VS500 User manual of Technical part

Rev 1.0

Index

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H/W 3 Team , R&D Center

VACOM WIRELESS INC.

Ch 1. General Description

1.1 Introduction

This equipment is a Single mode (CDMA only) portable mobile station of which frequency range is 824～894MHz. It uses 3G CDMA 1x-RTT solution, the MSM6000 Mobile Station Modem Chipset and Software are designed to the IS-2000 Rel.0 Standard and enables up to a doubling of overall IS-95A/B voice capacity and production of cost-optimized voice only handset. CDMA network consists of MSO (Mobile Switching Office), BSC (Base Station Controller), BTS (Base station Transmission System) and MS (Mobile station). And the standard of Mobile station is as below.

- IS-95A/B, IS-2000 Release 0 (Common Air Interface): Protocol provisions between handset and base station.
- IS-96A (Vocoder): Code of voice signal which is applied to mobile station and system. Provision relating to compression (Used 8Kbps EVRC)
- TIA/EIA-98-D (Minimum performance standard for handset): Minimum performance standard relating to handset's H/W.
- TIA/EIA-126 (Service Option 2,9): Voice Loop back Service Options.
- IS-637 (Additional service): SMS (Short Message Service)

1.1.1 Basic parts

a. Handset
b. Charger (Travel Charger)
c. Standard Battery (950mA/H)

1.1.2 Handset

a. Transmitter part
b. Receiver part
c. Audio/Logic part
d. Others

1.1.3 Charger

a. Power code
b. Power supply parts
c. Others

Ch 2. SPECIFICATION

2.1 BASIC SPECICATION

a. Size(Max`) : 105mm * 45.1mm * 19.9mm
b. Weight : 74.5 g (with Standard Battery)
c. Supply Voltage : DC 3.8V (±10%)
d. Operating Temp. : -30℃ ~ 60℃
e. Battery : 950mAh Li-Ion (Standard)
   - Talk time(CDMA mode) : 194 min (-92dBm/Half Rate/ 970mAh/E8285A)
   - Antenna Type : internal PIFA

2.2 ELECTRICAL SPECIFICATION

2.2.1 CDMA TRANSMITTER

a. Frequency Range : 824 ~ 849MHz
b. Bandwidth : 1.23MHz
c. ERP at Max. Output Power : 200mW ~ 1W
d. Modulation Type : OQPSK
e. Frequency Stability : ±2.5ppm
f. Occupied Bandwidth : 1.32MHz
g. Conducted Spurious Emission :

- - 42dBc/30KHz (±900KHz)
- - 54dBc/30KHz (±1.98MHz)
-

2.2.2 CDMA RECEIVER

a. Frequency Range : 869 ~ 894MHz
b. Bandwidth : 1.23MHz
c. Sensitivity : -104dBm
d. Single Tone Desensitization : -101dBm (offset : ±900KHz, -30dBm)
e. Intermodulation spurious Response Attenuation :
   - - 101dBm (offset : ±900KHz, ±1700KHz ,–43dBm)
   - - 90dBm (offset : ±900KHz, ±1700KHz ,–32dBm)
   - - 79Bm (offset : ±900KHz, ±1700KHz ,–21dBm)
f. Conducted Spurious Emission :

- Receiver Band : -81dBm/1MHz
- Transmitter Band : -61dBm/1MHz
- Other Band : -47dBm/30KHz

