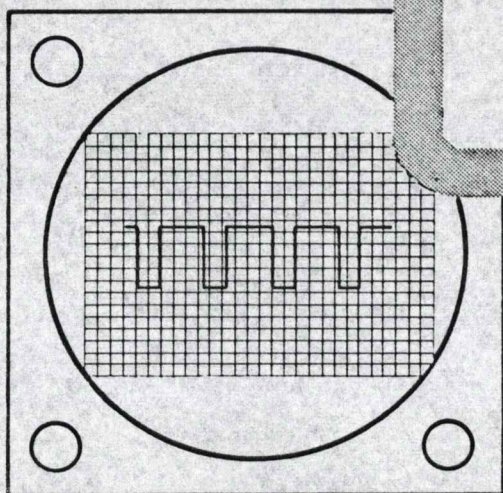


**MAINTENANCE
AND INSTRUCTION MANUAL
FOR
MODEL B1 TELEMETRY
OSCILLATOR ASSEMBLY**

(50M66503)



GEORGE C. MARSHALL SPACE FLIGHT CENTER
ASTRONICS LABORATORY - INSTRUMENTATION AND COMMUNICATIONS DIVISION
TELEMETRY SYSTEMS BRANCH

SUBCARRIER OSCILLATOR PRE-EMPHASIS AND BANDWIDTH RECORD

DATE:
REVISION

SATURN/APOLLO
LAUNCH OPERATIONS

PAGE
TEST NO.
VEHICLE

ELEMENTER PACKAGE

Operator

By:

Date:

IBM Quality Assurance

CENTRE FREQUENCY			PRE-EMPHASIS			LOW BAND EDGE $\pm 3\%$			HIGH BAND EDGE $\pm 3\%$		
Channel	Frequency	Measured	Peak Deviation in KHz $\pm 15\%$			Low Limit	Measured	High Limit	Low Limit	Measured	High Limit
2	560		5	4.25	5.75	515		521	599		605
3	730		5	4.25	5.75	672		687	782		788
4	960		5	4.25	5.75	884		892	1028		1036
5	1300		6	5.1	6.9	1196		1208	1393		1405
6	1700		6	5.1	6.9	1564		1580	1820		1836
7	2300		6	5.1	6.9	2117		2137	2463		2483
8	3000		7	5.95	8.05	2761		2789	3211		3239
9	3900		7	5.95	8.05	3589		3625	4175		4211
10	5400		9	7.65	10.35	4971		5019	5781		5329
11	7350		10	8.5	11.5	6766		6832	7868		7934
12	10500		11	9.35	12.65	9665		9759	11241		11335
13	14500		12	10.2	13.8	13347		13477	15523		15653
14	22000		15	12.75	17.25	20251		20499	23551		23749
15	30000		16	13.6	18.4	27615		27855	32115		32385
16	40000		18	15.3	20.7	36820		37180	43820		43180
17	52500		20	17.	23.	48326		48798	56202		56674
18	70000		21	17.85	24.15	64435		65065	74935		75565
X	70000		40	34.	46.	47740		50260	89740		92260
FM ³ - Channel 14											
2	560		All levels to be equal YES NO			515		521	599		605
3	730					672		678	782		788
4	960					884		892	1028		1036
5	1300					1196		1208	1393		1405
6	1700					1564		1580	1820		1836
FM ³ - Channel 17											
2	560		All levels to be equal YES NO			515		521	599		605
3	730					672		678	782		788
4	960					884		892	1028		1036
5	1300					1196		1208	1393		1405
6	1700					1564		1580	1820		1836
7	2300					2117		2137	2463		2483
8	3000					2761		2789	3211		3239

All units in Hertz unless otherwise noted.

SECTION I GENERAL DESCRIPTION

1.1 SCOPE

This manual contains a complete description of the physical and electrical characteristics of the Model B1 Telemetry Oscillator Assembly illustrated in the frontispiece. The manual is divided into four basic sections, namely:

- a. General Description
- b. Theory of Operation
- c. Operating Procedures
- d. Maintenance and Troubleshooting

1.2 GENERAL

The Model B1 Telemetry Oscillator Assembly provides an increased capability for transmitting measurement data by the telemetry system. The assembly employs FM/FM and FM/FM/FM techniques to provide continuous transmission of up to 28 channels of measurement data, depending on the assembly configuration, into a composite output signal.

1.3 TELEMETRY OSCILLATOR ASSEMBLY

The telemetry oscillator assembly will accept up to 28 data-input signals within the range of 0 to 5 vdc, or 5 vp-p biased at +2.5 vdc. These signals frequency modulate the subcarrier oscillators in the assembly. The outputs of the subcarrier oscillators are mixed in a mixer-amplifier and the composite amplified output signal is applied to an external FM transmitter assembly.

SUBASSEMBLIES

The telemetry oscillator assembly contains three basic sub-assemblies, an FM/FM subcarrier assembly, an FM/FM/FM subcarrier assembly, and a calibrate control relay assembly, as shown in figure 1-1. The FM/FM subcarrier assembly contains a maximum of 17 subcarrier oscillators, a mixer-amplifier, and the dc-to-dc converter for the telemetry oscillator assembly. The FM/FM/FM subcarrier assembly contains a maximum of 15 subcarrier oscillators and 2 mixer-amplifiers. The calibrate control relay assembly receives the external calibration signal and sends calibration commands through the program plugs to the calibrate relays in the subcarrier assemblies. Figure 1-2 illustrates the operation of the telemetry oscillator assembly. Figure 1-3 illustrates the location of the subcarrier oscillator for each channel and table 1-1 lists the frequency characteristics for each channel.

