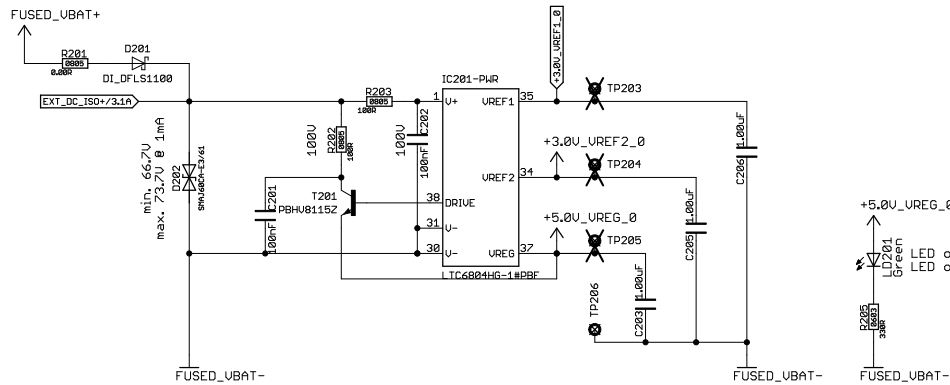
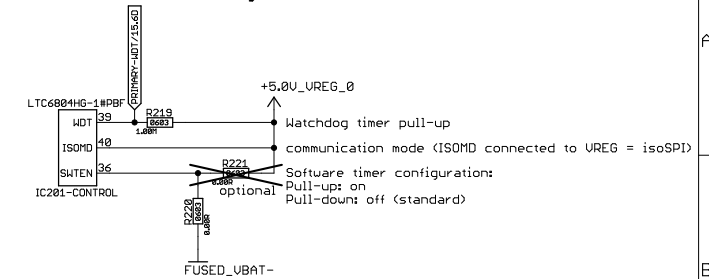


