

ON Semiconductor

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ArrayC Series

Silicon Photomultiplier (SiPM) 4-Side Scalable Arrays

ON Semiconductor’s range of C-Series, SMT (surface mount technology) SiPM sensors have been used to create compact and scalable arrays. The sensors are mounted onto PCB boards with minimal dead space. The ArrayC products are available in a variety of formats, and formed of pixels of different sizes. Details of the arrays available are given in the [Ordering Information](#) table on page 29 of this document.

The back of each ArrayC has either one or more multi-way connectors, or a BGA (ball grid array), that allow access to the fast output* and *standard* I/O from each pixel in the array, and a *common* I/O from the summed substrates of the pixels. The ArrayC products with connectors can be used to interface with the user’s own readout via the mating connector, or to ON Semiconductor’s Breakout Boards (BOBs). The BOBs allow for easy access to the pixel signals and performance evaluation of the arrays.

ArrayC products with the BGA can be reflow soldered to the user’s readout boards, or purchased ready-mounted on an Evaluation Board (EVB) for easy testing. The BGA ArrayC products cannot be removed from their EVBs. This contrasts with an ArrayC that has connectors, where multiple arrays can be evaluated with a single BOB.

ArrayC Inputs and Outputs (I/O)

Figure 1 summarizes the array schematic for a portion of an ArrayC. Each SiPM sensor in the array has three electrical connections: fast output*, standard output and common.

The substrates (cathodes) of all sensors are summed together to form the common I/O.

Each individual fast output* and standard I/O (anode) are routed to its own output pin.

The pixel-level performance of the sensors in the array can be found in the [C-Series](#) datasheet.

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* The ARRAYC-60035-4P does not have access to the fast output.



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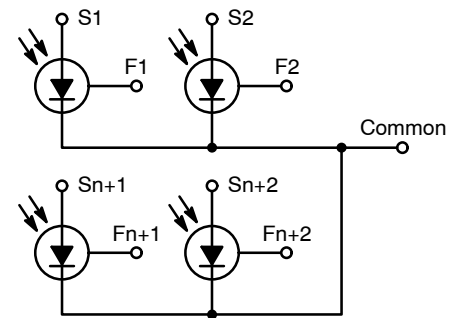
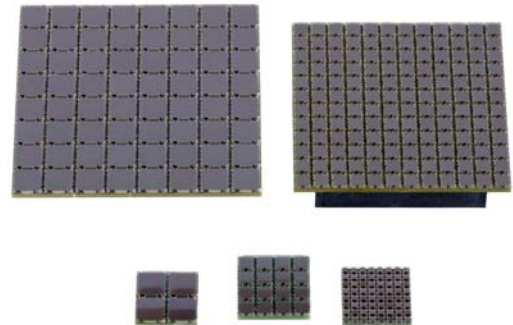


Figure 1. Signal connections at the pixel level of an ArrayC

ATTENTION!

Great care should be taken when disconnecting the ArrayC PCBs from the mating connectors, either on one of the BOBs, or the user’s own boards.

The board should be gently levered up, working progressively around the board to lever the PCB from the connector a little on all sides, and then repeating the process until the connectors are free from each other.

Note that a BGA ArrayC cannot be removed from its EVB.

ArrayC Series

ARRAYC-60035-4P-BGA (2 x 2 ARRAY OF 6 mm SMT SENSORS)

| Array Size | Sensor Type | Readout | Board Size | Pixel Pitch | No. Connections | No. Connectors |
|------------|-------------|---|-----------------------------|-------------|-----------------|----------------|
| 2 x 2 | 60035 | Pixel <td>14.2 x 14.2 mm²</td> <td>7.2 mm</td> <td>9</td> <td>3 x 3 BGA</td> | 14.2 x 14.2 mm ² | 7.2 mm | 9 | 3 x 3 BGA |

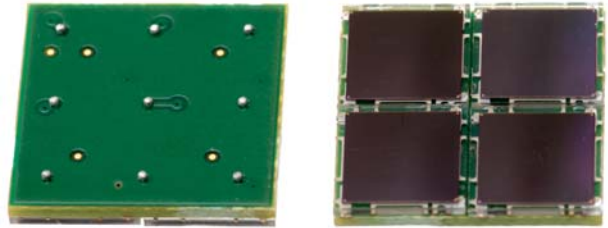
The ARRAYC-60035-4P is comprised of 4 individual 6mm C-Series sensors arranged in a 2 x 2 array.

The performance of the individual pixels and details of the bias to apply can be found in the [C-Series](#) datasheet.

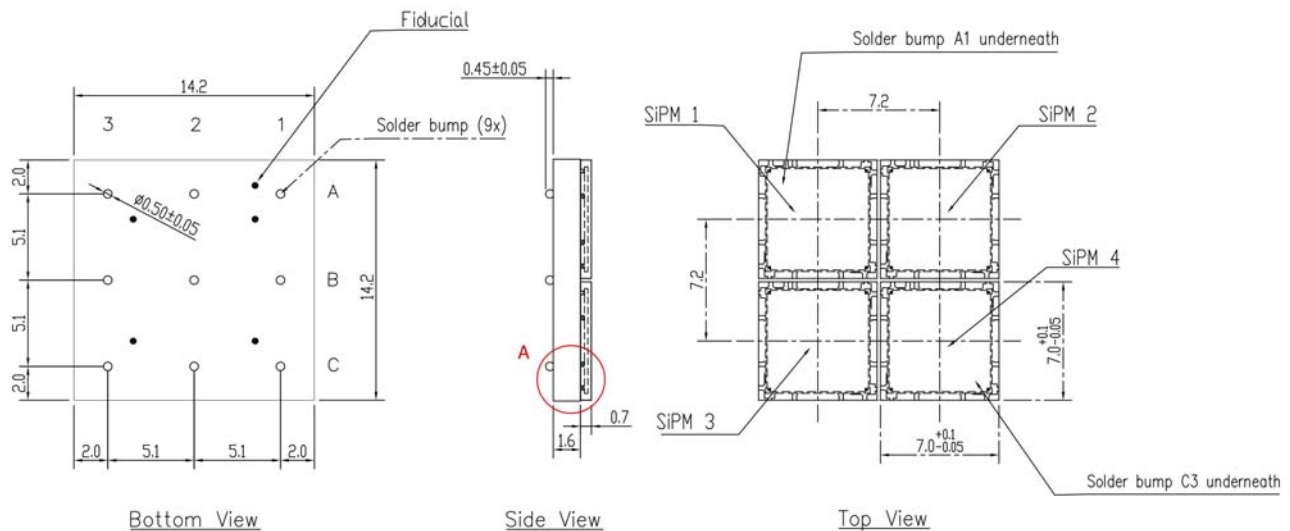
Connections to each sensor are provided by a BGA (ball grid array). The BGA can be used to mount the array on the user's board using reflow soldering.

The 4 SiPM sensors have all substrate connections (cathodes) connected together to form a common I/O. The 3 x 3 BGA provides connections as follows:

- 4 x standard I/O
- 5 x common I/O
- There is NO fast output



Schematics for the ARRAYC-60035-4P-BGA

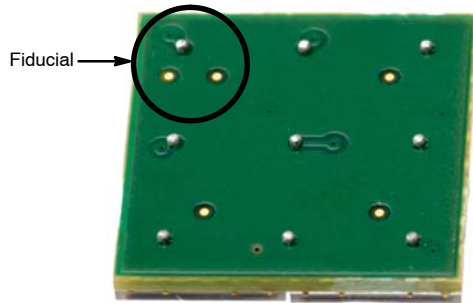


The complete ARRAYC-60035-4P-BGA CAD and solder footprint is available to [download](#).

ArrayC Series

BGA Connections for the ARRAYC-60035-4P-BGA

The fiducial is indicated in the image below. It marks the location of both pin A1 and pixel 1.



| Pin. No | Function |
|---------|----------------|
| A1 | Anode 1 |
| A2 | Anode 2 |
| A3 | Common Cathode |
| B1 | Anode 3 |
| B2 | Anode 4 |
| B3 | Common Cathode |
| C1 | Common Cathode |
| C2 | Common Cathode |
| C3 | Common Cathode |

ARRAYC-60035-4P-BGA - Solder Footprint and Reflow Solder Profile

The BGA package is compatible with standard reflow solder processes (J-STD-20) and so is ideal for high-volume manufacturing. The ARRAYC-60035-4P-BGA should be mounted according to specified soldering pad patterns, as given in of the [CAD file](#).

Solder paste (we recommend using no-clean solder paste) must be evenly applied to each soldering pad to insure

proper bonding and positioning of the array. After soldering, allow at least three minutes for the component to cool to room temperature before further operations.

Solder reflow conditions must be in compliance with J-STD-20, table 5.2. This is summarized in Figure 2. The number of passes should not be more than 2.

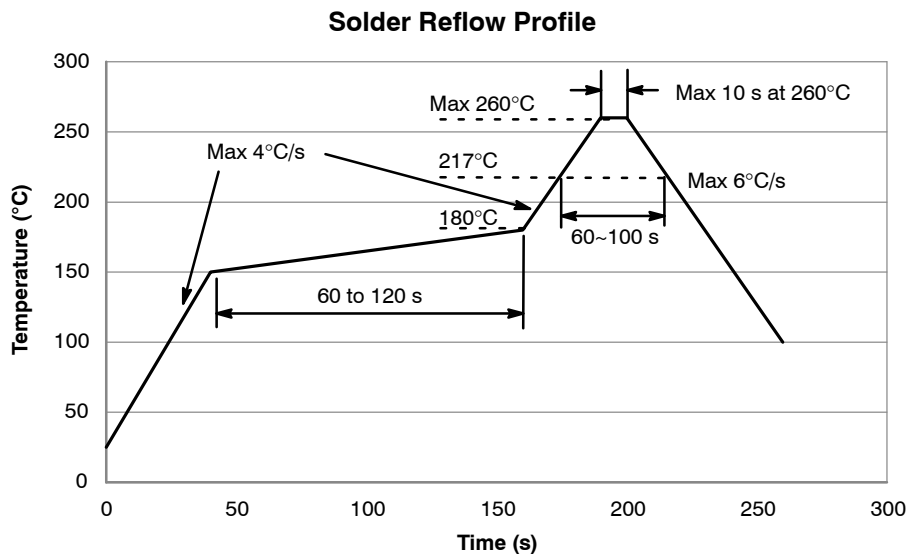


Figure 2. Solder reflow profile. Conditions must be in compliance with J-STD-20, table 5.2

ArrayC Series

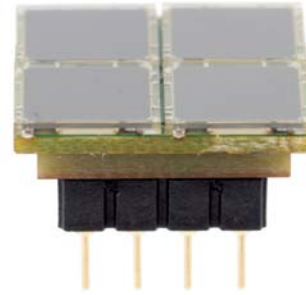
ARRAYC-60035-4P-GEVB (ARRAYC-60035-4P-BGA Evaluation Board)

The ARRAYC-60035-4P-GEVB is an evaluation board allowing easy access to the signals of a ARRAYC-60035-4P-BGA via pins.

The ARRAYC-60035-4P-GEVB has the array on the front and pins on the back of the PCB. The pins are compatible with a standard 8-pin DIL socket for evaluation purposes. Alternatively, the pins can be directly soldered into through-holes in the user's readout PCB. Four of the pins are connected to the anodes of the individual pixels and the other four pins are connected to the common cathode. An example mating 8-pin DIL socket is the [110-93-308-41-001000 from Mill-Max](#).

