VINTAGE RADIO

By Ian Batty

Toshiba 7TH-425 "fan" wall radio

This distinctive radio from around 1961 is a seven-transistor superhet receiver. But it doesn't look like a radio at all. It looks like a wall clock has somehow been crossed with a fan! It's certainly very distinctive. You could even call its looks unique. As you would expect from Japanese manufacturer Toshiba, it's also innovative and features impressive miniaturisation for its time.

Visually, this radio is a knockout. You might be excused for thinking it's a fan of some sort. But the large dial, calibrated in kilohertz, should be a giveaway. Behind the outrageous front panel, it's a fairly conventional seven-transistor superheterodyne AM radio receiver.

It's clearly designed for wall hanging, and later models provided a 3.5mm phono socket to accept audio from other devices. As it has two internal speakers, it's quite useful for boosting the volume from a small record player or tape recorder.

It was certainly meant to stand out, and the wall hanging allows it to remain out of the way in busy, cramped living areas while adding a unique decorative touch.

Aimed at the US market, it features the well-known CONELRAD (Control of Electromagnetic Radiation) markers that would be used in times of national emergency, albeit in reduced emphasis compared to many American radios of the day. The system, established in 1951, became the Emergency Broadcasting System in 1963.

A brief history of Toshiba

The Meiji era of Japan lasted from 23 October 1868 to 30 July 1912. It was one of rapid uptake of western industrial technologies and production methods. In 1873, the Ministry of Engineering commissioned Tanaka Hisashige to develop telegraphic equipment. His factory Tanaka Engineering Works (built in 1875) was one of the forerunners of Toshiba.

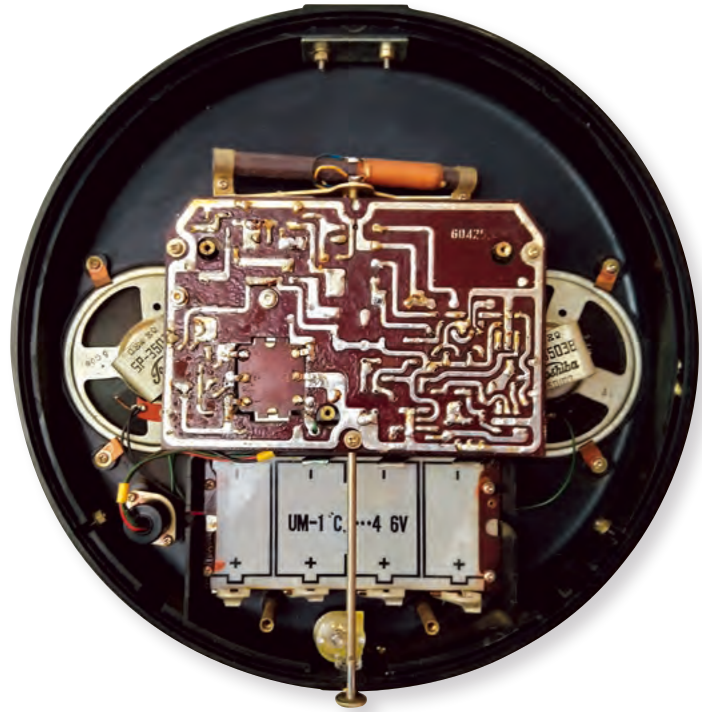
Separately in 1890, Fujioka Ichisuke and Shoichi Miyoshi established Hakunetsusha (changed to Tokyo Electric Company in 1899), to primarily manufacture light bulbs. The same company went on to manufacture the double-coil electric light bulb.

By the 1930s, iron and steel rationing had severely cut back on production of household appliances. Eventually, demand started to grow in the late 30s for home appliances that incorporated the advances made in heavy electric machinery. This led to the merger of Shibaura Engineering Works (formerly named Tanaka Engineering Works) and the Tokyo Electric Company, forming Tokyo Shibaura Electric Co Ltd.

The combined company did well during WWII by producing radios, generators and other military supplies for the state, but was hindered by bombing raids on their factories.

Postwar reconstruction, beginning with the resumption of heavy machinery manufacturing, took off in the 1950s with the re-establishment of electronics and communications industries. Sales and profits grew quickly as Tokyo Shibaura created novel products and developed original technologies.

