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COM Display Adapter
User's Guide
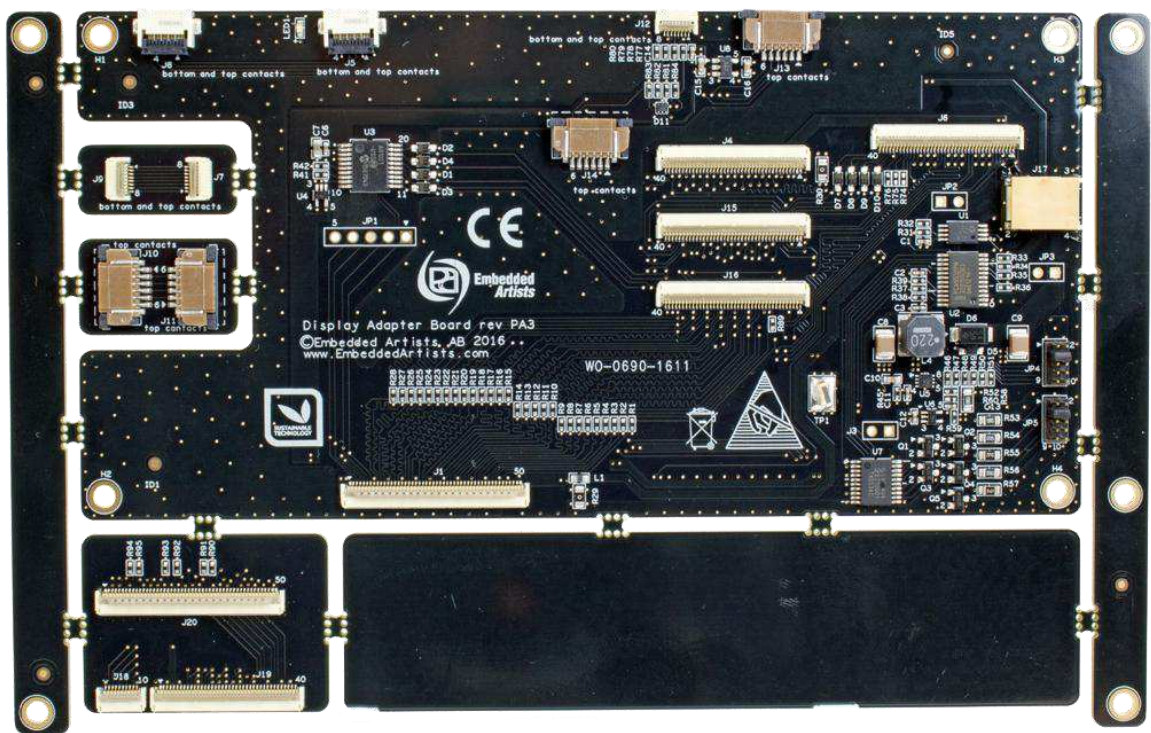
Embedded Artists AB

Davidshallsgatan 16
SE-211 45 Malmö
Sweden

http://www.EmbeddedArtists.com

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Table of Contents

1 Document Revision History

Revision	Date	Description
PA1	2016-05-16	First version.
PA2	2016-06-01	Added information about suitable FPC.
PA3	2016-09-24	Added information that many of the FPC connectors have both top and bottom contacts.
PA4	2016-12-05	Added extra information about how not to connect the COM Display Adapter and COM Carrier Board.

Rev A

2 Introduction

This document is a User's Guide that describes the *COM Display Adapter* mainly from a hardware point of view. Embedded Artists has also created a software framework for simple run-time configuration of display and touch panel interfaces. There is another document that describe the software side of adding a display with related touch panel interface. Available commands in the bootloader and Linux kernel are presented in that document.

The *COM Display Adapter* simplifies the process of **adding a display with parallel RGB interface** to an *iMX Developer's Kit*. There are many different *iMX Developer's Kits*, for different EACOM boards, and this document refers to all of these kits collectively as *iMX Developer's Kits*.

Figure 1 illustrates how the *COM Display Adapter* connects between an *iMX Developer's Kit* and a display. The *COM Display Adapter* takes the generic 50-pos parallel RGB display interface connector from the *COM Carrier Board* and creates specific display connectors for a large number of displays. Backlight driver and a resistive touch panel controller is also included on the board.

iMX Developer's Kit (with COM Carrier Board)	COM Display Adapter	Display (with parallel RGB interface)

Parallel RGB Display Interface 50-pos FPC generic connector interface	Contains specific display connectors. Backlight driver and resistive touch panel controller.	Specific display with backlight and resistive or capacitive touch panel.
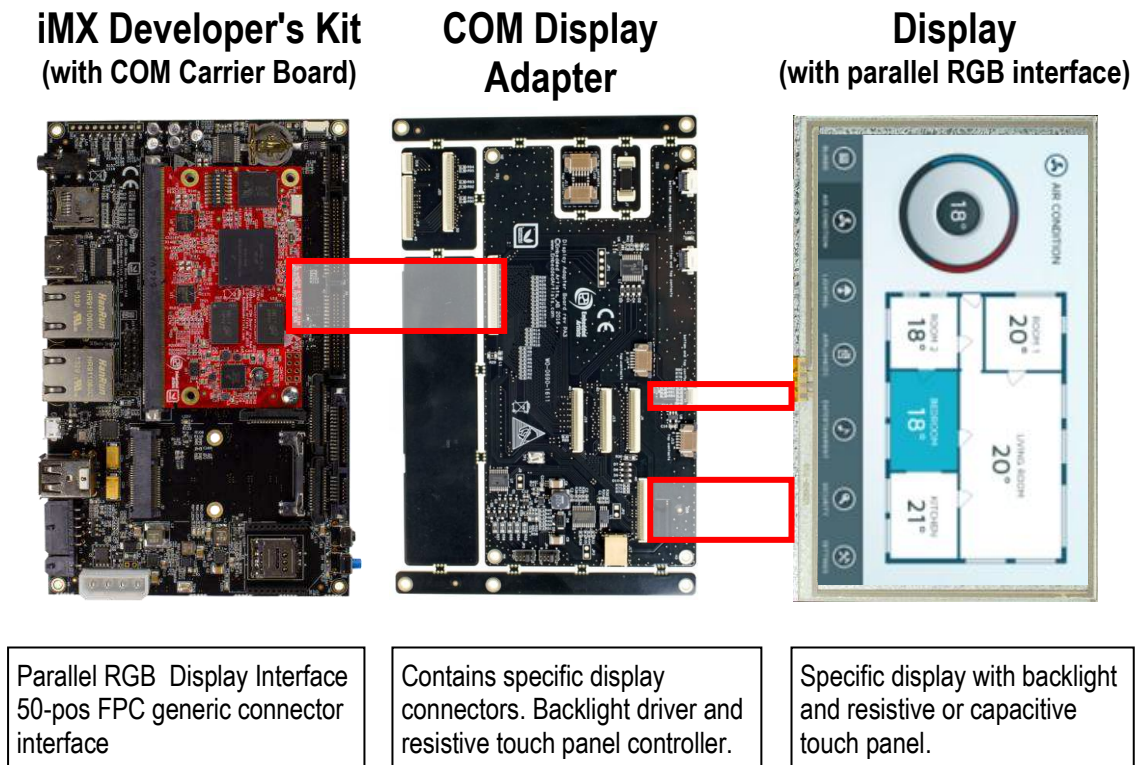
Figure 1 – COM Display Adapter Board with COM Carrier Board and Display

The *COM Display Adapter* is **meant to be a reference design** for interfacing a display with parallel RGB interface to EACOM boards. It is typically used in the proof-of-concept and prototype phase of a project, when the hardware is based on the *iMX Developer's Kit*.

When the final hardware is designed (i.e., a customer specific carrier board) different parts of the *COM Display Adapter* can be incorporated into this hardware.

Additional documentation that can be relevant are:

- *Adding Displays to iMX Developer's Kits*
- The *Getting Started* document for the *iMX Developer's Kit* you are using.
- *COM Carrier Board Datasheet*
- *EACOM Board Specification*

2.1   Features

The features of the *COM Display Adapter* are:

- Display Interfaces
  - 4 different 40-pos FPC connectors for a variety of common 18- and 24-bit parallel RGB display interfaces
  - Connects to COM Carrier Board, rev B, 50 pos display expansion connector
  - Connects to COM Carrier Board, rev A, 40 pos display expansion connector via adapter
- Connectors to different capacitive controllers to supported displays (with I2C interfaces)
- On-board resistive touch panel controller, AR1021 from Microchip
- White LED Backlight Driver with manual and software adjustable current: 20-160mA
  - Optional external +5V supply voltage feed to backlight supply input
- Dimensions
  - 165 x 104.3 mm (same size and hole pattern as *COM Carrier Board*)
  - 145 x 73 mm (after removing break-off parts)
- Powering via 50-pos generic display interface connector from the *COM Carrier Board*
  - +3.3V for logic
  - +5V for backlight
- Other
  - Proper ESD protection on touch panel interfaces
  - ISO 9001:2008 / ISO 14001:2004 produced
  - Production and shipping compensated for carbon dioxide emission

2.2   ESD Precaution

Please note that the *COM Display Adapter* come without any case/box and all components are exposed for finger touches – and therefore extra attention must be paid to ESD (electrostatic discharge) precaution. Only qualified personnel shall handle the product.

