

## Command line interface

### Electrical connection

You can use a commercially available USB-to-serial adapter cable to connect a PC to the sensor device. CAUTION: Use adapters with **3 V (max. 3.3 V)** TTL logic levels! Recommended cable: “TTL-232R-RPi Debug Cable for Raspberry Pi” by FTDI chip. Connect 3 wires to the device connector (female pin header socket, 2.54 mm pitch):

Cable	Device
	TCK
RXD	TXD
TXD	RXD
	RST
GND	GND

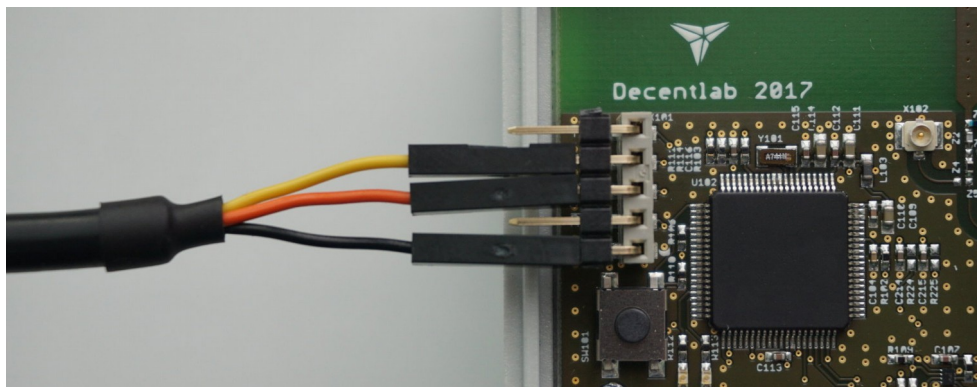


Illustration 1: Serial interface connection (3.3 V TTL levels).

### General remarks

- The ASCII command line interface is active only for 10 min after device reset / power-up. Entering any character restarts the 10 min timeout period.
- Connect using a serial terminal program with settings 115200, 8, N, 1.
- Characters are not echoed. Enable local echoing in your terminal program if needed.
- Terminate each command with CR ('\r', 0x0D), LF ('\n', 0x0A) or both.
- set and get commands operate on parameters in the device software, not directly on the radio module.
- Some commands only take effect after reset (e.g. set chmask + save).
- Parameter changes (set ...) are lost when the device is reset, except when save is issued.
- save permanently stores current parameter settings in flash. Exception: LoRaWAN keys: Please follow the command sequence in the examples below.

## Command list

reset	Reset; un-saved parameter changes are lost.
sleep	Enter sleep mode (power off).
version	Get device software version.
save	Save current parameter set in flash.
save keys	Save LoRaWAN keys in flash (DevEUI, AppEUI, AppKey, DevAddr, NwkSKey, AppSKey). See examples (below).
factory reset	Erase settings in flash and reset.
get period	Get sampling period in seconds.
set period <p>	Set sampling period in seconds (1...65535).
get send_period	Get send period relative to sampling period (default: 1).
set send_period <p>	Set send period. Examples: p = 0 or 1: send after every sampling; p = 4: send after every fourth sampling.
get mode	Get LoRaWAN activation mode.
set mode otaa	Select OTAA (over-the-air activation).
set mode abp	Select ABP (activation by personalization).
get dr	Get default Tx data rate. Actual data rate may vary, if ADR is enabled.
set dr <p>	Set default Tx data rate. Used for next Tx. Actual data rate for following Tx may vary, if ADR is enabled.
get adr	0: ADR disabled, 1: ADR enabled.
set adr on	Enable ADR.
set adr off	Disable ADR.
get pwridx	Get default Tx power index. Actual power index may vary, if ADR is enabled.
set pwridx <p>	Set default Tx power index. Used for next Tx. Actual power index for following Tx may vary, if ADR is enabled.
get deveui	Get DevEUI: 8 bytes in hex (16 hex characters).
set deveui <p>	Set DevEUI. Please follow the command sequence in the examples below.
get appeui	Get AppEUI: 8 bytes in hex (16 hex characters).
set appeui <p>	Set AppEUI. Please follow the command sequence in the examples below.
set appkey <p>	Set AppKey: 16 bytes in hex (32 hex characters). Please follow the command sequence in the examples below.

