External Supply 12V to 24V

Isolated Supply_1 Secondary
(+3.3V_1, +5.0V_1, GND_1)

Isolated Supply_0 Primary
(+3.3V_0, +5.0V_0, GND_0)

MCU_0
Primary
STM32F429
TQFP-176

MCU_0 including:
- RTC
- JTAG/SWD Interface
- USB (bootable)

Isolated Digital

9x Contactor
Control+Feedback

2x Isolated CAN

2x CAN
(one Bootable)

Isolated MCU to MCU Communication (SPI)

Isolated Digital/PWM

Bender Isometer

Memory Controler Interface

8 MB SDRAM

MCU_1
Secondary
STM32F429
TQFP-100

Isolated Digital

Interlock
Control+Feedback

SPI

Connector for
FPGA addon
(45MHz SPI)

SPI

Data Storage:
- EEPROM
- MicroSDCARD

MCU_1 including:
- JTAG/SWD Interface
- USB (Bootable)

Interlock
Control+Feedback

Isolated
Digital

Isolated Digital

RS485
(bootable)

SPI

Connector to
BMS-Interface_1
Secondary
incl. supply

SPI

Connector to
BMS-Interface_0
Primary
incl. supply

Interlock 10mA
Current Source

TITLE: foxBMS BMS-Extension
DESCRIPTION: Overview
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
DATE: 2017-05-16 | VERSION: 1.0.2 | SHEET: 1/22

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TITLE: foxBMS BMS-Extension		
DESCRIPTION: SUPPLY_1		
FILENAME: foxBMS_BMS-Extension		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-05-16	VERSION: 1.0.2	SHEET: 3/22

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TITLE: foxBMS BMS-Extension
DESCRIPTION: MCU_0 (PRIMARY)
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team

DATE: 2017-05-16 | VERSION: 1.0.2 | SHEET: 4/22

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TITLE: foxBMS BMS-Extension
DESCRIPTION: MCU_0 to MCU_1 Isolated Interface (SPI)
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
DATE: 2017-05-16 | VERSION: 1.0.2 | SHEET: 6/22

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TITLE: foxBMS BMS-Extension		
DESCRIPTION: BENDER Isometer Interface		
FILENAME: foxBMS_BMS-Extension		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-05-16	VERSION: 1.0.2	SHEET: 7/22

CAN_1 connector

SUPPLY_EXT_1

CAN_1_H
CAN_1_L
13045-0400
X801

SUPPLY_EXT_1

IC801
KA7805ERTF
IN   OUT
GND
CAN_TRANS_1_EXT_SUPPLY

2.2µ C801
100n C802
100n C803
LSP801
GND_EXT_1
GND_EXT_1

CAN_1 Extern   MCU_0 (Primary) CAN_1

CAN_TRANS_1_EXT_SUPPLY
100n C805
100n C806
IC803PWR2
VDD
GND
GND_EXT_1

+3.3V_0
VDD
IC803PWR1
GND
100n C807
GND_0

LSP802
CAN_1_H
LSP803
CAN_1_L
2x51,0µH
L801

R801 62R
R802 62R
C804 100n
GND_EXT_1

D801
PESD1CAN
GND_EXT_1

IC803
CANH
CANL
STB
TJA1052IT/1Y
TXD
RXD
LSP805
CAN_1_TX/22.4B
CAN_1_RX/22.5B
LSP806

CAN_TRANS_1_STANDBY

CAN_TRANS_1_EXT_SUPPLY
R803 10k
LSP804

+3.3V_0
R804 430

CAN_TRANS_1_STANDBY
IC802
Load CON+
Load CON-
CPC1008N
GND_EXT_1

T801
IRLML0100TRPBF
GND_0

LSP807
10
R806
CAN_1_TRANS_STANDBY_CONTROL/22.4B

R805 10k
GND_0

TITLE: foxBMS BMS-Extension
DESCRIPTION: CAN_1
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
DATE: 2017-05-16 | VERSION: 1.0.2 | SHEET: 8/22

