

# E Ink Segmented Displays

## Evaluation Guide Version 2.0

## Table of Contents

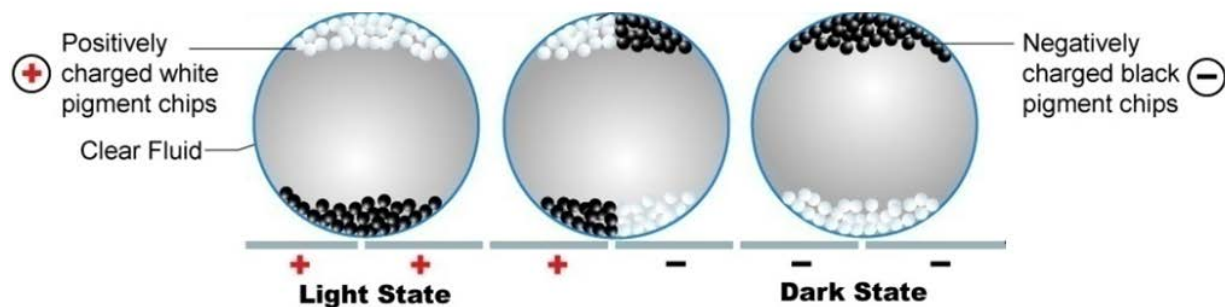
<b>1.0 E Ink Background .....</b>	<b>3</b>
1.1 How Does E Ink Work .....	3
1.2 E Ink Segmented Display Construction .....	3
<b>2.0 Benefits of E Ink Segmented Displays.....</b>	<b>4</b>
2.1 Design Examples.....	5
<b>3.0 The Electronics Ecosystem for Segmented Displays .....</b>	<b>6</b>
3.1 5 Volt Segmented Display Cell .....	6
3.2 15 Volt Segmented Display Cell .....	7
3.3 Segmented Display Module.....	7
3.4 Recommended Driving Specifications .....	8
3.5 15 Volt Display Drivers .....	8
3.6 5 Volt MCUs .....	9
<b>4.0 Connecting E Ink Displays .....</b>	<b>9</b>
4.1 Standard FPC Connections.....	9
4.2 ACF Tape Connections .....	10
<b>5.0 E Ink Standard Parts - Numeric .....</b>	<b>11</b>
<b>5.1 E Ink Standard Parts - Indicators .....</b>	<b>12</b>

## 1.0 E Ink Background

E Ink Corporation is the creator of electronic ink — the optical component of a proprietary film used in Electronic Paper Displays. Although futuristic in concept, electronic ink is a straightforward fusion of existing knowledge in chemistry, physics and electronics. E Ink displays offer high contrast, superior paper-like readability and low power consumption, drawing power only when switching the display.

### 1.1 How Does E Ink Work?

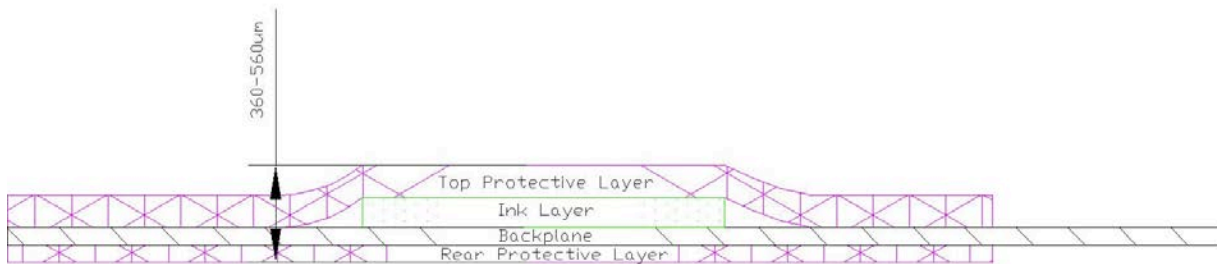
Electronic ink is made up of millions of tiny microcapsules, about the diameter of a human hair. Each microcapsule contains positively charged white particles and negatively charged black particles which are suspended in a clear fluid. When a positive or negative electric field is applied, corresponding particles move to the top of the microcapsule where they become visible to the user. This makes the surface appear white or black at that spot.



