

# The use of embedded DAS for electronic signal measurements

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**Abstract** — Data Acquisition Systems (DAS) are mainly used with transducers to gather changing parameters such as temperature, pressure, velocity, etc. The transducer will convert each parameter to small varying electrical signal which is then sampled and digitized by the DAS before it passes it to the host computer where it is going to be analyzed and / or stored. This paper discusses how embedded DAS can be used for measurement and generation of electronics signals, mainly for the purpose of experimenting. We will develop a prototype of embedded DAS that can generate and measure waveforms that are commonly used in the electronics field.

**Keywords:** DAS, data acquisition, embedded DAS on electronic measurements

## I. INTRODUCTION

Most modern digital electronics devices have to do some form of data collection and processing. Data Acquisition Systems (DAS) have gained more applications in both analog and digital electronics fields. They have been introduced to applications such as: satellite communications where they can be used in Mobile Satellites (MS) to acquire signals [1] control and automation in applications such as fusion experiments, computer networks applications, e.g. data acquisition systems used with the communication protocol called EtherCAT [3].

Other applications are electronics signal measurements that are used for dynamic simulation centrifuge test [4], global positioning as used for Mobile Satellites (MS) in determining the relationship between the signal performance with respect to the azimuth and elevation angles [6] and data compression [6].

This paper discusses the application of DAS in the field of electronics measurements. We built embedded DAS that is able to generate waveforms and that can measure input current, voltage level or frequency value from the supplied input. Cheaper boards such as Raspberry Pi or Arduino could have been used for this research. If we used Arduino we might have to use

the third party software as well. MyRIO was readily available to us for this research and National Instruments [11] staff was assisting with all technical queries in the past.

### A. Objectives

The main objective is to use embedded DAS for electronic signal measurements. The sub-objectives are:

- To develop a prototype of embedded DAS that can generate and measure waveforms that are commonly used in the electronics field.
- To measure AC and DC voltages, current using embedded DAS and generate appropriate waveforms.

The embedded DAS can save or export results on to computer software for detailed analysis and savings.

## II. EMBEDDED DAS ARCHITECTURE

### A. Hardware components

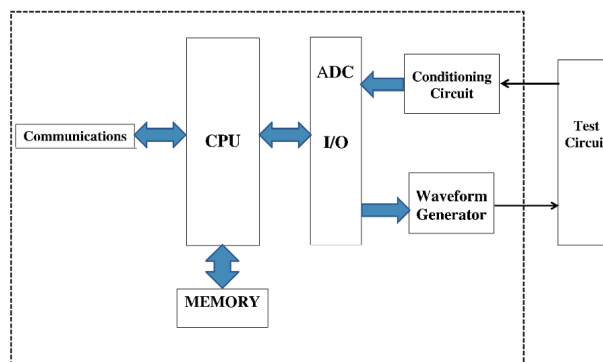


Figure 1. Embedded DAS hardware.

The TEST circuit represents a source or destination for the signals to and from the DAS respectively. When measurements are conducted, this circuit supplies the DAS with a signal. When the DAS is configured to generate signals, this test circuit forms the load to voltages supplied.

Conditioning circuit is used to maintain the magnitude of the incoming level to the desired limits. Weak signals are amplified, large signals are attenuated and noisy signals are cleaned [7]. Waveform generator consists of a waveform generating IC explained in [8] and an amplifying circuit; they are configured by DAS outputs to generate different type of waveforms at different voltage and frequency levels.

In figure 1, Input / Output port (I/O) represents input and output channel(s) of the DAS. When doing measurements, the input signal is sampled and digitized by the ADC channel within the DAS. When the DAS is operating as a signal source, an output channel transmits controlling commands to the waveform generator. Central processing unit (CPU) is used for timing of all operations by the DAS, polls channels for any input, set clear all interrupts, start and stop the timers, etc. Therefore CPU controls all DAS operations.

The memory provides a space to store saved values and allows for future retrieval. Micro controllers will have their own internal memory and this memory can be expanded by adding additional circuits that have memory chips.

Communication circuits will facilitate data transfers with the external systems. This can be done by using Universal serial bus (USB) or Universal asynchronous receiver/transmitter (USART).

The choice will be influenced by type of embedded DAS used as well as the desired transmitting speed. In some cases it might be necessary to include serial to USB interface that are illustrated in [9] since most computer do not provide serial ports any more.

### B. DAS firmware

Figure 2 illustrates the DAS firmware. The DAS will start by polling data on its input channels to determine if there is an input signal and configurations.

