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312MHz Smoke Detector Module

64004/74

Circuit Description

Filename

Y:\PR245 UL Smoke Detector\TRL Submission\smoke circuit description.doc

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Change History

Issue	Date	Reason for change
A		New

Contents

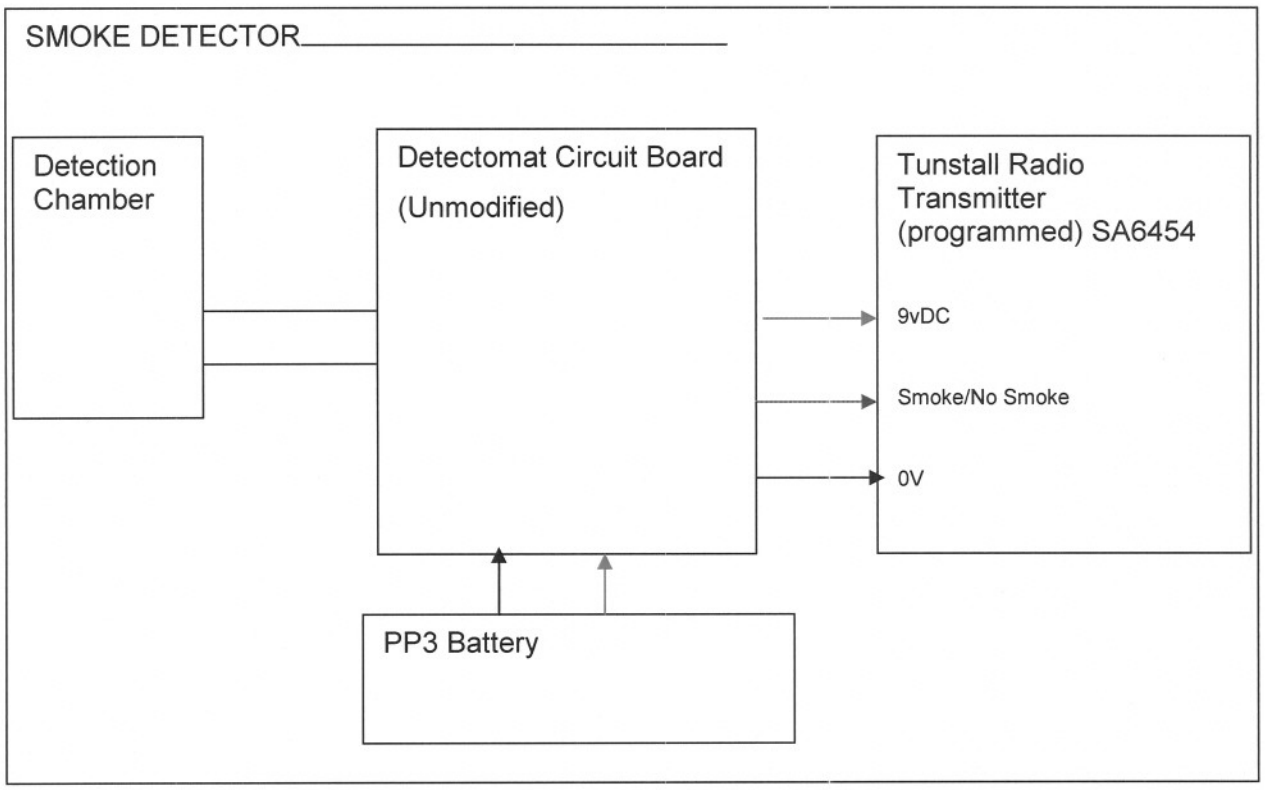
1 Circuit Description.

This document describes the circuit design of the Smoke detector module and its associated radio module.

The unit uses a proprietary smoke detector from Detectomat. The unit is opened up; a standard Tunstall transmitter PCB (which is specially shaped to fit) is inserted. The transmitter picks up the DC level of Smoke/No Smoke and the power from the PCB using three wires to the terminal block.

