Side-channel Attack Standard Evaluation Board
SASEBO-R Specification

- Version 1.0 -

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Research Center for Information Security,
National Institute of Advanced Industrial Science and Technology

Index

1. Overview

The Side-channel Attack Standard Evaluation Board (SASEBO) is a board specifically designed to develop standard evaluation schemes to secure the cryptographic module against physical attacks. The SASEBO-R board can incorporate a cryptographic LSI. Figure 1 is a photograph of the SASEBO-R. The basic features of the SASEBO-R are as follows:

- 230 mm x 180 mm x 1.6 mm, FR-4, eight layers.
- 160-pin QFP socket and footprint.
  One cryptographic LSI (130-nm process, 160-pin QFP) is mounted on the socket.
  (Cryptographic LSI)
- Xilinx Virtex-II Pro FPGA XC2VP30-5FG676C for LSI control.
  (Control FPGA)
- The cryptographic LSI and the control FPGA are connected through a 16-bit bidirectional data bus and a 16-bit address signal, controlled by four signals: RD, WR, RESET, and CLOCK.
- A 24-MHz oscillator is mounted to the control FPGA. Two 8-pin dip sockets are provided in order to mount clock oscillators for the cryptographic LSI. External clock input is also supported.
- Power regulators supply the voltages of the cryptographic LSI and the control FPGA with a 3.3-V input. The core voltage of the cryptographic LSI can be applied directly through an external power connector.
- Shunt resistance is provided for power measurement of the devices.
- RS-232 and USB ports for communicating with the host PC

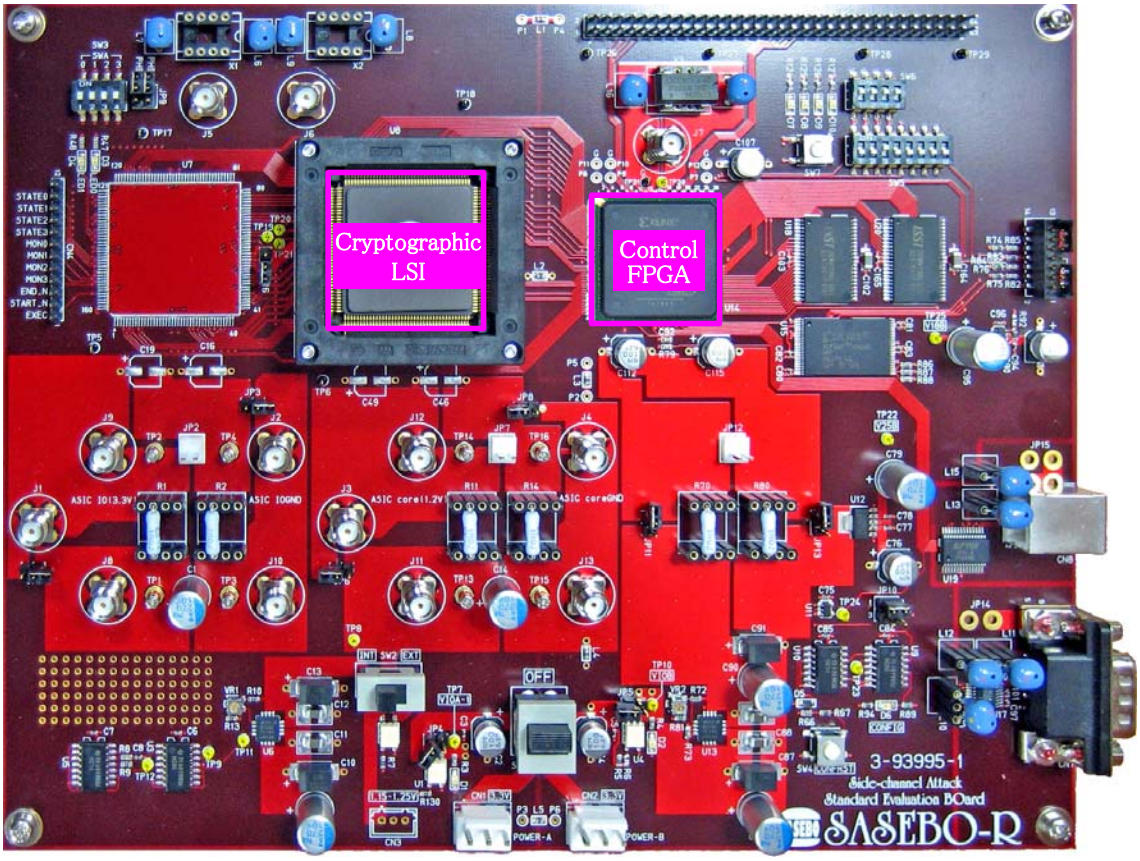


Figure 1: SASEBO-R

2. I/O Assignments

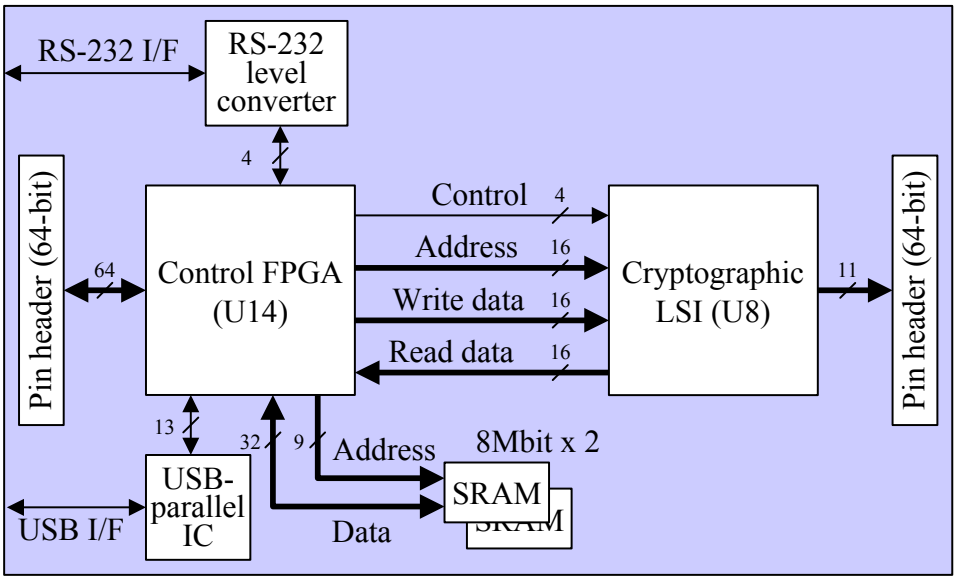


Figure 2: I/O signals

- Pin assignments of the cryptographic LSI (U8)

Table 1: LSI control

Signal Name	Pin Number	Input/Output	Description
CLKA	58	IN	CLOCK
HRST_N	63	IN	RESET
CLKB	56	IN	
LED0	135	OUT	
LED1	136	OUT	
SWA0	7	IN	SW3-8
SWA1	6	IN	SW3-7
SWA2	5	IN	SW3-6
SWA3	4	IN	SW3-5
PHIN0	10	IN	JP9
PHIN1	9	IN	JP9
PUSH	D9	IN	SW6

Table 2: Cryptographic circuit interface

Signal Name	Pin Number	INPUT/OUTPUT	Destination (U14)
FPGA_DI0	109	IN	F1
FPGA_DI1	110	IN	F2
FPGA_DI2	111	IN	E1
FPGA_DI3	112	IN	E2
FPGA_DI4	114	IN	D1
FPGA_DI5	115	IN	D2
FPGA_DI6	116	IN	C1
FPGA_DI7	117	IN	C2
FPGA_DI8	123	IN	K5
FPGA_DI9	124	IN	J4

FPGA_DI10	125	IN	J3
FPGA_DI11	126	IN	K4
FPGA_DI12	129	IN	K3
FPGA_DI13	130	IN	L5
FPGA_DI14	131	IN	L3
FPGA_DI15	132	IN	M4
FPGA_DO0	92	OUT	G2
FPGA_DO1	91	OUT	G1
FPGA_DO2	90	OUT	H2
FPGA_DO3	89	OUT	H1
FPGA_DO4	87	OUT	J2
FPGA_DO5	86	OUT	J1
FPGA_DO6	85	OUT	K2
FPGA_DO7	84	OUT	K1
FPGA_DO8	78	OUT	N5
FPGA_DO9	77	OUT	N4
FPGA_DO10	76	OUT	L2
FPGA_DO11	75	OUT	L1
FPGA_DO12	72	OUT	M2
FPGA_DO13	71	OUT	M1
FPGA_DO14	70	OUT	N2
FPGA_DO15	69	OUT	N6
FPGA_A0	52	IN	T2
FPGA_A1	51	IN	U1
FPGA_A2	50	IN	U2
FPGA_A3	49	IN	V1
FPGA_A4	46	IN	V2
FPGA_A5	45	IN	W1
FPGA_A6	44	IN	W2
FPGA_A7	43	IN	Y1
FPGA_A8	37	IN	Y2
FPGA_A9	36	IN	AA1
FPGA_A10	35	IN	AA2
FPGA_A11	34	IN	AB1
FPGA_A12	32	IN	AB2
FPGA_A13	31	IN	AC1
FPGA_A14	30	IN	AC2
FPGA_A15	29	IN	AD1
FPGA_WR	65	IN	R2
FPGA_RD	66	IN	R1
FPGA_RSV0	27	IN	AD2
FPGA_RSV1	26	IN	AE1

Table 3: LEDs and switches

Signal Name	Pin number	Input/Output	Description
STATE0	143	OUT	
STATE1	144	OUT	
STATE2	145	OUT	
STATE3	146	OUT	
EXEC	155	OUT	
MON0	149	-	

MON1	150	-	
MON2	151	-	
MON3	152	-	
START_N	138	-	
END_N	137	-	

- Pin assignments of the control FPGA (U14)

Table 4: Device control

Signal Name	Pin Number	Input/Output	Description
CDB0	AB21		Config
CDB1	AC21		Config
CDB2	Y20		Config
CDB3	AA20		Config
CDB4	AA7		Config
CDB5	Y7		Config
CDB6	AC6		Config
CDB7	AB6		Config
BUSY	AB22		Config
INIT_B	AC22		Config
GCLK	AE24		Config
PROG_B	B1		Config
DONE	AD23		Config
M0	AE3		SW5-1
M1	AF3		SW5-2
M2	AD4		SW5-3
TCLK	B26		JTAG
TDI	D3		JTAG
TDO	D24		JTAG
TMS	B24		JTAG
PWRDWN_B	AF24		SW5-4
HSWAP_EN	B3		SW5-5
VBATT	A24		P13
DXP	A3		P14
DXN	C4		P15
OSCX	N3	OUT	Clock
RESETB	Y9	IN	RESET
CLK	B13	IN	X3

Table 5: LEDs and switches

Signal Name	Pin Number	Input/Output	Description
D7	F24	OUT	LED
D8	J22	OUT	LED
D9	J24	OUT	LED
D10	J23	OUT	LED
DIPSW5	H22	IN	SW6-1
DIPSW6	K22	IN	SW6-2
DIPSW7	K23	IN	SW6-3
DIPSW8	K24	IN	SW6-4
PUSH	G22	IN	SW7

Table 6: RS-232

Signal Name	Pin Number	Input/Output	Destination
TX	AB14	OUT	Level converter
RX	AC15	IN	Level converter
CTS	AB15	OUT	Level converter
RTS	AA15	IN	Level converter

Table 7: Pin header

Signal Name	Pin Number	Input/Output	Destination
IOB0	F7	IO	CN6-1
IOB1	E6	IO	CN6-2
IOB2	E5	IO	CN6-3
IOB3	D6	IO	CN6-4
IOB4	D7	IO	CN6-5
IOB5	B8	IO	CN6-6
IOB6	A8	IO	CN6-7
IOB7	C9	IO	CN6-8
IOB8	C10	IO	CN6-9
IOB9	C7	IO	CN6-10
IOB10	F8	IO	CN6-11
IOB11	E8	IO	CN6-12
IOB12	E9	IO	CN6-13
IOB13	H9	IO	CN6-14
IOB14	D10	IO	CN6-15
IOB15	E10	IO	CN6-16
IOB16	E11	IO	CN6-17
IOB17	F11	IO	CN6-18
IOB18	E12	IO	CN6-19
IOB19	F12	IO	CN6-20
IOB20	C12	IO	CN6-21
IOB21	D12	IO	CN6-22
IOB22	F14	IO	CN6-23
IOB23	B14	IO	CN6-24
IOB24	C14	IO	CN6-25
IOB25	D14	IO	CN6-26
IOB26	E14	IO	CN6-27
IOB27	E15	IO	CN6-28
IOB28	E16	IO	CN6-29
IOB29	D17	IO	CN6-30
IOB30	E17	IO	CN6-31
IOB31	C15	IO	CN6-32
IOB32	C17	IO	CN6-33
IOB33	A19	IO	CN6-34
IOB34	B19	IO	CN6-35
IOB35	C20	IO	CN6-36
IOB36	F19	IO	CN6-37
IOB37	E19	IO	CN6-38
IOB38	D20	IO	CN6-39
IOB39	E20	IO	CN6-40
IOB40	D21	IO	CN6-41
IOB41	D22	IO	CN6-42
IOB42	E22	IO	CN6-43

IOB43	E21	IO	CN6-44
IOB44	G19	IO	CN6-45
IOB45	H17	IO	CN6-46
IOB46	J14	IO	CN6-47
IOB47	H11	IO	CN6-48
IOB48	H8	IO	CN6-49
IOB49	H10	IO	CN6-50
IOB50	G8	IO	CN6-51
IOB51	G11	IO	CN6-52
IOB52	E7	IO	CN6-53
IOB53	D5	IO	CN6-54
IOB54	H12	IO	CN6-55
IOB55	H14	IO	CN6-56
IOB56	F15	IO	CN6-57
IOB57	F16	IO	CN6-58
IOB58	G16	IO	CN6-59
IOB59	H19	IO	CN6-60
IOB60	F20	IO	CN6-61
IOB61	G20	IO	CN6-62
IOB62	H18	IO	CN6-63
IOB63	H16	IO	CN6-64

