RE866
AT Command Reference

80555ST10865A Rev.12 – 2018-07-06

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DOCUMENTATION

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APPLICABILITY TABLE

PRODUCTS

- RE866A1-EU
- RE866A1-NA

CONTENTS

1. INTRODUCTION

1.1. Scope

This document specifies the command interface for the RE866 LoRa BLE combo module.

1.2. Audience

This document is intended only for Telit customers that wants to include RE866 in their design.

1.3. Contact Information, Support

For general contact, technical support services, technical questions and report documentation errors contact Telit Technical Support at:

- TS-EMEA@telit.com
- TS-AMERICAS@telit.com
- TS-APAC@telit.com
- TS-SRD@telit.com

Alternatively, use:

https://www.telit.com/contact-us/

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

https://www.telit.com/

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.4. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.5. Related Documents

- RE866 Hardware User Guide, 1VV0301364 (EU), 1VV0301525 (NA)
- LoRaWAN® standards - https://www.lora-alliance.org/

2. FEATURES

The RE866 supports AT command mode and multiplexing mode.

2.1. AT Command Mode

Each command line consists of a prefix, a body and a terminator.

All command lines begin with the prefix AT (ASCII 065, 084) or at (ASCII 097, 116).

The body is a string of characters in the ASCII range 032-255. Control characters other than <CR> (carriage return; ASCII 013) and <BS> (back space; ASCII 008) in a command line are ignored.

Note: The control characters are configurable via S registers.

- Carriage return character (CR) S3 register
- Line feed character (LF) S4 register
- Back space character (BS) S5 register

The terminator is <CR>.

There is no distinction between upper-case and lower-case characters. A command line can have a maximum length of 80 characters. It is automatically discarded if the input is longer. Corrections are made using <BS>. Multiple commands on the same command line are not allowed.

Commands have the following syntax:

Syntax	Description
AT<command>=<value><CR>	Write the value of the command

Responses are sent back to the host and can be any of the following:

Responses	Description
<CR><LF>value<CR><LF>	Read only value (e.g. AT+BOAD)
<CR><LF>OK<CR><LF>	Successful final message
<CR><LF>ERROR<CR><LF>	Error message, command not supported

Exceptions of this syntax are marked separately.

2.2. Escape Sequence

To enter the command mode during an active data connection the following sequence (escape sequence) can be used:

<delay time [1]><+><+><+><delay time>

The time interval between each of the three plus signs must not exceed 1 second. The escape sequence remains transparent to the remote device.

The escape sequence character is configurable via S2 register

2.3. Multiplexing Mode (MUX)

The multiplexing mode is used to handle incoming and outgoing data of different remote endpoints and command data.

Data has to be sent and are received in the following framing (all values in hexadecimal format):

Name	Description	Length	Value
Start	Start of frame	8 bit	CC
Channel ID	Channel identifier	8 bit	00 – FF
Length	Length of data	8 bit	-
Data	Max. 255 bytes data	Min. 0 byte Max. 255 bytes	-

The start byte is used to detect the start of a frame.

The channel ID determines the channel to send data to. This can be the data channel of a BLE GATT characteristic or the TIO data channel or the AT command interface (value FF).

The length field sets the length of the payload to send or received in bytes.

The data field consists of the payload data to send or receive.

Start of frame, channel ID, length and data are always transmitted in direct, binary form. AT commands have to be sent to the channel ID FF, simply prefixed with start of frame, FF, and length byte. Data received from the AT command interface are marked by channel ID FF. Line editing using backspace is not available in multiplexing mode.

[1] Delay time defined in the S12 register (see page 25)

Examples:

CC 01 0B 31 32 33 34 35 36 37 38 39 30 0D	Send data “1234567890<CR>” to channel 1 via MUX protocol
CC FF 06 41 54 49 39 39 0D	Send AT command “ATI99<CR>” via MUX protocol
CC FF 06 0D 0A 4F 4B 0D 0A	Receive response “<CR><LF>OK<CR><LF>” from AT command interface via MUX protocol

Result messages like RING, CONNECT and NO CARRIER may be sent in multiple frames by the RE866 module. The host controller application needs to collect the data until the closing “<CR><LF>” is received.

2.4. Connection Establishment Procedure

The parameters AT+LECONINTMAX and AT+LESLAVELAT are used for central connection establishment. The connection supervision timeout used for connection establishment is calculated due to conform to the Bluetooth core spec..

On a peripheral, 200 ms after an incoming connection establishment the peripheral will check if the used connection parameters are compatible with the parameters AT+LECONINTMIN, AT+LECONINTMAX and AT+LESLAVELAT. If the parameters are not compatible, the peripheral will update the connection parameters automatically to the configured parameters. The connection supervision timeout used by automatic parameter update is calculated due to conform to the Bluetooth core spec. If connection parameter update fails, the peripheral retries the connection parameter update. The maximum number of attempts is 3 and the time between the retries is 5 seconds.

2.5. Hangup

All active data connections can be disconnected at once by setting the HANGUP pin (GPIO4) to high level.

3. BLUETOOTH INTERFACE AT COMMANDS

The description of the commands is structured into the following parts:

- General commands
- Bluetooth Low Energy (BLE) specific commands
- Generic Attribute Profile (GATT) specific commands

The factory-default values of the commands are marked using the bold letter format.

3.1. General

%B	Baud Rate

AT syntax: **AT%B<value>**

This command determines the baud rate for the UART.

The following standard baud rates are supported:

Value	Description
4	9,600 bps
5	19,200 bps
6	38,400 bps
7	57,600 bps
8	115,200 bps
9	230,400 bps
22	460,800 bps
23	921,600 bps

Additionally to the standard baud rates described above, it is possible to set the following baud rates.

Value	Description
1200	1,200 bps
2400	2,400 bps
4800	4,800 bps
9600	9,600 bps
14400	14,400 bps
19200	19,200 bps
28800	28,800 bps

Value	Description
38400	38,400 bps
57600	57,600 bps
76800	76,800 bps
115200	115,200 bps
230400	230,400 bps
250000	250,000 bps
460800	460,800 bps
921600	921,600 bps
1000000	1,000,000 bps

To set a baud rate write the desired value in the command.

Examples:

AT%B9	Set baud rate to 230,400 bps
AT%B250000	Set baud rate to 250,000 bps

Information regarding the deviation of the real baud rate to the value set can be found in the *RE866 Hardware User Guide*.

&F Load Factory Defaults

AT syntax: **AT&F<value>**

The factory-default values will be loaded. For storing values in non-volatile memory, use the **AT&W** command.

Value	Description
0	Set all parameters except **bndlist** to factory defaults
1	Set all parameters to factory defaults

Some restored values require an additional reset to get active (e.g. **AT+LETIO, AT+UICP**)

&W Store Active Configuration

AT syntax: **AT&W**

The active configuration is stored in non-volatile memory.

A Accept Incoming Call

AT syntax (normal mode): **ATA**
AT syntax (MUX mode): **ATA <channel ID>**

This command is supported for compatibility reasons only. A Bluetooth low energy device has to answer every connection automatically. See also register **S0** description.

Examples:

ATA	Accepts connection in normal mode
ATA 0x01	Accepts connection in MUX mode at channel ID 0x01

+BIOCAP SSP I/O Capabilities

AT syntax: **AT+BIOCAP=<value>**

This command sets the input and output capabilities of the device used for SSP.

Value	Description	Related commands	Related events
0	Display only		SSPPIN
1	Display Yes/No	BSSPCONF (secure connection)	SSPPIN (LE legacy pairing) SSPCONF (secure connection)
2	Keyboard only	BSSPPIN	SSPPIN
3	No input no output		
4	Display and keyboard	BSSPPIN (LE legacy pairing) BSSPCONF (secure connection)	SSPPIN(LE legacy pairing) SSPCONF (secure connection)

+BMITM SSP Man in the Middle Protection

AT syntax: **AT+BMITM=<value>**

This command is deprecated and only supported for backward compatibility reasons. Please use connection based (see **ATD** command) and service based (see **AT+LETIO** parameter) security configuration instead

This command controls the man in the middle (MITM) protection of the device during SSP. It has to be set in context with AT+BIOCAP command. In SSP there are scenarios where MITM protection is not possible.

Value	Description
0	Parameter disabled, connection and service based configuration applies (see ATD command and LETIO parameter)
1	Man in the middle protection enabled connection and service based configuration is ignored)

In case the user choose a scenario where MITM protection is not possible but one of the communication devices is configured to **AT+BMITM=1** (MITM protection enabled), the pairing is refused.

For possible combinations of I/O capabilities and the possibility of MITM protection/authentication level see command **+BIOCAP**.

+BMUX Activate Multiplexing Mode

AT syntax: **AT+BMUX=<value>**

This command is used to activate the multiplexing mode protocol.

Value	Description
0	Normal AT mode
1	Non persistent multiplexing mode
2	Persistent multiplexing mode

In the default configuration the device is working in normal AT mode. Setting **AT+BMUX=1** enables the multiplexing mode.

