AIR PUBLICATION

116E - 2206 - 1

FREQUENCY SHIFT TONE KEYER TELESIGNAL MODEL 302

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

L. T. Durrett

Ministry of Defence

FOR USE IN THE

ROYAL AIR FORCE

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LIST OF ASSOCIATED PUBLICATIONS

	A.P.
Digital keyer Telesignal model 301	116E-2205-1

TELE-SIGNAL CORPORATION
CV 1692(P)/UGC
MODEL 302
FREQUENCY SHIFT TONE RECEIVER

INSTRUCTION MANUAL
ISSUE 3

Tele-Signal Corporation
198 Miller Place
Hicksville, L.I.,N.Y.
WE 8-7110

Proprietary Information

FREQUENCY SHIFT TONE RECEIVER
CV 1692(P)/UGC
MODEL 302

INDEX
ISSUE 3

1.0 PURPOSE AND BASIC PRINCIPLES

1.01 Application

1. The Model 302 is one of the basic building block components used to form a voice frequency telegraph multiplex system, converting mark and space audio tones into DC binary signals. All receivers of a system are usually identical with the exception of bandpass filters and frequency determining networks.

2. Up to sixteen units may be paralleled across a nominal 3kc voice frequency line; however, the capabilities may be expanded by increasing the number of channels and the corresponding response of the VF line facility.

1.02 Unit Description

1. The Model 302 is a transistorized modular plug-in assembly capable of converting mark and space audio tones into corresponding DC binary signals

2. The unit is 2" wide, 5½" high and 19½" deep. It is mechanically a Tele-Signal two inch module designed to slide into Model 239-series equipment shelves. All signal and power connections are made by means of a shelf connector at the rear of the unit which is engaged when the unit is seated in the shelf.

3. The Model 302 is completely self contained and incorporates its own DC power supply.

2.0 SPECIFICATIONS CV 1692(P)/UGC

2.01 General Characteristics

General Characteristics:	Converts frequency shift audio tones into DC binary signals.
Size:	2" wide x 5¼' high x 19" deep.
Weight:	10 lbs. approximately.
Power Requirements:	115/230VAC, 47-/440 cps, single phase approximately 4 watts.
Input Frequency Range:	300cps to 8kc audio tones.
Input Impedance:	600ohms ±10%, unbalanced.
Input Level:	-45dbm to +5dbm.
Output Signal:	a. (Relay Output) Polar relay contacts, standard S-T-M configuration, electrically floating. b. (Direct Output) Neutral -12V ±10%. 10ma maximum. Source impedance approximately 200ohms.
Output Current:	10 to 100ma for relay output.
Output Keying Sense:	Direct or inverted by internal switch.
Total Bias Distortion:	Less than 5% when keyed with Model 301D keyer on a back-to-back basis at 90 baud.
Carrier Distortion:	Less than 2% at lowest standard center frequency.
Output Signal Delay:	Minimum adjustable range of 5 milliseconds.
Temperature Range:	Operating: -18 to +55°C. Storage: -62 to +85°C.
Elevation:	Operating: 10,000 feet above sea level. Non-Operating: 50,000 feet above sea level.
Humidity:	Up to 97% relative humidity for 20 hours.
Front Panel Controls:	CENTER FREQUENCY BIAS DELAY
Internal Controls:	SENSE switch
Monitoring Facilities:	TP-1 Filtered tone input monitor TP-2 Low level keyer output monitor TP-3 Polar detector output monitor TP-4 High level output monitor TP-5 Ground

3.0 INSTALLATION INSTRUCTIONS

3.01 Mechanical Arrangement

1. The unit is mechanically designed to mount in a Model 239 or 240-series equipment shelf.

   a. To install, slide the module into the appropriate shelf position until the module connector seats firmly into the shelf connector.

   b. Secure the module to the shelf with the two thumbscrews at the top and bottom of the front panel.

2. All connections to the module are made through the shelf connector.

3. The module should be physically and electrically located as close to associated equipment as possible to minimize extraneous signal pickup.

3.02 Power Connections

1. External AC power is brought into the module through connector P1 pins 1 (HI) and 13 (LO). The power source may be either 115VAC or 230VAC. The module is normally strapped for 115VAC unless otherwise specified by the customer.

2. To change the input power strapping.

Input Voltage	Power Transformer Straps	AC Power Fuse Size
115VAC	1 & 3 2 & 4	1 ampere
230VAC	2 & 3	½ ampere

3.03 Input Signal Connections

1. Input audio tones are connected to shelf pin 24 (high) and pin 12 (ground).

3.04 Output Signal Connections

1. The polar relay contacts appear on shelf pins 9 (space), 7 (tongue), and 20 (mark).

2. The low level neutral (0 -12VDC) signal appears on pin 5 (high) and pin 12 (ground).

4.0 OPERATING INSTRUCTIONS

4.01 Strapping

1. Normally the Model 302 leaves the factory strapped for 115VAC operation; for 230VAC operation remove the straps from terminals 1 to 3 and 2 to 4 on transformer T5. Strap terminals 2 to 3 and apply 230VAC across pins 1 and 13 of P1.

