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## GxEPD2

### Arduino Display Library for SPI E-Paper Displays

- With full Graphics and Text support using Adafruit\_GFX
- For SPI e-paper displays from Dalian Good Display
- and SPI e-paper boards from Waveshare

#### important note:

- the display panels are for 3.3V supply and 3.3V data lines
- never connect data lines directly to 5V Arduino data pins, use e.g. 4k7/10k resistor divider
- series resistor only is not enough for reliable operation (back-feed effect through protection diodes)
- 4k7/10k resistor divider may not work with flat cable extensions or Waveshare 4.2 board, use level converter then
- do not forget to connect GND
- the actual Waveshare display boards now have level converters and series regulator, safe for 5V
- use 3k3 pull-down on SS for ESP8266 for boards with level converters
- note that 7.5" e-paper displays don't work reliable if fed from 3.3V Arduino pin
- note that Waveshare boards with "clever" reset circuit may need shortened reset pulse
- use `init(115200, true, 2, false)` for Waveshare boards with "clever" reset circuit
- note that Waveshare boards with "clever" reset circuit need 1k pull-up on RST on ESP8266, or different pin
- note that the new Waveshare Universal e-Paper Raw Panel Driver HAT Rev 2.3 needs PWR connected to VCC or driven HIGH
- see [https://www.waveshare.com/wiki/E-Paper\\_Driver\\_HAT](https://www.waveshare.com/wiki/E-Paper_Driver_HAT)

#### Paged Drawing, Picture Loop

- This library uses paged drawing to limit RAM use and cope with missing single pixel update support
- buffer size can be selected in the application by template parameter `page_height`, see `GxEPD2_Example`
- Paged drawing is implemented as picture loop, like in U8G2 (Oliver Kraus)
- see <https://github.com/olikraus/u8glib/wiki/tpictureloop>
- Paged drawing is also available using `drawPaged()` and `drawCallback()`, like in `GxEPD`

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- `//GxEPD style paged drawing; drawCallback()` is called as many times as needed
  - `void drawPaged(void (*drawCallback)(const void*), const void* pv)`
  - paged drawing is done using Adafruit\_GFX methods inside picture loop or drawCallback

### Full Screen Buffer Support

- full screen buffer is selected by setting template parameter `page_height` to display height
- drawing to full screen buffer is done using Adafruit\_GFX methods without picture loop or drawCallback
- and then calling method `display()`

### Low Level Bitmap Drawing Support

- bitmap drawing support to the controller memory and screen is available:
- either through the template class instance methods that forward calls to the base display class
- or directly using an instance of a base display class and calling its methods directly

### Supporting Arduino Forum Topics:

- Waveshare e-paper displays with SPI: <http://forum.arduino.cc/index.php?topic=487007.0>
- Good Display ePaper for Arduino : <https://forum.arduino.cc/index.php?topic=436411.0>
- Note that these topics are closed. Use only for reference.
- create a new topic for each question or issue in <https://forum.arduino.cc/c/using-arduino/displays/23>

### Note on documentation

- GxEPD2 uses Adafruit\_GFX for Graphics and Text support, which is well documented there
- GxEPD2 uses meaningful method names, and has some comments in the header files
- consult the header files `GxEPD2_BW.h`, `GxEPD2_3C.h` and `GxEPD2_GFX.h`
- for the concept of paged drawing and picture loop see:
- <https://github.com/olikraus/u8glib/wiki/tpictureloop>

### Note on issues and pull requests

- issues should be reported in the Arduino Forum Displays.

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- issues on GitHub are disabled; there were too many false issues.
  - pull requests are not welcome, will not be merged.
  - pull requests can't be disabled, but will be closed.
  - please place information about interesting fork additions in the Arduino Forum Displays.