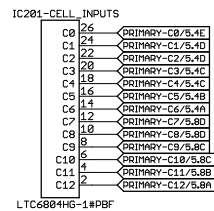
## Power Supply



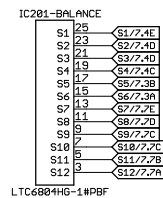
## Setting Pins



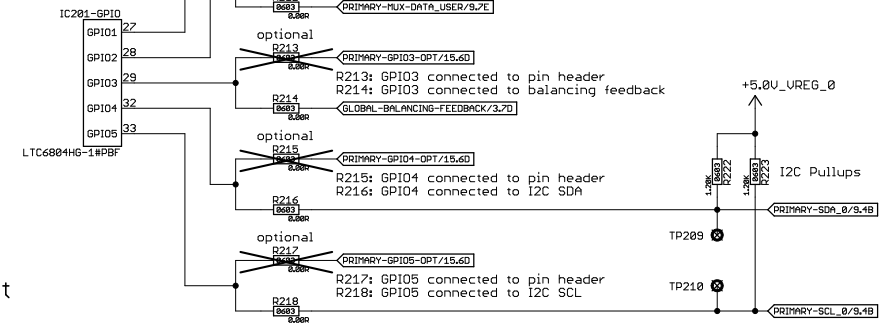
Cell voltage sense inputs



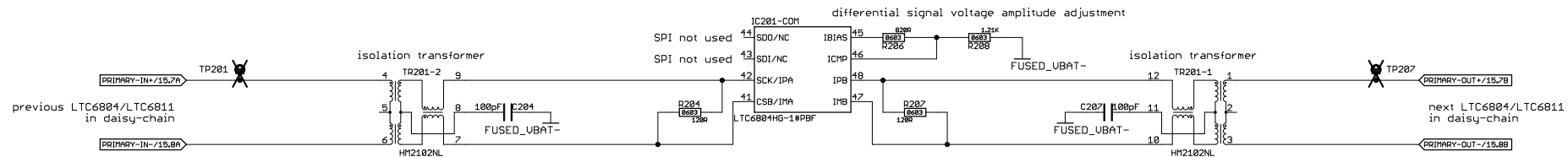
Cell balancing control



## GPIO Pins




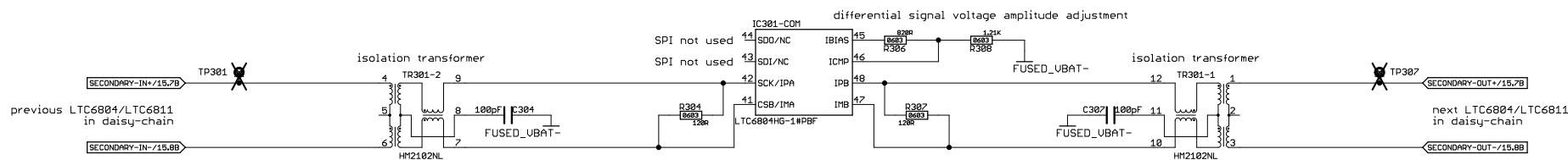
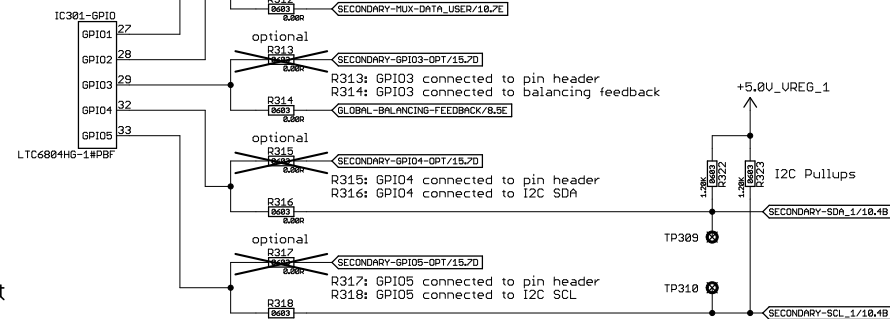
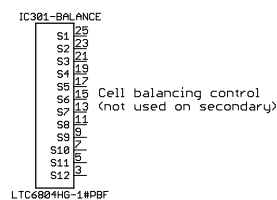
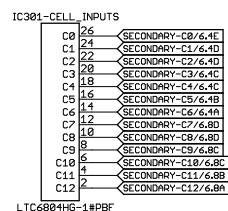
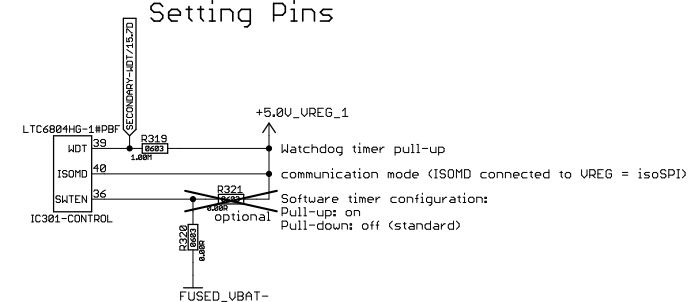
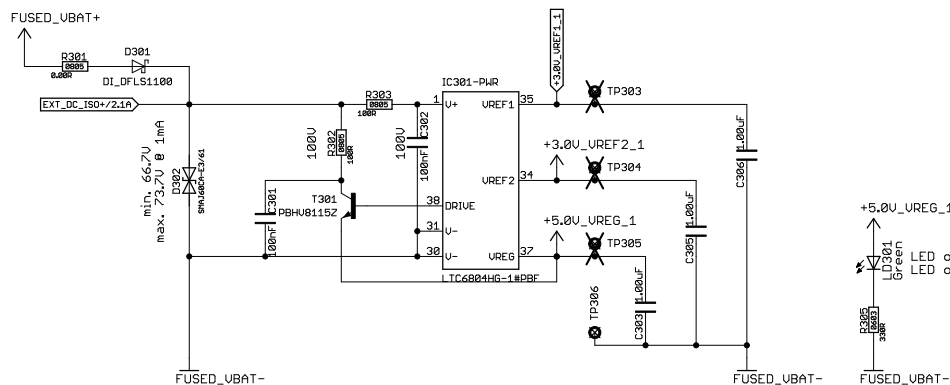
## Communication Circuit




Layout:

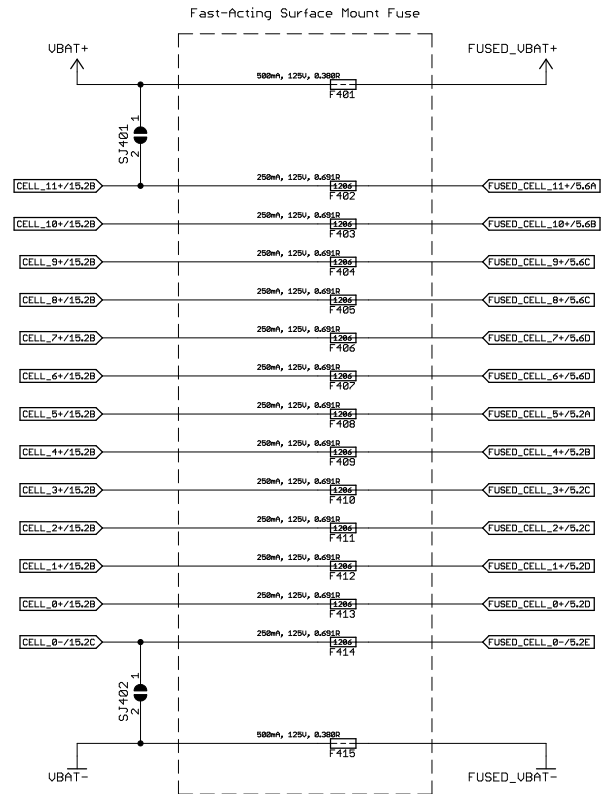
- The transformer should be placed as close to the isoSPI cable connector as possible.  
The distance should be kept less than 2cm.
- The LTC6804 should be placed at least 1cm to 2cm away from the transformer.
- On the top component layer, no ground plane should be placed under the transformer, the isoSPI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




- 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.
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No traces should cross the isoSPI signal lines, unless separated by a ground plane on an inner layer.

