Mercury LUX HF+6 Amplifier

Review by Dan Zeitlin, K2YWE

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Summary

The Mercury LUX is a compact self-contained 29 pound solid-state 160 - 6 M LDMOS linear amplifier manufactured in the USA by KM3KM Electronics LLC. I took delivery of my new Mercury LUX in early December of 2022. I checked operation on all bands (160-6) into my less-than-perfect dummy load and the Amp produced specified power. Since then I have exercised the LUX on the traditional (non-WARC) HF bands and found it to be an excellent performer. I customarily operate at around 1200 W indicated output and occasionally go up to 1500 W. Required drive varies with band and SWR. 20 W generally works well for me (Max allowable CW/SSB drive is 60 W and 20 W continuous). PC software that provides status information and controls is provided with the Amp.

My operations heavily favor CW and are a mix of contesting, rag-chewing, and DXing. The LUX's instant band switching makes it a pleasure to use and its protections are very effective. I can recommend the Mercury LUX for most Ops but it has a few limitations that may impact its suitability for some (read on).

Characteristics and Features

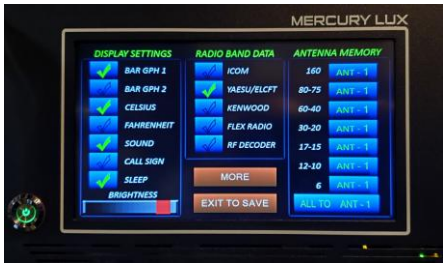
The LUX uses RF-sensing (>200 mW) or optional discrete Band Data for band switching. RF-sense overrides missing or conflicting Band Data. The Amp is rated at 1500 W SSB/CW and 800 W Dig on the six traditional HF bands. WARC band power is limited to 1350 W due to filter constraints. The LUX PA employs two BLF188 devices operating at 53 Vdd from an internal 120-240 VAC input auto-sense power supply. Harmonics are specified to be below 43 dBc on HF and 65 dBc on 6 M. A measured gain curve taken at 50 W input is displayed in the LUX manual. Harmonic spectrum data is included as a separate document

The LUX's two speed cooling fan automatically switches to high speed (MAX FAN) when indicated temperature is above 44 ºC. MAX FAN speed may also be manually initiated from the front panel at any time. The fan is barely audible at low speed and quiet at high speed. I believe that indicated temperature is measured at the PA heat spreader. The manual states that operation above 1200 W output requires 240 VAC input. My experience has been that the LUX can perform to full legal limit without operating issues when running from a dedicated 20 A - 120 VAC line.

Rx-Tx-Rx timing is internally controlled and the Amp does not need or benefit from transceiver or keyer transmit delay. The LUX is not inherently QSK-capable but is compatible with external QSK switches should the user require it. Three SO-239 antenna ports may be manually selected or switched automatically from user-programmed band memory. The amp operates into loads of up to 3:1 SWR (125 W reflected) without an internal ATU. A "companion" ATU called the ATS is available at $800. The ATS is fast and has 5:1 matching capability. However, it is only rated for 1500 W SSB, 1000 W CW, and 700 watts DIGI on HF and for 300 watts on 6 M. There are likely better options if you need a tuner.

The user interface is a 7-inch Color touch panel which provides one screen for operation, a second for for set-up, and a third with QR code links to an online manual, troubleshooting guide, and LUX owners closed FaceBook forum. The front of the LUX measures 5.5 in high x 10.75 in wide. Depth is approximately 14 inches.

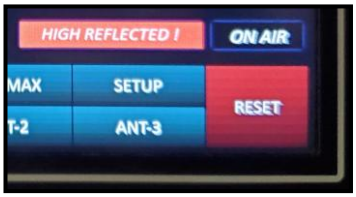
OPR/STB fault RESET, MAX FAN, and manual ANT and BANDS selections are available on the operating screen. Data presented includes Forward and Reflected Power, Temperature, Drain Current & Voltage, SWR, the selected Band filter, and any Warnings. Instrumented data is presented both numerically and as color bar graphs. A timer to put the display to sleep after 15 minutes of inactivity may be set. Activity or a front panel touch wakes it back up.