### **Supported SPI e-paper panels from Good Display:**

- GDEW0102T4 1.02" b/w 80x128, UC8175
- DEPG0150BN 1.50" b/w 200x200, SSD1681, e.g. LILYGO® TTGO T5 V2.4.1 1.50 inch
- GDEP0150C1 1.54" b/w 200x200, IL3829, no longer available
- GDEH0154D67 1.54" b/w 200x200, SSD1681, replacement for GDEP0150C1
- GDEW0154T8 1.54" b/w 152x152, UC8151 (IL0373)
- GDEW0154M09 1.54" b/w 200x200, JD79653A
- GDEW0154M10 1.54" b/w 152x152, UC8151D, DES
- GDEY0154D67 1.54" b/w 200x200, SSD1681
- GDEW0154Z04 1.54" b/w/r 200x200, IL0376F, no longer available
- GDEH0154Z90 1.54" b/w/r 200x200, SSD1681, replacement for GDEW0154Z04
- GDE0213B1 2.13" b/w 122x250, IL3895, phased out
- GDEH0213B72 2.13" b/w 122x250, SSD1675A (IL3897), replacement for GDE0213B1
- GDEH0213B73 2.13" b/w 122x250, SSD1675B, new replacement for GDE0213B1, GDEH0213B72
- GDEM0213B74 2.13" b/w 122x250, SSD1680
- GDEW0213I5F 2.13" b/w 104x212, UC8151 (IL0373), flexible
- GDEW0213T5D 2.13" b/w 104x212, UC8151 (IL0373)
- GDEW0213M21 2.13" b/w 104x212, UC8151 (IL0373), DES
- GDEW0213Z16 2.13" b/w/r 104x212, UC8151 (IL0373)
- GDEW0213Z19 2.13" b/w/r 104x212, UC8151D
- GDEY0213Z98 2.13" b/w/r 122x250, SSD1680
- DEPG0213BN 2.13" b/w 122x250, SSD1680, e.g. LILYGO® TTGO T5 V2.3.1 2.13 inch
- GDEY0213B74 2.13" b/w 122x250, SSD1680
- GDEW026T0 2.6" b/w 152x296, UC8151 (IL0373)
- GDEW026M01 2.6" b/w 152x296, UC8151 (IL0373), DES
- DEPG0266BN 2.66" b/w 152x296, SSD1680, e.g. LILYGO® TTGO T5 2.66 inch
- GDEY0266Z90 2.66" b/w/r 152x296, SSD1680
- GDEY0266F51H 2.66" 4-color 184x460, JD79667
- GDEW027C44 2.7" b/w/r 176x264, IL91874
- GDEW027W3 2.7" b/w 176x264, EK79652 (IL91874)
- GDEY027T91 2.7" b/w 176x264, SSD1680
- GDEH029A1 2.9" b/w 128x296, SSD1608 (IL3820)

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- GDEW029T5 2.9" b/w 128x296, UC8151 (IL0373)
  - GDEW029T5D 2.9" b/w 128x296, UC8151D
  - GDEW029I6FD 2.9" b/w 128x296, UC8151D, flexible
  - GDEM029T94 2.9" b/w 128x296, SSD1680
  - GDEW029M06 2.9" b/w 128x296, UC8151D, DES
  - GDEW029Z10 2.9" b/w/r 128x296, UC8151 (IL0373)
  - GDEH029Z13 2.9" b/w/r 128x296, UC8151D
  - GDEM029C90 2.9" b/w/y 128x296, SSD1680
  - DEPG0290BS 2.9" b/w 128x296, SSD1680, e.g. LILYGO® TTGO T5 V2.4.1 2.9"
  - GDEY029T94 2.9" b/w 128x296, SSD1680
  - GDEY029F51H 2.9" 4-color 168x384, JD79667
  - Waveshare3inch4color 3.0" 4-color 168x400
  - GDEQ031T10 3.1" b/w 240x320, UC8253
  - ED037TC1 3.7" b/w 280x480, SSD1677, Waveshare 3.7"
  - GDEW0371W7 3.7" b/w 240x416, UC8171 (IL0324)
  - GDEW042T2 4.2" b/w 400x300, UC8176 (IL0398)
  - GDEW042M01 4.2" b/w 400x300, UC8176 (IL0398), DES
  - GDEW042Z15 4.2" b/w/r 400x300, UC8176 (IL0398)
  - GDEQ042Z21 4.2" b/w/r 400x300, UC8276, (Waveshare V2)
  - GDEY042T81 4.2" b/w 400x300, SSD1683
  - GDEY0420F51 4.2" 4-color 400x300, HX8717
  - GDEQ0426T82 4.26" b/w 800x480, SSD1677
  - Waveshare437inch4color Waveshare 4.37" 4-color e-paper display 512x368
  - ACeP565 5.65" Waveshare 5.65" 7-color e-paper display 600x448
  - GDEW0583T7 5.83" b/w 600x448, UC8159c (IL0371)
  - GDEW0583T8 5.83" b/w 648x480, EK79655 (GD7965)
  - GDEW0583Z83 5.83" b/w/r 648x480, EK79655 (GD7965)
  - GDEQ0583T31 5.83" b/w 648x480, UC8179
  - GDEQ0583Z31 5.83" b/w/r 648x480, UC8179C
  - GDEY073D46 7.3" 800x480 7-color
  - ACeP730 7.3" Waveshare 7-color e-paper display 800x480, PhotoPainter
  - GDEW075T8 7.5" b/w 640x384, UC8159c (IL0371)
  - GDEW075T7 7.5" b/w 800x480, EK79655 (GD7965)
  - GDEY075T7 7.5" b/w 800x480, UC8179 (GD7965)
  - GDEW075Z09 7.5" b/w/r 640x384, UC8159c (IL0371)
  - GDEW075Z08 7.5" b/w/r 800x480, EK79655 (GD7965)
  - GDEH075Z90 7.5" b/w/r 880x528, SSD1677
  - GDEM102T91 10.2" b/w 960x640, SSD1677

