TECHNICAL DESCRIPTION

of the Liulin Data Acquisition System

designed by

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Introduction

The Liulin Data Acquisition System (DAS) main purpose is to monitor digitalize and record on 1 MB flash memory data from 8 analog channels. The unit is managed by the microcontrollers through specially developed firmware. Plug-in RS-232 link provide the transmission of the stored on the flash memory data toward the standard PC. PC provides to DAS standard serial communication port. Rockwell's Zodiac Global Positioning System receiver is used in DAS for processing the signals from all visible GPS satellites for 3D geographical and time positioning of the measurements. The Zodiac receiver provides an output timing pulse that is synchronized to one second Universal Time Coordinated (UTC) boundaries.
(http://dtelunix.dtcc.edu/rocket/99launch/downloads/Zodiac.pdf)

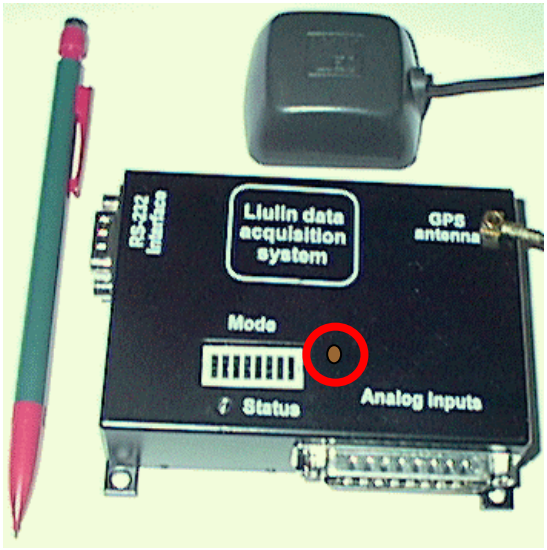

Figure 1a. Picture of the Liulin DAS together with the GPS antenna

DAS Description

After switching on, the DAS (see Figure 1.) starts to do measurements in the 8th analog channels. The exposition time of each measurement is fixed at 1 sec. The GPS data-recording interval is variable between 2 sec and 60 sec. All 8 analog channels data are stored every 1 sec in the 1 MB flash memory. New GPS data are stored at the end of every data-recording interval. After connection of the DAS with PC all data accumulated are transmitted to PC.

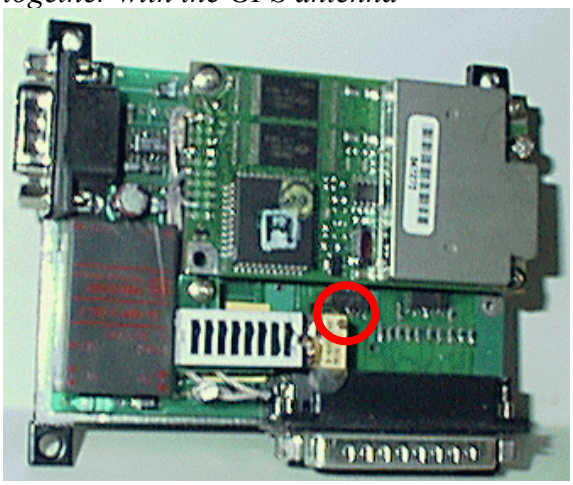

Figure 1b. Internal view of DAS

Inside of DAS is mounted standard Rockwell's Zodiac Global Positioning System (GPS) Jupiter receiver, which are on single-board. The GPS antenna is outside of DAS on a 4 m long cable. The power supply of DAS is performed with a DC/DC converter, which is electrically insulated from the DAS internal signal ground and from DAS external box.

DAS contains: one master microcontroller with 8 channels ADC, one slave microcontroller, low-level current preamplifier, 4 differential preamplifiers, 2 shapers and flash memory of 1 MB (1 megabytes). The unit is managed by the master microcontroller through

specially developed software. A block schema of DAS is presented in Figure 2, while the analog part principal electric circuit is presented on Figure 3.

The 8th analog input signals are treated by different way and amplification (see Figure 2 and 3.). Characteristics of the 8th channels are listed In Table 1:

Channel number	**Channel label**	**Input**	**Function**
0	AN0	0-5 V	Differential analog channel
1	AN1	0-5 V	Differential analog channel
2	AN2	0-5 V	Differential analog channel
3	AN3	0-5 V	Differential analog channel
4	AN4	0-5 V	Analog channel with buffer
5	AN5	10 nA-8 mA*	Current input (Ozone channel)
6	AN6	0-5 V	Analog channel with buffer
7	AN7	0-5 V	Analog channel without buffer

Table 1.

