

XGS X-Celerator Developer Kit

EVBUM2747/D

INTRODUCTION

The X-Celerator kit is designed to enable FPGA development around ON Semiconductor's XGS image sensor family. The kit provides a sensor HiSpi receiver example as starting point to allow for a quicker and more easy integration to standard FPGA evaluation environments. The interface example was created for a Xilinx™ Ultrascale™ architecture.

The headboard features ON Semiconductor XGS 45000, image sensor integrated on a standard High-Speed Array VITA 57.1 FPGA Mezzanine Card (FMC) with on-board power management.

IP CORE ARCHITECTURE

Reference RTL code for the HiSpi receiver (See Figure 2) is available under NDA and structured as three modular IP core blocks (deserializer, decoder and remapper) that convert the XGS HiSpi output to a AXI4 video streaming standard. These blocks are written in a flexible and generic form that is easily modified and inserted in any FPGA vendor technology or design methodology. The X-Celerator contains a ready to use block diagram example solution for each of the sensor variants, designed for the Xilinx Kintex™ UltraScale architecture.

Although the RTL IP core blocks have been validated to work on Altera (Intel) development boards, active support for the HiSpi receiver on these systems is currently not yet available.

SYSTEM OVERVIEW

Figure 1 shows the stripped XGS 45000 X-Celerator FMC headboard (100 x 69 mm). This is the single part that changes between the different Orderable Part Numbers (OPN's), provided in Table 1. The kit furthermore consists out of a F-mount lens holder, lens extension tube, fixing ring, THORLABS™ adaptor, High-pin Count (HPC) FMC cable, tripod mount and a tripod in order to enable a more user-friendly tripod configuration. The individual parts are discussed in more detail in the following subsections. Please note that these OPN's do NOT include a lens or development board.

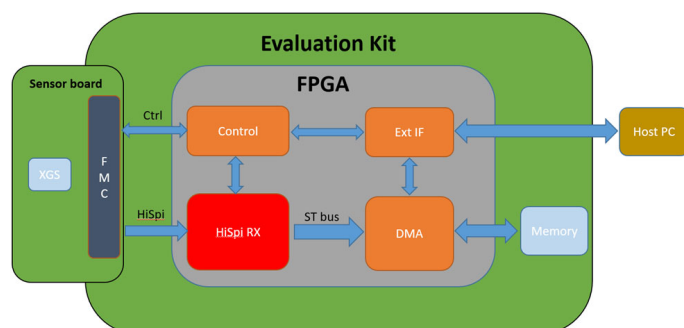


Figure 2. HiSpi Receiver in FPGA solution



ON Semiconductor®

www.onsemi.com

EVAL BOARD USER'S MANUAL

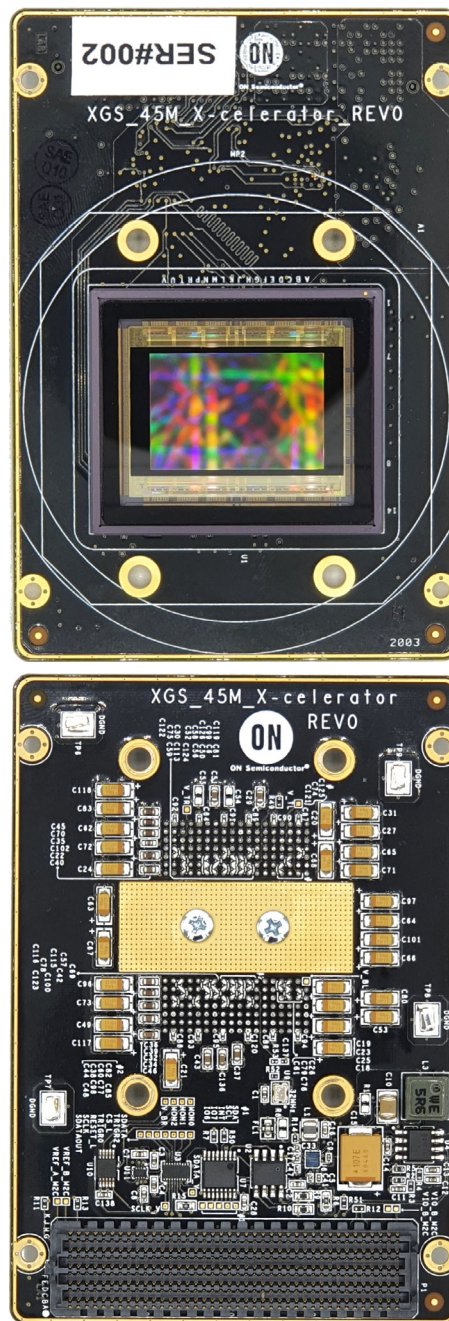


Figure 1. X-Celerator FMC Headboard

Table 1. ORDERABLE PART NUMBERS

Part Number	Product Description
XCEL-NOIX0SE045KBL-GEVK	X-Celerator – XGS 45000 – color image sensor board, includes HPC FMC cable, lens mount, tripod mount and tripod.
XCEL-NOIX0SN045KBL-GEVK	X-Celerator – XGS 45000 – monochrome image sensor board, includes HPC FMC cable, lens mount, tripod mount and tripod.

Image Sensor Board

This board features one of ON Semiconductor XGS image sensors implemented on a ANSI/VITA 57.1 single width FMC standard module board with full channel (48 lanes for XGS 45000) HiSpi video output, the necessary sensor control signals provided over SPI and a single 3.3 V power

supply input. The ON Semiconductor's NCP6914 Mini-PMIC provides all the necessary low noise power supplies for the image sensor operations.

