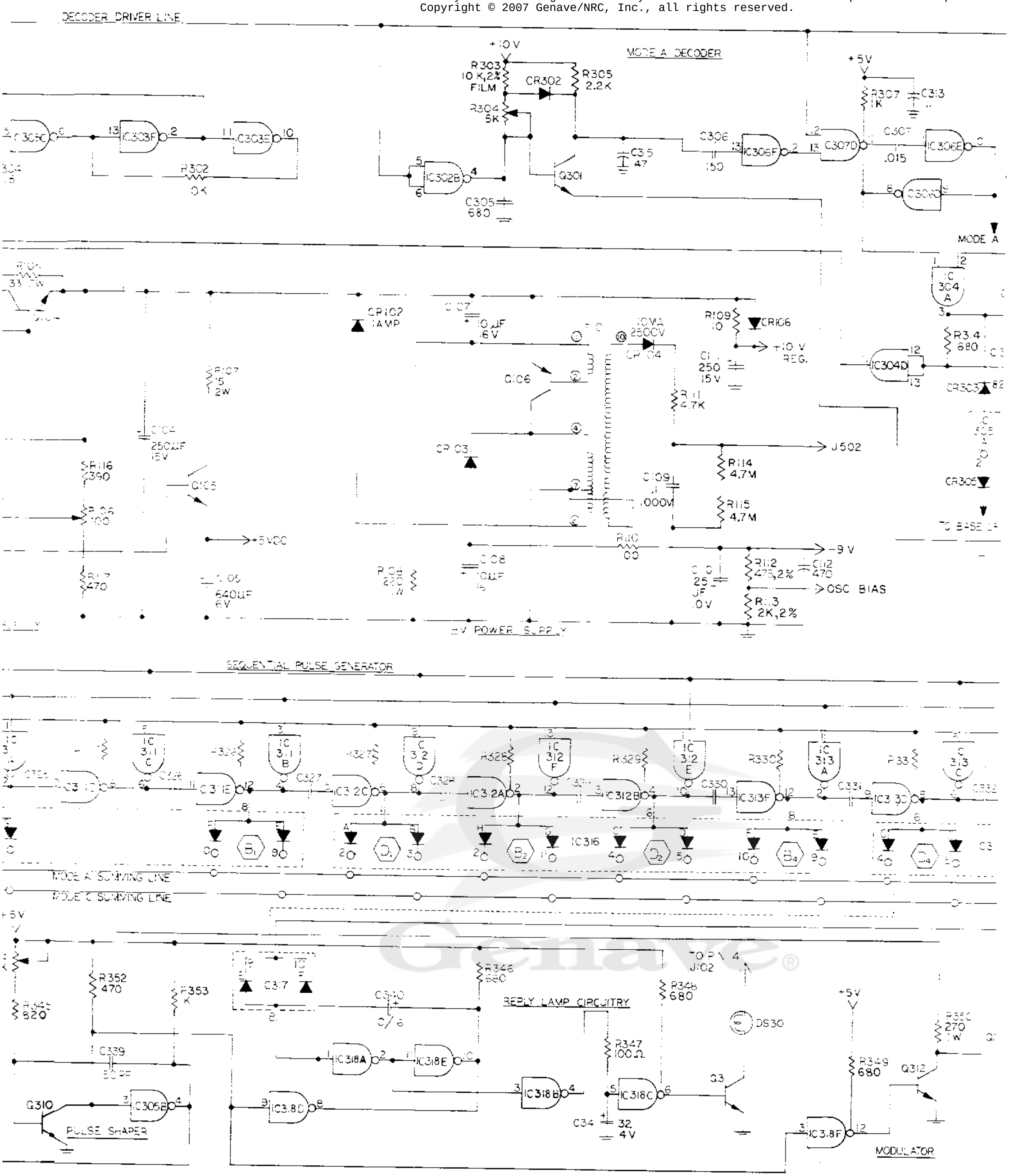


Figure 4-5-24
EXPANDED VIEW


SLS DECODER
FROM VIDEO PROCESSOR
MODE C ENCODING CABLE ASSEMBLY
TO DS 301
XMTR FIL
CLOCK
NOTE: R319 TO R332 ARE 680 Ω
C318 TO C334 ARE 560 PF
MODE A ENABLE
MODE C ENABLE
MODE A SUMMING
MODE C SUMMING
-10V
+5V

