XK-VOICE-L71 Development Kit

Release: Board revision 1V0-A, Document revision 1.0
Publication Date: 2023/04/12

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1 Overview

Based on XMOS's XU316 cross-over processor, the *XK-VOICE-L71* development board supports a wide range of application development and prototyping, including:

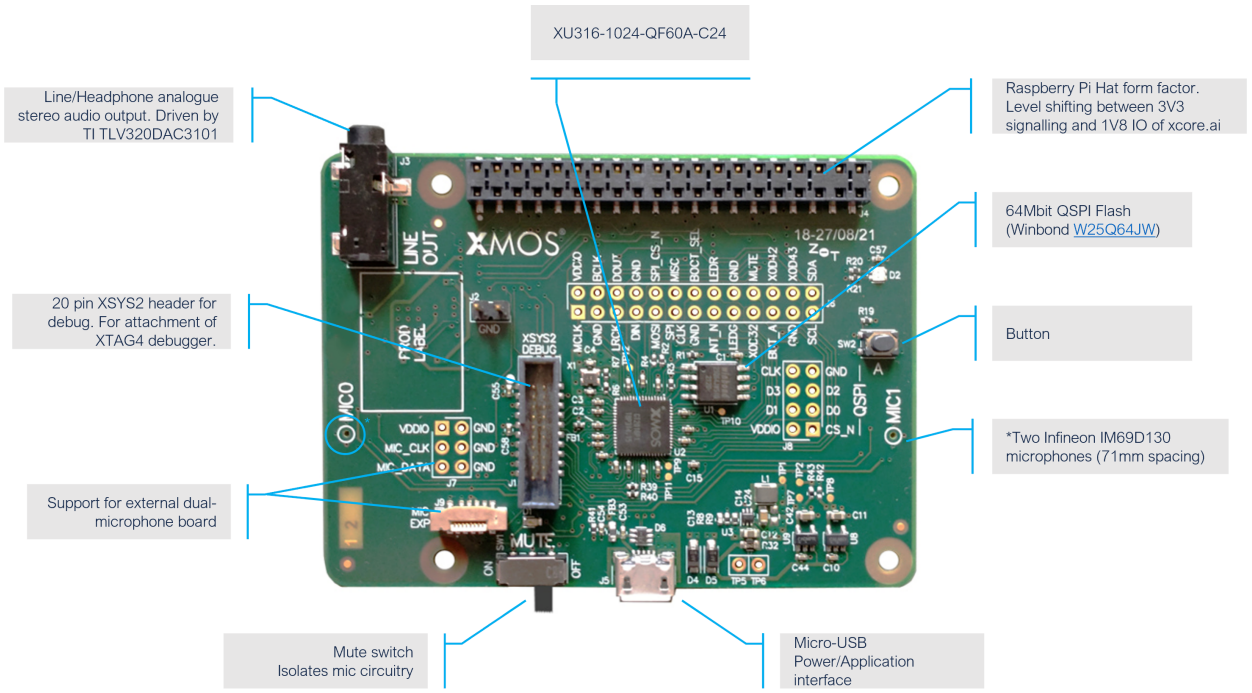

Fig. 1.1: *XK-VOICE-L71* Development Board

1.1 Example applications

XMOS provide multiple examples and pre-built binaries which target the *XK-VOICE-L71* development kit:

- XCORE-VOICE examples
- VOCALFUSION examples

1.2 Features

- XU316-1024-QF60A-C24 device. (1.8V IO).
- Two Infineon IM69D130 microphones (71mm spacing).
- External microphone expansion connector. (Allows connecting existing microphone array boards).
- 20 pin XSYS2 header for debug. For attachment of XTAG4 debugger.
- 64Mbit QSPI Flash (Winbond W25Q64JW).
- Hardware mute circuit as required by AVS.
- Raspberry Pi Hat compatible form factor.
- Level shifting between Rasb Pi 3V3 signalling and 1V8 IO of xcore.ai.

- I2C GPIO Expander for interface of low speed control signals from pi.
- Line/Headphone analogue stereo audio output. Driven by TI TLV320DAC3101. Required for generating a good quality audio output from the Pi. Can be driven from xcore.ai also for USB only demo.
- One Red/Green bi-colour LED.
- One tactile pushbutton switch.
- Powered by Raspberry Pi or USB.
- 77x56.5mm in size.

1.3 About this development kit version

Development kit part number: *XK-VOICE-L71*

Latest revision: *1V0-A*

Order from: Digikey

1.4 Setting up your development kit

The *XK-VOICE-L71* is designed to provide a very flexible development kit. The diagram below provides a basic introduction to he connectivity of the system. The *XK-VOICE-L71* can be used as a stand-alone USB device, or as a Raspberry Pi hat, which provides simple access to SPI, I2S and I2C connections.

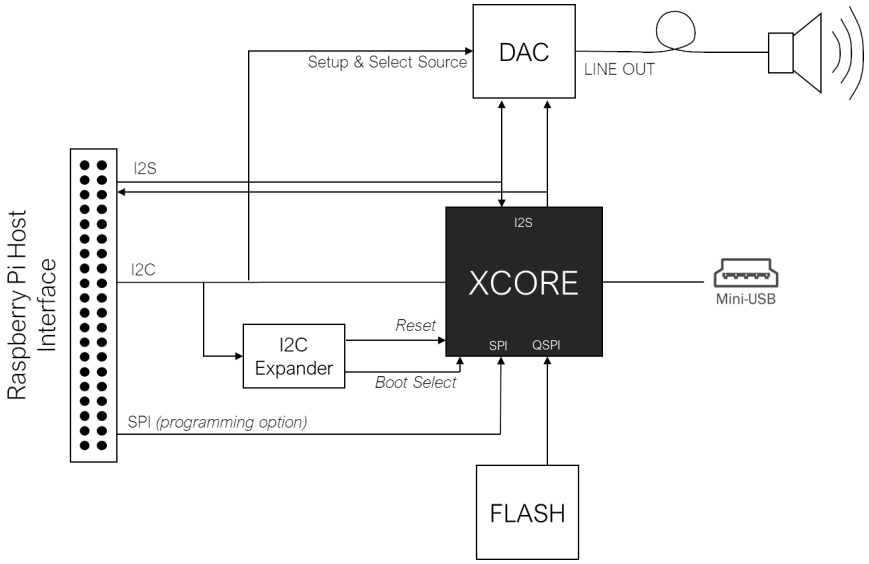

Fig. 1.2: *XK-VOICE-L71* Development board block diagram

1.4.1 Basic programming setup

Details of how to setup your development kit vary between example applications, and will be documented with that example. However, an important reminder when setting up the kit is to ensure that the necessary power supplies are provided during programming.

