MULTITECH®

xDot®

AT Command Reference Guide

xDot® AT Command Guide

Models: MTXDOT-xxx

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Contents

Chapter 1 Introduction 16
AT Commands 16
Using Commands 16
Querying 16
Assigning New Values 16
Terminology 17
LoRa Topology 17

Chapter 2 General AT Commands 18
AT Attention 18
Syntax 18
Parameters and Values 18
Command with Response Examples 18
ATI Request ID 18
Syntax 18
Parameters and Values 18
Command with Response Examples 18
ATZ Reset CPU 19
Syntax 19
Parameters and values 19
Command with Response Examples 19
ATE0/1 Echo Mode 19
Syntax 19
Parameters and Values 19
Command with Response Examples 19
ATV0/1 Verbose Mode 20
Syntax 20
Parameters and Values 20
Command with Response Examples 20
AT&K0/3 Hardware Flow Control 20
Syntax 20
Parameters and Values 21
Command with Response Examples 21
AT&F Reset to Factory Defaults 21
Syntax 21
Parameters and Values 21
Command with Response Examples 21
Example US 915MHz 21

Example EU 868MHz 22
AT+LW LoRaWAN Version 23
Syntax 23
Parameters and Values 23
Command with Response Examples 23
AT+FOTA Firmware over the Air 23
Syntax 23
Parameters and Values 24
Command with Response Examples 24
FOTA Passthrough 24
AT&W Save Configuration 24
Syntax 25
Parameters and Values 25
Command with Response Examples 25
AT+IPR Serial Speed 25
Syntax 25
Parameters and Values 25
Command with Response Examples 26
AT+DIPR Debug Serial Speed 26
Syntax 26
Parameters and Values 26
Command with Response Examples 26
AT+LOG Debug Log Level 27
Syntax 27
Parameters and Values 27
Command with Response Examples 27
AT+PP Ping Slot Periodicity 27
Syntax 28
Parameters and Values 28
Command with Response Examples 28
AT+GPSTIME GPS Time 28
Syntax 28
Parameters and Values 28
Command with Response Examples 29
AT+BLS Beacon Lock Status 29
Syntax 29
Parameters and Values 29
Command with Response Examples (for setup of a Class B device) 29
AT+BAT Battery Level 30
Syntax 30
Parameters and Values 30

Command with Response Examples 30
AT+MEM Available RAM 31
Syntax 31
Parameters and Values 31
Command with Response Examples 31
AT+ERASE Erase Flash Storage 31
Syntax 31
Parameters and Values 31
Command with Response Examples 31

Chapter 3 Network Management 33
AT+DI Device ID 33
Syntax 33
Parameters and Values 33
Command with Response Examples 33
AT+CDI Custom Device ID 33
Syntax 33
Parameters and Values 33
Command Example 34
AT+CSN Custom Serial Number 34
Syntax 34
Parameters and Values 34
Command Example 34
AT+DFREQ Default Frequency Band 35
Syntax 35
Parameters and Values 35
Command with Response Examples 35
Example for Global xDots 35
AT+FREQ Frequency Band 36
Syntax 36
Parameters and Values 36
Command with Response Examples 36
AT+FSB Frequency Sub-Band 36
US915MHz and AU915MHz models 37
Channel Details 37
Syntax 37
Parameters and Values 37
Command with Response Examples 38
CN470-510MHz models 38
Channel Details 38
Syntax 38

Parameters and Values 38
Command with Response Examples 39
AT+SW RF Sweep 39
Syntax 39
Parameters and Values 39
Command Examples 39
Example 40
AT+PN Public Network Mode 40
Private MTS Network 40
LoRaWAN Public 41
LoRaWAN Private 41
Syntax 41
Parameters and Values 41
Command with Response Examples 41
AT+JBO Join Byte Order 42
Deprecated 42
Syntax 42
Parameters and Values 42
Command with Response Examples 42
AT+NJM Network Join Mode 43
Syntax 43
Parameters and Values 43
Command with Response Examples 43
AT+JOIN Join Network 44
Syntax 44
Parameters and Values 44
Error Messages 44
Command with Response Examples 44
AT+JR Join Retries 44
Syntax 45
Parameters and Values 45
Command with Response Examples 45
AT+JD Join Delay 45
Syntax 45
Parameters and Values 45
Command with Response Examples 45
Over-the-Air Activation (OTA) 47
AT+NI Network ID 47
Syntax 47
Parameters and Values 47
Command with Response Examples 47

