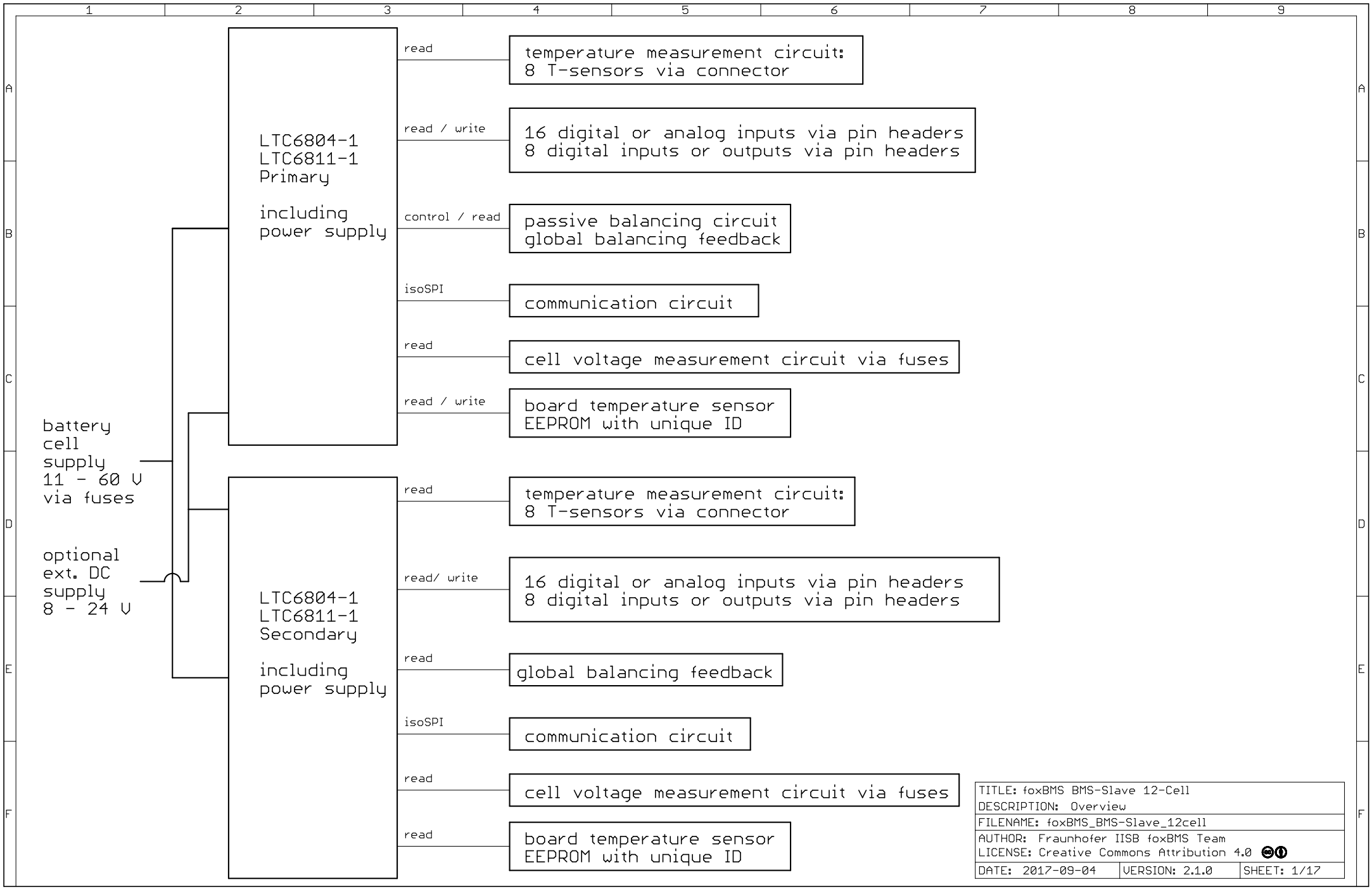
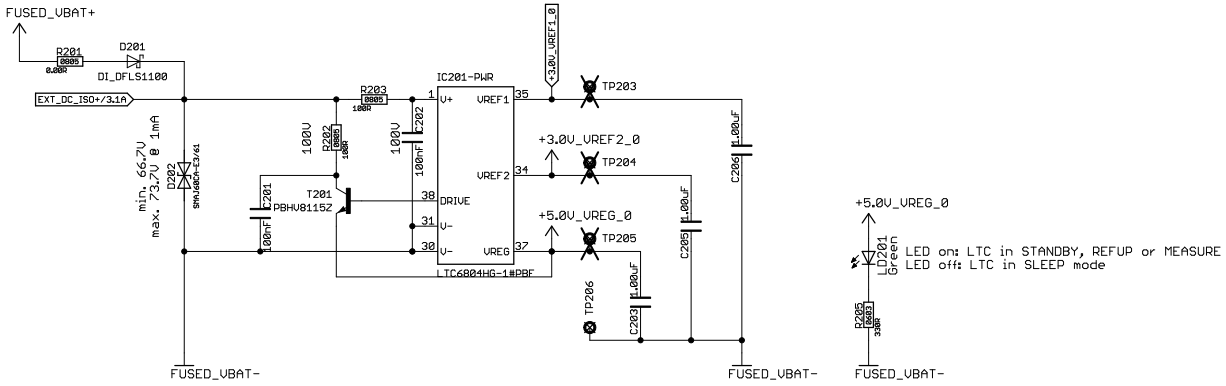
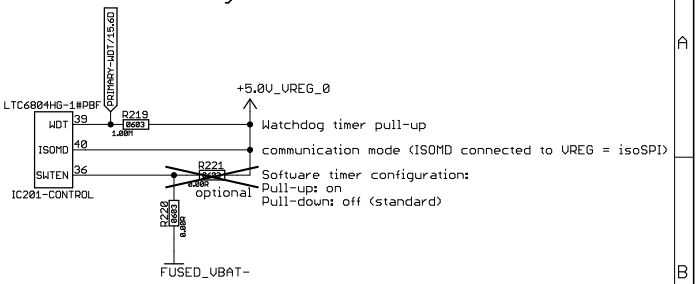

LTC6804-1
LTC6811-1
Primary
including
power supply
read
temperature measurement circuit:
8 T-sensors via connector
read / write
16 digital or analog inputs via pin headers
8 digital inputs or outputs via pin headers
control / read
passive balancing circuit
global balancing feedback
isoSPI
communication circuit
read
cell voltage measurement circuit via fuses
read / write
board temperature sensor
EEPROM with unique ID
battery
cell
supply
11 - 60 V
via fuses
optional
ext. DC
supply
8 - 24 V
LTC6804-1
LTC6811-1
Secondary
including
power supply
read
temperature measurement circuit:
8 T-sensors via connector
read/ write
16 digital or analog inputs via pin headers
8 digital inputs or outputs via pin headers
read
global balancing feedback
isoSPI
communication circuit
read
cell voltage measurement circuit via fuses
read
board temperature sensor
EEPROM with unique ID
TITLE: foxBMS BMS-Slave 12-Cell
DESCRIPTION: Overview
FILENAME: foxBMS_BMS-Slave_12cell
AUTHOR: Fraunhofer IISB foxBMS Team
LICENSE: Creative Commons Attribution 4.0
DATE: 2017-09-04
VERSION: 2.1.0
SHEET: 1/17

