Arduino PMBus

Power System Prototyping

by

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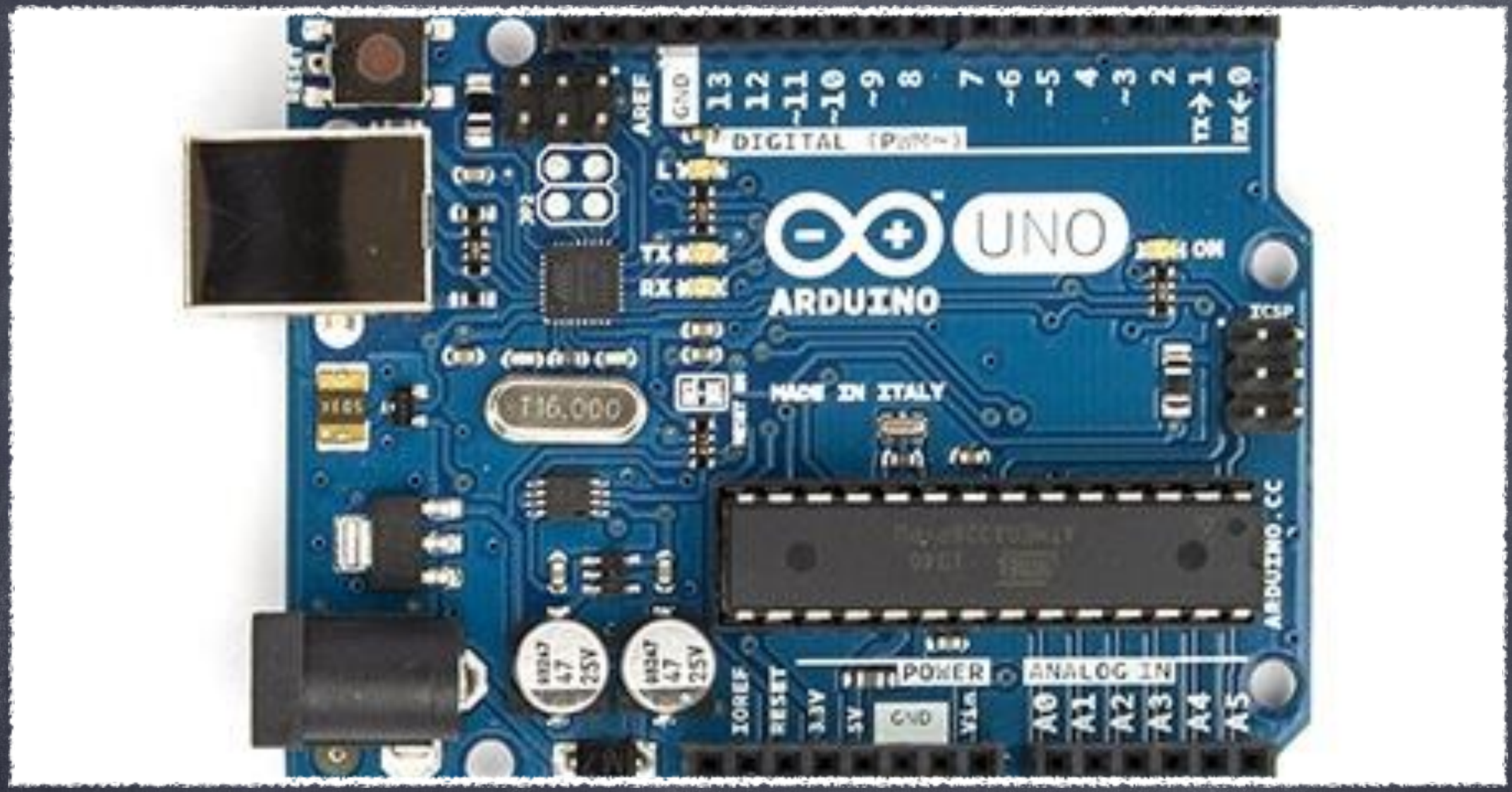
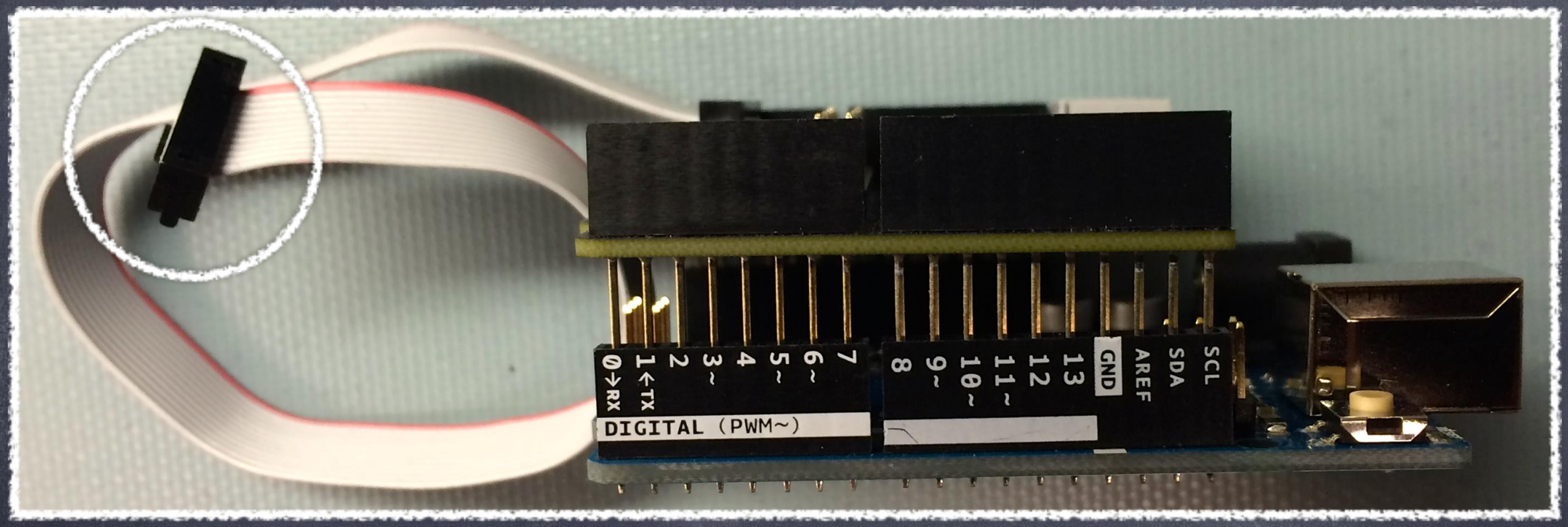
Topics

