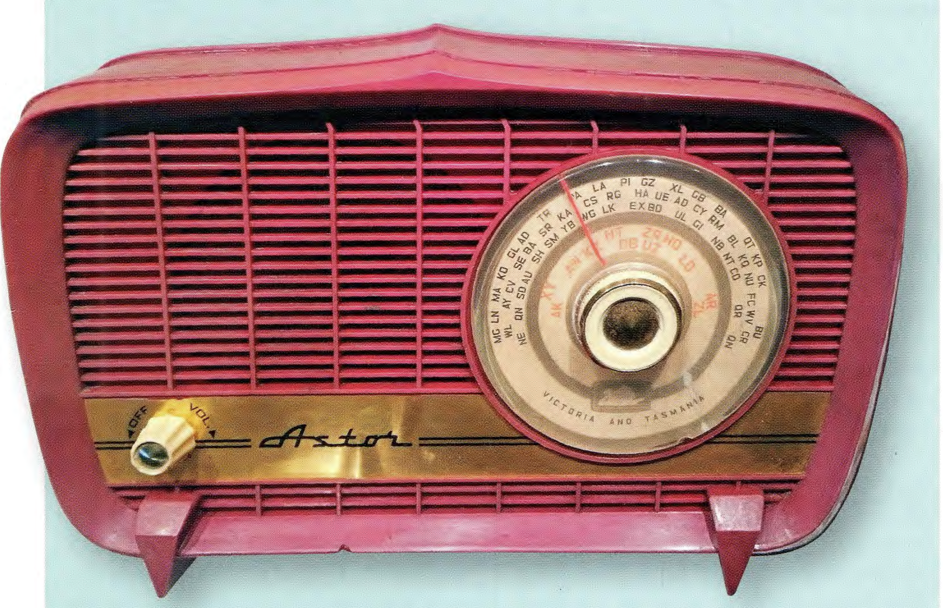
By Ian Batty



The Valve Mantel's Last Hurrah: Astor's DLP 2-Valve Receiver

Despite having just two valves, Astor's "cheap and cheerful" DLP mantel set still offers reasonable performance. It's a budget-priced set with some unusual design features and was designed to compete with early but still relatively expensive transistor portables.

SUPER-SIMPLE sets appeared quite early in the development of commercial receivers. Advanced sets were always more expensive compared to basic designs, so simpler sets attracted home constructors wanting their share of the "miracle" of radio.

Four and 5-valve superhet sets had become the design standard by 1940 but post-WW2 austerity led manufacturers to offer cut-down designs to keep prices low. Greater design complexity subsequently returned in the 1950s but a new challenge to valve radios emerged later in the decade with the introduction of the transistor.

Valve set manufacturers were stuck; they could survive either by offering high-end prestige designs or by offering "cheap and cheerful" sets aimed at undercutting the initial relatively high prices of transistor radios. The portability of transistor sets, for example, simply didn't justify their greater cost for those who simply wanted a kitchen mantel set that would sit on the fridge week after week.

The Astor DLP is one such cut-price kitchen mantel that was intended to compete with the early transistor portables. It uses just two valves but just how good is it?

First impressions

The Astor 3-valve DLP is built on a punched metal chassis with point-to-point wiring on tagstrips. Unusually, it sits at an angle within its moulded plastic case, as shown in one of the photos.

The controls are quite simple and consist of nothing more than a Volume/On-Off control and a large tuning dial with a 180°+ span. The dial directly drives variable-inductance coils to tune the aerial and local oscillator (LO) circuits (ie, this set uses permeability tuning rather than a variable tuning capacitor).

Circuit description

With three valve functions in just two "bottles", this must be the ultimate economy set, especially considering that it's a superhet design to boot. The cut-price features start with the tuned circuits – permeability tuning is cheaper to manufacture than a high-precision variable capacitor. In addition, permeability tuning systems are generally more robust than systems using conventional tuning gangs which are susceptible to corrosion, dust, dirt and mechanical wear.

