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AIRBORNE TRANSISTORIZED TELEMETER SYSTEM MODEL SST-I

by R. J. Stattel and J. E. Pownell

Goddard Space Flight Center
Greenbelt, Md.

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SUMMARY

The SST-1 Telemeter System is a small, light, 16-channel, pulse-position/amplitude (PPM/AM) modulated system developed to replace the AN/DKT-7 telemetry transmitter. It is intended for use in small sounding rockets and is compatible with existing ground station facilities. Features discussed include low power consumption, component type standardization, reduction of adjustment requirements, and reliability.

CONTENTS

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INTRODUCTION

The SST-1 Telemeter System (Figure 1) is a 16-channel, pulse-position/amplitude (PPM/AM) modulated system developed by the Goddard Space Flight Center as a replacement for the AN/DKT-7 telemetry transmitter. The AN/DKT-7 is proven, reliable equipment, as evidenced by its extensive use with Aerobee sounding rockets. The bulk and weight of the unit, however, do not permit application to smaller rockets such as the Nike-Apache or the Nike-Cajun.

The design goals required a small, lightweight, expendable unit, suitable for use with smaller sounding rockets and compatible with existing PPM/AM ground station facilities. Secondary goals included low power consumption, component type standardization, elimination of selected components, reliability, and reduction of adjustment requirements, both at the factory and in the field.

Visual comparison of the SST-1 system with the AN/DKT-7 (Figure 2) indicates how well the goals have been realized. Several major characteristics are directly compared below:

CHARACTERISTIC	AN/DKT-7	SST-1	REDUCTION
Volume (cubic inches)	891	100	89%
Weight (pounds)	19	5.5	71%
Power Consumption (watts)	175	25	86%

In addition, the three-unit design of the SST-1 system permits several options when fitting the system to space requirements of a sounding rocket. An example of this flexibility is the installation designed for Nike-Apache 14.111GT (Figure 3). The low power consumption with corresponding weight and volume savings permits increased vehicle maximum altitude and/or instrument payload.

With few exceptions, standard components are used throughout, and particular effort was made to minimize the number of different types used. The premodulator, for example, uses only five types of diodes and four types of transistors. Only eight components in the SST-1 system are

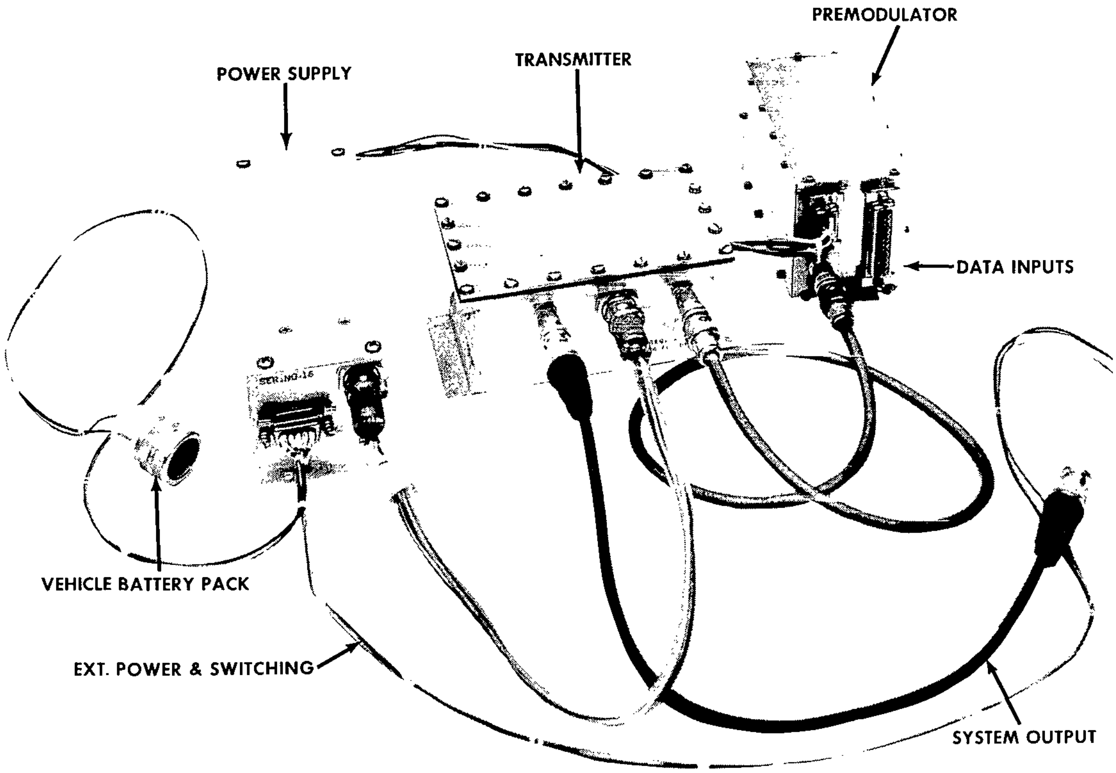


Figure 1—General view of SST-1 telemeter system.

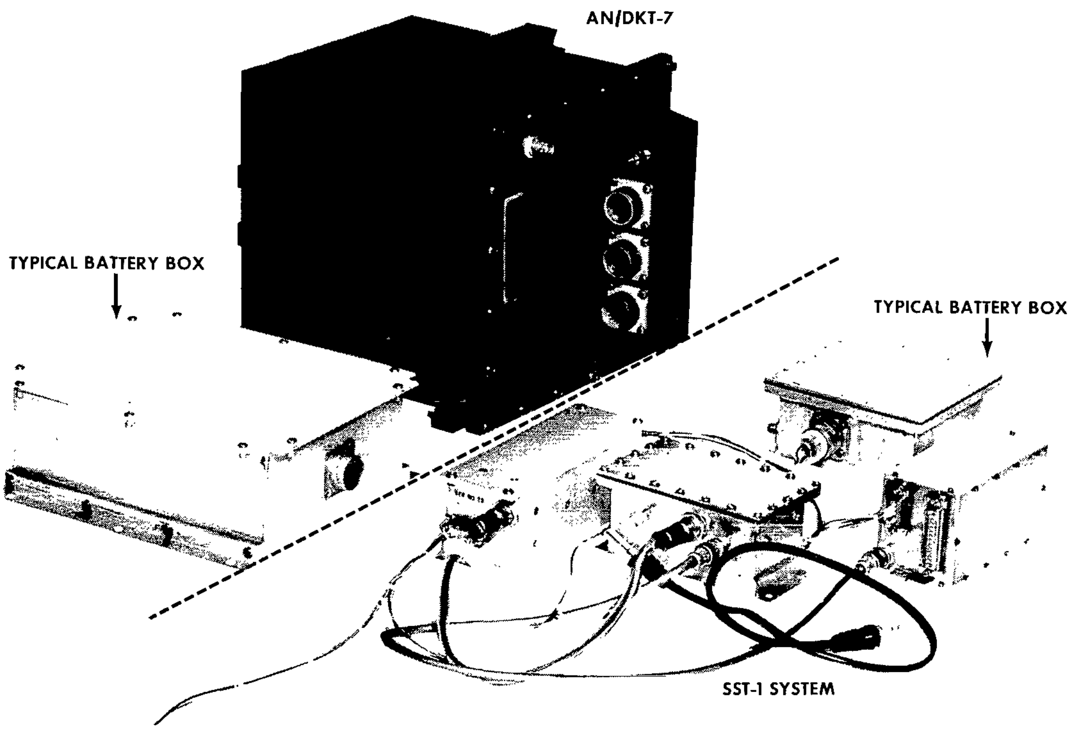


Figure 2—Comparison of SST-1 telemeter system with AN/DKT-7 telemetry transmitter.

selected or adjusted. Choke and coil windings in the transmitter and the toroidal transformer of the power supply are specially designed for this telemetry application.

In the assembly and testing of the SST-1 system, the transmitter and premodulator clock require factory calibration. The system will not normally require field adjustment or calibration. If one unit of the system should fail to operate properly, a replacement can be readily substituted without affecting either of the remaining units in the system.

By comparison, component selection and adjustment requirements for the AN/DKT-7 cannot readily be designated since many of the adjustments are interacting and must be repeated several times for optimum circuit operation. The procedure necessary to select and match the input tubes provides an illustration of the problem.

With the AN/DKT-7 warmed up and twenty or more tubes warmed up in a holding circuit, one tube in the unit is selected as a reference, and the guard bands are adjusted to that tube. Each of the succeeding input tubes (14 or 15, depending on unit model), is then matched to the reference tube by substitution. The stability of the reference must be regularly verified and, if necessary, the guard bands must be readjusted. When this occurs, all tubes previously matched must also be verified, substituting again as required.

A representative system, which was compared to the SST-1 system and which utilizes frequency division multiplex (FM/FM) modulation, requires over forty separate set-up adjustments. In addition to indirect costs for man-hours expended in bench and field adjustments, the basic equipment cost for sixteen FM/FM data channels is approximately double the cost of the SST-1 system.

Finally, reliability of the new equipment should equal or exceed that of the equipment it replaces. In the SST-1 system, extensive use of solid state components, combined with full vacuum potting of premodulator and power supply circuits, has provided improved resistance to extremes of shock, vibration, altitude and temperature. All flight prototypes have been subjected to exhaustive bench and environmental testing for vibration and shock based on flight parameters of the Aerobee and the Apache rockets. Test results have shown the accuracy of transmitted data, under all conditions, to be well within one percent of the full-scale data inputs. One premodulator has been vibration-tested at forces exceeding 60G without failure.

The SST-1 system has been installed on several Aerobee flights, including 4.15 GG, 4.31 GG, 4.60 GT, 4.81 GG, 4.87 GT, and 4.88 GT and on one Apache flight, 14.111 GT, with uniformly successful performance. For Aerobee flight 4.88 GT launched at White Sands Missile Range (WSMR) on 28 January 1964, two systems were provided, transmitting at 234.0 and 248.6 megacycles. One of the premodulator units installed had been recovered from an earlier flight (4.87 GT). Both systems functioned throughout flight, impact and recovery; continuing to transmit data until the payload was returned to the launch area by helicopter. The premodulator mentioned above was recovered along with several other units. These have now been examined for physical damage, retested, and are ready for installation on future payloads.

Appendix A contains a summary of specifications for the SST-1 system; appendix B contains schematic diagrams; and appendix C contains installation diagrams.

SYSTEM DESCRIPTION

Physical Characteristics

The SST-1 Telemetry System consists of three basic functional units: premodulator, power supply, and transmitter. These units and their associated cable assemblies are shown in Figure 1. Interconnecting wiring diagrams and connector pin assignments are shown in the System Block Diagram (Figure 4). Each unit of the system is completely enclosed in an aluminum alloy housing meeting the dimensional requirements of NASA-GSFC, Code 671.3 drawings C-023, C-024 and F-014 (See Appendix C). The premodulator and the power supply are built up of "cordwood" modules, vacuum-potted with Dow-Corning Sylgard 184 resin after assembly. The transmitter components are assembled on an aluminum alloy chassis which acts also to shield some of the operating functions. After assembly, the transmitter enclosure is sealed and pressurized to one atmosphere (14.7 psia), using dry air.

Operating Characteristics

Power Requirement

The nominal power requirement for the system is 28 volts, direct current (vdc), 0.9 ampere. Since the output of vehicle battery packs may range from 35 vdc to 26 vdc, the power supply is designed to provide regulated voltages to the premodulator and the transmitter for any input within this range. A latching relay in the power supply permits remotely controlled operation of the system using either vehicle or external power sources up to the moment of launch.

