Model 64B TMX
Telemetering Transmitter

DESCRIPTION

The Model 64B TMX Telemetering Transmitter is the transmitting component of a telemetering system in which a squarewave ac signal is transmitted with its frequency varied as an analog of the telemetered quantity. This transmitter generates such signals over the frequency range extending from 5 to 25 Hz in response to input voltages in the range from 0.4 to 2.0 volts. The output frequency is linearly related to the input voltage, with the lowest frequency corresponding to the lowest voltage. The transmitter operates from a single 12-volt supply. The CMOS output is a 12-volt squarewave used to drive a frequency-shift keyed voice-frequency carrier transmitter. A calibration circuit, offered as an option, provides voltages corresponding to 10%, 50%, and 90% of full span.

A block diagram of the circuit is shown as Figure 3.

An optional plug-on card is available, on special order, designated as the Model 44945 FSK V-F Carrier Transmitter. See Figure 2. This card transmits the data with a frequency-shifted audio tone. The output of the transmitter is balanced, nominally 600 ohms, and has a rising impedance out of band to minimize loading of adjacent channels.

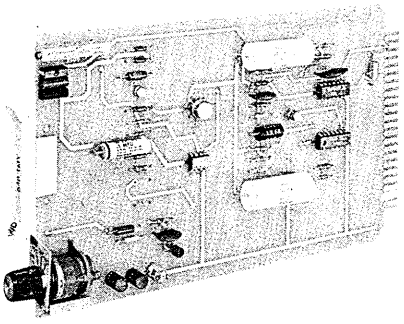


Figure 1. Model 64B TMX Telemetering Transmitter.

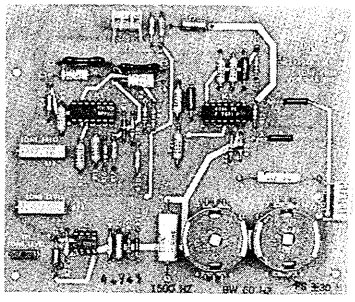


Figure 2. Model 44945 Frequency-Shift Keyed Transmitter, plug-on option.

