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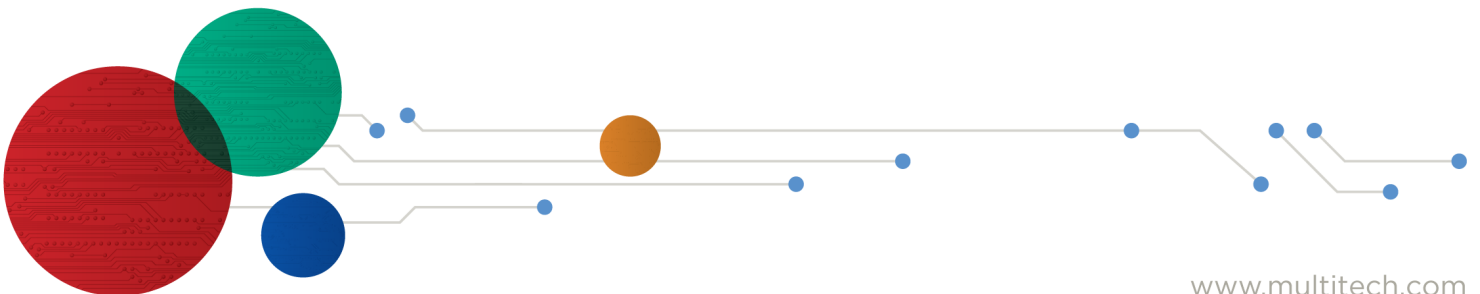
xDot®

AT Command Reference Guide

xDot® AT Command Guide

Models: MTXDOT-xxx

Part Number: S000768, Version 4.1

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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 and higher. 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
```

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 ■ 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

Parameters and Values

 None

Command with Response Examples

```
AT

OK
```

ATI   Request ID

Request ID returns product and software identification information.

Syntax

Command
ATI

Parameters and Values

 None

Command with Response Examples

```
ATI

MultiTech mDot
Firmware : 3.2.0-mbed51101
Library  : 3.2.0-mbed51101
MTS-Lora : 3.2.0-mbed51101
```

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

Parameters and values

None

Command with Response Examples

```
ATZ

OK
```

ATE0/1   Echo Mode

Enable or disable command mode echo.

Syntax

Command
ATE=<parameter1>

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>

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>

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
```

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

Parameters and Values

None

Command with Response Examples

```
AT&F

OK
```

Example US 915MHz

```
AT&F

OK
```

Example EU 868MHz

```
AT&F

OK
```

AT+LW   LoRaWAN Version

Shows support LoRaWAN MAC version.

Syntax

Command
AT+LW

Parameters and Values

None

Command with Response Examples

```
AT+LW
1.0.4

OK
```

AT+FOTA   Firmware over the Air

With FOTA enabled, the Conduit initiates the FOTA session. The Dot device responds to downlink messages automatically as needed. When the FOTA session is complete, the Dot device updates if the firmware successfully transferred, or deletes the FOTA session if the firmware transfer failed.

Note: xDot requires an external flash component in order for FOTA to work.

When you deploy Release 4.0 on an xDot, FOTA will be enabled by default.

Use this command to query the FOTA state and enable/disable/reset FOTA.

Syntax

Command
AT+FOTA=<parameter1>
AT+FOTA?

Parameters and Values

Parameter1

0	Disable FOTA
1	Enable FOTA (Default)
2	Reset FOTA
3	Multicast session information.

Command with Response Examples

```
AT+FOTA=1

OK


AT+FOTA=3
0 (0 seconds until session or multicast session in progress)

OK


AT+FOTA=3
-1 (No multicast session scheduled or in progress)

OK


AT+FOTA=3
23521 (23521 seconds until multicast session)

OK
```

AT&W   Save Configuration

Writes configuration settings to flash memory.

Syntax

Command
AT&W

Parameters and Values

 None

Command with Response Examples

```
AT&W

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 when the next trigger event is detected on the wake pin: a positive going edge (rising trigger), negative going edge (falling trigger), or either (any trigger). Upon waking, it waits +WD amount of time for an initial character then +WTO amount of time for each additional character. Both mode (no pull, pullup, or pulldown) and trigger parameters (any, rise, and fall) can also be set.

Syntax

Command
AT+WP=<parameter1>, <parameter2>, <parameter3>
AT+WP?

Parameters and Values

xDot

Parameter1 (Pin)

1	UART1_RX
2	GPIO0
3	GPIO1
4	GPIO2
5	GPIO3
6	WAKE

Parameter2 (mode)

0	NOPULL
1	PULLUP
2	PULLDOWN

Parameter3 (trigger)

0	ANY
1	RISE
2	FALL

Command with Response Examples