Data Inputs

The premodulator accepts and converts data inputs to pulse position modulated (PPM) format. The data inputs have a nominal linear range of 0 to 5 vdc. Overloads to plus 10 vdc or to minus 3 vdc can be sustained without damage to the system or adverse effect on other data channels. Such overloads are reflected in the format only to the extent of indications of "over high limit" or "below low limit."

System Output

The system output consists of a series of three-microsecond bursts of radio frequency energy in the format shown in Figure 5. Detailed elements contributing to the format are shown in Figures 6 and 7. Minimum transmitter output is 30 watts peak. Carrier frequency is selected in the range of 225 to 250 megacycles, depending upon the requirements of individual payloads and

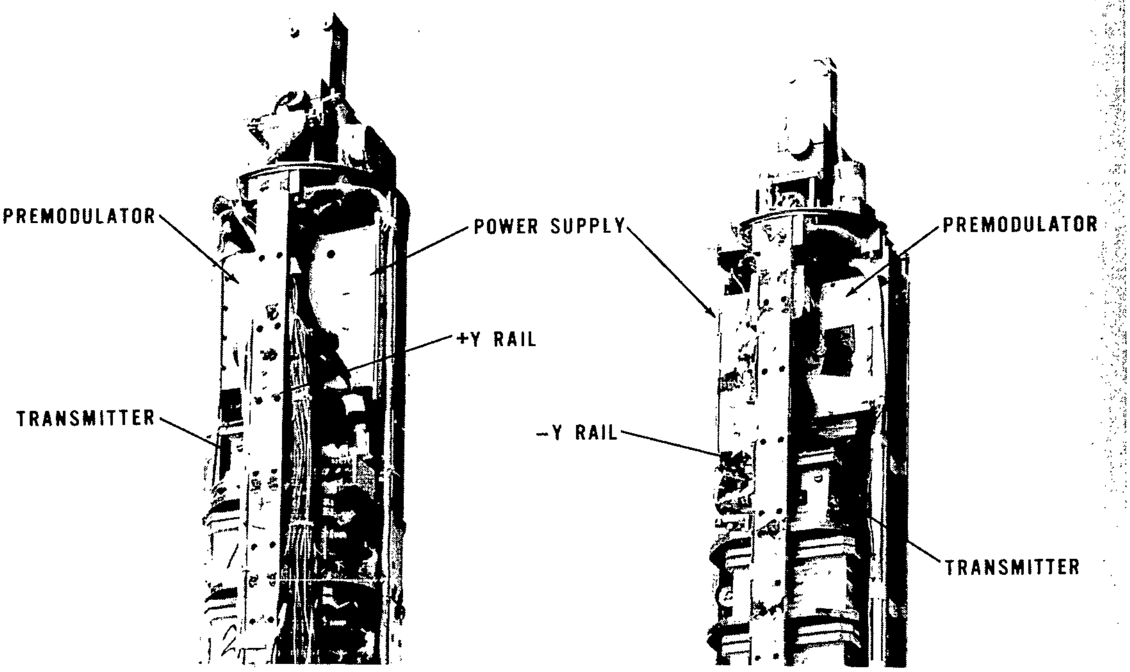


Figure 3—The SST-1 telemetry system as installed on the Nike-Apache 14.111 GT.

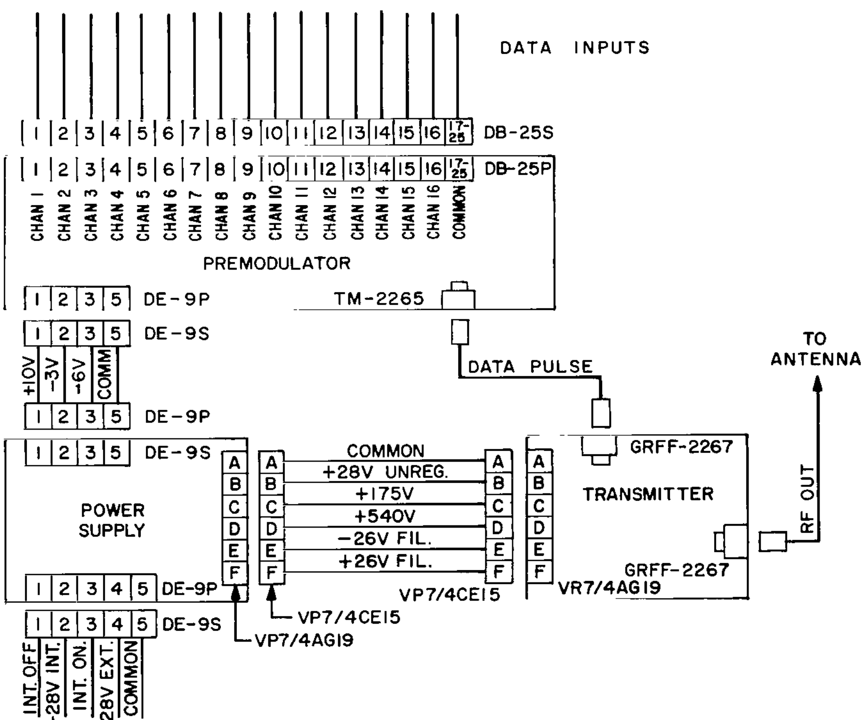


Figure 4—Block diagram of the SST-1 telemeter system.

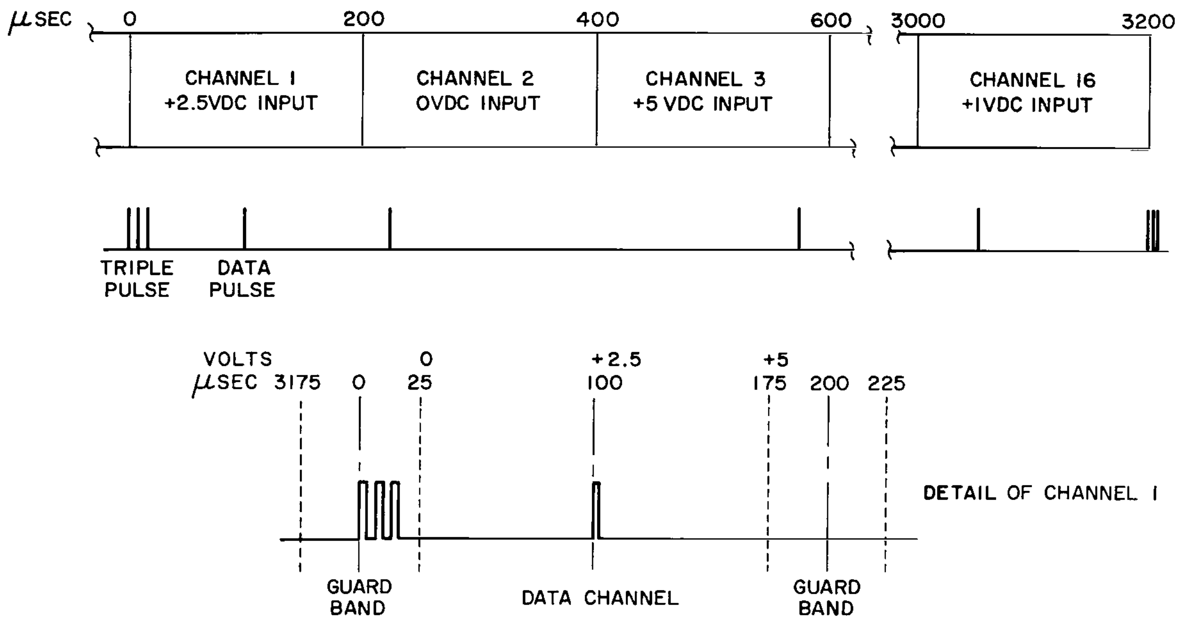


Figure 5—Basic information format for the SST-1 telemeter system.

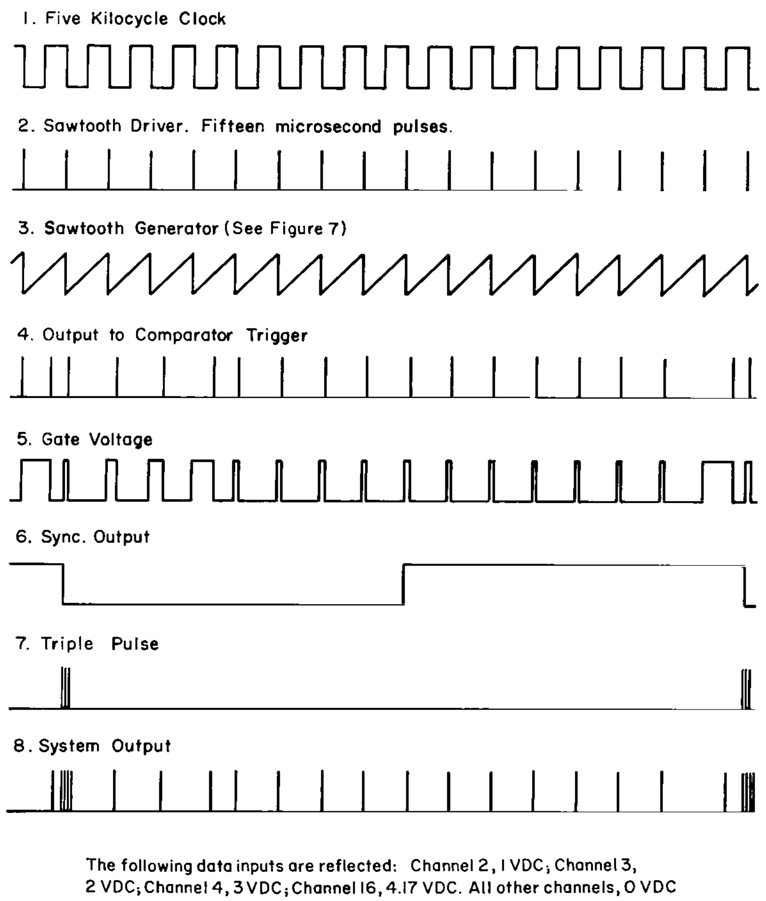


Figure 6—Information format elements for the SST-1 telemeter system.

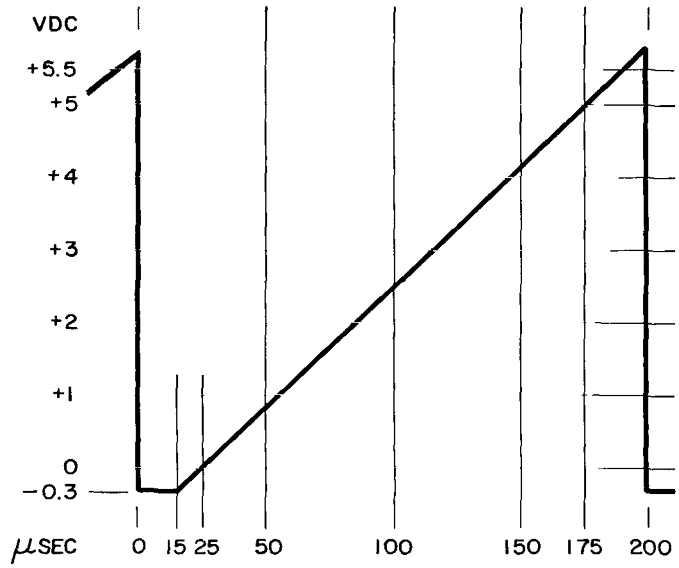


Figure 7—Sawtooth generator output waveform.

the frequencies approved for use at the launch site. Each transmitter is set to its assigned frequency by selection of the appropriate crystal oscillator.

