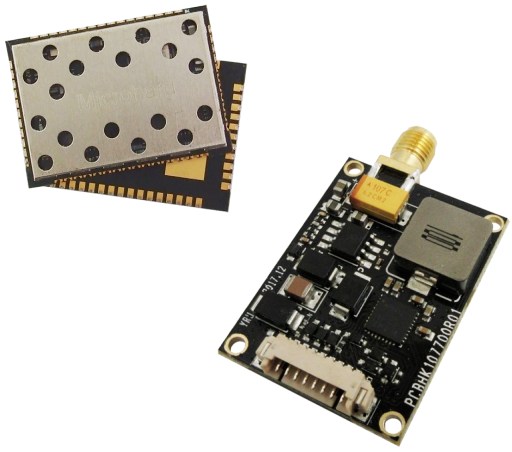
Operating Manual

Half Pico Series (hp840 | hp900)

Miniature OEM Wireless Module

Document: Half Pico.Operating Manual.v1.1.0.pdf



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Important User Information (continued)

About This Manual

It is assumed that users of the products described herein have either system integration or design experience, as well as an understanding of the fundamentals of radio communications.

Throughout this manual you will encounter not only illustrations (that further elaborate on the accompanying text), but also several symbols which you should be attentive to:

Caution or **Warning**
Usually advises against some action which could result in undesired or detrimental consequences.

Point to Remember
Highlights a key feature, point, or step which is noteworthy. Keeping these in mind will simplify or enhance device usage.

Tip
An idea or suggestion to improve efficiency or enhance usefulness.

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Important User Information (continued)

Half Pico Regulatory Requirements

WARNING:
To satisfy FCC/IC RF exposure requirements for mobile transmitting devices, a separation distance of 25 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

WARNING:
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.

WARNING:
Changes or modifications not expressly approved by Microhard Systems Inc. could void the user's authority to operate the equipment. This device has been tested with the antennas listed in Appendix A When integrated in OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions).

WARNING:
MAXIMUM EIRP
FCC Regulations allow up to 36 dBm equivalent isotropically radiated power (EIRP). Therefore, the sum of the transmitted power (in dBm), the cabling loss and the antenna gain cannot exceed 36 dBm.

WARNING:
EQUIPMENT LABELING
The FCC and IC numbers depend on the model of the radio module. Do NOT use the Marketing Name of the product but the Model to distinguish the Certifications Numbers. This device has been modularly approved. The manufacturer, product name, and FCC and Industry Canada identifiers of this product must appear on the outside label of the end-user equipment.

WARNING:
This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:
(1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

SAMPLE LABEL REQUIREMENT for Model hp900:

Contains:
FCCID: Pending IC: Pending

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.

Important User Information (continued)

WARNING:
Pour satisfaire aux exigences de la FCC/IC d'exposition RF pour la base et mobiles sur une distance de séparation de 25 cm ou plus doit être maintenue entre l'antenne de cet appareil et des personnes lors de fonctionnement du dispositif. Pour assurer la conformité des opérations au plus près que cette distance n'est pas recommandée. L'antenne utilisée pour ce transmetteur ne doit pas être co-localisés en conjonction avec toute autre antenne ou transmetteur.

WARNING:
Son fonctionnement est soumis aux deux conditions suivantes : (1) ce dispositif ne doit pas causer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, incluant les interférences qui peuvent provoquer un fonctionnement indésirable .

WARNING:
Les changements ou modifications non expressément approuvés par Microhard Systems Inc. pourraient annuler l'autorité de l'utilisateur à utiliser l'équipement . Ce dispositif a été testé avec antennes répertoriées à l'annexe A Lorsqu'il est intégré dans les produits OEM , antennes fixes nécessitent une installation empêchant les utilisateurs finaux de les remplacer par des antennes non approuvées . Antennes ne figurant pas dans les tableaux doivent être testés pour se conformer à la Section 15.203 (connecteurs d'antenne uniques) et à la Section 15.247 (émissions) .

WARNING:
MAXIMUM PIRE
Règlement FCC permettent jusqu'à 36 dBm puissance isotrope rayonnée équivalente (PIRE) . Par conséquent, la somme de la puissance émise (en dBm), la perte de câblage et le gain d'antenne ne peut pas dépasser 36 dBm.

WARNING:
ÉQUIPEMENT DE MARQUAGE
Les numéros FCC et IC dépendent du modèle du module radio . Ne pas utiliser le nom marketing du produit, mais le modèle de distinguer les numéros Certifications . Ce dispositif a été approuvé de façon modulaire . Le fabricant , nom du produit, et les identificateurs de la FCC et d'Industrie Canada de ce produit doivent figurer sur l'étiquette à l'extérieur de l'équipement de l'utilisateur final .

WARNING:
Cet appareil est conforme aux CNR exempts de licence d'Industrie Canada . Son fonctionnement est soumis aux deux conditions suivantes : (1) Ce dispositif ne peut causer des interférences ; et (2) Ce dispositif doit accepter toute interférence , y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.

L'EXEMPLE D'ÉTIQUETTE:

Contains:
FCCID: Pending IC: Pending

Cet appareil est conforme à la partie 15 des règles de la FCC. Son fonctionnement est soumis aux deux conditions suivantes : (1) ce dispositif ne doit pas causer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, incluant les interférences qui peuvent provoquer un fonctionnement indésirable .

Revision History

Revision	Description	Initials	Date
1.0.0	First Release (Pre-production)	PEH	May 2018
1.1.0	First production release. Based on firmware v1.03 build 1.3155	PEH	June 2018

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1.0 Overview

The Half Pico is capable of delivering high-performance, robust and secure wireless serial communications in point-to-point or point-to-multipoint network topologies.

The Half Pico Series is available as a tightly integrated OEM module, for the ultimate in design integration. When properly configured and installed, long range communications at very high speeds can be achieved.

Half Pico Series modules are available in 840 MHz and 900 MHz Models, providing flexible wireless data transfer between most equipment types which employ a serial interface.

The small size and superior performance of the Half Pico Series makes it ideal for many applications. Some typical uses for this modem:

- SCADA
- remote telemetry
- traffic control
- industrial controls
- remote monitoring
- fleet management
- GPS
- metering
- robotics
- display signs
- railway signaling

1.1 Performance Features

Key performance features of the Half Pico Series include:

- hp900 - 900 MHz ISM[1] Band Frequency Hopping Operation
- hp840 - 840-845 MHz Frequency Hopping or Fixed Channel Operation
- up to Tx of 1W Frequency Hopping, or 2W on a fixed channel (hp840)
- transparent, low latency link rates up to 500 kbps
- communicates with virtually all serial based devices
- wide temperature specification
- CRC, selectable retransmission and forward error correction
- ease of installation and configuration - the Half Pico utilizes a subset of standard AT-style commands, similar to those used by traditional telephone line modems
- 3.0-3.6 V_{DC} logic level compatibility

[1]902-928 MHz, which is license-free within North America; may need to be factory-configured differently for some countries, contact Microhard Systems Inc. for details.

1.0 Overview

1.2 Half Pico Series Specifications

Electrical/General

Supported Frequency: hp840 - 840-845 MHz
hp900 - 902-928 MHz

Spreading Method: Frequency Hopping, Frequency Table

Error Detection: CRC, ARQ

Forward Error Correction: Golay

Output Power: Up to 2W* (20-33dBm, adjustable)
*2W available on hp840 on fixed channel

Sensitivity: -122 dBm @ 19.2 kbps
-115 dBm @ 115.2 kbps
-111 dBm @ 230.4 kbps
-108 dBm @ 500 kbps

Link Rate: 19.2 to 500 kbps

Serial Baud Rate: 300 to 230.4 kbps

Core Voltage: OEM: 3.6VDC is required for 1W
Motherboard: 7-30 VDC

Power Consumption:

Tx Power (dBm)	V_{CC} (V)	V_{RF} (mA)	V_{dd} (mA)
21	3.6	520	30
25	3.6	720	33
28	3.6	990	36
30	3.6	1290	38
33	3.6	1800	54
Rx (link)	3.6	0	47-56

Caution: Using a power supply that does not provide proper voltage or current may damage the modem.

Environmental

Operation Temperature: -55°F(-55°C) to 185°F(85°C)
Humidity: 5% to 95% non-condensing

Mechanical

Dimensions: OEM: 26.5mm X 33mm X 3.5mm
Motherboard: 57mm X 95mm X 38mm

Weight: OEM: 2 grams
Motherboard: 120 grams

Connectors: Antenna: OEM: SMT Pad
Motherboard: RP-SMA
Data: OEM: 54 Pin/Pad SMT
Motherboard: 8-Pin Molex

2.0 Hardware Description

The Half Pico Series Modems are available as OEM modules. This OEM version supplies all the required raw signals to allow the unit to be tightly integrated into applications to efficiently maximize space and power requirements. The Microhard motherboard board can provide a convenient evaluation platform to test and design with the module. (Contact Microhard Systems for details)

Any Half Pico Series module may be configured as a Master or Remote in a PTP or PMP Topology. This versatility is very convenient from a 'sparing' perspective, as well for convenience in becoming familiar and proficient with using the module: if you are familiar with one unit, you will be familiar with all units.

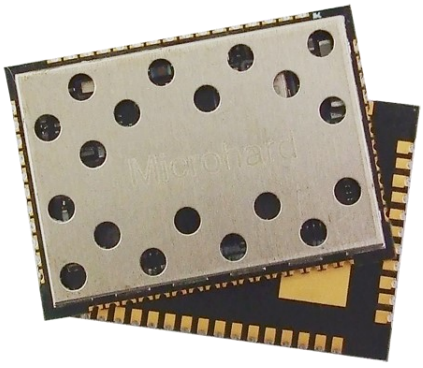


Image 2-1: Half Pico Top View

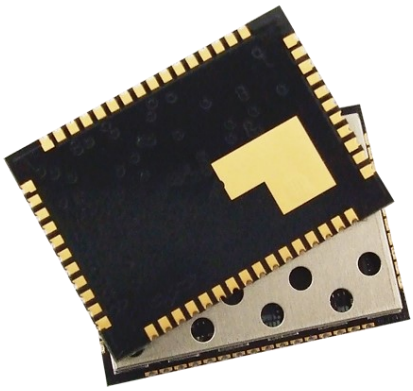
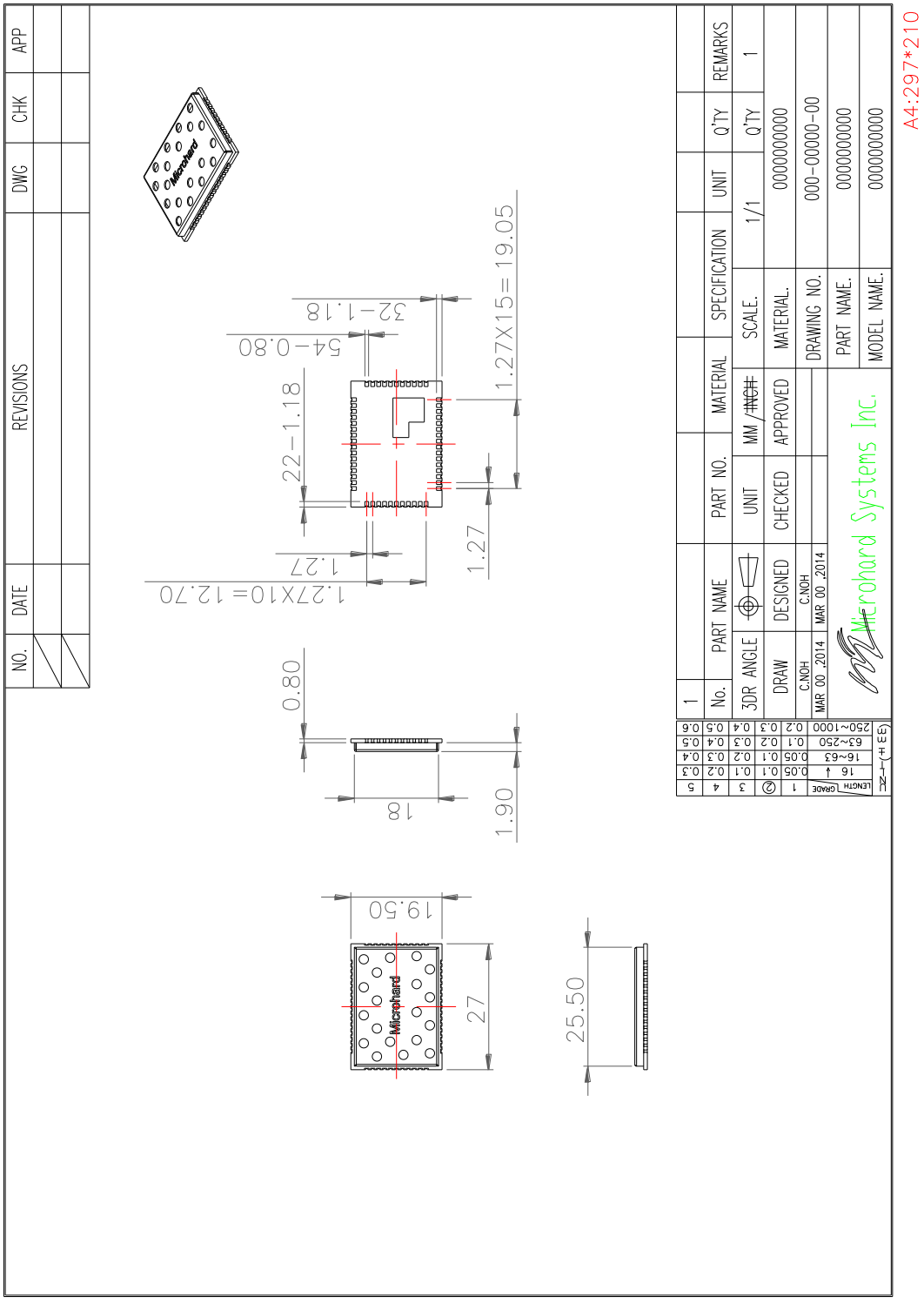


