Saturn Starter

User Manual

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Document History

Version	Date	Author	Comment
2.40	12.04.2010	CG	Added warning about short-circuiting supply voltages on the Apollo connectors
2.31	19.3.2010	CG	updated Apollo B1 pinout
2.3	16.11.2009	MO	Updated BAUD rate table with baud rates for Saturn SX1 Rev. B modules (Table 5, page 12)
2.2	15.06.2009	MO	Corrected USB UART baud rate table (Table 5, page 12) Improved USB UART connectivity table (Table 4, page 11)
2.1	20.04.2009	MO	Corrected Saturn SX1 Apollo connector B1 pinout (Table 19, page 20), Updated BOM (Table 23, page 26)
2.0	01.04.2009	MO	Adapted to HW Rev. B
1.0	26.02.2009	DS	First release describing HW Rev. A

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1 Overview

1.1 General

The Saturn Starter board represents the Saturn-specific part of the Apollo evaluation platform. It provides slots for one Saturn module and up to four Apollo extension cards.

A series of Apollo extension cards provide ready-to-use peripheral functions for the most common DSP and SoPC applications, enabling the rapid construction of prototyping systems.

The well-documented Apollo extension interface allows the creation of application-specific extension cards for special functionalities not covered by the already available Apollo extension cards.

1.2 Features

- One Saturn module slot
- Four Apollo extension card slots
- USB 2.0 high-speed interface (only for Saturn modules with integrated USB)
- UART-over-USB for host PC connection
    - Either connected to the Saturn module's monitor port or
    - to the Saturn module's FPGA pins.
- SD Card slot (FPGA configuration)
- 10- and 14-pin JTAG connectors
- Saturn module I/O voltage selection
- Reset button
- Protected 12V power input with DC/DC converter to 5V
- Optional 5V power input

1.3 Deliverables

- Saturn Starter board
- Saturn Starter user manual[1] (this document)
- Saturn Starter schematics[2]
- Saturn Starter assembly drawing[3]
- USB cable
- 12V power supply

1.4 Accessories

1.4.1 Saturn Modules

- **Saturn SX1** – Xilinx Spartan-3A DSP FPGA module

1.4.2 Apollo Extension Cards

- **Apollo CV1** – Camera/Display: Camera Link, DVI, LVDS TFT
- **Apollo NS1** – Network and Connectivity: GigE, USB2.0, RS232, PS/2
- **Apollo DT1** – Touch Display: TFT, Touch, GPIO
- **Apollo DR1** – Drive/Motion Control: FET H-Bridges, Encoder, CAN, 24V I/O
- **Apollo AD1** – Data acquisition: High-speed ADCs
- **Apollo DA1** – Signal generation: High-speed DACs

1.4.3 IP Packages

- **TBD** – TBD

1.5 Block Diagram

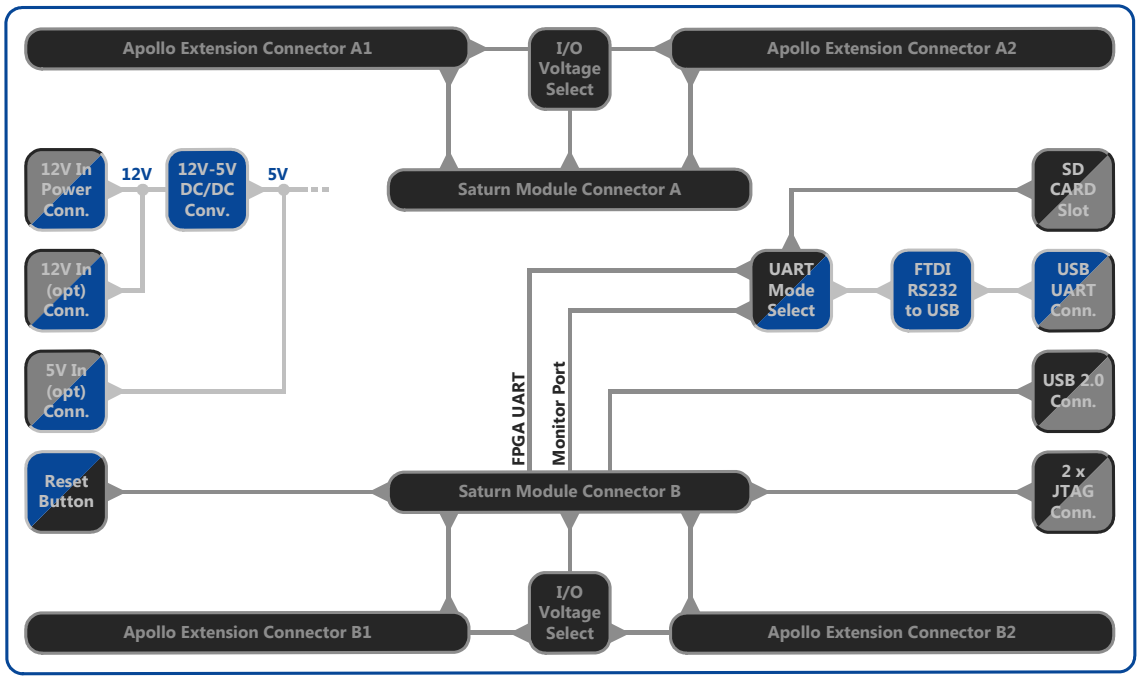

Figure 1: Hardware block diagram

One Saturn module and up to four Apollo extension cards may be plugged in to the Saturn Starter board. The Saturn module connects through two 140-pin Hirose connectors while the Apollo extension cards use 50-pin 2x2 mm dual row headers.

The Saturn Starter board provides a 12V power input connector for a standard 12V/2.5A power supply (included). A DC/DC-converter generates 5V/3A from the 12V input. Instead of the included 12V/2.5A power supply, a laboratory power supply may be connected through the 12V or 5V screw type terminals.

The most common Saturn module / Apollo extension card I/O voltages are configurable via jumpers. Externally generated custom I/O voltages may also be used.

An FTDI RS232 to USB device is integrated on the Saturn Starter board. This device enables host PC access to the SD Card, the Saturn module's monitor port or the Saturn module's FPGA pins. The USB UART connectivity and baud rate are configured via jumpers. Only one of the three USB UART targets may be connected at a time.

The SD Card may be used to store FPGA configuration bitstreams as Saturn modules are able to boot their FPGA from the SD Card. However, the Saturn Starter board does not provide the necessary connections to use the SD Card as external FPGA memory. Only SPI mode is supported.

A 14-pin JTAG connector (suitable for Xilinx programming cables) as well as a 10-pin JTAG connector (suitable for Altera programming cables) are equipped on the Saturn Starter board.

Additionally, a reset button is available on the Saturn Starter board. Pressing the reset button will cause reboot of the equipped Saturn module, including re-configuration of the FPGA.

