The G6ALU 23cm 18W Power Amplifier

Many amateurs have adopted the Comtech demonstration module as an easy entry into 23cms ATV transmission. Once modified [1] these modules give a good performance but with only 50mW of RF you will need a very local repeater to talk to anybody!

Presented here is a solution for generating at least 18W when driven by a Comtech module, often more than 30W can be generated but this is at some risk [2]. The amplifier is a LDMOS module from Mitsubishi type RA18H1213G, this is specified for an 18W output for frequencies between 1240 and 1300MHz making it very useful for ATV simplex and repeater input. By adjustment of the bias and controlling the input power the module will also amplify linearly at up to about 18W output so will also be useful for SSB.

Previous solutions from Mitsubishi were the M57762, M68719 and M67715, all these modules are now obsolete as the manufacturers have changed from bipolar to FET technologies.

Brief specifications

- 18W output for 50mW input
- Frequency range 1240 to 1300MHz
- Nominal supply of 13.8V @ 7.5A
- Output enable by + or – PTT input (no onboard RF relay)
- Reverse polarity protection
- Output power adjustable between 1 and 30W (18W maximum recommended [2])

Circuit description

This circuit is based on the data sheet[3] with the addition of a switched and adjustable bias supply. The regulated supply from IC2 is presented to the power module IC1 by preset R1; this allows the operating point (quiescent current) to be adjusted which in turn controls the available gain (and output power). The PTT function is provided by TR2 a MOSFET transistor, negative going PTT (0V to transmit) is applied to the gate via R5. TR1 inverts the positive PTT (5 – 12V to transmit) input switching TR2 via R6. D1 provides some protection in case of reverse polarity power connection, this will only work if the circuit is correctly fused; the use of a 10A inline fuse fitted to the + power lead is advised.

Heat sink

If purchasing new, the compromise will be between cost and dissipation, referring to the example given in the data sheet a dissipation of 0.42°C per watt will be required. The easiest way to achieve this dissipation is to use a heat sink fitted with a fan, CPU coolers with large flat bases may be suitable although the manufacturers don't generally quote the dissipation figures. For long term reliability I would advise to keep the module flange not too hot to touch. The heat sink used in the photos was an Akasa AK-860 available from Maplin and other PC component outlets.

Construction

Before PCB assembly commences it is sensible to use the board to mark hole positions for drilling the heat sink, if possible fit the power module centrally on the heat sink to for maximum cooling. Seven holes are

provided in the PCB for mounting, this is to achieve low impedance to ground across the PCB. To save tapping threads 3mm Taptite screws can be used, these and a suitable 2.65mm drill are supplied with kits.

Fit all components before fixing the PCB to the heat sink, a high wattage (25 – 60W) iron with a small (3mm) bit will be required due to many connections being made directly to the ground plane. The tab of D1 is soldered to the pad provided, again a large iron will be required, after fitting turn the pre-set (R1) fully anti clockwise for minimum bias volts.

Using 6mm x M3 screws with shake-proof and flat washers under their heads, assemble the PCB to heat sink, link –PTT to ground and connect a 13.8V (nominal) power supply. At this stage it is probably best to use a low current supply as only a few milli-amps are required. Monitor the RF module bias pad (2nd from left-hand side) whilst adjusting the preset resistor, the voltage measured should swing form 0 to 5V; leave the preset at 0V. Disconnect power, discharge the capacitors by shorting out. Fit the RF module; use 8mm x M3 screws with a shake-proof and flat washer under both heads. Ensure that the RF module is pushed as close to the PCB as possible using just a smear of heat sink compound on the end tabs. Elsewhere it has been suggested that an improvement in gain can be realised by filing the back of module flat, I have experimented and only found a small increase so it's probably best left as the manufacturer intended! This void may be filled with heat sink compound to increase the thermal efficiency, in time though this may leak out making a "mess".

Fit suitable coaxial terminations to the PCB, the photos show a coax tail on input and "N" connector on the output. Note that the "N" connector has been partly cut away so the termination can be made directly to PCB and also that minimum lead length are used on the coax tails. The minimum quality (diameter) coax that should be used on the output is RG58, but even with this the loss incurred is demonstrated by it getting warm. On the input side a lower quality, say RG174 could be used but beware of the loss; when driven by a Comtech module a little loss on the input can be tolerated. 13.8V and ground connections need suitably heavy wire with a fuse of 10A rating should be fitted in the positive lead. If a G6ALU controller is used the amplifier –PTT should be connected to the "Transmit OK" output, otherwise connect –PTT to ground.

Testing

Connect a 50mW source to the input and dummy load or suitable antenna with power meter to the output; supply the module with 13.8V via a current meter capable of reading 10 Amps. Initially current drawn should be very low, turn R1 clockwise until the power meter reads 18W; if a power meter isn't available set R1 for about 7.5 amps. The power can be increased up to a maximum of 30W but at this level failure of the device will be inevitable if the VSWR was to rise due to a cable disconnection etc.

