

CO2-Ampel

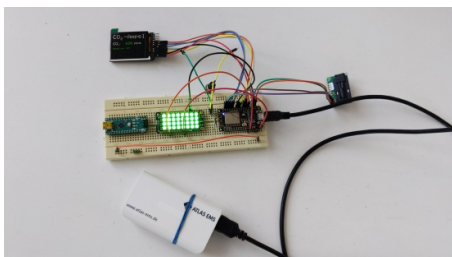
Quellen

Grundlagen und Projekthintergrund

- <https://www.heise.de/select/make/2020/5/2022015381334973804> MAKE Artikel zum Thema CO2-Ampel und die Grundlage meines Bastelprojektes
- https://www.heise.de/select/make/2020/5/softlink/xyrg?wt_mc=pred.red.make.make052020.010.softlink.softlink Downloads und weitere Informationen zum MAKE Artikel
- <https://www.umwelt-campus.de/forschung/projekte/iot-werkstatt> Webseite der IoT-Werkstatt
- <https://www.umwelt-campus.de/forschung/projekte/iot-werkstatt/ideen-zur-corona-krise-1> Hintergrundinformationen zum Projekt CO2-Ampel der IoT-Werkstatt

Informationen zur verwendeten Technik

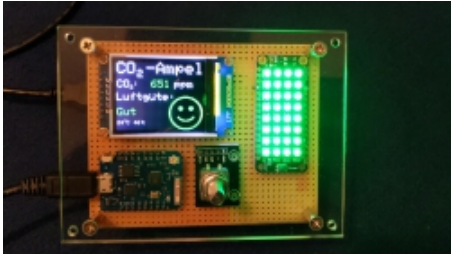
- <https://joy-it.net/de/products/SBC-NodeMCU> Der verwendete Mikrocontroller
- https://joy-it.net/files/files/Produkte/SBC-NodeMCU/SBC-NodeMCU_pinout.png Pinbelegung des verwendeten Mikrocontrollers
- <https://forbidenbit.com/en/arduino-projects/esp8266/nodemcu-and-1-8-spi-st7735-display/> Verdrahtung und Ansteuerung meines Displays
- <https://learn.adafruit.com/adafruit-neopixel-uberguide/arduino-library-use> Dokumentation zur Verwendung der Adafruit NeoPixel Bibliothek
- <https://learn.adafruit.com/adafruit-gfx-graphics-library/coordinate-system-and-units> Dokumentation zur Verwendung der Adafruit TFT Grafikdisplay Bibliothek
- <http://javl.github.io/image2cpp/http://javl.github.io/image2cpp/> Code-Generator für Byte Grafiken (für die Smiley Bilder im Dirsplay)
- <https://github.com/realholgi/Encoder> Dokumentation zur verwendeten Bibliothek für den Dreh-Encoder (Einstellung der LED Helligkeit)
- https://www.pjrc.com/teensy/td_libs_Encoder.html Homepage des Entwicklers der Encoder Bibliothek
- <https://www.instructables.com/Select-Color-Display-for-ESP32/> Übersicht verschiedener TFT-Displays
- <https://circuits4you.com/2019/01/08/esp8266-turn-off-wifi-save-power/> Konfiguration des WIFI am ESP8266
- <https://makesmart.net/esp8266-d1-mini-mqtt> Grundlagen zur Einbindung von MQTT im ESP8266



Prototyp auf Steckbrett



fertige Co2-Ampel an Powerbank



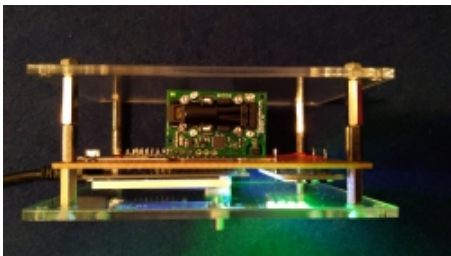
alles im grünen Bereich



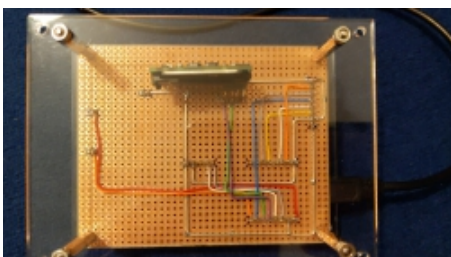
schlechte Luft



bald mal Lüften

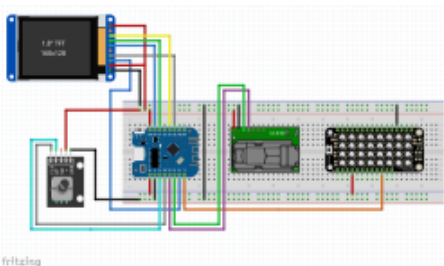


Ansicht von oben





Verdrahtung von hinten



Verdrahtung via Fritzing

Arduino IDE

IDE herunterladen und installieren:

```
wget
https://downloads.arduino.cc/arduino-1.8.16-
linux64.tar.xz
tar xJz arduino-1.8.16-linux64.tar.xz
cd arduino-1.8.16
./install.sh
```

