EMPOWER
RF SYSTEMS, INC.

Solid State Broadband High Power Amplifier

1163 – BBM2E3KLO	20 – 520 MHz / 125 Watts

The BBM2E3KLO (SKU 1163) is a 20 to 520 MHz amplifier which is guaranteed to deliver 125W output power (P3dB) and related RF performance under all specified temperature and environmental conditions. Typical power output is 150W and other typical performance parameters are also listed as a guide for consideration, but not guaranteed. This amplifier is suitable use as a broadband PA building block in target markets and related end applications for electronic attack, digital communications, and test and measurement in the UHF / VHF frequency bands. This compact module utilizes the latest high power RF LDMOS transistors and also features built in control and monitoring, with protection functions to insure high availability. The control system core has a built–in non-volatile memory for event recording, and factory setup recovery features.

- Solid-state Class AB linear design
- Instantaneous ultra broadband
- Suitable for CW and modulated carrier (measurement data from digital waveforms available upon request).
- Small and lightweight
- 50 ohm input/output impedance
- High reliability and ruggedness
- Built-in control, monitoring and protection circuits
- RS485 serial interface for monitoring and control

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Electrical Specifications

V_{DC} = 28.0V, over temperature and environmental conditions, as specified.

Parameter	Symbol	Units	Test Conditions	Min	Typ	Max
Operating frequency	BW	MHz		20		520
Peak output power	P_{3dB}	W	Measured with an IS-95, 9 channel forward link waveform without clipping. Channel bandwidth ~ 1.25MHz and PAR ~ 10dB at 0.01% probability.	125	150	
Gain, small signal	G_{SS}	dB	Measured with VNA in swept frequency mode at -10dBm CW or IS-95, 9 channel forward link waveform without clipping and PAR ~ 10dB at 0.01% probability. Input power calibrated / measured at the amplifier input port. Variable attenuator set to nominal attenuation.	51.5	54	56.5
Gain flatness, small signal	ΔG_{SS}	dB	Measured with VNA in swept frequency mode at -10dBm CW. Input power calibrated / measured at the amplifier input port. Variable attenuator set to nominal attenuation.			±2.5
Gain adjustment range, small signal	$G_{SS, ADJ}$	dB	Test conditions the same as G_{SS}	15		
Gain adjustment step size, small signal	$G_{SS, STEP}$	dB	Test conditions the same as G_{SS}		0.5	
Maximum input power without damage	$P_{IN, MAX}$	dBm	CW input signal for unlimited duration.			20
Input return loss	IRL	dB	Measured with VNA in swept frequency mode at -10dBm and 0dBm CW. Input power calibrated / measured at the amplifier input port. Variable attenuator set to nominal attenuation.			-10
Noise figure	NF	dB	Variable attenuator set to nominal attenuation.			15
2^{nd} harmonics	2^{nd}	dBc	Variable attenuator set to nominal attenuation. CW signal source at an output power of 125W.			-15
3^{rd} harmonics	3^{rd}	dBc	Variable attenuator set to nominal attenuation. CW signal source at an output power of 125W.			-9
Spurious	Spur	dBc	Variable attenuator set to nominal attenuation. CW signal source of 0dBm at the input to the amplifier. Input power is calibrated / measured at the amplifier input port. Spurious defined as any non-harmonic amplifier output. Spurious measured in a 1kHz resolution bandwidth, 10kHz video bandwidth. Specifications apply at offsets of greater than or equal to +/- 10kHz from the RF carrier. Maximum measurement frequency is 3GHz.			-60
Operating voltage	V_{DC}	V	Note: Output power capabilities and gain will vary with voltage.	26	28	32
Current consumption	I_{DC}	A	Variable attenuator set to nominal attenuation. Measurement at an output power of 125W with a CW source.			15
PA enable / Disable time	$T_{ON/OFF}$	uSec	Variable attenuator set to nominal attenuation. Measurement with 0dBm CW signal presented to the input of the amplifier. Rise and fall times of amplifier output envelope recorded. Rise and fall times at 10% / 90% of the output power in linear scale. PA Enable / Disable signal set to 10kHz repetition rate and 50% duty cycle.			1

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Amplifier Protection Features

The PA includes protection circuits for:

- Under / over temperature
- Under / over voltage
- Reverse polarity
- Over current

In addition to protection circuits, the PA will withstand full reflection at the RF output at any angle for up to 1 minute at 125W CW.

