PDL MK3 with U2768

RF Module
THEORY OF OPERATION

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Revision History

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0	Initial Release	All	June 9, 2000

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1 RF Section Overview

1.1 Introduction

The basic function of the base and handset RF sections is to provide a full duplex wireless link between the handset and base sections of the telephone. This is accomplished by setting up two simultaneous communications links between the handset and base RF boards. The RF receiver and transmitter circuitry essentially provides a link between the microphone and receiver in the handset to the telephone line in the base set. In this way the phone performs exactly as a corded phone, except without the cord.

The frequency at which the handset transmits to the base is centered around 922.45 MHz, and the frequency at which the base transmits to the handset is centered around 903.8 MHz. The data rate which is modulated onto the RF carrier is 48 kbps. On the receiver side, the data is extracted and then converted back into the original audio signal.

The following section will outline the transmit frequencies used as well as the corresponding LO frequency which is used for the receiver. This is followed by the Block diagram and a block by block functional description of the modules.

1.2 Overview of changes for U2768

The U2768 RF Module design is based on the original U2765 design. The U2768 contains:

1. All sections of U2765 IC
2. LNA Front End
3. RX VCO operating at 900MHz
4. Dual PLL (900MHz/450MHz)
5. PLL Demodulator.
6. Replaces the original mixer with an Image Reject Version

These sections remove a considerable amount of discrete circuits. The Baseband interface and test point locations are kept the same as to minimize the differences between the modules.

This module also removes the interstage SAW filter. For us to maintain and improve the pager rejection, we had to shift the Base RX frequencies. The updated table is shown below.

1.3 Frequency Tables

This section outlines the RF frequencies and corresponding channel numbers. The handset uses a high side LO while the base uses a low side LO to down-convert the incoming signal.

1.3.1 Handset Frequencies

Channel	Transmit	Receive	RX LO
0	920.25	902.3	913
1	920.4	902.45	913.15
2	920.55	902.6	913.3
3	920.7	902.75	913.45
4	920.85	902.9	913.6
5	921	903.05	913.75
6	921.15	903.2	913.9
7	921.3	903.35	914.05
8	921.45	903.5	914.2
9	921.6	903.65	914.35
10	921.75	903.8	914.5
11	921.9	903.95	914.65
12	922.05	904.1	914.8
13	922.2	904.25	914.95
14	922.35	904.4	915.1
15	922.5	904.55	915.25
16	922.65	904.7	915.4
17	922.8	904.85	915.55
18	922.95	905	915.7
19	923.1	905.15	915.85
20	923.25	905.3	916
21	923.4	905.45	916.15
22	923.55	905.6	916.3
23	923.7	905.75	916.45
24	923.85	905.9	916.6
25	924	906.05	916.75
26	924.15	906.2	916.9
27	924.3	906.35	917.05
28	924.45	906.5	917.2
29	924.6	906.65	917.35

1.3.2 Base Frequencies

Channel	Transmit	Receive	RX LO
0	902.3	920.25	909.55
1	902.45	920.4	909.7
2	902.6	920.55	909.85
3	902.75	920.7	910
4	902.9	920.85	910.15
5	903.05	921	910.3
6	903.2	921.15	910.45
7	903.35	921.3	910.6
8	903.5	921.45	910.75
9	903.65	921.6	910.9
10	903.8	921.75	911.05
11	903.95	921.9	911.2
12	904.1	922.05	911.35
13	904.25	922.2	911.5
14	904.4	922.35	911.65
15	904.55	922.5	911.8
16	904.7	922.65	911.95
17	904.85	922.8	912.1
18	905	922.95	912.25
19	905.15	923.1	912.4
20	905.3	923.25	912.55
21	905.45	923.4	912.7
22	905.6	923.55	912.85
23	905.75	923.7	913
24	905.9	923.85	913.15
25	906.05	924	913.3
26	906.2	924.15	913.45
27	906.35	924.3	913.6
28	906.5	924.45	913.75
29	906.65	924.6	913.9

1.4 Block Diagram

Both the handset and base RF sections follow the same block diagram shown below with only minor changes to incorporate the different transmit and receive frequencies.

