2 T856/857 Circuit Operation

This section provides a basic description of the circuit operation of the T856 transmitter and T857 exciter.

Refer to Section 6 where the parts lists, grid reference index and diagrams will provide detailed information on identifying and locating components and test points on the main PCB. The parts lists and diagrams for the memory and VCO PCBs are in Part E.

The following topics are covered in this section.

Section	Title	Page
2.1	**Introduction**	**2.3**
2.2	**Synthesiser**	**2.5**
2.3	**VCO**	**2.6**
2.3.1	Two-Point Modulation	2.6
2.3.2	VCO Supply	2.6
2.3.2.1	Early Issue T856/857 PCBs	2.6
2.3.2.2	T856 PCB Issue 220-01171-03 & Later	2.7
2.3.2.3	T857 PCB Issue 220-01140-04 & Later	2.7
2.4	**Audio Processor**	**2.8**
2.4.1	General	2.8
2.4.2	Audio Inputs	2.8
2.4.3	Keying Inputs	2.9
2.4.4	Compressor	2.9
2.4.5	Outputs To Modulators	2.9
2.5	**Power Supply & Regulator Circuits**	**2.10**
2.6	**T856 Drive Amplifier & PA**	**2.11**
2.6.1	Early Issue PCBs	2.11
2.6.2	Issue -03 & Later PCBs	2.11
2.7	**T857 Exciter Drive Amplifier**	**2.11**

Figure	Title	Page
2.1	T856 High Level Block Diagram (Early Issue PCBs)	2.3
2.2	T856 High Level Block Diagram (Issue -03 & Later PCBs)	2.3
2.3	T827 High Level Block Diagram	2.4
2.4	T826/827 Synthesiser Block Diagram	2.4
2.5	T826/827 Audio Processor Block Diagram	2.8
2.6	T826/827 Power Supply & Regulator Block Diagram	2.10

2.1 Introduction

The individual circuit blocks which make up the T856 and T857 are:

- synthesiser
- VCO
- audio processor
- drive amplifier
- power amplifier (T856 only)
- low pass filter (T826 only)
- voltage regulators.

Each of these circuit blocks is set in its own shielded compartment, formed as an integral part of the main chassis.

The configuration of the circuit blocks may be seen on a functional level in Figure 2.1, Figure 2.2, and Figure 2.3. Refer to the circuit diagrams for more detail.

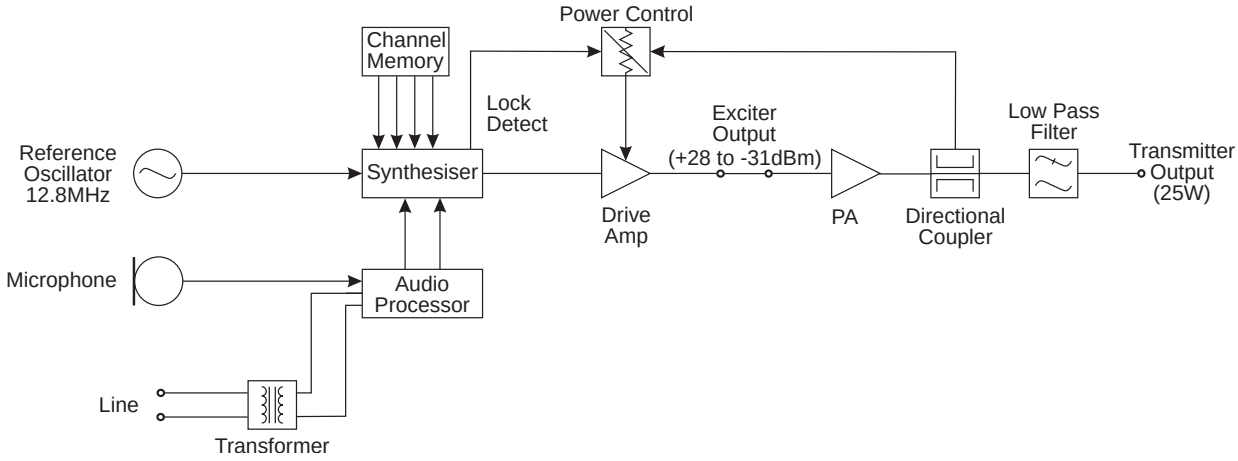

Figure 2.1 T856 High Level Block Diagram (Early Issue PCBs)

