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## Roland SH101 & ARP Axxe Brass Synthesis

### Synth Secrets

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By Gordon Reid

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Figure 1: Top panel of a Roland SH101.

**Gordon Reid concludes his attempts to adapt an idealised analogue brass patch so that it can be programmed on real synths. This month, he looks at the Roland SH101 and ARP Axxe.**

Last month, I used the Moog Minimoog to create a patch designed to represent — as far as possible — the acoustic principles of brass instruments, as discussed in Synth Secrets 24 and 25. The result was a range of sounds that, despite several compromises, exuded the *essence* of brassiness, if not the exact timbre.

Unfortunately, not many people are fortunate enough to own a Minimoog. Only 12,000 or so were ever made and, on those rare occasions that one appears for sale, the price tag is often in the region of £1,000... which puts it beyond the reach of most players. Cheaper, less endowed synths are far more common, so you're much more likely to own, for example, a small Roland than any Moog. But does this mean that brass sounds are the preserve of the fortunate few? Not a bit of it! This month, I'm going to take what is perhaps the most popular analogue monosynth of our time — the Roland SH101 — and apply the same principles as last month.

## Comparing The Roland SH101 & Minimoog

Figure 1 (above) shows the top panel of an SH101 with all its controls set to zero. It doesn't look much like the Minimoog from last month, does it? That's not surprising... much of its architecture is unlike that of the Moog. On the other hand, there's a surprising amount that's similar, and some that is identical. So, before going any further, let's compare the two synths, and get to grips with the problems you might encounter as you try to translate a patch from one to the other.

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Starting on the left, and ignoring trivia such as tuning knobs and On/Off switches, both synths offer a Modulation section. However, whereas the Minimoog limits you to using Osc3 and/or the noise generator as a modulator, the SH101 offers a dedicated LFO. This offers just four modulation waveforms (compared to the six on the Minimoog's oscillator) and is strictly low frequency... you cannot use it for two-operator FM synthesis as you can Osc3 on the Minimoog. Furthermore, noise is an LFO waveform, so you can't mix this with the cyclic waveforms as you can on the Moog. But on a positive note, the SH101 has a modulation option called 'Random', which is a Sample & Hold generator clocked at the LFO rate. This makes possible a number of effects that you cannot obtain from the Minimoog.

Moving to the right, you come to the synths' Oscillator sections. The major difference here is obvious: whereas the Minimoog has three audio frequency oscillators, the SH101 has just one. However, Roland has minimised the shortcomings of this by allowing you to modulate the pulse width of the square waveform using the LFO or the envelope generator. This means that the SH101 can produce a range of rich, chorused sounds that you can't obtain from the Minimoog. Furthermore, whereas the Minimoog has just a toggle to control the amount of Oscillator Modulation (vibrato), the SH101 has a dedicated control that allows you to apply as much or as little as you require.

Because the SH101 has just a single oscillator, you might think that it needs no Mixer. However, the oscillator in the Roland produces three waveforms simultaneously — a sawtooth, a pulse wave, and a square sub-oscillator — and the Mixer is where you recombine them. With a separate noise generator as well, the SH101's architecture may not be as flexible as the Minimoog's, but it's not shoddy either.

Next come the synths' 24dB-per-octave low-pass filters. Like the Minimoog, the SH101 offers control over the cutoff frequency, the resonance ('Emphasis'), and the amount of contour, but it also has variable controls for modulation and keyboard tracking. Unfortunately, whereas the Moog's filter has a dedicated ADS contour generator, the Roland's has to share its single ADSR with the audio VCA.

This brings us neatly to the VCA and its associated contour generator. On the Moog, the amplifier's contour generator is another ADSR gated by the keyboard. In contrast, the Roland has a true four-stage ADSR that can be triggered by the keyboard (Gate or Gate+Trigger) or by the LFO. Furthermore, you can disconnect the ADSR from the VCA by placing the switch into the 'Gate' position, thus leaving the contour generator free for purely VCF duties.

