

# User manual

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## 1 Introduction

The APOLLO series (including models CDMA/CDMA-B/CDMA-BA/CDMA-G/CDMA-B-G/CDMA-BA-G) are self-contained vehicle tracking devices that combine GPS location with CDMA connectivity.

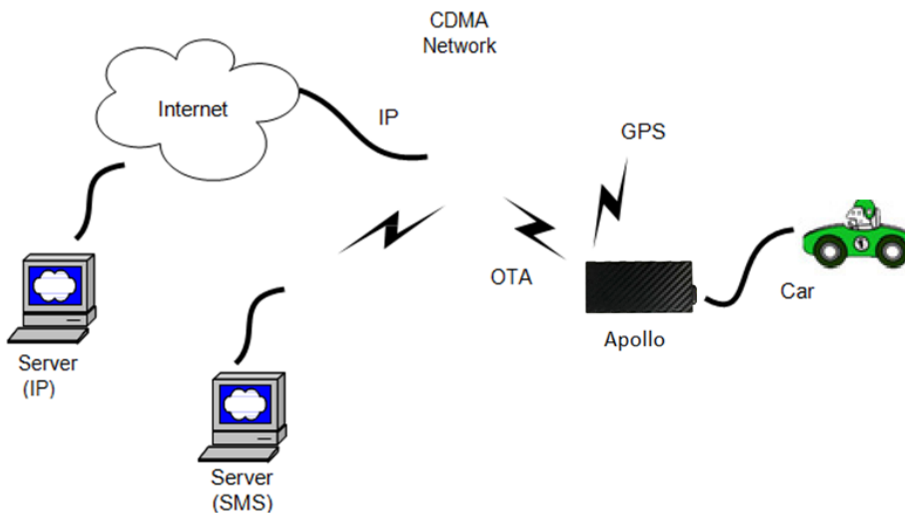
Logically, the APOLLO appears to a user or a server application as a single endpoint device. It can be queried, updated and configured either through a serial connection, an over the air CDMA IP connection, or through SMS messaging. The APOLLO series present themselves over these connections as an enhanced cellular modem with attached functional elements.

These elements include:

- GPS location engine
- 2 General Purpose Bidirectional I/O (GPIO) pins
- 1 Relay drive pin output
- Serial UART port
- Input voltage monitor (optional)
- Timers
- Watchdog lockup protection (Dedicated watchdog circuit is optional)
- Factory load option for motion detection

Access to these elements and general purpose interfaces is done through an extended AT command set as defined herein.

Application diagram:



This product is designed based on the VIA CBP8.2 CDMA 1X 800M&1900M Baseband chip, which includes GPS functionality, ARM CPU and CDMA protocol. This Baseband chip is connected to 256M serial flash, CDMA 800M/1900M/GPS RF Transceiver, and RF Front end circuit.

The device includes one dual band antenna (CDMA800&CDMA1900) and one dedicate GPS antenna.

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Marketing Information

Item	Description
Potential market	America
Product Design Requirement	Cost: Entry Level
Expected sample Date	
QTY of Samples	

## 2 ID and Tooling Design

The product appearance is shown as follows:



### 3 Hardware Requirements

#### 3.1 Basic Hardware Requirements

Items	Requirement
<b>Baseband Chipset</b>	VIA CBP8.2C/CBP8.2D
<b>RF Transceiver</b>	FCI7790
<b>Memory</b>	Serial Flash 256Mb PSRAM 128Mb/64Mb (optional)
<b>Air Interface</b>	CDMA 2000 1x, GPS
<b>Frequency</b>	CDMA2000 1x: 800MHz,1900MHz
<b>Antenna</b>	Internal Antenna(800M&1900M)
<b>GPS Antenna</b>	Dedicate high performance ceramic antenna
<b>UIM requirement</b>	No-UIM mode, UIM card connector optional
<b>Interface</b>	UART TX UART RX 12V DC Input (1A current) Relay Drive (12V Output ,500mA current) GPIO1 GPIO2
<b>Battery Monitor</b>	internal analog input scaled (Optional)
<b>Build in battery manager</b>	Required
<b>Dedicate Timers</b>	No
<b>Watchdog</b>	Required (Dedicate Watchdog is Optional)
<b>Motion Detect</b>	Optional (GPS/Sensor)
<b>LED</b>	2 LED required 2 LEDs (one is RED, one is Green)
<b>Battery</b>	Build in battery (80MAH Lion)
<b>Working Time</b>	4hours
<b>Power switch</b>	No
<b>Power Cable color</b>	8 colors
<b>Power Cable connector type</b>	8 pin
<b>Power Consumption</b>	< 5Watts

