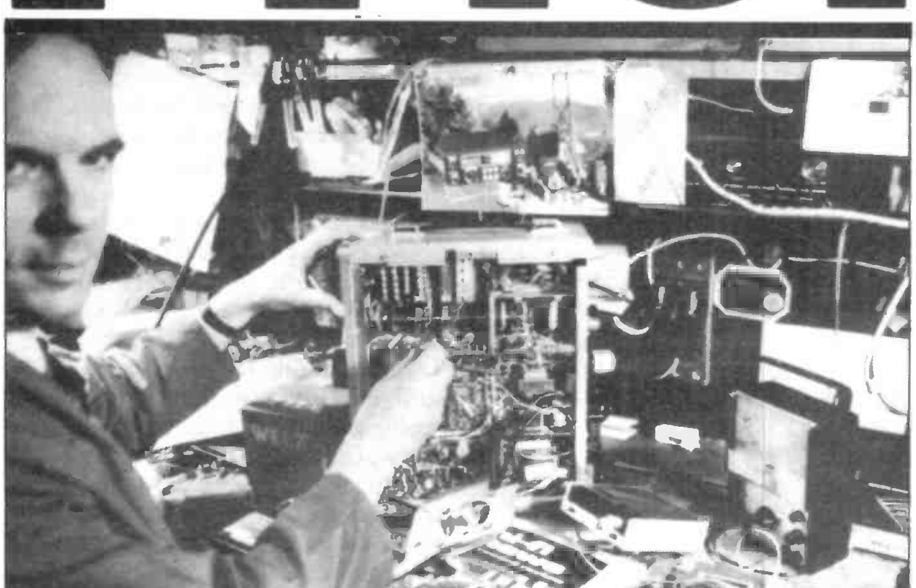
The FT101 series of transceivers still represent some of the best value for money to be had in secondhand HF gear.

Taking apart the FT101

Even the earliest versions are worth acquiring while a few simple modifications will bring the sets up to present day performance standards. *By Harry Leeming G3LLL*



"I'm just ringing up to see if you have any second-hand *FT101s* in stock."

The *FT101** must be the most sought-after piece of second-hand gear on the amateur radio market, and as the line seems destined to come to an end with the demise of the *FT101ZD,* it would seem an appropriate time to look back at, and discuss, this extremely popular unit.

Yaesu's original sales literature seems to indicate that the *FT101* was aimed at the Yank who had two homes, a large automobile, travelled around a lot, and wanted a second rig which would run from DC or AC supplies, fixed or mobile. Considering its power and versitility, the *FT101's* ssize and weight was a revelation in its time. Old heads wagged and predicted that it just wasn't possible, "the power supply is too small". They were wrong. Hundreds of thousands of users including now many of the original doubters have vindicated Yaésu and the *FT101* has proved to be one of

the most popular, reliable, and easy to maintain pieces of amateur radio gear ever made.

A Brief History of the FT101

Yaesu have gradually developed the *FT101* over the years, but have not always clearly indicated the existence of design improvements by altering the model's suffix. When servicing, buying, or selling an *FT101,* it is as well to know exactly what version one is dealing with, hence it is hoped that the following will help. Second-hand values are very approximate but, for what it is worth, they are given as of late 1982 (strange but they seem to be just about what the models cost in the first place; what else in electronics can you get your money back on after ten years' use?) dates apply to UK sales and are also approximate.

1971 Early FT101 Mark 1 (present value £200-£250). The *FT101* was not originally factory fitted with the 160 metre band but many units were modified for this by the importer. The earliest model can be identified by the absence of any "160" markings on the band switch and by the use of two output transistors on the audio unit. The main complaint with this early version of the FT101 is that it suffers from cross modulation and receiver overload — it just "falls to pieces" if used with a full-size aerial on 40 metres after dark. It was probably intended for use mainly with a mobile aerial.

1972 Late FT101 Mark 1 (present value £250-£300). This is as above except that the audio output transistors have been replaced with a 2½" by 1½" Sanyo I.C. which is very easy to spot on the audio unit if you open the lid.

* Marketed as Sommerkamp FT227 in most Continental European countries

Mark numbers are unofficial and are similar to those suggested by the FT Club in the United States — see end of article

Late 1972 FT101 Mark 2 (present value £250-£300). This model looks externally as above except "160" is marked on the band switch, there are larger DC/DC inverter transistors and a larger heat sink is fitted at the rear. Internally new circuit boards give more IF gain and less RF gain and the RF protection diode is removed and replaced with a fuse lamp. The noise blanker circuitry, which was part of the IF unit in the *Mark 1,* is re-designed as a separate board and perches on top of the VFO unit. Together with extra filters to clean up the transmitted signals, these modifications result in a considerably improved receiver and transmitter performance.

1973 Late FT101 Mark 2 (present value £260-£310). This unit is the same as the earlier *FT101 Mark 2* but is fitted with an extra receive audio pre-amplifier. This small printed circuit board, the circuitry of which is given in **Fig 1**, is mounted behind the mode switch.

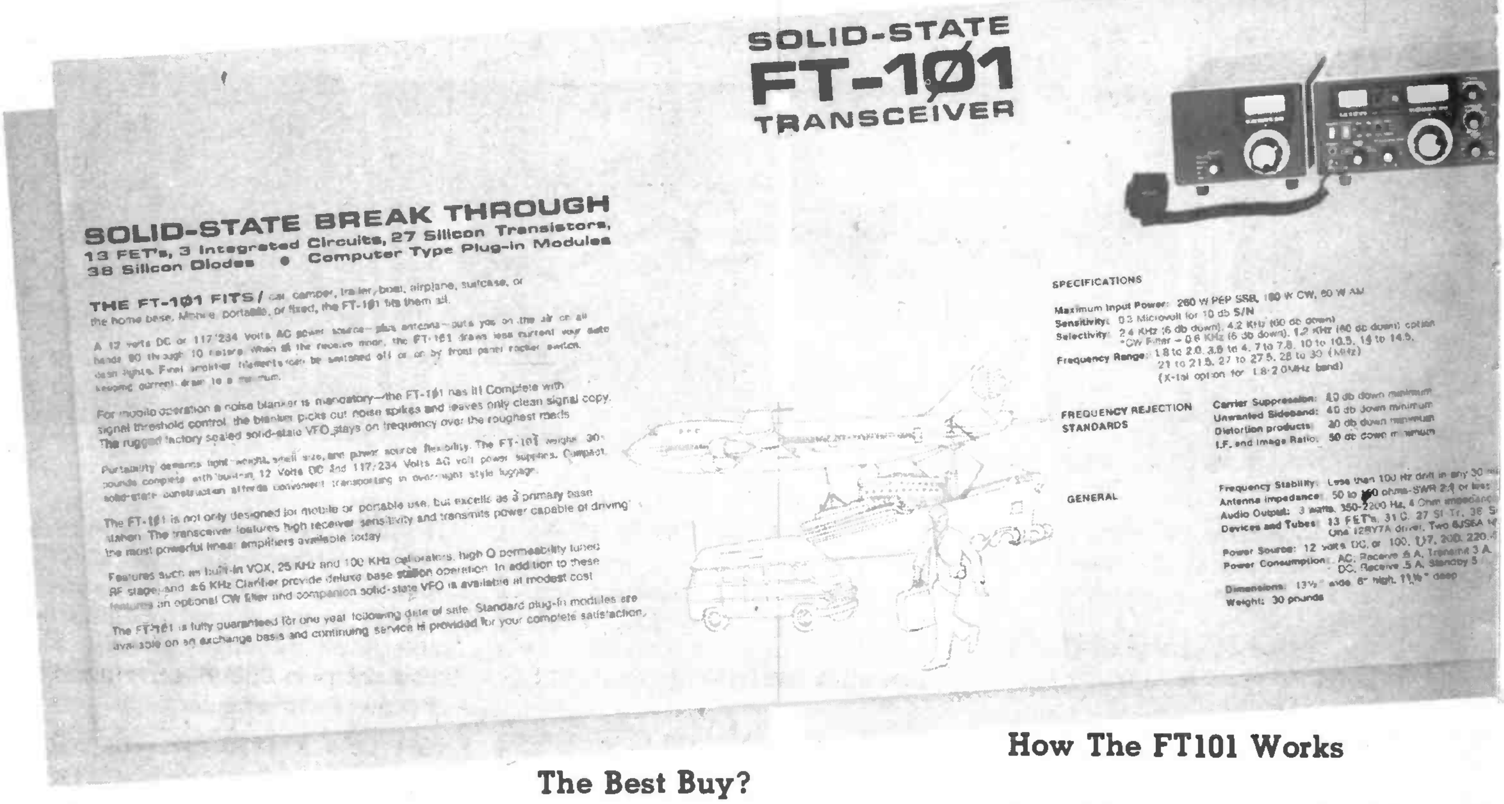
1974 Early FT101B (present value £275-£325). The rig is only slightly different from late *Mark 2s* but is clearly marked on the front panel "FT101B" and sports two LED's to indicate clarifyer and internal VFO operation. Inside the set the noise blanker board plugs in behind the mixer/high frequency IF unit, and an eight pole SSB filter is fitted to improve receiver selectivity.

1975 Late FT101B (present value £300-£350). As above but large Sanyo IC is replaced with smaller unit thus allowing audio pre-amplifier to be removed from behind the mode switch and incorporated in the AF unit.

Late 1975 FT101E Mark 1 (present value £325-£375). This unit is the same as late *FT101B* but is marked on the front panel "FT101E" and is fitted with an early version of Yaesu's speech processor. This early processor is not particularly successful or convenient due to the lack of an external level control.

1976 FT101 Mark 2 (present value £350-£400). In this model, the speech processor is completely redesigned and a dual gang potentiometer is fitted in the clarifier position on the front panel labelled "CLAR/—LEVEL". The processor is more convenient and effective than that fitted in the *FT101E Mark 1.*

1977/78 FT101E Mark 3 (present value £375-£425). DC/DC converter transistors reduced in size as per *FT101 Mark 1.* The power supply and noise blanker circuits are altered. This version can be identified by the noise blanker board which is numbered PB1582 and incorporates a 2.72 MHz. (No crystal, and board marked PB1292 on earlier units).



The first publicity blurb

1978 FT101ZD. This is entirely new design which probably was numbered "101" for marketing purposes. It is a single superhet and is basically an economy version of the *FT901* from which it was presumably developed. It is an excellent piece of equipment. It is not the subject of this article.

FT101EE as FT101E but speech processor an optional extra. FT101EX economy version omitting speech processor 12 volt power supply unit, microphone and fan. 160M, WWV, and three 10 metre crystals also omitted.

The Best Buy?

The basic circuitry and performance has not changed greatly since the *FT101 Mark 2,* and price and condition are the main consideration when purchasing a second hand unit. Some *Mark 1's* have been fitted with an official Yaesu upgrade kit (new noise blanker fitted on top of the VFO, new RF board, new mixer/high frequency IF module, plus extensive re-wiring and modification of other boards) and are more or less equivalent of a *Mark 2* if the work has been correctly done. A few models can be fitted with an external speech processor and with a few small mods, a *Mark 2* or *B* which is in good condition can be made to out perform an unmodified *FT101E.*

How The FT101 Works

The *FT101* uses a classic double superhet arrangement with a crystal controlled high frequency oscillator. This type of circuitry was used by many rigs of it's era, such as the TS510 and TS520 by Trio/Kenwood and the *FT560* and *FT401* by Yaesu to name but a few of dozens. The simplified block diagram in **Fig. 2** shows the *FT101* operating 15 metre band, and using this example let us follow the signal path through the transmitter.

Speak into the microphone and a few millivolts of audio are amplified by PB1315 for application to the balanced modulator circuitry on board PB1184. The output of PB1184 is a set of two sidebands either side of a suppressed carrier at a frequency just under or just over

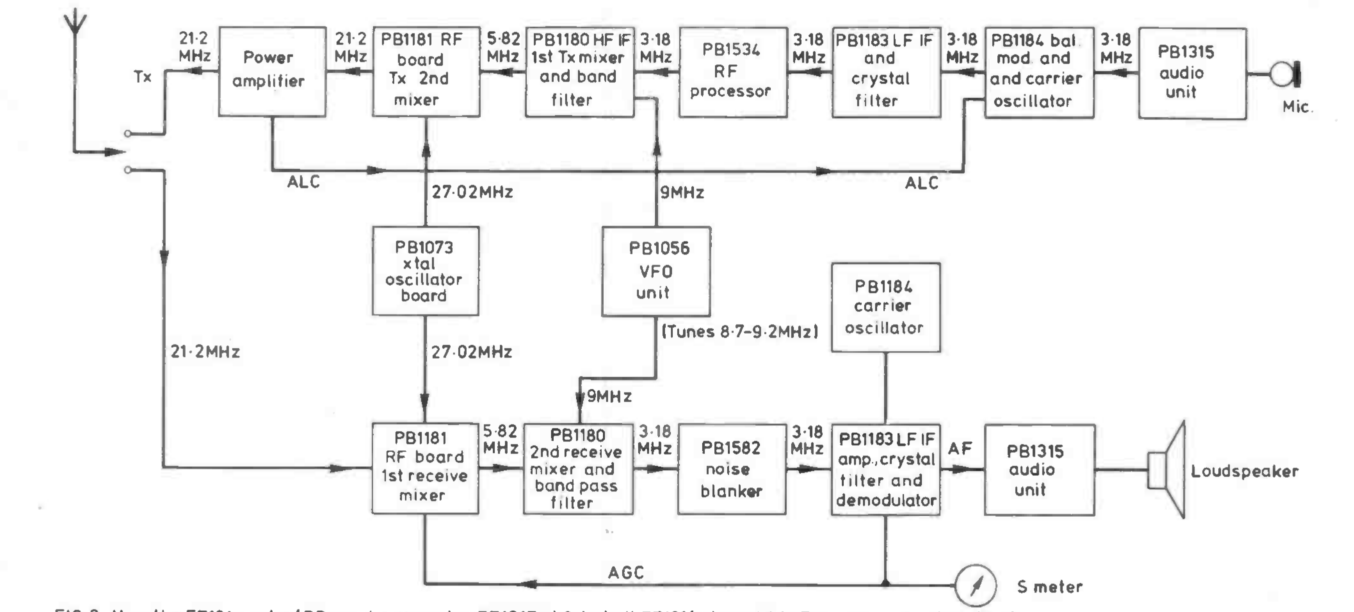


FIG. 2. How the FT101 works (PB numbers are for FT101EMk3 but all FT101's from Mk1–E use same basic set up) Units shown transmitting and receiving at 21·2MHz.

3.18MHz dependent on which sideband has been selected. These two sidebands are applied to PB1183 where the wanted side band is amplified, the unwanted sideband being suppressed by the crystal filter.

The 3.18MHz SSB signal then passes via PB1534, the RF processor, to the mixer unit PB1180 where it is mixed with the output of the VFO to provide a signal at some frequency between 5.520 and 6.020MHz, any mixer products outside this range being suppressed by the band pass filter.

This SSB signal (in the illustrated case at 9−3.18 = 5.82MHz) is applied to the second transmit mixer on PB1181 and is mixed with the output of a crystal oscillator whose frequency is selected by the band switch. In this instance 27.02MHz is selected producing the difference frequency (27.02−5.82 = 21.2MHz) at the input of the radio frequency power amplifier. This signal is then raised to a level of approximately 150 watts PEP by the driver and power amplifier valves, and is applied through the aerial changeover relay to the PL259 socket on the rear of the rig.

The Receiver Mode

The in-coming signal at 21.2MHz is applied via the aerial changeover relay to the RF board PB1181. Here it is amplified and mixed with 27.02MHz coming from PB1073 the crystal oscillator board. The output of the RF board is the difference between 21.2 and 27.02. Hence 5.82MHz is applied to the second receiver mixer via the band-pass filter. the VFO can be tuned from 8.7 to 9.2 MHz to convert any signal in the range of 5.520 to 6.020MHz to the second IF frequency of 3.18MHz. In this case it is tuned to 9MHz (9−5.82 = 3.18) to produce a signal for feeding to the noise blanker circuit.

PB1582 or its equivalent on earlier models is intended to reduce the effect of impulse type interference. Yaesu has swopped and changed with the noise blanker circuitry on the *FT101* considerably, but have never really got it to work well. If used as originally intended in a mobile location with S9 + 20 QRN from one's own engine, it does help, but even the elaborate version on late *FT101E*, which uses an extra stage to convert the noise to 450kHz does not seem to help much on the type of noise encountered on the

average domestic environment. A similar elaborate arrangement is used in the *FT902* which does not seem very impressive either. Strangely the *FT101XD* uses a much simpler circuit arrangement, and the noise blanker on this works wonders!

PB1183 is the low frequency IF amplifier and this contains the crystal filter which provides the receiver's selectivity. Prior to the crystal filter, most stages in the receiver have to handle *the entire radio spectrum for a few hundred kilohertz either side of the wanted station.* As well as ham stations running watts this will sometimes include broadcasting stations running mega-watts so that handling these extremes of signals without some cross modulation is an almost impossible task for the RF mixer and noise blanker stages. Also contained on PB1183 are the AM and SSB/CW detector stages along with the automatic gain control rectifier. AGC is applied to the IF amplifier integrated circuit on PB1183 and is also fed back to the RF stage, while detected audio is passed on to PB1315 for amplification prior to being fed by the loudspeaker.

The Transceiver Principle

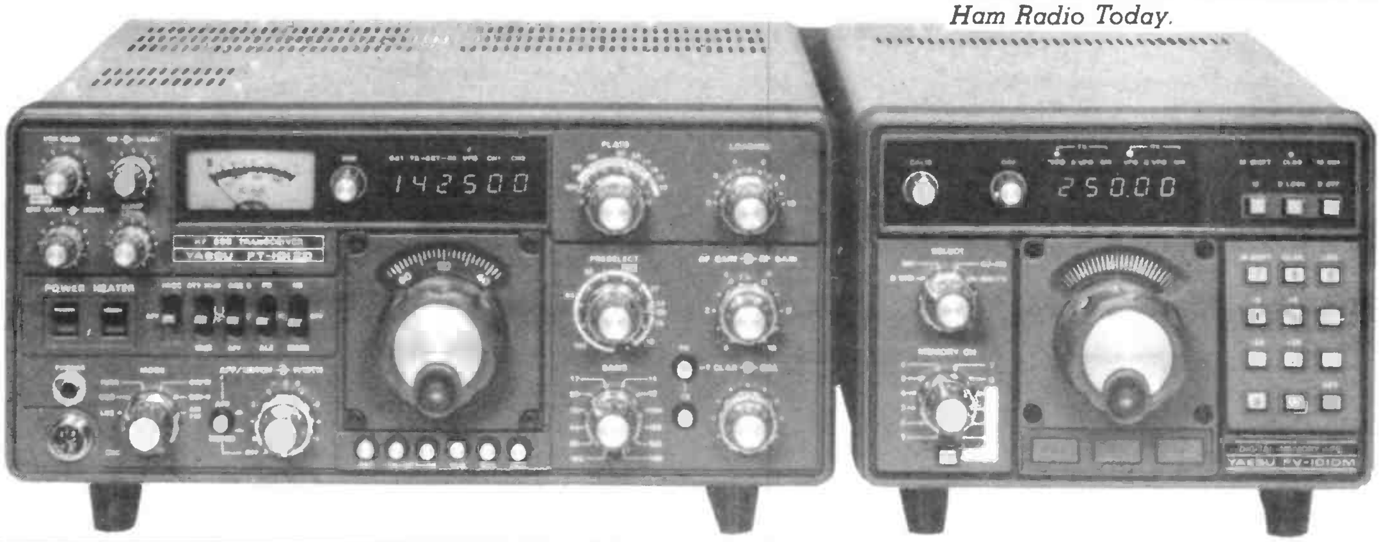
From examination of the above and the block diagram, it will be seen that many transmit stages are turned round and used in the opposite direction on receive, allowing a very considerable cost saving. One has only to compare the number of parts in Yaesu's separate transmitter the *FL101* with the *FT101* transmitter/receiver to realise why it costs almost as much to build a transmitter as it does to build a complete transceiver. While separate transmitters and receivers do have some operational advantages, cost effectiveness has resulted in the almost complete domination of the amateur radio market by the transceiver.

G3LLL asks us to point out that while he is happy to answer brief queries on the FT101 series, correspondence must contain a stamped, addressed envelope to obtain a reply.

