TG-LR

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Quickstart Guide

- Register device on LoRaWAN network server. Use tg-lrx2-2.0-ul-dec.js paylaod decoder script if device model not supported.
- Optionally deploy Grafana + Influx (telemetry_hub.zip) docker services for device capability evaluation.
- Activate device by holding magnet near reed switch and wait for 2x LED blinks (~1.5s).

Functionality

> New device is in SHUTDOWN mode. To activate use magnet switch commands.

Table 1 Models

Model	Description	Sensors
TG-LR82	LoRaWAN 1.0.4 Class A, B, 863.0 - 869.0 MHz band.	TMP116N, HDC2010, LIS2DW12
TG-LR92	LoRaWAN 1.0.4 Class A, B, 900.0 - 928.0 MHz band.	TMP116N, HDC2010, LIS2DW12

Table 2 Bands

Numeric code	Name	Description
1	BAND_1GHz	Sub-GHz operating band. Frequency range is based on device Model.
2	BAND_2GHz	2.4GHz ISM band.

Table 3 Operating modes

Numeric code	Mode	Description
0	SHUTDOWN	Device in low power mode with all functionality disabled.
1	RUN	Device joins network and sends uplinks based on current profile and configuration.

Table 4 Supported regions

X-Y Code	downlink	Common Name	TG-LR82	TG-LR92
1-1	1	EU868	Yes	
2-1	2	AS923_GRP1		Yes
3-1	3	US915		Yes
4-1	4	AU915		Yes
		WW2G4	Yes	Yes
6-1	7	AS923_GRP2		Yes

7-1	8	AS923_GRP3		Yes
8-1	9	IN865	Yes	
9-1	10	KR920		Yes

LoRaWAN

Device supports Class A and B, and can operate in two frequency bands: BAND_1GHz and BAND_2GHz. User can configure periodic link check, MAC time synchronization (DeviceTimeReq) and network ADR.

Join Procedure

Once activated (RUN) device will attempt to join network. Device sends Join-Request on primary band and if Join-Accept is not received it will wait back-off interval and send next Join-Request on secondary band if enabled, otherwise primary-band again.

> Join attempt interval depends on time on air for last Join-Request and total join time. See 1 section 7. If last join request used slower data rate - expect longer interval.

Join configuration commands: lora primary-band, lora second-band, lora join-cfg. See Command Encoding on how to convert text commands to binary encoding for downlink.

Link Check

Once device has joined network optional periodic link check can be performed. Link check can be configured specifically for each band using lora link-chk. If link check fails device leaves network and restarts join procedure.

> Any network downlink will restart link check timer to prevent unnecessary LinkCheckReq.

Time Synchronization

Device supports optional time synchronization using DeviceTimeReq MAC command. See command lora clk-sync for configuration parameters or to request immediate synchronization.

Class B

Device supports Class B operation. Class B operation can be either manually requested using lora class or device can be configured to automatically switch to class B on network join using lora cfg-class-b.

ADR Configuration

It is possible to disable network ADR and set fixed data rate using lora adr-cfg.

Leaving Network

In case of Link Check or confirmed uplink failure device leaves network and restarts join procedure.

Credentials

Device has factory configured default credentials that come with each device: DevEUI, JoinEUI, AppKey.

DevEUI and JoinEUI are IEEE 64-bit EUI (2) written MSB first. On air byte order is LSB first. See 1 section 6.2.5.

AppKey is 16 byte AES128 encryption key and is written as stored in device memory. AppKey must be kept secret!

To change JoinEUI and AppKey use commands: lora join-eui, lora net-key and lora cred. Commands lora join-eui and lora net-key can be issued in any order and multiple times to write new pending join credentials.

Once new pending credentials are written “lora cred 600,1” or “app reset 0” can be executed to attempt join with new credentials. If new credentials are not confirmed by join accept device will revert to previous. See LORA-275, LORA-276 for know issues!

Example sequence where JoinEUI and AppKey are written and join is attempted:

```
lora join-eui 87904163,0x00,0x16,0xC0,0x01,0xFF,0xFE,0x00,0x00
lora net-key 87904163,0x00,0x01,0x02,0x03,0x04,0x05,0x06,0x07,0x08,0x09,0x0A,0x0B,0x0C,0x0D,0x0E,0x0F
lora cred 600
app reset 0
// device reboots and attempts join using new credentials with 600s timeout
```

JoinEUI from previous example can be copy/pasted as is 00 16 C0 01 FF FE 00 00 to register new device. lora join-eui parameters are MSB first.

⚠ Executing *lora cred <confirm-timeout-s>,87904163* will force confirm credentials without verification join attempt! You may loose access to device!

Uplink Messages

Each LoRaWAN uplink message is formed by placing pending Data Frames ID and its contents in FPort and FRMPayload fields. All pending frames are packed in ascending order and differential encoding is used for IDs.

ⓘ See tg-lrx2-2.0-ul-dec.js script for frame encoding details. This script can be used as is in application server payload decoders.

Telemetry

Device Profiles

Device has 6 configurable profiles. Each profile stores independent sensor and uplink send configuration. This allows device to quickly change operating characteristics without requiring costly downlink configuration messages. Profile can be switched using Device Commands, magnet or even based on evaluated Data Rules. For instance switching between periodic keepalive mode with uplinks few times per day to more rapid telemetry every few minutes.

ⓘ MikroTik can support your specific use case, new devices with custom default configuration are available.