Environmental Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Operating Case Temperature	T_C	-40		+85	°C
Storage Temperature	T_{STG}	-40		+85	°C
Relative Humidity (non-condensing)	RH			95	%
Altitude (MIL-STD-810F Method 500.4)	ALT			30,000	Feet
Vibration/Shock MIL-STD-810F Method 514.5/516.5 – Proc I	VI/SH				

Mechanical Specifications

Parameter	Value	Units	Limits
Dimensions	7.0 x 4.0 x 1.2	Inch	Max
Weight	2	lb.	Max
RF Connectors	Type-SMA, Female		
DC Interface Connector	Hybrid D-Sub 17-Pin, Male (17W2)		
Cooling	External Heatsink (not supplied)		

DC Interface Connector

Pin #	Description	Specifications
A1	GND	Ground
A2	VDD	Supply Voltage: 26 to 32 Volts DC, 28.0 Volts DC nominal.
1	RS485 (-)	Serial communication bus
2	Temperature Reporting	N/A – *(Temperature Monitor Reporting is currently available only from RS485)*
3	Address 1	Hardware Address 1
4	Address 3	Hardware Address 3
5	Attenuator setting	Voltage input in the range of 0.5 to 3.0V. 0.5V corresponds with minimum attenuation; 3.0V maximum attenuation. This pin will be ignored if the RS485 bus is used for setting attenuation.
6	PA Enable/Disable	0/3.3V logic levels: Power Amplifier disable is a TTL Logic Low (0V). (*Internally Pulled-High 3.3V*)
7	Alarm	Amplifier alarm indicator: 0 / 3.3V logic levels. Normally TTL Logic Low (0V). TTL Logic High (3.3V) indicates a fault condition.
8	RS485 (+)	Serial Communication Bus
9	Current Reporting	Analog output voltage. 0.5V to 3.0V range. Linear output at 6 amperes per volt.
10	Address 0	Hardware Address 0 – least significant bit
11	Address 2	Hardware Address 2
12	Address 4	Hardware Address 4 – most significant bit
13	Not Used	No Connection
14	Not Used	No Connection
15	Reset	Hardware reset