Image 2-2: Half Pico Bottom View

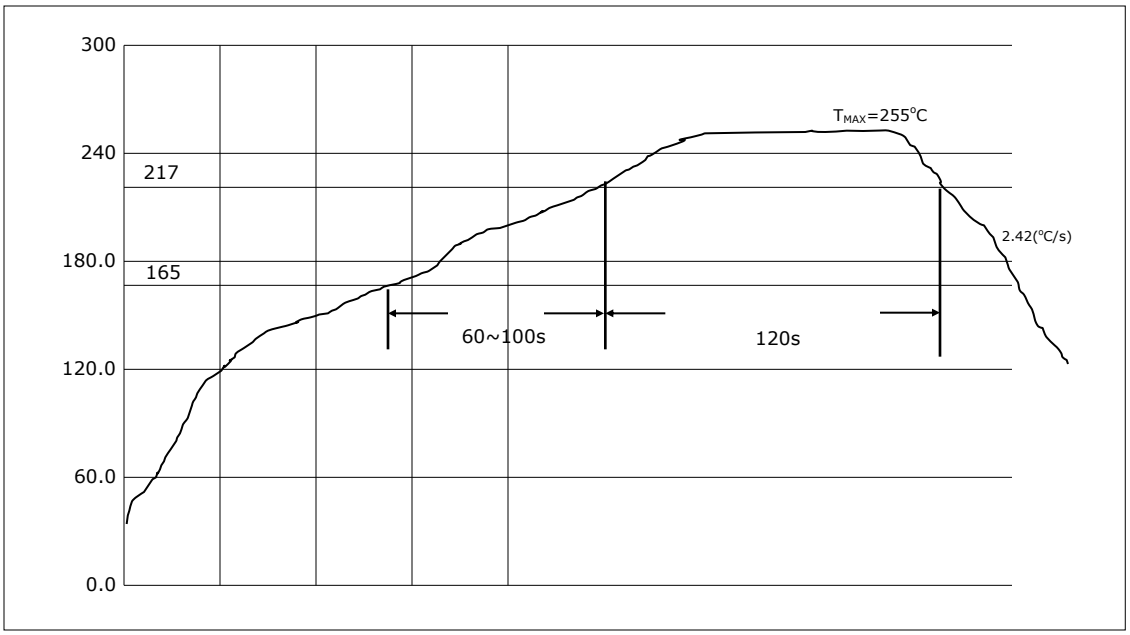
2.0 Hardware Description

2.1 Half Pico OEM Mechanical Drawings



2.0 Hardware Description

2.1.1 SMT Temperature Profile



Drawing 2-4: Reflow Profile

Temperature Zone	Time	Parameter
Preheat zone: (40°C - 165°C)	-	Heating rate: 0.5°C/s-2°C/s
Soak Zone: (165°C - 217°C)	60 - 100s	-
Reflow zone: (>217°C)	120s	Peak reflow: 255°C
Cooling zone	Cooling rate: 2°C/s ≤ Slope ≤ 5°C/s	

Table 2-1: Reflow Parameters

Zone	Temperature (°C)
1	120
2	140
3	160
4	180
5	215
6	255
7	255
8	255
9	250
10	130
Chain Speed: 60cm/min	

Table 2-2: Oven Temperature Profile

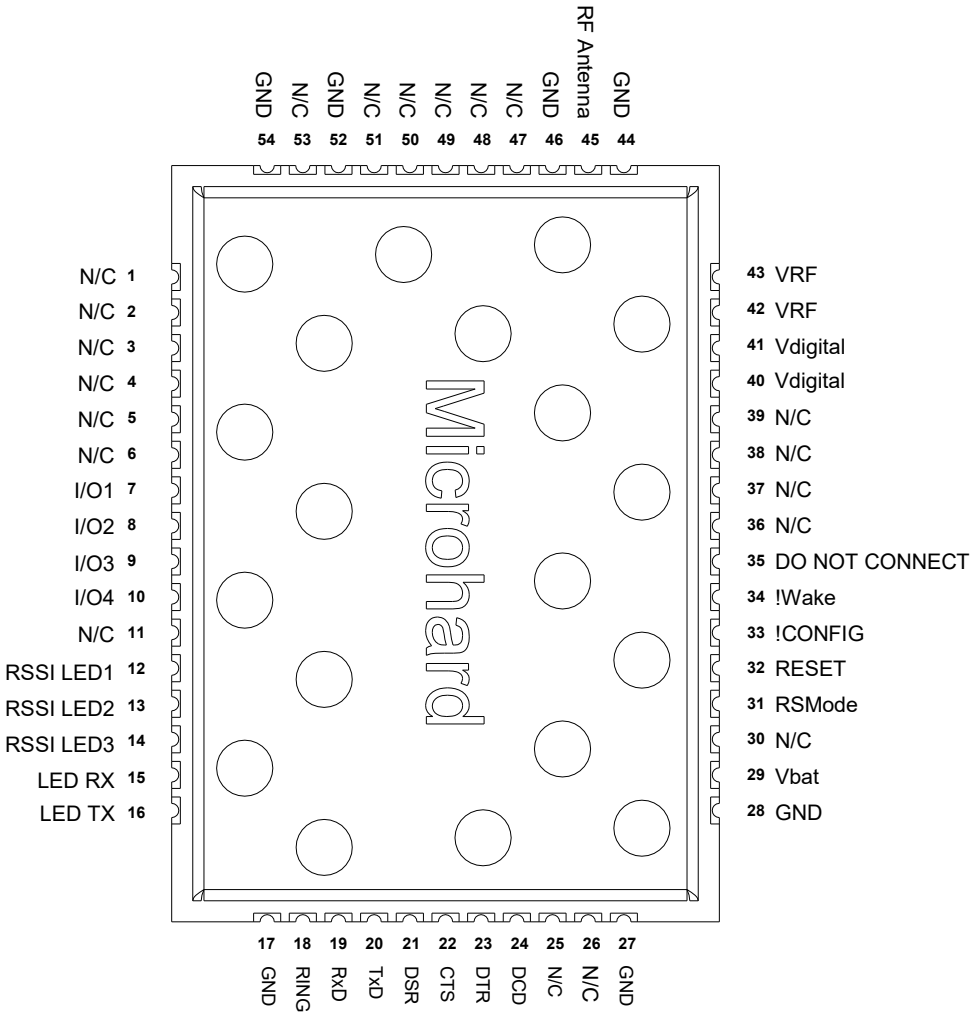
2.1.2 SMT Baking Instructions (MSL)

The Half Pico OEM modules must be baked before mounting, the following baking instruction should be followed for the best results:

a) Minimum of 8 to 12 hours at 125°C +/- 5°C for high-temperature device containers.
b) Unused modules should be stored at ≤ 10% RH

2.0 Hardware Description

2.2 Half Pico OEM Pin Descriptions



Drawing 2-4: Half Pico 54-pin OEM Connection Info

Inputs and outputs are 3.3V (± 0.3V) nominal unless otherwise specified.

The above drawing depicts a top view of the Half Pico OEM Module.

A full description of the connections and function of each pin is provided on the pages that follow.

2.0 Hardware Description

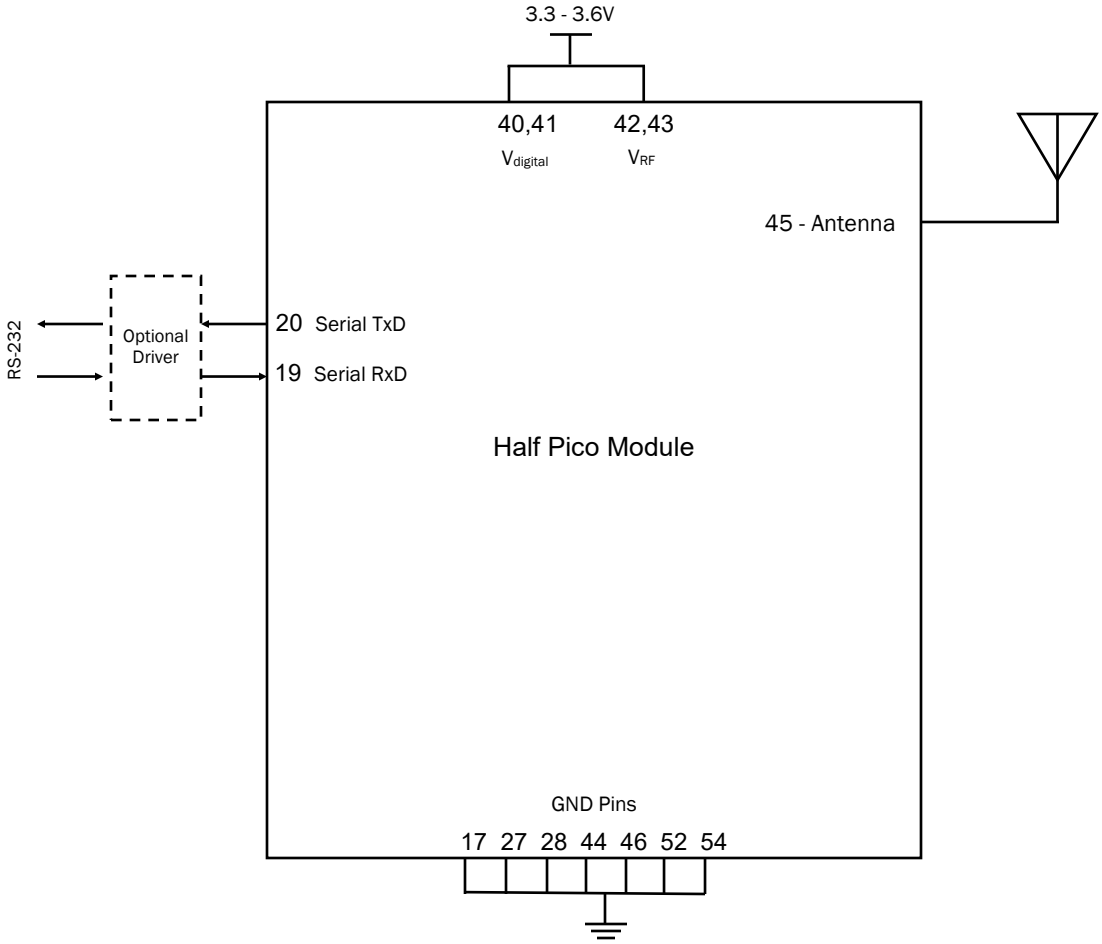
Caution: During power up or reset, output pins from the Pico are in an unknown state. It is advised to use pull up or pull down resisters as appropriate.

