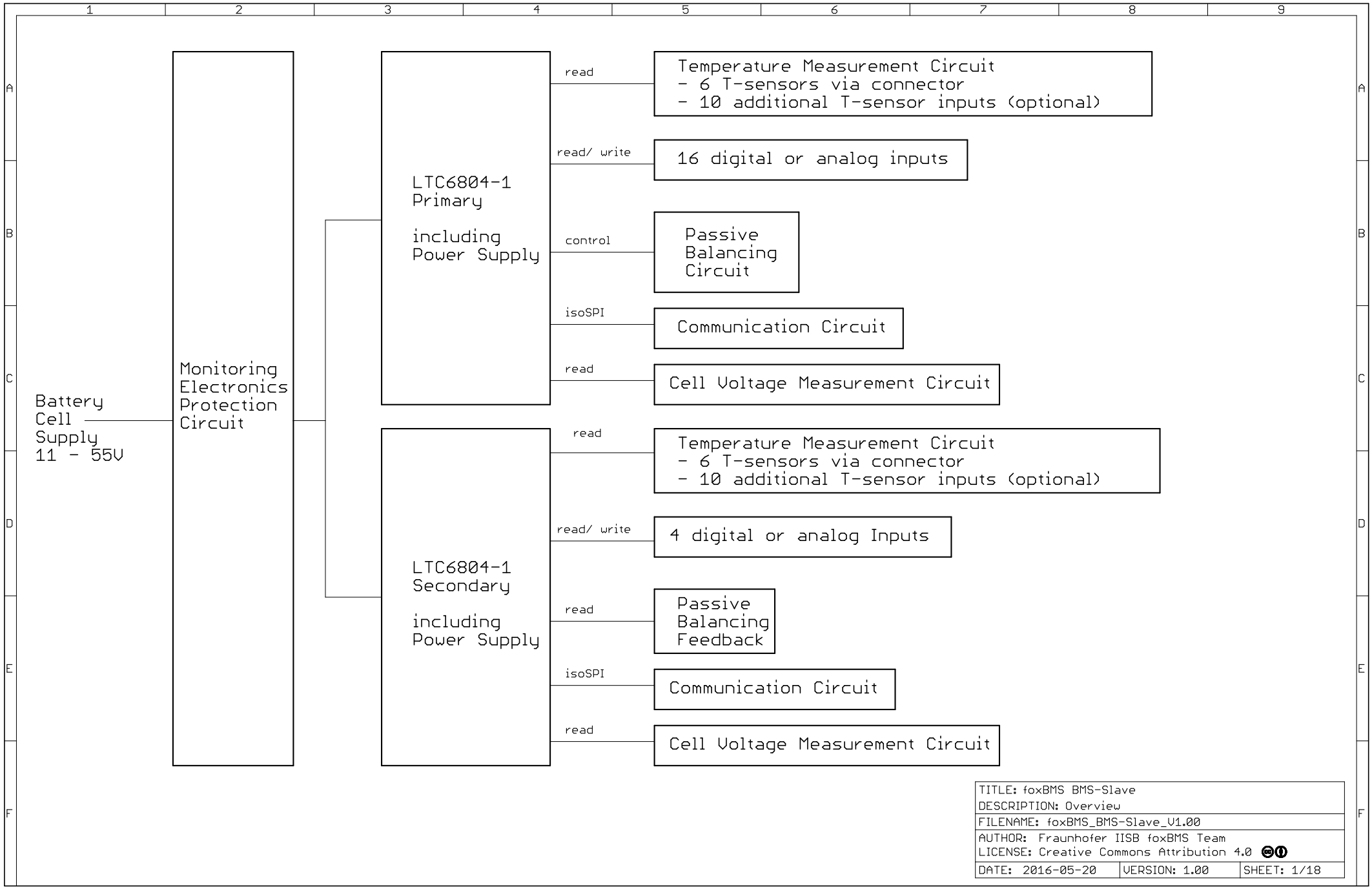
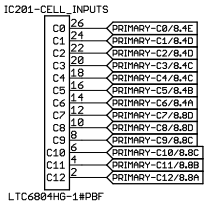
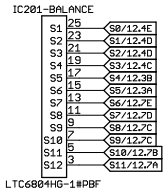


TITLE: foxBMS BMS-Slave		
DESCRIPTION: Overview		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 1/18

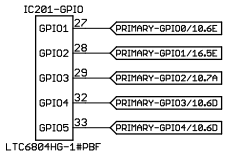
Cell voltage sense inputs



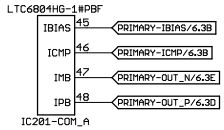
Cell balancing control

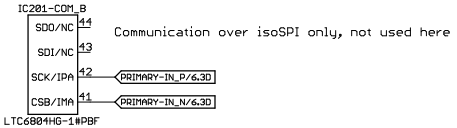


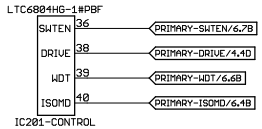
LTC6804 GPIO



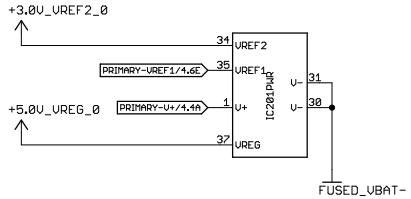
Communication input/output and configuration





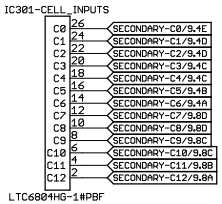


Internal voltage reference

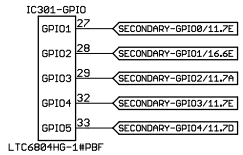


TITLE: foxBMS BMS-Slave		
DESCRIPTION: Primary LTC6804		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 2/18

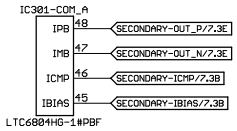
Cell voltage sense inputs

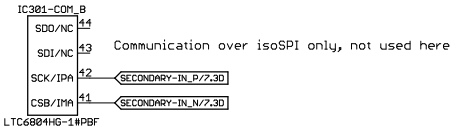


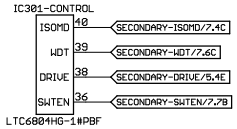
LTC6804 GPIO



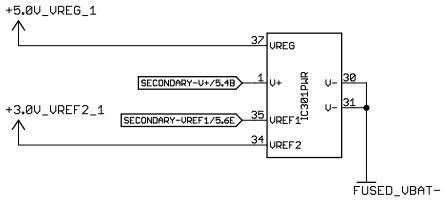
Communication input/output and configuration



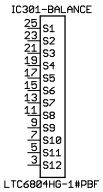




Internal voltage reference

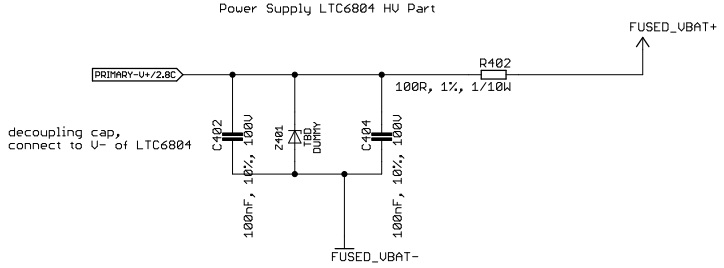


Cell balancing control
(not used on secondary LTC6804)