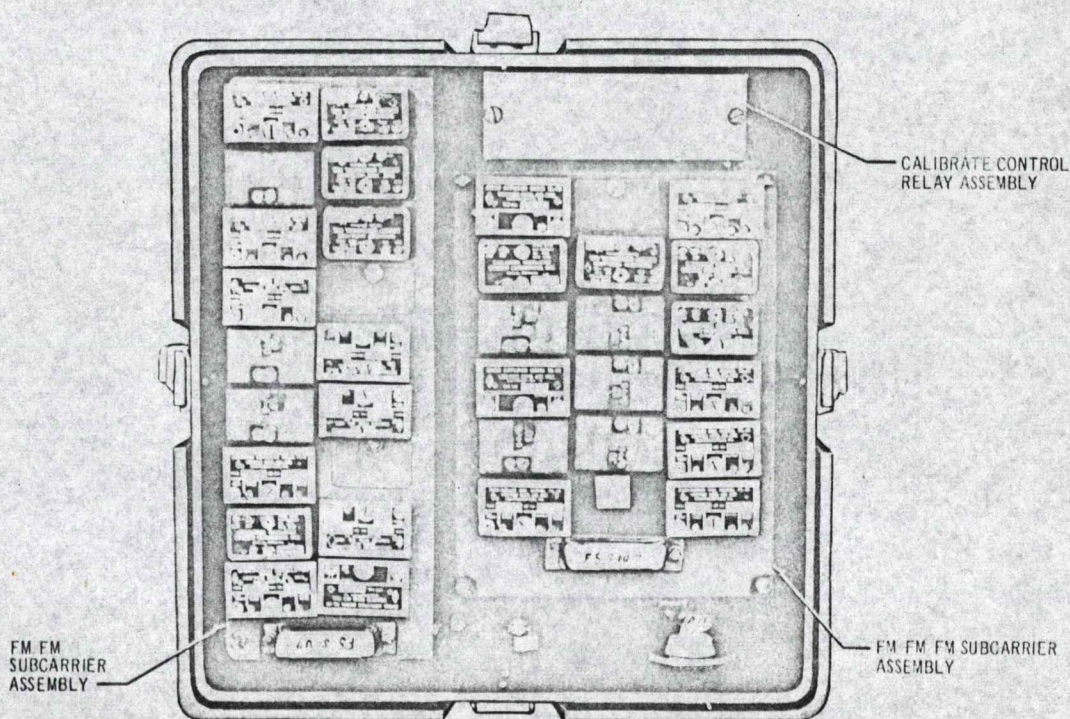


FIGURE 1-1. TELEMETRY OSCILLATOR ASSEMBLY
(COVER REMOVED)