When using your *XK-VOICE-L71* development board as a Raspberry Pi hat, the Raspberry Pi provides power to the *XK-VOICE-L71*:

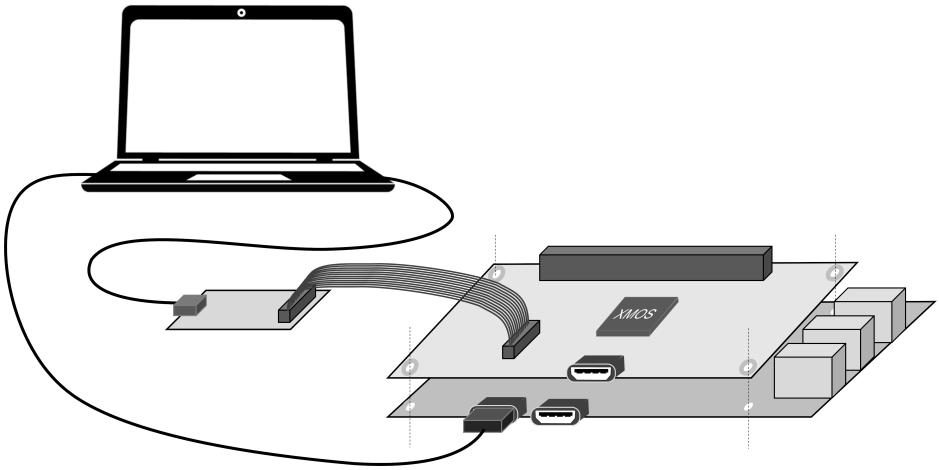

Fig. 1.3: *XK-VOICE-L71* Development board as a RaPi Hat

When using your *XK-VOICE-L71* development board as a USB device:

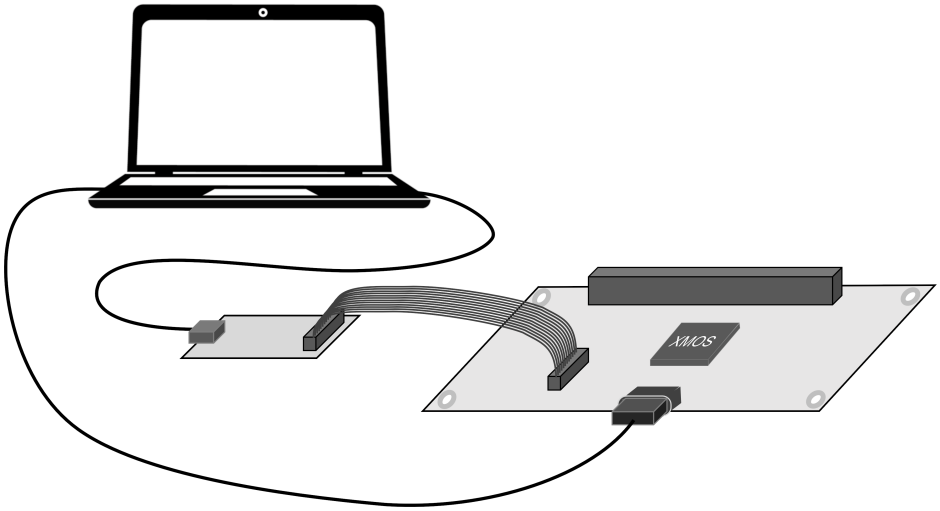

Fig. 1.4: *XK-VOICE-L71* Development board as a USB accessory

1.4.2 Boot control

The *XK-VOICE-L71* supports two boot modes. The default behaviour is to boot over QSPI from the Flash memory device on the development kit. Alternatively, the *XK-VOICE-L71* can be booted over SPI. To boot from SPI, the host (e.g., the Raspberry Pi) is required to set the xcore devices "Boot Select" over I2C and then trigger a reset, also over I2C. When the xcore exits reset, it will subsequently boot from SPI, provided by the host.

1.4.3 DAC setup

It should be noted that the DAC fitted to the *XK-VOICE-L71* requires configuring at run time. This is accomplished over I2C, which can be done by the host (e.g., the Raspberry Pi) or by the xcore itself.

2 Guidelines for designers

This development board utilizes XMOS's *XU316-1024-QF60A* processor.

The datasheet for *XU316-1024-QF60A* ia available to Download

Note: The *XU316-1024-QF60A* is a 1v8 IO device. This development kit makes use of level translators to connect to the 3v3 Raspberry Pi interface. Depending on your requirements, you may prefer to use the *XU316-1024-QF60B* which offers 3v3.

A complete list of XMOS processors can be found Here

2.1 CAD & Design files

The CAD design files are available to Download

This zip archive contains:

- Altium CAD data
- PCB, Assembly drawings & BOM
- Schematics

2.2 XU316-1024-QF60A-C24 Pin assignment

This development kit assumes that the *XU316-1024-QF60A* has been programmed to meet the following pin assignement:

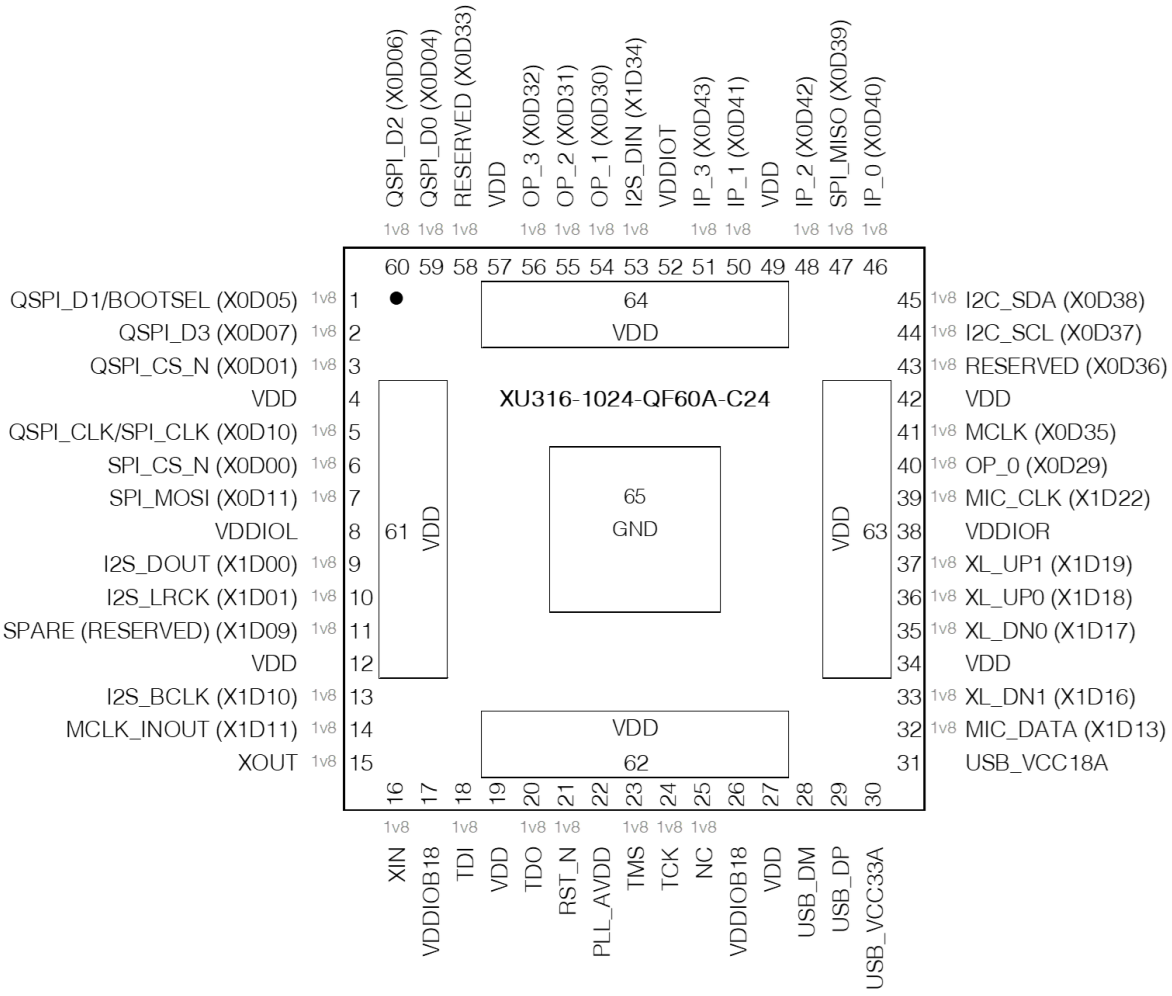

Fig. 2.1: XU316-1024-QF60A-C24 Pin assignment

2.3 Port map

2.3.1 Test Point J6

Table 2.1: Test Point J6 pin allocation

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
1	41	X0D35	MCLK	Master audio clock		I
2			VDDIO			
3			GND			