AT+NK Network Key 48
Syntax 48
Parameters and Values 48
Command with Response Examples 48
Manual Activation 49
AT+NA Network Address 49
Syntax 49
Parameters and Values 49
Command with Response Examples 50
AT+NSK Network Session Key 50
Syntax 50
Parameters and Values 50
Command with Response Examples 50
AT+DSK Data Session Key 51
Syntax 51
Parameters and Values 51
Command with Response Examples 51
AT+ULC Uplink Counter 51
Syntax 51
Parameters and Values 52
Command with Response Examples 52
AT+DLC Downlink Counter 52
Syntax 52
Parameters and Values 52
Command with Response Examples 52
AT+GK Generic App Key 53
Syntax 53
Parameters and Values 53
Command with Response Examples 53
AT+DWT Transmit Dwell Time 54
Syntax 54
Parameters and Values 54
Command with Response Examples 54
AT+DS Default Session 54
Syntax 54
Parameters and Values 54
Command with Response Examples 55
OTA Network Join 55
Auto OTA Network Join 55
AT+NJS Network Join Status 55
Syntax 55

Parameters and Values 55
Command with Response Examples 56
Pin Ouput 56
AT+JN Join Nonces 56
Syntax 56
Parameters and Values 56
Command with Response Examples 56
AT+JNV Enable Join Nonce Validation 57
Syntax 57
Parameters and Values 57
Command with Response Examples 57
AT+PING Send Ping 57
Syntax 57
Parameters and Values 57
Command with Response Examples 58
AT+ACK Require Acknowledgment 58
Syntax 58
Parameters and Values 58
Command with Response Examples 58
AT+NLC Network Link Check 58
Syntax 59
Parameters and Values 59
Command with Response Examples 59
AT+LCC Link Check Count 59
Syntax 60
Parameters and Values 60
Command with Response Examples 60
AT+LCT Link Check Threshold 60
Syntax 60
Parameters and Values 60
Command with Response Examples 60
AT+BTO Class B Timeout 61
Syntax 61
Parameters and Values 61
Command with Response Examples (for setup of a Class B device) 61
AT+CTO Class C Timeout 61
Syntax 61
Parameters and Values 61
Command with Response Examples (for setup of a Class C device) 61
AT+SS Save Network Session 62
Syntax 62

Parameters and Values 62
Command with Response Examples 62
AT+RS Restore Network Session 62
Syntax 62
Parameters and Values 62
Command with Response Examples 62
AT+PS Preserve Session 63
Syntax 63
Parameters and Values 63
Command with Response Examples 63
AT&WP Save Protected Settings 63
Syntax 63
Parameters and Values 63
Command with Response Examples 63

Chapter 4 Sending and Receiving Packets 64
Channels and Duty Cycles 64
AT+CHM Channel Mask 64
Syntax 64
Parameters and Values 64
US915/AU915 64
EU868 64
Command with Response Examples 64
AT+TXCH Transmit Channel 65
EU868 Adding a Channel 65
Syntax 66
Parameters and Values 66
Command with Response Examples 66
Add EU868 FSK Channel at Index 8 67
EU868 Before Join 67
EU868 After Join 67
AT+LBT Listen Before Talk 68
Syntax 68
Parameters and Values 68
Command with Response Examples 68
AT+TXN Transmit Next 69
Syntax 69
Parameters and Values 69
Command with Response Examples 69
AT+TOA Time On Air 69
Syntax 70

Parameters and Values 70
Command with Response Examples 70
AT+RXMS Time in MS Spent in RX Mode 70
Syntax 70
Parameters and Values 70
Command with Response Examples 70
AT+FO Frequency Offset 71
Syntax 71
Parameters and Values 71
Command with Response Examples 71
AT+DUTY Duty Cycle 72
Syntax 72
Parameters and Values 72
Command with Response Examples 73
AT+MAC Inject MAC Command 73
Syntax 74
Parameters and Values 74
Command with Response Examples 75
AT+DC Device Class 75
Syntax 76
Parameters and Values 76
Command with Response Examples 76
AT+URC Unsolicited Response Code 76
Syntax 76
Parameters and Values 77
Command with Response Examples 77
AT+AP Application Port 77
Syntax 77
Parameters and Values 77
Command with Response Examples 77
AT+TXP Transmit Power 78
Syntax 78
Parameters and Values 78
Command with Response Examples 78
AT+TXI Transmit Inverted 78
Deprecated 78
Syntax 78
Parameters and Values 78
Command with Response Examples 79
AT+RXI Receive Signal Inverted 79
Deprecated 79