As with other Astor sets, the original circuit diagram simply numbers the components in order. For example, the capacitors are numbered in order from largest non-electrolytic to smallest, with the electrolytics next and then the resistors (note: item #17 is not listed on the DLP's circuit).

It's an elegant method that aided assemblers during manufacture; they simply had to install numbered items

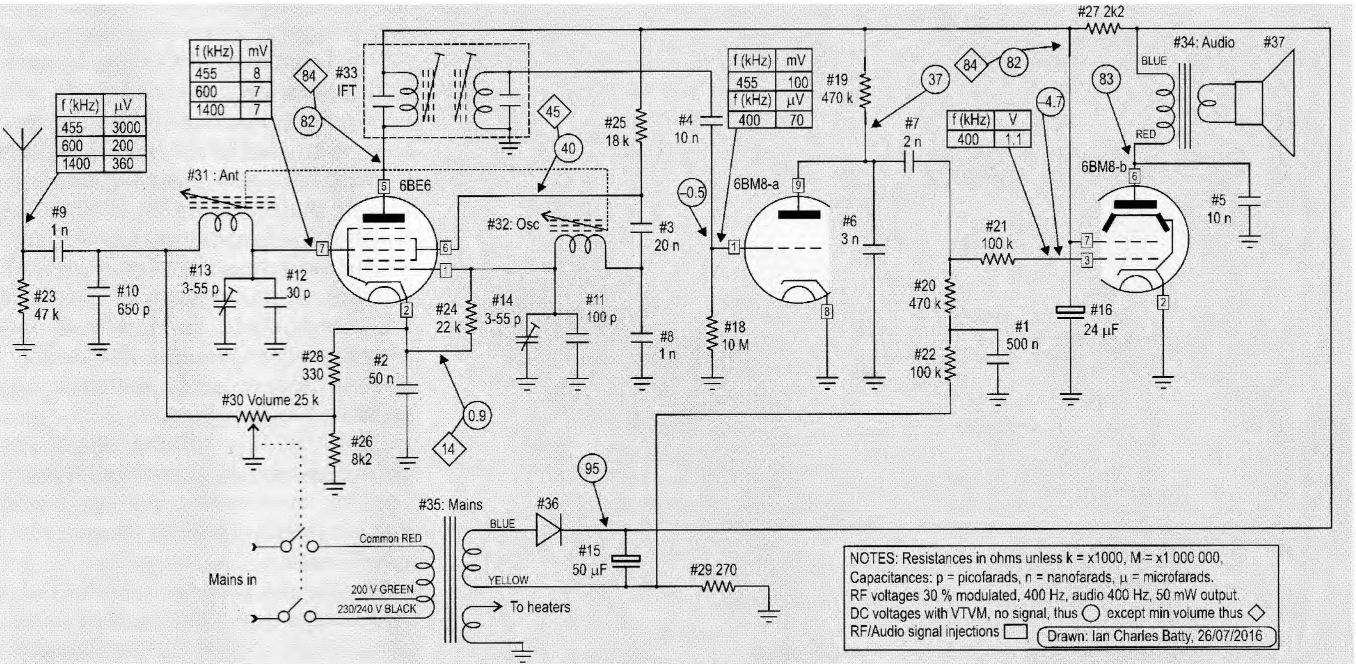


Fig.1: Astor's DLP mantel set is a superhet design using just two valves: a 6BE6 pentagrid converter stage and a 6BM8 triode-pentode which functions as a demodulator/audio preamplifier (6BM8a) and as an audio output stage (6BM8b). There's no IF amplifier stage, so the set's sensitivity is somewhat lacking compared to most other valve sets.

from bins in their appropriate locations in the chassis.