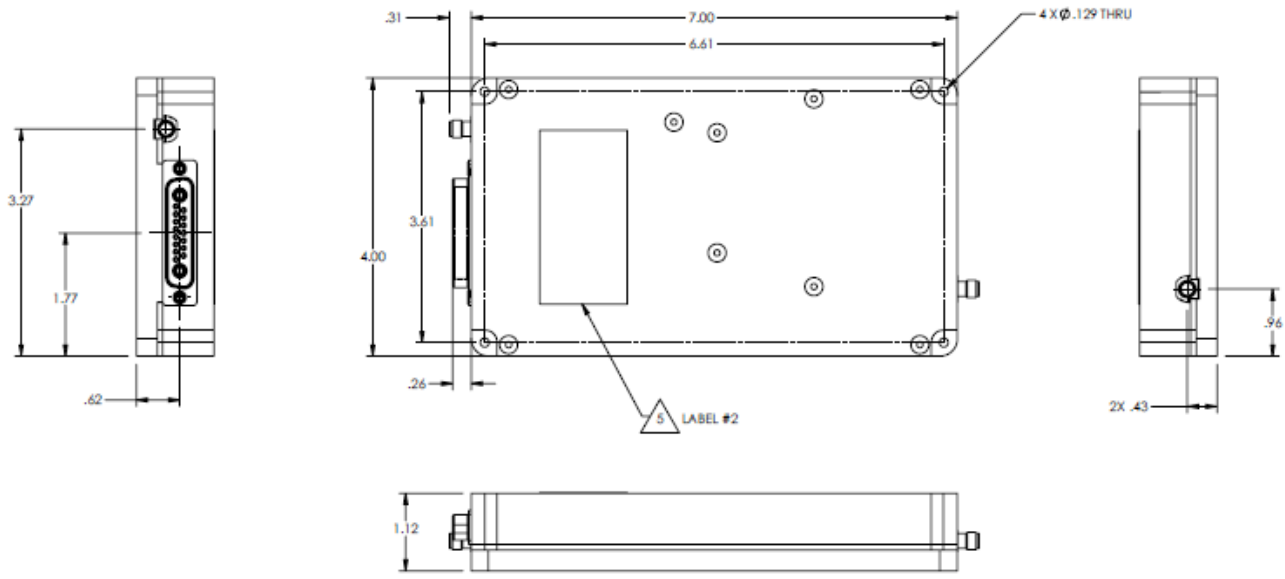

Figure 1: Outline drawing. Note: The RF input is closest to the 17W2 connector.

Typical Performance Data

The figures below provide typical performance data over temperature.

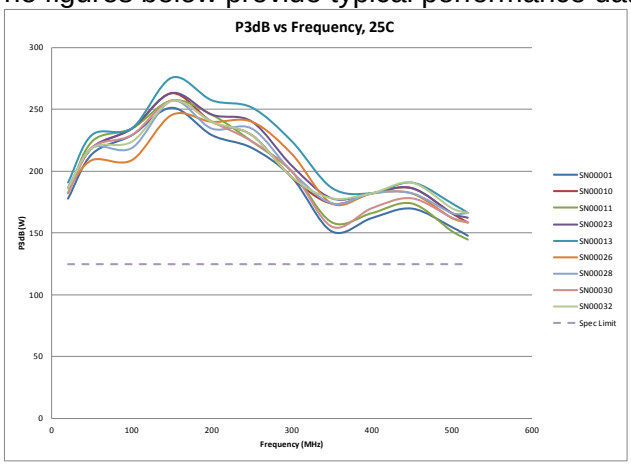

Figure 2: IS95, 9 channel forward P_{3dB} performance over frequency for 9 units. V_{SUPPLY} is 28V. Base plate temperature is 25 C.

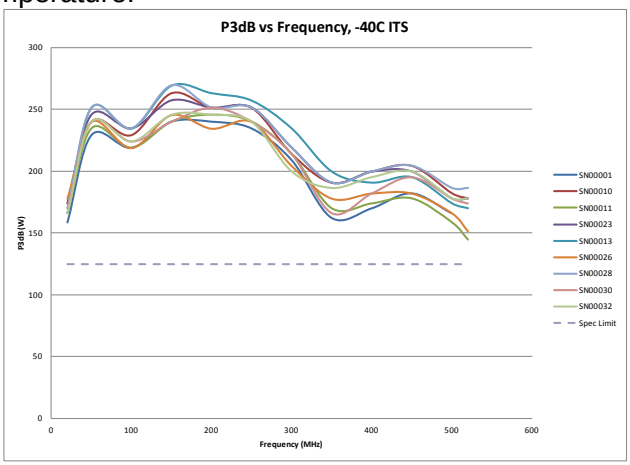

Figure 4: IS95, 9 channel forward P_{3dB} performance over frequency for 9 units. V_{SUPPLY} is 28V. Base plate temperature is -40 C.

