2 Circuit Description

This Section describes the operation of the basic circuit blocks found in the T3000 radio. Refer to the block diagrams in Figure 2.1, Figure 2.2 & Figure 2.3 and the circuit diagrams in Section 6 of this Manual.

The following topics are covered in this Section:

Section	Title	Page
2.1	Introduction	2.2
2.2	Synthesiser	2.4
2.3	Receiver	2.4
2.4	Transmitter	2.5
2.5	Audio Operation	2.6
2.6	Power Supplies	2.7
2.7	Control PCB Operation	2.8

2.1 Introduction

The T3000 radio is made up of two modules: the RF module and the control module. The RF module consists of an RF PCB, PA module and a VCO PCB, and the control module consists of a control PCB with control, audio and supply circuitry, front panel display and keypad.

The following circuit blocks are located in the RF module:

- The synthesiser, containing:
  - plug-in Tx/Rx VCO
  - 12.8MHz TCXO
  - PLL circuitry
  - +5V-ECON supply.

- The receiver, containing:
  - front end
  - mixer
  - demodulator
  - squelch circuitry
  - RSSI
  - IF circuitry.

- RF power amplifier module, low pass filter, Rx/Tx PIN switch, antenna switch and power control circuit.

The following circuit blocks are located in the control module:

- The microprocessor control circuitry.

- Audio processing, audio PA.

- Front panel display.

- Accessory and options connectors.

- +5V, +6V-TX and +14V power supplies.