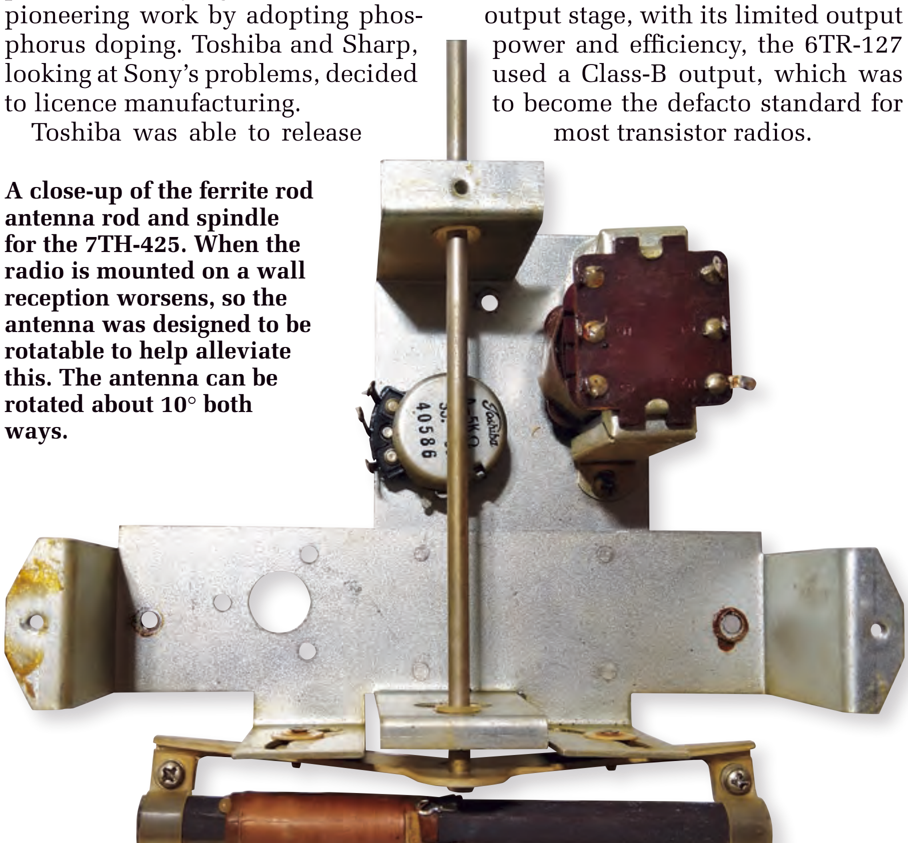
Around 1978 the company formally abbreviated its name to "Toshiba" and continues today as an innovator and supplier of heavy industrial machinery, semiconductors, computer and consumer goods. Their 1996 Libretto, a PC-class 'palmtop', which is just a bit bigger than a VHS cassette, is an outstanding example of ingenious miniaturisation.



The Toshiba 7TH-425 has a chain attached to the bottom of it; this functions as the power switch when pulled but it can also be used to attach keyrings etc to the radio. Often, due to the age of the radio, this switch will rust and stop working, so it's a good idea to check that first when repairing this set. Adjacent to the power switch is a long rod which is used to adjust the orientation of the antenna, as shown in the photo below.

Sony was the first Japanese transistor radio manufacturer, releasing their TR-55 in 1955. Sony had trod a long and often frustrating path to get to production, defying Bell Laboratories' pioneering work by adopting phosphorus doping. Toshiba and Sharp, looking at Sony's problems, decided to licence manufacturing.

Toshiba was able to release their first transistor radio, the six-transistor 6TR-127 in 1957, just two years after Sony's TR-55. The delay paid off; where Sony's drive to be first to market led to the use of a Class-A output stage, with its limited output power and efficiency, the 6TR-127 used a Class-B output, which was to become the defacto standard for most transistor radios.



A close-up of the ferrite rod antenna rod and spindle for the 7TH-425. When the radio is mounted on a wall reception worsens, so the antenna was designed to be rotatable to help alleviate this. The antenna can be rotated about 10° both ways.