```
AT+WP?
DI8,NOPULL,ANY

OK
AT+WP=8,1,2 1
```

```
OK
AT+WP?
DI8,PULLUP,FALL

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>
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

AT+IPR?
115200

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>
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

AT+DIPR?
115200

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>

Command
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

AT+LOG?
0

OK
```

AT+PP   Ping Slot Periodicity

Set the Class B ping slot periodicity as number of pings per interval up to 128 seconds, 2 ^ (7 - periodicity).

Syntax

Command
AT+PP=<parameter1>
AT+PP?

Parameters and Values

Parameter1

Value	How often the end device opens a ping slot during the beacon_window interval.
0	Approximately every second.
1	Every 2 seconds.
2	Every 4 seconds.
3	Every 8 seconds.

4	Every 16 seconds.
5	Every 32 seconds.
6	Every 64 seconds.
7	Every 128 seconds, which is the maximum ping period supported by the LoRaWAN Class B specification.

Command with Response Examples

```
AT+PP=7

OK
```

AT+GPSTIME   GPS Time

Use this to retrieve GPC synchronized time in milliseconds.

Syntax

Command
AT+GPSTIME
AT+GPSTIME?

Parameters and Values

 None

Command with Response Examples

```
AT+GPSTIME
1233592440906

OK
```

AT+BLS   Beacon Lock Status

Indicates if the beacon is locked or unlocked. A Class B end-device will start as Class A and attempt to acquire a Beacon signal from the network before opening synchronized Rx windows. Once AT+BLS returns 1 to note that a beacon has been locked, the end-device must send an uplink to notify the network that it is ready to receive downlinks in the Class B windows.

- 0 - Not locked
- 1 - Locked

Syntax

Command
AT+BLS

Parameters and Values

None

Command with Response Examples (for setup of a Class B device)

```
AT+DC
A

OK
AT+DC=B

OK

AT+BLS
0

OK

OK
AT+BLS
1

OK
AT+DC
B

OK
AT+SEND

OK
<<< Packets can not be received in Class B windows >>>
```

AT+BAT   Battery Level

Sets battery level descriptor.

Syntax

Command
AT+BAT
AT+BAT?

Parameters and Values

Parameter1

0 - 255   Maximum is 255

Command with Response Examples

```
AT+BAT
255

OK

AT+BAT=123

OK

AT+BAT
123

OK
```

AT+MEM   Available RAM

Shows available RAM.

Syntax

Command
AT+MEM

Parameters and Values

 None

Command with Response Examples

```
AT+MEM
114704 bytes

OK
```

AT+ERASE   Erase Flash Storage

Erase some areas of storage (in most cases, related to flash storage).

Option available to erase the area of external flash used for FOTA (if present) **OR** configuration in EEPROM.

Syntax

Command
AT+ERASE=<parameter1>
AT+ERASE?

Parameters and Values

 Parameter1

1   Erase the area of external flash used for FOTA if present

2   Erase the configuration on the EEPROM

Command with Response Examples

```
AT+ERASE=1

OK

AT+ERASE=2

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 and also change the device EUI.

Syntax

Command
AT+DI
AT+DI=<parameter 1>

Parameters and Values

Parameter 1	Device EUI-64, hex: 8

Command with Response Examples

```
AT+DI
00-80-00-00-00-00-00-06

OK

AT+DI=00-80-00-00-00-01-58-35
00-80-00-00-00-01-58-35
Change the Device EUI

OK
```

AT+DFREQ   Default Frequency Band

Use to query or set the protected factory default frequency band/channel plan. Selections include: NONE, US915, AU915, EU868, AS923, AS923-2, AS923-3, AS923-4, KR920, AS923-JAPAN, IN865, or RU864.

Syntax

Command
AT+DFREQ?
AT+DFREQ=<parameter 1>

Parameters and Values

Parameter 1	(NONE, US915, AU915, EU868, AS923, AS923-2, AS923-3, AS923-4 ,KR920 ,AS923-JAPAN ,IN865 ,RU864)

Command with Response Examples

```
AT+DFREQ?
US915

OK

AT+DFREQ=EU868

OK

AT+DFREQ?
EU868

OK
```

AT+FREQ   Frequency Band

Use to query the current frequency band. This is not configurable. It depends on the channel plan.

Syntax

Command
AT+FREQ
AT+FREQ?

Parameters and Values

None

Command with Response Examples

```
AT+FREQ
US915

OK
```

```
AT+FREQ
KR920

OK

AT+FREQ?
US915

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 or 2)

AT+FSB	Uplink Channels	Downlink channels on Rx1
1	902.3-903.7 - 125k	
2	903.9-905.3 - 125k	
3	905.5-906.9 - 125k	
4	907.1-908.5 - 125k	923.3-927.5 - 500kHz
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>
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

AT+FSB?
0

OK
```

AT+PN   Public Network Mode

In firmware Version 3.1, a private MTS network feature was added to this command. Parameter values changed to values listed in Parameters.