continues on next page

Table 2.1 – continued from previous page

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
4	13	X1D10	I2S_BCLK	I2S bit synchronisation clock	Configurable for 16KHz (1.024MHz) and 48KHz (3.072MHz) sample rates	O (master), I (slave)
5	10	X1D01	I2S_LRCK	I2S Left/Right clock	48kHz or 16KHz clock derived as I2S_BLCK/64.	O (master), I (slave)
6	9	X1D00	I2S_DOUT	I2S Data Out	Audio data out to host processor	O
7	53	X1D34	I2S_DIN	Peripheral I2S interface - I2S data input		I
8			GND			
9	7	X0D11	SPI_MOSI	SPI Master Out Slave In		I
10	6	X0D00	SPI_CS_N	Slave SPI boot / Peripheral SPI Master Chip Select	Pull high externally to the device using a 4.7k ohm resistor	I
11	5	X0D10	QSPI_CLK/ SPI_CLK	QSPI Clock		O
12	47	X0D39	SPI_MISO	SPI Master In Slave Out	May be left floating if not required	O
13				GND		
14	1	X0D05	QSPI_D1/ BOOTSEL	QSPI Data Line 1 and boot selection.	If pin is tied high via a 4.7k ohm resistor on startup the device will start in SPI slave boot mode. If the pin is left floating or connected to a quad SPI D1 pin on a memory memory device, the device will start in QSPI master mode and attempt to boot from the QSPI flash memory.	I / O
15	40	X0D29	OP_0	General purpose output	Eval kit - Used as interupt to the RaPi, via an I2C expander.	O
16	54	X0D30	OP_1	General purpose output	Eval kit - LED_R	O
17	55	X0D31	OP_2	General purpose output	Eval kit - LED_G	O
18				GND		
19	56	X0D32	OP_3	General purpose output	Eval kit - Test point (and DAC reset if no-fit resistor fitted)	O
20	46	X0D40	IP_0		Eval kit Mute	I
21	50	X0D41	IP_1		Eval kit BUTTON	I
22	48	X0D42	IP_2		General purpose input	I
23				GND		
24	51	X0D43	IP_3		General purpose input	I

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Table 2.1 – continued from previous page

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
25	44	X0D37	I2C_SCL	I2C serial clock line for receiving control command from I2C host		I / O
26	45	X0D38	I2C_SDA	I2C serial data line for receiving control command from I2C host		I / O

2.3.2 Microphone connectors

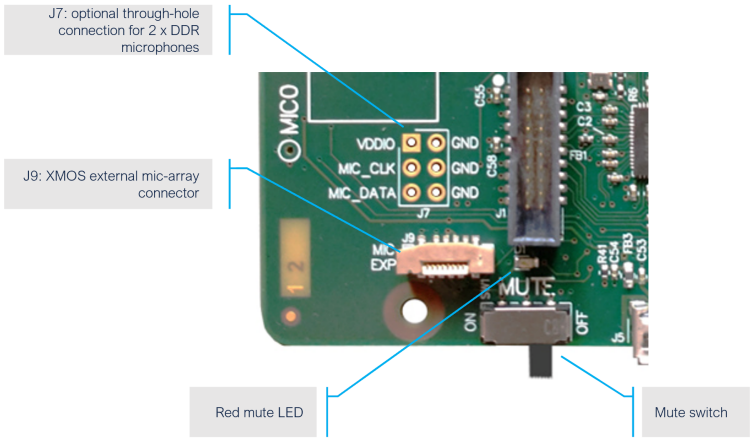

Fig. 2.2: Microphone options

Note: When the mute switch is set to “mute” (Red LED On) then an external pair of DDR microphones may be connected to either of the test point or microphoone array connector.

Table 2.2: Test Point J8 pin allocation

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
1	3	X0D01	QSPI_CS_N	QSPI Boot Flash - Chip Select	Pull high externally to the device using a 4.7k ohm resistor	O
2			VDDIO			
3	59	X0D04	QSPI_D0	QSPI Boot Flash / QSPI Data Line 0		I / O

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Table 2.2 – continued from previous page

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
4	1	X0D05	QSPI_D1/ BOOTSEL	QSPI Data Line 1 and boot selection.	If pin is tied high via a 4.7k ohm resistor on startup the device will start in SPI slave boot mode. If the pin is left floating or connected to a quad SPI D1 pin on a memory memory device, the device will start in QSPI master mode and attempt to boot from the QSPI flash memory.	I / O
5	60	X0D06	QSPI_D2	QSPI Data Line 2		I / O
6	2	X0D07	QSPI_D3	QSPI Data Line 3		I / O
7			GND			
8	5	X0D10	QSPI_CLK/ SPI_CLK	QSPI Clock		O

Table 2.3: External microphone connector J9 pin allocation

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
1			VDDIO			
2			GND			
3	39	X1D22	MIC_CLK	Microphone clock output.	3.072MHz	O
4			GND			
5	32	X1D13	MIC_DATA	PDM microphone input	Note that this is a DDR input, permitting a pair of digital DDR microphones to share this input	I
6			GND			
7			NC			
8			NC			

2.3.3 XMOS Debug interface (J1)

Table 2.4: Debug connector J1 pin allocation

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
1			1V8			
2	23	TMS	TMS	JTAG test mode select	This pin has a weak internal pull-up. See note on debug headers..	I
3			GND			

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Table 2.4 – continued from previous page

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
4	24	TCK	TCK	JTAG test clock input	This pin has a Schmitt trigger input and an internal weak pull-down. See note on debug headers.	I
5			GND			
6	20	TDO	TDO	JTAG test data output	See note on debug headers.	O
7			GND			
8	18	TDI	TDI	JTAG test data input	This pin has a weak internal pull-up. See note on debug headers.	I
9			GND			
10	21	RST_N	RST_N	Device reset	Active low. This pin has a Schmitt trigger input and an internal weak pull up	I
11			VDDIO			
12	33	X1D16	XL_DN1	XLINK	These 4 signals form a single 2-wire xlink connection for advanced debug only. Do not connect in production desings.	I
13			GND			
14	35	X1D17	XL_DN0	XLINK		I
15			GND			
16	36	X1D18	XL_UP0	XLINK		O
17			GND			
18	37	X1D19	XL_UP1	XLINK		O
19			GND			
20			NC			