Make it a habit always to first touch the ground connector (TP1) for a few seconds with both hands before touching any other parts of the boards. That way, you will have the same potential as the board and therefore minimize the risk for ESD.

In general touch as little as possible on the boards in order to minimize the risk of ESD damage.

Note that Embedded Artists does not replace boards that have been damaged by ESD.

2.3   Warranty Hints and General Handling Care

Handle the *COM Display Adapter* with care. The board is not mounted in a protective case/box and is not designed for rough physical handling. Only qualified personnel shall handle the product. Connectors can wear out after excessive use.

When working with displays, do not exercise excessive pressure on the LCD glass area. That will damage the display. Also, do not apply pressure on the flex cables connecting the LCD/touch screen. These are relatively sensitive and can be damaged if too much pressure is applied to them.

Embedded Artists products are subject to manufacturer's guarantee as long as the products are handled with adequate care and caution and in accordance to this manual.

For exact details about warranty, please read the *General Terms and Conditions* document that can be found at http://www.embeddedartists.com/shop/

The warranty does not cover defects caused by improper or inadequate installation, maintenance or handling by the user, unauthorized modification or misuse, operation outside the specification a non-compliance of this manual and related documents. In case of doubt, please contact Embedded Artists prior to intended activity.

Note that Embedded Artists does not replace boards that has been improperly handled. Also note that the warranty does also not cover any defects or damages of other equipment connected to the Embedded Artists product, faulty or not.

2.4   CE Assessment

The *COM Display Adapter* is CE marked. See separate *CE Declaration of Conformity* document.

The *COM Display Adapter* is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

EMC emission test has been performed on the *COM Display Adapter* together with an *iMX Developer's Kit*. Standard interfaces like Ethernet, USB, serial have been in use. General expansion connectors where internal signals are made available (for example processor pins) have been left unconnected. Connecting other devices to the product via the general expansion connectors may alter EMC emission. It is the user's responsibility to make sure EMC emission limits are not exceeded when connecting other displays and devices to the board.

3 Board Overview

The board consists of several parts that can be broken off. *Figure 2* illustrates the different parts.

The board is 165 x 104.3 mm in size, which is the same size and hole pattern as the *COM Carrier Board*. This simplifies the mechanical mounting of the board. It can be mounted under the *COM Carrier Board*. After removing the four break-off parts along the right, left and bottom edges (see *Figure 2* below) the board size is reduced to 145 x 73 mm.
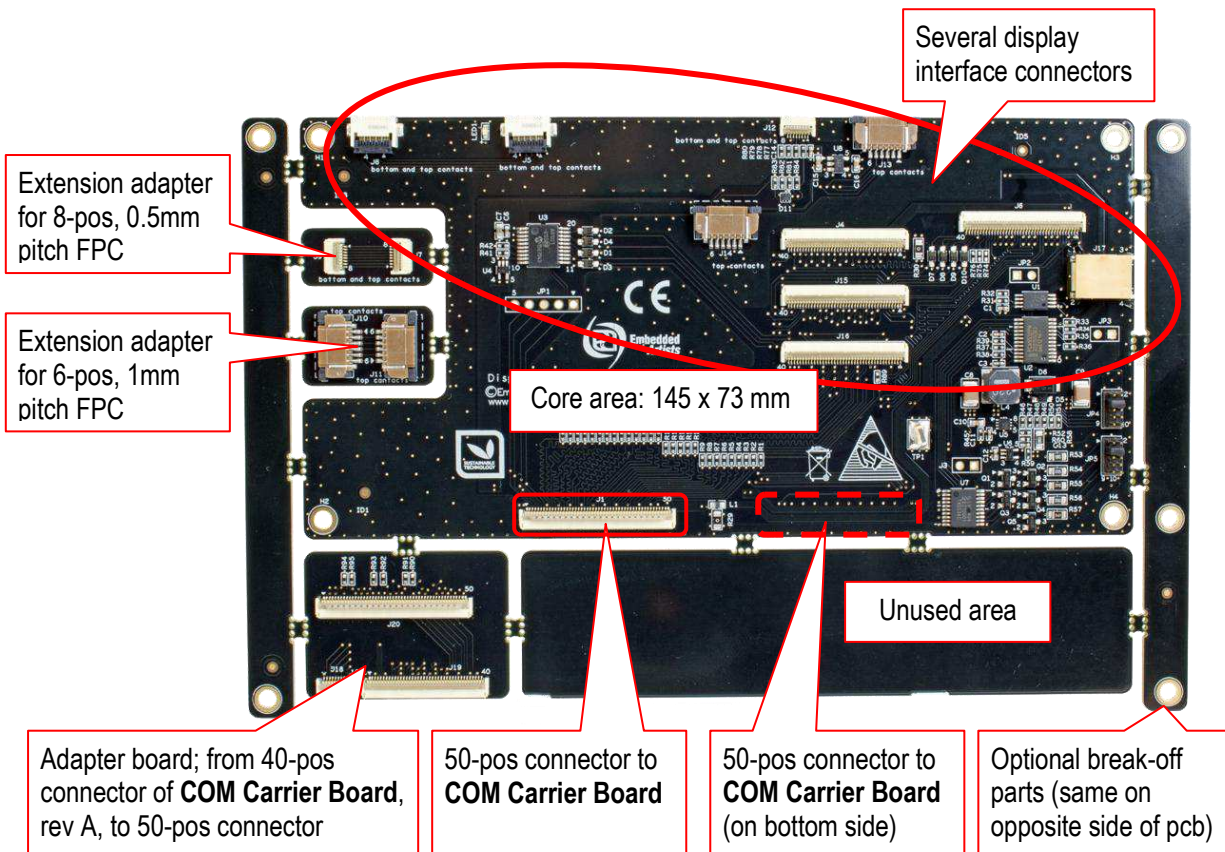

Figure 2 – COM Display Adapter Board Parts

On the left (see *Figure 2*) there are three special break-off parts:

- Adapter board that is needed when using *COM Carrier Board*, rev A. That board has a 40-pos connector for the generic parallel RGB display interface connector. This adapter board converts the 40-pos connector of *COM Carrier Board*, rev A boards to the 50-pos connector of rev B boards.

- Extension adapter for 8-pos, 0.5mm pitch FPC. On some displays the FPC to the touch panel controller is not possible to access directly to J12. For these displays an extension FPC cable is needed and this extension adapter solves the problem of connecting the extension FPC cable with the display FPC.

- Extension adapter for 6-pos, 1mm pitch FPC. On some displays the FPC to the touch panel controller is not possible to access directly to J13 or J14. For these displays an extension FPC cable is needed and this extension adapter solves the problem of connecting the extension FPC cable with the display FPC.

3.1   Connector to COM Carrier Board

The *COM Display Adapter* has been designed for maximum flexibility. Therefore there are two 50-pos connectors to the generic parallel display interface connector on the *COM Carrier Board*. Depending on how the *COM Display* Adapter is turned in relation to the *COM Carrier Board* J1 or J2 shall be used. There are many different ways to mount the boards and display together, as seen in *Figure 3* and *Figure 4*.
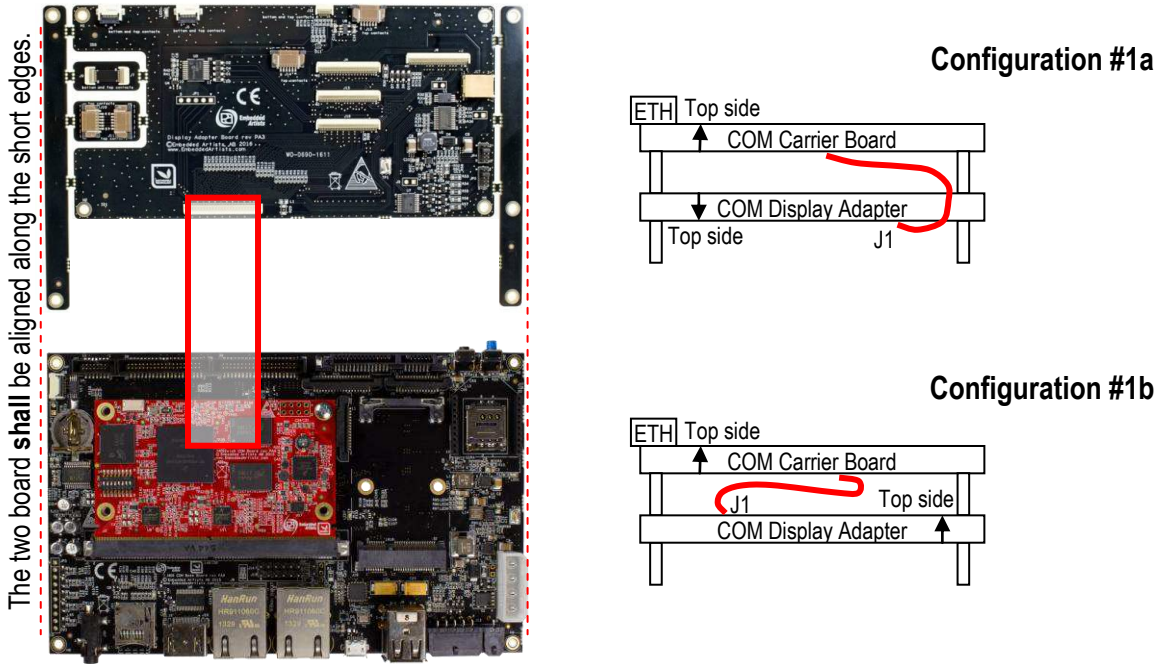