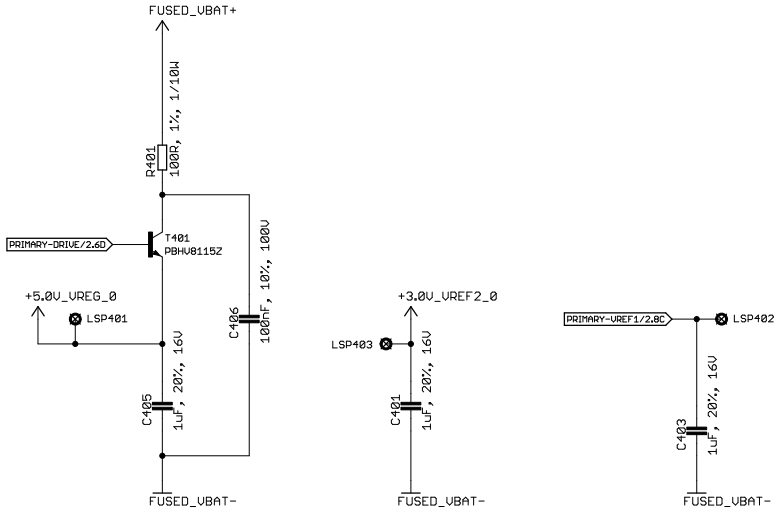


TITLE: foxBMS BMS-Slave		
DESCRIPTION: Secondary LTC6804		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 3/18

Power Supply LTC6804 HV Part

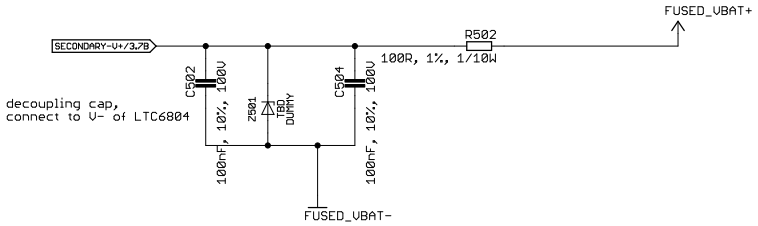


Power Supply LTC6804 LV Part

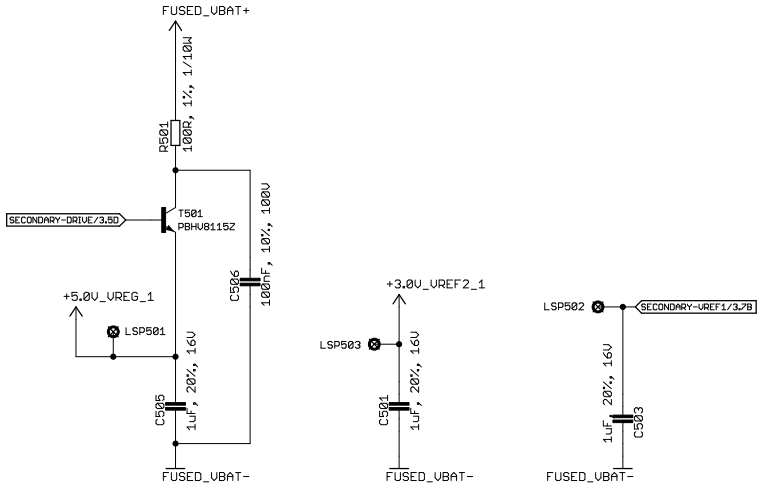


TITLE: foxBMS BMS-Slave		
DESCRIPTION: Primary Supply Circuit		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 4/18

Power Supply LTC6804 HV Part

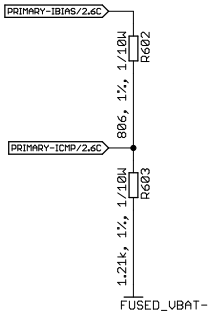


Power Supply LTC6804 LV Part

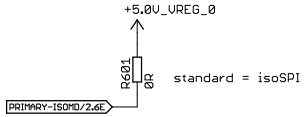


TITLE: foxBMS BMS-Slave		
DESCRIPTION: Secondary Supply Circuit		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 5/18

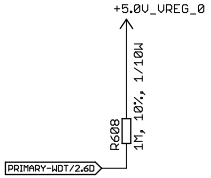
Adjustment of the amplitude
of the differential signal voltage



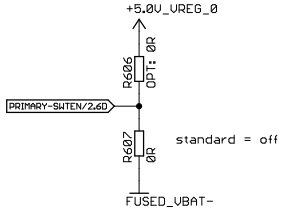
isoSPI mode or SPI mode configuration



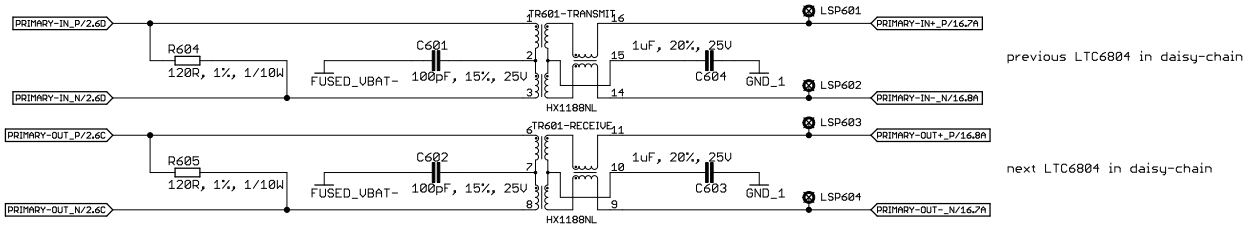
Watchdog timer configuration



Softwaretimer configuration



isoSPI isolation

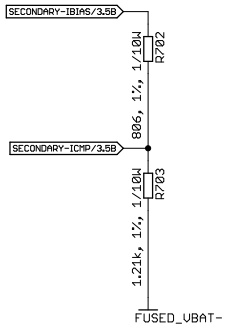


Layout:

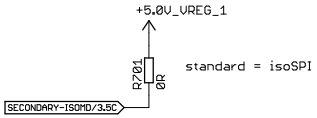
- The transformer should be placed as close to the isoSPI cable connector as possible.
  The distance should be kept less than 2cm.
- The LTC6804 should be placed at least 1cm to 2cm away from the transformer.
- On the top component layer, no ground plane should be placed under the transformer,
  the isoSPI connector, or in between the transformer and the connector.
- The isoSPI signal traces should be isolated from surrounding circuits and traces by ground metal or space.
  No traces should cross the isoSPI signal lines, unless separated by a ground plane on an inner layer.

