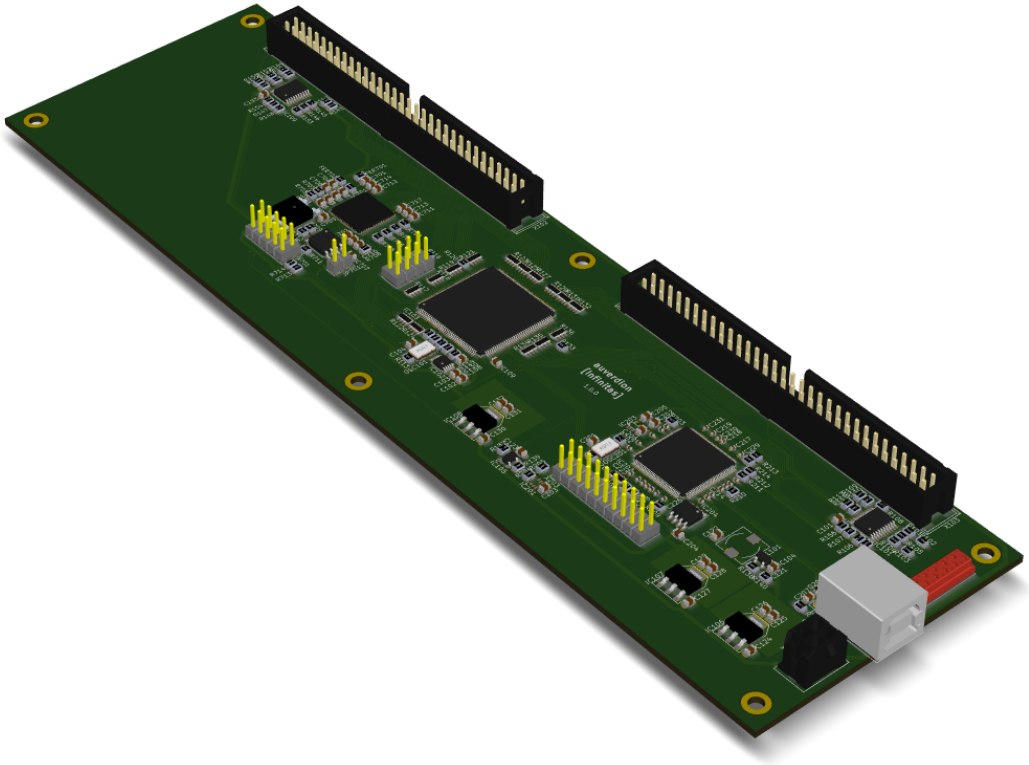


GETTING STARTED WITH INFINITAS

REVISION HISTORY

Revision	Description	Date
v1.0	Initial Version	30 Sep 2018

ABOUT INFINITAS

Infinitas is a cost-effective USB Audio Class 2.0 solution for researchers and the do-it-yourself community. It is a bare circuit board that can be incorporated into your own projects. It comes with no housing. It is based on XMOS XE216-512-TQ128 together with additional expansion boards for audio i/o connectivity. It supports up to 32 input channels and up to 32 output channels.

With the optional Analog Devices ADAU1452 DSP together with the free graphical development environment SigmaStudio the board becomes freeDSP-Infinitas. The programming model is function-block based – comparable to other graphical programming languages like PureData or Max/MSP. Many prebuilt blocks (e.g., filters, compressors, effects, or logic) can be placed in the signal path via drag and drop. If the included libraries do not have the functions needed, low-level blocks, such as multipliers and delays, can be wired together to create custom algorithms. For more information please refer to the Analog Devices website.

FreeDSP-Infintas and SigmaStudio offer a wide range of DSP processing options and interface controls with easy programmability. It can be used in various audio applications, e.g.:

Room compensation / system equalization
Digital crossovers in active loudspeaker concepts
Multiband dynamics processing
Delay compensation / phase shift
Bass enhancement
Subwoofer integration
Advanced instrument audio effect units
Stereo image widening
…

The plans for the Infinitas board are published under a Creative Commons Attribution NonCommercial ShareAlike 4.0 International (CC BY-NC-SA 4.0) license, which allows the

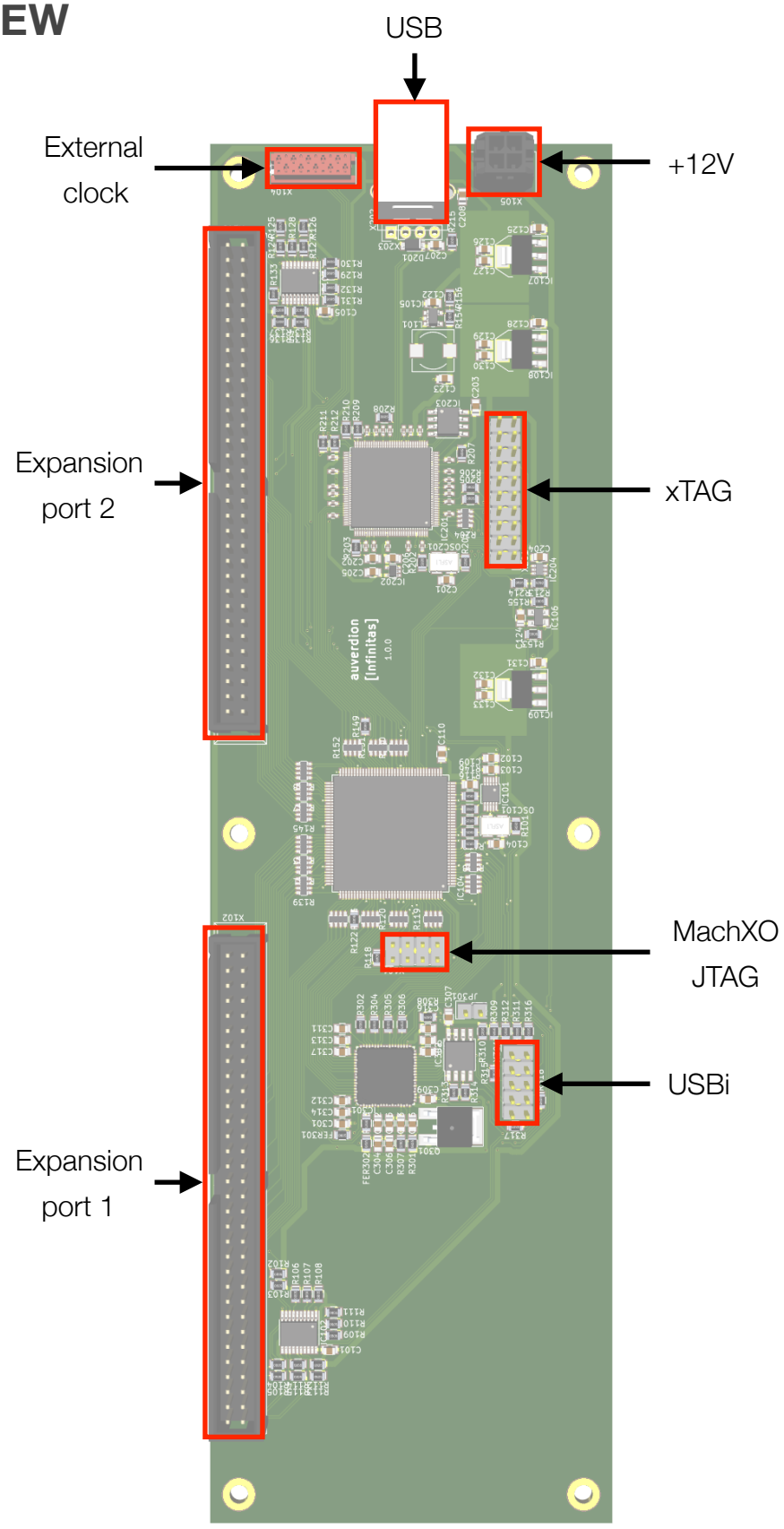
IMPORTANT INFORMATION

The Infinitas board might generate signals that may damage your audio equipment. Please read and understand this manual before starting to work with your board. Adjust all hardware settings and configure your software before connecting any audio equipment to Infinitas. Always start with low volume on your amplifier and slowly increase the level to reduce the risk of damaging your audio system.

