

Specification for 162.5 MHz Solid State, 7 kW, CW RF Amplifier PIP-II Project

Specification Number:
Date Released: 10 Jan 2017

Editor: David Peterson

Description

162.5 MHz, 7 kW, CW, Solid State RF amplifier

Including

19" rack mountable,
 Full documentation,
 Testing to specifications at factory,
 Final acceptance testing done at Fermilab,
 Shipping container adequate for return for repairs,
 Periodic design and progress review meetings specified
 by Fermilab and vendor prior to initialization of work.

Specifications

1. Electrical Specifications:

1.0 Operating Conditions:

The amplifier to be operated continuous duty into a Fermilab supplied circulator with a maximum VSWR of 2.0:1 at any phase angle. Typical operating conditions will be at 1 dB compression. Fast closed feedback system loops will be provided to stabilize accurately phase and amplitude over varying load conditions.

1.1	Center frequency	162.50 MHz
1.2	3dB Bandwidth	5 MHz minimum
1.3	Power output at 1 dB compression	7 kW CW
1.4	Gain	65 to 68 dB
1.5	Input drive to achieve full power	0 dBm to +3 dBm, lower levels acceptable
1.6	Harmonics	-25 dBc
1.7	Spurious	Better than -70 dBc \pm 10 MHz from center frequency
1.8	Minimum pulse for reverse power sensing	100 microseconds
1.9	AM to PM deviation	10° over a 10 dB range to 7 kW, includes phase shift from temperature variation

1.10 Group Delay	not to exceed 100 nanoseconds
1.11 Noise Figure	20 dB max, predriver stage
1.12 Input overdrive protection	+16 dBm max
1.13 Input/output impedance	50 ohms, return loss better than -15 dB (VSWR < 1.4:1)
1.14 Input connector	Type N female, rear panel
1.15 Output connector	1-5/8 inch EIA flange, rear panel of the RF section
1.16 Efficiency	AC plug to RF output >60% goal, 50% minimum at 1 dB compression power
1.17 AC power	480 VAC 60 Hz three phase delta, 4 wire (three phases and ground). Connector shall be compliant with applicable NEC, NEMA, CSA standards.

2. General Specifications:

2.0 Documentation to be provided: operating manuals, block diagrams, detailed schematics and interconnection drawings, parts list, assembly and maintenance procedures.

2.1 Packaging: 19-inch standard rack mountable, maximum depth of 27 inches (68.6 cm), maximum height < 84 inches. Preferred in two units, RF section and Power supply section. It is acceptable for the RF output connection to exceed the depth requirement.

2.2 Local interface: The control interface must support local operation of the amplifier. A touch screen (or equivalent means of self-contained local operation) built into the unit is acceptable. External screen, mouse, keyboard, etc. is not acceptable.

2.3 Remote interface

2.3.1 Hardware status of essential parameters such as On/Off, Fault, RF enabled, etc.

2.3.2 Hardware control of essential parameters such as On/Off, Fault reset, RF enable, etc.

2.3.3	Hardware signals: 24 VDC industrial levels preferred for low speed digital signals. 0 to 10 VDC for analog signals. 5V TTL, 50 ohm impedance, for any high speed digital signals.
2.3.4	Ethernet status of all internal amplifier parameters such as water flow, transistor current and temperature, power supply voltage, etc. ModbusTCP or EPICS protocol required.
2.4	Water cooling: low conductivity water (LCW)
2.4.1	Supply pressure maximum 150 psi
2.4.2	Supply pressure nominal 125 psi
2.4.3	Differential pressure minimum 60 psi
2.4.4	Supply temperature nominal 26 C to 30 C
2.4.5	Supply temperature for derated operation. Vendor to specify level of derating. 23 C to 33 C
2.5	Water plumbing: No plastic fittings. Limited use of O-rings. All internal piping should be stainless steel, copper, or high quality hose. Water connections on rear panel.
2.6	Air cooling
2.6.1	Ambient: +10 C to +40 C, 95% humidity non-condensing.
2.6.2	Airflow intake on front panel and exhaust at side or rear panels.
2.6.3	Front panel filter media, user replaceable from exterior.
2.6.4	Heat load values to ambient air to be provided by vendor.
2.7	Amplifier monitoring, local and remote
2.7.1	Forward and reverse RF power. Both signals should be split with one sample going to the front panel of the RF section, the other sample going to a calibrated log detector. Detector should respond in <100 microseconds.
2.7.2	DC power supply voltage and current
2.7.3	Water flow
2.7.4	Fan function
2.8	Amplifier protection
2.8.1	Reverse power trip with indicator.
2.8.2	Thermal overload: Internal heatsink temperature maximum of +65 C for trip. Front panel trip indication desired.
2.8.3	Water flow fault with indicator.
2.8.4	Air flow fault with indicator.

3. Acceptance testing at the factory before shipment:

3.0 Fermilab reserves the right to witness the testing before shipping.

-
- 3.1 The testing shall demonstrate full compliance with the specification Electrical and General contained in this document.
-
- 3.2 Operating into a test resistive load (VSWR of 2.0:1 or less) demonstrate or measure compliance with specifications:
- a) RF power at 1 dB compression
 - b) Gain
 - c) Bandwidth
 - d) Gain linearity
 - e) Harmonics
 - f) Spurious output
 - g) Input match
 - h) RF power output no RF drive
 - i) Efficiency
 - j) 100 hour heat run at full rated power
 - k) Two tone test 10 kHz spacing
-
- 3.3 The vendor shall provide standard quality conformance test procedures which documents optimum parameters and performance limits as part of the vendor's performance inspection tests. The inspections should include but not be limited to: cooling circuits, as well as RF power tests.
-

4. Final Acceptance Testing at Fermilab:

- 4.0 Operating into a test resistive load (VSWR of 2.0:1 or less) demonstrate or measure compliance with specifications:
- a) RF power at 1 dB compression
 - b) Gain
 - c) Bandwidth
 - d) Gain linearity
 - e) Harmonics
 - f) Spurious output
 - g) Input match
 - h) RF power output no RF drive
 - i) Efficiency
 - j) 100 hour heat run at full rated power
 - k) Two tone test 10 kHz spacing

5. Miscellaneous Items:

- 5.0 Full documentation to be provided: operating manuals, block diagrams, detailed schematics and interconnection drawings, parts list, assembly and maintenance procedures.
-