

ISLKU060DEMO1Z

Renesas Rad Hard Power Management Reference Design for AMD's Space Grade XQRKU060

Over the last decade satellites and spacecrafts have seen an exponential increase in the need for on-board data processing and storage demands. Additionally, major satellite manufacturers have recently announced their latest satellites to be modular, fully digital, and capable of in-orbit reconfigurability. To meet these demands, satellite and payload manufacturers are using high-end FPGAs, ASICs, and processors. AMD's Kintex XQRKU060 FPGA is a radiation hardened FPGA that has comparable performance to commercial counterparts in demanding computing applications. The Kintex XQRKU060 requires a complex power solution with multiple low voltage supply rails that can deliver high currents and a need for power supply sequencing to eliminate high inrush currents. In collaboration with AMD and Ibeos, Renesas offers a Kintex XQRKU060 development board with the FPGA powered by Renesas' Radiation Hardened products.

Features

- Radiation hardened QMLV power solution by Renesas (MIL-PRF-38535)
- Radiation tolerant AMD Kintex XQRKU060 FPGA
- 4x 4GB DDR3 Memory
- 512MB SPI Flash Memory
- RJ45 interface for 10/100/1000 Gigabit Ethernet
- DB9 RS-485 Communication Port
- JTAG Configuration Header

Power Supply Specifications

- 5V_{DC} ±10% (Banana Jack Connectors)

Related Information

- [ISL70002SEH](#), [ISL70001ASEH](#), [ISL75051ASEH](#), [ISL70005SEH](#), [ISL70321SEH](#) and [ISL70244SEH](#) device pages
- AMD Radiation Tolerant Kintex [FPGA Overview](#)
- AMD Radiation Tolerant Kintex [FPGA Datasheet](#)

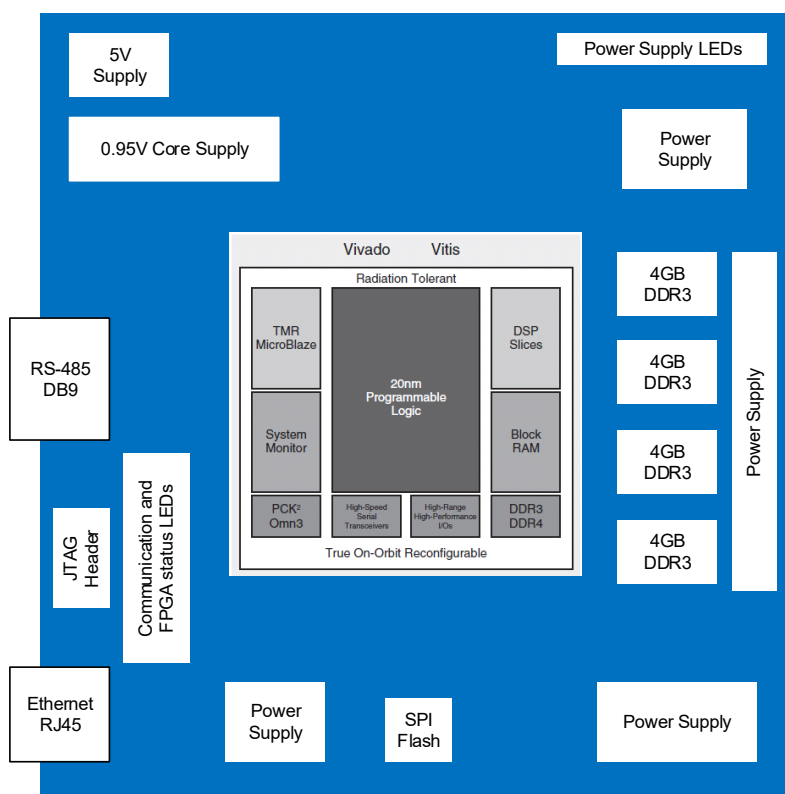


Figure 1. ISLKU060DEMO1Z Block Diagram

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1. Functional Description

The ISLKU060DEMO1Z development platform allows users to prototype and evaluate the performance of the FPGA in different applications. [Figure 1](#) shows a block diagram of the development board. The board includes 4x 4GB Double Data Rate 3 (DDR3) memory and 2x 256MB SPI flash memory, a Gigabit Ethernet (GbE) port, RS-485 communication port and a JTAG header for programming. On-board DC/DC Point-of-Load (PoL) Converters power the FPGA and peripherals from a 5V power supply input.

1.1 Getting Started

1. Power Switch SW1 switches power to the ISLKU060DEMO1Z. Before making connections, ensure it is in the down (OFF) position.
2. Apply +5VDC to the banana connectors J5 and J6. J5 is positive terminal and J6 is GND.
3. Move SW1 to the up (ON) position to power on board.
4. The LED indicators in the upper right sequence on to indicate power sequencing to the FPGA.
5. When the FPGA is properly powered and configured successfully, the FPGA_PROG_B, FPGA_INIT_B and FPGA_DONE LEDs in the lower left hand corner of the board illuminate green.
6. Visit the AMD Kintex [Ultrascale website](#) to download the Vivado Design Suite and get started on the design.

1.2 Kintex XQRKU060 Power Solution

[Table 1](#) summarizes the Renesas part numbers, descriptions and operation conditions of the various DC-DC converters used in the space grade design.

Table 1. Renesas Power Management Solution for Kintex RT XQRKU060

Part Number	Description	Input Voltage	Output Voltage	Function
ISL70002SEH	Radiation Hardened and SEE Hardened 22A Synchronous Buck Regulator with Current Sharing	5V	0.95V ^[1]	VCC Core
ISL70001ASEH	Radiation and SEE Tolerant 3V to 13.2V, 9A Buck Regulator	5V	2.5V	FPGA VCCO Ethernet AVDD and I/O
			1.8V	Auxiliary VCC, Auxiliary I/O and SYSMON ADC
			3.3V	VCC 3.3V I/O and SPI Flash
ISL75051ASEH	3A, Radiation Hardened, Positive, Ultra-Low Dropout Regulator	2.5V	1.0V	Ethernet DVDD
			1.0V	GTH Analog VCC
			1.2V	GTH Termination VTT
			1.8V	GTH Auxiliary VCC
ISL70005SEH	Radiation Hardened Dual Output Point-of-Load, Integrated Synchronous Buck and Low Dropout Regulator	5V	1.35V	DDR VDDQ
		1.35V	0.675V	DDR VTT

1. A mechanical potentiometer, labeled R4781, is available to tune the VCC Core voltage across a range of 0.95V to 0.98V. This feature allows adjusting to a specific core voltage as determined by the AMD Power Estimator (XPE) tool when configuring the Kintex XQRKU060.

In addition to the power management ICs in [Table 1](#), two ISL70321SEH quad power supply sequencers and an ISL70062SEH NMOS load switch control the power-up and power-down sequences of the eight power supply rails. An ISL70244SEH Radiation Hardened Op-Amp is also used for buffering the VREF of the DDR3 VTT supply.

Figure 2 shows the power tree connections from the two ISL70321SEH sequencer outputs to the enable inputs of the various DC-DC converters.

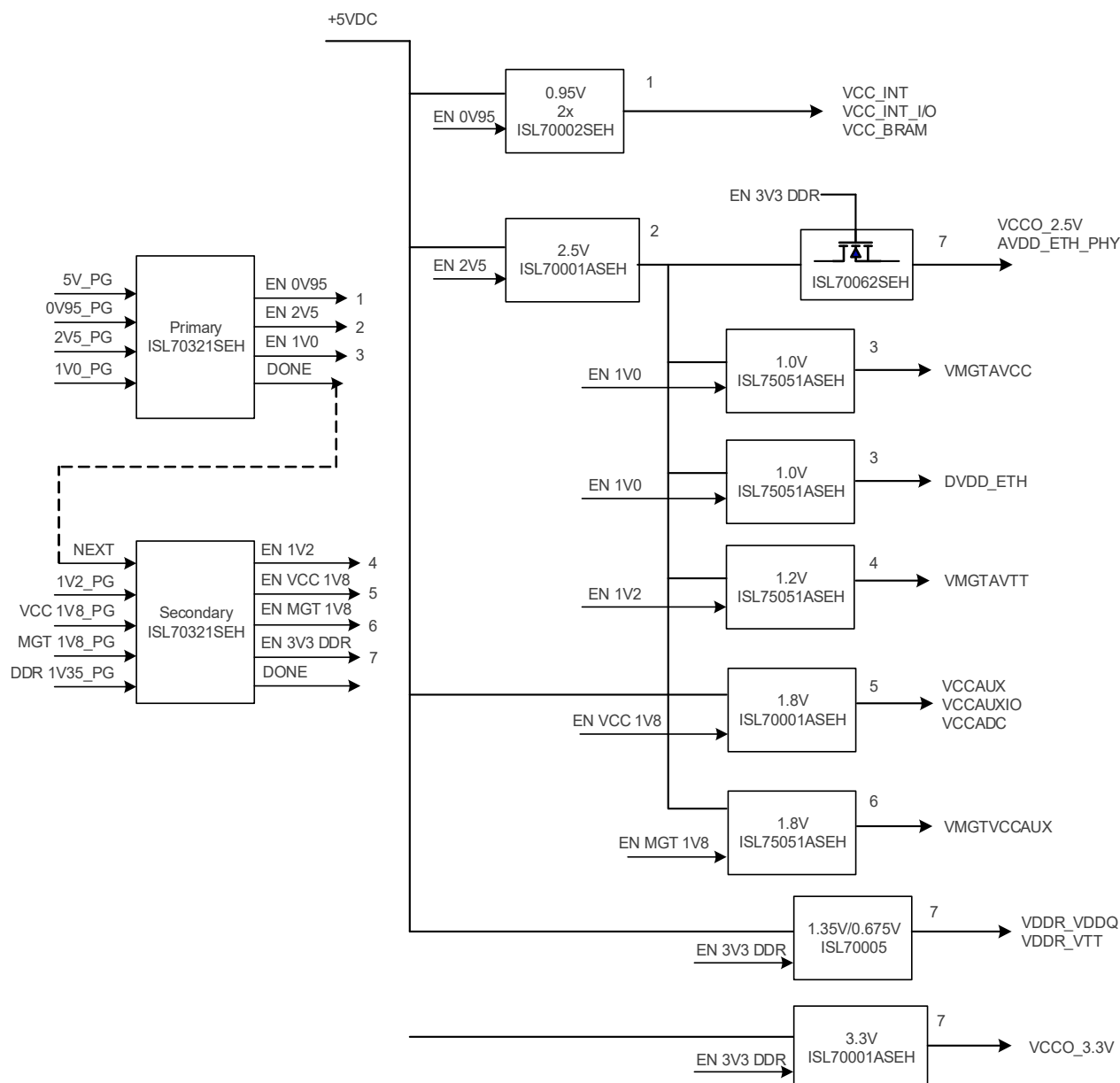


Figure 2. ISLKU060DEMO1Z Power Tree and Sequencing

The power-up sequence of the power supplies is summarized below:

1. The external 5V supply is monitored by the ISL70321SEH and when it reaches 4.3V, it enables the two ISL70002SEH set up in current-sharing configuration to provide 0.95V to the FPGA core.
2. When the 0.95V supply reaches 0.8V, an ISL70001ASEH is enabled to provide 2.5V for four down-stream ISL75051ASEH LDOs.
3. When the 2.5V supply reaches 2.1V, two ISL75051ASEHs are enabled. One provides 1.0V for the DVDD to the Ethernet controller. The other provides 1.0V for the GTH transceiver Analog VCC. To minimize power dissipation in the LDO, the ISL75051ASEH input voltage comes from the 2.5V rail.

4. When the 1.0V supply reaches 0.87V, an ISL75051ASEH is enabled to provide 1.2V for the GTH transceiver Termination VTT. To minimize power dissipation in the LDO, the ISL75051ASEH input voltage comes from the 2.5V rail.
5. When the 1.2V supply reaches 1.0V, an ISL70001ASEH is enabled to provide 1.8V for the Auxiliary VCC, Auxiliary I/O and to the SYSMON ADC supply.
6. When the 1.8V supply reaches 1.5V, an ISL75051ASEH is enabled to provide 1.8V for the GTH transceiver Auxiliary VCC. To minimize power dissipation in the LDO, the ISL75051ASEH input voltage comes from the 2.5V rail.
7. When the second 1.8V supply rail reaches 1.5V, the final two supply rails are enabled. An ISL70001ASEH is enabled to provide 3.3V for the VCC I/O and for the SPI Flash Memory. The ISL70005SEH is enabled to provide 1.35V for the VDDQ and 0.675V for the VTT of the DDR3 memory. The 0.675V before the VTT rail is also buffered by an ISL70244SEH op-amp to provide VREF for the DDR3 memory. There is also an ISL70062SEH NMOS load switch that is turned on by the second 1.8V supply rail, which provides 2.5V for the FPGA VCC I/O, Ethernet AVDD and I/O.

Figure 3 shows the power-up sequence of the ISLKU060DEMO1Z board.

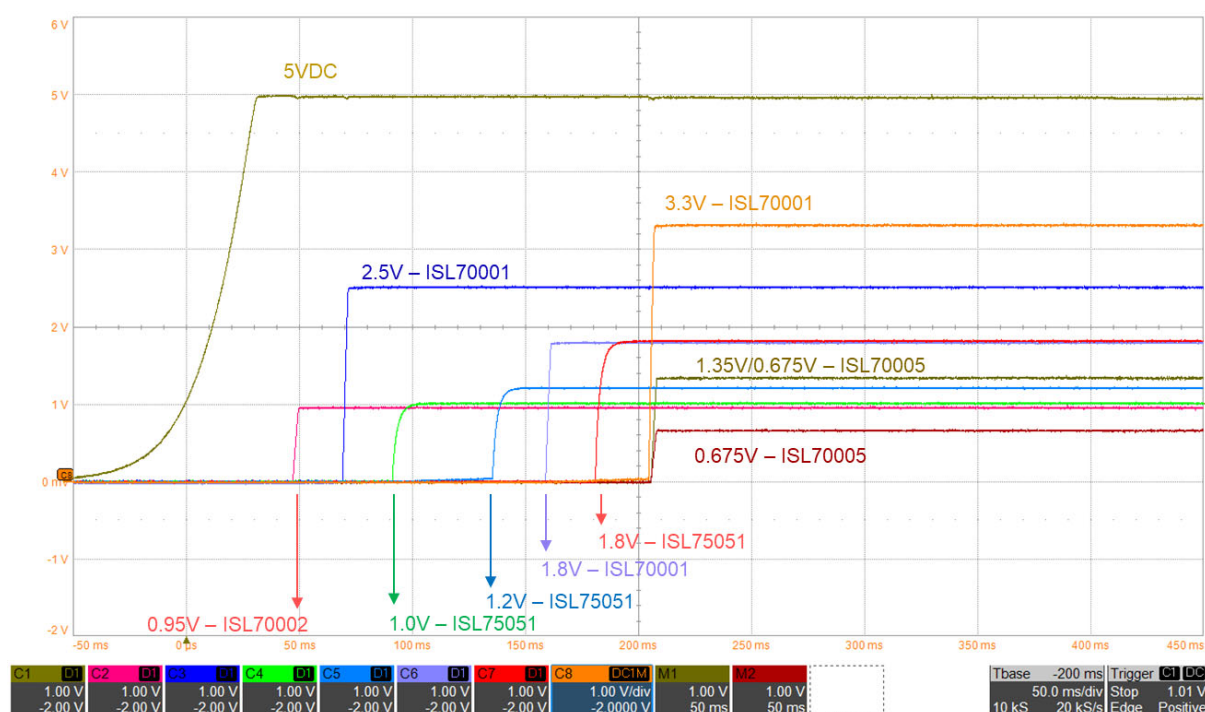


Figure 3. ISLKU060DEMO1Z Power-Up Sequencing

2. Typical Performance Graphs

Typical performance curves for Figure 9 through Figure 13 are derived from the datasheet of the associated part. Actual performance on the ISLKU060DEMO1Z may be different due to test conditions.

