CeoTronics

TC 917

Transmitter/Receiver

for wireless communication over short distances

Technical Specification

Part 3 Functional Description

Circuit Description - CeoTronics TC 917

1. RF - PCB (see block diagram)

a) General

The transceiver, TC 917 is a multi-channel radio with up to 16 channels for simplex communication over short distances.

The transmit and receive frequencies are controlled by a synthesizer and phased locked loop (PLL) circuit with the programming of the synthesizer being controlled by a microcontroller.

The transceiver TC 917 is designed for fitting in an ear defender or into a small portable radio housing. It can also be used within radio to wire interfaces.

b) Receiver (circuit diagram TC 917_2 HF A)

The receiver of the TC 917 is a double-superheterodyne type (doublesuperhet) with two intermediate frequencies (IF's) of 45 MHz and 455 kHz.

The received signal from the antenna is fed to a lowpass filter, to reduce the transmitter harmonic frequencies, and a PIN-diode switch (D1, D2) to the 1st selection circuit. This consists of two SAW filters (Q1, Q2) with a receiver front end amplifier (T1). This circuit is used for wide band selectivity and for increasing the sensitivity of the receiver with the amplifier.

Following the 2nd SAW filter Q2 the signal is fed to the 1st mixer (T2). This is designed as an active mixer. The required signal from the local oscillator is applied to the base connector of T2. It originates from the voltage controlled oscillator (VCO) via an amplifier T4.

The stage following the mixer T2 for the 45 MHz IF-Signal is the X-tal-filter Q3 and Q4 for the 1st adjacent channel selection. After this the signal is amplified again (T3) and then it is fed to the IF integrated circuit (IC1). This IC contains the 2nd mixer to the 2nd IF of 455 kHz and the 2nd LO (X-tal oscillator Q8, 44.545 MHz). After the 2nd mixer (pin3 of IC1) the signal path goes via the 2nd filter for the adjacent channel selection (Q5 and Q6) to a limiter amplifier and to the demodulator circuit (Q7).

The demodulated AF signal is then applied to pin 9 of IC1. The IC has also got a built in signal strenght indicator output (RSSI). This DC signal is applied to pin 10 of connector B1 for reading with the analog to digital converter on the Afboard. For further processing the audio signal is then fed to the AF pcb via the connector B1, pin 11.

c) Frequency generation, Synthesizer (Circuit diagram TC 917_2 HF B)

The generation of the frequencies is achieved with a voltage controlled oscillator (VCO) which is controlled by a syntesizer. The circuit operates as a phase locked loop (PLL).

The VCO (T12) is connected as a colpitts oscillator which is controlled by three voltages through capaciter diodes:

1) When transmitting the modulation signal is modulated through D8.
2) A switching voltage Vreg (D5, D7) which is generated on the AF pcb is switching the frequency from the required transmit frequency to the corresponding receive frequency (LO).

3) The control voltage Vr (D6) controls the frequency of the oscillator via the PLL according to the data supplied to the synthesizer (IC2) from the microcontroller on the AF board.

The programming of the synthesizer is done via the seriel input-output bus (SIO) of the microcontroller. According to the current channel, the synthesizer is loaded with data for two variable dividers:

1) The reference divider

2) The divider for the synthsizer frequency fo.

The reference divider divides the signal from the reference oscillator (T14 with Q9) to the internal comparison frequency. The fo divider divides the signal from the VCO over a built in pre-scaler to the comparison frequency as well.

Both divider signals are compared, and according to their phase difference a control voltage is applied at the output of the IC (pin6 of IC2). This control voltage is applied to a loop filter and controls the VCO frequency via D6 until the phases of both compared frequencies are equal.

The synthesizer IC also contains a divider for the reference oscillator. The divided and buffered frequency is available at pin 1 of the IC and is used also as the clock frequency for the microcontroller.

The synthesizer generates a signal LD (lock detect) at pin 2. LD is high when the VCO frequency is correct and it is low when the frequency fails the programmed frequency. This signal is fed via the connector B1/ pin 2 to the microcontroller which disables the transmitter when the VCO is generating the wrong frequency.

The generated VCO signal is now amplified by T10 and is fed to the prescaler part of the synthesizer IC and the 1st mixer (as described in »b«) via the amplifier T4. In transmit the signal is processed further as followes:

d) Transmitter (see circuit diagramm TC 917_2 HF B)

To activate the transmitter, the amplifier stages T5 and T6 will be turned on with the voltage +S. This voltage is generated with T7, T8, controlled from port OUTB of the synthesizer, loaded via the seriel I/O bus of the microcontroller.

