CHAPTER 13

630M TRANSMITTERS AND

RF POWER AMPLIFIERS
Chapter 13

630m Transmitters and RF Power Amplifiers

1/31/16 Wolf, DF2PY, sent some pictures of his breadboarded 630-meter transmitter and said that I could share them here. I really like seeing cobbled together systems using clip leads and point-to-point construction because it gets back to the roots of radio. This system apparently works very well as Wolf has successfully made a number of contacts. Well done!
DF2PY antenna matching – I’m making a guess!
3/26/16 WG2XIQ blogs: Neil, W0YSE/7 / WG2XSV, reports that he decoded nine unique stations and was decoded by 15 unique stations at 0.5-watts ERP. Neil recently completed a rebuild on his amp and experienced a failure on his FET during the session following the completion of the rebuild. We had been talking about the failure in the ON4KST chat/logger during the evening session and I had commented that I was due for a FET failure as both combined PA’s now have in excess of 12000-hours of RF emissions. I said this in jest and didn’t think anything else of it. This morning waking up late after a late night, I came into the ham shack and found one of the PA power supplies in current limit. The other amp was making full power but half of the power was being dumped to the reject load in the combiner due to one PA being off line. Further examination suggests that the screw and shoulder washer holding the FET against the heat sink had loosened, possibly a result of thermal cycling over the last few
years. Curiously enough, Neil speculated that his FET may have failed due to a thermal issue related to the interface with the heat sink. The FET here at WG2XIQ has been replaced and the station is running at full power again on both PA’s. I was very pleased at how well the combiner maintained 50-ohms for the functional PA in spite of the shorted PA that remained in circuit. With Neil’s FET failure and mine last night, the count is at two. Since these things happen in “three’s”, whose FET will fail next? Will I lose the other PA tonight or will someone else wake up to a failed PA tomorrow? Stay tuned!

5/1/16 Noise is just a reality this time of year but as Phil, VE3CIQ, notes, the band is hanging in there. Phil decoded WSPR signals from WE2XGR/3, WG2XIQ, WG2XKA and his own WSPR signal was decoded by SWL/K9, VE2PEP, WA3TTS/2, WD0AKX, WE2XGR/3, WG2XJM, WG2XKA, WI2XFI. Phil has a new homebrew amp that he was running during the session and apparently having great success.
1/17/16 Phil also reported that he completed his impromptu PA mentioned in yesterday’s report. The PA is built around a pair of 2N5302’s in push-pull configuration biased for class-B. This was a junk box project using EMI suppression ferrite for transformers taken from USB cables. He indicates that he is planning on replacing those with proper core material but is reporting no heating and better than 80% efficiency after adjusting the turns. So far nothing has smoked with 20-watts of drive for an output of 120-watts. Phil submitted this photo. It’s just amazing how simple PA’s can be:

Class-B junk box PA at VE3CIQ using an old power supply chassis (courtesy VE3CIQ)

7/5/16 Phil, VE3CIQ, operated WSPR at 75-watts TPO overnight and was decoded by SWL/K9, WA3TTS, WE2XGR/3, WG2XJM, WI2XFI, and WI2XHK. He also decoded VE3EFF, WG2XXM and WH2XNG. Phil recent made some station improvements and offers these details:
On my end, am pleased to announce the antenna was raised to 16 meters, [neighbour's boat is at the marina and out of my way], and power amp was reworked to hold steady at 200 watts, which puts me at 2 watts ERP, less the trees sucking energy. No sparks, and no smoke anywhere so far-woohoo!

I've also built a 500 w W1VD amp, learned some hard lessons about driving these amps like my class E amp- cost me 9 mosfets so far :-)
Have ordered the proper mosfet driver, and hope to get this running this week.

5/6/16 David, G0MRF, emailed with a report of his new prototype PA that he is developing for next season and offers the following details and picture:

After running my portable WSPR beacon during March, I decided to build another amplifier and refine its design for 630m.
Having looked around unsuccessfully for a suitable box, a reorganisation of the kitchen produced the perfect answer - A breadboard.

