See the Unseen™

Mosaic Core Datasheet

Version 12

Contents

Revision History

Date	Version	Description
3/31/2019	1	Initial release.
5/8/2019	2	Update part numbers.
5/29/2019	3	Update part numbers, typos.
8/9/2019	4	USB Connector part number updated.
9/12/2019	5	Updated specifications, photos.
1/6/2020	6	Added SPI interface details.
9/15/2020	7	Updates to USB and SPI reference schematics and BOM.
9/29/2020	8	Major format changes for readability. Added more details about SPI interface vs. USB interface. Changed 237K resistors to 182K on USB BOM, for 2.8V VDD.
9/30/2020	9	Minor wording updates.
1/15/2021	10	Correct Mosaic Core Connector Pinout table, the even number pins were flipped.
3/29/2021	11	Add details of sensor calibration flash pairing. Add details of sensor flex pinout and orientation. Added VREF to JTAG signals, removed incorrect DRC marker on sch. Minor wording and formatting updates.
4/7/2021	12	Fixed Figure 8 pin labeling on SPI board connector, changed from 23 to 19.

Specifications

TECHNICAL SUMMARY

200 x 150 RESOLUTION

Specifications	Description			
Microbolometer	Uncooled Vanadium Oxide			
Pixel Pitch	12 Microns			
Spectral Response	7.8 - 14 Microns			
Sensor Resolution (Array Format)	200 (h) x 150 (v); 30,000 pixels			
Frame Rate	<9Hz or up to 32Hz			
Scene Dynamic Range [1]	-40°C to 330°C Contact your sales rep for higher temperature applications			
Sensor Sensitivity	65 mK (typical), <100 mK (max) @ 25°C			
Non-Uniformity Correction (NUC)	Automatic NUC (with shutter)			
Video Output Interfaces [2]	USB			
Supply Voltage	3.3V to 5.5V			
Power: Core Only	<50mW			
Power: Core + Interface Board	300mW			
Output Formats (user selectable)	Linux / Windows SDK		Android SDK	
	16-bit filtered pre AGC. 32-bit ARGB post colorization. 32-bit floating point or 16-bit fixed point thermography data.		16-bit filtered pre AGC. 32-bit ARGB post colorization in the bitmap image. 16-bit fixed point thermography data.	
Optics & Mechanical				
Focal Length	**2.2mm**	**4.0mm**	**6.6mm**	**9.1mm**
F-number (focal length/aperture)	f/1.05	f/1.00	f/1.26	f/1.00
Spatial Resolution (IFOV, center)	5.23	3.00	1.82	1.32
HFOV	61°	35°	21°	15°
VFOV	45°	26°	15°	12°
Detection Range [3]	186m	333m	543m	758m
Recognition Range [3]	46m	83m	136m	190m
Identification Range [3]	27m	48m	78m	108m
Distance to Spot Ratio	31:1	56:1	91:1	126:1
Ingress Protection	N/A	IP67	IP67	IP67
Core Dimensions Without Cushion (L x W x H)	10 x 20 x 21mm	20 x 20 x 21mm	23 x 20 x 21mm	20 x 20 x 21mm
Core Weight	8 g	12 g	12 g	12 g
Focus	Fixed			
Lens Material	Chalcogenide			
Thermography				
Temperature Calibration	Calibrated Output in °C, °F, K			
Temperature Accuracy [1,4]	The greater of ±5°C or 5% between 5°C to 140°C scene temperatures Typical performance of ±10% between 140°C to 330°C scene temperatures Contact your sales rep for higher temperature accuracy up to 330°C and beyond			
Environmental				
Operating Temperature Range	-10°C to 60°C Contact your sales rep for higher operating temperature ranges			
Storage Temperature Range	-40°C to 80°C			
Solar Protection	Yes			
Humidity	10%~95%RH, non-condensing			
Regulatory	ROHS, WEEE, REACH			
Documentation and Tools				
Starter Kit	Available			
Data Sheet	Available			
Accessories	Interface Board and Flexes			

1. Specified at nominal 25°C ambient operating temperature and nominal measurement distance of 12 inches. Temperature reported is Center Spot temperature, which is an average of the center 36 pixels. Contact Seek Thermal for performance at other nominal operating temperatures and measurement distances.
2. SPI option available. Contact Seek Thermal for further details.
3. Based on Johnson Criteria.
4. Factory default emissivity is set to 0.97. Emissivity is adjustable using the SDK. See data sheet for more information.

Specifications and undocumented specifications are subject to change without notice.
For the most up-to-date specifications, visit thermal.com/oem

TECHNICAL SUMMARY

320 x 240 RESOLUTION

Specifications	**Description**			
Microbolometer	Uncooled Vanadium Oxide			
Pixel Pitch	12 Microns			
Spectral Response	7.8 - 14 Microns			
Sensor Resolution (Array Format)	320 (h) x 240 (v); 76,800 pixels			
Frame Rate	<9Hz or up to 27Hz			
Scene Dynamic Range [1]	-40°C to 330°C Contact your sales rep for higher temperature applications			
Sensor Sensitivity	65 mK (typical), <100 mK (max) @ 25°C			
Non-Uniformity Correction (NUC)	Automatic NUC (with shutter)			
Video Output Interfaces [2]	USB			
Supply Voltage	3.3V to 5.5V			
Power: Core Only	<50mW			
Power: Core + Interface Board	300mW			
Output Formats (user selectable)	Linux / Windows SDK		Android SDK	
	16-bit filtered pre AGC. 32-bit ARGB post colorization. 32-bit floating point or 16-bit fixed point thermography data.		16-bit filtered pre AGC. 32-bit ARGB post colorization in the bitmap image. 16-bit fixed point thermography data.	
Optics & Mechanical				
Focal Length	**2.2mm**	**4.0mm**	**6.6mm**	**9.1mm**
F-number (focal length/aperture)	f/1.05	f/1.00	f/1.26	f/1.00
Spatial Resolution (IFOV, center)	5.23	3.00	1.82	1.32
HFOV [5]	105°	56°	34°	24°
VFOV [5]	75°	42°	25°	18°
Detection Range [3]	186m	333m	543m	758m
Recognition Range [3]	46m	83m	136m	190m
Identification Range [3]	27m	48m	78m	108m
Distance to Spot Ratio	31:1	56:1	91:1	126:1
Ingress Protection	N/A	IP67	IP67	IP67
Core Dimensions Without Cushion (L x W x H)	10 x 20 x 21mm	20 x 20 x 21mm	23 x 20 x 21mm	20 x 20 x 21mm
Core Weight	8 g	12 g	12 g	12 g
Focus	Fixed			
Lens Material	Chalcogenide			
Thermography				
Temperature Calibration	Calibrated Output in °C, °F, K			
Temperature Accuracy [1,4]	The greater of ±5°C or 5% between 5°C to 140°C scene temperatures Typical performance of ±10% between 140°C to 330°C scene temperatures Contact your sales rep for higher temperature accuracy up to 330°C and beyond			
Environmental				
Operating Temperature Range	-10°C to 60°C Contact your sales rep for higher operating temperature ranges			
Storage Temperature Range	-40°C to 80°C			
Solar Protection	Yes			
Humidity	10%~95%RH, non-condensing			
Regulatory	ROHS, WEEE, REACH			
Documentation and Tools				
Starter Kit	Available			
Data Sheet	Available			
Accessories	Interface Board and Flexes			

1. Specified at nominal 25°C ambient operating temperature and nominal measurement distance of 12 inches.
   Temperature reported is Center Spot temperature, which is an average of the center 36 pixels.
   Contact Seek Thermal for performance at other nominal operating temperatures and measurement distances.
2. SPI option available. Contact Seek Thermal for further details.
3. Based on Johnson Criteria.
4. Factory default emissivity is set to 0.97. Emissivity is adjustable using the SDK. See data sheet for more information.
5. Actual usable FOV on 2.2mm lens may be less due to vignetting at the edges and corners.

Specifications and undocumented specifications are subject to change without notice.
For the most up-to-date specifications, visit thermal.com/oem

Overview

This document serves to facilitate the design of a system based on the Seek Thermal Mosaic sensor cores. This document covers performance, features, engineering interfaces and design recommendations. This document in conjunction with the Seek SDK documentation, other engineering documentation and references, as well as support from Seek Thermal's applications engineers will help guide a design to successful implementation.

Designed for performance and versatility, Mosaic Cores are available in 200 x 150 and 320 x 240 resolutions with several configuration options to meet the needs of a wide variety of applications. Implementing high-end thermal technology has never been this simple and affordable.

Mosaic cores store unit-specific calibration data on the sensor head itself. This feature allows for easier system integration, improved thermal performance due to remote locating the processor, and reduced cost and size by allowing the customer to integrate the coprocessor circuit into other electronics elsewhere in the system.

