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The Panda Cub

Dr Bruce Taylor HB9ANY describes a popular classic gang-tuned multiband rig.

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For over 50 years, SSB has proved the dominant mode for analogue phone communication on the HF bands. So much so that young SWLs could be forgiven for believing that the 'communications speech quality' resulting from audio pre-emphasis, brick-wall sideband filters, digital dynamic pre-distortion and range compression, envelope power overshoot (and often a slightly mistuned carrier insertion oscillator) is an unavoidable shortcoming of contacts by amateur radio. SSB is undoubtedly an efficient voice mode for clocking up DXCC countries and winning phone contests in difficult conditions on crowded wavelengths. But at times when the bands are quiet and propagation is good, the richer and more natural audio quality of older AM rigs incites warmer, longer and more memorable ragchews.

Many radio amateurs first discovered the hobby when they accidentally picked up an AM QSO on a domestic radio receiver. It's unfortunate that today any receiver without a BFO would mostly deliver only 'Donald Duck' SSB audio when tuned across the amateur bands.

AM Activity

Although AM operation is a minority speciality it has many keen adherents, especially among amateurs who enjoy experimenting with their equipment. LF band AM phone is still alive, thanks to dedicated enthusiasts and the support of a community of devotees who participate in regular nets on the 80m and 40m bands. Radiating a carrier makes for efficient net conversations in which all participants know unequivocally when each operator switches from transmit to receive.

AM stations are also active on Top Band (160m), 60m, and even on 10m during sunspot years. Many AM operators are members of the lively Vintage and Military Amateur Radio Society (URL below), which is affiliated with the RSGB and based in the UK but has an international reach.

www.vmars.org.uk

Panda Cub

Today, classic commercially-built AM/CW amateur band transmitters can be acquired cheaply at hamfests and mobile rallies. Their straightforward design and relatively spacious construction mean that they are easy to restore, maintain, modify and experiment with. Unlike much modern microelectronic equipment, there is very little to go wrong with these uncomplicated rigs that can't be repaired by any amateur. When combined with a cheap SDR dongle, they provide an opportunity for a young CW operator to get on the air on five or six bands with a serious amount of RF power for very little expenditure indeed. However, some of the higher power models can be rather unwieldy to transport because of their massive mains and modulation transformers.

Designed by **Louis Varney G5RV** of multiband dipole antenna fame, and manufactured by the Panda Radio Co. near Rochdale in Greater Manchester, the Panda Cub transmitter, **Fig. 1**, is a bandswitched gang-tuned rig that covers the 10, 15, 20, 40, 80 and 160m amateur bands. First introduced at the RSGB Exhibition of November 1953, the transmitter cost £62.50 in 1955 and £65 in 1956, before being reduced to £59.50 (around £1500 in today's money) in 1957 and 1958. The Serial No. of a Panda Cub is inscribed on a small plate riveted to the right side of the PA compartment.

Described as a 'table-top' rig, the Cub tips the scales at 43kg. Even the base of the chassis has a close-fitting metal cover that weighs over 1kg, while the sturdy main steel cabinet, a product of the Loughborough metalworks of **LJ Philpott G4BI**, weighs nearly 5kg. Its higher power brother, the Panda PR-120-V, which cost £125, weighs 25kg more, while the contemporary Labgear LG300 transmitter, which cost about £200 complete, was split into separate RF and power supply/modulator cabinets with a combined weight of over 66kg. Unlike the Cub, neither of these more powerful transmitters provides coverage of Top Band.

In 1960 I purchased a well-used Panda Cub, which I operated /A at several RAF stations, albeit cursing its lack of carrying handles as I moved it from one location to another. I even installed the transmitter in the rear of a Ford Anglia 307E van and operated it /M in Scotland, England, Wales and several countries in mainland Europe. When mobile, the HT supply was generated by a heavy ex-WD rotary transformer. With youthful imprudence, no seatbelts or airbags, a boom microphone at face level and two auxiliary car batteries behind my back, I shudder to think what would have happened in the event of a frontal collision!

