TEMP V3

Technical Reference Manual

868 EU - LoRa / Sigfox

Applicable for APP versions >= 2.0.0

adeunis®
Manage & optimize your assets & services
283, rue louis Néel 38920 CROLLES, France
Tél : +33 (0)4 76 92 07 77 E-mail : sales@adeunis.com
www.adeunis.com

NEW DOCUMENTATION / NOUVELLE DOCUMENTATION

	ENGLISH	FRANCAIS
USER GUIDE	• **Dedicated to a product** • Cautions & electrical warnings • Declaration of conformity • Product functionalities and modes • Casing dimensions • Characteristics (casing and electrical) • LED explanations • Specific wiring on terminal blocks	• **Dédié à un produit** • Recommandations et avertissements électriques • Déclaration de conformité • Fonctionnalités et modes du produit • Dimensions du boitier • Caractéristiques (boitier et électrique) • Explication des LED • Câblage sur bornier spécifique au produit
TECHNICAL REFERENCE MANUAL	• **Dedicated to a product** • Registers content • Frame explanations (uplink and downlink)	• **Dédié à un produit** • Contenu des registres • Explication des trames (uplink et downlink)
INSTALLATION GUIDE	• **For all adeunis® products** • Configuration of the products • Installation and fixing • Start-up of the products • Opening and closing the case • Replace battery	• **Pour tous les produits adeunis®** • Configuration des produits • Installation et fixation • Démarrage des produits • Ouvrir et fermer les boîtiers • Remplacer la batterie

TABLE OF CONTENTS

1. REGISTERS

1.1 Generic registers

Register	Size (bytes)	Base	Description	Default Value	Range (Min-Max)	Comments
304	2	10	PIN code	0 (deactivated)	0 - 9999	PIN code used with ATPIN command. Value 0 disables the PIN code.
306	1	10	Product mode	0	0: PARK 1: RUN	In PARK mode, product is not using Radio. In RUN mode, product will send/receive RF uplinks/downlinks.

1.2 Applicative registers

Register	Size (bytes)	Base	Description	Default value	Min-Max Value	Comments
300	2	10	Keep alive period	8640 (24h)	2 ... 65535	X 10 seconds
301	2	10	Transmit period of data	1	0 ... 65535	Number of backups (history logs) to be done before sending a frame (thus defining the sending period). The value 0 is equivalent to disabling the periodic mode.
308	4	16	LED activity	0x7F	0-0xFFFFFFFF	Default: 10007F Eco : 100070 Other values : reserved
320	2	10	History period	1	1 ... 65535	Number of readings to be performed before saving in the history logs The value 1 is equivalent to 1 backup per reading
321	2	10	Sampling period	1800 (1h)	15 ... 65535	X 2 seconds
322	2	10	Alarm repetition period	0	0 ... 65535	If an alarm is active, this register allows the product to send periodically a reminder. 0 : no repetition X sampling period (S321)
323	1	10	Number of additional (redundant) samples per frame	0	0 ... 23	Number of samples to be repeated in the next frame
324	1	10	Sensors activation	3	1: Sensor 1 2: Sensor 2 3: Both sensors	

1.3 Alarm registers

1.3.1 Sensor 1

Register	Size (bytes)	Base	Description	Default value	Min-Max value	Comments
330	1	10	Alarm type	0 (inactive)	0: Inactive 1: Low threshold 2: High threshold 3: Both thresholds	
331	2	10	High threshold value	0	-550 … 1550 (-55°C to +155°C)	tenth of °C
332	1	10	High threshold hysteresis	0	0…255	tenth of °C
333	2	10	Low threshold value	0	-550 … 1550 (-55°C to +155°C)	tenth of °C
334	1	10	Low threshold hysteresis	0	0… 255	tenth of °C

1.3.2 Sensor 2

Register	Size (bytes)	Base	Description	Default value	Min-Max value	Comments
340	1	10	Alarm type	0 (inactive)	0: Inactive 1: Low threshold 2: High threshold 3: Both thresholds	
341	2	10	High threshold value	0	-550 … 1550 (-55°C to +155°C)	tenth of °C
342	1	10	High threshold hysteresis	0	0…255	tenth of °C
343	2	10	Low threshold value	0	-550 … 1550 (-55°C to +155°C)	tenth of °C
344	1	10	Low threshold hysteresis	0	0 … 255	tenth of °C