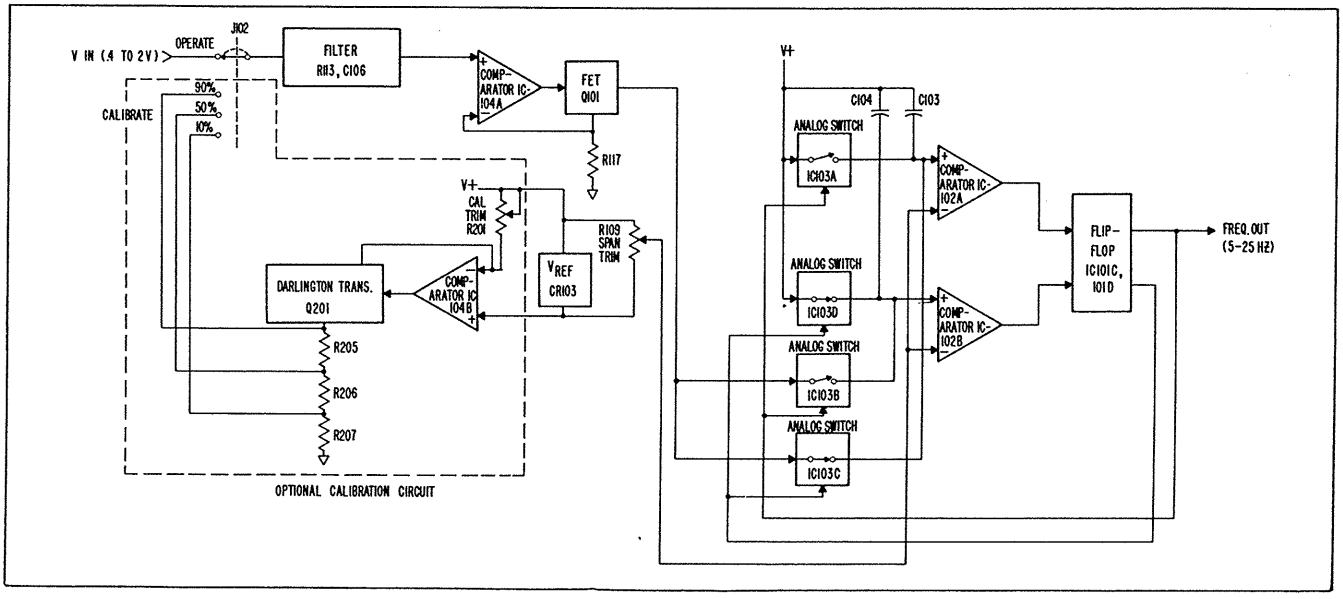


Figure 3. Block diagram of circuit, Model 64B TMX.

TECHNICAL SUMMARY

Input Signal: 0.4 to 2.0 volts. This signal may be developed across an external shunt resistor when current sources are used.

Input Impedance: 5 megohms minimum; 10 megohms typical.

Output Signal: 5 to 25 Hz squarewave, 12 volts peak-to-peak.

Accuracy: ±0.15% at 20°C when operated back-to-back with Model 64B TMR.

±0.5% from −3 to 47°C when operated back-to-back with Model 64B TMR.

±1% from −30 to 70°C when operated back-to-back with Model 64B TMR.

Settling Time: 1.5 second to 90% of full span when operated back-to-back with Model 64B TMR.

Power Requirements: 12 Vdc, 10 mA.

Dimensions: The transmitter is built on a circuit card 4.71 inches (11.96 cm) high by 8 inches (20.32 cm) deep, and it occupies two one-half-inch module spaces in an RFL Model 68 Chassis. With additional tone transmitter option; three one-half inch module spaces are required.

Optional FS Transmitter 44945

Frequency and Bandwidth: 300 to 3500 Hz center frequency. 120-Hz spacings are standard.

Frequency Tolerance and Drift: ±0.25% over the temperature range.

Output Level: Adjustable from −40 to −3 dBm.

Harmonic Content: Better than 50 dB below fundamental.

Output Impedance: Nominally 600 ohms within the band, with a rising impedance out of band. The two-section output filter is balanced.

Power Requirements: 12 Vdc, 10 mA.

MODEL 64B TMX ORDERING INFORMATION TELEMETRY MODULE	Telemeter Transmitter	Calibrator Option	FSK Tone Transmitter Option 44945	APPLICATION
64B TMX	•			*Standard input (4-20, 10-50 mA, etc.)
64B TMX-1	•	•		*Standard, but including Calibrator
64B TMX-2	•		•	Standard input but including Tone Transmitter
64B TMX-3	•	•	•	Standard input but including Calibrator & Tone Transmitter

*Note: Specify Input Range (4-20 or 10-50 mA, 1-5 Volts, etc.).

INSTALLATION

INTRODUCTION

When supplied by RFL as a unit of a complete telemetering system, the Model 64B TMX Telemetering Transmitter may be wired and interconnected in a chassis by RFL, in which case an interconnection drawing is supplied.

Figure 4 shows edge-connector terminal assignments on the circuit card. Reference to the schematic of the transmitter's circuit, Figure 5, will make the designations clearer. A suitable mating connector, which will mount in the Model 68 Chassis, is TRW/Cinch Part 251-22-30-261, RFL Part HA-38545.

For access to the sides of the circuit board while plugged into the chassis, the Model 68 EXT Universal Card Extender is a necessary accessory.

SPAN-TRIM ADJUSTMENT

Span of the output-frequency range is adjusted at midpoint by applying precisely 1.2 volts to the signal input at Terminal 11. With a frequency counter connected between output at Terminal 5 and ground, SPAN TRIM, R109, is adjusted for a period of 66.667 ±0.01 ms.

CAL-TRIM ADJUSTMENT

On units equipped with a calibrator, this adjustment is made only after the SPAN TRIM adjustment has been completed. After connecting a frequency counter to the output, set the calibrator switch to the 50% point and adjust CAL TRIM, R201, until the counter indicates a period of 66.667 ±0.01 ms.

