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Handy Book

INTER-OFFICE MEMORANDUM NO. 303

TO: All Sales

FROM: Harold L. Johnson

SUBJ: The TMC Tone Telegraph System

DATE: July 6, 1961

ENCLOSURES:

- 1. Brief description and technical data on Model TTS.
- 2. Brief explanation of bauds vs WPM for teletypewriter operation.

- 1. The SSB on subject equipment has been difficult to write due to the many sided faces of this equipment.
- 2. In order to provide early information on this equipment, Enclosure (1) has been prepared. The information of enclosure (1) will be a forthcoming bulletin.  
*CONDENSED IN*
- 3. Enclosure (2) provides a brief description of bauds vs words per minute for teletypewriter operation.

*Harold L. Johnson*  
 Harold L. Johnson  
 Sales Engineer



## THE TMC TONE TELEGRAPH SYSTEM MODEL TTS

The TMC Tone Telegraph System Model TTS (AN/FCC-60 (V)) is a completely transistorized telegraph and data transmission system capable of providing up to 24 individual teletypewriter channels at speeds up to 75 bauds, with higher speeds available on request.

Model TTS accepts teletypewriter or data signals, either polar or neutral, transforms these signals into audio frequency shifted tones, combines these tones, and prepares them for transmission in the voice frequency band of a suitable medium such as a sideband transmitter. The receive terminal accepts the aggregate tones from a suitable receiver, filters the individual frequency shifted tones, and transforms them into DC signals for keying the receive teletypewriter machines or data equipment.

The TMC Tone Telegraph system will accept a wide variety of keying information, synchronous or non-synchronous with DC signal regeneration, if desired. With the inclusion of voice frequency multiplexers and demultiplexers, TMC Models TMX-1 (TD-410/UGC) and RMX-1 (TD411/UGC), it is possible to provide up to 48 teletype channels within a 6 kc passband of an SSB communication system.

The TMC Tone Telegraph system is completely transistorized. Self-contained power supplies prevent complete system failure. Filter networks in the send and receive modules are included as a part of these units.

This equipment has proven itself in the field, in fixed station, shipboard, airborne and mobile applications.

All receive diversity configurations listed below require one TMC Model 510B diversity combiner for each intelligence channel utilized. As an example, the TTS-3-8 would consist of the following basic components, (less rack):

8 Model 501A Tone Telegraph Transmitters.

16 Model 502B Tone Telegraph Receivers.

8 Model 509 Transistor Switches.

8 Model 510B Diversity Combiners.



The TMC Model 539 shelf provides mounting and cable connection facilities for all the basic modules. It will accept any combination of 2", 4" or 8" modules up to 16" of panel space, 5½" in height.

Since there are a total of 40 four-inch modules in this configuration, 10 Model 539 equipment shelves would be required. This configuration would occupy 52½" of panel space in a standard 19" relay rack, exclusive of audio and DC patching controls.

Table I provides information on the different types of systems that may be ordered in this family.

TABLE I

MODEL TTS-1-( )YZ	Non Diversity Operation. Internal battery available to operate the receive teletypewriter loops on switch selection basis.
MODEL TTS-2-( )YZ	Non Diversity Operation. For operation with station battery.
MODEL TTS-3-( )YZ	Space Diversity on Receive. Internal battery available to operate the receive teletypewriter loops on switch selected basis.
MODEL TTS-4-( )YZ	Space Diversity on Receive. For operation with station battery.
MODEL TTS-5-( )YZ	Tone Frequency Diversity, Send and Receive. Internal battery available to operate the receive teletypewriter loops on switch selected basis.
MODEL TTS-6-( )YZ	Tone Frequency Diversity, Send and Receive. For operation with station battery.