- What is Arduino?
- How do I connect my PMBus devices?
- Is there a PMBus API I can use?
- How do I organize the code for an API?
- Can it handle block commands and PEC?
- Examples
- Cool Stuff
- Getting Started


AREF
GND
DIGITAL (PWM~)
UNO
ARDUINO
MADE IN ITALY
ICSP
POWER
ANALOG IN
IOREF
RESET
3.3V
5V
GND
A0
A1
A2
A3
A4
A5
ARDUINO.CC

Arduino Uno



Connecting

Wires or Shield and Cable

Connecting

- Long cables add capacitance and/or inductance
- Capacitance limits bus speed
- Inductance and bus accelerators cause communication errors
- Isolation may be desired to break ground loops and protect laptop

PMBus API?

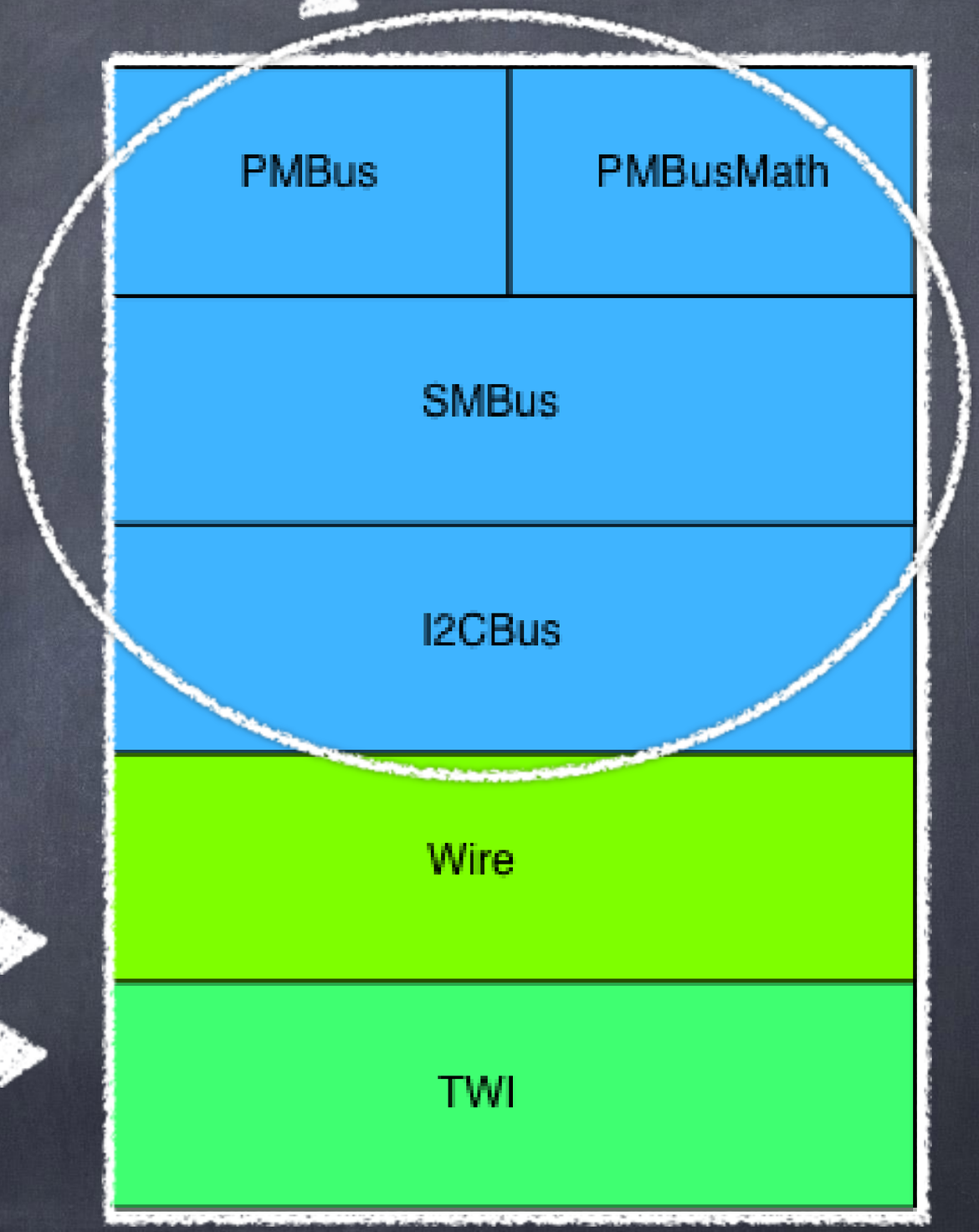
- Arduino has an I2C library, but…
- Arduino does not have SMBus or PMBus API
- Arduino hardware does support SMBus and PMBus protocol

Code Organization

- Layers are your friend
- Makes code portable
- Enables reuse
- Eases maintenance

Example Layers

Missing



Arduino Libraries

Arduino Challenges

- Block read/write limited to 32 bytes
- Block API count limited to byte
- TWI not quite an I2C API
- 2K RAM

TWI/Wire Patching

- Pass in buffer for block commands
  - Only use buffer size required
  - Allow deletion of buffer after use
- Allow larger count