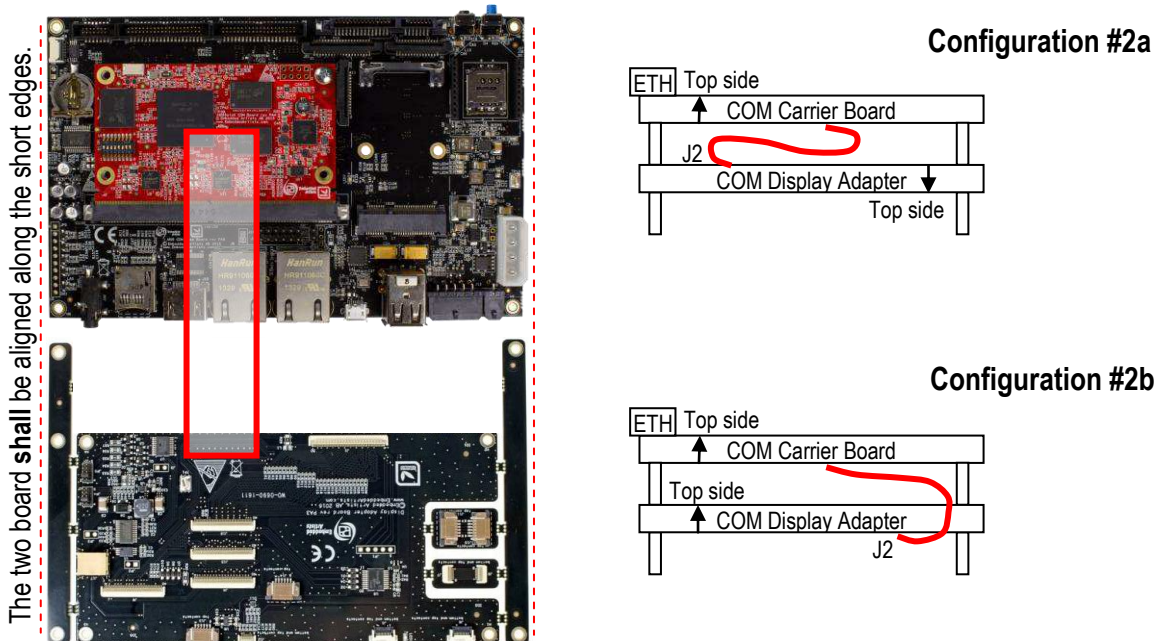Figure 3 – COM Carrier Board, rev B Connected to COM Display Adapter Board, J1

Figure 4 – COM Carrier Board, rev B Connected to COM Display Adapter Board, J2

It is important to align the two boards along the short edges, as illustrated in the two pictures above. The picture below illustrated how **NOT** to do. Connecting the boards unaligned **WILL** damage the boards.

The two board **shall** be aligned along the short edges.

Incorrect connection!
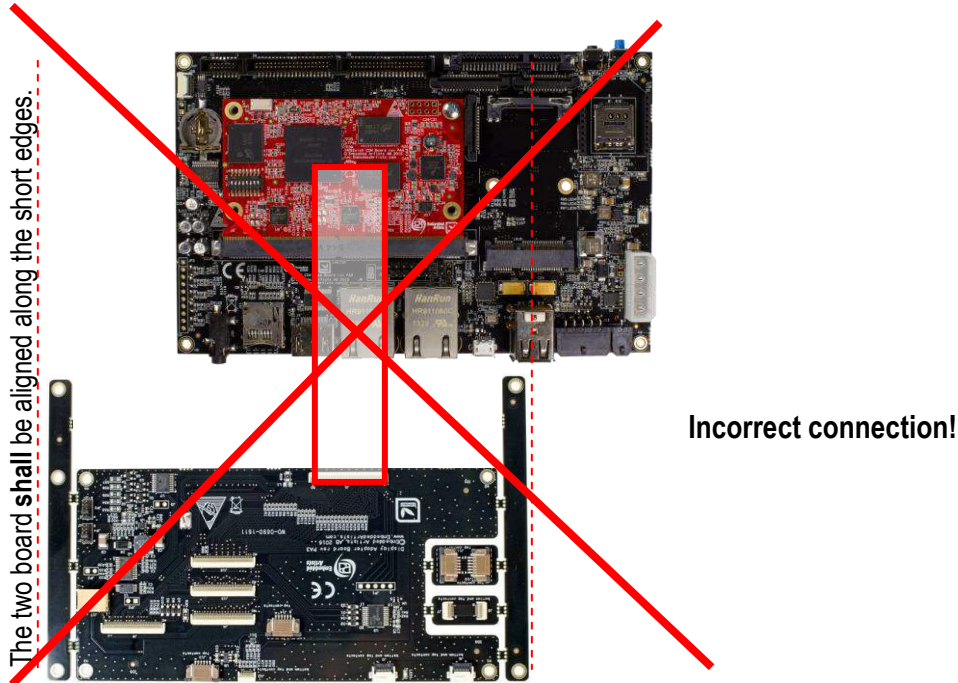
Figure 5 – COM Carrier Board, rev B Incorrectly Connected to COM Display Adapter Board

Figure 6 illustrates how the break-off adapter board is used to connect to a *COM Carrier Board*, rev A.

8-pos

40-pos

50-pos

Figure 6 – COM Carrier Board, rev A Connected to COM Display Adapter Board, J1

Note that the pin numbering on J1 and J2 on the *COM Display Adapter*, rev PA3 can be confusing. The 50 pos FPC shall be connected straight between the boards. J25, pin 1 on *COM Carrier Board* shall be connected to J1/J2, pin 50.

3.2   Flat Flex Cables (FFCs)

Flat flex cables (FFCs) is a commodity part and can be bought from many different sources. Below are just three examples of cables that have been tested. These examples cables can be used as reference to find other cables. 1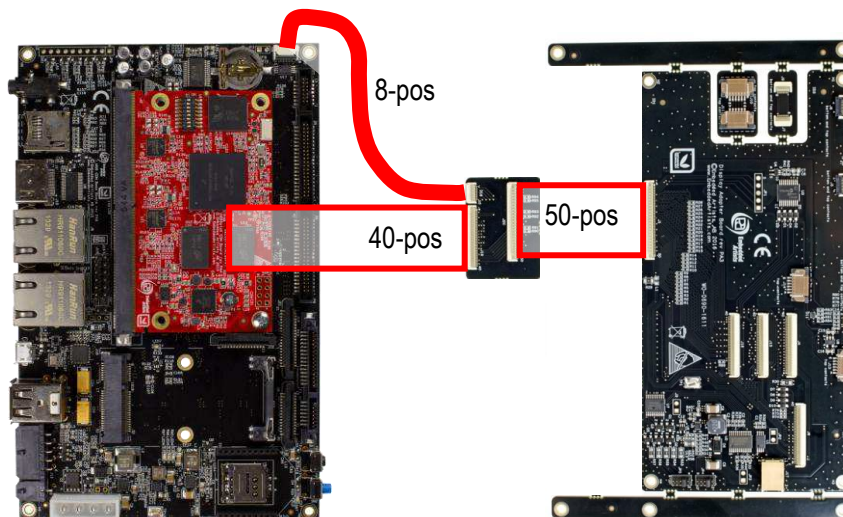00 mm is a good length for the 50 position cable when the *COM Display Adapter* is mounted under the *COM Carrier Board*.

- 50 pos, 0.5 mm pitch, 101 mm (4 inch) long, Molex 0152660541, Digikey: WM11535-ND

- 40 pos, 0.5 mm pitch, 101 mm (4 inch) long, Molex 0152660431, Digikey: WM10534-ND

- 8 pos, 0.5 mm pitch, 203 mm (8 inch) long, Molex 0152660087, Digikey: WM11491-ND

