EME110 2400MHz 2Watt HFET PA

SPECIFICATIONS:	Output Power	2 Watts (+33dBm) @ 1dB Compression
	Input Power	10mW (+10dBm) for 1Watt (+30dBm)Output
	Gain	20dB
	Bandwidth	100MHz
	Power Supply	11.5 - 15Volts 600mA

DESIGN: The object was to design a low cost poweramplifier that had reasonable gain & a output of greater than 1Watt. It had to be compatible with the current 2400MHz Transverter, & ATV Transmitter Kits. The gain required was a minimum of 20dB to allow a 10mW, (+10dBm) signal to produce 1Watt (+30dBm) output. Higher powered amplifiers were not considered as the cost would be too high, & the extra output only being a few dB higher. Many of the devices available were either designed for low powered, (500mW) ISM applications, or high powered >5Watt MMDS applications. The Stanford Microdevices HFETs, (Heterostructure FET) have been chosen as they were readily available & have very good gain & output power. Two stages were needed to produce the gain & the output power required. The predriver uses a SHF-0189 for its 13dB gain & +27dBm (500mW) 1dB compression output. The output uses a SHF-0589 for its 8dB gain & +34.7dBm (3W) 1dB compression output. The design of the power amplifier is based on data supplied by Stanford Microdevices, & CalTechs PUFF CAD software package has been used to design the initial prototype 2400MHz amplifier. A Ceramic based PC board has been used to keep losses to a minimum guaranteeing the gain & output power of the amplifier. Much of the amplifier construction is mechanical work, requiring taping of holes for bolts & mounting on an heatsink.

DESCRIPTION: The complete Poweramplifier is built on a single 74 x 38mm size PC board. 50ohm striplines, chip capacitors, & resistors form the impedance matching & tuning for 2400MHz operation. SMD resistors directly on the gates of the HFETs are for stability of the devices. For continuous operation, the amplifier requires good heatsinking of the HFET output devices. Methods used are 3 point mounting screws, & solder filled Via holes directly underneath the devices.

POWERSUPPLY: The main powersupply regulator uses a LM317T regulator that supplies a fixed +9 volts for the HFETs drain supply. A negative voltage is required to bias the HFETs gate, a is produced with an ICL7660 –ve voltage generator IC. The ICL7660 is supplied by a 78L06 6v regulator which allows the 7660 to produce slightly more than –5v output. There are two 5kohm trimpots for bias adjustment of each HFET. A protection circuit is built in to cut off the +9v to the HFETs if the –ve bias disappears. With a bias of 0v on the gates of the HFET, 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 devices instantly.** Under normal operation the –6v output from the ICL7660 is dropped across a 3v9 zener diode producing a slightly –ve voltage on the base of the BC847 transistor cutting it off. If the –ve voltage disappears, then the BC847 is turned on by the voltage supplied from the 10kohm resistor from the +ve supply. This effectively pulls the voltage on the Adj pin of the LM317T regulator to 0v shutting down the 9v supply.

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 the HFET devices for heat transfer & grounding. **Current boards are prebuilt & tuned, & only require mounting to a heasink.**

2. The PCB has been designed to fit a standard 74 – 75mm long heatsink to allow SMA connectors to be bolted on each end. To use a different size heatsink, an optional 74mm long, 10mm thick Aluminium Heatsink Plate is available, making it easier to bolt the PA to various heatsinks of different sizes. The heatsink size should be at least 130mm wide. The SHF-0589 is specified at 40 degrees maximum temperature for long life, so it will require good heatsinking. Just mounting the board onto a heatsink may not give good thermal transfer unless the black paint is scraped off. The mounting bolts must provide good contact with the top of the board to help with heat dissipation.

3. Next accurately mark & drill holes in the heatsink with a 2.5mm drill bit. Use the supplied 3mm Taptite screws for mounting the board. **Be careful when tightening the screws to mount the board to the heatsink. Overtightening could cause stress to the board & chip components.** Make sure that the board sits flat on the heatsink before mounting. Apply liberal heatsink compound under the PC board & mount to the heatsink. The LM317T regulator requires insulated heatsinking, & a washer & bush is supplied.

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CONNECTIONS:

1. The board is designed to use 4 hole flange mount SMA sockets for RF In & Out. 2mm holes need to be tapped in the heatsink or aluminium mounting plate to mount the connectors. Larger connectors like N type flange mounts are too cumbersome & may add too much stress to the PCB.

2. +12volts DC should be connected to the board via a 1nF feedthrough capacitor.

TESTING:

1. Connect a suitable 2400MHz antenna or 50ohm (>2W) dummy load to the output of the amplifier.

2. Connect a suitable powersupply & current meter to the +12v input to the amplifier. Apply power & check that the current is around 600mA.

3. Apply 10mW (+ 10dBm) drive to the input of the amplifier & confirm that the output is 1Watt (+30dBm). Driving the amplifier with around 40mW (+16dBm) should saturate the output to around 2.5 Watts (+34dBm)

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

PARTS LIST:
Bold Writing denotes standard Tuning Capacitor values. These may be different in value or not fitted on some amplifiers supplied.

RESISTORS

1 x 1R5	MELF 1206 1W Resistor
1 x 2R7	MELF 1206 Resistor
2 x 4R7	SMD 1206 Resistor
1 x 120R	SMD 1206 Resistor
2 x 180R	SMD 1206 Resistor
2 x 330R	SMD 1206 Resistor
1 x 750R	SMD 1206 Resistor
1 x 10K	SMD 1206 Resistor
2 x TPU5K	SMD 5mm Trimpot

CAPACITORS

1 x 1pF	SMD 0603 Chip Capacitor
3 x 1p2	SMD 0603 Chip Capacitor
1 x 2p2	SMD 0603 Chip Capacitor
2 x 22pF	SMD 0805 Chip Capacitor
5 x 1nF	SMD 0805 Chip Capacitor
5 x 10nF	SMD 0805 Chip Capacitor
2 x 0.1uF	SMD 1206 Chip Capcitor
3 x 10uF	SMD Electrolytic Capacitors
1 x 100uF	EXR Electrolytic Capacitor
1 x 1nF	Feedthrough Capacitor

INDUCTORS

1 x 1.8uH	0603 Chip Inductor

SEMICONDUCTORS

1 x SHF-0189	Stanford HFET
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1 x BC847	SMD NPN Transistor
1 x LM317T	Regulator Adj 1.5A
1 x 78L06	Regulator 6v 100mA
1 x ICL7660	-ve Generator IC
1 x C3v9	3.9v Zener Diode

MISCELLANEOUS

1 x PC Board	EME110
1 x Instructions	EME110
1 x TO220	Insulator Bush
1 x TO220	Insulator
8 x Bolt	M3 x 5mm Taptite
1 x Bolt	M3 x 10mm (Mounting of LM317T)

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