

# ARROW-C User Manual

## R1.0

Author	Revision	Changes	Date
Changyu	1.1	Initial version	2016-03-22

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## 1 Introduction

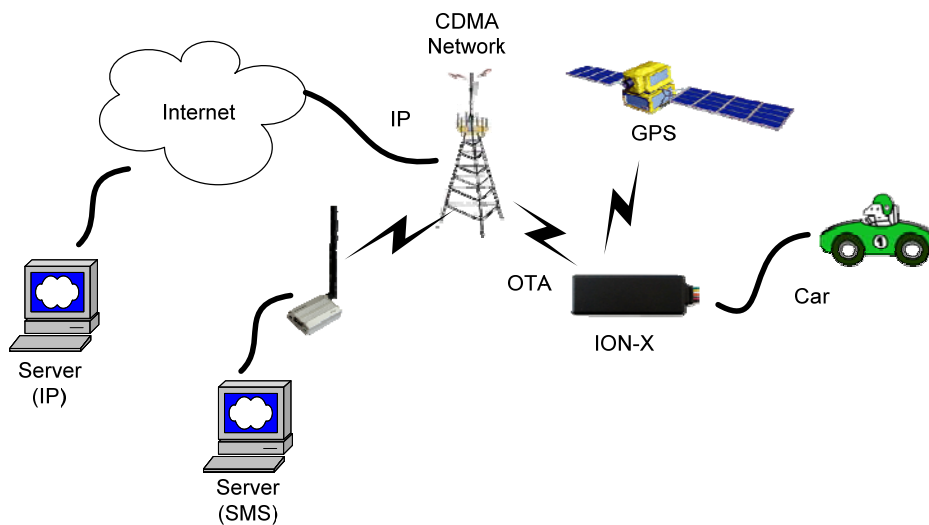
The ARROW-C is a self-contained vehicle tracking device that combines GPS location with CDMA connectivity.

The Arrow-C device series has 5 productions: [AR-2CX](#) / [SR-2CU](#) / [S4N-2CU](#) / [S6N-2CU](#) / [KT-2CU](#)  
Logically, the ARROW-C 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, or an over the air CDMA IP connection, or through SMS messaging. The ARROW-C presents itself 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 scene:



This product will be designed based on the VIA CBP8.2 CDMA 1X 800M&1900M Baseband chipset, which includes GPS functionality, ARM CPU and CDMA protocol. This baseband external connection 256M serial flash, CDMA 800M/1900M/GPS RF Transceiver, and RF Front end circuit.

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

## Hardware Design

### 1.1 Basic Hardware

Items	Requirement
Baseband Chipset	VIA CBP8.2C
RF Transceiver	GRF6416
Memory	Serial Flash 64Mb
	PSRAM 128Mb
Air Interface	CDMA 2000 1x, GPS
Frequency	CDMA2000 1x: 800MHz,1900MHz
Antenna	Internal Antenna(800M&1900M)
GPS Antenna	Dedicate high performance ceramic antenna
UIM requirement	No-UIM mode, UIM card connector optional
Interface	UART TX
	UART RX
	12V DC Input ( 1A current )
	Relay Drive (12V Output ,500mA current)
	GPIO1
	GPIO2
Battery Monitor	internal analog input scaled (Optional)
Build in battery manager	Supported
Dedicate Timers	No
Watchdog	Supported(Dedicate Watchdog is Optional)
Motion Detect	Optional ( GPS/Sensor )
LED	2 LED Supported
	2 LEDs(one is RED, one is Green)
Battery	Build in battery ( 80MAH Lion )
Working Time	4hours
Power switch	No
Power Cable color	8 colors
Power Cable connector type	8 pin
Power Consumption	< 5Watts

The ARROW-C 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 initialized but no connection <b>Flash Fast:</b> CDMA initialization in process <b>Off: No power or CDMA subsystem fault</b>

The ARROW-C provides user control allowing the LEDs to be extinguished once installation is verified. This feature reduces power and further conceals the ARROW-C 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 ARROW-C 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.