The amplifier runs nicely at 300W CW with the present toroid core selection, but is more comfortable at 250W with higher duty cycle modes like WSPR and DFCW. The final uses 2 x IRFP250 FETs and the output filter uses T157-2 toroids.

With over current and SWR protection it seems fairly robust, so the only job remaining is to draw a new PCB layout and get a few on order.

David continues in an additional email:

The PA is not linear but is a switching design with push pull drive from a D-Type flip flop and a dual FET driver from Micrel.
The drive requirement is at twice the wanted frequency at anything from 3.3V logic level up to 200mW at 50 ohms.

When thinking about suitable drivers for this, I had in mind the new signal generator project from QRP Labs ($29).
This can drive the amplifier input at 950kHz while its digital readout displays the final frequency at 475kHz.
It has a couple of outputs to drive external meters for forward and reflected power and a P channel FET for CW keying.

It’s never too early to start preparing for the next season!
David, G0MRF, sent a note that he has completed work on the 300-watt amplifier board reported recently and he has placed a draft article with details on his website. It was previously reported that the amp needed an external low pass filter for use in the US but this is not the case. The filter itself may be rated at 35 dB below fundamental but due to the balance and push-pull nature of the devices, the actual output at second harmonic is better than 60 dB. Many thanks to David for clarifying this details. David indicates that he will likely not
produce a full kit due to complications with VAT and component cost in Europe but he may offer the board with the three SMD chips soldered in addition to the 3C90 ferrites. This is a very attractive amp with protection facilities not afforded by the GW3UEP amp that many of us are using. It’s also amazingly compact!

9/3/16 David, G0MRF, has returned to air during this session testing, his new amplifier prototype on a real antenna, consisting of “a sloping wire that runs from the club building up to the top of an adjacent church. Total length is around 200 feet with the far end about 80 feet AGL.” David provided the following details of the session including some proof-positive data
illustrating a very high degree of spectral purity with his amplifier. It's great to see such innovation and attention to detail:

“I managed to give my new amplifier board a ‘soak test’ into a real antenna rather than a dummy load earlier this evening. Managed a couple of hours at my local radio club running 200W TPO on a 50% duty cycle while checking everything was running cool. Nice to see many people returning to 630m now the new season has begun. I received reports from 42 unique stations from around Europe with the best being SV8RV reporting -23 over 2252km. That was pretty much everyone….If only we had a station or two in the middle East or Africa.

After our debate last week about the harmonic content of the class D amplifier, I made some detailed measurements. The 2nd showed 58.7dB down on the wanted signal while the 3rd was -66dB. That’s probably OK for 95% of installations, but a notch at 950 would give some reassurance if you had a local AM broadcaster on that frequency and you wanted to ‘protect’ the immediate neighbours.”

2nd harmonic is down nearly 60-db!
5/18/16 630M CLASS C/D/E AMPLIFIERS

John, Content for tomorrow, Wednesday, May 18, blog. 73, Jim H W5EST

630M CLASS C/D/E AMPLIFIERS

On HF, hams often use a linear amplifier because nonlinear amplification would distort single sideband (SSB). Then digital modes are handled by supplying them in audio form as if they were audio input for transmission as SSB. Unfortunately, linear amplifiers inefficiently dissipate power.

By contrast on 630m, especially in the 7 KHz 472-479 KHz band awaiting FCC approval for Part 97 hams, the 2-3 KHz bandwidth of SSB occupies too much space and demands about +0 dB SNR in a 2.5KHz noise bandwidth.

Consequently, digital modes and CW are likely to rule 630m. Most of these modes can be generated by efficient nonlinear amplifiers without distorting the modulation. Practical 630m antenna systems are necessarily less efficient than HF antennas, so why sacrifice 630m transmitter efficiency in the shack?

