ENIGMA BROADCAST
4m 300W AMPLIFIER KIT

Set-up & Testing of the Amplifier

You will need:

- ✓ 1.5W CW/FM drive signal at 70MHz
- ✓ 48V/500W, variable power supply (preferably current-limited)
- ✓ Voltmeter
- ✓ Ammeter
- ✓ Hexagonal trimming tool for S18 coil
- ✓ Trimming tool or small flat screwdriver for bias control RV1
- ✓ Dummy load or antenna
- ✓ Cooling fan (at least 50cfm), 92mm type is recommended

1. Turn the brass screw of RV1 anticlockwise about 10 full turns. You may hear it faintly click at the end of its travel. This is the bias control for the RF power transistor and **needs to be set to minimum** before powering up.

2. Connect the power supply to the DC power pads near the top right of the board and set to a 50mA current limit.

3. Connect input and output coax cables to the amplifier from the drive source and dummy load. These are clearly marked RF IN and RF OUT at the left and right of the board.

4. Slowly increase voltage to the module and note the current draw. It should reach a maximum about 30mA. Stop at 48V. If the current exceeds 50mA there may be a fault, the bias preset incorrectly orientated, or not turned fully to minimum.

5. Using a voltmeter check voltages between ground (a screw head) and the following points
   - About 12-12.5V at the right-hand pad of D3
   - 5.6V at the top of C33 (near U1 regulator)
   - About 0.6V at the top of C15 (preset wiper)

6. Increase the current limit on the power supply to 200mA. Turn the bias control on RV1 clockwise until the current rises to about 180mA (about 150mA bias of the transistor). Note the bias voltage present at the top of C15 will have increased to about 2.5V.

7. Place a cooling fan at the right of the module so that it blows air across the heatsink fins and also the top of the board from right to left. The output coax and low pass filter sections will get hot during use and they need cooling airflow to prevent overheating.

8. Apply RF drive (about 1.5W) at 70MHz and slowly increase the current limit on the power supply. You should see output power increase with voltage and the module should easily exceed 300W at 48V and 1.5W input drive. Verify output power remains fairly constant between 65-75MHz if desired.

The amplifier module is now ready for FM use.

To further enhance the performance of the module you may connect a SWR meter between the input of the amplifier and the driving radio. Adjust L5 for lowest SWR at 70MHz. We've found that best input SWR is achieved with the ferrite core is nearly fully out of the blue coil former. If you don't have a SWR meter to hand, reduce the RF drive level to less than 1W and tune L5 for maximum output power.

It is possible optimise the drain efficiency & power output of the amplifier by slightly spreading or closing the low pass filter coils L8, L9 & L10.

We have found for best performance all coils should have roughly the same spacing. If the coils have been correctly wound as detailed in steps 16 & 17 they should need little to no adjustment.

We don't recommend making large adjustments to the low pass filter coils as this may degrade the harmonic suppression of the filter.

For linear operation, the bias to the power mosfet needs to be increased. During development the amplifier design was optimised for gain and efficiency using a CW signal with an output of about 330-350W. For linear operation we recommend increasing the bias to the region of 500-800mA and adjust for best performance as required. During development a bias level of 670mA was found to be suitable for good IMD performance at 220W PEP output power. Note that the voltage regulator circuit and LEDs draw around 30mA by themselves, so any bias current should be added to this value. For example, setting a bias current of 670mA for the transistor will show an overall current of 700mA when making adjustments to the complete module.

Bias Shutdown Facility

During linear operation, the amplifier draws bias current which can waste power and generate unwanted heat when the unit is idling. We have provided a dual-mode bias shutdown facility which is accessed via the 3-way JST connector, J2. To shut down the bias, either connect the $\overline{SD}$ (top) pin to ground, or apply 5-12V DC to the SD pin (centre). The bottom pin is ground. Note the BIAS ON LED will illuminate when bias is applied to the transistor and turn off when the bias is disabled, which can act as a useful PTT (push-to-talk) indicator.

Advanced Operation

For those that wish to build on their amplifier project even further, we have provided outputs for thermal monitoring of the heatsink and voltage outputs proportional to the forward and reflected output power via a directional coupler after the low pass filter. The user may wish to design their own power meter, SWR protection scheme or thermal monitoring of the heatsink for fan control or temperature readout.