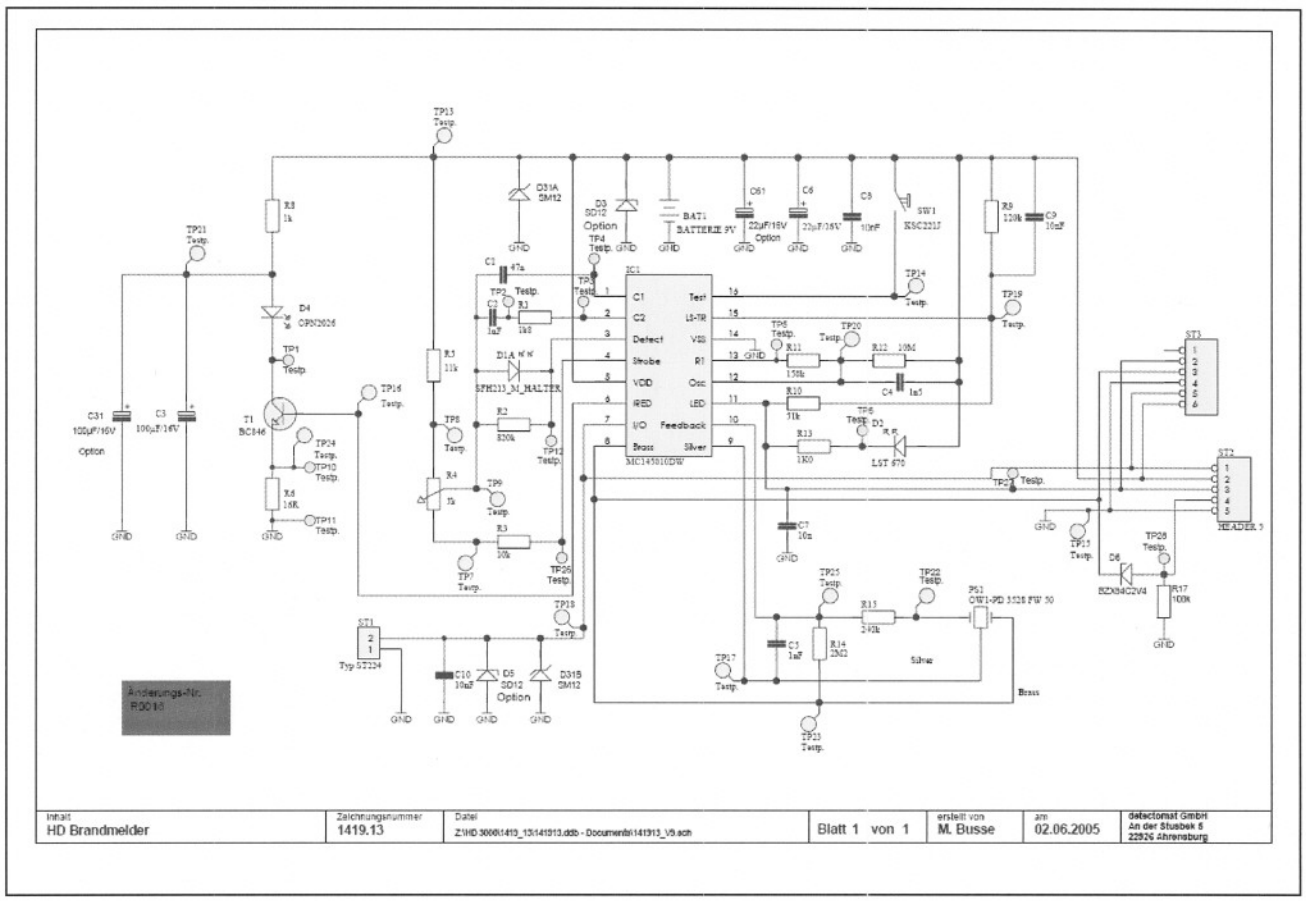
The detector generates its own acoustic low battery warning but the radio transmitter detects and transmits low battery independently at approximately 6.8v

