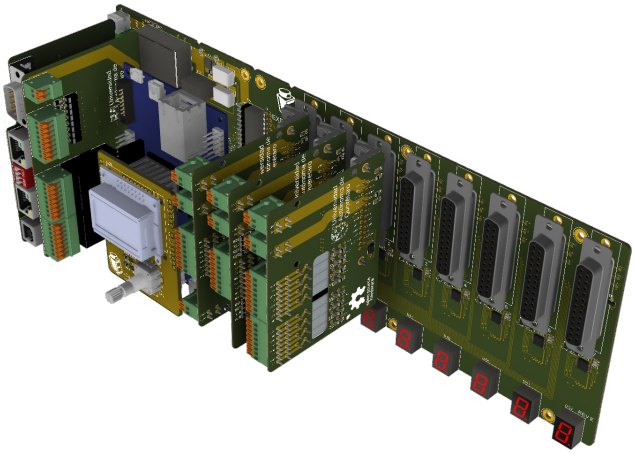
LOW-level Engineering

Controller Interconnect Base Board (Rev. E)

1 Overview



- Control and Data Acquisition Platform.
- Fully Modular I/O interface.
- Expansion Ports with $24V$ and $5V$ Power and Signal Isolation.
- Single $24V$ Power Supply Required.
- Multiple Communications Interfaces Supported, RS-485, CAN, RS-232, USB, SPI and I2C.

2 Description

- LOW-level Engineering modular data acquisition and control hardware platform. The system is a combination of a power supply, integrated I/O, integrated communications interfaces, signal and isolation to interface with expansion modules to tailor it to the application and an FPGA as a main controller.
- Integrated communications module available are UART to Full duplex RS-232 Bridge, UART to Full duplex RS-485 Bridge, UART to USB Bridge with FTDI driver, SPI to CAN FD controller and transceiver. Further information regarding the module can be found in its own Datasheet.
- Integrated digital I/O module provides a dedicated directly addressable 8 digital inputs with over-current and over-voltage protection, 8 digital outputs with SPST Relays to interface with up to $6A$ loads and quick connect spring terminals for ease of use. Further information regarding the module can be found in its own Datasheet.
- The system is designed around the DE-10 Nano FPGA board from Terasic, although any embedded controller can be adapted to interface with the two 40-pin IDC connectors.
- DS3231 real-time clock for scheduling applications, further information regarding the peripheral can be found in its own **Datasheet**.
- Additional peripherals can be interfaces through expansion modules can using CAN, SPI or I2C. Along with aggregated fault and interrupt signals per expansion port and I2C EEPROM identifier.

  2 SPI buses with 8 slaves are available and multiplexed for different configurations 8:0, 7:1, 6:2, 5:3, 4:4 devices to prioritize monitoring of certain ports on the shared bus. Slave number is indicated on the 7-segment numeric displays.

  Note: modules are not hot swappable and require power to be cut by either the internally controlled relays or directly form the main supply.

  The MCP2518FD CAN FD Controller with SPI interface is used as the main IC in the CAN interface providing a configurable interface with data packet generation and verification including CRC and Interrupts for data errors and data reception. Further information can be found in its own **Datasheet**.

The ADM3050E Signal Isolated CAN FD transceiver to complete the CAN interface while providing isolation from the external connected devices. Further information can be found in its own **Datasheet**.

The ADUM1250 I2C Signal Isolator provides a bidirectional link between the FPGA and additional peripherals. Further information can be found in its own **Datasheet**.

The ADuM3153 SPI Signal Isolator provides a bidirectional link between the FPGA and additional peripherals, chip select line multiplexing is handled separately to provide 8 slaves per SPI transceiver. Further information can be found in its own **Datasheet**.

- Only a single $24V$ power supply is required, the necessary $3.3V$ to power the isolated peripherals on the FPGA side along with the $24V$ and $5V$ to power modules connected to the expansion bus are derived internally.

  Power supply over-voltage and over-current protection on the 3 different voltage lines used.

  The TPS26600 protection circuit is used for the $24V$ line, further information regarding the peripheral can be found in its own **Datasheet**.

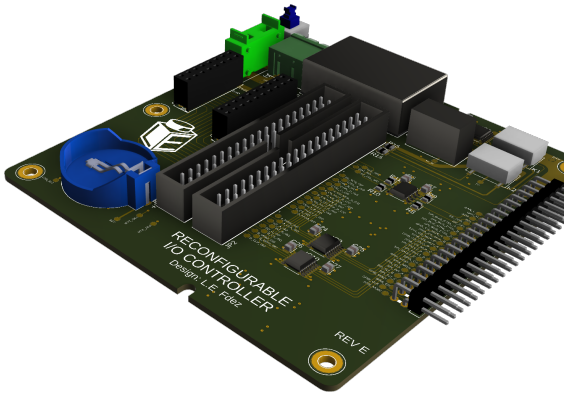
  The Traco Power TEL-5 2410 isolated regulator is used for the $3.3V$ line, further information regarding the peripheral can be found in its own **Datasheet**.

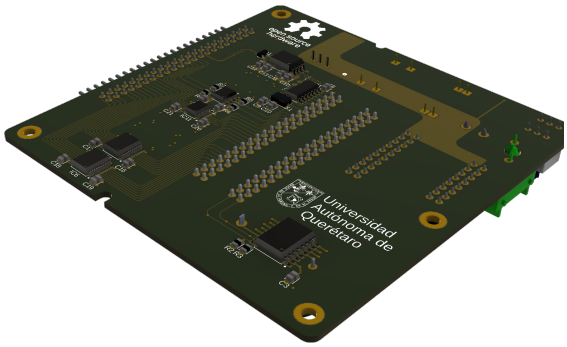
  The Traco Power TSR-2 2450 regulator is used for the $5V$ line, further information regarding the peripheral can be found in its own **Datasheet**.

- 4 layer PCB stack-up is used to provide power and signal reference plains (Signal, Power, Ground, Signal).

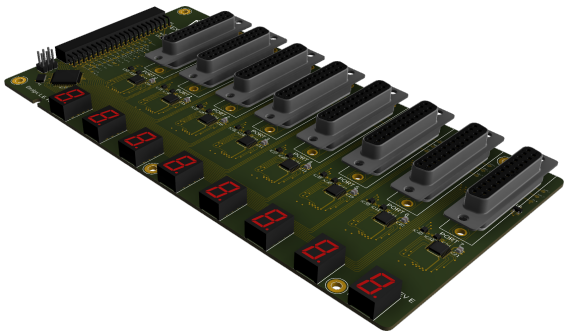
3 System components

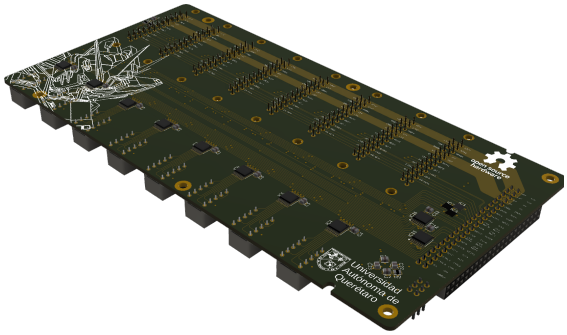
The Base board is divided into two separate sections. The Base board contains most of the electronics with the power supply, real-time clock, IDC connectors to interface with the FPGA, integrated digital I/O and communications pin headers CAN controller and signal isolation.





Additional modules are connected through the next section designated as Expansion Bay. This last one contains the expansion ports, SPI Bus multiplexing, CAN Bus termination, SPI slave number indicators.





4 Suggested Applications

- Industrial control unit, where a small form factor and modularity are important.
- Connected to a host PC can be used for supervisory and data acquisition purposes and for displaying logged data.