Connector from foxBMS Basic Board

SUPPLY_EXT_2

SUPPLY_EXT_0

SV901

8	7
6	5
4	3
2	1

INTERLOCK_STATUS

GND_EXT_2 GND_EXT_0

CONTACTORS_COMMON_NEG/10.4B

T901
BUK964R8-60E

R902
10

INTERLOCK_STATUS

10k
R901

LSP901

GND_EXT_2

GND_EXT_2

+3.3V_0

SUPPLY_EXT_2

F1001
1.00mm x 3.00mm
630mV/T

IC1001
AQV252G2S

R1003
430

T1001
IRLML0100TRPBF

D1001

CONTACTOR_6_COIL_POS/12.5C

CONTACTORS_COMMON_NEG/12.5C

CONTACTOR_6_CONTROL/22.5C

LSP1001
10
R1001

R1002
10k

GND_0 GND_0

+3.3V_0

SUPPLY_EXT_2

F1002
1.00mm x 3.00mm
630mV/T

IC1002
AQV252G2S

R1006
430

T1002
IRLML0100TRPBF

D1002

CONTACTOR_7_COIL_POS/12.5D

CONTACTORS_COMMON_NEG/12.5C

CONTACTOR_7_CONTROL/22.5B

LSP1002
10
R1004

R1005
10k

GND_0 GND_0

+3.3V_0

SUPPLY_EXT_2

F1003
1.00mm x 3.00mm
630mV/T

IC1003
AQV252G2S

R1009
430

T1003
IRLML0100TRPBF

D1003

CONTACTOR_8_COIL_POS/12.5D

CONTACTORS_COMMON_NEG/12.5C

CONTACTOR_8_CONTROL/22.5E

LSP1003
10
R1007

R1008
10k

GND_0 GND_0

TITLE: foxBMS BMS-Extension
DESCRIPTION: Contactor Control
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
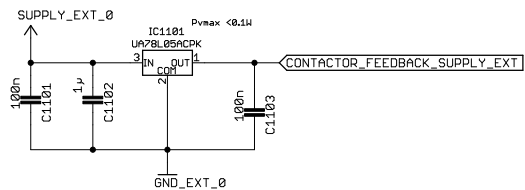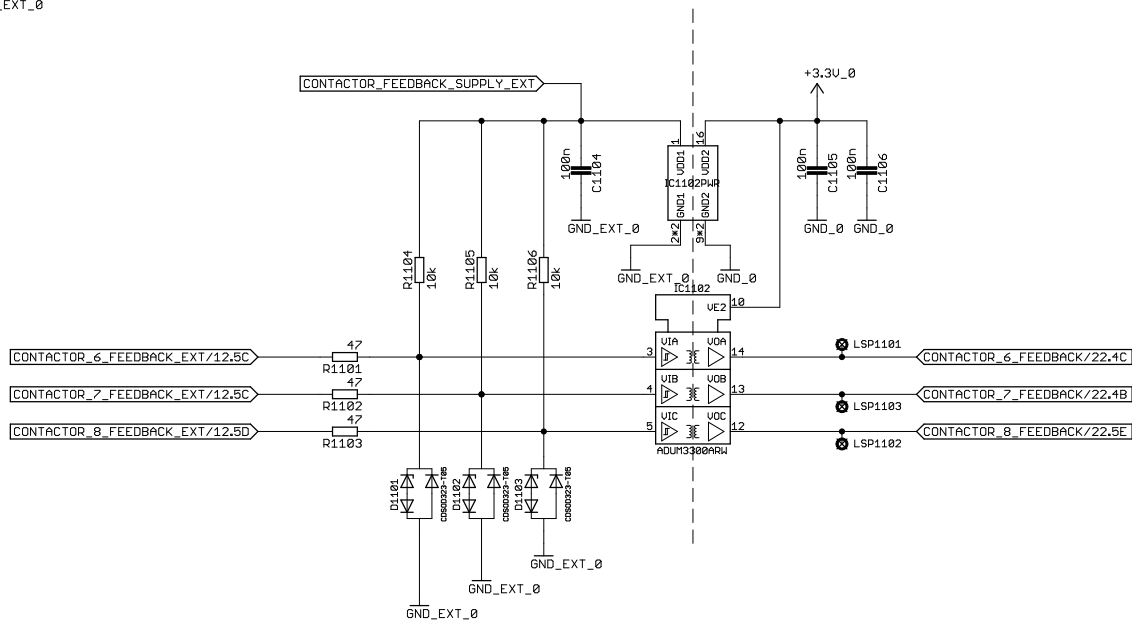DATE: 2017-05-16   VERSION: 1.0.2   SHEET: 10/22

