

**COLLINS
TCS-14
Transmitter**



Collins TCS-14 Transmitter User Guide

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COLLINS

Collins TCS-14 Transmitter



TCS to TCS-14 Radio Transmitting-Receiving Equipments

Use

Semiprotable—ship, shore.

Frequency Range

Transmitter and receiver—1500 to 12,000 kc. in three bands.

Power Output and Emission

25 watts, A₁; 15 watts, A₃.

Description

- The Navy Models TCS to TCS-14 semiprotable transmitting-receiving equipments are designed for medium and high frequency telegraph and telephone operation. These equipment are used extensively on patrol and landing craft, reconnaissance vehicles, and for similar purposes.
- All units are mounted in corrosion-proof cabinets of sheet steel utilizing the subassembly type of construction. The transmitter and receiver may be assembled either side by side or stacked vertically with the horizontal type of mounting preferred. The assembly may be located on a shelf or bulkhead.

Transmitter

The transmitter is composed of an oscillator, buffer-doubler, and power-amplifier stage with the modulator. The frequency range is covered by means of three bands. Crystal-control is provided on any harmonic of the oscillator within the range, and eight harmonics of these frequencies are available. The frequency of the oscillator tube and associated circuits are continuously variable, and both crystal and self-excited oscillators are available within the range used. The single-button carbon microphone works directly into the modulator stage which also serves as a speech-amplifier. The antenna loading coil is of the short length antenna type and is suitable for use with antennas of lengths down to 20 feet, although better efficiency is obtained with the use of a longer wire up to 75 feet in length.

Receiver

The receiver utilizes a superheterodyne circuit, with 1 radio-frequency stage and 2 I. F. stages, with AVC used for A₃ reception. A range of 1500–12,000 kc. is covered in 3 bands, utilizing either a continuously variable oscillator or crystal-control. Crystals may be employed on 4 frequencies in band 1, and on various higher frequencies determined by the harmonic frequencies of the crystals.

Remote-Control Unit

The remote-control unit, which may be mounted vertically or horizontally at a distance up to 20 feet from the power supply unit, contains a loudspeaker, audio volume-control, receiver output-switch providing for headphone or loudspeaker operation and ON-OFF switches for both receiver and transmitter. Headphone, microphone, and key jacks are also located in this unit. No frequency control of transmitter or receiver, or choice of emission is provided from this point. The remote-control unit is not interchangeable with any other Navy type.

Power Supply Units

Power supply units are of three types, dynamotor, motor-generator, and rectifier. Starting relays for these units are contained within the power supply units and are controlled from either the remote-control unit, or either the transmitter or receiver.

Dynamotor Operation

Dynamotor operation is obtained exclusively from 12-volt D. C. Units of interchangeable operation are available. Type 21770 is connected to the grounded terminal of the power source as indicated by the instructions on the unit. The types 21881 and 21035 are used with either power source lead connected to the grounded terminal. The high-voltage section of each unit has an input of 9.9 amperes at 12 volts, and an output of 0.180 ampere, at 400 volts. This supplies the transmitter power amplifier and modulator stages. The low voltage section has an input of 3.8 amperes at 12 volts and an output of 0.100 ampere at 220 volts, and operates the transmitter oscillator and

buffer-doubler stages as well as the receiver. When the dynamotor units are used, the filaments are operated directly from the power source.

Specifications

Component	Details
Transmitter	Oscillator, buffer-doubler, power-amplifier, modulator
Receiver	Superheterodyne circuit, 1 RF stage, 2 IF stages, AVC for A3 reception
Remote-Control Unit	Loudspeaker, audio volume-control, ON-OFF switches, jacks for headphones, microphone, key
Power Supply Units	Dynamotor, motor-generator, rectifier

UNCLASSIFIED

TCS to TCS 14 TCS TO TCS-14 RADIO TRANSMITTING-RECEIVING EQUIPMENTS

Use.

- Semiportable-ship, shore. Frequency range transmitter and receiver:—1500 to 12,000 ke. in three bands.
- Power output and emission.25 watts, A,; 15 watts, A3.

Description.

