TCR Users Manual

V2.2

Introduction

TCR are solar powered radar object counters with integrated LoRaWAN® connectivity.

The system includes powerful radar signal processing that enables bi-directional counting of moving objects in distances up to 10m. Objects can be categorized into up to 4 groups with speed and object size filters. Counter values are transmitted in regular intervals to the LNS (LoRaWAN® Network Server).

TCR GEN2 is a very versatile radar counting system. It enables various applications such as people counting, traffic statistics, use of sports facilities or even security applications.

TCR-Sxx types come with an integrated solar charging unit including tempered battery. The battery is used to backup up to 4 foggy days. The system can be installed very flexible on different locations including remote areas without any electricity.

Installation

To achieve the most accurate measurement possible, planning the installation is essential. This chapter therefore contains information on the correct choice of location for the TCR traffic counter.

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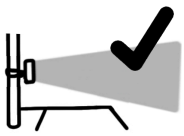
Horizontal or Top Down?

The devices can be operated both directly next to the road or elevated and looking down from above. We recommend using a laser measuring tool or a laser pointer to align the device correctly.

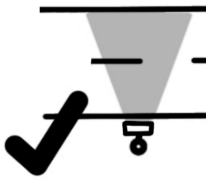
When mounted on a pole or mast you should point the sensor to the middle of the road (center line). This can be done easily by adjusting the tiltable bracket MT80-15. The bracket can be placed about 3-4 meters above ground. Please check the max range of the sensor. **Important: The pole must not move in the wind**



When mounted next to the street we recommend a mounting height of 1.2-1.5m above ground. Line of sight should be completely horizontal.

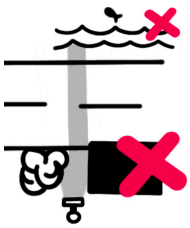
Important Rules

The device works best when the following rules are observed.



Lateral to movement__
TCR are side radars that detect motion from both directions simultaneously. The movement should be linear. Therefore place the sensor parallel to the movements direction and **keep away from curves, crossings, driveways**

50cm distance
The sensor must be at least 50cm away from the target to avoid signal overload.



Avoid obstacles in FOV
Make sure there are no obstacles such as walls, street signs, shrubberies, trees in the field of view. When placed beside water the device might detect the waves.

LTR vs RTL

The TCR traffic counters distinguish between 2 directions.

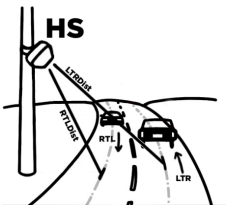
- RTL = objects which come from the right and disappear to the left. The left LED will pulse once in this case.
- LTR = objects which come from the left and disappear to the right. The right LED will pulse once in this case.

Measure distance to lanes

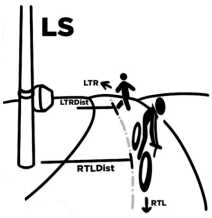
In order for the device to determine the velocities, the distance to the object must be known. The distance can be determined with a tape measure or a laser distance meter. Measurements are taken from the middle of a track to the front of the device.

- RTLDist = Distance in cm to the RTL movement line.
- LTRDist = Distance in cm to the LTR movement line.

Situation



Two lanes, cross traffic (2L2D) This is typical for HS applications such as measuring traffic on interstate roads. RTLDist and LTRDist are different.



Cross traffic on one lane (1L2D)
This is typical for low speed traffic (LS) measuring bicycle lanes or small paths. In this case get the distance to the center of the track and set RTLDist and LTR Dist to the same value.