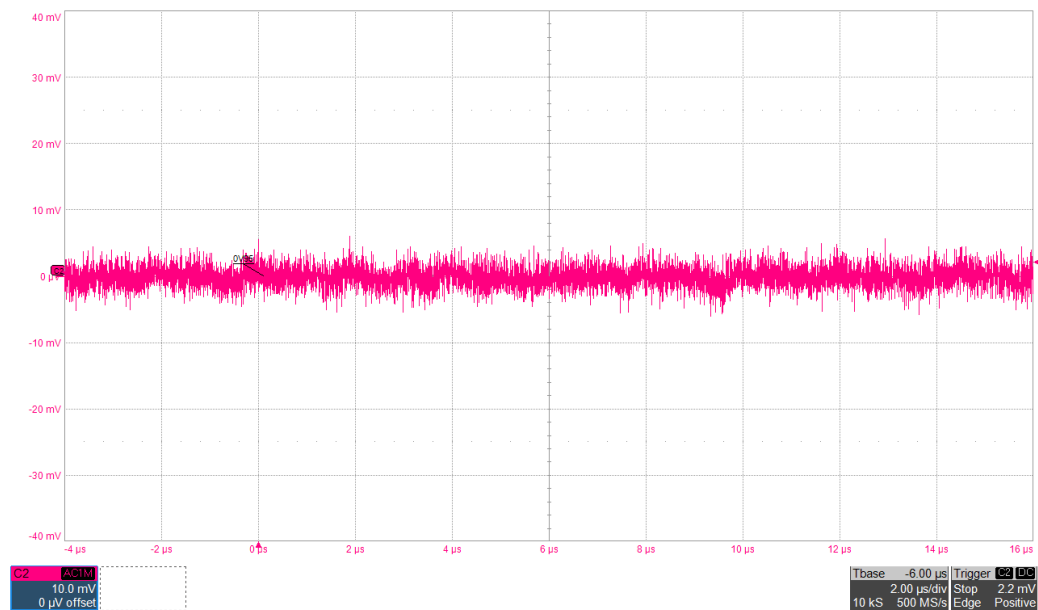


Figure 4. Output Ripple of ISL7002SEH for the FPGA VCCINT Core Voltage

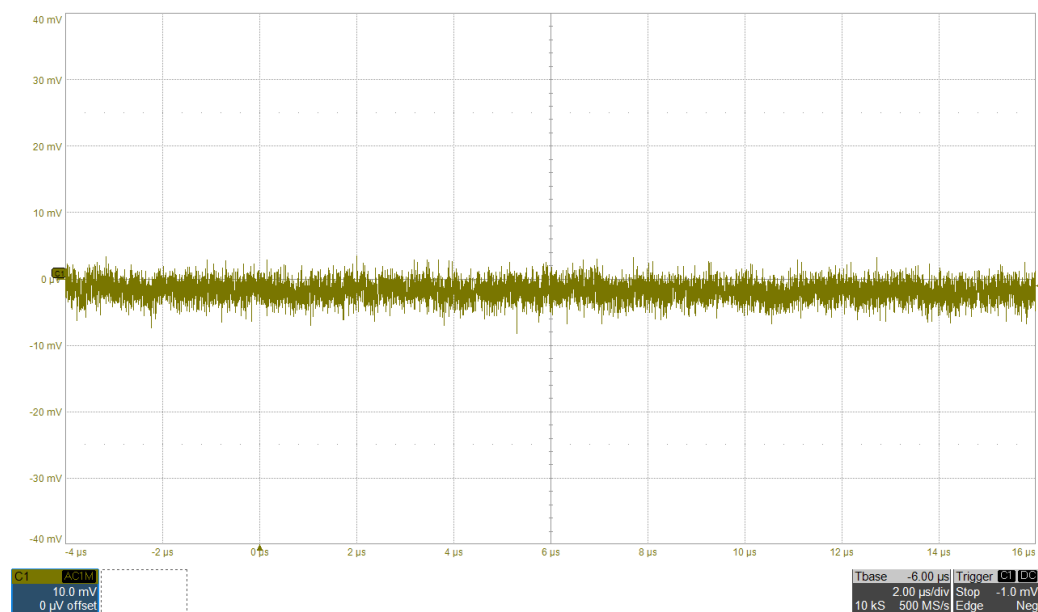


Figure 5. Output Ripple of ISL75051ASEH for the FPGA 1.0V VMGTAVCC Voltage

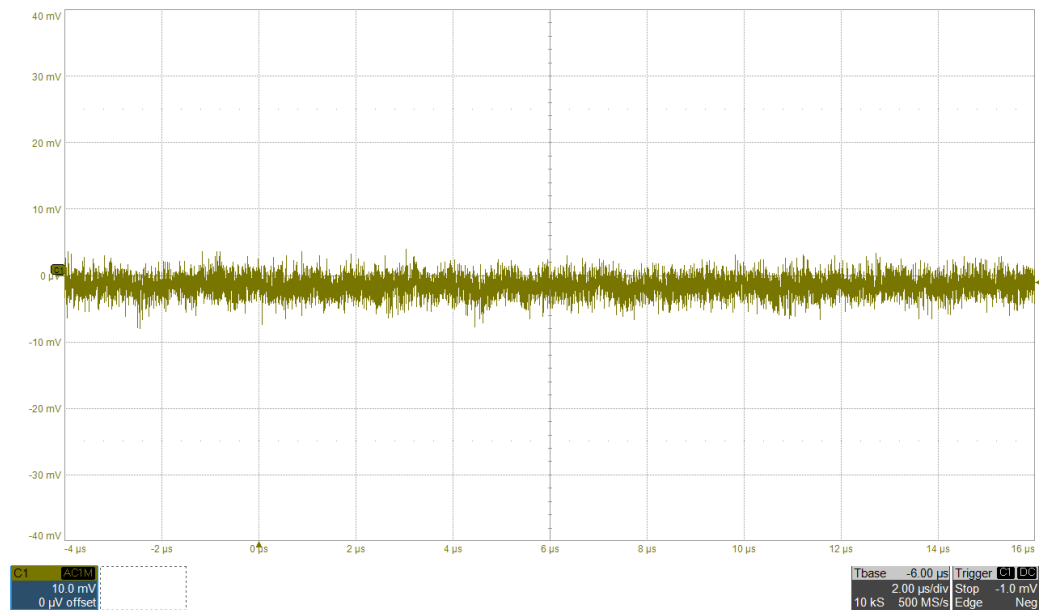


Figure 6. Output Ripple of ISL75051ASEH for the FPGA 1.2V VMGTAVTT Voltage

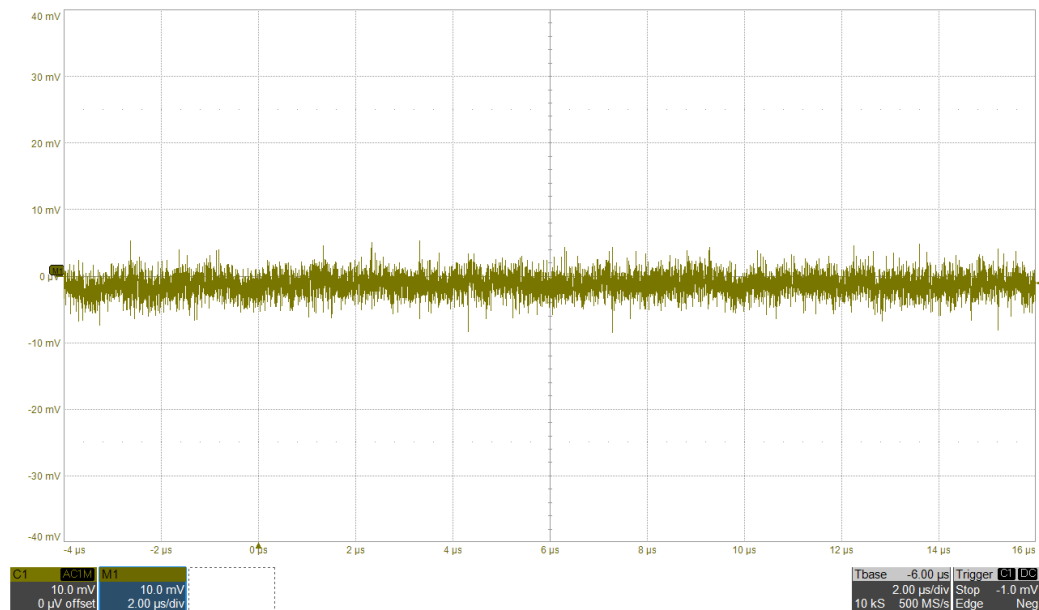


Figure 7. Output Ripple of ISL75051ASEH for the FPGA 1.8V VMGTACCAUX Voltage

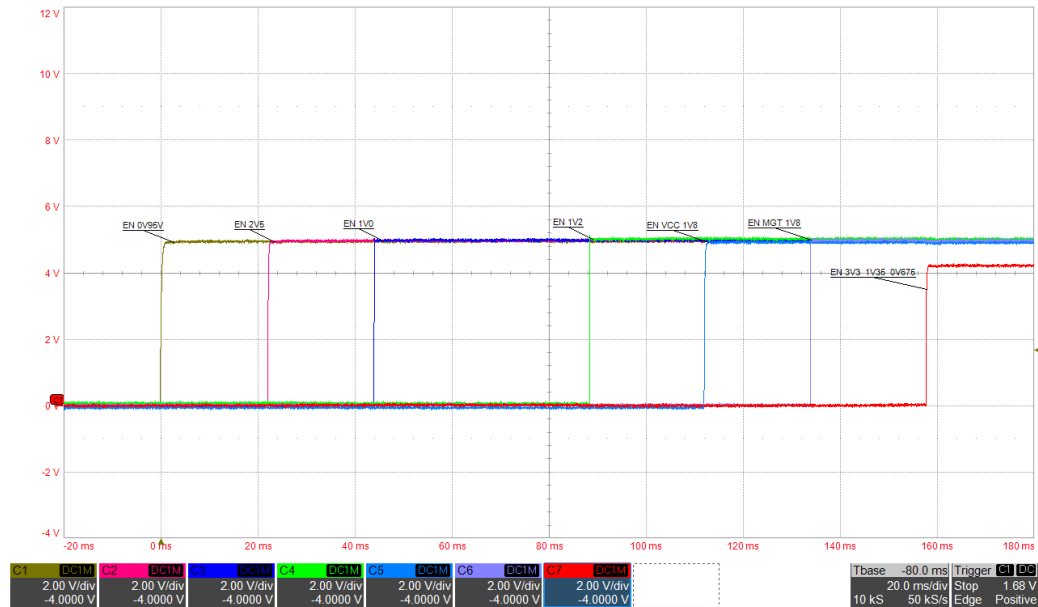


Figure 8. ISL70321SEH Power Sequencing Enable

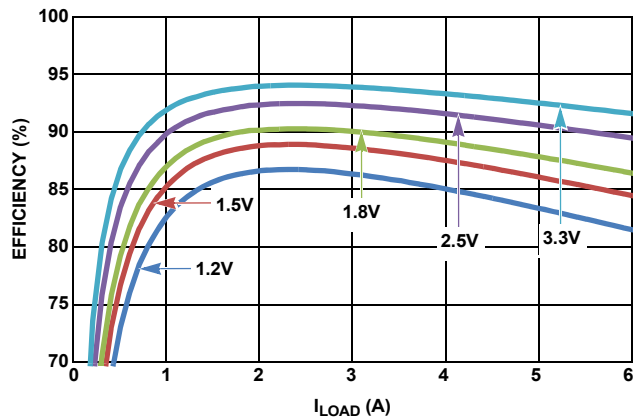


Figure 9. Efficiency vs Load, $V_{IN} = 5.0V$

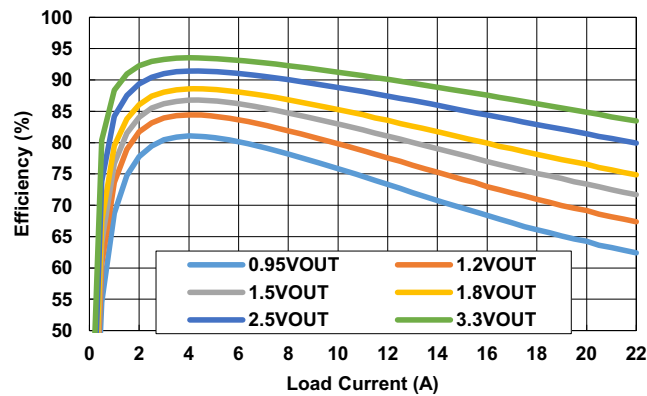


Figure 10. ISL70002SEH Efficiency, $V_{IN} = 5V$, 500kHz

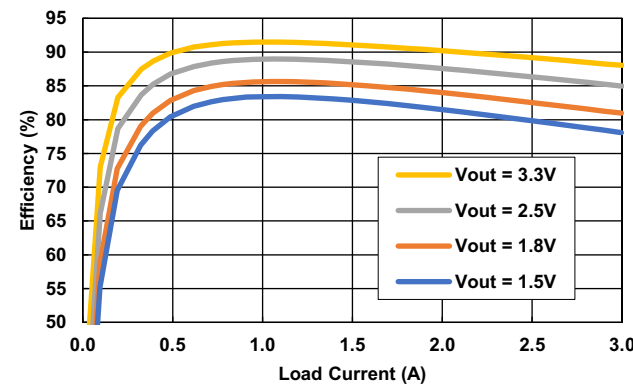


Figure 11. ISL70005SEH Buck Efficiency, $V_{IN} = 5V$, 1MHz

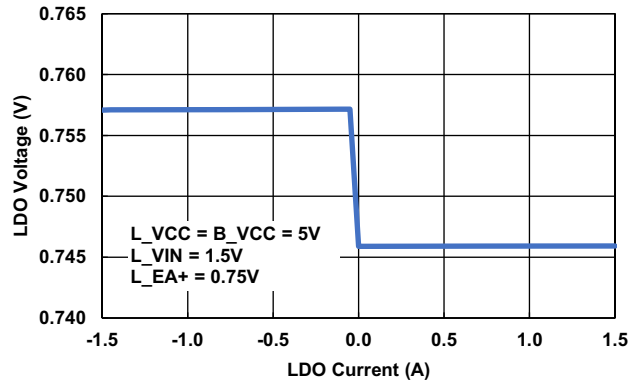


Figure 12. ISL70005SEH LDO Load Regulation

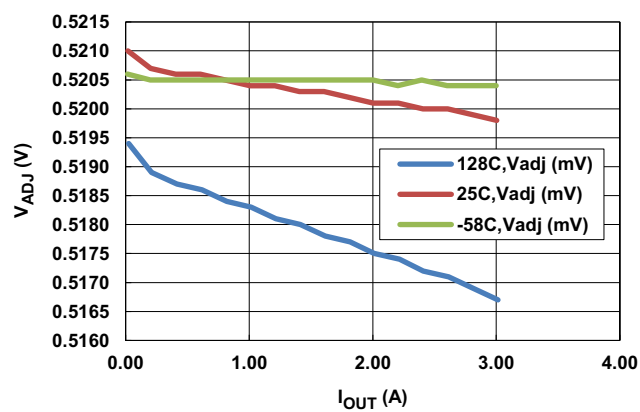


Figure 13. ISL75051ASEH Load Regulation, V_{ADJ} vs I_{OUT}

3. Board Design

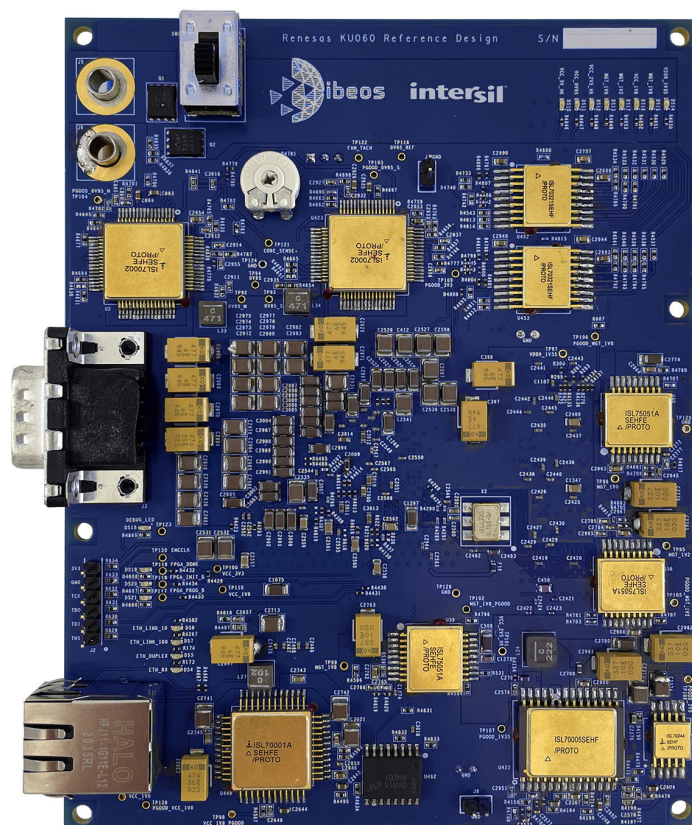


Figure 14. Top of Board

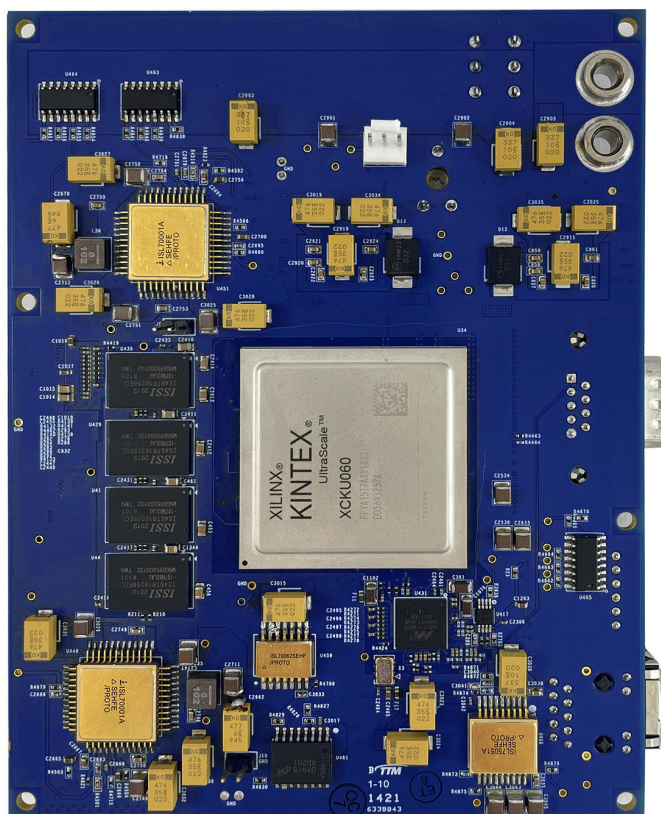


Figure 15. Bottom of Board

3.1 Layout Guidelines

As the AMD Kintex XQRKU060 is a high-performance FPGA, careful consideration must be taken with regards to the layout for the power management ICs. Per the FPGA datasheet for recommended operating conditions for each of the supply rails, it can be seen they must operate with the tolerances described. In addition to choosing the right components for the design, the layout is equally as critical in maintaining the electrical performance within the tolerance window. The load current transitions from one DC/DC regulator can cause voltage spikes across the interconnecting impedances and parasitic circuit elements. These voltage spikes can degrade efficiency, radiate noise into the circuit and lead to device overvoltage stress. Proper component layout and printed circuit board design minimizes these voltage spikes. Below are general recommended guidelines for proper layout:

- Ground planes have two important uses. They should be used to shield the switch node of Buck regulators to contain radiated EMI. Ground planes are also used to provide low impedance returns for the supply currents.
- Signal routing should be on dedicated layers. Avoid routing signals on every layer without regard to how layers above and below may interact with the signal. Typically, the top and bottom layer of the board are dedicated for signals. Always shield the layer above and below signal layers with ground planes.
- Keep the signal and power grounds for each IC separate but have them tied together in a low noise area of the PCB. **Note:** Be careful that noise or high current paths from the power supply grounds does not disrupt the signal ground. Avoid placing signal and sensitive analog grounds in the paths of these noise and high current grounds.
- Place low ESR ceramic bypass capacitors directly at the power supply inputs of DC/DC regulators. These capacitors are necessary to filter out any high frequency noise on the power supply traces.
- Provide enough PCB trace width to carry the power supply currents. This is especially important for the core rail which provides very high currents. Route the power dissipation across the PCB trace in such a way the thermal dissipation can be properly carried away from the board.
- For DC/DC regulator ICs that have a back side EPAD, expose the PCB solder mask to provide proper thermal transfer from the IC to the PCB. In addition, include the proper amount of vias to maximize thermal performance. The vias should connect to all ground layers to spread out the heat.