- The Navy Models TCS to TCS-14 semiportable transmitting-receiving equipments are designed for medium and high frequency telegraph and telephone operation. This equipments are used extensively on patrol and landing craft, reconnaissance vehicles, and for similar purposes. All units are mounted in corrosion-proof cabinets of sheet steel utilizing the subassembly type of construction. The transmitter and receiver may be assembled either side by side or stacked vertically with the horizontal type of mounting preferred. The assembly may be located on a shelf or bulkhead.
- The transmitter is composed of an oscillator, buffer, doubler and power-amplifier stage with the modulator. The frequency range is covered by means of three bands. Crystal-control is provided on any four desired frequencies within the range, and eight harmonies of these frequencies. For master oscillator use, a separate oscillator tube and associated circuits continuously variable and capable of controlling output at any frequency within the range are used.
- The single-button carbon microphone works directly into the modulator-stage without the use of a speech-amplifier. The loading coil permits the use of short length antennas down to 20 feet, although better efficiency is obtained with the use of a longer wire up to 75 feet in length.
- The receiver utilizes a superheterodyne circuit, with 1 radio-frequency stage and 2 I. F. stages, with AVC used for A, reception. A range of 1500-12,000 ke. is covered in 3 bands, utilizing either a continuously variable oscillator or crystal-control. Crystals may be employed on 4 frequencies in band 1, and on various higher frequencies determined by the harmonic frequencies of the crystals.
- The remote-control unit, which may be mounted vertically or horizontally at a distance up to 20 feet from the power supply unit, contains a loudspeaker. audio volume-control, receiver output-switch providing for

headphone or loudspeaker operation and ON-OFF switches for both receiver and transmitter. Head- phone, microphone, and key jacks are also located in this unit.

- No frequency control of transmitter or receiver, or choice of emission is provided from this point. The remote-control unit is not interchangeable with any other Navy type. Power supply units are of three types, dynamotor, motor-generator, and rectifier. Starting relays for these units are contained within the power supply units, and are controlled from either the remote control unit or panel switches in the transmitter and receiver.
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Model TOS transmitting-receiving equipment set up for operation The antenna loading coil is mounted on top of the transmitter.

CATALOGUE OF NAVAL ELECTRONIC EQUIPMENT-APRIL 1956

NOTES ON DESIGN AND CONSTRUCTION AND AMATEUR BAND APPLICATIONS

B. M. JOHNSON (G3I.OX)

- This article discusses a useful and interesting item of ex-U.S.N. equipment, which has been available on the "surplus" market for some time. Our contributor gives much factual information on the circuitry and operation of

the TCS apparatus, which covers the 160-80-40 metre amateur bands on both transmitter and receiver.—
Editor.

The TCS Transmitter -Receiver Assembly

NOTES ON DESIGN AND CONSTRUCTION. AND AMATEUR BAND APPLICATIONS B. M. JOHNSON (G3LOX)

- This article discusses a useful and interesting item of ex-U.S.N. equipment, which has been available on the “surplus” market for some time. Our contributor gives much factual information on the circuitry and operation of the TCS apparatus, which covers the 160-80-40 metre amateur bands on both transmitter and receiver.- Editor.
- One of the best buys on the “surplus” O market today is undoubtedly the TCS series of transmitters and receivers: they were designed and originally built for the U.S. Navy by the American Collins Company, though later several other contractors also made them. As far as the writer can ascertain. The series was numbered consecutively from TCS- I to TCS-13. The U.S. Navy numbers were 52245 for the transmitter, and 46159 for the receiver. The letters prefixing the Navy number is a code denoting the manufacturer. e.g., COL-52245 is a Collins-built transmitter. CHI-46159 Hamilton receiver. Although minor differences may be noted in the construction and layout, as between one manufacturer and another. all the units with the above Navy numbers are basically the same and interchangeable, irrespective of the TCS number
- The TCS series was supplied to the U.S. Navy for duties similar to the British W/S19., e.g. /P and /M from tanks. trucks and similar vehicles. The TCS was also used as emergency radio aboard merchant ships. Although intended to work as a single inter-connected unit, the transmitter and receiver are in fact physically separate, and it is proposed in this article to deal with them individually.

TRANSMITTER TYPE

52245 The transmitter consists of a VFO/Buffer- Doubler/PA with an integral push-pull modulator: there is provision for four switched crystals as an alternative to the VFO. The frequency coverage is in three switched bands, as follows: Band 1, 1.5 to 3.0 mc; Band 2, 3 to 6.0 mc; Band 3, 6 to 12.0 mc.

