Technical Description of iRetrofone

1. BASE UNIT

Base unit could access telephone line (PSTN) or Bluetooth linking (mobile phone). It communicates the cordless handset through DECT RF system. Thus, a user could use the cordless handset to make phone call with PSTN or mobile phone (through Bluetooth connection to the base unit).

Beside phone call, base unit serves as charging dock for iPhone or iPod products

1.1 Main controller

DCX78 is an integrated chip for DECT cordless phone from DSPG. It composed of MCU, DSP, RF transceiver and RF PA. It is an ARM based device which works with 13.824MHz crystal with on-chip tuning capability. It has on-chip 1MB Flash and 64KB RAM.

1.2 User interface

Keypad

Buttons	Operations	Descriptions
PAGE	Press once	When the base is in idle state, the base will page all registered DECT handsets. When the base is in paging mode, the base will stop paging.
BT	Press once	Initiate BT connection to the existing paired mobile(s).

LED

Functions	LED – Red	LED – Green	Remarks
DECT Registration mode (press & hold PAGE key for 10s)	200ms On/Off	N/A	2 minutes Sync with the other LED if the cell phone is also pairing mode
Cell phone Pairing mode	N/A	200ms On/Off	2 minutes

			Sync with the other LED if DECT is also in registration mode
Charge	On	N/A	-
PSTN In Use	500ms On/Off	N/A	Sync with the other LED if the cell phone is also in use
Cell In Use	N/A	500ms On/Off	Sync with the other LED if the PSTN is also in use
Paging	640ms On/ 1920ms Off	N/A	1 minute
PSTN Ringing	50ms On/Off	N/A	Sync with the other LED if the cell phone is also ringing
Cell phone Ringing	N/A	50ms On/Off	If the base is already connected to some cell phone (talk or ringing), the ringing of the other cell phone will be ignored. Sync with the other LED if the PSTN is also ringing.

1.3 Power Management

Power management includes generation of 2 regulated DC supplies: 3.2V and 5V from the adaptor 6.5VDC. The 5V DC is regulated by U2 which serves only battery charging for iPhone or iPod products. The 3.2V DC is regulated by U1 which supply the operation of base unit.

1.4 External Memory

There is one external memory: U3 (16KBit EEPROM). The EEPROM is for storing system parameters and call logs.

1.5 Telephone line Interface

The line interface circuit provides the following functions:

i.) Hook switch : Q6,7,12 perform the hook switch function

ii.) Line receive, transmit, sidetone cancellation are controlled by the circuit about Q2, Q3 & Q17

iii.) Ringer detection: Ringing signal is tapped through C104 and converted to logic by Q8

iv.) Line DC detection : The resistor network R16,58 feed the on-hook line DC level to the controller

v.) CID FSK detection: The on-hook FSK detection is done by the network C36 and 37. This couple the signal to CODEC input of controller for FSK decoding.