Contactor Feedback Supply from External Supply

SUPPLY_EXT_0

Pvmax <0.1W

IC1101
UA78L05ACPK

3 IN   OUT 1

2 COM

100n C1101
1µ C1102
100n C1103

CONTACTOR_FEEDBACK_SUPPLY_EXT

GND_EXT_0

Contactor Feedback Isolation 6 to 8

CONTACTOR_FEEDBACK_SUPPLY_EXT

+3.3V_0

100n C1104

IC1102PWR

11 VDD1   VDD2 16

GND1   GND2

2x2   9x2

GND_EXT_0   GND_0

GND_EXT_0

100n C1105
100n C1106

GND_0   GND_0

R1104 10k
R1105 10k
R1106 10k

IC1102

VE2 10

CONTACTOR_6_FEEDBACK_EXT/12.5C

47 R1101

CONTACTOR_7_FEEDBACK_EXT/12.5C

47 R1102

CONTACTOR_8_FEEDBACK_EXT/12.5D

47 R1103

3 VIA   VOA 14

4 VIB   VOB 13

5 VIC   VOC 12

ADUM3300ARW

LSP1101   CONTACTOR_6_FEEDBACK/22.4C

LSP1103   CONTACTOR_7_FEEDBACK/22.4B

LSP1102   CONTACTOR_8_FEEDBACK/22.5E

D1101 CD0603-Z6V8
D1102 CD0603-Z6V8
D1103 CD0603-Z6V8

GND_EXT_0

GND_EXT_0

GND_EXT_0

TITLE: foxBMS BMS-Extension
DESCRIPTION: Contactor Feedback
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
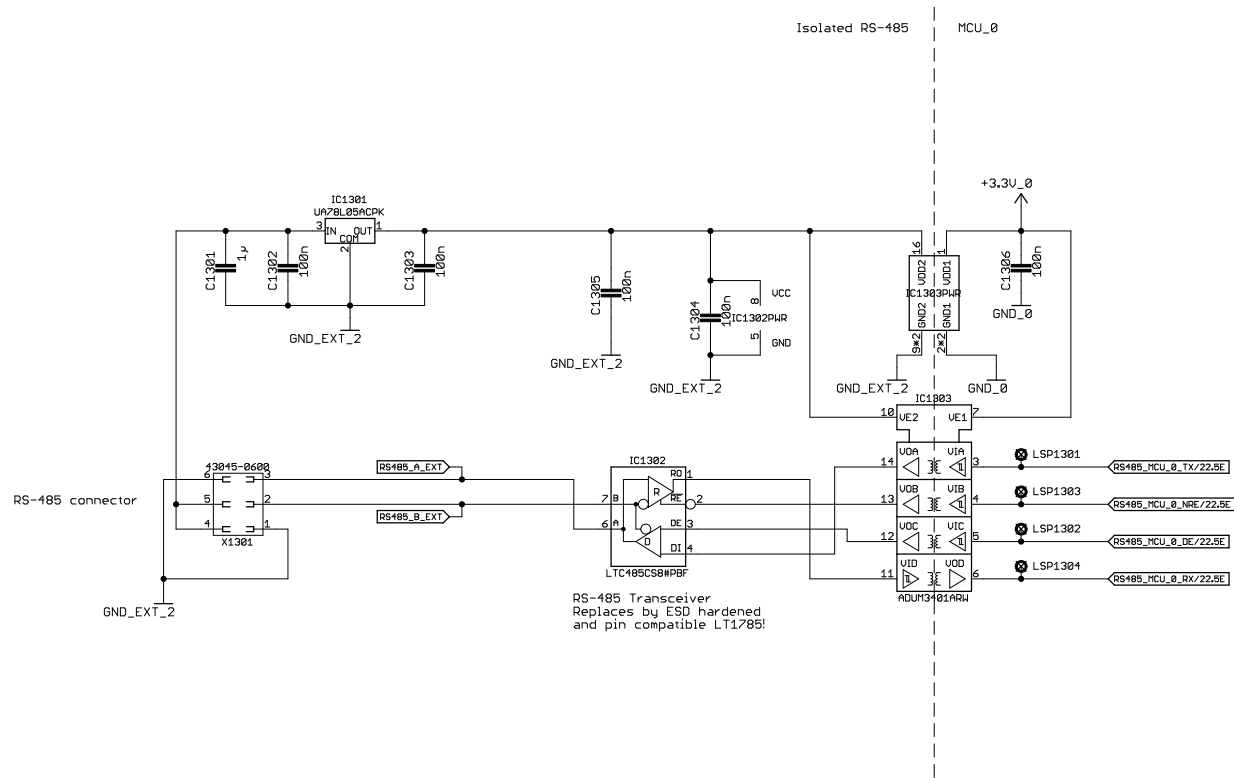DATE: 2017-05-16 | VERSION: 1.0.2 | SHEET: 11/22

One connector for each contactor:
- Coil supply
- Feedback contact

CONTACTORS_COMMON_NEG/10.7B
43045-0400
CONTACTOR_6_FEEDBACK_EXT/11.3D
CONTACTOR_6_COIL_POS/10.4B
X1201
GND_EXT_0

CONTACTORS_COMMON_NEG/10.7B
43045-0400
CONTACTOR_7_FEEDBACK_EXT/11.3D
CONTACTOR_7_COIL_POS/10.4D
X1202
GND_EXT_0

CONTACTORS_COMMON_NEG/10.7B
43045-0400
CONTACTOR_8_FEEDBACK_EXT/11.3D
CONTACTOR_8_COIL_POS/10.7B
X1203
GND_EXT_0

Isolated RS-485　　MCU_0

IC1301
UA78L05ACPK

C1301 1µ
C1302 100n
C1303 100n
GND_EXT_2

C1305 100n
C1304 100n
IC1302PWR
VCC
GND
GND_EXT_2

+3.3V_0

IC1303PWR
VDD2
VDD1
GND2 GND1
GND_EXT_2 GND_0

C1306 100n
GND_0

IC1303
VE2 VE1

43045-0600
RS-485 connector

RS485_A_EXT
RS485_B_EXT

X1301

GND_EXT_2

IC1302
RO
RE
DE
DI
LTC485CS8#PBF

RS-485 Transceiver
Replaces by ESD hardened
and pin compatible LT1785!