2.3.4 Raspberry Pi host interface (J4)

Table 2.5: Raspberry Pi Host interface pin allocation

Raspberry Pi	Signal	Pin	Pin	Signal	Raspberry Pi
3V3	NC	1	2	PI_5V	5V
GP2	PI_I2C_SDA	3	4	PI_5V	5V
GP3	PI_I2C_SCL	5	6	GND	GND
GP4	PI_MCLK	7	8	NC	GP14
GND	GND	9	10	NC	GP15
GP17	NC	11	12	PI_I2S_BCLK	GP18
GP27	PI_INT_N	13	14	GND	GND
GP22	NC	15	16	NC	GP23
3V3	NC	17	18	NC	GP24
GP10	PI_SPI_MOSI	19	20	GND	GND
GP9	PI_SPI_MISO	21	22	NC	GP25
GP11	PI_SPI_CLK	23	24	PI_SPI_CS_N	GP8
GND	GND	25	26	NC	GP7
ID_SD	NC	27	28	NC	ID_SC
GP5	NC	29	30	GND	GND
GP6	NC	31	32	NC	GP12

continues on next page

Table 2.5 – continued from previous page

Raspberry Pi	Signal	Pin	Pin	Signal	Raspberry Pi
GP13	NC	33	34	GND	GND
GP19	PI_I2S_LRCK	35	36	NC	GP16
GP26	NC	37	38	PI_I2S_DIN	GP20
GND	GND	39	40	PI_I2S_DOUT	GP21

2.3.5 Flash Test Point (J8)

Table 2.6: Flash test/programming test point J8 pin allocation

Pin	XU316 pin	XU316 port	Signal name	XU316 usage	Comments	Direction w.r.t XU316
1	3	X0D01	QSPI_CS_N	QSPI Boot Flash - Chip Select	Pull high externally to the device using a 4.7k ohm resistor	O
2			VDDIO			
3	59	X0D04	QSPI_D0	QSPI Boot Flash / QSPI Data Line 0		I / O
4	1	X0D05	QSPI_D1/ BOOTSEL	QSPI Data Line 1 and boot selection.	If pin is tied high via a 4.7k ohm resistor on startup the device will start in SPI slave boot mode. If the pin is left floating or connected to a quad SPI D1 pin on a memory memory device, the device will start in QSPI master mode and attempt to boot from the QSPI flash memory.	I / O
5	60	X0D06	QSPI_D2	QSPI Data Line 2		I / O
6	2	X0D07	QSPI_D3	QSPI Data Line 3		I / O
7			GND			
8	5	X0D10	QSPI_CLK/ SPI_CLK	QSPI Clock		O