3.3   Mounting of COM Display Adapter and COM Carrier Board

There are multiple options how to mount everything together. The four configurations in *Figure 7* illustrates how the LCD can be mounted in relation to the four mounting options for the *COM Carrier Board* and *COM Display Adapter*.
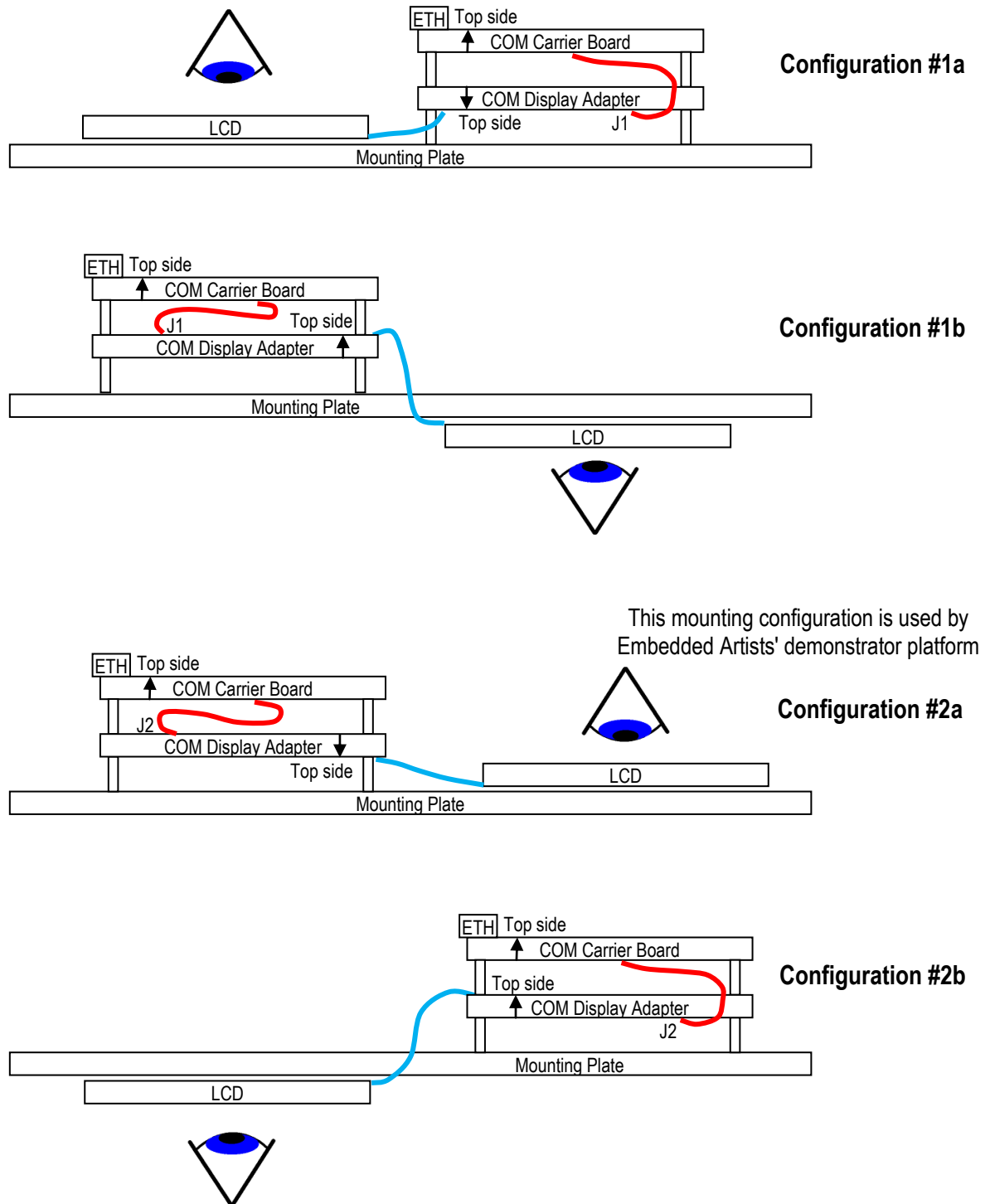

Figure 7 – COM Carrier Board, COM Display Adapter and LCD Mounting Options

4 Display Interfaces

There are four different display interface connectors for displays with parallel RGB interface. To support a variety of different displays, there are also five different connectors to resistive and capacitive touch panel interfaces. Figure 8 illustrates the location of all connectors.
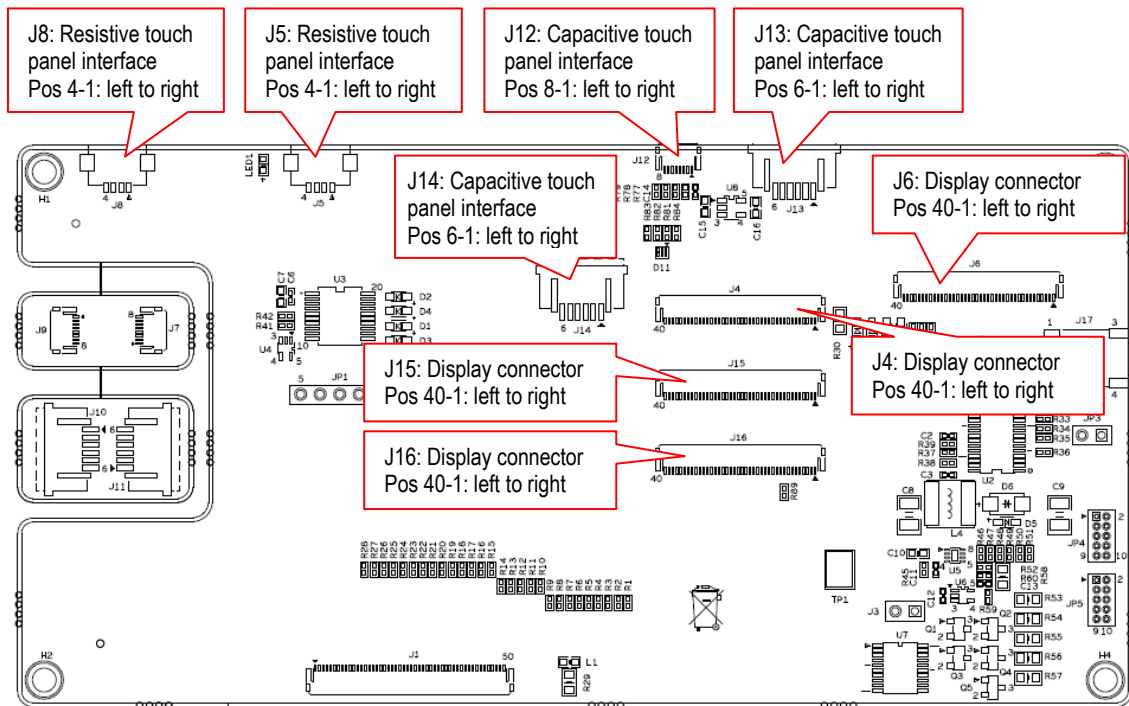
Figure 8 – Display Interface Connector Positions

The four display interfaces are available at the connectors listed below. These connectors support a large number of displays. **Note** that these FPC connectors have both top and bottom contacts.

J6   There is a 40 pos interface that is **commonly supported** by many LCD manufacturers. It supports both 18 and 24 color depth.

J15   The **Unified TFT interface** from EDT (Emerging Display Technologies) is a connector standard that is supported by many displays from 3.5 to 7 inch in size. 18-bit color depth is supported.

J4   Supports 18-bit color depth and is common for some 7.0 inch LCDs.

J16   Supports 18-bit color depth and is common for some 7.0 inch LCDs from U.R.T.

The table below lists *some* displays that are compatible with the four connectors. There are many more compatible displays.

Display Size in inches	Display Resolution	Touch Panel	Manufacturer	Part Number	Display Interface Connector	Touch Panel Interface Connector	Backlight Current, OVP
4.3	480 x 272	Resistive	Rogin	RX043A-0207-T	J6	-	40mA/20V
4.3	480 x 272	-	NewHaven	NHD-4.3-480272EF-ATXL#	J6	-	40mA/25V
4.3	480 x 272	Resistive	NewHaven	NHD-4.3-480272EF-ATXL#-T	J6	-	40mA/25V
4.3	480 x 272	Capacitive	NewHaven	NHD-4.3-480272EF-ATXL#-CTP	J6	J13	40mA/25V
4.3	480 x 272	-	NewHaven	NHD-4.3-480272EF-ASXN#	J6	-	40mA/30V
4.3	480 x 272	Resistive	NewHaven	NHD-4.3-480272EF-ASXN#-T	J6	-	40mA/30V
4.3	480 x 272	Capacitive	NewHaven	NHD-4.3-480272EF-ASXN#-CTP	J6	J13	40mA/30V
4.3	480 x 272	-	NewHaven	NHD-4.3-480272EF-ASXV#	J6	-	40mA/30V
4.3	480 x 272	Resistive	NewHaven	NHD-4.3-480272EF-ASXV#-T	J6	-	40mA/30V
4.3	480 x 272	Capacitive	NewHaven	NHD-4.3-480272EF-ASXV#-CTP	J6	J13	40mA/30V
4.3	480 x 272	-	EDT	ET043080DM6	J15	-	N/A
4.3	480 x 272	Resistive	EDT	ET043080DH6	J15	-	N/A
4.3	480 x 272	Capacitive	URT	UMSH-8864MD-10T	J6	J12	40mA/20V
5.0	800 x 480	Resistive	Rogin	RX050A-05-T	J6	-	40mA/25V
5.0	800 x 480	Capacitive	URT	UMSH-8837MD-4T	J6	J12	Use J17, 120mA/16V
5.0	800 x 480	-	NewHaven	NHD-5.0-800480TF-ATXL#	J6	-	60mA/26V
5.0	800 x 480	Resistive	NewHaven	NHD-5.0-800480TF-ATXL#-T	J6	-	60mA/26V
5.0	800 x 480	Capacitive	NewHaven	NHD-5.0-800480TF-ATXL#-CTP	J6	J13	60mA/26V
5.0	800 x 480	-	EDT	ET050080DM6	J15	-	N/A
5.0	800 x 480	Resistive	EDT	ET050080DH6	J15	-	N/A
7.0	800 x 480	-	NewHaven	NHD-7.0-800480EF-ATXL#	J6	-	60mA/20V
7.0	800 x 480	Resistive	NewHaven	NHD-7.0-800480EF-ATXL#-T	J6	-	60mA/20V
7.0	800 x 480	Capacitive	NewHaven	NHD-7.0-800480EF-ATXL#-CTP	J6	J14	60mA/20V
7.0	800 x 480	-	NewHaven	NHD-7.0-800480EF-ATXV#	J6	-	160mA/20V
7.0	800 x 480	Resistive	NewHaven	NHD-7.0-800480EF-ATXV#-T	J6	-	160mA/20V
7.0	800 x 480	Capacitive	NewHaven	NHD-7.0-800480EF-ATXV#-CTP	J6	J14	160mA/20V
7.0	800 x 480	-	EDT	ET070080DM6	J15	-	N/A
7.0	800 x 480	Resistive	EDT	ET070080DH6	J15	-	N/A
7.0	800 x 480	Resistive	Innolux	AT070TN83	J4	J5	N/A
7.0	800 x 480	Capacitive	URT	UMSH-8596MD-30T	J16	J12	Use J17, 210mA/16V
7.0	800 x 480	Capacitive	URT	UMSH-8596MD-33T	J16	J12	Use J17, 210mA/16V

4.1   Things to Note

It is very important to connect to displays to connect display interface connector and also to turn the flex cable from the LCD correctly. Displays and/or the *COM Display Adapter* board can **easily be damaged** by turning the flex cable the wrong way or in the wrong connector.