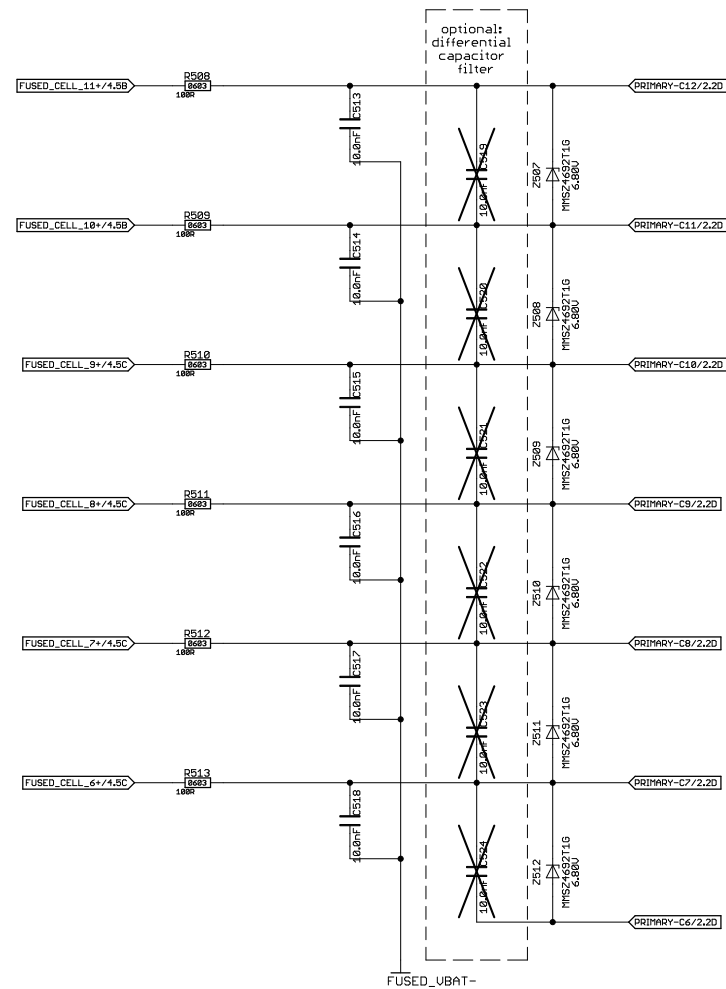
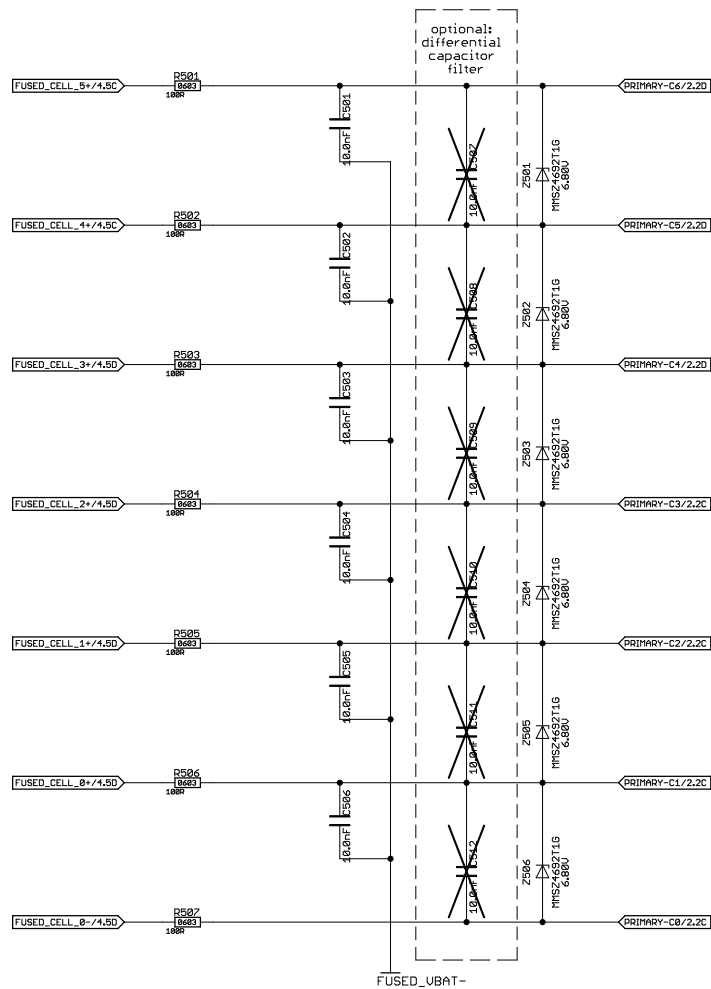
TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Secondary LTC6804/LTC6811		
FILENAME: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 3/17



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: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 4/17