After receiving “OK” in the response of the AT+BMUX=1 command all subsequent commands have to be entered in multiplexing frame format.

The multiplexing mode 1 is not stored persistent. To disable the multiplexing mode the device must be reset.

The multiplexing mode 2 is stored persistent. To disable the multiplexing mode the command **AT+BMUX=0** followed by **AT&W** must be entered. This mode is intended to be used with the **AT+SYSTEMOFF** command.

In multiplexing mode extended result codes are always active (see chapter 5.9).

+BNAME Local Device Name

AT syntax: **AT+BNAME=<name>**

This command allows the modification of the local device name. The device name is shown on a remote Bluetooth device during device/service discovery. It is limited to 19 characters.

The device name can contain a format element to include the device’s own address or parts of it in the name.

In BLE advertising the name is truncated to the first 10 characters.

Format: “%[<s>][<d>]a”

“%”	Identifier start format element
<s>	Character separator on byte order (optional)
<d>	Number (1-12) of digits included in device name (optional, default is 4)
“a”	Identifier end format element

Examples: Device address = “0123456789AB”

AT+BNAME=RE866 %3a	Display on remote end: RE866 9AB
AT+BNAME=RE866 %4a	Display on remote end: RE866 89AB
AT+BNAME=RE866 %:3a	Display on remote end: RE866 9:AB
AT+BNAME=RE866 %3a	Display on remote end: RE866 9AB
AT+BNAME=RE866 %:12a	Display on remote end: RE866 01:23:45:67:89:AB

+BNDDEL Delete Bonding Information

AT syntax: **AT+BNDDEL=<value>**

This command deletes the bonding information stored by the RE866.

Value	Description
Bluetooth address	Delete the bond of the device with specified address from the bonded-device list
*	Delete all bonded devices from the bonded-device list

This command can only be executed while not connected.

+BNDLIST Show Bonded Device List

AT syntax: **AT+BNDLIST**

This command shows information about the devices bonded with the RE866.

Each entry in the **bonded-device list** contains the Bluetooth address, the linktype (see chapter 5.8) and the role of the remote device (“C” for client or “P” for peripheral).

There may be exist two entries for one device if it supports client and peripheral role both.

Example:

AT+BNDLIST	0080254800DA 0x02 C 0080254800DA 0x02 P 9C04EB06ACA2 0x03 P OK

+BNDS Storage Mode for Bonds

AT syntax: **AT+BNDS=<mode>**

This command controls the storage mode for bonding information (link keys).

Mode	Description
0	Bonds persists for the duration of the authenticated connection
1	Bonds are permanently stored in the NVRAM of the RE866

By setting **AT+BNDS** to 0 the bonded-device list is deleted internally. The bonding information is stored in the module flash. If your application does not need to store bonds switch this parameter to 0, to protect the module flash from unnecessary clear and write operations. Every flash has a limited number of clear cycles.

+BNDSIZE Bonded Devices List Size

AT syntax: **AT+BNDSIZE=<value>**

This command reduces the number of entries (1…4) the bonded-device list can hold. The RE866 can store up to 4 devices. The default size is **4**.

Modification of this parameter will delete all entries in the bonded-device list. Two entries of the same device are counted as one device.

Example:

AT+BNDSIZE=1	Limit the number of bonded devices to 1

+BOAD Bluetooth Own Device Address

AT syntax: **AT+BOAD**

This command reads the Bluetooth devices' own device address.

This command is read only.

+BPAIRMODE Configure Pairable Mode

AT syntax: **AT+BPAIRMODE=<mode>**

This command controls the pairable mode of the RE866 peripheral part.

When set to “0” the module is only connectable for clients stored in the local bondlist. New pairing requests will be rejected.

Mode	Description
0	No pairing allowed, RE866 advertises TIO as “functional”
1	Pairing allowed, RE866 advertises TIO as “bondable and functional”

This command restricts the access only to security enabled characteristics. For Terminal I/O this means **AT+LETIO** has to be set to a value different than 0 or 2.

+BSSPCONF Security Pairing Confirmation

AT syntax: **AT+BSSPCONF <Bluetooth address>,<address type>,<value>**

If a pairing is initiated and LE secure connection is supported, depending on the security settings AT interface generates an event SSPCONF and asks the user for confirmation.

Event: SSPCONF <Bluetooth address>,<address type> <passkey> ?

The user has to confirm the passkey with the above command. If no confirmation is sent by the user within the bonding timeout or in case of active reject, the pairing is rejected with NO CARRIER message.

Value	Description
0	Reject passkey confirmation request
1	Accept passkey confirmation request

+BSSPPIN SSP Passkey Response

AT syntax: **AT+BSSPPIN <Bluetooth address>,<address type>,<SSP passkey>**

If an authentication is initiated, depending on the I/O capabilities (**AT+BIOCAP**) the AT interface generates an event SSPPIN and asks the user for the SSP passkey.

Event: SSPPIN <Bluetooth address>,<address type> ?

The user has to answer this request with the SSP passkey displayed on the remote device.

Example:

SSPPIN 00802507C08D,t2 ? AT+BSSPPIN 00802507C08D,t2,314546 OK RING CONNECT	Receive SSP passkey request Send SSP passkey response

+BSSPDBG SSP Debug Mode

AT syntax: **AT+BSSPDBG=<value>**

This command allows to enable the SSP debug mode of the device. This mode is required to trace the SSP Bluetooth connection by using a sniffer.

Value	Description
0	SSP debug mode off
1	SSP Debug mode on

SSP debug mode is for tracing purposes only and shall be deactivated for normal operation. Otherwise the connection may be unsecure.

D Initiate Bluetooth Low Energy Link

AT syntax: **ATD<brad>[,tx],TIO[,reusebond]**

This command addresses a Bluetooth device directly via its address.

Param.	Description
brad	Called Bluetooth remote device address (12 hex digits)
tx	x is the remote Bluetooth address type (see chapter Bluetooth Address) If not specified a public address is assumed.
reusebond	Optional parameter that automatically starts the encryption immediately after the GATT connection is established. This is possible only if bonding information is available for the remote device. If no such bonding information is available this parameter has no effect. Note: It is not possible to read out the information of an encrypted connection.

If the device is configured to “Central” role and initiates a connection to a peripheral device, it shall use the identifier TIO.

A TIO connection allows to transfer data transparently for the UART to the peer device.

If no identifier is given in the dial string, no connection attempt will be initiated. The command reports ERROR.

Any character input while the RE866 is dialing will cancel the dialing procedure.

Dialing procedure ends after a timeout specified by S register S7.

Dialing procedures which cause a security procedure have additional timeouts depending on the requested security procedure (see parameter **AT+BIOCAP**). The connection timeout specified in S7 is not valid after a security procedure is started.

Except for the <reusebond> parameter functionality described above all security procedures are expected to be requested by the remote device while connection setup or an active connection. In case the remote devices requests a security procedure the RE866 automatically performs all necessary procedures to satisfy the security needs of the remote device only limited by the remote and local I/O capabilities (**AT+BIOCAP**).

+DFUMODE Device Firmware Update Mode

AT syntax: **AT+DFUMODE=<value>**

This command sets the device firmware update mode.

To activate the mode it is necessary to store the settings and perform a reset or use the command **AT+DFUSTART**.

Value	Description
1	Device firmware update over serial interface
2	Device firmware update over the air (OTA)

+DFUNAME Over The Air Update Name

AT syntax: **AT+DFUNAME=<name>**

This command sets the device name for the over the air firmware update mode.

The name is limited to 8 characters.

To activate the mode it is necessary to store the settings and perform a reset or use the command **AT+DFUSTART**.

Name	Description
RE866DFU	Device firmware update name is “RE866DFU”

+DFUSTART Start Bootloader

AT syntax: **AT+DFUSTART**

This command sets the device into the configured firmware update mode. The command times out after 2 minutes.

E Local Echo

AT syntax: **ATE<value>**

This command selects the local echo in command mode.

Value	Description
0 or empty	No local echo
1	Local echo on in command phase

H Disconnect

AT syntax (): **ATH <connHnd>**

This command disconnects the existing Bluetooth connection addressed by connHnd from the corresponding CONNECT event.

Examples:

ATH 0x10	Disconnects connection with connHnd 0x10
ATH 0x01	Disconnects connection with connHnd 0x01

I Display Version Information

AT syntax: **ATI<value>**

Displays different information about version number and settings.

Value	Description
0 or empty	Returns the device name (e.g. “RE866“)
1	Returns “0”
2	Returns “OK”
3	Returns the version string: “V1.xyz”
4	Returns the manufacturers name: “Telit Communications PLC”
5	Returns “ERROR”
6	Returns the copyright string: “(c) Copyright Telit”
7	Returns “OK”
8	Returns “ERROR”
9	Returns “OK”
77	Returns bootloader version
99	Returns the firmware creation date

+LOAD Load Stored Parameter Setting

AT syntax: **AT+LOAD**

This command loads all parameters stored in non-volatile RAM.

