NINA-W1 series
Stand-alone Wi-Fi modules
Getting Started

Abstract

This document describes how to set up and use the NINA-W1 series ultra-compact modules with Wi-Fi. It also provides a technical overview of the NINA-W1 series and describes how to configure Wi-Fi.

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Document Information

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Product name	Type number	u-blox connectivity software version	PCN reference
NINA-W131	NINA-W131-00B-00	0.9.0.8	N/A
NINA-W132	NINA-W132-00B-00	0.9.0.8	N/A

Contents

1 Introduction

The NINA-W1 series is an ultra-compact stand-alone Wi-Fi module developed by u-blox for integration in demanding, reliable devices, such as those needed for industrial and medical applications. The NINA-W1, supporting 802.11b/g/n in the 2.4 GHz ISM band, can act as a Wi-Fi station and a micro access point..This document describes how to set up and use the modules.

1.1 Key features

One of the key features of the NINA-W1 series is the wireless serial cable replacement functionality. The basic functionality is to transfer data between the serial port and a wireless link. It is possible to configure the NINA-W1 series module to automatically set up a connection and/or accept an incoming connection using AT commands.

For a host, this means that an existing serial cable can be replaced by a wireless solution; in many cases without the need to modify the host.

Figure 1: NINA-W1 series setup

1.2 Modes of operation

The NINA-W1 series can operate in the following two different modes:

- Command mode
- Data mode

By default, NINA-W1 will enter command mode and has to be re-configured to start up in data mode. When in data mode, it is possible to enter the command mode by transmitting the escape sequence to the module. By default, the escape sequence is:

1. Silence 1 second
2. +++
3. Silence 1 second

☞ The +++ must be sent within 200 ms, which means that it is difficult or impossible to enter the escape sequence manually using a terminal window though the characters can typically be pasted instead. The module leaves the command mode and enters the data mode using the **ATO1** command. It is also possible to toggle the UART DTR pin from High to Low to enter the command mode.
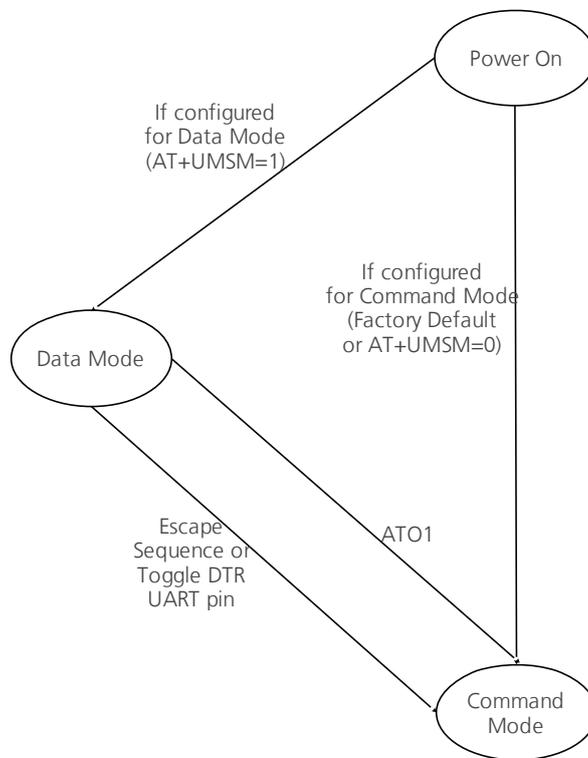
Figure 2: AT data mode

In command mode, the module is configured using AT commands. For information regarding all the available AT commands, see u-blox Short Range Modules AT Commands Manual *[1]*.