Pin Name	No.	Description	Dir
GND	*17,27,28,44,46, 52,54*	Ground reference for logic, radio, and I/O pins.	
DNC	35	Reserved for factory use only.	
N/C	1-6,11,26,30, 36-39, 47-51,53	**Currently Not Used. For Future Expansion**	
I/O1-4	7,8,9,10	Input/output Pins. -0.3 to +3.6 V input, 3.3 V Output @ 3mA maximum. **Future Use.**	I/O
LED_1 (RSSI1)	12	Receive Signal Strength Indicator 1. Active high, cannot drive LED directly. Requires current limiting resistor. 8mA maximum.	O
LED_2 (RSSI2)	13	Receive Signal Strength Indicator 2. Active high, cannot drive LED directly. Requires current limiting resistor. 8mA maximum.	O
LED_3 (RSSI3)	14	Receive Signal Strength Indicator 3. Active high, cannot drive LED directly. Requires current limiting resistor. 8mA maximum.	O
LED_RX	15	Active high output indicates receive and synchronization status. Active high, cannot drive LED directly. Requires current limiting resistor. 8mA maximum.	O
LED_TX	16	Active high output indicates module is transmitting data over the RF channel. Active high, cannot drive LED directly. Requires current limiting resistor. 8mA maximum.	O
RING	18	Internally connected to GND through a 22kΩ resistor. **Reserved for future use.**	O
RxD	19	Receive Data. Logic level input into the modem. It is recommended to wire this pin out through a zero ohm resister to a header and jumper block for external access to the serial port for modem recovery procedures.	I
TxD	20	Transmit Data. Logic level Output from the modem. It is recommended to wire this pin out through a zero ohm resister to a header and jumper block for external access to the serial port for modem recovery procedures.	O
DSR	21	Data Set Ready. Active low output.	O
CTS	22	Clear To Send. Active low output.	O
DTR	23	Data Terminal Ready. Active low input.	I
DCD	24	Data Carrier Detect. Active low output.	O
N/C	25	**Currently Not Used. For Future Expansion**	
Vbat	29	Input voltage sensing analog input line, up to 30VDC maximum. Used to measure the main supply voltage. User design must add a 10kΩ 1% 1/16W resistor in series.	I
RSMode	31	*Internally connected to GND through a 10kΩ resistor. *Reserved for future use.**	O
!RESET	32	Active low input will reset the module.	I
!CONFIG	33	Active low input signal to put module into default serial interface (RS232) and default baud rate (115200/8/N/1) during power up. Pull high or leave floating.	I
!Wake	34	*Low to sleep, high to wake up. (See register S143)*	I
Do Not Connect	35	**Reserved for factory use.**	
Vdigital	40,41	Positive voltage supply voltage for the digital section of the module (3.3-3.6V).	I
Vrf	42,43	Positive voltage supply voltage for the radio section of the module (3.3-3.6V). *Vcc of 3.6V is required for 1W or greater of output Tx power.*	I
RF Antenna	45	*Connection for external RF Antenna*	I/O

Table 2-1: Half Pico Series Pin Descriptions

2.0 Hardware Description

2.3 Minimum Connection Requirements



Drawing 2-5: Half Pico Minimum Connection Block Diagram

2.0 Hardware Description

2.4 Half Pico Motherboard

The Half Pico Motherboard provides a easy standalone solution with a 8 pin interface for Data & Power as well as a SMA Female connector for the anetnna. The Half Pico Motherboard is ideal for base stations or applications where complicated integration of the OEM module is not required, but a modem with a small footprint is still required. The Half Pico Motherboard can also be used to quickly evaluate the features and performance of the Half Pico modems.

The Half Pico Motherboard provides quick access to:

- Input Power (7-30VDC)
- RS232 Data Interface
- RSSI LED Indicators (Green)
- TX/RX LED Indicators (Red/Green)
- Antenna (SMA Female)

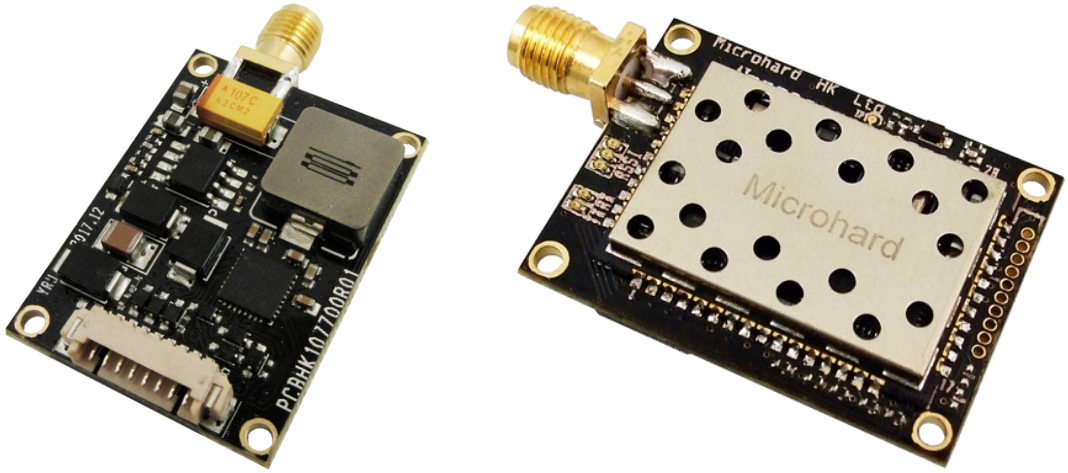
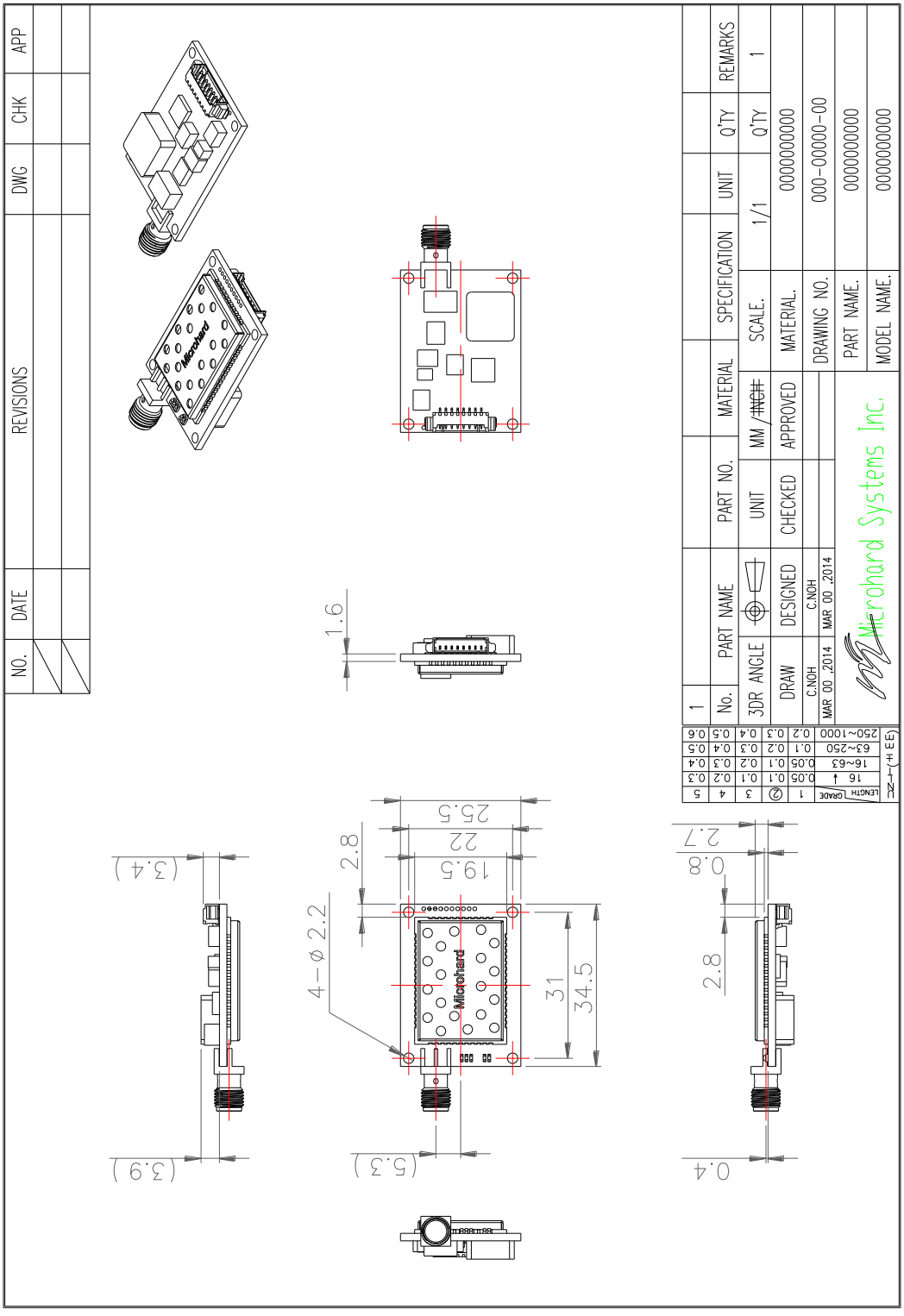


Image 2-4: Half Pico Motherboard

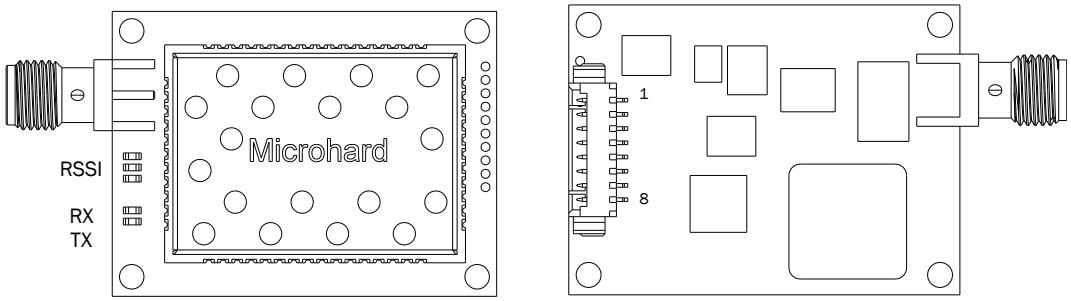
2.0 Hardware Description

2.4.1 Half Pico Motherboard Dimensional Drawings



2.0 Hardware Description

2.4.2 Half Pico Motherboard Connectors & LED Indicators



Drawing 2-9: Connectors & LED's

TX LED (Red)
This LED indicates that the modem is transmitting data over the air.

RX LED (Green)
This LED indicates that the modem is synchronized and has received valid packets.

RSSI (3x Green)
As the received signal strength increases, starting with the furthest left, the number of active RSSI LEDs increases. Signal strength is calculated based on the average RSSI from received packets. The value of RSSI is reported in S123.

MODE	Unit Type	LED STATUS		
		RX	TX	RSSI 1,2,3
COMMAND	All	OFF	OFF	OFF
DATA	Master	ON while receiving valid data	ON while Transmitting data	1-3 ON in proportion to signal strength received from remotes.
DATA - during sync. acquisition	Remote	OFF	OFF	Cycling with 300ms ON time
DATA - when synchronized	Remote	ON while synced	ON when transmitting	1-3 ON in proportion to signal strength received from Master

Table 2-14: LED Operation

The **SERIAL Port** (RS232) on the Motherboard is for:

- RS232 Serial data when in **DATA MODE**, or
- for configuring the modem when in **COMMAND MODE**.

*Refer to registers **S102**, **S110** and **AT&K** for additional serial port options.*

Vin+/Vin– is used to power the unit. The input Voltage range is 7-30 Vdc.

ANT
SMA Female Bulkhead Antenna connector.

Caution: Using a power supply that does not provide proper voltage may damage the modem.

Pin No.	Description
1	Power+
2	GND
3	TXD (Output)
4	RxD (Input)
5	CTS (Output)
6	GND
7	ON/OFF (GND to turn off)
8	CFG (GND to Config)

Table 2-15: 8-Pin Molex Pin Assignments

3.0 Configuration

To begin configuration, the Half Pico must be mounted onto a either a Microhard Motherboard, or be mounted into a customer designed platform. The Half Pico is configured using AT commands through the ***Data*** port, see **Section 2: Hardware Description** for information related to interfacing to, or powering the module.

To issue AT commands through the **Data** port, the Half Pico must first be set into **Command Mode** as described below.

3.1 Configuration/Unit Modes

3.1.1 Command Mode

- the Half Pico module is offline (data is not passing through the unit via it's local data lines or RF communications)
- if installed on a Motherboard, the only LED illuminated will be the blue power LED.
- the Half Pico's configuration options (registers) may be viewed and modified using AT commands.

Two methods are typically used to place the Half Pico Series into Command Mode.