VOA VIA
LSP1301   RS485_MCU_0_TX/22.5E
VOB VIB
LSP1303   RS485_MCU_0_NRE/22.5E
VOC VIC
LSP1302   RS485_MCU_0_DE/22.5E
VID VOD
LSP1304   RS485_MCU_0_RX/22.5E
ADUM3401ARW

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TITLE: foxBMS BMS-Extension
DESCRIPTION: Isolated USB MCU_0 + MCU_1
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
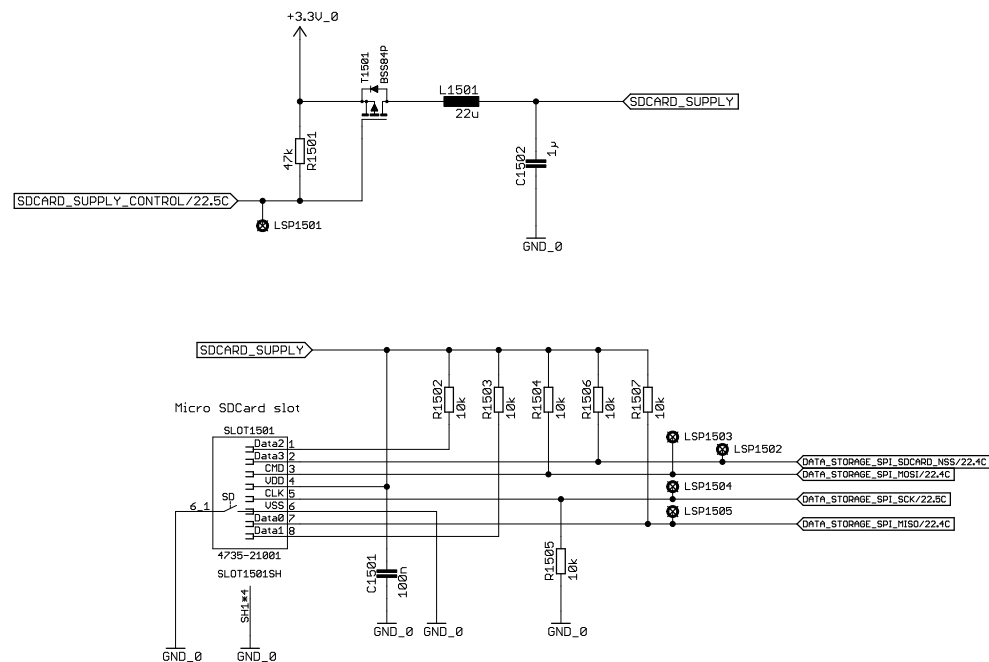DATE: 2017-05-16 | VERSION: 1.0.2 | SHEET: 14/22

+3.3V_0

T1501
BSS84P

L1501
22u

SDCARD_SUPPLY

R1501
47k

C1502
1μ

SDCARD_SUPPLY_CONTROL/22.5C

LSP1501

GND_0

SDCARD_SUPPLY

Micro SDCard slot

R1502 10k
R1503 10k
R1504 10k
R1506 10k
R1507 10k

LSP1503
LSP1502

SLOT1501
Data2 1
Data3 2
CMD 3
VDD 4
CLK 5
VSS 6
Data0 7
Data1 8

SD
6_1

4735-21001
SLOT1501SH

SH1*4

C1501
100n

R1505
10k

LSP1504
LSP1505

DATA_STORAGE_SPI_SDCARD_NSS/22.4C
DATA_STORAGE_SPI_MOSI/22.4C
DATA_STORAGE_SPI_SCK/22.5C
DATA_STORAGE_SPI_MISO/22.4C

GND_0   GND_0

GND_0   GND_0

GND_0

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TITLE: foxBMS BMS-Extension		
DESCRIPTION: BMS-Interface Interface		
FILENAME: foxBMS_BMS-Extension		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-05-16	VERSION: 1.0.2	SHEET: 16/22

Analog reference

+3.3V_0

IC1701
VIN   Vout Force
ENA   Vout Sense
       GND Sense
       GND Force

ADR3425ARJZ-R7

C1703 C1704
1µ   100n

GND_0 GND_0

GND_0 GND_0

Analog input connector
(not isolated!)