RF CIRCUITS SCHEMATIC



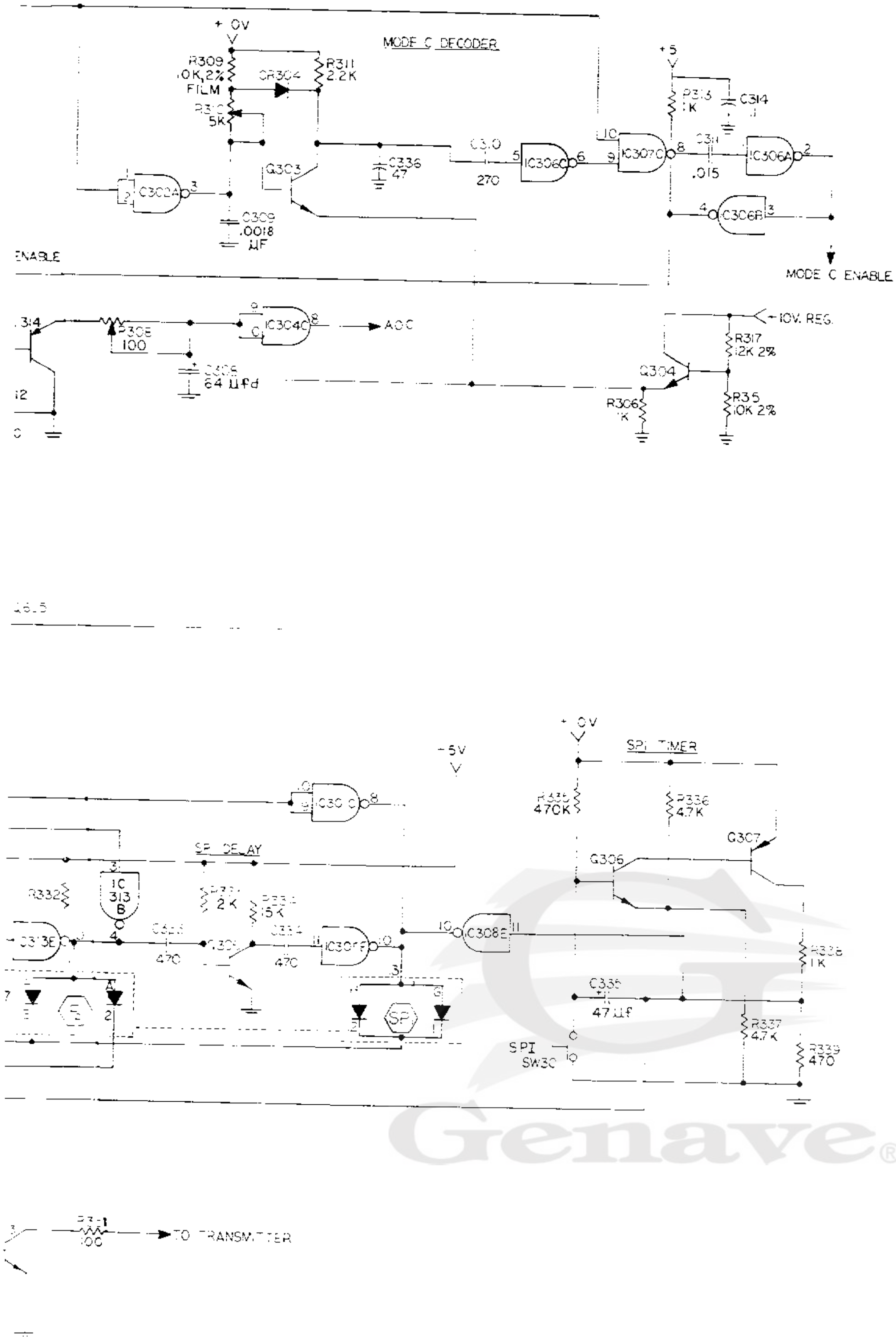


Figure 4-5-25
MAINBOARD SCHEMATIC