The "in field" management and the selection of the necessary interval for GPS data recording of the DAS is performet by the array of 8 micro switches with label "Mode" on the upper panel of DAS. First switch is on the right hand side of the array, while the 8th swith is on the left hand side of the array. Switches are in position ON when the lower side of the switch is toward the "Mode" label. First switch in the array is designated for the switching ON/OFF of the process of data recording in the flash memory. The selection of the GPS data recording time is performed by switching ON of one and only one switches wit number 2 to 8. Table 2. presents the GPS data recording intervals and the total operating times designated to diffent switches.

Switch number	2	3	4	5	6	7	8
GPS data recording Interval [seconds]	2	3	5	10	20	30	50
Total operating time [hours]	5.6	7.3	9.6	12.6	14.8	15.8	16.9

Table 2.

* Tree red circles on Figure 1 and Figure 3 presents the place of the potentiometer of 500 k, which can be used for further adjustment of the current in the channel.

DAS operate in 3 regimes: Working mode, Mode of Transferring the data from the flash memory to PC and Mode of flash memory cleaning of the unit:

- In the Working regime the instrument is operating under the software in the master microcontroller. The regime is switched on by the switching on of the first switch of "Mode" switches. This regime is indicated by the "Status" LED on the upper panel of DAS by blinking with 1 sec interval. The operational time of the instrument depends on the rate of the memory

fills up (See Table 2.). The working regime is switched OFF automatically when the memory is totally filled up. The fact that the memory is totally filled up is indicated by the "Status" LED on the upper panel of DAS by blinking with 3 sec interval. By same interval is indicated all other situations when the DAS system is **not** working properly.

- In the regime of data transferring the instrument is switched on by special command when it is connected to PC serial interface after the end of the experiments (See the Operating Manuel.). The regime allows the transfer of the accumulated in the flash memory data to the PC.
- In the regime of flash memory cleaning is switched on by special command when it is connected to PC serial interface before the experiments (See the Operating Manuel.).