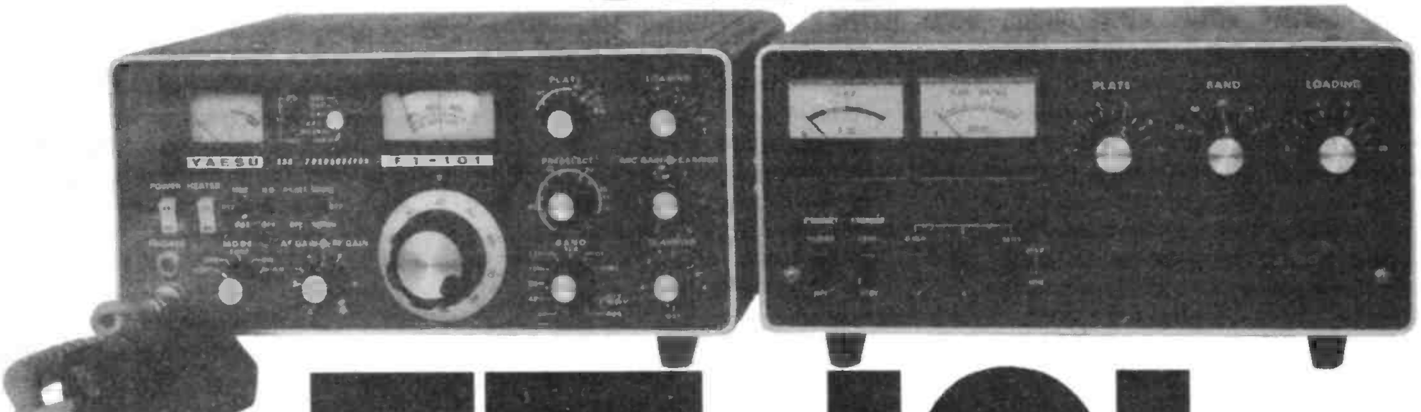
FT101 INFORMATION

G3LLL will be covering servicing and modifications in future FT 101 articles. Alignment and fitting 10, 18 & 24 MHz will be covered, together with AGC modifications and other Receiver and Transmitter improvements. But what about you?

"Bright ideas" and servicing experiences should be shared around so let us know what you have done with your FT 101 — please type (or print CLEARLY) and send your contributions to the editor for possible inclusion in part 4 of G3LLL's article. The best contribution will receive 12 months' subscription to Ham Radio Today.



Taking apart the



FT 101

Part 2

Troubleshooting and repair

by Harry Leeming G3LLL

Dismantling the FT101

Some circuit boards and parts are easily accessible once the lid and bottom covers have been removed. When servicing in the more difficult to get at sections, it is not worth struggling and risking doing damage, as it is very easy to remove the complete cabinet. To do this, proceed as follows:

1. Completely disconnect the *FT101* from the mains, aerial and all other equipment and place on bench in an inverted position.
2. Remove bottom cover and release hexagonal screws and two star-headed screws (four at the front and one at the rear) holding cabinet in place.
4. Gently slide cabinet off over rear of *FT101* ensuring that the lid catches do not foul the audio board or the metalic labels identifying this board's preset controls.

Faults and modifications

Mains fuse blows. If a replacement 3 amp fuse fails do not fit a larger one: there is a fault. The most likely cause of mains fuse failure is a short circuit in the HT rectifiers, and these should be checked with an ohm meter. A suitable replacement is the BY127 television type HT rectifier, and it is advisable to replace all eight rectifiers in the HT bridge even if only a couple are faulty. Note that early *FT101 Mk 1s* used only four HT rectifiers, but for reliability these should be replaced with eight rectifiers fitted with the 470k equalising resistors as in Fig. 1.

Set works on receive, but won't transmit, or vice versa. A common cause of this is that the junior operator has had his fingers on and has left the INT/EX/CH switch in the wrong position. Many *FT101s* have been returned for this.

No transmit, no PA current, receive OK. Check that power amplifier valve heaters are lit. The 11-pin plug at the rear must be fitted and must have a link between pins one and two before the power amplifier stage will function.

No SSB transmit, three or more S-points down on receive, final amplifier resting current OK at 50 to 60 mA. CW and tune gives full output. This fault is occasionally caused by Q1 on the IF board having blown. You can replace this FET with almost any RF FET such as the MPF102, provided that you get the pin connections correct.

Any weird fault, particularly if intermittent. High resistance contacts on the plug-in circuit boards can cause some very odd effects. Standard service procedure is to remove the plug-in circuit boards, squirt the contacts with contact cleaner, and plug them in and out half a dozen times to clean the connections.

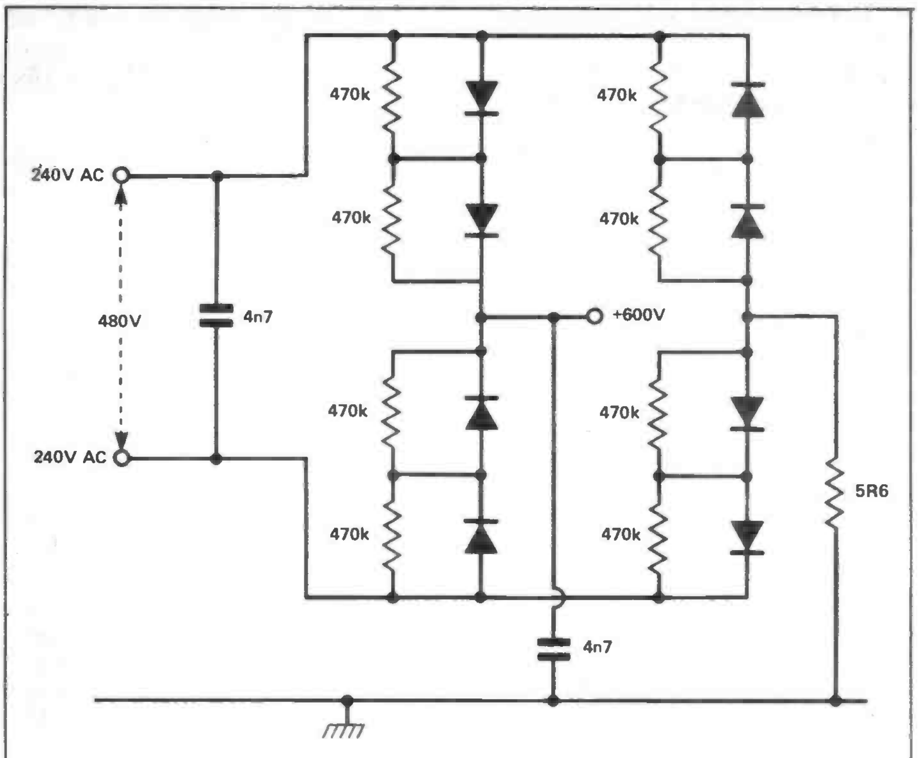


Fig. 1. HT rectifier circuit in most FT101s

Fuse blowing but HT rectifiers OK. Try operating the rig with the power amplifier valves removed. If all is OK, leave the valves out and measure the bias voltage at the grid connection of the power amplifier valves. This should be about −50V on transmit or −65V on recieve. Turn the band change switch and if the voltage falls below this, or even goes positive on any band, replace the relevant coupling capacitor from the anode of the driver valve. Note that a coupling capacitor of 80 or 100pF goes direct to the anode, whilst other capacitors are switched in parallel with this on 160m and 80m in some models. A short circuit here will have ruined the PA valves so once this fault has been cleared it will be necessary to fit new ones.

Fuse still blows, but PA and HT rectifiers OK. Sometimes the DC/DC inverter ('chopper') transistors go short circuit even if the rig is never used on a 12V supply, and cause fuse blowing. The *FT101* will work perfectly on an AC supply with the chopper transistors disconnected, hence the easiest way to test these is to disconnect them and try a new fuse. If these transistors are faulty, the cost of replacement is in the region of £20 to £40 a pair. If you do not anticipate DC operation simply remove them.

Fuse still blows! If all the suggested tests come to nothing try operating the *FT101* from a 24V AC supply. At such a low voltage even a bad short is unlikely to blow the fuse and every output of the rig's power supply should give one tenth of its rated voltage. Find the power supply output that is less than this and you are in with a fighting chance of discovering the cause.

ALC faults

Valves operating in class AB1 do not pass grid current until they are slightly overdriven. In the *FT101* any grid current caused by overdriving is rectified and fed back as a negative ALC voltage, rather like automatic gain control on a receiver, and so turns down the gain of a previous stage. In practice *slightly* over-driving a class AB1 amplifier does not do any harm and this system is used in much amateur equipment and works well.

No ALC indications. This is almost always a result of low drive to the power amplifier valves, and is commonly caused by an aging driver valve or misalignment.

ALC too active on one or more bands on some FT101's. The trouble here is usually caused by the radio frequency choke L12 picking up RF from the PA coil. The simple cure is to replace the choke with a 2.2K resistor. Only a limited number of *FT101Es* used this extra choke L12. Later *FT101Es* reverted back to the original circuit, see **Fig. 2.**

No transmit, ALC meter 'pings' hard over and is not adjustable. This fault is caused by a short circuit ALC transistor (Q1 on mod and oscillator board *FT101 Mk1, Mk2, B, EE, EX* and *E Mark 1;* or Q6 on processor on *FT101 Mk2* and *Mk3*). This fault may have been caused by a flashing PA valve or a leaky ALC coupling capacitor. As a replacement FET, an MPF102 will do if you get the connections right, or you can fit the 'spare' FET in the fix oscillator circuit which you are unlikely to use.

Set intermittently dead on one band, often 15m. This fault is usually caused by the first conversion crystal oscillator refusing to start. Slightly adjusting the relevant trimmer (see manual 'heterodyne crystal oscillator alignment') will usually bring it back to life again. The manual suggests adjusting using a

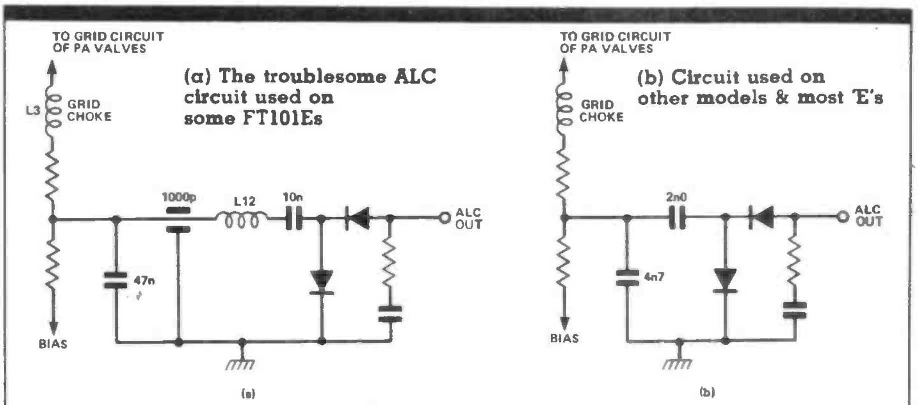


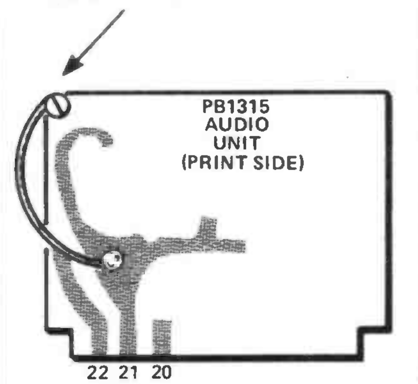
Fig. 2 ALC Circuits

diode probe volt meter, but in practice turning the trimmer the minimum amount needed to give reliable operation of the oscillator is all that is required.

Receive signals and calibrator very weak but sounds lively and transmits OK. This fault usually indicates that Q1 on the RF board has blown. It can be replaced with an RCA 40673 or 3N201 etc. If the replacement blows suspect that the 12BY7A driver valve is flashing over and damaging it.

Receive audio quality slightly below par — a bit 'gritty' FT101B Mk2 — FT101E. If you suspect the receive audio quality, try adding an extra earth wire to the audio IC as shown in **Fig. 3.** If there is an immediate improvement leave this wire in position.

Fig. 3 'Gritty' audio: add extra earth wire from printed circuit to screw as shown



Preselector peaks at different points on receive and transmit. This could be an alignment fault, but it also occurs if the wrong make of 12BY7A driver valve is fitted. Use a Toshiba or an NEC valve in this stage.

Drive slightly low on 10 and 15m even with new valves and after full alignment. This fault sometimes happens when the original Toshiba valves have been replaced by NEC, as these usually give a fraction less gain. Replace R22 in the RF unit (was 56 ohms) with a 22 ohm resistor. This modification is introduced by Yaesu in the last production batch of *FT101Es*. A little extra drive can also be obtained by turning VR1 on the RF unit the *minimum* amount that is needed to produce maximum output.

Transmit and receive frequencies not coinciding. This is a simple alignment problem. Set VFO in approximately mid-position and connect a general coverage receiver to a short length of aerial wire, and poke its *insulated* end through the centre of the eight pin VFO socket on the rear of the *FT101*. Tune the general coverage receiver around 9MHz and you will pick up the VFO of the *FT101*. Adjust the position of the length of pick up wire until the signal is about S9, and in the CW or SSB position of the general coverage receiver tune in a steady beat note. With the heaters of the *FT101 switched off* wait until things stabilise and any drift stops, and with the clarifier in the off position switch from PTT to MOX and the beat note should not change. If the note does change adjust the zero control on the regulator board until the note is the same on transmit as it is on receive. When this has been achieved switch the *FT101* to receive and adjust the preset control mounted at the rear of the clarifier underneath the chassis until the note is the same with the clarifier off as it is in the central position. These adjustments should be repeated until the note does not change with the rig switched to transmit or recieve, with the clarifier on or off.

Main tuning very lumpy or loose. The main gear box seldom gives trouble but the 6/1 epicyclic drive does wear or dry out after considerable use. This bit of the *FT101* is available quite cheaply, as (believe it or not) it is made for Yaesu in the UK. Whilst no doubt it could be cleaned and regreased it is much less trouble to swop it. Lay the set on its rear with the tuning knob pointed vertically and the bottom cover removed. Once the main tuning knob has been removed, how to remove the drive is self evident, but note the order of the various washers as you remove them. Otherwise, putting it back together again might not be as simple! While you are at it put a little grease or oil on the gears in the main gear box.

VOX operation — all models. The VOX has a tendency to 'hang on', especially if you talk too long without a breath! Much less critical operation will result if D3 and D1 are shunted with resistors of about 2 or 3 Megohms and C21 (in the Mk1 or C23 in the Mk2 or MkB) is shunted with an additional capacitor of about 100 or 200nF and the controls are reset.

Reduction in receive gain when operating mobile with low battery voltage FT101 Mk1. This is caused by the voltage on the low-frequency IF unit varying. To cure this defect, operate the *FT101* from a mains supply, tune in to the crystal calibrator, and note the S-meter reading. Disconnect the unit from the mains and connect an 11-volt Zener diode in parallel with C36 (this will be found at the top left-hand corner of the circuit on page 15 of *FT101 Mk1* manual. When the Zener diode has been fitted, connect the unit to the mains and note that the S-meter reading will have fallen. The gain can now be brought to normal by adjusting the value of R15 in the base bias circuit of Q2. Usually about 4.3k is correct, but the exact value will depend on the characteristics of the transistors. Once this modification has been carried out, the gain of the receiver will be much less affected by variation of battery voltage.

RF gain only works through one third of rotation. This effect is common and many hams have ordered new RF gain potentiometers only to find that no improvement ensues. The problem is one of compatibility between the RF/FET/Q1 on the RF board and the IC and transistor fitted in the IF amplifier. If the effect worries you try a few different 40673s or 3N201s as replacements for Q1;

No signals on receive but crystal calibrator at normal strength — FT101 Mk2 FT101E. This fault indicates a blown aerial protection lamp. This is mounted under a plastic cover adjacent to the aerial socket. A pilot lamp can be used as an emergency replacement here.

Intermittent non-operation of fan and transmit function on DC supply particularly when cold FT101 Mk2E. This is caused by the chopper/inverter transistors refusing to oscillate due to lack of gain. The cheap cure is to reduce the value of R3 to about 100 ohms.

Faulty heater switch. Intermittent operation of the heater supply is usually due to high resistance contacts on the heater switch. This switch is a double pole type, one pole for switching the sidetone oscillator on and off, the other pole switching the heater supply. A quick cure here is to clean the switch and swop the wires over as the slightly faulty contacts will usually handle the sidetone oscillator, and the original sidetone contacts will be as good as new.

Plugging phones in does not cut out speaker. This is usually caused by the use of the wrong type of jack plug. Stereo jack plugs or 'Post Office' types with small tips are not suitable, round tipped mono plugs being the order of the day. If this does not cure the trouble note that quite a few *FT101's* seem to have escaped with the phone jack socket wrongly wired, so if the internal speaker still does not cut out, consult **Fig. 4** and rewire if necessary.

Plenty of PA current but poor PA dip and RF output low. The causes of this effect can be many and have included a faulty 600V feed choke, faulty pi-tank coupling capacitor, or a blob of solder on the PA coil.

Oscillation or distortion as mike gain advanced at some frequencies on the 160m band. The trouble here is that the RF choke on the patch input socket is resonant. This can either be disconnected entirely if the socket is not used, or the choke can be replaced by one with a ferrite core. This fault seems to mainly occur on *FT101B's,* and probably later units are already fitted with a different choke.

Workshop manual. A very good operating and maintenance manual is supplied with the *FT101.* These notes — whilst it is hoped they will be of general interest — presume that this is available. Owners wishing to delve further into their rigs might like to know that a full workshop manual is also available via Yaesu dealers.

Safety. The on/off switch is a single pole type and does not isolate the *FT101* from the mains supply. You must therefore remove the mains plug from the wall socket before attempting service work. The *FT101* contains large capacitors and high voltages. Some points such as the top caps of the power amplifier valves remain live at 700V for some considerable time after the set has been switched off. *Never* touch any point in the PA cage without first shorting the top caps of the PA valves to chassis (leave the rig to stand for 1 minute after disconnecting mains supply before doing this, or use a resistor of a few hundred ohms to avoid an excessive discharge current.)

Fuses. The fuse should be a 3 amp quick blow type for use on 220/240 volt supplies.

Swopping the pilot lamps. Several owners have damaged their *FT101* by causing a short circuit when replacing the pilot lamps. These are run from the rectified DC supply, and a short circuit will burn out the rectifiers in the power supply. Do not try and swop them when the rig is switched on, or fit them wrongly so that the wire shorts to the chassis. Equipment which has been imported by the approved importer is normally stamped on the rear "234V". Many unofficial imports, and some *Sommerkamp* equipment is set on 220V and should be rewired as per the instructions in the manual. Operation at UK mains voltages on the 220 volt setting will considerably reduce the life of components in the *FT101.*

Valves. The *FT101* is designed to function with Japanese valves and NEC or Toshiba are recommended by Yaesu. Some other brands will give poor results, refuse to neutralise, or even oscillate in the receive mode and cause damage.

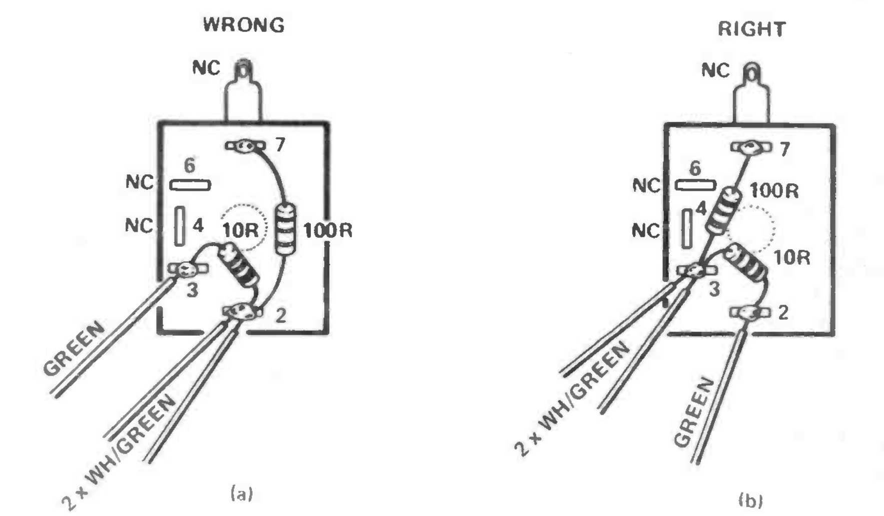


Fig. 4 rear view of headphone jack socket

Test generator. Pull the aerial out of the *FT101*, switch on the crystal calibrator and note the maximum reading which can be obtained with the pre-selector peaked, and set tuned to 14.2MHz. This should normally be between S9 and S9+20dB. Keep a note of this reading as it will be a most valuable guide when later making comparisons if there is any doubt as to whether or not the receiver is up to scratch.

