



# DOT Series

---

## AT Command Reference Guide

## DOT Series AT Command Guide

Models: MTDOT-915-xxx, MTDOT-868-xxx, MTXDOT-915-xx, MTXDOT-898-xx,

Part Number: S000643, Version 2.1

### Copyright

This publication may not be reproduced, in whole or in part, without the specific and express prior written permission signed by an executive officer of Multi-Tech Systems, Inc. All rights reserved. **Copyright © 2016 by Multi-Tech Systems, Inc.**

Multi-Tech Systems, Inc. makes no representations or warranties, whether express, implied or by estoppels, with respect to the content, information, material and recommendations herein and specifically disclaims any implied warranties of merchantability, fitness for any particular purpose and non-infringement.

Multi-Tech Systems, Inc. reserves the right to revise this publication and to make changes from time to time in the content hereof without obligation of Multi-Tech Systems, Inc. to notify any person or organization of such revisions or changes.

### Trademarks and Registered Trademarks

MultiTech, and the MultiTech logo, and MultiConnect are registered trademarks and mDot, xDot, and Conduit are a trademark of Multi-Tech Systems, Inc. All other products and technologies are the trademarks or registered trademarks of their respective holders.

### Legal Notices

The MultiTech products are not designed, manufactured or intended for use, and should not be used, or sold or re-sold for use, in connection with applications requiring fail-safe performance or in applications where the failure of the products would reasonably be expected to result in personal injury or death, significant property damage, or serious physical or environmental damage. Examples of such use include life support machines or other life preserving medical devices or systems, air traffic control or aircraft navigation or communications systems, control equipment for nuclear facilities, or missile, nuclear, biological or chemical weapons or other military applications (“Restricted Applications”). Use of the products in such Restricted Applications is at the user’s sole risk and liability.

MULTITECH DOES NOT WARRANT THAT THE TRANSMISSION OF DATA BY A PRODUCT OVER A CELLULAR COMMUNICATIONS NETWORK WILL BE UNINTERRUPTED, TIMELY, SECURE OR ERROR FREE, NOR DOES MULTITECH WARRANT ANY CONNECTION OR ACCESSIBILITY TO ANY CELLULAR COMMUNICATIONS NETWORK. MULTITECH WILL HAVE NO LIABILITY FOR ANY LOSSES, DAMAGES, OBLIGATIONS, PENALTIES, DEFICIENCIES, LIABILITIES, COSTS OR EXPENSES (INCLUDING WITHOUT LIMITATION REASONABLE ATTORNEYS FEES) RELATED TO TEMPORARY INABILITY TO ACCESS A CELLULAR COMMUNICATIONS NETWORK USING THE PRODUCTS.

The MultiTech products and the final application of the MultiTech products should be thoroughly tested to ensure the functionality of the MultiTech products as used in the final application. The designer, manufacturer and reseller has the sole responsibility of ensuring that any end user product into which the MultiTech product is integrated operates as intended and meets its requirements or the requirements of its direct or indirect customers. MultiTech has no responsibility whatsoever for the integration, configuration, testing, validation, verification, installation, upgrade, support or maintenance of such end user product, or for any liabilities, damages, costs or expenses associated therewith, except to the extent agreed upon in a signed written document. To the extent MultiTech provides any comments or suggested changes related to the application of its products, such comments or suggested changes is performed only as a courtesy and without any representation or warranty whatsoever.

### Contacting MultiTech

#### Knowledge Base

The Knowledge Base provides immediate access to support information and resolutions for all MultiTech products. Visit <http://www.multitech.com/kb.go>.

#### Support Portal

To create an account and submit a support case directly to our technical support team, visit: <https://support.multitech.com>.

#### Support

Business Hours: M-F, 8am to 5pm CT

Country	By Email	By Phone
Europe, Middle East, Africa:	<a href="mailto:support@multitech.co.uk">support@multitech.co.uk</a>	+(44) 118 959 7774
U.S., Canada, all others:	<a href="mailto:support@multitech.com">support@multitech.com</a>	(800) 972-2439 or (763) 717-5863

#### Warranty

To read the warranty statement for your product, visit [www.multitech.com/warranty.go](http://www.multitech.com/warranty.go). For other warranty options, visit [www.multitech.com/es.go](http://www.multitech.com/es.go).

#### World Headquarters

Multi-Tech Systems, Inc.  
 2205 Woodale Drive, Mounds View, MN 55112  
 Phone: (800) 328-9717 or (763) 785-3500  
 Fax (763) 785-9874

# Contents

<b>Chapter 1 Introduction .....</b>	<b>8</b>
AT Commands .....	8
Using Commands .....	8
Querying.....	8
Assigning New Values .....	8
Terminology .....	9
LoRa Topology.....	9
<b>Chapter 2 General AT Commands .....</b>	<b>10</b>
AT Attention .....	10
Syntax.....	10
Parameters and Values .....	10
Command with Response Examples .....	10
ATI Request ID .....	10
Syntax .....	10
Parameters and Values .....	10
Command with Response Examples .....	11
ATZ Reset CPU .....	11
Syntax.....	11
Parameters and values.....	11
Command with Response Examples .....	11
ATE0/1 Echo Mode .....	12
Syntax.....	12
Parameters and Values .....	12
Command with Response Examples .....	12
ATV0/1 Verbose Mode .....	12
Syntax .....	12
Parameters and Values .....	13
Command with Response Examples .....	13
AT&K0/3 Hardware Flow Control .....	13
Syntax .....	13
Parameters and Values .....	13
Command with Response Examples .....	13
AT&F Reset to Factory Defaults .....	14
Syntax .....	14
Parameters and Values .....	14
Command with Response Examples .....	14
Example US 915MHz.....	15
Example EU 868MHz.....	16

AT&W Save Configuration .....	18
Syntax .....	18
Parameters and Values .....	18
Command with Response Examples .....	18
AT+WP Wake Pin .....	19
Syntax .....	19
Parameters and Values .....	19
Command with Response Examples .....	19
AT+IPR Serial Speed .....	20
Syntax.....	20
Parameters and Values .....	20
Command with Response Examples .....	20
AT+DIPR Debug Serial Speed .....	21
Syntax.....	21
Parameters and Values .....	21
Command with Response Examples .....	21
AT+LOG Debug Log Level .....	22
Syntax .....	22
Parameters and Values .....	22
Command with Response Examples .....	22
<b>Chapter 3 Network Management.....</b>	<b>24</b>
Configuring.....	24
AT+DI Device ID .....	24
AT+FREQ Frequency Band .....	25
AT+FSB Frequency Sub-Band (915MHz models only).....	25
AT+PN Public Network Mode .....	27
AT+JBO Join Byte Order .....	29
AT+NJM Network Join Mode .....	29
AT+JOIN Join Network .....	31
AT+JR Join Retries .....	32
AT+JD Join Delay .....	32
Over-the-Air Activation (OTA).....	34
AT+NI Network ID .....	34
AT+NK Network Key .....	35
AT+ENC AES Encryption .....	36
Manual Activation.....	37
AT+NA Network Address .....	37
AT+NSK Network Session Key .....	38
AT+DSK Data Session Key .....	38
AT+ULC Uplink Counter .....	39
AT+DLC Downlink Counter.....	40

Network Joining .....	41
OTA Network Join .....	41
Auto OTA Network Join.....	41
Ensuring Network Connectivity.....	41
AT+NJS Network Join Status .....	41
AT+PING Send Ping .....	42
AT+ACK Require Acknowledgment .....	43
AT+NLC Network Link Check .....	44
AT+LCC Link Check Count .....	45
AT+LCT Link Check Count .....	46
Preserving, Saving, and Restoring Sessions .....	46
AT+SS Save Network Session .....	46
AT+RS Restore Network Session .....	47
AT+PS Preserve Session .....	48
<b>Chapter 4 Sending and Receiving Packets .....</b>	<b>49</b>
Channels and Duty Cycles .....	49
AT+CHM Channel Mask .....	49
AT+TXCH Transmit Channel .....	50
AT+TXN Transmit Next .....	53
AT+TOA Time On Air .....	54
Configuring.....	55
AT+MAC Inject MAC Command .....	55
AT&V Settings and Status .....	57
AT+DC Device Class .....	59
AT+AP Application Port .....	60
AT+TXP Transmit Power .....	61
AT+TXI Transmit Inverted .....	61
AT+RXI Receive Signal Inverted .....	62
AT+RXD Receive Delay .....	63
AT+FEC Forward Error Correction .....	64
AT+CRC Cyclical Redundancy Check .....	65
AT+ADR Adaptive Data Rate .....	66
AT+TXDR TX Data Rate .....	66
AT+SDR Session Data Rate.....	68
AT+REP Repeat Packet .....	69
Sending Packets .....	69
AT+SEND Send .....	69
AT+SENDB Send Binary .....	71
Receiving Packets.....	72
AT+RECV Receive Once .....	72
AT+RXO Receive Output .....	73

AT+DP Data Pending .....	73
AT+TXW Transmit Wait .....	74
Statistics .....	75
AT&R Reset Statistics .....	75
AT&S Statistics .....	76
AT+RSSI Signal Strength .....	77
AT+SNR Signal to Noise Ratio .....	77
Serial Data Mode.....	78
AT+SD Serial Data Mode .....	78
AT+SMODE Startup Mode .....	79
AT+SDCE Serial Data Clear on Error .....	80
<b>Chapter 5 Power Management .....</b>	<b>82</b>
AT+SLEEP Sleep Mode .....	82
Syntax .....	82
Parameters and Values .....	82
Command with Response Examples .....	82
AT+WM Wake Mode .....	82
Syntax .....	83
Parameters and Values .....	83
Command with Response Examples .....	83
AT+WI Wake Interval .....	83
Syntax .....	83
Parameters and Values .....	84
Command with Response Examples .....	84
AT+WD Wake Delay .....	84
Syntax .....	84
Parameters and Values .....	84
Command with Response Examples .....	85
AT+WTO Wake Timeout .....	85
Syntax .....	85
Parameters and Values .....	85
Command with Response Examples .....	85
AT+ANT Antenna Gain .....	86
Syntax .....	86
Parameters and Values .....	86
Command with Response Examples .....	86
<b>Chapter 6 Testing and Compliance .....</b>	<b>87</b>
AT+RXDR Receive Data Rate .....	87
Syntax .....	87
Parameters and Values .....	87
Command with Response Examples .....	87

EU 868MHz.....	87
AT+RXF Receive Frequency .....	88
Syntax .....	88
Parameters and Values .....	88
Command with Response Examples .....	88
AT+RECV Receive Continuously .....	88
Syntax .....	89
Parameters and Values .....	89
Command with Response Examples .....	89
AT+SENDI Send on Interval .....	89
Syntax .....	89
Parameters and Values .....	89
Command with Response Examples .....	90
AT+TXF Transmit Frequency .....	90
Syntax .....	90
Parameters and Values .....	90
Command with Response Examples .....	91
US 915MHz.....	91
EU 868 MHz.....	91
<b>Chapter 7 Examples .....</b>	<b>92</b>
Network Configuration and Joining .....	92
US 915MHz - Frequency Sub-band .....	92
Join Mode.....	93
Ensuring Network Connectivity.....	93
Serial Mode .....	95
Peer to Peer .....	95
Configuration .....	96
Peer-to-Peer Throughput.....	96

# Chapter 1 Introduction

---

## AT Commands

This reference provides AT Command information for the MultiTech Dot Series. These commands are available in firmware Version 2.0.x. Note that some commands are not available in older firmware versions.

