GENERAL CONCEPT

The PRF500 telephone is a radio transceiver designed to make or receive a telephone call without connecting a wire between the handset and the base station unit.

Physically, PRF500 is equipped with two separate parts. The first part is the base unit. The base unit houses 2 physically separated hardware systems, namely phone system and Personal Data Assistant (PDA) docking system.

The phone system functions as the base unit of the cordless phone, communicating with the handset and interfacing with phone line. This system includes a wide band transceiver and a telephone line interface. The PDA docking system is for docking of the PDA and interfacing with PC via a cable.

The second part of PRF500 is a piggy-back handset module plugged into the expansion slot of the PDA, sharing the LCD of the PDA for telephone functionality. This handset module consists of a wide band FM transceiver, earpiece and headset jack. Once plugged into the PDA, the handset module will utilize the PDA's LCD touch screen dialpad and microphone to function as a cordless phone handset.

The phone system of the base unit and the handset module are operating in full duplex mode on one of the 20 channels in 902-928 MHz band. Their linking can only be achieved by means of a matched security code to prevent unauthorized access to one's telephone line. There are up to 16.8 million (24-bit) digital security codes set by the microprocessor software.

The detailed explanation of the theory of cordless phone system operation is described in the following sections.

1. FUNCTIONAL DESCRIPTION OF BASE UNIT

(See Section on BLOCK DIAGRAM)

1.1 Microprocessor

The 8-bit MCU U201 operates at 8 MHz resonator frequency and on 5V DC.

The device provides digitally generated DTMF. Other I/O pins are used to activate hook switch and LED indication, to page the handset, to detect cradle signal, extension phone and incoming ring, to activate data transfer to PC through Hot Sync, and for various controls such as Rx data and Tx data. An external power-up reset is incorporated to prevent the MCU from hanging. Internal watchdog is utilized to minimize erratic software operation.

1.2 CID DECODING

The CID Decoder IC U501 with Visual Message Waiting Indicator supports both on-hook and off-hook CID. When U501 detects CID in an incoming ring during standby mode, it activates the FSK signal decoding section. The incoming FSK signal from Tip/Ring is converted into digital data. The data (1 byte) is buffered in the decoder, waiting to be latched out by the MCU until the next byte comes in. After processing the CID data, the CID Decoder sends the CID data through the Tx data path to the Handset. When there is a second incoming call and the phone is in talk mode, phone call alert message will appear on the PDA screen.

1.3 Ring Detect

The ring detect circuit detects the presence of an incoming ringing signal. When the ringing voltage exceeds 40 Vrms, a current will flow through the LED section of the optocoupler U901. The output transistor of the optocoupler will give logic signal to the MCU in accordance with the frequency and cadence of the incoming ring.

1.4 Battery Charging

The voltage supply for this charging unit is 9V DC from the AC power adaptor. A series resistor in the circuit limits the maximum charging current.

1.5 Cradle data

When handset is on the base, on-cradle is detected by Q102. MCU will send out command data through an inverter Q101 to the charging contacts and hence to the handset.

1.6 Baseband Signal Processor

2.6.1 Transmit Audio

The audio signal from the phone line interface is amplified by U301C before it is sent to RF module.

2.6.2 Receive Audio

The demodulated audio from the RF module is amplified by U301A and U301D before it is sent to the phone line interface.

1.7 Line Interface

At the line interface, the transformer T901 and optocouplers U901/U902 provide isolation between the phone network and the Base. The transformer also acts as a 2-to-4-wire hybrid network for transmit, receive, and sidetone signals to and from the telephone line.

For protection against surges, there are two major protective components. The first one is a fuse FU901 that will open when there is large in-rush current (250 mA or more). The second one is a 275Vrms varistor VS901 which will limit the maximum voltage induced across the telephone line. High voltage capacitors C904 and C905 with 2kV isolation capability are provided for CID detection circuitry.

1.8 RF Module

The RF modules of the base and handset share the same design except that the transmit and the receive frequencies are interchanged and different Duplexer types are used due to space constraint. Detailed description is in item 3.

2. FUNCTIONAL DESCRIPTION OF HANDSET UNIT

(See Section on BLOCK DIAGRAM)

2.1 Microprocessor

The 8-bit MCU U1 operates at 4 MHz resonator frequency and down to 3.3V.

The I/O pins are used for data tranfer between PDA and MCU. Others are used for various controls such as Rx data, Tx data, buzzer tones, cradle detect, enabling RF transmit and receive and LED indicator.