Devices come preconfigured with evaluation configuration to showcase some of possible use case:

Table 5 Default profile configuration

Profile Number	Name	Description
0	Sensor Telemetry	Send current-state, device-orientation every 5 minutes. Send remaining telemetry every 60 minutes.
1	Activity Monitor	Send activity, full-activity, current-state every 60 min and send activity_state events on activity idle transition.
2	Magnet Switch	Send mag-switch, current-state, device-events every 60 minutes and send mag_sw_cnt event when magnet is removed for at least 15 seconds. Save up to 10 events.
3	Orientation	Send current-state, device-events, device-orientation every 60 minutes. Send device-orientation frame in case of fast rotation by 30 degrees after idle ~30 seconds. Send angle_1 event in case of specific orientation: V=(0,1,1). Save up to 3 events.
4	Asset Monitor	Send asset healt info every 3h with different frames based on events.
5	Empty	

See default-cfg.txt for exact factory default configuration commands.

Configuring Sensors

Sampling Intervals

Periodic temperature, humidity and battery voltage sampling can be configured for specific use cases using data poll-cfg command. Device can sample data at a higher rate than uplink frames are sent. This gives opportunity to send average values or to perform rule based decisions. Since sampling interval influences device power consumption this can be leveraged to improve lifetime.

Averaging

Device also tracks average of sampled values in: temperature_ema, humidity_ema, battery_mv_ema, angle_ema. Command data ema-cfg configures exponential moving average (EMA) period and optionally can send EMA values in current-state, dev-health, device-orientation if *send-ema-** is enabled.

Count parameters *temp-cnt*, *humid-cnt*, *bat-cnt*, *orient-cnt* in data ema-cfg determine coefficient *a* used for moving average calculation. Moving EMA is calculated based on previous value *ema* and new value *sample* as:

```
ema(t) = sample(t) * a + ema(t-1) * (1 - a)
```

To get approximate time constant *t* of EMA you need to use sampling intervals configured by data poll-cfg and data orient-cfg (*interval*) and respective count parameter (*N*):

```
t ~ (N + 1) * interval / 2
```

To get required count parameter value for data ema-cfg:

```
N ~ 2 * t / interval - 1
```

Example:

Temperature sampling interval *th-poll-int* is configured to 30s using data poll-cfg. To configure EMA with time constant t ~ 60 minutes:

```
temp-cnt = 2 * 3600 / 30 - 1 = 239
```

Assuming profile #0 is used and we don't want to change other parameters we need to send command:

```
data ema-cfg 1,239
```

Histogram

All periodic samples are added to temperature and humidity histograms. Histograms can be used in addition to regular telemetry or simply stand alone to monitor temperature and humidity distribution. Configure bins and epoch intervals using data temp-histo-cfg, data humid-histo-cfg commands and/or enable temp-histogram, humid-histogram frames. All histogram frames contain epoch number to detect histogram counter reset. Since frame size is limited to 1B per bin, if internal bin counter value is above 255 histogram will be normalized (probability type) for uplink.

Example configuration:

```
data temp-histo-cfg 1,86400,0,0,1,1,-10,0,10,15,17.5,20,22.5,25.0,30
data humid-histo-cfg 1,86400,0,0,1,1,10,20,30,40,50,60,70,80,90
```

Orientation

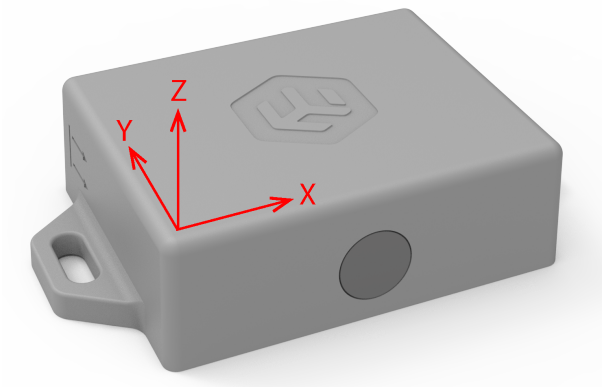

Fig. 1 Device accelerometer axis.

Periodic device 3D orientation sampling relative to Earth can be configured using command: data orient-cfg. In addition 3 user orientation vectors ref-1, ref-2, ref-3 can be configured to detect specific device orientations. User variables angle_1, angle_2, angle_3 contain current angle between device last sampled orientation and user defined vector. These variables can be used in Data Rules to trigger on specific orientation. angle_ema is angle between last sampled device orientation and EMA value of samples. In addition coarse orientation is also available with major_axis_orientation variable.

Table 6 major_axis_orientation description

Value	Numeric code	Description
XH	0	X up
HL	1	X down
YH	2	Y up
YL	3	Y down
ZH	4	Z up
ZL	5	Z down
DISABLED	7	sensor disabled

Coarse orientation has advantage that it is sent in current-state frame.

Activity Monitor

Device has activity monitoring service based on accelerometer. This service will automatically manage simple state machine that determines movement /activity. activity_s, high_activity_s, total_activity_s count accumulated time in each state activity_state, activity_state_etm hold state information.

Command data activity-cfg can be used to configure mode and thresholds for activity monitoring. data activity-cal can be used to automatically perform calibration for specific mode.

level1-th and *level2-th* units are *1/64 * 2G* irrespective of other accelerometer settings (like in *data acc-cfg*). *level2-cnt* is internally computed and not user configurable. *level2-cnt* is always in range 7..15 and calculated as:

```
level2-cnt = 7 + round((1 - ((level2-th - level1-th - 1) / 61)) * 8)
```

Table 7 activity_state description

Numeric code	Value
0	IDLE
1	LOW
2	HIGH
3	DISABLED

Single Mode

Mode in data activity-cfg is set to single.

- If accelerometer sample value in any axis is above *level1-th* device transitions from IDLE to LOW state.
- If all samples for at least 1.3s are below *level1-th* device transitions from LOW to IDLE state.