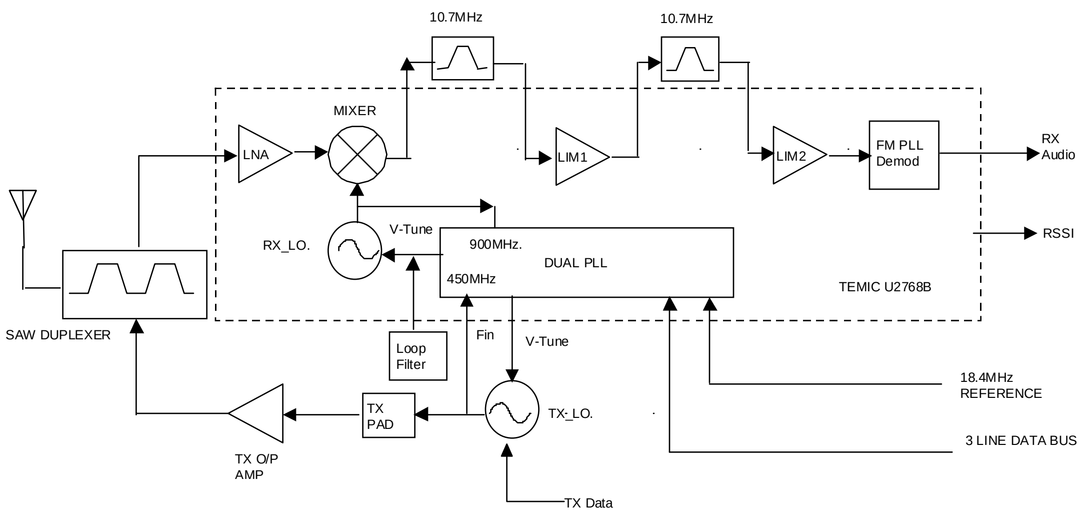

Figure 2.3 RF Section Block Diagram

As can be seen by the block diagram, there are several important input/output signals that are necessary for operation of the RF section (this does not include the separate supply lines for both TX and RX sections). An 18.4 MHz reference is present for use in the frequency synthesizers that built inside the U2768. The accuracy of this 18.4 MHz input will affect the transmitting and receiving frequencies. In order to ensure proper operation of the RF sections, the 18.4 MHz reference signal must be at least 500 mV in amplitude. Also present is the 3-line serial synchronous data bus on which data is transferred to the synthesizers to set both transmit and receive frequencies.

In the transmit direction, modulation input allows digital data to be modulated directly onto the TX carrier.

In the receive direction, the receiver RF signal will directly go to the U2768 chip. After LNA and Mixer, the RF signal will be converted to a 10.7 MHz IF signal. The IF signal will be amplified by LIM1, LIM2 and demodulated by FM PLL Demod. The demodulated signal is sent to Baseband section.

The following sections explain in detail the individual blocks in the RF section module. All references to part numbers correspond to the handset schematic.

2 RF Section Detailed Operation

2.1 Antenna Section

2.1.1 Antenna

The antenna is a device that allows effective conversion of energy from air to the RF circuitry. The antennas used are a retractable 1/2 wave with 2.5 dB gain relative to an isotropic radiator and a fixed 1/4 wave antenna with roughly 0 dB gain relative to an isotropic radiator. The duplexer and filters that follow the antenna, require a 50 ohm match to operate properly. The antenna is roughly matched to 50 ohms and requires a simple microstrip matching network to achieve this. If a network analyzer is attached to the BFA connector after disconnecting the duplexer, the antenna match may be measured. In order to achieve a good 50 ohm match, one must be careful not to obstruct the antenna as any object near the antenna will affect its impedance.