3.2 Schematic Diagrams

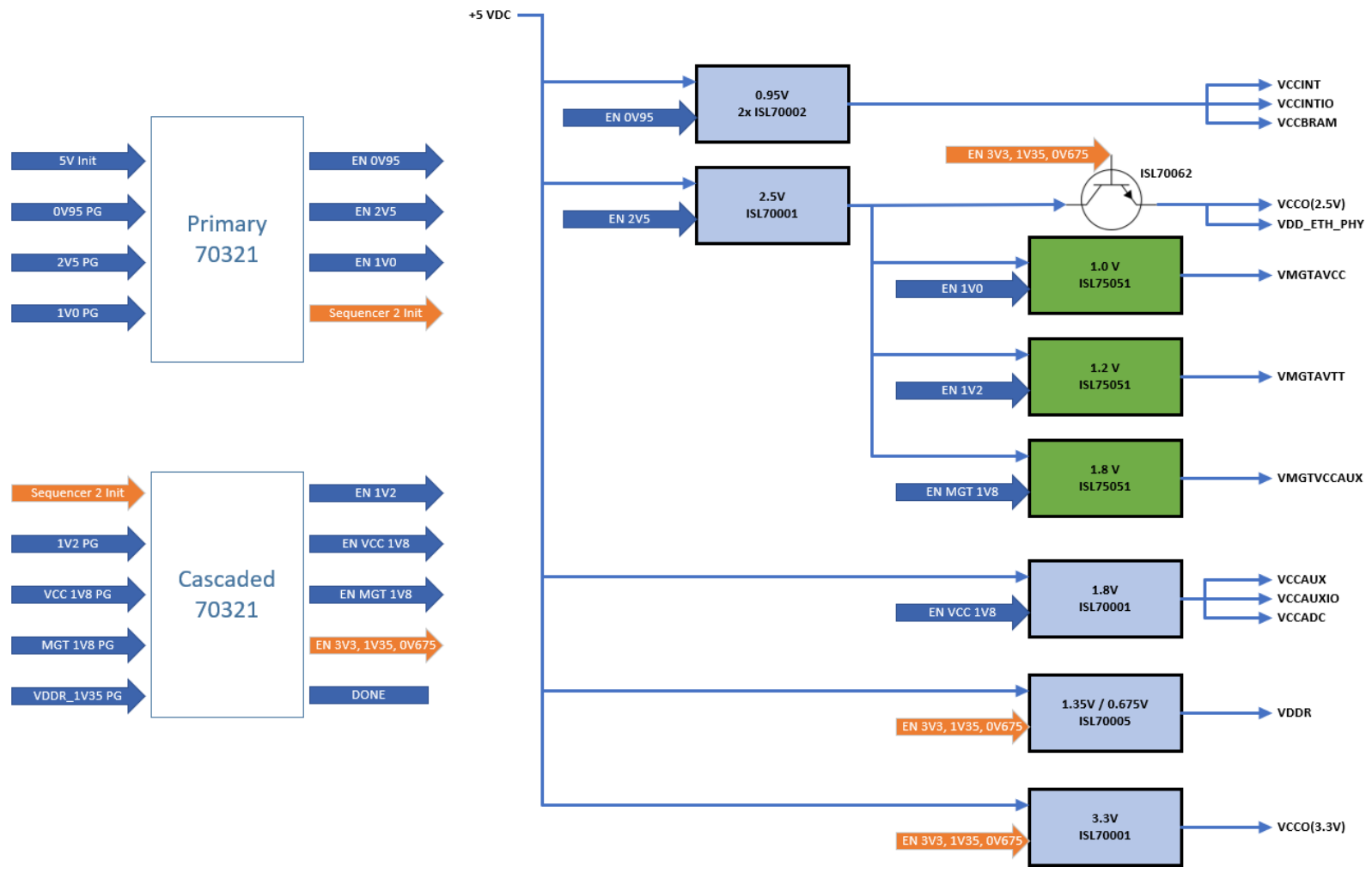


Figure 16. Schematic Page 1

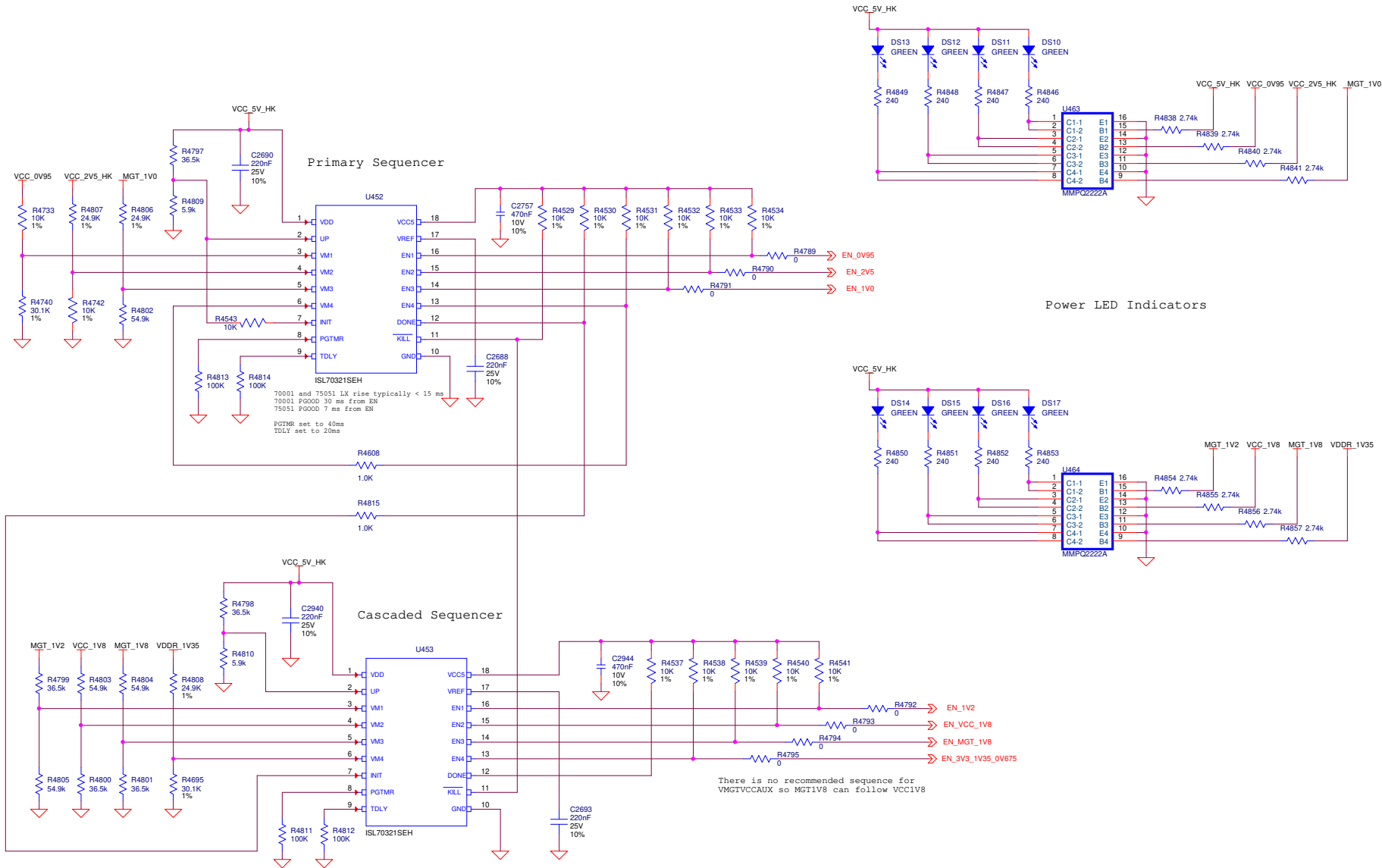


Figure 17. Schematic Page 2



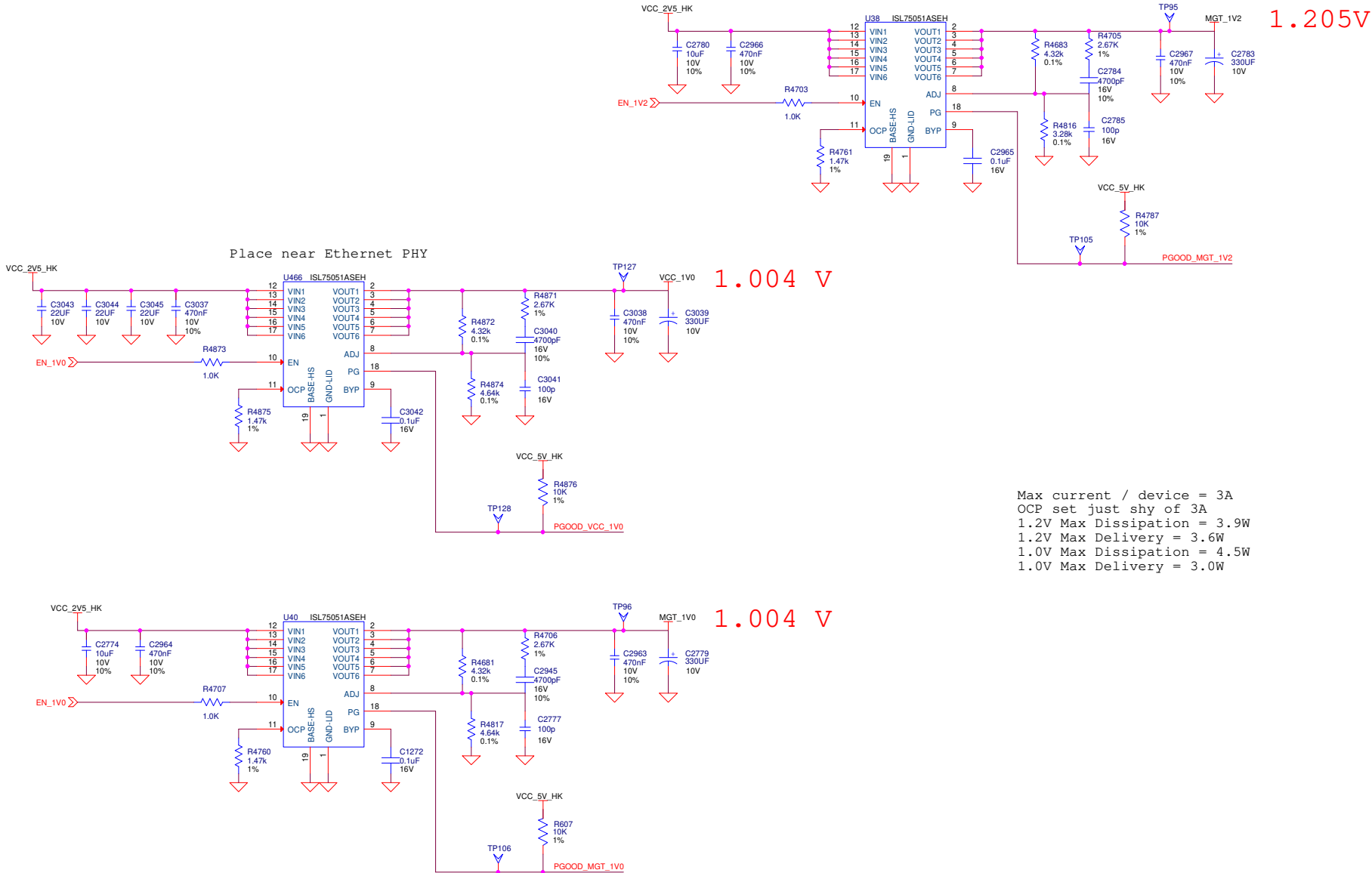


Figure 19. Schematic Page 4



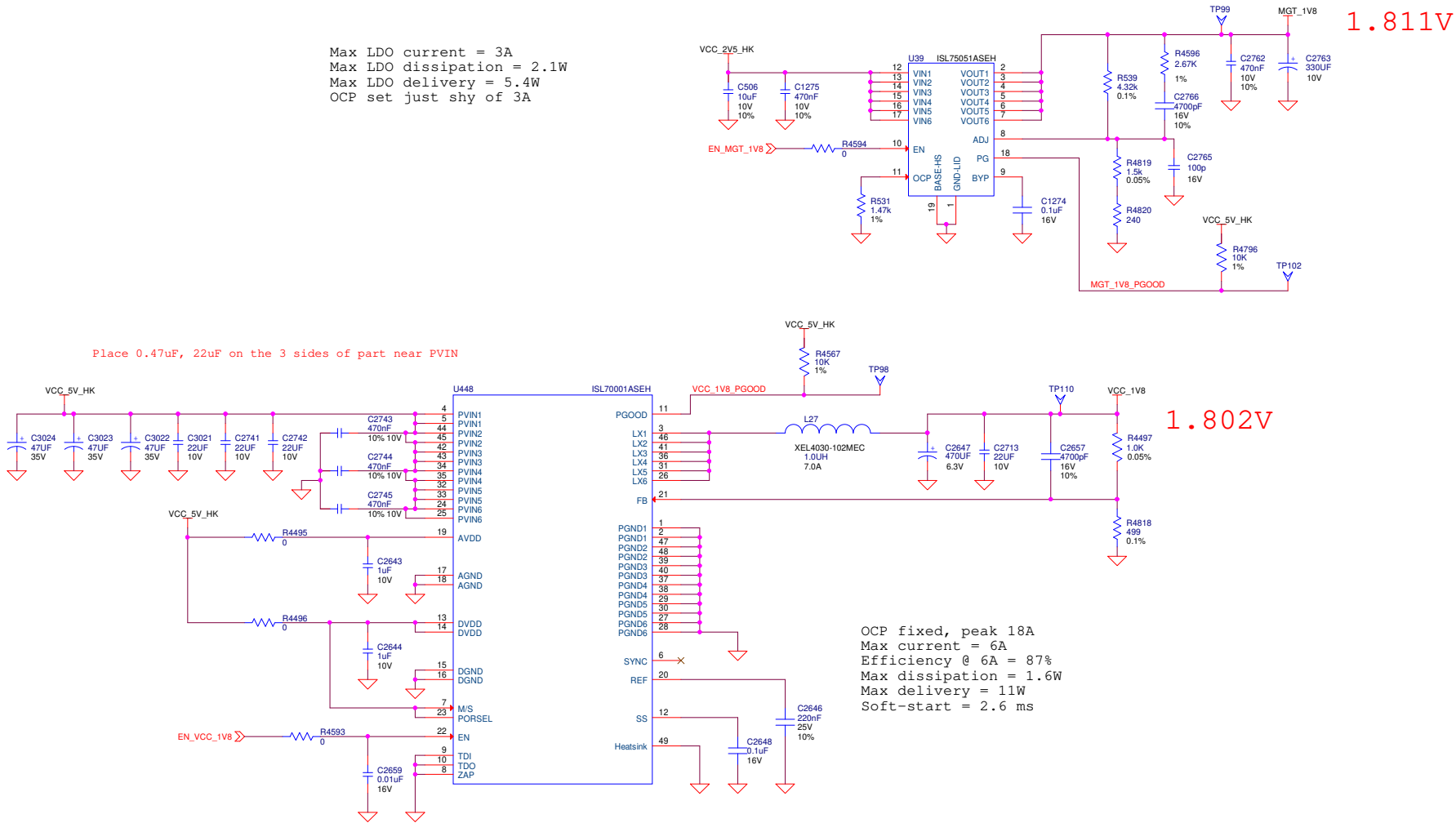
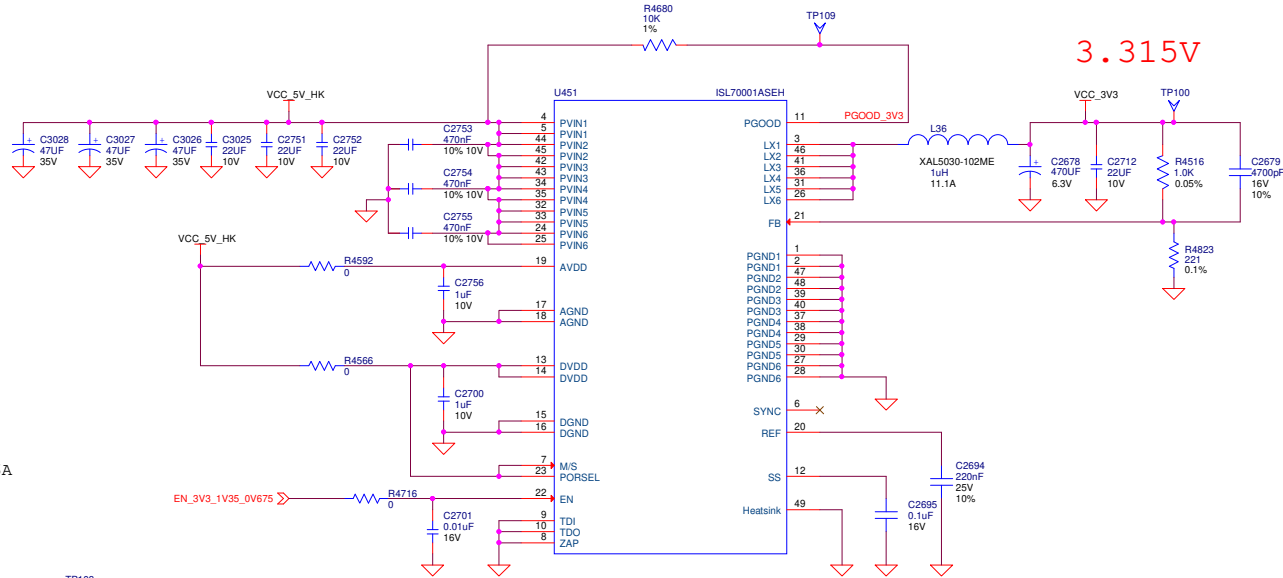


Figure 21. Schematic Page 6



OCP fixed, peak 18A
 Max current = 6A
 Efficiency @ 6A = 87%
 Max dissipation = 3W
 Max delivery = 20W
 Soft-start = 2.6 ms

OCP fixed, peak 18A
 Max continuous current = 6A
 Efficiency @ 6A = 87%
 Max dissipation = 2.3W
 Max delivery = 15.3W
 Soft-start = 2.6 ms

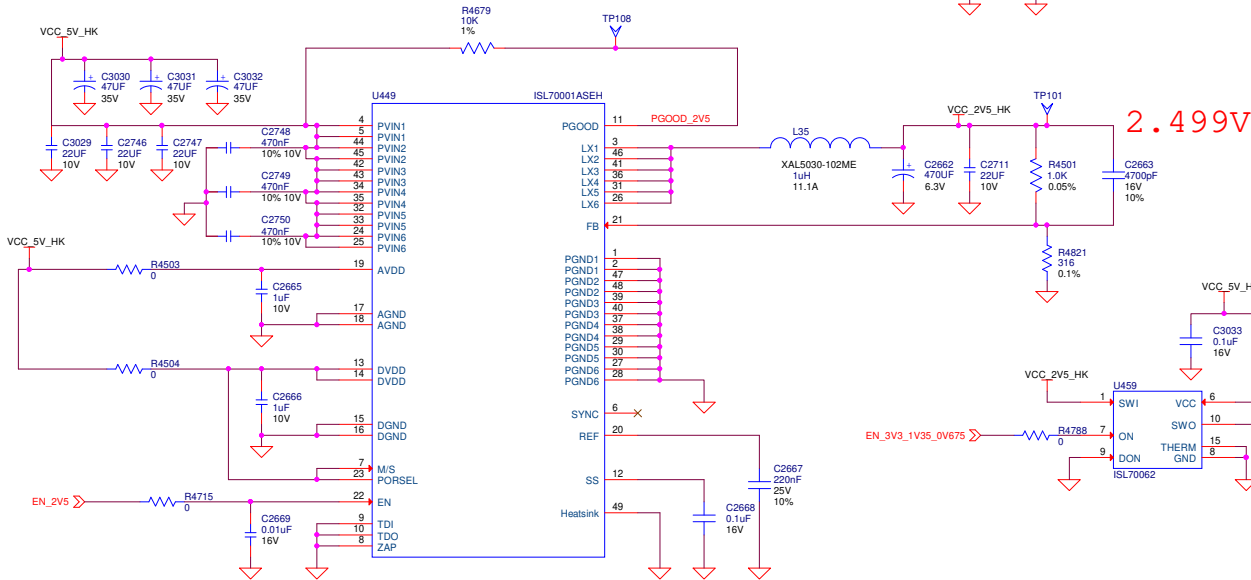
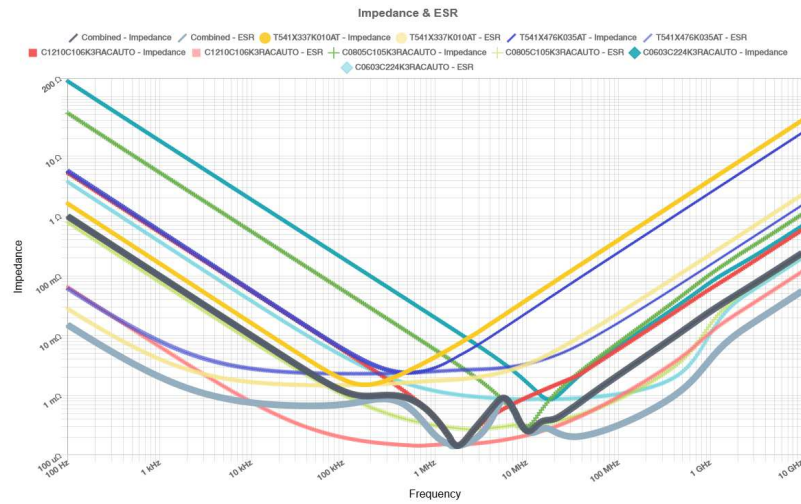
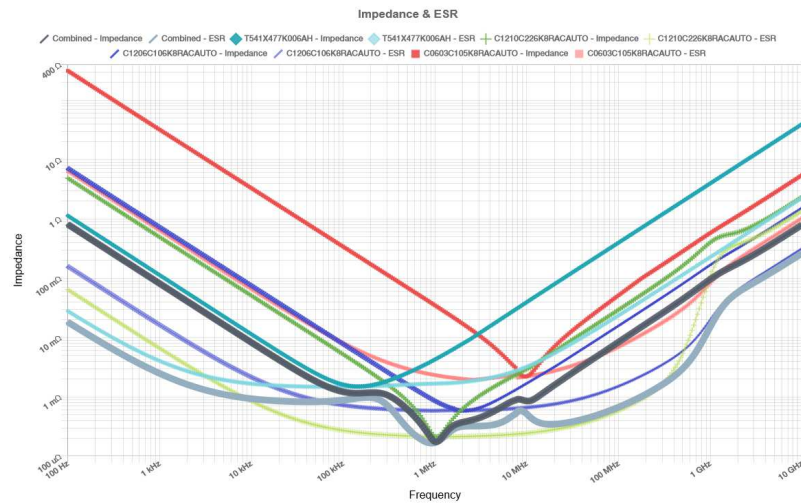


Figure 22. Schematic Page 7

AMD Reference Decoupling Network Impedance:



BOM-Optimized Decoupling Network Impedance:



Decoupling designed to a 6A load step

Recommended PCB Capacitors per Device

Example decoupling capacitor quantities for the XORU060-CNA1509 device are listed in Table 77 to Table 81. The optimized quantities of PCB decoupling capacitors assume that the voltage regulators have stable output voltages and meet the regulator manufacturer's minimum output capacitance requirements. These recommendations assume a regulator (DC) tolerance of $\pm 2\%$ and an AC tolerance of $\pm 1\%$, except for V_{CCINT} which assumes an AC tolerance of $\pm 2\%$. The total of the DC and AC tolerances must be within the recommended operating conditions specified in Table 5.

Table 77: Decoupling Capacitor Quantities for V_{CCINT} with Sample Step Currents

$V_{CCINT}/V_{CCBRAM}/V_{CCINT_IO}$ Combined or V_{CCINT}/V_{CCINT_IO} Combined ⁽¹⁾					
Step current (A)	330 μ F	47 μ F	10 μ F	1.0 μ F	0.22 μ F