Configures the end device to function on a public or private LoRaWAN network or a private MTS network. When either public or private LoRaWAN network is enabled, the device functions as a LoRaWAN device as specified in LoRa Alliance documentation.

Private MTS Network

When you enable Private MTS mode, the device operates on a private network with the following modifications adjusted for the local network server available on the Conduit:

- Syncword 0x12 is used
- Select downlink frequencies for US915/AU915 using UPLINK-CHANNEL / 8. For example, an uplink using channel 34 would be responded to in Rx1 on 500 kHz Channel 4.
- Join Delay settings are independently configurable with the AT+JD command (refer to AT+JD).
- Private MTS default Join windows open at 0.5 seconds after transmission ends for OTA.
- Rx1 and Rx2 windows are fixed to each AT+FSB setting (refer to AT+FSB).

LoRaWAN Public

This is the default setting.

- Syncword 0x34 is used.

- Select downlink frequencies for US915/AU915 using UPLINK-CHANNEL % 8. For example, an uplink using channel 34 would be responded to in Rx1 on 500 kHz Channel 2.
- Join Delay settings are independently configurable with the AT+JD command (refer to AT+JD). LoRaWAN Join windows open at the default 5/6 seconds after end of transmission for OTA
- Set AT+FSB=1-8 to enable hybrid functionality (refer to AT+FSB).

LoRaWAN Private

- Syncword 0x12 is used.
- Select downlink frequencies for US915/AU915 using UPLINK-CHANNEL % 8. For example, an uplink using channel 34 would be responded to in Rx1 on 500 kHz Channel 2.
- Join Delay settings are independently configurable with the AT+JD command (refer to AT+JD). LoRaWAN Join windows open at the default 5/6 seconds after end of transmission for OTA
- Set AT+FSB=1-8 to enable hybrid functionality (refer to AT+FSB).

Syntax

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

Parameters and Values

Parameter1

0	Private MTS network mode
1	Public LoRaWAN network mode. (Default)
2	Private LoRaWAN network mode.

Command with Response Examples

```
AT+PN=0

OK
```

Public/Private LoRaWAN Mode Example

```
US 64 channel
AT+FSB=0
(AT+PN=1) sets the SyncWord to 0x34
(AT+PN=2) sets the SyncWord to 0x12
(AT+JD=5) sets Join Delay to 5 seconds
Downlink channel is (uplink_channel modulo 8)
OK
```

Public/Private LoRaWAN Hybrid Mode Example

```
US 8 channel
AT+FSB=(1 - 8)
(AT+PN=1) sets the SyncWord to 0x34
```

```
(AT+PN=2) sets the SyncWord to 0x12
(AT+JD=5) sets Join Delay to 5 seconds
Downlink channel is (uplink_channel modulo 8)
OK
```

Private MTS Hybrid Mode Example

```
AT+FSB=(1 - 8)
(AT+PN=0) sets the SyncWord to 0x12
(AT+JD=1) sets Join Delay to 1 seconds
Downlink channel is (uplink_channel / 8)
OK
```

AT+JBO   Join Byte Order

Deprecated

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>
AT+JBO?

Parameters and Values

Parameter1

0   LSB first (Default)

1   MSB first

Command with Response Examples

```
AT+JBO=0

OK

AT+JBO?
0

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>
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

AT+NJM?
1

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

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
```

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>
AT+JR?

Parameters and Values

Parameter1

0   Disable

1-255   Seconds enabled (Default is 2)

Command with Response Examples

```
AT+JR=5

OK

AT+JR?
5

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>
AT+JD?

Parameters and Values

Parameter1

        1-15 seconds (Default is 5)

Command with Response Examples

```
AT+JD=1

OK

AT+JD?
1

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, or AppEUI/Join EUI. (App EUI in LoRaMac.) If AppEUI/JoinEUI is set then this value will be used as the default AT+NI setting when AT&F is issued.

Syntax

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

Parameters and Values

Parameter1

0   Second parameter is a hex key.

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

2   Second parameter is a hex key (set the AppEUI/JoinEUI).

Parameter2

16 bytes of hex data.

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

AT+NI=2,cd-d7-15-e5-2b-dd-a6-27
Set Protected AppEUI: cd-d7-15-e5-2b-dd-a6-27
```

```
OK

AT+NI?
61-63-4d-b3-8a-2b-86-22
Passphrase: 'This string can be up to 128 characters long.'