2.1.2 SAW Duplexer

The SAW Duplexer consists of two bandpass filters to provide the necessary isolation between transmit and receive sections and to pass the correct frequencies to transmit and receive sections. To ensure that the Duplexer is operating correctly, the match looking into the filters from the BFA connector may be measured. To do this it is necessary to remove the 0-ohm resistor that connects the antenna to the Duplexer. A return loss of approximately 15 dB should be measured for both the TX and RX bands.

2.2 Receive Section

2.2.1 LNA

U2768 first stage is LNA. The purpose of the LNA is to provide enough gain at a low noise figure so that the receiver can pick up the signal correctly. It must provide a good 50 Ω match to the RX bandpass filter.

2.2.2 RX Mixer

The second stage of the U2768 is Mixer. The function of the mixer is to combine the incoming signal with a LO signal in order to convert the desired signal to the 10.7 MHz IF frequency. The mixer output is connected by 4:1 transformer, which has balance inputs and single output. The transformer output connects to 10.7MHz ceramic filter. This ceramic filter has 330 ohm input and output impedance and its bandwidth 150 kHz.

2.2.3 RX VCO

The RX VCO is provided by U2768 chip. This VCO oscillate at frequency 870-970MHz. This VCO output internally connects to U2768 PLL while its loop filter should be connected externally.

2.2.4 RX Synthesizer

The U2768 also has Dual PLL for both the TX and RX sides. The Synthesizers receive channel information from the embedded microprocessor in the AMD ASIC via the serial buss. It also requires a stable 18.4 MHz reference clock that is also supplied by the AMD ASIC.

A passive loop filter is employed to connect the synthesizer of the internal VCO. This tuning voltage may be observed from test point RX_LOOP_V on the bottom side of the PCB. The loop filter cutoff frequency is set to about 1 kHz to allow relatively fast power-up times (<15ms).

2.2.5 IF Amplifier Stage

There are two stages of IF amplification in the U2768, namely LIM1and LIM2. LIM1 and LIM2 provide the enough gain for the signal. Both of the LIM1 and LIM2 require external 10.7 MHz ceramic IF filters.

2.2.6 IF Filtering

The choice of 10.7 MHz as an IF frequency, allows the use of relatively inexpensive filters. Two ceramic filters are used to achieve the desired adjacent channel suppression. Two different bandwidth filters are used, 230 kHz and 150 kHz, so that any shifting in the passband does not narrow the bandwidth excessively.

2.2.7 Demodulator

The U2768 contains FM PLL Demod. This demodulator will demodulate the FM signal to the analog signal and this analog signal is sent to the baseband. The quadrature voltage can also be observed at the ATE test point connector. This voltage should nominally be 1.5 V for both the base and handset when a signal is center tuned.

2.2.7.1 RSSI Comparator

The U2768 provides an RSSI voltage that is proportional to the input signal level that is then sent to the ASIC A/D pin.

2.3 Transmit Section

2.3.1 TX Amp

There is one transistor which provide the necessary gain for the transmit section. Transistor Q3 amplifies the signal from the TX VCO. The output power is set through TX PAD (attenuation pad) such that we guarantee less then 50mV/meter radiated field strength measured at 3 meters.

2.3.2 TX VCO

TX VCO oscillates at 450MHz and the transistor Q1 output circuitry resonates at 2^{nd} harmonic, which is the TX frequency. The TX VCO is also FSK modulated by the transmit data through a second varactor in the tank (25kHz peak). The data to be modulated is first filtered and then the amplitude is set via a precision resistor divider (R42/R46 both on handset and base) to set the deviation of the data modulation.

2.3.3 TX Synthesizer/PLL

The TX PLL is also provided by U2768. The TX frequency synthesizer is working at 450MHz. The loop filter cutoff frequency is about 100 Hz. This allows the data modulation to include frequencies down to about 100 Hz. The power-up time of the TX PLL is not critical (<60ms).