Syntax 79
Parameters and Values 79
Command with Response Examples 79
AT+RXD Receive Delay 80
Syntax 80
Parameters and Values 80
Command with Response Examples 80
AT+FEC Forward Error Correction 80
Deprecated 80
Syntax 80
Parameters and Values 81
Command with Response Examples 81
AT+CRC Cyclical Redundancy Check 81
Syntax 81
Parameters and Values 81
Command with Response Examples 81
AT+ADR Adaptive Data Rate 82
Syntax 82
Parameters and Values 82
Command with Response Examples 82
Auto Increment DR 83
AT+TXDR TX Data Rate 84
Syntax 85
Command with Response Examples 85
AT+SDR Session Data Rate 86
Syntax 86
Parameters and Values 86
Command with Response Examples 86
AT+STXP Session Tx Power 86
Syntax 86
Parameters and Values 86
Command with Response Examples 86
AT+REP Repeat Packet 87
Syntax 87
Parameters and Values 88
Command with Response Examples 88
AT+SEND Send 88
Syntax 89
Parameters and Values 89
Command with Response Examples 89
AT+SENDB Send Binary 90

Syntax 90
Parameters and Values 90
Command with Response Examples 90
AT+RECV Receive Once 90
Syntax 90
Parameters and Values 90
Command with Response Examples 91
Pin Output 91
AT+RXO Receive Output 91
Syntax 91
Parameters and Values 91
Command with Response Examples 92
AT+DP Data Pending 92
Syntax 92
Parameters and Values 92
Command with Response Examples 92
AT+TXW Transmit Wait 92
Syntax 93
Parameters and Values 93
Command with Response Examples 93
AT+MCRX Multicast Rx parameters 93
Syntax 93
Parameters and Values 93
Command with Response Examples 94
AT+RSSI Signal Strength 94
Syntax 94
Parameters and Values 94
Command with Response Examples 94
AT+LBTRSSI Listen Before Talk Signal Strength 94
Syntax 95
Parameters and Values 95
Command with Response Examples 95
AT+SNR Signal to Noise Ratio 95
Syntax 95
Parameters and Values 95
Command with Response Examples 95
AT+TXS Available Payload 96
Syntax 96
Parameters and Values 96
Command with Response Examples 96
AT+SD Serial Data Mode 96

Syntax 96
Parameters and Values 97
Command with Response Examples 97
AT+SMODE Startup Mode 97
Syntax 97
Parameters and Values 97
Command with Response Examples 97
AT+SDCE Serial Data Clear on Error 98
Syntax 98
Parameters and Values 98
Command with Response Examples 98

Chapter 5 Power Management 99
AT+SLEEP Sleep Mode 99
Syntax 99
Parameters and Values 99
Command with Response Examples 99
AT+WP Wake Pin 101
Syntax 101
Parameters and Values 101
xDot 101
Command with Response Examples 101
AT+WM Wake Mode 102
Syntax 102
Parameters and Values 102
Command with Response Examples 102
AT+WI Wake Interval 102
Syntax 102
Parameters and Values 103
Command with Response Examples 103
AT+WD Wake Delay 103
Syntax 103
Parameters and Values 103
Command with Response Examples 103
AT+WTO Wake Timeout 104
Syntax 104
Parameters and Values 104
Command with Response Examples 104
AT+ANT Antenna Gain 104
Syntax 104
Parameters and Values 104

Command with Response Examples 105

Chapter 6 Testing and Compliance 106
AT+RXDR Receive Data Rate 106
Syntax 106
Parameters and Values 106
Command with Response Examples 106
EU 868MHz 106
AT+RXF Receive Frequency 106
Deprecated 106
Syntax 107
Parameters and Values 107
Command with Response Examples 107
AT+RECVC Receive Continuously 107
Deprecated 107
Syntax 107
Parameters and Values 108
Command with Response Examples 108
AT+SENDC Send Continuous Wave 108
Syntax 108
Parameters and Values 108
Command with Response Examples 108
AT+SENDI Send on Interval 108
Syntax 108
Parameters and Values 109
Command with Response Examples 109
AT+TXF Transmit Frequency 109
Syntax 109
Parameters and Values 109
Command with Response Examples 109

Chapter 7 Examples 110
Network Configuration and Joining 110
US 915MHz - Frequency Sub-band 110
Join Mode 111
Ensuring Network Connectivity 112
Serial Mode 113
Peer to Peer 114
Configuration 114
Peer-to-Peer Throughput 115

Warranty 116

Contact Information **116**

Chapter 1 Introduction

AT Commands

This reference provides AT Command information for the MultiTech Dot Series. These commands are available in firmware Version 1..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

Attention: Global xDot models, with WW in the model name, do not have a default frequency band. You must set the frequency band/channel plan for your country/region to use the device. Refer to AT+DFREQ for more information.

