https://forums.qrz.com/index.php?threads/180w-ebay-amp-anyone-looked-at-one.505475/page-5

The "bag o' parts" arrived today, looks like one of the output transformer ferrite cores has a chip out of it, but otherwise the parts are there. Before I dive in to construction, any words of wisdom?

Built the "bag o parts" yesterday. The aforementioned damaged toroid core (17 were supplied with the kit) was not needed; 14 are used in the output transformer and 2 in the RF choke. Soldering the output transformer (tubing, PC board and cores) required use of a Metcal SP200 soldering iron with broad tip, as the bench iron I normally used could not heat the assembly quickly enough to flow solder (using 63/37 on this).

I'm using a 4" x 4" x 3/8" bar of aluminum as a heat sink for now - yes, it's not adequate for any sort of production use - a homebrew NE-555 based "tuning pulser" to let me drive it with a controllable (low) duty cycle, 10 db power attenuator between radio & amplifier input, a current limited bench power supply (Longwei LW-K3010D), Diamond SX-200 wattmeter at input, Kenwood SW-2000/SWC-3 at output, and a 250W 50 ohm dummy load on the output. No LPF at this point. Thermal link between the two IRFP250s and the heat sink are 0.635mm thick alumina wafers with a little heatsink compound on both sides of each (as the aluminum heatsink isn't machined to any given flatness) - this was used in lieu of the provided silicone pads. The PC board overhangs the ends of the 4x4" aluminum slab, so only the inner pair of mounting holes (with 1/4" spacers) and the two FETs provide mechanical support. Before trying to use the amplifier normally, I'll mount the slab to larger heatsink. The PC board is dated 20180125. Without documentation supplied, I relied on a previous posting in this thread (schematic image dated 8/14/2018 - about 3 years ago.)

Construction was done using the posted schematic image, with a couple of clues provided by the photographs from a previous builder. Two mechanical problems arose during trial assembly of the board to the heat sink, related to SMD capacitors in the back-side "shadow" of the TO-247 packages (on the bottom side of the PCB) which is a risk to the SMD parts. Fixing this required moving a 0.1 uF bypass capacitor (supporting one of the bias pots - it's either C3 or C13) to a different location, and required moving two 0.01 uF blocking capacitors (supporting RF path from input transformer to device base, those are either C1/C2 or C8/C11) somewhat to clear the interference and provide a visible gap between the capacitors (those two caps are now stacked vertically, one on top of the other, to maximize clearance) and the body of the impacted TO-247 package.

I've not made any attempt to RF match input or output (the matching capacitors shown on the schematic as C7 and C23 on input; C5 and C12 on output), nor measured reflection at the input. The schematic shows R12 and it's counterpart as 10K - the board silkscreening shows these as 5.6 ohms (same as R11 and it's counterpart) - I followed the silkscreen hint and used the supplied 5.6 ohm 0805 resistors in all 4 places.)

Initially set bench supply to 24V and 500 mA current limit. Bias setting is (as expected) touchy (single turn pots I'll likely replace with 10-turn pots - also the pots rotate in opposite directions based on the layout). Starting from 0 volts on both devices, I set idling current to 100 mA on the first part, then 200 mA with addition of the second part, however, the two settings appeared initially to interact (this could be some unrelated issue), but at this point I'm not certain that the total idling current is equally distributed.

Adjusted bench supply to 24V and 5A current limit. Set tuning pulser to about 10% duty cycle, set radio output to ~10W going into the 10 dB attenuator (an old ICOM IC-730), then applied 10.1 MHz drive power. The input wattmeter (a Diamond SX200) wasn't connected to a DC supply, so it's peak reading mechanism wasn't likely accurate. The output wattmeter (a Kenwood SW-2000/SWC3) was also set to peak reading and is powered, so it's readings are adequate for this purpose. Increased drive up to the point where output wattmeter stopped increasing - about 70W PEP; the input wattmeter read about two watts (but that reading isn't likely accurate). The power supply at this point was probably going into current limiting, however, it's current display was not showing peak current, just a rough average (that is, the supply appeared to be properly current limiting, but it's displays were not geared to showing peak current). The aluminum bar "heatsink" become only mildly warm to the touch.

So, nothing smoked, the amplifier is making power, and other than uncertainty about the bias current settings, I think the project is off to a good start.

Next steps are to try 80, 40 and 20M bands, and to investigate input match (the kit included six SMD capacitors that appear to be 1210 package size, but they're unlabeled and I've not measured them yet.)

These may be for output matching. Other than these mystery parts, the kit was otherwise complete and provided ample spares for the remaining (0805-package) X7R blocking and bypass caps.