ORDERING INFORMATION

When ordering TMC Models TTS, the selected system configuration, number of channel frequencies are indicated as shown in the following example:

TTS-1-8 AB

Model	Frequencies of
System Configuration for Non Diversity Operation. (selected from TABLE I)	425, 595, 765, 935, 1105, 1275, 1445, 1615. (selected from TABLES II OR III)
	Channel System



STANDARD FREQUENCY DETERMINING NETWORKS

75 baud (100 WPM) channel frequencies for those applications where less than the total available frequencies are utilized, are grouped as follows:

TABLE II

NATIONAL STANDARD

GROUP I

170 cps channel spacing  
± 42.5 cps shift for 75 baud\*  
(100 WPM) operation

- A. 425, 595, 765, 935
- B. 1105, 1275, 1445, 1615
- C. 1785, 1955, 2125, 2295
- D. 2465, 2635, 2805, 2975
- E. 3145, 3315

GROUP II

340 cps channel spacing  
± 85 cps shift for 150 baud  
(200 WPM) operation

- F. 595, 935, 1275, 1615
- G. 1955, 2295, 2635, 2975

TABLE III

INTERNATIONAL STANDARD

GROUP III

120 cps channel spacing  
± 35 cps shift for 75 baud\*  
(100 WPM) operation

- M. 420, 540, 660, 780
- N. 900, 1020, 1140, 1260
- O. 1380, 1500, 1620, 1740
- P. 1860, 1980, 2100, 2220
- Q. 2340, 2460, 2580, 2700
- R. 2820, 2940, 3060, 3180

GROUP IV

240 cps channel spacing  
± 70 cps shift for 150 baud  
(200 WPM) operation

- S. 540, 780, 1020, 1260
- T. 1500, 1740, 1980, 2200
- U. 2460, 2700, 2940, 3180

GENERAL SPECIFICATIONS FOR MODELS TTS

OPERATING TEMPERATURE:

-10 to +55° C.

STORAGE TEMPERATURE:

-25° C. to +85° C. (further extended ranges on special order).

POWER REQUIREMENTS:

115/230 volts, 50/60 cps, (400 cps optional), single phase.

CHANNEL FREQUENCIES:

See Tables II and III

COMPONENTS AND CONSTRUCTION:

All equipment manufactured in accordance with JAN/MIL specifications wherever practicable.

\* 100 baud operation can be provided at a slight increase in cost.



## SPECIAL ORDERING INFORMATION

Audio and DC patching facilities can be provided for monitor and control of individual and aggregate send tones and for monitoring the incoming received aggregate tones, as well as providing DC patching for inputs to the Tone Telegraph Transmitters and the outputs from the Tone Telegraph Receivers. In those cases where audio level from distant receivers is inadequate, the TMC Model 525, line amplifier (AM-2731/UGC), with its associated power supply, TMC Model 526A (PP-2713/UGC), can be incorporated into this system to control the incoming signal level. This equipment is manufactured for the Technical Material Corporation by Telesignal Corporation.

## INDIVIDUAL MODEL SPECIFICATIONS

### TMC Model 501A (KY-346(P)/UGC) Tone Telegraph Transmitter

The TMC Model 501A accepts DC keyed signals, transforms them into audio tone frequency shifted signals and prepares these signals for transmission via an acceptable audio transmission medium. Frequency determining networks are included as a part of the basic module. Operating frequencies can be selected from the National Standard and the International Standard.

### Technical Specifications

**OUTPUT LEVEL:** Continuously adjustable; 3dbm maximum for standard networks; 10 dbm for special networks (less insertion loss of channel filter).

**OUTPUT IMPEDANCE:** 600 ohm; when used with standard single-ended filter, unbalanced operation is recommended.

**HARMONIC CONTENT:** 50 db below standard output level.

**FREQUENCY STABILITY:** The frequency stability of the system as determined by the individual tones generated in Models 501A is better than 2 cycles per second with plus or minus 10% line voltage variation. Better than 3 cps over a temperature range of 0 to +50° C.

**KEYING SPEED:** 75 baud. Higher speeds available on special order.



INPUT CHARACTERISTICS: Electrically floating; either input terminal may be grounded or left ungrounded.

INPUT KEYING: Dry Contact Keying--- 1 ma keying current provided by transmitter to the contacts.  
Neutral Positive or Negative Keying---1 ma (min.) into 2200 ohm internal load or 40.65 ma into 220 ohm internal load.  
Polar Keying, Direct or Inverted---  $\pm$  1 ma into 2200 ohm internal load or + 30 ma, into 220 ohm internal load.  
Fifty Micro-Amp Keying---Adaptor for keying into 100K ohm available as optional attachment.

POWER SUPPLY: Self-contained. 115/230 volt 50/60 cps 1 watt

WEIGHT: 5 lb. 8 oz. including standard network and filter.

DIMENSIONS: 5 $\frac{1}{2}$ " high x 4" wide x 10 $\frac{1}{2}$ " deep.

