PERVASIVE DISPLAY EXT3 kit E-Paper EPD Development Kit User Manual
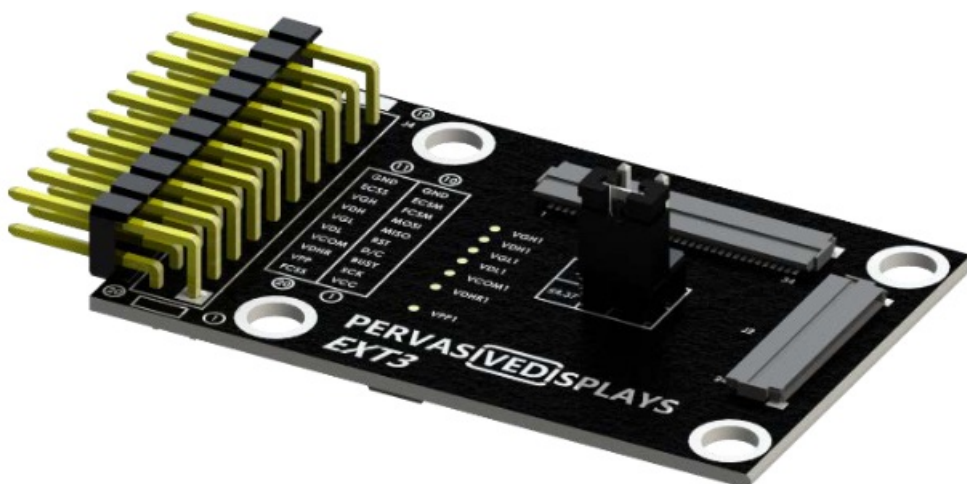
User Manual of EXT3 Kit
Rev. 02 (Mar 2022)

Preface

EPD Extension Kit Generation 3 (EXT3 kit) is a new driving extension board to connect with your product to kick-start low power display application with EPDs (e-Paper displays). This document describes how to work with EXT3 kit and use the sample code to refresh image on EPD screen.

Contents

Overview

EPD Extension Kit Generation 3 (EXT3 Kit) is a new extension board to connect with your product to kick-start low power display application with iTC driver type of EPDs (EPD: Electrophoretic display, Electronic paper display. E-Paper display). It provides 20 pins of bridging cable to any of your chosen development board or current design platform.

1.1 E ink imaging film (FPL)

E ink imaging film is also called FPL (Front Panel Laminate) has two main material films for industrial applications. The name of two FPLs are Aurora and Spectra. It can be subdivided into the following different FPL types:

EoL: End of life, discontinued.

FPL group	FPL name	Alias name	Colors	Operating Temperature
Aurora	Aurora Ma	V230(EoL)	Black, White	-20°C to +10°C
	Aurora Mb	V231	Black, White	0°C to +50°C
	Aurora -25	V430	Black, White	-25°C to +30°C
Spectra	Spectra Red	R1.1(EoL) R1.2, R2.0	Black, White, Red	0°C to +40°C
	Spectra Yellow	Y1.2	Black, White, Yellow	0°C to +40°C

How to make your selection for a suitable FPL in your application? Visit this webpage for more information.

