From: Kees Talen <windy10605@juno.com>
To: glowbugs@piobaire.mines.uidaho.edu
Date: Tue, 4 Jan 2005 18:46:18 -0600
Subject: GB> Low Voltage Transmitter – Comparison of possible tube types.

Here is some additional information for those interested in a low voltage transmitter. The net is that many of the sweep tubes and the xxC5/xxCU5 tubes appear to work fine. With the test fixture (http://www.qsl.net/k5bcq/REGEN2/tubeselect.JPG) some of the physically larger tubes like the 6DQ5 and 6KD6 appear to go into oscillation at points around Plate Voltage = Screen Voltage at low bias levels. I think this is VHF/UHF oscillation since its affected by hand capacitance. It's indicated on the meters by a rapid increase in screen current (also effects the bias level).
The smaller sweep tubes like the 6DQ6 or 6BQ6 also have it, but self oscillation seems to be more difficult to create and is generally outside the range I would want to try operating at. YMMV .....NOTE: I have not tested at RF yet.

73 Kees K5BCQ

==========

Purpose of Test #1 was to find tube types which might work in a low voltage transmitter. Low voltage defined as 48VDC B+, maybe 36VDC, maybe 24VDC. 24-48VAC transformers are readily available. I think 12VDC works great for receivers (http://www.qsl.net/k5bcq/REGEN2/regen3.html) but not for transmitters if you want more than a few hundred mW. I'm looking for 5-10W+.

Tubes (most NOS) were tested at 42VDC B+ (arbitrary low voltage, one of the available steps on my power supply). A quick/rough Transconductance number was generated by varying the bias level 1V and measuring the plate current change in mA (assume +/-20%). Plate current measured at "0" bias, plate and screen at the same potential, correct AC on the filaments, supressor grid grounded, values are for each section in dual triodes.

TEST #1
Tube, plate current, transconductance
6N7 metal octal, 2ma, -- 6SN7 octal, 4ma, --
955 acorn, 5ma, --
12U7 (not 12AU7) 9-pin miniature, 9ma, 7K 12BH7A 9-pin miniature, 10ma, 5K
6AG7 metal octal, 13.5ma, 7.5K 7044 9-pin mimiature, 14ma, 7K
5763 (used) 9-pin miniature, 14ma, 5K
2E26 (used) octal, 17ma, 3K
6L6 (used) metal octal, 18ma, 3K
6EM5 (used) compactron, 21ma, 6K

829B sceptar, 35ma, --
12C5 7-pin miniature, 43ma, 9K
6BQ6 octal, 57ma, 10K
6JB6A compactron, 76ma, 13K

Conclusion: Looks like the high current at low voltage for optimized power are going to be the tubes which draw lots of filament power (to boil those electrons). The "beam power" tubes look good as do sweep tubes, especially the compactron types and the 12C5 audio output tube.
==========

Purpose of Test #2 is to find additional possibilities per Test #1

TEST #2
Tube (type), filament power, plate current, power, transconductance
6HE5 (compactron), 5W, 15ma, 0.7W, 4K
6JB5 (used compactron), 5W, 31ma, 1.4W, 6K
6AU5 (octal), 7.8W, 36ma, 1.6W, 6K
6BQ6 (octal), 7.5W, 57ma, 2.5W,10K
6GE5 (compactron), 7.5W, 70ma, 3.0W, 11K
6JB6A (used compactron)), 7.5W, 76ma, 3.4W, 13K
6HB5 (compactron), 9.5W, 80ma, 3.5W, 17K
6080WA (octal regulator), 15.7W, 147ma, 6.5W, 9K

