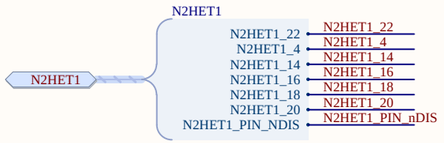
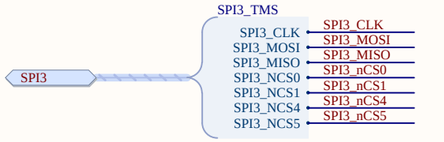
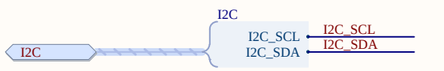
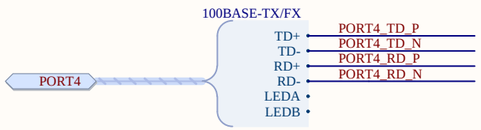
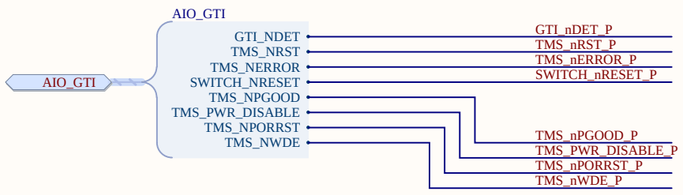
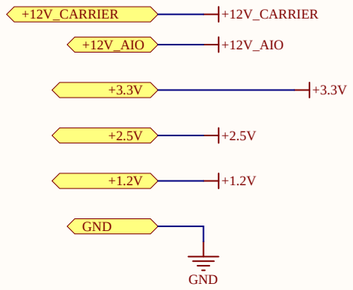


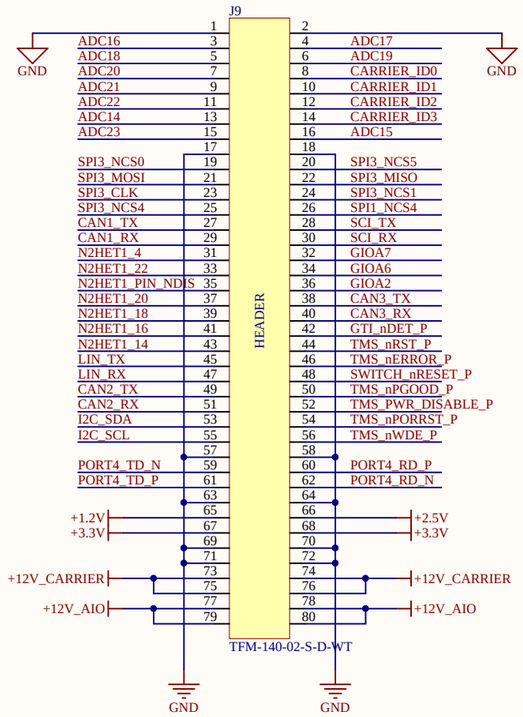


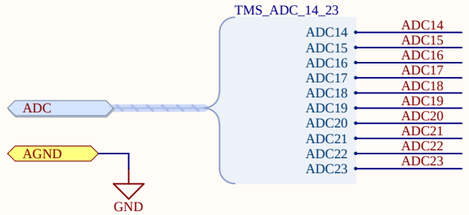










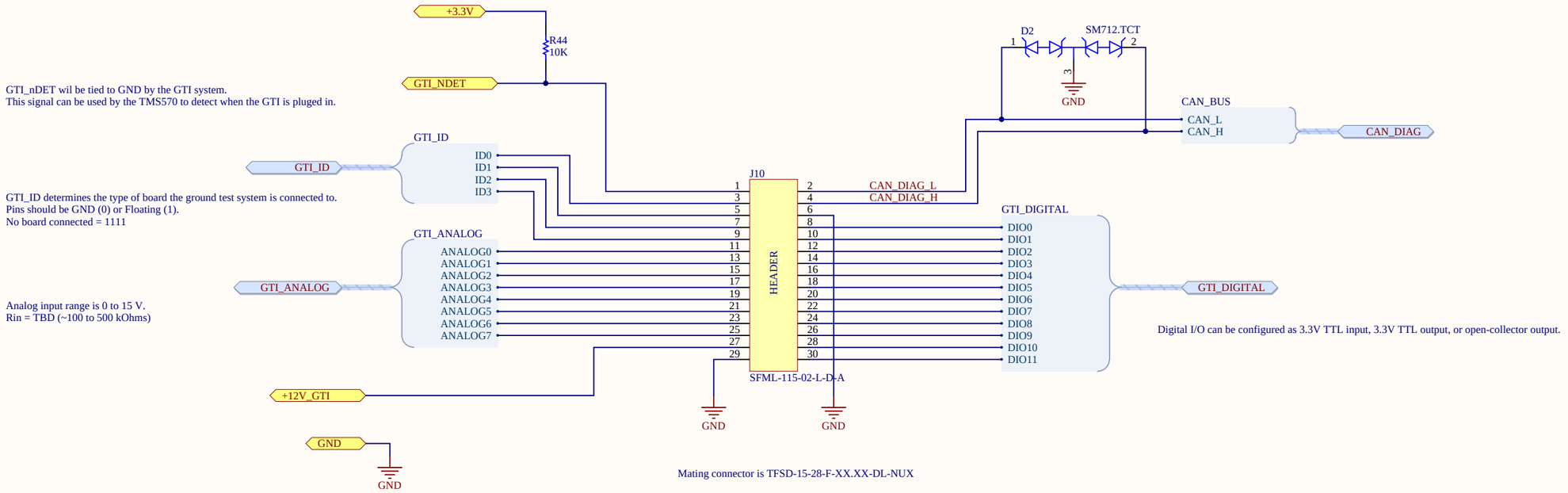


CARRIER_ID encodes the type of carrier board.
Pins should be grounded (0) or left floating (1).
No carrier board = 1111

