Vintage Radio

By Ian Batty

Astor M2 Cry-baby

a radio, intercom and baby monitor all in one

You might think that baby monitors are a fairly recent innovation but this battery-powered solid-state mantel radio from Astor incorporated an intercom and baby monitor in a design from 1962 – 56 years ago!

This mantel radio looks similar to the Astor M5 and M6 mantel sets that I wrote up in the September 2016 issue (www.siliconchip.com.au/Article/10149). Those mains-powered sets had Class-A audio output stages. At the time, I'd pondered the design brief but supposed that mains sets could easily support the power drain penalty of Class-A.

I did wonder about a battery version and assumed it would need to use the more complex (and thus more costly) Class-B design for battery economy. The 1962 M2 does indeed do this. The Class-B output stage gives an overall drain of around 10mA, meaning that the original Eveready 276-P carbon-zinc battery would last for some 150 hours of use.

As well as the M5/M6's radio function, a remote speaker connected to the M2 allows baby monitoring, playing radio programs at the remote speaker, or conventional "half-duplex" intercom operation. Being able to use the extension speaker for the radio program would be a useful feature even today.

We usually think of loudspeakers as output transducers but (like many electromechanical devices), we can capitalise on their reciprocal nature and use them as microphones. This is what the M2 does with its remote speaker, using it either as a speaker or with a suitable step-up transformer, as a microphone.

I was offered this set for review by a fellow member of the Historical Radio Society of Australia (HRSA), whom I have credited at the end of this article.

Appearance and controls

The cabinet of the Astor M2 is very similar to that of the previously-reviewed M5 and has the same hand-span dial for tuning and a 4-inch speaker on the left-hand side of the front panel.

The set retailed for £37.16s with the case and external speaker presented in a variety of different colours such as cherry red, yellow, brown etc.

The major difference is a 5-position function switch on the right-hand side of the panel, while the volume control-cum-power switch is on the left-hand side. The monitor speaker is in a black circular housing with no styling similarity to the radio.