OK
```

AT+NK   Network Key

Configures network key/passphrase. (App key in LoRaMac). Also, you can set the default AppKey, and if set, this will be used as the default AT+NK setting when AT&F is issued.

Syntax

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

Parameters and Values

Parameter1

0   Second parameter is a hex key.

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

2   Second parameter is a hex key (set default AppKey).

Parameter2

  16 bytes of hex data.

  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

AT+NK=2,bc.0b.bb.99.9b.17.4c.36.38.8c.0f.cf.ea.68.f3.f8
Set Protected AppKey: bc.0b.bb.99.9b.17.4c.36.38.8c.0f.cf.ea.68.f3.f8
```

```
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
```

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. (Supports modifying 8 multicast sessions, which can be saved and restored using AT+SS/AT+RS).

Note: There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

Syntax

Command
AT+NA=<parameter1>,<parameter2>
AT+NA=<parameter1>,?

Parameters and Values

Parameter1

> For unicast: 4 bytes of hex data **OR** For multicast: Number of Multicast session [1-8]

Parameter2

> For multicast only: 4 bytes of hex data.

Command with Response Examples

```
AT+NA= 1,01:fa:b0:1c
Set Network Address: 01:fa:b0:1c

OK

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

OK
```

AT+NSK   Network Session Key

Sets network session key in MANUAL join mode, will be automatically set in OTA modes. Also supports modifying multicast sessions.

Note: There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

Syntax

Command
AT+NSK=<parameter1>, <parameter2>
AT+NSK=<parameter1>,?

Parameters and Values

Parameter1

    For unicast, 16 bytes of hex data **OR** For multicast, Number of Mulitcast session [1-8].

Parameter2

    For multicast only, 16 bytes of hex data.

Command with Response Examples

```
AT+NSK=1,00:11:22:33:44:55:66:77:88:99: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

AT+NSK=1,?
00.11.22.33.44.55.66.77.88.99.aa.bb.cc.dd.ee.ff

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. Supports modifying multicast sessions.

Note: There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

Syntax

Command
AT+DSK=<parameter1>, <parameter2>
AT+DSK=<parameter1>, ?

Parameters and Values

Parameter1

For unicast, 16 bytes of hex data **OR** for multicast, Number of Multicast session [1-8]

Parameter2

For multicast only, 16 bytes of hex data.

Command with Response Examples

```
AT+DSK=1,FF:EE:DD:CC:BB:AA:99:88:77:66:55:44:33:22:11:00
Set Multicast Application Session Key 1:
ff.ee.dd.cc.bb.aa.99.88.77.66.55.44.33.22.11.00

OK

AT+DSK=1,?
ff.ee.dd.cc.bb.aa.99.88.77.66.55.44.33.22.11.00

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>
AT+ULC?

Parameters and Values

Parameter1

0-4294967295 (Default is 1).

Command with Response Examples

```
AT+ULC=1

OK

AT+ULC?
1

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. Also, supports modifying multicast sessions.

Note: There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

Syntax

Command
AT+DLC=<parameter1>,<parameter2>
AT+DLC=<parameter1>,?

Parameters and Values

Parameter1

> For Unicast, Value of the Downlink Counter, a 32-bit unassigned integer with a range of 0-4294967295 (Default is 1) **OR** For Multicast, Number of the Multicast session [1-8].

Parameter2

> For Multicast only, Value of the Downlink Counter, a 32-bit unassigned integer with a range of 0-4294967295 (Default is 1).

Command with Response Examples

```
AT+DLC=1,1
Sets the downlink counter of session #1
OK

AT+DLC=1,?
1

OK


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

OK

AT+DLC=?
AT+DLC: (0-4294967295) or (1-8),(0-4294967295)

OK
```

AT+GK Generic App Key

Set generic app key for multicast McKEKey derivation.

Syntax

Command
AT+GK
AT+GK=<parameter 1>

Parameters and Values

Parameter1

Gen App Key   (hex:16)

Command with Response Examples

```
AT+GK
00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00

OK

AT+GK=bc.0b.bb.99.9b.17.4c.36.38.8c.0f.cf.ea.68.f3.f8
Set Gen App Key: bc.0b.bb.99.9b.17.4c.36.38.8c.0f.cf.ea.68.f3.f8

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. Join status is also available on Associate Pin (mDot:A2, xDot:GPIO0).

Syntax

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

Parameters and Values

Parameter1

0	Not joined.
1	Joined

Command with Response Examples

```
AT+NJS
0

OK

AT+NJS?
0

OK
```

Pin Ouput

Join status is also available on Associate Pin (mDot:A2, xDot:GPIO0).

AT+JN   Join Nonces

Sets OTA Join Nonce. Join Dev Nonce increments with each Join Request sent. Join App Nonce is validated to increment with each Join Accept received. Both are reset to 0 when the NetworkID/AppEUI changes.

Syntax

Command
AT+JN
AT+JN=<parameter1>,<parameter2>
AT+JN?

