STATEMENT OF WORK

Travelling Wave Tube (TWT) RF Microwave Amplifiers

1 INTRODUCTION

This specification establishes the design, construction, quality assurance, and performance requirements of an amplifier system consisting of two Traveling Wave Tube (TWT) RF Microwave Amplifiers. The two TWT amplifiers shall cover the frequency range from 18 GHz to 40 GHz

2 BACKGROUND

Over the last several years, more electronic systems are being designed to operate in the higher Millimeter Wave (mmW) frequency bands. Significant new work in military avionics and space electronics are dependant on the ability to validate the safety and mission success attributes of that design. Daily we hear of military avionics and EM Interference that lead to mission failures. The ability the validate designs incrementally during the design cycle is key to getting that design fielded in a timely, successful fashion. This has lead to an extreme need to test and verify the electromagnetic compatibility of these systems developed in Code 8000 and other NRL codes.

3 SCOPE

The contractor shall be responsible for the design and construction of the RF amplifier system with the technical requirements as stated herein

4 TECHNICAL REQUIREMENTS

The RF Amplifier System shall consist of two sub-octave TWT amplifier units. The Technical requirements stated herein, inclusive of Sections 4.2, 4.3, and 4.4, shall apply to each unit unless stated otherwise.

4.1 RF PERFORMANCE

4.1.1 CW Output Power

40 Watts (Minimum) Saturated Power
10 Watts (Minimum) Linear at 1dB Compression

4.1.2 Frequency Response

TWT Amplifier Unit #1: 18 GHz to 26.5 GHz, 8.5 GHz Instantaneous Bandwidth TWT Amplifier Unit #2: 26.5 GHz to 40 GHz, 13.5 GHz Instantaneous Bandwidth

4.1.3 Gain. 46 dB (minimum)

4.1.4 Variable Gain Control Range. Continuously variable gain adjustments from 0 – 20 dB

4.1.5 Gain Flatness. +/- 8dB (maximum)

4.1.6 Spurious. -50dBc (maximum)

4.1.7 Output Noise Power Density. -60 dBm/Hz (maximum)

4.1.8 Input for Rated Output. 1.0 milliwatt (maximum)

4.1.9 Input Impedance. 50 ohms, VSWR 2.0:1 (maximum)

4.1.10 Output Impedance. 50 ohms, VSWR 2.7:1 (maximum)

4.1.11 RF Forward Power Sample Port. The unit shall have a directional coupler to monitor the forward power of the TWT amplifiers

4.1.12 RF Reverse Power Sample Port. The unit shall have a directional coupler to monitor the reverse power going back to the TWT amplifiers

4.1.13 Mismatch Tolerance. The amplifiers shall operate without damage or oscillation with any magnitude/phase of source and load impedance for an infinite period of time. There shall be VSWR protection and foldback protection of the output power at reflected powers exceeding 10 watts.

4.1.14 TWT Fault Protection. The TWT shall be protected, at a minimum, in the event of the following faults:

- Cathode Overcurrent
- Helix Overcurrent
- TWT Overtemperature
- Grid Undervoltage

4.1.15 Modulation Capability. The amplifiers shall operate within the specifications stated herein with AM, FM, BPSK, FSK or pulse modulation appearing on the input signal, with the peak envelope output power of the modulation specified by the CW power of the amplifier units.

4.2 FRONT PANEL DISPLAY

The front panel shall have a display that the user can locally monitor the performance and status of the TWT Amplifiers. The display shall, at a minimum, provide the following operational parameters:

- Forward and Reflected Output Power
- Power-on, Warm-up, Standby, and Operate Status
- System Faults
- Excess Reflected Power Warnings
- TWT Helix Currents
- Cathode, and Collector Voltages
- Heater Currents and Voltages
- Baseplate and Cabinet Temperatures

4.3 FRONT PANEL CONTROL

The amplifier units shall have the following front panel controls, as a minimum, for manual control of the units:

- Power On/Off
- Standby/Operate
- Local/Remote
- Gain Control
- Fault Reset
- RF Safety Interlock/Inhibit

4.4 REMOTE OPERATION AND MONITORING

The amplifier system shall have a built in IEEE-488 interface. The amplifiers shall be capable of being programmed, controlled, and monitored from a Government furnished remote computer. All locally available push button key functions at the front panel of the units shall have corresponding remote command protocols. All status and operational parameters visible on the front panel displays shall have corresponding remote command queries. The command protocols and syntax shall be compatible with all commercially available applications that have IEEE-488 software drivers. The command protocols and syntax shall be provided in the “Programmers Guide”.