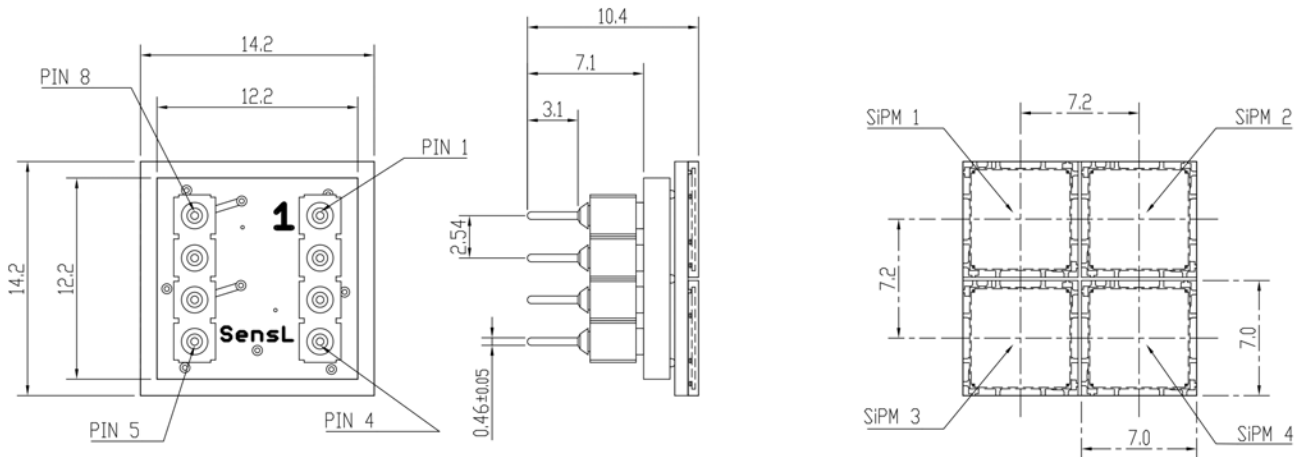
The GEVB PCB is slightly smaller than the actual array, allowing for tiling.

The GEVB does NOT provide access to the fast output.



| Pin. No | Function |
|---------|----------------|
| 1 | Anode 1 |
| 2 | Common Cathode |
| 3 | Anode 3 |
| 4 | Common Cathode |
| 5 | Common Cathode |
| 6 | Anode 4 |
| 7 | Common Cathode |
| 8 | Anode 2 |

Schematics for the ARRAYC-60035-4P-GEVB



The complete ARRAYC-60035-4P-GEVB CAD and solder footprint is available to [download](#).

ArrayC Series

ARRAYC-60035-64P-PCB (8 x 8 ARRAY OF 6 mm SMT SENSORS)

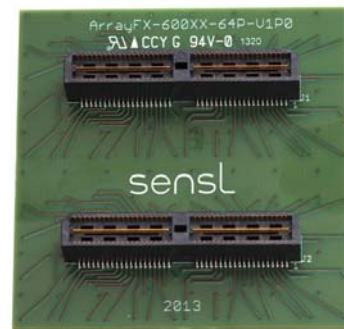
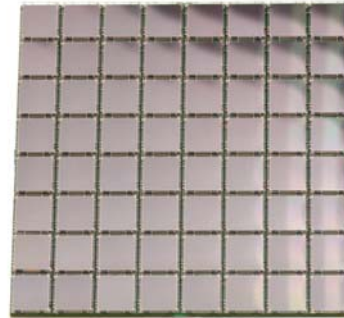
| Array Size | Sensor Type | Readout | Board Size | Pixel Pitch | No. Connections | No. Connectors |
|------------|-------------|---------|-----------------------------|-------------|-----------------|----------------|
| 8 x 8 | 60035 | Pixel | 57.4 x 57.4 mm ² | 7.2 mm | 160 | 2 x 80-way |

The ARRAYC-60035-64P is comprised of 64 individual 6mm SMT sensors arranged in a 8 x 8 array.

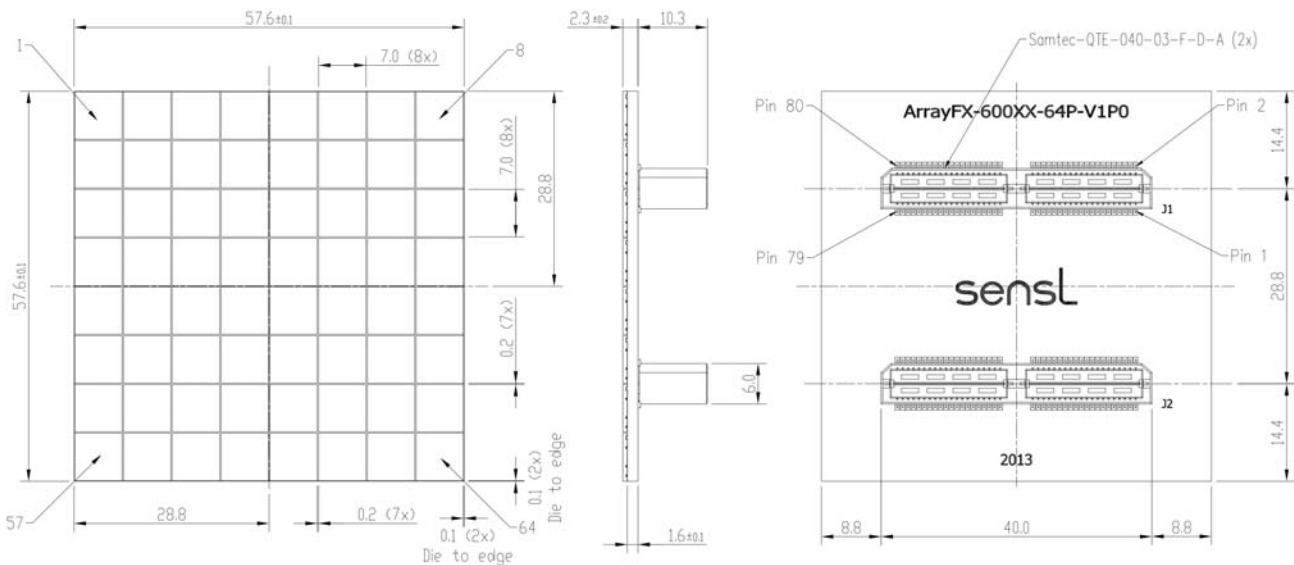
The performance of the individual pixels and details of the bias to apply can be found in the [C-Series](#) datasheet.

The connections to each array are provided by two **Samtec 80-way connectors, type QTE-040-03-F-D-A**. These connectors mate with the Samtec QSE-040-01-F-D-A board-to-board connector and the Samtec EQCD High Speed Cable Assemblies. The 64 SiPM pixels all have substrate connections (cathode) summed to form a common I/O. The 80-way connectors provide connections as follows:

- 64 x fast output
- 64 x standard I/O
- 32 x common I/O



Schematics for the ARRAYC-60035-64P-PCB



The complete ARRAYC-60035-64P-PCB CAD is available to [download](#).

ArrayC Series

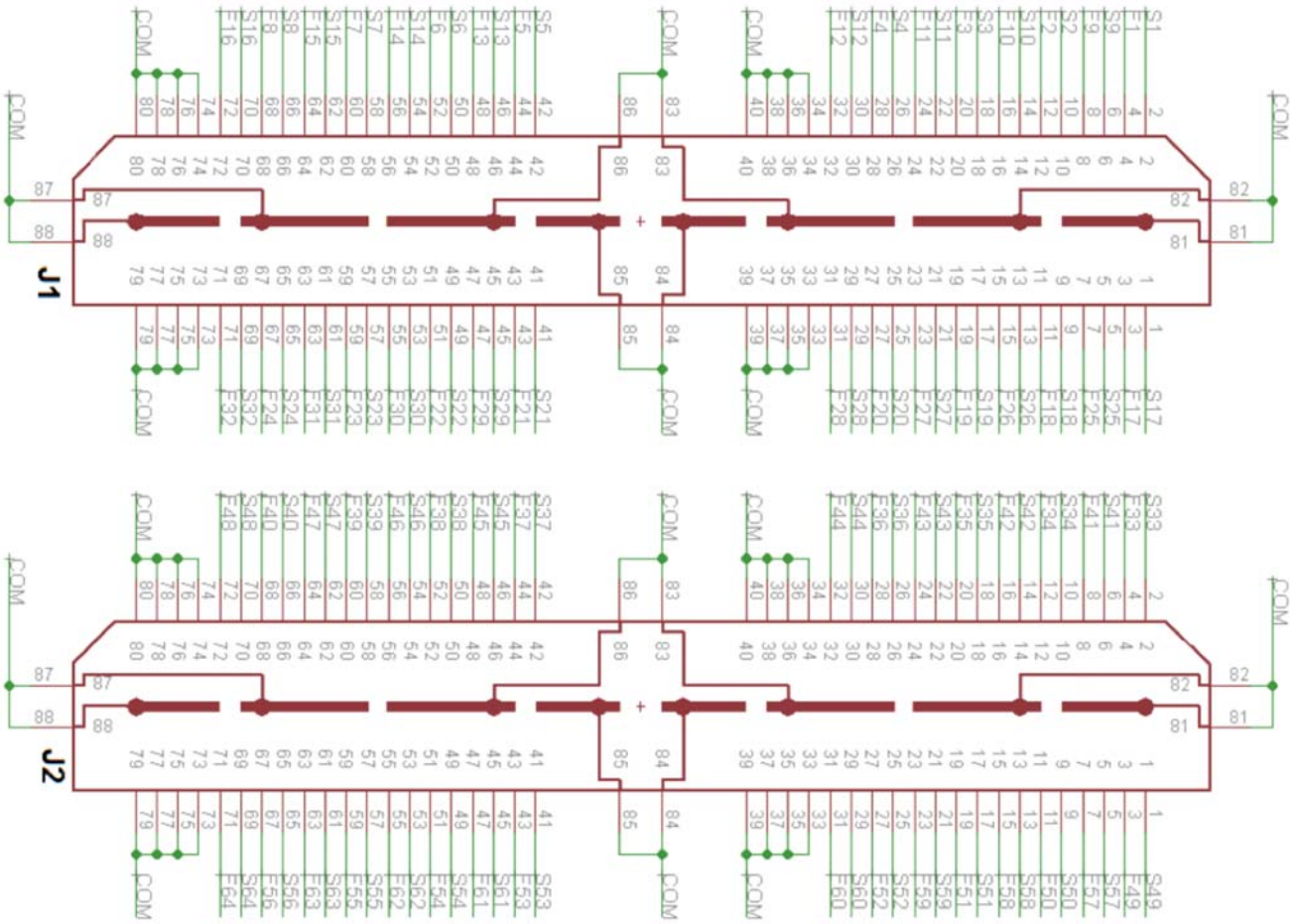


Figure 3. Connector schematic for the ARRAYC-60035-64P

ArrayC Series

Table 1. Connector Pin-Outs for the ARRAYC-60035-64P-PCB

| J1 | | | | J2 | | | |
|-----|--------|-----|--------|-----|--------|-----|--------|
| PIN | SIGNAL | PIN | SIGNAL | PIN | SIGNAL | PIN | SIGNAL |
| 1 | S17 | 2 | S1 | 1 | S49 | 2 | S33 |
| 3 | F17 | 4 | F1 | 3 | F49 | 4 | F33 |
| 5 | S25 | 6 | S9 | 5 | S57 | 6 | S41 |
| 7 | F25 | 8 | F9 | 7 | F57 | 8 | F41 |
| 9 | S18 | 10 | S2 | 9 | S50 | 10 | S34 |
| 11 | F18 | 12 | F2 | 11 | F50 | 12 | F34 |
| 13 | S26 | 14 | S10 | 13 | S58 | 14 | S42 |
| 15 | F26 | 16 | F10 | 15 | F58 | 16 | F42 |
| 17 | S19 | 18 | S3 | 17 | S51 | 18 | S35 |
| 19 | F19 | 20 | F3 | 19 | F51 | 20 | F35 |
| 21 | S27 | 22 | S11 | 21 | S59 | 22 | S43 |
| 23 | F27 | 24 | F11 | 23 | F59 | 24 | F43 |
| 25 | S20 | 26 | S4 | 25 | S52 | 26 | S36 |
| 27 | F20 | 28 | F4 | 27 | F52 | 28 | F36 |
| 29 | S28 | 30 | S12 | 29 | S60 | 30 | S44 |
| 31 | F28 | 32 | F12 | 31 | F60 | 32 | F44 |
| 33 | CM | 34 | CM | 33 | CM | 34 | CM |
| 35 | CM | 36 | CM | 35 | CM | 36 | CM |
| 37 | CM | 38 | CM | 37 | CM | 38 | CM |
| 39 | CM | 40 | CM | 39 | CM | 40 | CM |
| 41 | S21 | 42 | S5 | 41 | S53 | 42 | S37 |
| 43 | F21 | 44 | F5 | 43 | F53 | 44 | F37 |
| 45 | S29 | 46 | S13 | 45 | S61 | 46 | S45 |
| 47 | F29 | 48 | F13 | 47 | F61 | 48 | F45 |
| 49 | S22 | 50 | S6 | 49 | S54 | 50 | S38 |
| 51 | F22 | 52 | F6 | 51 | F54 | 52 | F38 |
| 53 | S30 | 54 | S14 | 53 | S62 | 54 | S46 |
| 55 | F30 | 56 | F14 | 55 | F62 | 56 | F46 |
| 57 | S23 | 58 | S7 | 57 | S55 | 58 | S39 |
| 59 | F23 | 60 | F7 | 59 | F55 | 60 | F39 |
| 61 | S31 | 62 | S15 | 61 | S63 | 62 | S47 |
| 63 | F31 | 64 | F15 | 63 | F63 | 64 | F47 |
| 65 | S24 | 66 | S8 | 65 | S56 | 66 | S40 |
| 67 | F24 | 68 | F8 | 67 | F56 | 68 | F40 |
| 69 | S32 | 70 | S16 | 69 | S64 | 70 | S48 |
| 71 | F32 | 72 | F16 | 71 | F64 | 72 | F48 |
| 73 | CM | 74 | CM | 73 | CM | 74 | CM |
| 75 | CM | 76 | CM | 75 | CM | 76 | CM |
| 77 | CM | 78 | CM | 77 | CM | 78 | CM |
| 79 | CM | 80 | CM | 79 | CM | 80 | CM |

