INSTRUCTION DATA

Dowty RFL Industries Inc. • Boonton, New Jersey

Model 64B TMR Telemetering Receiver

DESCRIPTION

The Model 64B TMR Telemetering Receiver is the receiving component of a telemetering system in which a squarewave signal is transmitted with its frequency varied as an analog of the telemetered quantity. This receiver accepts such signals, in the range from 5 to 25 Hz, and it delivers an output current which varies between 4 and 20 mA in proportion to the frequency of the incoming signal. The lower current corresponds to the lower frequency.

Other output-current ranges are easily attainable up to a range of 10 to 50 mA, by changing the value of an external current shunt, provided that the ratio of maximum to minimum current is kept at 5.

An optional signal-failure alarm includes an output-signal relay with two Form-C contact sets, and a supervisory lamp indicating when signal is present. Approximately one second after loss of signal the relay drops out and the lamp extinguishes.

A block diagram of the circuit is shown as Figure 2.

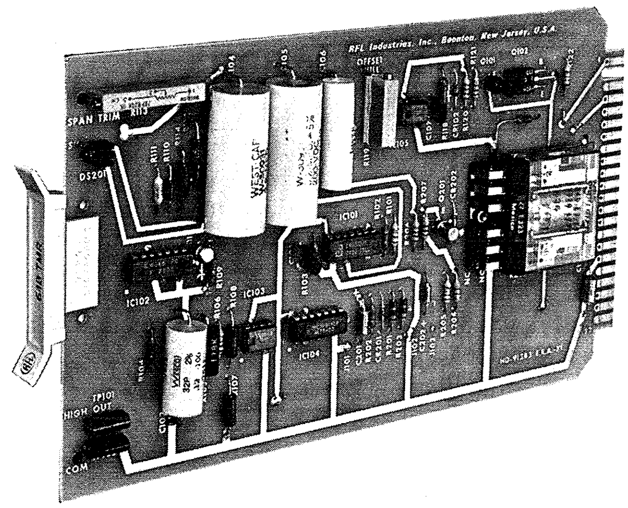

Figure 1. Model 64B TMR Telemetering Receiver.

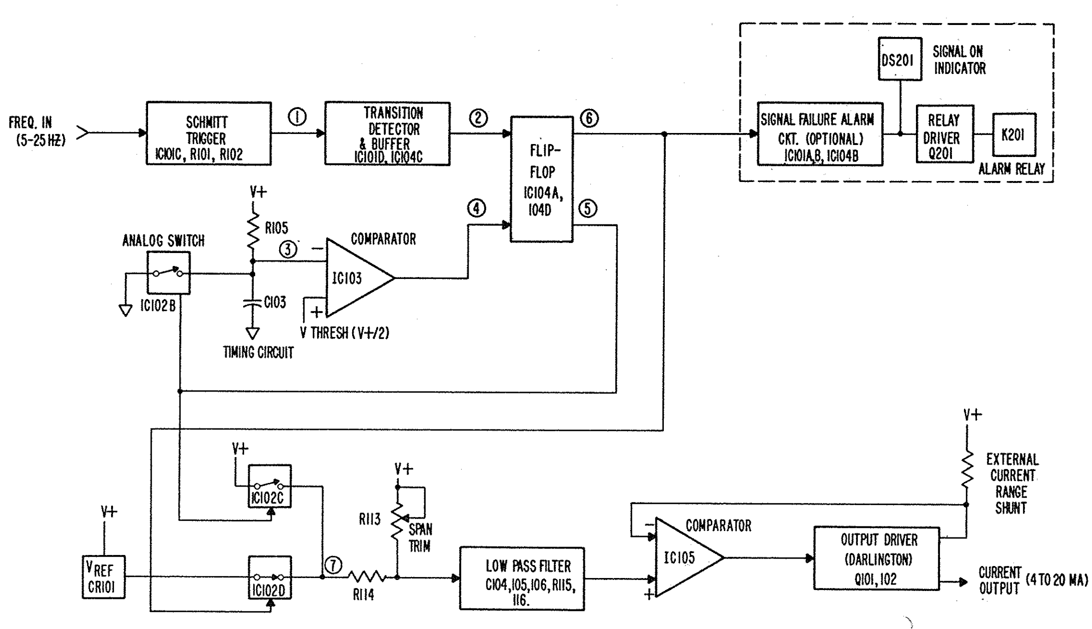

Figure 2. Block diagram of circuit, Model 64B TMR.

