DAS1414C

DSP DATA ACQUISITION SYSTEM

User's manual

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Introduction

Real world signal processing can be made very flexible, if the signals are translated to the digital domain, i.e. to integer numbers and vica versa. The real world signal is first converted to an electronic quantity (e.g. current or voltage) using a sensor, then this signal is amplified, filtered and converted to numbers by analog-to-digital converters (A/D converter, ADC). These numbers are treated by digital electronics, processors or computers, and the algorithm performing the necessary tasks is executed. Of course, the control needs the computed numbers to be converted back to the analog domain using digital-to-analog converters (D/A converter, DAC) and this voltage or current will control objects – this latter conversion is realized by actuators. In this way most of our equipment is realized by software, which gives extreme flexibility.

The diagram of this kind of real world signal processing is shown below.

Another advantage of this arrangement is that one can easily compute and display quantities that cannot be measured directly. In such way it is possible to track quantities that was not enabled by older methods. Modern measurement and control uses this architecture. There are many kinds of sensors, actuators that suit almost all types of problems. Addition of a general purpose data acquisition system like the DAS1414C performs the data conversion and allows the user to realize incredibly large number of instruments by just replacing the software only. Since the main part of the instrument is software, sometimes these instruments are called virtual instruments. But don't forget: they carry out very real measurements! Just to give an idea: using the DAS1414C data acquisition system you can build your multi-channel programmable gain chart recorder, programmable power supply, temperature controller, motor driver, arbitrary waveform generator, digital storage oscilloscope, transient recorder, spectrum analyser, digital lock-in amplifier, ECG/EEG recorder and many-many more.

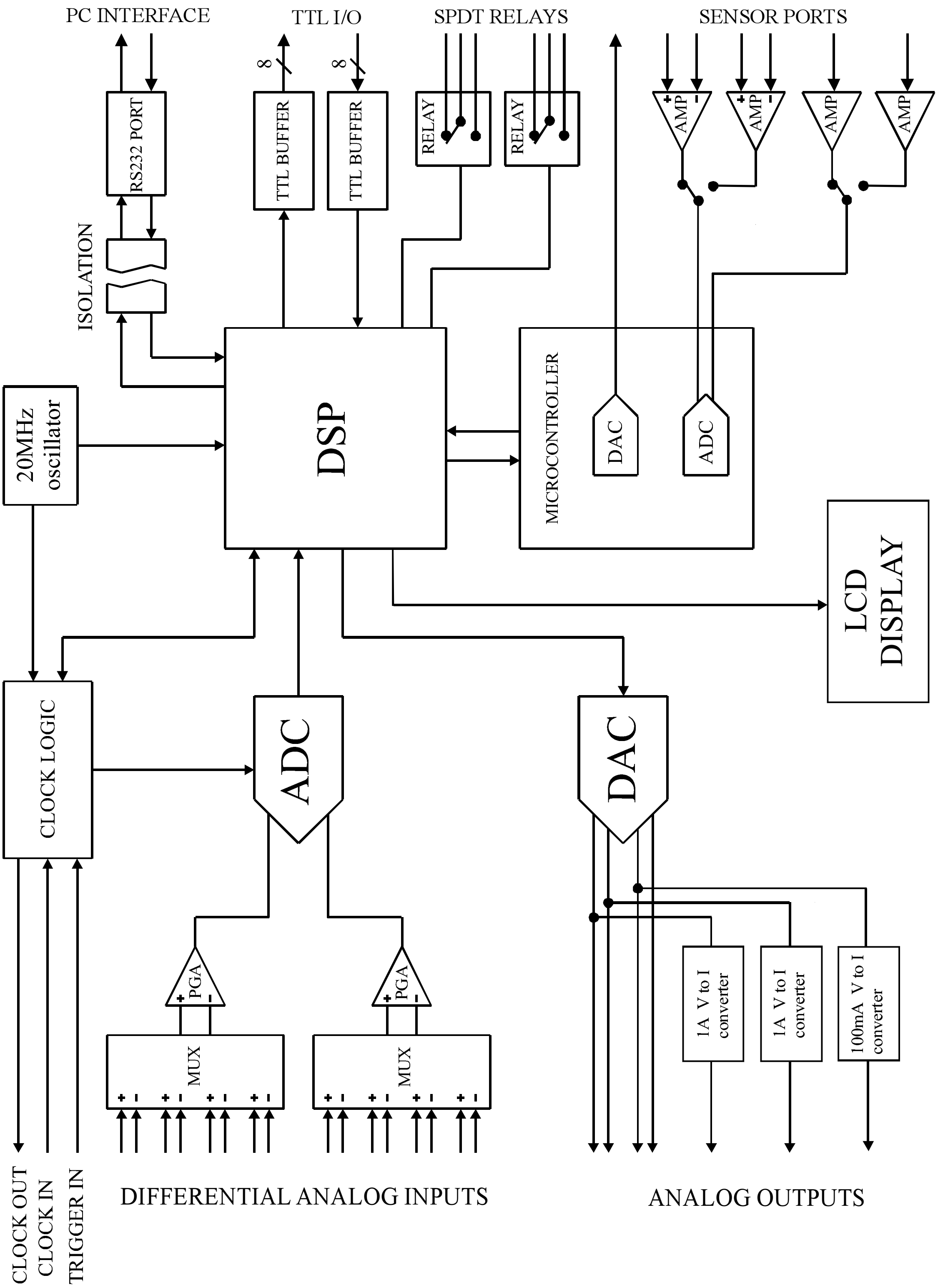
The DAS1414C is an intelligent data acquisition system built around a high performance digital signal processor (DSP) and precision data converters. Since its heart is a DSP, the program running on it can control its other functional parts with a very simple control from a host personal computer (PC). The DSP runs some kind of an operating system that allows the user to control the instrument without extensive knowledge about the hardware. You can send commands to the DAS1414C that will be interpreted and executed by the built-in DSP. The commands include simple tasks such as setting a desired output voltage and more sophisticated processes like simultaneous arbitrary time dependent signal generation and acquisition with averaging and transient skipping when only the result is sent to the host PC. These commands are simple strings of bytes that can be sent easily via the serial interface using almost any kind of operating system and programming environment thanks to the RS232 serial port, which is one of the most widely supported interfaces.