Parameters and Values

Parameter1

Dev Nonce	(0-65535)

Parameter2

App Nonce   (0-16777215)

Command with Response Examples

```
AT+JN
1,1

OK

AT+JN=2,2

OK

AT+JN?
2,2

OK
```

AT+JNV   Enable Join Nonce Validation

Eanble or disable join app nonce validation in join accept from network. Default is enabled (1). Disable value is 0. NOTE: If you use disjoint join servers (multiple independent Conduits), then you will need a Lens Join Sever to ensure the join nonce counter works.

Syntax

Command
AT+JNV
AT+JNV=<parameter1>

Parameters and Values

Parameter1

Disable or Enable   (0, 1) Default is 1, enabled

Command with Response Examples

```
AT+JNV
1

OK

AT+JNV=0

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

Parameters and Values

None

Command with Response Examples

```
AT+PING
-31,10.0

OK

AT+PING
Network Not Joined

ERROR
```

AT+ACK   Require Acknowledgment

The maximum number of times the end device tries to retransmit an unacknowledged packet. Options are from 1 to 15.

> **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>
AT+ACK?

Parameters and Values

Parameter1

0   ACKs are not required. (Default)

1-15   The maximum number of attempts without an acknowledgment.

Command with Response Examples

```
AT+ACK=0

OK

AT+ACK?
0

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.

When the network link check is performed, an empty packet is sent to the gateway and the network server may include a downlink payload with the command answer. If a payload is included it displays on the next line. The AT+RXO setting determines payload format.

Syntax

Command
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

AT+NLC
26,1
40

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>

Command
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

AT+LCC?
3

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>
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

AT+LCT?
3

OK
```

AT+BTO   Class B Timeout

Set the timeout the network expects to receive an ACK for a confirmed downlink received in a Class B window.

Syntax

Command
AT+BTO=<paramter1>

Parameters and Values

Parameter 1   Timeout period from 0-120 seconds. (Default is 8).

Command with Response Examples (for setup of a Class B device)

```
AT+BTO=10

OK
```

AT+CTO   Class C Timeout

Set the timeout the network expects to receive an ACK for a confirmed downlink received in a Class C window.

Syntax

Command
AT+CTO=<parameter1>

Parameters and Values

Parameter 1   Timeout period from 0-120 seconds. (Default is 8).

Command with Response Examples (for setup of a Class C device)

```
AT+CTO=10

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
AT+SS?

Parameters and Values

None

Command with Response Examples

```
AT+SS

OK
```

AT+RS   Restore Network Session

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

Syntax

Command
AT+RS
AT+RS?

Parameters and Values

None

Command with Response Examples

```
AT+RS

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>
AT+PS?

Parameters and Values

Parameter1

0	Off (Default)
1	On

Command with Response Examples

```
AT+PS=0

OK

AT+PS?
```

O

OK

AT&WP Save Protected Settings

Saves protected settings available in all firmware. This command creates a write protected configuration to flash (DevEUI, AppEUI, AppKey, and Frequency Band)

Syntax

Command
AT&WP

Parameters and Values

 None

Command with Response Examples

AT&WP

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>
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

US915

```
AT+FSB=0

OK

AT+CHM
00FFFFFFFFFFFFFFFFFF

OK
```

```
AT+FSB=1

OK

AT+CHM
000100000000000000FF

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
AT+TXCH?

Parameters and Values

None

Command with Response Examples

```
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


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
```

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

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>
AT+LBT?

Parameters and Values

Parameter1

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

Parameter2

0	Disable
-127-128 dBm	Threshold

Command with Response Examples

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
```

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
AT+TXN?

Parameters and Values

 None

Command with Response Examples

```
AT+TXN
0

OK

AT+TXN?
0

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>
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

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

ERROR
```

AT+FO   Frequency Offset

Used to adjust TX frequency offset.

Syntax

Command
AT+FO=<parameter1>
AT+FO?

Parameters and Values

Parameter1

Transmit frequency offset in Hz (-32768,32768)

Command with Response Examples

```
AT+FO
0

OK

AT+FO=5000

OK

AT+FO
5000

OK
```

AT+DUTY   Duty Cycle

Set duty cycle maximum or per band.

NOTE: The system applies the most restrictive value of the different settings.

Syntax

Command
AT+DUTY=<parameter1> OR AT+DUTY= <parameter1>, <parameter2>

Parameters and Values

Parameter1

Duty cycle maximum (0-15) OR Duty band index (when there are 2 parameters)

Parameter2

Duty band off-ratio (0-65535)

Value1 (for Duty Cycle Max or Duty Band Index)   Percentage

0	100%
1	50%
2	25%
3	12.5%
4	6.25%
5	3.13%
6	1.56%
7	0.78%
8	0.39%
9	0.20%
10	0.097%
11	0.049%
12	0.024%
13	0.012%
14	0.006%
15	0.003%
Value2 (for Duty band off-ratio using two parameters)	Percentage

Note: Using two parameters, Duty cycle = 1/value2

2	50%
3	33%
4	25%
5	20%
10	10%
100	1%
1000	0.1%
10000	0.01%

Command with Response Examples

```
AT+DUTY=1

OK
AT+DUTY=0,100
0 915000000 928000000 100

OK
AT+DUTY?
Max 1
Index    Freq Low    Freq High   Off Ratio
```

```
0          915000000    928000000    100
```

```
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.

