

MCC DAQ HATs

Using Raspberry Pi® for DAQ

History and Popularity of Raspberry Pi

Raspberry Pi's original aim was far from the typical engineering lab. Originally designed to be a cheap, almost disposable computer, Raspberry Pi was created to get kids interested in programming. Since its introduction in 2012, Raspberry Pi has become the 3rd best-selling general-purpose computer platform, trailing only the Microsoft® Windows® PC and Apple® Macintosh®. Over 35 million units have been sold to date and it's estimated that up to 44% of Raspberry Pi's are now being bought by "industrial" customers. A powerful feature set along with the Raspberry Pi community and \$35 price tag have continued to fuel this tremendous growth. Raspberry Pi has quickly moved from being a cheap computer designed for children into the hobbyist/maker market and increasingly into industrial/commercial markets.

The current pandemic has also helped grow the Raspberry Pi market. With more people working from home, the demand for small, inexpensive engineering projects has soared. Raspberry Pi has become an ideal fit for these types of applications and has made programming and engineering even more accessible.

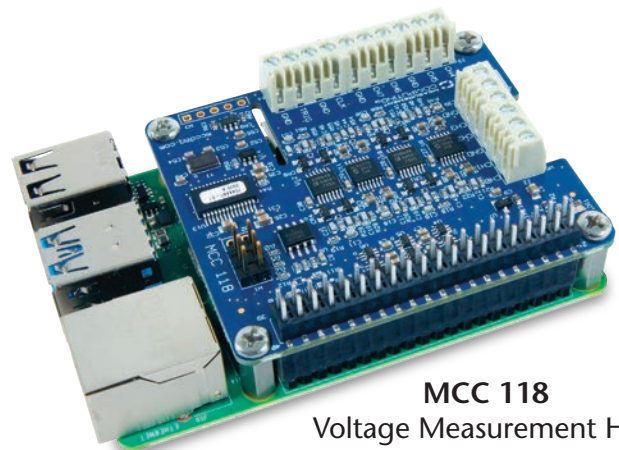
DAQ for Raspberry Pi

Raspberry Pi does not have built-in Test and Measurement capabilities such as Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs), or conditioned Digital Inputs and Outputs (DIO). However, these capabilities can be added through the 40-pin GPIO header. A device that connects directly to the 40-pin header and stacks onto the Raspberry Pi is called a HAT (Hardware Attached on Top).

Over the years, individuals have published open-source designs and small companies have sold low-cost HATs for a variety of tasks, including support for analog and digital I/O. These designs and products are adequate for the education and hobbyist/maker market but have some serious shortcomings for professional Test and Measurement applications. Most of these devices are provided partially assembled, without specifications or programming support, and without performance guarantees that can only be achieved with a thorough device validation process.

MCC DAQ HATs

To bring professional-quality measurement products to the Raspberry Pi platform, Measurement Computing (MCC) has developed a series of DAQ HATs. These HATs offer similar specs and accuracy as traditional USB and Ethernet-based DAQ products from MCC with resolution up to 24-bits and sample rates up to 100 kS/s.



MCC 118
Voltage Measurement HAT

The DAQ HAT plugs into the 40-pin GPIO header on a Raspberry Pi computer.

MCC offers five products designed for Test and Measurement applications that conform to the Raspberry Pi HAT standard. These devices provide data acquisition features like analog and digital I/O in a small, stackable format.

Voltage Measurement HATs

MCC 118 is an eight-channel voltage measurement HAT. It allows users to measure 12-bit data at an overall throughput of 100 kS/s. Eight devices can be stacked on a single Raspberry Pi to create a 64-channel device capable of reading data at a combined rate of 320 kS/s.

MCC 128 features 16-bit resolution and includes eight analog inputs with a maximum sample rate of 100 kS/s. Multiple gains ranges are also included which provides users the ability to make precision measurements.

Voltage Output and Digital I/O HAT

MCC 152 provides two 12-bit analog outputs along with eight 5 V or 3.3 V DIO channels enabling the creation of a full multifunction Raspberry Pi measurement and control system.

Thermocouple Measurement HAT

MCC 134 is designed for temperature measurement applications and features four thermocouple input channels. A 24-bit A/D and cold junction compensation provide professional grade accuracy. Multiple thermocouple types are selectable on a per channel basis. MCC has a long history of designing and building accurate DAQ devices for measuring thermocouples. Thermocouples provide a low-cost and flexible way to measure temperature, but measuring thermocouples accurately is difficult. Through innovative design and extensive testing, MCC overcame the challenge of measuring thermocouples accurately in the uncontrolled Raspberry Pi environment.

