REDUNDANT DAQ SYSTEMS

FOR SIGNAL MONITORING DURING ROCKET LAUNCHES

DEWETRON

> **> Redundant data acquisition**
> **> Purely analog signal conditioning modules**
> **> Networked data acquisition system**
> **> High channel count data acquisition systems**
> **> Easy-to-use data acquisition software**

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THE APPLICATION AND ITS CHALLENGES

A rocket has thousands of individual mechanical components and technical subsystems whose reliability is the main factor of success for a rocket launch. The correct functionality of all these components must be monitored during the countdown before the take-off phase.

The following application solution introduces a data acquisition system which is used for monitoring the deformation and vibration of rocket surfaces and the temperature on critical points during the rocket development phase and the countdown before the take-off.

The challenge is that the signal conditioning and data acquisition system must be close to the DUT in bunkers to protect the systems from the enormous physical forces which are unleashed during a rocket launch. For safety reasons, the signal conditioning and data acquisition systems are split up in several individual and redundant subsystems. These subsystems are set up in several locally distributed bunkers to avoid data loss in case any unexpected and safety critical event occurs.

For sure, it is not allowed to enter these bunkers during the countdown and the take-off due to safety reasons. Thus, the data must be transferred to the control room and the data acquisition system must be controlled from there.

DEWETRON's APPLICATION SOLUTION

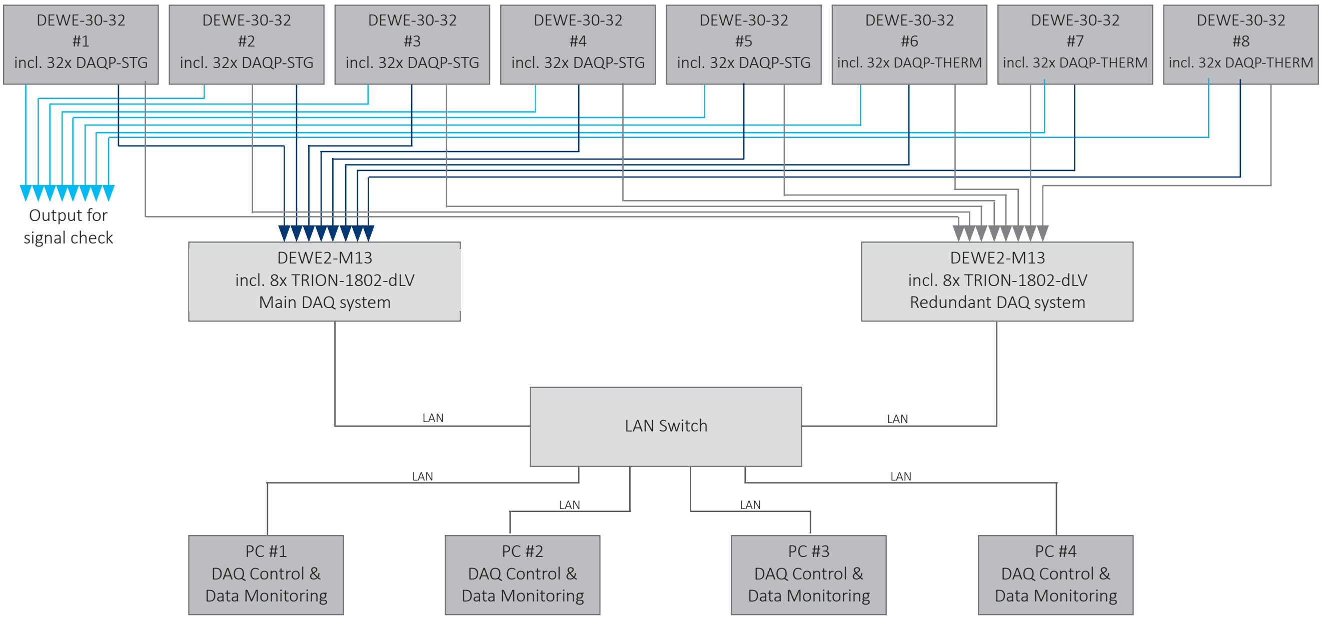

Figure 1: Block diagram of the entire system

DEWETRON's solution for this complex application is split into three different parts:
> A 256 channel signal conditioning system
> Two 256 channel data acquisition systems for redundant data storing
> A data monitoring and control system consisting of four independent workstations
A block diagram of the whole structure can be seen in Figure 1.

