$AA5ATT := READPRN(AA5VIN)$

$AA5ORG := READPRN(AA5ORG)$

$AA51N34A := READPRN(AA51N34A)$

$AA51N34ADELAY := READPRN(AA51N34ADELAY)$

$AA51N34ADELAYNFB := READPRN(AA51N34ADELAYNFB)$

$AA5NFBRD := READPRN(AA5NFBRD)$

$F := last\left(AA5NFBRD^{\langle 0 \rangle}\right)$ $F = 7$ $f := 0..F$

$N := last\left(AA5ATT^{\langle 0 \rangle}\right)$ $N = 10$

$n := 0..N$

Joe Sousa
December 30th 2008
(share widely)

$BE6BA6 := READPRN(BE6BA6)$

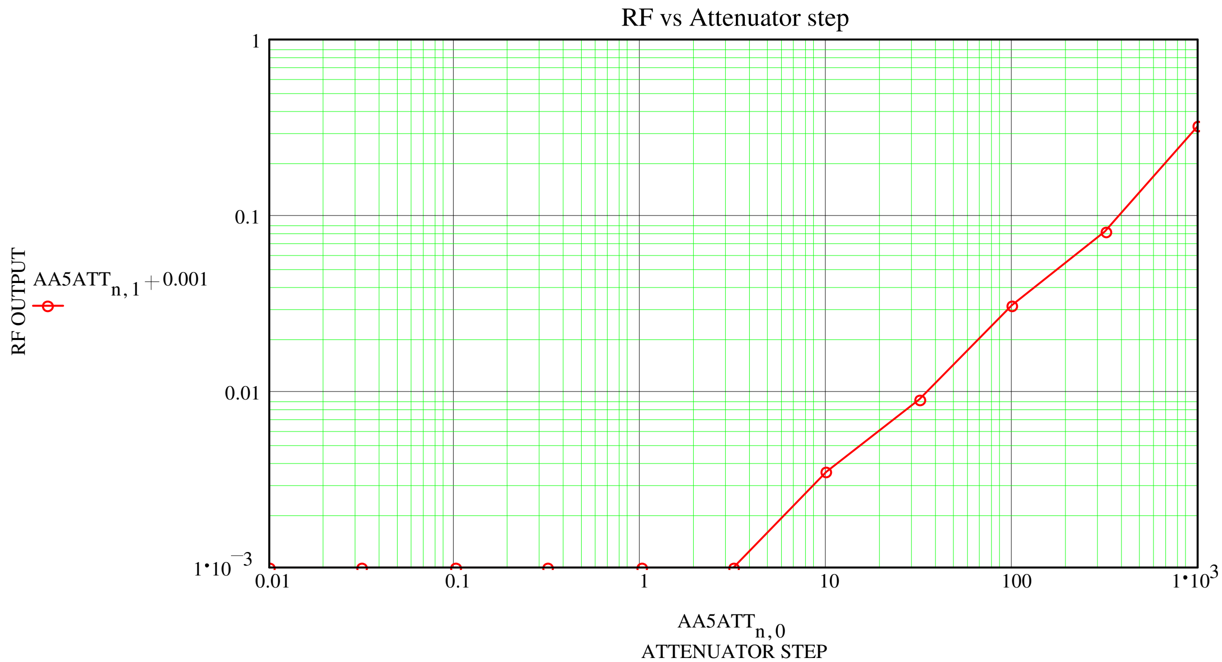
$B := last\left(BE6BA6^{\langle 0 \rangle}\right)$