With calibration data stored on the core, units can be interchanged in a system (during manufacture, service, repair) without the need to re-program the main electronics with new calibration data for the new sensor.

This document is not intended as a standalone comprehensive source of information required to design a system around the Mosaic cores. Please consult Seek Thermal for full design support.

Coprocessor Options

Seek Thermal's Mosaic cores must interface to a coprocessor that interfaces to the Seek image processing pipeline. There are two main options for the coprocessor in a system:

1. Purchase a coprocessor board from Seek.
2. Using Seek's reference design, add the coprocessor circuit to the customer's system main board between the Seek sensor and the Host processor.

For Option 2, Seek provides:

- Schematic for coprocessor circuit (pages 17 & 19).
- BOM for coprocessor circuit (pages 16 & 18).
- Compiled binary file(s) for the coprocessor code.
- Interface details for connecting the core to the coprocessor circuit on the system main board (page 9).
- Optional flex cables, if the customer prefers to use the Seek design.
- Seek SDK for implementation on customer's Host Processor

For Option 2, the Customer will:

- Design the system main board around one of the coprocessor options (USB or SPI).
- Optionally design the flex connections if the Seek flex solutions are not appropriate.

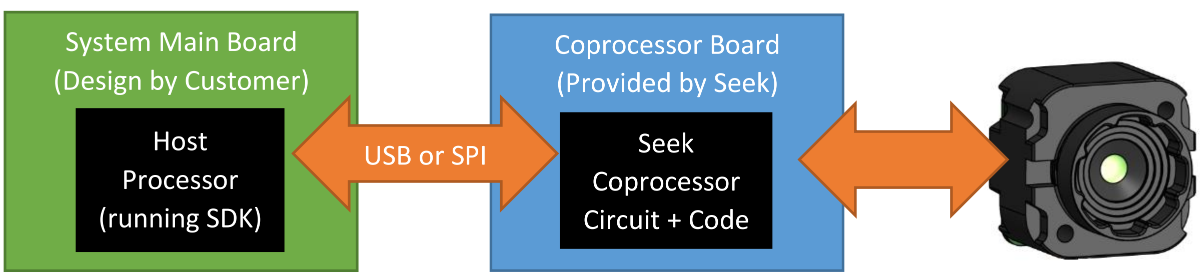


Figure 1: Coprocessor Option 1 Block Diagram

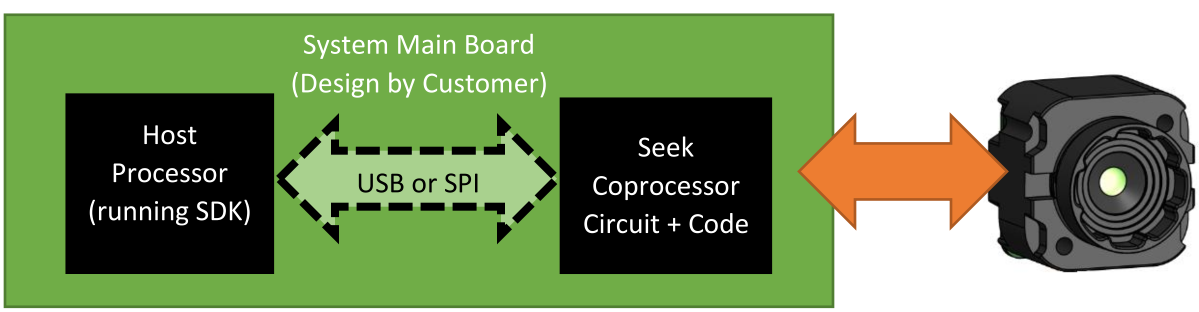
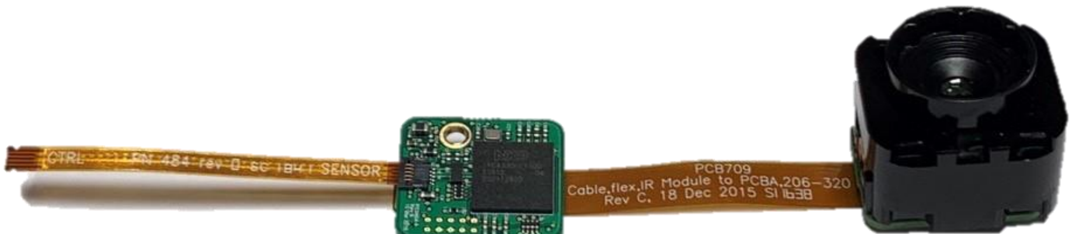


Figure 2: Coprocessor Option 2 Block Diagram

Pairing the Core and Coprocessor

Mosaic cores can be purchased with or without the Mosaic Interface Kit. The Mosaic Interface Kit includes the coprocessor board, the sensor flex and the USB flex (in the case of a USB core). In either configuration, at initial power up the Mosaic core will need to undergo a pairing process with the coprocessor. Mosaic cores contain memory that holds the image and thermography calibration data for the sensor. During the initial power-up of the core and coprocessor, a pairing process occurs that transfers the calibration data from the core to the coprocessor. This process occurs any time a coprocessor detects that a new core has been connected. Thus, it is possible to replace a core or coprocessor during manufacture and servicing of the system.



USB Flex Coprocessor Board Sensor Flex Mosaic Core

Figure 3: Mosaic Core with Mosaic Interface Kit

Using Seek Interface Kit

When a Mosaic core is purchased with the Interface Kit, the following process must occur at the first power up:

1. Connect the Mosaic Core to the correct Coprocessor Board using the Sensor flex. Refer to Table 1 for appropriate Core and Coprocessor Board pairs.
2. Connect to the Coprocessor Board using the USB flex to the system's Host Processor and apply power to start the pairing process.
3. Do not disconnect power during the pairing process as damage may occur to the coprocessor system. After approximately 20 seconds, the Core and Coprocessor Board will reboot and be ready to connect over the data interface.
4. Once paired, the Coprocessor Board and Core can be swapped or exchanged, though it is necessary to repeat the above pairing process.

Seek Thermal OEM Cores	Interface Board
C20xSP (200x150, Slow Frame)	2973
C21xSPX (200x150, Fast Frame)	2972X
C30xSP (320x240, Slow Frame)	2971
C31xSPX (320x240, Fast Frame)	2970X

Table 1: Mosaic Core and Interface Board Pairs

Using Customer Designed System Main Board

When a Mosaic core is purchased without the Interface Kit, typically the customer has designed a custom system main board that contains the coprocessor circuit. In this case, the following process must occur at the first power up:

1. Program the Seek Coprocessor with the Seek provided Mosaic firmware appropriate for the core and data interface used in the system (USB or SPI).
2. Connect the Mosaic Core to the coprocessor on the system main board using the Sensor Flex.
3. Apply power to the coprocessor on the system main board to start the pairing process.
4. Once paired, the Core may be swapped with another, though it is necessary to repeat the above pairing process.

Data Interfaces

USB Data Interface

The Mosaic core USB data interface utilizes USB Vendor Class data and requires use of the Seek SDK in order to receive and process thermal image data from the core. The Seek SDK handles control of the core as well as the thermography calibration and all image processing. The USB interface requires the least amount of custom image processing code from a customer's software.

The USB interface works with the "libusb" library in Linux or Windows, and the "android.hardware.usb" drivers in Android. There is not currently a supported option to use USB without the SDK or without an OS such as Linux, Windows or Android.

SPI Data Interface

The Mosaic core SPI data interfaces directly to a customer processor without the use of the Seek SDK. The SPI data requires more image processing to be performed by the customer's software, and SPI data **does not support thermographic (temperature) data**. Additionally, the SPI interface requires the customer to write a SPI driver for the specific processor that will be used to interface to the Mosaic core.

SPI data is typically used in image-only applications, though a customer may attempt to perform their own thermography calibration of the Mosaic core data in their system. The Mosaic SPI interface does provide data that has been non-uniformity corrected and bad pixel replaced. Additionally, interleaved among the image frames, there are "flat field" frames generated that may be used to perform intermittent flat field correction to the data. When using the Mosaic SPI interface, the customer will be responsible for implementing image processing features such as noise filtering, AGC/histogram equalization, colorization of the image, and so on.

The Mosaic SPI interface is a SPI master interface. Further details can be found in the Seek Thermal document "*Mosaic SPI Interface Datasheet*".

Electrical Interfaces

This section defines the electrical interface to the C2x and C3x cores when used without a coprocessor board.

- Connector on Mosaic Core Sensor Board:

    - Hirose DF40C-24DP-0.4V(51)
- Mating Connector:
    - Hirose DF40C-24DS-0.4V(51) (various stack height options available)

NOTE: These connectors are 24 pin connectors but they physically have 28 pins. The 4 corners pins are used for mechanical retention and are connected to GND.