The Apollo series provides support for specialized hardware features through extended AT commands. The features supported include the following:

#### GPS

The major functionality of the GPS module is to compute the correlation results between the incoming signal and the selected PRN code based on certain Carrier Doppler Frequency, Code Doppler Frequency, code phase, carrier phase, and the particular satellite the module is tracking or acquiring.

## GPIO

Two GPIO pins, GP1 and GP2, are presented to the external environment on the main connector. They are general purpose, bidirectional lines capable of providing system interrupts to generate a report or drive logic levels to external devices. These lines are 2.8V logic level and are 15V tolerant. These pins default to input. GP1 is pulled down representing 0 when disconnected; GP2 is pulled up representing logical 1 when disconnected. They should be asserted to a known value if used. GP1 is intended to use for Ignition Sensing.

## LED's

Two LED status indicators are provided to verify correct installation and operation. The status LEDs are color coded and directly convey the status of the CDMA and GPS subsystems as described in the table below. Their valid operation also indicates operational status and power.

LED	Function	Status
Red	GPS	<b>On: GPS satellites acquired and Locked</b> <b>Flash Slow:</b> GPS satellite search is in progress <b>Off: No power or GPS subsystem fault</b>
Green	CDMA/CDMA Connection	<b>On: Indicates CDMA connection is made</b> <b>Flash Slow:</b> CDMA subsystem initialization in process <b>Flash Fast:</b> CDMA initialization but no data connection available <b>Off: No power or CDMA subsystem fault</b>

The APOLLO provides user control allowing the LEDs to be extinguished once installation is verified. This feature reduces power and further conceals the APOLLO Tracker from untrained parties wishing to defeat its operation.

## UART

A UART port is provided for AT command and data interaction and optionally for application specific control. When in power down mode, a character must be sent to the UART first to wake it up. The port will stay awake for 5 seconds after any character received.

## Relay Driver

A 500mA sink capable output pin is provided. This pin is meant to drive a relay coil indented to interrupt the starter solenoid relay for the ignition circuit to a car.

## Battery Monitor

The battery monitor is internal analog input scaled such that the DC value of the power input pin to the APOLLO system is measured. This value is scaled to span the most significant 8 bits of the A/D and consequently covers a scale from 0 to 25.5 Volts.

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## Timers

Timers resident on the CDMA baseband chip generate periodic interrupts for power down wakeup, watchdog support, report generation and other timer related functions. Report timers are supported by related AT command and cause generation of periodic reports.

## Watchdog

The watchdog is a dedicated part external to the main CPU.

## Accelerometer (Option)

The optional accelerometer can be used for motion detection and driver behavior monitoring.

### 3.2 Basic RF Performance Requirements

Items	Requirements	Remark
TRP free space	$\geq 20$ dBm	TRP free space
TIS free space	$\leq -104$ dBm	TIS free space
Antenna loss	$\leq -3$ dB	TRP-TX Power Conducted
Antenna Loss	$\leq -3$ dB	RX receive sensitivity conducted – TIS