Ch 3. CIRCUIT DESCRIPTION

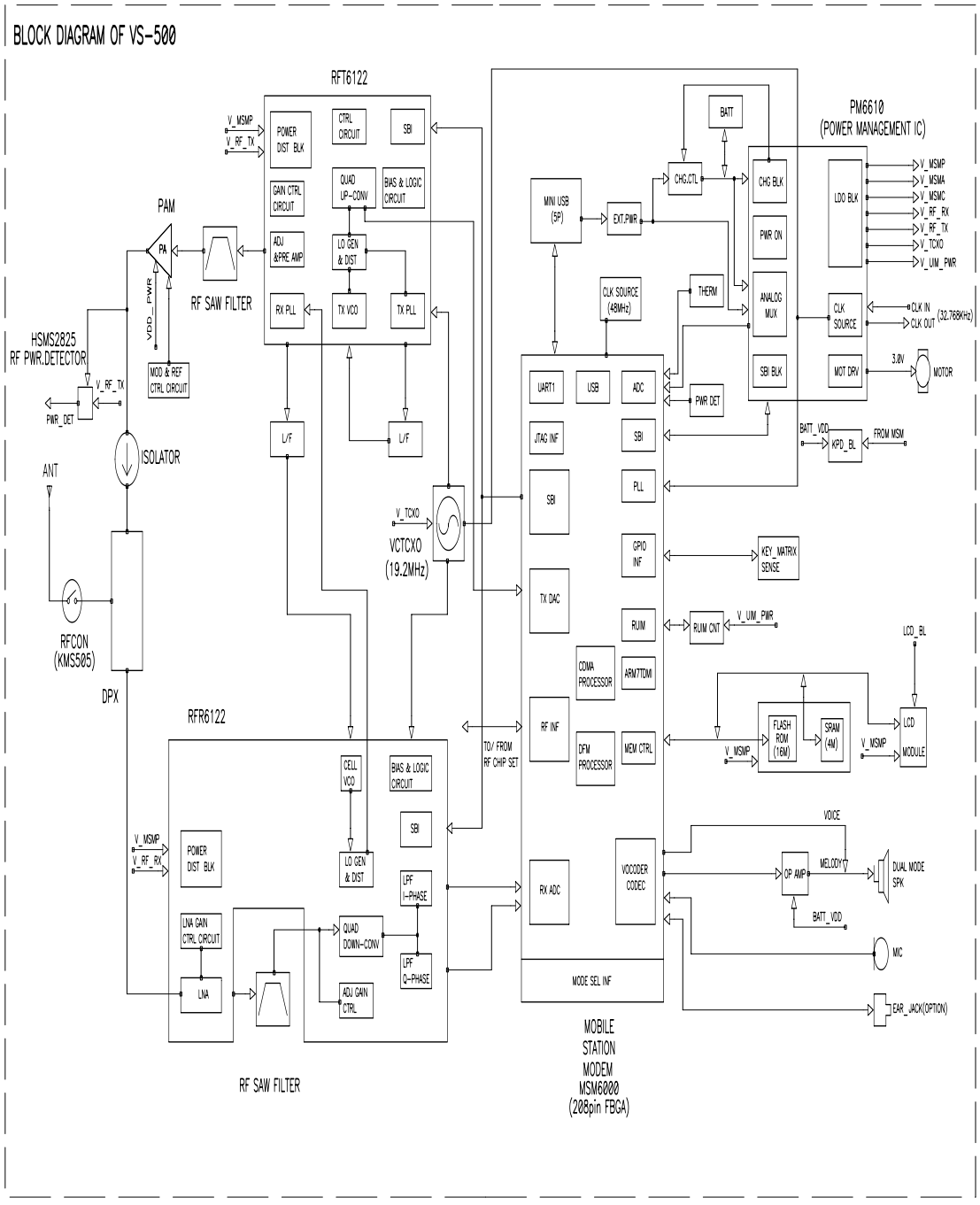
3.1 GENERAL

- RF (Radio frequency) Block & Base band Block
- Audio/Logic Part, Receiver Part, Transmitting Part,
- Audio/Logic Part : Power Management, Base band Signal Processor, Audio, User Interface, PC Interface, Clock, RX/TX Control
- TX Part : Transmitter part converts the frequency of signal to transmit into radio frequency, amplifies the signal and transmits signals to Base Station through Duplexer and Antenna.
- RX Part : Receiver part amplifies received signal through LNA (Low Noise Amplifier) and converts it into base band frequency.