The C3x Electrical Interface can also be used to interface to a C2x core, the Seek coprocessor software is capable of auto-negotiating which type of core is connected and re-purposing the IO pins. For designs intended to support both core types, please use the C3x electrical interface.

Mosaic Core Connector Pinout

PIN #	PIN NAME	SIGNAL TYPE	SIGNAL LEVEL	DESCRIPTION
1	PCLK	In	2.8	Pixel Clock
3	RW	In	2.8	Bus Direction
5	FRAME	In	2.8	Frame Sync
7	GND	Power	0	Power Return and Signal Reference
9	DATA0	I/O	2.8	Data Bus Bit 0
11	DATA1	I/O	2.8	Data Bus Bit 1
13	DATA2	I/O	2.8	Data Bus Bit 2
15	DATA3	I/O	2.8	Data Bus Bit 3
17	DATA4	I/O	2.8	Data Bus Bit 4
19	DATA5	I/O	2.8	Data Bus Bit 5
21	DATA6	I/O	2.8	Data Bus Bit 6
23	DATA7	I/O	2.8	Data Bus Bit 7
2	GND	Power	0	Power Return and Signal Reference
4	MOSI	In	2.8	Sensor SPI MOSI
6	SCLK	In	2.8	Sensor SPI Clock in from Sensor
8	MCLK	Out	2.8	Not Used
10	SCT_NSS	Out	2.8	Sensor SPI Chip Select
12	FPA_EN	Out	2.8	Sensor Power Enable to LDO
14	MISO	Out	2.8	Sensor SPI MISO
16	ARESET_N	Out	2.8	Sensor Reset
18	FLAG-	Out	VIN	Shutter Drive – to Sensor
20	FLAG+	Out	VIN	Shutter Drive + to Sensor
22	VIN_A	Power	3.3-5.0	Supply Voltage
24	GND	Power	0	Power Return and Signal Reference

Table 2: Mosaic Core Connector Pinout

Mosaic Core Connector Orientation

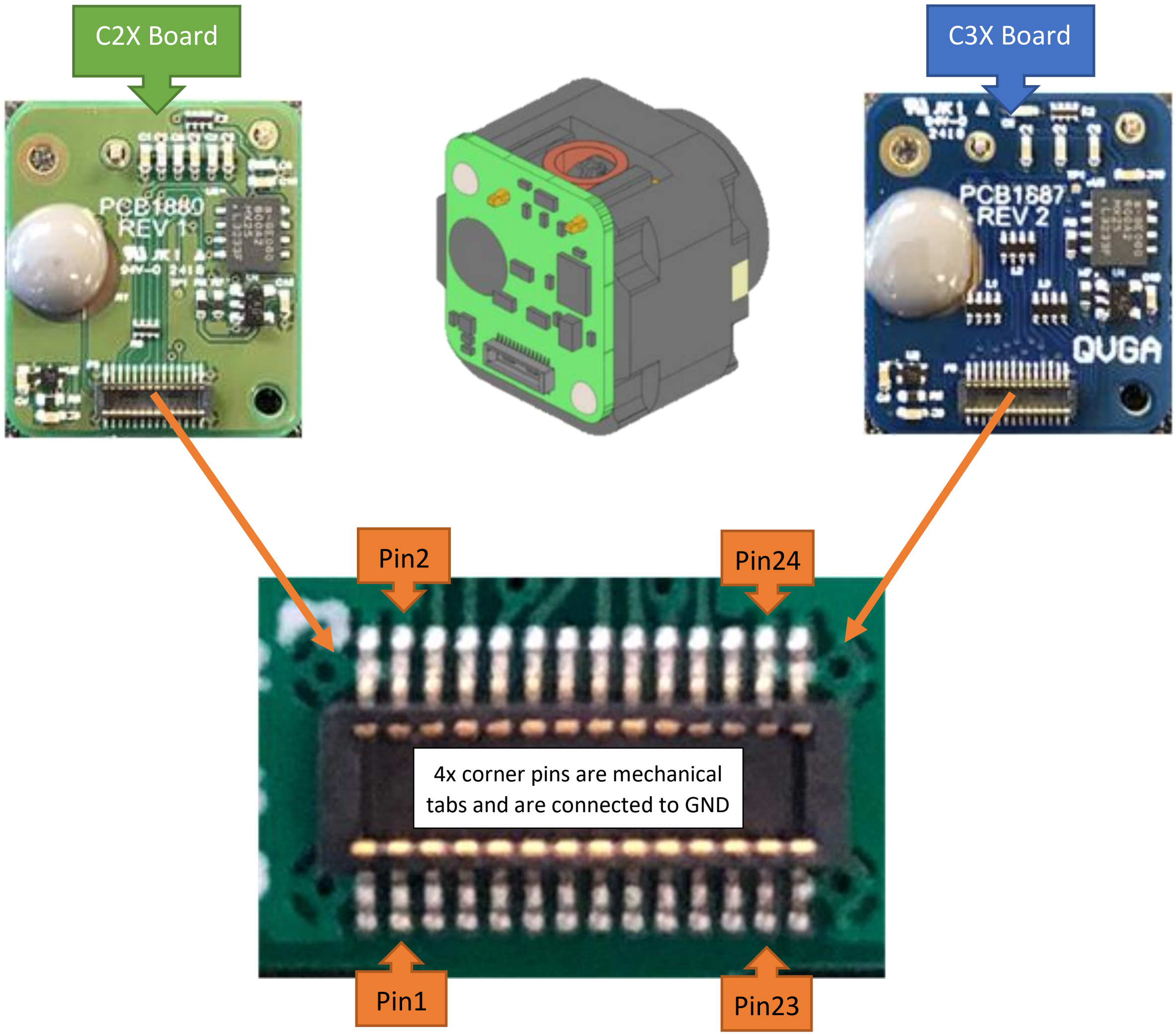


Figure 4: Mosaic Core Sensor Connector Orientation

Sensor Flex

The Mosaic Sensor Flex connects the Mosaic Core to the coprocessor board, or to the coprocessor on a customer's main board. The Sensor Flex is not a straight-through flex so it can not be used in any orientation.

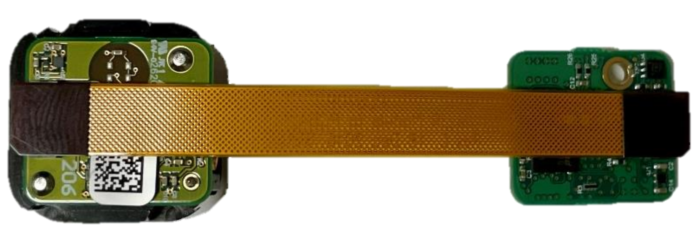


Figure 5: Sensor Flex Installation Orientation

When using the Sensor Flex to connect to a system main board that houses the coprocessor, the orientation of the flex and the connectors must be considered. Seek can provide Altium layout files of the Sensor Flex as reference for customers designing new flex lengths or shapes.

Board to Board Connector (Processor Side)

P1

PCLK	1	2	GND
RW	3	4	MOSI
FRAME	5	6	SCLK
GND	7	8	MCLK
DATA0	9	10	nSS
DATA1	11	12	FPA_EN
DATA2	13	14	MISO
DATA3	15	16	ARESET_N
DATA4	17	18	FLAG-
DATA5	19	20	FLAG+
DATA6	21	22	VIN
DATA7	23	24	GND
		0	GND

DF40C-24DP-0.4V(51)

Board to Board Connector (Sensor Side)

J1

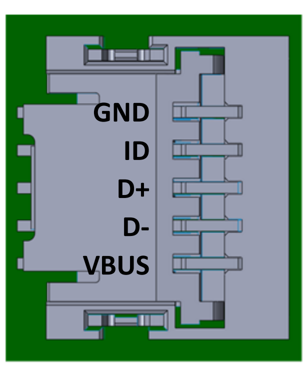
DATA7	1	2	GND
DATA6	3	4	VIN
DATA5	5	6	FLAG+
DATA4	7	8	FLAG-
DATA3	9	10	ARESET_N
DATA2	11	12	MISO
DATA1	13	14	FPA_EN
DATA0	15	16	nSS
GND	17	18	MCLK
FRAME	19	20	SCLK
RW	21	22	MOSI
PCLK	23	24	GND

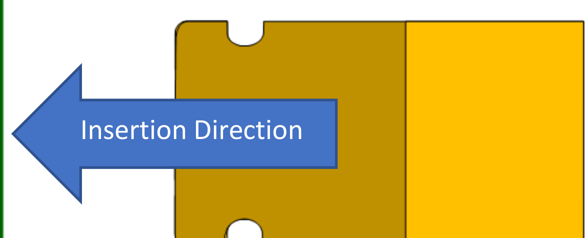
DF40C-24DS-0.4V(51)

USB Coprocessor Board Electrical Interface

The Mosaic core optional USB coprocessor board uses the following connector for USB signal output:

- Connector on Mosaic USB Coprocessor Board:
  - Amphenol FCI 59453-051110ECHLF or equivalent
- Mating FFC/FPC Cable:
  - See connector datasheet for dimensional and fabrication details.