The 4-way edge connector provides these outputs in a handy format. Just below the connector are (from left to right) labels identifying Ground, F (Forward power), R (Reflected power) and T (temperature). Simply use the 4-way cable provided to connect these outputs to your own equipment.

The forward and reflected ports are simple Schottky diode detectors followed by potential dividers halving the output voltage of each detector. At 350W output into a 50Ω load, the forward port will output about 1.5V and the reflected about 550mV, both suitable for connecting directly to a microcontroller.

The thermal sensor is a precision 1% 10K thermistor, type MF52 (B value 3950) connected via a 3.9K resistor to the on-board 5V reference, again as a potential divider. At 25°C the output will be in the region of 1.4V, increasing with increasing temperature.

We sincerely hope you get enjoyment from using this product and welcome any feedback or comments. Please email us at info@enigma-shop.com

Specifications

Power Gain: >22.5dB @48V/ 150mA bias

Efficiency: Approximately 75% @330W/ 48V (FM mode)

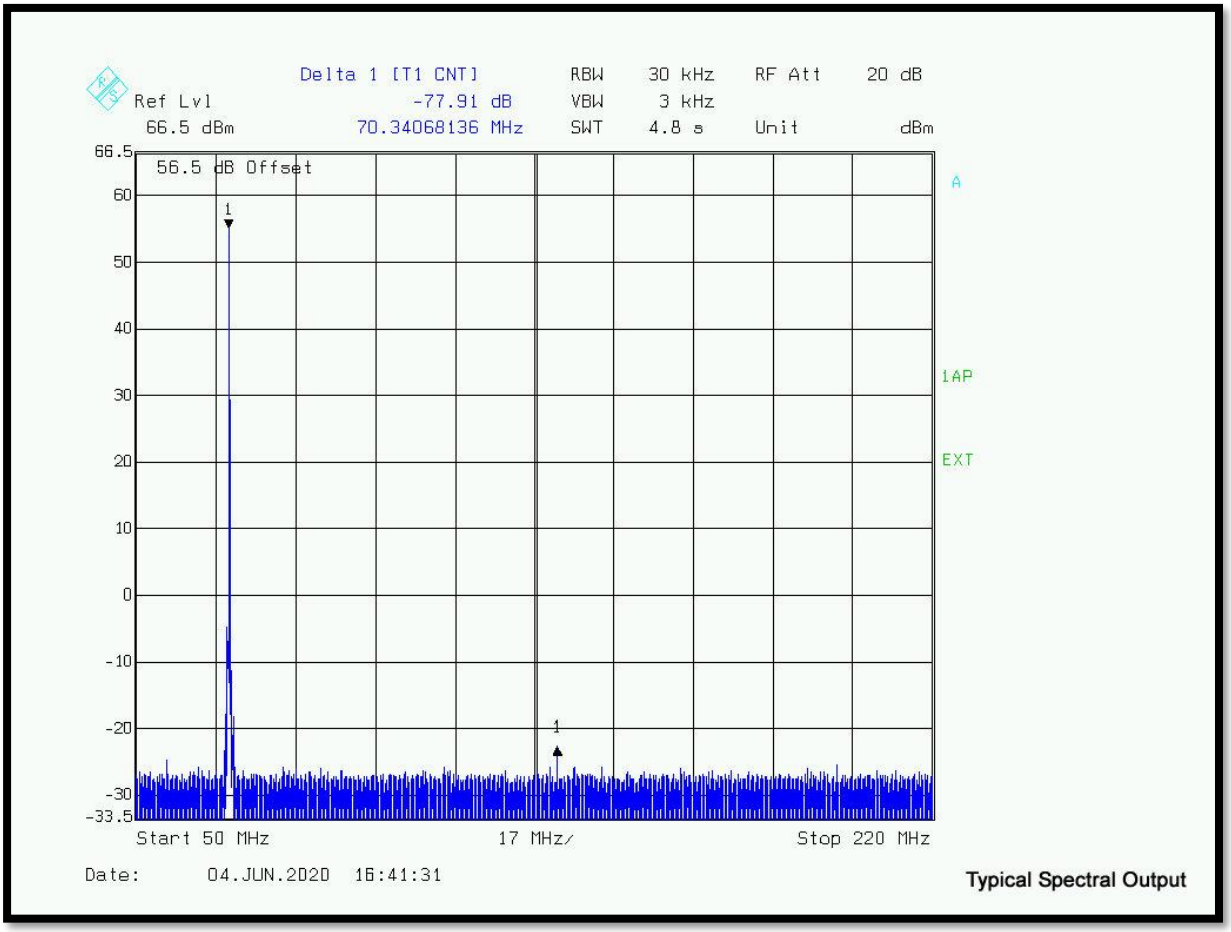
Harmonic output: <-70dBc, 65-75MHz

Current draw: Typical 9A at 48V

Mismatch ruggedness: >SWR 65:1. Tested into open and short circuit loads at the output without damage.

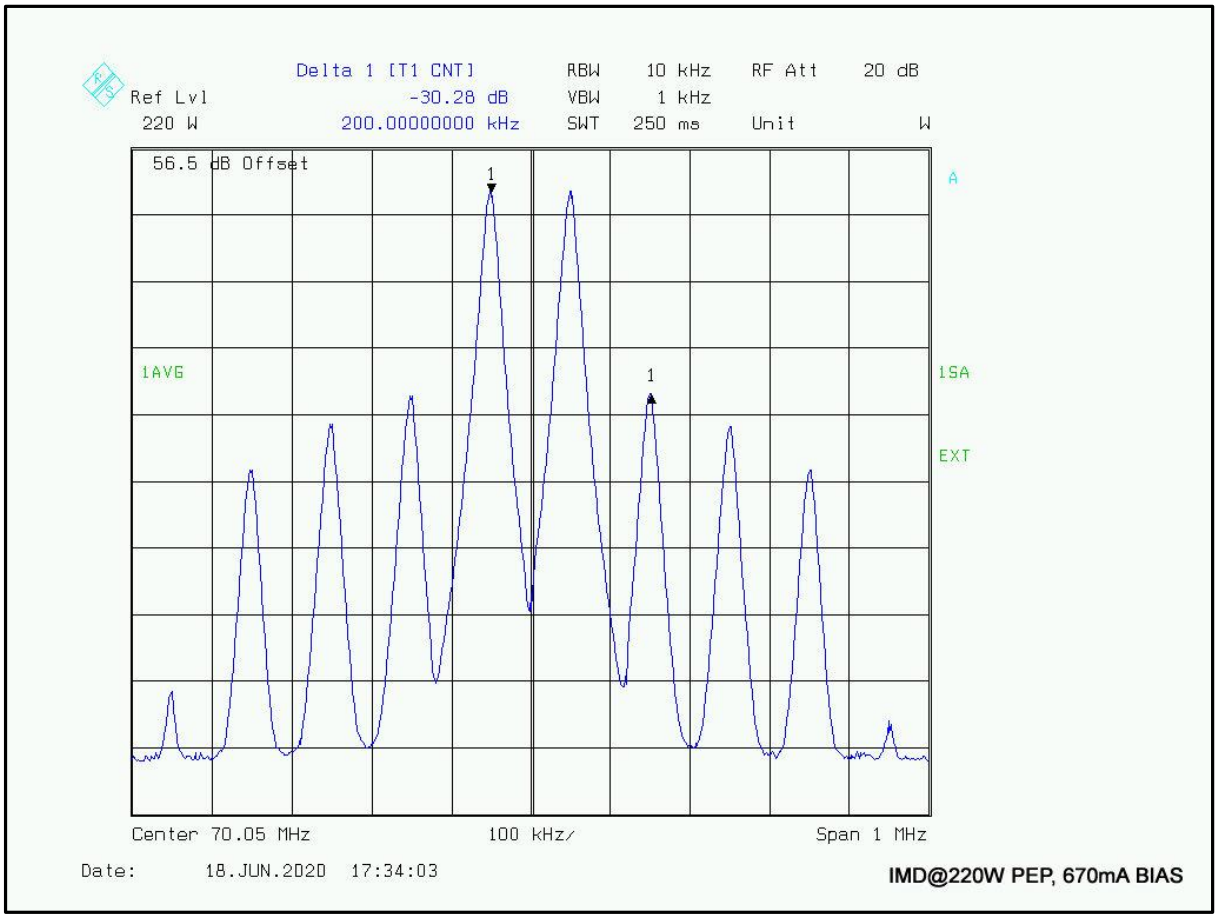
Size: 150 (L) x 100 (W) x 75 (H)mm, mounted on Enigma HS150 heatsink.