3.2 AUDIO/LOGIC PART

a. Mobile Station Modem: U1 (MSM6000)
b. Memory: U4 (PH28F160C3BD70) - 16Mbit Flash ROM
   U2 (K6F4016U6G-AF70) - 4Mbit Static RAM
   U5 (CAT24FC256WI) - 256Kbit EEPROM
c. Power Management: U3 (PM6610-2)
d. Audio Amplifier & Audio Interface: U10 (TPA751DGN)
e. KEY PAD / LCD MODULE
f. Mini USB Type Connector(Support only RS232C)

- SYSTEM BLOCK DIAGRAM



VS-500

2005.07.05 VS-500 BLOCK DIAGRAM

3.2.1 CIRCUIT DESCRIPTION

a. MSM6000: MSM6000 is a chipset responsible for User Interface, RF Interface, Digital Interface and especially for base-band digital signal processing of CDMA/FM.
b. FLASH MEMORY / SRAM: FLASH MEMORY & SRAM is for storing operation program, system parameters and additional parameters to manage handset. And it is a temporally place to preserve all system parameters and data related with Base Station.
c. Power Management : Basically it supplies controllable regulated powers to each parts for handset operation and offers charging control function for battery in the meaning of power management And it also conducts functions such as clock buffer, driver circuit for UI, sensor of initial power ignition.
d. Audio amplifier / Audio Interface: Audio signal for indicating notice of incoming calls needs to be amplified by audio AMP for noticeable sounds. Voice or key sounds are inputted directly to speaker from audio AMP output of MSM.
e. KEY PAD / LCD MODULE: These are interface parts between user and the handset like sensing of key pressing and displaying of handset states.
f. IO Connector : It offers physical connectivity for data communication and Diagnostic Monitor using RS232C protocol, and external power from charger or Level Translator circuit for test.

3.2.1.1 MOBILE SYSTEM MODEM – MSM6000

MSM6000 is a core component including ARM7TDMI CPU core for CDMA type cellular phones. It has 208 BALL FBGA package type and handles signals from RF, Digital and user action

a. Clock Interface (reference clock / 19.2MHz, Input) : It is the interface and processing part of 19.2MHz clock signal from VC-TCXO Crystal Oscillator, reference signal for all of clock regime
b. Reset Interface: It makes RESET signal for CPU reset at power on
c. Microprocessor Interface: It stands for embedded ARM CPU core in MSM6000 and its interface. It consists of CPU interface for memories or devices which need CPU control such as Flash/RAM, EEPROM, LCD and others. Address Bus(A1-A20) is for addressing to memory space of each device to forward or receive data. Data Bus(D0-D15) is the path for forwarding the data to devices or receiving the data from devices. And also there are signals to control data flows between device and CPU like RAM_CS, ROM_CS, LCD_CS, GP_CS, HWR_N, LWR_N and so on.
d. CODEC (Coder/Decoder) Interface: MSM6000 has a Voice Band Audio CODEC and provides Receiver/C-Mic, Hands-Free, Ear Phone Interface through 3pairs of embedded audio AMPs.
e. UART (Universal Asynchronous Receiver Transmitter) Interface: It is the RS-232 protocol interface for diagnosis of handset or data communication with PC. And it consists of UART1 and

UART2. UART1 is used for test and debugging and user-defined download program.

f. JTAG (Joint Test Action Group) Interface: It is used for board test and debugging with Boundary Scan. And it can be used as S/W Upgrade by S/W Downloading function.

g. RF Transmit Interface: It controls Tx RF Signal and output power through providing differential Base band I/Q Signals and TX_AGC_ADJ signal.

Transmit power strength is controlled by TX_AGC_ADJ which is result of RF calibration in RFT6122.

RF Receive Interface : It manages received RX_IM, RX_QM, RX_IP, RX_QP signals from RFR6122

h. Serial Bus Interface: It controls the action of RFR6122, RFT6122 and PM6610 using serial bus interface protocol.

i. Others

A. Reference Oscillator Tracking: Compensates error of VCTCXO frequency with TRK_LO_ADJ signal.

B. ADCs : There are seven 8bit House-Keeping ADCs which can be used for user-defined functions.

In this model, we use MSM embedded ADCs for earphone detection, earphone send/end function, RF Tx Power detection, temperature check, voltage and current of PM6610 check

C. GPIOs : There are totally 50 General Purpose Input/Output ports as interrupt sources

But many of these have alternative inherent functions, so we use a part of these as user-defined function.