- When used in conjunction with its receiver, the TCS transmitter has full “push-to-talk” or (W “break-in” facilities. In its unmodified form, the transmitter will run to about 35 watts input. on the Phone and 80 watts or so on CW. The power requirements for the standard trans- mitter are as follows: HT (1) 400 volts DC at 200 mA: HT (2) 220 volts DC at 40 mA: LT 12 volts AC/DC at 21 amps.; Relay supply 12 volts DC at 1 amp.
- Exciter Circuit Reference to Fig. I will show the circuit of the VFO, crystal oscillator, and the buffer/ doubler stages that form the RE exciter section. All the valves in this stage. V101, 102, 103. are 12A6's. (The designation of valves and components in this article follows that which will be found used in the actual units lity of the components being marked.) is the oscillator, the familiar Hartley type: it is continuously tunable from 1,500 to 3,000 kc, the tuning being effected by C101.
- Being designed for mobile work under active service conditions, the mechanical and electrical stability of this VFO is outstanding; it will take considerable vibration with no appreciable change in note and will accept up to a 10% variation above or below the normal line voltage for a frequency shift of as little as .01%. Referring again to Fig. I, it will be seen that the oscillator function is controlled by a six-position switch, S104. When this switch (Oscillator Selector) is turned to the “MO Test” position. HT is applied to the anode and screen of the VFO and buffer/doubler stage (V101. V103): this permits netting. With the switch in the “MO” position, the stages will only operate via the relay K103. which is part of the push-to-talk arrangements. The remaining four positions on the switch select the crystals (up to four), which, used in conjunction with a 12A6 (V102). from the crystal oscillator,

available as an alternative to the VFO.

- The switch, S104, removes the HT from the oscillator not in use. The crystals are ground to be in the same range as the VTO. i.e. 1.5 to 3.0 mc: They are the 3-pin TCS Type 249. When the bandswitch, S101, is in position 1 or 2 (1.5 to 3 mc). The anode of the oscillator – VFO or crystal is untuned and is directly resistance-capacity coupled to the buffer/ doubler. V103: in these two positions, the output of the oscillator is in the range 1.5 to 3.0 mc, which is the fundamental frequency of the VFO. When the switch is turned to Band 3 (6 to 12.0 mc), a tuned circuit consisting of L103, C101, and C107 is coupled to the anode of the oscillator.
- This circuit resonates at the second harmonic of the VFO; on Band 3, therefore, the output of the stage is doubled to the range 3 to 6.0 mc. V103 is the buffer/doubler. On Band 1 the stage operates as a straight amplifier and as a doubler on Bands 2 and 3. The appropriate inductance for the frequency doubler. 1.104. L105 or L106 is selected by the switch S101, which is ganged to the bandswitch in the oscillator section.

The PA

Referring to Fig. 2, it will be seen that the PA consists of two tetrodes in parallel; the valves used are 1625's which, with the exception of the heater voltage and the base, are the same as 807's. (1625's require 12.6 volts at 45 amps. for their heaters.) The PA valves only work in parallel when the system switch on the front panel is set to the "CW" condition. In the "Voice" position, the switch S105 disconnects the heater voltage from one of the PA valves (V105). Therefore on Phone, the PA consists of a single 1625. It should be noted, however, that the anode and screen HT remains on the unused valve. These considerations apart, the P. A stage of the TCS transmitter is quite conventional. Auto-bias is obtained from the resistance R 107 and R112. The PA tank circuit is formed by L107 and C116. S106 is ganged to the band switch in the exciter and doubler, and it selects the appropriate taps and padding