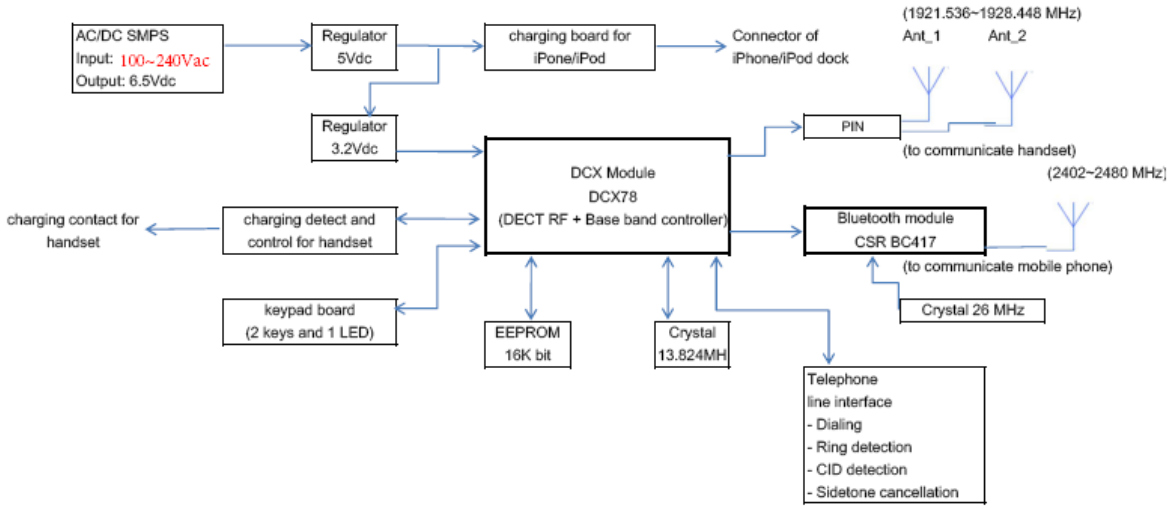
1.6 Charging Circuit and Detection

Charging current is defined by R50 and D11. The detection is generated by Q15 and feed to the controller.

1.7 Bluetooth module

The Bluetooth module is used for base unit to communicate with external mobile phone. The main chip is CSR 417 by CSR. The operation is under specification of Bluetooth 2.1+EDR with profile HFP 1.5.

1.8 BLOCK DIAGRAM



2. Handset

Handset could work with the base unit through RF of DECT standard. It is able to make phone call through PSTN or BT device attached to the base unit.

2.1 Baseband Controller

DCX78 is an integrated chip for DECT cordless phone from DSPG. It composed of MCU, DSP, RF transceiver and RF PA. It is an ARM based device which works with 13.824MHz crystal with on-chip tuning capability. It has on-chip 1MB Flash and 64KB RAM.

2.2 User interface

Keypad: Using on-chip triangular scanning keypad, it provides 20 keys.

Display: The display is a 35x15mm, mono colour LCD. It is controlled by the controller through the data bus.

2.3 Power Management

The handset unit could work with a battery of 2.4Vdc. Battery level and power failure detection is done by the resistor network R46 & 47, feeding signal to the A/D of controller.

The controller could generate 3.2Vdc with voltage-doubler of itself. The 3.2Vdc is used for LED backlight and EEPROM IC.

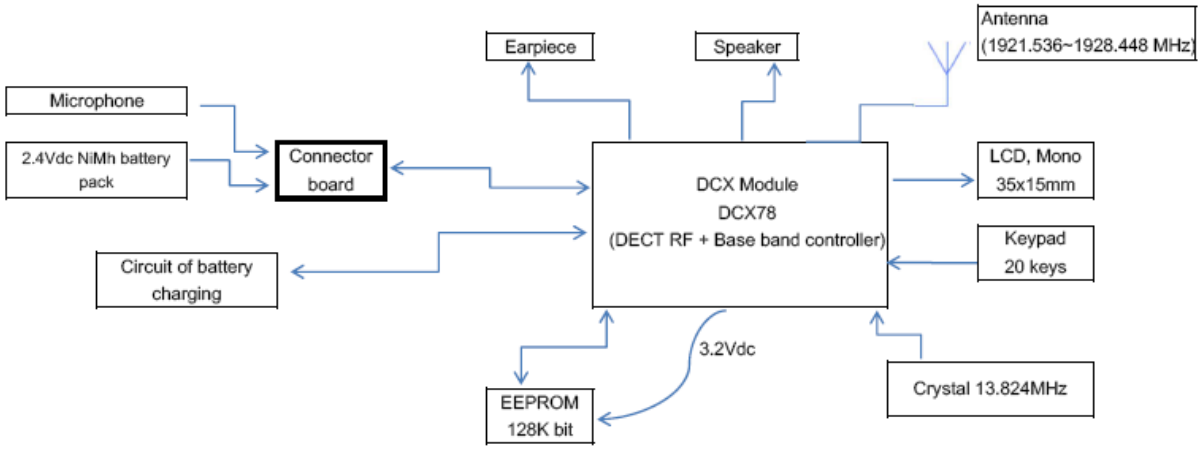
2.4 External Memory

The system contains one external EEPROM of size 128KBit, which stores system data as well as phonebook and redial buffers.