Figure 3 and Table 2 show the board layout and the Bill of Materials (BOM) for the X-Celerator. Detailed layout files and schematics are available under NDA.

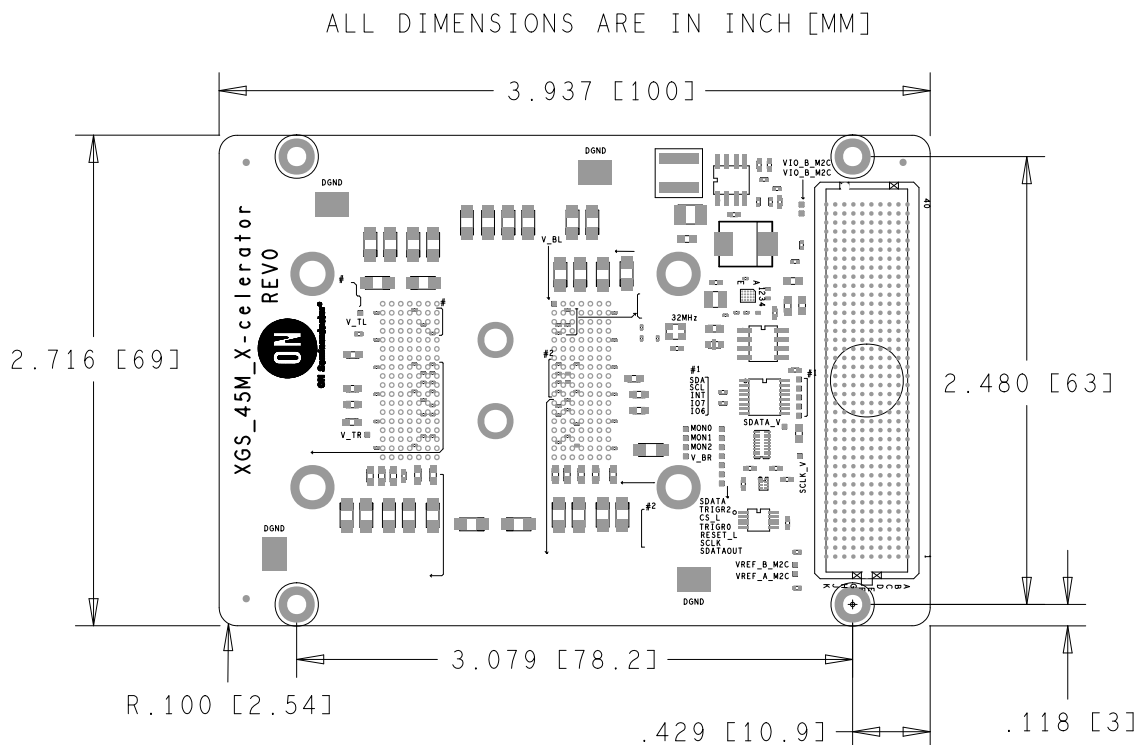


Figure 3. X-Celerator Headboard Dimensions

High-pin Count (HPC) FMC Cable

Provided with the OPN's comes a VITA 57.1 FMC Samtec HPC HDR Cable, as shown in Figure 4, to connect the headboard in its tripod configuration. Specifications on the usable cables can be found on the [Samtec VITA family webpage](http://www.samtec.com/vita-family).

The provided cable (HDR-169468-01) is the HPC variant of the FMC connection in order to send all 48 data channels to the FPGA.

More details on the pin usage can be found in Table 3.