Conclusion: There are MANY compactron sweep tubes which look like they perform quite well at low voltages. The possibility of decent low power levels (a few watts) at 48VDC, 36VDC, or even 24VDC looks to be possible ....especially if the screen is fed at a HIGHER DC level than the plate but from a very low current source (easier to do than a high current plate source). Many of the tube guys will cringe at this idea and it may not work in the long run, but what the heck, let's try. The idea is to use the screen as an additional electron accelerator, but below where it starts to draw much current. For example the 6GE5 screen normally draws 2-3ma, if you drop the plate from 44VDC to 24VDC and leave the screen at 44VDC the screen current goes up by 2ma and the plate current remains high at 66ma (was 70ma). The 6080 was tested for interest and shows excellent current levels but the inter-element capacitances are quite high making it unuseable (maybe) at RF frequencies. The assumption is, based on the widespread use of sweep tubes, that inter-electrode capacitances there are acceptable. Now come the tradeoffs relative to filament power and B+, same or separate (great opportunity for cheaper series filament tubes), paper or plastic, and some looking into RF capabilities, linearity, costs, etc. I do have some 25BQ6 tubes on order ($1.50 each). The more common ham sweep tubes are sometimes $10-$20 each, but tubes like the 6GE5 or 17GE5 are less than $3. The 6HB5 looks like a good tube but there is only the 6V filament offered and the tubes sell for $10 (and the inter-electrode capacitances are higher). But there

are MANY types, selling for less than $3, which were not tested. Maybe someone has a stash of less popular beam power tubes out there he'll sell cheap. I'll probably build this rig with a separate filament supply (12V or 6V) and allow use of 12V, 24V, or 48V B+ supplies, whatever you have. Power goes up quickly with the higher voltage levels .....but we're looking for low voltage solutions.
==========

Purpose of Test #3 is to look at some tubes in more detail

Filament voltages available and filament power are available in the tube manuals. As the screen voltage is increased, it's important to not exceed screen power max. These are all static measurements. YMMV

TEST #3
Tube
Plate/Screen Voltage, Plate/Screen Current at Bias 0, -1, -2, -3, -4, -5V
NOTE: First voltage is the plate and the Second (sometimes higher) is the screen (trying it as an extra "electron accelerator" in low voltage mode. Sorta like Space Charge tubes ?

The interelectrode capacitances are given as:
Grid to Plate pf / Input pf / Output pf

6KD6 (physically large compactron sweep tube, plate cap, 0.8/40/16pf)

50/50V 250/10ma, 230/7.5ma, 186/6ma, 154/5ma, 131/4ma, 106/3.5ma
40/40V tube goes into oscillation easily at low bias levels
30/30V
20/20V

6DQ5 (physically large octal sweep tube, plate cap, 0.5/23/11pf)
same oscillation as 6DK6

6GW6/6DQ6B (physically medium octal sweep tube, plate cap, 0.5/17/7pf)
50/50V 93ma, 79ma, 68ma, 57ma, 47ma, 40ma
40/40V 67ma, 56ma, 45ma, 37ma, 28ma, 22ma
30/30V 43ma, 34ma, 25ma, 19ma, 14ma, 10ma
20/20V 23ma, 16ma, 10ma, 6.5ma -- --

50/75V 166/8ma, 148/8ma, 132/8ma, 116/7ma, 104/6.5ma, 92/6ma
40/60V 120/6ma, 106/6ma, 92/6ma, 78/5ma, 66/4.5ma, 58/4ma
30/45V 80/4.5ma, 66/4ma, 54/4ma, 44/3.5ma, 36/3ma, 28/2.5ma
20/30V 44/4ma, 32/3ma, 24/2.5ma, 18/2ma -- --

can make the tube oscillate under some conditions

6BQ6GTB/6CU6 (physically small octal sweep tube, plate cap, 0.6/15/7pf)
50/50V 63ma, 55ma, 46ma, 38ma, 31ma, 25ma
40/40V 46ma, 37ma, 31ma, 24ma, 18ma, 14ma
30/30V 31ma, 24ma, 18ma, 13ma, 9ma, 6ma
20/20V 17ma, 12ma, 8ma, 4ma -- --

50/75V 108/9.5ma, 98/6.5ma, 88/6ma, 76/5.5ma, 68/5ma, 56/4.5ma
40/60V 80/5ma, 69/5ma, 59/4ma, 51/4ma, 43/3.5ma, 36/3ma
30/45V 53/3.5ma, 45/3.2ma, 36/3ma, 29/2.5ma, 22/3ma, 18/2ma
20/30V 30/3ma, 22/2ma, 17/2ma, -- -- --

can make the tube oscillate under some conditions

6JB6A (physically small compactron sweep tube, plate cap, 0.2/15/6pf)
50/50V 100ma, 76ma, 62ma, 54ma, 47ma, 39ma
40/40V 68ma, 52ma, 42ma, 35ma, 29ma, 19ma
30/30V 44ma, 34ma, 25ma, 18ma, 13ma, 8ma
20/20V 24ma, 16ma, 10ma, 6ma -- --