TITLE: foxBMS BMS-Slave		
DESCRIPTION: Primary Communication Circuit		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 6/18

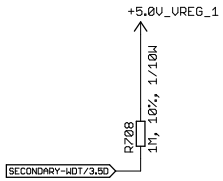
Adjustment of the amplitude
of the differential signal voltage



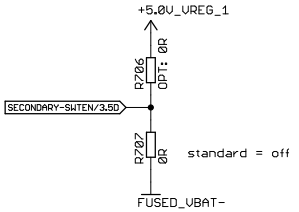
isoSPI mode or SPI mode configuration



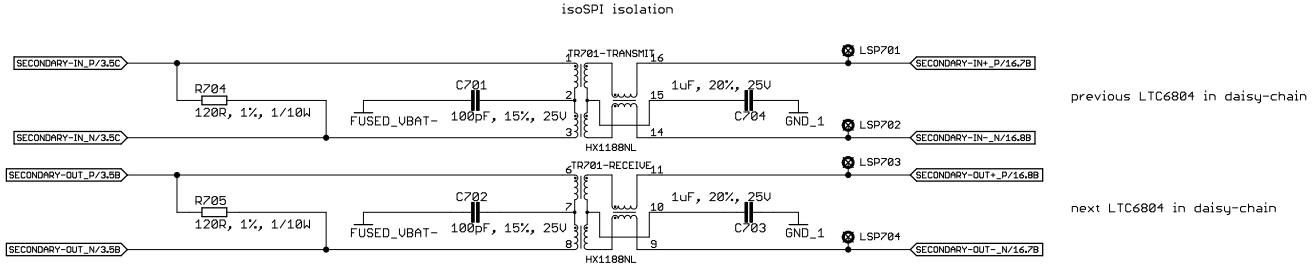
Watchdog Timer



Softwaretimer configuration



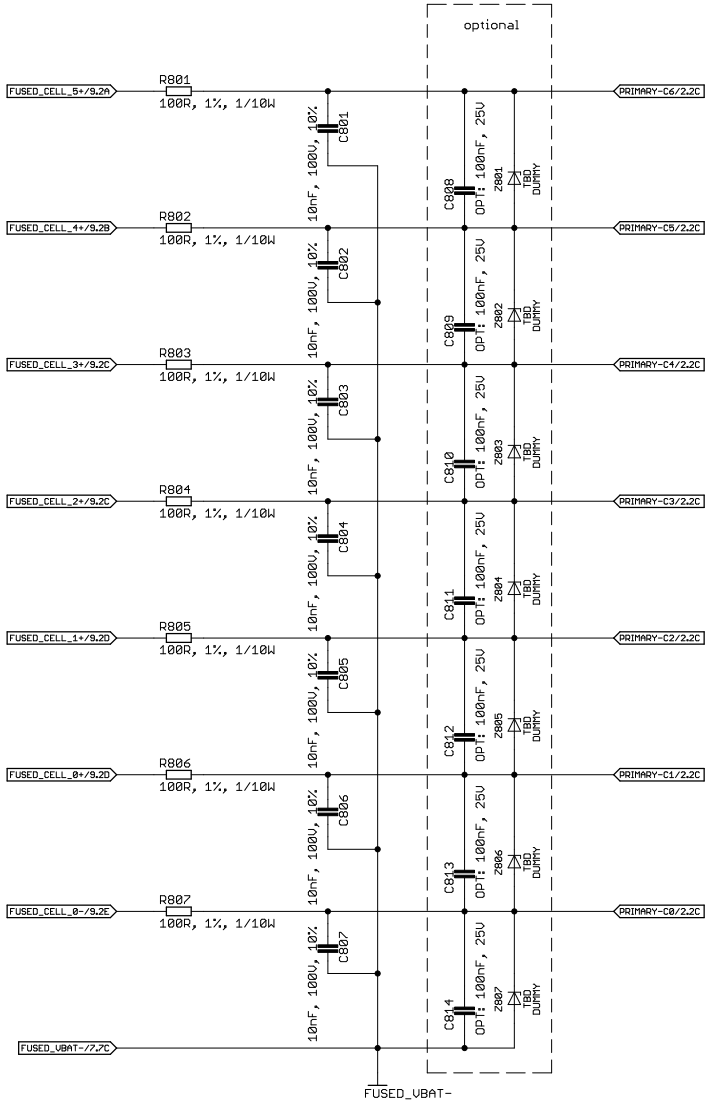
isoSPI isolation

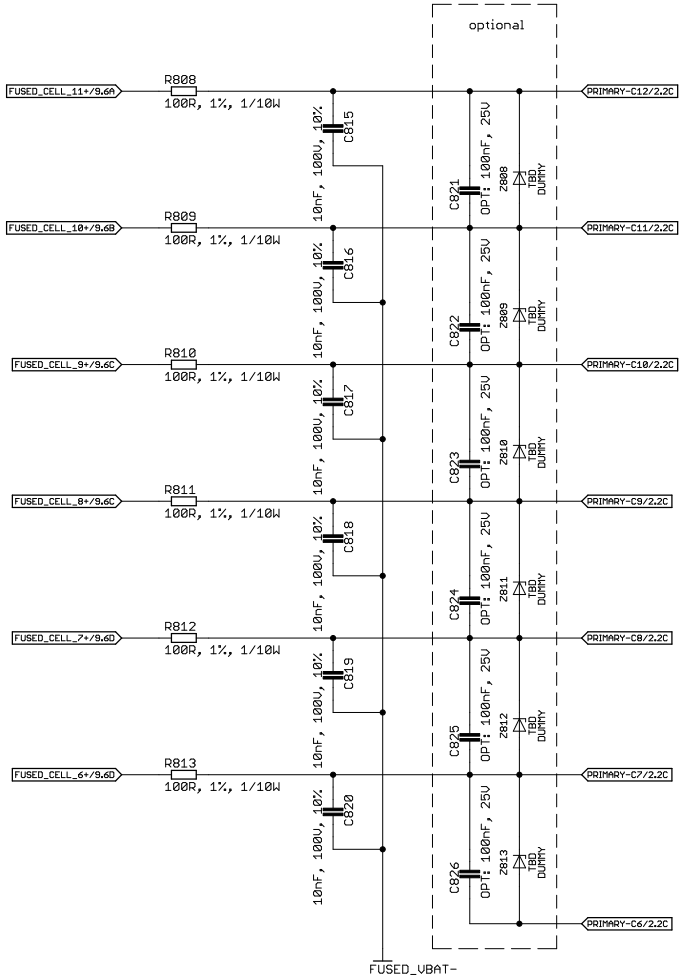


Layout:

- The transformer should be placed as close to the isoSPI cable connector as possible.
  The distance should be kept less than 2cm.
- The LTC6804 should be placed at least 1cm to 2cm away from the transformer.
- On the top component layer, no ground plane should be placed under the transformer,
  the isoSPI connector, or in between the transformer and the connector.
- The isoSPI signal traces should be isolated from surrounding circuits and traces by ground metal or space.
  No traces should cross the isoSPI signal lines, unless separated by a ground plane on an inner layer.