A green lighted physical front panel button toggles the LUX on and off but some circuitry and the fan at its normal whisper-quiet low speed always remain powered. A separate rocker switch on the back panel turns AC to the amplifier on and off. The LUX will come back on in the same state it was in after an AC power interruption provided the front panel switch is left on.

Protections

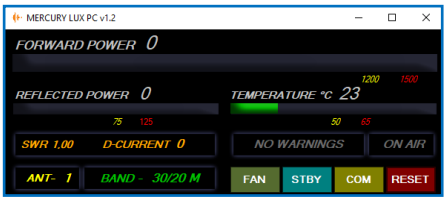
Exceeding the LUX's protection thresholds against damaging conditions results in immediate transition to STB and display of a related fault WARNING. Touching RESET clears the fault, but a fault trip will recur if the fault condition is still present when transmit is again initiated. Fault trip annunciation with a loud tone in addition to the panel display can be optionally set.



I use an external antenna switch and have inadvertently selected the wrong antenna or operated at frequencies at which reflected power was too high. The LUX un-dramatically faulted and recovered with a RESET after I corrected the problem.

Monitor/Remote Software

A PC application which repeats front panel data and permits exercising OPR/STB, RESET, MAX FAN, and ANT selection using mouse clicks is provided. Connection is via a USB-B on the back of the LUX. The amplifier can be turned on and off with an external remotely-operated switch on its AC input so long as the front panel button is left on (green).



The PC application window is not resizable at this writing. Users have requested that feature in future releases.

Testing

I first looked at T/R sequencing. I observed both RF input and output on an oscilloscope while transmitting CW with a 20 ms delay between PTT assertion and RF application. The first 11 ms of the first character element was cut off. Foreshortening remained the same no matter where I set lead-in delay ("TX delay"). I concluded that Rx-Tx timing is internally controlled by the LUX (from RF detection) and subsequently set my external lead-in delay to minimum. Keep in mind that only the first element after an RX-TX transition is foreshortened.

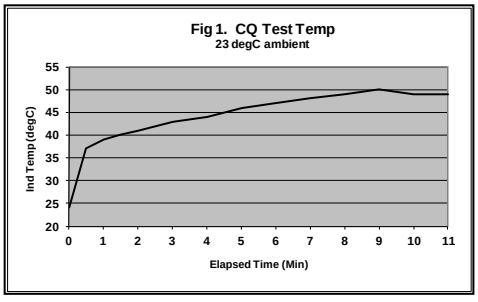
I next turned my attention to waveshape. I observed that the rise time of a string of CW character elements closely followed the 6 ms rise set in my transceiver's menu. However, there was a steep 40 us rise time on the leading edge of the foreshortened first element. Since the LUX natively operates in semi-QSK, I concluded the noted first element foreshortening and steep rise time are not problematic as that condition only occurs once at the very start of a transmission and does not recur until after QSK delay drops and a new transmission is initiated. The LUX may be operated full QSK with an appropriate external QSK T-R box, in which case its internal timing does not come into play and no foreshortening occurs. Users report that external full-QSK boxes like the QSK-2500 work well with the LUX.

Temperature Rise Tests

Extended operation at high duty cycles is important to CW contesters and rag chewers. CW inherently exhibits about a 45% duty cycle independent of speed. My antennas are mostly well-matched, but reflected power can rise to the LUX's 125 W limit in some upper band segments. I set aside band edge concerns and focused on operation under well-matched conditions. CQ-ing without a response is a worst case contest condition as it has the highest duty cycle (very short receive period). Mercury says not to exceed 65 ºC indicated temperature and that automatic cutoff occurs at 75 ºC.

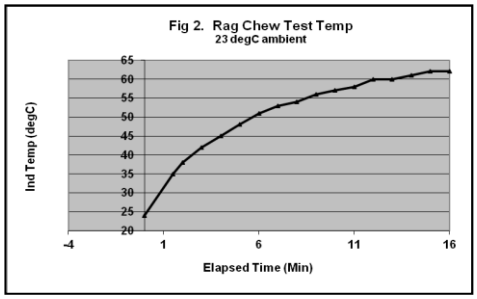
CW Contest Test

I set up a 30 WPM repeating test message of "CQ K3AU K3AU" with a 3 second period between transmissions. Output power was near 1500 W with 10 W reflected from the dummy load on 20 M. I took temperature data periodically over 11 minutes of elapsed time. Ambient air around the LUX was 23 ºC. An indicated steady-state (presumably heat spreader) temperature of 49 ºC was reached after seven minutes. See the accompanying chart. I had the LUX automatically control the fan speed. Asserting MAX FAN at the outset would have slowed the temperature rise somewhat. 49 ºC at the spreader is quite comfortable. Of course spreader temperature can be expected to rise higher with more reflected power.

