2 T826/827 Circuit Operation

This section provides a basic description of the circuit operation of the T826 transmitter and T827 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.

2.1 Introduction

The individual circuit blocks which make up the T826 and T827 are:

- synthesiser
- VCO
- audio processor
- drive amplifier
- power amplifier (T826 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 and Figure 2.2, while Figure 2.3 and Figure 2.4 show their location on the PCBs.

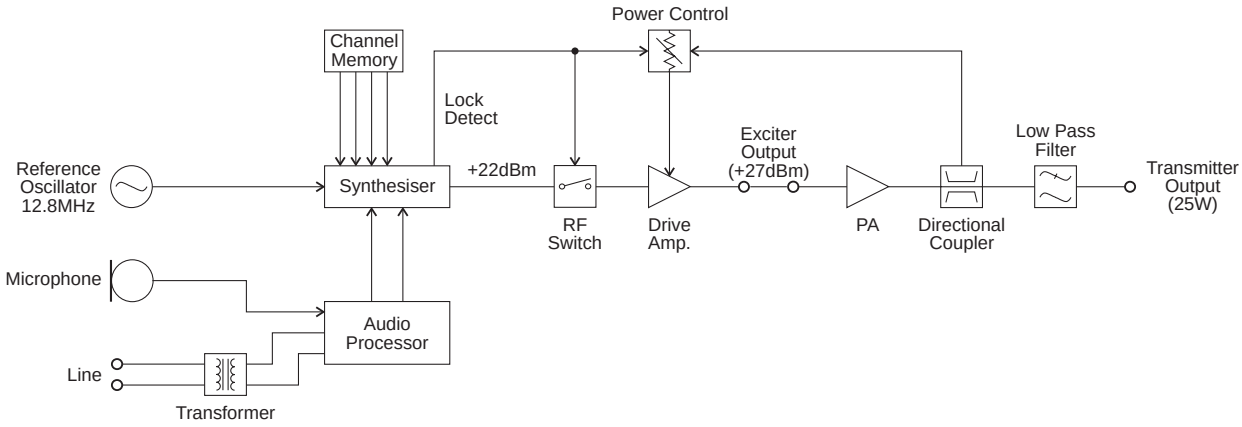


Figure 2.1 T826 High Level Block Diagram

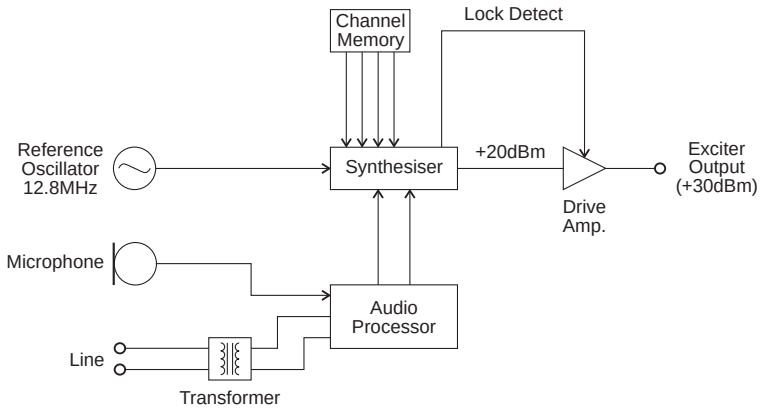
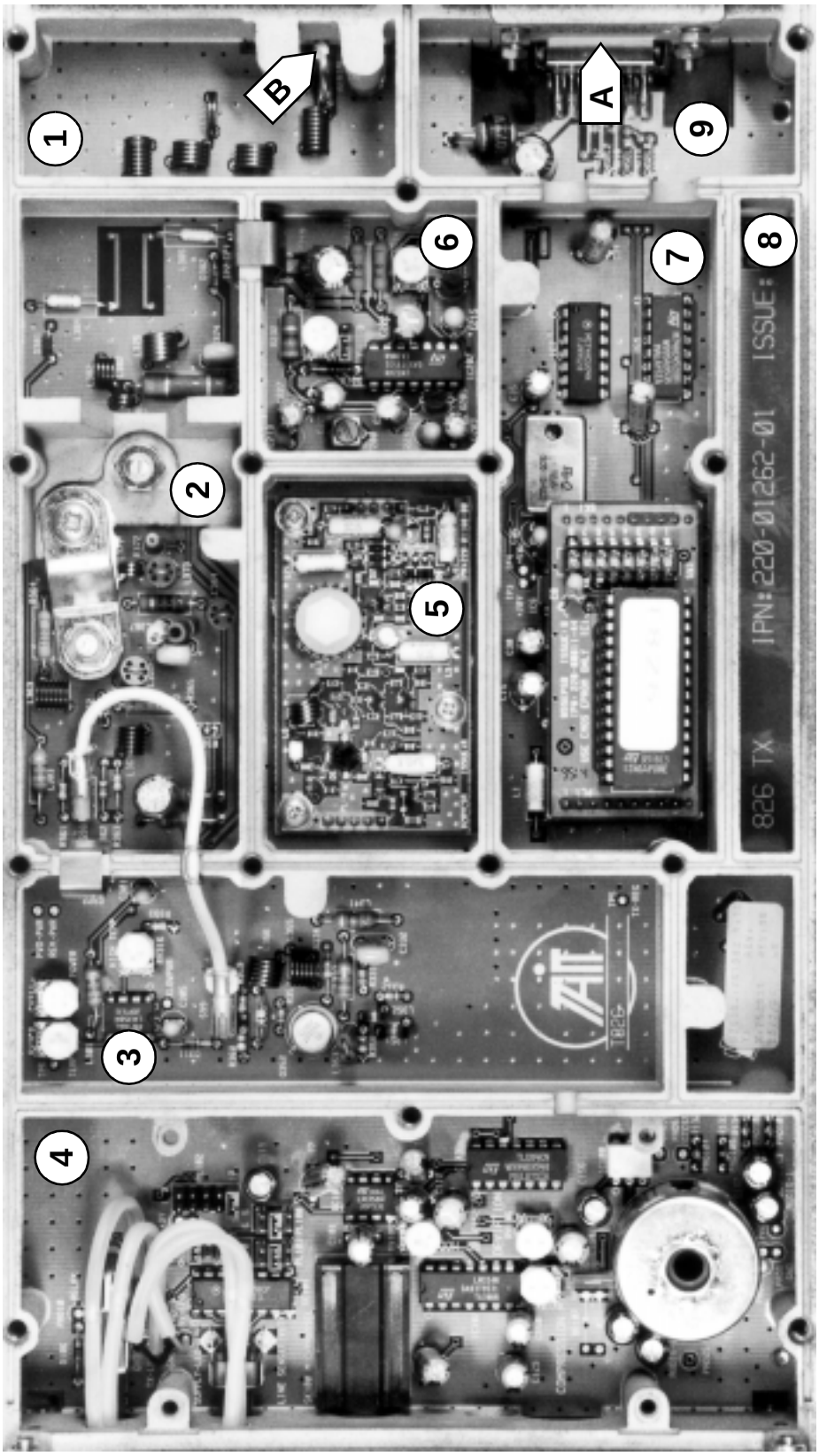