2.4 Schematics

These schematics are available in the CAD data, available to Download

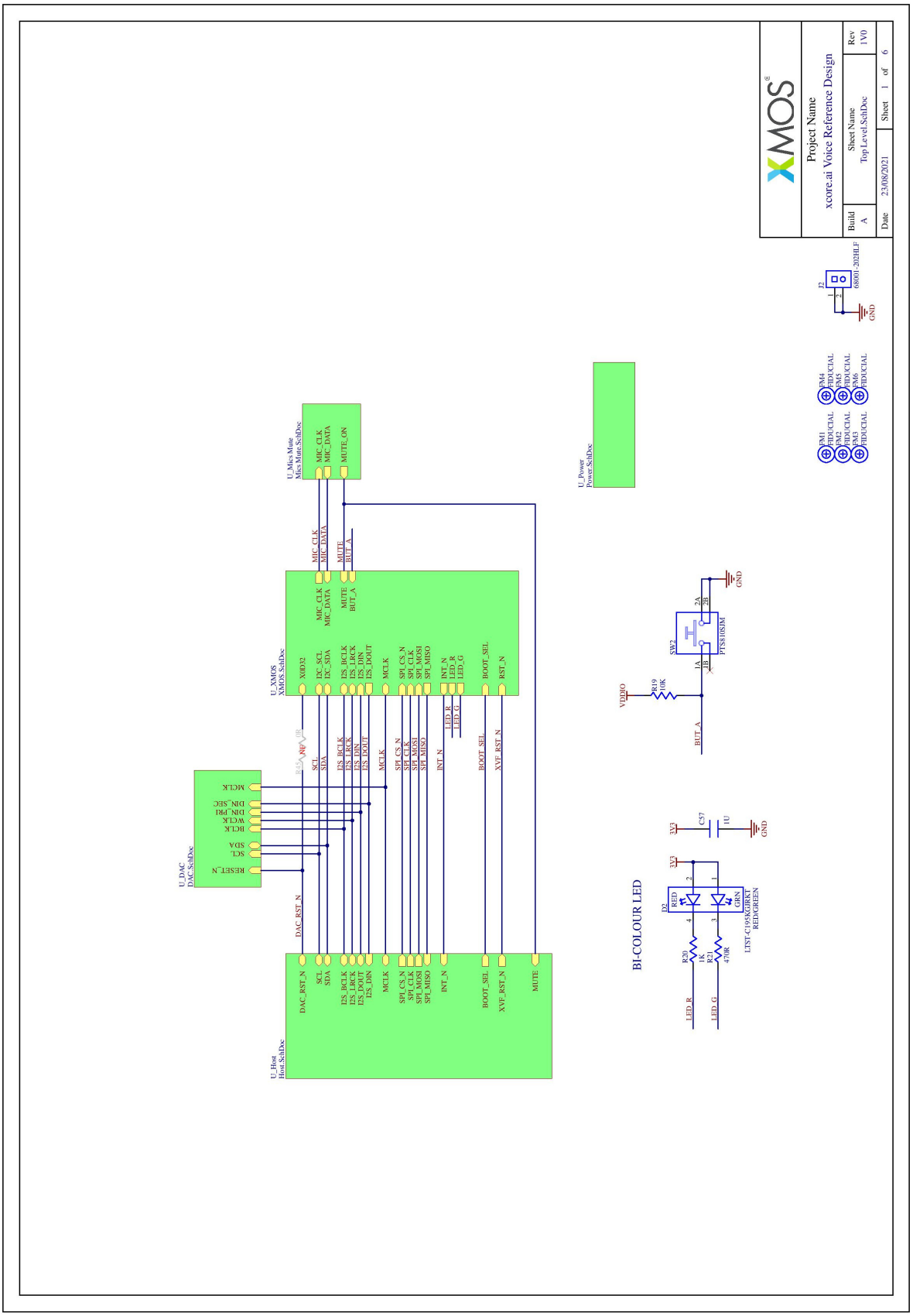

Fig. 2.3: *XK-VOICE-L71* Schematic, page 1

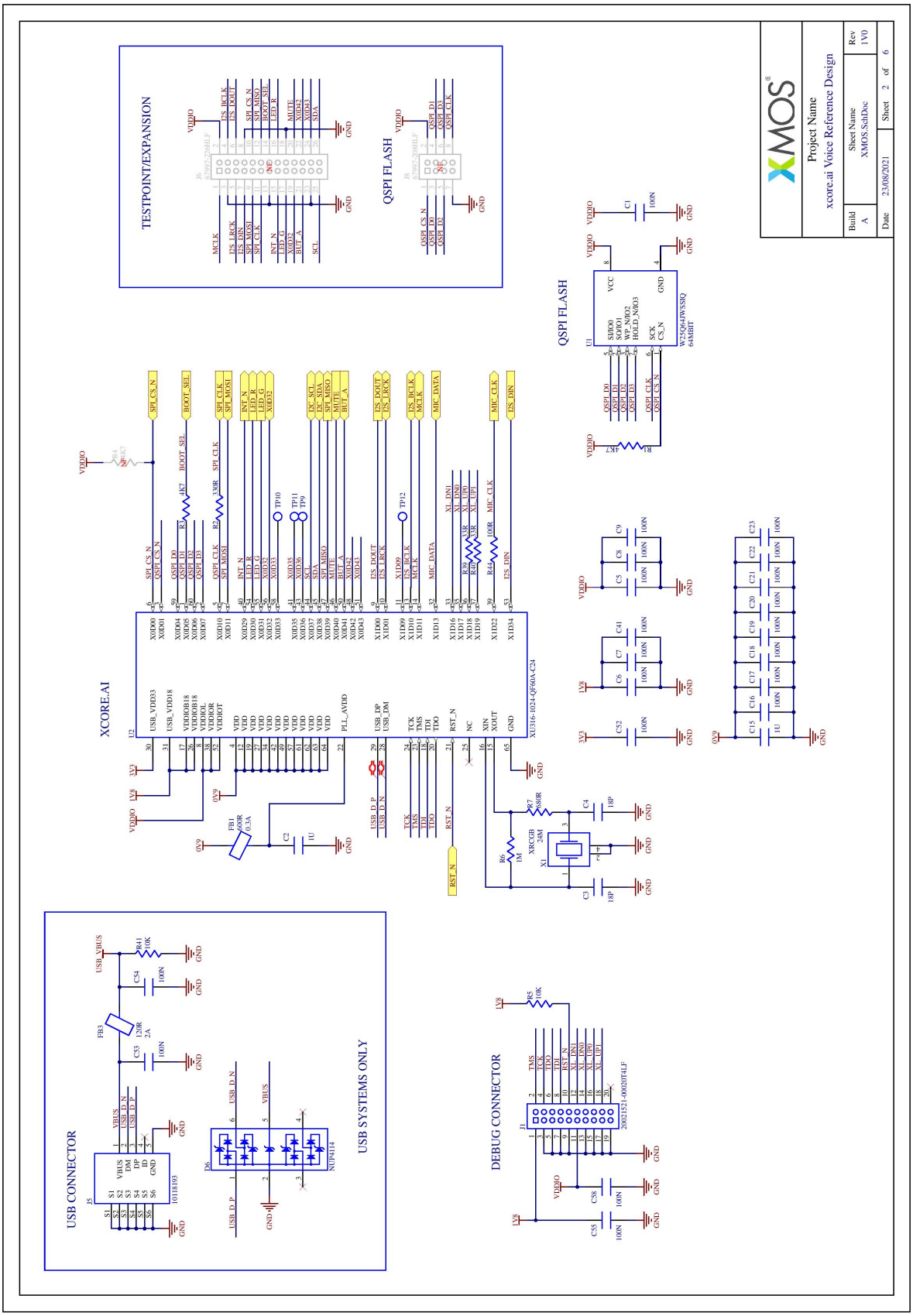

Fig. 2.4: *XK-VOICE-L71* Schematic, page 2

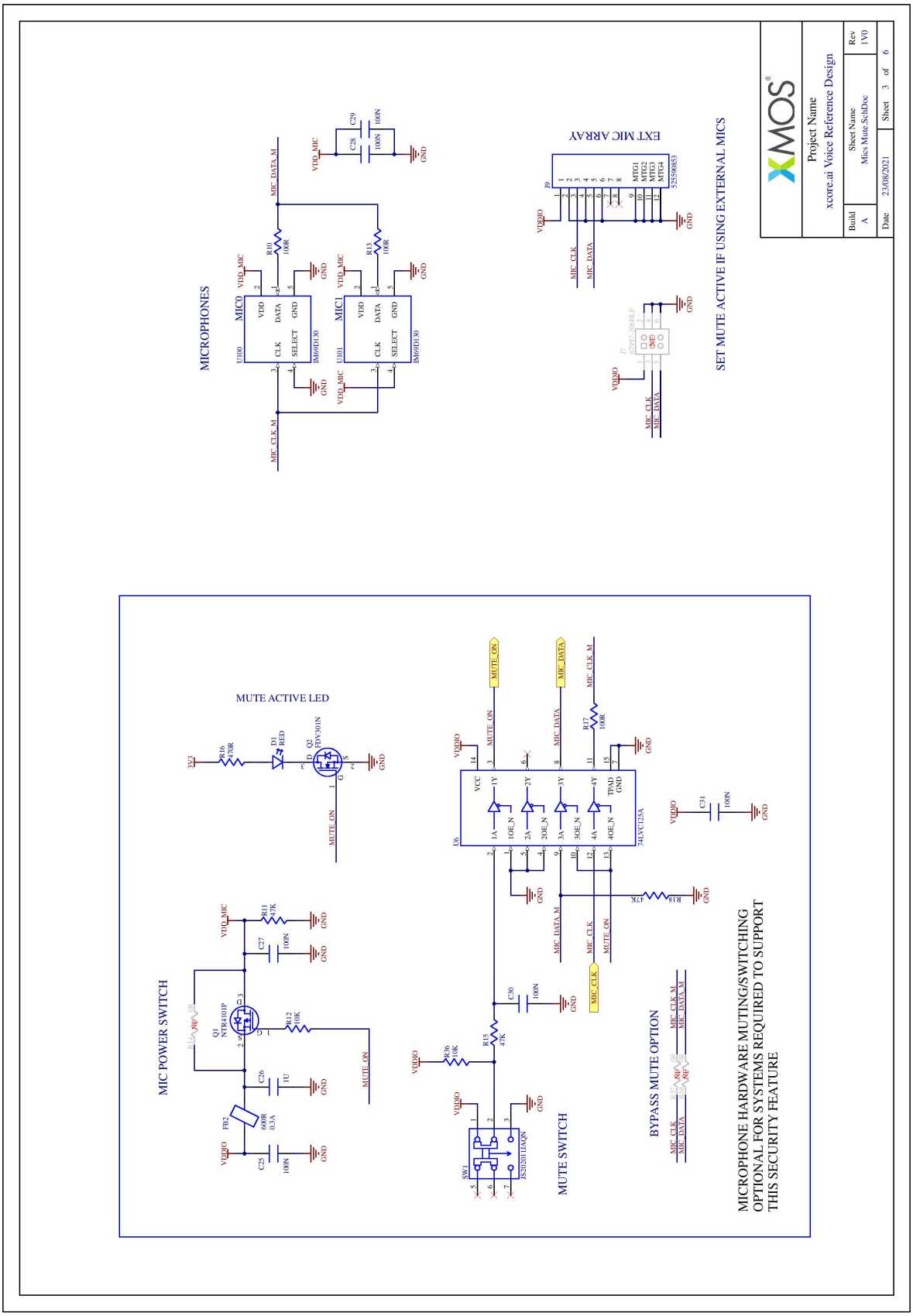

Fig. 2.5: *XK-VOICE-L71* Schematic, page 3

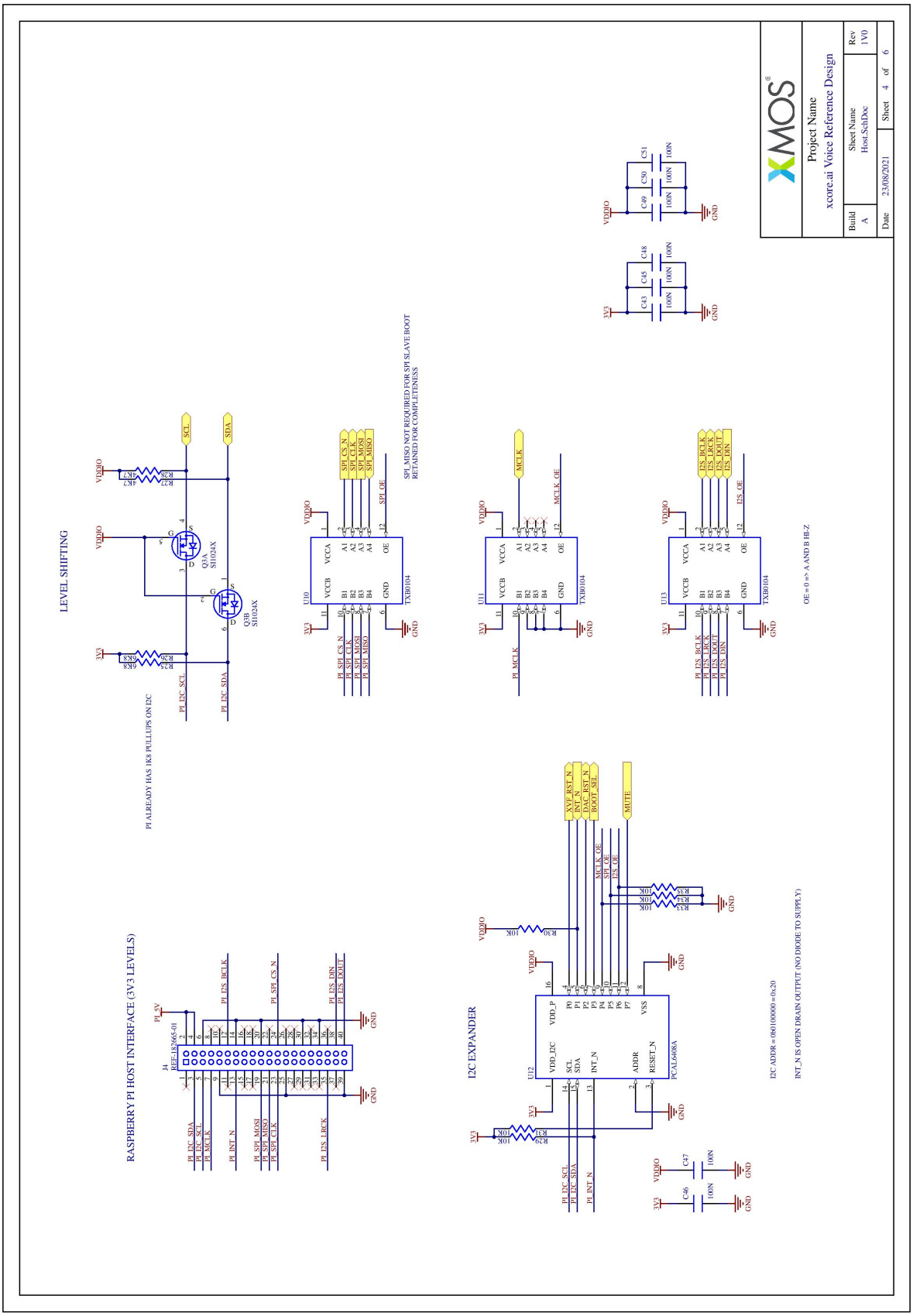

Fig. 2.6: *XK-VOICE-L71* Schematic, page 4

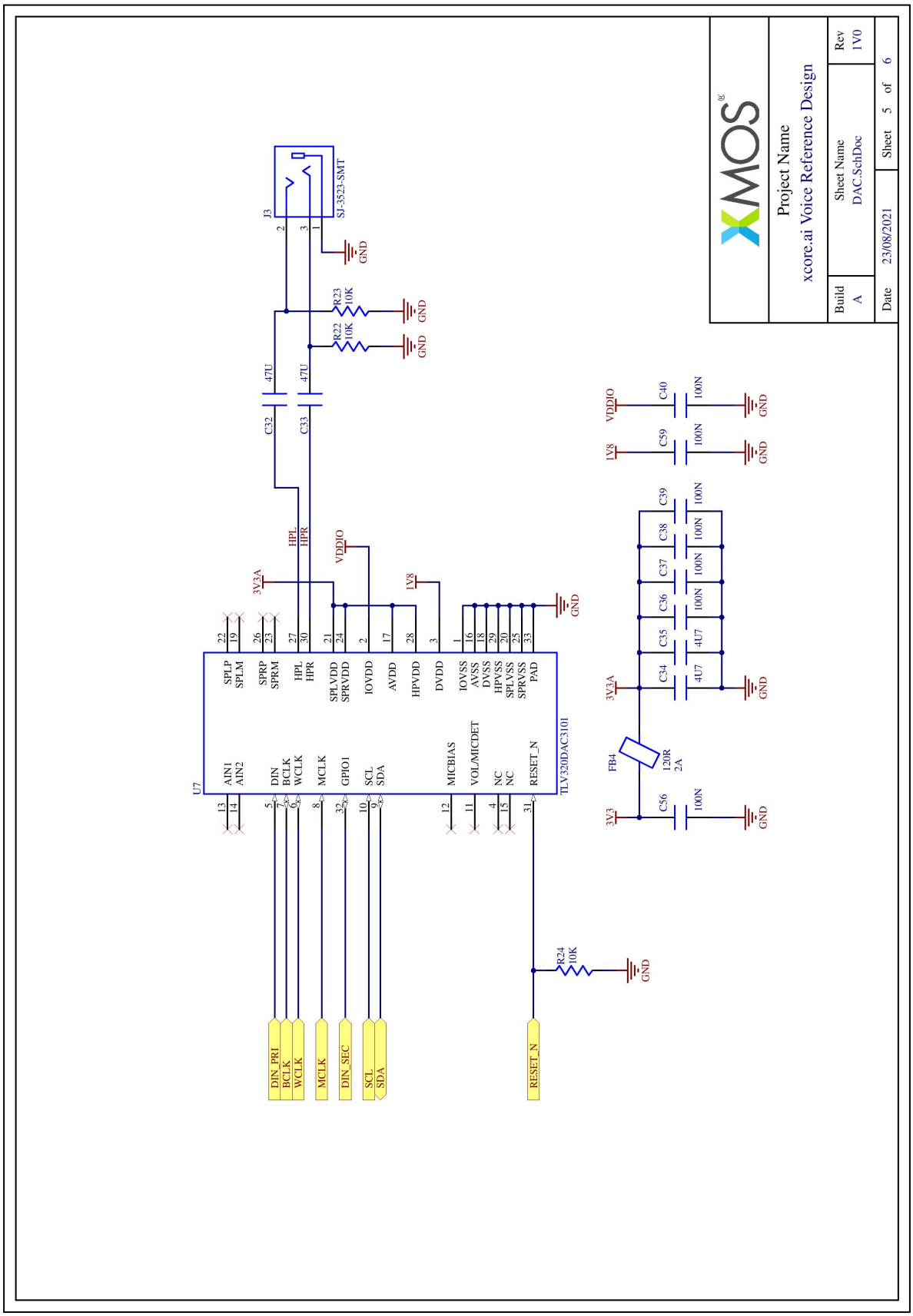

Fig. 2.7: *XK-VOICE-L71* Schematic, page 5

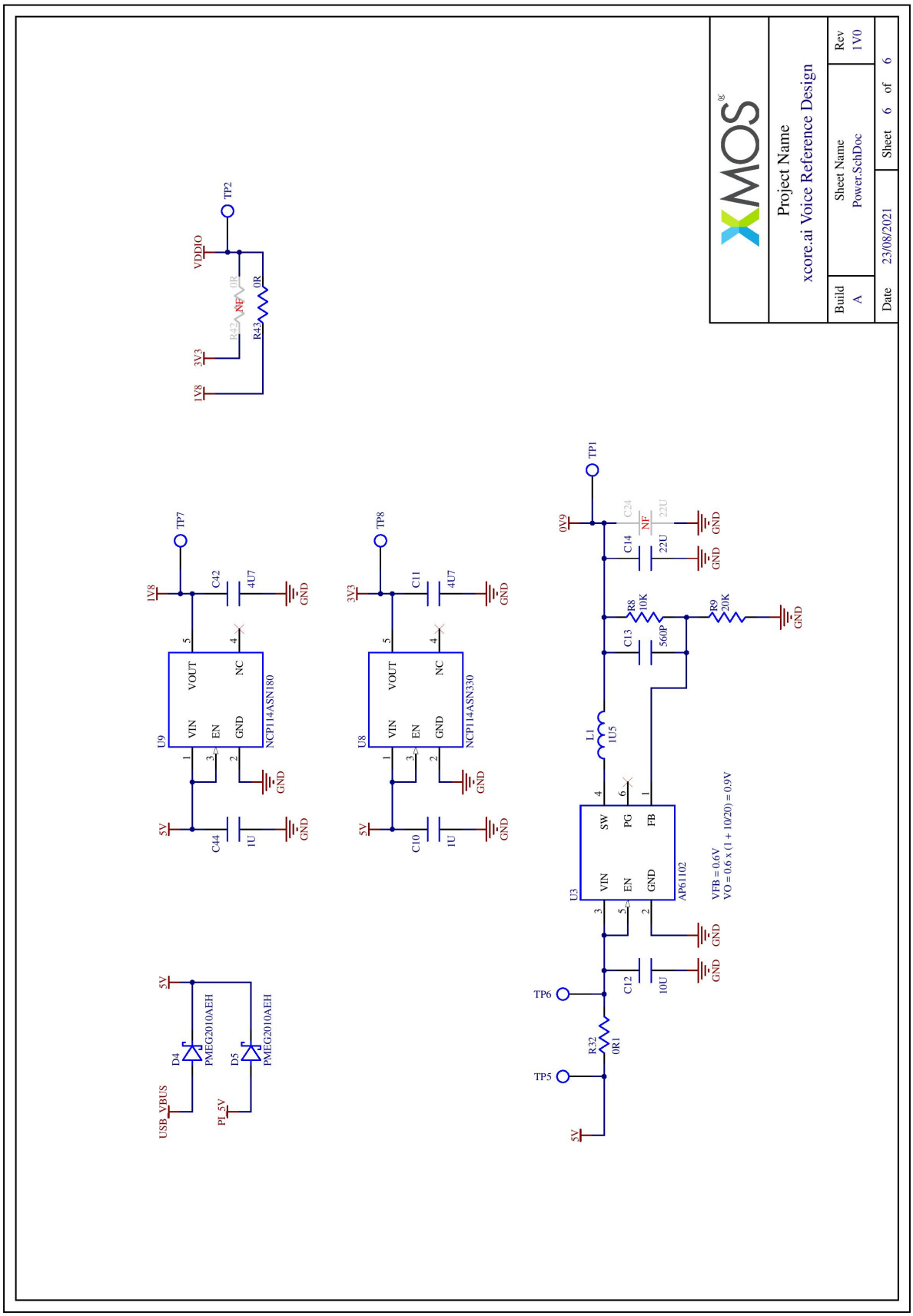

Fig. 2.8: *XK-VOICE-L71* Schematic, page 6

2.5 Bill of Materials

This BOM is available as an Excel spreadsheet in the CAD data, available to Download

Table 2.7: Development kit BOM - Version

DE-SIGN	XMS0001				
REVI-SION	1V0				
VARI-ANT	A				
DATE	23/08/2021 12:15:45				

Table 2.8: Development kit BOM

ITEM	DESCRIPTION	MANUFAC-TURER	PART NUM-BER	QUAN-TITY	DESIGNATOR
1	Pin Header, Male, Vertical, Through Hole, 2 Way, 1x2, 0.1 Inch Pitch	FCI	68001-202HLF	1	J2
