2400MHz 2Watt MMIC PA EME128

SPECIFICATIONS:	Output Power	2 Watts (+33dBm) @ 1dB gain Compression
	Input Power	2.5mW (+4dBm) for 2Watt (+33dBm)Output **Maximum Input without damage 10mW +10dBm**
	Gain	29dB minimum depends on tuning
	Bandwidth	100MHz
	Power Supply	+12Volts 650mA **(Power supply input 5v min to 14v max)**

DESIGN: This Modern High Performance 2.4GHz Power Amplifier uses a low cost Transcom TC3141 PHEMT MMIC IC. The MMIC provides a gain of 29dB & a saturated output power of more than +33dBm. The MMIC requires minimal input & output matching to 50ohms, & makes other discrete PA designs using GaAs & HFETs etc, virtually obsolete for these power levels. The PA is suitable for use with the current 2400MHz Transverter, & ATV Transmitter Kits. The PA uses a high performance switching power supply to provide high efficiency over a wide input voltage range, & has very low heat dissipation. The MMIC requires a thin PC Board with large Vias, (plated holes) directly under the device for heat transfer. A Ceramic based PC board has been used with lots of plated Vias for grounding to keep RF losses to a minimum, guaranteeing the gain & output power of the amplifier. Much of the amplifier construction is mechanical work, requiring taping of holes in a heatsink to mount the Amplifier board, & RF connectors etc.

DESCRIPTION: The complete Power amplifier is built on a single 48 x 37mm size PC board. The TC3141 device internally is probably two PHEMT FETs in parallel, (Refer to the circuit diagram). The device requires +7volts on pins 6,7, &8. A negative bias supply is required on pin 4 to set the quiescent current to 800mA without RF drive. The RFC on pins 6 & 7 was designed to handle a current in excess of 1Amp, & with the combination of the 4p7 capacitor effectively blocks the 2400MHz RF from radiating into the power supply. The wire wound RFC was designed on a network analyzer & found to be much superior to a 1/4 wave stripline filter etched on the board. Printed striplines, & chip capacitors are used on the input & output of the MMIC for impedance matching & tuning for 2400MHz operation. For continuous operation, the amplifier requires good heat sinking. Methods used are 2 point mounting screws, & solder filled Via holes directly underneath the device.

POWERSUPPLY: The power supply uses a high performance 500Khz LT1507 switching regulator IC providing up to 90% efficiency. The switching regulators output is filtered through a 140uH Inductor & low ESR Tantalum capacitor to provide a constant 7v supply for the MMIC PA. A negative voltage is required to bias the MMICs gate, & is produced with an ICL7660 –ve voltage generator IC. The ICL7660 is powered by the 7v switching regulator which allows the 7660 to produce around –7v output. There is a 5kohm trimpot for bias adjustment of the MMIC. A protection circuit is built in to cut off the +7v to the MMIC if the –ve bias disappears. With a bias of 0v on the gate of the MMIC, it will try & sink as much current through its drain/source until it destroys itself. **Shorting of the gate connection to Gnd causes excessive drain current that can destroy the device instantly.** Under normal operation, the –7v output from the ICL7660 is dropped across a 5v6 zener diode, producing a slightly –ve voltage of around –1.5v on the emitter of the BC847 transistor compared with its base voltage turning it on. The collector voltage is pulled low, which in turn pulls the gate (pin4) of the NDS9400A MosFET low, turning on the MosFET. The 7v supply is then switched through the drain to source providing a 7v supply to the MMIC. If the –ve bias voltage disappears, then the BC847 is turned off & the collector voltage rises to 7v turning off the MosFET which cuts the 7v supply to the MMIC.

CONSTRUCTION:

1. The PCB supplied is a Fiberglass reinforced Ceramic board with one side being used as a groundplane. The board has extensive via holes around & underneath the MMIC device for heat transfer & RF grounding. **Current Kits are prebuilt & tuned amplifier modules, & only requiring mounting to a heatsink along with RF sockets & miscellaneous hardware. A suitable 38mm long heatsink is currently available for this Kit making construction much easier.**

2. The PCB has been designed to fit a 38mm long heatsink to allow SMA connectors to be bolted onto each end. Alternatively a milled box with an internal width of 38mm to suit the PA may be available from Mini-Kits. To use a different size heatsink, an optional 37mm long, 10mm thick Aluminium Plate is available, allowing the PA to bolt to various heatsinks of different sizes. The heatsink size should be at least 100D x 38W x 40Hmm . The mounting bolts must provide good contact with the top of the board each side of the MMIC to help with heat dissipation.