### 1.2 Segmented Display Construction

E Ink Segmented displays are comprised of four layers. The ink is coated onto a sheet of plastic film that is then laminated to a back plane with electrical connections. The back plane is manufactured using either printed carbon (PET) or Polyimide. When manufacturing a Segmented display, the film and back plane are then sealed between top and rear environmental protective layers, ensuring the internal conditions of the display are maintained and optimized for switching the ink.

The figure below shows a cross-section view of an E Ink Segmented display including from top to bottom: Top protective layer, E Ink film, back plane connection, and rear protective layer.



Each segment on an E Ink display has an individual electrode on the back plane. Each electrode is routed on the back plane, forming a display connector or tail off the edge of the display. For a Segmented Display Cell (SDC), the tail includes one trace for each segment plus two additional traces for top plane and back plane connection. For example, if your display uses 96 segments, the tail would include 98 traces or pin outs.

## 2.0 Benefits of E Ink Segmented Displays

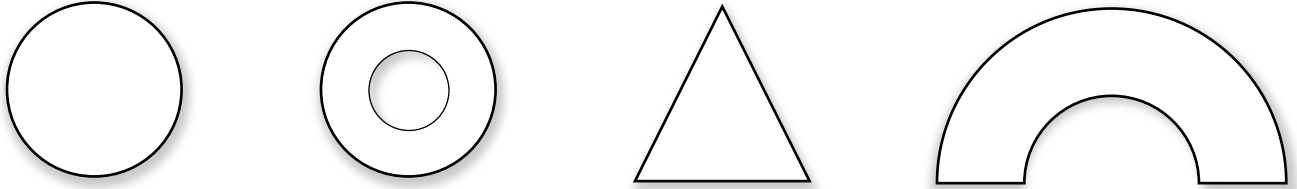
E Ink Segmented displays are ultra-low power, thin, and rugged. E Ink's unique reflective display technology is sunlight readable and can display an image with no power. **This enables engineers and designers to add displays to products where power and space limitations have made it impossible to do so before.** Applications for the technology are broad, including a wide variety of consumer electronics, watches, medical devices, industrial gauges, PC-accessories, smart cards, electronic shelf labels, and mobile communications.

The disruptive benefits of E Ink Segmented displays include:

- **Ultra Low Power** –E Ink displays are bi-stable, drawing power only when updating the display. Consuming approximately 0.5 micro amps per  $\text{cm}^2$  while switching the display, E Ink displays require zero power to display a static image.
- **Thinness** – E Ink Segmented display thickness can be between 380 and 560 microns
- **Rugged** – E Ink Segmented displays are non-glass and shatterproof for added durability.
- **High contrast** – E Ink Segmented displays are daylight readable with a 180 degree viewing angle.
- **Design** – E Ink Segmented displays can be manufactured in any 2D shape such a circle, triangle, or abstract shape, enhancing industrial designs. In addition, E Ink's unique capabilities allow for the foreground and background to be reversed from black on white or white on black.

## 2.1 Design Examples

E Ink Displays can be manufactured in any 2D Shape:



Examples of reversed foreground and background:



Example of an E Ink Segmented display (left) compared to a traditional segmented LCD:



### 3.0 Segmented Display Options and the Electronics Ecosystem

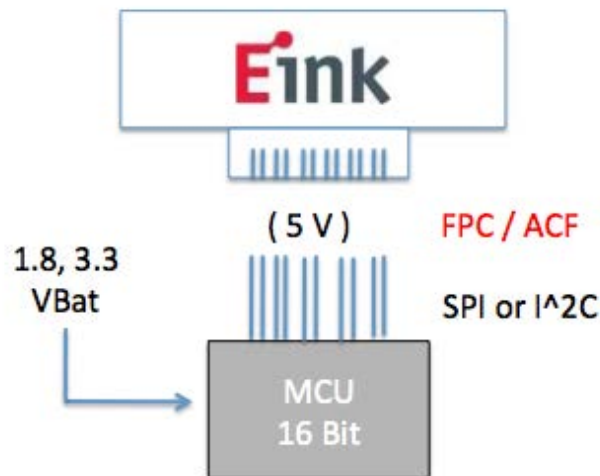
E Ink offers two types of Segmented displays: **Segmented Display Cells (SDCs)**, and **Segmented Display Modules (SDMs)**.

SDCs are independent display cells that do not include any embedded electronics; they can be driven at either 5V or 15V. Typically, SDCs are used in simpler designs with lower segment counts and fewer pin outs. Designs that have adequate space and less restrictive PCB integration needs are ideal for SDC applications.

SDMs include an integrated E Ink display driver for a complete display solution, typically for designs that have demanding integration requirements. SDMs simplify the integration effort by reducing the number of pin outs required between the MCU and display. As a result, less space is needed for connection to the PCB.

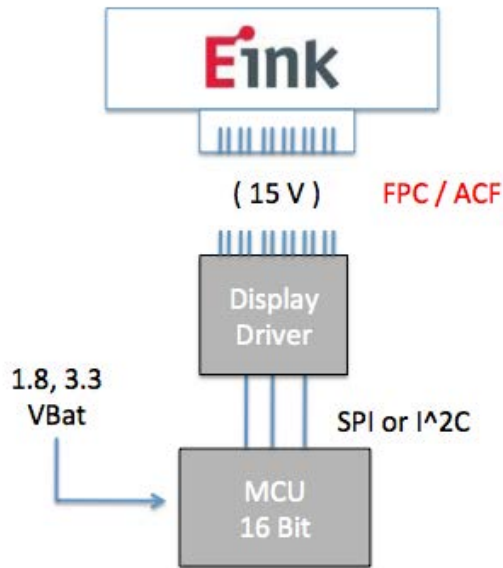
#### 3.1 5V Segmented Display Cell (SDC)

E Ink Segmented Display Cells (SDCs) can be driven as low as 5V, depending upon the nature of the application. At 5V, contrast/reflectance will be 60-80% of the performance at 15V, and will refresh at 720 milliseconds.



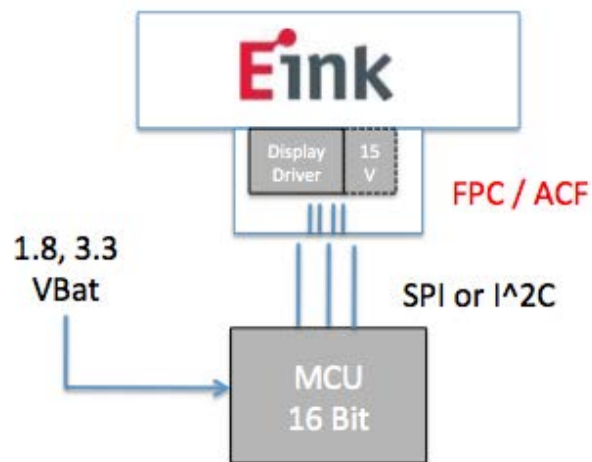
### 3.2 15V Segmented Display Cell (SDC)

E Ink Segmented Display Cells (SDCs) driven at 15V ensure optimal contrast/reflectance and the fastest refresh rate (240 milliseconds).



### 3.3 Segmented Display Module (SDM)

E Ink Segmented Display Modules (SDMs) include an integrated E Ink driver which operates at 15V to ensure optimal contrast/reflectance and fastest refresh rate.