The last set of controls lies in the performance panel found to the left of the keyboard on both synths. The Minimoog has Pitch and Mod wheels, but the Roland is somewhat more flexible. You can set the maximum amount of pitch-bend and filter modulation produced by moving its bender controller in a left/right direction, and set the maximum amount of LFO modulation produced when you push it away from you. You have more control over portamento, too. Whereas the Moog offers a Glide rate control and an On/Off switch, the Roland adds an 'Auto' function, which applies portamento only when you hold two keys simultaneously.

The SH101 has one more trick up its sleeve. When you set the VCA mode to 'Gate', the synth responds to its keyboard in the same way as the Minimoog does. It is low-note priority and when you play, it only retriggers its contour generator after you have released all previous keys. But when you set it to 'Gate+Trig' it becomes last-note priority, and generates a trigger every time you press a note, or when you release a note to allow an older one to sound again. This type of response is of huge benefit for certain types of playing. Unfortunately, it is not available on the Minimoog.

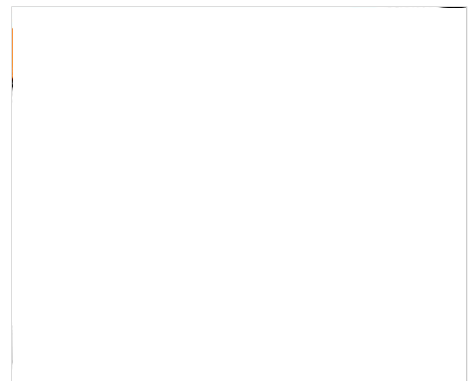
## The Brass Patch On The SH101

Now that you appreciate many of the differences between the two synths, you're in a position to think about defining the idealised brass sound using the more limited (single-oscillator, single-contour-generator) architecture offered by the SH101. Let's start by referring back to the block diagram for a brass patch, first shown in Part 25 of Synth Secrets (see Figure 2).

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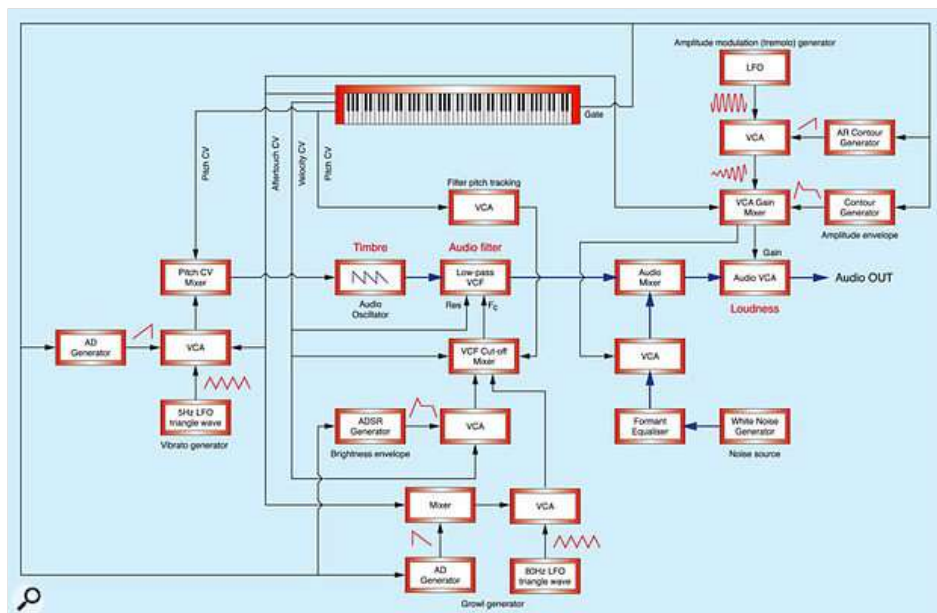


Figure 2: The block diagram for the brass patch from Part 25 of Synth Secrets.

Clearly, the SH101 has far too few component modules to recreate this in full, so I'll have to restrict myself to the most important elements of the sound. This means that the delayed vibrato to the left of Figure 2 will have to go. Similarly, the shaped noise is a goner. As for the tremolo and some of the complexities of the growl generator... sorry chaps, but there's no place for you, either. So what can I do?