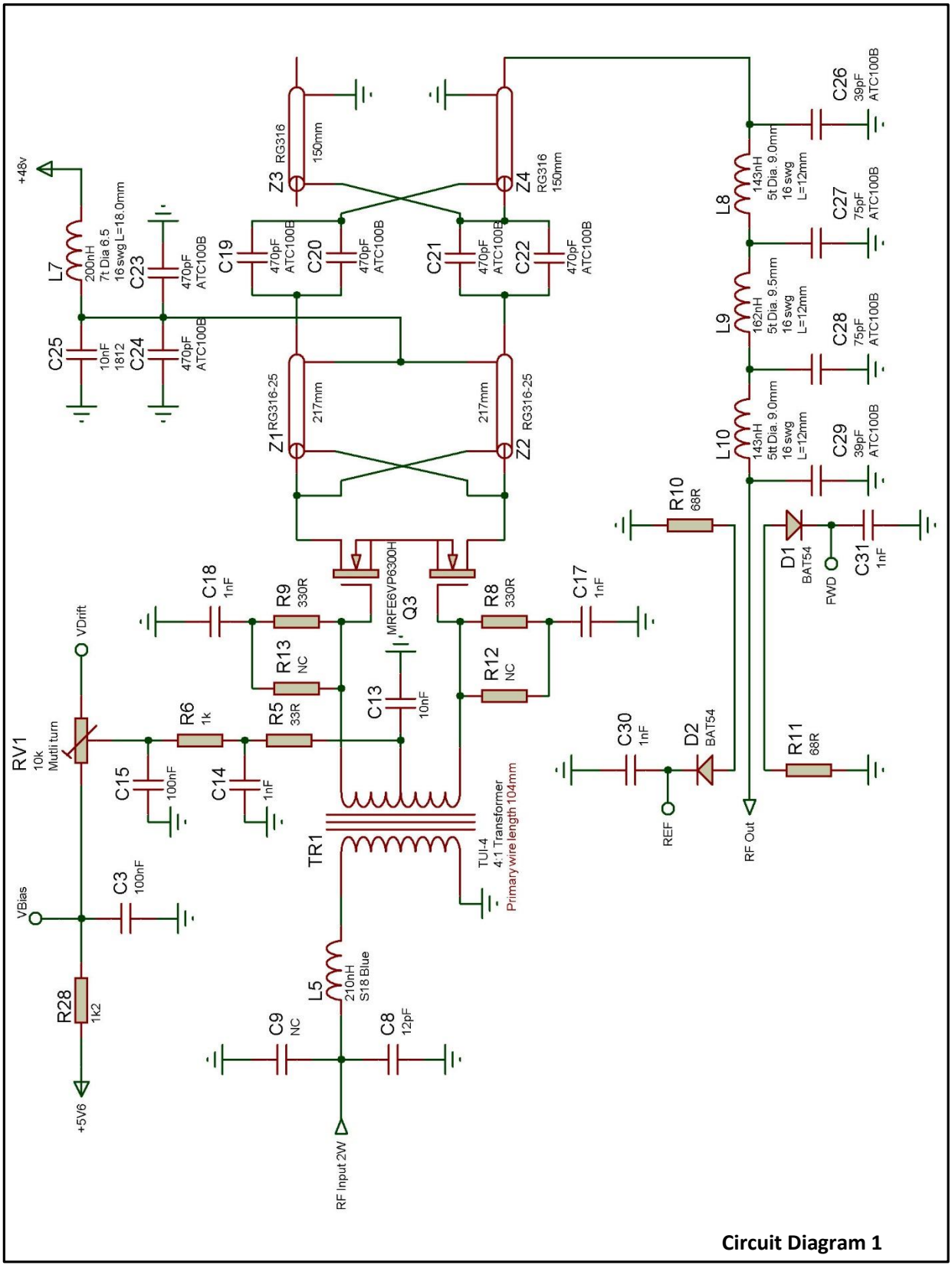
Typical output spectrum @ 350W output, 48V