In data mode, the module transmits data transparently between the serial UART and the wireless connection(s). There is no additional protocol for the UART. Data transmitted on the UART to the module will be transmitted (and broadcasted for all connections), over air, to all wireless connections. Data received from the wireless connections may be mixed upon reception, and it may be difficult or impossible to figure out from what remote device data is received. This "multipoint strategy" is called as Wireless Multidrop. It is suitable mainly for master/slave polled protocols such as Modbus and point-to-point communication.
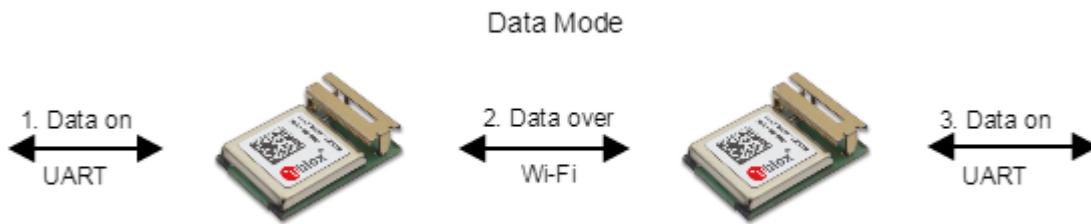
Figure 3: Data mode

1.3 Peers

A connection consists of a sender and a receiver of data. It can also consist of a sender and several receivers in the case of a wireless multidrop/broadcast data. In both cases, every sender and receiver in a setup is referred to as a peer. Thus, a peer is capable of either receiving and/or sending data.

There are two kinds of peer classes in the serial port adapter:

- Local peer
- Remote peer

The local peer is (currently) synonymous with the UART. In contrast to the local peer, the remote peer is another device or broadcast range on the network. Several remote peers can be defined if a multi-drop scenario is needed.

A remote peer is addressed using a Uniform Resource Locator, URL. These locators are strings representing nodes on internet or on a local net. This is the same addressing technology used in for example a web browser. For more information about URLs, check out http://www.rfc-base.org/txt/rfc-1738.txt.

In general, URLs are written as follows:

<scheme>:<scheme-specific-part>

Where <scheme> is the scheme or protocol used while communicating and <scheme-specific-part> is normally the address and port number of the remote node.

For example, a web server on the internet can have the following address:

http://www.u-blox.com/

This tells the browser to use the HTTP protocol and connect to the node at address http://www.u-blox.com/. Similar addressing scheme is used by the module to pinpoint the remote peer. The scheme is not "http", but the node addressing is identical.

Available schemes:

- tcp: TCP connection
- udp: UDP connection, broadcast capabilities

Syntax:

- tcp/udp: <scheme>://ipaddress<:portnumber>

Remarks:

- IP address can be either a numeric IP address or a host and domain name that can be resolved using the configured DNS servers.

Examples

- tcp://10.0.0.9:5003
- tcp://echo.u-blox.com:7
- udp://192.168.0.42:6809

A peer can be set up using either the default remote peer command **AT+UDDRP** or dynamically created using the connect peer command **AT+UDCP**. A connection is closed using **AT+UDCC**.

To enable incoming connections, servers must be enabled using the command **AT+UDSC**. One server of each type can be created, but it can allow for multiple incoming connections.

2 Wi-Fi Network setup

To use TCP and UDP peers, a Wi-Fi network must be activated and connected. This is done using the **AT+UWSC** and **AT+UWSCA** commands for Wi-Fi Station Configuration and **AT+UWAPC** and **AT+UWAPCA** commands for Wi-Fi Access Point Configuration. To define a network, IP address assignment behavior must be defined. Default behavior is DHCP client, static address is also supported.

Currently only Wi-Fi Station or Wi-Fi Access point can be configured at any given time and not both of them simultaneously.

3 Evaluation board

The evaluation board for NINA-W1 is EVK-NINA-W1.

3.1 LED Indications and buttons

There are two operational buttons and one multi LED as shown in Figure 4.

Figure 4 EVK-NINA-W132 evaluation board

The LED indicates what mode is currently active and what activity that is currently in progress. The following color indications are used. See *EVK-NINA-W1 User Guide [3]* for more information about the EVK-NINA-W1.