ESP8266 Unterstützung installieren:

Arduino IDE → Datei → Voreinstellungen →
zusätzliche Boardverwalter URLs:

```
https://arduino.esp8266.com/stable/package_es
p8266com_index.json
https://raw.githubusercontent.com/espressif/a
rduino-esp32/gh-
pages/package_esp32_dev_index.json
```

Einkaufsliste

Material:	Quelle:	ca. Preis	Link
D1 Mini Pro - ESP8266	Reichelt	7,30 €	https://www.reichelt.de/d1-mini-pro-esp8266-cp2104-d1-mini-pro-p266066.html
Sensirion SCD30	Mouser	43,46 €	https://www.mouser.de/ProductDetail/Sensirion/SCD30/?qs=rrS6PyfT74fdywu4FxpYjQ%3D%3D
NeoPixel FeatherWing - 4x8 RGB LED	Mouser	12,66 €	https://www.mouser.de/ProductDetail/Adafruit/2945/?qs=ivJcBTdythXnjfcjhuHaQ%3D%3D
DEBO ROT SWITCH	Reichelt	2,65 €	https://www.reichelt.de/entwicklerboards-kodierter-drehschalter-debo-rot-switch-p239260.html
Display LED, 1,8", 128x160, ST7735R	Reichelt	10,50 €	https://www.reichelt.de/entwicklerboards-display-led-1-8-128x160-st7735r-debo-tft-1-8-p192139.html
H25PR075 Lochrasterplatine, Hartpapier, 75x100mm	Reichelt	1,15 €	https://www.reichelt.de/lochrasterplatine-hartpapier-75x100mm-h25pr075-p8269.html