Modifications

It is possible to have a remote mounting power control, use a 1K panel mounted potentiometer wired to the existing R1 pads on the PCB with screened cable. As the control will only function over a small range it might be best to "pad" its lower end with a preset.

If the module is to be placed where its temperature can't be monitored (in the loft or at the mast head for instance) then a thermal switch could be fitted to the heat-sink – perhaps under a module mounting screw – and wired in series with the bias supply.

Component availability

Kits of parts including PCB mounted components and RF module will be available from me and built units complete with heat sink from 13cm.co.uk[4]. For those wishing to manufacture there own PCB the design is available on my web-site as an Acrobat file, note that the supplied PCBs are manufactured using through

vias, these are important for track connectivity and to decrease the ground impedance especially at de-coupling points.

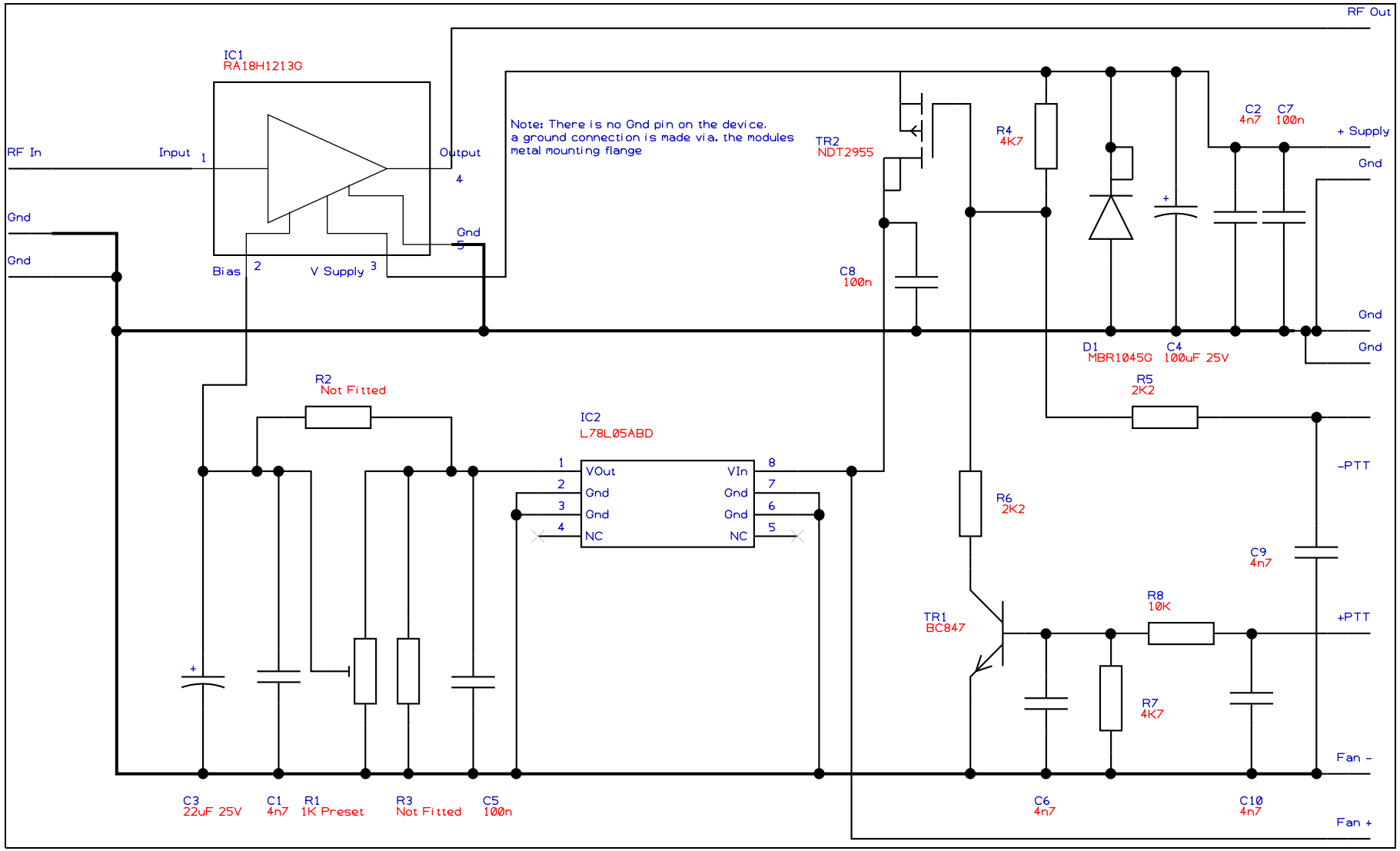
References

1 Modifications to Comtech modules - see http://www.sbszoo.com/ve6atv/6a-mods.htm
2 Data sheet specifies 18W output with maximum of 30W.
3 The data sheet can be obtained by visiting my web-site at http://radio-kits.co.uk and follow links, email address steve@radio-kits.co.uk
4 Assembled units and Comtech modules are available from www.13cm.co.uk