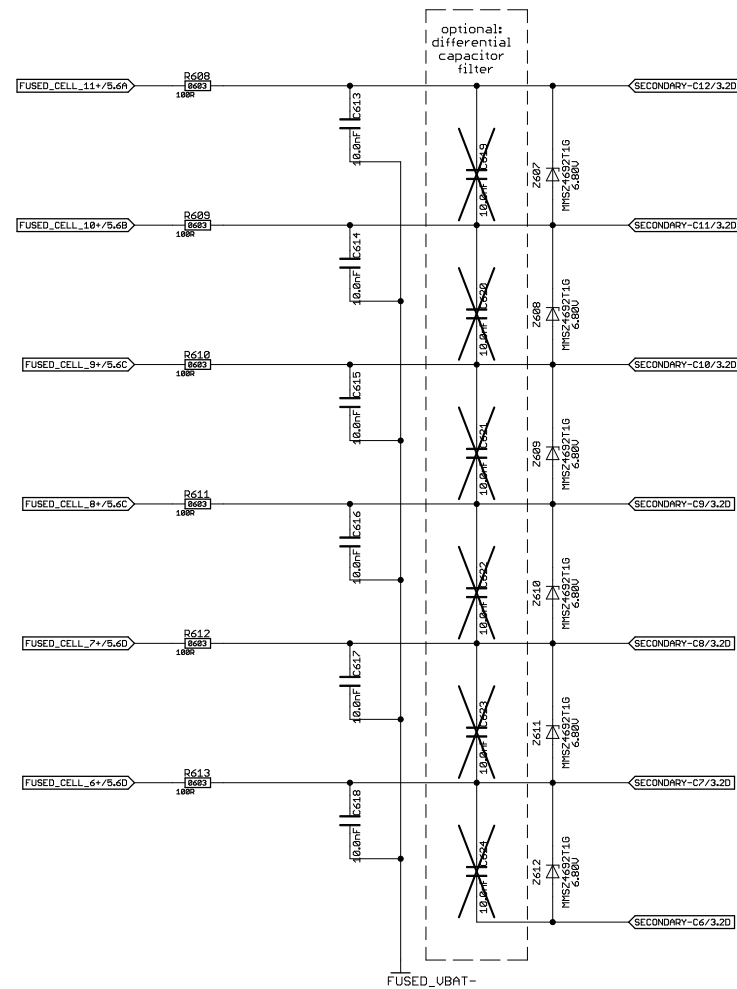
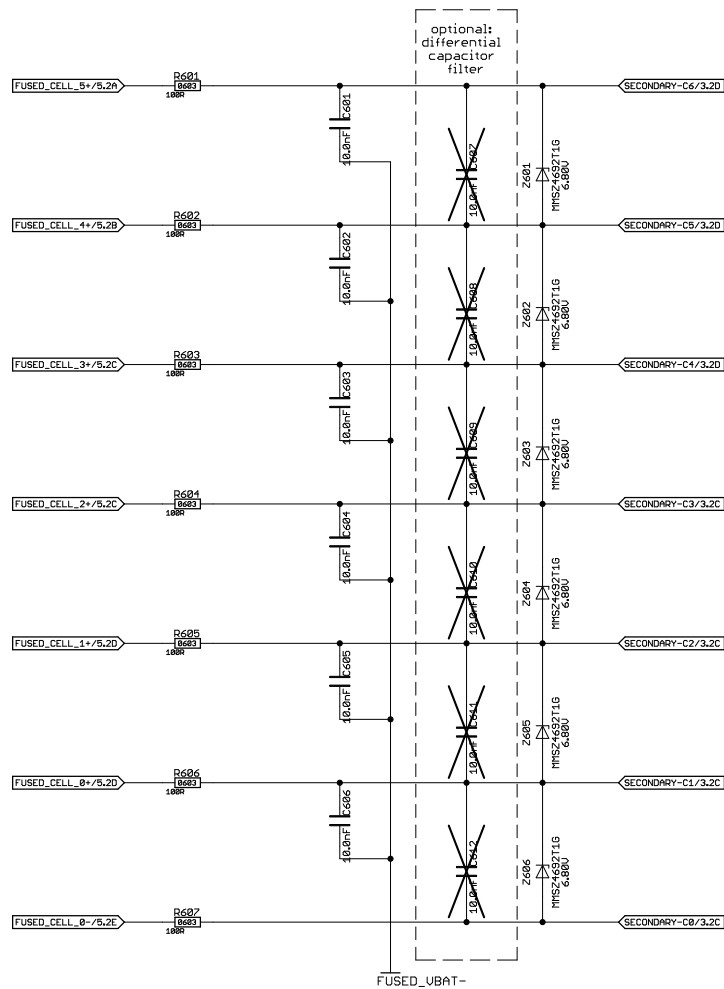


-3dB corner frequency of LTC6804 internal digital low-pass filter:  
fast mode: 27kHz  
normal mode: 6.8kHz  
filtered mode: 26Hz

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: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 5/17