### 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

CBP8.2 chipset provide internal software Watchdog, and a physically dedicate Watchdog circuit requirement is optional.

## Motion Detect (Option)

A factory populates option for motion detector is provided. If populated at the time the ARROW-C is manufactured, this option will work with firmware power down options to keep the ARROW-C in a very low power down state until motion is detected. Upon waking, a report can then be generated.

### 1.2 Basic RF Performance

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	20 ~ 24.5dBm
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: $-60\text{dBm}/1.23\text{MHz}$ ) $-7.7\pm 9.5\text{dBm}$
	(test3: $-93.5\text{dBm}/1.23\text{MHz}$ ) $20.3\pm 9.5\text{dBm}$
Conducted spurious emission	$-42\text{dBc}/30\text{KHz}$ or $-54\text{dBm}/1.23\text{MHz}$ ( $ \Delta f : 1.25\text{MHz}\sim 1.98\text{MHz}$ )
	$-50\text{dBc}/30\text{KHz}$ or $-54\text{dBm}/1.23\text{MHz}$ ( $ \Delta f : 1.98\text{MHz}\sim 4.00\text{MHz}$ )
	$<-36\text{dBm}/1\text{kHz}$ ( $ \Delta f  > 4\text{MHz}, 9\text{KHz} < f < 150\text{KHz},$ )
	$<-36\text{dBm}/10\text{kHz}$ ( $ \Delta f  > 4\text{MHz}, 150\text{kHz} < f < 30\text{MHz},$ )
	$<-36\text{dBm}/100\text{kHz}$ ( $ \Delta f  > 4\text{MHz}, 30\text{MHz} < f < 1\text{GHz}$ )
	$<-30\text{dBm}/1\text{MHz}$ ( $ \Delta f  > 4\text{MHz}, 1\text{GHz} < f < 12.75\text{GHz}$ )
<b>PCS Band RX</b>	
Frequency range	1930MHz ~ 1990MHz
Sensitivity	-108dBm (FER $\leq$ 0.5%)
Dynamic range	-25 ~ -108dBm (FER $\leq$ 0.5%)
Single tone Desensitization	-102.4dBm(FER $\leq$ 1%,-40dBm@ $\pm 1250\text{KHz}$ )
Intermediation Spurious Response Attenuation	-102.4dBm(FER $\leq$ 1%,-43dBm@ $\pm 1250\text{KHz}/\pm 2050\text{KHz}$ )
Conducted Spurious Emission	$<-76\text{dBm}/1\text{MHz}$ (RX band)
	$<-61\text{dBm}/1\text{MHz}$ (TX band)
	$<-47\text{dBm}/30\text{KHz}$ (other frequency)
<b>PCS Band TX</b>	
Frequency range	1850MHz ~ 1910MHz
Maximum Frequency error	$\pm 150\text{KHz}$
Maximum output power	20 ~ 24.5dBm
Minimum controlled output power	$<-50\text{dBm}$
Standby output power	$<-61\text{dBm}$
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	$\pm 1.0\mu\text{s}$
Waveform quality	$>0.944$
Range of open loop output power	(test1: $-25\text{dBm}/1.23\text{MHz}$ ) $-50.7\pm 9.5\text{dBm}$
Conducted spurious emission	(test2: $-60\text{dBm}/1.23\text{MHz}$ ) $-10.7\pm 9.5\text{dBm}$
	(test3: $-91.3\text{dBm}/1.23\text{MHz}$ ) $20.3\pm 9.5\text{dBm}$

	-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 $ > 4MHz, 9KHz < f < 150KHz)
	<-36dBm/10kHz ( $ \Delta f $ > 4MHz, 150kHz < f < 30MHz)
	<-36dBm/100kHz ( $ \Delta f $ > 4MHz, 30MHz < f < 1GHz)
	<-30dBm/1MHz ( $ \Delta f $ > 4MHz, 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: -153dBm Acquisition: -144dBm
Tracking Time Requirement	Acquisition time: Hot: <2s Warm: <30s Cold: <60s Reacquisition: 2s - 10s Depends on signal level