Example to set profile #0 single mode with threshold 0.25G:

```
data activity-cfg 1,1,8,63
```

Dual Mode

Mode in data activity-cfg is set to dual.

In dual mode LOW state has two sub states: LOW1 and LOW2 that both represent LOW. Device will report LOW state during both of these and actvity counter values are incremented as if in LOW state. Only difference is transition logic between these states.

Table 8 activity_state dual mode state transitions

Current	Next	Condition
IDLE	LOW2	sample > *level1-th*
LOW2	LOW1	sample < *level2-th* at least 5s
LOW1	LOW2	sample > *level1-th*
LOW2	HIGH	sample > *level2-th* at least *level2-cnt* times
LOW1	IDLE	sample < *level1-th* at least 5s
HIGH	LOW1	sample < *level2-th* at least 5s

Example to set profile #0 dual mode with thresholds 0.25G and 0.5G:

```
data activity-cfg 1,2,8,16
```

Calibration

In addition to manually configuring *level1-th* and *level2-th* there is activity calibration functionality. Executing command data activity-cal will perform auto calibration of *cal-level*. *level-one* will calibrate *level1-th* and *level-two* will calibrate *level2-th* for all profiles selected in *profile-mask*. For dual mode you can run *level-one* and *level-two* in sequence. Calibration time is 15s. This functionality is mostly suited for periodic motion/vibration.

It may be useful to enable LED during calibration procedure or activity monitor testing to ensure correct operation.

Example to calibrate profile #0 with single level activity monitor:

Activity calibration with orientation enabled causes fault and device reboot. Disable using data orient-cfg before calibration and re-enable after finished. See LORA-279.

- Place device in environment with periodic motion/activity to calibrate.
- Send commands:

  ```
  data activity-cfg 1,1,,,1
  data activity-cal 1,1,1
  ```

- Observe LED periodic blink 2x/1.5s for ~ 15s.
- Test motion detection. During LOW activity device will blink LED 3x/1s.
- If calibration results are acceptable send command to disable LED:

  ```
  data activity-cfg 1,,,,0
  ```

Example to calibrate profile #0 with dual level activity monitor:

- Place device in environment with periodic motion/activity for level 1 calibration.
- Send commands:

  ```
  data activity-cfg 1,2,,,1
  data activity-cal 1,1,1
  ```

- Observe LED periodic blink 2x/1.5s for ~ 15s.
- Place device in environment for level 2 calibration.
- Send commands to calibrate level 2:

```
data activity-cal 1,2,1
```

- Observe LED periodic blink 2x/1.5s for ~ 15s.
- Test motion detection. During HIGH activity device will blink LED 6x/1s.
- If calibration results are acceptable send command to disable LED:

```
data activity-cfg 1,,,,0
```


After calibration *level1-th* and *level2-th* can be manually changed using command data activity-cfg.

Impact and Free fall

Command data acc-cfg can be used to configure device accelerometer for basic impact and free-fall detection. Frames: motion-events, impact-count contain relevant data fields. current-state contains impact_evnt, free_fall_evnt flags that indicate new event. These can be used if explicit read is preferred.

Variables impact_cnt, impact_cnt_x, impact_cnt_y, impact_cnt_z, impact_etm, free_fall_cnt, free_fall_etm allow rule based logic.

If Activity Monitor is enabled impact and free fall detection can't be used and will be ignored.

Data Rules

Up to 32 custom user rules are configurable using commands: data set-rule, data del-rule. Rules have test expression, optional input rules and actions to perform.

Command syntax to add or override rules:

```
data set-rule [<rule-num>],<test-expr>,[<input-expr>],[<switch-profile>],[<make-event-0>],[<make-event-1>],
[<make-event-2>],[<make-event-3>],[<send-frame-0>],[<send-frame-1>],[<send-frame-2>],[<send-frame-3>],[<clr-
timer-mask>]
```

Test Expression

<test-expr>: [^] variable-type <operator> <argument>

[^]	use variable absolute value in expression
variable-type	variable name or ID
<operator>	>, >=, <, <=, ==, !=, %
<argument>	numeric value

Example:

```
data set-rule 0,profile == 0
data set-rule 1,^temperature > 30.55
data set-rule 2,impact_etm < 60
```

Same rules can be given using User Variables numeric IDs:

```
data set-rule 0,0 == 0
data set-rule 1,^8 > 30.55
data set-rule 2,24 < 60
```

Input Expression

Input expression is used if rule needs to depend on result of other rules. This allows constructing sophisticated logic based on multiple test expressions.

<input-expr>: [&][|][!]<input-rule>[<]

[&]	logical AND of <rule-num> and <input-rule>
[|]	logical OR of <rule-num> and <input-rule>
[!]	logical NOT of input value
<input-rule>	rule number to add as a input
[<]	use rule combined state as input value, otherwise local state.

Following configuration will send current-state data frame if magnet switch changed state less than 15s ago and temperature or humidity are out of range (-5..55 and 10..90%):

```
data del-rule
data set-rule 0,temperature < -5
data set-rule 1,temperature > 55
data set-rule 2,humidity < 10
data set-rule 3,humidity > 90,|0|1|2
data set-rule 4,mag_sw_etm < 15,&3<,,,,,,current-state
```

⚠ Input rules are evaluated in numeric order irrespective of ordering in set-rule command.

Actions

Rule Test Expression evaluated value represents data rule local state. Local state evaluated with optional input rules represents combined state.

If combined state changes to TRUE state optional rule actions are performed: profile switching, event generation, frame scheduling, user timer reset.

If <switch-profile> parameter is given, current profile will be changed. For example if temperature drops below 15 C device will switch to profile 5 (Device Profiles):

```
data set-rule 1,temperature < 15,,5
```

Up to 4 different Data Frames can be scheduled per rule:

```
data set-rule 0,impact_cnt % 10,,,,,,,current-state,device-orientation,dev-health,ema-temp
```

ⓘ Rule chaining can be used if more than 4 frames should be sent.