2. Provide strapping for diversity or non-diversity operation as follows:

   a. For non-diversity operation: strap A, B & C.

   b. For diversity operation: strap C.

3. If a common power supply is used for a number of units remove strap D and connect the common power supply to pin 4 (-) and pin 11 (+) on the shelf connector.

4.02 Sense Switch Position

1. The SENSE switch is set to the position designated by the system requirements.

   a. With the SENSE switch in the DIRECT position, a frequency higher than center frequency at the receiver input will close the tongue to the mark contact on the polar relay.

   b. With the SENSE switch in the INVERTED position, a frequency lower than center frequency at the receiver input will close the tongue to the mark contact on the polar relay.

4.03 Test Equipment Required for Adjustments

1. Volt-ohm-milliammeter - Simpson 260 or equivalent.

2. Oscilloscope - Hewlett-Packard 122A or equivalent.

3. Frequency shift or digital keyer with matching network and filter - Model 301D or equivalent.

4. Dotter to key the keyer with 1:1 reversals - Model 320 or equivalent.

5. Delay measuring device - Model 320 or equivalent.

4.04 Initial Check on Operating Conditions:

1. The DC power supply and bias circuits may be checked as follows:

   a. Apply power to the Model 302 receiver.

   b. Connect a VOM set to read 4VDC between TP3 (-) and TP5 (+).

   c. Short TP1 to TP5 or chassis ground.

   d. Turn the BIAS control full CCW. The VOM should read 0VDC.

e. Turn the BIAS control full CW. The VOM should read a nominal -3.5VDC ± 20%.

f. If the reading is low, insure that the power supply output is 12VDC ± 10%.

2. The trigger circuit output may be checked as follows:

a. Connect a VOM set to read 12VDC to TP2 (-) and TP5 (+).

b. Short TP1 to TP5 or chassis ground.

c. Turn the BIAS control full CCW. The VOM should read -12VDC ± 1.5V.

d. Turn the BIAS control full CW. The VOM should read between 0VDC and and -1.5VDC.

4.05 <u>Center Frequency Adjustment</u>

1. The center frequency of the discriminator is controlled by adjustment of L101. This screw driver adjustment is accessible from the front panel and is labeled CENTER FREQ.

2. Connect the output of a frequency shift tone keyer/transmitter to the input of the Model 302 receiver.

a. Insure that the keyer meets all operational specifications.

b. Connect a telegraph test generator capable of generating 1:1 reversals at 90 baud to the input of the keyer.

c. Lower keying speeds may be used but should not be less than the speed of transmission on the channel in traffic conditions.

3. Connect an oscilloscope between TP3 and TP5 (ground).

a. Set the scope for no sync (free running).

b. Adjust the sweep speed for two or three cycles of waveform per Figure 1.

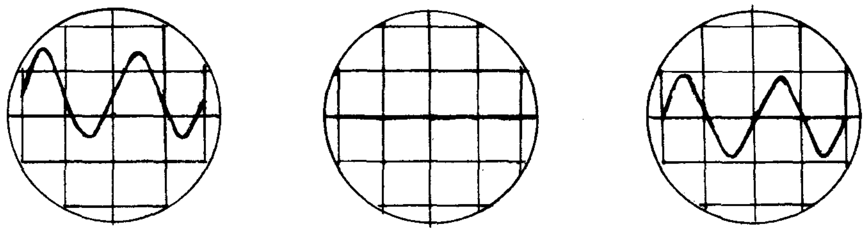
4. Adjust the CENTER FREQ control for a symmetrical waveform per Figure 2. This is a coarse adjustment only and there is no need for accuracy.

Figure 1

Figure 2

5. With no sync on the scope, adjust the scope sweep frequency for a figure-8 pattern per Figure 3A.

a. Short TP1 and TP5. This shorts out the input signal and a horizontal trace will be seen on the scope.



3A 3B 3C

Figure 3

b. Set this horizontal trace to the center cursor line on the scope per Figure 3B.

c. Remove the short from TP1 and TP5.

d. Adjust the CENTER FREQ control so that the figure-8 crossover points fall exactly on the zero signal reference line.

6. This completes the normal discriminator alignment procedure.

7. When required, slightly better peak telegraph distortion characteristics may be obtained by refining alignment as outlined in the following paragraphs.

8. Alignment at a constant bit rate such as 1:1 reversals does not yield optimum results when the channel is keyed at a varying bit rate as in traffic.

a. If the channel is keyed with a locked character containing the the longest signal elements and the shortest signal elements, discriminator alignment can be made on an averaging basis so that peak telegraph distortion will be minimized under traffic conditions.

b. Figure 4 shows a 7 bit start stop signal used as a test signal. The short signal elements are bits 2 and 3. The long signal elements are bits 4, 5, stop, start, and 1.

c. Figure 5 shows the discriminator output for the Figure 4 test signal.

d. Alignment on such a signal will yield, generally, an improvement of 1-2% over 1:1 reversal alignment at the maximum bit rate.