The Restore/Function Button will restore to factory default with serial settings if pressed for 10 seconds during power up. The Restore/Function button will have the "External Connect" functionality when NINA-W1 is in normal mode.

- **Green:** The current mode is data mode and no connection attempts are in progress.
- **Orange:** The current mode is command mode.
- **Purple:** A connection attempt is in progress.
- **Blue:** A connection is currently active.
- **Blue Blinking:** A connection is active and data is transmitted or received over air.
- **Red Blinking:** Error detected. Typically this means buffer overflow, parity or framing error detected on the UART.

☞ The LED on the USB adapter board is a 3-colour LED which means that, on the module, it corresponds to three IO pins. On another board it may have different meaning.

3.2 Restore factory settings

If both the default serial settings and the external connect button is pressed during power on, the factory settings are restored. You can also restore to factory settings using the **AT+UFACTORY** command followed by power off/on.

3.3 Wi-Fi Configuration

To use Wi-Fi as transport for serial data, setup both the network and peers. It is possible to setup both TCP and UDP peers and they can be both client and server.

3.4 Network setup

To set up a network, Wi-Fi Station or Access Point Network configuration **AT+UWSC** or **AT+UWAPC,** and Wi-Fi Station or Access Point action **AT+UWSCA** or **AT+UWAPCA** command shall be used. With the **AT+UWSC** or **AT+UWAPC** command, all necessary Wi-Fi and network parameters are configured, like network address, SSID and security settings. Multiple Wi-Fi networks can be configured, but only one can be active at any given point of time.

☞ Both **AT+UWSCA** and **AT+UWAPCA** has a function to store the parameters to flash memory without using the AT&W command; all other AT commands must be saved to the startup database using the AT&W.

3.5 Wi-Fi Security

NINA-W1 supports several security modes. The matrix below shows valid security combinations for the module.

	Unencrypted	WEP64	WEP128	TKIP	AES/CCMP
Open	Valid	Valid (only Station)	Valid (only Station)		
Shared					
WPA				Valid	Valid
WPA2				Valid	Valid

Table 1: Security combinations

⚠ **WEP is considered highly unsecure, is deprecated in the 802.11i specification and should not be used. TKIP is also considered as unsecure.**

3.6 Peer setup

Peer setup is used using the "Default Remote Peer" **AT+UDDRP** and "Server Configuration" **AT+UDSC** commands.

3.7 TCP Peer

When a TCP peer is connected, data can flow in both directions irrelevant of whether the peer is a server or client. For example, to connect to port 8080 with an optimized latency, provide the following URL:

"**tcp://192.168.0.1:8080"** (Using IPv4 address)

3.8 UDP Peer

For an UDP peer, the behavior differs for servers and clients. A server will accept data from any IP address sent to the activated port number.

A client can be used to both send and receive data to and from the address specified. To listen on a different port than the remote port, the <local_port> can be specified in the URL. For example, to send on port 8080 and receive on port 8081 gives the following URL:

"**udp://192.168.0.1:8080/?local_port=8081"**

4 Use case examples - Software 0.9.0

4.1 Setup a TCP Listener (using Wi-Fi) and a Static IP

Station

- **Network part using DHCP**
  - o Deactivate network id 0.
    - ▪ `AT+UWSCA=0,4`
  - o Disable DHCP Client (static IP address will be used).
    - ▪ `AT+UWSC=0,100,1`
  - o Set Network IP address.
    - ▪ `AT+UWSC=0,101,192.168.0.100`
  - o Set Network Subnet mask.
    - ▪ `AT+UWSC=0,102,255.255.0.0`
  - o Configure to be active on startup.
    - ▪ `AT+UWSC=0,0,1`
  - o Store Wi-Fi configuration.
    - ▪ `AT+UWSCA=0,1`