The following pictures illustrates how displays are typically connected. If the COM Display Adapter is placed with component side up, the displays face down.
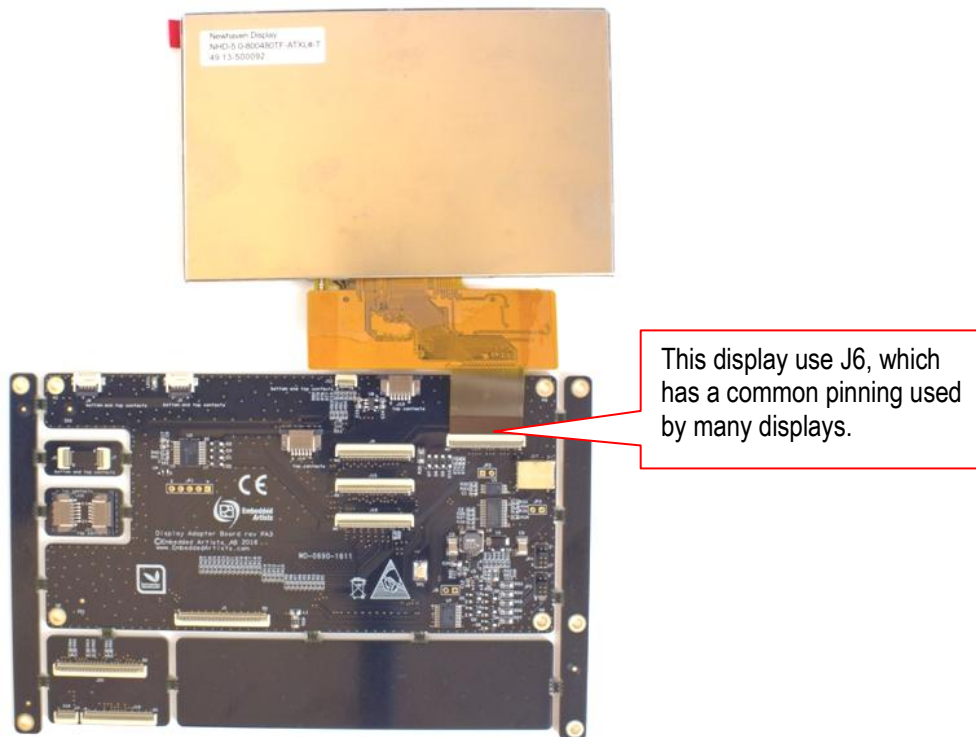

This display use J6, which has a common pinning used by many displays.

Figure 9 – Example Display #1 Connected

This display use the 8-pos expansion adapter since the capacitive touch panel FPC cannot be directly connected to J12.

This display use J17 for backlight

This display use J16, which has a pinning used by many 7 inch displays that has on-board backlight driver.
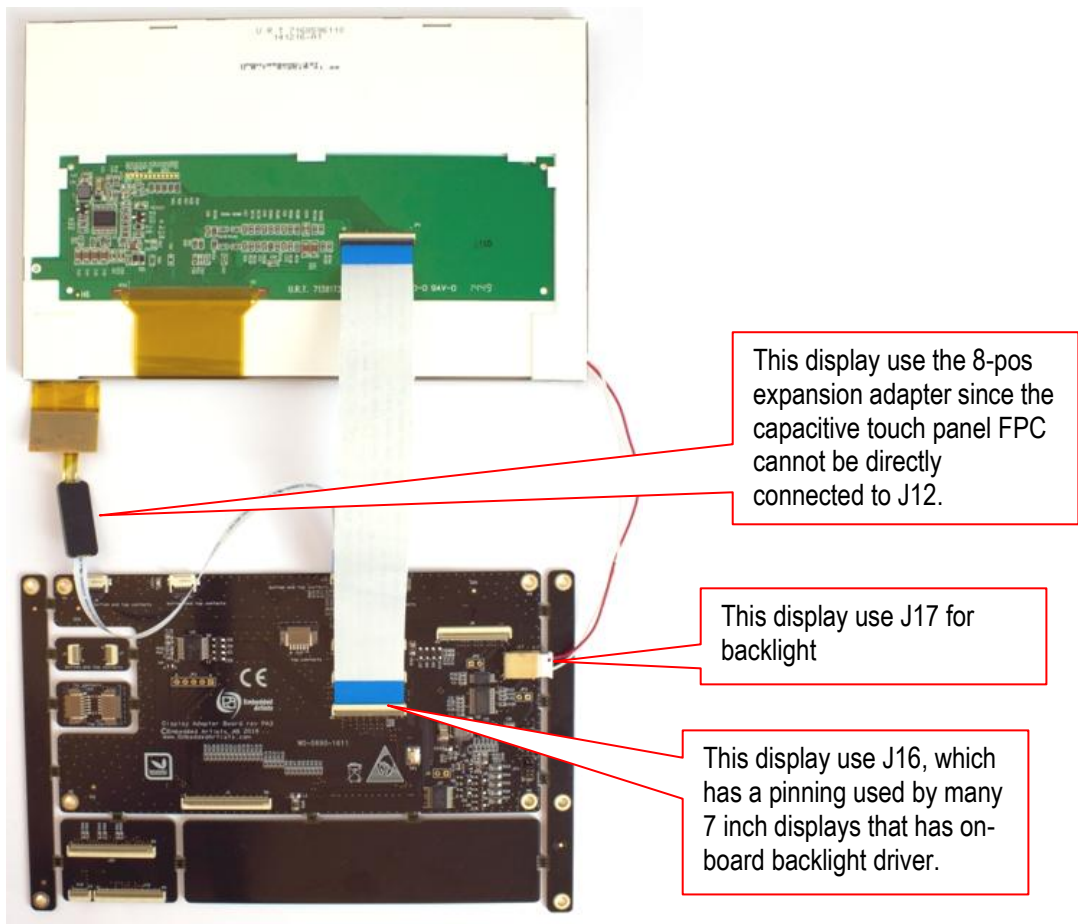
Figure 10 – Example Display #2 Connected

This display use J14 for the capacitive touch panel FPC

This display use J6, which has a common pinning used by many displays.