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 xDot-ES
Firmware : 4.2.3-4-g439be61-mbed61700
Library : 4.2.3-1-gc373ed0-mbed61700
MTS-Lora : 4.2.3-1-g25a039c-mbed61700
LoRaWAN : 1.0.4
RegParams : 1.0.3
```

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

Note: xDots only respond as V0, even if set to V1.

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 CTS and RTS pins. 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 (also known as FUOTA) 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 and xDot Essentials require an external flash component in order for FOTA to work. xDot Advanced includes flash. xDot essentials only supports FOTA pass through. It does not detect and use an attached flash memory like the legacy xDot.

When you deploy Release 4.0 or newer on an xDot, FOTA is enabled by default.

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

In Release 4.2.0 or newer, FOTA settings are saved to flash during configuration.

Note: The AT+FOTA feature handles MULTICAST and FOTA operations. When disabled, over-the-air multicast session setup is also disabled.

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
```

FOTA Passthrough

Pass FOTA messages through to the host MCU by enabling Unsolicited Result Code (URC) and select the Rx Output for 2:RAW or 3:HEX data on the serial port. This will send the full FOTA message over serial to the host MCU for processing.

For more on FOUTA and Dots, refer to https://multitechsystems.github.io/fragmentation

```
AT+RXO=2 or 3

AT+URC=1
```

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+IPR Serial Speed

Sets serial baud rate for the AT command port. Changes to this setting take effect after a save and reboot of the device.

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 port baud rate. 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>
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. This value is sent as part of the DevStatusAns response to a DeveStatusReq from the LoRaWAN network server.

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

xDot Advanced only. 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

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+CDI Custom Device ID

This command allows you to create a custom device ID. User defined format up to 16 characters to be programmed into the saved configuration for tracking purposes. An example use would be a custom SKU.

Syntax

Command
AT+CDI=<parameter 1>

Parameters and Values

Parameter 1	16 characters.

Command Example

```
AT+CDI=12345678

AT&W

OK
```

AT+CSN Custom Serial Number

This command allows you to create a custom serial number.

Syntax

Command
AT+CSN=<parameter 1>

Parameters and Values

Parameter 1	16 characters

Command Example

```
AT+CSN=12345678

AT&W

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.

Attention: Global xDot models, with WW in the model name, do not have a default frequency band. You must set the frequency band/channel plan for your country/region to use the device.

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
```

Example for Global xDots

Setting the frequency band/channel plan for global, save as protected settings, and then reset the CPU. To read the active plan, use AT+FREQ.

Example Set to EU868 Channel Plan

```
AT+DFREQ=EU868

AT&WP

ATZ
```

```
AT+FREQ
EU868
```

Example Set to AS923-4 Channel Plan

```
AT+DFREQ=AS923-4

AT&WP

ATZ
```

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

Configures the frequency sub-band for US915MHz/AU915MHz and CN470-510 regional models.

US915MHz and AU915MHz models

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

Query the listed frequencies after configuring the AT+FSB setting. For detailed frequency tables and additional regional parameter specifications, refer to the current version of the **LoRaWAN Regional Parameters** document published by the LoRa Alliance.

The US915MHz and AU915MHz bands use the following channel structure:

US915MHz Band

- **Uplink:** 64 channels (numbered 0 to 63) utilizing LoRa 125 kHz BW varying from DR0 to DR3, using coding rate 4/5, starting at 902.3 MHz and incrementing linearly by 200 kHz to 914.9 MHz
- **Uplink:** 8 channels (numbered 64 to 71) utilizing LoRa 500 kHz BW at DR4, starting at 903.0 MHz and incrementing linearly by 1.6 MHz to 914.2 MHz
- **Downlink:** 8 channels (numbered 0 to 7) utilizing LoRa 500 kHz BW at DR8 to DR13, starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz

AU915MHz Band

- **Uplink:** 64 channels (numbered 0 to 63) utilizing LoRa 125 kHz BW varying from DR0 to DR5, using coding rate 4/5, starting at 915.2 MHz and incrementing linearly by 200 kHz to 927.8 MHz
- **Uplink:** 8 channels (numbered 64 to 71) utilizing LoRa 500 kHz BW at DR6, starting at 915.9 MHz and incrementing linearly by 1.6 MHz to 927.1 MHz
- **Downlink:** 8 channels (numbered 0 to 7) utilizing LoRa 500 kHz BW at DR8 to DR13, starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz

Downlink Channel Selection

- The RX1 receive channel is a function of the upstream channel used to initiate the data exchange
- **AT+PN=0 (Private MTS Network):** RX1 Channel Number = Transmit Channel Number / 8
- **AT+PN=1 or 2 (LoRaWAN Public/Private):** RX1 Channel Number = Transmit Channel Number modulo 8