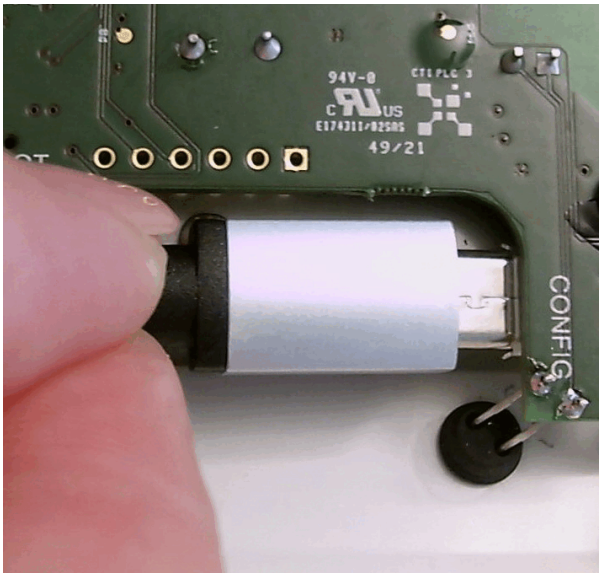
Device Settings

TCR traffic counters **must be configured correctly** to **obtain good results**. This chapter therefore describes all settings individually.

For most applications only the following settings needs to be changed:

- **LTRDist** to set the distance to movement from the left
- **RTLDist** to set the distance to movement from the right
- **RadarSens** to set the radar sensitivity level (comparable with the the shutter on a photo camera)

Configuration is via a USB cable, connected to the CONFIG port and using the PPX Setup Tool (recommended) or alternatively via the command line interface CLI.



Note: On first generation TCR units (TCR-LS, TCR-LSS, TCR-HS, TCR-HSS), the configuration port is located on the main board. To connect the USB cable, the unit must be opened.

Symbols used

- Setting can be changed over USB with the PPX Setup Tool
- Setting can be changed over USB using the TCR Command Line Interface
- Setting can be changed remotely by sending TCR LoRaWAN Config Downlink Commands

Application Settings

Operation Mode

You can select different types of uplink behaviour using the Operation Mode setting.

Mode	Description	Applications
Timespan	The device will accumulate vehicles or people counting over a certain time. Then the counter values will be transmitted over the LoRaWAN Network. Time period is defined by the LoRaWAN Uplink Interval Setting.	Most Applications use this mode
NotZero	Same as Timespan Mode, but the uplinks will be skipped if there is no count during the Uplink Interval Period. The setting can be used to reduce uplinks for LoRaWAN networks with limited number of allowed uplinks/downlinks per day. As the radar is the largest contributor to energy consumption, this setting will not have a noticeable energy saving effect.	Reducing uplinks
Trigger	Sends an uplink immediately when an object is detected. Unfortunately, the LoRaWAN standard does not allow uplinks to be sent in succession at any speed. Instead, the duty cycle must be observed. This also applies to this mode. This means that a trigger is only executed immediately if there was a sufficiently long waiting time without counts beforehand (something like 3 minutes).	Train detection Security Applications

Hold-Off

The hold-off function has been introduced to the device firmware to be able to count connected vehicles (trains, trailers) **as one** instead of multiple counts.

Hold-off is enabled by entering a value bigger than zero.
As an example: If Hold-off time is set to 10 seconds the device will increase the counters as soon as an object has been detected. Then the radar will be off for 10s
.

Value range: **1-600s** (0 = disabled).

Default: 0

Auto-Zero

The Auto-zero Timeout will set the account to zero after this time has elapsed. This is useful if you are using confirmed uplinks. If the uplinks fail, the counter will be reset to zero after this time.

Default: 120min

Totalizer

This setting defines how to increment the counter values.

Totalizer	Counter	Reset
Disabled	Counter values represent object counts during the **last time period**	After a LoRaWAN Uplink ACK is received the counter values are cleared.
Enabled	Counter values start with 0 and go up to 65535 max.	Reset counters with a LoRaWAN Downlink Command

Default: Disabled

Fallback Category

We try to measure object size and speed. In some situations, however, it is not possible to determine the size and speed in addition to the direction of movement. This is mainly if the object is too fast or covers the field of view (FOW). In this cases, no classification into categories is made and instead the counter of the **fallback category** is increased.

> Try to place the sensor a little further away from the object so that the objects fits into the FOW.

Traffic Categories

Criteria defining each type of detection. The radar determines the category based on the speed and size of the object.

Low Speed device: You can only select two categories (People and Two-Wheelers)

High Speed device: You can select all 4 categories (People, Two-Wheelers, Cars, HGV)

Important: These settings will need to be changed depending on where the radar is installed, what you are trying to detect and the type of vehicles likely to pass underneath.