2	USB Micro B Receptacle, Right Angle, SMD w/2 DIP Legs	FCI	10118193-0001LF	1	J5
3	TRS jack, 3.5mm, SMD	CUI	SJ-3523-SMT	1	J3
4	FFC/FPC Connector, 8 Way, 0.5mm Pitch, Slide Lock, Vertical, SMD	Molex	525590853	1	J9
5	Header, Female, Vertical, 40 Way, 2x20, 0.1 Inch Pitch, Locating Pegs, Bottom Entry, SMD	Samtec	REF-182665-01	1	J4
6	Box Header, Male, Vertical, Polarised, 20 Way, 2x10, 0.05 Inch Pitch, SMD	Amphenol FCI	20021521-00020T4LF	1	J1
7	CHIP RESISTOR, 0.1 OHM, 100mW, 1%, 0603	Yageo	RL0603FR-070R1L	1	R32
8	CHIP CAPACITOR, CERAMIC, 47UF, 6.3V, 20%, X5R, 1206	Samsung	CL31A476MQHN2NNE	2	C32, C33
9	CHIP CAPACITOR, CERAMIC, 10UF, 10V, 20%, X5R, 0603	Murata	GRM188R61A106ME69	1	C12

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Table 2.8 – continued from previous page

ITEM	DESCRIPTION	MANUFACTURER	PART NUMBER	QUANTITY	DESIGNATOR
10	CHIP CAPACITOR, CERAMIC, 22UF, 6.3V, 20%, X5R, 0603	Murata	GRM188R60J226MEA0	1	C14
11	Ferrite Bead, 120R AT 100MHz, For Power Lines, 0603, 2A	Murata	BLM18PG121SN1	2	FB3, FB4