Figure 4. High-pin Count (HPC) FMC Cable

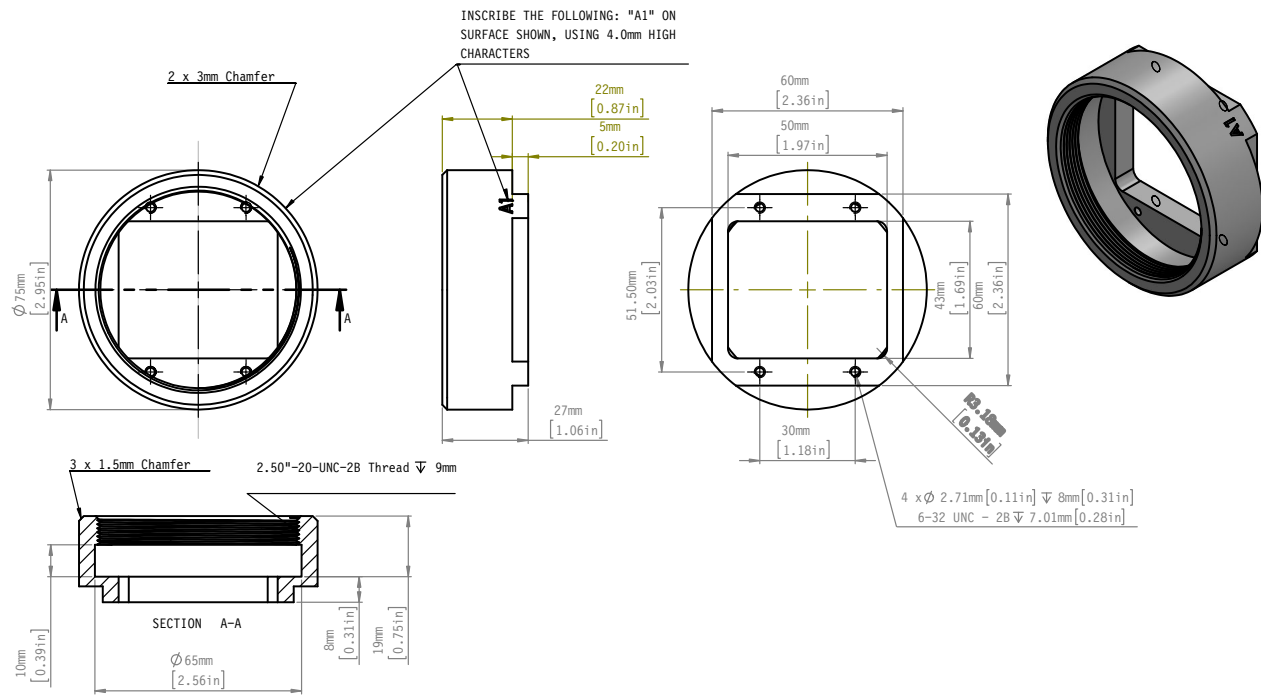


Figure 5. F-Mount Lens Holder Base

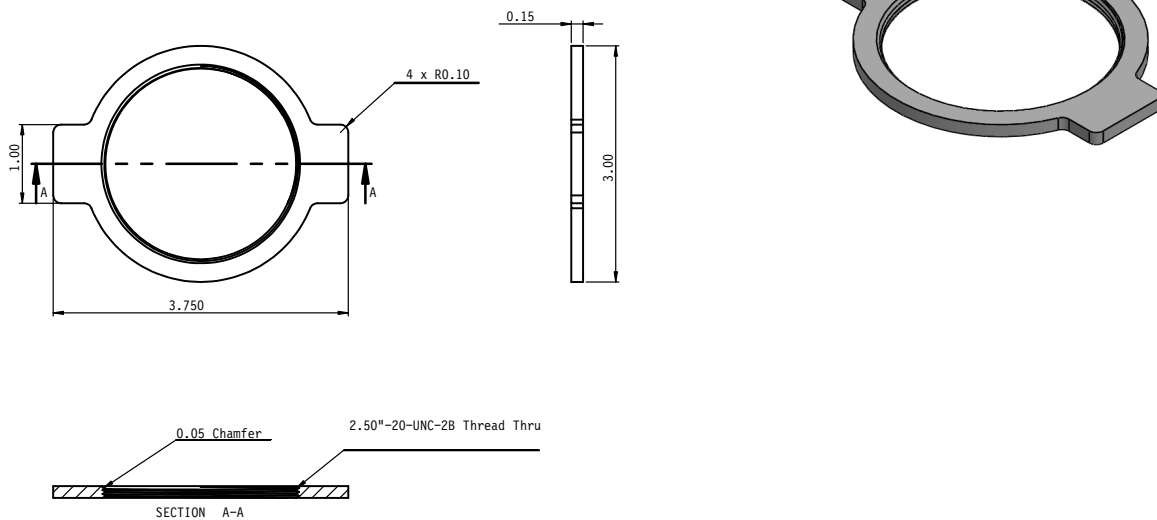


Figure 6. Fixing Ring for F-Mount Extension Tube

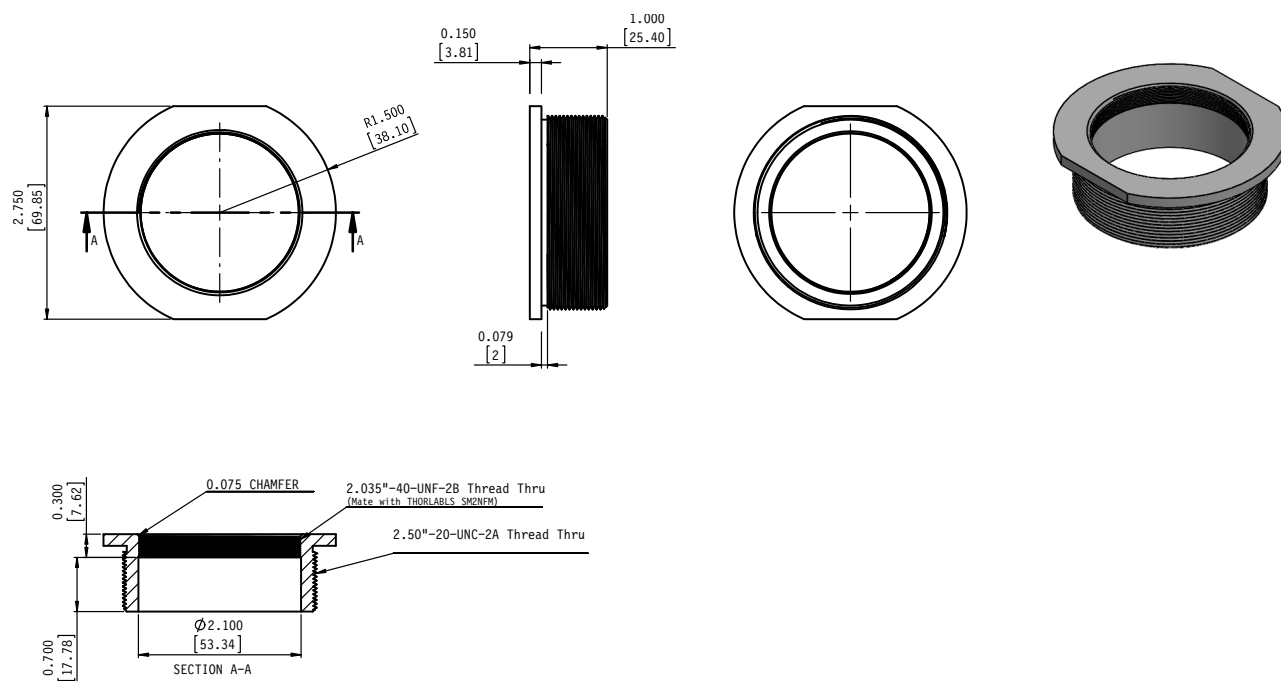


Figure 7. Lens Holder Extension Tube

Lens Mount

The headboard comes with a standard F-mount lens holder that is screwed onto the board. The lens mount is made of black aluminium and fits closely around the XGS 45000 sensor, as shown in Figure 4.