+NFCMODE Set NFC Mode

AT syntax: **AT+NFCMODE=<value>**

This command sets the operation mode of the NFC interface.

The RE866 provides the possibility to connect an NFC antenna directly to the Module (refer to the *RE866 Hardware User Guide*).

Value	Description
0	NFC interface off
1	Automatic mode

O Return to Online State

AT syntax: **ATO**

If the RE866 is in command mode after issuing an escape sequence while a connection is active, **ATO** returns the RE866 to data mode.

+PNPPID PnP Product ID

AT syntax: **AT+PNPPID=<value>**

This command sets the product ID provided in the device information service (DIS). The format is a 16 bit hex value. The default value is 0xB015 (Telit product ID for RE866 firmware).

To activate a new value it is necessary to store the settings (**AT&W**) and perform a reset (**AT+RESET**).

+PNPPVER PnP Product Version

AT syntax: **AT+PNPPVER=<value>**

This command sets the product version provided in the device information service (DIS). The format is a 16 bit hex value. The default value is the version number of the particular Telit RE866 firmware, e.g. 0x3004 for firmware version 3.004.

To activate a new value it is necessary to store the settings (**AT&W**) and perform a reset (**AT+RESET**).

After setting the vendor ID (**AT+PNPVID**) to a different value than the default 0x008F the user has to set his own product version (otherwise the value 0x0200 will be used).

+PNPVID PnP Vendor ID

AT syntax: **AT+PNPVID=<value>**

This command sets the vendor ID provided in the device information service (DIS). The format is a 16 bit hex value. The default value is 0x008F (Telit vendor ID).

To activate a new value it is necessary to store the settings (**AT&W**) and perform a reset (**AT+RESET**).

+PNPVSRC PnP Vendor ID Source

AT syntax: **AT+PNPVSRC=<value>**

This command sets the vendor ID source provided in the device information service (DIS).

Value	Description
1	Bluetooth SIG assigned company ID
2	USB assigned company ID

To activate a new value it is necessary to store the settings (**AT&W**) and perform a reset (**AT+RESET**).

Q Suppress Results

AT syntax: **ATQ<value>**

This command allows/suppresses result codes and messages.

Value	Description
0 or empty	Enable result messages after command input
1	Suppress result messages after command input

+RESET Reset Device

AT syntax: **AT+RESET**

This command resets the whole functionality of the RE866 by a forced hardware reset (like power off/on).

+RFMAXTXPWR Maximum Output Power

AT syntax: **AT+RFMAXTXPWR=<value>**

This command sets the maximum output power of the Bluetooth radio of the device. A changed value becomes active immediately.

Value	Description
-128	Use factory default maximum output power of +4 dBm
+4	+4 dBm
+3	+3 dBm
0	0 dBm
-4	-4 dBm
-8	-8 dBm
-12	-12 dBm
-16	-16 dBm
-20	-20 dBm
-40	-40 dBm

All other values in the range of -127 to 127 could be set with this command as well, but the equal or next lower value from the power table will be set internally. Furthermore the value will be set to a value amongst minimum and maximum output power value of the device.

Example:

AT+RFMAXTXPWR=0	The maximum output power will be set to 0 dBm

S AT S Register

AT syntax: **ATSx=<value>**

This command configures the S register settings.

Mode	Description
Sx?	Show the current setting of register Sx
Sx=1	Set register Sx to 1

AT command S register set (all values in decimal format):

Register	Value	Description
S0	**1**	Immediate call acceptance Note: Setting of S0 only allow value 1 for BLE. In case of BLE connections always one RING is signalised and automatic call acceptance is set.
S2	**43**	Character for escape sequence
S3	**13**	Carriage-return character
S4	**10**	Line-feed character
S5	**08**	Backspace character
S7	**30**	Wait time for connection (in s). 0 means no timeout.
S12	**100**	Delay time by using the escape sequence in 10 ms increments

+SYSTEMOFF Enter System Off Mode

AT syntax: **AT+SYSTEMOFF[=<value>]**

This command sets the module into low power mode during the time the module is not used.

When setting **AT+SYSTEMOFF** (or **AT+SYSTEMOFF=1**) the module will restart on GPIO activity. To achieve the lowest power consumption set **AT+SYSTEMOFF=2**. In this case the module will wake-up by RESET signal.

The host can use the IOA pin to monitor the system status.

Value	Description
1	Wake up by GPIO (toggle UART-RTS#)
2	Wake up by RESET signal

Possible use cases and an usage example are described in the *RE866 Software User Guide.*

+UICP Set UART Interface Control Protocol

AT syntax: **AT+UICP=<mode>**

This command sets the mode of the UART Interface Control Protocol (UICP).

To activate UICP, it is necessary to store the settings and perform a reset.

Mode	Description
0	UICP off
1	UICP on

The valid sequence to e.g. activate UICP is:

AT+UICP=1

AT&W

AT+RESET

V Result Message Format

AT syntax: **ATV<value>**

This command determines the format of the result messages.

Value	Description
0 or empty	Result message is presented numerically (followed by <CR>)
1	Result message is presented as text

W Extended Result Codes

AT syntax: **ATW<value>**

This command enables/disables extended result codes.

Value	Description
0 or empty	Result message is presented without extended result codes
1	Result message is presented with extended result codes (include error causes)

3.2. Bluetooth Low Energy

+LEFIXPIN Fix PIN for Pairing Procedure

AT syntax: **AT+LEFIXPIN=fixpin**

This command specifies a 6 digit fixpin, to be used for the security procedure. If this value has a length of 0 (no digit specified in command) "**AT+LEFIXPIN="** a randomly generated PIN is used. The default is a fixpin with length 0. To use this feature see also commands **AT+LETIO**, **AT+BIOCAP**.

For further information see *RE866 Software User Guide*.

Param.	Description
fixpin	6 digits pin value e.g. "000000" (digit 0..9 only) (default is 0 length pin "")

+LEADINTMAX Maximum Advertising Interval

AT syntax: **AT+LEADINTMAX=<value>**

This command configures the maximum advertising interval (in milliseconds) for a Bluetooth Low Energy Peripheral.

Value	Description
n=20…10240	Use maximum advertising interval of *n* ms
1280	Use maximum advertising interval of 1280 ms

Make sure that the value of **AT+LEADINTMAX** is higher or equal the value of **AT+LEADINTMIN**.

+LEADINTMIN Minimum Advertising Interval

AT syntax: **AT+LEADINTMIN=<value>**

This command is not used in the RE866. It is just provided for compatibility reasons. The used advertising interval is set by **AT+LEADINTMAX** parameter.

+LECONINTMAX Maximum Connection Interval

AT syntax: **AT+LECONINTMAX=<value>**

This command configures the maximum connection interval for a Bluetooth Low Energy connection. The unit is in 1.25 milliseconds timeslots.

Value	Description
n=6…3200	Use maximum connection interval of *n* * 1.25 ms
32	Use maximum connection interval of 40 ms

Make sure that the value of **AT+LECONINTMAX** is higher or equal the value of **AT+LECONINTMIN**.

+LECONINTMIN Minimum Connection Interval

AT syntax: **AT+LECONINTMIN=<value>**

This command configures the minimum connection interval for a Bluetooth Low Energy connection. The unit is in 1.25 milliseconds timeslots.

Value	Description
n=6…3200	Use minimum connection interval of *n* * 1.25 ms
16	Use minimum connection interval of 20 ms

Make sure that the value of **AT+LECONINTMAX** is higher or equal the value of **AT+LECONINTMIN**.

+LECONPARAM Connection Parameter Handling

AT syntax:

AT+LECONPARAM=connHnd,[connIntMin],connIntMax,slaveLat[,connTimeout]
AT+LECONPARAM?connHnd

The command **AT+LECONPARAM** used with "=" requests new connection parameters to be used for the connection defined by connHnd.

The command **AT+LECONPARAM** used with "?" shows the active connection parameters used by the connection defined by connHnd. A LECONPARAM event is generated containing the active connection parameters.

Param.	Description
connHnd	Connection handle from CONNECT event
connIntMin	6…3200 minimum connection interval in steps of 1.25 ms (mandatory for peripheral)
connIntMax	6…3200 maximum connection interval in steps of 1.25 ms
slaveLat	0…499 connection intervals
connTimeout	Optional connection supervision timeout in steps of 10 ms. Will be calculated internally if not specified. Has to be calculated according to Bluetooth core spec.

The connection establishment procedure is described in chapter 2.4.

In central role the optional parameter connIntMin is used for negotiation procedure with the peripheral. If the central does not support this feature, it will report an error. In peripheral role the parameter connIntMin is mandatory.

The new connection parameters are signalled by event LECONPARAM.

The result is OK or ERROR.

+LECPEVENT Enable LECONPARAM Event Signaling

AT syntax: **AT+LECPEVENT =<enable>**

This command enables/disables the automatic signaling of LECONPARAM events.

enable	Description
0	Disable automatic LECONPARAM event signaling
1	Enable automatic LECONPARAM event signaling

The result is OK or ERROR.