| | |
|----|-------------------------|
| CM | Common I/O |
| Sn | Standard I/O of pixel n |
| Fn | Fast output of pixel n |

ArrayC Series

ARRAYX-BOB6-64P (ARRAYC-60035-64P Breakout Board)

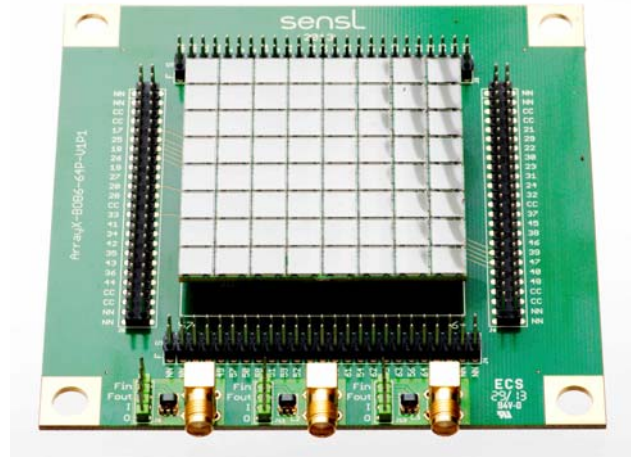
The ARRAYX-BOB6-64P is an evaluation board allowing easy access to all the signals of a ON Semiconductor ARRAYC-60035-64P, 6 mm 8 x 8 SiPM array.

The Breakout Board features two Samtec 80-way connectors, type QSE-040-01-F-D-A. These connectors mate with the Samtec QTE-040-03-F-D-A board-to-board connector on the array. Since the connectors are keyed, orientating the array on the BOB is straightforward.

All signals on the array are routed via the mating connectors to header pins. These pins are formed of four 50-way (25 x 2 row) 2.54 mm pitch headers; J3, J4, J5 and J6. Each of the four headers also has 8 pins left unconnected to allow prototyping for evaluation purposes. The layout of the board can be seen in Figure 4.

The three SMA connectors on the board can be connected via the supplied jumper cable to any of the array header pins and used for accessing signals or supplying bias voltage. Four 7 mm holes are aligned on a 25 mm grid to allow mounting of the board on an optical breadboard.

See Appendices A and B for examples of Breakout Board usage.



Schematics for the ARRAYC-60035-4P-EVB

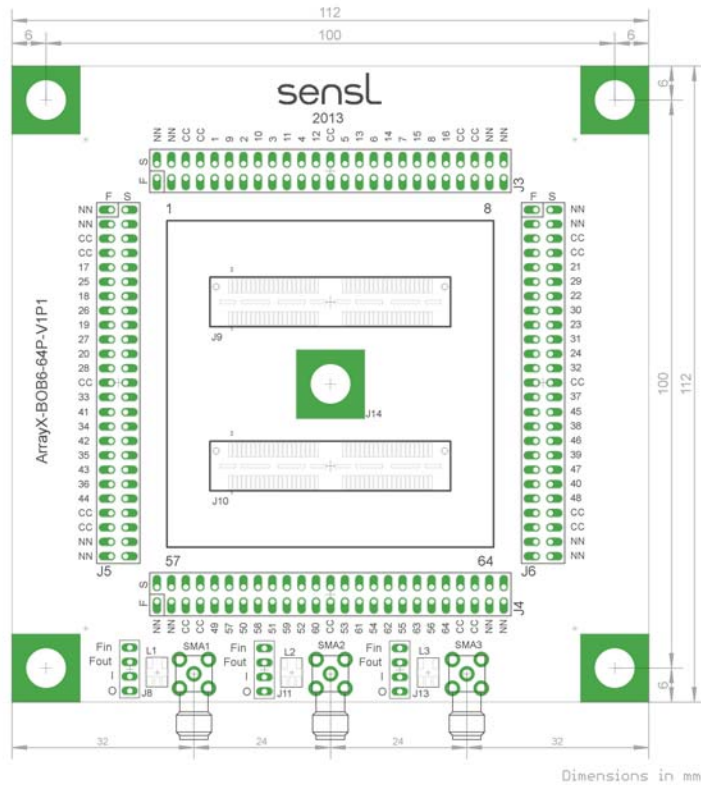


Figure 4. Layout of the ARRAYX-BOB6-64P. The dimensions of the board are 112 mm x 112 mm

ArrayC Series

Table 2. HEADER SIGNALS ON THE ARRAYX-BOB6-64P

| Pin | | J3 | | J4 | | J5 | | J6 | |
|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | 2 | NC | NC | NC | NC | NC | NC | NC | NC |
| 3 | 4 | NC | NC | NC | NC | NC | NC | NC | NC |
| 5 | 6 | CM | CM | CM | CM | CM | CM | CM | CM |
| 7 | 8 | CM | CM | CM | CM | CM | CM | CM | CM |
| 9 | 10 | F1 | S1 | F49 | S49 | F17 | S17 | F21 | S21 |
| 11 | 12 | F9 | S9 | F57 | S57 | F25 | S25 | F29 | S29 |
| 13 | 14 | F2 | S2 | F50 | S50 | F18 | S18 | F22 | S22 |
| 15 | 16 | F10 | S10 | F58 | S58 | F26 | S26 | F30 | S30 |
| 17 | 18 | F3 | S3 | F51 | S51 | F19 | S19 | F23 | S23 |
| 19 | 20 | F11 | S11 | F59 | S59 | F27 | S27 | F31 | S31 |
| 21 | 22 | F4 | S4 | F52 | S52 | F20 | S20 | F24 | S24 |
| 23 | 24 | F12 | S12 | F60 | S60 | F28 | S28 | F32 | S32 |
| 25 | 26 | CM | CM | CM | CM | CM | CM | CM | CM |
| 27 | 28 | F5 | S5 | F53 | S53 | F33 | S33 | F37 | S37 |
| 29 | 30 | F13 | S13 | F61 | S61 | F41 | S41 | F45 | S45 |
| 31 | 32 | F6 | S6 | F54 | S54 | F34 | S34 | F38 | S38 |
| 33 | 34 | F14 | S14 | F62 | S62 | F42 | S42 | F46 | S46 |
| 35 | 36 | F7 | S7 | F55 | S55 | F35 | S35 | F39 | S39 |
| 37 | 38 | F15 | S15 | F63 | S63 | F43 | S43 | F47 | S47 |
| 39 | 40 | F8 | S8 | F56 | S56 | F36 | S36 | F40 | S40 |
| 41 | 42 | F16 | S16 | F64 | S64 | F44 | S44 | F48 | S48 |
| 43 | 44 | CM | CM | CM | CM | CM | CM | CM | CM |
| 45 | 46 | CM | CM | CM | CM | CM | CM | CM | CM |
| 47 | 48 | NC | NC | NC | NC | NC | NC | NC | NC |
| 49 | 50 | NC | NC | NC | NC | NC | NC | NC | NC |

| | |
|----|-------------------------|
| NC | Not Connected |
| CM | Common I/O |
| Sn | Standard I/O of pixel n |
| Fn | Fast output of pixel n |

ArrayC Series

ARRAYX-BOB6-64S (Summed Breakout Board for the ARRAYC-60035-64P)

The ARRAYX-BOB6-64S is an evaluation board allowing easy access to the sum of all of standard pixel signals of a ON Semiconductor ARRAYC-60035-64P, 6 mm 8x 8 SiPM array, in addition to all of the individual fast output signals. The Breakout Board features two Samtec 80-way connectors, type QSE-040-01-F-D-A. These connectors mate with the Samtec QTE-040-03-F-D-A board-to-board connector on the array. Since the connectors are keyed, orientating the array on the BOB is straightforward. A schematic of the board is shown in Figure 5 below.

Fast signals: All of the fast output signals (Fn) from the array are routed via the mating connectors to header pins.

These pins are formed of four 50-way (25 x 2 row) 2.54 mm pitch headers; J3, J4, J5 and J6. Each of the four headers also has 10 pins that connect to the common cathode (CM) and 8 pins left unconnected (NC) to allow prototyping for evaluation purposes.

Two SMA connectors and Balun transformers are provided with 4-pin headers to allow any fast signal to be connected directly to the SMA or via the transformer using jumper wires.

Summed output: A summed output (the anodes of pixels 1 to 64 connected together) is routed to jumper pins (SM) in close proximity to a third SMA connector. Four 7 mm holes are placed on a 25 mm grid to allow mounting of the board on an optical breadboard.

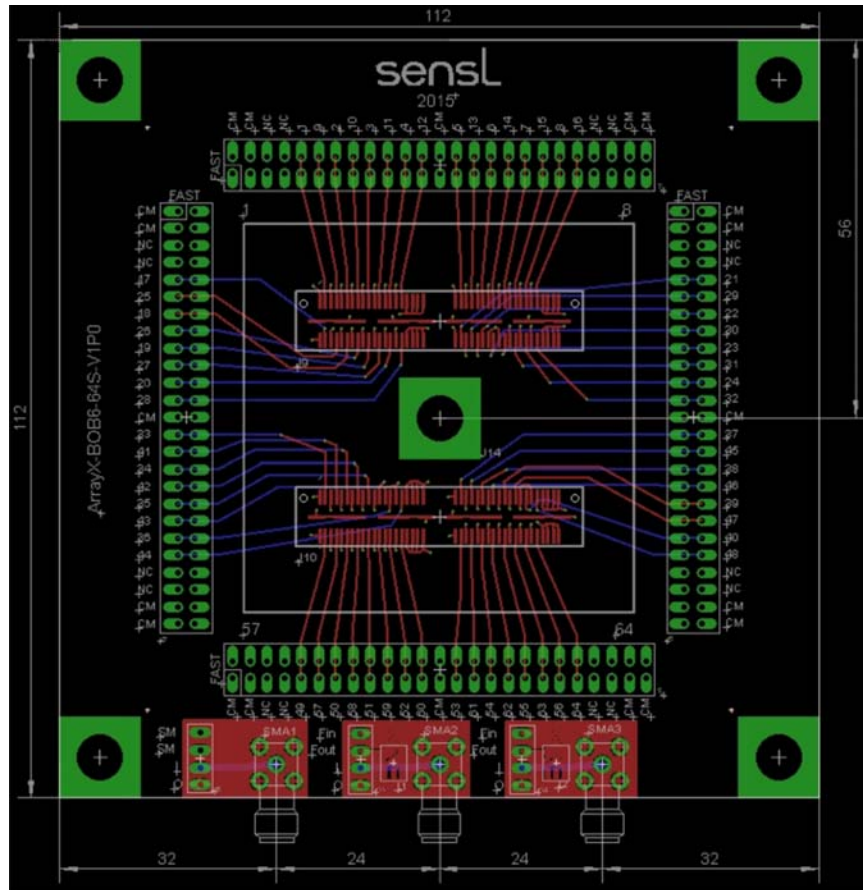


Figure 5. Layout of the ARRAYX-BOB6-64S. The dimensions of the board are 112 mm x 112 mm