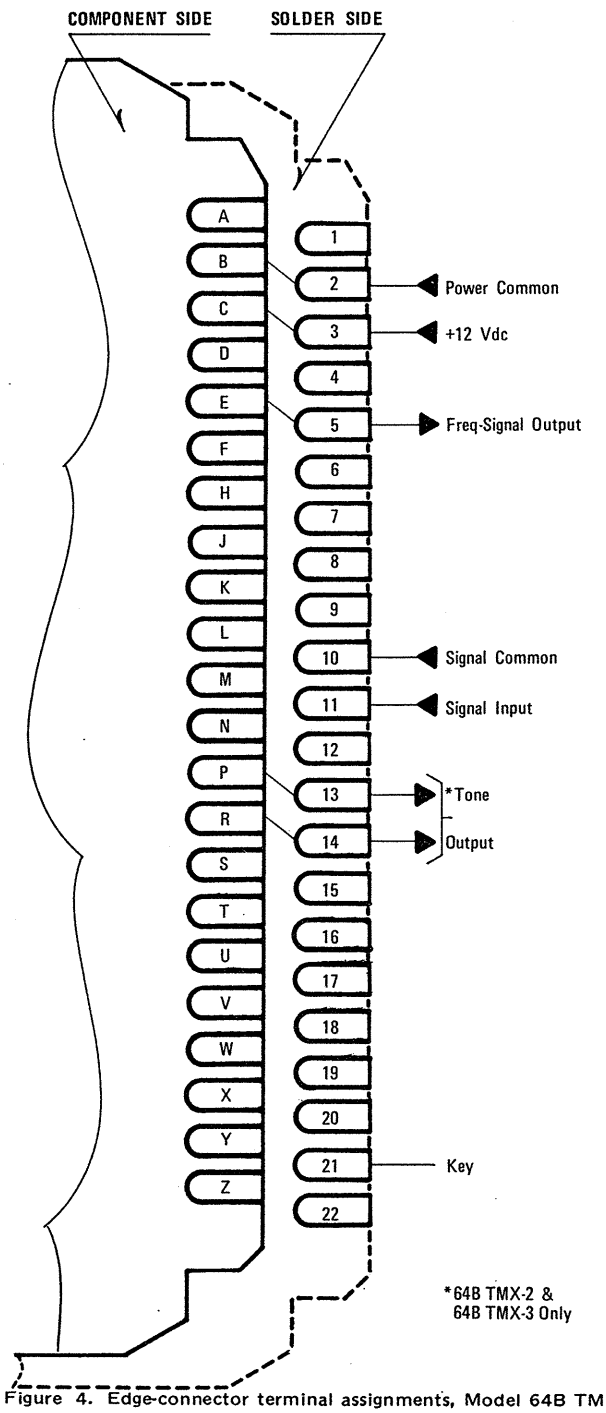


Figure 4. Edge-connector terminal assignments, Model 64B TMX.

CIRCUIT DESCRIPTION

An input voltage, in the range from 0.4 to 2.0 volts, is applied at Terminal 11, Figure 5, passes through the calibrator, if supplied, and then through a noise filter and protective diodes to the non-inverting input of opamp IC104A. This amplifier, with Q101 and associated components, forms a voltage-driven current source from the drain of Q101.

Since the voltages at the two inputs of IC104A are equal, the source current of Q101 will produce a voltage across R117 equal to the input voltage.

The drain current of Q101 is alternately switched between C103 and C104 by analog switches IC103B and IC103C, whose control-terminal voltages are set by the outputs of the flip-flop formed by IC101C and IC101D. The flip-flop also controls the other two analog switches.

When IC103A and IC103B are open, IC103C and IC103D are closed, and vice versa. Hence, when C103 is charging through IC103C and Q101, C104 is discharging rapidly through R107 and IC103D. When the flip-flop changes state, C103 discharges through R106 and IC103A, while C104 charges through IC103B and Q101. Diodes CR101 and CR102 prevent one capacitor from charging the other during the switching transition when both analog switches may be conducting simultaneously.