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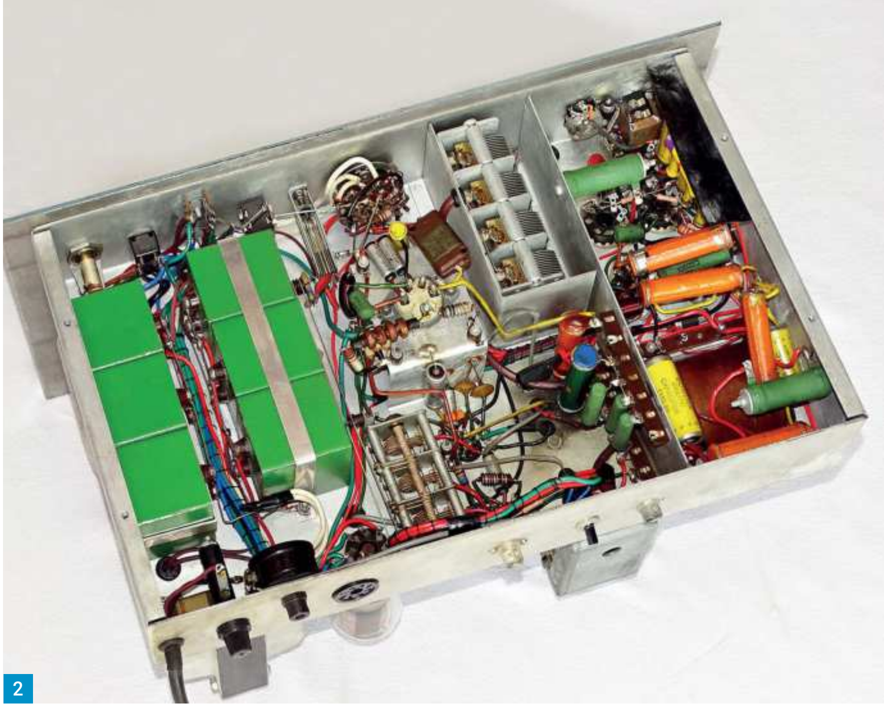
Fig. 1: The bandswitched gang-tuned Panda Cub transmitter is rated at up to 40W input to a single 807.
Fig. 2: The underside view of the Cub shows a neat layout with good access to all the components. The green boxes are the HT smoothing capacitors.
Fig. 3: This rear view of the Cub shows the AF stages on the left, the power supply on the right and the RF stages with the louvred PA screening compartment in the middle.
Fig. 4: Below 30MHz the adjustable Panda low pass filter *(upper)* has an insertion loss of less than 0.25dB. The ATU 150 *(lower)* has a thermocouple ammeter in each feedline.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Design

I've provided the original factory circuit diagrams and documents for the Panda Cub here:
Sales brochure
https://tinyurl.com/SalesBroch
Power supply section:
https://tinyurl.com/PwrSchem
Modulator section:
https://tinyurl.com/ModSchem
RF section:
https://tinyurl.com/RfSchem
Components list:
https://tinyurl.com/CmpsList
Operating instructions:
https://tinyurl.com/OpInstns

Although the manufacturer's documentation is of mediocre quality, and suffers from errors and omissions, the construction and wiring of the transmitter itself is of a good standard, **Fig. 2**. It has eight valves (plus a 5U4G rectifier and VR150/30 neon stabiliser) and is rated for up to 40W input on CW and 25W on phone. The final PA is a single 807 with a pi-network tank circuit designed to couple to a 72Ω load.

An international octal socket on the rear panel permits the connection of a transmit/receive control relay or an external power supply. For full power operation, an HT supply of about 500V is required. Be sure to check the internal wiring to the socket before connecting it to any external equipment. That's because it appears that these sockets have been wired in different ways at origin, apart from any changes that may have been made by previous owners. For example, pins 4 and 5 may be in series with the HT supply, as shown in the power supply schematic diagram, or connected to the relay contacts of switch B2, as shown in the modulator schematic!

Produced at a time when Band I TVI was a major concern, the Cub is built in several screened compartments, **Fig. 3**, and has RF filters for mains input and the PA heater. But there is no tuneable harmonic trap or lowpass filter in the RF output, and contrary to the claim in Panda advertisements the transmitter could hardly be described as *"incorporating all the best TVI proofing technique"*. However, as an extra £4.90 accessory the company offered an adjustable lowpass filter that was specified to have an attenuation of 85dB at 42MHz and over 72dB throughout the TV spectrum. For £15 an 'ATU 150' was also available that employed Faraday screened links on all bands for increased protection against harmonic radiation, **Fig. 4**. Today these useful accessories are unfortunately somewhat rarer than the Cub transmitters themselves.

Modulation is by a pair of push-pull 6V6s, driven by a 6SN7 twin triode phase splitter and a 6SL7 preamplifier for a high impedance crystal microphone. These valves don't appear on the components list. The modulation transformer, a critical component for high quality audio, is a reputable Woden UM1 or equivalent, which is conservatively rated for 30W of audio and 60W of RF input.

