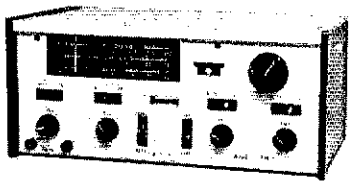
Recent Equipment

To acquaint you with the technical features of current amateur gear.

Ten Tec PM-2



HERE IS a piece of solid-state equipment that is practical and inexpensive as well as novel. The basic transceiver package provides for operation on 80 and 40 meters, VFO or crystal control. The transmitter section of the PM-2 also covers 15 meters, but the receiver portion of the equipment cannot function on 21 MHz without an accessory converter (which is available from Ten Tec). Other models of this equipment are available, permitting operation on 20 meters, in addition to one other band.[1]

The transmitter PA operates at approximately 2-watts dc input, and delivers between 1.5 and 1.75 watts rf output to a 50-or 75-ohm load. No provision is made for operating the transmitter into loads of other impedances, but a Transmatch would enable the operator to use an antenna whose impedance was other than the range specified by the manufacturer.

Modular construction is used in the PM-2. The transmitter is a separate assembly, as is the VFO, the product-detector (receiver front end), and the IC audio board. One may wish to purchase the basic kit of modules and assemble his own transceiver, or he can obtain the PM-2 assembled in its cabinet.

An operating voltage of plus 12 is required for the PM-2, and maximum current taken (during transmit) is approximately 200 mA. The manufacturer recommends that the equipment be operated from a good stiff battery pack, rather than from an ac-operated dc supply. An ac supply can introduce hum on the received signal, and may result in hum on the transmitted signal when the VFO is being used. Experiences while using regulated ac supply tend to bear this theory out.

The Receiver

The prospective buyer should not be misled by the apparent simplicity of the PM-2 receiver section. This is one of the "hottest" receivers of simple design that one can find. The direct-conversion technique is used here, meaning that the first stage of this unit consists of a tunable product detector whose BFO operates at the incoming signal frequency.[2] Fig. 1 shows the product-detector circuit. An RCA dual-gate MOSFET provides good cross-modulation and overload immunity, and assures good conversion gain and low noise figure. Two silicon diodes are cross-connected across the tap on the input tuned circuit to prevent damage to the 40604 MOSFET should excessive rf energy appear on the receiver antenna lead. BFO injection is supplied to gate 2, which is forward biased by the voltage developed across the source resistor of the detector. Forward bias is also applied to signal-gate 1, no doubt to increase the transconductance of the MOSFET. Gate 1 is tapped down on the tuned circuit, probably to aid the *Q* of the input tank. Selectivity for the receiver is established after the detector, by means of FL1, a potted inductor and three

[1] Other models of this equipment are available. The PM-2 and PM-1 are electrically identical, but the PM-1 is supplied without the cabinet. The PM-3 covers the 40- and 20-meter bands, but is otherwise the same as the PM-2. The PM-3A is identical to the PM-3 except that it features break-in keying.

[2] Another name for this receiving technique is "synchrodyne". For additional information see April and May 1969 *QST*.

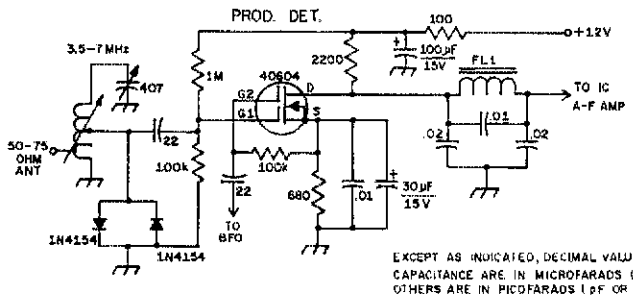


Fig.1 — Circuit of the Ten Tec product detector and audio filter. A dual-gate MOSFET is used in this circuit. It is followed by a 2-kHz audio filter, FL1.