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- GDEH116T91 11.6" b/w 960x640, SSD1677
  - GDEY116Z91 11.6" b/w/r 960x640, SSD1677
  - GDEW1248T3 12.48" b/w 1304x984, UC8179
  - GDEY1248Z51 12.48" b/w/r 1304x984, UC8179
  - GDEM133T91 13.3" b/w 960x680, SSD1677
  - GDEM133Z91 13.3" b/w/r 960x680, SSD1677 ##### Supported SPI e-paper panels & boards from Waveshare: compare with Good Display, same panel ##### other supported panels
  - GYE042A87 4.2" b/w 400x300, SSD1683 (HINK-E042-A07-FPC-A1)
  - SE0420NQ04 4.2" b/w 400x300, UC8276C (OPM042A2\_V1.0)
  - ED060SCT 6" grey levels, on Waveshare e-Paper IT8951 Driver HAT
  - ED060KC1 6" grey levels, 1448x1072, on Waveshare e-Paper IT8951 Driver HAT
  - ED078KC2 7.8" grey levels, 1872x1404, on Waveshare e-Paper IT8951 Driver HAT
  - ES103TC1 10.3" grey levels, 1872x1404, on Waveshare e-Paper IT8951 Driver HAT

### **I can and will only support e-paper panels I have!**

- promotion panels from suppliers are welcome, to add support to GxEPD2
- donation panels from users are welcome, to add support to GxEPD2

### **Version 1.5.6**

- version for ongoing fixes and additions
- added support for GYE042A87 4.2" b/w 400x300
- added support for SE0420NQ04 4.2" b/w 400x300
- added support for GDEQ0583Z31 5.83" b/w/r 648x480
- added support for GDEM102T91 10.2" b/w 960x640, SSD1677
- added support for GDEY116Z91 11.6" b/w/r 960x640, SSD1677
- added support for GDEM133T91 13.3" b/w 960x680, SSD1677
- added support for GDEM133Z91 13.3" b/w/r 960x680, SSD1677
- improved differential refresh for SE0420NQ04
- improved full refresh for SE0420NQ04
- fixed driver class GxEPD2\_213.cpp ##### Version 1.5.5
- updated 7-color driver classes (design cleanup fixed)
- note: Waveshare PhotoPainter doesn't work with MBED Pico package
- note: use package <https://github.com/earlephilhower/arduino-pico> for PhotoPainter ##### Version 1.5.4
- added support for GDEQ031T10 3.1" b/w 240x320