1. Force to Command Mode

- Power down off the Motherboard assembly.
- Connect a serial cable from the PC serial port to the data port of the modem.
- Launch a terminal communications program (e.g. HyperTerminal) and configure for 115,200 bps, 8 data bits, No parity, 1 stop bit (8N1), no flow control
- press and hold the CONFIG button
- continue to press the CONFIG button and apply power to the modem
- release the CONFIG button
- On power up the terminal session window should show "NO CARRIER OK" as seen below:

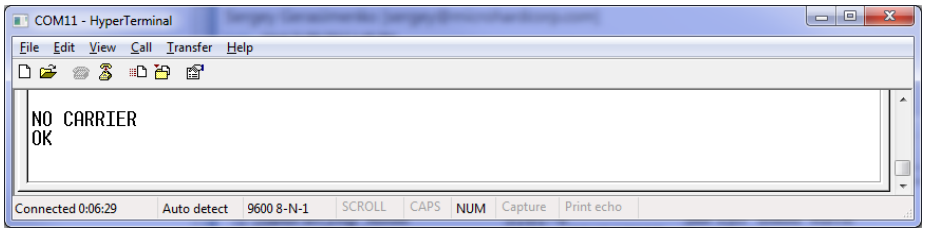


Image 3-1: Command Mode

- the Half Pico is now in command mode, and AT commands can be used to configure or query the settings. AT&V will display the current configuration, and the registers can be queried using the ATSXXX=? Command where XXX = the register number. Help is available using the ATSXXX /? Command.
- Any and all changes must be written to NVRAM using the AT&W command.

3.0 Configuration

2. Escape from Data Mode

- With the unit powered up and 'online', connect a serial cable from the PC serial port to the RS-232 port on the motherboard.
- Launch a terminal program (e.g. HyperTerminal) and configure for the units's established serial baud rate parameters (PC & modem must match).
- Pause 1 second, type '**+++**' , pause 1 second: the monitor should show the module response of 'NO CARRIER OK'

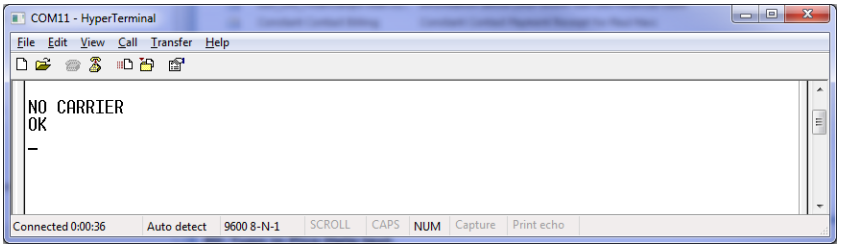


Image 3-2: Command Mode

- The unit is now in command mode, and AT commands can be used to configure or query the settings.
- Entering the AT&V command as shown will show the current configuration as seen below: (The data displayed varies based on network and unit type.)

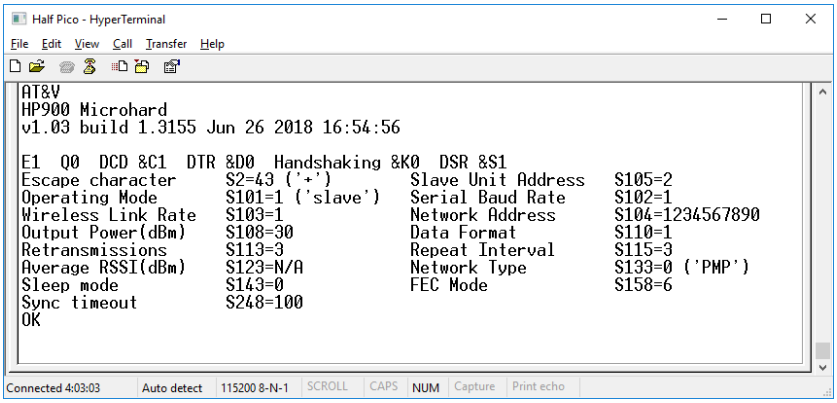


Image 3-3: Command Mode - AT&V Display

3.1.2 Data Mode

Data Mode is the normal operational state of all deployed Half Pico modules. In this mode the module is prepared to exchange data as per its configuration settings. Available LED indications can provide an indication of the data exchange (TX and RX LEDs).

To enter DATA mode from COMMAND mode, enter the command: ***ATA [Enter]***

3.0 Configuration

3.1.3 Network Type (S133)

Registers can be changed by entering the AT command as seen below:

Example:
ATS133=1 <enter>

Any registers that are changed must be written to flash using the **AT&W** command>

When configuring the Half Pico the Network Type must be decided and planned for a successful deployment. The Half Pico currently supports Point to Point and Point to Multipoint network topologies.

To change the network type the register S133 (Network Type) is used as seen below:

Network Type **S133** = **0 - Point to Multipoint**
= 1 - Point to Point

Ensure the correct network type is set before proceeding. It is recommended to start with the factory default settings to aid in initial configuration (discussed later), and then changing registers as required.

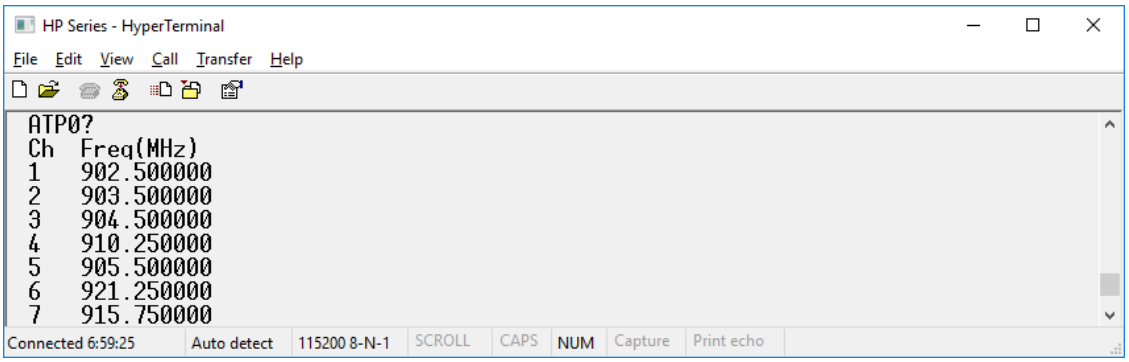
3.1.4 Frequency Table (ATP0)

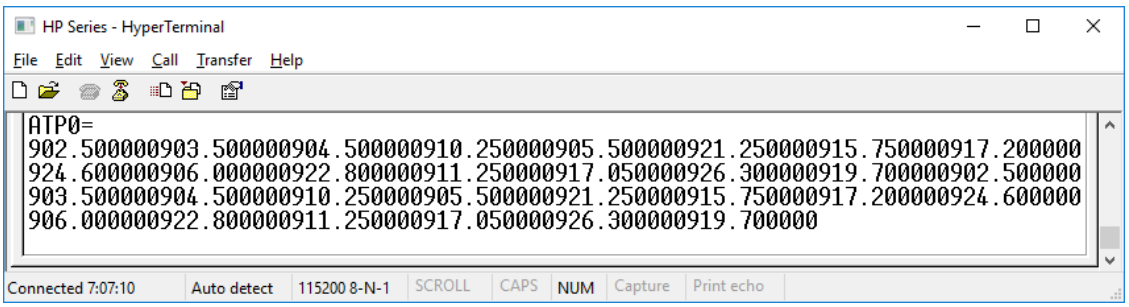
Before deployment and during configuration of the Half Pico the Frequency Table must be populated.

Frequency tables are a list of frequencies used by the modem to communicate with each other. The modem hops onto one frequency and communicates for a certain amount of time, then hops to the next one in the list. (840-845 MHz for hp840 and 902-928 MHz for hp900)

The ATP0 Commands can be used to view and populate the Frequency Table.

ATP0<enter>	Will list one channel frequency at a time, you can step through the table.
ATP0?<enter>	Will list the entire Frequency table at once, as shown below.
ATP0=<enter>	Allows each frequency in the table to be added one at a time, or all at once by sending the modem a properly formatted text file

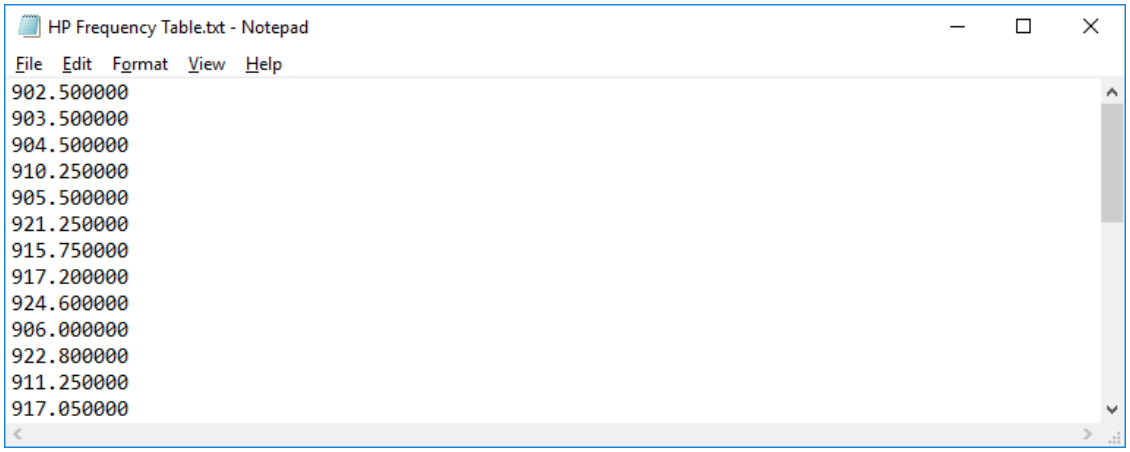




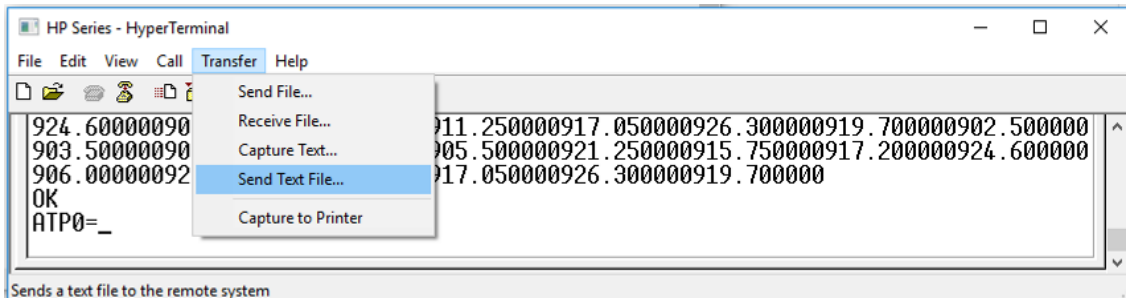
When entering frequencies manually, you will need to press <enter> after each frequency, and then immediately begin typing the next entry. The format is XXX.XXXXXX (in MHz).

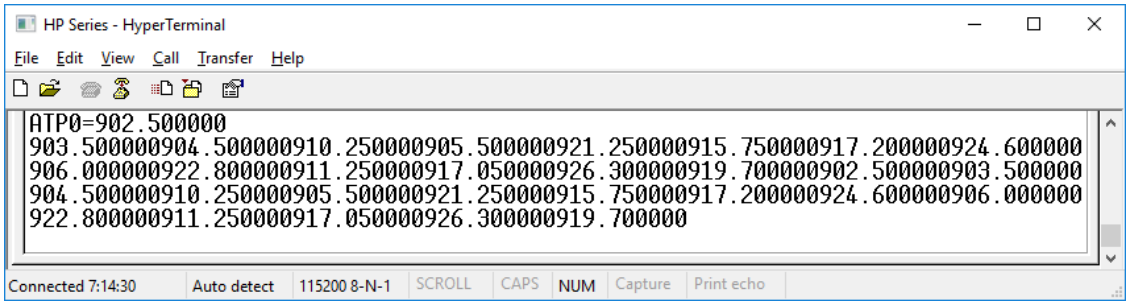
3.0 Configuration

If the Frequency Table is very large it can be time consuming to enter the table in manually, also if errors are made, the entire table needs to be entered again. It is recommended to use a text file and format it as seen below:



Once the table text file is created, issue the ATP0=<enter> and then send the file as a “Text File” using your terminal program. The screen shot below shows what it would look like using Hyperterm.





Press the “Esc” key one the file has been transferred.

3.0 Configuration

3.2 Point to Point Network

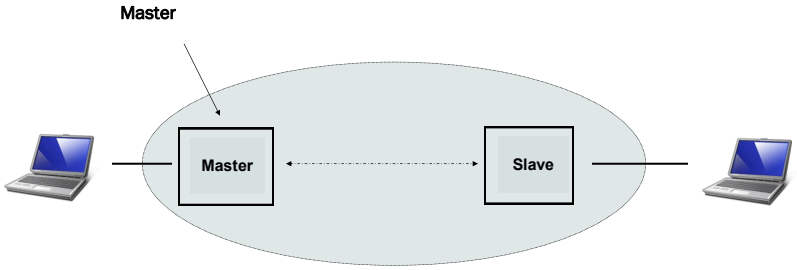
In a point-to-point network, a path is created to transfer data between Point A and Point B, where Point A may be considered the Master modem and Point B a Slave. Point to Point is enabled by setting register S133 to 1 (*ATS133=1, Network Type*).