The output format selected for the SST-1 differs from the AN/DKT-7 format in placement of the synchronizing triple pulse within the format and in the relationship of the data input voltage level to the data pulse position. In the AN/DKT-7 format, the triple pulse is initiated at the midpoint of channel 16, reducing the effective data transmission width of the channel from 150 to approximately 55 microseconds (zero to plus 2 VDC). The leading edge of the SST-1 triple pulse (Figure 5) coincides with the beginning of channel 1, placing the entire triple pulse cycle within the 25 microsecond guard band and permitting full-scale data transmission on all channels. Data pulse position in the AN/DKT-7 format is based on a descending ramp voltage and in the SST-1 format on a rising ramp voltage, reversing the time-voltage relationship. These differences must be compensated for when correlation of data involving both systems is attempted.

PREMODULATOR

Description

Conversion of the experiment data inputs to the PPM format (Figure 5) is accomplished by the premodulator (Figure 8). Each function contributing to the data conversion process is reflected in the assembly of the premodulator by modules which may be individually tested both before and after final assembly. Defective components are readily isolated and corrective measures may be completed without disturbing other modules or functions. If necessary, a complete module may be

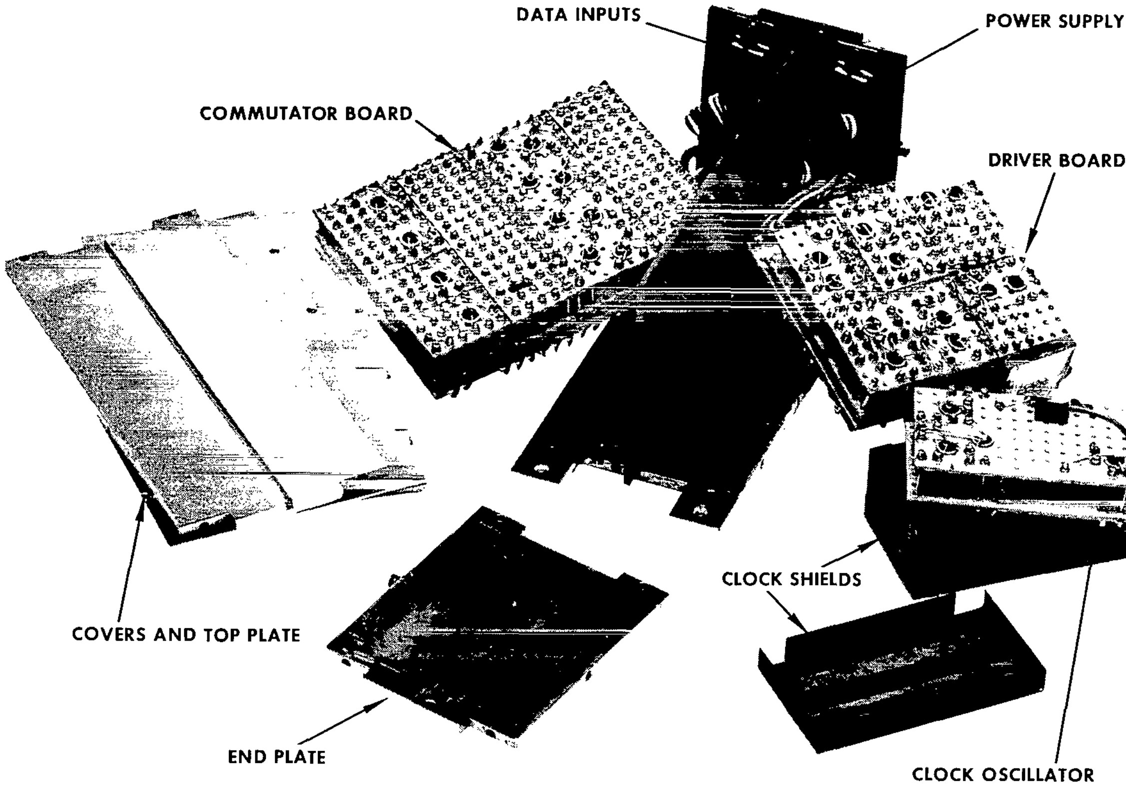


Figure 8—View of components of the SST-1 premodulator.

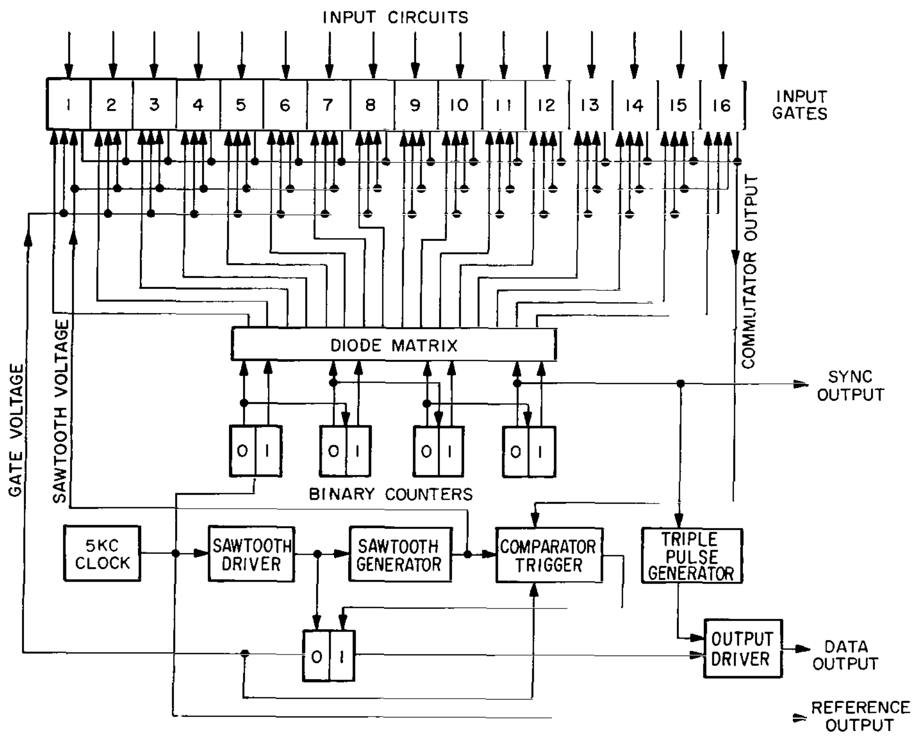


Figure 9—Premodulator block diagram.

removed and replaced. The enclosure for the preproduction units has been designed to permit access to all areas of the wired and assembled unit at any time throughout the life of the equipment.

Functionally, the premodulator consists of three major subassemblies: The 5-kilocycle clock-oscillator; the driver board; and the commutator board. The clock oscillator is a separate, shielded subassembly which provides basic timing reference. The commutator board consists of ten functional modules assembled on a common base: four identical flip-flops comprising a binary counter; a standard sequential diode matrix; four identical input gate modules, each having four identical circuits; and an input circuit board. The driver board has six functional modules assembled to a common base: the sawtooth driver; the sawtooth generator; the comparator trigger; the gate flip-flop; the triple pulse generator; and the output one-shot. The relationship of the various modules is shown in Figure 9 and in the schematic diagrams (Appendix B).

Operating Characteristics

The premodulator is designed to operate with closely regulated voltages of plus 10 vdc, minus 3 vdc, and minus 6 vdc, provided by the system power supply. As noted above, in the general description of the system, the data inputs supplied to the premodulator are in the range from zero to plus 5 vdc.

Basic timing reference for the premodulator is provided by the five-kilocycle clock-oscillator, a highly stable Clapp inductance-capacitance oscillator. As the final assembly step, the room temperature clock rate is set to within 10 cycles per second of 5 kilocycles by selection of capacitor C-35. The sine wave oscillator output is shaped and amplified by a three-stage transistor circuit (Q-26, Q-27 and Q-28) to produce the square wave clock output (line 1 of Figure 6). The trailing edge of the square wave triggers the first flip-flop of the binary counter and the sawtooth driver module, synchronizing the commutation and driver functions of the unit.

A distinctive feature of the SST-1 system is the input gate circuit. The circuit design is a key factor in weight reduction and low power consumption. Earlier PPM systems employed various means to multiplex data inputs in analog form, before comparison and generation of the positioned data pulse. In the SST-1, data conversion is a one-step process performed by the input gates. The one-channel functional diagram (Figure 10) illustrates the essential elements of the function.

The data input voltage is applied to the base of the 2N936 input gate transistor through the input circuit module. Negative overloads are limited to minus 0.2 vdc at channel 1 by the 1N100 input circuit diode and to minus 0.7vdc at channels 2 through 16 by 1N626 diodes. Channel 1 is more closely limited to avoid possible interference with the triple pulse cycle. The sawtooth driver pulse (line 2 of Figure 6) triggers the sawtooth generator and gate flip-flop, 15 microseconds after the beginning of each channel. The sawtooth generator output (line 3 of Figure 6) is applied simultaneously to the emitters of the input gate transistors through 1N798 diodes. The plus 10 vdc output of the gate flip-flop (line 5 of Figure 6) is similarly applied to the emitters through 5.1 K ohm resistors.

The emitters are normally held at minus 3 vdc through the diode matrix and binary counter networks until the count sequence enables the channel by applying a positive voltage to all four matrix diodes. The sawtooth voltage then appears on the emitter. When the sawtooth voltage reaches the level of the data input voltage, the input gate transistor is driven into conduction. The resulting collector output (line 4 of Figure 6) is applied to the comparator trigger module, which provides a negative-going pulse to reset the gate flip-flop and cutting off the gate voltage at the input gate transistor. The emitter then returns to minus 3 vdc and turns off the transistor. Cut-off of the gate voltage also triggers the output one-shot module, producing the positioned data pulse.

In the sequence described above, the input gate transistor is in conduction for less than one microsecond in each frame period of 3200 microseconds, placing negligible current drain on the data input. During development, test units were operated with 50 megohm input circuit resistors in place of the standard one megohm values. With these high values, no appreciable voltage developed due to transistor forward conduction or reverse leakage current. Input impedance was measured at 50 megohms.

The 1-megohm value shown is standard and has been selected as suitable for a majority of applications. Higher values can be provided, if necessary, to meet special conditions; however, higher resistance requires particular attention to shielding the data inputs.

