System Integration UniDAQ4.DSP-AD

Revision   1.0

Date   10/20

History   1.0, 2020-09-30, initial release

Contents

1 Overview

Figure 1.1: UniDAQ4 System Overview

With its eight versatile voltage, IEPE and current loop analog inputs and digital I/O, UniDAQ4 is already suited for may tasks in vibration and machine condition monitoring. This document describes several options to expand the UniDAQ4 functionality beyond the usual data acquisition board for a variety of target applications.

Please feel free to contact us at info@dsignt.de if you need further information or assistance. We also offer to design and manufacture customer-specific Expansion Cards and Connector Panels.

2 Basic DAQ System

The basic system solely requires to add a custom connector panel and a DC power supply.

Since the sensor connectors differ widely the connector panel is not included with the UniDAQ4. Commonly used connectors are BNC for IEPE-powered acceleration sensors and microphones, 1/4-28 UNF for triaxial accelerometers, terminal blocks or M12 for auxiliary 4/20mA pressure and temperature sensors, banana jacks for general voltage inputs, etc.

The connector panel must include ESD protection for all signals which are prone to be touched by users during installation, for example the shield of the BNC jacks used for IEPE sensor attachments. ESD protection devices should be located as close as possible to the connector and routed to the cabinet and protective earth with thick PCB traces. Please refer to the UniDAQ4 User's Guide for additional information.

If additional user controls or signaling is desirable on the connector panel, use the I²C Analog Control Expansion Connector and add an I²C port expander. Make sure to avoid slave address conflicts with the on-board I²C devices (refer to User's Guide).
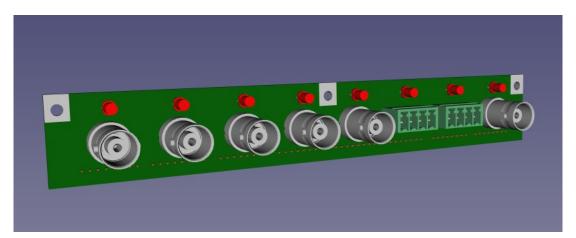

Figure 2.1: Connector Panel Front View

The next image shows the rear view of a typical connector panel with TVS diodes for ESD protection and the routing to the protective earth / housing.
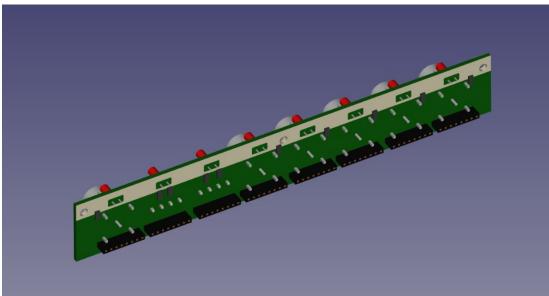

Figure 2.2: Connector Panel Rear View

3   Data Logger

A recommendable mass storage device for a data logger is a (micro-)SD-Card, connected to the UniDAQ4 Expansion Port SD/MMC interface. Only a few passive components are required: pull-up resistors and a power supply reservoir capacitor. Recording eight channels at 100kS/s requires a capacity of 12 Gbytes per hour. The SD card is connected in 4-bit mode with a clock up to 38 MHz. If highest SD card throughput is a requirement, a reduction of the DSP clock from 456 to 408 MHz allows for a 51 MHz card clock.

If the UniDAQ USB port is not used for communications it can be routed to the Expansion Port by swapping the position of two SMD 0-ohms resistors. OTG mode supports a USB memory stick for mass storage. This implementation requires a 5V load switch (TPS22916 or similar device) to control the USB VBUS, a reservoir capacitor, and ESD protection for the USB connector (TPD4S012 or similar).

In harsh environments vibration and shock may prohibit the use of a detachable card or memory stick. In this case use an eMMC chip (embedded MMC) soldered to the expansion board. The eMMC can then be read-out from the UniDAQ via USB (mass storage device class) or Ethernet FTP protocol.