Infinitas is provided to you ‘as is’. We make no express or implied warranties whatsoever with respect to its functionality, operability, or use, including, without limitation, any implied warranties of merchantability, fitness for a particular purpose, or infringement. We expressly disclaim any liability whatsoever for any direct, indirect, consequential, incidental or special damages, including, without limitation, lost revenues, lost profits, losses resulting from business interruption or loss of data regardless of the form of action or legal theory under which the liability may be asserted, even if advised of the possibility or likelihood of such damages. Features and specifications might change without prior notice.

Please keep in mind that Infinitas is an open-source spare-time project. Because Infinitas is very flexible, many applications are possible. Questions and new ideas can be discussed online with other DIYers. Please use the *Digital Line Level* subforum @ diyAudio.com or the *Truth Table* subforum @ groupdiy.com to connect with other people working with Infinitas. Please create individual threads for your topics only if you cannot find your issue in the existing threads. Some questions can be answered by carefully reading this manual. We cannot provide individual support via email. Thank you for your understanding!

OVERVIEW


USB
External clock
+12V
Expansion port 2
xTAG
MachXO JTAG
USBi
Expansion port 1

HOW TO GET INFINITAS UP AND RUNNING

GET EVERYTHING NEEDED

You will need a soldering iron with a fine tip plus some soldering experience to assemble the surface mounted and through hole components.
Additionally you need:

- a FTx232 module, e.g. https://www.ftdichip.com/Products/Modules/DevelopmentModules.htm#FT2232H_Mini or similar
- a XTAG debug adapter https://www.xmos.com/support/boards?product=19480
- an USBi adapter from Analog Devices (EVAL-ADUSB2EBZ) or the freeUSBi programmer (see the freeDSP website) for programming the DSP if you want to use the freeDSP option.

Order the Infinitas kit. Sometimes centralized buying of PCB and all parts is offered on the forums. Please keep in mind that Infinitas is a spare-time project. It may take some time until a new batch of boards and/or kits is offered.

(a) Alternatively, order the PCB via www.tindie.com. You will also need to order all electronic parts. The components can be ordered via DigiKey (or other distributors). This might be the fastest option.
(b) Alternatively, you can manufacture your own circuit board or modify and extend the original design. This might be the most flexible option, but needs more expertise (and money) to get up and running.
(c) Alternatively, manufacture the printed circuit board and order all parts yourself. You might want to locally organize centralized buying and board production together with some friends. You can find the necessary KiCAD files of the board on the freeDSP website www.freeDSP.cc. You will also need to order all electronic parts. The components can be ordered via DigiKey (or other distributors).

SOLDER THE BOARD

You should start with soldering the most difficult part: The ICs. On youtube you can find tutorials how to solder the QFPs packages, e.g.
https://www.youtube.com/watch?v=YUryJOAiPa4
and how to solder the QFNs packages, e.g.
https://www.youtube.com/watch?v=BvhE16vBfX4
Then continue with all the other SMDs and finally solder the THT components. Always start with the components with lowest height.

FREEDSP OPTION

By mounting the optional DSP circuit Infinitas becomes freeDSP-Infinitas. Without the freeDSP option Infinitas is a pure USB Audio Class 2 interface. The freeDSP option adds the power of the SIgmaDSP ADAU1452 to the system. Within the FPGA you can route any TDM8 stream to and from the DSP either to or from the expansion boards or to to or from your computer.

CONNECTIONS

Infinitas comes without any audio input or output. Therefore, you have to connect expansion boards on the two expansion ports X101 and X102. On each port you can connect up to four expansion boards. Infinitas expects TDM8 streams. You may need to modify the routing inside the MachXO depending on your configuration. In the git repository you can find example configurations e.g. two expansion boards on each port.

Since the expansion port header provides four times the pin layout of the freeDSP I2S expansion header you can connect any board with this header from the freeDSP project.

On the external clock connector X104 you can connect the wordclock IO board (coming soon). Infinitas comes already with a wordclock PLL. The additional board provides only the BNC connectors and some buffering / voltage level shifting.

Your host computer connects on the USB-B connector. Infinitas was designed to be class compliant with UAC2. Thus, on macOS and Linux you don't need to install any driver. For Windows there are some open source drivers available, although, Microsoft claims, that Windows 10 comes now with a UAC2 driver as well.

Infinitas needs a power supply of +12V on X105.

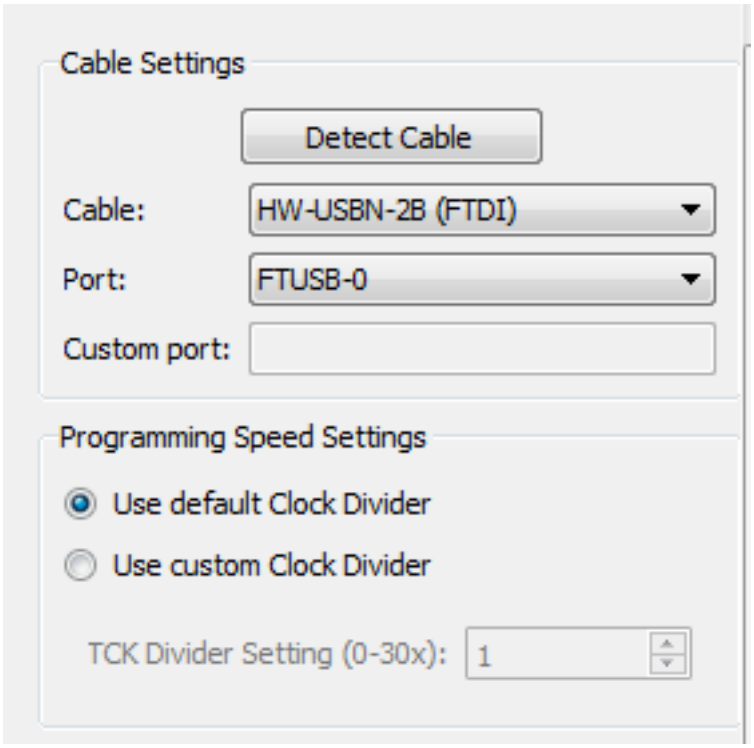
PROGRAMMING THE LATTICE SEMICONDUCTOR LCMXO2-1200HC

You need to program the MachXO2 FPGA to get the board working:

