AERINOS® LoRaWAN IoT Platform

ADS-270 LoRa End Node

User Guide

infinite

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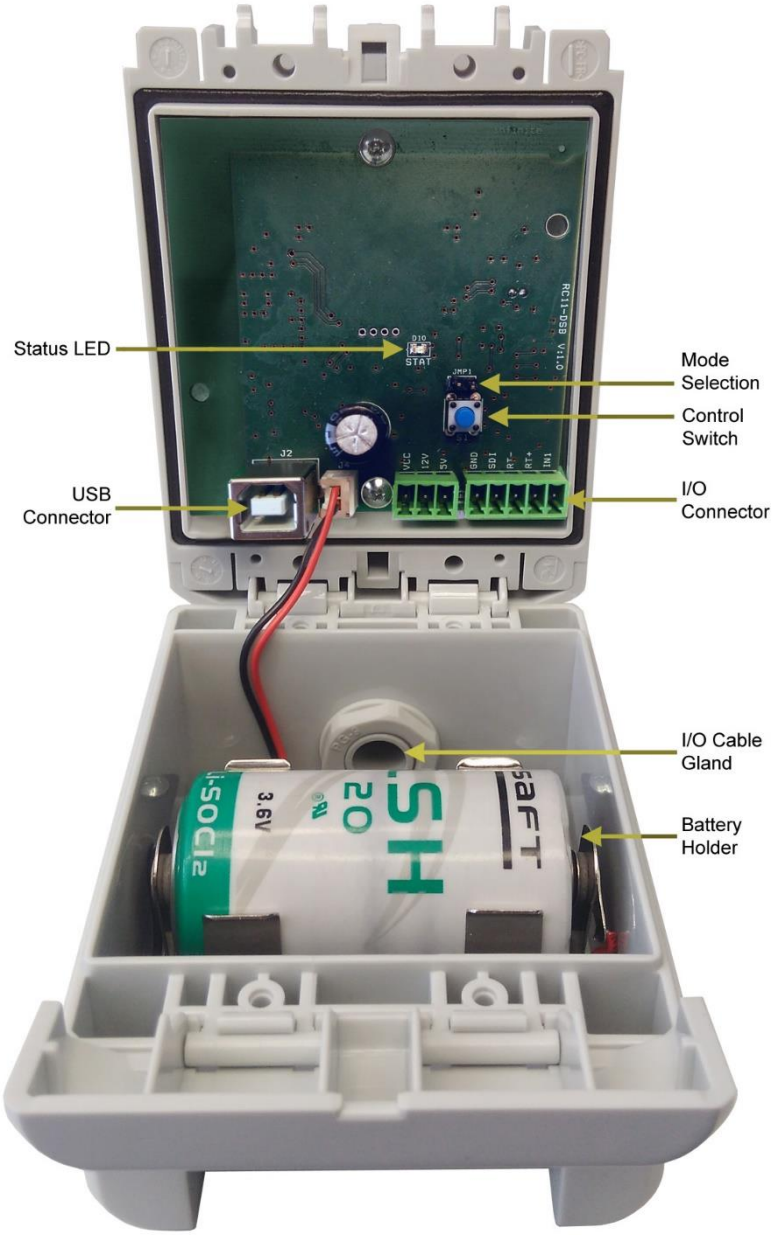
Contents

1. Introduction

LoRaWAN is a communication protocol and a system architecture that is used to read data from sensors through a dynamic network of gateways (end devices do not join a single base station). LoRaWAN uses a chirp spread spectrum (CSS) modulation and operates in the license free bands (ISM).

ADS-270 is an ultra low power, battery powered end node for the LoRa network. The unit is available for the 863 to 870 MHz band. It incorporates two inputs, one digital with pulse counter capability and one analog, as well as multiple excitation options for powering transducers.

The device supports acquisition of up to 8 measurement channels, based on the popular SDI-12 communication protocol and 8 channels, based on the MODBUS protocol. ADS-270 can send an unlimited number of messages per day. The unit incorporates a Lithium Thionyl Battery supplying system operation for up to 10 years.



2. Operation modes

Modes of operation include:

1. Battery supplied cyclic operation.
2. External power adaptor supplied cyclic operation. The transition between the two operation modes is uninterruptible.
3. Operation suspension for the device configuration.