Board RF Specification	
<b>Cellular Band RX</b>	
Frequency range	869MHz ~ 894MHz
Sensitivity	-108dBm (FER $\leq$ 0.5%)
Dynamic range	-25 ~ -108dBm (FER $\leq$ 0.5%)
Single tone Desensitization	-102.4dBm(FER $\leq$ 1%,-30dBm@ $\pm$ 900KHz)
Intermediation Spurious Response Attenuation	-102.4dBm(FER $\leq$ 1%,-43dBm@ $\pm$ 900 KHz/ $\pm$ 1700KHz)
	-91.4dBm(FER $\leq$ 1%,-32dBm @ $\pm$ 900 KHz/ $\pm$ 1700KHz)
	-80.4dBm(FER $\leq$ 1%,-21dBm @ $\pm$ 900 KHz/ $\pm$ 1700KHz)
Conducted Spurious Emission	$< -76$ dBm/1MHz (RX band)
	$< -61$ dBm/1MHz (TX band)
	$< -47$ dBm/30KHz (other frequency)
<b>Cellular Band TX</b>	
Frequency range	824MHz ~ 849MHz
Maximum Frequency error	$\pm 300$ KHz
Maximum output power	24dBm [-3dB~+2dB] ;
Minimum controlled output power	$< -50$ dBm
Standby output power	$< -61$ dBm
Code domain power	The code domain power in each inactive code channel shall be 23 dB or more below the total output power measured on both the I and Q data channel combined.
Time reference	$\pm 1.0$ uS
Waveform quality	$> 0.944$
Range of open loop output	(test1 : $-25$ dBm/1.23MHz) – $47.7 \pm 9.5$ dBm



power	(test2 : - 60dBm/1.23MHz) - 7.7±9.5dBm (test3 : - 93.5dBm/1.23MHz) 20.3±9.5dBm
Conducted spurious emission	-42dBc/30KHzor-54dBm/1.23MHz ( Δf :1.25MHz~1.98MHz)
	-50dBc/30KHzor-54dBm/1.23MHz ( Δf : 1.98MHz~4.00MHz)
	<-36dBm/1kHz ( Δf  > 4MHz, 9KHz < f < 150KHz,)
	<-36dBm/10kHz ( Δf  > 4MHz, 150kHz<f<30MHz,)
	<-36dBm/100kHz ( Δf  > 4MHz, 30MHz<f<1GHz)
	<-30dBm/1MHz ( Δf  > 4MHz, 1GHz<f<12.75GHz)
<b>PCS Band RX</b>	
Frequency range	1930MHz ~ 1990MHz
Sensitivity	-108dBm (FER≤0.5%)
Dynamic range	-25 ~ -108dBm (FER≤0.5%)
Single tone Desensitization	-102.4dBm(FER≤1%,-40dBm@±1250KHz)
Intermediation Spurious Response Attenuation	-102.4dBm(FER≤1%,-43dBm@±1250KHz/±2050KHz)
Conducted Spurious Emission	<-76dBm/1MHz (RX band)
	<-61dBm/1MHz (TX band)
	<-47dBm/30KHz (other frequency)
<b>PCS Band TX</b>	
Frequency range	1850MHz ~ 1910MHz
Maximum Frequency error	±150KHz
Maximum output power	23dBm [-3dB~~+2dB]
Minimum controlled output power	<-50dBm
Standby output power	<-61dBm
Code domain power	The code domain power in each inactive code channel shall be 23 dB or more below the total output power measured on both the I and Q data channel combined.
Time reference	±1.0uS
Waveform quality	>0.944
Range of open loop output power	(test1: -25dBm/1.23MHz) -50.7±9.5dBm
Conducted spurious emission	(test2: -60dBm/1.23MHz) -10.7±9.5dBm
	(test3: -91.3dBm/1.23MHz) 20.3±9.5dBm