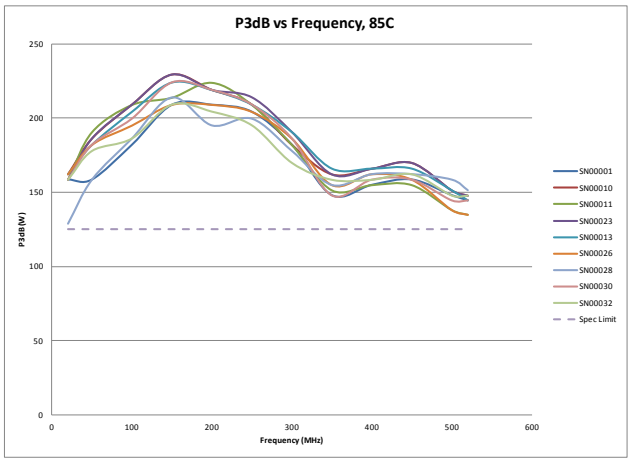

Figure 3: IS95, 9 channel forward P_{3dB} performance over frequency for 9 units. V_{SUPPLY} is 28V. Base plate temperature is 85 C.

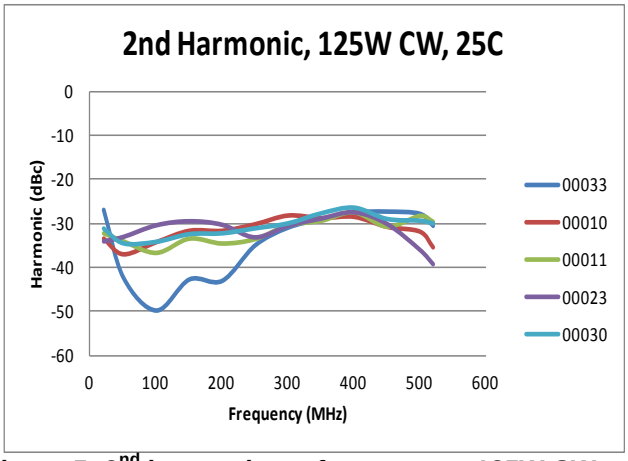

Figure 5: 2nd harmonic performance at 125W CW output power over frequency. Base plate temperature is 25 degrees C.

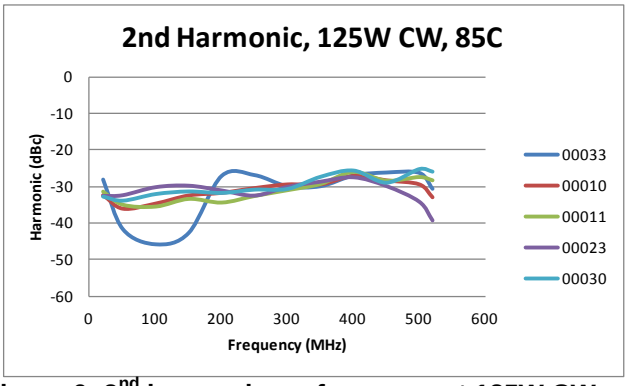

Figure 6: 2nd harmonic performance at 125W CW output power over frequency. Base plate temperature is 85 degrees C.

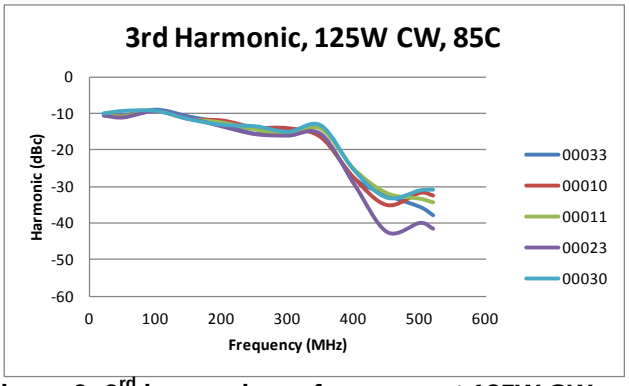

Figure 9: 3rd harmonic performance at 125W CW output power over frequency. Base plate temperature is 85 degrees C.