### 1.3 Certification and Safety

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



## 2 Software Features

### 2.1 Basic Software

Items	Requirement
Air Interface	CDMA 2000 1x 800/1900MHz; GPS
1x Data	Supported
IP Stack	Ipv4/IPV6
Upgrade Method	Remote update / PC tool
RUIM	Optional
Compatible with None-RUIM	Supported
Remote Update	Supported
Power Modes	Supported
AT Command	Supported
Report	Supported; 3000records
Driver	GPIO, LED, GPS, UART
GPIOs	Interrupt for Door Open Detect, Ignition Status
LEDs	GPS Status, CDMA Status
Watch Dog	Supported (CBP8.2 integrated)
Reset	Soft reset
Startup Banner	Supported

### 2.2 Remote Update

The ARROW-C supports OTA field upgrades of the ARROW-C 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 ARROW-C and that file replaces the previous application image.

#### 2.2.1 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.

### 2.3 Power Modes

The ARROW-C device supports 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 ARROW-C and cause it 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.

## 2.4 AT Command

ARROW-C commands are AT extensions specific to ARROW-C devices. They are closely based on commands that are as similar as possible to other industry common devices and are essentially subsets of standard ARROW-C commands. Common commands used with CDMA modems supporting IP connectivity are not included within the ARROW-C command 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 TALONCV001. 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

## 2.5 Report

The ARROW-C captures 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 TALONCV001. Other information can be queried separately using separate AT commands.

Reports are always generated by interrupts 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.

## 2.6 Reset

There is an internal soft reset.

### 2.6.1 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.

## 2.7 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>

## 3 Test Method

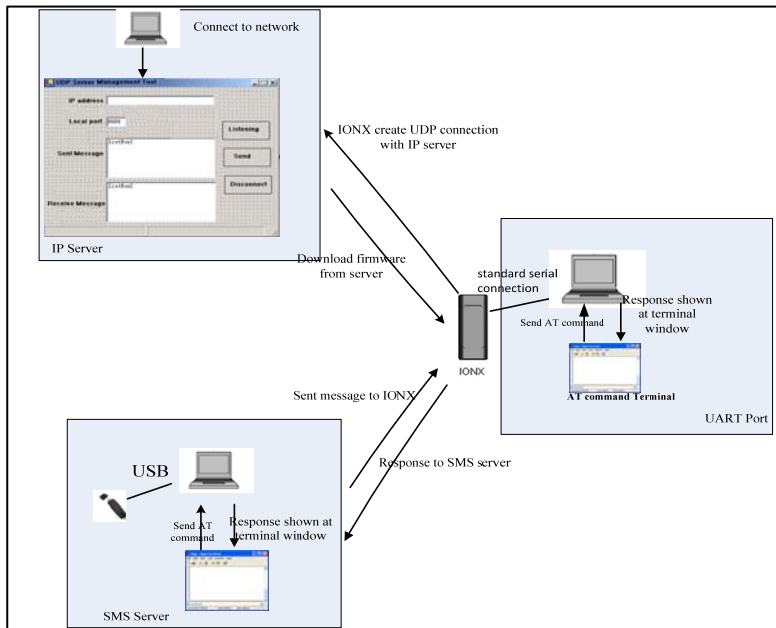
### 3.1 Hardware

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>

### 3.2 Software Test

#### Test Environment Construct

- message Test environment
  - 1.usb dongle and PC as message server
  - 2.send message to IONX
- UDP Test environment
  - 1.connect dongle to PC and create dialup as ip server
  - 2.IONX create IP connection to server
- UART Test environment
  - 1.connect IONX to pc with com serial cable
  - 2.open Terminal tool and send at command
  - 3.reponse can be shown at terminal window



## 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.

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

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.

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.