Quellcode

CO2-Ampel.ino

```
/*
Author:   Christoph von Thülen
Version:  1.0 10/23/2020

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Dieses Programm wird in der Hoffnung bereitgestellt, dass es nützlich
sein wird, jedoch
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Gewähr der MARKTFÄHIGKEIT oder EIGNUNG FÜR EINEN BESTIMMTEN ZWECK.
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diesem
Programm erhalten haben. Wenn nicht, siehe
<https://www.gnu.org/licenses/>.
-----
-----*/

// Libs to controll the 1.8" 120x160 px Display with ST7735 Controller:
#include <Adafruit_GFX.h>
#include <Adafruit_ST7735.h>
#include <SPI.h>

// Libs for the MCU itself
#include <ESP8266WiFi.h> // Wifi part

// Lib for quadrature encoder like KY-040 or similar:
#include <Encoder.h>
```

```
#define ENCODER_OPTIMIZE_INTERRUPTS

// Libs to control the Sensirion CO2 sensor:
#include <SparkFun_SCD30_Arduino_Library.h>
#include <Wire.h>

// Adafruit NeoPixel FeatherWing
#include <Adafruit_NeoPixel.h>

// Include the Smiley grafics as byte array...
#include "graphics.c"

// Define some important things ...
// Used Pins to control the Display:
#define TFT_CS          15      // Use GPIO15 for Chip Select (CS)
#define TFT_RST          3      // Use GPIO0 for RESET
#define TFT_DC          16      // Use GPIO2 for DC

// Used pins to control the NeoPixel LEDs:
#define NEOPIXEL_DATA_PIN  1 // Use GPIO 1 for NeoPixel DIN (Data In)

// time intervall in seconds to read out the CO2 sensor
#define INTERVALL 5 // seconds
#define CO2_BAD_LOWER_LIMIT    2000
#define CO2_GOOD_UPPERLIMIT    1000

// Used rotary ecoder Pins:
#define ENC_DT  2      // use GPIO 2 for DT
#define ENC_CLK 0      // use GPIO 0 for CLK
#define ENC_BUTTON 12  // use GPIO 12 for button click

// some color definitions:
#define BLACK    0x0000
#define BLUE     0x001F
#define RED      0xF800
#define GREEN    0x07E0
#define CYAN     0x07FF
#define MAGENTA  0xF81F
// #define ORANGE  0xFC20
#define ORANGE   0xFC00
#define YELLOW   0xFFE0
#define WHITE    0xFFFF

// some (font) size definitions
#define SMALL  1
#define MEDIUM 2
#define LARGE  3

// Internal state definitions
#define STATE_UNDEFINED 0
#define STATE_GOOD     1
```

```
#define STATE_NORMAL    2
#define STATE_BAD       3

// Lets call our 1.8" TFT Display (Controller Type: ST7735) simply:
"tft" ;- )
Adafruit_ST7735 tft = Adafruit_ST7735(TFT_CS, TFT_DC, TFT_RST); //Those
things are for the display

// Objekt SCD30 environment sensor
SCD30 airSensorSCD30;

// Declare some usefull variables ...
// ... for the CO2 Sensor:
int CO2 = 0 ;
char CO2_BUFFER[5] = {};
int Temperature = 0;
int Humidity = 0;

// ... for the LEDs:
#define MAX_BRIGHTNESS 38      // set maximum brightness value
#define MAX_LED_ROWS    8
#define LEDS_PER_ROW    4
#define NEOPIXEL_NO_OF_LEDS (MAX_LED_ROWS * LEDS_PER_ROW)
//NEOPIXEL_NO_OF_LEDS 32      // NeoPixel PCB has n LEDs
#define LED_OFF 0              // set corresponding color brightness to
zero --> LED is switched of
int Brightness = 16;           // set default brightness to 16
int count = 0;                 // set counter to 0
int Row = 0;

// ... for the display graphics:
int graphics_width = 64;
int graphics_height = 64;
int Title_x_pos = 2;
int Title_y_pos = 1;
int CO2_Value_x_pos = 2;
int CO2_Value_y_pos = 34;
int InfoText_x_pos = 1;
int InfoText_y_pos = 58;
int State_y_Offset = 28;
int gfx_x_pos = 96;
int gfx_y_pos = 64;
int Temp_Humid_x_pos = 2;
int Temp_Humid_y_pos = 110;

extern const unsigned char smiley_good [];
extern const unsigned char smiley_normal [];
extern const unsigned char smiley_bad [];

// internal states
```

```
int last_state = STATE_UNDEFINED;      // set startup state to
undefined
int new_state = STATE_UNDEFINED;      // set startup state to
undefined

// Init Adafruit NeoPixel Matrix:
Adafruit_NeoPixel neoWing = Adafruit_NeoPixel(NEOPIXEL_NO_OF_LEDS,
NEOPIXEL_DATA_PIN, NEO_GRB + NEO_KHZ800);

// Init encoder lib with uses interrupt pins connected to encoder