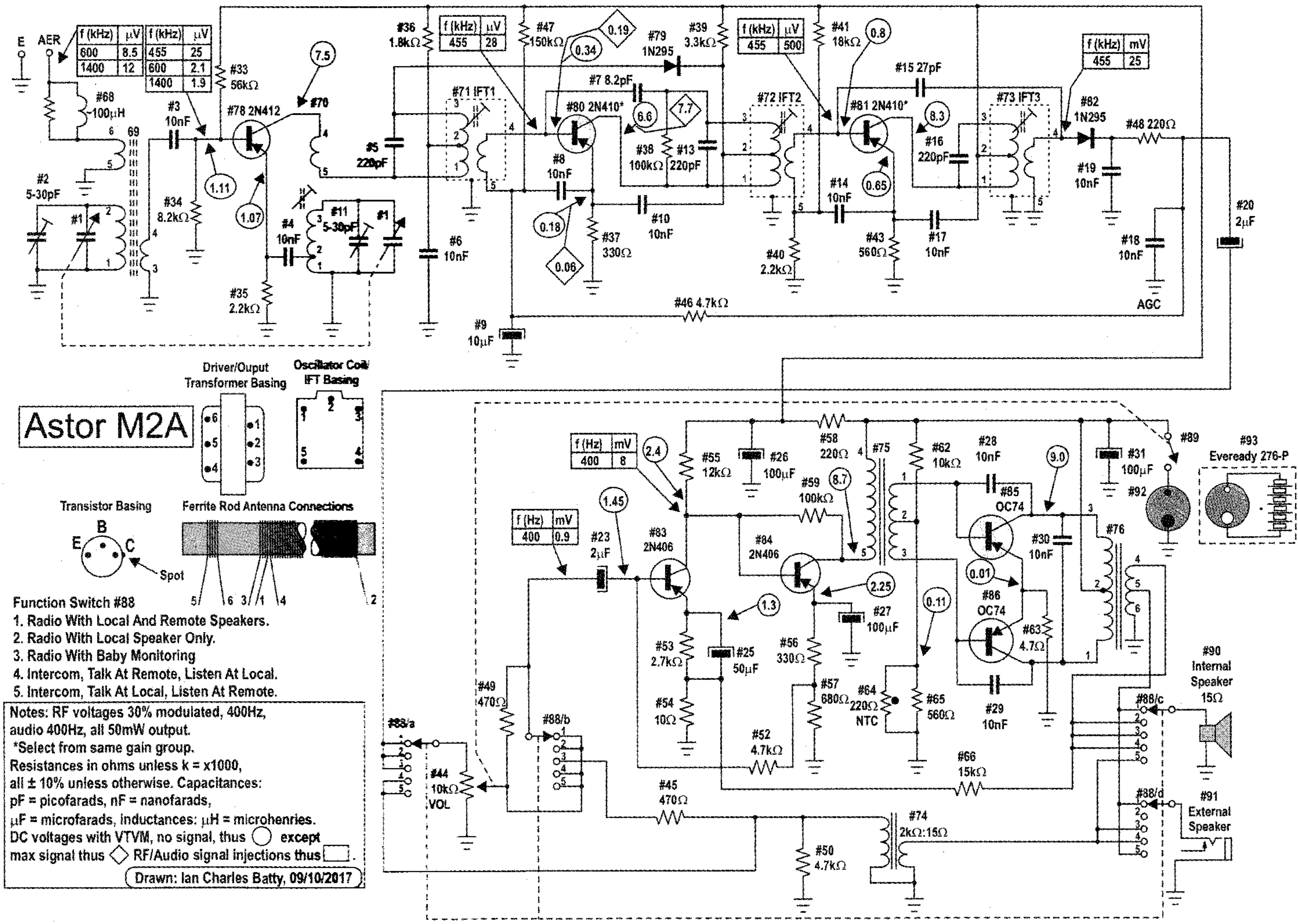


Fig.1: the complete circuit for the Astor Cry-baby. Note the complex wiring for the 4-pole function switch. The loudspeaker was connected via a step-up transformer (#74) when it was being used as a baby monitor.

Position 1 of the function switch simply parallels the monitor speaker with the set's internal speaker, so it operates as an extension to play the received program. Position 2 switches off the monitor speaker.

Position 3 adds remote (baby) monitoring to the radio function but with the remote input at full gain while the radio program is subject to the volume control setting. This would be ideal for baby monitoring; you'd be alerted to anything happening in the nursery while listening to the radio or you could turn the radio down while still monitoring your infant.

Position 4 is a simple intercom working from remote speaker to the set while position 5 reverses the conversation, going from set to monitor.

Just as an aside, if you have one of these sets, make sure that the remote speaker is reasonably remote before switching to position 3: insufficient separation will result in very loud acoustic feedback.

Construction

Like the Astor M5 & M6, the M2 uses a single-sided phenolic PCB mounted behind the plastic front panel and anchored by the volume pot and function switch's shafts, and by two screws; there is no metal chassis.

The only unusual component is the 3.5mm external speaker jack mounted in the rear of the case, and connected to pins on the circuit board by fly leads.

Like the M5/6, tuning knob removal requires gently prising off the gold dress cap in the centre of the dial, undoing the three small screws and securing ring that hold the tuning knob on, then (for circuit board removal), undoing two screws in the tuning boss and sliding it off the gang's shaft.

The set provides for external Aerial and Earth connections to improve reception in fringe areas. As with the M5 model, these "hide" under the set and connect via the two bottom case screws.