5 Technical specification

	Unit	Value		
		Min	Rated	Max
Supply voltage	V	18	24	36
Supply current	A	-	3	-
Internal isolated supply voltage V	-	3.3	-	
Internal non-isolated supply voltage V	-	5	-	
Combined Dimensions	mm	300.97 x 101.93 x 13.43		
Combined Weight	g	-	268	-
Operating Temperature range	$^{\circ}C$	0	-	85

6 Connector pinout

6.1 Integrated I/O Module Port (2x10 Pin Header)

Pin	Signal
1	$5V$ (referenced to Analog Ground
2	Analog Ground
3	$3.3V$ (referenced to Digital Ground
4	Digital Ground (isolated ground)
5	Digital input #7
6	Digital input #8
7	Digital input #5
8	Digital input #6
9	Digital input #3
10	Digital input #4
11	Digital input #1
12	Digital input #2
13	Digital output #7
14	Digital output #8
15	Digital output #5
16	Digital output #6
17	Digital output #3
18	Digital output #4
19	Digital output #1
20	Digital output #2

6.2 Integrated Communications Module Port (2x8 Pin Header)

Pin	Signal
1	USB UART RX
2	USB UART TX
3	NC
4	CAN controller interrupt pin
5	CAN controller SPI MOSI
6	CAN controller SPI CLK
7	CAN controller SPI CS
8	CAN controller SPI MISO
9	RS-485 UART TX
10	RS-485 UART RX
11	RS-232 UART TX
12	RS-232 UART RX
13	Digital Ground (isolated ground)
14	$3.3V$ (referenced to Digital Ground)
15	Analog Ground
16	$5V$ (referenced to Analog Ground)

6.3 Integrated Peripherals Port (40-Pin IDC Connector)

Pin	Signal
1	Real-time clock SDA
2	Real-time clock SCL
3	NC
4	NC
5	NC
6	NC
7	NC
8	NC
9	USB UART RX
10	USB UART TX
11	NC
12	Digital Ground (isolated ground)
13	NC
14	CAN controller interrupt pin
15	CAN controller SPI MOSI
16	CAN controller SPI CLK
17	CAN controller SPI CS
18	CAN controller SPI MISO
19	RS-485 UART TX
20	RS-485 UART RX
21	RS-232 UART TX
22	RS-232 UART RX
23	Digital output #2
24	Digital output #1
25	Digital output #4
26	Digital output #3
27	Digital output #6
28	Digital output #5
29	NC
30	Digital Ground (isolated ground)
31	Digital output #8
32	Digital output #7
33	Digital input #2
34	Digital input #1
35	Digital input #4
36	Digital input #3
37	Digital input #6
38	Digital input #5
39	Digital input #8
40	Digital input #7

6.4 Expansion Port (40-Pin IDC Connector)

Pin	Signal
1	$5V$ power delivery control
2	$24V$ power delivery control
3	CAN controller SPI CS
4	CAN controller SPI MISO
5	CAN controller SPI MOSI
6	CAN controller SPI SCK
7	CAN controller interrupt pin
8	I2C SCL
9	I2C SDA
10	I2C EEPROM identifiers SCL
11	NC
12	Digital Ground (isolated ground)
13	I2C EEPROM identifiers SDA
14	2x SPI Bus multiplexer control signal A
15	2x SPI Bus multiplexer control signal B
16	2x SPI Bus multiplexer control signal C
17	2x SPI Bus multiplexer control signal D
18	SPI Bus 1 CS multiplexer control signal A
19	SPI Bus 1 CS multiplexer control signal B
20	SPI Bus 1 CS multiplexer control signal C
21	SPI Bus 2 CS multiplexer control signal A
22	SPI Bus 2 CS multiplexer control signal B
23	SPI Bus 2 CS multiplexer control signal C
24	Aggregated Fault signal A
25	Aggregated Fault signal B
26	Aggregated Fault signal C
27	SPI Bus 1 CS
28	SPI Bus 1 MISO
29	
30	Digital Ground (isolated ground)
31	SPI Bus 1 MOSI
32	SPI Bus 1 CLK
33	Aggregated interrupt signal A
34	Aggregated interrupt signal B
35	Aggregated interrupt signal C
36	SPI Bus 2 CS
37	SPI Bus 2 MISO
38	SPI Bus 2 MOSI
39	DPI Bus 2 CLK
40	NC

6.5 Expansion Ports (DB-25 Connector)

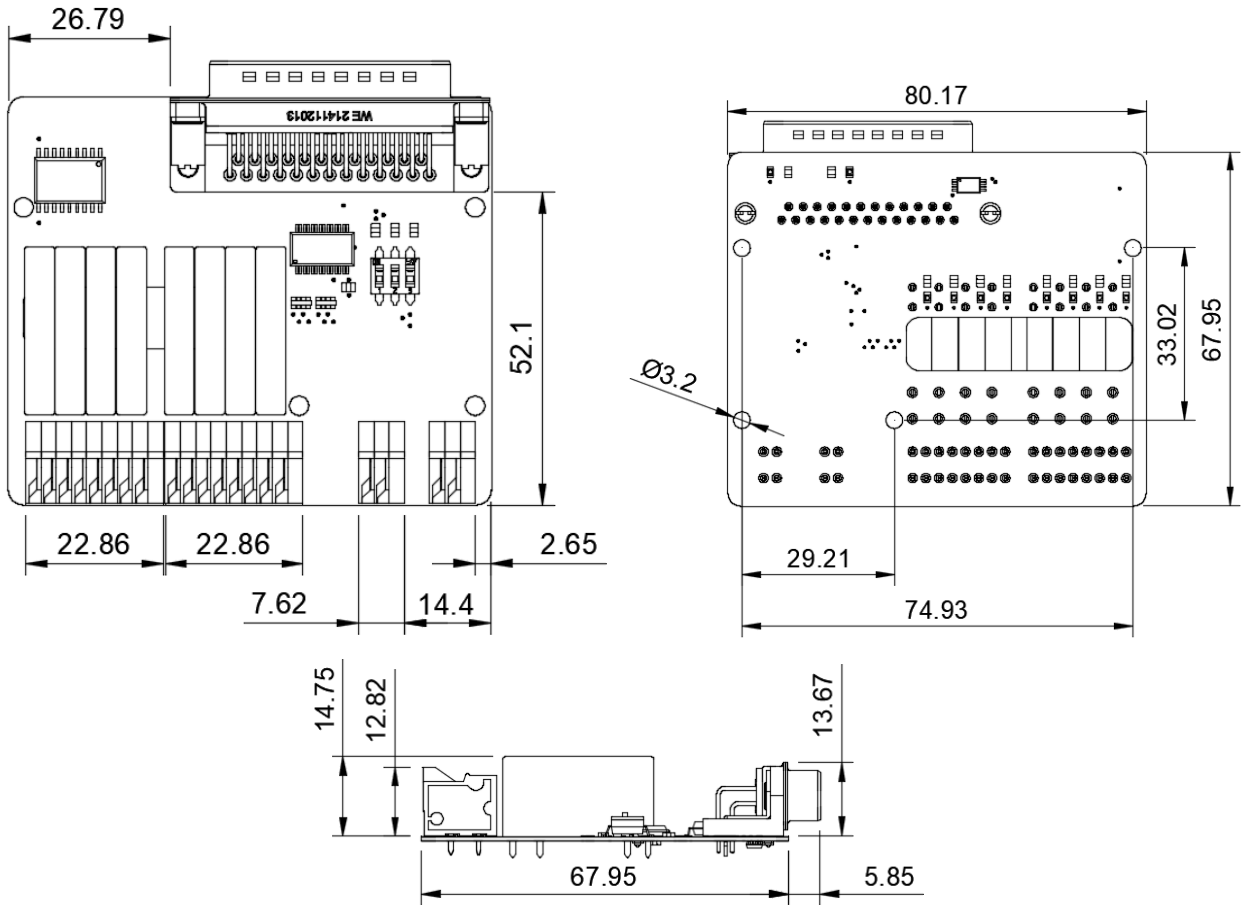
Pin	Signal
1	$24V$ Supply passthrough
2	$24V$ Supply passthrough
3	Ground
4	$5V$ Supply passthrough
5	$5V$ Supply passthrough
6	SPI MISO
7	SPI MOSI
8	Interrupt pin 0 (not available)
9	CAN Bus Low (not available)
10	I2C SDA (not available)
11	I2C EEPROM SDA
12	I2C EEPROM Address pin 0
13	I2C EEPROM Address pin 1
14	I2C EEPROM Address pin 2
15	I2C EEPROM SCL
16	I2C SCL (not available)
17	CAN Bus High (not available)
18	Interrupt pin 1 (not available)
19	Fault pin (not available)
20	SPI CLK
21	SPI CS
22	$5V$ Supply passthrough
23	Ground
24	Ground
25	$24V$ Supply passthrough

