OPERATIONAL DESCRIPTION

SYSTEM DESCRIPTION

The wireless PBX uses a spread spectrum frequency hopping RF link to transfer control data and digital compressed voice at a bit rate of approximately 115Kbit/sec in each direction. PBX features such as digital voice data switching, CO lines interface control and extension controls are all done at the base module. System basic configuration is done from the handsets.

The Base unit manages the Handsets (Data and control). It acts as two CO lines interface and perform all PBX function. Other system options are two additional CO lines interface and TAD.

Following, a short description of the block diagram:

- Base CPU - The 80930 processor communicates over the WINGS™ network utilizing a coprocessor as RF controller (BFC2204). It manages all PBX functions (switching, etc.), handles the CO lines interface, controls the analog matrix, and handles the DSPs (up to four CO lines, two analog matrixes and four DSPs, operating with the additional configuration). It also controls a TAD, telephone answering device (when options assembled in any configuration). For maximum performance the 80930 runs in Page-mode with zero wait-states (see also base memory description).
- RF Module – Based on the Butterfly's MMIC BFM9011J and BFM9021J for 900MHz SSFH.
- Base Band – BFC2201 net controller and BFC2204 RF controller.
- Memory – 128K bytes SRAM with 25nS access time and 128K bytes with 90nS access time Flash memories, are used to run the 80930 in Page-mode with zero wait-states performing a bootstrap mechanism (see section 2.3) at power-up. Large SRAM with a non-volatile Flash memory allows an easy maintenance for features such as phone-book and software upgrade.
- DSP's – CT8015 TrueSpeech® DSPs (up to four DSPs for four CO lines).
- Matrix – 8 x 16 analog matrix (up to two analog matrixes for four CO lines) for switching and conferencing.
- Line interfaces – CO line interface circuit (up to four CO lines), with echo canceller of 64mS for each line, Caller ID type II decoders, DTMF receivers, call progress detection, one POTS connection per system.
- DC – 9 volts 1 Amp transformer regulated and filtered to 5 volts. RF module uses separate regulator and set of filters. Additional minus 5 volts converter is used to operate OpAmps.
- TAD – to be defined.

General

The transmitter and receiver in the RF module share a single antenna terminal which is switched between them on a TDD basis (time division duplex), i.e., when a data packet is received the transmitter is inactive and does not interfere with the reception, and the reception is inactive during transmissions.

The transceiver employs frequency hopping spread spectrum which is managed by the baseband processor (external to the RF module).

The transmission and reception are based on synthesized oscillators that share the same 12 MHz reference clock which is provided as an input to the module.

- **Carrier Frequencies**

The transceiver's 50 frequencies are: 902.5MHz, 903.0MHz, 903.5MHz…927.0MHz (902.5MHz to 927.0MHz with 0.5MHz channel separation).

- **Modulation and Bandwidth**

The modulation index of the FSK modulation is set to $h \cong 0.5$, which creates a modulated signal with a 20dB bandwidth of about 500kHz (maximum allowed by the FCC in this frequency band).

Receiver

The receiver is a dual conversion heterodyne receiver with a second IF at 10.7 MHz, where the FSK demodulation is performed. Its circuitry is based on the BFM9021J incorporating a low-noise-amplifier, two frequency conversions, an FM demodulator and an RSSI output (received signal strength indication). An external baseband stage functions as a data slicer and provides a logic-level output which is interfaced with the digital logic external to the module.

The first conversion is based on a synthesized local oscillator which is set at 110.7 MHz above the received frequency (the first IF is at 110.7MHz). The second conversion is based on a fixed crystal oscillator at 100MHz which down-converts the modulated signal to the second IF of 10.7MHz.

The receiver sensitivity for a bit error rate (BER) of 10^{-5} is about **–93dBm**.

Transmitter

The transmitter is based on the BFM9011 IC, which incorporates the modulator and the power amplifier.

The transmission power may be adjusted externally between a few power levels reaching a maximum of about **20dBm** (100mW).

