

Now this takes guts ... W7DGJ hadn't picked up a soldering iron in 50 years, so what's his first project after getting back on the air? Building a linear amplifier from a kit! Here's his story and review of the KM3KM Mercury III S amplifier kit.

# Build Your Own Solid-State Linear Amplifier

## CQ Reviews: KM3KM Electronics Mercury III S Amplifier Kit

BY DAVE JENSEN,\* W7DGJ

I'm not your usual reviewer supported by a lab filled with test gear to show CQ readers how a new product specs out. In fact, I'm the reason they sell pre-packaged dipoles and plug-and-play radios. My rig is an ICOM IC-7300 and my antenna is a Buckmaster 7-band OCF (off-center-fed) dipole in an inverted-V configuration. But I know better than to think

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that my sense of curiosity and fascination with radio gear will forever be satisfied with that 100 watts and a wire.

I always wanted to have more power, to reach farther and compete better in the usual pileups, and earlier I'd tried (without much success) a large and finicky tube amp. I'm sure the need for a bigger, better signal is an almost universal goal amongst amateur radio enthusiasts (*except QRPers – ed.*), but the cost-per-watt of the solid-state amps had always



Photo A. The author's "workbench" for assembling his Mercury III S amplifier kit ... previously known as the dining room table! (All photos by the author)



seemed out of reach. It was that curiosity and the desire to learn more and dive deeper into my hobby that drove me to explore the Mercury IIS solid-state linear amplifier kit by KM3KM Electronics.<sup>1</sup>

## The Backstory

On a recent weekend, ZS6CCY (Bill, a game rancher in Waterberg, South Africa) pointed his 120-foot, 40-meter Yagi at the U.S. and the stack of “Hey, Bill!” calls he got in return from old friends was staggering. During one of those QSOs, I listened as one U.S. ham spoke about what a difference his Mercury IIS amplifier had made for him. While I eventually added Bill to the log with my little signal out of Arizona, I remembered that amp and the comments I heard from others while reading the mail that day.

## My History with “Build it Yourself” Gear

Like other companies run by enthusiasts, the Mercury IIS is a product of an active ham, Kenny Martinez, KM3KM, of Miami, Florida. Kenny’s business is unusual, because his focus is on products that are “educational and fun to build,” as opposed to gear that you can take home and plug in. In fact, KM3KM Electronics sells nothing with a power cable. He’s a manufacturer of components and circuit boards for various homebrew projects, but KM3KM also sells a pre-packaged set of these components along with instructions on how to complete a state-of-the-art LDMOS<sup>2</sup> linear amplifier if you so please — except you’ll need to bring your own AC cable.

After poring over existing reviews as well as the KM3KM owner’s manual and assembly manual for the Mercury IIS (both available online; see sidebar for specifications), I felt that it was time to put a soldering iron in my hand once again and give it a try. It has been more than five decades since I had failed miserably at amateur radio kit-building and the recollection both stung and challenged me. Can a soon-to-be-retired ham compete with his 15-year-old self on an aspect of ham radio that everyone needs to have in their hobby repertoire?

My original radio, at age 15, had been a Heathkit. I enjoyed the assembly experience and the anticipation was intense, but upon completion, the darn thing put out nothing but smoke. It took the intervention of my Elmer and another \$75 from Dad before it came back to life and served my needs for the next year or two. That experience, and five decades of “he’s all thumbs” declara-

tions from others, kept me away from a soldering iron until the day the Mercury IIS showed up on my doorstep.

## Ordering, Shipment, and First Impressions

KM3KM had a 2-month wait time when I ordered, which was concerning because when you want gear, you want it *now*. But after checking with retailers like

DX Engineering and Ham Radio Outlet, I discovered that many other amplifiers had similar wait times as a result of pandemic supply chain issues. Despite it being a “hurry up and wait” process, I decided to take the gamble, and sent KM3KM a deposit with my order, leaving the balance until the projected date of shipment. I was surprised that no shipping charges were added to my order for this heavy shipment. (*Increased ship-*