	-42dBc/30KHz or -54dBm/1.23MHz ( $ \Delta f $ : 885KHz~1.98MHz)
	-54dBc/30KHz or -54dBm/1.23MHz ( $ \Delta f $ : 1.98MHz~4.00MHz)
	<-36dBm/1kHz ( $ \Delta f  > 4$ MHz, 9KHz < f < 150KHz)
	<-36dBm/10kHz ( $ \Delta f  > 4$ MHz, 150KHz < f < 30MHz)
	<-36dBm/100kHz ( $ \Delta f  > 4$ MHz, 30MHz < f < 1GHz)
	<-30dBm/1MHz ( $ \Delta f  > 4$ MHz, 1GHz < f < 12.75GHz)
<b>GPS</b>	
AGPS Support	Embedded AGPS software supporting an internal GPS subsystem solution E911 FCC mandated phase 1 and phase 2 (optional1)
Frequency Support	L1-band (1.57542GHz) Channels: 210 PRN, 66 Search, 22 Simultaneous tracking
Sensitivity	Sensitivity (UHS): Tracking: -156dBm Reacquisition: --53dBm Acquisition: -144dBm
Tracking Time Requirement	Acquisition time: Hot: <2s Warm: <30s Cold: <60s Reacquisition: 2s - 10s Depends on signal level

### 3.3 Certification and Safety Requirements

Items	Requirement
<b>Drop Design</b>	1.2meter 6 direction standard drop test
<b>Temperature Range</b>	-40 to 85°C Operation -50 to +100° C Storage
<b>Humidity:</b>	20% to 90% Operation 10% to 95% Storage
<b>Altitude:</b>	-500 to +18,000m
<b>Vehicle ISO Test</b>	ISO+7637-2-2004; ISO+7637-3-2007; ISO_10605-2008; ISO+16750-2-2010
<b>FCC Certification</b>	FCC 47 CFR Part 2, Part 22 and Part 24
<b>Safety</b>	UL Listing
<b>Others Operator Requirement</b>	Industry Canada/ AT&T (optional)
<b>ESD Requirement</b>	15KV non-conductive

## 4 Software Requirements

### 4.1 Basic Software Requirements

Items	Requirement
<b>Air-Network Interface</b>	CDMA 2000 1x 800/1900MHz; GPS
<b>1x Data</b>	Required
<b>IP Stack</b>	Ipv4/IPV6
<b>Upgrade Method</b>	Remote update / PC tool
<b>RUIM</b>	Optional
<b>Compatible with None-RUIM</b>	Required
<b>Remote Update</b>	Required
<b>Power Modes</b>	Required
<b>AT Command</b>	Required
<b>Report</b>	Required ; 23000records
<b>Driver</b>	GPIO, LED, GPS, UART
<b>GPIOs</b>	Interrupt for Door Open Detect, Ignition Status
<b>LEDs</b>	GPS Status, CDMA Status
<b>Watch Dog</b>	Required (CBP8.2 integrated)
<b>Reset</b>	Soft reset
<b>Startup Banner</b>	Required

### 4.2 Remote Update

The Apollo series support OTA field upgrades of the Apollo series resident application. An over the air TFTP (Trivial File Transfer Protocol) connection is made over a UDP/IP connection. A replacement file is then transferred from a server to the Apollo series and that file replaces the previous application image.

#### 4.2.1 Auto Execute

The Auto Execute Utility copies the contents of file system.exf into system executable RAM and executes it from there. This file is the factory default application. Another file named custom.exf can be loaded into the file system.

Auto Execute will look first for a file named update.exf and load and execute that in place of custom.exf if it exists. If update.exf executes successfully, the previous copy of custom.exf is deleted from the file system and update.exf is renamed to custom.exf.

### 4.3 Power Modes

The Apollo series devices support several power modes that are set by the power mode command. In full power mode the cellular subsystem will maintain a persistent cellular connection whenever service is available as well as an IP connection where available. Any hardware or software reset will interrupt any power mode and return the device to full power mode. In summary, the conditions permanently restoring full power mode include:

- Power cycle
- Watchdog timeout
- Reset command
- CDMA phone call reset
- SMS or UART power mode command
- Motion detect (if detector installed and enabled)

When in a power down mode, the following resources will cause interrupts that will wake the Apollo series and cause them to attempt complete the function associated with the interrupt. Simultaneous interrupts will cause sequential completion of each associated function. These interrupts include:

- Report timer
- GPIO change
- Battery threshold
- Heartbeat
- Watchdog
- Power-up

The related interrupt function will be attempted for a total duration set the associated parameter in the power mode command.

