Radio Evaluation Program

Commands Reference

Introduction

This document is the AT Command Reference Manual for the Radio Evaluation Program (RadioEvalApp).
Note: This software is free of charge for evaluation purposes only and provides no guarantee.

Version

V4.60

Features

- Supports LoRa modulation and FSK modulation
- Supports User Command Interface based on AT Commands format
- Supports unmodulated and modulated wave transmission
- Supports packet transmission with 4 types of payload data (PN9, DevEUI, user-defined data, Sensor)
- Supports continuous or single packet reception
- Supports LBT (Listen Before Talk), ED (Energy Detection), and ToA (Time on Air) calculation
- Supports radio configurations validation for regional radio regulations

Target Devices

- MCU: Renesas RA2E1, RA2L1, RA0E1, RA0E2, RL78/G23, RL78/G22, RL78/L23 or RL78/G14
- Transceiver: Semtech SX1261 (max: +15dBm) or SX1262 (max: +22dBm)
- Sensor: Renesas HS3001 (Humidity and Temperature Sensor)

Figure 1. Overview

Reference Document

	Document No.	Title	Language
[1]	R11AN0227	Radio Driver Reference Guide	English
[2]	R11AN0834	Radio Driver Support Functions for Regional Radio Regulations	English
[3]	R11AN0595	RL78/G23, RL78/G22, RL78/L23, RL78/G14 LoRa®-based Wireless Software Package	English
[4]	R11AN0596	RA2E1, RA2L1, RA0E1, RA0E2 LoRa®-based Wireless Software Package	English
[5]	R11AN0937	Smart Configurator Usage for RL78 LoRa®-based Wireless Software Reference Guide	English

Contents

1. Getting Started

1.1 Set up the Radio Evaluation Program

Refer to [3] for RL78 and [4] for RA2 and RA0 for the setup.

1.2 Serial/UART Interface Configuration

The settings for the Serial/UART interface are shown in Table 1.

Table 1. Serial/UART interface configuration

Configuration Items	Value
Baud rate	115200 bps (*)
Data bit	8 bits
Parity bit	None
Stop bit	1 bit
Flow control	None
Local echo back	Yes
Line terminator	Transmission: CR+LF Reception: CR+LF

(*)Note: For RL78/L23, when UARTAn is used and sub clock (fSXP) is selected as the operation clock of UARTAn, the maximum baud rate is 2400 bps.

1.3 Sensor/I2C Interface Configuration (Optional)

By default, the HS3001 Sensor driver and I²C interface driver are implemented. If you do not need those drivers, you can delete those drivers to save ROM size:

- For RL78, delete “RP_USE_IICA” macro from IDE C/C++ preprocessor settings.
- For RA, delete “g_hs300x_sensor0” from the Stack view of the RA Configurator.

2. AT Command Syntax

2.1 Definitions

The following syntactical definitions apply:

<CR> Carriage return character such as “\r”.

<LF> Linefeed character such as “\n”.

<…> Name enclosed in angle brackets is a syntactical element.

[…] Optional parameter of a command. Brackets themselves do not appear in the command line.

2.2 Syntax

2.2.1 General Command Syntax

The prefix “AT” or “at” (not case sensitive) should be included at the beginning of each command line. All commands must be terminated by <CR><LF>. A new command must not be issued before the firmware has terminated the sending of its response result code (for example, “OK”). All commands are not case sensitive.

2.2.2 Extended Command Syntax

The Extended Command syntax has several formats, as shown in Table 2.

Table 2. Extended Command Syntax

Type	Syntax	Description	Example
Get	AT+<name>?	Get current parameter settings.	AT+FREQ?
Set	AT+<name>=<params>	Set new parameters.	AT+TXPWR=10
Action	AT+<name>	Execute without parameters.	AT+SEND
Set & Action	AT+<name>=<params>	Execute with parameters.	AT+RECV=0

2.2.3 Response Syntax

The command responses consist of the <Information Response> and <Result Code> as described below:

- <CR><LF><Information Response><CR><LF> for Extended Command only
- <CR><LF><Result Code><CR><LF> for Basic and Extended Command

The <Information Response> syntax is “+<command>:<messages>”. For example: “+FREQ:923000000”.

The <Result Code> syntax is “OK”, “ERROR”, or “BUSY”:

- “OK”: Command runs correctly without error.
- “ERROR” Command is cancelled with error (for example: command format error, parameter out of range, and so on.).
- “BUSY”: Command is cancelled because the previous command is still running.

3. AT Commands

Table 3 summarizes the available AT Commands.