Encoder encoder(ENC_CLK, ENC_DT);

void FillLEDMatrix(int, int, int);

// Some things to set up before the main loop starts:
void setup() {

// Display Setup
  //tft.initR(INITR_GREENTAB);  // use for displays with green tab
  aka. Joy-IT
  tft.initR(INITR_BLACKTAB);  // use for displays with red or black
  tab
  tft.setRotation(1);        // Displayinhalt um 90° (1) gedreht
  (Landscape Mode); (2) = 180°, (3) = 270°

// Configure serial interface (UART) for debug output:
  Serial.begin(115200);      // Note: if GPI/O Pin 1 is used other
  than UART TxD

                               // then debug output prints via
  "serial.print" will not work correctly in loop()
  Serial.println("Co2 Monitor is starting ...");

//Turn off WiFi
  WiFi.mode(WIFI_OFF);      //This also works

// Initialize the I2C-Bus:
  Wire.setClock(100000L);    // 100 kHz SCD30
  Wire.setClockStretchLimit(200000L); // CO2-SCD30
  Wire.begin();
  if (Wire.status() != I2C_OK) Serial.println("Something wrong with
I2C");

// Initialize CO2 Sensor:
  if (airSensorSCD30.begin() == false) {
    Serial.println("The SCD30 did not respond. Please check wiring.");
    while(1) {
      yield();
      delay(1);
    }
  }
}
```

```
airSensorSCD30.setAutoSelfCalibration(false); // Sensirion no auto
calibration
airSensorSCD30.setMeasurementInterval(INTERVALL); // C02
measurement every 5 seconds

// Initialize NeoPixel LEDs:
neoWing.begin();
delay(1);

// Print static elemets on display screen:
// Title:
tft.fillScreen(ST77XX_BLACK);
tft.setTextWrap(false);
tft.setCursor(Title_x_pos, Title_y_pos); //Horiz (ma. 160
px)/Vertical (max. 128 px)
tft.setTextSize(LARGE);
tft.setTextColor(ST77XX_WHITE,ST77XX_BLACK);
tft.print("C0 -Ampel");
tft.setCursor(Title_x_pos+37, Title_y_pos+14); //Horiz (ma. 160
px)/Vertical (max. 128 px)
tft.setTextSize(MEDIUM);
tft.setTextColor(ST77XX_WHITE,ST77XX_BLACK);
tft.print("2");

// Text for C02 Value:
tft.setCursor(C02_Value_x_pos, C02_Value_y_pos);
tft.setTextSize(MEDIUM);
tft.setTextColor(ST77XX_WHITE,ST77XX_BLACK);
tft.print("C0");
tft.setCursor(C02_Value_x_pos+24, C02_Value_y_pos+10);
tft.setTextSize(SMALL);
tft.print("2");
tft.setCursor(C02_Value_x_pos+29, C02_Value_y_pos);
tft.setTextSize(MEDIUM);
tft.print(":");
tft.setCursor(C02_Value_x_pos+105, C02_Value_y_pos);
tft.setTextSize(MEDIUM);
tft.print("ppm");

// Info Text
tft.setCursor(InfoText_x_pos, InfoText_y_pos);
tft.setTextSize(MEDIUM);
tft.setTextColor(ST77XX_WHITE,ST77XX_BLACK);
tft.print("Luftg "\201"te:");
}

// Begin main loop:
void loop() {

// Read new C02 measurement from sensor:
```

```
C02 = airSensorSCD30.getC02();           // get new C02 value
from sensor
Temperature = airSensorSCD30.getTemperature(); // get new
temperature value from sensor
Humidity = airSensorSCD30.getHumidity();     // get new humidity
value from sensor

// Debug output via serial interface:
// Serial.println("C02: "+String(String(C02)));
// Serial.println();

// display temperatur & humidity
tft.setCursor(Temp_Humid_x_pos, Temp_Humid_y_pos);
tft.setTextSize(SMALL);
tft.setTextColor(ST77XX_WHITE,ST77XX_BLACK);
tft.print(Temperature);
tft.setCursor(Temp_Humid_x_pos+12, Temp_Humid_y_pos-4);
tft.print((char)9);
tft.setCursor(Temp_Humid_x_pos+17, Temp_Humid_y_pos);
tft.print("C");
tft.setCursor(Temp_Humid_x_pos+30, Temp_Humid_y_pos);
tft.print(Humidity);
tft.setCursor(Temp_Humid_x_pos+44, Temp_Humid_y_pos);
tft.print("%");

tft.setCursor(InfoText_x_pos, InfoText_y_pos+State_y_Offset);
tft.setTextSize(MEDIUM);

// Compare C02 value to three ranges:
if(C02 < C02_GOOD_UPPERLIMIT) {           // we are in
state GOOD
    new_state = STATE_GOOD;
    if ( last_state != new_state) {        // when the state has
changed, draw new text and simley
        tft.setTextColor(ST77XX_GREEN,ST77XX_BLACK);
        tft.print("Gut      ");
        tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_bad, graphics_width,
graphics_height, BLACK);
        tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_normal,