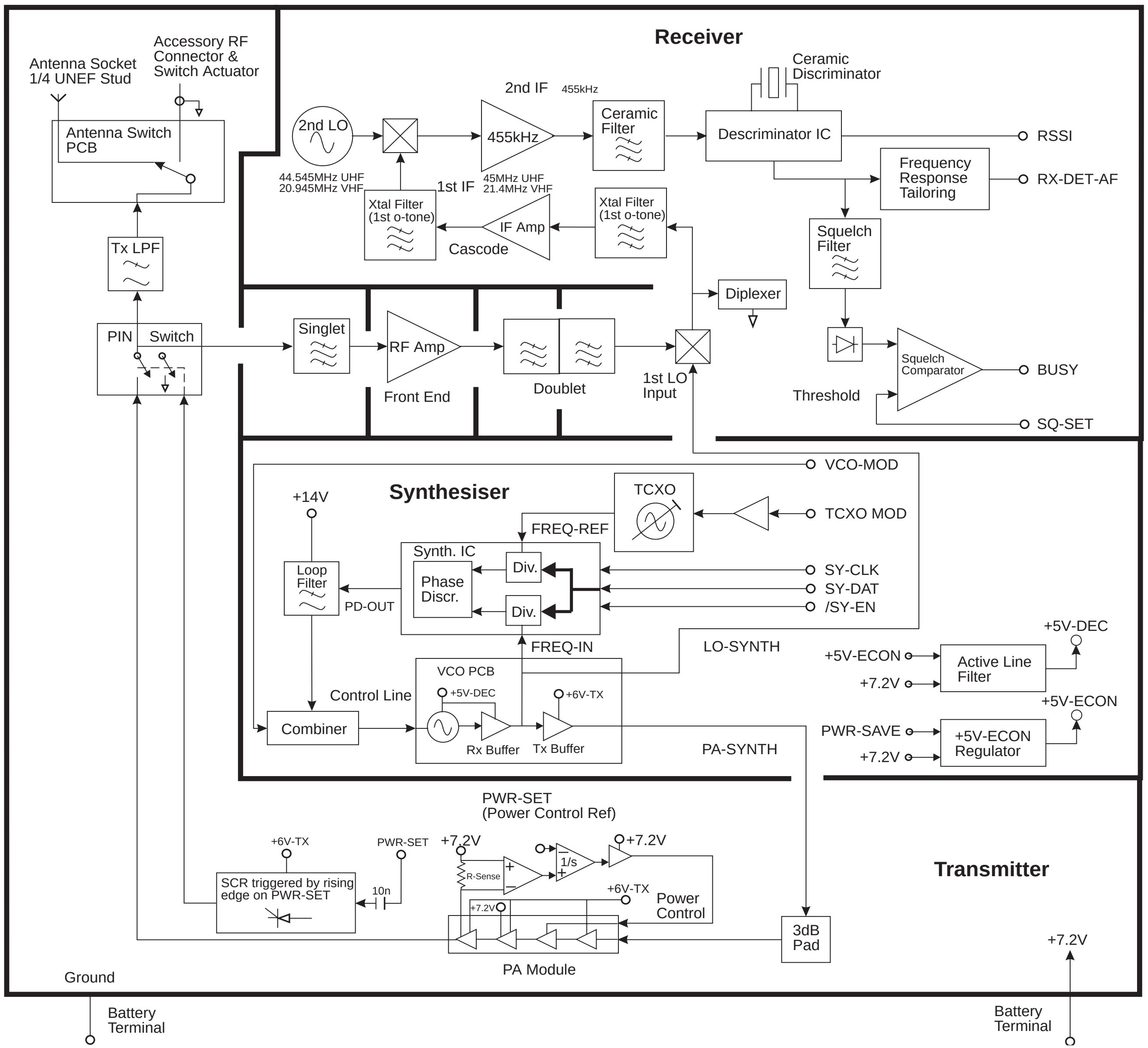


Figure 2.1 T3000 RF PCB Block Diagram

2.2 Synthesiser

The synthesiser device receives channel and reference frequency information from the microprocessor via a three line serial interface:

SY-DAT - synthesiser data:
SY-CLK - synthesiser clock
/SY-EN - synthesiser latch

Once the data has been latched in, the synthesiser IC processes the incoming signals: f_{in} from the VCO and f_{ref} from the TCXO, operating at 12.8MHz. The TCXO signal is divided by the reference counter to provide 6.25kHz or 5kHz at the phase detector. The VCO signal, f_{in}, is processed by the internal divider and can be tuned to the reference frequency. The phase detector output is fed via the integrator to the control line. The VCO frequency increases with a positive change in control line voltage.

The synthesiser produces a signal called LCK-DET which is fed to the control PCB after some processing, to prevent transmission and to advise the control microprocessor when the synthesiser is out of lock. The time lapse between the synthesiser latch pulse and the lock detect line going low is typically 15ms (maximum is 20ms).

The combined transmit audio and DC biasing signal, TCXO-MOD, is amplified and fed to the control input of the TCXO. The transmit audio signal, VCO-MOD, is summed onto the control line and fed to the VCO. The loop filter amplifier is supplied from the +14V regulator on the control PCB, while the VCO receives its supply from +5V-ECON via an active supply filter.

2.3 Receiver

The incoming signal from the aerial passes via the LPF and PIN switch and through a varicap tuned singlet band pass filter to the RF amplifier. The output from the amplifier is coupled to a varicap tuned doublet which provides the spurious response rejection necessary for the first mixer.

The VCO output is fed to the double balanced mixer. The frequency of the VCO signal is lower than the RF signal by the value of the IF frequency. The mixer output is fed to the first crystal filter, buffered by the IF amp and then fed to the second crystal filter.

The output of the second crystal filter is mixed to 455kHz then goes via an amplifier and ceramic filter to the demodulator. The demodulator IC uses a ceramic discriminator and provides both detected audio and RSSI outputs.

The front end tuning voltage is provided by the control board via a DAC.

The squelch detector compares the rectified audio out-of-band noise to a threshold set by the control board via a DAC.

2.4 Transmitter

The TX-VCO output of the VCO is fed through a fixed attenuator to the PA module. The module is supplied with +7.2V from the battery, +6V-TX from the control board and a control voltage from the power control circuitry.