Figure 11 – Example Display #3 Connected

This display use J12 for the capacitive touch panel FPC

This display use J6, which has a common pinning used by many displays.
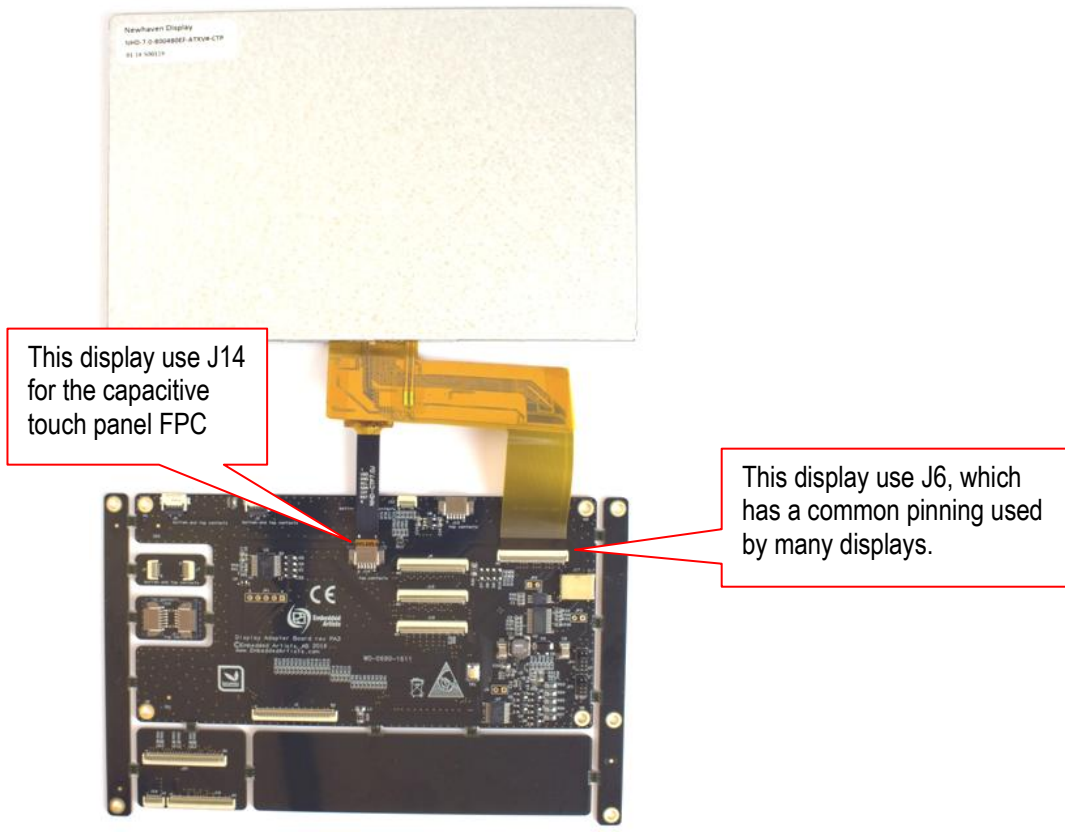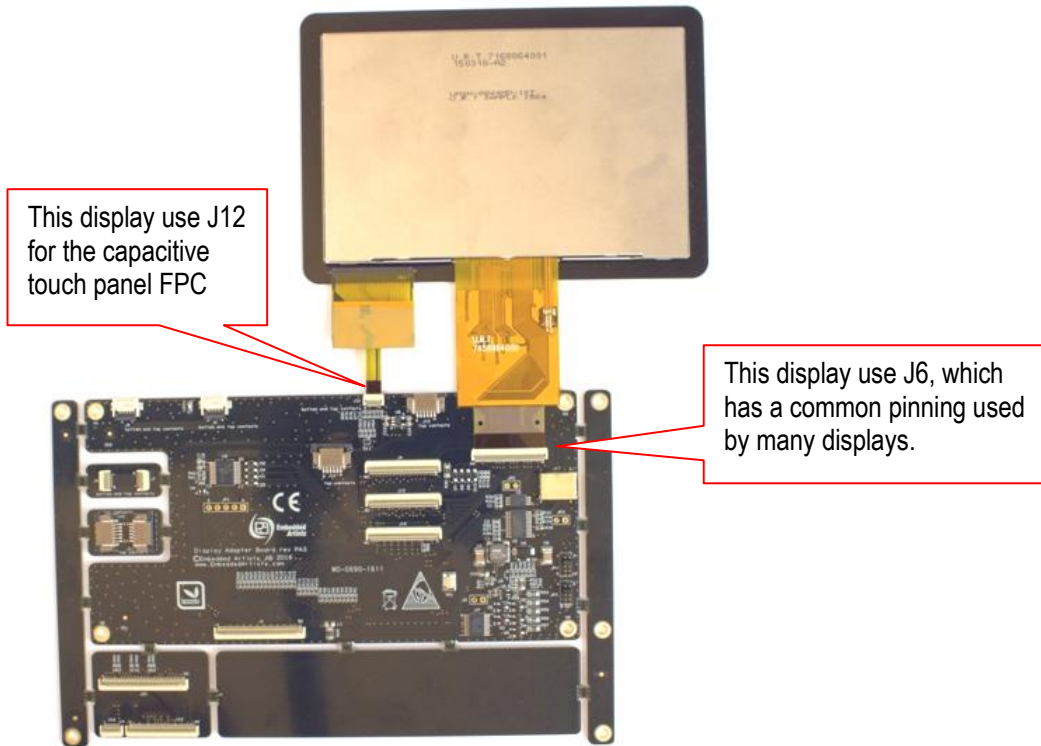
Figure 12 – Example Display #4 Connected

5 Resistive Touch Panel Controller

The board contains a resistive touch panel controller, AR1020 from Microchip. Communication with the controller is carried out via an I2C channel.

Resistive touch panels with 4 wires are supported.

The controller is connected to four different connectors. Only one of them can be used at any given time. See *Figure 13* for connector locations.

J5 and J8 are 4-position 1mm pitch FPC connectors that connects directly to the resistive touch panel. **Note** that these FPC connectors have both top and bottom contacts.

J6 and J15 are 40-pos connectors where the resistive touch panel wires are placed on the same connector as the parallel RGB interface. **Note** that these FPC connectors have both top and bottom contacts.

All connectors have both top and bottom contacts for maximum flexibility when connecting touch panels.
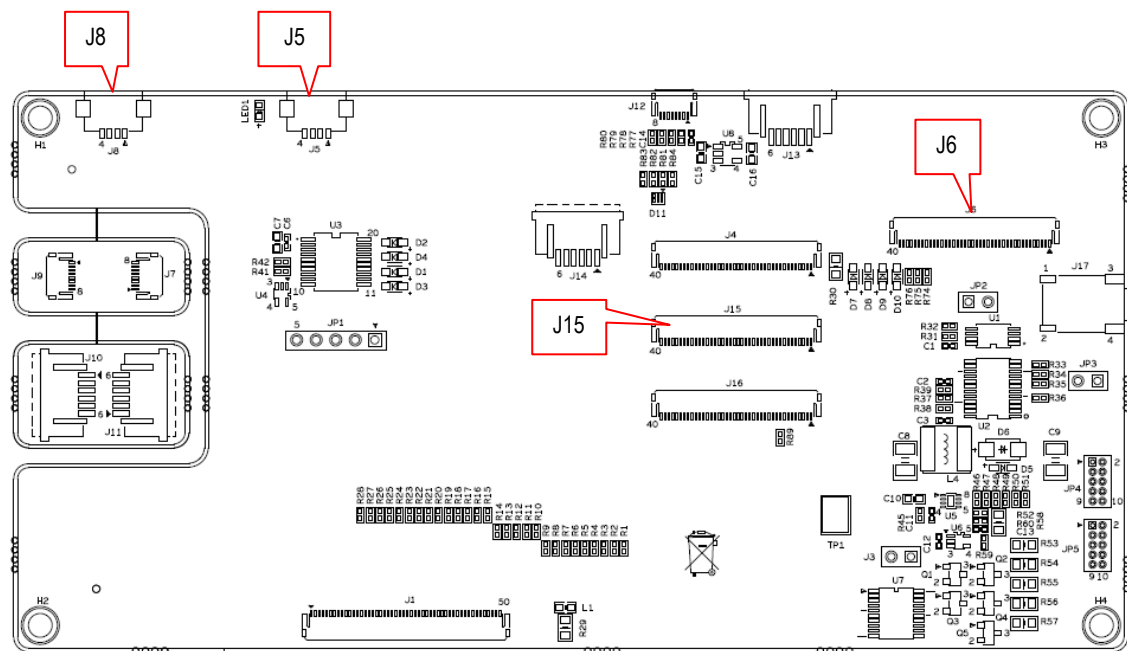

Figure 13 – Resistive Touch Panel Connector Positions

5.1   Things to Note

COM Carrier Board, rev A, has one AR1021 mounted on the board. This must be disabled. This is accomplished by removing the zero ohm resistors in R108, R118 and SJ12.

See section 8.1 in the *Things to Note* chapter for more information.

A resistive touch panel requires calibration. The AR1021 has built-in functionality to handle calibration and corresponding correction of coordinate. The software must however implement a calibration procedure where the calibration point are stored in the AR1021 on-chip memory.

6 Backlight Driver

The board contains a white LED driver, for display backlight driving, PAM2841 from Diodes Inc. It is a flexible driver that operates in many different configurations (when it comes to number of LEDs in series and parallel).

Currents between 20-160mA can be set and over-voltage protection between 10-30V can be set. Conversion efficiency is typically between 80-90% with a +5V input supply.

The +5V supply is called VLED on the schematic and comes from J1/J2 (that is connected to the *COM Carrier Board*) or via J3. If J3 is used, SJ4 must change to 2-3 position. See section 8.3 for a description of where to locate J3 and SJ4.

The backlight driver is normally controlled by controlling the +5V supply voltage. This is normally done with a voltage distribution switch on the *COM Carrier Board*. By changing SJ5 to 2-3 position it is possible to control on/off with signal LCD_BL_ON. See chapter 7 for more details about this signal.

Backlight current is set via pin header JP5. See *Figure 14* where to located JP5. As seen it is possible to set the current to 20mA, 40mA, 60mA, 100mA, 120mA or 160mA via one jumper.