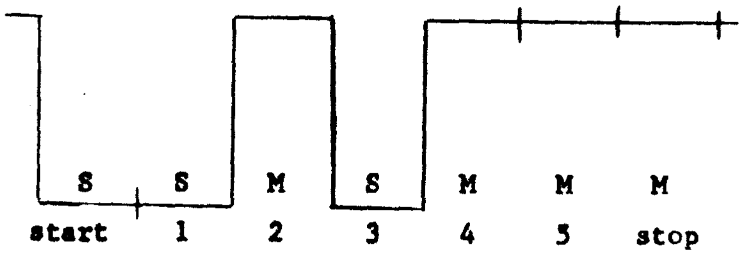


Figure 4

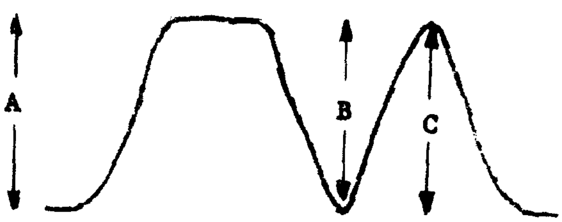


Figure 5

9. Final alignment is made by adjusting the CENTER FREQ control slightly to optimize discriminator output in the following steps:

a. With 90 baud reversals, set the scope for a reversal pattern spread per Figure 6.

b. With the 90 baud test signal per Figure 4, readjust the scope as required for the keying signal crossover pattern per Figure 7.

c. Note that the rising edges of two signal elements and the falling edge of two signal elements form an appropriate diamond figure in the center of the pattern.

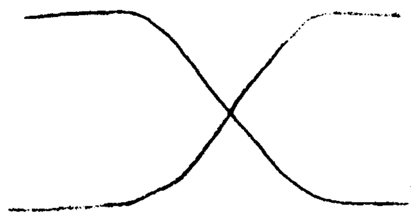
d. Adjust the CENTER FREQ control to optimize the following requirements:

(1) Minimize the horizontal width of the diamond pattern (spread between points of intersection).

(2) When the scope is switched to yield a presentation per Figure 5, dimensions B or C shall have not decreased more than 10% less than dimension A.

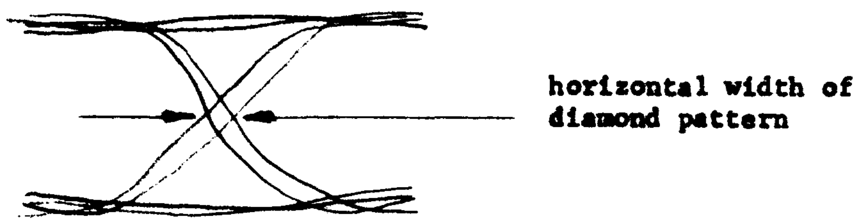
e. Averaging to meet all these requirements will optimize discriminator alignment.

f. Following alignment, reset the BIAS control as described later and measure output distortion.



Scope Presentation
1:1 Reversals

Figure 6



Scope Presentation
Keying Signal Crossover

Figure 7

10. An alternative method of final alignment is to change the CENTER FREQ control in small increments, in each case setting BIAS to zero, and measuring output distortion. In this case, the discriminator is left at the point of minimum distortion. The input test signal is per Figure 4.

4.06 Bias Adjustment

1. With 1:1 reversals at the keyer input and the oscilloscope at twice the signal speed (without synch), place the scope lead between TP2 and TP5 (ground) of the receiver. Adjust the BIAS control for a 50/50 weighted squarewave pattern on the scope as indicated in figure 8.

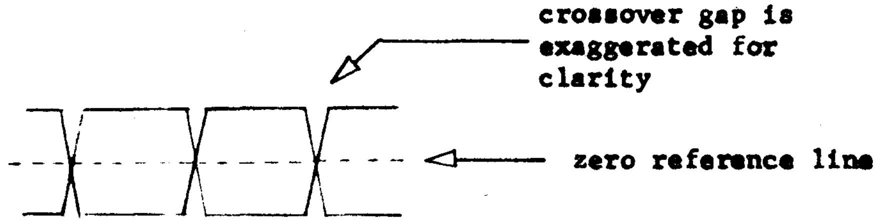


Figure 8

4.07 Delay Adjustment

1. The delay adjustment on the Model 302 receiver must be made using the receiver in a system configuration with another Model 302 as a reference receiver, (the lowest frequency channel receiver should be used as the reference) a Model 320 metering panel, and appropriate jacking facilities.

2. Terminate the receive DC loops of the Model 302 reference receiver and the Model 302 to be adjusted into the Model 320 DELAY #1 and DELAY #2 respectively.

3. With both receivers on steady mark, adjust both receiver loops for 60ma. Controls are on Model 320. Set the dealy meter CIRCUIT switch to BAL and carefully adjust one of the loop currents so that the delay meter reads exactly zero. Increase meter sensitivity and carefully readjust. Return delay meter switch to low sensitivity.