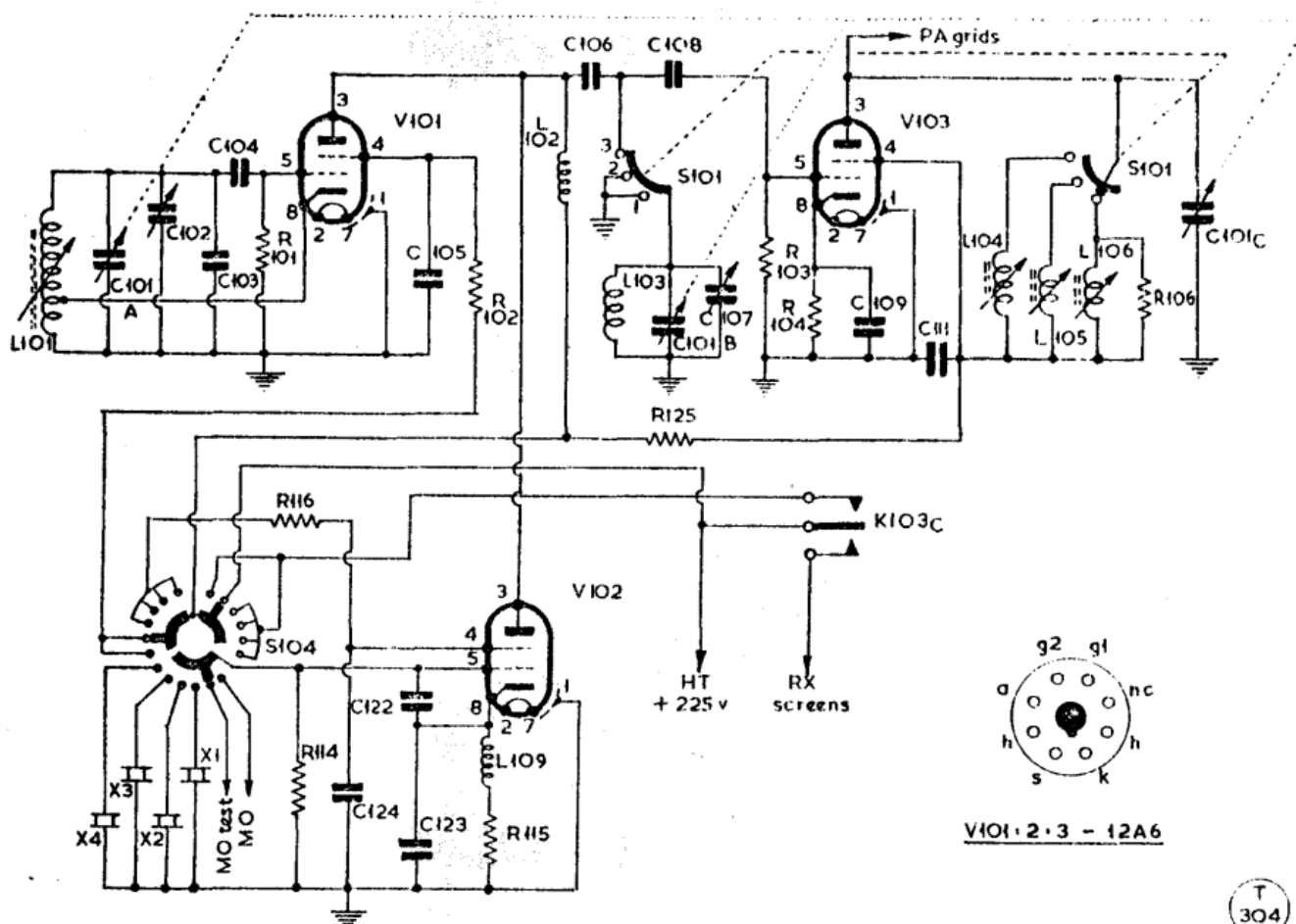


Fig. 1. RF Exciter and Buffer-Doubler, TCS Tx.

C101A	= 360 $\mu\mu\text{F}$	R103	= 100,000 ohms
C101B,		R104,	
C101C	= 280 $\mu\mu\text{F}$	R115	= 1,500 ohms
C102	= 75 $\mu\mu\text{F}$	R106	= 6,800 ohms
C103	= 30 $\mu\mu\text{F}$	R114,	
C104	= 40 $\mu\mu\text{F}$	R116	= 47,000 ohms
C105,		R125	= 47 ohms
C108,		L101	= 1.5-3.0 mc
C111	= .001 μF	L102,	
C106	= .002 μF	L107	= 1 mH RF choke
C107	= 25 $\mu\mu\text{F}$	L103	= 3.0-6.0 mc
C109,		L104	= 6.0-12.0 mc
C124	= .006 μF	L105	= 3.0-6.0 mc
C122	= 50 $\mu\mu\text{F}$	L106	= 1.5-3.0 mc
C123	= 250 $\mu\mu\text{F}$	V101,	
R101	= 1 megohm	V102,	
R102	= 22,000 ohms	V103	= 12A6

(Note: Circuit element numbering is in accordance with original.)

Fig. 1. RF exciter and buffer-doubler section of the 'TCS transmitter unit, which uses 12A6's in all three positions. Either the crystal or VO operation can be selected by switch S104 and the output frequency by S101. The PA section is shown in Fig. 2, and the whole transmitter is inter-switched with a corresponding receiver unit to make the complete assembly.

