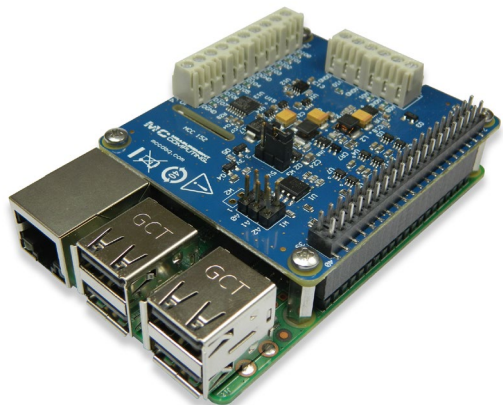


# MCC 152

## Voltage Output and DIO DAQ HAT for Raspberry Pi®



The MCC 152 is a 12-bit analog voltage output and digital input/output DAQ HAT. The MCC 152 is shown here connected to a Raspberry Pi (not included).

### Features

- Two 12-bit simultaneous voltage outputs
- 5 mA output drive, sourcing
- 0.8 V/ $\mu$ s slew rate
- Eight bidirectional digital bits
- 5V / 3.3V operation; CMOS input thresholds
- Programmable input polarity
- Screw terminal connections
- Stack up to eight MCC HATs onto a single Raspberry Pi

### Software

- MCC DAQ HAT Library; available on GitHub

### Supported Operating Systems

- Linux®/Raspbian

### Programming API

- C, C++, Python

### Overview

The MCC 152 is a voltage output and digital input/output HAT (Hardware Attached on Top) designed for use with Raspberry Pi, the most popular single-board computer on the market today.

A HAT is an add-on board with a 40W GPIO (general purpose input/output) connector that conforms to the Raspberry Pi HAT specification.

The MCC 152 HAT provides two analog outputs and eight digital I/O bits. Up to eight MCC HATs can be stacked onto one Raspberry Pi. With CMOS input thresholds, selectable voltage operation, and 5 V tolerance for the digital inputs, the digital channels support both 3.3 V and 5 V logic types.

### Raspberry Pi Interface

The MCC 152 header plugs into the 40-pin general purpose I/O (GPIO) connector on a user-supplied Raspberry Pi. The MCC 152 was tested for use with all Raspberry Pi models with the 40-pin GPIO connector.

### HAT configuration

HAT configuration parameters are stored in an on-board EEPROM that allows the Raspberry Pi to automatically set up the GPIO pins when the HAT is connected.

### Stackable HATs

Up to eight MCC HAT boards can be stacked onto a single Raspberry Pi. Users can mix and match MCC HAT models in the stack.

### Analog Voltage Output

The MCC 152 provides two 12-bit analog outputs with a 0 V to 5 V output range and 5 mA output drive, sourcing. Both outputs can be updated simultaneously with software.

### Digital I/O

The MCC 152 provides eight bidirectional digital bits.

Each digital bit is configurable for pull-up or pull-down, or can be disabled. Each output bit can source 10 mA and sink 25 mA.

Users can configure the software to generate an interrupt when the state of a digital input bit changes.

The MCC 152 can interface with 3.3 V or 5 V logic types; the voltage is selectable with an onboard jumper.

The input polarity is software programmable for normal (active high, default) or inverted logic (active low).

### Power

Power is provided by the Raspberry Pi through the GPIO header connector.

### MCC DAQ HAT Library

The open-source MCC DAQ HAT Library of commands in C/C++ and Python allows users to develop applications on the Raspberry Pi using Linux.