Table 3. AT Commands

Type	Command	Description	State
INIT	AT	Test serial connection.	ANY
	AT+RESET	Reset and load all settings from data flash memory.	ANY
RF	AT+MODEM	Set modem type (LoRa or FSK).	IDLE
	AT+FREQ	Set the radio center frequency.	IDLE
	AT+LMCFG	Set LoRa modulation parameters.	IDLE
	AT+LPCFG	Set LoRa packet parameters.	IDLE
	AT+FMCFG	Set FSK modulation parameters.	IDLE
	AT+FPCFG	Set FSK packet parameters.	IDLE
TX	AT+SEND	Start transmitting the packets.	IDLE
	AT+TXPWR	Set Tx output power.	IDLE
	AT+TXTO	Set Tx timeout.	IDLE
	AT+PKT	Set Tx packet data. / Set Rx expected data for PER/BER test.	IDLE
	AT+LBT	Set LBT (Listen Before Talk) parameters. / Test LBT.	IDLE
	AT+TXCW	Start transmitting the unmodulated continuous wave.	IDLE
	AT+TXCP	Start transmitting the modulated continuous wave.	IDLE

RX	AT+RECV	Start receiving the packets.	IDLE
	AT+RXTO	Set Rx timeout and Symbol timeout.	IDLE
	AT+RXGAIN	Set Rx gain mode.	IDLE
	AT+RSSI	Set RSSI offset. / Show instantaneous RSSI value.	IDLE
CTRL	AT+STOP	Stop Tx and Rx. / Show the statistical result of Rx.	ANY
	AT+STAT	Show the current state of the program.	ANY
UTIL	AT+XTRIM	Set XTAL trimming register to adjust radio center frequency.	IDLE
	AT+SAFE	Set safe mode to support Japanese radio regulation.	IDLE
	AT+TOA	Show the Time on Air.	IDLE
	AT+REGW	Write RF device register.	ANY
	AT+REGR	Read RF device register.	ANY
	AT+SLEEP	Test sleep mode.	IDLE
	AT+DEVEUI	Set the Device EUI (MAC Address).	IDLE
	AT+SAVE	Store all settings into the data flash memory.	IDLE
	AT+ERASE	Erase data flash memory and store system default settings.	IDLE
	AT+HELP	Show the usage of AT Commands.	ANY
	AT+LIST	Show the current settings.	ANY
	AT+VER	Show the program version.	ANY

3.1 AT Commands Sequence

The AT Commands should be issued in the sequence shown in Figure 2 since some commands have a dependency on each other.