50/75V 160/10ma, 140/9ma, 124/8ma, 104/7ma, 92/6ma, 84/6ma
40/60V 112/7ma, 92/6ma, 80/5ma, 68/5ma, 60/5ma, 50/4ma
30/45V 72/5ma, 60/5ma, 52/4ma, 48/4ma, 44/4ma, 40/3ma
20/30V 40/6ma, -- -- -- -- --

can make the tube oscillate sometimes under some conditions

6HB5 (physically small compactron sweep tube, no plate cap, 0.4/22/9pf)
50/50V 108ma, 88ma, 68ma, 50ma, 39.5ma, 29ma
40/40V 72ma, 56ma, 40ma, 30ma, 20ma, 14ma
30/30V 45ma, 31ma, 21ma, 13ma, 8ma, --
20/20V 23ma, 13ma, 7ma, -- -- --

can make the tube oscillate sometimes under some conditions

6GE5 (physically small compactron sweep tube, no plate cap, 0.34/16/7pf)

50/50V 88/4ma, 74/3ma, 60/2.5ma, 50/2ma, 40/2ma, 31/1.5ma
40/40V 66ma, 50ma, 38ma, 31ma, 23ma, 16.5ma
30/30V 42ma, 31ma, 21ma, 15ma, 10ma, 6ma
20/20V 22ma, 14ma, 9ma, 5ma -- --

50/75V 148/7ma, 134/7ma, 116/6ma, 100/5ma, 88/5ma, 74/4.5ma
40/60V 108/5ma, 92/4.5ma, 70/4ma, 64/4ma, 52/3.5ma, 44/3ma
30/45V   76/4ma,   68/4ma, 56/3.5ma   --   --   --
20/30V   --   --   --   --   --   --

can make the tube oscillate sometimes under some conditions

6KN6 (physically large compactron dual sweep tube, plate cap, 1/44/18pf)
waiting for delivery, tube is in the mail

12C5 (7-pin miniature audio output tube, 0.6/13/8.5pf)
50/50V 59ma, 45ma, 35ma, 27ma, 20ma, 15ma
40/40V 44ma, 32ma, 23ma, 17ma, 11ma, 8ma
30/30V 29ma, 20ma, 14ma, 9ma,   5ma,   --
20/20V 17ma, 11ma, 6ma   --   --   --

50/75V 94ma, 81ma,   73ma, 57ma, 47ma, 39ma
40/60V 67ma, 56ma,   46ma, 37ma, 30ma, 23ma
30/45V 46ma, 36ma, 28ma, 21ma, 15ma, 11ma
20/30V 28ma, 20ma, 14ma, 9ma   5ma   --

50/85V   100/12ma great bias control (I'm impressed)
          this is about the 'Max screen power'
24/64V   66/11ma   great bias control
12/50V   36/12ma   great bias control
          more power on the screen than the plate

tried, can not make this one oscillate

6080WA (octal dual triode regulator, 8/6/2.2pf ...high)
50V 200ma, 192ma, 176ma, 164ma, 152ma, 136ma
40V 146ma, 134ma, 120ma, 108ma, 98ma,   86ma
30V   96ma,   84ma,   76ma,   64ma,   56ma,   46ma
20V   50ma,   44ma,   34ma,   28ma,   22ma,   16ma
10V   18ma,   12ma,   8ma,   5ma   --   --

Conclusion (at these voltages): A 6JB6A is roughly equivalent to the 6DQ6B (6JB6A has slightly better interelectrode capacitance), a 6BQ6/6CU6 is about 70% of a 6JB6A/6DQ6B, a 6GE5 is about 90% of a 6JB6A/6DQ6B (but the 6JB6A costs more). The xxC5/xxCU5 and 6080WA looks really interesting. I'll probably end up with a 6J6? as a push-pull Jones oscillator. I'd try: 1) a 6080WA as "most power from one tube" ....if it works at RF, 2) a pair or 6-pack of xxC5/xxCU5s for small and

"interesting", 3) a single/pair of 6DQ6B or 6BQ6/6CU6s for "octal", or 4) a single/pair of 6JB6A/6GE5 for "compactron". IMHO