TaiChi
Service Manual

1. Preface/Foreword/General Safety Information

Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It is intended primarily to support basic servicing, which consists primarily of mechanical repairs and circuit board replacement.

Authorized distributors may opt to receive additional training to become authorized to perform limited component repairs. Contact your regional Customer Support Manager for details.

Model and Kit Identification

Motorola products are all specifically identified by an overall model number on the product FCC label. In most cases, assemblies and kits which make up the equipment also have kit numbers stamped on them.

Service

Motorola's regional Cellular Subscriber Service Centers offer some of the finest repair capabilities available to Motorla Subscriber equipment users. The Cellular Subscriber Service Centers are able to perform computerized adjustments and repair most defective transceivers and boards. Contact your regional Customer Service Manager for more information about Motorola's repair capabilities and policy for in-warranty and out-of-warranty repairs in your region.

Replacement Parts Ordering

Motorola maintains a parts office staffed to process parts orders,identify part numbers,and otherwise assist in the maintenance and repair of Motorola Cellular products.Orders for all parts should be send to the Motorola (China) Inc.Personal Communication Enterprise Department Full Quality Service Center Spare Parts Department at the following address:

Address:
A39,Zizhuyuan Road,Haidian,Beijing
Motorola (China) Inc.
Personal Communication Enterprise Department
Full Quality Service Center Spare Parts Department
Call: 68437222-1011 or 68438724
Fax: 68420990

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components,kits,and chassis.If the component part number is not known,the order should include the number of the chassis

or kit of which it is a part, and sufficient description of the desired component to identify it.

General Safety Information

CAUTION

Do not jump start vehicle or use an automotive battery charger while the vehicle adapter option and the portable radiotelephone are connected to the vehicle electrical system as this may cause serious damage to the radio. Disconnect the radio by removing the cable kit tuses.

Portable Operation

DO NOT hold the radio so that the antenna is very close to, or touching, exposed parts of the body, especially the face or eyes, while transmitting. The radio will perform best if it is held in the same manner as you would hold a telephone handset, with the antenna angled up and over your shoulder. Speak directly into the mouthpiece.

DO NOT operate the telephone in an airplane.

DO NOT allow children to play with any radio equipment containing a transmitter.

Mobile Operation

As with other mobile radio transmitting equipment, users are advised that for satisfactory operation of the equipment and for the safety of personnel, it is recommended that no part of the human body shall be allowed to come within 20 centimeters of the antenna during operation of the equipment.

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere. Mobile telephones are under certain conditions capable of interfering with blasting operations. When in the vicinity of construction work, look for and observe signs cautioning against mobile radio transmission. If transmission is prohibited, the cellular telephone **must be turned off** to prevent any transmission. *In standby mode, the mobile telephone will automatically transmit to acknowledge a call if it is not turned off.*

All equipment must be properly grounded according to installation instructions for safe operation.
All equipment only can be maintained by qualified specialist.

Driving and Mobile Operation

Give full attention to the safety while driving. The driver can only use the mobile telephone when it is safety. Using wireless telephone while driving in some regions is illegal .

See relating section of the Products Service Manual for other information of safety.

2.Content

3.General Description

3.1Product Description

Overview

A6188 is a microprocessor controlled, full duplex, synthesized FM radiotelephone using digital modulation techniques, for use in compatible 900MHz/1800MHz cellular radiotelephone systems. When operated properly, the equipment will provide the user with land-linked telephone service through individual cell site base stations, all linked to a central control office.

Physical Packing

It introduces Five major new IC's known as WHITECAP,MAGTC,GCAP? ,MCIC, TX-VCO IC and Dragonball.All IC's are BGA parts(Ball Grid Array) except TX-VCO module.The antennas style is Telescopic direct connect.Vibrator is at the bottom of the back housing and not in the flip.There is no auxiliary battery. The type of the battery is CD928, and the charge/discharge parameters are readjusted. The battery selecting circuit is eliminated.

There are six cans covering the PC board, it uses a mini SIM Card holder and connector is protected by the battery as in d560 and Modulus? .

The RF power levels of A6188 are the same as for all previous GSM products.

The accessory connector, situated at the top of the A6188 on the main board, allows connections to the circuity and antenna for accessory applications such as a mobile adaptor. When the accessory RF connector is used, the RF to the antenna is disconnected. Grounding shields,(with removable covers) on the main board provide electrical isolation and protection to the RF circuits.

3. 2 Features/Feature List

Features

Dual Band Capability: The phone can automatically change the phone operation from GSM band to DCS 1800 band and vice verse.This provides advantages for two different types of Network Operators:

*A DCS1800 Operator may allow users to roam onto GSM nerworks. Thus,the DCS1800 user potentially has the same geographical coverage as a GSM user, often wider than he would with a pure DCS1800 phone.

*A Network Opeator with both GSM and DCS1800 systems may allow users to use either system.Thus, if the DCS1800 system is busy or there is no system coverage, the phone can attempt a call on the GSM band and vice verse.

Taichi Feature List:

Note: The products research work is not completed,so the feature listed below is subject to changed.

·Selective housing color: gray/silver, size: about 157cc,weight:about 175g(Standard 900mAh Li Battery)
·Li Battery ,900mA, standby time: 130-260 hours,talk time: 4-6 hours.*
·GSM900/1800MHz automatic dual band*
·Icon user interface,full touch display(320*240 Grid Array),including keys such as: On/Off,Scroll,Volume,Record etc.
·Handwritting identification: Chinese/English. Creating Telephone Book in Chinese
·Sending and receiving short message in Chinese *
·Infrared interface, working with PC(installed Truesync software Chinese version),can provide functions such as Telephone Book transfering, short message editing and tranmitting, network access etc.
·Build-in headset jack
·Length of recoding time :3 minutes
·Vibrate alert
·New ringing tones
·Electroluminescent backlight as in Baodian,providing more uniform and efficient lighting than LED.
·Full rate/Enhanced full rate/Half rate coding, proving high clear voice quality. *
·Supporting Chinese SIM card increment service *
·English/Chinese, Chinese/English dictionary
·Calendar,Schedule,Alarm
·Notepad
·Calculator
·Real time worldwide clock
·Enhanced telephone book, supporting up to 1000 entries
·Supporting telephone book copy between SIM card and mobile telephone
·Sending and receiving email *
·Customing fixed phrase and automatic signature used in short message/email by user
·Unique base charger and special cable, when working together,can also be used as the communication connector of the mobile telephone and the PC **
·Carry case, Headset,and toughing pen(free)

* Need system support

3. 3 Key Unique Featuresof the phone

A6188 Key/Unique Features

A6188 operates in GSM 900 and DCS 1800 bands and utilizes phased signaling.It allows automatic seamless hand over between bands(GSM 900 or DCS 1800) during a call.This phone supports automatic selection of single band networks in either band

depending on the list of preferred networks. There is no indication to the user which band the phone is currently operating on other than display of the PLMN.Manual selection of band mode by the user is not possible although a user may manually select a single PLMN. Although the A6188 has dual band capability each model is flexed as either a GSM or DCS primary phone.

4. Taichi Specifications

General

Function	GSM Specification	DCS Specifications
Frequency Range	890-915 MHz Tx, 935-960 MHz Rx	1710-1785MHz TX 1805-1880 MHz RX
Channel Spacing	200 KHz	
Channels	124 carriers with 8 channels per carrier	375 carriers with 8 cahnnels per carrier
Modulation	GMSK at BT = 0.3	
Transmitter Phase Accuracy	5 Degrees RMS, 20 Degrees peak	
Duplex Spacing	45 MHz	95 MHz
Frequency Stability	+/- .10 ppm of the downlink frequency (Rx)	
Operating Voltage	+3.9 Vdc to + 6.0 dc (battery)	
Transmit Current	200 mA average, 1.0 A peak	
Stand-by Current	Average 10mA (DR X 2)	Average 6mA DC X 2, 4 mA DC X 9
Dimensions	140mm(L) X 50mm(W) X 27mm (D) ???	
Size (Volume)	157cc ???	
Weight	Approximately 160g. Includes 700mAh Nicad battery pack and antenna. ???	
Temperature Range	-20 °C to +55 °C	-25 °C to +55 °C

Transmitter

RF Power Output	32 dBm +/- 2dBm	30 dBm +/- 2dBm
Output Impedance	50 ohms (nominal)	
Spurious Emissions	-36 dBm up to 1GHz, (<-30dBm > 1GHz) 22	
Power Steps	15	10

Receiver

RF Level	-102 dBm	-100 dBm
RX bit error rate (100 kbits)	< 2%	< 2%
Channel Hop Time	500 microseconds	
Time to Camp	Approximately 10 seconds	

Speech Coding

Speech Coding Type	Regular Pulse Excitation / Lineara Predictive Coding with Long Term Prediction. (RPE LPC with LTP.	
Bit Rate	13.0 kbps	
Frame Duration	20 ms	
Block Length	260 bits	
Classes	Class 1 bits = 182 bits. Class 2 bits = 78 bits	
Bit Rate with FEC Encoding	22.8 kbps	

5. Idetity and Security

5.1 Transceiver Labelling

Introduction

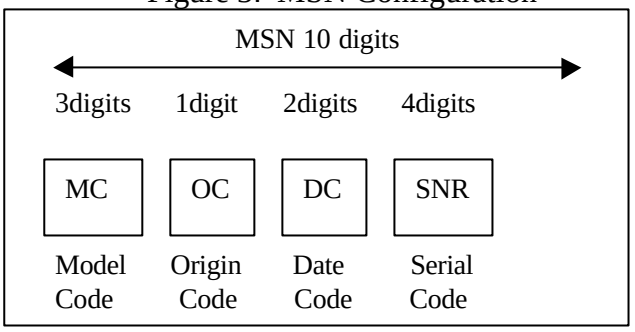
Each Motorola GSM transceiver will be labeled with various number configurations.The following information shows and explains the common labeling titles.

Title Explanations

MSN

The Mechaniacal Serial Number(MSN) is an individual number, uniquely identifying the unit. The MSN will remain the same throughout the units life, even if the main board is replaced. Because the MSN is unique to the unit, it is often used for logging and tracking purposes by Motorola National Service Centres on EPPRS. The MSN is divided into the sections shown below.

Figure 3: MSN Configuration

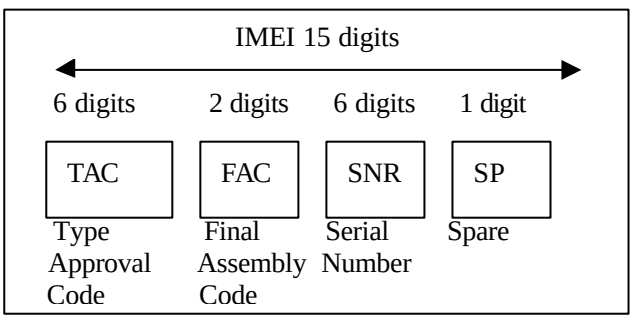


CEPT GSM

This is the International Mobile Station Equipment Identity (IMEI) number. The IMEI is held in the logic circuity.

If the main board is replaced then the units IMEI will change, therefore the units labellings should be updated with the new IMEI. An IMEI uniquely identifies a mobile station equipment to the system, and is divided into the sections shown below.

Figure4 : IMEI Configuration



REV S/H

This configuration consists of two blocks of two digits, and denotes the software and hardware versions within the unit. The first two digits correspond to the software version, and the last two digits correspond to the hardware version. If a version update is carried out on the unit, the correspongding change information should be made apparent on the labeling.

Model

The model number defines the type of product. Each product type is issued a common model number.

Package
The package number is used to determine the type of equipment, the mode in which it was sold, and the language with which it was shipped.

5.2 SIM CARDS

Introduction

Motorola V998 is designed to work with the mini size Subscriber Identity Module (SIM). The mini SIM card is inserted between the back housing of the phone and the battery. The SIM card contains all the personal data required to access GSM services. Data held by the SIM card includes:

- ·International Mobile Subscriber Identity
- ·Temporary Mobile subscriber Identity
- ·Home system
- ·Services subscribed to
- ·PIN and unblocking codes
- ·Call barring codes

The SIM card may also be capable of storing phone numbers and names.

SIM Card Insertion/Removal

The SIM card must be inserted into the unit correctly so that the card can be read, and the data checked for validity, before operation on the system will be enabled. The card contains all of the user's personal identification numbers and details of the system the phone operates on.

To remove the mini SIM card from the phone, open the battery door , then remove the SIM card after removing the battery. Whole information on mini SIM card insertion/removal can be derived from the unit's User Gude.

Security Information

To stop unauthorized personnel using your SIM card, the option of using a Personal Identity Number (PIN) is available. When enabled the option requires (on power up) a verification number to be entered via the unit's keypads, before the card can be used. Three attempts to enter the correct PIN may be made. If after the three entries the correct PIN has not been entered, the card becomes blocked. To unblock the card an unblocking/supper PIN code must be entered. Ten attempts to enter the correct unblocking code are permitted, if after ten attempts the correct code has not been entered, the SIM card is corrupted and becomes useless.

Another option available for the SIM card is call barring. If subscribed to, the call barring of incoming and/or outgoing calls may be accomplished by entering a special key sequence. The key sequence includes a "barring code", which determines the type of restriction incorporated, and a password to validate the request. The initial password is provided when
you subscribe to the service. The password can be changed by entering a set key sequence.