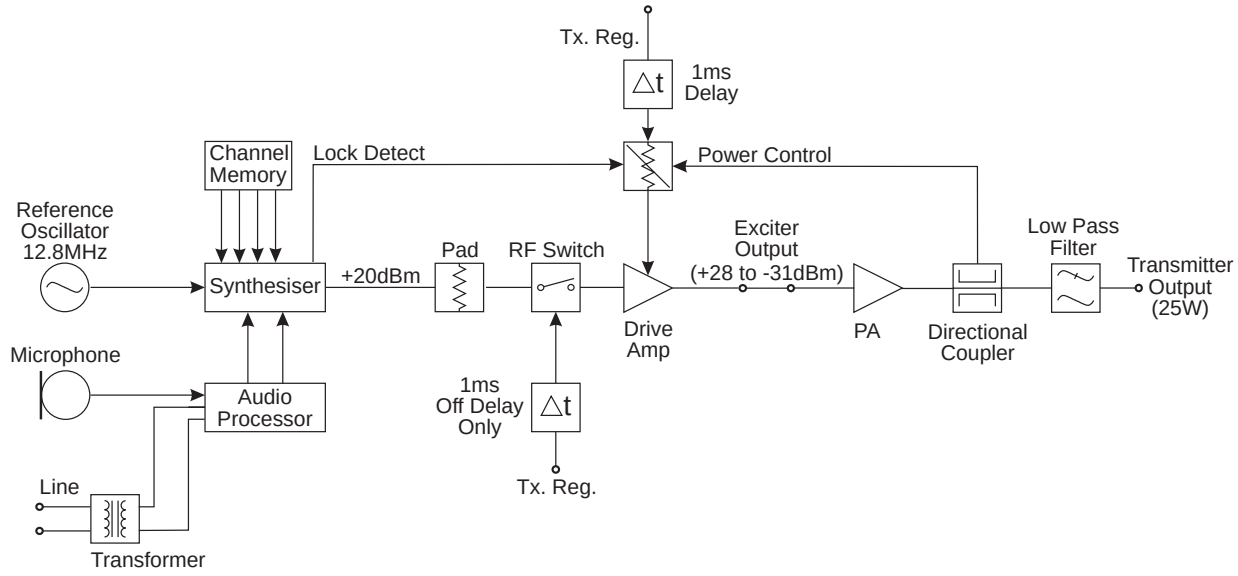

Figure 2.2 T856 High Level Block Diagram (Issue -03 & Later PCBs)