Using the DAS1414C data acquisition system allows you to develop your special function virtual instruments based on the powerful features and ease of use of this system – you can create a software for your real world measurement and control application which will perform all the necessary operations. With a PC-hosted development software (LabVIEW is recommended) it provides a general working environment enabling the user to create and use almost any kind of virtual, but really working instrument.

For applications and ideas please visit www.noise.physx.u-szeged.hu .

System components

The block diagram of the system



DAS1414C internal structure and the central signal processing units

The data acquisition system has modular structure consisting of a power supply unit, a backplane for euro-style cards and the plug-in cards. There are three cards in the unit by default: a DSP card, an ADC/DAC card and a sensor and digital interface card.

The DAS1414C data acquisition system uses three processors: a DSP for high speed acquisition and control, a microcontroller for controlling the sensor ports and another microcontrooller for driving the LCD display.

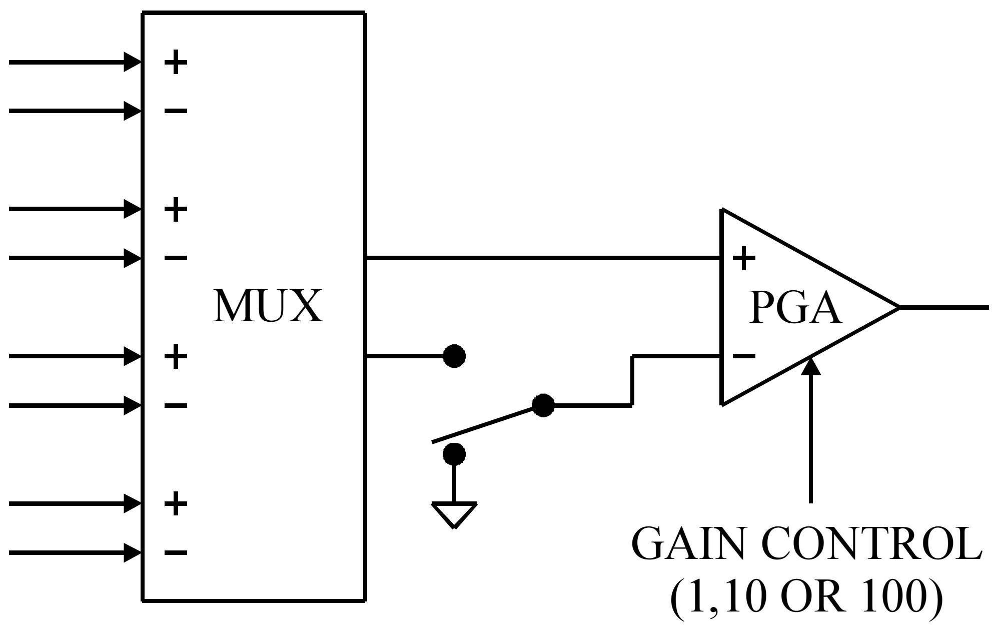
The DSP has 80kbytes of on-chip memory for program and data storage. The acquired data is temporarily stored here for asynchronous uploading to the host PC. It may also serve as a buffer for arbitrary waveform generation. The current memory limit is 4k words of data both for acquisition and signal generation (may depend on software and external memory options).