4. Apply identical 1:1 reversals to each companion keyer. Set the delay meter CIRCUIT switch to DELAY.

5. Set the DELAY control on the reference receiver to ¼ rotation from maximum CW and adjust the DELAY control of the other receiver for minimum delay time (zero microamperes) as read on the Model 320 meter.

4.08 Test Point Waveforms and Voltages

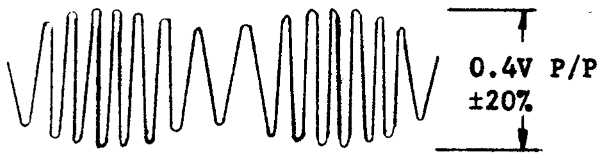
1. Input - companion keyer, keyed at 1:1 AC reversals.

2. Output viewed on oscilloscope with horizontal sweep set to twice keying speed.

3. All readings taken with respect to TP-5.

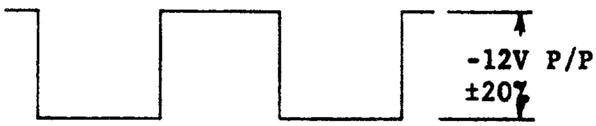
TEST POINT — **WAVEFORMS** — **VOLTAGES**

TP-1



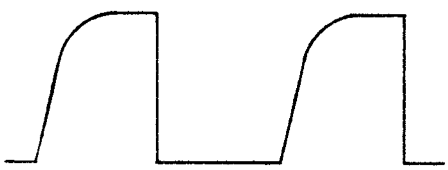
Amplitude with -10dbm ±10% tone input.

TP-2



TP-3

TP-4



Amplitude dependent upon loop battery supply voltage and external loading
External loop battery common must be grounded

TP-5 — Common (ground)

5.0 THEORY

5.01 General

1. Reference is made to drawings D 302-01 and D 302-02, the schematic and block diagram of the unit.

2. The Model 302 Frequency Shift Tone Receiver basically consists of ten functional circuits detailed as follows:

a. Bandpass Filter which separates the tones of one particular channel from all other tones on the aggregate tone line.

b. Two-stage push-pull amplifier which provides amplification and limiting of the incoming tones.

c. Phaseshift network capable of shifting the phase of the voltages fed to the polar detector.

d. Phaseshift amplifier and limiter which drives a section of the polar detector.

e. Polar detector which converts the mark and space frequencies into positive and negative DC binary pulses.

f. Triggered keyer circuit which provides waveshaping for the DC pulses from the polar detector.

g. Delay amplifier which is capable of providing a variable time delay of the binary signals fed to the transistor switch.

h. An AND gate which triggers the transistor switch.

i. A transistor switch which provides drive few the polar relay.

j. A polar relay which isolates the DC telegraph line from the internal circuitry of the Model 302.

5.02 Input Amplifier - Limiter Circuit Description

1. The incoming aggregate audio tones are fed through the bandpass filter. The filter passes only the band of frequencies containing the mark and space tones of a designated channel. The output of the filter is transformer coupled to push-pull amplifier-limiter stage Q1 and Q2. The circuit is arranged such that weak signals will be amplified and strong signals will be limited. The output of this stage is transformer coupled to a second push-pull limiter stage Q3 and Q4. This circuit will limit all signals and provide a constant amplitude output. Two outputs are taken from the second push-pull limiter the first output is taken from the collector of Q3 and fed to the phase shift network L101, C101 and C102. The second output of the limiter is transformer coupled to the polar detector.

5.03 Phaseshift Network Circuit Description

1. Coil L101 and capacitors C101 and C102 shifts the phase of one of the output voltages of the limiter. The phase shifted voltage is fed to isolation stage Q5 which drives limiter stage Q6. The output of Q6 is

transformer coupled to one section of the polar detector.

5.04 Polar Detector Circuit Description

1. The polar detector comprises diodes CR1 through CR4. The circuit is arranged so that when the two input voltages are 90° out of phase, the output of the detector, across R17 and R18, will be zero volts. This represents an input signal at the center frequency of the particular channel. The 90° phase shift is accomplished by tapping the voltage across the inductance of a tuned series circuit. When the input frequency changes to either the mark or space frequency, the phase relationship between the two applied voltages will depart from 90° , and the polar detector will deliver either a positive or negative DC voltage. The direction and amplitude of this voltage depends upon the phase and time duration of the two applied voltages.

5.05 Triggered Keyer Circuit Description

1. The output of the polar detector is fed through the SENSE switch to a post-detection lowpass filter comprised of L1 and C103. The output of the lowpass filter feeds the Schmitt-trigger circuit Q8 and Q9 through the impedance converting stage Q7. The Schmitt-trigger circuit provides normalized output, the weight of which is determined by the bias control R20. Transistor Q10 is a phase inverter which drives the time delay circuit.