A PTP configuration may also be used in a more dynamic sense: there may be many Slaves within such a network, however the Master may have its 'Destination Address' (S140) changed when required to communicate with a specific Slave.

Drawing 3-1: Point to Point Network Topology

3.2.1 Operating Modes / Unit Types

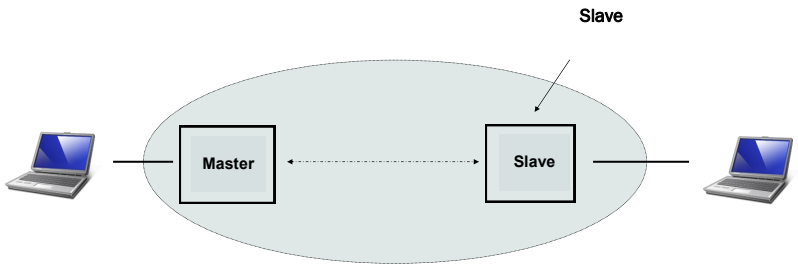
In a Microhard Point to Point Network, two unit types or operating modes are available: the Master and the Remote. The ***Masters*** role is to provide network synchronization for the system, which ensures all units are active and able to communicate as required. The Master controls the flow of data through the system; all data passes through it. The diagram below shows a unit configured as a Master.



Drawing 3-2: Point to Point Master

3.0 Configuration

A ***Slave (Remote)*** is an endpoint/node within a network to which a local device is attached. Communicates with Master directly.



Drawing 3-4: Point to Point Slave

Units can be configured to perform the various roles discussed by setting register S101 as follows:

ATS101 = 0 - Master
ATS101 = 1 - Slave (Remote)

3.0 Configuration

3.2.2 Configuration Using Factory Defaults

Factory default setting commands can be used to aid in the configuration and deployment of the Half Pico modules, providing a known starting point in the configuration process for each unit type. Using the factory default commands sets all applicable registers to factory recommended settings and allows for initial connectivity between units. Configuring modems using the factor default settings have the following benefits:

- hastens the configuration process - l*oad default settings and, if necessary, apply only minor settings / adjustments*
- aids in troubleshooting - *if settings have been adjusted and basic communications cannot be established, simply revert to the factory default setting and any improper adjustments will be overwritten and a 'fresh start' can be made with known-to-work settings*

For many networks, the factory default commands may be all that is necessary to configure and deploy a simple Point to Point Network. Other applications may require additional registers to be configured. Regardless of the complexity of the configuration, the factory default settings provide a starting point for all configurations. All unit types have a factory default setting command.

AT&F3	-	Point to Point Master
AT&F4	-	Point to Point Slave

The screen shots in the following pages for each unit type highlight the key registers that are automatically changed to create a Point to Point configuration. There may also be additional registers such as the Network ID that are recommended to be changed.

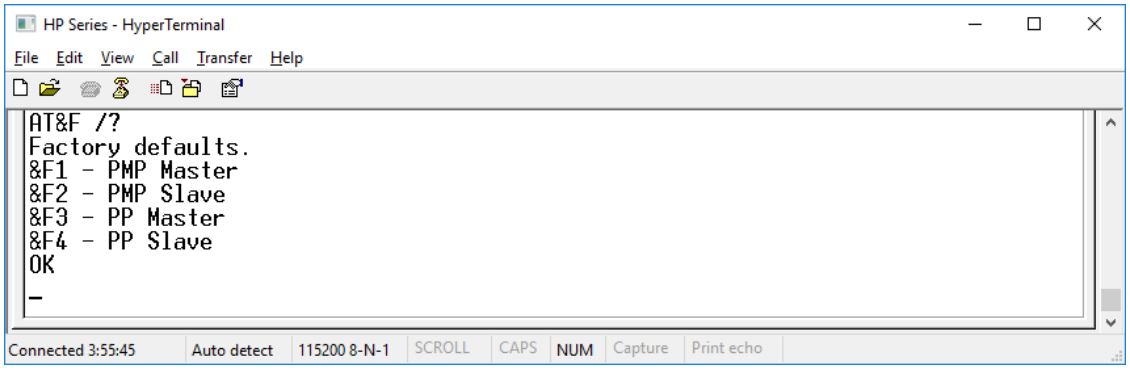


Image 3-5: Frequency Hopping Factory Defaults

Each PTP Network must have a unique network ID. This can be changed using register S104: Network Address.

3.0 Configuration

AT&F3 Point to Point Master

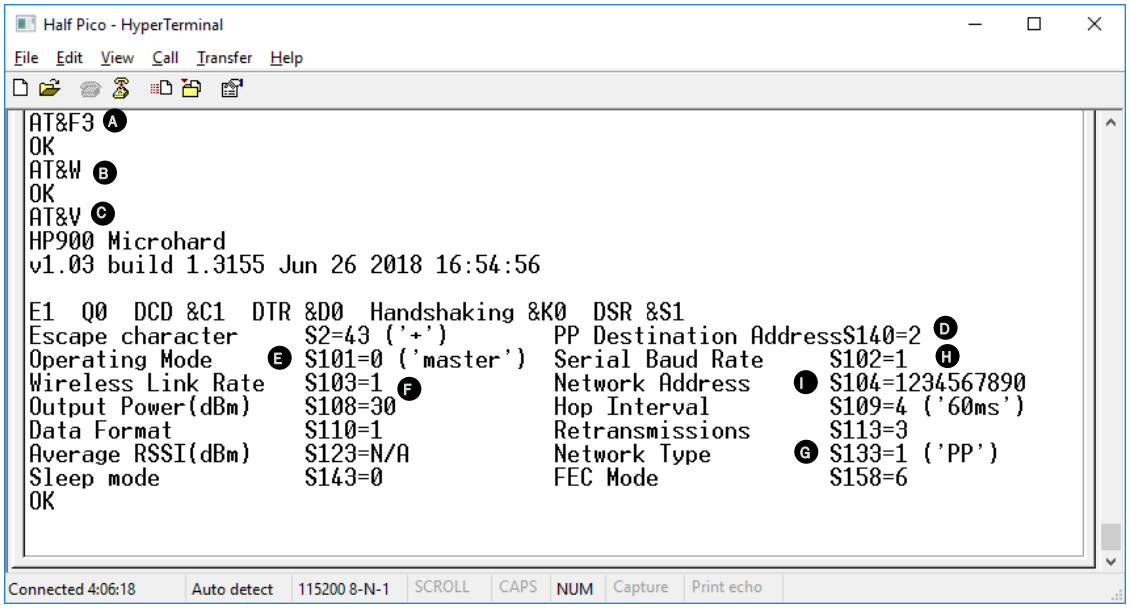


Image 3-6: Factory Defaults AT&F3 - Point to Point Master

A) AT&F3 - Sets the factory defaults for a Point to Point Master.
B) AT&W - Writes the changes to NVRAM.
C) AT&V - Displays the configuration as seen above.
D) S140 - The destination address is unit address of the final destination, which all data is to be sent. The address entered would generally be the unit address of the Slave.
E) S101 - The operating mode defines the unit type and is set to 0, which is a Master.
F) S103 - Wireless Link Rate must be set to the same value of each unit in the system. Higher link rates may result in higher throughput, but lower link rates usually provide better sensitivity and overall robustness.
G) S133 - The network type must be set to 1 for Point to Point operation. The content displayed by the AT&V command will vary with the network type.
H) S102 - The serial baud rate (and data format S110) must match that of the connected device.
I) S104 - Each unit in a Network must have the same Network Address. It is strongly recommended to never use the default setting of 1234567890. To change the Network Address, the ATS104=XXXXXXX command can be used.

Remember, populate the Frequency Table using the ATP0 command.

Remember, when registers are changed the values must be written to NVRAM using the AT&W command. To switch from command mode to data mode (online mode), the ATA command can be issued.

3.0 Configuration

AT&F4 Point to Point Slave

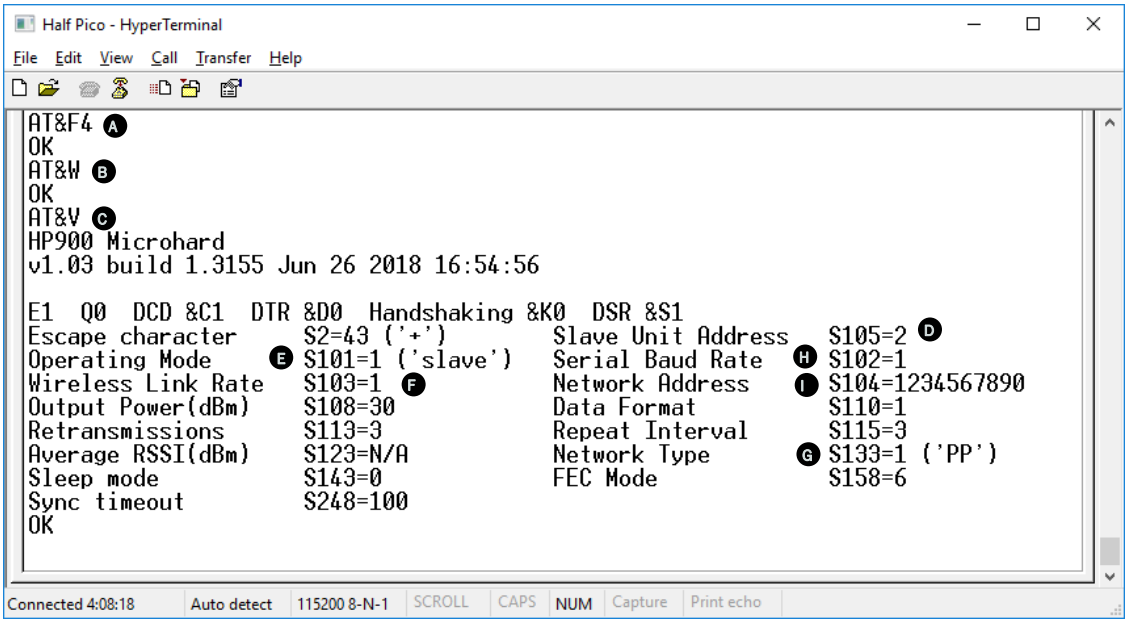


Image 3-7: Factory Defaults AT&F7 - Point to Point Slave

A) AT&F4 - Sets the factory defaults for a Point to Point Slave.
B) AT&W - Writes the changes to NVRAM.
C) AT&V - Displays the configuration as seen above.
D) S105 - Every unit in a Point to Point Network must have a unique unit address. The address of the slave (remote) is automatically set to 2. *This can be changed, but ensure that the destination address on the master is also changed!*
E) S101 - The operating mode defines the unit type and is set to 2, which is a Slave (Remote).
F) S103 - Wireless Link Rate must be set to the same value of each unit in the system.
G) S133 - The network type must be set to 1 for Point to Point operation. The content displayed by the AT&V command varies with the network type.
H) S102 - The serial baud rate (and data format S110) must match that of the connected device.
I) S104 - Each unit in a Network must have the same Network Address. To change the Network Address, the ATS104=XXXXXXX command can be used.

Remember, populate the Frequency Table using the ATP0 command. The same table (entries) must be used for each modem in a network.

3.0 Configuration

3.2.3 Retransmissions

Packet Retransmissions can be used to ensure data reaches its intended destination by resending the same packet over and over. In Point to Point system all data is acknowledged by the destination, resulting in retransmissions only being used if no acknowledgement is received. The overall impact on system performance, while not as significant as it is in Point to Multipoint networks, should still be considered. The more times a modem retransmits data, the more the overall throughput of the system is reduced. To adjust the retransmission rate, use register S113, the default value is 3 (+ the initial transmission).

S113 = 3 - Packet Retransmissions (0-254)

Retransmissions are typically used in noisy environments to combat interference and low signal strength, ensuring data is received at the intended destination.

3.2.4 Network Synchronization

Network Synchronization is what allows all units to hop from frequency to frequency at the same time. For units to synchronize with the network, each unit must have the same:

- Network ID (S104)
- Network Type (S133)

Sync Timeout

Once synchronized to the network the unit does not need to receive sync data often to keep track of where the system is supposed to be (in time and frequency). The sync Timeout defines the number of hops where no sync data is received from a Master before losing sync. In other words, how long a unit will remain synchronized with the network without receiving any sync packets before it gives up and loses sync.