Circuit description

All transistors in the set are Toshiba manufactured 2SA/2SB series germanium PNPs, and it uses a negative power supply (ie, positive ground). This makes the circuit simpler and easier to understand.

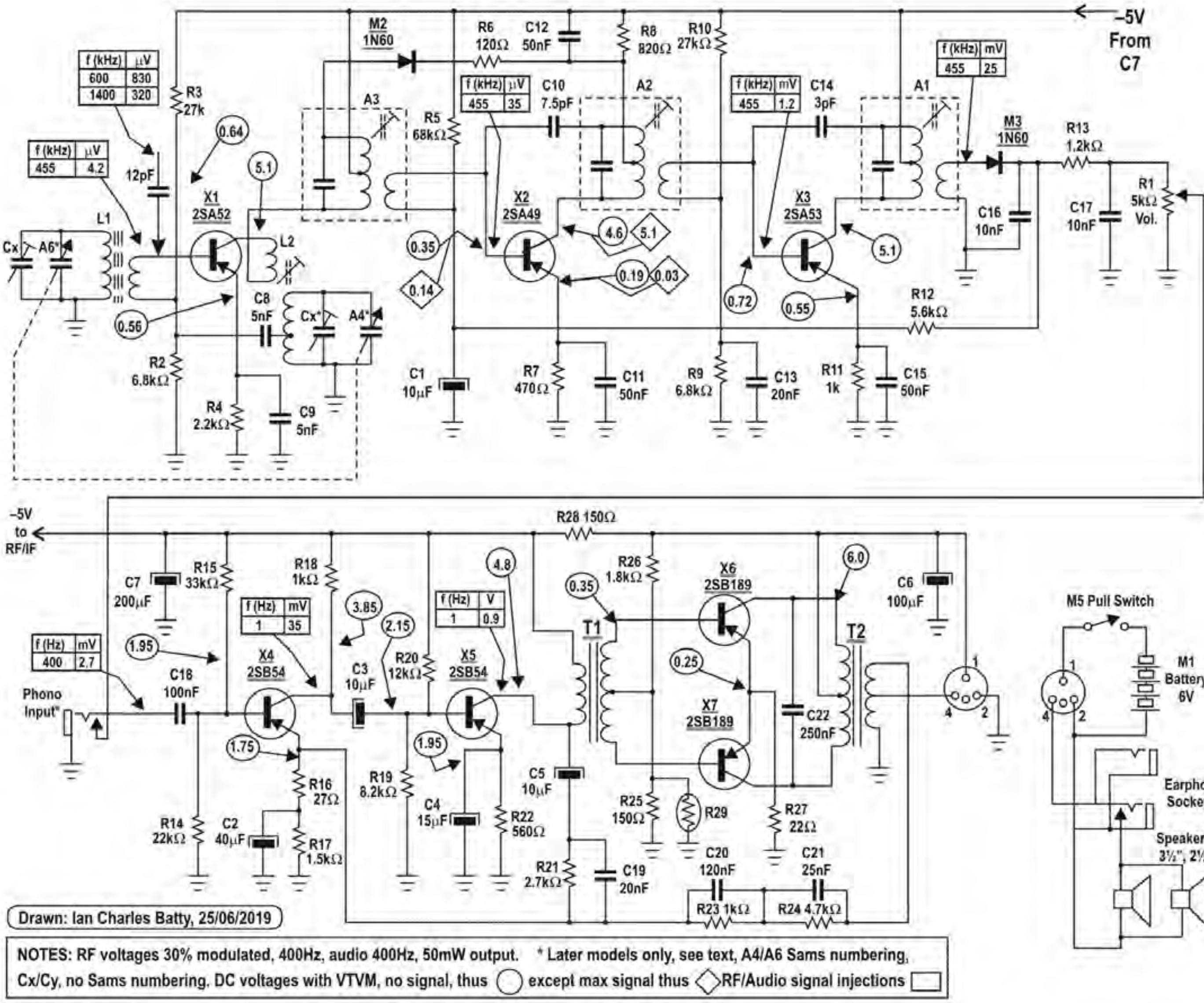
Converter X1, a 2SA52 (similar to an OC45) uses self-excitation and base injection, with the LO signal fed back via the antenna coil's secondary.