Field effect transistors. The *FT101* contains a fair quantity of field effect transistors which can very easily be damaged by heat or voltage. Plugging the *FT101* into the mains supply — whether switched on or not — will usually guarantee a potential difference between the tip of your soldering iron and the circuitry. Touch the soldering iron on certain points and the nearest FET has gone for the chop! Your only safe way to solder on the *FT101* is to completely detatch it from the mains, aerial, earth, and any other equipment, and then to use an iron which is earthed to the chassis of the *FT101*. Familiarity with the normal bipolar transistors can lead one to become careless, but heat shunts really are essential when soldering FETs. A piece of cotton wool soaked in water provides ideal heat and static protection if stuffed between the four legs of MOSFETs when soldering. An elastic band and a pair of snipe nosed pliers provide a third hand and a heat shunt when working on the three legged variety of FET.

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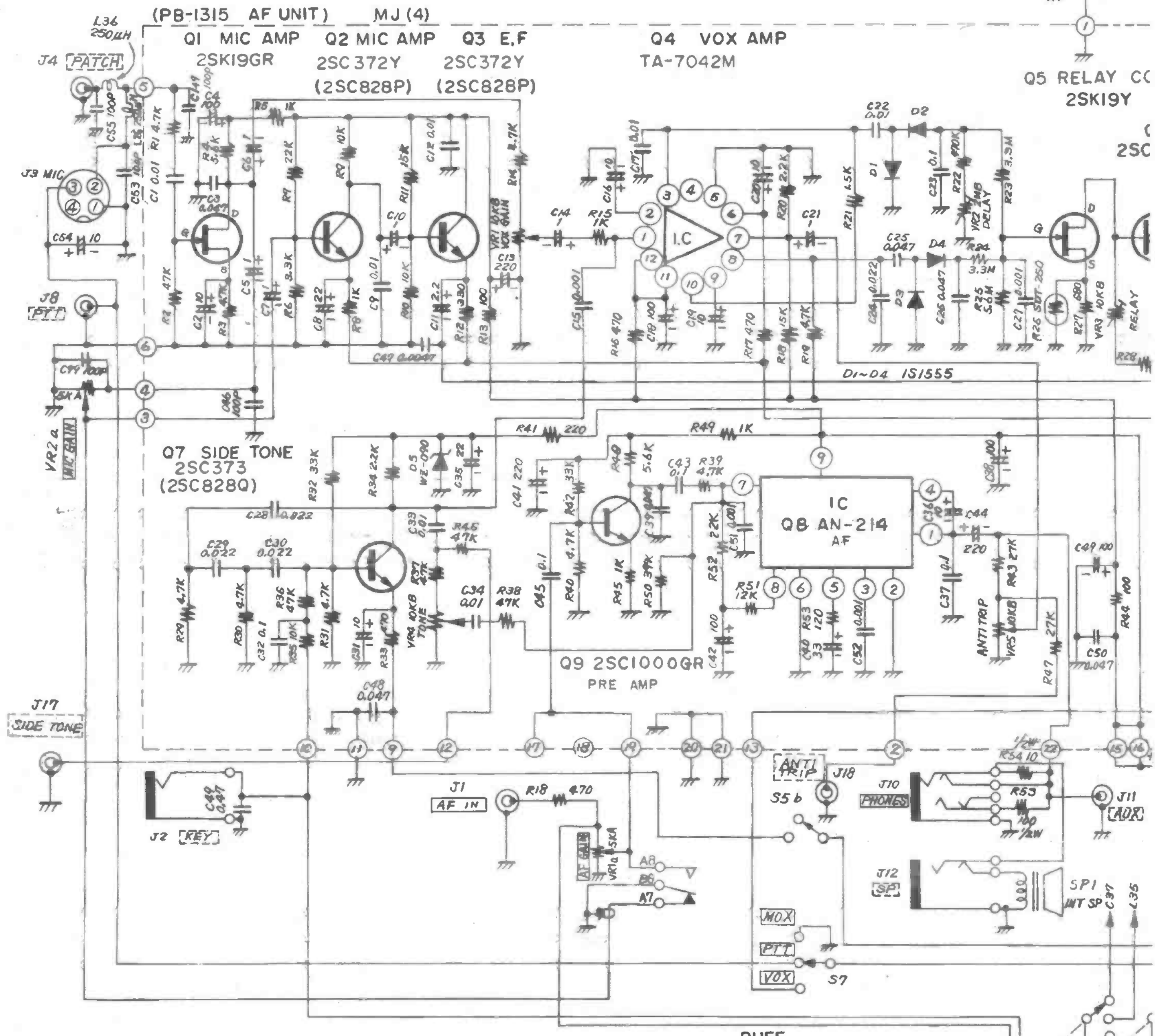
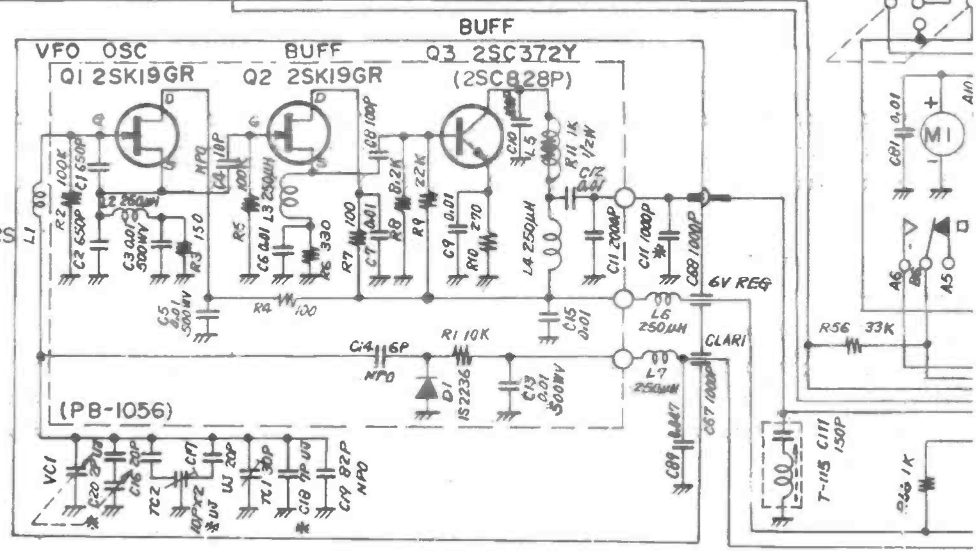
NB In our April issue (p.21) the paragraph beginning "1976 FT101 Mark 2" should have been "1976 FT101E Mark 2".

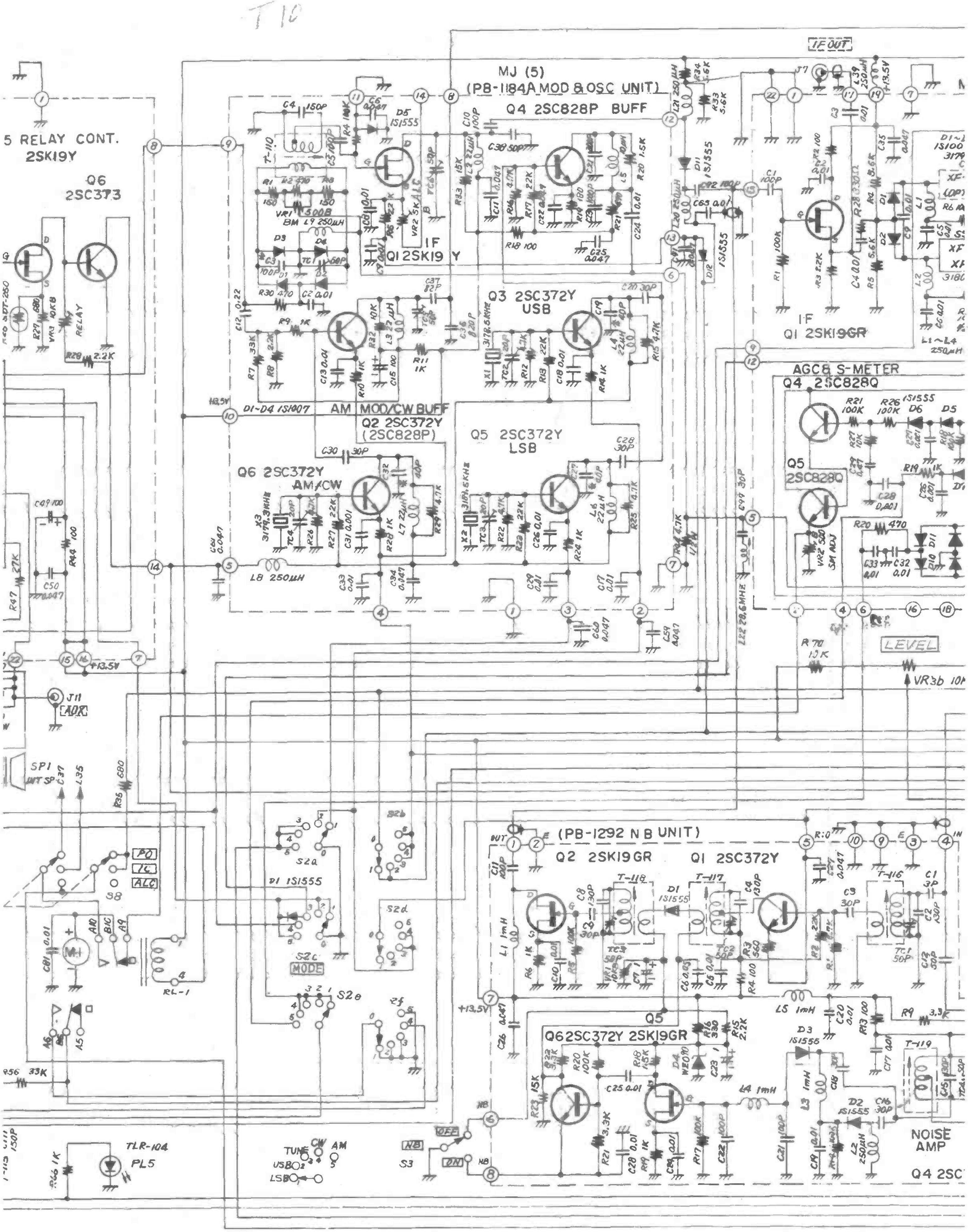


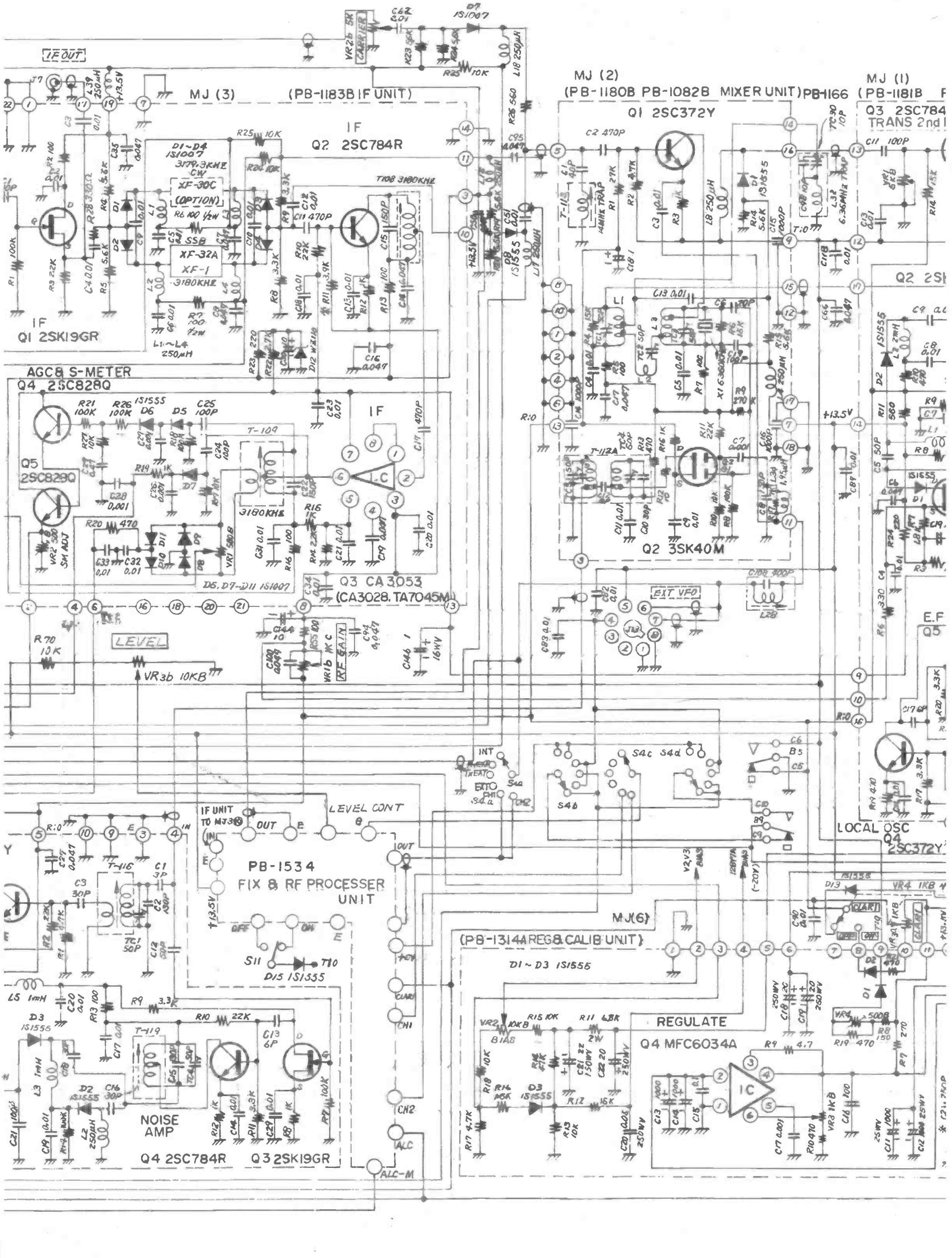
NOTES

1. ALL RESISTORS ARE IN 1/4W UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS ARE IN uF UNLESS OTHRWISE NOTED.
3. ALL ELECTROLYTIC CAPACITORS ARE 16WV UNLESS OTHRWISE NOTED.
4. ※ VALUE IS NOMINAL.