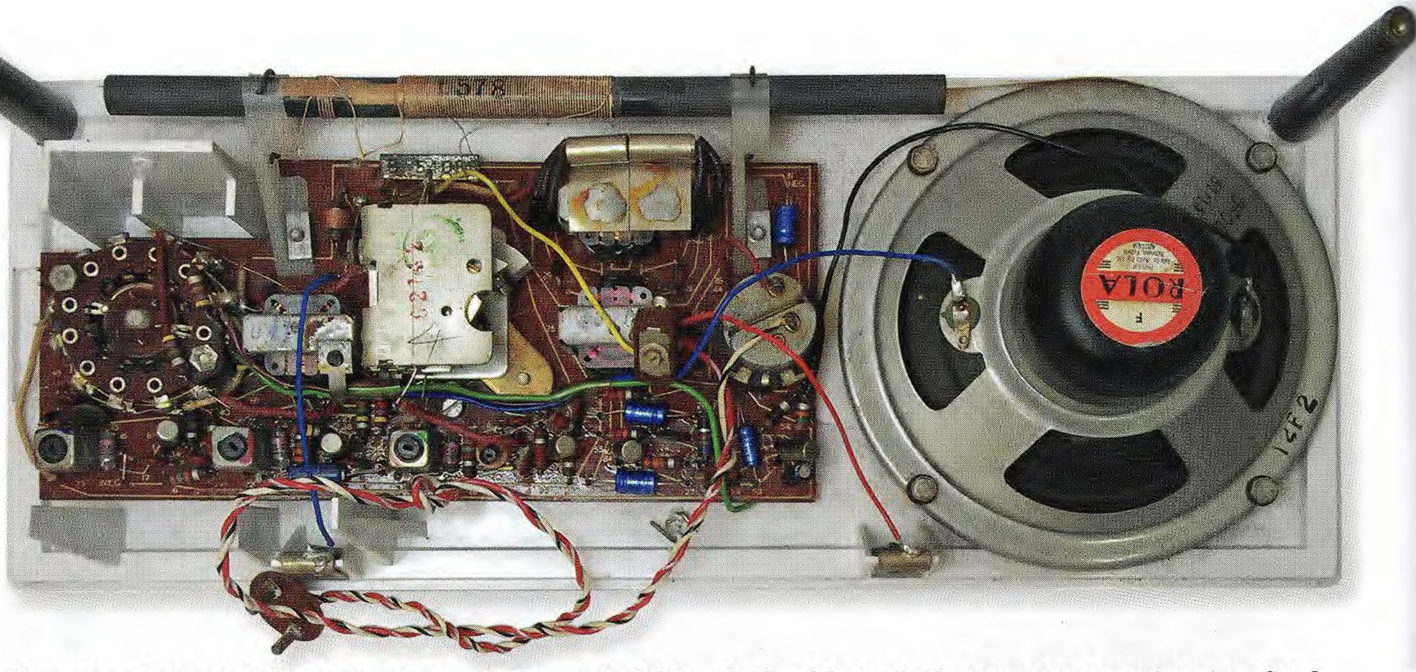
While such connections are always welcome, you'd need to be a long way from the station before this sensitive set needed external assistance.

Fig.1 shows the full circuit and as with other Astor radios, each component has a simple "hash" number. All the transistors are PNP germanium types while the two diodes are also germanium.

However, the battery supply is unconventional, with positive Earth and the circuit has been drawn to show conventional flow from positive to negative, "up the page".

A comparison with the circuit of the Astor M5 featured in the September 2016 issue shows that it is quite similar to that of the M2 model, with the exception of the M2's Class-B audio output amplifier; more correctly termed "Class-AB" because the output transistors do have a small bias to provide quiescent current.

The self-oscillating converter #78, a 2N412, uses collector-emitter feedback with the incoming RF signal applied



The large rotary switch for the function control is on the left hand side of the PCB. The two output transistors are fitted with flag heatsinks which have been soldered to the frame of the output transformer. This photo was taken after replacing numerous electrolytic capacitors.

to the base of the converter (from the ferrite antenna via 10nF capacitor #3). Like almost all such converters, no AGC is applied to this stage.

The tuning gang uses a cut plate oscillator section, so there is no padder capacitor.

The converter feeds through oscillator coil #70's primary to the primary of first IF transformer #71. Its tuned, tapped primary couples to the untuned, untapped secondary.

The first IF amplifier (#80), a 2N410, gets its bias via a 150kΩ resistor (#47) connected to the +9V supply. It is neutralised via an 8.2pF capacitor. Its output goes to the second IF transformer's tuned, tapped primary and its untuned, untapped secondary feeds the second IF amplifier, another 2N410 (#81).

Astor recommended that both IF transistors are picked from the same gain group.

The 1st IF amplifier has AGC applied from the 1N295 detector diode (#82) via a 4.7kΩ resistor (#46). This directly controls the amplifier's gain, and brings AGC extension diode #79, another 1N295, into action with stronger signals.

It's the conventional "Mullard" design, allowing the set to respond to varying signal strengths with a near-constant output level.