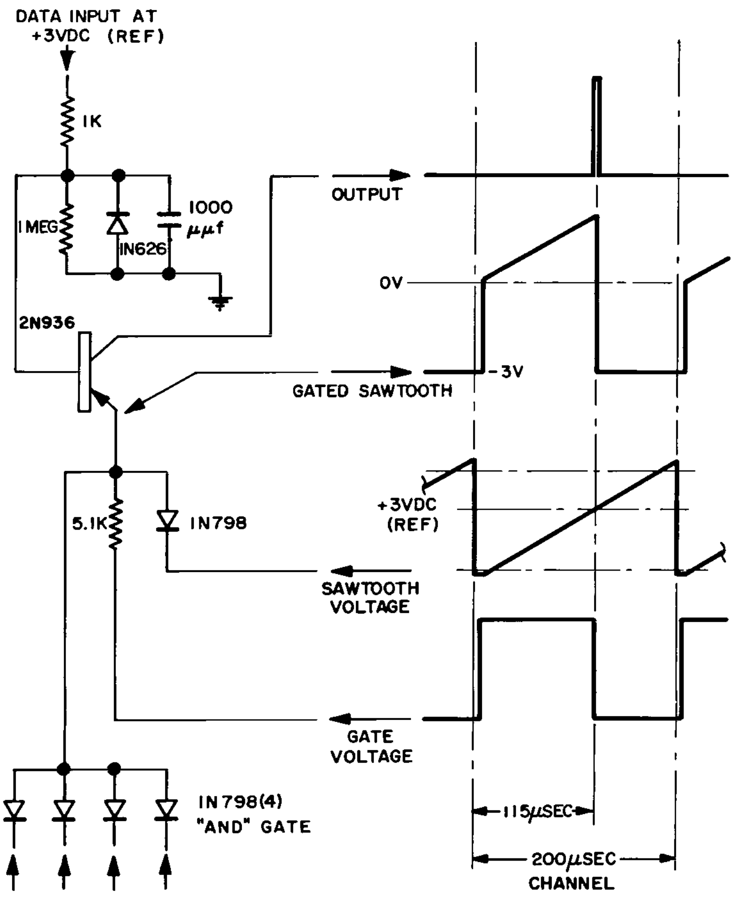


Figure 10—Premodulator single channel block diagram and output waveforms.

In the case of a positive data input overload, the emitter of transistor Q-34, in the comparator trigger module, is connected through diode D-112 to the sawtooth generator output, and through resistor R-114 to the gate flip-flop output; thus partially duplicating the input gate circuit. A voltage splitter, R-111 and R-112, provides a nominal plus 5.2 vdc to the base of Q-34. When the sawtooth voltage reaches the level of the base voltage, Q-34 is driven into conduction, triggering the comparator trigger output.

The sawtooth voltage continues to rise during each channel, as shown in Figure 7, until the leading edge of the next sawtooth driver pulse drives transistor Q-38 into conduction, discharging the capacitors and returning the output to the slightly negative starting point for the next channel.

Ground station functions are synchronized with the transmitted data by the triple pulse shown in the frame format (Figure 5). When the fourth flip-flop in the binary counter resets at the end of channel 16 (line 6 of Figure 5) the negative-going voltage triggers the triple pulse generator, a free-running multivibrator controlled by a one-shot circuit of sufficient duration to permit only three cycles, (line 7 of Figure 6). Spacing of the pulses is controlled by selected resistor R-136 and duration of the one-shot by selected resistor R-130.

Since the sawtooth voltage (Figure 7) begins its sweep at approximately minus 0.3 vdc, a negative data input at channel 1 could trigger a data pulse interfering with the triple pulse pattern. A negative "AND" gate, located in the gate flip-flop module (D-108, D-109, and R-102) prevents such interference by gating the gate flip-flop and triple pulse generator one-shot output, holding the output at terminal 9 of the gate flip-flop module positive until the triple pulse cycle is completed. Under normal conditions for triple pulse spacing and pulse width and with a maximum negative data input at channel 1, no data pulse will be triggered.

When the normal channel sampling rate of 312.5 samples per second is not adequate for the requirements of a particular data element, a minor modification to the wiring of the diode matrix module (Figure 11) permits the sampling rate of a particular channel to be doubled or quadrupled. As may be seen from the example, the increase in rate is reflected by a loss in the number of channels of data.

An increased sampling rate may also be obtained through altering the values of certain components to provide a higher clock rate. Several modified Premodulators, incorporating a 10-kilocycle clock, have been assembled and tested preparatory to flight installations in the near future. Environmental test results closely parallel those recorded for the standard 5-kilocycle units since physical changes in the modification are minimal. The 10-kilocycle rate appears to be a practical limit for modification to the basic design since higher rates require substantial component changes and revisions to the circuits.

During the testing program and in early flights, prototype units have exhibited excellent stability under all environmental conditions. Variation in rate has been maintained well within one percent and short-term jitter within the frame period of 3200 microseconds has not exceeded 0.1 microsecond.

POWER SUPPLY

Regulated voltages for operation of the premodulator and the transmitter are provided by the system power supply (Figure 12). As in the design of the premodulator, separate functions are reflected by modules which may be built up and independently tested before assembly. In flight, the unit operates on a nominal 28 vdc provided by the vehicle battery pack. A remotely controlled latching relay within the unit permits operation on either the vehicle or external power sources as well as on-off control up to the moment of launching.

The initial output of the vehicle battery pack, immediately after launch, may be as high as 35 vdc for a nominal 28 volt supply. The input regulator network (Appendix B) regulates the input voltage at any level from 26 to 35 vdc, providing 25 to 27 vdc to the transmitter, and to the chopper circuit (Q-5, Q-6). The chopper circuit output is applied to the primary winding of transformer T-1 which provides outputs of 10 and 17 vac through half-wave rectifier circuits to the low voltage regulator; and 300 vac to the high voltage power supply.

The low voltage regulator consists of three, series-type, adjustable voltage regulator circuits, providing plus 10 vdc ±½%, minus 3 vdc ±1%, and minus 6 vdc ±1% for operation of the premodulator. The high voltage power supply includes a voltage doubler-filter circuit providing both 550 vdc for the transmitter output stage and a half-wave rectifier-filter providing plus 175 vdc for the transmitter oscillator.

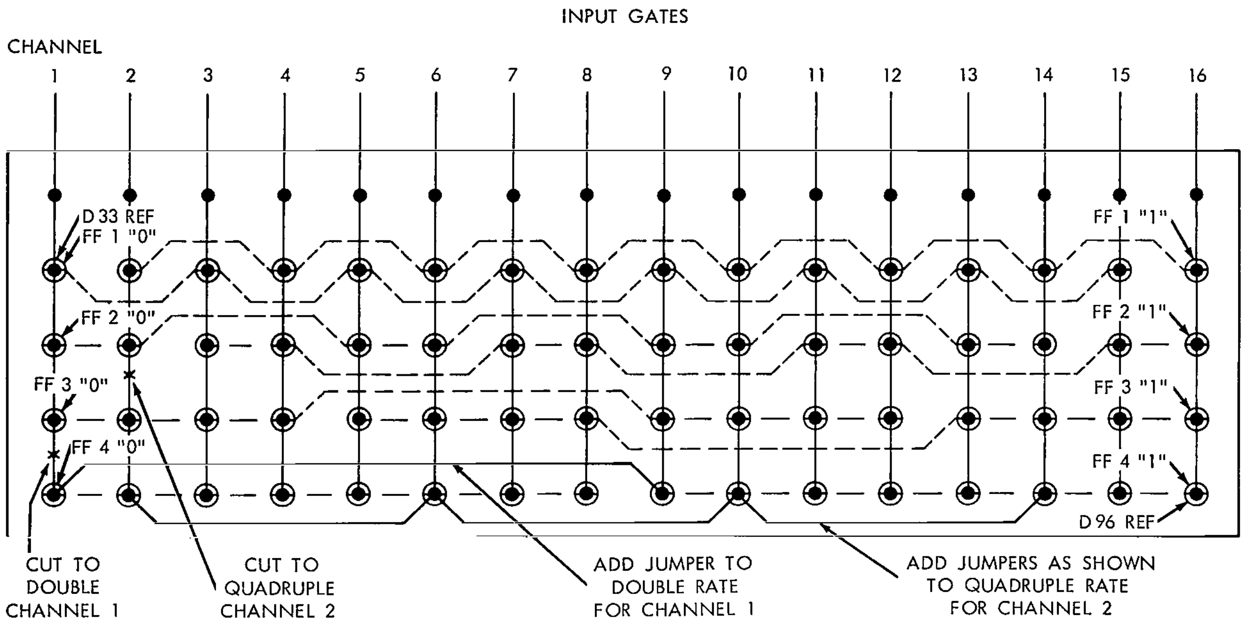
TRANSMITTER

The transmitter (Figures 13 through 16) is a four-stage cathode modulated pulse transmitter, designed to operate in the standard telemetry band of 225 to 250 megacycles. The transmitter output is a series of constant amplitude radio frequency pulses, duplicating the pulse width and spacing of the premodulator input. The unit is designed to produce a minimum of 30 watts peak power into an antenna load of 50 ohms impedance with a maximum vswr of 2:1.

The circuits employed are conventional, using three ruggedized, subminiature tubes. V-1 is a type 6021 dual triode, one section of which acts as the first stage oscillator; the other section serving as the second stage tripler. Refer to the schematic (Appendix B).

V-2 is a type 5718 single triode operating as the third stage driver-amplifier. V-3 is another type 6021 dual triode used as the fourth stage, push-pull, final amplifier.

In operation, the selected carrier frequency is applied to the grid of V-2 by the first and second stage networks of V-1. The cathodes of V-2 and V-3 are normally biased "off" by transistor Q-1 until an input pulse from the premodulator drives Q-1 into conduction, grounding the cathodes of V-2 and V-3 and sending rf energy to the output circuit.



Frame sequence: 1, 2, 3, 4, 5, 2, 7, 8, 1, 2, 11, 12, 13, 2, 15, 16.
Channels 6, 9, 10, & 14 not used.
Channel 1 sampling rate: 625 per second.

Channel 2 sampling rate: 1250 per second.
All other channels: 312.5 per second.
Total channels available: 12

Figure 11—Premodulator diode matrix diagram.

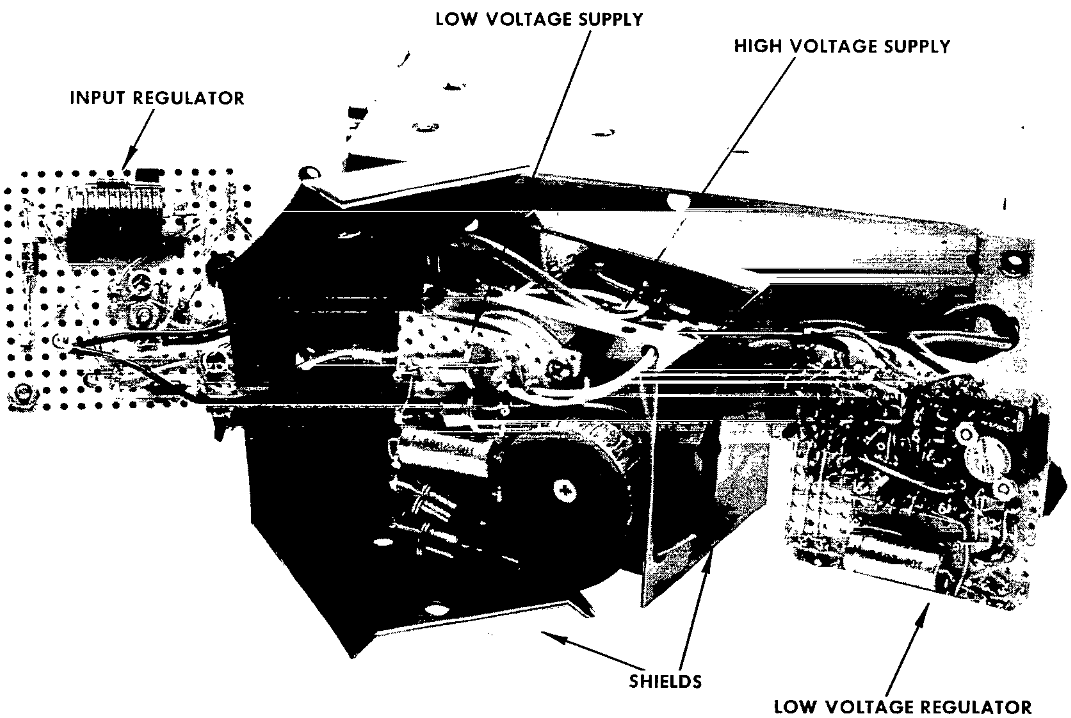


Figure 12—View of SST-1 power supply.