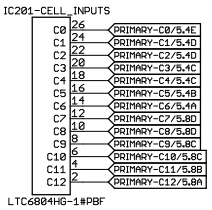
Power Supply



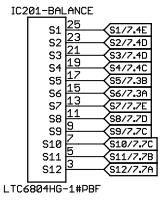
Setting Pins



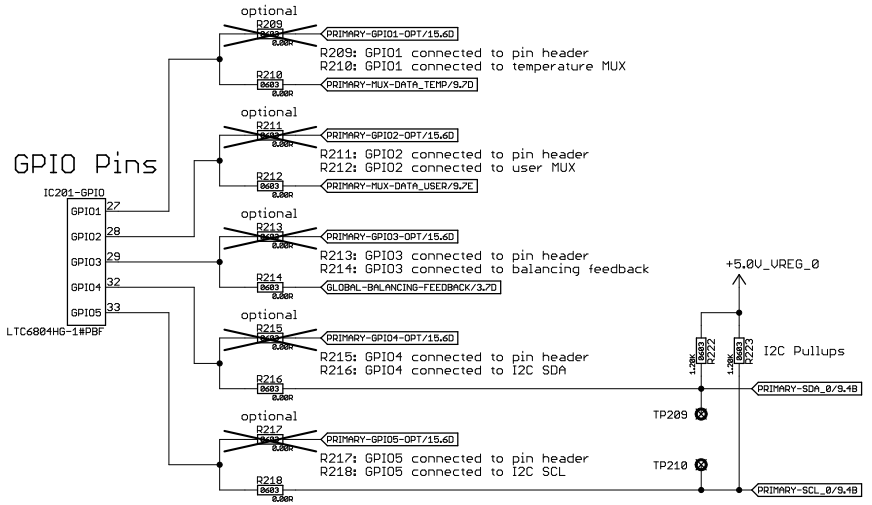
Cell voltage sense inputs



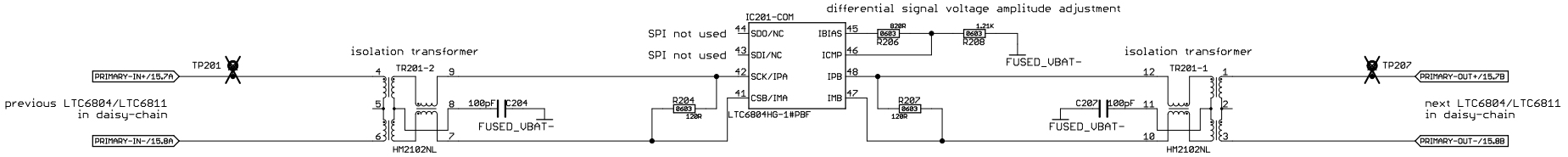
Cell balancing control



GPIO Pins



Communication Circuit

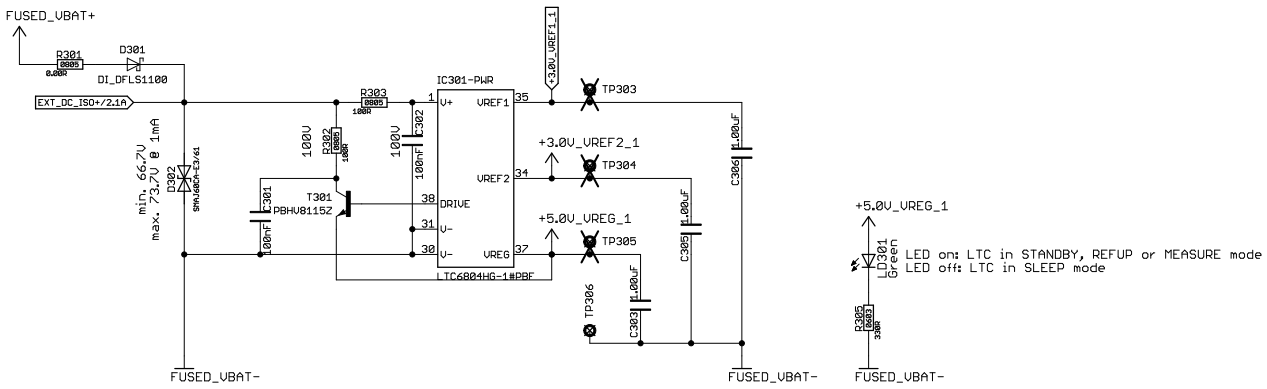


Layout:

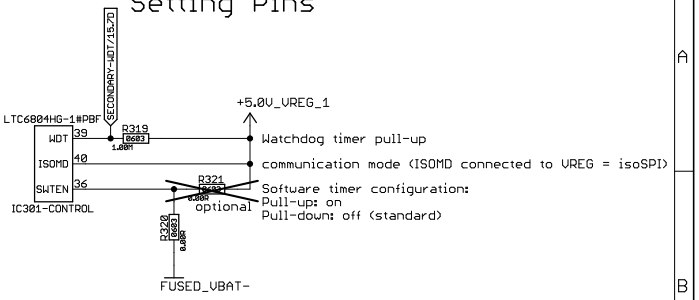
- The transformer should be placed as close to the isoSPI cable connector as possible.
  The distance should be kept less than 2cm.
- The LTC6804 should be placed at least 1cm to 2cm away from the transformer.
- On the top component layer, no ground plane should be placed under the transformer,
  the 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 12-Cell		
DESCRIPTION: Primary LTC6804/LTC6811		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 2/17