Syntax

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

Parameters and Values

Parameter1

0	Allows channel hopping of all 64 channels. (Default)
1-8	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
```

CN470-510MHz models

Configures the frequency sub-band for CN470-510MHz models. This enables hybrid mode for private network channel management.

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

Channel Details

Query the listed frequencies after configuring the AT+FSB setting.

The CN470-510MHz band uses:

- **Uplink:** 96 channels (numbered 0 to 95) utilizing LoRa 125 kHz BW varying from DR0 to DR5, starting at 470.3 MHz and incrementing linearly by 200 kHz to 489.3 MHz
- **Downlink:** 48 channels (numbered 0 to 47) utilizing LoRa 125 kHz BW varying from DR0 to DR5, starting at 500.3 MHz and incrementing linearly by 200 kHz to 509.7 MHz

Note: Channel Index 6 to 38 and 45 to 77 are mainly used by China Electric Power. In areas where these channels are used by China Electric Power, they should be disabled.

The RX1 receive channel is determined by: **RX1 Channel Number = Uplink Channel Number modulo 48**. For example, when transmitting on channel number 49, the RX1 channel number is 1.

Syntax

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

Parameters and Values

Parameter1

0	Allows channel hopping of all 96 channels. (Default)
1-12	Enter a value from 1-12 to configure the end device to use one set of eight channels out of 96 possible. This must match the gateway settings.

Command with Response Examples

```
AT+FSB
0

OK

AT+FSB?
0

OK

AT+FSB=1

OK
```

AT+SW RF Sweep

Use RF sweep to send un-modulated data from a minimum to a maximum frequency. The command initiates one sweep over the range of frequencies. Repeat the command to initiate another sweep.

Syntax

Command
AT+SW=[START],[STOP],[STEP],[DURATION],[POWER]
AT+SW?

Parameters and Values

Parameter	Value
Start	Beginning RF range value Hz
Stop	Ending RF range value in Hz
Step	Step size in Hz
Duration	How long at each step in ms.
Power	Transmit power value 0-20 dB.

Command Examples

```
AT+SW
```

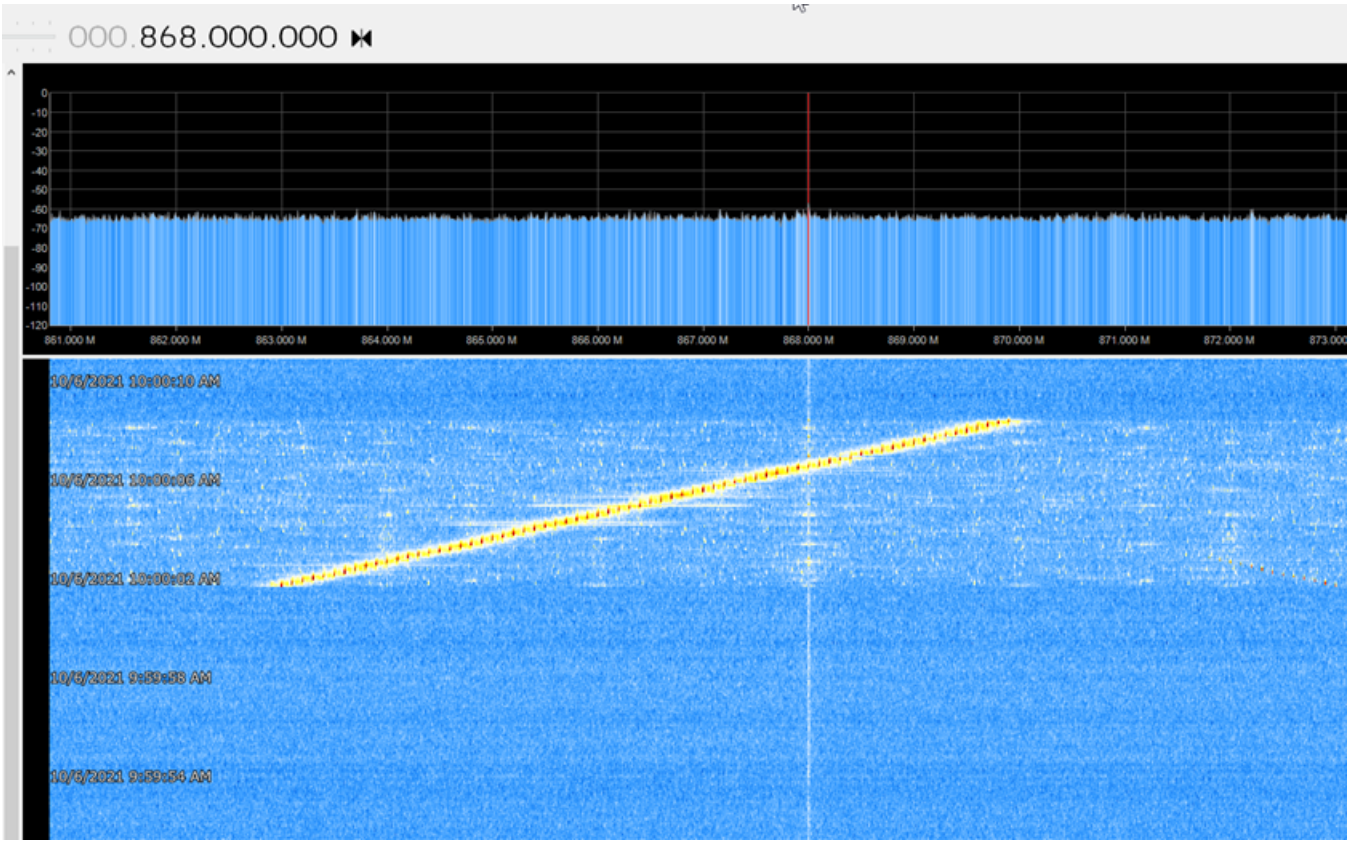
```
AT+SW=902000000,915000000,1000000,1000,20