ArrayC Series

Table 3. HEADER SIGNALS ON THE ARRAYX-BOB6-64S

| Pin | | J3 | | J4 | | J5 | | J6 | |
|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | 2 | CM | CM | CM | CM | CM | CM | CM | CM |
| 3 | 4 | CM | CM | CM | CM | CM | CM | CM | CM |
| 5 | 6 | NC | NC | NC | NC | NC | NC | NC | NC |
| 7 | 8 | NC | NC | NC | NC | NC | NC | NC | NC |
| 9 | 10 | F1 | F1 | F49 | F49 | F17 | F17 | F21 | F21 |
| 11 | 12 | F9 | F9 | F57 | F57 | F25 | F25 | F29 | F29 |
| 13 | 14 | F2 | F2 | F50 | F50 | F18 | F18 | F22 | F22 |
| 15 | 16 | F10 | F10 | F58 | F58 | F26 | F26 | F30 | F30 |
| 17 | 18 | F3 | F3 | F51 | F51 | F19 | F19 | F23 | F23 |
| 19 | 20 | F11 | F11 | F59 | F59 | F27 | F27 | F31 | F31 |
| 21 | 22 | F4 | F4 | F52 | F52 | F20 | F20 | F24 | F24 |
| 23 | 24 | F12 | F12 | F60 | F60 | F28 | F28 | F32 | F32 |
| 25 | 26 | CM | CM | CM | CM | CM | CM | CM | CM |
| 27 | 28 | F5 | F5 | F53 | F53 | F33 | F33 | F37 | F37 |
| 29 | 30 | F13 | F13 | F61 | F61 | F41 | F41 | F45 | F45 |
| 31 | 32 | F6 | F6 | F54 | F54 | F34 | F34 | F38 | F38 |
| 33 | 34 | F14 | F14 | F62 | F62 | F42 | F42 | F46 | F46 |
| 35 | 36 | F7 | F7 | F55 | F55 | F35 | F35 | F39 | F39 |
| 37 | 38 | F15 | F15 | F63 | F63 | F43 | F43 | F47 | F47 |
| 39 | 40 | F8 | F8 | F56 | F56 | F36 | F36 | F40 | F40 |
| 41 | 42 | F16 | F16 | F64 | F64 | F44 | F44 | F48 | F48 |
| 43 | 44 | NC | NC | NC | NC | NC | NC | NC | NC |
| 45 | 46 | NC | NC | NC | NC | NC | NC | NC | NC |
| 47 | 48 | CM | CM | CM | CM | CM | CM | CM | CM |
| 49 | 50 | CM | CM | CM | CM | CM | CM | CM | CM |

| | |
|----|------------------------|
| NC | Not Connected |
| CM | Common I/O |
| Fn | Fast output of pixel n |

ArrayC Series

ARRAYC-30035-16P-PCB (4 x 4 ARRAY OF 3 mm SMT SENSORS)

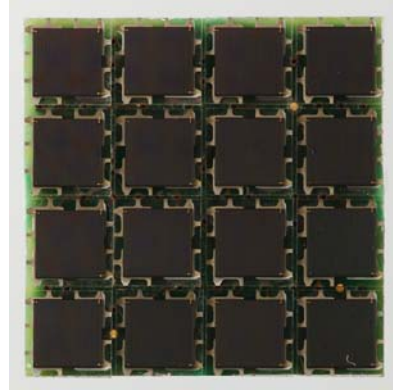
| Array Size | Sensor Type | Readout | Board Size | Pixel Pitch | No. Connections | No. Connectors |
|------------|-------------|---------|-----------------------------|-------------|-----------------|----------------|
| 4 x 4 | 30035 | Pixel | 16.6 x 16.6 mm ² | 4.2 mm | 40 | 1 x 40-way |

The ARRAYC-30035-16P-PCB is comprised of 16 individual 3 mm C-Series sensors arranged in a 4 x 4 array.

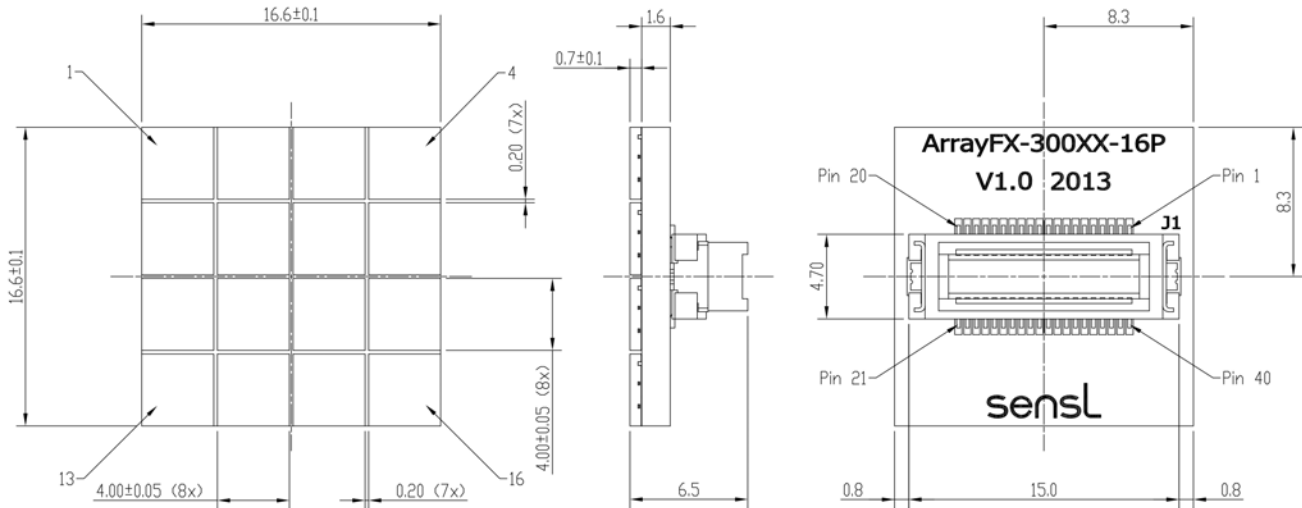
The performance of the individual pixels and details of the bias to apply can be found in the [C-Series](#) datasheet.

Connections to each sensor are provided by a 40-way Hirose plug-type board-to-board connector DF17(2.0)-40DP-0.5V(57). These connectors mate with the Hirose DF17(3.0)-40DS-0.5V(57). The 16 SiPM pixels have all substrates (cathodes) connected together to form a common I/O. The 40-way connector provides connections as follows:

- 16 x fast output
- 16 x standard I/O
- 8 x common I/O



Schematics for the ARRAYC-30035-16P-PCB



The complete ARRAYC-30035-16P-PCB CAD is available to [download](#).

ArrayC Series

Connector Pin-Outs for the ARRAYC-30035-16P-PCB

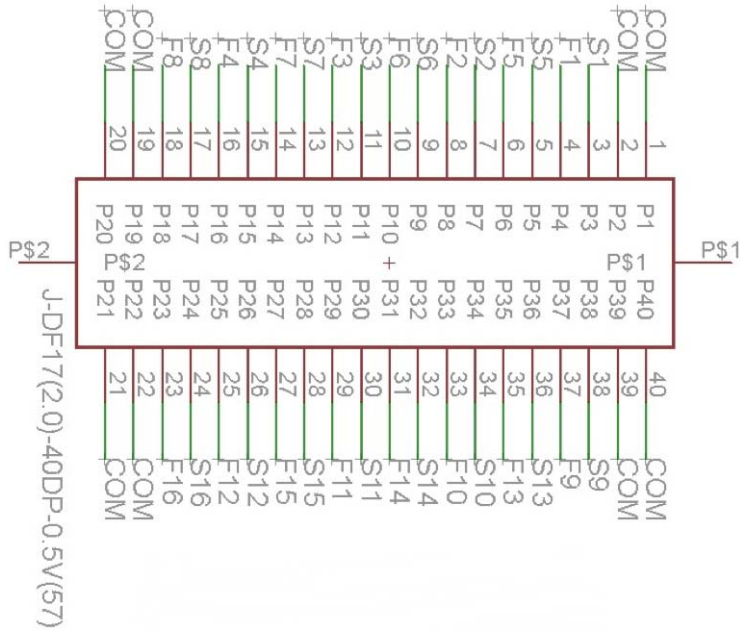


Figure 6. Connector schematic for the ARRAYC-30035-16P

| PIN | SIGNAL | PIN | SIGNAL |
|-----|--------|-----|--------|
| 1 | CM | 40 | CM |
| 2 | CM | 39 | CM |
| 3 | S1 | 38 | S9 |
| 4 | F1 | 37 | F9 |
| 5 | S5 | 36 | S13 |
| 6 | F5 | 35 | F13 |
| 7 | S2 | 34 | S10 |
| 8 | F2 | 33 | F10 |
| 9 | S6 | 32 | S14 |
| 10 | F6 | 31 | F14 |
| 11 | S3 | 30 | S11 |
| 12 | F3 | 29 | F11 |
| 13 | S7 | 28 | S15 |
| 14 | F7 | 27 | F15 |
| 15 | S4 | 26 | S12 |
| 16 | F4 | 25 | F12 |
| 17 | S8 | 24 | S16 |
| 18 | F8 | 23 | F16 |
| 19 | CM | 22 | CM |
| 20 | CM | 21 | CM |

| | |
|----|-------------------------|
| CM | Common I/O |
| Sn | Standard I/O of pixel n |
| Fn | Fast output of pixel n |

ArrayC Series

ARRAYX-BOB3-16P (ARRAYC-30035-16P Breakout Board)

The ARRAYX-BOB3-16P is an evaluation board allowing easy access to the signals from a ON Semiconductor ARRAYC-30035-16P, 3 mm 4 x 4 SiPM array. See Figure 7 for details on orientating the array correctly on the BOB.

The Breakout Board has a centrally located Hirose 40-way connector DF17(2.0)-40DS-0.5V(57). This connector mates with the Hirose DF17(2.0)-40DP-0.5V(57) board-to-board connector on the ARRAYC-30035-16P. All signals on the ARRAY are routed via the mating connector to header pins. These pins are formed by two 20-way (10 x 2 row) 2.54 mm pitch headers; J2 and J3.

Three SMA connectors and Balun transformers are provided with 4-pin headers to allow any signal to be connected directly to the SMA or via the transformer using jumper wires. Four 7 mm holes are aligned on a 25 mm grid to allow mounting of the board on an optical breadboard.

See Appendices A and B for examples of Breakout Board usage.