2.5 Charge Control and Cradle-detection

The charging control is done by Q5, Q6 & Q8. The controller can switch on/off the charging current through Q8 while current limitation is defined by R9. Note that R83 is to provide over-current protection for safety. Cradle detection is done by R11 & R12. Hence one MCU’ s I/O is working as input and output to perform charging control and cradle-detection functions.

2.6 Block Diagram



3. DECT RF between Handset and Base Unit

The same RF part is embedded on DCX78 chip in both handset and base. It is including a transceiver and a power amplifier.

The transceiver handles all the DECT RF transmit and receive. The power amplifier increase the

transmit power to increase the range of the system.

* Only layout is different for handset RF and base RF

3.1 Transmit chain

As the output frequency of the synthesizer is determined by adjusting the digital control stream to the dual modulus divider, it is relatively simple to frequency modulate the PLL. A digital word (proportional to the desired instantaneous amplitude of the TX modulation data) is simply summed with the digital control stream output of the Δ-Σ modulator. This causes the output frequency to increase or decrease proportional to the digital word. The digital modulation word is not held constant across the duration of a bit applied to the TR_DATA input, but rather is stepped in a sequence that synthesizes a Gaussian-filtered (BT=0.5, 0.6, 0.7) version of the input data stream. Thus the TR_DATA input data stream is not actually digitally filtered, but instead the edge transitions on the TR_DATA input pin are used to synchronously recall a digitally synthesized waveform from an internal lookup table. The signal at the TR_DATA input is processed as a digital data stream; the resulting deviation is not a function of the amplitude of this input. The magnitude of the Deviation can be adjusted via Register 0x92

2-stage PA with +25.5dBm output (typical) and programmability over a 10dB range. The ramp up and ramp down characteristic are programmable to allow shaping of response within desired Power-Time template. Furthermore, the PLL can be predistorted prior to/during ramp up to accelerate relock time and stabilization of frequency-time template.
The output of the printed BPF is routed to the antenna with a power level of <1W conducted in to the antenna as per the FCC requirement

3.2 RX Chain

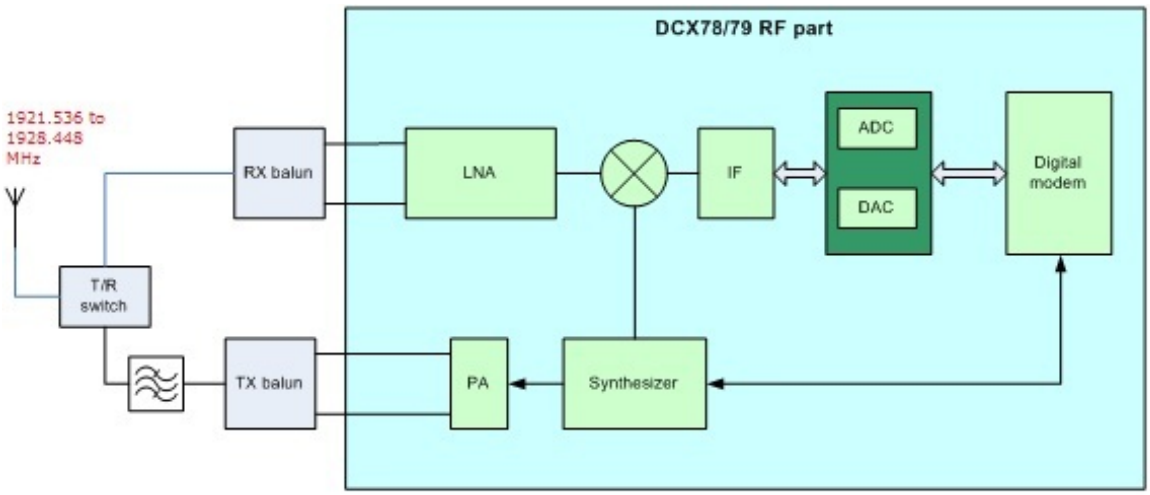
The front end circuitry is the same as the TX Chain. The antenna is connected to the bandpass filter and balun.

The differential input LNA is biased internally so AC coupling to RXp and RXn is required.