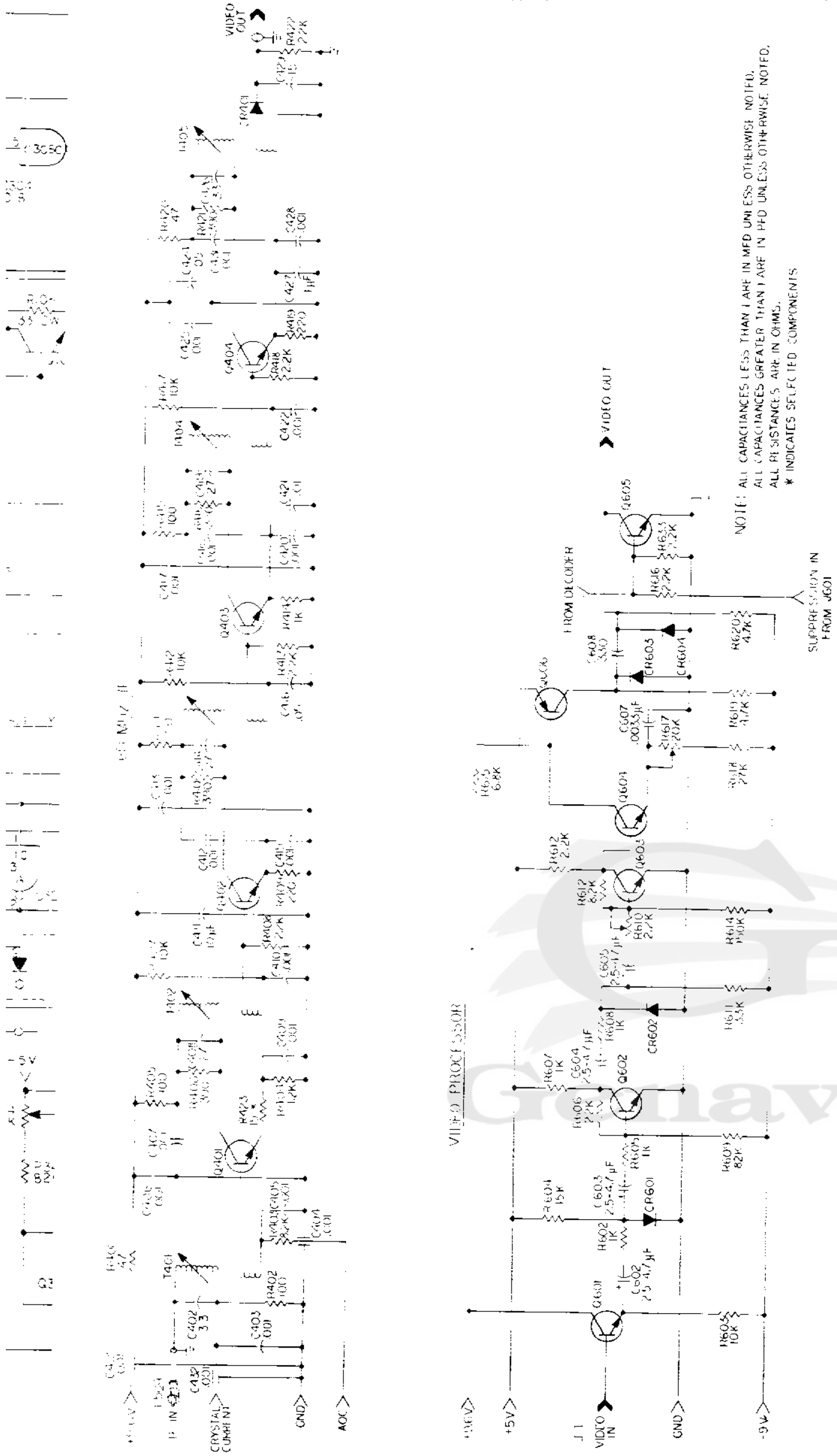
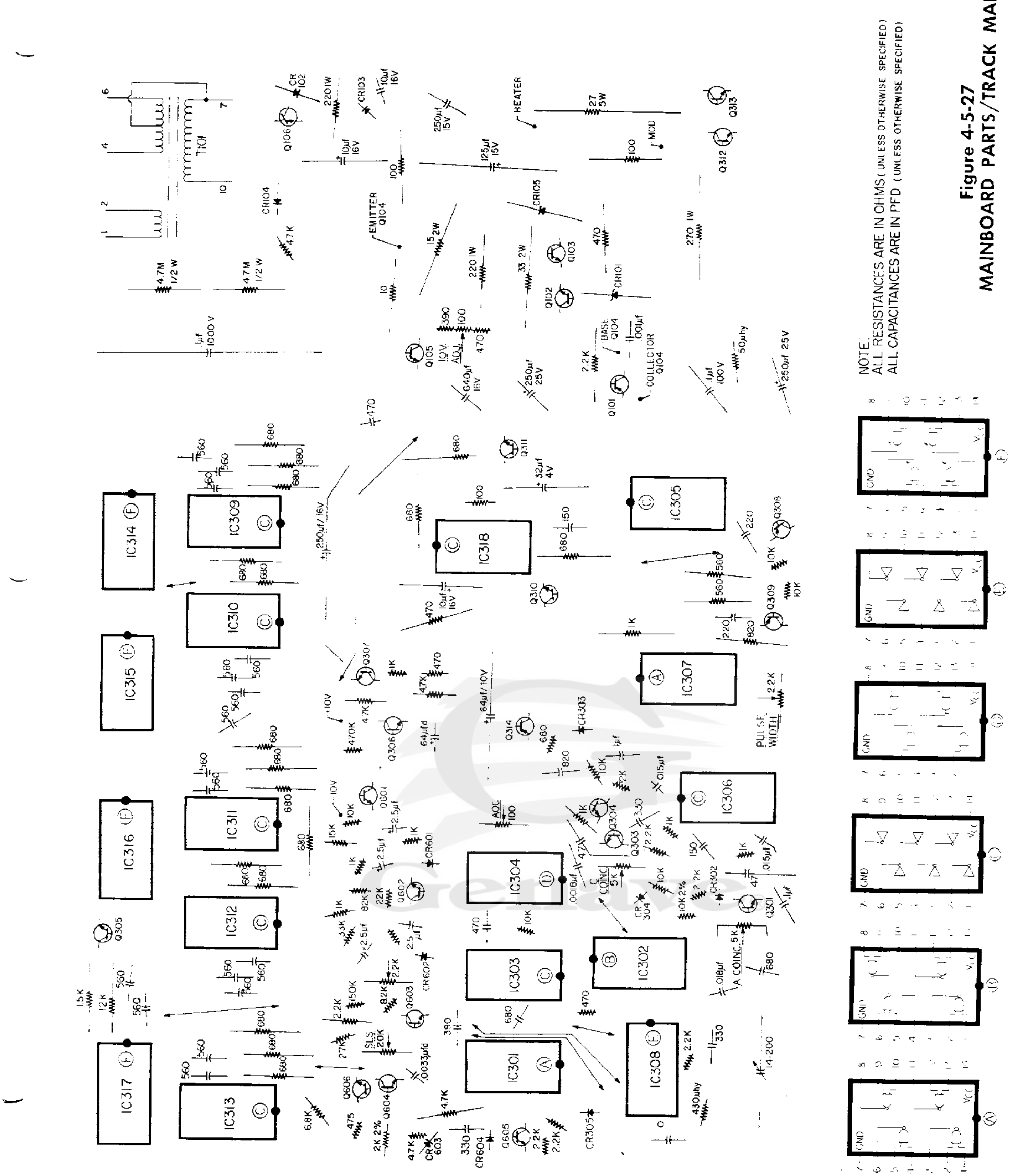