#### TMC Model 502A(CV-972(P)/UCC) Tone Telegraph Receiver

The TMC Model 502A accepts audio tone frequency shifted signals of a composite nature, filters out the wanted signal and transforms this signal into a DC keyed low level signal to key an external teletypewriter loop, with an appropriate keyer such as the TMC Model 509 (providing its own battery to the line), or the TMC Model 509P/B (used where external battery is available). Information on the keyers will be contained in following paragraphs. Frequency determining networks are included as a part of the basic module. Operating frequencies can be selected from the National Standard and the International Standard.

#### Technical Specifications

INPUT CHARACTERISTICS: 600 ohm, unbalanced.

INPUT LEVEL: -45 dbm to +5 dbm (higher or lower signal levels can be accommodated on special request).

CONTROLS: All controls accessible from the front panel.

MONITORING: All cardinal circuit points available on front panel test jacks.

TRANSIENT RESPONSE: 40 db amplitude keyed input signal will not produce errors on a receiving teleprinter.

POWER REQUIREMENTS: 1 watt approximately 115/230v 50/60 cycles



KEYING SPEED: 75 baud. Higher speeds available on special order.

SIGNAL DISTORTION: Bias Distortion: less than 1% (Adjustable).  
History Distortion: less than 1%.  
Carrier Distortion: depends on desired speed and channel frequency.

OUTPUT LEVEL: Neutral 5 volt into 10 K (or larger), or neutral 1 ma into 330 ohm.

When equipped with TMC Model 509 Transistor Switch; neutral, floating output of 65 ma max. into 2000 ohms.

WEIGHT: 5 lb. 8 oz. inclusive of standard network and filter.

DIMENSIONS: 5½" high x 4" wide x 10½" deep.

TMC Models 509 (SA-733/UGC) and 509P/B Transistor Keyer

The TMC Model 509 accepts the low level DC keyed signal from the Model 502A and transforms this signal into an appropriate level capable of operating an external teletypewriter loop with internal or external battery selected by a front panel switch. Inclusion of this unit in a system requires panel space. The TMC Model 509P/B performs the same function as the Model 509 except that no provision is made for internal battery operation. When this unit is included in a system, no additional panel space is required as it rides "piggy-back" on the rear of the shelf containing the Model 502A.

Technical Specifications

MODELS 509 and 509P/B

SIGNALING SPEED: 2000 baud max. (1000 dot-cycles).

INPUT SIGNAL: 1 MA (min.) neutral, negative keying.

INPUT IMPEDANCE: 2K (approx.)

OUTPUT: Space---open Circuit.

Mark---short circuit, 75 ma maximum, with external battery.

With self-contained line battery: Space---open circuit. Mark ---65 ma into 2K load. Open circuit voltage---150 volts max.

EFFICIENCY: 60% (at 60 MA load current and --120 VDC Line Battery).

OPEN CIRCUIT LEAKAGE: Less than 100 micro-amperes.

PROTECTIVE FEATURES: 1/8-ampere load fuse. Load circuit silicon-diode protected against high transient voltages and accidental polarity inversion of line battery.



MODEL 509 ONLY:

OUTPUT SIGNAL: 75MA (max.) neutral keying.

PHYSICAL SIZE: 10½" deep x 5½" high x 4" wide.

WEIGHT: Approximately 1½ lbs.

STRUCTURE: Front-panel mounting in Model 539 equipment shelf.

POWER REQUIREMENTS: 115/230 volt 50/60 cps at .2 amp.

CONTROLS: Load current adjustment (0-2.5K, 25W).  
BATTERY Selector: INT./External.

MODEL 509P/B ONLY:

OUTPUT SIGNAL: 75MA (max.) neutral, negative keying.

PHYSICAL SIZE: 5" deep x 3½" high x 3½" wide.

WEIGHT: Approximately ½ lb.

STRUCTURE: Plug-in assembly.

INPUT POWER REQUIREMENTS: Normal: 120-130VCD.  
Negative Battery (Positive grounded) at appx.  
100MA.  
Current: 75 MA max.

CONTROLS: Load current adjustment (0-2.5K, 25W).

TMC Model 510B (CM-186/UGC) Diversity Combiner

The TMC Model 510B is incorporated into the Receive system whenever space or frequency diversity is desired. This unit co-relates the relative strength of two receive channels containing the same information and allows the channel with the strongest signal to control the output keyer. Switching is accomplished by means of diodes, thus eliminating switching transients.

