A Check List for putting the Toshiba 20 and 40 watt 3.4MHz Linear Amplifiers on the air

..... by John Jaminet, W3HMS

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Editor's Comment: This very useful article by W3HMS should be of interest to those readers who have bought, or intend to buy, the very economically priced 9cm SSPAs from "Pyrojoseph" on Ebay.

Introduction

This paper was created from several messages received on the Internet Lists in Septem-ber/October 2001 by Steve, **N2CEI**, at DEMI, Rick, **K1DS** and an article in the MUD 2003 Proceedings, pages 66-70, by Dave, **WW2R**. Important new info was received from Owen, **K6LEW** in November 2001 on the importance of voltage regulation. It is incorporated in the text. In addition, our own **N3TWT-ATV** experiences with 24/7 operation in FM ATV (key down for months on end!) service are reflected in this update.

Basic Information There are **two** versions of this amplifier:
a. 20 Watts output @ 3.4GHz with 1mW input.
b. 40 Watts output @ 3.4GHz with 1mW input. Supply Voltage: + 12.6VDC (exactly)

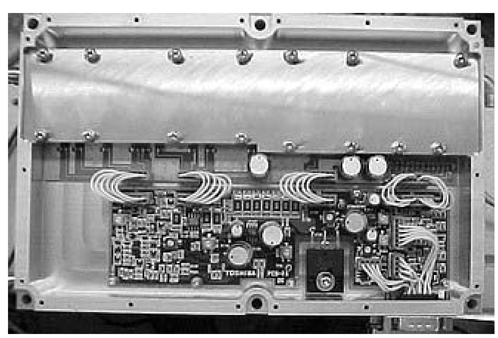
Vendor Info on the 20 Watt Amplifier

This is a Toshiba 20W Linear Microwave Amplifier for use in the 3.44 to 3.68 GHz range. It is sold
in the original manufacturers packaging.
Heat sinking: Required...it gets hot..
Size: 5" x 8" x 1 ".
Weight: About 2 pounds.
Input power: For full output, this is about 1 milliwatt or 0dBm.
Specifications: The specs on these amps are very "tight" and are typically as follows:
Linear Gain = 42.5dB; Gain: Ripple = .1dB

Linearity is -45dB; Return Loss (in and out)= 25dB;
DC Power Supply current: Typically +12 VDC at 10.6 amps.
Power Jack: The DC power and control connector is a DB-15 male.
DB-15 Pinout. There are 3 rows of 5 pins each.
The ground is made from pins 3,7,10,11 connected together.
The +12VDC lead is made from pins 1,2,12,13 connected together
All VCC and ground pins need to be connected to handle the 10.6 amps.
Pin 9 is the enable pin (TTL) which must be connected to ground in transmit to switch the inter-
nal power supply on.
When pin 9 is not grounded, the 12VDC supply draws about 15mA. and the amp is in stand-by
mode.
This is a Class A amp and as a linear amp, it will draw about 10.6A with no signal input.
Pins 4,5,8,15 are assorted alarm output pins low true....no more is known..

The 40 Watt Amplifier

This is a new Toshiba UM2683A 40W Linear Microwave Amplifier for use in the 3.4 to 3.6GHz range. It is sold in the original manufacturers packaging. This amplifier differs from the "2683B" "20W" version on other auctions because there is a TMD0305-2 MMIC instead of the discrete circuitry in the front end. The TMD305-2 part is a 3.4-5.1GHz amp with 2 watt output and 22dB Power Gain. Turning the two pots at the far left on the lower board in the photo fully clockwise (shutting down the attenuator) and peaking the power with the third pot (2nd and 3rd stage bias) yielded 46dBm, 40 watts @ 3.456GHz using 12.0 - 12.6VDC (as measured at the connector) with about 0dBm input power. Power supply requirement is 12.6VDC @ 15amps after readjusting gain and bias.



Size

The size of these amps is 5 x 8 x 1 inch and weight is almost 2 pounds. Input power required for full output is about 0dBm. DC power and control connector is a DB-15 male.

Pinout is as follows:
Ground are pins 3,7,10,11; +12VDC are pins 1,2,12,13;
All VCC and ground pins need to be connected to handle the 15 amps.
Pin 9 is the enable pin (TTL) which must be grounded to switch the internal supply on.
When not grounded, the 12VDC supply draws only about 15mA. and the amp is in a stand-by
mode. Since this is a linear amp, it will draw about 14-15 amps without signal input. Pins 4,5,8,15
are assorted alarm output pins low true...no more is known. Only new amps are being shipped.