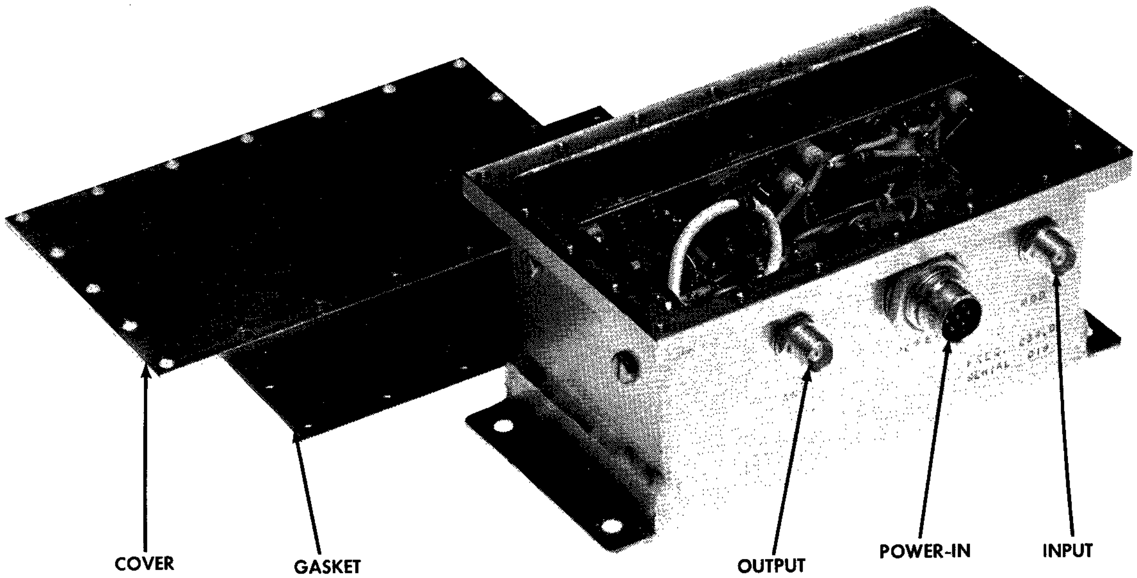


Figure 13—Overall view of the SST-1 transmitter.

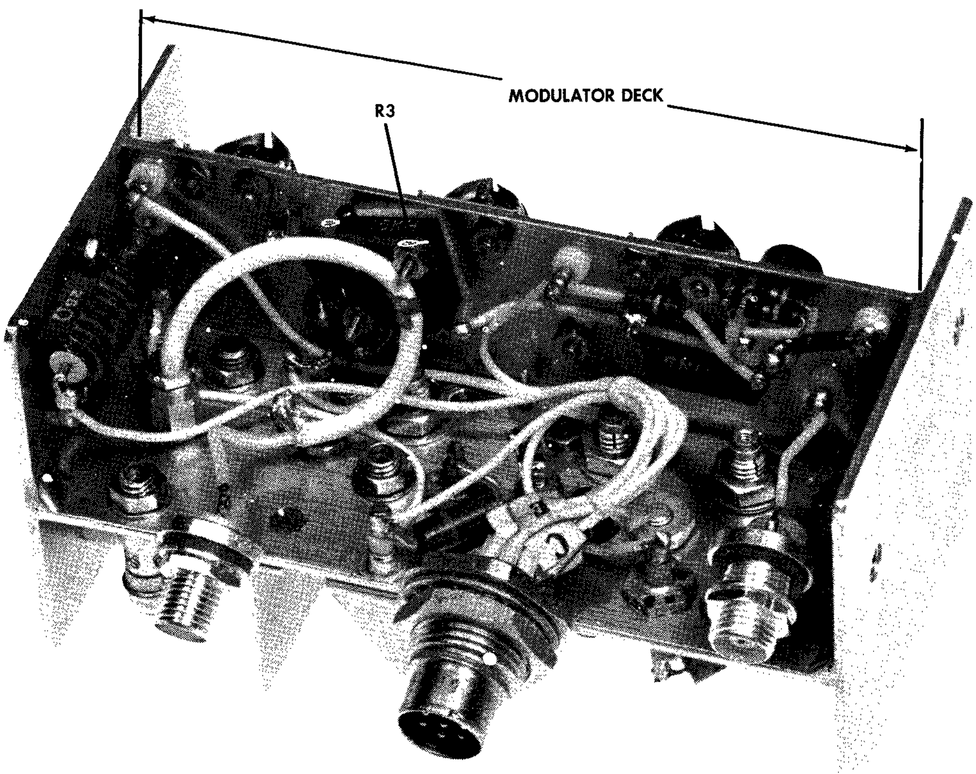


Figure 14—Top view of transmitter chassis.

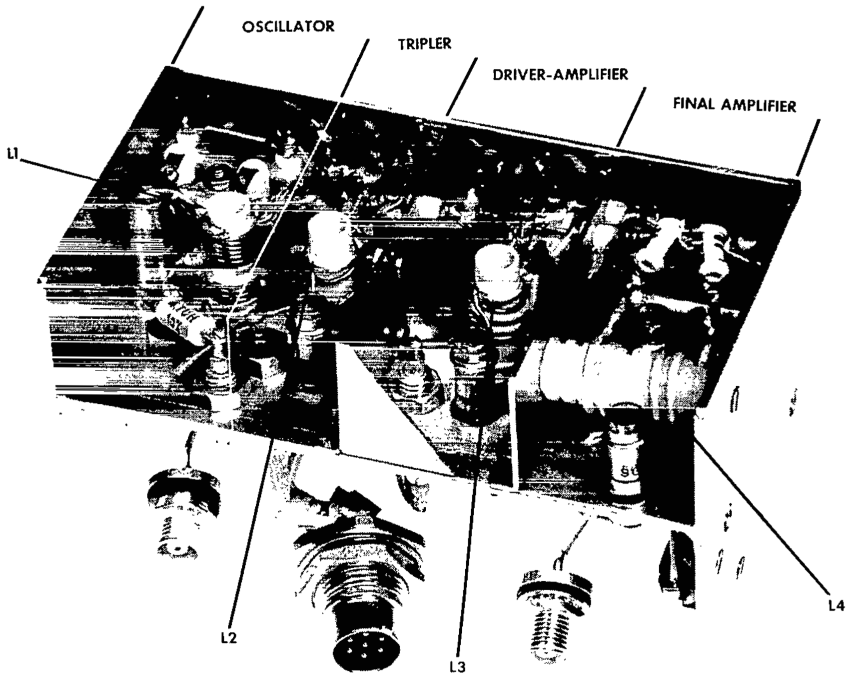


Figure 15—Bottom view of transmitter chassis.

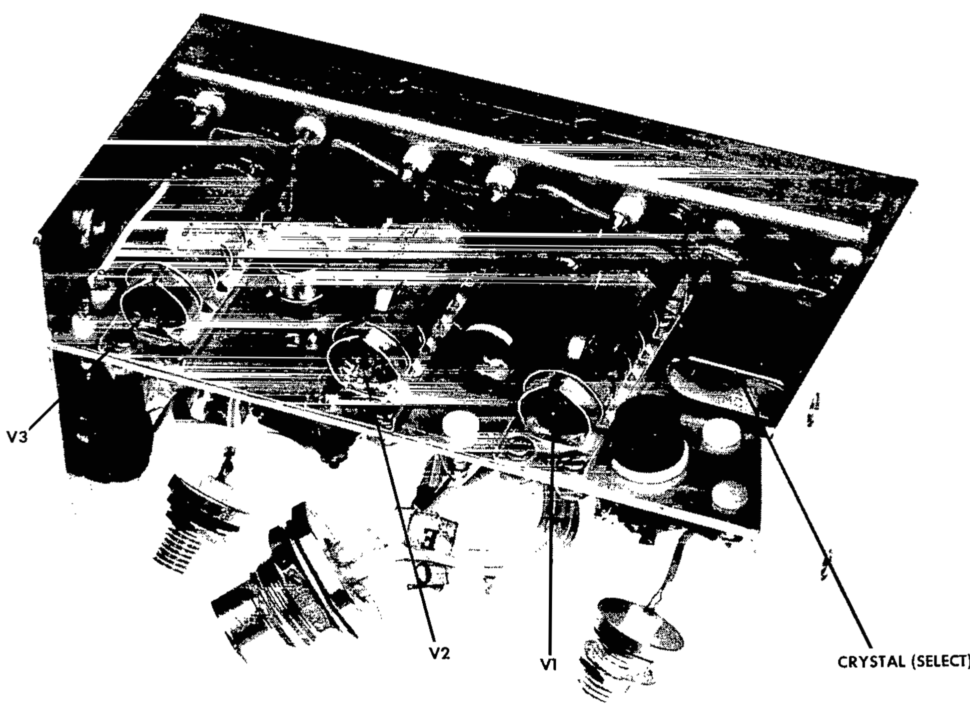


Figure 16—View of transmitter tubes and crystal oscillator.

CONCLUSION

As a result of the development of the SST-1 Telemetry System, pulse position modulation is available for use with the smaller sounding rockets such as Nike-Apache and Nike-Cajun. In the case of larger vehicles, such as Aerobee, where the AN/DKT-7 has been extensively used, PPM capability is continued with improved reliability and substantial savings in weight, volume and power consumption. Production quantities of the system are now on order to meet current commitments.

(Manuscript received June 12, 1964)

Appendix A

Summary of Specifications

ELECTRICAL

Power Input	26-35 vdc, 0.9 amp.
Data Inputs	
Number of Channels	16
Nominal Range	0 to plus 5 vdc
Overload	Minus 3 vdc to plus 10 vdc
Impedance	1 Megohm, shunted by 1000 $\mu\mu$f
Transmitter Frequency	225-250 Mc
Transmitter Output	30 W, peak
Pulse Width	3 microseconds
Channel Sampling Rate	312.5 per second

MECHANICAL

Weight	5.5 pounds
Volume	100 cubic inches
Vibration - All axes	
Random	20-2000 cps, 20G rms
Sinusoidal	10-3000 cps, 15G maximum
Shock - All axes	40G in 11 milliseconds
Altitude	No limit
Temperature	+70°C to -20°C

Appendix B

Schematic Diagrams

Schematic diagrams for the SST-1 Telemeter System are contained on pages 20 thru 23.