7 Expansion Module Specifications

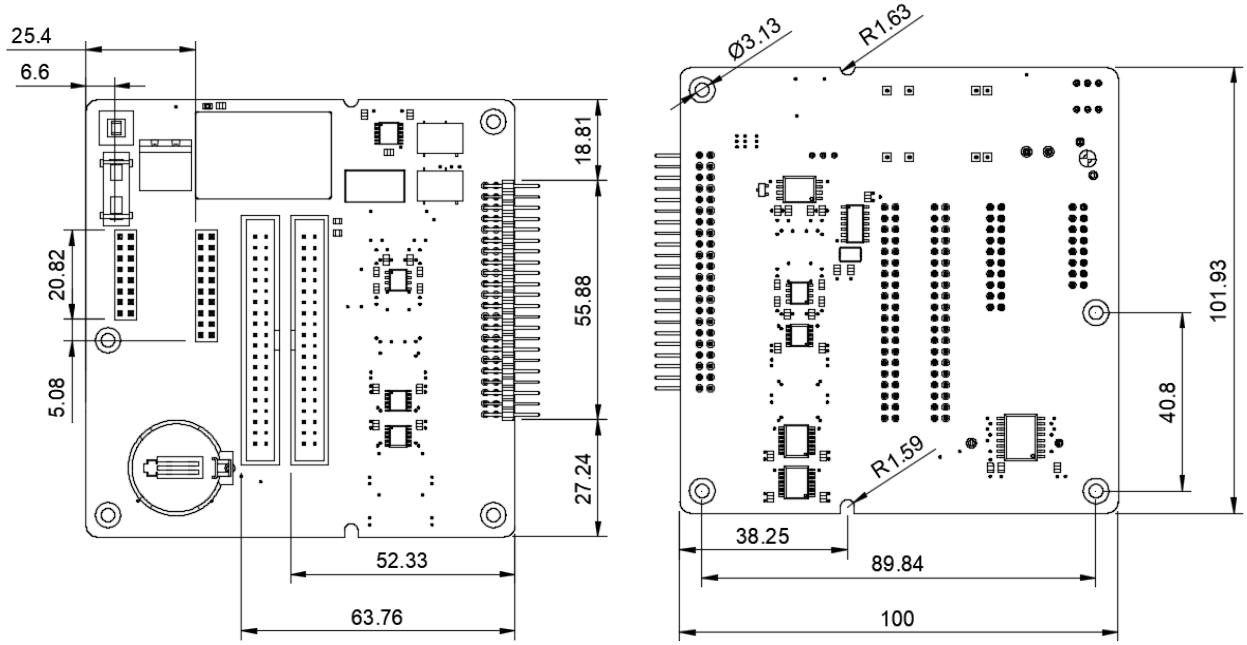
The following are guidelines for development of expansion modules:

- Expansion modules can use either of the communications interfaces available CAN, I2C or SPI with the 0,0 or 1,1 configuration.
- Power may be supplied through either the DB-25 connector, with 24V and 5V at 250mA max., or externally in case more current is required.
- Module must contain a 24LC246 I2C EEPROM encoded with the board's data.
- Board size must be 80.17 x 67.95 mm and when assembled must not exceed 16.25 mm tall for prop per clearance with adjacent boards. If required a two board design occupying 2 slots may be used.