Figure 4-5-26
IF/VIDEO PROCESSOR SCHEMATIC

RF CIRCUITS SCHEMATIC

Model BETA/500



NOTE:
ALL RESISTANCES ARE IN OHMS (UNLESS OTHERWISE SPECIFIED)
ALL CAPACITANCES ARE IN PFD. (UNLESS OTHERWISE SPECIFIED)

Figure 4-5-27
MAINBOARD PARTS/TRACK MAP

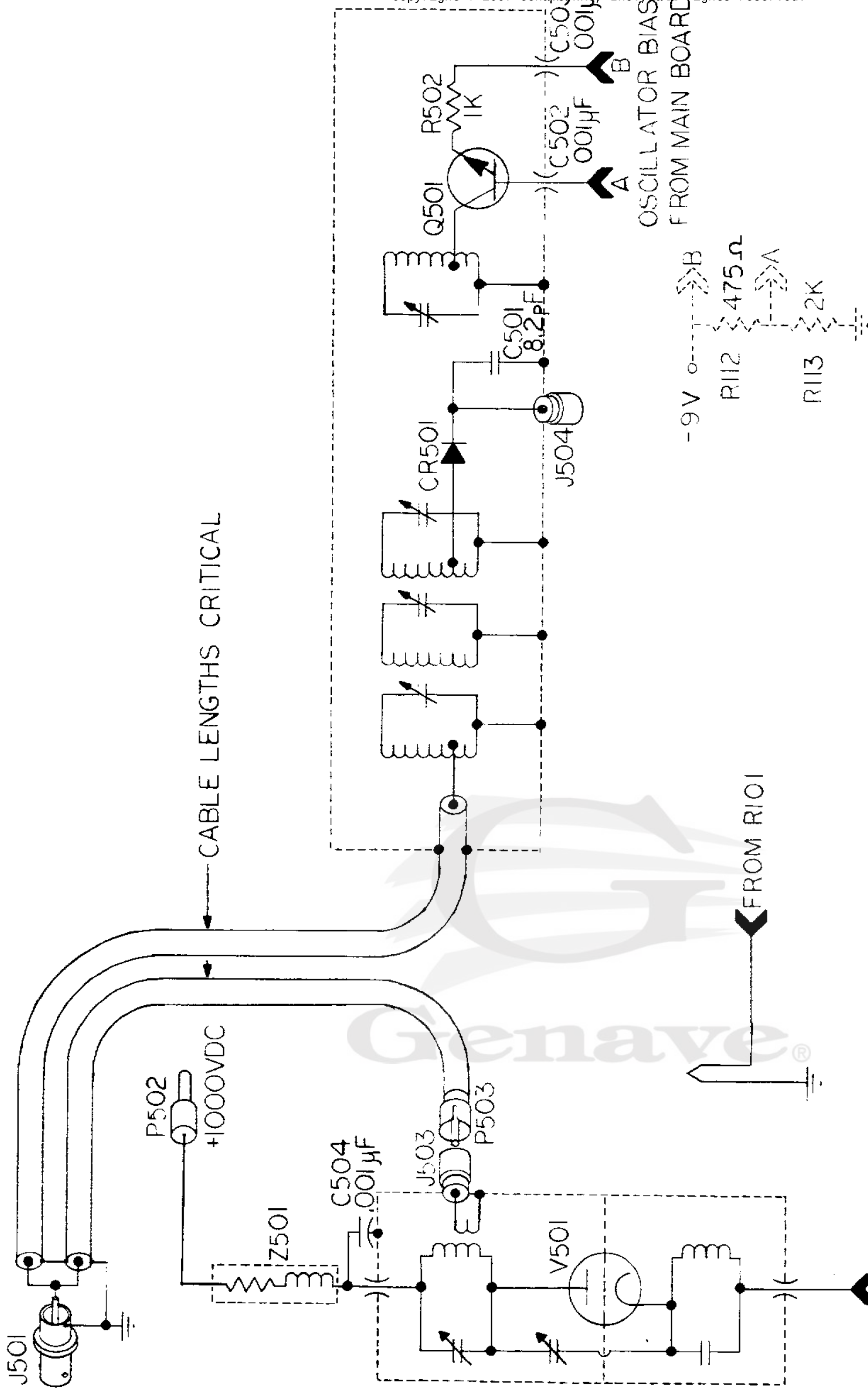


Figure 4-5-28
RF CIRCUITS SCHEMATIC

Model BETA/500

SECTION V

BETA/500 PARTS LIST

Ref. No.	Genave Part No. B-500-	Description
		CAPACITORS
C101	32	Mylar, .1 mfd, 100 V
C102	40	Electrolytic, 250 mfd, 25 V
C103	20	Z5P Disc, .001 mfd ±10%
C104	43	Electrolytic, 250 mfd, 15 V
C105	44	Electrolytic, 640 mfd, 6.4 V
C106	40	Electrolytic, 250 mfd, 25 V
C107	35	Tantalum, 3.3 mfd, 35 V
C108	36	Electrolytic, 10 mfd, 16 V
C109	31	Mylar, .1 mfd, 1000 V
C110	41	Electrolytic, 125 mfd, 10 V
C111	43	Electrolytic, 250 mfd, 15 V
C112	14	Y5E Disc, 470 pfd ±10%
C113		Unassigned
C114		Unassigned
C301	13	Y5E Disc, 390 pfd ±10%
C302	14	Y5E Disc, 470 pfd ±10%
C303	18	Silver Mica, 680 pfd ±10%
C304	27	Tubular Mylar, .018 mfd, 200 V
C305	18	Silver Mica, 680 pfd ±10%
C306	8	N750 Disc, 150 pfd ±10 %
C307	26	Tubular Mylar, .015 mfd, 200 V
C308	39	Electrolytic, 64 mfd, 10 V
C309	23	Poly, .0018 mfd
C310	15	Y5F Disc, 270 pfd ±10%
C311	26	Tubular Mylar, .015 mfd, 200 V
C312	19	Y5E Disc, 820 pfd ±10%
C313	30	Disc, .1 mfd +80−20%, 12 V
C314	30	Disc, .1 mfd +80−20%, 12 V
C315	7	Disc, 47 pfd ±10%
C316	12	Polystyrene, 330 pfd ±10%
C317	45	Variable, 14−200 pfd
C318	17	Disc, 560 pfd ±10%
C319	17	Disc, 560 pfd ±10%
C320	17	Disc, 560 pfd ±10%
C321	17	Disc, 560 pfd ±10%
C322	17	Disc, 560 pfd ±10%
C323	17	Disc, 560 pfd ±10%
C324	17	Disc, 560 pfd ±10%
C325	17	Disc, 560 pfd ±10%
C326	17	Disc, 560 pfd ±10%
C327	17	Disc, 560 pfd ±10%
C328	17	Disc, 560 pfd ±10%
C329	17	Disc, 560 pfd ±10%
C330	17	Disc, 560 pfd ±10%
C331	17	Disc, 560 pfd ±10%
C332	17	Disc, 560 pfd ±10%
C333	17	Disc, 560 pfd ±10%
C334	17	Disc, 560 pfd ±10%