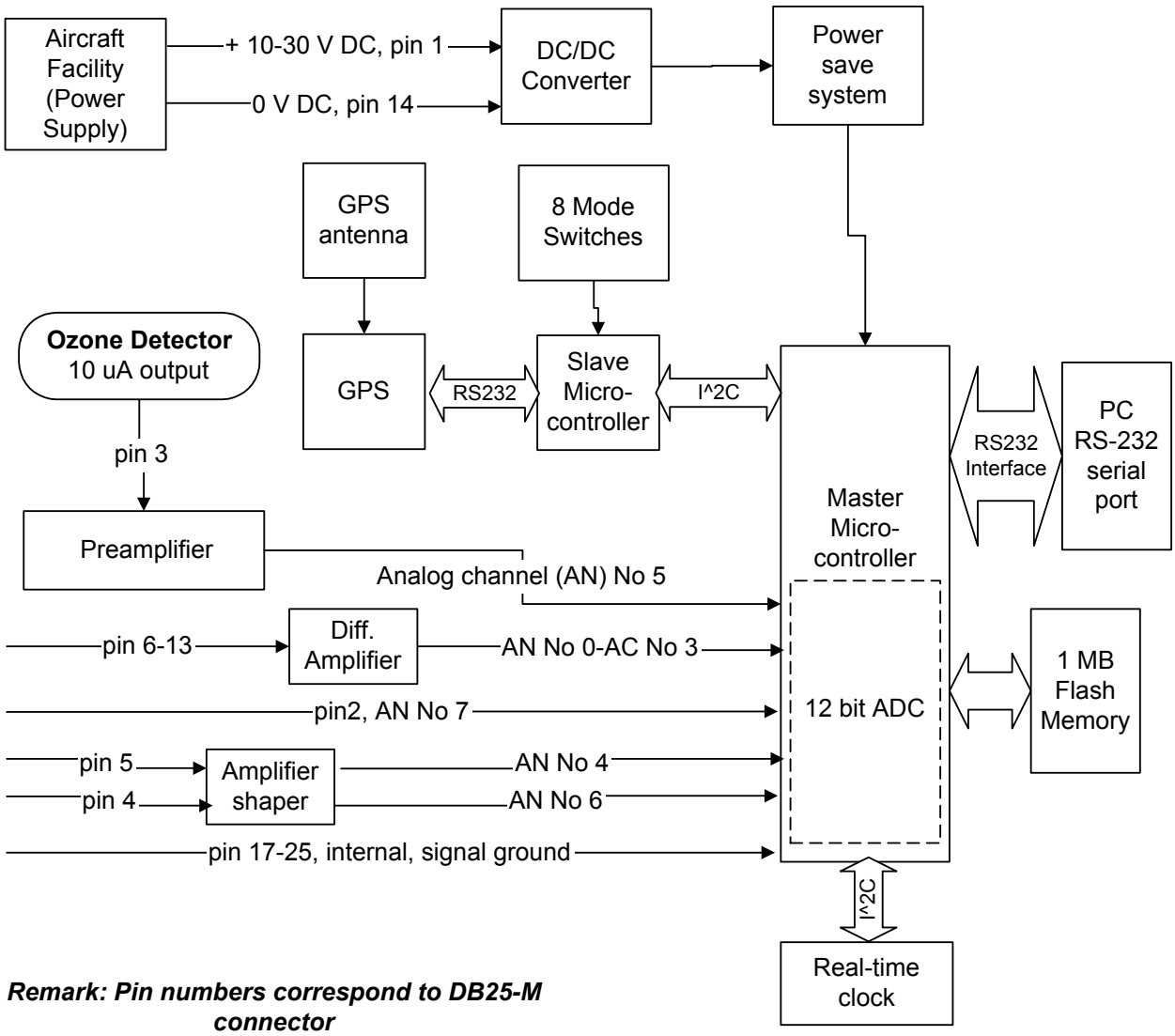

Figure 2. Block-diagram of the DAS

The "DASystem.exe" software product is developed in "WIN95/98/NT" environment. At the PC it creates in selected by the user directory the DAS hexadecimal files, which are named automatically with name FYYMMDDHH.hex, where "YYMMDDHH" is the date and time of the moment of the creation of the hexadecimal file. This file contains the rough binary data and is for permanent storage of data from the DAS, because of the minimal volume of the file. One ASCII files is created automatically from each binary file when "Read File" function is used in the DASystem.exe" software. The names of

these ASCII files contain the same "FYYMMDDHH" string as the binary files. The files extensions are of type "txt".

One row of the ASCII (FYYMMDDHH.txt) file looks as follows:

08/01/03 13:54:26 0 16 8 0 42.67 23.37 592.73 02.05 02.55 02.35 2 2 22 0 18 0 7 5 33 0 0 0 7 6 43 0 0 0 7 25 40 7 10 28 7 15 46 7 30 43 7 23 34 7 17 44 0 0 0 0 0 0 6 303

The meaning of the information in the 56 columns of this file is described in Table 3. Columns: “Table ID”, “Word number” and “Word description; Units; range” information from the “Zodiac.pdf” file is used.

Column No	**Table ID**	**Word number**	**Word description; Units; range**
1	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	19/20/21	UTC DD/MM/YY
2	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	22:23:24	UTC hh:mm:ss
3	Table 5-5. Message 1000: Geodetic Position Status Output Message (1 of 3)	10.0-10.15	Navigation Solution Validity (10.0-10.15)
4	Table 5-5. Message 1000: Geodetic Position Status Output Message (1 of 3)	11.0-11.15	Navigation Solution Type (11.0-11.15)
5	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	12	Number of Measurements Used in Solution
6	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	13	Polar Navigation
7	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	27-28	Latitude Degree.00
8	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	29-30	Longitude Degree.00
9	Table 5-5.	31-32	Height Meters.00

	Message 1000: Geodetic Position Status Output Message (2 of 3)		
10	Table 5-5. Message 1000: Geodetic Position Status Output Message (3 of 3)	40-41	Expected Horizontal Position Error (Note 7); Meters; 0-320000000
11	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	42-43	Expected Vertical Position Error (Note 7); Meters; 0-250000
12	Table 5-5. Message 1000: Geodetic Position Status Output Message (2 of 3)	44-45	Expected Time Error (Note 7); Meters 0-300000000
13	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*0) 15.1+(3*0) 15.2+(3*0) 15.3+(3*0)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
14	Table 5-7. Message 1002: Channel Summary Message	16+(3*0)	Satellite PRN; 0-32
15	Table 5-7. Message 1002: Channel Summary Message	17+(3*0)	dBHz; 0-60
16	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*1) 15.1+(3*1) 15.2+(3*1) 15.3+(3*1)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
17	Table 5-7. Message 1002: Channel Summary Message	16+(3*1)	Satellite PRN; 0-32
18	Table 5-7. Message 1002: Channel Summary Message	17+(3*1)	dBHz; 0-60
19	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*2) 15.1+(3*2) 15.2+(3*2) 15.3+(3*1)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
20	Table 5-7. Message 1002: Channel Summary Message	16+(3*2)	Satellite PRN; 0-32