A valid standard mini SIM card can be used in any working GSM transceiver, regardless of the manufacturer, which is compatible with the standard mini size SIM card.

To protect the actual unit from unauthorized use, a lock function on the hardware is available. When enabled, this function requires that a three or four digit unlock code be entered, via the units keypad, before normal operation of the transceiver can take place. The lock code can be changed by entering a set key sequence.

Further information on set sequences can be derived from the unit's User Gude.

6. Theory Of Operation

6.1 GSM System Overview

Note
The following description is intended only as a preliminary general introduction to the Global System for Mobile communications (GSM) cellular network. This description is greatly simplified and does not illustrate the full operating capabilities, techniques, or technology incorporated in the system.

6.2 General Cellular Concept

The cellular systems are used to provide radiotelephone service in the frequency range 890-960MHz. A cellular system provides higher call handling capacity and system availability than would be possible with conventional radiotelephone systems (those which require total system area coverage on every operaing channel) by dividing the system coverage area into several adjoining sub-areas or cells.

Each cell contains a base station (cell site) which provides transmitting and receiving facilities, for an allocated set of duplex frequency pairs (channels). Since each cell is a relatively small area, both the cell site and the radiotelephone that it supports can operate at lower power level than would be used in conventional system.

Using this technique, radiation on a given channel is virtually contained in the cell operating on that channel and, to some extent, those cells directly adjacent to that cell.

Since the coverage area of a cell on a given channel is limited to a small area (relative to the total system coverage area), a channel may be reused in another cell outside the coverage area of the first. By this means, several subscribers may operate within the same geographic area, without interference with each other, on a single channel.

6.3 GSM Description

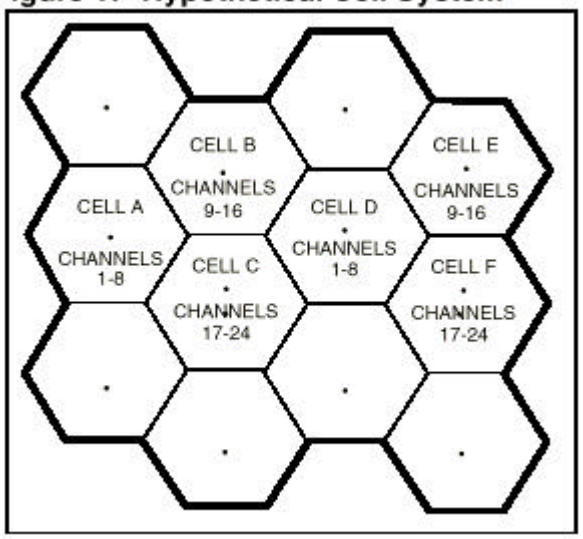
Unlike previous cellular systems, GSM uses digital radio techniques. The GSM system has the following advantages over previous analogue systems:

- International Roaming – Due to international harmonization and standardization, it will be possible to make and receive calls in any country which supports a GSM system.

- Digital Air Interface – The GSM phone will provide an entirely digital link between the telephone and the base station, which is, in turn, digitally linked into the switching subsystems and on into the PSTN.
- ISDN compatibility – ISDN is a digital communications standard that many countries are committed to implementing.. It is designed to carry digital voice and data over existing copper telephone cables. The GSM phone will be able to offer similar features to the ISDN telephone.
- Security and Confidentiality – Telephone calls on analogue systems can very easily be overheard by the use of a suitable radio receiver. GSM offers vastly improved confidentiality because of the way in which data is digitally encrypted and transmitted.
- Better Call Quality – Co-channel interference, handover breakes, and fading will be dealt with more effectively in the digital system. The call quality is also enhanced by error correction, which reconstructs lost information.
- Efficiency – The GSM system will be able to use spectral resources in a much more efficient way than previous analogue systems.

In the figure below, the area bounded by bold lines represents the total coverage area of a hypothetical system. This area is divided into several cells, each containing a cell site (base station) operating on a given set of channels which interfaces radiotelephone subscribers to the telephone switching system.

Figure 1: Hypothetical Cell System



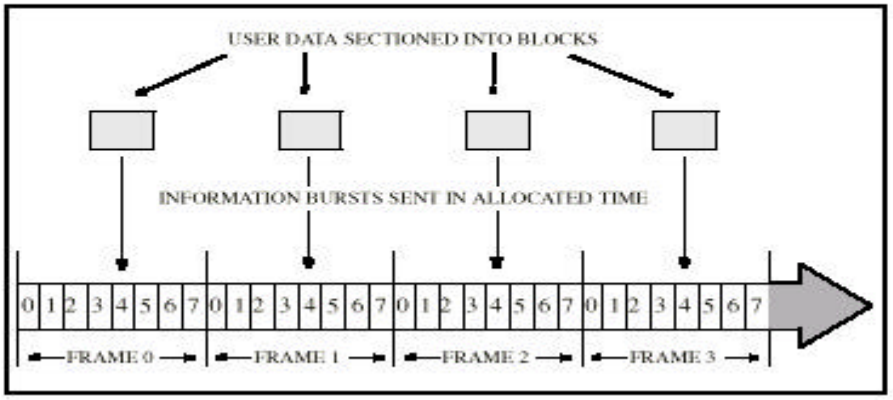
The radiotelephones themselves are capable of operation on any channel in the system, allowing them to operate in any cell. Due to the low power requirements for communications between radiotelephones in a particular cell and the cell site, operating channels may be repeated in cells which are outside the coverage area of each other.

For example, presume that cell A operates on channels arbitrarily numbered 1 through 8, cell B opeates on channels 9 through 16, cell C operates on channels 17 through 24 and cell D operates on channels 1 through 8 (repeating the usage of those channels used by cell A). In this system,subscribers in cell A and subscribers in cell D could simultanuously operate on channles 1 through 8.

The implementation of frequency re-use increases the call handling capability of the system, without increasing the number of available channels. When re-using identical frequencies in a small area, co-channel interference can be a problem. The GSM system can tolerate higher levels of co-channel interference than analogue systems, by incorporating digital modulation, forward error correction and equalization. This means that cells using identical frequencies can be physically closer, than similar cells in analogue systems. Therefore the advantage of frequency re-use can be further enhanced in a GSM system, allowing greater traffic handling in high use areas.

By incorporating Time Division Multiple Access (TDMA) several calls can share the same carrier. The carrier is divided into a continuous stream of TDMA frames, each frame is split into eight time slots. When a connection is required the system allocates the subscriber a dedicated time slot within each TDMA frame. User data (speech/data) for transmission is digitized and sectioned into blocks. The user data blocks are sent as information bursts in the allocated time slot of each TDMA frame, see Figure 2: “TDMA Transmission” following:

Figure 2: TDMA Transmission



The data blocks are modulated onto the carrier using Gaussian Mininum Shift Keying (GMSK), a very efficient method of phase modulation.

Each time an information burst is transmitted, it may be transmitted on a different frequency. This process is known as frequency hopping. Frequency hopping reduces the effects of fading, and enhances the security and confidentiality of the link. A GSM radio telephone is only required to transmit for one burst in each frame, and not continually, thus enabling the unit to be more power efficient.

Each radio telephone must be able to more from one cell to another, with minimal inconvenience to the user. The mobile itself carries out signal strength measurements on adjacent cells, and the quality of the traffic channel is measured by both the mobile and the base station. The handover criteria and thus be much more accurately determined, and the handover made before the channel quality deteriorates to the point that the subscriber notices.

When a radio telephone is well within a cell, the signal strength measured will be high. As the radio telephone moves towards the edge of the cell, the signal strength and quality measurement decreases.

Signal information provides an indication of the subscriber's distance from the base station. As the radiotelephone moves from cell to cell, its control is handed from one base station to another in the next cell.

This change is handled by the radiotelephone and base stations, and is completely transparent to the user.

Service Area

The area within which calls can be placed and received is defined by the system operators. (Because this is a radio system, there is no exact boundary that can be drawn on a map.) If the telephone is outside a coverage area, the ∅ (no service) indicator will illuminate and calls will be unable to be placed or received. If this happens during a conversation, the call will be lost. There may also be small areas within a particular service area where communications may be lost.

The radio telephone's identity information is held by its lcal GSM system in its Home Location Register (HLR) and Visitor Location Register (VLR). The VLR contains identity informatino on all local active radio telephones. Should you roam to another area, system or country the radiotelephones identity information is sent to the VLR in the new system. The new system will then check the radio telephones details with your home system for authenticity. If everything is in order it will be possible to initiate and receive calls whilst in the new area.

7.Detailed description of Schematic Diagram

7.1 Transceiver

The main chip for Taichi RF is MAGIC. The MAGIC IC is intended to support the needs of the GSM/DCS1800 portable telephone products.

For Taichi the MAGIC IC will provide the first LO (RX VCO) to the receiver at 1325.2 to 1359.8 MHz for EGSM with 400 MHz high side injection, and 1405.2 to 1479.8 MHz for DCS 1800 with 400 MHz low side injection. An external RF mixer will convert the received signal to 400 MHz. The 400 MHz signal will then pass through an external SAW filter. The filtered signal will then enter the IC where it will be mixed with an internally generated 400 MHz signal to generate baseband I and Q signals. These baseband signals will then be filtered and amplified to provide RxI and Q. The RxI and Q signals will be converted into digital outputs and sent over a serial bus. The chip will provide for AGC control through the SPI bus. TX Data will be input serially. The present data bit and the three previous data bits will be used to set up one of 16 possible waveforms based on the sum of Gaussian pulses stored in a look up ROM. The resulting signal will then be clocked out at a 16X oversample rate. This data pattern will be input to a four accumulator fractional N synthesizer with 24 bit resolution. The synthesizer output will be 880.2 to 914.8 MHz for EGSM and 1710.2 to 1784.8 MHz for DCS 1800 with GMSK modulation and will be directly amplified to the transmitter output. The reference oscillator will be a free running 26 MHz crystal for MAGIC. AFC will be provided through the SPI bus as a programming offset to the fractional N division system. Resolution will be approximately 3Hz (6 Hz with Pass 2) with relative accuracy of less than 1Hz (2 Hz for Pass 2). Since the 26 MHz crystal will not be locked to the AFC, a second fractional divider system will be provided to derive an accurate 200kHz reference. This reference will then be multiplied in a PLL to 13MHz for use as an accurate clock to the logic sections of the radio.

Two tracking regulators will be provided to power the IC. A superfilter will also be provided to power the external main VCO.

Finally, an interface system of digital to analog converters will be provided to control the PAC IC. This will allow the logic sections of the radio to transmit data over SPI and then activate the transmitter with a single digital line as opposed to the present D/A output and saturation correction software.

Reference Oscillator

The reference oscillator will use a crystal at 26 MHz for MAGIC with a stability over temperature of ± 20 ppm for GSM and ±11ppm for DCS 1800 to cover the camping requiremments in Taichi. An SPI controlled AFC is provided for by offsetting the fractional N division. Since an accurate clock is needed for the logic sections of the radio, a secondary fractional N division system is provided to derive an accurate low frequency clock. This low frequency clock

is then multiplied up in the reference oscillator step up loop to an output frequency of 13MHz. The reference oscillator will be within 150ppm of 26MHz within 100msec of the REG_REF input rising to 2.775V.
The 13MHz reference will be provided externally for the logic sections as a CMOS output at 1Vp-p at CLK_OUT. At power up, the crystal oscillator divided by 2 will be routed to the CLK_OUT pin by pulling CLK_SEL low. An SPI bit is then used to activate the digital AFC. Finally CLK_OUT is pulled high to route the output of the multiplied 200kHz reference to the CLK_OUT pin.

RX 2nd Local Oscillator

The 2nd LO VCO will be 800 MHz for both GSM and DCS-1800 in the Taichi radio with the MAGIC IC. The VCO frequency will be divided by 2 internal to the IC. Note that in the programming the factor of two is ignored so that if an IF frequency of 400MHz is desired, the programming is calculated as if the LO was at 400MHz even though it is actually at 800MHz.

Power Supplies

The IC will contain 2 tracking regulators (external PNP or PMOS pass transistors) which will generate the supplies for the entire IC as well as the front end and the main VCO. A voltage of 2.775v must be provided to the REG_REF input. This pin has a maximum current draw of 200µA in mode. The reference voltage will be filtered and buffered for use on the IC. The buffered voltage should track the reference within ± 50mV. A raw supply voltage will be provided to the IC tracking regulators which will be at least 100mV above the reference (50mA output) and could be as high as 6.5Vdc. A superfilter will be needed for the external VCO power supply. This superfilter, cascaded with the normal regulator and any filtering in front of the IC, will need to provide 80dB of rejection to a 0.1V step (risetime = 20µS) in the raw supply (battery). The superfilter will use an internal pass transistor that will be capable of driving a 45mA load with a voltage drop of less than 300mV relative to V2_OUT from the SF_OUT pin. An external .01µF cap will be required on SF_OUT.

All supplies within the IC must be within 5% of their final values after 10msec. The power on reset circuit contained within the crystal reference oscillator may be used to aid this functionality.