A little testing this AM ---

The Diamond SX-200 is proving to be incapable peak reading wattmeter in this application (pulsed power) - as I increase duty cycle (from 0% towards 100%), the Kenwood SWC-2000/SWC-3 in peak mode plateaus at perhaps 10% duty cycle (I've not measured exact duty cycle with scope), however, the SX-200 doesn't hit a plateau at all as I further increase duty cycle (up to the point where the bench power supply is running out of headroom and folding back.) This makes gain measurements unusable right now.

Idle current drifts up as the (trivial) heatsink gets warmer - after the four output tests below (each for about 15 seconds at 10% duty cycle), idle current increased from 0.2A to about 1.2 amps, and the trivial heatsink (4x4x3/8" aluminum bar) was too hot to handle comfortably.

Output power seen on SW-2000/SWC-2 into dummy load with duty cycle just high enough to plateau it's peak reading measurement (about ~10% duty cycle, driven with IC-730 at full (~100W) PEP pulsed output through a 10 dB power attenuator, so drive power probably ~10W PEP):

3.6 MHz 160 watts
7.1 MHz 90 watts
10.1 MHz 60 watts (saw ~70W during yesterday's initial testing)
14.1 MHz 40 watts

Although I can't measure drive power at the input port (SX-200) because peak reading isn't cooperating with this kind of measurement, reflected power appears to consistently be 50% of drive power (so if I see 3 watts drive, I see 1.5 watts reflected.) This is the case on all 4 bands tested.

Next step is to connect nanovna S11 port directly to amplifier input port (with supply and bias power on and output connected to dummy load) and investigate input port impedance. So far no sign of amplifier oscillation.

Worked on-and-off on this project since the last post --- some improvements to the test case (IC-730 via 10 dB attenuator, keyed with a low duty cycle pulser, driving dummy load and peak-reading power meter.) The input and output matching capacitors (indicated in the schematic and shown on the PC board layout but otherwise unspecified) were found initially by substituting an air variable capacitor and looking for lowest SWR (input) and highest power (output). Output power levels were only slightly increased from those reported in the prior posting.

Assembled a carrier-operated switch arrangement and a current limiting circuit (to disable amplifier transmit path and bias during drain over-current condition) courtesy of G0KLA/AC2CZ design.

3 watts of drive from the Norcal 38 Special going into the amplifier yields about 30 watts into a dummy load on 10 MHz band. The catch is that DC current draw from the two FETs totals about 8 amperes at 24 VDC, so efficiency is about 12%. Perhaps "180W" moniker for the amplifier refers to thermal dissipation???

Going-forward plan is to go back to the drawing board on output impedance matching. If anyone reading this recalls working on one of these and having some insight into output matching (number of turns, drain-to-drain added capacitance, or other ideas) I'd be grateful. Currently operating on assumption that the IRFP250N's that were delivered were indeed that part, but perhaps they're remarked versions of some other part.

Dave

The instructions I found stated "5 laps" (1:25 ratio) on the output transformer secondary (which from the pictures I'd seen looked like the secondary wire passes through each of the two cores 5 times.) Tried removing one turn at a time from the output transformer - best result was with three turns (1:9 ratio) -

output 60 watts (on 10 MHz) when driven by 3 watts CW from the Norcal 38 Special, and drain current is now about 7 amps (24V) so efficiency looks like about 35% - about 3X improvement from prior experiment and gain now about 13 dB vs at best 10 dB before on 10 MHz band). Likely some further room for improvement (revisit capacitor between the two drains, currently 150 pF from prior experiment.)

First QSO today on 30M CW with Norcal 38 special and the "180W" ebay amplifier.

Added 3-pole LPF (will go to 5 pole next), increased supply power to Norcal 38 special to 15V (the basic radio is powered from an internal 8V regulator; the DC input connector only supplies the IRF510 final amplifier) which increased it's output to 5 watts. Increased the bench supply to 28V. Removed the 150 pF cap I had between the drains. Added/removed turns in the output transformer to find best efficiency, which turns out to be 1-1/2 turns (twice through one core, once through the other.) Don't know if there's an issue with this being unbalanced this way. At this point, 5 watt CW drive produces 80 watts output with 28 watts and 6 amps on drains, so efficiency is about 50%. Tried adjustable capacitor between the two drains but no significant effect between 60 and 660 pF so leaving that open for now.

Brief testing on 80 & 40M --- same amplifier configuration (with 10 MHz 3-pole LPF in output path, 28V bench supply that has 10A current limit, different drive source, and forced-air cooled heatsink) --- 40M 4 watts CW drive produced 90 watts CW output - approx same 13 dB gain as seen on 30M band, but poor efficiency (28V @ 9A so around 35% efficiency.) 80M produced 150W CW output (probably includes some second harmonic energy) with 28V power supply beginning to fold back at 10A from 1W CW drive, so much higher gain (over 20 dB) and similar efficiency as 30M (a bit over 50%). All of these results differ from initial testing where a low duty-cycle pulsed drive signal was used. 24V (+/-) 20A power supply arrived from Amazon today with caved-in housing, replacement being sent. Some work ahead, particularly on 40M.