3.2.1.2 AUDIO PART

Audio part is composed of transmit/receive phonetic treatment part .

3.2.1.2.1 TX AUDIO PATH

The microphone interface consists of two differential microphone inputs, one differential auxiliary input. Each has a two-stage gain programmable amplifier. And there are two optional digital filters on Tx path prior to the vocoder, a slope filter and a high-pass filter which has a user programmable frequency response.

3.2.1.2.2 RX AUDIO PATH

The Receive path can be directed to one of two earphone amplifiers or the auxiliary output. Their gain and path can be controlled by software. And it has user selectable high-pass filter, 2's complement FIR filter after the amplifier.

3.2.1.2.3 Audio AMP/Audio Interface

Audio AMP amplifies and sounds Alert Tone or Receiving Call Ringing. Its signal source is from internally generated codec circuit of MSM6000. Its output gain is set by H/W but sound volume can be controlled by S/W.

Key Tone is transmitted to Receiver unit after converting VOCODER DTMF Signal in MSM6000 to AUDIO RX PATH Signal. If a hand-free mode is started by using like earphone, Key Tone is sounded through the hands-free path. And also during the conversation, Ring Back Tone or Voice is sounded through a Hands-free speaker and MIC in this mode.

3.2.1.3 POWER MANAGEMENT PART

The PM6610 device integrates all handset power management and some user interface functions.

a. Input Power Management: An unregulated external power requires the PM6610 IC to provide closed-loop control of the pass transistor. In this mode, the handset supply voltage and current are regulated by the PM6610 IC for battery charging or normal operation
b. Output Voltage Regulation: Seven voltage regulators are provided all have programmable voltages and derived from a common band-gap reference using low dropout voltage circuits.
c. ADC interface: it allows precise voltage and current measurement of external power and battery for charging control and voltage/current control of main power. PM6610 forwards multiplexed analog voltage to one of HKADC in MSM for analog to digital conversion
d. User interfaces: PM6000 IC also supports common handset-level user interfaces like power-on key sensing and driving LEDs or vibration motor.
e. IC interfaces: The primary IC-level interface is the MSM-compatible 3-line serial bus interface(SBI) that provides efficient initialization, status checking and control of chipsets. Configurable device parameters are set through SBI control register, while many other registers are available to report parameter settings, device status, and interrupt events.

3.2.1.4 I/O Interface

It provides with interface between handset and peripheral accessory such as charger, level translator or data cable for data communication. Basically it has a pin for supply external power to power management part and two data lines for RS232C protocol. One pin to detect level translator or charger ignition is provided.

3.3 RECEIVER PART

- RFR6122 (LNA + RF to baseband Receiver_Quadrature I/Q Downconverter and internal VCO for CDMA mode)
- Receiver band Pass Filter (balance 100ohm out put impedance)
- Antenna
- Duplexer

3.3.1 MAIN FUNCTION

- Divide Receive/Transmit signal
- Low noise Amplify
- Direct Conversion
- Quadrature Demodulation
- Filtering of TX band signal and noise

3.3.2 BASIC OPERATION

RX Frequency (881.5 ±12.5MHz) which is passed by duplexer amplified through LNA(Low Noise Amplifier) path of RFR6122 and then input to pre-amplifier through RF SAW filter with balanced output. The pre-amplifier drive RF signal to quadrature RF to baseband downconverter. The downconverted baseband signals are multiplexed and routed to low pass filter. The filter output are buffered and passed on to the MSM device.

3.3.2.1 ANTENNA: (AT500)

It optimizes transmit/receive of radio wave in the air. It is internal PIFA type.