Wire Code Changes

Original

Fixed Size

```
#define BUFFER_LENGTH 32

class TwoWire : public Stream
{
  private:
    static uint8_t rxBuffer[];
    static uint8_t rxBufferIndex;
    static uint8_t rxBufferLength;


uint8_t requestFrom(uint8_t address,
                    uint8_t quantity,
                    uint8_t sendStop
                   );
```

8bit

Modifed

Dynamic Size

```
class TwoWire
{
  private:
        static uint8_t* commBuffer;
    static uint16_t commBufferIndex;
    static uint16_t commBufferLength;


uint8_t requestFrom(uint8_t address,
                    uint8_t* acceptBuffer,
                    uint16_t quantity,
                    uint8_t sendStop
                   );
```

16bit

I2C/SMBus/PMBus Layers

- SMBus Layer adds:
  - SMB Alert
  - Wait for ACK
  - Bus probe
  - PEC support
- PMBus Layer adds:
  - set commands
  - read commands
  - Hides command codes
  - Data conversion

SMBus API

readAlert
writeByte
writeBytes
readByte
writeWord
readWord
writeBlock
writeReadBlock
readBlock
sendByte
waitForAck
probe

PMBus API

```
void setVoutWithPage(uint8_t address,   //!< Slave address
                     float voltage,     //!< Voltage
                     uint8_t page           //!< PAGE PLUS PAGE
                    );

void setVout(uint8_t address,    //!< Slave address
             float voltage       //!< Output voltage
            );

void setVoutWithSupervisionWithPage(uint8_t address,          //!< Slave address
                                    float voltage,        //!< Voltage
                                    float margin_percent,   //!< Amount to margin
                                    float warn_percent,     //!< Amount of warning limit
                                    float fault_percent,    //!< Amount of fault limit
                                    uint8_t page                //!< PAGE PLUS PAGE
                                   );

void setVoutWithSupervision(uint8_t address,          //!< Slave address
                            float voltage,        //!< Voltage
                            float margin_percent,  //!< Amount to margin
                            float warn_percent,       //!< Amount of warning limit
                            float fault_percent   //!< Amount of fault limit
                            );
```

PMBus Code

```
void LT_PMBus::setVout(uint8_t address, float voltage)
{
	uint16_t vout;

	LT_PMBusMath::lin16_t exp;
	exp = (int8_t)(smbus_.readByte(address, VOUT_MODE) & 0x1F);
	vout = math_.float_to_lin16(voltage, exp);

	smbus_.writeWord(address, VOUT_COMMAND, vout);
}
```

Generic code has cost

Programmers like float

What should application code look like?

```
void print_all_voltages()
{
  float   voltage;
  uint8_t page;

  for (page = 0; page < 2; page++)
  {
    pmbus->setPage(ltc3880_i2c_address, page);
    voltage = pmbus->readVout(ltc3880_i2c_address, false);
    Serial.print(F("LTC3880 VOUT "));
    Serial.println(voltage, DEC);
  }
}
```

Hide the details

What can C++ do?

```
case 2:
      pmbus->enablePec(ltc3880_i2c_address);
      pmbus->enablePec(ltc2974_i2c_address);
      pmbus->enablePec(ltc2977_i2c_address);
   delete smbus;
   delete pmbus;
      smbus = new LT_SMBusPec();
      pmbus = new LT_PMBus(smbus);
      break;
  case 3:
      pmbus->disablePec(ltc3880_i2c_address);
      pmbus->disablePec(ltc2974_i2c_address);
      pmbus->disablePec(ltc2977_i2c_address);
delete smbus;
delete pmbus;
      smbus = new LT_SMBusNoPec();
      pmbus = new LT_PMBus(smbus);
      break;
```