12	Ferrite Bead, 600R AT 100MHz, For GHz Noise, 0402, 0.3A	Taiyo Yuden	BKH1005LM601T	2	FB1, FB2
13	Power Inductor, 1.5uH, 2.6A, 65mR DCR, 2.5x2.0x1.2mm, SMD	Taiyo Yuden	MAMK2520H1R5M	1	L1
14	Stereo Audio DAC, Low-Power, Headphone Amplifier, Stereo Class-D Speaker Amplifier, PLL, QFN32	Texas Instruments	TLV320DAC3101IRHB	1	U7
15	Processor, xcore.ai, 7x7mm 60QFN, 1200MIPS, 1.8V VDDIO	XMOS	XU316-1024-QF60A-C24	1	U2
16	8-bit I2C I/O Port, Agile IO, with interrupt and reset, TSSOP16	NXP	PCAL6408APW	1	U12
17	Bidirectional Voltage-Level Translator, Auto-Direction Sensing, 4 bit, UQFN-12	Texas Instruments	TXB0104RUTR	3	U10, U11, U13
18	Quad Logic Buffer, 3-state, LVC Series, VQFN14	NXP	74LVC125ABQ	1	U6
19	Memory, Flash, SPI, Multi-IO, 64Mb (32Kx256), 1.7 to 1.95V, QE = 1, SOIC-8-W	Winbond	W25Q64JWSSIQ	1	U1
20	MEMS Microphone, Digital, PDM, Bottom Port, 69dB SNR, 4x3mm, LGA-5	Infineon	IM69D130V01XTSA1	2	U100, U101
21	Voltage Regulator, Linear, Fixed, 3V3, 300mA, Output Active Discharge, TSOT23-5	ON Semiconductor	NCP114ASN330T1G	1	U8