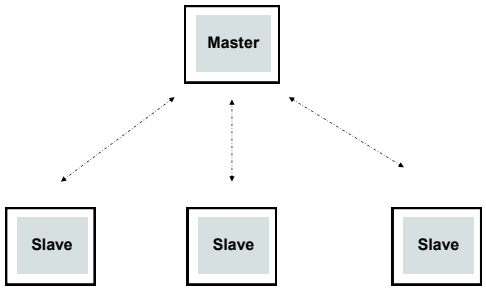
S248 = 100 Sync Timeout (4-65534)

Setting a value too low will cause the unit to lose sync easily and time will be wasted trying to re-sync to the network. Several hops can go by without receiving a sync packet, and this is completely normal. If this value is set too high, the unit will assume for a long time that the network is still out there, when especially in mobile applications, it may not be.

3.0 Configuration

3.3 Point to Multipoint Network

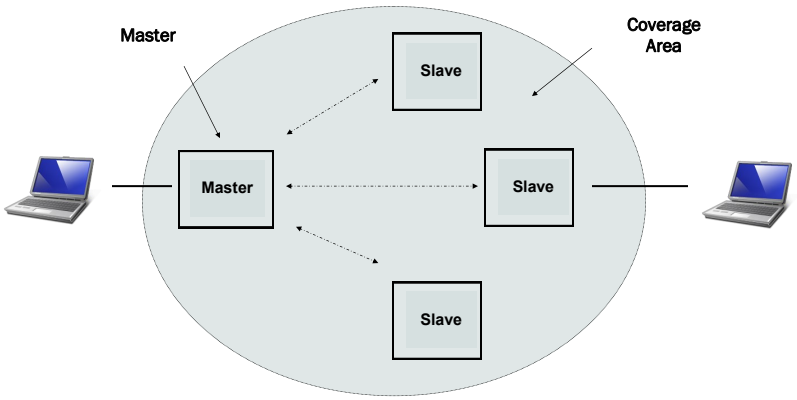
In a Point to Multipoint Network, a path is created to transfer data between the Master modem and numerous remote modems. Point to Multipoint is enabled by setting register S133 to 0 (*ATS133=0, Network Type*).



Drawing 3-1: Point to Multipoint Network Topology

3.3.1 Operating Modes / Unit Types

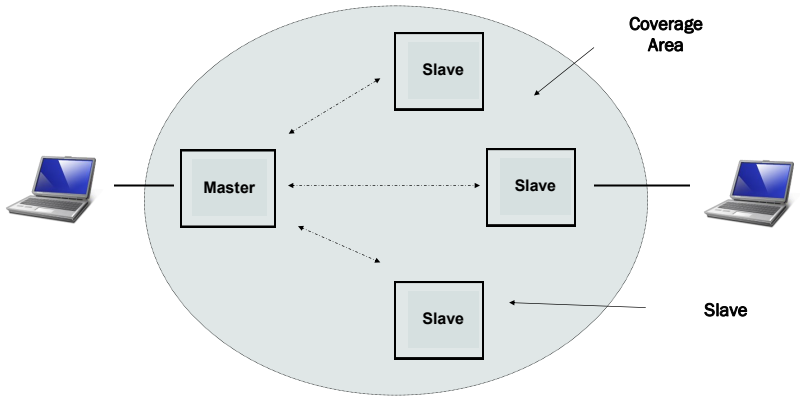
In a Microhard Point to Multipoint Network, two unit types or operating modes are available: the Master and the Remote. The ***Master*** modems role is to provide network synchronization for the system, which ensures all units are active and able to communicate as required. The Master controls the flow of data through the system; all data passes through it. The diagram below shows a unit configured as a Master.



Drawing 3-2: Point to Multipoint Master

3.0 Configuration

A ***Slave (Remote)*** is a endpoint or node within a network to which a local serial device is attached. Communicates with the Master directly.



Drawing 3-4: Point to Multipoint Slave

Units can be configured to perform the various roles discussed by setting register S101 as follows:

ATS101 = 0 - Master
ATS101 = 1 - Slave (Remote)

The next section discussed using Factory Default commands to configure the various types of units that are available in a Point to Multipoint network, simplifying the configuration process.

3.0 Configuration

3.3.2 Configuration Using Factory Defaults

Factory default setting commands can be used to aid in the configuration and deployment of the Half Pico series modules, providing a known starting point in the configuration process for each unit type. Using the factory default commands sets all applicable registers to factory recommended settings and allows initial connectivity between units. Configuring modems using the factor default settings have the following benefits:

- hastens the configuration process - l*oad default settings and, if necessary, apply only minor settings / adjustments*
- aids in troubleshooting - *if settings have been adjusted and basic communications cannot be established, simply revert to the applicable factory default setting and any improper adjustments will be overwritten and a 'fresh start' can be made with known-to-work settings*

For many networks, the factory default commands may be all that is necessary to configure and deploy a simple Point to Multipoint Network. Other applications may require additional registers to be configured. Regardless of the complexity of the configuration, the factory default settings provide a starting point for all configurations. All PMP unit types have a factory default setting command.

AT&F1	-	Point to Multipoint Master
AT&F2	-	Point to Multipoint Slave

The screen shots for each unit type will highlight the key registers that are automatically changed to create a Point to Multipoint configuration. There may also be additional registers such as the Network ID that are recommended to be changed.

Each PMP Network must have a unique network ID. This can be changed using register S104: Network Address.

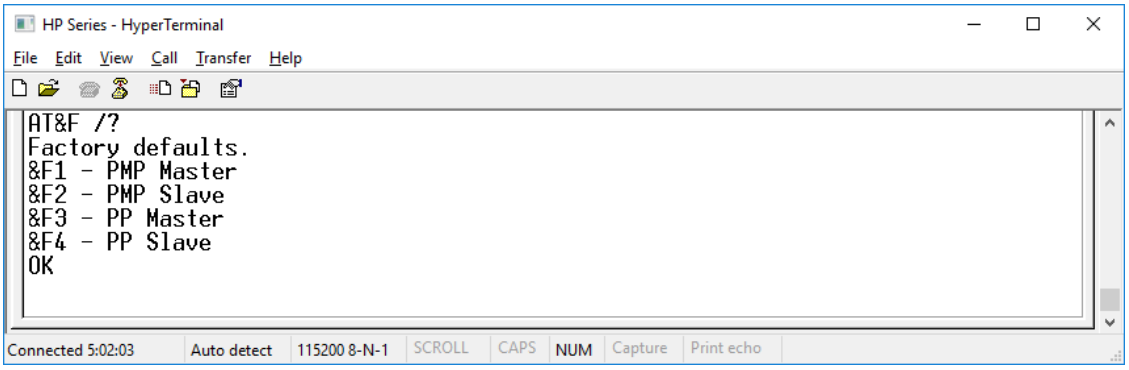


Image 3-4: Frequency Hopping Factory Defaults

3.0 Configuration

AT&F1 Point to Multipoint Master

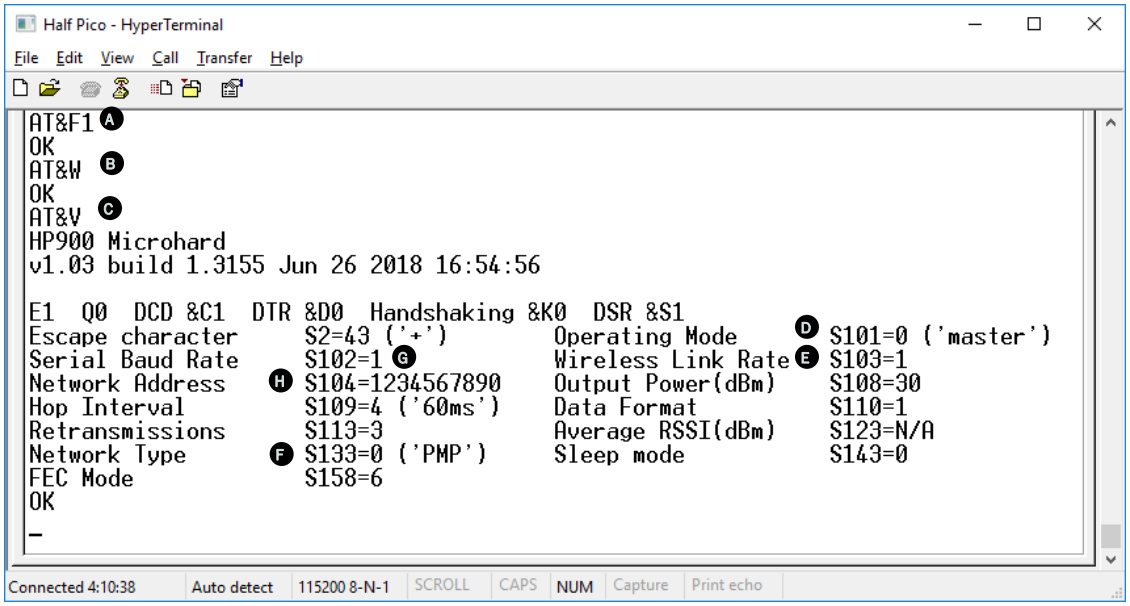


Image 3-5: Factory Defaults AT&F1 - Point to Multipoint Master

A) AT&F1 - Sets the factory defaults for a Point to Multipoint Master.
B) AT&W - Writes the changes to NVRAM.
C) AT&V - Displays the configuration as seen above.
D) S101 - The operating mode defines the unit type and is set to 0, which is a Master.
E) S103 - Wireless Link Rate must be set to the same value of each unit in the system. Higher link rates may result in higher throughput, but lower link rates usually provide better sensitivity and overall robustness.
F) S133 - The network type must be set to 0 for Point to Multipoint operation. The content displayed by the AT&V command will vary with the network type.
G) S102 - The serial baud rate (and data format S110) must match that of the connected device.
H) S104 - Each unit in a Network must have the same Network Address. It is strongly recommended to never use the default setting of 1234567890. To change the Network Address, the ATS104=XXXXXXX command can be used.

Remember, you need to populate the Frequency Table using the ATP0 command before deployment. Each unit in a network must use the same Frequency Table.

Remember, anytime registers are changed the values must be written to NVRAM using the AT&W command. To switch from command mode to data mode (online mode), the ATA command can be issued.

3.0 Configuration

AT&F2 Point to Multipoint Slave

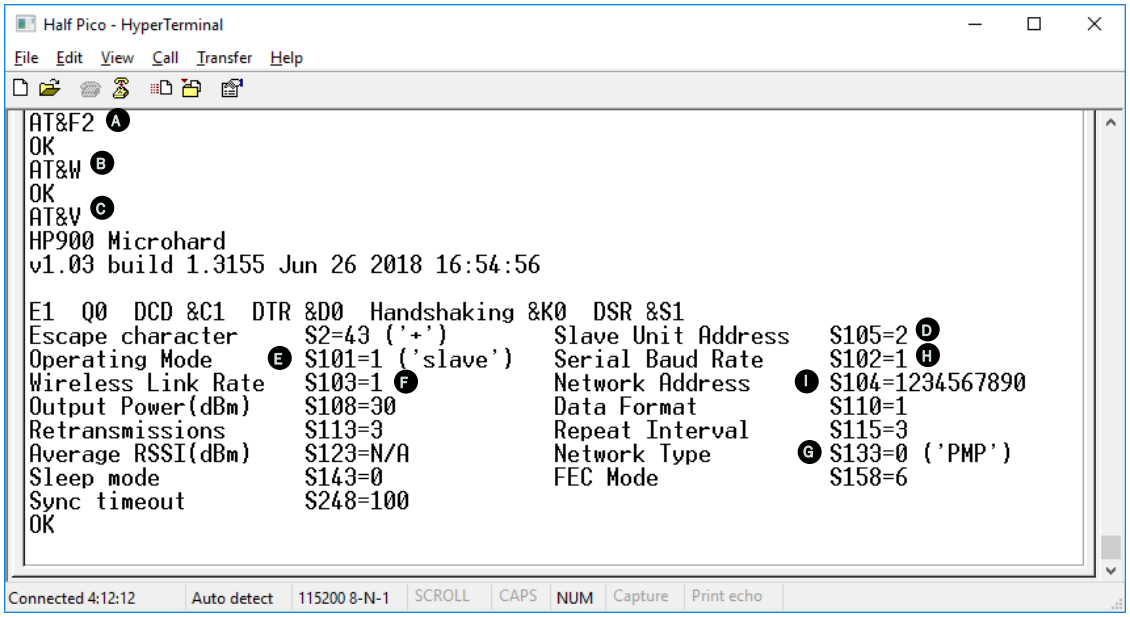


Image 3-6: Factory Defaults AT&F2 - Point to Multipoint Slave

A) AT&F2 - Sets the factory defaults for a Point to Multipoint Slave.
B) AT&W - Writes the changes to NVRAM.
C) AT&V - Displays the configuration as seen above.
D) S105 - Every unit in a Point to Multipoint Network must have a unique unit address. The address of the slave (remote) is automatically set to 2. If adding more than 1 Slave, this will need to be modified for each unit added.
E) S101 - The operating mode defines the unit type and is set to 2, which is a Slave (Remote).
F) S103 - Wireless Link Rate must be set to the same value of each unit in the system.
G) S133 - The network type must be set to 0 for Point to Multipoint operation.
H) S102 - The serial baud rate (and data format S110) must match that of the connected device.
I) S104 - Each unit in a Network must have the same Network Address. To change the Network Address, the ATS104=XXXXXXX command can be used.