Instead, says this train of thought, drive a good 630m transmitting antenna system with a nonlinear amplifier. Get more transmitter power output (TPO) from the power supply’s input to the final. Put up the best 630m receiving antenna system you can, too.

What types of nonlinear amplifiers are there, in terms of the principle of operation? Several! Their efficiency is high at two levels. First, when a power amplifier (PA) device is off (current I
dissipation $P = VI = (V \times 0) = 0$. When a power amplifier (PA) device is on, it’s full on so the voltage across it is near zero (voltage $V \approx 0$). $P = (0 \times I) = 0$ when the PA is on.

**Class C** amplification feeds a 630m sine wave to a power amplifier that is sufficiently biased that it delivers a pulse once per 630m cycle. Since a pulse contains lots of harmonic content, a tank circuit or filter tunes the output to keep unwanted frequencies away from your antenna system. Your outdoor 630m antenna tuning unit (ATU) further rejects them.

**Class D** (see endnote*) switches the analog input signal to create pulse width modulation (PWM) or pulse density modulation that’s more fully at work than Class C throughout each 475KHz 2 microsecond cycle. Then a PA-LPF (PA low pass filter) passes signal and rejects switching frequency and harmonics.

**Class E** ** amplifier design even more fully confronts the challenge of getting PA voltage down to zero by each time the PA conducts. Class E artisans determine the right drive circuit and PA circuit inductances and capacitances so that economical FETs devices achieve remarkably low power dissipation in class E throughout the start, middle and end of transmission.

Do you have experiences you’d like to add, beyond what’s said in the cited web sites? Let us know!

*https://en.wikipedia.org/wiki/Amplifier#Class_E (Scroll down 60%.)
http://www.gw3uep.ukfsn.org/100W_QTX/100WTX/PA_cmos.gif (472-479KHz)
http://www.gw3uep.ukfsn.org/100W_QTX/100WTX/100WTX_2july11.htm (Scroll halfway.)
** http://www.classeradio.com/theory.htm
http://ve7sl.blogspot.com/2014/09/gw3uep-630m-tx-complete.html

5/19/16 PART 2: CLASS D AMPLIFIERS FOR MF/LF

PWM and 10x switching as discussed under the heading for Class D on May 18, this blog, are seen in audio amplifiers, but not familiar on ham/experimental MF/LF.*

Today let’s look at an example MF/LF Class D pulse amplifier. See its MF/LF push-pull amplifier schematic (13.8vdc, 100w) at http://www.g0mrf.com/classd.htm . **

An input flip-flop circuit responds to input at twice (2X) the output frequency to generate staggered non-overlapping pulses that ultimately drive push-pull PA FETs. The action resembles two people alternately pushing a child’s playground swing (LPF) from each end of its travel to reach desired height (power output) in the presence of friction (the antenna load).

To eliminate harmonics, the antenna system load receives amplifier’s RF power via an LPF L1-L2, C1-C3 or another suitable LPF design. The MF/LF Class D amplifier delivers two pulses of energy to the LPF per RF cycle instead of Class C’s one per cycle.

Tell us your experiences with amplifiers at MF/LF. TU & GL!

*Thanks to John WG2XKA WA3ETD for encouragement on today’s topic. Any errors are mine.
5/20/16 PART 3: CLASS D/E AMPLIFIER DIALOG

John WG2XIQ: Class-E amps don't have to be turned completely off or on to work efficiently. (Or avoid violent failure!) I've driven GW3UEP amps with sine waves with no issues and no additional heat...

Jim W5EST: RR. I'm impressed with the experience 630m folks have accumulated.* The Sokal QEX paper deep-down may tell about 'not completely off or on': p. 13 col. 2, p. 17 col. 3, p. 18 col. 1. Sine wave drive is mentioned at p. 18, col. 2. Would you tell about the way you do sine wave drive?