Up to 4 different events can be generated per rule:

```
data set-rule 0,impact_cnt % 10,,,temperature_ema,humidity_ema,activity_state,timer_1
```

Events

Actions can optionally generate events. Events are time stamped User Variables that are sent in device-events frame. Event storage can be configured using data event-cfg command. If device has received absolute time using Time Synchronization events will have POSIX time stamp. This allows collecting specific historic data to report later. Event uplink can be triggered periodically, based on some rule or manually using downlink command.

Magnet Switch

Device has magnet switch that can be used for command input or as magnetic field sensor. If unused, command input can be completely disabled or PIN protected using mag svc command.

Unique PIN code comes with each device.

Command Input

User must apply command sequence of 1 to 4 digits. Each digit is entered consecutively. After 2.5s idle, valid input command is executed and device indicates result using LED. Successfully executed command is indicated with 3x 0.2s LED blinks and failure is 1s long LED pulse. Invalid commands are ignored.

When magnetic field is applied to device, LED starts blinking with interval 500ms ON, 500ms OFF (or according to mag cfg configured blink-mode). When LED is switched on, internal counter is incremented starting from 0. When magnetic field is removed counter value is latched as user input digit. If magnetic field is applied again, next digit in input sequence is started. If interval after applying digit is larger than 2.5s, sequence is evaluated.

When applying input code based on time, ensure to follow this equation: T = N - 0.5, where N is input digit from 1 to 9 and T is time in seconds to apply magnetic field. The interval between digits must be less than 2.5s, but more than 200ms.

Some commands require PIN mode to be entered and some can be optionally protected by PIN mode. See table Magnet switch commands. To enter PIN mode, user must apply sequence of PIN digits provided with the device. Once PIN mode is entered it will expire after configurable time and device will return back to normal mode.

It is also possible to completely disable magnet commands. Only way to re-enable is using LoRaWAN downlink command. This can be useful if magnet sensor is used only for detecting external signals and no user commands are expected or allowed.

Table 9 Magnet switch commands

Sequence	PIN mode	Command description
2	optional	Activate - enable RUN mode.
3-1	optional	Trigger current-state frame uplink.
4-1-X	optional	Switch device profile, where X is Profile Number + 1 [1..6].
4-2-1	optional	Set primary band to BAND_1GHz.
4-2-2	optional	Set primary band to BAND_2GHz.
4-3-1	optional	Enable secondary band.
4-3-9	optional	Disable secondary band.
6-1	optional	Device restart.
6-2-9	optional	Deactivate device - SHUTDOWN mode.
9-X-Y	optional	Set region for sub GHz band as per Supported regions.
6-9-9	mandatory	Device factory reset.
3-1-5	mandatory	Exit PIN mode.
A-B-C-D	–	Enter PIN mode. A-B-C-D are digits of device factory PIN code.
5-3-1	optional	Reserved.

LED indications during digit input can be changed based on device configuration. It is possible to change or completely disable LED indications using mag cfg.

Magnet Sensor

Magnetic sensor is always operational (even when commands are applied). This sensor can be utilized to detect switching events mag_sw_flag or to count number of these events mag_sw_cnt. Device can report current switch state, number of state changes and last time stamp (UNIX/uptime) mag_switch_ts. Additionally you can create rules based on these attributes.

Command Encoding

Device commands are binary encoded to reduce downlink message size. We provide Python utilities to verify, encode and publish commands as LoRaWAN binary downlink messages.

tg-lrx2-utils.zip or install with *pip install tg-lrx2-utils*

Example configuration to set current-state and activity frame uplink every 600 seconds and mag-switch every 43200 seconds as confirmed message:

```
# lora-script.txt
frame set-cfg 1,601,0,0,current-state,activity
frame set-cfg 1,43200,1,0,mag-switch
```

We can use *tg-lrx2-encode* to convert text commands to binary messages for downlink:

```
tg-lrx2-encode --script ./lora-script.txt --dev-desc ./tg-lrx2-2.0-desc.yml --max-len=50 --out ./lora-pub.yml
```

tg-lrx2-2.0-desc.yml contains full device characterization and is used by other tools. Make sure to use correct file for specific device and FW version!

lora-pub.yml will contain serialized binary payloads to use for downlink. You can either manually schedule them using available web tools or use *tg-lrx2-pub* to schedule them on The Things Network:

```
tg-lrx2-pub --host ./ttn-app.yml --dl-msg ./lora-pub.yml device-id
```

Example TTN credential file:

```
# ttn-app.yml
app-id: "ttn-tag-demo@ttn"
host: "eu1.cloud.thethings.industries"
port: 1883
user: "ttn-tag-demo@ttn"
password: "NNSXS.5G..."
```

tg-lrx2-encode accepts command strings on CLI as well. This can be used for single or few lines of commands:

```
tg-lrx2-encode --cmd $'frame send device-orientation\napp profile 1,0' --dev-desc ./tg-lrx2-2.0-desc.yml --max-
len=50 --out ./lora-pub.yml
tg-lrx2-pub --host ./ttn-app.yml --dl-msg ./lora-pub.yml device-id
```

Device Commands

All device commands consist of *group-name* and *cmd-name*. Optional parameters are given in square brackets. Parameters must be comma separated for *tg-lrx2-encode* script. *group-name* and *cmd-name* can also be comma separated but spaces are also accepted.

Example:

```
app factory-reset <key>,[<fw-def>],<delay-ms>
```

Parameters **<key>** and **<delay-ms>** are mandatory, but **<fw-def>** is optional and can be omitted:

```
app factory-reset 984651411,,2500
```

Each parameters has valid input range and format. Some parameters allow only specific choice between parameters or choice between ranges.