5.06 Time Delay Circuit Description

1. Transistors Q11, Q12 and Q13 comprise the time delay stage which provides a variable delay from the output of Q10 to the input of the transistor switch Q14 and Q15. Q11 and Q12 is a one-shot multivibrator with Q12 normally saturated and Q11 cutoff. The output from the collector of Q10 is a coupled through differentiating capacitors C8 and C11 to the base of Q11 and Q12 through CR8 and CR11, and will cause Q12 to become cutoff and Q11 to become saturated. After a time delay determined by the time constant of C13, R39, Q11,R40 and CR9 in series, the one shot multivibrator Q11 and Q12 will return to its original state, providing a positive pulse to drive Q14 or Q15. At this instant Q13 conducts and provides a fast charging time for C13.

5.07 AND Gate and Transistor Switch circuit Description

1. The positive pulse from the collector of Q12 is coupled through differentiating capacitors C14 and C15 to the AND gate comprised of CR13, R42 and CR14, R41. In order for CR13 or CR14 to pass this pulse, it is necessary that its anode be at approximately zero volts DC level. The emitter of Q9 is coupled to the anode of CR13 through R42, and the collector of Q10 is coupled to the anode of CR14 through R41. When one of these points is at zero DC level, the other point will be at approximately -12VDC level. The negative 12 volts will back bias one of the diodes and will inhibit the pulse from Q12 from appearing at the base of either output switch transisters Q14 or Q15. Only the diode with zero volts DC on its anode will pass the pulse, therefore causing either Q14 or Q15 to become saturated and the other to become cutoff. When Q9 and Q10 change state, Q14 and Q15 will also change state after a number of milliseconds as determined by the delay circuit.

5.08 Output Circuit Description

1. The collector output of the transistor switch Q14 and Q15 are connected to the windings of the polar relay. CR15 and CR16 are used to suppress the inductive voltage spikes generated by the relay windings. The contacts of the relay are connected directly to the telegraph line. C18, R50 and C19, R51 provide spark suppression for the relay contacts.

5.09 Power Supply Circuit Description

1. The power supply is isolated from the AC line by transformer T5. This transformer has a split primary and may be strapped for either 115VAC or 230VAC operation. The bridge rectifier is comprised of CR17 through CR20 and filtering is accomplished by C20 and R52. The output is zener regulated by CR21 yielding a DC voltage of approximately -12V with respect to ground.

ELECTRICAL PARTS LIST

Frequency Shift Tone Receiver

Model 302

Symbol	Description	Per MIL Spec	Mfr.	Part No.
C1	Capacitor, Electrolytic, Tantalum, 22 mfd ± 20% 15V	MIL-C-26655	MC	CS12AD220M *
C2	Capacitor, Electrolytic, Tantalum, 22 mfd ± 20% 15V	MIL-C-26655	MC	CS12AD220M *
C3	Capacitor, Electrolytic, Tantalum, 180 mfd ± 10% 6V	MIL-C-26655	MC	CS12AB181K *
C4	Capacitor, Metallized Paper, .25 mfd ±20% 200V	N.A.	AV	P8292ZN11
C5	Capacitor, Metallized Paper,.1 mfd ± 20% 200V	N.A.	AV	P8292ZN10
C6	Capacitor, Metallized Paper, .1 mfd ± 20% 200V	N.A.	AV	P8292ZN10
C7	Capacitor, Electrolytic, Tantalum, 22 mfd ±20% 15V	MIL-C-26655	MC	CS12AD220M *
C8	Capacitor, Metallized Paper, .01 mfd ± 20% 200V	N.A.	AV	P8292ZN6
C9	Capacitor, Ceramic, .0047 mfd ± 20% 100V	MIL-C-11015B	AV	CK13AX472M *
C10	Capacitor, Ceramic, .0047 mfd ± 20% 100V	MIL-C-11015B	AV	CK13AX472M *
C11	Capacitor, Metallized Paper, .1 mfd ± 20% 200V	N.A.	AV	P8292ZN10
C12	Capacitor, Ceramic, .0047 mfd ± 20% 100V	MIL-C-11015B	AV	CK13AX472M *
C13	Capacitor, Paper, .22 mfd ± 10% 100V	MIL-C-25C	AC	CP09A1KB224K1 *
C14	Capacitor, Ceramic, .0047 mfd ± 20% 100V	MIL-C-11015B	AV	CK13AX472M *
C15	Capacitor, Ceramic, .0047 mfd ± 20% 100V	MIL-C-11015B	AV	CK13AX472M *
C16	Capacitor, Metallized Paper, .01 mfd ± 20% 200V	N.A.	AV	P8292ZN6
C17	Capacitor, Metallized Paper, .01 mfd ± 20% 200V	N.A.	AV	P8292ZN6
C18	Capacitor, Metallized Paper, .25 mfd 400V	N.A.	AV	P8292ZN20