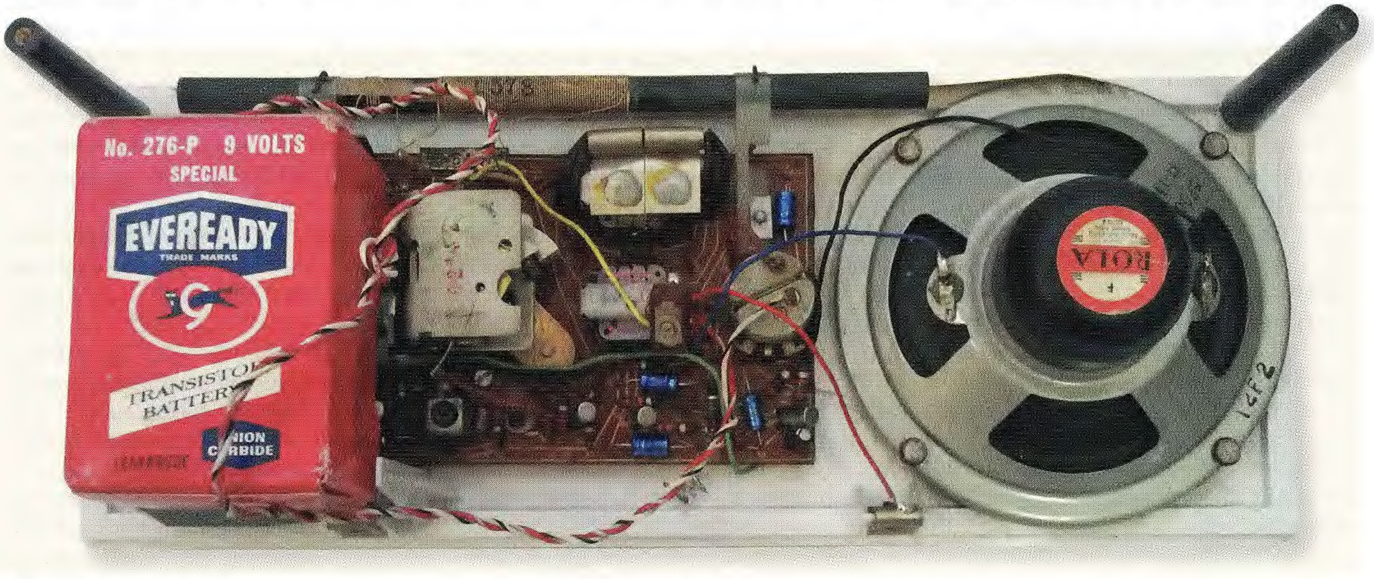
The 2nd IF amplifier is neutralised via a 27pF capacitor (#15). Its value is some three times that of #7, necessary since #15 is fed from the IFT's secondary rather than the primary as with the 1st IF amplifier's #7.

As well as providing the AGC signal, diode #82 provides the demodulated audio signal which is filtered by two 10nF capacitors (#18 and #19) and a 220Ω resistor (#48).

The recovered audio signal is fed to the 10kΩ volume control via a 2μF capacitor and a section of the 4-pole function switch wiring when set the "radio" position.

Audio stages

The audio section of the M2 radio comprises three stages, with the first two 2N406 audio transistors, #83 and #84, operating in a high-gain, direct-



The Aegis branded extension speaker is clearly not the original Astor-branded speaker which was made by Rola. It was supplied with 23m of 2-core flex and it could be used as a baby monitor, extension speaker or as an intercom.

coupled configuration and with DC feedback applied from #84's emitter to #83's base, with the actual voltage picked off from the 330Ω/680Ω (#56/#57) voltage divider. Some local negative feedback is applied across driver transistor #84 via 100kΩ resistor #59.

Both the emitter circuits are bypassed for audio, with transistor #83 having a 10Ω resistor (#54) allowing overall AC feedback to be applied from the speaker output via a 15kΩ resistor (#66).

Transistor #84 feeds the primary of driver transformer #75 and its centre-tapped secondary feeds the two output transistors, #85 and #86. These two OC74s drive the output transformer in push-pull fashion.

They are fitted with flag heatsinks soldered to the frame of the output transformer, giving a large thermal mass to help keep transistor junctions at a constant temperature.

The bias for the output transistors is derived from a voltage divider comprising resistors #62 (10kΩ) and #65 (560Ω) combined with a negative temperature coefficient (NTC) thermistor (#64, 220Ω) to give temperature compensation.

It's the usual arrangement whereby the thermistor reduces bias at higher temperatures to prevent excessive current in the output stage.

This bias network cannot compensate for falling battery voltage and nor can the bias be optimised for individual transistors. This is borne out by the small amount of crossover distortion present even at full battery voltage.

Local feedback is provided by 10nF capacitors #28 and #29 from the collectors to the bases of the output transistors, with further treble cut provided by 10nF capacitor #30.

Monitoring and intercom

Position 3 of the function switch sees a 470Ω resistor (#49) in series between the volume pot's wiper and audio input, with #88/b also connecting a 470Ω resistor (#45) to the audio input via the 2μF capacitor to the base of transistor #83.

This allows audio from the external speaker (operating as a microphone, stepped up by 2kΩ:15Ω matching transformer #74) to be passively mixed with the audio coming via the volume control.

Thus, while it's possible to adjust the level of the radio program, audio from the remote speaker is conveyed at maximum gain.