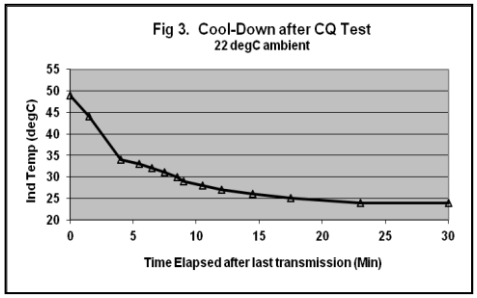


CW Rag Chew/Traffic Test

A text file at 30 WPM was used for the rag chew test. Power was 1200 W (7 W reflected), in keeping what my real world rag-chew power would be. The text file ran continuously for 16 minutes. The temperature initially rose to 53 ºC in 7 minutes, after which the rise slowed to less than a 1 ºC/min. Spreader temperature was 62 ºC after 16 minutes of continuous sending. Sixteen minutes comfortably exceeds real-world uninterrupted rag-chew or traffic transmissions.



A temperature of 48 ºC would be expected after a five minute transmission under the test conditions above, so a temperature between 48 ºC and 62 ºC can reasonably be expected for a set of repeated long transmissions with short breaks (like a long traffic "book"). Cool-down recovery data taken after the CQ test is shown in figure 3. I have used the LUX at near 1500 W for extended periods in CW and in RTTY contests as well as rag chews without exceeding the 65 ºC limit (more about RTTY later). Note that I run the LUX from 120 VAC.



ALC

The amplifier's output for a given drive varies a little by band, SWR, and temperature. Occasionally adjusting drive or allowing the output power to vary a bit is not problematic for me, but I wanted to see how well the ALC would stabilize it. The LUX ALC output range is -2 to -7 V. The ALC range of the FTdx-5000 (FT5K) I was driving the LUX with is 0 to -4 V. I reasoned it was safe to try without modification. I connected the ALC and adjusted key down output for 1500 W with drive set at 50 W per the LUX manual. I found some moderate overshoot during the first 3 seconds of CW transmission. Overshoot was not detectable on SSB using voice input. I inserted a small circuit to make the LUX's ALC range match the FT5K's. It made no performance difference.

I knew from operating without ALC that it took considerably less than 50 W to drive the LUX to full output. Thus, I reduced drive to 25 W and re-checked the Amp's output on CW with ALC. There was still 1500+/-25 W on all bands, except 10M, and no overshoot on any band. The 25 W setup produced 1200 W on 10 M where it took 50 W of drive to produce 1500 W under ALC. It appears that setting up ALC using just above the minimum drive required without ALC eliminates overshoot under ALC, at least it does with the FTdx5000.

The observed behavior under ALC is no surprise. Amplifiers and exciters are designed independently and with no related external ALC standards. Predictably, designers try to preclude instability by conservatively slowing and damping their external ALC provisions. I found no benefit to using ALC at my station and have chosen to run without it so I can easily change the Amp's power out up or down using the power adjustment on my transceiver. ALC ADJUST is a screwdriver adjustment on the back of the LUX.

Digi and RTTY
Mercury specifies Digi (FTx and other such modes) at 800 W max and warns that a continuous carrier output over 800 W for more than 6 seconds will trigger a CARRIER fault. I tested the limit and it trips as specified.

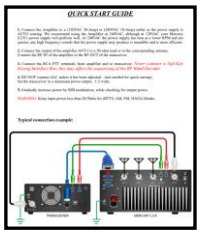
FTx Test
The LUX manual says, "Duty cycle in digital mode: Maximum 1 minute of TX, minimum 15 seconds of RX. … Cycle for FT 8 has been tested by more than 5 hours of QSO."
I selected MAX fan on the LUX and continuously called CQ on FT8 into a dummy load at 800 W output. Heat spreader temperature stabilized at 49ºC after 30 minutes of continuous CQ cycles and dropped to 39ºC two minutes after I stopped transmitting. I also ran an FT4 test at 1500 W since FT4 transmissions do not exceed the LUX's 6 second CARRIER limit. Temperatures remained under control without a CARRIER trip.