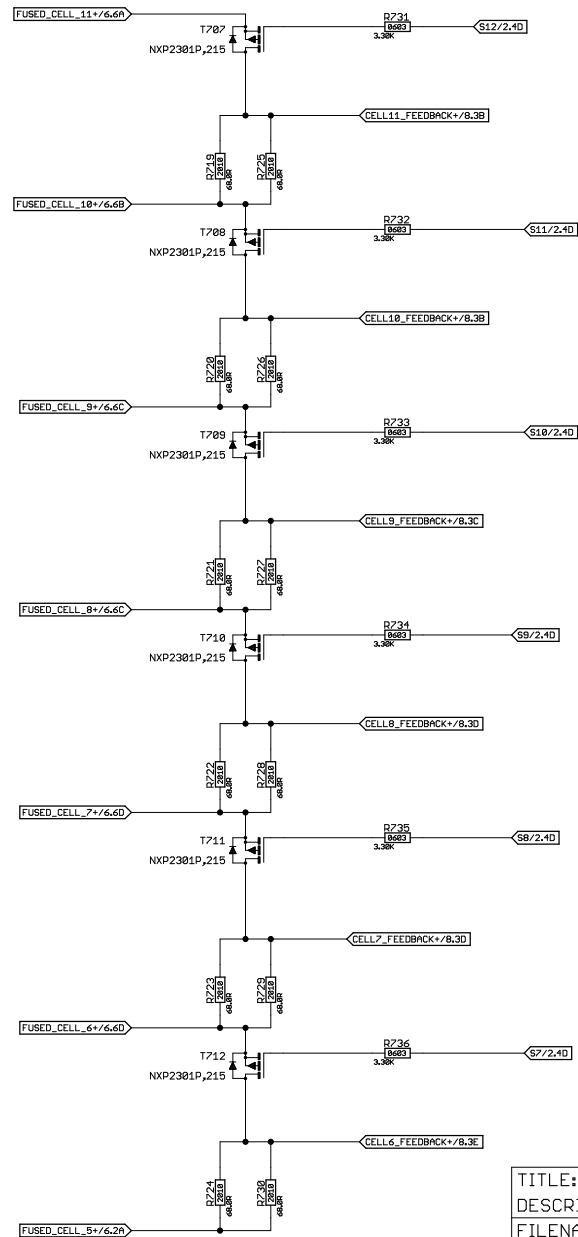
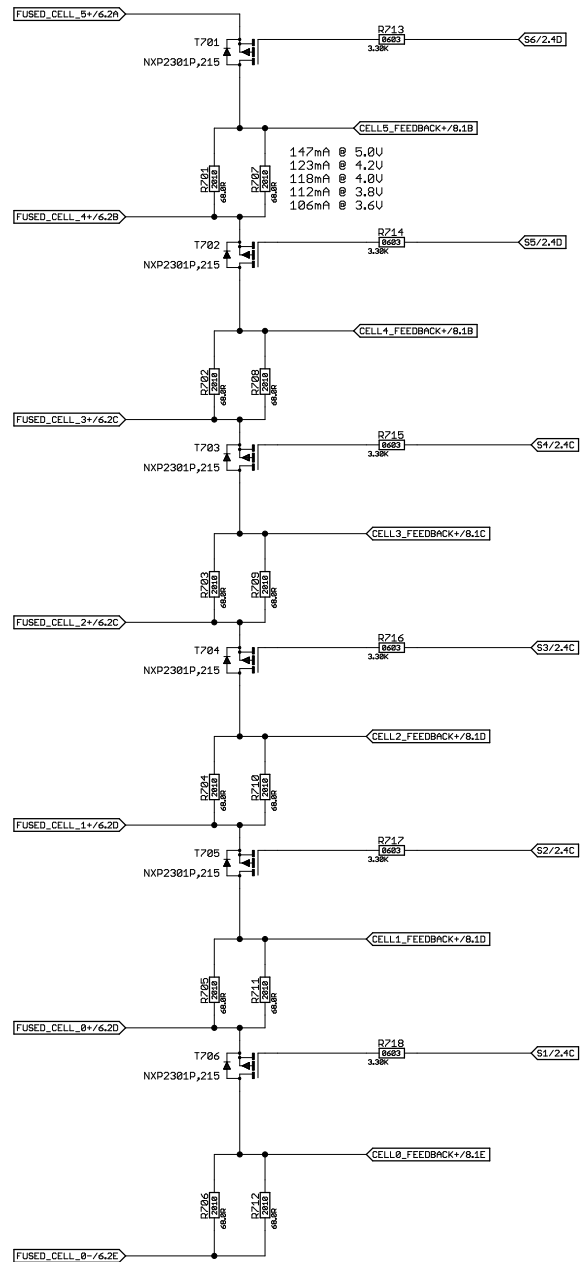



-3dB corner frequency of LTC6804 internal digital low-pass filter:  
 fast mode: 27kHz  
 normal mode: 6.8kHz  
 filtered mode: 26Hz