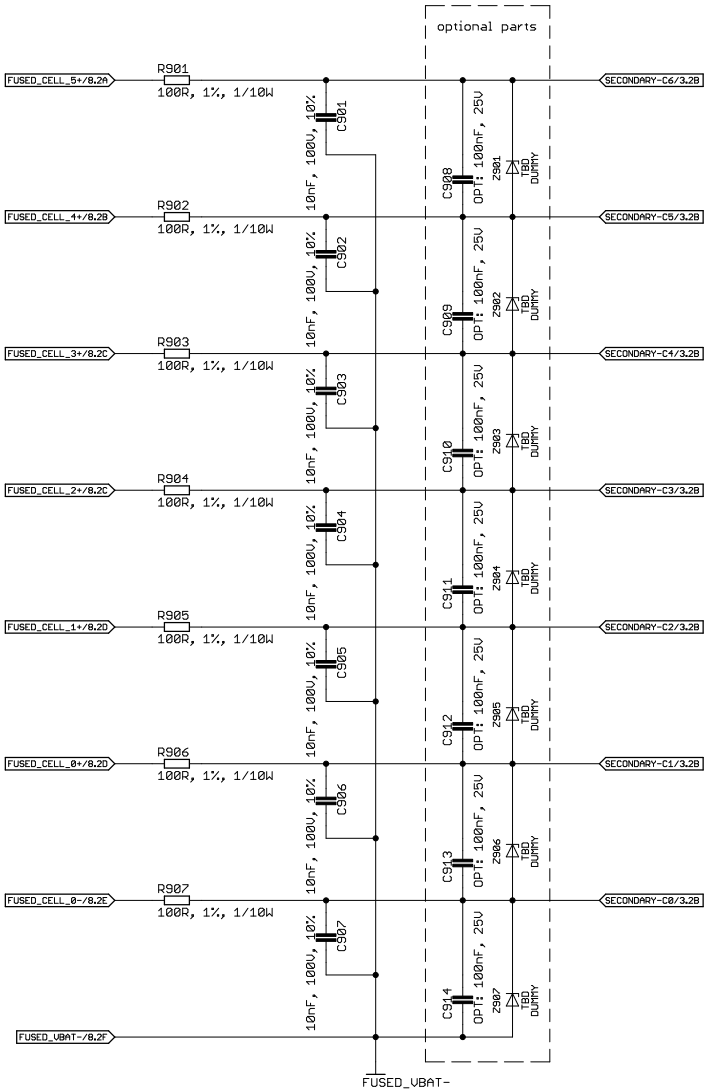
TITLE: foxBMS BMS-Slave		
DESCRIPTION: Secondary Communication Circuit		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 7/18

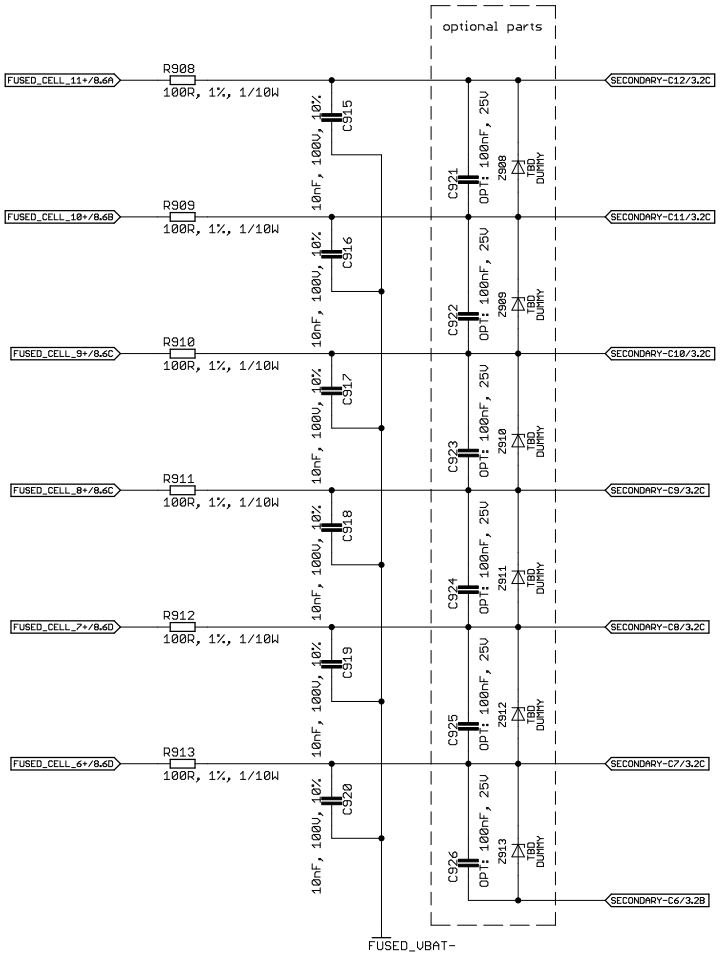




low-pass filter
C = 100nF -> fg = 16kHz
C = 22nF -> fg = 72kHz
C = 10nF -> fg = 160kHz (datasheet value)

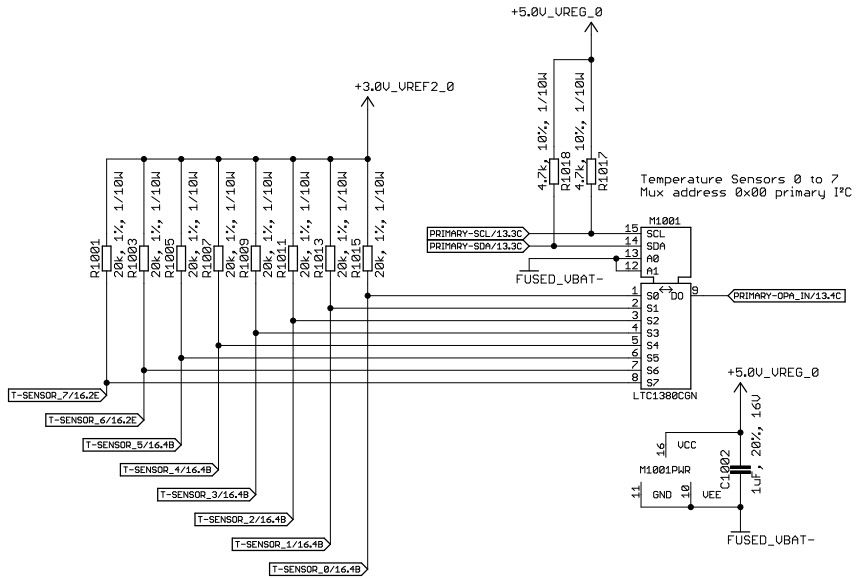
TITLE: foxBMS BMS-Slave		
DESCRIPTION: Primary Voltage Measurement		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 8/18