1.2 Driver IC (CoG) and driving waveform

Driver IC is a timing controller (Tcon) to output different sources/data and control the gates per pixel on EPD. It's always bonded on TFT backplane which is also called CoG (Chip on Glass). The output image on an EPD is realized by controlling the pixel electrode voltage, thus affecting motion of charged particles in the neutral suspension. A voltage sequence applied to the pixel electrode is called a driving waveform. Different manufacturer of EPD selects different driver IC and the E ink FPL is always varied batch by batch. Therefore, each design of a driving waveform is completed manually and always need to be tuned from different batch of FPL. Simultaneously, under different temperature conditions, more sets of driving waveform matched with different temperature conditions are required.
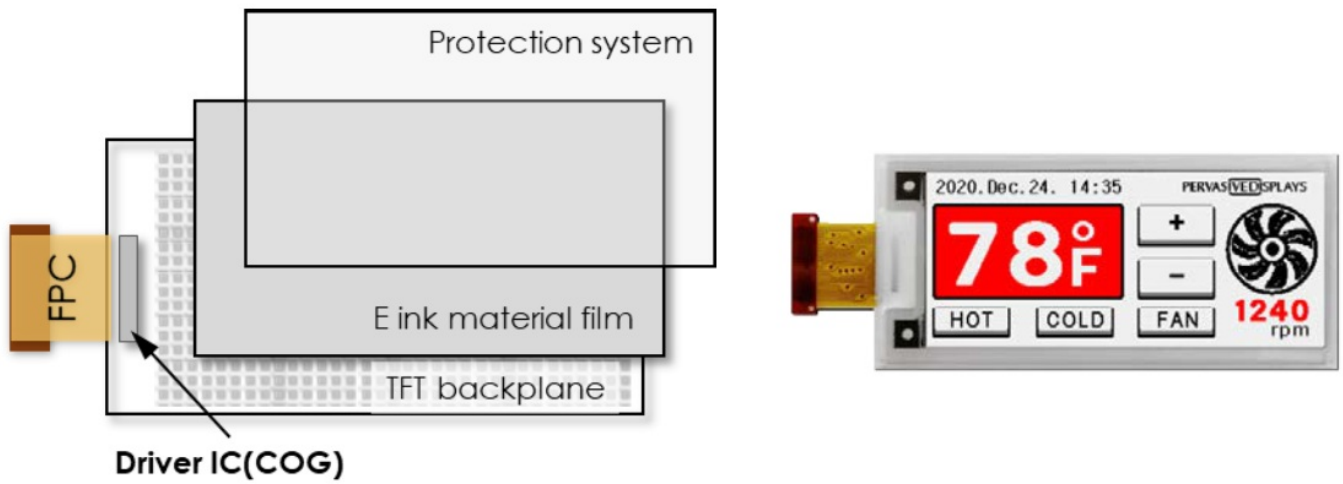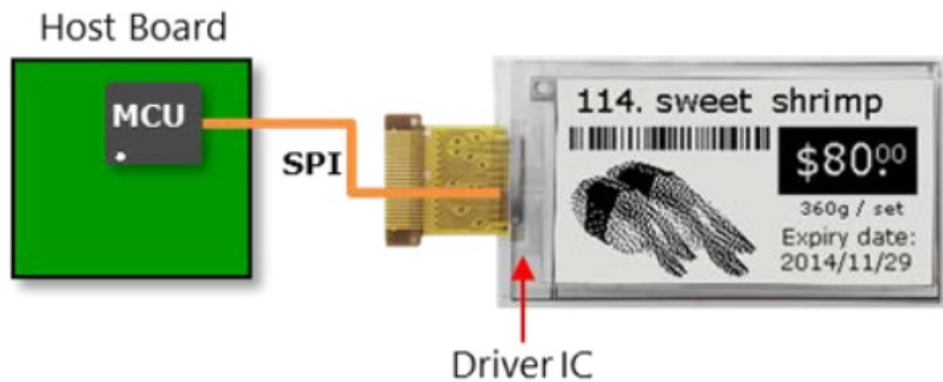
Figure 1   Layer structure of EPD module

Charge pump, a kind of DC to DC converter (DC/DC) that uses capacitors for energetic charge storage to raise or lower voltages. A positive charge pump and a negative charge pump to provide adjustable regulated output voltages. EPD needs charge pumps to step up the voltages to supply different voltage levels to drive different color pigments in EPD module. When the DC/DC is embedded in the CoG and driving waveform is pre-programmed in CoG, we call it internal timing controller (iTC) ,and similarly, if the DC/DC circuit is arranged outside the EPD module and driving waveform is controller from MCU, we call it external timing controller (eTC).
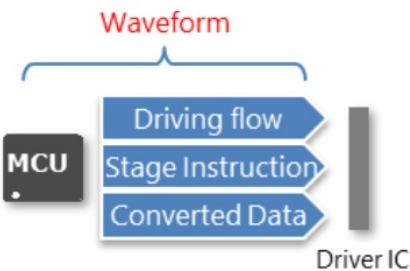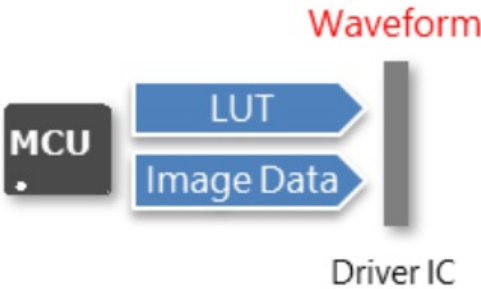
	eTC (external Tcon)	iTC (internal Tcon)
Driver type		
Driving waveform	Controlled by MCU	Embedded in driver IC (CoG)
Customization / Design flexibility	Higher	Normal
Design-in effort	Normal	Easier
Power consumption	Lower	Normal
Explanation	· Following our driving guide, developers can fully control the driving flow and stage from the MCU. · Developers need to send converted image data at each specific stage.	· The driving waveforms (LUTs, lookup tables) have been pre- programmed in the driver IC. Developers just need to send image data and update command to complete the screen refresh. · If developers need special support to change the waveforms, extra LUTs can be sent externally.

Table 2 eTC vs. iTC

1. 💡 We provide both approaches of timing controller for EPD modules. The eTC model is our unique structure, which is different from the vendors on the market.
2. EXT3 kit supports iTC model only. If you have chosen the eTC modules, please order our EXT2 kit which supports iTC and eTC models.

