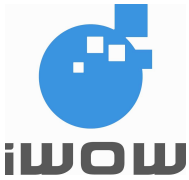

Duo Technical Operation

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1. INTRODUCTION

1.1 Purpose

This document will describe the technical operation of Duo phone.

1.2 Overview

The document will covered antennas, RF, Iden, Bluetooth and baseband peripheral.

1.3 References

NA

1.4 Abbreviation

Tx Transmit

Rx Receive

2. Antenna

There are two antenna designs implemented for the Duo phone. A Planar Inverted-F type Antenna (PIFA) is designed for the Tri-band (EGSM, DCS and PCS). A folded-J antenna is designed for the iDEN800/900 and GPS.

Band/Freq	Tx(MHz)	Rx(MHz)	Max. Tx pwr (dBm)
EGSM900	880-915	925-960	33
DCS1800	1710-1785	1805-1880	30
PCS1900	1850-1910	1930-1990	30

Table 2.: The frequency operation for EGSM, DCS and PCS bands.

3. GSM RF System

Duo GSM system supports EU Tri-Band GSM system, which comprises EGSM 900, DCS 1800, and PCS 1900 bands. The GSM system consists of a few main chips; they are TritonLite, which handles power and audio, Locosto Plus, which handles the Digital Base Band (DBB) and Digital Radio Processor (DRP), and RF Front End Module (FEM), which includes RF Switch and Power Amplifier (PA). The whole system runs on a 32.768 kHz real time clock, while the DRP also makes use of the 13 MHz clock produced from a 26 MHz crystal.

Besides the GSM RF system, Locosto Plus and TritonLite also handle other peripherals such as USB, audio, SIM, and interfaces to other chips, but this part of the document will only focus on the GSM RF portion.

TritonLite

TritonLite chip is the analog and power management part of the system. This IC controls the power to the whole system including power for the DRP. The power supplied from TritonLite to the DRP mainly consists of VCORE, VDDOSC, VDDRF, and VDDX. All these supplies are pre-regulated supplies, which are regulated in the Locosto Plus chip. VCORE is the main 1.3V digital supply for the DRP core. VDDOSC is a 1.4V supply for the oscillator. VDDRF supplies the Pre-PA circuitry with 1.4V. VDDX is to supply 1.4V to the DCXO.

Locosto Plus

Locosto is the main radio processor for GSM in the whole system; it consists of DBB and DRP. Its DRP part is a digital RF transceiver that supports Quad-Band GSM system and also GPRS. But in Duo phone, only EU Tri-Band is supported, which comprises of EGSM 900, DCS 1800, and PCS 1900. The DBB part supports the processing of GSM radio signals in switching circuit mode and also packet data mode. Basically the whole RF related signals are processed inside Locosto chip before they are passed to other components such as RF FEM.

Locosto radio interface is based on a DRP module which integrates a receiver based on a near zero Intermediate Frequency (IF) or a zero IF architecture and a transmitter based on an All-Digital Phase Locked Loop (ADPLL) synthesizer which has a phase/frequency modulation capability. The receiver Local Oscillator (LO) generation is performed by the ADPLL synthesizer.

All the power rails in Locosto are supplied by TritonLite and regulated by LDOs inside Locosto as mentioned above. Digital grounds and RF grounds of Locosto chip are separated from each other to avoid disturbance and coupling through the grounds.

An external 26MHz crystal is connected to Locosto crystal input. The reference clock in Locosto is based on DCXO architecture. Hence, this 26MHz crystal is needed by the internal oscillator. The Automatic Frequency Control (AFC) in Locosto DRP is done by programming the corresponding registers through the control interface. Frequency correction is accomplished by digital control of the internal oscillator capacitor.

One of the most important parts of Locosto RF is the Automatic Power Control (APC). The APC generates an envelope signal to control the power ramp-up, power ramp-down, and the power level of the radio burst coming out of the power amplifier. Its structure is intended to support single-slot and multi-slot transmissions with smooth power transitions when consecutive bursts are transmitted at different power levels.

The APC is placed inside the DRP wrapper, which interfaces the DRP to the DBB. It consists of a digital section (APCD) and an analog section. APCD generates the correct ramping profiles from coefficients stored in a RAM and handles the sequencing of the ramp-up/ramp-down operations. Analog section of the APC consists of a DAC, an output amplifier, a reference, and a LDO to produce the correct output power levels.

Locosto APC generates an output signal to control the ramping of the RF FEM. Locosto also manages the signals to control the RF FEM switching. There are a few control signals to the RF FEM which need to be configured correctly in order to set the RF FEM to the correct band (EGSM/DCS/PCS) and mode of operation (Tx/Rx).

Locosto output RF signals (Tx) are connected through a Pre-PA circuitry before going to the PA inside the RF FEM. Only discrete components (RLC) are used in this circuitry. The purpose of this Pre-PA circuitry is to amplify the signals to the appropriate level such that they can be recognized by the PA. Locosto input RF signals (Rx) come from the RF FEM through SAW Filter and matching circuitry. The purpose of this SAW filter circuitry is to pass/filter the signals according to the appropriate band of operation.

RF FEM

The RF FEM used in Duo phone is a PA with integrated front end antenna switch with harmonic filtering functionality. The main purpose of this chip is to switch the antenna connection to the corresponding band of operation, and to amplify the RF signals output from Locosto such that they can be transmitted by the antenna.