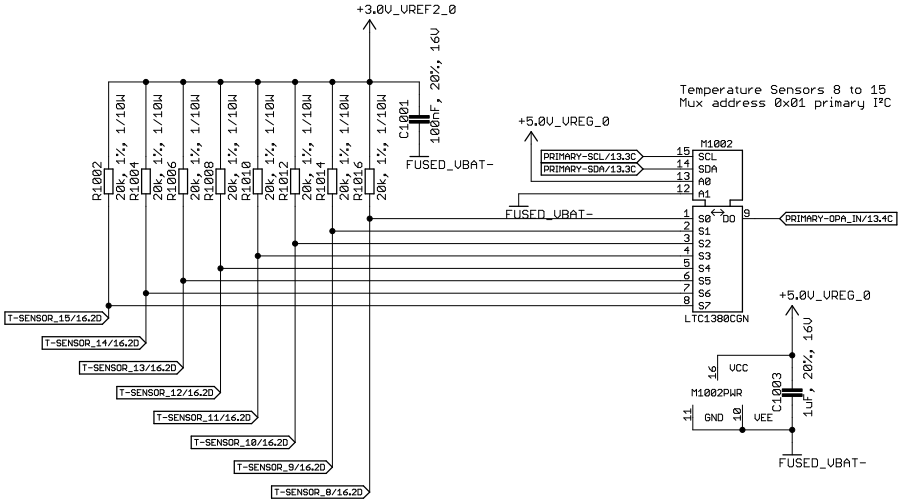


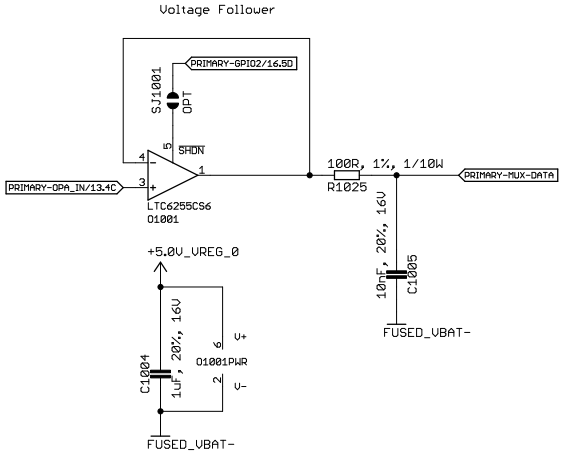


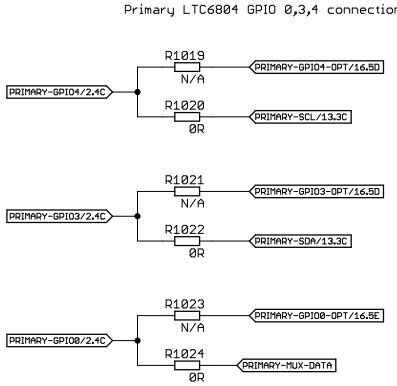
low-pass filter
C = 100nF -> fg = 16kHz
C = 22nF -> fg = 72kHz
C = 10nF -> fg = 160kHz (datasheet value)

TITLE: foxBMS BMS-Slave		
DESCRIPTION: Secondary Voltage Measurement		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 9/18

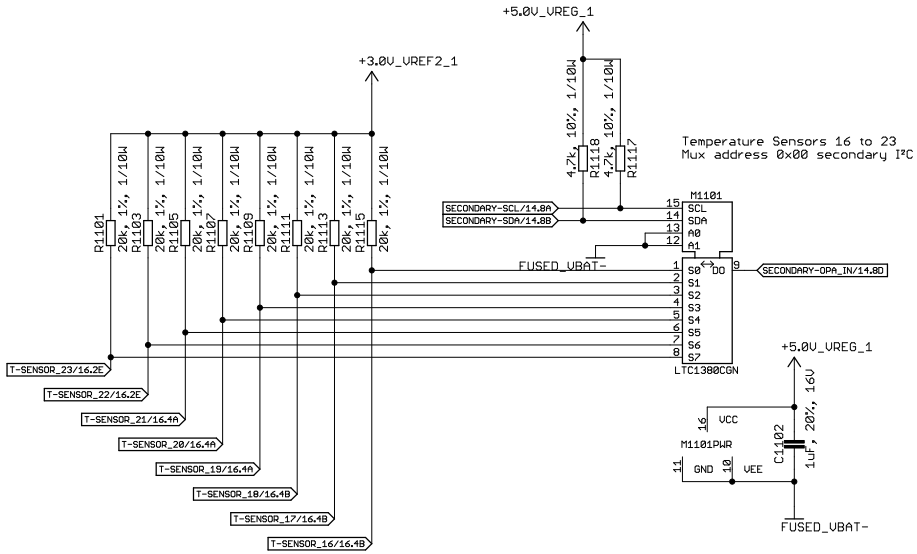


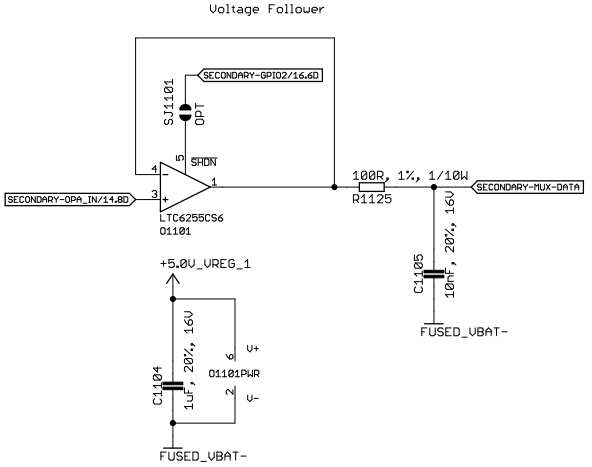


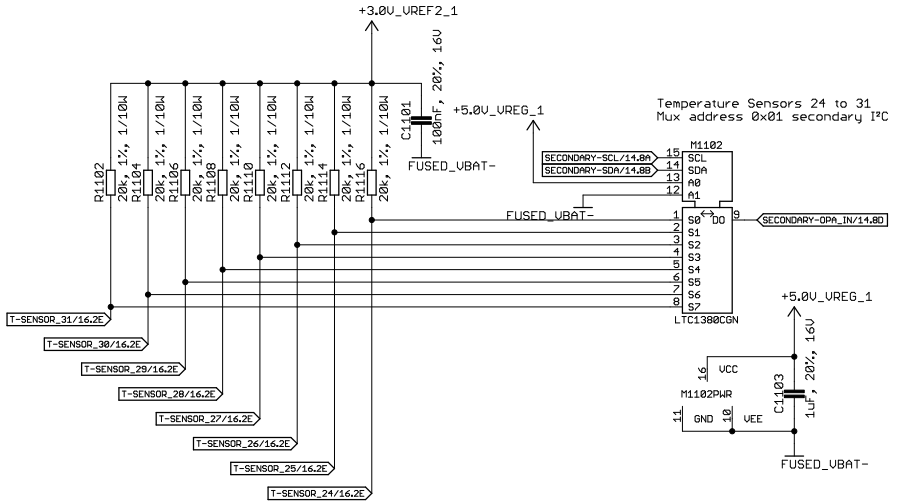


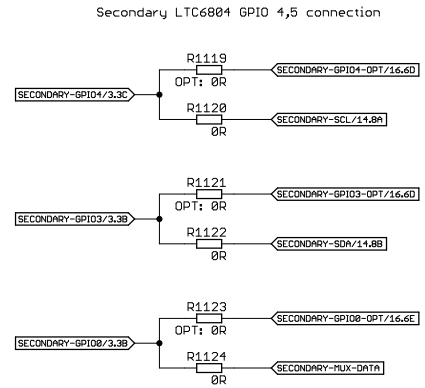


TITLE: foxBMS BMS-Slave		
DESCRIPTION: Primary Temperature Measurement		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 10/18