3. Next accurately align the amplifier board on the heatsink & mark the mounting hole locations with a scriber. Next centre

punch the centre of the scribed markings for drilling. Drill the holes in the heatsink with a 2.1mm drill bit. Tap the holes with a M2.5 metric Tap using CRC or similar lubricant. Clean the swarf from the surface of the heatsink & check that the board sits flat. Apply liberal heatsink compound under the PC board where the MMIC sits & mounts to the heatsink. Use the supplied M2.5 bolts to mount the board. **Be careful when tightening the bolts, as over tightening could cause stress to the board & chip components.**

4. If you are using the recommended heatsink available for this Kit then it is recommended that you use 4 hole flange mount SMA sockets for RF In & Out. M2 bolts are recommended for mounting the connectors to the heatsink. Solder the centre pin of an SMA connector to one end of the board & mark the hole locations with a scriber. Do the same with the other end of the board & remove the connectors from the board. Centre punch & drill the holes with a 1.6mm drill bit. Tap the holes with a M2 metric Tap using CRC or similar lubricant. Clean the swarf from the surface of the heatsink & mount the SMA connectors, soldering the centre pin afterwards.

5. RF amplifiers should always be in a shielded enclosure due the RF safety hazards. As an addition to section 4. above. The heatsink already forms the basis of 2 sides & bottom of a box. Simple end covers can be fabricated from Tinplate or Brass & bolted to the ends of the heatsink before the RF connectors are fitted. A simple lid can then be made from the same material & placed over the top of the heatsink & soldered to the end covers. Use some 5 minute Araldite or silicone to seal along the sides of the end & top covers to the heat sink.

CONNECTIONS:

1. You have to decide how you are going to connect +12volts to the Amplifier. You could either use a simple DC socket or maybe a bolt in type feedthrough capacitor on the heatsinks end cover or box. For extra power supply filtering another 140uH inductor can be fitted between the DC socket & the PC board. The filter is the same as used in the power supply, & is 34 to 38turns of 0.4mm ECW on a BN-61-202 Balun core. This is an option only & is not required for Amateur operation of the amplifier.

TESTING:

1. Connect a suitable 2400MHz antenna or 50ohm (>5W) dummy load to the output of the amplifier, & a suitable 50ohm load on the input.

2. Apply +12 volts to the amplifier & check that the current is close to 0.65A **(with No RF drive).** The current changes with power supply voltage, & increases with lower power supply voltages. The amplifiers switching supply will operate down to nearly +4volts but will draw over 1.2Amps.

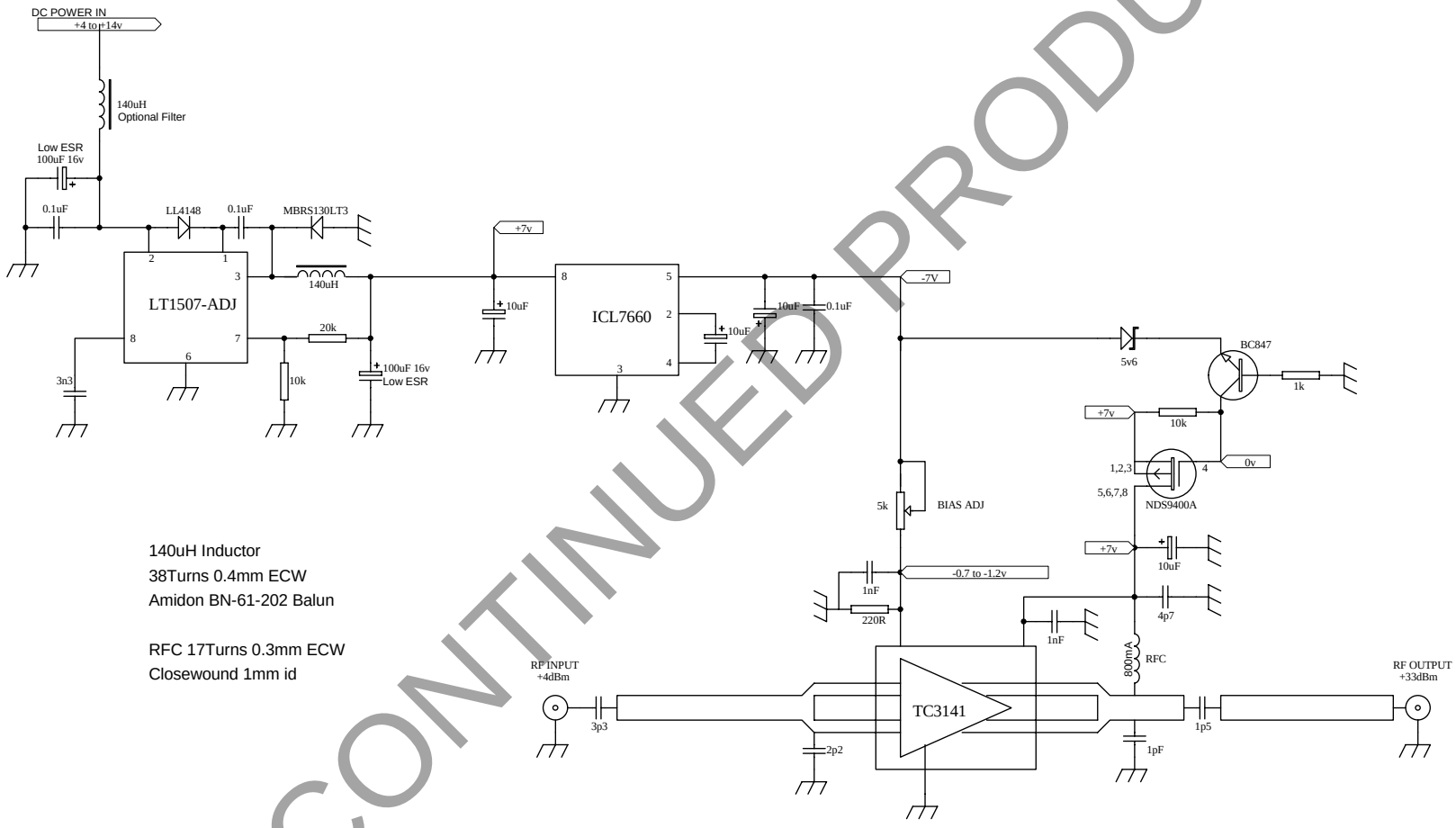
3. If you have got an RF power meter or Spectrum Analyzer ,connect RF to the input of the amplifier & check the RF output & gain of the amplifier. The TC3141 MMIC amplifier has so much gain, that you might have to add an RF attenuator on the input so that you do not over drive the amplifier. **Excess RF input can drive the amplifier into saturation producing up to +35dBm. Maximum input without damage to the MMIC is specified as 10mW +10dBm.**