RTTY Operation
I found CARRIER faults to generally not be an issue at full power in RTTY contesting with no QTCs, as transmissions are characteristically less than 6 seconds long. I ran my first two RTTY contests at 1200 W with macro key messages programmed to run less than 6 seconds. No CARRIER faults were experienced and temperature stayed well under the 65ºC limit.

I then ran just under 1500 W in WAE RTTY. Again, Calling and exchange transmissions were again kept under 6 seconds. I sent each QTC line separately, initiating the next line as soon as the PTT dropped from the previous one. There were no CARRIER faults and temperatures stayed under control operating that way. Most all QTC books went through with no fills required and without comment about the carrier dropping between lines. I think it made no difference at the other end as it was similar to sending QTC fills. One station complained and twice couldn't copy any of the QTC book. I moved on.

For me, the 6 second CARRIER limitation means being mindful of how the LUX works and running under 800 W if I ever venture into RTTY rag chewing. The 800 W CARRIER limitation may be a deal killer for those looking for continuous full-power RTTY capability. The LUX is not a legal limit amplifier in the "brick-on-the-key" sense.

Start-up and Operation
Setting up per the manual's quick start guide was plug and play. I connected power, antenna, PTT, and RF in and was on the air. I perused the LUX menu and set a few preferences. RF sense worked flawlessly. I later added a band data cable so the LUX would follow the transceiver. I figured it might save a few milliseconds of filter switching (OK, I did it because I could).


QUICK START GUIDE

I've used the LUX for a year now, primarily on CW with some SSB and RTTY. Operation included a significant number of contests. I am still powering the LUX from 120 V and normally run about 1200 W, the LUX's specified limit with 120 V input. I do run up to 1500 W when I feel the need and no issues have surfaced. I have inadvertently set the drive too high on several occasions where the LUX put out considerably more than the legal limit. The LUX just kept on going.

Documentation
A USB stick containing pdf versions of the LUX Manual, a Fault Guide, Harmonic Spectrum Measurements, and the PC application comes with the Amp. The latest versions of documentation, firmware, and PC software are available online. There is virtually no technical content available to the user beyond a very high level, not even a block diagram. Mercury considers elements of the electrical and mechanical design to be proprietary and will not provide meaningful details. They believe that their warranty offsets the lack of available technical information.

Warranty
The LUX has a one year defects in material and workmanship warranty (shipping included) to the first owner. Mercury also provides lifetime replacement of any component at no labor cost after the one year period without regard to ownership, i.e. the lifetime warranty stays with the LUX hardware. The foregoing warranty and service understandably exclude cases of improper installation or use.

Support
Communicating with the factory directly by email elicits quick responses. There is little activity in the user groups because there are few problems. Comments are positive ones about observed performance and sometimes feature requests. LUX firmware and PC software versions were recently updated to include some requested features.

Conclusion and Recommendation
The Mercury LUX is an excellent 120-240 VAC input light-weight HF+6M amplifier that is capable of legal limit operation into reasonably matched antennas (SWR <3:1) on all HF contest bands (non-WARC) and meets the manufacturer's operational claims in all regards. The Amp is limited to 1350 W on WARC bands and 950 W on 6 M. Continuous "key-down" carrier transmissions over 6 seconds must kept to 800 W or less. The LUX has a reflected power limit of 125 W and works into loads of SWR 3:1. My LUX has proven to be well-protected against user-induced faults.

Band switching is instantaneous using RF-sense or Band Data (RF-sense wins in case of conflicts). While not QSK, the LUX's transitions to transmit and receive (11 ms/3 ms) allow very fast semi-QSK. External full-QSK boxes work well with the LUX for those that need that capability. I customarily operate semi-QSK with hang times of 300 - 500 mS.

I recommend the Mercury LUX without hesitation to those whose operating needs fall within the LUX's operational envelope. The LUX is not for you if you require a brick-on-the-key all day legal limit Amp, built-in QSK, or full legal limit digital carrier operation under all conditions.