SIGFOX NETWORK & STAR NETWORK protocols user guide

1VV0301109 Rev.3 –2015-01-07

Making machines talk.

APPLICABILITY TABLE

PRODUCT
LE51-868 S

SW Version
GP.S03.02.00-B002

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1. Introduction

1.1. Scope

Scope of this document is to present the features and the application of the SIGFOX® embedded firmware, available on the LE51.

1.2. Audience

This document is intended for developers who are using the LE51 modules and SIGFOX® embedded firmware.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

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

http://www.telit.com

To register for product news and announcements or for product questions contact Telit Technical Support Center (TTSC).

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

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1.4. Document Organization

This document contains the following chapters (sample):

"Chapter 1: "Introduction" provides a scope for this document, target audience, contact and support information, and text conventions.

"Chapter 2: "LE51 Star Network Protocol-SIGFOX architecture" gives an overview of the features of the product.

"Chapter 3: "Configuring LE51-SIGFOX module" describes in details how to configure the product.

1.5. 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.

1.6. Related Documents

- [1] Star Network Protocol Stack User Guide 1vv0300873
- [2] LE51-868 S RF module User Guide 1VV0301131

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2. LE51 Star Network Protocol-SIGFOX architecture

The LE51-868 adds to the Star Network Protocol Telit proprietary technology the possibility to use SIGFOX long range technology.

LE51-868 S, with up to 35 mW output power and -126dBm@ 600 bps sensitivity is suited for short range to long range applications.

LE51-868 can be used to create local communications network in a star architecture and for long-chain communication with the new, "smart repeater" function to long range communication with natural gateway to Sigfox network.

2.1. SIGFOX network

One of the keys to SIGFOX's incredibly competitive low throughput Machine-to-Machine and Internet of Things communication technology ultimately lies in its radio technology. This UNB , that stands for Ultra Narrow Band, technology uses free frequency radio bands (no license needed) to transmit data over a very narrow spectrum to and from connected objects.

Designed for low throughput transmission (10b/s and 1kb/s typical range), the UNB Wireless technology benefits from a high level of sensitivity. Data transportation becomes very long range (distances up to 40km in open field) and communication with buried, underground equipment becomes possible, all this being achieved with high reliability and minimal power consumption. Furthermore, the narrow throughput transmission combined with sophisticated signal processing provides effective protection against interference. This also ensures that the integrity of the data transmitted is respected.

SIGFOX provides an end-to-end solution for your transmission chain, from your equipment through to your information system. With a clear Internet focus and a specifically designed and tailored cloud service, SIGFOX's network uses web communication protocols that make it easy to integrate your applications.

SIGFOX's network is designed around a hierarchical structure:

- UNB modems communicate with base stations, or cells, covering large areas of several hundred square kilometers,
- Base stations route messages to servers,
- Servers check data integrity and route the messages to your information system.

2.2. Star Network Protocol

The Star Network Protocol Stack is dedicated to point to point and star communications, with broadcast, smart repeater, addressed secured, IO copy functionalities.

Ready to use and easy to handle (also usable for cable replacement) with Data encryption (AES128) available, Cyclic wake up (the module wakes up periodically and listens the radio link).

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Mod. 0806 2011-07 Rev.2

For any further information about Star Network Protocol Stack please refer to [1]

2.3. LE51

The LE51 comes from the need to have two different radio technologies in the same module: short range and long range.

The short-range technology allows creating a network of devices; once the network has been created the external host controlling the LE51 can switch the module to SIGFOX mode to signal specific events or send specific data to a remote back end.

In order to select the specific behavior, the external host shall configure properly the register **S220** or use specific AT command made for SIGFOX® platform.

The LE51 module has two different working modes:

- DATA mode (only Star Network Protocol)
- COMMAND mode

2.3.1. Data Mode

When the module starts, it is always in DATA mode.

The module is always able to receive data from serial port and forward them on the air. Moreover when configured in Star Network Protocol Stack mode the module is also able to receive data from the radio and forward them on the serial according to the Star Network Protocol Stack protocol [1].

When Star Network Protocol Data mode is selected, the LE51 will send and receive data according to the register S220. Data management can be either in '*Transparent*' or '*Addressed Secured*' as described in [1].