- **TCP and data part**
  - o Set server configuration id 1, using TCP and port 8080.
    - ▪ `AT+UDSC=1,1,8080`
  - o Set startup mode to data mode.
    - ▪ `AT+UMSM=1`

- **Restart module for settings to take effect**
  - o Store configuration to startup database.
    - ▪ `AT&W0`
  - o Reboot NINA-W1, and, the following will happen:
  - o Start to scan for the network with the SSID = "my network".
  - o When Wi-Fi is connected and the Network is up, the TCP connection will be set up as well.
    - ▪ `AT+CPWROFF`

4.2 Set a Default Remote Peer (Wi-Fi and TCP) using DHCP that connects automatically

Station

☞ The prerequisites for this use case are that a server is available on IP address 192.168.0.100 and that it accepts connections on port 8080, as explained in chapter 4.1.

- **Network part using DHCP**
  - o Deactivate network id 0.
    - ▪ `AT+UWSCA=0,4`
  - o Active on startup.
    - ▪ `AT+UWSC=0,0,1`

- **Wi-Fi part**
  - o Set the Network SSID to connect to.
    - ▪ `AT+UWSC=0,2,"my ssid"`
  - o Use WPA2 as authentication type.
    - ▪ `AT+UWSC=0,5,2`
  - o Recommended to use a secured WPA2 password.
    - ▪ `AT+UWSC=0,8,"my password"`
  - o Set Network IP address.
    - ▪ `AT+UWSC=0,101,192.168.0.99`
  - o Set Network Subnet mask.
    - ▪ `AT+UWSC=0,102,255.255.0.0`
  - o Store Wi-Fi configuration.
    - ▪ `AT+UWSCA=0,1`

- **TCP and data part**
  - o Set default remote peer id 0, using TCP and always connected.
    - ▪ `AT+UDDRP=0,"tcp://192.168.0.100:8080",2`
  - o Configure to startup to data mode.
    - ▪ `AT+UMSM=1`