IEPE Measurement HAT

MCC 172 is designed for sound and vibration applications and offers two IEPE inputs channels capable of measuring IEPE sensors like accelerometers



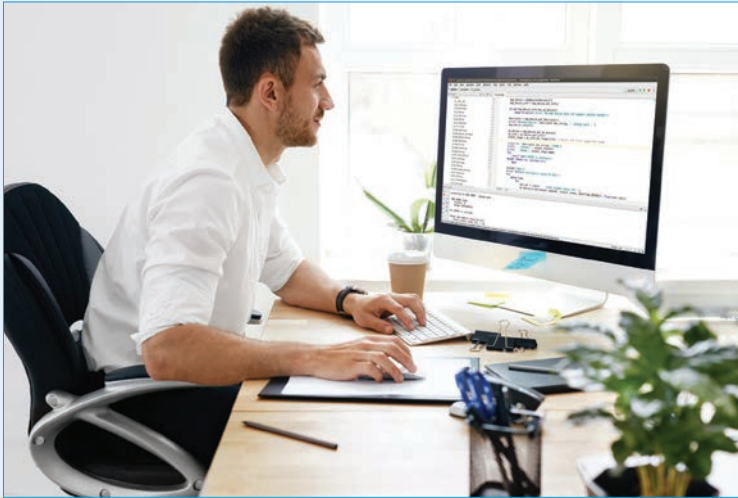
Up to eight MCC DAQ HATs can be stacked onto one Raspberry Pi. HATs are available with voltage inputs, thermocouple inputs, IEPE-based sensor inputs, analog outputs, and digital I/O, allowing users to configure multifunction, Raspberry Pi-based solutions.

and microphones without any additional signal conditioning. Inputs can be simultaneously sampled at up to 51.2 kS/s per channel.

DAQ HATs can be used in basic applications with just a few voltage input channels or more sophisticated applications with up to 64 channels of multiple signal types.



MCC 172
IEPE Measurement HAT for
Sound and Vibration Applications



MCC DAQ HATs come with software libraries that support Python™ and C/C++® to facilitate quick and easy development. Comprehensive API and hardware documentation are also provided. The DAQ HAT software library was created and is supported by MCC. The development repository is located on GitHub where users can find libraries, examples, firmware updates, and more: <https://github.com/mccdaq/daqhats>

MCC 118 – 12-Bit Voltage Measurement HAT		
Inputs	Sample Rate	Resolution
8 SE Analog	100 kS/s	12-Bit
MCC 128 – 16-Bit Voltage Measurement HAT		
Inputs	Sample Rate	Resolution
8 SE/4 DIFF Analog	100 kS/s	16-Bit
MCC 134 – Thermocouple Measurement HAT		
Inputs	Update Interval	Resolution
4 Thermocouple	1 Sec	24-Bit
MCC 152 – Voltage Output / DIO HAT		
Outputs	Digital I/O	Resolution
2 Analog	8	12-Bit
MCC 172 – IEPE Measurement HAT		
Inputs	Sample Rate	Resolution
2 IEPE	51.2 kS/s/ch	24-Bit

MCC DAQ HAT products provide high quality measurements so you don't have to compromise between accuracy and convenience.

Applications for Raspberry Pi DAQ

Raspberry Pi is a good fit for many DAQ applications. MCC DAQ HATs have been used in a variety of applications and industries. These applications can be lab-based, remote and IoT solutions, and OEM/ embedded systems. Some customer applications/ industry examples include, biomechanics, wind energy, power monitoring, machine condition monitoring, predictive maintenance, and more.



[AC Power Monitoring IoT Solution using MCC 118 with Raspberry Pi](#)

A mobile communications company used the MCC 118 to create an IoT solution to monitor and analyze the external city power being supplied to their facilities.



[Probe Permeameter Machine using MCC 118 and MCC 134 with Raspberry Pi](#)

RO Scientific used the MCC 118 voltage measurement HAT and the MCC 134 thermocouple measurement HAT in the design of a probe permeameter machine used in testing rock samples for the oil and gas industry.



[Machinery Monitoring and Predictive Maintenance using MCC 172 and MCC 134 with Raspberry Pi](#)

The MCC 172 IEPE measurement HAT and MCC 134 thermocouple measurement HAT are used to measure vibration and temperature respectively, and collect the data needed to create accurate measurements, analysis, and strategy.



[Neuromuscular Biomechanics Test System Using MCC 172 and Raspberry Pi](#)

The Raspberry Pi and MCC 172 allowed researchers to create a lightweight and wearable DAQ solution to measure dynamic activity for testing neuromuscular biomechanics.