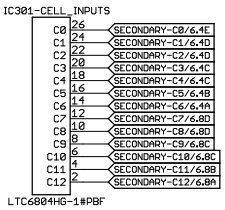
Power Supply



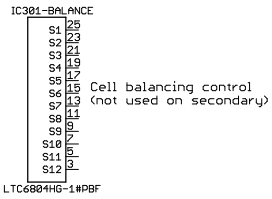
Setting Pins



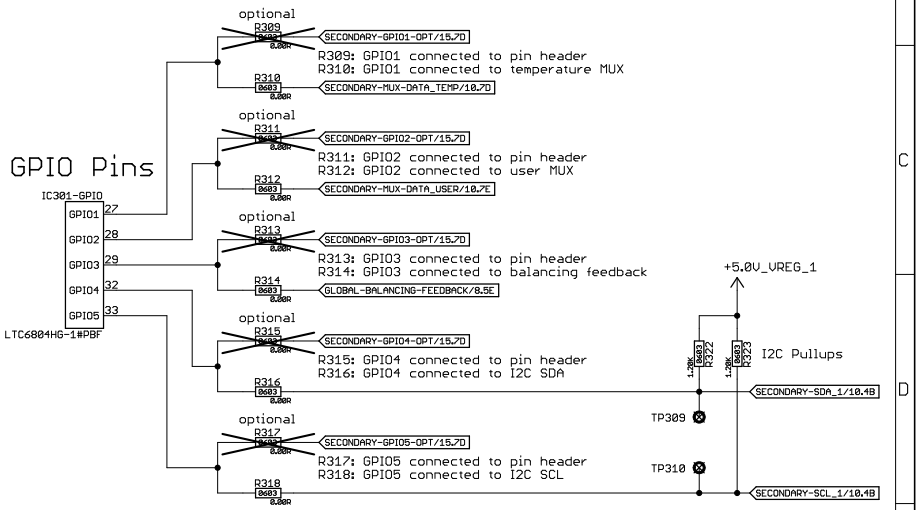
Cell voltage sense inputs



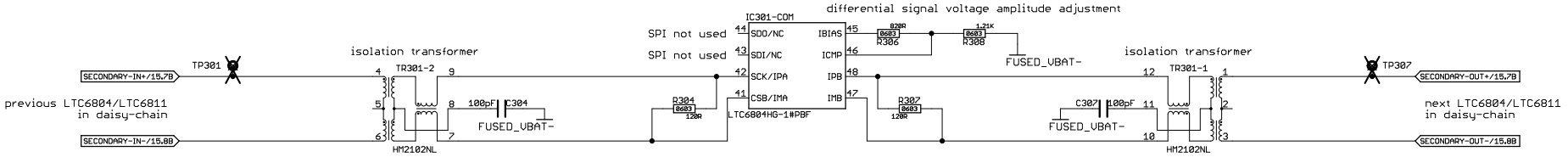
Cell balancing control



GPIO Pins



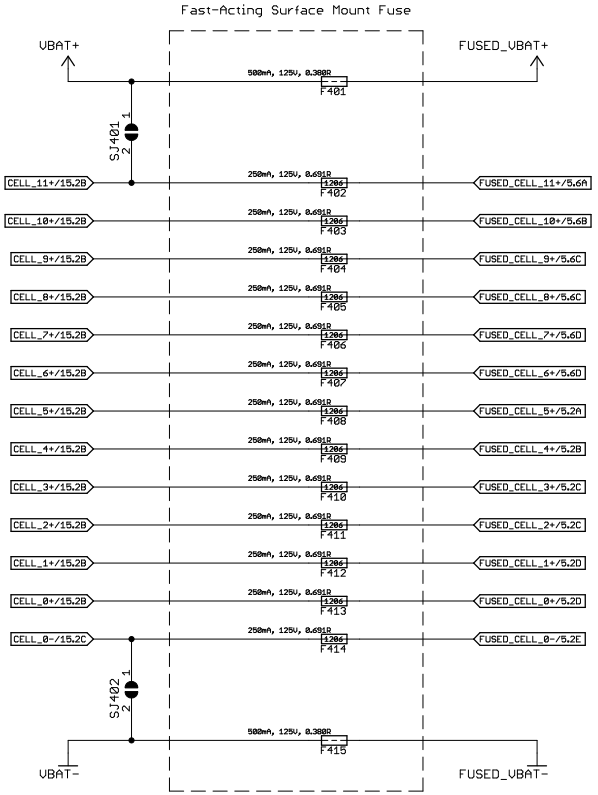
Communication Circuit



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.

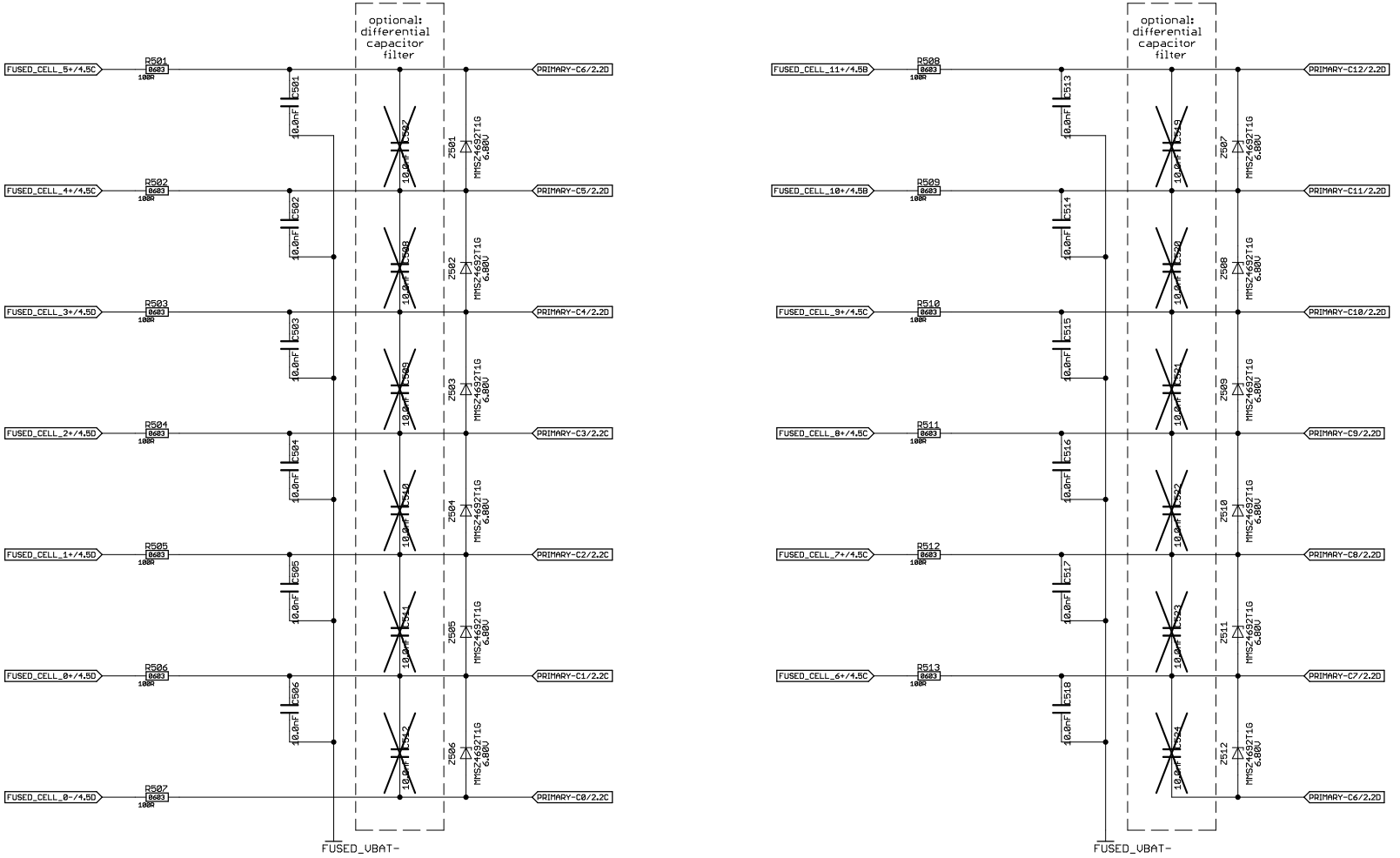
TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Secondary LTC6804/LTC6811		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 3/17



For Cell Balancing/ Measuring Inputs: Max. 0.250A Balancing Current
Reaction Time:
200% Load (0.500A) = ca. 20ms
300% Load (0.750A) = <10ms

For Power Supply Inputs: Max. 0.500A Current
Reaction Time:
200% Load (1.000A) = ca. 200ms
300% Load (1.500A) = ca. 70ms

TITLE: foxBMS BMS-Slave 12-Cell DESCRIPTION: Cell Voltage Sense Fuses		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 4/17