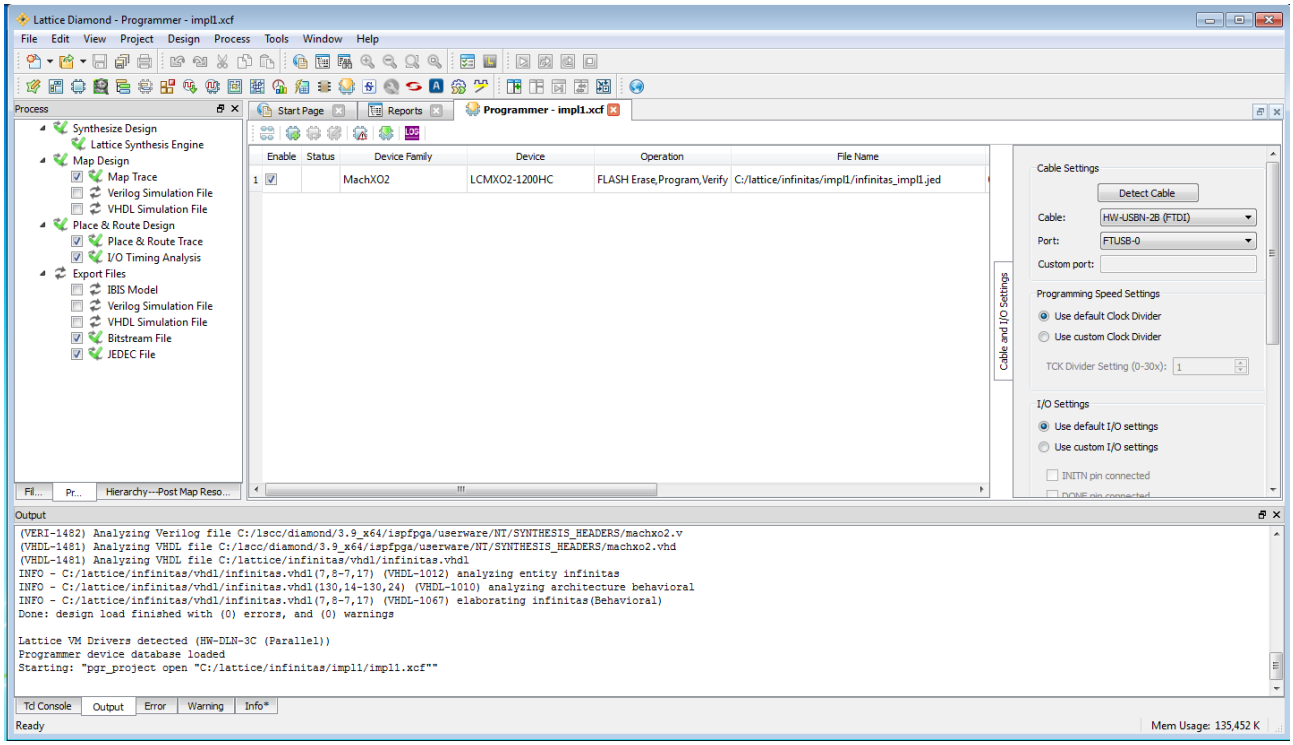
1. Download Lattice Diamond Free License from http://www.latticesemi.com/Products/DesignSoftwareAndIP/FPGAandLDS/LatticeDiamond with no charge. Alternatively, you can download the programmer software only if you don't want to make changes (e.g. audio channel routing) to the VHDL code.
2. Programming of the MachXO2 can be down with a cheap FTx232 module if you do not own an original Lattice programmer. To use a FTx232 module you have make the following connections to the MachXO2 JTAG connector (X101) on the Infinitas board:

FTx232	X101
TXD	TCK
RXD	TDI
RTS#	TDO
CTS#	TMS
GND	GND

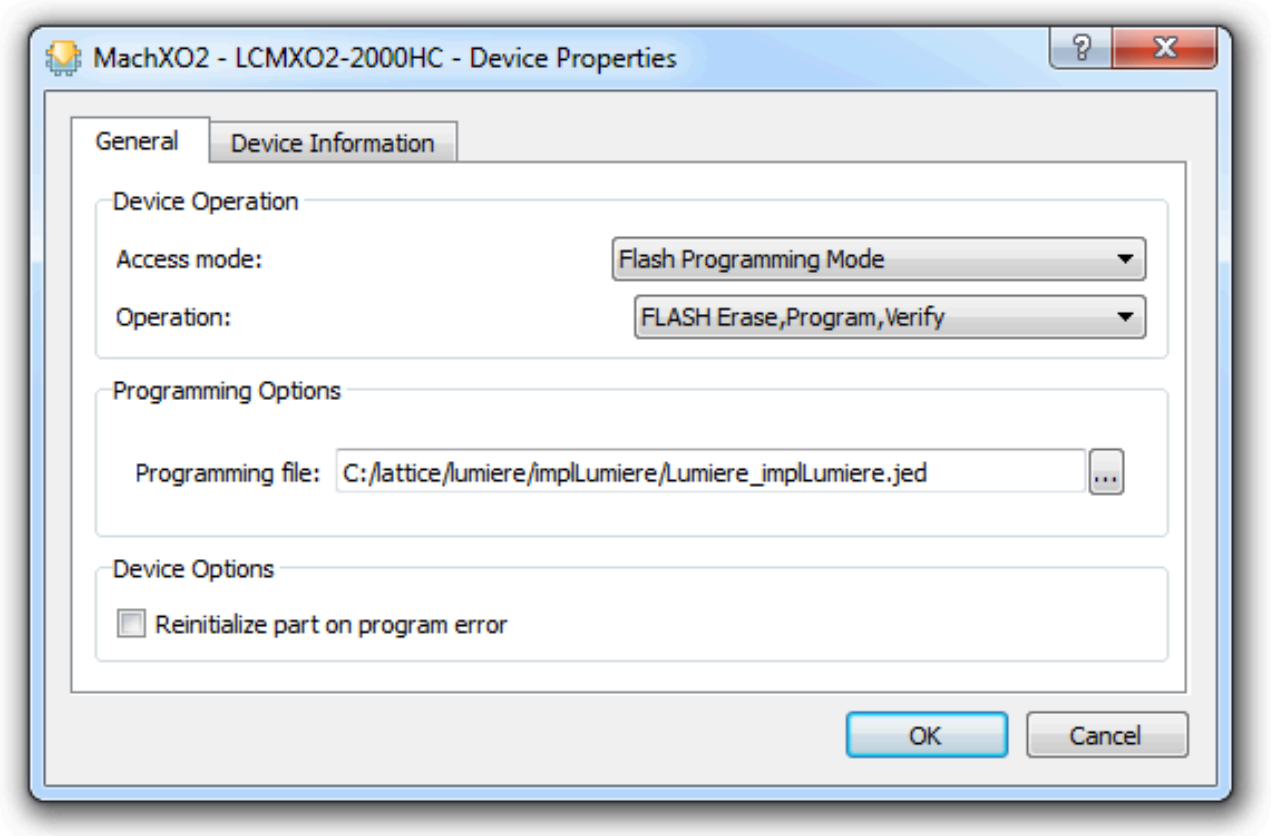
   Please refer to http://www.latticesemi.com/-/media/LatticeSemi/Documents/Solutions/Partner-Solutions/USB-Programming-and-Circuit-Guide.ashx?la=en for further details about using a FTx232 for programming.
3. Connect the programmer to your computer, start Lattice Diamond and load the Infinitas project (infinitas.ldf).
4. Open the Programmer tool from the Menu „Tools".
5. Make sure that you have made the following settings for Cable Settings:



6. Your programmer window should look like this:



Double-click on the *Operation* cell and make the following settings:



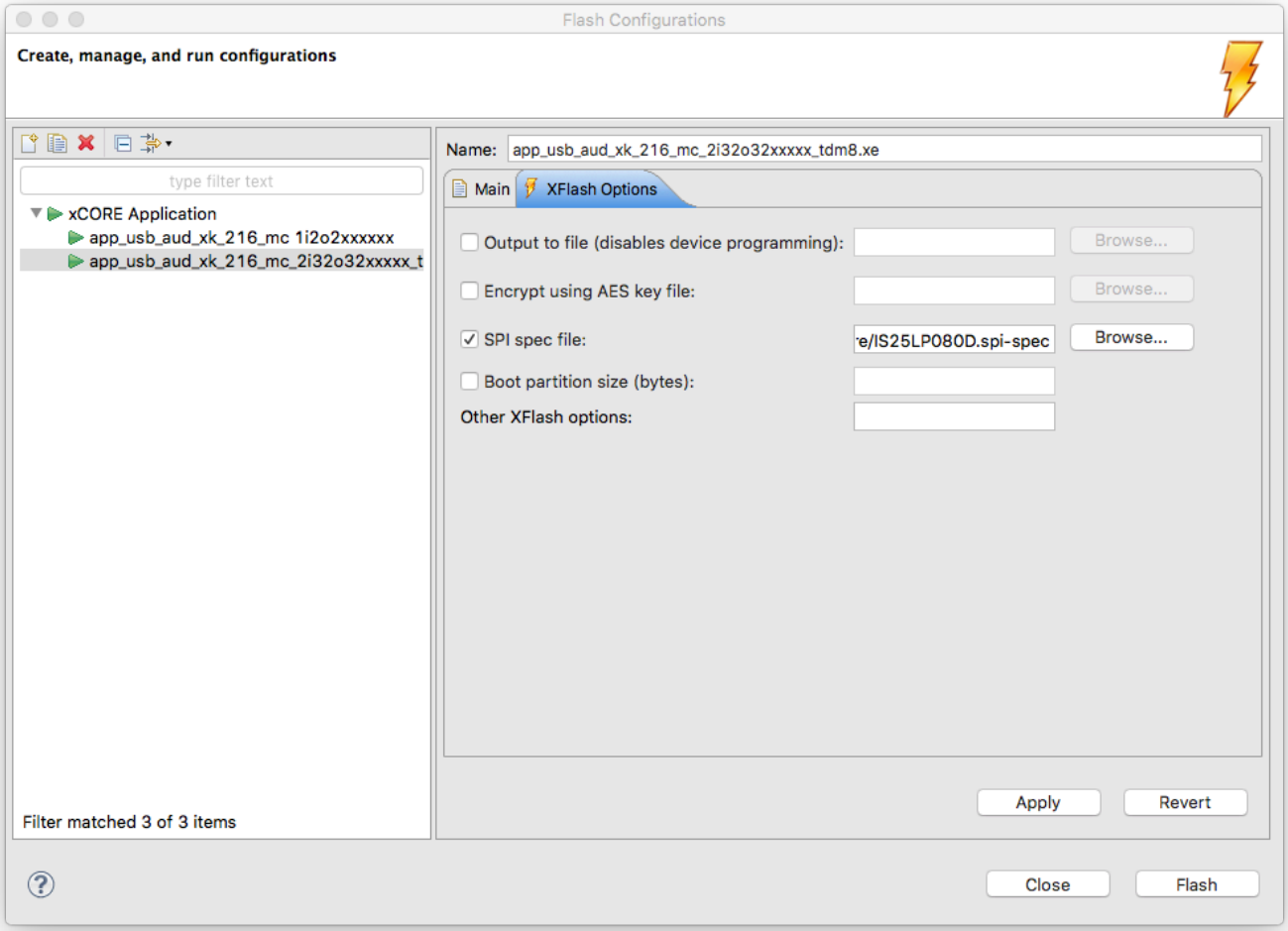
For *Programming file* select the file you want to program. This can be either a file from the git repository or your own file in case that you made changes to the VHDL code. In the future there might be more files in the git repository available with new routing settings or features.

7. Your are now ready to program the MachXO2.
   Click on the program button to start programming of the MachXO2 flash.
8. After success remove the FTx232 module.

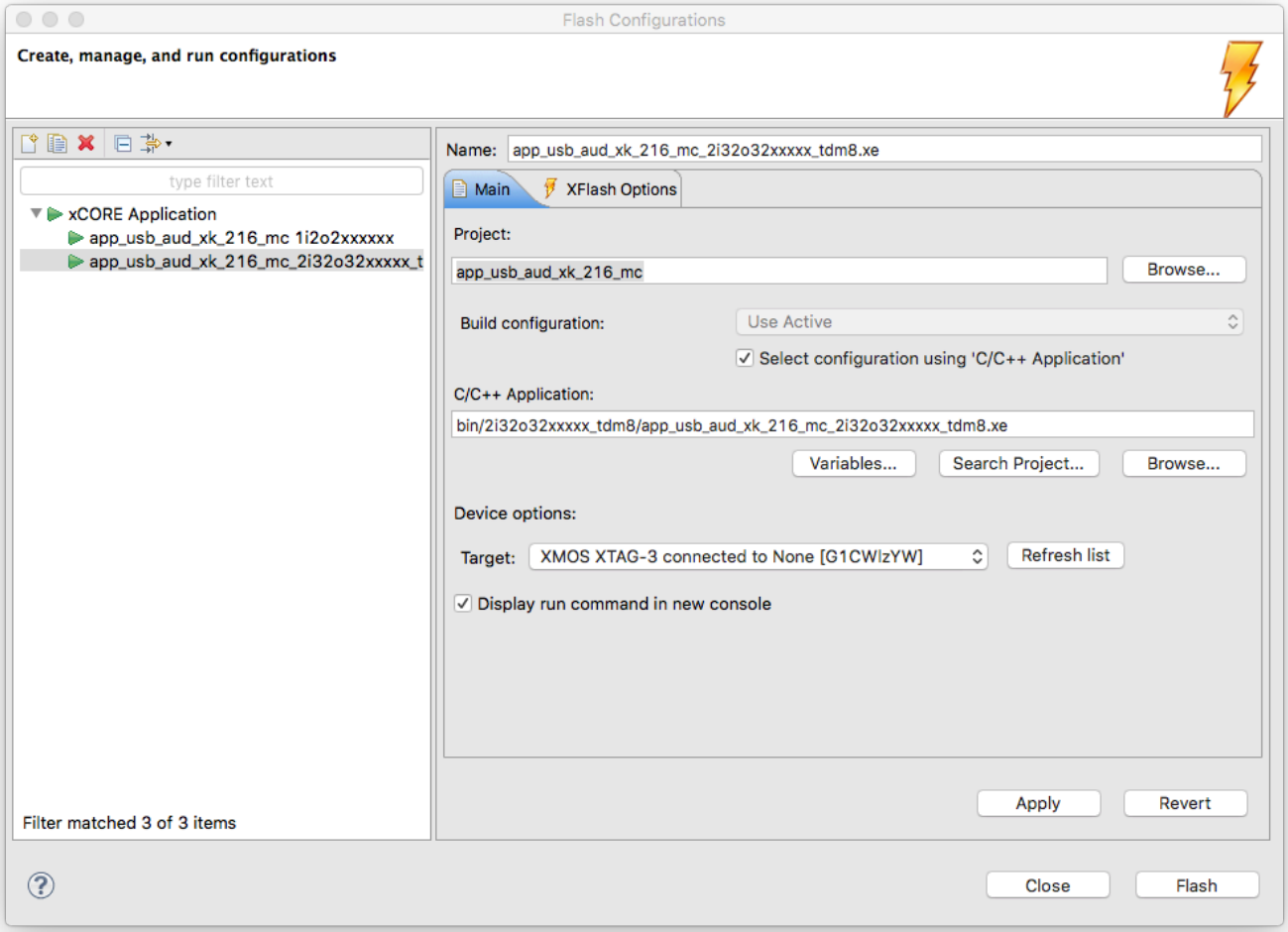
PROGRAMMING THE XMOS XE216-512-TQ128

You need to program the XE216-512-TQ128 to get the board working:

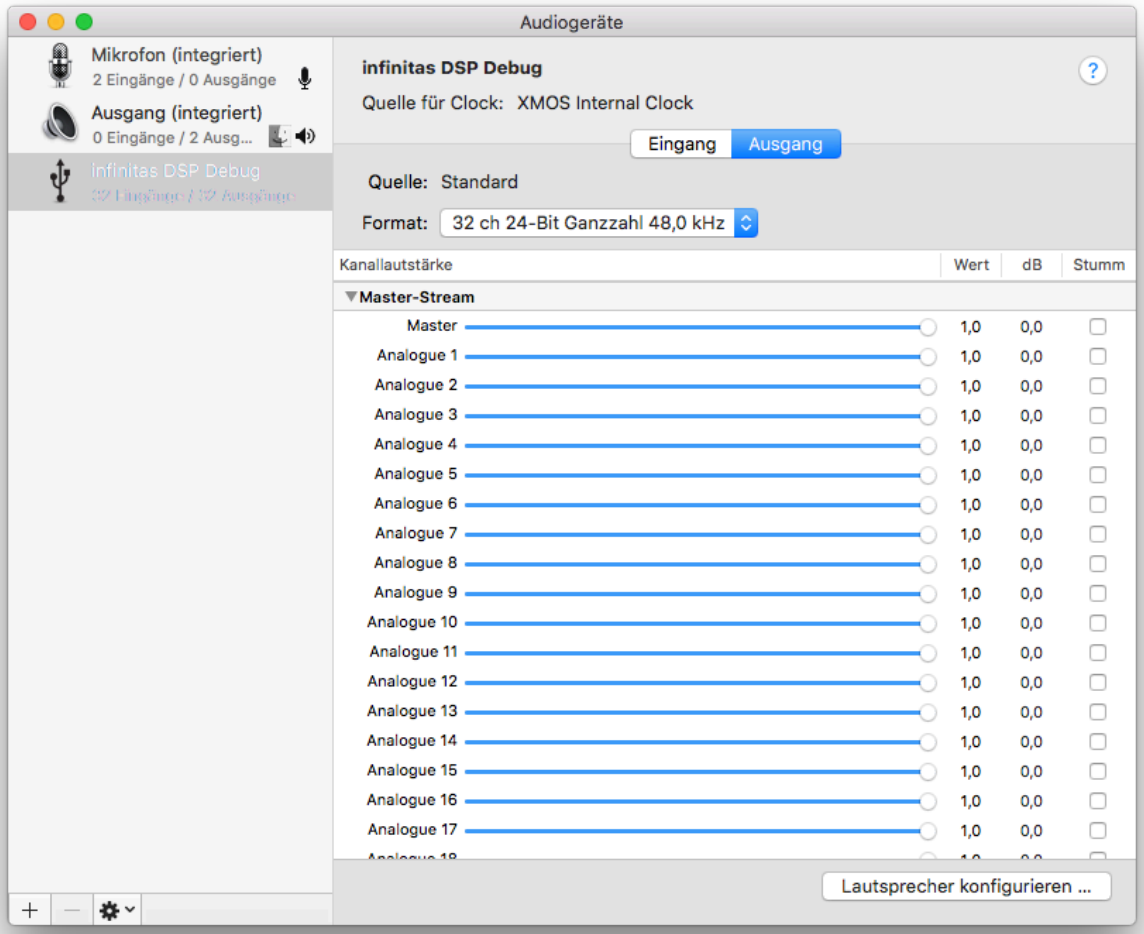
1. Download xTimeComposer Studio from https://www.xmos.com/support/tools without charge.
2. Download the XMOS USB Audio 2.0 Device Software Version: 6.15.2rc1 source code from http://www.xmos.com/published/usbaudiodevice-software?version=all without charge and import it into your xTimeComposer workspace.
3. Copy the files from <git repository>/SOURCE/XMOS/app_usb_aud_xk_216_mc to <workspace>/app_usb_aud_xk_216_mc. Confirm replacing existing files by the files from the git repository.
4. Connect the XMOS xTAG to X201 and to your computer.
5. To tell the programmer which SPI flash we are using go to *Run->Flash Configurations…* and change to tab *XFlash Options* and select IS25LP080D.spi-spec from the git repository for SPI Spec file.



6. After you have made sure that you are using the right flash configuration (see screenshot below) you are ready to flash the XE216-512-TQ128 by clicking on the *Flash* button.



7. After success you should remove the xTAG and connect your Infinitas to your computer on the USB-B connector. It should now be enumerated by the operating system and e.g. for macOS being listed in the Audio-MIDI-Setup:


Audiogeräte
Mikrofon (integriert)
2 Eingänge / 0 Ausgänge
Ausgang (integriert)
0 Eingänge / 2 Ausg...
infinitas DSP Debug
infinitas DSP Debug
Quelle für Clock: XMOS Internal Clock
Eingang
Ausgang
Quelle: Standard
Format: 32 ch 24-Bit Ganzzahl 48,0 kHz
Kanallautstärke
Wert
dB
Stumm
Master-Stream
Master 1,0 0,0
Analogue 1 1,0 0,0
Analogue 2 1,0 0,0
Analogue 3 1,0 0,0
Analogue 4 1,0 0,0
Analogue 5 1,0 0,0
Analogue 6 1,0 0,0
Analogue 7 1,0 0,0
Analogue 8 1,0 0,0
Analogue 9 1,0 0,0
Analogue 10 1,0 0,0
Analogue 11 1,0 0,0
Analogue 12 1,0 0,0
Analogue 13 1,0 0,0
Analogue 14 1,0 0,0
Analogue 15 1,0 0,0
Analogue 16 1,0 0,0
Analogue 17 1,0 0,0
Lautsprecher konfigurieren ...

PROGRAMMING THE ANALOG DEVICES ADAU1452

If you have installed the freeDSP option you can program the DSP in two ways: Via USBi connector or by downloading the program from XE216-512-TQ128.

Programming DSP by using USBi

This option is most useful for static programming of the DSP. Please refer to the notes in the schematic regarding configuring the board for it. Then connect your freeUSBi or your Analog Devices USBi programmer to X301. The programming itself can be done with SigmaStudio. The procedure is the same as in any other freeDSP based on ADAU1452. Please refer to manuals of other freeDSPs or the EVAL-ADAU1452MINIZ User Guide (http://www.analog.com/media/en/technical-documentation/user-guides/EVAL-ADAU1452MINIZ_User_Guide.pdf) for details about programming the DSP. SigmaStudio can be downloaded from http://www.analog.com/en/design-center/processors-and-dsp/evaluation-and-development-software/ss_sigst_02.html with no charge.
Make sure that jumper JP301 is not installed to allow the DSP to operate in selfboot mode.