1.3 EXT3 Kit introduction
1.3.1 Features

- EXT3 Kit supports driving EPDs made by Pervasive Displays (PDi) with iTC driver IC (excluded eTC) from full range of 1.54″ to 12″ EPDs (a connector board to work with 9.7″ and 12″ as EXT3 Giant)

- On board driving circuit as a starter kit to easily develop EPD application with your product
- On board 20 pins of 90 degrees header with provided 20 pins of bridging colored cable easily to connect with any development board
- On board 8M bits of Flash memory
- Second available non-populated SOIC-8 pads for additional memory
- A variety of expansion options to meet your development needs and use cases
- Open driving source code and design resources
- Integrate graphic library (as EXT3 Plus) and touch board (as EXT3 Touch) to extend interactive application cases

1.3.2 EXT3 Kit
Model no. B3000MS036
Targeted user: Makers, Hobbyists, Engineers, Fast prototyping Suitable EPD models: 1.54″ to 7.4″ EPD with iTC driver
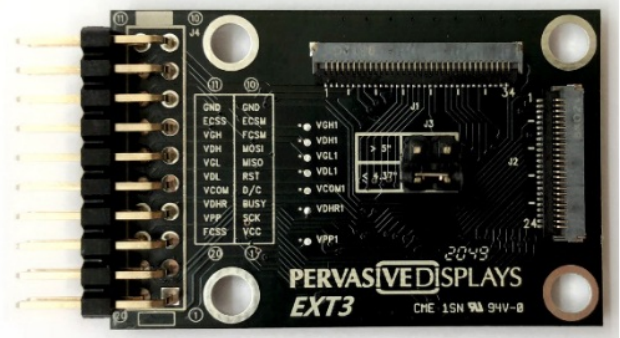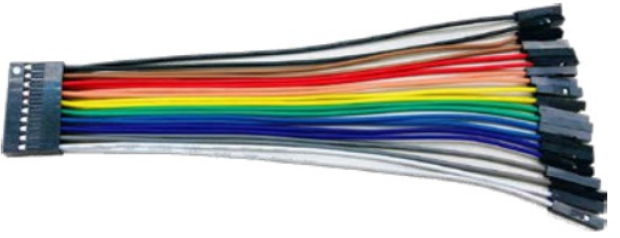
EXT3 Kit contents

#	Item name	Quantity	Thumbnail
1	EPD Extension board	1	
2	20 pins of bridging cable, 15cm [(matching the electronic color codes)](#)	1	

Table 3 EXT3 Kit contents
1.3.3 EXT3 Giant
Model no. B3000MS037
Targeted user: Makers, Hobbyists, Engineers, Fast prototyping Suitable EPD models: 9.7″ or 12" EPD with iTC driver
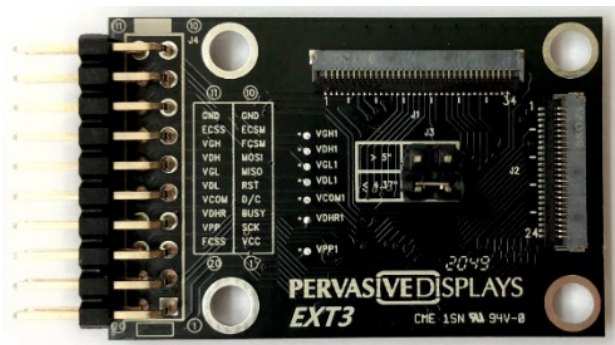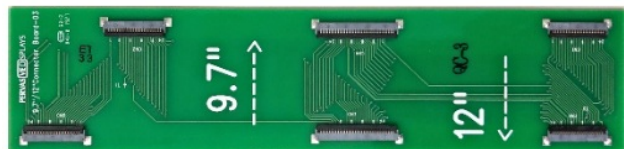**EXT3 Giant contents**

#	Item name	Quantity	Thumbnail
1	EPD Extension board	1	
2	20 pins of bridging cable, 15cm **(matching the electronic color codes)**	1	
3	Connector board	1	
4	34 pins FFC cable, 10cm	1	

Table 4 EXT3 Giant contents

1.3.4 EXT3 Plus

Model no. B3000MS038

Targeted user: Makers, Hobbyists, Engineers, EPD technology evaluation

EXT3 Plus contents

💡 This EXT3 Plus will be launched in March 2021 and will update more detailed information in next revision of user manual.

#	Item name	Quantity	Thumbnail
1	TI **MSP-EXP430F5529LP**	1	
2	EPD_screen library **advanced**	1	Charged, $TBD Advanced version of EPD l ibrary is pr eloaded in L aunchPad above . Please click here (TBD) for more information.

Table 5 EXT3 Plus contents

We also provide a gratis Basic version of EPD graphic library for EXT3 Kit. You could find the sample source code here on GitHub. With EPD graphic library, you are able to generate characters, fonts, shapes and object orientations easily on EPD screen.

1.3.5 EXT3 Touch

Model no. B3000MS039

Targeted user: Engineers, Fast prototyping, EPD technology evaluation, Complete solution

EXT3 Touch contents

💡 This EXT3 Touch will be launched in March 2021 and will update more detailed information in next revision of user manual.