+LEROLE Bluetooth Low Energy Device Role

AT syntax: **AT+LEROLE=<value>**

This command configures the Bluetooth Low Energy role of the device.

Value	Description
0	Set device role to “Peripheral”
1	Set device role to “Central”
2	Set device role to combined “Peripheral” and “Central”

When set to “Peripheral”, the device advertises and accepts incoming BLE connections. Searching for Bluetooth Low Energy devices with **AT+LESCAN** command is not possible.

When set to “Central”, the device is invisible and does not accept incoming BLE connections. The device can search for peripherals using **AT+LESCAN** command and initiate outgoing connections using the **ATD** command.

When set to the combined “Peripheral” and “Central” role (default) all above features are supported and have to be handled. If you only need one single role, please use parameter 0 or 1.

+LESLAVELAT Slave Latency

AT syntax: **AT+LESLAVELAT=<value>**

This command configures the slave latency (in connection intervals) for a Bluetooth Low Energy connection.

Value	Description
n=0…499	Use a slave latency of *n* connection intervals
0	Use no slave latency

+LETIO Enable Terminal I/O Service

AT syntax: **AT+LETIO=<value>**

This command controls the Terminal I/O service. If set to 0 the Terminal I/O service is disabled. To activate the change, it is necessary to store the settings (**AT&W**) and perform a reset (**AT+RESET**).

Value	Description
0	Terminal I/O service disabled (no advertising, no characteristics)
1	Terminal I/O service enabled, security is required with encryption (no MITM)
2	Terminal I/O service enabled, no security (authentication or encryption) required
3	Terminal I/O service enabled, authenticated pairing with encryption (MITM required)
4	Terminal I/O service enabled, authenticated LE Secure connections pairing with encryption (MITM required, LE secure connections required)

The valid sequence to change the setting is:

AT+LETIO=1

AT&W

AT+RESET

+LEADDATA Setup Advertise Data for Customized Advertising

AT syntax: **AT+LEADDATA=<value$_1$> .. <value$_n$>**

This command is used to setup the advertise data for a customized advertising.

Value$_k$ represents an octet in hexadecimal format, k <= 31.

The coding of the data is according to the *Bluetooth 4.0 Core Specification / Vol. 3, Part C, Chapter 11 and 18 (Length/Type/Value coding) [3]*.

Example:

41 54 2B 4C 45 41 44 44 41 54 41 3D 30 32 30 31 30 36 30 33 30 32 30 46 31 38 0D *(human readable: AT+LEADDATA=02010603020F18)*	Set flags + UUID of battery service

+LEADE Enable Customized Advertising

AT syntax: **AT+LEADE=<value>**

This command controls the advertising behavior.

With **AT+LEADE=0** only the build in Terminal I/O service is advertised.

With **AT+LEADE=1** only the customized advertising value is advertised.

With **AT+LEADE=3** the module stops all advertising. With disabled advertising the client (e.g. iPhone) is not able to discover the device or to connect to the device. This should only be done when the service is not in use to save battery power.

With disabled internal TIO due to **AT+LETIO=0**, the values 0 and 3 show the same behavior. There will be no advertising and no connection.

Value	Description
0	Customized advertising disabled, internal TIO advertising enabled
1	Customized advertising enabled, internal TIO advertising disabled
2	Reserved for future use
3	Advertising off, customized advertising disabled, internal TIO advertising disabled

+LEADPAR Setup Parameters for Customized Advertising

AT syntax: **AT+LEADPAR=par$_1$=<value$_1$>[, .. [,par$_n$=<value$_n$>]]**

This command is used to setup parameters for a customized advertising.

par$_n$	**value$_n$**
advtype Optional Coding: decimal.	Type of advertising: 0: undirected (default) 2: scannable 3: non-connectable

This command is optional, if not submitted these defaults apply:

- advtype = 0 - advertising type “undirected”

The values for the minimum and maximum of the advertising interval may be set with the AT+LEADINTMIN and AT+LEADINTMAX commands.

Example:

AT+LEADPAR=ADVTYPE=0	Set type of advertising “undirected”

+LESCDATA Setup Scan Response Data for Customized Advertising

AT syntax: **AT+LESCDATA=<value$_1$> .. <value$_n$>**

This command is used to setup the scan response data for a customized advertising.

Value$_k$ represents an octet in hexadecimal format, k <= 31.

The coding of the data is according to the *Bluetooth 4.0 Core Specification / Vol. 3, Part C, Chapter 11 and 18 (Length/Type/Value coding) [3]*.

Example:

41 54 2B 4C 45 53 43 44 41 54 41 3D 30 33 30 32 30 46 31 38 0D *(human readable: AT+LESCDATA=03020F18)*	Set UUID of battery service

3.3. GATT Client Specific AT Mode Commands

All commands described in this chapter can only be used in AT mode or in the AT channel in multiplexing mode (**AT+BMUX=1**).

+LEBUUIDSET Set 128 bit Base UUID

AT syntax: **AT+LEBUUIDSET=ux**

This command configures base UUIDs needed by the stack to identify 128 bit UUIDs correct.

128 bit UUIDs are module internally treated as 16 bit UUIDs with a defined base UUID. The Telit defined base UUID for Terminal IO V2 is 0000xxxx000010008000008025000000 with xxxx as the variable 16 bit UUID part.

To set a base UUID the 16 bit UUID part could have any legal 16 bit value. It is internally ignored for this command. If the internal base UUID table is full the command reports ERROR, otherwise it reports OK.

The UUID list shall be saved permanent with **AT&W**.

Param.	Description
ux	With x= 128 bit base UUID

+LEBUUIDDEL Delete Base UUID

AT syntax: **AT+LEBUUIDDEL=<value>**

This command deletes the base UUID information stored by the RE866 in RAM.

To delete the UUID permanently from the flash, it is required to save the reduced list by **AT&W**, wait for OK and perform an **AT+RESET** command.

Value	Description
ux	With x= 128 bit base UUID
*	Delete all base UUIDs from the base UUID table.

+LEBUUIDLIST Show Base UUID List

AT syntax: **AT+LEBUUIDLIST**

This command shows information about the configured 128 bit base UUIDs within the RE866.

The variable 16 bit UUID part is marked with the character ‘x’.

Example:

AT+LEBUUIDLIST	0000xxxx000010008000008025000000 0000xxxx111100002222008033330000 OK

+LESCAN Search Bluetooth Low Energy Devices

AT syntax: **AT+LESCAN**
AT+LESCAN=GATT[,<rssix>][,RAW]
AT+LESCAN=<ux>[,<rssix>][,RAW]
AT+LESCAN=<brad>[,<tx>][,<rssix>][,RAW]

With this command an automatic search for all discoverable Bluetooth Low Energy devices will be initiated. The discovery will last for a time defined by the command **AT+LESCANDURATION**.

Param.	Description
rssi	Filter for devices with RSSI value stronger x
brad	Filter for Bluetooth remote device address (12 hex digits)
tx	x is the remote Bluetooth address type see chapter LinkType If not specified a public address is assumed
ux	With x=UUID of a service (4 or 32 hex digits)
GATT	Show all found devices
RAW	Hexdump of advertising and scan response data without duplicate filtering

Any character input while the RE866 is searching will abort the search procedure.

The resulting list depends on the used command parameters.

As a result, a list will be output containing the Bluetooth addresses of the visible devices in range, the advertisement type, the RSSI, the Bluetooth friendly name, the TX level, manufacturer specific data and all UUIDs contained in the advertising and scan response data, if available, of the remote device. Please note that more AD types could be decoded in future releases.

Bluetooth address, RSSI and TYPE are always provided. All other values like Bluetooth friendly name, TX level, manufacturer specific data and UUID are optional and depends of the advertising data of the discovered device. UUIDs can be 16-bit or 128-bit values.

The output is filtered to show each unique advertising packet only once. If the internal filter table is full, all new advertising packets are shown unfiltered. The output in RAW mode is also unfiltered.

The optional parameter <rssi> (8-bit signed value) can be used to perform a search only for devices with a rssi value higher than the provided value. E.g. **AT+LESCAN=rssi-50** will show all devices with a rssi value higher than –50dBm. This means -45dBM devices are shown, -55dBm devices are filtered.

The optional parameter <brad> (12 hex digits) can be used to perform a search for a device with the specified Bluetooth address. The optional parameter <tx> specifies the type of Bluetooth low energy address.

The optional parameter <ux> (16-bit or 128-bit uuid value) can be used to perform a search for devices which advertises a specific service.

To show devices supporting Terminal I/O only, the UUID FEFB shall be used (**AT+LESCAN=uFEFB**).

If the “RAW” parameter is given, the output will not contain decoded AD type data. Instead it will contain the Bluetooth address of the visible device in range, the RSSI, the advertisement type and the complete advertise or scan response data from the remote device. The data is displayed as an ascii coded byte steam in hexadecimal values.

There will be no duplicate filtering for advertising packets. All received packets (advertise or scan response) will be printed as soon they are received. If UUID filtering is on (**AT+LESCAN=ux,RAW**), the output will be printed after receiving the complete advertising data. In active scan mode these are the advertising and scan response packets.