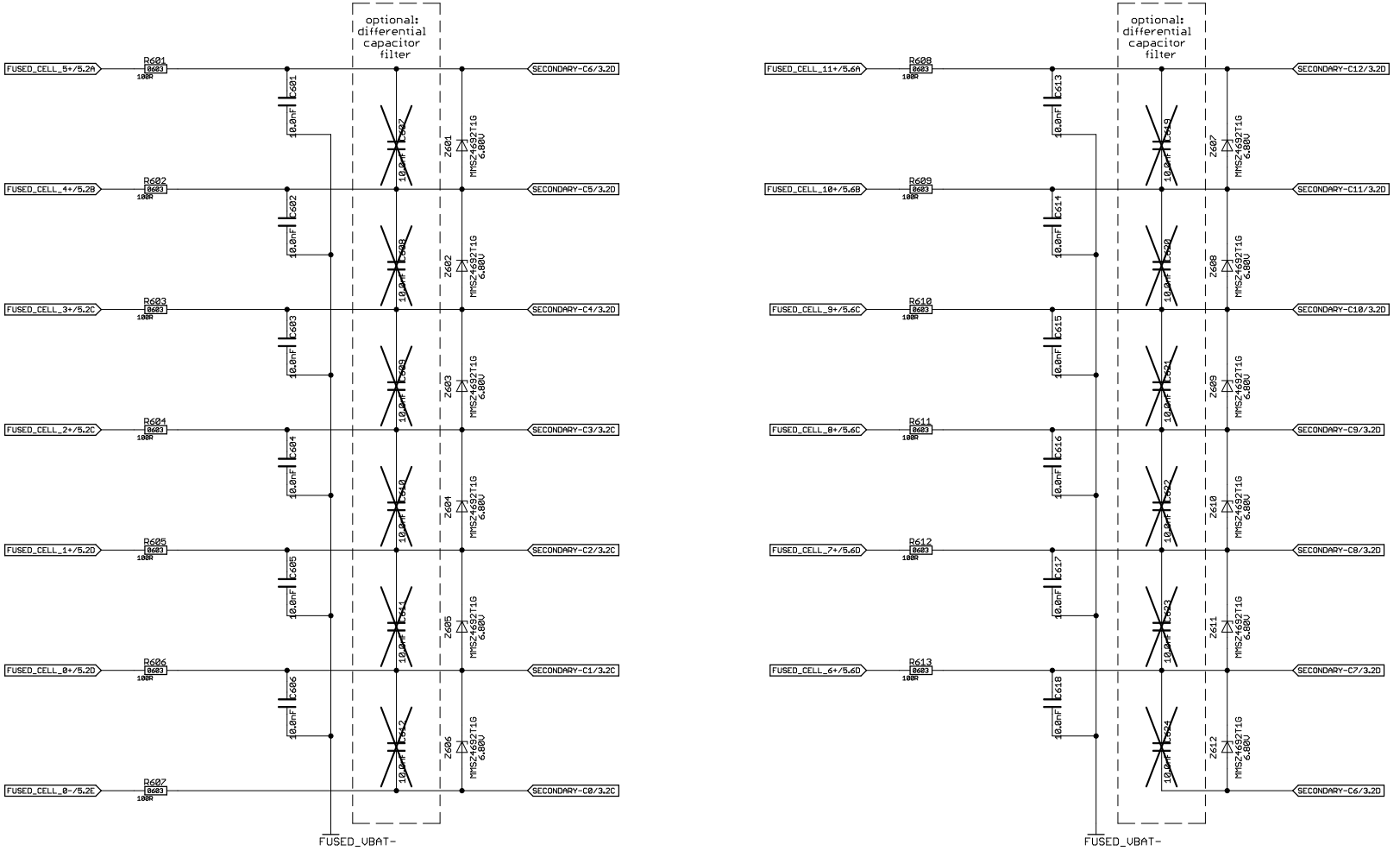


-3dB corner frequency of LTC6804 internal digital low-pass filter:
fast mode: 27kHz
normal mode: 6.8kHz
filtered mode: 26Hz

Grounded capacitor low-pass filter:
C = 100nF -> fg = 16kHz
C = 22nF -> fg = 72kHz
C = 10nF -> fg = 160kHz (recommended)

Differential capacitor low-pass filter (lower cost):
C = 100nF -> fg = 11kHz
C = 22nF -> fg = 50kHz
C = 10nF -> fg = 112kHz

TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Primary Voltage Measurement		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 5/17