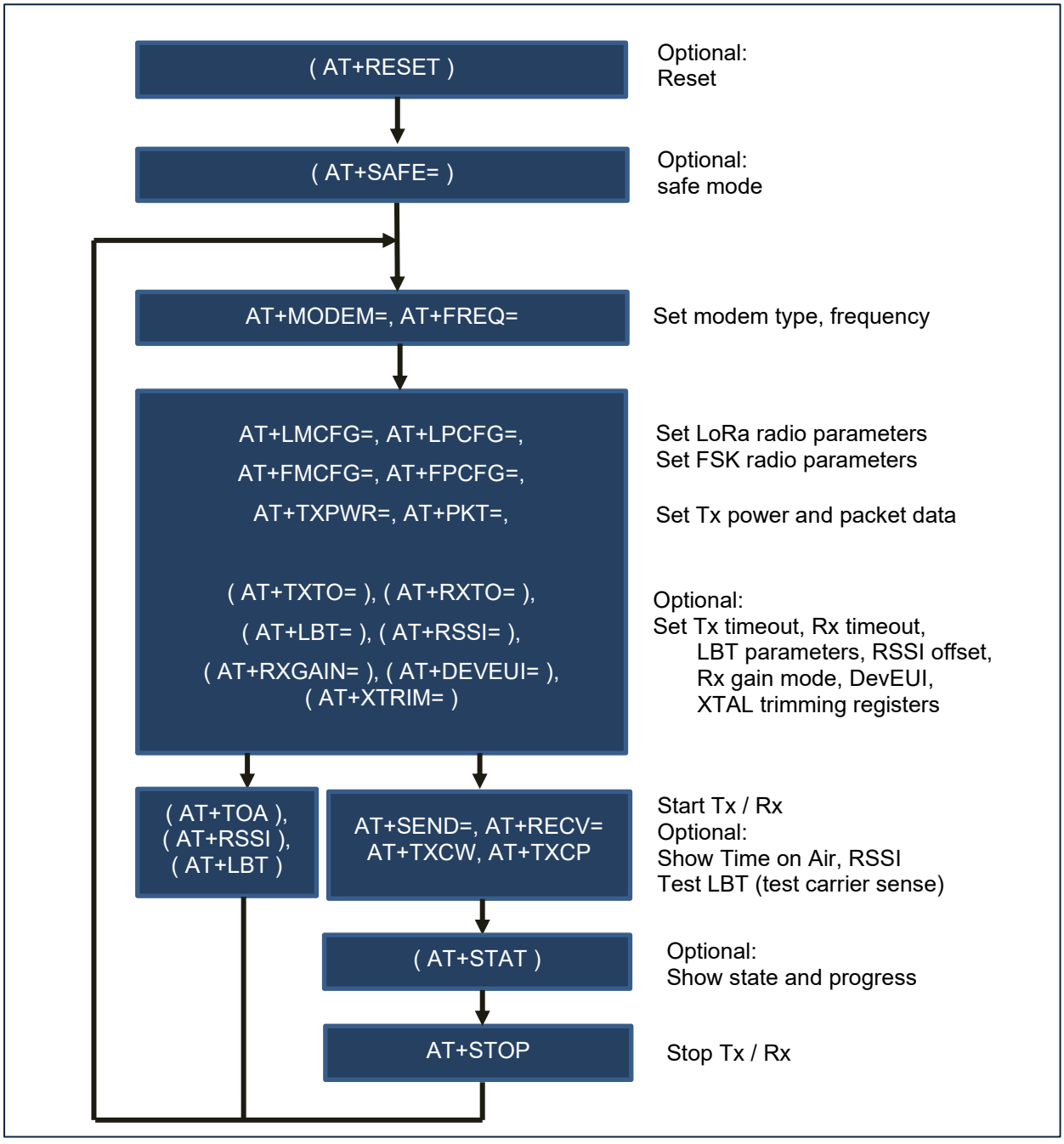

Figure 2. AT Command Sequence

3.2 AT Commands Reference

3.2.1 AT

[Command syntax]

```
AT
```

[Description]

This command tests the serial connection. If the device is connected, the returned Result code is “OK”.

[Result codes]

OK

3.2.2 AT+RESET

[Command syntax]

```
AT+RESET
```

[Description]

This command performs the hardware reset and loads all the settings from the data flash memory.

[Result codes]

OK

3.2.3 AT+MODEM

[Command syntax]

```
AT+MODEM=<ModemType>
AT+MODEM?
```

[Description]

This command sets the modem type (FSK or LoRa).

[Parameters]

<ModemType>	0: FSK 1: LoRa (default)

[Result codes]

OK, ERROR, or BUSY

3.2.4 AT+FREQ

[Command syntax]

```
AT+FREQ=<Frequency>
AT+FREQ?
```

[Description]

This command specifies the radio center frequency.

[Parameters]

<Frequency>	The radio center frequency (resolution: 100 [Hz]): 426000000 to 928000000 [Hz] (default: 923000000 [Hz]).

[Result codes]

OK, ERROR, or BUSY

3.2.5 AT+LMCFG

[Command syntax]

```
AT+LMCFG=<spreadFactor>,<bandWidth>,<codingRate>
AT+LMCFG?
```

[Description]

This command specifies the LoRa modulation configuration.

[Parameters]

<spreadFactor>	The spread factor: 5: SF5 6: SF6 7: SF7 (default) 8: SF8 9: SF9 10: SF10 11: SF11 12: SF12
<bandWidth>	The bandwidth: 0: 125 [kHz] (default) 1: 250 [kHz] 2: 500 [kHz] 3: 62 [kHz] 4: 41 [kHz] 5: 31 [kHz] 6: 20 [kHz] 7: 15 [kHz] 8: 10 [kHz] 9: 7 [kHz]
<codingRate>	The coding rates: 1: 4/5 (default) 2: 4/6 3: 4/7 4: 4/8

[Result codes]

OK, ERROR, or BUSY

3.2.6 AT+LPCFG

[Command syntax]

```
AT+LPCFG=<preambleLen>,<fixedLength>,<crcOn>,<invertIQ>,<publicNetwork>
AT+LPCFG?
```

[Description]

This command specifies the LoRa packet (frame) configuration.

[Parameters]

<preambleLen>	The number of preamble symbols: 1 to 65535 [symbols] (default 8 [symbols]).
<fixedLength>	The packet length type (header type): 0: Variable length packet (explicit header) (default) 1: Fixed length packet (implicit header).
<crcOn>	The payload CRC(CRC16-CCITT) enable:

	0: CRC off 1: CRC on (default).
<invertIQ>	The IQ polarities: 0: Standard IQ setup (uplink in LoRaWAN) (default) 1: Inverted IQ setup (downlink in LoRaWAN).
<publicNetwork>	The network type (sync word type): 0: Private Network (default) 1: Public Network (LoRaWAN).

[Result codes]

OK, ERROR, or BUSY

3.2.7 AT+FMCFG

[Command syntax]

```
AT+FMCFG=<dataRate>,<bandWidth>,<fDev>
AT+FMCFG?
```

[Description]

This command specifies the FSK modulation configuration.

[Parameters]

<dataRate>	Tx bit rate: 600 to 300000 [bps] (default 50000 [bps]).
<bandWidth>	Rx bandwidth: 1 to 467000 [Hz] (default 50000 [Hz]). <bandWidth> is rounded up to the following internal value: 4800 5800 7300 9700 11700 14600 19500 23400 29300 39000 46900 58600 (actual default value) 78200 93800 117300 156200 187200 234300 312000 373600 467000 For example, <bandWidth>=50000 → Actual internal bandwidth=58600[Hz].
<fDev>	Tx frequency deviation [Hz] (default 25000 [Hz]).

[Result codes]

OK, ERROR, or BUSY

3.2.8 AT+FPCFG

[Command syntax]

```
AT+FPCFG=<preambleLen>,<fixedLength>,<crcOn>
AT+FPCFG?
```

[Description]

This command specifies the FSK packet (frame) configuration.