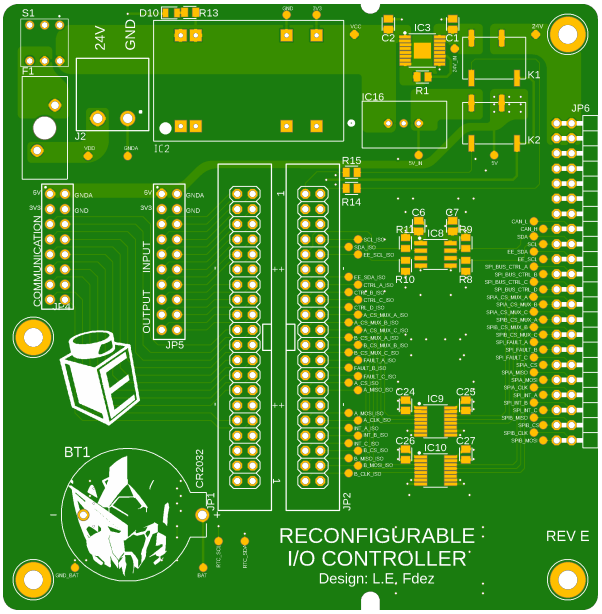
8 Example physical dimensions

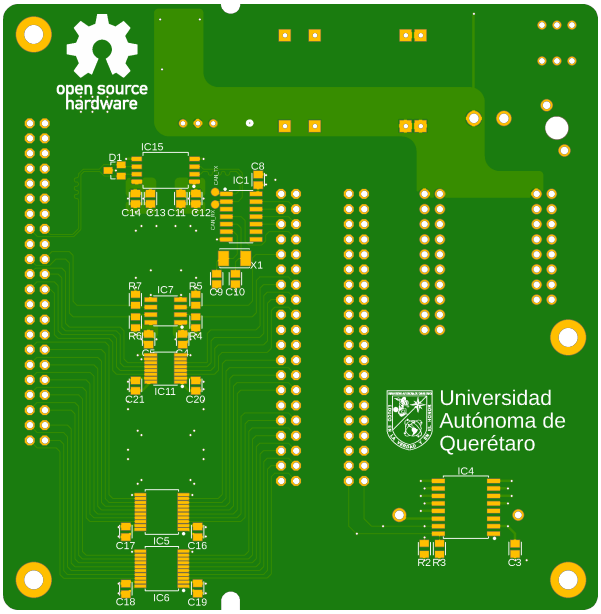


9 Base Board physical dimensions

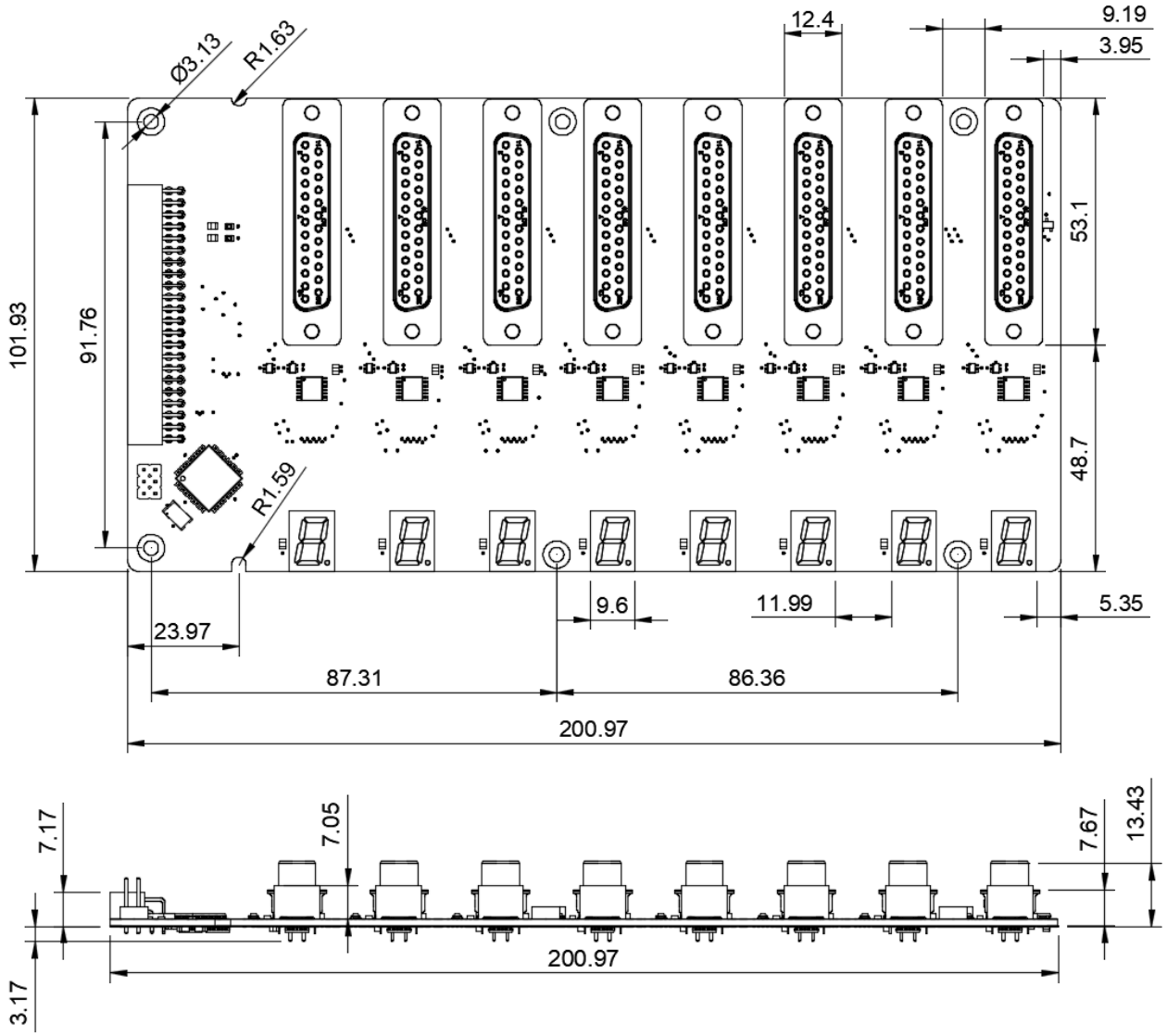


10 Base board printed circuit

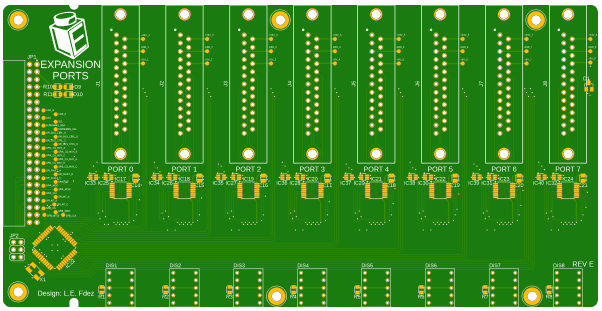


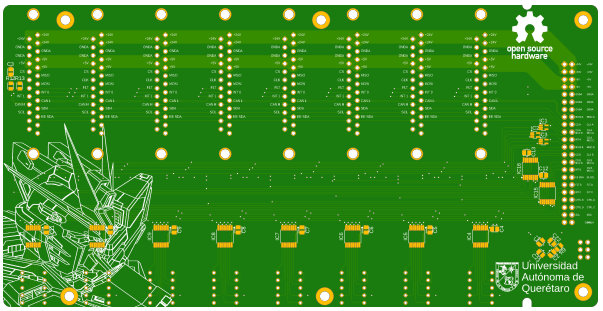


11 Expansion bay physical dimensions

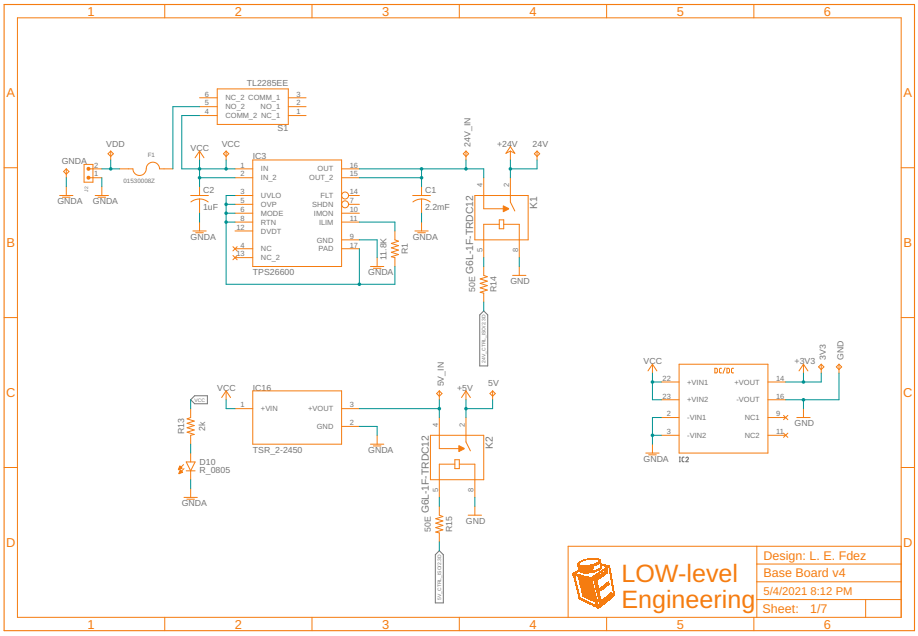


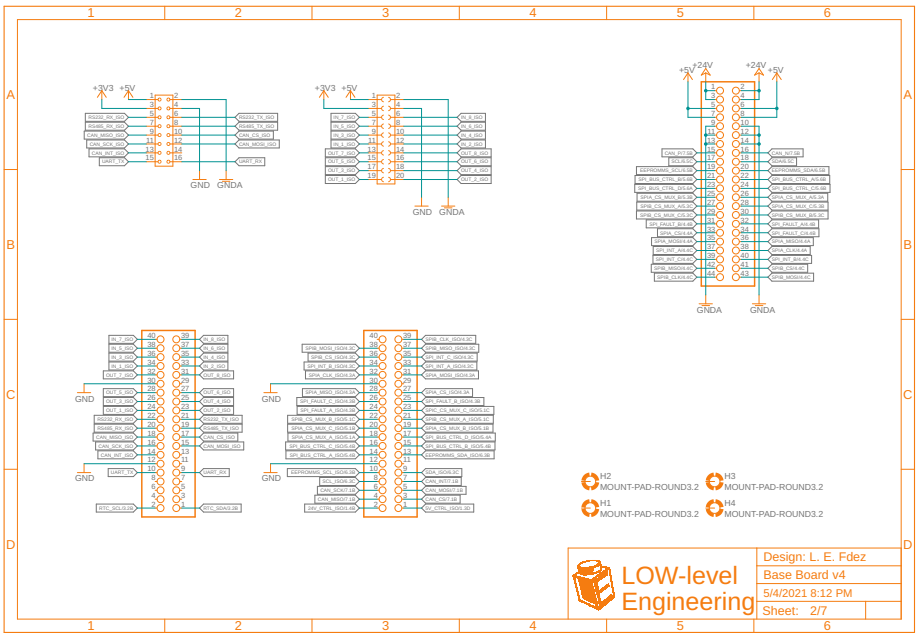
12 Expansion bay printed circuit

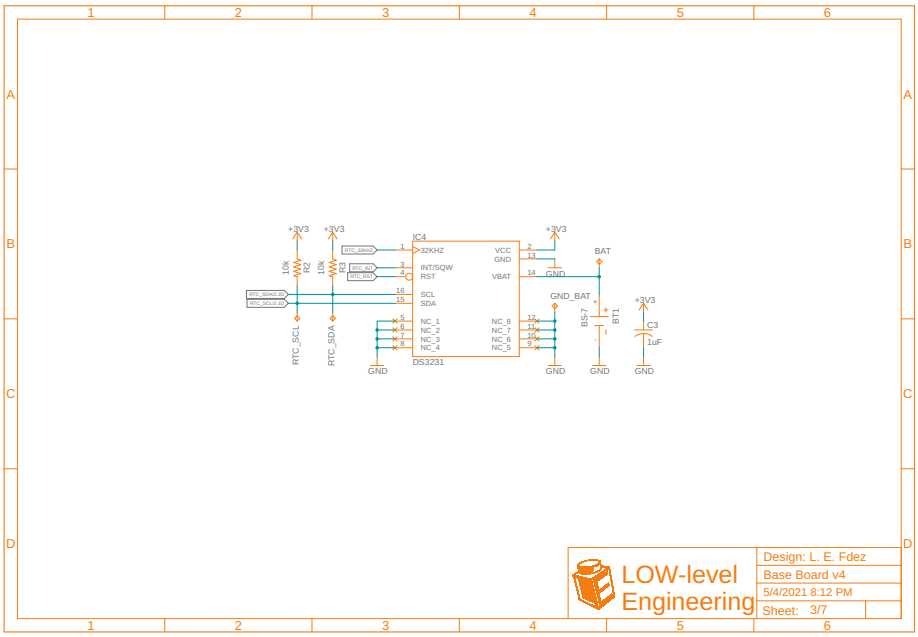


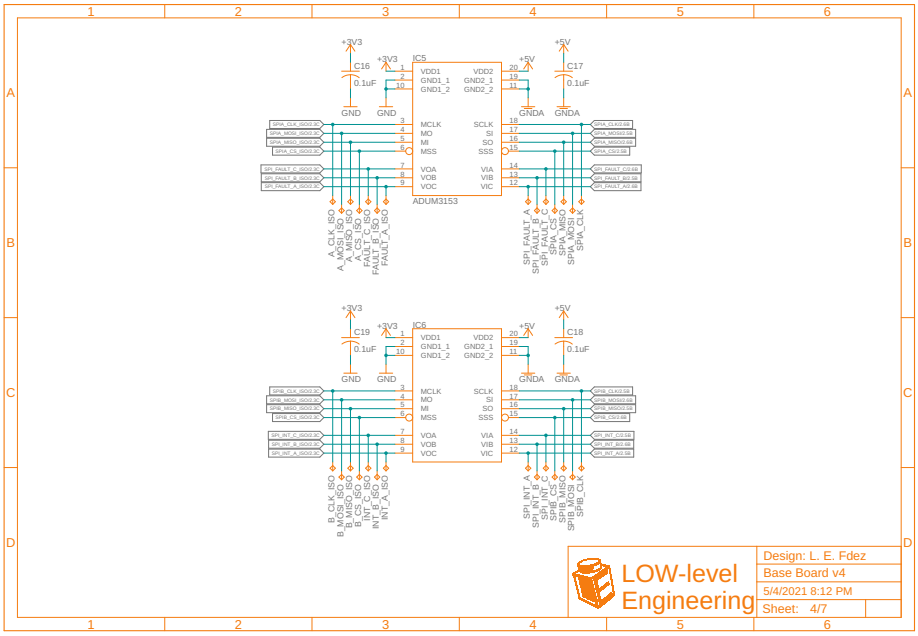


13 Base board schematic diagram






IC4
DS3231
32KHZ
INT/SQW
RST
SCL
SDA
VCC
GND
VBAT
NC_1
NC_2
NC_3
NC_4
NC_5
NC_6
NC_7
NC_8
+3V3
GND