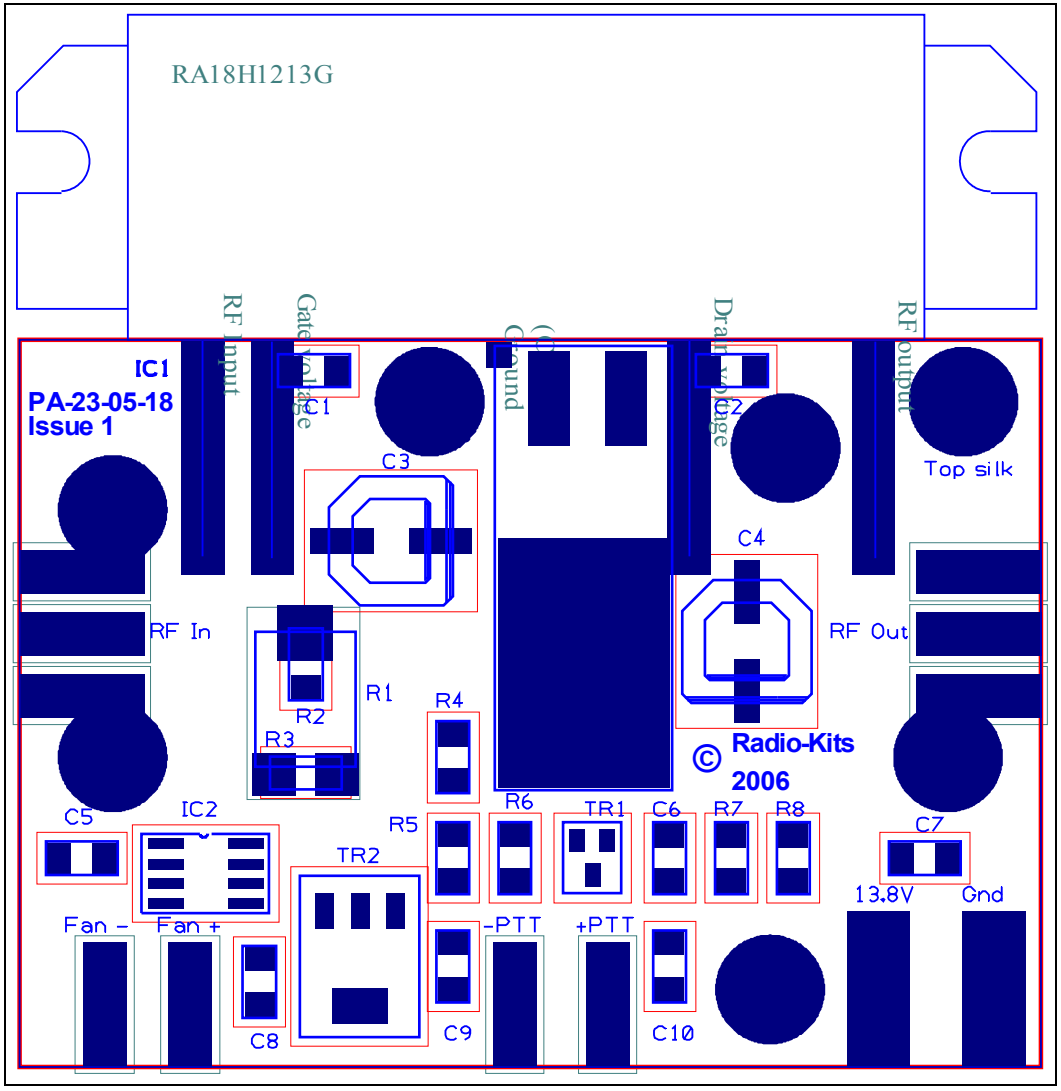
Component list

Component ID	Value
C3	22uF 25V
C4	100uF 25V
C5	100n
C7	100n
C8	100n
C1	4n7
C2	4n7
C6	4n7
C9	4n7
C10	4n7
D1	MBR1045G
IC1	RA18H1213G
IC2	L78L05ABD
R1	1K Preset
R4	4K7
R8	10K
R2	Removed from design
R3	Removed from design
R5	2K2
R6	2K2
R7	4K7
TR1	BC847
TR2	NDT2955
	PCB

Circuit diagram



PCB Overlay


RA18H1213G
RF Input
Gate voltage
Ground
Drain voltage
RF output
IC1
PA-23-05-18
Issue 1
C1
C2
C3
C4
Top silk
RF In
RF Out
R1
R2
R3
R4
R5
R6
TR1
C6
R7
R8
C7
© Radio-Kits
2006
C5
IC2
TR2
13.8V
Gnd
Fan -
Fan +
-PTT
+PTT
C8
C9
C10