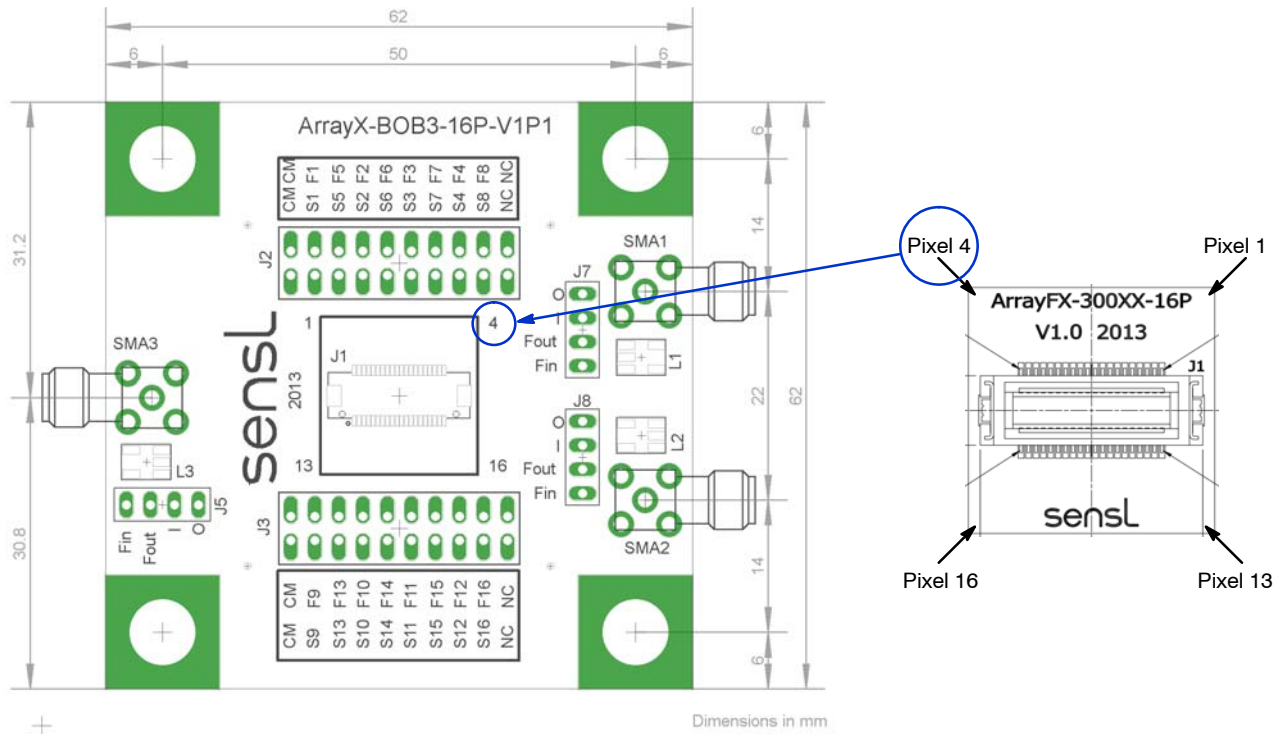
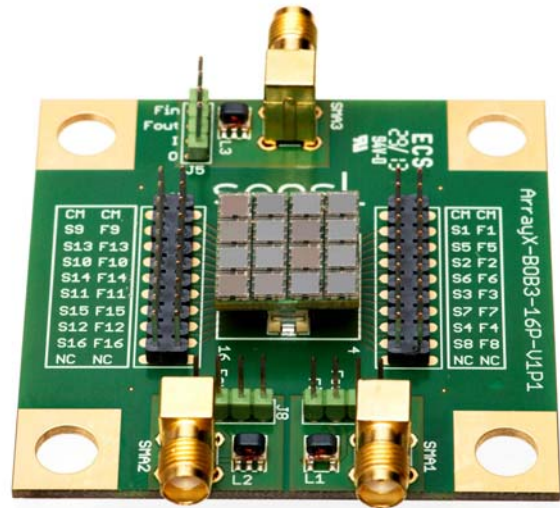


Figure 7. Layout of the ArrayX-BOB3-16P (left). The board dimensions are 62 mm x 62 mm. The underside of the ArrayC-30035-16P is also shown (right). The pixel numbering is shown, and can be matched the pixel numbers that are marked on the BOB, as indicated. This allows for the correct orientation of the array on the BOB

ArrayC Series

Header Signals for the ARRAYX-BOB3-16P

| PIN | | J2 | | J3 | |
|-----|----|----|-----|-----|-----|
| 1 | 2 | CM | CM | CM | CM |
| 3 | 4 | S1 | F1 | S9 | F9 |
| 5 | 6 | S5 | F5 | S13 | F13 |
| 7 | 8 | S2 | F2 | S10 | F10 |
| 9 | 10 | S6 | F6 | S14 | F14 |
| 11 | 12 | S3 | F3 | S11 | F11 |
| 13 | 14 | S7 | F17 | S15 | F15 |
| 15 | 16 | S4 | F4 | S12 | F12 |
| 17 | 18 | S8 | F6 | S16 | F16 |
| 19 | 20 | NC | NC | NC | NC |

| | |
|----|-------------------------|
| NC | Not Connected |
| CM | Common I/O |
| Sn | Standard I/O of pixel n |
| Fn | Fast output of pixel n |

ArrayC Series

ARRAYX-BOB3-16S (Summed Breakout Board for the ARRAYC-30035-16P)

The ARRAYX-BOB3-16S is an evaluation board allowing easy access to the sum of all of standard pixel signals of a ON Semiconductor ARRAYC-30035-16P, 3 mm 4 x 4 SiPM array, in addition to all of the individual fast output signals. The Summed Breakout Board has a centrally located Hirose 40-way connector DF17(2.0)-40DS-0.5V(57). This connector mates with the Hirose DF17(2.0)-40DP-0.5V(57) board-to-board connector on the ARRAYC-30035-16P. See Figure 7 in the previous section for information on orientating the array on the BOB. A schematic of the board is shown in Figure 8 below.

Fast signals: All of the fast output signals (Fn) from the array are routed via the mating connectors to header pins.

These pins are formed by two 20-way (10 x 2 row) 2.54 mm pitch headers; J2 and J3. Each of the headers also has 2 pins that connect to the common cathode (CM) and 2 pins left unconnected (NC) to allow prototyping for evaluation purposes.

Two SMA connectors and Balun transformers are provided with 4-pin headers to allow any fast signal to be connected directly to the SMA or via the transformer using jumper wires.

Summed output: A summed output (the anodes of pixels 1 to 16 connected together) is routed to jumper pins (SM) in close proximity to a third SMA connector. Four 7 mm holes are placed on a 25 mm grid to allow mounting of the board on an optical breadboard.

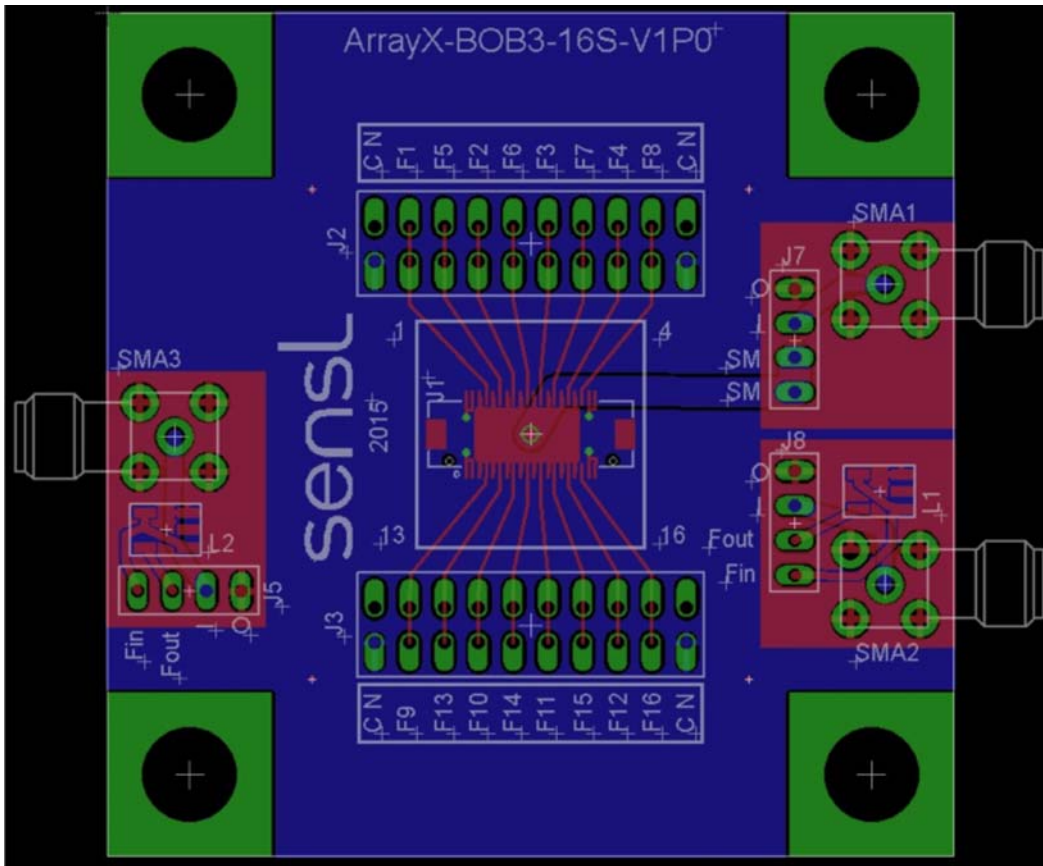


Figure 8. Layout of the ARRAYX-BOB3-16S. The board dimensions are 62 mm x 62 mm

ArrayC Series

Header Signals for the ARRAYX-BOB3-16S

| PIN | | J2 | | J3 | |
|-----|----|----|----|-----|-----|
| 1 | 2 | CM | NC | CM | NC |
| 3 | 4 | F1 | F1 | F9 | F9 |
| 5 | 6 | F5 | F5 | F13 | F13 |
| 7 | 8 | F2 | F2 | F10 | F10 |
| 9 | 10 | F6 | F6 | F14 | F14 |
| 11 | 12 | F3 | F3 | F11 | F11 |
| 13 | 14 | F7 | F7 | F15 | F15 |
| 15 | 16 | F4 | F4 | F12 | F12 |
| 17 | 18 | F8 | F8 | F16 | F16 |
| 19 | 20 | CM | NC | CM | NC |

| | |
|----|-------------------------|
| NC | Not Connected |
| CM | Common I/O |
| Sn | Standard I/O of pixel n |
| Fn | Fast output of pixel n |

ArrayC Series

ARRAYC-30035-144P-PCB (12 x 12 ARRAY OF 3 mm SMT SENSORS)

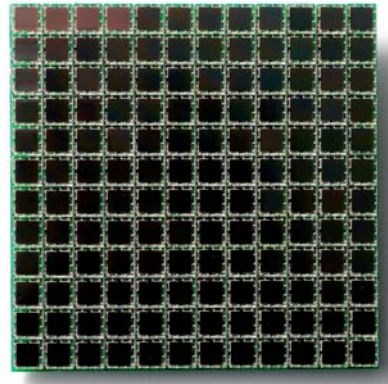
| Array Size | Sensor Type | Readout | Board Size | Pixel Pitch | No. Connections | No. Connectors |
|------------|-------------|---------|-----------------------------|-------------|-----------------|----------------|
| 12 x 12 | 30035 | Pixel | 50.2 x 50.2 mm ² | 4.2 mm | 320 | 4 x 80-way |

The ARRAYC-30035-144P is comprised of 144 individual 3 mm C-Series sensors arranged in a 12 x 12 array.

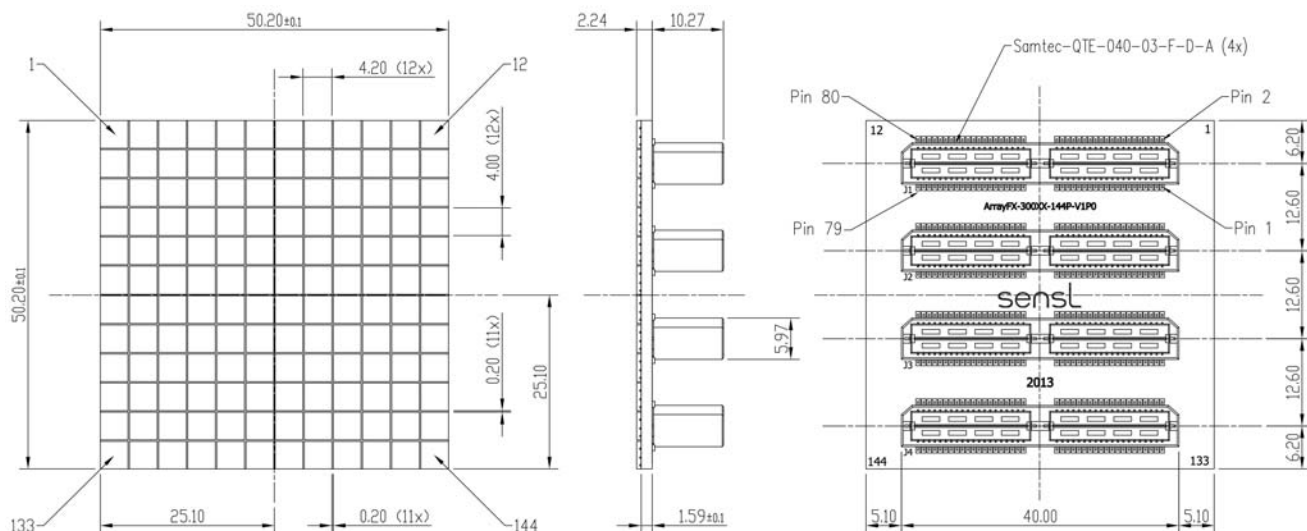
The performance of the individual pixels and details of the bias to apply can be found in the [C-Series](#) datasheet.