2 Smoke Sensor Block Diagram



3 Smoke Sensor Circuit.

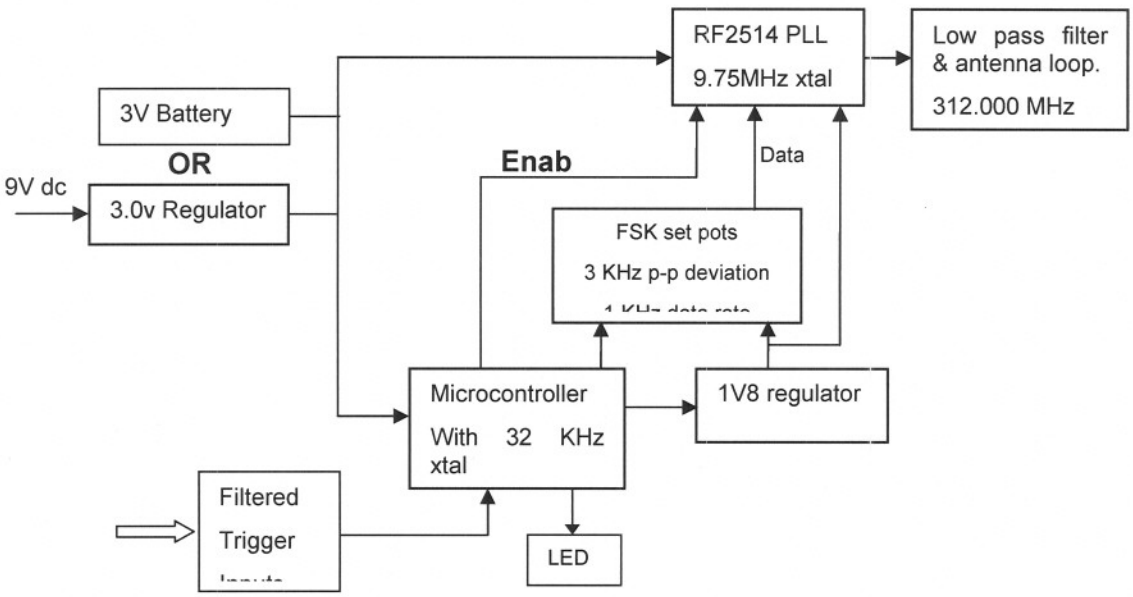
The Smoke sensor consists of a white plastic case 90mm in diameter and 33mm high. The unit is placed on the ceiling where smoke might circulate... The unit sounds an alarm on smoke or if there is a flat battery.



4 Radio Module Circuit Description

The 312 Radio Module comprises a propriety Phase Locked Loop (PLL) Radio integrated circuit (IC2) controlled by a low power microcontroller (IC3) accommodated on a small printed circuit board along with associated components. Major functional circuit areas are indicated below. A brief description of each block follows, culminating in a more detailed overview of the RF2514 PLL: -

4.1 312 Radio Module Functional Block diagram



4.2 3V Battery/3V Regulator

The main 9v battery for the smoke detector is monitored.

4.3 Microcontroller

A programmed microcontroller, IC3, generates a digital identify code with a sequence held on chip in flash memory. Each of the three part numbers has a different program. The IC has integral timers to determine bit periods and overall timings. The coding word is generated using pulse position modulation. Each bit is 1ms wide, with a pulse width of either 0.666ms (Data 0) or 0.333ms (Data 1).

IC3 also controls transmission time by enabling the PLL, IC2, during normal transmission; the LED remains on for 3 seconds. If the battery voltage is sensed low during a transmission, the LED will flash for 3 seconds.

Battery low sensing is undertaken with both the on-board and off-board batteries by switching on TR2 to load the circuit and TR4 which allows the microcontroller on-board comparator to monitor the voltage level of the battery via TR3 and the potential divider, R34 and R35. R35 is not fitted if monitoring the on-board battery. The time taken for C15 to charge, via R39, over a preset time defines the battery voltage level. C15 is discharged prior to measurement.

A 32.768 KHz watch crystal is used as the basis of timing for the processor.

IC3 runs programmed code that senses switch trigger operation and initiates transmission as necessary.

4.4 LED

A Light Emitting Diode (LED) is always fitted. When the Radio Module is configured as a ROM, the LED is visible (R10 is 1kΩ) to the User through the module enclosure and is a 'conventional' type.