- For mDot firmware upgrade instructions and to download the latest firmware, go to <http://www.multitech.net/developer/software/mdot-software/mdot-firmware-upgrade/>.
- For xDot firmware upgrade instructions and to download the latest firmware, go to <http://www.multitech.net/developer/flashing-xdot-firmware/>.

## Using Commands

### Querying

Some commands allow you to query the current value. Enter the command with no argument or followed by a question mark (?):

- Query a value  
AT+TXP  
11  
  
OK
- Query a value with optional ?  
AT+TXP?  
11  
  
OK

### Assigning New Values

Some commands allow you to assign a new value:

- To assign a new value, pass the value as an argument  
AT+TXP=10  
  
OK
- To see a range of input or output values for a command, give ? at the only argument.  
AT+TXP=?  
AT+TXP: (0-20)  
  
OK



## Terminology

Term	Description
End device	Mote (sensor node)
EUI	Extended Unique Identifier (EUI), a 64-bit global identifier
Gateway	Concentrator or base station
Uplink	In the direction from end device to network server
Downlink	In the direction from network server to end device
ISM	Industrial, scientific and medical radio bands
Frequencies	US: 902-928MHz ISM band (915MHz)
	EU: 863-870MHz ISM band (868MHz)
Channel frequencies	Physical layer
	EU 868MHz <ul style="list-style-type: none"> <li>■ 868,100,000Hz</li> <li>■ 868,300,000Hz</li> <li>■ 868,500,000Hz</li> </ul>
Data rates	300bps to 50Kbps
OTA	Over the air

## LoRa Topology

A LoRa network is usually a star or star of stars topology where gateways relay messages between end devices and a central network server. Gateways, like MultiTech's Conduit, may contain the network server. However, the Conduit can be configured to work with an external network server. Gateways communicate with a network server over standard IP connections..

## Chapter 2 General AT Commands

### AT Attention

Attention, used to verify the COM channel is working. AT required at the beginning of every command.

#### Syntax

Command
AT
help AT
AT=?

#### Parameters and Values

None

#### Command with Response Examples

AT

OK

help AT  
AT: Attention

OK

AT=?  
AT: NONE

OK

### ATI Request ID

Request ID returns product and software identification information.

#### Syntax

Command
ATI
help ATI
ATI=?

#### Parameters and Values

None

## Command with Response Examples

ATI

MultiTech mDot  
Firmware: 1.0.0-preview  
Library : 1.0.0-preview

OK

help ATI

ATI: Request Identification

OK

ATI=?

ATI: NONE

OK

## ATZ Reset CPU

Resets the CPU, the same way as pressing the reset button. The program is reloaded from flash and begins execution at the main function. Reset takes about 3 seconds.

### Syntax

Command
ATZ
help ATZ
ATZ=?

### Parameters and values

None

## Command with Response Examples

ATZ

OK

help ATZ  
ATZ: Reset the CPU

OK

ATZ=?  
ATZ: NONE

OK

## ATE0/1 Echo Mode

Enable or disable command mode echo.

### Syntax

Command
ATE=<parameter1>
help ATE
ATE=?

### Parameters and Values

Parameter1

0	Disables echo
1	Enables echo (Default)

### Command with Response Examples

ATE0

OK

ATE1

OK

## ATV0/1 Verbose Mode

Enable or disable verbose mode. Affects the verbosity of command query responses. For example, without verbose mode, AT+IPR? responds with 115200. With verbose mode AT+IPR? responds with Serial Baud Rate: 115200. Does not affect OK responses.

### Syntax

Command
ATV=<parameter1>
help ATV
ATV=?

## Parameters and Values

Parameter1

- 0 Disables verbose mode (Default)
- 1 Enables verbose mode

## Command with Response Examples

ATV0

OK

ATV1

OK

## AT&K0/3 Hardware Flow Control

Enable or disable hardware flow control. Hardware flow control is useful in serial data mode to keep from overflowing the input buffers.

This uses pins NCTS\_DIO7(CTS) and RTS\_AD6\_DIO6(RTS). When in serial data mode, use hardware flow control to prevent buffer overflow. (Serial data mode is AT+SMODE=1 or AT+SD.) Changes CTS signal to low with &K0 and to high with &K3.

**Note:** RTS of the dot pinout is an output. When used as a DCE device, connect this RTS pin to the CTS of a connected DTE device. The dot RTS pin is an input and connects to CTS of a DTE interface.

## Syntax

Command
AT&K=<parameter1>
help AT&K
AT&K=?

## Parameters and Values

Parameter1

- 0 Disables hardware flow control
- 3 Enables hardware flow control

## Command with Response Examples

AT&K0

OK

AT&K3

OK

AT&K?

3

OK

help AT&K

AT&K: AT&K0: disable, AT&K3: enable

OK

## AT&F Reset to Factory Defaults

Changes the current settings to the factory defaults, but does not store them. To store the default settings, use with AT&W. Otherwise, resetting or power cycling the device restores the previous settings.

### Syntax

Command
AT&F
help AT&F
AT&F=?

### Parameters and Values

None

### Command with Response Examples

AT&F

OK

help AT&F

AT&F: Reset current configuration to factory defaults

OK

AT&F=?

AT&F: NONE

OK

## Example US 915MHz

AT&F

OK

AT&V

Device ID:	be:7a:00:00:00:00:07:7a
Frequency Band:	FB_915
Frequency Sub Band:	0
Public Network:	off
Start Up Mode:	COMMAND
Network Address:	00000000
Network ID:	2b:7e:15:16:28:ae:d2:a5
Network ID Passphrase:	
Network Key:	2b.7e.15.16.28.ae.d2.a6.ab.f7.15.88.09.cf.4f.45
Network Key Passphrase:	
Network Session Key:	00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Data Session Key:	00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Network Join Mode:	OTA
Network Join Retries:	2
Preserve Session:	off
Join Byte Order:	LSB
Join Delay:	1
App Port:	1
Link Check Threshold:	off
Link Check Count:	off
Error Correction:	1 bytes
ACK Retries:	off
Packet Repeat:	1
Encryption:	on
CRC:	on
Adaptive Data Rate:	off
Command Echo:	on
Verbose Response:	off

Tx Frequency:	0
Tx Data Rate:	DR0 - SF10BW125
Tx Power:	11
Tx Antenna Gain:	3
Tx Wait:	on
Tx Inverted Signal:	off
Rx Delay:	1 s
Rx Inverted Signal:	on
Rx Output Style:	HEXADECIMAL
Debug Baud Rate:	115200
Serial Baud Rate:	115200
Serial Flow Control:	off
Serial Clear On Error:	on
Wake Mode:	INTERVAL
Wake Interval:	10 s
Wake Delay:	100 ms
Wake Timeout:	20 ms
Wake Pin:	DI8
Log Level:	0

OK

### Example EU 868MHz

AT&F

OK

AT&V

Device ID:	be:7a:00:00:00:00:07:7a
Frequency Band:	FB_868
Frequency Sub Band:	0
Public Network:	off
Start Up Mode:	COMMAND
Network Address:	00000000
Network ID:	2b:7e:15:16:28:ae:d2:a5



---

Network ID Passphrase:	
Network Key:	2b.7e.15.16.28.ae.d2.a6.ab.f7.15.88.09.cf.4f.45
Network Key Passphrase:	
Network Session Key:	00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Data Session Key:	00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Network Join Mode:	OTA
Network Join Retries:	2
Preserve Session:	off
Join Byte Order:	LSB
Join Delay:	1
App Port:	1
Link Check Threshold:	off
Link Check Count:	off
Error Correction:	1 bytes
ACK Retries:	off
Packet Repeat:	1
Encryption:	on
CRC:	on
Adaptive Data Rate:	off
Command Echo:	on
Verbose Response:	off
Tx Frequency:	0
Tx Data Rate:	DR0 - SF12BW125
Tx Power:	11
Tx Antenna Gain:	3
Tx Wait:	on
Tx Inverted Signal:	off
Rx Delay:	1 s
Rx Inverted Signal:	on
Rx Output Style:	HEXADECIMAL
Debug Baud Rate:	115200
Serial Baud Rate:	115200
Serial Flow Control:	off
Serial Clear On Error:	on

Wake Mode:	INTERVAL
Wake Interval:	10 s
Wake Delay:	100 ms
Wake Timeout:	20 ms
Wake Pin:	DI8
Log Level:	0

OK

## AT&W Save Configuration

Writes all configuration settings displayed in AT&V to flash memory.

### Syntax

Command
AT&W
help AT&W
AT&W=?

### Parameters and Values

None

### Command with Response Examples

AT&W

OK

help AT&W

AT&W: Save configuration to flash memory

OK

AT&W=?

AT&W: NONE

OK

## AT+WP Wake Pin

Sets the pin that the end device monitors if wake mode is set to interrupt mode. The end device wakes if a positive going edge is detected on the wake pin. Upon waking, it waits +WD amount of time for an initial character then +WTO amount of time for each additional character.

### Syntax

Command
AT+WP=<parameter1>
help AT+WP
AT+WP?
AT+WP=?

### Parameters and Values

Parameter1

- |   |   |
|---|---|
| 1 | DIN                                     |
| 2 | AD2_DIO2                                |
| 3 | AD3_DIO3                                |
| 4 | AD4_DIO4                                |
| 5 | ASSOCIATE_AD5_DIO5                      |
| 6 | RTS_AD6_DIO6 (Not available with AT&K3) |
| 7 | NCTS_DIO7 (Not available with AT&K3)    |
| 8 | NDTR_SLEEPREQ_DIO8 (Default)            |

### Command with Response Examples

help AT+WP

AT+WP: Wakeup DIO pin of sleep mode (1-8) (default: DIO8, 1:DIN), deep-sleep uses DIO7

OK

AT+WP?

DIO8

OK

AT+WP=?

AT+WP: (1-8)

OK

## AT+IPR Serial Speed

Sets serial baud rate for interface on header pins 2 and 3. Changes to this setting take effect after a save and reboot of the Dot.

### Syntax

Command
AT+IPR=<parameter1>
help AT+IPR
AT+IPR?
AT+IPR=?

### Parameters and Values

Parameter1

1200

2400

4800

9600

19200

38400

57600

115200 (Default)

230500

460800

921600

### Command with Response Examples

```
AT+IPR
115200
```

OK

```
help AT+IPR
AT+IPR: Set serial baud rate, default: 115200
```

OK

```
AT+IPR?
115200
```

OK

AT+IPR=?

AT+IPR: (2400,4800,9600,19200,38400,57600,115200,230400,460800,921600)

OK

## AT+DIPR Debug Serial Speed

Sets debug serial baud rate for interface on DEBUG header pins 30 and 31. Changes to this setting take effect after a save and reboot of the Dot. power-cycle or reset.

### Syntax

Command
AT+DIPR=<parameter1>
help AT+DIPR
AT+DIPR?
AT+DIPR=?

### Parameters and Values

Parameter1

2400

4800

9600

19200

38400

57600

115200 (Default)

230500

460800

921600

### Command with Response Examples

AT+DIPR

115200

OK

help AT+DIPR

AT+DIPR: Set debug serial baud rate, default: 115200

OK

AT+DIPR?  
115200

OK

AT+DIPR=?  
AT+DIPR: (1200, 2400,4800,9600,19200,38400,57600,115200,230400,460800,921600)

OK

## AT+LOG Debug Log Level

Sets the debug message logging level. Messages are output on the debug port. Higher settings log more messages.

### Syntax

Command
AT+LOG=<parameter1>
help AT+LOG
AT+LOG?
AT+LOG=?