Saga continues... Replaced the output winding (which originally was "5 laps" of the teflon-jacketed #18AWG wire they supplied) with a single turn (that is, through each of the two cores once) of #12AWG teflon-jacketed wire I have here (cautionary note - the ends of the copper tubing are sharp and not easily to smooth out after the transformer is built; my first attempt with this wire resulted in a short to ground.)

At 28V supply with CW drive and 30M 3-pole LPF in place and no shunt capacitance (across drains):

80M 3W drive produces 120W out (probably with harmonic energy), 5.2A drain, 75% efficiency, 16dB gain; 40M 4W drive produces 110W out, 6.0A drain, 65% efficiency, ~14 dB gain, and 30M 5W drive produces 45W out, 6A drain, 25% efficiency, ~9 dB gain.

So, no magic smoke yet, and while the efficiency figure on 80M probably reflects harmonics getting picked up by the output power meter, 40 and 80M show progress, and 30M is now a dud efficiency-wise. Next will go back to the input network to see if there's a problem getting drive into the gates on 30M.

Modified the input transformer from 25:1 (5:1 turns ratio) to 6:1 (5:2 turns ratio) in attempt to increase RF voltage at the gates, and removed the input shunt capacitors (across the input transformer secondary). Input SWR (on 80, 40 and 30M) went from about 2:1 down to no detectable reflected power, but output power remained about the same.

Modified the output transformer from 1:1 (one turn each primary & secondary) to 1:4 (one turn primary, two turns secondary), output shunt capacitance (between drains) now 680 pF (experimental). Now back to hitting power supply current limit (10A) and poor efficiency, but now enough gain to work well with the Norcal 38 special and the Argonaut 509 (only example below at max radio output was on 30M with 4 watts from the Norcal 38 special running 15V):

80M 3.6 MHz 1 watt drive 90 watts out 19 dB gain 28V@10A drain 32% efficiency
40M 7.1 MHz 2 watts drive 90 watts out 16 dB gain 28V@10A drain 32% efficiency
30M 10.1 MHz 4 watts drive 110 watts out 14 dB gain 28V@10A drain 40% efficiency
30M 10.1 MHz 3 watts drive 85 watts out 14 dB gain 28V@8A drain 38% efficiency

Next test will be 1-1/2 turns on output transformer secondary (1 pass through one core, 2 passes through other core.)

Tried "1-1/2" turns on the output transformer secondary and no real change in output or efficiency on 40M (only tested there), so left it as 2- turns on the output transformer secondary.

Got most of the way through inaugural 40M CW QSO (2W from Argonaut 509, 90W from the amplifier) and then succeeded at extracting the magic smoke from one of the two IRFP250N's (shorted drain-to-source while transmitting CW - was adjusting the power supply current/voltage limits while transmitting, probably not a good idea...) so tomorrow will replace the FET(s) - about a 50 cent part - get other LPFs built for 17/20 and 80M, and test on-air with Norcal 40.

Are you sure your output transformer windings have the correct phasing ?
Also, transformer asymmetry in this kind of amplifier is not a good idea.

Agreed asymmetry seems like a bad idea; anyway here's some famous last words (!) --- I thinking I'm getting the hang of this stuff a little...

Replaced the output transistors (only one was dead but the replacements were from a different ebay source so I figured they'd not be identical.) This required resetting idling bias (initially much too high, was tripping the overcurrent cut-out circuit.) The gain of these transistors seems to be somewhat higher.

After some testing with a single turn and 32V on the drains, I tried going to two full turns on the output winding (so no more asymmetry). Reduced supply voltage to 18V (from 28V) and setting drive to take 10A (power supply limit) on drains.

Lesson seemingly learned is that the output transformer ratio and 50 ohm load requirement fixes the drain/collector impedance, so the drain voltage cannot be freely set, but rather must be a decent match for the transformer and power supply current capability. As the transformer ratio can only make really large steps (1:1, 1:4, 1:9, etc.) this constrains supply voltage and drain current.

Now at 18V/max 10A on drains, amplifier seems to be behaving better, but with the 10A limit on the power supply, this imposes some output power limitations:

3.6 MHz 1/2 watt drive 90 watts out (with harmonics), 20 dB gain, 18V/10A on drains (no valid efficiency due to harmonic content.)
7.1 MHz 1 watt drive 80 watts out,19 dB gain, 18V/10A on drains, 44% efficiency
10.1 MHz 2 watts drive 70 watts out, 15 dB gain, 18V/8A on drains, 50% efficiency
10.1 MHz 4 watts drive 80 watts out, 13 dB gain, 18V/9A on drains, 50% efficiency

Probably at a stopping point for now until the replacement power supply from Amazon arrives, which should be adjustable down to 22V but support up to 20A drain current. On air testing tonight with Norcal 40 (1 watt output).