For all other Radio Module variants the LED is surface mount and is not visible to the User. It is provided for diagnostic purposes during manufacturing test.

4.5 1V8 Voltage Regulator

This voltage regulator provides a stable bias voltage to the PLL and provides a constant RF output level over the battery lifetime. A stable voltage is also ensures that a constant frequency deviation is provided.

4.6 FCC Set Potentiometers.

Frequency Shift Keying (+/- 1.5 kHz) of the nominal 312MHz carrier is undertaken by the circuitry associated with variable potentiometers VR1 and VR2. VR1 and VR2 are set up at Manufacture to provide the correct frequency deviation. TR1, when switched on by IC3 'shorts VR2' and forces high deviation. When switched off low deviation is enabled, the default condition.

4.7 Filtered Trigger Inputs

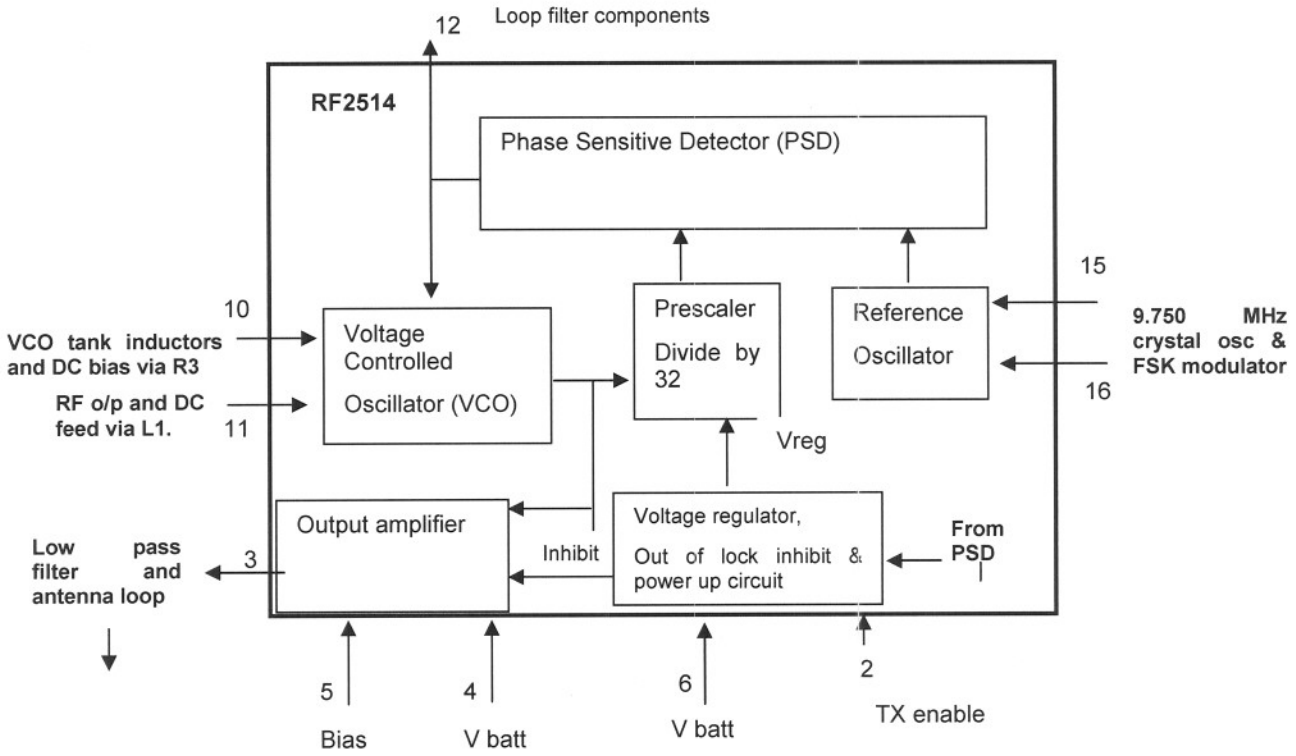
A number of trigger input variations are provided. All inputs are filtered to minimise conducted emissions. Trigger input selection is fixed, dependent on application. E.g. for PER, Pullcord and Smoke applications, variations on input CN3 are utilised. For ROM applications CN6/SW2 are utilised. For Telecare Interface Module applications, where the Radio module is configured as a Telecare Radio Module (TRM) input CN8 is used.