graphics_width, graphics_height, BLACK);
        tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_good, graphics_width,
graphics_height, GREEN);
    }
    FillLEDMatrix(1, MAX_LED_ROWS, LED_OFF, Brightness, LED_OFF);
}
else if (C02 >= C02_BAD_LOWER_LIMIT) {     // we are in
state BAD!
    new_state = STATE_BAD;
    if ( last_state != new_state) {        // when the state has
changed, draw new text and simley
        tft.setTextColor(ST77XX_RED,ST77XX_BLACK);
```

```
tft.print("Schlecht");
tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_good, graphics_width,
graphics_height, BLACK);
tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_normal,
graphics_width, graphics_height, BLACK);
tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_bad, graphics_width,
graphics_height, RED);

}
FillLEDMatrix(1, MAX_LED_ROWS, Brightness, LED_OFF, LED_OFF);
}
else {                                     // we are in state NORMAL
    new_state = STATE_NORMAL;
    if ( last_state != new_state) {        // when the state has changed,
draw new text and simley
        tft.setTextColor(ST77XX_YELLOW,ST77XX_BLACK);
        tft.print("Normal ");
        tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_bad, graphics_width,
graphics_height, BLACK);
        tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_good, graphics_width,
graphics_height, BLACK);
        tft.drawBitmap(gfx_x_pos, gfx_y_pos, smiley_normal,
graphics_width, graphics_height, YELLOW);
    }
    Row = (((C02-1000)/125)+1);             // calculate how many
LED rows we have to fill
    FillLEDMatrix(1, Row, (Brightness*2), Brightness, LED_OFF);

    // fill the rest with green color to get a rolling traffic light
effect
    if (Row < MAX_LED_ROWS){
        FillLEDMatrix((Row+1), MAX_LED_ROWS, LED_OFF, Brightness,
LED_OFF);
    }
}
last_state = new_state; // set new state

// set color to update C02 value on display
switch(last_state) {
case 1: tft.setTextColor(ST77XX_GREEN,ST77XX_BLACK); break;
case 2: tft.setTextColor(ST77XX_YELLOW,ST77XX_BLACK); break;
case 3: tft.setTextColor(ST77XX_RED,ST77XX_BLACK); break;
}

// refresh C02 Value on display:
tft.setCursor(C02_Value_x_pos+50, C02_Value_y_pos);
tft.setTextSize(MEDIUM);
sprintf(C02_BUFFER, "%4d", C02);
tft.print(String(C02_BUFFER));
```

```
// read encoder:
count = encoder.read();

// Debug output via serial terminal
//Serial.print("Count: ");
//Serial.print(count);
//Serial.print(", Brightness: ");
//Serial.print(Brightness);

// if encoder was turned left or right, set new brightness values:
// don't go higher than MAX_BRIGHTNESS limit
if ((Brightness + count) > MAX_BRIGHTNESS ) {
    Brightness = MAX_BRIGHTNESS;
}
// don't go negative!
if ((Brightness + count) < 0 ) {
    Brightness = 0;
}else {
    // increase or decrease brightness value according to positiv or
    // negative count value
    Brightness += count;
}
Serial.println(Brightness);

// Debug output via serial terminal
//    Serial.print(", Red: ");
//    Serial.print(Led_red);
//    Serial.print(", Green: ");
//    Serial.print(Led_green);
//    Serial.print(", Blue: ");
//    Serial.print(Led_blue);
//    Serial.println();

// reset encoder value for next read cycle:
encoder.write(0);

// delay(1000); // for debug and test purpose only
}

// Function to fill LED matrix row by row
void FillLEDMatrix(int row_start, int row_end, int LED_red, int
LED_green, int LED_blue){

// use for filling the LED matrix from left to right
// for (uint16_t j=row_start-1; j < row_end; j++) {
//     for(uint16_t i=0+j; i < NEOPIXEL_NO_OF_LEDS ; i+= MAX_LED_ROWS)
//     {
//         neoWing.setPixelColor(i,LED_red,LED_green,LED_blue);
//     }
// }
```

```
// use for filling the LED matrix from right to left
for (uint16_t j=row_start-1; j < row_end; j++) {
    for(uint16_t i=0+j; i < NEOPIXEL_NO_OF_LEDS ; i+= MAX_LED_ROWS) {
        neoWing.setPixelColor((NEOPIXEL_NO_OF_LEDS-1-
i),LED_red,LED_green,LED_blue);
    }
}
neoWing.show();
}
```