Symbol	Description	Per MIL Spec	Mfr.	Part No.
C19	Capacitor, Metallized Paper, .25 mfd 400V	N.A.	AV	P8292ZN20
C20	Capacitor, Electrolytic, Tantalum, 250 mfd 25V	MIL-C-3965B	MC	CL24BG251UP3 *
C21	Capacitor, Electrolytic, Tantalum, 22 mfd±20%15V	MIL-C-26655	MC	CS13AD220M *
CR1	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR2	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR3	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR4	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR5	Diode, Germanium, Temperature Compensating	N.A.	GE	4JA2FX355
CR6	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR7	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR8	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR9	Diode, Germanium	MIL-S-19500/192	SY	JAN 1N276 *
CR10	Diode, Germanium	MIL-S-19500/192	SY	JAN 1N276 *
CR11	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR12	Diode, Silicon	MIL-S-19500/118	SY	1N483B *
CR13	Diode, Germanium	MIL-S-19500/192	SY	JAN 1N276 *
CR14	Diode, Germanium	MIL-S-19500/192	SY	JAN 1N276 *
CR15	Diode, Germanium	MIL-S-19500/192	SY	JAN 1N276 *
CR16	Diode, Germanium	MIL-S-19500/192	SY	JAN 1N276 *
CR17	Diode, Silicon Rectifier	MIL-E-1/1084	GI	JAN 1N538 *
CR18	Diode, Silicon Rectifier	MIL-E-1/1084	GI	JAN 1N538 *
CR19	Diode, Silicon Rectifier	MIL-E-1/1084	GI	JAN 1N538 *
CR20	Diode, Silicon Rectifier	MIL-E-1/1084	GI	JAN 1N538 *

Symbol	Description	Per MIL Spec	Mfr.	Part No.
CR21	Diode, Zener, Voltage Regulating	MIL-S-19500/124	IR	1N2976B *
F1	Fuse, Quick acting, 1 amp ¼" dia. x 1¼" lg.	MIL-F-15160	LI	F02A250V1A
J1	Connector, 15 pin Female	N.A.	AE	17-10150
K1	Relay,	N.A.	TS	XR10004
L1	Inductor, Toroidal, 15 Hy	MIL-T-27A	TS	IF20002-15*
P1	Connector, 24 Pin Male	N.A.	AE	57-10240
Q1	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q2	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q3	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q4	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q5	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q6	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q7	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q8	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q9	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q10	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q11	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q12	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q13	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q14	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
Q15	Transistor, Germanium, PNP	MIL-S-19500/44	IT	JAN 2N428 *
R1	Resistor, Fixed, Composition, 10K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF103K *
R2	Resistor, Fixed, Composition, 2.2K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF222K *

Symbol	Description	Per MIL Spec	Mfr.	Part No.
R3	Resistor, Fixed, Composition, 15K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF153K *
R4	Resistor, Fixed, Composition, 15K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF153K *
R5	Resistor, Fixed, Composition, 470 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF471K *
R6	Resistor, Fixed, Composition, 10K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF103K *
R7	Resistor, Fixed, Composition, 4.7K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF472K *
R8	Resistor, Fixed, Composition, 470 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF471K *
R9	Resistor, Fixed, Composition, 470 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF471K *
R10	Resistor, Fixed, Composition, 10K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF103K *
R11	Resistor, Fixed, Composition, 1.5K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF152K *
R12	Resistor, Fixed, Composition, 120 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF121K *
R13	Resistor, Fixed, Composition, 220 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF221K *
R14	Resistor, Fixed, Composition, 220 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF221K *
R15	Resistor, Fixed, Composition, 220 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF221K *
R16	Resistor, Fixed, Composition, 220 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF221K *
R17	Resistor, Fixed, Composition, 5.6K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF562K *
R18	Resistor, Fixed, Composition, 5.6K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF562K *
R19	Resistor, Fixed, Composition, 5.6K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF562K *
R20	Resistor, Variable, Composition, 2.5K ohm ± 20% ½W	MIL-R-94B	AB	RV6NAYSL252B *
R21	Resistor, Fixed, Composition, 15K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF153K *
R22	Resistor, Fixed, Composition, 470 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF471K *
R23	Resistor, Fixed, Composition, 1K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF102K *
R24	Resistor, Fixed, Composition, 100 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF101K *
R25	Resistor, Fixed, Composition, 2.2K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF222K *