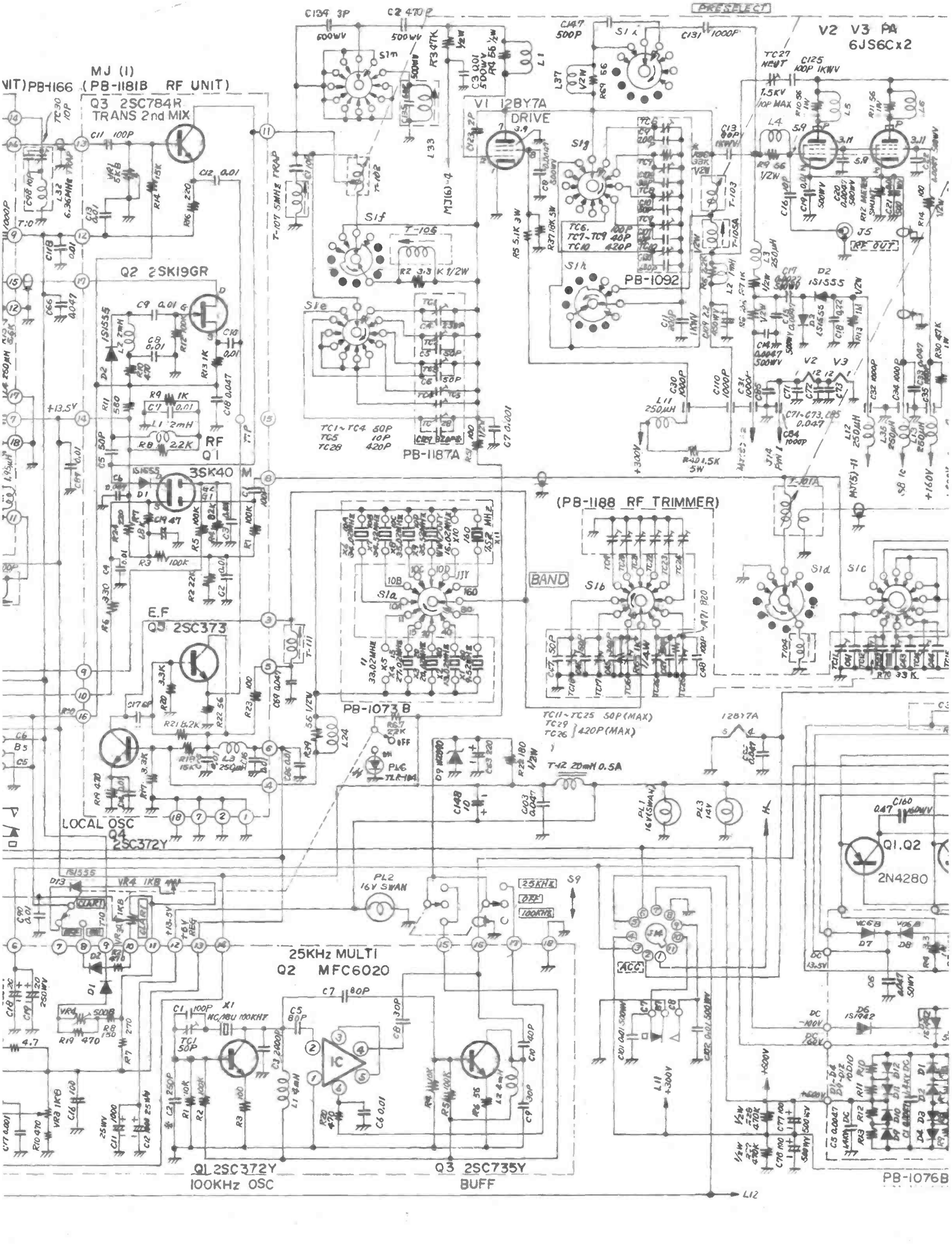


FT-101E
CIRCUIT DIAGRAM

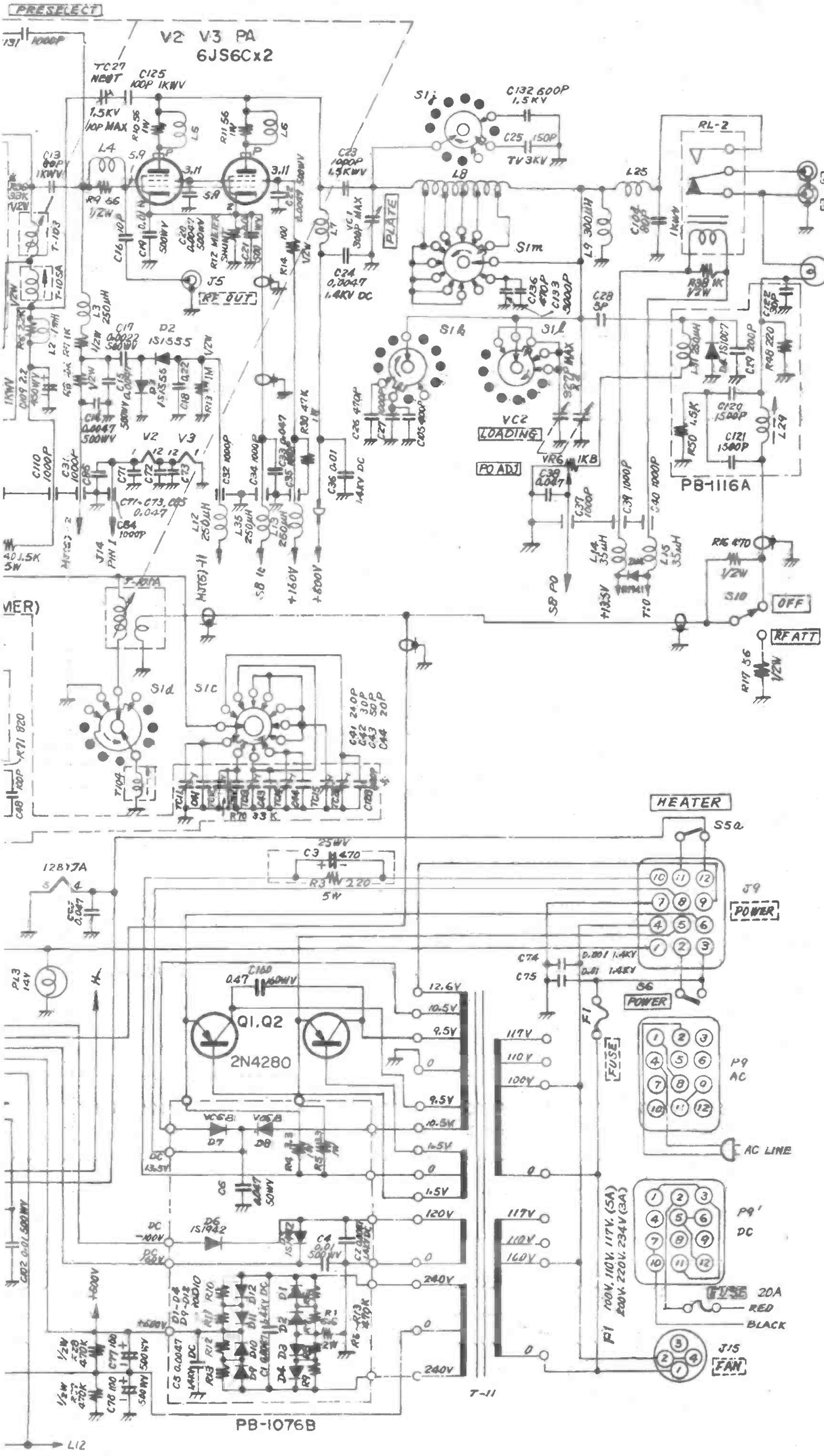

T10
MJ (5)
(PB-1184A MOD & OSC UNIT)
Q4 2SC828P BUFF
5 RELAY CONT.
2SK19Y
Q6
2SC373
IF
Q1 2SK19 Y
Q3 2SC372Y
USB
AM MOD/CW BUFF
Q2 2SC372Y
(2SC828P)
Q5 2SC372Y
LSB
Q6 2SC372Y
AM/CW
D1~D4 1S1007
IF OUT
IF
Q1 2SK19GR
AGC & S-METER
Q4 2SC828Q
Q5
2SC828Q
LEVEL
(PB-1292 N B UNIT)
Q2 2SK19GR
Q1 2SC372Y
Q5
Q6 2SC372Y 2SK19GR
NOISE
AMP
Q4 2SC
J11
AUX
SP1
EXT SP
PO
IC
ALC
S8
RL-1
S2a
S2b
S2c
MODE
S2d
S2e
S2f
D1 1S1555
TUNE
CW
AM
USB
LSB
NB
OFF
ON
S3
TLR-104
PL5
+13.5V



IF OUT
MJ (3)
(PB-1183B IF UNIT)
IF
Q2 2SC784R
IF
Q1 2SK19GR
XF-30C
(OPTION)
CW
SSB
XF-32A
XF-1
3180KHZ
AGC & S-METER
Q4 2SC828Q
Q5
2SC828Q
VR2 SM ADJ
T-109
3180KHZ
IF
Q3 CA3053
(CA3028, TA7045M)
D6, D7~D11 1S1007
LEVEL
VR3b 10KB
VR1b 1KC
RF GAIN
VR2b 5K
CARRIER
MJ (2)
(PB-1180B PB-1082B MIXER UNIT)
PB-1166
Q1 2SC372Y
Q2 3SK40M
EXT VFO
MJ (1)
(PB-1181B
Q3 2SC784
TRANS 2nd
Q2 2S
E.F
Q5
LOCAL OSC
Q4
2SC372Y
INT
EXT
S4a
S4b
S4c
S4d
IF UNIT
TO MJ3
OUT
LEVEL CONT
PB-1534
FIX & RF PROCESSER
UNIT
S11
D15 1S1555
CLAR
CH1
CH2
ALC
ALC-M
NOISE
AMP
Q4 2SC784R
Q3 2SK19GR
T-116
T-119
V2V3
BIAS
12BY7A
BIAS
(-20V)
MJ(6)
(PB-1314A REG & CALIB UNIT)
D1 ~ D3 1S1555
REGULATE
Q4 MFC6034A
VR2 10KB
BIAS
VR3 1KB
VR4 1KB
CLAR



PRESELECT
V2 V3 PA
6JS6Cx2
MJ (1)
(PB-1181B RF UNIT)
Q3 2SC784R
TRANS 2nd MIX
V1 12BY7A
DRIVE
Q2 2SK19GR
RF
Q1
3SK40
PB-1092
PB-1187A
(PB-1188 RF TRIMMER)
BAND
E.F
Q5 2SC373
PB-1073 B
LOCAL OSC
Q4
2SC372Y
J5
RF OUT
T-12 20mH 0.5A
PL1 16V (SWAN)
PL3 14V
PL2 16V SWAN
25KHz
OFF
100KHz
S9
25KHz MULTI
Q2 MFC6020
Q1.Q2
2N4280
ACC
Q1 2SC372Y
100KHz OSC
Q3 2SC735Y
BUFF
PB-1076B



PRESELECT
V2 V3 PA
6JS6Cx2
TC27
C125 100P 1KWV
C132 600P 1.5KV
C25 150P
TV 3KV
RL-2
J6
ANT
J16
REC
L8
L25
PLATE
S1m
RF OUT
J5
PL4
16V
D2
1S1555
S1k
S1l
VC2
LOADING
PO ADJ
VR6
PB-1116A
R16 470
S10
OFF
RF ATT
R17 56
S1d
S1c
R70 33K
HEATER
S5a
12BY7A
C3 470
25WV
R3 220
5W
J9
POWER
PL3
14V
Q1,Q2
2N4280
S6
POWER
F1
FUSE
P9
AC
AC LINE
P9'
DC
20A
RED
BLACK
J15
FAN
T-11
PB-1076B
D7
D8
D6
1S1942
12.6V
10.5V
9.5V
1.5V
120V
240V
117V
110V
100V
160V
100V, 110V, 117V (5A)
200V, 220V, 234V (3A)
L12

Taking apart

the FT101

Part 3

Improvements and modifications

By Harry Leeming G3LLL

Cross modulation

Prior to the crystal filter most stages in the receiver have to handle all the unwanted signals for a few hundred kilohertz either side of the wanted station. Consider the 40 metre band after dark. Hundreds of powerful stations in some cases running Megawatts, are operating inside and just outside the amateur band, and if a great deal of amplification is used, these signals will completely overload the front end of the receiver and cross modulate with each other producing a steady background mush. Reducing the amount of amplification or switching in an attenuater will reduce the overload but then the weaker amateur signals will tend to become lost in receiver noise. Over the years Yaesu have altered component values and played with stage gain to try and strike the best possible compromise, and from the *FT101 Mk2* onwards results — whilst not perfect — have been reasonable.

Some unofficial mods

The original *FT101 Mark 1* was pretty bad for cross modulation, and in desperation many owners fitted the 'VK blob'. This was a double balanced mixer made with miniature components and encapsulated in a blob of resin about the size of a sugar cube. If you purchase a second hand *FT101 Mark 1* look for this item squeezed inside the second mixer module PB1080. The blob is no longer made but a similar circuit on a small printed circuit board is available from the FT-Club in America. Fitting these units to the *FT101 Mark 1* results in a considerable improvement, with a noticeable but less dramatic enhancement in later models.

A couple of years ago Plessey introduced a high signal level double balanced mixer integrated circuit and I decided to have a go at using this. The results obtained by fitting it in the second mixer, VK blob style, were disappointing; but after some experimenting a small circuit board was made up fitting in place of the first mixer. This noticeably improved the receiver of *FT101s* from the *Mark 2* onwards, and dramatically improved the *Mark 1*. It was decided to market this unit and it is now available commercially, and takes about ten minutes to wire to an *FT101*. When this double balanced first mixer is installed, using a double balanced mixer in the second stage does not seem to make much further improvement.

AGC system

Fig. 1 shows how the automatic gain control voltage is applied to the gate of Q1 in the RF unit. For maximum gain Q1 has about four volts on its gate when no signal is being

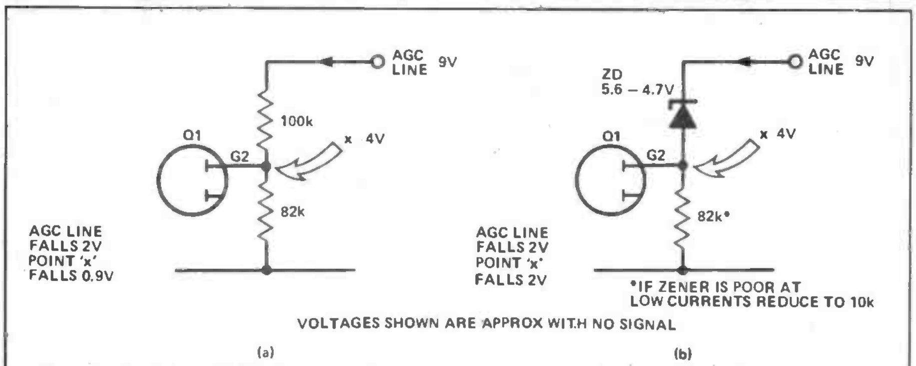


Fig. 1. Original AGC circuit **Modified circuit by VK3NS**

received. When a strong signal is tuned in the AGC line voltage falls reducing the gain of Q1. Note however, that slightly less than half the voltage change arrives at the gate of Q2 — ie. if the AGC line drops two volts the voltage on gate 2 of Q1 only falls 0.9 volts due to the potential divider action of the two resistors. Most of the AGC action of the FT101 occurs in the later IF stages and under strong signal conditions the AGC applied to the first stage is not always sufficient to prevent front end overload. The following modification, which is an adaption of an idea by VK3NS, will be found to vastly improve the AGC action.

1) Remove the aerial, switch to 20 metres, check and note reading on S-meter at 14.2 Megahertz calibration point.
2) De-tune pre-selector until S meter falls to S3 and leave pre-selector in this position.
3) Remove the RF board and locate R5 which is the 100k resistor feeding gate 2 of Q1, and remove same.
4) Fit 5.6 volt zener diode in place of the resistor — the end without the line on it going to the FET gate.
5) Refit RF board and check that after one minute or so that the S meter still reads about S3. If it has fallen below S2 replace zener diode first with 5.1 volt diode and try again, and if the reading is still below S2 replace with a 4.7 volt zener diode.
6) Tune pre-selector to maximum and note that due to improved AGC action the reading obtained in step 1 will have fallen by about three S units.
7) Reset S meter calibration control so that reading originally obtained in step 1 is once again shown. Note that the zener diodes must be of a very low current type, or it may be necessary to replace the resistor going from gate 2 to chassis with one of about 10k to get the modification to work correctly.

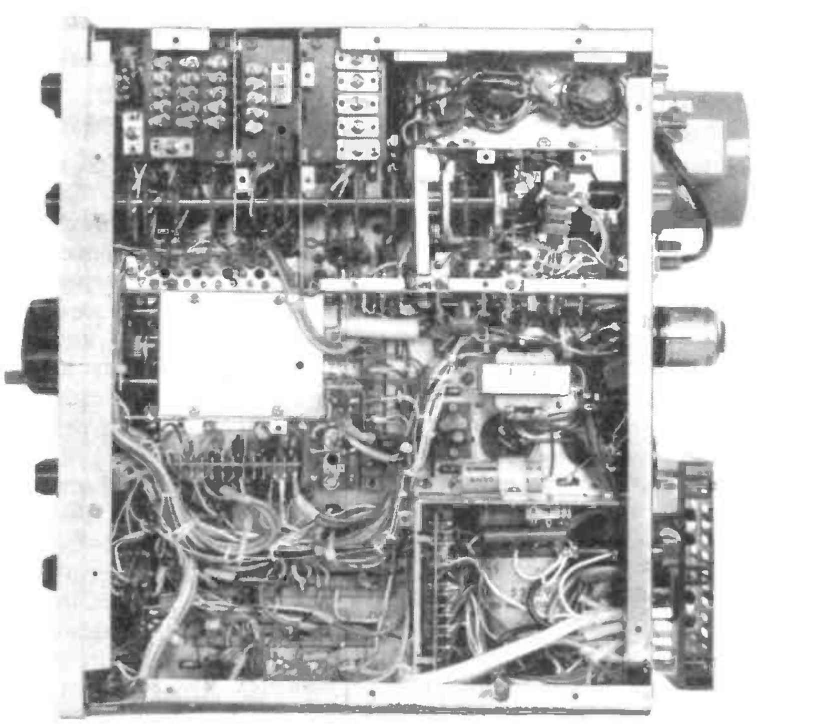
Use with a 2m transverter

Several two metre transverters and even repeater shift and FM units are available for those who wish to use their *FT101* as a prime mover for VHF operation. The only real problem is RF feedback into the microphone amplifier stages causing distortion or oscillation. Some ham operators have rejected perfectly good transverters as being faulty for no other reason than this. To make the *FT101* suitable for use with a VHF transverter locate the audio board (PB1081, 1189, or 1315) and remove it. Locate the microphone amplifier transistors Q2 and Q3 and solder de-coupling capacitors with ultra short leads directly between the base and emitter of these transistors mounting the capacitors on the solder side of the printed circuit board. The capacitors must be low inductance disc ceramic types and should have a value somewhere in the region of 200 to 1000pF. Note that the base and emitter connections of these transistors are the outer two pins, the centre pin being the collector.

Radio frequency speech processing and the *FT101*.

In the early 1970s several articles appeared in radio journals in praise of radio frequency speech processing. RF speech processing or clipping is carried out after the audio frequencies have been converted to a radio frequency, see **Fig. 2.** As with any clipping process harmonic distortion is produced, but in the case of RF speech clipping it is at multiples of the radio frequency used. If the clipping is done at IF frequency (3.18 Megahertz in the case of the *FT101*) the distortion products at two, three and four times the IF frequency are easily removed, leaving the signal clipped but free of harmonic distortion.

Inspired by these articles I decided to give the idea and try and was so impressed by the results that



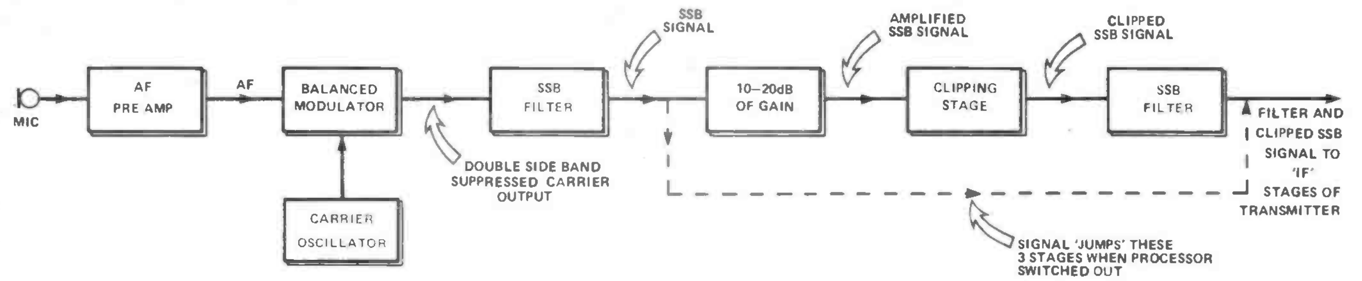


Fig. 2. RF speech clipping in the *FT101*, which will be described in a future article.

the idea was commercialised as the *G3LLL FT101* speech processor.

And finally...

Yaesu made the *FT101* but in many ways the *FT101* also 'made Yaesu'. The Yaesu Musen company started operations in 1960 but it was only the advent of the *FT101* at the end of the decade that brought the name to most hams' attention. The *FT101* is by no means perfect but it is an extremely well made piece of equipment that gives very great user satisfaction. Some of its imperfections even contributed to its success!

Its quirks and shortcomings as well as its excellent points have all added to owner interest and resulted in the formation of the Fox Tango Club in 1971* originally intended for *FT101* owners, but this association was originally formed by *N4ML* when Milt wanted to find something to fill his time in after taking early retirement. The Club publishes a newsletter which is of great value and interest to Yaesu owners, and to which due acknowledgement is given for some of the ideas used in this article.

Yaesu is now the largest specialist amateur radio manufacturing company in the world, and it employs 750 people. Around 10% of them are qualified electronics engineers. They are not too big however, and respond in good English to requests for advice and are extremely responsive to suggestions for improvements to their products. One wonders who the unsung hero is who designed the *FT101*, and if Yaesu would have become the force it has if he hadn't!?

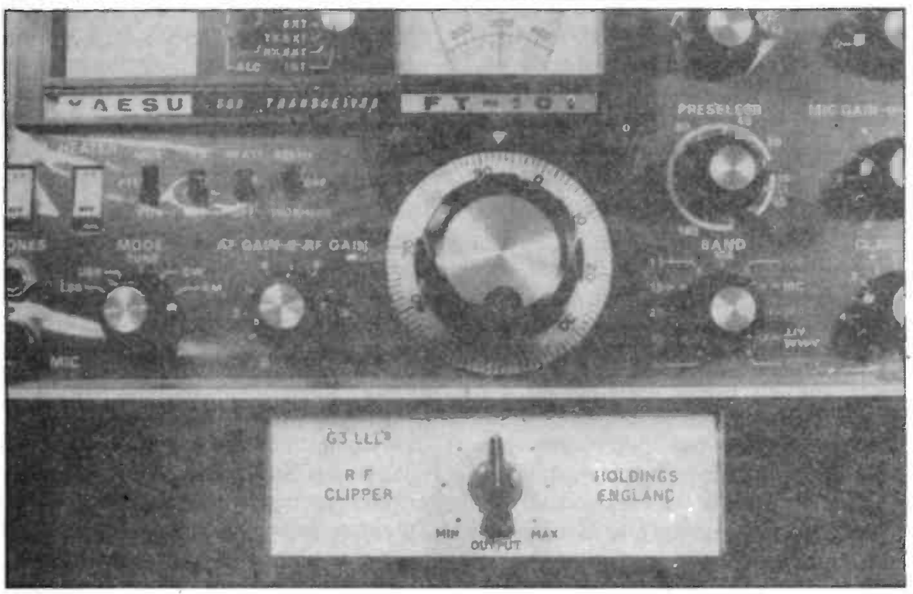
*FT Club, 248 Lake Dora Drive West Palm Beach, Florida 33411, USA. A few enrolment forms are held by the author and these can be had upon receipt of a stamped envelope (ie. no SAE — no leaflet!)

Taking apart the FT101 Part 4

RF SPEECH PROCESSING

Initially the G3LLL RF Speech Clipper was developed to aid my own signals, but very encouraging results led to commercialisation. The circuit of the unit is shown in **Fig.A.** whilst **Fig.B.** (printed as Fig.2. in August issue) shows how RF speech processing functions in block diagram form. In

Harry Leeming, G3LLL, describes two methods of RF Speech Processing and gives simplified alignment details.



the case of the G3LLL Clipper, which is only made for the FT101, input and output connections are made by plugging the unit into the VFO socket, after attaching 3 jumper leads to spare pins.

Circuit Description

On transmit, the double band suppressed carier signal from the FT101 is applied to Q1, amplified slightly, and then converted to SSB by the SSB filter. As with any SSB signal, each voice frequency then represents one (and only one) radio frequency, and this signal is further amplified by Q2 and Q3. As the mic gain is advanced the signal eventually becomes strong enough for the peaks to be clipped by the second set of clipping diodes. Q3 has a gain of about 8-10dB so that if the mic gain is advanced to give a total of around 20dB of clipping this is shared by the two sets of diodes ensuring that neither of the stages can be overloaded. Q4 provides isolation from the clipping diodes, and passes the signal back to the transmitter via the output control. The clipped signal is then processed by the transceiver's SSB filter, thus ensuring that any out-of-channel intermodulation products are removed, giving a clean signal free from splatter.