Position 4 of the function switch removes the radio program but connects to the matching transformer's secondary and conveys its signal to the volume control, while #88/b shorts out resistor #49 to deliver the full signal to the audio amplifier. The set is now a conventional intercom in the "listen" position.

Signal direction, from the external speaker to the internal speaker, is controlled by #88/c conveying the amplifier's output to the internal speaker, and #88/d connecting the external speaker to the input of matching transformer #74.

Position 5 selects "talk" operation. Switch #88/c connects the internal speaker to matching transformer #74 to allow the internal speaker to act as a microphone, while #88/d sends audio output to the external speaker.

Fixing it up

As presented to me, the M2 needed only a light clean and polish to make it sparkle but electrically it was dead. However, my Local Oscillator test brought out that "swishing" sound from my bench radio, so it looked like an audio problem.

Homing in on and replacing electrolytic coupling capacitors #20 and #23 brought immediate results. For good measure, I replaced bypass caps #9, #26 and #31, and got improved performance with emitter bypasses #25 and #27.

Poor quality manufacture? Well, the set had probably been sitting unused for some decades and it's too much to expect the chemically-formed dielectric to persist for so long with no refreshing.

I did try reforming the capacitors but with no success. I'm also pessimistic about the long-term stability of such old components anyway.

If you're having difficulty getting axial-lead electrolytic capacitors, both low-voltage (transistor radios, valve cathode bypasses) and high-voltage (valve power supplies) types are available from local surplus stores and online.

A tip though: chatting with one local store revealed that axial electrolytics are getting harder to find. I found a range of axial electrolytics at Rockby Electronics in Melbourne. You might like to check out their online catalog.

How good is it?

The Astor M2 is right up there with the best of the alloyed-junction germanium designs. Its sensitivity is aided by the high-gain, three-stage audio section.

For 50mW output, it needed around 45μV/m at 600kHz and 35μV/m at 1400kHz, but at signal-to-noise (S/N) ratios of only -7dB and -10dB, respectively. For the more usual S/N value of -20dB, the equivalent signals were 90μV/m at 600kHz and 65μV/m at 1400kHz.

At the antenna terminal, it needed only 8.5μV at 600kHz and 12μV at 1400kHz, for S/N ratios of -9dB and -10dB. For the usual -20dB ratios: 16μV and 21μV, respectively.

IF bandwidth is ±1.5kHz at -3dB down and ±24kHz at -60dB down. AGC allows some 6dB rise in audio for a 50dB signal increase. I did finally get it to overload at around 200mV/m; an exceptional performance.

Audio response from antenna to speaker was 50Hz to 1500Hz, with a peak at about 80Hz. From volume control to speaker, it's 65Hz to 7800Hz.

From the monitoring speaker input, it's around 135Hz to 8500Hz, with a 7dB peak at 5kHz. This may be due to input transformer resonance but it would help compensate for the monitor speaker's expected weak high-frequency response.

At 50mW, audio distortion was commendably low, at only 0.8% but it rose to 1.5% at 10mW, with discernible crossover distortion. This confirms the limitations of non-adjustable bias circuits.

It went into clipping at 400mW, with 10% distortion at 500mW. At a low battery voltage of 4.5V, it clips at 80mW, with around 5% THD at 50mW, noticeably crossover distortion.

As a radio, it's great. And for its special features, it's equally so. The remote speaker input gives 50mW out with only 250μV of audio input at full volume.

Women's Weekly, 18th July, 1962: https://trove.nla.gov.au/aww/read/222697

This is certainly adequate to pick up sounds from the monitor speaker, even with "house-length" runs of common speaker cable. In fact, the radio was supplied with 75 feet (23m) of 2-core flex for this purpose.

Whether used as a portable radio, nursery monitor or as an ordinary intercom, the audio section's high sensitivity and generous audio output mean that it easily fills the bill.

Would I Buy One?

That's tempting but I'd like to get an M2 with the original Astor speaker. While the substitute Aegis monitor works just fine, there's no substitute for the genuine article (actually made by Rola).

If you happen to have either the complete radio-and-speaker kit that you'd like to move on, or even just the speaker, please drop Graham or me a line via Silicon Chip ([02]9939-3295 or silicon@siliconchip.com.au).

Acknowledgement:

Special thanks to Associate Professor (retired) Graham Parslow of the HRSA, for this interesting example of fine Australian engineering and manufacture.

Further reading

You will find the circuit and service info on Kevin Chant's excellent site at www.kevinchant.com/uploads/7/1/0/8/7108231/m2a.pdf SC