John WG2XIQ: I drive the input of the amp with about 0.5 - 1 watt sine wave. Here at WG2XIQ, two amplifiers** split drive output. I control PA drain voltage to regulate output of the final. On the GW3UEP platform, 0 dBm (1 milliwatt) drives a squarer that yields a 12v square wave at the input of the PA.***

Jim W5EST: What other features are there?

John WG2XIQ: A 2nd harmonic trap modification at L3 improves the match. The trap is a modification of L3 on Roger’s GW3UEP design, and recommended to me by XKA who encouraged more 2nd harmonic rejection. Wound with #18 enamel wire, L3 is modified to 13 uH, or about 31 turns on T106-2 toroid instead of PVC. Across the toroid and as close to the core as practical, a 2200 pF, 2.5% minimum pulse-rated cap is placed in parallel.

Jim W5EST: How would you describe the overall performance?

John WG2XIQ: I just wind them and they just work every time, centered on the middle of the band. The trap seems to clean up potential match problems as well. The amp screams power after the mod and the 2nd harmonic is basically gone. That amp makes 100W all day long into 50 ohms, and it's capable of power beyond the nominal design--if the power supply and the output network can handle it. The FET is less efficient over 100W but works up to some failure point. I've seen 150W+ with a big matching network and I stopped there.

Jim W5EST: Thanks, John. I look forward to other readers sending us more amplifier experiences too!


*** http://njdtechnologies.net/a-simple-commentary-on-power-combining-or-how-to-get-about-3-db-more-from-low-cost-amplifiers/

http://njdtechnologies.net/hot-spare-gw3uep-class-d-amp-is-in-the-bullpen-if-needed-for-this-weekends-field-day-message-event/

http://www.gw3uep.ukfsn.org/100W_QTX/100WTX/PA_cmos.gif (472-479KHz. 2011.)
Compare with these two web pages:
http://www.gw3uep.ukfsn.org/100W_QTX/100WTX/100WTX_2july11.htm (Alternative keying ckt for PA, photo, scope waveforms and auxiliary test oscillator circuit.)
http://www.wireless.org.uk/qtt.htm (See construction photo based on different 2009 schematic.)

OUTPUT COMBINERS

5/20/16 John WG2XIQ reports: During my morning CW sked at 474.5 kHz, I was testing a pair of keyed and waveform shaped GW3UEP amps (a variation on the 3rd schematic at link) combined using the W1VD zero degree combiner in the same arrangement that I use with my non-keyed GW3UEP PA’s that are driven via the MF Solutions transmit converter. At contention was how to successfully key both amps at the same time to avoid AMing and other problems that would negate the effects of the waveform shaping. A simple available DPDT relay actuated by the bug or paddle appears to yield very good simultaneous contact closures to key the amps and no spike, harmonics, or AMing has been observed. The output waveform was excellent, yielding in excess of 240-watts into 50 ohms resistive. As the 2nd amp was retrofitted with the IRF9530 keying FET and support circuit, the heat sinking is not ideal due to a lack of space in the chassis so this may need to be addressed in the long term but after a 30-minute QSO today, the situation is manageable.

5/21/16 HOW AN RF POWER COMBINER WORKS

I’m repeating John’s WG2XIQ commentary* on the W1VD zero-degree combiner and add some of my notes [in brackets] too. Here, I’ve redrawn the combiner schematic without changing the circuit connections. As illustrated, it depicts each coax-wound toroid T1 or T2 like a transformer using a coax center conductor and its concentric shield as transformer windings in schematic.

The winding sense of 1:1 transformer T1 is shown by labeling “T1” by each winding in the places of the usual dots. Ditto for T2. Winding voltage unknowns v1, v2 turn out to be near-zero when the bridge or lazy-H circuit is driven by both transmitters TX1 and TX2. T3 is an impedance-matching transformer matching its 25Ω input to 50Ω output.