DIFFERENCE BETWEEN MODELS

64B TMR
Basic unit; no options included.

64B TMR-1
Basic unit with Signal-Failure Alarm Option HB-91386.

> **NOTE**
>
> When ordering, specify desired output voltage or current range. Any range can be specified, providing minimum value is 20% of maximum value (4 to 20 mA, 10 to 50 mA, 1 to 5 V, etc).

SPECIFICATIONS

Input Frequency: 5 to 25 Hz squarewave, +6 volts minimum, referenced to common.

Output Current: 4 to 20 mA standard, adjustable up to 10 to 50 mA maximum. A ratio of 5 for maximum to minimum current must be maintained.

Accuracy: ±0.15% of full span at 20°C when used back-to-back with Model 64B TMX.

±0.5% of full span from –3°C to +47°C when used back-to-back with Model 64B TMX.

±1.0% of full span from –30°C to 70°C when used back-to-back with Model 64B TMX.

Speed of Response: 1.5 second to within 10% of full span, measured back-to-back with Model 64B TMX.

Ambient Operating Temperature: –30 to 70°C.

Power Requirements:

With Signal-failure alarm: +12 Vdc, 70 mA, including load current of 4 to 20 mA.

Without Signal-failure alarm: +12 Vdc, 35 mA including load current of 4 to 20 mA.

Dimensions: The receiver 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.

INSTALLATION

INTRODUCTION

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

Figure 3 shows edge-connector terminal assignments on the circuit card. Reference to the schematic of the receiver'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.

Typical waveforms, at significant points in the circuit, are shown on Figure 4. Points in the circuit at which these appear are identified on Figures 2 and 5.

CALCULATING VALUE OF EXTERNAL CURRENT SHUNT

The receiver's circuit operates to maintain a predetermined voltage drop, conforming to the frequency of the input signal, across the current shunt, connected externally across Terminals 5 and 6. Thus, for a 25-Hz input signal, the voltage at Terminal 6 is controlled to be 2.0 volts with respect to Terminal 5 when the current is 20 mA. For a full-scale output current of 20 mA at Terminal 20, therefore, the resistance of the current shunt connected across Terminals 5 and 6 should be

$$R = e/i = 2.0/20\ (10^{-3}) = 100 \text{ ohms.}$$

Similarly, if the required full-scale current were to be 50 mA, then the shunt across Terminals 5 and 6 should be

$$R = 2.0/50\ (10^{-3}) = 40 \text{ ohms.}$$

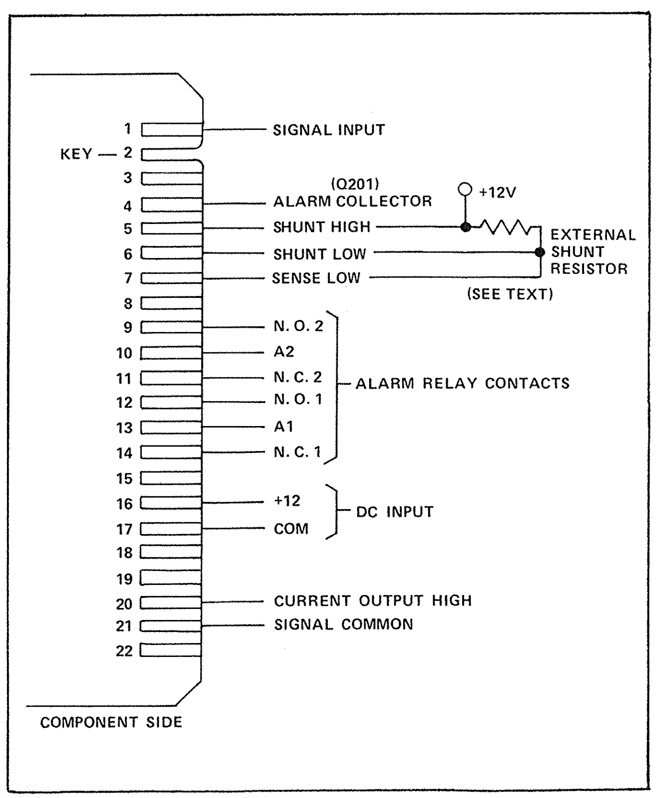

Figure 3. Edge Connector Terminal Assignments.