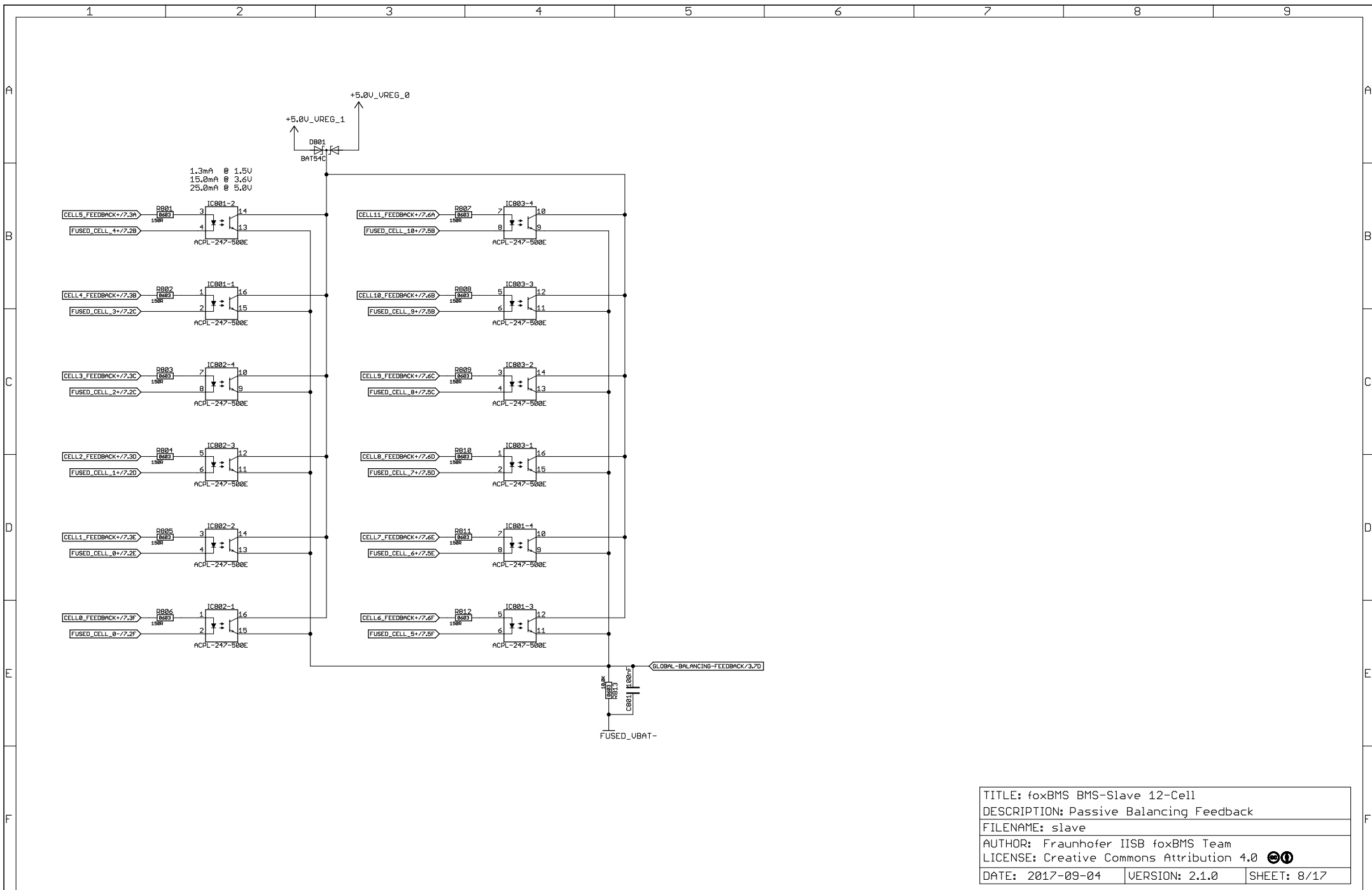
Grounded capacitor low-pass filter:  
 C = 100nF -> fg = 16kHz  
 C = 22nF -> fg = 72kHz  
 C = 10nF -> fg = 160kHz (recommended)


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: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 6/17