PARTS LIST FOR THE SST-1 PREMODULATOR

RESISTORS

R1 thru R16 = 1K
R17 thru R32 = 1 MEG
R33 thru R49 = 5.1K
R50 = 620Ω
R51 thru R54 = 3.9K
R55 = 620Ω
R56-R57 = 5.1K
R58 = 620Ω
R59 thru R62 = 3.9K
R63 = 620Ω
R64-R65 = 5.1K
R66 = 620Ω
R67 thru R70 = 3.9K
R71 = 620Ω
R72-R73 = 5.1K
R74 = 620Ω
R75 thru R78 = 3.9K
R79 = 620Ω
R80 = 5.1K
R81 = 12K
R82 = 4.7K
R83 = 100K
R84 = 5.1K
R85 = 220Ω
R86 = 62K
R87 = 10K
R88 = 1K

R89 = 20K
R90-R91 = 10K
R92 = 27Ω
R93 = 620Ω
R94 = 5.1K
R95 thru R98 = 3.9K
R99 = 620Ω
R100 = 5.1K
R101 = ________
R102 = 3K
R103-R104 = 20K
R105 = 1K
R106 = 10K
R107 = 8.2K
R108 = 15K
R109 = 1K
R110 = 2.2K
R111 = 12K
R112 = 13K
R113 = 27Ω
R114-R115 = 5.1K
R116 = 10K
R117 = 820Ω
R118 = 5.1K
R119 = 27Ω
R120 = 20K POT

R121 = 20K
R122 = 3K
R123 = 1K POT
R124 = 33K
R125 = 750Ω
R126 = 6.8K
R127 = 22K
R128 = 1K
R129 = 470Ω
R130 = **
R131 = 27Ω
R132 = 330Ω
R133 = 51Ω
R134 = 7.5K
R135 = 1K
R136 = **
R137 = 1K
R138 thru R140 = 5.1K
R141 = 27Ω
R142-R143 = 20K
R144 = 8.2K
R145 = 1K
R146 = 10K
R147 = 15K
R148-R149 = 1K
R150 = 680Ω

CAPACITORS

C1 thru C16 = 1000μμf
C17-C18 = 47μμf
C19-C20 = 120μμf
C21-C22 = 47μμf
C23-C24 = 120μμf
C25-C26 = 47μμf
C27-C28 = 120μμf
C29-C30 = 47μμf
C31-C32 = 120μμf
C33 = .047 μf
C35 = *
C36 = .01μf
C37 = .1μf
C38 = .05μf

C39 = .01 μf
C40 = .0033μf
C41 = 47 μf
C42-C43 = 47μμf
C44 = 470μμf
C45 = 120μμf
C46 = 47 μμf
C47-C48 = 120 μμf
C49 = 1000μμf
C50 = 560μμf
C51 = .005μf
C52-C53 = 1μf
C54 = .047μf
C55 = .01μf

C56-C57 = 1μf
C58 = 1.0μf
C59 = 47 μμf
C60 = 6800μμf
C61 = .47μf
C62 = 680μμf
C63-C64 = 1000 μμf
C65 = 1.0μf
C66 = 910μμf
C67-C68 = 390 μμf
C69 = 82μμf
C70-C71 = 120μμf
C72 = 330μμf
C73 = 1.0μf

DIODES

D1 = 1N100
D2 thru D16 = 1N626
D17 thru D96 = 1N798
D97 thru D104 = 1N626
D105 = 1N270

D106-D111 = 1N626
D112-D113 = 1N798
D114-D115 = 1N270
D116 = 1N626

D117 = 1N755A
D118-D119 = 1N270
D120 thru D125 = 1N100
D126 = 1N626

CHOKE

L1 = 130mh

TRANSISTORS

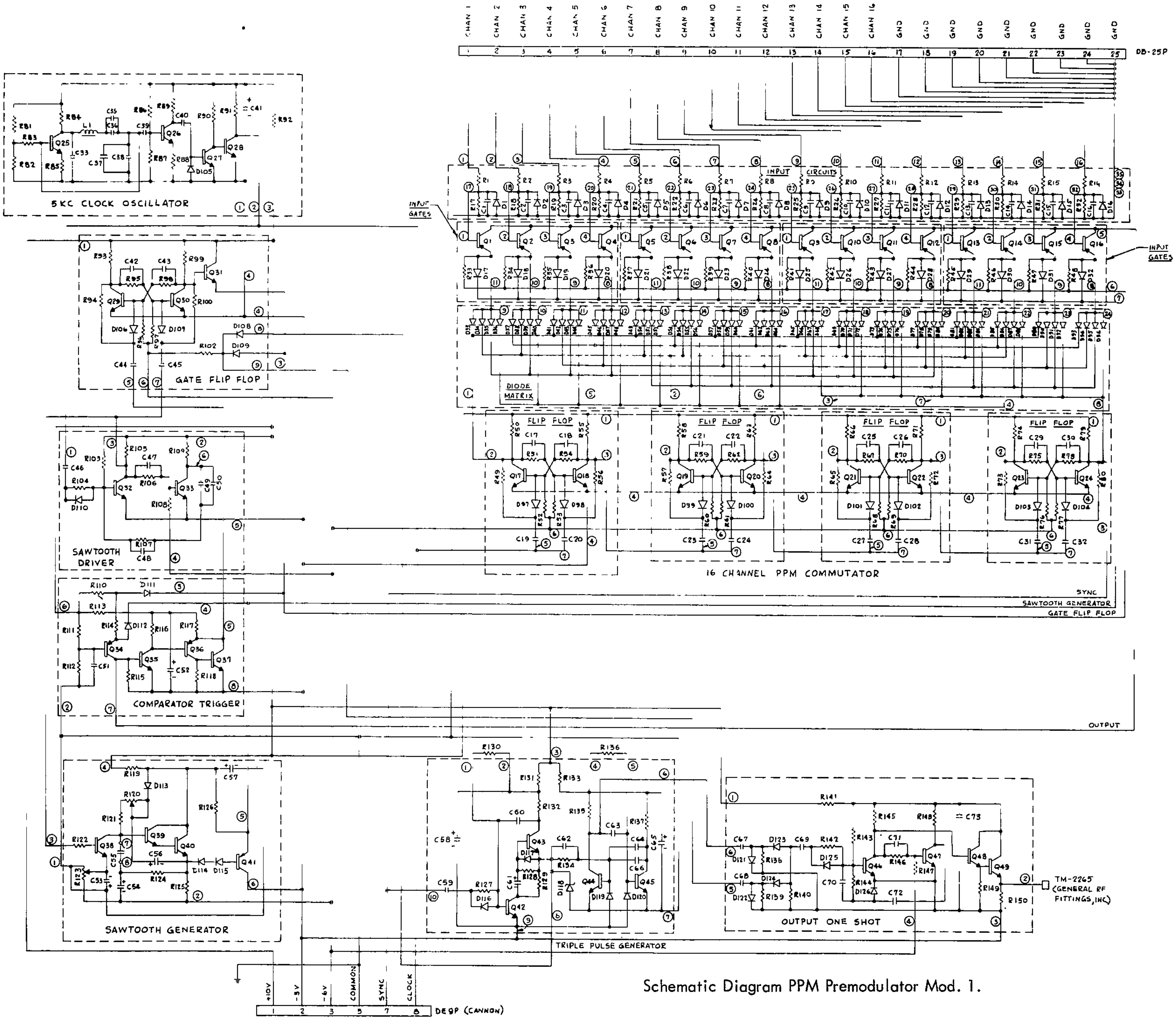
Q1 thru Q16 = 2N936
Q17 thru Q27 = 2N706
Q28 = 2N760
Q29 thru Q33 = 2N706

Q34 = 2N936
Q35 = 2N706
Q36 = 2N936
Q37-Q38 = 2N706

Q39-Q40 = 2N916
Q41 = 2N940
Q42 thru Q49 = 2N706

---

* = Selected capacitor to pad oscillator to 5 KC.
** = To be determined.



Schematic Diagram PPM Premodulator Mod. 1.

PARTS LIST FOR THE SST-1 POWER SUPPLY

RESISTORS

R1 = 20K	R11 = 430Ω	R21 = 300Ω
R2 = .5Ω	R12 = 100Ω POT	R22 = 300Ω
R3 = 470Ω	R13 = 430Ω	R23 = 300Ω
R4 = 3.3K	R14 = 3K	R24 = 4.7K
R5 = 150Ω	R15 = 1K	R25 = 3.9K
R6 = 5.1K	R16 = 300Ω	R26 = 560Ω
R7 = 5.1K	R17 = 100Ω POT	R27 = 50Ω POT
R8 = 150Ω	R18 = 6.8K	R28 = 1K
R9 = 5K	R19 = 5.1K	R29 = 160Ω
R10 = 2K	R20 = 2.7K	R30 = 1K

CAPACITORS

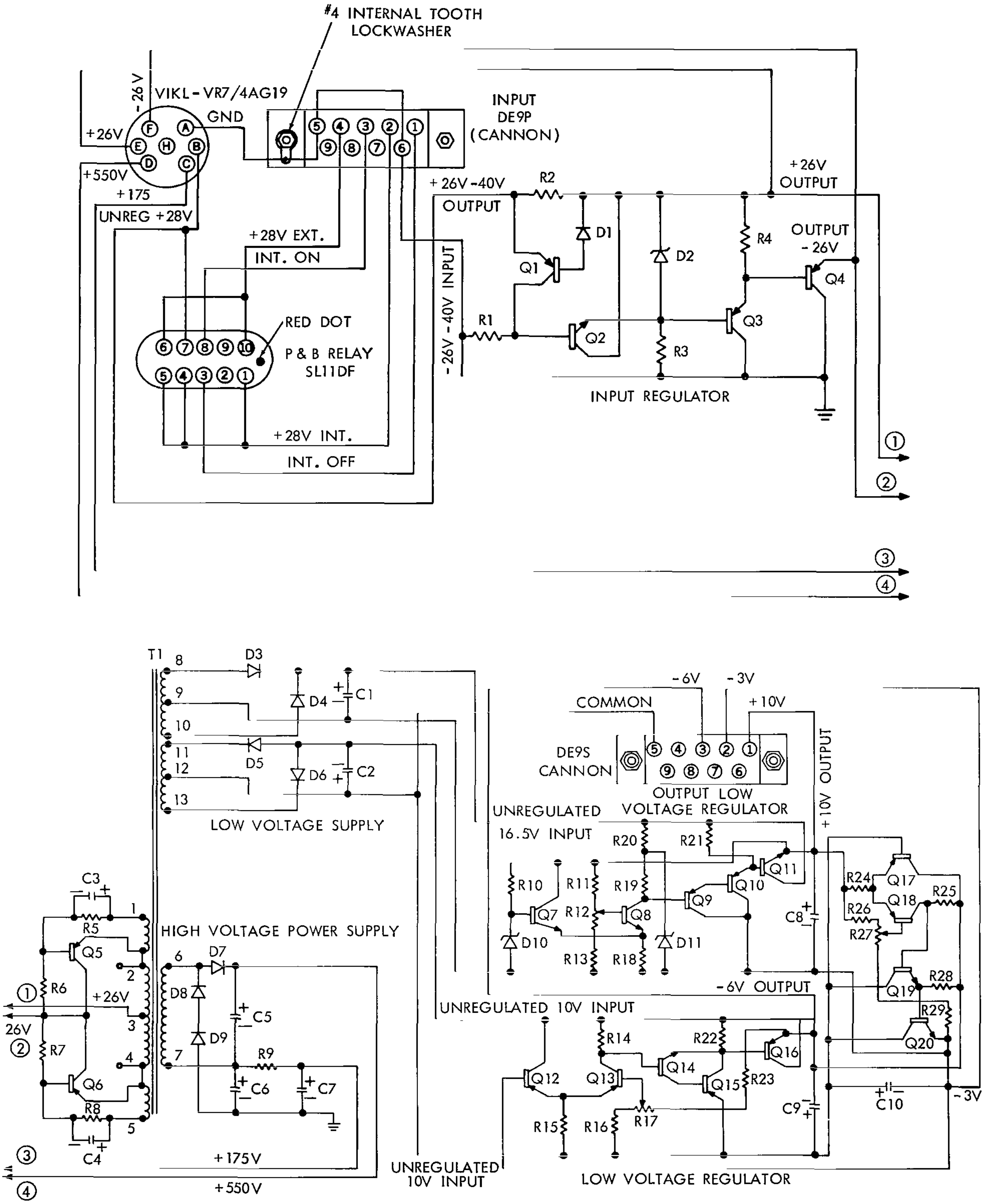
C1 = 100μf 20V	C6 = 3μf 300V
C2 = 100μf 20V	C7 = 3μf 300V
C3 = 1μf 35V	C8 = 100μf 20V
C4 = 1μf 35V	C9 = 100μf 20V
C5 = 4μf 450V	C10 = 100μf 20V