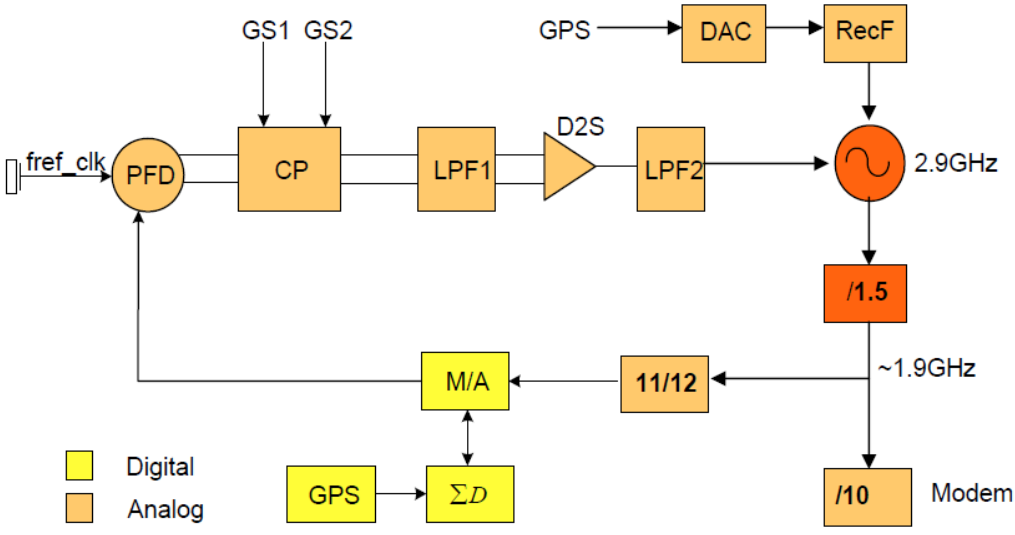
The use of a low order Δ-Σ modulator with a multi-level quantizer allows for low current consumption and high dynamic range. The ADC design utilizes a second order Δ-Σ modulator with an internal three bit flash ADC. The sampling rate of the ADC is 47MHz with a signal bandwidth of 1MHz which results in an over-sampling ratio of 32. The expected SNR over this bandwidth is 55dB. The input peak-to-peak differential voltage is 3V. The ADC’s effective number of bits is 8.5 with a SFDR of 55dB.
Using high performance Σ Δ ADC’s allows channel filtering, image rejection and demodulation to be performed in the digital domain where it can be done with less area, be more reconfigurable, and flexible. Decimation filters and Complex Selectivity filters will follow the ADCs. The RSSI will be

measured and evaluated at this point and used to control the Antenna Selection Switch and Receive Gain Control Switch. Following the Complex Selectivity filters are the IF Signal Normalizer, and the Frequency Descriminator Block. The signal is then equalized, sliced and fed to the baseband for further processing.

3.3 RF Block diagram



RF block diagram



Synthesizer block diagram

3.4 System Description

In standby mode, the system will consist of a maximum of 4 Portable Parts (PP – i.e. handsets) and a single Fixed Part (FP – i.e. base station). In talking mode, each base unit could talk with 2

handsets in maximum. It will use Multi Carrier, Time Division Multiple Access and Time Division Duplex (MC/TDMA/TDD) in the 1921.536 to 1928.448 MHz frequency band. The base and the multiple handsets will be multiplexed using a Time Division Multiple Access (TDMA) method. Time Division Duplex (TDD) is employed for exchanging information between the base station and the various handsets. The slot format of a single frame is shown below in Figure 1.