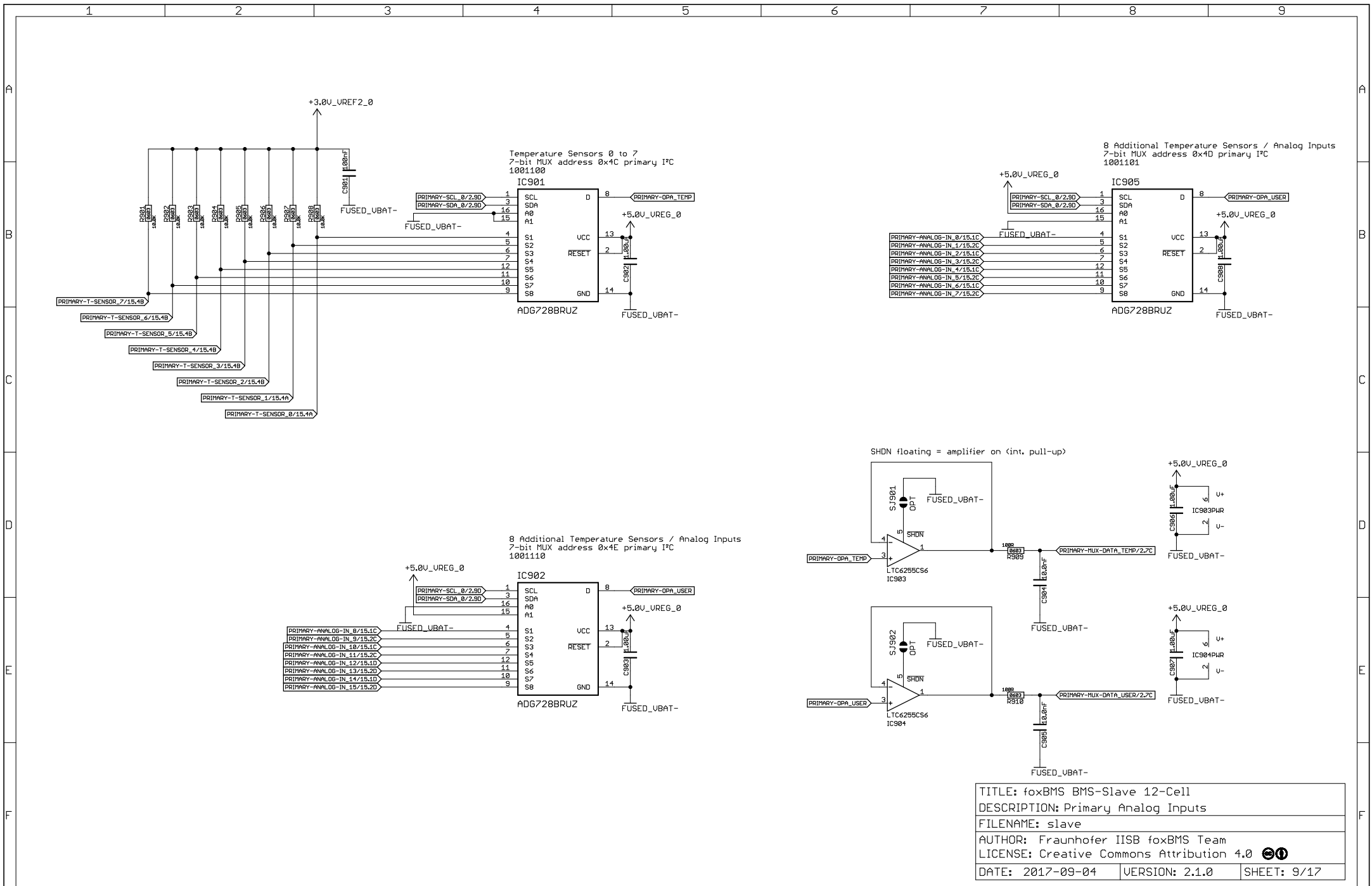


TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Passive Cell Balancing		
FILENAME: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 7/17