“Combining is the act of taking two or more signals that are in all ways equal and adding them together in-phase [AT T3 INPUT]. Variations in phase relationship or amplitude result [IN NONZERO DIFFERENCE (I1-I2) CURRENT] in a portion of the power being rejected, typically to a resistive load [RLOAD] and wasted as heat. A well isolated two-port system [TX1, TX2] will still see a 50 ohm load resistance even when the second port [TX2] is inactive or no amplifier is present, however, half of the power from the operating port will be lost to the resistive load [RLOAD] as heat.

“The process starts with an input signal that is typically from a single source but can come from multiple sources as long as they are phase locked…[D]ownconverter output passes through a small attenuator whose output is a T-splitter. The splitter is the connection point for equal lengths of coax to drive each amplifier. And I mean EQUAL LENGTHS. If you are duplicating this project and are unsure of your ability to build two, absolutely identical cables, buy the machine-built cables from a reputable seller. They will likely be identical. Each identicale cable connects to an identical amplifier.”

“The outputs of each amp [TX1, TX2] feed each input port of the combiner [T1, T2] with IDENTICAL cables. The output [T3, 50 ohm side] of the combiner can be any length but should pass through a low pass filter [LPF] that is capable of handling the output power…[O]utputs of combiners are apparently pretty harmonic rich… W1VD zero-degree combiner…. port isolation is phenomenal and I know that my amplifiers are going to see 50 ohms even if one should fail.”
In this way the combiner delivers twice the power of each transmitter TX1 or TX2 alone. The combiner sees the antenna system as 25Ω at the input of its transformer T3, which impedance matches the two 50Ω transmitters TX1 or TX2 effectively put in parallel 50Ω/2 by the combiner. Suppose transmitter TX2 goes off-line (open T2 input at lower left). Then the other winding of T2 at upper right presents a very high inductive reactance amounting to a near-open circuit there. Now voltages v1 across the windings of T1 are no longer zero, but they do cancel each other. That leaves 25Ω \( R_{LOAD} \) in series with the 25Ω offered by the input of transformer T3.

This way, transmitter TX1 remains matched to 50Ω and delivers half its TX1 power to the antenna and ground system even if transmitter TX2 goes off-line. Compared to power from both transmitters TX1 and TX2 active, the radiated signal level when TX2 goes off-line falls by 6dB, or a factor of 4. But this 630m system is still on the air!

Depending on particular TX1 and TX2 circuitry and failure scenarios and possible shorting of cable connections, suppose TX2 fails to a low impedance instead of an open circuit (or some essentially-equivalent high impedance). In that case, 25Ω \( R_{LOAD} \) power dissipation can go into action. The remaining transmitter TX1 would likely see a departure from 50Ω match that's somewhat less-serious at its TX1 output than for hypothetically failed TX2.

Lastly, consider a scenario in which the antenna system becomes disconnected or significantly altered due to wind gusts, or Murphy’s Law attacks the system or circuitry some other way. The impedance at the input of transformer T3 changes significantly and the change is symmetrically presented to the outputs of transmitters TX1 and TX2. To handle that scenario, it may be desirable to have an SWR cutout or other PA protective circuit to shut down each transmitter. 25Ω \( R_{LOAD} \) power dissipation remains near-zero under that scenario.

*http://njdtechnologies.net/a-simple-commentary-on-power-combining-or-how-to-get-about-3-db-more-from-low-cost-amplifiers/
7/10/16 Roger, VK4YB, sent a picture with details of his very compact and neat station. It’s interesting to see that the voltage on his coil is low enough to couple to a wall receptacle. I suppose this is just a sign of Roger’s very large antenna, whose voltages are much lower than what many of us experience:

Hi John,

Nothing very exciting to report. No unexpected wiggles etc. So I thought I would send you a picture of my 630m Station in stead. It shows my CW set-up. The red wire goes to the end-fed antenna, which is about 900 ft long with a 120 ft vertical section near the middle. Because of the slope of the hill, the highest part is about 200 ft above the lowest. The tapping point is carefully chosen for best SWR, about 1.08 to 1. The capacitor is tuned for maximum glow in the neon tube. The input and output of the transverter are on 160m, so the KX3 is set to 1802.5 which corresponds to 472.5, our CW calling frequency in VK.

