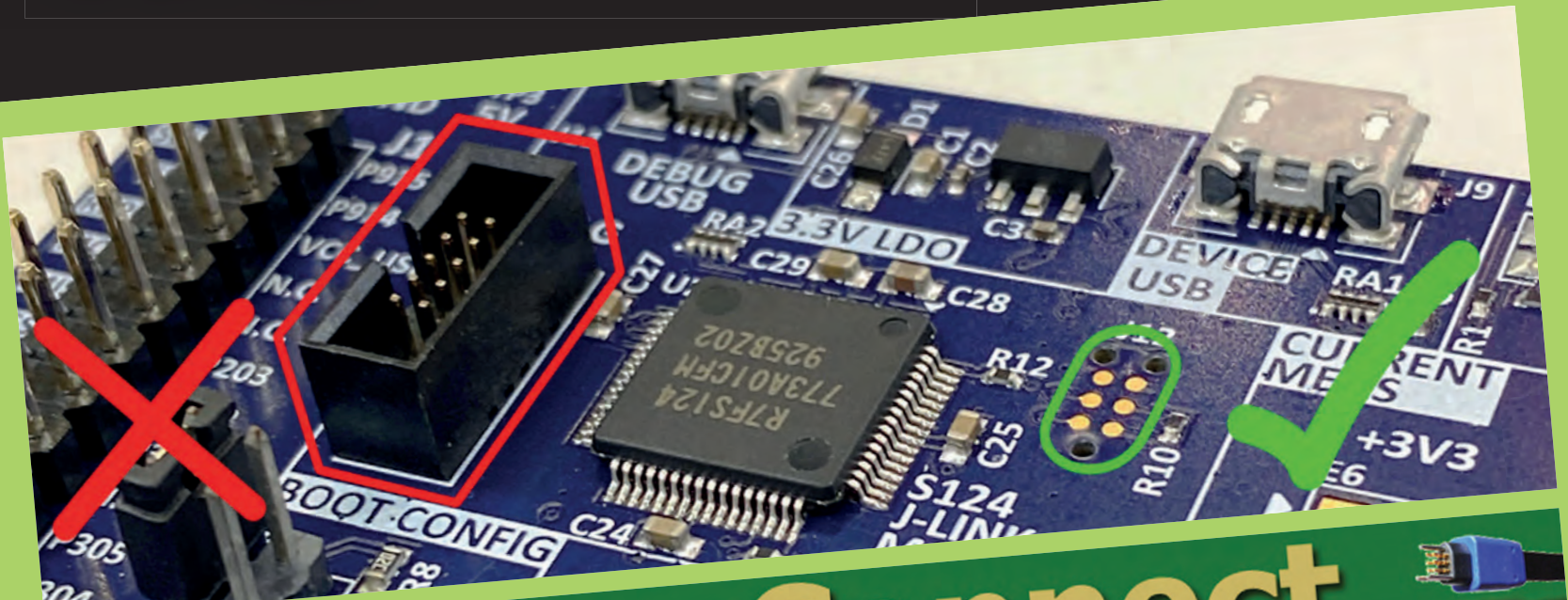


# ELECTRONICS FOR ENGINEERS

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## Tag-Connect solutions for all PCBs