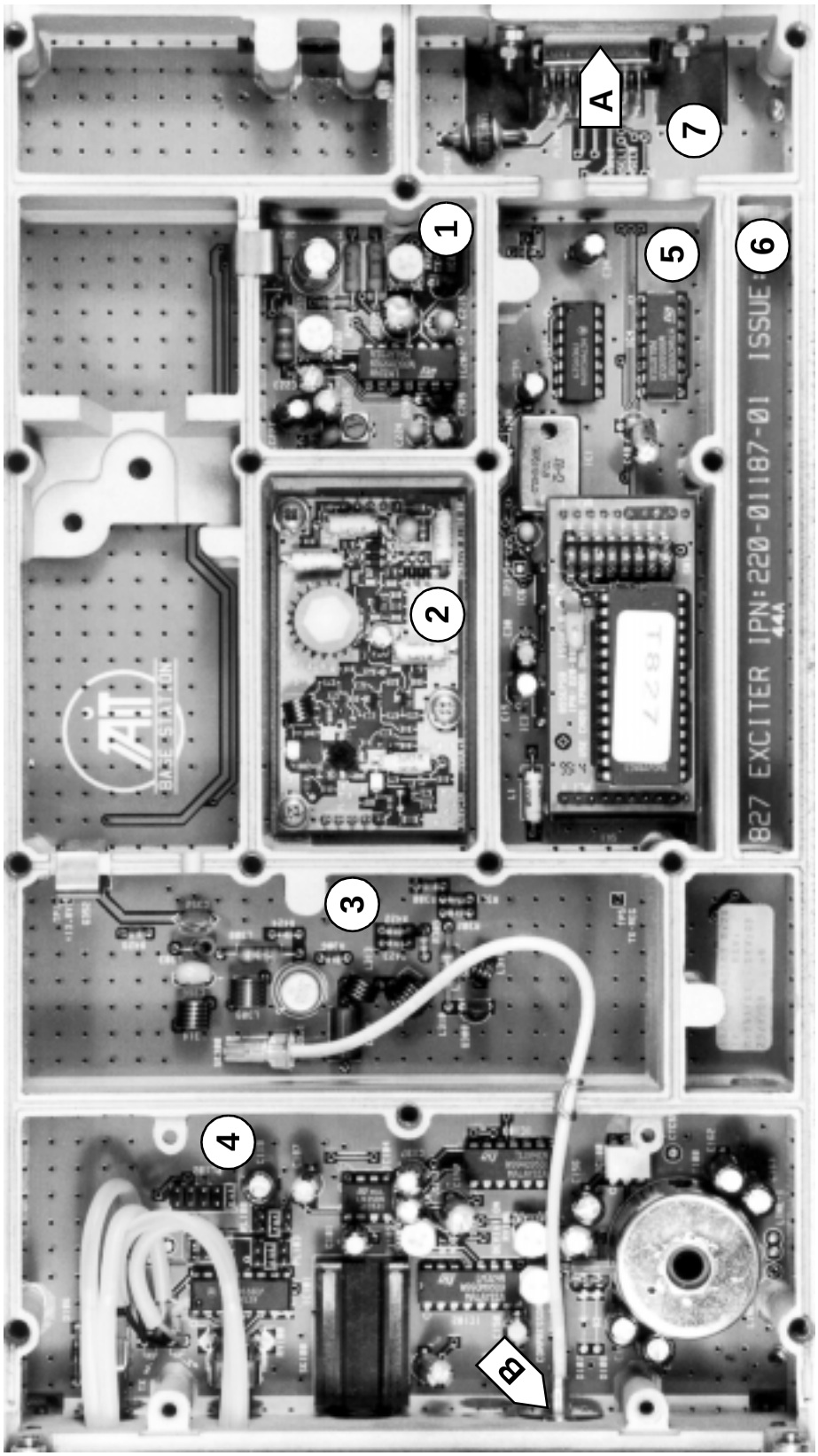
Figure 2.2 T827 High Level Block Diagram



Key:

1 low pass filter
2 PA
3 exciter drive amplifier
4 audio processor
5 VCO
6 regulators
7 synthesiser
8 duct for cabling to extra D-range (if fitted)
9 D-range
A D-range connector (incl. audio in & DC in - refer to Section F1.2)
B RF out

Figure 2.3 T826 Main Circuit Block Identification



Key:

1 regulators
2 VCO
3 exciter drive amplifier
4 audio processor
5 synthesiser
6 duct for cabling to extra D-range (if fitted)
7 D-range
A D-range connector (incl. audio in & DC in - refer to Section F1.2)
B RF out

Figure 2.4 T827 Main Circuit Block Identification

2.2 Synthesiser

(Refer to the T826 or T827 synthesiser circuit diagrams in Section 6 and Figure 2.5.)

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 in the T826; IC1 in the T827) is buffered (IC7c & b) and divided down to 200kHz (IC4). This 200kHz square wave is then summed with the modulating audio and passed to an integrator (IC7f, Q8, Q9). 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. This is followed by a similar phase shifting stage (IC7d & a, Q10, Q11), before being divided down to 6.25kHz or 5kHz within the synthesiser IC (IC5).

A buffered output of the VCO is divided with a programmable divider, comprising a VHF 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) provides rapid coarse tuning of the VCO until the phase error is within the range of the high gain sample and hold detector (PDA). 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 IC6, producing the lock detect signal used to shut off the power supply (and the VCO output in the T826) to the 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.