The 455kHz IF signal from the converter is developed across the tuned, tapped primary of first IF transformer A3. Its untapped, untuned low-impedance secondary feeds first IF amplifier X2, a 2SA49 (also similar to the OC45). It's an alloyed-junction type with significant collector-base capacitance.

It's neutralised by 7.5pF capacitor C10, connected between its collector and base. X2's collector feeds second IF transformer A2's tapped, tuned primary.

A2's untuned low-impedance secondary feeds second IF amplifier X3, a 2SA53, again similar to the OC45. It also has significant collector-base capacitance. Neutralisation is applied from its collector to base by 3pF capacitor C14.

X3's collector feeds third IF transformer A1's tapped, tuned primary, and A1's untuned, untapped second-



This circuit diagram was redrawn from the SAMS Photofact (551-14) documents for the Toshiba 7TH-425. It's worth noting that this circuit differs from the "original" schematic which can be found on the inside rear cover of the radio (missing from this set). These changes may have been regional, or due to difficulties in obtaining certain components etc. Some of the changes, apart from numbering, include: R13 → 12kΩ; C22 → 120nF; R22 → 2.2kΩ; many of the 10μF capacitors were marked as 8μF etc. You can find a photo of this "original" schematic at: siliconchip.com.au/link/aau1

ary feeds demodulator M3, a 1N60 diode. M3's output feeds audio via IF filter C16-R13-C17 to volume control pot R1.

The DC voltage at M3's cathode feeds the AGC line via 5.6kΩ resistor R12, filtered by capacitor C1, through to the base of first IF amplifier X2. Forward bias for X2 is provided by 68kΩ resistor R5, but this is counteracted by the AGC voltage, reducing the forward bias on X2 with strong signals, and thus its gain.

X2 is decoupled from the supply via 820Ω resistor R8. AGC extension diode M2 (another 1N60) connects (via R6) from the collector end of X2 to the signal end of first IF transformer A3's primary, opposite the converter's collector).

With no signal, M2's cathode is some 200mV less negative than its anode, putting it into reverse bias. As the AGC becomes active, M2's cathode voltage becomes more negative. As X2 approaches cut-off and reaches the end of its possible gain reduction, M2 comes into conduction and shunts some of the signal voltage developed at A3's primary.

This improves the AGC action, allowing the set to handle much stronger stations without excessive volume rise or the risk of saturation.

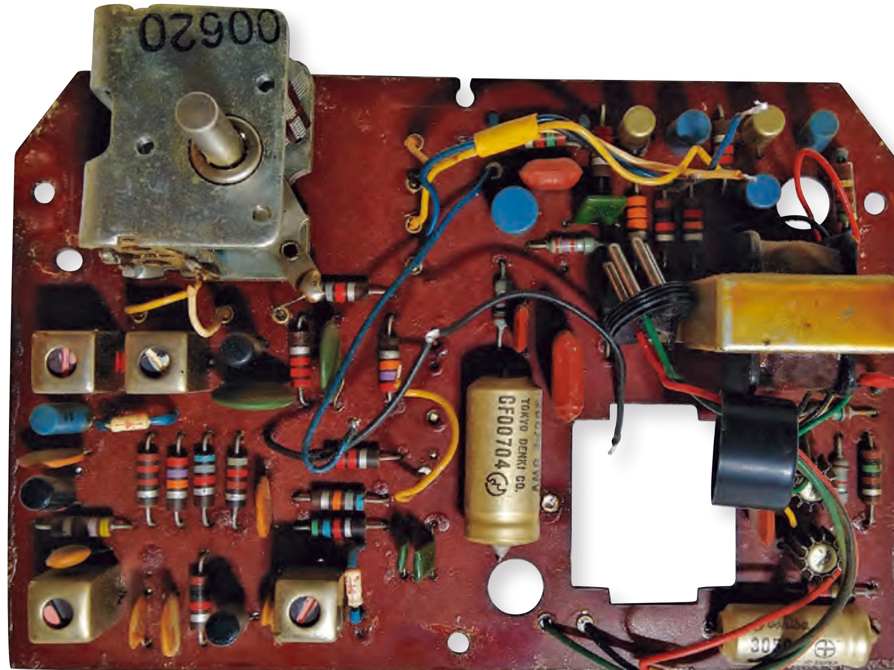
Audio amplification is handled by a four-transistor circuit. X4 and X5, both alloyed-junction 2SB54s similar to the AC125 (the successor to the OC71) operate with combination bias. My set has audio from volume control pot R1 coupled directly to X4's input, but later versions included a change-over 3.5mm phono socket as shown on this diagram, allowing an external source to be fed to the base of X4 instead.