Built 3-pole LPF for 15/17/20M today; on 20M 2 watts drive produces 50W output at 18V/5A (90W) input, so 14 dB gain and a bit over 50% efficiency. Wasn't set up to test on 17M, but on 15M 2 watts drive produced at best about 15W output, so that's likely beyond the reach of these FETs. Made one 20M QSO with Small Wonder Labs DSW-20.

Did an experiment to see if boosting drain voltage would increase output on 20M which is clearly underdriven at 2W drive (this scheme did work on 30M at 2W drive level - 25V/10A input yielded 110W output), however, there was little output increase (output and corresponding drain current increased modestly, so efficiency was declining as drain voltage increased), and upon reaching 28V on drains one of the FETs shorted (I'm uncertain of the failure mode - probably dissipation limit -- much literature exists describing FET failures in RF power amplifiers). In the interest of reproducing the result, I replaced one of the FETs (all from same batch), reset idling current, and ended up with the same outcome (little output improvement and eventually source/gate/drain short in one of the two FETs.)

FET replacement hint - cut the three pins first (remove the FET body), unsolder each of the 3 leads that remain, then use a solder sucker and solder wick to clear the holes (seems easier done from top side of the board.)

Revisiting 20 and 17M --- rearranged the amplifier so that the low pass filter(s) are now external in a small switch box, so I can test the LPF's independent of the amplifier (also makes band switching easier than resoldering coax patch cables).

I had built 3-pole Chebyshev filters with cutoffs at 4 (80M), 10 (30/40M) and 20 MHz (20/17/15M). Turns out Chebyshev has a poor return loss at about 70% of the cutoff frequency, so amplifier was seeing worse than 3:1 SWR on 20M - idea of using a single LPF for 3 bands doesn't look promising. Redid this filter for 18 MHz cutoff frequency (17/20M only); LPF no longer an issue on 20M.

20M - 2W in 50W out 18V @ 4.5A 14 dB gain 60% efficiency, 2W in 100W out 32V @ 8A 17 dB gain 40% efficiency. Efficiency drops off at higher drain voltages, however, the amplifier survived just fine (prior experiments at elevated drain voltage resulted in transistor destruction once 28V was tried.)

17M - 2W in 40W out 18V @ 5.5A 13 dB gain 44% efficiency; 2W in 50W out 22V @ 10A 14 dB gain 22% efficiency. Amplifier doesn't look to be successful on 17M.

Nice CW QSOs today on 20M (DSW-20), 30M (Norcal 38 Special) and 40M (Norcal 40A) with the amplifier. Can't find my 80M Pixie so nothing to try on 80M yet. No more dead FETs. Other than power supply limitation, this (amplifier for use with some old QRP CW rigs) was the original intent for the project.

On the 24V 20A power supply I've been waiting for (this was the replacement for the first one which was found crushed inside good packing material) --- post office today delivered a torn-open empty padded envelope complete with sticker indicating among other things (*found empty at local post office"). Amazon refunded (again, and without question, argument or complaint) and I've placed a *third* order for the same supply, due to arrive middle next week.

The (second) replacement 24V 20A supply from Amazon not due to arrive til next week, so pulled an old industrial switcher out of the junkpile, fitted it with voltage set, current limit and ovp protect set controls, set it to 28V with 10A limit, and resumed testing and operating.

A number of prior experiments attempting to increase gain by increasing drain voltage resulted in several more destroyed FETs (due to exceeding dissipation limit), so with about 50% of the current supply of IRFP250N's in the bin, sticking with 28V 10A on drains.

Now using an ICOM IC-730 (not 7300) with 6 dB power attenuator as drive source; this provides 0-25W CW drive on 10M thru 80M bands (including WARC, but not including 160M.)

3-pole low pass filters built for 160, 80, 40, 30, 20 an 15M (was hoping 15M would suffice for 17M, but insertion and return loss on 17M are not favorable).

Input matching network is 5 turns primary, 2 turns secondary, 680 pF shunt (between gates). Output matching network is 1 turn primary, 2 turns secondary, no shunt capacitance. Shunt capacitance settings were left over from earlier experiments; no attempt was made to adjust the shunt capacitance before doing the testing below. Brief experiment with 3 turns on secondary put a couple more FETs in the bin (testing was not thorough in this case - gain appeared low and didn't proceed further.) No attempt made to operate at 13.8V.

Below are CW (steady carrier, into dummy load) test results (10 & 12M have no LPF and 17M has 15M LPF, no drive available on 160M for this test).

Deficiency on 17M is due to 15M low pass filter properties (it is reflective at 17M). On upper bands (17 thru 10M) drive power was limited to 25W (100W from ICOM IC-730 through 6 dB attenuator). On lower bands (30M thru 80M) drive power was set to the point of saturation (considerable compression was observed before saturation; for example, on 40M with 2 watts from Norcal 40, 100 watts output was available; on 80M with 1 watt drive over 100 watts output was available.)