get devaddr	Get DevAddr: 4 bytes in hex (8 hex characters).
set devaddr <p>	Set DevAddr. Please follow the command sequence in the examples below.
set nwkskey <p>	Set NwkSKey: 16 bytes in hex (32 hex characters). Please follow the command sequence in the examples below.
set appskey <p>	Set AppSKey: 16 bytes in hex (32 hex characters). Please follow the command sequence in the examples below.
get nodeid	Get Decentlab device ID (0...65535).
set nodeid <p>	Set Decentlab device ID (0...65535).
read	Read sensors now (and send, if send_period has elapsed).
send	Read sensors now and send data.
get dr_min	Get minimum data rate (overrides ADR settings).
set dr_min <p>	Set minimum data rate (overrides ADR settings).
get dr_max	Get maximum data rate (overrides ADR settings).
set dr_max <p>	Set maximum data rate (overrides ADR settings).
get pwridx_min	Get minimum Tx power index (overrides ADR settings).
set pwridx_min <p>	Set minimum Tx power index (overrides ADR settings).
get pwridx_max	Get maximum Tx power index (overrides ADR settings).
set pwridx_max <p>	Set maximum Tx power index (overrides ADR settings).
get param <i>	Get parameter i, i = 0...15.
set param <i> <p>	Set parameter i, i = 0...15, p = 0...65534 (65535: invalid).
get chmask	Get LoRaWAN channel mask: 9 bytes in hex (18 hex characters).
set chmask <p>	Set LoRaWAN channel mask. Issue save and reset afterwards. See examples (below).
get join_period	Get re-join period in hours.
set join_period <p>	Set re-join period in hours (0...1000). Examples: 24: re-join network every 24 hours. 0: never re-join.
get linkcheck_period	Get linkcheck period (default: 36).
set linkcheck_period <p>	Set linkcheck period.
get linkcheck_tolerance	Get linkcheck tolerance (default: 6).
set linkcheck_tolerance <p>	Set linkcheck tolerance.
get linkcheck_limit	Get linkcheck limit (default: 12).
set linkcheck_limit <p>	Set linkcheck limit.

<others> Invalid command. Answer: unknown command.

## Configure LoRaWAN keys for OTAA

Note: Devices use OTAA by default. Please follow the command sequence below. It is important to set all necessary keys, because the command “save keys” erases all previous keys.

reset (using serial interface or push button)	Reset
sleep	Prepare device
set deveui 0123456789ABCDEF	Set DevEUI
set appeui 000ABC394380221F	Set AppEUI
set appkey 0123456789ABCDEF0123456789ABCDEF	Set AppKey
save keys	Save keys
(wait until completion, about 8 sec)	
reset	Reset

## Configure LoRaWAN keys for ABP

Note: Devices use OTAA by default. Please follow the command sequence below. It is important to set all necessary keys, because the command “save keys” erases all previous keys.

reset (using serial interface or push button)	Reset
sleep	Prepare device
set devaddr 013F4B90	Set DevAddr
set nwkkey FEDCBA9876543210FEDCBA9876543210	Set NwkSKey
set appskey 0123456789ABCDEF0123456789ABCDEF	Set AppSKey
save keys	Save keys
(wait until completion, about 8 sec)	
reset	Reset

## Examples (EU868 band)

set dr 3	Set default data rate: SF9 / 125 kHz. Used for next Tx. Actual data rate for following Tx may vary, if ADR is enabled.
set pwridx 1	Set default Tx power index: 14 dBm. Used for next Tx. Actual power index for following Tx may vary, if ADR is enabled.
set adr on	Enable ADR from now on.
set mode abp	Set ABP mode; save; reset. Make sure DevAddr, NwkSKey and AppSKey are valid!
save	
reset	

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set mode otaa save reset	Set OTAA mode; save; reset. Make sure DevEUI, AppEUI and AppKey are valid!
set dr_min 2	Use only SF10...SF7, overriding ADR settings.
set dr_max 2	Use only SF12...SF10, overriding ADR settings.
set pwridx_min 2	Use maximum 11 dBm, overriding ADR settings.
set pwridx_max 1	Use minimum 14 dBm, overriding ADR settings.
set param 0 1000	Set parameter 0 to 1000.
set param 1 2000	Set parameter 1 to 2000.