DIODES

D1 = 1N626	D7 = 1N561
D2 = 1N971B	D8 = 1N561
D3 = 1N540	D9 = 1N561
D4 = 1N540	D10 = 1N827
D5 = 1N540	D11 = 1N718
D6 = 1N540	

TRANSISTORS

Q1 = 2N936	Q11 = 2N2034
Q2 = 2N706	Q12 = 2N936
Q3 = 2N224	Q13 = 2N936
Q4 = 2N677C	Q14 = 2N706
Q5 = 2N677C	Q15 = 2N936
Q6 = 2N677C	Q16 = 2N328A
Q7 = 2N336	Q17 = 2N936
Q8 = 2N336	Q18 = 2N936
Q9 = 2N936	Q19 = 2N706
Q10 = 2N936	Q20 = 2N706



Schematic Diagram for SST-1 Power Supply.

PARTS LIST FOR THE SST-1 TRANSMITTER

RESISTORS

R1 = 22K 1/4W	R6 = 10K 1/4W
R2 = 15K 1/4W	R7 = 10K 1/4W
R3 = 15K 1/4W	R8 = 10K 1/4W
R4 = 1K 1/4W	R9 = 25Ω 5W
R5 = 10K 1/4W	R10 = 47Ω 5W

CAPACITORS

C1 = .001μf	C15 = .001μf
C2 = 1500μμf	C16 = .001μf
C3 = 1-28μμf	C17 = .001μf
C4 = 100μμf	C18 = .001μf
C5 = 1500μμf	C19 = .001μf
C6 = 1500μμf	C20 = .001μf
C7 = .8-8.5μμf	C21 = .8-4.2μμf
C8 = 5μμf	C22 = .001μf
C9 = .001μf	C23 = .8-8.5μμf
C10 = .001μf	C24 = 1.5μμf
C11 = .8-8.5μμf	C25 = 1.5μμf
C12 = .001μf	C26 = .1μf
C13 = .001μf	C27 = .1μf
C14 = .001μf	

DIODE

CR1 = 1N798

CHOKES

RFC1 = 4.7μh	RFC7 = .68μh
RFC2 = .68μh	RFC8 = .68μh
RFC3 = .68μh	RFC9 = .68μh
RFC4 = .68μh	RFC10 = .68μh
RFC5 = .68μh	RFC11 = .68μh
RFC6 = .68μh	RFC12 = .68μh

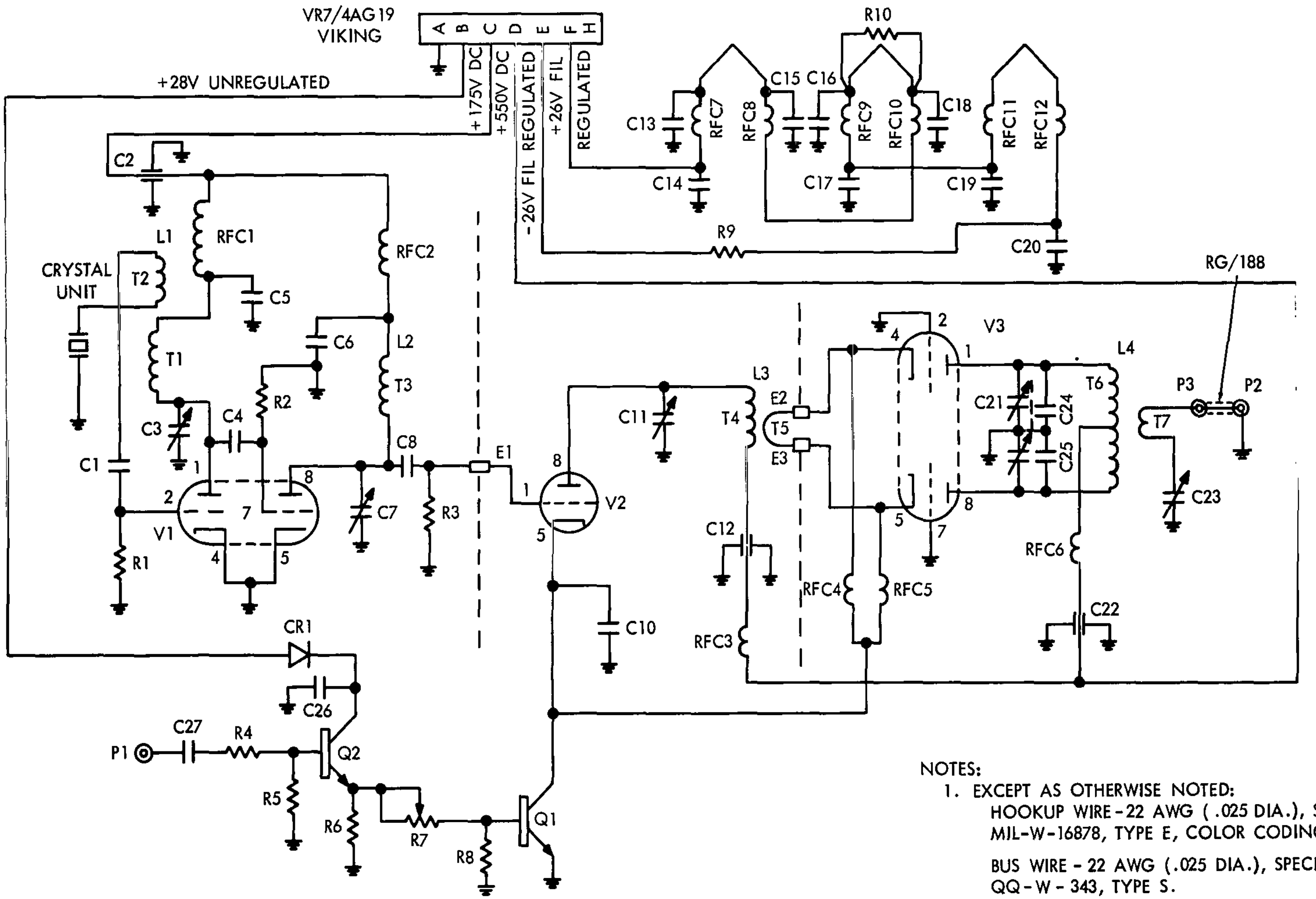
TRANSISTORS

Q1 = 2N2658

Q2 = 2N656

TUBES

V1 = 6021	V3 = 6021
V2 = 5718	



NOTES:

1. EXCEPT AS OTHERWISE NOTED:
   HOOKUP WIRE - 22 AWG (.025 DIA.), SPECIFICATION MIL-W-16878, TYPE E, COLOR CODING OPTIONAL.

   BUS WIRE - 22 AWG (.025 DIA.), SPECIFICATION QQ-W-343, TYPE S.

Schematic Diagram for SST-1 Transmitter.

Appendix C

Installation Diagram

Installation diagrams for the SST-1 Telemeter System are contained on pages 28 thru 30.

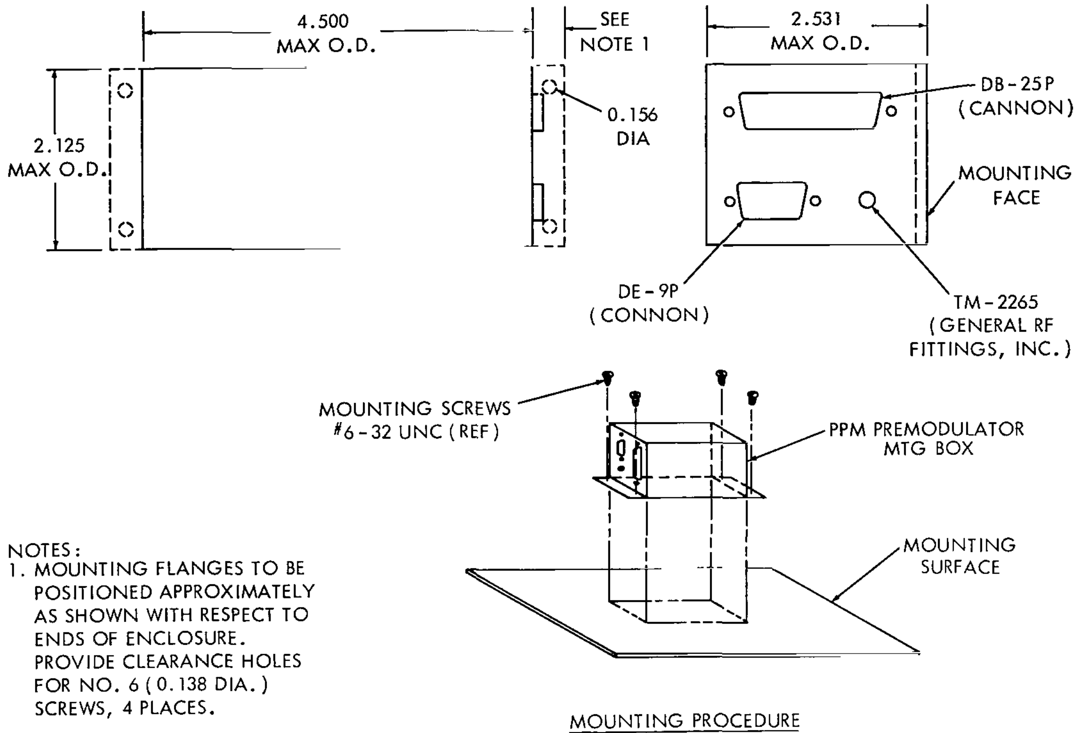


Figure C1—Installation drawing for SST-1 premodulator.