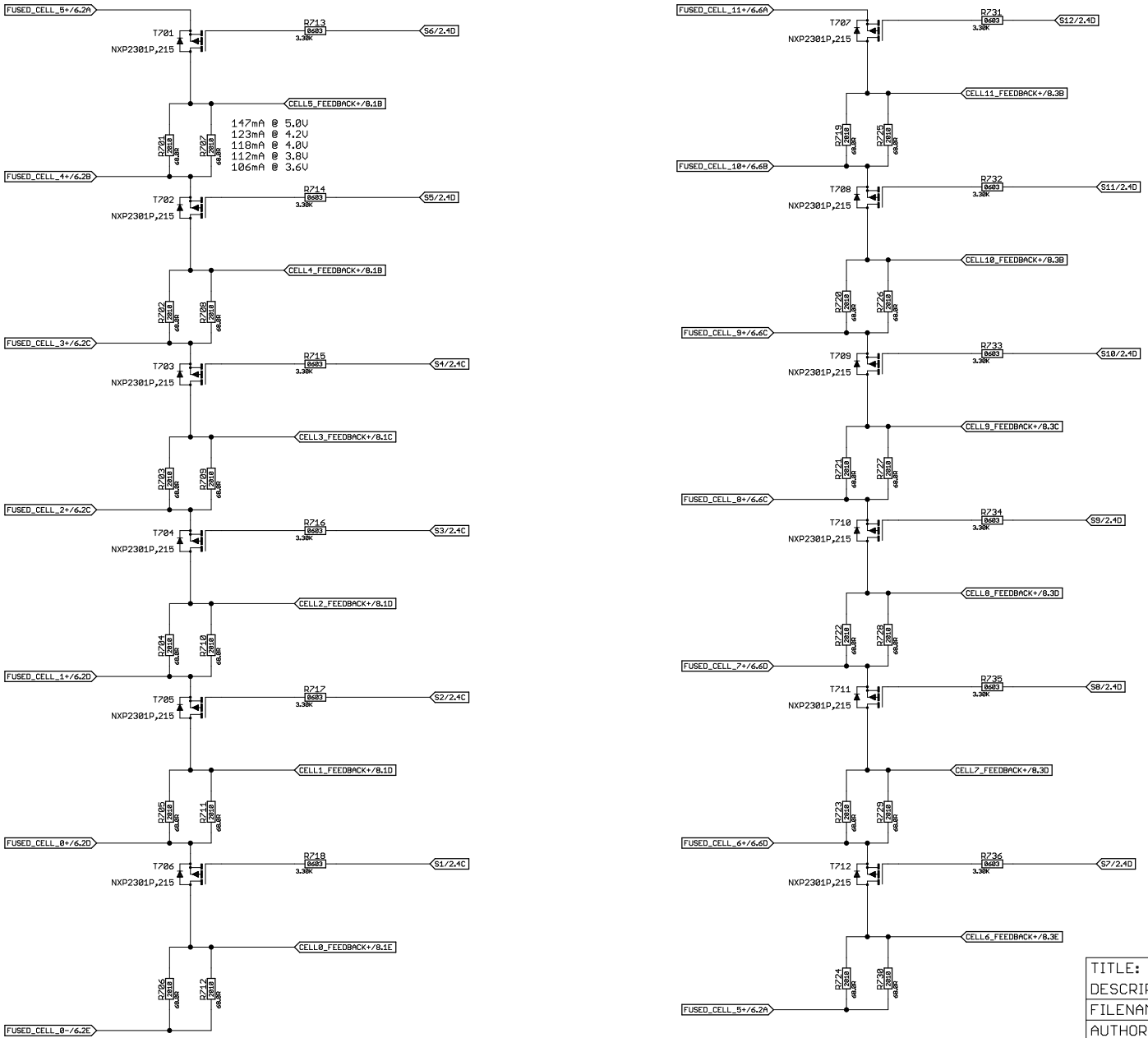


-3dB corner frequency of LTC6804 internal digital low-pass filter:
fast mode: 27kHz
normal mode: 6.8kHz
filtered mode: 26Hz

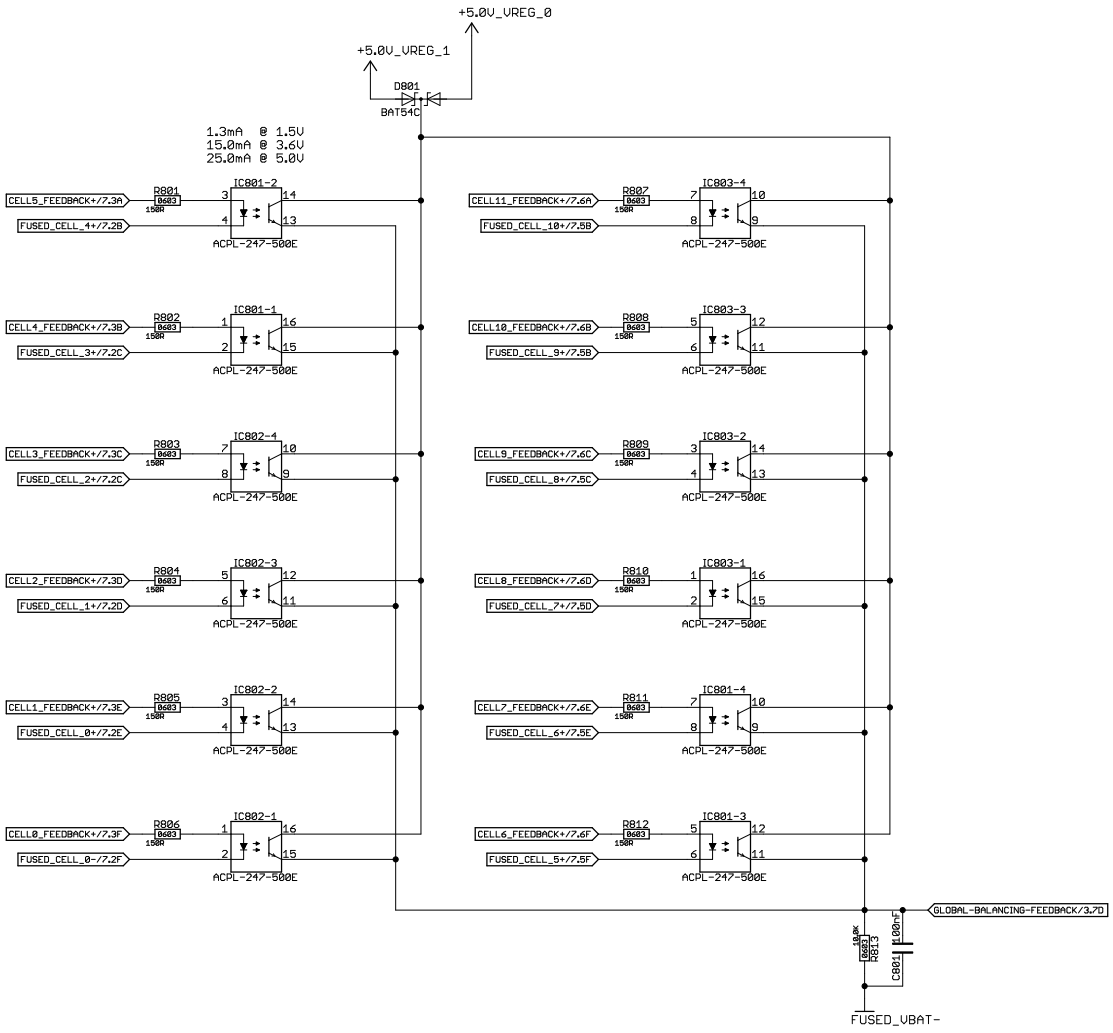
Grounded capacitor low-pass filter:
C = 100nF -> fg = 16kHz
C = 22nF -> fg = 72kHz
C = 10nF -> fg = 160kHz (recommended)

Differential capacitor low-pass filter (lower cost):
C = 100nF -> fg = 11kHz
C = 22nF -> fg = 50kHz
C = 10nF -> fg = 112kHz

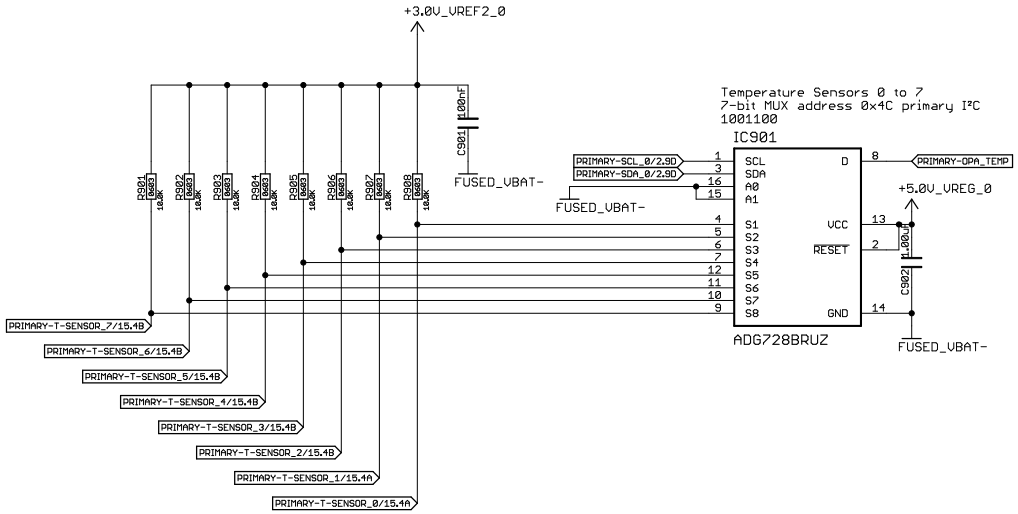
TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Secondary Voltage Measurement		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 6/17