BAT
GND_BAT
BS-7
BT1
C3
1uF
R2
R3
10k
RTC_SCL
RTC_SDA
LOW-level Engineering
Design: L. E. Fdez
Base Board v4
5/4/2021 8:12 PM
Sheet: 3/7


IC5
IC6
ADUM3153
VDD1
VDD2
GND1_1
GND2_1
GND1_2
GND2_2
MCLK
SCLK
MO
SI
MI
SO
MSS
SSS
VOA
VIA
VOB
VIB
VOC
VIC
C16
C17
C18
C19
0.1uF
+3V3
+5V
GND
GNDA
LOW-level Engineering
Design: L. E. Fdez
Base Board v4
5/4/2021 8:12 PM
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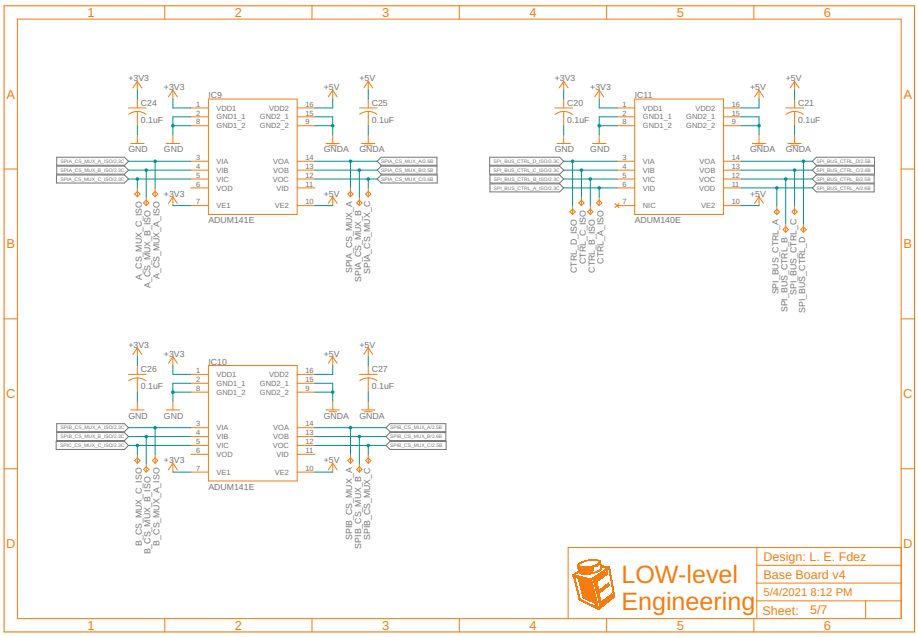
IC9
ADUM141E
IC11
ADUM140E
IC10
ADUM141E
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Design: L. E. Fdez
Base Board v4
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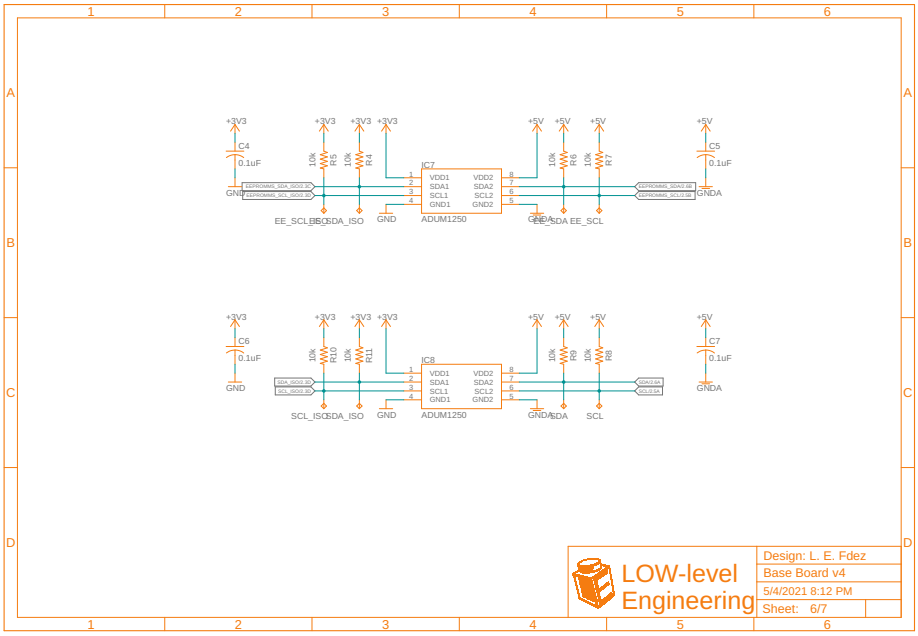
Sheet: 5/7