Most parameters accept integer values. *%f* indicates that parameter accepts fractional value. Use of these values results in larger downlink payload so if possible integer values should be preferred. variable-type indicates that parameter accepts either user variable name or respective integer ID. frame-type indicates that parameter accepts either data frame name or integer ID. *tg-lrx2-encode* automatically converts these names to numeric ID.

app set-mode

app set-mode <mode>		
Set device operating mode		
Parameter	Range	Description
mode	0	SHUTDOWN
	1	RUN

app profile

app profile <profile-num>,<make-default>		
Switch active profile and optionally make default		
Parameter	Range	Description
profile-num	0..5	
make-default	0	no
	1	yes

app reset

app reset <type>		
System reset		
Parameter	Range	Description
type	0	board
	1	app only

app factory-reset

app factory-reset <key>,[<fw-def>],<delay-ms>		
Reboot device, clear saved configuration and set to defaults (optional)		
Parameter	Range	Description
key	984651411	
fw-def	784565141	don’t apply default configuration
delay-ms	0..65535	

app led

app led [<enable>]		
Configure application LED signals		
Parameter	Range	Description
enable	0	no
	1	yes

app set-time

app set-time [<unix-time-s>],<uptime-s>		
Set UNIX time relative to device uptime		
Parameter	Range	Description

unix-time-s	0..4294967295	
uptime-s	0..4294967295	

lora set-region

lora set-region <region-code>		
Set LoRaWAN region for sub GHz band		
Parameter	Range	Description
region-code	1	EU868
	2	AS923-1
	3	US915
	4	AU915
	7	AS923-2
	8	AS923-3
	9	IN868
	10	KR920

lora primary-band

lora primary-band <band>		
Select primary band		
Parameter	Range	Description
band	1	<1GHz
	2	2.45GHz

lora second-band

lora second-band <mode>		
Enable or disable secondary band		
Parameter	Range	Description
mode	0	off
	1	on

lora join-cfg

lora join-cfg <band>,<duty>		
Configure join duty cycle for band		
Parameter	Range	Description
band	1	<1GHz
	2	2.45GHz
duty	0	0.1%
	1..254	
	255	1%

lora link-chk

lora link-chk <band>,<int-minutes>		
Set band specific link check interval and timeout		
Parameter	Range	Description
band	1	<1GHz
	2	2.45GHz
int-minutes	0	off
	5..500000	

lora adr-cfg

lora adr-cfg <en-netw-adr>,[<fixed-data-rate>]		
Enable network ADR or configure fixed data rate		
Parameter	Range	Description
en-netw-adr	0	off
	1	on
fixed-data-rate	0..6	

lora clk-sync

lora clk-sync [<int-minutes>],[<leap-sec>],<sync-now>,[<retry-s>],[<retry-cnt>]		
Absolute time synchronization		
Parameter	Range	Description
int-minutes	0	off
	1..65535	
leap-sec	-128..127	
sync-now	0	no
	1	yes
retry-s	0..255	
retry-cnt	0..255	

lora cfg-class-b

lora cfg-class-b [<auto-en>],[<ping-slot-int-s>]		
Configure LoRaWAN Class B		
Parameter	Range	Description
auto-en	0	off
	1	on
ping-slot-int-s	1	
	2	
	4	
	8	
	16	
	32	
	64	

	128	

lora class

lora class <class>		
Switch LoRaWAN class		
Parameter	Range	Description
class	0	A
	1	B

lora join-eui

lora join-eui <cred-ch-key>,<eui-0>,<eui-1>,<eui-2>,<eui-3>,<eui-4>,<eui-5>,<eui-6>,<eui-7>		
Override network JoinEUI		
Parameter	Range	Description
cred-ch-key	87904163	
eui-0	0..255	
eui-1	0..255	
eui-2	0..255	
eui-3	0..255	
eui-4	0..255	
eui-5	0..255	
eui-6	0..255	
eui-7	0..255	

lora net-key

lora net-key <cred-ch-key>,<key-0>,<key-1>,<key-2>,<key-3>,<key-4>,<key-5>,<key-6>,<key-7>,<key-8>,<key-9>,<key-10>, <key-11>,<key-12>,<key-13>,<key-14>, <key-15>		
Override network AppKey		
Parameter	Range	Description
cred-ch-key	87904163	
key-0	0..255	
key-1	0..255	
key-2	0..255	
key-3	0..255	
key-4	0..255	
key-5	0..255	
key-6	0..255	
key-7	0..255	
key-8	0..255	
key-9	0..255	
key-10	0..255	
key-11	0..255	
key-12	0..255	

key-13	0..255	
key-14	0..255	
key-15	0..255	

lora cred

lora cred [<confirm-timeout-s>],[<action>]		
User network credential management		
Parameter	Range	Description
confirm-timeout-s	60..65535	revert if not joined
action	0	clear pending
	1	try now
	87904163	force confirm

frame send

frame send <frame-id>,…		
Schedule uplink frames		
Parameter	Range	Description
frame-id	frame-type	

frame set-cfg

frame set-cfg <profile-mask>,[<ul-period-s>],[<confirmed>],[<on-join>],<frame-id>,…		
Set uplink frame configuration		
Parameter	Range	Description
profile-mask	1..63	bitfield
ul-period-s	0	off
	1..65535	
confirmed	0	no
	1	yes
on-join	0	no
	1	yes
frame-id	frame-type	

frame clear-cfg

frame clear-cfg <profile-mask>		
Clear all frame config for specified profiles (as if 'set-cfg profile-mask,0,0,0,…')		
Parameter	Range	Description
profile-mask	1..63	bitfield