3. Hardware setup

3.1 Packing list

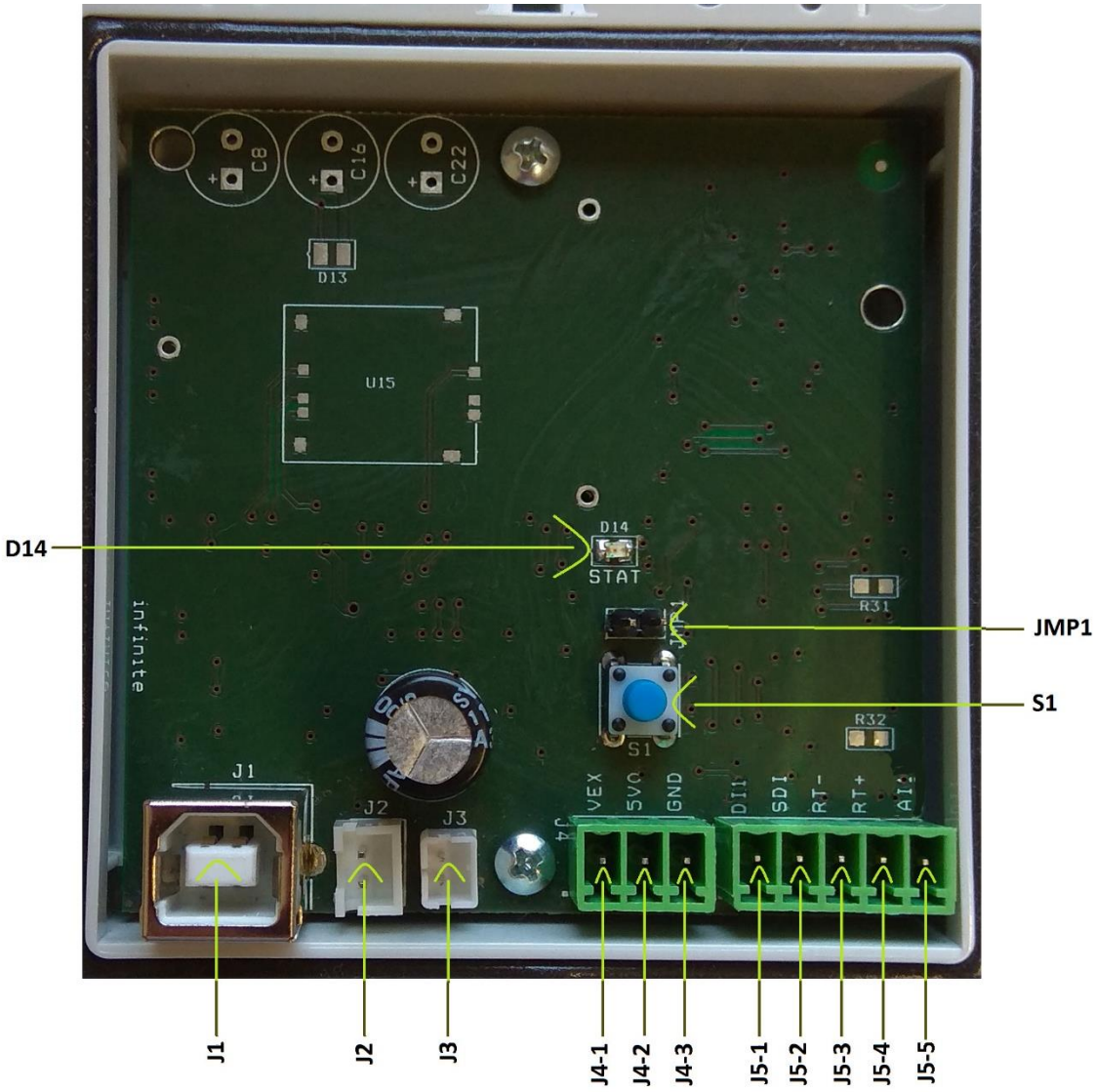
1. ADS-270 Unit
2. Lithium Thionyl Battery (optional)

3.2 Opening the enclosure

Open the unit enclosure by inserting a screwdriver in the slot on the enclosure's top.

Right Wrong

3.3 Connectors & Jumper settings



3.3.1 LED

D14: Status LED, Blinking in configuration mode.

3.3.2 Connectors

JMP1: Put a Jumper to enter configuration mode.

J1: USB Serial connector. The unit can be supplied through the USB connector for configuration and test.

Caution: Remove the external power supply (J3), if applied, before connecting the USB connector!

J2: Battery connector.

J3: External power supply, 5V (stabilized).

J4-1: 12VDC sensor excitation (switched)

J4-2: 5VDC sensor excitation (switched)

J4-3: GND (COM), Common for AI1

J5-1: DI1, Digital Input (Counter: software selectable)

J5-2: SDI-12 data line

J5-3: RS-485 bus (-)