1.4 Radio registers

1.4.1 LoRaWAN Network Registers

Register	Description	Encoding	Details
201	Spreading Factor (SF) by default	Decimal	Default: 12 Min/max: 4 to 12 Unit: None
204	Reserved	Hexadecimal	Do not use
214	LORA APP-EUI (first part – MSB)	Hexadecimal	Default: 0 Key encoded on 16 characters. Each register contains a part of the key. Used during the JOIN phase in OTAA mode E.g.: APP-EUI = 0018B244 41524632 • S214 = 0018B244 • S215 = 41524632
215	LORA APP-EUI (second part – MSB)	Hexadecimal	

216	LORA APP-KEY (first part – MSB)	Hexadecimal	Default: 0 Key encoded on 32-byte characters. Each of the 4 registers contains 8 characters. Used during the JOIN phase in OTAA mode E.g.: APP-KEY = 0018B244 41524632 0018B200 00000912 • S216 = 0018B244 • S217= 41524632 • S218=0018B200 • S219= 00000912
217	LORA APP-KEY (second part – MID MSB)	Hexadecimal	
218	LORA APP-KEY (third part – MID LSB)	Hexadecimal	
219	LORA APP-KEY (fourth part – LSB)	Hexadecimal	
220	LoRaWAN Options	Hexadecimal	Default: 5 Bit 0: Activation of the ADR ON(1)/OFF(0) Bit 1: Reserved Bit 2: DUTYCYCLE ON(1)/DUTYCYCLE OFF(0) Bits 3 & 4: Reserved Bits 5 to 7: Reserved CAUTION: Deactivation of the Duty Cycle may result in a violation of the conditions of use of the frequency band, depending on the use of the device, thus violating the regulations in force. In the case of disabling the Duty Cycle, liability is transferred to the user.
221	Mode of activation	Decimal	Default: 1 Choice: (see NOTE 1 after the table) • 0: ABP • 1: OTAA
222	LORA NWK_SKEY (first part – MSB)	Hexadecimal	Default: 0 Parameter encoded on 16 bytes. Each of the 4 registers contains 4 bytes.
223	LORA NWK_SKEY (second part - MID MSB)	Hexadecimal	
224	LORA NWK_SKEY (third part - MID LSB)	Hexadecimal	
225	LORA NWK_SKEY (fourth part – LSB)	Hexadecimal	
226	LORA APP_SKEY (first part – MSB)	Hexadecimal	Default: 0 Parameter encoded on 16 bytes. Each of the 4 registers contains 4 bytes.
227	LORA APP_SKEY (second part - MID MSB)	Hexadecimal	
228	LORA APP_SKEY (third part - MID LSB)	Hexadecimal	
229	LORA APP_SKEY (fourth part – LSB)	Hexadecimal	
257	Configuration RX2	Decimal	Default: 1 0 : Channel disabled 1 : Default configuration: LoRaWAN Other: User configuration
260	Reserved	Decimal	Do not use
261	Reserved	Decimal	Do not use
280	NETWORK ID	Hexadecimal	Default: 0 Read only
281	DEVICE ADDRESS	Hexadecimal	Default: 0

NOTE 1: The “Over The Air Activation” (OTAA) mode uses a JOIN phase before being able to transmit on the network. This mode uses the APP_ EUI (S214 and S215) and APP_KEY (S216 to S219) codes during this phase to

create the keys for network communication. Once this phase is completed, the codes APP_sKEY, NWK_sKEY and DEVICE ADDRESS will be present in the corresponding registers. A new JOIN phase is started every time the device exits Command mode, a reset is performed or the device is turned on.
Codes:
• APP_EUI identifier for global use (provided by default by adeunis®)
• APP_KEY device application key (provided by default by adeunis®)
The “Activation by personalization” (ABP) mode has no JOIN phase; it transmits directly on the network using the codes NWK_sKEY (S222 to S225), APP_sKEY (S226 to S229) and DEVICE ADDRESS (S281) to communicate.
Codes:
• NWK_sKEY network session key (provided by default by adeunis®)
• APP_KEY applicative session key (provided by default by adeunis®)
• DEVICE ADDRESS Address of the device in the network (provided by default by adeunis®)
NOTE 2: By default, channels 0 to 2 use the default settings of the LoRaWAN network; the other 4 channels are inactive. A register value different from 0 or 1 allows the channel to be configured as follows:

Bit	7	6	5	4	3	2	1	0
Description	Fréquence du canal						DR Max	DR Min
Example	868100						5	3

Data Rate value (DR)	Description
0	SF12
1	SF11
2	SF10
3	SF9
4	SF8
5	SF7
6	SF7 – BW 250kHz
7	FSK 50 kps

The example given allows the user to configure a frequency of 868.1 Hz and authorizes a SF 7 to 9. The command to be sent to perform this
operation is: ATS250=86810053<cr>

Register	Size (bytes)	Base	Description	Default Value	Range (Min-Max)	Minimum required Application version	Comments
303	1	10	LORA Confirmed mode	0	0-1	V1.2.0	LoRa only – activation or deactivation of the confirmed mode 0: deactivation 1: activation

1.4.2 Sigfox Network Registers

Register	Size (bytes)	Base	Description	Default Value	Range (Min-Max)	Minimum required Application version	Comments
307	2	10	Sigfox Downlink period	1440 (24h)	0-65535	>= V2.0.0	X 1 minute ⇨ Period : 1 min to 45 days
317	1	10	Sigfox DutyCycle	1	0-1	V1.2.0	0 : dutycycle activated 1 : dutycycle deactivated Not displayed anymore in LoRa since 2.0.0

1.5 Coherency check

A configuration coherency check is made at the time of the backup (AT&W).
Cases where backups are refused (AT&W returns "E") because considered as inconsistent:

Cases refused	Description
(S330 = 3) && (S333 > S331)	CH1 : Low threshold > High threshold
(S330 = 3) && ((S333 + S334) > (S331 - S332))	CH1 : (Low threshold + Low hysteresis) > (High threshold - High hysteresis)
(S324 = 2) && (S330 != 0)	CH1 : Sensor not activated and alarm activated
(S340 = 3) && (S343 > S341)	CH2 : Low threshold > High threshold
(S340 = 3) && ((S343 + S344) > (S341 - S342))	CH2 : (Low threshold + Low hysteresis) > (High threshold - High hysteresis)
(S324 = 1) && (S340 != 0)	CH2 : Sensor not activated and alarm activated

2. RADIO PROTOCOL

Data with size greater than 1 byte will be transmitted MSB first.
In LoRa, frames are sent on port 1.

1.6 Status byte

All frames sent by the product contain a status byte. Its format is identical for all IoT Adeunis products.

Alarm Status	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Frame Counter			AppFlag2	AppFlag1	HW	Low Bat	Config
No Error	0x00 to 0x07			0	0	0	0	0
Configuration done				0	0	0	0	1
Low bat				0	0	0	1	0
HW Error				0	0	1	0	0
AppFlag1				0	1	0	0	0
AppFlag2				1	0	0	0	0

The status byte provides two bits reserved for a specific use of each product (AppFlag1 and AppFlag2).
For this product:

- AppFlag1: configuration inconsistency
  - Samples lost in periodic data frame because the payload is not sufficient.
- AppFlag2: Number of channels
  - 0: 1 channel activated
  - 1: 2 channels activated

1.7 Uplink Frame format

1.7.1 Product configuration (0x10)

This frame is sent following the reception of a frame with code 0x01, or at the start of the product.

Offset (in byte)	Data	Description
0	0x10	Frame code
1	Status	Status byte
2-3	S300	Transmission period of the Keep Alive frame
4-5	S301	Transmission period of the periodic frame
6-7	S320	History period
8-9	S321	Sampling period
10	S323	Number of additional (redundant) samples per frame

Decoding example:

Offset (in byte)	Data	Description
0	0x10	Frame code
1	0x10	Frame counter: 0 Bit4@1: 2 sensors activated Bit1@0: no LowBat
2-3	0x21C0	8640 => 8640 x 10s = 86400s = 24h
4-5	0x0001	1
6-7	0x0001	1
8-9	0x0708	1800 => 1800 x 2s = 3600s = 1h
10	0x00	No redundancy

1.7.2 Network configuration (0x20)

This frame is sent following the reception of a frame with code 0x02, or at the start of the product.