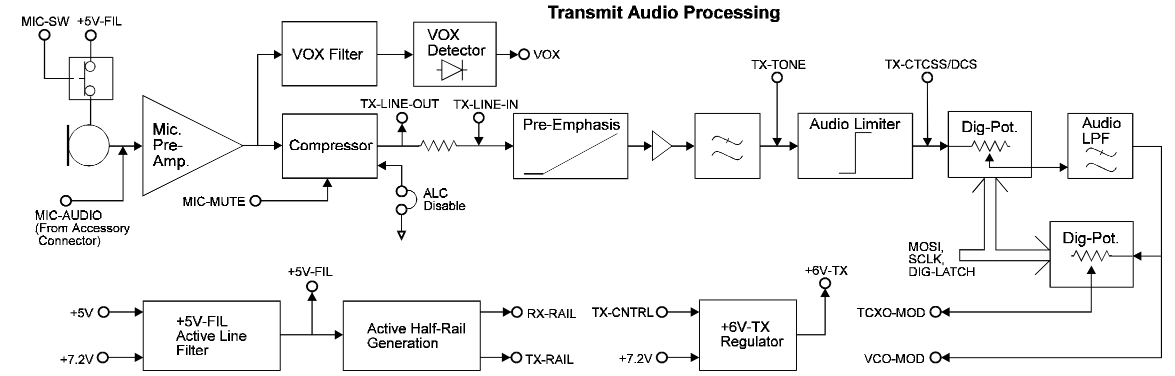
The output of the module is presented to the antenna socket via a PIN switch, low pass filter and a mechanical antenna switch.

Power control circuitry detects the DC current drawn by the final stage of the PA module and maintains it at a preset level by varying the control voltage fed back to the module power control stage. The reference for the power control loop is provided by the control PCB via a DAC.

The PIN switch enters the transmit state when a rising edge on the PWR-SET signal triggers the SCR, and reverts to the receive state when +6V-TX is switched off.

The mechanical antenna switch is a make-before-break switch that normally connects the low-pass filter to the antenna socket. Upon connection of an accessory, the RF is routed through the accessory RF pin, and connection is broken to the antenna socket.

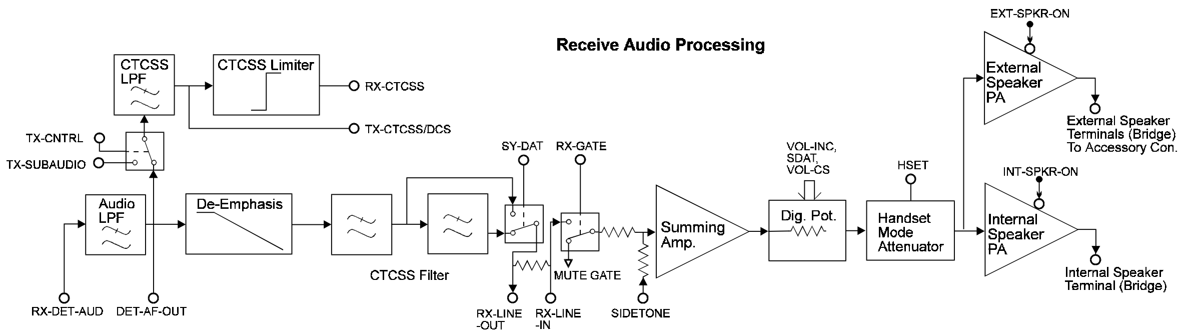
2.5 Audio Operation



Note: All switches are drawn in the position where the relevant control signal is 0V.

Transmitter speech from the microphone is preamplified and fed into an automatic level control circuit which also has two mute facilities (one for options and one for the microprocessor). The speech is pre-emphasised and high pass filtered, then passed to the limiter.