If any form of data is received, it will analyze this data by checking any request to save or export. If a request to save or export is found, it will be serviced accordingly. If a request is to generate a particular waveform, appropriate commands are sent to the waveform generator to create the requested wave. If signal is found at the inputs, the ADC captures it into the DAS.

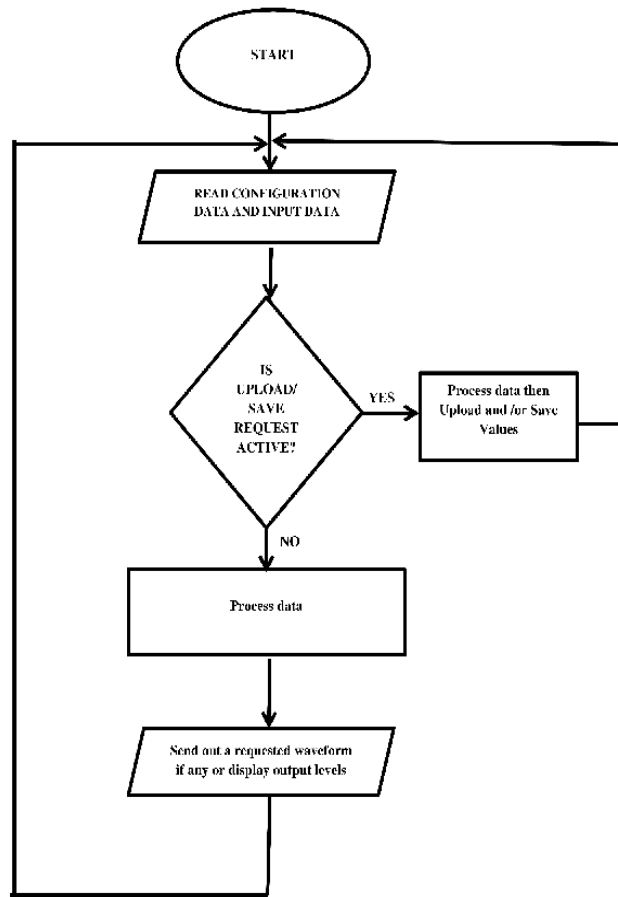


Figure 2. DAS firmware

### III. METHODOLOGY

The DAS is setup to supply the connected load with sinusoidal waveform. The frequency and peak voltage on each waveform is changed to give different test values. As in Figure 2 we will be generating AC waveforms using an application software. A multimeter is also connected across the load to measure the R.M.S values of the signals.

For each signal frequency and amplitude that is applied; R.M.S reading from the meter, peak voltage and frequency given by oscilloscope are compared to those displayed by the DAS.

The signal input is saved and removed at the input to the DAS, there after recalled and checked if it still matches the meter and the oscilloscope readings. After each reading the results are uploaded to the host computer. An embedded DAS was successfully used to track the current drawn by a microwave oven during the warming cycle.

#### IV. RESULTS AND DISCUSSIONS

Any multimeter will be reading R.M.S values since all outgoing signals are of alternative current (A.C). The voltage reading is verified with the peak voltage values displayed on the oscilloscope. The R.M.S values can also be calculated as discussed in [10]. Each DAS output readings are compared to both Oscilloscope and multimeter values.

If it happens the DAS reading mismatch the multimeter reading, the system will have to be calibrated. Same procedure is followed for current, except that the multimeter will be in series with the load and Ohms laws is used when analyzing oscilloscope display. The unit was tested for AC currents, AC voltage and DC voltage response.

Since this is only a prototype, for simplicity reasons calibration has been performed to match the maximum input / output channel ratings of the chosen data acquisition card, namely: myRIO. Sections A to C will highlight a sample of results that were collected and saved to the DAS memory system shown in figure 1. All these results are accompanied by short discussions.

##### A. AC Current Measurements.

Current measurements has been restricted to AC since the current transformer has been used on the sensing circuitry. The induced voltage from the sensor circuit was applied to the 5V input channel of DAS.

AC and Current selections were made on the front panel. It was saved each time when the current was changed. The following results were obtained.

TABLE I. AC CURRENT STIMULATED BY 230 V MICROWAVE OVEN'S WARMING CYCLE

Time	Current (A)
12/03/2015 21:24:21.980	0.79895
12/03/2015 21:24:28.748	3.791992
12/03/2015 21:24:33.166	4.529174
12/03/2015 21:24:37.368	4.45935
12/03/2015 21:24:41.872	0.956055
12/03/2015 21:24:43.845	0.811035
12/03/2015 21:24:53.892	0.785522
12/03/2015 21:24:59.087	4.505004

Table 1 illustrate that an embedded DAS was successfully used to track the current drawn by a microwave oven during the warming cycle. Note that all the readings has time stamped.