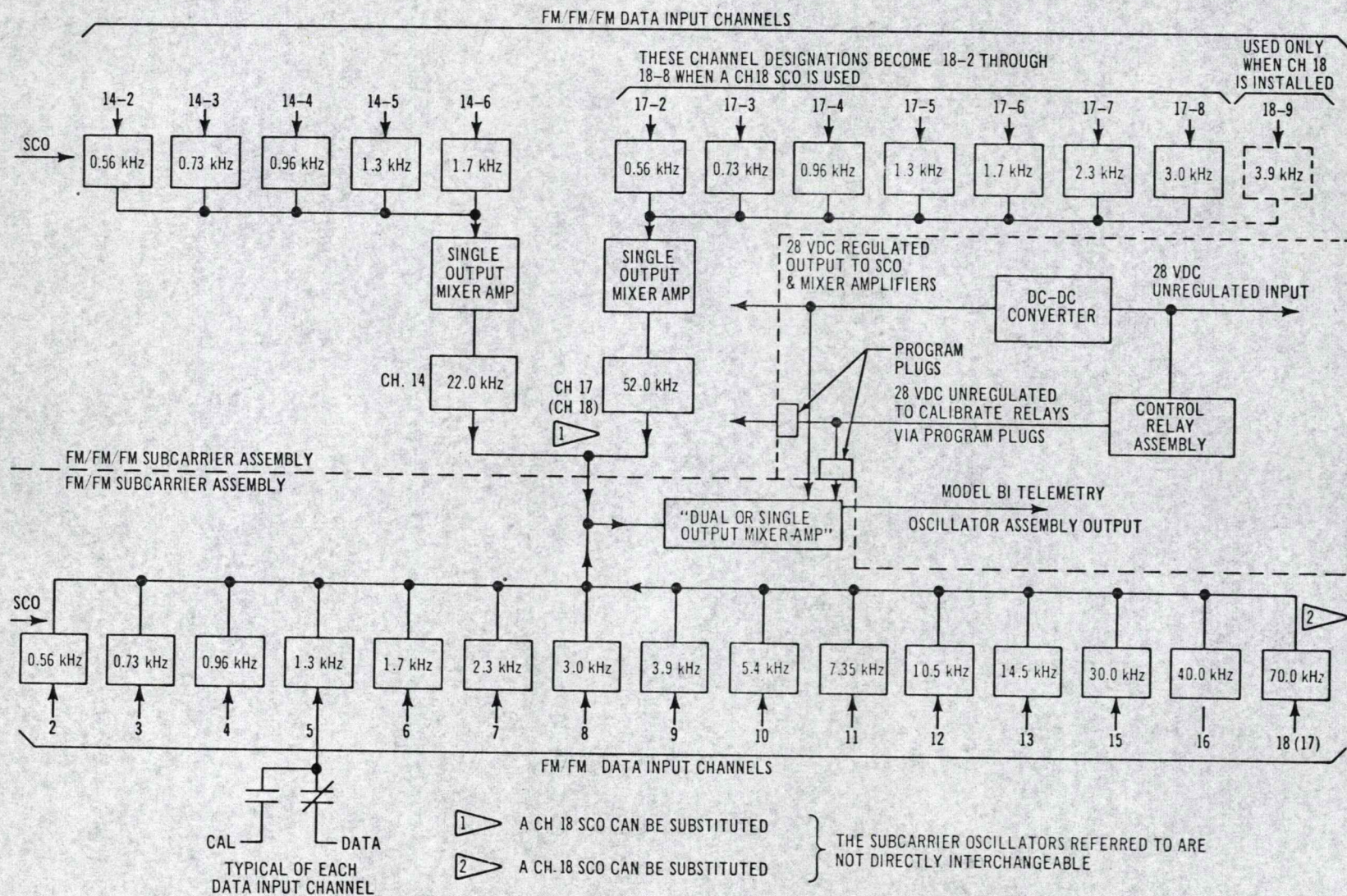
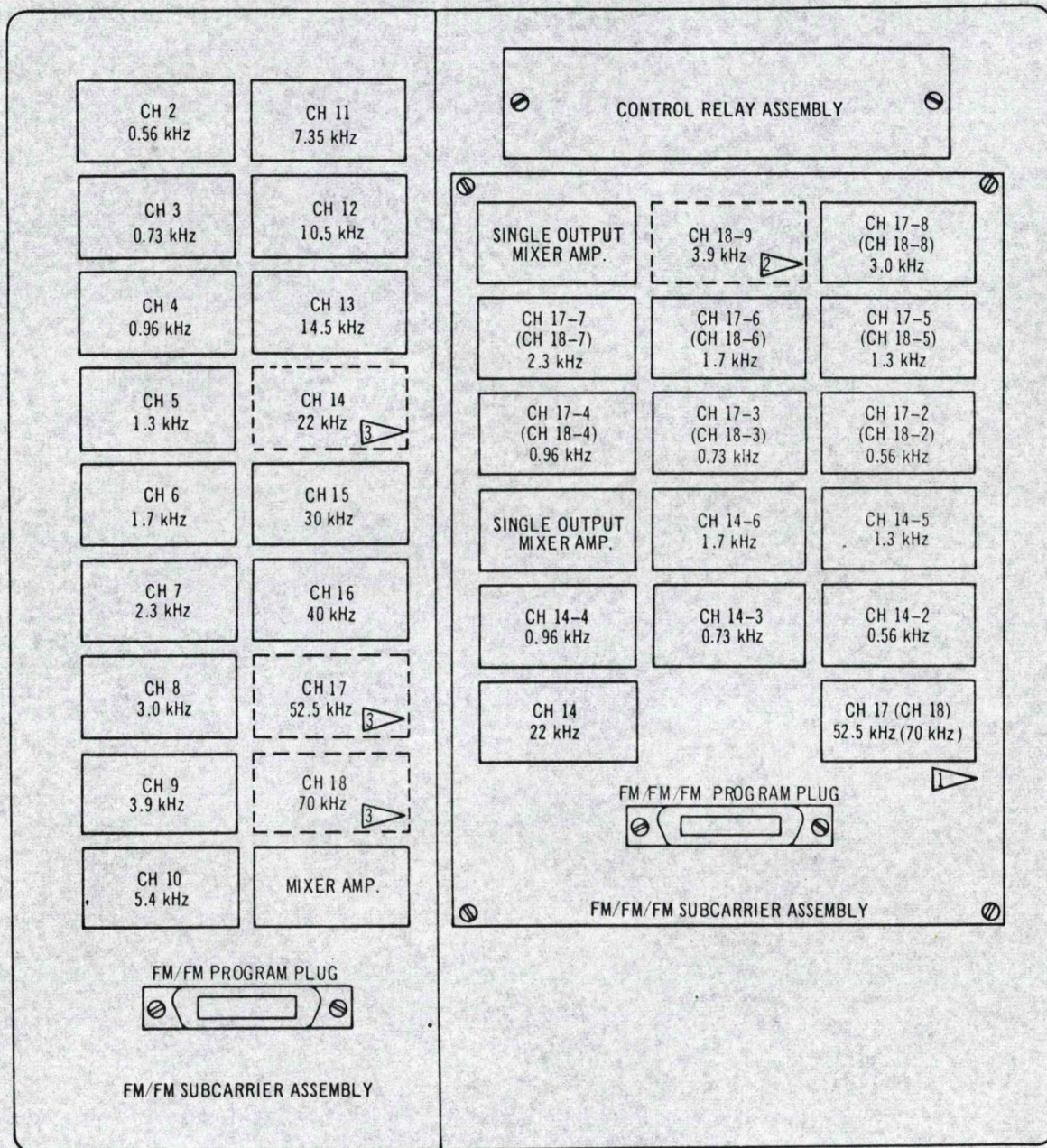


FIGURE 1-2. FUNCTIONAL BLOCK DIAGRAM

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- ▶ CH.17 OR 18 SCO CAN BE USED AT THIS LOCATION.
- ▶ AN SCO TO BE INSTALLED AT THIS LOCATION ONLY IF CH.18 SCO IS INSTALLED IN THE FM/FM/FM SUBCARRIER ASSEMBLY.
- ▶ NO SCO TO BE INSTALLED AT THIS LOCATION IF THIS CH. SCO IS INSTALLED IN THE FM/FM/FM SUBCARRIER ASSEMBLY.