Fortunately, the idealised brass patch requires only one oscillator, so the SH101's limitation in this area doesn't affect the sound. I can select the 4' range in the VCO section, and raise the sawtooth volume fader in the Mixer to allow this waveform to enter the signal path. At the same time, I must make sure that the pulse, sub-oscillator and noise faders are at zero, or these waves will change the fundamental nature of the sound, making it unsuitable for brassy timbres (see Figure 3). I'll also set the Month's sound, this patch will have no LFO-driven

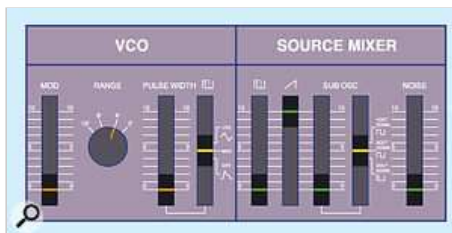


Figure 3: The SH101 oscillator and mixer settings.

Since I'm using only the sawtooth wave, I can ignore the Pulse Width controls in the VCO section (they affect only the pulse wave) and the sub-oscillator waveform selector in the Mixer.

## Shaping The Waveform — Loudness & Tone

Again, it's time to filter and shape the sawtooth waveform. You'll remember that last month I used the contour generator in the Loudness Contour section to generate an envelope with a short Attack and instantaneous Release. At the same time, the contour generator in the Filter section generated a more 'shaped' contour to determine how the tone changed over time (see Figure 4). Well... this can't be done on an SH101, because it only has one contour generator.

However... I've already mentioned that you can disconnect the SH101's VCA from its contour generator, and connect it directly to the Gate from the keyboard. This means that I can create the loudness contour shown in Figure 5, which is close enough to the Minimoog contour to give the result I want. I have shown the control panel setting for this in Figure 6 (below).

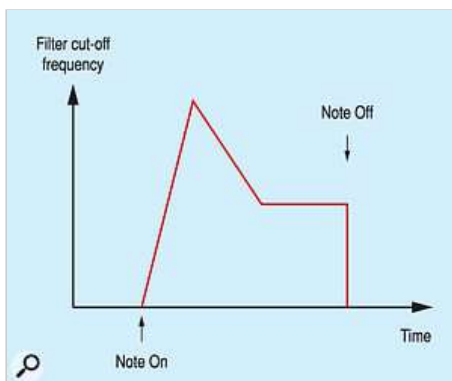


Figure 4: The desired filter contour for the SH101 brass patch.

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Returning now to the filter contour, the SH101 has a distinct advantage over the Minimoog... it has a dedicated Release stage in its contour generator. You might think that there's no point in setting the release slider to anything other than zero for this patch, since the gain of the VCA will return to zero the moment you release the key. However, the SH101 envelope is very rapid, and you can hear it snap shut when the Release is set to zero (many novices complain that the contour generators on their synths generate 'clicks' when the Attack and/or Release controls are set to low values, not realising that this is a compliment to the electronics, not a fault). Setting the Release fader to '2' gives a nice, smooth tail to each note.

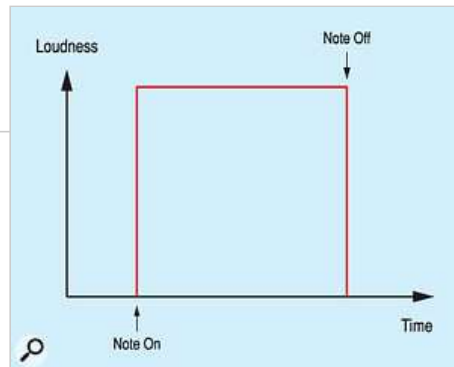


Figure 5: The loudness envelope generated by connecting the Gate to the VCA.



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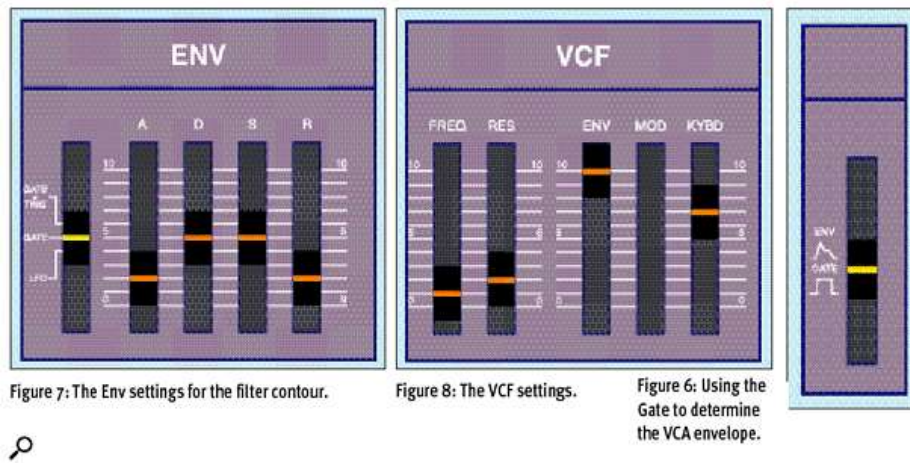