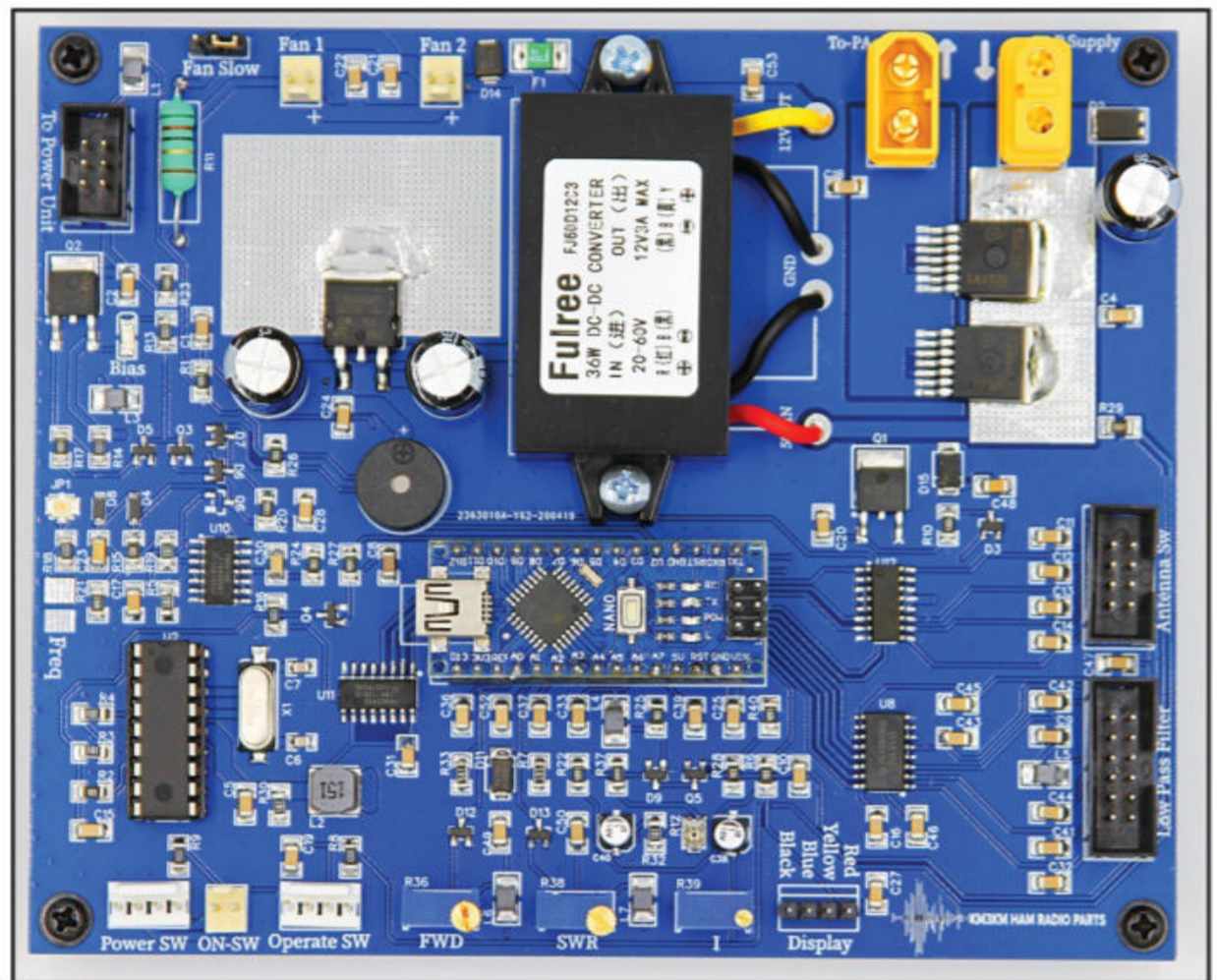


Photo B. The Mercury IIS circuit boards are things of beauty. This is the controller board.