DCS/CTCSS signals are generated by the microprocessor, then fed through a DAC controlled level shifting buffer. The output of this is low pass filtered then summed with the audio output of the limiter. A microprocessor controlled potentiometer sets the overall deviation of the system followed by the audio low pass filter. A second microprocessor controlled potentiometer then sets the relative contribution of the VCO-MOD and TCXO-MOD modulation paths.



Note: All switches are drawn in the position where the relevant control signal is 0V.

Receiver audio passes through a low pass filter where it is split into signalling and speech paths. Selcall signals are coupled to the Selcall module. DCS/CTCSS passes through a low pass filter and limiter before arriving at the microprocessor. Speech is de-emphasised and passed through one or two high pass filters, depending on the signalling used. Processed speech passes through the mute to an amplifier where speech and confidence tones are summed. The signal then passes via the volume control to the audio power amplifiers. The microprocessor selects whether the internal or external power amplifier is active.

2.6 Power Supplies

The +7.2V rail is the unswitched supply from the battery terminals. It is distributed to all regulator inputs, the audio and transmitter power amplifiers and the accessory and options connectors. Decoupling is placed where required, with the main reservoir capacitance being provided by the batteries themselves. The microprocessor monitors the +7.2V rail to ascertain battery condition.

The +5V supply is always on when the radio is on, and basically supplies the digital section of the control board. When the user first presses the [On] key, the +5V regulator is switched on, and the microprocessor then latches the regulator on, so that the key can be released without power being lost. An LVI device monitors the +5V rail and resets the control circuitry in the event that the rail drops below approximately 4.5V. The +5V regulator is located on the control PCB.

+5V-ECON supplies the receiver, synthesiser and transmitter on the RF PCB and the analog circuitry on the control PCB. It is switched on or off by the control PCB microprocessor as required and is physically located in the synthesiser area of the RF PCB.

The +6V-TX regulator incorporates both current and voltage boosting, and is based on the same switchable low-dropout-voltage +5V regulator used for the +5V and +5V-ECON regulators. It is switched on only when transmitting, and supplies the transmitter and one stage of the VCO. This regulator is located on the control PCB.

+14V is generated for the loop filter supply in the synthesiser. The regulator is physically located on the control PCB and is a self-oscillating design, using the +5V-ECON supply as a reference for regulation.

2.7 Control PCB Operation

2.7.1 T3010 Operation

The T3010 control section is based on the 68HCO5C9 microprocessor, which incorporates internal ROM and RAM for program and run-time storage, and uses an external serial EEPROM for database storage.

The microprocessor interfaces with the radio via two shift registers, direct input ports, external analog to digital and digital to analog convertors, a Selcall module (incorporating another microprocessor and an FX803 Selcall modem), direct output ports and an asynchronous serial bus.

The following alert and confidence tones are generated by the microprocessor controlled tone generator: ‘off’, ‘high tone’, ‘low tone’ or ‘warble’ (alternation rapidly between ‘high’ and ‘low’).

The microprocessor communicates with the outside world via an LCD driver on the asynchronous serial port to the LCD display, a 3X3 matrix keypad and via an asynchronous full duplex 4800 baud serial port.