On receive, the signal path is the same, but the gain is reduced and the output control is disconnected. This is achieved by wiring the clipper to the FT101 Tx/Rx switching circuits, resulting in 13 volts being applied to pin 7 in the transmit mode only. R8 is available so that the receive gain can be adjusted to suit the operator's preference. Concern has been expressed in some quarters that the clipping diodes are still in circuit on receive, but this is of no consequence as only a colossal local signal could cause them to conduct. In any case, as they are after the SSB filter, this would not matter. The extra gain provided by the clipper is within the automatic gain control loop, which results in better AGC action. The FT101 therefore has less tendency to overload on strong local signals when the Clipper is fitted. Leaving the Clipper in the circuit on receive produces a noticeable improvement in skirt selectivity. At the time I was told that cascading filters was something that "wasn't done". Now it is a common way of improving selectivity in commercial ham gear.

Yaesu's RF Processor

A few years' later with the FT101E came Yaesu's RF speech processor which was not a great success at first, particularly as it was necessary to open the lid and adjust an internal pre-set level control with a screwdriver every time a band change was made! The processor was quickly re-designed and a level control (concentric with the clarifier) fitted — the circuit is shown in **Fig.C.** Yaesu's processor takes the SSB signal after the IF unit, amplifies it by Q1, and clips it in the integrated circuit Q2. Q3 matches the clipped signal to the SSB filter, which removes out of channel intermodulation products. Then the clipped and filtered signal is returned to the transmit chain via Q6 and T3. Q5 acts as a variable resistor in the level control circuit and avoids RF having to be piped direct on the level control on the front panel. When the clipper is switched off, the signal is re-routed via Q4 instead of via the clipping and filtering circuits. Initially, some FT101E speech processors functioned better on one sideband than the other, depending upon the setting of a non-clipped pre-set gain control VR1. The writer traced this to unclipped signals leaking via the inter-

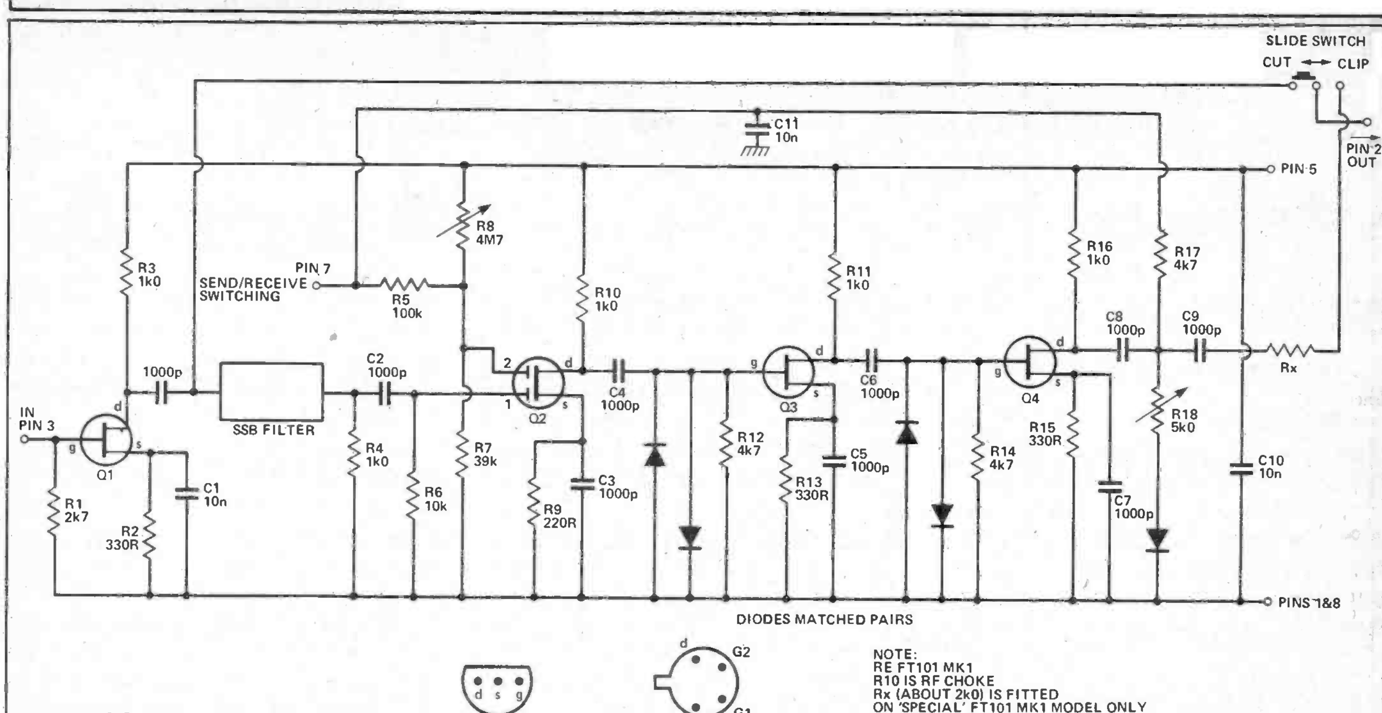


Fig.A. G3LLL RF Speech Processor

nal capacitance of Q4 and cured it by connecting a 200pF capacitor from the source of Q4 to chassis. This simple modification effectively shorts out any signal when Q4 is electrically off, but is not of low enough impedance to short out signals when Q4 is switched on and is acting as a source follower. From about 1977 onwards FT101Es are factory fitted with this capacitor on the reverse side of the processor circuit board, although it is not shown in the circuit in the manual.

Audio Quality

Properly adjusted, even 15 to 20 dbs of RF processing can sound quite reasonable; why then do some stations using the G3LLL or Yaesu clippers sound a muddy, muddled games? RF clipping does seem to 'amplify' any existing audio faults and the main trouble with almost all Japanese microphones is that they are short of treble. Recent correspondence with Yaesu has revealed that this is not so much because the difference in pitch between the oriental and european voice, but because of different syllable emphasis in the languages. Yaesu are now deliberately 'brightening' the audio on their export equipment.

When using speech processing with older equipment much better results will be obtained if a "bright' microphone is used together with a series capacitor (about 0.002 u for 50 Kohm input) to roll off the low frequencies. Even fitting this capacitor to the original mic makes quite a difference at the expense of a slight loss of mic gain. From experience, the Shure 444 plus a little extra LF roll off seems about the best mic to use with the FT101, but unfortunately it is getting rather pricey. Funnily enough, at the abosolute opposite end of the price range, if you can find an original gold coloured Accos (Mic 43) crystal insert, fit it in the Yaesu hand mic without any matching transformer; you will find this comes a very close second.

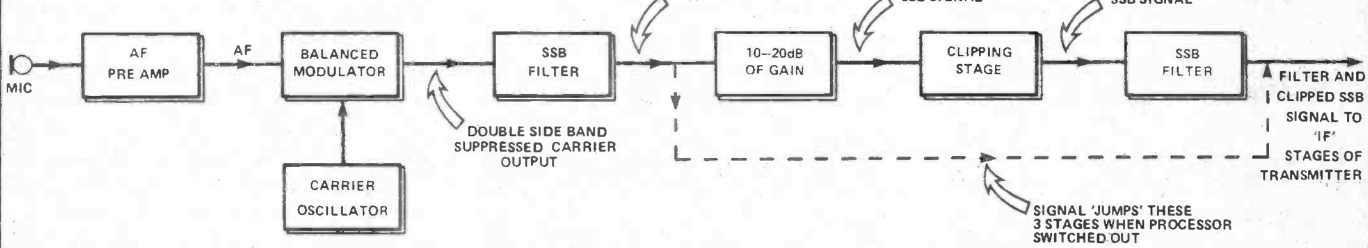
FT101 ALIGNMENT

Correct alignment makes the difference between mediocre and superb performance with the best equipment, and the FT101 is no exception. Alignment details are given in Yaesu's manual but experience has shown that the full procedure is only necessary if the alignment has been interfered with. In general it is advised that coil cores should be left alone unless there is clear evidence that they have need of adjustment. First, a couple of faults that come under the heading of 'alignment'.

PA and Driver oscillates or exhibits poor neutralization on the 40m band only FT101 MK2 — E. This is caused by misalignment of the extra coil L33 which is switched in on 40m to improve rejection of the transmit 'I.F.'. To cure, melt the wax holding L33 core with a hot iron and then trim until good transmit drive is obtained together with stability. The core is very easy to damage and difficult to obtain so use the correct trimming tool and *do not force it.*

'S' meter does not fall to zero. This effect sometimes only occurs on one side band, and is caused by RF from

Fig.B. RF Speech Processing an SSB Signal



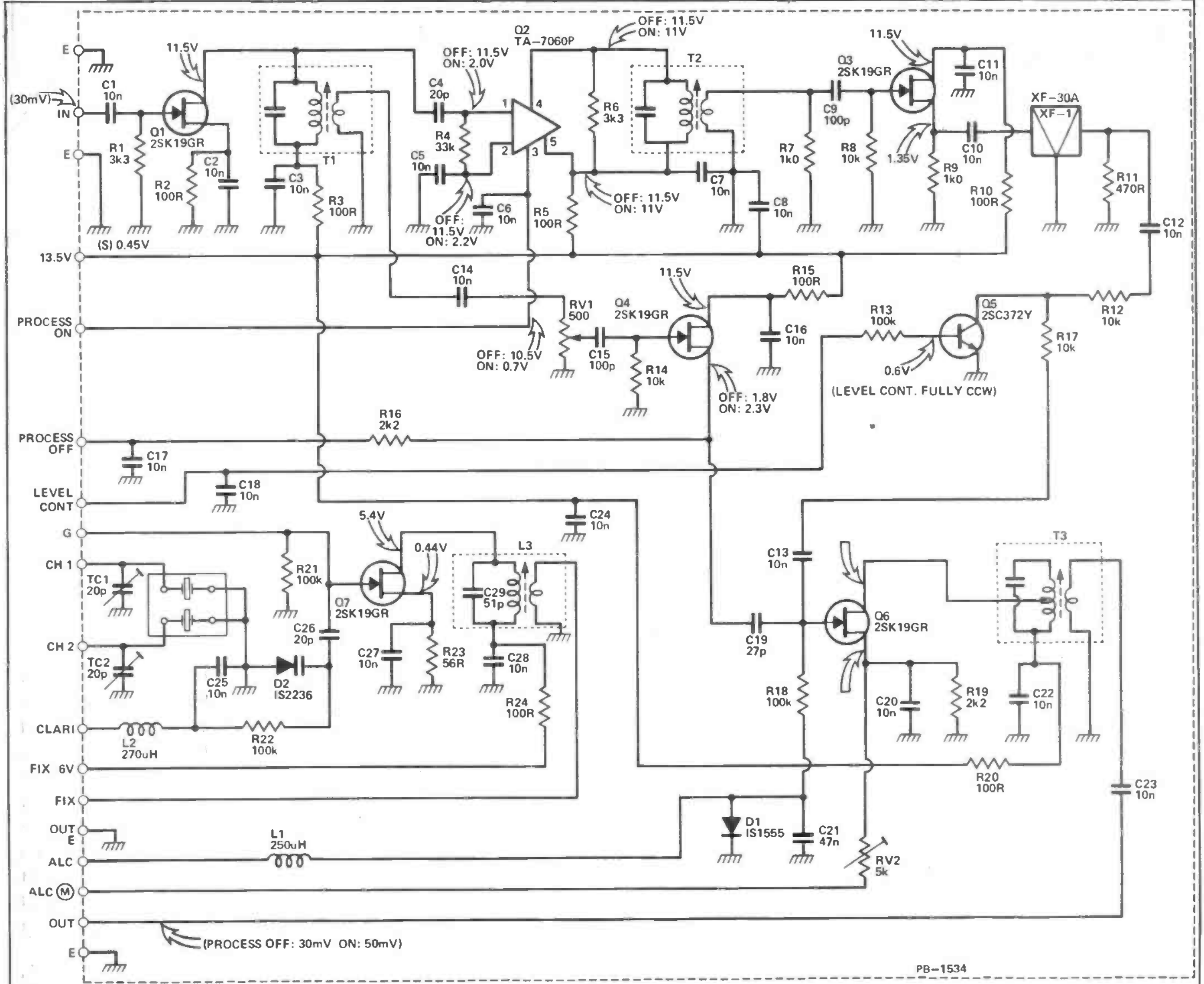
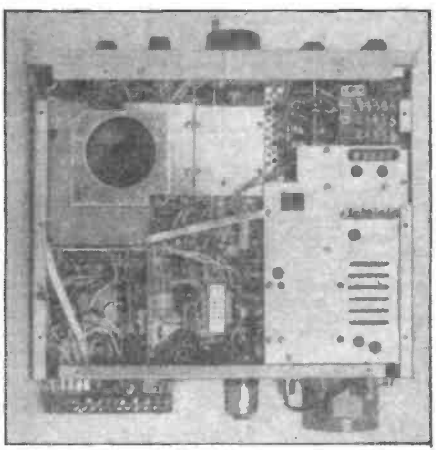


Fig.C. Yaesu Rf Speech Processor

the BFO getting into the AGC system. To cure, carefully adjust the balance pot VR1 in the product detector circuit on the low frequency IF board until the reading disappears. Note that if VR1 is badly out of alignment the receiver will be almost dead with the S meter reading S9 + .

Underside of FT101E



Location Of Adjustments

Yaesu have not done a particularly good job of indenting the various adjustments in the FT101 users manual (perhaps to discourage unnecessary fiddling!). The alignment and adjustment location chart published by the FT Club and printed by their permission as **Figs.D** and **E** helps no end, but please only adjust if you really know what you are doing, unless of course you wish to pay me £10 an hour to sort out the mess!

Simplified Alignment

If you are reasonably competent, and your rig is not badly out of alignment the following adjustment procedure is quite simple to follow through, and will normally considerably improve performance on the older rigs which have drifted a little. *Do not force trimmers if they are stiff.* Try warming *slightly* with an iron but watch you don't melt the solder.

160-15 Metres

(1) . . . Tune to calibration point in centre of band and peak pre-selector for maximum on receive. (2) . . . Leave pre-selector set, switch to transmit, set carrier control to give about 70ma and tune load and PA for maximum RF output. (3) . . . Trim driver anode tuning capacitor on band in use (TC6-TC10) for maximum RF power out reducing drive control if PA current exceeds 100MA. Repeat above once or twice until pre-selector peaks on receive at same point as on transmit. *Compromise for MAX TX drive if necessary.* Note Some makes of 12BY7A will make Tx & Rx peaks differ.

An article describing the modification of the FT101 series for 10, 18 and 24MHz will follow shortly.

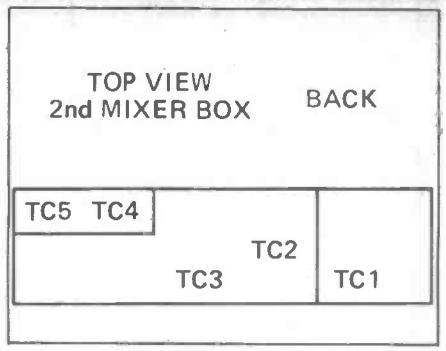
10 Metres

(1) . . . Tune to 28.6MHz (or wherever in the 10m band peak performance is required), and tune pre-selector for maximum on receive. (2) . . . Switch to transmit and with a small amount of carrier inserted, tune PA and load and *retune* pre-selector for maximum RF power output, noting as to whether it is necessary to tune pre-selector HF or LF. (3) . . . Set pre-selector half-way between points of peak performance on receive and transmit, and trim grid capacitor TC5 for maximum RF output, reducing drive if PA current exceeds 100ma. Repeat 1-3 a few times until points of peak performance in transmit and receive coincide. Compromise for MAX TX drive if necessary. **Note.** Some makes of 12BY7A will make Tx & Rx peaks differ.

If desired, the aerial trimmer capacitors can be set on signal for maximum receive strength, but this is seldom needed, likewise, rarely will it be necessary to interfere with the coil settings.

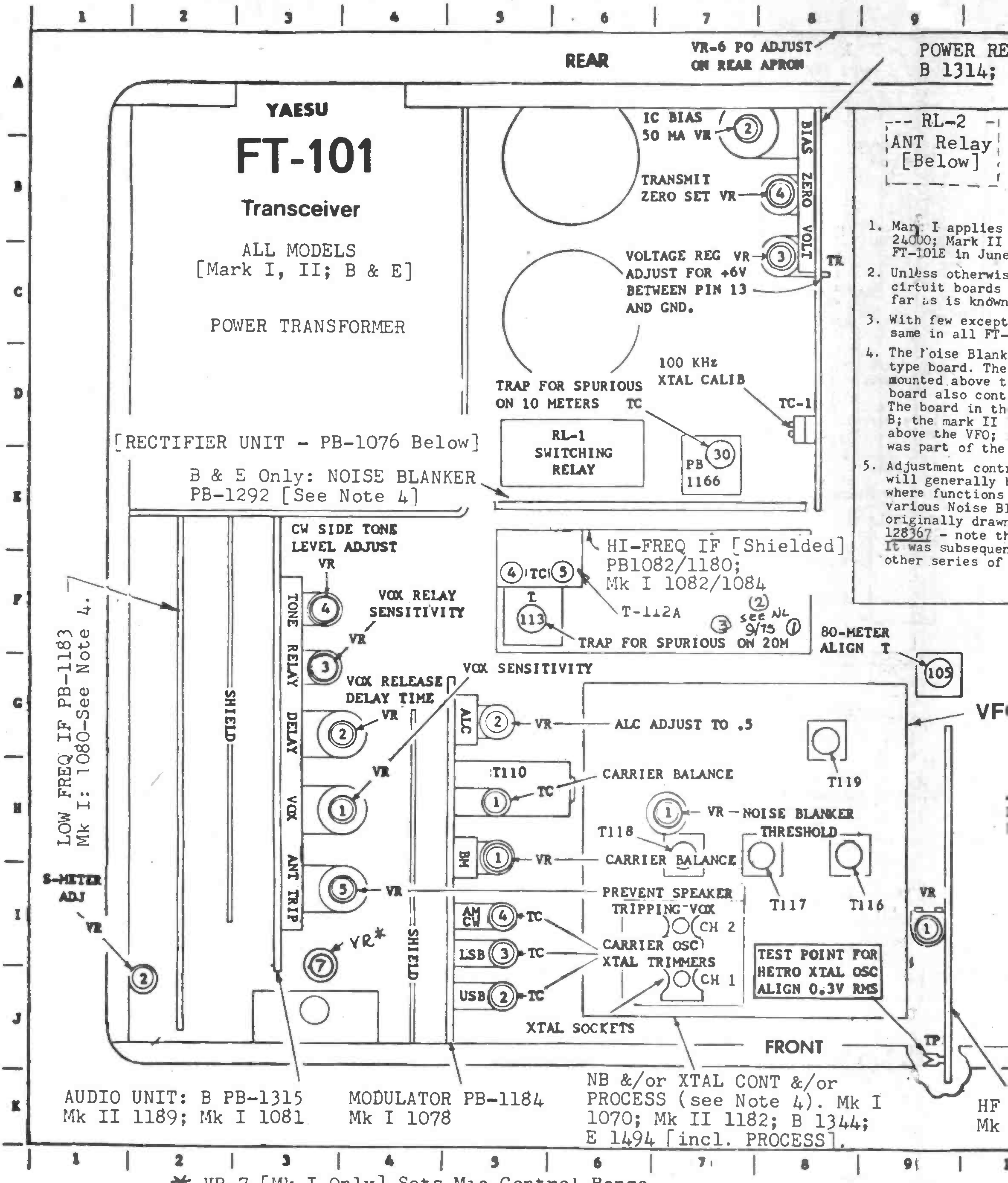
Local Oscillator Trimmers If set suddenly goes dead on one band (usually 15 metres), slightly adjust oscillator trimmer until unit comes to life. Set trimmers for maximum Rx gain, but not too near point where oscillation ceases.