2.3.2. Command Mode

Besides Data mode the LE51 can also be configured to work in Command mode.

The command mode is entered by issuing "+++" command on the module serial port and waiting for the "OK" answer.

When in Command mode the LE51 is not receiving any data on the radio, it is only able to execute AT commands received on the serial ports.

It is useful to say that the LE51 allows sending SIGFOX packets simply issuing particular AT commands (AT$SF, AT$SK and AT$SB).

2.4. Typical scenario

Typical example of LE51 use is a network of communicating devices. When, in the data exchanged using short range technology, the host controller recognizes a specific pattern in the LE51 serial data, the host changes the working mode from data mode to command mode, and then it sends a '*specific data stream*' to the back end SIGFOX®, in order to alert an external operator or to communicate with automatic tools.

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3. Configuring LE51-SIGFOX module

In order to exit from data mode and be able to configure the module, the user shall send the command '+++' and wait the answer **OK<cr>**.

Once in Command mode it will be possible either to get or to set a register value.

In order to get a register value, the user shall send:

- **ATSxxx?< cr>**, where 'xxx' is the register address.
- The answer will be: **Sxxx=yy<cr>**, where 'xxx' is the register address and 'yy' the register value (up to 255, it depends to the available values).

In order to set a new register value, the user shall send:

- **ATSxxx=yy<cr>**, where 'xxx' is the register address and 'yy' the register value (up to 255, it depends to the available values).
- The answer will be **OK<cr>** or **ERROR<cr>**, it depends to the register value or register address or command syntax

3.1. Star Network Protocol Stack registers

Except some differences reported below, LE51868S is fully compatible over the air with LE50-868 in transparent and addressed secured modes and for a full description of the Star Network Protocol Stack registers refer to [1].

By the way, due to the specific HW solution, some of the Star Network Protocol Stack register had to be modified.

Below it is reported the list of the modified registers and their possible values in the LE51 module.

Register	Access	Register Name	Possible Values	Description
201	R/W	Radio baud rate	0: 4.8 kbps 1: 9.6 kbps 2: 19.2 kbps **3: 38.4 kbps** 4: 100 kbps	This register sets the data rate on the RF link (for Star Network Protocol Stack)
202	R/W	Output Power	0 : -8 dBm 1 : -5 dBm 2 : -2 dBm 3 : +1 dBm	

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			4 : +4 dBm 5 : +7 dBm 6 : +10 dBm 7 : +14 dBm 8: Maximum pow**er**	
203	R/W	SigFox Output Power	From **0** to 10	This register allows to decrease the Sigfox output power. 0 means default power, and each step subtracts about 0.5 dBm to the maximum output power
208	R/W	SigFox delay duration	From **0** to 200	This register allows user to set the delay duration between Sigfox frame repetitions from 0 to 2 seconds. The value is expressed in hundredths od second.
245	R/W	Wake on Radio Duration	See [1]	The user set a time from 1 to 255 ms but the firmware allows just setting a percentage of Cyclic wake up period (S243). From 0.5% to 8%

All the registers from S200 to S209 (Radio configuration registers) are valid only for the Star Network Protocol side.

The maximum value allowed for register S206 is 10. The value 11 is not allowed because the LE51 is not able to work at 915 MHz

3.1.1. Current LE51 Star Network Protocol Stack limitations

Compared to LE50-868, the LE51-868 S has some limitations due to new hardware configuration.

The RF part does not allow reaching the baud rate of 115.2 kbps. The maximum value is 100 kbps.

About **Wake on Radio Duration** register (S245): it is not possible to set a very precise wake up time duration but just a percentage of **Cyclic wake up Period** (S243).

When the module is in Sigfox mode and the Wake On Radio is selected, the module can't exit from stand by using the Wake On Radio.

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3.2. Available SIGFOX® commands

When operating in command mode the LE51 allows to execute dedicated AT commands not available in the typical Star Network Protocol Stack technology:

The list of dedicated SIGFOX command is reported below.

Please note that every command shall be followed by the <cr>.