### Parameters and Values

Parameter1

- 0 Off – No debug messages (Default)
- 1 FATAL – Output FATAL debug messages.
- 2 ERROR – Outputs ERROR and FATAL debug messages
- 3 WARNING – Outputs WARNING and all lower level debug messages
- 4 INFO – Outputs INFO and all lower level debug messages
- 5 DEBUG – Output DEBUG and all lower level debug messages
- 6 TRACE – Output TRACE and all lower level debug messages

### Command with Response Examples

AT+LOG=0

OK

help AT+LOG  
AT+LOG: Enable/disable debug logging. (0: off, 1:Fatal - 6:Trace)

OK

AT+LOG?

0

OK

AT+LOG=?

AT+LOG: (0-6)

OK

# Chapter 3 Network Management

## Configuring

### AT+DI Device ID

The device ID is an EUI. The EUI is programmed at the factory. This command allows you to query the EUI, but not change it.

#### Syntax

Command
AT+DI
help AT+DI
AT+DI?
AT+DI=?

#### Parameters and Values

None

#### Command with Response Examples

```
AT+DI
00:80:00:00:00:00:06
```

OK

```
help AT+DI
AT+DI: Device EUI-64 (MSB) (unique, set at factory) (8 bytes)
```

OK

```
AT+DI?
00:80:00:00:00:00:06
```

OK

```
AT+DI=?
AT+DI: (hex:8)
```

OK



## AT+FREQ Frequency Band

Use to query the supported frequency band. This is not configurable. It is either 915MHz or 868MHz.

### Syntax

Command
AT+FREQ
help AT+FREQ
AT+FREQ?
AT+FREQ=?

### Parameters and Values

None

### Command with Response Examples

```
AT+FREQ
FB_915
```

OK

```
help AT+FREQ
AT+FREQ: Configured Frequency Band '868' or '915'
```

OK

```
AT+FREQ?
FB_915
```

OK

```
AT+FREQ=?
AT+FREQ: (868,915)
```

OK

## AT+FSB Frequency Sub-Band (915MHz models only)

Configures the frequency sub-band for 915MHz models. This enables hybrid mode for private network channel management.

**Note:** AT+TXCH lists channels used in the current AT+FSB setting.

### Channel Details (AT+PN=0)

AT+FSB	Uplink Channels	Downlink on Rx1 and Rx2
1	902.3-903.7 - 125k, 903.0 500k	923.3 kHz
2	903.9-905.3 - 125k, 904.6 500k	923.9 kHz

AT+FSB	Uplink Channels	Downlink on Rx1 and Rx2
3	905.5-906.9 - 125k, 906.2 500k	924.5 kHz
4	907.1-908.5 - 125k, 907.8 500k	925.1 kHz
5	908.7-910.1 - 125k, 909.4 500k	925.7 kHz
6	910.3-911.7 - 125k, 911.0 500k	926.3 kHz
7	911.9-913.3 - 125k, 912.6 500k	926.9 kHz
8	913.5-914.9 - 125k, 914.2 500k	927.5

**Note:** Rx1 and Rx2 Downlink on 923.3 - 927.5 depending on uplink channel used (channel / 8)

### Channel Details (AT+PN=1)

AT+FSB	Uplink Channels	Downlink channels on Rx1
1	902.3-903.7 - 125k	923.3-927.5 - 500kHz
2	903.9-905.3 - 125k	
3	905.5-906.9 - 125k	
4	907.1-908.5 - 125k	
5	908.7-910.1 - 125k	
6	910.3-911.7 - 125k	
7	911.9-913.3 - 125k	
8	913.5-914.9 - 125k	

**Note:** Rx1 Downlink on 923.3 - 927.5 depending on uplink channel used (channel / 8) Rx2 Downlink on 923.3

### Syntax

Command
AT+FSB=<parameter1>
help AT+FSB
AT+FSB?
AT+FSB=?

### Parameters and Values

Parameter1

- 0 Allows channel hopping of all 64 channels. (Default)
- 1 Enter a value from 1-8 to configure the end device to use one set of eight channels out of 64 possible. This must match the gateway settings.

### Command with Response Examples

AT+FSB  
0

OK

help AT+FSB

AT+FSB: Set the frequency sub-band for US 915, (0:ALL, 1-8)

OK

AT+FSB?

0

OK

AT+FSB=?

AT+FSB: (0-8)

OK

## AT+PN Public Network Mode

Configures the end device to function on either a public or private LoRa network.

When public network is enabled, the device functions as a LoRaWAN device as specified in LoRa Alliance documentation.:

- Syncword 0x34 is used
- Join windows open at the default 5/6 seconds after end of transmission for OTA
- Set AT+FSB=1-8 to enable hybrid functionality, Rx windows open at the default 1/2 seconds after end of transmission.

When not enabled, (default) the device functions on a private network with the following modifications, adjusted for the local network server available on the Conduit:

- Syncword 0x12 is used
- Join windows open at 1/2 seconds after end of transmission for OTA
- Rx1 and Rx2 windows are fixed to each AT+FSB setting (see AT+FSB)

### Syntax

Command
AT+PN=<parameter1>
help AT+PN
AT+PN?
AT+PN=?

### Parameters and Values

Parameter1

- |   |                                       |
|---|---------------------------------------|
| 0 | Disable public network mode (Default) |
| 1 | Enable public network mode.           |

### Command with Response Examples

AT+PN=0

OK

help AT+PN

AT+PN: Enable/disable public network mode. (0: off, 1: on)

OK

AT+PN?

0

OK

AT+PN=?

AT+PN: (0,1)

OK

#### Public Mode Example

US 64 channel

AT+FSB=0

(AT+PN=1) sets the SyncWord to 0x34 and uses join rx windows of 5/6 seconds.

Downlink channel is (uplink\_channel modulo 8)

OK

#### Public Hybrid Mode Example

US 8 channel

AT+FSB=(1 - 8)

(AT+PN=0) sets the SyncWord to 0x34 and uses join rx windows of 5/6 seconds.

Downlink channel is (uplink\_channel / 8)

OK

#### Private Hybrid Mode Example

AT+FSB=(1 - 8)

(AT+PN=1) sets the SyncWord to 0x12 and uses join rx windows of 1/2 seconds.

Downlink channel is (uplink\_channel modulo 8)

OK

## AT+JBO Join Byte Order

Sets the byte order (LSB or MSB first) in which the device EUI is sent to the gateway in a join request.

**Note:** Used only for connecting to non-compliant network servers.

### Syntax

Command
AT+JBO=<parameter1>
help AT+JBO
AT+JBO?
AT+JBO=?

### Parameters and Values

Parameter1

- 0            LSB first (Default)
- 1            MSB first

### Command with Response Examples

AT+JBO=0

OK

help AT+JBO

AT+JBO: Send EUI's in join request with configured byte ordering (0:LSB,1:MSB)

OK

AT+JBO?

0

OK

AT+JBO=?

AT+JBO: (0:LSB,1:MSB)

OK

## AT+NJM Network Join Mode

Controls how the end device establishes communications with the gateway.

- When AT+NJM=2 (AUTO\_OTA) and AT+PS is set to 1 the session is not be defaulted on reset or power.
- When AT+NJM=1 (OTA) AT+PS will not be applied and session stays in flash in either case.

## Syntax

Command
AT+NJM=<parameter1>
help AT+NJM
AT+NJM
AT+NJM=?

## Parameters and Values

Parameter1

0 Manual configuration

1 OTA network join (Default)

2 Auto OTA network join on start up

**CAUTION:** Setting +NJM=2 causes the Dot to join immediately. Configure network settings and OTA mode before setting to AUTO\_OTA mode.

3 Peer-to-peer mode

## Command with Response Examples

AT+NJM=1

OK

help AT+NJM

AT+NJM: 0: Manual configuration, 1: OTA Network Join, 2: Auto OTA Network Join on start up, 3: Peer-to-Peer (default: 1)

OK

AT+NJM?

1

OK

AT+NJM=?

AT+NJM: (0-3)

OK

## AT+JOIN Join Network

Join network. For US915 and EU868 models +NI, +NK must match gateway settings in order to join. US915 must also match +FSB setting.

### Syntax

Command
AT+JOIN
help AT+JOIN
AT+JOIN=?

### Parameters and Values

None

If Parameter1 is set to 1, a character string up to 128 characters.

### Error Messages

- Failed to join network – No join response received from gateway.
- Join backoff – End device must wait for next available free channel to join. Issue AT+TXN to get the wait time.

### Command with Response Examples

AT+JOIN

Successfully joined network

OK

AT+JOIN

Join Error - Failed to join network

ERROR

AT+JOIN

Join Error - Join backoff

ERROR

help AT+JOIN

AT+JOIN: Join network, provide argument of '1' to force join (acquire network address and session keys)

OK

AT+JOIN=?

AT+JOIN: (force:1)

OK

## AT+JR Join Retries

This is the maximum number of join attempts that will be made if none are successful. Such a sequence is initiated by the AT+JOIN command.

Enabling this setting allows the dot to search each sub-band when trying to join the Conduit when in AUTO\_OTA mode. The dot can then recover if the Conduit changes sub-band after it detects the lost network connection with AT+LCT used with AT+LCC or AT+ACK. The dot attempts to join on the configured AT+FSB the number of join retries, if unsuccessful it attempts on the next AT+FSB setting.

### Syntax

Command
AT+JR=<parameter1>
help AT+JR
AT+JR?
AT+JR=?

### Parameters and Values

Parameter1

0	Disable
1-255	Seconds enabled (Default is 2)

### Command with Response Examples

```
AT+JR=5
```

```
OK
```

```
help AT+JR
```

```
AT+JR: US915 AUTO_OTA Frequency sub-band search retries (0:disable,1-255:attempts)
```

```
OK
```

```
AT+JR?
```

```
5
```

```
OK
```

```
AT+JR=?
```

```
AT+JR: (0-255)
```

```
OK
```

## AT+JD Join Delay

Allows the dot to use non-default join receive windows, if required by the network it is attempting to connect to. Initiating a join request opens a receive window to listen for the response. This command allows you to alter the default timing of the window.



## Syntax

Command
AT+JD=<parameter1>
help AT+JD
AT+JD?
AT+JD=?

## Parameters and Values

Parameter1

1-15 seconds (Default is 1)

## Command with Response Examples

AT+JD=1

OK

help AT+JD

AT+JD: Number of seconds before receive windows are opened for join (1 - 15)

OK

AT+JD?

1

OK

AT+JD=?

AT+JD: (1-15)

OK

## Over-the-Air Activation (OTA)

LoRa allows OTA activation between a device and a network to generate session keys based on a pre-shared key. During OTA, the device exchanges Device and Network IDs with the server. If the Network ID matches the server's configuration, session keys are generated using the pre-shared keys and random nonce values from the device and server. Then, a join accept message is sent to the device with the server's random nonce value encrypted with the pre-shared key. After this initial exchange, only session keys are used for subsequent message encryption.

To use OTA, configure the network ID and network key and enable encryption.

### AT+NI Network ID

Configures network EUI/Name. (App EUI in LoRaMac.)

#### Syntax

Command
AT+NI=<parameter1>,<parameter2>
help AT+NI
AT+NI?
AT+NI=?

#### Parameters and Values

Parameter1

0 Second parameter is a hex key.

1 Second parameter is a string up to 128 characters long.

Parameter2

16 bytes of hex data using a colon (:) to separate each byte from the next byte.

If Parameter1 is set to 1, a character string up to 128 characters.