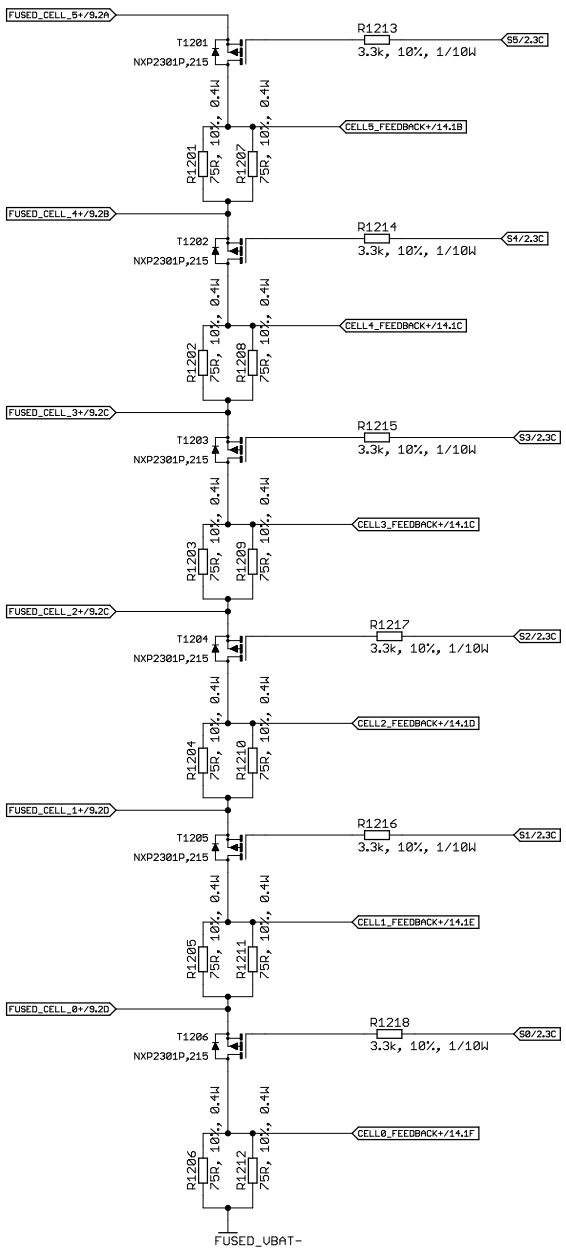


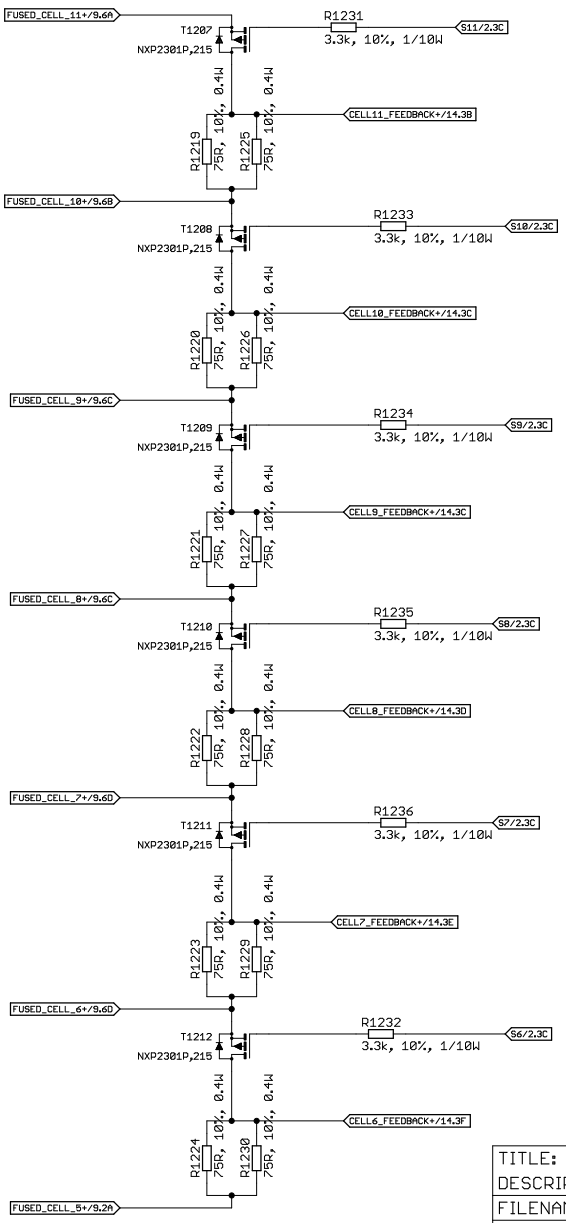






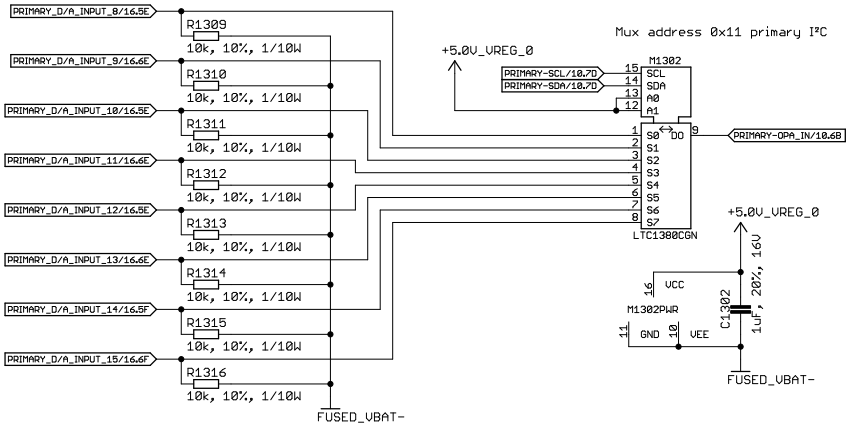
TITLE: foxBMS BMS-Slave		
DESCRIPTION: Secondary Temperature Measurement		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 11/18