Fig.1 shows the circuit of the Astor DLP. It lacks of an IF amplifier stage and this, coupled with a low high-tension (HT) voltage (just over 80V), would seem to be a recipe for "radio deafness". If this cheap-and-cheerful set is to give any reasonable performance, Astor's designers must have pulled some magic tricks. But what were they?

The converter, a 6BE6 pentagrid, has a typical conversion conductance of some 450 microsiemens. In practice, a (high) IF primary impedance of 100kΩ would normally give a voltage gain of around 45, assuming plate and screen voltages of 100V.

This set, however, only applies some 40V to the screen and lowering the screen voltage causes a significant gain reduction in all screen-grid valves. So does the aerial circuit help compensate for the lack of gain in the converter stage?

Harking back to tuned circuit design in transmitters, capacitors #10, #12 & #13 in this set form a tuned circuit with variable inductor #31. As shown, the signal from the aerial is fed via capacitor #9 and appears across 650pF capacitor #10. This is paralleled by tuning inductor #31 and capacitors #12 and #13.

Basically, it's the classic Pi filter arrangement. In domestic radios, this configuration is commonly used as a power supply filter, to smooth the rectifier's pulsating DC output. Valve transmitters also commonly use a Pi filter to present a load of "a few" kilohms to the final power amplifier and to provide an impedance step-down to the antenna connection (usually 50 ohms). Conversely, transistor transmitters may use it to step impedances up, from a few ohms at the output stage collector to the 50-ohm antenna.

In the Astor DLP set, the capacitance ratio is roughly 650pF to some 40pF. This gives an input-output voltage ratio of around 1:15 by virtue of the capacitive reactance being inversely proportional to the capacitance. You can think of it as a step-up tuned circuit and we'll confirm its operation in the "How Good Is It?" section later on.

Another Pi filter is used in the local oscillator which is configured as a classic Colpitts circuit. Capacitor #3 (20nF) provides DC blocking in the feedback path from the converter's screen (LO plate) to its grid. The oscillator circuit is tuned by variable inductor #32 and capacitors #8, #11 and #14.

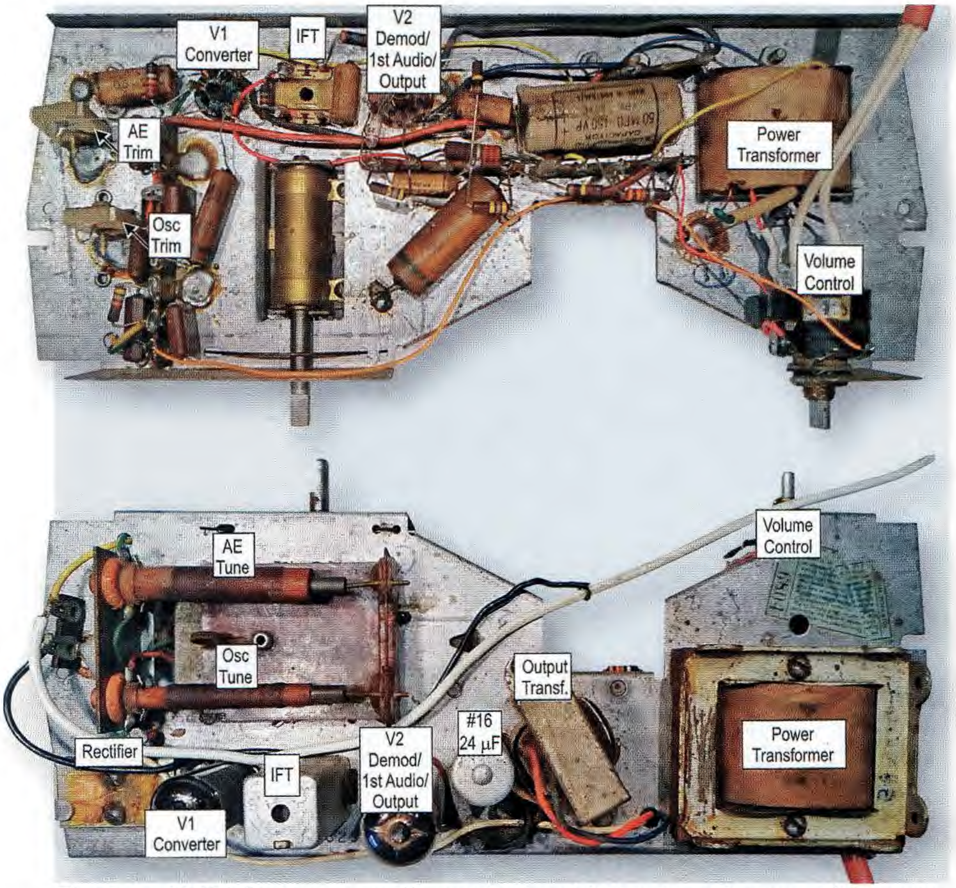
The capacitance ratio of capacitor #8 to capacitor #11 and trimmer capacitor #14 is approximately 10:1. This creates a step-up between the converter's screen (acting as a plate) and the oscillator's grid (grid 1) and ensure that the converter oscillates. Trimmer #14 sets the top of the LO's frequency span.

