I2cDiscreteIoExpander

v3.0.0

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Contents

1 Arduino library for TI PCF8575C 16-bit I2C I/O expander.

Version

3.0.0

Date

13 Sep 2016

Source Code Repository

https://github.com/4-20ma/I2cDiscreteIoExpander

Programming Style Guidelines

http://geosoft.no/development/cppstyle.html

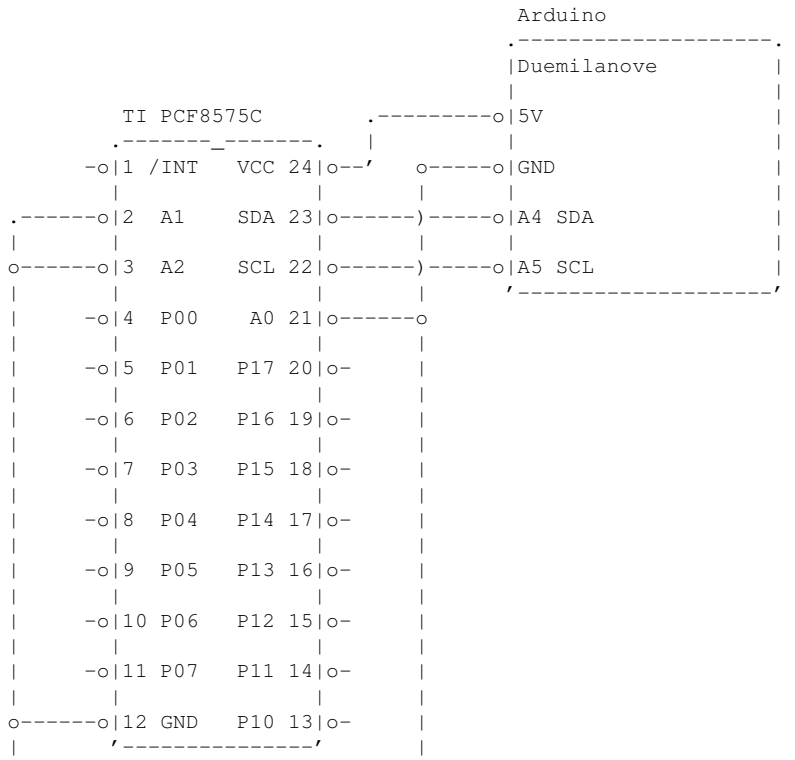
Features

The PCF8575C provides general-purpose remote I/O expansion for most microcontroller families via the I2C interface serial clock (SCL) and serial data (SDA).

The device features a 16-bit quasi-bidirectional input/output (I/O) port (P07..P00, P17..P10), including latched outputs with high-current drive capability for directly driving LEDs. Each quasi-bidirectional I/O can be used as an input or output without the use of a data-direction control signal. At power on, the I/Os are in 3-state mode. The strong pullup to VCC allows fast-rising edges into heavily loaded outputs. This device turns on when an output is written high and is switched off by the negative edge of SCL. The I/Os should be high before being used as inputs. After power on, as all the I/Os are set to 3-state, all of them can be used as inputs. Any change in setting of the I/Os as either inputs or outputs can be done with the write mode. If a high is applied externally to an I/O that has been written earlier to low, a large current (IOL) flows to GND.

The fixed I2C address of the PCF8575C (0x20) is the same as the PCF8575, PCF8574, PCA9535, and P↩ CA9555, allowing up to eight of these devices, in any combination, to share the same I2C bus or SMBus.

Schematic



Caveats

Arduino 1.0 or later is required.

Support

Please submit an issue for all questions, bug reports, and feature requests. Email requests will be politely redirected to the issue tracker so others may contribute to the discussion and requestors get a more timely response.

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2 Optional Functions List (Troubleshooting)

Member I2cDiscreteIoExpander::getAddress ()

This function is for testing and troubleshooting.

3 Required Functions List

Member I2cDiscreteIoExpander::digitalRead ()

Call this from within `loop()` in order to read from device.

Member I2cDiscreteIoExpander::digitalWrite (uint16_t)

Call this from within `loop()` in order to write to device.

Member I2cDiscreteIoExpander::getPorts ()

Call this from within `loop()` to retrieve ports.

Member I2cDiscreteIoExpander::I2cDiscreteIoExpander (uint8_t)

Call this to construct I2cDiscreteIoExpander object.