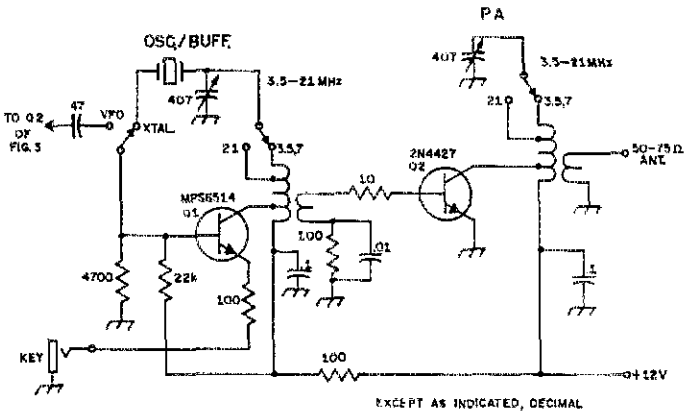


Fig.2 — Circuit of the basic transmitter. Provision is made for crystal or VFO operation. The collector tanks of Q1 and Q2 use tapped toroidal inductors to permit operation on three bands, 3.5, 7, and 21 MHz. A fixed-impedance output link permits the use of antennas whose impedances are between 50 and 75 ohms.

associated resonating capacitors. Phone selectivity is used, and the filter provides a bandwidth of 2 kHz. Though this is ideal for ssb reception, it leaves a great deal to be desired when operating cw. However, since the audio channel has gain to spare, an outboard 900-Hz cw filter, active or passive, can be added for code reception.

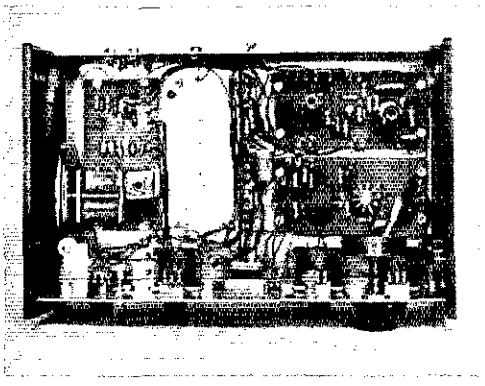
The filter is followed by a high-gain IC amplifier. It uses an RCA CA3035V1; this circuit operates with a gain of 100 dB. Provision is made for headphone output only, but it was discovered that a 1000-ohm to 4-ohm output transformer provided sufficent volume for loudspeaker operation on all but the weakest of signals. The transformer was added as an outboard accessory. Under normal conditions, while using a pair of 2000-ohm headphones, the signals were so loud that the audio-gain control was nearly at zero setting for comfortable listening.

Single-signal reception is not possible with this type of receiver, but all one has to do to reject an interfering cw signal is to tune to the opposite side of zero beat. The receiver can handle either upper- or lower-sideband signals if the operator tunes to the proper side of zero beat when tuning in the ssb signal. A-m signals can be received by tuning to exact zero beat, but the quality of a-m signals that are copied on a direct-conversion receiver is less than ideal.

Since the dynamic range of FETs is excellent, as compared to bipolar transistors and ICs, strong local broadcast and ham signals have little effect on this receiver. The writer lives but two blocks from an a-m station which operates in the high end of the broadcast band. No evidence of a-m detection or overload could be noted. This was not true, however, when testing other tube and transistorized receivers at the same location.

Transmitter Circuit

Fig. 2 shows the circuit of the two-stage transmitter. Bipolar transistors are used for both stages, and toroidal inductors are employed in the tuned circuits to achieve high Q and compactness. A switch provides for crystal or VFO operation. The VFO functions as a BFO during receive. It operates at the signal frequency, but much to the writer's amazement it proved to be relatively



Interior view of the Ten Tec PM-2. The VFO/BFO tuning capacitor is seen at the left-center of the photo, the remainder of the tuning capacitors are located along the bottom edge of the front panel. The VFO circuit board is at the far left. An open space is adjacent to the VFO module. The 15-meter receiving converter can be installed in that area. The product-detector board is visible at the upper right of the photo, and the two-stage transmitter module is directly below it. The audio-amplifier board is mounted on its edge at the center of the base plate, directly behind the panel meter. The input and output jacks, and the power receptacle, are located on the rear lip of the cabinet.