Symbol	Description	Per MIL Spec	Mfr.	Part No.
R26	Resistor, Fixed,Composition, 22K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF223K*
R27	Resistor, Fixed,Composition, 4.7K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF472K*
R28	Resistor, Fixed,Composition, 12K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF123K*
R29	Resistor, Fixed,Composition, 1.8K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF182K*
R30	Resistor, Fixed,Composition, 2.2K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF222K*
R31	Resistor, Fixed,Composition, 47K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF473K*
R32	Resistor, Fixed,Composition, 12K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF123K*
R33	Resistor, Fixed,Composition, 15K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF153K*
R34	Resistor, Fixed,Composition, 8.2K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF822K*
R35	Resistor, Fixed,Composition, 4.7K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF472K*
R36	Resistor, Fixed,Composition, 100 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF101K*
R37	Resistor, Fixed,Composition, 12K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF123K*
R38	Resistor, Fixed, Composition, 20K ohm ± 5% ½W	MIL-R-11D	AB	RC20GF203J*
R39	Resistor, Fixed, Composition, 1.8K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF182K*
R40	Resistor, Variable, Composition, 50K ohm ± 20% ½W	MIL-R-94B	AB	RV6NAYSL503B*
R41	Resistor, Fixed, Composition, 12K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF123K*
R42	Resistor, Fixed, Composition, 12K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF123K*
R43	Resistor, Fixed, Composition, 4.7K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF472K*
R44	Resistor, Fixed, Composition, 4.7K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF472K*
R45	Resistor, Fixed, Composition, 4.7K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF472K*
R46	Resistor, Fixed, Composition, 4.7K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF472K*
R47	Resistor, Fixed, Composition, 10 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF100K*

Symbol	Description	Per MIL Spec	Mfr.	Part No.
R48	Resistor, Fixed, Composition, 10 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF100K *
R49	Resistor, Fixed, Composition, 100 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF101K *
R50	Resistor, Fixed, Composition, 1.5K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF152K *
R51	Resistor, Fixed, Composition, 1.5K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF152K *
R52	Resistor, Fixed, Wirewound, 75 ohm ± 5%, 6.5W	MIL-R-26C	SP	RW57V750 * or equiv.
R53	Resistor, Fixed, Composition, 220K ohm ± 10% ½W	MIL-R-11D	AB	RC20GF224K *
R54	Resistor, Fixed, Composition, 820 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF821K*
R55	Resistor, Fixed, Composition, 820 ohm ± 10% ½W	MIL-R-11D	AB	RC20GF821K*
S1	Switch, Toggle - DPDT	N.A.	CH	8363K7
T1	Transformer, Interstage	MIL-T-27A	UT	DO-T23 *
T2	Transformer, Interstage	MIL-T-27A	UT	DO-T23 *
T3	Transformer, Interstage	MIL-T-27A	UT	DO-T36 *
T4	Transformer, Interstage	MIL-T-27A	UT	DO-T23 *
T5	Transformer, Power, 18V, .18 amp	MIL-T-27A	TS	XF10010
TP1	Jack, Pin	N.A.	CE	45E-1
TP2	Jack, Pin	N.A.	CE	45E-1
TP3	Jack, Pin	N.A.	CE	45E-1
TP4	Jack, Pin	N.A.	CE	45E-1
TP5	Jack, Pin	N.A.	CE	45E-3
XF1	Fuse, Extractor Post, Finger Operated Knob, Bayonet type	N.A.	LI	342004
XK1	Socket, Octal	MIL-S-12883	EL	TS101P01