mag cfg

mag cfg [<pin-timeout>],[<pin-protect>],[<blink-mode>]
Set configuration

Parameter	Range	Description
pin-timeout	0..65535	
pin-protect	0	off
	1	on
blink-mode	0	half duty
	1	pulse
	2	off

mag svc

mag svc <new-state>,<key>		
Enable or disable magnet command interface		
Parameter	Range	Description
new-state	0	off
	1	on
key	649864801	

data sample

data sample
Force sensor polling

data next-epoch

data next-epoch <type>		
Manually start next histogram epoch		
Parameter	Range	Description
type		

data poll-cfg

data poll-cfg <profile-mask>,[<th-poll-int>],[<sync-period>],[<on-mag-switch>],[<on-activity-change>],[<on-impact>], [<on-free-fall>],[<on-ul-stale>],[<bat-poll-int>]		
Set data polling configuration		
Parameter	Range	Description
profile-mask	1..63	bitfield
th-poll-int	1..4294967295	temperature and humidity
sync-period	0	no
	1	yes
on-mag-switch	0	no
	1	yes
on-activity-change	0	no
	1	yes
on-impact	0	no
	1	yes
on-free-fall	0	no

	1	yes
on-ul-stale	0	no
	1	yes
bat-poll-int	1..4294967295	battery voltage

data temp-histo-cfg

data temp-histo-cfg <profile-mask>,[<epoch-interval-s>],[<epoch-interval-cnt>],[<epoch-max-bin-cnt>], [<frame-on-new-epoch>],[<lim-divider>],[<bin-limit-0>],[<bin-limit-1>],[<bin-limit-2>],[<bin-limit-3>],[<bin-limit-4>], [<bin-limit-5>],[<bin-limit-6>],[<bin-limit-7>],[<bin-limit-8>]		
Set temperature histogram configuration		
Parameter	Range	Description
profile-mask	1..63	bitfield
epoch-interval-s	0	off
	1..4294967295	
epoch-interval-cnt	0	off
	1..4294967295	
epoch-max-bin-cnt	0	off
	1..4294967295	
frame-on-new-epoch	0	no
	1	yes
lim-divider	1..4294967295	
bin-limit-0	-128..127	°C
	%f	
bin-limit-1	-128..127	°C
	%f	
bin-limit-2	-128..127	°C
	%f	
bin-limit-3	-128..127	°C
	%f	
bin-limit-4	-128..127	°C
	%f	
bin-limit-5	-128..127	°C
	%f	
bin-limit-6	-128..127	°C
	%f	
bin-limit-7	-128..127	°C
	%f	
bin-limit-8	-128..127	°C
	%f	

data humid-histo-cfg

data humid-histo-cfg <profile-mask>,[<epoch-interval-s>],[<epoch-interval-cnt>],[<epoch-max-bin-cnt>], [<frame-on-new-epoch>],[<lim-divider>],[<bin-limit-0>],[<bin-limit-1>],[<bin-limit-2>],[<bin-limit-3>],[<bin-limit-4>], [<bin-limit-5>],[<bin-limit-6>],[<bin-limit-7>],[<bin-limit-8>]
Set humidity histogram configuration

Parameter	Range	Description
profile-mask	1..63	bitfield
epoch-interval-s	0	off
	1..4294967295	
epoch-interval-cnt	0	off
	1..4294967295	
epoch-max-bin-cnt	0	off
	1..4294967295	
frame-on-new-epoch	0	no
	1	yes
lim-divider	1..4294967295	
bin-limit-0	0..99	RH%
	%f	
bin-limit-1	0..99	RH%
	%f	
bin-limit-2	0..99	RH%
	%f	
bin-limit-3	0..99	RH%
	%f	
bin-limit-4	0..99	RH%
	%f	
bin-limit-5	0..99	RH%
	%f	
bin-limit-6	0..99	RH%
	%f	
bin-limit-7	0..99	RH%
	%f	
bin-limit-8	0..99	RH%
	%f	

data ema-cfg

data ema-cfg <profile-mask>,[<temp-cnt>],[<humid-cnt>],[<bat-cnt>],[<orient-cnt>],[<send-ema-temp>],[<send-ema-humid>], [<send-ema-bat>],[<send-ema-orient>]		
Set exponential moving average (EMA) configuration		
Parameter	Range	Description
profile-mask	1..63	bitfield
temp-cnt	1..32766	a = 2 / (temp-cnt + 1)
humid-cnt	1..32766	a = 2 / (humid-cnt + 1)
bat-cnt	1..32766	a = 2 / (bat-cnt + 1)
orient-cnt	1..32766	a = 2 / (orient-cnt + 1)
send-ema-temp	0	no
	1	yes
send-ema-humid	0	no

	1	yes
send-ema-bat	0	no
	1	yes
send-ema-orient	0	no
	1	yes

data activity-cfg

data activity-cfg <profile-mask>,[<mode>],[<level1-th>],[<level2-th>],[<en-led>]		
Set activity monitor configuration		
Parameter	Range	Description
profile-mask	1..63	bitfield
mode	0	off
	1	single
	2	dual
level1-th	1..63	
level2-th	1..63	
en-led	0	off
	1	on

data acc-cfg

data acc-cfg <profile-mask>,[<full-scale>],[<en-impact-x>],[<en-impact-y>],[<en-impact-z>],[<impact-th>],[<impact-dur>], [<en-ff>],[<ff-th>],[<ff-dur>],[<data-rate>], [<filter>],[<lp-mode>],[<low-noise>]		
Set accelerometer configuration		
Parameter	Range	Description
profile-mask	1..63	bitfield
full-scale	0	2G
	1	4G
	2	8G
	3	16G
en-impact-x	0	off
	1	on
en-impact-y	0	off
	1	on
en-impact-z	0	off
	1	on
impact-th	1..63	impact-th * full-scale / 64
impact-dur	0..3	
en-ff	0	off
	1	on
ff-th	0..7	
ff-dur	0..63	
data-rate	2	Hz