Programming DSP by using XE216-512-TQ128

Alternatively, the XE216-512-TQ128 can download a program to the DSP via the I2C bus. This is useful if don't want to connect a programmer everytime you want to make a change to the DSP program. The DSP program is now part of the XE216 binary. You have to copy the SigmaStudio output to the xTimeComposer project and rebuild the binary and upload it to the XE216-512-TQ128 either via the xTAG or DFU. In the future there might be a program that allows an upload of a new DSP program on the fly without the need of a rebuild by xTimeComposer.
Make sure that jumper JP301 is installed to allow the DSP to operate in non-selfboot mode.

APPENDIX

PART LIST

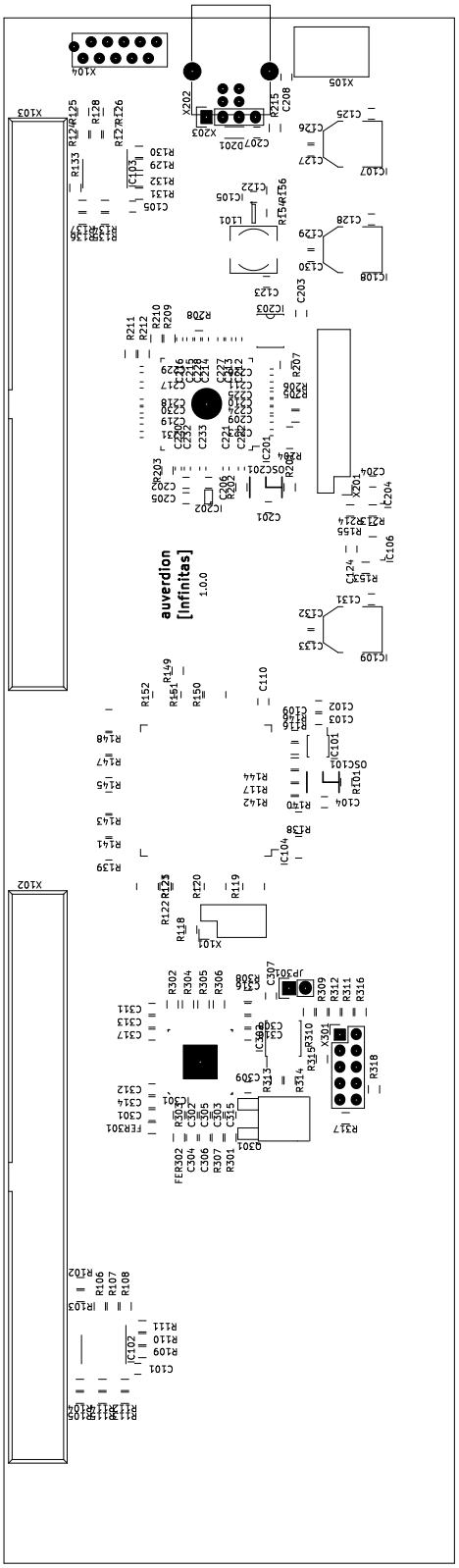
Reference	Qty	Value1	Value2	Footprint	Order No. digikey
B101 B102 B103 B104 B105 B106	6	-	-	MountingHole_3.2mm_M3_DIN965_Pad	-
C102 C122 C125 C127 C128 C130 C131 C133 C205 C206	10	10u0	20% 25V X5R	C0805-X7R	490-10748-1-ND
C101 C103 C104 C105 C106 C107 C108 C109 C110 C111 C112 C113 C114 C115 C116 C117 C118 C119 C120 C121 C124 C126 C129 C132 C202 C203 C204 C207	28	100n	5% 50V X7R	C0805-X7R	399-1170-1-ND
C123	1	22u0	20% 10V X5R	C0805-X7R	490-10511-1-ND
C201	1	10n0	10% 50V X7R	C0805-X7R	311-1136-1-ND
C208	1	1n00	10% 50V X7R	C0805-X7R	399-1147-1-ND
C209 C210 C211 C212 C213 C214 C215 C216 C217 C218 C219 C220 C221 C222 C223 C224 C225 C226 C227 C228 C229 C230 C231 C232 C233	25	100n	10% 10V X7R	C_0402	490-6321-1-ND
D201	1	MBR120VLSFT	Schottky 20V 1 A	SOD123	MBR120VLSFT3GOSCT-ND
IC101	1	CS2100CP	Fractional-N Clock Multiplier	MSOP-10_3x3mm_Pitch0.5mm	598-1750-ND

Reference	Qty	Value1	Value2	Footprint	Order No. digikey
IC102 IC103	2	PCA9545APW	I2C Switch 4ch	TSSOP-20_4.4x6.5mm_Pitch0.65mm	568-1865-1-ND
IC104	1	LCMXO2-1200HC-6TG144C	FPGA	TQFP-144_20x20mm_Pitch0.5mm	220-2040-ND
IC105	1	TLV62565	1.5A	SOT-23-5	296-43657-1-ND
IC106	1	ADM811TARTZ	Spannungsmonitor	SOT-143	ADM811TARTZ-REELCT-ND
IC107	1	LM1117MP-5.0	LDO	SOT223	LM1117MP-5.0/NOPBCT-ND
IC108 IC109	2	NCP1117LPST33	LDO	SOT223	NCP1117LPST33T3GOSCT-ND
IC201	1	XE216-512-TQ128	xCore	TQFP-128_14x14mm_Pitch0.4mm_EP_Handsoldering	880-1096-ND
IC202	1	NCP4681DSQ25T1G	2,5V 150mA	SC-70-5	NCP4681DSQ25T1GOSCT-ND
IC203	1	IS25LP080D	8Mb	SOIC8_3.9x4.9mm_Pitch1.27mm	706-1580-ND
IC204	1	NC7WZ07	Noninverting Buffer	SC-70-6	NC7WZ07P6XCT-ND
L101	1	2u20	30% 4.5A 26 mOhm	MCSDRH73B	811-1157-1-ND
OSC101	1	24M576	-	ASFL1	300-8253-1-ND
OSC201	1	24M0	-	ASFL1	300-8252-1-ND
R101 R201 R213 R214	4	10K0	1% 0.125W Thick	C0805-RES	311-10.0KCRCT-ND
R118	1	4K70	1% 0.125W Thick	C0805-RES	311-4.70KCRCT-ND
R102 R103 R104 R105 R112 R113 R114 R115 R124 R125 R126 R127 R134 R135 R136 R137 R211 R212	18	2K00	1% 0.125W Thick	C0805-RES	311-2.00KCRCT-ND
R106 R107 R108 R109 R110 R111 R128 R129 R130 R131 R132 R133	12	47K0	1% 0.125W Thick	C0805-RES	311-47.0KCRCT-ND