graphics.c

```
#include <avr/pgmspace.h>

// 'Simley_good_bw_64x64px', 64x64px
const unsigned char smiley_good [] PROGMEM = {
    0x00, 0x00, 0x00, 0x1f, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x00, 0x01,
    0xff, 0xff, 0x80, 0x00, 0x00,
    0x00, 0x00, 0x0f, 0xff, 0xff, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x3f,
    0xff, 0xff, 0xfe, 0x00, 0x00,
    0x00, 0x00, 0xff, 0xc0, 0x03, 0xff, 0x00, 0x00, 0x00, 0x03, 0xfe,
    0x00, 0x00, 0x3f, 0xc0, 0x00,
    0x00, 0x07, 0xf0, 0x00, 0x00, 0x0f, 0xe0, 0x00, 0x00, 0x0f, 0xc0,
    0x00, 0x00, 0x03, 0xf8, 0x00,
    0x00, 0x1f, 0x00, 0x00, 0x00, 0x00, 0xfc, 0x00, 0x00, 0x7e, 0x00,
    0x00, 0x00, 0x00, 0x7e, 0x00,
    0x00, 0x7c, 0x00, 0x00, 0x00, 0x00, 0x3f, 0x00, 0x00, 0xf8, 0x00,
    0x00, 0x00, 0x00, 0x1f, 0x80,
    0x01, 0xf0, 0x00, 0x00, 0x00, 0x00, 0x07, 0x80, 0x03, 0xe0, 0x00,
    0x00, 0x00, 0x00, 0x07, 0xc0,
    0x07, 0xc0, 0x00, 0x00, 0x00, 0x00, 0x03, 0xe0, 0x07, 0x80, 0x00,
    0x00, 0x00, 0x00, 0x01, 0xf0,
    0x0f, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0xf0, 0x0f, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0x78,
    0x1e, 0x00, 0x02, 0x00, 0x00, 0x00, 0x00, 0x78, 0x1e, 0x00, 0x0f,
    0x80, 0x01, 0xf8, 0x00, 0x3c,
    0x3c, 0x00, 0x1f, 0xc0, 0x03, 0xfc, 0x00, 0x3c, 0x3c, 0x00, 0x3f,
    0xe0, 0x03, 0xfc, 0x00, 0x3c,
    0x3c, 0x00, 0x3f, 0xe0, 0x07, 0xfe, 0x00, 0x1e, 0x78, 0x00, 0x3f,
    0xe0, 0x07, 0xfe, 0x00, 0x1e,
    0x78, 0x00, 0x3f, 0xe0, 0x07, 0xfc, 0x00, 0x1e, 0x78, 0x00, 0x1f,
    0xc0, 0x03, 0xfc, 0x00, 0x0f,
    0x70, 0x00, 0x1f, 0xc0, 0x01, 0xf8, 0x00, 0x0f, 0xf0, 0x00, 0x07,
    0x00, 0x00, 0xe0, 0x00, 0x0f,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0x0f,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x07, 0xf0, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0x07,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x07, 0xf0, 0x00, 0x00,
```

```

0x00, 0x00, 0x00, 0x00, 0x07,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x0f,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0x70, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x0f,
    0x78, 0x00, 0x60, 0x00, 0x00, 0x07, 0x00, 0x0f, 0x78, 0x00, 0xf0,
0x00, 0x00, 0x0f, 0x00, 0x1e,
    0x78, 0x00, 0xf8, 0x00, 0x00, 0x1f, 0x00, 0x1e, 0x38, 0x00, 0x7c,
0x00, 0x00, 0x3f, 0x00, 0x1e,
    0x3c, 0x00, 0x3f, 0x00, 0x00, 0xfe, 0x00, 0x3c, 0x3c, 0x00, 0x1f,
0xc0, 0x03, 0xfc, 0x00, 0x3c,
    0x1e, 0x00, 0x0f, 0xfc, 0x3f, 0xf0, 0x00, 0x3c, 0x1e, 0x00, 0x03,
0xff, 0xff, 0xe0, 0x00, 0x78,
    0x1f, 0x00, 0x01, 0xff, 0xff, 0x80, 0x00, 0x78, 0x0f, 0x00, 0x00,
0x3f, 0xfc, 0x00, 0x00, 0xf0,
    0x07, 0x80, 0x00, 0x00, 0x00, 0x00, 0x01, 0xf0, 0x07, 0xc0, 0x00,
0x00, 0x00, 0x00, 0x03, 0xe0,
    0x03, 0xe0, 0x00, 0x00, 0x00, 0x00, 0x03, 0xc0, 0x01, 0xf0, 0x00,
0x00, 0x00, 0x00, 0x07, 0xc0,
    0x01, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x0f, 0x80, 0x00, 0xfc, 0x00,
0x00, 0x00, 0x00, 0x1f, 0x00,
    0x00, 0x7e, 0x00, 0x00, 0x00, 0x00, 0x7e, 0x00, 0x00, 0x3f, 0x00,
0x00, 0x00, 0x00, 0xfc, 0x00,
    0x00, 0x1f, 0xc0, 0x00, 0x00, 0x01, 0xf8, 0x00, 0x00, 0x07, 0xf0,
0x00, 0x00, 0x07, 0xf0, 0x00,
    0x00, 0x03, 0xfc, 0x00, 0x00, 0x3f, 0xc0, 0x00, 0x00, 0x00, 0xff,
0x80, 0x01, 0xff, 0x80, 0x00,
    0x00, 0x00, 0x7f, 0xff, 0xff, 0xfe, 0x00, 0x00, 0x00, 0x00, 0x1f,
0xff, 0xff, 0xf8, 0x00, 0x00,
    0x00, 0x00, 0x03, 0xff, 0xff, 0xc0, 0x00, 0x00, 0x00, 0x00, 0x00,
0x3f, 0xfe, 0x00, 0x00, 0x00
};

// 'Simley_normal_bw_64x64px', 64x64px
const unsigned char smiley_normal [] PROGMEM = {
    0x00, 0x00, 0x00, 0x1f, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x00, 0x01,
0xff, 0xff, 0x80, 0x00, 0x00,
    0x00, 0x00, 0x0f, 0xff, 0xff, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x3f,
0xff, 0xff, 0xfe, 0x00, 0x00,
    0x00, 0x00, 0xff, 0xc0, 0x03, 0xff, 0x00, 0x00, 0x00, 0x03, 0xfe,
0x00, 0x00, 0x3f, 0xc0, 0x00,
    0x00, 0x07, 0xf0, 0x00, 0x00, 0x0f, 0xe0, 0x00, 0x00, 0x0f, 0xc0,
0x00, 0x00, 0x03, 0xf8, 0x00,
    0x00, 0x3f, 0x00, 0x00, 0x00, 0x00, 0xfc, 0x00, 0x00, 0x7e, 0x00,
0x00, 0x00, 0x00, 0x7e, 0x00,
    0x00, 0xfc, 0x00, 0x00, 0x00, 0x00, 0x3f, 0x00, 0x00, 0xf8, 0x00,
0x00, 0x00, 0x00, 0x1f, 0x80,
    0x01, 0xf0, 0x00, 0x00, 0x00, 0x00, 0x0f, 0x80, 0x03, 0xe0, 0x00,
0x00, 0x00, 0x00, 0x07, 0xc0,
    0x07, 0xc0, 0x00, 0x00, 0x00, 0x00, 0x03, 0xe0, 0x07, 0x80, 0x00,
0x00, 0x00, 0x00, 0x01, 0xe0,