4.7.1 CN2

A voltage activated switch is also available via CN2/3. This is realised using TR5 and associated components. An input trigger voltage as low as 0.8V can activate the Radio Module. The Smoke detector uses this input.

4.8 Phase locked loop integrated circuit functions

A phase locked loop (PLL) circuit is used to generate the required output frequency, centred on the 312.000 MHz channel. All the active functions of the PLL are achieved with IC2, the RF2514 from RF MicroDevices.



4.8.1 Reference oscillator and modulator

The PLL reference oscillator runs at one 32nd (9.750 MHz) of the final output frequency. IC2 pins 15 and 16 are the base and emitter of the internal transistor, configured with C1, C2 to form a Colpitts oscillator. The crystal XT1 has a series circuit including varicap diode D1, to provide the necessary pulling (+/- 1.5 KHz) for direct FSK (frequency shift keyed) operation. The crystal requires 10pF of load capacitance to oscillate at its nominal frequency. C14 and C17, in series with the oscillator feedback circuit and transistor, provide the necessary 10pF load.

R17 provides a RF decoupling function to the varicap and feeds the modulation waveform from the data shaping RC network R1, C20. This shaping is required to reduce the emissions (from the data high frequency content) in adjacent channels to below regulatory levels. The output from the reference oscillator is internally fed to IC2 phase detector.

4.8.2 Phase Sensitive Detector (PSD)

The phase locked loop requires a post phase detector filter to define the loop bandwidth. Since we use a frequency shifted reference oscillator to achieve our modulation, the loop bandwidth is set to handle the highest frequencies required in the transmitted data together with a speedy lock up time. Since the incidental phase noise outside the loop bandwidth is quite high on this simple PLL, the loop filter is not allowed to be too wide and a compromise value of around 50kHz is selected. The loop filter components R5, C10 and C11 determine the loop bandwidth.