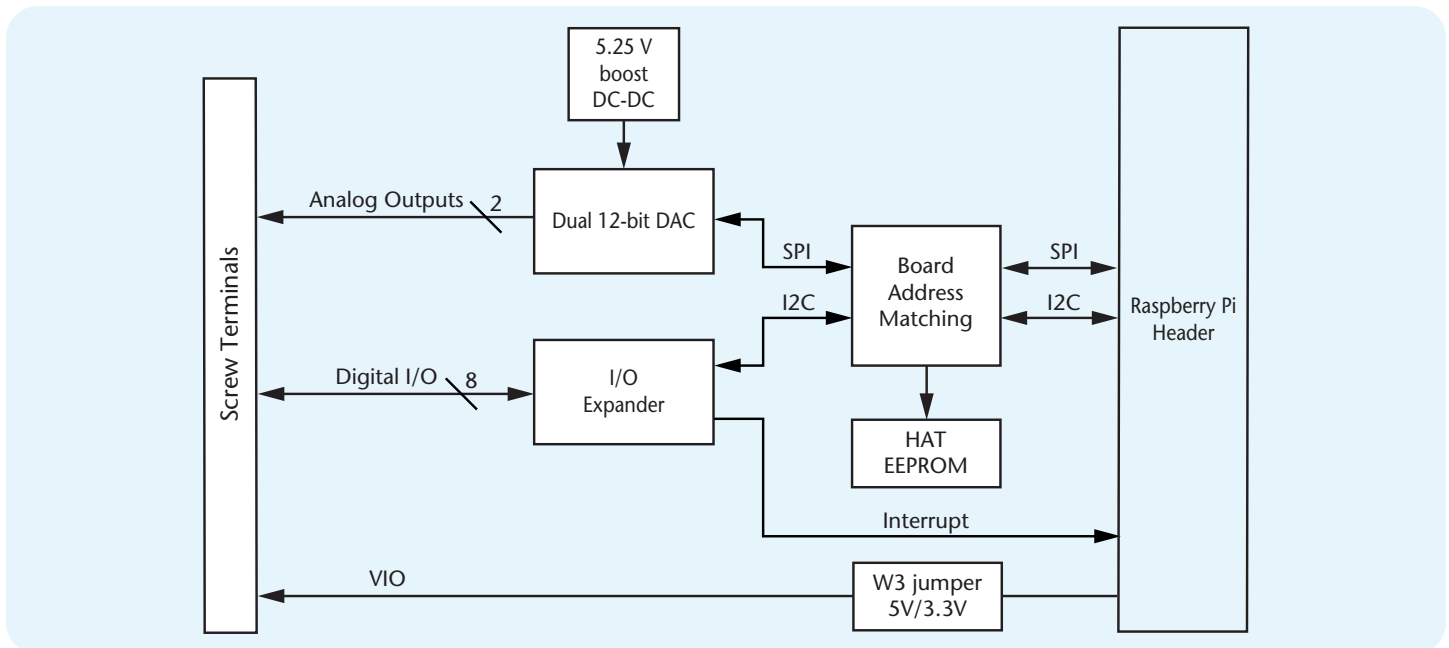
The library is available to download from [GitHub](#). Comprehensive API and hardware [documentation](#) is available.

The MCC DAQ HAT Library supports operation with multiple MCC DAQ HATs running concurrently.

Console-based example programs are available for each API.

# MCC 152

## Block Diagram and Example Programs



### MCC DAQ HAT Examples

The MCC DAQ HAT Library includes console-based example programs developed in C/C++ and Python that users can run to become familiar with the library and the MCC 152.

Each example includes a description and a list of the functions demonstrated in the program. An example is shown here.

Users can verify MCC 152 functionality out-of-the-box by running the **MCC 152 App** from the **MCC DAQ HAT Manager** utility program. This utility requires the Raspbian desktop interface, and is accessible from the Applications menu.

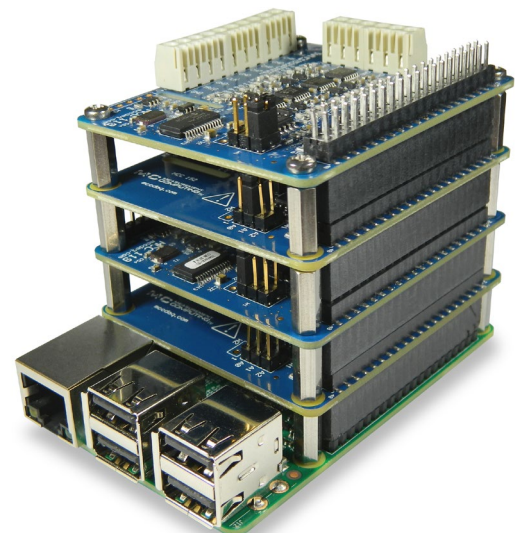
```
pi@janet_pi: ~/daqhats_dev/exam/~/mcc152/digital_output_write_bit - x
File Edit Tabs Help
MCC 152 digital output write example.
Sets all digital I/O channels to output then gets channel and
value input from the user and updates the output.
Functions demonstrated:
mcc152_dio_reset
mcc152_dio_output_write_bit
mcc152_dio_config_write_bit
mcc152_info

Using address 1.
Enter a channel between 0 and 7, non-numeric character to exit: 4
Enter the output value, 0 or 1, non-numeric character to exit: 1
Enter a channel between 0 and 7, non-numeric character to exit:
```

*Ready-to-run examples are included with the DAQ HAT library*

### Stackable

Connect up to eight MCC DAQ HATs onto a single Raspberry Pi. Onboard jumpers identify each board in the stack.



### Specifications

All specifications are subject to change without notice.  
Typical for 25 °C unless otherwise specified.

#### Analog output

**Resolution:** 12 bits, 1 in 4,096  
**Output range:** 0 V to 5.0 V  
**Number of channels:** 2  
**Write time:** 12  $\mu$ s, typ  
**Power on and reset voltage (Initializes to 000h code):** 0 V,  $\pm$ 10 mV  
**Output drive (each D/A OUT):** 5 mA, sourcing  
**Slew rate:** 0.8 V/ $\mu$ s typ  
**Differential nonlinearity:**  $\pm$ 0.25 LSB max  
**Zero-scale error<sup>1</sup> (000h code):** 2 mV typ, 10 mV max  
**Full-scale error<sup>2</sup> (FFFh code):** -0.1 % of FSR typ,  $\pm$ 1 % of FSR max  
**Offset error<sup>2</sup>:**  $\pm$ 1 mV typ,  $\pm$ 10 mV max  
**Gain error<sup>2</sup>:**  $\pm$ 1.5 % of FSR max