#### Command with Response Examples

```
AT+NI=0,00:11:22:33:44:55:66:77
```

```
Set Network ID: 00.11.22.33.44.55.66.77
```

```
OK
```

```
AT+NI?
```

```
00:11:22:33:44:55:66:77
```

```
OK
```

```
AT+NI=1,This string can be up to 128 characters long.
```

```
Set Network Name: This string can be up to 128 characters long.
```

```
OK
```

```
help AT+NI
```

AT+NI: Configured Network EUI/Name (App EUI in LoraMac) AT+NI=0,hex AT+NI=1,network\_name (Net ID = crc64(network\_name)) (8 bytes)

OK

AT+NI?

61:63:4d:b3:8a:2b:86:22

Passphrase: 'This string can be up to 128 characters long.'

OK

AT+NI=?

AT+NI: (0,(hex:8)),(1,(string:128))

OK

## AT+NK Network Key

Configures network key/passphrase. (App key in LoRaMac.)

### Syntax

Command
AT+NK=<parameter1>,<parameter2>
help AT+NK
AT+NK?
AT+NK=?

### Parameters and Values

Parameter1

0 Second parameter is a hex key.

1 Second parameter is a string up to 128 characters long.

Parameter2

16 bytes of hex data using a colon (:) to separate each byte from the next byte.

If Parameter1 is set to 1, a character string up to 128 characters.

### Command with Response Examples

AT+NK=0,88:99:AA:BB:CC:DD:EE:FF:00:11:22:33:44:55:66:77

Set Network Key: 88.99.aa.bb.cc.dd.ee.ff.00.11.22.33.44.55.66.77

OK

AT+NK?

88.99.aa.bb.cc.dd.ee.ff.00.11.22.33.44.55.66.77

OK

AT+NK=1,This String can be up to 128 characters long.  
Set Network Passphrase: This String can be up to 128 characters long.

OK

help AT+NK

AT+NK: Configured network key/passphrase (App Key in LoraMac) ## AT+NK=0,hex AT+NK=1,passphrase  
(Net key = cmac(passphrase)) (16 bytes)

OK

AT+NK?

e1.07.15.95.06.50.46.80.89.cf.2e.6e.2b.ea.f9.cf  
Passphrase: 'This String can be up to 128 characters long.'

OK

AT+NK=?

AT+NK: (0,(hex:16)),(1,(string:128))

OK

## AT+ENC AES Encryption

Enables or disables AES encryption of payload data.

**Note:** Must be enabled for use with nearly all network servers."

### Syntax

Command
AT+ENC=<parameter1>
help AT+ENC
AT+ENC?
AT+ENC=?

### Parameters and Values

Parameter1

0 Disabled  
1 Enabled (Default)

### Command with Response Examples

AT+ENC=1

OK

help AT+ENC

AT+ENC: Enable/disable AES encryption (0: off, 1: on)

OK

AT+ENC?

1

OK

AT+ENC=?

AT+ENC: (0,1)

OK

## Manual Activation

If supported by the network server, the Dot can be activated manually. To do this, configure the network address, network session key, and data session key.

### AT+NA Network Address

Sets network address in MANUAL join mode, the server will assign an address in OTA modes.

#### Syntax

Command
AT+NA=<parameter1>
help AT+NA
AT+NA?
AT+NA=?

#### Parameters and Values

Parameter1

4 bytes of hex data using a colon (:) to separate each byte from the next byte.

#### Command with Response Examples

AT+NA=01:fa:b0:1c

Set Network Address: 01:fa:b0:1c

OK

help AT+NA

AT+NA: Network address (devAddr in LoraMac) (4 bytes)

OK

AT+NA?

01:fa:b0:1c

OK

AT+NA=?  
 AT+NA: (hex:4)

OK

## AT+NSK Network Session Key

Sets network session key in MANUAL join mode, will be automatically set in OTA modes..

### Syntax

Command
AT+NSK=<parameter1>
help AT+NSK
AT+NSK?
AT+NSK=?

### Parameters and Values

Parameter1

16 bytes of hex data using a colon (:) to separate each byte from the next byte.

### Command with Response Examples

AT+NSK=00:11:22:33:44:55:66:77:88:99:AA:BB:CC:DD:EE:FF  
 Set Network Session Key: 00.11.22.33.44.55.66.77.88.99.aa.bb.cc.dd.ee.ff

OK

help AT+NSK  
 AT+NSK: Network session encryption key (16 bytes)

OK

AT+NSK?  
 00.11.22.33.44.55.66.77.88.99.aa.bb.cc.dd.ee.ff

OK

AT+NSK=?  
 AT+NSK: (hex:16)

OK

## AT+DSK Data Session Key

Sets data session key in MANUAL join mode, will be automatically set in OTA modes. Used for AES-128 encryption of transferred data.

## Syntax

Command
AT+DSK=<parameter1>
help AT+DSK
AT+DSK?
AT+DSK=?

## Parameters and Values

Parameter1

16 bytes of hex data using a colon (:) to separate each byte from the next byte.

## Command with Response Examples

```
AT+DSK=FF:EE:DD:CC:BB:AA:99:88:77:66:55:44:33:22:11:00
Set Data Session Key: ff.ee.dd.cc.bb.aa.99.88.77.66.55.44.33.22.11.00
```

OK

```
help AT+DSK
AT+DSK: Data session encryption key (16 bytes)
```

OK

```
AT+DSK?
ff.ee.dd.cc.bb.aa.99.88.77.66.55.44.33.22.11.00
```

OK

```
AT+DSK=?
AT+DSK: (hex:16)
```

OK

## AT+ULC Uplink Counter

A device using MANUAL join mode a network server may reject uplink packets, if they do not have the correct counter value. This setting is available for an application to manage this session parameter. Otherwise, use AT+SS and AT+RS to save this setting to flash in any join mode.

## Syntax

Command
AT+ULC=<parameter1>
help AT+ULC
AT+ULC?
AT+ULC=?

### Parameters and Values

Parameter1

0-4294967295 (Default is 1).

### Command with Response Examples

AT+ULC=1

OK

help AT+ULC

AT+ULC: Get or set the uplink counter for the next packet

OK

AT+ULC?

1

OK

AT+ULC=?

AT+ULC: (0-4294967295)

OK

### AT+DLC Downlink Counter

A device using MANUAL join mode, it may reject downlink packets if they do not have the correct counter value. This setting is available for an application to manage this session parameter. Otherwise, use AT+SS and AT+RS to save this setting to flash in any join mode.

#### Syntax

Command
AT+DLC=<parameter1>
help AT+DLC
AT+DLC?
AT+DLC=?

### Parameters and Values

Parameter1

0-4294967295 (Default is 1).

### Command with Response Examples

AT+DLC=0

OK



```
help AT+DLC
AT+DLC: Get or set the downlink counter
```

```
OK
```

```
AT+DLC?
0
```

```
OK
```

```
AT+DLC=?
AT+DLC: (0-4294967295)
```

```
OK
```

## Network Joining

### OTA Network Join

After configuring the network ID and network key on the mDot, send a join packet with the device ID, network ID, and a dev-nonce value. The network server checks the network ID and assigns an address, which is returned with the network ID and app-nonce value. Session keys are generated independently on the device and network server using the network address, network ID, nonce-values, and network key.

- **AT+NJM=1** Configure mDot for OTA join mode (default).
- **AT+JOIN** Send a join request to the server.
- **AT+NJS** Display current join status 0:not joined, 1:joined.

### Auto OTA Network Join

After a successful join, the session information is stored in flash. This session information is restored when waking from sleep. If the device is reset or the power cycled, session information is reset and a join is attempted. The session information is valid as long as the Dot checks in before the Conduit's lease-time expires.

- **AT+NJM=2** Configure Dot for AUTO OTA join mode.
- **AT+JOIN** Reloads the session info from flash.
- **AT+JOIN=1** Force Dot to perform OTA join regardless for saved session.

## Ensuring Network Connectivity

### AT+NJS Network Join Status

Displays the last known network join state, which helps determine if communication has been lost.

#### Syntax

Command
AT+NJS=<parameter1>
help AT+NJS
AT+NJS?

**Command**

AT+NJS=?

**Parameters and Values**

Parameter1

0 Not joined.

1 Joined

**Command with Response Examples**

AT+NJS

0

OK

help AT+NJS

AT+NJS: 0: Not joined, 1: Joined

OK

AT+NJS?

0

OK

AT+NJS=?

AT+NJS: (0,1)

OK

**AT+PING Send Ping**

Sends a ping to the gateway. The gateway responds with a pong containing RSSI and SNR, which the end device displays. RSSI ranges from -140dB to -0dB and SNR ranges from -20dBm to 20dBm.

**Syntax****Command**

AT+PING

help AT+PING

AT+PING=?

**Parameters and Values**

None

**Command with Response Examples**

AT+PING

-31,10.0

OK

AT+PING  
Network Not Joined

ERROR

help AT+PING  
AT+PING: Sends ping and displays the servers received rssi and snr

OK

AT+PING=?  
AT+PING: (-140-0),(-20.0-20.0)

OK

## AT+ACK **Require Acknowledgment**

The maximum number of times the end device tries to retransmit an unacknowledged packet. Options are from 1 to 8.

**Note:** When ACKs are enabled, the AT+SEND command does not return until the ACK is received or attempts are exhausted.

### Syntax

Command
AT+ACK=<parameter1>
help AT+ACK
AT+ACK?
AT+ACK=?

### Parameters and Values

Parameter1

- 0 ACKs are not required. (Default)
- 1-8 The maximum number of attempts without an acknowledgment.

### Command with Response Examples

AT+ACK=0

OK

help AT+ACK  
AT+ACK: Enable to require send acknowledgment (0: off, N: number of attempts until ACK received)

OK

AT+ACK?  
0

OK

AT+ACK=?  
AT+ACK: (0-8)

OK

## AT+NLC Network Link Check

Performs a network link check. The first number in the response is the dBm level above the demodulation floor (not be confused with the noise floor). This value is from the perspective of the signal sent from the end device and received by the gateway. The second number is the number of gateways in the end device's range.

### Syntax

Command
AT+NLC
help AT+NLC
AT+NLC?
AT+NLC=?

### Parameters and Values

None

### Command with Response Examples

AT+NLC  
11,2

OK

AT+NLC  
No response from network

ERROR

AT+NLC  
Network Not Joined

ERROR

help AT+NLC  
AT+NLC: Perform network link check, displays dBm above floor, number of gateways in range and optional packet payload if received

OK

AT+NLC=?

AT+NLC: (-20.0-20.0),(1-)

OK

## AT+LCC Link Check Count

Performs periodic connectivity checking. This feature is an alternative to enabling ACK for all packets in order to detect when the network is not available or the session information has been reset on the server.

### Syntax

Command
AT+LCC=<parameter1>
help AT+LCC
AT+LCC?
AT+LCC=?

### Parameters and Values

Parameter1

0 Disabled (Default)

1-255 Number of packets sent before a link check is performed. Link checks are not be sent if ACKs are enabled.

### Command with Response Examples

AT+LCC=3

OK

help AT+LCC

AT+LCC: Set number of packets between each link check if ACK's are disabled

OK

AT+LCC?

3

OK

AT+LCC=?

AT+LCC: (0:off,N:Pkets (max 255))

OK

## AT+LCT Link Check Count

Threshold for the number of consecutive link check or ACK failures to tolerate before setting the join status to not joined.

### Syntax

Command
AT+LCT=<parameter1>
help AT+LCT
AT+LCT?
AT+LCT=?

### Parameters and Values

Parameter1

0 Disabled (Default)

1-255 Number of failures before not joined status is set

### Command with Response Examples

AT+LCT=3

OK

help AT+LCT

AT+LCT: Set threshold for number of link check or ACK failures to tolerate, (0: off, N: number of failures)

OK

AT+LCT?