#	Item name	Quantity	Thumbnail
1	2.71" EPD with projected – capacitive touch panel	1	TBD
2	EXT3 touch board	1	TBD
3	6 pins bridging cable	1	TBD

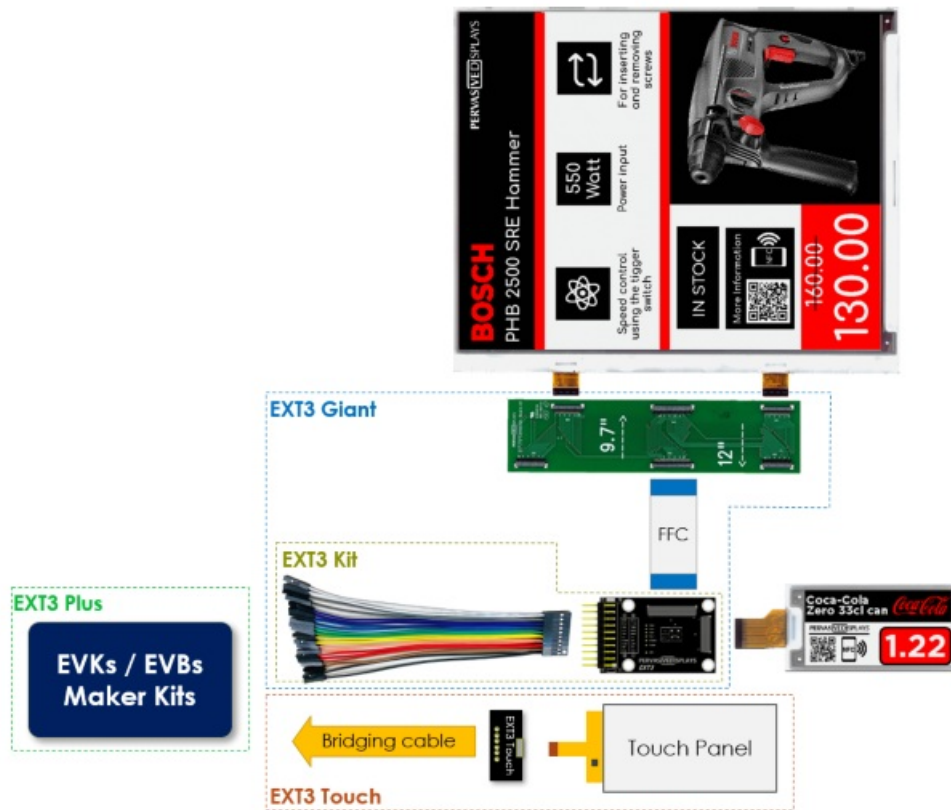Table 6   EXT3 Touch content

1.3.6 EXT3 connectivity

Figure 2   EXT3 Connectivity

EVK means Evaluation Kit and EVB means Evaluation Board like Arduino, TI LaunchPad, Raspberry Pi or Adafruit Feather. If your product has arranged pin headers for external jumper wires, you are able to use our 20 pins of bridging cable in EXT3 kit to bridge EXT3 board towork with our EPDs and design your own new applications.

2. EXT3 board
The EXT3 board supports driving all our EPD modules with 24 pins FPC connector. The board
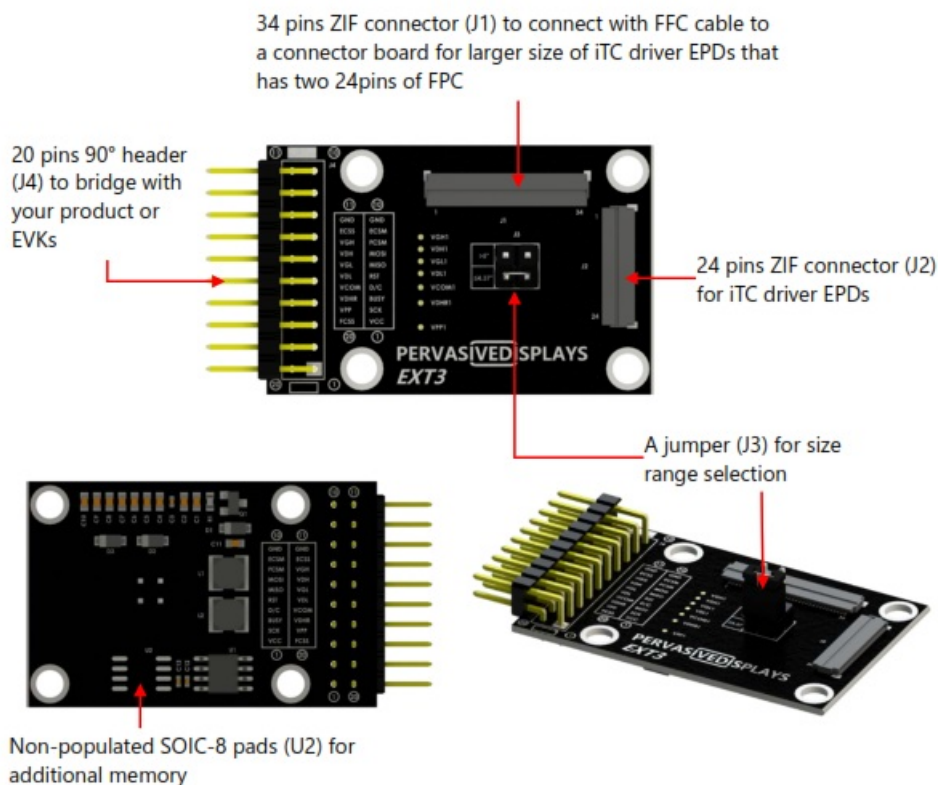has populated EPD driving circuit where the components are soldered at the backside.