Band Pass Filter Adjustment — All Modes It is important that the band pass filter be correctly aligned. If it has been altered or if new boards have been fitted, it is important that filter be checked. Proceed as follows: Set transmitter for output on 14MHz into a 50 ohm dummy load. In TUNE position at 14000 KHz adjust PRE-SELECTOR, PLATE and LOADING for maximum power output. *Do NOT exceed IC reading of 200MA.* Adjust carrier control for 200mA. Use transmit mode for minimum time necessary to adjust controls (five seconds at intervals of 10-15 secs). Do not touch CARRIER control after setting. Adjust PRE-SELECTOR PLATE and LOADING for maximum output at 14250 KHz, note IC meter reading. Repeat at 14500 KHz. If readings are much different at these frequencies, 14000, 14250, and 14500 KHz, then alignment of band-pass is required.



In TUNE position at 14000 KHz adjust PRE-SELECTOR, PLATE and LOADING for maximum output with IC reading of 100mA. Adjust TC3 for maximum. Repeat at 14500 KHz, but adjust TC1 for maximum output. Repeat both at 14000 and 14500 KHz as adjustments will interact. Now check that maximum output at 14000 KHz and 14500 KHz are the same, If not, adjust TC2 as follows: If output is lower at 14500 KHz, increase TC2, if lower at 14000 KHz decrease TC2. After adjustment of TC2 repeat adjustments of TC1 and TC3, then re-check output.

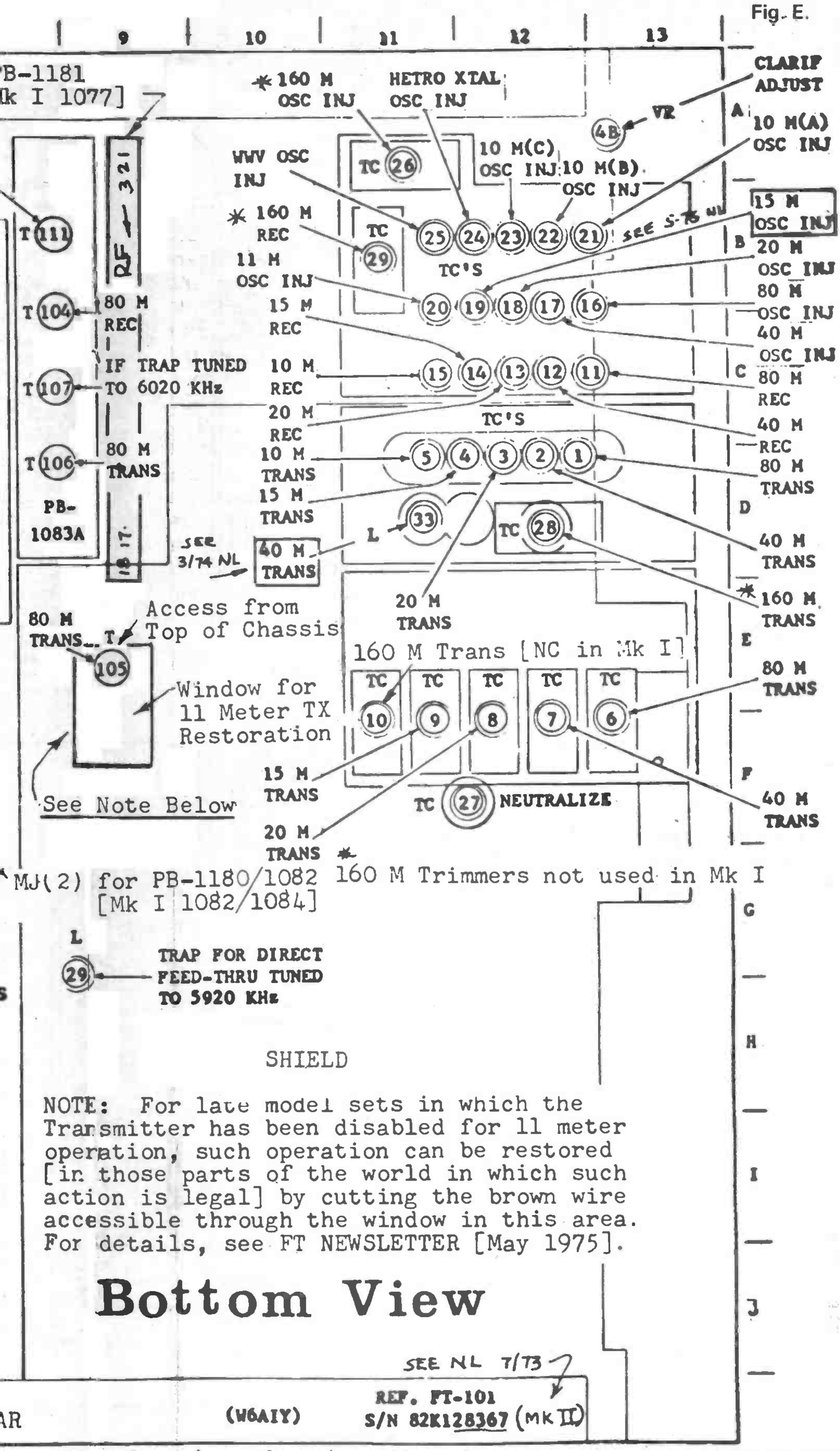
Receive Band Pass Filter. Peak TC5 and TC4 for best signal using internal crystal calibrator of FT101.



* VR-7 [Mk I Only] Sets Mic Control Range

For grea

Fig. E.



HAM RADIO TODAY

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For greater convenience in use, pull out this page.

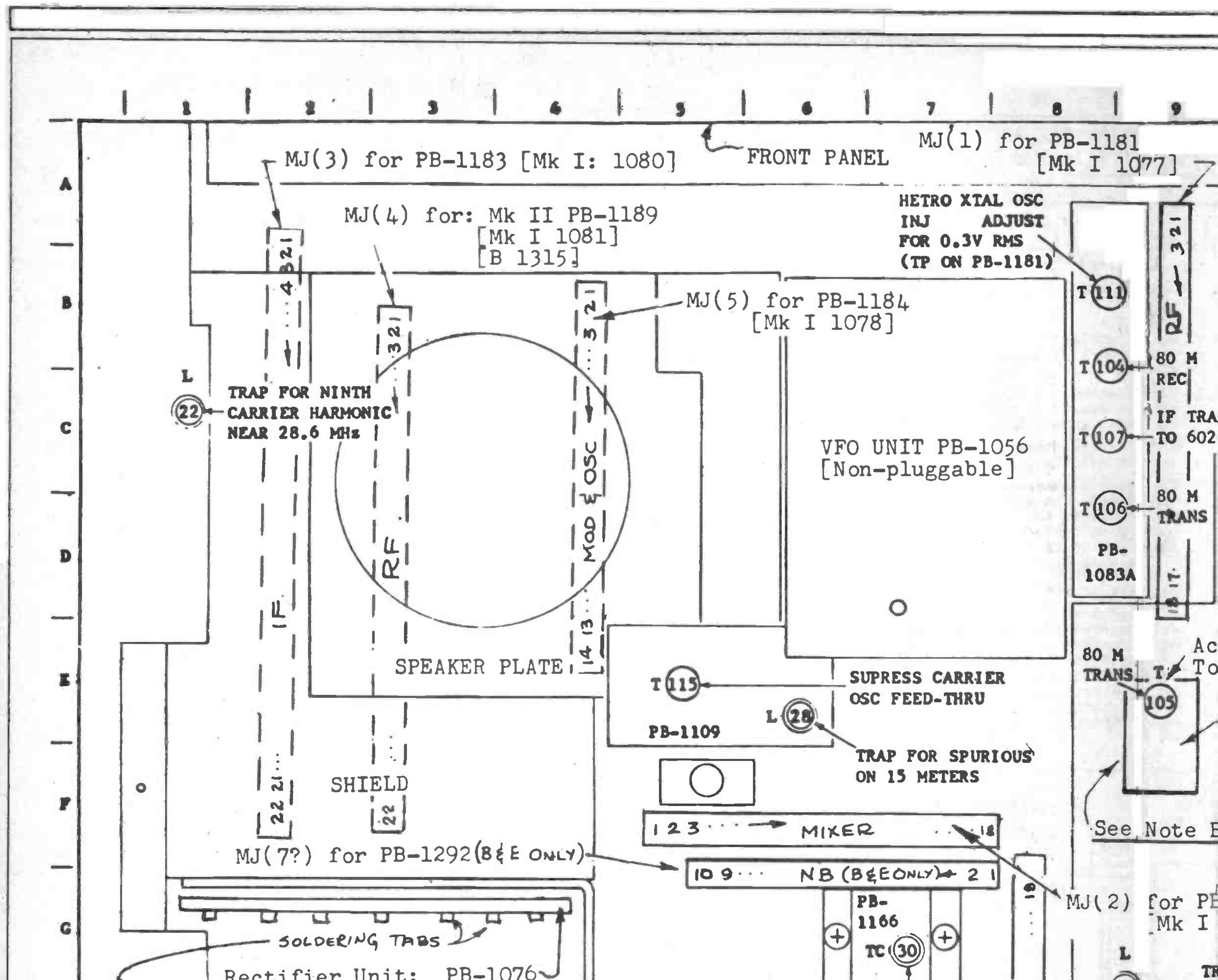
FRONT PANEL
MJ(1) for PB-1181 [Mk I 1077]
MJ(3) for PB-1183 [Mk I: 1080]
MJ(4) for: Mk II PB-1189 [Mk I 1081] [B 1315]
HETRO XTAL OSC INJ ADJUST FOR 0.3V RMS (TP ON PB-1181)
MJ(5) for PB-1184 [Mk I 1078]
TRAP FOR NINTH CARRIER HARMONIC NEAR 28.6 MHz
VFO UNIT PB-1056 [Non-pluggable]
80 M REC
IF TRA
TO 602
80 M TRANS
PB-1083A
IF
RF
MOD & OSC
SPEAKER PLATE
SUPRESS CARRIER OSC FEED-THRU
80 M TRANS
PB-1109
TRAP FOR SPURIOUS ON 15 METERS
SHIELD
See Note B
MIXER
MJ(7?) for PB-1292 (B & E ONLY)
NB (B&E ONLY)
MJ(2) for PB
Mk I
PB-1166
SOLDERING TABS
Rectifier Unit: PB-1076 [Vertically mounted--- Non-pluggable]
TRAP FOR SPURIOUS ON 10 METERS ADJUST FROM TOP OF CHASSIS
POWER TRANSFORMER
MJ(6) for PB-1185 [Mk I 1079]
REG & CALIB
NOTE: For Transmitte operation, [in those action is accessible For detail
Note: The Printed Circuit-board edge connector sockets [MJ (for Master Jack?)] are indicated in this view. The specific boards with which each MJ is associated is indicated by number. Unless otherwise indicated, the PB number applies to all models of the Mark II, B, and E series. The Mark I series usually uses PB numbers lower than 1099.
PB-1076B
Bot
Revised June 1975 ML
REAR

Fig. D.

REVISED EDITION - June 1975

Service & Alignment Control Layout

Designed and Drawn by
Frank W. Sechrist W6AIY

Edited and Adapted by
Milton Lowens WA2AOQ

Published by the

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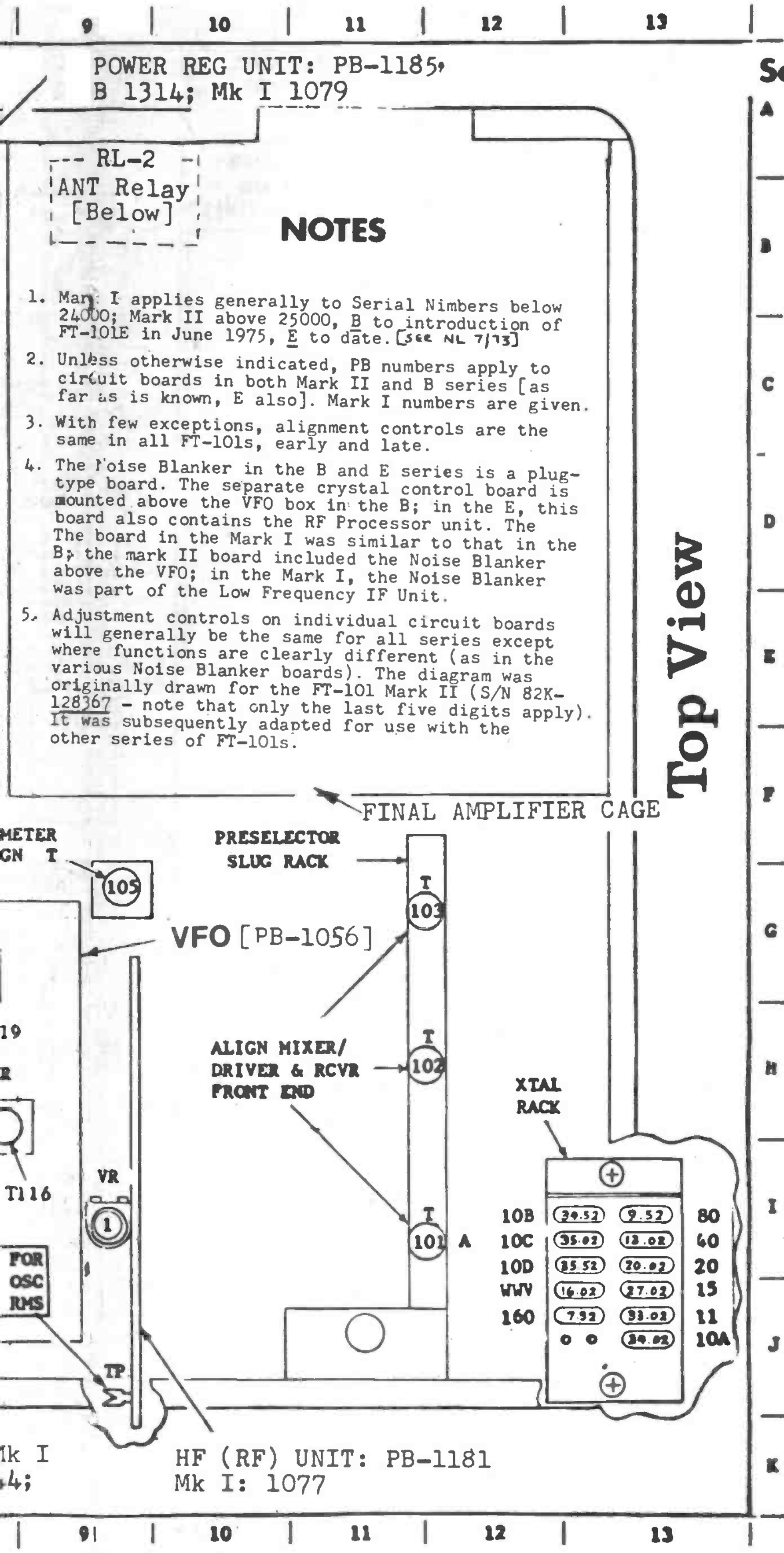

NOTES

1. Mark I applies generally to Serial Nimbers below 24000; Mark II above 25000, B to introduction of FT-101E in June 1975, E to date. [SEE NL 7/73]
2. Unless otherwise indicated, PB numbers apply to circuit boards in both Mark II and B series [as far as is known, E also]. Mark I numbers are given.
3. With few exceptions, alignment controls are the same in all FT-101s, early and late.
4. The Noise Blanker in the B and E series is a plug-type board. The separate crystal control board is mounted above the VFO box in the B; in the E, this board also contains the RF Processor unit. The The board in the Mark I was similar to that in the B; the mark II board included the Noise Blanker above the VFO; in the Mark I, the Noise Blanker was part of the Low Frequency IF Unit.
5. Adjustment controls on individual circuit boards will generally be the same for all series except where functions are clearly different (as in the various Noise Blanker boards). The diagram was originally drawn for the FT-101 Mark II (S/N 82K-128367 - note that only the last five digits apply). It was subsequently adapted for use with the other series of FT-101s.

Adjustment of Slugs, Trimmers, Pots, etc.

Slugs. These are adjusted by inserting the plastic trimmer tool into the hexagonal hole and rotating the tool. First, however, the wax used at the factory to lock the slug must be softened by carefully inserting a short length of heated bare No. 14 wire into the hole for a minute or two. To heat the wire, wrap one end around the tip of a small soldering iron. Slugs should turn easily---do not use force! The wax will lock the slug again as it cools.

Ceramic Trimmers. These are locked with unthinned enamel paint. The trimmers are mechanically delicate and easily broken. Use a tool that fits the screw slot well to avoid undue pressure; make adjustments slowly and gently. Usually very little angular rotation is required and the exact position for peaking requires much care.

Can Cores. These are like the ones used in the Preselector assembly: they have a thin threaded brass rod sticking out of the top. They are difficult to adjust except with jewelers tools because the slot in them is so narrow. Also the material used to lock the rods is quite tough---use a solvent like nail-polish remover---some recommend removing the entire assembly of 3 cores while removing the locking material. Use rubber cement after adjustments for locking. If slotted end of rod breaks, force a small brass nut on it and solder it in place---then use a suitable tool.

Circuit Board Potentiometers. These are quite rugged but a properly fitting screwdriver is recommended to avoid the need for undue pressure.

Small IF-type cans. If the hole is full of wax, use the same technique described above for slugs.

ALIGNMENT: See back of this page.

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Milt Lowens, WA2AOQ
3977-F Sedgwick Ave.
Bronx, New York 10463

For greater convenience in use, pull out this page

FT101 + New Bands

Want to work 10, 18 and 24MHz? If you have an FT101E or earlier marque, put that cheque book away and listen to Harry Leeming, G3LLL.

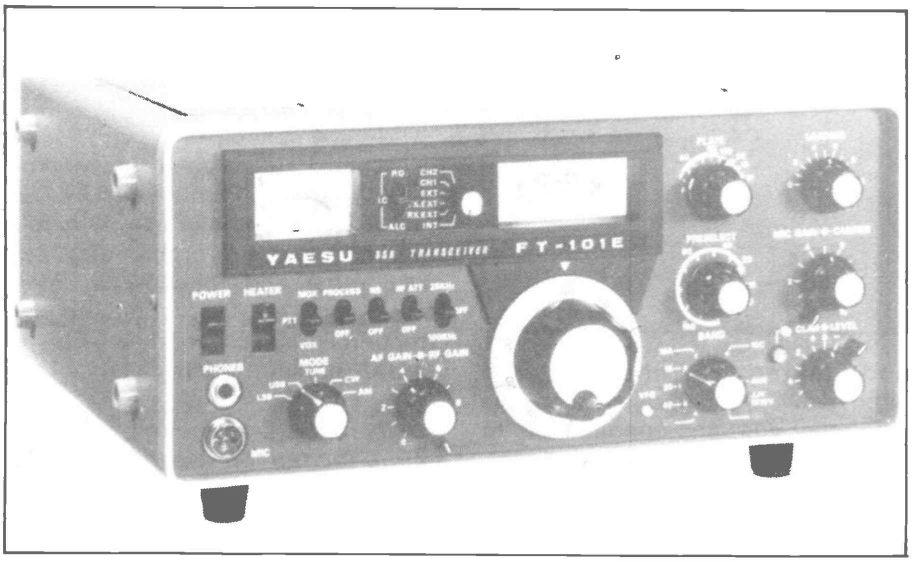
The FT101 can be put on most frequencies between 1.8 and 30 MHz and fairly comprehensive instructions are included in the Yaesu workshop manual which is available for this series. The disadvantages of the official modifications is that they involve a fair amount of work, and entail removing some of the existing bands. The modification which follows is admittedly a compromise, but works well provided you do not try and run too much power, is quite simple and cheap to do and only looses you the CB band!!

The FT101 MK1-E series is quite exceptional in its ease of new band convertability so please don't write asking if you can do the same to your FT101ZD or TS520 because I am afraid as far as the writer is concerned the answer is 'no'. If, however, *you* have a magic mod which puts the new bands on an existing popular rig for a few quid please don't keep it to yourself; if it really works the Editor will, no doubt, pay you to spill the beans *(I'll second that — Ed)*. The following instructions are part of the G3LLL Kit and whilst we have no objection to anyone 'rolling their own' they are copyright and must not be used commercially.