AT+SW=902000000,915000000,100000,100,11

AT+SW=863000000,870000000,100000,100,11

AT+SW=863000000,870000000,100000,100,10
```

Example



AT+PN Public Network Mode

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 will 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.

AT+NI Network ID

Configures network EUI, Name, or AppEUI/Join EUI. (App EUI in LoRaMac.) If AppEUI/JoinEUI is setm=, 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 GenAppKey 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
```

AT+DWT Transmit Dwell Time

Set or get transmit dwell time for AS923 and AU915 channel plans. Normally this is enabled and set by the network server after joining the network. In manual mode, this may need to be set on the module out-of-band. New command for xDot essentials & advanced.

Syntax

Command
AT+DWT=<parameter 1>,<parameter 2>
AT+DWT

Parameters and Values

Parameter1	
Disable or Enable uplink dwell time	(0, 1) Default is 1, enabled
Parameter2	
Disable or Enable downlink dwell time	(0, 1) Default is 1, enabled

Command with Response Examples

```
AT+DWT=1,1

OK

AT+DWT
1,1

OK
```

AT+DS Default Session

Reset the manual session to the default RF parameters. The session RF parameters can be changed by the network, use this command to reset them. New command for xDot essentials & advanced.

Syntax

Command
AT+DS

Parameters and Values

None

Command with Response Examples

```
AT+DS

OK
```

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.

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

Enable or disable join nonce validation in join accept from network. Default is enabled (1). Disable value is 0. NOTE: When enabled, the network must consist of a single LNS or Join server. If moving between networks, the join accept will be rejected.

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>
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
```

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?
0

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
00FFFFFFFFFFFFFFFFF

OK

AT+FSB=1

OK

AT+CHM
000100000000000000FF

OK

AT+FSB=2

OK

AT+CHM
00020000000000000FF00

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+RXMS Time in MS Spent in RX Mode

Time in milliseconds (MS) spent in RX mode since last AT+SEND. If no packet is received, the time returned is the number of milliseconds (MS) from window opened to timeout and is different per spreading factor. When a packet is received, the time returned is the number of milliseconds (MS) to receive the packet and any RX1 timeout if packet was received in RX2.

Syntax

Command
AT+RXMS

Parameters and Values

None

Command with Response Examples

```
AT+RXMS
0

OK

AT+JOIN
```

```
Failed to join network

ERROR

AT+RXMS
239

OK

AT+JOIN
Successfully joined network

OK

AT+RXMS
52

OK
```

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
```

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. Ports 200, 201, and 202 are used for Multicast and FOTA.

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. Allows for intelligent link optimization. After the network server receives several uplinks, it calculates the available link budget based on the signal strength and quality of those uplinks. If it determines that a higher data rate can be used, it sends a link ADR request to increase the data rate. With a poor signal, Parameter2 and Parameter3 are used to determine how aggressively to reduce the data rate.

The AckLimit is the number of uplinks sent before the ADRACKReq bit is set requesting a downlink response. If the response does not come within the number of uplinks set by the AckDelay parameter, the data rate is reduced one step. If +ACK is enabled and a particular packet is retransmitted, ADR only counts it as one packet.

Starting in version 4.2.0: (Optional) Parameter 4 enables or disables data rate auto increment based on the requested payload size. If the payload provided to AT+SEND exceeds the allowed maximum payload of the current data rate, the date rate increases to send the packet without error.