21	Table 5-7. Message 1002: Channel Summary Message	17+(3*2)	dBHz; 0-60
22	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*3) 15.1+(3*3) 15.2+(3*3) 15.3+(3*3)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
23	Table 5-7. Message 1002: Channel Summary Message	16+(3*3)	Satellite PRN, 0-32
24	Table 5-7. Message 1002: Channel Summary Message	17+(3*3)	dBHz; 0-60
25	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*4) 15.1+(3*4) 15.2+(3*4) 15.3+(3*4)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
26	Table 5-7. Message 1002: Channel Summary Message	16+(3*4)	Satellite PRN; 0-32
27	Table 5-7. Message 1002: Channel Summary Message	17+(3*4)	dBHz, 0-60
28	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*5) 15.1+(3*5) 15.2+(3*5) 15.3+(3*5)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
29	Table 5-7. Message 1002: Channel Summary Message	16+(3*5)	Satellite PRN; 0-32
30	Table 5-7. Message 1002: Channel Summary Message	17+(3*5)	dBHz; 0-60
31	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*6) 15.1+(3*6) 15.2+(3*6) 15.3+(3*6)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
32	Table 5-7. Message 1002: Channel Summary Message	16+(3*6)	Satellite PRN; 0-32
33	Table 5-7. Message 1002: Channel Summary	17+(3*6)	dBHz; 0-60

	Message		
34	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*7) 15.1+(3*7) 15.2+(3*7) 15.3+(3*7)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
35	Table 5-7. Message 1002: Channel Summary Message	16+(3*7)	Satellite PRN, 0-32
36	Table 5-7. Message 1002: Channel Summary Message	17+(3*7)	dBHz; 0-60
37	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*8) 15.1+(3*8) 15.2+(3*8) 15.3+(3*8)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
38	Table 5-7. Message 1002: Channel Summary Message	16+(3*8)	Satellite PRN, 0-32
39	Table 5-7. Message 1002: Channel Summary Message	17+(3*8)	dBHz; 0-60
40	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*9) 15.1+(3*9) 15.2+(3*9) 15.3+(3*9)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
41	Table 5-7. Message 1002: Channel Summary Message	16+(3*9)	Satellite PRN, 0-32
42	Table 5-7. Message 1002: Channel Summary Message	17+(3*9)	dBHz; 0-60
43	Table 5-7. Message 1002: Channel Summary Message	15.0+(3*10) 15.1+(3*10) 15.2+(3*10) 15.3+(3*10)	Measurement Used (Note 4) Ephemeris Available Measurement Valid DGPS Corrections Available
44	Table 5-7. Message 1002: Channel Summary Message	16+(3*10)	Satellite PRN; 0-32
45	Table 5-7. Message 1002: Channel Summary Message	17+(3*10)	dBHz; 0-60
46	Table 5-7. Message 1002:	15.0+(3*11) 15.1+(3*11)	Measurement Used (Note 4) Ephemeris Available

	Channel Summary Message	15.2+(3*11) 15.3+(3*11)	Measurement Valid DGPS Corrections Available
47	Table 5-7. Message 1002: Channel Summary Message	16+(3*11)	Satellite PRN; 0-32
48	Table 5-7. Message 1002: Channel Summary Message	17+(3*11)	dBHz; 0-60
49			Analog channel 0 (AN0); 0-4096
50			Analog channel 1 (AN1); 0-4096
51			Analog channel 2 (AN2); 0-4096
52			Analog channel 3 (AN3); 0-4096
53			Analog channel 4 (AN4); 0-4096
54			Analog channel 5 (AN5); 0-4096
55			Analog channel 6 (AN6); 0-4096
56			Analog channel 7 (AN7); 0-4096