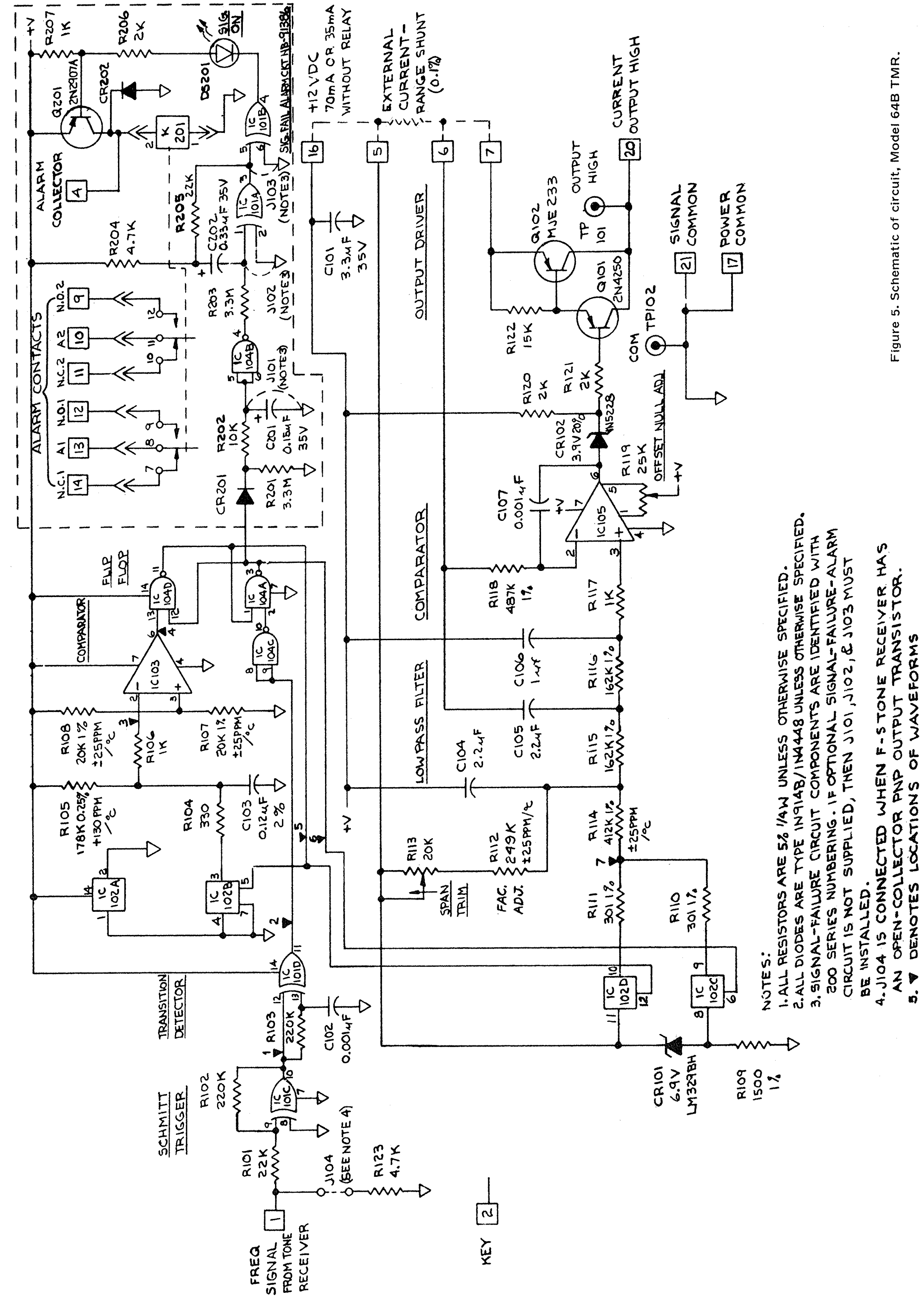

Figure 5. Schematic of circuit, Model 64B TMR.

THEORY OF OPERATION

BASIC CIRCUITS

IC101C, with R101 and R102, Figure 5, forms a Schmitt trigger which insures that the rising and falling edges of the received squarewave signal are sharp. The output of IC101C is shown on Waveform 1, Figure 4. EXCL-OR gate IC101D, with R103 and C102, forms a transition detector which produces a positive-going pulse, approximately 200 μs wide, coincident with each transition of the incoming signal. The output of IC101D is shown on Waveform 2, Figure 4. Note there are two pulses for every cycle of telemetering signal.