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- updated support for GDEY075T7 7.5" b/w 800x480
  - renamed driver class GxEPD2\_750\_YT7 to GxEPD2\_750\_GDEY075T7
  - the actual GDEY075T7 panels have fast full refresh capability
  - added support for Waveshare 7.3" 7-color, driver class GxEPD2\_730c\_ACeP\_730
  - added support for Waveshare 7.3" 7-color PhotoPainter with RPi Pico RP2040
  - updated b/w driver classes for SSD controllers
  - updated 7-color driver classes (design cleanup) ##### Version 1.5.3
  - added support for GDEQ0426T82 4.26" b/w 800x480
  - added support for GDEY0266F51H 2.66" 4-color 184x460
  - added support for GDEY029F51H 2.9" 4-color 168x384
  - added support for GDEY0420F51 4.2" 4-color 400x300
  - added support for Waveshare 3.00" 4-color e-paper display 168x400
  - updated support for Waveshare 4.37" 4-color e-paper display 512x368
  - the 4-color displays have partial window addressing and refresh
  - renamed GDEY042T91 to its new official name GDEY042T81 ##### Version 1.5.2
  - added support for Waveshare 4.37" 4-color e-paper display 512x368
  - fixed \_\_has\_include test (for packages that don't support \_\_has\_include)
  - added WIDTH\_VISIBLE for correct graphics width for 2.13" b/w 122x250
  - added end() method, to release SPI and reset all pins to INPUT ##### Version 1.5.1
  - added support for GDEY0154D67 1.54" b/w 200x200
  - added support for GDEY0213B74 2.13" b/w 128x250
  - updated support for GDEY027T91 2.7" b/w 176x264
  - renamed driver class for GDEY027T91 to GxEPD2\_270\_GDEY027T91
  - added support for GDEY029T94 2.9" b/w 128x296
  - added support for GDEY042T91 4.2" b/w 400x300
  - added support for GDEQ0583T31 5.83" b/w 648x480
  - these panels have fast full refresh capability
  - fast full refresh can be disabled in the class header for low temperature use
  - added support for GDEY073D46 7.3" 800x480 7-color
  - all these new panels have been donated by Good Display
  - added \_\_has\_include test to GxEPD2\_BW.h, GxEPD2\_3C.h, GxEPD2\_7C
  - this allows to remove or put aside unused driver classes for faster compile
  - several fixes and improvements ##### Version 1.5.0
  - added support for GDEY075T7 7.5" b/w 800x480
  - updated GxEPD2\_Example, added HSPI use for Waveshare ESP32 Driver Board
  - updated GxEPD2\_SD\_AVR\_Example, fixes for BMP handling
  - updated GxEPD2\_SD\_Example, fixes for BMP handling, added HSPI use for Waveshare ESP32 Driver Board
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- updated GxEPD2\_SerialFlash\_Example, fixes for BMP handling
  - updated GxEPD2\_SerialFlash\_Loader, updated https certificates and use
  - updated GxEPD2\_Spiffs\_Example, fixes for BMP handling
  - updated GxEPD2\_Spiffs\_Loader, updated https certificates and use
  - added GxEPD2\_WiFi\_CertStore\_Example, use of a BearSSL CertStore on ESP8266, like a browser
  - added GxEPD2\_WiFi\_CertStore\_Loader, download root certificates (from Mozilla) to ESP8266 flash
  - updated GxEPD2\_WiFi\_Example, fixes for BMP handling, updated https certificates and use
  - updated GxEPD2\_WS\_ESP32\_Driver, added HSPI use for Waveshare ESP32 Driver Board ##### Version 1.4.9
  - added missing constructor lines to GxEPD2\_display\_selection.h
  - added panel details to comments in GxEPD2\_display\_selection.h
  - added panel details to Supported SPI e-paper panels in README.md ##### Version 1.4.8
  - added support for GDEY027T91 2.7" b/w 176x264
  - added support for GDEY1248Z51 12.48" b/w/r 1304x984
  - fixed name of panel DEPG0150BN
  - updated certificate and fingerprint for GitHub download in GxEPD2\_WiFi\_Example ##### Version 1.4.7
  - added support for DEPG0150BN 1.50" b/w 200x200, e.g. LILYGO® TTGO T5 V2.4.1 1.50 inch
  - added support for DEPG0213BN 2.13" b/w 128x250, e.g. LILYGO® TTGO T5 V2.3.1 2.13 inch
  - added support for DEPG0266BN 2.66" b/w 152x296, e.g. LILYGO® TTGO T5 2.66 inch
  - added support for DEPG0290BS 2.9" b/w 128x296, e.g. LILYGO® TTGO T5 V2.4.1 2.9"
  - added support for ES103TC1 10.3" grey levels, 1872x1404, on Waveshare e-Paper IT8951 Driver HAT ##### Version 1.4.6
  - added support for GDEY0266Z90 2.66" b/w/r 152x296
  - added support for GDEW0583Z83 5.83" b/w/r 648x460 ##### Version 1.4.5
  - added support for GDEY0213Z98 2.13" b/w/r 122x250
  - tested with LOLIN 2.13" Tri-Color elnk / ePaper 250x122 Display Shield
  - <https://www.aliexpress.com/item/1005003020667903.html> ##### Version 1.4.4
  - interim update to solve compiler warnings (ALL for GCC for AVR) ##### Version 1.4.3
  - added option to select an alternate HW SPI channel and/or SPI settings
  - by method selectSPI(SPIClass& spi, SPISettings spi\_settings) of driver base class GxEPD2\_EPД
  - by calling selectSPI before calling init() of display class
  - or by calling extended init() method that has these parameters added
  - tested with RPi Pico RP2040 using Good Display DESPI-PICO connection shield
  - updated GxEPD2\_Example to show use with DESPI-PICO
  - DESPI-PICO: see <https://www.good-display.com/product/393.html> ##### Version 1.4.2
  - added support for Waveshare 3.7" b/w board and panel ED037TC1
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- waveform tables for ED037TC1 are taken unmodified from Waveshare demo code