Magic / Whitecap MQSPI Interace

The following is the interconnection between MAGIC and WHITECAP in Taichi:

Board Signal Name	**MAGIC ball**	MAGIC Pin Name	WHITECAP ball	WHITECAP Signal Name
DX1	**Ball J3, input**	SPI DATA	Ball M7, output	DX1
MQSPI CLK1	**Ball H4,**	SPI CLK_SC	Ball M8,	MQSPI CLK1

	input	CLK4	output	
MQSPI CS1	**Ball G5, input**	CE	Ball L8, output	MQSPI CS1
DR1			Ball P5, output	DR1

DX1 (SPI_DATA): Serial Peripheral Interface Data, Data will be transmitted from WhiteCap to the
MAGIC IC. Data will be latched into MAGIC either on rising edge or falling edge of clock depending on the control bit settings.
MQSPI_CLK : Clock used to shift data out serially.
MQSPI_CSI : Chip select signal used to latch data into MAGIC.

DR1 : Not connected to MAGIC .

MAGIC will interface with the Serial Peripheral Interace 1 (SPI1) of the WHITECAP IC. Data on the bus will be changed on the fallling edge of the clock and sampled on the rising edge. The IC will only accept data if a valid chip select is given (active high) and data is latched in on the falling edge of MQSPI_CS1. There are 4 groups of SPI bits. Data is written most significant bit first. Each SPI transfer must consist of the full 64 bit field. Thus, additional dummy bits must be padded to those sequences which are not full length. The two most significant bits are used to select which SPI group is addressed.

7.2 Logic circuitry

7.2.1 GSM Logic

We call the GSM signal processing control circuit as GSM logic. GSM logic employed two main chip for its operations – WhiteCap and GCAP-II.

There are two function parts in WhiteCap which provides digital signal processing and general control.

The WhiteCap IC is a digital processing IC for GSM radiotelephones. It contains a TI cLEAD DSP core, a TI ARM/Thumb microcontroller core and custom peripherials implemented in TI's TSC5000 ASIC standard cell technology. This part will be used for s/w and radio development.

The DSP core contains 80K words of DSP RAM for software development. The production version of this part will store DSP and ARM boot-code in on-chip ROM.

Whitecap contains the following:

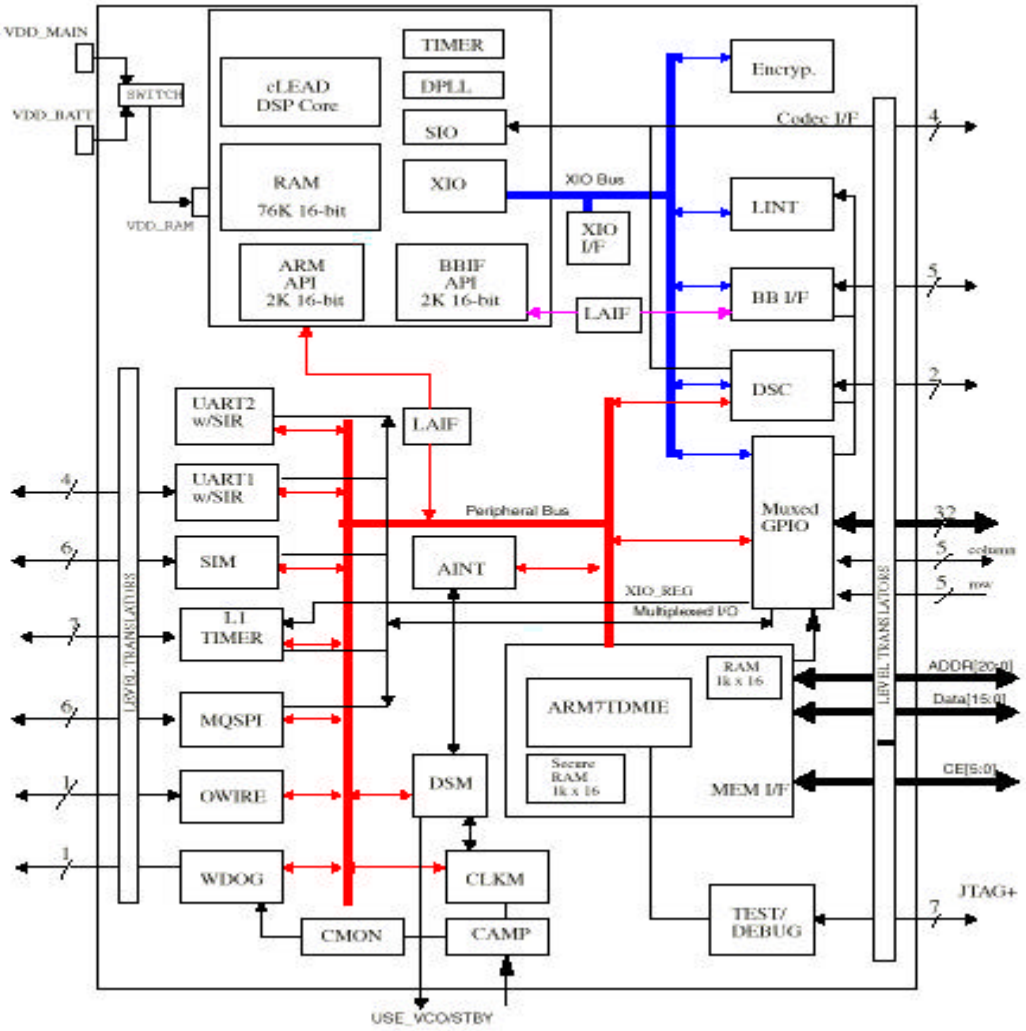
- **ARM7TDMIE core (Thumb 32/16 bit micro controller core)**
- **cLEAD Mega Module (DSP w/ 80K words RAM + ARM-API + BBIF-API + SP + DPLL)**

- **ASIC Microcontroller peripherals**
  - Memory Interface
  - Deep Sleep Controller
  - Layer1 Timer
  - MQSPI
  - SIM Card Interface
  - Two UARTs with Infrared Rx/Tx data capability and
  - DMA for multi-slot high-speed GSM data service
  - One Wire Interface
  - Watchdog Timer
  - Clock Monitor
  - ARM Interrupt Handler (AINT)
  - DSC Interface
  - GPIO
  - Deep Sleep Controller (DSM)

- **ASIC DSP peripherals**
  - DSC Interface
  - Encryption Co-Processor
  - GPIO
  - Lead Interrupt Handler (LINT)
  - Baseband Interface

- **Special Cells**
  - Clock Monitor
  - Input Clock Amplifier
  - Battery Power Switch

WhiteCap chip’s block diagram shows as below:



WhiteCap Block Diagram

GCAP-II integrated nearly all the analog functions into one chip, those funcitons includes power supplies, voltage regulators, A/D and D/A converters for battery charger, audio CODEC, real time clock, and amplifiers for speaker and microphone etc. This chip is intended to support the needs of portable cellular telephone products. It provides control, audio, and regulator functions of the Taichi radio. The following functions are performed:

- *Turn On control signals to properly activate the radio*
- *Turn off control signals to turn off the radio if an error is detected*
- *Audio amplification for the speaker*
- *Audio amplification for the alert*
- *Audio amplification for EXT audio*
- *Audio amplification fo the microphone*
- *13 bits linear audio CODEC*
- *Band gap reference voltage*
- *Linear regulators for DC voltages*
- *Two BUCK/BOOST switching regulators*
- *Op-amps for use in the battery charger*
- *Internal D/A for the battery charger*

- *8 Channel 8 bit A/D*
- *PA high end regulator*
- *Real Time Clock (RTC)*

The detail applications for this chip in Taichi can be found in GSM block diagram.

7.2.2 PDA Control Logic

PDA logic mainly provides the interface control functions for Taichi radio. DragonBall is the core chip which fetchs executive code from external flash memory through data bus and address bus.

DragonBall introduced by Motorola as the newest member of the DragonBall's Series of MC68328 family.

Inherited the display capability of the original DragonBall's processor, the MC68EZ328 features a more flexible LCD controller with streamlined list of peripherals placed in a smaller package. This processor mainly targeted for portable consumer products which require less peripherals and a more flexible LCD controller. By providing 3V, fully static operation in an efficient 100 TQFP package, the MC68EZ328 delivers cost-effective performance to satisfy the extensive requirements of today's portable consumer market.

DragonBall has the following features:

- **Static 68EC000 Core Processor-Identical to MC68EC000 Microprocessor**
  1. Full Compatibility with MC68000 and MC68EC000
  2. 32-Bit internal address bus
  3. 24-Bit external address bus capable of addressing maximum 4 x 16MB blocks with chip selects CSA, CSB and 4 x 4 MB blocks with chip selects CSC, CSD.
  4. 16-Bit on-chip data bus for MC68000 bus operations
  5. Static design allows processor clock to be stopped to provide power savings
  6. 2.7 MIPS Performance at 16.58 MHz processor clock
  7. External M68000 Bus interface with selectable bus sizing for 8-bit and 16-bit data ports

- **System Integration Module (SIM28-EZ), Incorporating Many Functions Typically Related to External Array Logic, such as:**
  1. System configuration, programmable address mapping
  2. Glueless interface to SRAM, EPROM, FLASH memory
  3. 8 programmable chip selects with wait state generation logic
  4. 4 programmable interrupt I/O and with keyboard interrupt capability
  5. 5 general purpose, programmable edge/level/polarity interrupt IRQ
  6. Other programmable I/O, multiplexed with peripheral functions up to 47 parallel I/O
  7. Programmable interrupt vector response for on-chip peripheral

modules
8. Low-Power mode control

- **DRAM Controller**
  1. Support CAS-before-RAS refresh cycles and self-refresh mode DRAM
  2. Support 8 bit / 16 bit port DRAM
  3. EDO or Automatic Fast Page Mode for LCDC access
  4. Programmable refresh rate
  5. Support up to 2 banks of DRAM/EDO DRAM
  6. Programmable column address size

- **UART**
  1. Support IrDA physical layer protocol up to 115.2kbps
  2. 8 Bytes FIFO on Tx and 12 Bytes FIFO on Rx

- **Serial Peripheral Interface Port**
  1. 16 bit programmable SPI to support external peripherals
  2. Master mode support

- **16-Bit General Purpose Counter / Timer**
  1. Automatic interrupt generation
  2. 60-ns resolution at 16.58-MHz system clock
  3. Timer Input/Output pin

- **Real Time Clock / Sampling Timer**
  1. Separate power supply for the RTC
  2. One programmable alarm
  3. Capable to count up to 512 days
  4. Sampling Timer with selectable frequency (4Hz, 8Hz, 16Hz, 32Hz, 64Hz, 256Hz, 512Hz, 1kHz). Generate interrupt for digitizer sampling, or keyboard debouncing.

- **LCD Controller**
  1. Software programmable screen size (up to 640*512) to support single (Non-Split) monochrome/ color STN panels
  2. Capable of direct driving popular LCD drivers/modules from Motorola, Sharp, Hitachi, Toshiba etc.
  3. Support up to 4 grey levels out of 16 palettes.
  4. Utilize system memory as display memory
  5. LCD contrast control using 8-bit PWM

- **Pulse Width Modulation (PWM) Module**
  1. 8 bit resolution
  2. 5 Byte FIFO provide more flexibility on performance
  3. Sound and melody generation

- **Build-in Emulation Function**
  1. Dedicated memory space for Emulator Debug Monitor with Chip Select
  2. Dedicated interrupt (Interrupt Level 7) for ICE
  3. One address signal comparator and one control signal comparator with

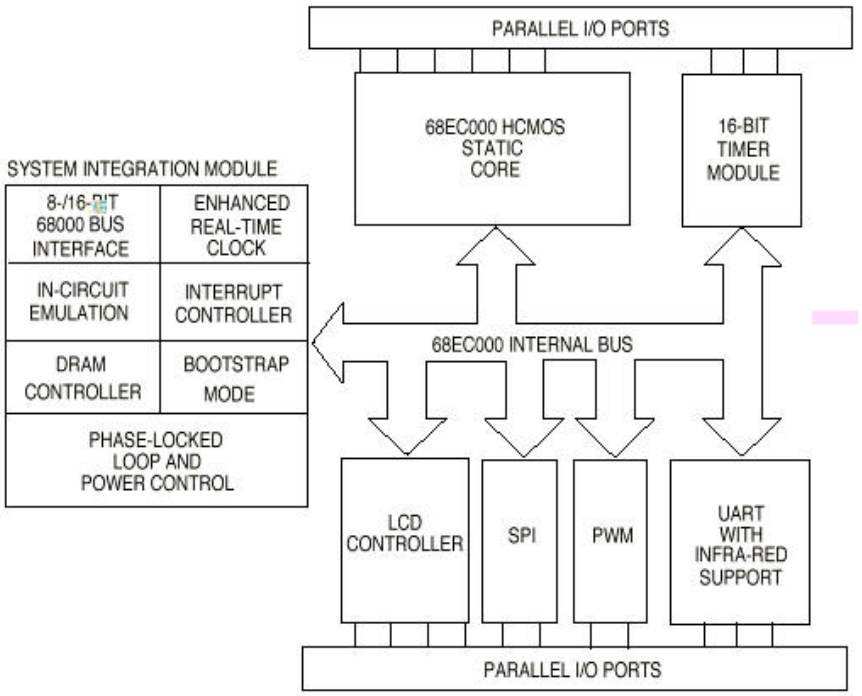
masking to support single or multiple Hardware Execution Breakpoint
4. One breakpoint instruction insertion unit

- **Boot Strap Mode Function**
  1. Allow User to initialize system and download program/data to system memory through UART
  2. Accept execution command to run program stored in system memory
  3. Provide an 8-byte long Instruction Buffer for 68000 instruction storage and execution

- **Power Management**
  1. Fully static HCMOS technology
  2. Programmable clock synthesizer using 32.768 kHz/38.4 kHz crystal for full frequency control
  3. Low power stop capabilities
  4. Modules can be individually shut-down
  5. Lowest power mode control

- **Operation from DC To 16.58 MHz (processor clock)**
- **Operating Voltage of 2.7V-3.3V**
- **Compact 100-Lead Thin Quad Flat Pack (TQFP) and 144 Pin Ball Grid Array (PBGA) packages**

This chip's block diagram is showing as below:



DragonBall Block Diagram

LCD module gives the user an visible interface. Detailed LCD module descriptions can be found in LCD module circuit description. The connections between DragonBall and LCD module are joint by J9805. There is one EL panel on LCD

module which can give backlight in darkness environment. U9812 drives IR diodes for communication link between PC and DragonBall. Alert circuit is also controlled by DragonBall. Alert circuit is also controlled by DragonBall. Analog switches provide multiple communication path control which give the serial port different link under different use conditions. Refer to the PDA logic block diagram.