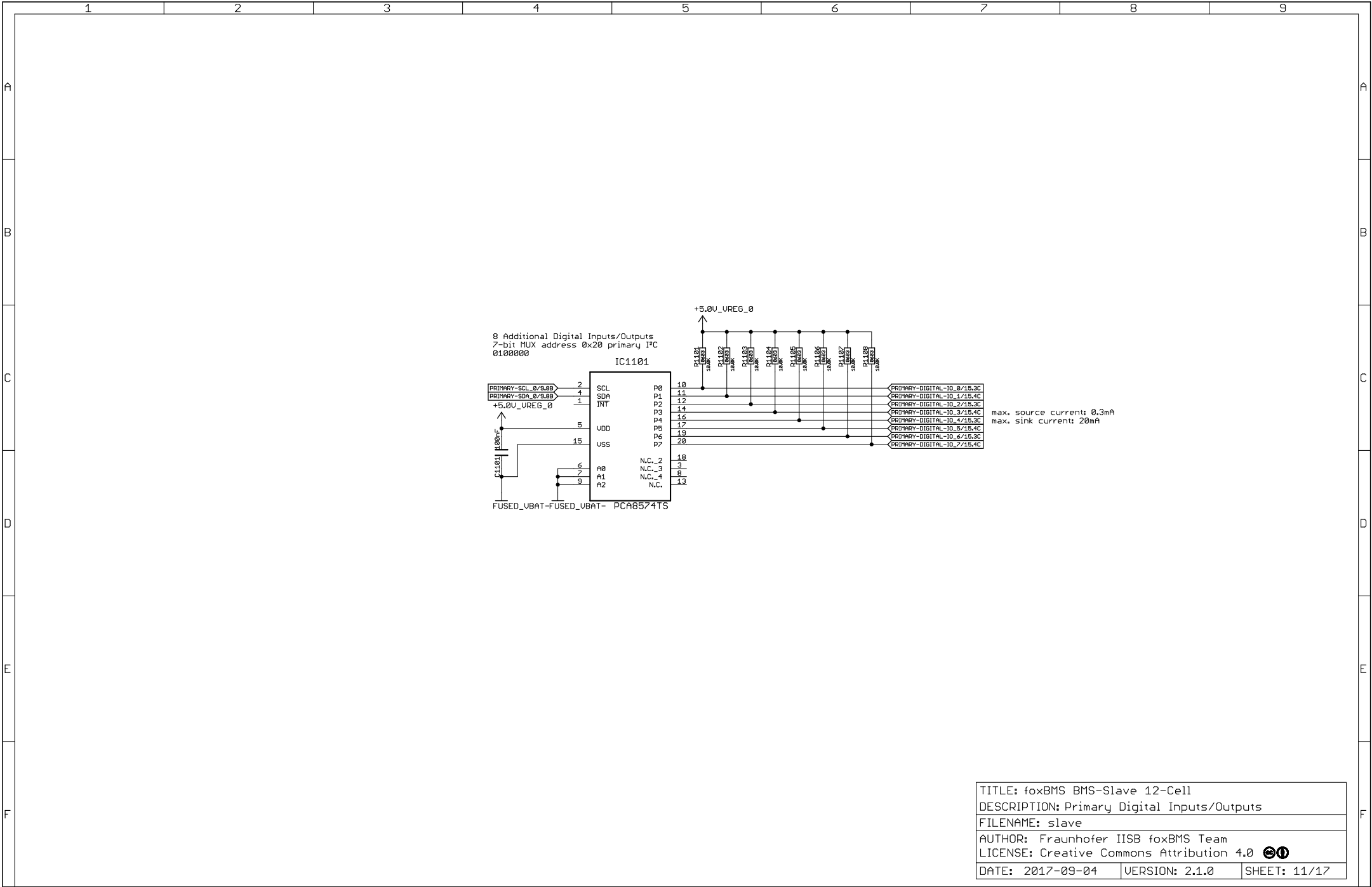


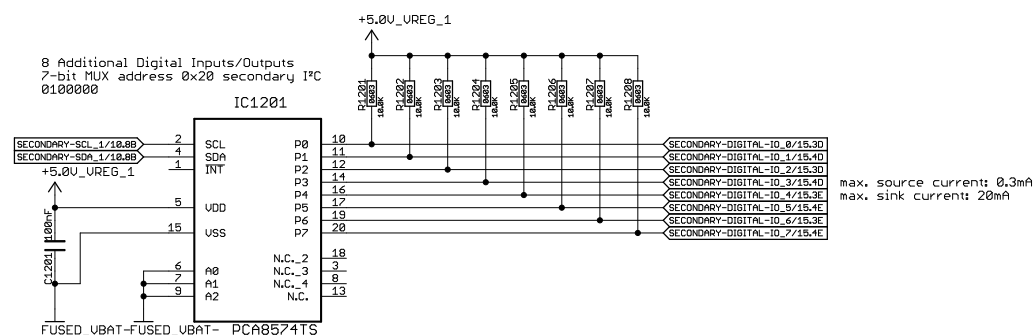
TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Passive Balancing Feedback		
FILENAME: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 8/17












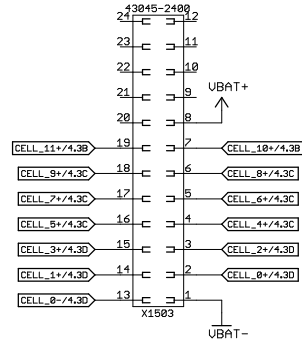
TITLE: foxBMS BMS-Slave 12-Cell		
DESCRIPTION: Secondary Digital Inputs/Outputs		
FILENAME: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 12/17





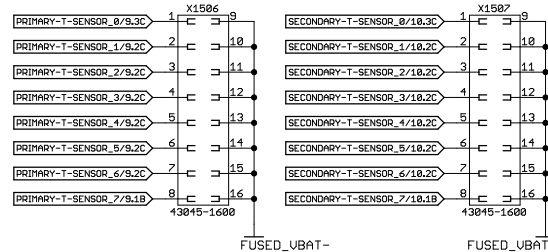
## Batterie Cell Voltage Sense Connector

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



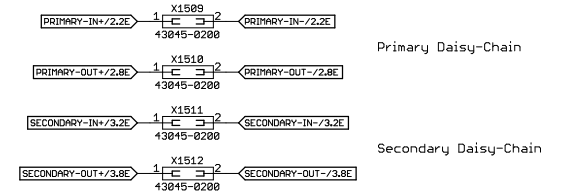
## Temperature Sensor Connector

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

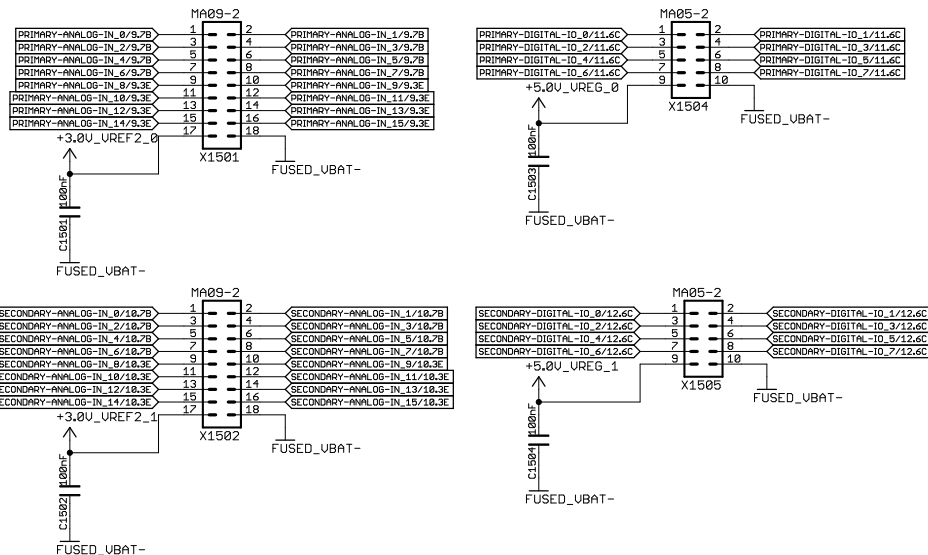


## Daisy Chain Connectors

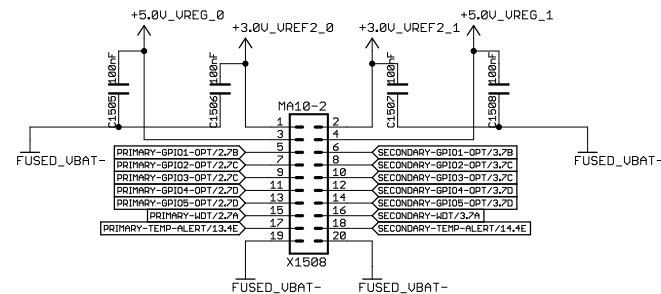
4x 2p connector equal for 12/15/18/20 cell version



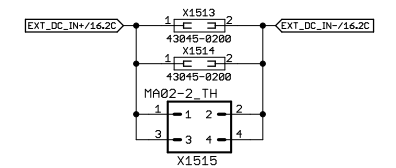
## Pin-Header for additional analog and digital inputs/outputs




## GPIO Extension Connector



## External Power Supply




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





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: slave		
AUTHOR: Fraunhofer IISB foxBMS Team		
LICENSE: Creative Commons Attribution 4.0 		
DATE: 2017-09-04	VERSION: 2.1.0	SHEET: 17/17