Example:

AT+LESCAN	008025497826,t2 RSSI:-62 TYPE:CONN NAME:BM+SR 7 TX:4 MNF:8F0009B0011000 UUID:53544D544552494F5345525631303030 UUID:FEFB OK
AT+LESCAN=GATT,RAW	0080254800DD,t2 RSSI:-77 TYPE:CONN DATA:02010608FF8F0009B0011000 0080254800DD RSSI:-79 TYPE:SCANRSP DATA:1107303030315652455345525F4D4530302 FBFE08086A75657267656E OK

+LESCANDURATION — Duration for +LESCAN

AT syntax: **AT+LESCANDURATION=<value>**

This command configures how long the RE866 is searching for discoverable Bluetooth Low Energy devices when the command **AT+LESCAN** is used.

Value	Description
0	Sets duration time to infinite.
1..300	Sets duration time between 1 seconds and 300 seconds (**default=10**)

4. LORA® INTERFACE AT COMMANDS

4.1. +LDEVADDR

+LDEVADDR – Set LoRa® device address	
AT+LDEVADDR=<addr>	Set command for the device address. <addr> - 8 characters hexadecimal string Example: AT+LDEVADDR=aabbccdd
AT+LDEVADDR?	Read command returns the currently set device address. +LDEVADDR:<addr> <addr> - device address

4.2. +LNWKSKEY

+**LNWKSKEY** – Set network session key	
AT+LNWKSKEY=<netwskey>	Set command for the network session key. <netwskey> - 32 characters hexadecimal string Example: AT+LNWKSKEY=00112233445566778899aabbccddeeff

4.3. +LAPPSKEY

+**LAPPSKEY** – Set application session key	
AT+LAPPSKEY=<appskey>	Set command for application session key. <appskey> - 32 characters hexadecimal string Example: AT+APPSKEY=00112233445566778899aabbccddeeff

4.4. +LSENDDATA

+**LSENDDATA** – Send data to LoRa net	
AT+LSENDDATA=<data>, [frametype], [port]	Sends data over LoRa network. Will asynchronously write the status of the command when receive has been finished (in case of confirmed frame or unconfirmed frame with data). <data> - data to send in hexadecimal format [Frametype] - (optional) 0: unconfirmed (default) 1: confirmed [port] – (optional) 0-255 If this is omitted the port set by LPORT command is used, else this command overrides that setting. Example: AT+LSENDDATA=1234,1,1 Responses are listed below.

The asynchronous response from the send command will be one of the following:

+DL:ACK – Downlink with ACK received.
+DL:ACK,DATA – Downlink with ACK and data received.
+DL:DATA – Downlink with data received.

+DL:TIMEOUT – No downlink received.
+DL:TIMEOUT,RETRANSMISSION – No downlink received, retransmitting (only valid for confirmed frame with retransmissions enabled).
+DL:TIMEOUT,RETRANSMIT,INCORR_FRAME_LEN – Retransmission failed since the frame length is higher than what is allowed for the current data rate.

+DL:SRV_ACK_REQ: The gateway has requested ACK. This is only valid for class C devices and it will only arrive when the end node receives a confirmed frame that can't be automatically acknowledged due to duty cycle restrictions.

4.5. +LGETDATA

+**LGETDATA** – Get latest data, rssi & snr	
AT+LGETDATA	Returns the latest data along with RSSI,SNR and port. +LGETDATA:<data>,<rssi>,<snr>,<port> Data received will be shown as a hex string In case of timeout on the previous send command the response will be: +LGETDATA:TIMEOUT In case of the latest data being an ack only, the response will be: +LGETDATA:ACK,<rssi>,<snr>,<port>

4.6. +LSAVESET

+**LSAVESET** – Save current LoRa settings	
AT+LSAVESET	Saves current LoRa settings. These saved settings are automatically read back and applied on power-up.

4.7. +LRESTFACT

+**LRESTFACT** – Restore factory LoRa settings	
AT+LRESTFACT	Restores factory settings, including the factory set device EUI.

4.8. +LDEVEUI

+**LDEVEUI** – Set the LoRa device EUI	
AT+LDEVEUI=<deveui>	Set command for device EUI. <deveui> - 16 characters hexadecimal string Example: AT+LDEVEUI=0011223344556677
AT+LDEVEUI?	Read command returns the currently set device EUI. +LDEVEUI:<deveui> **<**deveui**> -** device EUI

4.9. +LAPPEUI

+**LAPPEUI** – Set the LoRa application EUI	
AT+LAPPEUI=<appeui>	Set command for application EUI <appeui> - 16 characters hexadecimal string Example: AT+LAPPEUI=0011223344556677
AT+LAPPEUI?	Read command returns the currently set application EUI. +LAPPEUI:<appeui> **<**appeui**> -** application EUI

4.10. +LAPPKEY

+**LAPPKEY** – Set application key	
AT+LAPPKEY=<appkey>	Set command for application key. <appkey> - 32 characters hexadecimal string Example: AT+LAPPKEY=00112233445566778899aabbccddeeff

4.11. +LTXPWR

+**LTXPWR** – Set LoRa transmit power	
AT+LTXPWR=<txpwr>	Set command for transmit power. <txpwr> - decimal string with output power. This setting is regional specific. See below for allowed values in the different regions. Example: AT+LTXPWR=1
AT+LTXPWR?	Read command returns the currently set output power. +LTXPWR:<txpwr> **<**txpwr**> -** transmit output power, refer to the above table for mapping.

EU 863-870MHz ISM Band:

LoRa transmit power value at module antenna pin without antenna gain.

Value	Description
0	14 dB **(default)**
1	12 dB
2	10 dB
3	8 dB
4	6 dB
5	4 dB
6	2 dB
7	0 dB

US 902-928MHz ISM Band:

LoRa transmit power value at module antenna pin without antenna gain.

Value	Description
0 *)	20 dBm
1 *)	20 dBm
2 *)	20 dBm
3 *)	20 dBm
4 *)	20 dBm
5	20 dBm **(default)**
6	18 dBm
7	16 dBm
8	14 dBm
9	12 dBm
10	10 dBm

*) *Maximum LoRa transmit power value is 20 dBm*

4.12. +LDATARATE

+**LDATARATE** – Set LoRa datarate	
AT+LDATARATE=<datarate>	Set command for datarate. <datarate> - decimal string with datarate. This setting is regional specific. See below for allowed values in the different regions. Example: AT+LDATARATE=0
AT+LDATARATE?	Read command returns the currently set datarate. +LDATARATE:<datarate> **<**datarate**> -** datarate value, refer to the above table for mapping.

EU 863-870MHz ISM Band:

Value	Description
0	SF12 / 125 kHz **(default)**
1	SF11 / 125 kHz
2	SF10 / 125 kHz
3	SF9 / 125 kHz
4	SF8 / 125 kHz
5	SF7 / 125 kHz
6	SF7 / 250 kHz
7	FSK: 50 kbps

US 902-928MHz ISM Band:

Value	Description
0	SF10 / 125 kHz
1	SF9 / 125 kHz
2	SF8 / 125 kHz
3	SF7 / 125 kHz **(default)**
4	SF8 / 500 kHz
8	SF12 / 500 kHz
9	SF11 / 500 kHz
10	SF10 / 500 kHz
11	SF9 / 500 kHz
12	SF8 / 500 kHz
13	SF7 / 500 kHz

4.13. +LPORT

+**LPORT** – Set LoRa transmit port	
AT+LPORT=<port>	Set command for the default transmit port. <port> - decimal string with port number. Allowed values are: 0-255 Please note that data sent on port 0 is only encrypted with NWKSKEY and not APPSKEY. Example: AT+LPORT=1
AT+LPORT?	Read command returns the currently set default transmit port. +LPORT:<port> **<**port**> -** default transmit port.

4.14. +LJOINM

+**LJOINM** – Set LoRa join mode	
AT+LJOINM=<joinmode>	Set command for the join mode. <joinMode> - decimal string with join mode setting. Allowed values are: 0: Activation by personalization (ABP) 1: Over the air activation (OTAA) Example: AT+LJOINM=0
AT+LJOINM?	Read command returns the currently set join mode. +LJOINM:<joinmode> <joinmode> - join mode, refer to the above table for mapping

4.15. +LADR

+**LADR** – Set LoRa adaptive data rate	
AT+LADR=<adr>	Set command for adaptive data rate. <adr> - ADR setting. Allowed values are: 0: Adaptive data rate disabled 1: Adaptive data rate enabled Example: AT+LADR=0
AT+LADR?	Read command returns the current ADR setting. +LADR:<adr> . Refer to the above table for mapping of ADR setting. **<**adr**> -** ADR setting.