The DSP card has two independent UART ports: one for internal communications with the plug-in cards and another for galvanically isolated communication with the host computer.

The DSP card manages a special 16-bit digital bus for intercard communications, two independent synchronous serial buses and control signals such as address and I/O control.

Analog inputs, A/D conversion

The eight analog input channels are organized as two four-channel blocks. Each block has a four-channel differential multiplexer, a switch for selecting single ended operation and a programmable gain amplifier for gains of 1,10 and 100. The inputs are overvoltage protected up to 20V below or above the supplies (-15V and +15V if swithed on). The input range is –10V to 10V for gain=1. The output is a 2’s complement 16-bit left justified number.



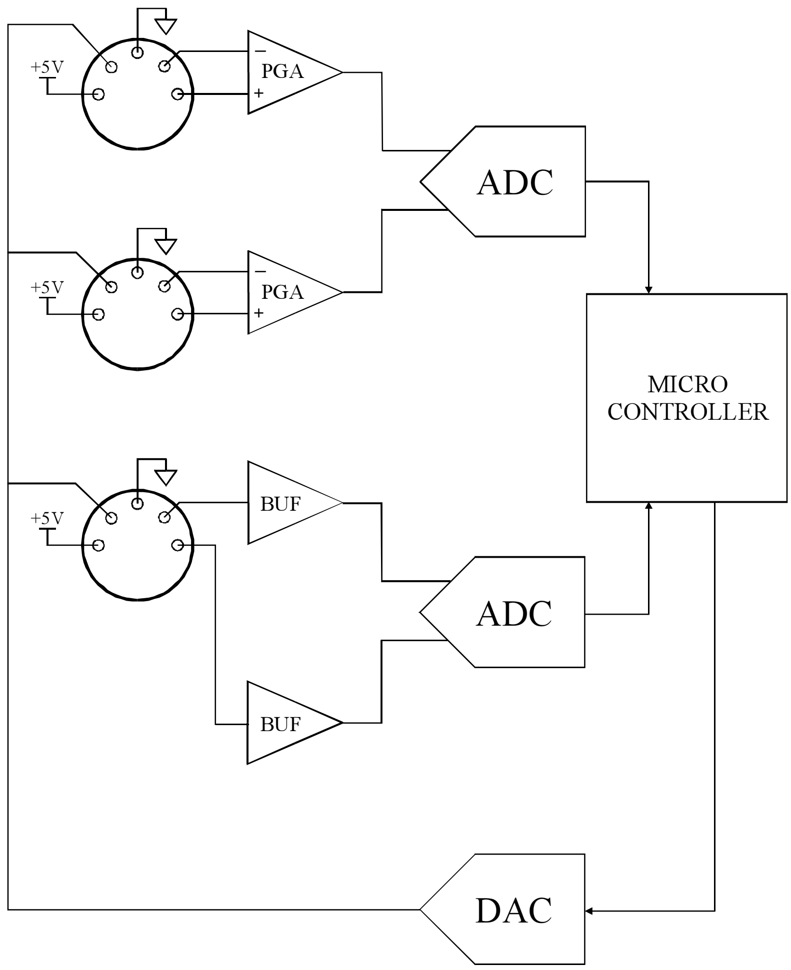
Analog outputs, D/A conversion, current outputs

The four independent analog outputs are driven by a quad 14-bit DAC. The output voltage range is –10V to 10V, and the three current sources are driven by the first three DAC output voltages – they are not independent. The first two current outputs can source or sink up to 1A, while the third one is limited to –100mA..100mA. The absolute accuracy must be guaranteed by calibration.

Note that the DACs should be set by a 16-bit 2's complement integer number.