The input power taken by the PA ranges from 2 to 6 dBm and the output power produced is up to 33 dBm. The ramping of the output power for different power levels is controlled by Locosto by varying the power control voltage to the Vramp input of the PA. Four controlling signals are used to configure the FEM to the corresponding band of operation (EGSM/DCS/PCS) and to transmit or receive. At the same time, the FEM will also attenuate the harmonic spurious at the corresponding frequency bands.

	EGSM900	DCS1800	PCS1900	Units
Output (Tx) Frequency	880-915	1710-1785	1850-1910	MHz
Input (Rx) Frequency	925-960	1805-1880	1930-1990	MHz
Number of Channels	173	374	299	channels
Max. Transmit Power	33	30	30	dBm
Frequency Stability	±0.1	±0.1	±0.1	ppm
Max. RMS Phase Error	5	5	5	degree
Max. Peak Phase Error	20	20	20	degree
	EGSM900	**DCS1800**	**PCS1900**	**Units**
Output (Tx) Frequency	880-915	1710-1785	1850-1910	MHz
Input (Rx) Frequency	925-960	1805-1880	1930-1990	MHz
Number of Channels	173	374	299	channels
Max. Transmit Power	33	30	30	dBm
Frequency Stability	±0.1	±0.1	±0.1	ppm
Max. RMS Phase Error	5	5	5	degree
Max. Peak Phase Error	20	20	20	degree

Table 3: Fundamental Technical Specifications for Duo GSM System

4. Iden

The Iden module used in Duo is from Motorola iO270. It includes the following features:

i) Digital dispatch – allows groups of users to communicate among each other.
ii) Cellular-like telephone interconnects communications via the Public Switched Telephone Network.
iii) Short Message Service – SMS
iv) Circuit switched data capabilities.
v) Digital Data Networking.
vi) Allow private and group calling.

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Band/Freq	Tx(MHz)	Rx(MHz)
iDEN800	806-825	851-870
iDEN900	896-901	935-941

Table 4.: The frequency operation for iDEN800 and 900 bands.

5. Bluetooth

The Duo phone makes use of BlueCore 4-ROM WSP, which is a single-chip radio and baseband IC for Bluetooth 2.4GHz systems including EDR to 3Mbps. With the on-chip CSR Bluetooth software stack it provides a fully compliant Bluetooth system to v2.0+EDR of the specification for data and voice communications. It support A2DP , FTP ,OPP, HS, HF profile.

6. GPS

GPS SIRF 2 as defined by the io270 module. Duo shall be able to connect to existing GPS assistance infrastructure for location services.

7. Multimedia

The multimedia chip within Duo handset is a Renesas 32-Bit RISC Microcomputer, SH-Mobile series. This LSI uses SH4AL-DSP, a new generation of CPU core, delivering a clock speed of up to 216 MHz. It also includes MPEG4 and H.264 encoding/decoding accelerators to achieve high-speed multimedia processing, and a variety of interfaces such as a camera interface, NAND flash interface and more. It support interface to SD, nand, Bluetooth, camera, and LCD.

Camera

Duo support 2 Mega pixel camera that with QCIF, QQVGA, QVGA, VGA, SXGA, and UXGA picture size.

LCD

Duo support 2” TFT LCD, 176x220, 262K color.

SD card

Duo supports USB mass storage and SD size up to 2 GB.

Nand Flash

Duo support 512Mb Nand flash.

Bluetooth

Duo support UART interface to Bluetooth.

8. Audio Codec

The audio peripheral used here is a Mobile Multimedia CODEC with Dual-mode Class AB/D Speaker Driver. The speaker driver integrated within can support up to 1W in both classes AB or D. Low leakage; high PSRR and pop suppression enable direct battery connection for speaker supply. An extra 2.5W mono class D power amplifier is added to boost up the loudness of the audio when Duo is used in speaker phone mode. Two unit of stereo speaker is attached to the output of this power amplifier and another unit of stereo speaker is attached to the codec, used as the receiver.

9. Capacitor Sensing Keypad

The keypad makes use of an integrated CDC with on-chip environmental calibration. The keypad has 12 inputs channeled through a switch matrix to a 16-bit, 250 kHz sigma-delta (Σ-Δ) converter.
The CDC is capable of sensing changes in the capacitance of the external sensors and uses this information to register sensor activations. The result of each capacitance-to-digital conversion is stored in on-chip registers. The host subsequently reads the results over the I^2C.

The keypad can be set up to implement any set of input sensors by programming the on-chip registers. The registers can also be programmed to control features such as averaging, offsets, and gains for each of the external sensors. There is an on-chip sequencer that controls how each of the capacitance inputs is polled.

The keypad has on-chip digital logic and 528 words of RAM that are used for environmental compensation for the effects of humidity, temperature, and other environmental factors. Transparent to the user, the keypad performs continuous calibration to compensate for these effects, allowing the keypad to consistently provide error-free response.

Capacitance-Sensing Theory

The keypad measures capacitance changes from single-electrode sensors. The sensor electrode on the PCB comprises one plate of a virtual capacitor. The other plate of the capacitor is the user's finger, which is grounded with respect to the sensor input. The keypad first outputs an excitation signal to charge the plate of the capacitor. When the user comes close to the sensor, the virtual capacitor is formed, with the user acting as the second capacitor plate.

10. Light Sensor

The ambient light sensor is used to detect the brightness of the room. It should activate the backlight of the keypad in a dark environment and turned off the backlight of the keypad in a bright environment.