6	3	6	30	30	40
5	2	5	19	21	25
4	1	4	16	16	16
3	1	2	8	8	8
2	1	1	3	3	3

Notes:

- V_{CCINT_IO} is tied internally in the CNA1509 package to V_{CCINT} .
- Step current is typically a fraction of dynamic current; roughly 15–33%.

Table 78: Decoupling Capacitor Quantities for V_{CCBRAM}

V_{CCBRAM}	
47 μ F	10 μ F
1	1

Table 79: Decoupling Capacitor Quantities for V_{CCCAUX}/V_{CCCAUX_IO}

V_{CCCAUX}/V_{CCCAUX_IO} (combined)	
47 μ F	10 μ F
1	1

Notes:

- Based on 2.0A of I_{CCCAUX} + I_{CCCAUX_IO} dynamic current.

Table 80: Decoupling Capacitor Quantities for V_{CCD} per Bank

V_{CCD_IO} (per bank) or V_{CCD_HE} (per bank)	
47 μ F	10 μ F
1	1

Notes:

- When combining banks, one 47 μ F can power up to four connected banks.

Table 81: Decoupling Capacitor Specifications and Sample Part Numbers

Value (μ F)	Case	Type	ESR (m Ω)	ESL (nH)	Sample Part Number
330	D	Tant Poly	5.84	1.90	Kemet T541X337M010ATE
47	D	Tant Poly	15.22	1.90	Kemet T541D476M3.5ATE
10	1210	X7R	20	1.62	
1.0	0805	X7R	19	2.50	
0.22	0603	X7R	12	2.50	

Decoupling methods other than those presented in these tables can be used, but the decoupling network should be designed to meet or exceed the performance of the simple decoupling networks presented here. The impedance of the alternate network is recommended to be less than or equal to that of the recommended network across frequencies from 100 kHz to approximately 10 MHz.

Using KEMET's K-SIM capacitor simulation software we find that the AMD design has peak impedance of about 1.5 mOhm over frequency. Iterating in the same tool we derive a network with a similar figure, but fewer components. This reduces the BOM and simplifies PCB layout.

Both designs are under $Z_{target} = 3\text{mOhm}$.