TOP VIEW OF A RECOMMENDED FLEX PCB, REFERENCE FCI 59453-051110ECHLF DATASHEET

Figure 6: Top View of Mosaic USB Flex and Insertion Orientation

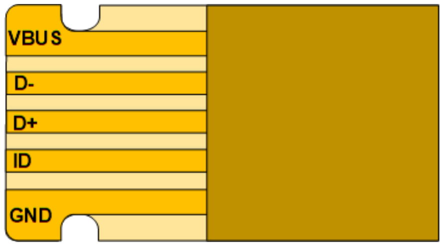


Figure 7: Bottom View of Mosaic USB Flex

USB Coprocessor Board Electrical Properties

Line	PROPERTY	MIN	TYPICAL	MAX
1	Supply Voltage [VBUS]	3.3V	3.3-5.0V	5.0V
2	Supply Power Consumption @ 25°C			300mW
3	Supply Current @ 25°C - Vin = 5.0V - Vin = 3.3V		 58mA 80mA	
4	USB BUS supply voltage - VDD(IO) ≥ 2.2V - VDD(IO) ≥ 0V	 0 0		 5.25V 3.60V
5	USB D+ Input voltage - VDD(IO) ≥ 2.2V - VDD(IO) ≥ 0V	 0 0		 5.25V 3.60V
6	USB D- Input voltage - VDD(IO) ≥ 2.2V - VDD(IO) ≥ 0V	 0 0		 5.25V 3.60V
7	Pull-down resistance (kΩ)	48	64	80
8	Differential input mode voltage (mV)	100	400	1100

Table 3: USB Coprocessor Board Electrical Properties

USB Absolute Maximum Ratings

Line	PROPERTY	MIN	TYPICAL	MAX
1	Input Voltage (VIN or VBUS)			5.25V
2	Voltage on any pin			5.25V

Table 4: USB Absolute Maximum Ratings

USB Dynamic Characteristics

Line	PROPERTY	MIN	TYPICAL	MAX
1	Rise time (10% to 90%) (ns)	4		20
2	Fall time (90% to 10%) (ns)	4		20
3	Output signal crossover voltage (V)	1.3		2.0
4	Source SE0 interval of EOP (ns)	160		175
5	Source jitter for differential transition to SE0 transition (ns)	-2		5

Table 5: USB Dynamic Characteristics

Note: Test condition: CL = 50pF, Rpu = 1.5kΩ on D+ to VDD, 3.0V ≤ VDD ≤ 3.6V, See details for NXP LPC4330 processor datasheet.

SPI Coprocessor Board Electrical Interface

The Mosaic core optional SPI coprocessor board uses the following connector for the SPI signal output:

- Connector on the Mosaic SPI Coprocessor board:
    - Hirose DF40C-20DP-0.4V(51)
- Mating Connector:
    - Hirose DF40C-20DS-0.4V(51) (various stack height options available)

NOTE: These connectors are 20 pin connectors, but they physically have 24 pins. The 4 corners pins are used for mechanical retention and are connected to GND.

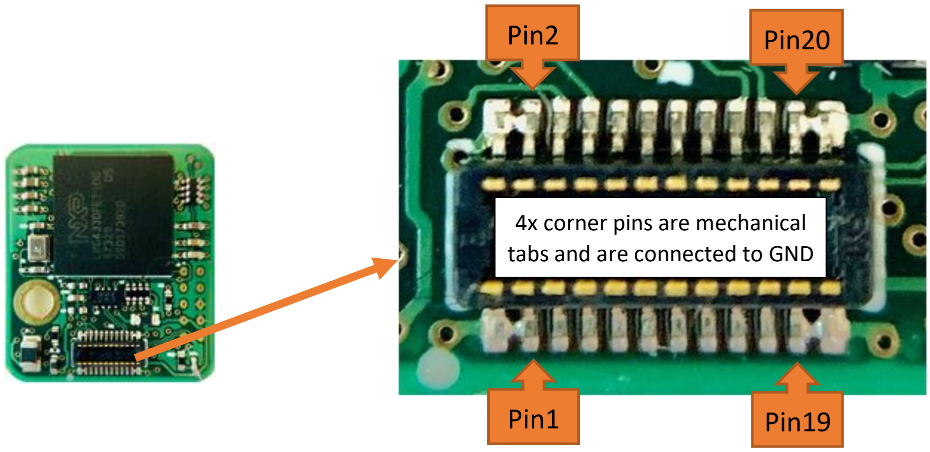


Figure 8: SPI Coprocessor Connector Orientation

SPI Coprocessor Board Connector Pinout

PIN #	PIN NAME	SIGNAL TYPE	SIGNAL LEVEL	DESCRIPTION
1	GND	Power	0	Power Return and Signal Reference
2	GND	Power	0	Power Return and Signal Reference
3	I2C_SCL	In	2.8	I2C clock signal, mastered by customer host controller
4	VIDMOSI	Out	2.8	Video data MOSI signal, mastered by SPI coprocessor
5	I2C_SDA	I/O	2.8	I2C data signal, mastered by customer host controller
6	VIDSCLK	Out	2.8	Video data SPI clock, mastered by SPI coprocessor
7	NC	NC		No connect
8	RESERVED	Reserved		Reserved pin, do not connect
9	NC	NC		No connect
10	VIDSSn	Out	2.8	Video data Slave Select signal, mastered by SPI coprocessor
11	RESETn	In	2.8	Coprocessor Reset signal
12	VIDMISO	In	2.8	Video data MISO signal, mastered by host controller
13	RESERVED	Reserved		Reserved pin, do not connect
14	FRAME_SYNCn	Out	2.8	Video data SYNC signal, mastered by SPI coprocessor
15	PWR_EN	In	VBUS	Active high power enable, pulled up with 182k
16	USB_P	IO		USB positive signal
17	VBUS	Power	3.1-5.0	Supply Voltage
18	USB_N	IO		USB negative signal
19	GND	Power	0	Power Return and Signal Reference
20	GND	Power	0	Power Return and Signal Reference

Table 6: SPI Coprocessor Board Connector Pinout

Coprocessor Circuit Reference Designs

These coprocessor circuits are provided as reference designs that a customer may build into their system to reduce the cost vs. buying the coprocessor board from Seek. Seek will provide binary files for programming the coprocessor and flash. The C2X and C3X Mosaic cores may utilize different programming files depending on the model and output interface.

Seek can provide reference Altium schematics and PCB files upon request. Seek recommends that the Altium files are used **only as a reference** and starting point for the design of a customer's circuit. Seek **does not** advise a customer to copy the schematic without performing their own design analysis and verification. The BOM should be pulled from this datasheet and not be extracted from the Altium schematic files. The footprints in the Altium layout are not guaranteed accurate and do not necessarily match the BOM in this datasheet. Customer BOM footprints may vary from the Seek layout files for parts designated as "generic". It is the customer's responsibility to verify the accuracy of their schematic, BOM and PCB layout. **Altium files are intended only as a reference guide**. Please contact Seek for support. If there is any conflict between the Altium files and this document, this document takes precedence.

Additional Reference Designs

Contact Seek applications engineering or check the developer portal for additional Altium reference designs such as flexes and starter kits.