Remember, you need to populate the Frequency Table using the ATP0 command before deployment. Each unit in a network must use the same Frequency Table.

Remember, anytime registers are changed the values must be written to NVRAM using the AT&W command. To switch from command mode to data mode (online mode), the ATA command can be issued.

3.0 Configuration

3.3.3 Unit Addressing

In a Point to Multipoint Network each unit must have a unique unit address, which can be configured using register S105. Duplicate addresses may result in unpredictable problems in the network.

3.3.4 Retransmissions

Packet Retransmissions can be used to ensure data reaches its intended destination by resending the same packet over and over. In Point to Multipoint system data is not acknowledged by the remotes, meaning the master will always transmit a packet an additional number of times specified by S113, resulting in a significant impact on system performance. The more times a modem retransmits data, the more the overall throughput of the system is reduced. To adjust the retransmission rate, use register S113, the default value is 3 (+ the initial transmission). This number should be as low as possible to keep as much bandwidth in the system as possible. When remotes transmit data back to the master, the mast does acknowledge those packets, so remotes will only retransmit if required.

S113 = 3 - Packet Retransmissions (0-254)

Retransmissions are typically used in noisy environments to combat interference and low signal strength, ensuring data is received at the intended destination.

3.3.5 Network Synchronization

Network Synchronization is what allows all units to hop from frequency to frequency at the same time.

For units to synchronize with the network, each unit must have the same:

- Network ID (S104)
- Network Type (S133)

Sync Timeout

Once synchronized to the network the unit does not need to receive sync data often to keep track of where the system is supposed to be (in time and frequency). The sync Timeout defines the number of hops where no sync data is received from a Master before losing sync. In other words, how long a unit will remain synchronized with the network without receiving any sync packets before it gives up and loses sync.

S248 = 100 Sync Timeout (4-65534)

Setting a value too low will cause the unit to lose sync easily and time will be wasted trying to re-sync to the network. Several hops can go by without receiving a sync packet, and this is completely normal. If this value is set too high, the unit will assume for a long time that the network is still out there, when especially in mobile applications, it may not be.

4.0 Register/Command Reference

4.1 AT Commands

Appendix B is a quick reference for the available AT commands; in this sub-section are details regarding the most commonly used. To invoke an AT command, enter Command Mode, then type **AT <*command*>[Enter]**.

If changes were made to the modem's configuration and it is intended that those changes be saved to non-volatile memory, do so with the AT command '&W' prior to placing the modem online.

A **Answer**

Upon completion of tasks being done with the modem in Command Mode, invoking this command will place the modem back 'online' (into Data Mode).

I*n* **Identification**

The I command returns information about the Half Pico.

1	Product Code
3	Product Identification (Firmware Version)
4	Firmware Date
5	Firmware Copyright
6	Firmware Time
255	Factory-Configured Options listing

N **Advanced Spectrum Analyzer**

The Advanced Spectrum Analyzer feature provides for a very detailed analysis of a particular area of the radio frequency spectrum within which the Half Pico operates.

The specific start (of scan) and stop frequencies, along with step (increment) size and dwell (on frequency) time are user-definable.

Following is the format for the ATN command:

In Command Mode

ATN F_{start} F_{stop} S D*[Enter]*

where

F_{start} = start frequency in MHz (including 0-6 decimal places)
F_{stop} = stop frequency in MHz (including 0-6 decimal places)
S = step increment in kHz (from 1-1000)
D = dwell time in ms (from 1-1000)

Example:

ATN 910.250 915.250 25 100

Note: Be sure to enter spaces as shown in the format detailed above.

The hp840 frequency range is 840 to 845 MHz and the hp900 uses 902 to 928 MHz.

4.0 Register/Command Reference

&F*n*	**Load Factory Default Configuration**

Loading Factory Default settings allow for quick configuration of systems by setting a known starting point with factory recommended settings for each type of unit. The Factory settings change all settings required to initiate default communication with other unit types.

Values
&F1 PMP Master &F2 PMP Slave &F3 PP Master &F4 PP Slave

ATP0	**Frequency Table**

Frequency tables are a list of frequencies used by the modem to communicate with each other. The modem hops onto one frequency and communicates for a certain amount of time, then hops to the next one in the list. (840-845 MHz for hp840 and 902-928 MHz for hp900)

The ATP0 Commands can be used to view and populate the Frequency Table.

ATP0<enter>	Will list one channel frequency at a time, you can step through the table.
ATP0?<enter>	Will list the entire Frequency table at once.
ATP0=<enter>	Allows each frequency in the table to be added one at a time, or all at once by sending the modem a properly formatted text file

See Section **3.1.4 Frequency Table (ATP0)** for more information.

4.0 Register/Command Reference

4.2 Settings (S) Registers

The majority of modem configuration is done via the Settings (S) Registers.

The previous sections provide configuration detail related to different operating modes and network topologies; this section examines each S register in detail for reference or advanced/custom networks. Appendix C is a quick reference for the S register options.

In the following descriptions, default settings (where applicable) are in **boldface**. In Command Mode,

Query format: **ATS<*S register #*>*?* [Enter]**
Change format : **ATS<S register #>=<value> [Enter]**
Help format: **ATS<S register #><space>/? [Enter]**

y <command command name> ***x***

S2 — Escape Code

Escape character. If >127, escape feature is disabled. Modification of this register may be necessary when connecting the modem to a telephone modem where the +++ character string may result in undesired consequences.

Values
any ASCII value **+ (decimal 43)**

S101 — Operating Mode

The Operating mode defines the role in the network a unit plays. A Half Pico modem may be configured for any role required within a radio network.

Master: Only one per network. In PP/PMP network types (see S133) data either originates at, is destined to, or passes through the Master.

Slave: Interfaces with remote devices and communicates with the Master.

Values (selection)
0 - Master 1 - Slave

S102 — Serial Baud Rate

The serial baud rate is the rate at which the modem is to communicate with the attached local asynchronous device. This value must match the PC or serial device that is connected to data port on the Half Pico.

When forcing a module to Command Mode the data port will temporarily communicate at the default value. When the radio is retuned to Data Mode, the serial port settings are returned to those specified in S102 and S110.

Values (bps)			
0	230400	8	7200
1	115200	9	4800
2	57600	10	3600
3	38400	11	2400
4	28800	12	1200
5	19200	13	600
6	14400	14	300
7	**9600**		

Note: Most PC's do not readily support serial communications greater than 115200bps.

4.0 Register/Command Reference

S103	Wireless Link Rate

This register determines the rate at which RF communications will occur over a given network. All modems within a particular network must be configured with the same wireless link rate. Faster link rates result in greater throughput, however, for each 'step' increase in link rate, there is an approximately 1dB reduction in sensitivity.

Values (bps)
0 - 19200 1 - 38400 2 - 76800 3 - 115200 4 - 172800 5 - 230400 6 - 345600 8 - 500000

Change the default value for the Network ID to something unique for your network. Do this for an added measure of security and to differentiate your network from others which may be operating nearby.

S104	Network Address (ID)

All modems in a given network must have the same Network Address. This unique network address is not only a security feature for a particular network, but also allows other networks - with their own unique network address - to operate in the same area without the possibility of undesired data exchange between networks.

Values (0 - 4,294,967,295)
1234567890

S105	Unit Address

The unit address is, and must be, a unique identifier of each modem in a network.

The Master has by default, and must retain, a unit address of 1. Refer to the specific modem type for more information in regards to unit addressing.

Values (2-254)
1

S108	Output Power

This setting establishes the transmit power level which will be presented to the antenna connector at the rear of the modem.

Unless required S108 should be set not for maximum, but rather for the minimum value required to maintain an adequate system fade margin.

**2W is available on hp840 operating on a fixed channel*

Values (dBm)	
25	31
26	32
27	33 (2W)*
28	
29	
30 (1W)	

4.0 Register/Command Reference

S109 Hop Interval

This register is effective only on the Master and is responsible for establishing the rate at which all modems within a particular network change frequency (hop - from frequency to frequency).

Long hop intervals typically result in the greatest data throughput, however shorter hop intervals may decrease latency, particularly of smaller packets of data.

The default setting of 60ms is satisfactory for most applications. If adjustment of S109 is being considered, also consider the serial baud rate, wireless link rate, and maximum packet size (S102, S103, and S112).

For higher link rates users may want to consider changing S109 to 0 (20ms).

S109	time (ms)
0	20
1	30
2	40
3	50
4	**60**
5	70
6	80
7	90
8	100
9	125
10	150
11	200
12	250
13	300

Hop Interval S109 should only be changed if recommended by Microhard Support and/or for specific applications!

S110 Data Format

This register determines the format of the data on the serial port. The default is 8 data bits, No parity, and 1 Stop bit. The value must match the PC or Serial Based device that is connected to the data port.

When forcing a module to Command Mode the data port will temporarily communicate at the default value. When the unit is retuned to Data Mode, the serial port settings are returned to those specified in S102 and S110.

Values

1	**8N1**	6	7N2
2	8N2	7	7E1
3	8E1	8	7O1
4	8O1	9	7E2
5	7N1	10	7O2

S113 Packet Retransmissions

This register determines the maximum number of times that a packet will be retransmitted (in addition to the initial transmission). Retransmissions can be used to provide system robustness and to ensure data delivery due to noisy environments or weak signal levels. Retransmissions should not be used as the only means to correct for data collisions. Retransmissions create additional traffic and can have a significant impact on overall throughput of a system.

Values (0 - 254)

3

In a PMP system, set S113 to the minimum value required as, effectively, the data throughput from Master to Remote is divided by 1 plus the number stored in S113.

4.0 Register/Command Reference

S115	Repeat Interval

In *PP/PMP* S115 determines the number of slots which are available within a window of opportunity for Remote units to submit channel requests to the Master modem. For a large number of remotes, the value of S115 should be set relatively high:

Values (0 - 255)
3

Remotes will randomly contend for the ability to access the channel request slots. For a small number of Remotes, it is advisable to keep S115 closer to the default value so as to not 'waste bandwidth' by maintaining a relatively large window housing a greater-than-necessary number of channel reservation request slots.

S123	Average RSSI(dBm)

This register displays the average signal strength received over the previous 8 hop intervals. The value in this register is also reflected in status lines RSSI 1, 2, and 3, which connect to the modem's RSSI LEDs.

Values (dBm)
-120 to –20dBm (max reading)

S133	Network Type

This register defines the type of network being deployed. This register must be set to the same value on every unit in the system.

Point to Multipoint - The Master broadcasts data to all units, and all remote units send data back to the Master.
Point to Point - Point to point traffic between a Master and a Slave.

Values
0 - Point to Multipoint (PMP) 1 - Point to Point (PP)

S140	Destination Address

This register specifies the ultimate destination for a master modem's data in ***Point to Point*** mode - the range is 2 to 254.

Values
2-254

S143	Sleep Mode

This register enables sleep mode based on the status of !Wake (Pin 34).

0 - Modem is active at all time (Sleep disabled)
1 - Deep sleep on low level of the !Wake line (Pin 34). Wake up on the rising edge of the !Wake line.

Values
0 - Active all the time 1 - Sleep mode (!Wake)

4.0 Register/Command Reference

If throughput is not of primary concern and there is an emphasis on providing the most robust data communications, FEC should be considered.

S158 FEC (Forward Error Correction) Mode

Values
0 No FEC 6 Golay (23,12,7)

FEC consumes significant bandwidth: depending on which coding rate is chosen, a number of coding bits are transmitted along with the 'data' bits. In 'noisy' or long-range communications environments, FEC may effectively increase throughput by decreasing the amount of packet retransmissions which would otherwise be required.

Communications range may also be extended with the use of FEC: at a certain distance where data would otherwise be unacceptably corrupted, employing FEC may be all that is required to maintain the integrity of that data at that distance.