C1707
100n

GND_0

X1701

ANALOG_IN_CH_0   ANALOG_IN_CH_3
ANALOG_IN_CH_1   ANALOG_IN_CH_4
ANALOG_IN_CH_2

43045-1200

GND_0

ANALOG_IN_CH_0

Replace if voltage
divider is needed

R1701

LSP1701
ADC_MCU_0_CH_0/22.5E

Remove for direct
analog input

R1702
4,75k

C1701
100n

D1701
MM3Z4V7T1G

GND_0   GND_0 GND_0

ANALOG_IN_CH_1

Replace if voltage
divider is needed

R1705

LSP1704
ADC_MCU_0_CH_1/22.5E

Remove for direct
analog input

R1706
4,75k

C1705
100n

D1703
MM3Z4V7T1G

GND_0   GND_0 GND_0

ANALOG_IN_CH_2

Replace if voltage
divider is needed

R1709

LSP1705
ADC_MCU_0_CH_2/22.5D

Remove for direct
analog input

R1710
4,75k

C1708
100n

D1705
MM3Z4V7T1G

GND_0   GND_0 GND_0

ANALOG_IN_CH_3

Replace if voltage
divider is needed

R1703

LSP1702
ADC_MCU_0_CH_3/22.5D

Remove for direct
analog input

R1704
4,75k

C1702
100n

D1702
MM3Z4V7T1G

GND_0   GND_0 GND_0

ANALOG_IN_CH_4

Replace if voltage
divider is needed

R1707

LSP1703
ADC_MCU_0_CH_4/22.5E

Remove for direct
analog input

R1708
4,75k

C1706
100n

D1704
MM3Z4V7T1G

GND_0   GND_0 GND_0

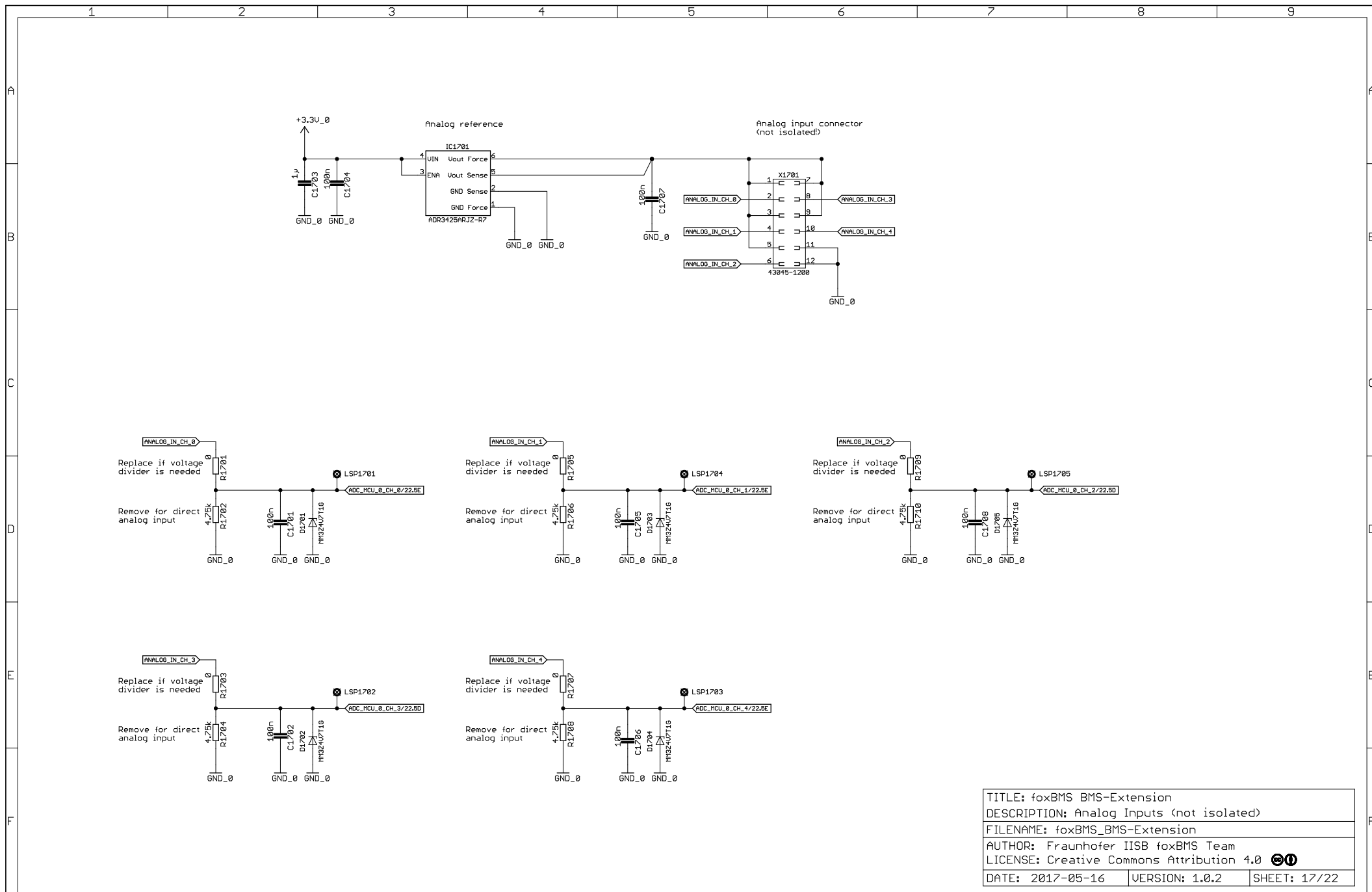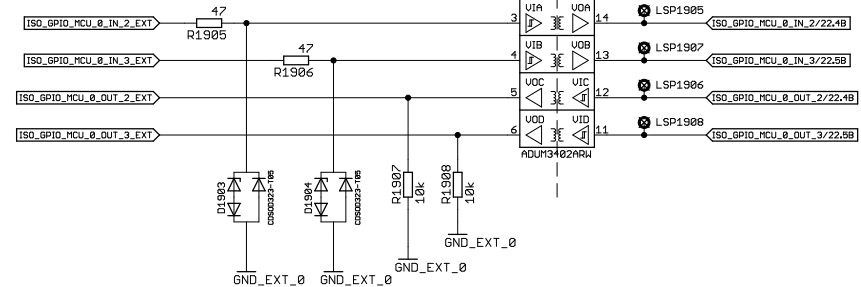| TITLE: foxBMS BMS-Extension |
| DESCRIPTION: Analog Inputs (not isolated) |
| FILENAME: foxBMS_BMS-Extension |
| AUTHOR: Fraunhofer IISB foxBMS Team |
| LICENSE: Creative Commons Attribution 4.0 |