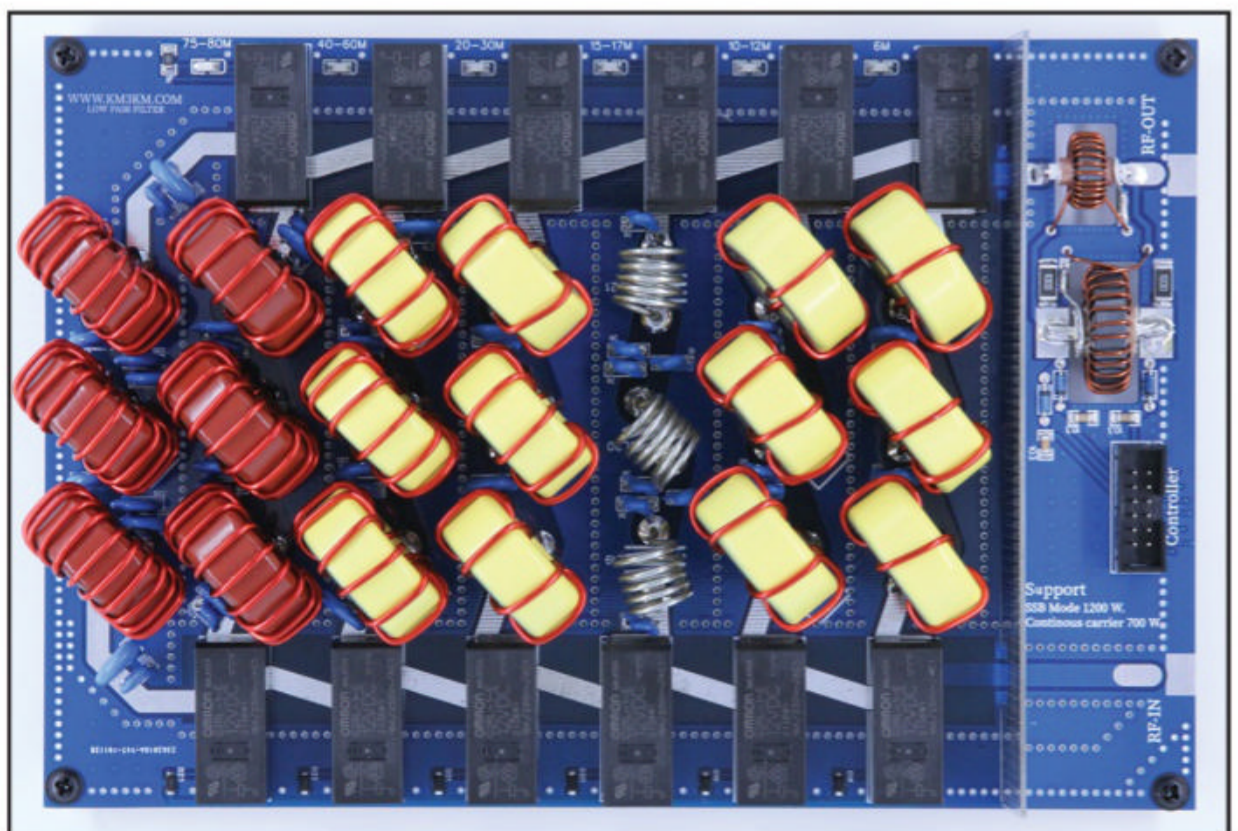


Photo C. All of the toroids are pre-wound and pre-installed, such as these on the low-pass filter board.



ping costs have forced Ken to now charge separately for shipping. See note 3 for more details. — ed.)