The lens mount comes with a F-mount extender tube, fixing ring and Thorlabs SM2NFM adaptor. See Figure 5 and Figure 6 for the tube and fixing ring.

Tripod Mount

In order to mount the cable firmly to the provided headboard, two different aluminium mounting pieces are provided that serve a dual purpose. Both as tripod mount for the provided tripod, see Figure 8, and as FMC cable

connector lock, see Figure 9, to secure your hardware connection. These pieces are connected by two M2.5 screws and nuts.

Tripod

The last part to make the development kit complete is a standard adjustable tripod to aim the image sensor in any direction that is desired.

Not Included: Lens and FPGA Development Platform

The development kit does not include a F-mount lens or FPGA development platform as different needs require different platforms.

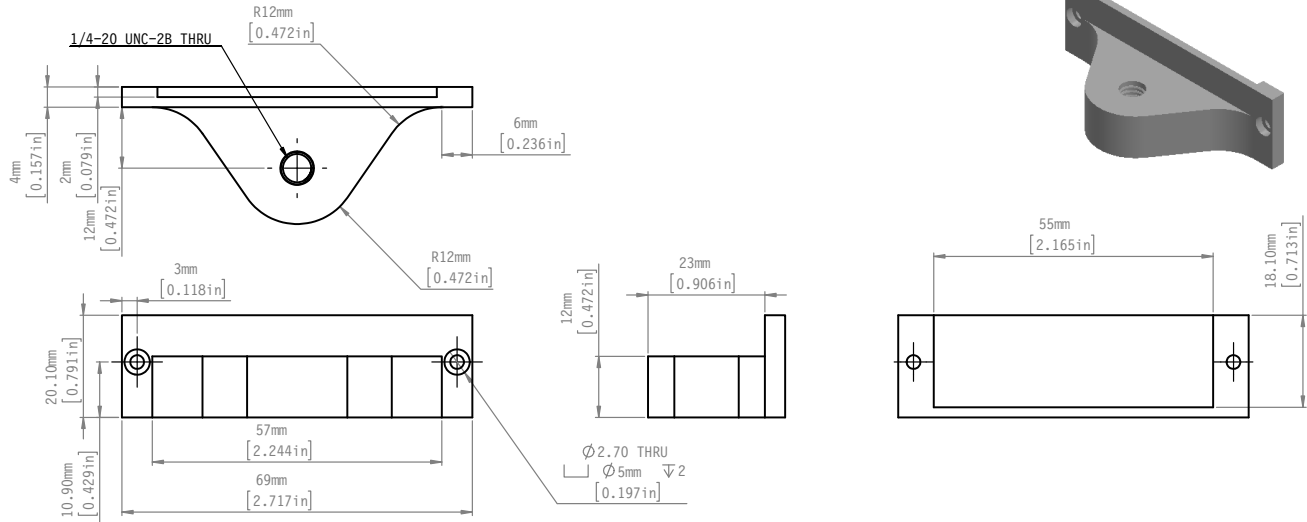


Figure 8. Frontside Tripod Mount Piece

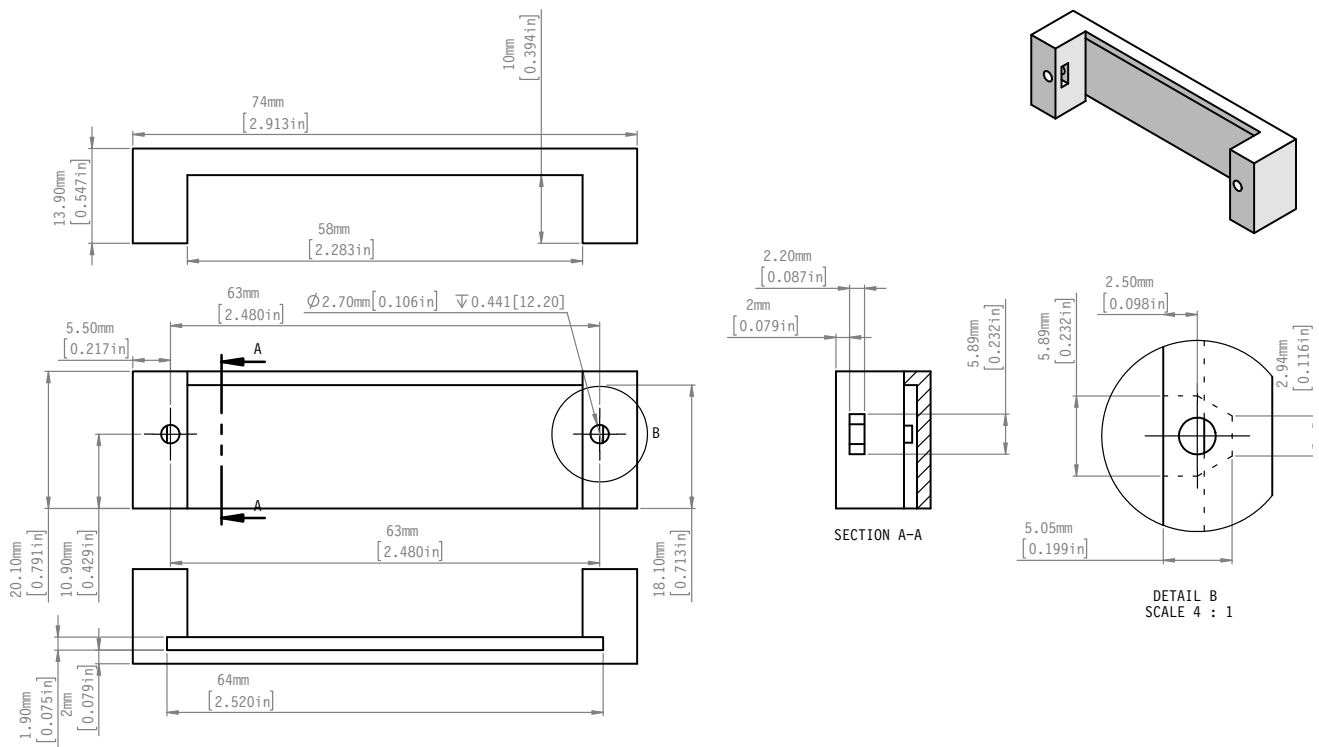


Figure 9. Backside FMC Cable Connector Piece

Table 2. XGS 45000 X-CELERATOR BOM

Item	Qty	Part Reference	Value	Package	Description	Manufacturer	Manufacturer Part Number
1	8	C1 C2 C3 C4 C7 C8 C28 C138	100nF	402	CAP, CERAMIC, 100nF, 16V, X7R, 10%, 0402	Murata	GRM155R71C104 KA88D
2	6	C5 C107 C108 C109 C111 C112	2.2uF	201	CAP, CERAMIC, 2.2uF, 10V, X5R, 10%, 0201	Murata	GRM033R61A225K E47D