  - refresh behavior with ED037TC1 with GxEPD2 is not perfect, could not be resolved
  - ISSUE RESOLVED: RESE needs to be 3 ohms on DESPI-C02 for this panel, Waveshare schematics is wrong
  - added differential refresh for GDEH116T91, waveform table taken from ED037TC1
  - differential refresh for GDEH116T91 looks ok; can be disabled with `hasFastPartialUpdate = false`
  - increased sustain phase for differential refresh on GDEW042T2 ##### Version 1.4.1
  - fix for Waveshare “clever” reset circuit: power controller before reset pulse ##### Version 1.4.0
  - changed the default reset duration to 10ms instead of 20ms
  - changed the delay after reset to 10ms or reset duration, whichever is higher, instead of 200ms
  - added a `busyCallback` feature, to allow to service periodic actions during wait for BUSY termination
  - `//register a callback function to be called during _waitWhileBusy continuously.`
  - `void setBusyCallback(void (*busyCallback)(const void*), const void* busy_callback_parameter = 0);`
  - added example `GxEPD2_RotaryUsingBusyCallback.ino` ##### Version 1.3.9
  - fix for STM32 official package pin number range (`int16_t`)
  - fix for `refresh(int16_t x, int16_t y, int16_t w, int16_t h)` methods screen intersection ##### Version 1.3.8
  - added support for GDEQ042Z21 4.2” b/w/r 400x300 panel or Waveshare 4.2” V2 b/w/r board
  - the Waveshare 4.2” V2 b/w/r board requires the shortened reset pulse
  - added support for GDEW029I6FD 2.9” b/w 128x296 flexible board
  - some fixes and improvement for the new style panel selection ##### Version 1.3.7
  - added support for GDEW0102T4 1.02” b/w 80x128 panel or Waveshare 1.02” b/w board
  - the GDEW0102T4 panel has a different connector than the other SPI panels
  - the GDEW0102T4 panel can be used with the DESPI-C102 connection module
  - <https://buy-lcd.com/products/connection-board-demo-kit-for-102-inch-e-ink-display-despi-c102>
  - my test have been done with the Waveshare 1.02” b/w board ##### Version 1.3.6
  - added support for Waveshare 2.9” b/w V2, driver class `GxEPD2_290_T94_V2`
  - Waveshare 2.9” b/w V2 uses a GDEM029T94 variant without partial update wft in OTP
  - driver class `GxEPD2_290_T94_V2` uses partial update wft written to registers
  - added NOTE for RST pull-up on ESP8266 with “clever” reset circuit, or alternate pin ##### Version 1.3.5
  - added support for GDEM0213B74 122x250 b/w e-paper panel
  - added support for ED078KC2, 7.8” grey levels, 1872x1404, on Waveshare e-Paper IT8951 Driver HAT ##### Version 1.3.4
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- added support for GDEH116T91 960x640 b/w e-paper panel
  - GDEH116T91 has only full screen refresh, no wavetable for differential refresh yet
  - added support for processor Arduino Nano RP2040 Connect to the examples
  - added general fast b/w refresh for capable 3-color displays GDEW0213Z19, GDEW029Z13
  - added example GxEPD2x\_FastBlackWhiteOnColor.ino for GDEW0213Z19, GDEW029Z13
  - evaluation of other fast b/w capable 3-color panels may follow ##### Version 1.3.3
  - added b/w differential refresh method to GDEW0213Z19
  - added b/w differential refresh method to GDEW029Z13
  - up to 100 b/w fast refreshes have been possible (resulting in slightly reddish background)
  - added experimental example GxEPD2x\_MixedTest for proof of concept
  - GxEPD2x\_MixedTest needs enough RAM for 2 GFXCanvas1 objects
  - general 3-color mixed refresh in GxEPD2 is in evaluation, for capable panels ##### Version 1.3.2
  - added support for GDEW0213T5D 104x212 b/w e-paper panel
  - added support for GDEW029T5D 128x296 b/w e-paper panel
  - added support for GDEW0213Z19 104x212 b/w/r e-paper panel
  - added support for GDEW029Z13 128x296 b/w/r e-paper panel
  - both GDEW0213Z19 and GDEW029Z13 support only full screen refresh (controller issue) ##### Version 1.3.1
  - added support for GDEM029C90 128x296 b/w/y e-paper panel
  - GDEM029C90 has a very long refresh time of about 27 seconds
  - GDEM029C90 has partial update (window addressing) of controller memory
  - GDEM029C90 supports only full refresh of screen ##### Version 1.3.0
  - added support for GDEM029T94 128x296 b/w e-paper panel
  - added support for GDEW026M01 152x296 b/w new DES e-paper panel
  - the new GDEW026M01 DES b/w e-paper panel has higher contrast and wide temperature range
  - differential refresh (fast partial update) is supported for normal temperature range
  - disable differential refresh for extended temperatures by setting hasFastPartialUpdate = false;
  - the differential waveform table for GDEW026M01 is experimental and may need improvement
  - major update of display selection in the examples to make additions easier:
  - old style selection is now in separate include files GxEPD2\_display\_selection.h
  - and GxEPD2\_display\_selection\_added.h
  - added new style display selection in include file GxEPD2\_display\_selection\_new\_style.h
  - either selection style can be used. old style is intended for easy copying of constructor lines.  
##### Version 1.2.16
  - fix for GDEH0154D67, to work independent of OTP version (ping-pong issue) ##### Version 1.2.15
  - added support for GDEW0213M21 2.13" 104x212 b/w new DES e-paper panel
  - added support for GDEW029M06 2.9" 128x296 b/w new DES e-paper panel
  - added support for GDEW042M01 4.2" 400x300 b/w new DES e-paper panel