C-H 9600-1

FIGURE 1-3. COMPONENT LOCATION

TABLE 1-1. SUBCARRIER CHANNELS

Channel	Center Frequency Hz	Lower Band-Edge Hz	Upper Band-Edge Hz	Band Width Hz	Frequency Response Hz	Output Amplitude mv p-p	Frequency Deviation kHz
2	560	518	602	84	8	85	5
3	730	675	785	110	11	85	5
4	960	888	1,032	144	14	85	5
5	1,300	1,202	1,398	196	20	115	6
6	1,700	1,572	1,828	256	25	115	6
7	2,300	2,127	2,473	346	35	115	6
8	3,000	2,775	3,225	450	45	120	7
9	3,900	3,607	4,193	580	59	120	7
10	5,400	4,995	5,805	810	81	150	9
11	7,350	6,799	7,901	1,102	110	170	10
12	10,500	9,712	11,288	1,576	160	190	11
13	14,500	13,412	15,588	2,176	220	220	12
14	22,000	20,350	23,650	3,300	330	230	15
15	30,000	27,750	32,250	4,500	450	280	16
16	40,000	37,000	43,000	6,000	600	320	18
17	52,500	48,562	56,440	7,880	790	330	20
18	70,000	64,750	75,250	10,500	1,050	370	21
14-2	560	518	602	84	8	1,000	20
14-3	730	675	785	110	11	1,000	20
14-4	960	888	1,032	144	14	900	20
14-5	1,300	1,202	1,398	196	20	900	20
14-6	1,700	1,572	1,828	256	25	900	20
17-2 (18-2)	560	518	602	84	8	1,000	20
17-3 (18-3)	730	675	785	110	11	1,000	20
17-4 (18-4)	960	888	1,032	144	14	900	20
17-5 (18-5)	1,300	1,202	1,398	196	20	950	20
17-6 (18-6)	1,700	1,572	1,828	256	25	1,000	20
17-7 (18-7)	2,300	2,127	2,473	346	35	1,000	20
17-8 (18-8)	3,000	2,775	3,225	450	45	1,000	20
(18-9)	3,900	3,607	4,193	580	59	1,000	20

1.5 SUBASSEMBLY COMPONENTS

1.5.1 Subcarrier Oscillator

The subcarrier oscillators (SCO) shown in figure 1-4 are potted modules, each measuring 0.8 by 1.36 by 1.8 inches (2.03 by 3.45 by 4.57 cm). They plug into either the FM/FM or FM/FM/FM subcarrier assembly connector board assemblies.

The subcarrier oscillators convert data signals, within the ranges of 0 to 5 volts dc or 5 volts p-p biased at +2.5 vdc, into the modulated frequencies shown in table 1-1. The output amplitude is variable, between the ranges of 75 mv and 1 volt p-p for channels 1 through 12 and 100 mv and 1.5 volts p-p for channels 13 through 18, when operated into a 10,000-ohm load.

A test point is located preceding the series output resistor. This test point is used only for determining the presence of an output signal. Due to the common calibrate signal used in the calibrate mode, all SCO's in a particular model B1 assembly must accept the same input signal range.

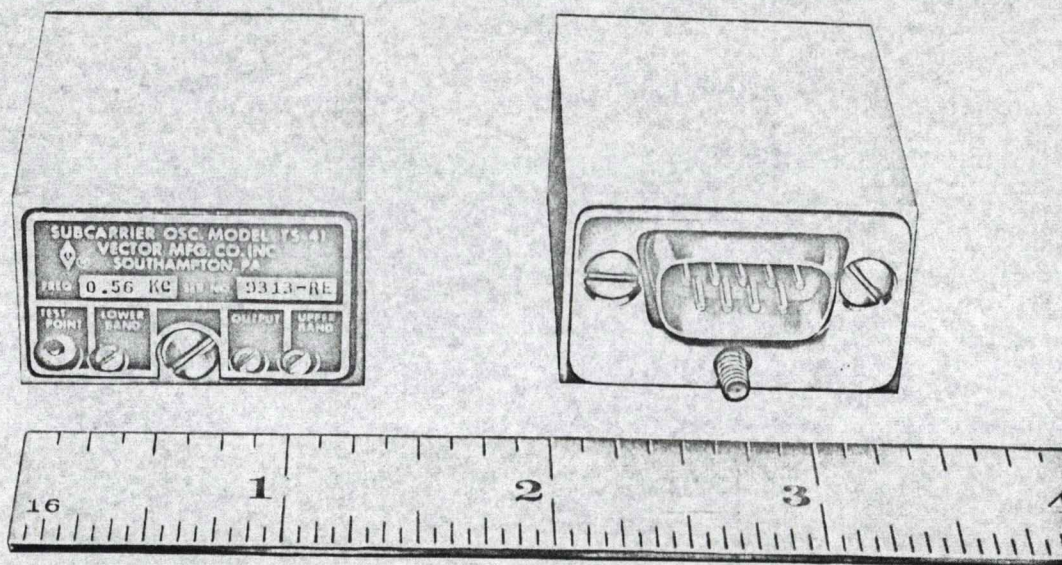


FIGURE 1-4. SUBCARRIER OSCILLATOR

1.5.2 Mixer-Amplifier

The mixer-amplifier shown in figure 1-5 is a potted module that plugs into either the FM/FM or the FM/FM/FM subcarrier assembly connector board assemblies. The three types of mixer-amplifiers used for summing and amplifying in the telemetry oscillator assembly are the dual output, single output (isolated) and single output (nonisolated). The dual output mixer-amplifier is used in the FM/FM subcarrier assembly. The single output (nonisolated) mixer-amplifier is used in the FM/FM/FM subcarrier assembly. The single output (isolated) mixer-amplifier may be used in either assembly.

1.5.3 Connector Board Assembly

Each FM/FM and FM/FM/FM subcarrier assembly has a connector board assembly to serve as a base on which the connectors are mounted. The connectors are used as the mounting receptacles for the plug-in subcarrier oscillators and mixer-amplifiers.