3

OK

AT+LCT=?

AT+LCT: (0-255)

OK

## Preserving, Saving, and Restoring Sessions

### AT+SS Save Network Session

Saves the network session information (join) over resets allowing for a session restore (AT+RS) without requiring a join. This command should be issued after the Dot has joined. See *AT+PS* if using auto join mode.

## Syntax

Command
AT+SS
help AT+SS
AT+SS?
AT+SS=?

## Parameters and Values

None

## Command with Response Examples

AT+SS

OK

help AT+SS

AT+SS: Save network session info to flash

OK

AT+SS=?

AT+SS: NONE

OK

## AT+RS Restore Network Session

Restores the network session information (join) that was saved with the AT+SS command.

## Syntax

Command
AT+RS
help AT+RS
AT+RS?
AT+RS=?

## Parameters and Values

None

## Command with Response Examples

AT+RS

OK

HELP AT+RS

AT+RS: Restore network session info from flash

OK

AT+RS=?

AT+RS: NONE

OK

## AT+PS Preserve Session

Preserves the network session information over resets when using auto join mode (AT+NJM). If not using auto join mode, use with the save session command (AT+SS).

### Syntax

Command
AT+PS=<parameter1>
help AT+PS
AT+PS?
AT+PS=?

### Parameters and Values

Parameter1

0 Off (Default)

1 On

### Command with Response Examples

AT+PS=0

OK

help AT+PS

AT+PS: Save network session info through reset or power down in AUTO\_OTA mode (0:off, 1:on)

OK

AT+PS?

0

OK

AT+PS=?

AT+PS: (0,1)

OK



# Chapter 4 Sending and Receiving Packets

## Channels and Duty Cycles

For reference, use the +TXCH command to display channels used with frequency hopping.

### AT+CHM Channel Mask

Sets a channel mask to enable or disable channels to be used to transmit packets.

- US915/AU915 — 72 bit mask (MSB)
- EU868 — 16 bit mask (MSB)

### Syntax

Command
AT+CHM=<parameter1>,<parameter2>
help AT+CHM
AT+CHM?
AT+CHM=?

### Parameters and Values

#### US915/AU915

Parameter1,Parameter2

0,00FF	Enables channels 0-7, disables channels 8-15
0,FFFF	Enables channels 0-15
2,00FF	Enables channels 32-39, disables channels 40-47
4,00FF	Enables channels 64-71

#### EU868

Parameter1,Parameter2

0,0007	Enables default channels 0-3, disables channels 4-15
--------	--

### Command with Response Examples

```
help AT+CHM
AT+CHM: Get/set channel mask (OFFSET:0-4,MASK:0000-FFFF)
```

OK

#### US915

```
AT+FSB=0
```

OK

```
AT+CHM
00FFFFFFFFFFFFFFFF
```

```
OK
```

```
AT+FSB=1
```

```
OK
```

```
AT+CHM
0001000000000000FF
```

```
OK
```

```
AT+FSB=2
```

```
OK
```

```
AT+CHM
0002000000000000FF00
```

```
OK
```

### **EU868**

```
AT+CHM=0,00FF
```

```
OK
```

```
AT+CHM
00FF
```

```
OK
```

## **AT+TXCH    Transmit Channel**

With an US 951MHz model, lists the available channels in the current AT+FSB setting

With an EU 868MHz model, lists the available channels, including additional channels sent by the network server with the JoinAccept message. With an EU 868MHz model, this command can be used to add additional channels

### **EU868 Adding a Channel**

```
AT+TXCH=<INDEX>,<FREQUENCY>,<RANGE> INDEX - 3-15 FREQUENCY - 863000000-870000000 RANGE - datarate
range
```

For example, 40 -> DR4:max DR0:min, 77 -> DR7:max DR7:min

## Syntax

Command
AT+TXCH
help AT+TXCH
AT+TXCH?
AT+TXCH=?

## Parameters and Values

None

## Command with Response Examples

help AT+TXCH

AT+TXCH: List Tx channel frequencies for sub-band

OK

AT+FSB=1

OK

AT+TXCH

Index	Frequency	DR	Max	Min	On
0	902300000		3	0	1
1	902500000		3	0	1
2	902700000		3	0	1
3	902900000		3	0	1
4	903100000		3	0	1
5	903300000		3	0	1
6	903500000		3	0	1
7	903700000		3	0	1
U	903000000		4	4	1
R2	923300000		8	8	

OK

OK

AT+TXCH=?

AT+TXCH: TABLE

OK

Note the following for US915:

- U : Uplink Channel for DR4:SF8BW500
- R2 : Frequency and datarate for second receive window
- In public mode, R2 defaults to 923.3 DR8

- In private mode, R2 is defaulted by AT+FSB setting 1:923.3,2:923.9,...

### Add EU868 FSK Channel at Index 8

```
AT+TXCH=?
AT+TXCH: <INDEX>,<FREQUENCY>,<DR_RANGE>
```

OK

```
AT+TXCH=8,868800000,77
```

OK

### EU868 Before Join

```
AT+TXCH
Index  Frequency  DR Max Min  On
  0     868100000    5  0   1
  1     868300000    6  0   1
  2     868500000    5  0   1
  3         0         0  0   0
  4         0         0  0   0
  5         0         0  0   0
  6         0         0  0   0
  7         0         0  0   0
  8         0         0  0   0
  9         0         0  0   0
 10         0         0  0   0
 11         0         0  0   0
 12         0         0  0   0
 13         0         0  0   0
 14         0         0  0   0
 15         0         0  0   0
 R2     869525000    0  0
```

OK

### EU868 After Join

```
AT+TXCH
Index  Frequency  DR Max Min  On
  0     868100000    5  0   1
  1     868300000    6  0   1
  2     868500000    5  0   1
  3     866100000    5  0   1
  4     866300000    5  0   1
  5     866500000    5  0   1
```

6	866700000	5	0	1
7	866900000	5	0	1
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
R2	869525000	0	0	

## AT+TXN Transmit Next

Returns the time, in milliseconds, until the next free channel is available to transmit data. The time can range from 0-2793000 milliseconds.

EU868 time to wait may be duty-cycle limit on channel or network imposed Join duty-cycle. US915 will only be affected by the network imposed Join duty-cycle.

Network imposed join duty-cycle in LoRaWAN 1.0.1:

1.0%	0-1 hour
0.1%	1-10 hours
0.01%	10+ hours

### Syntax

Command
AT+TXN
help AT+TXN
AT+TXN?
AT+TXN=?

### Parameters and Values

None

### Command with Response Examples

```
AT+TXN
0
```

OK

```
help AT+TXN
AT+TXN: Get time in ms until next free channel
```

OK

```
AT+TXN?  
0
```

```
OK
```

```
AT+TXN=?  
AT+TXN: (0-2793000)
```

```
OK
```

## AT+TOA Time On Air

Displays the amount of on air time, in milliseconds, required to transmit the number of bytes specified at the current data rate. (Included for informational purposes. )

### Syntax

Command
AT+TOA=<parameter1>
help AT+TOA
AT+TOA?
AT+TOA=?

### Parameters and Values

Parameter1

0-242 The number of bytes used to calculate the time on air.

### Command with Response Examples

```
AT+TOA=128  
738
```

```
OK
```

```
help AT+TOA  
AT+TOA: Get time in ms of packet tx with current datarate
```

```
OK
```

```
AT+TOA?  
Invalid parameter, expects (0-242)
```

```
ERROR
```

```
AT+TOA=?  
AT+TOA: (0-242)
```

```
OK
```

## Configuring

### AT+MAC Inject MAC Command

When used without a parameter the MAC command buffer to be sent with the next packet is displayed. The MAC command buffer can be cleared by passing an argument of '0'. Changes made by MAC commands through this command or made by the server can be saved with AT+SS and restored with AT+RS.

- **LinkADDRReq:** If ADR is enabled, changes device's datarate and power. Changes the channel mask and redundancy regardless of ADR setting.
- **DutyCycleReq:** Sets device's total time on air duty cycle.
- **RxParamSetupReq:** Changes downlink frequency and datarates.
- **DevStatus:** Requests the device's status, battery, and RX packet SNR value.
- **NewChannelReq:** Requests the device to add or delete a channel.
- **RxTimingSetup:** Changes the delay from end of TX to opening of RX1.

#### Syntax

Command
AT+MAC=<parameter1>
help AT+MAC
AT+MAC?
AT+MAC=?

#### Parameters and Values

##### Parameter1

LinkADDRReq	Format: ID (1)   DR_PWR (1)   MASK (2)   CTRL_REP (1)
	Example: 0350FF0001 -> DR: 5 PWR: 0 MASK: FF00 CTRL: 0 REP: 1
	ID                      MAC command ID
	DR                      Datarate index US915 0-4, AU915 0-4, EU868 0-7
	PWR                     Power index US915 0-10, AU915 0-10, EU868 0-5
	MASK                    16 bit mask for enabling channels
	CTRL                    Instructions for applying the 16-bit mask field
	REP                      Redundancy setting to repeat a packet unless downlink is received
DutyCycleReq	Format: ID (1)   MDC (1)
	ID                      MAC command ID
	MDC                    MAX_DUTY_CYCLE (MDC) – duty cycle setting ( 1 / 2^MDC )
	Values:
	0400                    100%
	0401                    50%
	040F                    0.003 %

RxParamSetupReq	Format: ID (1)   DLSettings (1)   Frequency (3) Example: 050468E28C ? RX1O: 0 RX2: 5 FREQ: 923300000 ID                   MAC command ID DLSettings         Datarate offset for RX1 and datarate index for RX2 Frequency          3 bytes of frequency in 100 Hz (LSB)
DevStatus	Format: ID (1) Example: 06 ID                   MAC command ID
NewChannelReq	<b>Note:</b> EU868 only, Channels 0-2 cannot be changed. Format: ID (1)   INDEX (1)   FREQ (3)   RANGE (1) Example: 0703F87D8440 -> INDEX: 3 FREQ: 868300000 RANGE: MAX:4 MIN:0 ID                   MAC command ID INDEX               Channel Index FREQ                Channel frequency in 100 Hz RANGE               Datarate range (MAX:4,MIN:4)
RxTimingSetup	Format: ID (1)   DELAY (1) Example: 0801 ? DELAY: 1 second ID                   MAC command ID Delay               Delay in seconds until RX1

### Command with Response Examples

#### Inject Device Status MAC Command

AT+MAC=06

OK

#### Show MAC Commands Buffer to be Sent in Next Packet

AT+MAC  
06ff00

OK

#### Clear MAC Commands Buffer to be Sent in Next Packet

AT+MAC=0

OK

AT+MAC

OK



**Help**

help AT+MAC

AT+MAC: Inject MAC command to MAC layer or read uplink MAC command buffer, pass '0' argument to clear buffer

OK

**AT&V Settings and Status**

Displays device settings and status in a tabular format.

**Syntax**

Command
AT&V
help AT&V
AT&V=?