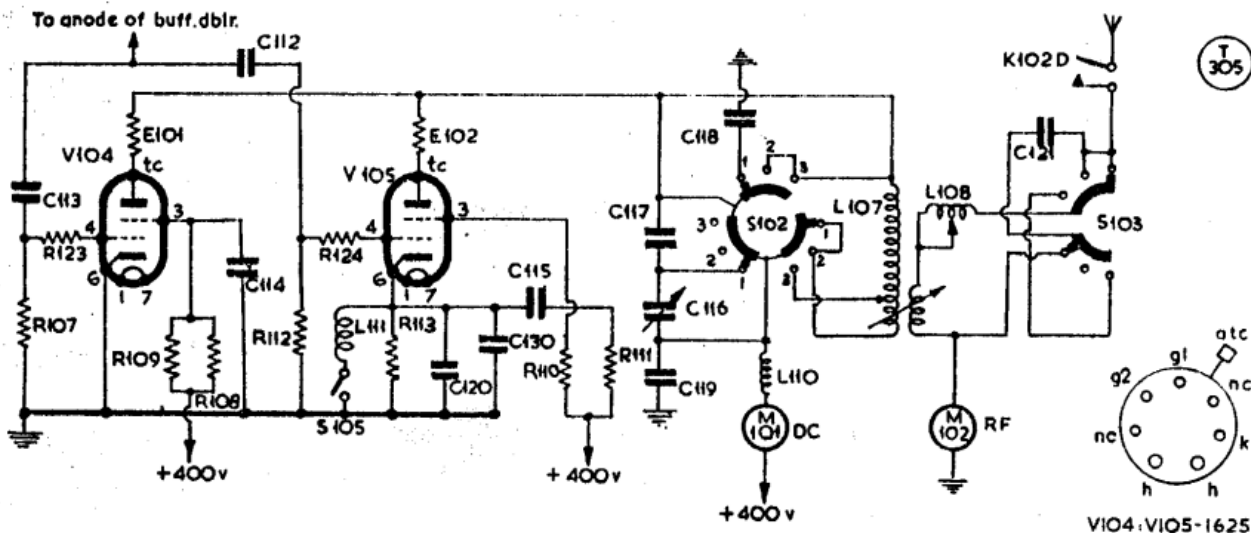


Fig. 2. The RF power amplifier section of the TGs "surplus" transmitter. The valves, V104/V105, are a pair of 1625's in parallel; these are 807's with 12v. heaters. On CW both valves are driven, but for phone one is switched out, the PA circuit then being as shown in Fig. 3. All values are given in the table, and it should be noted that circuit element numbering is in accordance with the original; many of the circuit references are given on the transmitter chassis. The TCS is not self-powered, so a separate HT/LT supply must be provided; the connections are shown in Fig. 4.

Fig. 2. Circuit of the PA section, TCS Tx.

C112,		R108,	
C113	= .001 μF	R109,	
C114,		R110	= 47,000 ohms
C115	= .002 μF	R113,	
C116	= 425 $\mu\mu\text{F}$	R123,	
C117	= 630 $\mu\mu\text{F}$	R124	= 47,000 ohms
C118	= 50 $\mu\mu\text{F}$	L108	= 0.30 μH , var.
C119	= .01 μF	L110	= 1.0 mH RFC
C120,		M101	= 0-200 mA DC
C130	= .008 μF	M102	= 0-3 amps., RF
C121	= 500 $\mu\mu\text{F}$	E101,	
R107,		E102	= Anti-parasitic chokes
R112	= 22,000 ohms	V104,	
		V105	= 1625

(Note: Circuit element numbering is in accordance with original.)

condensers on L107. This tapped coil (L107) covers the entire frequency range of the trans- mitter, 1.5 to 12.0 mc.

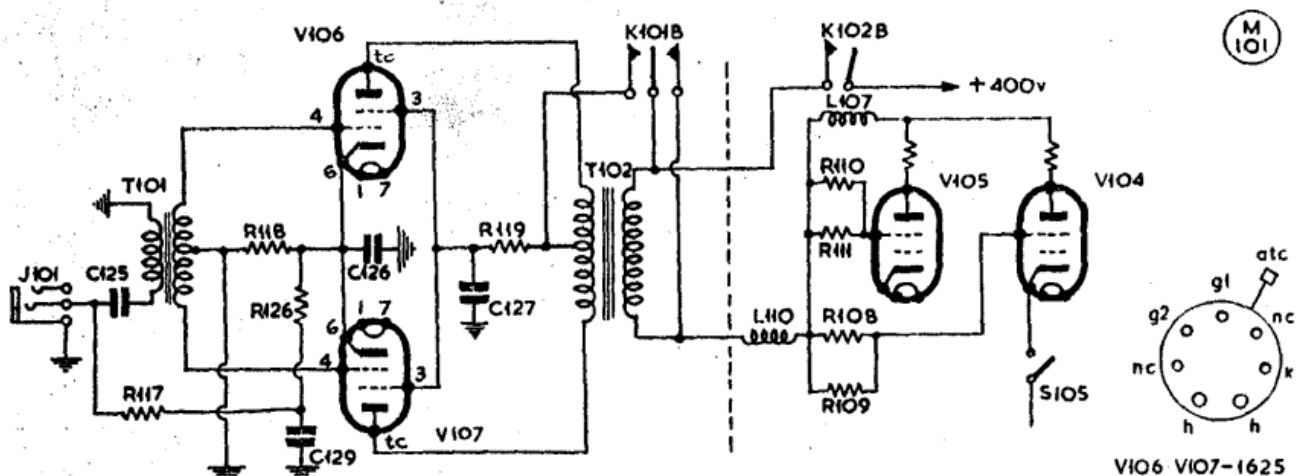
Aerial Coupling

The tank coil L107 is coupled to the aerial by a variometer, which controls the degree of coupling between the aerial and the PA tank. The "Antenna Loading" inductance, L108 is in series with the aerial. The switch S103 is the "Antenna Condition" switch, and it connects the padding condenser C121 either in series or parallel with the aerial. The meter M102 is an RF ammeter; some of the TCS transmitters have this meter in the aerial lead and not, as shown in Fig. 2, in series with the earth. The relay contact shown, K102D, is part of the aerial send/receive change-over. The TCS aerial coupling and loading circuits enable almost any aerial to be matched and loaded.