34 pins ZIF connector (J1) to connect with FFC cable to a connector board for larger size of iTC driver EPDs that has two 24pins of FPC

20 pins 90° header (J4) to bridge with your product or EVKs

24 pins ZIF connector (J2) for iTC driver EPDs

A jumper (J3) for size range selection

Non-populated SOIC-8 pads (U2) for additional memory

Figure 3   Overview of EXT3 board

2.1 Reference circuit and BOM

Please refer to "Reference circuit_BOM of EXT3_Rev##_[Date]" doc on EXT3 webpage for more details of driving circuit, pin assignments and BOM list.

2.2 Connect EPD to EXT3 board

2.2.1 Connecting EPD with 24 pins of ZIF connector (J2)
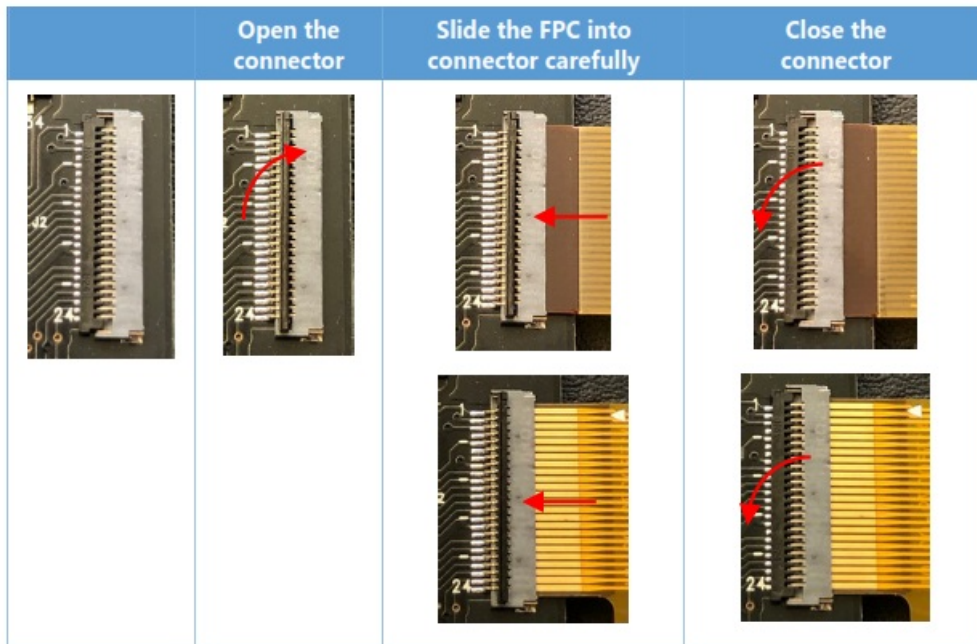
J2 is a double-sided contact of 0.5mm pitch FPC connector.

Figure 4   24 pins J2 connector

2.2.2 Connecting FFC with 34 pins of ZIF connector (J1)

J1 is a double-sided contact of 0.5mm pitch FPC connector.
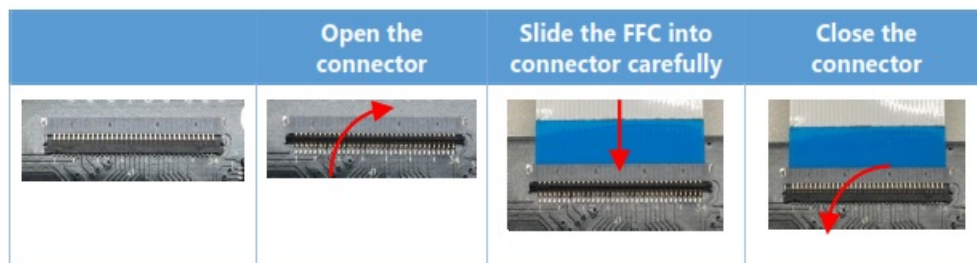
Figure 5   34 pins J1 connector