It is also possible to control the backlight current from software. More details about that can be found in chapter 7 . In this case, no jumper shall be inserted in JP5.
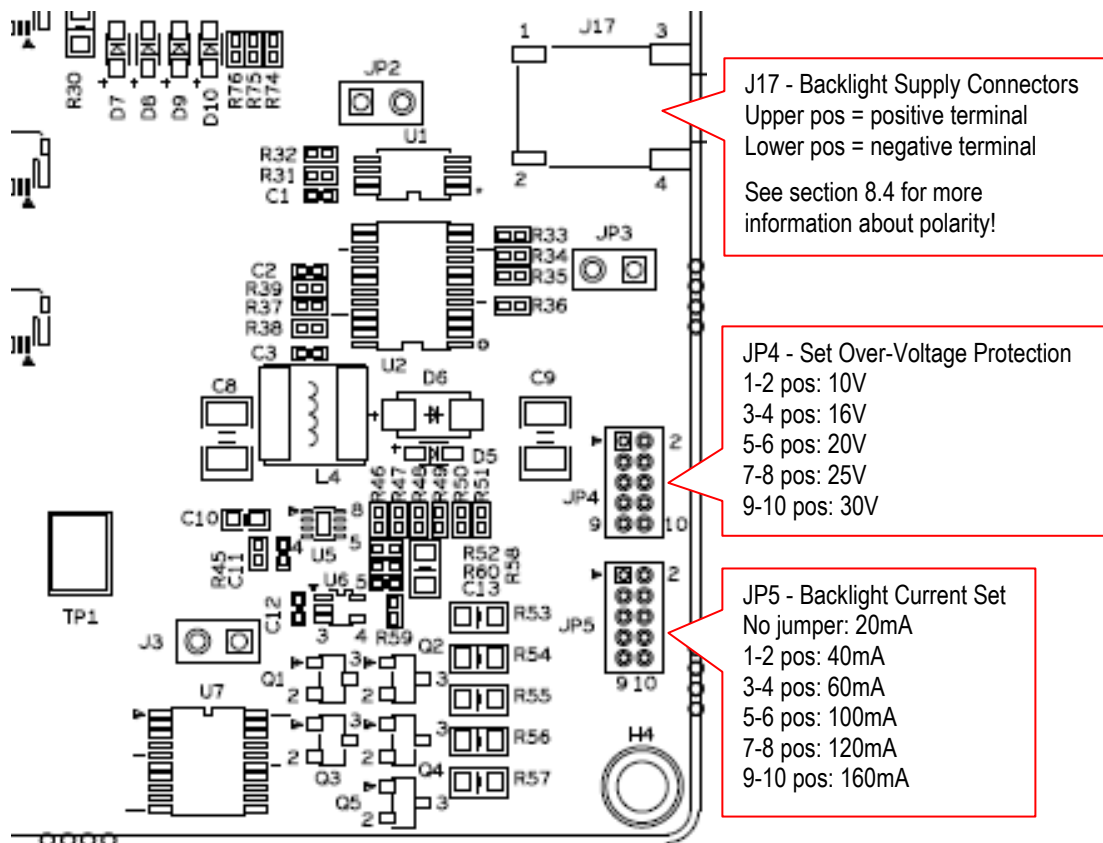

J17 - Backlight Supply Connectors
Upper pos = positive terminal
Lower pos = negative terminal

See section 8.4 for more information about polarity!

JP4 - Set Over-Voltage Protection
1-2 pos: 10V
3-4 pos: 16V
5-6 pos: 20V
7-8 pos: 25V
9-10 pos: 30V

JP5 - Backlight Current Set
No jumper: 20mA
1-2 pos: 40mA
3-4 pos: 60mA
5-6 pos: 100mA
7-8 pos: 120mA
9-10 pos: 160mA

Figure 14 – Backlight Jumper Settings

The backlight driver has an over-voltage protection function that limits the output voltage in case of an open circuit. White LEDs have a forward voltage of about 3-4V. Check the display datasheet and set the over-voltage protection level to just over what the backlight driving voltage shall be.

The over-voltage protection level is controlled by JP4. See *Figure 14* where to locate JP4 and jumper settings. Note that a jumper **must** always be inserted in one of the positions in JP4.

The backlight driving voltage is available on display connectors J6 and special connector J17 (which is typically used when display connector J16 is used).

J4, which is one of the other display connectors, take the +5V supply (VLED) directly. Displays connected to J4 have internal backlight drivers, operating from +5V.

Similarly, J15 (another display connector), take the +3.3V supply directly. Displays connected to J15 have an internal backlight driver voltage, operating from the +3.3V.

6.1   PWM Control - Diming of Backlight

Besides setting the 100% on-current level via JP5 it is possible to dim the backlight with a Pulse-Width Modulated (PWM) signal. This can be useful for manual (by operator) or automatic adjustment of backlight intensity given ambient light intensity. It can also be used to turn on and off the backlight by ramping up and down the intensity rather than abruptly turn it on/off.

Normally signal BL_PWM, which comes from the *COM Carrier Board* via the 50-pos connector J1/J2 controls the intensity with a 200-1kHz PWM signal.

Alternatively the controlling PWM signal can be generated on the *COM Display Adapter* board. In this case signal BL_PWM_I2C is used and SJ6 must change to 2.3 position. See chapter 7 for more details about this signal.

6.2   Things to Note

If the backlight current is set to a high value (>100mA) there can be a dip on the +5V supply when the backlight power supply is turned on. This can cause a reset on the *COM Carrier Board*.

See section 8.3 in the *Things to Note* chapter for more information.

If there is an audible noise from the backlight driver, it is likely that the over-voltage protection level is set too low (i.e., too close to the limit). Just move up one voltage step on JP4.

The polarity on the terminals on connector J17 is **not correct** for LCDs from U.R.T. This applies to *COM Display Adapter board*, rev PA3.

See section 8.4 in the *Things to Note* chapter for more information.

Rev A

7 I2C-Connected Components

The 50-pos generic parallel RGB display interface connector from the *COM Carrier Board* contains one I2C channel. The idea with this communication channel is to have method for adding different control functions that might be needed for a display. I2C is also a common interface used for many touch panel controllers.

The *COM Display Adapter* has the following components connected to the I2C channel:

7-bit I2C-address	8-bit I2C-address	Device
0x4D	0x9A / 0x9B	AR1021, resistive touch panel controller See chapter 5 for more information.
0x56	0xAC / 0xAD	64kbit EDID E2PROM For future functionality (possibility to automatically detect which display that is connected to the parallel RGB interface), but this is currently not implemented or used.
0x64	0xC8 / 0xC9	PCA9532 GPIO Expander See description below.
Depending on display	Depending on display	External capacitive touch panel controller

7.1 I2C-GPIO Expander

The PCA9532 is an I2C-connected GPIO expander. It is used to create extra GPIO and PWM signals. The following signals are created:

- LCD_DISP_EN: This signals is routed to J6, DisplayEnable signal (active high). The signals is high by default. Setting the signal low will place the display (connected to J6) in standby mode. Optionally the signal can be routed to J15, PWCTRL (via SJ11 in 2-3 position, which is not default).

- LCD_BL_ON: This signals is routed to J15, PWCTRL signal (active high). The signal is high by default and is the BacklightPowerEnable signals. Setting the signal low will disable the backlight.
The signal can also optionally control the backlight driver on/off. SJ5 must be in 2-3 position for this (which is not default).

- LCD_RESET: This signal is routed to J15, /RESET signal (active high). The signals is high by default. Setting the signal low will place the display in reset.

- BL_PWM_I2C: This signal can optionally dim control (via PWM signal) the backlight driver. SJ6 must be in 2-3 position for this (which is not default).

- CURR_CTRLx (x=1..5): These five signals can control the backlight current level. The signals are high by default, which is the inactive state. Pulling one signal low correspond to inserting one of the possible five jumper positions in JP5.

- WP_CTRL: This signal controls the write protect signal for the EDID E2PROM. The signal is high by default, which write protects the E2PROM. Setting the signal low will disable write protection.

7.2   Things to Note

The I2C channel is called I2C-A on the *COM Carrier Board* (which is typically I2C0 on the iMX processors).

Make sure the I2C address of an external capacitive touch panel controller does not collide with any of the other component on the I2C-A bus. Do not forget to also check the *COM Carrier Board* components on this bus.

Specifically note that there are capacitive touch panel controllers from Sitronix with I2C address 0x55. It is possible to change the I2C address of these controllers. Contact the display supplier for details about this.

8 Things to Note

This chapter contains information that is important to note when working with the *COM Display Adapter*.

8.1 Special Consideration for COM Carrier Board, rev A

Note that *COM Carrier Board*, rev A, already has one AR1021 mounted on the board. This must be disabled. This is accomplished by removing the zero ohm resistors in R108, R118 and SJ12.

See *Figure 15* for information where R108, R118 and SJ12 can be found on COM Carrier Board, rev A.
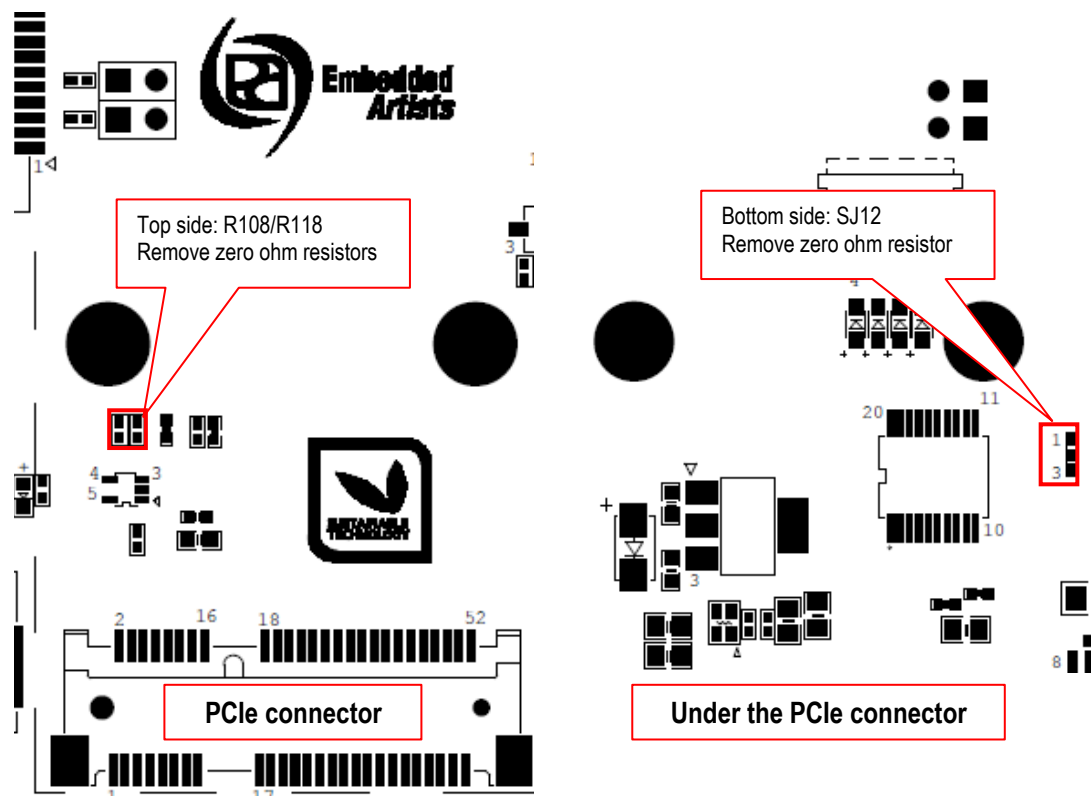