### 3.4 Recommended Driving Specifications

The table below outlines the comparative performance of the key specifications of E Ink Segmented displays. See the table below for recommended drive times based on voltage.

Feature	5V	15V
Contrast/Reflectance	60 – 80%	100%
Refresh Rate	720ms – 1200ms	240ms
Display Driver Required	No	Yes
Temperature	25C	25C

### 3.5 15 Volt Display Drivers

Dialog Semiconductor – Contact Anne Joubert <a href="mailto:anne.joubert@dialogsemi.com">anne.joubert@dialogsemi.com</a>			
Part	Segments	Packages	Interface
DA8541	96	Bare die (100mm pitch)	SPI or I2C
<a href="#">DA8527</a>	24	36-pin 4x4mm LGA	SPI
<a href="#">DA8521</a>	64	80-pin 5x5mm LGA	SPI
<a href="#">DA8523</a>	192	208-pin 7x12mm LGA	SPI
<a href="#">DA8531</a>	64	80-pin 5x5mm BGA	SPI

Solomon Systech – Contact Raymond Cheung <a href="mailto:raymondcheung@solomon-systech.com">raymondcheung@solomon-systech.com</a>			
Part	Segments	Packages	Interface
<a href="#">SSD1621</a>	94	V Bare Die / Z gold bump Die / U COF	SPI
<a href="#">SSD1623</a>	97	V Bare Die / Z gold bump Die / UR1 COF	SPI

Epson			
Part	Segments	Packages	Interface
S1D14F51	24	PFBGA / Gold bump chip / Bare chip	SPI or I2C
S1D14F57	256	Gold bump chip / Bare chip	SPI or I2C



TTC			
Part	Segments	Packages	Interface
TT30036D	40	Bare Die / BGA / COF	I2C
TT31090	94	Bare Die / COF	I2C
TT30120	122	Bare Die / COF	I2C/SPI
TT30160	160	Bare Die / COF	I2C/SPI
TT30256	256	Bare Die / COF	I2C/SPI

### 3.6 5 Volt MCUs

E Ink Segmented displays work with a variety of MCUs from different vendors. Any 5V supply with sufficient I/Os will be compatible.

MCU Vendor	URL	Contact Information
Renesas	<a href="#">RL78 MCUs</a>	<a href="#">Contact Renesas Support</a>
Freescale	<a href="#">9S08 MCUs</a>	<a href="#">Contact Freescale Support</a>
Microchip	<a href="#">PIC24 MCUs</a>	<a href="#">Contact Microchip Support</a>

## 4.0 Connecting Segmented Displays to your PCB

E Ink Segmented displays can be connected to your PCB by a number of different methods, supporting a wide array of applications. The key determinant of the method of connection is the number of segments in your display, which determines the pin out count. Displays with fewer than 60 segments can use traditional FPC connectors.

When segment counts exceed that range, E Ink recommends the use of ACF tape and heat seal bonding. ACF bonding is common scenario for exceptionally small displays, and or applications in which thinness is a requirement for a successful design.

### 4.1 Standard FPC Connections

E Ink Segmented displays can work with any Flat Printed Circuit (FPC) connectors. The advantages of using an FPC connector include ease of assembly, ease of rework, and no need for specialized equipment in mass production. E Ink Segmented displays work with a variety of standard, commercially available connectors.

For more information about FPC connectors, see the table below, or refer to Section 5.0 for standard parts connectors:

Vendor	URL	Contact Info
Hirose	<a href="http://www.hirose.com">www.hirose.com</a>	<a href="#">Contact Hirose Support</a>
Molex	<a href="http://www.molex.com">www.molex.com</a>	<a href="#">Contact Molex Support</a>
Kyocera	<a href="http://www.kyocera.com">www.kyocera.com</a>	<a href="#">Contact Kyocera</a>

### 4.2 ACF Tape Connections

ACF Tape is the recommended connection method for E Ink Segmented displays which have a larger number of pin outs. The ACF bonding process involves the application of anisotropic tape to a substrate, with the bond being completed by a combination of heat, pressure and time. Anisotropic film is comprised of an epoxy/acrylate adhesive matrix loaded with conductive particles. The particles allow interconnection of circuit lines after bonding. ACF tape can be used to bond one FPC to another FPC or to a PCB. Final bonding must be done with a typical bond line temperature of 135 - 150°C.