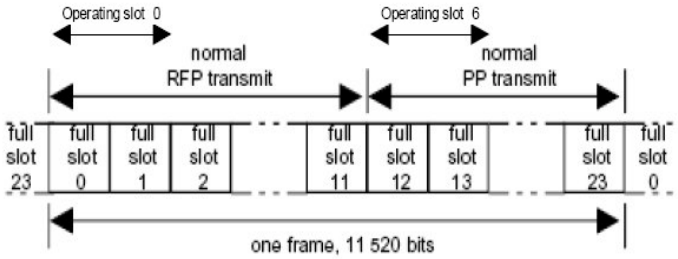


Figure 1: TDMA Frame

Each frame is 10 ms long. A frame is divided into 24 slots and the length of time for a slot is about 417μs. A packet of data is completely transmitted within a slot time. The data rate is 1152 kbps. The operation slot is based on single-slot. Each voice communication link will use up the slots as follow: Slots 0 through 11 are only used by the base for transmitting to the handsets and slots 12 through 23 are only for the base to receive data from the handsets. When a link between the base and handset is active, the slot-pair used are spaced half a frame apart, that is slots 1 and 13, slots 2 and 14, slots 3 and 15, and slots 4 and 16, are the of slot-pairs that are exclusively used for communication link or connection; for example slot 1 and slot 7 would never be used for a link.

3.5 Wireless Link Operation

The slot-pairs are not permanently assigned to a handset but instead are dynamically assigned to a handset/base link as necessary. This system can support more than four handsets, although, only four communication links can be active at any time. The base transmits a dummy bearer on the 1st slot. Any of the handsets registered to the system are able to receive and synchronize to the dummy bearer. The handsets periodically wake and receive the dummy bearer from the base. If required, the handsets transmit a packet back to the base on the dummy bearer' s corresponding receive slot time. When a dedicated link or connection between the base and a handset is required, a traffic bearer is created on one of the other slot-pairs. The handset and base then begin exchanging data using the traffic bearer. The dummy bearer remains active and the remaining handsets remain synchronized to it. At the end of the link, the traffic bearer is released and the handset returns to the dummy bearer. At maximum capacity, when a fourth link is set up, the dummy bearer is switched to a traffic bearer. Once a dedicated link has been terminated and the traffic bearer is released, the dummy bearer is

re-established.

3.6 RF Channel Plan

Following table shows the RF channel plan for the telephone. The table displays the channel number and the transmit frequencies for both fixed and portable parts.

RF Channel Plan Common Frequencies

XTALFreq	13.824MHz
Channel Spacing	1.728MHz

Frequency table

RF Channel	TX/RX frequency (MHz)	VCO frequency (MHz)
0	1928.448	2892.672
1	1926.720	2890.080
2	1924.992	2887.448
3	1923.264	2884.896
4	1921.536	2882.304

Antenna gain

Handset = 0 dBi

Base unit= 0 dBi for both Ant_1 and Ant_2

Note

1.) The monitoring bandwidth of this system is equal to the emission bandwidth of intend emission

2.) The telephone system support up to 2 handsets in single slot mode

3.7 Security Code Information:

Base and Handset unit have a unique 40bit ID to distinguish between different bases and handsets. It is sequential assigned in factory. During registration, a 64bit security code is randomly generated and stored in the non-volatile memory (EEPROM) of base and handset. During communication, this security code must be matched with the 40bit ID of the registration pair. This function is used to provide protection against unintentional access to the telephone network by the base unit and unintentional ringing by the handset. Each handset and base has unique security code.

3.8 Special Declaration

It does not use the provisions of 47CFR 15.323 (c) (6), random waiting mechanism is not used in this system.

The provisions of 47CFR 15.323 (c) (10) and 47CFR 15.323 (c) (11) are not used to extend the range of spectrum occupied over space or time for the purpose of denying fair access to spectrum to other devices.

Only the handset will act as the initiating device, which will initiate the establishment of the duplex connection.

4. Technical description of Bluetooth Module

4.1 System design

There is BC4 single chip radio and baseband IC for Bluetooth in module. It interfaces to 8Mbit of external flash memory. It provides a fully compliant Bluetooth system to V2.0 of the specification for data and voice communications.

4.2 Theory of operation

The Bluetooth module interfaces to host MCU through PCM digital audio and UART interface.
The RF output of BC4 chip connects to antenna through 2.4GHz bandpass filter.