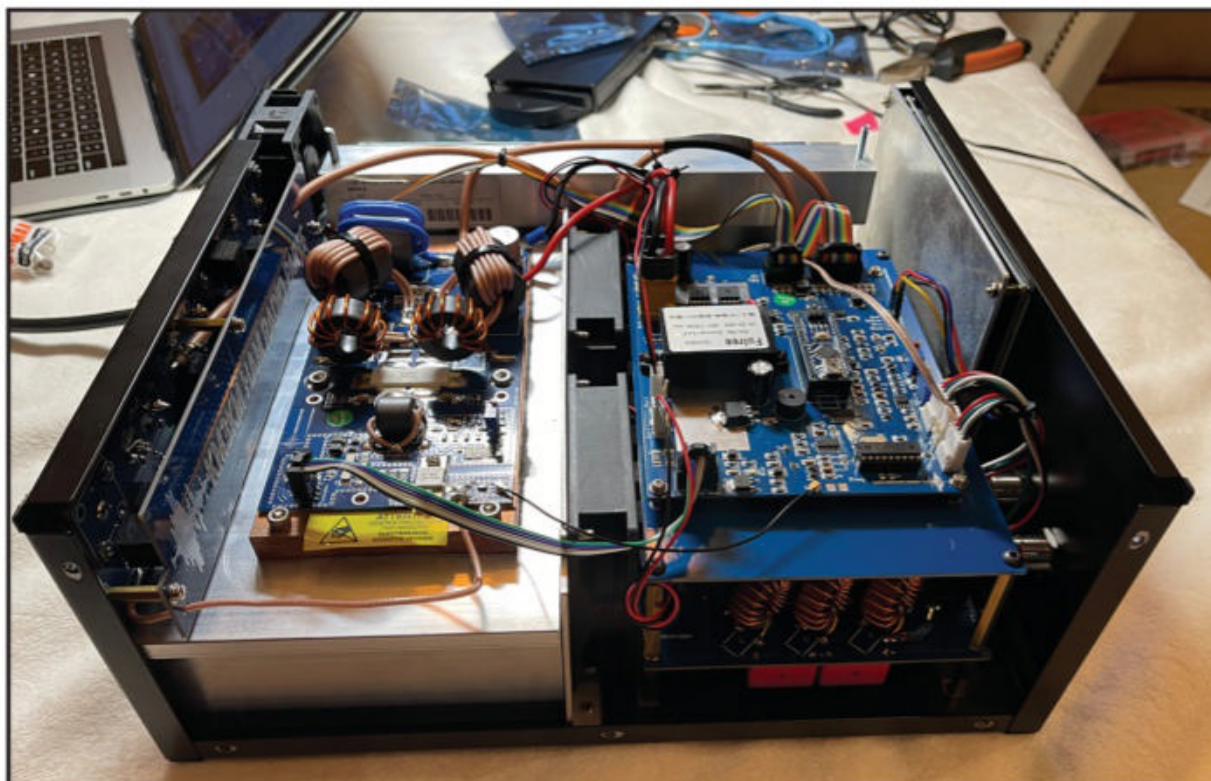
When it arrived by FedEx — a couple of weeks earlier than promised — I was blown away by the packaging. Ever bought an Apple product and remarked on how cool and organized everything is inside the box? This is the ham radio version of the same. It was 30 pounds of neatly organized and pre-wired component boards, sub-assemblies, and hardware packets. Thrilled, I began to spread out the various items across my work surface (*Photo A*), which before the explosion of electronics had resembled a dining room table. That's when I ran into my first obstacle on this build — my wife.

After some negotiation, it turned out that I could take a maximum of three days for my project, as company was coming for the following weekend and this “big mess” would have to be cleared away prior to the pending visit. A short hop over to Home Depot for a set of Allen keys and a power cord and I was ready to begin my project. With a switching power supply that lets you choose between 110 and 220 volts, the decision on how to wire the Mercury IIIS is easy and reversible. I chose standard household voltage. At any point in the future, if 110 volts isn't working out for me, I'll bring high voltage around to my shack and simply change out the cable.