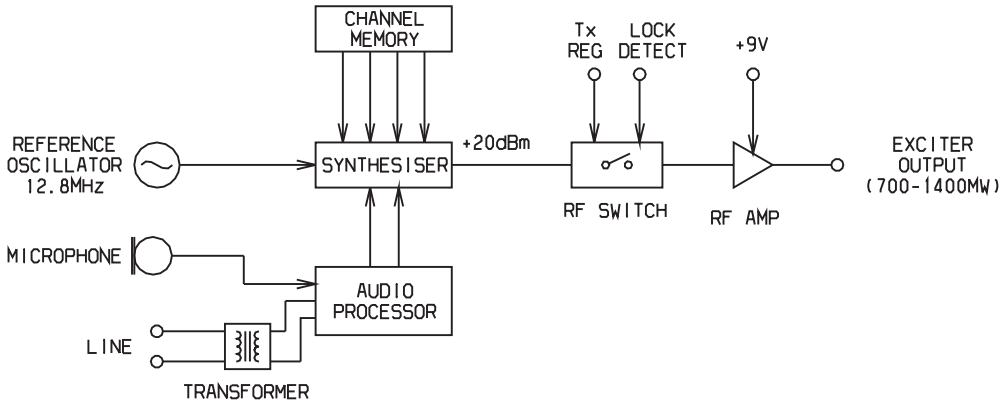

Figure 2.3 T857 High Level Block Diagram

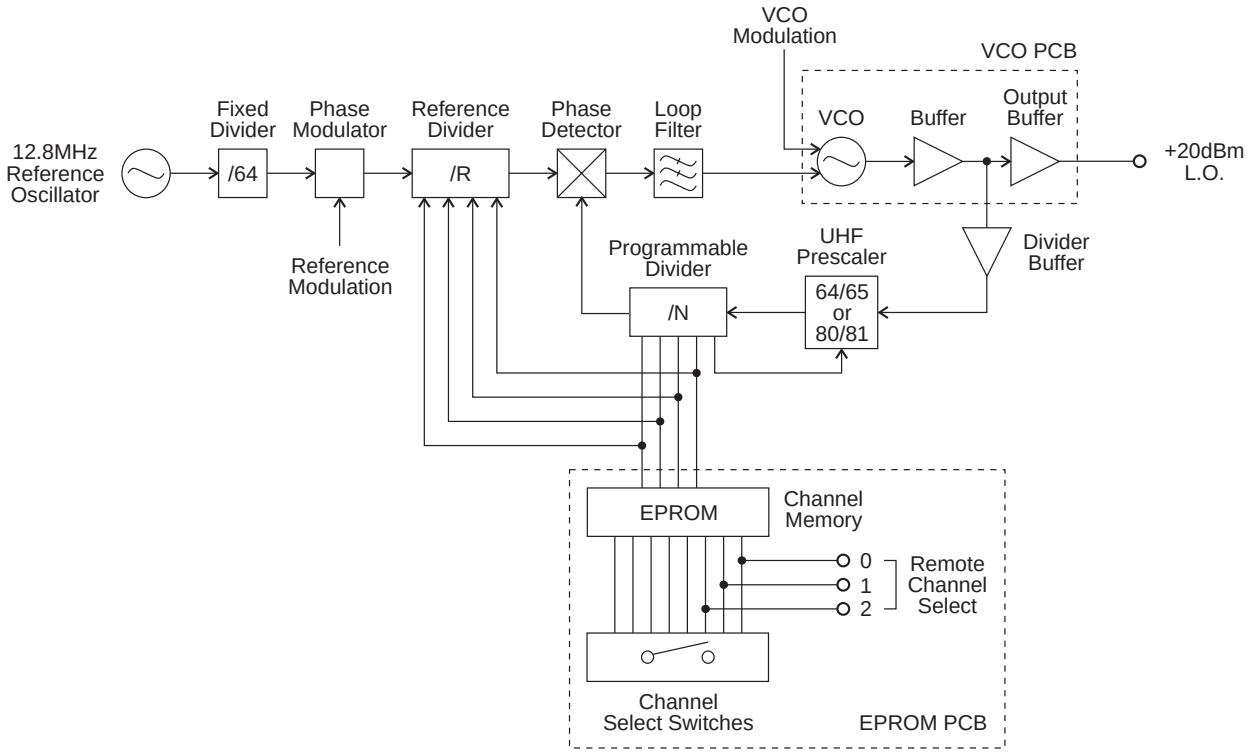

Figure 2.4 T856/857 Synthesiser Block Diagram

2.2 Synthesiser

(Refer to the T856 or T857 synthesiser circuit diagrams in Section 6 and Figure 2.4.)

The synthesiser employs a phase-locked loop (PLL) to lock a voltage controlled oscillator (VCO) to a given reference frequency. A reference oscillator at 12.8MHz (=IC1) is buffered (IC7a, b & c) and divided down to 200kHz (IC4). This 200kHz square wave is then summed with the modulating audio and passed to an integrator (IC7f). This produces a ramping waveform which is centred around a DC level determined by the incoming audio. IC7e performs as a comparator, ultimately producing a phase-modulated 200kHz square wave which is divided down to 12.5 or 6.25kHz within the synthesiser IC (IC5).

A buffered output of the VCO is divided with a programmable divider, comprising a UHF prescaler (&IC3) and a divider within IC5. This signal is compared with the phase modulated reference signal at the phase detectors in IC5. A digital phase detector PDB (IC5 pin 2) provides rapid coarse tuning of the VCO until the phase error is within the range of the high gain sample and hold detector PDA (IC5 pin 1). The phase detector outputs are passed through an active loop filter (IC6a) which produces a DC voltage between 0V and 20V to tune the VCO. This VCO control line is further filtered to attenuate noise and other spurious signals. Note that the VCO frequency increases with increasing control voltage.

If the synthesiser loop loses lock, a pulsed signal appears at LD (pin 3) of IC5. This signal is filtered and buffered by IC6b, producing the lock detect signal used to gate either the RF output of the T857 exciter or the VCO output to the T856 drive amplifier.

The division ratio of the programmable divider is stored within EPROM memory. Up to 128 frequencies can be stored within the EPROM and are addressed using the internal DIP switches. Three of the address lines are also available for external frequency control via an extra D-range connector at the rear of the chassis. A change of state of any of these three lines commences a programming cycle, during which time the frequency data in the EPROM is down loaded to the divider (IC5). 32 bits of data are loaded in eight 4-bit words.