It appears on 10 and 12M that the amplifier is not being fully driven (<8A drain current), however, no attempt was made to test with more than 25W drive power (the 1N914 used to detect RF and put the amplifier into transmit was destroyed several times when drive exceeded about 35W, even as a spike from the ICOM IC-730 before the attenuator was used, however, the FET gates were unaffected - the same pair of FETs was used for the entire test below.

Although the test equipment is not precise, the amplifier does indeed appear to be "180 watts" per the ebay seller's claim, however, only on 80M (160M was not tested.)

Efficiency and gain are not realistic on 10 and 12M due to no low pass filter present on output.

Band	Drive	Drain V	Drain A	Input power	Output power	Gain	Efficiency
10M	25W	28V	7.8A	220W input	130W output	NO LPF: 7.0 dB	NO LPF: 59%
12M	25W	28V	7.5A	210W input	140W output	NO LPF: 7.5 dB	NO LPF: 66%
15M	25W	28V	10.0A	280W input	150W output	15M LPF: 7.9 dB	15M LPF: 53%
17M	25W	28V	6.6A	185W input	100W output	15M LPF: 8.6 dB	15M LPF: 54%
20M	7W	28V	10.0A	280W input	150W output	20M LPF: 13.3 dB	20M LPF: 53%
30M	4W	28V	10.0A	280W input	160W output	30M LPF: 16 dB	30M LPF: 57%
40M	4W	28V	10.0A	280W input	140W output	40M LPF: 15.4 dB	40M LPF: 50%
80M	5W	28V	10.0A	280W input	180W output	80M LPF: 15.5 dB	80M LPF: 64%

The drive power reads in previous (Monday 8/30) posting may be uncertain (possibly low) by about 20% (vs. the Diamond SX-200 I'm using in today's experiment which has 5W and 20W ranges.)

Today ran a "power sweep" test (with manually adjusted drive to the point of saturation, with a range of drain voltages) on 10.1 MHz. Monday's report reflected an arbitrary 10A limit on drain current. Today's test does not limit drain current, and the idea is to test to the point of destruction and also get some insight into output impedance matching behavior. At the point of destruction (34.0V drain with 2.5W drive), one of the FETs developed a drain/source short and the test was stopped as the power supply went into short circuit detection state.

10 MHz 3-pole Chebyshev LPF output feeding SWC-3 feeding 50 ohm load.
CW drive signal at 10.1 MHz, total duration each test about 10 seconds.
2:5 turns ratio on input. 1:2 turns ratio on output.
Drive SWR (attenutor looking into amplifier input) 1:1.
Drive source ICOM IC-730 with power attenuator (10 dB up to 26V, then 6 dB)
Drive increased from 1W to saturation (up to 26.0V drain voltage)
Drive increased from 2.5W to saturation (at/above 28.0V drain voltage)
Final transistors are 2x IRFP250N sourced from ebay china seller
Idling current preset to 100 mA per transistor @ 28V initial drain voltage.
Output power measurements made using Kenwood SW-2000 with SWC-3 and SWC-2.
Output power measurements above 200W were on 2KW scale with SWC-3 coupler.
Output power measurements below 200W were on 200W scale with SWC-2 coupler.

Drive Power	Drain Voltage	Drain Current	Input power	Output Power	Efficiency
5W Drive	13.8V Drain	5.0A Drain	70W input	45W output	65% eff.
5W Drive	16.0V Drain	5.8A Drain	93W input	60W output	65% eff.
5W Drive	18.0V Drain	6.5A Drain	117W input	80W output	68% eff.
6W Drive	20.0V Drain	7.2A Drain	144W input	90W output	62% eff.
7W Drive	22.0V Drain	8.0A Drain	176W input	120W output	68% eff.
7W Drive	24.0V Drain	8.6A Drain	206W input	130W output	63% eff.
7W Drive	26.0V Drain	9.1A Drain	237W input	150W output	63% eff.
10W Drive	28.0V Drain	10.4A Drain	291W input	180W output	62% eff.
12W Drive	30.0V Drain	10.9A Drain	327W input	210W output	64% eff.
13W Drive	32.0V Drain	11.4A Drain	365W input	220W output	60% eff,
2.5W Drive	34.0V Drain	Destruction point (one fet shorted drain/source)			

Here's a picture of the Alumina thermal wafers I replaced today (these have been the ones in place since I began playing with this amplifier.) I cleaned the wafers and heatsink with acetone to remove the white thermal compound (normally when replacing transistor I have cleaned both transistors, reapplied thermal compound to the transistors, and inspected the wafers (which stick to the heatsink) for any obvious voids.