	13	
	25	
	500	
	100	
	200	
filter	2	cutoff = data-rate/filter
	4	
	10	
	20	
lp-mode	0..3	
low-noise	0	no
	1	yes

data orient-cfg

data orient-cfg <profile-mask>,[<enable>],[<max-1G-offset>],[<poll-interval-s>],[<ref-1-x>],[<ref-1-y>],[<ref-1-z>], [<ref-2-x>],[<ref-2-y>],[<ref-2-z>],[<ref-3-x>],[<ref-3-y>],[<ref-3-z>]		
Set orientation sense configuration		
Parameter	Range	Description
profile-mask	1..63	bitfield
enable	0	off
	1	on
max-1G-offset	1..20	
poll-interval-s	1..4294967295	
ref-1-x	-32768..32767	
ref-1-y	-32768..32767	
ref-1-z	-32768..32767	
ref-2-x	-32768..32767	
ref-2-y	-32768..32767	
ref-2-z	-32768..32767	
ref-3-x	-32768..32767	
ref-3-y	-32768..32767	
ref-3-z	-32768..32767	

data event-cfg

data event-cfg <profile-mask>,[<max-count>],[<send-th>],[<discard>],[<send-all>]			
Set event storage configuration			
Parameter	Range	Description	
profile-mask	1..63	bitfield	
max-count	0	disabled	
	1..100		
send-th	0..65535	if count >= send-th: send(device-events)	
discard	0	oldest	if no free space
	1	newest	
send-all	0	off	

	1	on

data erase-events

data erase-events [<num-oldest>]		
Erase <num-oldest> events if provided, otherwise all		
Parameter	Range	Description
num-oldest	0..65535	

data del-rule

data del-rule [<rule-num>]		
Delete <rule-num> rules if provided, otherwise delete all		
Parameter	Range	Description
rule-num	0..31	

data set-rule

data set-rule [<rule-num>],<test-expr>,[<input-expr>],[<switch-profile>],[<make-event-0>],[<make-event-1>], [<make-event-2>],[<make-event-3>],[<send-frame-0>], [<send-frame-1>],[<send-frame-2>],[<send-frame-3>],[<clr-timer-mask>]		
Set data rule <rule-num>		
Parameter	Range	Description
rule-num	0..31	
test-expr		
input-expr		
switch-profile	0..5	
make-event-0	variable-type	
make-event-1	variable-type	
make-event-2	variable-type	
make-event-3	variable-type	
send-frame-0	frame-type	
send-frame-1	frame-type	
send-frame-2	frame-type	
send-frame-3	frame-type	
clr-timer-mask	0..15	

data timer

data timer [<timer_1>],[<timer_2>],[<timer_3>],[<timer_4>]		
Set user timer value		
Parameter	Range	Description
timer_1	0..4294967295	timer_1
timer_2	0..4294967295	timer_2
timer_3	0..4294967295	timer_3
timer_4	0..4294967295	timer_4

data activity-cal

data activity-cal <profile-mask>,<cal-level>,<cal-led>		
Run activity monitor calibration and apply result to profiles		
Parameter	Range	Description
profile-mask	1..63	bitfield
cal-level	1	level-one
	2	level-two
cal-led	0	no
	1	yes

Data Frames

ID	Size [B]	Name	Data Fields
1	5	current-state	temperature, humidity, mag_sw_cnt_u8, major_axis_orientation, activity_state, free_fall_evnt, impact_evnt, pending_evnt
2	variable	device-events	event-list
3	11	temp-histogram	temp_histo_epoch, temp_histo_bin[10]
4	11	humid-histogram	humid_histo_epoch, humid_histo_bin[10]
5	3	device-orientation	orientation_x, orientation_y, orientation_z
6	9	full-activity	activity_state, activity_s, high_activity_s
7	8	motion-events	impact_cnt, free_fall_cnt
8	8	mag-switch	mag_sw_cnt, mag_switch_ts
9	8	impact-count	impact_cnt_u16, impact_cnt_x_u16, impact_cnt_y_u16, impact_cnt_z_u16
10	2	last-temp	temperature
11	2	ema-temp	temperature_ema
12	1	last-humid	humidity
13	1	ema-humid	humidity_ema
14	5	activity	activity_state, total_activity_s
20	8	dev-time	uptime_s, unix_time
21	2	dev-health	battery_mv
22	11	version	version_pid, version_maj, version_min, version_rev, version_hash[6]
23	11	serial-number	serial_number[11]
24	10	cfg-state	cfg_app_crc, cfg_net_crc, cfg_frames_crc, cfg_data_crc, cfg_rules_crc
25	variable	full-cfg	content-offset, content-final, content-len, content-binary-blob
26	variable	app-cfg	content-offset, content-final, content-len, content-binary-blob
27	variable	net-cfg	content-offset, content-final, content-len, content-binary-blob
28	variable	frame-cfg	content-offset, content-final, content-len, content-binary-blob
29	variable	data-cfg	content-offset, content-final, content-len, content-binary-blob
30	variable	rules-cfg	content-offset, content-final, content-len, content-binary-blob

User Variables

ID	Size [B]	Encoding	Name	Description
0	1	u8	profile	current data profile (0..5)
1	4	u32	profile_etm	elapsed time [s] since last profile switch
2	4	u32	daytime_tm	seconds since midnight 00:00 GMT or 0 if unknown
3	4	u32	unix_time	current UNIX time or device uptime if unknown
4	4	u32	net_frame_etm	elapsed time since last network uplink
5	1	bool	net_joined_flag	network join state