Sensor interface

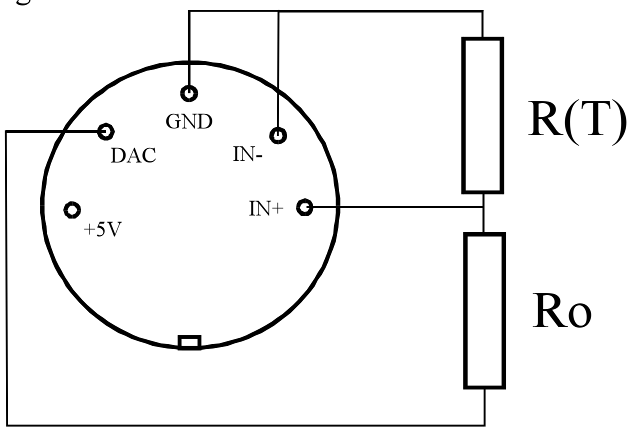
The three sensor ports have the structure shown in the following figure:



The ports labeled with A and B have differential inputs and connected to two ADC input channels, while port C uses two single ended buffers for another two ADC input channels referenced to GND. The input range for sensor ports A and B may be selected by software (20mV, 40mV, 80mV, 160mV, 320mV, 640mV, 1.2V and 2,56V) and fixed 2.5V for the two channels of port C.

5V power and a single DAC output drives a pin for all three ports.

Example of connecting a thermistor:

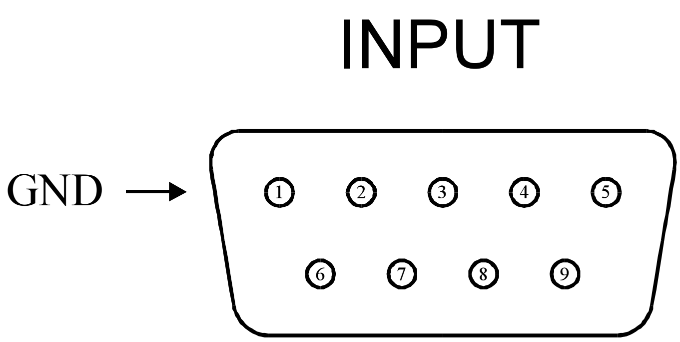


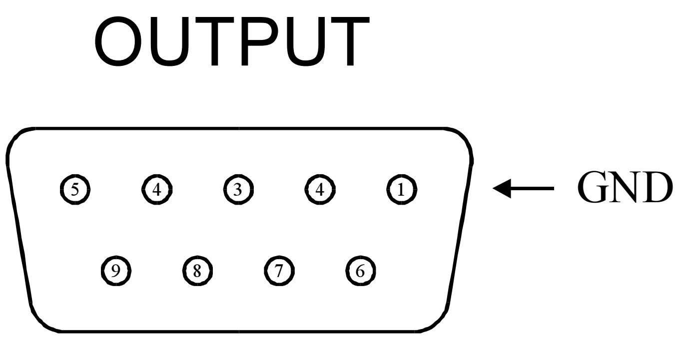
Here Ro has a known and stable value, the sensor DAC should be set so that the voltage between the resistors stays within the measurement range (practically from 0V to 2.5V). Note that the DAC can drive low impedance loads, but must not source more than 10mA for reliable operation.

The 5V power (<100mA) can drive even your low power external signal conditioning circuitry for more complex applications.

TTL ports

The TTL digital ports are unidirectional (8-bit input and 8-bit output), uses TTL compatible CMOS buffers and latches. The DB-9 connectors' pinout is shown in the next figure. Note, that the pin numbering is mirrored on the male and female connector. Pin 1 is the digital ground, the data bits 0..7 correspond to pins 2..9.





Relays

Two SPDT relays are available for switching external devices. The switched voltage limit is 50V, current limit is 1A. The relays' connections are isolated from the instrument.

Clock and trigger signals

External clock and trigger connectors are available for clocking the ADC by a TTL compatible signal and synchronize the sampling process.

Clock out TTL signal is provided for external use. It can be configured as the ADC sampling clock, programmable clock and a bit programmed by the user.

Using the data acquisition system

Beginning a measurement project

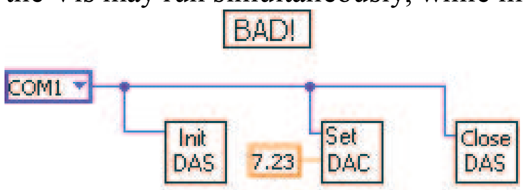
Starting of a measurement project consists of the following steps:

1. Switch on your data acquisition system. Be sure, that it is connected to your PC's free serial port.
2. Download the system software using the *DasInit.exe* program.
3. The instrument is now ready for measurements, the LCD display indicates the software version.

Note: if the communication with the instrument hangs or the instrument does not respond, press the RESET button. After doing so, you need to download the system software again.