- **Restart module for settings to take effect**
  - o Store configuration to startup database.
    - ▪ `AT&W0`
  - o Reboot NINA-W1, and the following will happen:
  - o Start to scan for the network with the SSID = "my network".
  - o When Wi-Fi is connected and the Network is up, the TCP connection will be set up as well.
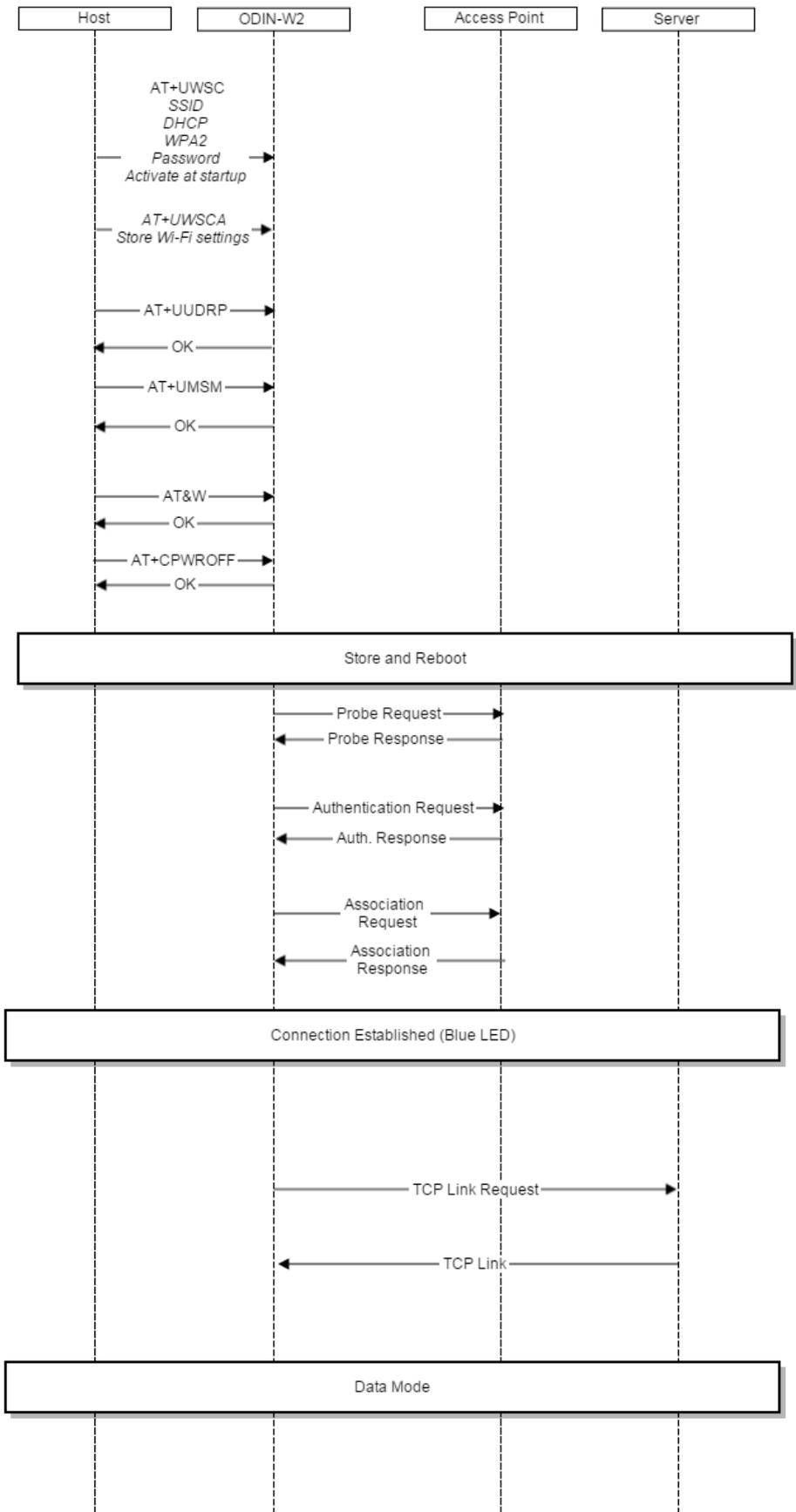   - ▪ `AT+CPWROFF`

Figure 5: NINA-W2 Wi-Fi Connection

4.3 Set a Default Remote Peer (Wi-Fi and TCP) using Static IP Address that connects automatically

Station

☞ The prerequisites for this use case are that a server is available on IP address 192.168.0.100 and that it accepts connections on port 8080, similar to the one mentioned in chapter 4.1.

- **Network part using Static IP Address**
  - Deactivate network id 0.
    - `AT+UWSCA=0,4`
  - Active on startup.
    - `AT+UWSC=0,0,1`
  - Disable DHCP Client (static IP address will be used).
    - `AT+UWSC=0,100,1`
  - Network IP address.
    - `AT+UWSC=0,101,192.168.0.99`
  - Network Subnet mask.
    - `AT+UWSC=0,102,255.255.0.0`

- **Wi-Fi part**
  - Set the Network SSID to connect to.
    - `AT+UWSC=0,2,"my ssid"`
  - Use WPA2 as authentication type.
    - `AT+UWSC=0,5,2`
  - The secret WPA2 Password.
    - `AT+UWSC=0,8,"my password"`
  - Store Wi-Fi configuration.
    - `AT+UWSCA=0,1`

- **TCP and data part**
  - `AT+UDDRP=0,"tcp://192.168.0.100:8080",2`
    - Set default remote peer id 0, using TCP and always connected.
  - `AT+UMSM=1`
    - Set startup mode to data mode.