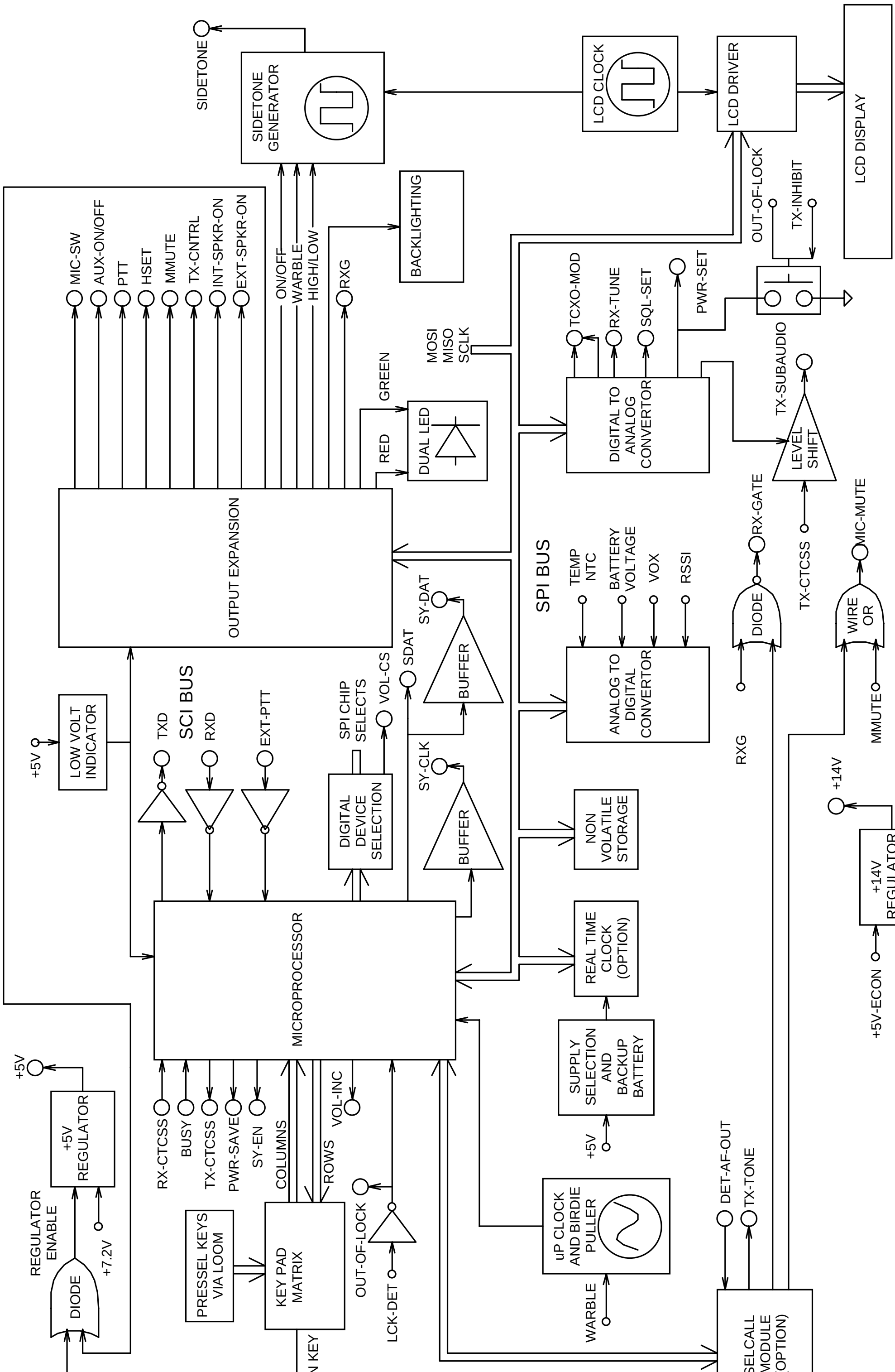


Figure 2.2 T3010 Control PCB Block Diagram

2.7.2 T3020, T3030, T3035 & T3040 Operation

The T3020, T3030, T3035 and T3040 control section is based on the 68HC11F1 microprocessor. It has external memory on a non-multiplexed bus, to provide program storage, database and run-time volatile storage (EPROM, EEPROM and RAM respectively).

The microprocessor interfaces with the radio via a gate array, direct input ports (both digital and analog), an external digital to analog convertor, an external FFSK modem, direct output ports and an asynchronous serial bus.

The microprocessor communicates with the outside world via LCD drivers on the microprocessor's data bus to the LCD display, via a 3X8 matrix keypad and via an asynchronous full duplex 4800 baud serial port.