Compared with other commercial and homebrew multiband transmitters of this vintage, the Panda Cub has very few separate switches and tuning controls. The PA is driven by an exciter that uses an ECC81 double triode and a 5763 beam tetrode in frequency multiplier service, all controlled by a band-change switch with a total of nine poles. The multiplier stages are tuned by a 3-gang capacitor that is coupled to the VFO tuning control by an ingenious cord drive, so that only the PA tank capacitor requires separate adjustment when changing frequency.


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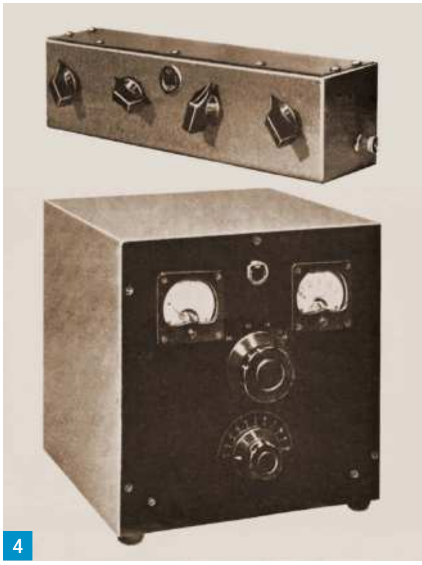
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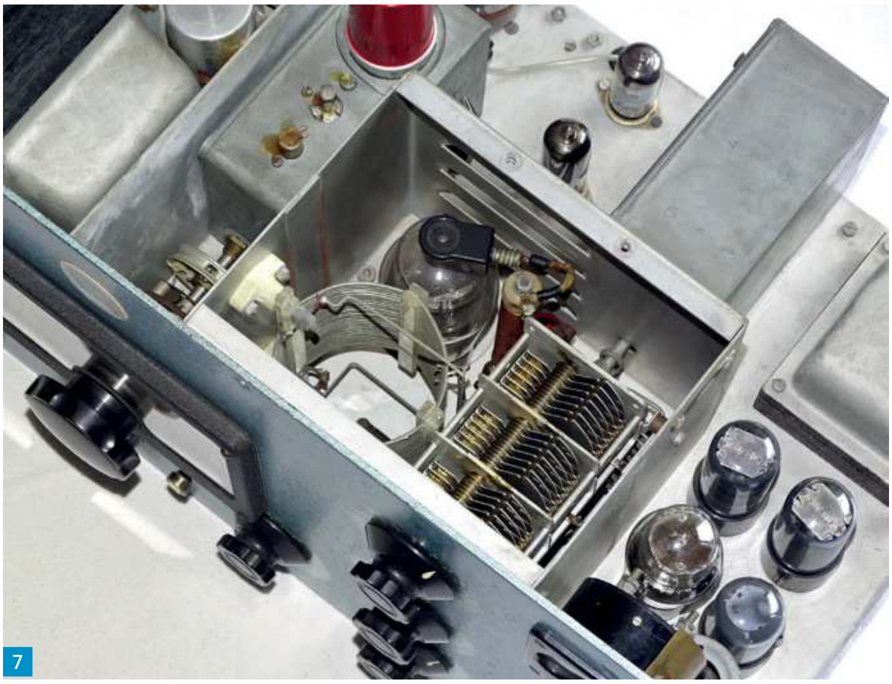

Fig. 5: Trimmers are provided on the top of the VFO box, which nestles between the power supply and the PA compartment. The cord drive from the drum on the tuning shaft allows the exciter stages to track the VFO frequency.

Fig. 6: The revolutionary B9G pressed-glass base of the EF50 has very short electrode connections to nine chromium-iron alloy pins. The valve has an all-glass envelope covered by a spun-metal 'Jackson cap' for screening purposes.

Fig. 7: The well-screened 807 PA compartment contains the tank circuit and RF choke. A 3-wafer bandswitch under the 3-gang tuning capacitor is coupled directly to the 6-wafer switch in the diecast multiplier coilbox behind it.

Fig. 8: The exciter is tuned by nine ferrite cores; three for each of the three multiplier stages.

Fig. 9: Voltmeter probe locations for measuring the PA drive. The 4-gang PA loading capacitor is upper left, while the 3-gang exciter tuning capacitor on the right is driven by a cord from the VFO shaft.