[Parameters]

<preambleLen>	The length of preamble: 1 to 8191 [bytes] (default 5 [bytes]).
<fixedLength>	The packet length type (header type): 0: Variable length packet (explicit header) (default) 1: Fixed length packet (implicit header).
<crcOn>	The payload CRC (CRC16-CCITT) enable: 0: CRC off 1: CRC on (default).

[Result codes]

OK, ERROR, or BUSY

3.2.9 AT+SEND

[Command syntax]

```
AT+SEND=<pktNum>[,<pktDelay>[,<verboseMode>]]
AT+SEND
```

[Description]

This command starts transmitting the packets, with delay, until reaching the limit or sending “AT+STOP”. The packet payload is specified by “AT+PKT”. The limit is specified by parameter <pktNum>. The packet delay is specified by parameter <pktDelay>. If no parameter is specified, this command is performed with latest parameter settings. While sending packets, if the Tx timeout specified by “AT+TXTO” expires, the indication is reported with “+INFO:TX_TIMEOUT”.

[Parameters]

<pktNum>	1 to 400000000 in decimal (default 1).
<pktDelayl>	1 to 3600000 [ms] (default 3000 [ms]).
<verboseMode>	0: Silent Mode. No additional information is reported. Use Silent Mode for PER/BER test. 1: Verbose Mode (default). Reports current sequence number (see [Response]).

[Response]

Response	+TX:<seqNum>
<seqNum>	Current sequence number (1 ... <pktNum>).

[Result codes]

OK, ERROR, or BUSY

3.2.10 AT+TXPWR

[Command syntax]

```
AT+TXPWR=<txPower>
AT+TXPWR?
```

[Description]

This command specifies the transmission power for LoRa and FSK.

[Parameters]

<txPower>	SX1261: -17 to 15 [dBm] in decimal (default 0 [dBm]). SX1262: -9 to 22 [dBm] in decimal (default 0 [dBm]).

[Result codes]

OK, ERROR, or BUSY

3.2.11 AT+TXTO

[Command syntax]

```
+TXTO=<txTimeout>
+TXTO?
```

[Description]

This command sets the transmission command timeout duration for a single packet for the current modem. Therefore, the setting for LoRa and FSK can be specified separately.

[Parameters]

<txTimeout>	1 to 65535 [ms] (default 1000 [ms]).

[Result codes]

OK or ERROR

3.2.12 AT+PKT

[Command syntax]

```
AT+PKT=<payloadType>,<payloadLen> or <payloadData>
AT+PKT?
```

[Description]

This command specifies the transmission data and expected reception data for PER/BER testing.

[Parameters]

<payloadType>	1: PER (default) Pre-defined payload data for PER test: Format: “PER” (504552) + Sequence Number (4 bytes) + PN9 (binary) Length: <payloadLen> 2: BER Pre-defined payload data for BER test: Format: PN9 (binary) Length: <payloadLen> 3: ANY User-defined payload data specified by <payloadData> in hex: Length: Bytes of <payloadData> 4: EUI Pre-defined payload data including the Device EUI: Format: “EUI (455549) + Device EUI (8 bytes) + PN9 (binary) Length: <payloadLen> 5: EXT(Sensor) Sensor values with ID (ID is lowest byte of the Device EUI): Format: ID (1 byte) + Humidity (2 bytes) + Temperature (2 bytes) Humidity: uint16_t unit 0.1%, Temperature: int16_t unit 0.1°C Length: <payloadLen> (Len < 5: truncated. Len > 5: padding 0x00)

	Note: The sensor takes 4 seconds to measure.
<payloadLen>	The payload length for <payloadType> = 1(PER) or 2(BER) or 4(EUI): 0 to 255 in decimal (default 16).
<payloadData>	The payload data for <payloadType> = 3(ANY): 1 to 255 [bytes] in hex (see [Examples]).

[Result codes]

OK, ERROR, or BUSY

[Examples]

```
AT+PKT=03,112233445566778899AABBCCDDEEFF
OK
```

The pre-defined payload for PER/BER

	The pre-defined payload (max 255 [bytes]), sending/receiving MSB first)
PN9 data	FF83DF1732094ED1E7CD8A91C6D5C4C44021184E5586F4DC8A15A7EC92DF93533018C A34BFA2C759678FBA0D6DD82D7D540A57977039D27AEA243385ED9A1DE1FF07BE2E6 4129DA3CF9B15238DAB89888042309CAB0DE9B9142B4FD925BF26A6603194697F458EB 2CF1F741ADBB05AFAA814AF2EE073A4F5D448670BDB343BC3FE0F7C5CC8253B479F3 62A471B571311100846139561BD37228569FB24B7E4D4CC06328D2FE8B1D659E3EE835B 760B5F550295E5DC0E749EBA890CE17B6687787FC1EF8B9904A768F3E6C548E36AE262 20108C272AC37A6E450AD3F6496FC9A9980C651A5FD163ACB3C7DD06B6EC16BEAA05 2BCBB81CE93D751219C2F6CD0EF

3.2.13 AT+LBT

[Command syntax]

```
AT+LBT=<lbtEnable>[,<rssiThreshold>,<ccaDuration>,<ccaBandWidth>]
AT+LBT?
AT+LBT
```

[Description]

This command sets the LBT (Listen Before Talk) parameters. If LBT is enabled while energy is detected on the air, the transmission is canceled and is re-scheduled at the next transmission. If no parameter is specified, this command performs carrier sense to detect energy and returns the result (see [Response]).