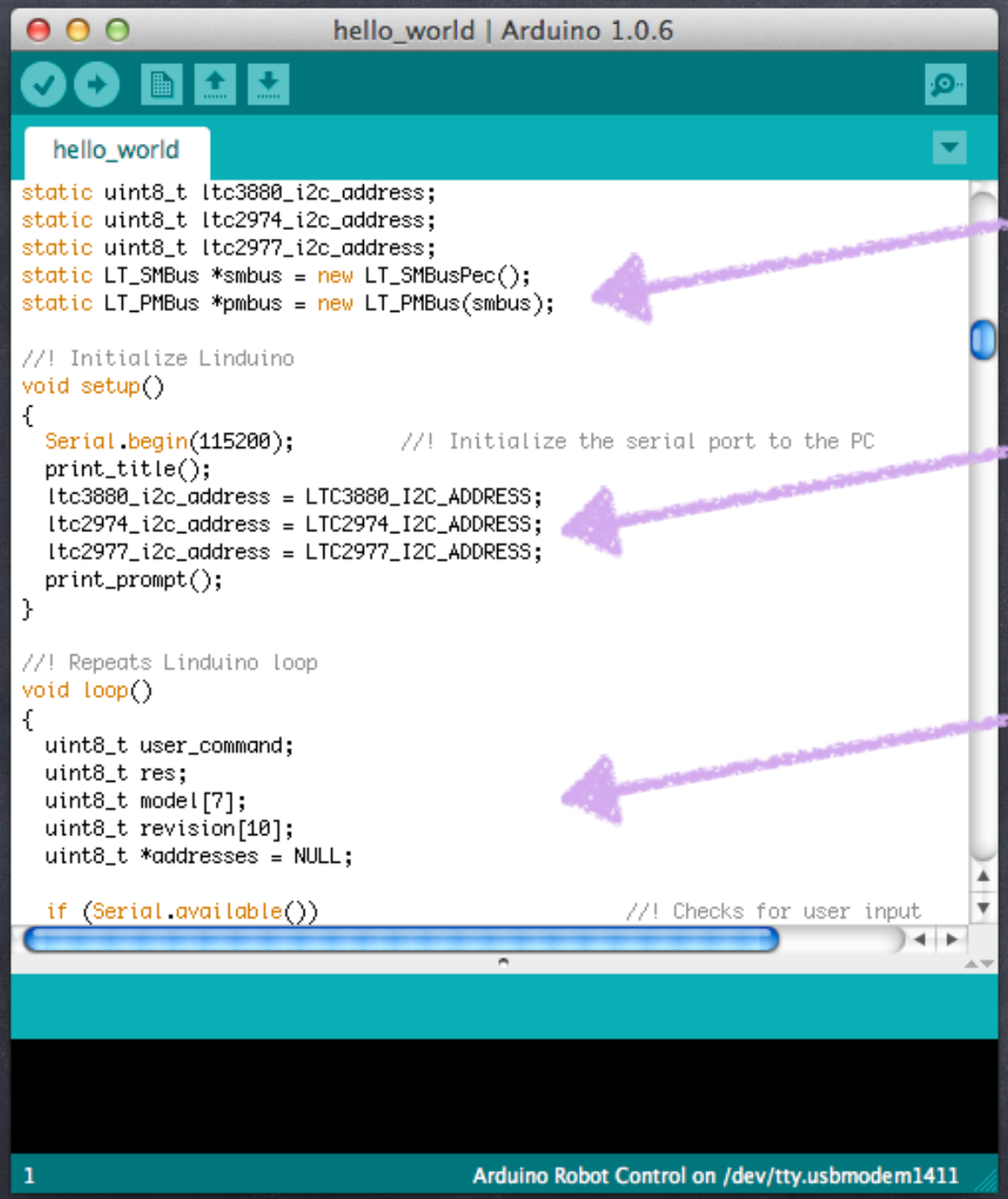
Change slave

Change master

API unaffected by PEC mode

What is a Sketch?