## Tag-Connect



# Introduction to e-paper technology

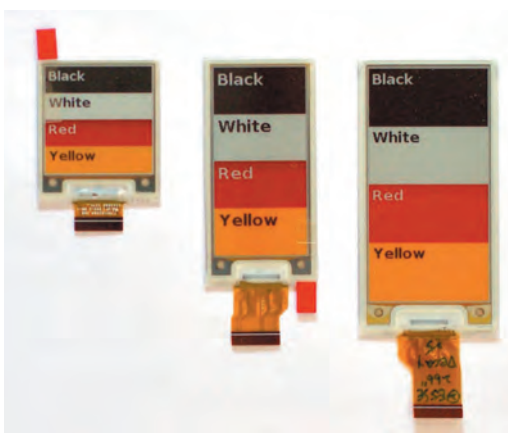
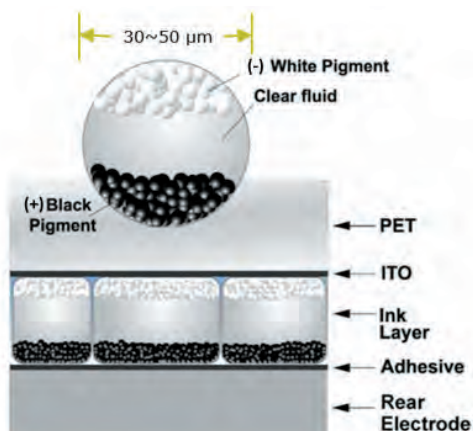
E-paper technology is ubiquitous. There is an e-paper display on the e-readers like Kindle at home; there are tens of thousands of e-paper displays in retail store with electronic shelf labels or ESL. How do they work, what are their benefits, how do you design a product with this **ultra-low** power display?

## How e-paper technology works

An e-paper display or EPD consists of a film of small capsules of polarised pigments in a clear fluid. The film is sandwiched between two conductive layers, a transparent layer on the front and a solid layer on the back.

The two conductive layers generate a voltage difference that attracts or repels the pigment particles. In the example below, the top layer is positive and attracts the white pigment particles, while the rear panel is negative and attracts the black pigment particles. Once moved, the pigment particles remain in the clear fluid.

Unlike other technologies, the first image is generated in an external frame-buffer and then the whole screen is updated. The standard update mode produces the well-known blinking effect and ensures an optimal image quality. The fast update mode is much faster, typically less than one second, as it only updates the pixels that change colour. The controller of the EPD stores the optimised waveforms for each mode, which is the key to this display technology.



## The key benefits of e-paper technology

The immediate benefit of the bi-stable nature of e-paper is the ultra-low power consumption. Because EPDs only require power to change the image and maintain the image displayed with no power needed, the entire system can enter deep sleep. As an example, an ESL typically operates for more than ten years on two coin-cells.

Because the EPD does not emit light, it is highly readable outdoors and even under direct sunlight, with a special coating protects it from the UVs. A front-lighting with edge LEDs can be placed on top for indoor use.

Similarly, the viewing angle is very wide, reaching 180° just like printed paper. The high density, from 110 to 180dpi even more, makes texts and images crisp.

EPDs are not limited to black and white. After the introduction of the red colour, the four-colour screens add red and yellow colours to black and white. Full colour EPDs have also been released, offering a wider range of advertising and public information applications.

Pervasive Displays offers specific lines aimed at different operating temperatures. The Wide temperature film operates from -15 to +60°C, making it the world's only

solution for industrial, logistics and reusable transit applications where environmental conditions vary. The Spectra with red colour and the Spectra 4 with four colours operate from 0 to +40°C, perfect for indication, alarm, highlighting application and price promotions.

Another option is to add a touch sensor, turning the EPD into an ultra-low power human-machine interface for interactive applications.

## From idea to product

Pervasive Displays has designed development kits for exploring e-paper technology and designing new projects with EPD easily. The kits include extension boards to drive the EPD and self-contained introductory bundles.

Pervasive Displays opens the drivers and provides a graphics library, with multiple fonts and advanced GUI interface, to develop e-paper devices. The comprehensive documentation complements the library to reduce time-to-market development time. The wiki provides a gradual introduction to the e-paper technology and how to use it. The User Guide includes commented examples, applications notes and reference designs. Finally, the reference manual lists all the functions and their respective parameters.

The e-paper technology is ideally suited for applications where ultra-low power, constrained power budget, high readability and wide operating temperatures are critical. Applications include IoT (Internet of Things), building automation systems, smart home devices, updatable identity badges, smart inventory, digital signage, vending machines, price tags, cold chain monitoring devices, medical equipment, healthcare monitoring, edge computing and HMI (Human Machine Interface).