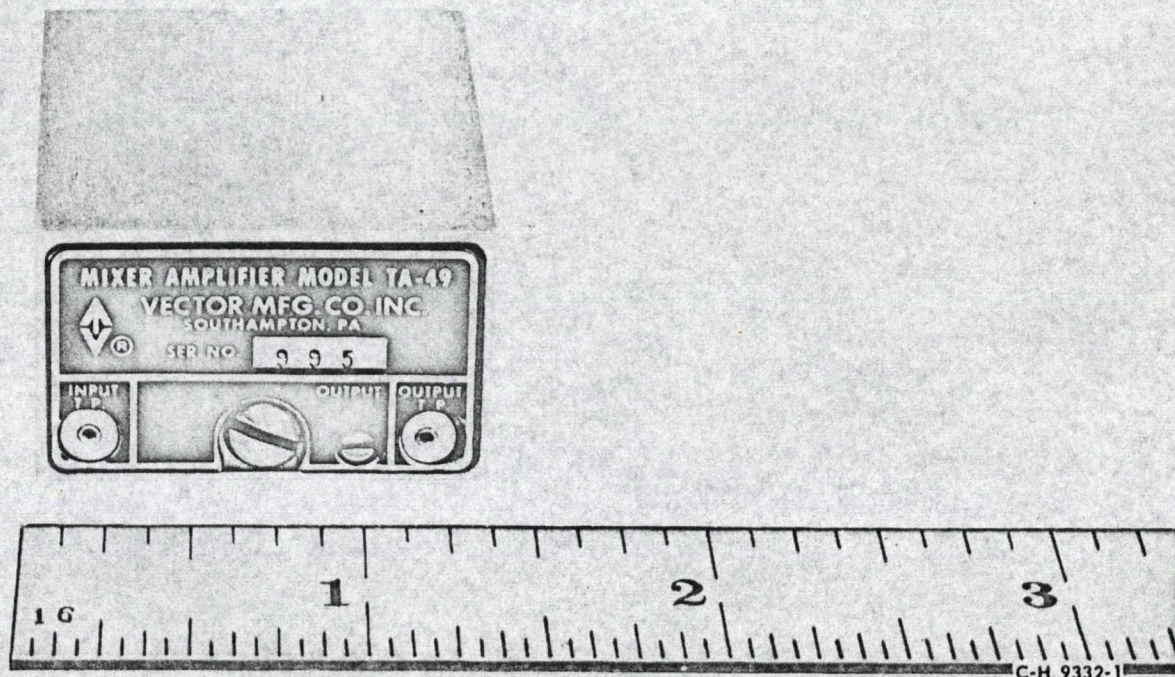


FIGURE 1-5. TYPICAL MIXER-AMPLIFIER

SECTION II THEORY OF OPERATION

2.1 INTRODUCTION

This section contains the theory of operation for the Model B1 Telemetry Oscillator Assembly. See Figure 2-1 for FM/FM and FM/FM/FM typical data channels.