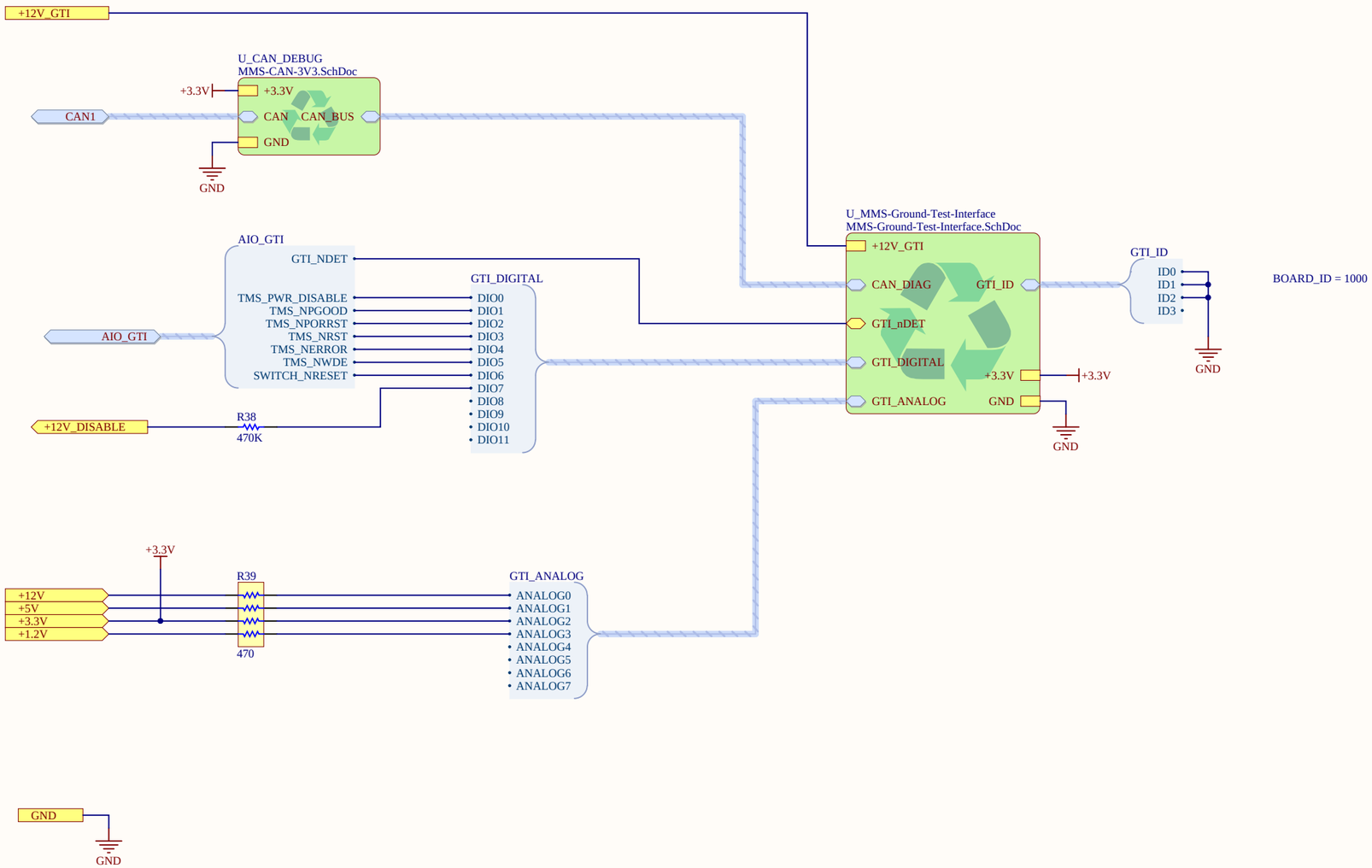
NOTES ON POWER

+1.2V: For monitoring only.
+2.5V: For PORT4 ethernet bias and monitoring only.
+3.3V: Limit current to 250 mA (needs verification).
+12V_CARRIER: Supplied by the carrier board to the AIO board.
+12V_AIO: Supplied by the AIO board to the carrier board.

Sheet Title: *AIO Module Interface*			**Makani Project**
Project Title: *BMB-AIO-Carrier.PrjPCB*			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 5/10/2016	Time: 2:41:02 PM	Sheet 7 of 13	*Alameda CA, 94501*
Author: EAC	File: MMS-AIO-Module-Interface.SchDoc		*USA*