Figure 15 – Locating R108/R118/SJ12 on COM Carrier Board, rev A

8.2 HSYNC and VSYNC Signals Missing

Some displays require HSYNC and VSYNC signals, but far from all. Many displays synchronize to the pixel stream via just the DATA-ENABLE signal.

COM Carrier Board, rev A and rev B, does not have R176/R177 mounted as default. This means the HSYNC and VSYNC signals do not arrive to the *COM Display Adapter* board. For some displays this is a problem.

See *Figure 16* below to locate R176/R177 on top side on COM Carrier Board, rev A. See *Figure 17* below to locate R176/R177 on top side on COM Carrier Board, rev B. Mount a zero ohm resistor on these locations.
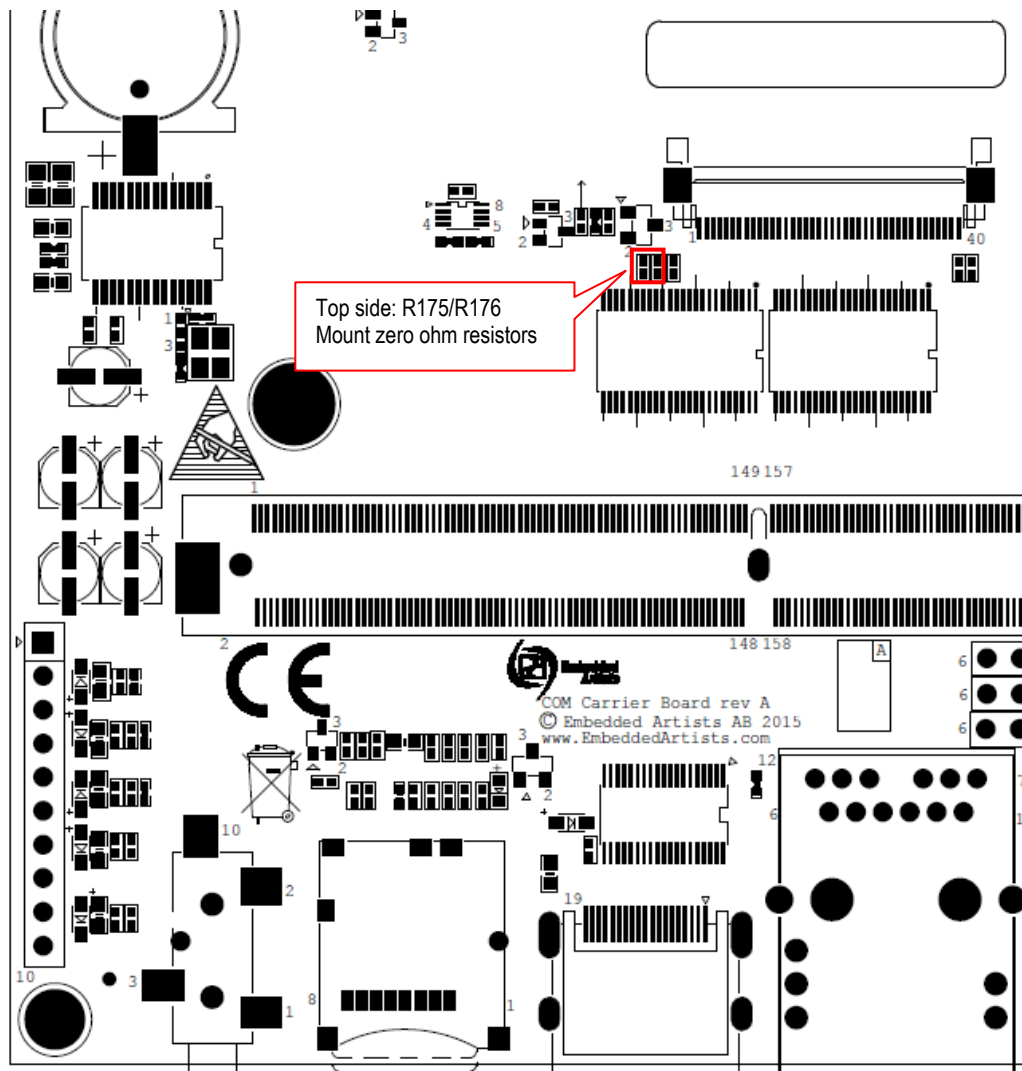

Top side: R175/R176
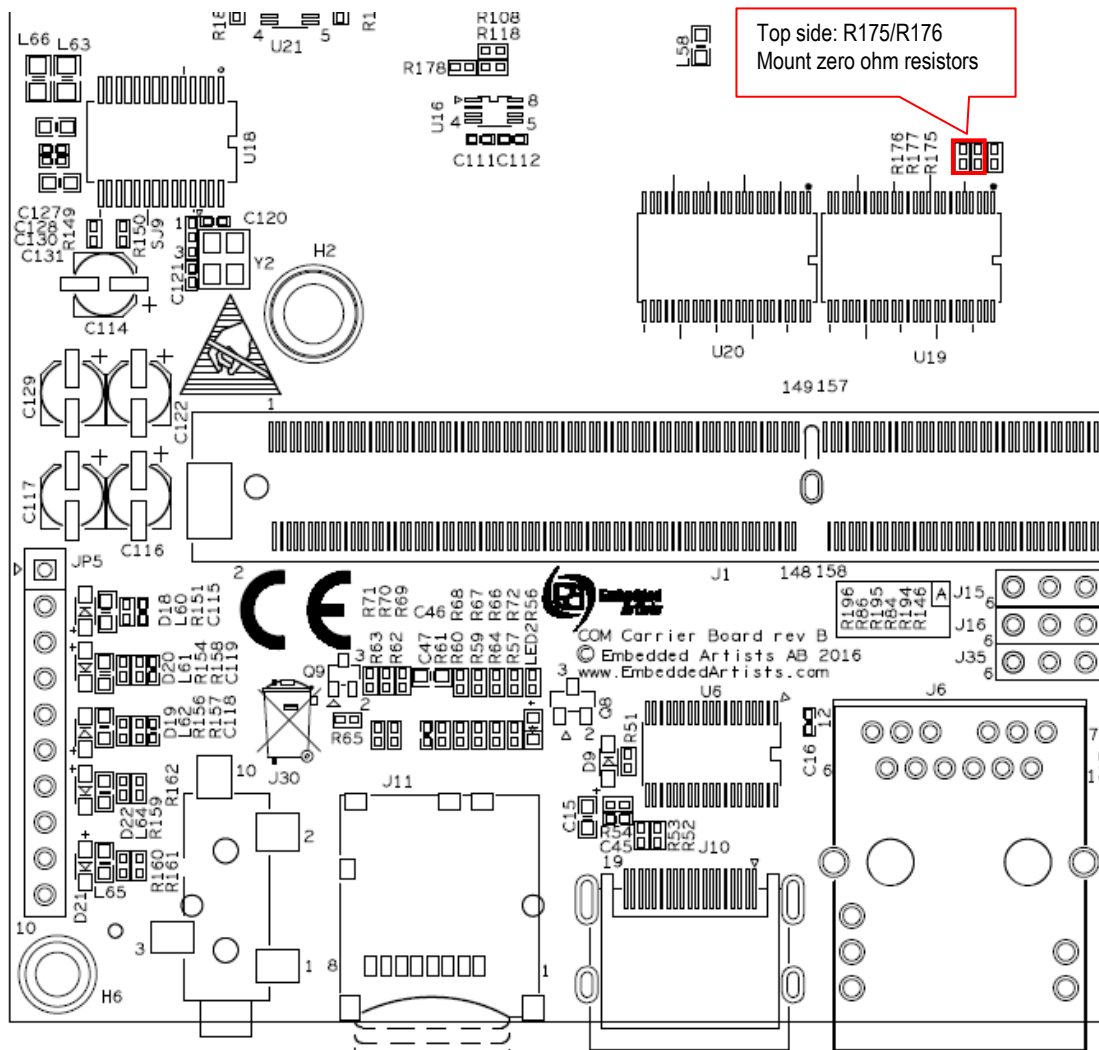Mount zero ohm resistors

Figure 16 – R176/R177 on COM Carrier Board rev A

Figure 17 – R176/R177 on COM Carrier Board rev B