Based on the number of uploaded values which are dependent on the speed of the processor and the frequency of the measured wave; you can use application program of the host computer to give traces of input signals.

##### B. DC Voltage Measurements.

The DAS was configured to produce DC signals ranging from 1 to 10V. Each DC value was saved onto file by using the save feature. The following results were observed:

TABLE II. DC VOLTAGE READINGS DERIVED FROM INTERNALLY CREATED SIGNAL

Time	Voltage (V)
11/28/2015 17:31:09.757	1.992188
11/28/2015 17:31:15.759	2.993164
11/28/2015 17:31:21.760	3.994141
11/28/2015 17:31:25.762	4.003907
11/28/2015 17:31:31.764	5.000001
11/28/2015 17:31:39.765	6.000977
11/28/2015 17:31:49.769	7.006837
11/28/2015 17:32:01.773	8.002931
11/28/2015 17:32:19.777	9.98047

Table II illustrate that an embedded DAS was successfully used to track the DC voltage changes. Note that all the readings were time stamped. The table provides voltage responses for different timings. A bar chart could be generated as in Figure 2.

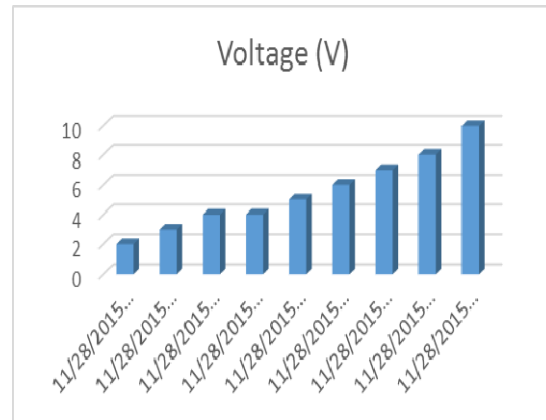


Figure 2: Bar chart for DC voltage measurement

### C. AC Voltage Measurements.

The DAS was configured to produce a 50 Hz, 5 V sinusoidal waveform. The following results were observed:

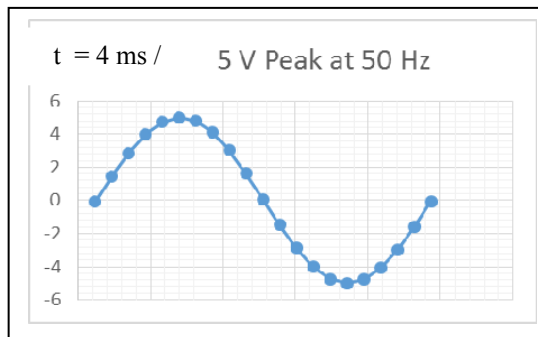


Figure 3: Waveform from collected data.

As illustrated by figure 3, an embedded DAS has successfully produced a 50 Hz, 5V peak sinewave signal from the analog output channel which was then acquired back to it through its analog input channel. This is a very important phenomenon of this system since the traces can be easily shared, distributed and printed.

All other important benefits of the DAS can be read from Table III where features of embedded DAS measurement tool are compared to those of a traditional multimeter and function generator. Some of the parameters that mentioned are whether it measured peak voltage directly, exported results to PC, if it stored measured values and if it gave frequency, if it supported firmware upgrade and voltage with one measure.

TABLE III. DAS PERFORMANCE COMPARED TO THAT OF MULTIMETER/ FUNCTION GENERATOR.

Comparing embedded DAS with Traditional multimeter / function generator		
Parameter or Feature	DAS	Multimeter /Function Gen
Generate and measure signals	Yes	NO (Either measure / generate signal)
Store measured values	Yes	NO
Export results to PC	Yes	NO
Firmware upgrade supported	Yes	NO
Measure peak voltages directly	Yes	NO
Give frequency and voltage with one measure.	Yes	NO

### V. CONCLUSIONS

Embedded DAS can be utilized to create and measure electronic signals. They offer much flexibility than traditional instruments such as function generators and multimeters since their firmware can be easily improved. Our research demonstrated that their flexibility allows for an addition of many functions that may not be supported by traditional instruments. In this paper we illustrated embedded DAS has successfully produced a 50 Hz, 5V peak sinewave signal from the analog output channel which was then acquired back to it through its analog input channel. Depending on the change in hardware it can go up to 250V or above. We can use similar device for measuring high voltages and pinpointing when incidents occur.

The DAS also enable easy and fast data sharing. Therefore by using embedded DAS, shortage of laboratory instruments in venues such as university Laboratories can be easily addressed since the results from one DAS can be shared and then evaluated by more than one candidate.

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