Connections to each sensor are provided by four Samtec 80-way connectors, type QTE-040-03-F-D-A. These connectors mate with the Samtec QSE-040-01-F-D-A board-to-board connector and the Samtec EQCD High Speed Cable Assemblies. The 144 SiPM sensors have all substrate connections (cathodes) connected together to form a common I/O. The 80-way connectors provide connections as follows:

- 144 x fast output
- 144 x standard I/O
- 32 x common I/O



Schematics for the ARRAYC-30035-144P-PCB



The complete ARRAYC-30035-144P-PCB CAD is available to [download](#).

ArrayC Series

Connector Schematics for the ARRAYC-30035-144P

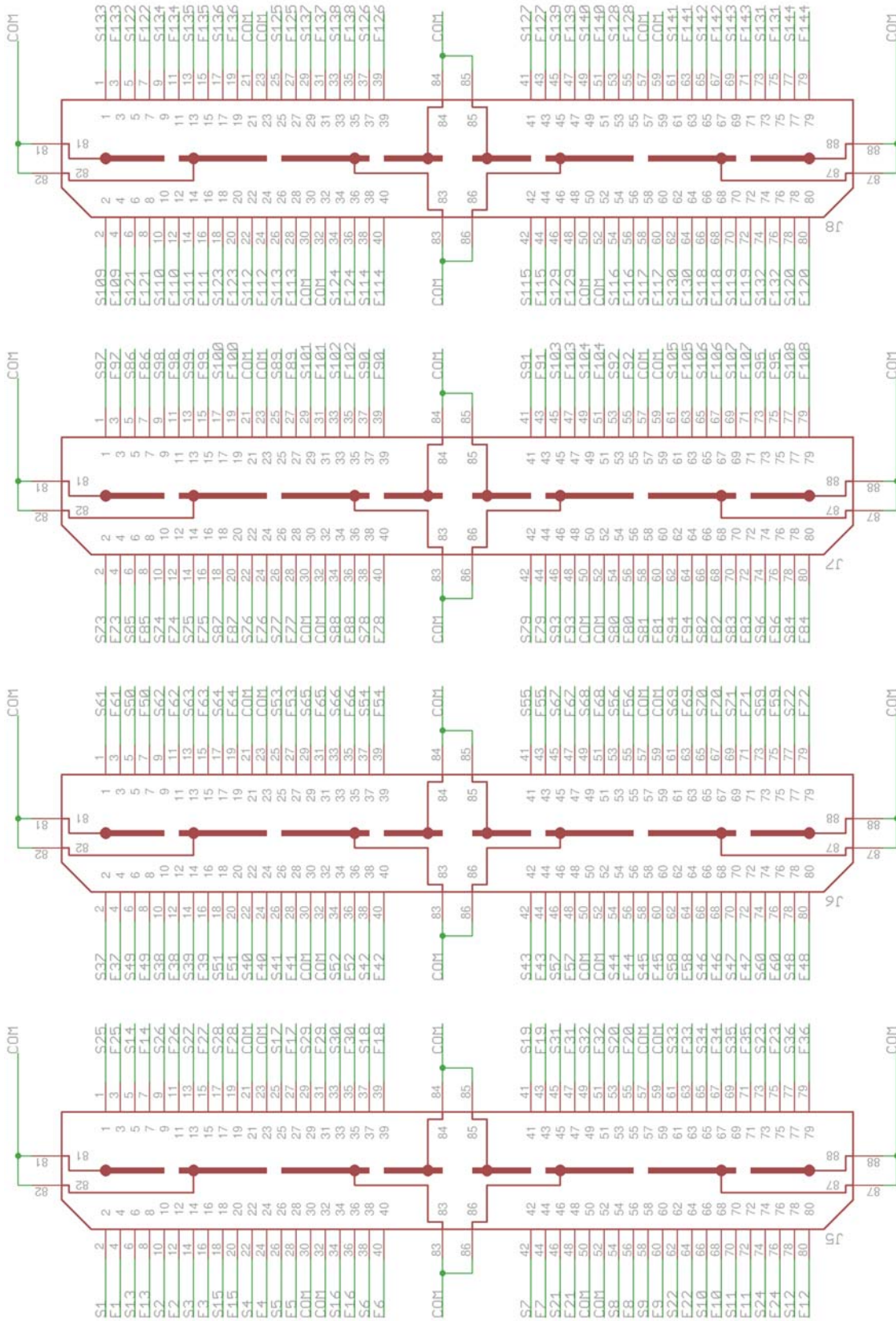


Figure 9. Connector pin-outs for the ARRAYC-30035-144P

ArrayC Series

Table 4. Connector Pin-Outs for the ARRAYC-30035-144P

| J1 | | | | J2 | | | |
|-----|--------|-----|--------|-----|--------|-----|--------|
| PIN | SIGNAL | PIN | SIGNAL | PIN | SIGNAL | PIN | SIGNAL |
| 1 | S25 | 2 | S1 | 1 | S61 | 2 | S37 |
| 3 | F25 | 4 | F1 | 3 | F61 | 4 | F37 |
| 5 | S14 | 6 | S13 | 5 | S50 | 6 | S49 |
| 7 | F14 | 8 | F13 | 7 | F50 | 8 | F49 |
| 9 | S26 | 10 | S2 | 9 | S62 | 10 | S38 |
| 11 | F26 | 12 | F2 | 11 | F62 | 12 | F38 |
| 13 | S27 | 14 | S3 | 13 | S63 | 14 | S39 |
| 15 | F27 | 16 | F3 | 15 | F63 | 16 | F39 |
| 17 | S28 | 18 | S15 | 17 | S64 | 18 | S51 |
| 19 | F28 | 20 | F15 | 19 | F64 | 20 | F51 |
| 21 | CM | 22 | S4 | 21 | CM | 22 | S40 |
| 23 | CM | 24 | F4 | 23 | CM | 24 | F40 |
| 25 | S17 | 26 | S5 | 25 | S53 | 26 | S41 |
| 27 | F17 | 28 | F5 | 27 | F53 | 28 | F41 |
| 29 | S29 | 30 | CM | 29 | S65 | 30 | CM |
| 31 | F29 | 32 | CM | 31 | F65 | 32 | CM |
| 33 | S30 | 34 | S16 | 33 | S66 | 34 | S52 |
| 35 | F30 | 36 | F16 | 35 | F66 | 36 | F52 |
| 37 | S18 | 38 | S6 | 37 | S54 | 38 | S42 |
| 39 | F18 | 40 | F6 | 39 | F54 | 40 | F42 |
| 41 | S19 | 42 | S7 | 41 | S55 | 42 | S43 |
| 43 | F19 | 44 | F7 | 43 | F55 | 44 | F43 |
| 45 | S31 | 46 | S21 | 45 | S67 | 46 | S57 |
| 47 | F31 | 48 | F21 | 47 | F67 | 48 | F57 |
| 49 | S32 | 50 | CM | 49 | S68 | 50 | CM |
| 51 | F32 | 52 | CM | 51 | F68 | 52 | CM |
| 53 | S20 | 54 | S8 | 53 | S56 | 54 | S44 |
| 55 | F20 | 56 | F8 | 55 | F56 | 56 | F44 |
| 57 | CM | 58 | S9 | 57 | CM | 58 | S45 |
| 59 | CM | 60 | F9 | 59 | CM | 60 | F45 |
| 61 | S33 | 62 | S22 | 61 | S69 | 62 | S58 |
| 63 | F33 | 64 | F22 | 63 | F69 | 64 | F58 |
| 65 | S34 | 66 | S10 | 65 | S70 | 66 | S46 |
| 67 | F34 | 68 | F10 | 67 | F70 | 68 | F46 |
| 69 | S35 | 70 | S11 | 69 | S71 | 70 | S47 |
| 71 | F35 | 72 | F11 | 71 | F71 | 72 | F47 |
| 73 | S23 | 74 | S24 | 73 | S59 | 74 | S60 |
| 75 | F23 | 76 | F24 | 75 | F59 | 76 | F60 |
| 77 | S36 | 78 | S12 | 77 | S72 | 78 | S48 |
| 79 | F36 | 80 | F12 | 79 | F72 | 80 | F48 |

ArrayC Series

| J3 | | | | J4 | | | |
|-----|--------|-----|--------|-----|--------|-----|--------|
| PIN | SIGNAL | PIN | SIGNAL | PIN | SIGNAL | PIN | SIGNAL |
| 1 | S97 | 2 | S73 | 1 | S133 | 2 | S109 |
| 3 | F97 | 4 | F73 | 3 | F133 | 4 | F109 |
| 5 | S86 | 6 | S85 | 5 | S122 | 6 | S121 |
| 7 | F86 | 8 | F85 | 7 | F122 | 8 | F121 |
| 9 | S98 | 10 | S74 | 9 | S134 | 10 | S110 |
| 11 | F98 | 12 | F74 | 11 | F134 | 12 | F110 |
| 13 | S99 | 14 | S75 | 13 | S135 | 14 | S111 |
| 15 | F99 | 16 | F75 | 15 | F135 | 16 | F111 |
| 17 | S100 | 18 | S87 | 17 | S136 | 18 | S123 |
| 19 | F100 | 20 | F87 | 19 | F136 | 20 | F123 |
| 21 | CM | 22 | S76 | 21 | CM | 22 | S112 |
| 23 | CM | 24 | F76 | 23 | CM | 24 | F112 |
| 25 | S89 | 26 | S77 | 25 | S125 | 26 | S113 |
| 27 | F89 | 28 | F77 | 27 | F125 | 28 | F113 |
| 29 | S101 | 30 | CM | 29 | S137 | 30 | CM |
| 31 | F101 | 32 | CM | 31 | F137 | 32 | CM |
| 33 | S102 | 34 | S88 | 33 | S138 | 34 | S124 |
| 35 | F102 | 36 | F88 | 35 | F138 | 36 | F124 |
| 37 | S90 | 38 | S78 | 37 | S126 | 38 | S114 |
| 39 | F90 | 40 | F78 | 39 | F126 | 40 | F114 |
| 41 | S91 | 42 | S79 | 41 | S127 | 42 | S115 |
| 43 | F91 | 44 | F79 | 43 | F127 | 44 | F115 |
| 45 | S103 | 46 | S93 | 45 | S139 | 46 | S129 |
| 47 | F103 | 48 | F93 | 47 | F139 | 48 | F129 |
| 49 | S104 | 50 | CM | 49 | S140 | 50 | CM |
| 51 | F104 | 52 | CM | 51 | F140 | 52 | CM |
| 53 | S92 | 54 | S80 | 53 | S128 | 54 | S116 |
| 55 | F92 | 56 | F80 | 55 | F128 | 56 | F116 |
| 57 | CM | 58 | S81 | 57 | CM | 58 | S117 |
| 59 | CM | 60 | F81 | 59 | CM | 60 | F117 |
| 61 | S105 | 62 | S94 | 61 | S141 | 62 | S130 |
| 63 | F105 | 64 | F94 | 63 | F141 | 64 | F130 |
| 65 | S106 | 66 | S82 | 65 | S142 | 66 | S118 |
| 67 | F106 | 68 | F82 | 67 | F142 | 68 | F118 |
| 69 | S107 | 70 | S83 | 69 | S143 | 70 | S119 |
| 71 | F107 | 72 | F83 | 71 | F143 | 72 | F119 |
| 73 | S95 | 74 | S96 | 73 | S131 | 74 | S132 |
| 75 | F95 | 76 | F96 | 75 | F131 | 76 | F132 |
| 77 | S108 | 78 | S84 | 77 | S144 | 78 | S120 |
| 79 | F108 | 80 | F84 | 79 | F144 | 80 | F120 |

| | |
|----|-------------------------|
| NC | Not Connected |
| CM | Common I/O |
| Sn | Standard I/O of pixel n |
| Fn | Fast output of pixel n |

ArrayC Series

ARRAYX-BOB3-144P (ARRAYC-30035-144P Breakout Board)

The ARRAYX-BOB3-144P is an evaluation board allowing easy access to the signals from a ON Semiconductor ARRAYC-30035-144P, 3 mm 12 x 12 SiPM array.