| DATE: 2017-05-16 | VERSION: 1.0.2 | SHEET: 17/22 |

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TITLE: foxBMS BMS-Extension		
DESCRIPTION: 8MB SDRAM		
FILENAME: foxBMS_BMS-Extension		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-05-16	VERSION: 1.0.2	SHEET: 18/22

Isolated GPIO connector

Power supply section:
- SUPPLY_EXT_0
- IC1901 UA78L05ACPK
- IN / OUT / COM
- C1901 100n, C1902 1µ, C1904 100n
- GND_EXT_0
- ISO_GPIO_SUPPLY

Isolated GPIO connector X1901 43045-1000:
- ISO_GPIO_MCU_0_IN_1_EXT — 6 — 1 — ISO_GPIO_MCU_0_OUT_0_EXT
- ISO_GPIO_MCU_0_IN_2_EXT — 7 — 2 — ISO_GPIO_MCU_0_OUT_1_EXT
- ISO_GPIO_MCU_0_IN_3_EXT — 8 — 3 — ISO_GPIO_MCU_0_OUT_2_EXT
- 9 — 4 — ISO_GPIO_MCU_0_OUT_3_EXT
- 10 — 5 — ISO_GPIO_MCU_0_IN_0_EXT
- GND_EXT_0

Left isolator (IC1902 ADUM3402ARW):
- ISO_GPIO_SUPPLY
- +3.3V_0
- C1903 100n, IC1902PWR (VDD1/VDD2/GND1/GND2), C1905 100n
- GND_EXT_0, GND_0
- VE1 (7), VE2 (10)
- VIA (3) / VOA (14) — LSP1903 — ISO_GPIO_MCU_0_IN_0/22.5E
- VIB (4) / VOB (13) — LSP1901 — ISO_GPIO_MCU_0_IN_1/22.5E
- VOC (5) / VIC (12) — LSP1904 — ISO_GPIO_MCU_0_OUT_0/22.4B
- VOD (6) / VID (11) — LSP1902 — ISO_GPIO_MCU_0_OUT_1/22.5B
- ISO_GPIO_MCU_0_IN_0_EXT — R1901 47
- ISO_GPIO_MCU_0_IN_1_EXT — R1902 47
- ISO_GPIO_MCU_0_OUT_0_EXT
- ISO_GPIO_MCU_0_OUT_1_EXT
- D1901, D1902 (CD5Q0323-TR5), R1903 10k, R1904 10k
- GND_EXT_0

Right isolator (IC1903 ADUM3402ARW):
- ISO_GPIO_SUPPLY
- +3.3V_0
- C1906 100n, IC1903PWR (VDD1/VDD2/GND1/GND2), C1907 100n
- GND_EXT_0, GND_0
- VE1 (7), VE2 (10)
- VIA (3) / VOA (14) — LSP1905 — ISO_GPIO_MCU_0_IN_2/22.4B
- VIB (4) / VOB (13) — LSP1907 — ISO_GPIO_MCU_0_IN_3/22.5B
- VOC (5) / VIC (12) — LSP1906 — ISO_GPIO_MCU_0_OUT_2/22.4B
- VOD (6) / VID (11) — LSP1908 — ISO_GPIO_MCU_0_OUT_3/22.5B
- ISO_GPIO_MCU_0_IN_2_EXT — R1905 47
- ISO_GPIO_MCU_0_IN_3_EXT — R1906 47
- ISO_GPIO_MCU_0_OUT_2_EXT
- ISO_GPIO_MCU_0_OUT_3_EXT
- D1903, D1904 (CD5Q0323-TR5), R1907 10k, R1908 10k
- GND_EXT_0