IC102A and IC102B are comparators. One monitors the voltage across C103 and the other the voltage across C104. The inverting inputs are biased at approximately 6.3 volts, as set by the SPAN TRIM control, R109. As C103 and C104 charge, the voltages at the corresponding non-inverting inputs fall linearly, at a rate controlled by the drain current of Q101.

When either capacitor's voltage falls to the reference voltage controlled by CR103 and set by R109, the output of its comparator drops to the common-buss level and changes the state of the flip-flop IC101C and IC101D. The other capacitor is then released from the discharged condition and begins to charge linearly through Q101 until it reaches the reference voltage and resets the flip-flop to complete a full cycle. The capacitors are matched to within 1% to insure that the output is symmetrical.

The time required for either capacitor to charge to the reference voltage of its comparator will be determined, in part, by the drain current of Q101. As this current increases, the charging time decreases and the frequency of the squarewave generated becomes higher. As the drain current decreases, the frequency also decreases. Because the drain current of Q101 is directly proportional to the input voltage applied at Terminal 11, the frequency of the squarewave generated is, therefore, an analog of the input voltage. The variable-frequency squarewave is buffered by IC101A and, through Terminal 5, drives an external voice-frequency-carrier transmitter.

CR103 is a special, highly stable zener diode, whose output voltage is quite constant under all operating conditions. Through the SPAN TRIM control, R109, CR103 establishes a stable reference voltage at the inverting inputs of the two voltage comparators, IC102A and IC102B, which is the voltage to which C103 and C104 are permitted to charge. The SPAN TRIM control adjusts the frequency span to exactly 5 to 25 Hz.

IC104B is half of a dual opamp. It is not used unless the optional calibrator is installed. When the calibrator is not used, J101 must be in place.

CALIBRATOR OPTION

When the optional calibrator circuit is installed, J101 is removed and IC104B and Q201 form a precision current source. The emitter current of Q201 is a function of the voltage across R201 and R202, which voltage equals the reference voltage from CR103. This current is set to exactly 2.0 mA by CAL TRIM control R201. This precisely controlled current flows through R205, R206, and R207 to produce voltages equal to 10%, 50%, and 90% of full-scale voltage. They are selected by switch S201 and applied to the input of the transmitter to check the calibration of the system.