3.3.2.2 DPX (DUPLEXER): (DX501)

It has the function of separating transmit/receive signals in the full duplex system using the transmit/receive common antenna. Duplexer consists of the receive part band pass filter and the transmit part band pass filter, and ideal duplexer provides perfect isolation between transmit and receive parts. In other words, the transmit part band pass filter is used to suppress noises and spurious waves entering the receive band among transmit signals in order to improve sensitivity.

	RX	TX
Center Frequency	881.5 MHz	836.5 MHz
Bandwidth	± 12.5 MHz	± 12.5 MHz
Insertion Loss	1.9 dB (Typ.)	1.7 dB (Typ.)
Attenuation	824~894 MHz (57dB)	869~894 MHz (45dB)

3.3.2.3 LNA part of RFR6122:(U511 - LNA part)

LNA transfers RF signal received through duplexer from base station as the most suitable signal. Because the first amplifier after the antenna in a receiver block contributes most significantly to system noise figure, LNA is used.

Division	Specification	Division	Specification
Frequency range	869 ~894 MHz		
CDMA Gain mode 0		CDMA Gain mode 2	
Gain	16 dB (Typ.)	Gain	-5 dB (Typ.)
Noise figure	1.5 dB (Type.)	Noise figure	5.5 dB (Type.)
IIP3	10 dBm	IIP3	15 dBm
CDMA Gain mode 1		CDMA Gain mode	
Gain	4 dB (Typ.)	Gain	-20 dB (Typ.)
Noise figure	5 dB (Type.)	Noise figure	20 dB (Type.)
IIP3	7 dBm	IIP3	15 dBm

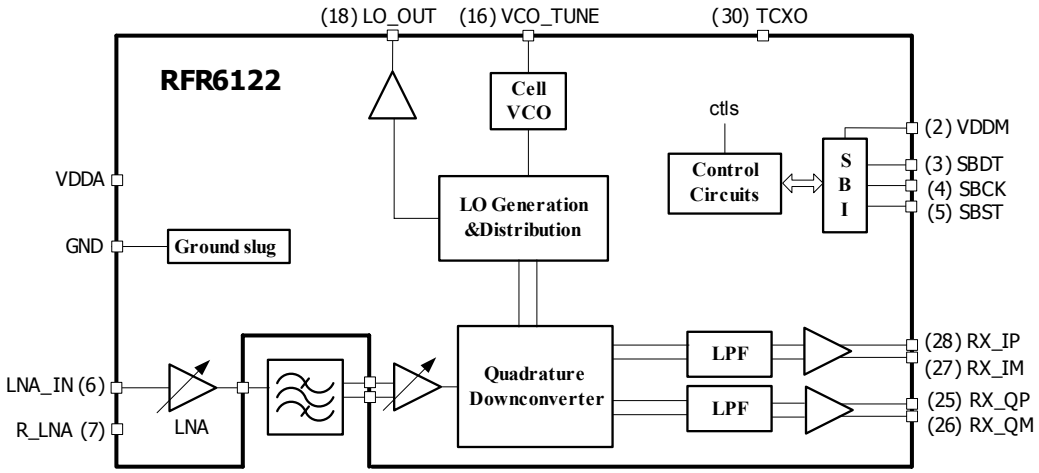
3.3.2.4 RF SAW FILTER: (SW511)

It takes receive frequency (881.5 ±12.5MHz) only and the bandwidth is 25MHz. And it eliminates signal except receive frequency like thermal noise contributed by TX signal. And it is consists of single input and balanced output port.

Division	Specification
Insertion loss	3.0 dB max
In-out VSWR	2.5 max
In band ripple	1.5 dB
Stop band attenuation (Tx band)	30 dB min

3.3.2.5 Quadrature I/Q Downconverter of RFR6122 : (U511 Mixer part)

Quadrature downconverter is to convert the RF signal (881.5 ±12.5MHz) amplified by LNA with the baseband signal directly. Rx signal path include MSM-controlled gain adjustments. And driven Rx signal passing AGC amplifier drive the RF port of the quadrature RF-to-baseband downconverter. The downconverted baseband outputs are multiplexed and routed to low pass filter. The filter outputs are buffered and passed on to the MSM processing.