**Parameters and Values**

None

**Command with Response Examples**

AT&V

```

Device ID:                00:00:00:00:00:00:00:00
Frequency Band:          FB_915
Frequency Sub Band:      0
Public Network:          off
Start Up Mode:           COMMAND
Network Address:         00000000
Network ID:              2b:7e:15:16:28:ae:d2:a5
Network ID Passphrase:
Network Key:              2b.7e.15.16.28.ae.d2.a6.ab.f7.15.88.09.cf.4f.45
Network Key Passphrase:
Network Session Key:     00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Data Session Key:        00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Network Join Mode:       OTA
Network Join Retries:    2
Preserve Session:        off
Join Byte Order:         LSB
Join Delay:              1

```

App Port:	1
Link Check Threshold:	off
Link Check Count:	off
Error Correction:	1 bytes
ACK Retries:	off
Packet Repeat:	1
Encryption:	on
CRC:	on
Adaptive Data Rate:	off
Command Echo:	on
Verbose Response:	off
Tx Frequency:	0
Tx Data Rate:	DR0 - SF10BW125
Tx Power:	11
Tx Antenna Gain:	3
Tx Wait:	on
Tx Inverted Signal:	off
Rx Delay:	1 s
Rx Inverted Signal:	on
Rx Output Style:	HEXADECIMAL
Debug Baud Rate:	115200
Serial Baud Rate:	115200
Serial Flow Control:	off
Serial Clear On Error:	on
Wake Mode:	INTERVAL
Wake Interval:	10 s
Wake Delay:	100 ms
Wake Timeout:	20 ms
Wake Pin:	DI8
Log Level:	0

OK

help AT&V

AT&V: Displays current settings and status

OK

AT&V=?

AT&V: TABLE

OK

## AT+DC Device Class

Sets the device class. The LoRaWAN 1.0 specification defines the three device classes, Class A, B and C as follows:

**Note:** Currently only Class A and Class C are supported.

- **Class A: Bi-directional End Devices** allow for bi-directional communications where each end device's uplink transmission is followed by two short downlink receive windows. The transmission slot scheduled by the end device is based on its communication needs with a small variation based on a random time basis (ALOHA-type protocol). This Class A operation is the lowest power end device system for applications that only require downlink communication from the server shortly after the end device has sent an uplink transmission. Downlink communications from the server at any other time have to wait until the next scheduled uplink.
- **Class B: Bi-directional end devices with scheduled receive slots** allow for more receive slots. In addition to the Class A random receive windows, Class B devices open extra receive windows at scheduled times. For the end device to open a receive window as scheduled, it must receive a time synchronized beacon from the gateway. This allows the server to know when the end device is listening.
- **Class C: Bi-directional end devices with maximal receive slots** have nearly continuously open receive windows, which close only when transmitting. Class C end devices use more power to operate than Class A or Class B, but they offer the lowest latency for server to end device communication.

### Syntax

Command
AT+DC=<parameter1>
help AT+DC
AT+DC?
AT+DC=?

### Parameters and Values

Parameter1

- |   |  |
|---|--|
| A | Class A device. (Default)                                |
| B | Class B device. (Not supported in Version 2.0 or older.) |
| C | Class C device.  |

### Command with Response Examples

```
AT+DC=A
```

```
OK
```

```
help AT+DC
```

```
AT+DC: Device class (A,B,C)
```

```
OK
```

```
AT+DC=?
```

```
AT+DC: (A,B,C)
```

```
OK
```

### AT+AP Application Port

Sets the port used for application data. Each LoRaWAN packet containing data has an associated port value. Port 0 is reserved for MAC commands, ports 1-223 are available for application use, and port 233-255 are reserved for future LoRaWAN use.

#### Syntax

Command
AT+AP=<parameter1>
help AT+AP
AT+AP?
AT+AP=?

#### Parameters and Values

Parameter1

1-223      The port used for application data.

### Command with Response Examples

```
AT+AP=1
```

```
OK
```

```
HELP AT+AP
```

```
AT+AP: Port used for application data (1 - 223)
```

```
OK
```

```
AT+AP=?
```

```
AT+AP: (1-223)
```

```
OK
```

AT+AP?

1

OK

## AT+TXP Transmit Power

Configures the output power of the radio in dBm, before antenna gain. The mac layer will attempt to reach this output level but limit any transmission to the local regulations for the chosen frequency.

**Note:** Refer to AT+ANT to configure antenna gain.

### Syntax

Command
AT+TXP=<parameter1>
help AT+TXP
AT+TXP?
AT+TXP=?

### Parameters and Values

Parameter1

0-20 dB. (Default is 11).

### Command with Response Examples

AT+TXP=11

OK

help AT+TXP

AT+TXP: Set the Tx power for all channels

OK

AT+TXP?

11

OK

AT+TXP=?

AT+TXP: (0-20)

OK

## AT+TXI Transmit Inverted

Sets TX signal inverted.

**Note:** Transmitted signals are inverted so motes/gateways do not see other mote/gateway packets.

## Syntax

Command
AT+TXI=<parameter1>
help AT+TXI
AT+TXI?
AT+TXI=?

## Parameters and Values

Parameter1

0 Not inverted (Default)

1 Inverted

## Command with Response Examples

AT+TXI=0

OK

help AT+TXI

AT+TXI: Set Tx signal inverted, (default:off)

OK

AT+TXI?

0

OK

AT+TXI=?

AT+TXI: (0,1)

OK

## AT+RXI Receive Signal Inverted

Sets RX signal inverted.

**Note:** Transmitted signals are inverted so motes/gateways do not see other mote/gateway packets.

## Syntax

Command
AT+RXI=<parameter1>
help AT+RXI
AT+RXI?
AT+RXI=?

## Parameters and Values

Parameter1

- 0 Receive signal not inverted
- 1 Receive signal inverted (Default)

## Command with Response Examples

AT+RXI=1

OK

help AT+RXI

AT+RXI: Set Rx signal inverted, (default:on)

OK

AT+RXI?

1

OK

AT+RXI=?

AT+RXI: (0,1)

OK

## AT+RXD Receive Delay

Allows the dot to use non-default rx windows, if required by the network it is attempting to communicate with. Opens receive window to listen for a response when sending packets with one of the +SEND commands.

**Note:** Setting must match that of network server, in case of OTA join the value sent in Join Accept message overwrites this setting.

### Syntax

Command
AT+RXD=<parameter1>
help AT+RXD
AT+RXD?
AT+RXD=?

## Parameters and Values

Parameter1

- 1-15 seconds (Default)

### Command with Response Examples

AT+RXD=1

OK

help AT+RXD

AT+RXD: Number of seconds before receive windows are opened (1 - 15)

OK

AT+RXD?

1

OK

AT+RXD=?

AT+RXD: (0,1)

OK

### AT+FEC Forward Error Correction

Sends redundant data to compensate for unreliable communication with the goal of reducing the need to retransmit data. Increasing redundancy increases time-on-air, LoRaWAN specifies a setting of 1 (4/5).

#### Syntax

Command
AT+FEC=<parameter1>
help AT+FEC
AT+FEC?
AT+FEC=?

#### Parameters and Values

Parameter1

- 1 Sends 5 bits to represent 4 bits.
- 2 Sends 6 bits to represent 4 bits.
- 3 Sends 7 bits to represent 4 bits.
- 4 Sends 8 bits to represent 4 bits.

### Command with Response Examples

AT+FEC=1

OK

help AT+FEC

AT+FEC: Configure Forward Error Correction bytes (1 to 4)



OK

AT+FEC?

1

OK

AT+FEC=?

AT+FEC: (1-4)

OK

## AT+CRC Cyclical Redundancy Check

Enable or disable Cyclical Redundancy Check(CRC) for uplink and downlink packets. Must be enabled to be compliant with LoRaWAN. Packets received with a bad CRC are discarded.

### Syntax

Command
AT+CRC=<parameter1>
help AT+CRC
AT+CRC?
AT+CRC=?

### Parameters and Values

Parameter1

0 CRC disabled

1 CRC enabled (Default)

### Command with Response Examples

AT+CRC=1

OK

help AT+CRC

AT+CRC: Enable/disable CRC (0: off, 1: on)

OK

AT+CRC?

1

OK

AT+CRC=?

AT+CRC: (0,1)

OK

## AT+ADR Adaptive Data Rate

Enable or disable adaptive data rate for your device. For more information on Adaptive Data Rate, refer to your device's Developer Guide.

### Syntax

Command
AT+ADR=<parameter1>
help AT+ADR
AT+ADR?
AT+ADR=?

### Parameters and Values

Parameter1

0 ADR disabled (Default)

1 ADR enabled

### Command with Response Examples

AT+ADR=0

OK

help AT+ADR

AT+ADR: Enable/disable Adaptive Data Rate (0: off, 1: on)

OK

AT+ADR?

0

OK

AT+ADR=?

AT+ADR: (0,1)

OK

## AT+TXDR TX Data Rate

Sets the current data rate to use, DR0-DR15 can be entered as input in addition to (7-12) or (SF\_7-SF\_12). Output has changed as shown in the following table:

From	To
------	----

AT+TXDR SF_12 OK	AT+TXDR DR0 - SF12BW125 OK
------------------------	----------------------------------

**US Data Rates Max Payload (bytes)**

DR0 : 11  
 DR1 : 53  
 DR2 : 129  
 DR3 : 242  
 DR4 : 242

**EU Data Rates Max Payload (bytes)**

DR0 : 51  
 DR1 : 51  
 DR2 : 51  
 DR3 : 115  
 DR4 : 242  
 DR5 : 242  
 DR6 : 242  
 DR7 : 50

**Note:** Data rate is directly related to spreading factor. Spreading factor determines the amount of redundant data spread across the transmission. A higher spreading factor means more redundant data is transmitted, which results in a longer range but a lower data rate. For more information on spreading factor, refer to the device's developer guide

**Syntax**

Command
AT+TXDR=<parameter1>
help AT+TXDR
AT+TXDR?
AT+TXDR=?

**Parameters and Values**

Parameter1

7-10      915MHz Models (Default is 9)  
 7-12      868MHz Models

**Command with Response Examples**

AT+TXDR=9

OK

help AT+TXDR

AT+TXDR: Set the Tx data rate for all channels

OK

```
AT+TXDR?  
DR0 - SF12BW125
```

```
OK
```

```
AT+TXDR=?  
AT+TXDR: (7-10)
```

```
OK
```

## AT+SDR Session Data Rate

Display the current data rate the LoRaMAC layer is using. It can be changed by the network server if ADR is enabled.

### Syntax

Command
AT+SDR
help AT+SDR
AT+SDR?
AT+SDR=?

### Parameters and Values

None

### Command with Response Examples

```
AT+SDR  
DR0
```

```
OK
```

```
help AT+SDR
```

```
OK
```

```
AT+SDR?
```

```
OK
```

```
AT+SNR=?
```

```
OK
```

## AT+REP Repeat Packet

Repeats each frame as many times as indicated or until downlink from network server is received. This setting increases redundancy to increase change of packet to be received by the gateway at the expense of increasing network congestion. When enabled, debug output shows multiple packets being sent. On the Conduit, an MQTT client can listen to the 'packet\_recv' topic to see that duplicate packets are received, but not forwarded to the up topic.

### Syntax

Command
AT+REP=<parameter1>
help AT+REP
AT+REP?
AT+REP=?

### Parameters and Values

Parameter1

0-15          Number of send attempts. (Default)

### Command with Response Examples

AT+REP

0

OK

HELP AT+REP

AT+REP: Configure number of times to repeat a packet

OK

AT+REP?

0

OK

AT+REP=?

AT+REP: (0-15)

OK

## Sending Packets

### AT+SEND Send

Sends supplied data and opens a receive window to receive data from the gateway/network server. If a data packet is received, it is output following AT+SEND. To configure the receive data format, use the AT+RXO command. Although parameter1 can be up to 242 bytes, it is limited by the payload size as determined by +TXDR setting as shown in the following table:

US 915 MHz Device		EU 868MHz Device	
DR0-DR4	Payload Size	DR0-DR7	Payload
DR0	11	DR0	51
DR1	53	DR1	51
DR2	129	DR2	51
DR3	242	DR3	115
DR4	242	DR4	242
		DR5	242
		DR6	242
		DR7	50

+SEND commands response is significantly impacted by the AT+ACK setting. The following table shows the theoretical worst case timing from +SEND to OK or ERROR response using a 915Mhz device. Retransmit delay is random 1-3s delay before a retransmit if an ACK has not been received. Time on air is the amount of time consumed transmitting. Wait for receive is the max time waiting to receive a data packet from the gateway/network server.