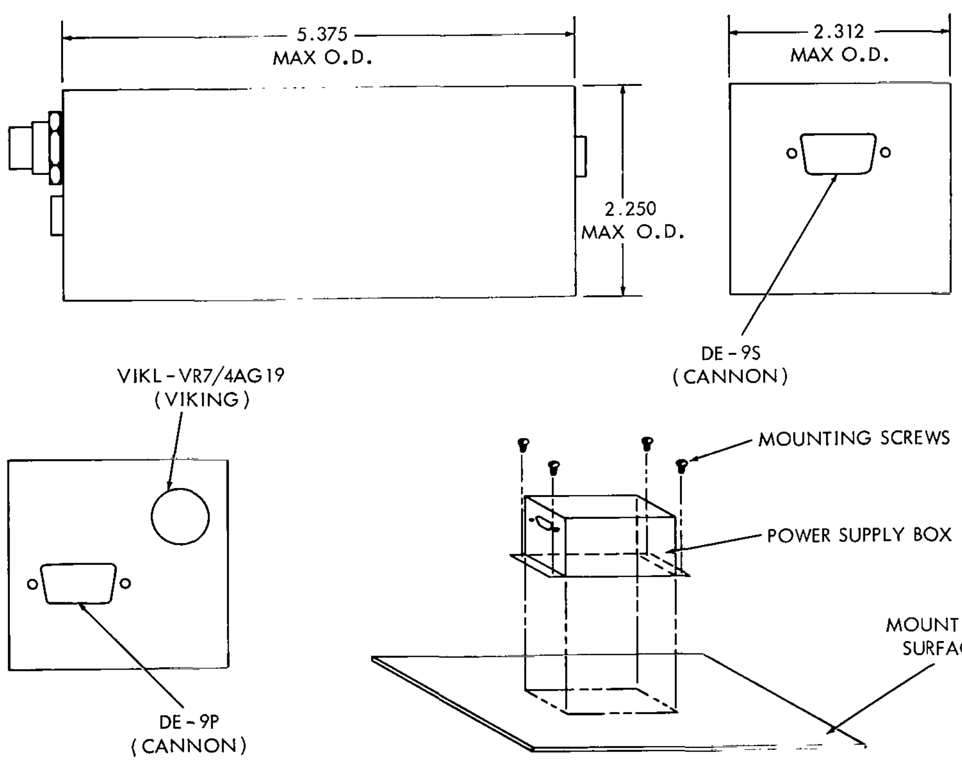
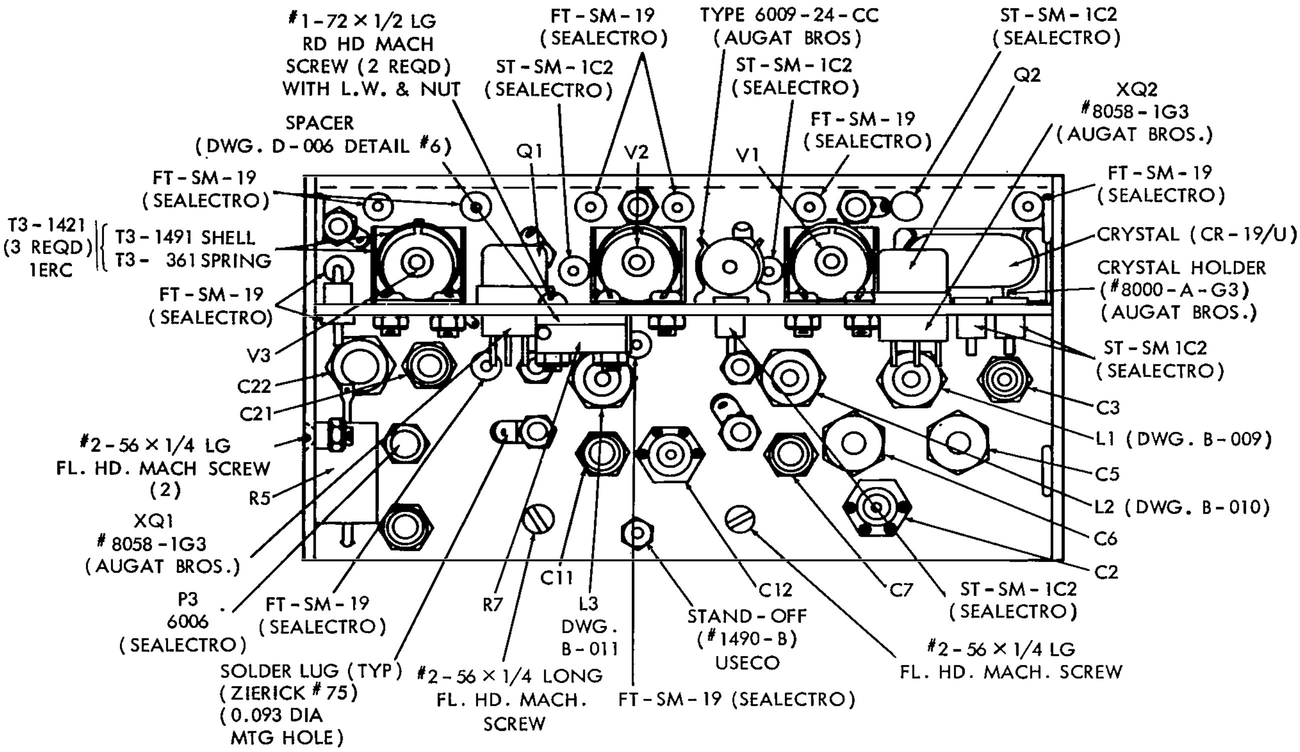
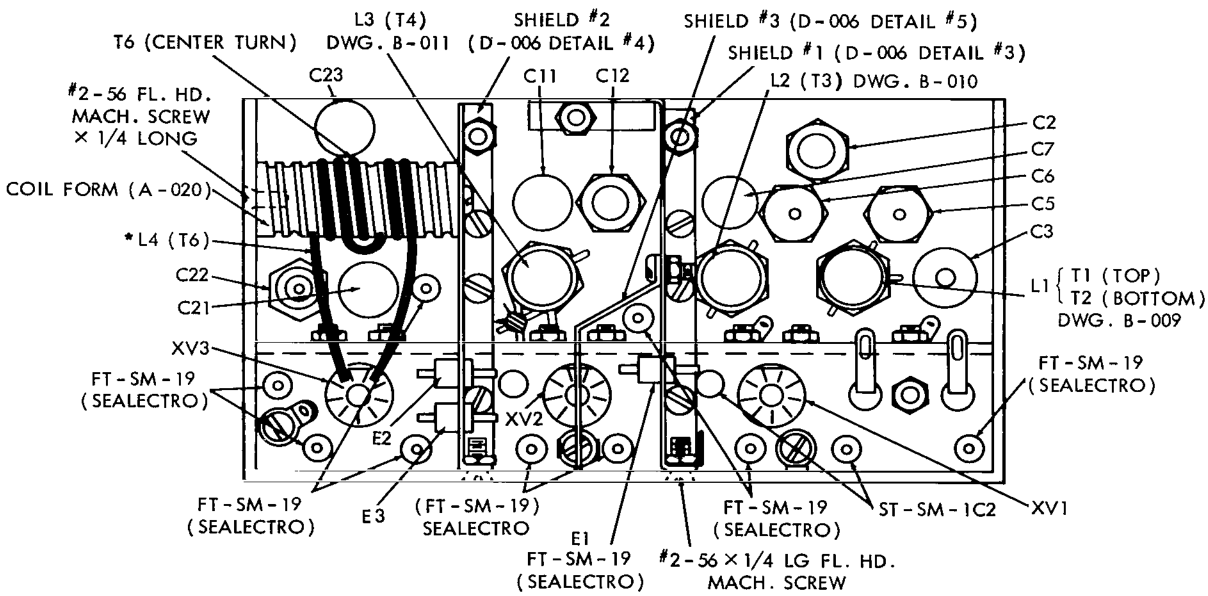


Figure C2—Installation drawing for SST-1 power supply.



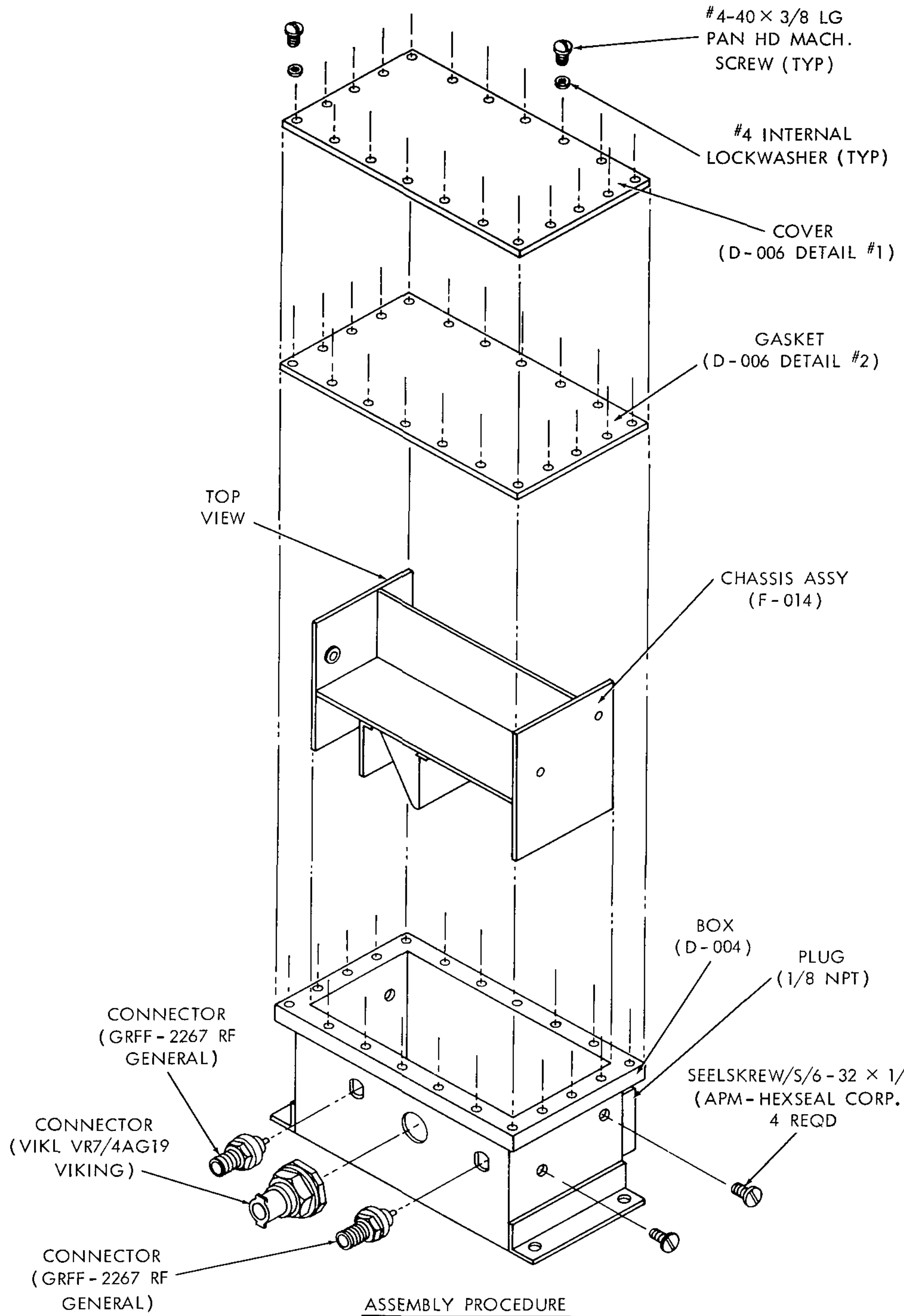
Top View



Bottom View

CHASSIS ASSEMBLY

Figure C3—Installation drawing for SST-1 transmitter (sheet 1).



NOTE:
ALL MOUNTING HARDWARE IS #2-56 PAN HEAD (NICKEL PLATED STEEL) MACHINE SCREW, EXCEPT AS NOTED, AND WILL HAVE INTERNAL LOCKWASHERS AND SMALL PATTERN NUTS IN ALL CASES.

Figure C4—Installation drawing for SST-1 transmitter (sheet 1).

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