7. 3 Power Supplies

Global Control Audio Power II (GCAP-II) is a power and audio management IC. It incorporates many of the functions of various different power and audio management Ics into one platform. For power supplies, GCAP-II provides five programmable linear regulators (VSIM1, Ref, V1, V2, and V3) which give all voltages for the logic IC's and two Buck or Boost switching regulators (PWM #1 and PWM #2).

Power Management

- PGM0,1,2 Hardware configuration

PGM0 and PGM1 alone determine the battery mode of GCAP-II. This is necessary because the startup and shutdown voltages need to be available without processor intervention. At power-up PGM2 alone determines the output of V3. If PGM2 is connected to B+, V3 is 2.775V. If PGM2 is connected to ground, as in Taichi, V3 is 2.003V. No processor intervention is necessary.

- V2 Linear Regulator

V2 is a programmable linear regulator. It is programmed through the SPI bus to outputs from 2.775V to 3.6V in 0.12V steps. For Taichi V2 is programmed to 2.775V. The regulator is supplied by B+. This regulator is on whenevey the radio is turned on. V2 is the supply for WhiteCap logic outputs, RAM FLASH, and display.

- V3 Linear Regulator

V3 is a programmable linear regulator with an output voltage which is determined by PGM2 at power-up. It is either 2.008V if PGM2 is connected to ground or 2.775V if PGM2 is connected to B+. After power-up V3 can be programmed through the SPI bus to voltages from 1.8V to 2.8V in 0.13V steps.For Taichi V3 is programmed to 1.8V.The regulator is supplied by B+. V3 is the fupply for the WhiteCap core (does not include logic output supply). For example, V3 supplies the ARM core, Clock amplifier, DSP Core, and input logic. For RAM 2 Whitecap V3 is programmed to 1.8V.

- VSIM Regulator

VSIM is a programmable linear regulator. It is programmed through the SPI bus to either 5.0V or 3.0V. For TaiChi VSM is programmed dynamically to 5.0V. VSIM is spplied by V_BOOST1 and supplies the SIM card.

- V1 Regulator

V1 is a programmable linear regulator. It is programmed through the SPI bus to either 5.0V or 2.775V. For Taichi V1 is programmed to 5.0V and is supplied by V_BOOST1. This regulator is on whenever the radio is turned on. V1 supplies the DSC bus.

- V_BOOST1 Switcher Regulator

V_BOOST1 is a switching regulator. At power up pins PMG0 and PMG1 determine the mode of the switcher. For Taichi V_BOOST1 is programmed to 5.6V because PMG0 is shorted to B+ and PMG1 is shorted to ground. The regulator is on whenever the radio is turned on. V_BOOST1 supplies V1 and VSIM.

- V_BUCK Switcher

V_BUCK is a switching regulator. At power up, pins PMG0 and PMG1 determine the mode of swither. For Taichi V_BUCK is not used.

- PA_DRV Alert/Backlight Regulator

PA_DRV is a programmable linear regulator which drives an external P channel MOSFET. It is programmed by setting PA_B3-0 to one of 16 codes corresponding to an output of 2.6V to 7.00V incremented by 0.40V steps. Initially PA_DRV is off until set via SPI. For Taichi PA_DRV regulates ALRT_VCC to 3.0V (PA_B3-0 = 000). This regulator is turned on and off by LS3_TX if PA_ON1 is enabled (high). PA_DRV powers the alert and backlights.

7.4 Battery Charge

Taichi battery

There is a charge control circuit built into Taichi radio. When a battery is attached and with a external charger insert into the radio through BUTT-PLUG, the radio will charge the attached battery according to the battery type. Before describing this radio charger circuitry, lets introduce the battery package itself.

There is four pins output from battery package: Serial Data, Ground, Power(+) and Thermister.

SERIAL DATA connection is used by GSM radio to communicate to and from the internal EEPROM, located inside the battery, to the radio's microprocessor. This bi-directional line is used to adjust the operation of the battery charger and battery meters.

GROUND connection is used as a reference ground for the battery to the GSM radio.

POWER (+) connection provides sufficient voltage to the GSM radio. The voltage range of a GSM battery ranges from 1.4 volts DC (fully discharged) to 5.1 volts DC (fully charged).

During charging the Whitecap will monitor the thermister line and the BATT Sense line through A/D convertor within GCAP-II. The thermister is inside the battery and indicates its temperature during charging. The temperature of the battery defines the end of battery charge cycle in some cases and must be monitored continuously during charging.

The energy flows along the dashed wider line from **EXT_B+** to **BATT+** as above diagram indicated.

7. 5 LCD module

1. Overview

Taichi LCD module is assembled by Touch panel, LCD panel and EL panel. LCD panel is a 320X240 pixels with transflective display film,STN type LCD. The driving signals for Touch panel, LCD and EL come from Taichi main board and LCD power circuit PCB. See figure 1.

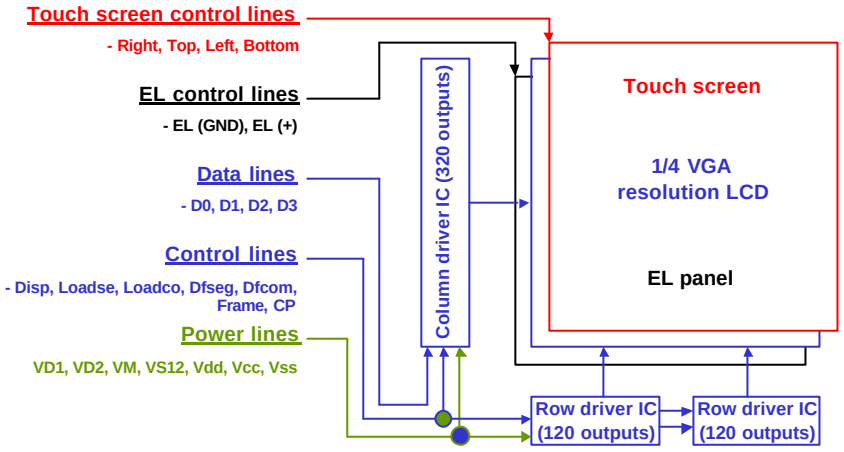


Fig.1 LCD module electrical block diagram

2. Driving signal for LCD panel

2.1 LCD panel electrical block

LCD panel is driven by signals come from Dragonball microprocessor and LCD power circuit PCB. LCD controller in Dragonball generates LCD logical control signal and display data. Power circuit PCB is used to generate LCD operating voltage and temperature compensation. It also controls power management for the PCB and LCD common&segment drivers. See Figure 2.

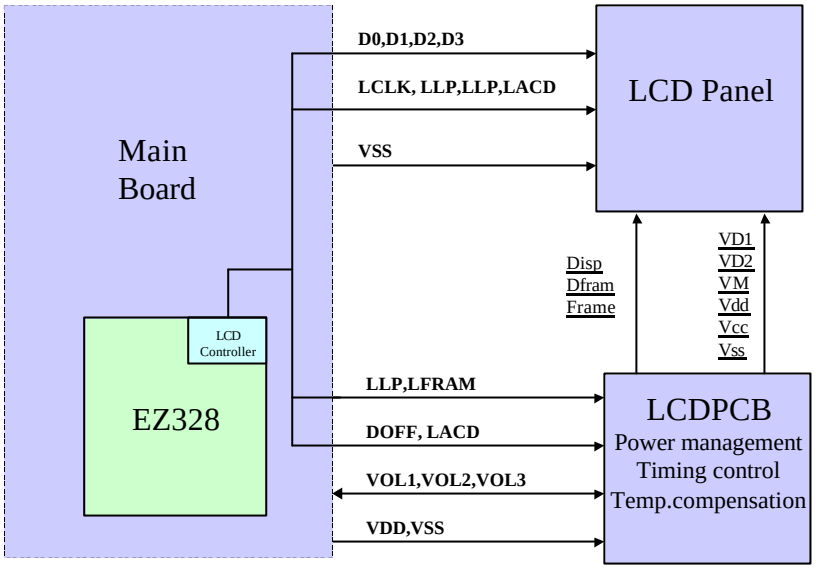


Figure 2.Taichi LCD Panel Electrical Block

2.2 Driving signal from LCD controller

The function of each signal is as follows:

D0-D3---------LCD data bus is used to transfer pixel data to the LCD panel.
LFRAME-----LCD frame scan signal indicates the start of a new frame.
LLP----------LCD line scan signal is used to latch a line of shifted data.
LCLK---------LCD shift clock signal is the clock output which the display data is synchronized.
LACD---------LCD alternate crystal direction output signal is toggled to alternate the crystal polarization on the panel.
DOFF----------LCD ON/OFF control signal.

Figure 3 is the timing waveform for these signals.

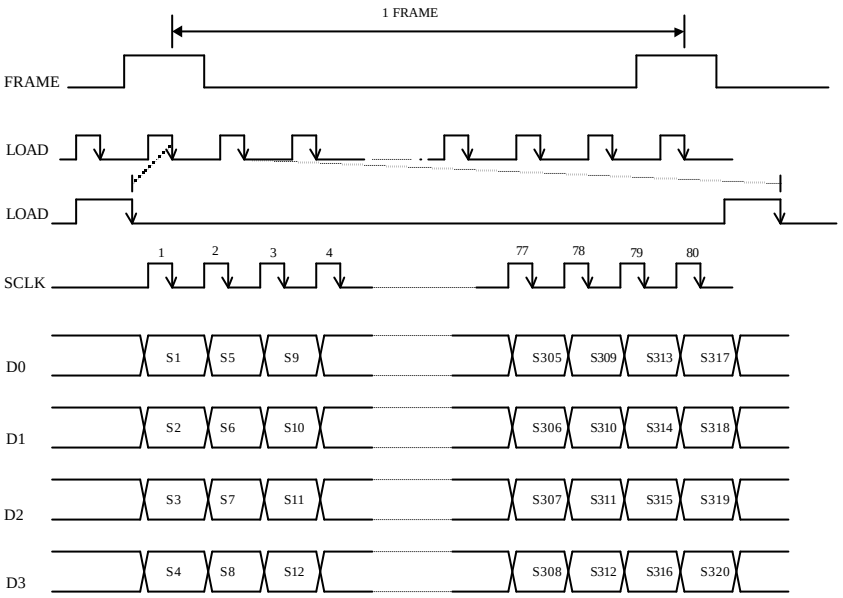


Figure 3. Waveform for LCD control and data signals

3.Driving signal for EL

A DC/DC converter generates EL driving voltage. See Figure 4.

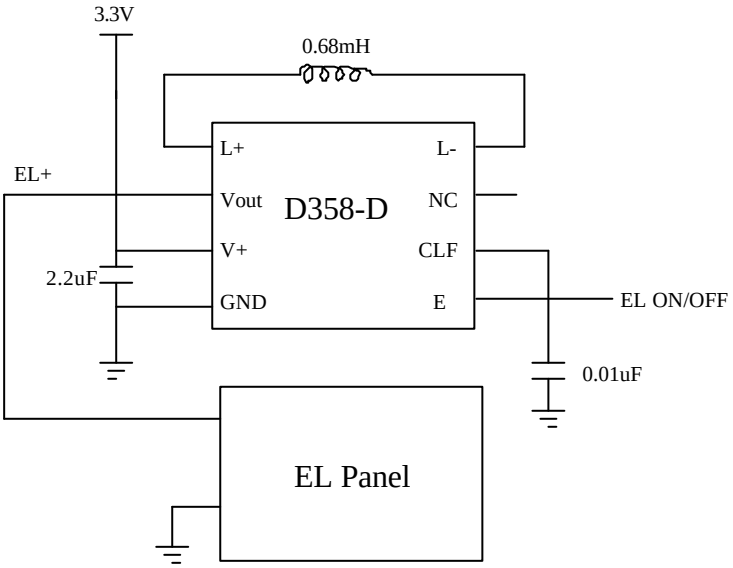


Figure 4. EL Driving Circuit

The waveform of EL+ shows in Figure 5

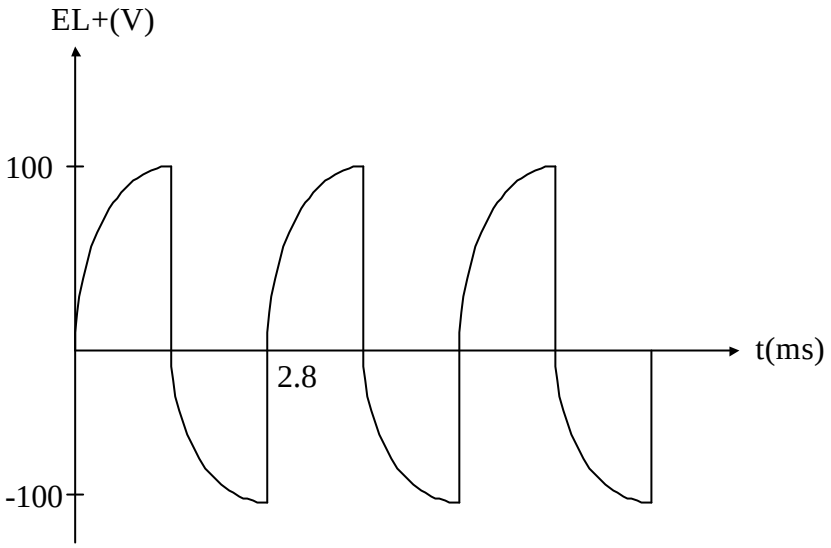


Figure 5. EL+ Driving Signal

4.Touch panel driving signal

A 12-bit A/D converter is used to generate an interrupt request signal to Dragonball ,receive control instruction and sample and transmit touch data from Touch panel to Dragon. See Figure 6.