Table 8: Cryptographic circuit interface

Signal Name	Pin Number	Input/Output	Destination (U8)
FPGA_DI0	F1	OUT	109
FPGA_DI1	F2	OUT	110
FPGA_DI2	E1	OUT	111
FPGA_DI3	E2	OUT	112
FPGA_DI4	D1	OUT	114
FPGA_DI5	D2	OUT	115
FPGA_DI6	C1	OUT	116
FPGA_DI7	C2	OUT	117
FPGA_DI8	K5	OUT	123
FPGA_DI9	J4	OUT	124
FPGA_DI10	J3	OUT	125
FPGA_DI11	K4	OUT	126
FPGA_DI12	K3	OUT	129
FPGA_DI13	L5	OUT	130
FPGA_DI14	L3	OUT	131
FPGA_DI15	M4	OUT	132
FPGA_DO0	G2	IN	92
FPGA_DO1	G1	IN	91
FPGA_DO2	H2	IN	90
FPGA_DO3	H1	IN	89
FPGA_DO4	J2	IN	87
FPGA_DO5	J1	IN	86
FPGA_DO6	K2	IN	85
FPGA_DO7	K1	IN	84
FPGA_DO8	N5	IN	78
FPGA_DO9	N4	IN	77
FPGA_DO10	L2	IN	76
FPGA_DO11	L1	IN	75

FPGA_DO12	M2	IN	72
FPGA_DO13	M1	IN	71
FPGA_DO14	N2	IN	70
FPGA_DO15	N6	IN	69
FPGA_A0	T2	OUT	52
FPGA_A1	U1	OUT	51
FPGA_A2	U2	OUT	50
FPGA_A3	V1	OUT	49
FPGA_A4	V2	OUT	46
FPGA_A5	W1	OUT	45
FPGA_A6	W2	OUT	44
FPGA_A7	Y1	OUT	43
FPGA_A8	Y2	OUT	37
FPGA_A9	AA1	OUT	36
FPGA_A10	AA2	OUT	35
FPGA_A11	AB1	OUT	34
FPGA_A12	AB2	OUT	32
FPGA_A13	AC1	OUT	31
FPGA_A14	AC2	OUT	30
FPGA_A15	AD1	OUT	29
FPGA_WR	R2	OUT	65
FPGA_RD	R1	OUT	66
FPGA_RSV0	AD2		27
FPGA_RSV1	AE1		26

Table 9: USB

Signal Name	Pin Number	Input/Output	Destination
USB0	AB16	IO	USB I/F
USB1	AA16	IO	USB I/F
USB2	AB17	IO	USB I/F
USB3	AE14	IO	USB I/F
USB4	AC17	IO	USB I/F
USB5	AC14	IO	USB I/F
USB6	AD14	IO	USB I/F
USB7	AB20	IO	USB I/F
USBTXE	AE19	IN	USB I/F
USBRXF	AD20	IN	USB I/F
USBRD	AD17	OUT	USB I/F
USBWR	AF19	OUT	USB I/F
USBWREN	AD15	IN	USB I/F

Table 10: SRAM

Signal Name	Pin Number	Input/Output	Destination
MEMD0	U25	IO	Memory
MEMD1	V26	IO	Memory
MEMD2	V25	IO	Memory
MEMD3	W26	IO	Memory
MEMD4	W25	IO	Memory
MEMD5	Y26	IO	Memory
MEMD6	Y25	IO	Memory
MEMD7	AA26	IO	Memory
MEMD8	R26	IO	Memory
MEMD9	R25	IO	Memory

MEMD10	T26	IO	Memory
MEMD11	T25	IO	Memory
MEMD12	N25	IO	Memory
MEMD13	M26	IO	Memory
MEMD14	M25	IO	Memory
MEMD15	L26	IO	Memory
MEMD16	J26	IO	Memory
MEMD17	K25	IO	Memory
MEMD18	K26	IO	Memory
MEMD19	L25	IO	Memory
MEMD20	H26	IO	Memory
MEMD21	H25	IO	Memory
MEMD22	G26	IO	Memory
MEMD23	G25	IO	Memory
MEMD24	E25	IO	Memory
MEMD25	E26	IO	Memory
MEMD26	F25	IO	Memory
MEMD27	F26	IO	Memory
MEMD28	D26	IO	Memory
MEMD29	D25	IO	Memory
MEMD30	C26	IO	Memory
MEMD31	C25	IO	Memory
MEMA0	V22	OUT	Memory
MEMA1	U23	OUT	Memory
MEMA2	T22	OUT	Memory
MEMA3	R22	OUT	Memory
MEMA4	N22	OUT	Memory
MEMA5	N23	OUT	Memory
MEMA6	R21	OUT	Memory
MEMA7	R23	OUT	Memory
MEMA8	Y21	OUT	Memory
MEMA9	Y22	OUT	Memory
MEMA10	AA23	OUT	Memory
MEMA11	AD25	OUT	Memory
MEMA12	AD26	OUT	Memory
MEMA13	AC25	OUT	Memory
MEMA14	AC26	OUT	Memory
MEMA15	AB25	OUT	Memory
MEMA16	AB26	OUT	Memory
MEMA17	AE26	OUT	Memory
MEMA18	W22	OUT	Memory
MEMCS	U26	OUT	Memory
MEMCS1	J25	OUT	Memory
MEMWR	AA25	OUT	Memory
MEMUB	U24	OUT	Memory
MEMLB	V24	OUT	Memory
MEMOE	T24	OUT	Memory

3. Operational Instructions

➢ **Power Supply**

Figure 3 shows the composition of the power supply block on the SASEBO-R. Table 11 shows the functions of the power supply connectors. Figure 4 shows the power sequence of the SASEBO-R.

DC 3.3V is supplied to the SASEBO-R through both CN1 and CN2 by the power source, which has a maximum current capacity of 2.0 A. The main power switch (SW1) must be toggled off or the power source must be unplugged. D1 and D2 indicate that DC 3.3V is supplied through CN1 and CN2, respectively. Toggle SW2 to "EXT" supplying the cryptographic FPGA core voltage of 1.2 V through CN3. SW1 must be also toggling off SW2.

Table 11: Power supply settings

Connector		CN1	CN2	CN3
Description		Cryptographic LSI power supply	Control FPGA power supply	Cryptographic LSI core voltage
SW2 setting		INT	INT	EXT
Pin	1	3.3V±0.16V	3.3V±0.16V	1.2V±0.05V
	2	0V	0V	0V
	3	NC	NC	NC

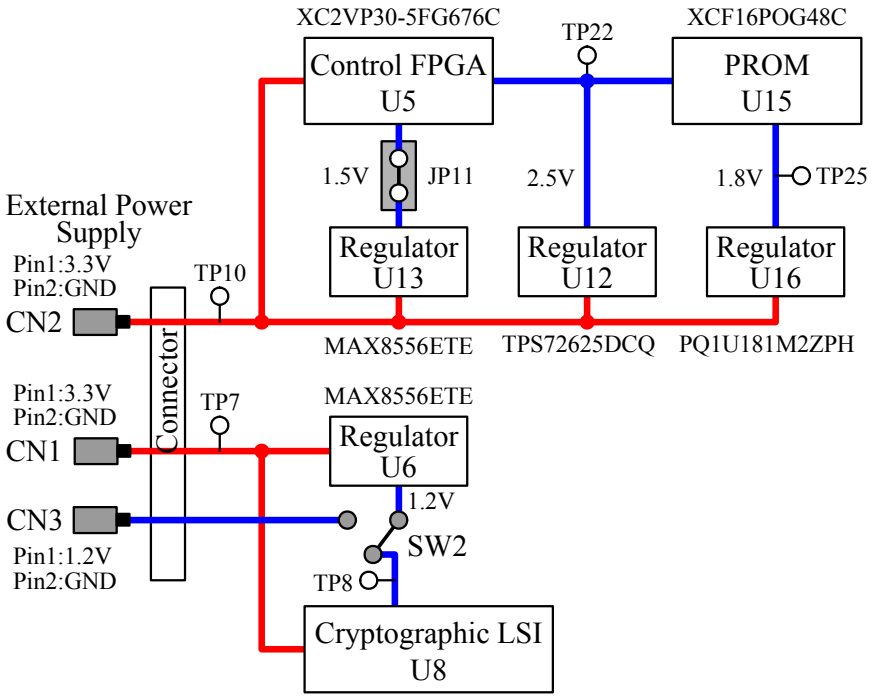


Figure 3: Power supply block on the SASEBO-R

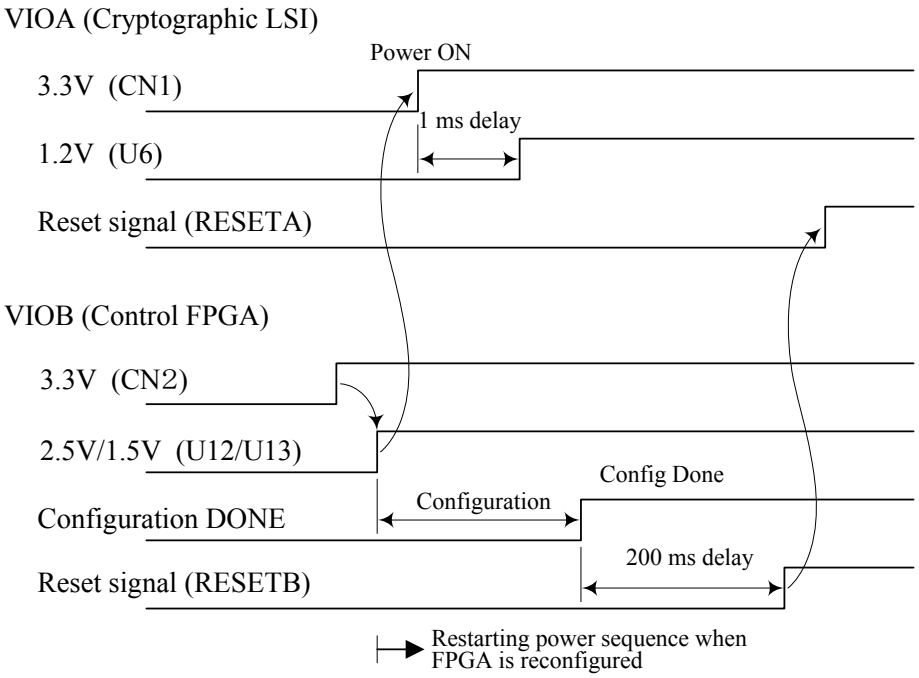


Figure 4: Power sequence of SASEBO-R

- **Jumper Settings**

Table 12: Jumper settings

Function	Pin	Setting	Description
Power sequence	JP4	Short	Disable the power sequence of the cryptographic LSI.
		Open	Enable the power sequence of the cryptographic LSI.
	JP5	Short	Disable the power sequence of the control FPGA.
		Open	Enable the power sequence of the control FPGA.
Configuration sequence	JP10	1-2Short	Configure the control FPGA after 2.5V line is stable.
		3-4Short	Configure the control FPGA after 1.5V line is stable.
Power consumption measurement	JP1	Short	Bypass R4 shunt resistor on I/O VCC of the cryptographic LSI.
		Open	Enable R4 shunt resistor on I/O VCC of the cryptographic LSI.
	JP3	Short	Bypass R2 shunt resistor on I/O GND of the cryptographic LSI.
		Open	Enable R2 shunt resistor on I/O GND of the cryptographic LSI.
	JP6	Short	Bypass R11 shunt resistor on core VCC of the cryptographic LSI.
		Open	Enable R11 shunt resistor on core VCC of the cryptographic LSI.
	JP8	Short	Bypass R14 shunt resistor on core GND of the cryptographic LSI.
		Open	Enable R14 shunt resistor on core GND of the cryptographic LSI.
	JP11	Short	Bypass R70 shunt resistor on core VCC of the control FPGA.
		Open	Enable R70 shunt resistor on core VCC of the control FPGA.

JP2, JP7, and JP13 are voltage test points. DO NOT SHORT these points.

➢ **FPGA configuration**

Figure 5 is a block diagram of the control FPGA configuration chain. Table 13 shows the pin assignment of CN5. The configuration mode settings (SW5) are listed in Table 14. D6 indicates that FPGA is configured successfully. Push down SW4 to reconfigure the control FPGA.

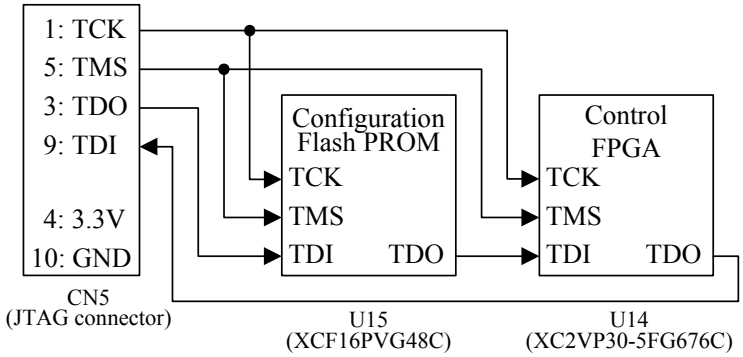


Figure 5: FPGA configuration chain on the SASEBO-R

Table 13: Pin assignment of the JTAG Connector (CN5)

Pin1	TCK	Pin2	GND
Pin3	TDO	Pin4	3.3V
Pin5	TMS	Pin6	
Pin7	TDI	Pin8	GND

Table 14: Configuration mode settings (SW5)

Dip1	M0	OFF
Dip2	M1	OFF
Dip3	M2	ON
Dip4	PWRDWN	OFF
Dip5	HSWAP	OFF
DipP6~8	Not used	

➢ **Clock source**

The clock source connection of the SASEBO-R is shown in Figure 6. One 24-MHz oscillator is connected to the control FPGA. Two clock sources are provided to the cryptographic LSI from the control FPGA, the clock oscillator socket (X1 and X2), and the SMA connector (J5 and J6). An external clock can be supplied to the control FPGA through the J7 SMA connector.

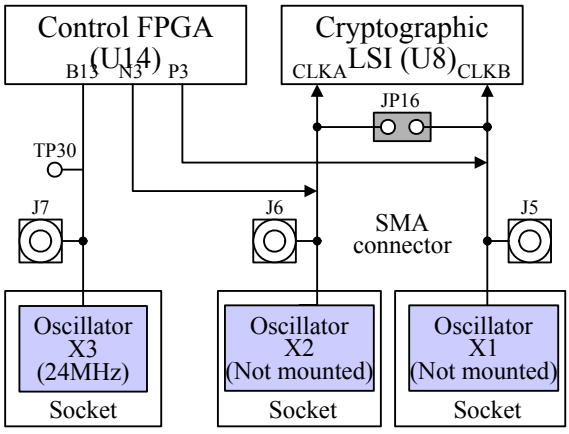


Figure 6: Clock source connection

➢ **Host Interface**

RS-232 and USB is provided on the SASEBO-R for communicating with the host PC. Tables 15 and 16 shows the signal assignments of the RS-232 and USB interfaces. A 9-pin female-female straight cable connects the SASEBO-R to the PC through the RS-232 interfaces. The driver and API of the USB interface for Windows/Linux/Macintosh are provided by FTDI (Future Technology Device International Ltd. http://www.ftdichip.com/Products/FT245R.htm).