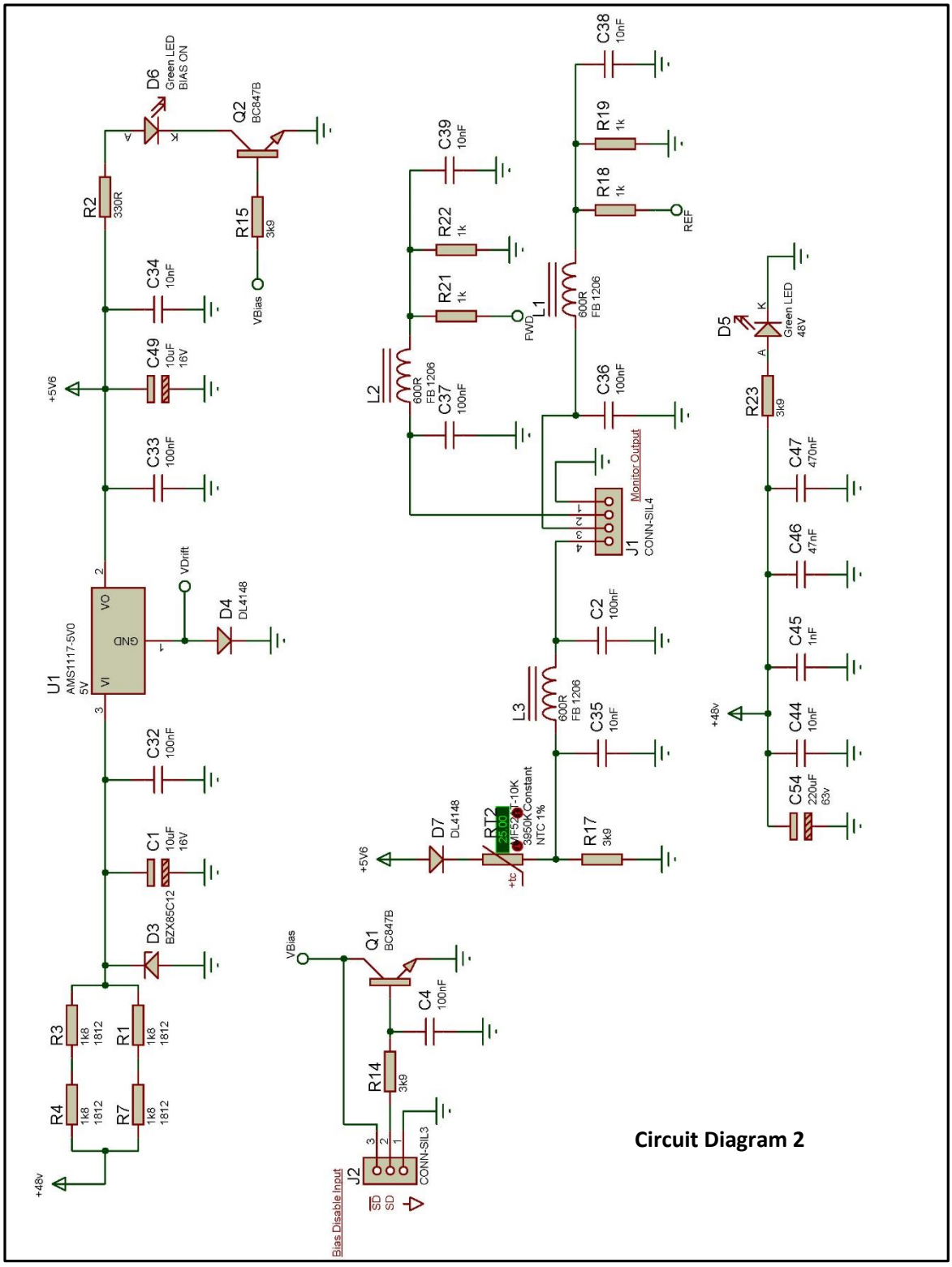
Typical Spectral Output

IMD Performance at 250W PEP, Bias 650mA





Circuit Diagram 1



Circuit Diagram 2