2.2 Baseband Signal Processor

2.2.1 Transmit Audio

The audio signal is sent from the mic of the PDA to the RF module through the Amplifier Q11.

2.2.2 Receive Audio

The demodulated and expanded audio signal from the IF module is amplifed by Q13 and sent to earpiece or headset jack. The earpiece will be muted during data transmission.

2.2.3 Transmit Data to PDA

The handset MCU U1 has direct data path with the PDA.

2.2.4 Receive Data from PDA

Data from PDA will be received through First In First Out registers U6 and U7.

2.3 Cradle data

When the handset is away from the base and has gone into idle sleep mode, its “sleep” will be interrupted by transistor Q14 when the handset is placed in the base. Once in cradle, the handset receives commands from the base through the charging contacts. These commands include new security code and channel information. After receiving the commands, the handset will send an acknowledgement to the base by RF.

2.4 Battery Charging

When the handset is placed in the base, current will flow from the base through the charging contacts to charge the handset battery. Zener diode DZ801 protects the battery from excessive charging voltage. Besides, there is a series diode D801 to ensure charging current of correct polarity. The diode also prevents the battery from discharging when the charging contacts are short-circuited by accident.

2.5 Low Battery Comparator

A comparator is built into the voltage regulator U2. If the battery voltage drops to below 3.3V, the MCU will be informed of the status. The MCU will then give out alert tone through the buzzer.

3. RF MODULE

(See Section on BLOCK DIAGRAM)

General

The RF modules of the base and handset have similar design except that the transmit and the receive frequencies are interchanged and SAW Duplexer is used in Handset due to space constraint. For transmission, analog voice or digital command goes to an FM modulating circuit for modulating the carrier. The local oscillator in the modulating circuit is locked to the desired channel frequency by a phase-locked loop (PLL). The modulated RF goes through a power amplifier and then a bandpass filter to the antenna

At the receiving side, signal picked up by the antenna goes through two stages of low-noise amplifier and then to a mixer. There are interstage bandpass filters. The mixing circuit is supplied with a PLL controlled local oscillator signal. The RF signal is down converted in frequency at the mixer to an intermediate frequency (IF) of 10.7 MHz. This IF signal goes through an IF filter and then to the IF amplifier/demodulator.

3.1 Audio Signal Paths

When the handset is in Talk Mode, it will unmute the compander part of U1. The audio signal received from the Base RF module will go through expander part of U1 and then into the earpiece through amplifier / buffer. The audio signal received from the mic will go through compressor part of U1 and then into RF modulation / amplifier for transmission at the Handset antenna.

3.2 Duplexer and Antenna

The Surface Acoustic Wave (SAW) duplexer F4 is a splitter for the transmit and receive signals from a common antenna. The antenna is matched to the duplexer.

3.3 Dielectric/Saw Filters

SAW filter F3 (on handset RF module) and dielectric filters F3, F4 and F5 (on base RF module) are for in-band receive and transmit frequencies while rejecting out-of-band spurious.

3.4 LNA

The low-noise and high-gain amplifier Q3 in series with amplifier Q5 provides gain and, in conjunction with interstage filters, selectivity to incoming RF signal at the input of the mixer.

3.5 Mixer

The amplified signal is mixed at Q6 with the signal injected from the local voltage- controlled oscillator Q4 to yield an IF signal of 10.7 MHz.

3.6 Amplification of IF signal

IF signal from the mixer is amplified by the IF Amplifier Q7 and filtered by two series Ceramic Filters (F2 and F1 on Base RF module, F2 and F5 on Handset RF module). The signal is then processed by the RF MCU U1.

3.7 Phase Locked Loop

The PLL inside the RF MCU U1 is a combined pre-scaler and phase-locked loop which controls independently the receive and transmit local oscillators. The desired channels can be selected by specifying the frequency dividing ratio of the variable frequency dividing circuit contained within the PLL circuit. The clock frequency is derived from a crystal with fundamental frequency of 4MHz.

3.8 IF Amp/Demodulator

The transistor Q7 is a pre-amp for incoming IF signal prior to the input of the RF MCU. The IF amp has a 10.7 MHz ceramic filter for selectivity. The 10.7 MHz IF signal is driven to limiting before the audio signal is recovered by quadrature detection.

3.9 IF Ceramic Filters

These are filters to reject harmonics and spurious from the local oscillator and mixer.

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