**Note:** These are theoretical values. With no response from the network server, the +ACK=0 time has been observed at about 2.5 seconds.

+ACK	Cumulative Retransmit Delay	Cumulative Time on Air (seconds)	Cumulative Wait for Receive (seconds)	Max Response Time (seconds)
0	0	.4	1-2	2.4
1	0	.4	3-4	4.4
2	1-3	.8	5-6	9.8
3	2-6	1.2	7-8	15.2
4	3-9	1.6	9-10	20.6
5	4-12	2	11-12	26
6	5-15	2.4	13-14	31.1
7	6-18	2.8	15-16	36.8
8	7-21	3.2	17-18	42.2

### Syntax

Command
AT+SEND=<parameter1>
help AT+SEND
AT+SEND=?

### Parameters and Values

Parameter1

Up to 242 bytes of data or the maximum payload size based on spreading factor (See AT+TXDR)

### Command with Response Examples

```
AT+SEND=<data to send>
<data received from the gateway/network server>
```

OK

```
AT+SEND <data to send> (the "=" sign is optional)
<data received from the gateway/network server>
```

OK

```
AT+SEND=This is a test with SF10
Data exceeds datarate max payload
```

ERROR

```
AT+SEND (sends an empty packet and opens a receive window)
<data received from the gateway/network server>
```

OK

```
AT+SEND
Network Not Joined
```

ERROR

```
help AT+SEND
AT+SEND: Sends supplied packet data one time and return response, (max:242 bytes)
```

OK

```
AT+SEND=?
AT+SEND: (string:242)
```

OK

### AT+SENDB Send Binary

Functions as the +SEND command, but sends hexadecimal data.

#### Syntax

Command
AT+SENDB=<parameter1>
help AT+SENDB
AT+SENDB=?

## Parameters and Values

Parameter1

String of up to 242 eight bit hexadecimal values. Each value may range from 00 to FF.

## Command with Response Examples

AT+SENDB=6174 (sends the letter a and t)  
<data received from the gateway/network server>

OK

help AT+SENDB

AT+SENDB: Sends supplied binary (hex) packet data one time and return response

OK

AT+SENDB=?

AT+SENDB: (hex:242)

OK

## Receiving Packets

### AT+RECV    Receive Once

Displays the last payload received. It does not initiate reception of new data. Use +SEND to initiate receiving data from the network server.

#### Syntax

Command
AT+RECV
help AT+RECV
AT+RECV=?

## Parameters and Values

None

## Command with Response Examples

AT+RECV  
<last received data payload>

OK

help AT+RECV

AT+RECV: Receive and display one packet.

OK



AT+RECV=?  
 AT+RECV: (string:242) or (hex:242)

OK

## AT+RXO Receive Output

Formats the receive data output. Data is either processed into hexadecimal data or left unprocessed/raw. Hexadecimal outputs the byte values in the response. Raw/Unprocessed outputs the actual bytes on the serial interface.

### Syntax

Command
AT+RXO=<parameter1>
help AT+RXO
AT+RXO?
AT+RXO=?

### Parameters and Values

Parameter1

- 0 Hexadecimal (Default)
- 1 Raw/Unprocessed

### Command with Response Examples

AT+RXO=0

OK

help AT+RXO  
 AT+RXO: Set the Rx output type (0:hexadecimal, 1:raw)

OK

AT+RXO?  
 0

OK

AT+RXO=?  
 AT+RXO: (0,1)

OK

## AT+DP Data Pending

Indicates there is at least one packet pending on the gateway for this end device. This indication is communicated to the end device in any packet coming from the server. Each packet contains a data pending bit.

## Syntax

Command
AT+DP
help AT+DP
AT+DP?
AT+DP=?

## Parameters and Values

None

## Command with Response Examples

AT+DP  
0

OK

help AT+DP  
AT+DP: Indicator of data in queue on server

OK

AT+DP?  
0

OK

AT+DP=?  
AT+DP: (0,1)

OK

## AT+TXW Transmit Wait

Enables or disables waiting for RX windows to expire after sending.

**Note:** Non-blocking operation may disrupt the Dot's ability to receive downlink packets.

## Syntax

Command
AT+TXW=<parameter1>
help AT+TXW
AT+TXW?
AT+TXW=?

## Parameters and Values

Parameter1

- 0 Do not wait. Not recommended.
- 1 Wait (Default)

## Command with Response Examples

AT+TXW=1

OK

help AT+TXW

AT+TXW: Enable/disable waiting for rx windows to expire after send. (0: off, 1: on)

OK

AT+TXW?

1

OK

AT+TXW=?

AT+TXW: (0,1)

OK

## Statistics

### AT&R Reset Statistics

Resets device statistics displayed with the AT&S command.

#### Syntax

Command
AT&R
help AT&R
AT&R=?

## Parameters and Values

None

## Command with Response Examples

AT&R

OK

help AT&R

AT&R: Reset statistics

OK

AT&R=?

AT&R: NONE

OK

## AT&S Statistics

Displays device statistics including join attempts, join failures, packets sent, packets received and missed acks. Use AT&R to reset/clear the statistics.

### Syntax

Command
AT&S
help AT&S
AT&S=?

### Parameters and Values

None

### Command with Response Examples

AT&S

```
Join Attempts:      1
Join Fails:         0
Up Packets:         25
Down Packets:       5
Missed Acks:        0
```

OK

help AT&S

AT&S: Display statistics

OK

AT&S=?

AT&S: TABLE

OK

## AT+RSSI Signal Strength

Displays signal strength information for all packets received from the gateway since the last reset. There are four signal strength values, which, in order, are: last packet RSSI, minimum RSSI, maximum RSSI and average RSSI. Values range from -140dB to 0dB.

### Syntax

Command
AT+RSSI
help AT+RSSI
AT+RSSI?
AT+RSSI=?

### Parameters and Values

None

### Command with Response Examples

```
AT+RSSI
-54, -54, -50, -52
```

OK

```
help AT+RSSI
AT+RSSI: Displays signal strength information for received packets: last, min, max, avg
```

OK

```
AT+RSSI?
0, 0, 0, 0
```

OK

```
AT+RSSI=?
AT+RSSI: (-140-0),(-140-0),(-140-0),(-140-0)
```

OK

## AT+SNR Signal to Noise Ratio

Displays signal to noise ratio for all packets received from the gateway since the last reset. There are four signal to noise ratio values, which, in order, are: last packet SNR, minimum SNR, maximum SNR and average SNR. Values range from -20dBm to 20dBm.

## Syntax

Command
AT+SNR
help AT+SNR
AT+SNR?
AT+SNR=?

## Parameters and Values

None

## Command with Response Examples

```
AT+SNR
2.9, 2.8, 3.0, 2.9
```

OK

```
help AT+SNR
AT+SNR: Display signal to noise ratio of received packets: last, min, max, avg
```

OK

```
AT+SNR?
2.9, 2.8, 3.0, 2.9
```

OK

```
AT+SNR=?
AT+SNR: (-20.0-20.0),(-20.0-20.0),(-20.0-20.0),(-20.0-20.0)
```

OK

## Serial Data Mode

### AT+SD Serial Data Mode

Reads serial data, sends packets, and then sleeps using wake settings. The escape sequence is +++.

- When +++ is received to escape serial data mode all buffer data will be discarded.
- CTS is handled by the serial driver and is relative to its buffer size. When flow control is enabled, see AT&K.
- mDot firmware serial buffer size is 512 bytes.
- If an RX packet requires an ACK or data pending bit is set, an empty packet is sent automatically.

## Syntax

Command
AT+SD
help AT+SD
AT+SD=?

## Parameters and Values

None

## Command with Response Examples

AT+SD

CONNECT

<send data>

<send +++ to escape>

OK

help AT+SD

AT+SD: Enter serial data mode, exit with '+++'

OK

## AT+SMODE Startup Mode

Configures which operation mode the end device powers up in, either AT command mode or serial data mode.

- **AT Command mode:** The end device powers up or resets in command mode. AT commands are used to send and receive data.
- **Serial data mode:** Allows the end device to send and receive data without entering AT commands. Data is sent and received based on wake command settings. This mode requires network join mode to be set for either auto join or peer-to-peer mode. (AT+NJM=2 or 3).

**Note:** To exit serial data mode, reset the end device and input+++ within one second. If the end device responds to AT commands, the +++ was successful. After exiting data mode issue AT+SMODE=0 to disable data mode and AT&W to save the change.

## Syntax

Command
AT+SMODE=<parameter1>
help AT+SMODE
AT+SMODE?
AT+SMODE=?

## Parameters and Values

Parameter1

- 0 AT command mode (Default)
- 1 Serial data mode

### Command with Response Examples

AT+SMODE=0

OK

help AT+SMODE

AT+SMODE: 0: AT command mode, 1: Serial data mode

OK

AT+SMODE?

0

OK

AT+SMODE=?

AT+SMODE: (0,1)

OK

### AT+SDCE Serial Data Clear on Error

Sets the device to either keep or discard data in the serial buffer when an error occurs.

In serial data mode, the dot wakes periodically to received data on the serial pins and transmit out the radio. If the data cannot be sent, this setting indicates the how device handles the buffered data. Data can either be kept in the buffer to be resent until successful or be discarded.

#### Syntax

Command
AT+SDCE=<parameter1>
help AT+SDCE
AT+SDCE?
AT+SDCE=?

#### Parameters and Values

Parameter1

- 0 Data that cannot be sent remains in the serial buffer for later transmission
- 1 Data that cannot be sent is discarded

### Command with Response Examples

AT+SDCE

1



OK

help AT+SDCE

AT+SDCE: Serial clear on error if enabled data that cannot be sent will be discarded

OK

AT+SDCE?

1

OK

AT+SDCE=?

AT+SDCE: (0:off,1:on)

OK

# Chapter 5 Power Management

## AT+SLEEP Sleep Mode

Puts the end device in sleep mode. The end device wakes on interrupt or interval based on AT+WM setting. Once awakened, use AT+SLEEP again to return to sleep mode.

**Note:** Deep sleep is only available for xDot devices.

### Syntax

Command
AT+SLEEP=<parameter1>
help AT+SLEEP
AT+SLEEP=?

### Parameters and Values

Parameter1

- 0 Deep sleep (ST Micro standby mode)
- 1 Sleep (ST Micro stop mode )

### Command with Response Examples

AT+SLEEP

AT+SLEEP=0

AT+SLEEP=1

help AT+SLEEP

AT+SLEEP: Enter sleep mode

OK

AT+SLEEP=?

AT+SLEEP: NONE

OK

## AT+WM Wake Mode

Configures the end device to wake from sleep mode either on a time interval (set by AT+WI) or by an interrupt. For details on interval mode, refer to +WI. For details on interrupt mode, refer to +WP.

## Syntax

Command
AT+WM=<parameter1>
help AT+WM
AT+WM?
AT+WM=?

## Parameters and Values

Parameter1

- 0 Wake on interval. (Default)
- 1 Wake on interrupt

## Command with Response Examples

AT+WM=0

OK

help AT+WM

AT+WM: Wakeup mode, INTERRUPT uses DIO7 as wake-up pin (0:INTERVAL,1:INTERRUPT)

OK

AT+WM?