4.16. +LJOINNET

+**LJOINNET** – Join LoRa network	
AT+LJOINNET	This command joins a LoRa network using the AppEUI and AppKey set previously. It has the return code below: +DL:JOIN_SUCESSS : join accepted +DL:JOIN_FAIL : join not accepted +DL:TIMEOUT : no response received In order to use this command the AT+LJOINM should be = 1 (OTAA). If completed successful, this command updates and stores APPSKEY, NWKSKEY, DEVADDR.
AT+LJOINNET?	Read command return the JOIN status. +LJOINNET:<joinstatus> <joinstatus> - join status. 0: Not joined 1: Joined

4.17. +LRX1DELAY

+**LRX1DELAY** – Set LoRa Receive 1 Delay	
AT+LRX1DELAY=<delay>	This command sets the delay after finished transmission until the first receive window opens. It also sets the second receive window delay to be RX1Delay + 1000 milliseconds. <delay> - delay in milliseconds. Allowed values are: 0 <= delay <= 511000 Example: AT+LRX1DELAY=1000
AT+LRX1DELAY?	Read command returns the currently set RX1Delay. +LRX1DELAY:<delay> <delay> - delay in milliseconds.

4.18. +LDEVCLASS

*) *Supported since firmware version 1.1*

+**LDEVCLASS** – Set LoRa Device Class	
AT+LDEVCLASS=<device class>	This command sets the device class. <device class> - character string with device class. Allowed values are: A: Class A C: Class C Example: AT+LDEVCLASS=C
AT+LDEVCLASS?	Read command returns the currently set device class. +LDEVCLASS:<device class> <device class> - character string with device class.

The switching between the different classes becomes active after sending a frame.

4.19. +LRX2FREQUENCY

+**LRX2FREQUENCY** – Set LoRa Receive 2 Frequency	
AT+LRX2FREQUENCY=<frequency>	This command sets the frequency for the second receive window. <frequency> - frequency in hertz. This setting is regional specific. See below for allowed values in the different regions. Example: AT+LRX2FREQUENCY=869525000
AT+LRX2FREQUENCY?	Read command returns the currently set RX2 frequency. +LRX2FREQUENCY:<frequency> <frequency> - frequency in hertz.

EU 863-870MHz ISM Band:

Allowed values are: 863000000 <= frequency <= 870000000
869525000 **(default)**

US 902-928MHz ISM Band:

Allowed values are: 902000000 <= frequency <= 928000000
923300000 **(default)**

4.20. +LRX2DATARATE

+**LRX2DATARATE** – Set LoRa Receive 2 Datarate	
AT+LRX2DATARATE=<datarate>	Set command for datarate. <datarate> - decimal string with datarate. This setting is regional specific. See below for allowed values in the different regions. Example: AT+LRX2DATARATE=0
AT+LRX2DATARATE?	Read command returns the currently set RX2 datarate. +LRX2DATARATE:<datarate> <datarate> - decimal string with datarate.

EU 863-870MHz ISM Band:

Value	Description
0	SF12 / 125 kHz **(default)**
1	SF11 / 125 kHz
2	SF10 / 125 kHz
3	SF9 / 125 kHz
4	SF8 / 125 kHz
5	SF7 / 125 kHz
6	SF6 / 250 kHz
7	FSK: 50 kbps

US 902-928MHz ISM Band:

Value	Description
0	SF10 / 125 kHz
1	SF9 / 125 kHz
2	SF8 / 125 kHz
3	SF7 / 125 kHz
4	SF8 / 500 kHz
8	SF12 / 500 kHz **(default)**
9	SF11 / 500 kHz
10	SF10 / 500 kHz
11	SF9 / 500 kHz
12	SF8 / 500 kHz
13	SF7 / 500 kHz

Note: Value Range 9 – 13 are defined for future extensions only.

4.21. +LJOIN1DELAY

+**LJOIN1DELAY** – Set LoRa Join Accept 1 Delay	
AT+LJOIN1DELAY=<delay>	This command sets the delay after finished transmission until the first join accept window opens. <delay> - delay in milliseconds. Example: AT+LJOIN1DELAY=5000
AT+LJOIN1DELAY?	Read command returns the currently set join 1 accept delay. +LJOIN1DELAY:<delay> <delay> - delay in milliseconds.

4.22. +LJOIN2DELAY

+**LJOIN2DELAY** – Set LoRa Join Accept 1 Delay	
AT+LJOIN2DELAY=<delay>	This command sets the delay after finished transmission until the join 2 accept window opens. <delay> - delay in milliseconds. Example: AT+LJOIN2DELAY=6000
AT+LJOIN2DELAY?	Read command returns the currently set join 2 accept delay. +LJOIN2DELAY:<delay> <delay> - delay in milliseconds.

4.23. +LNEXTTXTIME

+**LNEXTTXTIME** – Get wait time until next allowed transmission	
AT+LNEXTTXTIME	Returns the wait time needed until the next allowed transmission. In case the duty cycle management is disabled this command will return 0. +LNEXTTXTIME:<time> **<**time**> -** required wait time in milliseconds until next transmission.

4.24. +LUPCOUNTER

+**LUPCOUNTER** – Manage the uplink counter	
AT+LUPCOUNTER=<upcounter>	Sets the uplink counter to the specified value. <upcounter> - Uplink counter. Example: AT+LUPCOUNTER=1234
AT+LUPCOUNTER?	Returns the uplink counter. The uplink counter is saved to flash with the rest of the LoRa settings using the AT+LSAVESET command. It is also saved if the AT+DFUSTART command or the AT+SYSTEMOFF command is called. In addition to this it is also saved in the interval set with the AT+LCNTSAVEINT command. +LUPCOUNTER:<counter> **<**counter**> -** Uplink counter.

4.25. +LDOWNCOUNTER

+**LDOWNCOUNTER** – Manage the downlink counter	
AT+LDOWNCOUNTER	Returns the downlink counter. The downlink counter is saved to flash with the rest of the LoRa settings using the AT+LSAVESET command. It is also saved if the AT+DFUSTART command or the AT+SYSTEMOFF command is called. In addition to this it is also saved in the interval set with the AT+LCNTSAVEINT command. +LDOWNCOUNTER:<counter> **<**downcounter**> -** Downlink counter.

4.26. +LNUMRETR

+**LNUMRETR** – Set number of retransmissions	
AT+LNUMRETR=<retransmissions>	This command sets the number of retransmissions in case a confirmed frame fails to receive an ack. <retransmissions> - number of retransmissions. Allowed values are: 0 <= retransmissions <= 255 Example: AT+LNUMRETR=7
AT+LNUMRETR?	Read command returns the currently set number of retransmissions. +LNUMRETR:<retransmissions> <retransmissions> - number of retransmissions.

If the frame type is confirmed +LNUMRETR:1 is used internally even if another value is set with AT+LNUMRETR command.

4.27. +LCNTSAVEINT

+**LCNTSAVEINT** – Set interval for saving counters	
AT+LCNTSAVEINT=<interval>	This command sets the interval at which the uplink and downlink counter is saved to memory. <interval> - interval at which the counters are saved. Allowed values are: 0 <= interval <= 16384 Example: AT+LCNTSAVEINT=7
AT+LCNTSAVEINT?	Read command returns the currently set number of transmissions. +LCNTSAVEINT:<interval> <interval> - interval at which the counters are saved.

4.28. +LCHANCONF

+**LCHANCONF** – Modify channel configuration	
AT+LCHANCONF=<index>,<txfrequency>, <rx1frequency>,<drmax>,<drmin>	Allows modification of the channel configuration used by the device. This setting is regional specific. See below for allowed values in the different regions. <index> - index of the channel to change. <txfrequency> - TX frequency of the channel. <rx1frequency> - RX1 frequency of the channel. <drmax> - maximum datarate of the channel. <drmin> - minimum datarate of the channel. Example: AT+LCHANCONF=3,867100000,867100000,5,0
AT+LCHANCONF=<index>?	Read command returns the currently set channel configuration for the specified index. +LCHANCONF:<txfrequency>,<rx1frequency>,<drmax>,<drmin> <txfrequency> - TX frequency of the channel. <rx1frequency> - RX1 frequency of the channel. <drmax> - maximum datarate of the channel. <drmin> - minimum datarate of the channel.

EU 863-870MHz ISM Band:

A total of up to 16 channels is allowed. Channel configuration indexes 0,1 and 2 are reserved, can only be read and cannot be changed.

Allowed values for channel creation / modification are:

3 <= index <= 15
863000000 <= txfrequency <= 870000000
863000000 <= rx1frequency <= 870000000
0 <= drmax <= 7
0 <= drmin <= 7

Default channels: Index 0, 868.1 MHz, DR0-DR5
Index 1, 868.3 MHz, DR0-DR5
Index 2, 868.5 MHz, DR0-DR5

US 902-928MHz ISM Band:

A total of 72 channels are supported by RE866. All 72 channels are predefined. All channels can only be read and cannot be changed.