Note: The three address lines must change their state decisively and simultaneously. External frequency control should therefore be achieved by use of the T800-07 multichannel memory PCB. Methods which allow the states of the three lines during transition to be undefined for indeterminate lengths of time, as with some mechanical BCD switches, are unsuitable.

2.3 VCO

(Refer to the VCO circuit diagram in Part E.)

The VCO transistor (Q1) operates in common emitter mode and uses a low loss transmission line resonator (TL1). The transmission line is used in a two port configuration with varicaps positioned at one of its ends. The VCO control voltage from the loop filter (IC6a) is applied to the varicaps (D1 & D2) to facilitate tuning. The output from the oscillator circuit drives a cascode amplifier stage (Q2, Q3) which supplies +10dBm (typically) to a further stage of amplification, Q5. This is the final amplifier on the VCO PCB, and delivers +20dBm (typically) to the exciter drive amplifier.

A low level "sniff" is taken from the input to Q5 and used to drive the divider buffer for the UHF prescaler. The prescaler divides by 64/65 for 12.5kHz channel increments, or 80/81 for 6.25kHz channel increments.

The VCO operates at the actual output frequency of the exciter, i.e. there are no multiplier stages. It is modulated by superimposing the audio signal onto the control voltage. A compensation stage (Q8) is fitted in the synthesiser to smooth out variations in VCO sensitivity to modulation across the switching band.

2.3.1 Two-Point Modulation

Both the VCO and reference oscillator are modulated so that the phase detectors of IC5 see no frequency error under modulation. Thus, the synthesiser loop will not attempt to correct for modulation and the response of the transmitter remains unaffected.

2.3.2 VCO Supply

2.3.2.1 Early Issue T856/857 PCBs

The VCO is supplied with two switched supplies from the +9V rail under the control of the Tx reg. supply:

- VCO
- output buffer amplifier

The VCO supply is switched by Q6 via the C multiplier Q5, C34. The buffer supply is switched by Q10.

2.3.2.2 T856 PCB Issue 220-01171-03 & Later

The VCO is supplied with two switched supplies from the +9V rail under the control of the Tx reg. supply:

- VCO
- output buffer amplifier

The VCO supply is switched by Q6 via the C multiplier Q5, C34. The buffer supply is switched by Q10.

C41, R53 provide a 1ms delay when Tx reg. is keyed off. The VCO is kept on for this time to allow the power control to turn off the drive amplifiers (Q300, Q301) in the exciter in a controlled manner.

LINK A is provided to enable the VCO to run continuously to achieve the short transmit key time option. Refer to Section 2.7 in Part G.

2.3.2.3 T857 PCB Issue 220-01140-04 & Later

The VCO is supplied with two switched supplies from the +9V rail under the control of the Tx reg. supply:

- VCO
- output buffer amplifier

The VCO supply is switched by Q6 via the C multiplier Q5, C34. The buffer supply is switched by Q10.

LINKS A & B and R78 are provided to enable the VCO to run continuously to achieve the short transmit key time option. Refer to Section 2.7 in Part G.

2.4 Audio Processor

(Refer to the T856 or T857 audio processor circuit diagrams in Section 6.

Note: IC102, IC103 and RV106 are designated "&IC102", "&IC103" and "&RV106" in the T856.)