Figure 7: The Env settings for the filter contour.

Figure 8: The VCF settings.

Figure 6: Using the Gate to determine the VCA envelope.

Figures 6, 7 and 8: Gate, Env and VCF settings, respectively.

This brings me to some thoughts about how brass players move between notes. If they are tonguing notes, there will be a short break between each, and you must play the keyboard in a slightly staccato style to emulate this. However, if the player is using a valve instrument, and presses a valve to change pitch, the transition will be smoother. (Actually, it could be very uneven because the player's lip tension is no longer appropriate to the length of tube... but that's not a discussion for today.) Anyway, the important point is that there will be no re-triggering of the notes' contours in this case. This means that I must set the filter contour to respond to Gate only, and not Trig. The Env settings are therefore as shown in Figure 7 (above).

Of course, all these settings will be useless if the VCF itself is not set up correctly. It needs to be almost closed at the start of the note, and should open a great deal during the Attack phase of the envelope. This means that the Freq slider in the VCF section must be close to zero, and the Env fader must be at or near its maximum. Furthermore, as you should know from the theory explained two months ago, there must be just a touch of resonance to create the correct harmonic profile, and the cutoff frequency must track the keyboard at a little less than 100 percent. If I ignore the Mod fader, this allows me to define the VCF section as shown back in Figure 8 (above).

Now for some bad news. Like the Minimoog, the SH101 has only one source of modulation. This means that I must make a choice. Do I want to use the Modulator to add gentle vibrato to the patch, or the more dramatic 'growl' that is so effective in brass patches? Clearly, by the way I've worded that sentence, it's the latter. But, since the SH101 lacks the EGs and VCAs needed to control the growl, I will have to do this manually, using the Mod fader in the VCF, adding modulation at the start of the note and removing it as the note approaches its steady state. I find that an initial setting of about 60 percent works well, reducing this to 0 percent by the time the filter contour reaches the Sustain Level (see Figure 9).

Of course, I also need to set the Modulator appropriately. Because the SH101 Modulator is purely an LFO, I do this by setting it at its highest rate. As for the waveform... I use the triangle wave, as I did on the Minimoog.

Last month, I showed that the Attack of the Loudness contour, coupled with the slower Attack of the Filter contour, allowed the harmonics to enter the sound at close to the appropriate rates, as defined by the analysis of real brass instruments (see Figure 10(a)). This month, I don't have the luxury of the VCA contour so, as shown in Figure 10(b), the lower harmonics enter rather too quickly (this is the consequence of the square loudness contour shown in Figure 5.)

The audible consequence of this is that the start of the note is rather less authentic than it was on the Minimoog. But... (and it's a big 'but') two things save the day. Firstly, no VCA responds instantaneously, so there is still a slight lag in the rise time of the loudness contour. Secondly, any residual deficiency can be masked using the growl effect described above.

Moving on, it would be nice to be able to add the shaped noise described in Part 25 of Synth Secrets. Unfortunately (and in common with the Minimoog's noise generator), the SH101's noise generator lacks the formant shaping of the turbulent noise in a real instrument, and sounds very unnatural. As on the Minimoog, it is best omitted.

It would also be beneficial to add delayed pitch modulation (vibrato) to the patch. And, yet again, I have run out of facilities... the SH101 has only one modulation source, so it isn't capable of this. At a pinch, I could try the same trick as last month, and use the pitch bender to add vibrato manually. If I set the VCO Bender fader to a small value, I can then move the Bender itself from side to side to create the desired effect (see Figure 11).