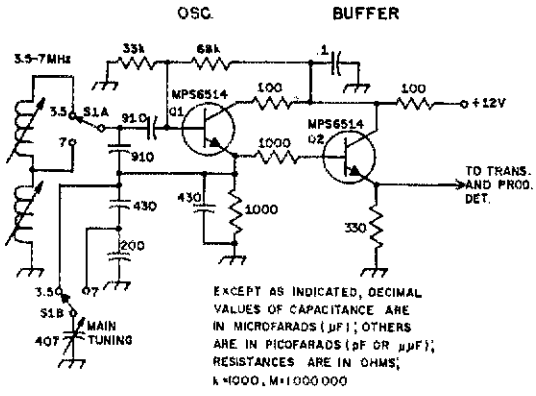


Fig.3 – Schematic diagram of the VFO portion of the transceiver. Transistors Q1 and Q2 are high-beta, high-fT types. The tank circuit uses a high value of parallel capacitance as an aid to stability. Main-tuning capacitor C1 is tapped down on the feedback network to provide bandspread. During receive, the VFO functions as the BFO for the product detector of Fig. 1. Q2 operates as an untuned emitter-follower buffer. S1 is the band switch.

chirp-free.[3] Here, again, a good stiff battery supply is important to good operation. A voltage that shifts as the load changes will cause a chirpy cw signal. Q1 is a high-beta transistor whose f_T rating is in the uhf spectrum. This type of device makes an excellent oscillator or amplifier, provided spurious oscillations can be suppressed. No evidence of instability was noted when testing the rig. The collector of Q1 is tapped down on its tuned circuit to provide an impedance match. A 407-pF broadcast variable tunes the toroidal inductor to resonance at 3.5, 7, and 21 MHz. A band switch selects the appropriate taps on the coil for the band of operation. Keying is done in the emitter return of Q1. Though no shaping is incorporated, the cw note is relatively clean and free of clicks. It would be an easy matter to add some shaping to the keying, and the operator may wish to do so.[4]

The PA stage, Q2, Fig. 2, uses a 2N4427 which operates essentially Class C. Its tank circuit is arranged in a like manner to that of Q1. Output is taken from a fixed link which is designed to look into a 50- or 75-ohm termination. A panel meter reads relative collector current of the PA. The oscillator is tuned for maximum meter reading. The PA is tuned for a dip in meter reading. The PA appears to be stable, because the dip in collector current coincides with maximum rf output. There are no protective measures to prevent damage to Q2 should the transmitter be keyed at a time when there is no load, or when a severe mismatch occurs.

The VFO

As outlined earlier, the VFO operates as a BFO during receive and is shown schematically in Fig. 3. Both transistors are high-beta, high-f_T types. By selecting a high-beta device for Q1 it is possible to use large amounts of C in the tuned circuit and still enable Q1 to sustain oscillation. The capacitance used is very high for 7-MHz operation, hence contributing to good stability. There is no evidence of oscillator "pulling" when the transmitter is keyed, or when the input of the detector is tuned to resonance during receive. The VFO tuning capacitor is tapped down on the feedback network to provide suitable bandspread. For operation on 80 meters an additional slug-tuned inductor is added to the circuit, but the shunt capacitance remains unchanged. Therefore, the vfo is not quite as "stiff" on 3.5 MHz.

Output from Q1 is taken across a 1000-ohm emitter resistor. Forward bias for Q2 is set by a second 1000-ohm resistor which connects to the base of Q2. This resistor also helps to isolate the VFO from its buffer, Q2. The buffer operates as an emitter-follower, and its output is taken across a 330-ohm resistor. No Zener diode is used to regulate the oscillator voltage. The manufacturer assumes that the equipment will be operated from a battery supply with ample current capacity to assure a steady operating voltage as the transmitter is keyed.

Operation

The transmitter has very low harmonic output, which is not always true of solid-state transmitters. All harmonics are down at least 25 dB from the fundamental, an acceptable figure when operating at QRP level. There was no evidence of TVI when the equipment was operated into an antenna which was only 10 feet from the writer's TV antenna.

Numerous contacts were made on 80 and 40 meters. The greatest distance covered was 1000 miles, and the signal report was RST 569. Many reports of RST 599 were received at distances up to 500 miles. Two series-connected 6-volt lantern batteries were used to power the transceiver, and after several hours of operation the batteries did not show any signs of depletion.