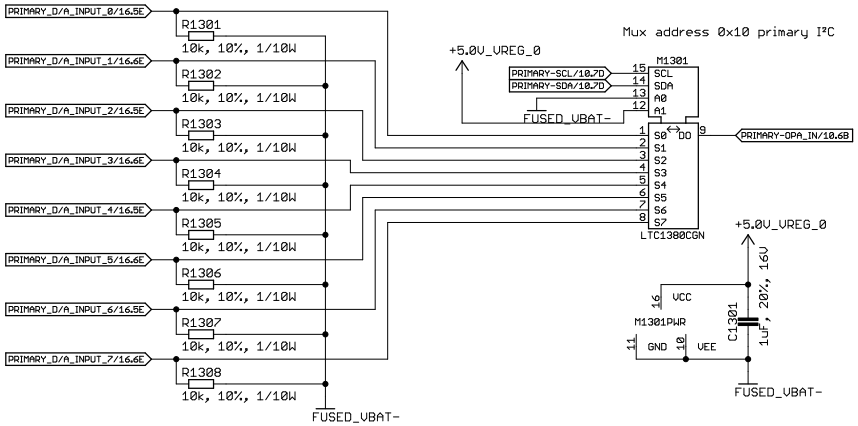




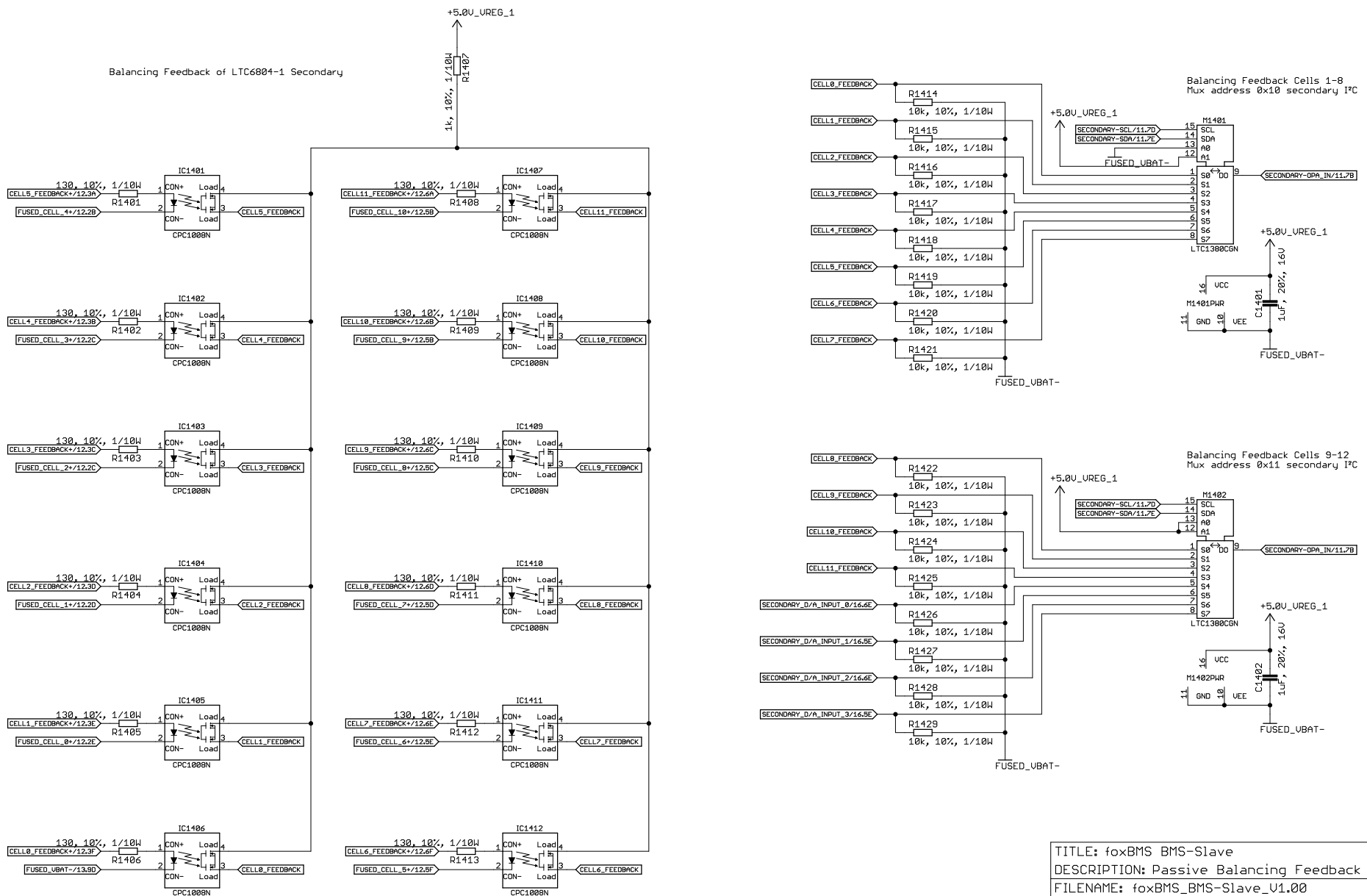
Passive cell balancing controlled by primary LTC6804

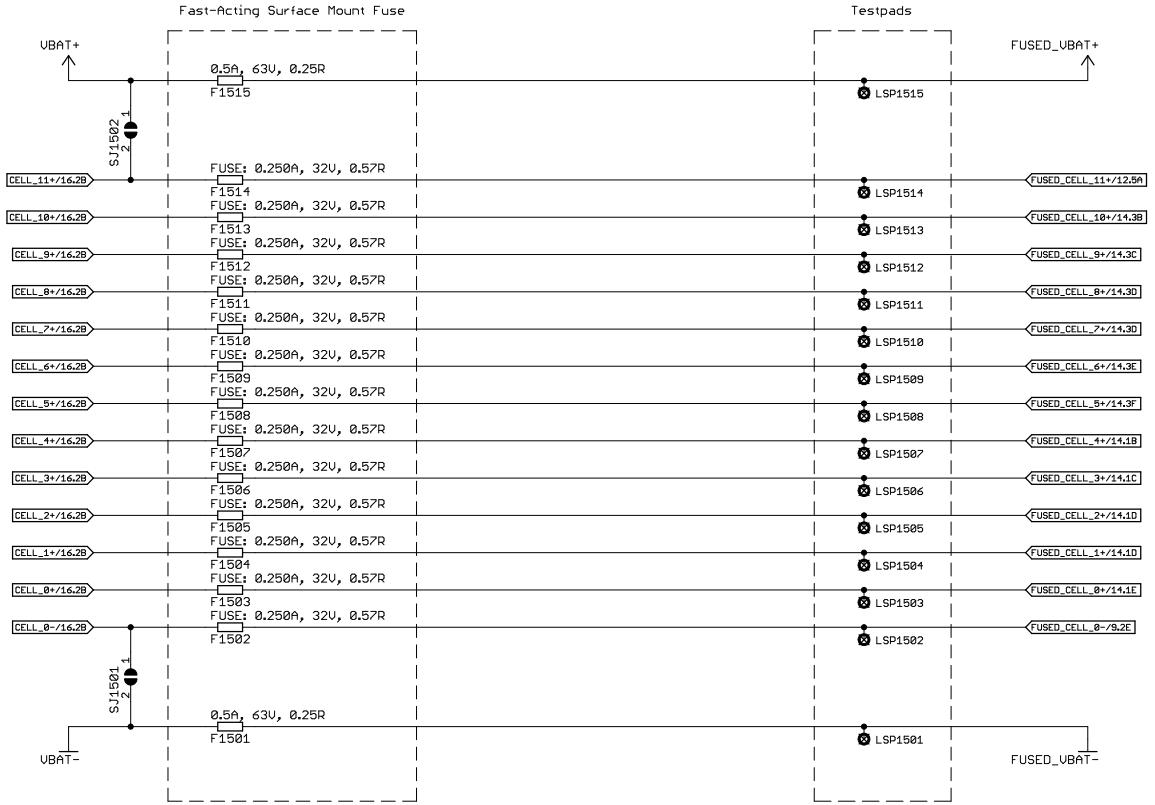
TITLE: foxBMS BMS-Slave		
DESCRIPTION: Passive Cell Balancing		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 12/18





TITLE: foxBMS BMS-Slave		
DESCRIPTION: A/D Inputs Primary LTC6804		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 13/18