$b := 0..B$

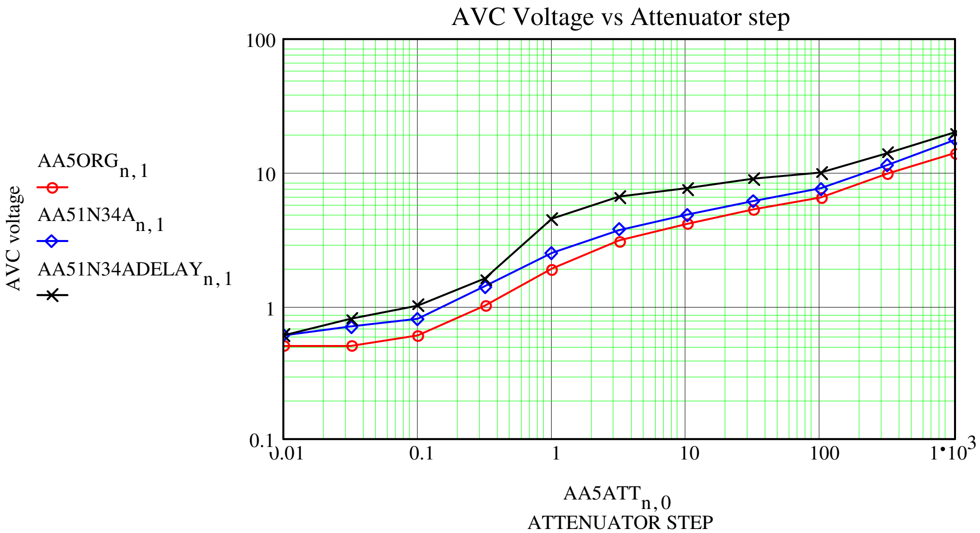
Attenuator check. 1000's stepped by Sencore, 316's stepped by external Heathkit attenuator. Last attenuator step with Sencore generator off.

$AA5ATT_{N,0} := 0.01$

$AA5ATT_{n,0}$	$AA5ATT_{n,1}$
1000	0.32
316	0.08
100	0.03
31.6	0.008
10	0.0025
3.16	0
1	0
0.316	0
0.1	0
0.0316	0
0	0



Comparison of AGC between the canonical AA5 with 12BE6 12BA6 12AV6 50C5 35W4 and two improved versions.



Red Trace (lowest) shows original AGC voltage (magnitude) and a compression from a 40dB range to 10.7dB for AGC from -1.9V to -6.5V.

INPUT RANGE in dB:

$$20\cdot\log\left(\frac{AA5ATT_{2,0}}{AA5ATT_{8,0}}\right)=60$$

Output Range in dB:

$$20\cdot\log\left(\frac{AA5ORG_{2,2}}{AA5ORG_{8,2}}\right)=21$$

Blue trace taken with 100k resistor at detector output replaced by 1N34A diode to get p-p detection instead of just peak detection of standard 12AV6 circuit. In the compressed range beyond 1V of AGC there is about 20-30% of signal increase. Below 1V of AGC the increase approaches a doubling. The compression range is very similar to the original 12AV6 circuit.

INPUT RANGE in dB:

$$20\cdot\log\left(\frac{AA5ATT_{2,0}}{AA5ATT_{8,0}}\right)=60$$

Output Range in dB:

$$20\cdot\log\left(\frac{AA51N34A_{2,2}}{AA51N34A_{8,2}}\right)=18.3$$

Output below 0.5V is dominated by grid leak bias voltage.

Remote cutoff of 12BE6 and 12BA6 reduce compression slightly for AGC beyond 6.5V

$AA5ORG^T =$

	0	1	2	3	4	5	6	7	8	9
0	1000	316	100	31.6	10	3.16	1	0.316	0.1	0.032
1	14	9.8	6.5	5.3	4.1	3.1	1.9	1	0.6	0.5
2	2.73	2.03	1.35	1.07	0.82	0.62	0.4	0.21	0.12	0.09

$AA51N34A^T =$

	0	1	2	3	4	5	6	7	8	9
0	1000	316	100	31.6	10	3.16	1	0.316	0.1	0.032
1	17.5	11.4	7.6	6.1	4.8	3.7	2.5	1.4	0.8	0.7
2	3.3	2.4	1.65	1.25	0.99	0.78	0.565	0.36	0.2	0.167

$AA51N34ADELAY^T =$

	0	1	2	3	4	5	6	7	8	9
0	$1\cdot10^3$	316	100	31.6	10	3.16	1	0.316	0.1	0.032
1	20	14	10	9	7.6	6.6	4.5	1.6	1	0.8
2	3.45	2.93	2.14	1.46	1.23	1	0.85	0.64	0.4	0.3