4.3 Description of Bluetooth RF

The receiver features a near-zero Intermediate Frequency (IF) architecture that allows the channel filters to be integrated onto the die. Sufficient out-of-band blocking specification at the low Noise Amplifier (LNA) input allows the radio to be used in close proximity to Global System for Mobile Communications (GSM) and Wideband Code Division Multiple Access (W-CDMA) cellular phone transmitters without being desensitized. The use of a digital Frequency Shift Keying (FSK) discriminator means that no discriminator tank is needed and its excellent performance in the presence of noise allows BlueCore4-External to exceed the Bluetooth requirements for co-channel and adjacent channel rejection.
The Analogue to Digital Converter (ADC) is used to implement fast Automatic Gain Control (AGC). The ADC samples the Received Signal Strength Indicator (RSSI) voltage on a slot-by-slot basis. The front-end LNA gain is changed according to the measured RSSI value, keeping the first mixer input signal within a limited range. This improves the dynamic range of the receiver, improving performance in interference limited environments.

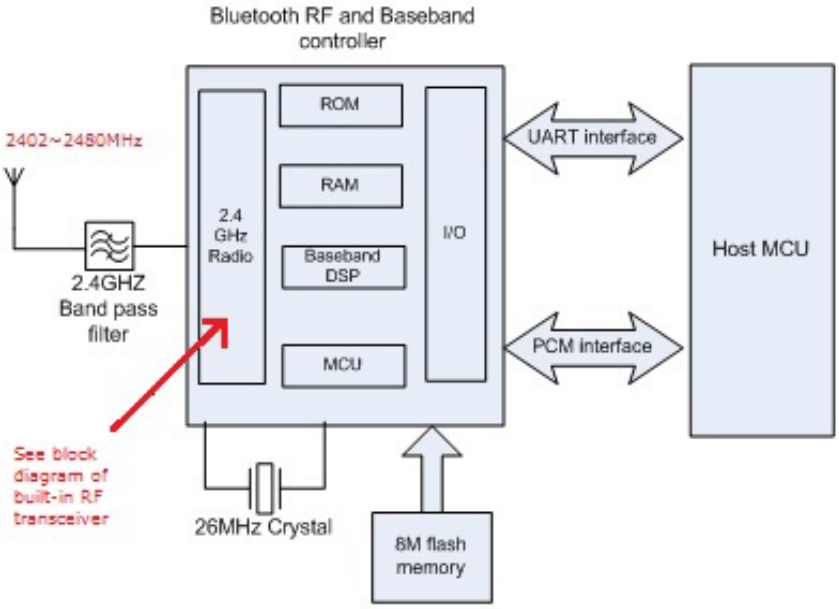
The transmitter features a direct IQ modulator to minimize the frequency drift during a transmit timeslot, which results in a controlled modulation index. Digital baseband transmit circuitry provides the required spectral shaping. The internal Power Amplifier (PA) has a maximum output

power of +6dBm. This allows BlueCore4-Extemal to be used in Class 2 and Class 3 radios without an external RF PA.

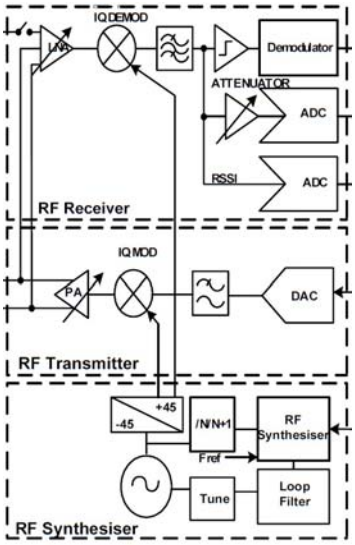
The radio synthesizer is fully integrated onto the die with no requirement for an external Voltage Controlled Oscillator (VCO) screening can, varactor tuning diodes, LC resonators or loop filter. The synthesizer is guaranteed to lock insufficient time across the guaranteed temperature range to meet the Bluetooth v2.0 specification. The reference clock for the system is generated from a TCXO or crystal input between 8MHz and 40MHz. All internal reference clocks are generated using a phase locked loop, which is locked to the external reference frequency

4.4 Block diagram

i.) Block diagram of Bluetooth module



ii.) Block diagram of built-in RF transceiver



4.4 RF specifications of Bluetooth module:

- Operation voltage: 3.3V
- Antenna gain: 0dB
- Number of channels: 79

Channel number	Channel frequency (MHz)
0	2402
1	2403
2	2404
3	2405
4	2406
5	2407
6	2408
7	2409
8	2410
9	2411
10	2412
11	2413
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