Balancing Feedback of LTC6804-1 Secondary
+5.0V_VREG_1
R1407
1k, 10%, 1/10W
IC1401
130, 10%, 1/10W
CELL5_FEEDBACK+/12.3A
R1401
FUSED_CELL_4+/12.2B
CELL5_FEEDBACK
CPC1008N
IC1402
130, 10%, 1/10W
CELL4_FEEDBACK+/12.3B
R1402
FUSED_CELL_3+/12.2C
CELL4_FEEDBACK
CPC1008N
IC1403
130, 10%, 1/10W
CELL3_FEEDBACK+/12.3C
R1403
FUSED_CELL_2+/12.2C
CELL3_FEEDBACK
CPC1008N
IC1404
130, 10%, 1/10W
CELL2_FEEDBACK+/12.3D
R1404
FUSED_CELL_1+/12.2D
CELL2_FEEDBACK
CPC1008N
IC1405
130, 10%, 1/10W
CELL1_FEEDBACK+/12.3E
R1405
FUSED_CELL_0+/12.2E
CELL1_FEEDBACK
CPC1008N
IC1406
130, 10%, 1/10W
CELL0_FEEDBACK+/12.3F
R1406
FUSED_VBAT-/13.9D
CELL0_FEEDBACK
CPC1008N
IC1407
130, 10%, 1/10W
CELL11_FEEDBACK+/12.6A
R1408
FUSED_CELL_10+/12.5B
CELL11_FEEDBACK
CPC1008N
IC1408
130, 10%, 1/10W
CELL10_FEEDBACK+/12.6B
R1409
FUSED_CELL_9+/12.5B
CELL10_FEEDBACK
CPC1008N
IC1409
130, 10%, 1/10W
CELL9_FEEDBACK+/12.6C
R1410
FUSED_CELL_8+/12.5C
CELL9_FEEDBACK
CPC1008N
IC1410
130, 10%, 1/10W
CELL8_FEEDBACK+/12.6D
R1411
FUSED_CELL_7+/12.5D
CELL8_FEEDBACK
CPC1008N
IC1411
130, 10%, 1/10W
CELL7_FEEDBACK+/12.6E
R1412
FUSED_CELL_6+/12.5E
CELL7_FEEDBACK
CPC1008N
IC1412
130, 10%, 1/10W
CELL6_FEEDBACK+/12.6F
R1413
FUSED_CELL_5+/12.5F
CELL6_FEEDBACK
CPC1008N
Balancing Feedback Cells 1-8
Mux address 0x10 secondary I²C
CELL0_FEEDBACK
CELL1_FEEDBACK
CELL2_FEEDBACK
CELL3_FEEDBACK
CELL4_FEEDBACK
CELL5_FEEDBACK
CELL6_FEEDBACK
CELL7_FEEDBACK
R1414
R1415
R1416
R1417
R1418
R1419
R1420
R1421
10k, 10%, 1/10W
FUSED_VBAT-
+5.0V_VREG_1
SECONDARY-SCL/11.7D
SECONDARY-SDA/11.7E
M1401
SCL
SDA
A0
A1
S0
S1
S2
S3
S4
S5
S6
S7
DO
SECONDARY-OPA_IN/11.7B
LTC1380CGN
VCC
M1401PWR
GND
VEE
C1401
1uF, 20%, 16V
Balancing Feedback Cells 9-12
Mux address 0x11 secondary I²C
CELL8_FEEDBACK
CELL9_FEEDBACK
CELL10_FEEDBACK
CELL11_FEEDBACK
SECONDARY_D/A_INPUT_0/16.6E
SECONDARY_D/A_INPUT_1/16.5E
SECONDARY_D/A_INPUT_2/16.6E
SECONDARY_D/A_INPUT_3/16.5E
R1422
R1423
R1424
R1425
R1426
R1427
R1428
R1429
10k, 10%, 1/10W
FUSED_VBAT-
+5.0V_VREG_1
SECONDARY-SCL/11.7D
SECONDARY-SDA/11.7E
M1402
SCL
SDA
A0
A1
S0
S1
S2
S3
S4
S5
S6
S7
DO
SECONDARY-OPA_IN/11.7B
LTC1380CGN
VCC
M1402PWR
GND
VEE
C1402
1uF, 20%, 16V
TITLE: foxBMS BMS-Slave
DESCRIPTION: Passive Balancing Feedback
FILENAME: foxBMS_BMS-Slave_V1.00
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
DATE: 2016-05-20
VERSION: 1.00
SHEET: 14/18

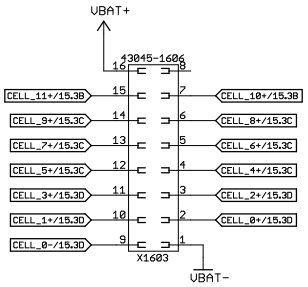


For Cell Balancing/ Measuring Inputs: Max. 0.200A Balancing Current
Reaction Time:
200% Overload = max. 5s
300% Overload = max. 0.2s

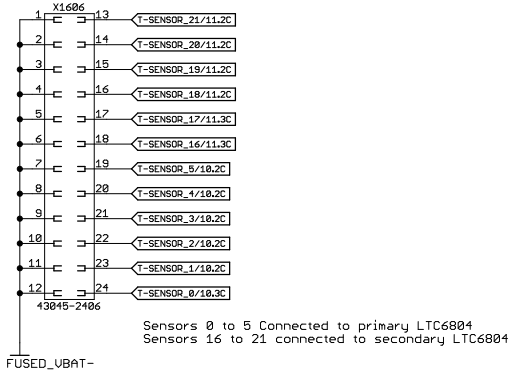
For Power Supply Inputs: Max. 0.500A Current
Reaction Time:
200% Overload = max. 5s
300% Overload = max. 0.2s

TITLE: foxBMS BMS-Slave		
DESCRIPTION: Cell Voltage Sense Fuses		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 15/18

Batterie Cell Voltage Sense Connector

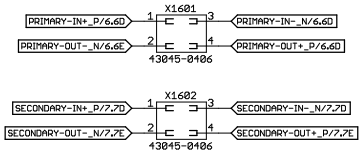


Temperature Sensor Connector

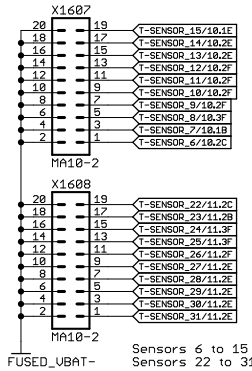


Sensors 0 to 5 Connected to primary LTC6804
Sensors 16 to 21 connected to secondary LTC6804

Daisy Chain Connectors

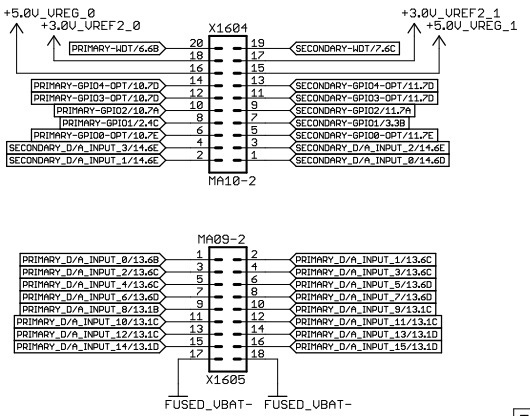


Pin-Header for additional Temperature Sensos

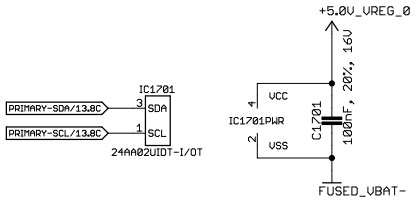


Sensors 6 to 15 connected to primary LTC6804
Sensors 22 to 31 connected to secondary LTC6804

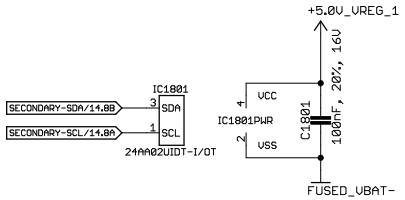
GPIO Connectors



TITLE: foxBMS BMS-Slave		
DESCRIPTION: Connectors		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 16/18



TITLE: foxBMS BMS-Slave		
DESCRIPTION: Primary EEPROM		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 17/18



TITLE: foxBMS BMS-Slave		
DESCRIPTION: Secondary EEPROM		
FILENAME: foxBMS_BMS-Slave_V1.00		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2016-05-20	VERSION: 1.00	SHEET: 18/18