1.6 Board Top View

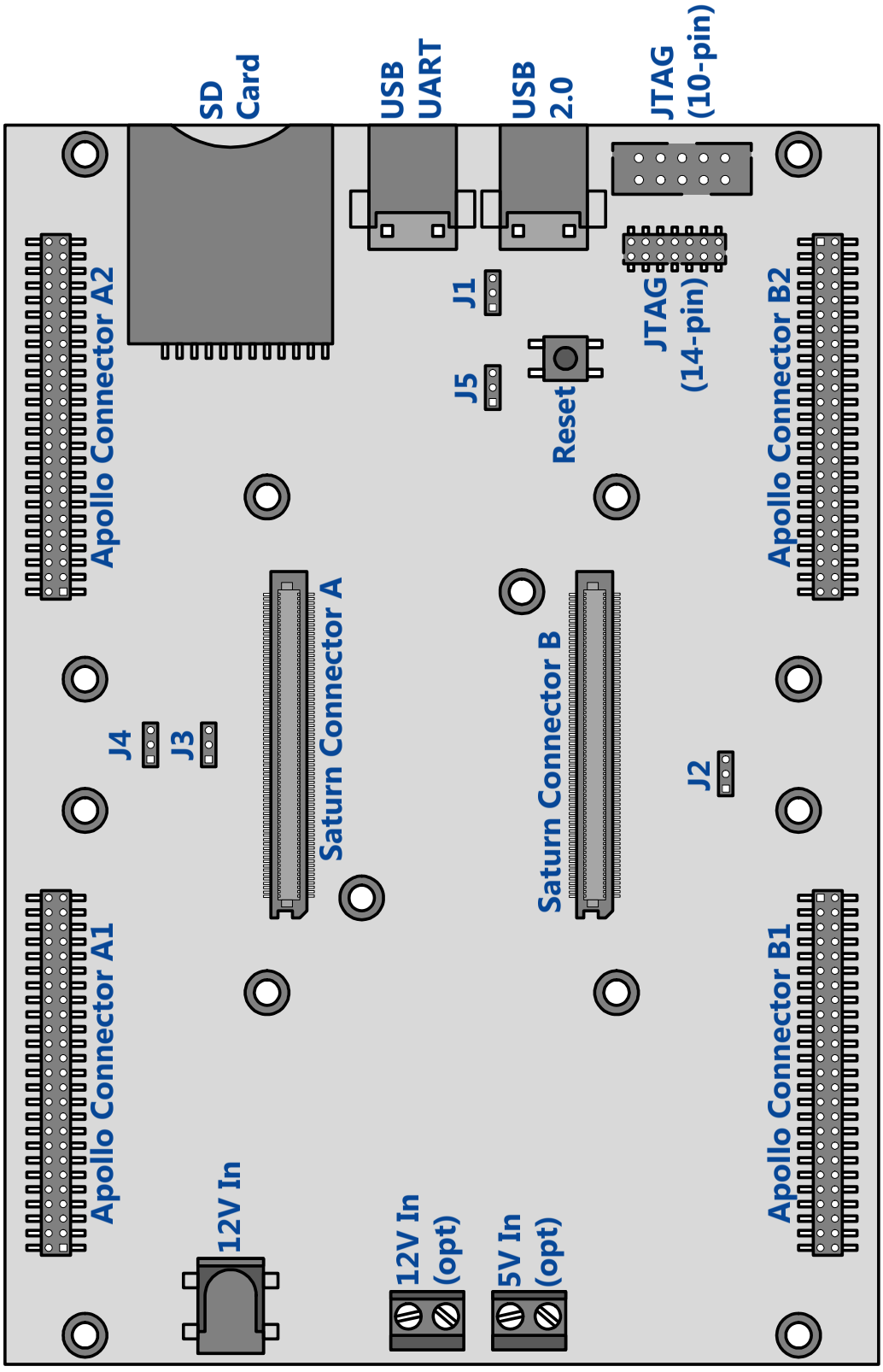

Figure 2: Saturn Starter board top view

2 Board Setup

2.1 Saturn Module Equipment

The Saturn connectors are keyed to prevent from equipping a Saturn module the wrong way.

Up to four M3 screws may be used to mechanically fasten a Saturn module to the Saturn Starter board.

***Attention**: Do not use excessive force to latch a Saturn module into the Saturn connectors on the Saturn Starter board as this could damage the Saturn module as well as the Saturn Starter board. Always make sure that the Saturn module is oriented the right way before plugging it into the Saturn Starter board.*

2.2 Apollo Extension Card Equipment

There is no keying and no alignment help with the Apollo connectors, so care has to be taken at plugging in an Apollo extension card.

Up to two M3 screws may be used to mechanically fasten an Apollo extension card to the Saturn Starter board.

***Attention**: Be careful when connecting or measuring supply voltages on the Apollo connectors. Connecting two supply voltages will destroy the Saturn FPGA module! Modules with failures due to faulty operations like applying wrong voltages are not subject of any warranty.*

***Attention**: Do not use excessive force to latch an Apollo extension card into the Apollo connectors on the Saturn Starter board as this could damage the Apollo extension card as well as the Saturn Starter board. Always make sure that the Apollo extension card is oriented the right way and properly aligned before plugging it into the Saturn Starter board.*

2.3 I/O Voltage Configuration

The Apollo connector I/O voltages are configurable to 2.5V or 3.3V via jumpers[1]. The Apollo connector A1 and A2 I/O voltages are configurable independently while the Apollo connectors B1 and B2 share the same I/O voltage.

The configured I/O voltage is available at pin 50 of the corresponding Apollo connector.

***Attention**: Only use I/O voltages compliant with the equipped Saturn module. Any other voltages may damage the equipped Saturn module as well as equipped Apollo extension cards. Some Saturn modules may have specific restrictions in terms of I/O voltage usage.*

***Attention**: Do not leave an I/O voltage jumper middle pin floating. Doing so may damage the equipped Saturn module as well as the equipped Apollo extension card.*

[1] Custom I/O voltages are also possible. The desired voltage must be applied to the according jumper's middle pin. The allowed I/O voltage levels are dependent on the equipped Saturn module.

2.3.1 Apollo Connector A1 I/O Voltage Configuration

Jumper J4 Position	A_VCCO_IN Configuration
	Custom (desired I/O voltage must be connected to the jumper's middle pin)
	A_VCCO_IN = 3.3V (factory setting)
	A_VCCO_IN = 2.5V

Table 1: A_VCCO_IN setting (jumper J4)

2.3.2 Apollo Connector A2 I/O Voltage Configuration

Jumper J3 Position	C_VCCO_IN Configuration
	Custom (desired I/O voltage must be connected to the jumper's middle pin)
	C_VCCO_IN = 3.3V (factory setting)
	C_VCCO_IN = 2.5V

Table 2: C_VCCO_IN setting (jumper J3)

2.3.3 Apollo Connectors B1 and B2 I/O Voltage Configuration

Jumper J2 Position	B_VCCO_IN Configuration
	Custom (desired I/O voltage must be connected to the jumper's middle pin)
	B_VCCO_IN = 3.3V (factory setting)
	B_VCCO_IN = 2.5V

Table 3: B_VCCO_IN setting (jumper J2)

2.4 USB UART Configuration

2.4.1 Connectivity

The USB UART connectivity is configured via jumper J5. Table 4 lists the three available configurations.