4 Class Index

4.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

5 Class Documentation

5.1 I2cDiscreteIoExpander Class Reference

Public Member Functions

- I2cDiscreteIoExpander (uint8_t)
  Constructor.
- uint8_t digitalRead ()
  Retrieve discrete values from device.
- uint8_t digitalWrite (uint16_t)
  Write discrete values to device.
- uint8_t getAddress ()
  Retrieve device address.
- uint16_t getPorts ()
  Retrieve ports 1 (P17..P10), 0 (P07..P00).
- void enableBitwiseInversion ()
  Enable bitwise inversion.
- void disableBitwiseInversion ()
  Disable bitwise inversion.
- bool isInverted ()
  Indicate whether bitwise inversion is enabled.

Private Attributes

- uint8_t address_
  Device address as defined by pins A2, A1, A0.
- uint16_t ports_
  Storage object for I2cDiscreteIoExpander ports 1 (P17..P10), 0 (P07..P00).
- bool shouldInvert_
  Flag indicating whether bits are to be inverted before read/write (false=don't invert, true=invert).

Static Private Attributes

- static const uint8_t BASE_ADDRESS_ = 0x20
  Factory pre-set slave address.

Related Functions

(Note that these are not member functions.)

- static const uint8_t TWI_SUCCESS = 0

  I2C/TWI success (transaction was successful).
- static const uint8_t TWI_DEVICE_NACK = 2

  I2C/TWI device not present (address sent, NACK received).
- static const uint8_t TWI_DATA_NACK = 3

  I2C/TWI data not received (data sent, NACK received).
- static const uint8_t TWI_ERROR = 4

  I2C/TWI other error.

5.1.1 Detailed Description

Examples:

examples/BareMinimum/BareMinimum.ino, and examples/MultipleDevices/MultipleDevices.ino.

5.1.2 Constructor & Destructor Documentation

5.1.2.1 I2cDiscreteIoExpander()

```
I2cDiscreteIoExpander::I2cDiscreteIoExpander (
            uint8_t address )
```

Constructor.

Assigns device address, resets storage object, enables bitwise inversion.

Required Function Call this to construct I2cDiscreteIoExpander object.

Usage:

```
...
I2cDiscreteIoExpander exampleA(1);             // device with address 1
I2cDiscreteIoExpander exampleB[2] = { 2, 3 };  // devices with addresses 2, 3
I2cDiscreteIoExpander exampleC[2] = { I2cDiscreteIoExpander(4),
      I2cDiscreteIoExpander(5) }; // alternate constructor syntax; devices with addresses 4,
       5
I2cDiscreteIoExpander exampleD[8] = { 0, 1, 2, 3, 4, 5, 6, 7 }; // addresses 0..7
...
```

This is an overloaded member function, provided for convenience. It differs from the above function only in what argument(s) it accepts.

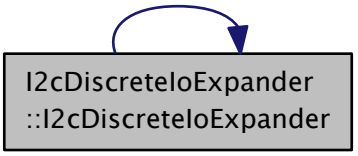
Assigns device address, resets storage object, enables bitwise inversion.

Usage:

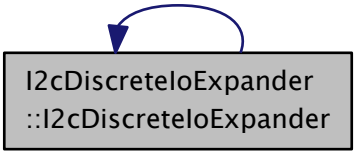
```
...
I2cDiscreteIoExpander device;        // implies device address 0
...
```

```
44 {
45   address_ = address & 0b111;
46   ports_ = 0;
47   shouldInvert_ = true;
48 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



5.1.3 Member Function Documentation

5.1.3.1 digitalRead()

`uint8_t I2cDiscreteIoExpander::digitalRead ( )`

Retrieve discrete values from device.

Required Function Call this from within `loop()` in order to read from device.

Return values

0	success
1	length too long for buffer
2	address send, NACK received **(device not on bus)**
3	data send, NACK received
4	other twi error (lost bus arbitration, bus error, ...)

Usage:

```
...
I2cDiscreteIoExpander device;
...
uint8_t status = device.digitalRead();
if (TWI_SUCCESS == status)
{
  // do something with device.getPorts()
}
...
```

Examples:

examples/BareMinimum/BareMinimum.ino, and examples/MultipleDevices/MultipleDevices.ino.