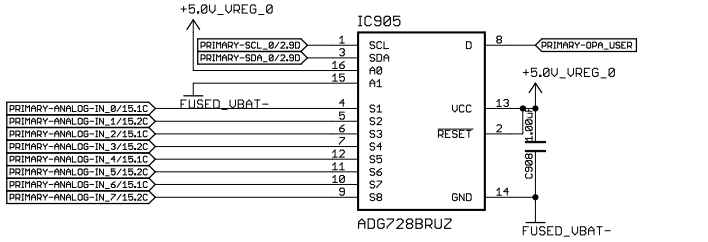


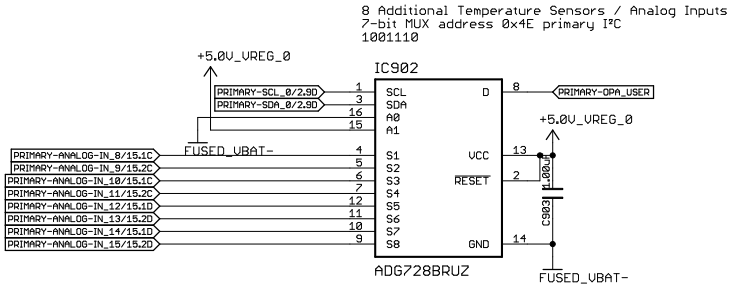
TITLE: foxBMS BMS-Slave 12-Cell DESCRIPTION: Passive Cell Balancing		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 7/17

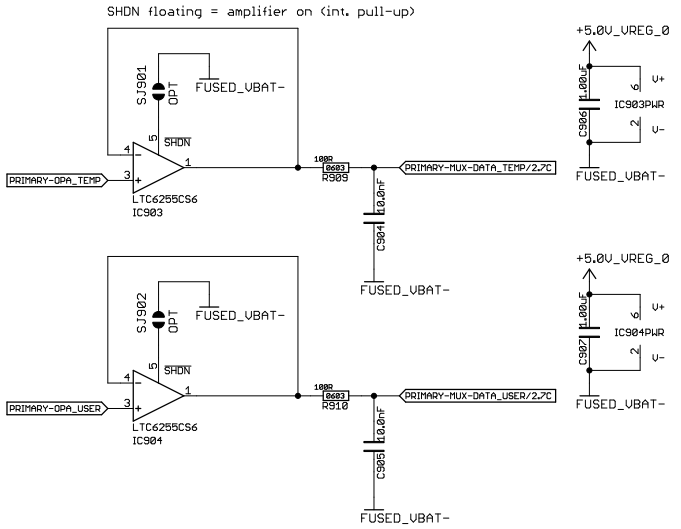


TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Passive Balancing Feedback		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 8/17

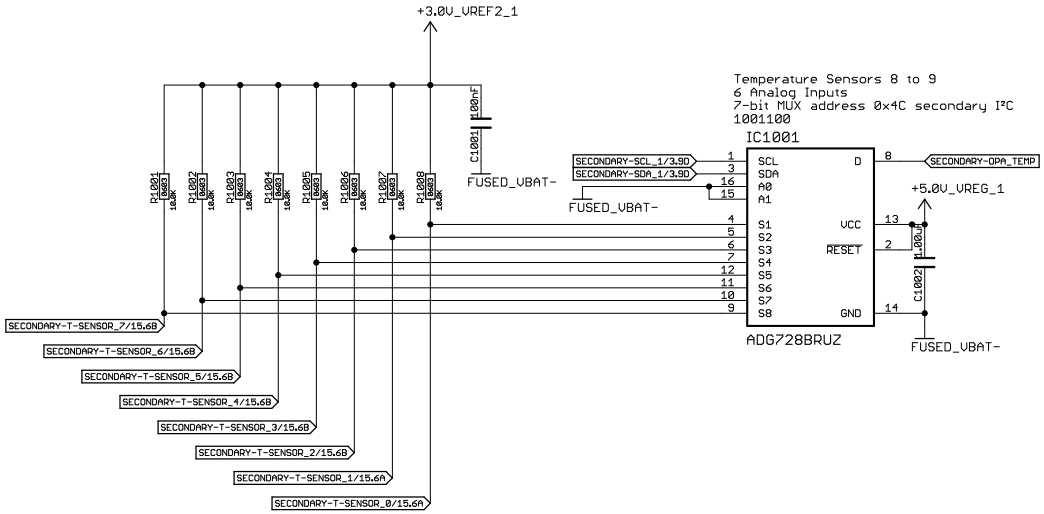


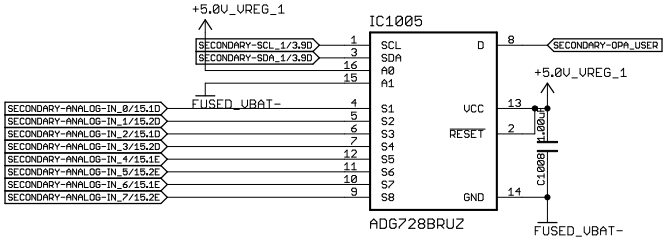


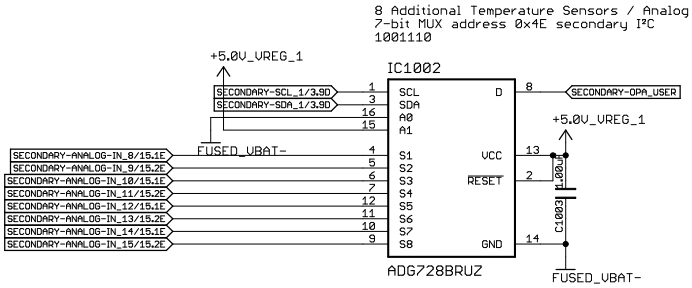


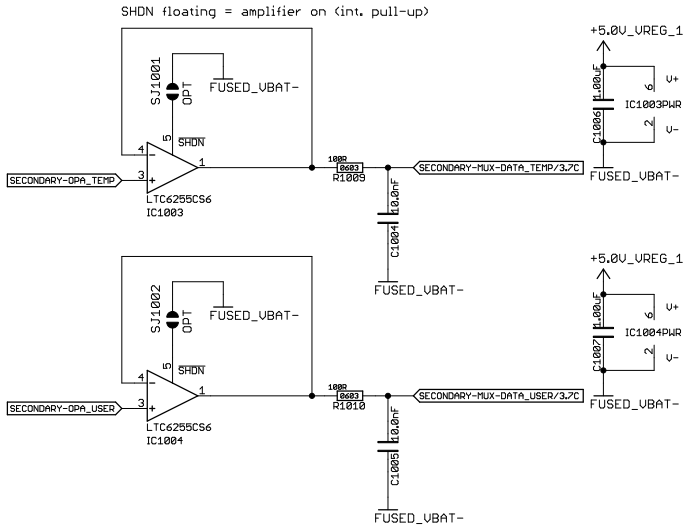


TITLE: foxBMS BMS-Slave 12-Cell DESCRIPTION: Primary Analog Inputs		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 9/17