Pulses at IC101D-11 are inverted by IC104C, the output of which sets the flip-flop consisting of IC104A and IC104D. When the flip-flop is set, IC104D-11 is at a logic low which will hold analog switch IC102B off. This will allow C103 to charge toward V+ through R105, as shown in Waveform 3. When the inverting input of IC103 reaches the threshold voltage set at its noninverting input by R107 and R108, the output of IC103 will pull down as shown with Waveform 4, and reset the flip-flop so that the voltage at IC104D-11 is high as shown with Waveform 5. At this point, switch IC102B becomes conducting and C103, therefore, will discharge rapidly to common through R104.

The circuit consisting of the flip-flop, comparator IC103, and the analog switches, forms a precision monostable circuit which generates a very accurate pulse width, T_A on Waveform 7, on every half cycle of the incoming signal.

Analog switches IC102C and IC102D conduct alternately, under control of the flip-flop. Hence, the junction of R110 and R111 is alternately switched between V+ (Terminals 5 and 16 are always connected together externally), when IC102D is conducting, and a reference voltage when IC102C conducts, during the period shown on Waveform 6. The reference voltage is generated by zener diode CR101, which maintains a very stable voltage. The average voltage appearing at the junction of R110 and R111 is, therefore, proportional to the frequency of the received signal.

Period T_A, Waveform 7, is held constant by the precision monostable circuit, and period T_B varies with the frequency of the incoming signal. The average of these periods determines the average voltage at the junction of R110 and R111.

This voltage is scaled by a voltage divider consisting of R114, R112, and SPAN TRIM control R113. C104, C105, and C106, with associated resistors, form a low-pass filter which removes the ripple frequency. The smoothed dc voltage, which is linearly related to the incoming telemetering frequency, is applied, through R117, to the non-inverting input of IC105.

Operational amplifier IC105 drives a Darlington-connected transistor pair through zener diode CR102 and R121. The collector supplies output current to the external load downward from the V+ buss. IC105 and the Darlington pair forms a voltage-driven current source. Voltage at the opamp's non-inverting input is compared with the voltage across an external shunt applied to the inverting input. The output current is, therefore, equal to the input voltage divided by the shunt resistance (referenced to V+). The voltage across the external shunt is measured by four-wire sensing so that edge-connector resistance will not introduce an error.

Signal-Failure Alarm

If the optional signal-failure alarm is supplied, then gates IC104B, IC101A, and IC101B will be used. Otherwise jumpers J101, J102, and J103 must be installed.

The output of the flip-flop, IC104A and IC104D, rapidly charges C201 through CR201 and R202. During the off time of the flip-flop, within each cycle of the telemetering signal, C201 will discharge slowly through R201 and R202. But at the lowest telemetering frequency C201 will not have discharged sufficiently to cause a change in the output of IC104B. If, however, the telemetering signal disappears for more than several hundred milliseconds, C201 will discharge sufficiently to change the output of IC104B from low to high. This will turn off DS201, SIGNAL ON, and de-energize alarm relay K201. On turn-on, when IC104B-4 goes low in response to the presence of a telemetering signal, the time constant, R203, C202, delays action until the signal has continued for at least a few tenths of a second. This prevents spurious indications of presence of signal due to noise bursts. When a signal is present, the output of buffer IC101B goes low and turns on Q201. Current flows through DS201, SIGNAL ON, to indicate presence of a signal. K201 is a small, plug-in relay driven by the collector of Q201. It is energized so long as a telemetering signal is received.