The Modulator

The TCS transmitters are among the few on the "surplus" market to have an incorporated modulator. The circuit of the audio stage is given in Fig. 3. It consists of a pair of 1625's operating in Class-B push-pull, modulating the PA (V104) on the plate and screen via the transformer T102. There is no pre-amplifier, the 1625's being driven direct from the microphone transformer T101, which is designed to work with a carbon-button microphone of about 100 ohms. Auto-bias and the energising voltage for the microphone develop across the resistor

- R118. The "Emission Selector" switch, \$105 (Fig. 2), which, as has been mentioned, cuts the heater volts from the parallel PA valve when placed in the "Voice" position, also switches on the heaters of the two modulator valves. V106 and V107. It also places the modulator valves on the HT rail via the relay contacts K101B, though no HT will be available until the push-to-talk switch is closed and the relay K102 applies the HT. When the transmitter is switched to the "CW" condition, the modulator valves have neither HT nor heater volts applied; it follows, therefore, that when changing from one function to another, time must be allowed for the heaters to warm up. All the supplies to the transmitter are fed through a 16-pin Cannon plug. Type SK-C16-231AC. The connections will be found in Fig. 4.



MODULATOR PA STAGE

Modulator arrangement in the 'IGS transmitter, using a pair of 1625's, V106/V107. As explained in the article, the speech output with a carbon microphone and the circuit as shown here leaves something to be desired, and it is better to drive the 1625's with a separate high-gain speech amplifier suitable for a crystal microphone. (Vote: In this diagram, V104 should be shown in the V105 position, 5to5 being as given under V105 is Fig. 2.)

Fig. 3. TCS Tx Modulator section

C125,	T101 =	100 ohms, push-
C126 = 4 μ F	pull to grids,	mic. xformer
C127 = 0.25 μ F	T102 =	6000/6000 ohms
C129 = 2 μ F	mod. xformer,	20w.
R117,	J101 =	Mic jack
R126 = 470 ohms	V106,	
R118 = 330 ohms	V107 =	1625
R119 = 20,000 ohms		

(Note: Circuit element numbering is in accordance with original.)

TCS RECEIVER TYPE 46159

The TCS transmitter has a companion receiver, U.S. Navy number 46159. The size, panel layout and construction are very similar to the transmitter. The frequency range is identical. As the receiver is a conventional seven-valve superhet it is not proposed to deal with it in any detail here, but merely to give the valve line up and the plug connections. The valve run is as follows: RF, 12SK7; Mixer, 12SA7; Osc.. 12A6; 1st IF. 12SK7; 2nd IF, 12K7 ; Det/BFO, 12SQ7; Audio, 12A6. The IF is 455 kc.

- It will be seen from this that the receiver has a separate oscillator valve (12A6). On the front panel will be found a switch marked "Oscillator Selector," and one of four crystals can be used as an alternative to the IF oscillator. The crystals are ground to be 455 kc above the signal frequency. It is doubtful whether in the ordinary way this facility will be required (it spot-tunes the receiver), so the switch will be left in the "MO" (IF Osc.) position. Other controls on the front panel are: HT on/off, BFO on/off, CW pitch, RF gain/AVC on/off, LF gain, band switch, and the main tuning control. When the BFO is on, the AVC is inoperative. The power and control circuits from the transmitter arrive via a twelve-pin Cannon clo Tune Ck.19.2314061
- Though designed to work in conjunction with the TCS transmitter, the receiver, with the exception of the power supply, is self-contained. The receiver is muted during transmission by cutting off the HT to the screens of the RF and IF valves. The relay K103 in the transmitter switches the HT from the exciter to the receiver screens when the push-to-talk switch, or the position. CW key is open. The relay rests in the receive. So much for the two major units of the TCS equipment. Apart from the Rx/Tx as described, there were several power supplies made for the series; these are rather rare (particularly the 230 AC mains unit) and inclined to be expensive; however, a list is appended for those who may be interested.