IC7
ADUM1250
IC8
ADUM1250
LOW-level Engineering
Design: L. E. Fdez
Base Board v4
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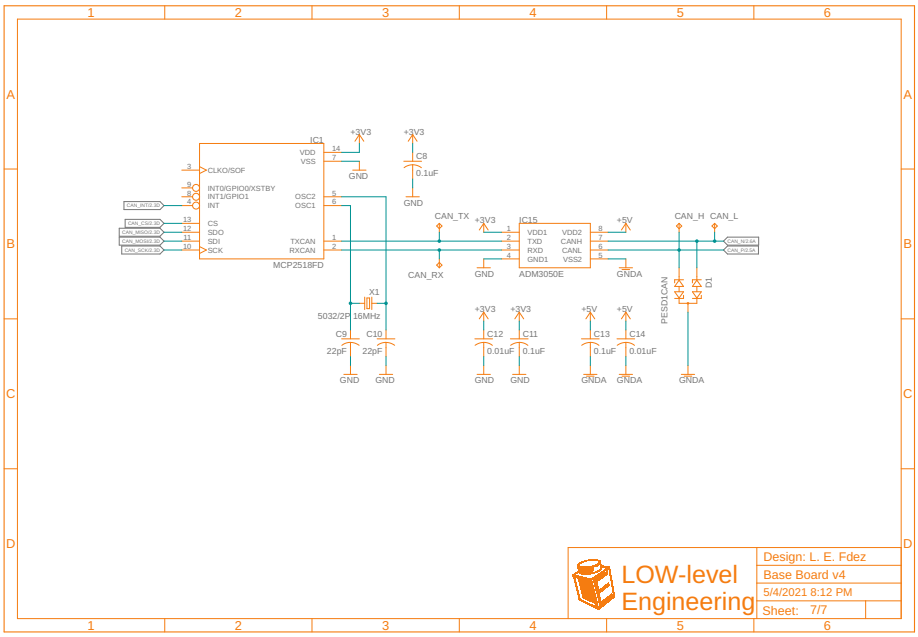
Sheet: 6/7


IC1
MCP2518FD
VDD
VSS
CLKO/SOF
INT0/GPIO0/XSTBY
INT1/GPIO1
INT
CS
SDO
SDI
SCK
OSC2
OSC1
TXCAN
RXCAN
+3V3
GND
C8
0.1uF
X1
5032/2P 16MHz
C9
C10
22pF
CAN_TX
CAN_RX
IC15
ADM3050E
VDD1
VDD2
TXD
CANH
RXD
CANL
GND1
VSS2
+5V
GNDA
CAN_H
CAN_L
PESD1CAN
D1
C12
C11
0.01uF
0.1uF
C13
C14
Design: L. E. Fdez
Base Board v4
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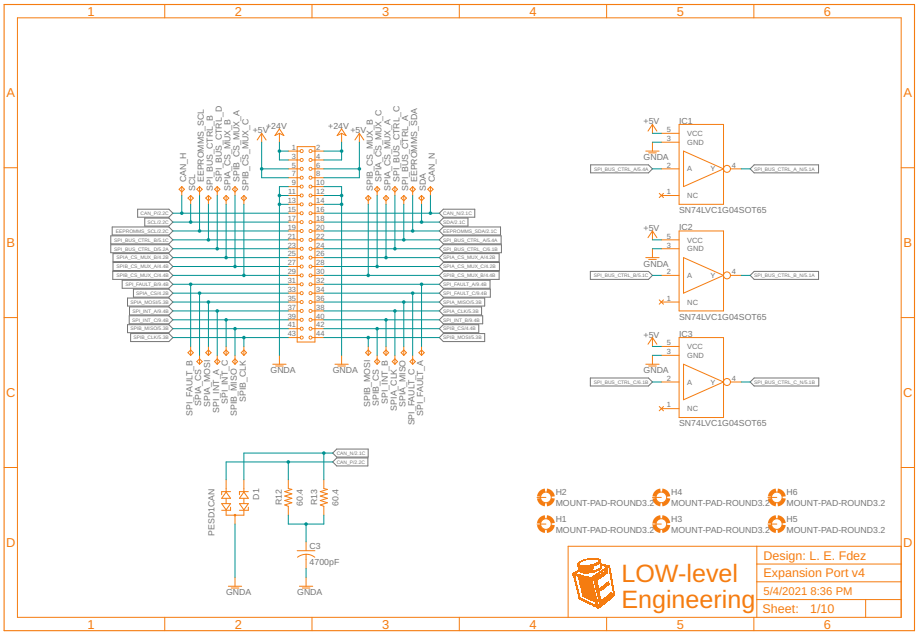
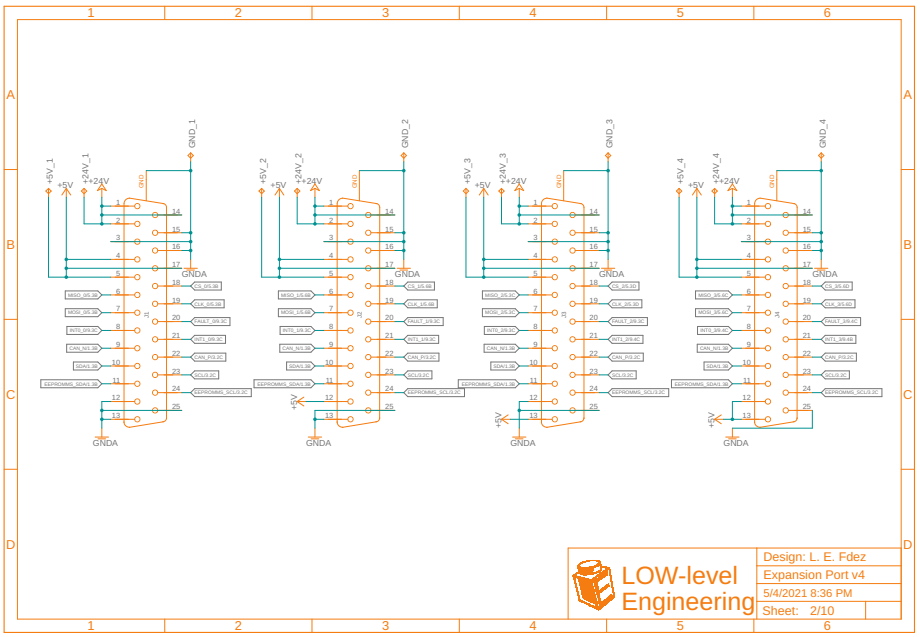
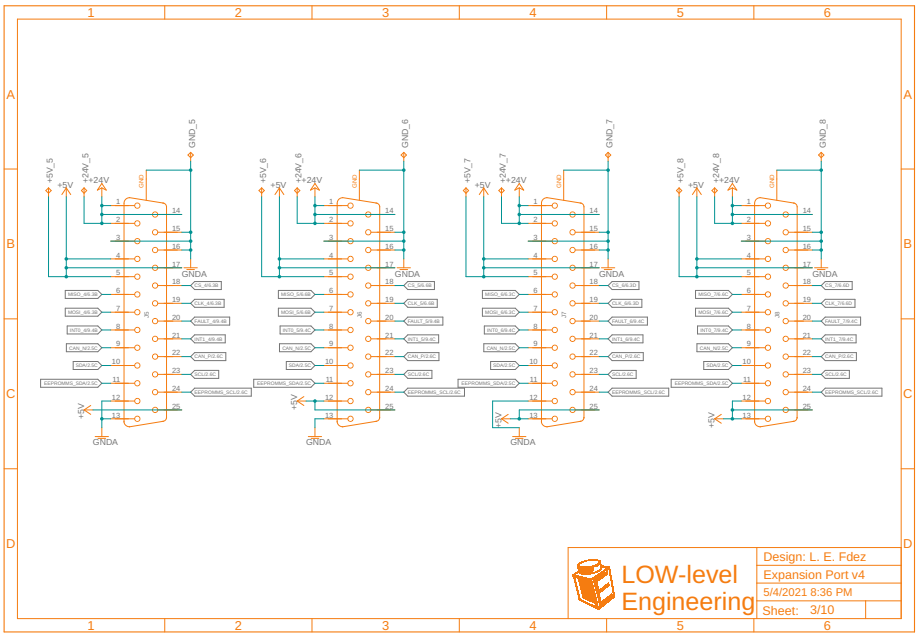
Sheet: 7/7
LOW-level Engineering