Unfortunately, this will be at the expense of the growl, because you can't play the note, manipulate the bender, and manipulate the Mod fader simultaneously. So the best you can do is play the notes and add *either* growl or vibrato, depending upon the requirements of the music.

Putting everything together into a single patch, Figure 12 (below), combines everything I've described. It looks very different from the Minimoog patch shown towards the end of last month's instalment of Synth Secrets, but the audible result is nevertheless as similar as it is possible for two such different synths to be. Moreover, although the SH101 is unable to recreate much of the patch in Figure 2, set up carefully and played sympathetically it can still sound remarkably brassy.

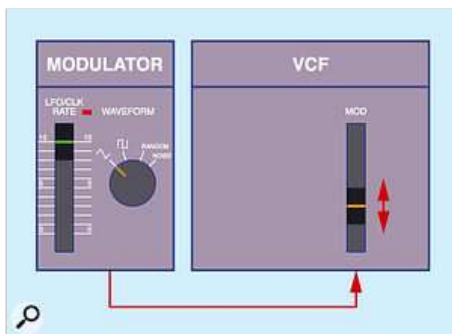


Figure 9: Applying rapid modulation to obtain growl at the start of the note.

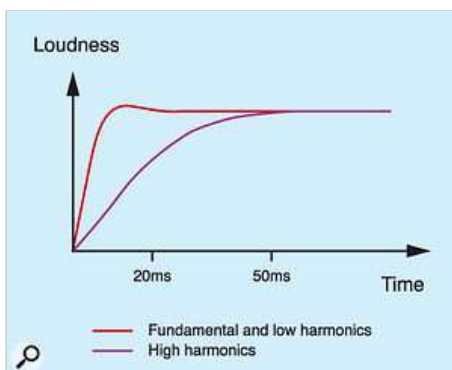


Figure 10(a): The ideal rise times for lower and upper harmonics.

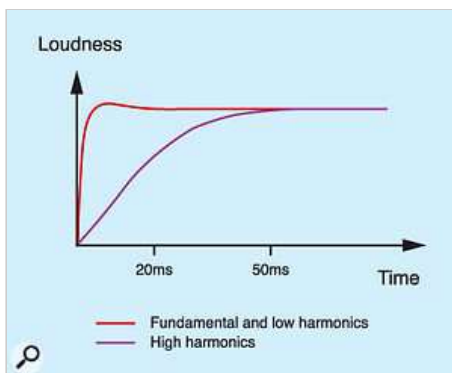


Figure 10(b): The SH101 response for lower and upper harmonics.

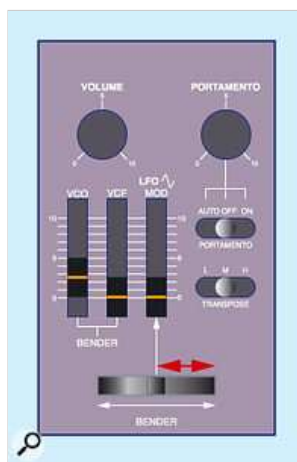


Figure 11: Adding a little manual vibrato.

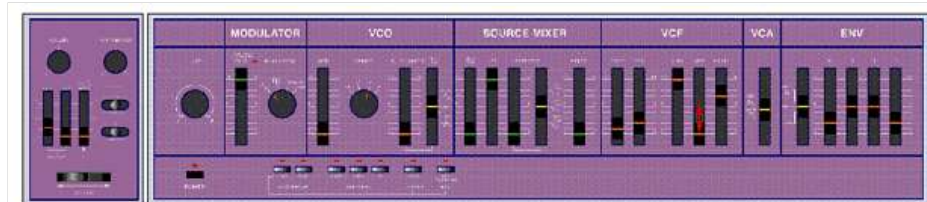


Figure 12: The SH101s brass patch. Note: the performance panel control has been placed at the right end of the diagrams on this page for clarity.