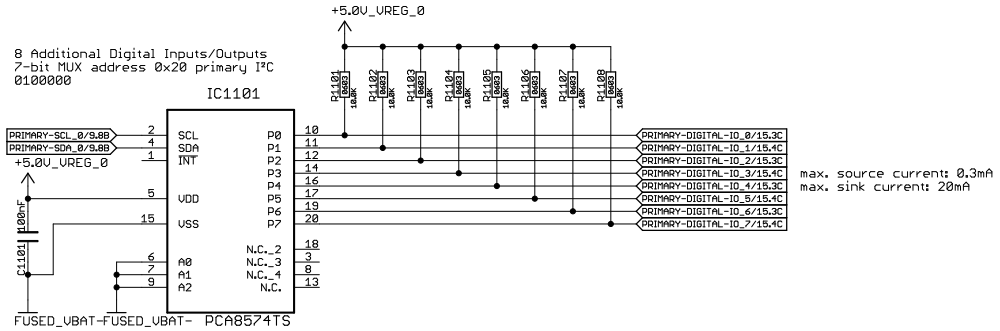




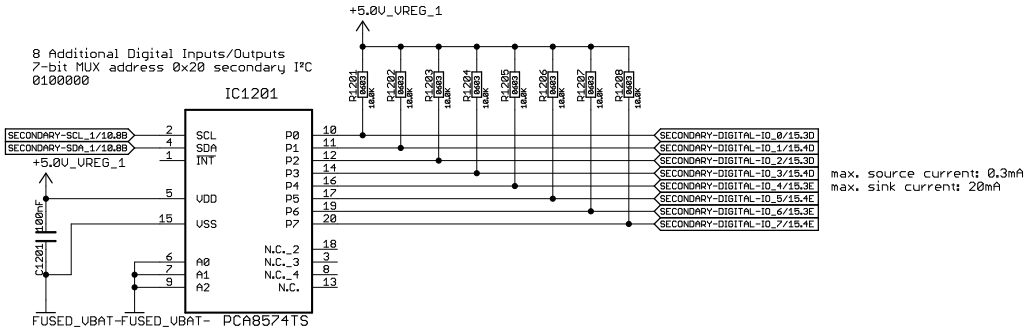




TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Secondary Analog Inputs		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 10/17

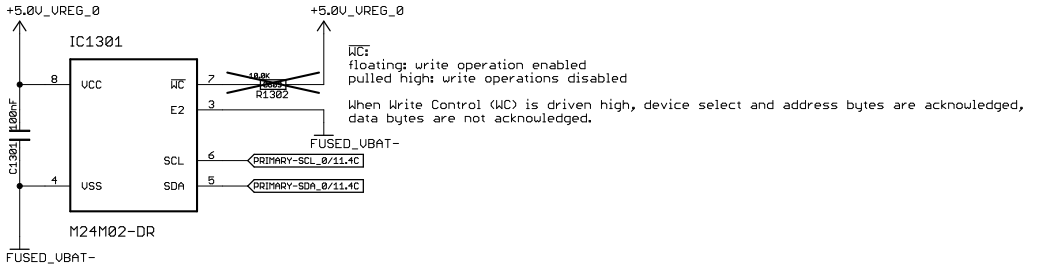


TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Primary Digital Inputs/Outputs		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 11/17

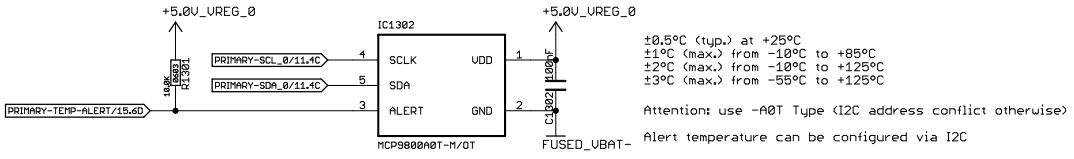


TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Secondary Digital Inputs/Outputs		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 12/17

EEPROM
7-bit base address 0x50 primary I²C
10100 (A17) (A16)
A17, A16: MSB address bits

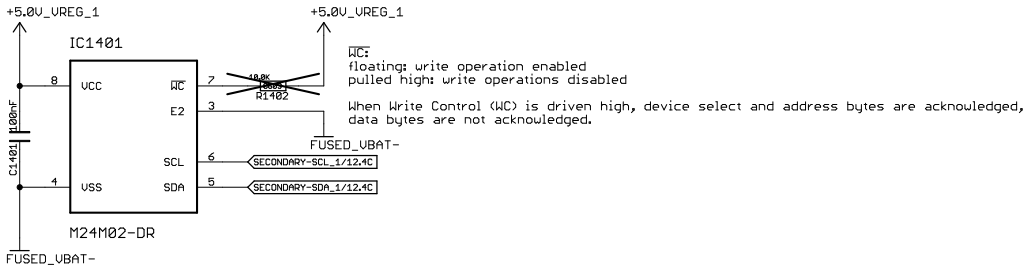


Temperature Sensor
7-bit address 0x48 primary I²C
1001000

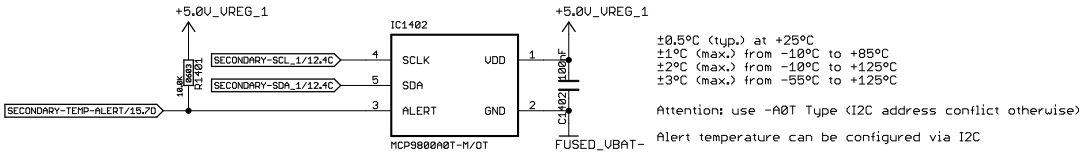


TITLE: foxBMS BMS-Slave 12-Cell DESCRIPTION: Primary EEPROM and Board T-Sensor		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 13/17

EEPROM
7-bit base address 0x50 secondary I²C
10100 (A17) (A16)
A17, A16: MSB address bits



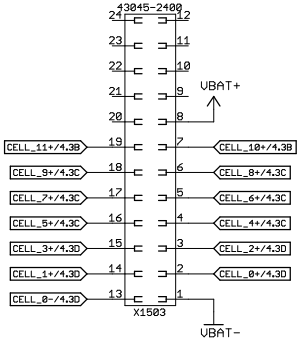
Temperature Sensor
7-bit address 0x48 secondary I²C
1001000



TITLE: foxBMS BMS-Slave 12-Cell DESCRIPTION: Secondary EEPROM and Board T-Sensor		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 14/17