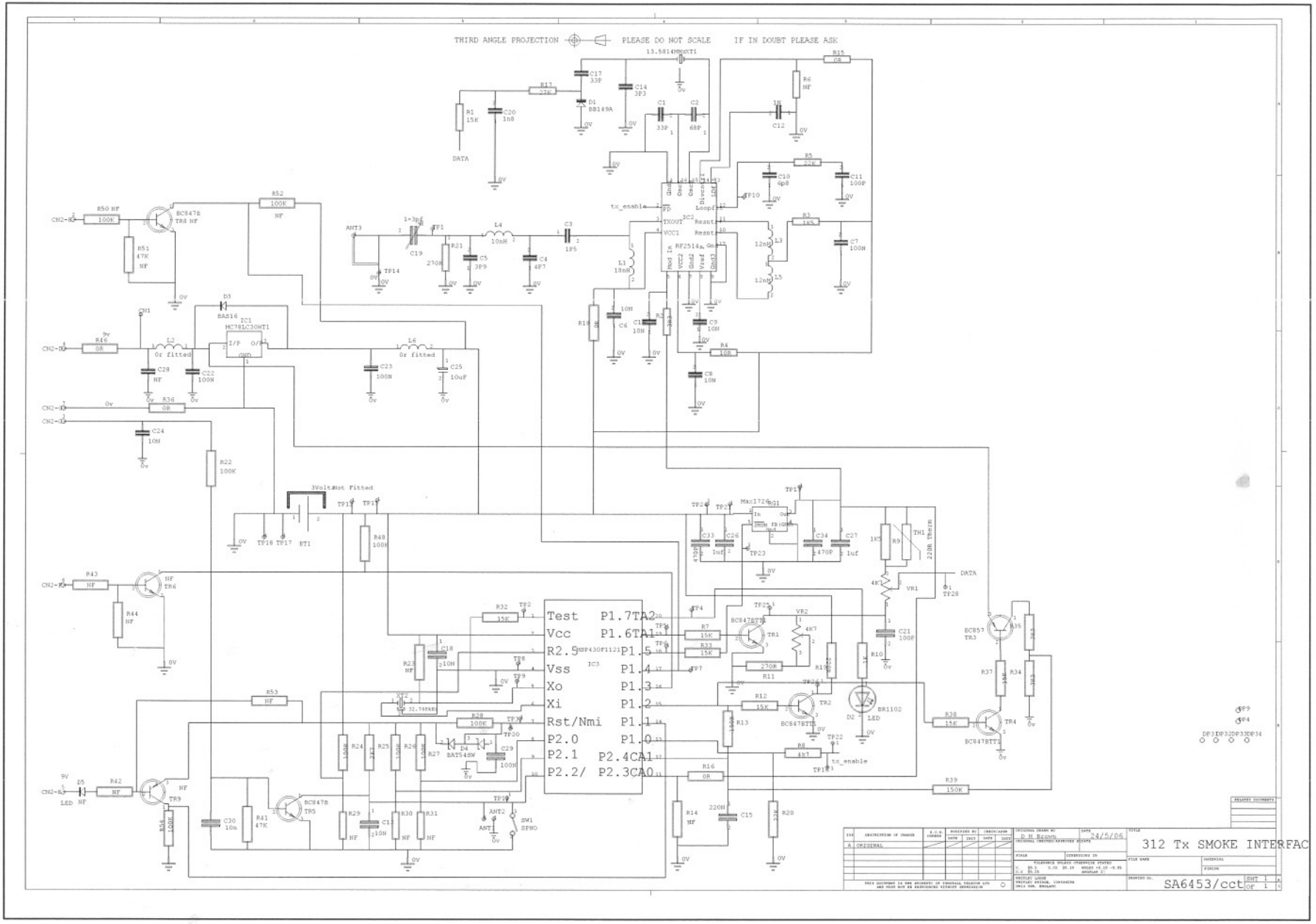
4.8.3 Voltage Controlled Oscillator (VCO)