## Examples (US915 band)

Note: The examples for EU868 (above) also apply to US915 devices, only that the values for data rates and power indexes differ.

set chmask FF0000000000000000 save reset	Set LoRaWAN channel mask: Enable channels 0...7, disable channels 8...71.
set chmask 00FF00000000000002 save reset	Set LoRaWAN channel mask: Enable channels 8...15 and 65, disable all others.
set chmask 010000000000000000 save reset	Set LoRaWAN channel mask: Enable channel 0, disable all others.
set chmask 030000000000000000 save reset	Set LoRaWAN channel mask: Enable channels 0 and 1, disable all others.
set chmask FFFFFFFFFFFFFFFF save reset	Set LoRaWAN channel mask: Enable all channels (0...71).

## Downlink command interface

### General remarks

- Parameter changes without the save option are lost after a reset or power cycle.
- Command with the save option permanently store the current parameter settings in flash.
- Use with caution: Certain commands / parameters (e.g. “sleep”) may render a device unresponsive / unreachable in the field until it is manually reset.
- Send downlink command using LoRaWAN port 1.
- Downlink command format: | Code | Parameter | CRC |.
- Code: 16-bit unsigned integer, see table below.
- Parameter: 16-bit unsigned integer. Set to 0x0000 if not used.
- CRC: CRC-16 (Modbus) of | Code | Parameter |. See Section Error: Reference source not foundError: Reference source not found. Online calculator: e.g. <https://www.lammertbies.nl/comm/info/crc-calculation.html>
- If CRC does not match, the command is ignored.

### Command list

Command	Code	Description
set period	0x0001	Set sampling period in seconds (1...65535).
set period + save	0x0002	... + save settings.
set dr	0x0003	Set default Tx data rate. Used for next Tx. Actual data rate for following Tx may vary, if ADR is enabled.
set dr + save	0x0004	... + save settings.
set adr on	0x0005	Enable ADR.
set adr on + save	0x0006	... + save settings.
set adr off	0x0007	Disable ADR.
set adr off + save	0x0008	... + save settings.
set dr_min	0x0009	Set minimum data rate (overrides ADR settings).
set dr_min + save	0x000A	... + save settings.
set dr_max	0x000B	Set maximum data rate (overrides ADR settings).
set dr_max + save	0x000C	... + save settings.
set pwridx_min	0x000D	Set minimum Tx power index (overrides ADR settings).
set pwridx_min + save	0x000E	... + save settings.

Command	Code	Description
set pwridx_max	0x000F	Set maximum Tx power index (overrides ADR settings).
set pwridx_max + save	0x0010	... + save settings.
set send_period	0x0011	Set send period. Examples: 0 or 1: send after every sampling; 4: send after every fourth sampling.
set send_period + save	0x0012	... + save settings.
set join_period	0x0013	Set re-join period in hours (0...1000). Examples: 24: re-join network every 24 hours. 0: never re-join.
set join_period + save	0x0014	... + save settings.
set pwridx	0x0015	Set default Tx power index. Used for next Tx. Actual pwridx for following Tx may vary, if ADR is enabled.
set pwridx + save	0x0016	... + save settings.
set linkcheck_period	0x0017	Set link check period (default: 36).
set linkcheck_period + save	0x0018	... + save settings.
set linkcheck_tolerance	0x0019	Set link check tolerance (default: 6).
set linkcheck_tolerance + save	0x001A	... + save settings.
set linkcheck_limit	0x001B	Set link check limit (default: 12).
set linkcheck_limit + save	0x001C	... + save settings.
set param 0	0x0020	Set parameter 0 (0...65534; 65535: invalid).
set param 1	0x0021	Set parameter 1 (0...65534; 65535: invalid).
...	...	...
set param 15	0x002F	Set parameter 15 (0...65534; 65535: invalid).
set param 0 + save	0x0030	... + save settings.
set param 1 + save	0x0031	... + save settings.
...	...	...
set param 15 + save	0x003F	... + save settings.
reset	0xFEFE	Reset device; un-saved parameter changes are lost.
factory reset	0xFEFO	Erase settings in flash and reset.
sleep	0xFEFO	Enter sleep mode (power off).