Jumper J5 Position	Configuration
	UART: Not used SD Card: Connected to the Saturn module's monitor port This setting allows FPGA configuration from the SD Card, but the UART interface is inoperable.
	UART: Connected to the Saturn module's monitor port SD Card: Not used This setting allows access to the Saturn module's monitor port over the UART, but FPGA configuration from the SD Card is inoperable. The monitor port uses 8 data bits, no parity bit, 1 stop bit and no flow control.
	UART: Connected to the Saturn module's FPGA UART pins SD Card: Connected to the Saturn module's monitor port This setting allows access to the Saturn module's FPGA UART pins over the USB UART while FPGA configuration from the SD Card is available.

Table 4: USB UART connectivity select (jumper J5)

2.4.2 Baud Rate

Jumper J1 is used to select the USB UART baud rate. Table 5 shows the possible UART baud rate configurations.

Jumper J1 Position	UART Baud Rate
	38400 baud
	460800[2,3] / 750000 baud[2,3]

[2] This baud rate is not supported by the monitor port. If this baud rate is selected when using the monitor port, the baud rate is automatically reset to 38400 baud.

[3] Saturn SX1 Rev. A modules run with 460800 baud while Saturn SX1 Rev. B modules run with 750000 baud.

	115200 baud

Table 5: USB UART port baud rate select (jumper J1)

2.5 Powering the Board

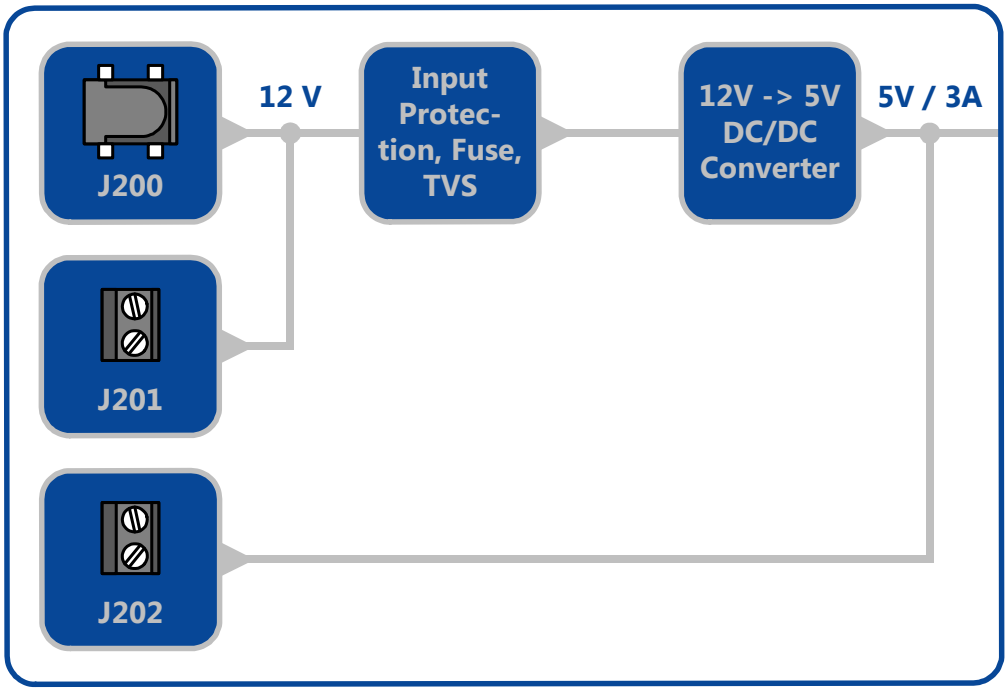

Figure 3: Power supply input

The Saturn Starter board provides a power supply input connector (J200) on board, which fits to the included 12V / 2.5A power supply. The 12V input is protected against over voltage and over current. A DC/DC converter is used to generate the 5 V voltage (max. 3 A).

In place of the included 12V power supply, a suitable laboratory power supply may be connected to either the 12V (J201) or 5V (J202) screw type terminal. Please note that the 5V input is not protected against over voltage and over current. Only one power input must be used at a time.

3 Connectors

3.1 Saturn Connectors (J501/J601)

Table 6 shows the connector type as well as some additional information.

Reference	Type	Description	Digikey part number
J501, J601	FX8-140P-SV(91)	Hirose FX8, 140-pin, 0.6 mm pitch, 3mm stacking height	H10690-ND

Table 6: Saturn connector types

Figure 4 shows the pin numbering for the Saturn module connectors.

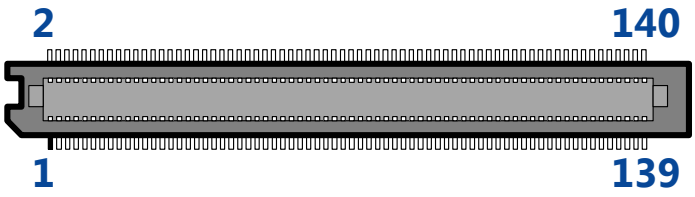

Figure 4: Pin numbering for the Saturn module connector (Saturn Starter board top view)

A detailed description of the Saturn connector pinout can be found in the respective user manual of the equipped Saturn module.

3.2 Apollo Connectors (J502/J503/J602/J603)

Table 7 shows the connector type as well as some additional information.

Reference	Type	Description	Digikey part number
J502, J503, J602, J603	151250-2420-RB-WF	3M, 2x2mm, 50 pos, dual row, male header, SMD	3M5376CT-ND
Female counterpart on Apollo extensions	150250-2020-RB-WF	3M, 2x2mm, 50pos, dual row female socket, SMD	3M5340CT-ND

Table 7: Apollo connector types

Figure 5 and Figure 6 show the pin numbering of the Apollo connectors. In top view, the pin numbering of the B1/B2 connectors is rotated by 180° with respect to the A1/B2 connectors.

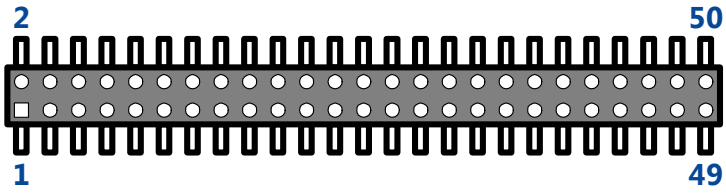

Figure 5: Pin numbering for Apollo connectors A1 and A2 (Saturn Starter board top view)

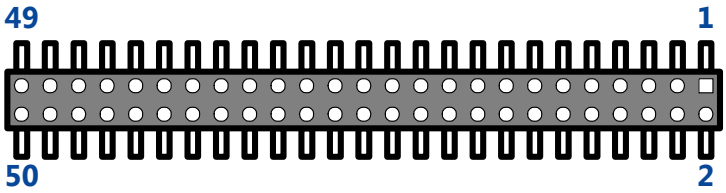

Figure 6: Pin numbering for Apollo connectors B1 and B2 (Saturn Starter board top view)

The actual pin usage/availability is dependent on the equipped Saturn FPGA Module. Section 4 gives detailed information about the module-specific Apollo connector pinouts.