TCS AUXILIARY EQUIPMENT

<i>Item</i>		<i>US Navy No.</i>
416T-3 Dynamotor	12v. DC input	21770
416T-4 Dynamotor	12v. DC input	211035
416T-4 Dynamotor	12v. DC input	21881
Motor Generator	24v. DC input	21826
Motor Generator	32v. DC input	21775
Motor Generator	115v. DC input	21776
Motor Generator	115v. AC input	21777
Motor Generator	230v. DC input	21827
Rectifier Unit	115v. AC input	20218
Rectifier Unit	230v. AC input	20242

THE TCS ON THE LF AMATEUR BANDS

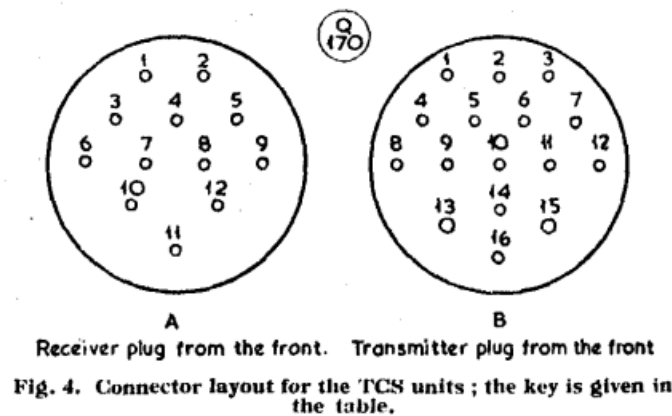
The TCS equipment can be used "as is" on the three LF bands; all that is required is a suitable power. The requirements will be found in the foregoing notes. The pin connections for both the transmitter and the receiver plugs are given in Fig. 4. Unless you are very lucky, the units will not have plugs when purchased, so they will have to be modified. The correct plugs can be obtained new from Films & Equipment, Wardour St., London (but not at "surplus" prices!). The types to specify are: Transmitter, Cannon SK-23c-1/2; Receiver, Cannon GK-12-233AC.

Modulation

- A carbon button microphone will modulate the transmitter to about 80%, but the system is a little marginal, to

say the least. A vast improvement in both the quality and depth of modulation can be achieved by the addition of a pre-amplifier. The writer removed the mic. transformer, T101, and disconnected J101, —see Fig. 3. R118 in this circuit was returned directly to earth.

- The leads from the 1625 grids, taken from tags 3 and 5 on T101, were then connected to the tip and ring of the jack J101 (this jack requires the small GPO "sleeve. tip and ring" plug).
- The tip and ring of the jack are insulated from the earth. An external pre-amplifier consisting of two EF37As and a 6SN7 phase inverter was found to work very well, with ample gain, using either a ribbon or moving coil microphone.
- Having disconnected J101. The push-to-talk and CW key will now have to be taken to pin 4 on the supply plug (Fig. 4b), and earthing this pin will put the transmitter on to transmit.
- No additional wiring is needed as this pin was originally in parallel with the mic. switch. So much for Phone operation. CW can be worked with full "break in" (BK) if desired, but there are snags in this; the relays are rather noisy, and if the rig is used in a living room this can be very irritating to the other occupants. If the keying speed goes much above 15 w.p.m.. the sending sounds a bit ragged, as the relays do not follow well. Careful ad-