The same steps of connecting FFC with connector board and large size of EPD. Find the final connected picture with a 9.7" EPD and connector board at next page.
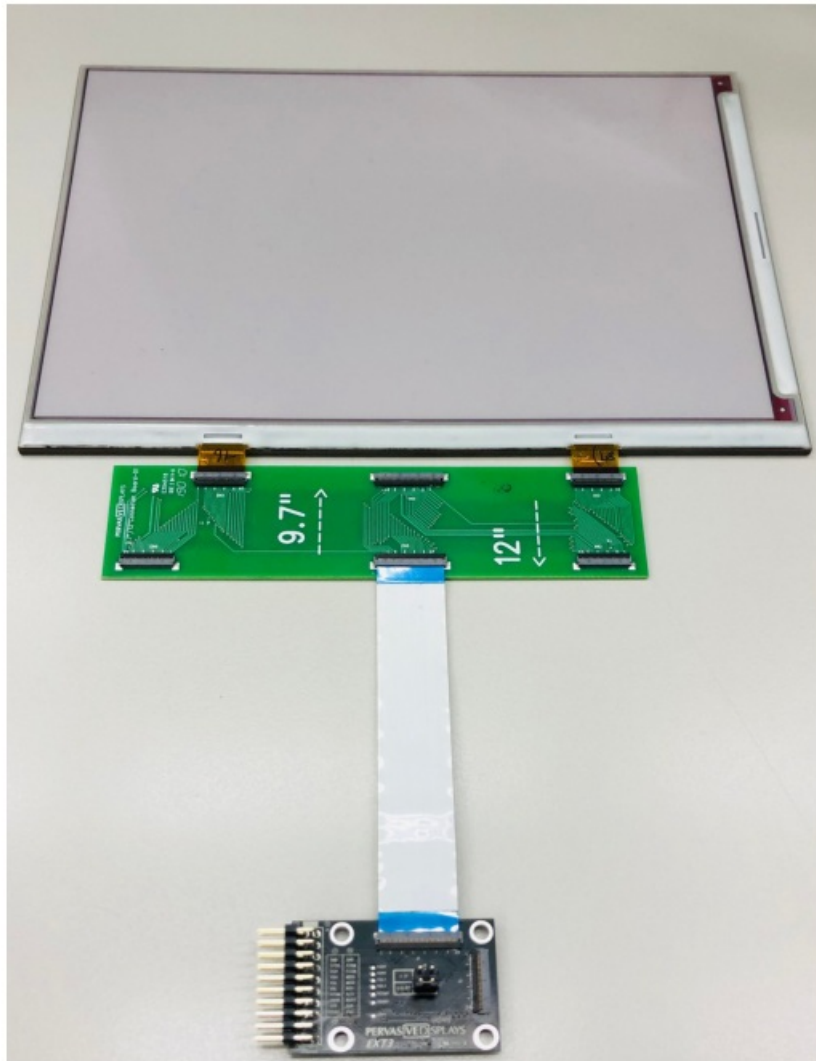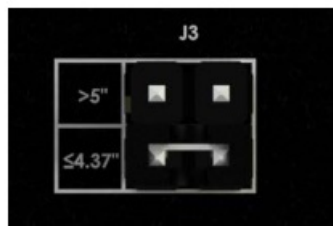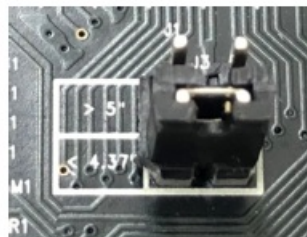
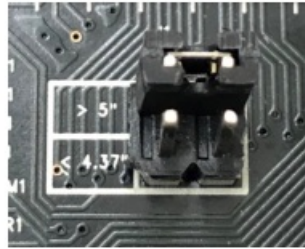Figure 6　Connecting 9.7″ EPD and connector board

2.2.3 Switch J3 Jumper
There is a J3 jumper to select the corresponding inductor for different size range.

- If the EPD size that you are working with is greater than 5 inch, please short the jumper on the option of ">5".

- If the EPD size is smaller 5 inch, please short the jumper on the option of "≤ 4.37".