FS TRANSMITTER OPTION, ACTIVE FILTER OSCILLATOR

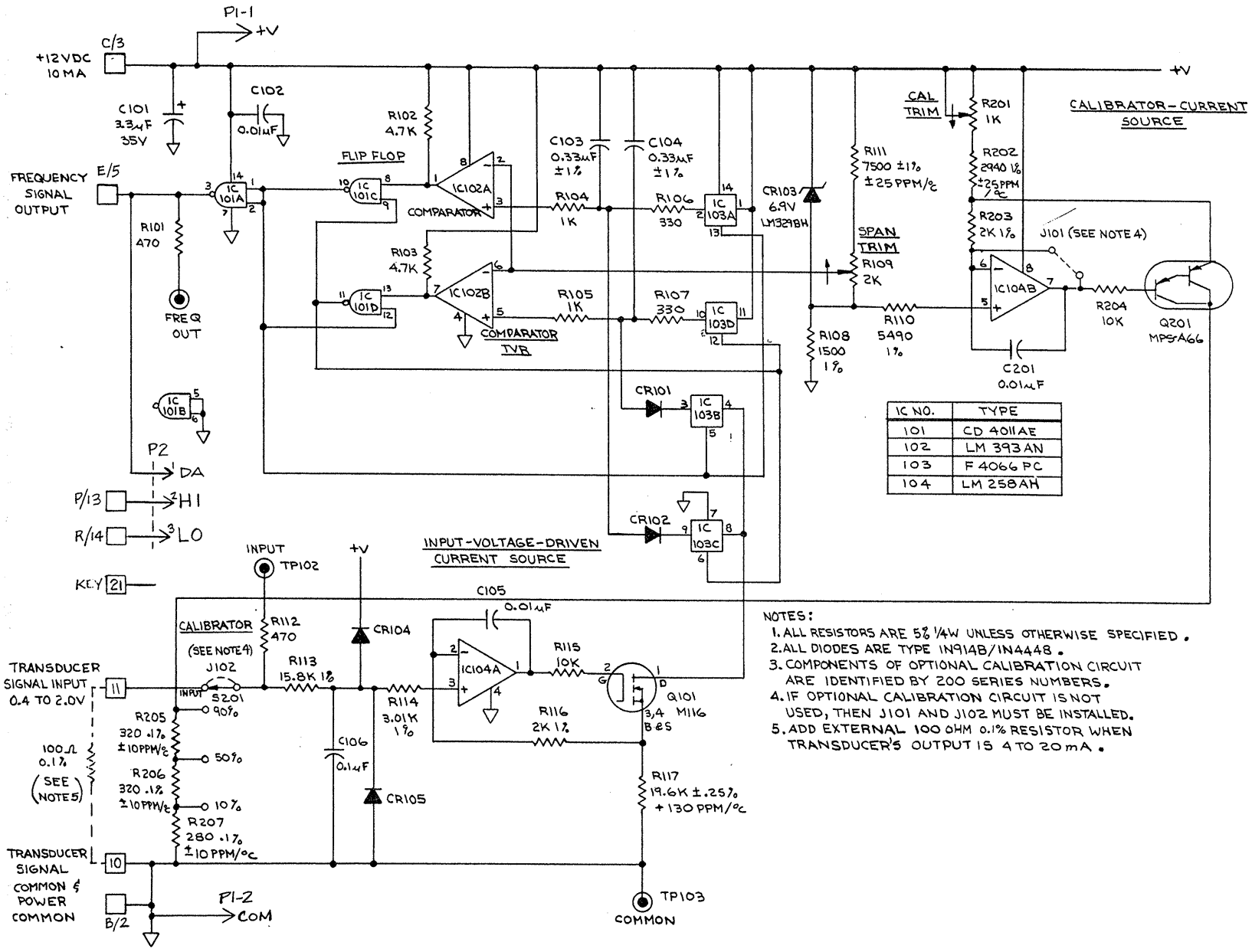
Figure 6 is the schematic of the circuit of the FS transmitter. Operational amplifiers IC1A, IC1C, and IC1D, with associated passive components, form a high-Q bandpass filter. IC1C and IC1D are identical integrators connected in series and with their output fed back to the input through inverting amplifier IC1A. The resonant frequency of the filter is controlled by the time constant of the integrators and the gain of IC1A. The gain-adjustment potentiometer, R13, FREQ, enables frequency trimming. The filter is made to oscillate by feedback from IC1C through inverting amplifier IC1B and R15 to the non-inverting input of IC1A. Limiting in IC1B stabilizes the sinewave output of IC1C to approximately 1 volt peak.

The frequency of the oscillator is shifted by switching shunt resistors across the driving resistance of each integrator. IC2A and IC2C are FET bilateral switches controlled simultaneously by logic signals. The filter oscillates at the low frequency when the switches are open, and it will shift to a higher frequency when the switches are closed.