6	1	u8	net_class	currently selected LoRaWAN class
7	1	u8	net_region	currently used LoRaWAN region code
8	2	f8.8	temperature	last measured temperature
9	2	f8.8	temperature_ema	EMA of measured temperature
10	1	u8	humidity	last measured humidity
11	1	u8	humidity_ema	EMA of measured humidity
12	4	u32	mag_sw_cnt	magnetic switch state change counter
13	4	u32	mag_sw_etm	elapsed time since last magnetic switch change [s]
14	1	bool	mag_sw_flag	current state of magnetic switch
15	1	activity	activity_state	current device activity state
16	4	u32	activity_s	low activity (level 1) state counter [s]
17	4	u32	high_activity_s	high activity (level 2) state counter [s]
18	1	orient	major_axis_orientation	coarse device orientation
19	4	u32	impact_cnt_x	X axis impact event counter
20	4	u32	impact_cnt_y	Y axis impact event counter
21	4	u32	impact_cnt_z	Z axis impact event counter
22	4	u32	impact_cnt	impact event counter
23	1	bool	impact_evnt	impact event flag, cleared by current-state, motion-events, impact-count frames
24	4	u32	impact_etm	elapsed time since last impact event event [s]
25	4	u32	free_fall_cnt	free-fall event counter
26	1	bool	free_fall_evnt	free-fall event flag, cleared by current-state, motion-events frames
27	4	u32	free_fall_etm	elapsed time since last free-fall event [s]
28	1	u8	angle_1	angle between current orientation and user ref-1 vector, see data orient-cfg
29	1	u8	angle_2	angle between current orientation and user ref-2 vector, see data orient-cfg
30	1	u8	angle_3	angle between current orientation and user ref-3 vector, see data orient-cfg
31	1	u8	angle_ema	angle between current orientation and EMA of device orientation
32	2	u16	battery_mv	last measured battery voltage [mV]
33	2	u16	battery_mv_ema	EMA of battery voltage [mV]
34	2	u16	meta_rule_id	meta variable to send generate event with rule number
35	4	u32	timer_1	resettable continues up counting timer [s]
36	4	u32	timer_2	resettable continues up counting timer [s]
37	4	u32	timer_3	resettable continues up counting timer [s]
38	4	u32	timer_4	resettable continues up counting timer [s]
39	4	u32	activity_state_etm	time since activity_state state change [s]

Frame Data Fields

Size [B]	Encoding	Name	Description
1	u8	mag_sw_cnt_u8	LSB of internal magnet switch counter mag_sw_cnt
1/8	bool	pending_evnt	indicates device has stored events
0		event-list	variable length list of: event time stamp, code and optional value
1	u8	temp_histo_epoch	temperature histogram epoch number
10	u8[10]	temp_histo_bin[10]	temperature histogram bin counter values
1	u8	humid_histo_epoch	humidity histogram epoch number
10	u8[10]	humid_histo_bin[10]	humidity histogram bin counter values
1	i8	orientation_x	device orientation normal vector X axis
1	i8	orientation_y	device orientation normal vector Y axis
1	i8	orientation_z	device orientation normal vector Z axis
4	u32	mag_switch_ts	time stamp of last time magnetic switch state change

2	u16	impact_cnt_u16	impact event counter
2	u16	impact_cnt_x_u16	X axis impact event counter
2	u16	impact_cnt_y_u16	Y axis impact event counter
2	u16	impact_cnt_z_u16	Z axis impact event counter
4	u32	total_activity_s	total activity state time (level 1 + level 2)
4	u32	uptime_s	device FW uptime
2	u16	version_pid	TG-LR82:0x0000, TG-LR92:0x0001
1	u8	version_maj	FW version major number
1	u8	version_min	FW version minor number
1	u8	version_rev	FW version patch number
6	u8[6]	version_hash[6]	FW version hash
11	u8[11]	serial_number[11]	last 11 characters of device serial number
2	u16	cfg_app_crc	app & mag configuration group 16 bit checksum
2	u16	cfg_net_crc	net configuration group 16 bit checksum
2	u16	cfg_frames_crc	frame configuration group 16 bit checksum
2	u16	cfg_data_crc	data configuration group 16 bit checksum
2	u16	cfg_rules_crc	data rule configuration 16 bit checksum
1/8	bool	content-final	flag indicating last chunk of content
15/8	u15	content-offset	byte offset of content data
1	u8	content-len	length of content
0		content-binary-blob	binary data of content chunk

Known Issues

ID	FW	Description
LORA-275	2.0.0	No timeout changing credentials with secondary band disabled.
LORA-276	2.0.0	Incorrect credential change command timeout.
LORA-279	2.0.0	Activity calibration with orientation enabled causes fault.

LORA-275

Description: If credential changes are initiated with secondary band disabled - device will not timeout join. Device will be stuck attempting join until either it succeeds or is restarted.

Workaround: If new credentials are invalid restart device physically with magnet switch command.

LORA-276

Description: When lora cred is executed device will timeout join procedure on next join attempt based on total uptime instead of command execution time. If uptime is longer than *confirm-timeout-s* parameter device will timeout exactly after single failed join attempt.

Workaround: Issue device reset command app reset before attempting to change credentials. Or manually retry credential change multiple times.

LORA-279

Description: If activity calibration is performed while orientation detection is enabled device may fault and restart.

Workaround: Disable orientation detection with data orient-cfg before performing activity calibration and re-enable after.

Related Documents

No	Name

1	TS001-1.0.4 LoRaWAN® L2 1.0.4 Specification
2	Guidelines for 64-bit Global Identifier (EUI-64)