TABLE 1.
REPLACEABLE PARTS
DRFL Model 64B TMR Telemetering Receiver

Circuit Symbol (Figure 5)	Description	DRFL Part Number
	BASIC MODULE – Assembly Number HB-91380	
	CAPACITORS	
C101	Capacitor, tantalum, 3.3µf, 20%, 35V, Kemet T322C335M035AS or equiv.	1007-1260
C102, 107	Capacitor, ceramic disc, .001µf, 10%, 500V, Erie 801-000-X5F0-102K or equiv.	1007-235
C103	Capacitor, polystyrene, .120µf, 2%, 100V, Wesco 32P or equiv.	5115-86
C104, 105	Capacitor, mylar, 2.2µf, 5%, 200 V, Wesco 32MM or equiv.	1007-833
C106	Capacitor, mylar, 1µf, 2%, 200V, Wesco 32MM or equiv.	1007-482
	RESISTORS	
R101	Resistor, metal film, 22.1K, 1%, ¼W, Type RN¼	0410-1417
R102, 103	Resistor, metal film, 221K, 1%, ¼W, Type RN¼	0410-1513
R104	Resistor, metal film, 332 ohm, 1%, ¼W, Type RN¼	0410-1242
R105	Resistor, wire wound, 178K, .25%, ¼W, 130PPM/°C temperature coefficient, Precision Resistor Type TX-145N or equiv.	1780-268
R106, 117	Resistor, metal film, 1K, 1%, ¼W, Type RN¼	0410-1288
R107, 108	Resistor metal film, 20.0K, 1%, 1/8W, Type RN60E	1510-1908
R109	Resistor, metal film, 1.5K, 1%, ¼W, Type RN¼	0410-1305
R110, 111	Resistor, metal film, 301 ohm, 1%, ¼W, Type RN¼	0410-1238
R112	Resistor, metal film, factory selected value,	
	1%, 1/8W, Type RN60E 243 K	1510-2125
	249 K (nominal value)	1510-2005
	261 K	1510 2040
R113	Resistor, variable, cermet, 50K, 10%, ¾W, Beckman 78PR50K or equiv.	42929
R114	Resistor, metal film, 412K, 1%, 1/8W, Type RN60E	1510-2006
R115, 116	Resistor, metal film, 162K, 1%, 1/8W, Type RN60C	1510-1722
R118	Resistor, metal film, 487K, 1%, 1/8W, Type RN60C	1510-1632
R119	Resistor, variable, cermet, 15-turn, 25K, 10%, ¾W, Beckman 89WHR25K, or equiv.	29211
R120, 121	Resistor, metal film, 2K, 1%, ¼W, Type RN¼	0410-1317
R122	Resistor, metal film, 15K, 1%, ¼W, Type RN¼	0410-1401
R123	Resistor, metal film, 4.75K, 1%, ¼W, Type RN¼	0410-1353
	SEMICONDUCTORS	
CR101	Diode, precision voltage reference, 6.9V, 30mA, National Semiconductor LM329BZ or equiv.	0620-137
CR102	Diode, Zener, 3.9V, 20%, 500mW, 1N5228	91387
IC101	MOS quad exclusive-OR gate, RCA CD4030BE or equiv.	0615-22
IC102	MOS quad bilateral switch, Fairchild F4066PC (no equiv)	0615-65
IC103	Operational amplifier, LM301	0620-76
IC104	MOS quad 2-input NAND gate, RCA CD4011BE or equiv.	0615-5
IC105	Operational amplifier, JFET-input, National Semiconductor LF355N or equiv.	0620-139
Q101	Transistor, PNP, 2N4250	39964
Q102	Transistor, PNP, 4A, 15W, 60V, Motorola MJE-233 or equiv.	34757

TABLE 1.
REPLACEABLE PARTS
DRFL Model 64B TMR Telemetering Receiver - continued

Circuit Symbol (Figure 5)	Description	DRFL Part Number
	MISCELLANEOUS COMPONENTS	
J101-103	Jumper, 22AWG, 0.300 x 0.250", Fancort Industries J-0.300X0.250-T22, or equiv.	90787-2
J104	Jumper, 22AWG, 0.250 x 0.250", Fancort Industries J-0.250X0.250-T22, or equiv.	90787-1
TP101	Test jack, green, E. F. Johnson 105-2204-101 or equiv.	38116-5
TP102	Test jack, black, E. F. Johnson 105-2203-101 or equiv.	38116-3
	SIGNAL-FAILURE ALARM, OPTIONAL, Assembly Number HB-91386	
	CAPACITORS	
C201	Capacitor, tantalum, 0.15µf, 20%, 35V, Kemet T322A154M035AS or equiv.	1007-514
C202	Capacitor, tantalum, 0.33µf, 20%, 35V, Kemet T322A334M035AS or equiv.	1007-871
	RESISTORS	
R201, 203	Resistor, composition, 3.3M, 5%, ¼W, Allen-Bradley CB Series or equiv.	1009-801
R202	Resistor, metal film, 10K, 1%, ¼W, Type RN¼	0410-1384
R204	Resistor, metal film, 4.75K, 1%, ¼W, Type RN¼W	0410-1353
R205	Resistor, metal film, 22.1K, 1%, ¼W, Type RN¼	0410-1417
R206	Resistor, metal film, 2K, 1%, ¼W, Type RN¼	0410-1317
R207	Resistor, metal film, 1K, 1%, ¼W, Type RN¼	0410-1288
	SEMICONDUCTORS	
CR201, 202	Diode, silicon, 1N914B or 1N4448	26482
DS201	LED, Dialight 550-0102 or equiv.	39568
Q201	Transistor, PNP, 2N2907A	37439
	MISCELLANEOUS COMPONENTS	
K201	Relay, DPDT, 320 ohm coil, 12V, AMF/Potter & Brumfield R40-E1-Y2-V320 12VDC or equiv.	29591