Table 15: Signal assignment on the RS-232 interface

Signal	CN8 (XM2C-0912-111)	U17 (ADM3202ARN)		U14 (XC2VP30-5FG676C)
TX	2 pin	14 pin	11 pin	AB14
RX	3 pin	13 pin	12 pin	AC15
CTS	8 pin	7 pin	10 pin	AB15
RTS	7 pin	8 pin	9 pin	AA15

Table 16: Signal assignment on the USB interface

Signal	CN7 (XM7B-0422)	U13 (FT245RL)	U14 (XC2VP30-5FG676C)
USBDP	2 pin	15 pin	-
USBDM	3 pin	16 pin	-
USBD0	-	1 pin	AB16
USBD1	-	5 pin	AA16
USBD2	-	3 pin	AB17
USBD3	-	11 pin	AE14
USBD4	-	2 pin	AC17
USBD5	-	9 pin	AC14
USBD6	-	10 pin	AD14
USBD7	-	6 pin	AB20
USBTXE	-	22 pin	AE19
USBRXF	-	23 pin	AD20
USBRD	-	13 pin	AD17
USBWR	-	14 pin	AF19
USBPWREN	-	12 pin	AD15

4. BOARD SCHEMATIC AND LAYOUT

The parts list for the SASEBO-R is shown in Table 17. The board schematic and layout of the SASEBO-R are presented in pages 17 to 35.

Table 17: Parts List

Board Name	SASEBO-R
Model Number	E3-93995-1

Description	Part Number	Maker	Qty	Reference Designator
Ceramic Capacitor	GRM155F11H103ZA57E	MURATA	31	C31,C32,C33,C34,C35,C36,C37,C38,C39, C40,C41,C42,C43,C44,C45,C60,C61,C62, C63,C64,C65,C66,C67,C68,C69,C70,C71, C72,C73,C74,C96,C134,C135,C136,C137, C138,C139,C140,C141,C142,C143,C144, C145,C146,C147,C148,C149,C150,C151, C152,C153,C154,C155,C156,C157,C158, C159,C160,C161,C162,C163
Ceramic Capacitor	GRM155F11E104ZA01D	MURATA	39	C3,C5,C6,C7,C8,C15,C22,C23,C24,C25, C26,C27,C28,C29,C30,C52,C53,C54,C55, C56,C57,C58,C59,C77,C78,C80,C81,C82, C83,C84,C85,C94,C97,C98,C99,C100, C101,C104,C105,C106,C118,C119,C120, C121,C124,C125,C126,C127,C128,C129, C130,C131,C132,C133,C103,C165
Ceramic Capacitor	GRM188B11H102KA01D	MURATA	1	C92
Ceramic Capacitor	GRM155F10J105ZE01D	MURATA	11	C17,C18,C20,C21,C47,C48,C50,C51,C75, C108,C109,C110,C111,C113,C114,C116, C117,C122,C123
Ceramic Capacitor	JMK316BJ476ML-T	TAIYO YUDEN	5	C11,C12,C88,C89,C102,C164
Capacitor	EMV-6R3ADA101MF55G	Nippon Chemi-Con	7	C2,C4,C16,C19,C46,C49,C76,C93,C107, C112,C115
Capacitor	EEFUE0J151	Panasonic	4	C10,C13,C87,C91
Capacitor	APSA100ELL271MHB5S	Nippon Chemi-Con	7	C1,C9,C14,C79,C86,C90,C95
Resistor	RK73Z1JTTD 0Ω	KOA	4	R60,R62,R100,R101
Resistor	RR0816-101-D	SSM	4	R5,R6,R7,R9,R69,R92,R130
Resistor	RR0816-103-D	SSM	20	R8,R12,R49,R50,R51,R52,R53,R54,R63, R64,R65,R66,R73,R79,R118,R119,R120, R121,R122,R129
Resistor	RR0816-102-D	SSM	18	R10,R13,R59,R61,R67,R68,R71,R74,R75, R76,R77,R78,R83,R90,R91,R93,R94,R128
Resistor	RR0816-220-D	SSM	3	R82,R84,R85
Resistor	RR0816-202-D	SSM	1	R72
Resistor	RR0816-331-D	SSM	8	R3,R4,R47,R48,R124,R125,R126,R127
Resistor	RR0816-472-D	SSM	9	R86,R87,R88,R95,R96,R97,R98,R99,R123
Resistor	RR0816-471-D	SSM	2	R81,R89
Resistor	RR0816-473-D	SSM	50	R15,R16,R17,R18,R19,R20,R21,R22,R23, R24,R25,R26,R27,R28,R29,R30,R31,R32, R33,R34,R35,R36,R37,R38,R39,R40,R41, R42,R43,R44,R45,R46,R55,R56,R57,R58, R102,R103,R104,R105,R106,R107,R108, R109,R110,R111,R112,R113,R114,R115, R116,R117
Diode	1SS352(-TPH3)	TOSHIBA	1	D5
DIP Switch	A6S-4104-H	OMRON	2	SW3,SW6
DIP Switch	A6S-8104-H	OMRON	1	SW5

Push Button	B3S-1000	OMRON	2	SW4,SW7
Switch, Slide	CS-12AAP1	Nikkai	1	SW2
Switch, Slide	CS-22AAP1	Nikkai	1	SW1
LSI	LSI-160	TSMC	1	U7
QFP Socket	OTQ-160-0.65-5	Enplas	1	U8
FPGA	XC2VP30-5FG676C	Xilinx	1	U14
EEPROM	XCF16PVOG48C	Xilinx	1	U15
CMOS	SN74HC08NS	TI	2	U3,U9
CMOS	SN74HC14NS	TI	2	U5,U10
SRAM	IS62WV51216BLL-55TLI	ISSI	1	U18,U20
USB IC	FT245RL	FDI	1	U19
RS-232 Level Converter	ADM3202ARUZ	Analog Devices	1	U17
Reset IC	BD45292G	ROHM	1	U11
Regulator IC	MAX8556ETE	MAXIM	2	U6,U13
Regulator IC	PQ1U181M2ZP	SHARP	1	U16
Regulator IC	TPS72625DCQ	TI	1	U12
Inductor	ELC0607RA-100J1R6-PF	TDK	11	L6,L7,L8,L9,L10,L11,L12,L13,L14,L15, L16
Filter	BLM18AG102SN	MURATA	5	L1,L2,L3,L4,L5
LED	SML-210MTT86	ROHM	9	D1,D2,D3,D4,D6,D7,D8,D9,D10
Pin Header	A1-64PA-2.54DSA(71)	HIROSE	1	CN6
Connector	B3P-VH(LF)(SN)	JST	1	CN3
Connector	87832-1420	MOLEX	1	CN5
USB Connector	XM7B-0442	OMRON	1	CN8
D-sub Connector	XM2C-0912-111	OMRON	1	CN7
MOS Relay	G3VM-61GR1	OMRON	3	U1,U2,U4
SG-8002DC	24.000M-PTB	EPSON	1	X1,X2,X3
SMA Connector	T124 426 000N	TAKITEK	13	J1,J2,J3,J4,J5,J6,J7,J8,J9,J10,J11,J12,J13
Resistor	ERX1SJ1R0	Panasonic	6	R1,R2,R11,R14,R70,R80
Shunt	XG8S-0231	OMRON	9	JP1,JP3,JP4,JP5,JP6,JP8,JP11,JP13,JP16
Connector	B2P-SHF-1AA(LF)(SN)	JST	3	JP2,JP7,JP12
Jumper Socket	XG8T-0431	OMRON	2	JP9,JP10
IC Socket	R110-91-308	PRECI-DIP	3	

外部入力電源３
コア電源　　1.15-1.25

CN3
B3B-XH-A(LF)(SN)
未実装（添付品）

ＬＳＩ入力電源
3.3V

CN1
B3P-VH

ＦＰＧＡ入力電源
3.3V

CN2
B3P-VH

SW1
CS-22AAP1

C2 100u/6.3V
C3 0.1u
C4 100u/6.3V
C5 0.1u

VCC
VIOB
VIOA-1

U2 AQY212GS
U1 AQY212GS
U4 AQY212GS

JP4 XG8S-0231
JP5 XG8S-0231

TP7
TP10

R2 330
R3 330
R4 330

D1 SML-210MTT86
ＬＳＩ I/O電源
D2 SML-210MTT86
ＦＰＧＡメイン電源

74HC08
U3A
U3D
R7 100
R130 100
R5 100
R6 100
未実装

EXT
INT
SW2
CS-12AAP1
TP8

J8 089-NV98B
J9 089-NV98B
J1 089-NV98B
JP1 XG8S-0231
ソケット
R1 1
シャント抵抗
電流テストポイント
TP1 MM-2-1
TP2 MM-2-1
VIOA

C1 270u/10V(OS)
J10 089-NV98B
J2 089-NV98B
JP2 XG8S-0231
JP3 XG8S-0231
ソケット
R2 1
シャント抵抗
TP3 MM-2-1
TP4 MM-2-1
TP5
TP6

J11 089-NV98B
J12 089-NV98B
J3 089-NV98B
JP6 XG8S-0231
ソケット
R11 1
シャント抵抗
TP13 MM-2-1
TP14 MM-2-1
V12A

C14 270u/10V(OS)
J13 089-NV98B
J4 089-NV98B
JP7 XG8S-0231
JP8 XG8S-0231
ソケット
R14 1
シャント抵抗
TP15 MM-2-1
TP16 MM-2-1
TP17
TP18