3	37	C6 C26 C57 C59 C60 C61 C74 C75 C76 C77 C78 C79 C81 C82 C84 C85 C86 C87 C88 C89 C90 C91 C92 C93 C94 C95 C98 C99 C116 C119 C120 C121 C122 C123 C124 C125 C126	100nF	201	CAP, CERAMIC, 100nF, 10V, X7S, 20%, 0201, -55/+125C	TDK	C0603X7S1A104M 030
4	1	C10	100uF	1210	CAP, CERAMIC, 100uF, 6.3V, X5R, 20%, 1210	Murata	GRM32ER60J107 ME20L
5	1	C11	680pF	402	CAP, CERAMIC, 680pF, 25V, X7R, 10%, 0402	Panasonic	ECJ0EB1E681K
6	1	C12	12nF	402	CAP, CERAMIC, 12nF, 16V, X7R, 10%, 0402	Panasonic	ECJ0EB1C123K
7	1	C13	150pF	402	CAP, CERAMIC, 150pF, 50V, X7R, 10%, 0402	AVX	04025C151KAT2A
8	1	C14	10nF	402	CAP, CERAMIC, 10nF, 50V, X6S, 10%, 0402	TDK Corporation	C1005X6S1H103K
9	1	C15	100uF	7361-38	CAP, TANTALUM CHIP, LOW ESR, 100uF, 25V, 10%, 7361	AVX	TPSV107K025R01 00
10	28	C18 C19 C20 C21 C23 C24 C25 C27 C31 C49 C53 C62 C63 C64 C65 C66 C67 C68 C71 C72 C73 C80 C83 C96 C97 C101 C117 C118	10uF	3216-18	CAP, TANTALUM CHIP, LOW ESR, 10uF, 10V, 10%, 3216	AVX	TPSA106K010R09 00
11	6	C22 C32 C35 C39 C45 C70	10uF	603	CAP, CERAMIC, 10uF, 10V, X5R, 10%, 0603	Murata	GRM188R61A106K AALD
12	7	C29 C34 C36 C37 C40 C43 C51	4.7uF	603	CAP, CERAMIC, 4.7uF, 6.3V, X7R, 10%, 0603	Samsung_Electr o_mechanic	CL10B475KQ8NQ N
13	5	C30 C38 C42 C113 C115	220nF	201	CAP, CERAMIC, 220nF, 10V, X5R, 20%, 0201	Taiyo Yuden	LMK063BJ224MP- F
14	7	C44 C48 C50 C52 C56 C58 C69	100nF	201	CAP, CERAMIC, 100nF, 10V, X5R, 20%, 0201	Murata	GRM033R61A104 ME15D
15	2	C46 C136	2.2uF	603	CAP, CERAMIC, 2.2uF, 10V, X7R, 10%, 0603	Murata	GRM188R71A225K E15D

Table 2. XGS 45000 X-CELERATOR BOM (continued)