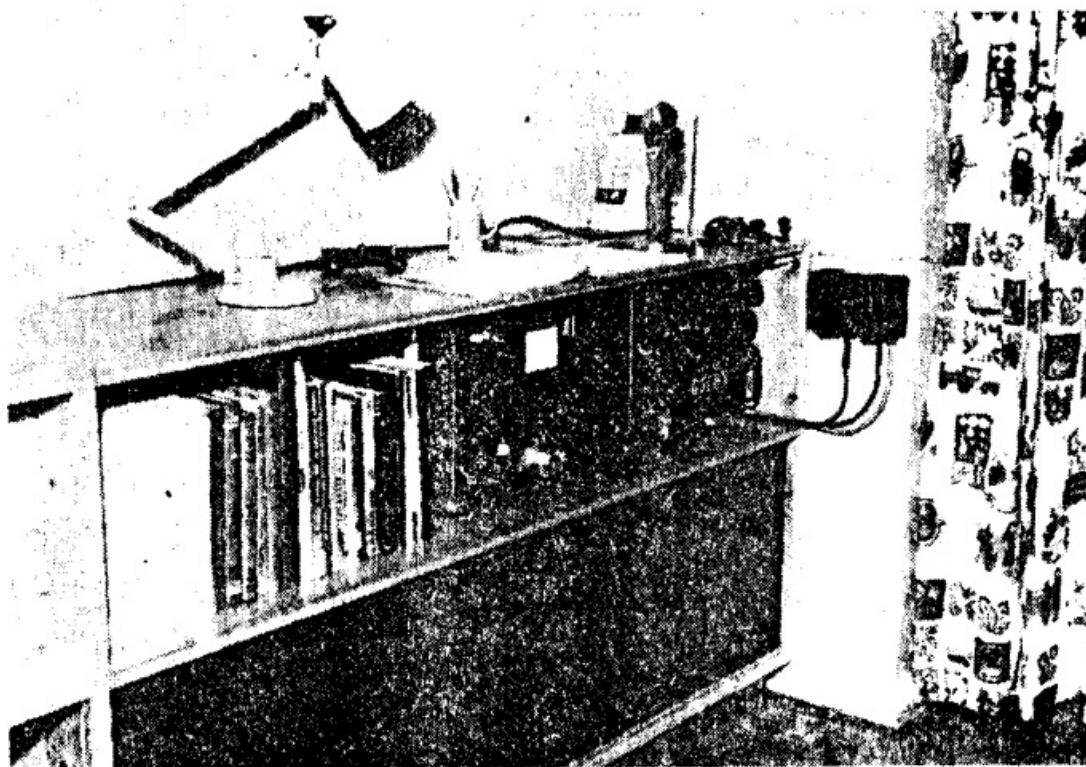
(A) Rx Plug from Front

1. Not used
2. 225v. DC
3. RF screens
4. Not used
5. 12v. heaters
6. Earth
7. Not used
8. Joined 12
9. Speaker 10, Joined 11
10. On/Off, remote control
11. On/Off other side, joined 8

(B) Tx Plug from Front

- 2. 400v. HT
- 4. Key, or send switch, fest grid mA To 12 via interlock

- 8, Mic. across J101 9, Earthed on send 11, M7 to R.x screens
- 12, As 7 13, 12v. AC, heaters
- 14, 225v. NT
- 15, Common earth, and heaters
- 16, 12v. DC for relitys (Pins 1, J, 6, 10 mat used)



- As this photograph shows, the TCS equipment makes quite a neat living room installation. GLOX has a BC-453 run as an "O5'er" to improve the receiver side, as explained in his article, which dives a lot of practical information on the TOS assembly. The nower upply and auxiliary audio amplifler (sèe Fig. 3) are in the lower cupboard. In effect, G3LOX has his whole station fitted in a bookshelf, the top of which serves as an operating table...or so on CW, the parallel PA valve, V105, was removed and the cathode of V104 keyed A small shorting jack was fitted next to the microphone plug on the front panel. The jack is in the PA cathode, and when a Phone is required, the plug is removed. (If a break jack cannot be found, a shorted plug can be used in place of the key, or the key can be • locked down.) For Top Band the input must be reduced ; the writer uses a separate low power HT supply as the most convenient solution.

The Receiver

The receiver requires no modification, except the plug. The output is about 500 ohms and will, with a suitable transformer, drive a speaker with ample gain. The sensi- ;tivity is very good; the selectivity, however, is not all it might be, but a BC-453 as a "Q5'er" takes care of this. An insulated lead is twisted around pin 4 (diode anode) of V206 (detector) and taken, well screened, to the aerial of the BC-453. (For further details of the "Q5'er" application, see page 465 of the November 1956 issue of Short Wave Magazine.)

- If an S-meter is considered essential a suitable design will be found on page 39 of March 1957 issue of the Muguzine.

Conclusion

- The TCS units offer a compact amateur station for our LF bands, with all the facilities one requires for efficient working on either phone or CW. It can be arranged as a neat living-room rig, either as an alternative to a main station or as a starting point for a newly-licensed operator who wants to get on the air quickly. The writer has been using TCS units for about two years and so far no TVi has been reported; however, two apparently identical transmitters may differ one from the other in this respect.
- The writer has been using TCS units for about two years and so far no TVi has been reported; however, two apparently identical transmitters may differ one from the other in this respect.
- No rare DX has been raised (or sought), but many fine QSO's have been enjoyed, invariably with good reports both for the signal strength and the phone quality; CW reports have always been T9. The construction of the units is of the highest class, and for the price of a secondhand DX receiver, you can have a complete station.

FAQs

What is the frequency range of the TCS to TCS-14 equipment?

The frequency range is 1500 to 12,000 kc. in three bands.

What type of emission does the equipment support?

The equipment supports 25 watts, A1 and 15 watts, A3 emissions.

Can the remote-control unit be used with other Navy types?

No, the remote-control unit is not interchangeable with any other Navy type.

How is the dynamotor operated?

The dynamotor operates exclusively from 12 volts D.C.

Documents / Resources



[Collins TCS-14 Transmitter](#) [pdf] User Guide
TCS-14, TCS-14 Transmitter, TCS-14, Transmitter

References

- [User Manual](#)

[Manuals+](#), [Privacy Policy](#)

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