Default channels:

Index 0.. Index 63:

TXFrequency:_ 902.3 MHz + Index * 200 KHz,
RX1Frequency: 923.3 MHz + (Index modulo 8) * 600 kHz
Data Rate Range: DR0-DR3

Index 64.. Index 71:

TXFrequency: 903.0 MHz + (Index-64) * 1600 kHz
RX1Frequency: 923.3 MHz + (Index modulo 8) * 600 kHz
Data Rate Range: DR4-DR4

4.29. +LSUBBAND

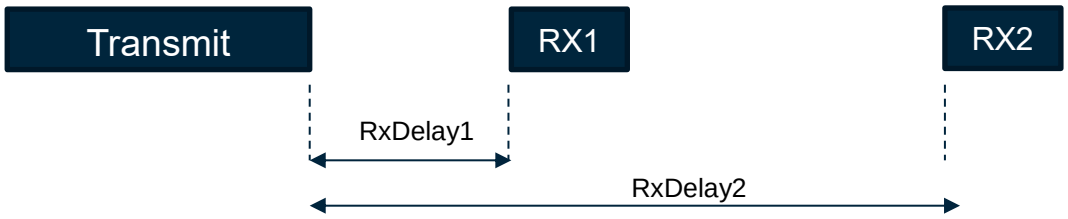
+**LSUBBAND** – Set sub band	
AT+LSUBBAND=<band>	Allows modification of which sub band to use. This setting is regional specific and is only applicable for US915. <band> - Which band to use. Use 0-7 to select a specific band and -1 to use all sub bands. (Default is -1) When set to specific sub band <n>, RE866 will use 8 consecutive uplink channels with 200 kHz channel spacing, starting at 902.3 MHz + 1.6 MHz * <n> for DR0-DR3 and one uplink channel at 903 MHz + 1.6 MHz * <n> for DR4. Example: AT+LSUBBAND=1
AT+LSUBBAND?	Read command returns the currently set sub band configuration. +LSUBBAND:<band> <band> - Which sub band to use. 0-7 if a specific band has been selected otherwise -1 (all bands are used)

5. APPENDIX

5.1. LoRa Class A device typical timing

Main characteristics:

- Bidirectional communications
- Unicast messages
- Small payloads, long intervals
- End-device initiates communications (uplink)
- Server communicates with end-device (downlink) during predetermined response windows:



Typical timing on the different intervals.

The following parameters are recommended values for the EU863-870MHz band.

RECEIVE_DELAY1 1 s

RECEIVE_DELAY2 2 s (must be RECEIVE_DELAY1 + 1s)

JOIN_ACCEPT_DELAY1 5 s

JOIN_ACCEPT_DELAY2 6 s

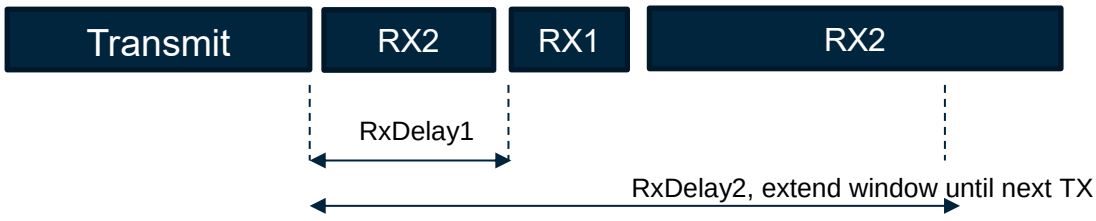
RX windows also depend on if you timeout (very short) and the datarate on RX2 and the length of the message.

On RE866 all the transaction TX and RX are completed if you receive the +DL:ACK, +DL:ACK,DATA or +DL:TIMEOUT.

5.2. LoRa Class C device typical timing

Main characteristics:

- Bidirectional communications
- Unicast and downlink multicast messages (multicast not supported by RE866)
- Higher payloads possible when compared to Class A
- Class C device will listen with RX2 window parameters as often as possible
- Higher current consumption of end device
- Both devices (end-device and server) can initiate communications
- The end-device uses the following response communicates with end-device (downlink) during predetermined response windows:



5.3. LoRa network ABP activation

In this case you have already all the information of the network and you can configure the module with the following information:

Device Address (DevAddr) - **AT+LDEVADDR=<addr>**

Network Session Key (NwkSkey) - **AT+LNWKSKEY=<netwskey>**

Application Session Key (AppSkey) - **AT+LAPPSKEY=<appskey>**

No over the air handshaking is performed and you have to set **AT+LJOINM=0.**

In this case you are ready to send the data as below.

```
[TX] - AT+LSENDDATA=1234,1<CR>
[RX] - AT+LSENDDATA=1234,1<CR>
<CR><LF>
OK<CR><LF>
+DL:ACK<CR><LF>
```

In case you will send data from the gateway to the node you can have also

```
[TX] - AT+LSENDDATA=1234,1<CR>
[RX] - AT+LSENDDATA=1234,1<CR>
<CR><LF>
OK<CR><LF>
+DL:ACK,DATA<CR><LF>
```

Where you can see also the DATA indication that mean that the server send data to the module and you can read with the following command.

```
[TX] - AT+LGETDATA<CR>
[RX] - AT+LGETDATA<CR>
<CR><LF>
+LGETDATA:1234,-64,27,1<CR><LF>
<CR><LF>
```

In this case the data sent by the server was 1234.

5.4. LoRa network OTAA activation

On OTAA activation the end device will do the following:

End-Device send the Join request

End-Device authenticates the Join Accept

End-Device decrypt the Join Accept

End-Device extracts and stores the device Address (DevAddr)

End-Device derives:

Network Session Key (NwSkey)

Application Session Key (AppSKey)

On the RE866 the following AT command should be executed.

Set AppEUI

```
[TX] - AT+LAPPEUI=0123456789abcdef<CR>
[RX] - AT+LAPPEUI=0123456789abcdef<CR>
<CR><LF>
```

Set the AppKey

```
[TX] - AT+LAPPKEY=0123456789abcdef0123456789abcdef<CR>
[RX] - AT+LAPPKEY=0123456789abcdef0123456789abcdef<CR>
<CR><LF>
```

Set the activation mode as OTAA with the following command.

```
[TX] - AT+LJOINM=1<CR>
[RX] - AT+LJOINM=1<CR>
<CR><LF>
```

We are ready now to join the network but before it, let's disable the BT advertising with the command.

```
[TX] - AT+LEADE=3<CR>
[RX] - AT+LEADE=3<CR>
<CR><LF>
```

Let's join the network.

```
[TX] - AT+LJOINNET<CR>
[RX] - AT+LJOINNET<CR>
<CR><LF>
OK<CR><LF>
+DL:JOIN_SUCCESS<CR><LF>
```

As shown if success you will get JOIN SUCCESS message otherwise JOIN FAIL or timeout.

Now we can send data with

```
[TX] - AT+LSENDDATA=1234,1<CR>
[RX] - AT+LSENDDATA=1234,1<CR>
<CR><LF>
OK<CR><LF>
+DL:ACK<CR><LF>
```

In case you will send data from the gateway to the node you can have also

```
[TX] - AT+LSENDDATA=1234,1<CR>
[RX] - AT+LSENDDATA=1234,1<CR>
<CR><LF>
OK<CR><LF>
+DL:ACK,DATA<CR><LF>
```

Where you can see also the DATA indication that mean that the server send data to the module and you can read with the following command.

```
[TX] - AT+LGETDATA<CR>
[RX] - AT+LGETDATA<CR>
<CR><LF>
+LGETDATA:1234,-64,27,1<CR><LF>
<CR><LF>
```

In this case the data sent by the server was 1234.

5.5. RE866 Factory Default Settings

The following are the factory default settings for LoRa related parameters of the module.

Setting name	Associated command	Factory setting
Device EUI	AT+LDEVEUI	Factory programmed Device EUI.
Device Address	AT+LDEVADDR	Cleared.
Network session key	AT+LNWKSKEY	Cleared.
Application session key	AT+LAPPSKEY	Cleared.
Application EUI	AT+LAPPEUI	Cleared.
Application Key	AT+LAPPKEY	Cleared
TX Power	AT+LTXPWR	Region specific setting
TX Datarate	AT+LDATARATE	Region specific setting
TX Port	AT+LPORT	1
Number of retransmissions	AT+LNUMRETR	7
Join Mode	AT+LJOINM	1 (OTAA)
Network Joined	AT+LJOINNET	0 (not joined)
Adaptive Datarate	AT+LADR	1 (enabled)
RX1 Delay	AT+LRX1DELAY	1000
Join Accept 1 Delay	AT+LJOIN1DELAY	5000
Join Accept 2 Delay	AT+LJOIN2DELAY	6000
RX2 Frequency	AT+LRX2FREQUENCY	Region specific setting
RX2 Datarate	AT+LRX2DATARATE	Region specific setting
Uplink Counter	AT+LUPCOUNTER	1
Downlink Counter	AT+LDOWNCOUNTER	0
Channel Configuration	AT+LCHANCONF	Region specific setting
Counter save interval	AT+LCNTSAVEINT	1000

5.6. RE866 Uplink Counter Management

RE866 handles the uplink counter automatically. In case of an unexpected power loss the end device will start up with the latest saved counter value. This will cause the LoRa server to reject all future packets unless a recovery is made or the network is rejoined. Rejoining is not possible with ABP, therefore it is suggested that the end device takes the action to increase the uplink counter by the interval setting returned from AT+LCNTSAVEINT command should an unexpected power loss occur.