The Breakout Board is comprised of four Samtec 80-way connectors, type QSE-040-01-F-D-A. These connectors mate with the Samtec QTE-040-03-FD- A board-to-board connector on the array. Since the connectors are keyed, orientating the array on the BOB is straightforward.

All signals on the array are routed via the mating connectors to header pins. These pins are formed by eight 50-way (25 x 2 row) 2.54 mm pitch headers.

Three SMA connectors and Balun transformers are provided with 4-pin headers to allow any signal to be connected directly to the SMA or via the transformer using jumper wires. Four 7 mm holes are placed on a 25 mm grid to allow mounting of the board on an optical breadboard. The layout of the board is shown in Figure 10.

See Appendices A and B for examples of Breakout Board usage.

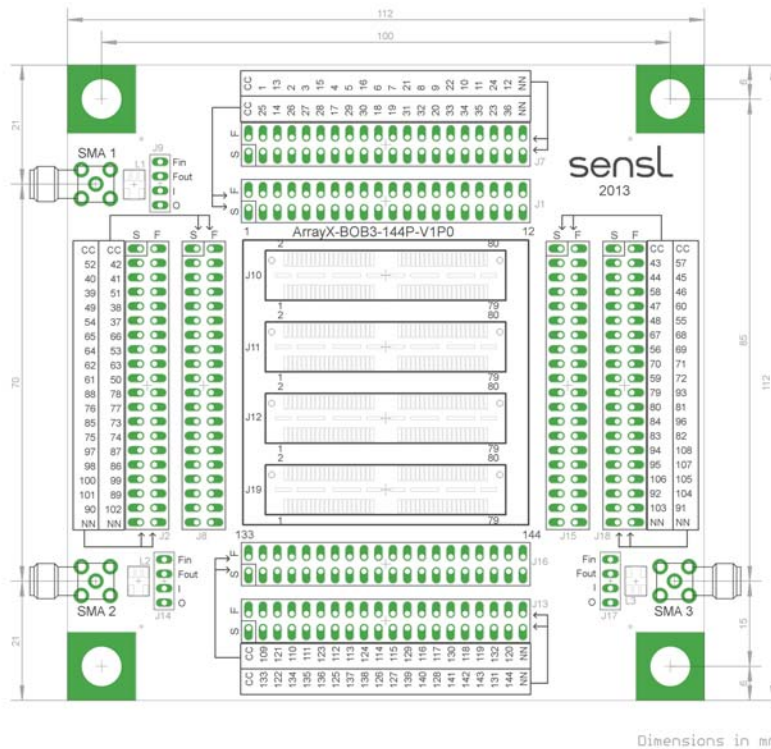
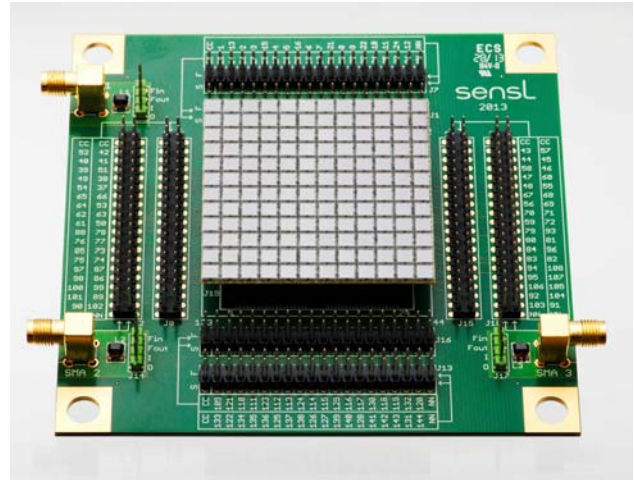


Figure 10. Layout of the ARRAYX-BOB3-144P. The board dimensions are 112 mm x 112 mm

ArrayC Series

Table 5. HEADER SIGNALS ON THE ARRAYX-BOB3-144P

| Pin | | J1 | | J2 | | J7 | | J8 | |
|-----|----|------|------|------|------|------|------|------|------|
| 1 | 2 | CM | CM | CM | CM | CM | CM | CM | CM |
| 3 | 4 | S25 | F25 | S52 | F52 | S1 | F1 | S42 | F42 |
| 5 | 6 | S14 | F14 | S40 | F40 | S13 | F13 | S41 | F41 |
| 7 | 8 | S26 | F26 | S39 | F39 | S2 | F2 | S51 | F51 |
| 9 | 10 | S27 | F27 | S49 | F49 | S3 | F3 | S38 | F38 |
| 11 | 12 | S28 | F28 | S54 | F54 | S15 | F15 | S37 | F37 |
| 13 | 14 | S17 | F17 | S65 | F65 | S4 | F4 | S66 | F66 |
| 15 | 16 | S29 | F29 | S64 | F64 | S5 | F5 | S53 | F53 |
| 17 | 18 | S30 | F30 | S62 | F62 | S16 | F16 | S63 | F63 |
| 19 | 20 | S18 | F18 | S61 | F61 | S6 | F6 | S50 | F50 |
| 21 | 22 | S19 | F19 | S88 | F88 | S7 | F7 | S78 | F78 |
| 23 | 24 | S31 | F31 | S76 | F76 | S21 | F21 | S77 | F77 |
| 25 | 26 | S32 | F32 | S85 | F85 | S8 | F8 | S73 | F73 |
| 27 | 28 | S20 | F20 | S75 | F75 | S9 | F9 | S74 | F74 |
| 29 | 30 | S33 | F33 | S97 | F97 | S22 | F22 | S87 | F87 |
| 31 | 32 | S34 | F34 | S98 | F98 | S10 | F10 | S86 | F86 |
| 33 | 34 | S35 | F35 | S100 | F100 | S11 | F11 | S99 | F99 |
| 35 | 36 | S23 | F23 | S101 | F101 | S24 | F24 | S89 | F89 |
| 37 | 38 | S36 | F36 | S90 | F90 | S12 | F12 | S102 | F102 |
| 39 | 40 | NC | NC | NC | NC | NC | NC | NC | NC |
| Pin | | J13 | | J15 | | J16 | | J18 | |
| 1 | 2 | CM | CM | CM | CM | CM | CM | CM | CM |
| 3 | 4 | S133 | F133 | S43 | F43 | S109 | F109 | S57 | F57 |
| 5 | 6 | S122 | F122 | S44 | F44 | S121 | F121 | S45 | F45 |
| 7 | 8 | S134 | F134 | S58 | F58 | S110 | F110 | S46 | F46 |
| 9 | 10 | S135 | F135 | S47 | F47 | S111 | F111 | S60 | F60 |
| 11 | 12 | S136 | F136 | S48 | F48 | S123 | F123 | S55 | F55 |
| 13 | 14 | S125 | F125 | S67 | F67 | S112 | F112 | S68 | F68 |
| 15 | 16 | S137 | F137 | S56 | F56 | S113 | F113 | S69 | F69 |
| 17 | 18 | S138 | F138 | S70 | F70 | S124 | F124 | S71 | F71 |
| 19 | 20 | S126 | F126 | S59 | F59 | S114 | F114 | S72 | F72 |
| 21 | 22 | S127 | F127 | S79 | F79 | S115 | F115 | S93 | F93 |
| 23 | 24 | S139 | F139 | S80 | F80 | S129 | F129 | S81 | F81 |
| 25 | 26 | S140 | F140 | S84 | F84 | S116 | F116 | S96 | F96 |
| 27 | 28 | S128 | F128 | S83 | F83 | S117 | F117 | S82 | F82 |
| 29 | 30 | S141 | F141 | S94 | F94 | S130 | F130 | S108 | F108 |
| 31 | 32 | S142 | F142 | S95 | F95 | S118 | F118 | S107 | F107 |
| 33 | 34 | S143 | F143 | S106 | F106 | S119 | F119 | S105 | F105 |
| 35 | 36 | S131 | F131 | S92 | F92 | S132 | F132 | S104 | F104 |
| 37 | 38 | S144 | F144 | S103 | F103 | S120 | F120 | S91 | F91 |
| 39 | 40 | NC | NC | NC | NC | NC | NC | NC | NC |

| | |
|----|-------------------------|
| NC | Not Connected |
| CM | Common I/O |
| Sn | Standard I/O of pixel n |
| Fn | Fast output of pixel n |

ArrayC Series

Biasing and Readout from the Standard Breakout Boards

The purpose of the Breakout Boards is to allow easy access to either standard or fast I/O from individual pixels for testing purposes. It should be stressed that the breakout boards are for evaluation purposes only and do not allow for full readout of all pixels simultaneously.

The various Breakout Boards described in this document have features in common. All pixel fast and standard signals are brought out to headers. The header pins can be interfaced with the SMA connectors with the option of routing the signal via a balun transformer. The common I/O consists of all of the substrate connections summed together. It is not recommended to apply the bias to the common I/O.

The Breakout Boards are each shipped with 3 x shunt jumpers and 6 x 10 cm wire cables (3 x red, 3 x black) with crimp sockets at each end.

All header pins are suitable for use with wire wrapping in addition to the jumpers and crimp socket leads supplied.

The 'NC' signals are unconnected pins that can be used for prototyping.

SMA Connector

Each Breakout Board has three SMA connectors that can be used for supplying bias voltage and accessing signals. In

addition, each SMA has a balun transformer in close proximity for impedance matching of the fast signals, shown in Figure 13. To interface signals from the array to the SMA connectors, there is a 4-pin header, shown in Figures 11 and 12. The pins are labelled; **Fin**, **Fout**, **I** (Inner) and **O** (Outer).

- **Fin** provides the input to the balun transformer.
- **Fout** is the output of the balun transformer.
- **I** provides direct connection to the inner part of the SMA connector.
- **O** provides direct connection to the outer part of the SMA connector.

Balun Transformer

The Balun transformer (RFMD RFXF9503) allows impedance matching of the fast output signal to the readout electronics. For a customer considering their own design, the Balun is not required if the readout amplifiers are placed in close proximity to the sensor pixels of the array.

For optimized timing performance, the impedance matching and signal propagation from the SiPM sensor to the readout electronics must be carefully considered.

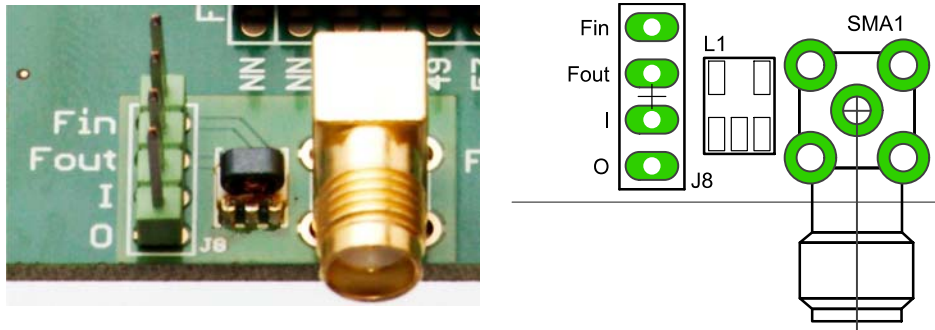
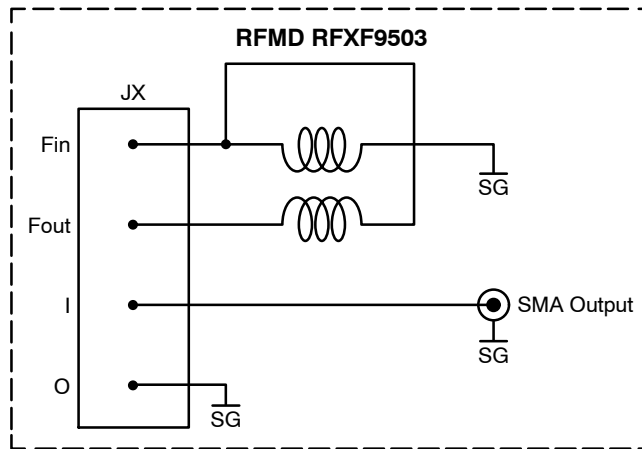


Figure 11. (right) photo and (left) schematic of the BOB SMA, balun transformer and 4-pin header arrangement.