File	
Renesas KU060 Reference Design	
Rev	1.0

Figure 23. Schematic Page 8



U34-27			
A3	NC 1	NC 42	J4
A4	NC 2	NC 43	J7
A7	NC 3	NC 44	J8
A8	NC 4	NC 45	K1
B1	NC 5	NC 46	K10
B10	NC 6	NC 47	K5
B2	NC 7	NC 48	K6
B5	NC 8	NC 49	K9
B6	NC 9	NC 50	L3
B9	NC 10	NC 51	L4
C3	NC 11	NC 52	L7
C4	NC 12	NC 53	L8
C7	NC 13	NC 54	M1
C8	NC 14	NC 55	M2
D1	NC 15	NC 56	M5
D2	NC 16	NC 57	M6
D5	NC 17	NC 58	M9
D6	NC 18	NC 59	M10
D9	NC 19	NC 60	N3
E3	NC 20	NC 61	N4
E4	NC 21	NC 62	N7
E7	NC 22	NC 63	N8
E8	NC 23	NC 64	P1
F1	NC 24	NC 65	P10
F2	NC 25	NC 66	P2
F10	NC 26	NC 67	P5
F5	NC 27	NC 68	P6
F6	NC 28	NC 69	P9
F9	NC 29	NC 70	R3
G3	NC 30	NC 71	R4
G4	NC 31	NC 72	R7
G7	NC 32	NC 73	R8
G8	NC 33	NC 74	T1
H1	NC 34	NC 75	T2
H10	NC 35	NC 76	T5
H2	NC 36	NC 77	T6
H5	NC 37	NC 78	U3
H6	NC 38	NC 79	U4
H9	NC 39	NC 80	U7
J3	NC 40	NC 81	U8
J3	NC 41	NC 82	

XCKU060-1FFVA15171

Bank 224 corner transceiver moved
to pins T1,T2 on XQRK060 Package

T1/T2 tied to GND according to
DS882 "QTH Transceiver Migration"

B1 is NC on A1517 (CGA) Pinout

U34-25			
B11	GND 175	GND 263	N37
B18	GND 176	GND 264	N5
B3	GND 177	GND 265	N8
B38	GND 178	GND 266	P12
B7	GND 179	GND 267	P22
C1	GND 180	GND 268	P31
C10	GND 181	GND 269	P39
C11	GND 182	GND 270	P35
C15	GND 183	GND 271	P7
C25	GND 184	GND 272	R1
C35	GND 185	GND 273	R10
C5	GND 186	GND 274	R19
G9	GND 187	GND 275	R29
D11	GND 188	GND 276	R31
D12	GND 189	GND 277	R33
D22	GND 190	GND 278	R37
D3	GND 191	GND 279	R5
D35	GND 192	GND 280	R9
D7	GND 193	GND 281	T12
E1	GND 194	GND 282	T16
E10	GND 195	GND 283	T14
E11	GND 196	GND 284	T26
E19	GND 198	GND 286	T3
E28	GND 199	GND 287	T31
E38	GND 200	GND 288	T35
E5	GND 201	GND 289	T39
F1	GND 202	GND 290	U1
F16	GND 203	GND 291	U13
F26	GND 204	GND 292	U15
F3	GND 205	GND 293	U17
F36	GND 206	GND 294	U19
G1	GND 207	GND 295	U21
G17	GND 208	GND 296	U23
G10	GND 209	GND 297	U25
G11	GND 210	GND 298	U29
G13	GND 211	GND 299	U27
G23	GND 212	GND 300	U31
G33	GND 213	GND 301	U33
G5	GND 214	GND 302	U37
G9	GND 215	GND 303	U5
H11	GND 216	GND 304	V10
H20	GND 217	GND 305	V12
H3	GND 218	GND 306	V14
H30	GND 219	GND 307	V16
H7	GND 220	GND 308	V18
J1	GND 221	GND 309	V20
J10	GND 222	GND 310	V22
J11	GND 223	GND 311	V24
J17	GND 224	GND 312	V26
J27	GND 225	GND 313	V28
J37	GND 226	GND 314	V3
K1	GND 227	GND 315	V30
K11	GND 228	GND 316	V31
K14	GND 229	GND 317	V35
K24	GND 230	GND 318	V39
K3	GND 231	GND 319	V7
K34	GND 232	GND 320	W1
K7	GND 233	GND 321	W13
L1	GND 234	GND 322	W17
L10	GND 235	GND 323	W19
L11	GND 236	GND 324	W21
L21	GND 237	GND 325	W23
L31	GND 238	GND 326	W25
L5	GND 239	GND 327	W27
L9	GND 240	GND 328	W29
M11	GND 241	GND 329	W31
M18	GND 242	GND 330	W33
M28	GND 243	GND 331	W37
M3	GND 244	GND 332	W5
M33	GND 245	GND 333	Y10
M34	GND 246	GND 334	Y12
M35	GND 247	GND 335	Y14
M36	GND 248	GND 336	Y18
M37	GND 249	GND 337	Y20
M38	GND 250	GND 338	Y22
M39	GND 251	GND 339	Y24
M7	GND 252	GND 340	Y26
N1	GND 253	GND 341	Y28
N10	GND 254	GND 342	Y3
N11	GND 255	GND 343	Y30
N15	GND 256	GND 344	Y31
N25	GND 257	GND 345	Y35
N31	GND 258	GND 346	Y38
N32	GND 259	GND 347	Y39
N37	GND 260	GND 348	Y7
N38	GND 261	GND 349	Y8
N39	GND 262	GND 350	

XCKU060-1FFVA15171

AW2 is NC on A1517 (CGA) Pinout

U34-24			
A10	GND 1	GND 88	AH30
A11	GND 2	GND 89	AH33
A2	GND 3	GND 90	AH34
A21	GND 4	GND 91	AH35
A31	GND 5	GND 92	AH38
A5	GND 6	GND 93	AH39
A6	GND 7	GND 94	AH7
A9	GND 8	GND 95	AJ1
AA1	GND 9	GND 96	AJ10
AA13	GND 10	GND 97	AJ11
AA17	GND 11	GND 98	AJ17
AA19	GND 12	GND 99	AJ27
AA21	GND 13	GND 100	AJ35
AA23	GND 14	GND 101	AJ36
AA25	GND 15	GND 102	AJ37
AA27	GND 16	GND 103	AJ38
AA29	GND 17	GND 104	AJ5
AA31	GND 18	GND 105	AJ9
AA33	GND 19	GND 106	AK11
AA37	GND 20	GND 107	AK14
AA5	GND 21	GND 108	AK24
AB10	GND 22	GND 109	AK3
AB12	GND 23	GND 110	AK34
AB14	GND 24	GND 111	AK7
AB18	GND 25	GND 112	AL1
AB20	GND 26	GND 113	AL10
AB22	GND 27	GND 114	AL11
AB24	GND 28	GND 115	AL21
AB26	GND 29	GND 116	AL31
AB28	GND 30	GND 117	AL5
AB31	GND 31	GND 118	AL9
AB30	GND 32	GND 119	AM11
AB31	GND 33	GND 120	AM18
AB35	GND 34	GND 121	AM28
AB38	GND 35	GND 122	AM3
AB7	GND 36	GND 123	AM38
AC1	GND 37	GND 124	AM7
AC13	GND 38	GND 125	AN1
AC15	GND 39	GND 126	AN10
AC17	GND 40	GND 127	AN11
AC19	GND 41	GND 128	AN15
AC21	GND 42	GND 129	AN25
AC23	GND 43	GND 130	AN35
AC25	GND 44	GND 131	AN6
AC27	GND 45	GND 132	AN9
AC29	GND 46	GND 133	AP11
AC31	GND 47	GND 134	AP12
AC33	GND 48	GND 135	AP22
AC37	GND 49	GND 136	AP3
AC5	GND 50	GND 137	AP32
AD12	GND 51	GND 138	AP7
AD22	GND 52	GND 139	AR1
AD3	GND 53	GND 140	AR10
AD30	GND 54	GND 141	AR11
AD31	GND 55	GND 142	AR19
AD35	GND 56	GND 143	AR29
AD38	GND 57	GND 144	AR39
AD7	GND 58	GND 145	AR5
AE1	GND 59	GND 146	AR9
AE10	GND 60	GND 147	AT11
AE19	GND 61	GND 148	AT26
AE29	GND 62	GND 149	AT3
AE31	GND 63	GND 150	AT36
AE33	GND 64	GND 151	AT7
AE37	GND 65	GND 152	AU1
AE5	GND 66	GND 153	AU10
AE9	GND 67	GND 154	AU11
AF16	GND 68	GND 155	AU13
AF26	GND 69	GND 156	AU23
AF3	GND 70	GND 157	AU33
AF31	GND 71	GND 158	AU5
AF35	GND 72	GND 159	AU9
AF38	GND 73	GND 160	AV11
AF7	GND 74	GND 161	AV20
AG1	GND 75	GND 162	AV3
AG10	GND 76	GND 163	AV30
AG13	GND 77	GND 164	AV7
AG23	GND 78	GND 165	AW10
AG31	GND 79	GND 166	AW11
AG32	GND 80	GND 167	AW17
AG33	GND 81	GND 168	AW2
AG5	GND 82	GND 169	AW27
AG8	GND 83	GND 170	AW37
AH11	GND 84	GND 171	AW6
AH20	GND 85	GND 172	AW6
AH3	GND 86	GND 173	AW9
AH9	GND 87	GND 174	

XCKU060-1FFVA15171

A2 is NC on A1517 (CGA) Pinout

Figure 25. Schematic Page 10

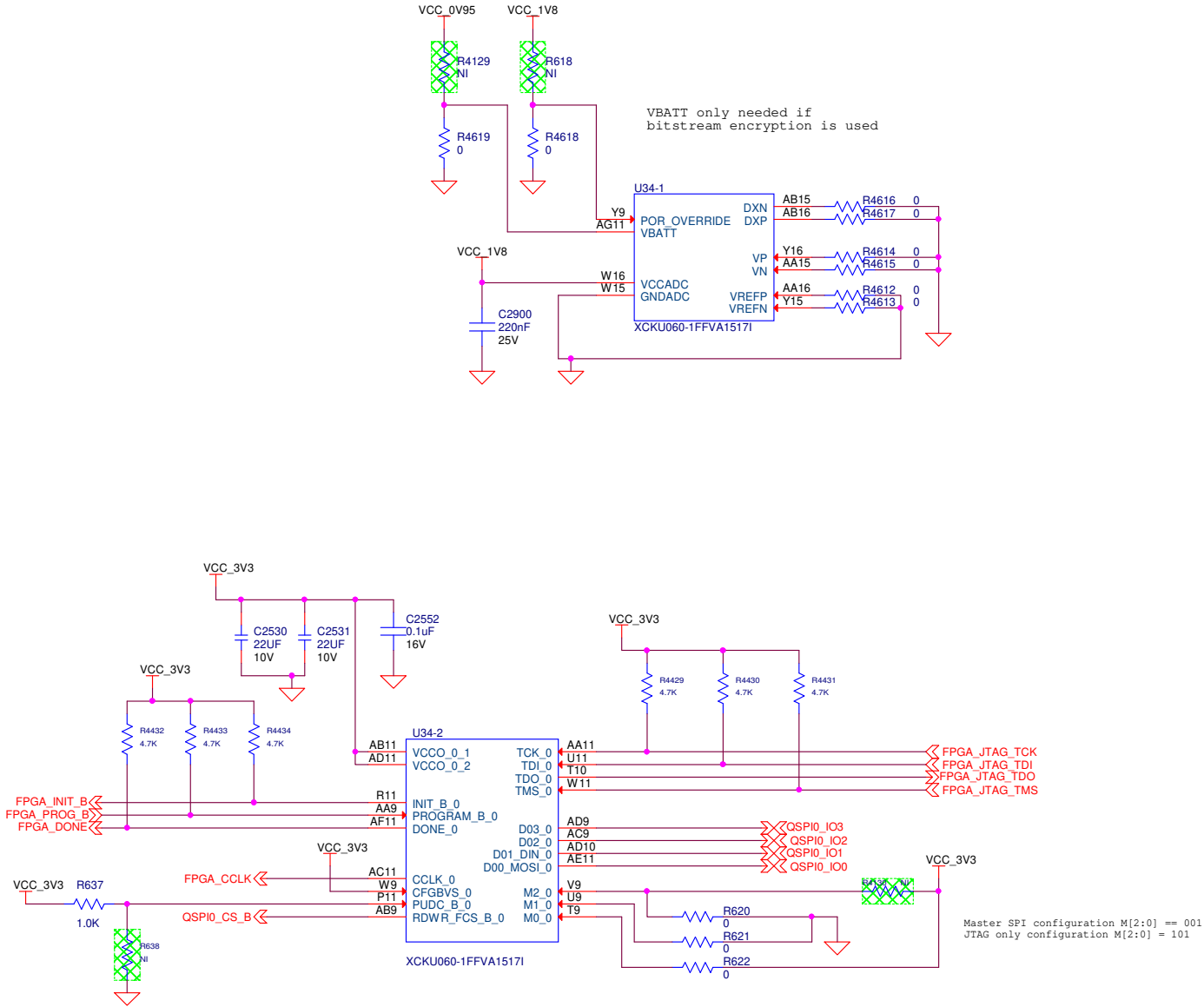


Figure 26. Schematic Page 11

HP Voltage = 0.950 V to 1.890 V
Maximum clamp-current per pin = 10mA
Maximum clamp-current per 52-pin bank = 200mA