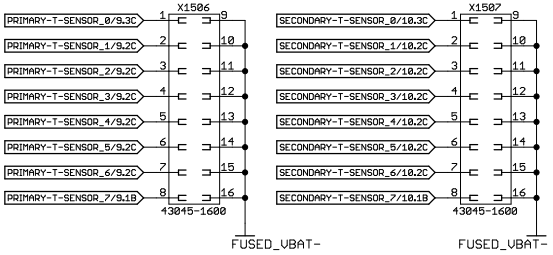
Batterie Cell Voltage Sense Connector

24p connector equal for 12/15/18/20 cell version



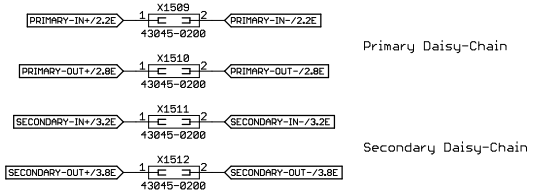
Temperature Sensor Connector

2x 16p connector equal for 12/15/18/20 cell version

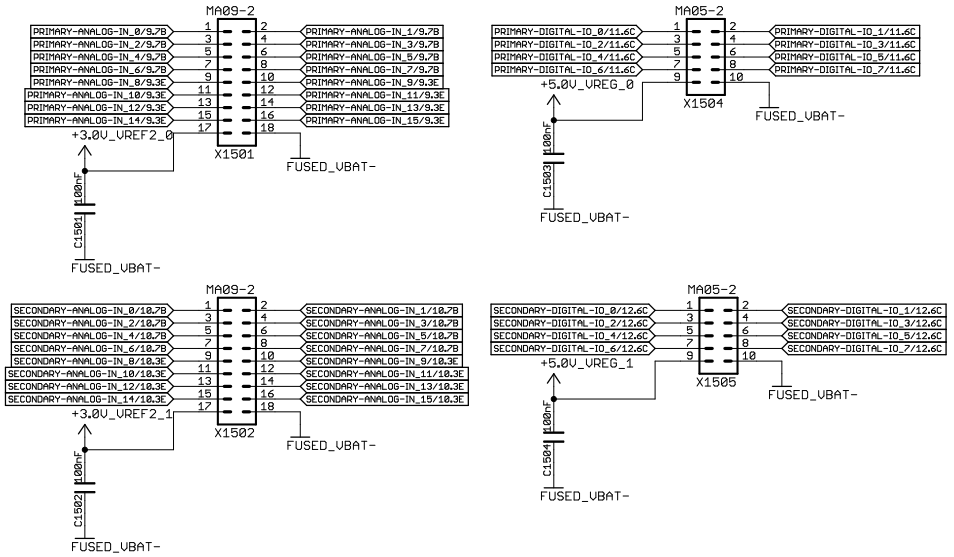


Daisy Chain Connectors

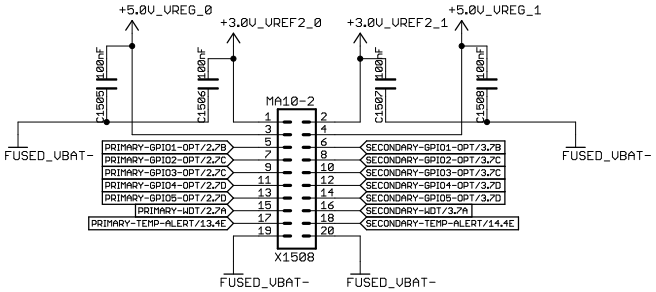
4x 2p connector equal for 12/15/18/20 cell version



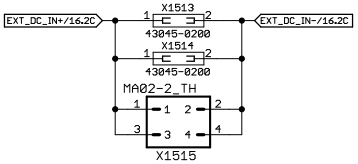
Pin-Header for additional analog and digital inputs/outputs



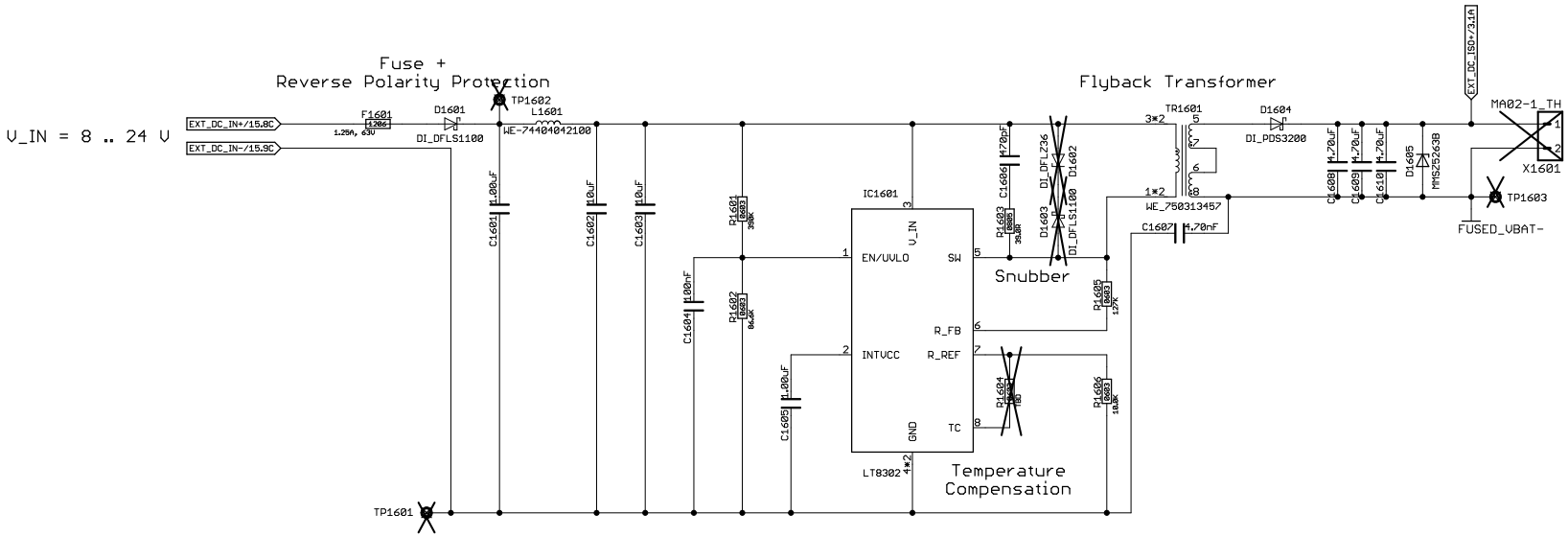
GPIO Extension Connector



External Power Supply



TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Connectors		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 15/17



TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: External Power Supply		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 16/17

Version	Date	Editor	Comment
2.0.0	2016-09-29	Sebastian Wacker	Initial Version
2.0.1	2016-11-15	Sebastian Wacker	Added missing cooling areas on bottom side, adjusted silk screen Enlarged PCB tracks, R201/202/301/302 other package Enlarged T201/301 cooling area Replaced PCF8574 with PCA8574 (400 kHz I2C)
2.0.2	2016-11-24	Sebastian Wacker	Replaced LTC1380 MUXs with ADG728 (400 kHz I2C) Adjusted connection of 100 ohm resistors for V+ / V_REG supply Reduced value of I2C pullups to 1k2
2.0.3	2017-04-13	Sebastian Wacker	Fixed isoSPI transformer CMC issue
2.1.0	2017-09-04	Sebastian Wacker	Added 8-24 V isolated external power supply Replaced I2C EEPROM 24AA02UID with M24M02-DR (ECC) Switched connection of balancing resistors from serial to parallel

Device	I2C Address (without R/W bit)	I2C clock
MUX Temp. Sens. 0-7	0x4C	400 kHz (max.)
MUX Analog In 0-7	0x4D	400 kHz (max.)
MUX Analog In 8-15	0x4E	400 kHz (max.)
Port Expander	0x20	400 kHz (max.)
EEPROM	0x50 (see manual for MSB addressing)	1 MHz (max.)
Board Temp. Sens.	0x48	400 kHz (max.)

TITLE: foxBMS BMS-Slave 12-Cell DESCRIPTION: Changelog		
FILENAME: foxBMS_BMS-Slave_12cell		
AUTHOR: Fraunhofer IISB foxBMS Team LICENSE: Creative Commons Attribution 4.0		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 17/17