Potentiometer #30 (25kΩ) functions as the volume control. Its circuit arrangement is similar to sets of the 1930s that commonly used no AGC. As shown, one end of potentiometer #30 connects to the aerial input circuit, while the other end goes to the converter's cathode via resistor #28. Its wiper goes to ground.

When the volume pot is turned fully clockwise, its righthand end is connected to ground, leaving only the converter's 330Ω cathode resistor (#28) in the bias circuit. As a result, the converter's gain will be at maximum, while shunting of the aerial circuit will be at a minimum. The set's overall gain will thus be at maximum.

Conversely, when the pot is fully anticlockwise (ie, just before switching off), the pot's full resistance (shunted by 8.2kΩ resistor #26) will be in series with the 6BE6's cathode. As a result, the converter's gain will be at a minimum and the pot shunts the input signal from the aerial to ground.

A final wrinkle here is that the oscillator section is biased by the voltage across 22kΩ resistor #24 due to the grid current. However, it should be



The Astor DLP is built on a small, punched metal chassis with many of the parts mounted on tagstrips. The on/off switch is on the back of the volume control and as with all mains-powered sets, the condition of the mains wiring should be carefully checked before applying power.

noted that any change to the oscillator's bias will affect its operation and drag it off-frequency due to its input impedance (especially) changing with plate current. That in turn would mean that changing the volume would detune the set.

As a result, the bias must be undisturbed by other circuit changes and so the other end of resistor #24 is connected to the converter's cathode. This means that even though volume control pot #25 can raise the converter's cathode by some 12V above ground, the oscillator's bias conditions remain unaffected.

Audio stages

The two audio stages are based on a single 6BM8 triode-pentode valve. This valve combines a high-mu triode for audio preamplification with a power pentode capable of 3.5W output with a 200V HT supply.

So where's the demodulator? The answer is that the triode section uses 10MΩ grid resistor #18 to create "contact potential" bias. This method exploits the tendency of a valve's control grid to drift negative under the influence of the electron "cloud" (space charge) created by the heated cathode.

What this also does is reduce the valve's plate current to a low value. Applying a large IF signal to such a circuit will therefore bias the valve into cut-off on the negative peaks. It's the classic "grid leak" demodulator seen in early radios, either as a straight demodulator or with regeneration applied in Reinartz circuits.

Basically, this simple circuit combines demodulation with audio amplification, overcoming the attenuation that a conventional diode demodulator would create.

The output stage is back-biased by the voltage developed across resistor #29 (270Ω). This back-bias supply is filtered using 100kΩ resistor #22 and 500nF capacitor #1.

With only 90V HT available, the 6BM8's pentode bias is reduced from the more usual -16V to just -5V. As a result, this stage has a maximum audio output of just 300mW.