73 Roger, VK4YB
The very compact 630-meter operating position at VK4YB
8/11/16  MF SOLUTIONS TRANSMIT CONVERTER DRIVEN BY ELAD DUO
John WG2XIQ reports:  Doug K4LY / WH2XZO, was decoded here for the first time in months while using 25-watts from the MF Solutions transmit converter driven by the Elad Duo. Doug provided the following comments:

“Conditions may not have been as good last night as the previous, based on my reception, but with about 6 db more power using the MF SOLUTIONS MF Transmit Converter, WH2XZO was heard by three additional stations. The transmit converter was easy to set up with my Elad DUO transceiver and has the following specs-

INPUT: 3.663.68 MHz (80 meter band) or 4.464.48 MHz @ 0.11.0 Watts
OUTPUT: 460480 KHz, 2225 W into 50 Ohms, nonreactive @13.6V
EFFICIENCY: 85%  93%
DC INPUT: 13.6V @ 2.2A maximum (1.82.0A typical)
HARMONIC OUTPUT: minimum 50 dB below fundamental
NO TUNE DESIGN: No special test equipment required, “Plug ‘N Play”!
MODES: CW, MSK, FSK, “WSPR” supported (NO linear modes)

It’s probably a better choice for 630M than the 5 W Chinese linear amp I used the previous nights unless you want to use linear modes such as PSK and SSB. I bought the Chinese amp a year ago before I knew about the MF Solutions transmit converter or the NJDT Class E amp.

As John cautioned yesterday, the claim by the Chinese amp seller that it is appropriate for 630M is bogus. Its low pass filter attenuates 160M harmonics, but not the 630M 2nd and 3rd harmonic. Using the Chinese amp without an outboard LPF, I could hear the 2nd harmonic beating with a local 950 kHz station up to a mile away, but with the MF Solutions transmit converter, there was no indication of the 2nd harmonic even one tenth mile from my home. For the Chinese amp, I used one of the QRP Labs very inexpensive LPF kits, good for up to 10W and appropriate for the Chinese amp or their own low power 2200M, 630M, and higher frequency transmitters.”

8/15/16  John WG2XIQ blogged: Rick, W7RNB / WI2XJQ, reports that the thermal problem with his PA is resolved. Below are details and pictures of his very attractive four-port combined amplifier system based on the stock GW3UEP design:

“Hi John — At your suggestion, and that of Larry W7IUV I isolated my FETS with individual heat sinks and use fans for additional cooling. The FETS are mounted directly to the heat sink for maximum heat transfer.
This is a new amplifier
28Vdc 21 Amps input
500 watts output
85% efficiency
2.42 amps of antenna current
7.89 watts ERP
12.98 watts EIRP
I am using 4x IRF740’s each in the GW3UEP configuration with a 4 port Wilkenson power combiner. This is all done with “dead bug” construction.”
Four independent FET Amplifiers in a very well organized and attractive enclosure
Cooling system for FET amplifiers
Express your support for QST articles like the ones I brief today. Log into your ARRL member account http://www.arrl.org/users/login (Username is not case-sensitive. Your password is case-sensitive.) Paste this URL http://www.arrl.org/cover-plaque-poll into your browser’s URL field while logged in; then press “Enter” on your keyboard to go to the poll. Vote there by
clicking on the button for your favorite article on the list, and then click SUBMIT at bottom of page.

**Transverter** [See also John WG2XKA comments 8/21/16.]


An FT-817* or other transceiver drives the transverter unit with 0.5 watts at 3.675 MHz. 630m output from the transverter is fed to an external 2nd harmonic rejection LPF, tapped ferrite transformer ATU, and 475 kHz TX antenna.