```
88 {
89   uint8_t hi, lo, status;
90
91   Wire.beginTransmission(BASE_ADDRESS_ | address_);
92   status = Wire.endTransmission();
93
94   if (TWI_SUCCESS == status)
95   {
96     if (Wire.requestFrom(BASE_ADDRESS_ | address_, 2) == 2)
97     {
98       lo = Wire.read();
99       hi = Wire.read();
100       ports_ = shouldInvert_ ? word(~hi, ~lo) : word(hi, lo);
101     }
102     else
103     {
104       return TWI_ERROR;
105     }
106   }
107
108   return status;
109 }
```

5.1.3.2 digitalWrite()

```
uint8_t I2cDiscreteIoExpander::digitalWrite (
              uint16_t ports )
```

Write discrete values to device.

Required Function Call this from within `loop()` in order to write to device.

Parameters

ports	word to be written to device (0x0000..0xFFFF)

Return values

0	success
1	length too long for buffer
2	address send, NACK received **(device not on bus)**
3	data send, NACK received
4	other twi error (lost bus arbitration, bus error, ...)

Usage:

```
...
I2cDiscreteIoExpander device;
...
uint8_t status = device.digitalWrite(0xFFFF);
if (TWI_SUCCESS == status)
{
  // do something
}
...
```

Examples:

examples/BareMinimum/BareMinimum.ino, and examples/MultipleDevices/MultipleDevices.ino.

```
133 {
134   ports_ = shouldInvert_ ? ~ports : ports;
135   Wire.beginTransmission(BASE_ADDRESS_ | address_);
136   Wire.write(lowByte(ports_));
137   Wire.write(highByte(ports_));
138   // Wire.write(lowByte(shouldInvert_ ? ~ports_ : ports_));
139   // Wire.write(highByte(shouldInvert_ ? ~ports_ : ports_));
140
141   return Wire.endTransmission();
142 }
```

5.1.3.3 getAddress()

```
uint8_t I2cDiscreteIoExpander::getAddress ( )
```

Retrieve device address.

Optional Function (Troubleshooting) This function is for testing and troubleshooting.

Returns

address of device (0..7)

Usage:

```
...
I2cDiscreteIoExpander device;
...
address = device.getAddress();
...
```

Examples:

examples/BareMinimum/BareMinimum.ino.

```
157 {
158   return address_;
159 }
```

5.1.3.4 getPorts()

```
uint16_t I2cDiscreteIoExpander::getPorts ( )
```

Retrieve ports 1 (P17..P10), 0 (P07..P00).

Required Function Call this from within `loop()` to retrieve ports.

Returns

ports of device (0x0000..0xFFFF)

Usage:

```
...
I2cDiscreteIoExpander device;
...
ports = device.getPorts();
...
```

Examples:

examples/BareMinimum/BareMinimum.ino.

```
174 {
175   return ports_;
176 }
```

5.1.3.5 enableBitwiseInversion()

```
void I2cDiscreteIoExpander::enableBitwiseInversion ( )
```

Enable bitwise inversion.

All bits will be inverted prior to future read/write operations.

Usage:

```
...
I2cDiscreteIoExpander device;
...
device.enableBitwiseInversion();      // bits will now inverted
...
```

See also

I2cDiscreteIoExpander::disableBitwiseInversion()
I2cDiscreteIoExpander::isInverted()

```
192 {
193   ports_ = shouldInvert_ ? ports_ : ~ports_;
194   shouldInvert_ = true;
195 }
```

5.1.3.6 disableBitwiseInversion()

```
void I2cDiscreteIoExpander::disableBitwiseInversion ( )
```

Disable bitwise inversion.

Bits will not be inverted prior to future read/write operations.

Usage:

```
...
I2cDiscreteIoExpander device;
...
device.disableBitwiseInversion();     // bits will no longer be inverted
...
```

See also

I2cDiscreteIoExpander::enableBitwiseInversion()
I2cDiscreteIoExpander::isInverted()

```
211 {
212   ports_ = shouldInvert_ ? ~ports_ : ports_;
213   shouldInvert_ = false;
214 }
```

5.1.3.7 isInverted()

```
bool I2cDiscreteIoExpander::isInverted ( )
```

Indicate whether bitwise inversion is enabled.

Returns

status of bitwise inversion (false=not inverted, true=inverted)

Usage:

```
...
I2cDiscreteIoExpander device;
...
if (device.isInverted())
{
  // do something
}
...
```

See also

I2cDiscreteIoExpander::enableBitwiseInversion()
I2cDiscreteIoExpander::disableBitwiseInversion()

```
233 {
234   return shouldInvert_;
235 }
```

The documentation for this class was generated from the following files:

- I2cDiscreteIoExpander.h
- I2cDiscreteIoExpander.cpp

6 Example Documentation

6.1 examples/BareMinimum/BareMinimum.ino

```
/*

  BareMinimum.ino - example using I2cDiscreteIoExpander library

  Library:: I2cDiscreteIoExpander
  Author:: Doc Walker <4-20ma@wvfans.net>

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  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
```

```
  See the License for the specific language governing permissions and
  limitations under the License.

*/


#include <Wire.h>
#include <I2cDiscreteIoExpander.h>


// instantiate I2cDiscreteIoExpander object
I2cDiscreteIoExpander device;


void setup()
{
  // initialize i2c interface
  Wire.begin();

  // initialize serial interface
  Serial.begin(19200);
}


void loop()
{
  uint8_t status;
  static uint16_t i;

  // display device information on serial console
  Serial.print("Loop ");
  Serial.print(++i, DEC);
  Serial.print(", address ");
  Serial.print(device.getAddress(), DEC);
  Serial.print(", ");

  // attempt to write 16-bit word
  status = device.digitalWrite(i);
  if (TWI_SUCCESS == status)
  {
    // display success information on serial console
    Serial.print("write 0x");
    Serial.print(i, HEX);
    Serial.print(", ");
  }
  else
  {
    // display error information on serial console
    Serial.print("write error ");
    Serial.print(status, DEC);
    Serial.print(", ");
  }

  // attempt to read 16-bit word
  status = device.digitalRead();
  if (TWI_SUCCESS == status)
  {
    // display success information on serial console
    Serial.print("read 0x");
    Serial.print(device.getPorts(), HEX);
    Serial.println(".");
  }
  else
  {
    // display error information on serial console
    Serial.print("read error ");
    Serial.print(status, DEC);
    Serial.println(".");
  }

  delay(1000);
}
```

6.2 examples/MultipleDevices/MultipleDevices.ino

```
/*
```

```
  MultipleDevices.ino - example using I2cDiscreteIoExpander library

  Library:: I2cDiscreteIoExpander
  Author:: Doc Walker <4-20ma@wvfans.net>

  Copyright:: 2009-2016 Doc Walker

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  limitations under the License.

*/


#include <Wire.h>
#include <I2cDiscreteIoExpander.h>


// instantiate I2cDiscreteIoExpander objects
// device addresses purposely out of order to illustrate constructor
I2cDiscreteIoExpander device[8] = { 6, 4, 2, 0, 1, 3, 5, 7 };


void setup()
{
  // initialize i2c interface
  Wire.begin();

  // initialize serial interface
  Serial.begin(19200);
}


void loop()
{
  uint8_t status, i;
  static uint16_t j;

  // loop to write/read each device
  for (i = 0; i < 8; i++)
  {
    // display device information on serial console
    Serial.print("Loop ");
    Serial.print(j, DEC);
    Serial.print(", device[");
    Serial.print(i, DEC);
    Serial.print("], address ");
    Serial.print(device[i].getAddress(), DEC);
    Serial.print(", ");

    // attempt to write 16-bit word
    status = device[i].digitalWrite(j);
    if (TWI_SUCCESS == status)
    {
      // display success information on serial console
      Serial.print("write 0x");
      Serial.print(j, HEX);
      Serial.print(", ");
    }
    else
    {
      // display error information on serial console
      Serial.print("write error ");
      Serial.print(status, DEC);
      Serial.print(", ");
    }

    // attempt to read 16-bit word
    status = device[i].digitalRead();
    if (TWI_SUCCESS == status)
    {
      // display success information on serial console
      Serial.print("read 0x");
```

```
      Serial.print(device[i].getPorts(), HEX);
      Serial.println(".");
    }
    else
    {
      // display error information on serial console
      Serial.print("read error ");
      Serial.print(status, DEC);
      Serial.println(".");
    }
  }

  j++;
  Serial.println("- - - - - - - - - - - - - - - - - - - - - -");
  delay(1000);
}
```

Index