Final Comments

The manufacturer has a number of accessories which can be used with the PM-2. Among these units are a 15-meter receiving converter, a side-tone monitor, an antenna tuner, and an SWR indicator. A solid-state electronic keyer is available to those

Ten Tec PM-2 Transceiver

Height: 4 1/2 inches.
Width: 10 3/8 inches.
Depth: 6 5/8 inches.
Weight: 2 lb.
Price Class: $55
Power Requirements: 12 volts dc at 200 mA.
Manufacturer: Ten Tec, Inc. Sevierville, TN 37862

[3] Ordinarily it is quite difficult to obtain a chirp-free cw note when a VFO operates at the transmitter's output frequency. The difficulty is particularly troublesome when using transistorized equipment because of the poor isolation between the transistor's input and output ports.

[4] Information on shaped keying is given in the ARRL *Radio Amateur's Handbook*, 47th Edition.

wishing to really go "high hat" during QRP excursion.

When using the transmitter for 15-meter operation, Q1 of Fig. 2 operates as a tripler to drive Q2 straight-through on 21 MHz. The efficiency of the transmitter is not quite as good on 15 meters as it is on the two lower bands. The measured output was approximately 1 watt on 21 MHz.

There is sufficient frequency offset when going from receive to transmit to permit compatibility of operation with stations that use transceivers. The Ten Tec receiver should be tuned to the *high-frequency* side of the other station's signal when VFO operation of the transmitter is contempleted. This practice will provide the correct offset relationship.

The PM-2 is packaged in an attractive heavy-gauge aluminum cabinet. The end plates of the case are made of moulded plastic, and have a wood-grain finish. The top of the cabinet is painted an off white, and can be removed to provide access to the circuit boards. A two-tone finish sets off the front panel to impart a professional appearance. The main tuning-dial calibration is silk-screened on the panel.

This little package should make an excellent companion for the camper, vacationer, CD operator, or the QRP enthusiast who likes to garner his DX the hard way. – *W1CER*

Some QST Abbreviations used in Text and Drawings

A – ampere
ac – alternating current
af – audio frequency
afc – automatic frequency control
afsk – audio frequency-shift keying
agc – automatic gain control
alc – automatic load (or level) control
a-m – amplitude modulation
anl – automatic noise limiter
ARC – amateur radio club
AREC – Amateur Radio Emergency Corps
ARPSC – Amateur Radio Public Service Corps
ATV – amateur television
avc – automatic volume control
bc – broadcast
BCD – binary-coded decimal
bci – broadcast interference
bcl – broadcast listener
BFO – beat-frequency oscillator
BPL – Brass Pounders league
ccw – counterclockwise
c.d. – civil defense
CD – Communications Department (ARRL)
coax – coaxial cable, connector
COR – carrier-operated relay
CP – Code Proficiency (award)
CR – cathode ray
CRT – cathode-ray tube
ct – center tap
cw – continuous wave (code), clockwise
dB – decibel
dc – direct current
DF – direction finder
dpdt – double-pole double-throw
dpst – double-pole single-throw
dsb – double sideband
DX – long distance
DXCC – DX Century Club
EC – Emergency Coordinator
ECO – electron-coupled oscillator
EME – earth-moon-earth
emf – electromotive force (voltage)
FAX – facsimile
FCC – Federal Communications Commission
FET – field-effect transistor
FD – Field Day
fm – frequency modulation
fsk – frequency-shift keying
GDO – grid-dip oscillator
H – henry
hf – high frequency
Hz – Hertz
IC – intigrated circuit
ID – inside diameter
i-f – intermediate frequency
IW – Intruder Watch
k – kilo
kc – kilocycle
kHz – kilohertz
lf – low frequency
LO – local oscillator
lsb – lower sideband
luf – lowest usable frequency
mA – milliampere
MARS – Military Amateur Radio System
Mc – Megacycle
mf – medium frequency
MG – motor-generator
mH – millihenry
MHz – Megahertz
mic – microphone
mix – mixer
MO – master oscillator
MOSFET – metal-oxide semiconductor field-effect transistor
MOX – manually-operated switching
ms – millisecond
m.s. – meteor scatter
muf – maximum sutable frequency
mV – millivolt
mW – milliwatt
nbfm – narrow-band frequency modulation
NC – normally closed
NCS – net control station