Fig. 10: Identification of the inductor locations on the side of the diecast coilbox for the multiplier stages V2a, V2b and V3.

The VFO, **Fig. 5**, uses the classic Eddystone 598 'full vision' epicyclic ball-bearing drive. It is directly calibrated in frequency for the six bands, although scale intervals of 12.5kHz on 160m and 150kHz on 15m are more artistic than practical. The VFO is housed in a sturdy Eddystone diecast box and uses a temperature-compensated electron-coupled Clapp circuit covering 1.75-2MHz. For netting purposes a push switch activates the VFO alone.

The EF50

Immediately recognisable by the bright red metal 'Jackson cap' that shields its all-glass envelope, the VFO valve in the Panda Cub is an Air Ministry surplus EF50 high gain remote cutoff RF pentode. Often described as 'the valve that helped to win WWII', the EF50 proved a vital component in the development of effective VHF radar for the UK Chain Home Low (CHL), Airborne Interception (AI) and Anti-Surface Vessel (ASV) systems.

The EF50 was initially developed by Philips for early VHF television receivers, and six of them were used in a fixed-frequency 45MHz TRF TV receiver chassis with a bandwidth of 4MHz that was built by Pye for receiving the pre-war BBC broadcasts from Alexandra Palace. It is believed that Pye may have originated the addition of the metal shield to the valve design. This receiver unit had a very good performance, and by May 1939 scores of them had been made in an initial production run. So, when **Taffy Bowen's** group of radar boffins at Bawdsey Manor was tipped off about it by **Edward Appleton**, they immediately adopted it as an IF strip (Type 153) for VHF airborne radar use, replacing the Cossor prototype receiver that had proved completely unsatisfactory.

On 9 May 1940 a Dutch ferry docked at Harwich with a very precious cargo that had been hastily evacuated from the Philips factory at Eindhoven. On board were 25,000 EF50 valves, together with production machinery, tooling and enough of the special pressed glass valve bases to allow around 250,000 more to be manufactured. It was a close-run thing. During the crossing the ship narrowly escaped an aerial bombardment and just hours later Germany invaded the Netherlands without a declaration of war and the Philips factories and hi-tech research centre came under Nazi control. On 6 December 1942 the RAF mounted a relatively successful low-level attack on the plant, dropping over 60 tons of bombs for a loss of 15 aircraft and 62 aircrew.

The revolutionary EF50 represented an important milestone in valve development because its novel all-glass base, **Fig. 6**, greatly reduced the inter-electrode capacitance and the inductance of the electrode connections compared with conventional designs that had a glass pinch (like an incandescent light bulb). The only contemporary design with these features was the RCA Acorn type, which was much more difficult and expensive to manufacture. The original EF50 production line saved from Philips was set up in the

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UK and run by its subsidiary Mullard, and to meet the huge wartime demand for the valve it was also made by Marconi-Osram and Cossor, as well as Rogers in Canada and Sylvania in the US.

In the immediate post-war period EF50 valves were very popular in amateur radio and TV designs because they were versatile and available at attractive prices on the surplus market.

As late as September 1965, when they cost about 1/6d (7.50p) each, a *Practical Wireless* article described their use in nine different circuits. The EF50 was an excellent choice for a VFO because it doesn't suffer from the interelectrode capacitance drift that afflicts valves with a pinch structure. This defect is caused by the fact that the connections of a multi-electrode valve are very close together in the pinch, and separated by glass that has a dielectric constant that is highly dependent on temperature.

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PA

The tank circuit and the upper section of the countersunk 807 PA valve are housed in a screening box provided with ventilation louvres, **Fig. 7**. After removing the securing screws, the lid of the box can be detached by sliding it towards the rear of the chassis. The tank capacitor is a wide-spaced 80pF 3-gang component that is mounted inside the box, while the 500pF 4-gang loading capacitor is mounted underneath the chassis, **Fig. 2**. One large tapped airspaced coil supported on ceramic pillars covers the four bands from 1.8 to 14MHz, and a second smaller coil located below the tank capacitor is used for 21 and 28MHz.

A rotary switch with three ceramic wafers connects the appropriate variable capacitor sections, fixed capacitors and coil taps for the selected band. By means of a flexible shaft coupler, this switch is connected to another 6-pole rotary switch inside the multiplier coilpack that is housed in an Eddystone diecast box to the rear of it. In this way, the whole transmitter can be switched over six bands with a single front panel control.