Transistor X5 drives phase-splitter transformer T1's primary. Its secondary provides matched anti-phase signals to drive the low-impedance bases of output transistors X6 and X7. These are both 2SB189s, similar to the OC74. Shared 22Ω emitter resistor R27 helps equalise gains between X6 and X7, as well as providing some local negative feedback.

The bias circuit comprises 1.8kΩ resistor R26 and 150Ω resistor R25, in parallel with thermistor R29, providing about 100mV of Class-B bias for X6 and X7. Quiescent (no-signal) current is about 5mA for the pair.

The output transistors' collectors drive output transformer T2, which matches their output characteristics to the two speakers. T2 has two taps: a low-impedance tap for the speakers, and a higher-impedance tap that provides feedback for the audio section, via a tone control filter network (R21-C19-C5) back to the bottom end of T1's primary (ie, X5's collector) and also the emitter of first audio stage transistor X4.

The feedback is frequency-dependent, conditioned by 1kΩ resistor R23 shunted by 120nF capacitor C20, in series with 4.7kΩ resistor R24 shunted by 25nF capacitor C21. The aim is to compensate for the excessive treble response of the 7TH-425's two small loudspeakers. There's also some top-cut applied by 250nF capacitor C22, between the two output transistor collectors.



The top of the 7TH-425 phenolic circuit board, with the SAMS overlay diagram shown below.