C335	38	Electrolytic, 64 mfd, 10 V
C336	7	Disc, 47 pfd ±10%
C337	10	Y5E Disc, 220 pfd ±10%
C338	10	Y5E Disc, 220 pfd ±10%
C339	9	Y5E Disc, 150 pfd ±10%
C340	36	Electrolytic, 10 mfd, 16 V
C341	37	Electrolytic, 32 mfd, 4 V
C342		Unassigned
C401	22	Feedthrough, .001 mfd
C402	1	NPO Disc, 3.3 pfd ±10%
C403	20	Z5P Disc, .001 mfd ±10%
C404	22	Feedthrough, .001 mfd
C405	20	Z5P Disc, .001 mfd ±10%
C406	20	Z5P Disc, .001 mfd ±10%
C407	20	Z5P Disc, .001 mfd ±10%
C408	4	NPO Disc, 27 pfd ±10%
C409	20	Z5P Disc, .001 mfd ±10%
C410	20	Z5P Disc, .001 mfd ±10%
C411	36	Electrolytic, 10 mfd, 16 V
C412	20	Z5P Disc, .001 mfd ±10%
C413	20	Z5P Disc, .001 mfd ±10%
C414	4	NPO Disc, 27 pfd ±10%
C415	20	Z5P Disc, .001 mfd ±10%
C416	29	NZ5 Disc, .05 mfd +80−20%
C417	20	Z5P Disc, .001 mfd ±10%
C418	20	Z5P Disc, .001 mfd ±10%
C419	4	NPO Disc, 27 pfd ±10%
C420	20	Z5P Disc, .001 mfd ±10%
C421	28	NPO Disc, .01 mfd ±20%
C422	20	Z5P Disc, .001 mfd ±10%
C423		Unassigned
C424	29	NZ5 Disc, .05 mfd +80−20%
C425	20	Z5P Disc, .001 mfd ±10%
C426	5	NPO Disc, 33 pfd ±10%
C427	34	Electrolytic, 1 mfd, 5 V min.
C428	20	Z5P Disc, .001 mfd ±10%
C429	3	NPO Disc, 15 pfd ±10%
C430		Unassigned
C431	20	Z5P Disc, .001 mfd ±10%
C432	22	Feedthrough, .001 mfd
C433		Unassigned
C501	2	NPO Disc, 8.2 pfd ±10%
C502	22	Feedthrough, .001 mfd
C503	22	Feedthrough, .001 mfd
C504	21	Z5P Disc, .001 mfd ±10%, 1KV
C505		Unassigned
C601		Unassigned
C602	35	Tantalum, 3.3 mfd, 35V
C603	35	Tantalum, 3.3 mfd, 35V
C604	35	Tantalum, 3.3 mfd, 35V
C605	35	Tantalum, 3.3 mfd, 35V
C606		Unassigned
C607	25	.0033 μfd ±10%
C608	11	Y5F Disc, 330 pfd ±10%
C609		Unassigned
		DIODES
CR101	93	Zener, 5.6 V ±5%, ¾ Watt
CR102	95	Silicon, General Purpose, 50 V, 0.2 A
CR103	95	Silicon, General Purpose, 50 V, 0.2 A
CR104	97	Silicon, High Voltage, 3KVDC, 5 ma, IN3646
CR105	95	Silicon, General Purpose, 50 V, 0.2 A
CR106	95	Silicon, General Purpose, 50 V, 0.2 A
CR301		Unassigned