4.5 MECHANICAL SPECIFICATIONS

4.5.1 Cabinet Enclosure. Each amplifier unit shall have enclosures designed for both benchtop operation and for rack mounting, sized for a 19 inch rack. The TWT Amplifier Units shall be enclosed in either of the following configurations: Two (2) chassis where each chassis shall combine both the power supply and RF unit for each TWT Amplifier, or a split mount configuration that shall have four (4) separate individual chassis one for each of the two power supplies and two RF units.

4.5.2 Size. The size of each amplifier unit shall be suitable for both benchtop operation and for rack mounting.

4.5.3 Weight

80 lbs (maximum) for each TWT amplifier unit, (containing both the Power supply and the RF unit), or

50 lbs (maximum) for each unit for a split mount configuration, if applicable

4.5.4 Ambient Operating Temperature. 0 degrees C to 50 degrees C

4.5.5 Cooling. Each chassis shall contain its own forced air internal unit

4.5.6 RF Input Connectors. Type K female either on front or rear panel

4.5.7 RF Output Connectors

TWT Amplifier Unit #1: WR-42 Waveguide flange either on front or rear panel
TWT Amplifier Unit #2: WR-28 Waveguide flange either on front or rear panel

4.5.8 Forward Power Sample Port. Type K female either on front or rear panel

4.5.9 Reflected Power Port. Type K female either on front or rear panel

4.5.10 Remote Computer Interface. IEEE-488 (GPIB) either on front or rear panel

4.5.11 Interconnecting Cables (if applicable). For a split mount amplifier configuration, the HV/LV interconnect cables shall be 12 meters in length

4.6 PRIMARY POWER INTERFACE

4.6.1 Voltage. 190 – 260 VAC

4.6.2 Frequency. 50 / 60 Hz, Single Phase

4.6.3 Power. 1200 VA (maximum)

4.6.4 Power Connector. The power connector shall be a NEMA approved locking connector for the single phase voltage and current rating of the amplifier units.

4.7 WAVEGUIDE ASSEMBLIES

To connect the amplifier units to the existing infrastructure, the amplifier system shall include the following waveguide assemblies. The flanges on the ends of the W/G assemblies shall be North American EIA Standard Flanges. One end shall have a square Cover Flange, and the opposite end shall have a square Choke Flange. For the components that have only one flange, a square Cover Flange shall be used.

4.7.1 Waveguide Size WG42

Rectangular WG42, Straight Section, Copper/Bronze, 36 inches, 3 each
Rectangular WG42, Straight Section, Copper/Bronze, 12 inches, 3 each
Rectangular Flex-Twist WG42, 36 inches, 1 each
Rectangular WG42, 90 degree Twist Section, Copper/Brass, 3 inches, 1 each
Rectangular WG42 90 degree E Bend, Copper/ Brass, 1 in x 1 in, 2 each
Rectangular WG42 90 degree H Bend, Copper/ Brass, 1 in x 1 in, 2 each
WG42 –SMA Coax Adapter, Right Angle, Copper/ Brass, 2 each

4.7.2 Waveguide Size WG28

Rectangular WG28, Straight Section, Copper/Bronze, 36 inches, 3 each
Rectangular WG28, Straight Section, Copper/Bronze, 12 inches, 3 each
Rectangular Flex-Twist WG28, 36 inches, 1 each
Rectangular WG28, 90 degree Twist Section, Copper/ Brass, 3 inches, 1 each
Rectangular WG28 90 degree E Bend, Copper/ Brass, 1 in x 1 in, 2 each
Rectangular WG28 90 degree H Bend, Copper/ Brass, 1 in x 1 in, 2 each
WG28 –2.9mm Coax Adapter, Right Angle, Copper/ Brass, 2 each

5 DOCUMENTATION

All documentation shall be submitted in either hardcopy form, or in PDF format on a Compact Disk.

5.1 USERS MANUAL

The contractor shall provide a users manual for the TWT RF Amplifiers. The manual shall describe the procedures to install and operate the RF Amplifiers.

5.2 CALIBRATION DATA

The contractor shall provide calibration data for all the forward and reflected sample ports. The calibration data shall contain a minimum of 50 points evenly spaced over the specified frequency response of the amplifiers.

5.3 PROGRAMMERS GUIDE

The contractor shall provide a programmers guide for the TWT RF Amplifiers. The manual shall describe the procedures to remotely operate and monitor the RF Amplifiers, and shall contain the command syntax to be used by any commercially available programming language to communicate with the RF Amplifiers.

5.4 SERVICE AND MAINTENANCE MANUAL

The contractor shall provide a service and maintenance manual for the TWT RF Amplifiers. The manual shall include the procedures to maintain the RF Amplifiers after the contractor’s warranty period. It shall also contain all information, diagrams, and schematic designs to troubleshoot and service problems encountered with the Amplifiers.