SIGNAL CONDITIONING SYSTEM

The signal conditioning system consists of 160 DAQP-STG modules, 96 DAQP-THERM modules and 8 DEWE 30-32 signal conditioning racks.

DAQP-STG and DAQP-THERM Modules

DAQP-STG modules (see Figure 2 on the left) can acquire signals from (full, half, 120 Ω and 350 Ω quarter) bridge sensors with constant voltage (up to 12 V) and current (up to 20 mA) excitation. In addition, signals from RTD sensors (25 mΩ to 100 kΩ) and voltage up to ±10 V can be connected directly to these modules. The isolated signal conditioning path is completely analog and ensures highest reliability demands.
DAQP-THERM modules (see Figure 3 on the right) support a wide range of different thermocouple types (K, J, T, R, S, N, E, B, L, C, U).
On the output side, both DAQP-STG and DAQP-THERM modules provide a conditioned ±5 V signal for all these signals. The modules can be programmed via RS-485 interface.

Figure 2: DAQP-STG (left) and DAQP-THERM (right) module

DEWE-30-32 signal conditioning rack

DEWE 30-32 racks (see Figure 3) are signal conditioning racks with 32 slots for DAQP modules. The conditioned ±5 V output signal of the DAQP modules can be distributed to one, two or even three measurement systems in parallel (optional ±10 V output available as well).
The parallel signal output turns the DEWE 30-32 into the dedicated signal conditioning solution for safety critical tests where data loss must be avoided at any circumstances. Just split your data acquisition system up into two or three redundant systems to be safe in case one of the systems should fail during safety-critical or destructive tests.
The triple signal output was chosen for this safety-critical application. All signals are forwarded to two separate data acquisition systems to store the data redundantly. The third signal output is reserved for signal check during the sensor application and troubleshooting.

Figure 3: DEWE 30-32 equipped with DAQP-STG modules

DATA ACQUISITION SYSTEM DEWE2-M13 WITH TRION-1802-dLV BOARDS

TRION-1802-dLV boards provide either 16 differential or 32 single-ended input channels for up to ±10 V. Each channel is sampled with a separate 18 bit SAR A/D-Converter with up to 200 kS/s. In addition, each channel provides a freely programmable on-board filter with selectable Bessel or Butterworth characteristic with 2nd, 4th, 6th or 8th order.
In addition, the board provides a RS-485 interface, 2 counter inputs, 1 CAN bus, 8 digital inputs and 4 digital outputs.
16 TRION-1802-dLV boards were split up equally into two DEWE2-M13 data acquisition mainframes. Each DEWE2-M13, equipped with eight TRION-1802-dLV boards, is used as individual data acquisition system with 256 input channels each to digitize the signals of the DAQP modules redundantly (see Figure 4).
Both DEWE2-M13 are connected to four additional desktop PCs over Ethernet. The desktop PCs are installed in the control room and are used for data monitoring and triggering the measurement while the DEWE2-M13 are installed close to the DUT to keep the cable lengths as short as possible.

Figure 4: DEWE2-M13 with 8x TRION-1802-dLV

WHERE IT COMES TOGETHER: OXYGEN DATA ACQUISITION SOFTWARE

DEWETRON's OXYGEN data acquisition software is the core component which combines all these individual hardware components to one big, locally distributed and redundant measurement system.
OXYGEN is running on the DEWE2-M13 mainframes and stores the data locally on both systems redundantly. The DAQP module configuration is also done by OXYGEN as not only the signal connections but also RS-485 interfaces are installed between the DEWE2-M13 and each DEWE 30-32.
In addition, the OXYGEN Ethernet Sender plugin outputs the signals acquired from the DAQP modules at a reduced sampling rate via a UDP data stream and transmits the data to the desktop PCs in the different control rooms. OXYGEN is installed on the desktop PCs as well. On the receiver side, the Ethernet Receiver plugin is used for decoding the UDP data streams again. This functionality ensures that data can be distributed to different receivers and each individual receiver can visualize and monitor only the certain signals that are important to that system without distraction by other signals.
In case the signals reach a certain threshold, reduced data can be stored automatically on each desktop PC for analysis and post-processing. Moreover, a trigger command can be sent over Ethernet to the DEWE2-M13 mainframes to control their recording state.