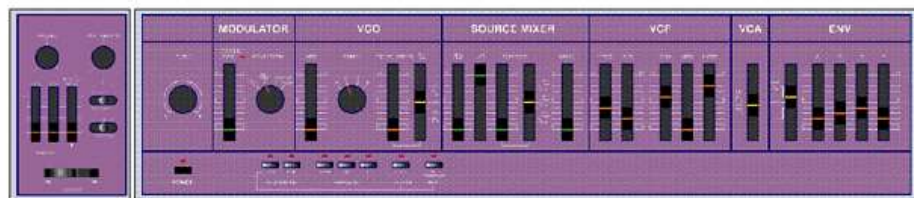


Figure 13: Roland's Trumpet patch for the SH101.

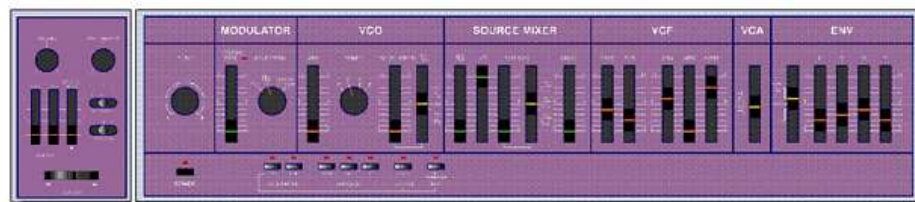


Figure 14: Roland's Tuba patch for the SH101.

Figures 12, 13 (trumpet) and 14 (tuba).

## Other SH101 Patches

Before leaving the SH101 behind, I thought that it would again be instructive to analyse a couple of the factory patches; one good, one bad. Let's start with Figure 13 (above): Roland's Trumpet patch in the original SH101 manual.

This is a very disappointing sound. The Attack/Decay stages of the Env are too short, the amount of Env control in the filter is too low, and the higher initial cutoff frequency allows too many harmonics through when you first press a key. Furthermore, there's no modulation, so there's no movement in any portion of the note. Yurgh!

The Tuba patch from the SH101 manual fares much better, and introduces another concept: that of adding different waveforms to achieve a particular timbre. Take a peek at the Mixer section in Figure 14 (above). You'll see that the sawtooth is present at 60 percent of its maximum, but that there's also a square wave sub-oscillator present, one octave down and at 100 percent of its full loudness. The result is the harmonic spectrum shown in Figure 15, and the waveform shown in Figure 16.

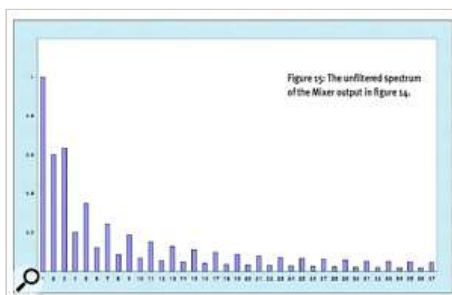


Figure 15: The unfiltered spectrum of the Mixer output in Figure 14.

As you can see, while remaining sawtooth-like, both the spectrum and the waveform are more complex than those of a simple sawtooth and, of course, the timbre changes appropriately. If you have access to an SH101, listen to the patch with the sawtooth alone (it lacks body) and then to the square wave sub-oscillator alone (it sounds hollow, and not at all brassy). In this patch, the combination of the waveforms defines the sound, almost as much as the filter and amplitude settings. This is something that will come up again in later parts of this series.

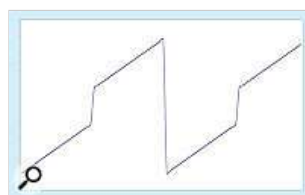


Figure 16: The waveform described by the spectrum in Figure 15.

## The Brass Patch On The ARP Axse

Figure 17 shows the control panel of the ARP Axse, another low-cost, single oscillator monosynth. At first sight, this appears to be very different from the SH101, but look more closely. There's just one voltage-controlled oscillator, which produces both sawtooth and pulse



waveforms simultaneously. There's also a noise generator, variable pulse width on the pulse (square) waveform, and pulse-width modulation courtesy of the LFO and the ADSR. The LFO produces sine, square, and S&H waveforms. You can modulate the 24dB-per-octave, resonant low-pass filter using the LFO and/or the contour generator, and it will track the keyboard in any amount from 0 percent to 100 percent. There's just a single contour generator, and it's a four-stage ADSR... The list goes on and on. Sure, there are differences between the Axxe and SH101 too. For example, the Axxe has no sub-oscillator, and like the Minimoog, it possesses an external signal input, not included on the SH101. Nevertheless, the important elements of the SH101 and the Axxe are the same.