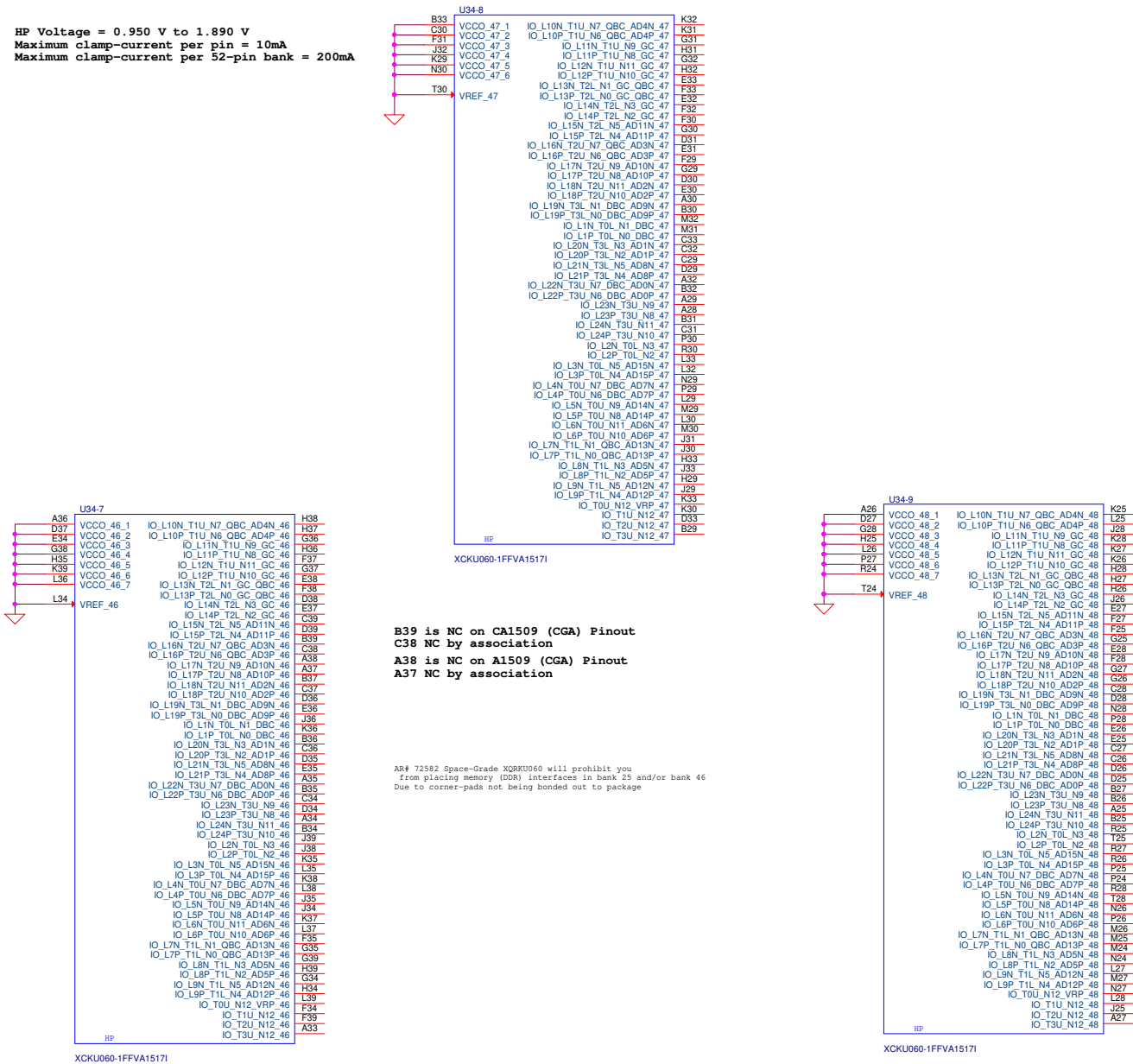
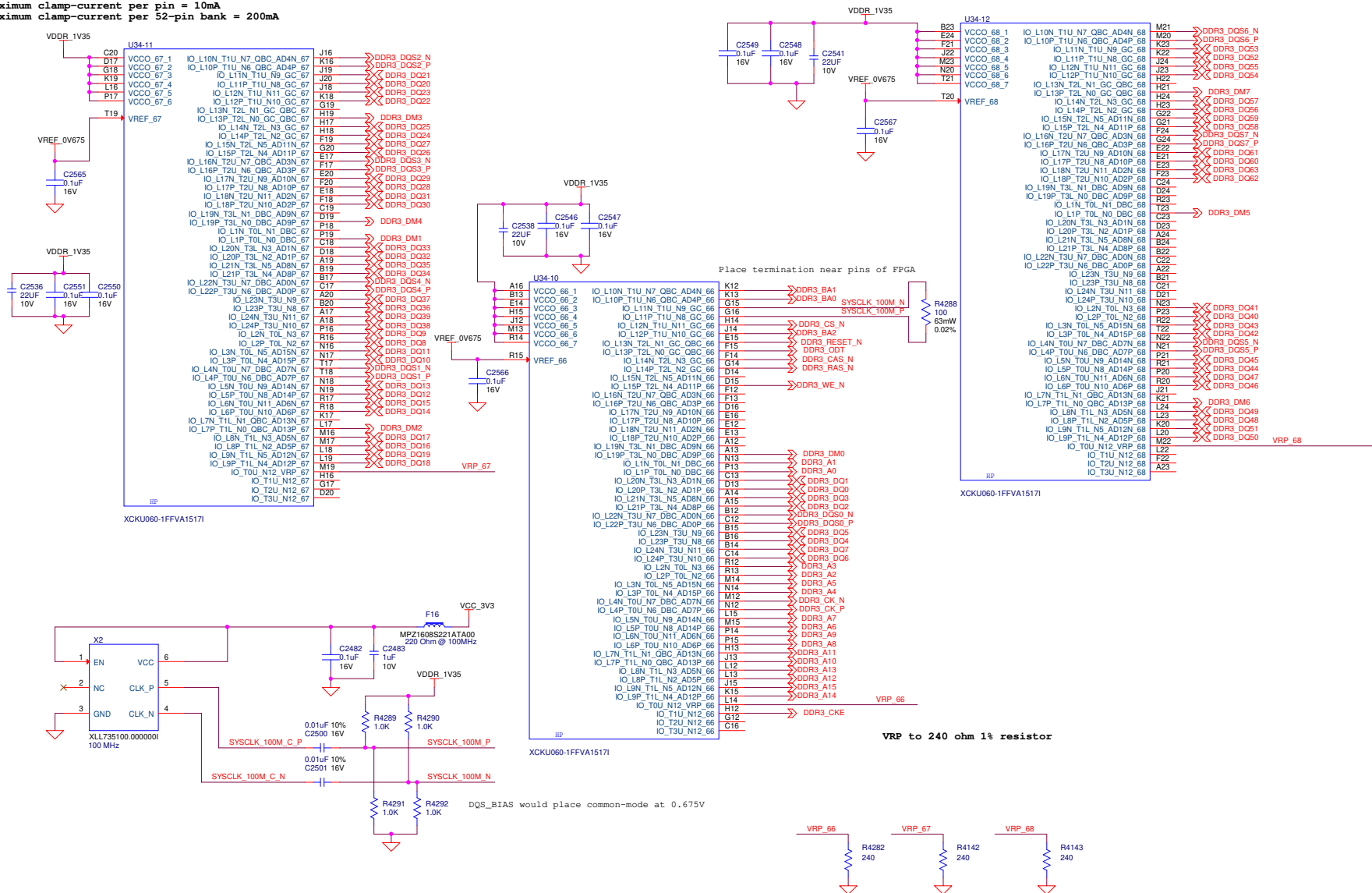
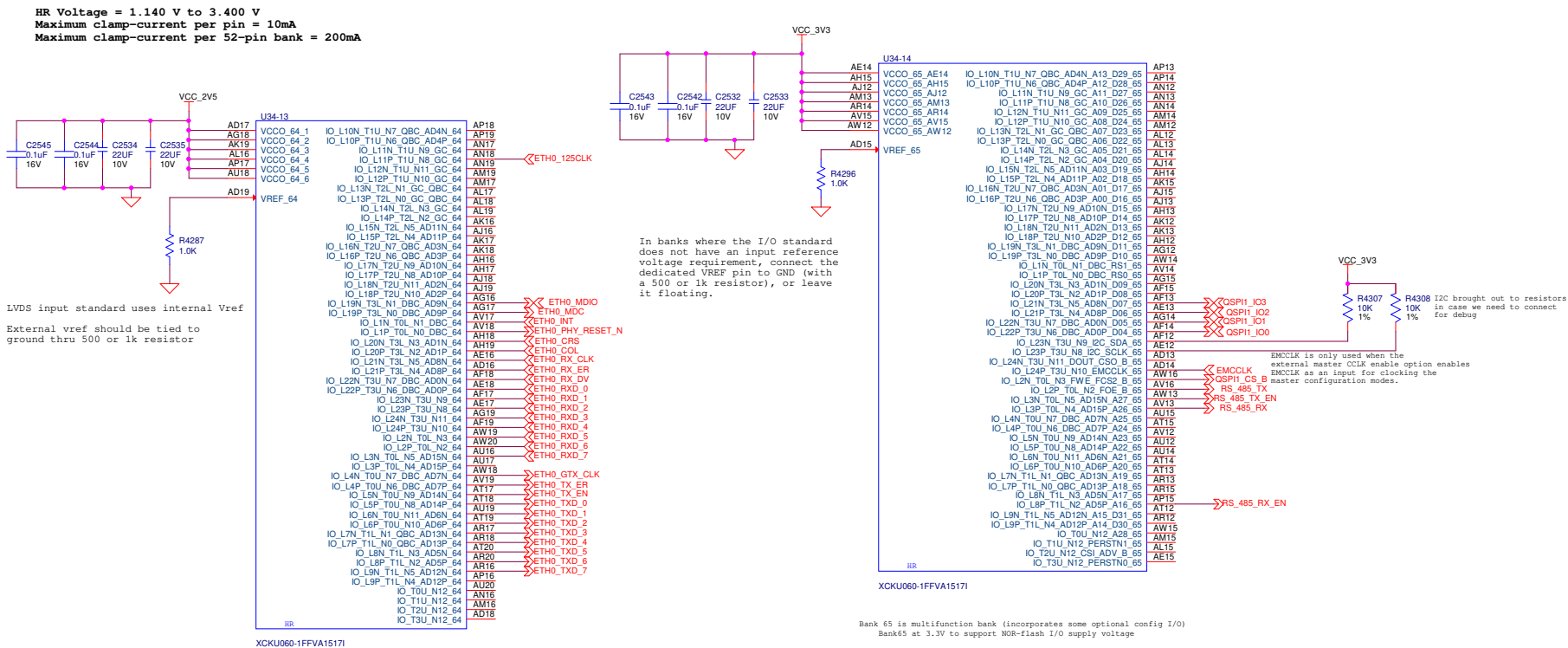
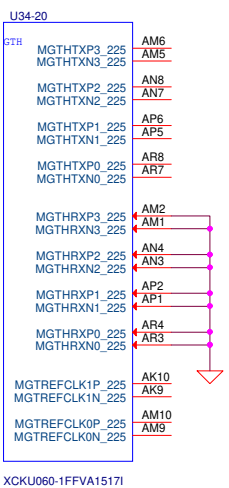
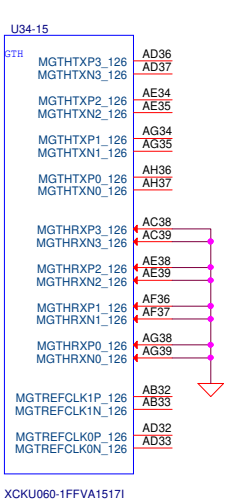
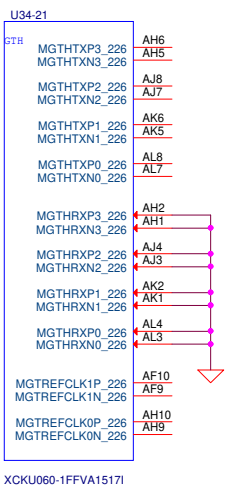
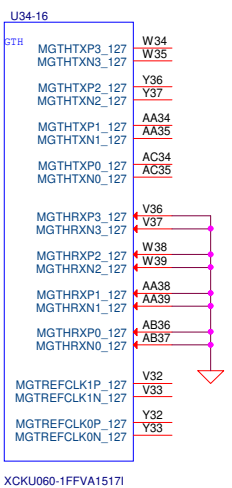
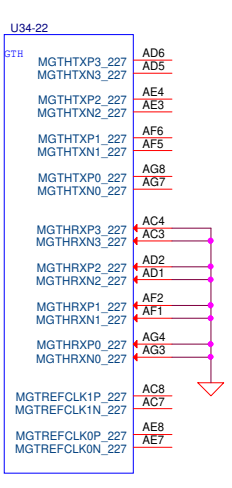
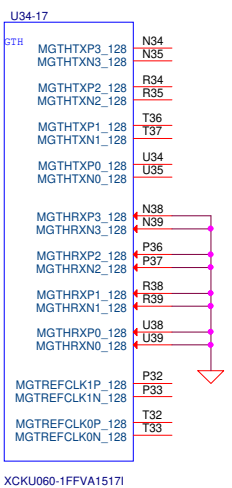
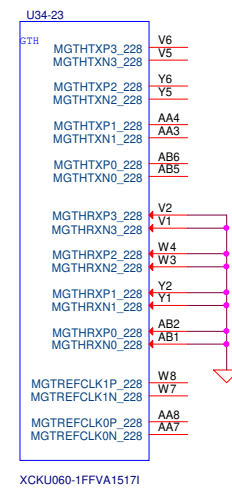
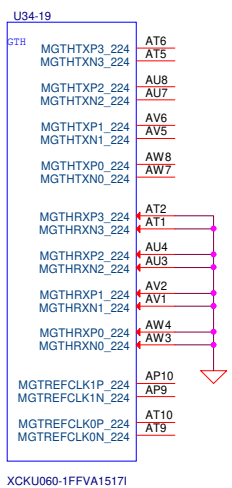


Figure 28. Schematic Page 13

Max memory interfaces speed is 1600Mb/s according to table 26 in DS892 (-1L speed grade, 0.95V core, FF package)