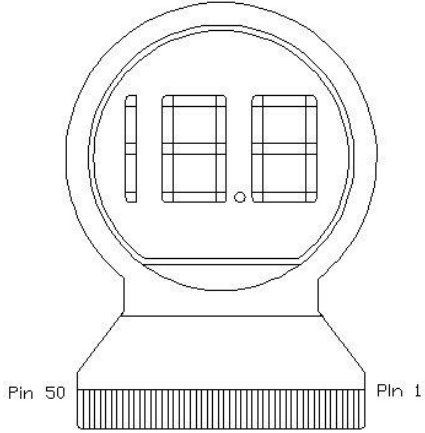
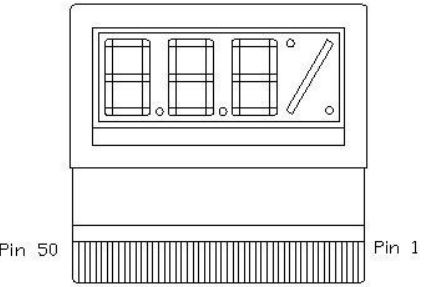
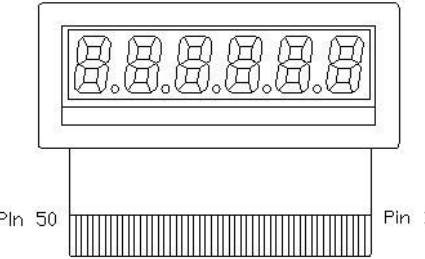
For more information on ACF Technology:

[3M Anisotropic Tape](#)

[Using ACF Tapes](#)

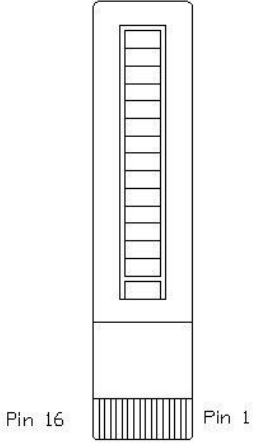
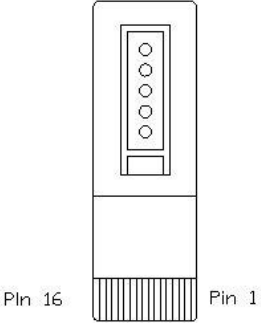
## 5.0 E Ink Segmented Display Cell Standard Parts - Numeric Displays

The following table outlines part numbers, connector options and other information for E Ink Standard Segmented Display Cells (SDCs).

Part Number	Drawing	Active Area H x W / Segments	Connectors
2.5 Digit Numeric Round E Ink SC009221		37.94 mm X 25.5 mm  39 Segments	Tyco 517345920
3 Digit Numeric E Ink SC004221		24.25 mm X 26.07 mm  44 Segments	Tyco 517345920
6 Digit Numeric E Ink SC005221		21.57 mm X 30.57 mm  49 Segments	Tyco 517345920

### 5.1 E Ink Segmented Display Cell Standard Parts - Indicators

The following table outlines part numbers, connector options and other information for E Ink Standard Segmented Display Cells (SDCs).

Part Number	Drawing	Active Area H x W / Segments	Connectors
14 Bar Capacity Indicator E Ink SC002221		37.5 mm X 8.5 mm  14 Segments	Tyco 517345926
5 Bar Capacity Indicator E Ink SS001221		26.3 mm X 8.5 mm  5 Segments	Tyco 517345926