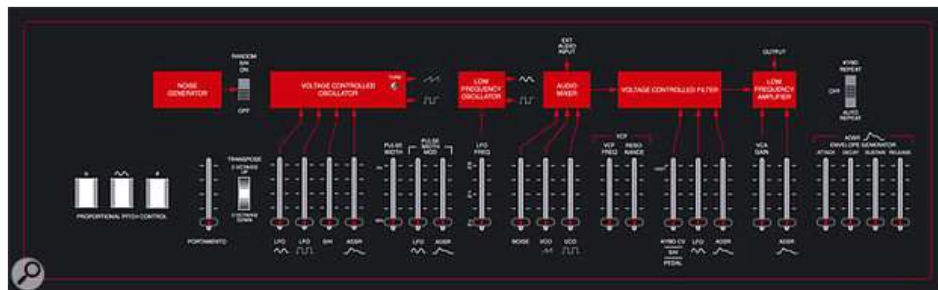


Figure 17: The ARP Axxe front panel.

So why do they look so different? The reason is simply one of presentation. The controls and panel graphics for the Axxe are based on ARP (ie. American) designs that first appeared on the ARP 2600 in 1970. In contrast, the SH101's panel is a development of the Japanese Roland Juno 6, which first hit the streets in 1981. Same facilities, different countries, different eras; hence the different appearance.

Now, ignoring these superficial differences, turn your mind back to brass patches. Logic tells you that, if the two synths' facilities are the same, I should be able to set up a brass patch on the Axxe, simply by remembering how I did so on the SH101.

Locating the Audio Mixer section on the Axxe, I find the sawtooth waveform produced by the VCO, and raise this to its maximum. At the same time (and for the same reasons as before) I must ensure that the square waveform and noise faders are at zero.

Next, I locate the five faders that control the Voltage Controlled Filter, and raise the VCF Freq (initial cutoff frequency) and the Resonance faders slightly. Then, I set the ADSR tracking fader to a high value, and the Kybd CV tracking to a moderate value. The sine wave LFO modulation fader can be left at zero.

Moving to the right, I raise the initial VCA Gain in the Voltage Controlled Amplifier. However, I leave the ADSR fader at zero. This disconnects the VCA from the ADSR, just as on the SH101.

Finally, at the far right of the panel, I set the ADSR Envelope Generator to something approximating the SH101's 20 percent, 50 percent, 50 percent, and 20 percent values.

Figure 18 shows the patch thus defined. If I now stop and play the Axxe, I'll find that I have something that sounds *similar* to the SH101 and Minimoog brass patches but, in a number of ways, isn't quite right. And, for some reason, there's some sound leaking through all the time... Arghh! The note never dies!

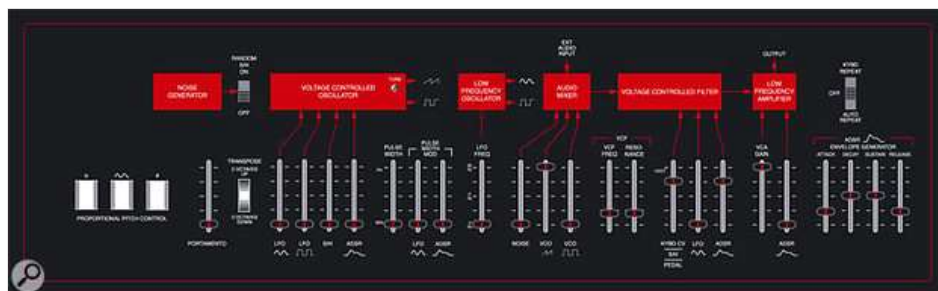


Figure 18: The idealised trumpet sound recreated on the ARP Axxe.

## Final Tweaks

Let's deal with the big problem first. There are apocryphal stories of ARP 2600 owners who, in the early days, contacted ARP to say, "Wow! It's amazing... but how do you make it stop?" The

reason lies in the combination of the VCA Gain and VCF Freq sliders. If the first of these is greater than zero, the VCA is always amplifying (ie. passing) any audio signal received at its input. This means that the only way to silence the sound is to remove all its harmonics using the filter. Therefore, I must reduce the cutoff frequency to zero between notes if silence is to reign, and I can do this by moving the VCF Freq slider to zero.