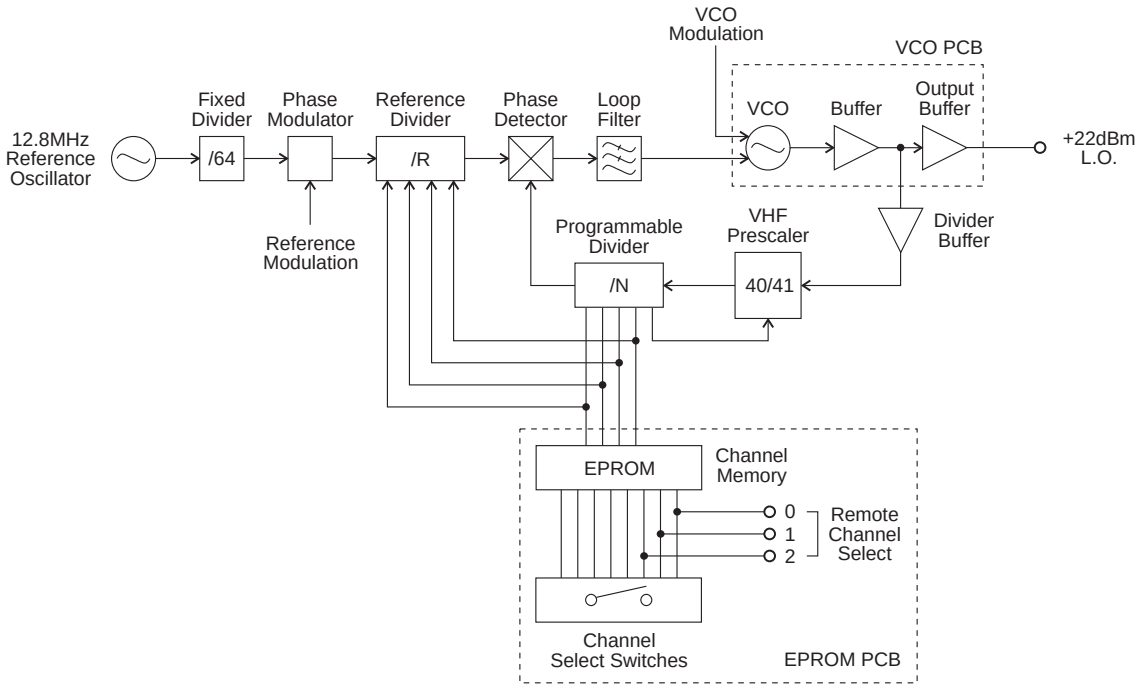


Figure 2.5 T826/827 Synthesiser Block Diagram

2.3 VCO

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

The VCO transistor (Q1) operates in a common source configuration, with an LC tank circuit coupled between its gate and drain to provide the feedback necessary for oscillation. The VCO control voltage from the loop filter (IC6) is applied to the varicaps (D1-D6) to facilitate tuning within an 8MHz band of frequencies. A trimcap (VC1) is used for coarse tuning of the VCO. 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 +22dBm (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 VHF prescaler (IC3). The prescaler divide ratio is 40/41.

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 and by phase modulating the reference signal.

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

(Refer to the T826 regulators or T827 regulators & exciter circuit diagrams in Section 6.)

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

The VCO and buffer amplifier are supplied from the +9V switched supply by Q6 via the C multiplier (Q5, C34).

The output amplifier is supplied from Tx reg.

2.4 Audio Processor

(Refer to the T826 or T827 audio processor circuit diagrams in Section 6.)