0

OK

AT+WM=?

AT+WM: (0:INTERVAL,1:INTERRUPT)

OK

## AT+WI Wake Interval

When using wake mode set to interval, use this command to configure the number of seconds the end device sleeps when in sleep mode. Upon waking, it waits +WD amount of time for an initial character then +WTO amount of time for each additional character.

## Syntax

Command
AT+WI=<parameter1>
help AT+WI
AT+WI?

**Command**

AT+WI=?

**Parameters and Values**

Parameter1

2-2147483647 seconds (Default is 2)

**Command with Response Examples**

AT+WI=10

OK

help AT+WI

AT+WI: Wakeup interval (seconds)

OK

AT+WI?

10

OK

AT+WI=?

AT+WI: (2-2147483647) s

OK

**AT+WD Wake Delay**

Configures the maximum amount of time to wait for data when the device wakes up from sleep mode. If this timer expires, the device goes back to sleep. If the device received at least one character before this timer expires, the device continues to read input until either the payload is reached or the +WTO timer expires at which time it sends the collected data and goes to sleep.

**Syntax****Command**

AT+WD=&lt;parameter1&gt;

help AT+WD

AT+WD?

AT+WD=?

**Parameters and Values**

Parameter1

2-2147483647 milliseconds (Default is 100)

## Command with Response Examples

AT+WD=100

OK

help AT+WD

AT+WD: Time to wait for data after wakeup signal (milliseconds)

OK

AT+WD?

100

OK

AT+WD=?

AT+WD: (2-2147483647) ms

OK

## AT+WTO Wake Timeout

Configures the amount of time that the device waits for subsequent characters following the first character received upon waking. Once this timer expires, the collected data is sent and the end device goes back to sleep.

### Syntax

Command
AT+WTO=<parameter1>
help AT+WTO
AT+WTO?
AT+WTO=?

### Parameters and Values

Parameter1

0-65000 milliseconds (Default is 20)

## Command with Response Examples

AT+WTO=20

OK

help AT+WTO

AT+WTO: Read serial data until timeout (milliseconds)

OK

```
AT+WTO?  
20
```

```
OK
```

```
AT+WTO=?  
AT+WTO: (0-65000) ms
```

```
OK
```

## AT+ANT    Antenna Gain

Allows a non-default antenna to be used while still adhering to transmit power regulations.

### Syntax

Command
AT+ANT=<parameter1>
help AT+ANT
AT+ANT?
AT+ANT=?

### Parameters and Values

Parameter1

-128 to 127 (Default is 3)

### Command with Response Examples

```
AT+ANT=3
```

```
OK
```

```
help AT+ANT  
AT+ANT: Gain in dBi of installed antenna (-128-127)
```

```
OK
```

```
AT+ANT?  
3
```

```
OK
```

```
AT+ANT=?  
AT+ANT: (-128-127)
```

```
OK
```

# Chapter 6 Testing and Compliance

## AT+RXDR Receive Data Rate

Sets the receive data rate. Used to configure the receive data rate that AT+RECV uses for receiving packets.

**Note:** This command is used for compliance testing. It is not intended for the typical end user.

### Syntax

Command
AT+RXDR=<parameter1>
help AT+RXDR
AT+RXDR?
AT+RXDR=?

### Parameters and Values

Parameter1

7-10 915MHz model (Default is 9)

7-12 868MHz model

### Command with Response Examples

AT+RXDR=9

OK

help AT+RXDR

AT+RXDR: Set the Rx data rate

OK

AT+RXDR?

SF\_9

OK

AT+RXDR=?

AT+RXDR: (7-10)

OK

### EU 868MHz

AT+RXDR?

SF\_12

## AT+RXF Receive Frequency

Configures the frequency that +RECV listens to for received packets.

**Note:** This command is used for compliance testing. It is not intended for the typical end user.

### Syntax

Command
AT+RXF=<parameter1>
help AT+RXF
AT+RXF?
AT+RXF=?

### Parameters and Values

Parameter1

0

902000000-928000000 (Default is 903700000)

### Command with Response Examples

```
AT+RXF=902123456
```

```
OK
```

```
help AT+RXF
```

```
AT+RXF: Set the Rx frequency for +RECV,+RECV
```

```
OK
```

```
AT+RXF?
```

```
902123456
```

```
OK
```

```
AT+RXF=?
```

```
AT+RXF: (0,902000000-928000000)
```

```
OK
```

## AT+RECV Receive Continuously

Causes the device to receive packets continuously on the frequency configured via AT+RXF and at the data rate configured via AT+RXDR. Use +++ to exit this mode. It can take many seconds to get an OK following +++.

**Note:** This command is used for compliance testing. It is not intended for the typical end user.



## Syntax

Command
AT+RECV
help AT+RECV
AT+RECV?
AT+RECV=?

## Parameters and Values

None

## Command with Response Examples

AT+RECV

OK

help AT+RECV

AT+RECV: Continuously receive and display packets. (escape sequence: +++)

OK

AT+RECV=?

AT+RECV: out: (string:242) or (hex:242)

OK

## AT+SENDI Send on Interval

Functions the same as the +SEND command, except that it takes an additional parameter as the interval then continually sends and receives on that interval. Issue +++ to stop sending.

**Note:** This command is used for compliance testing. It is not intended for the typical end user.

## Syntax

Command
AT+SENDI=<parameter1>, <parameter2>
help AT+SENDI
AT+SENDI=?

## Parameters and Values

Parameter1

100-2147483647 milliseconds

Parameter

Up to 242 bytes of data or the max payload size based on the spreading factor (see AT+TXDR)

## Command with Response Examples

```
AT+SENDI=1000,<data to send>
<data received from the gateway/network server>
```

OK

```
AT+SENDI
Invalid arguments
```

ERROR

```
help AT+SENDI
AT+SENDI: Sends supplied packet data on interval between sends, output any received packets (escape
sequence: +++)
```

OK

```
AT+SENDI=?
AT+SENDI: (100-2147483647) ms,(string:242)
```

OK

## AT+TXF Transmit Frequency

Set Tx frequency used in Peer-to-Peer mode. To avoid interference with LoRaWAN networks, use 915.5-919.7 MHz for US 915 devices and a fixed 869.85 MHz for EU 868 devices.

**Note:** The parameter ranges below are used for compliance testing and are not intended for the typical end user.

### Syntax

Command
AT+TXF=<parameter1>
help AT+TXF
AT+TXF?
AT+TXF=?

### Parameters and Values

Parameter1

US915 - (0,902000000-928000000)

EU868 - (0,863000000-870000000)

## Command with Response Examples

AT+TXF=902123456

OK

help AT+TXF

AT+TXF: Set Tx frequency

OK

AT+TXF?

902123456

OK

## US 915MHz

AT+TXF=?

AT+TXF: (0,902000000-928000000)

OK

## EU 868 MHz

AT+TXF=?

AT+TXF: (0,863000000-870000000)

OK

## Chapter 7 Examples

---

### Network Configuration and Joining

Configure Network ID and Network Key with either a hexadecimal value or name/passphrase.

- To configure with a hexadecimal value, provide a first argument of 0:  
AT+NI=0,0011223344556677

OK

AT+NK=0,00112233445566770011223344556677

OK

- To configure with a name/passphrase value provide a first argument of 1:  
AT+NI=1,MTS-LORA-1

OK

AT+NK=1,MTS-LORA-PASSPHRASE

OK

### US 915MHz - Frequency Sub-band

Before joining to a Conduit in the US, set the frequency sub-band to join using the frequencies the Conduit is configured to listen on.

To configure the frequency sub-band:

AT+FSB=5

OK

## Join Mode

The Dot supports both OTA and manual provisioning or joining. See *OTA Activation* in *Chapter 3 Network Management*.

- To configure for OTA join mode and connect to the network:  
AT+NJM=1  
  
OK  
  
AT+JOIN  
  
OK
- To configure for AUTO OTA join mode and connect to the network, if you are not already joined, a join attempt will be made:  
AT+NJM=2  
  
OK  
  
Joining Network... Network Joined  
  
OK
- To configure for MANUAL provisioning, change the mode, then set the network address and session keys:  
AT+NJM=0  
  
OK  
  
AT+NA=0011223344556677  
  
OK  
  
AT+DSK=00112233445566770011223344556677  
  
OK  
  
AT+NSK=00112233445566770011223344556677  
  
OK

## Ensuring Network Connectivity

To ensure the Dot is still connected to the network, request a response from the server. One method is to require ACKs for each packet, but under a heavy load, the server may not be able to respond to every packet. The other option is to periodically require an ACK using AT+LCC, this maintains join status without overburdening the network server. In the following examples, the gateway is powered off to simulate network loss. Refer to *Ensuring Network Connectivity* in *Chapter 3 Network Management*.

- Using acknowledgments to detect network loss requires a response for each packet. With a threshold set to one, the network is no longer joined after only one lost packet. Increasing the LCT value allows some missed packets without the need to rejoin the network. If AUTO\_OTA is enabled the device automatically attempts to rejoin after network is lost.

[Gateway Powered On]  
AT+JOIN

Successfully joined network

OK  
AT+ACK=1

OK  
AT+LCT=1

OK  
AT+SEND=message

OK  
[Gateway Powered Off]  
AT+NJS  
1

OK  
AT+SEND=message  
Operation Timed Out - ACK not received

OK  
AT+NJS  
0  
OK

- When using link checks to detect network loss, you can configure how many responses are required. With a threshold set to one, the network is no longer joined after only one lost packet. Increasing the LCT value allows some missed packets without the need to rejoin the network. If AUTO\_OTA is enabled the device automatically attempts to rejoin after network is lost.

[Gateway Powered On]  
AT+JOIN  
Successfully joined network

OK  
AT+LCC=2

OK  
AT+LCT=1

OK  
AT+SEND=message

OK  
[Gateway Powered Off]  
AT+SEND=message

OK  
AT+NJS

```
1
OK
AT+SEND=message
Network Not Joined

ERROR
AT+NJS
0
OK
```

## Serial Mode

Configure the device to wake periodically or on interrupt, wait for data on serial port, send data out, and go back to sleep. Refer to *Chapter 5, Power Management* for more information.

- Configure the device to wake up after 10 seconds of sleep and send data from the serial port:

```
AT+WM=0

OK
AT+WI=10

OK
AT+WD=100

OK
AT+WTO=20

OK
AT+SMODE=1

OK
AT&W

OK
ATZ

OK
```

Device resets into Serial Mode.

## Peer to Peer

mDots using 1.0.8 AT Firmware or Library can be configured for Peer to Peer communication. To allow communication between mDots, configure two or more mDots with the same network settings. Enabling ACKs guarantees packet delivery; however, this may disrupt higher level protocols such as zmodem or ymodem file transfers. Communication between mDots is half-duplex, so both ends should not transmit at the same time or communication will be disrupted.

The frequency can be set for US 915 models. We advise using 915.5-919.7 to avoid interference with LoRa Networks.

For Europe 868 models, use a fixed frequency, 869.85, with 7 dBm power setting to allow 100% duty-cycle usage.

### Configuration

This example sets up each side with identical settings and starts serial data mode. Then, text can be entered into a terminal on either side and it will show as received on the other mDot.

```

AT+NJM=3
AT+NA=00112233
AT+NSK=00112233001122330011223300112233
AT+DSK=33221100332211003322110033221100
AT+TXDR=DR8 (US:DR8-DR13,EU:DR0-DR6)
AT+TXF=915500000 (US-ONLY:915.5-919.7)
AT&W
ATZ
AT+SD
    
```

### Peer-to-Peer Throughput