14 Expansion bay schematic diagram



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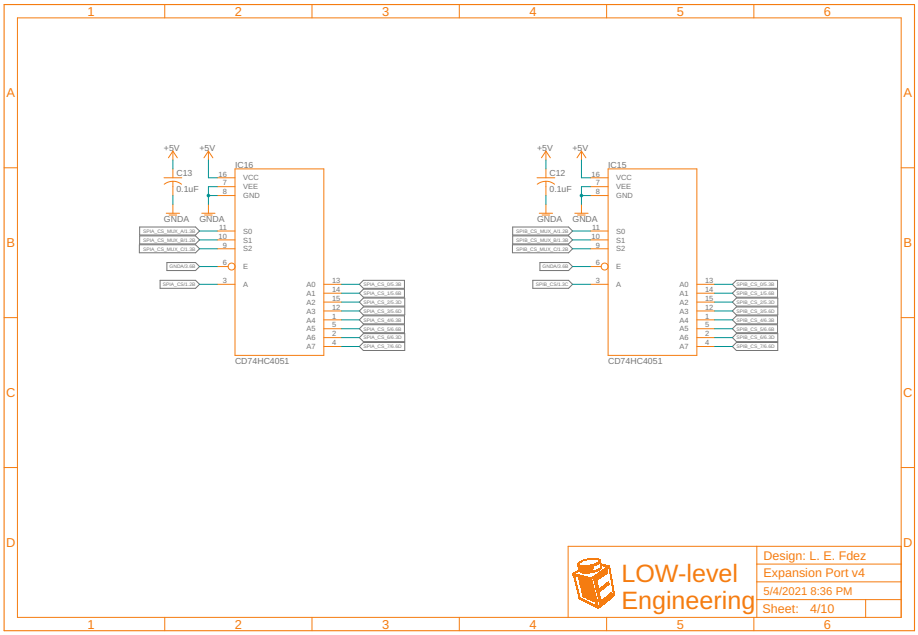
IC16
IC15
C13
C12
0.1uF
CD74HC4051
LOW-level Engineering
Design: L. E. Fdez
Expansion Port v4
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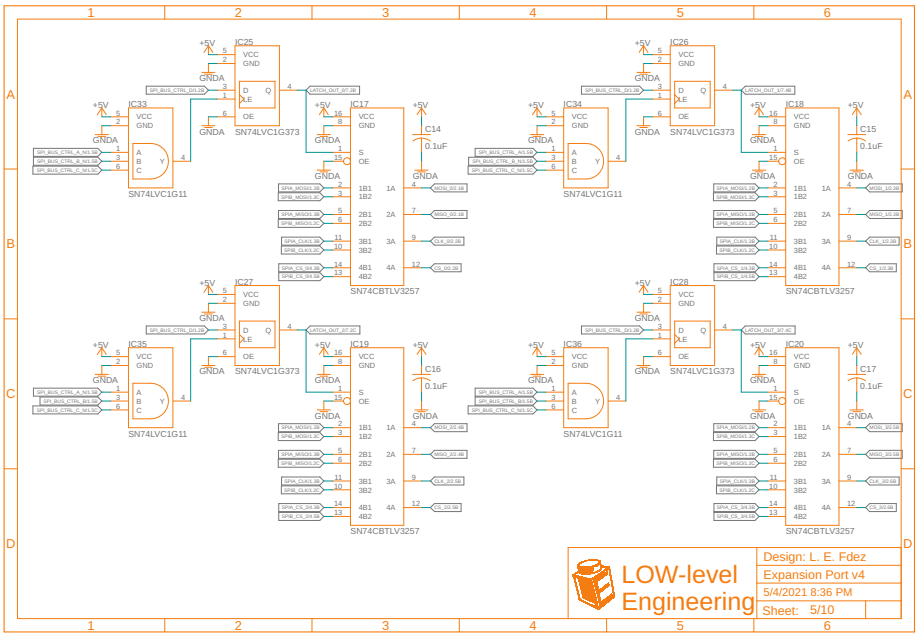
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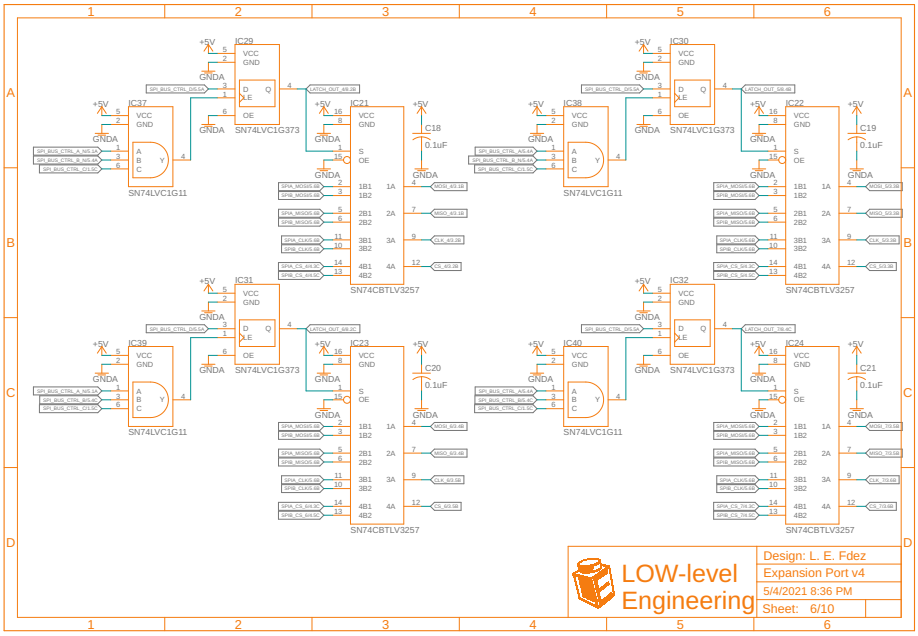
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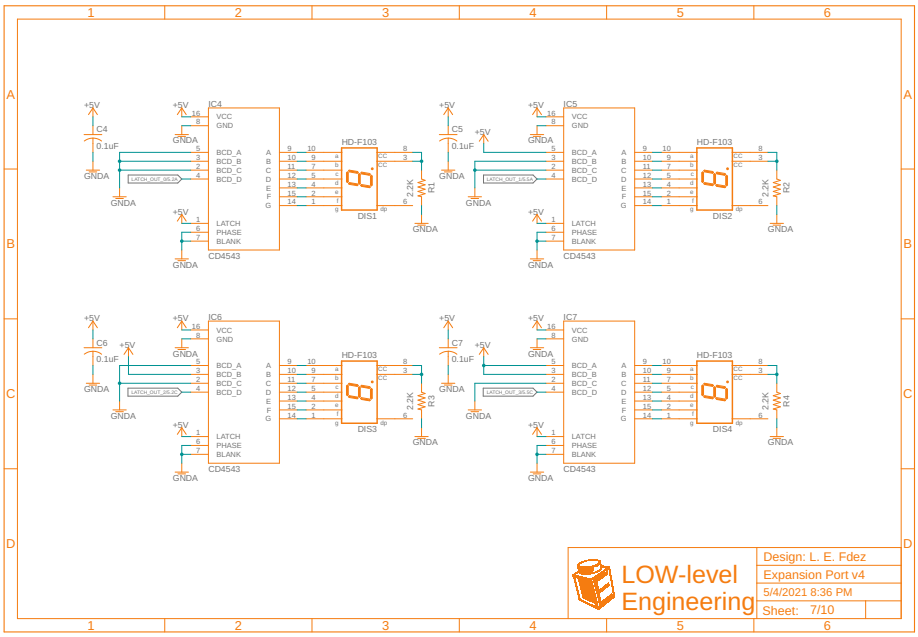
IC4
IC5
IC6
IC7
CD4543
HD-F103
DIS1
DIS2
DIS3
DIS4
LOW-level Engineering
Design: L. E. Fdez
Expansion Port v4
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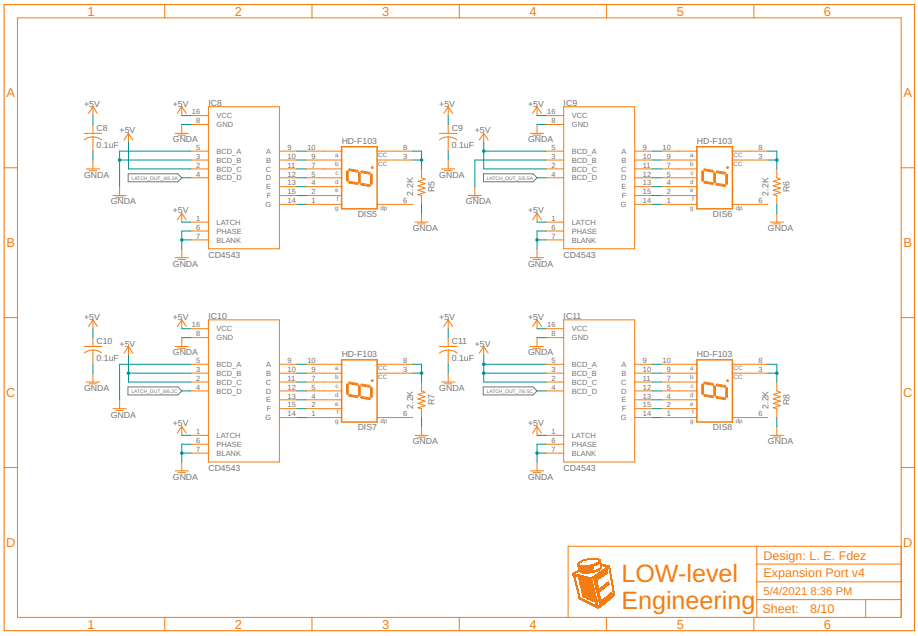
IC8
IC9
IC10