POWER_OK
R12 10k
VIOB
U5F 74HC14
R8 10k
C6 0.1u
1ms遅延
R9 100
U5E 74HC14
TP9
TP12
U3B 74HC08
TP11

C9 150u/6.3V
C10 270u/10V(OS)
C11 47u
U6 MAX8556ETE
IN
OUT
POK
FB
EN
NC
GND
R10 1k
VR1
R13 1k
C12 47u
C13 150u/6.3V

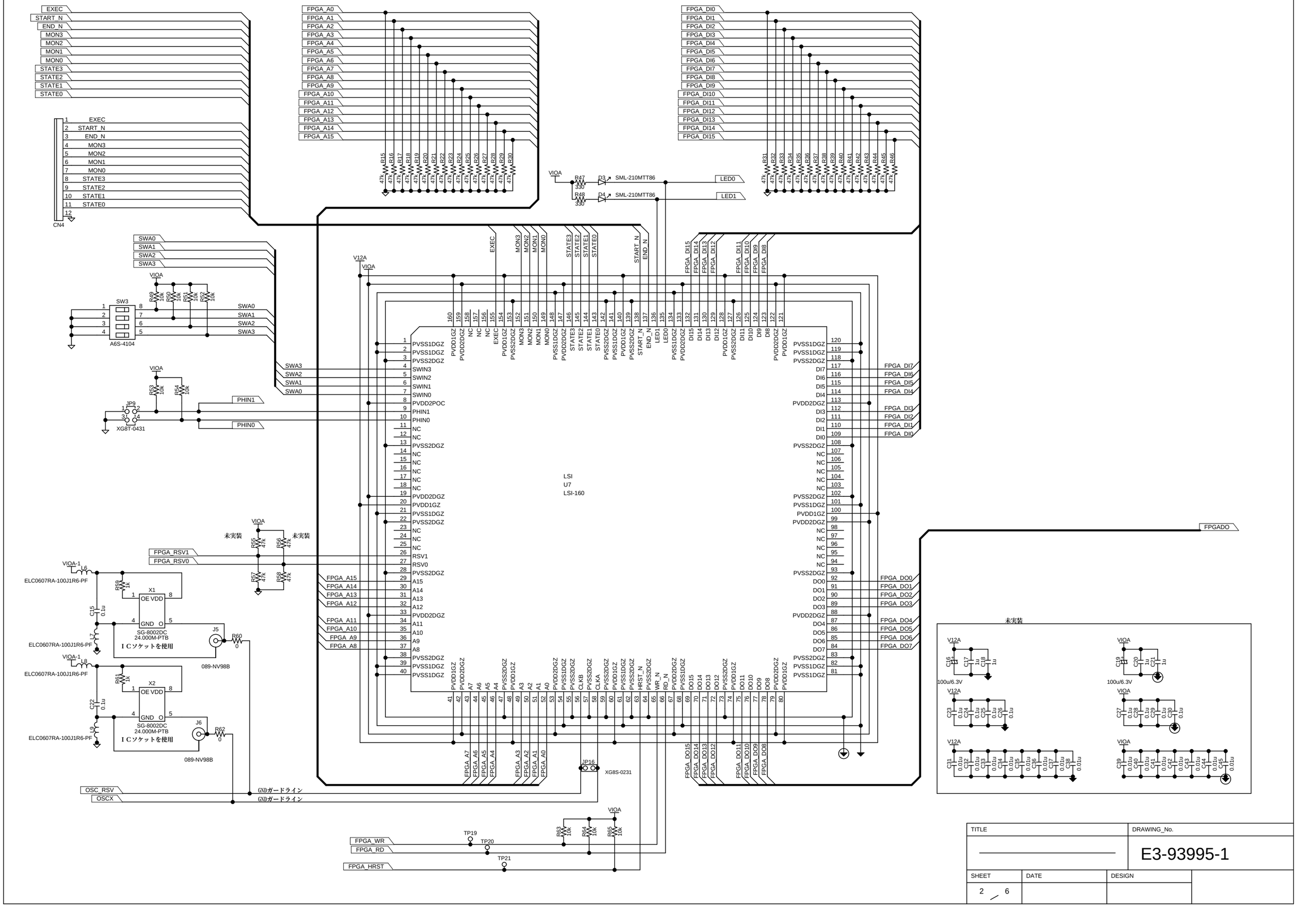
L1 BLM18AG102SN
L2 BLM18AG102SN
L3 BLM18AG102SN
L4 BLM18AG102SN
L5 BLM18AG102SN

P1
P2
P3

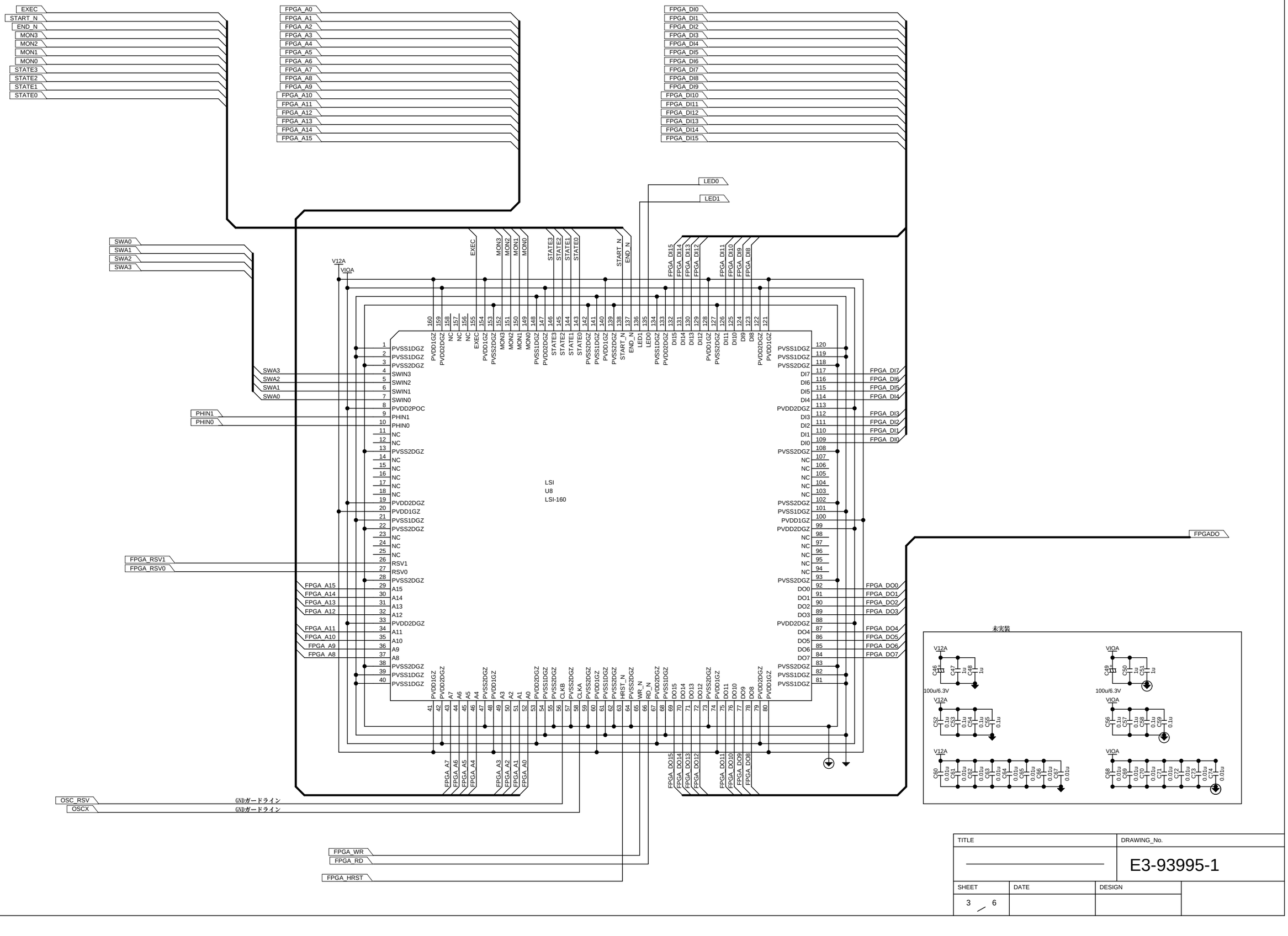
U5A 74HC14
U5B 74HC14
U5C 74HC14
U5D 74HC14
U3C 74HC08

C6 0.1u
C7 0.1u

TITLE	DRAWING_No.
———	E3-93995-1
SHEET 1 / 6	DATE
DESIGN	



TITLE	DRAWING_No.
	E3-93995-1
SHEET	DATE	DESIGN
2 / 6		



TITLE	DRAWING_No.
	E3-93995-1
SHEET 3 / 6	DATE
	DESIGN

CONFRST_BUTTON
B3S-1000
SW4
R67 1k
R66 10k
1SS352
U10A 74HC14
U10F 74HC14
U9A 74HC08
U9B 74HC08
U9C 74HC08
U10D 74HC14
U11 BD45292G
C75 1u
TP24 RESETB
200ms遅延
POWER_OK
JP10 XG8T-0431
TPS72625DCQ
U12
C76 100u/6.3V
C77 0.1u
R68 1k
R69 100
未実装
C78 0.1u
C79 270u/10V(OS)
TP22
V25B
VIOB
C80 0.1u
C81 0.1u
C82 0.1u
C83 0.1u
V18B
C84 0.1u
C85 0.1u
JP11 XG8S-0231 ショート
JP13 XG8S-0231 ショート
JP12 XG8S-0231
R70 シャント抵抗
R80 シャント抵抗
U13 MAX8556ETE
C86 150u/6.3V
C87 150u/6.3V
C88 47u
C89 47u
C90 47u
C91 150u/6.3V
270u/10V(OS)
R72 2k
R73 10k
未実装
R81 470
VR2 1k
R71 1k
U15 XCF16PVOG48C
R74 1k
R75 1k
R76 1k
R77 1k
R78 1k
R79 10k
C92 1000p
R86
R87
R88 4.7k
CDB7
CDB6
CDB5
CDB4
CDB3
CDB2
CDB1
CDB0
CN5
TMS
TCK
TDO
TDI
87832-1420
R82 22
R83 1k
R84 22
R85 22
U14F
BANK5
L75N/GCLK7S
L75P/GCLK6P
L74N/GCLK5S
L74P/GCLK4P
L69N/VREF
L69P
L67N
L67P
L57N/VREF
L57P
L55N
L55P
L54N
L54P
L53
L50
L49N
L49P
L48N
L48P
L46N
L46P
L45N
L45P
L43N
L43P
L39N
L39P
L37N
L37P
L09N/VREF
L09P
L07N/VREF
L07P
L06N/VRP
L06P/VRN
L05
L03N/D4
L03P/D5
L02N/D6
L02P/D7
L01N/RDWR_B
L01P/CS_B
U16 未実装
PQ1U181M2ZP
TP25
C93 100u/6.3V
C94 0.1u
R90 1k
R92 100
C95 270u/10V(OS)
C96 0.01u
R91 1k
R93 1k
CONFIG
D5 SML-210MTT86
R83 470
R84 1k
R94 4.7k
R95 4.7k
R96 4.7k
R97 4.7k
R98 4.7k
R99 4.7k
SW5 A6S-8104
U14J XC2VP30
AE24 CCLK
B1 PROG_B
AD23 DONE
AE3 M0
AF3 M1
AD4 M2
B26 TCK
D3 TDI
D24 TDO
B24 TMS
AF24 PWRDWN_B
B3 HSWAP_EN
C23 RSVD
A24 VBATT
A3 DXP
C4 DXN
U14E
BANK4
L01N/BUSY/DOOUT
L01P/INIT_B
L02N/D0/DIN
L02P/D1
L03N/D2
L03P/D3
L05
L06N/VRP
L06P/VRN
L09N
L09P/VREF
L37N
L37P
L39N
L39P
L43N
L43P
L45N
L45P/VREF
L46N
L46P
L48N
L48P
L49N
L49P
L50
L53
L54N
L54P
L55N
L55P
L57N
L57P/VREF
L67N
L67P
L69N
L69P/VREF
L74N/GCLK3S
L74P/GCLK2P
L75N/GCLK1S
L75P/GCLK0P
P4
P5
P6
P7
P8
P9
P10
P11
P12
GND TPペアで引き出し
U9D 74HC08
U10C 74HC14
U10E 74HC14
U10B 74HC14
U19 FT245RL
USBTXE
USBRXF
USBD0
USBD4
USBD2
USBD1
USBD7
USBD5
USBD6
USBD3
USBPWREN
USBRD
USBWR
R122 10k
R123 4.7k
L13 ELC0607RA-100J1R6-PF
ソケット
C104 0.1u
C105 0.1u
CN8
USB Bタイプコネクタ
JP15 XM7B-0422
5,6ピンはシャーシ
未実装
L15 ELC0607RA-100J1R6-PF
ソケット
等長並行配線
CN7 XM2C-0912-111
JP14
L10 ELC0607RA-100J1R6-PF
L11 ELC0607RA-100J1R6-PF
L12 ELC0607RA-100J1R6-PF
オス
U17 ADM3202ARU
C97 0.1u
C98 0.1u
C99 0.1u
C100 0.1u
C101 0.1u
TX
RX
CTS
RTS
USBD7
USBRXF
USBD2
USBD0
USBD4
USBRD
USBD1
USBD5
USBD6
USBD3
USBPWREN
USBTXE
USBWR

TITLE	DRAWING_No.
	E3-93995-1
SHEET 4 / 6	DATE
	DESIGN

CN6
A1-64PA-2.54DSA(71)
IOB0 1 2 IOB1
IOB2 3 4 IOB3
IOB4 5 6 IOB5
IOB6 7 8 IOB7
IOB8 9 10 IOB9
IOB10 11 12 IOB11
IOB12 13 14 IOB13
IOB14 15 16 IOB15
IOB16 17 18 IOB17
IOB18 19 20 IOB19
IOB20 21 22 IOB21
IOB22 23 24 IOB23
IOB24 25 26 IOB25
IOB26 27 28 IOB27
IOB28 29 30 IOB29
IOB30 31 32 IOB31
IOB32 33 34 IOB33
IOB34 35 36 IOB35
IOB36 37 38 IOB37
IOB38 39 40 IOB39
IOB40 41 42 IOB41
IOB42 43 44 IOB43
IOB44 45 46 IOB45
IOB46 47 48 IOB47
IOB48 49 50 IOB49
IOB50 51 52 IOB51
IOB52 53 54 IOB53
IOB54 55 56 IOB55
IOB56 57 58 IOB57
IOB58 59 60 IOB59
IOB60 61 62 IOB61
IOB62 63 64 IOB63

TP26 TP27 TP28 TP29

BANK1
U14B
IOB23 B14 L75N/GCLK3P
IOB24 C14 L75P/GCLK2S
IOB25 D14 L74N/GCLK1P
IOB26 E14 L74P/GCLK0S
IOB55 H14 L69N/VREF
IOB46 J14 L69P
IOB31 C15 L67N
D15 L67P
IOB22 F14 L57N/VREF
IOB27 E15 L57P
IOB56 F15 L55N
G15 L55P
H15 L54N
J15 L54P
IOB57 F16 L53
IOB58 G16 L50
IOB32 C17 L49N
IOB29 D17 L49P
IOB28 E16 L48N
IOB30 E17 L48P
IOB63 H16 L46N
IOB45 H17 L46P
C18 L45N/VREF
D18 L45P
E18 L43N
F18 L43P
G18 L39N
IOB62 H18 L39P
IOB33 A19 L37N
IOB34 B19 L37P
IOB37 E19 L09N/VREF
IOB36 F19 L09P
IOB44 G19 L07N
IOB59 H19 L07P
IOB35 C20 L06N
IOB38 D20 L06P
IOB39 E20 L05
IOB60 F20 L03N/VREF
IOB61 G20 L03P
IOB40 D21 L02N
IOB43 E21 L02P
IOB41 D22 L01N/VRP
IOB42 E22 L01P/VRN

BANK0
U14A
IOB2 E5 L01N/VRP
IOB53 D5 L01P/VPN
IOB1 E6 L02N
IOB3 D6 L02P
G7 L03N
IOB0 F7 L03P/VREF
IOB52 E7 L05
IOB4 D7 L06N
IOB9 C7 L06P
IOB48 H8 L07N
IOB50 G8 L07P
IOB10 F8 L09N
IOB11 E8 L09P/VREF
IOB5 B8 L37N
IOB6 A8 L37P
IOB13 H9 L39N
G9 L39P
F9 L43N
IOB12 E9 L43P
D9 L45N
IOB7 C9 L45P/VREF
IOB49 H10 L46N
IOB47 H11 L46P
IOB15 E10 L48N
IOB16 E11 L48P
IOB14 D10 L49N
IOB8 C10 L49P
IOB51 G11 L50
IOB17 F11 L53
J12 L54N
IOB54 H12 L54P
G12 L55N
IOB19 F12 L55P
IOB18 E12 L57N
F13 L57P/VREF
IOB21 D12 L67N
IOB20 C12 L67P
J13 L69N
H13 L69P
E13 L74N/GCLK7P
D13 L74P/GCLK6S
C13 L75N/GCLK5P
B13 L75P/GCLK4S

OSCX
GNDガード
R100 0
FPGA_DO14 N2 L90P
N3 L90N
FPGA_DO9 N4 L88P
FPGA_DO8 N5 L88N/VREF
N8 L86P
N9 L86N
FPGA_DO13 M1 L85P
FPGA_DO12 M2 L85N
FPGA_DI15 M4 L60P
M5 L60N
FPGA_DO15 N6 L58P
M6 L58N/VREF
M8 L56P
M9 L56N
FPGA_DO11 L1 L55P
FPGA_DO10 L2 L55N
FPGA_DI13 L5 L54P
L6 L54N
M7 L52P
L7 L52N/VREF
FPGA_DO7 K1 L50P
FPGA_DO6 K2 L50N
FPGA_DI14 L3 L49P
FPGA_DI12 K3 L49N
FPGA_DI11 K4 L48P
FPGA_DI8 K5 L48N
L8 L46P
K8 L46N/VREF
FPGA_DO5 J1 L44P
FPGA_DO4 J2 L44N
FPGA_DI10 J3 L43P
FPGA_DI9 J4 L43N
J5 L42P
J6 L42N
J7 L40P
J8 L40N/VREF
FPGA_DO3 H1 L38P
FPGA_DO2 H2 L38N
H6 L37P
H7 L37N
FPGA_DO1 G1 L36P
FPGA_DO0 G2 L36N
G3 L34P
G4 L34N/VREF
H5 L32P
G5 L32N
FPGA_DI0 F1 L31P
FPGA_DI1 F2 L31N
F3 L24P
F4 L24N
G6 L06P
F6 L06N
FPGA_DI2 E1 L04P
FPGA_DI3 E2 L04N/VREF
F5 L03P
E4 L03N
FPGA_DI4 D1 L02P
FPGA_DI5 D2 L02N
FPGA_DI6 C1 L01P/VRN
FPGA_DI7 C2 L01N/VRP