The example *transceiver* has a single antenna coax connector and can split-mode *receive* 475 kHz. The transverter includes an auxiliary 630m series resonant circuit associated with transverter. When not transmitting, the transverter PA output filter gets coupled by the series resonant circuit back to the transverter’s input and back to the transceiver. That way, the series resonant circuit bypasses receivable 630m signals around the transverter’s active devices and conveys the signals to the transceiver.

If separate TX and RX antennas are used, I surmise that a user provides some T/R box not shown to connect the 475 kHz RX antenna directly to the transceiver. In that scenario the internal series-resonant bypass circuit could be omitted.

**600 Meter Experiment** (non-votable *QST* note)

That *QST* issue’s pp. 79-80 reports 202,400+ hours of operation with zero interference complaints in 465-515 kHz band. Experiment coordinator Fritz Raab’s 3/1-5/31/16 report was released July 3. Rudy Severns N6LF and John Langridge KB5NJD were mentioned. In the report period, WD2XSH had 16 contacts on 630m for a running total of 578.

**Loop antenna preamplifiers**

*QST* also at pp. 36-38 carries Christoph DK6ED’s “Activate Your Loop Receiving Antenna,” oriented to low bands. Ops may find this thought-provoking for 630m too. Antennas like EWE, K9AY, flags, and DK6ED Double Loop can have high impedance that’s tough to match to 50Ω without degrading system noise figure, he advises. Christoph’s Figure 4 circuit replaces the usual step down transformer at the antenna with a push-pull common source RF preamp having two, easily obtained N-channel FETs delivering positive dB gain instead.

* Yaesu’s FT817ND manual can be viewed at:  

---

**8/21/16 LPF BETWEEN MIXER AND SQUARER**

After recent discussions about the September *QST* article by Roger, G3XBM, John provided some comments about measurements and observations that he has made with the same design, particularly with respect to low pass filtering between the mixer and squarer:

“Considering the number of semi-commercial, commercial, and homebrew transmit converters around today, there is often an overlooked, yet important circuit element ‘glossed-over’ : a proper low-pass filter between the mixer output and subsequent stages. Looking at common designs using an IF frequency in the 80m band at 3.2 MHz, the output of the mixer contains the desired DIFFERENCE product at nominally 475 kHz as well as the SUM at ~6.875 MHz. Clearly, the sum product must be stripped while passing the
desired LF/MF frequency. Failure to properly do so will impact the performance of subsequent PA circuits, often causing excessive heating and lower than expected power output, ESPECIALLY with a Class E PA.

Having built multiple transmit converters over the past four years I have observed these issues. For example, a popular homebrew design recently published in QST Magazine employs a 10nF capacitor at the output of the mixer as the LPF. With a LO frequency at 3.2 MHz, it marginally works; however the HF sum frequency can be observed slightly modulating the desired 475 kHz waveform. With a LO at 4.0 MHz the effect is reduced, as the reactance of the cap at HF decreases, causing an increased ‘shorting effect’ of the undesired sum component. With a 10 MHz (GPSDO) LO, the 10nF cap does a reasonable job as a LPF.

On a specific test rig here, I found that when using a LO of 3.2 MHz, a popular choice, the power output increased from ~19W to ~24W by using a PROPER mixer post LPF…device heating was dramatically reduced as well.

The choice of post-mixer LPF is critical when using a DDS derived f0 as well – many DDS designs are shockingly dirty! (I have several cheap DDS boards available on ‘Epay’.) An examination of the DDS derived f0 signal in the commercial JUMA 500 kHz rig reveals a very aggressive post DDS LPF consisting of 2, 3-pole filters in series!