Power supply

The half-wave power supply uses selenium "flat pack" rectifier #36. Its output is filtered by 50µF capacitor #15 to produce the main HT rail, while resistor #27 and capacitor #16 (24µF) provide further filtering for the output stage screen and for the audio preamp and converter plate circuits.

The set's total current drain is only about 20mA, so rectifier #36 and power transformer #35 have an easy life.

Cleaning up

As it came to me, the set's plastic cabinet had badly faded, a common problem with economy designs. I was hoping that the fading was only "skin deep", so I initially hit it with some heavy-duty abrasive in an out-of-the-way place. This revealed that the fading was only some micrometres deep, so it will be possible to successfully restore the cabinet by simply polishing away the faded material.

This will need a day or so's work with suitable tools and materials but it's a practical alternative to spray painting.

The set also proved to be in non-working order. When I applied power, there was no audible output and while I

Identifying A Mystery Set

When I first obtained this set, it had no manufacturer's label and so its model number was a mystery. Fortunately, if you can't identify a set, you can always refer to Ernst Erb's Radiomuseum website (see "Further Reading" panel) which has an extensive listing of radios from around the world.

In this case, I knew that the set was a 2-valve Astor model. After bringing up the Radiomuseum website, I went to the Advanced Search pane, typed "Astor" for the manufacturer and hit "Go". This brought up almost 500 results but hitting the "Model Name" heading gave me a sorted list that I was easily able to scroll through. My 2-valve set (6BE6, 6BM8) turned out to be the DLP from around 1960.

After later cleaning the set, I eventually did discover a chassis stamping that also identified the set. Still, it's good to know that there are other ways of identifying a "mystery" set.

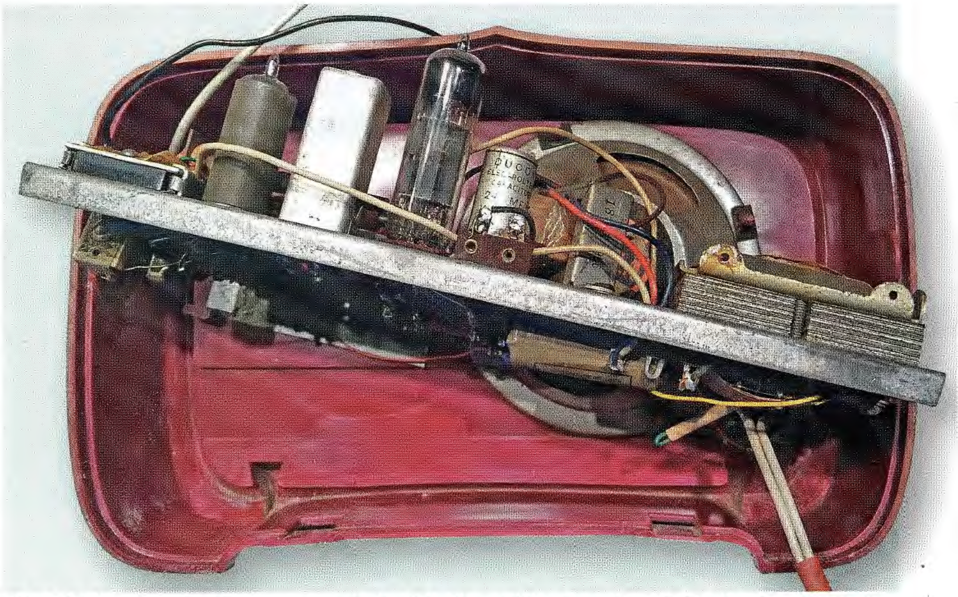
really didn't expect the usual between-station noise with a set this old before restoration, I did hope for something.

Applying several hundred millivolts of IF signal to the demodulator's grid did, however, result in useful output from the speaker and I also found that a strong IF signal would find its way through from the aerial terminal. This indicated that the converter stage wasn't working properly, probably due to an inoperative local oscillator (LO).