Row0: ATTENUATOR. Row1: AGC, Row2:RMS

Black Trace with 3V AGC delay was taken with 100k resistor at detector output replaced by 1N34A for p-p detection and a 3V battery with a 1N914 diode added in series with 1Meg AGC filter resistor. A 5Meg resistor loads the battery and diode. A 33 Ohm resistor was added to the cathode of the 12BA6 to produce a 0.5V back bias that keeps the grid leakage at zero for 0V AGC. This resistor also tends to make 12BA6 input capacitance less dependent on AGC. This implementation of AGC delay lets the AGC voltage go near zero when signal is absent. This AGC delay circuit was measured to see if it would be worthwhile to implement with a permanent circuit.
AGC delay of 3V improved compression in the 40dB=100 to 0.1 signal range to a 6.9dB AGC between 4.5V and 10V. The delay also increased gain over the entire signal range. For levels below 1V, the AGC voltage drops toward zero with zero input, and the 3V delay lets the detected carrier be 3V larger than AGC voltage for AGC voltages above 3V. The greatest effect of the delay is for signals that were 1.9V previously, and are now 4.5V.
The 3V delay was just right for the signals in my area, in part because it centered these signals around the region of sharpest gm drop in the remote cut-off characteristic of the 12BA6 and 12BE6.

INPUT RANGE in dB:

$$20\cdot\log\left(\frac{AA5ATT_{2,0}}{AA5ATT_{8,0}}\right)=60$$

Output Range in dB:

$$20\cdot\log\left(\frac{AA51N34ADELAY_{2,2}}{AA51N34ADELAY_{8,2}}\right)=14.6$$

RMS Audio output voltages measured at top of volume control.

Red trace: for original 12AV6 circuit.

Blue trace: with 1N34A p-p detector to double output before AGC compression.

Black trace: with 1N34A p-p detector to double output before AGC compression, and 3V of AGC delay

Magenta and Cyan traces: with 1N34A p-p detector to double output before AGC compression, 3V of AGC delay and 100% negative feedback from voice coil to 12AV6 cathode.

The Magenta trace was measured with the Volume control set to 50%, and the Cyan trace was measured with the volume control set to 100%.

When sufficient negative feedback is applied to the cathode of the 12AV6, such that the cathode follows the grid, the detector output nearly doubles.

When the volume control is increased to 100% in the cyan trace, the complete bootstrap of the 12AV6 cathode with the respect to the detected output the total increase in signal exceeds 2X.