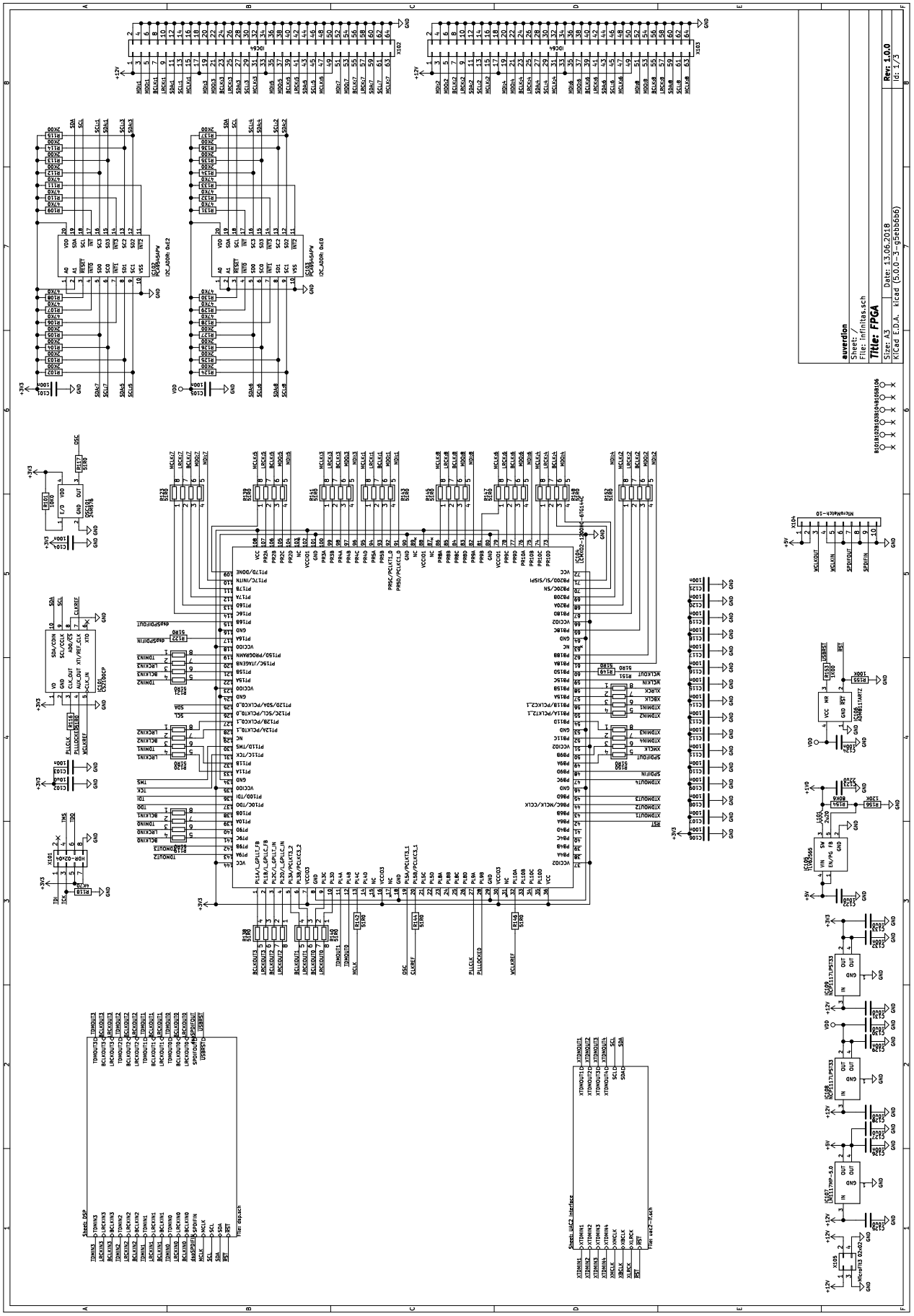
Reference	Qty	Value1	Value2	Footprint	Order No. digikey
R119 R120 R121 R123 R138 R139 R140 R141 R143 R145 R147 R148 R150 R151 R152 R204	16	51R0	5% 62,5mW	R_Array_Convex_4x0603	TC164J-51CT-ND
R116 R117 R122 R142 R144 R146 R149 R202 R205 R206 R209 R210	12	51R0	1% 0.125W Thick	C0805-RES	311-51.0CRCT-ND
R153 R207	2	1K00	1% 0.125W Thick	C0805-RES	311-1.00KCRCT-ND
R154	1	80K6	1% 0.125W Thick	C0805-RES	311-80.6KCRCT-ND
R155 R215	2	100K	1% 0.125W Thick	C0805-RES	311-100KCRCT-ND
R156	1	120K	1% 0.125W Thick	C0805-RES	311-120KCRCT-ND
R203	1	4R70	1% 0.125W Thick	C0805-RES	311-4.70CRCT-ND
R208	1	43R2	1% 0.125W Thick	C0805-RES	P43.2CCT-ND
X101	1	HDR-02x04	-	HDR_02x04	952-3276-ND
X102 X103	2	IDC64	-	IDC64	ED10532-ND
X104	1	MicroMatch-10	-	MM-10G	A110869-ND
X105	1	MicroFit3 02x02	-	Microfit3_43045-0428	WM10670-ND
X201	1	HDR-02x10	-	HDR_02x10	S2011EC-10-ND
X202	1	USB_B	horizontal	USB_B	ED2983-ND
X203	1	HDR-01x04	-	HDR_01x04	732-5317-ND
freeDSP Option					
C301 C304 C308 C313	4	10u0	20% 25V X5R	C0805-X7R	490-10748-1-ND
C302 C305 C307 C309 C310 C311 C312 C314 C315 C316 C317	11	100n	5% 50V X7R	C0805-X7R	399-1170-1-ND
C303	1	5n60	10% 50V X7R	C0805-X7R	311-1134-1-ND
C306	1	150p	5% 50V C0G	C0805-X7R	399-1125-1-ND

Reference	Qty	Value1	Value2	Footprint	Order No. digikey
FER301 FER302	2	600R	@100MHz 600mA	C0805-RES	490-1040-1-ND
IC301	1	ADAU1452	-	QFP72_10x10_EP_Handsoldering	ADAU1452WBCPZ-ND
IC302	1	25AA1024	1Mbit	SOIJ-8_5.3x5.3mm_Pitch1.27mm	25AA1024T-I/SMCT-ND
JP301	1	Jumper	-	HDR_01x02	732-5315-ND
Q301	1	STD2805	PNP 60V 5A 150MHz 15W	TO-252-2Lead	497-7465-1-ND
R308 R313 R314	3	10K0	1% 0.125W Thick	C0805-RES	311-10.0KCRCT-ND
R302 R303 R304 R305 R306	5	51R0	1% 0.125W Thick	C0805-RES	311-51.0CRCT-ND
R301	1	1K00	1% 0.125W Thick	C0805-RES	311-1.00KCRCT-ND
R307	1	4K32	1% 0.125W Thick	C0805-RES	311-4.32KCRCT-ND
R309 R310 R315 R316	4	DNP	-	C0805-RES	-
R311 R312 R317 R318	4	0R00	1% 0.125W Thick	C0805-RES	311-0.0ARCT-ND
X301	1	HDR-02x05	-	HDR_02x05	952-2117-ND

