

**MTT-20 STUDENT DESIGN COMPETITION AT IMS'25****Prepared by F. H. Raab****Revision -, August 26****1. GENERAL INFORMATION****Title:**

High-Efficiency Power Amplifier for 144 MHz.

**Abstract**

The student(s) will design a power amplifier and driver to produce 10 W CW at 144 MHz from a 12-V supply. The winning design will have the highest overall efficiency, subject to meeting the specifications below.

**General Notes**

The resultant design should be useable on the 2-meter amateur band, and should produce about 50 W when operated from a higher supply voltage. (Not part of contest).

The VHF operating frequency necessitates the use of discrete components, making this design quite different from the usual 1+ GHz of the MTT-12 PA-design contest. Measurements can be made with relatively simple equipment. Inclusion of the driver presents the student with a number of interesting design trade-offs.

**2. DETAILED SPECIFICATIONS AND RULES**

Output power: 10-11 W CW into a 50-ohm load. Only the fundamental-frequency component of the output will be counted toward the measured power.

Frequency: 144.0 MHz

Power Supply: 12 V (measured at the supply connectors). Final amp, driver, bias, etc. must all work from the single 12-V supply.

RF power transistor for final amplifier: Up to the student but must be transistor, not IC.

Final amplifier, Driver and Intermediate Stages: At discretion of student but must use discrete components as noted below.

Input from External Signal Source: +10 dBm (10 mW). CW, constant-amplitude sine wave, no modulation.

Input SWR: < 2:1 relative to 50 ohms.

Harmonics: < 40 dBc (up to 1000 MHz)

Non-harmonic spurs: < -70 dBc (100 kHz to 1000 MHz).

Oscillations: No oscillation if signal input is removed.

Subassemblies: No commercial subassemblies are allowed. For example, if a dc to dc converter is used, it must be designed and built with discrete parts and/or ICs, and included in the circuit schematic.

Batteries: Not permitted.

Connectors: SMA input and output for RF. Female banana jacks for the 12-V supply.

### **Evaluation Process and Scoring**

The winning design:

- (a) Provides the information specified by the due dates.
- (b) Presents working amplifier for judging at IMS.
- (c) Must meet all specs above.
- (d) Will have the highest overall efficiency defined as

$$(\text{RF output power}) / (\text{Total dc-input power})$$

Awards will be made per the rules of the Student Design Competition. The judges reserve the right to make no awards in case of poor performance.

### **Eligibility**

Teams of one to four full-time students.

The work must be entirely by the named students without assistance from others.

### **3. SPONSORING TECHNICAL COMMITTEE**

MTT-20, HF/VHF/UHF Technology  
Contact: Frederick H. Raab, fraab@gmrr.biz.

#### 4. PAST PARTICIPATION

Typically three teams have actually completed the design and shown up at IMS.

Professors whose students may be interested:

"Taylor Barton" <taylor.w.barton@colorado.edu>

"Dr. Peter Asbeck" <asbeck@ece.ucsd.edu>

"Apolinar Reynoso-Hernandez" <apolinar@cicese.mx>

Prof. Rainer Kronberger Rainer.Kronberger @th-koeln.de

Prof. Juan Riva-Davila jmrivas@stanford.edu

Youngoo Yang youngooyang@gmail.com

David Peroulis dperouli@purdue.edu

"Robert Caverly" <caverly@ece.villanova.edu> Member MTT-20

#### 5. EQUIPMENT NEEDED

Equipment must have stand-alone operation, not computer-controlled. We prefer simple equipment that is simple to operate and requires no set-up.

One Power Supply

Adjustable 12+ V 2+ A

Keysight has provided in past.

E36103B, 6621A, or 6622A power supply

Two (2) Digital Multimeters

One measures dc voltage 0 - 15 V.

Other measures dc current 0 - 2 A.

Keysight has provided in past.

Keysight 34470A DMM

If the power supply has a precision current meter, then only one multimeter is needed.

Spectrum Analyzer

Keysight Fieldfox N9917A

Signal Generator

144 MHz +10 dBm CW

RF Power Meter

Boonton 4542 with 51011A-EMC average power sensor

Stand-alone meter – Must NOT require use of computer to read.

Boonton provided in the past.

Cables, attenuators, etc. will be provided by GMRR.

## 6. OTHER INFORMATION NEEDED AND DUE DATES

### Needed by April 1, 2025

Potentially interested participants must submit registration information on the participants as soon as possible. This information includes the designated contact person and the following for each participant:

Name  
Address  
Phone  
E-mail  
Institution  
Degree program and advisor

### Needed by May 1, 2024

By May 1, the team must provide:

Updates if any on the team members  
Description of the amplifier  
Photo of the amplifier  
Circuit  
Parts list  
Measured performance data

**Certification by advisor that work was done by students.**

Submit your information as a single PDF to [fraab@gmrr.biz](mailto:fraab@gmrr.biz).

You may make improvements on your amplifier between this date and the judging.

### Attendance and Judging

At least one team member must register for and attend IMS and be present at the judging.

Judging will be done on Tuesday of IMS in the exhibit area. Please check the IMS web site for the specific time and place. We will give you a time slot.

We will provide a signal generator, power supply, and measurement equipment.

During the judging, you will set-up and check your hardware. You may re-adjust before we take the official measurements. Only students on the team may participate.

You may bring spare parts and tools to use in case there is a problem.

Additional Award from Rohde & Schwarz:

Rohde & Schwarz is pleased to include an additional award to the 1st place team for this project. Through our Technology Academy, we have developed a new IEEE-certified online course series called RF Engineering Essentials.

**What's Included?**

- 7 courses covering a range of essential RF and microwave topics
- Unlimited individual access to all course content on-demand 24/7 for 365 days
- IEEE Certificate of Completion
- Time needed to complete: approximately 10.5 hours

**Technical Level**

While no formal prerequisites are required, students will benefit from a basic technical background. The course presents complex RF concepts without heavy mathematical treatment, making it accessible to those with fundamental technical knowledge and a willingness to learn specialized RF terminology and principles.

Rohde & Schwarz will award up to four course vouchers to the 1st place team which provide free access to the course material (valued at \$1500 per student).