Intermediate values are acceptable. All resistors should be of 0.1% accuracy, or better, and they should have a dissipation rating of at least 1/4 watt.

Resistors used for setting the current range are mounted at the back of the chassis containing the Model 64B TMR circuit card. To compensate for the variable and unpredictable IR drop through the resistance of the fingers of the edge connector, a four-wire voltage-sensing system is used. Terminals 16 and 5, thus are connected together only at the leads of the current-range-setting resistor, with the lead from Terminal 16 connected as close to the body of the resistor as possible. The same precaution applies at Terminal 6, where the lead from Terminal 7 should be connected as close to the body of the resistor as possible.

ADJUSTMENT OF SPAN TRIM

To adjust SPAN TRIM, R113, connect a digital voltmeter across the external current shunt. Note that the voltmeter must be capable of operating off ground, for its common side will be connected to +12 Vdc for this adjustment.

Apply an input signal of precisely 25 Hz to the input of the receiver, and adjust R113 for a voltmeter reading of precisely 2.000 volts.

An alternate approach, which permits the voltmeter to be grounded, is to connect a precision resistor, of resistance equal to that of the current-range shunt, between Terminals 20 and 21. Connect the voltmeter across this resistor and adjust R113 for 2.000 volts. To preserve the accuracy of the adjustment, the resistor used must be within ±0.02% of the calculated value for the current range chosen.

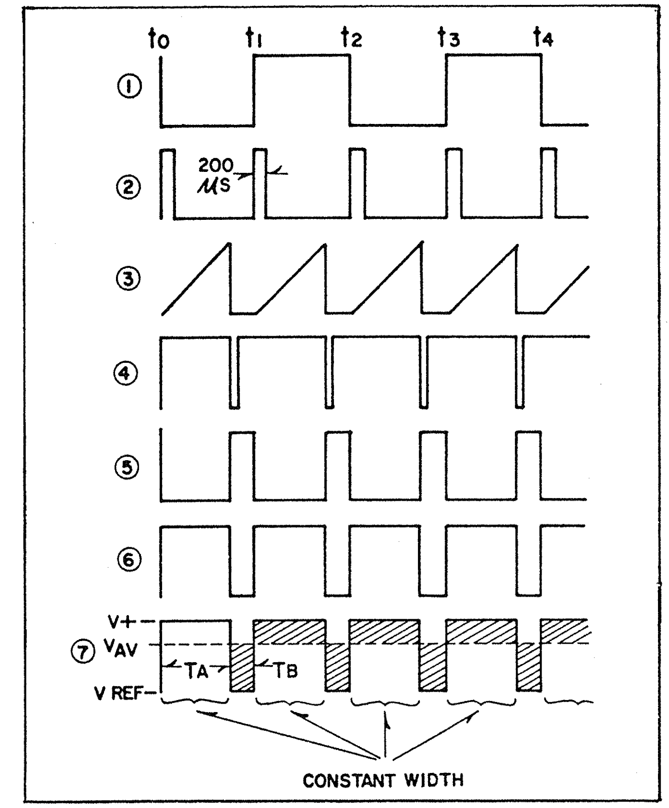

Figure 4. Waveforms at selected points. Numbers correspond to the points so identified on Figure 5.

OFFSET ADJUSTMENT

Potentiometer R119 provides for adjusting the null of opamp IC105. It is adjusted at the factory for the particular opamp installed. No further adjustment is recommended, nor should it be necessary unless the opamp is replaced. In that event, it is adjusted so that the ratio of maximum to minimum output current is precisely 5.0.