[Parameters]

<lbtEnable>	0: Disables LBT (default) 1: Enables LBT.
<rssiThreshold >	0 to -128 [dBm] (default -80 [dBm]).
<ccaDuration>	1 to 10 [ms] (default 5 [ms]).
<ccaBandWidth>	0: (Use the bandwidth specified by “AT+FMCFG/LMCFG” (default). Other values: 4800, 5800, 7300, 9700, 11700, 14600, 19500, 23400, 29300, 39000, 46900, 58600, 78200, 93800, 117300, 156200, 187200, 234300, 312000, 373600, 467000 [Hz]

[Response]

Response(Action)	+LBT:<detection>,<rssiValue>
<detection>	0: Not detected 1: Detected.
<rssiValue>	0 to -127 [dBm].

[Result codes]

OK, ERROR, or BUSY

3.2.14 AT+TXCW

[Command syntax]

```
+TXCW
```

[Description]

This command transmits the unmodulated continuous wave until the “AT+STOP” command is sent. If safe mode is enabled (AT+SAFE=1), this command returns ERROR.

[Result codes]

OK, ERROR, or BUSY

3.2.15 AT+TXCP

[Comman”d syntax]

```
+TXCP
```

[Description]

This command transmits the modulated wave until the “AT+STOP” command is sent. If safe mode is enabled (AT+SAFE=1), this command returns ERROR.

[Result codes]

OK, ERROR, or BUSY

3.2.16 AT+RECV

[Command syntax]

```
AT+RECV=<rxMode>[,<verboseMode>]
AT+RECV?
AT+RECV
```

[Description]

This command starts receiving the packets. If no parameter is specified, this command is executed with latest parameter settings.

[Parameters]

<rxMode>	0: Continuous Rx Mode (default) Repeats single Rx with no Rx timeout until “AT+STOP” is sent. 1: Single Rx Mode Performs single Rx with Rx timeout specified by “AT+RXTO”. If Rx timeout is expired, indication is reported as: +INFO:RX_TIMEOUT
<verboseMode>	0: Silent Mode No additional information is reported. Use Silent Mode for PER/BER test. 1: Verbose Mode (default) Received packet information is reported (see [Response]).

[Response]

Response	+RX:<payload>,<rssi>,<snr>,<error>
<payload>	HEXASCII (for example, 001122AABBCC).
<rssi>	Decimal [dBm] (for example, -78).
<snr>	Decimal [dB] (for example, 10).
<error>	0:No error 1:CRC error 2:Rx timeout.

[Result codes]

OK, ERROR, or BUSY

3.2.17 AT+RXGAIN

[Command syntax]

```
+RXGAIN=<gainMode>
+RXGAIN?
```

[Description]

This command specifies the Rx Gain mode for both LoRa and FSK.

[Parameters]

<gainMode>	0: Rx Power Saving Gain mode (default) 1: Rx Boosted Gain mode.

[Result codes]

OK, ERROR, or BUSY

3.2.18 AT+RXTO

[Command syntax]

```
AT+RXTO=<rxTimeout>[,<symbolTimeout>]
AT+RXTO?
```

[Description]

This command specifies the reception timeout and symbol timeout. The symbol timeout setting for LoRa and FSK can be specified separately.

[Parameters]

<rxTimeout>	1 to 65535 [ms] (default 1000[ms]).
<symbolTimeout>	1 to 255 [symbols] in decimal (default 5 [symbols]) for LoRa. 1 to 65535 [bytes] in decimal (default 5 [bytes]) for FSK.

[Result codes]

OK, ERROR, or BUSY

3.2.19 AT+RSSI

[Command syntax]

```
AT+RSSI=<rssiOffset>
AT+RSSI?
AT+RSSI
```

[Description]

This command sets the offset of the RSSI value. If no parameter is specified, this command reports the instantaneous RSSI using FSK modem. Before using this command, AT+MODEM=0(FSK) is required.

[Parameters]

<rssiOffset>	-20 to 20 [dBm] in decimal (default 0 [dBm]).

[Result codes]

OK, ERROR, or BUSY

3.2.20 AT+STOP

[Command syntax]

```
AT+STOP
```

[Description]

This command stops transmitting and receiving. In the reception state, this command returns the statistical information response regarding received packets.