Unfortunately, this contravenes one of the principles of the idealised brass sound... that the fundamental should pass as soon as you play a note. So maybe a better compromise would be to reduce the VCA Gain to zero, and use the ADSR to open and close the amplifier. Now, the amplifier is controlled by the ADSR and, again, silence will reign between notes (see Figure 19).

Playing the Axxe patch again, it still isn't quite right. To understand this, you must remember that all synths are not created equal. The circuits within different models will respond to the controls in slightly different ways. So I must tweak the settings to obtain the right results on the ARP. In this case, I find it pleasing to increase the Decay time, reduce the Sustain Level, and reduce the ADSR CV in the VCF... all of which emphasise the initial parp of the brass sound.

One thing I can't do, however, is produce the filter rasp that was so successful on both the Minimoog and the SH101. This is because the LFO has a maximum frequency of just 20Hz, which is not fast enough to create the desired effect. However, the last thing I want is a static, boring sound, so I'll use the LFO to introduce a gentle vibrato — something that also sounds good on brass instruments.

I could do this by setting the LFO rate to around 5Hz, and by raising the LFO sine wave CV fader in the VCO (it's the second fader from the left). However, there's a better solution. This 'Mark 2' Axxe has Proportional Pitch Controls (PPCs) shown on the far left of the panel. When you press down on the middle one of these pressure-sensitive pads, it adds modulation, just like an aftertouch-sensitive keyboard. The PPC therefore allows you to add vibrato in a realistic fashion... it's far better than the fixed amount of low-frequency modulation that would have been introduced using the LFO slider.

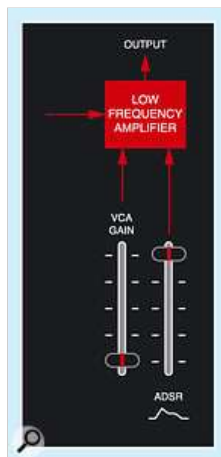


Figure 19: Silencing the ARP Axxe.

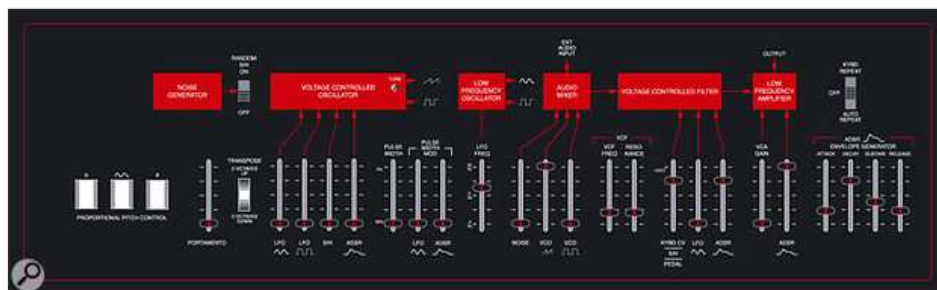


Figure 20: The final ARP Axxe brass patch.

The final Axxe brass patch appears in Figure 20, and you won't be surprised to learn that it sounds very similar to the both the Minimoog and SH101 patches. OK, so each of these synths has an individual character, and there are many analogue aficionados who could distinguish between them. But that's not the point. The important thing here is that I've succeeded in programming the same sound on all three instruments. Indeed, you may not realise it, but you've learned an important lesson over the past couple of months. It's this:

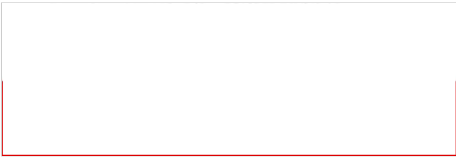
*Once you've learned how to create a brass patch on one synth, you can recreate it on any synth capable of doing so.*

So, whether you're programming a 1970s Minimoog, a 1980s Roland SH101, a 1990s Nord Lead or a 21st-century Access Virus Indigo, the principles for a given sound remain identical. Once you understand what it is that defines 'brassiness', you can program the equivalent patch on any subtractive synth. Neat, huh?

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