The mass storage expansion leaves the SPI port and some GPIO signals on the Expansion Interface unused. It is therefore possible to combine mass storage with an additional interface, e.g wireless communications, to configure and monitor the Data Logger remotely.
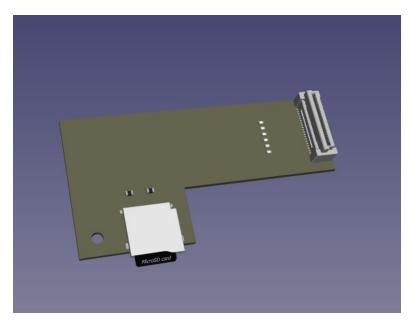

Figure 3.1: SD Card Expansion

The next image shows a rear view of the UniDAQ4 with the SD Card expansion attached.
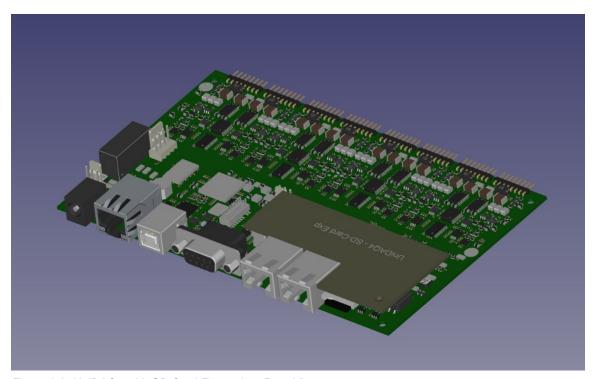
Figure 3.2: UniDAQ4 with SD Card Expansion, Rear View

4 Wireless Connectivity

Controllers and modules for WiFi and other wireless communication protocols, such as LoRa, are available from many manufacturers. Choose a controller supporting a SPI or SDIO host connection. SPI can be operated up to 45MHz on the UniDAQ4. The 4-bit SDIO mode of the MMC/SD-Card interface provides even higher data throughput. An example is the WFM200 transceiver from Silicon Laboratories.

An external antenna is required if the UniDAQ4 is mounted in a metal housing. WiFi antennas typically use a reverse SMA connector.
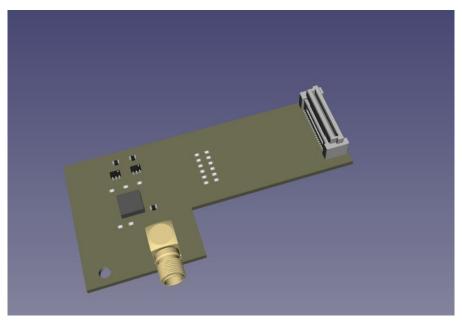

Figure 4.1: WiFi Expansion

5 Industrial Digital I/O

The UniDAQ4 provides four TTL inputs and two outputs on the D-Sub9 connector. Additional digital I/O ports can be implemented on the Expansion Port. Nine GPIO signals are available. Do not expose the DSP GPIO signals directly to the outside world, always use buffers and appropriate protection measures. It is also possible to access the DIN[3:0] and DOUT[1:0] signals on the expansion connector, yielding a total of 15 I/Os. In this case order the UniDAQ4 with the D-Sub9 connector removed.

The expansion card may also contain level translators and isolation devices. The image below shows a sample configuration with OptoMOS relays to implement four isolated industry-standard outputs, accessible on an 8-pin terminal block.
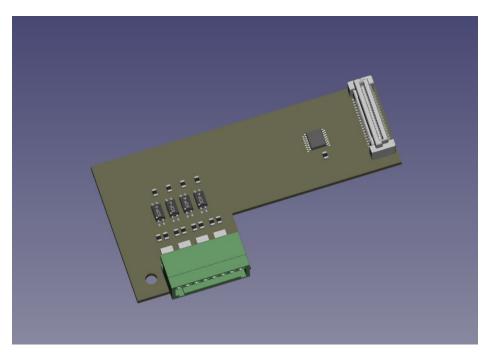

Figure 5.1: Digital-I/O Expansion

6 Fieldbuses and Industrial Networks

The UniDAQ4 is an excellent platform for machine health monitoring in a production environment, which calls for integration into an industrial network / fieldbus infrastructure. A variety of standards are in use, such as EtherCAT, Profinet, CC-Link, CANopen, to name but a few.