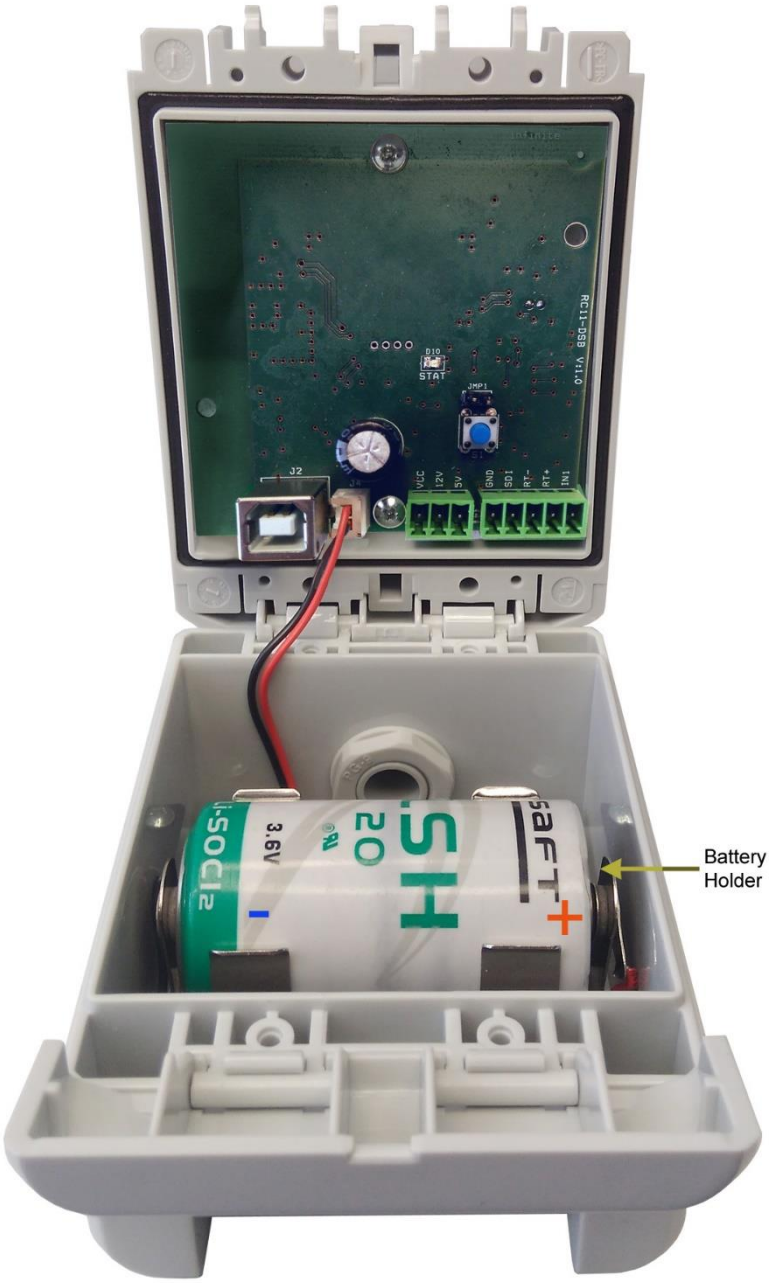
J5-4: RS-485 bus (+)

J5-5: AI1, Analog Input

3.3.3 Switches

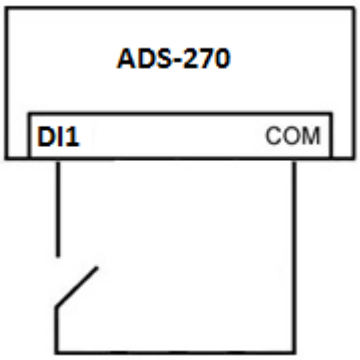
S1: Test mode button

3.4 Battery installation



WARNING: Pay attention to the correct polarity during battery installation! The right polarity is marked up on the Battery Holder. The unit is protected against reverse polarity.

3.5 Wiring the digital (Counter) Input



COM: GND

Digital Input states are:

Contact closed → Input state: ON (logical 'H')

Contact open → Input state: OFF (logical 'L')

3.6 Wiring the analog input

ADS-270 incorporates 1 analog input with 12 bit resolution. The Analog input is scanned according to the selected message transmission period (see 4.5.2).

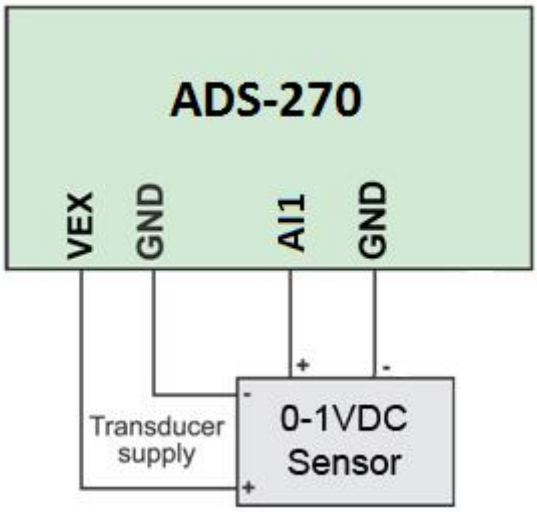
For current measurements, an external 47R/0.25W resistor can be applied between the input terminals (J4-3 and J5-5) on AI1.

ADU-270 incorporates two excitation outputs (12V, 5V) to supply external transducers. **The excitation output switches ON/OFF according to the selected message transmission period (see 4.5.2).**

Low power transducers are recommended for preserving longer battery lifetime.

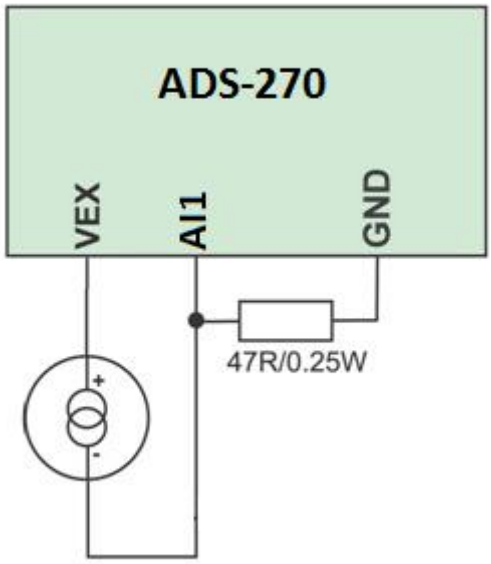
The unit performs 100 consecutive readings of the analog input for every sample, thereby neglecting the maximum and minimum values and calculates the average of the remaining 98 values.