USB Coprocessor BOM

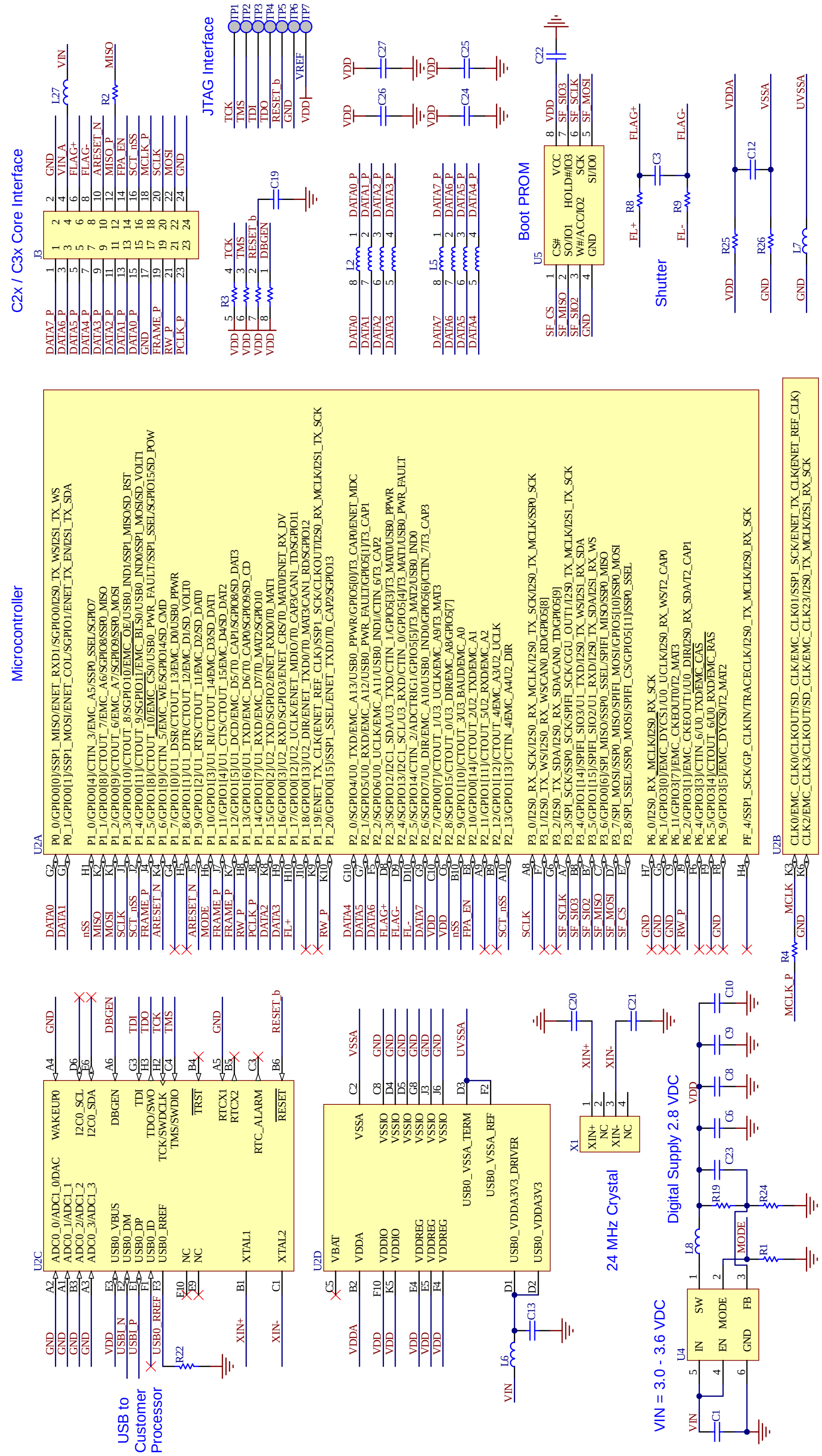
DESCRIPTION	QTY	REF DES	MFR	MFR PN
CAP CER 4.7UF 6.3V 20% X5R	2	C1,C6	Generic	
CAP CER 1000PF 25V 5% NPO	1	C10	Generic	
CAP CER 18PF 50V 5% NPO	2	C20,C21	Generic	
CAP CER 22PF 50V 5% NPO	1	C23	Generic	
CAP CER 0.1UF 16V 10% X7R	10	C3,C8,C12,C13,C19, C22,C24,C25,C26,C27	Generic	
CAP CER 10000PF 16V 10% X7R	1	C9	Generic	
CONN RCPT 24POS 0.4MM SMD GOLD	1	J3	Hirose	DF40C(2.0)-24DS-0.4V
FERRITE BEAD 120 OHM 0804 4LN	2	L2,L5	Taiyo Uden	BK20104M121-T
IND 2.2UH 30mA 5% SMD 0402	1	L27	TDK	MLF1005G2R2JT000
FERRITE CHIP 600 OHM 300MA 0402	2	L6,L7	Samsung	CIM05U601NC
IND 2.2UH 600mA 160MOHM 0805 20%	1	L8	TDK	MLZ2012M2R2HT000
RES 182K OHM 1,16W 1%	2	R1,R24	Generic	
RES 665K OHM .066W 1%	1	R19	Generic	
RES 100 OHM 1/10W 5%	4	R2,R4,R8,R9	Generic	
RES 12K OHM 0.1W 1%	1	R22	Generic	
RES 10 OHM 1/10W 5%	1	R25	Generic	
RES 0.0 OHM .066W JUMP	1	R26	Generic	
RES ARRAY 10K OHM 4 RES	1	R3	Generic	
IC MCU 32BIT ROMLESS 100TFBGA	1	U2	NXP	LPC4330FET100,551
IC REG BUCK SYNC ADJ 0.6A 6SON	1	U4	TI	TPS62560DRV or TPS62590DRV
IC FLASH 32MBIT 104MHZ 8WSON	1	U5 (two alternate parts)	Macronix	MX25L3233 (any package)
			Winbond	W25Q32JVZPIQ
CRYSTAL HYBRID 24MHZ 6PF SMD	1	X1	Murata	XRCGB24M000F0L00R0

Table 7: USB Coprocessor Circuit BOM

NOTES:

1. JTAG interface part number is not defined in order to allow customer to define the connector or use a pogo pad interface as required by manufacturing needs.
2. Parts labeled with “Generic” for manufacturer may be sourced from any manufacturer that meets the requirements of the part description.
3. Alternate flash components may NOT be substituted, the firmware detects the specific JEDEC device ID.
4. Alternate components (except the microprocessor and flash) may be used at the customer’s risk as they have not been verified by Seek.

USB Coprocessor Schematic



SPI Coprocessor BOM

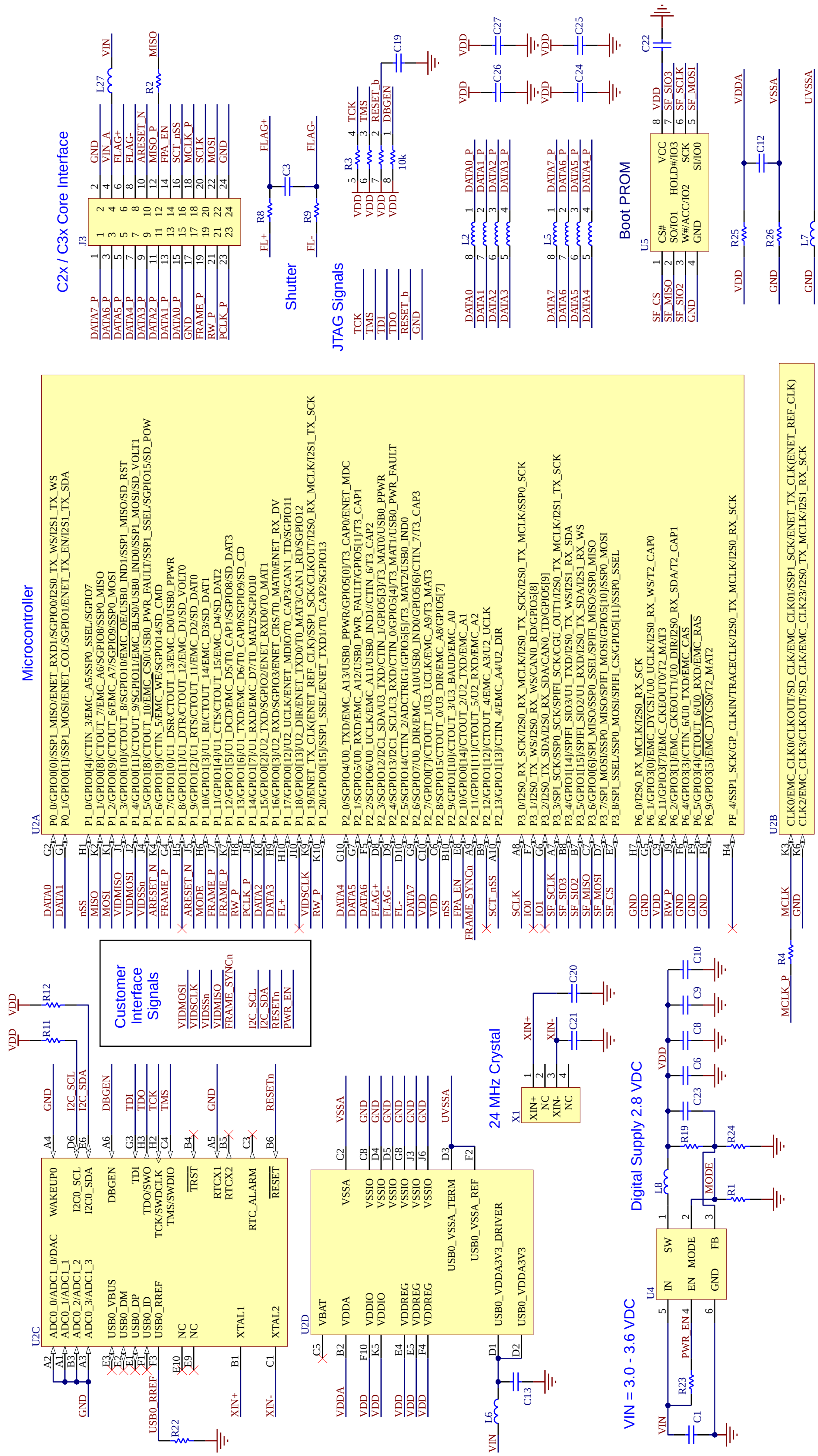
DESCRIPTION	QTY	REF DES	MFR	MFR PN
CAP CER 4.7UF 6.3V 20% X5R	2	C1,C6	Generic	
CAP CER 1000PF 25V 5% NP0	1	C10	Generic	
CAP CER 18PF 50V 5% NP0	2	C20,C21	Generic	
CAP CER 22PF 50V 5% NPO	1	C23	Generic	
CAP CER 0.1UF 16V 10% X7R	10	C3,C8,C12,C13,C19, C22,C24,C25,C26,C27	Generic	
CAP CER 10000PF 16V 10% X7R	1	C9	Generic	
CONN RCPT 24POS 0.4MM SMD GOLD	1	J3	Hirose	DF40C-24DS-0.4V(51)
FERRITE BEAD 120 OHM 0804 4LN	2	L2,L5	Taiyo Uden	BK20104M121-T
IND 2.2UH 30mA 5% SMD	1	L27	TDK	MLF1005G2R2JT000
FERRITE CHIP 600 OHM 300MA 040	2	L6,L7	Samsung	CIM05U601NC
IND 2.2UH 600mA 160MOHM 0805 20%	1	L8	TDK	MLZ2012M2R2HT000
RES 182K OHM 1,16W 1%	2	R1,R24	Generic	
RES 2.2K OHM 1/10W 5%	2	R11,R12	Generic	
RES 665K OHM .066W 1%	1	R19	Generic	
RES 100 OHM 1/10W 5%	4	R2,R4,R8,R9	Generic	
RES 12K OHM 0.1W 1%	1	R22	Generic	
RES 22K OHM 0.1W 5%	1	R23	Generic	
RES 10 OHM 1/10W 5%	1	R25	Generic	
RES 0.0 OHM .066W JUMP	1	R26	Generic	
RES ARRAY 10K OHM 4 RES	1	R3	Generic	
IC MCU 32BIT ROMLESS 100TFBGA	1	U2	NXP	LPC4330FET100,551
IC REG BUCK SYNC ADJ 0.6A 6SON	1	U4	TI	TPS62560DRV or TPS62590DRV
IC FLASH 32MBIT 104MHZ 8WSON	1	U5 (two alternate parts)	Macronix	MX25L3233 (any package)
			Winbond	W25Q32JVZPIQ
CRYSTAL HYBRID 24MHZ 6PF	1	X1	Murata	XRCGB24M000F0L00R0