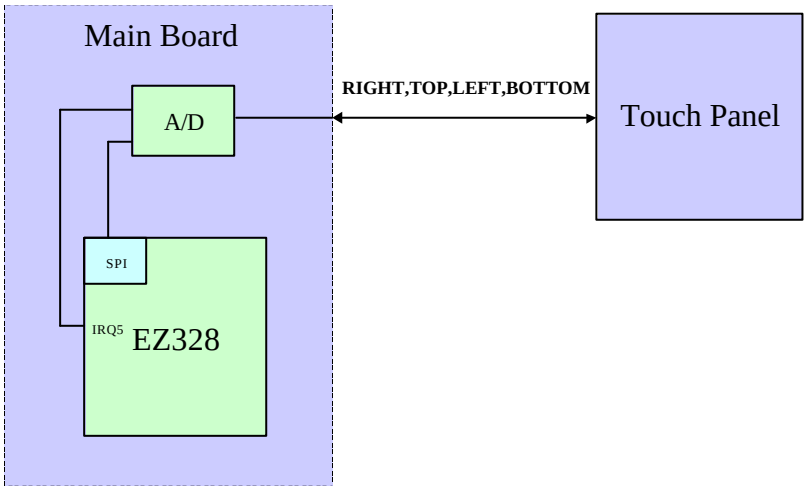


Figure 6. Taichi Touch Panel Block

7.6 Other circuitries

Audio Management

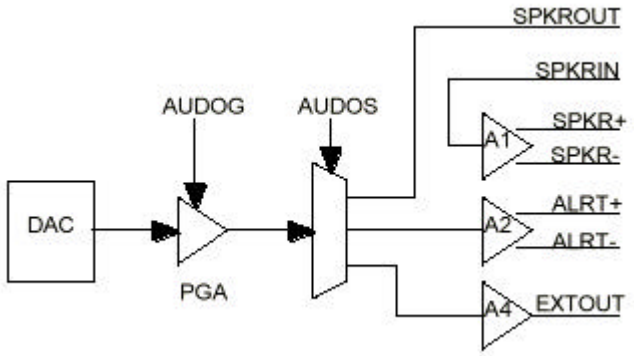
1. Audio Output

There are three audio outputs provided by GCAP-II, Taichi used two for its application. One is for its earpiece speaker and another one is for external speaker audio output. For driving those audio output signals, one amplifier is connected with each of the three outputs. For those amplifiers: A1 is for transceiver earpiece speaker amplifier, A2 is for Alert amplifier and A4 is for External audio output amplifier.

A1 – Earpiece Speaker Amplifier, is powered by V2 and is driven through a multiplexer by the audio CODEC output.

A2 – Alert amplifier. Is powered by ALRT_VCC and is driven through a multiplexer by the audio CODEC output.

A4 – External Audio Output Amplifier, is powered by V2 and is driven through a multiplexer by the audio CODEC output.



Above is a block diagram of the audio output section. Any one of three outputs can be selected. These outputs connect to the earpiece speaker amplifier, A1, the alert amplifier, A2, and the external audio out amplifier, A4. All outputs use the same converter so only one output is active at a time. The gain of the output can be selected in 5dB steps from -35dB to +0dB. This gain block is an analog system.

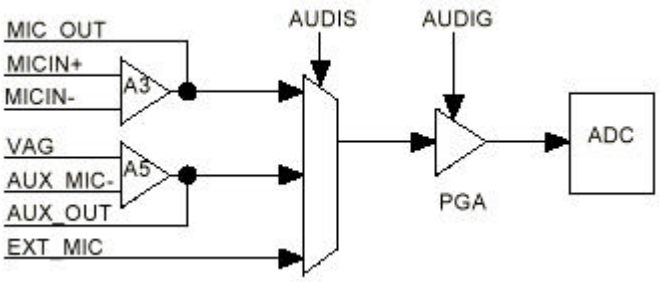
The Audio Output bits are programmed via SPI and they control the configuration of the output section. These bits select the gain, enable or disable the audio output, select or deselect dithering, and select or deselect the high pass output filter.

2. Audio Input

There are three audio inputs provided by GCAP-II, Taichi used two for its application also. One is for its transceiver microphone and another one is for its external microphone input. For driving those audio input signals, one amplifier is connected with each of the three inputs. For those amplifiers: A3 is for transceiver microphone amplifier, A5 is for the AUX microphone Amplifier. No audio amplifier was connected with external audio input. Amplifiers of A3 and A5 are powered by V2 and drive the audio CODEC input. Taichi phone use the without amplification external microphone input for the headset microphone.

Below is the block diagram of the audio input section. Any one of three equivalent

microphone inputs can be selected. These inputs are EXT_MIC, the output of the differential input microphone amplifier, A3 or , the output of the differential auxiliarymicorphone amplifier, A5.



These three inputs are single ended with respect to VAG.

Note that MIC IN+ should be DC connected to VAG to avoid an offset relative to the A/D input. MIC_BIAS is derived from VAG for best noise performance. MB_CAP bypasses the gain from VAG to MIC_BIAS to keep the noise balanced.

Following the input stage and multiplexer is a selectable gain stage and 30kHz low-pass antialiasing filter. This lowpass filter may be designed to whatever order is needed to insure that aliased components are not present in the output. The gain of the selectable gain stage can be selected in 1dB steps from -7dB to +8dB. Depending on the design of the A/D converter the output of the antialiasing filter may be clamped to keep from overdriving the A/D converter.

The audio input A/D converter converts the incoming signal to 13-bit 2's compliment linear PCM words at an 8 or 8.1 kHz rate. Following the A/D converter, the signal is digitally filtered, low-pass and selectable high-pass.

The audio input bits control the configuration of the input section. These bits select the gain, enable or disable the input, select between the EXT_MIC, A5 amplifier output, or A3 amplifier output, and select or deselect the high pass input filter. Also, these bits can select a loopback mode that takes the digital output of the input A/D converter, and loops it directly back to the D/A output section for testing.

WhiteCap Logic Interfaces

1.DSC Module

The DSC module implements the GSM Data Speech Control interface in the Whitecap IC. It accepts manchester encoded data input on the DSC bus and generated manchester coded data onto the DSC bus. DSC data may be transmitted to or received from the TI LEAD megamodule or TI ARM megamodule via the XIO interface and PIF interface, respectively. The PIF interface also provides control of the DSC module.

The DSC module generates a clock and frame sync to the audio codec interface. The frame sync is synchronized so the DSC LEAD interrupt occurs

at the same time as the Audio CODEC interrupt. An ARM interrupt is generated to synchronize the ARM megamodule to the DSC interrupt. The DSC time slots are the basic data structures in the DSC module. The function of the DSC is to transmit and receive DSC frames on the DSC bus. These frames may come from or be sent to the Lead DSP Audio Coder XIO port, the ARM Call Processor PIF port, or the Manchester coded DSC bus.

The DSC module in Whitecap operates only in the Master mode at a controllable bit rate of 128kHz or 512kHz. The audio CODEC clock always operates at 512Khz. Switching the DSC from 128kHz to 512kHz is held off until DSC time slot boundaries. This functionality is changed from BIC 4.X for the Whitecap DSC module to accommodate the CODEC interface and synchronization for the Lead DSP.

2. UART-RS232

The UART is based upon a TL16C550 compatible UART. It is used to communicate serially over an RS232 interface. The module sends and receives characters of 8 bits. The number of stop bits can be programmed to 1 or 2. Parity can be programmed to even, odd, or disabled completely. The module contains a 32 deep FIFO for the received characters and a 16 deep FIFO for transmit. It generates its own baud rate based upon a programmable divisor and its input clock.

3.SIM INTERFACE

The SIM Interface is a peripheral in the Whitecap Chip that allows the ARM Core to communicate with pre-paid cards or SIM cards. It communicates with the ARM via the 16-bit internal Peripheral Bus. The SIM interface contains 2 ports, one allowing synchronous or asynchronous (pre-paid cards) serial transmission and the other allowing only asynchronous serial transmission.

8. Personality Transfer

8. 1 Introduction

Due to the different variations of the (OEM looks) of the personal cellular telephones, each main board must be configured correctly to ensure that the unit takes on the correct personality required. Therefore, when a main board is replaced its personality must be transferred into the new board, so that it functions correctly in the customers unit. There are two possible methods of transfer:

·Normal Transfer,and:

·Master Transfer.

If the defective unit powers up, then the Normal Transfer method should be followed. If the faulty unit will not power up, then a Master transfer will be required to configure the replacement board, once installed.

8. 2Normal Transfer

This method allows the personality, selected features and stored phone numbers of a defective radio, to be transferred into a repaired radio. Data is transferred from the donor unit into the recipient unit using a Transfer card (Part No 5104025D01).The instruction steps should be followed in order.

Step 1: Insert the Transfer card into the slot located on the back of the donor unit.Turn the donor unit on, the display should show'Clone'.

Step 2: The donor unit is now in the cloning mode, and ready to transfer the first block of data.

Step 3: Enter 021# via the units keypad.This command will cause the first block of information to be uploaded into the Transfer card.

Step 4: While data transfer is taking place between the unit and the card, 'Please wait' will be displayed. After a short period of time, if the data transfer has been completed correctly, 'Clone'will re-appear in the donor units display.

Step 5: When the first data block has been successfully uploaded, remove the card from the donor.

Step 6: Insert the Transfer card into the slot located on the back of the recipient unit. Turn the recipient unit on, the display should show 'Clone'.

Step 7: The recipient unit is now in the cloning mode, and ready to receive the first block of data.

Step 8: Enter 03# via the units keypad. This command will cause the recipient unit to download the first data block from the Transfer card.

Step 9: While data transfer is taking place between the card and the unit, 'Please wait' will be displayed. After a short period of time, if the data transfer has been completed correctly, 'Clone'will re-appear in the recipient units display.

Step 10: The second data block must now be transferred. Repeat steps 1 to 9, but enter 022# to program the second data block into the Transfer card.

Step 11: The third data block (known as table5#) must now be transferred. Repeat steps 1 to 9, but enter 025# to program the third data block into the Transfer card.

Step 12: When the third block of data has been transferred successfully,remobe the Transfer card and check the repaired radio functions correctly. See to the information in 'Testing'.

8. 3 Master Transfer

This method of transfer should only be followed when the defective unit will not power up, or complete a Normal Transfer. As mentioned earlier, there are different variations (OEM looks) of the Motorola cellular telephones, each model requiring the main board to be configured differently for correct operation. When carrying out a Master Transfer it is not possible to transfer the customers selected features or stored phone numbers, only the personality can be programmed into the repaired unit.

Each different version of the cellular telephone, has its own Master card which contains essential set up information. Master SIM cards may be ordered preprogrammed, or created from a Normal Transfer card. The instruction steps should be followed in order.

Step 1: Select the required Master SIM card.
Step 2: Insert the Master Transfer card into the slot located on the back of the repaired unit.Turn the donor unit on, the display should show'Clone'.
Step 3: Enter 04# via the units keypad.This command will cause the configuration data to be downloaded from the Master Transfer card.
Step 4: While data transfer is taking place between the card and the unit, 'Please wait' will be displayed. After a short period of time, if the data transfer has been completed correctly, 'Clone'will re-appear in the recipient units display.
Step 5: When the third block of data has been transferred successfully,remobe the Master Transfer card and check the repaired radio functions correctly. See to the information in 'Testing'.

At no point should either 021# or 022# be entered while a Master Transfer card is in the radio. If either of the stated commands is entered, the master information on the card will be erased. To prevent the above happening the card can be locked by entering 06# via the units keypads, with the card inserted. Unlocked the card by entering 07# .

·If during either transfer process a problem arises, an error message will be displayed. If the Transfer card is removed before the data transfer is completed 'Bad Data on Card' will appear in the display. If either situation arises, the process should be repeated.

8. 4 Master SIM Card Creation

When required a Master SIM card can be created by:

Step 1: Insert a Transfer card into a unit which is already configured in the desired way.Turn the unit on, the display should show'Clone'.
Step 2: Enter 024# via the units keypad.This command copies the personality

information in the unit onto the Transfer card to create a Master Transfer card.?