3.3 USB 2.0 and USB UART Connectors (J301/J302)

Both connectors (J301/J302) are standard type B connectors as specified in the USB 2.0 specification.[4]

3.4 SD Card Slot (J402)

The SD Card slot (J402) is a standard 32x24 mm SD Card slot as specified in the SD specifications.[5] Only the SPI interface is connected, SD mode is thus not supported.

3.5 14-pin JTAG Connector (J303)

The 14-pin JTAG connector's type and pinout are chosen to directly fit the Xilinx Platform Cable USB II download cable. This connector should thus be used if a Saturn module incorporating a Xilinx FPGA is equipped to the Saturn Starter board.

Table 8 shows the connector type as well as some additional information.

Reference	Type	Description	Digikey part number
J303	87832-1420	Molex dual row 14-pin header, SMD	WM18641-ND

Table 8: 14-pin JTAG connector type

Figure 7 shows the pin numbering for the 14-pin JTAG connector.

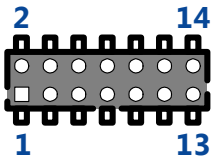

Figure 7: Pin numbering for the 14-pin JTAG connector (Saturn Starter board top view)

Table 9 shows the pinout of the 14-pin JTAG connector.

Pin number	Signal name	Pin number	Signal name
1	GND	2	VREF
3	GND	4	TMS
5	GND	6	TCK
7	GND	8	TDO
9	GND	10	TDI
11	GND	12	-
13	GND	14	-

Table 9: 14-pin JTAG connector pinout

3.6 10-pin JTAG Connector (J304)

The 10-pin JTAG connector's type and pinout are chosen to directly fit the Altera USB Blaster download cable. This connector should thus be used if a Saturn module incorporating an Altera FPGA is equipped to the Saturn Starter board.

Table 10 shows the connector type as well as some additional information.

Reference	Type	Description	Digikey part number
J304	5103308-1	Tyco dual row 10-pin header, THT	A33159-ND

Table 10: 10-pin JTAG connector type

Figure 8 shows the pin numbering for the 10-pin JTAG connector.

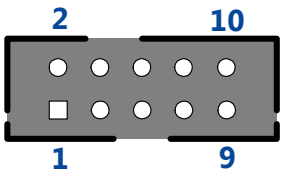

Figure 8: Pin numbering for the 10-pin JTAG connector (Saturn Starter board top view)

Table 11 shows the pinout of the 10-pin JTAG connector.

Pin number	Signal name	Pin number	Signal name
1	TCK	2	GND
3	TDO	4	VCC
5	TMS	6	-
7	-	8	-
9	TDI	10	GND

Table 11: 10-pin JTAG connector pinout

3.7 Power Connectors (J200/J201/J202)

Table 12 shows the connector type as well as some additional information.

Reference	Type	Description	Digikey part number
J200	PJ-002AH-SMT	CUI power jack connector SMD	CP-002AHPJCT-ND
J201, J202	MKDSN 1,5/2-5,08	Phoenix screw type print header, 2pol, 5.08mm	-

Table 12: Power connector types

Figure 9 shows the power/GND connections for the power connectors in Saturn Starter board front view.

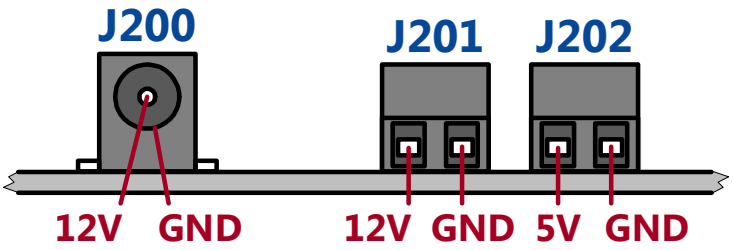

Figure 9: Power/GND connections for the power connectors (Saturn Starter board front view)

3.8 Monitor UART Connector Footprint (J7)

Attention: *The monitor UART connector J7 is not equipped by default and has – if required - to be equipped by the user.*

The Monitor UART connector pins are not connected to any Apollo connector and are powered by VCC_3V3.

Table 13 shows the connector type as well as some additional information.

Reference	Type	Description	Digikey part number
J7	22-03-2051	Molex pin header, 5 x 2.54 mm pitch	WM4003-ND

Table 13: Monitor UART connector type

Figure 10 shows monitor UART connector footprint (J7) as seen in Saturn Starter board top view.

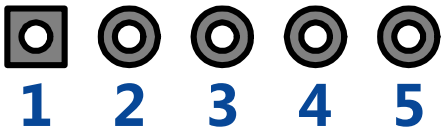

Figure 10: Monitor UART connector footprint (Saturn Starter board top view)

Table 14 shows the pinout of the monitor UART connector.

Pin number	Signal name
1	MON_CTS#
2	MON_RTS#
3	GND
4	MON_RX
5	MON_TX

Table 14: Monitor UART connector pinout

3.9 Module UART Connector Footprint (J6)

Attention: *The module UART connector J6 is not equipped by default and has - if required - to be equipped by the user.*

The Module UART connector pins are not connected to any Apollo connector and are powered by B_VCCO_IN.

Table 15 shows the connector type as well as some additional information.

Reference	Type	Description	Digikey part number
J6	22-03-2051	Molex pin header, 5x 2.54mm pitch	WM4003-ND

Table 15: Module UART connector type

Figure 11 shows module UART connector footprint (J6) as seen in Saturn Starter board top view.

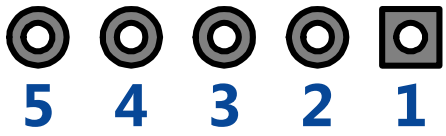

Figure 11: Monitor UART connector footprint (Saturn Starter board top view)

Table 16 shows the pinout of the monitor UART connector.

Pin number	Signal name	Module connector pins
1	B_DIFFIO_N_9	B30
2	B_DIFFOP_P_9	B28
3	GND	
4	B_DIFFIO_N_0	B5
5	B_DIFFIO_P_0	B3