5.7. Data Formats

5.7.1. Data Array

Data arrays (hex strings) are encoded as a hexadecimal Ascii based byte stream.

E.g. a Byte array containing the four bytes 0x11, 0x22, 0x33 and 0x44 is encoded as:
11223344

5.7.2. Bluetooth Address

The RE866 supports public and random Bluetooth addresses. The differentiation between the address types is done using the parameter “t2” for public addresses and “t3” for random addresses.

A Bluetooth address value itself is a special byte array variant. There are two valid representations.

The Bluetooth addresses “**008025540203**” and **00:80:25:54:02:03** are equivalent.

e.g. public address: 00:80:25:54:02:03,t2 or 008025540203,t2

random address: F1:B9:EB:41:D8:1E,t3 or F1B9EB41D81E,t3

5.7.3. UUID

UUIDs are special byte array variants.

16 Bit UUIDs are encoded with four hexadecimal digits. E.g. UUID 0xFEFB is encoded as FEFB.

128 Bit UUIDs are encoded with 32 hexadecimal digits.
E.g. 00000002000010008000008025000000.

The format 00000002-0000-1000-8000-008025000000 known from the profile specifications is also supported for 128 bit UUIDs.

5.7.4. Values

A parameter value could be encoded hexadecimal or signed decimal. The value range depends on the command specification.

Hexadecimal values shall be encoded with a leading “0x” e.g. 0x01FF.

Positive decimal values shall be encoded without a leading character e.g. 512.

Negative decimal values shall be encoded with a leading “-“ e.g. -69.

5.7.5. Bit Arrays

Bit arrays shall be coded as hexadecimal values with a leading “0x”.

For an example see parameter PROP in command AT+LESCAN.

5.8. Linktype

Linktype	Meaning
0x02	Bluetooth low energy using public address
0x03	Bluetooth low energy using random address

5.9. AT Result Codes

Result codes (numerical and verbose):

Numeric	Text	Meaning	Extended Result Codes
0	OK	Command completed	No
2	RING	Indicates an incoming call	Yes
3	NO CARRIER	Connection disconnected	Yes
4	ERROR	Illegal command or error	No
10	CONNECT TIO	TIO connection established	Yes

Extended result codes (numerical and verbose) are available after activation with **ATW1** command.

In multiplexing mode extended result codes are always active.

OK — Command Completed

Syntax: **OK**

Command completed successfully.

CONNECT — Connection Established

Syntax: **CONNECT connType connHnd [<bdaddr linktype>]**

With this result code the user is informed about the establishment of a connection. The connHnd hast to be used for characteristic access for this device.

Param.	Description
connType	Type of connection TIO
connHnd	Connection handle or TIO MUX channel ID
Bdaddr	Remote Bluetooth address, only as extended result code
Linktype	Remote Bluetooth address type see chapter Linktype, only as extended result code

The parameter connType has different meanings depending on operation mode.

AT mode: connType represents the connection handle used for ATH and GATT client access commands like AT+LEREAD, etc..

MUX mode: Additionally to AT mode description, the value of connHnd represents the channel ID of the automatically established data MUX channel for connections with connType=TIO. Data MUX channels for connections with connType=GATT have to be established using the AT+LEADDCHAN command.

NO CARRIER — Connection Disconnected

Syntax: **NO CARRIER connHnd [<error code>]**

With this result code the user is informed about the disconnection of a connection.

Param.	Description
connHnd	Connection handle from CONNECT event
error code	Bluetooth release code

RING — Link Request Received

Syntax: **RING [<bdaddr linktype>]**

With this result code the user is informed about an incoming connection request.

Param.	Description
Bdaddr	Remote Bluetooth address, only as extended result code
Linktype	Remote Bluetooth address type see chapter Linktype, only as extended result code

ERROR	Illegal Command or Error

Syntax: **ERROR**

With this result code the user is informed about an error condition. This could be e.g.:

- an illegal command syntax
- an illegal state for the command
- an error that cannot be indicated otherwise

5.10. Release/Error Codes

The following table shows the release/error codes:

Error code	Meaning
0x0000	Success
0x0001	Accept
0x0002	Reject
0x0003	Resource error
0x0004	Invalid parameter
0x0005	Invalid state
0x0006	Connection disconnect
0x0007	Connection paused
0x0008	Connection lost
0x0009	Authentication failed
0x000A	Flow control violation
0x000B	Init timeout
0x000C	Init out of sync
0x000D	Init hardware failure
0x000E	Lower layer error
0x00FD	Unspecified
0x00FE	Not supported

Examples:

Normal mode	Numerical (ATV0)	3 <0006>
	Verbose (ATV1)	NO CARRIER <0006>
MUX mode	Numerical (ATV0)	3 <0006 0x01>
	Verbose (ATV1)	NO CARRIER <0006 0x01>

5.11. Events

SSPPIN — SSP Passkey Request

Syntax: **SSPPIN Bdaddr,tx ?**

With this event the module requests the entry of the PIN displayed on the remote device.

Param.	Description
Bdaddr	Remote Bluetooth address
tx	x is the remote Bluetooth address type (see chapter Bluetooth Address)

SSPPIN — SSP Passkey Display

Syntax: **SSPPIN Bdaddr,tx Passkey**

With this event the module shows the PIN to be entered on the remote device.

Param.	Description
Bdaddr	Remote Bluetooth address
tx	x is the remote Bluetooth address type (see chapter Bluetooth Address)
Passkey	PIN to be entered on remote side

LEIND — Indication Received

Syntax: **LEIND:connHnd,charHnd,<hexData>**

With this event data received over the air with an indication is displayed to the user. To receive these type of event please enable indications with command AT+LECCCD if allowed for the characteristic.

Param.	Description
connHnd	Connection handle from CONNECT event
charHnd	Characteristic handle from AT+LESRVD
hexData	Ascii coded byte stream as hexadecimal values e.g. 017aFF for a three byte value

LENOTI Notification Received

Syntax: **LENOTI:connHnd,charHnd,<hexData>**

With this event data received over the air with a notification is displayed to the user. To receive these type of event please enable notifications with command AT+LECCCD if allowed for the characteristic.

Param.	Description
connHnd	Connection handle from CONNECT event
charHnd	Characteristic handle from AT+LESRVD
hexData	Ascii coded byte stream as hexadecimal values e.g. 017aFF for a three byte value

LEERROR Error Condition Occurred

Syntax: **LEERROR:type, [parameter]**

With this event the user is informed about error conditions. Depending on error type different parameters are provided.

Type	Parameter	Mode	Description
LEWRITE	connHnd, charHnd, cause	MUX	Write with response
LEREAD	connHnd, charHnd, cause	MUX	Read
LEMUX	connHnd, charHnd, cause	MUX	Generic error for several situations
LECHAN	channel,cause	MUX	Wrong channel number in command

LECONPARAM Connection Parameters Updated

Syntax: **LECONPARAM:connHnd,connInt,slaveLat,connTimeout**

With this event the user is informed about a connection parameter update.

Param.	Description
connHnd	Connection handle from CONNECT event
connInt	Actual connection interval in steps of 1.25 ms
slaveLat	Actual slave latency in connection intervals
connTimeout	Actual connection supervision timeout in steps of 10 ms

SSPCONF SSP Passkey Confirmation

Syntax: **SSPCONF: Bdaddr,tx Passkey ?**

With this event the module requests the confirmation of the passkey displayed on both devices.

Param.	Description
Bdaddr	Remote Bluetooth address
tx	x is the remote Bluetooth address type (see chapter Bluetooth Address)
Passkey	Passkey to be acknowledged on local side (see command BSSPCONF)

6. GLOSSARY AND ACRONYMS

AT	Attention Command
GATT	Generic Attribute Profile
MUX	Multiplexing
SSP	Secure Simple Pairing
UUID	Universal Unique Identifier
TTSC	Telit Technical Support Centre
USB	Universal Serial Bus
DTE	Data Terminal Equipment
UART	Universal Asynchronous Receiver Transmitter

7. DOCUMENT HISTORY

Revision	Date	Changes
9	2017-10-26	First release
10	2018-01-03	Corrected value of +PNPPID Reworked formatting
11	2018-05-02	Added new +LDEVCLASS command Corrected default values of +LJOINM and +LADR Revised value range of +LDATARATE and +LNUMRETR Added value range of +LRX1DELAY Revised description of +SYSTEMOFF Removed read command of +LNWKSKEY, +LAPPSKEY, +LAPPKEY Removed +LDUTYCYCLE Added RE866A1-NA variant Added region specific settings for EU and US
12	2018-07-06	Added new +LSUBBAND command

SUPPORT INQUIRIES

Link to **www.telit.com** and contact our technical support team for any questions related to technical issues.

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