RFR6122 Block diagram

3.3.2.6 Others of RFR6122 (U511)

Numerous secondary functions are integrated on-chip; the RX LO generation and distribution circuits, the UHF(Cellular-CDMA) VCO circuits, and various interface, control and status circuits,

3.4 TRANSMITTER PART

- RFT6122 (Baseband to RF transmitter IC of qualcomm's radioOne Zero-IF chipset.)
- Power Amp
- TX Frequency Band Pass Filter
- Power Detection circuits
- Isolator

3.4.1 MAIN FUNCTION

- Quadrature Modulation and Upconvertion
- Filtering
- Power Amplify
- Tx AGC
- Power detection

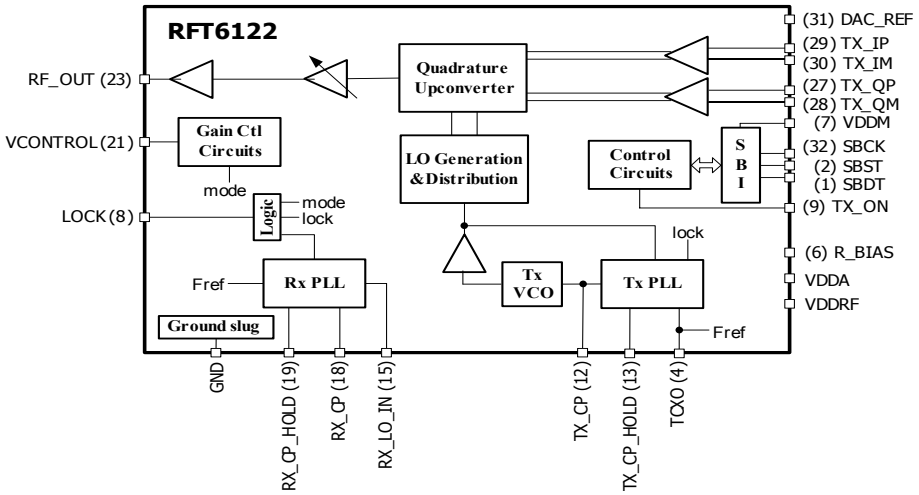
3.4.2 BASIC OPERATION

I and Q differential baseband Signals from MSM6000 are changed to Tx RF Signal through quadrature upconverter and drive to gain controlled amplifier. This signal is input to Power Amplifier through passing RF SAW FILTER and then it is amplified as high power and radiated through duplexer and

antenna.

3.4.2.1 RFT6122 : (U541)

The RFT6122 provides the Zero-IF transmitter signal path, from analog baseband to RF drive amplifier, for single band single-mode. Secondary functions are integrated on chip , two PLL circuits(TX LO and RX LO), TX VCO circuit, TX LO generation and distribution circuits, and various interface, control, etc..



3.4.2.2 RF SAW FILTER: (SW571)

It eliminates other signals except transmit frequency of CDMA handset (836.5±12.5MHz) and bandwidth is 25MHz.

Division	Specification
Insertion loss	2.5 dB max
In-out VSWR	2.0 max
In band ripple	1.5 dB
Stop band attenuation (Tx band)	30 dB min

3.4.2.3 POWER AMPLIFIER (PA): (U572)

Power AMP is to amplify the signal to reach Base Station.

Division	Specification
Power output level	28 dBm (CDMA) // 31 dBm(AMPS)
Power gain	27.5 dB typ
Power added efficiency	40 % typ @ max power
Input VSWR	2 : 1
Load matching stress VSWR	8 : 1

3.4.2.4 POWER DETECTOR (D571)

It is to detect of Tx output signal for HDET Data. Using schottky barrier diode.

3.4.2.5 Isolator (U573)

It is to provide constant load and impedance to PAM. It's Insertion loss is 0.7 dB typical and isolation is over 15 dB.