3.6.1 0-1V Transducers



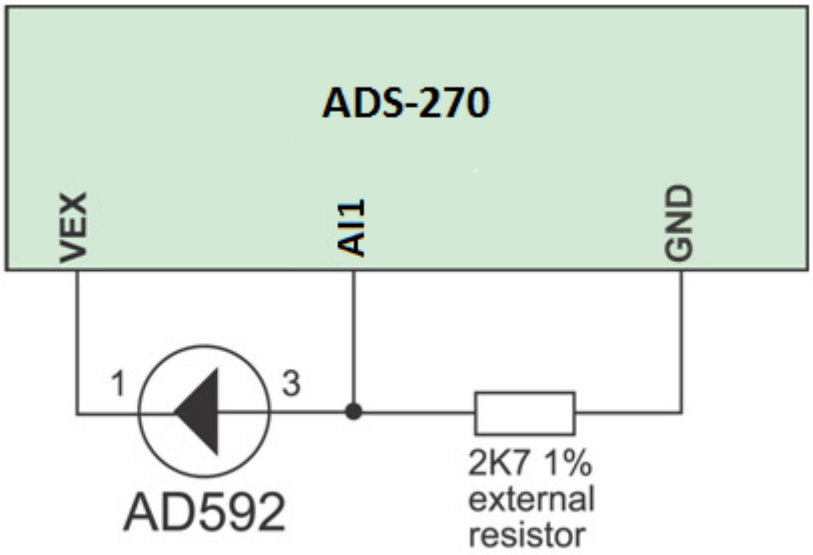
Scale settings: 0..1V → Raw scale:0..4095

3.6.2 Two Wire 0-20/4-20mA transducers



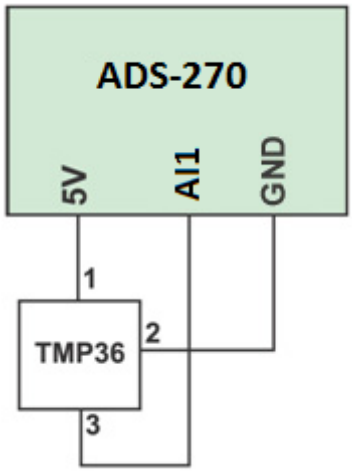
Scale settings: 0..20mA, Raw scale:0..3846

3.6.3 AD592 temperature transducer (-25°C … 105°C)



Scale settings: -25°C … 105°C
Sensor Output: 0.641V..0.977V, Raw scale: 2625..4001

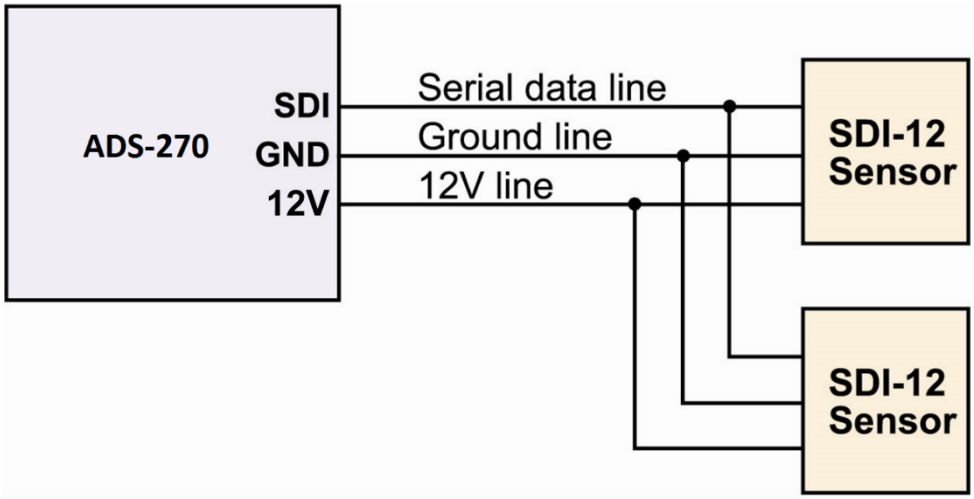
3.6.4 TMP36 temperature transducer (-40°C … 50°C)



Scale settings: -40°C … 50°C
Sensor Output: 0.1V..1V, Raw scale: 410..4095

3.7 Wiring the SDI-12 Serial Bus

SDI-12 is an asynchronous, ASCII, serial communications protocol that was developed for intelligent sensory instruments that typically monitor environmental data. The communication is achieved by digital communications. The addressing system allows data recorder to communicate with several microprocessor-based sensors over a single line.