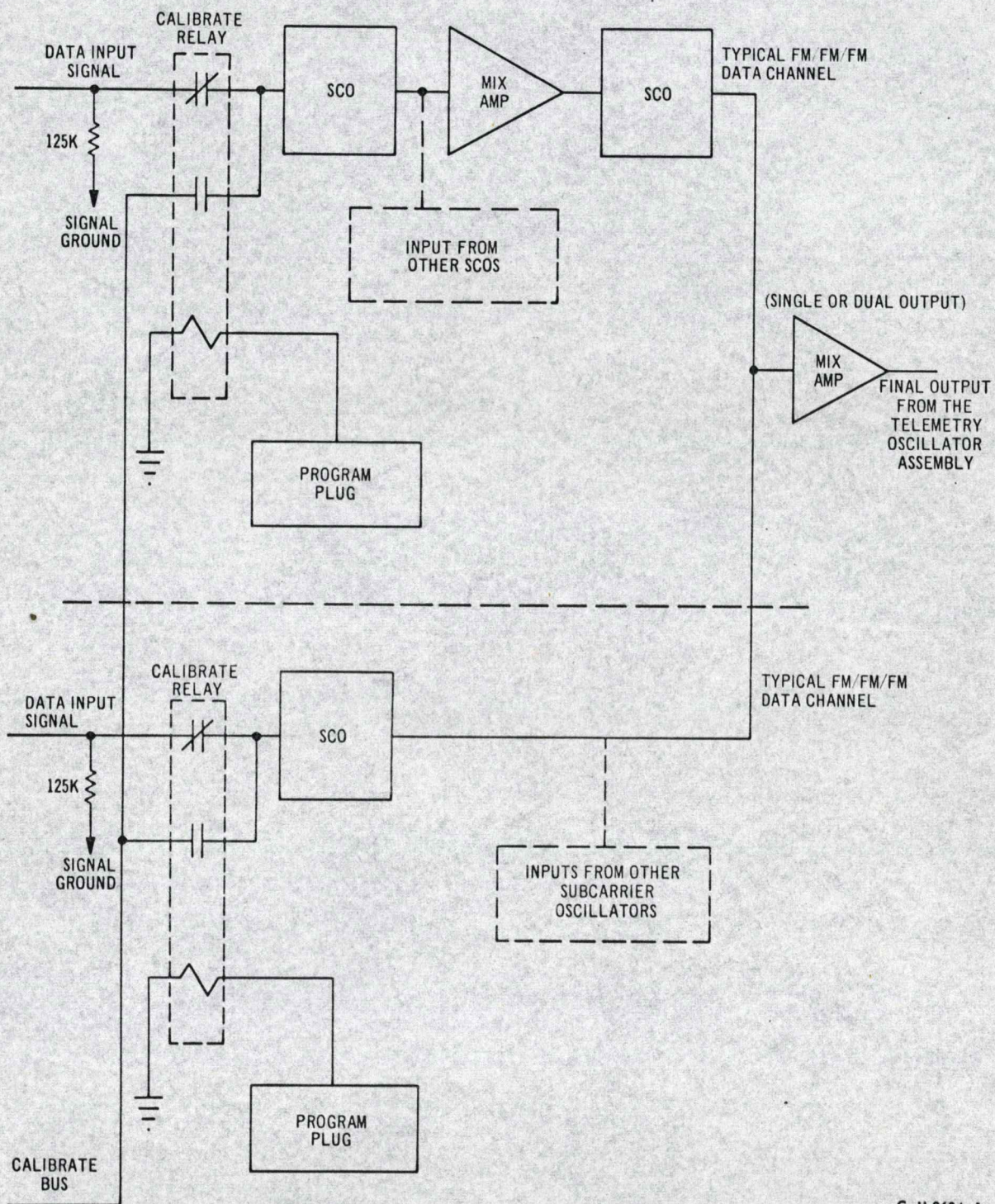
2.2 FM/FM SUBCARRIER ASSEMBLY

The FM/FM subcarrier assembly (figure 2-2) contains 15 to 17 SCO's corresponding in frequency to IRIG subcarrier standard channels 2 through 13, 15, 16, and either 17 or 18 (whichever is not used in the FM/FM/FM assembly). It should be pointed out that the channel 14, 17, or 18 SCO's used in the FM/FM/FM subcarrier assembly are not directly interchangeable with those used in the FM/FM subcarrier assembly because of the input signal requirements. Some types of SCO's are interchangeable after adjustments. The channel 14, 17, or 18 SCO's used in the FM/FM/FM subcarrier assembly require -2.5vdc and +2.5vdc to deviate the frequency to lower band edge (LBE) and upper band edge (UBE), respectively, while those used in the FM/FM subcarrier assembly require 0 and +5vdc to deviate the frequency to LBE and UBE respectively.

Each data-input channel provides an input to its associated SCO. The output of the SCO provides part of the input to the dual output mixer-amplifier, which provides the composite output signal of the Model B1 Telemetry Oscillator Assembly.

2.3 FM/FM/FM SUBCARRIER ASSEMBLY

The FM/FM/FM subcarrier assembly (figure 2-3) contains 14 or 15 SCO's which, depending upon their configuration, will receive 12 or 13 data-inputs. Their outputs, in accordance with IRIG subcarrier standard channels 2 through 6 (table 1-1), are mixed in a mixer-amplifier; the resulting



C-H 9604-1

FIGURE 2-1. TYPICAL DATA CHANNELS

multiplexed signal then frequency-modulates IRIG sub-carrier standard channel 14. The input frequencies to the channel 2 through 6 SCO's are designated 14-2, 14-3, etc., through 14-6.

In a like manner, IRIG subcarrier standard channel 17 is frequency-modulated by IRIG subcarrier standard channels 2 through 8, and the data-inputs to their SCO's are designated 17-2, 17-3, etc., through 17-8. It is also possible to substitute a channel 18 SCO in place of the channel 17 SCO, in which case IRIG subcarrier standard channels 2 through 9 can be used to frequency-modulate the channel 18 SCO. The data inputs to these channels are then designated 18-2, 18-3, etc., through 18-9.

Again, it must be understood that the channel 14, 17, or 18 SCO's used in the FM/FM/FM subcarrier assembly are not directly interchangeable with those used in the FM/FM subcarrier assembly.

The outputs of IRIG subcarrier standard channels 14 and 17 (or 18) are mixed and amplified with the outputs of IRIG subcarrier standard channels 2 through 13, 15, 16, and 18 (or 17) from the FM/FM subcarrier assembly. This amplified, composite signal is the final output signal from the telemetry oscillator assembly.

2.4 CALIBRATE CONTROL RELAY ASSEMBLY

The calibrate control relay assembly (figure 2-4) of the telemetry oscillator assembly consists of three relays (K1, K2, and K3). They are designated, respectively, 'Preflight,' 'Inflight/Calibrate,' and 'Withhold' controls.

The purpose of these relays is to energize various combinations of the 'yes,' 'no,' and 'withhold' buses, which in turn energizes programmed calibrate relays through the program plugs (J121 and J201). The 'Preflight' relay (K1) controls all three buses. The 'Inflight' calibrate control relay (K2) controls the 'yes' bus. This bus is used for those channels which receive normal inflight calibration. The 'Withhold' relay (K3) controls the 'withhold' bus. This bus will withhold inflight calibration of preselected channels when relay K2 is also energized.

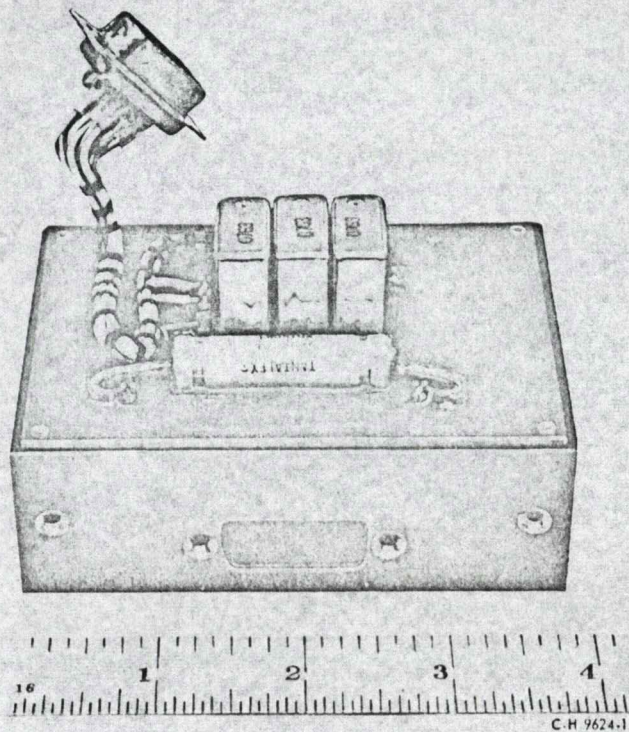


FIGURE 2-4. CALIBRATE CONTROL RELAY ASSEMBLY,
REMOVED FROM HOUSING

In the preflight condition K1 is energized and 28vdc will be supplied, through the normally open contacts of K1, to pin 23 ('yes' bus), pin 24 ('no' bus), and pin 25 ('withhold' bus) of the program plugs (J121 and J201). In this condition, all channels programed to receive 'yes,' 'no,' or 'withhold' calibration will receive calibration.