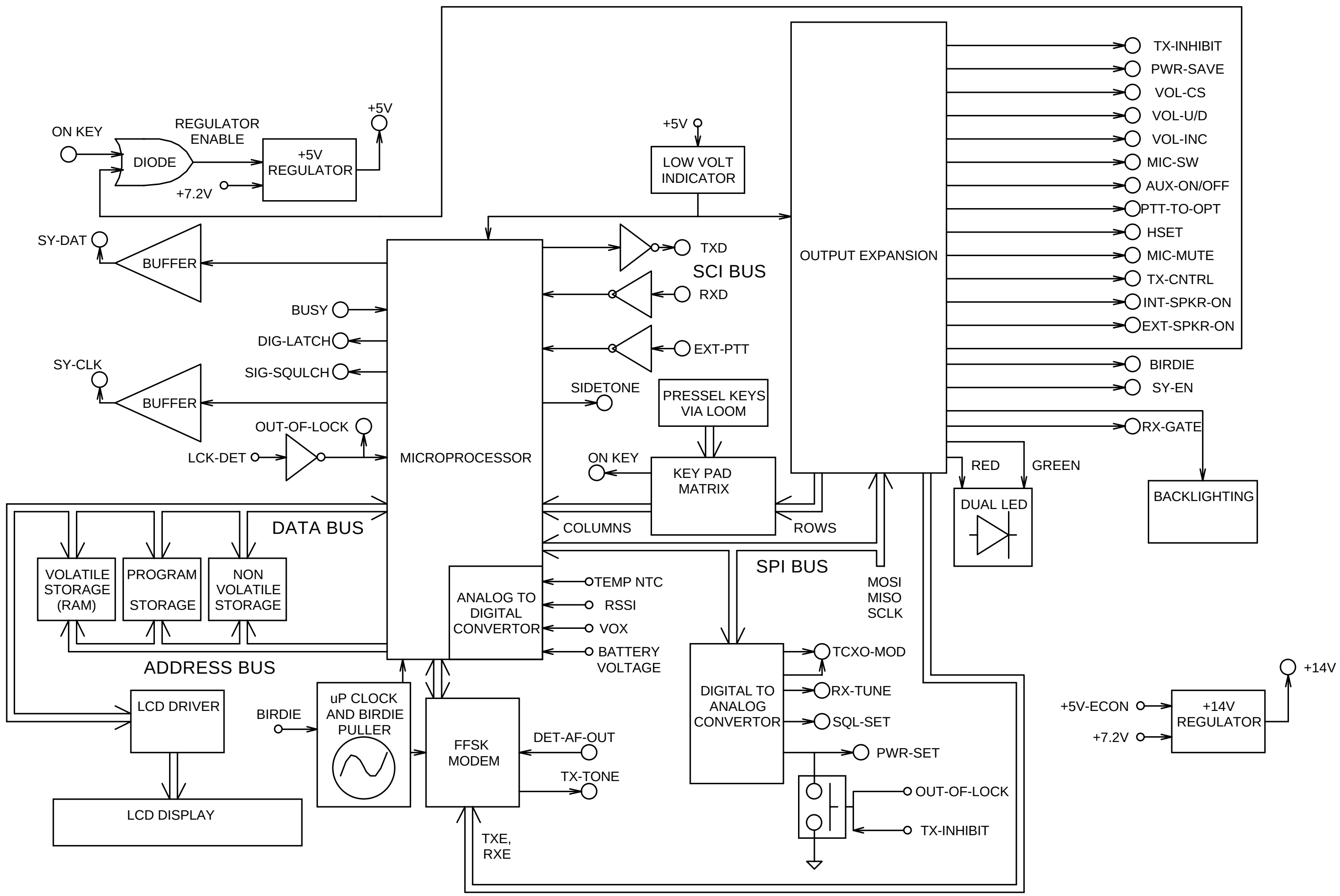


Figure 2.3 T3020, T3030, T3035 & T3040 Control PCB Block Diagram