Syntax

Command
AT+ADR=<parameter1>,[<parameter2>],[<parameter3>],[<parameter4>]
AT+ADR?

Parameters and Values

Parameter1	ADR Enable/Disable
0	ADR disabled
1	ADR enabled (Default)
Parameter2	AckDelay (Optional)
1-127	Range
Parameter3	AckLimit (Optional)
1-127	Range
Parameter 4	AutoIncrementDR (Optional). To set data rate auto increment, you must provide AckDelay and AckLimit.
0	Disabled
1	Enabled. (Default)

Command with Response Examples

```
AT+ADR=0

OK

AT+ADR?
0
```

```
OK
```

Auto Increment DR

```
AT&F

OK

AT+ADR
1,32,64,1

OK

AT+ADR=1,32,64,0

OK

AT+ADR
1,32,64,0

OK
```

AT+TXDR TX Data Rate

Sets the current data rate to use, DR0-DR15 or 0-15 depending on channel plan. If ADR is enabled, the data rate of the current session might be different. When ADR is enabled use the +SDR command to query the current session's data rate.

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.

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
```

CN 470-510 Data Rates Max Payload (bytes)

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

Syntax

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

Command with Response Examples

```
AT+TXDR=3

OK

AT+TXDR?
D-0 - SF12BW125

OK
```

AT+SDR Session Data Rate

Display the current session's data rate. 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+STXP Session Tx Power

Shows the current session transmission power (Tx) power limit in place by the network through ADR commands. Actual transmission power (Tx) may be lower than the limit based on frequency and region regulations.

Syntax

Command
AT+STXP

Parameters and Values

None

Command with Response Examples

```
AT+SEND

OK
```

```
AT+STXP
30

OK

AT+SEND

OK

AT+SEND

OK

AT+STXP
30

OK

AT+SEND

OK

AT+SEND

OK

AT+STXP
12

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
```

AT+SEND Send

Sends supplied data and opens a receive window in Class A mode 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 session by the data rate and any MAC commands scheduled to be sent. Use +TXS to determine the available payload. Sending an empty payload clears the MAC commands.

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
```

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 in Class A mode. 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
4 bytes:			Rx Address :
4 bytes : LSB			LSB Frame Count :
1 Byte			Rx Port :
N Bytes			Payload:
	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

Set to indicate a reason exists to send an uplink.

1. There are downlinks pending for this device.
2. There are MAC command answers pending on this device.
3. The network server has requested an acknowledgment.

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
```

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

Availabl e Payload	0-242

Command with Response Examples

```
AT+TXS?
11

OK
```

AT+SD Serial Data Mode

Reads serial data and sends packets, received packets are output to serial. See AT+RXO for serial output display options.

- Send +++ to escape serial data mode and enter AT command mode. 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.
- 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. Upon waking, GPIO2 is raised indicating it is ready to receive data. When data input stops and the wake timeout is met, the device goes to sleep and the GPIO goes low.
- 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.

Starting in version 4.2.0: Automatic Session Save Over Sleep When using AT+SLEEP=0, the session is saved automatically when AT+SLEEP=0 is called and restored when the device wakes from sleep. You no longer need to call AT+SS before and AT+RS after AT+SLEEP.

Deep Sleep (On xDot: ST Micro standby mode. On xDot Essential or xDot Advanced: MAX32670 backup 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 (On xDot: ST Micro stop mode. On xDot Essential or xDot Advanced: MAX32670 deep sleep mode) is maintains RAM and keeps peripherals on. Execution resumes from the call to sleep.

For xDot Essential and Advanced, sleeping with wake on interrupt only draws less power than with wake from interval as the RTC domain is powered down.

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
1	Sleep

Command with Response Examples

```
AT+SLEEP

AT+SLEEP=0

AT+SLEEP=1
```

```
AT+JOIN

OK
AT+SEND=DATA

OK
AT+SLEEP=0

OK
AT+NJS
1

OK
AT+SEND=DATA

OK
```

AT+WP Wake Pin

Sets the pin the device monitors to wake mode from interrupt. Parameter 2 configures an internal pull resister option. Parameter 3 configures the edge to trigger on.

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+WM Wake Mode

Configures the end device to wake from sleep mode on a time interval, by an interrupt, or both. 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
2	Wake on interval or interrupt

Command with Response Examples

```
AT+WM=0

OK

AT+WM?
0

OK
```

AT+WI Wake Interval

When using wake mode set to interval or interval or interrupt, use this command to configure the number of seconds the end device sleeps.

Syntax

Command
AT+WI=<parameter1>

Command
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

This is used only when +SMODE=1

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

This is used only when +SMODE=1.

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 Continuous Wave

Used for testing. Sends un-modulated data continuous wave transmission.

Syntax

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

Parameters and Values

Parameters

<parameter1>	Timeout
<parameter2>	Frequency
<parameter3>	Power

Command with Response Examples

Command to send for 10s at 923.3 MHz and 20 dBm

```
AT+SENDC=10000,923300000,20

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.