ADS-200 is compliant to the SDI-12 Standard Version 1.2 and supports extended commands for sensor configuration, in terminal mode. ADS-200 can collect data from several SDI-12 sensors for a total amount of 8 measurement channels.

SDI-12 connections:

J5-2: SDI data line

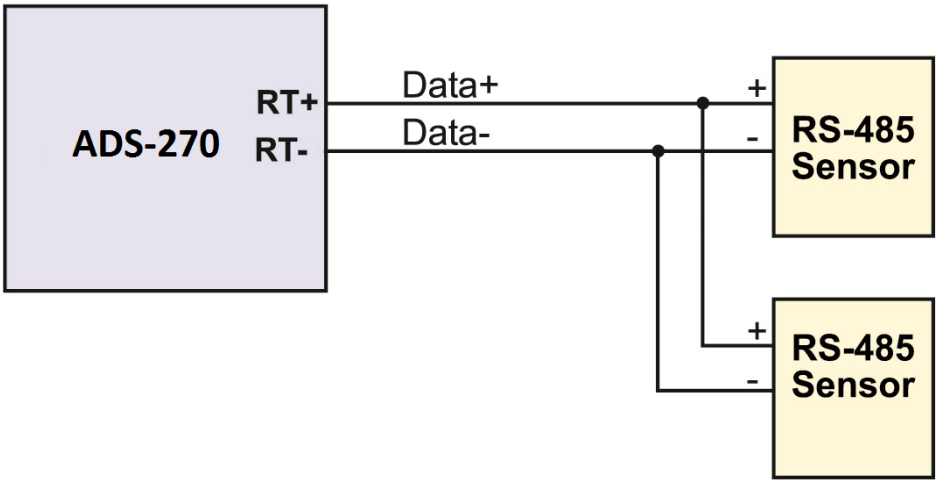
J4-3: GND

J4-1: 12V excitation output. The 5V excitation output (**J4-2)** can be used instead, for sensors with a 5VDC supply option.

It is recommended to read the sensor manufacturers' Sensor Manual and the SDI-12 Specification by the SDI-12 Support Group [1] before utilizing the corresponding functions of the ADS-270 device.

3.8 Wiring the RS-485 Bus

ADU-500 supports the popular MODBUS protocol over a differential RS-485 bus. The bus line is internally terminated with a 120Ω resistor.



4. Device configuration

4.1 Configuring DI1 as Counter input

The command enables counting mode on DI1. The Counter (0-65535) is cleared according to a Clear Mode parameter, thereby acting as a Totalizer.

1150,n

1150: Command ID
n: 1, CNT number

4.1.1 Counter Scale factor

1154,n,f

1154: Command ID
n: 1, CNT number
f: 0.000-0.999, Counter Scale factor

4.1.2 Set Counter Clear Mode

1158,n,c

1158: Command ID
n: 1, CNT number
m: 0-1, 0→ No Clear (Totalizer), 1→ Clear on Sampling

4.1.3 Counter Preset

1181,n,v

1154: Command ID
n: 1, CNT number
f: Preset value

4.1.4 Reset Counter

Resets the counter value to 0.

1180,n

1154: Command ID
n: 1, CNT number

4.1.5 Clear Counter Configuration

1160,n

1160: Command ID
n: 1, CNT number

4.2 Configuring the Analog Input

The AI configuration command structure is:

1200,n,ssl,ssh,sl,sh

1200: Command ID

n: 1, AI number

ssl: Sensor scale low (Row value 0-4095)

ssh: Sensor scale high (Row value 0-4095)

sl: User scale low

sh: User scale high

4.2.1 Clear AI Configuration

1210,n

1210: Command ID

n: 1, AI number

4.3 Configuring the SDI-12 channels

ADS-270 supports up to 8 channels.

The configuration command for a SDI-12 channel is:

1230,n,a,m,i

1230: Command ID

n: Channel number (1-8)

a: Sensor address

m: Measurement set (0 for the aM! command, 1-9 for the aM1!–aM9! commands)

i: Parameter

ADS-270 addresses the SDI-12 sensors using the basic measurement starting commands aM! (aMx!) and the D0!...D9! send data commands.

4.3.1 SDI-12 acquisition scheme

ADS-270 sends a start measurement command to the SDI-12 serial bus:

aMm!

where,

a: sensor address

M: Start measurement command

m: void or 1-9, Measurement set (aM! or aM1! to aM9!)

This command tells the sensor with address ‘a’ to take a measurement.

The sensor responds with:

atttn

where,

a: sensor address

ttt: the specified time, in seconds, until the sensor will have the measurement(s) ready

n - the number of measurement values the sensor will make and return in one or more subsequent D commands; n is a single digit integer with a range of 0 to 9

ADS-270 waits for either of two events to occur before issuing a D0 command:

1) receipt of a service request (a<CR><LF>) from the sensor

2) the specified time to elapse (ttt seconds)

ADS-270 issues one or more read commands (aD0! to aD9!) to read the measurement parameters. Each parameter corresponds to one channel according to the channel configurations:

aD0! (aD1!...aD9!)