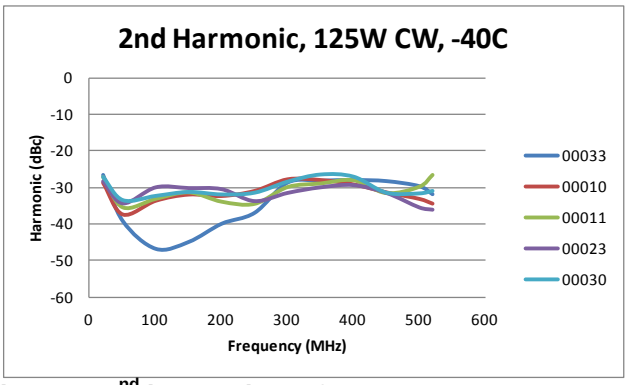

Figure 7: 2nd harmonic performance at 125W CW output power over frequency. Base plate temperature is -40 degrees C.

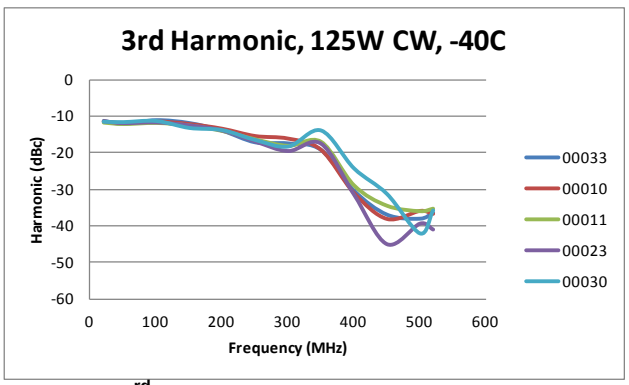

Figure 10: 3rd harmonic performance at 125W CW output power over frequency. Base plate temperature is -40 degrees C.

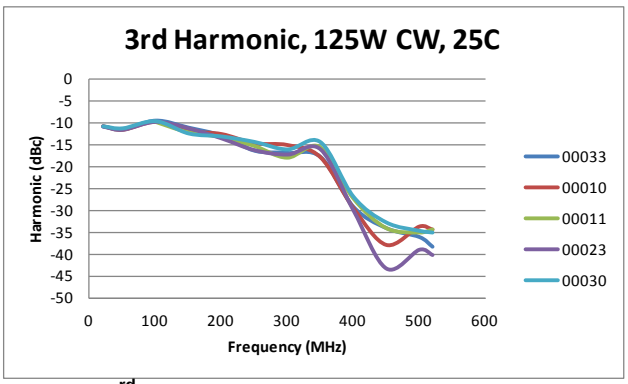

Figure 8: 3rd harmonic performance at 125W CW output power over frequency. Base plate temperature is 25 degrees C.

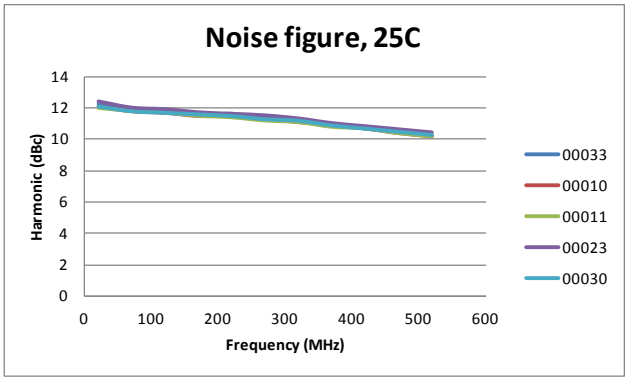

Figure 11: Noise figure performance at 25 degrees C.