In the inflight condition K1 is deenergized and no voltage will be supplied to pins 23, 24, or 25 of the program plugs. In this condition, no channel will receive calibration. During the normal inflight transmission of measurement data, relays K3 and K2 are deenergized. Transfer of the telemetry system to the calibration mode is accomplished by applying 28 vdc to relay K2 through pin 9 of J123. Energizing K2 will supply power to pin 23 ('yes' bus) in the program plugs and all channels programmed 'yes' will receive calibration. If, in addition to K2, K3 is also energized, 28 vdc will be supplied to pins 23 ('yes' bus) and 25 ('withhold' bus) of the program plugs. This will cause all channels programmed 'yes' and 'withhold' to receive calibration.

When calibration is complete, power is removed from K3 and K2 and the telemetry system will return to the normal data measurement mode of operation.

2.5 SUBASSEMBLY COMPONENTS

Except for slight differences in certain SCO's, both sub-carrier assemblies (FM/FM and FM/FM/FM) utilize the same individual subunits. Theory of operation for these subunits follow:

2.5.1 Subcarrier Oscillator

The subcarrier oscillators receive data signals from the transducer, or signal conditioner, of the parameter being measured. The variable input signal (0 to +5 vdc) deviates the reference frequency (center frequency) in proportion to the level of the input data signal. Maximum deviation of the reference frequency is; -7.5 percent for an input voltage signal level of zero; and +7.5 percent for an input signal voltage level of +5 vdc.

For IRIG subcarrier standard channels 14 and 17 or 18, used in the FM/FM/FM subcarrier assembly, the maximum deviation is; -7.5 percent for an input signal voltage level of -2.5 vdc; and +7.5 percent for an input signal voltage level of +2.5 vdc. For this reason, the channels 14, 17, and 18 SCO's are not directly interchangeable between the FM/FM and FM/FM/FM subcarrier assemblies.

Each SCO contains a solid state voltage controlled oscillator, a voltage regulator, a compensating amplifier, and a bandpass filter. Adjustments are provided on the SCO for frequency and output amplitude control. Some SCO's have adjustments for frequency (center), sensitivity (bandwidth), and output. The upper and lower band edge frequencies, center frequency, frequency response, bandwidth, and output amplitude of each standard IRIG subcarrier standard channel used is shown in table 1-1. The SCO output amplitude is variable within the range of from 75 mv to 1.0 vp-p for channels 2 through 12, and from 100 mv to 1.4 vp-p for SCO channels 13 through 18. The output test point, provided on the SCO to determine the presence of an output signal, is connected directly to the output of the SCO, and bypasses the isolation resistor in series with the normal output.

2.5.2 Mixer-Amplifier

- 2.5.2.1 Dual Output Mixer-Amplifier. The dual output mixer-amplifier is a potted module that plugs into the FM/FM subcarrier assembly connector board assembly. This unit is designed to combine the outputs of the subcarrier oscillators, amplify the signal, and provide two separate composite outputs.

This wideband amplifier is capable of amplifying, with a gain of from 0.5 to 10, signals within the 300 Hz to 100 kHz range. The total distortion of the amplifier will not exceed 0.5 percent and the output amplitude will not vary more than ± 0.5 db. Each output is independently variable within the range of from 75 mv to 5 volts p-p with an output load of 1,000 ohms shunted by a capacitance of from 0 to 3,200 pf.

- 2.5.2.2 Single Output (Nonisolated) Mixer-Amplifier. The single output (nonisolated) mixer-amplifier is a potted module that plugs into the FM/FM/FM subcarrier assembly connector board assembly. The wideband amplifier has a frequency response of ± 0.25 db and a gain of from 0.5 to 20 within the frequency range of 100 Hz and 100 kHz. The output is variable over a range between 75 mv and 6 volts p-p as measured across a 4,000-ohm resistive load. The distortion shall not exceed 0.3 percent under the above conditions.

The mixer-amplifier receives FM signals from the SCO outputs (channels 14.2-14.6, 17.2-17.8, or 18.2-18.9) for summing and amplifying. The output of the amplifier modulates IRIG subcarrier channel 14, 17, or 18, respectively. This output provides part of the signal input to the dual output mixer-amplifier.

- 2.5.2.3 Single Output (Isolated) Mixer-Amplifier. The single output (isolated) mixer-amplifier is a potted module that plugs into the FM/FM subcarrier assembly connector board assembly. The amplifier has the output and the output return terminals isolated from power, signal, and chassis ground with a minimum of 50 megohms resistance. The total distortion of the output is not more than 1.0 percent from 350 Hz to 1,000 Hz and 0.5 percent from 1,000 Hz to 100 kHz with an output amplitude of from 75 mv p-p to 5 vp-p when measured across a resistive load of 1,000 ohms

shunted by a capacitance of from 0 to 3,200 pf and with a gain of from 0.5 to 10 db. The output amplitude shall not vary more than 1.0 db under the above conditions.

