MARS 2.4GHz

Description of transmitter and receiver architecture

1. Overview

The MARS system is a frequency hopping system.

2. Baseband

The baseband circuit consist primarily of a microcontroller and a DECT baseband processor (Two different are used for the base and handset respectively). The microcontroller is driven by a 9.302131 MHz crystal.

The baseband processor handles all audio, signal and data processing needing in a handset/base. The baseband processor includes CODEC and ADPCM coder/decoder. The baseband processor for the base also includes an echo chancellor and an echo suppressor.

The baseband controller also include a Burst Mode Controller that performs the generation and decoding of the frames used. The BMC also generates the control signals for the radio part. The bit rate is 1.033570 Mbit/s.

The baseband processor has a gaussian filter to perform the gaussian filtering of the transmitted data. The output signal (TRADAT) is an analog signal.

The base processor has a comparator to transform the analog RECDAT signal to a digital signal. The data and clock recovery circuit extracts the timing information from the received signal.

3. Transmitter

The MARS system uses the open loop modulation scheme. In the guard band between two slots, (136 bittimes) the synthesizer is programmed with the new data and the PLL obtains phase lock on the desired frequency. Just before the PA is powered up the synthesizer is powered down and the phase detector output is tri-stated. Thus, the VCO runs freely during the transmission with the frequency determined by the voltage on the loop capacitors.

It is now possible to modulate the VCO with an analog signal (TRADAT) at its modulation input.

The VCO signal is doubled in the RF chip. After the doubler, a driver amplifier is used to obtain the correct power level for the PA. The doubler and driver amplifier is turned on in the guard band during the lock-in time. The PA is only turned on when a burst is transmitted. The power up and power down of the PA is slowed down to reduce the generated switching spectrum.

There is a TX-RX switch to switch the antenna between the PA and the LNA. Between the TX-RX a BPF (ceramic) is used to perform some filtering.

In the base station, a diversity switch is implemented to switch between to antennas. A circuit is implemented to use the best antenna for receiving the signal. The choice is based on the measured RSSI value from a few bits in the preamble.

In the base station there are two internal antennas. There is no indented gain in the antennas.

In the handset an internal inverted F antenna is used. This antenna has a gain of omni-directional antenna pattern.

4. Receiver

The front-end consists of the antennas, bandpass filter and TX-RX switch as described in the transmitter section. There is also a single transistor LNA before the second bandpass filter (ceramic).

The mixer is internal in the RF chip. The LO signal comes from the doubler used in the transmitter.
The VCO is band-switched, so a different mode of the VCO is used for RX and TX. The PLL and doubler are common for the TX and RX path. This is possible as the transceiver only operates in either TX or RX mode.

The down-converted signal has an frequency of 110.592 MHz. The IF signal is filtered in a SAW filter with a approx. 1.2 MHz bandwidth. The SAW filter gives most of the channel selectivity. After the filter a limiter and a discriminator is used. The discriminator has a LC tank centered at the IF.
The demodulated signal is lowpass filtered with RC filter to obtain a better channel selectivity and noise reduction. The lowpass filter has a cut off frequency of approx. 500 kHz.

A sample and hold circuit is used to extract the DC offset of the received data to improve the comparator performance. The received data is sampled in the preamble where the alternating sequence ensures a correct average value.

5. Frequencies

The crystal used has a frequency of 9.302131 MHz. The microcontroller runs on this frequency or a fraction of this.

During transmission is the VCO half the transmitted frequency.

The IF frequency in the receiver is 110.592 MHz. The MARS system uses the lower LO signal. The same VCO is signal is doubled and used as LO signal. The frequencies in the system are as follows.

The channel spacing is 1.033570 MHz

All frequencies are given in MHz

Channel	TX VCO freq.	TX freq.	RX VCO freq.	RX LO freq.	IF
0	1200,492	2400.983	1145,196	2290,391	110.592
40	1221,163	2442.326	1165,867	2331,734	110.592
78	1240,801	2481,602	1185,505	2371,010	110.592