The 6BE6 converter valve came up as weak on my valve tester but popping a known good replacement into the socket didn't improve things. It was time for some good old-fashioned circuit analysis.

I began by checking the voltages around this stage and this showed that both the converter's plate and screen voltages were at 0V. When I looked under the chassis, I discovered that the lead that connected the +84V HT to the converter stage had been neatly cut off at both ends (and the wire completely removed). Restoring this connection gave me a working set.

A quick tweak of the IF transformer proved fruitful and adjusting the two trimmer capacitors completed the circuit restoration. But why had the HT lead to the converter been cut? Who knows? It's a real mystery!



The DLP's chassis sits at an angle inside the cabinet so that it fits in the allotted space. This view shows the set prior to restoration. The 2-core mains flex was later replaced with 3-core mains cable so that the chassis could be earthed.

How good is it?

So just how well does it perform? The answer is that with just a few metres of aerial lead, it's not too bad.

Astor's alignment guide mentions the use of a "25 foot antenna" and that's pretty much an admission of low sensitivity. However, although it can't match more complex designs, Astor's DLP has an audio output of 50mW output for a 200μV input signal at 600kHz and a 360μV signal at 1400kHz. Signal-to-noise ratios exceed 30dB in both cases.

The IF bandwidth is commendable for a set with single IF transformer, being ±2kHz at -3dB and ±73kHz at -60dB. However, the audio frequency response from antenna to speaker measured just 100Hz to 700Hz, which is really quite poor.

So what could be done about it? Checking the circuit indicated that the 3nF filter capacitor at the demodulator's plate (#6) was likely to be the main culprit. While the narrow IF bandwidth wasn't going to allow a top end much above 2kHz, that 3nF capacitor just had to go. I normally resist the temptation to "hot up" equipment but substituting a 220pF capacitor extended the audio frequency response out to 1.6 kHz and resulted in a much "brighter" sound.

Overall though, the audio performance is modest. The output is just 330mW at 10% distortion and 50mW at about 4.5% distortion.

By the way, grid leak demodulators can potentially respond to strong signals by increasing their DC grid bias voltage, thereby reducing the stage gain. This set did show some gain reduction but only when operating at full volume and with aerial signals exceeding many tens of millivolts. Effectively then, the Astor DLP lacks any type of AGC.

Tested in my kitchen with a few metres of aerial wire, the set pulls in the usual ABC Melbourne stations plus a few regional stations. So despite its modest performance, it's still a very useful little set.

More on the aerial network

I initially thought that the aerial tuned circuit based on #10, #31, #12 & #13 would give a voltage step-up of perhaps 15 times. Subsequent measurements at 600kHz revealed that an input signal voltage of some 200μV was required for 50mW out, while an injection of 7mV at the converter's grid was necessary to give the same output. That represents a gain from the aerial terminal to the converter's grid of some 35 times. It's a neat trick – transformer/tuned circuit gain is essentially noise-free.

This aerial circuit gain is multiplied by the converter's gain of some 14 times (ie, from its grid to the demodulator's grid). Overall, from the aerial terminal to the demodulator's grid, the "RF section" manages a gain of around 500, so "hats off" to the designers.

Special handling

The Astor DLP uses two steel clips on the underside to hold the front and rear case halves together. Unfortunately, this particular set had suffered a breakage in the clamped area, either due to being dropped or careless clip removal. So take care when undoing the clips.

Note also that the alignment is done with a 200pF capacitor in series between the signal generator and the aerial terminal. In addition, Astor states that you should not attempt to adjust the two moving ferrite cores. SC

Further Reading

(1) For complete service data and the circuit, refer to Kevin Chant's website at www.kevinchant.com/astor1.html and search for "Astor DLP".

(2) You can also refer to Ernst Erb's radio museum for photos and circuit – see www.radiomuseum.org/r/astor_dlp.html