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- these new DES b/w e-paper panels have higher contrast and wide temperature range
  - differential refresh (fast partial update) is supported for normal temperature range
  - disable differential refresh for extended temperatures by setting `hasFastPartialUpdate = false`;
  - the GDEW042M01 I have is a preliminary version, differential waveform may need update #####  
Version 1.2.14
  - added support for 6" 1448x1072 ED060KC1 on Waveshare e-Paper IT8951 Driver HAT
  - fixed GxEPD2\_WiFi\_Example.ino: new GitHub fingerprint for ESP8266, certificate for ESP32
  - fixed color discriminator for 7-color display in GxEPD2\_7C.h
  - added multicolor support for 7-color display in GxEPD2\_WiFi\_Example, GxEPD2\_Spiffs\_Example,
  - and GxEPD2\_SD\_Example, GxEPD2\_SerialFlash\_Example
  - fixed paged write to 7-color display controller (transaction and CS handling issue)
  - some more fixes ##### Version 1.2.13
  - added support for GDEH0154Z90 1.54" 200x200 b/w/r, replacement for GDEW0154Z04
  - GDEH0154Z90 has partial window addressing, but no partial window refresh
  - added some missing constructor examples, e.g. for IT8951 Driver HAT on Due
  - cleaned-up wiring information in the examples ##### Version 1.2.12
  - fixed GxEPD2\_MinimumExample.ino to draw black on white (white on white was invisible)
  - added example GxEPD2\_HelloWorld.ino
  - updated wiring info and constructor parameters for the actual Waveshare e-Paper ESP8266 Driver Board
  - added some missing explicit initializers (nobody noticed as compilers usually initialize simple members) ##### Version 1.2.11
  - added support for Waveshare 5.65" 7-color e-paper display 600x448
  - the unknown controller of this display doesn't support partial update, as far as known
  - 7-color graphics support is available with class GxEPD2\_7C
  - 7-color graphics support requires paging even on ESP32
  - 7-color graphics support causes heavy paging on Arduino UNO, gets very slow
  - refresh is quite fast for a color e-paper display: 12 seconds ##### Version 1.2.10
  - added support for GDEH075Z90 7.5" b/w/r 880x528
  - the controller of GDEH075Z90 supports partial update, but refresh is full screen
  - the controller of GDEH075Z90 doesn't support differential update (not possible on 3-color anyway)
  - note: the connector of the GDEH075Z90 is mirrored; connects downward on DESPI-C02
  - added optional init parameter "reset\_duration" in ms, same default 20ms as before
  - reset\_duration = 2 may help with "clever" reset circuit of newer boards from Waveshare #####  
Version 1.2.9
  - added support for GDEW0154T8 1.54" b/w 152x152
  - added support for GDEW0154M09 1.54" b/w 200x200
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- added support for GDEW0154M10 1.54" b/w 152x152 DES
  - added support for GDEW0583T8 5.83" b/w 648x460
  - added option to use class GFX of library GFX\_Root instead of Adafruit\_GFX
  - differential update on GDEW0154M10 is experimental, there is no partial update demo yet #####  
Version 1.2.8
  - improved transfer speed for the bigger displays (3.71" and up) ##### Version 1.2.7
  - fix paged drawing of initial screen on GDEH029A1
  - sometimes true is false, if applied the wrong way round ##### Version 1.2.6
  - slightly improved differential refresh for GDEW1248T3
  - minor fixes ##### Version 1.2.5
  - added support for GDEW1248T3 12.84" b/w panel on Waveshare 12.48 e-paper display frame
  - tested with Waveshare Epaper ESP32 Driver Board mounted on connection board
  - tested with Arduino UNO mounted on connection board, is extremely slow
  - doesn't work with Arduino MEGA on connection board with switch set to ICSP and pins bent out of way, reason unknown
  - not tested with other processors
  - caution: wiring connector is on 5V side of level converters! ##### Version 1.2.4
  - added support for GDEH0154D67 1.54" b/w, replacement for GDEP015OC1
  - added GxEPD2\_SerialFlash\_Loader, WiFi bitmap downloader for SPI-flash
  - added GxEPD2\_SerialFlash\_Example, SPI-flash example, e.g. for Winbond 25Q16BVSIG
  - minor fixes and comment cleanups
  - fix refresh(false) in upper layer: add powerOff() after full refresh ##### Version 1.2.3
  - fixed partial update for 2.13" 3-color and 2.9" 3-color e-paper
  - partial update can be disabled with attribute usePartialUpdateWindow = false
  - added GxEPD2\_GFX\_Example to show uses of GxEPD2\_GFX base class
  - replaced GxEPD2\_MultiDisplayExample code, same code as GxEPD2\_GFX\_MultiDisplayExample
  - added extras/examples/GxEPD2\_T\_MultiDisplayExample, alternate example using template functions
  - major and minor fixes, such as typos that survived too long ##### Version 1.2.2
  - fixed BMP handling, e.g. for BMPs created by ImageMagick
  - see also Arduino Forum Topic <https://forum.arduino.cc/index.php?topic=642343.0> #####  
Version 1.2.1
  - added support for GDEW075T7 7.5" b/w 800x480
  - GDEW075T7 has differential update (1.6s) using a charge balancing waveform
  - added optional SW SPI support, see /extras/sw\_spi/README
  - added /extras/tests/GxEPD2\_RefreshTests/GxEPD2\_RefreshTests.ino, for waveform tuning
  - minor fixes
  - note that 7.5" e-paper displays don't work reliable if fed from 3.3V Arduino pin ##### Version