The addressed sensor responds with:

a<values><CR><LF>

where,

<values> - pd.d

p - the polarity sign (+ or -)

d - numeric digits before the decimal place . - the decimal point (optional)

d - numeric digits after the decimal point. the maximum number of digits for a data value is 7, even without a decimal point, the minimum number of digits for a data value (excluding the decimal point) is 1, the maximum number of characters in a data value is 9 (the (polarity sign + 7 digits + the decimal point))

Example:

A soil measurement sensor returns three parameters:

1. Soil moisture in Water fraction by Volume (wfv)
2. Soil Conductivity in Siemens/Meter (S/m)
3. Temperature in °C

Two sensors (addresses 1 and 2) are connected to the SDI-12 serial bus.

The configuration commands are:

1230,1,1,0,1

1230,2,1,0,2

1230,3,1,0,3

1230,4,1,0,1

1230,5,1,0,2

1230,6,1,0,3

4.3.2 Clear SDI-12 channel configuration

The command clears the specified SDI-12 channel configuration.

1238,n

1238: Command ID

n: 1-8, SDI-12 number

4.3.3 Clear all SDI-12 channels

The command clears all declared SDI-12 channels.

1239

1239: Command ID

4.4 Configuring the MODBUS (RS-485) channels

ADU-500 supports up to 8 MODBUS channels.

The configuration command for a MODBUS channel is:

1241,n,a,c,sr,nr

1241: Command ID

n: Channel number (1-8)

a: RS-485 address

m: MODBUS command

sr: Start register

nr: Number of registers

4.4.1 Start Measurement Trigger command

The command concerns sensors requiring a trigger to make a measurement.

1240,a,r,v

1240: Command ID

a: RS-485 address

r: Register

v: Value

4.4.2 Clear MODBUS channel configuration

The command clears a MODBUS channel configuration.

1248,n

1248: Command ID

n: Channel number

4.4.3 Clear all MODBUS channels

The command clears a MODBUS channel configuration.

1249

1249: Command ID

4.4.4 Set MODBUS baud rate

The command sets the baud rate for the MODBUS communications. The other settings are fixed: Data bits: 8, Parity: none, Stop bits: 1

1245,b

1245: Command ID

b: Baud rate: 9600, 19200, 38400, 57600, 115200

4.4.5 Set MODBUS protocol

The command sets the protocol for the MODBUS communications.

1244,p

1244: Command ID

p: Protocol: 0: RTU, 1: ASCII

4.5 Data Acquisition Parameters

4.5.1 Sampling delay (Warm up time)

The parameter defines an idle period between switching on the excitation and reading the measurements from the analog and the SDI-12 channels. This option should be set according to the transducer with the longest warm up time for stable reading. **The value of this parameter affects strongly the battery life.**

`1291,d`

d: 0-255 sec

4.5.2 Message transmission period

The parameter defines the message transmission period to the LoRaWAN network. The period should be set according to the number of channels selected for acquisition. Every message contains one channel. The minimum value is 1 minute. **The value of this parameter affects strongly the battery life.**

`1292,p`

p: 1-255 min

4.6 Message Format

The message is in ASCII format and has a fixed length of 12 byte.

L1	L0	D9	D8	D7	D6	D5	D4	D3	D2	D1	IN

L0, L1: 0-F, HEX, Channel Number

D1-D9: Measurement value

D9: +/-, Sign

D1-D8: Value, can contain a decimal point

IN: 0-1, Digital Input value

Channel numbers:

01: Analog input value, AI1

15 , 16, 17, 18, 19, 1A, 1B, 1C: SDI-12 Channels 1-8

5B: Counter value

AB, AC, AD, AE, AF, B0, B1, B2: MODBUS Channels 1-8

IN: Digital Input value: 1: ON, 0: OFF

Examples:

AI1 has the value of -16.7, Digital input is ON.
The Message contents is: 01-000016.71

SDI-12 Channel 7 has the value of 23.3440, Digital input is ON.
The Message contents is: 1B+023.34401

MODBUS Channel 2 has the value of 48546, Digital input is OFF.
The Message contents is: AC+000485460

4.7 LORAWAN Parameters

4.7.1 Device Address

The command sets the unique device address.

9410,s

s: 00000000-FFFFFFFF, 4-byte hexadecimal number representing the device address, from

4.7.2 Device EUI

The command sets the globally unique device address.

9420,s

s: 8-byte hexadecimal number representing globally unique device identifier (EUI).

The parameter is internally set**. It is recommended not to change this value**.

4.7.3 Set Application EUI

The command sets the Application identifier.

9430,s

s: 8-byte hexadecimal number representing the Application EUI.

4.7.4 Set the Network Session Key

The command sets the Network Session Key.

9440,s

s: 16-byte hexadecimal number representing the network session key.

4.7.5 Set the Network Application Key

The command sets the Network Session Key.

9450,s

s: 16-byte hexadecimal number representing the network application key.

4.7.6 Set LoRa Data Rate

The command sets the LoRa Data Rate.

9460,n

n: 0-7, decimal number representing the data rate.

4.7.7 Set uplink frame counter

The command presets the uplink frame counter.