The RF oscillator runs at the carrier frequency and is frequency modulated directly by the data signal while the synthesizer loop is disabled.

Frequency Hopping Communications Parameters in the WPBX-9000

Scope & Purpose

This document specifies some of the frequency hopping communication parameters of the wireless PBX WPX-9000, and is intended to provide proof of its compliance with FCC Part 15.247 requirements.

The chipset on which the product is based implements the WiNGs wireless protocol (**W**ireless **I**ndoor **N**etwork – a **G**eneric **S**olution) developed by Butterfly Communications (now the Short Distance Wireless Division of Texas Instruments). The communications protocol and other technical details regarding the chipset implementing it can be found at: www.Butterfly.com.

Hopping Sequences

The frequency hopping communications in the WPBX-9000 is based on a periodic use of **25** frequencies, which are selected at system initialization according to environmental occupancy.

This is the minimal number of frequencies required for systems transmitting up to 0.25W (the transmission power in the WPBX-9000 is 100mW). The order of appearance of the selected frequencies is randomized and scrambled to obtain a pseudo-random pattern, as required in section 15.247. In addition, this ensures that other systems of this type, which might be using the same set of frequencies, have a very low probability of using them in the same order. Such orthogonality minimizes possible mutual interference between the neighboring systems.

During the operation of the system, each of the handsets which communicates with the base has an individual frequency hopping link with the base, with multiplexing performed on the time axis (TDMA). Each of these separate channels is monitored and dynamically changed according to the link failures encountered in it. Consequently, the system may end up using different frequency sequences for the various handsets in it, depending on the link conditions of each of them.

The **25** frequencies used at any given point for each of these channels are chosen out of a pool of 50 frequencies (**902.5 MHz** to **927.0 MHz** in steps of **0.5 MHz**).

Time Parameters of the FH Transmission

All frequencies are used evenly since each of them appears once in a cycle (a cycle = 25 hops), and the duration of all transmissions is equal (about **0.8 msec**). Since this synchronous system transmits every **0.0138 sec**, a cycle is completed in 0.0138 msec $\times$ 25=**0.345 seconds**.

Synchronized Reception

The receiver's IF bandwidth is in the order of that of the modulated signal (~**500 kHz**), as required. The receiver is based on two frequency conversions to a first and then second fixed intermediate frequencies.

The receiver's first local oscillator hops in synchronization with the transmitter's hopping sequence. The adaptive frequency hopping mechanism of the WiNGs protocol is supported at both ends, so that an interfered frequency is replaced by an unused one only once this is confirmed by both sides (no transmissions are "wasted"). Following such replacement initiative, a group of frequencies may be abandoned and another one will be adopted instead simultaneously at both ends of the wireless link.

Description of the Antennas in the WPBX-9000

General

This document provides a basic description of the antennas used in the handsets and base of the WPBX-9000. This includes parameters such as their location, type, dimension, polarization, and maximal gain. The antennas may be viewed in the photographs provided as part of the FCC registration documentation.

Base Antenna

Location

The base's antenna is an external rotational element with an internal extension element intended to bridge the gap between the external mounting point of the antenna (on the plastic housing) and the internal antenna port of the transceiver. The internal extension is perpendicular to the external one.

Type & Dimensions

The antenna is a vertical element which can be rotated so as to support vertical positioning both for table placement and for wall mounting of the base. The vertical element emits with an omni-directional vertically polarized radiation. The internal horizontal element creates some horizontally polarized radiation.

The antenna dimensions are: external element: **120 mm** , internal element: **100 mm**

The RF transceiver module incorporates passive matching components which serve to match the 50 Ohm output impedance of the transmitter to the impedance of the antenna element. These components differ from those used in the handset due to the difference in the antenna elements used (the only difference in the RF circuitry between the base and handset transceivers).

Gain & ERP

The maximal gain achieved by this antenna is **3 dBi**.
Since the transmitter output power is limited to 20 dBm, the maximal ERP is **23 dBmi**.