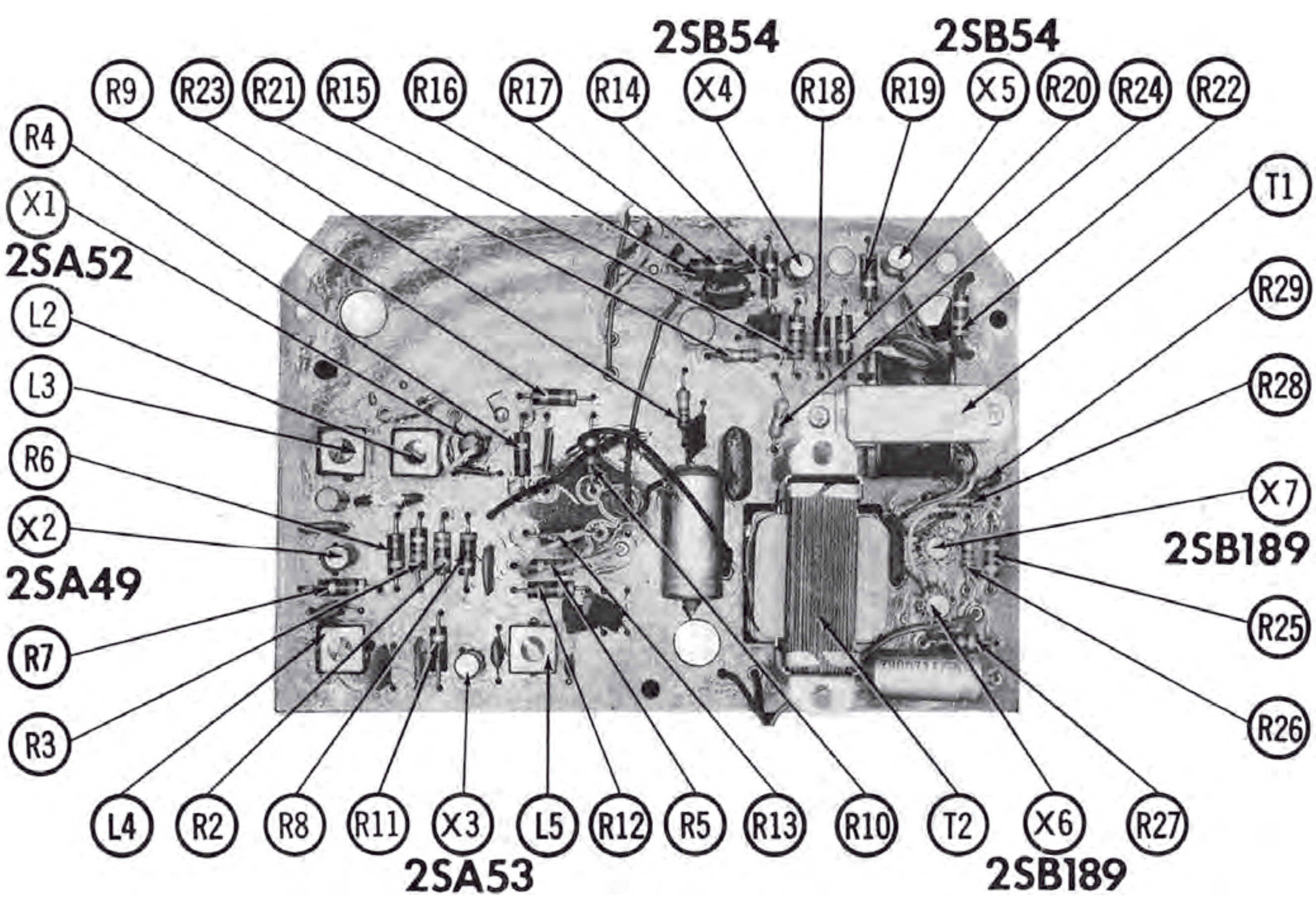
Construction

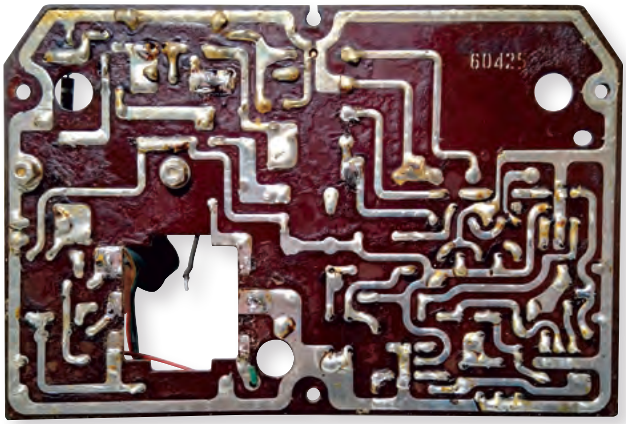
Most components are mounted on a conventional phenolic (brown) printed circuit board. A metal chassis supporting the ferrite antenna, the phase splitter transformer and the tuning gang overlays the circuit board. It's a bit of a mechanical bodge.

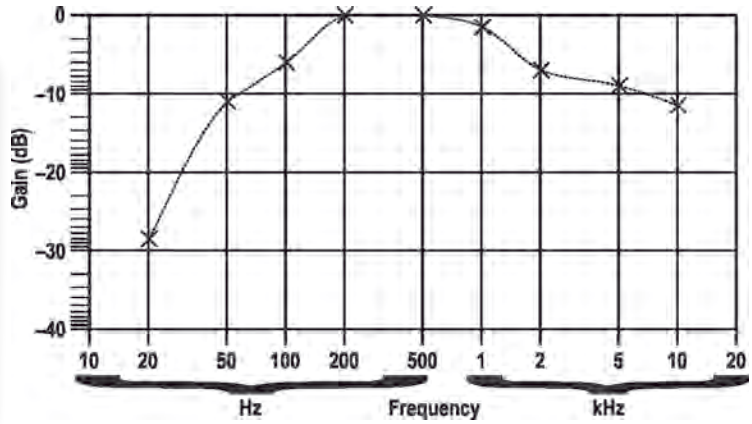
While I was able to take measurements from the unobscured rear of the board, and to get access to all alignment points, the metal chassis blocks access to sections of the component side. The output transformer is soldered and attached to the circuit board, while the phase splitter transformer attaches to the chassis, but its solder tags reach through a square cutout to the solder side of the board. It's far from ideal.