Step 3: While data transfer is taking place between the unit and the card ‘Please wait’ will be displayed. After a short period of time, if the data transfer has been completed correctly, ‘Clone’will re-appear in the recipient units display.

Step 4: A Master Transfer card has now been created. Lock the card to prevent accidental information erasure (the card can be locked by entering 06# via the units keypad, with the card inserted).Remove the card from the unit, and store until required.

9 TESTING

GSM Verification

Introduction

To test the phone for functional verification,the following equipment is required.

• GSM compatible communications analyzer.

• Antenna test adaptor (Part Number SKN4870A) and an appropriate cable/connectors.

• Test SIM card (Part Number8102430Z01).

• Charged battery pack.

Equipment Configuration

Initially insert the test SIM card into the slot at the rear of the personal cellular telephone. If required, further information on SIM card insertion is available on page 18. Slide a charged battery on to the back of the phone, so that the telephone can be powered up. Finally, connect a cable from the accessory connector to the RF in/out port of the communication analyzer, and power both the analyzer and personal telephone on. The equipment set up shown in figure .. “GSM/DCS testing configuration should now be in place.

GSM/DCS Manual Test Mode.

Introduction

Telephones are equipped with a Manual Test Mode capability. This capability allows service personnel to take control of the tele-phone. and by entering certain keypad sequences, make the telephone perform desired functions. to enter the Manual Test Mode, a test SIM card (Part number 8102430Z01) is required.

DCS Testing Procedure

All information required to perform the desired tests and measurements, should be obtained from the communication analyzer’s manual. Ensure that the unit being tested is capable of both initiating a call to the analyzer, and recieving a call from the analyzer. Confirm thet the displayed Temprary Mobile Subscriber Identify (TMSI), International Mobile Equipment Identify (IMEA), and dialled number are correct. When a call is in progress the following tests should be carried out on channels 512, 700, and 885. The recorded results must be within the acceptable stated limits, if the unit being tested passes all the tests it should be taken as functioning correctly. If the unit being tested fails to confirm with any of the expected measurements, it should be taken as

faulty and repaired accordingly.The following table states the required test and tolerances.

Accessing The Manual Test Mode

• When the Test SIM card is in place, power up the telephone. Once the initial automatic 'wake up' sequence has taken place correctly, depress the # key (on the units keypad) for three seconds. After three seconds 'TEST' should appear in the display, indicating that the unit is now in the Manual Test Mode. The table below shows the avail-able Manual Test commands and their corre-sponding results.If a customer should forget the security code in their unit, it can only be read or changed by using a Test SIM card.

General Information For DCS Radios

• Number of Channels are 375.
• Low Channel Number 512.
• Low Channel Tx Freq 1710 MHz.
• Low Channel Rx frequency 1805 Mhz.
• Mid Channel number 700
• Mid Channel Tx Freq 1747.8 MHz.
• Mid Channel Rx Frequency 1842.8 MHz
• High Channel Number 885
• High Channel Tx Frequency 1785 MHz.
• High Channel Rx Frequency 1880 MHz.

GSM/DCS Key Sequence	GSM/DCS Test Function/Name
#(hold down for 2 seconds)	Enter manual test mode
01#	Exit manual test mode
02xxyyy#	Display/modify TX power level DAC & load PA calibration table
03x#	DAI
05x#	Initiate Exec Error Handler Test
07x#	Mute RX audio path
08#	Unmute RX audio path
09#	Mute TX audio path
10#	Unmute TX audio path
11xxx#	Program main LO to channel
12xx#	Set TX power level to fixed value
13x#	Display memory block usage
14x#	Initiate Out of Memory condition
15x#	Generate tone
16#	Mute tone generator
19#	Display S/W version number of Call Processor
20#	Display S/W version number of Modem
22#	Display S/W version number of Speech Coder
24x#	Set step AGC

25xxx#	Set continuous AGC
26xxxx#	Set continuous AFC
31x#	Initiate Pseudo-Random Sequence-with Midamble
32#	Initiate RACH Burst Sequence
33xxx#	Synchronize to BCH carrier
34xxxyy#	Configuration to TCH/FS & Enable TCH loopback w/o Frame Ensure Indication
36#	Initiate acoustic loopback
37#	Stop test
38#	Activate SIM
39#	Deactivate SIM
40#	Initiate sending all 1's
41#	Initiate sending all 0's
42#	Disable echo processing
43x#	Change audio path
45xxx#	Serving cell power level
46#	Display current value of AFC DAC
47x#	Set audio volume
51#	Enable sidetone
52#	Disable sidetone
57#	Initialize non-volatile memory
58#	Display security code
58xxxxxx#	Modify security code
59#	Display lock code
59xxx#	Modify lock code
60#	Display IMEI
61#	Display MCC portion of the LAI
61xxx#	Modify MCC portion of the LAI
62#	Display MNC portion of the LAI
62xx#	Modify MNC portion of the LAI
63#	Display LAC portion of the LAI
63xxxxx#	Modify LAC portion of the LAI
64#	Display Location Update Status
64x#	Modify Location Update Status
65#	Display IMSI
GSM/DCS Key Sequence	**GSM/DCS Test Function/Name**
66xyyy#	Display/modify TMSI
67#	Zero PLMN Selector
68#	Zero forbidden PLMN list
69x#	Display/modify Cipher Key Sequence Number
70xxyyy#	Display/modify BCCH allocation table
71xx#	Display internal information
72xx#	Display Passive Fail codes
73xyyy#	Display/modify Logger Control Block
7536778#	Initiate transfer to Flash Memory

980#	DCS Mode
981#	GSM Mode

Table 1:

DCS Test to be performed	Lower Limit	Upper Limit
Transmit average phase error (RMS) at max and min power		5 degrees
Transmit average phase error (peak) at max and min power		20 degrees
Transmit average frequency error at max and min power	-90Hz	+90Hz
Transmit power error at level 7 (29 dBm)on CH62	-2db	+2db
Transmit power error at level 10 (23 dBm)on CH62	3db	+3db
Transmit power error at level 15 (13 dBm)on CH62	-3db	+3db
Transmit power error at max and min power	within DCS specification envelope	
Receive Bit Error Test for RES II (at 102 dBm)	2%	
Receive Frame Erasure Rate for RES II(at 102 dBm)	0.12%	
Received level (RX_LEV) indication at 100 dBm	104 dB	96 dB
Received level (RX_LEV) indication at -45 dBm	-49 dB	-41 dB
Received quality (RX_QUAL) indication for RX_LEV tests	not above 2	

Note: The transmit average test values should be derived from 10 seperate readings. The Receive signal strength for transmit measurements should be -85 dBm. The Receive test values should be derived from the reception of 20K bits of data.

10. Assembly and Disassembly

10. 1 Introduction

In order to perform thorough disassembly,before the phone disassembly, the antenna must be removed first.

Reasonable care should be taken in order to avoid damaging or stressing the housing and internal components. Motorola recommends the use of a properly grounded high impedance conductive wrist strap while performing any of these procedures.

CAUTION

Many of the integrated circuit devices used in this equipment are vulnerable to damage from static charges. For sure to use anti-statc handling procedures during the operation, transportation, and maintenace of the integrated parts of the phone.

10. 2 Tools

Recommended Tools

The following tools are recommended for use during the disassembly and reassembly of the phone:

•Anti-Static Tools(01-80386A82)
includes:
—Anti_Static Mat(66-80387A95)
—Ground Cord(66-80334B36)
—Wrist Band(42-80385A59)
•Dental Tool
•Plastic prying Tool(SLN7223A)
•Torx Hexangular Screwdriver

10. 3 Disassembly

Disassembly Produce

The following steps describe the produce for removing each part of the phone.

NOTE

During the procedure of disassembly or assembly , see to the ‘Phone Schematc Diagram’ if necessary.

Assembly Procedure

Once the unit is disassembled and the repair is carried out it then becomes obvious that to assemble the unit, the assembly procedure is the reverse of that previously completed for disassembly.

Back Housing Disassembly

Step 1

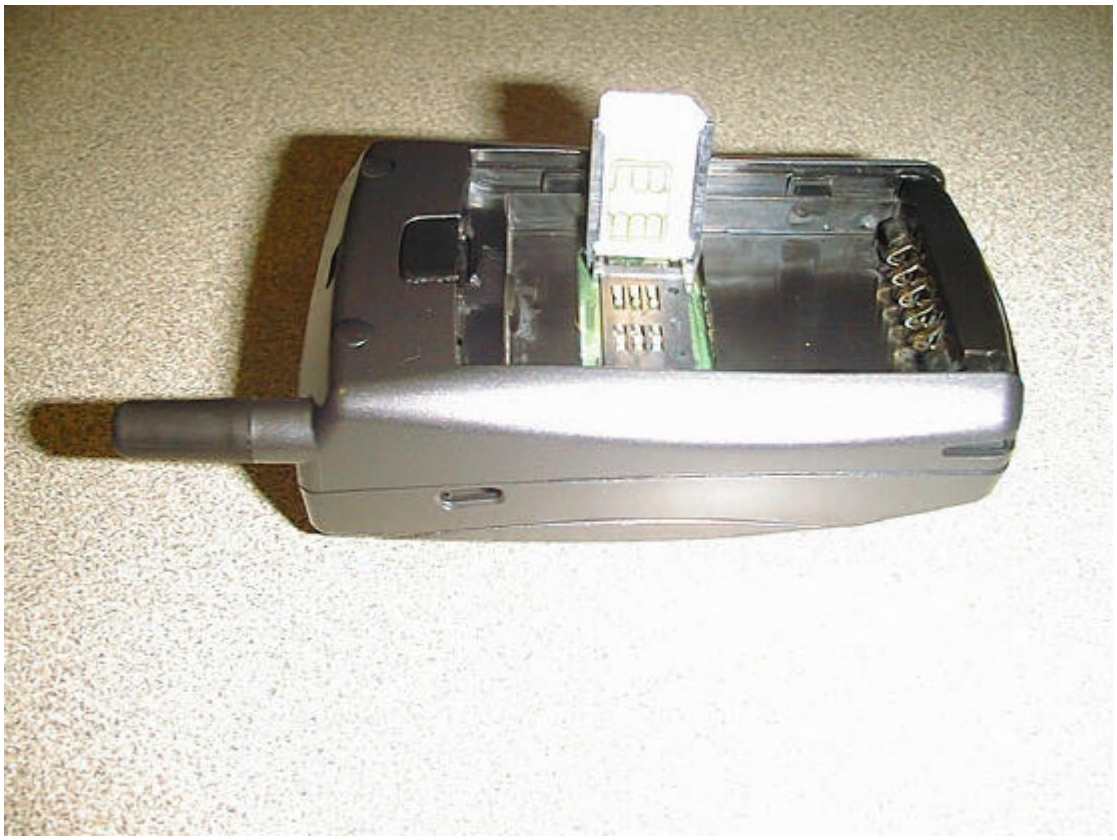
Turn off the telephone

Step 2
Unscrew the antenna .

Step 3
Remove the two rubber pads in the back housing.

Step 4
Press the battery door lock, remove the battery door, then remove the battery by pushing it downward in the direction indicated.

Step 5
Remove the Sim card.



Step 6

Holding the phone with the back housing up, remove the four screws in the back housing using the special driver screw.

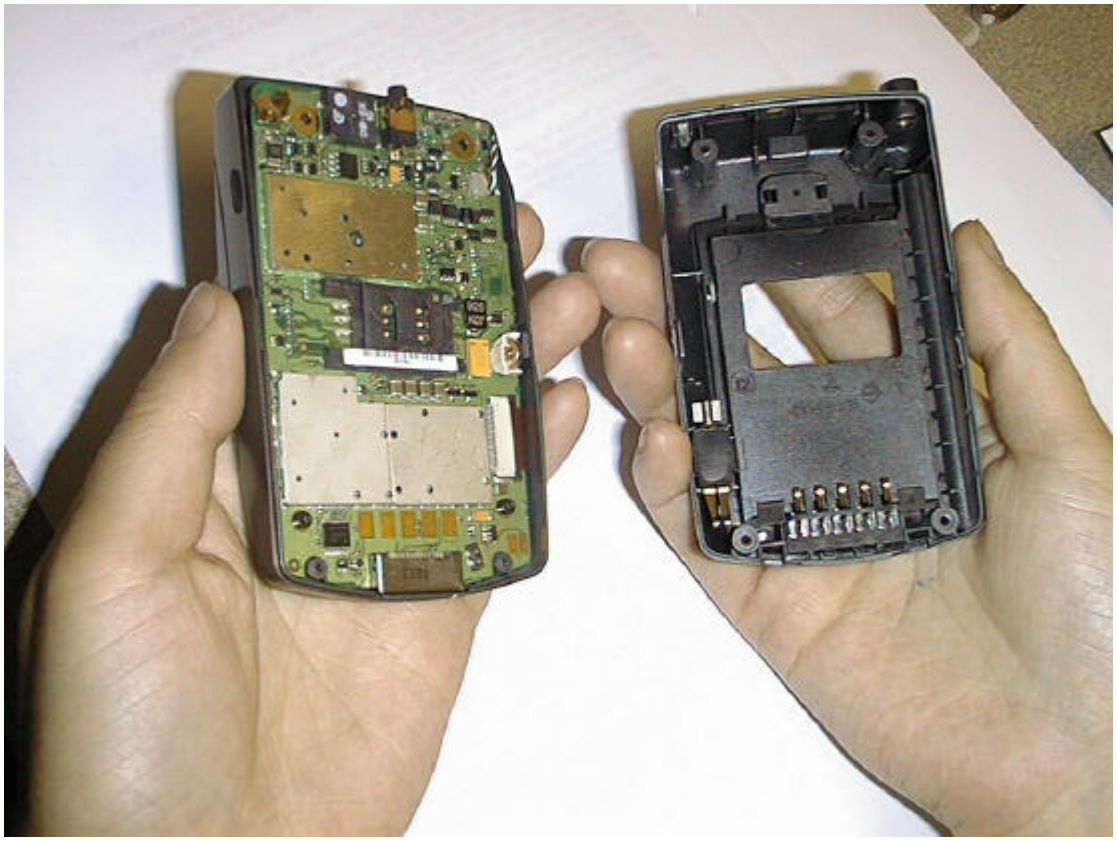
Step 7

Press the middle of the left side (the other side of the jack) in the back housing with your thumb until the button is detached.A snap will be heard.