I was interested to see some dark markings on the wafer sides that face the transistors, as well as several dark but reflective distinct circular dots (<1mm diameter). There were no such markings on the opposite sides of the wafers (facing the heatsink.) These I'm sure have accumulated over the (dozen so far) transistors that have been sacrificed for this project.

Tried another test-to-destruction experiment (my stock of IRFP250N's is now over half gone, but at about 50 cents each plus about $40 for the kit, is totally worth the learning experience!)

But first...

During one of my endurance tests several days ago (CQing on 15M with ~20W drive and 150W output) I noticed a bit of a smell, but couldn't localize it. Today while replacing a FET (after the test-to-destruction experiment below) I realized the failure was in the 10 ohm 5W film resistor that sits across the input transformer's secondary. I don't know the specific purpose of this resistor, but it absorbs drive power and perhaps helps the input match at expense of gain. The resistor had clearly overheated and was now reading about 20 ohms. I replaced it with ten 2512-package 100 ohm 1 watt SMD resistors for 10 ohms 10 watts (what I had on hand), did some testing, then changed to five such resistors (for 20 ohms 5 watts) which improved gain and input match somewhat. After this, I rechecked the capacitance value on input (across gates) and output (across drains), in both cases using an air variable capacitor temporarily in the position. Input (seeking minimum input SWR at 18.1 MHz) ends up at 150 pF; output (seeking maximum output) ends up with no capacitor in this position (for some time I had 680 pF on input and 150 pF on output, however, the differences in any event are minimal).

Will need to revisit these (input C, R and output C) components.

Also reconfigured the 15M low pass filter to favor 17M (capacitance values were same, inductor turns were same, just pushed the turns together until the nanovna indicated minimum insertion loss and best return loss at 18 MHz).

This test-to-destruction experiment was with 1:9 output transformer (3 windings on secondary, vs the 2 windings I've been using) - otherwise similar (10.1 MHz at a series of increasing drain voltages, increase drive to the point of saturation, measure drain current and output power, which allows calculation of gain and efficiency.)

This test didn't last long - at each drain voltage point tried (13.8, 16.0, 18.0, 20.0, 22.0, allowing up to 15 amps drain current) output power and gain were significantly reduced from the corresponding tests with 1:4 output transformer ratio, and destruction occurred at 24.0 volts with the familiar source/drain short (almost certainly exceeding dissipation tolerance.)

I've not ever tried 1:16 output ratio (4 turns on secondary), and the very first few trials with 1:25 output ratio (5 turns on secondary, which is cited in what bits of documentation I could find) were never successful (very poor gain/efficiency).

At one point I experimented with 1:1 output ratio which resulted in low drain current and output at any voltage tried; 1:4 output ratio seems to be the most useful configuration.

My take-away from these experiences is that running a higher drain/source voltage (consistent with device limits and corresponding impedance matching components) is preferable in terms of power gain and output power. I don't plan to revisit 1:1 for a destructive test as that would call for higher drain voltage - probably exceeding 50V - than some of the onboard components will stand.

So, back to 1:4 output ratio (2 turns on secondary), nominally 26-28V on drain, with expectation of 150-200W output up to 14 MHz, around 100W output on 18 MHz (all with adequate drive for each band), and will forego further use at/above 21 MHz due to insufficient gain (7-8 dB) to be useful with 5-watt class QRP transceivers.