BANK7
U14H

FPGA_DO0 FPGA_DO1 FPGA_DO2 FPGA_DO3 FPGA_DO4 FPGA_DO5 FPGA_DO6 FPGA_DO7 FPGA_DO8 FPGA_DO9 FPGA_DO10 FPGA_DO11 FPGA_DO12 FPGA_DO13 FPGA_DO14 FPGA_DO15
R102 R103 R104 R105 R106 R107 R108 R109 R110 R111 R112 R113 R114 R115 R116 R117
47k

BANK6
U14G
FPGA_RSV1 AE1 L01P/VRN
FPGA_A15 AD1 L01N/VRP
FPGA_RSV0 AD2 L02P
AC3 L02N
FPGA_A14 AC2 L03P
FPGA_A13 AC1 L03N/VREF
AB4 L05P
AA5 L05N
FPGA_A12 AB2 L06P
FPGA_A11 AB1 L06N
AA6 L23P
Y6 L23N
AA4 L24P
AA3 L24N
FPGA_A10 AA2 L31P
FPGA_A9 AA1 L31N
Y5 L33P
W5 L33N/VREF
Y4 L35P
Y3 L35N
FPGA_A8 Y2 L36P
FPGA_A7 Y1 L36N
W7 L37P
W6 L37N
FPGA_A6 W2 L39P
FPGA_A5 W1 L39N/VREF
V8 L41P
V7 L41N
V6 L42P
V5 L42N
V4 L43P
V3 L43N
FPGA_A4 V2 L45P
FPGA_A3 V1 L45N/VREF
U8 L47P
T8 L47N
U5 L48P
U4 L48N
U3 L49P
T3 L49N
FPGA_A2 U2 L51P
FPGA_A1 U1 L51N/VREF
T7 L53P
R7 L53N
T6 L54P
T5 L54N
FPGA_A0 T2 L55P
FPGA_HRST T1 L55N
R9 L57P
R8 L57N/VREF
R6 L59P
P6 L59N
R5 L60P
R4 L60N
FPGA_WR R2 L85P
FPGA_RD R1 L85N
P9 L87P
P8 L87N/VREF
P5 L89P
P4 L89N
P3 L90P
P2 L90N

OSC_RSV
GNDガード
R101 0

VIOB
L14 ELC0607RA-100J1R6-PF
R128 1k
C106 0.1u
L16 ELC0607RA-100J1R6-PF
X3
OE VDD 8
GND O 5
1 4
SG-8002DC
24.000M-PTB
GND TPペアで引き出し
OSCI
TP30
GNDガード
TP31
ICソケットを使用
J7
089-NV98B

BANK2
U14C
MEMD31 C25 L01N/VRP
MEMD30 C26 L01P/VRN
MEMD29 D25 L02N
MEMD28 D26 L02P
E23 L03N
F22 L03P
MEMD24 E25 L04N/VREF
MEMD25 E26 L04P
F21 L06N
G21 L06P
F23 L24N
F24 L24P
MEMD26 F25 L31N
MEMD27 F26 L31P
G22 L32N
H22 L32P
G23 L34N/VREF
G24 L34P
MEMD23 G25 L36N
MEMD22 G26 L36P
H20 L37N
H21 L37P
MEMD21 H25 L38N
MEMD20 H26 L38P
J19 L40N/VREF
J20 L40P
J21 J42N
J22 L42P
J23 L43N
J24 L43P
MEMCS1 J25 L44N
MEMD16 J26 L44P
K19 L46N/VREF
L19 L46P
K22 L48N
K23 L48P
K24 L49N
L24 L49P
MEMD17 K25 L50N
MEMD18 K26 L50P
L20 L52N/VREF
M20 L52P
L21 L54N
L22 L54P
MEMD19 L25 L55N
MEMD15 L26 L55P
M18 L56N
M19 L56P
M21 L58N/VREF
N21 L58P
M22 L60N
M23 L60P
MEMD14 M25 L85N
MEMD13 M26 L85P
N18 L86N
N19 L86P
MEMA4 N22 L88N/VREF
MEMA5 N23 L88P
N24 L90N
MEMD12 N25 L90P

BANK3
U14D
P25 L90N
P24 L90P
P23 L89N
P22 L89P
P19 L87N/VREF
P18 L87P
MEMD8 R26 L85N
MEMD9 R25 L85P
MEMA7 R23 L60N
MEMA3 R22 L60P
P21 L59N
MEMA6 R21 L59P
R19 L57N/VREF
R18 L57P
MEMD10 T26 L55N
MEMD11 T25 L55P
MEMA2 T22 L54N
T21 L54P
R20 L53N
T20 L53P
MEMCS U26 L51N/VREF
MEMD0 U25 L51P
MEMOE T24 L49N
MEMUB U24 L49P
MEMA1 U23 L48N
U22 L48P
T19 L47N
U19 L47P
MEMD1 V26 L45N/VREF
MEMD2 V25 L45P
MEMLB V24 L43N
V23 L43P
MEMA0 V22 L42N
V21 L42P
V20 L41N
V19 L41P
MEMD3 W26 L39N/VREF
MEMD4 W25 L39P
W21 L37N
W20 L37P
MEMD5 Y26 L36N
MEMD6 Y25 L36P
Y24 L35N
Y23 L35P
MEMA18 W22 L33N/VREF
MEMA9 Y22 L33P
MEMD7 AA26 L31N
MEMWR AA25 L31P
AA24 L24N
MEMA10 AA23 L24P
MEMA8 Y21 L23N
AA21 L23P
MEMA16 AB26 L06N
MEMA15 AB25 L06P
AA22 L05N
AB23 L05P
MEMA14 AC26 L03N/VREF
MEMA13 AC25 L03P
AC24 L02N
MEMA12 AD26 L02P
MEMA11 AD25 L01N/VRP
MEMA17 AE26 L01P/VRN

VIOB
SW7 B3S-1000
R129 10k
R124 330 D7 SML-210MTT86
R125 330 D8 SML-210MTT86
R126 330 D9 SML-210MTT86
R127 330 D10 SML-210MTT86
SW6 A6S-4104
R118 10k
R119 10k
R120 10k
R121 10k

U20
MEMA4 1 A4 A5 44 MEMA5
MEMA3 2 A3 A6 43 MEMA6
MEMA2 3 A2 A7 42 MEMA7
MEMA1 4 A1 OE 41 MEMOE
MEMA0 5 A0 UB 40 MEMUB
MEMCS1 6 CS1 LB 39 MEMLB
MEMD16 7 IO0 I/O15 38 MEMD31
MEMD17 8 IO1 I/O14 37 MEMD30
MEMD18 9 IO2 I/O13 36 MEMD29
MEMD19 10 IO3 I/O12 35 MEMD28
11 VDD GND 34
12 GND VDD 33
MEMD20 13 IO4 IO11 32 MEMD24
MEMD21 14 IO5 IO10 31 MEMD25
MEMD22 15 IO6 IO9 30 MEMD26
MEMD23 16 IO7 IO8 29 MEMD27
MEMWR 17 WE A18 28 MEMA18
MEMA16 18 A16 A8 27 MEMA8
MEMA15 19 A15 A9 26 MEMA9
MEMA14 20 A14 A10 25 MEMA10
MEMA13 21 A13 A11 24 MEMA11
MEMA12 22 A12 A17 23 MEMA17
IS62WV51216BLL-55TLI
C104 47u
C105 0.1u

U18
MEMA4 1 A4 A5 44 MEMA5
MEMA3 2 A3 A6 43 MEMA6
MEMA2 3 A2 A7 42 MEMA7
MEMA1 4 A1 OE 41 MEMOE
MEMA0 5 A0 UB 40 MEMUB
MEMCS 6 CS1 LB 39 MEMLB
MEMD0 7 IO0 I/O15 38 MEMD15
MEMD1 8 IO1 I/O14 37 MEMD14
MEMD2 9 IO2 I/O13 36 MEMD13
MEMD3 10 IO3 I/O12 35 MEMD12
11 VDD GND 34
12 GND VDD 33 VIOB
MEMD4 13 IO4 IO11 32 MEMD8
MEMD5 14 IO5 IO10 31 MEMD9
MEMD6 15 IO6 IO9 30 MEMD10
MEMD7 16 IO7 IO8 29 MEMD11
MEMWR 17 WE A18 28 MEMA18
MEMA16 18 A16 A8 27 MEMA8
MEMA15 19 A15 A9 26 MEMA9
MEMA14 20 A14 A10 25 MEMA10
MEMA13 21 A13 A11 24 MEMA11
MEMA12 22 A12 A17 23 MEMA17
IS62WV51216BLL-55TLI
C103 0.1u
C102 47u

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SHEET	DATE	DESIGN
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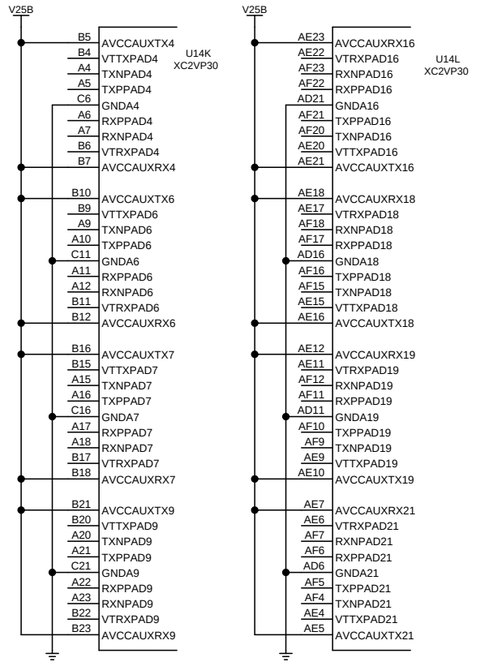

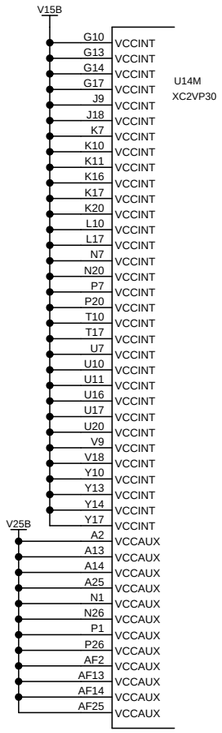

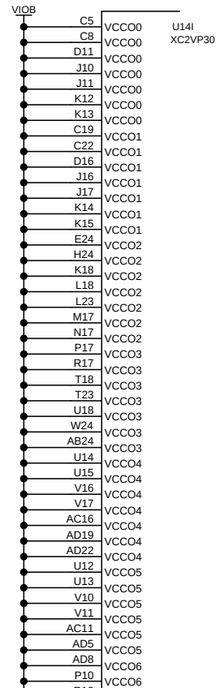

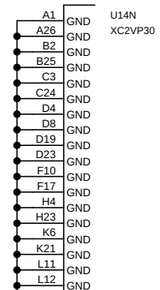

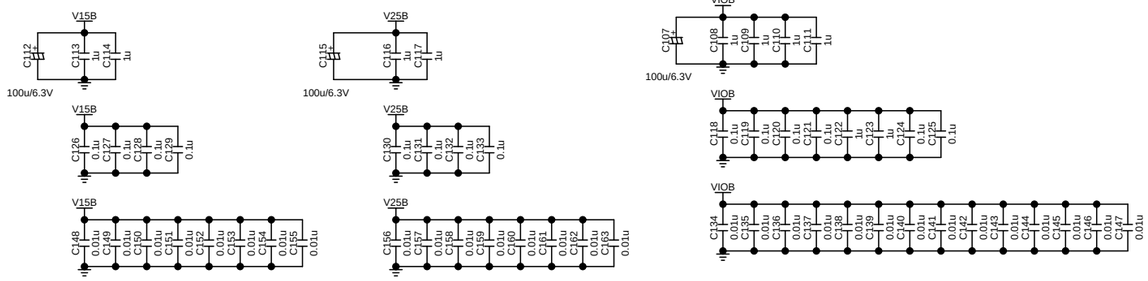

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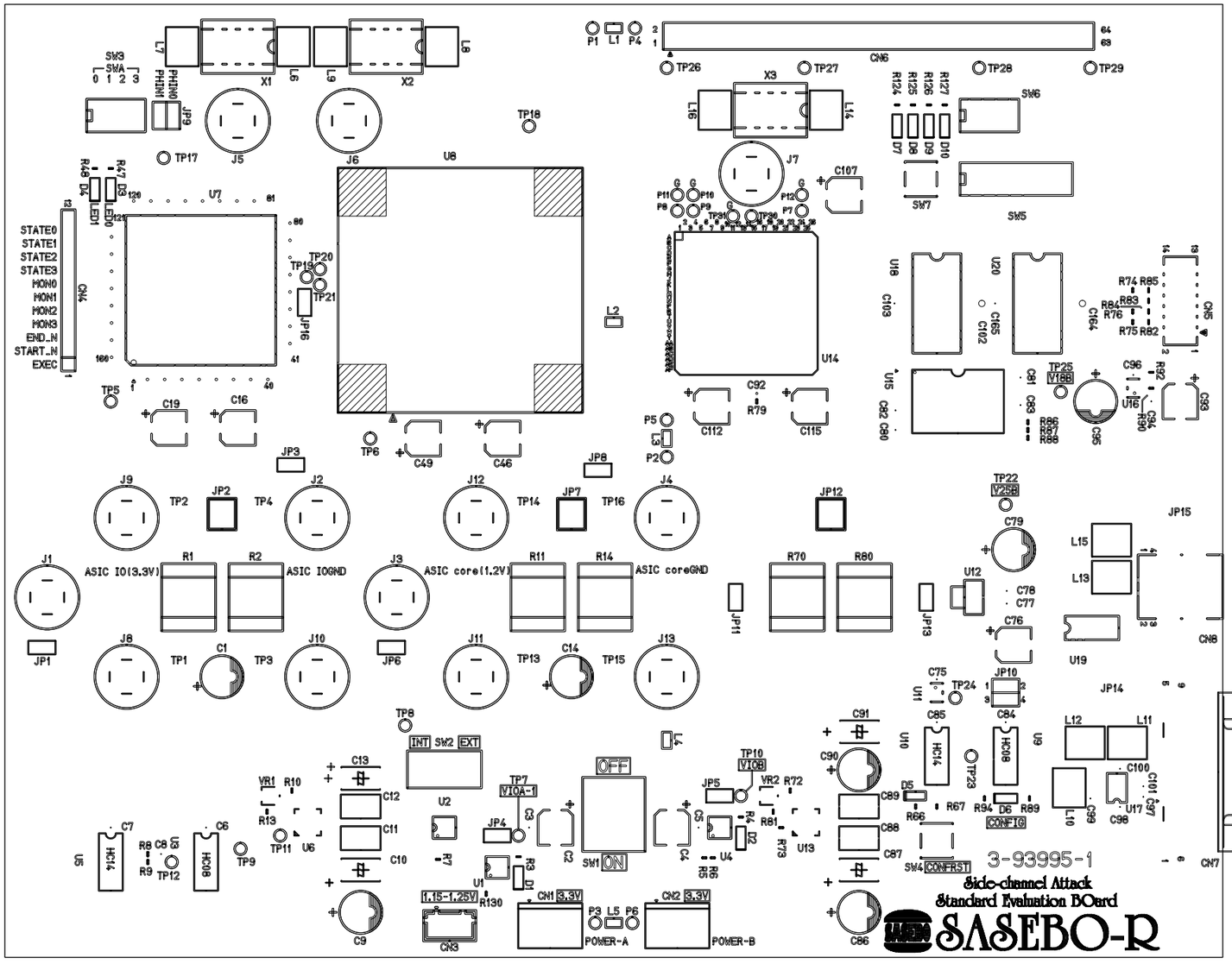