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Table 2.8 – continued from previous page

ITEM	DESCRIPTION	MANUFACTURER	PART NUMBER	QUANTITY	DESIGNATOR
22	Voltage Regulator, Linear, Fixed, 1V8, 300mA, Output Active Discharge, TSOT23-5	ON Semiconductor	NCP114ASN180T1G	1	U9
23	DC-DC Synchronous Buck Converter, Adjustable, PFM/PWM, Power Good, 2.2MHz, 1A, SOT563	Diodes Incorporated	AP61102Z6-7	1	U3
24	Crystal, 24MHz, Freq Tol. ±10ppm, Freq Stab. ±10ppm, CL 10pF, Max ESR 80 Ohm, 2.0x1.6mm SMD	Murata	XRCGB24M000F1H02R0	1	X1
25	MOSFET, P-Channel, Logic Level, 20V, 2.4A, SOT23	ON Semiconductor	NTR4101PT1G	1	Q1
26	MOSFET, N-Channel, Logic Level, Gate-Source Protection, 25V, 220mA, SOT23	ON Semiconductor	FDV301N	1	Q2
27	ESD Protection Diode Array, 0.6pF, SC-70-6 (SC-88)	ON Semiconductor	NUP4114UCLW1T2G	1	D6
28	Schottky Diode, 20V, 1.0A, SOD123F	Nexperia	PMEG2010AEH	2	D4, D5
29	Dual MOSFET, N-Channel, Logic Level, Gate-Source Protection, 20V, 0.35A, SOT-563	Vishay Siliconix	SI1024X-T1-GE3	1	Q3
30	LED, Top View, RED/GREEN, SMD, 0606	Lite-On	LTST-C195KGJRKT	1	D2
31	LED, Hyper Red, 0603	Kingbright	APT1608SURCK	1	D1
32	Tactile Switch, Momentary, 160gf, 2.5mm High, 4.2x3.2mm, J Bend SMD	C&K	PTS810SJM250SMTRLFS	1	SW2
33	Sub Miniature Slide Switch, DPDT, 3.5mm High, 9.0x3.5mm, Right Angle, SMD	C&K	JS202011JAQN	1	SW1

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Table 2.8 – continued from previous page

ITEM	DESCRIPTION	MANUFACTURER	PART NUMBER	QUANTITY	DESIGNATOR
34	CHIP RESISTOR, ZERO OHM JUMPER, 1A, 0402	Yageo	RC0402JR-070RL	1	R43
35	CHIP RESISTOR, 33 OHM, 63mW, 1%, 0402	Yageo	RC0402FR-0733RL	2	R39, R40
36	CHIP RESISTOR, 100 OHM, 63mW, 1%, 0402	Yageo	RC0402FR-07100RL	4	R10, R13, R17, R44
37	CHIP RESISTOR, 330 OHM, 63mW, 1%, 0402	Yageo	RC0402FR-07330RL	1	R2
38	CHIP RESISTOR, 470 OHM, 63mW, 1%, 0402	Yageo	RC0402FR-07470RL	2	R16, R21
39	CHIP RESISTOR, 680 OHM, 63mW, 1%, 0402	Yageo	RC0402FR-07680RL	1	R7
40	CHIP RESISTOR, 1.0K OHM, 63mW, 1%, 0402	Yageo	RC0402FR-071KL	1	R20
41	CHIP RESISTOR, 4.7K OHM, 63mW, 1%, 0402	Yageo	RC0402FR-074K7L	4	R1, R3, R27, R28
42	CHIP RESISTOR, 6.8K OHM, 63mW, 1%, 0402	Yageo	RC0402FR-076K8L	2	R25, R26
43	CHIP RESISTOR, 10K OHM, 63mW, 1%, 0402	Yageo	RC0402FR-0710KL	15	R5, R8, R12, R19, R22, R23, R24, R29, R30, R31, R33, R34, R35, R36, R41
44	CHIP RESISTOR, 20K OHM, 63mW, 1%, 0402	Yageo	RC0402FR-0720KL	1	R9
45	CHIP RESISTOR, 47K OHM, 63mW, 1%, 0402	Yageo	RC0402FR-0747KL	3	R11, R15, R18
46	CHIP RESISTOR, 1.0M OHM, 63mW, 5%, 0402	Yageo	RC0402JR-071ML	1	R6
47	CHIP CAPACITOR, CERAMIC, 18PF, 50V, 5%, NP0, 0402	Yageo	CC0402JRNP09BN180	2	C3, C4
48	CHIP CAPACITOR, CERAMIC, 100NF, 16V, 10%, X7R, 0402	Yageo	CC0402KRX7R7BB104	41	C1, C5, C6, C7, C8, C9, C16, C17, C18, C19, C20, C21, C22, C23, C25, C27, C28, C29, C30, C31, C36, C37, C38, C39, C40, C41, C43, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C58, C59
49	CHIP CAPACITOR, CERAMIC, 1.0UF, 16V, 10%, X5R, 0402	Murata	GRM155R61C105MA12D	6	C2, C10, C15, C26, C44, C57

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Table 2.8 – continued from previous page

ITEM	DESCRIPTION	MANUFACTURER	PART NUMBER	QUANTITY	DESIGNATOR
50	CHIP CAPACITOR, CERAMIC, 560PF, 50V, 5%, NP0, 0402	Yageo	CC0402JRNP09BN561	1	C13
51	CHIP CAPACITOR, CERAMIC, 4.7UF, 16V, 10%, X5R, 0603	Murata	GRM188R61C475KE11D	4	C11, C34, C35, C42
NA	NO FIT COMPONENTS	NA	NA	0	J8, J7, J6, C24, R14, R37, R38, R42, R45, R4

3 Appendix

3.1 Further information on the XTAG4 adapter

Your kit comes supplied with the XTAG4

Fig. 3.1: XTAG4 Adapter

The XTAG4 is a USB to XCORE adapter, which provides a connection with to a PC or Mac to debug and programming XCORE devices. Using the XMOS tools, XTC Tools® ,you can use this adapter to program the flash memory on the development kit. Once this is done, the adapter can be disconnected and the kit will boot your program every time it powered on.

Learn more about the XTAG4 adapter in the Download

The CAD design files are also available to download: Download

You can order additional XTAG4 adapters from: Digikey