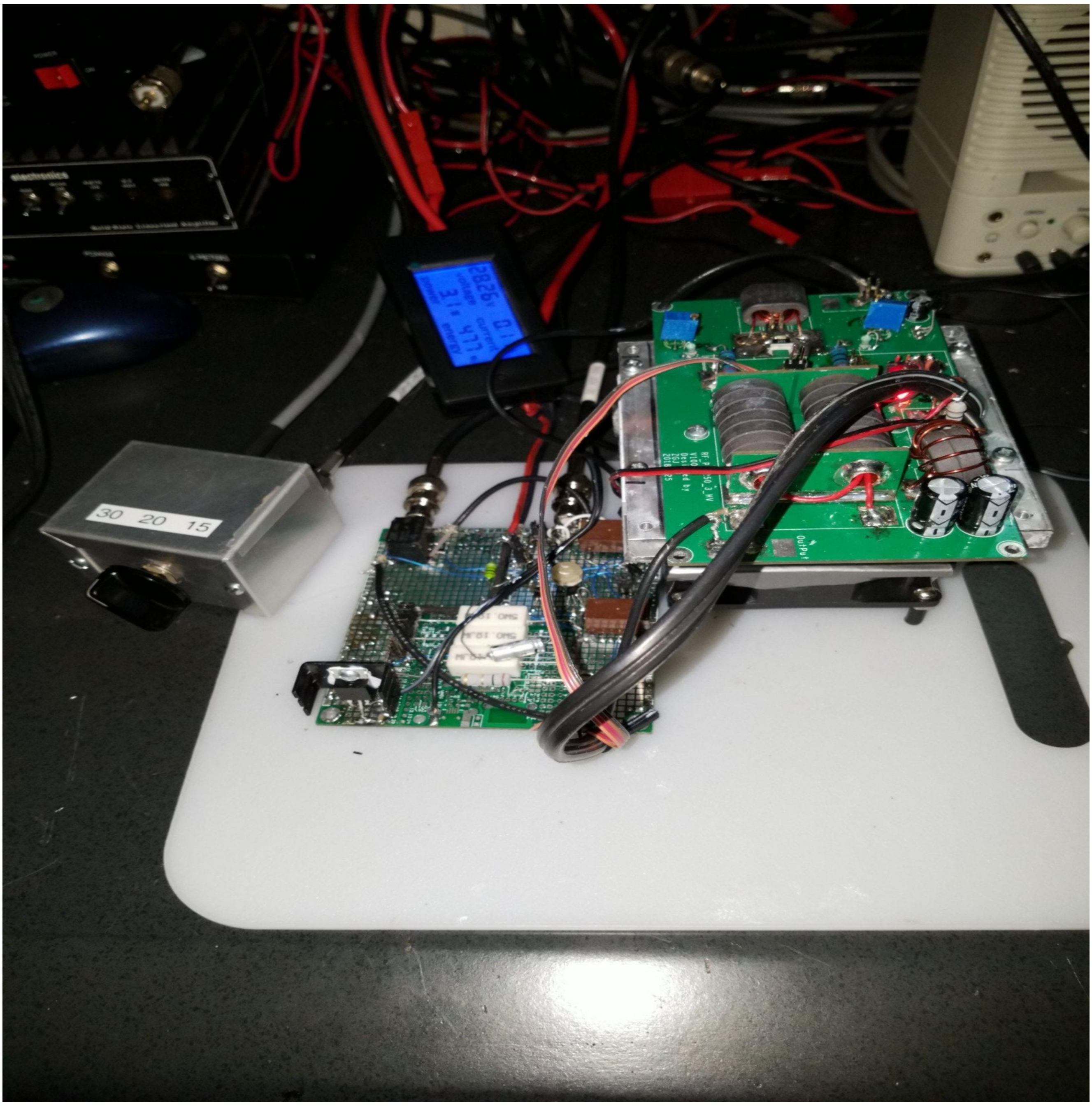
Any comments/observations are welcome.

This story is mostly wrapped up for now. Future experiments will include FQH44N10 and IRFP350LC (both have lower gate charge than IRFP250N; the FQH44N10 also has substantially lower input capacitance, but also is only rated at 100V vs. 200V for the IRFP250N and 400V for the IRFP350LC) and with a different PCB, two or three devices in parallel on each side of push-pull (this board is self design but generally similar to the "180W" kit, and requires a different heatsink arrangement.

Here's a photo of the amplifier project as it currently stands.

The kit board is mounted on a 4x4x3/8" aluminum bar, which in turn is mounted on a small heatsink (thermal compound between the two), and the heatsink is mounted over a 75mm PC case fan (12V DC fan fed from drain voltage through 100 ohm resistor, so fan is running faster than it would at 12V), which is on four short "legs" to give room for air exhaust (fan is backwards - it is pulling warm air down, which isn't ideal, but has been adequate for these experiments.)

The board to the left is a prototyping board that contains carrier sense detection, t/r relays (input side and output side), DC overcurrent bias cutout (the power resistors), gate bias-on relay, and a 15V regulator to power the attached radio. Low pass filter is to the left (two small boxes, this one has 30, 20 and (now) 17M 3-pole LPFs; the other one not shown has 160, 80 & 40M 3-pole LPFs.) The blue display behind is a DC voltmeter/ammeter/power meter (about $8 on ebay.) This all looks a little shopworn as it has been on the bench for FET replacement maybe a dozen times over the last couple of weeks.
Hello EA7KNW,



I did not answer your questions before, sorry!

>I gathered from your posts that you ended up with 20R and 150pf across T1 secondary, 2 turns on T2 Secondary and eliminated C5 and C12 which were across T2 primary (the FET drains).

Yes, that sounds correct. Some supplied matching capacitors (case 1111 or cases 1210) was included, but I did not use them. 20R and 150 pF across T1 secondary made small improvement in gain, but it is not big improvement. I did not find any help from capacitor across T2 primary.

I found 1:2 winding (1:4 impedance) ratio of T2 works well at 28V drain voltage. I think original amplifier photograph had 1:5 winding (1:25 impedance) ratio. Maybe this was for 12V drain voltage, I did not test it. I preferred higher drain voltage, 28V. Once you choose T2 ratio, then there seems to be preferred drain voltage (28V, I found.) If you reduce drain voltage, output power is reduced. If you increase drain voltage, output power is increased, but higher risk of FET destruction was observed. This was "destruction tests" I performed. Important! If you do not have enough drive power (my 40M radio is Norcal 40, not enough power to fully drive amplifier), then you may try to increase drain voltage higher (I tried >30V), however, this was many times the cause of FET destruction in my experiments.