2.5.3 SCO Connector Board Assemblies

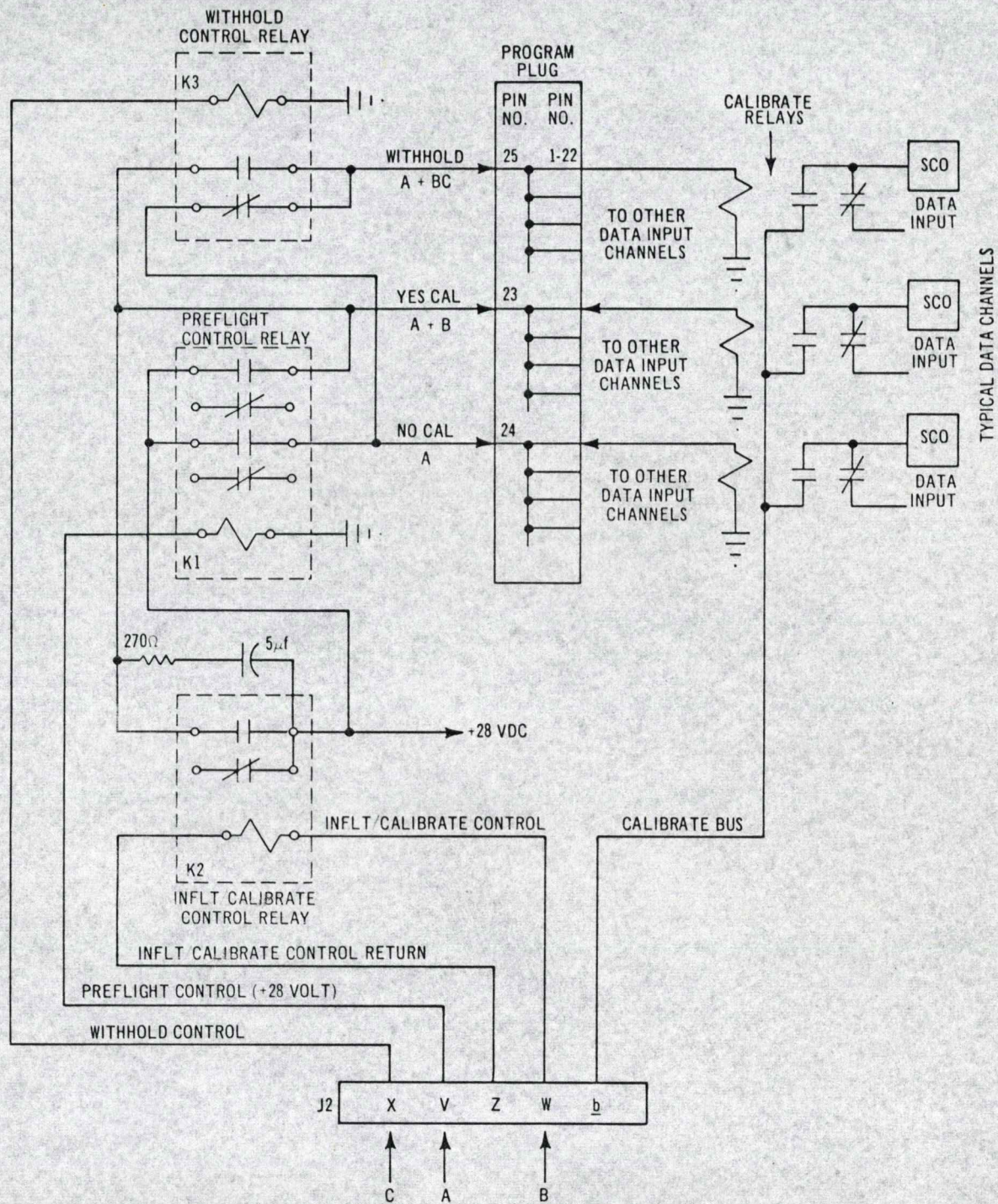
The SCO connector board assemblies provide interconnecting circuitry and connectors for the main components (SCO's and mixer-amplifiers) of the telemetry oscillator assembly.

2.5.4 Calibrate Relay Board Assemblies

The calibrate relay board assemblies contain relays and resistors which provide a means of individually switching the input of an SCO from the measurement signal source to a calibration signal source. The calibrate relay board assembly used in the FM/FM subcarrier assembly contains 17 relays, while that used in the FM/FM/FM subcarrier assembly contains 13 relays. A 125 kilohm resistor, on the signal input side of the normally closed contacts of each relay, is used to present a nearly constant input impedance to the data signal source regardless of the position of the relay. The calibration bus is common to all channels.

2.5.5 Program Plug Assemblies

The two 25-pin program plug assemblies provide the interconnection between the contacts of the control relays in the calibrate control relay assembly and the coils of the calibrate relays in the subcarrier assemblies. The 'yes,' 'no,' and 'withhold' buses are connected to pins 23, 24, and 25, respectively, in connectors J121 and J201. The calibration mode of each channel can be established by the wiring in the program plugs. The actual configuration of the program plug wiring for a particular unit is determined by the instrumentation program and components list. Figure 1-7 shows how a sample program plug might be wired and the pin number of each bus. Figure 2-5 shows how the program plug would connect typical data input channels to each bus.



NOTE: K1 IS ENERGIZED DURING PREFLIGHT.
K1 IS NOT ENERGIZED DURING INFIGHT.

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FIGURE 2-5. CONTROL RELAY SCHEMATIC

2.5.6

DC-to-DC Converter

The solid state dc-to-dc converter supplies a regulated and isolated voltage to both the FM/FM and the FM/FM/FM subcarrier assemblies. With a source voltage that is between 23.8 and 32.2 vdc, the converter will supply 28 vdc ± 2 percent if the load is within 50 and 120 percent of its rated output of 600 ma. Minimum efficiency is 45 percent and the ripple voltage is less than 85 mv p-p.