

# Pico e-Paper 2.13

## Overview

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2.13inch E-Paper E-Ink Display Module For Raspberry Pi Pico, 250×122 Pixels, Black / White, SPI Interface

## Features

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- No backlight keeps displaying last content for a long time even when power down
- Ultra-low power consumption, basically power is only required for refreshing
- SPI interface requires minimal IO pins

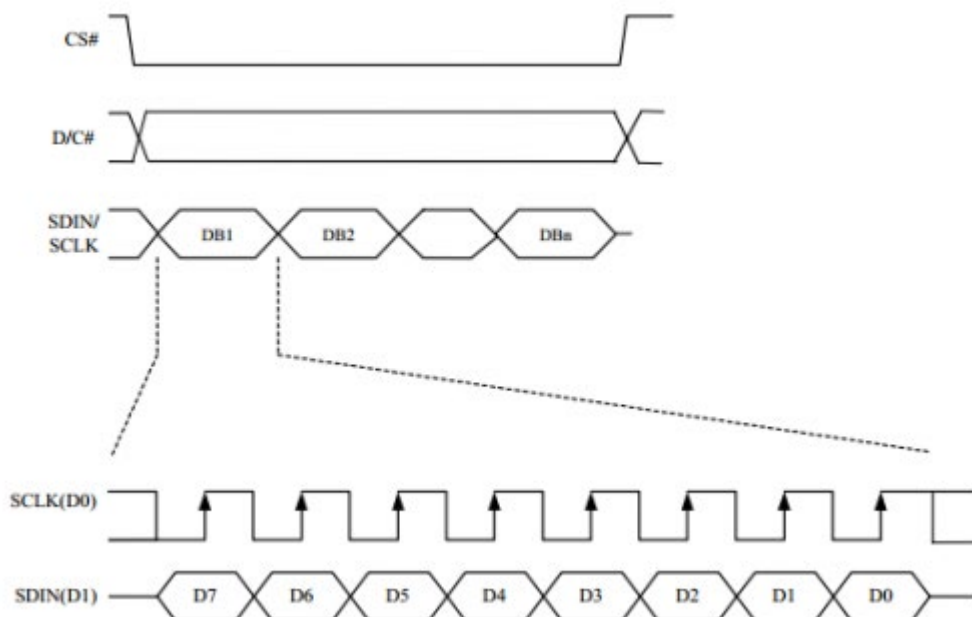
## Specification

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- Operating voltage: 3.3V/5V
- Interface:3-wire SPI, 4-wire SPI
- Outline dimensions: 65.00 × 30.50mm
- Display size:48.55 × 23.70mm
- Dot pitch: 0.194 × 0.194mm
- Resolution: 250×122 pixels
- Display color: Black, white
- Greyscale: 2
- Partial refresh time: 0.3s
- full refresh time: 2s
- Refresh power: 26.4mW(typ.)
- Standby current: <0.01uA(almost none)
- Viewing Angle: > 170°

## SPI Timing

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Note: Different from the traditional SPI protocol, the data line from the slave to the master is hidden since the device only has a display requirement.

- CS is slave chip select, when CS is low, the chip is enabled.
- DC is data/command control pin, when DC = 0, write command, when DC = 1, write data.
- SCLK is the SPI communication clock.
- SDIN is the data line from the master to the slave in SPI communication.

SPI communication has data transfer timing, which is combined by CPHA and CPOL.

1. CPOL determines the level of the serial synchronous clock at an idle state. When CPOL = 0, the level is Low. However, CPOL has little effect on the transmission.
2. CPHA determines whether data is collected at the first clock edge or at the second clock edge of the serial synchronous clock; when CPHL = 0, data is collected at the first clock edge.

- There are 4 SPI communication modes. SPI0 is commonly used, in which CPHL = 0, CPOL = 0.

As you can see from the figure above, data transmission starts at the first falling edge of SCLK, and 8 bits of data are transferred in one clock cycle. Here, SPI0 is in used, and data is transferred by bits, MSB first.

## Working Protocol

This product is an E-paper device adopting the image display technology of Microencapsulated Electrophoretic Display, MED. The initial approach is to create tiny spheres, in which the charged color pigments are suspending in the transparent oil and would move depending on the electronic charge. The E-paper screen display patterns by reflecting the ambient light, so it has no background light requirement. **(Note that the e-Paper cannot support updating directly under sunlight).**

## How to define pixels

In a monochrome picture we define the pixels, 0 is black and 1 is white.

White : □, Bit 1

Black : ■ : Bit 0

- The dot in the figure is called a pixel. As we know, 1 and 0 are used to define the color, therefore we can use one bit to define the color of one pixel, and 1 byte = 8pixels
- For example, If we set the first 8 pixels to black and the last 8 pixels to white, we show it by codes, they will be 16 bit as below:

Pixel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bit	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Color	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□

For computer, the data is saved in MSB format:

Pixel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Index	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Bit	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Color	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□
Byte	0x00								0xFF							

So we can use two bytes for 16 pixels.