Heat Sink Requirements

These amplifiers get VERY HOT! Heat sinking is required, particularly for FM ATV service many hours per day. We have found that the heat sink should be about 2.5 or more times the size of the amp and be blown with two high cfm blowers of no less than about 85 cfm capacity. We use two 12VDC blowers for twice the air flow and for redundancy in case of the failure of one blower.

In physics, we learned that heat rises and so it does indeed! Resist the temptation to mount the fins anyway but pointing UP as we have seen some disastrous results with the fins pointing down.

Even with fins up and 2 blowers we find the amp runs about 20 degrees higher than the temperature on the amp chassis, even in winter. We have mounted a small RS dual indoor and outdoor thermometer permanently on the chassis. We use the outdoor probe on the hottest part of the amp and heatsink. As I write this, an amp under test is showing 75F from the chassis probe and 55 F on the chassis. In summer, in a non-air conditioned space, the difference can be 30 degrees F.

The results of poor heat removal have been small fires at the interior of the final amp shielding as revealed by the charred parts of two amps. Photos are available.

We recommend you use a very stiff power supply designed for 24 hour per day operation with at least twice the normal load of 15 amps. In our case this is 30 amps adjusted to give 12.6VDC on the amp terminals. Note that some commercial power supplies arrive giving 13.6VDC output. In some cases, the output is adjustable internally by a pot that is tough to find and adjust; a design indeed by Murphy, de Sade, or the village idiot.

System View

When the amplifier is integrated into a system such that relays, etc. are involved, the TX mode requires that the amplifier Pin 9, the PTT, be grounded for the amplifier to amplify, i.e. it turns on the power supply built into the amplifier. For RX, removing ground from Pin 9 places the amplifier into standby, drawing perhaps as much as 15mA, while the T/R relays all reposition for receive.

There is no feed-through via the amp. Changing from RX to TX involves just grounding Pin 9. There are no relays internal to the amplifier for switching RF between RX and TX, hence, external relays for switching between RX and TX are required.

Critical Voltage Levels

Please refer to Step 9 (below) which is VERY critical. These amplifiers, especially the 40W version, will go into "foldback" and be hard to recognize in so doing. The 12.6 VDC +/- 0.2 is critical because the output FET regulator has an extremely narrow window due to the heavy current drain.

If you allow your primary voltage to get outside of this window, the FET bias voltage , as adjusted by R150 as measured on Pin 1 of the regulator interconnect to the amp section, you will note the need for drive in excess of 0dBm for 40dBm output (40W). (W3HMS used about 950 microwatts drive for 40 watts output). Excess drive is not good and indicates foldback which generates excess heat causing the "final" to generate more heat than it should.

These amps should draw 15 amps key down, not 14 amps, though some do vary. The set-up is simple enough but it has been necessary for several amps to be readjusted. This is because some operators did not see the importance of the relationship between the primary voltage at 12.6VDC and the 10.3VDC from the regulator controlled by R150 and measured at Pin 1. This 12.6VDC should be measured inside the unit with the cover off while the amp is under load, i.e. key down or Pin 9 grounded on the subminiature DB 15.

Given that this pin is hard to use when the amp is fully set up, we found that we had about 0.09 VDC drop under load between the terminal strip on our chassis and internal pin 1 of Plug 6. Knowing this, we now do set up by putting 12.66VDC under load on our terminal strip. With the amplifier off the air, thus no load, we see 13.05VDC on our terminal strip.

NOTE: You do NOT need any RF drive for this set up as the amp runs in Class A. If you have a power supply with remote sensing use it. If it does either voltage or current drain sensing, use voltage sensing. The voltage MUST stay steady at 12.6VDC or something will surely be damaged, most probably the regulator, to be followed shortly thereafter by the costly output FET.

It is not necessary to monitor the drive level if you have reliable and repeatable equipment for the "exciter". Once you establish 0 dBm at the input port to the amplifier it should stay adjusted. If somehow the equipment is not reliable as to its output, and there is time to adjust, then monitoring the input level would be necessary.

Most modern transmitting equipment of today is reliable such that once power levels are set, the input level to the amp should remain set.