## Downlink command examples

set period 60 seconds	0001003CF551
set period 600 seconds	000102587E51
set period 3600 seconds	00010E104854
set period 60 seconds + save	0002003CF5A1
set period 600 seconds + save	000202587EA1
set period 3600 seconds + save	00020E1048A4
set dr 0	0003000024F0
set dr 1	00030001E431
set dr 2	00030002E571
set dr 3	0003000325B0
set dr 4	00030004E7F1
set dr 5	000300052730
set dr 0 + save	00040000E541
set dr 1 + save	000400012580
set dr 2 + save	0004000224C0
set dr 3 + save	00040003E401
set dr 4 + save	000400042640
set dr 5 + save	00040005E681
set adr on	000500002510
set adr on + save	0006000025E0
set adr off	00070000E5B1
set adr off + save	00080000E681
set send_period 1	00110001E191
set send_period 10	0011000A26D0
set send_period 20	001100142E50
set send_period 1 + save	00120001E161
set send_period 10 + save	0012000A2620
set send_period 20 + save	001200142EA0
set param 0 1000	002003E85001
set param 0 1000 + save	003003E89500
set param 1 2000	002107D08253
set param 1 2000 + save	003107D04752
reset	FEFE00003C50
factory reset	FEF00000FF31



## Appendix

### Link check feature

The link check feature enables the device to know if it is (still) connected to the LoRaWAN network or not. If it is not connected (anymore), it will try to (re-)join the network. The link is checked periodically by requesting an acknowledgment (ACK) packet from the network server. If an ACK is received, the device knows that it is connected. If no ACK is received, the device will keep on requesting ACKs (with increasing transmit power and spreading factor) until it receives one, or until the link check limit is reached. In the latter case, it will try to rejoin the network.

The following configuration parameters are available:

- `linkcheck_period` (default: 36): Request an ACK for every nth transmission.  
`linkcheck_period = 0`: Link check feature is disabled.
- `linkcheck_tolerance` (default: 6): After requesting n ACKs without receiving one, switch to higher transmit power and higher spreading factor (increase range).
- `linkcheck_limit` (default: 12): After requesting n ACKs without receiving one, rejoin the network.

### Data rate and power index (EU868 band)

Data rate	Configuration	Bit rate	Power idx	Tx Power
0	SF12 / 125 kHz	250 bit/s	1	14 dBm
1	SF11 / 125 kHz	440 bit/s	2	11 dBm
2	SF10 / 125 kHz	980 bit/s	3	8 dBm
3	SF9 / 125 kHz	1760 bit/s	4	5 dBm
4	SF8 / 125 kHz	3125 bit/s	5	2 dBm
5	SF7 / 125 kHz	5470 bit/s		

### Data rate and power index (US915 band)

Data rate	Configuration	Bit rate	Power idx	Tx Power
0	SF10 / 125 kHz	980 bit/s	5	20 dBm
1	SF9 / 125 kHz	1760 bit/s	7	16 dBm
2	SF8 / 125 kHz	3125 bit/s	8	14 dBm
3	SF7 / 125 kHz	5470 bit/s	9	12 dBm
4	SF8 / 500 kHz	12500 bit/s	10	10 dBm

## CRC-16 computation function

```
////////////////////////////////////////////////////////////////  
// CRC-16-IBM (used by Modbus, USB, others. polynomial: 0x8005 / 0xA001)  
////////////////////////////////////////////////////////////////  
  
uint16_t crc16(uint8_t* buf, uint16_t size) {  
    uint16_t crc;  
    uint8_t n, m, x;  
    crc = 0xFFFF;  
    m = size;  
    x = 0;  
    // loop over all bits  
    while (m > 0) {  
        crc = crc ^ buf[x];  
        for (n=0; n<8; n++) {  
            if (crc & 1) {  
                crc = crc >> 1;  
                crc = crc ^ 0xA001;  
            }  
            else {  
                crc = crc >> 1;  
            }  
        }  
        m--;  
        x++;  
    }  
    return crc;  
}
```