Alignment

The basic frequency range of the VFO (up to 1.75-2MHz) is the same for all six frequency bands. If the calibration requires adjustment, this can be done by the trimmers that are readily accessible on the top of the diecast VFO box, **Fig. 5**. The exciter stages are tuned by adjusting the nine ferrite cores on the side of the multiplier coilbox, **Fig. 8**, while monitoring the PA grid current. This may be accomplished by measuring the voltage across the parallel group of three 50Ω resistors comprising R9. As shown in **Fig. 9**, a convenient tag has been provided for the attachment of the negative probe of the voltmeter and ground is available at pin 1 of the 807 base.

Table 1 indicates the inductors that are associated with the **a** and **b** sections of ECC81 V2 and 5763 V3, as well as the bands on which they should be tuned. The physical locations of the adjustable cores on the side of the multiplier coilbox are shown in **Fig. 10**, with the designations given in the schematic diagram. The tuning is quite broad and it should be possible to achieve over 3mA of grid drive (corresponding to 50mV across R9) on all bands.

Modifications

Safety should be the first concern when working on an equipment that has AC mains input and over 1kV AC between the anodes of the HT rectifier valve. If the original rubber insulated mains cable shows any signs of ageing, it should be replaced. As the HT smoothing capacitors have low leakage and no bleed resistors they can retain a dangerous charge after power is switched off. Note that the full HT voltage is present on the terminals of the PA anode current meter, which are exposed when the lid of the cabinet is lifted, **Fig. 3.** Since cathode keying is employed, the live contact of the Morse key should be insulated. And if it has not been done already, one of the first modifications should be to fit the cabinet with four rubber feet of height at least 15mm, before the sharp lower edges of the case damage the operating table!

Since the accessible layout of the Panda Cub invites experiment, completely unmodified examples are rather uncommon. Mains hum can be reduced by adding high voltage electrolytic smoothing capacitors in parallel with the original banks of three 2μF solid-dielectric ones. When choosing the capacitors note that on key-up the HT voltage can approach 600V. If series-connected capacitors of lower rating are used, be sure to wire resistors across them to balance the voltage. In addition to this change, the modifications on my model visible in the photos include a coax socket on the rear panel for the standard bipolar input from a teleprinter, and controls on the VFO box and rear panel for selecting and adjusting the appropriate RTTY FSK shift on 3.5 and 14MHz. For compatibility with my other transmitters the front panel coax socket for the microphone has been replaced by a screened jack socket. The globe symbol above the tuning dial isn't original – it replaces the Panda logo that had become badly worn.

The modifications listed in the operating instructions should be carried out if they haven't already been applied at the factory. The 10kΩ VR150/30 feed resistor modification listed is just an omission from the schematic diagram – it will of course be present in the transmitter.

A 150mA anode current meter that is provided for tuning the PA also gives a

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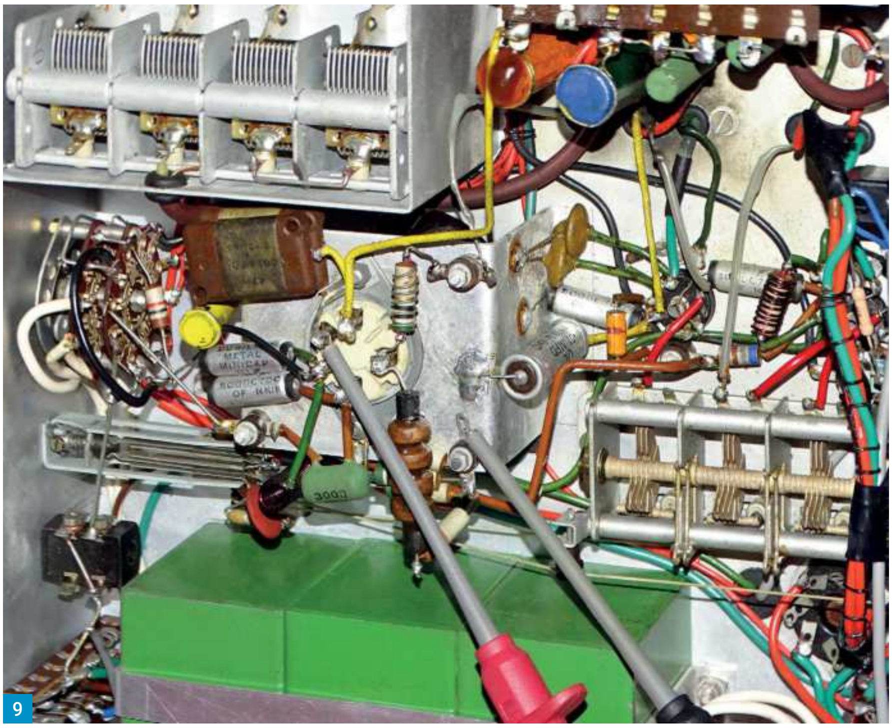
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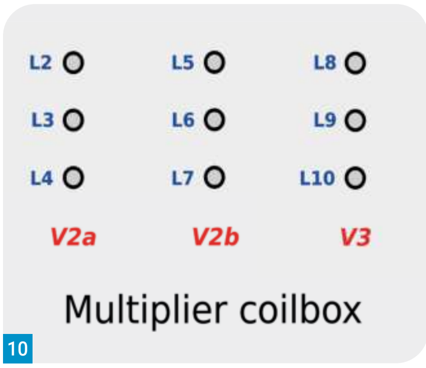
Stage	160m	80m	40m	20m	15m	10m
V2a	L2 1.8MHz		L3 3.5MHz			L4 7MHz
V2b		L5 3.5MHz	L6 7MHz			L7 14MHz
V3				L8 14MHz	L9 21MHz	L10 28MHz