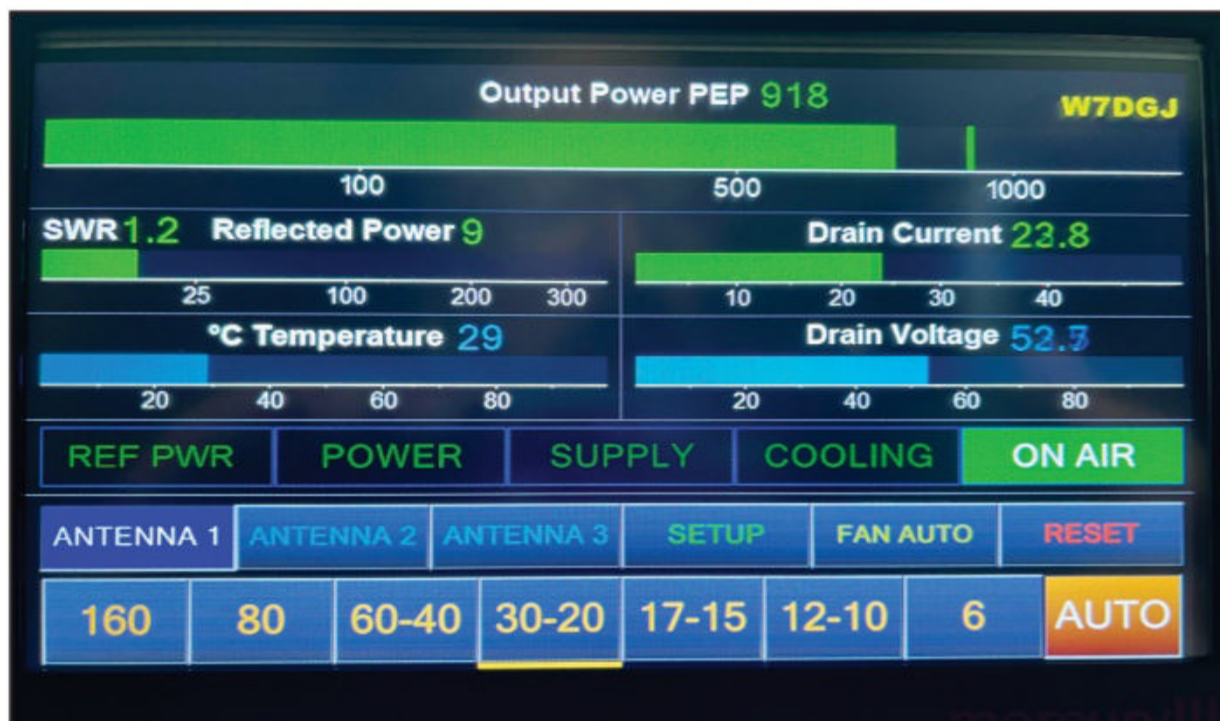
### On-Screen Instructions

I prefer the old-school approach of paper instructions for projects as opposed to a computer taking up more space in my work area, so the included USB thumb drive seemed more of a pain than a blessing. But I cleared a spot for my laptop, opened up the drive and took the first steps. The first thing I saw was that the manufacturer had included a set of very detailed photos, so I immediately started putting it together based on those graphics. Sure enough, that bit of over-confidence cost me. If I had seen the big red warning “Do not overtighten the RCA jacks as they may break,” I could have saved myself some trouble. I had snapped off the back end of my ALC jack.

It was midnight on the east coast, but the letter inside the kit had a note from founder Kenny Martinez saying that he was there to help me personally. I wrote his email with photos of my RCA jack for the ALC and, expecting good service, looked to hear back from him within a day or two. However, 10 minutes later, at 12:10 a.m. his time, Kenny had replied and stated that he was sending



*Photo D. The kit-builder needs to connect the boards to each other and carefully mount them in the case. There is very little clearance between the boards, so following instructions closely is essential.*



*Photo E. The touch screen and lighted power/operate buttons have the same look and feel as the author's high-end HiFi equipment.*

a replacement part to me, overnight. That experience said something about how KM3KM views customer service.

### “Just Hours to Completion”

When I first investigated the Mercury IIIS amp on websites and on YouTube videos, the assembly times and overall difficulty level were described in different ways. To one ham, it was “a very easy process, and completed in about four hours.” To another, it was “moderately difficult, with a number of coax welds at critical junctions, requiring some time if you plan to go back and carefully check each connection.” Generally, most people reported that the kit required just one day to com-

plete. I was never very certain what my situation would be, due to my limited device-building skills.

At this point in my build, I already had a problem requiring a wait time and delay, and I had just started. I could see my precious 3-day window for the assembly process melting away like the ice in my Arizona tea. That mess on the dining room table started to look rather bleak, even to me.