Step 8

Pull the top of the back housing until the headset jack is detached from the back housing,

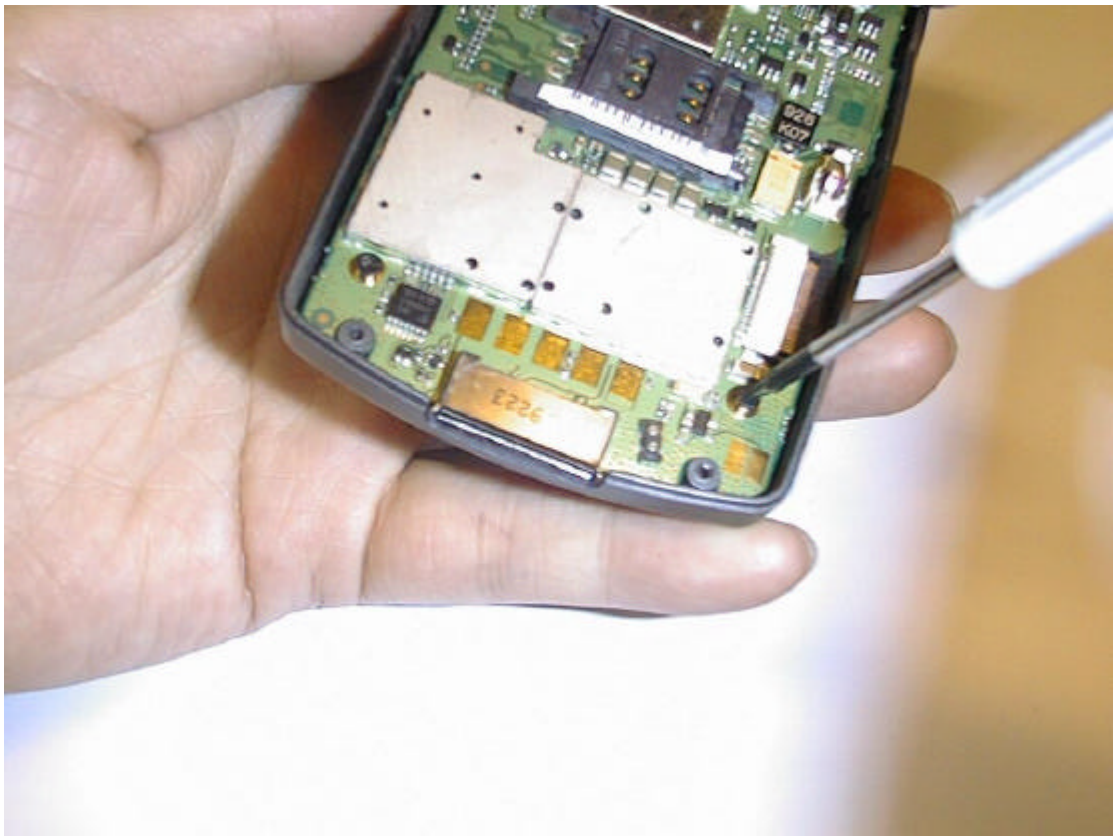
Remove the back housing gently.



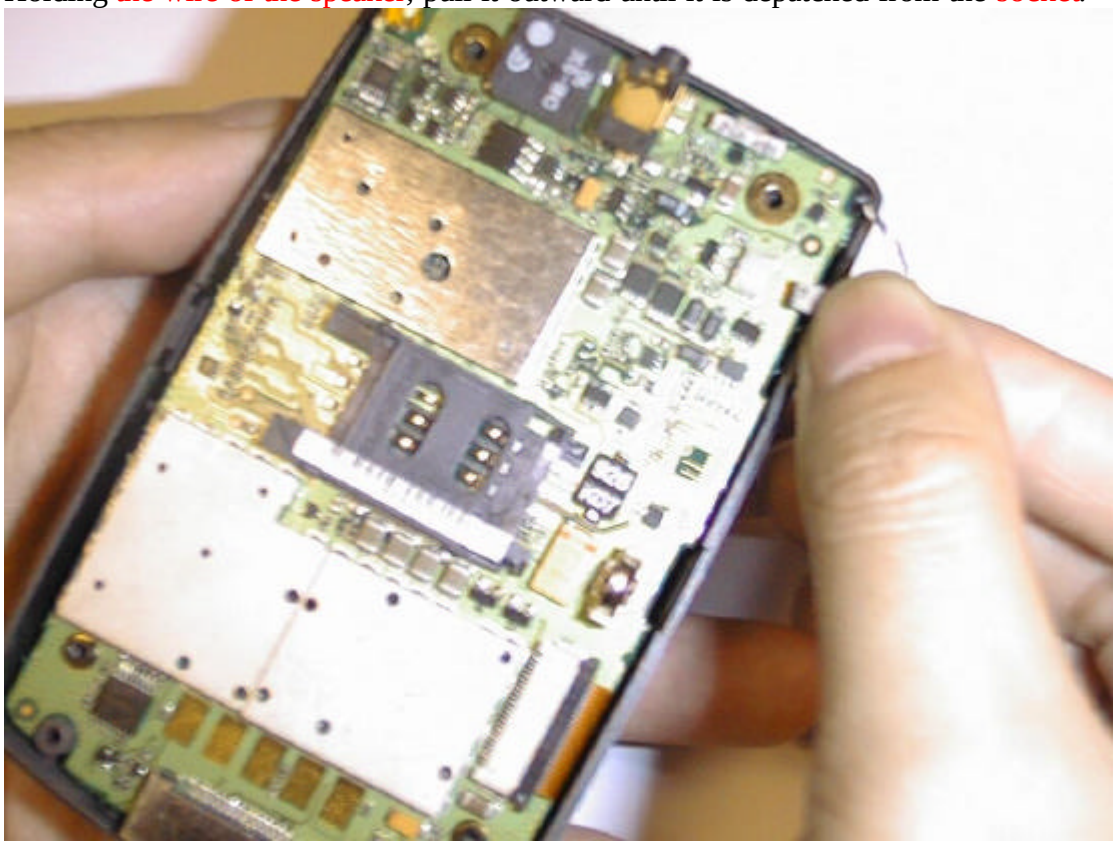
Board and LCD removal

Remove the back housing as described in the previous procedures

Step 1
Remove the two screws in the board using special screw driver.



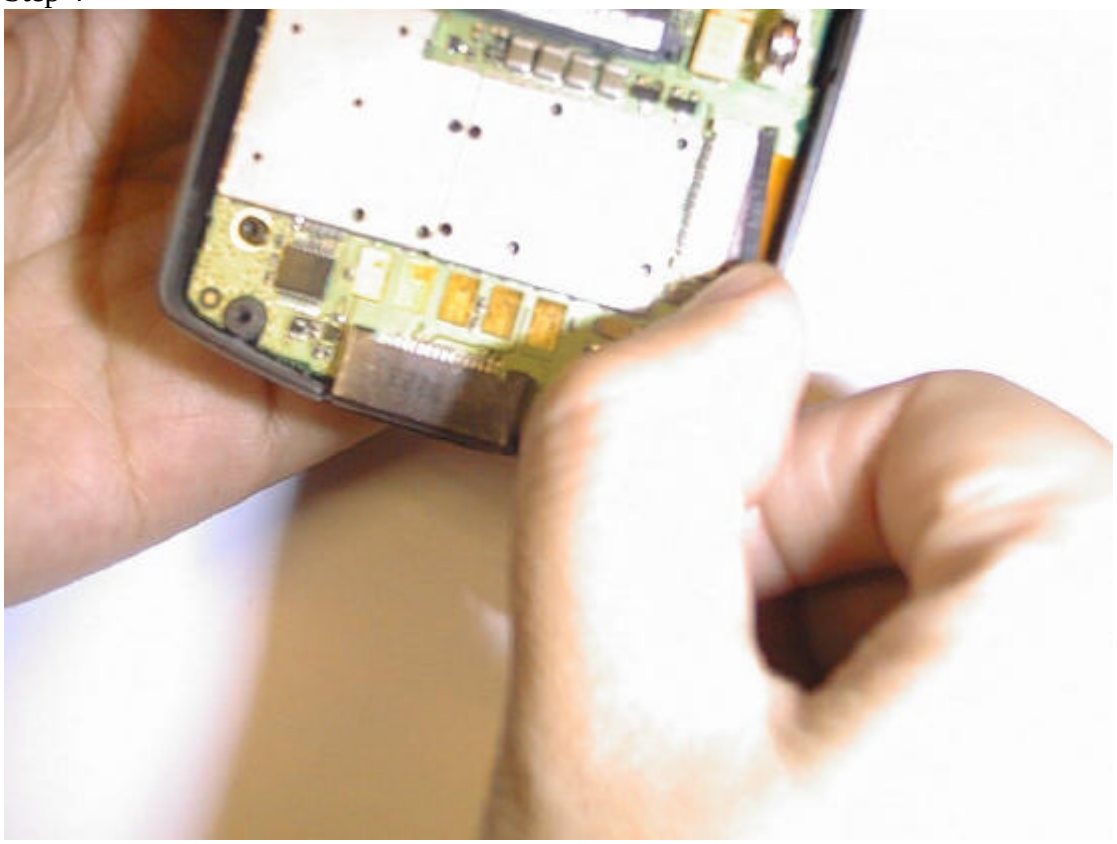
Step 2
Holding the wire of the speaker, pull it outward until it is depatched from the socket.



Step 3

Pull the LCD cord latch out. Holding the cord , pull it outward until it is depatched from the socket.

Step 4



Using the plastic pry tool remove the board carefully.

Be cautious to not damage the Rocker Swith.

Step 5
Open the Flip,remove the LCD from the front housing by pushing it upward.

Flip ,Hinge,front housing removal

Remove the back housing, board, and LCD as described in the previous process.

Step 1
Remove the wire nip(rubber) from the front housing.

Step 2

Put the Dental tool into the gap of the Flip, pull the hinge inward, while pulling the front housing up to remove the hinge from the front housing.

Step 3

Holding the Flip, remove the wire of the speaker from the other hinge hole in the front housing.

Step 4

11 TROUBLESHOOTING

Introduction

Assembly replacement level troubleshooting and repair of the *Taichi* portable telephone is limited to those components listed in the “Replacement Parts”. It is recommended that known good replacement parts and assemblies be available to be used for troubleshooting by substitution, and for replacement of parts/assemblies found to be effective.

Troubleshooting and Repair

The troubleshooting chart shows some typical malfunction symptoms and the corresponding verification and repair procedures. Additionally the “Troubleshooting Supplements” are offered to assist in corrective action of more detailed symptoms.

Refer to the instructions on removing and replacing parts/assemblies from the portable telephone. If the Logic /Rf assembly is replaced a personality transfer will be necessary. See the personality transfer page.

> **NOTE:** Defective Logic/RF assemblies must be replaced with pre-tested, pre-phased assemblies.

GSM Testing after Repair

After any repair work has been carried out, the unit should be thoroughly tested to ensure that it operates correctly. This is especially important if the Logic / RF assembly is replaced.

For general repairs which do not include replacing the Logic/RF assembly, simply placing a call and checking signal strength, and transmit and receive audio quality is normally sufficient.

When the Logic/RF assembly is replaced, the unit must have a comprehensive test on a GSM/DCS compatible communications analyzers. See “Testing” for further details. Placing a call on air is usually carried out at this stage to complete the testing procedure.

> **Note:** To replace U900 (GCAP II), BGA Part, you must have proper equipment and proper repair training**.**

TROUBLE SHOOTING AND REPAIR CHART

1.PHONE WILL NOT TURN ON

TROUBLESHOOTING	OBSERVATION	REPAIR SUGGESTED
1. Check with a known good battery	O.K.	Replace battery
2. Check the battery contacts	NOT O.K.	Replace Battery contacts
3. Keypad back light on but no display	YES	replace keyboard
4. Check the power button on the keypad and mylar	NOT O.K.	Replace keypad/Mylar
5. Check for V_Boost 1 at C934 for 4.5V	NO/Low Voltage	U900 Suspect bad
6. Check for V1 C225 for xxV	NO/Low Voltage	U900 Suspect bad
7. Check for LS_V1 at C929	NO/Low Voltage	U900 Suspect bad
8. Check for V2 at C924 for 2.775V	NO/Low Voltage	U900 Suspect bad
9. Check for V3 at C926 for 2.00V	NO/Low Voltage	U900 Suspect bad
10. Check for Vref at C939 for 2.75V	NO/Low Voltage	vU900 Suspect bad
11. Check for Reset at C724 for 2.75V	NO/Low Voltage	vU900 Suspect bad
12. Check for RF_V1 at C240 for 2.75V	NO/Low Voltage	Replace Q240 then suspect bad U201
13. Check for RF_V2 at C242 for 2.75V	NO/Low Voltage	Replace Q242 then suspect bad U201
14. Check for 13MHz Clk at R224	CLK not present	Replace y230 then suspect bad U201

2.PHONE CANNOT MAKE OR RECIEVE CALL

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1. Phone will not Camp(Register)	No service strength indicator bar(s)	1. Check the Receiver problems section. 2. Send for Rephasing
2. Phone Camps but will make a call	Shows Service Strength indicator	1. Check the Transceiver problems section. 2. Send for Re-Phasing.