#### **4.4 AT Command**

Apollo series commands are AT extensions specific to Apollo series devices. They are closely based on commands that are as similar as possible to other industry common devices and are essentially subsets of standard Apollo commands. Common commands used with CDMA modems supporting IP connectivity are not included within the Apollo series commands set extensions. These commands are left in their native structure, as defined by the respective baseband CDMA chip supplier which product already in use.

#### **Command Summary**

The following commands are highly specialized to the Apollo series. The commands listed are intended to be similar to counterparts found in common CDMA modem command extension.

1. AT+IONAA: Set append mode
2. AT+IONACK: Set acknowledgement mode
3. AT+IONAPN: Set APN
4. AT+IONBIN: Read the factory core software version (read only)
5. AT+IONBZ: Buzzer setting
6. AT+IONCV: Configuration version
7. AT+IONDI: Set distance interval interrupt

8. AT+IONDTE: Set driving time events
9. AT+IONFR: Restore factory defaults
10. AT+IONGF: Set geo fence borders
11. AT+IONGFH: Set geo fence around current location
12. AT+IONGPIO: GPIO Read/Write
13. AT+IONGS: GPS State report
14. AT+IONHB: Heartbeat
15. AT+IONHC: Heading Change
16. AT+IONINFX: List system information segments
17. AT+IONIP: Set target server IP address and port number
18. AT+IONIPC: IP Change report
19. AT+IONIS: Ignition State
20. AT+IONLT: LEDs' Timing and Intensity
21. AT+IONLPORT: Set the local IP port number
22. AT+IONNR: Set time before IP session is closed and restarted
23. AT+IONNW: Set watchdog timeout if no network found
24. AT+IONPM: Set auto power down mode
25. AT+IONRF: Report Format - ASCII/Binary
26. AT+IONRI: Set report timer interval
27. AT+IONRM: Report Mask
28. AT+IONRN: Queue report record for transmission
29. AT+IONRR: Set reset report
30. AT+IONRS: Reset setting - soft/hard, periodic
31. AT+IONSD: Set SMS response destination
32. AT+IONSI: Set interrupt
33. AT+IONSQ: Set queue length
34. AT+IONSR: Set relay driver (GP3) state high or low
35. AT+IONSV: Read the factory application software version (read only)
36. AT+IONTA: Tow Alert
37. AT+IONTID: CDMA tower ID and location data
38. AT+IONUA: Update application firmware OTA

39. AT+IONUC: Update configuration files OTA

40. AT+IONVO: Virtual Odometer

41. AT+IONVTO: Virtual Trip Odometer

## 4.5 Report

The Apollo series capture data and forms a report record with that data. This is a single data structure intended to contain all of the typically useful data on the Apollo series. Other information can be queried separately using separate AT commands.

Reports are generated following specified events such as periodic timeout, speed threshold, geofence crossing, etc., or in response to a Report Now command.

Reports are generated regardless of whether or not there is a GPS lock. If no lock has ever been attained since hardware reset, default values of 0 are returned for all GPS fields. If a lock has been attained and lost, the report will contain the last valid GPS data including the timestamp of that data.

Base Requirements :

1. A report is generated in response to either an interrupt event or in response to execution of associated AT commands explicitly requesting one.
2. GPS coordinates are stored in reports as signed hex values to save space.
3. To reduce data transmission costs, the data within a report record can be masked and removed before it is transmitted.
4. Every report has a tag and each enabled interrupt or event generates a separate report. The report tags indicate the cause of the generated report, which can be an interrupt, an event or in response to a command.

## 4.6 Reset

There are two types of resets supported; soft reset which restarts the main application without performing a power cycle and hard reset that occurs from a power event triggered by power failure or system watchdog.