Table 8: SPI Coprocessor Circuit BOM

NOTES:

1. JTAG interface part number is not defined in order to allow customer to define the connector or use a pogo pad interface as required by manufacturing needs.
2. Parts labeled with “Generic” for manufacturer may be sourced from any manufacturer that meets the requirements of the part description.
3. Alternate flash components may NOT be substituted, the firmware detects the specific JEDEC device ID.
4. Alternate components (except the microprocessor and flash) may be used at the customer’s risk as they have not been verified by Seek.

SPI Coprocessor Schematic



Software and Firmware

The Mosaic Core software system is comprised of the Mosaic Firmware and the Seek SDK modules. These modules, provided by Seek Thermal, facilitate the integration and development of the Mosaic Core thermal sensor into a customer's targeted platform. Each module is comprised of some level of software that permits each block to interface to each other.

The SDKs are a vital part of the Mosaic Core pipeline. Depending on the target development platform and data interface, the Seek SDK performs thermal sensor non-uniformity correction, gain, color application and thermography calculations. The SDK is run at the Android or Linux level as library function calls.

The Mosaic firmware is utilized in the Mosaic Coprocessor. The firmware is responsible for interfacing to the Seek sensor for command, control and data retrieval. On USB based systems, the firmware interfaces directly with the Seek SDK. On SPI based systems, the firmware interfaces with a customer written application code that performs the image processing functions.

Seek SDK Details

The Seek SDK supports the following operating systems:

- Windows
- Linux
- Android

Supported Linux Compile Environments:

- Allwinner
- HiSilicon
- Rockchip
- Raspberry Pi 3+
- Most ARM V7 based systems
- Most ARM V8 based systems
- i686 and x86_64
- Others may be supportable, contact Seek

Only certain processors from each example manufacturer and environment have been verified. Contact Seek when planning a system architecture. For more detailed system requirements please see the Seek SDK manual.

Mosaic Firmware Details

During development and prototype phases, it may be easiest to use JTAG to program the coprocessor circuit. Seek recommends the Segger J-Link programming tool along with the appropriate cable/connector for the application. Seek can provide programming scripts that use the Segger J-Link tool.

After a production, when using the USB coprocessor interface, firmware on the coprocessor may be field updated through the Seek SDK firmware upload function *Seekware_UploadFirmware().* This function works provided the customer's system allows for external write access to the OS file system that the SDK has read access to. See the Seek SDK manual for further details.

Mechanical Interfaces

The Mosaic Core is sensitive to damage from shock and vibration. To reduce the chance of damage, the core must not be hard mounted against any surface. The example installation method illustrated achieves this through use of compliant cushion and bracket as shown. Mosaic cores, cushions and brackets are not rated for any shock, vibe or drop specifications. The ability for the core to survive a hard environment is entirely dependent on the system design around the core. Mosaic cores have been designed into a variety of commercial and industrial systems that have successfully passed typical shock, vibe and drop testing.

Bracket shown is around 85 Shore A durometer flexible urethane. Softer brackets may be used depending on installation details but harder brackets are not normally recommended.

Cushion shown is around 35 Shore A durometer, this is the recommended hardness for similar installations though cushions up to 70 Shore A durometer with different geometry have been successfully implemented.

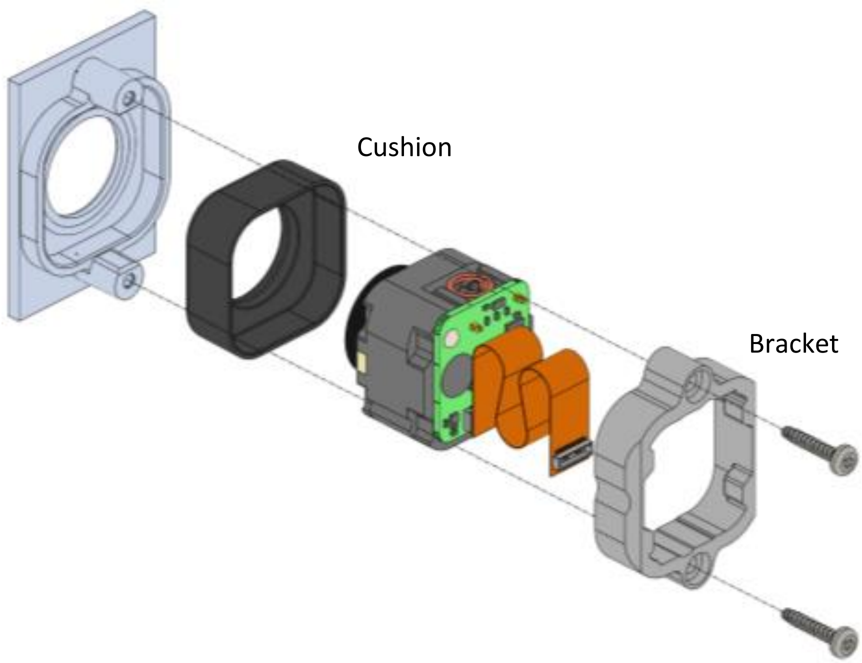


Figure 9: Example Mounting Configuration

To achieve IPxx sealing, the core is designed to seal around the diameter of the lens barrel where it interfaces with the cushion. The cushion incorporates an 'O-ring' feature to achieve this. C2x cores and cushions are not designed with IP rating capability. In the installation shown the face plate that the cushion mounts to has a rigid 'O-ring' feature that seals to the cushion. Alternatively, O-ring features can be incorporated in the cushion allowing use of a flat face plate. See Figure 10: IPxx Sealing Features. Note the installed orientation of the optionally available Seek flex cable.