ArrayC Series



SG = Local signal ground

Each SMT/Balun/4 Way Header circuits has its own local signal ground

Figure 12. Schematic of the 4-pin header and balun transformer

EMI Considerations

It has been shown that the EMI (Electromagnetic Interference) can be picked up on the unshielded wires on the BOB. It is recommended that customers who experience excessive EMI seek to reduce the EMI in their lab, ideally at the EMI source. If this is not possible then improved shielding should be used. In all cases, testing of the SiPM sensor should be performed in total darkness.

For a system design, it is recommended that the customer consider shielding of all lines. The readout requirements for a SiPM are similar to that of a PMT and similar care should be taken with both sensor types. In comparison to an APD which has significantly lower gain than a SiPM, the SiPM will provide much improved resistance to EMI due to the higher gain of the SiPM sensor.

ArrayC Series

APPENDIX B - EXAMPLE OF USING THE BREAKOUT BOARD TO READOUT STANDARD SIGNALS

The Figure 14 shows the ARRAYX-BOB6-64P set up for readout of standard signals (anode-cathode) from pixel 49.

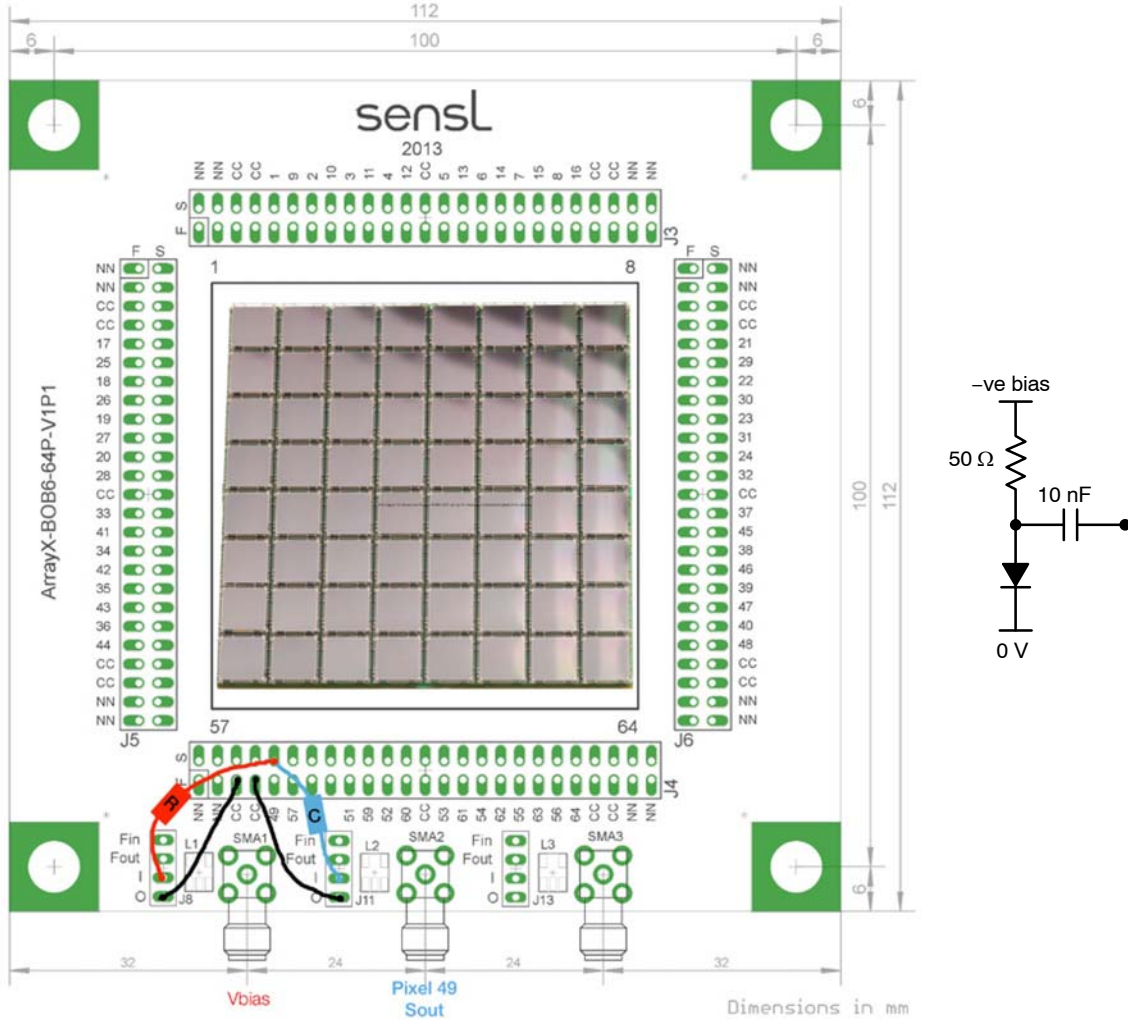


Figure 14. Example of an ARRAYC-60035-64P connected to an ARRAYX-BOB6-64P for the readout of the standard (anode-cathode) signal from pixel 49 (left), with simplified readout schematic (right).

Here, SMA 1 is used for supplying Vbias and SMA2 for reading out the standard output from pixel 49. In this example an ARRAYC-60035-64P is assumed and so the “S” (standard I/O) is the anode.

To bias the array, the inner (“I”) of SMA1 is connected to the S49 (anode) header pin via a load resistor of 50 Ω. The cathode is common to all pixels and is connected via a “C” pin on the header to the outer (“O”) of SMA1. Vbias is then applied to SMA1, which for an ArrayC sensors has a negative polarity with respect to the common cathode.

To access the standard output, the S49 header pin is then connected to the inner (“I”) of SMA2 via a decoupling capacitor of 10 nF. The outer (“O”) of SMA 2 is again connected to the common cathode (“C”). The standard signal is then available from SMA2.

ArrayC Series

APPENDIX C - EXAMPLE OF USING THE SUMMED BREAKOUT BOARD

The Figure 15 shows the ARRAYX-BOB6-64S set up for readout of all of the pixels summed together.

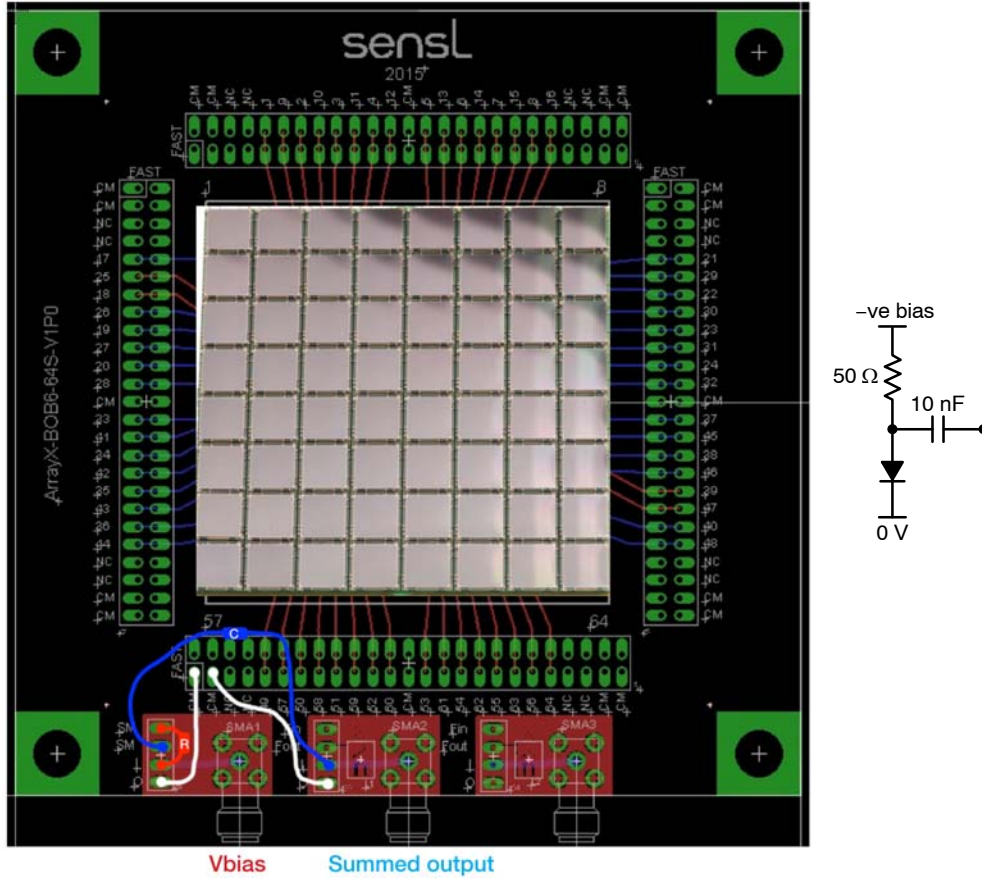


Figure 15. Example of an ARRAYC-60035-64P connected to an ARRAYX-BOB6-64S for the summed readout of all of the pixels (left), with simplified readout schematic (right).

SMA 1 is used for supplying Vbias and SMA2 for reading out the summed standard output from all pixels in the ARRAYC-60035-64P.

To bias the array, the inner (“I”) of SMA1 is connected to the SM (summed anode) pin on the same header, via a load resistor of 50 Ω. The cathode is also common to all pixels and is connected via a “CM” pin to the outer (“O”) of SMA1.

Vbias is then applied to SMA1, which for an ArrayC has a negative polarity with respect to the common.

To access the summed standard output, the second SM header pin is then connected to the inner (“I”) of SMA2 via a decoupling capacitor of 10 nF. The outer (“O”) of SMA2 is again connected to the common cathode (“CM”). The summed signal is then available from SMA2.

ArrayC Series

ORDERING INFORMATION

| Product Code | Microcell Size (Total Number per Pixel) | Array Size | I/O Interface |
|--|---|------------|---------------|
| 6 mm Sensor Arrays | | | |
| ARRAYC-60035-4P-BGA | 35 μ m (18,980 microcells) | 2 x 2 | BGA |
| ARRAYC-60035-64P-PCB | | 8 x 8 | Connector |
| 3 mm Sensor ARRAYS | | | |
| ARRAYC-30035-16P-PCB | 35 μ m (4,774 microcells) | 4 x 4 | Connector |
| ARRAYC-30035-144P-PCB | | 12 x 12 | Connector |
| Optional Breakout Boards | | | |
| ARRAYX-BOB6-64P-GEVK | Breakout board with connectors for use with the 8 x 8 arrays of 6 mm pixels | | |
| ARRAYX-BOB3-16P-GEVK | Breakout board with connectors for use with the 4 x 4 arrays of 3 mm pixels | | |
| ARRAYX-BOB3-144P-GEVK | Breakout board with connectors for use with the 12 x 12 arrays of 3 mm pixels | | |
| Optional Summed Breakout Boards | | | |
| ARRAYX-BOB6-64S-GEVK | Summed breakout board for use with the 8 x 8 array of 6 mm pixels | | |
| ARRAYX-BOB6-16S-GEVK | Summed breakout board for use with the 4 x 4 array of 3 mm pixels | | |
| Evaluation Board with ARRAYC Permanently Attached | | | |
| ARRAYC-60035-4P-GEVB | Evaluation board with a permanently attached 2 x 2 array of 6 mm pixels | | |

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