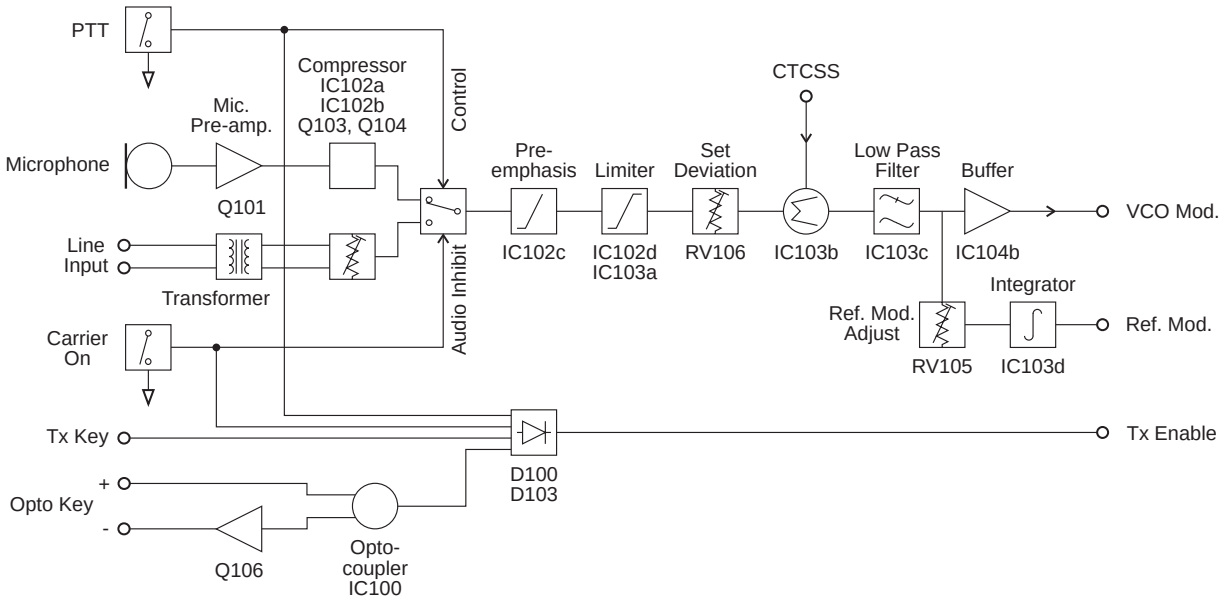

Figure 2.5 T856/857 Audio Processor Block Diagram

2.4.1 General

The audio processor comprises several link selectable circuit blocks which may be configured in a variety of combinations to suit individual requirements. The pre-emphasis network and compressor may be linked individually or cascaded between either or both audio inputs and the limiter.

Refer to Section 3.3.1 for linking details.

2.4.2 Audio Inputs

Two audio inputs are available: one from a 600 ohm balanced (or unbalanced) line, and the other from a local microphone. The microphone signal is passed first to a Preamplifier (Q101) and ultimately to a multiplexer (IC101), but in between may pass through the compressor (depending on the linking details). The line transformer is also connected to the multiplexer and is disabled by the microphone PTT switch.

A third input for CTCSS tones is also provided.

2.4.3 Keying Inputs

There are four ways to key the exciter:

- pulling the Tx-key line low (pin 13 on the D-range connector at the rear of the set);
- pushing the "Carrier" button on the front panel - this will inhibit all audio;
- using the PTT button on the local microphone, disabling audio from the line;
- via the opto-key inputs (pins 11 and 12 on the D-range connector) where electrical isolation is required. This features a constant current source (Q106) to ensure reliable activation of the opto-coupler (IC100) at low keying voltages.

2.4.4 Compressor

The input signal is fed via a current controlled attenuator (Q103, Q104) to a high gain stage (IC102a) from which the output signal is taken. This signal is passed to a comparator (IC102b) which toggles whenever the audio signal exceeds a DC threshold determined by RV104. Thus, the comparator produces a square wave whose mark-space ratio is determined by the amplitude of the audio signal. This square wave pumps up the reservoir capacitor (C129) which controls the attenuator (Q103, Q104), thus completing the feedback loop.

The compression level is set by adjustment of the comparator threshold (RV104).

Note: Although the high dynamic range of the compressor allows the use of very low audio signal levels, such conditions will be accompanied by a degradation of the signal to noise ratio. Very low audio input levels should therefore be avoided where possible.

2.4.5 Outputs To Modulators

The output signal from the limiter (IC102d, IC103a) is added to any incoming CTCSS tone at a summing amplifier (IC103b). The signal is then low pass filtered (IC103c) and split to supply the two modulators.

Since the VCO modulator is a true frequency modulator, its audio is simply buffered (IC104b). The reference modulator, however, is a phase modulator and its audio must first be integrated (IC103d).

It is vital that the audio levels to the modulators are accurately set, ***relative to each other***. Hence the inclusion of level adjustment in the reference modulator path (RV105). Once set, adjustments to absolute deviation may be made only via the deviation pot (RV106).

Note: If the two point modulation is incorrectly set it is possible for the synthesiser to believe it is in an out of lock condition when audio is applied.

2.5 Power Supply & Regulator Circuits

(Refer to the T856 regulators or T857 regulators & exciter circuit diagrams in Section 6.)