ASSEMBLY PRINT



SCHEMATIC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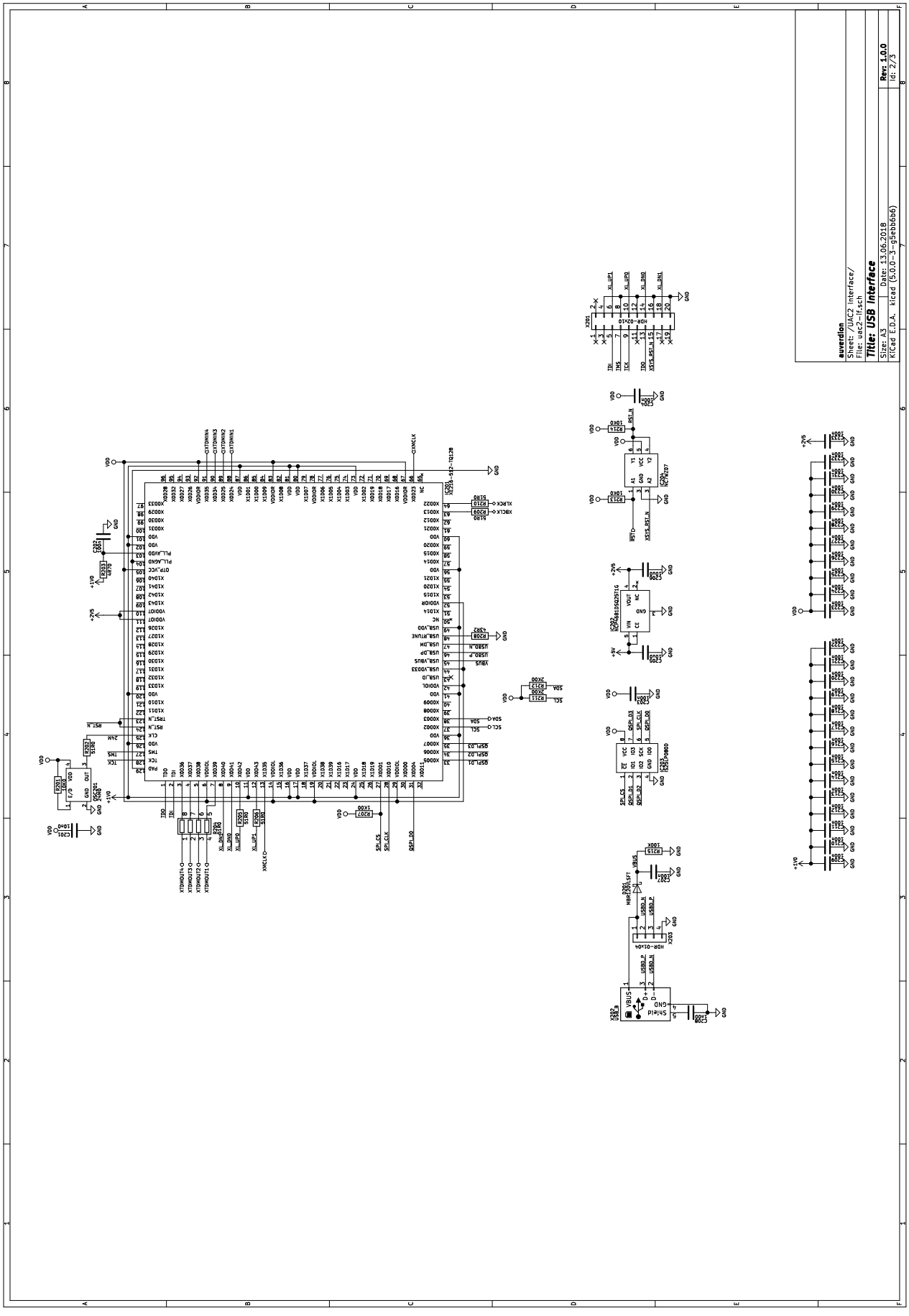
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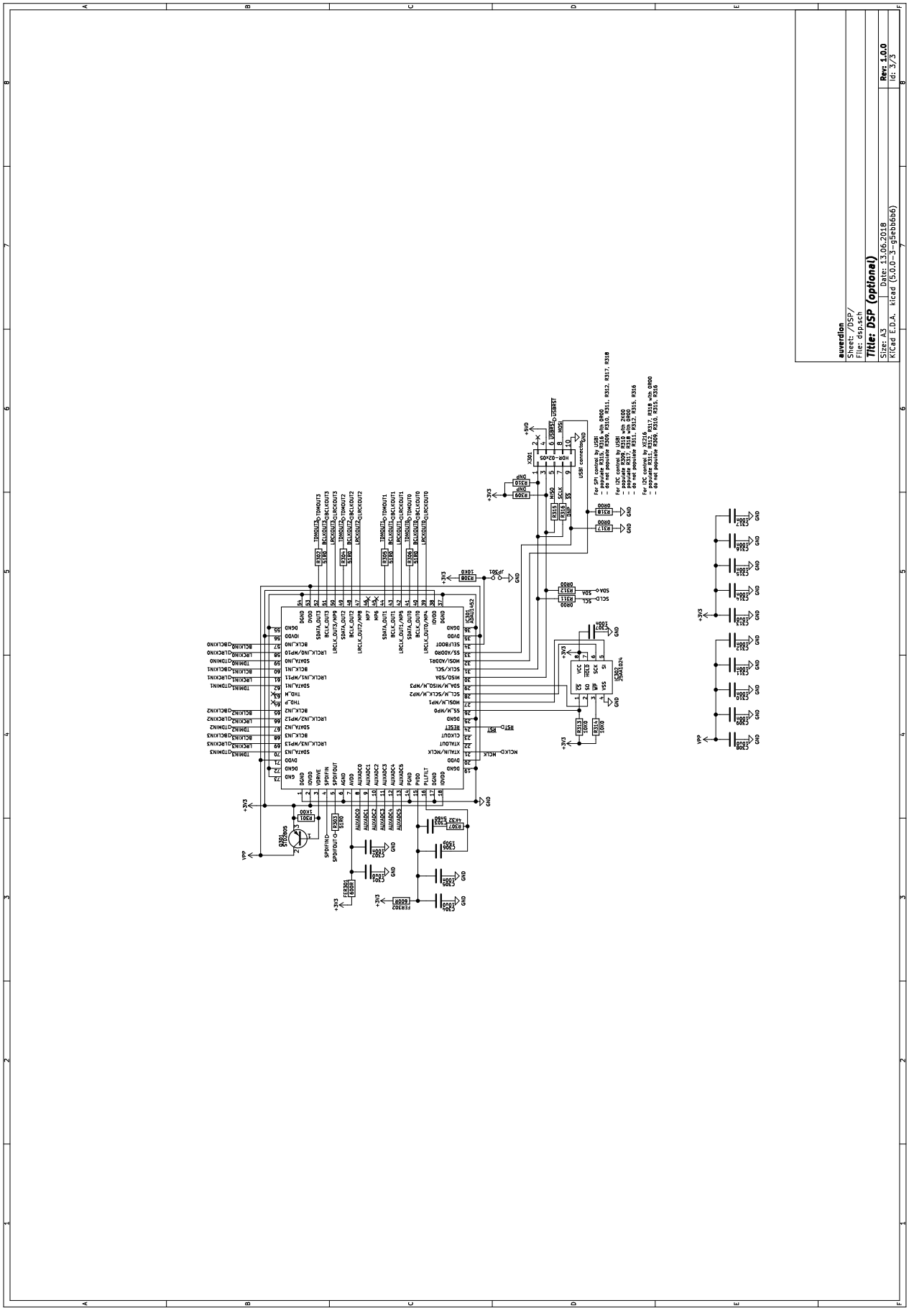
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