[Response]

Response	+STOP:<totalPkts>,<okPkts>,<ngPks>,<totalBits>,<okBits>,<ngBits>, <rssiAve>,<rssiMin>,<rssiMax>,<snrAve>,<snrMin>,<snrMax>
<totalPkts>	Total number of received packets.
<okPkts>	Number of received packets with no CRC error.
<ngPkts>	Number of received packets with CRC error.
<totalBits>	Total number of bits of the received packets. Fixed to 0 when AT+PKT=1.
<okBits>	Number of the same bits specified by AT+PKT=2|3|4. 0 when AT+PKT=1.
<ngBits>	Number of the different bits specified by AT+PKT=2|3|4. 0 when AT+PKT=1.
<rssiAve>	Average RSSI [dBm].
<rssiMin>	Minimum RSSI [dBm].
<rssiMax>	Maximum RSSI [dBm].
<snrAve>	Average SNR [dBm] (for LoRa only, 0 for FSK).
<snrMin>	Minimum SNR [dBm] (for LoRa only, 0 for FSK).
<snrMax>	Maximum SNR [dBm] (for LoRa only, 0 for FSK).

[Result codes]

OK or ERROR

[Notes]

To perform a PER or BER test, the same RF setting is required for the sender and receiver sides. CRC is required in the PER test to count packets properly. CRC should not be included in the packet in the BER test because the CRC is removed before counting received bits, which causes a mismatch between the received bits and the expected bits.

3.2.21 AT+STAT

[Command syntax]

```
AT+STAT
```

[Description]

This command reports the current program state and Tx/Rx progress.

[Response]

Response	+STAT:<state>
<state>	IDLE: Waiting for new AT commands. TX,<Number of packets sent>: AT+SEND command is running. RX,<Number of packets received>: AT+RECV command is running. CX: AT+TXCW or AT+TXCP command is running.

[Result codes]

OK or BUSY

3.2.22 AT+XTRIM

[Command syntax]

```
AT+XTRIM=<xtaTrim>,<xtbTrim>
AT+XTRIM?
```

[Description]

This command specifies the internal foot capacitance for the XTAL to adjust the center frequency. For more detail, refer to the section “XTAL Control Block” in the SX1261/SX1262 datasheet.

[Parameters]

<xtaTrim>	The internal foot capacitor setting for XTA: 00 to 2F (11.3 to 33.4 step 0.47 [pF]) in hex (default 13).
<xtbTrim>	The internal foot capacitor setting for XTB: 00 to 2F (11.3 to 33.4 step 0.47 [pF]) in hex (default 13).

[Result codes]

OK, ERROR, or BUSY

3.2.23 AT+SAFE

[Command syntax]

```
AT+SAFE=<safeMode>
AT+SAFE?
```

[Description]

This command specifies safe mode to support the radio configurations validation functions for the regional radio regulations (See [1], [2]). When safe mode is enabled, the radio settings (frequency, bandwidth, transmission power, Time on Air, duty cycle) are validated before transmission, and LBT (Listen before Talk) is enabled. If invalid radio settings are detected, the transmission is canceled. In safe mode, AT+TXCW and AT+TXCP always return ERROR, AT+FREQ returns ERROR when the frequency is out of range, AT+SEND and AT+RECV invoke the special response (see [Response]) when violations are detected.
The region or country for the radio configurations validation functions can be specified by AT+REGION command.

[Parameters]

<safeMode>	Safe mode: 0: Disable (default) 1: Enable.

[Response]

Response	+SAFE:<errorCause>
<errorCause>	FAIL_RX_CFG: Detected invalid frequency or bandwidth. FAIL_TX_CFG: Detected invalid frequency, bandwidth or Time on Air. FAIL_TX_DUTY_CYCLE: Detected invalid pause duration or duty cycle. FAIL_TX_CHANNEL_BUSY: Detect invalid RSSI threshold or CCA duration.

[Result codes]

OK, ERROR, or BUSY

3.2.24 AT+TOA

[Command syntax]

```
AT+TOA
```

[Description]

This command shows the current Time on Air.

[Response]

Response	+TOA:<toa>
<toa>	Time on Air [ms].

[Result codes]

OK, ERROR, or BUSY

3.2.25 AT+REGR

[Command syntax]

```
AT+REGR=<address>,<size>
```

[Description]

This command reads the device registers in SX1261/SX1262.

[Parameters]

<address>	0000 to FFFF: The start address of the register in hex/
<size>	1 to 8: The length [bytes] to read in decimal.

[Result codes]

OK or ERROR

3.2.26 AT+REGW

[Command syntax]

```
AT+REGW=<address>,<byte1>,<byte2>,<byte3>,<byte4>, … ,<byteN>
```

[Description]

This command writes the device registers in SX1261/SX1262.

[Parameters]

<address>	0000 to FFFF: The start address of the register in hex.
<byte1>,…<byteN>	The write data in hex (comma-separated), N: 1 to 8.

[Result codes]

OK or ERROR

3.2.27 AT+SLEEP

[Command syntax]

```
AT+SLEEP=<sleepMode>,<sleepPeriod>
AT+SLEEP?
```

[Description]

This command tests sleep mode.