Item	Qty	Part Reference	Value	Package	Description	Manufacturer	Manufacturer Part Number
16	1	C100	470nF	201	CAP, CERAMIC, 470nF, 6.3V, X5R, 10%, 0201	Murata	GRM033R60J474K E90D
17	1	C102	680nF	402	CAP, CERAMIC, 680nF, 6.3V, X6S, 5%, 0402	Samsung_Electr o_mechanic	CL05X684JQ5NNN C
18	2	C103 C110	10uF	402	CAP, CERAMIC, 10uF, 6.3V, X5R, 20%, 0402	Murata	GRM155R60J106M E15D
19	1	C104	4.7uF	402	CAP, CERAMIC, 4.7uF, 6.3V, X5R, 20%, 0402, Automotive AEC-Q200	Taiyo Yuden	JMK105BBJ475MV HF
20	2	C114 C127	1uF	603	CAP, CERAMIC, 1uF, 16V, X7R, 10%, 0603, Automotive AEC-Q200	TDK Corporation	CGA3E1X7R1C105 K080AC
21	1	FL1	1uF	603	EMI FILTER, MLC CAPACITORS, LOW ESL, 1uF, 2A, 6.3V, 0603	Murata	NFM18PC105R0J3 D
22	1	L2	1.0uH	805	IND, CHIP COIL, MULTILAYER, SMD, 1.0uH, 1.3A, +/-30%, 0805	Murata	LQM21PN1R0NGR
23	1	L3	5.6uH	254x262x240	IND, POWER, SMD, 5.6uH, 6.9A, .254"L x .262"W x .240"H	Wurth ElectroniK	74439346056
24	1	P1	HDR400-10x40-P		CONN, HEADER, SINGLE END ARRAY, 10x40, 400 PIN, 1.27MM PITCH, ALGNMNT PINS, SMD	Samtec	ASP-134488-01
25	1	R2	24K	402	RESISTOR, PRECISION THICK FILM CHIP, SMD, 24K, 0.1W, 1%, 0402, AEC-Q200 compliant	Panasonic	ERJ2RKF2402X
26	1	R3	1K	402	RESISTOR, PRECISION THICK FILM CHIP, SMD, 1K, 0.1W, 1%, 0402, Automotive grade, AEC-Q200 compliant	Panasonic	ERJ-2RKF1001X

Table 2. XGS 45000 X-CELERATOR BOM (continued)

Item	Qty	Part Reference	Value	Package	Description	Manufacturer	Manufacturer Part Number
27	1	R4	14.7K	402	RESISTOR, PRECISION THICK FILM CHIP, SMD, 14.7K Ohm, 0.1W, 1%, 0402, Automotive grade, AEC-Q200 compliant	Panasonic	ERJ-2RKF1472X
28	1	R5	7.15K	402	RESISTOR, PRECISION THICK FILM CHIP, SMD, 7.15K, 0.1W, 1%, 0402	Panasonic	ERJ2RKF7151X
29	2	R6 R15	0	603	RESISTOR, THICK FILM CHIP, SMD, 0 OHM JUMPER, 0.1W, 5%, 0603, AEC-Q200 compliant	Panasonic	ERJ3GEY0R00V
30	3	R7 R50 R51	4.7K	402	RESISTOR, THICK FILM CHIP, SMD, 4.7K, 0.063W, 5%, 0402	Panasonic	ERJ2GEJ472X
31	2	R9 R10	10K	603	RESISTOR, PRECISION THICK FILM CHIP, SMD, 10K, 0.1W, 1%, 0603	Panasonic	ERJ3EKF1002V
32	1	R11	300K	402	RESISTOR, PRECISION THICK FILM CHIP, SMD, 300K, 0.1W, 1%, 0402	Panasonic	ERJ-2RKF3003
33	2	R12 R13	0	402	RESISTOR, PRECISION THICK FILM CHIP, SMD, 0 Ohm, 0.1W, 1%, 0402, Automotive grade, AEC-Q200 compliant	Panasonic	ERJ2GE0R00X
34	1	R49	10K	402	RESISTOR, THICK FILM CHIP, SMD, 10K, 0.063W, 5%, 0402, AEC-Q200 compliant	Panasonic	ERJ2GEJ103X
35	1	R52	0	201	RESISTOR, THICK FILM CHIP, SMD, 0 OHM JUMPER, 0.05W, 5%, 0201	Panasonic	ERJ1GE0R00C

Table 2. XGS 45000 X-CELERATOR BOM (continued)

Item	Qty	Part Reference	Value	Package	Description	Manufacturer	Manufacturer Part Number
36	4	TP6 TP7 TP8 TP9	TSTPT-5016		CONN, TERMINAL, TEST POINT COMPACT, .015 THICK, SMT	Keystone Electronics	5016
37	1	U1	XGS45M_PG A251_HS	PGA251	IC, SENSOR, ACTIVE-PIXEL DIGITAL IMAGE, CMOS, XGS45M, PGA251, WITH HEATSINK PIN	ON Semiconductor	XGS45M_PGA251
38	1	U2	CAT24C64	SO8	IC, SERIAL EEPROM, I2C, 64Kbit, +1.7V TO +5.5V, -40°C to +85°C, SO8 Narrow	ON Semiconductor	CAT24C64WI-GT3
39	1	U3	NLSV8T244	UDFN20	IC, LEVEL TRANSLATOR, NON-INVERTIN G, DUAL SUPPLY, 8-BIT, 0.9V TO 4.5V, UDFN20	ON Semiconductor	NLSV8T244MUTA G
40	1	U4	NCP3170	SO8	IC, VOLTAGE REGULATOR, 500kHz SYNCHRONOU S BUCK CONVERTER, 4.5 TO 18V IN, ADJUSTABLE OUT, 3A, SO8	ON Semiconductor	NCP3170ADR2G
41	1	U6	FAN53880	WLCSP25	IC, PMIC, 6 CHANNEL, ONE BUCK, ONE BOOST AND FOUR LDO, WLCSP25	ON Semiconductor	FAN53880UC002X
42	1	U7	PCA9654E	TSSOP16	IC, I/O EXPANDER, I2C, 8-BIT, 1MHz, 1.65V TO 5.5V, TSSOP16	ON Semiconductor	PCA9654EDTR2G
43	1	U8	NCP167-2.8V	XDFN4	IC, VOLTAGE REGULATOR, LDO, +2.8V, 700mA, 1.9V TO 5.5V INPUT, Ultra-Low Noise and High PSRR, XDFN4	ON Semiconductor	NCP167AMX280T BG
44	1	U9	32Mhz		OSC, SPXO, 32Mhz, 50 ppm, SMD, 1.6V - 3.6V, 2.5MM x 2.0MM x 0.8MM	SEIKO EPSON CORPORATON	SG-210STF 32.0000ML