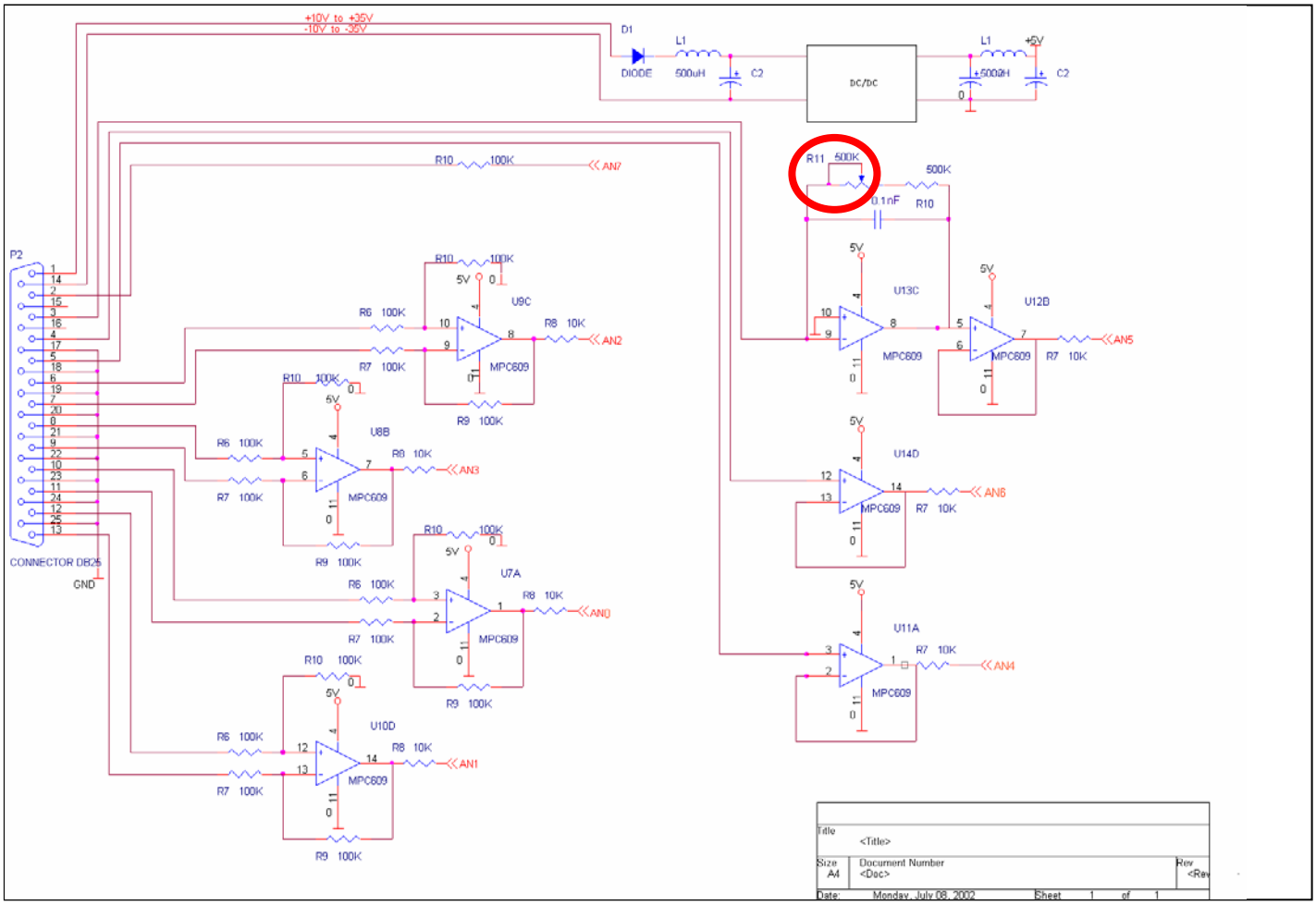

Figure 3. Principal diagram of DAS

DB25-M Pin assignment

Pin № 1 is the first pin on the left end of the upper row pins of the DB25-M connector, when looking in front of the connector and the smaller edge of it is below.

Pin № 2 is the second pin on the left end of the upper row pins of the DB25-M connector, when looking in front of the connector and the smaller edge of it is below.

Pin № 14 is the first pin on the left end of the lower row pins of the DB25-M connector, when looking in front of the connector and the smaller edge of it is below.

Pin number	**Function/Channel**	**Channel label**
1	+(Plus) 10-30 V power input	
2	Analog channel № 7 input	AN7
3	Current (Ozone) channel input (Analog channel № 5)	AN5
4	Analog channel № 6 input	AN6
5	Analog channel № 4 input	AN4
6	Differential analog channel № 2 input (plus side)	AN2
7	Differential analog channel № 2 input (minus side)	
8	Differential analog channel № 3 input (plus side)	AN3
9	Differential analog channel № 3 input (minus side)	
10	Differential analog channel № 0 input (plus side)	AN0
11	Differential analog channel № 0 input (minus side)	
12	Differential analog channel № 1 input (plus side)	AN1
13	Differential analog channel № 1 input (minus side)	
14	Ground power input	
15	Not connected	
16	Not connected	
17	Internal signal ground	
18	Internal signal ground	
19	Internal signal ground	
20	Internal signal ground	
21	Internal signal ground	
22	Internal signal ground	
23	Internal signal ground	
24	Internal signal ground	
25	Internal signal ground	

SPECIFICATIONS OF DAS

- *Temperature range: -20^{O}C - +50^{O}C;*
- *Size:* 100x70x25 mm
- *Total mass: 0.18 kg.*