3.PHONE SHOWS POOR RECEPTION

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1. Phone shows poor reception in a known good area.	Low Signal Strength Indicator.	1. Check the Receiver problems section. 2. Send for Re-Phasing.

4.PHONE DROPS THE CALL

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1.Establish a call and check if it drops the call	YES	1, Check Reciever and Transmitter problem Section. 2. Send for Re-Phasing.

5.LOW OR NO ALERT (RINGER) TONE

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1.Check Alert and Alert Contacts on the radio board	O.K.	Replace Alert
2.Check Voltage on Alert_VCC at C940 should measure 4.5V (almost B+)	Not O.K.	Replace Q938.
3.Check for Unsolder/Cold Solder components	O.K.	Suspect bad U900

6.SPEAKER LOW AUDIO OR NO AUDIO

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1.Check Speaker	Not O.K.	Replace Speaker Flip Assembly
2.Check for Cold solder or Unsolder pins on J700 and.	Not O.K.	Reflow J700.

7.UPLINK AUDIO POWER

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1.Check Microphone and J802 Connector	Not O.K.	Replace Microphone or Replace/ Reflow J910 Connector.
2. Check for Cold solder or Unsolder components	O.K.	Suspect bad U900

8.RECIEVER PROBLEMS

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1. Check the Antenna and Antenna Contact Clip on the PCB.	Not O.K.	Replace Antenna or Reflow or Replace Antenna Clip.
2. For GSM-Check for Cold Solder or UNsolder or Damaged FL460 and FL470.	Not O.K.	Reflow or Replace FL460 and or FL470.
3. For DCS-Check for cold solder or unsolder or	Not O.K.	Reflow or Replace FL450 and or FL465.

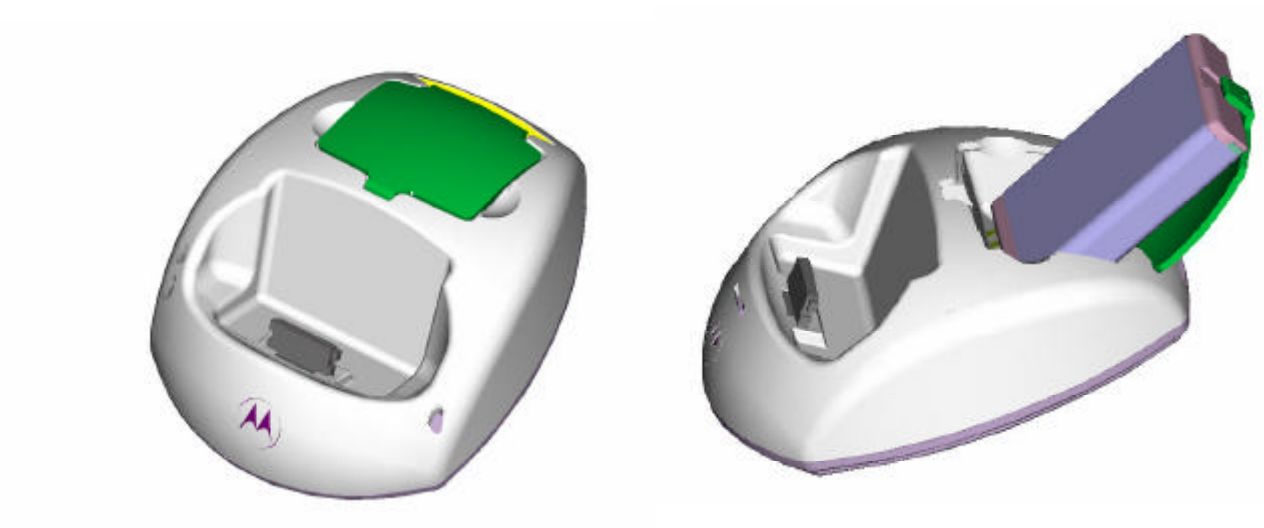
damaged part.		
4. Check for Cold Solder or Unsolder or Damaged FL457	Not O.K.	Reflow or Replace FL457.

9.TRANSMITTER PROBLEMS

TROUBLE SHOOTING	OBSERVATION	REPAIR SUGGESTED
1. Check the Antenna and Antenna Contact Clip on the PCB.	Not O.K.	Replace Antenna or Reflow or Replace Antenna Clip.
2. Check PA U400 for GSM Band.	Not O.K.	Replace PA U400.
3. Check PA U300 for DCS Band.	Not O.K.	Replace PA U300.
4. Check exiter Amp Q455	Not O.K.	Replace Exiter Amp Q455.
5. Check Tx Vco IC U250	Not O.K.	Replace U250
6. Check MCIC (FL300)	Not O.K.	Replace FL300

12. Accessory

Charger Base



A6188

Charger Base

1.Introduction

In order to support the TaiChi phone rollout in the Chinese market we need to develop the charger base/docking station for the phone. The charger base will have data passthrough functionality to support the integrated mobile organizer in the phone, as well as use the existing Kramer Rapid Travel Charger. The new charger must provide the following capabilities:

- Charge the single TaiChi battery (standard Zap LSQ8) in the phone.
  - Charge a spare battery in the rear pocket (standard Zap LSQ8 only).
  - Hold phone in front pocket, and main battery in the rear pocket at the same time.
  - Be compatible with the Kramer Rapid Travel Charger: SPN4654A
  - Capable of charging Nickel Metal Hydride or Lithium Ion batteries.
  - Provide LED readout's as to the charging status of the batteries, and indicate data transfer.
  - Phone flip must be able to open while charging.
  - Have TrueSynch data transfer capability via the data cable, which will use the Hirose Startac connector on the back of the unit.

2.Product Description

2.1 Part Numbers & Physical Characteristics

Part Numbers

SPN4801A	**A6188 Dual Pocket Desktop Charger Base (PRC label version)**
SPN4654A	**Rapid Travel Charger (PRC version)**
SKN6133A	**Sync cable**

2.2 Physical Characteristics

2.2A Top Housing

- Top Housing will be designed to accept the A6188 phone in the front facing upright position.
- Gray textured plastic.
- Motorola logo with "Motorola" on top housing.

2.2B Bottom Housing

- The bottom housing will use the Hirose female connector to accommodate the data cable. If desired the travel charger can be plugged directly into the charger unit, but data functionality will not be available in this configuration.
- Rubber Friction feet on front two corners of bottom housing

- Gray textured plastic.
- Label to indicate required agency approval information (CE only)
- Label to indicate different colors for LED with battery only charging or phone with battery charging

2.2C LED

- Low Cost LED sequencing solution:
  - There will be one tri-color, and two single color LEDs on the top housing.
  - First LED indicates main battery in phone is charging.
  - Second LED indicates battery in the rear pocket (rear LED).
  - LED Indications: Solid red: battery in rapid charge mode; Solid green: battery charged>90%; Flashing yellow: battery waiting to be charged (low priority); Flashing red: indicates a faulty battery and will not charge; Solid yellow (front pocket only): look at phone display for charging status.
  - A third LED will be located away from the other two and will flash green when data transfer is occurring, otherwise the LED will be off.

2.2D Cables

The TaiChi charger will use the Kramer rapid travel charger (SPN4654A) as the power input, this can be plugged directly into the charger base for power only functionality, or into an auxiliary connector on the data cable for full functionality.

The data cable will be a smart cable that connects to the phone via the bottom Hirose connector.

2.3 Electrical Specifications

2.3A Compatibility

- **Power Source**- A6188 Standard Travel Charger
- **Batteries**- Lithium Ion LSQ8 Zap batteries(SNN 5557A). Capable of reading battery thermistor and battery EPROM. Capable of determining battery temperature, battery voltage, and battery rate of change of temperatures.

2.3B Capacity Levels

- The charger will be capable of detecting whether it is receiving power from a Standard Travel Charger, and must be capable of reading the battery EPROM.

2.3C Temperature Range

- Operating Temperature 0°C to +50°C
- Storage Temperature -40°C to +85°C

2.4 Data/Connectivity

- This charger base will transfer data to a connected PC through an RS-232 cable. All phone to RS-232 conversions will take place in the phone with the exception of level shifting. Level shifting takes place in the data cable, allowing the user to travel with the cable only and have full data functionality.

3.0 Performance Characteristics and Features

- Full battery-charging capability (EP+).
- Battery only charging software will include ability to lockout batteries that are not detected to have EPROM
- Charge times determined by use with Rapid Travel Charger.

With Rapid Travel Charger Lithium Ion 1-2 hours

3.1 Compatibility

The A6188 Charger Base is compatible with only A6188 Series phones.

Appendix

Equipments and Tools

The following equipments and tools are recommended to use for Taichi radio repairing and troubleshooting.

1. **HP8922P / CMD55 – GSM Test Set**
2. **HP8594E – Spectrum Analyzer**
3. **HP54520 – Oscilloscope**
4. **HP34401A – Multimeter**
5. **LPS-105 – AMRFL DC Power Supply**
6. **JetEye – IRDA Adaptor**
7. **HAKO926 – Soldering Station**
8. **HAKO851 – SMD Rework Station**

Taichi Unique Part List

Item		PN	Des	U/P
1		0609261R25	Res	1
2		0609261R49	Res	1
3		0609261R53	Res	2
4		0609261R60	Res	1
5		0609451U02	Res	1
6		0660076N84	Res	1
7		0660076P06	Res	1
8		0660076P21	Res	1
9		0662057M09	Res	1
10		0662057P95	Res	1
11		0662057T98	Res	4
12		0664549E01	Res	1
13		0664550E01	Res	2
14		0664551E01	Res	2
15		0664552E01	Res	1
16		0664554E01	Res	1
17		0964393E01	Connector	1
18		0964445E01	Connector	1
19		0964455E01	Connector	1
20		2109296T01	Cap	6
21		2109370C01	Cap	3
22		2113743G24	Cap	1
23		2113928H02	Cap	1
24		2113928N01	Cap	1
25		2164538E01	Cap	3
26		2164555E01	Cap	1
27		2164556E01	Cap	3
28		2311049C31	Cap	1
29		2464545E01	IND	1
30		2664513E01	Shield	1
31		2664514E01	Shield	1
32		3964483E01	Antenna Clip	1
33		4064404E01	SW	1
34		4813824A07	XSTR	4
35		4864546E01	Diode	1
36		4864548E01	XSTR	2
37		4864553E01	XSTR	2
38		4864557E01	Diode	1
39		4870360C15	Diode	2
40		5064529E01	Buzzer	1
41		5109522E16	IC Flip Flop	1
42		5109781E55	IC Lin	2
43		5109781E98	IC Lamp	1
44		5164377E01	IC DRAM	2
45		5164388E01	IC Dragonball	2
46		5164540E01	IC	1

47		5164541E01	IC	1
48		5164542E01	IC	1
49		5164543E01	IC	1
50		5164544E01	IC	1
51		5164547E01	IC	1
52		8464373E01	PCB	1
53		0164008E01	FH	0
54	Front Housing	1564420E01	FH	1
55		3864485E01	Keypad Left	1
56		3864486E01	Keypad Right	1
57		4064460E01	OnOff Switch	1
58		3264430E01	Gasket Up	1
59		7564491E01	Flip Stopper	1
60		7564492E01	Wire Guide	1
61		0164010E01	Flip	0
62	Flip	1564413E01	Flip Front	1
63		1564414E01	Flip Rear	1
64		2864452E01	Wire Connector	1
65		3564443E01	Grill Cloth	1
66		1164482E01	Pad w/Adhesive	1
67		0164011E01	RH	0
68	Rear Housing	1564433E01	RH	1
69		1564450E01	Stylus Holder	1
70		3864487E01	Record Button	1
71		4364520E01	Bushing Instert	1
72		5564489E01	Latch	1
73		6164440E01	IR Lens	1
74		6164457E01	Light Pipe	1
75		0164481E01	Antenna	1
76		0309315B03	Screw	6
79		1564439E01	Battery Door	1
80		5564437E01	Hinge	1
82	MOtor	5909374B12	Motor	1
83		0564488E01	Vibrator Pad	1
84		6003710K08	RTC-Batt	1
85		7564435E01	Feet Rubber	2
86		7564453E01	Snubber	1
87		CHHN4065A	LCD	0
88	LCD	6464431E01	LCD Holder	1
89		0164006E01	Display	1
90		1164429E01	D/S Adh.Tape	1
91		3264432E01	Gasket Bottom	1
92		1564454E01	Stylus A	1
93		0564515E01	Alert Boot	1
94		7564521E01	Poron	3
95		0564533E01	Mic Grommet	1

Note:There is another part number need to set up.