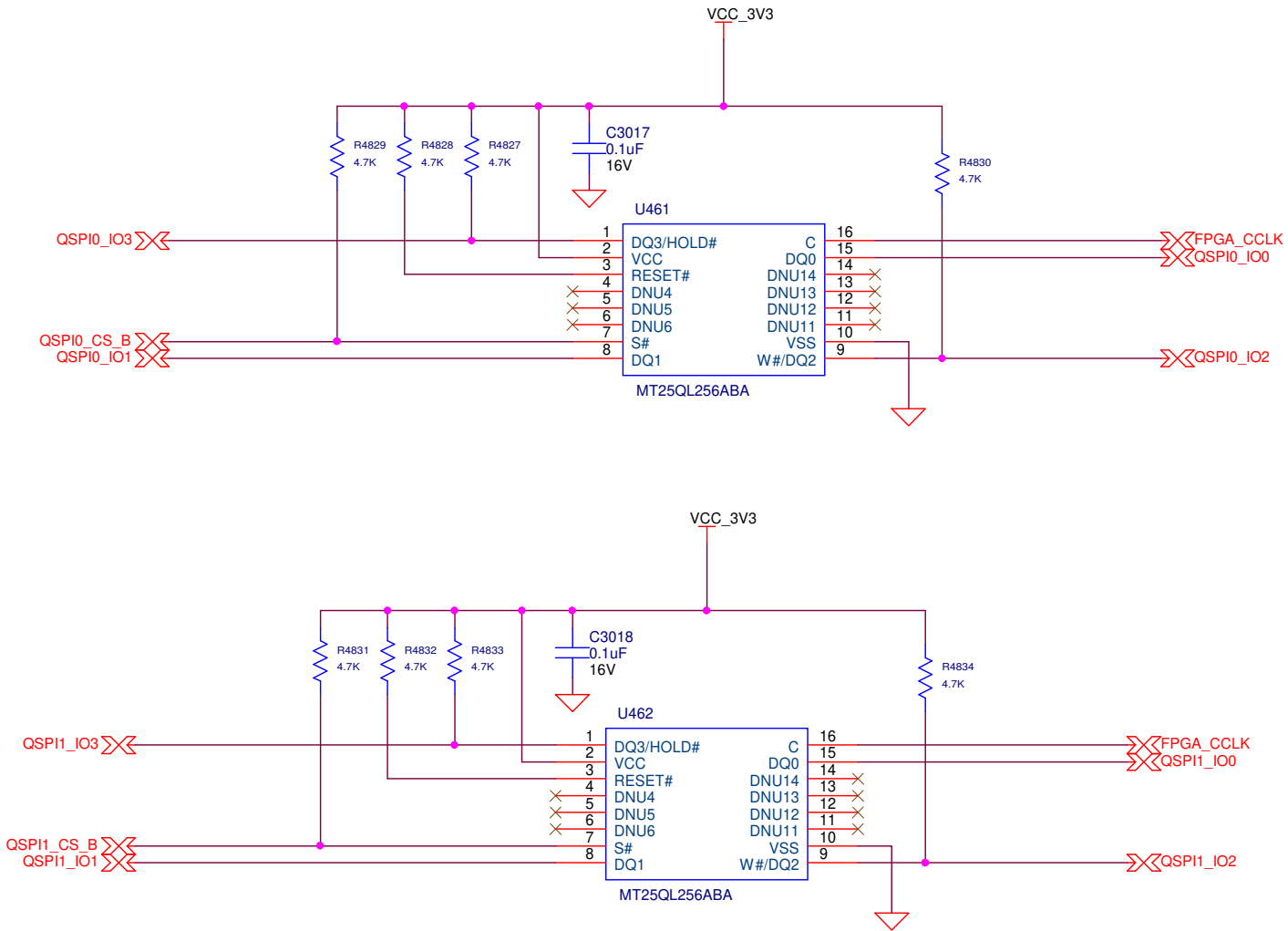


Figure 32. Schematic Page 17

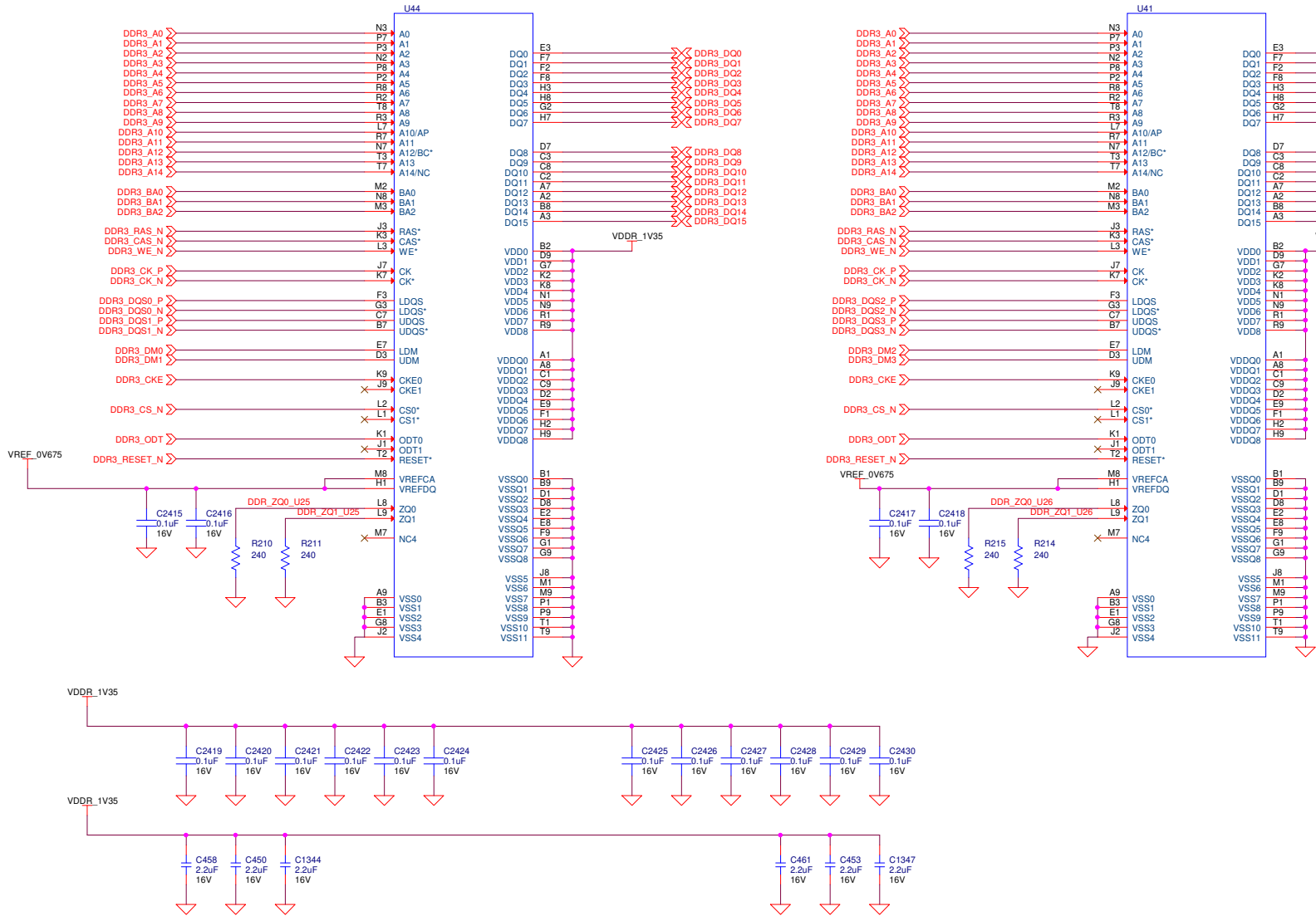


Figure 33. Schematic Page 18

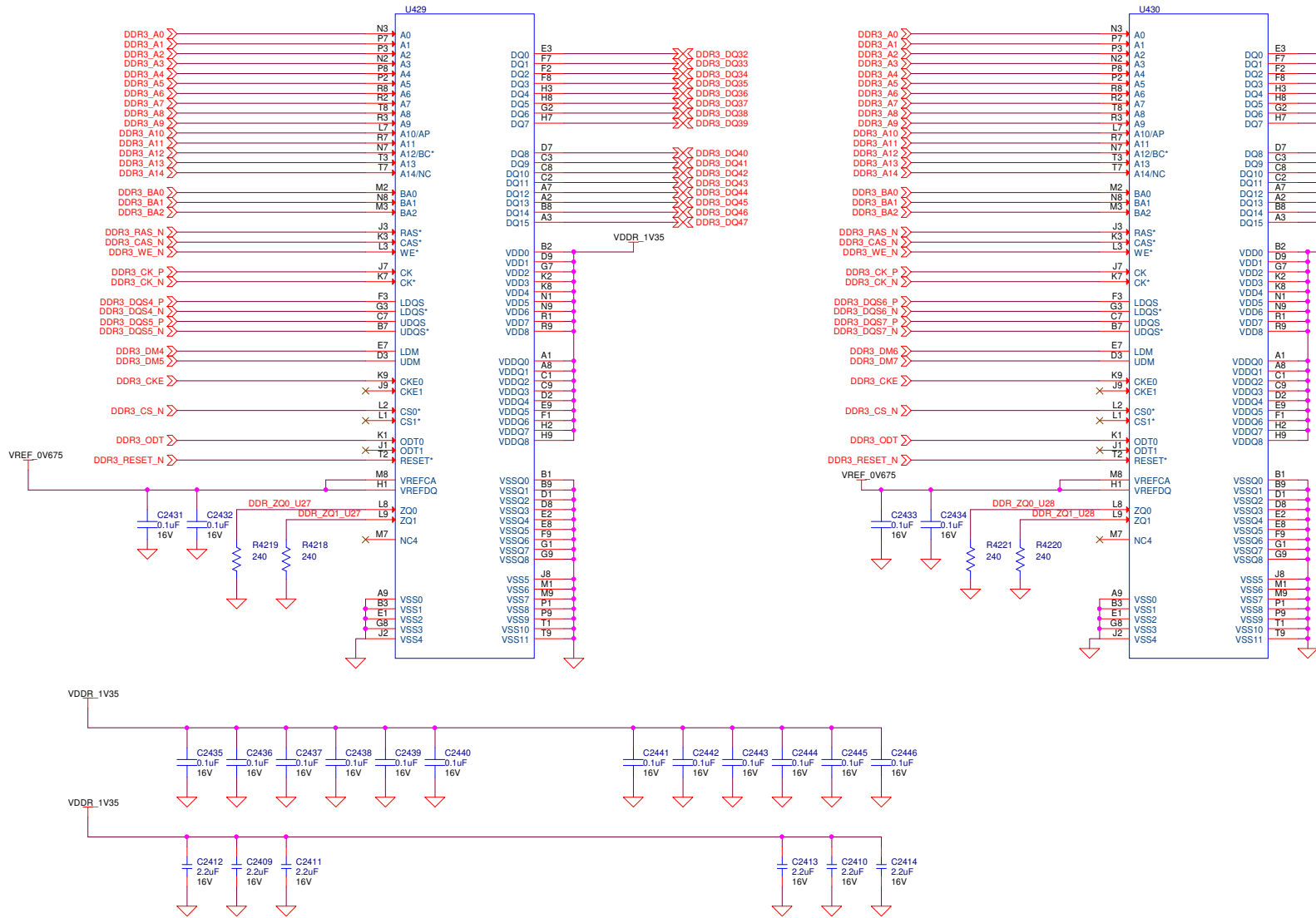


Figure 34. Schematic Page 19

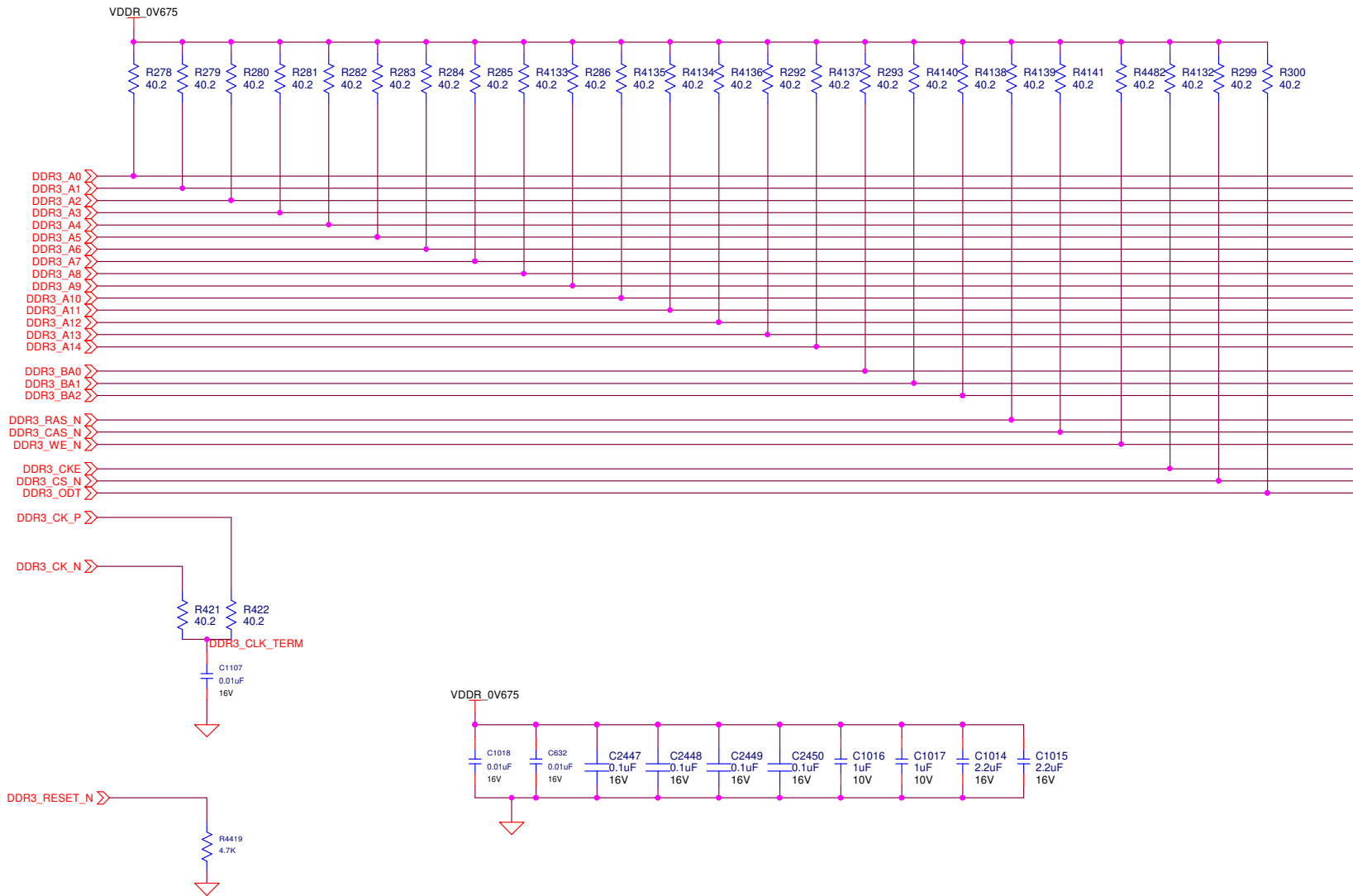
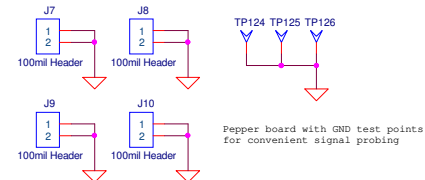
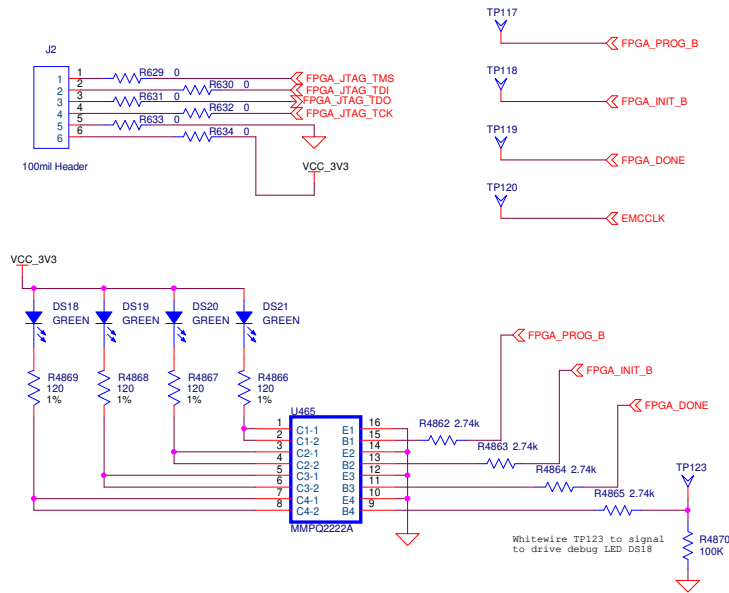


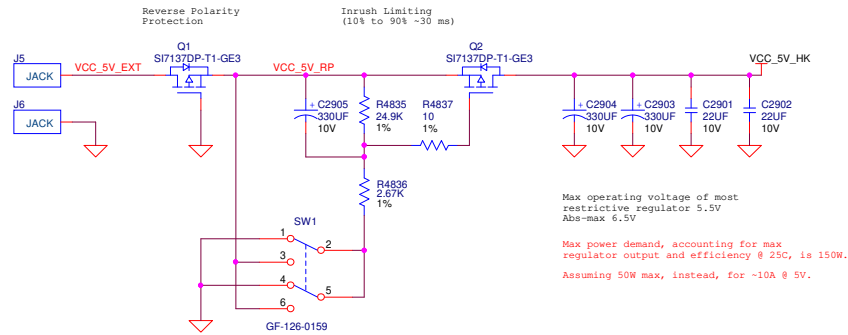
Figure 35. Schematic Page 20



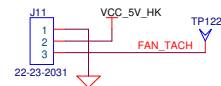
JTAG and FPGA Configuration



5V Power Input



FPGA Fan



RS-485

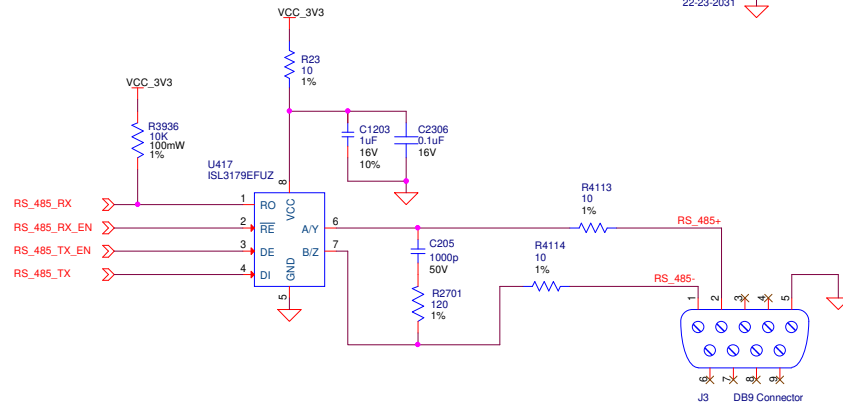


Figure 37. Schematic Page 22

3.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1		PWB-PCB, ISLKU060DEMO1Z, REVA, ROHS	Imagineering Inc	ISLKU060DEMO1ZREVAPCB
4	C2765, C2777, C2785, C3041	CAP, SMD, 0402, 100pF, 16V, 10%, C0G/NP0, ROHS	Kemet	C0402C101K4GACTU
5	C205, C2576, C2578, C2911, C2935	CAP-AEC-Q200, SMD, 0402, 1000pF, 50V, 5%, C0G/NP0, ROHS	Kemet	C0402C102J5GACAUTO
16	C632, C865, C1018, C1107, C2495, C2496, C2497, C2498, C2500, C2501, C2659, C2669, C2701, C2927, C2955, C2956	CAP-AEC-Q200, ESD, SMD, 0402, 0.01μF, 16V, 10%, X7R, ROHS	Kemet	C0402C103K4RECAUTO
96	C869, C1272, C1274, C2306, C2415, C2416, C2417, C2418, C2419, C2420, C2421, C2422, C2423, C2424, C2425, C2426, C2427, C2428, C2429, C2430, C2431, C2432, C2433, C2434, C2435, C2436, C2437, C2438, C2439, C2440, C2441, C2442, C2443, C2444, C2445, C2446, C2447, C2448, C2449, C2450, C2455, C2460, C2461, C2462, C2463, C2464, C2465, C2466, C2467, C2468, C2469, C2470, C2471, C2482, C2484, C2488, C2489, C2492, C2493, C2523, C2524, C2525, C2526, C2542, C2543, C2544, C2545, C2546, C2547, C2548, C2549, C2550, C2551, C2552, C2555, C2563, C2564, C2565, C2566, C2567, C2599, C2600, C2601, C2602, C2603, C2604, C2648, C2668, C2695, C2932, C2951, C2965, C3017, C3018, C3033, C3042	CAP-AEC-Q200, SMD, 0402, 0.1μF, 16V, 10%, X7R, ROHS	Kemet	C0402C104K4RACAUTO
1	C2575	CAP-AEC-Q200, SMD, 0402, 2200pF, 50V, 10%, X7R, ROHS	Kemet	C0402C222K5RACAUTO
8	C2657, C2663, C2679, C2766, C2784, C2945, C3016, C3040	CAP-AEC-Q200, SMD, 0402, 4700pF, 16V, 10%, X7R, ROHS	Kemet	C0402C472K4RACAUTO

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	C2952	CAP-AEC-Q200, SMD, 0402, 0.047µF, 25V, 10%, X7R, ROHS	Kemet	C0402C473K3RACAUTO
1	C2577	CAP-AEC-Q200, SMD, 0402, 680pF, 50V, 10%, X7R, ROHS	Kemet	C0402C681K5RACAUTO
4	C2912, C2914, C2933, C2937	CAP-AEC-Q200, SMD, 0402, 6800pF, 50V, 10%, X7R, ROHS	Kemet	C0402C682K5RACAUTO
1	C1291	CAP-AEC-Q200, SMD, 0402, 82pF, 25V, 5%, C0G/NP0, ROHS	Kemet	C0402C820J3GACAUTO
27	C863, C864, C1016, C1017, C1203, C2366, C2368, C2376, C2483, C2485, C2606, C2643, C2644, C2665, C2666, C2700, C2708, C2709, C2756, C2925, C2926, C3009, C3010, C3011, C3012, C3013, C3014	CAP, SMD, 0603, 1.0µF, 16V, 10%, X7R, ROHS	Kemet	C0603C105K4RACTU
11	C2367, C2646, C2667, C2688, C2690, C2693, C2694, C2900, C2940, C2953, C2954	CAP-AEC-Q200, SMD, 0603, 0.22µF, 25V, 10%, X7R, ROHS	Kemet	C0603C224K3RACAUTO
30	C857, C858, C859, C860, C861, C1275, C2743, C2744, C2745, C2748, C2749, C2750, C2753, C2754, C2755, C2757, C2762, C2920, C2921, C2922, C2923, C2924, C2944, C2960, C2963, C2964, C2966, C2967, C3037, C3038	CAP-AEC-Q200, SMD, 0603, 0.47µF, 16V, 10%, X7R, ROHS	Kemet	C0603C474K4RACAUTO
20	C450, C453, C458, C461, C1014, C1015, C1344, C1347, C2409, C2410, C2411, C2412, C2413, C2414, C2557, C2558, C2559, C2560, C2561, C2562	CAP-AEC-Q200, SMD, 0805, 2.2µF, 16V, 10%, X7R, ROHS	Kemet	C0805C225K4RACAUTO721
38	C361, C506, C1075, C1076, C1102, C1267, C1268, C2517, C2518, C2519, C2520, C2521, C2522, C2774, C2780, C2895, C2987, C2988, C2989, C2990, C2991, C2992, C2993, C2994, C2995, C2996, C2997, C2998, C2999, C3000, C3001, C3002, C3003, C3004, C3005, C3006, C3007, C3008	CAP-AEC-Q200, SMD, 1206, 10µF, 16V, 10%, X7R, ROHS	Kemet	C1206C106K4RACAUTO