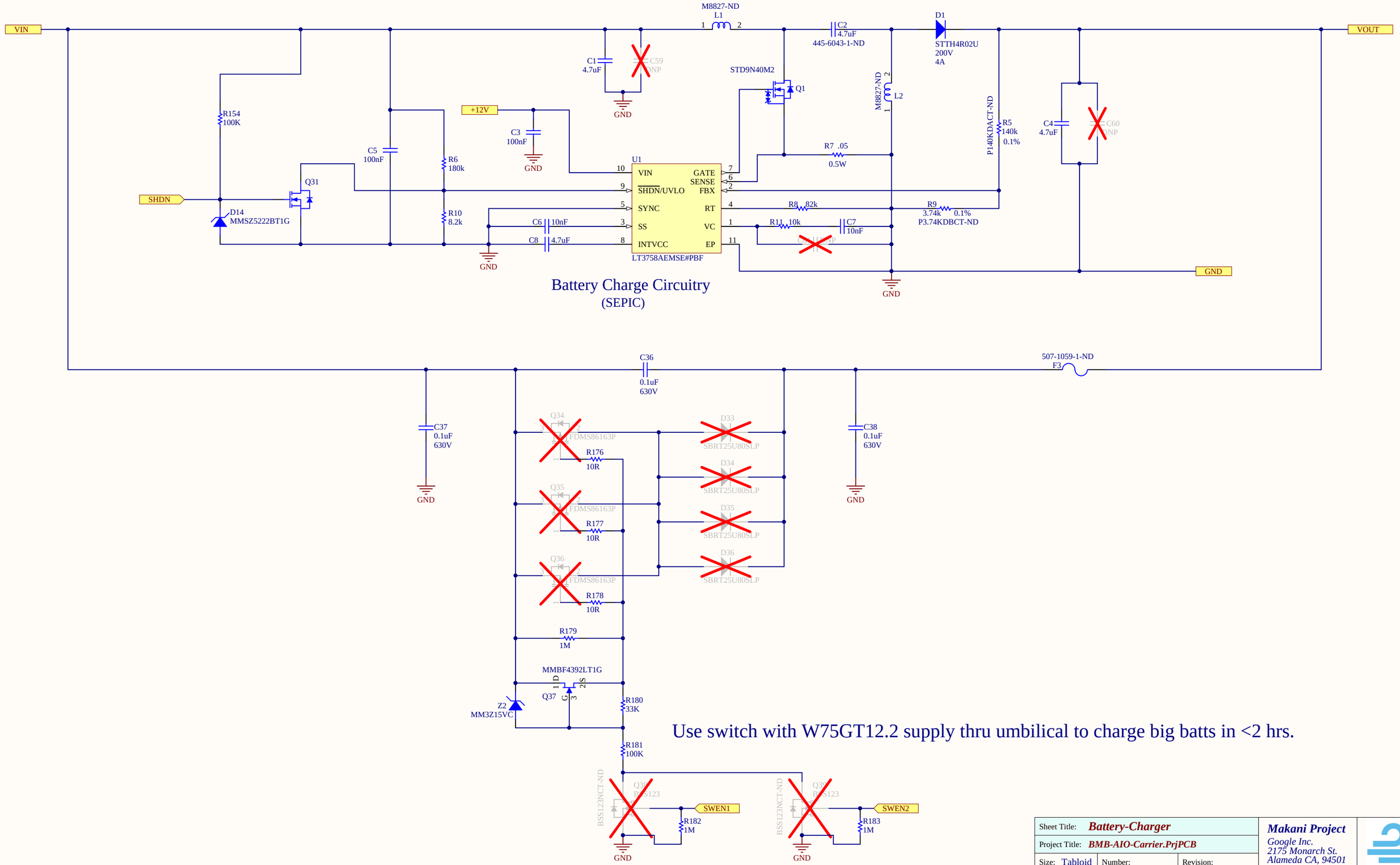


Sheet Title: *Ground Test Interface*		**Makani Project**
Project Title: *BMB-AIO-Carrier.PrjPCB*		*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number: / Revision:	
Date: 5/10/2016 Time: 2:41:03 PM	Sheet 8 of 21	
Author: EAC	File: MMS-Ground-Test-Interface.SchDoc	



Sheet Title:	***Ground Test Interface***		
Project Title:	***BMB-AIO-Carrier.PrjPCB***		
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:03 PM	Sheet 8 of 21	
Author: EAC	File: Ground_Test_Interface.SchDoc		

Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA



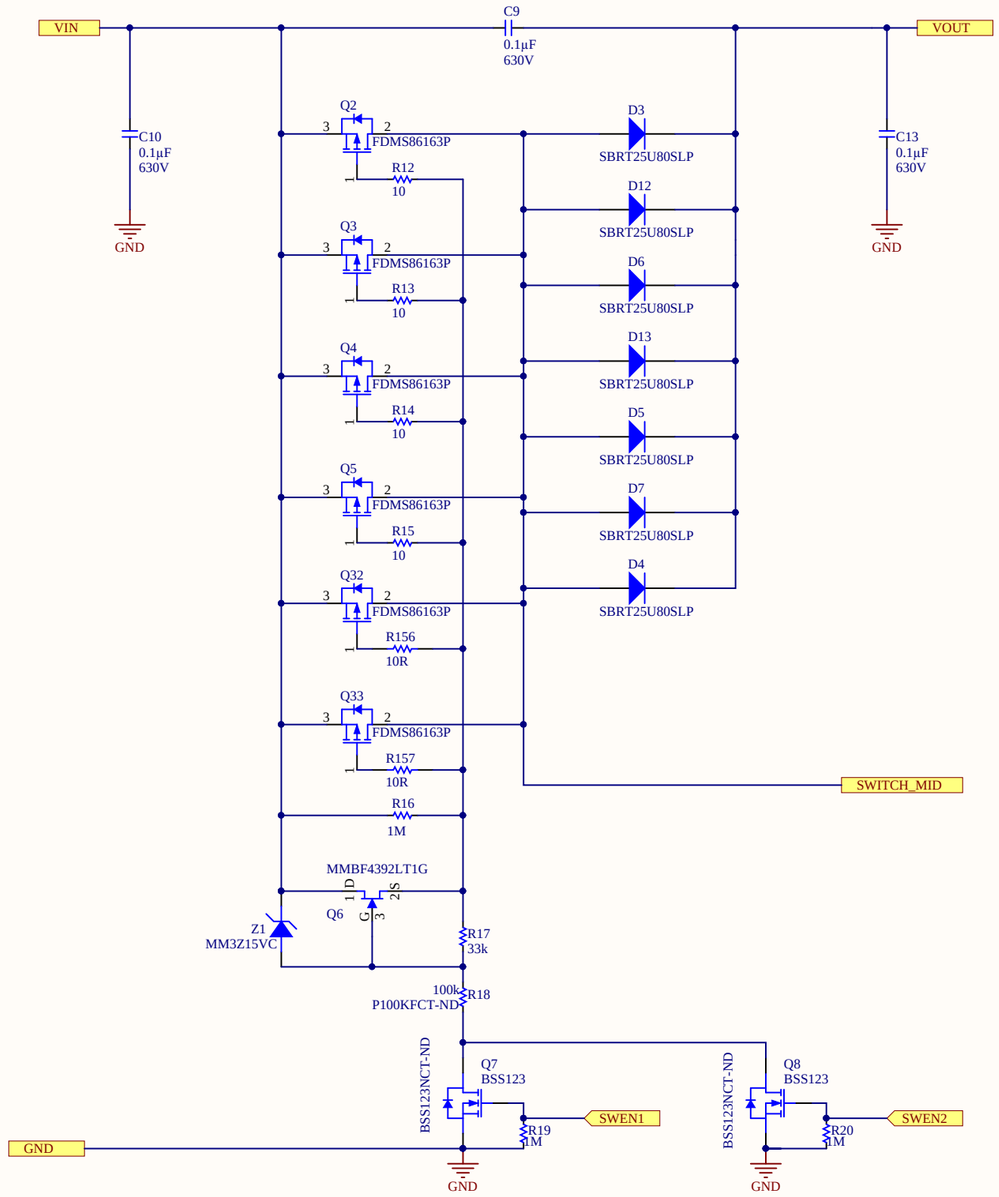
Battery Charge Circuitry
(SEPIC)

Use switch with W75GT12.2 supply thru umbilical to charge big batts in <2 hrs.