- Application code with main(…)
- Example to study and copy
- Cool tool…



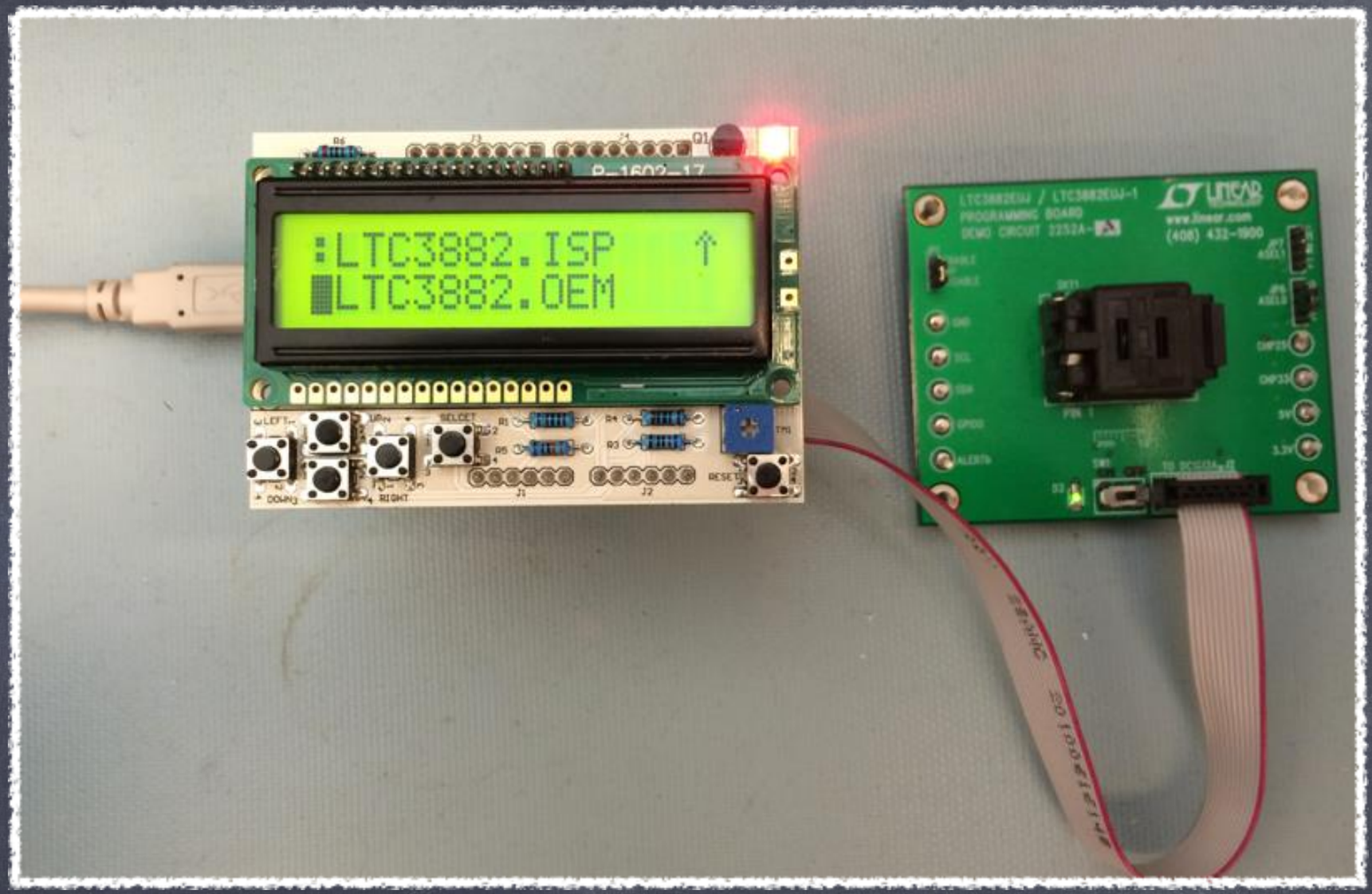
Init statics

Called once

Runs forever

Sketch

Arduino Sketch Editor with PMBus Code



Cool Stuff

Device EEPROM Programmer

“Classic engineering relies on a strict process for getting from A to B; the Arduino Way delights in the possibility of getting lost on the way and finding C instead.”

–Arduino Way

How to Get Lost…

http://arduino.cc/en/Guide/HomePage

http://www.linear.com/linduino