>Of course there will be an LPF before this thing hits an antenna. As i (currently) have no spectrum analyser, is there another way to adjust the bias settings to get the 'best' harmonic supression ?

I adjusted bias setting for ~100 mA idle drain current for each transistor. I began at cut-off (bias voltage = 0), then slowly increase bias voltage on transistor #1 (either, you can choose one), until 100 mA, then slowly increase bias voltage on other transistor until ~200 mA. This is "class AB". I changed variable resistor potentiometer from original kit (1 turn) to 10 turn type. It is easier to slowly adjust drain current.

It it is possible that odd harmonic will have greater energy than even harmonic below - there are some properties of push-pull amplifier. Fourier transform of square wave is primarily odd harmonics.

I do not think setting idle current can avoid need for low pass filter; harmonic energy is property of class of operation (D, C, B, AB) and linearity limitation of device and circuit.

I did not measure for harmonic output, however, I did find that antenna coupler I use (for match transmitter to wire antenna, it is adjustable "T" network, common design) could provide some indication of harmonic energy.

If I have no low-pass filter at all (just amplifier > antenna coupler), I adjust antenna coupler for minimum SWR, but I cannot find 1:1 SWR because harmonic energy is being reflected back to amplifier.

If I insert low-pass filter between amplifier and coupler (amplifier > low pass filter > antenna coupler), then I can adjust coupler to minimum SWR, and I can easily find 1:1 SWR. This is not accurate method, but at least provide some possibility that low pass filter reflects harmonic energy back to amplifier before remaining fundamental signal reaches antenna coupler.

A large hazard is if you use no low pass filter, and use antenna with good harmonic property (like dipole with harmonic #3, #5, #7, etc.) or full-wave wire loop with harmonic #2, #3, #4, #5, etc.) In these cases, antenna will be happy to radiate harmonic energy just same as fundamental energy.

Good luck with your project! 73 Dave WB0GAZ wb0gaz@yahoo.com

Thanks for the info and tips !
Yes, with no LPF the power meter showed a bunch more power, so the harmonic content is significant.

Yesterday the smoke escaped while driving the amp with 15W on 40m, giving about 135W, so will get a transistor swap (again).
It did manage 2 QSOs, so with these cheap transistors, that's only about 30 cents per QSO

As the Xiegu has a max 20W output, i'll settle for 80W from this amplifier, giving it a chance at longerterm survival.

The antenna is a Continuously Variable Inverted V, covering 40m to 10m, with pretty much a 1 : 1 SWR all the way

135 watts output, and I remember your efficiency << 50%, so then possibly ~300 watts input?

Can you measure DC voltage at amplifier input (DC side of collector RF choke), under load? Maybe your DC voltage is too low there.

Can you measure input SWR (from radio to amplifier?)

I think almost always when I murder transistor, it is due to exceeding junction temperature (high input power, low output power, almost always caused by low efficiency operating point - symptom is low gain.) When I try increase output watts, but not watch input volts/amps closely, then this seems like time of death for transistor.

15 watts drive seems high for 40M band (gain 15 watts input, 135 watts output = *9 = 9.5 dB); from my experiment, gain on 40M was higher >> 10 dB. I think this is major risk for transistor life.

Dave

Personally i feel that i just over-worked the poor thing !
135W is way more than anyone can reasonably expect from a $40 kit for any length of time, especially with dig modes.

15W is way too much drive ! I think i calculated that 8W drive would be the maximum safe limit to keep under 20V in this circuit.
It was a surprise that they worked after the drive was increased past 10W.

A thermal cut-off circuit (thermistor, LM311, relay) was added some time ago, to cut the power if it gets too hot.
Every time i have blown a transistor in this amplifier (about 12 of them) it has not been due to general Heat.
Possibly the Junction does get too hot, too fast, and the heat does not dissipate fast enough.

These MOSFETS are rated for an absolute max of +/- 20V Gate-Source voltage, so one idea i had was to put a couple of 18V zeners back-to-back from gate to source to see if that helped keep the magic smoke in. Not tried that yet although the zeners arrived.

The gate bias circuit looked suspect to me, so i removed the inductor and added a diode, the same as the EB104 Motorola design.
It made no difference, but allows for adding more un-matched transistors in parallel.

Today i reverted to 5 turns on the output transformer secondary and ~14V supply.
It is terrible compared to 2 turns and 26V, so tomorrow i'll chop some wire off.

https://forums.qrz.com/index.php?threads/180w-ebay-amp-anyone-looked-at-one.505475/page-5