PARTS LIST

CIRCUIT SYMBOL	DESCRIPTION	PART NUMBER
	MODEL 64B TMX TELEMETER TRANSMITTER, Assembly HB-91370	
C101	Capacitor, tantalum, 3.3 μF, 20%, 35 V, Kemet T324C335M035AS, or eq.	H-1007-1260
C102, 105	Capacitor, ceramic disc, 0.01 μF, 20%, 500 V, Erie 811000Z5U0103M, or eq.	H-1007-83
C103, 104	Capacitor, polystyrene, 0.33 μF, 1%, 100 V, F-Dyne Electronics PST-11-.33-100-1, or eq.	H-5115-286
C106	Capacitor, polyester, 0.1 μF, 10%, 100 V, Cornell-Dubilier WMF-1P1, or eq.	H-1007-624
CR101, 102, 104, 105	Diode, silicon, Type 1N914B/1N4448	HA-26482
CR103	Linear voltage reference, 6.9 V, National LM329BH, or eq.	H-0620-137
IC101	Quad, 2-input NAND gate, RCA CD4011AE, or eq.	H-0615-5
IC102	Dual voltage comparator, National LM393AN, or eq.	H-0620-144
IC103	Quad bilateral switch, Fairchild F4066PC only	H-0615-65
IC104	Dual opamp, National LM258AH, or eq.	H-0620-145
Q101	Transistor MOS FET N-Channel, Siliconix M116, or eq.	H-0715-11
R101–108, R110–116	Resistor, metal-film, precision, 1%, 1/8W, per RFL Spec HA-38301, value per schematic	H-0410-(xxx)
R109	Resistor, variable, metal-film, 2K, 20%, 0.75 watt, Helipot 78PR2K, or eq.	HA-31854
R117	Resistor, wirewound, precision, 19.6K, 0.25%, 0.25W, +130ppm/°C, Prec. Resistor Co. TX-095N, or eq.	H-1780-267
----	Schematic (Figure 5)	HC-91374

CIRCUIT SYMBOL	DESCRIPTION	PART NUMBER
	CALIBRATOR CIRCUIT, Option HB-91376	
C201	Capacitor, ceramic disc, 0.01 μF, 20%, 500 V, Erie 811000Z5U0103M, or eq.	H-1007-83
Q201	Transistor, silicon, PNP, Darlington, Motorola MPS-A66, or eq.	HA-26902
R201	Resistor, variable, metal-film, 1K, 10%, 0.75W, Helipot 79PR1K, or eq.	HA-39574
R202–204, R207	Resistor, metal-film, 1%, 1/8W, per RFL Spec HA-38301, value per schematic	H-0410-(xxx)
R205, 206	Resistor, wirewound, precision, 320 ohms, 0.1%, 0.25W, Type 5013, RFL Spec HA-38310	H-1770-934
	FREQUENCY-SHIFT TRANSMITTER, Option HB-44945	
C1	Capacitor, tantalum, 33μF, 20%, 10V, Kemet T324D336M010AS, or eq.	H-1007-653
C2, 3	Values are frequency-dependent	
C4 - 7	Capacitor, tantalum, 2.2μF, 20%, 25V, Kemet T324B225M025AS	H-1007-645
C8, 9	Values are frequency-dependent	
C10	Capacitor, tantalum, 15μF, 20%, 20V, Kemet T324B156M020AS, or eq.	H-1007-716
IC1	Quad, linear opamp, Raytheon RC4136NB, or eq.	H-0620-149
IC2	Quad, bilateral switch, Fairchild F4066PC only	H-0615-65
IC3	Linear opamp, RC4131NB	H-0620-133
L1	Value is frequency-dependent	
R1–12, R14–23. R25–28	Resistor, metal-film, 1%, 1/8W, per RFL Spec HA-38301, value per schematic	H-0410-(xxx)
R13	Resistor, variable, metal-film, 1K, 10%, 0.75W, Beckman 79PR1K, or eq.	HA-39574
R24	Resistor, variable, metal-film, 10K, 10%, 0.75W, Beckman 79PR10K, or eq.	HA-39539
	Schematic (Figure 6)	HC-44949



IC NO.	TYPE
101	CD 4011AE
102	LM 393AN
103	F 4066 PC
104	LM 258AH

NOTES:
1. ALL RESISTORS ARE 5% 1/4W UNLESS OTHERWISE SPECIFIED.
2. ALL DIODES ARE TYPE IN914B/IN4448.
3. COMPONENTS OF OPTIONAL CALIBRATION CIRCUIT ARE IDENTIFIED BY 200 SERIES NUMBERS.
4. IF OPTIONAL CALIBRATION CIRCUIT IS NOT USED, THEN J101 AND J102 MUST BE INSTALLED.
5. ADD EXTERNAL 100 OHM 0.1% RESISTOR WHEN TRANSDUCER'S OUTPUT IS 4 TO 20 mA.

Figure 5. Schematic of circuit, Model 64B TMX.