TITLE: foxBMS BMS-Extension
DESCRIPTION: Isolated GPIO 4x In / 4x Out
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
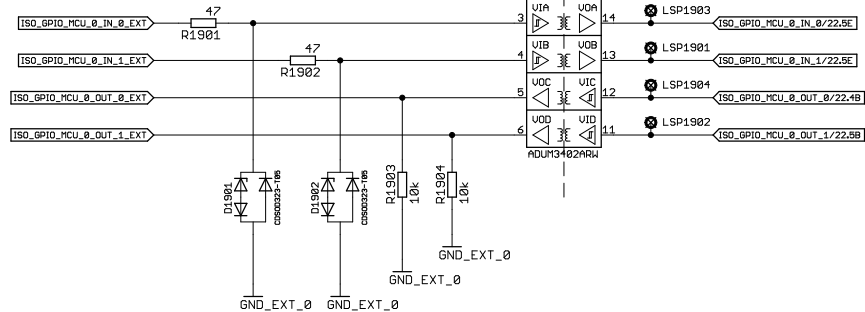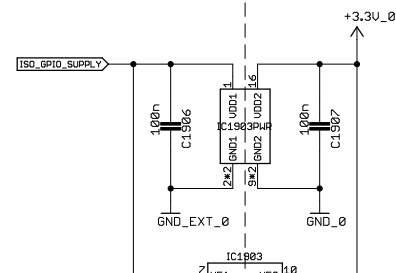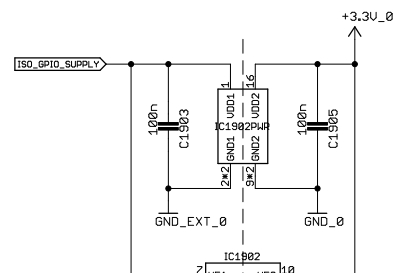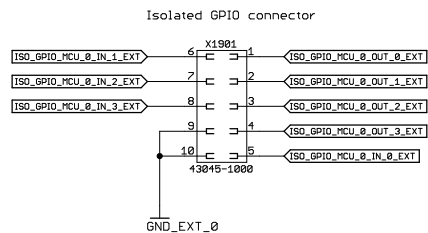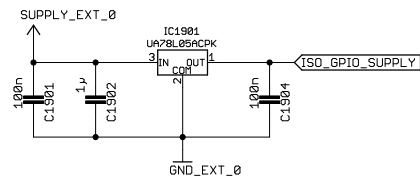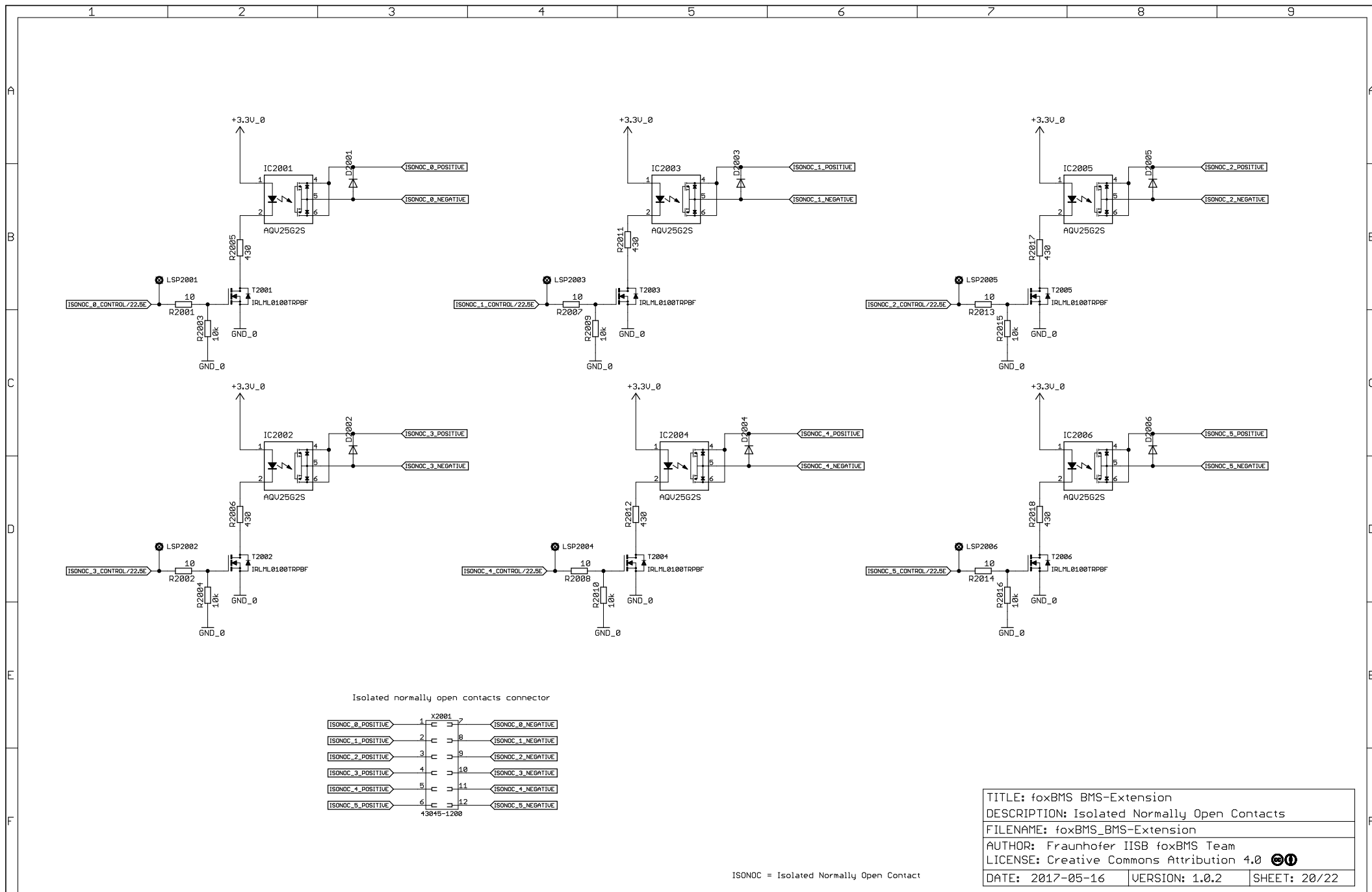DATE: 2017-05-16   VERSION: 1.0.2   SHEET: 19/22