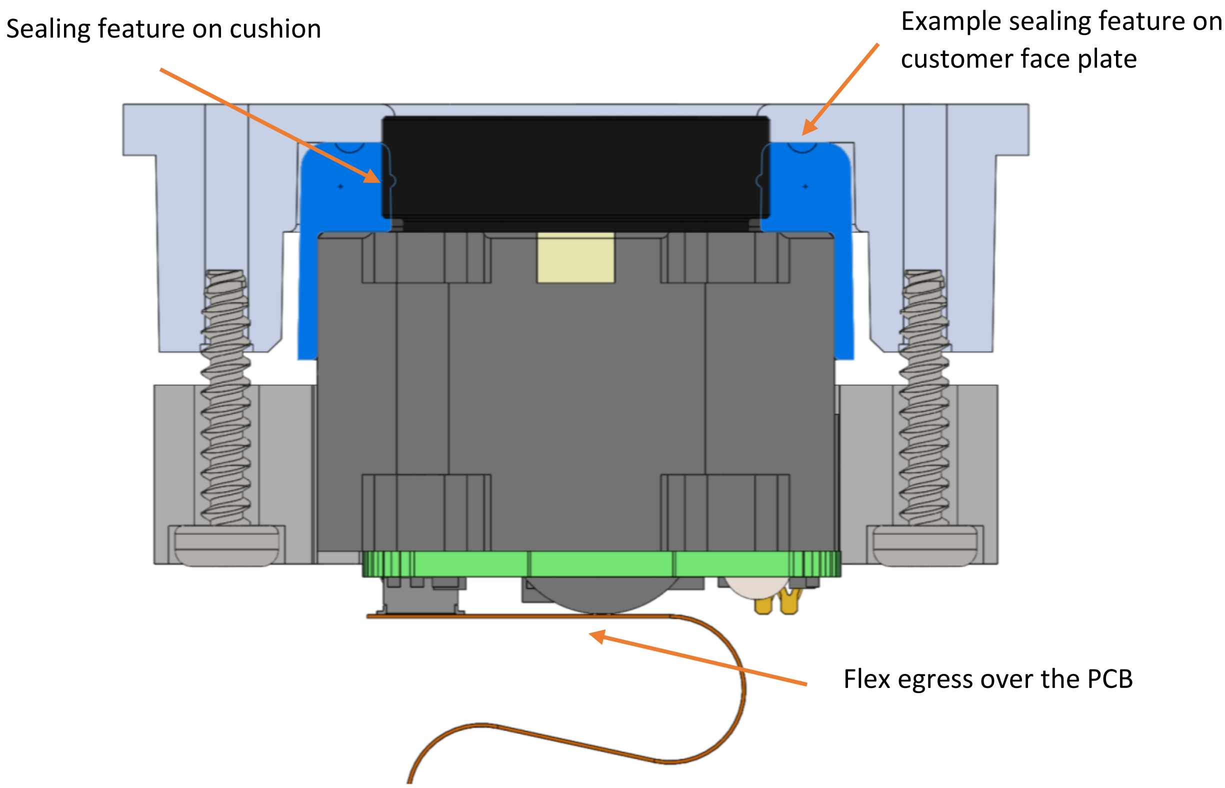
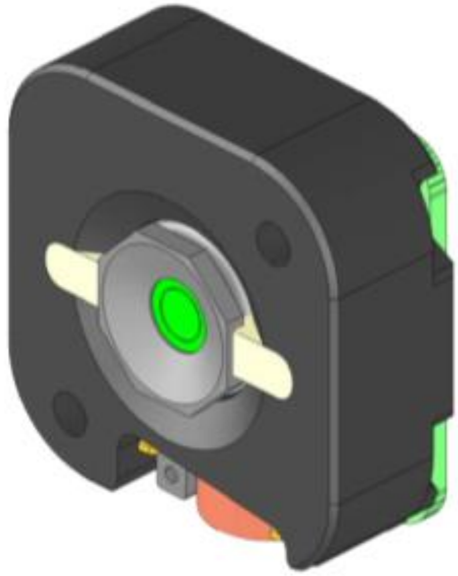
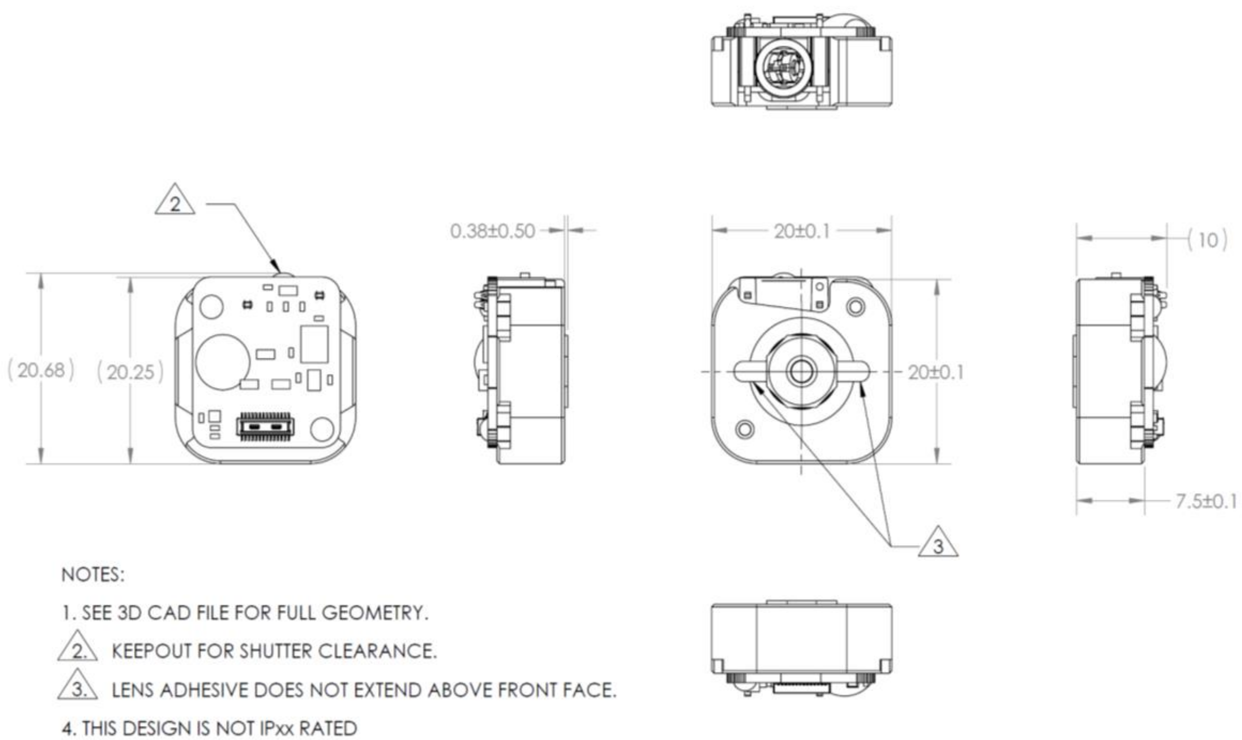