- **AT/L><cr>**: displays the library version number as follows: TLT.zz.yy-Txk.j.l<cr>, where the first part (zz, yy) is the Telit library version and the second part (xk,j) is the SigFox library version. zz, yy, k, j and l are numbers.
- **AT$SB=<status>,<ack>><cr>**: using this command is possible to send a SIGFOX status bit frame while the module is in Command mode . Available values are:
  - **status**: 0 or 1
  - **ack**: 0 or 1
- **AT$SF=<frame>,<ack>><cr>:** using this command is possible to send a SIGFOX® frame while the module is in Command mode. Available values:
  - **frame:** it is a sequence of digit representing the value of byte stream expressed in hexadecimal value (i.e.: AT$SF=12A435,0 – the payload is composed by the following byte stream: 0x12, 0xA4, 0x35 – 6 digit converted in 3 bytes). The maximum length of frame is 24 digit (12 bytes)
  - **ack**: 0 or 1
- **AT$SK<cr>**: using this command is possible to send a SIGFOX® Keep Alive frame while the module is in Command mode.
- **AT$ST=<count>,<period>,<channel><cr>**: using this command is possible to send a test SIGFOX frame across a specific channel
  - **count** = 0..32767or -1: infinite loop sending user frames. Default value: 10
  - **period** = 1..255 seconds for sending test frame every period seconds. Default value: 1
  - **channel** = 0 - 480 or -1 (random channel)
- **AT$SR=<seqnum>,<channel>,<time><cr>**: using this command is possible to receive a test SIGFOX frame across a specific channel
  - **seqnum** = 0 - 65535
  - **channel** = 0 - 480
  - **time** = 0..32767or -1: infinite waiting time.
- **AT$IF=<frequency><cr>**: using this command is possible to set the carrier frequency. Frequency must be expressed in Hertz (range: 100000000 – 999999999); the value is not saved in EEPROM, then after rebooting the module the default value is 868130000.
- **AT$IF?<cr>**: use this command in order to know the sending frequency configured on the module.

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- **AT$DR=<frequency><cr>**: using this command is possible to set the receiving center frequency. Frequency must be expressed in Hertz (range: 100000000 – 999999999); the value is not saved in EEPROM, then after rebooting the module the default value is 869525000.
- **AT$DR?<cr>**: use this command in order to know the receiving frequency configured on the module.
- **AT$TR=<value><cr>**: use this command to set number of sending repetitions in case of downlink.
  - **value** = 0 – 2 (default is 2)
- **AT$TR?<cr>**: use this command in order to know the number of sending repetitions configured on the module.
- **AT$ID<cr>**: using this command is possible to read the SIGFOX module Id composed by 8 digits in hexadecimal format.
- **AT$CW=<frequency>,<enable>{,<power>}<cr>**: using this command is possible to radiate continuous wave without any modulation
  - **frequency**: center frequency for carrier
  - **mode**: 0: off – 1: on
  - **power**: value of output power in dBm, from -16 to 14 (optional).

  After an 'on' command, the 'off' command must have the same frequency parameter.

The sending commands work also without the <ack>. Then the following commands are valid:

AT$SB=0<cr> as the same behaviour of AT$SB=0,0<cr>

AT$SF=0102030405<cr> as the same behavior of AT$SF=0102030405,0<cr>

NOTE:

The commands AT$Sx return OK/ERROR after SIGFOX® frame has been successfully sent or the operation has failed. The operation can take up to 60 seconds. No data shall be sent until OK or ERROR is received on the serial.

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4. ACRONYMS AND ABBREVIATIONS

UNB Ultra Narrow Band

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5. Document History

Revision	Date	Changes
0	2013-12-20	First issue
1	2014-03-11	Integration with Star Network Protocol Stack
2	2014-04-16	Added new Sigfox AT commands: AT$SK, AT$ST, AT$IF, AT$ID. Modified Star Network Protocol Stack registers S220 and S245; removed register S240 limitations. Added new value to register S202. Added register S203. Added register S208
3	2014-07-02	Added downlink feature in SigFox. Added following AT commands: AT$IF?, AT$DR=x, AT$DR?, AT$TR?, AT$TR=x, AT$SR=<x,y,z> Changed default Tx center frequency (from 868.2 MHz to 868.13 MHz) Removed SIGFOX serial protocol

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