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
52	C412, C2373, C2374, C2527, C2528, C2530, C2531, C2532, C2533, C2534, C2535, C2536, C2538, C2541, C2597, C2598, C2711, C2712, C2713, C2741, C2742, C2746, C2747, C2751, C2752, C2901, C2902, C2910, C2931, C2938, C2939, C2972, C2973, C2974, C2975, C2976, C2977, C2978, C2979, C2980, C2981, C2982, C2983, C2984, C2985, C2986, C3021, C3025, C3029, C3043, C3044, C3045	CAP-AEC-Q200, SMD, 1210, 22 μ F, 10V, 10%, X7R, ROHS	Kemet	C1210C226K8RACAUTO
9	C2763, C2779, C2783, C2903, C2904, C2905, C2961, C2962, C3039	CAP-TANT, SMD, 7.3x4.3x4.3, 330 μ F, 10V, 20%, 5m Ω ESR, COTS, ROHS	Kemet	T541X337M010AH6510
17	C2894, C2915, C2919, C3015, C3019, C3020, C3022, C3023, C3024, C3026, C3027, C3028, C3030, C3031, C3032, C3034, C3035	CAP-TANT, SMD, 7.3x4.3x4.3, 47 μ F, 35V, 20%, 60m Ω ESR, COTS, ROHS	Kemet	T541X476M035AH6510
10	C397, C398, C2647, C2662, C2678, C2909, C2929, C2969, C2970, C2971	CAP-TANT, SMD, 7.3x4.3, 470 μ F, 6.3V, 20%, 10m Ω ESR, COTS, ROHS	Kemet	T541X477M006AH6710
2	L35, L36	COIL-PWR INDUCTOR, AEC-Q200, SMD, 5.2x5.4mm, 1 μ H, 20%, 14A, ROHS	Coilcraft	XAL5030-102MEB
1	L24	COIL-PWR INDUCTOR, SMD, 5.2x5.4mm, 2.2 μ H, 20%, 9.2A, 13.2m Ω , ROHS	Coilcraft	XAL5030-222MEB
1	L27	COIL-PWR INDUCTOR, AEC-Q200, SMD, 4mm, 1 μ H, 20%, 9A, ROHS	Coilcraft	XEL4030-102MEB
2	L33, L34	COIL-PWR INDUCTOR, AEC-Q200, SMD, 6.1x5mm, 0.47 μ H, 20%, 22A, ROHS	Coilcraft	XGL6060-471MEB
1	J11	CONN-HEADER, 1x3, SOLID, 2.54mm, FRICTION LOCK, ROHS	Molex	22-23-2031
2	J5, J6	CONN-JACK, MINI BANANA, 0.175 PLUG, NICKEL/BRASS, ROHS	Keystone	575-4

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
4	J7, J8, J9, J10	CONN-HEADER, 1x2, 2.54mmCENTER, 0.236X0.118in., ROHS	Wurth Elektronik	61300211121
1	J2	CONN-HEADER, 1x6, BREAKAWAY, 2.54mmPITCH, 0.236inx0.118in, ROHS	Wurth Elektronik	61300611121
1	J4	CONN-MODULAR, FEMALE JACK, ETHERNET, RJ45, TH, 1PORT, R/A, ROHS	Halo Electronics	HFJ11-1G11E-L12RL
1	J3	CONN-D-SUB, MALE PLUG, TH, 9POSITION, R/A, ROHS	Amphenol/FCI	LD09P13A4GX00LF
2	D12, D13	DIODE-RECTIFIER, SMD, SMC, 2P, 20V, 3A, ROHS	On Semiconductor	MBRS320T3G
12	DS10, DS11, DS12, DS13, DS14, DS15, DS16, DS17, DS18, DS19, DS20, DS21	LED, SMD, 0603, GREEN/DIFFUSED, 2.2V, 20mA, 18MCD, 565nm, ROHS	Lumex	SML-LX0603GW-TR
4	DS4, DS5, DS7, DS8	LED, SMD, 0603, YELLOW/DIFFUSED, 2.1V, 20mA, 14MCD, 585nm, ROHS	Lumex	SML-LX0603YW-TR
3	F11, F16, F17	FERRITE CHIP, SMD, 0603, 50mΩ, 2.2A, 220Ω at 100MHz, ROHS	TDK	MPZ1608S221ATA00
4	U41, U44, U429, U430	IC-DRAM MEMORY, 3.3V, DDR3, 256Mx16, SMD, 96P, BGA, AUTOMOTIVE, ROHS	ISSI (Lumissil Microsystems)	IS46TR16256ECL-107NB2LA2 IS46TR16256BL-107MBLA2 (alternative p/n; Non error correction code (ECC) version)
3	U448, U449, U451 *Sub ISL70001ASEHFE/MS	IC-PROTO, RAD/SEE HARD 6A REGULATOR, 48P, CQFP, W/HEATSINK, ROHS	Renesas Electronics America	ISL70001ASEHFE/PROTO
2	U2, U423 *Sub ISL70002SEHFE/MS	IC-12A SYNC BUCK REGULAT, 64P, CQFP, W/HEATSINK, ROHS	Renesas Electronics America	ISL70002SEHFE/PROTO
1	U422 *Sub ISL70005SEHF/MS	IC-RAD HARD LDO REGULATOR, SMD, 28P, CFP, ROHS	Renesas Electronics America	ISL70005SEHF/PROTO
1	U459 *Sub ISL70062SEHF/MS	IC-RAD HARD, LOW VOLT SWITCH, 14P, CFP, ROHS	Renesas Electronics America	ISL70062SEHF/PROTO
1	U460 *Sub ISL70244SEHF/MS	IC-19MHz RAD HARD R/R OP AMP, 10P, FP, ROHS	Renesas Electronics America	ISL70244SEHF/PROTO
2	U452, U453 *Sub ISL70321SEHF/MS	IC-RADHARD QUAD SEQUENCER, 18P, FLATPAK, ROHS	Renesas Electronics America	ISL70321SEHF/PROTO

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
4	U38, U39, U40, U466 *Sub ISL75051ASEHFE/MS	IC-RADHARD, CMOS 3A LDO REGULATOR, 18P, CFP, ROHS	Renesas Electronics America	ISL75051ASEHFE/PROTO
2	U461, U462	IC-AEC-Q100, NOR FLASH MEMORY, 256Mb, SMD, 16P, SOP2, ROHS	Micron Technology	MT25QL256ABA8ESF-0AAT
1	U34 *Sub XQDAISY- CNA1509	IC-FPGA, FLIP-CHIP, 624 I/O, SMD, 1517P, BBGA, ROHS	AMD	XCKU060-1FFVA1517I
3	U463, U464, U465	IC-TRANSISTOR-4 NPN, 40V, 0.5A, 16P, SOIC, ROHS	On Semiconductor	MMPQ2222A
2	Q1, Q2	TRANSISTOR-MOS, P- CHANNEL, 8P, PWRPAK, - 20V, -60A, ROHS	Vishay/Siliconix	SI7137DP-T1-GE3
1	X3	OSC-CRYSTAL, 25MHz XO, HCMOS, 2.5V, SMD, 6P, 5.15x3.35mm, ROHS	Renesas Electronics	XLH526025.000000I
1	X2	OSC-CRYSTAL, 100MHz XO, LVDS, 3.3V, SMD, 6P, 7.5x5.2mm, ROHS	Renesas Electronics	XLL735100.000000I
1	R4781	POT-TRIM, CERMET, TH, 10.3x4.8, 10K, 1/3W, 10%, 1 TURN, TOP ADJ, ROHS	AMP-Piner	PTC10LV10-103A1010
1	R4780	RES-AEC-Q200, SMD, 0402, 10.5K, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2AEB1052X
1	R4779	RES-AEC-Q200, SMD, 0402, 1.87K, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2AEB1871X
1	R4823	RES-AEC-Q200, SMD, 0402, 221Ω, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2AEB2210X
1	R4821	RES-AEC-Q200, SMD, 0402, 316Ω, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2AEB3160X
3	R4478, R4479, R4818	RES-AEC-Q200, SMD, 0402, 499Ω, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2AEB4990X
2	R4817, R4874	RES-AEC-Q200, SMD, 0402, 4.64K, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2APB4641X
1	R4156	RES-AEC-Q200, SMD, 0402, 20K, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2ARB203X
1	R4268	RES-AEC-Q200, SMD, 0402, 4.99K, 1/16W, 0.1%, TF, ROHS	Panasonic	ERA-2ARB4991X

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	R4819	RES-AEC-Q200, SMD, 0402, 1.5K, 1/10W, 0.5%, THINFILM, ROHS	Panasonic	ERA-2VRW1501X
62	R620, R621, R622, R629, R630, R631, R632, R633, R634, R4194, R4195, R4196, R4199, R4264, R4266, R4279, R4495, R4496, R4503, R4504, R4566, R4592, R4593, R4594, R4612, R4613, R4614, R4615, R4616, R4617, R4618, R4619, R4631, R4632, R4644, R4645, R4652, R4654, R4662, R4663, R4664, R4665, R4677, R4697, R4698, R4700, R4701, R4708, R4714, R4715, R4716, R4777, R4778, R4782, R4788, R4789, R4790, R4791, R4792, R4793, R4794, R4795	RES-AEC-Q200, SMD, 0402, 0Ω, 1/10W, ROHS	Panasonic	ERJ-2GE0R00X
28	R637, R4262, R4283, R4284, R4285, R4286, R4287, R4289, R4290, R4291, R4292, R4296, R4464, R4467, R4468, R4469, R4470, R4471, R4472, R4473, R4474, R4608, R4696, R4702, R4703, R4707, R4815, R4873	RES-AEC-Q200, SMD, 0402, 1K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1001X
29	R607, R3936, R4154, R4307, R4308, R4529, R4530, R4531, R4532, R4533, R4534, R4537, R4538, R4539, R4540, R4541, R4543, R4567, R4635, R4639, R4656, R4657, R4679, R4680, R4733, R4742, R4787, R4796, R4876	RES-AEC-Q200, SMD, 0402, 10K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1002X
5	R4811, R4812, R4813, R4814, R4870	RES-AEC-Q200, SMD, 0402, 100K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1003X
4	R531, R4760, R4761, R4875	RES-AEC-Q200, SMD, 0402, 1.47K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1471X
1	R4713	RES-AEC-Q200, SMD, 0402, 169K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1693X

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	R4709	RES-AEC-Q200, SMD, 0402, 180Ω, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1800X
23	R210, R211, R214, R215, R4142, R4143, R4218, R4219, R4220, R4221, R4282, R4463, R4667, R4668, R4820, R4846, R4847, R4848, R4849, R4850, R4851, R4852, R4853	RES-AEC-Q200, SMD, 0402, 240Ω, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2400X
5	R4688, R4806, R4807, R4808, R4835	RES-AEC-Q200, SMD, 0402, 24.9K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2492X
5	R4596, R4705, R4706, R4836, R4871	RES-AEC-Q200, SMD, 0402, 2.67K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2671X
16	R4763, R4765, R4766, R4767, R4838, R4839, R4840, R4841, R4854, R4855, R4856, R4857, R4862, R4863, R4864, R4865	RES-AEC-Q200, SMD, 0402, 2.74K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF2741X
2	R4695, R4740	RES-AEC-Q200, SMD, 0402, 30.1K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF3012X
5	R4797, R4798, R4799, R4800, R4801	RES-AEC-Q200, SMD, 0402, 36.5K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF3652X
30	R173, R174, R278, R279, R280, R281, R282, R283, R284, R285, R286, R292, R293, R299, R300, R421, R422, R4132, R4133, R4134, R4135, R4136, R4137, R4138, R4139, R4140, R4141, R4267, R4482, R4582	RES-AEC-Q200, SMD, 0402, 40.2Ω, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF40R2X
20	R4419, R4420, R4421, R4422, R4423, R4424, R4429, R4430, R4431, R4432, R4433, R4434, R4827, R4828, R4829, R4830, R4831, R4832, R4833, R4834	RES-AEC-Q200, SMD, 0402, 4.7K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF4701X
10	R4271, R4272, R4273, R4274, R4275, R4276, R4277, R4278, R4476, R4477	RES-AEC-Q200, SMD, 0402, 49.9Ω, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF49R9X
5	R4193, R4802, R4803, R4804, R4805	RES-AEC-Q200, SMD, 0402, 54.9K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RKF5492X

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
2	R4809, R4810	RES-AEC-Q200, SMD, 0402, 5.9K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-2RK5901X
6	R23, R4113, R4114, R4759, R4783, R4837	RES-AEC-Q200, SMD, 0402, 10Ω, 1/5W, 1%, TF, ROHS	Panasonic	ERJ-PA2F10R0X
5	R2701, R4866, R4867, R4868, R4869	RES-AEC-Q200, SMD, 0402, 120Ω, 1/5W, 1%, TF, ROHS	Panasonic	ERJ-PA2F1200X
4	R4288, R4293, R4465, R4466	RES-AEC-Q200, SMD, 0402, 100Ω, 1/16W, 0.02%, THINFILM, ROHS	Susumu	RG1005V-101-P
6	R4197, R4198, R4497, R4501, R4516, R4641	RES-AEC-Q200, SMD, 0603, 1K, 1/10W, 0.05%, THINFILM, ROHS	Susumu	RG1608N-102-W-T1
4	R539, R4681, R4683, R4872	RES, SMD, 0402, 4.32K, 1/16W, 0.1%, THINFILM, ROHS	Yageo	RT0402BRD074K32L
1	R4816	RES-AEC-Q200, SMD, 0402, 3.28K, 1/10W, 0.1%, Thin Film, ROHS	Vishay/Dale	TNPW04023K28BEED
1	SW1	SWITCH-SLIDE, TH, 6P, DPDT, 3A, 125V, ROHS	CW Industries	GF-126-0159
4	Four corners	SCREW, 4-40X1/4in, PHILLIPS, PANHEAD, STAINLESS, ROHS	Building Fasteners	PMSSS 440 0025 PH
4	Four corners	STANDOFF, 4-40X3/4in, F/F, HEX, ALUMINUM, 0.25 OD, ROHS	Keystone	2204
1	U431	TRANSCEIVER-ETHERNET, SMD, 96P, aQFN, INDUSTRIAL, ROHS	Marvell	88E1111-B2-NDC2I000
0	R618, R638, R4129, R4130, R4228, R4263, R4265, R4280, R4630, R4651	DO NOT POPULATE OR PURCHASE		
0	TP92, TP93, TP94, TP95, TP96, TP97, TP98, TP99, TP100, TP101, TP102, TP103, TP104, TP105, TP106, TP107, TP108, TP109, TP110, TP116, TP117, TP118, TP119, TP120, TP121, TP122, TP123, TP124, TP125, TP126, TP127, TP128	DO NOT POPULATE OR PURCHASE		
1	U417	IC-TRANSCEIVER, 3.3V HALF DUPLEX, RS-485/RS-422, ROHS	Renesas Electronics	ISL3179EFUZ

4. Ordering Information

Part Number	Description
ISLKU060DEMO1Z	Rad Hard Power Management KU060 Reference Design

5. Revision History

Revision	Date	Description
1.02	Jul 25, 2024	Changed Xilinx to AMD throughout document.
1.01	Oct 18, 2022	Updated Figure 2.
1.00	Oct 15, 2021	Initial release

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