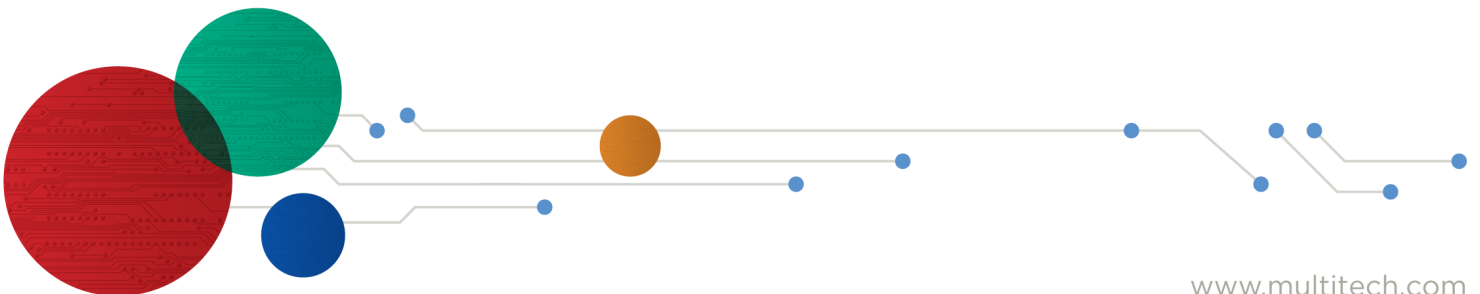


DOT Series

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 3.0

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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/downloads/#xdot>

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"> ■ 868,100,000Hz ■ 868,300,000Hz ■ 868,500,000Hz |
| 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.c
                    f.4f.45
```


Network Key Passphrase:

| | |
|------------------------|---|
| Network Session Key: | 00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00 |
| Data Session Key: | 00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00 |
| 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
00:80:00:00:00:00:00:06
```

OK

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

OK

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

OK

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

OK

AT+DFREQ Default Frequency Band

Use to query the factory default frequency band/channel plan. This is not configurable. It is either 915MHz or 868MHz.

Syntax

| Command |
|---------------|
| help AT+DFREQ |
| AT+DFREQ? |

Parameters and Values

None

Command with Response Examples

```
help AT+DFREQ=?
```

```
AT+DFREQ: (NONE,US915,AU915,EU868,AS923,KR920,AS923-JAPAN)
```

```
OK
```

```
AT+DFREQ?
```

```
US915
```

```
OK
```

```
AT+DFREQ?
```

```
EU868
```

```
OK
```

```
AT+DFREQ?
```

```
EU868
```

```
OK
```

```
AT+DFREQ?
```

```
AU915
```

```
OK
```

```
AT+DFREQ?
```

```
AS923
```

```
OK
```

```
AT+DFREQ?
```

```
KR920
```

```
OK
```

```
AT+DFREQ?
```

```
AS923-JAPAN
```

```
OK
```

```
AT+DFREQ?  
NONE
```

```
OK
```

This information also appears in the AT&V results.

AT+FREQ Frequency Band

Use to query the current 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  
US915
```

```
OK
```

```
AT+FREQ  
KR920
```

```
OK
```

```
help AT+FREQ
```

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

```
OK
```

```
AT+FREQ?  
US915
```

```
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 |
| 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>

| Command |
|------------|
| 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=1) sets the SyncWord to 0x34 and uses join rx windows of 5/6 seconds.
Downlink channel is (uplink_channel modulo 8)

OK

Private Hybrid Mode Example

```
AT+FSB=(1 - 8)
```

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

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 to 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 count of gateways reporting the link-check request to the network server.

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:Packets (max 255))

OK

AT+LCT Link Check Threshold

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.

Note: Europe 868 MHz deployments have a 1% duty cycle, meaning your devices can be on air only 1% of the time per hour. This limitation is part of the European radiated emission requirements and cannot be avoided or changed. Sending more data than the air time allows results in a transmit error - no free channel debug notice.

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

| | |
|--------|--|
| 0,000F | 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+LBT Listen Before Talk

Enables or disables the Listen Before Talk function.

Syntax

| Command |
|----------------------------------|
| AT+LBT=<parameter1>,<parameter2> |
| help AT+LBT |
| AT+LBT? |
| AT+LBT=? |

Parameters and Values

Parameter1

| | |
|---------|---|
| 0 | Disable |
| 0-65535 | Time for the listen before talk delay in microseconds (μ s). |

Parameter2

| | |
|--------------|-----------|
| 0 | Disable |
| -127-128 dBm | Threshold |

Command with Response Examples

```
AT+LBT=?
AT+LBT: time(0-65535 us),threshold(-127-128 dBm) (0,0: disable,
time,threshold: enable)
```

OK

Get current LBT configuration: 0,0 means it is disabled:

AT+LBT
0,0

OK

Set LBT to -65dB threshold and 5ms sample time:

$$AT + LBT = 5000, -65$$

OK

Verify configuration:

```
AT+LBT
5000,-65
```

```
OK
```

These settings also appear in the AT&V results.

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 ($1 / 2^{\text{MDC}}$) |
| | 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 | Note: 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. |
| C | Class C device.(Not supported in Version 2.0 or older.) |

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> |

| Command |
|-------------|
| 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 |

| US 915 MHz Device | | EU 868MHz Device | |
|-------------------|-----|------------------|-----|
| 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 not available for mDot devices.

Deep Sleep (ST Micro standby mode) is the lowest power mode. All RAM is lost and peripherals are off. You can use backup registers to retain the state over sleep. The dot library keeps the running state in the backup registers to be reloaded automatically to maintain the session. Execution begins at the start of the program as it would from power up.

Sleep (ST Micro stop mode) maintains RAM and keeps peripherals on. Execution resumes from the call to sleep.

If you need to wake the device at a specific 1 msec timing, take the following values into account.

- Waking from Deep Sleep takes 314-407 usec
- Waking from Sleep takes 13-14 usec
- RTC period is 30.5 usec

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? |
| AT+WI=? |

Parameters and Values

Parameter1

2-2147483647 seconds (Default is 10)

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=<parameter1> |
| help AT+WD |
| AT+WD? |

Command

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

Parameter2

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