#### Digital input/output

**Digital input type:** CMOS  
**Number of I/O:** 8  
**Configuration:** Each bit may be configured as input (power on default) or output  
**Pull-up configuration:** Each bit has a programmable 100 k $\Omega$  pull resistor (50 to 150 k $\Omega$  range) that may be programmed as pull-up (power on default), pull-down, or disabled. The pull-up/down resistors are disabled on outputs when in open-drain mode.  
**DIO supply voltage (VIO):** 5 V or 3.3 V, selectable with jumper W3 (factory default is 5 V.)  
**Port read time:** 400  $\mu$ s typ  
**Port write time:** 500  $\mu$ s typ  
**Interrupt functionality:** Each bit may be configured to generate an interrupt on change when in input mode.  
**Input low voltage threshold:**  $0.3 \times$  VIO V max  
**Input high voltage threshold:**  $0.7 \times$  VIO V min  
**Input voltage limits** (both 3.3 V and 5 V modes)  
6.5 V absolute max<sup>3</sup>, -0.5 V absolute min  
**Input voltage recommended range**  
5 V mode: 5.5 V max, 0 V min  
3.3 V mode: 3.8 V max<sup>3</sup>, 0 V min  
**Output type:** CMOS, entire port may be configured as push-pull or open-drain.

1 Zero-scale error may result in a “dead-band” digital input code region. In this case, changes in requested output voltage may not produce a corresponding change in the output voltage when the voltage is less than 10 mV. The offset error is tested and specified at 10 mV.

2 Error tested at no load.

3 When VIO is 3.3 V the input will tolerate voltages up to 6.5 V, but the voltage must be current-limited or it will change the VIO voltage due to current flowing into the MCC 152. An external current limiting resistor of 700  $\Omega$  or larger is recommended on each input that is higher than 3.3 V when the W3 jumper is in the 3.3 V position.

**High level output current:** 10 mA max<sup>4</sup>

**Low level output current:** 25 mA max

#### Output high voltage

VIO = 3.3 V: 2.5 V min (IOH = -10 mA)

VIO = 5 V: 4.0 V min (IOH = -10 mA)

#### Output low voltage

VIO = 3.3 V: 0.25 V max (IOL = 10 mA)

VIO = 5 V: 0.2 V max (IOL = 10 mA)

#### Memory

**Non-volatile memory:** 4 KB (ID and serial storage, no user-modifiable memory)

#### Power

##### Supply current, 5V supply

Typical, 5V DIO selection: 15 mA

Maximum, 5V DIO selection: 35 mA<sup>5,6</sup>

Typical, 3.3V DIO selection: 10 mA

Maximum, 3.3V DIO selection: 12 mA<sup>5</sup>

##### Supply current, 3.3V supply<sup>4</sup>

Typical, 5V DIO selection: 0.01 mA

Maximum, 5V DIO selection: 6 mA

Typical, 3.3V DIO selection: 3.5 mA

Maximum, 3.3V DIO selection: 11 mA<sup>5</sup>

#### Interface specifications

##### Raspberry Pi GPIO pins used

GPIO 8, GPIO 10, GPIO 11 (SPI interface)

GPIO 2, GPIO 3 (I2C interface)

ID\_SD, ID\_SC (ID EEPROM)

GPIO 12, GPIO 13, GPIO 26, (Board address)

GPIO 21 (Interrupt)

##### Data interface type

SPI slave device, CE0 chip select (Analog output)

I2C slave device (Digital I/O)

##### SPI mode: 1

**SPI clock rate:** 50 MHz max

**I2C address:** 0x20 to 0x27, depending on board address jumper setting

**I2C clock rate:** 400 kHz max

#### Environmental

**Operating temperature range:** 0 °C to 55 °C

**Storage temperature range:** -40 °C to 85 °C

**Humidity:** 0% to 90% non-condensing

#### Mechanical

**Dimensions (L  $\times$  W  $\times$  H):** 65  $\times$  56.5  $\times$  12 mm (2.56  $\times$  2.22  $\times$  0.47 in.) max

4 The power consumed by all DAQ HATs must be within the capacity of the Raspberry Pi power supply. Extra care must be taken with sourcing 3.3 V loads since they are supplied by the regulator on the Raspberry Pi; MCC recommends using the 5V DIO selection when sourcing large load currents such as LEDs.

5 This specification doesn't include user loading on analog outputs.

6 This specification doesn't include user loading on digital outputs or the I/O terminal.

## Order Information

### Hardware

Part No.	Description
MCC 152	12-bit voltage output DAQ HAT. Raspberry Pi model with the 40-pin GPIO connector required.

### Software

Part No.	Description
MCC DAQ HAT Library	Open-source library for developing applications in C, C++, and Python on Linux for MCC DAQ HAT devices; available for download on GitHub at <a href="https://github.com/mccdaq/mcchats">https://github.com/mccdaq/mcchats</a> .