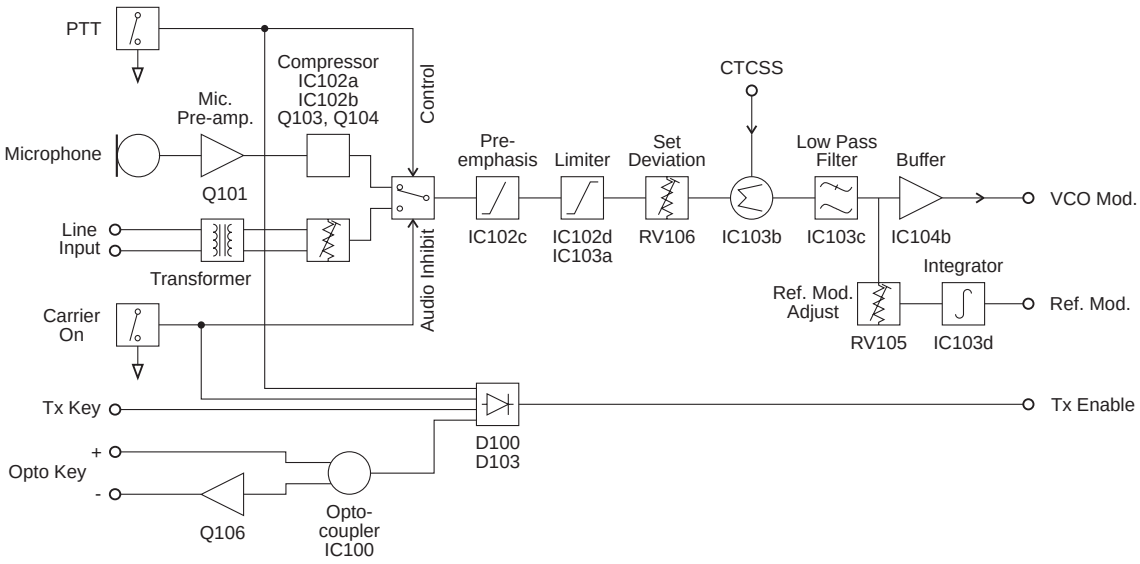


Figure 2.6 T826/827 Audio Processor Block Diagram

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 pre-amplifier (Q201 in the T826; Q101 in the T827) 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).

2.5 Power Supply & Regulator Circuits

(Refer to the T826 regulators or T827 regulators & exciter circuit diagrams in Section 6.)

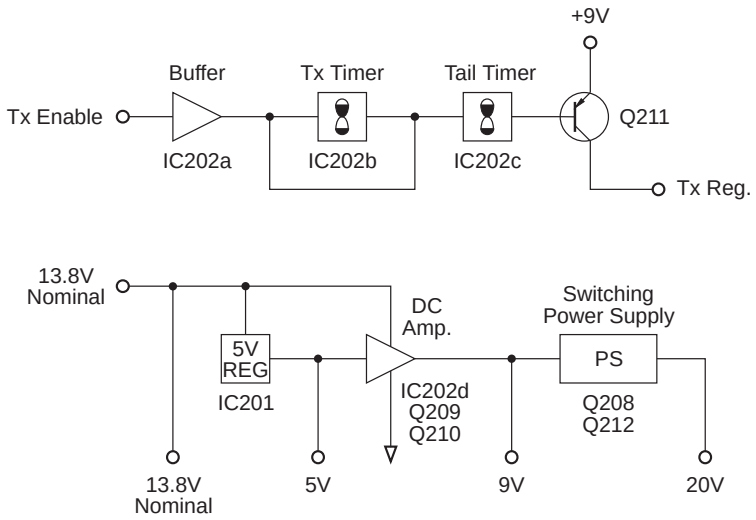


Figure 2.7 T826/827 Power Supply & Regulator Block Diagram

The T826 and T827 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 in the T826, or by removing R257 in the T827.

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

2.6 T826 Drive Amplifier & PA

(Refer to the T826 PA circuit diagram in Section 6 and Figure 2.1.)

A two-stage, wide band amplifier (Q351, Q352) provides an output level of approximately 500mW (+27dBm) for an input of 170mW (+22dBm) from the VCO. An 11V zener (D311) on the supply of IC301 provides a 10.5V regulated rail for the exciter.

To reduce the spurious output level, the synthesiser out-of-lock signal inhibits the exciter power supply via Q312 and IC301a, and operates an RF switch at the exciter input (D341, D342, D343 and associated circuitry).

R351 and R352 form a "minimum loss" matching pad from 50 ohms to Q351 input impedance to provide good VCO / exciter isolation.

The output attenuator (R358, R359 and R360) aids in reducing exciter / PA interaction while also ensuring a reasonable match for Q352.

The RF output from the exciter (approximately 500mW) is fed to the driver stage (Q361) and then to the final (Q371).

The directional coupler provides the required feedback for the power control loop while harmonics are attenuated by the low pass filter.

2.7 T827 Exciter Drive Amplifier

(Refer to the T827 regulators & exciter circuit diagram in Section 6 and Figure 2.2.)

A two-stage, wide band amplifier (Q300, Q301) provides an output level of approximately 1W (+30dBm) for an input of 150mW (+22dBm) from the VCO. The amplifier takes its supply from the +13.8V rail via a series pass transistor (Q352); however, a feedback diode to the emitter of Q353 keeps this amplifier supply at approximately 9V.

To reduce the spurious output level when the synthesiser is not locked, the lock detect signal from the synthesiser can turn off Q352 & Q353 (and hence the amplifier power supply) via Q354.

R300, R301 & R302 form a 12dB attenuator to provide good VCO / drive amplifier isolation and reduce the high VCO output level.