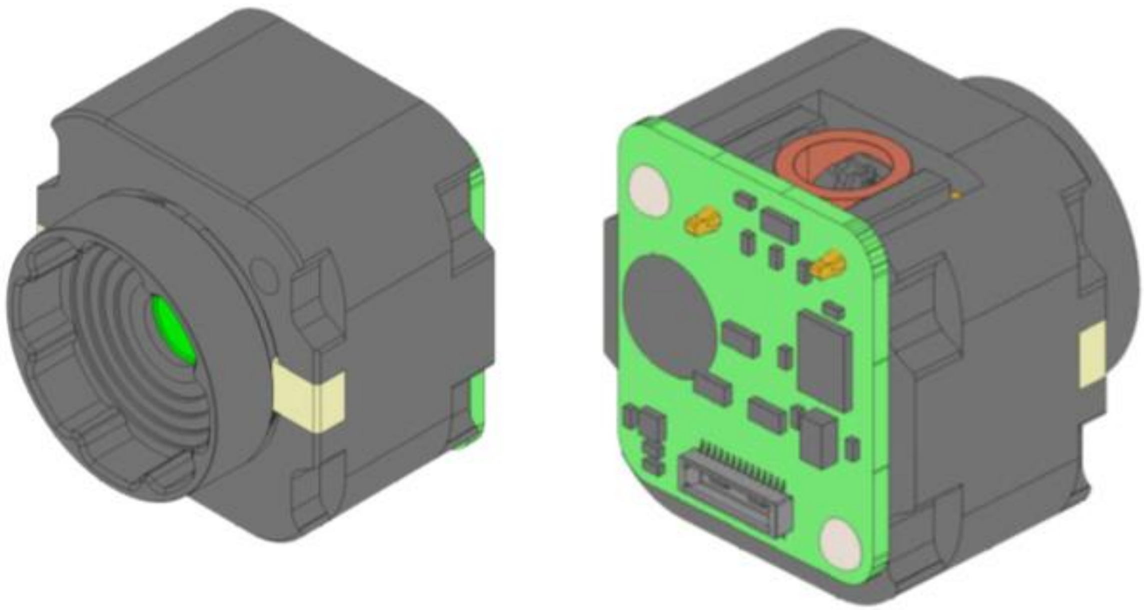
Figure 10: IPxx Sealing Features

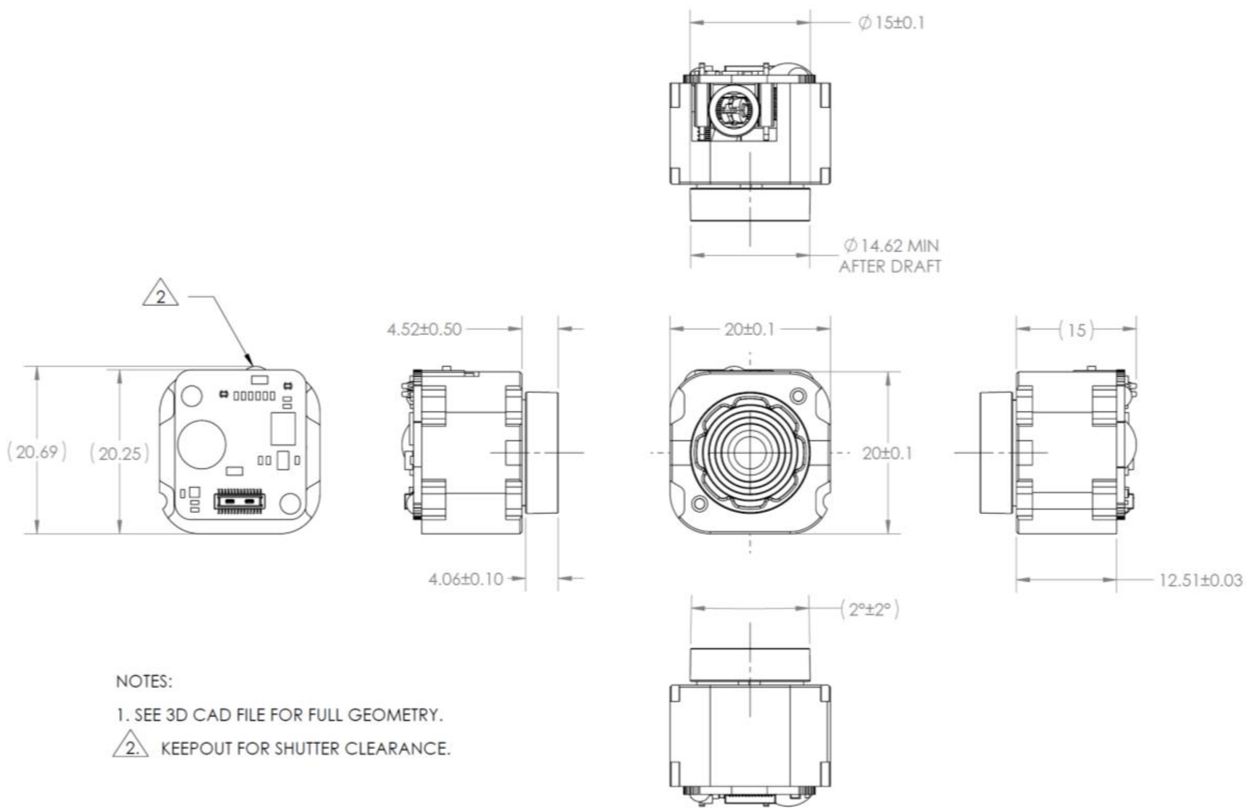
Mechanical Outline – 2.2mm Lens Cores



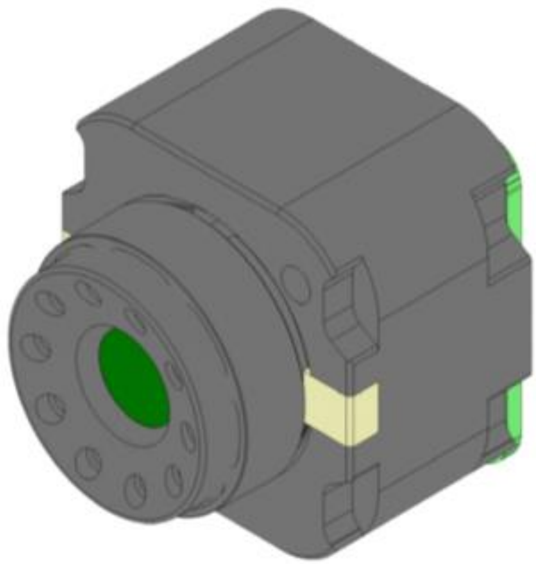


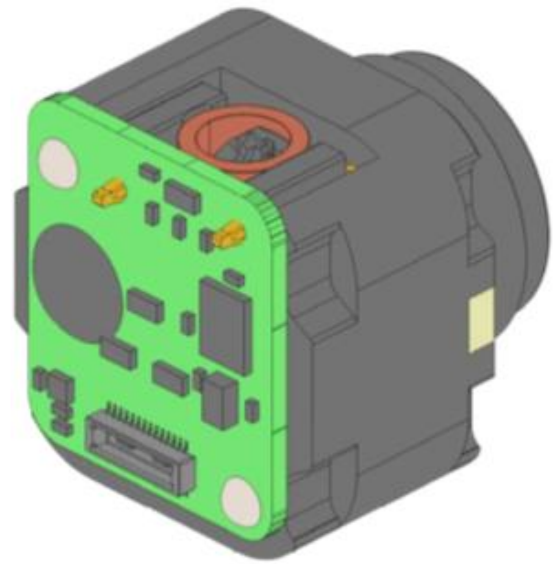
Mechanical Outline – 4.0mm Lens Cores

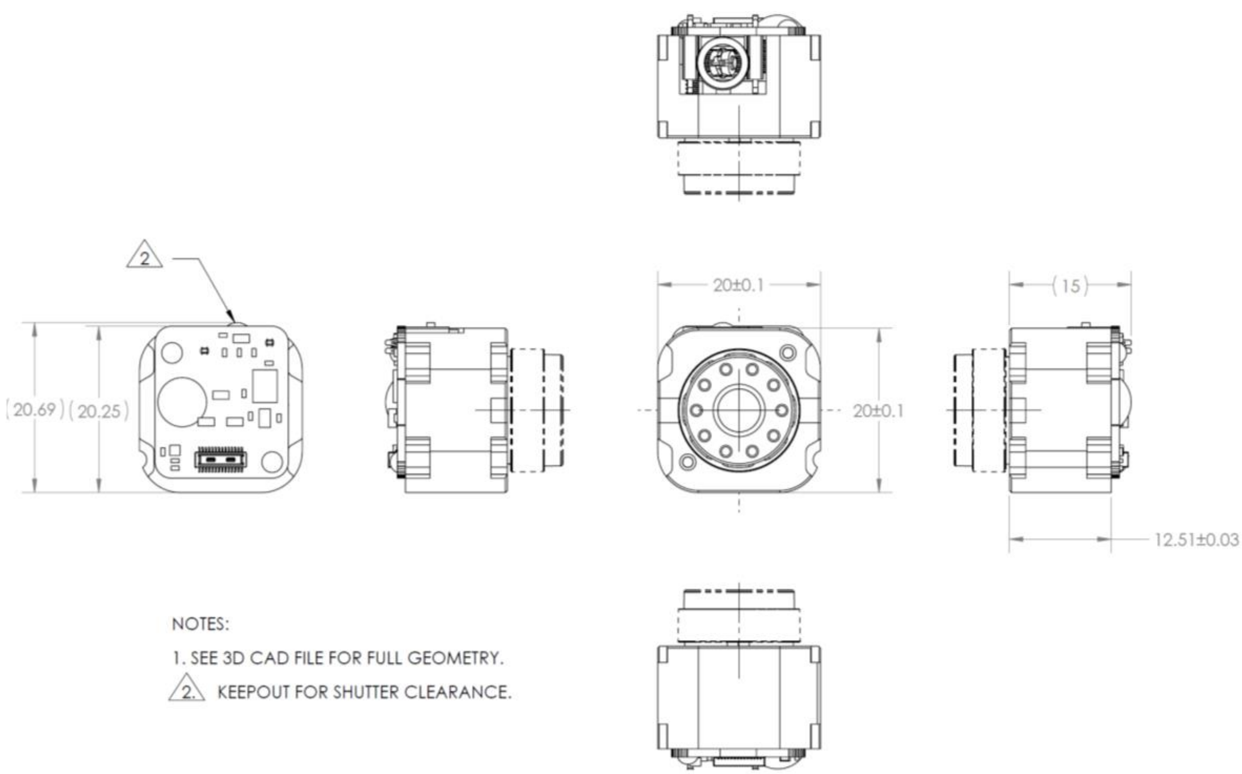




Mechanical Outline – 6.6mm Lens Cores







Mechanical Outline – 9.1mm Lens Cores