- **LinkADRReq:** 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 packect 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>
AT+MAC?

Parameters and Values

Parameter1

LinkADRReq   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	**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
```

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>
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
```

AT+URC   Unsolicited Response Code

Enable or disable unsolicited response codes. When you enable Class B and C, downlinks are presented in the serial output. Use with AT+RXO=3 to set output to extended HEX with additional packet info, Type, Addr, FCNT, Port, Payload. If AT+RXO != 3 RECV is displayed and use AT+RECV to retrieve the packet.

Syntax

Command
AT+URC=<parameter1>

Parameters and Values

Parameter1

Enable or disable	(0: disable,1: enable)

Command with Response Examples

```
AT+URC=0

OK

AT+URC=1

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>
AT+AP?

Parameters and Values

Parameter1

1-223	The port used for application data.

Command with Response Examples

```
AT+AP=1

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>
AT+TXP?

Parameters and Values

Parameter1

0-20   dB. (Default is 11).

Command with Response Examples

```
AT+TXP=11

OK

AT+TXP?
11

OK
```

AT+TXI   Transmit Inverted

Deprecated

Sets TX signal inverted.

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

Syntax

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

Parameters and Values

Parameter1

0   Not inverted (Default)

1   Inverted

Command with Response Examples

```
AT+TXI=0

OK

AT+TXI?
0

OK
```

AT+RXI   Receive Signal Inverted

Deprecated

Sets RX signal inverted.

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

Syntax

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

Parameters and Values

Parameter1

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

Command with Response Examples

```
AT+RXI=1

OK

AT+RXI?
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>
AT+RXD?

Parameters and Values

Parameter1

       1-15 seconds (Default)

Command with Response Examples

```
AT+RXD=1

OK

AT+RXD?
1

OK
```

AT+FEC   Forward Error Correction

Deprecated

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>
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

AT+FEC?
1
```

```
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>
AT+CRC?

Parameters and Values

Parameter1

0	CRC disabled
1	CRC enabled (Default)

Command with Response Examples

```
AT+CRC=1

OK

AT+CRC?
1

OK
```

AT+ADR   Adaptive Data Rate

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

Syntax

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

Parameters and Values

Parameter1

0	ADR disabled
1	ADR enabled (Default)

Command with Response Examples

```
AT+ADR=0
```

```
OK

AT+ADR?
0

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

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

US 915 Data Rates Max Payload (bytes)

```
DR0  : 11
DR1  : 53
DR2  : 125
DR3  : 242
DR4  : 242
```

EU 868 Data Rates Max Payload (bytes)

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

AU 915 Data Rates Max Payload (bytes)

```
DR0 : 51
DR1 : 51
DR2 : 51
DR3 : 115
DR4 : 242
DR5 : 242
DR6 : 242
```

KR 920 Data Rates Max Payload (bytes)

```
DR0 : 51
DR1 : 51
DR2 : 51
DR3 : 115
DR4 : 242
DR5 : 242
```

IN 865 Data Rates Max Payload (bytes)

```
DR0 : 51
DR1 : 51
DR2 : 51
DR3 : 115
DR4 : 242
DR5 : 242
DR7 : 242
```

> **Note:** There is no DR6 for India.

AS 923 Data Rates Max Payload (bytes)

```
          No Dwell      Dwell
DR0 :       51           N/A
DR1 :       51           N/A
DR2 :       51           11
DR3 :       115          53
DR4 :       242          125
DR5 :       242          242
DR6 :       242          242
DR7 :       242          242
```

Syntax

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

Command with Response Examples

```
AT+TXDR=3

OK

AT+TXDR?
DR0 – SF12BW125

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
AT+SDR?

Parameters and Values

None

Command with Response Examples

```
AT+SDR
DR0

OK

AT+SDR?

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>
AT+REP?