2.3 Connect EXT3 board to EVK
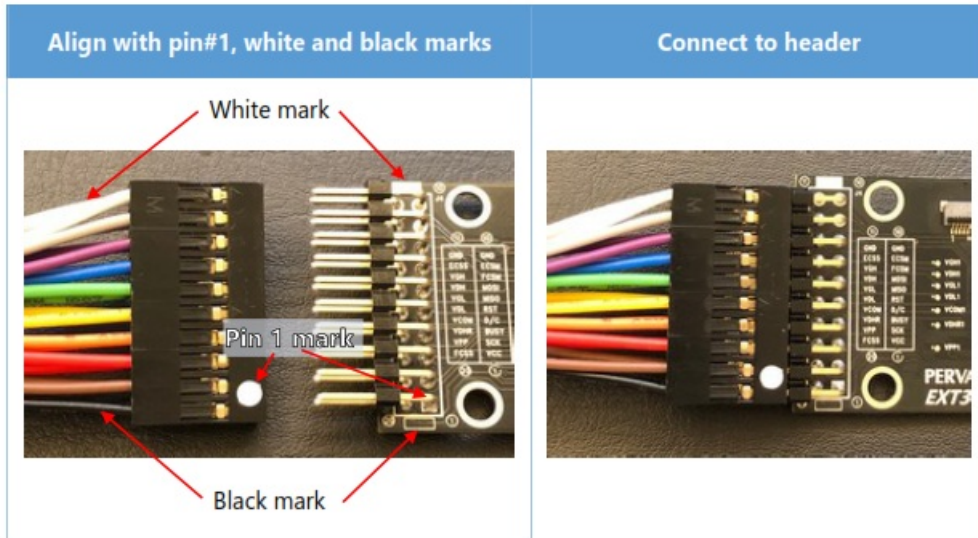### 2.3.1 20 pins of bridging cable to EXT3 board

Figure 7   20 pins bridging cable to EXT3 board

💡 Please note that the power and logic voltage level for EXT3 is 3.3V.
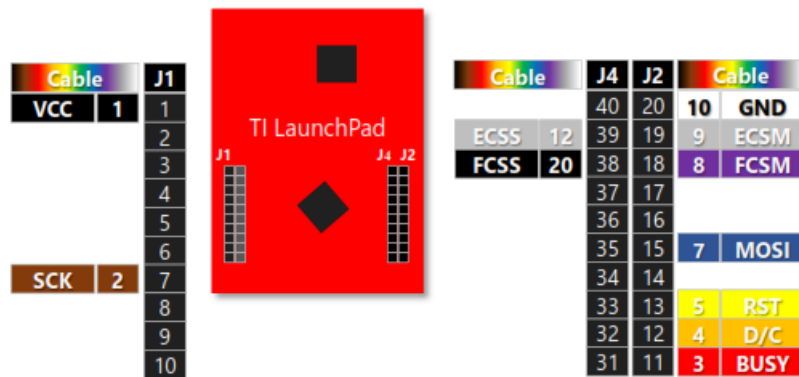
2.3.2 Bridging cable to TI LaunchPad

Figure 8   Pin Map of connecting bridging cable with TI LaunchPad

The diagram above shows the complete pin map connecting with colored code of bridging cable for most of the LaunchPad. If your LaunchPad has 40 pins, please use the outer two rows.
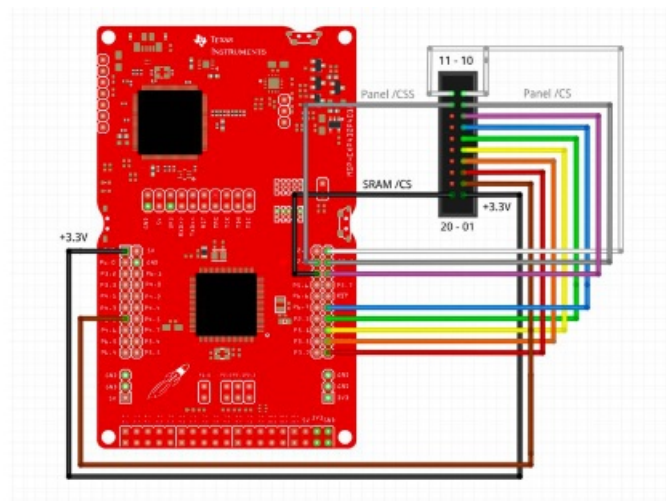Find the connected picture with TI EK-TM4C123GXL LaunchPad at next page.

Figure 9   TI LaunchPad MSP432 Pin Map
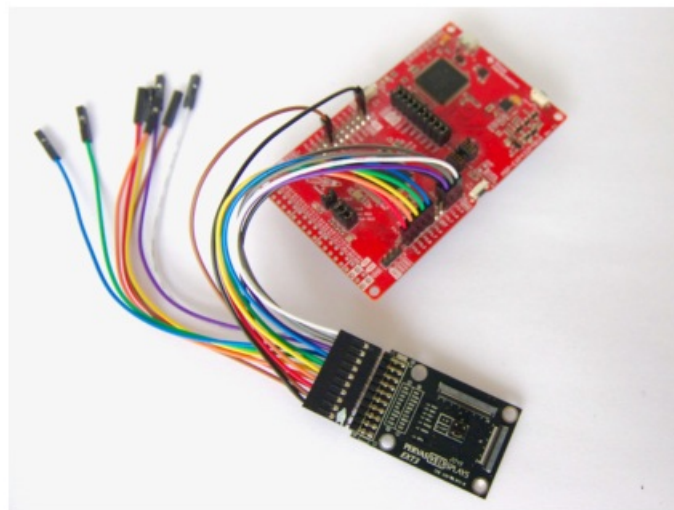

Figure 10   Connecting with TI LaunchPad
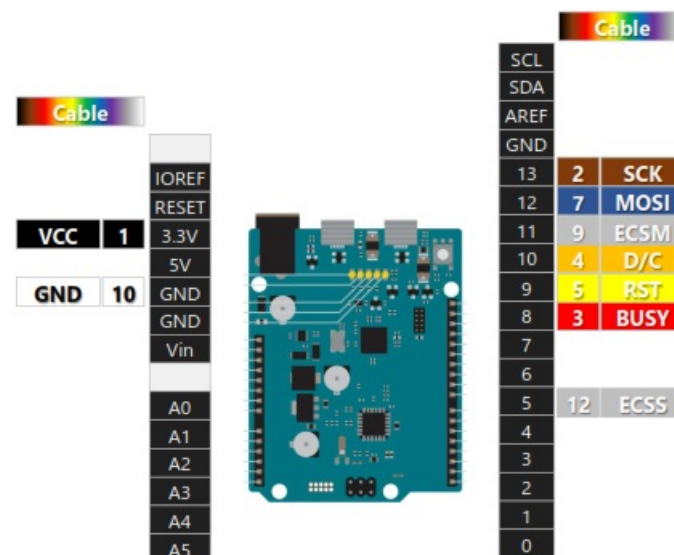
2.3.3 Bridging cable to Arduino M0 PRO