THE ENTIRE SYSTEM AT A GLANCE

Summarizing, the signal conditioning and data acquisition system consists of the following components:
> 160x DAQP-STG
> 96x DAQP-THERM
> 8x DEWE 30-32 with triple redundant signal output
> 2x DEWE2-M13
> 16x TRION-1802-dLV
> 4x Desktop PCs
> 6x OXYGEN data acquisition software

Figure 5: Signal Conditioning and DAQ system during quality check (Desktop PCs not included)

BENEFITS USING DEWETRON HARDWARE FOR SIGNAL MONITORING

Purely analog signal conditioning

DAQP-STG modules provide purely analog signal conditioners on the input side and a conditioned ±5 V signal on the output side without any digital component in between (see Figure 6). This ensures highest reliability and turns DAQP modules into the preferred signal conditioning solution.

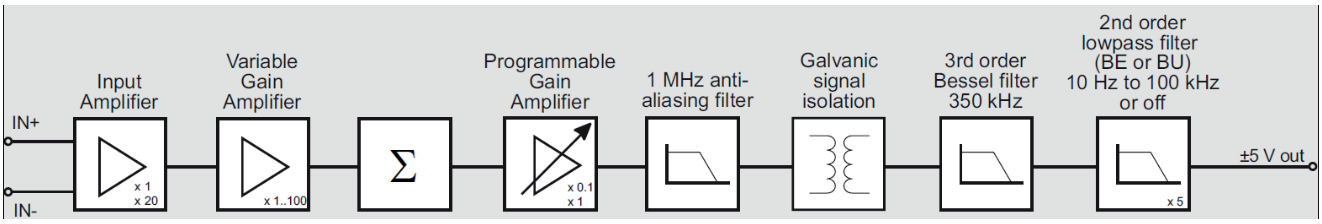

Figure 6: Isolated amplifier block diagram of a DAQP-STG module

Redundant data acquisition

DEWE 30-32 signal conditioning racks provide single, dual or triple analog signal output for each DAQP module assembled into the rack. For this certain application, the triple signal output was chosen. This means that the conditioned ±5 V signal on the output side of each DAQP module can be picked up three times (see Figure 7).

On the one hand, the signal is forwarded to two independent data acquisition systems (DEWE2-M13) for data recording and on the other hand one signal output is reserved for signal check during sensor assembly and in case of troubleshooting. This means that in the unlikely event that one of the two independent data acquisition systems fails, data is not lost and still available on the second mainframe.

Figure 7: Rear side of a DEWE 30-32 with triple redundant signal output

Highest modularity

In case if the DAQP-STG or DAQP-THERM signal conditioners need to be calibrated or checked for service reasons, it is possible to only unplug this certain signal conditioner and replace it by another one or leave the slot empty while the rest of the system is still fully functioning.
In addition, the single components of the system (DAQP-modules, DEWE 30-32 and DEWE2-M13 are working independently and could be split up into several small data acquisition and signal conditioning systems.

Highest channel density

TRION-1802-dLV boards provide 16 differential or 32 single-ended input channels (for up to ±10 V) on one single 37-pin DSUB connector. Each channel is sampled with a separate 18-bit SAR A/D converter with up to 200 kS/s and provides selectable on-board low pass filters. This board in combination with the DEWE2-M13 turns your data acquisition system in a high channel count system with up to 416 analog input channels in one single mainframe occupying only 5 U in a 19'' rack.

THE EXPERT

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FURTHER QUESTIONS?
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