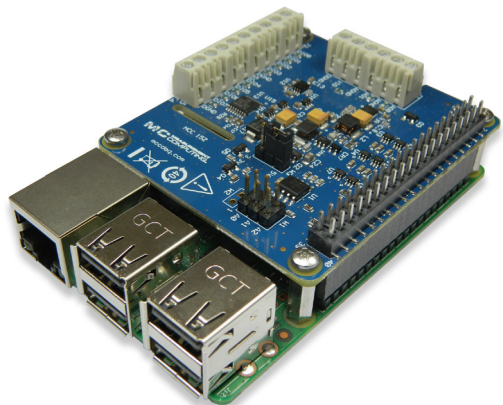


# MCC 152

## 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 Raspberry Pi 3 A+, 3 B+, 3, 2, and A+ models.

### 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.

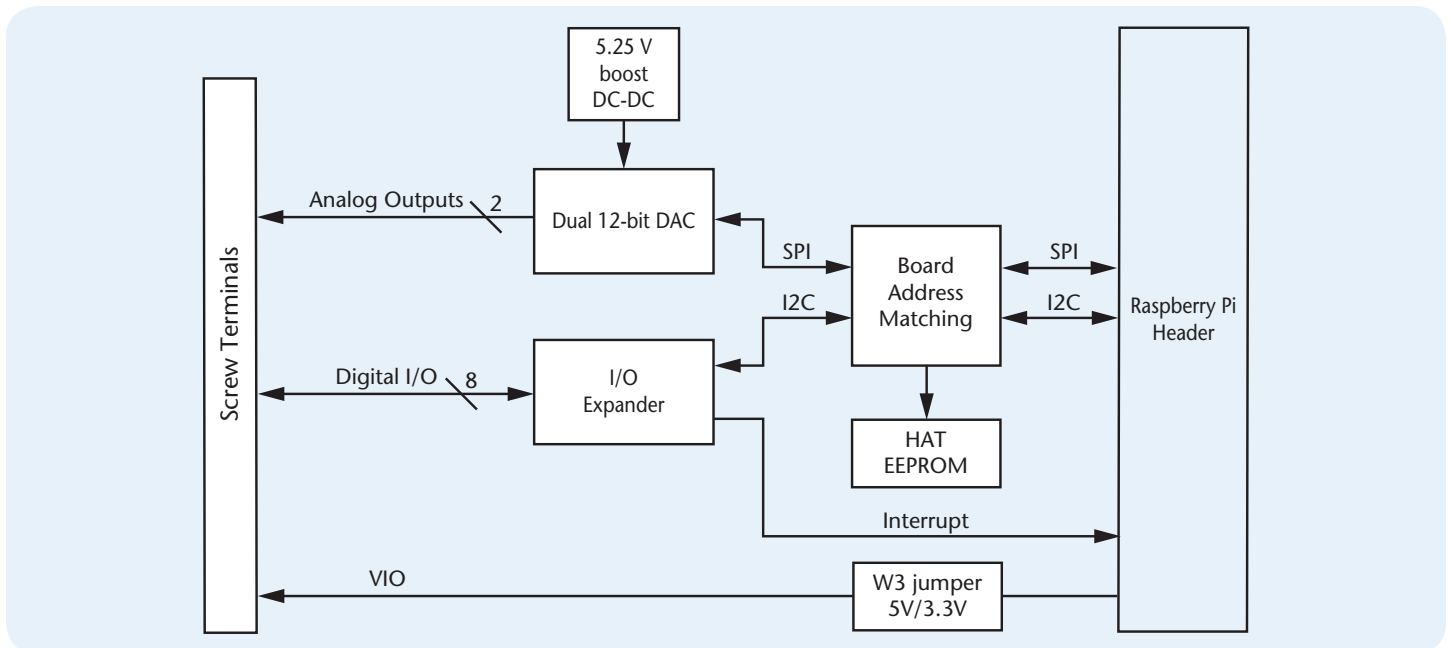
The library is available to download from [GitHub](#). Comprehensive API and hardware [documentation](#) is available.

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.

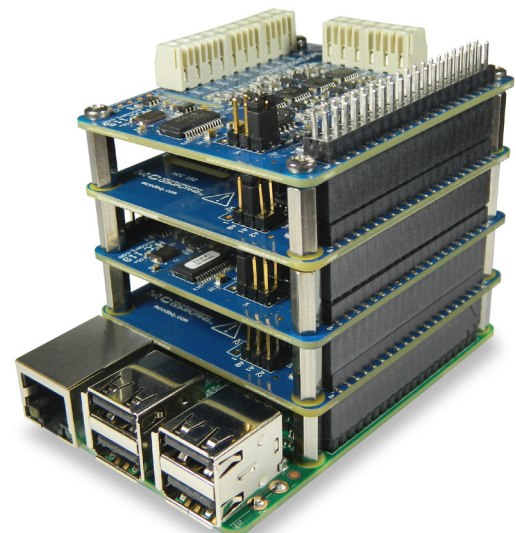
```
pi@janet_pi: ~/daqhats_dev/exam/~/mcc152/digital_output_write_bit - x
File Edit Tabs Help
MCC 152 digital output write example.
Sets all digital I/O channels to output then gets channel and
value input from the user and updates the output.
Functions demonstrated:
mcc152_dio_reset
mcc152_dio_output_write_bit
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 3.3V 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 3.3V 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 x W x H):

65 x 56.5 x 12 mm (2.56 x 2.22 x 0.47 in.) max

##### Footnote 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 3.3V 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.

##### Footnote 5:

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

##### Footnote 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 A+, 2, 3 or later 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> .