Sheet Title:	***Battery-Charger***		
Project Title:	***BMB-AIO-Carrier.PrjPCB***		
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:04 PM	Sheet * of *	
Author: *	File: Battery-Charger.SchDoc		

Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA

Battery Connection Switch

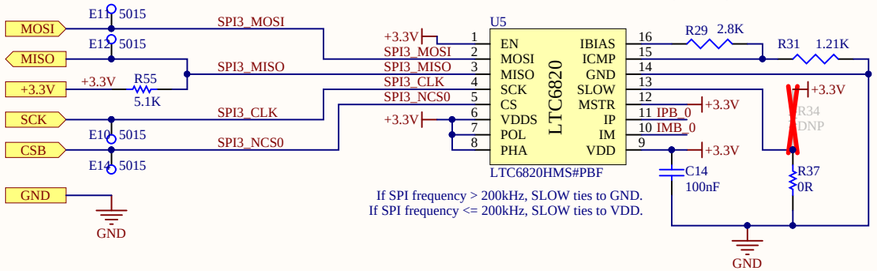


Sheet Title:	***Battery-Connection-Switch***		
Project Title:	***BMB-AIO-Carrier.PrjPCB***		
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:04 PM	Sheet * of *	
Author: *	File: Battery-Connection-Switch.SchDoc		

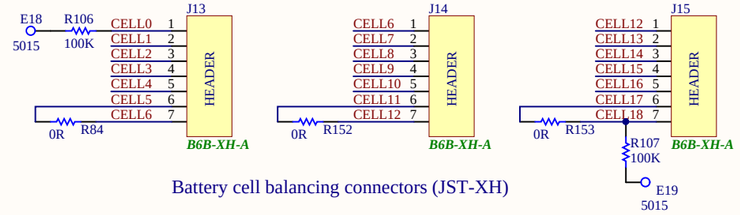
Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA

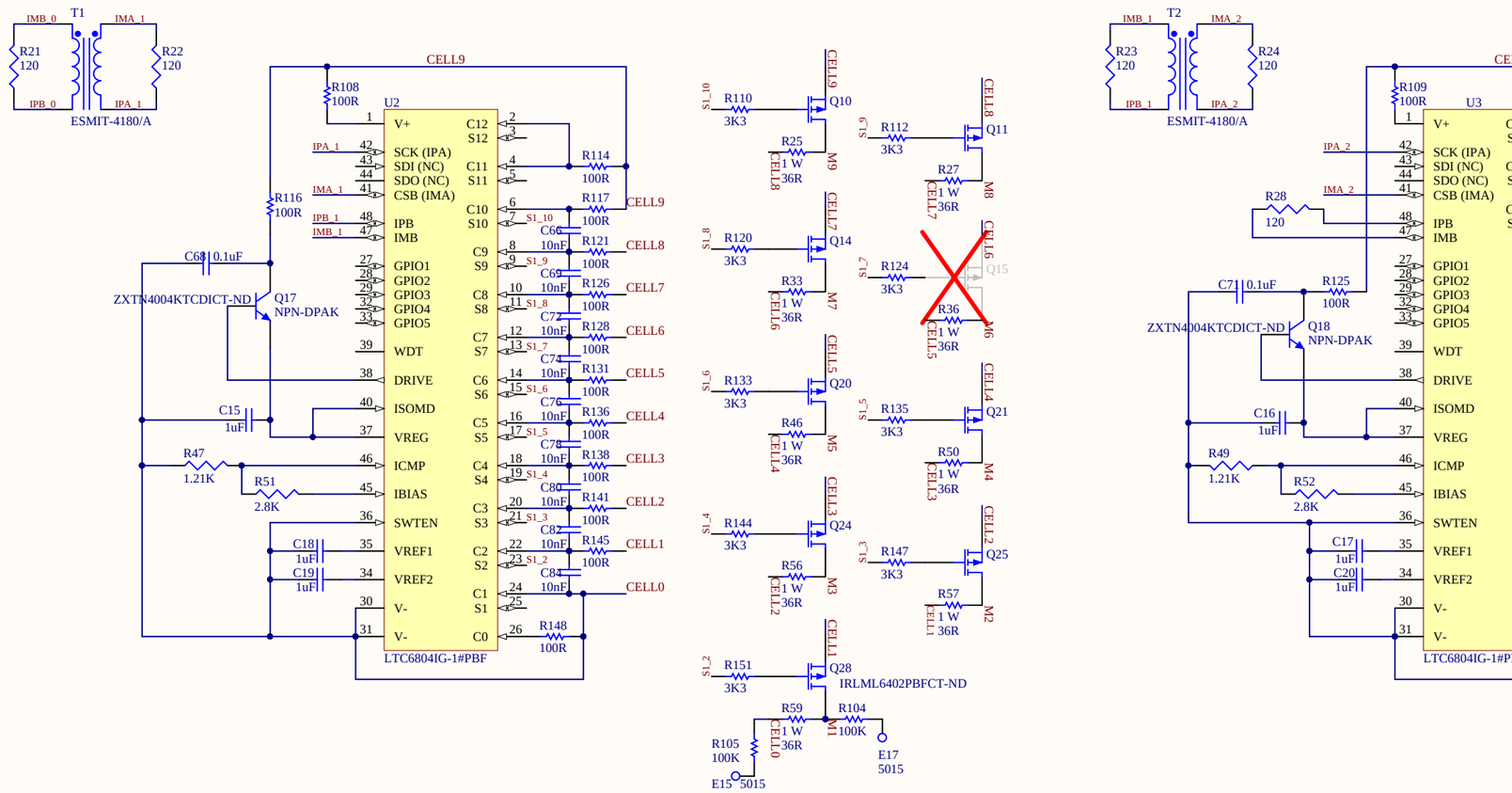
Cell Balancing

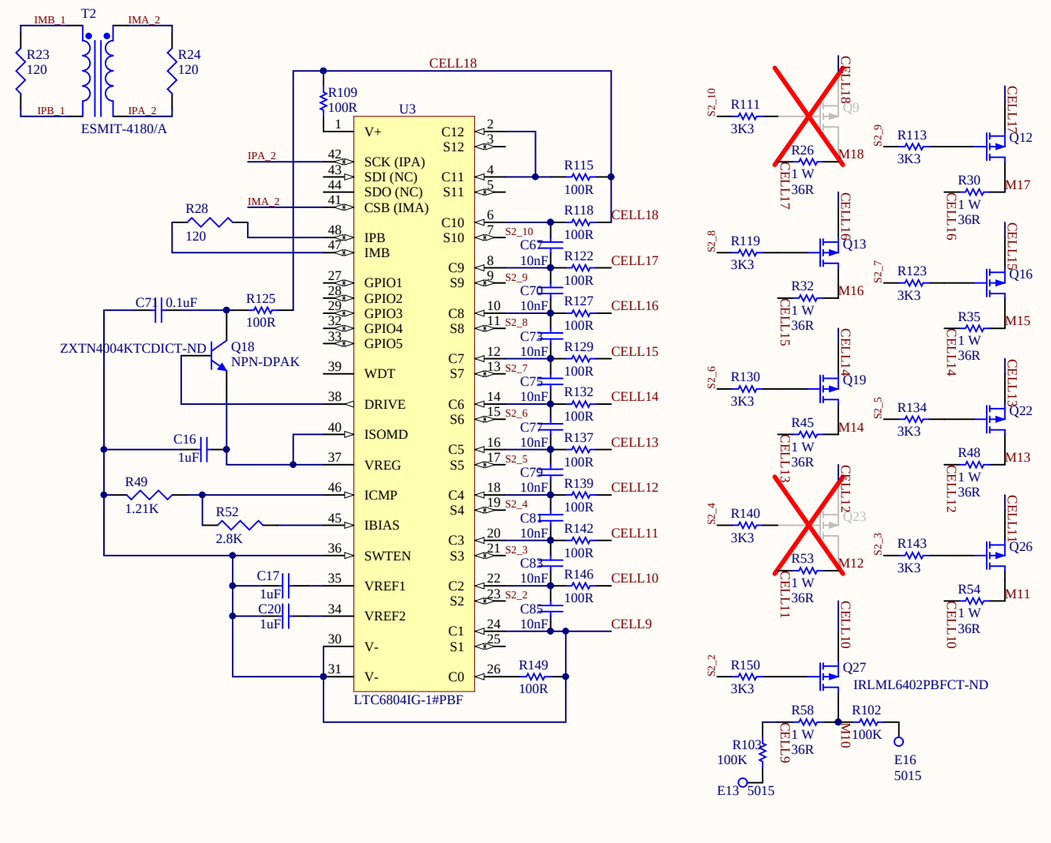
SPI to isolated communication (isoSPI)

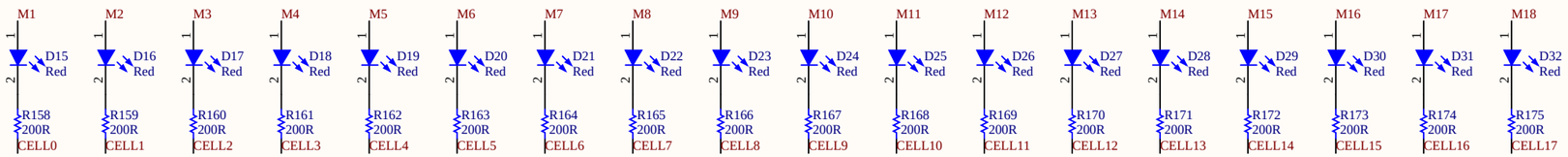


Battery cell balancing connectors (JST-XH)