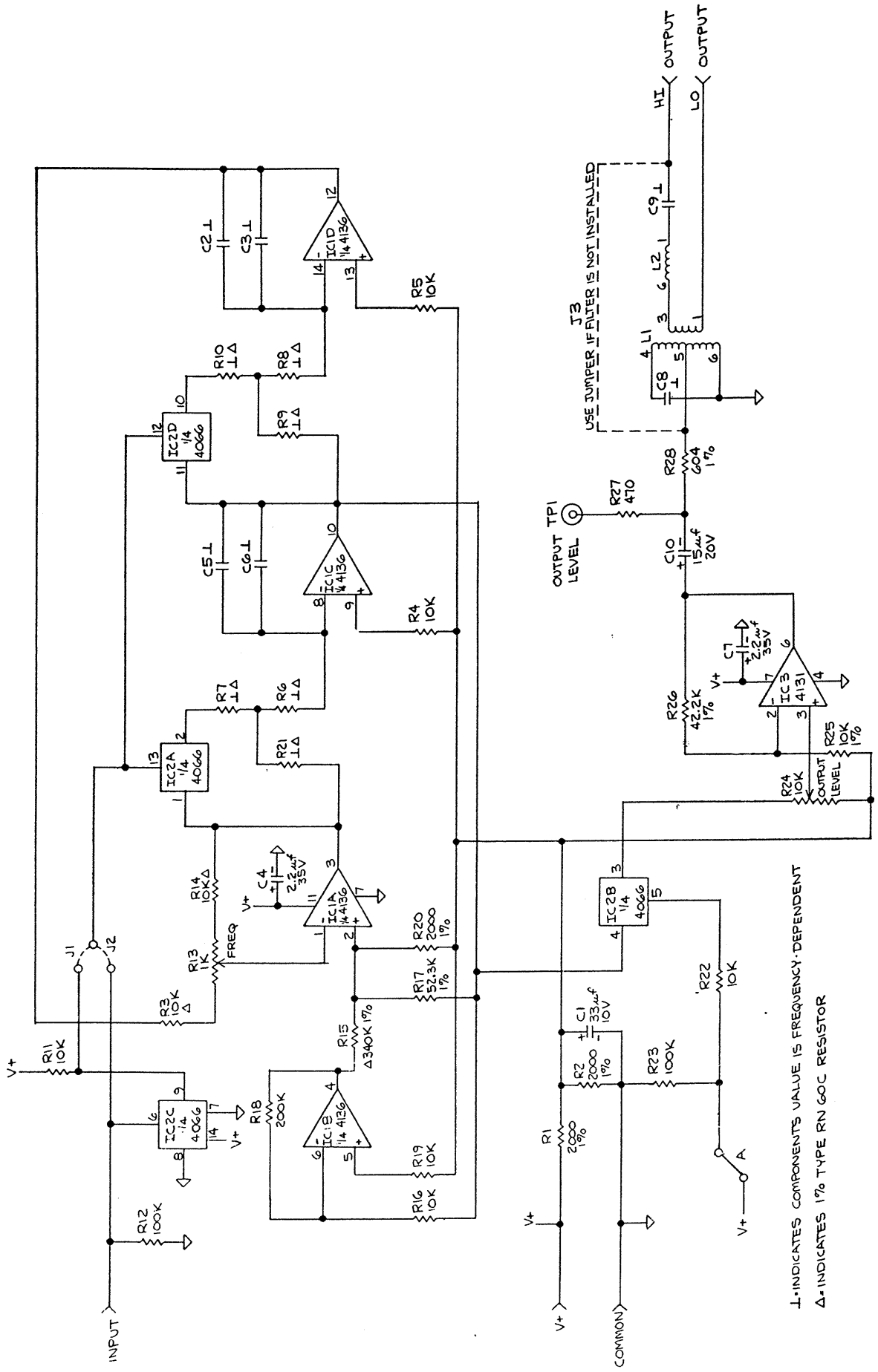


Figure 6. Schematic of circuit for FS Transmitter, Option HB-44945.