[Parameters]

<sleepMode>	The sleep mode (SX1261/SX1262) in decimal: 0: Cold sleep mode

	1: Warm sleep mode (default).
<sleepPeriod>	The sleep duration: 1 to 1000 [s] in decimal (default 10 [s]) 0: Infinite (This mode can be canceled by pressing the reset switch.)

[Result codes]

OK, ERROR, or BUSY

3.2.28 AT+DEVEUI

[Command syntax]

```
AT+DEVEUI=<devEui>
AT+DEVEUI?
```

[Description]

This command sets the Device EUI.

[Parameters]

<devEui>	8 bytes in hex (default 0123456789ABCDEF).

[Result codes]

OK, ERROR, or BUSY

3.2.29 AT+SAVE

[Command syntax]

```
AT+SAVE
```

[Description]

This command saves all of the settings to the data flash memory. The saved settings are automatically loaded at the next start-up (power-on-reset, reset, and AT+RESET).

[Result codes]

OK or BUSY

3.2.30 AT+ERASE

[Command syntax]

```
AT+ERASE
```

[Description]

This command initializes the data flash memory with system default settings and performs a reset.

[Result codes]

OK or BUSY

3.2.31 AT+LIST

[Command syntax]

```
+LIST
```

[Description]

This command shows the current parameter settings.

[Result codes]

OK

3.2.32 AT+HELP

[Command syntax]

```
+HELP
```

[Description]

This command shows the usage of all AT Commands.

[Result codes]

OK

3.2.33 AT+VER

[Command syntax]

```
+VER?
```

[Description]

This command shows the program version.

[Result codes]

OK

3.2.34 AT+REGION

[Command syntax]

```
AT+REGION=<region>
AT+REGION?
```

[Description]

This command specifies region or country index used if the radio configurations validation functions are enabled by AT+SAFE.

[Parameters]

<region>	Region or country index: 0: EU region (default) 1: US 2: Australia 6: Asia region 1 7: Korea 8: India 22: Asia region 2 23: Asia region 3 24: Asia region 4 30: Japan (without low duty cycle) 31: Japan (with low duty cycle)

[Result codes]

OK, ERROR, or BUSY

4. Example Scripts

Figure 3 shows the test environment for the example scripts.

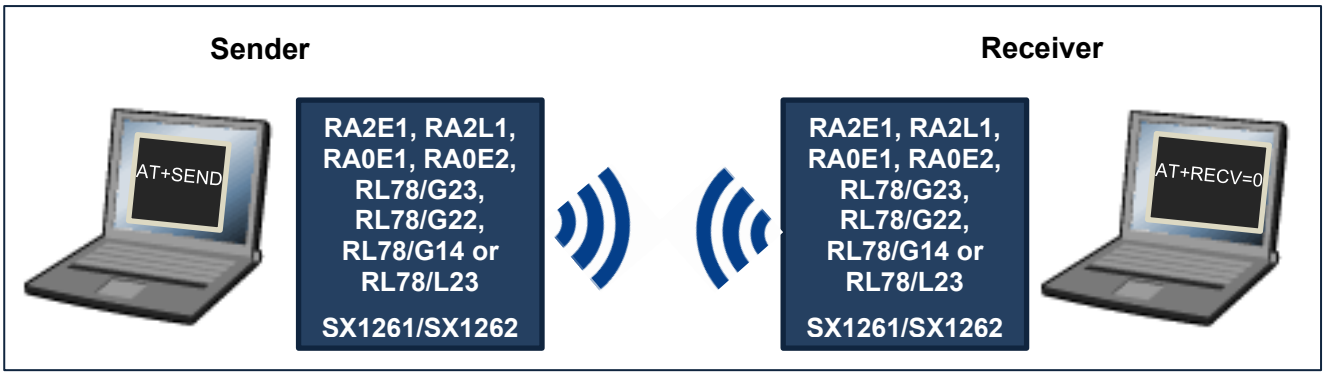

Figure 3. Test Environment for Example Scripts

4.1 Simple Script for LoRa

Table 4 shows a simple test script for LoRa.

Table 4. Simple script for LoRa

Sender	Receiver	Remark
AT+RESET		Reset all settings.
	AT+RECV=0	Start Rx with continuous Rx mode (0).
AT+SEND=10		Start Tx with 10 [packets].
(AT+STOP)		Wait for the completion of the Tx, or force to stop Tx.
	AT+STOP	Stop Rx and report statistical information.

The script in Table 5 is functionally equivalent to the script in Table 4.

Table 5. Expanded script for LoRa

Sender	Receiver	Remark
AT+RESET		Reset all settings.
AT+FREQ=923000000 AT+MODEM=1		Frequency: 923 [MHz] Modulation: LoRa (1).
AT+PKT=1,16		Payload is PER format (1), Payload length: 16 [bytes].
AT+LMCFG=7,0,1 AT+LPCFG=8,0,1,0,0		SF: 7 (7), BW:125 kHz (0), CR: 4/5 (1) Preamble: 8 [symbols], Variable Length Packet (0), CRC on (1), Standard IQ (0), Private Network (0).
AT+TXPWR=0		Tx Power: 0 [dBm].
	AT+RECV=0,1	Start Rx with continuous Rx mode (0), verbose mode (1).
AT+SEND=10,3000,1		Start Tx with 10 [packets], Tx delay:3000 [ms], verbose mode (1).
(AT+STOP)		Optional. Wait for the completion of the Tx, or force to stop Tx.
	AT+STOP	Stop Rx and report the statistical information.