A straightforward solution to implement this connectivity is the Anybus® series of chips and bricks from HMS Networks. The UniDAQ4 expansion port high-speed SPI is used as the host interface. Up to 9 GPIO pins are available as control, trigger and synchronization signals. The Anybus bricks are ready-to-use modules containing the network interface controller, memories and PHYs. Only the physical interface needs to be implemented. In case of EtherCAT two RJ45 connectors and magnetics are required. Space and cost constrained applications may use a protocol controller chip and implement the supplementary circuits on the Expansion Card itself.

In these applications the SYNC_IN and SYNC_OUT connectors of the UniDAQ are not required, synchronization is provided via the network. Please order the UniDAQ without SYNC connectors to make space for the additional network connectors. The following images show an example using an Anybus brick.
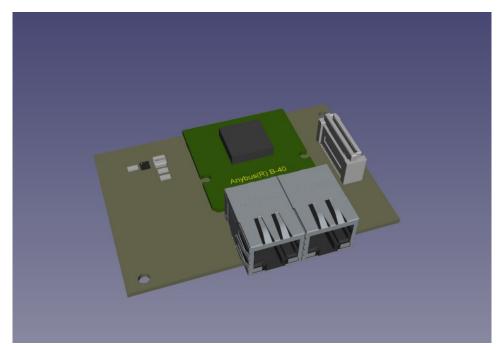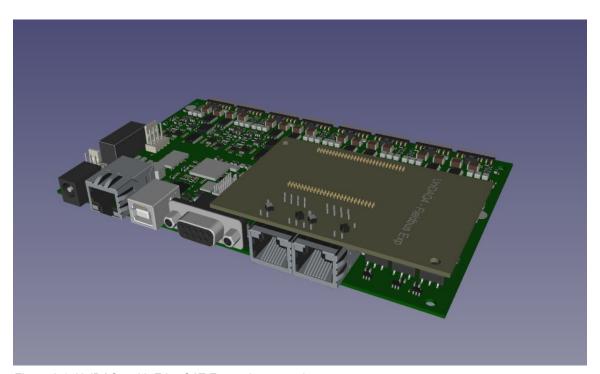
Figure 6.1: Fieldbus Expansion

Figure 6.1: UniDAQ4 with EtherCAT Expansion, rear view

7 User Interface

Some applications such as machine monitoring may benefit from a display and user interface to let service technicians evaluate the machine status on-site. Also handheld measuring devices can be build based on the UniDAQ platform.

This expansion adds a dedicated micro-controller to handle the user interface: a display with a touch screen and additional pushbuttons. The micro-controller communicates with the DSP via the high-speed SPI port, or optionally via USB.

The power requirements of such a user interface may exceed the available Expansion Port power supply. Use a dedicated point-of-load buck converter powered from DCIN (9-36V) via the PWR_SWITCH connector on the UniDAQ4.
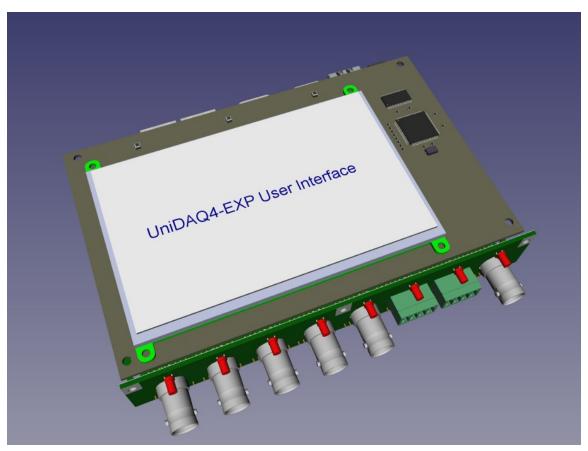

Figure 7.1: UniDAQ4 with User Interface Expansion and Connector Panel

8   Power Supply

The DC power supply requirements depend on sampling rate and sensor supplies. A typical configuration sampling 8 channels at 100kS/s and streaming the data via USB consumes 4.5W. Enabling IEPE constant current supply for all 8 channels adds 2W. Using the 24V EXC sensor excitation supply at its max. 200mA will add 6W (including DC/DC losses). If the DSP and DRAM are used extensively for data post-processing, power consumption will rise by up to 1.5W.