ADDITIONAL NOTES IF YOU HAVE BUILT THE KIT:

1. Temporarily disconnect one side of the RFC (wire coil) from the MMIC supply pins. Connect a suitable 12 volt power supply with current limiting, or a 1.5Amp fuse inline to the power supply input to the amplifier. Apply power & check with a multimeter on the output side of the switching regulators filter choke for the 7volts switching regulator supply. Then check that the –ve supply from the ICL7660 is on pin 4 of the MMIC. Set this –ve voltage to around –2 volts on pin 4 with the 5kohm trimpot. Next measure that the 7 volt supply is appearing on the output of the MosFET switch pins 5,6,7,&8. The 7 volt supply should remain constant if the 12 volt power supply is varied between 4volts & 15volts. If all is OK then disconnect the power supply from the amplifier & resolder the RFC coil back & then disconnect the output side of the switching regulators filter choke from the board. Connect a current meter in series with the coil & where the coil is normally connected to the board. Reapply power to the amplifier board & set the quiescent current on the meter to around 800mA with the 5kohm trimpot.

2. Apply 1mW (0dBm) drive to the input of the amplifier & confirm that the output is around 400mW (+26dBm). Driving the amplifier with around 10mW (+10dBm) should take the output to around 2 Watts (+33dBm)

NOTE: Chip components crack easily so if you have problems getting the amplifier going properly, then it will have to be returned for repair.



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2400MHz 2WATT MMIC PA

RESISTORS

1 x 220R	SMD 1206 Resistor
1 x 1K	SMD 1206 Resistor
2 x 10K	SMD 1206 Resistor
1 x 20K	SMD 1206 Resistor
1 x TPU5K	SMD 5mm Trimpot

CAPACITORS

2 x 1pF	SMD 0603 Chip Capacitor
1 x 1p5	SMD 0603 Chip Capacitor
1 x 1p8	SMD 0603 Chip Capacitor
1 x 2p2	SMD 0603 Chip Capacitor
1 x 2p7	SMD 0603 Chip Capacitor
1 x 3p3	SMD 0603 Chip Capacitor
1 x 4p7	SMD 0603 Chip Capacitor
2 x 1nF	SMD 0603 Chip Capacitor
1 x 3n3	SMD 0603 Chip Capacitor
7 x 0.1uF	SMD 0603 Chip Capacitor
4 x 10uF	SMD 20v Capacitor
2 x 100uF	SMD 16v LOW ESR Capacitor

SEMICONDUCTORS

1 x TC3141	PHEMT MMIC Transcom
1 x LT1507CS8	Switching Regulator SMD
1 x NDS9400A	MosFET SMD
1 x ICL7660	-ve Generator Switching IC SMD
1 x BC847	PNP Transistor SMD
1 x MBRS130LT3	Diode SMD
1 x LL4148	Diode SMD
1 x C5v6	5.6v Zener Diode SMD

MISCELLANEOUS

1 x PC Board	EME128
1 x Instructions	EME128
1 x BN-61-202	Toriod
1 x 10cm length	0.315mm ECW
1 x 70cm length	0.4mm ECW
1 x 10cm length	wire wrap wire
6 x Bolt	M2.5 x 5mm

Bold Writing denotes standard Tuning Capacitor values. These may be different in value on some amplifiers modules supplied.

TOP PCB OVERLAY

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