9470,c

c: 0 - 4294967295, decimal number representing the value of the uplink frame counter that will be used for the next uplink transmission.

4.7.8 Set Power Index

The command sets the LoRa Power Index.

9480,p

p: 1-5, decimal number representing the power index.

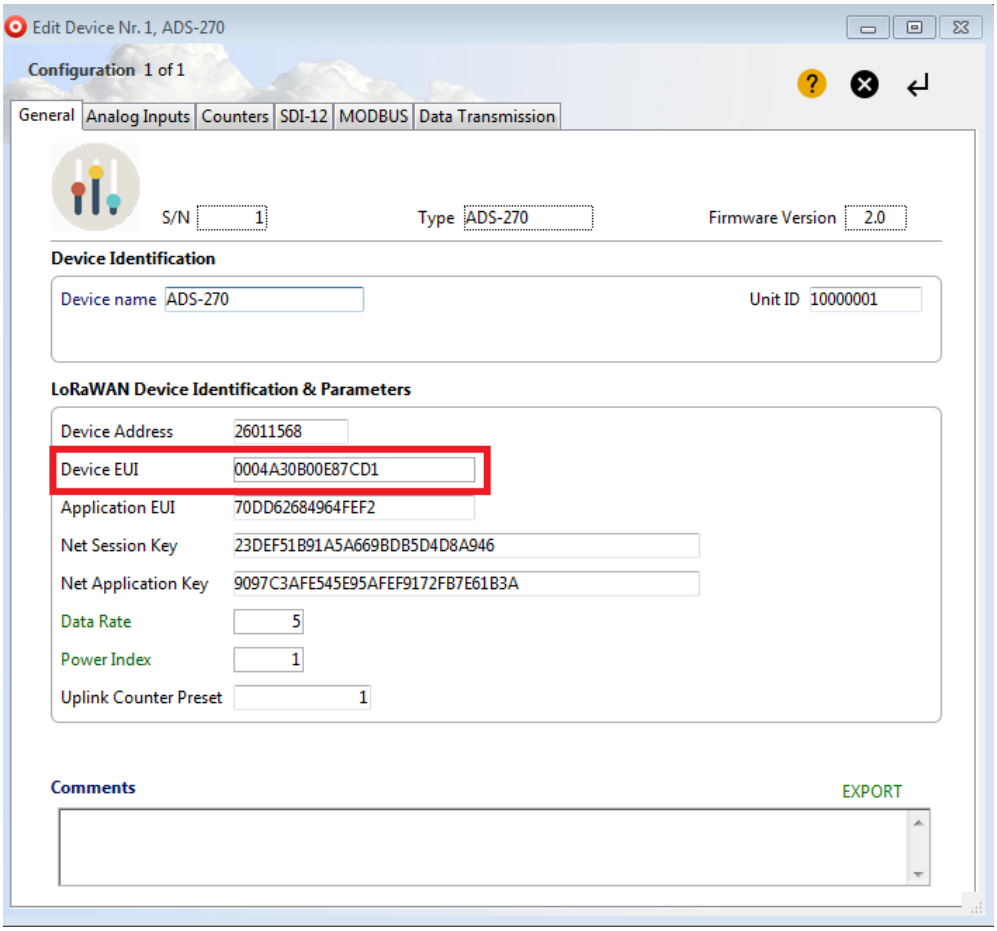
5. Programming the unit

The way to enter the unit setup mode is the following:

1. Install the USB driver on a PC.
2. Connect the USB port to a PC. The Status LED is lighting for 2 sec.
3. Put a Jumper on JMP1. The Status LED starts blinking, indicating setup mode. Program execution is suspended.

There are two ways to program the unit:

1. Connecting the unit to a PC and using a terminal program to pass the ASCII commands to the unit, according to the scheme: “Command, Parameters <CR>”. The terminal settings should be: Baud rate: 115200 bps, Data bits: 8, Parity: none, Stop bits: 1, Flow control: none.
2. Connecting the unit to a PC and using the WA Manager software. This is the most convenient way. The Device EUI, which is necessary for connecting the unit to the LoRaWAN network, is automatically read during downloading the parameter file to the device. The Device EUI is also printed on a label in the device interior.



6. Technical characteristics

Power supply	Internal 3.6V Ah Lithium Thionyl battery External 5VDC stabilized power adaptor USB interface (Configuration)
Temperature Operation Storage	 -40 to 65 ºC -45 to 85 ºC
Current draw Standby Measurement Messaging	 18 uA max 6.5 mA (w/o sensor current) 44.5 mA
Radio characteristics 863-870 MHz Band	Uplink data rate (TX): up to 300Kbps with FSK modulation Max output power: +14dBm
Digital inputs	1, 0-30VDC or potential free contacts
Pulse counters	1, 2KHz, DI1
Analog inputs	1, 12bit resolution, AI1
SDI-12 Bus	8 Channels, multiple sensor support
RS-485	8 Channels, multiple sensor support
Excitation	12VDC/250mA, 5VDC/200mA
Serial port	USB 2, 9600 to 115200bps
Indications	1 LED, Device status
Protection	IP66
Dimensions	130 x 130 x 75 mm
Weight	0.5 kg