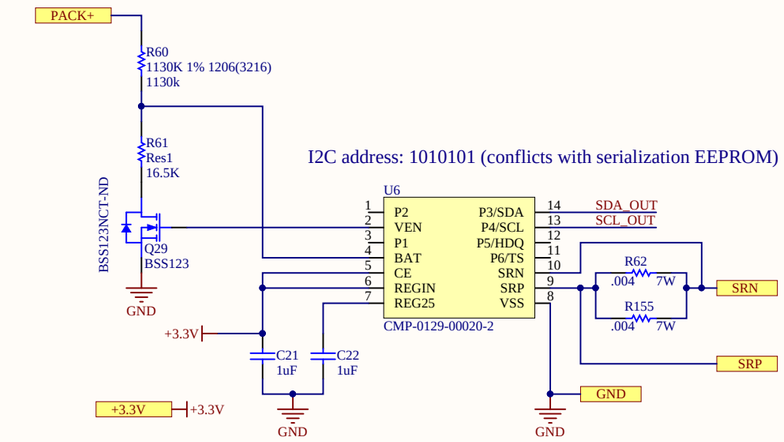




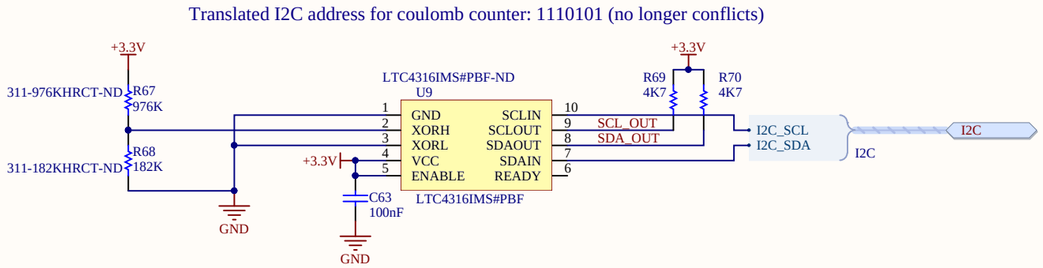




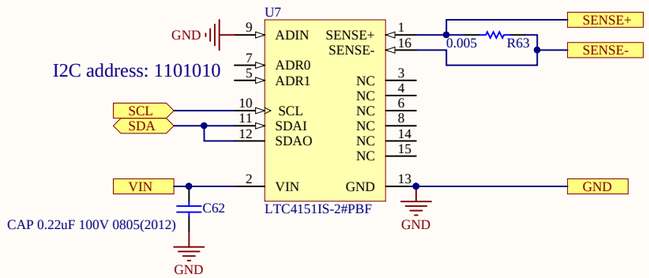
Sheet Title: *Cell-Balancing*			**Makani Project**
Project Title: *BMB-AIO-Carrier.PrjPCB*			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 5/10/2016	Time: 2:41:05 PM	Sheet * of *	*Alameda CA, 94501*
Author: *	File: Cell-Balancing.SchDoc		*USA*



Coulomb Counter

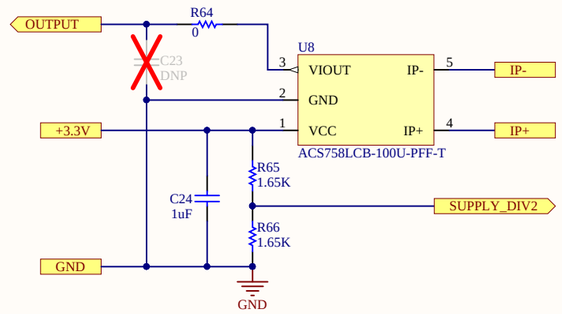


Sheet Title: *Coulomb-Counter*			**Makani Project**
Project Title: *BMB-AIO-Carrier.PrjPCB*			*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 5/10/2016	Time: 2:41:06 PM	Sheet * of *	*Alameda CA, 94501*
Author: *	File: Coulomb-Counter.SchDoc		*USA*



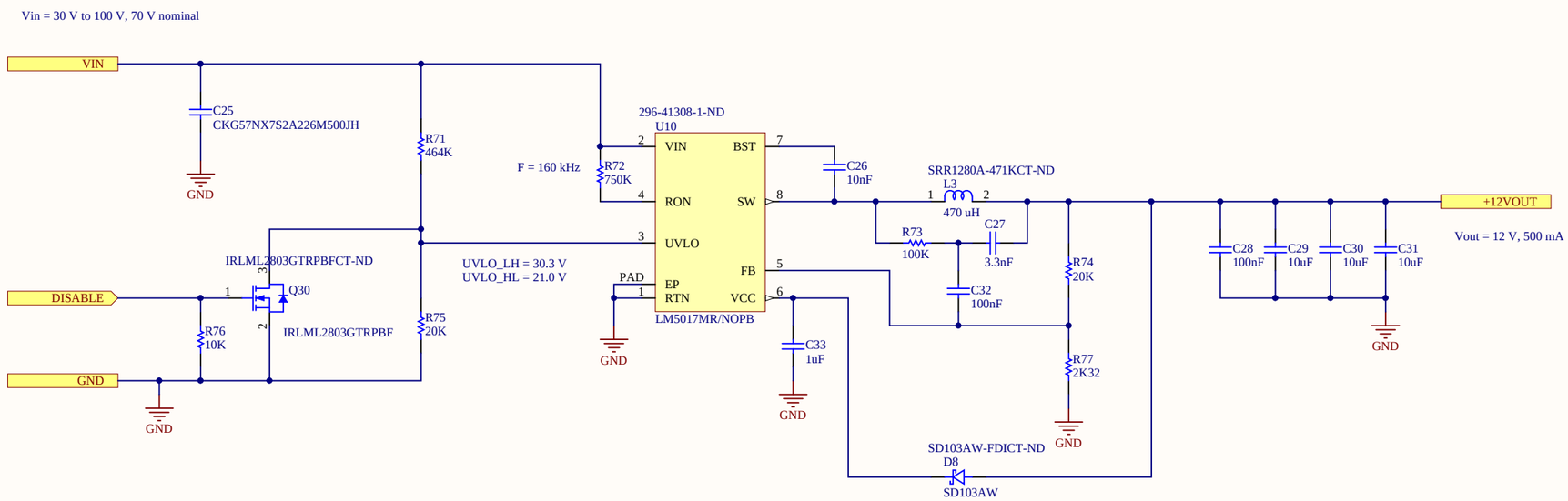
Charge Current and Voltage Sensor

Sheet Title: *Current-Shunt-and-Bus-Sensor*			**Makani Project**
Project Title: *BMB-AIO-Carrier.PrjPCB*			*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:06 PM	Sheet * of *	
Author: *	File: Current-Shunt-and-Bus-Sensor.SchDoc		