### 4.6.1 Context Preservation

When a reset is caused by the Network Watchdog or by the Reset command (modes 0,1), the context of the system is being preserved and is restored after the reset. The context includes all the periodic timers, the report queue, the odometer, etc. This allows to reset the unit as a troubleshooting measure either periodically or due to Network Watchdog without losing reports that are already in the queue or are pending on running timers. Note that the reset process may cause 1-2min of inaccuracy in the timers and should not be considered as very precise. Modes 8/9 of the IONRS command perform soft and hard reset respectively without preserving any context. Factory reset (IONFR) also does not preserve any context of the system.

## 4.7 Startup Banner

After a reset a startup banner is printed through the UART only. The format and content of the banner shown below:

```
FW:<firmware version>; BIN:<bin version>; MEID/ESN:<MEID/ESN>
APN1:<apn1 name>; IP:<IP>:<port>; LPORT:<lport>
RI:<s,v,t>; DTE:<t1,t2,t3>; DI:<t>; HB:<t>; NR:<t,c,r>; RS:<a,t,r>
```

## 5 Test Plan

### 5.1 Hardware Test

Test Item	Description
Baseband Function Test	<ul style="list-style-type: none"><li>• Power Input Test</li><li>• Power Consumption and Current Test</li><li>• Heat Dissipation Test</li><li>• UART Stability Test</li><li>• GPIO Level Test</li><li>• LED Stability Test</li><li>• Drop Down Test</li><li>• ESD Test</li><li>• High/Low Temperature Test</li><li>• Humidity Test</li></ul>
RF Test	<ul style="list-style-type: none"><li>• RF Performance Test</li><li>• GPS Performance Test</li><li>• Antenna Performance Test</li></ul>

### 5.2 Software Test

#### Test Environment Construct

message Test environment

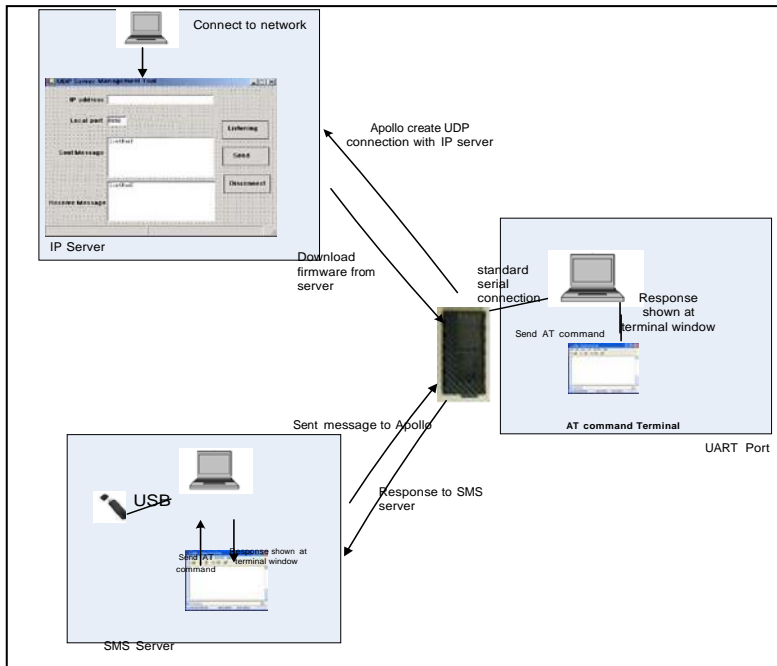
- 1.usb dongle and PC as message server
- 2.send message to Apollo

UDP Test environment

- 1.connect dongle to PC and create dialup as ip server
2. Apollo create IP connection to server

UART Test environment

- 1.connect Apollo to PC with COM serial cable
- 2.open Terminal tool and send at command
- 3.reponse can be shown at terminal window



Test Items	Description
Extension Features Test	
CDG23 Test	
Basic Function Test	
Field Test	



## **FCC Statement**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.