Isolated normally open contacts connector

ISONOC = Isolated Normally Open Contact

TITLE: foxBMS BMS-Extension		
DESCRIPTION: Isolated Normally Open Contacts		
FILENAME: foxBMS_BMS-Extension		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-05-16	VERSION: 1.0.2	SHEET: 20/22

Connector for optional FPGA extension board

+3.3V_0   +5.0V_0

● LSP2101

| 1 | 2 |
MCU_TO_FPGA_INTERFACE_MCU_0_MISO | 3 | 4 | MCU_TO_FPGA_INTERFACE_MCU_0_SCK
| 5 | 6 |
MCU_TO_FPGA_INTERFACE_MCU_0_MOSI | 7 | 8 | MCU_TO_FPGA_INTERFACE_MCU_0_CS

SV2101
● LSP2102

GND_0

JP2201 connector

+3.3V_0

GND_0

Pin	Signal (left)		Pin	Signal (right)
1	CAN_1_TRANS_STANDBY_CONTROL/8.8D		2	
3			4	
5	CAN_1_TX/8.8C		6	CAN_1_RX/8.8C
7			8	
9	ISO_GPIO_MCU_0_OUT_0/19.4D		10	ISO_GPIO_MCU_0_IN_3/19.8D
11	ISO_GPIO_MCU_0_OUT_2/19.8D		12	ISO_GPIO_MCU_0_OUT_3/19.8E
13	ISO_GPIO_MCU_0_IN_2/19.8D		14	ISO_GPIO_MCU_0_OUT_1/19.4E
15	CONTACTOR_7_FEEDBACK/11.6D		16	CONTACTOR_7_CONTROL/10.2E
17	CONTACTOR_6_FEEDBACK/11.6D		18	CONTACTOR_6_CONTROL/10.2B
19	DATA_STORAGE_SPI_MOSI/15.6D		20	DATA_STORAGE_SPI_SCK/15.6D
21	DATA_STORAGE_SPI_MISO/15.6D		22	SDCARD_SUPPLY_CONTROL/15.4C
23	DATA_STORAGE_SPI_SDCARD_NSS/15.6D		24	

JP2202 connector

+3.3V_0

GND_0

Pin	Signal (left)		Pin	Signal (right)
1	ADC_MCU_0_CH_3/17.3E		2	ADC_MCU_0_CH_2/17.7D
3	ADC_MCU_0_CH_1/17.5D		4	ADC_MCU_0_CH_0/17.3D
5	ADC_MCU_0_CH_4/17.5E		6	CONTACTOR_8_CONTROL/10.6B
7	CONTACTOR_8_FEEDBACK/11.6D		8	RS485_MCU_0_TX/13.7C
9	RS485_MCU_0_RX/13.7D		10	RS485_MCU_0_NRE/13.7D
11	RS485_MCU_0_DE/13.7D		12	ISONOC_0_CONTROL/20.1B
13	ISONOC_1_CONTROL/20.4B		14	ISONOC_2_CONTROL/20.7B
15	ISONOC_3_CONTROL/20.1D		16	ISONOC_4_CONTROL/20.4D
17	ISONOC_5_CONTROL/20.7D		18	ISO_GPIO_MCU_0_IN_0/19.4D
19	ISO_GPIO_MCU_0_IN_1/19.4D		20	
21			22	
23			24	

TITLE: foxBMS BMS-Extension
DESCRIPTION: Connectors to BMS-Master
FILENAME: foxBMS_BMS-Extension
AUTHOR: Fraunhofer IISB foxBMS Team
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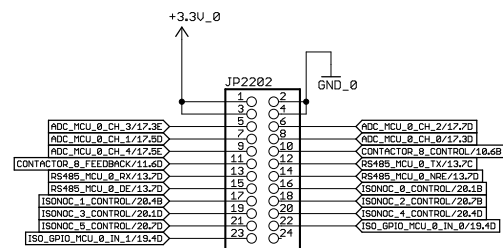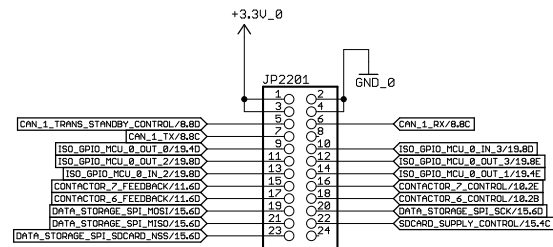DATE: 2017-05-16   VERSION: 1.0.2   SHEET: 22/22