4.2 PER Test Script for LoRa

Table 6 shows the example PER test script for LoRa.

Table 6. PER test script for LoRa

Sender	Receiver	Remark
AT+RESET		Reset all settings.
AT+FREQ=923400000 AT+MODEM=1		Frequency: 923.4 [MHz] Modulation: LoRa (1).
AT+PKT=1,16		Payload is PER format (1), Payload length: 16 [bytes].
AT+LMCFG=7,0,1 AT+LPCFG=8,0,1,0,0		SF: 7 (7), BW: 125 kHz (0),CR: 4/5 (1) Preamble: 8 [symbols], Variable Length Packet (0), CRC on (1), Standard IQ (0), Private Network (0).
AT+TXPWR=10		Tx Power: 10 [dBm].
	AT+RECV=0,0	Start Rx with continuous Rx mode (0), silent mode (0).
AT+SEND=100,10,0		Start Tx with 100 [packets], Tx delay:10 [ms], Silent Mode (0)
(AT+STOP)		Optional. Wait for the completion of the Tx, or force to stop Tx.
	AT+STOP	Stop Rx and report the PER result.

4.3 BER Test Script for FSK

Table 7 shows the example BER test script for FSK.

Table 7. BER test script for FSK

Sender	Receiver	Remark
AT+RESET		Reset all settings.
AT+FREQ=923400000 AT+MODEM=0		Frequency: 923.4 [MHz] Modulation: FSK (0).
AT+PKT=2,16		Payload is BER format (2), Payload length: 16 [bytes].
AT+FMCFG=50000,58600,25000 AT+FPCFG=5,1,0		dataRate: 50 [kbps], bandwidth: 58600 [Hz], fDev: 25 [kHz]. PreambleLen: 5 [bytes], Fixed Length Packet (1), CRC: off (0).
AT+TXPWR=10		Tx Power: 10 [dBm].
	AT+RECV=0,0	Start Rx with continuous Rx mode (0), silent mode (0).
AT+SEND=100,10,0		Start Tx with 100 [packets], Tx delay:10 [ms], silent mode (0).
(AT+STOP)		Optional. Wait for the completion of the Tx, or force to stop Tx.
	AT+STOP	Stop Rx and report the BER result.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jan.11.19	All	First official release for Generation 1
2.10	Jul.1.20	All	First official release for Generation 2 Generation 1 is based on the Renesas original Radio Driver. Generation 2 is based on the GitHub LoRaMAC-node V4.4.4 reference Radio Driver. Generation 2 is NOT compatible with Generation 1.
2.20	Sep.16.20	1, 4, 15	Supports HS3001/2/3/4 (Humidity and Temperature sensor) Add AT+PKT=5 to send the sensor values as payload data.
3.00	Mar.05.21	1, 4, 26 All	Supports RL78/G23(R7F100GLG) No functional Changes from V2.20
3.01	Jun.07.21	23	Add infinite sleep mode on AT+SLEEP.
3.10	Sep.20.21	1, 4 15	Supports RL78/G23(R7F100GSN) Changed the sensor measurement time to 4 seconds.
4.00	Aug.29.22	3 3 3 7 17 21 All	Supports RA2E1(R7FA2E1A9xxFM) Setup procedure has been moved to a separate document. Add a description how to remove sensor and I^2C drivers. Fixed default value of AT+TXPWR to 0 dBm. Delete MCU specific description on AT+SLEEP. Fixed a typo. Formatting and editorial updates.
4.10	Nov.29.22	4 24	Fixed a typo. Add revision history regarding AT+TXPWR on V4.0.0
4.20	Mar.31.23	1, 3, 18	Supports RA2L1(R7FA2L1ABxxFP)
4.30	Jun.30.23	1, 3, 18	Supports RL78/G22(R7F102GGE)
4.40	Dec.22.23	1 All 16 19	Added reference document list. Changed 'Japan radio regulation' to 'radio configurations validation'. Delete an invalid tx power condition from FAIL_TX_CFG specified in AT+SAFE command description. Added AT+REGION command description.
4.50	May.24.24	1, 3, 20	Supports RA0E1(R7FA0E1073CFJ)
4.60	Sep.27.24	1	Added reference document [5].
4.70	Apr.18.25	1, 3, 20	Supports RA0E2(R7FA0E2094CFM)
4.80	Apr.21.25	1, 3, 20 3 12	Supports RL78/L23(R7F100LPL) Added description about baud rate for RL78/L23. Fixed the ccaBandWidth parameter from 34300 to 234300.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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