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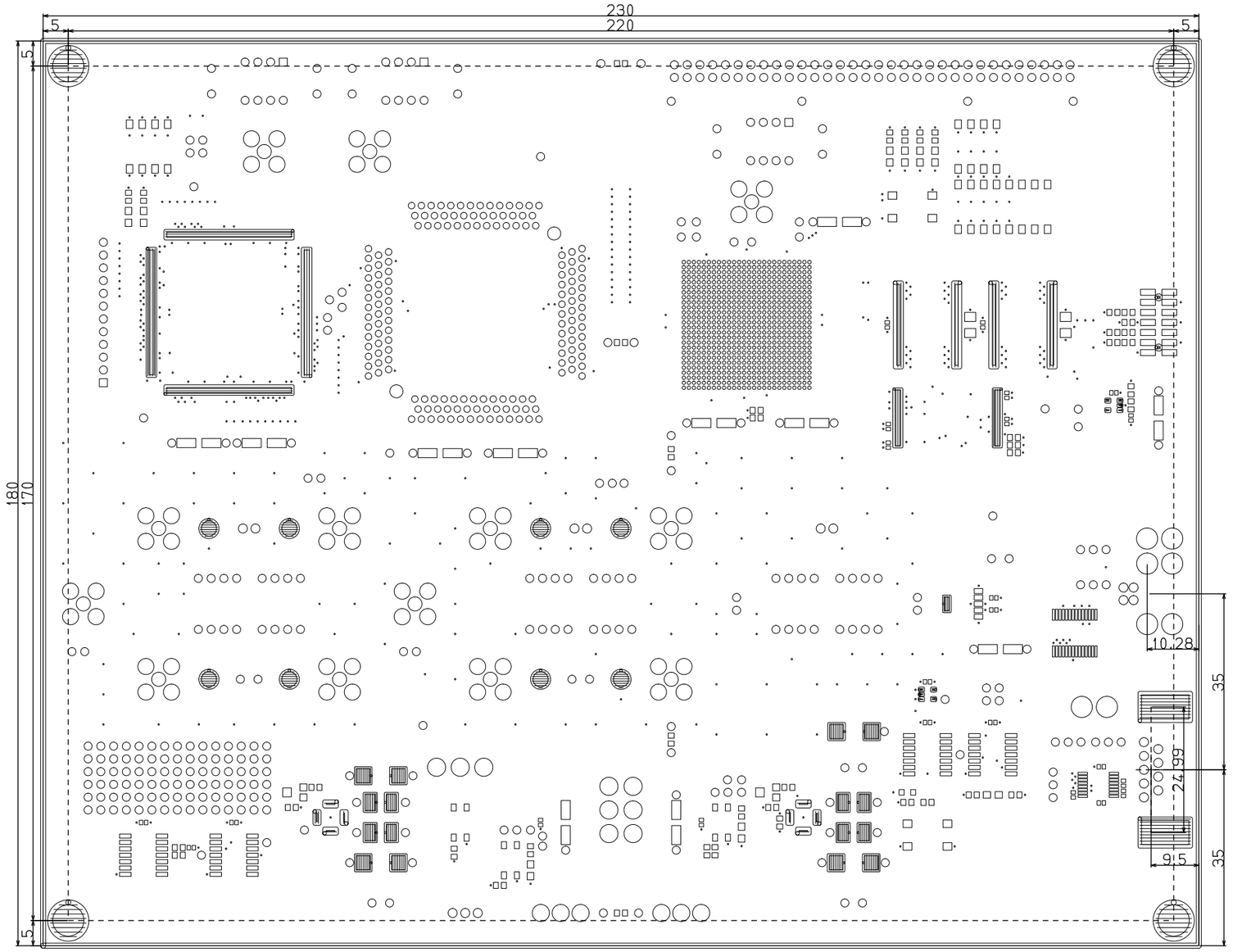
3-93995-1　　2008/01/11



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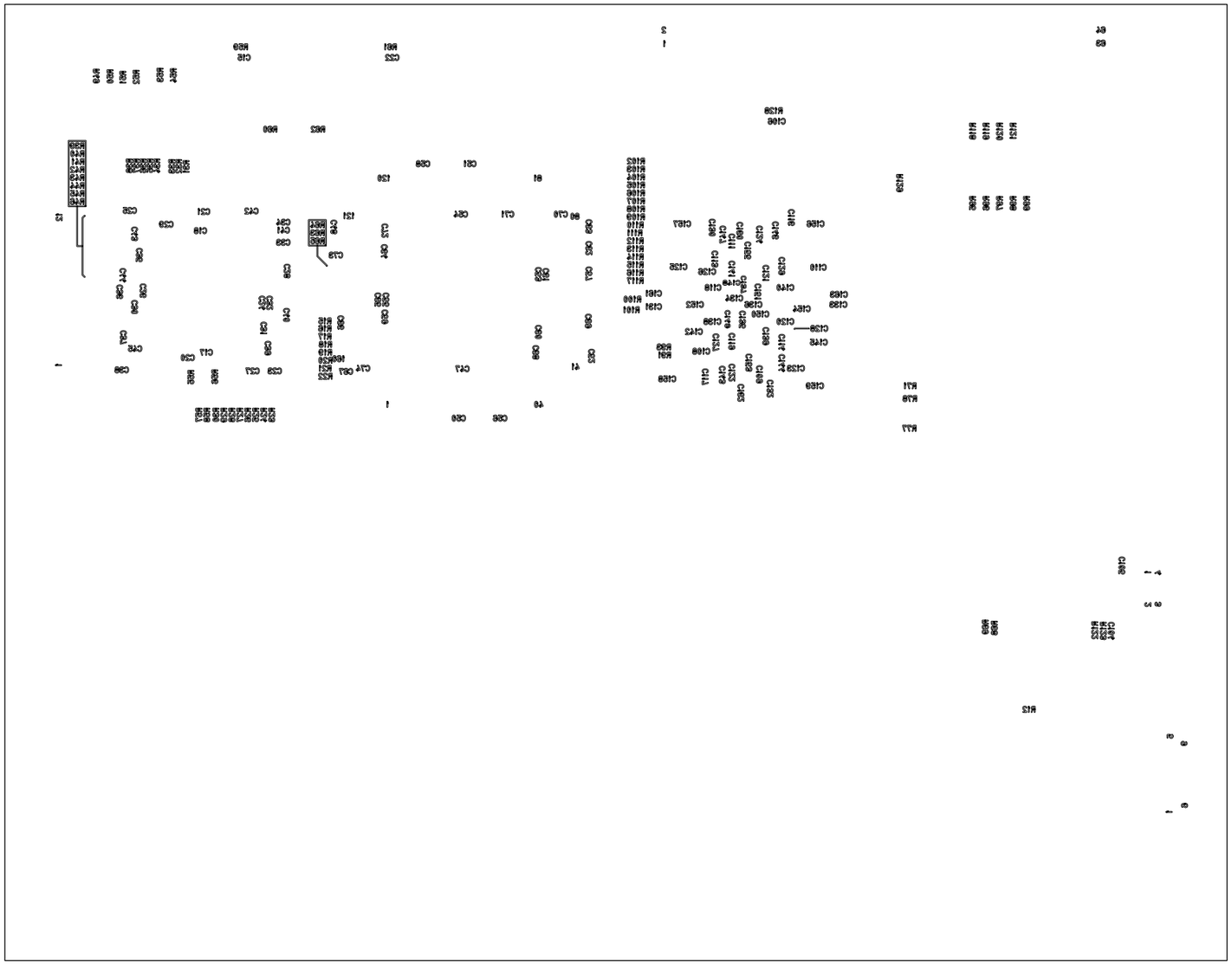

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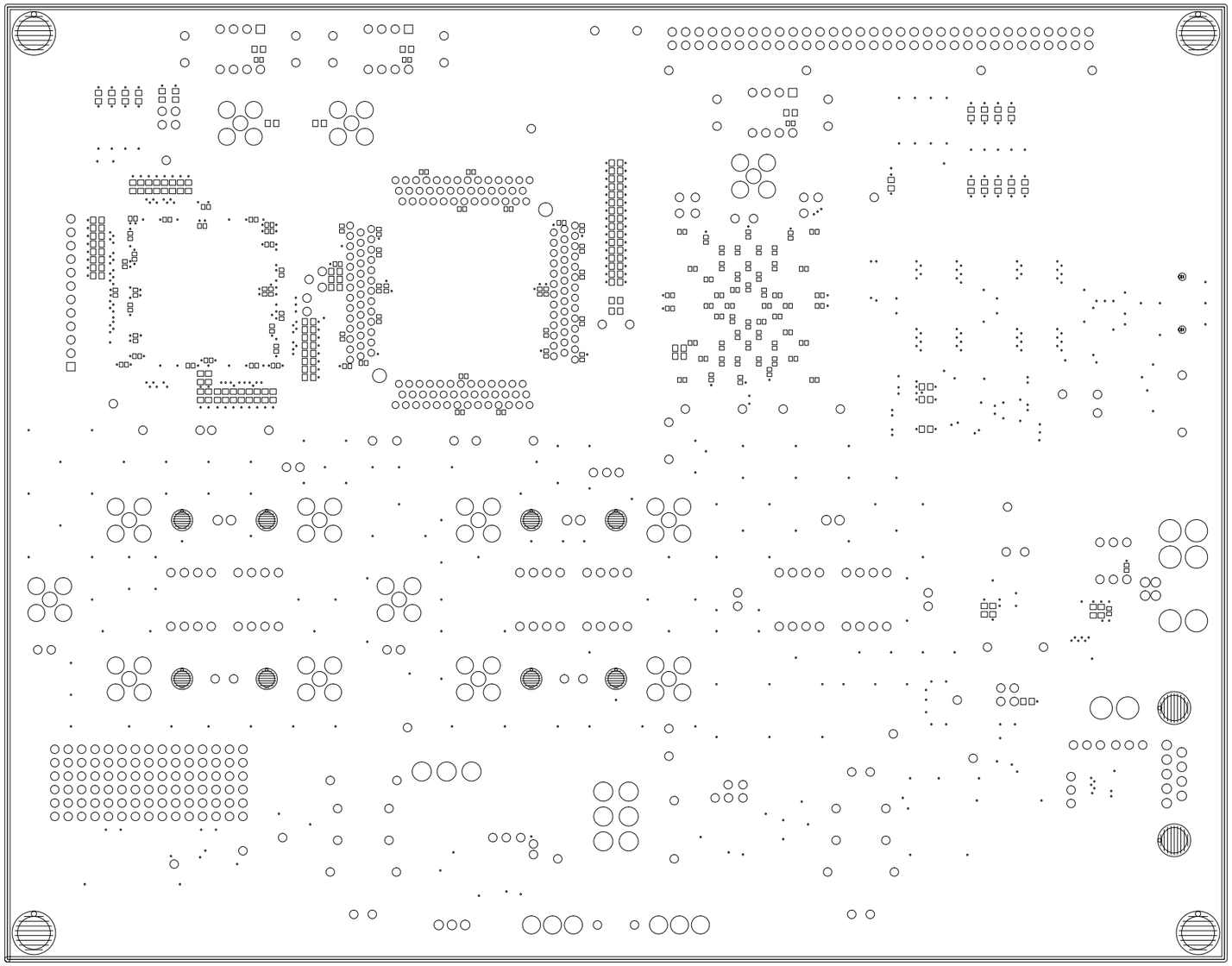