Row0: ATTENUATOR
Row1: AGC
Row2: RMS

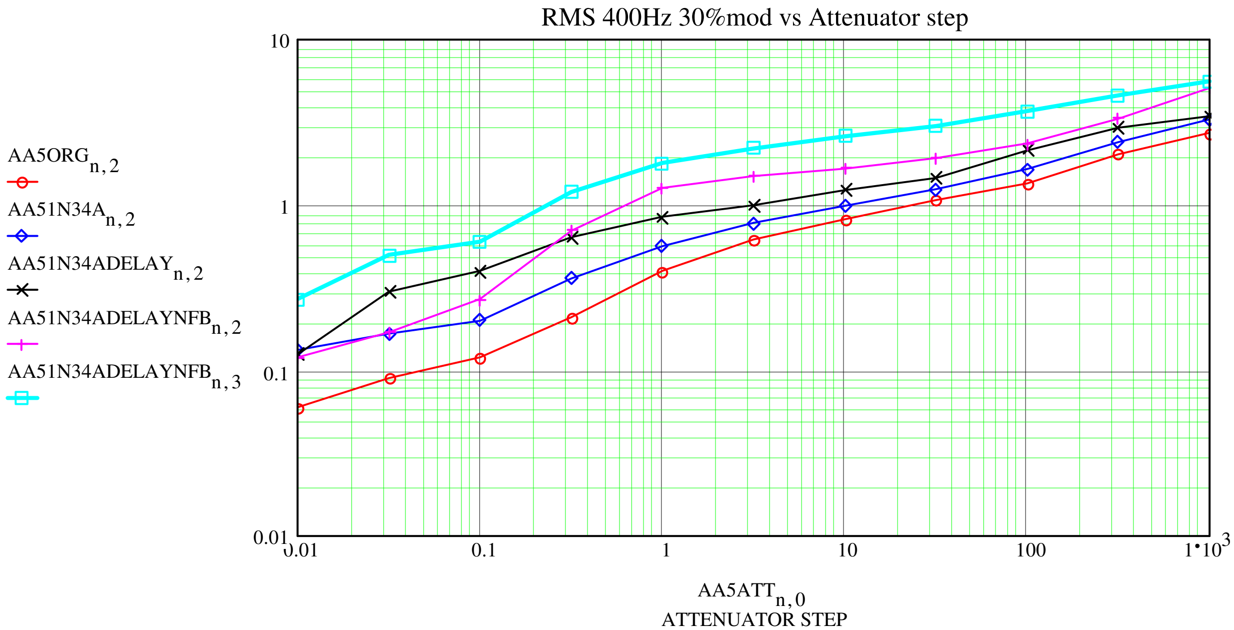
$AA51N34ADELAY^T$ =

	0	1	2	3	4	5	6	7	8	9
0	$1\cdot10^3$	316	100	31.6	10	3.16	1	0.316	0.1	0.03[illegible]
1	20	14	10	9	7.6	6.6	4.5	1.6	1	0.8
2	3.45	2.93	2.14	1.46	1.23	1	0.85	0.64	0.4	0.3

Row0: ATTENUATOR
Row1: AGC
Row2: RMS
Row3: RMS

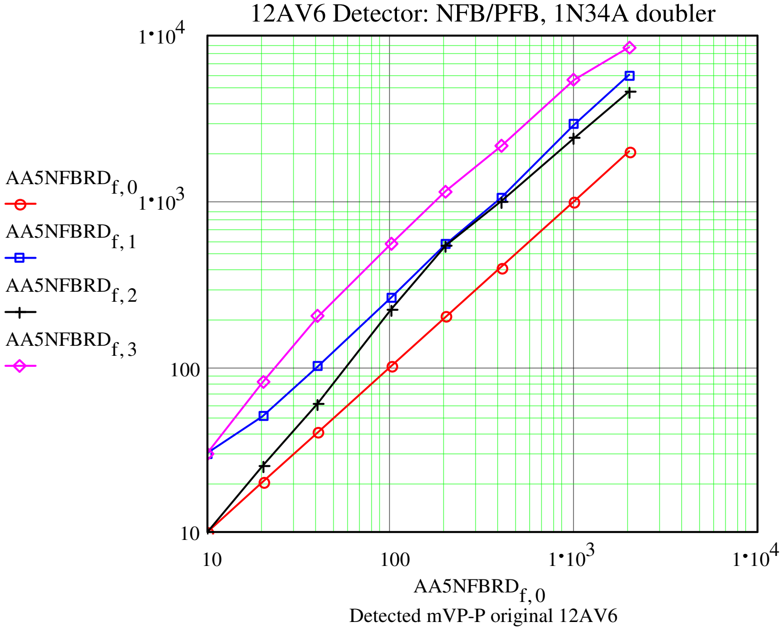
$AA51N34ADELAYNFB^T$ =

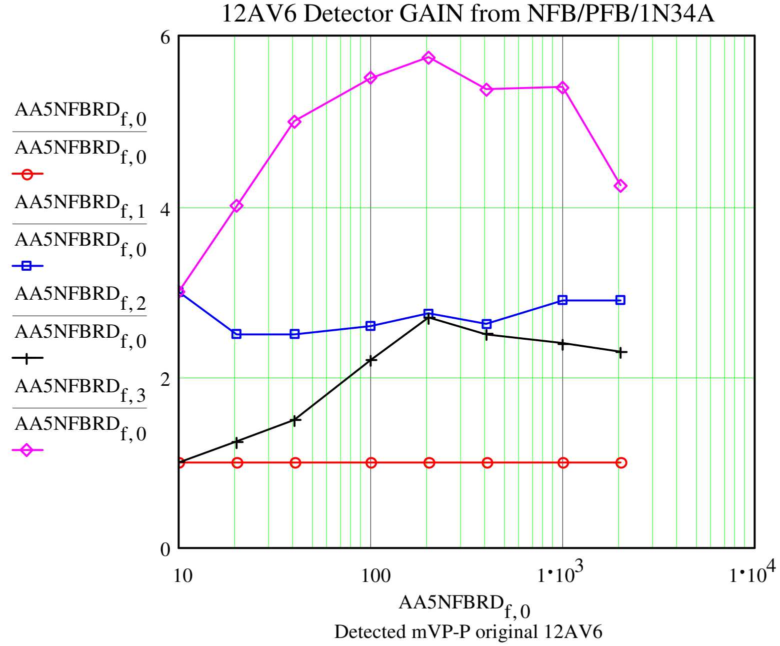
	0	1	2	3	4	5	6	7	8	9
0	$1\cdot10^3$	316	100	31.6	10	3.16	1	0.316	0.1	0.03
1	20	14	10	9	7.6	6.6	4.5	1.6	1	0.8
2	5.1	3.33	2.36	1.92	1.66	1.5	1.27	0.7	0.27	0.17
3	5.6	4.6	3.7	3	2.6	2.2	1.8	1.2	0.6	0.5