Radar Settings

Radar Enabled

Radar on by default

Channels

1 set by default

2 if you have a radar in the same

Sensitivity

After entering *LTRDist* and *RTLDist* the sensitivity is automatically determined based on those values. The further the distance to the measurement, the higher the sensitivity.

Note: Small adjustments of sensitivity can be done manually. If the ratio (sensitivity vs. RTL/LTR) is not correct, the radar may incorrectly categorize the measured object.

Beam Angle

Beam size from left to right

Note: In areas where you may have obstacles in the way, you may need to narrow the angle of the beam.

Beam Directions

Can be offset by up to 30 degrees in any direction. Once again cater for things link tree and things in the way.

LTRDist

Distance between the radar surface and the object you are trying to detect approaching from the left.

LTRDist

Distance between the radar surface and the object you are trying to detect approaching from the right.

> Note: If you get inaccurate measurement data, check the accuracy of the distance settings .

see more instruction: Measure distance to lanes

Autotune

Turn on autotune to allow the radar to adjust the sensitivity.

If the sensitivity is to high, the object might blur and therefore gets too big (Size value) If the distance is incorrect the size get too big too.

With Autotune enabled the Radar Sensitivity will be controlled automatically. It’s comparable to the automatic exposure setting at a photo camera.

LoRaWAN Settings

LoRa Modem Enabled

LoRa Modem on by default

Uplink Internval (10min)

Time span of the counts that are sent

Device Class

Class A Device:

Class B Device:

Class C Device:

Confirmed Uplinks

ON:

OFF:

ADR Enabled

ON:

OFF:

RTC Timesync Enabled

ON:

OFF:

Operation Mode (mode)

TCR can be operated in 3 different modes.

Mode	Description	Used for
Timespan	Device is counting during a certain time interval (see *lora_interval* setting). After the time is up, counter values are transmitted.	Default behavior. This can be used for creating histograms or controlling actors like street lights.
NotZero	Same as Timespan but uplinks are blocked as long as there is no movement.	This can be used to save uplinks or energy.
Trigger	This will send an uplink as soon as an object has been detected	This can be used for alam applications.

Note: Trigger mode is limited by the LoRaWAN® standard. It is not possible to transfer as many times and in arbitrarily short intervals. (See ETSI Duty Cycle for more information)

Hold-Off Timer (holdoff)

This function is used to filter fast consecutive counts.

As an example, if Hold-off time is set to 10 seconds, no second count will occur for 10s after a first count.

This function is useful in situation where you want to count a queue of objects e.g. count the train and not the waggons.

Value range: **1-600s** (0 = no filter applied)

The Hold-off timer setting can also be changed via a LoRaWAN® Config Downlink.

Defaults Settings

Following table shows factory defaults for two possible speeclass configurations LS and HS.

Setting	TCR-xxx/LS	TCR-xxx/HS
mode	0	0
sumup	0	0
holdoff	0	0
timeout	120	120
fallbackcat	1 (A)	2 (B)
cat_p_enabled	1	0
cat_p_minspeed	1	1
cat_p_maxspeed	7	7
cat_p_minsize	1	1
cat_p_maxsize	100	100
cat_a_enabled	1	1
cat_a_minspeed	5	5
cat_a_maxspeed	40	40
cat_a_minsize	100	100
cat_a_maxsize	250	250
cat_b_enabled	0	1
cat_b_minspeed	10	10
cat_b_maxspeed	100	100
cat_b_minsize	250	250

cat_b_maxsize	600	600
cat_c_enabled	0	1
cat_c_minspeed	10	10
cat_c_maxspeed	80	80
cat_c_minsize	600	600
cat_c_maxsize	1000	1000
lora_enabled	1	1
lora_class	0 (A)	0
lora_confirmed	1	1
lora_adr	1	1
lora_fsb	0	0
lora_interval	10	10
lora_lci	1440	1440
lora_ula	10	10
lora_timesync	1	1
radar_enabled	1	1
radar_channel	0	0
radar_sens	90	95
radar_beam	80	80

radar_dir	0	0
radar_ltrdist	250	800
radar_rtldist	250	400
radar_autotune	1	1

Device Profile

Usually device profiles are saved once during the production of the devices. E.g. TCR-DLI**/LS/EU868**

However starting with TCR GEN2 and Firmware V2.1, both the **Speed Class** as well as the **LoRaWAN® Region** may be changed by the user too.