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### 1.2.0

- added “fast partial update” (differential update) for GDEW0371W7 3.7” b/w 240x416
- improved differential update waveform for GDEW026T0 2.6” b/w 152x256
- fixed init code & improved differential update for GDEW042T2 4.2” b/w 300x400
- note that all differential refresh waveforms are a compromise (ghosting, big font use)
- parameters for differential waveform for these display can easily be changed for experimenting
- GDEW042T2 would have greyed background without sustain phase
- GDEW042T2 needs multiple full refreshes after extended use of partial updates ##### Version 1.1.10
- added support for GDEH0213B73 2.13” b/w, replacement for GDE0213B1, GDEH0213B72
- added support for GDEW026T0 2.6” b/w 152x256
- added support for GDEW0371W7 3.7” b/w 240x416
- added support for GDEW075Z08 7.5” b/w/r 800x480
- GDEW075Z08 does allow (slow) partial update, set usePartialUpdate = false to disable for better image
- changed 4.2” b/w waveform table, for better result with actual panels ##### Version 1.1.9
- note for ESP8266 when using SS for CS: (wiring suggestion)
- connect 4.7k pull-down from GPIO15 to GND if your board or shield has level converters
- fixes for large displays (use uint16\_t for buffer index) ##### Version 1.1.8
- fix for incomplete download in GxEPD2\_WiFi\_Example
- added missing method displayWindow() to GxEPD2\_GFX base class
- fix and clean up of initial refresh for panels with differential update
- initial refresh needs to be full update, not “fast partial update”, for these panels,
- as the screen content may differ from the “previous buffer” content.
- add clean of controller buffer(s) on initial write to controller, for partial update. ##### Version 1.1.7
- enhanced support for full buffered, non-paged use, for processors with enough RAM
- use void display(bool partial\_update\_mode = false); corresponds to update() in GxEPD
- use added void displayWindow(uint16\_t x, uint16\_t y, uint16\_t w, uint16\_t h);
- use added writeImagePart(...), drawImagePart(...), used by displayWindow()
- added example GxEPD2\_NotPagedExample.ino
- several fixes, e.g. parameter range check in setPartialWindow() ##### Version 1.1.6
- added support for GDEH0213B72 2.13” b/w, replacement for GDE0213B1
- changed SPI speed for IT8951 Driver HAT to 24MHz for write, 10MHz for read
- minor fixes, e.g. centering of text bounding box in GxEPD2\_Example ##### Version 1.1.5
- added support for 6” ED060SCT on Waveshare e-Paper IT8951 Driver HAT
- uses 3.3V data lines, but 5V supply (~80mA active, ~20mA stand-by, sleep doesn’t work)
- note: 5V supply needs to be exact and strong; 5V over diode from USB (e.g. Wemos D1 mini)

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doesn't work!