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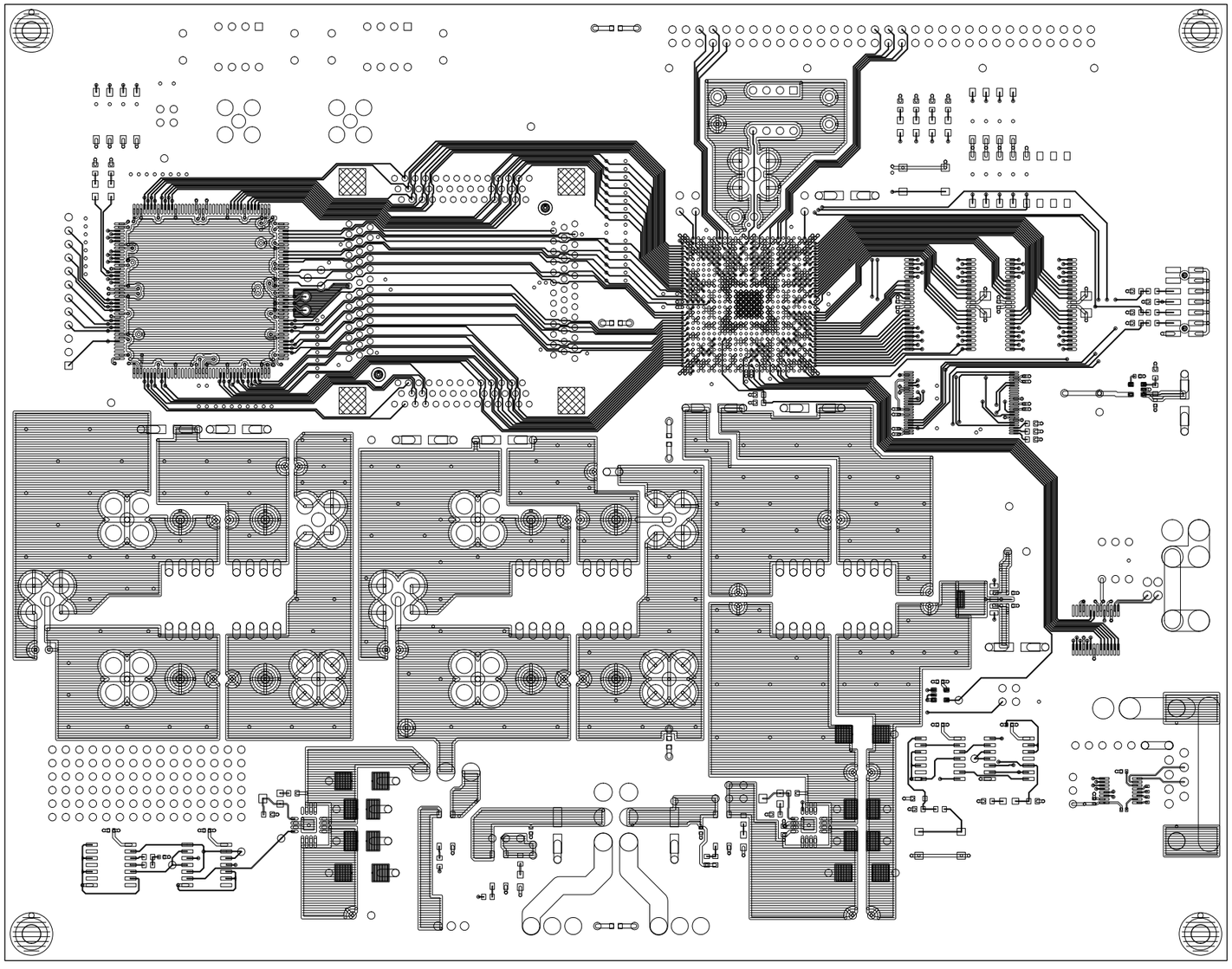

L1

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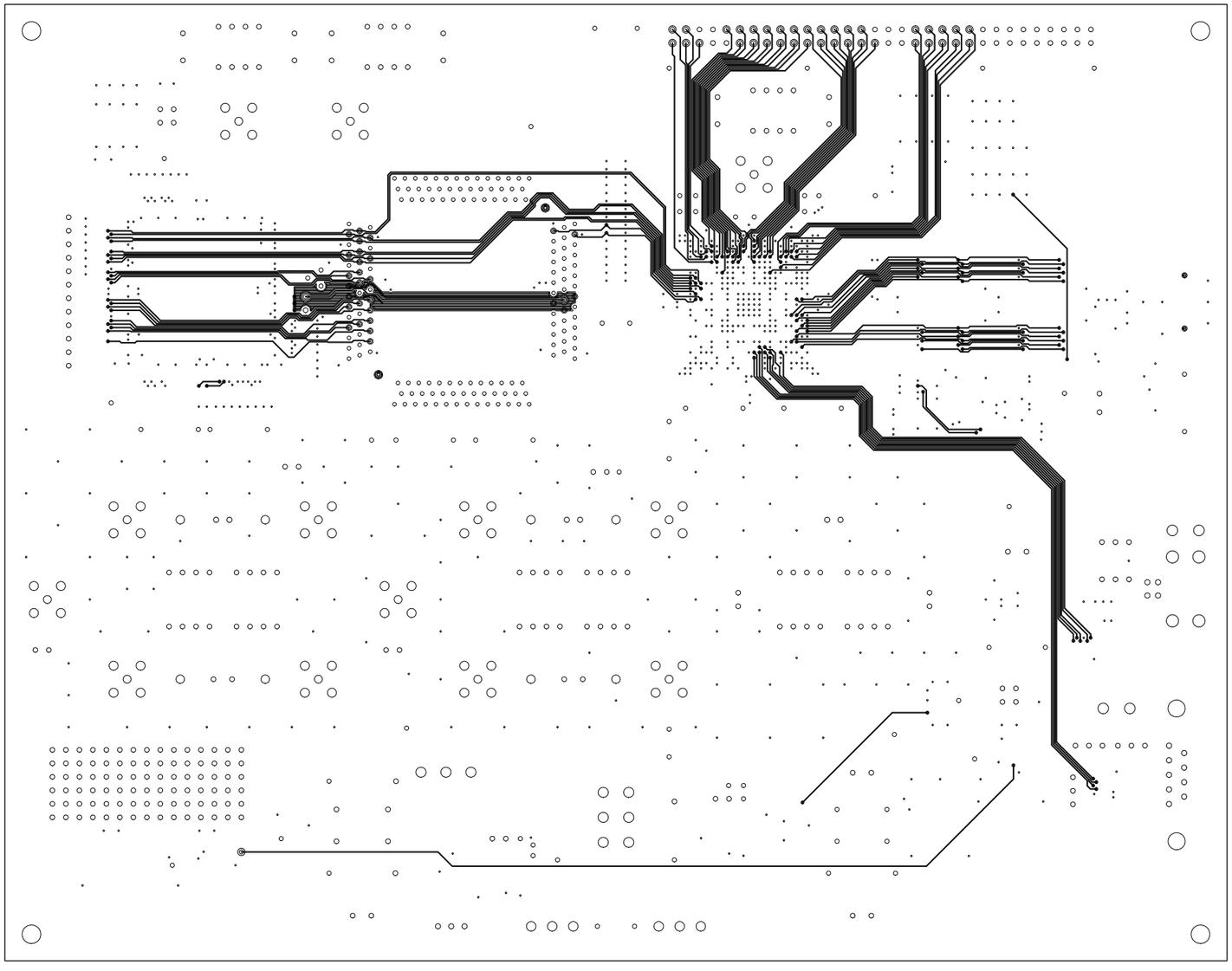

L5 sig

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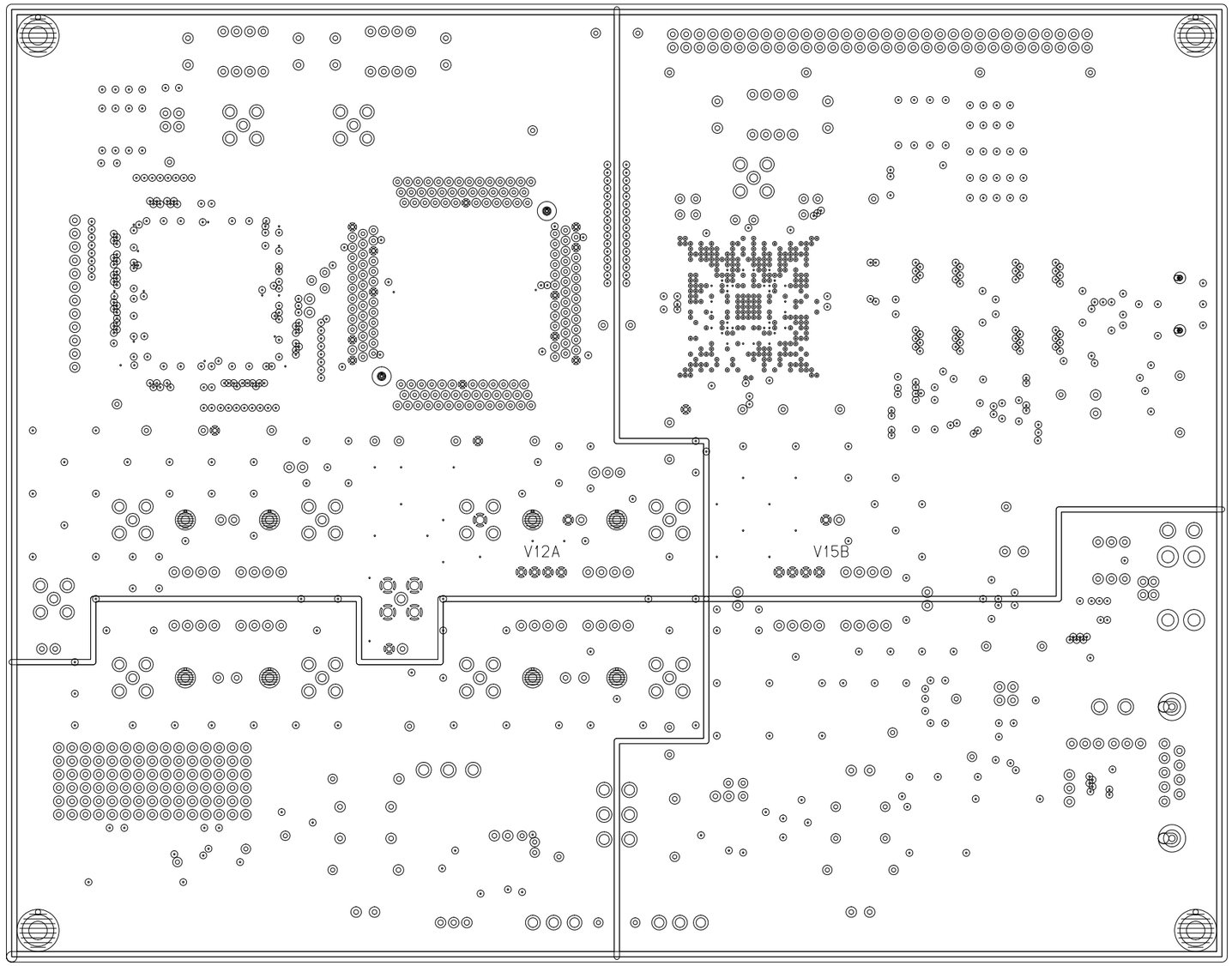

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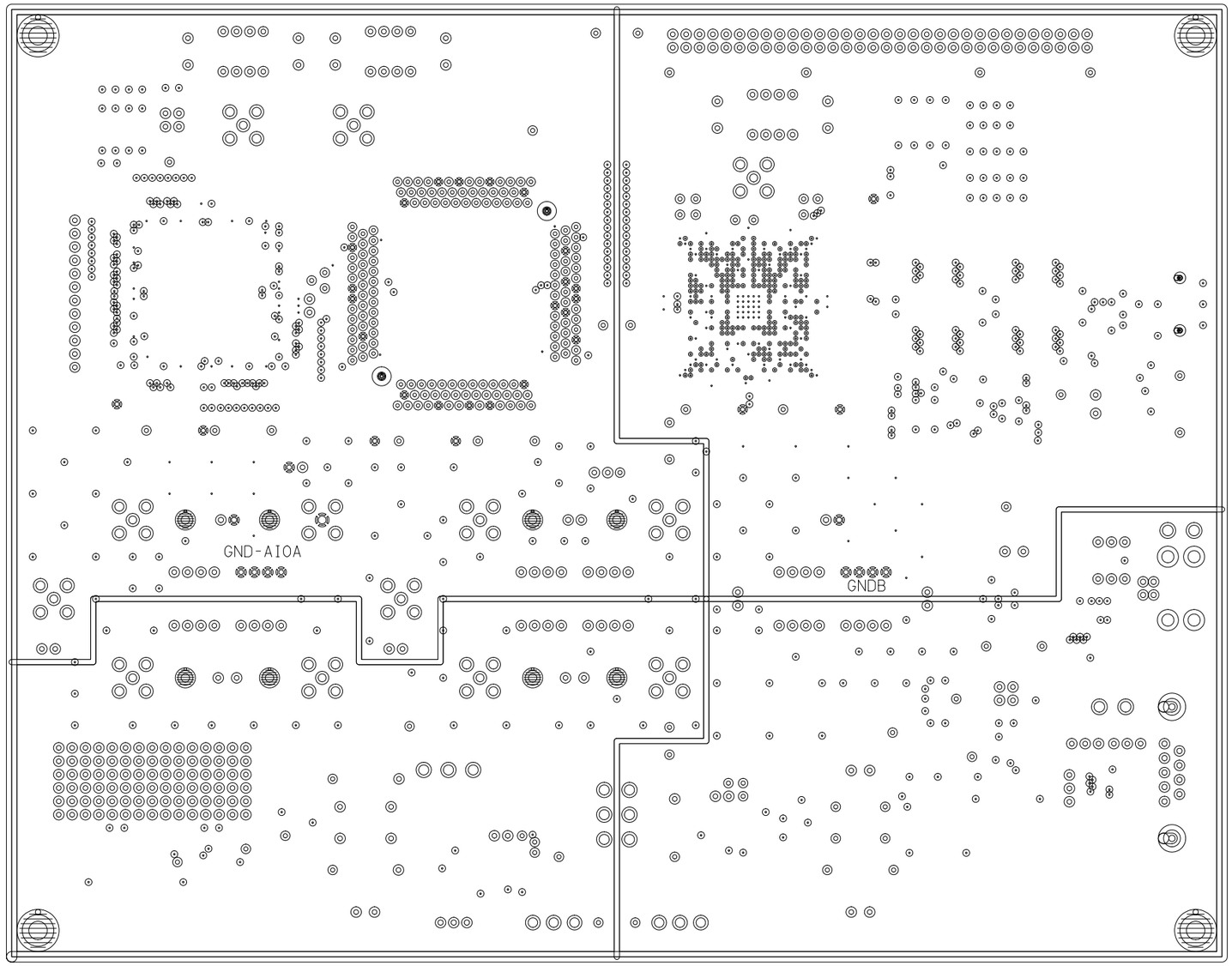
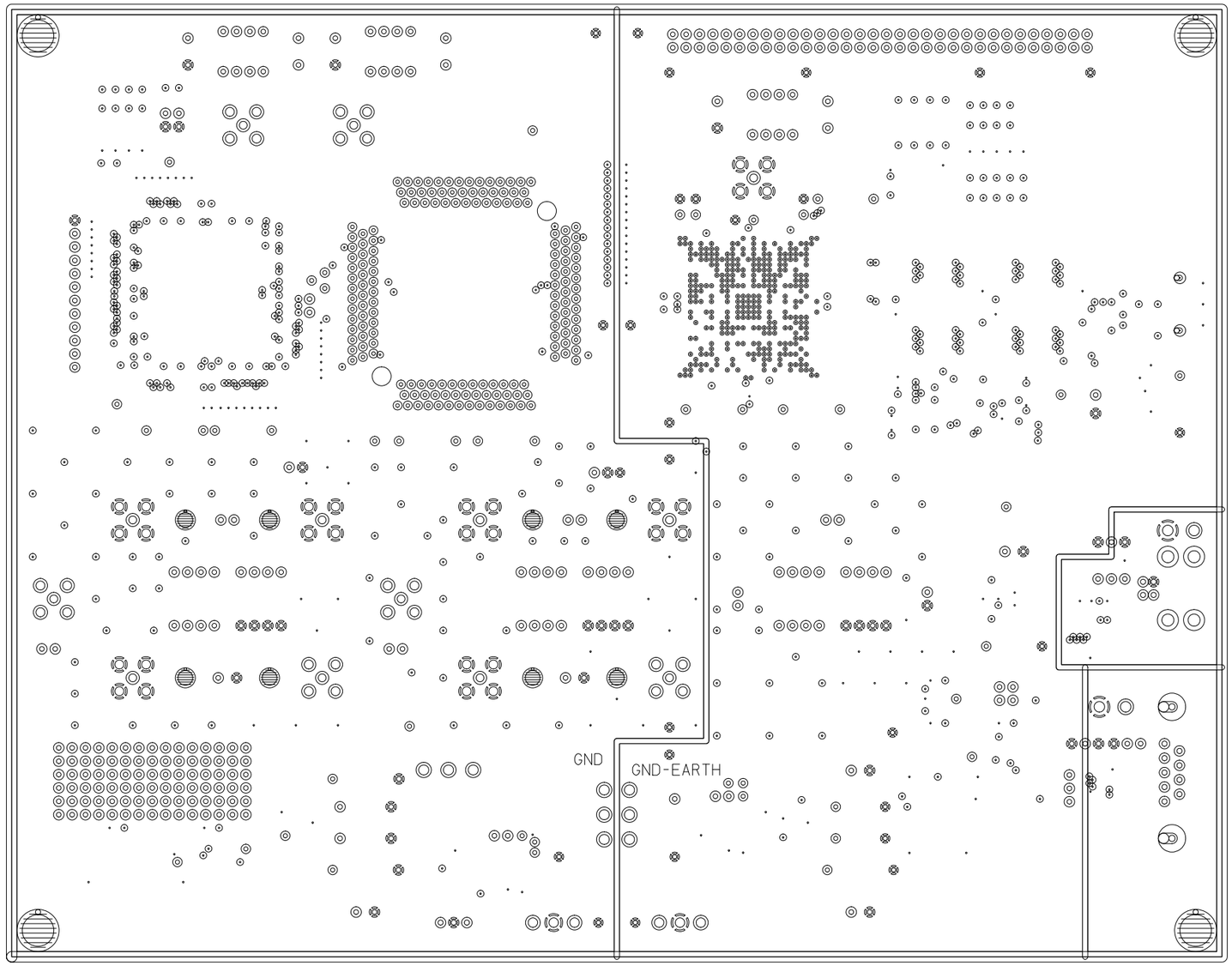