CR302	94	Silicon, High Speed Switching, FD 1936
CR303	94	Silicon, High Speed Switching, FD 1936
CR304	94	Silicon, High Speed Switching, FD 1936
CR305	94	Silicon, High Speed Switching, FD 1936
CR401	98	Germanium, IN 295
CR501	99	Silicon, Hot Carrier
CR601	94	Silicon, High Speed Switching, FD 1936
CR602	94	Silicon, High Speed Switching, FD 1936
CR603	94	Silicon, High Speed Switching, FD 1936
CR604	94	Silicon, High Speed Switching, FD 1936
		LAMPS
DS101	235	Clear, 14 V, 80 ma, 50,000 Hr.
DS102	235	Clear, 14 V, 80 ma, 50,000 Hr.
DS301	236	Amber, 14 V, 80 ma, 50,000 Hr.
		INTEGRATED CIRCUITS
IC301	115	DTL, Quad 2-Input "Nandy" Power Gate, MC 846 P
IC301	115	DTL, Quad 2-input "Nand" Power Gate,
IC302	116	DTL, Quad 2-Input Power Gate, IC 302
IC304	119	DTL, Quad 2-Input "And" Gate, MC 1806 P
IC305	117	DTL, Hex Inverter, MC 840 P
IC306	117	DTL, Hex Inverter, MC 840 P
IC307	115	DTL, Quad 2-Input "Nand" Power Gate, MC 846 P
IC308	118	DTL, Hex Inverter, MC 837 P
IC309	117	DTL, Hex Inverter, MC 840 P
IC310	117	DTL, Hex Inverter, MC 840 P
IC311	117	DTL, Hex Inverter, MC 840 P
IC312	117	DTL, Hex Inverter, MC 840 P
IC313	117	DTL, Hex Inverter, MC 840 P
IC314	120	DTL, Quad 2-Input Gate Expander, MC 847 P
IC315	120	DTL, Quad 2-Input Gate Expander, MC 847 P
IC316	120	DTL, Quad 2-Input Gate Expander, MC 847 P
IC317	120	DTL, Quad 2-Input Gate Expander, MC 847 P
IC318	117	DTL, Hex Inverter, MC 840 P
		COILS
L101	122	Line Filter Choke, 50 uhy
L301	124	Clock Oscillator, 430 uhy
		TRANSISTORS
Q101	113	Silicon, PNP, MPS A70
Q101	113	Silicon, PNP, MPS A70
Q102	104	Silicon, NPN, MPS A10
Q103	104	Silicon, NPN, MPS A10
Q104	107	Silicon, PNP, MJE 520
Q105	106	Silicon, NPN, MPS U02
Q106	109	Silicon, PNP, MJE 105
Q301	108	Silicon, NPN, MPS 5172
Q302		Unassigned
Q303	108	Silicon, NPN, MPS 5172
Q304	108	Silicon, NPN, MPS 5172
Q305	108	Silicon, NPN, MPS 5172
Q306	108	Silicon, NPN, MPS 5172