Some examples:

Baseline + DSP max + 8 channels IEPE
= 4.5W   + 1.5W   + 2W   = 8W
Baseline + DSP max + 5 channels IEPE + 3 channels 4/20mA powered by EXC
= 4.5W   + 1.5W   + 5/8 * 2W   + 3 * 24V*25mA / 70%   = 10W

The UniDAQ4 on-board DC/DC converter is rated at 12.5W. The remaining power is available for devices attached to the Expansion Port.

8.1 AC/DC Adapter

Any commercially available AC/DC converter with an output voltage between 9 and 36V can be used to power the UniDAQ4. A 15-20W converter is sufficient for all use cases. The DC power feed cable should contain a common mode choke and/or ferrite clamp close to the DC connector to suppress EM interference.

8.2 Automotive and Industrial

Use the commonly available 12V or 24V supply. The UniDAQ will operate reliably down to 9V-10% = 8V and thus tolerate the voltage drop during starting-up in 12V automotive use. Add a common-mode choke or clamp-ferrite close to the DC connector to improve EMC.

Note that the Digital-I/O on the D-Sub9 connector and the USB interface share a common GND with the power supply.

8.3 Battery-Powered

For portable use a rechargeable Li-Ion battery pack and the charger electronics are connected to the PWR_SWITCH header on the UniDAQ4 board. The power jack on the rear panel is then used to power and/or charge the unit in stationary use.
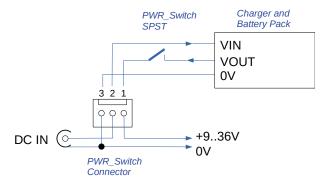

Figure 8.1: Battery Pack and Charger Connection

Most battery packs and chargers allow to monitor the charge state via I²C / SMB. Two options exist to implement this interface:

1.   Use two of the GPIO signals from the Expansion Port and implement a software I²C.

2. Use the I²C Analog Control Expansion Connector. This I²C Interface shares GND with the analog circuits and requires bidirectional I²C isolation, e.g using an ADum1250, ISO1540, or Si8600, to keep the analog and digital / power supply GNDs separated. The Analog Control Expansion Connector provides 3.3V to supply the 'analog' side of the isolator.

8.4 Powering Expansion Modules

The Expansion Port provides 3.3V and 5V power rails. The maximum available current is 100mA on the 3.3V rail and 500mA on the 5V rail. If an expansion card requires more power connect it to the PWR_SWITCH connector on the UniDAQ4 and use a POL (point of load) DC/DC buck converter on the expansion card. Suitable converters are available as small modules, such as the TPSM53602.

9 Mechanical Integration

The standard 160 x 100 mm Euro-Card size of the UniDAQ4 provides for straightforward mounting in a variety of commercially available housings. The mounting holes on the rear side are placed to accommodate conventional panel fixing brackets.

Expansion cards can be mounted with 10, 14, or 18mm board-to-board spacing by selecting the appropriate receptacle connector.
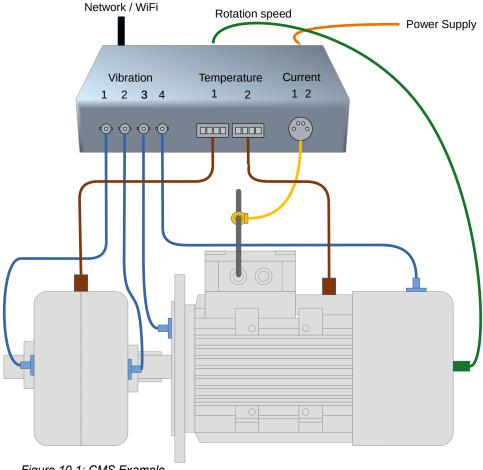
10 Example: Condition Monitoring System

Figure 10.1: CMS Example

Bill of Materials:

1 x UniDAQ4
1 x Connector Panel
optional: 1x Expansion Board WiFi or Fieldbus
1 x Metal Housing ~160x120x25mm inner dimensions

4 x IEPE Acceleration Sensors
2 x Temperature Sensors 4/20mA Interface
2 x Current Transformer + Shunt
1 x Tachometer or Quadrature Encoder, TTL

11 Support

Please feel free to contact us at info@dsignt.de if you need additional information or assistance. We also offer design and manufacturing of custom Expansion Cards and Connector Panels.

3D models of the UniDAQ4 board and sample models of Expansion Cards and Connector Panels are available on request to assist in mechanical design.