Technical Specifications

INPUT IMPEDANCE: For bridging across a 600 ohm load.

INPUT LEVEL: 0 dbm to -30 dbm.

MODULATION: F.S.K.

FREQUENCY RANGE: 400 cps to 10 KC carrier.

KEYING SPEED: 0 to 100 dots/sec (speeds up to 500 dots/sec on special order).



DIVERSITY SELECTION: Balanced-limiter output level control and polar-diode switching.

OUTPUT SIGNAL: Neutral, negative, 5v into 5K or open circuit (Derived from F/S Tone Receiver).

FRONT PANEL CONTROLS: a. Channel "A" input attenuator  
b. Channel "B" input attenuator  
c. Signal-sense switch

FRONT PANEL ADJUSTMENTS: (recessed screwdriver type)  
a. Gain Balance  
b. D.C. Balance

INTERNAL ADJUSTMENTS: None

MONITORING FACILITIES: a. Channel "A" level Meter  
b. Channel "B" level Meter  
c. 3 Front-panel test points  
d. rear accessories socket for tuning monitor

POWER CONSUMPTION: 0.25 Watt appx. (supplied by one F/S Tone Receiver).

TRANSISTOR COMPLEMENT: 6 C.B.S. Type 2N180 PNP junction transistors.

WEIGHT: 4 lbs. approximately

DIMENSIONS: 5½" high by 4" wide by 10 ¾" deep.

#### TMC Model 507 Transistor Relay

The TMC Model 507 Transistor Relay provides polar or neutral relay output of teletype signals when used in conjunction with TMC Model 502A Tone Telegraph receiver. Transistor circuitry provides control of a polar relay to key the external battery loop. Spark suppressors are provided to minimize keying line transients. Front panel metering of the DC loop is provided. A "piggy-back" version, the TMC Model 507P/B is electrically identical to the Model 507 except that the front panel meter is eliminated, and the unit is constructed for mounting on the rear of the Model 502A module for savings of front panel space.

#### Technical Specifications

INPUT SIGNAL: From associated Model 502A F/S Tone Receiver Model 510B Diversity Comparator, etc.

POWER: 8 VDC at 30 ma approximately, (from Model 502A)



OUTPUT: Dry contacts with standard spark suppressors and output-shaping network.

OUTPUT SIGNAL: Neutral or Polar, 65 ma 130 V. max.

SIGNAL SPEED: 75 baud max.

LOOP CURRENT CONTROL: 0-2.5K, 25 W internal Rheostat. (Accessible from front panel).

SIGNAL BIAS CONTROL: Internal (accessible from front panel).

METERING: Front-Panel meter, two scales 100-0-100 ma and 50-0-50 ma.

DIMENSIONS: 4" x 5½" x 10½"

WEIGHT: 3 lbs. approximately

CONNECTORS: Single rear connector for direct plug-in connection to equipment shelf (Model 519).

#### TMC Model 525 Line Amplifier (AM-2731/UGC)

The TMC Model 525 Line Amplifier is a completely transistorized audio amplifier providing 600 ohm transformer isolation between input and output with 36 dbm of gain available. It is useful in a multichannel telegraph system where it is desirable to control or raise the level of the incoming aggregate tone line. This unit receives its operating power from the TMC Model 526 (PP-2713/UGC) Power supply.

#### Technical Specifications

INPUT AND OUTPUT: Transformer isolated.

INPUT AND OUTPUT IMPEDANCE: Nominal 600 ohms.

GAIN: Nominal 36 dbm.

FREQUENCY RESPONSE: 300 to 10 Kc  $\pm$  2 db.

INPUT POWER: -15 V., 55 ma (from Model 526).

DISTORTION (3RD HARMONIC): -40 db (operating level of 10 dbm).

CONTROL: Front Panel Gain Control

WARM UP TIME: None.

DIMENSIONS: 5½" x 2" x 11".

WEIGHT: 1 lb. 4 oz.



### TMC Model 526 (PP-2713/UGC) Power Supply

TMC Model 526 (PP-2713/UGC) Power Supply is a completely transistorized power supply used to provide operating power to the TMC Model 525 Line Amplifier as well as the TMC Model 520B (SB-1178/UGC) Meter panel. This power supply is capable of providing the DC operating power to as many as four Model 525 or 520B, in any combination.