Parameters and Values

Parameter1

0-15   Number of send attempts. (Default)

Command with Response Examples

```
AT+REP
0

OK

AT+REP?
0

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>

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
```

AT+SENDB   Send Binary

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

Syntax

Command
AT+SENDB=<parameter1>

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
```

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. Rx Packet pin is brought high when packet is received. When you issue a new command, the pin is reset (mDot:D12, xDot:GPIO1). AT+RECV retrieves the packet and resets the pin.

Syntax

Command
AT+RECV

Parameters and Values

 None

Command with Response Examples

```
AT+RECV
<last received data payload>

OK
```

Pin Output

Rx Packet pin is brought high when packet is received. When you issue a new command, the pin is reset (mDot:D12, xDot:GPIO1). AT+RECV retrieves the packet and resets the pin.

AT+RXO   Receive Output

Formats the receive data output. Data is processed into hexadecimal data, left unprocessed/raw, in serial data mode, or extended hexadecimal format.

- Hexadecimal outputs the byte values in the response.
- Raw/Unprocessed outputs the actual bytes on the serial interface.
- Serial outputs:

	Downlink:	Ack Requested :	1 byte : 0 true 1 false
		Rx Address :	4 bytes:
		LSB Frame Count :	4 bytes : LSB
		Rx Port :	1 Byte
		Payload:	N Bytes

Uplink:	Port :	1 Byte
	ACK or Repeat :	1 Byte : 0 = ACK, 1 = Repeat
	# of Acks/Reps :	1 Byte 0 - 8
	Payload :	N Bytes

Syntax

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

Parameters and Values

Parameter1

0	Hexadecimal (Default)
1	Raw/Unprocessed
2	Used to send payloads in serial data mode.
3	Extended Hexadecimal format

Command with Response Examples

```
AT+RXO=0

OK

AT+RXO?
0

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
AT+DP?

Parameters and Values

 None

Command with Response Examples

```
AT+DP
0
```

```
OK

AT+DP?
0

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>
AT+TXW?

Parameters and Values

Parameter1

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

Command with Response Examples

```
AT+TXW=1

OK

AT+TXW?
1

OK
```

AT+MCRX   Multicast Rx parameters

Query or set the multicast receive (Rx) parameters which include index, datarate, frequency, and period. For period, if you set the value to -1 then Class C is configured. For all other values (1-8), Class B is set. **Note:** Multicast session is part of the session. Use save, AT+SS, and restore, AT+RS.

Syntax

Command
AT+MCRX=<parameter1>,<parameter2>, <parameter 3>, <parameter4.>
AT+MCRX=<parameter 1>

Parameters and Values

Parameter1

1- 8 (index)

Parameter2

DR0 - DR15 (datarate)

Parameter3

UINT (frequency)

Parameter4

-1 - 7 (1-7: period, -1: Class C)

Command with Response Examples

```
AT+MCRX=1,2,923300000,1
Set Multicast Rx Settings: 1,2,923300000,1

OK

AT+MCRX=1
DR2,923300000,1

OK
```

Statistics

AT&R   Reset Statistics

Resets device statistics.

Syntax

Command
AT&R

Parameters and Values

None

Command with Response Examples

```
AT&R

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
AT+RSSI?

Parameters and Values

None

Command with Response Examples

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

OK

AT+RSSI?
0, 0, 0, 0

OK
```

AT+LBTRSSI   Listen Before Talk Signal Strength

Read the LBTRSSI.

Syntax

Command
AT+LBTRSSI
AT+LBTRSSI?

Parameters and Values

None

Command with Response Examples

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

OK

AT+LBTRSSI?
0, 0, 0, 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
AT+SNR?

Parameters and Values

None

Command with Response Examples

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

OK

AT+SNR?
2.9, 2.8, 3.0, 2.9

OK
```

AT+TXS   Available Payload

Get available payload.

Syntax

Command
AT+TXS?

Parameters and Values

Value1

| Available Payload | 0-242 |

Command with Response Examples

```
AT+TXS?
11

OK
```

Serial Data Mode

AT+SD   Serial Data Mode

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

- There are one second guard times for +++. After sending data and before entering +++, you must wait one second. After entering +++ and before sending other data, you must also wait one second.

- 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

Parameters and Values

None

Command with Response Examples

```
AT+SD

CONNECT
<send data>
<send +++ to escape>
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>
AT+SMODE?

Parameters and Values

Parameter1

0   AT command mode (Default)

1   Serial data mode

Command with Response Examples

```
AT+SMODE=0

OK

AT+SMODE?
0

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>
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

AT+SDCE?
1

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>

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
```

AT+AS   Auto Sleep

Deprecated

This command has been deprecated in version 3.2. Use the Mbed sleep manager.

Syntax

Command
AT+AS=<parameter1>

Command
AT+AS?

Parameters and Values

Parameter1

0	Disable auto sleep (Default)
1	Enable auto sleep

Command with Response Examples

```
AT+AS=0

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>
AT+WM?

Parameters and Values

Parameter1

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

Command with Response Examples

```
AT+WM=0

OK

AT+WM?
0

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>
AT+WI?

Parameters and Values

Parameter1

　　　　2-2147483647 seconds (Default is 10)

Command with Response Examples

```
AT+WI=10

OK

AT+WI?
10

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>
AT+WD?