Table 16: Module UART connector pinout

4 Module Specific Information

4.1 Saturn SX1

4.1.1 Apollo Connectors Pinout

4.1.1.1 Apollo Connector A1

FPGA Pin	FPGA I/O	Signal	Connector A1 Pin		Signal	FPGA I/O	FPGA Pin
B3	IO_L30P_0	A_DiffIo_P<0>	1	2	A_DiffIo_N<0>	IO_L30N_0	A3
D5	IO_L29P_0	A_DiffIo_P<1>	3	4	A_DiffIo_N<1>	IO_L29N_0	C4
B4	IO_L28P_0	A_DiffIo_P<2>	5	6	A_DiffIo_N<2>	IO_L28N_0	A4
C6	IO_L21P_0	A_DiffIo_P<3>	7	8	A_DiffIo_N<3>	IO_L21N_0	D6
-	-	GND	9	10	GND	-	-
A6	IO_L25P_0	A_DiffIo_P<4>	11	12	A_DiffIo_N<4>	IO_L25N_0	A5
E7	IO_L31P_0/VREF_0	A_DiffIo_P<5>	13	14	A_DiffIo_N<5>	IO_L31N_0/PUDC_B	F7
C7	IO_L26P_0	A_DiffIo_P<6>	15	16	A_DiffIo_N<6>	IO_L26N_0	D7
B6	IO_L24P_0	A_DiffIo_P<7>	17	18	A_DiffIo_N<7>	IO_L24N_0/VREF_0	A7
-	-	GND	19	20	GND	-	-
F8	IO_L27P_0	A_DiffIo_P<8>	21	22	A_DiffIo_N<8>	IO_L27N_0	E8
C8	IO_L22P_0	A_DiffIo_P<9>	23	24	A_DiffIo_N<9>	IO_L22N_0	D9
A8	IO_L20P_0/GCLK10	A_DiffIo_P<10>	25	26	A_DiffIo_N<10>	IO_L20N_0/GCLK11	B8
G8	IO_L23P_0	A_DiffIo_P<11>	27	28	A_DiffIo_N<11>	IO_L23N_0	F9
-	-	GND	29	30	GND	-	-
A9	IO_L18P_0/GCLK6	A_DiffIo_P<12>	31	32	A_DiffIo_N<12>	IO_L18N_0/GCLK7	B9
C9	IO_L16P_0	A_DiffIo_P<13>	33	34	A_DiffIo_N<13>	IO_L16N_0	D10
C5	IP_0	A_Input<0>	35	36	A_Input<1>	IP_0	C10
A10	IP_0	A_Input<2>	37	38	A_Input<3>	IP_0/VREF_0	C11
-	-	GND	39	40	GND	-	-
-	-	*Clk_Out<0>*	41	42	GND	-	-
-	-	GND	43	44	GND	-	-
-	-	VCC_1V2_Out	45	46	VCC_3V3_Out	-	-
-	-	VCC_1V8_Out	47	48	*VCC_5V0*	-	-
-	-	VCC_2V5_Out	49	50	A_VCCO_In	-	-

Table 17: Saturn SX1 Apollo A1 connector pinout

4.1.1.2 Apollo Connector A2

FPGA Pin	FPGA I/O	Signal	Connector A2 Pin		Signal	FPGA I/O	FPGA Pin
E13	IO_L09P_0	A_DiffIo_P<19>	1	2	A_DiffIo_N<19>	IO_L09N_0	D13
F14	IO_L13P_0	A_DiffIo_P<20>	3	4	A_DiffIo_N<20>	IO_L13N_0	F13
D14	IO_L12P_0	A_DiffIo_P<21>	5	6	A_DiffIo_N<21>	IO_L12N_0/VREF_0	C15
A14	IO_L10P_0	A_DiffIo_P<22>	7	8	A_DiffIo_N<22>	IO_L10N_0	B15
-	-	GND	9	10	GND	-	-
D15	IO_L08P_0	A_DiffIo_P<23>	11	12	A_DiffIo_N<23>	IO_L08N_0	C16
E15	IO_L05P_0	A_DiffIo_P<24>	13	14	A_DiffIo_N<24>	IO_L05N_0	F15
A16	IO_L06P_0/VREF_0	A_DiffIo_P<25>	15	16	A_DiffIo_N<25>	IO_L06N_0	A17
E16	IO_L04P_0	A_DiffIo_P<26>	17	18	A_DiffIo_N<26>	IO_L04N_0	F16
-	-	GND	19	20	GND	-	-
C18	IO_L02P_0/VREF_0	A_DiffIo_P<27>	21	22	A_DiffIo_N<27>	IO_L02N_0	B19
B17	IO_L03P_0	A_DiffIo_P<28>	23	24	A_DiffIo_N<28>	IO_L03N_0	C17
D19	IO_L01P_0	A_DiffIo_P<29>	25	26	A_DiffIo_N<29>	IO_L01N_0	C19
B20	IO_L07P_0	A_DiffIo_P<30>	27	28	A_DiffIo_N<30>	IO_L07N_0	A19
-	-	GND	29	30	GND	-	-
F10	IO_L19P_0/GCLK8	A_DiffIo_P<14>	31	32	A_DiffIo_N<14>	IO_L19N_0/GCLK9	E11
E12	IO_L17P_0/GCLK4	A_DiffIo_P<16>	33	34	A_DiffIo_N<16>	IO_L17N_0/GCLK5	F11
C13	IO_L14P_0	A_DiffIo_P<17>	35	36	A_DiffIo_N<17>	IO_L14N_0	C12
A13	IO_L11P_0	A_DiffIo_P<18>	37	38	A_DiffIo_N<18>	IO_L11N_0	B13
-	-	GND	39	40	GND	-	-
-	-	*Clk_Out<1>*	41	42	GND	-	-
-	-	GND	43	44	GND	-	-
-	-	VCC_1V2_Out	45	46	VCC_3V3_Out	-	-
-	-	VCC_1V8_Out	47	48	*VCC_5V0*	-	-
-	-	VCC_2V5_Out	49	50	C_VCCO_In	-	-

Table 18: Saturn SX1 Apollo A2 connector pinout

4.1.1.3 Apollo Connector B1

FPGA Pin	FPGA I/O	Signal	Connector B1 Pin		Signal	FPGA I/O	FPGA Pin
AA20	IO_L30P_2	B_DiffIo_P<17>	1	2	B_DiffIo_N<17>	IO_L30N_2	AB20
AB19	IO_L27P_2	B_DiffIo_P<16>	3	4	B_DiffIo_N<16>	IO_L27N_2	AA19
AB17	IO_L23P_2	B_DiffIo_P<15>	5	6	B_DiffIo_N<15>	IO_L23N_2	AB18
U16	IO_L28P_2	B_DiffIo_P<14>	7	8	B_DiffIo_N<14>	IO_L28N_2	V16
-	-	GND	9	10	GND	-	-
Y17	IO_L29P_2	B_DiffIo_P<13>	11	12	B_DiffIo_N<13>	IO_L29N_2	Y16
U14	IO_L25P_2	B_DiffIo_P<12>	13	14	B_DiffIo_N<12>	IO_L25N_2	U15
AA15	IO_L19P_2	B_DiffIo_P<11>	15	16	B_DiffIo_N<11>	IO_L19N_2	AB14
Y13	IO_L21P_2	B_DiffIo_P<10>	17	18	B_DiffIo_N<10>	IO_L21N_2	W14
-	-	GND	19	20	GND	-	-
Y8	IO_L13P_2	B_DiffIo_P<7>	21	22	B_DiffIo_N<7>	IO_L13N_2	Y9
V10	IO_L10P_2	B_DiffIo_P<6>	23	24	B_DiffIo_N<6>	IO_L10N_2	U9
AB7	IO_L08P_2	B_DiffIo_P<5>	25	26	B_DiffIo_N<5>	IO_L08N_2	AA8
W8	IO_L06P_2	B_DiffIo_P<4>	27	28	B_DiffIo_N<4>	IO_L06N_2	V8
-	-	GND	29	30	GND	-	-
U12	IO_L17P_2/GCLK0	B_DiffIo_P<8>	31	32	B_DiffIo_N<8>	IO_L17N_2/GCLK1	V12
V7	IO_L11P_2	B_DiffIo_P<3>	33	34	B_DiffIo_N<3>	IO_L11N_2	U8
AB5	IO_L05P_2	B_DiffIo_P<2>	35	36	B_DiffIo_N<2>	IO_L05N_2	AB6
AB4	IO_L04P_2	B_DiffIo_P<1>	37	38	B_DiffIo_N<1>	IO_L04N_2	AA4
-	-	GND	39	40	GND	-	-
-	-	*Clk_Out<2>*	41	42	GND	-	-
-	-	GND	43	44	GND	-	-
-	-	VCC_1V2_Out	45	46	VCC_3V3_Out	-	-
-	-	VCC_1V8_Out	47	48	*VCC_5V0*	-	-
-	-	VCC_2V5_Out	49	50	B_VCCO_In	-	-