But sure enough, the KM3KM package arrived as promised with the new RCA jack. This time, I followed the instructions on the thumb drive — to the letter. In the ham world, I'm used to minimal instructions and a lot of “figure it out yourself” from manufacturers. The





Photo F. The finished amplifier, a showpiece as well as a functional piece of gear.

manual for my last amp had been a photocopied few pages that made zero sense to me. I had to rely on a user group because we help each other in amateur radio, which is one of the beautiful things about our hobby. Believe me, I was not used to the kind of detailed instructions provided by this manufacturer. KM3KM provides you with high-def, full-color photos and videos of how to assemble the kit. It's really very well done, and my build proceeded nicely. At least for the first two hours.

I had my confidence back and felt that I had a good start on my project. When

I was installing the antenna board onto the back of the case after making some coax connections, I noticed how everything is so precise on the Mercury III S. For example, the protruding backsides of the chassis-mounted SO-239s are designed to fit through the holes on the antenna board perfectly. However, it was here that I chose to veer from the instructions (again!) and decided that before I mounted the board, I would pre-tin the four points where the SO-239s are soldered to make my job a little easier. Unfortunately, doing so also made the holes for those protruding SO-239s

imperceptibly smaller. I didn't like the feeling of having to push the board onto SO-239s that didn't want to squeeze through the made-smaller holes. And I sure didn't like the "ping" I heard when one of them shot its center pin across my dining room table! *OOPS.*

## Moving to Completion

Luckily for me, that was my last catastrophe in building the new amp. There is indeed a lot of mechanical installation involved in the process, and I went through that aspect of the build just fine. My hands still shook whenever it came to a crucial solder connection, but I tested every one of them with my multimeter and had problems only once, when I had inadvertently created a tiny solder bridge across a connection. The instructions caution you to check these as you go along.

The boards themselves are things of beauty (*Photo B*). There's no winding of toroids as KM3KM has already done a great job with that (*Photo C*). All the intricate work has been completed, and the assembly involves making the connections between these boards with coax, and then placing the boards into their positions in the case (*Photo D*). Each piece is well fabricated — they fit together like puzzle pieces — and it ends up being a remarkably compact size and shape. Individual boards are stacked on



Photo G. Off the dining room table and installed in the shack (at right in photo) ... with an hour to spare before the table-clearing deadline!



top of each other with standoffs and separator panels. KM3KM has made good use of every bit of internal space. I was happy to see three powerful fans included in the design at various points inside the amp, to ensure that this tightly packed environment wouldn't exceed the temperature requirements of the LDMOS.

I also enjoyed placing the touch screen (*Photo E*) into position, as the manufacturer provides you with an adaptor to turn on the screen, which helps position it properly on the front panel (it was fun to light it up and to see my callsign already in the programming). And I've seen the same lit-up, soft-touch buttons I installed on my Mercury IIS on the very best high-end Hi-Fi equipment (another of my hobbies); that reinforced the good feeling about having built a very high-quality amp (*Photo F*).

I celebrated each step of the final testing process. I began by driving the amp with only 1 watt — lo and behold, I saw no smoke! I put the transceiver into RTTY mode and my 1 watt into the amplifier delivered 30-35 watts to the dummy load. I then began to slowly move up the exciter output and played with different frequencies; I watched as the amp matched my change in frequency with its autotune function. I checked to ensure that all three fans were operational, and finally — just an hour under my forced timeline — brought it into my shack and hooked it up for some serious hamming (*Photo G*). Oh ... and I cleaned up that big mess on the dining room table.

## Now, the Real World

The first pileup I heard after getting my Mercury IIS installed was W9IMS, the special event station at the Indianapolis Motor Speedway, operating the first of three speedway events for a valued certificate. (Hey, I'm down for any new wallpaper!) Before the amp, my 100 watts and a wire would get me 10<sup>th</sup> place at best in a surge like this one. But here,

### Published Specs – Mercury IIS LDMOS Power Amplifier Kit

Designed and Manufactured in the USA by KM3KM Electronics, LLC.