In an NTMS Feedpoint “article, also cited in MUD Proceedings 2003 on Page 66, Dave Robinson, WW2R, discussed his experience with this amp. In one tune up case of a new amp, we could not find the voltage controlled by R150 as addressed above so we followed Dave's advice to tune R150 and R138 for maximum output.

One could easily think about installing two VDC measurement jacks and make R150 an external pot so as to monitor and adjust both the 12.6 and 10.3VDC (at the VR) levels. No, the better choice is to monitor the output from a known and acceptable starting level. If you see the output begin to vary, then it is time to check the input level.

To clarify this point, R150 adjusts the output of the regulator BUT it does so in a very narrow window based on the primary input voltage of 12.6VDC and the amount of current being drawn and R138 will adjust this on the 40W version.

In summary

This is to say that R150 adjusts for 10.3VDC ONLY when the primary voltage is 12.6VDC with the amp under load (Pin 9 grounded) and the amp is drawing current. If 12.6VDC in either direction is exceeded by about 0.3 -0.4 VDC, adjusting R 150 will NOT regain 10.3VDC. Thus, make absolutely certain you have sufficient heat sinking mounted to the amp for any tests or operation. The devices in this amp are extremely expensive and will not accept much heat.

This amp gets VERY hot very quickly without a heat sink attached. One could also use a muffin fan blowing across the heat sink. One of the "alarm" functions available on the subminiature DB 15 appears to provide a "temperature" alarm. It is not known what the temperature should be when this function is energized but there is a voltage on one of the alarm lines that appears to relate to an increase in temperature. This amp does not self protect, i.e. shut down, so be very careful !

Perhaps the voltage could be used to control a relay which would remove PTT-ON from pin 9 but we do not know how much current it can handle. It may not be enough to control a relay, but it might control a NPNB transistor which could in turn control a relay, but this is not sure.

Output Power Monitoring

In an NTMS Feedpoint "article, also cited in MUD Proceedings 2003 on Page 66, Dave Robinson, WW2R, found a terminal in the amp which provides 5VDC equal to 40 watts output. This terminal is in a 6-pin connector at the right end of the amp, 3rd pin from left, when the shielded amplifier box is above the connector.

Another way to say it is the output connector will be on your right and the input connector on your left. This is the forward voltage, + voltage where 5VDC = 40 watts output. Doug connected a wire to an empty pin on the DB15 connector. I chose to drill a hole on the closest wall in a clear spot for a feed-through capacitor and then connected a 0-10VDC meter via a shielded cable.

Conversion Steps

♦ Obtain power plug DB-15 male at RS or other. RS # is 276-1502 for about $2 ♦ Find and install heat sink size about 5" by 8" (size of amp) or larger and muffin fan if desired ♦ Calculate and obtain the attenuator value needed if you have more than 1mW output from

your rig. FYI, the DB6NT units have about 200+ mW output and I will use 24dB of attenuation. ♦ Connect DB 15 power plug pins # 3,7,10,11 to ground. ♦ Connect DB 15 power plug pins 1,2,12,13 as the + 12.6VDC lead usable at 15 amps load. ♦ Connect a switch or relay to ground pin #9 for XMT ♦ Install antenna relay and necessary DC power ♦ Remove cover to see the 4 pots R217, R210, R136 on 20 watt model, R138 on the 40 watt model, and R150. These first 3 are the first 3 counting from the left and R150 is directly to the right of the voltage regulator ♦ Counting from left, turn pots R217 and R 210 fully clockwise ♦ Connect exactly + 12.6VDC power and power up ♦ Measure +12.6VDC at pin 4 on P6 to ground ♦ Connect input signal on 3.4561GHz (3.4001 in Europe) at the level of 1mW or 0dBm ♦ Monitor supply current and regulate to 15.0 amps with R138 on 40W model and R136 on 20W model ♦ Connect up the antenna or dummy load using good quality N or SMA fittings* ♦ If needed, adjust R150 for 10. VDC (CRITICAL) on right hand pins of P3

♦ Peak the power output with the third pot (This is R136 or R138) to yield 40 watts output

Testing

We have found that the output connectors can become quite HOT if the SWR is higher than desired, often too hot to touch! N fittings are desired but SMA fittings may simply have to be used per your individual needs. We recommend a careful “touchy/feely” exam even as little as 3 minutes after the on the air test commences.

Input for inclusion or questions can be made to: **W3HMS@aol.com**

73 from John, W3HMS