Table 19: Saturn SX1 Apollo B1 connector pinout

4.1.1.4 Apollo Connector B2

FPGA Pin	FPGA I/O	Signal	Connector B2 Pin		Signal	FPGA I/O	FPGA Pin
J21	IP_L27P_1	B_UserIn_P<5>	1	2	B_UserIn_N<5>	IP_L27N_1	J22
L18	IP_L23P_1/VREF_1	B_UserIn_P<4>	3	4	B_UserIn_N<4>	IP_L23N_1	K17
R21	IP_L16P_1/VREF_1	B_UserIn_P<3>	5	6	B_UserIn_N<3>	IP_L16N_1	P20
R17	IP_L12P_1	B_UserIn_P<2>	7	8	B_UserIn_N<2>	IP_L12N_1/VREF_1	P17
-	-	GND	9	10	GND	-	-
V22	IP_L08P_1	B_UserIn_P<1>	11	12	B_UserIn_N<1>	IP_L08N_1/VREF_1	U21
W21	IP_L04P_1	B_UserIn_P<0>	13	14	B_UserIn_N<0>	IP_L04N_1/VREF_1	W20
T18	IO_L05P_1	B_UserIo_P<1>	15	16	B_UserIo_N<1>	IO_L05N_1	T17
W19	IO_L03P_1/A0	B_UserIo_P<0>	17	18	B_UserIo_N<0>	IO_L03N_1/A1	V20
-	-	GND	19	20	GND	-	-
C22	IP_L39P_1/VREF_1	B_UserIn_P<7>	21	22	B_UserIn_N<7>	IP_L39N_1	C21
H21	IP_L31P_1/VREF_1	B_UserIn_P<6>	23	24	B_UserIn_N<6>	IP_L31N_1	G20
W18	IP_2/VREF_2	B_Input<13>	25	26	B_Input<12>	IP_2	AB15
V15	IP_2/VREF_2	B_Input<11>	27	28	B_Input<10>	IP_2/VREF_2	Y14
-	-	GND	29	30	GND	-	-
W13	IP_2/VREF_2	B_Input<9>	31	32	B_Input<8>	IP_2	Y12
AB11	IP_2/VREF_2	B_Input<7>	33	34	B_Input<6>	IP_2	W10
W9	IP_2/VREF_2	B_Input<5>	35	36	B_Input<4>	IP_2	Y7
AA6	IP_2	B_Input<3>	37	38	B_Input<2>	IP_2	Y6
-	-	GND	39	40	GND	-	-
-	-	*Clk_Out<2>*	41	42	GND	-	-
-	-	GND	43	44	GND	-	-
-	-	VCC_1V2_Out	45	46	VCC_3V3_Out	-	-
-	-	VCC_1V8_Out	47	48	*VCC_5V0*	-	-
-	-	VCC_2V5_Out	49	50	B_VCCO_In	-	-

Table 20: Saturn SX1 Apollo B2 connector pinout

4.1.2 FPGA UART

UART signal	Connected to Signal	FPGA Pin	FPGA Location	UART connector pin
FTDI_RTS#	B_DIFFIO_N_9	AA14	I/O_L18N_2/GCLK3	1
FTDI_CTS#	B_DIFFIO_P_9	AB13	I/O_L18P_2/GCLK2	2
FTDI_TX	B_DIFFIO_N_0	Y4	I/O_L03N_2	5
FTDI_RX	B_DIFFIO_P_0	W5	I/O_L03P_2	4

Table 21: FPGA UART pinout

Please note that the FPGA UART pins are only available with the correct jumper settings. Please see section 2.4.1 for details.

4.1.3 VCCO Settings

The FPGA I/Os routed to the Apollo connectors A1 and A2 are all connected to the same FPGA bank (bank 0). Therefore, the I/O voltages of the Apollo connectors A1 and A2 must be the same.

Attention: *Always set A_VCCO_IN and C_VCCO_IN to the same voltage!*

4.1.4 USB Availability

The USB 2.0 interface is available with the Saturn SX1-3400 module, but not with the Saturn SX1-1800 module.

5 Apollo Design Guidelines

5.1 Power Requirements

The 1.2V / 1.8V / 2.5V and 3.3V supplies are generated within the Saturn module and directly taken from the Saturn module power outputs. The available currents must be shared between all equipped Apollo extensions cards. The available power depends on the module used. Please see the respective Saturn module user manual for detailed information.

For the 5V supply, a total of 3A are available for the Saturn module and the equipped Apollo extension cards together. The available power depends on the module used. Please see the respective Saturn module user manual for detailed information.

In conclusion, if an Apollo extension card requires a lot of power on 1.2V, 1.8V, 2.5 V and/or 3.3V, the respective voltages have to be generated from the 5V power input, or a separate power input has to be integrated into the Apollo extension card.

5.2 Differential Pair Lengths

All differential pairs on the Saturn Starter board are length matched to 99 mm.

5.3 Equipment Options

5.3.1 Differential Pair Termination

Footprints for parallel termination resistors (0402) on all differential pairs close to the module connectors are available on the Saturn Starter board. However, these termination resistors are not equipped by default and have – if required – to be equipped by the user

Signal	Resistor	Signal	Resistor	Signal	Resistor
A_DIFFIO_X_0	R700	A_DIFFIO_X_21	R720	B_DIFFIO_X_12	R740
A_DIFFIO_X_1	R701	A_DIFFIO_X_22	R721	B_DIFFIO_X_13	R741
A_DIFFIO_X_2	R702	A_DIFFIO_X_23	R722	B_DIFFIO_X_14	R742
A_DIFFIO_X_3	R703	A_DIFFIO_X_24	R723	B_DIFFIO_X_15	R743
A_DIFFIO_X_4	R704	A_DIFFIO_X_25	R724	B_DIFFIO_X_16	R744
A_DIFFIO_X_5	R705	A_DIFFIO_X_26	R725	B_DIFFIO_X_17	R745
A_DIFFIO_X_6	R706	A_DIFFIO_X_27	R726	B_USERIN_X_0	R746
A_DIFFIO_X_7	R707	A_DIFFIO_X_28	R727	B_USERIN_X_1	R747