Table 1: Multiplier tuning table

rough indication of modulation depth, but the grid drive is not monitored. There is room to add a grid current meter in the vacant space above the VFO tuning dial. The meter can be wired between R9 and ground and should be bypassed by a 1000pF capacitor.

A switch on the rear panel allows the power output to be reduced to the legal limit of 32W PEP in the frequency range 1.85-2MHz by transferring the reservoir capacitor of the power supply to the output side of the HT smoothing choke. Since this results in some increase in the carrier hum level, a better solution is to modify the circuit to increase the negative bias of the PA valve on this segment of Top Band. There is room in the cabinet to incorporate a small −100V power supply for this, and a potentiometer can be used to tap off the bias voltage required for any desired power level.

On other frequencies the power input can be increased and heat dissipation reduced by replacing the 5U4G rectifier by silicon diodes. An even greater increase in power is possible by providing a higher HT voltage from an external power supply. With a supply of 650V, the power input can be increased to 45W on AM and 75W on CW. The greater modulation



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power required can be obtained by replacing the 6V6 valves by 6L6's.

Many radio amateurs enjoy experimenting with transmitter electronics, but are understandably reluctant to devalue a complex expensive modern transceiver by custom modifications. A classic rig such as the Panda Cub is fun to operate, simple to maintain, and offers a convenient and inexpensive base for trying out ideas and gaining useful RF experience and practical skills. Within the many diverse facets of our hobby, twentieth century 'heavy metal' could have a worthwhile role to play for some time to come!

Continued from page 48

It seems to me that this radio does just about everything except make the proverbial tea, SSB and CW excepted. Joking aside, what this radio does it does well. I wouldn't say that it's quite as intuitive as some I've worked with but it's certainly the most sophisticated and comprehensive one to date. It feels robust, nice to handle, well made and in a class of its own. It's got to be 5 stars rated on available features alone.

However, what personally frustrates me more than just a little is that I keep forgetting that it doesn't have a touchscreen. Initially confusing but doubtless with time and constant use, I might just get the hang of it. I instinctively want to press the on screen, top-level menu icons. I have to remember to use the central pad to move around the screen, like those little tile puzzles with just one missing tile.

The often-used 'memory' icon is on page 2 of the top-level display, requiring a second button press. I just keep forgetting where the icon is!

Features and functions related to each icon are accessed on a tree menu system, with one branch leading to another. Believe me, there are lots of branches!

FinalVerdict

I said at the outset my intention was to find out why and how this radio commands a premium price. I've now had the ID-52E experience for some considerable time. It's been a mix of pleasure, head scratching and quite a learning curve, with still more to explore.

Considering its extensive facilities and taking account of the commercial/manufacturing aspects, exchange rates and ever rising import costs, I'm beginning to realise that it's more than a hand portable radio and so commands it's value. A better description might be that it's a, comprehensive, portable communications device.

Icom, if you're listening, the inclusion of a lightweight protective case, a USB cable or maybe a screen protector or two in the box as standard, might sweeten the deal.

Judging by dealer demand it's already a winner, and my initial misgivings are certainly a thing of the past. I will just have to get myself on the waiting list and start saving up.

My grateful thanks to Icom UK Ltd for the opportunity to review this item at an early stage. Available from Icom dealers circa £529.00 inc. VAT.

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