Types of FEC available within the Half Pico Modems:

Golay (23, 12, 7)	:	Information rate 0.5, corrects 3 bits out of 23

S248 Sync Timeout

Values
4-65534 **100**

This register defines how many hop intervals where the slave does not receive a synchronization packet from the master, before it will become unsynchronized and begins to search for a master.

4.0 Register/Command Reference

4.3 Serial Interface Commands

A number of register settings are specifically related to the serial data interface. Some, which have been discussed previously, include:

S102 Serial Baud Rate	determines the rate of communications between the modem and the local device
S110 Data Format	defines the data, stop, and parity bit count

Also, there are AT commands which effect the configuration of the module, specifically with respect to the handling of data at the RS-232 interface:

&C Data Carrier Detect (DCD)
&D Data Terminal Ready (DTR)
&K Handshaking
&S Data Set Ready (DSR)

&C*n* — Data Carrier Detect (DCD)

Controls the module's DCD output signal to the attached device. Determines when the DCD line is active.

Values

0 - DCD always on
1 - DCD on when synchronized

&D*n* — Data Terminal Ready (DTR)

Controls the action that the module will perform when the DTR input line's state is modified.

Values

0 - DTR ignored
2 - DTR disconnects and switches to command mode

&K*n* — Handshaking

Enables or disables hardware handshaking.

Values

0 **Handshaking disabled**
3 RTS/CTS handshaking enabled

Software flow control (XON/XOFF) is not supported.

&S*n* — Data Set Ready (DSR)

Controls the module's DSR line and determines when it is active.

Values

0 - DSR always on
1 - DSR = 0 in data mode, 1 command mode

5.0 Installation

The are a number of factors to consider when preparing to deploy a radio network, several of which have been touched-upon or detailed elsewhere within this manual. Following is a listing of a number of factors, in no particular order:

The installation, removal, or maintenance of any antenna system components must be undertaken only by qualified and experienced personnel.

Network Topology

The Half Pico currently operates in the 840-845 MHz or 902-928 MHz Bands and support Point-to-Point and Point-to-Multipoint topologies.

Throughput

The Half Pico is capable of up to 500 kbps link rate. The network topology and design has an effect on how much of this available throughput is available and how much is 'shared' between all nodes on the network.

Distance

The physical distance between the modems dictates such things as required antenna performance and heights. When contemplating antenna types, keep in mind the directivity (omnidirectional or directional) of the antennas being used.

Terrain

Along with distance, the terrain is a very important consideration with respect to antenna height requirements. The term 'line-of-sight' (LOS) refers to being able to 'see' one location from another - a minimum requirement for a radio signal path. In addition to LOS, adequate clearance must also be provided to satisfy 'Fresnel Zone' requirements - an obstruction-free area much greater than the physical LOS, i.e. LOS is not enough to completely satisfy RF path requirements for a robust communications link.

Transmit Power

Having read thus far through the factors to be considered, it should be clear that they are all interrelated. Transmit power should be set for the minimum required to establish a reliable communications path with adequate fade margin. Required transmit power is dictated primarily by distance, antenna type (specifically the 'gain' of the antennas being used), and the receive sensitivity of the distant modem. Cable and connector losses (the physical path from the modem's 'antenna connector' to the antenna's connector) must also be taken into account.

Receive Sensitivity

The Half Pico has exceptional receive sensitivity, which can produce a number of benefits, such as: added fade margin for a given link, being able to use less expensive coaxial cable or antenna types, being able to operate at greater distances for a given distant transmitter power. Distance, antenna gain, transmit power, and receive sensitivity are critical 'numbers' for radio path calculations. Fortunately, the Half Pico Series features the maximum available transmit power combined with exceptional receive sensitivity - two 'numbers' which will produce the most favorable path calculation results.

5.0 Installation

Fade Margin

When all radio path numbers are being considered and hardware assumptions are being made, another factor to consider is the 'fade margin' of the overall system. the fade margin is the difference between the anticipated receive signal level and the minimum acceptable receive level (receive sensitivity). Being that the Half Pico Series performs to exacting specifications, the overall deployment should be such that the modems may be utilized to their full potential to provide a reliable and robust communications link. A typical desired fade margin is in the order of 20dB, however oftentimes a 10dB fade margin is acceptable.

Frequency

The frequency ranges supported are not effected by rain to any significant degree, and is also able to penetrate through foliage and 'around obstacles' to a certain degree. This being the case, some may choose to scrimp on the physical deployment, particularly when it comes to antenna (tower) heights. Path calculations provide results which specify 'required' antenna heights. For cost savings and in taking advantage of the characteristics of the frequency range, sometimes the height requirements are not adhered to: this may result in unreliable communications.

Power Requirements

The Half Pico Series may be integrated into a system (Development Board, or custom) which accepts a range of DC input voltages (supply current requirements must also be met). In some deployments, power consumption is critical. A number of features related to minimizing power consumption are available with the Half Pico such the ability to operate at lower transmit power given the receive sensitivity of the distant modem.

Interference

The frequency hopping spread spectrum (FHSS) operation of the Half Pico Series most often allows it to work well in an environment within which there may be sources of in-band interference. The Frequency Table is a built-in feature which may be utilized to avoid specific frequencies or ranges of frequencies; the Spectrum Analyzer function may be used to identify areas of potential interference. Cavity filters are also available if required: contact Microhard Systems Inc. for further information.

5.0 Installation

5.1 Path Calculation

FCC regulations allow for up to 36dBi effective isotropic radiated power (EIRP). The sum (in dBm) of the transmitted power, the cabling loss, and the antenna gain cannot exceed 36dBi.

Assuming adequate antenna heights, a basic formula to determine if an adequate radio signal path exists (i.e. there is a reasonable fade margin to ensure reliability) is:

Fade Margin = System Gain - Path Loss

where all values are expressed in dB.

As discussed on the previous page, a desired fade margin is 20dB.

System gain is calculated as follows:

System Gain = Transmitter Power + (Transmitter Antenna Gain - Transmitter Cable and Connector Losses) + (Receiver Antenna Gain - Receiver Cable and Connector Losses) + | Receiver Sensitivity |.

where all values are expressed in dB, dBi, or dBm, as applicable.

Assuming a path loss of 113dB for this example, the fade margin = 143-113 = 30dB.
30dB exceeds the desired fade margin of 20dB, therefore this radio communications link would be very reliable and robust.

On the following page are examples of actual path loss measurements taken in an open rural environment; the path loss numbers do not apply to urban or non-LOS environments.

Example:

Tx power = 30dBm
Tx antenna gain = 6dBi
Tx cable/connector loss = 2dB
Rx antenna gain = 3dBi
Rx cable/connector loss = 2dB
Rx sensitivity = -108dBm

System Gain = [30+(6-2)+(3-2)+108]dB
= [30+4+1+108]dB
= 143dB.

5.0 Installation

Distance (km)	Master Height (m)	Remote Height (m)	Path Loss (dB)
5	15	2.5	116.5
5	30	2.5	110.9
8	15	2.5	124.1
8	15	5	117.7
8	15	10	105
16	15	2.5	135.3
16	15	5	128.9
16	15	10	116.2
16	30	10	109.6
16	30	5	122.4
16	30	2.5	128.8

Table 5-1: Path Loss (900 MHz)

To satisfy FCC radio frequency (RF) exposure requirements for mobile transmitting devices, a separation distance of 23cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operation at less than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

Once the equipment is deployed, average receive signal strength may be determined by accessing S Register 123.

5.2 Installation of Antenna System Components

The installation, removal, or maintenance of any antenna system components must be undertaken only by qualified and experienced personnel.

5.2.1 Antennas

The two most common types of antenna are the omnidirectional ('omni') and directional (Yagi).

An **omni** typically has 3-6dBi gain and spreads its energy in all directions (hence the name 'omnidirectional'). The 'pattern' of the energy field is in the shape of a donut, with the antenna mounted vertically at the centre. This vertical-mounted antenna produces a signal which is vertically 'polarized'.

Never work on an antenna system when there is lightning in the area.

A **Yagi** has a more focused antenna pattern, which results in greater gain: commonly, 6-12dBi. The pattern of a Yagi is in the shape of a large raindrop in the direction in which the antenna is pointed. If the elements of the Yagi are perpendicular to the ground (most common orientation) the radiated signal will be vertically polarized; if parallel to the ground, the polarization is horizontal.

The network topology, application, and path calculation are all taken into consideration when selecting the various antenna types to be used in a radio network deployment.

5.0 Installation

Direct human contact with the antenna is potentially unhealthy when a radio is generating RF energy. Always ensure that the radio equipment is powered down (off) during installation.

5.2.2 Coaxial Cable

The following types of coaxial cable are recommended and suitable for most applications (followed by loss at 900MHz, in dB, per 100 feet):

- LMR 195 (10.7)
- LMR 400 (3.9)
- LMR 600 (2.5)

For a typical application, LMR 400 may be suitable. Where a long cable run is required - and in particular within networks where there is not a lot of margin available - a cable with lower loss should be considered.

When installing cable, care must be taken to not physically damage it (be particularly careful with respect to not kinking it at any time) and to secure it properly. Care must also be taken to affix the connectors properly - using the proper crimping tools - and to weatherproof them.

To comply with FCC regulations, the maximum EIRP must not exceed 36dBm.

5.2.3 Surge Arrestors

The most effective protection against lightning-induced damage is to install two lightning surge arrestors: one at the antenna, the other at the interface with the equipment. The surge arrestor grounding system should be fully interconnected with the transmission tower and power grounding systems to form a single, fully integrated ground circuit. Typically, both ports on surge arrestors are N-type female.

All installation, maintenance, and removal work must be done in accordance with applicable codes.

5.2.4 External Filter

Although the Half Pico Series is capable of filtering-out RF noise in most environments, there are circumstances that require external filtering. Paging towers and cellular base stations in close proximity to the radio's antenna can desensitize the receiver. Microhard Systems Inc.'s external cavity filter eliminates this problem. The filter has two N-female connectors and should be connected inline at the interface to the RF equipment.

Appendix A: AT Utility Firmware Upgrade Procedure

To update the firmware, it is recommended to use the Microhard Utility called ***AT Firmware Upgrade V2***.

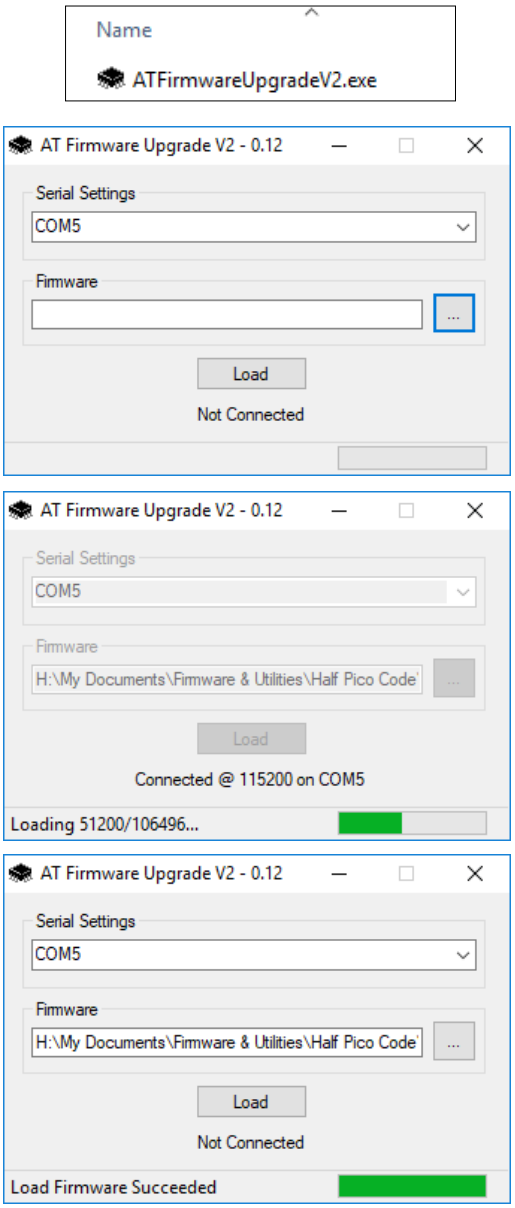


Image C-1: Firmware Upgrade

1. Power up the Modem and Connect a straight through serial cable to the DATA Port of the module. (If installed in development board).
2. Run the firmware utility obtained from Microhard Systems.

   "ATFirmwareUpgradeV2.exe"

3. Select the COM port on your PC that is connected to the Module.
4. Browse to the firmware file supplied by Microhard Systems. (.img) to be uploaded to the module.
5. Click the "Load" button.
6. The utility will establish a connection to the module and load the firmware. Once complete, a message will be display at the bottom of the utility window indicating that the process succeeded.

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