1.7.2.1 LoRa 868

Offset (in byte)	Data	Description
0	0x20	Frame code
1	Status	Status byte
2	S220	LoRa options Bit 0: Activation of the ADR ON(1)/OFF(0) Bit 1: Reserved Bit 2: DUTYCYCLE ON(1)/DUTYCYCLE OFF(0) Bits 3 & 4: Reserved Bit 5: CLASS A (0) Bits 6 to 7: Reserved
3	S221	Provisionning mode (0: ABP, 1:OTAA)

Decoding example:

Offset (in byte)	Data	Description
0	0x20	Frame code
1	0x30	Frame counter: 1 Bit4@1: 2 sensors activated Bit1@0: no LowBat
2	0x05	CLASS A Dutycycle activated ADR ON
3	0x01	OTAA

1.7.2.1 Sigfox 868

Offset (in byte)	Data	Description
0	0x20	Frame code
1	Status	Status byte
2	S202	Retry count

Decoding example:

Offset (in byte)	Data	Description
0	0x20	Frame code
1	0x30	Frame counter: 1 Bit4@1: 2 sensors activated Bit1@0: no LowBat
2	0x02	2 retries

1.7.3 Keep alive frame (0x30)

This frame is sent:
- after an amount of time determined by S300 register
- following the reception of a frame with code 0x02

1.7.3.1 1 channel activated

Offset (in byte)	Data	Description
0	0x30	Frame code
1	Status	Status byte
2-3	$T°_{(t0)}$	Status byte

Decoding example:

Offset (in byte)	Data	Description
0	0x30	Frame code
1	0xE2	Frame counter: 7 Bit4@0: 1 sensor activated Bit1@1: LowBat detected
2-3	0x01B3	435 => 43.5°C

1.7.3.2 2 channels activated

Offset (in byte)	Data	Description
0	0x30	Frame code
1	Status	Status byte
2-3	$T°_{CH1(t0)}$	In tenth of °C
4-5	$T°_{CH2(t0)}$	In tenth of °C

Decoding example:

Offset (in byte)	Data	Description
0	0x30	Frame code
1	0xF2	Frame counter: 7 Bit4@1: 2 sensors activated Bit1@1: LowBat detected
2-3	0x01B3	435 => 43.5°C for sensor 1
4-5	0xFF9C	-100 => -10°C for sensor 2

1.7.4 Periodic data frame (0x57)

The measure frequency is defined by: S321 * S320
The sending frequency is defined by: S321 * S320 * S301
The number of samples per channel is defined by: (S301 + S323)

1.7.4.1 1 channel activated

Maximum number of samples per frame:
- LoRa 868: 24 samples
- Sigfox 868: 5 samples

Offset (in byte)	Data	Description
0	0x57	Frame code
1	Status (AppFlag2 = 0)	Status byte
2-3	$T°_{(t0)}$	In tenth of °C
4-5	$T°_{(t-1)}$	In tenth of °C
6-7	$T°_{(t-2)}$	In tenth of °C
8-9	$T°_{(t-3)}$	In tenth of °C
10-11	$T°_{(t-4)}$	In tenth of °C
12-13	$T°_{(t-5)}$	In tenth of °C
14-15	$T°_{(t-6)}$	In tenth of °C
…	…	

Decoding example (for 2 samples):

Offset (in byte)	Data	Description
0	0x57	Frame code
1	0x80	Frame counter: 4 Bit4@0: 1 sensor activated Bit1@0: LowBat not detected
2-3	0x01B3	435 => 43.5°C for t=0
4-5	0x8000	Invalid measure for t=-1 (sensor disconnected)

1.7.4.2 2 channels activated

Maximum number of samples per frame and per channel:

- LoRa 868: 12 samples per channel
- Sigfox 868: 2 samples per channel

Offset (in byte)	Data	Description
0	0x57	Frame code
1	Status (AppFlag2 = 1)	Status byte
2-3	$T°_{CH1(t0)}$	In tenth of °C
4-5	$T°_{CH2(t0)}$	In tenth of °C
6-7	$T°_{CH1(t-1)}$	In tenth of °C
8-9	$T°_{CH2(t-1)}$	In tenth of °C
10-11	$T°_{CH1(t-2)}$	In tenth of °C
12-13	$T°_{CH2(t-2)}$	In tenth of °C
14-15	$T°_{CH1(t-3)}$	In tenth of °C
…	…	

Decoding example (for 2 samples):

Offset (in byte)	Data	Description
0	0x57	Frame code
1	0x92	Frame counter: 4 Bit4@1: 2 sensors activated Bit1@1: LowBat detected
2-3	0x01B3	435 => 43.5°C for sensor 1 @ t=0
4-5	0xFF9C	-100 => -10°C for sensor 2 @ t=0
6-7	0x01F4	500 => 50.0°C for sensor 1 @ t=-1
8-9	0xFFFF	-1 => -0.1°C for sensor 2 @ t=-1

1.7.5 Alarms (0x58)

This frame is sent during the appearance, or disappearance, of a threshold exceeding alarm.

1.7.5.1 1 active channel

Offset (in byte)	Data	Description
0	0x58	Frame code
1	Status (AppFlag2 = 0)	Status byte
2	Alarm status	0: No alarm 1: High threshold 2: Low threshold
3-4	Temperature	In tenth of °C

Decoding example:

Offset	Data	Description
0	0x58	Frame code
1	0x80	Frame counter: 4 Bit4@0: 1 sensor activated Bit1@0: LowBat not detected
2	0x01	1: temperature is higher than the configured threshold
3-4	0x0032	50 => 5.0°C

1.7.5.2 2 active channels

Offset	Data	Description
0	0x58	Frame code
1	Status (AppFlag2 = 1)	Status byte
2	CH1 Alarm status	0: No alarm 1: High threshold 2: Low threshold
3-4	CH1 Temperature	In tenth of °C
5	CH2 Alarm status	0: No alarm 1: High threshold 2: Low threshold
6-7	CH2 Temperature	In tenth of °C

Decoding example:

Offset	Data	Description
0	0x58	Frame code
1	0x90	Frame counter: 4 Bit4@1: 2 sensors activated Bit1@0: LowBat not detected
2	0x01	1: temperature is higher than the configured threshold
3-4	0x0032	50 => 5.0°C
5	0x00	0: no alarm
6-7	0x0032	50 => 5.0°C

1.7.6 Response to Get register request (0x31)

Following reception of a downlink frame with the code 0x40, the frame 0x31 is transmitted. It contains all the values of the registers requested in the downlink frame 0x40.

Offset (in byte)	Data	Description
0	0x31	Frame code
1	Status	Status byte
2-3	Value 1	If value 1 is a 2-byte register
4	Value 2	If value 2 is a 1-byte register
5-8	Value 3	If value 3 is a 4-byte register
…		

If an error is detected in the request, the returned 0x31 frame will be empty.

Note: the size of the data registers is variable depending on the register number. Refer to the list of registers to determine the size of each one and to deduce the total size of the data returned by the 0x31 frame.

Decoding example:

Offset (in byte)	Data	Description
0	0x31	Frame code
1	0x80	Frame counter: 4 Bit4@0: 1 sensor activated Bit1@0: LowBat not detected
2-3	0x1234	4660 (considering that value 1 is a 2-byte register)
4	0xFF	255 (considering that value 2 is a 1-byte register)
5-8	0x00000000	0 (considering that value 3 is a 4-byte register)
…		

1.7.7 Response to Set register request (0x33)

Following reception of a downlink frame with the code 0x41, the frame 0x33 is transmitted. It shows whether the downlink frame (0x41) has been received and gives information on the support status of the latter.