Note: * Indicates Government source inspection

LIST OF MANUFACTURERS DESIGNATIONS

Model 302

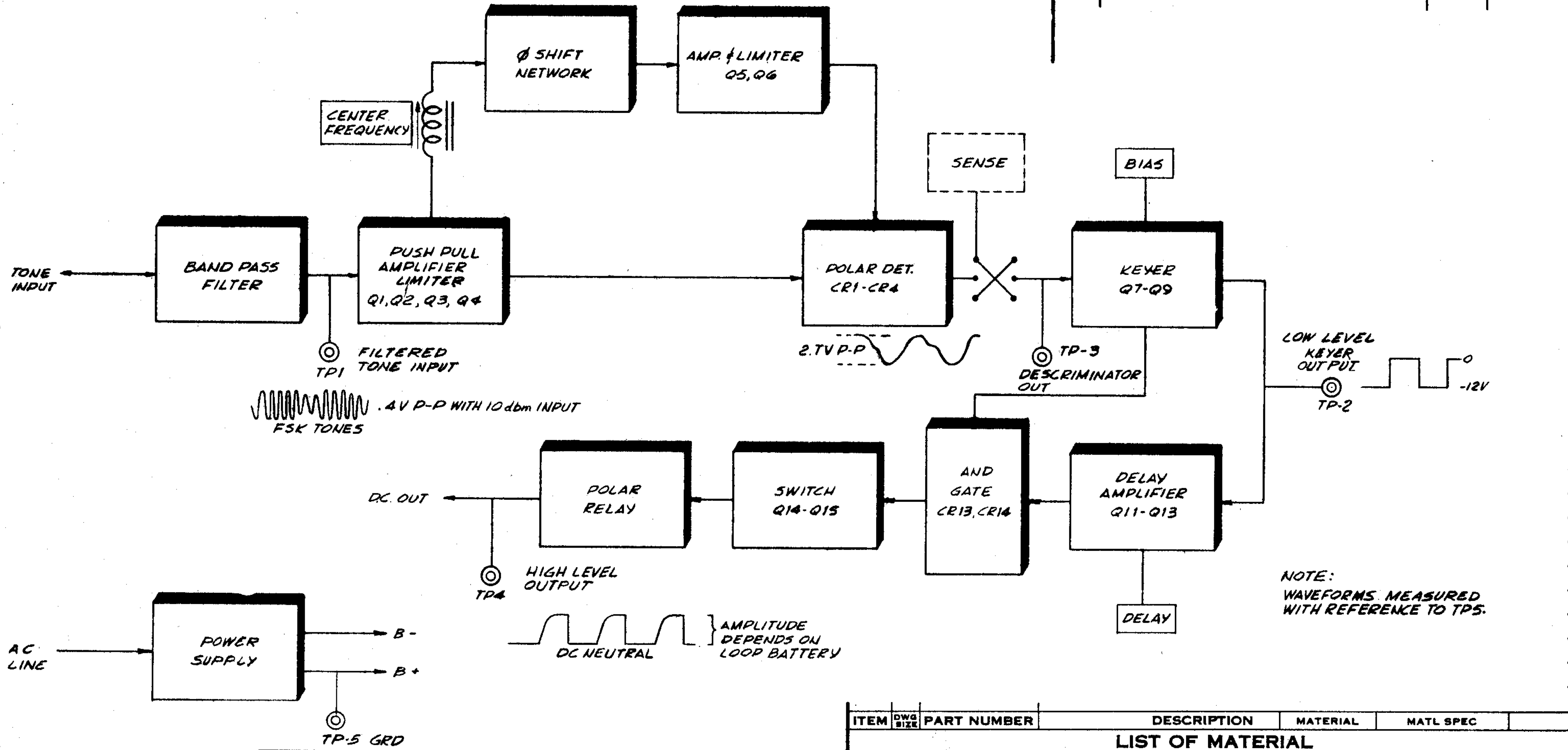
AB	Allen-Bradley Company
AC	Astron Corporation
AE	Amphenol Electronics Corporation
AV	Aerovox Corporation
BC	Burnell and Company, Incorporated
CE	Cannon Electric Company
CH	Cutler-Hammer, Incorporated
EI	Eby Sales Company
EL	Elco Corporation
FT	Freed Transformer Company, Incorporated
GE	General Electric Company
GI	General Instrument Company
IR	International Rectifier Corporation
IT	Industro Transistor Corporation
LI	Littlefuse, Incorporated
MC	Mallory and Company, Incorporated
MD	Magnetic Devices, Incorporated
SP	Sprague Electric Company
SY	Sylvania Electric Products, Incorporated
UT	United Transformer Corporation

DRAWING NUMBER	REV.
302-02	

A ORIGINAL SYMBOL

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVAL



ITEM	DWG SIZE	PART NUMBER	DESCRIPTION	MATERIAL	MATL SPEC

LIST OF MATERIAL

NEXT ASSY	USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:

FRACTIONS	DECIMALS	ANGLES
± 1/64	± .005	± 0°30'

MATERIAL

FINISH

	SIGNATURE	DATE
DRAWN	HB	3-5-63
CHKD.		
MECH. APPVL.		
ELECT. APPVL.	[illegible]	3-15-63
STD.		
APPD.		

BLOCK DIAGRAM
F.S. TONE RECEIVER
MODEL 302

SCALE

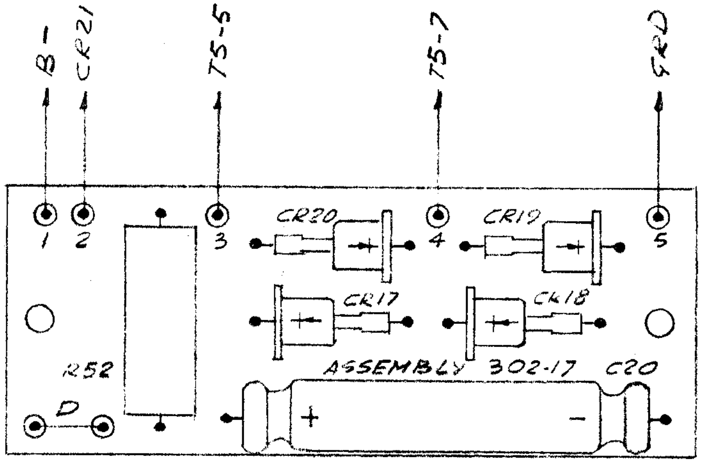
CODE IDENT. NO.

TELE-SIGNAL CORP.
HICKSVILLE, N. Y.

DWG. SIZE **B** 302-02

SHEET 1 OF 1

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL



				UNLESS OTHERWISE SPECIFIED	PROJECT			ASSEMBLY TB3 F.S. TONE RECEIVER MODEL 302	TELE-SIGNAL CORP. HICKSVILLE, N. Y.
				DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 0°30'	DRAWN	SB	2-2-63		
					CHECKED	[illegible]	2/4/63		
				MATERIAL —	SUBMITTED				
					APPROVED				DWG NO. 302-17
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY	FINISH —	APPROVED [signature]		DATE 3/11/63		
APPLICATION		QTY REQD						SCALE — SPEC	SHEET 1 OF 1