Cleaning it up

This was an easy one as it just needed a little bit of work. The case







Right: the radio's frequency response was equivalent to similar portables.

and dial were in great condition. The power switch had disintegrated, but I found a replacement switch online for a few dollars. Otherwise, it was OK electrically. A quick check showed it could benefit from alignment, and this brought it up to full performance.

Testing and performance

My signal test voltages were about what you'd expect, but the converter's emitter and base voltages came out about half those indicated on the circuit diagram.

Attempting to inject a test signal into the base interrupts the LO signal, so I used my substitute method of coupling via a small 12pF capacitor. While this doesn't indicate the actual signal voltage at the base, it does allow anyone to replicate the results. This gave an IF signal of around 4.2µV, a creditable sensitivity.

Overall, its performance is about what you'd expect. Being wall-mounted, you may be unlucky enough to find your favourite local station is off one end of the antenna rod. Our old enemy, the law of cosines, may prevent reception of a favourite station, but the silver knob behind the power switch does allow you to swing the ferrite rod a few degrees either way, for better pickup.

Under my test conditions, and for the standard 50mW output, it needs around 290µV/m at 600kHz and 250µV/m at 1400kHz. Signal-to-noise ratios exceeded 20dB in each case.

On air, it was able to pull in my reference 3WV over in Western Victoria with ease. RF bandwidth is just better than ±2kHz at -3dB; at -60dB, it's ±32kHz. AGC action is acceptable; a 40dB increase at the input gave an output rise of just 6dB.

Audio response is 85~1100Hz from volume control to speaker. From antenna to speaker, it's 130~1250Hz. But it sounds better than these figures suggest.

A typical set with an upper -3dB point just over 1kHz would be -6db down (or worse) at 2kHz, But as the frequency response graph above shows, the response dips at 1kHz, but flattens off towards 10kHz, due to the design of the feedback network.

Audio output is about 230mW at clipping, with 270mW at 10% THD. At 50mW, THD is around 3.4%; at 10mW, it's about 2.5%.

Turning to the low-battery performance now, at 3V, it clips at 50mW, with 4.5% THD at 30mW output. There was a notable asymmetry between the two half-cycles which indicates a mismatch in the output transistor pair.

Distortion increased with lower output power levels; the extreme was 8% at 1mW output.

Conclusion

Toshiba is famous for its innovative designs. Their early transistor sets often combine stunning visuals with sound engineering. So I am fond of this radio.

But I already have the quirky 9TM-40 "Robot" sitting under my bench. With its unique visual design and elaborate electronics, you can expect to see an article on that set from me in the near future.

Different versions

As mentioned earlier, later sets added a 3.5mm phono input socket. Those revised sets also had two 3.5mm output sockets, as shown in the diagram, which my set also lacks.

Like many other Japanese sets, one of the speaker sockets (the lower on in the diagram) disconnects the internal speakers and routes audio to an external speaker; the upper socket leaves the internal speakers in circuit and connects the external speaker in parallel, presumably for earphone listening while allowing others to hear program through the speakers.

Special handling

Like the Bush TR82C I described in the September 2013 issue (siliconchip.com.au/Article/4404), it's important not to try levering the control knobs off. Remove the volume knob first by running two lengths of string or dial cord at right angles underneath the knob. Pulling on the strings and rocking the knob will ease it off. Repeat this for the tuning knob.

I found the taking them off the first time to be the most difficult, but was able to remove the volume knob with firm finger pressure after that.

Further Reading

At the time of writing this article, I could not find a circuit diagram for the 7TH-425 online. But Howard W. Sam's Photofact sheets are available internationally for around $20 plus postage.

Photofacts are thorough and very informative. Some would consider them better than the manufacturer's documentation. Postage costs do vary widely between shops, so be sure to check the total price first.

I used the Photofact sheet as a source when drawing my own circuit diagram, reproduced here. Be aware that the circuit's component numbering follows the Photofact progression, left-to-right, as I prefer. SC