7. Command Summary

7.1 Configuration Commands

Cmd	Description	Syntax	Comments
0160	Clear Event Log	cmd	
0183	Set Factory Defaults	cmd,cmd	
0205	Reset Unit Operation	cmd,cmd	
0301	Set Device ID	cmd,id,p	id: unit ID, p: password
0790	Show Status Messages	cmd	
0791	Hide Status Messages	cmd	
1150	Enable Counter	cmd,n	n: counter
1154	Set Counter Scale Factor	cmd,n,f	n: counter, f: factor
1158	Set Counter Auto Clear	cmd,n,c	n: counter, c: auto clear (0: no, 1: yes)
1160	Clear Counter Configuration	cmd,n	n: counter
1180	Clear Counter	cmd,n	n: counter
1181	Preset Counter	cmd,n,v	n: counter, v: value
1200	Set AI Configuration	cmd,n,ssl,ssh,sl,sh	ssl/ssh: sensor scale l/h, sl/sh: User scale l/h
1210	Clear AI Configuration	cmd,n	n: AI
1230	Set SDI-12 Channel Configuration	cmd,n,a,m,i	n: SDI AI, a: sensor address, m: parameter set, i: parameter index
1238	Clear SDI-12 Channel Configuration	cmd,n	n: SDI AI
1239	Clear All SDI-12 Channel Configuration	cmd	
1240	Set Modbus Trigger Command	cmd,a,r,v	a: address, r: reg, v: value
1241	Set Modbus Channel Configuration	cmd,n,a,c,sr,nr	n: Modbus AI, a: address, c: command, sr: start reg, nr: number of regs
1248	Clear Modbus Channel Configuration	cmd,n	n: Modbus AI
1249	Clear All Modbus Channels Configuration	cmd	
1250	Set Massa AI Configuration	cmd,n,a,u,o	n: Massa AI, a: address, u: unit (0:in, 1:cm), o: offset
1259	Clear Massa AI Configuration	cmd,n	n: Massa AI
1291	Set AI Power Up Delay	cmd,d	d: delay (sec)
1310	Set Send Period	cmd,p	p: period (minutes)
1600	Set Unit RTC Time	cmd,d,m,y,h,n,s	d: day, m: month, y: year, h: hour, n: minutes, s: seconds
9900	Save LoRa Params to NV RAM	cmd	
5000	Join ABP Method	cmd	
9300	Send Module Cmd with 2 Responses	cmd,s	s: String
9400	Send Module Cmd with 1 Responses	cmd,s	s: String
9410	Set LoRa Device Address	cmd,s	s: device address
9420	Set LoRa Device EUI	cmd,s	s: device EUI
9430	Set LoRa Application EUI	cmd,s	s: application EUI
9440	Set LoRa Network Session Key	cmd,s	s: network session key
9450	Set LoRa Network Application Key	cmd,s	s: network application key
9460	Set LoRa Data Rate	cmd,n	n: data rate (0-7)
9470	Set LoRa Up Frame Counter	cmd,n	n: up frame counter (0 - 4294967295)
9480	Set LoRa Power Index	cmd,p	p: 1-5

7.2 Verification Commands

Cmd	Description	Syntax	Comments
2000	Get Device Status	cmd	
2160	Get Event Log Entries Number	cmd	
2161	Get Event Log Last Entries	cmd,n	n: event log entries (0: all)
2301	Get Device ID	cmd	
3160	Get Counter Settings	cmd,n	n: counter
3210	Get AI Settings	cmd,n	n: AI
3230	Get SDI AI Configuration	cmd,n	n: SDI AI
3240	Get Modbus Trigger Command	cmd	
3241	Get Modbus AI Configuration	cmd,n	n: Modbus AI
3250	Get Massa AI Configuration	cmd,n	n: Massa AI
3291	Get AI Power Up Delay	cmd	
3310	Get Send Period	cmd	
3600	Get Unit RTC Time	cmd	
5100	Get Current AI/DI Values	cmd	
8100	Set AI (AI1) Correction Factor	cmd,n,r,c	n: AI, r: real value, c: corrected value
9100	Get Correction Factor	cmd,n	n: AI
9210	Send SDI Command	cmd,s	s: SDI command string
9220	Send Modbus Command	cmd,a,c,p1,p2	a: address, c: command, p1-p2: function dependent parameters
9225	Send Massa Command	cmd,a,rc,p1,p2	a: address, rc: request code, p1-p2: request code dependent parameters
9226	Get Massa Value	cmd,a	a: address
9810	Get LoRa Device Address	cmd	
9820	Get LoRa Device EUI	cmd	
9830	Get LoRa Application EUI	cmd	
9860	Get LoRa Data Rate	cmd	
9870	Get LoRa Up Frame Counter	cmd	
9880	Get LoRa Power Index	cmd	

8. References

[1)] SDI-12, A Serial-Digital Interface Standard for Microprocessor-Based Sensors Version 1.3.
January 3, 2012
SDI-12 Support Group (Technical Committee),
165 East 500 South, River Heights, Utah,
435-752-4200, 435-752-1691 (FAX),
http://www.sdi-12.org