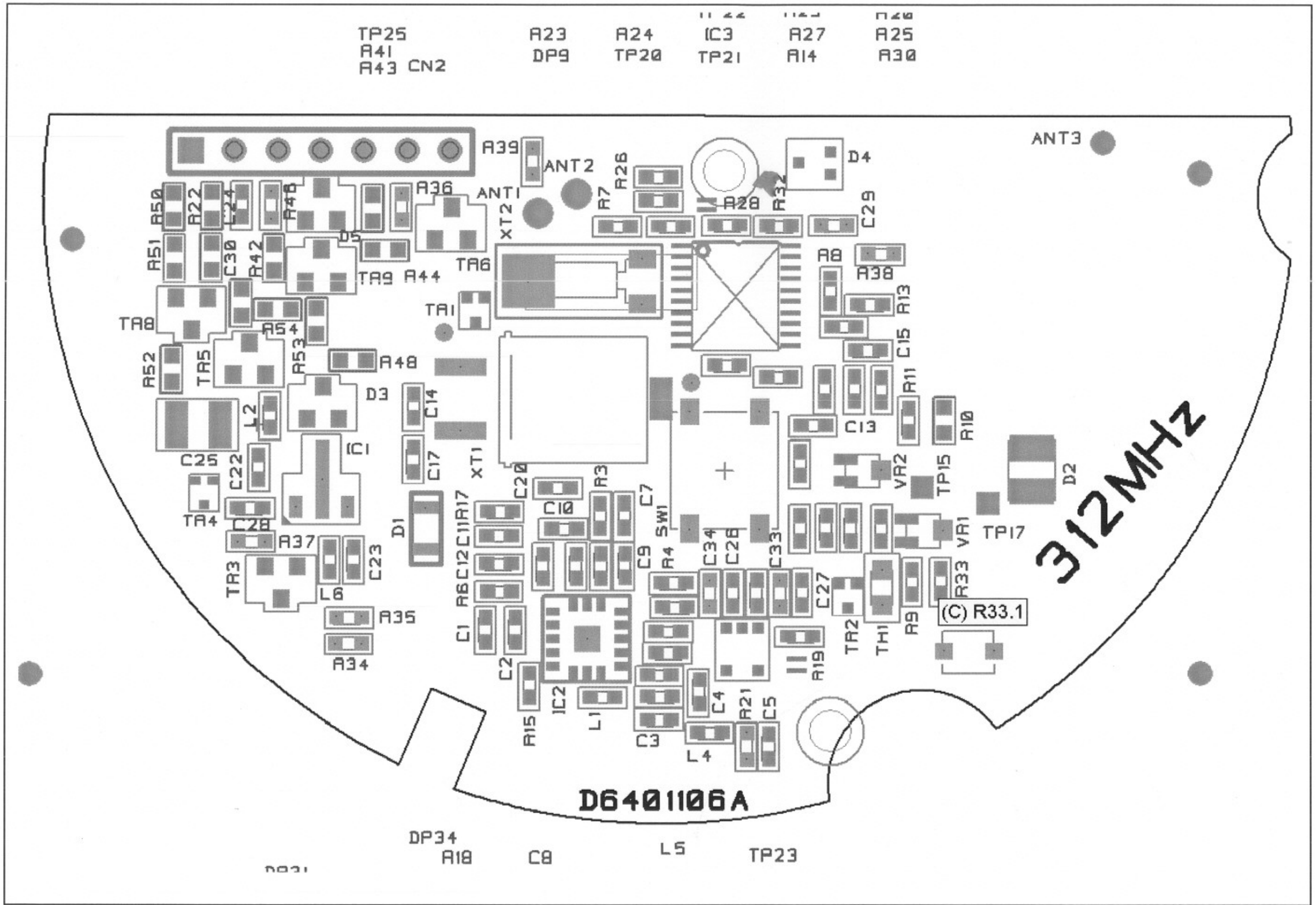
IC2 includes a VCO. All components, including the tuning varicap diode are on chip, with the exception of the tank circuit inductor. L3 and L5 form this inductor in series. Two components are used to obtain a finer selection resolution than would be offered by the preferred values of a single component. R3 provides the DC feed to the VCO transistors on chip.

4.8.4 RF2514 output amplifier

The on chip output stage offers an open collector on IC2 pin 3 fed to a resonant circuit at 312 MHz, formed by L1, C3 and C4. The impedance transformer formed by the tapped capacitor configuration offers a match to 50 ohms. DC is fed through L1 from Vbatt and decoupled by C6. L4, C4 and C5 form a 3 element low pass filter network matched to 50 ohms. In this case C4 value is a composite of the value required for the output tank circuit and the low pass filter input component. R21 (270R) provides a resistive termination to the RF amplifier to improve stability.

A bias feed is required to the output transistor base on pin 5 of IC2 and this is fed via R2, decoupled by C16, from the 1.8v regulator RG1. Using the regulated source helps to provide a constant RF output level over the life time of the battery. RF output varies by typically less than 1.5dB from 3.0v to 2.35v.


THIRD ANGLE PROJECTION
PLEASE DO NOT SCALE
IF IN DOUBT PLEASE ASK
312 Tx SMOKE INTERFAC
SA6453/cct


TP25
R41
R43 CN2
R23
DP9
R24
TP20
IC3
TP21
R27
R14
R25
R30
R39
ANT2
R26
D4
ANT3
R36
ANT1
R7
R28
R32
C29
R50
R22
C24
R46
XT2
R51
C30
R42
D5
TR9
R44
TR6
R8
R38
TR8
R54
TR1
R13
R52
TR5
R53
R48
C15
D3
C14
R11
L2
C13
R10
C25
C22
IC1
C17
XT1
C20
R3
C7
TP15
VR2
D2
TR4
C28
R17
C11
C12
R6
C10
SW1
TP17
VR1
312MHz
D1
R37
C23
C9
R4
C34
C26
C33
C27
R33
TR3
L6
R35
C1
TR2
TH1
R9
(C) R33.1
R34
C2
IC2
R19
R15
L1
C4
R21
C5
C3
L4
D6401106A
DP34
R18
C8
L5
TP23