Ref. No.	Genave Part No. B-500-	Description
Q307	100	Silicon, PNP, 2N 5227
Q308	100	Silicon, PNP, 2N 5227
Q309	100	Silicon, PNP, 2N 5227
Q310	110	Silicon, NPN, MPS 5224
Q311	101	Silicon, NPN, MPS 6532
Q312	103	Silicon, NPN, 2N 5220
Q313	111	Silicon, NPN, MPS U05
Q314	100	Silicon, PNP, 2N 5227
Q401	102	Silicon, NPN, Blue Dot, SPS 1528
Q402	102	Silicon, NPN, Blue Dot, SPS 1528
Q403	102	Silicon, NPN, Blue Dot, SPS 1528
Q404	102	Silicon, NPN, Blue Dot, SPS 1528
Q501	112	Silicon, NPN, EL 617
Q601	108	Silicon, NPN, MPS 5172
Q602	108	Silicon, NPN, MPS 5172
Q603	108	Silicon, NPN, MPS 5172
Q604	108	Silicon, NPN, MPS 5172
Q605	108	Silicon, NPN, MPS 5172

RESISTORS

Ref. No.	Genave Part No. B-500-	Description
R101	88	Wire Wound, 27 ohm, 5 W, 10%
R102	61	2.2 K, ½ W, 10%
R103	50	220 ohm, ½ W, 10%
R104	54	470 ohm, ½ W, 10%
R105	86	Wire Wound, 33 ohm, 2 W, 10%
R106	89	Trimmer, 100 ohm, ¼ W, 20%
R107	85	Wire Wound, 11 ohm, 2 W, 10%
R108	81	220 ohm, 1 W, 10%
R109	46	10 ohm, ½ W, 10%
R110	49	100 ohm, ½ W, 10%
R111	62	4.7 K, ½ W, 10%
R112	77	Metal Film, 475 ohm, ¼ W, 2%
R113	80	Metal Film, 2 K, ¼ W, 2%
R114	76	4.7 M, ½ W, 10%
R115	76	4.7 M, ½W, 10%
R116	52	330 ohm, ½ W, 10%
R117	54	470 ohm, ½ W, 10%
R301	54	470 ohm, ½ W, 10%
R302	66	10 K, ½W, 10%
R303	82	Metal Film, 10 K, 1%, ¼ W
R304	91	Trimmer, 5 K, ¼ W, 20%
R305	61	2.2 K, ½ W, 10%
R306	57	1 K, ½ W, 10%
R307	57	1 K, ½ W, 10%
R308	89	Trimmer, 100 ohm, ¼ W, 20%
R309	82	Metal Film, 10 K, 1%, ¼ W
R310	91	Trimmer, 5 K, ¼ W, 20%
R311	61	2.2 K, ½ W, 10%
R312		Unassigned
R313	57	1 K, ½ W, 10%
R314	56	680 ohm, ½ W, 10%
R315	82	Metal Film, 10 K, 1%, ¼ W
R316	70	22 K, ½ W, 10%
R317	83	Metal Film, 12 K, ¼ W, 2%
R318	56	680 ohm, ½ W, 10%
R319	56	680 ohm, ½ W, 10%
R320	56	680 ohm, ½ W, 10%
R321	56	680 ohm, ½ W, 10%
R322	56	680 ohm, ½ W, 10%
R323	56	680 ohm, ½ W, 10%
R324	56	680 ohm, ½ W, 10%
R325	56	680 ohm, ½ W, 10%
R326	56	680 ohm, ½ W, 10%
R327	56	680 ohm, ½ W, 10%
R328	56	680 ohm, ½ W, 10%
R329	56	680 ohm, ½ W, 10%
R330	56	680 ohm, ½ W, 10%
R331	56	680 ohm, ½ W, 10%
R332	56	680 ohm, ½ W, 10%
R333	67	12 K, ½ W, 10%
R334	59	1.5 K, ½ W, 10%
R335	75	470 K, ½ W, 10%
R336	62	4.7 K, ½ W, 10%
R337	62	4.7 K, ½ W, 10%
R338	57	1 K, ½ W, 10%
R339	54	470 ohm, ½ W, 10%
R340	66	10 K, ½ W, 10%
R341	55	560 ohm, ½ W, 10%
R342	66	10 K, ½ W, 10%
R343	55	560 ohm, ½ W, 10%
R344	90	Trimmer, 2.2 K, ¼ W, 20%
R345	63	3.3 K, ½ W, 10%
R346	56	680 ohm, ½ W, 10%
R347	49	100 ohm, ½ W, 10%
R348	56	680 ohm, ½ W, 10%
R349	56	680 ohm, ½ W, 10%
R350	84	270 ohm, 1 W, 10%
R351	49	100 ohm, ½ W, 10%
R352	54	470 ohm, ½ W, 10%
R353	57	1 K, ½ W, 10%
R354		Unassigned
R401	47	47 ohm, ½ W, 10%
R402	49	100 ohm, ½ W, 10%
R403	65	8.2 K, ½ W, 10%
R404	58	1.2 K, ½ W, 10%