IC11
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HD-F103
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DIS6
DIS7
DIS8
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Design: L. E. Fdez
Expansion Port v4
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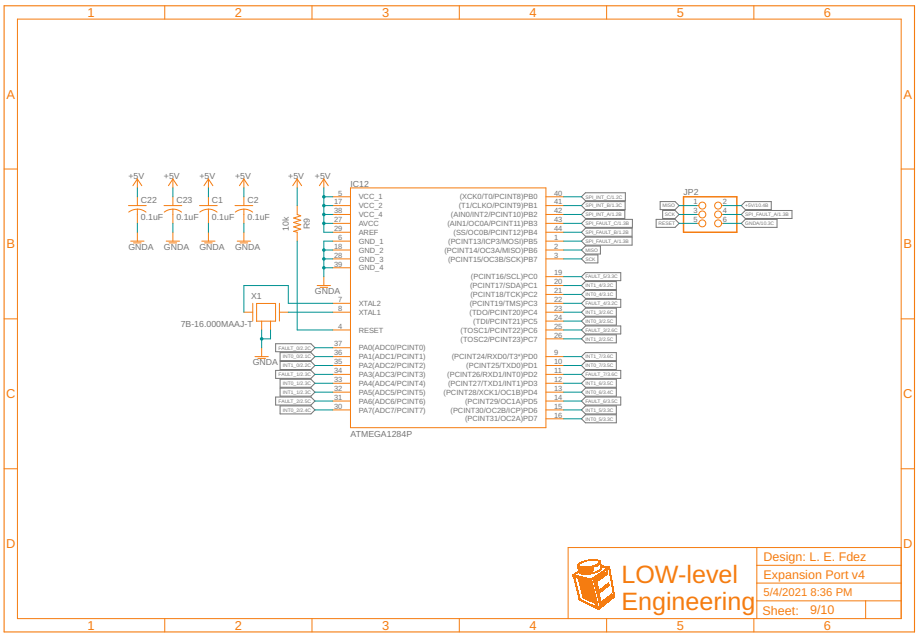
C22
C23
C1
C2
0.1uF
GNDA
10k
R9
X1
7B-16.000MAAJ-T
IC12
ATMEGA1284P
JP2
LOW-level Engineering
Design: L. E. Fdez
Expansion Port v4
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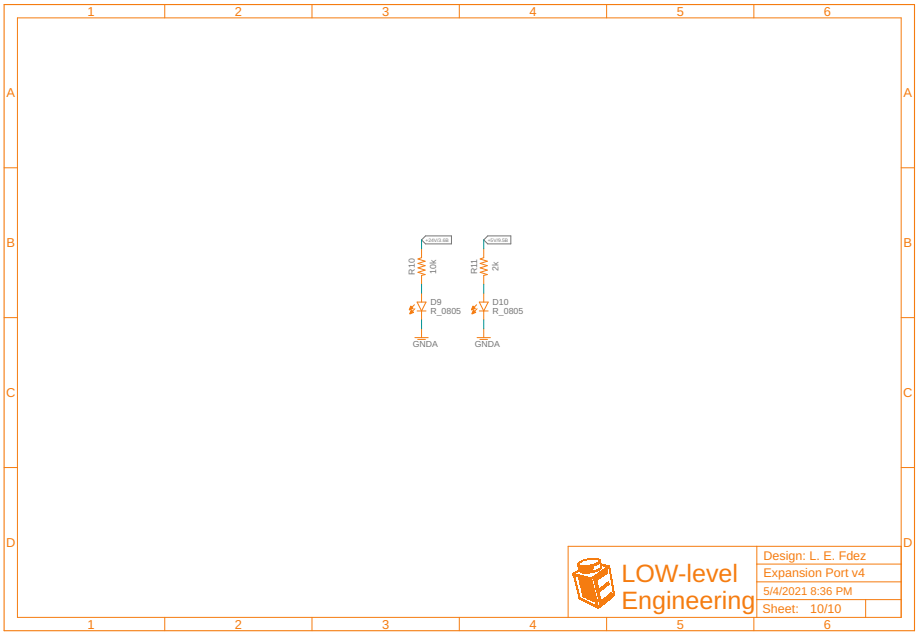
Sheet: 9/10


R10
10k
R11
2k
D9
R_0805
D10
R_0805
GNDA
LOW-level Engineering
Design: L. E. Fdez
Expansion Port v4
5/4/2021 8:36 PM
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