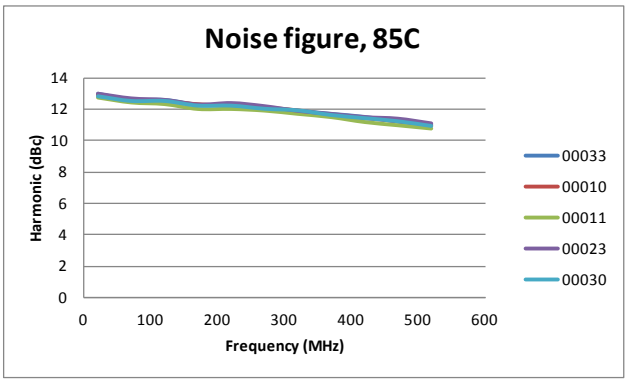

Figure 12: Noise figure performance at 25 degrees C.

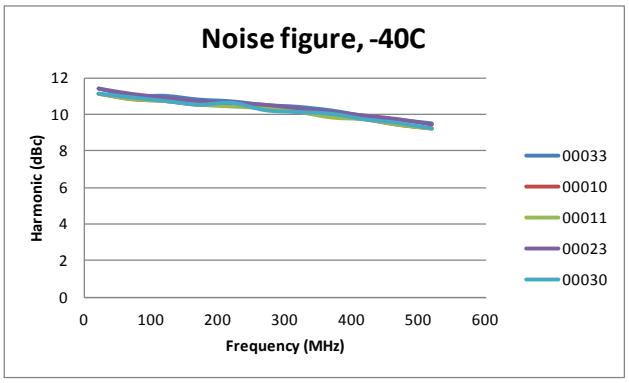

Figure 13: Noise figure performance at -40 degrees C.

Basic Operation

Initial setup and turn on

The 1163 module requires minimal setup for basic operation. After mounting to an appropriate heat sink, simply apply 28 V_{DC} nominal across the A1 and A2 pins of the 17W2 connector and leave all other pins disconnected; i.e. floating. Upon application of DC voltage the module will initialize and the amplifier bias will be enabled. Typical current consumption at 28 V_{DC} and no RF drive is approximately 150 mA for roughly 2 seconds during initialization. After initialization the current will be approximately 1.65 A. This represents the quiescent current of the module. After initialization, the amplifier is ready for basic operation and RF input power may be applied.

Hardware PA enable and disable

The hardware PA enable on pin 6 of the 17W2 connector is pulled up to 3.3V internally. Shorting the PA enable pin to ground will disable the bias.

Turn on with bias disabled

The PA may be turned on with bias disabled. The first and simplest method is to ground the PA enable pin before the supply voltage (28 VDC nominal) is applied. The PA may then be enabled by wither pulling the PA enable pin up to 3.3V or leaving the pin open.

The second method for turn on with bias disabled is to use the serial interface. Please see the Empower RF Systems RS485 Protocol for detailed information.

Alarms and alarm conditions

Several protection features are included in the module. These include over / under temperature, voltage and current.

If the internal temperature of the module is above 95 or below -45 degrees centigrade, the module will disable bias and raise the hardware alarm line on pin 7 of the 17W2 connector. Note that temperature is monitored at initial application of DC voltage. If the temperature is out of range, the unit will not enable.

If the supply voltage is above 32 or below 24 VDC, the module will disable bias and raise the hardware alarm line on pin 7 of the 17W2 connector. Similar to temperature, if the supply voltage is not in range, the unit will not enable. However, communications with the module are available at voltages as low as roughly 12 VDC.

If the current consumption is above 15A, the module will first attempt to lower the RF output power and reduce the current. The RF output power is reduced by increasing the attenuation near the input of the RF amplifier chain. If the current is still too high, the module will set maximum attenuation, disable the bias and disable internal power supplies.

Recovery from all alarms is similar. A DC power cycle or reset is required to clear the alarm.

Temperature compensation

Modules are shipped with automatic temperature compensation for quiescent current and gain.

Further information

For further information on this product, please consult Empower RF Systems.