This allows to stock standard types (TCR-DLI, TCR-DLE, TCR-SLI, TCR-SLE) and configure it later according to customers need.

> Note: Device profiles can only be changed via the command line interface. Changes will be stored in a secure element (a separate chip on the mainboard) and will not be overwritten by Firmware Updates.

Changing Speed Class

Speed classes are used to better adapt the radar algorithm to the objects to be measured.

- Speed class 1 (low speed) is used for pedestrians and bicycles or very slow-moving cars in parking areas. The typical range is about 1 to 40 km/h
- Speed class 2 (high speed) goes up to 120km/h. However, slow objects (< 10km/h) such as pedestrians can no longer be detected reliably.

The boundaries are not absolute like nothing in this world is absolutely deterministic. Changing radar scanning frequencies shift the detection characteristic.

> Important: An incorrectly selected speed class can strongly influence the measurement results.

In order to change the speed class of your device use the following command sequence in the CLI.

Set to low speed (LS)

```
set speedclass 1
1

set defaults
ok

save
ok
```

Set to high speed (HS)

```
set speedclass 2
1

set defaults
ok

save
ok
```

Check devicetype

```
get typestr
```

This should return the device's SKU, TCR-xxx/**LS**/xxxxx or TCR-xxx/**HS**/xxxxx

Changing LoRaWAN® Region

The integrated LoRaWAN® modem in TCR GEN2 devices can be adapted to LoRaWAN® frequency plans used in different regions. A complete list of countries can be found in the LoRaWAN® 1.0.3 Regional Parameters Document.

> Important: TCR-DLI and TCR-SLI use wide band 868MHz/915MHz internal antennas that can match all supported regions. For devices with external antennas, please check the frequency range of the antennas.

EU868

Enable frequency plan EU863-870 used in most European countries and parts of Africa.

```
lora set region 1
1

save
```

```
ok

get typestr
TCR-xxx/xx/EU868
```

AS923

Enable channel plan AS920-923 (sometimes called “AS1”) used mostly in Japan, Malaysia, Singapore and sometimes Australia.

```
lora set region 2
1

save
ok

get typestr
TCR-xxx/xx/AS923
```

AU915

Enable channel plan AU915-928 used mostly in Australia and New Zealand

```
lora set region 3
1


save
ok

get typestr
TCR-xxx/xx/AU915
```

Please also set the frequency sub-band for AU915 as few LoRaWAN® gateways do support more than 8 channels.

```
lora set fsb [x]
```

Subband	Channels	CLI Command
0	0-63 (all)	lora set fsb 0
1	0-7	lora set fsb 1
2	8-15	lora set fsb 2
3	16-23	lora set fsb 3
4	24-31	lora set fsb 4
5	32-39	lora set fsb 5
6	40-47	lora set fsb 6
7	48-55	lora set fsb 7
8	56-63	lora set fsb 8

US915 (Experimental)

Enable channel plan US902-928 used mostly in USA, Canada and South America.

Note: The device does support the US915 frequency plans. However, FCC/IP certification is still pending.

```
lora set region 4
1

save
ok

get typestr
TCR-xxx/xx/US915
```

Please also set the frequency sub-band for AU915 as few LoRaWAN® gateways do support more than 8 channels.

lora set fsb [x]

Subband	Channels	CLI Command
0	0-63 (all)	lora set fsb 0
1	0-7	lora set fsb 1
2	8-15	lora set fsb 2
3	16-23	lora set fsb 3
4	24-31	lora set fsb 4
5	32-39	lora set fsb 5
6	40-47	lora set fsb 6
7	48-55	lora set fsb 7
8	56-63	lora set fsb 8

IN865 (Experimental)

Channel plan IN865-867 is used mostly in India. It has never been tested outside the lab. Feedback is appreciated!

```
lora set region 5
1

save
ok

get typestr
TCR-xxx/xx/IN865
```