- note that the IT8951 Driver HAT is panel specific, with flash parameterized by supplier
- this is an initial version ##### Version 1.1.4+
- added GxEPD2\_WS\_ESP32\_Driver example for Waveshare ESP32 Driver Board ##### Version 1.1.4
- eliminated double refresh for “fast partial update”
- moved wavetables to the driver classes
- added one explicit drawImage(...) and writeImage(...) method (for removed default parameter values for 1.1.3)
- added init method with added parameter initial, for re-init after processor deep sleep wakeup
- added init parameter pulldown\_rst\_mode, for special RST handling (not needed for waveshare shield) ##### Version 1.1.3
- fixed wavetables for GDEW029T5 and GDEW0213I5F
- fixed drawImage(...) overloaded methods signature matching ambiguity ##### Version 1.1.2
- added support for GDEW029T5
- fixed (added) clipping for partial window
- fixed (added) powerOff() after full update (partial update keeps power on)
- added hibernate() for minimum power use by displays that support it ##### Version 1.1.1
- 2.7” b/w GDEW027W3 with fast partial update support, based on new demo code wavetable
- mapping suggestion added for Arduino MEGA
- NOTE: use voltage divider resistors for 5V Arduinos, series resistor is not reliable enough
- ConnectingHardware.md updated ##### Version 1.1.0
- added support for GDEW0213I5F for 2.13” b/w 104x212 flexible display
- updated GxEPD2\_WiFi\_Example and GxEPD2\_Spiffs\_Loader to use BearSSL on ESP8266, for large bitmap downloads ##### Version 1.0.9
- add GxEPD2\_U8G2\_Fonts\_Example, e.g. for use of Umlauts ÄÖÜäéöü
- NOTE: you need to SAVE the modified example to a saveable location for UTF-8 characters to work ##### Version 1.0.8
- add GxEPD2\_SD\_AVR\_boards\_added.h to GxEPD2\_SD\_AVR\_Example
- with example definitions for non-AVR boards (low level display class use example) ##### Version 1.0.7
- add GxEPD2\_boards\_added.h to GxEPD2\_Example
- with example definitions for Arduino DUE and MKR1000 ##### Version 1.0.6
- add buffered drawing option to GxEPD2\_WiFi\_Example
- allows use with 1.54” 3-color 200x200 display, may also be useful for small bitmaps ##### Version 1.0.5
- add buffered drawing option to GxEPD2\_SD\_Example and GxEPD2\_Spiffs\_Example
- allows use with 1.54” 3-color 200x200 display, may also be useful for small bitmaps ##### Version

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#### 1.0.4

- add GxEPD2\_GFX base class support (optional, selectable, uses slightly more code)
- base class GxEPD2\_GFX can be used to pass references or pointers to the display instance as parameter
- add GxEPD2\_GFX\_MultiDisplayExample, uses GxEPD2\_GFX reference parameter
- modify GxEPD2\_MultiDisplayExample for ESP8266 (template issue: class expected instead of typename) ##### Version 1.0.3
- fix GxEPD2\_SD\_Example & GxEPD2\_SD\_AVR\_Example
- add GxEPD2\_MultiDisplayExample (preliminary version) ##### Version 1.0.2
- initial release version 1.0.2
- tested with ESP8266, ESP32, STM32F103C8T6, AVR Arduino (Pro Mini 3.3V)
- 1.54" 3-color GxEPD2\_154c can be used with paging for AVR
- wave tables in program space, 4.2" b/w can be used with GxEPD2\_SD\_AVR\_Example
- issues enabled and welcome, please use Forum Topic for enhancement suggestions ##### Version 1.0.1
- pre-release test version
- GxEPD2\_SD\_AVR\_Example added, has no graphics buffer to reduce RAM usage (base display class use)
- issues disabled so far, use Arduino Forum Topics instead
- in this version 1.54" 3-color GxEPD2\_154c can only be used with full size buffer (or with no buffer base display class) ##### Version 1.0.0
- preliminary version, under construction