```

```
0x0f, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0xf0, 0x1f, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0xf8,
0x1e, 0x00, 0x02, 0x00, 0x00, 0x40, 0x00, 0x78, 0x1e, 0x00, 0x0f,
0x80, 0x01, 0xf8, 0x00, 0x7c,
0x3c, 0x00, 0x1f, 0xc0, 0x03, 0xfc, 0x00, 0x3c, 0x3c, 0x00, 0x3f,
0xe0, 0x03, 0xfc, 0x00, 0x3c,
0x3c, 0x00, 0x3f, 0xe0, 0x07, 0xfc, 0x00, 0x1e, 0x78, 0x00, 0x3f,
0xe0, 0x07, 0xfc, 0x00, 0x1e,
0x78, 0x00, 0x3f, 0xe0, 0x07, 0xfc, 0x00, 0x1e, 0x78, 0x00, 0x1f,
0xc0, 0x03, 0xfc, 0x00, 0x0e,
0x70, 0x00, 0x1f, 0xc0, 0x01, 0xf8, 0x00, 0x0f, 0xf0, 0x00, 0x07,
0x00, 0x00, 0xe0, 0x00, 0x0f,
0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x0f,
0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x0f,
0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x0f,
0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x0f,
0x70, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0x78, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x1e,
0x78, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x1e, 0x38, 0x00, 0x0f,
0xff, 0xff, 0xf0, 0x00, 0x1e,
0x3c, 0x00, 0x1f, 0xff, 0xff, 0xf8, 0x00, 0x3c, 0x3c, 0x00, 0x1f,
0xff, 0xff, 0xfc, 0x00, 0x3c,
0x3e, 0x00, 0x1f, 0xff, 0xff, 0xf8, 0x00, 0x3c, 0x1e, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x78,
0x1f, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x78, 0x0f, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0xf0,
0x07, 0x80, 0x00, 0x00, 0x00, 0x00, 0x01, 0xf0, 0x07, 0xc0, 0x00,
0x00, 0x00, 0x00, 0x03, 0xe0,
0x03, 0xe0, 0x00, 0x00, 0x00, 0x00, 0x03, 0xc0, 0x01, 0xf0, 0x00,
0x00, 0x00, 0x00, 0x07, 0xc0,
0x01, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x0f, 0x80, 0x00, 0xfc, 0x00,
0x00, 0x00, 0x00, 0x1f, 0x00,
0x00, 0x7e, 0x00, 0x00, 0x00, 0x00, 0x7e, 0x00, 0x00, 0x3f, 0x00,
0x00, 0x00, 0x00, 0xfc, 0x00,
0x00, 0x1f, 0xc0, 0x00, 0x00, 0x01, 0xf8, 0x00, 0x00, 0x07, 0xf0,
0x00, 0x00, 0x07, 0xf0, 0x00,
0x00, 0x03, 0xfc, 0x00, 0x00, 0x3f, 0xc0, 0x00, 0x00, 0x00, 0xff,
0x80, 0x01, 0xff, 0x80, 0x00,
0x00, 0x00, 0x7f, 0xff, 0xff, 0xfe, 0x00, 0x00, 0x00, 0x00, 0x1f,
0xff, 0xff, 0xf8, 0x00, 0x00,
0x00, 0x00, 0x03, 0xff, 0xff, 0xc0, 0x00, 0x00, 0x00, 0x00, 0x00,
0x7f, 0xfe, 0x00, 0x00, 0x00
};
```

```
// 'Simley_bad_bw_64x64px', 64x64px
const unsigned char smiley_bad [] PROGMEM = {
    0x00, 0x00, 0x00, 0x1f, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x00, 0x01,
    0xff, 0xff, 0x80, 0x00, 0x00,
    0x00, 0x00, 0x0f, 0xff, 0xff, 0xf8, 0x00, 0x00, 0x00, 0x00, 0x7f,
    0xff, 0xff, 0xfe, 0x00, 0x00,
    0x00, 0x00, 0xff, 0xc0, 0x03, 0xff, 0x00, 0x00, 0x00, 0x03, 0xfe,
    0x00, 0x00, 0x3f, 0xc0, 0x00,
    0x00, 0x07, 0xf0, 0x00, 0x00, 0x0f, 0xe0, 0x00, 0x00, 0x0f, 0xc0,
    0x00, 0x00, 0x03, 0xf8, 0x00,