The RF signal coming from the VCO will be amplified with the two stage amplifier T5 and T6 to an RF output power of approx. 50 mW. The impedance matching between the transistors with respect to the antenna is achieved with a LC lowpass circuit which decreases the harmonics as well.

The amplified signal goes via the diode switch (D1 and D2) and the lowpass filter (C40, C41, L16) which is also necessary for the reduction of harmonics to the antenna.

2. AF - PCB (circuit diagram TC 917_2 NF A and TC 917_2 NF B)

a) Microcontroller and digital part (circuit diagram TC 917_2 NF A)

The main controlling of the TC 917 transceiver is done with a 8 bit microcontroller (IC 4). The controller is a one time programmable type (OTP) of the National COP 8 series.

Input functions are:

- reading the actual channel number from the BCD coded channel switch
- reading the PTT and VOX switches
- reading the VOICE input signal (when VOX is activated)

Output functions are:

- Chip enables for all seriel controlled input/output circuits

Functions controlled via the seriel input/output bus (SIO) are:

- Read/Write the channel and radio specific data, stored in the EE-Prom, via the programming port (B8) of the transceiver.
- Read/Write the seriel EE-Prom which has stored the channel specific data.
- Read the 4 channel analog to digital converter (ADC),
  - one channel for battery voltage to generate a low battery signal.
  - one channel for RSSI signal to mute the received audio signal
  - two channels are reserved for the future and not used at the moment.
- Write to the 1 channel digital to analog converter (DAC) to generate the switching voltage Vreg to control the VCO according the actual frequency.
- Write to audio processing circuit (IC 9) where all switching, filtering and amplification of the microphone signal and the received audio signals are be done (see also part »b« of this description).
- Write to the synthesizer circuit on the RF board.

b) Audio processing (circuit diagram TC 917_2 NF B)

Nearly the complete audio processing is done in the serial controlled audio IC FX 806 (IC 9).

- Received signal

The incoming received signal from the RF board via B6/pin 11 is fed to pin 7 of the audio IC. The first steps inside of the IC are a deemphasis filter and an amplifier.

The filtered signal applies to pin 15 for external processing such as decoding signalling sequences or PL tones and the internal connection to the following IC functions can be switched off for external processing. When working with external components, the signal is fed to pin 14 of the IC again. This input is also used as the input pin for audio signalling, e.g. low battery warning or "roger beep" coming from the timer output port of the microcontroller (IC 4/pin 28).

The signal inside the audio IC goes then through a high pass filter, a low pass filter, an amplifier and a switchable attenuator to the audio output pin (pin 21). Finally the signal is amplified by IC 11 to the required audio output power. The speakers are connected to the solder pads P1 and P2 and to the connector B1, pins 1 and 2.

- Microphone signal

The incoming microphone signal which is connected at the connector B5 is fed to the audio IC at pin 11. It is amplified with a built in amplifier stage with its output at pin 13 of the IC. Inside the IC the signal passes a low pass filter, a high pass filter, an amplifier, the preemphasis filter, the deviation limiter, an additional amplifier stage and is then divided to the audio output attenuator to generate the "sidetone" (simultaneous hearing of transmitted voice) and to the modulation summing amplifier. In this stage external signals, e.g. PL tones can be added to the microphone signal.

Finally the signal passes an attenuator stage to the modulation output pin (pin 22). It then applies to connector B6/pin 9 for modulating the VCO on the RF board.

In addition the microphone signal is fed to the VOX amplifier IC 10A coming from the output of the first amplifier stage inside the audio IC (pin 13).

The amplification of the VOX amplifier is adjustable with the potentiometer R36 to control the VOX sensitivity. After that the signal is rectified with T4 and the »schmidtt-trigger« IC 10B generates a high/low signal which is used from the microcontroller to key the transmitter when operating in VOX mode.

c) Voltage regulators

Three voltage regulators are used to supply the AF and RF boards:

- a +5V regulator (IC 6) for the microcontroller, the audio IC, the digital circuits and the synthesizer IC.
- a +6V regulator (IC 3) for some audio processing on the AF pcb such as VOX amplifier, the audio output amplifier and for the transmitter and receiver voltages (+S, +E) on the RF pcb.
- a voltage doubler (IC 5) which provides a +12 V voltage from the regulated 6 V. This voltage is used to generate the switching voltage Vreg from 0 to approx. 10 V DC to operate the VCO over the complete stated frequency range.