A_DIFFIO_X_8	R708	A_DIFFIO_X_29	R728	B_USERIN_X_2	R748
A_DIFFIO_X_9	R709	A_DIFFIO_X_30	R729	B_USERIN_X_3	R749
A_DIFFIO_X_10	R710	B_DIFFIO_X_1	R730	B_USERIN_X_4	R750
A_DIFFIO_X_11	R711	B_DIFFIO_X_2	R731	B_USERIN_X_5	R751
A_DIFFIO_X_12	R712	B_DIFFIO_X_3	R732	B_USERIN_X_6	R752
A_DIFFIO_X_13	R713	B_DIFFIO_X_4	R733	B_USERIN_X_7	R753
A_DIFFIO_X_14	R714	B_DIFFIO_X_5	R734	B_USERIN_X_6	R754
A_DIFFIO_X_16	R715	B_DIFFIO_X_6	R735	B_USERIN_X_7	R755
A_DIFFIO_X_17	R716	B_DIFFIO_X_7	R736	B_USERIO_X_0	R756
A_DIFFIO_X_18	R717	B_DIFFIO_X_8	R737	B_USERIO_X_1	R757
A_DIFFIO_X_19	R718	B_DIFFIO_X_10	R738		
A_DIFFIO_X_20	R719	B_DIFFIO_X_11	R739		