The following page shows detector action in detail.

Enhancements to 12AV6 detector. AGC voltage set to -10V. 1.2MHz RF input with 30% modulation at 400Hz.





Red Traces:
original 12AV6 detector

Blue Traces:
100% NFB to cathode.
Volume=100%

Black Traces:
1N34A replaces 100k

Magenta Traces:
1N34A replaces 100k,
100% NFB to cathode.
Volume=100%

Note soft clipping at high end of magenta trace.

Two different methods of increasing detector output are compared and also combined. The first method is to achieve p-p detection by replacing the 100k output filter resistor with a 1N34A diode.

The second method is to increase drive to the existing 12AV6 diode(s) by adding the detected audio to the diode cathode. The cathode audio comes from the output voice coil and may be 100% or a lot less. The negative feedback needs to be set high enough such that normal NFB action will make the cathode track the grid. An adequate amount of feedback is that which lowers the forward gain by a factor of at least 4. The other requirement for the cathode to track the detected output is that the volume control be set near full-on.

This NFB enhancement alone gives a large signal boost around 3X, but more for small signals that are brought out of square law detection.

With the volume set to 100%, the gain exceeds 2X because of positive feedback from detector anode to grid to cathode and back to anode. This added PFB gain explains why the combined effects of p-p detection and NFB/PFB add up to a gain in excess of 5 over single grounded diode detecton for signals larger than 20mVp-p.

Listening tests showed a marked improvement in the fidelity and inteligibility of weak signals that were buried in static. The low level of these signals prompts a volume control increase which, in turn, boosts detector efficiency.

I also found that the radio still has plenty of gain for the weakest noisy signals. This is because the gain that is lost in the audio amp with negative feedback is partly recovered in the detector.