Table 2. XGS 45000 X-CELERATOR BOM (continued)

Item	Qty	Part Reference	Value	Package	Description	Manufacturer	Manufacturer Part Number
45	1	U10	TMUX1104D GSR	VSSOP10	IC, PRECISION MULTIPLEXER, 4:1, LOW LEAKAGE CURRENT, 1.08V TO 5.5V, VSSOP10	Texas Instruments	TMUX1104DGSR
46	1	U11	NLSV2T244	UDFN8	IC, LEVEL TRANSLATOR, NON-INVERTIN G, DUAL SUPPLY, 2-BIT, 0.9V TO 4.5V, UDFN8	ON Semiconductor	NLSV2T244MUTA G

DEVWARE AS INTERFACING SOFTWARE LAYER

From DevWare version 6.0.38 onward, Devware is able to recognize and interface with FPGA boards, that contain the latest X-Celerator bitfiles. With the RADON driver from MyON installed. DevWare should automatically recognize the X-Celerator on your FPGA board connected to the PC the correct sensor INI file still needs to be selected (and downloaded from the image sensor portal) to load the latest

register settings and demonstrate the best capabilities of the sensor.

Figure 10 shows a complete development kit setup using the XGS 45000 X-Celerator headboard, lens mount, extension tube with fixing ring. Together with a tripod, FMC cable and their corresponding fixtures. All parts are included in the kit.

Table 3. FMC CONNECTOR P1 PIN DESCRIPTION

Pin No.	Dir	Function	Pin No.	Dir	Function	
H16	OUT	DATA_20_P	H17	OUT	DATA_20_N	1
G15	OUT	DATA_22_P	G16	OUT	DATA_22_N	1
C14	OUT	DATA_18_P	C15	OUT	DATA_18_N	1
D14	OUT	DATA_16_P	D15	OUT	DATA_16_N	1
H13	OUT	DATA_14_P	H14	OUT	DATA_14_N	1
G12	OUT	DATA_12_P	G13	OUT	DATA_12_N	1
D11	OUT	DATA_0_P	D12	OUT	DATA_0_N	1
C10	OUT	DATA_8_P	C11	OUT	DATA_8_N	1
G9	OUT	DATA_6_P	G10	OUT	DATA_6_N	1
H10	OUT	DATA_10_P	H11	OUT	DATA_10_N	1
D8	OUT	DATA_4_P	D9	OUT	DATA_4_N	1
H7	OUT	DATA_2_P	H8	OUT	DATA_2_N	1
H31	OUT	DATA_1_P	H32	OUT	DATA_1_N	1
G30	OUT	DATA_3_P	G31	OUT	DATA_3_N	1
G27	OUT	DATA_5_P	G28	OUT	DATA_5_N	1
H28	OUT	DATA_7_P	H29	OUT	DATA_7_N	1
C26	OUT	DATA_9_P	C27	OUT	DATA_9_N	1
D26	OUT	DATA_11_P	D27	OUT	DATA_11_N	1
H25	OUT	DATA_13_P	C26	OUT	DATA_13_N	1
G24	OUT	DATA_15_P	G25	OUT	DATA_15_N	1
D23	OUT	DATA_17_P	D24	OUT	DATA_17_N	1
H22	OUT	DATA_19_P	H23	OUT	DATA_19_N	1

Table 3. FMC CONNECTOR P1 PIN DESCRIPTION

Pin No.	Dir	Function	Pin No.	Dir	Function	
C22	OUT	DATA_21_P	C23	OUT	DATA_21_N	1
G21	OUT	DATA_23_P	G22	OUT	DATA_23_N	1
H4	OUT	D_CLK_2_P	H5	OUT	D_CLK_2_N	1
G2	OUT	D_CLK_3_P	G3	OUT	D_CLK_3_N	1
F4	OUT	DATA_32_P	F5	OUT	DATA_32_N	1
E2	OUT	DATA_26_P	E3	OUT	DATA_26_N	1
K7	OUT	DATA_36_P	K8	OUT	DATA_36_N	1
J6	OUT	DATA_34_P	J7	OUT	DATA_34_N	1
F7	OUT	DATA_30_P	F8	OUT	DATA_30_N	1
E6	OUT	DATA_24_P	E7	OUT	DATA_24_N	1
K10	OUT	DATA_46_P	K11	OUT	DATA_46_N	1
J9	OUT	DATA_38_P	J10	OUT	DATA_38_N	1
F10	OUT	DATA_42_P	F11	OUT	DATA_42_N	1
E9	OUT	DATA_28_P	E10	OUT	DATA_28_N	1
K13	OUT	DATA_44_P	K14	OUT	DATA_44_N	1
J12	OUT	DATA_40_P	J13	OUT	DATA_40_N	1
F13	OUT	DATA_37_P	F14	OUT	DATA_37_N	1
E12	OUT	DATA_45_P	E13	OUT	DATA_45_N	1
J15	OUT	DATA_47_P	J16	OUT	DATA_47_N	1
F16	OUT	DATA_43_P	F17	OUT	DATA_43_N	1
E15	OUT	DATA_29_P	E16	OUT	DATA_29_N	1
K16	OUT	DATA_41_P	K17	OUT	DATA_41_N	1
J18	OUT	DATA_39_P	J19	OUT	DATA_39_N	1
F19	OUT	DATA_27_P	F20	OUT	DATA_27_N	1
E18	OUT	DATA_25_P	E19	OUT	DATA_25_N	1
K19	OUT	DATA_35_P	K20	OUT	DATA_35_N	1
J21	OUT	DATA_31_P	J22	OUT	DATA_31_N	1
K22	OUT	DATA_33_P	K23	OUT	DATA_33_N	1
G6	OUT	D_CLK_8_P	G7	OUT	D_CLK_8_N	1
D20	OUT	D_CLK_9_P	D21	OUT	D_CLK_9_N	1
C35, C37	PWR	12 V FMC	C39, D36, D38, D40	PWR	3.3V FMC	1
F40, E39, G39, H40	PWR	VADJ (for voltage convertor)	D32	PWR	3.3V VAUX_FMC (EEPROM)	1
H1	PWR	VREF_A_M2C	K1	PWR	VREF_B_M2C	1
J39, K40	PWR	VIO_B_M2C	H19	IN	RESET_L_VADJ	1
H20	IN	TRIGGER_INT_VADJ	G19	IN	TRIGGER_RD_VADJ	1
D17	IN	SCLK_VADJ	D18	IN	SDATA_VADJ	1
C18	IN	CS_L_VADJ	C19	OUT	SDATAOUT_VADJ	1
C30	IN	SCL (EEPROM)	C31	IN / OUT	SDA (EEPROM)	
C34	IN	GA0 (EEPROM)	C35	IN	GA1 (EEPROM)	