The LabVIEW drivers (das1414.llb) and example programs help you to use the DAS1414C promptly or can serve as a basis for development of your own virtual instruments. The LabVIEW Vis included in the package are quite self documenting to aid the development process. The most important things to remember are listed below:

1. The system software must be downloaded before using the instrument.
2. Always open the communication with InitDAS.vi, close with CloseDAS.vi. These must be the first and last Vis executed in any application
3. Do not run two DAS1414 related Vis simultaneously. For example if you put two Vis without any guaranteed execution order, LabVIEW will run them simultaneously and this may corrupt the communication. The next figure shows this situation: on the upper program the Vis may run simultaneously, while in the other the execution sequence is guaranteed.



4. Do not stop your program with LabVIEW's Abort execution button. This also may corrupt and hang the communication since may happen during a communication process. Implement your own stop method using for example while loops.
5. The indexing is based on zero, so the first analog output is indexed as 0, the second analog input is indexed as 1.
6. Do not modify the DAS1414.llb library, the routines are tested. If you find a bug, please report it to us.

easurements of static or slo signals

When slow signals are measured, first the user must set up the ADC input parameters (channel, gain, differential mode) by adcsetup.vi. The parameters will be valid until you modify them. This means that if you measure many times with the same parameters, you need to setup only once. However, if you measure for example on two channels, the setup should be applied before each conversion. Channel parameter is a zero based index.

Note that the ADC converts continuously at a rate defined by the latest command.

Static voltage or current generation

Output voltages and currents can be generated by SetDAC.vi. This VI can set one channel at a time, accepts voltage or integer code (2's complement, 16-bit) as well. The current generators are connected to the DAC outputs so they are not independent. DAC number is a zero based index.

Time dependent measurements

Time dependent measurements are realised as periodic sampling at a given rate. The rate can be programmed by dividing the 20MHz master clock by a 16-bit integer number. The LabVIEW driver has a VI dedicated to this function called SetFreq.vi. Note that since the resolution is not infinite, one should consider the real sampling frequency returned by this VI.

You have two choices:

1. Start an untriggered sampling.
2. Start a hardware/software triggered sampling.

For the first you simply may use Sampling.vi, which starts an acquisition, waits for end of sampling and reads data.

For triggered measurements first you should setup the sampling parameters (SetupSampling.vi), start the sampling process (StartTriggeredSampling.vi), wait for end of sampling (IsSampling.vi) and the read the acquired data (ReadTrigData.vi).

For more information please see the examples.

Sensor measurements

There are three sensor ports on DAS1414C labelled A,B and C. Ports A and B have differential inputs, a DAC output (same for all) and 5V supply for low power external circuitry. Port C has two single ended, buffered inputs and the same DAC and 5V power. Sensor ports A and B are connected to a two channel ADC with software programmable input range (20mV..2.56V) and the two inputs of port C are connected to another two channel ADC. The sample rate can be set up to 20Hz, the resolution is 16 bits. The sensor DAC has 12-bit resolution and 0..5V output range.

Using the sensor port related VIs in DAS1414.llb you access all features of the sensor ports.

eci ications

DAS1414C DSP data acquisition system

Host processor card

- 40 MIPS high performance 16-bit fixed point digital signal processor (ADSP-2181)
- 80kbytes of on-chip memory (code and data)
- 64kbyte program EEPROM
- simple monitor program for serial port downloading
- system software downloaded from the host PC – extreme flexibility
- easy communication with the host PC using simple serial port communications

A/D conversion and analog inputs

- 8 differential or single ended inputs (software selectable)
- overvoltage protection for -35V..35V out of operating range
- software programmable gain/input range : 0.1V, 1V, 10V
- approximately 1MHz bandwidth
- 300kHz maximum sample rate, 14-bit resolution
- 10us settling time to 0.01
- simultaneous sampling capability of 2 selected channels
- integral non-linearity: 1LSB typical
- total harmonic distortion (THD): 90 dB typical
- external digital triggering, software analog triggering based on converted input voltage
- external clock for conversion

D/A conversion and analog outputs

- four independent channels with fixed 10V range
- 14-bit resolution, 1LSB typical nonlinearity
- 100 Hz update rate
- 10us settling to 0.01
- three current generator outputs (1A,1A,100mA, 5ms settling time)

Digital ports

- 8 TTL outputs
- 8 TTL inputs
- programmable TTL clock out up to 20MHz

Relays

- two independent SPDT isolated relays
- max. current: 1A

Sensor ports

- three ports for sensors, four channels
- 5V power, DAC outputs
- high resolution 16-bit sigma-delta A/D conversion, two differential and two single ended inputs
- software programmable gain on differential inputs
- 20Hz maximum sample rate

Serial communication port

- one isolated RS232 compatible serial port, 115200 bits per second data rate
- one asynchronous serial port for internal communications

LCD display

- 4 lines, 16 characters per line

Software support

- DSP system software and system loader
- LabVIEW library and examples