Parts Required

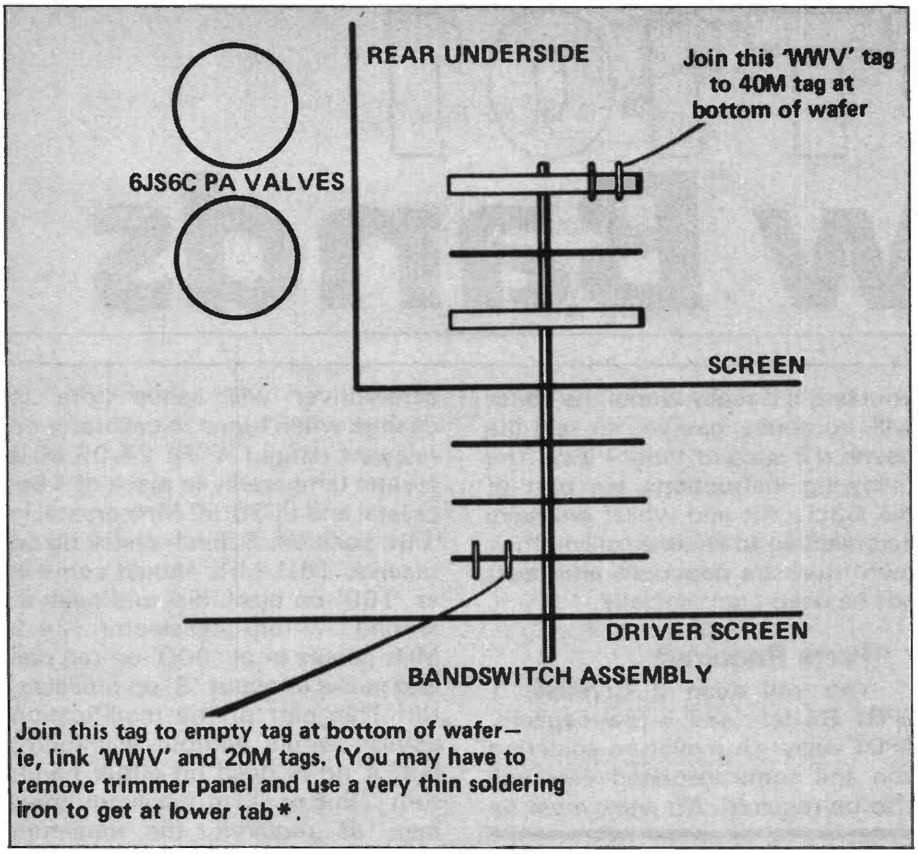
You will need 2 Crystals, 1 SPST Switch, and 1 low capacity SPDT relay. (A miniature soldering iron and some insulated wire will also be required. *No work must be carried out with AC mains supply connected,* and your soldering iron must be earthed to chassis or you may 'blow' an FET (or yourself). If you are not familiar with normal safety prodecures, get someone else who is to do the work.

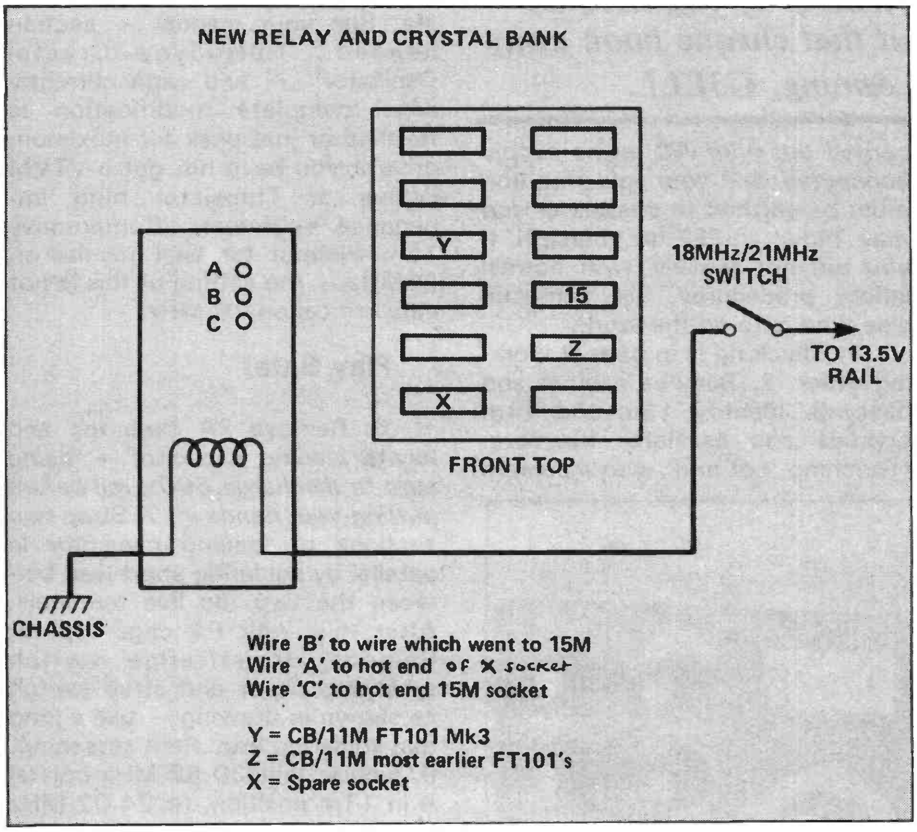
1. Check rig is in perfect working order. 2. Remove cabinet and base. 3. Identify 15m and 11m crystals and oscillator trimmers. (Touching 'hot end' with insulated screwdriver will cause note to change when tuned to calibrator on relevant range.) 4. Fit 24.02 MHz crystal temporarily in place of 15m crystal and fit 30.52 MHz crystal in 11m position. 5. First, check rig on receive. 18.1 MHz should come in at '100' on black dial and peak at around '7' on preselector. 24.9 MHz comes in at '900' on red dial and peaks at about '8' on preselector. This part of the modification usually works without alignment, but, if rig is dead on either band, turn 15m or 11m oscillator trimmer, as required, the minimum amount needed for rig to burst into life. See your manual — section headed "Hetrodyne Crystal Oscillator" — and align correctly *after* complete modification is finished or just peak for maximum drive if you have not got a VTVM (Valve or Transistor high impedance voltmeter). Compromise 15m trimmer for best results on 21MHz — the setting of this is not very critical on 18 MHz.



Play Safe!

6. Remove PA cage top and locate loading capacitor — *being sure to discharge 600V rail before putting your hands in!* 7. Strap two sections of loading capacitor in parallel by soldering short lead between the two top live terminals. After this, refit PA cage top. 8. Remove driver/range switch screening cover and strap switch as shown in drawing — use a long thin soldering iron. Refit screening. 9. Ensure that 30.52 MHz crystal is in 11m position, fit 24.02 MHz crystal in spare 'X' position and refit 15m crystal in its original position. 10. Remove two screws from crystal panel and withdraw it a little. Place FT101 on its side (watch you don't loose the spacers) and unsolder lead from 'hot end' of 15m crystal socket. ('Hot end' is





Top diag. View of bottom of FT101 chassis showing modifications to bandswitch.

Bottom diag. Modifications to crystal bank.

the end not common with the crystals.) 11. Wire two short insulated leads to hot ends of 'X' position and 15m crystal sockets and refit crystal panel. 12 Mount the relay in inverted position adjacent to 'X' position crystal socket and fasten to chassis with adhesive. Solder thick wire to one side relay coil, and connect this to chassis under crystal board screw, to earth the relay coil (and help hold relay in place). 13. Wire the centre contact of the relay (ie the pole) to the wire which originally went to 15m crystal socket, keeping this and all crystal/relay wiring *as short as possible.* 14. Wire the contact of the relay which is 'made' when th relay is energized, to the hot end of 'X' socket. 15. Wire the contact of the relay which is made when the relay is *not* energized, to the hot end of 15m crystal socket. 16. Wire the free end of relay coil to length of insulated wire going to the back of FTk101. 17. Fit 21/18 MHz switch by filing out hole that holds cabinet screw above 'IF' and 'AF' phone sockets are rear of FT101. 18. Wire one side of switch to 13.5V HT rail and other side to wire going to relay coil.

Modifications Complete

Check crystal oscillator trimming, see instruction 5.

Now 15m position of the bandswitch 'tunes' 21-21.5 or 18-18.5 (18/21 MHz switch), 11m 'tunes' 24.5-25MHz and WWV 'tunes' 10-10.5 MHz.

10 and 15m bands operate as before except PA loading is moved approx. 2 points clockwise. PA on new bands 'tunes' at around 15-20m point. We advise keeping power to a maximum of 50 watts and using an antenna tuner to ensure a clean signal. (Note, 10 watts is equivalent to about 100ma PA current and 200 ma gives around 50 watts CW, 130 ma peak approx. 50 watts PEP SSB).

Final Notes

The 11m crystal is marked 33.02 and the 15m crystal 27.02. If the 'X' socket is in use, wire in a crystal holder, one end to relay (see 14.) other end to common point "cold end" of 'X' crystal. Late production FT101Es label the CB band 'AUX', earlier models call it '11m'.

**When the bandswitch is set to 20m, the tag the wiper makes contact with will be the 20m tag. The WWV tag can be similarly identified.*

EQUIPMENT REVIEW

Holdings' G3LLL FT101 fm accessories

by T. G. GILES, G4CDY*

The fm discriminator mounted on top of an FT101

ONE of the most popular ways of getting on to the vhf and uhf bands is still to use a transverter with an hf transceiver. This is fine for ssb, cw and possibly a.m., but very few hf transceivers have facilities for fm; which is arguably the most popular mode. Holdings of Blackburn have built up a reputation for being experts on all things connected with the Yaesu Musen FT101, mainly through their rf clipper and their numerous "mod" sheets. They manufacture three units which make the FT101 perform as an fm transceiver with built-in repeater shift, and kindly loaned them for this review. The fm demodulator is priced £39.90, the modulator £10 and the repeater shift unit £10.

FM discriminator

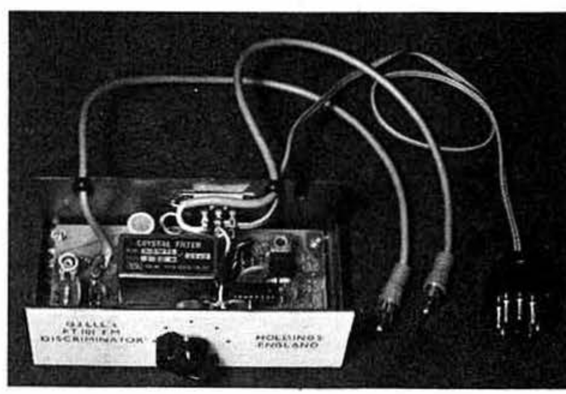
The unit is built into a steel box, 140 by 75 by 50mm, which is the same as the one used for the rf clipper. The front panel is white with black lettering and covered in clear perspex. It has two controls: a squelch potentiometer on the front panel and a small slide switch marked AM/FM on the rear panel. There are three fly leads, each terminated in suitable plugs to go straight into the back of the FT101. Connecting the unit only involves plugging these leads into the IF OUT, AF IN and vfo sockets, and does not involve any internal changes.

The circuit consists of a dual-gate fet preamplifier and matching stage feeding a 15kHz bandwidth six-pole crystal filter. Gain of this stage can be adjusted with a preset potentiometer. The remainder of the circuit uses a CA3089 type of ic limiting i.f. amplifier and quadrature detector. A single tuned circuit provides the phase shift element for the detector. This coil is slug tuned and preset in manufacture, but its alignment can be checked by screwing the core in or out to obtain best audio quality. The squelch control operates the ic's internal carrier operated squelch detector. A clever feature of the unit is the application of some dc bias to the a.m. detector diode of the FT101 to cut it off when the fm unit is switched on. This seemed quite effective and removes the need to attack the FT101 with a soldering iron or to unplug the fm unit when a.m. or ssb is being used.

The unit was tested on the reviewer's Mk3 FT101, and by G3LHZ on his Mk1 version. It worked satisfactorily on both transceivers and provided good audio quality from fm signals. On the earlier rig, the tuning was found to be a little asymmetric, probably due to loading from the ssb filter. Holdings suggest a minor modification (the inclusion of a resistor) to overcome this effect. Also on the earlier FT101, even on strong signals, some high frequency noise was present, but could probably be removed with a simple top cut circuit. The noise was not present on the later transceiver, possibly because there is some high frequency roll-off built into the audio output stage or, alternatively, the reviewer's ears do not respond at this high frequency.

The mute does work but requires some juggling with the rf gain and squelch controls in order to set up the threshold. It does not have any hysteresis or a very clean switching action, as many other people have found when using this type of consumer integrated circuit on narrow-band fm. A proper noise-operated squelch circuit would overcome these problems but would also put up the cost of the unit.

A 0·28μV emf 144MHz fm signal into a home-brew two-dual-gate fet converter in front of the FT101 tuned to 28MHz



FM discriminator with case removed

*54 The Mount, Coulsdon, Surrey.

produced a signal + noise-to-noise ratio of 10dB. Although this was not really a test of the fm unit (the sensitivity is more a function of the converter and FT101) it did show that the performance of such a system is similar to that of a dedicated vhf fm receiver.

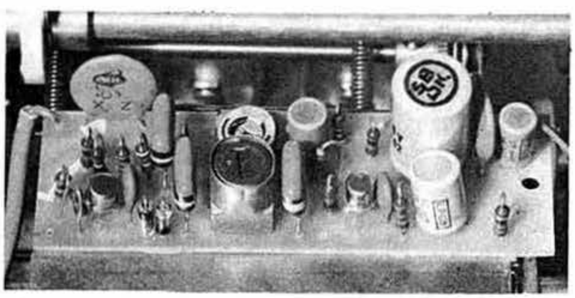
FM transmit unit

The normal way of obtaining fm on the FT101 is to apply audio to the clarifier line when on transmit. Holdings suggest a very simple way that this can be achieved without any additional circuitry. This consists of disconnecting the link between the microphone amplifier and modulator boards (pin 8 of PB1315 and pin 9 of PB1184). The output of the microphone amplifier (pin 8 of PB1315) is then connected to the clarifier line on either the vfo or the fix board. A simple single-pole changeover switch can be used to select normal operation or fm. The FT101 function switch must be set to a.m., and the carrier level adjusted for the required output power.

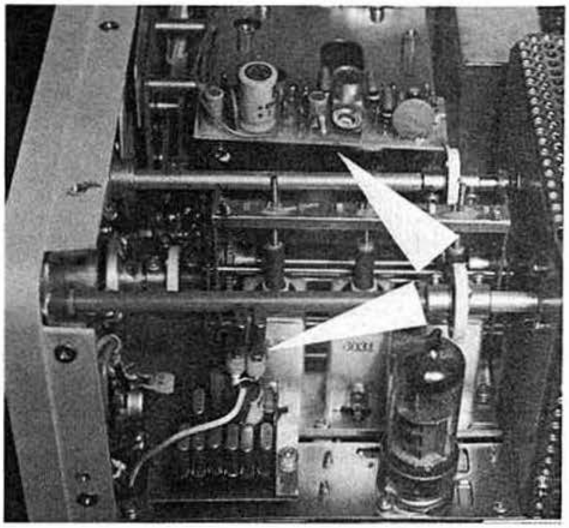
Using the normal hand microphone, setting the MIC GAIN to "2" produced 5kHz peak deviation. Reports received using this simple technique were satisfactory, but the general comment was that it lacked the punch of a normal fm rig. This was obviously due to the lack of frequency response tailoring and clipping normally used on fm. To overcome this, Holdings manufacture a small printed circuit board which contains the necessary clipping and filtering. The board has a simple single-stage amplifier with pre-emphasis, a double-diode clipper, an LC low-pass filter followed by another single transistor amplifier. In operation the unit is wired between the FT101 microphone amplifier output and the clarifier line.

Full installation instructions for the unit are supplied and the total time required is about two hours. Most of the time is taken up in mounting a miniature toggle switch which is supplied so that normal modulation or fm can be selected. Holdings suggest that the switch can be fitted over the smoothing capacitor adjacent to the IF OUT socket. However, the reviewer found it easier to mount it just below the key jack socket. The printed circuit board can be mounted alongside the vfo on the top of the chassis, see photograph. The board was attached by two 6BA solder tags soldered to the ground track and held under the screws securing the side screen to the vfo. The board requires a +13·5V supply and connection to the clarifier line. Both of these can be obtained from the FIX and/or RF PROCESSOR UNIT mounted on top of the vfo.

There is no alignment involved in the use of the fm modulator, and the only adjustment is a preset potentiometer. It was found that with the preset half-way, 3kHz deviation was achieved; and when fully clockwise, 6kHz. The FT101 MIC GAIN was found to be best at about position 1, but could be increased as high as position 4 to give extra clipping for dx contacts.



FM transmit unit board



The fm transmit unit (above) and the shift module (below) installed in an FT101

One minor problem was experienced with this method of obtaining fm; the deviation and speech quality varied slightly with the position of the clarifier control. This is probably due to ac loading from the clarifier circuitry, even when switched out. The modulation became badly distorted when the clarifier was set fully clockwise, ie at −5kHz. With the control in the normal central position no problems were experienced.

Repeater shift module

One disadvantage of using an ssb transceiver on fm is that duplex operation through repeaters is not possible. Theoretically it could be done by changing ranges and retuning the transceiver between transmit and receive, but it is not a very practical technique for fast break-in operation!

Holdings give two methods that can be used to provide a −600kHz shift in the FT101.

The first is by a small diode switching module which plugs into the 28MHz D-range crystal socket. The module then has two sockets on top, one for the original crystal and the other for a special crystal supplied to give the desired shift. Normally the D-range crystal is in circuit, but if +13·5V is applied to the control wire of the module it will switch to the shift crystal. This can then be wired through a repeater shift switch to a point that has 13·8V on transmit. Full details are given in the instructions. The instructions also say that the unit introduces some losses into the oscillator circuit which can reduce the sensitivity of the receiver. On the reviewer's FT101 EX no reduction in sensitivity was experienced.

The second method Holdings suggest is to use a small relay to switch the crystal, and they will supply details of how this can be done. The relay switching technique is said to overcome the loss of local oscillator injection that the diode circuit can give.

(Continued on page 934)

microwaves

Charles Suckling, G3WDG *

Optimizing microwave receivers

For the amateur interested in getting the best performance from his equipment, perhaps the most seemingly difficult task is that of optimizing the receiver. Most microwave receivers are, at least in part, homebuilt, and so will require alignment. The traditional way of doing this entails finding a weak signal on the band, such as a beacon, and adjusting all the variables for best audible signal-to-noise ratio. This method has the disadvantages that the signal may vary in strength with changing propagation conditions, and that it relies on operator skill.

A better method is to connect a source of wideband noise to the input of the receiver, via an attenuator to ensure that the receiver sees its correct input impedance (suitable attenuators were described in *Microwaves* March 1979) and, where possible, at least 10dB of attenuation should be used. The noise source is switched on and off manually, and the ratio of the noise output powers from the receiver with the noise source on and with the noise source off is measured. This ratio is proportional to the overall sensitivity of the receiver, an increase in the on-to-off ratio corresponds to a decrease in its noise figure. The receiver should be operated in its linear region and with maximum i.f. bandwidth. A suitable noise level indicator is an audio output meter (see *Microwaves* July 1977 and July 1979). It is more convenient to reset the receiver gain (at rf preferably) after adjustments have been made to give a chosen reference noise level with the noise source off. This normalizes the measurement so that the noise power output with noise source on can be used directly as a measure of receiver sensitivity, without the need to compute the ratio. The value of attenuation between the noise source and the receiver should be such as to give only a few decibels increase in noise when the noise source is switched on. Suitable noise sources for 0–1GHz and 10GHz are described below. For manual use, the sources should be fed with + 12V via a 1kΩ resistor to the "input from voltage amplifier" connection.

*31 Oakwood Road, Chandler's Ford, Hants SO5 1LW.