All that being said, in my design I use a crude but highly effective post-mixer LPF consisting of a 3-pole Chebyshev, consisting of a 15uH series element and two, 6800pF shunt elements. With this filter there is essentially no HF component passed on to subsequent stages…my two cents. --John WA3ETD/WG2XKA

https://en.wikipedia.org/wiki/GPS_disciplined_oscillator
LO: local oscillator

10/8/16 2E26 TX 18 WATTS

Hideo, JH3XCU, reported on the 600-meter research group that JD1AHC has been granted permission to operate from the Ogasawara Islands in the near future. It unclear at this time which island will be on the air but Steve, VE7SL, reported that using google translate to decipher http://6212.teacup.com/472khz/bbs/875, it seems he will be using a 2E26 transmitter at 18-watts. That may not sound like much but from this potentially quiet and remote outpost surrounded by sea water it may be enough for a number of ports of call to hear the signal and exchange reports. This is exciting news… stay tuned!

1028/16 QRP TX ON MF

Stefan, DK7FC, reported: “Today i’m running some QRP on MF, just for fun. Raspberry Pi - > ICL7667CPA @ 13.8VDC - pi-filter - > antenna matched to 50 Ohm. I measured 3.4 V rms on a 50 Ohm dummy load, i.e. abt 23 dBm output. What could the ODX become this night, with such inefficient amateur antennas?!? :)”

[ODX - The farthest DX.. http://www.qsl.net/sp9hzx/img/SLANG.txt ]

11/30/16 David, G0MRF, provided a very nice assessment of his new, and recently modified for 630-meters, Icom-7300. Those measurements and comments are posted on the instructional page of this website and can be viewed here. Thanks to David for providing this information.
11/30/16  10-30mw QRP 630M WITH HACKED U3 GOES ALL OVER N. AMERICA  
by John WG2XIQ:  I got in late last night and was pretty “ragged out” but I felt like working on 
a project to decompress rather than just turning on WSPR and going to bed.  I missed the 
evening CW session but wasn’t in the right frame of mind to operate.  I also didn’t want to get 
bogged down in a multi-day project, just something to clear my head.  

Sitting in a box for the last two years that was destined for trash was my Ultimate-3 which 
saw an abrupt end due to an unidentified failure.  I decided to spend a few minutes 
troubleshooting.  I originally thought the problem was only a power supply failure but after 
repairing that for another project, it was obvious that the U3 continued to struggle.  My U3 is 
probably more hacked than most U3’s.  I had pulled the low pass filter for use in my Altoids tin 
transmitter so that was going to need to be addressed.  It seems all three FETs were dead and I 
only had one replacement so I pulled the old ones and installed the only spare that I had on 
hand.  

Probing the unfiltered and unmatched output into 50 ohm with the scope, I was observing 
about 2.1 volts RMS but since there was no matching and the signal was not a sine wave, I don’t 
think that applying Ohm’s law to find power provides an accurate picture.  Either way, I was 
likely making less than 100 mW at 12-volts PA voltage.  Whether it was 50 mW or 150 mW 
was immaterial.  There wasn’t much there – that was clear.  

I routed a makeshift “twisted pair to BNC connector” and found an unused coax jumper to 
my W1VD low pass filter that was currently connected to the output of the combiner.  Powering 
up with the auxiliary fixed 12-volt and 5-volt outputs on one of my variable power supplies, the 
U3 appeared to be working.  GPS synced relatively quickly and I was seeing a clean waveform 
on the scopematch.  I found that the match was tenuous enough that it was causing the signal to 
drop out intermittently when operating into the antenna in spite of being in a matching 
condition.  I found that I could stabilize this by detuning the antenna just a bit.  

I was registering no base current on the meter but I was receiving near detection limit 
reports from stations around North America.  It was a bit surprising given amount of noise and 
such low TPO which translated to even lower ERP.  I don’t know how low the ERP actually is 
but its probably in the 10-30 mW range as a best case.  I received reports into Canada, Hawaii, 
Cayman and many points in between.  My WSPR transmission reports can be viewed here.