Table 22: Differential pairs termination resistors

6 Assembly Drawing

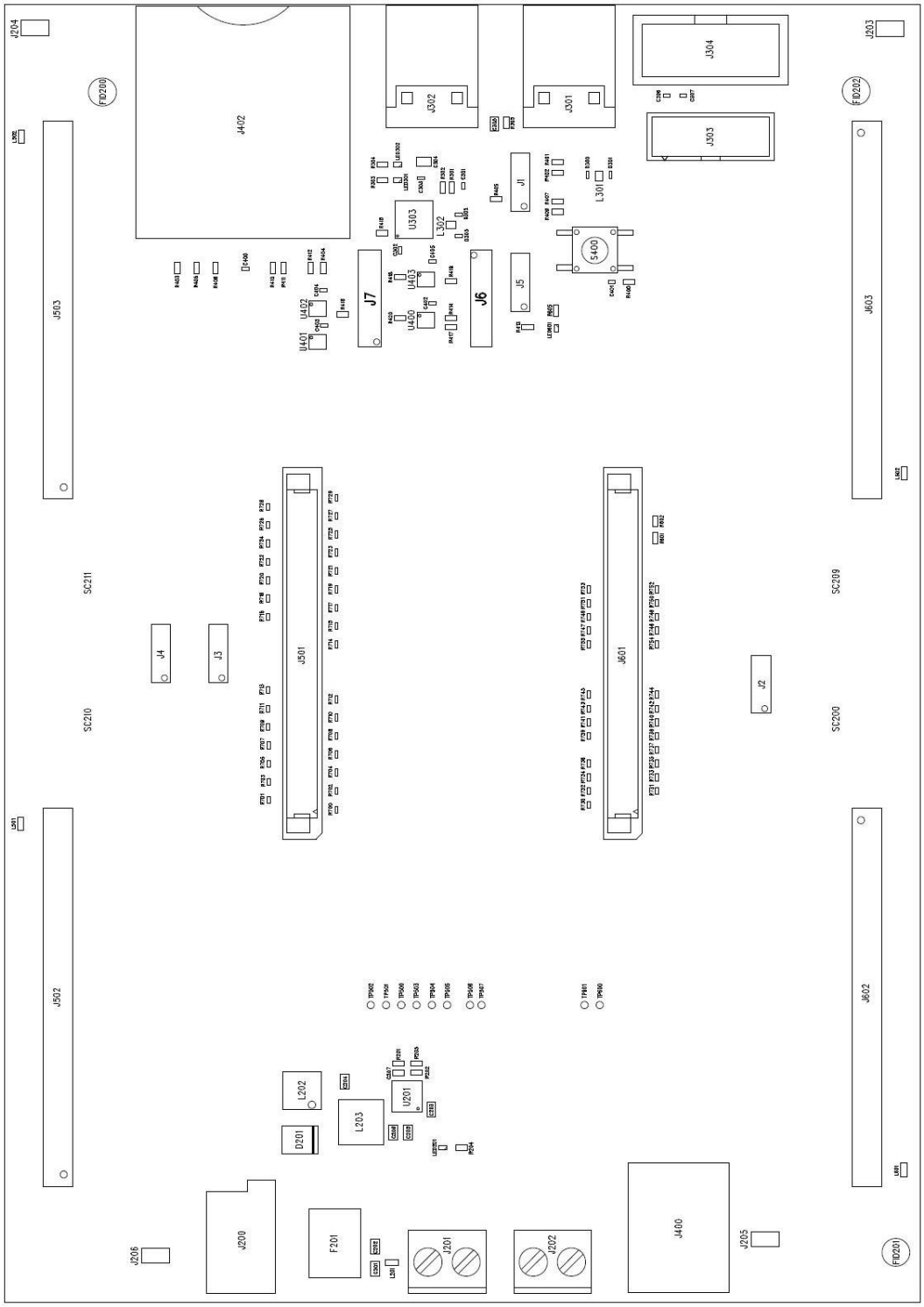

Figure 12: Assembly drawing

7 Bill of Materials

Reference	Part Number	Value	Tolerance	Description	Manufacturer
C201-202	-	4n7	250V X7R 10%	Capacitor ceramic 4700PF 250V X7R 10% 0805	TDK Corporation
C203-204 C304	-	10u	16V X5R 10%	SMD Capacitor	Murata
C205-206	-	22u	6.3V X5R	SMD Capacitor	Kemet
C207	-	4n7	50V X7R	SMD Capacitor	-
C208-209	-	100u	16V ±10%	SMD Tantalum Capacitor low ESR	Kemet
C210	-	1u	16V	SMD Capacitor	-
C301-303 C306-307 C400 C402-405	-	1u	6V3 X5R	SMD Capacitor	Panasonic
C305	-	4n7*	250V X7R 10%	Capacitor ceramic 4700PF 250V X7R 10% 0805	TDK Corporation
C401	-	1n *	50V X7R	SMD Capacitor	-
D201	SMBJ13A-TP	-	13.0V	TVS 600W 13V UNIDIRECT	Micro Commercial Co
D300-303	PESD0402-140	-	-	ESD Protector bidir 0402 14VDC	Tyco Electronics
F201	SMD150F-2	-	1.5A	Polyswitch 1.50A Hold SMD	Tyco Electronics
J1-5	68301-1014	-	-	CONN HEADER 3POS .100" VERT	Molex
J1B J2B J3B J4B J5B	EDJ2G0	-	-	SHUNT .100" BLACK	On Shore Technology Inc
J200	PJ-002AH-SMT	-	-	CONN POWER JACK 2.1X5.5MM HI CUR	CUI Inc
J201-202	MKDSN 1,5/2-5,08	-	-	Printheader 2x5.08mm,low profile, Schraubenanschluss	Phoenix Contact
J203-206	S1751_46	-	-	SMT Test Point	Harwin
J301-302	1734346-1	-	-	USB Type B receptacle, SMD	Tyco Electronics
J303	87832-1420	-	-	2x7 pin 2mm SMD JTAG connector	Molex
J304	5103308-1	-	-	Connector header 10 pos, JTAG Altera	Tyco Electronics
J400	44144-0005*	-	-	Connector Jack 6/6Pos Gold	Molex
J402	SD-RSMT-2-MQ-WF	-	-	Connector SD-Card PUSH-PUSH SMD	3M
J501 J601	FX8-140P-SV	-	-	Module Connector, 140-Pin Hirose FX8	Hirose
J502-503 J602-603	151250-2420-RB-WF	-	-	Connector 50Pos 2mm HEADER SMD	3M
J6-7	-	1x5 2.54mm*	-	Pin Header 1X5 254	-
L201 L501-502 L601-602	BLM18SG121TN1D	-	120R@100MHz 0.025 DCR	Ferrite, 3A, 120R@100MHz, 0.025R DCR	Murata
L202	DLW5BSN191SQ2L	-	50V 5.0A	SMD EMI Filters/Chip Ferrite Beads 50V 5.0A COMMON MODE	Murata Electronics
L203	-	3uH	+/- 30%	SMD inductor	Taiyo Yuden
L301-302	DLP11SN900HL2L	-	-	CHOKE COIL COMMON MODE 150MA SMD	Murata Electronics North America
LED201 LED601	SML-P12PTT86	-	13mcd 2.2V 20mA	LED 0402 Green	Rohm
LED301-302	SML-P12YTT86	-	130mcd 2.1V 20mA	LED 0402 Yellow	Rohm
R201 R401-402 R409	-	82k	1%	SMD Resistor	-
R202	-	12k	1%	SMD Resistor	-
R203	-	18k	1%	SMD Resistor	-
R204	-	680R	1%	SMD Resistor	-
R301	-	4k7	1%	SMD Resistor	-
R302	-	10k	-	SMD Resistor	-
R303-304	-	470R	1%	SMD Resistor	-
R305 R400	-	0R	1%	SMD Resistor	-
R403-404 R406 R408 R410 R412-416	-	10k	1%	SMD Resistor	-
R405	-	39k	1%	SMD Resistor	-
R407	-	22k	1%	SMD Resistor	-
R411	-	10k *	1%	SMD Resistor	-
R417-420	-	100R	1%	SMD Resistor	-
R601-602	-	18R	1%	SMD Resistor	-
R605	-	270R	1%	SMD Resistor	-
R700-755	-	100R *	1%	SMD Resistor	-
S400	FSM4JSMA	-	-	Tactile Switch, 6x6mm, 160g, 50mA@12V	Tyco Electronics
U201	ST1S10PUR	-	-	IC REG STEPDOWN 3A 900KHZ	STMicroelectronics
U303	FT232RQ R	-	-	IC USB TO SERIAL UART	FTDI
U400-403	NC7WB66K8X	-	-	Dual bus switch	Fairchild

Table 23: Bill of materials

8 Mechanical Drawing

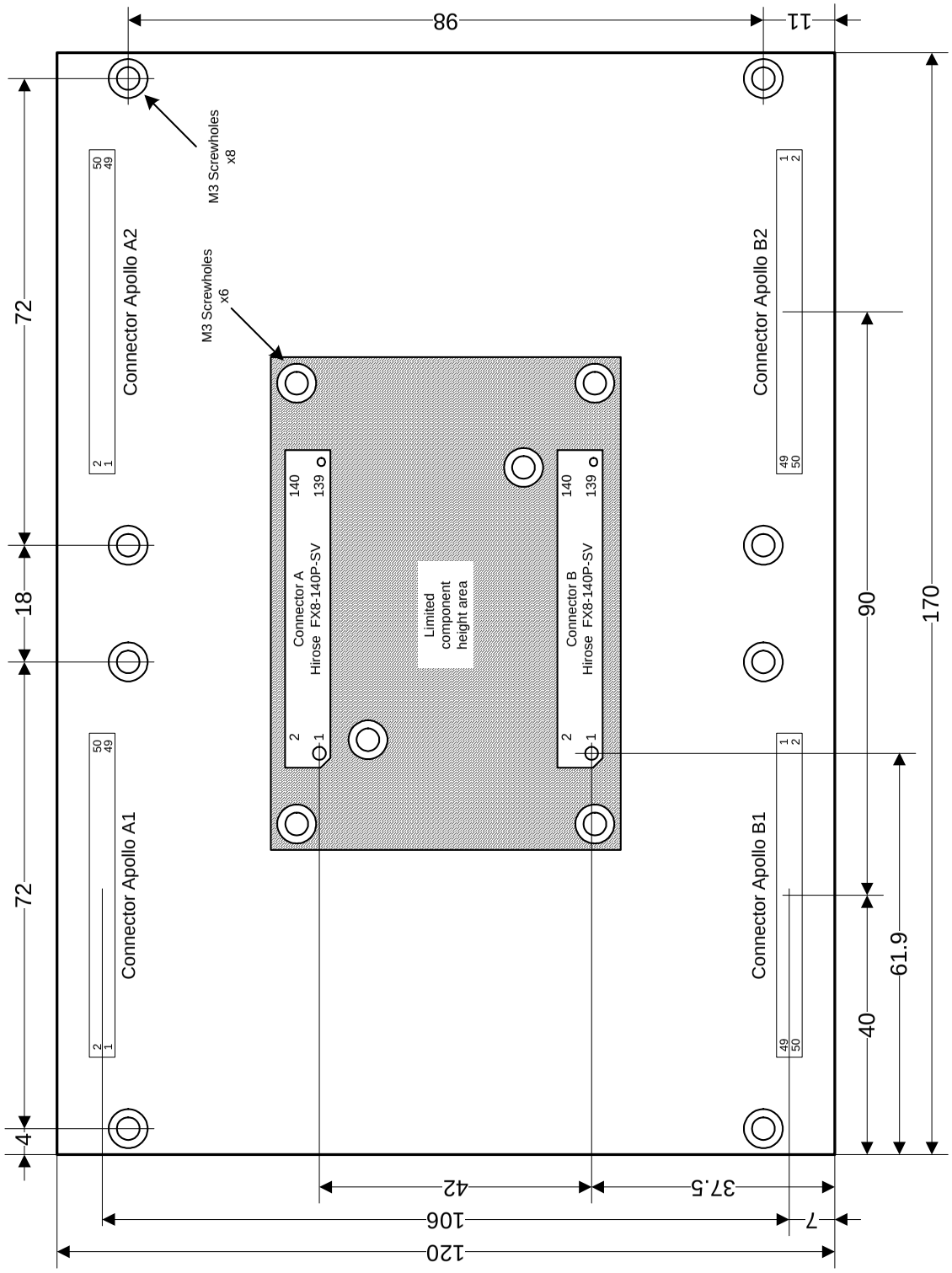

Figure 13: Mechanical drawing (all units in mm)

Figures

Tables

References

[1] *Saturn Starter User Manual, Enclustra GmbH, 2009, www.enclustra.com/saturnstarter*

[2] *Saturn Starter Schematics, Enclustra GmbH, 2009, www.enclustra.com/saturnstarter*

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