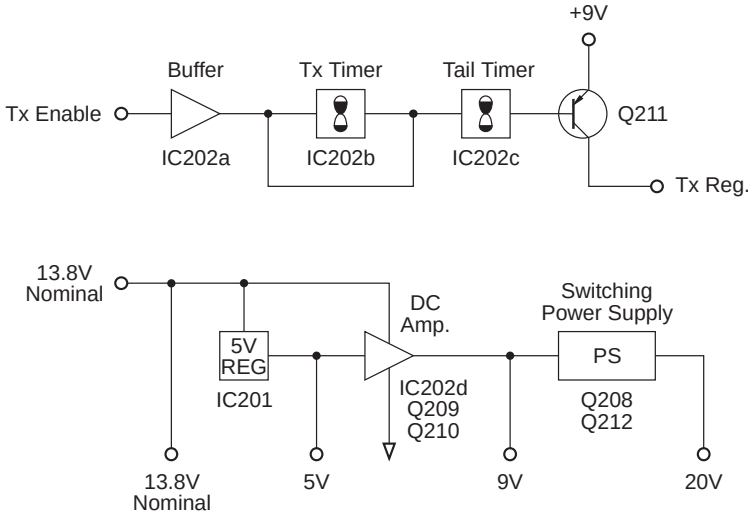

Figure 2.6 T826/827 Power Supply & Regulator Block Diagram

The T856 and T857 are designed to operate from a 10.8-16V DC supply, although the standard test voltage is 13.8V. A 5.3V regulator (IC201) running directly from the 13.8V rail drives much of the synthesiser circuitry. It is also used as the reference for a DC amplifier (IC202d, Q209, Q210) which provides a medium current capability 9V supply.

A self-oscillating, switching power supply (Q208, Q212) runs from the 9V supply, producing a low current capability +20V supply. This is used to supply the synthesiser loop filter (IC6), giving a VCO control voltage range of up to 20V.

Ultimate control of the transmitter is via the Tx reg. supply, switched from 9V by Q211. This is enabled by the Tx enable signal from the audio processor, but is subject to gating by the transmit timer (IC202b). If the transmitter is keyed continuously for a time exceeding that set by RV201 and C222, the Tx timer will force the Tx reg. supply off until the transmitter is keyed again. If required, the Tx timer may be disabled by transferring the link on PL201 from pins 1-2 to pins 2-3.

The tail timer provides a repeater tail of up to several seconds and is adjusted by RV202.

2.6 T856 Drive Amplifier & PA

2.6.1 Early Issue PCBs

(Refer to the relevant T856 PA circuit diagram in Section 6 and Figure 2.1.)

A two-stage, wide band amplifier (Q300, Q301) provides an output level of approximately 1W (+30dBm) for an input of 100mW (+20dBm) from the VCO. The amplifier is powered from the +13.8V rail via a series pass transistor (Q352).

The PA consists of Q401 & Q402 and a directional coupler for power control feedback, followed by a low pass harmonic filter. The RF output is taken from a rear mounted "N" type connector.

2.6.2 Issue -03 & Later PCBs

(Refer to the relevant T856 PA circuit diagram in Section 6 and Figure 2.2.)

The output from the VCO at +20dBm is applied through a pad and PIN diode switch to a two-stage, wide band amplifier (Q300, Q301) which provides an output level of approximately +30dBm.

The amplifier is powered from the +13.8V rail via the power control circuitry. To reduce spurious transmissions when keyed on and off, the power control line is turned on and off in a controlled manner by the "Millar" action of Q350 and C354..

The RF switch is controlled by Tx reg. through an off-delay circuit (C310, R310) of approximately 1ms. The switch provides the isolation between the VCO and output to the PA when the VCO is run continuously for the short key time option. The off-delay allows the controlled turn-off action to function.

The PA consists of an input pad, Q401/Q402, a directional coupler for power control feedback and a low pass harmonic filter. The RF output is taken from a rear mounted "N" type connector.

2.7 T857 Exciter Drive Amplifier

(Refer to the T857 regulators & exciter circuit diagram in Section 6 and Figure 2.3.)

A two-stage, wide band amplifier (Q300, Q301) provides an output level of approximately 1W (+30dBm) for an input of 100mW (+20dBm) from the VCO. The amplifier powered from the 9V rail.

To reduce the spurious output level when the synthesiser is not locked, an RF switch (also gated by lock detect) is included at the input to the amplifier.