Parameters and Values

Parameter1

　　　　2-2147483647 milliseconds (Default is 100)

Command with Response Examples

```
AT+WD=100
```

```
OK

AT+WD?
100

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>
AT+WTO?

Parameters and Values

Parameter1

0-65000 milliseconds (Default is 20)

Command with Response Examples

```
AT+WTO=20

OK

AT+WTO?
20

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>
AT+ANT?

Parameters and Values

Parameter1

-128 to 127 dBi (Default is 3)

Command with Response Examples

```
AT+ANT=3

OK

AT+ANT?
3

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+RECVC 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>
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

AT+RXDR?
SF_9

OK
```

EU 868MHz

```
AT+RXDR?
SF_12
```

AT+RXF   Receive Frequency

Deprecated

> Note: *Beginning in firmware version 3.2, this command has been removed from production firmware. It will remain available in de-bug firmware.*

Configures the frequency that +RECVC 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>
AT+RXF?

Parameters and Values

Parameter1

   0

   902000000-928000000 (Default is 903700000)

Command with Response Examples

```
AT+RXF=902123456

OK

AT+RXF?
902123456

OK
```

AT+RECVC   Receive Continuously

Deprecated

> **Note:** *Beginning in firmware version 3.2, this command has been removed from production firmware. It will remain available in de-bug firmware.*

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+RECVC
AT+RECVC?

Parameters and Values

None

Command with Response Examples

```
AT+RECVC

OK
```

AT+SENDC   Send

Used for testing. Sends un-modulated data continuously.

Syntax

Command
AT+SENDC=<parameter1>,<parameter2>,<parameter3>

Parameters and Values

Parameters

<paramet er1>	Timeout
<paramet er2>	Frequency
<paramet er3>	Power

Command with Response Examples

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

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>

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
```

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>
AT+TXF?

Parameters and Values

Parameter1

US915 - (0,902000000-928000000)

EU868 - (0,863000000-870000000)

Command with Response Examples

```
AT+TXF=902123456

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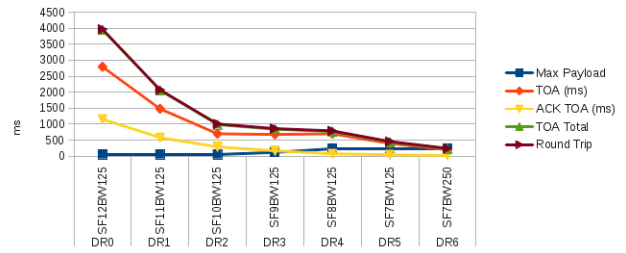
```
AT+NJM=3
AT+NA=00112233
AT+NSK=00112233001122330011223300112233
AT+DSK=33221100332211003322110033221100
AT+TXDR=DR8 (US:DR8-DR13,EU:DR0-DR6)
AT+TXF=915500000 (US-ONLY:915.5-919.7)
AT&W
ATZ
AT+SD
```

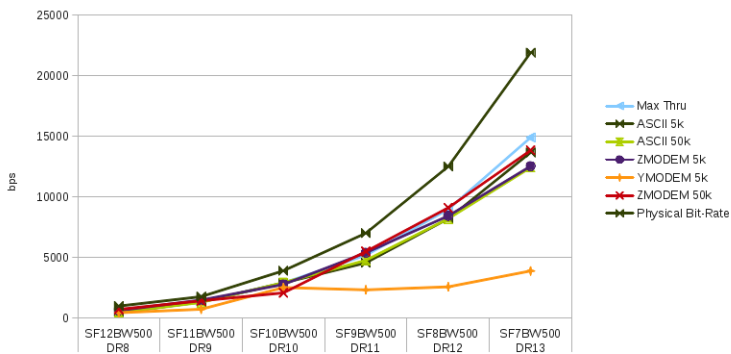## Peer-to-Peer Throughput

US915 Datarate - Time On Air
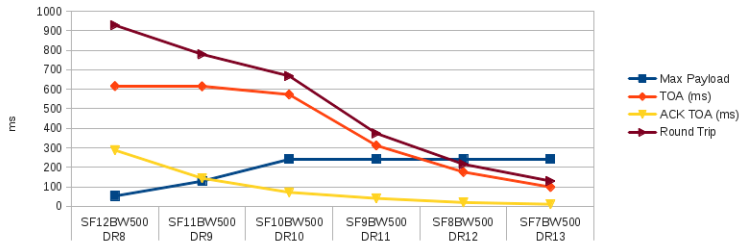
EU868 Datarates - Time On Air

US915 Datarates - Throughput

EU868 Datarates - Throughput