L3 GND-AIOA GNDB



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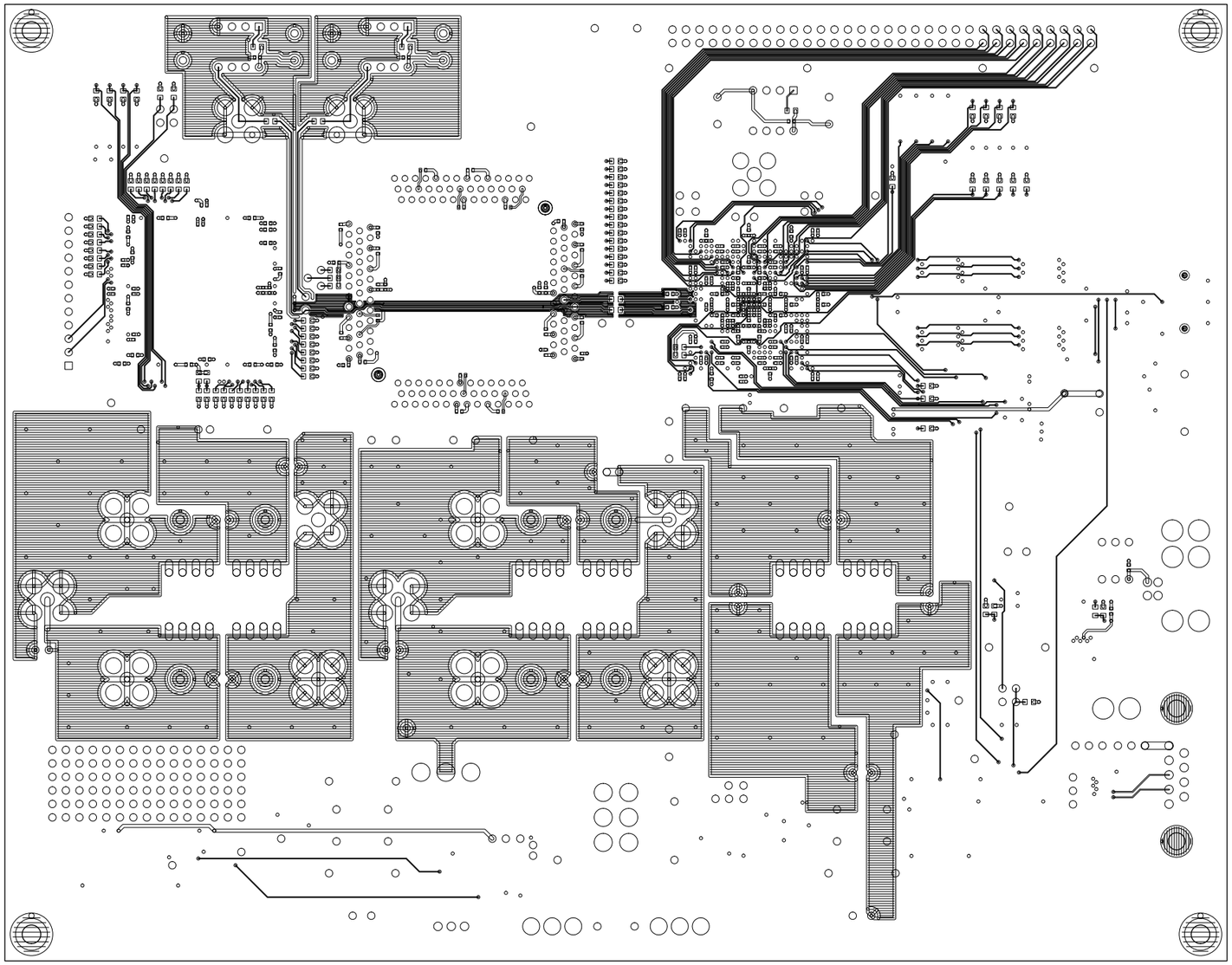

L8

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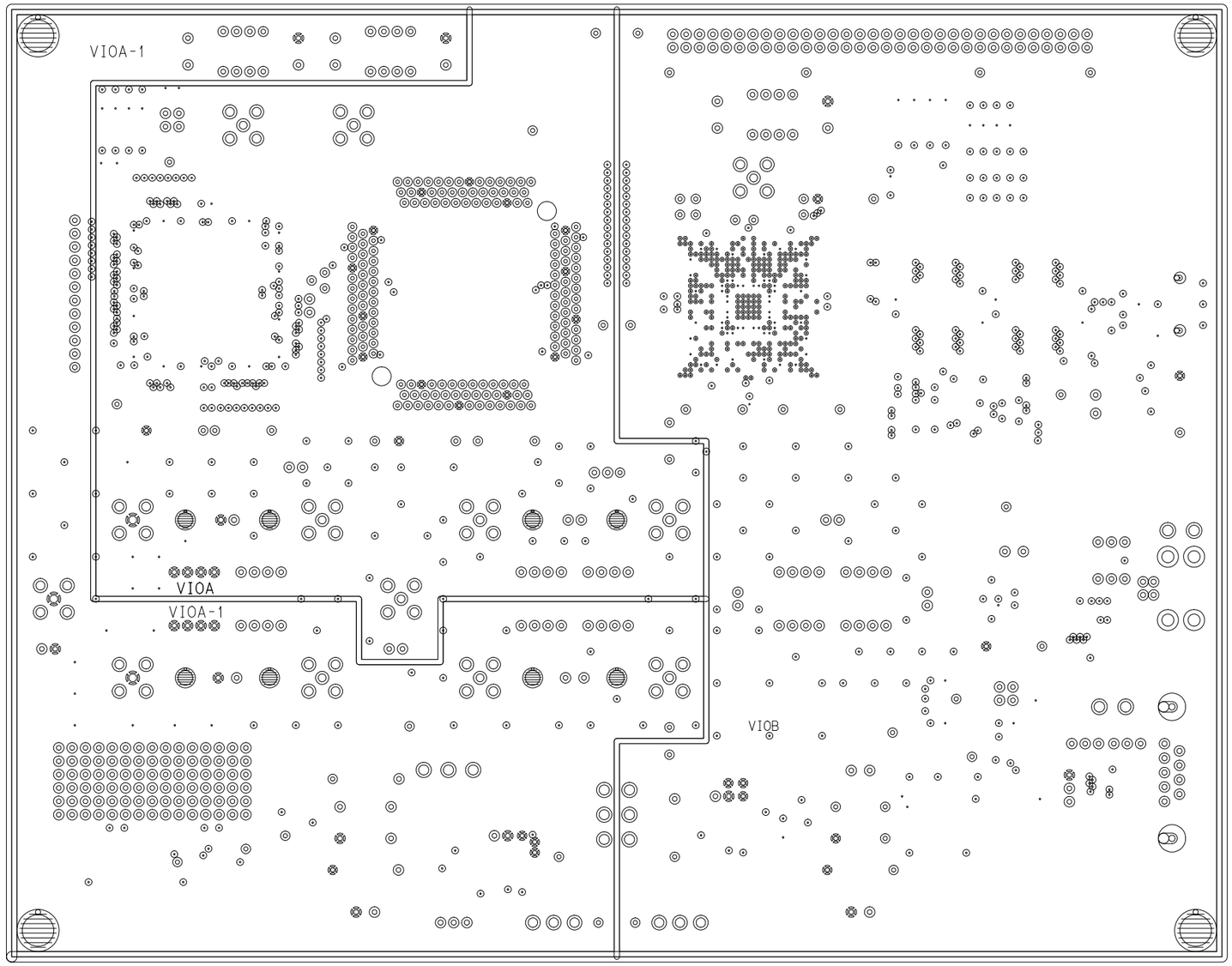
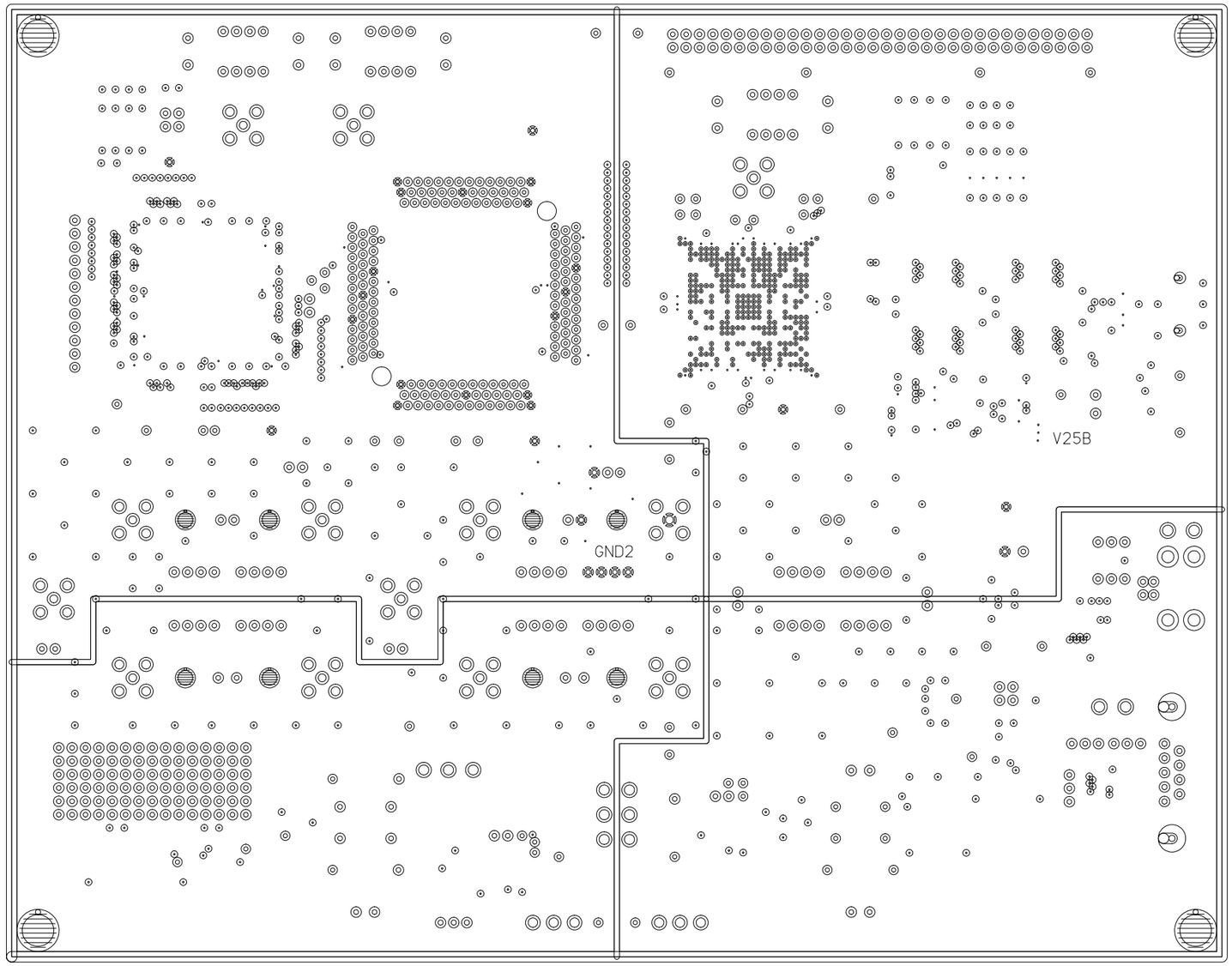


L7 VIO



L6 GND2 V25B

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