Offset (in byte)	Data	Description
0	0x33	Frame code
1	Status	
2	Request status	- 0x00 : N/A - 0x01 : success - 0x02 : success – no update (value to set is the current register value) - 0x03 : error – coherency - 0x04 : error – invalid register - 0x05 : error – invalid value - 0x06 : error – truncated value - 0x07 : error – access not allowed - 0x08 : error – other reason
3-4	Register Id	Indicates to the user the register that caused the error (only if “Request Status” is different from 0x01).

CAUTION: if the request 0x41 concerns several registers, the device will stop the analysis of the Downlink request at the first error and will send the Status frame with the reason and the identifier of the register concerned.

In the event of an error, if a partial reconfiguration has taken place before the error was detected, the device restarts and returns to its last valid configuration. As a result, you will have to configure the device again with the new data.

Decoding example:

Offset (in byte)	Data	Description
0	0x33	Frame code
1	0x80	Frame counter: 4 Bit4@0: 1 sensor activated Bit1@0: LowBat not detected
2	0x04	invalid register
3-4	0x0140	320: register S320 does not exist (should be S3XX)

1.7.8 Transmit conditions

Frame code	Description	Sending conditions
0x10	Status (configuration)	• Product start up • Exit configuration mode (AT command) • Reception of frame 0x01 (get product config)
0x20	Network configuration	• Product start up • Exit configuration mode (AT command) • Reception of frame 0x02 (get network config)
0x30	Keep alive	• Periodically if no periodical data is defined • Reception of frame 0x05 (get value)
0x57	Periodic data	• Periodically
0x58	Alarm	• Threshold crossing

1.8 Downlink Frame format

1.8.1 Get applicative configuration (0x01)

Offset (in byte)	Data	Description
0	0x01	Frame code

When the device receives the downlink, it will generate a product configuration frame (0x10).

1.8.2 Get network configuration (0x02)

Offset (in byte)	Data	Description
0	0x02	Frame code

When the device receives the downlink, it will generate a network configuration frame (0x20).

1.8.3 Get value (0x05)

Offset (in byte)	Data	Description
0	0x05	Frame code

When the device receives the downlink, it will generate a KEEP ALIVE frame (0x30) with instant measured temperatures.

1.8.4 Get registers (0x40)

This frame (0x40) allows you to inform the device through the network that it must send the values of specific S3XX registers in an uplink frame (0x31).

Offset (in byte)	Data	Description
0	0x40	Frame code
1	CONFID1	Index of the register to be sent. The corresponding register is 300 + CONFIDX value.
2	CONFID2	
3	CONFID3	

IMPORTANT: the user can specify several CONF IDs in the downlink frame but it is up to the user's responsibility to verify that according to the protocol, the size of the data available in a downlink will be large enough to contain all the desired data. Otherwise, the application will send only the first values.

In Sigfox mode: backend may request to send 8 bytes in a downlink. All unused bytes should set to 0xFF to ask the product to stop the downlink frame parsing.

Coding example:

Offset (in byte)	Data	Description
0	0x40	Frame code
1	0x00	Get register S300
2	0x14	Get register S320
3	0x20	Get register S332
4-7	0xFFFFFFFF	In SFX : ignored by product

1.8.5 Set registers (0x41)

This frame (0x41) allows you to change the value of requested S3XX registers.

Offset (in byte)	Data	Description
0	0x41	Frame code
1	CONFID1	Index of the register to be changed. The corresponding register is “300 + CONFID1“
2	Value of CONF ID 1	Value to set In this example, its value is contained in 1 byte
3	CONFID2	Index of the register to be changed. The corresponding register is “300 + CONFID2”
4-5	Value of CONF ID 2	Value to set In this example, its value is contained in 2 bytes
…		

Following the sending of the downlink 0x41, the associated uplink 0x33 is immediately returned. If the update of the register(s) went well, the device will perform a backup and begin its restart procedure automatically. In addition, the Config bit of the status byte will be set to 1 in the next scheduled uplink frame (periodic or alarm or keep alive frame) if everything went well.

Coding example:

Offset (in byte)	Data	Description
0	0x41	Frame code
1	0x14	Register to modify is S320
2-3	0x00AA	Value to set in S320 is 170 (S320 is a 2-byte register)
4	0x1E	Register to modify is S330
5	0x02	Value to set in S330 is 2(S330 is a 1-byte register)
…		