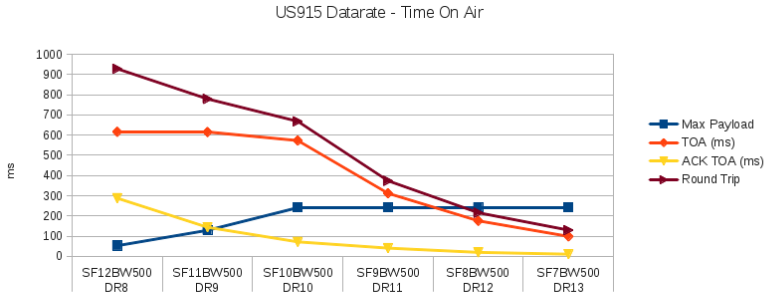
For Europe 868 models, use a fixed frequency, 869.85, with 7 dBm power setting to allow 100% duty-cycle usage.

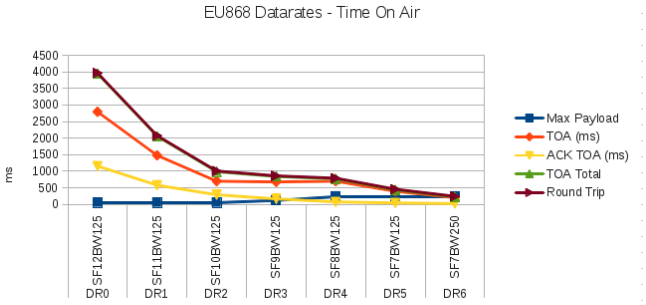
Configuration

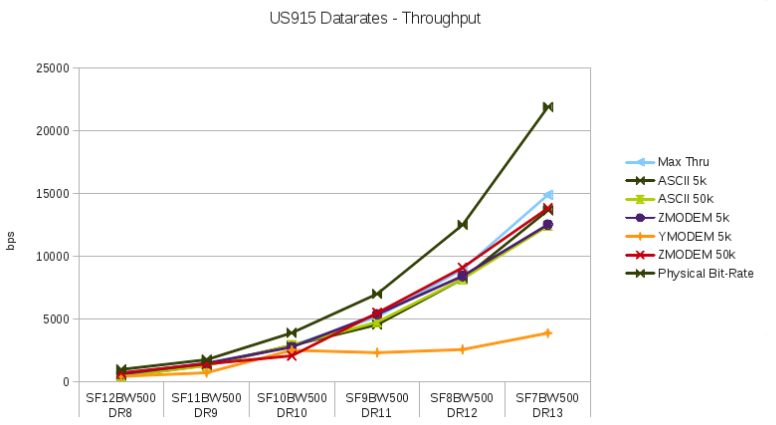
This example sets up each side with identical settings and starts serial data mode. Then, text can be entered into a terminal on either side and it will show as received on the other mDot.

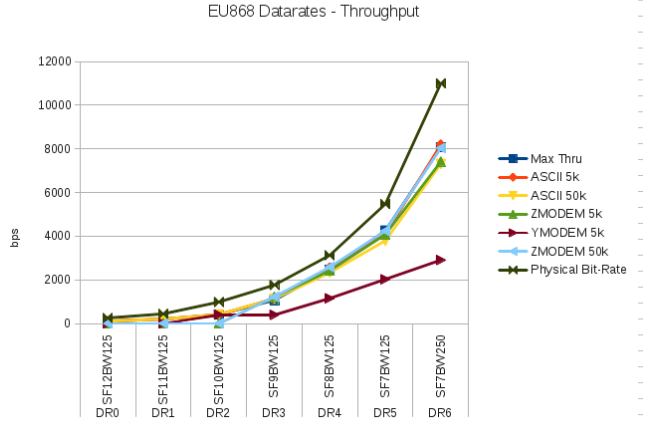
```
AT+NJM=3
AT+NA=00112233
AT+NSK=00112233001122330011223300112233
AT+DSK=33221100332211003322110033221100
AT+TXDR=DR8 (US:DR8-DR13,EU:DR0-DR6)
AT+TXF=915500000 (US-ONLY:915.5-919.7)
AT&W
ATZ
AT+SD
```

Peer-to-Peer Throughput









Warranty

To read the warranty statement for your product, go to https://www.multitech.com/warranty.

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