- **Restart module for settings to take effect**
  - Store configuration to startup database.
    - `AT&W0`
  - Reboot NINA-W1, and the following will happen:
  - Start to scan for the network with the SSID = "my network".
  - When Wi-Fi is connected and the Network is up, the TCP connection will be set up as well.
    - `AT+CPWROFF`

4.4 Connect NINA-W1 using Wi-Fi and Cellular Internet sharing connection

Station

- **Enable Internet Sharing on the cellular device and select a Wi-Fi password**
  - o Settings > Internet Sharing > Enable.
- **Scan for the Internet Sharing network**
  - o `AT+UWSCAN`
  - o `+UWSCAN:F2A637C90E9E,1,"my phone",6,-33,16,8,8`

- **Wi-Fi setup**
  - o Deactivate network id 0.
    - ▪ `AT+UWSCA=0,4`
  - o Active on startup.
    - ▪ `AT+UWSC=0,0,1`
  - o Set the Network SSID to connect to.
    - ▪ `AT+UWSC=0,2,"my Phone"`
  - o Use WPA2 as authentication type.
    - ▪ `AT+UWSC=0,5,2`
  - o The secret WPA2 Password.
    - ▪ `AT+UWSC=0,8,"my password"`
  - o Activate Wi-Fi configuration.
  - o NINA-W1 will now try connect immediately.
    - ▪ `AT+UWSCA=0,3`

- **Wait for the Wi-Fi link and network to go up**
  - o Mac address received and connected on Channel 11.
    - ▪ `+UUWLE:0,F2A637C90E9E,11`
  - o Network is up, it is now possible to read the IP Address.
    - ▪ `+UUNU:0`

- **Read IP address and gateway**
  - o NINA-W1 has got the IP Address 172.20.10.2.
    - ▪ `AT+UNSTAT=0,101`
    - ▪ `+UNSTAT:0,101,172.20.10.2`
  - o The gateway on IP Address 172.20.10.1.
    - ▪ `AT+UNSTAT=0,103`
    - ▪ `+UNSTAT:0,103,172.20.10.1`

Proceed by starting an app on the cellular device. Sample apps that work well are "TCP console" for iOS and "TCP UDP Terminal" for Android, which support both TCP client and server. Start a TCP Server; the port 5003 is used in this example, but any port can be used on the phone.
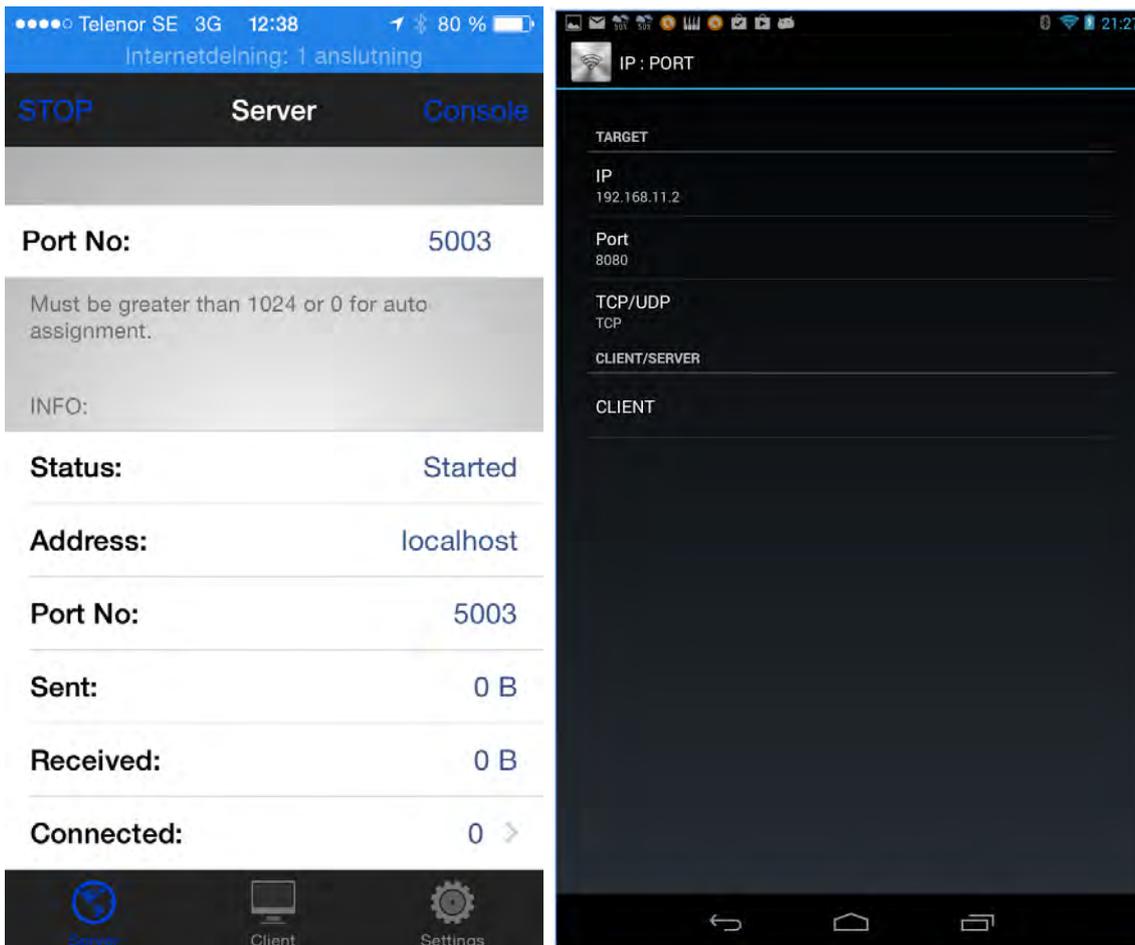
Figure 6: TCP console for iOS and TCP UDP Terminal for Android