    0x00, 0x3f, 0x00, 0x00, 0x00, 0x00, 0xfc, 0x00, 0x00, 0x7e, 0x00,
    0x00, 0x00, 0x00, 0x7e, 0x00,
    0x00, 0xfc, 0x00, 0x00, 0x00, 0x00, 0x3f, 0x00, 0x00, 0xf8, 0x00,
    0x00, 0x00, 0x00, 0x1f, 0x80,
    0x01, 0xf0, 0x00, 0x00, 0x00, 0x00, 0x0f, 0x80, 0x03, 0xe0, 0x00,
    0x00, 0x00, 0x00, 0x07, 0xc0,
    0x07, 0xc0, 0x00, 0x00, 0x00, 0x00, 0x03, 0xe0, 0x07, 0x80, 0x00,
    0x00, 0x00, 0x00, 0x01, 0xe0,
    0x0f, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0xf0, 0x1f, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0xf8,
    0x1e, 0x00, 0x02, 0x00, 0x00, 0x40, 0x00, 0x78, 0x3e, 0x00, 0x1f,
    0x80, 0x01, 0xf8, 0x00, 0x7c,
    0x3c, 0x00, 0x3f, 0xc0, 0x03, 0xf8, 0x00, 0x3c, 0x3c, 0x00, 0x3f,
    0xe0, 0x07, 0xfc, 0x00, 0x3c,
    0x38, 0x00, 0x3f, 0xe0, 0x07, 0xfc, 0x00, 0x1e, 0x78, 0x00, 0x3f,
    0xe0, 0x07, 0xfc, 0x00, 0x1e,
    0x78, 0x00, 0x3f, 0xe0, 0x07, 0xfc, 0x00, 0x1e, 0x70, 0x00, 0x3f,
    0xc0, 0x03, 0xfc, 0x00, 0x0e,
    0xf0, 0x00, 0x1f, 0xc0, 0x01, 0xf8, 0x00, 0x0f, 0xf0, 0x00, 0x07,
    0x00, 0x00, 0xe0, 0x00, 0x0f,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0x0f,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0x0f,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0x0f,
    0xf0, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00,
    0x00, 0x00, 0x00, 0x00, 0x0f,
    0x70, 0x00, 0x00, 0x0f, 0xf0, 0x00, 0x00, 0x0e, 0x78, 0x00, 0x00,
    0xff, 0xff, 0x00, 0x00, 0x1e,
    0x78, 0x00, 0x03, 0xff, 0xff, 0xc0, 0x00, 0x1e, 0x78, 0x00, 0x07,
    0xff, 0xff, 0xf0, 0x00, 0x1e,
    0x3c, 0x00, 0x1f, 0xe0, 0x07, 0xf8, 0x00, 0x3c, 0x3c, 0x00, 0x3f,
    0x80, 0x00, 0xfc, 0x00, 0x3c,
    0x1e, 0x00, 0x7e, 0x00, 0x00, 0x7e, 0x00, 0x7c, 0x1e, 0x00, 0xf8,
    0x00, 0x00, 0x1f, 0x00, 0x78,
    0x1f, 0x00, 0xf0, 0x00, 0x00, 0x0f, 0x00, 0x78, 0x0f, 0x00, 0xe0,
    0x00, 0x00, 0x07, 0x00, 0xf0,
    0x07, 0x80, 0x00, 0x00, 0x00, 0x00, 0x01, 0xf0, 0x07, 0xc0, 0x00,
```

```
0x00, 0x00, 0x00, 0x03, 0xe0,  
    0x03, 0xe0, 0x00, 0x00, 0x00, 0x00, 0x03, 0xc0, 0x01, 0xe0, 0x00,  
0x00, 0x00, 0x00, 0x07, 0xc0,  
    0x01, 0xf0, 0x00, 0x00, 0x00, 0x00, 0x0f, 0x80, 0x00, 0xfc, 0x00,  
0x00, 0x00, 0x00, 0x1f, 0x00,  
    0x00, 0x7e, 0x00, 0x00, 0x00, 0x00, 0x7e, 0x00, 0x00, 0x3f, 0x00,  
0x00, 0x00, 0x00, 0xfc, 0x00,  
    0x00, 0x1f, 0x80, 0x00, 0x00, 0x01, 0xf8, 0x00, 0x00, 0x07, 0xf0,  
0x00, 0x00, 0x07, 0xf0, 0x00,  
    0x00, 0x03, 0xfc, 0x00, 0x00, 0x3f, 0xc0, 0x00, 0x00, 0x01, 0xff,  
0x80, 0x01, 0xff, 0x80, 0x00,  
    0x00, 0x00, 0x7f, 0xff, 0xff, 0xfe, 0x00, 0x00, 0x00, 0x00, 0x1f,  
0xff, 0xff, 0xf8, 0x00, 0x00,  
    0x00, 0x00, 0x03, 0xff, 0xff, 0xc0, 0x00, 0x00, 0x00, 0x00, 0x00,  
0x7f, 0xfe, 0x00, 0x00, 0x00  
};
```

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