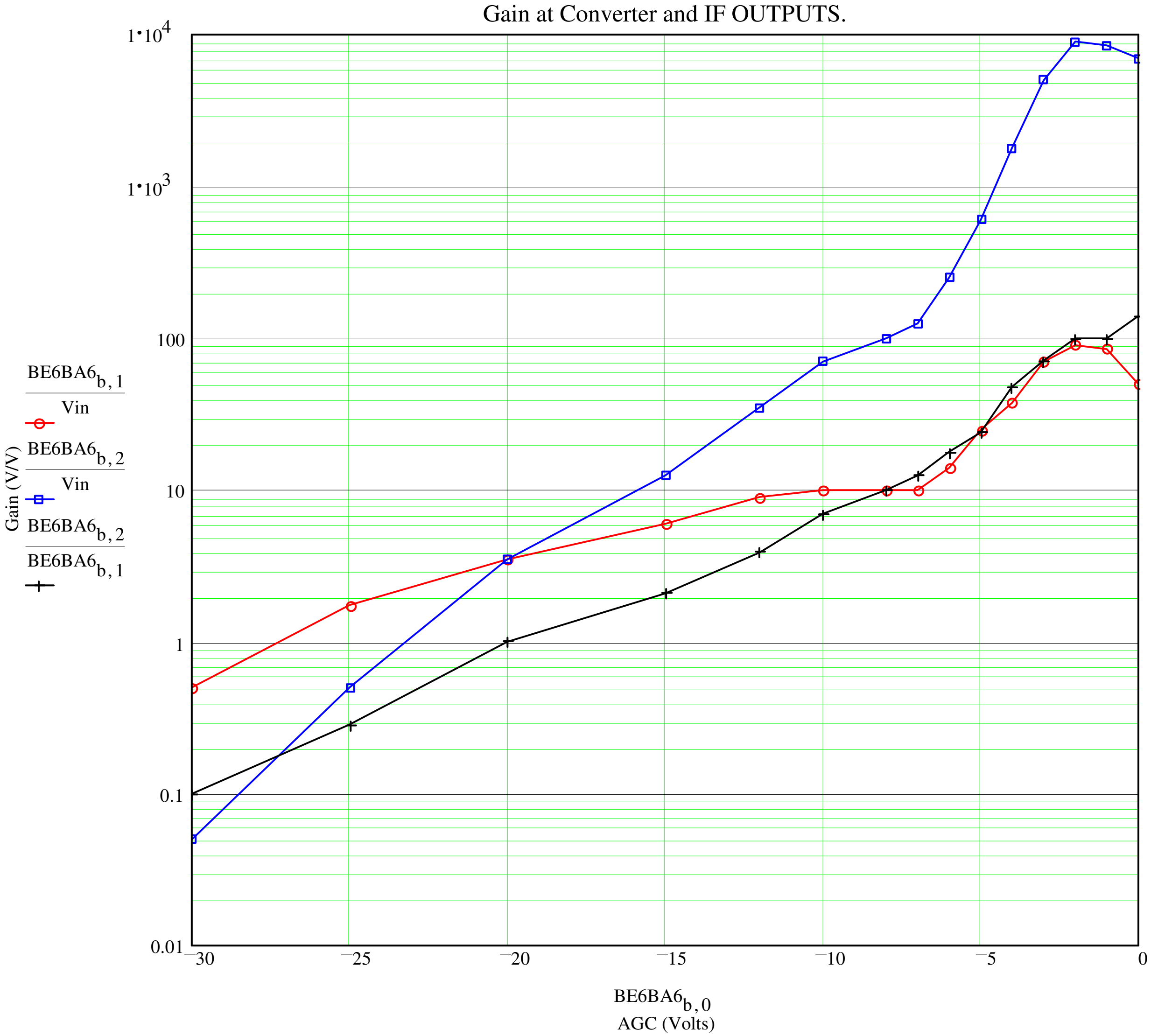
The negative feedback also improved the tonal quality of the radio, which was a bit on the tinny side, given the small flat speaker found in this late production 1960's japanese AA5. This set is a TOPLINE SM-100.

AA5NFBRD =

10	30	10	30
20	50	25	80
40	100	60	200
100	260	220	550
200	550	540	1150
400	1050	1000	2150
1000	2900	2400	5400
2000	5800	4600	8500

Vin := 0.2

Voltage gain at 12BE6 Converter and 12BA6 IF outputs, as a function of AGC Voltage.



Voltage measurements conducted with 200mV p-p 1.2MHz at Ferrite terminals which was reduced for the higher gains to 20mVp-p or 2mVp-p.

Red Trace: measured after 12BE6 Pentagrid converter, at 12BA6 IF pentode input grid, with gain normalized for 1.5pF probe loading at 455kHz. This trace shows 12BE6 gain.

Blue Trace: measured at 12BA6 IF pentode plate with gain normalized for 1.5pF probe loading at 455kHz. This trace shows combined 12BE6 and 12BA6 gain.

Black trace: is gain for 12BA6 IF amplifier with 1N34A p-p detector load. All measurements done with 33 Ohm resistor at IF cathode. The 12BA6 load is single tank circuit driving the detector.

Signal generated by Sencore SG165, measured on TEK475 scope and TEK p6201 900MHz fet scope probe with 100Meg 1.5pF tip.

$BE6BA6^T =$

	0	1	2	3	4	5	6	7	8	9	10	
0	0	-1	-2	-3	-4	-5	-6	-7	-8	-10	-12	AGC voltage
1	10	17	18	14	7.5	5	2.8	2	2	2	1.8	12BA6 grid
2	1400	1700	1800	1000	360	120	50	25	20	14	7	12BA6 plate