You can download the Apps using the following URLs:

https://itunes.apple.com/se/app/tcp-console/id642104251?mt=8

https://play.google.com/store/apps/details?id=nextprototypes.tcpudpterminal

Now connect TCP and enter Data Mode on NINA-W1.

TCP and data part

- o Connect using TCP.
  - **`AT+UDCP="tcp://172.20.1:5003"`**
- o When **`+UDCP:1`** is received, the TCP is connected.
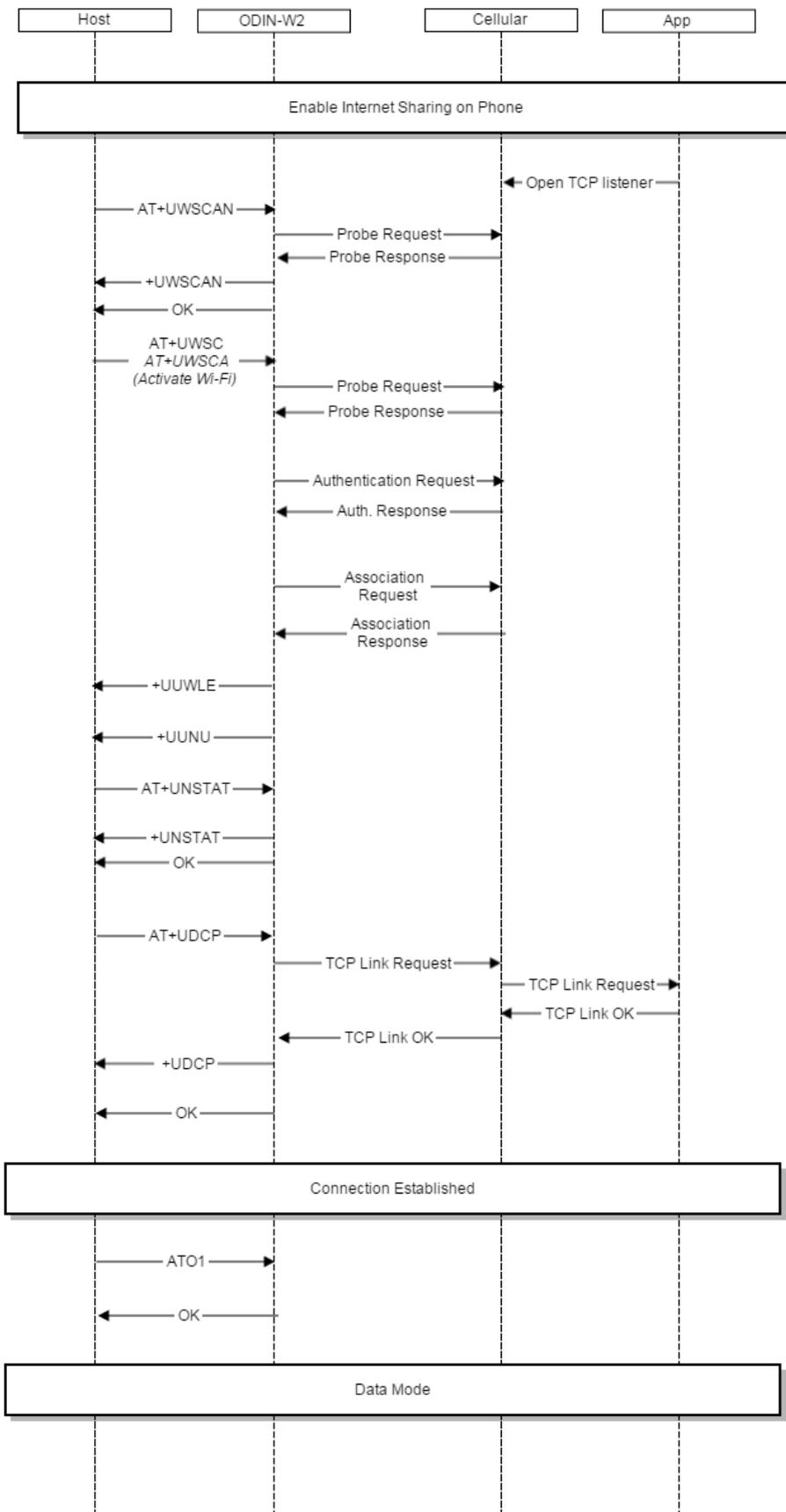
- o Enter Data Mode.
  - **`ATO1`**

Figure 7: NINA-W1 Wi-Fi Connection to iPhone

Appendix

A List of acronyms

Abbreviation / Term	Explanation / Definition
ACL	Asynchronous Connection-Less
AP	Access Point
ATEX	Equipment for potentially explosive atmospheres
DHCP	Dynamic Host Configuration Protocol
DTR	Data Terminal Ready
EDM	Extended Data Mode
GATT	Generic Attributes
HTTP	Hypertext Transfer Protocol
LED	Light-Emitting Diode
PPP	Point-to-Point Protocol
PHY	Ethernet Physical Transceiver
RMII	Reduced Media Independent Interface
RSSI	Received signal strength indication
SPP	Serial Port Profile
SPS	Serial Port Service
SSID	Service Set Identifier
TCP	Transmission Control Protocol
UDCP	Universal Dispenser Communication Protocol
UDDRP	Uniform Domain Dispute Resolution Policy
UDP	User Datagram Protocol
URL	Uniform Resource Locator
WEA	Wireless Ethernet Adapter

Related documents

[1]   u-blox Short Range Modules AT Commands Manual, Document No. UBX-14044127

[2]   NINA-W1 series Data Sheet, Document No. UBX-17006694

[3]   EVK-NINA-W1 User Guide, Document No. UBX-17011007

Revision history

Revision	Date	Name	Comments
R01	3-Jul-2017	cmag, kgom	Initial release.

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