- Operating bands 160-6 meters
- RF auto band decoding
- 7-inch color touch screen
- FWD / REF / SWR meter
- Voltage /current meter
- Advanced protection circuits
- Selection for three antennas w/memory
- 1,200 watts SSB / CW output
- 700 watts DIGI mode output

Additional Specs as noted:

- AC total consumption – 1,750 watts
- AC line load: 120V 14A, 240V 8A
- Maximum output limit PEP – 1,300 watts\*
- Digital modes limit – 700 watts\*
- Input limit – 80 watts; standby input limit – 100 watts\*
- Reflected power limit – 125 watts\*
- Drain current limit – 41 amps
- Temperature limit – 65°C (149°F)\*

\*These items are tied to protection circuits in the amplifier, which shut down the Mercury IIS with an audible warning and a screen shot indicating what correction is required (for example, a reduction in the power input). Press the reset button and the amp is back on the air.

on my first attempt, operator Don at W9IMS came back to me with a, "Really solid signal, W7DGJ, great audio," as his comment. And then I looked down and found that I was only tip-toeing into the amp's capabilities by driving it with 20 watts and generating 550 to 600 watts of SSB output.

I don't have a legal limit antenna tuner, so I consider myself lucky to have a resonant dipole that works well on several bands without a tuner and can handle up to 3,000 watts. The direct-read meter on the Mercury IIS showed my SWR at about 1.1:1 to 1.3:1 on most 40-meter frequencies. Because the amp includes a built-in protection circuit if it detects an SWR of 2.0:1 or greater, I had a feeling of comfort that I could cruise the band without a lot of concern, as I'd be protected when the Mercury IIS gives its audible warning. Most importantly, gone was the fiddling with "plate" and "load" that I had to deal with on the old tube amp ... I could actually tune through the frequencies and jump on DX quickly. Even if I had the Mercury set on another band entirely, the automatic band switching function would protect me. After lunch yesterday, I turned on my ICOM and a station from Latvia was coming in loud and clear from over the North Pole on 20 meters. I snagged him within 30 seconds of turning on my radio, something I would never have been able to do with vacuum tubes. I'm now a solid-state convert.

Recently, I've been enjoying my classes in the CW Academy, the training ground for CWOps.<sup>4</sup> I wouldn't be happy with my new amp if it gave me trouble cranking out my seriously improved code at new power levels. This was a bit of a question because KM3KM makes a point of stating that 220 volts is best for CW operations, and as you may recall, I had opted for the 110-volt power source. However, I've found that it's easy to make most contacts at the 600- to 750-watt level, which is still more than six times the output of my IC-7300, and the amp stays happy and cool. When I need to go after a call from a DX operator, I can crank the amp to a kilowatt and know that I'm still OK.

The next afternoon, before moving over to 17 meters (the noise on 40 was intense), I connected with two Haitian stations, one right after the other, who both reported solid copy. I kicked the ICOM up a couple of notches and watched the Mercury IIS take it in stride, moving to the range of about 1,200 watts SSB output as I answered an Australian CQ on 17 who picked me up over the short path with a 59++ report. I also had a great ragchew session with a new Canadian friend from his home on an island in British Columbia where passing cruise ships are headed to Alaska. In short, I was in heaven ... suddenly so much more "visible" on the bands than ever before.

Despite my successful build, I realize that raw power is still only one part of the equation. Antennas are terribly important, and someday I'll build a tower and put up a big Yagi like my friend Bill in South Africa (although Scottsdale, Arizona, may be a bit more restrictive on height than the African bush). But for now, the increased power output has changed my station completely and given me a new rush of enjoyment for my hobby.

The Mercury IIS kit retails for \$2,499 plus shipping, from <[www.km3km.com](http://www.km3km.com)>.

Notes:

1. <[www.km3km.com/elementor-1915](http://www.km3km.com/elementor-1915)>
2. LDMOS stands for *laterally-diffused metal oxide semiconductor*, a specialized MOSFET (metal oxide semiconductor field effect transistor) frequently used in RF amplifiers.
3. As of press time, the required deposit was \$1,200, with the balance plus shipping charges due when the kit is ready to ship. Each set of boards is prepared individually after an order is placed.
4. <[www.cwops.org](http://www.cwops.org)>