Figure 11   Pin Map of connecting bridging cable with Arduino M0 PRO

The diagram above shows the complete pin map with colored code of bridging cable for Arduino M0PRO.
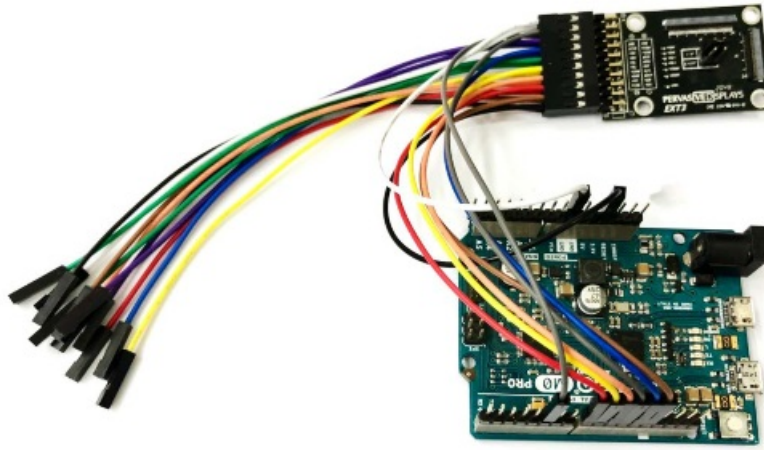Find the connected picture with Arduino M0PRO below.

Figure 12   Connecting with Arduino M0 PRO

Working with Arduino and Energia

3.1 Programming language
Arduino: is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. Arduino boards are available commercially from the official website or through authorized distributors. The Arduino project provides an integrated development
environment (IDE) can be downloaded from here.
Energia: is an open source & community-driven IDE & software framework. Based on the Wiring and Arduino framework, Energia provides an intuitive coding environment as well as a robust framework of easy-to-use functional APIs & libraries for programming a microcontroller. Energia supports many TI processors, primarily those available in the LaunchPad development ecosystem. The Energia ID can be downloaded from here.
The driving source code can be used between Arduino and Energia, just the supported libraries of microcontroller kit are different. Arduino and Energia language are based on C/C++ where the file name extension is .ino file.

3.2 Driving code on GitHub
GitHub, is a provider of Internet hosting for software development and version control using Git. It offers the distributed version control and source code management (SCM) functionality of Git, plus its own features.
Our driving reference source codes and manual for EXT3 kit are opened on GitHub. Find the repositories for EXT3 kit as follows:

- ePaper_EXT3_DrivingCode: for small sizes (1.54″ to 4.37″) , medium sizes (5.81″ to 7.4″) or large sizes (9.7″ above) the driving reference code for EXT3 kit with iTC driver EPDs
- ePaper_EXT3_Basic_Library

  the basic version of graphic library for EXT3 kit You can download the code from website or use GitHub Desktop to checkout branches with pull requests.

3.3 Porting the code

- For getting started with Arduino IDE or Energia IDE, please learn from internet first.
- Understand what the model name of your Arduino board or LaunchPad. Select from menu "Tools" / "Board" to switch on the board you will work with. If it's not showed up, select "Boards Manager" and type the model name of the board in the search box to install the driver and library. Please ensure the model name is included in the list accurately. If you board has version difference, you have to select the correct version from provided dropdown list then install it.

- After installed the correct driver and library for the board you are using, connecting the board with your computer via USB cable and check the detected serial COM port number. Click from menu "Tool" / "Port" to select the COM port your computer has just detected. Ensure the final configuration is ready to show correct information at the bottom right corner of IDE.

- Open the sketch code file of EPD size you have connected that was downloaded from our repository of GitHub. Click on [✓] or [✓] compiling errors.
- Click on [↻] or [→] button to load and program into your board and then you should see the EPD is refreshing. button to verity the sketch code has no

Glossary of Acronyms

BOM	Bill Of Material
COG	Chip on Glass, Driver IC
EoL	End of life, product discontinued
EPD	Electrophoretic Display, e-Paper Display
eTC	External Timing controller
EVB/EVK	Evaluation Board / Evaluation Kit
FPL	E ink material film, Front Panel Laminate
iTC	Internal timing controller
LUT	LookUp Table
MCU	Microcontroller unit
PDI, PDi	Pervasive Displays Incorporated

Revision History

Version	Date	Page (New)	Section	Description
Ver. 01	2021/1/27	All	All	First issued
Ver. 02	2022/3/8	16	3.2	The GitHub repositories are updated

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Documents / Resources

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Manuals+,