SPECIFICATIONS AND USEFUL REFERENCES

Detailed schematics, layout files, EEPROM bin content and FPGA bitfiles of the X-Celerator together with the sensor specific DevWare software can be found under NDA on the [image sensor portal](#).

The X-Celerator headboard outline was designed according to the ANSI/VITA 57.1 standard specifications.

More information about this standard can be found at: <https://www.samtec.com/standards/vita/fmc>

More information on ON Semiconductor XGS 45000 image sensor can be found on the [image sensor portal](#) under standard products → XGS.



Figure 10. XGS 45000 Development Kit Setup

onsemi, **onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

The evaluation board/kit (research and development board/kit) (hereinafter the "board") is not a finished product and is not available for sale to consumers. The board is only intended for research, development, demonstration and evaluation purposes and will only be used in laboratory/development areas by persons with an engineering/technical training and familiar with the risks associated with handling electrical/mechanical components, systems and subsystems. This person assumes full responsibility/liability for proper and safe handling. Any other use, resale or redistribution for any other purpose is strictly prohibited.

THE BOARD IS PROVIDED BY ONSEMI TO YOU "AS IS" AND WITHOUT ANY REPRESENTATIONS OR WARRANTIES WHATSOEVER. WITHOUT LIMITING THE FOREGOING, ONSEMI (AND ITS LICENSORS/SUPPLIERS) HEREBY DISCLAIMS ANY AND ALL REPRESENTATIONS AND WARRANTIES IN RELATION TO THE BOARD, ANY MODIFICATIONS, OR THIS AGREEMENT, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY AND ALL REPRESENTATIONS AND WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, NON-INFRINGEMENT, AND THOSE ARISING FROM A COURSE OF DEALING, TRADE USAGE, TRADE CUSTOM OR TRADE PRACTICE.

onsemi reserves the right to make changes without further notice to any board.

You are responsible for determining whether the board will be suitable for your intended use or application or will achieve your intended results. Prior to using or distributing any systems that have been evaluated, designed or tested using the board, you agree to test and validate your design to confirm the functionality for your application. Any technical, applications or design information or advice, quality characterization, reliability data or other services provided by **onsemi** shall not constitute any representation or warranty by **onsemi**, and no additional obligations or liabilities shall arise from **onsemi** having provided such information or services.

onsemi products including the boards are not designed, intended, or authorized for use in life support systems, or any FDA Class 3 medical devices or medical devices with a similar or equivalent classification in a foreign jurisdiction, or any devices intended for implantation in the human body. You agree to indemnify, defend and hold harmless **onsemi**, its directors, officers, employees, representatives, agents, subsidiaries, affiliates, distributors, and assigns, against any and all liabilities, losses, costs, damages, judgments, and expenses, arising out of any claim, demand, investigation, lawsuit, regulatory action or cause of action arising out of or associated with any unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of any products and/or the board.

This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and may not meet the technical requirements of these or other related directives.

FCC WARNING – This evaluation board/kit is intended for use for engineering development, demonstration, or evaluation purposes only and is not considered by **onsemi** to be a finished end product fit for general consumer use. It may generate, use, or radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment may cause interference with radio communications, in which case the user shall be responsible, at its expense, to take whatever measures may be required to correct this interference.

onsemi does not convey any license under its patent rights nor the rights of others.

LIMITATIONS OF LIABILITY: **onsemi** shall not be liable for any special, consequential, incidental, indirect or punitive damages, including, but not limited to the costs of requalification, delay, loss of profits or goodwill, arising out of or in connection with the board, even if **onsemi** is advised of the possibility of such damages. In no event shall **onsemi**'s aggregate liability from any obligation arising out of or in connection with the board, under any theory of liability, exceed the purchase price paid for the board, if any.

The board is provided to you subject to the license and other terms per **onsemi**'s standard terms and conditions of sale. For more information and documentation, please visit www.onsemi.com.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at www.onsemi.com/support/sales