Ref. No.	Genave Part No. B-500-	Description
R405	49	100 ohm, ½ W, 10%
R406	53	390 ohm, ½ W, 10%
R407	66	10 K, ½ W, 10%
R408	61	2.2 K, ½ W, 10%
R409	50	220 ohm, ½ W, 10%
R410	53	390 ohm, ½ W, 10%
R411	49	100 ohm, ½ W, 10%
R412	66	10 K, ½ W, 10%
R413	61	2.2 K, ½ W, 10%
R414	57	1 K, ½ W, 10%
R415	49	100 ohm, ½ W, 10%
R416	53	390 ohm, ½ W
R417	66	10 K, ½ W, 10%
R418	61	2.2 K, ½ W, 10%
R419	50	220 ohm, ½ W, 10%
R420	47	47 ohm, ½ W, 10%
R421	53	390 ohm, ½ W, 10%
R422	61	2.2 K, ½ W, 10%
R423	48	15 ohm, ½ W, 10%
R424		Unassigned
R501	49	100 ohm, ½ W, 10%
R502	52	330 ohm, ½ W, 10%
R503		Unassigned
R601		
R602	57	1 K, ½ W, 10%
R603	66	10 K, ½ W, 10%
R604	68	15 K, ½ W, 10%
R605	57	1 K, ½ W, 10%
R606	70	22 K, ½ W, 10%
R607	57	1 K, ½ W, 10%
R608	57	1 K, ½ W, 10%
R609	73	82 K, ½ W, 10%
R610	90	Trimmer, 2.2 K, ¼ W, 20%
R611	72	33 K, ½ W, 10%
R612	65	8.2 K, ½ W, 10%
R613	61	2.2 K, ½ W, 10%
R614	74	150 K, ½ W, 10%
R615	64	6.8 K, ½ W, 10%
R616	61	2.2 K, ½ W, 10%
R617	92	Trimmer, 20 K, ¼ W, 20%
R618	71	27 K, ½ W, 10%
R619	62	4.7 K, ½ W, 10%
R620	62	4.7 K, ½ W, 10%
R621		Unassigned
R633	61	2.2 K, ½ W, 10%
R634		Unassigned

SWITCHES

Ref. No.	Genave Part No. B-500-	Description
SW101	153	Off/On
SW301	158	Ident.
SW302	153	Mode Selector
SW303	140	A Code Selector
SW304	139	B Code Selector
SW305	140	C Code Selector
SW306	139	D Code Selector

TRANSFORMERS

Ref. No.	Genave Part No. B-500-	Description
T101	128	Power
T401	125	First IF
T402	126	Second IF
T403	126	Third IF
T404	126	Fourth IF
T405	127	Fifth IF

TUBES

Ref. No.	Genave Part No. B-500-	Description
V501	121	Pencil Triode, 4058

MISCELLANEOUS

Ref. No.	Genave Part No. B-500-	Description
J102	225	Connector, 16 Pin Female
P102	226	Connector, 16 Pin Male
J501	221	Connector, UG 1094/U
J502	224	Connector, Banana Jack, Sub-Miniature
P502	223	Connector, Banana Plug, Sub-Miniature
J503	219	Connector, Phono Female
P503	220	Connector, Phono Male
J504	219	Connector, Phono Female
P504	220	Connector, Phono Male
J601	216	Connector, Phono Female, Screw-In
	227	Cover, Connector, J102 and P102

HARDWARE

Ref. No.	Genave Part No. B-500-	Description
	133	Knob, Code Selector
	138	Code Selector Dial
	159	Panel, Trim
	163	Panel, Sub
	164	Panel, Right Side (Notched)
	165	Panel, Left Side
	166	Panel, Rear
	167	Panel, Shield
	169	Panel, Top
	170	Rack, Mounting
	171	Shield, H.V.
	174	Clip, Retaining
	177	Plug, Button