#### Technical Specifications

POWER SUPPLY: Bridge rectifier with individual filter resistors and condensers for each loading unit.

OUTPUT DC VOLTAGE: Four outputs providing -15V.  $\pm$  10% at 55 MA each.

CONTROLS: On/off Power Switch.

MONITORING: Neon pilot light and 5 front panel test points.

DIMENSIONS: 5½" x 4" x 11".

WEIGHT: 4 lbs. 9 oz.

### TMC Model 520B (SB-1178/UGC) Meter Panel

TMC Model 520B (SB-1178/UGC) Meter Panel provides for monitoring of audio tones within the range of -40 DBM to +20 DBM and DC current from -75 MA to +75 MA. This unit receives its operating power from the TMC Model 526 Power Supply.

#### Technical Specifications

VU RANGE OF MEASUREMENT: -40 dbm to +20 dbm.

DC RANGE OF MEASUREMENT: -75 ma to +75 ma.

CALIBRATION ACCURACY: 300 to 10 Kc  $\pm$ 2 db.

INPUT POWER: -15 V., 55 ma (from Model 526).

CONTROLS: Calibration control and 2 db step attenuator (40 db range).

DIMENSIONS: 5½" x 6" x 11".

WEIGHT: 3 lbs. approximately.

### TMC Model 522 (SB-1177/UGC) Power Distribution Panel

TMC Model 522 (SB-1177/UGC) Power Distribution Panel provides for control



of incoming AC power and distribution of this power to the individual modules.

Technical Specifications

INPUT: Single phase 115/230 V., 50/60 cps.

OUTPUT: (a) Main power circuit, switch controlled, providing power to the units of a complete Tone Telegraph System, and (b) Auxiliary power circuit, providing power for 2 convenience outlets.

FUSING: Separate fuses and blown fuse indicators for main and auxiliary power circuits. Main circuit fuse - 3 amp; Convenience outlets - 5 amp.

EMC Model 521T (SB-1179/UGC) Signal Distribution Panel

EMC Model 521T (SB-1179/UGC) Signal Distribution Panel provides for connection of all external lines, audio and DC, when incorporated as part of a complete system.

Technical Specifications

TERMINAL CONNECTIONS: 3 W.E. type 6 by 8 terminal blocks (50% spares) for connection to overhead signal ducts.

DC CIRCUIT (MINIMUM): 3 transmit lines, 8 receive lines, 3 DC trunks, +130V, -130V and ground connections.

TOONE CIRCUITS (MINIMUM): One transmit 600 ohm circuit equipped with attenuator and line isolation transformer.

TOONE CIRCUIT CHARACTERISTICS: 600 ohm balanced on line side + dbm max. level.

DIMENSIONS: Standard 3½" x 19" Panel.



## BAUDS VS WORDS PER MINUTE

The modulation speed capability of any teletypewriter system is best stated in terms of baud rate of the signal being handled. As an example, the length of an individual signal element for 75 baud operation is 13.33 milliseconds. Assuming a teletypewriter machine to be operating in the 7.0 Baudot Code, in which the start element, the five intelligence elements, and stop element are of equal lengths, the time required to complete one character operation will be 93.31 milliseconds. Relating this in terms of 6 characters for average word gives us a teletypewriter speed of approximately 106 words per minute. When these same factors are applied to a teletypewriter machine operating in the 7.42 Baudot Code, in which the stop element is 1.42 times the length of a signal element, we arrive at a word per minute operation of approximately 101.

There are various factors involved in the selection of the 7.42 Baudot Code, the most logical of which was to allow the receiving machine sufficient time to keep up with the send machine in an era in which electrical and mechanical tolerances were looser than those today.

It is possible, and in fact most desirable, to operate in the 7.0 Baudot Code, since the application of cryptographic masking devices is easier with a uniform signal. The last recommendation of the CCIT was to adopt as a standard 50, 75 and multiples of 75 baud operating rates in the 7.0 code.

For your information, 50 baud operation in the 7.42 unit code is approximately 67.33 words per minute and 71.43 words per minute in the 7 unit code.

It is evident from the foregoing explanation that baud rate is the most logical definition of the modulation capability of any teletypewriter transmission system. For this reason all technical specifications on such equipment will specify baud rate rather than words per minute.