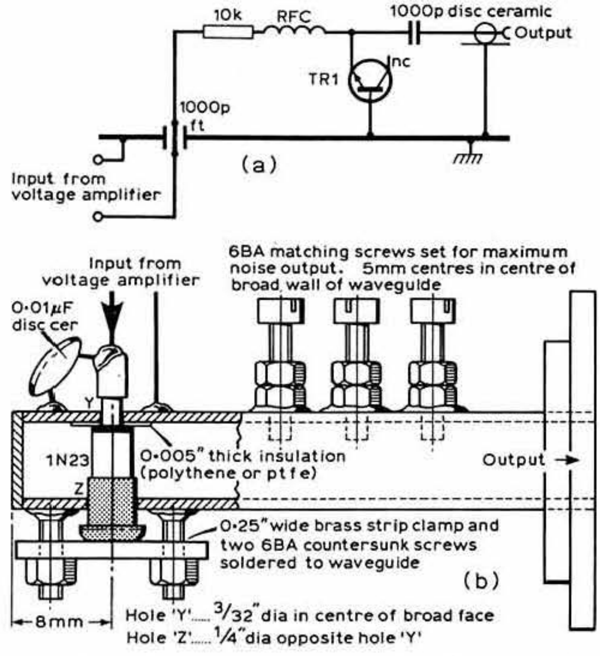


Fig 1. (a) A noise source suitable for 0-1GHz. RFC: 3t 2mm id wound in resistor lead. TR1: 2N2369, or similar vhf transistor (see text). (b) A noise source for 10GHz

If the receiver to be optimized has any significant response at the image frequency (as have most receivers without deliberate filtering between the preamplifier and mixer), a filter should be placed between the noise source and attenuator to prevent the receiver being set up for some optimum point for the signal and image frequencies combined. The use of such a filter is good practice anyway—some designs of mixer may be transparent at the i.f. frequency, and energy from the noise source on the i.f. frequency could leak through and upset the readings.

While this method is capable of very good results, it is extremely tedious to have to reset the receiver gain every time an adjustment is made. Fortunately a device has been designed to perform the measurements automatically ("An alignment aid for vhf receivers" by G4COM *Radio Communication* January 1976); this device allows the receiver sensitivity to be displayed directly on a meter.

In the light of considerable experience with this unit, several useful modifications have been made. First, the original noise source has been improved upon, and two suggested designs are shown in Fig 1. The first is suitable for all bands from hf to 1·3GHz, and possibly even 2·3GHz. The selection of the transistor is very important as some devices give very little noise. Several transistors of different types should be tried to find one with high noise output. Unfortunately it is not possible to quote a particular transistor, as even some devices of the same type by the same manufacturer vary considerably. Usually variants of the 2N2369 (BSX19/20) seem to work well. The other noise source uses a 1N23 diode mounted in WG16, and

Holdings G3LLL FT101 fm accessories

(Continued from page 933)

Conclusion

The three units all worked very well and made fm operation of the FT101 very satisfactory. Use of the demodulator required no modification to the transceiver, the installation of the modulator and shift units is fairly easy, and the internal changes needed would probably not affect the resale value of the equipment.

The use of fm is not restricted to the vhf and uhf bands. There are a number of stations on both sides of the Atlantic which are operating fm around 29·6MHz. One important consideration when using fm on an ssb transmitter is that the power input should be reduced to the a.m. operating conditions. If this is not done the pa valves could easily be damaged and the 150W dc power input limit could be exceeded. □

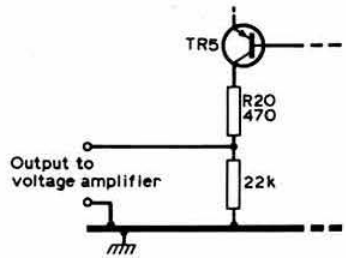


Fig 2. Voltage amplifier to enable the G4COM alignment aid to drive the above noise sources

covers 10-10·5GHz. Similar types of mounts using this diode could be built for 3·4 and 5·6GHz. A 1N26 diode may prove suitable for noise generation at 24GHz, but this has yet to be tried. Again, device selection is necessary.

Both types of noise source require biasing with a greater voltage than that provided by the G4COM device. Fig 2 shows the simple ic amplifier used by the writer to produce sufficient voltage to drive the noise sources, and Fig 3 shows the method used to interface this to the G4COM unit. TR5 and R20 are the components so marked in the original circuit diagram.

In use, the noise source, filter, attenuator and receiver conditions should be arranged as for the manual method described above. The requirement for receiver linearity is not so critical, for an ssb receiver, since the agc action will not follow the chopping rate. With an fm receiver it is still very critical, since any limiting will reduce the on-to-off ratio measured by the alignment aid, giving serious errors. Adjust the input attenuator to the receiver so that this does not occur. In checking this, the noise source may be switched on permanently by removing the −12V supply to the alignment aid, and switched off by also removing the +12V supply. Initially choose a value of attenuation so that the on-to-off ratio is about 3dB. The audio gain of the receiver should be advanced until the meter reading is independent of the audio gain setting, over a reasonable range. This should correspond to a gently audible "puttering" sound from the loudspeaker. If the meter reading cannot be made independent of the audio gain setting, the value of C1 may be increased to 0·33μF. Too great an on-to-off ratio may also cause this effect. If very large improvements are made to the receiver during alignment, ensure that the increased on-to-off ratio does not overload the unit.

Used in the above way, receivers are aligned to an input impedance set by the designed value of the attenuator's impedance, usually 50Ω. However, antennas, changeover relays etc will not, in general, present this impedance exactly to the receiver. This mismatch may be acceptable on transmit, but on receive could well degrade the noise figure considerably, particularly with very-low-noise preamplifiers. The G4COM device can also be used to complete the optimization of the receiver, in situ on the antenna. In this case the noise source is connected directly to a dipole or similar antenna, placed sufficiently close to the receiving antenna. The changeover relays etc should be assembled exactly as they are intended to be used (with the same leads). The receiver can then be optimized in its real environment. If the preamplifier has a very low noise figure, the antenna should be pointed skywards to reduce the pick-up of ground noise, which would tend to mask the receiver noise and make alignment more difficult.

The writer has used the G4COM device for optimizing 144 and 432MHz equipment, as well as for 1·3, 2·3 and 10GHz receivers. It enables such things as tapping points, matching circuits, device dc conditions etc all to be set up without difficulty. On 10GHz it is vital for optimizing more complex devices such as the G3JVL narrow band mixer, as well as for simpler wideband equipment. Many improvements were made to the writer's wideband equipment by optimizing the matching to the i.f. preamplifier, the level of local oscillator injection, Gunn diode bias point etc. It was even noticed that having a 1mA meter in the dc return path for the mixer diode caused about 0·5dB degradation in noise figure. A switch is now fitted to short out the meter, when it is not required for monitoring purposes! Also it is possible to select the best mixer diode if several are available—there is a considerable variation in noise figure of the common types of diode.

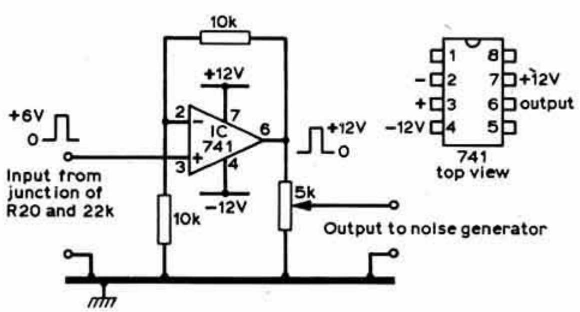


Fig 3. Modification to the G4COM circuit to interface with the voltage amplifier

New 10GHz world record

The 521km world record on 10GHz held for nearly three years by G4BRS/P and GM3OXX/P was broken on 12 July by I0SNY/7 (HB19f) and I3RGH/3 (FF19b) with a contact over a 550km path. Then followed a spate of new world records!

On 18 July I4CHY/7 (HB10c) worked I3CLZ/3 (FF17j) over 571km, only to lose the record eight minutes later when I3CLZ/3 worked I0SNY/7 at 582km. This record lasted for three days until I2FZD/3 (FF25h) worked I4CHY/7 over a distance of 589km.

The current world record QSO took place on 27 July at 1818gmt between I2FZD/2 (FF12a) and I4CHY/7 (IB01g) over a 633km path. This contact, and most of the others, were monitored by the Italian microwave manager I4BER from his holiday QTH at GD27h. The equipment in use for the record-breaking QSO was typical of that generally used in Italy—Gunnplexers to 1m dishes. Signal reports over the 633km path were 59 with heavy QSB.

Congratulations indeed to all those who took part in these very successful tests.

24GHz

Over the next few months it is planned to publish constructional details for 24GHz equipment based on the Plessey GDO33 Gunn oscillator. The writer would be very pleased to receive any contributions on this subject.

The 24GHz beacons for GB3IOW and GB3ALD are on the point of becoming licensed, and G3VPF is starting their construction. He desperately needs some lengths of WG20 and components for the beacons. Any donations of hardware would be greatly appreciated.

(Continued on page 952)

FT101 strong-signal modifications

The item in *TT* in August (page 739) reporting ZL2BAF's low-cost but very effective method of improving the strong-signal performance of the receiver section of the FT101 attracted considerable interest; but as a result it was soon discovered that the abridgements of the *Break-in* article on which the *TT* item was based had unfortunately omitted part of a sentence referring to Models 101B and E. The appropriate passage (with corrections and additions in italics) should be: "Remove screw securing noise-blanker board PB1182 (PB1292 in FT101E and 101B). For 101 Mk2 locate Q2 and bias resistors (R5 4·7kΩ and *R6* 22kΩ); *Q1 in the 101B and E, and its bias resistors R1 4·7kΩ and R2 22kΩ*".

G3SEU also notes that there appears to be an error in some FT101E manuals, as the noise blanker board is PB1582 on the Yaesu circuit diagram but PB1292 in the manual. He also points out that the third from last paragraph in the August item refers to FT101E and B models, as the previous paragraph provides alternative instructions for the FT101 Mk2. Those who have successfully completed the modifications confirm that they really do what ZL2BAF claimed.

Second look

TT (August) gave details of a simple 28MHz preamplifier for use on receivers lacking sensitivity on this band. This resulted in a reminder from Ron Broadbent, G3AAJ (94 Herongate Road, Wanstead Park, London E12 5EQ) that AMSAT-UK can supply constructional details of a useful 40673 dual-gate mosfet preamp for this band, complete with a printed circuit board, for 60p.

TT (February) noted the absence of any comprehensive public collection of second world war clandestine radio equipments (which owed much to pre-war amateur practice). To some extent this has now been rectified by a new exhibit at GB2SM (Science Museum, London) with a show case devoted to "clandestine and infiltration" units, including: MCR1 miniature communications receiver (built in large numbers for Special Forces by Philco); B2 (Type 3 Mk2) suitcase set; the Polish AP4 2–16MHz three-waveband transmitter/receiver with 6L6 power oscillator; Marconi beach landing set Type F; and some much more recent compact units, including Mk122, Mk123, Type 53/1. But, so far, none of the SIS/MI6 equipments, which would be interesting in showing the use of very simple "straight" rather than superhet receivers which often suffered from excessive second channel response. A recent contact on 7MHz with old-timer Bill Daly, G2VZ, shows that a B2 with external vfo still puts out a useful signal.

The simplest el-bug?

The HB9ABO cmos el-bug (*TT* February) has proved a popular design, and recently Jim Bolton, G3HBN, demonstrated to me "on-air" the excellent code that can be produced by its use. It may therefore seem a little premature to draw attention to a very simple keyer based on that most common of all ic devices, the 555 timer: Fig 7. It comes from a note by Alan Monet, WA9KAN, in *QST* June 1979, pp42–43, although he acknowledges an earlier article in *73 Magazine* of May 1977. The NE555 forms the basic keyer with TR1 forming a relay driver. The use of a keying relay permits the keyer to be used for positive or negative keying systems, although there would seem to be no reason why the LA8AK technique (*TT* February 1979) should not be used instead.

The relay should be a 12V device with 300Ω coil and a pull-in

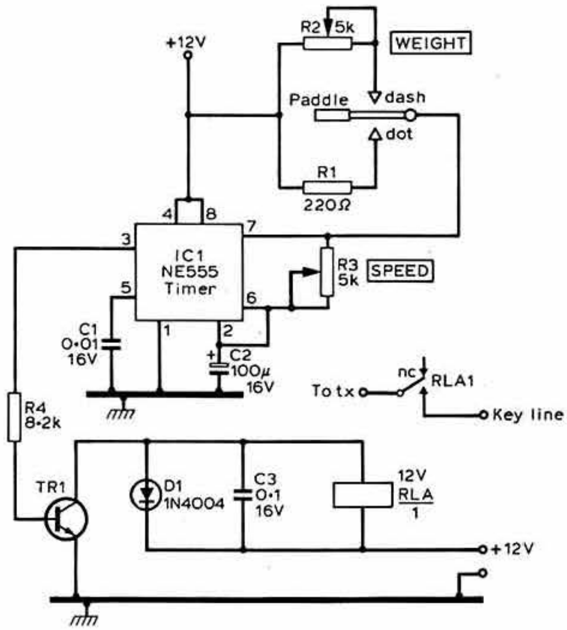


Fig 7. Simple 555 el-bug keyer that (with relay isolation) can be used on positive or negative keying systems. D1 may be 1N4004 or equivalent. TR1 can be 2N697, 2N2222, 2N3904 or equivalent

between 20 and 30mA. Power consumption will be quite significant, and it will be advisable to use either a 12V mains supply, reasonably high-capacity rechargeable battery or a physically large dry battery.

When the unit is keyed, pin 3 of the 555 goes "high", so forward-biasing the relay-driver transistor, TR1, which can be a 2N697, 2N2222, 2N3904 or equivalent. When saturated, almost the full 12V is developed across the relay coil. R3 controls the speed of the keyer, while R2 regulates the weight of the dah, and R1 governs the dit.

The "dasher" key

(The wrong diagram was accidentally included last month with this item which is repeated here with the correct diagram).

A means of converting a normal mechanical bug key into a simple form of mechanical/electronic el-bug is described by Joseph Fenn, KH6JF, in *Ham Radio* (March 1979, p68). This uses a 555 ic timer in conjunction with a small 6V dc, sensitive relay to provide automatic dashes when the dash control is held over, while of course also providing automatic dots by means of the usual vibrating action. The two controls provide speed and weight adjustment, and unlike most el-bugs it can be set to provide dashes of any required ratio to the dots, permitting the long-dash style of sending sometimes cultivated by amateurs. A rechargeable nicad battery is used, and the unit is enclosed in a small screening box, connected by two-core-plus-shield cable to the bug key, with the screen taken to the frame post. If, in spite of these precautions, strong rf fields cause erratic dash lengths, this can usually be cured by putting ferrite beads on the input and output leads. The only change needed to a Vibroplex-type key is to disconnect the lead under the base from the dash contact post.

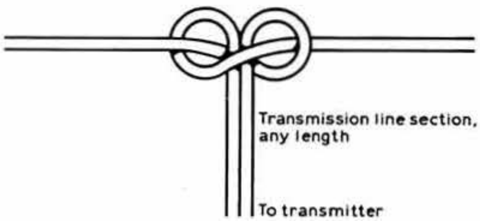


Fig 10. Electrician's knot prevents a zip-cord antenna from unzipping under tension

antennas of this type, with a dipole length of 5ft, are quite often used for Band 2 vhf/fm broadcast reception.

G3DMC reports that the transparent zip-cord available from Currys and Woolworth stores is effective when used as a four-wire feeder to a low-slung 3·5MHz vee antenna. He writes:

"Opposites are commoned at either end, the two lengths being taped in a neat square with plumbers' thin ptfe tape that clings without adhesive. The vee from eaves to fence has a very low impedance, which I would put at about 20Ω. Coupling to the transmitter coaxial cable output is via a ferrite ring balun in the shack (an old RSGB *Handbook* design modified by peeling back turns to achieve a correct match). The result is virtually unity swr when driven with a low-power (7W) transmitter, and brings in contacts with Sweden and Finland since erected three years ago."

Incidentally it should be remembered that with a high-loss feeder the swr at the transmitter end may appear deceptively low.

FT101 and strong signals

The world-wide popularity of the FT101 series of hf transceivers has been achieved in spite of the recognized tendency of the receiver section to suffer from overloading and cross-modulation in the presence of strong signals. Richard Thurlow, G3WW, recently drew my attention to the work of C. J. Donoghue, ZL2BAF, who has analysed the problem, pinpointed its prime source, and devised what appears to be a very effective modification which costs only pennies to those prepared to delve inside the black box. And even if you do not own an FT101 there is food for thought in this illustration of how a simple design "fault" can affect the performance of equipment. The article "Modifications to the FT101 to cure strong signal overload" appeared first in *Break-in* March 1978, then *Amateur Radio* November 1978, and most recently in a supplement to the March 1979 issue of the *International Fox-Tango Club Newsletter*. It applies to a high percentage of FT101 Mk2, FT101B and FT101E models, and the following notes use the maker's component designations.

ZL2BAF located the main source of the non-linearity problem as arising from the operation of transistor Q2 (2SC784R) on circuit board PE1183B i.f. unit. A study of the agc biasing arrangements for this stage showed the reason: since Q2 is a bipolar transistor it needs to be forward biased, and in normal operating conditions forward bias is obtained from the agc rail by means of a potential divider: 27kΩ (101E 22kΩ) and 3·9kΩ resistors. As the agc voltage drops with increasing signal, so the forward bias applied to the transistor decreases, reducing its gain. However, as Q2 is a silicon device it requires at least 0·65V on its base (with reference to the emitter) and this implies that the minimum voltage at the top of the potential divider must be greater than about 5V. When the agc is forced below this value, the transistor cuts off and introduces severe non-linearity in the signal path.

ZL2BAF found that the trouble could be minimized very simply by providing a small fixed bias current to the base of Q2. However, further work resulted in a rather more elegant and effective modification of the agc arrangements, after which the receiver "refused to show any signs of overload right up to full output of his signal generator, about 50mV".

ZL2BAF continues: "The most brutal test was devised. This was to modify another FT101 in the same way, with both equipments then installed in their vehicles (both were normally operated mobile). With the cars parked alongside each other contact was made at full power. Although the antennas were only about 8ft apart and the overload protection lamps on the rear of the transceivers were flashing brightly with rf, the audio was clean and easy to resolve even with rf gain full on and the S-meter reading about 40dB over S9. Cross-modulation has disappeared and the FT101 works happily with other local amateurs on the same band, unless they are very close together."

Step-by-step details of this modification are set out by ZL2BAF as follows:

Remove af unit PB1189 (2nd board from left when viewed from front of set) by undoing two screws and carefully rocking the board endwise while lifting it up. This board is removed to gain access to i.f. board PB1183B on the extreme left of the set.

Remove two screws holding vertical metal shield supporting this board, and ease it up and out complete with shield. Remove shield. Locate Q2, on top edge of board, and its associated base bias resistors (R10/R11 in FT101B and 101E; R16/R17 in 101 Mk2). Remove these resistors *carefully*. The board is double-sided printed circuit with plated-through holes, so use solder-sucker or solder-wick and not too much heat. R10, 11 are 22kΩ and 3·9kΩ in 101E; 27kΩ and 3·9kΩ in 101B, while R16, 17 are 27kΩ and 3·9kΩ in 101 Mk2.

Replace R10(R16) with 1·8MΩ resistor; do not replace R11(R17). Make sure no specks of solder remain on the board. Re-assemble i.f. board to shield and re-fit, then re-fit af unit.

Remove screw securing noise-blanker board PB1182 (PB1292 in FT101E and 101B). For 101 Mk2 locate Q2 and bias resistors (R5 4·7kΩ and R2 22kΩ). Remove these resistors with similar care to above. Replace either R6 or R2 with 1·2MΩ, leaving no resistor in one position. Connect base-end only at this stage. For 101B and 101E locate pin 3 on edge connector and isolate it from pin 2 by cutting copper connection between them. Solder the free end of the 1·2MΩ resistor to pin 3 and re-fit board. On the 101 Mk2 the noise-blanker board is mounted on top of the vfo unit with wires connecting it to the main equipment. Find a suitable anchor point (fit a solder lug) and connect agc end of the 1·2MΩ resistor to it, with a wire to the agc rail under the chassis. Re-fit board.

Remove bottom cover and internal speaker panel. Locate pin 13 on i.f. unit edge connector socket (this is agc rail). Solder a wire to pin 13 and route this to noise-blanker board edge connector socket. Isolate pin 3 from earth, and connect agc wire to pin 3. Then re-assemble.

Switch on. Tune to 14,200kHz. Turn on calibrator and peak preselector for maximum S-meter reading. Locate S-meter adjust control on i.f. board and set to S9. It should then be possible to check agc voltage, which should be 4±0·25V.

That completes the modification which should result in a receiver of respectable dynamic range. □