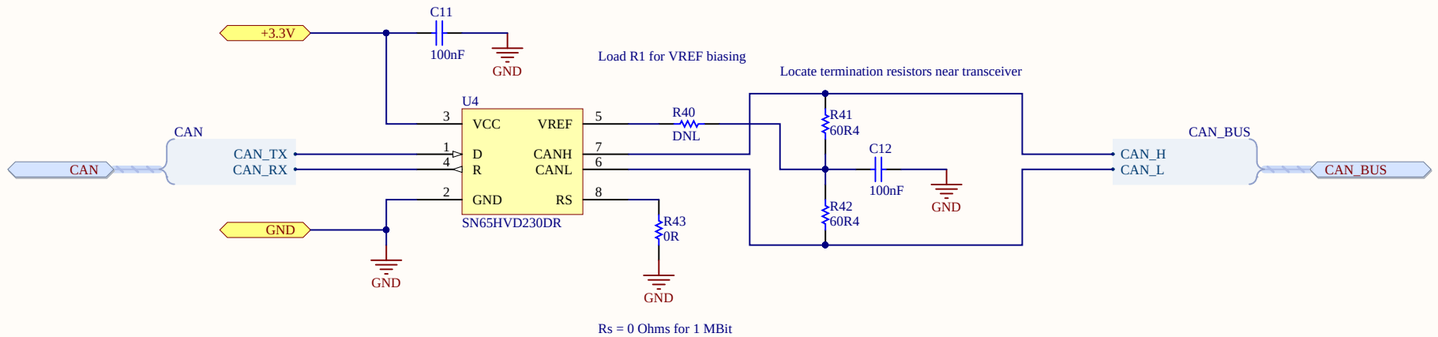


Hall Effect Sensor

Sheet Title:	***Hall-Effect-Current-Sensor***		***Makani Project***
Project Title:	***BMB-AIO-Carrier.PrjPCB***		*Google Inc.*
Size: Tabloid	Number:	Revision:	*2175 Monarch St.*
Date: 5/10/2016	Time: 2:41:07 PM	Sheet * of *	*Alameda CA, 94501*
Author: *	File: Hall-Effect-Current-Sensor.SchDoc		*USA*



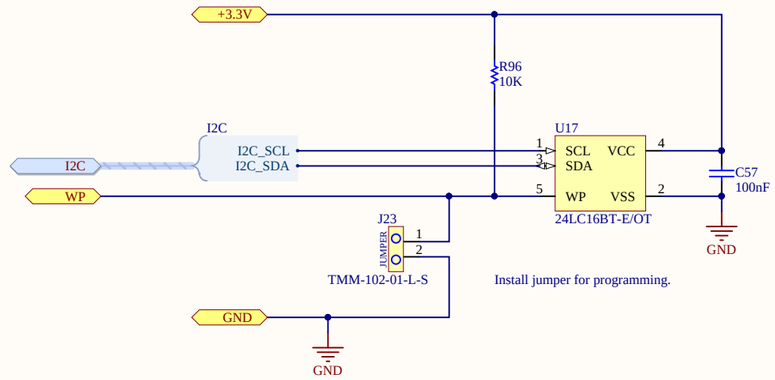
Sheet Title: *LM5017-LV-12V-Supply*		**Makani Project**
Project Title: *BMB-AIO-Carrier.PrjPCB*		*Google Inc.* *2175 Monarch St.* *Alameda CA, 94501* *USA*
Size: Tabloid	Number: / Revision:	
Date: 5/10/2016	Time: 2:41:07 PM / Sheet * of *	
Author: *	File: LM5017-LV-12V-Supply.SchDoc	



Rs = 0 Ohms for 1 MBit

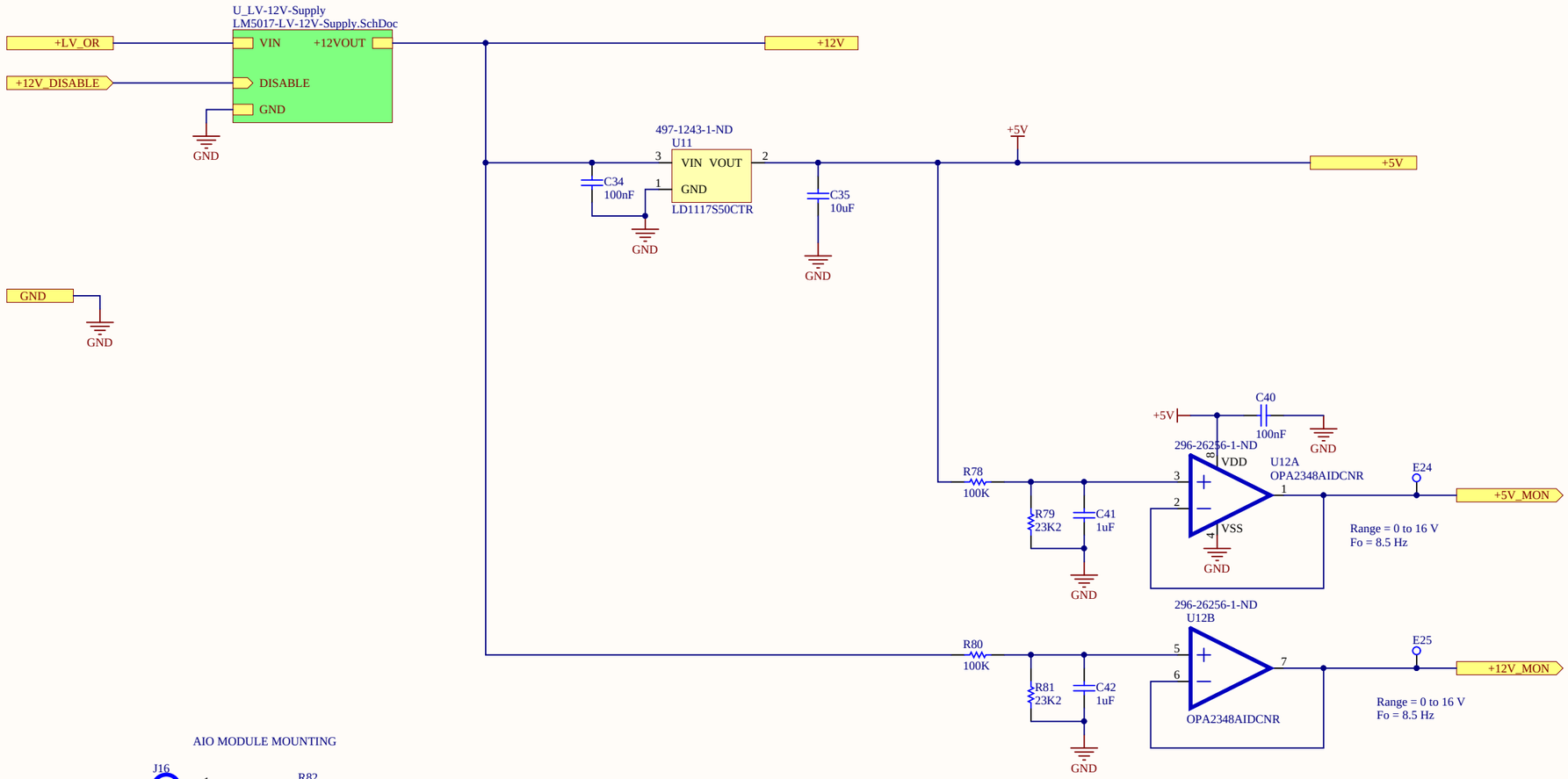
Sheet Title:	***CAN Transceiver***		
Project Title:	***BMB-AIO-Carrier.PrjPCB***		
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:07 PM	Sheet * of *	
Author: EAC	File: MMS-CAN-3V3.SchDoc		

Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA



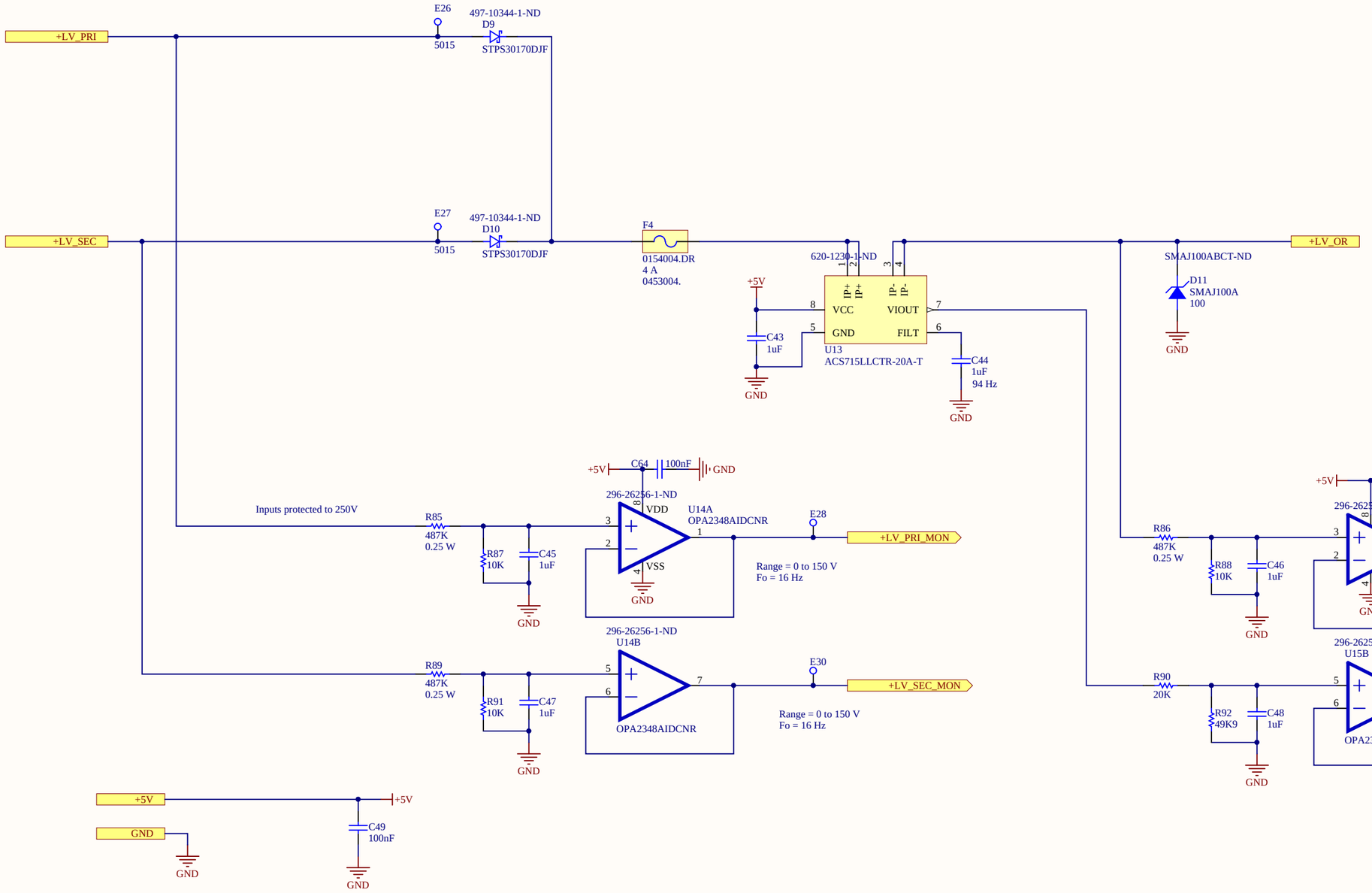
Sheet Title:	***I2C EEPROM***		
Project Title:	***BMB-AIO-Carrier.PrjPCB***		
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:07 PM	Sheet * of *	
Author: EAC	File: MMS-I2C-EEPROM.SchDoc		

Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA



Sheet Title:	***Power_12V***		
Project Title:	***BMB-AIO-Carrier.PrjPCB***		
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:07 PM	Sheet * of *	
Author: *	File: Power_12V.SchDoc		

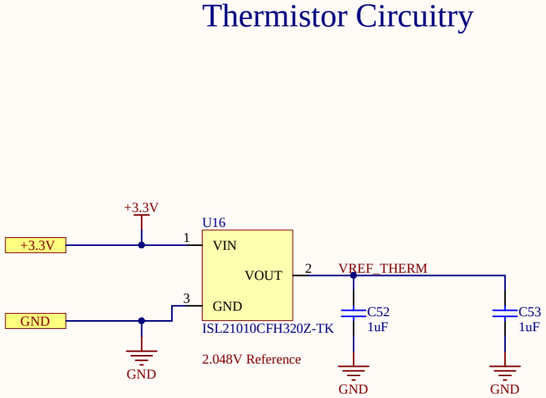
Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA

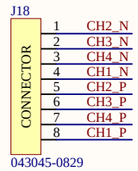


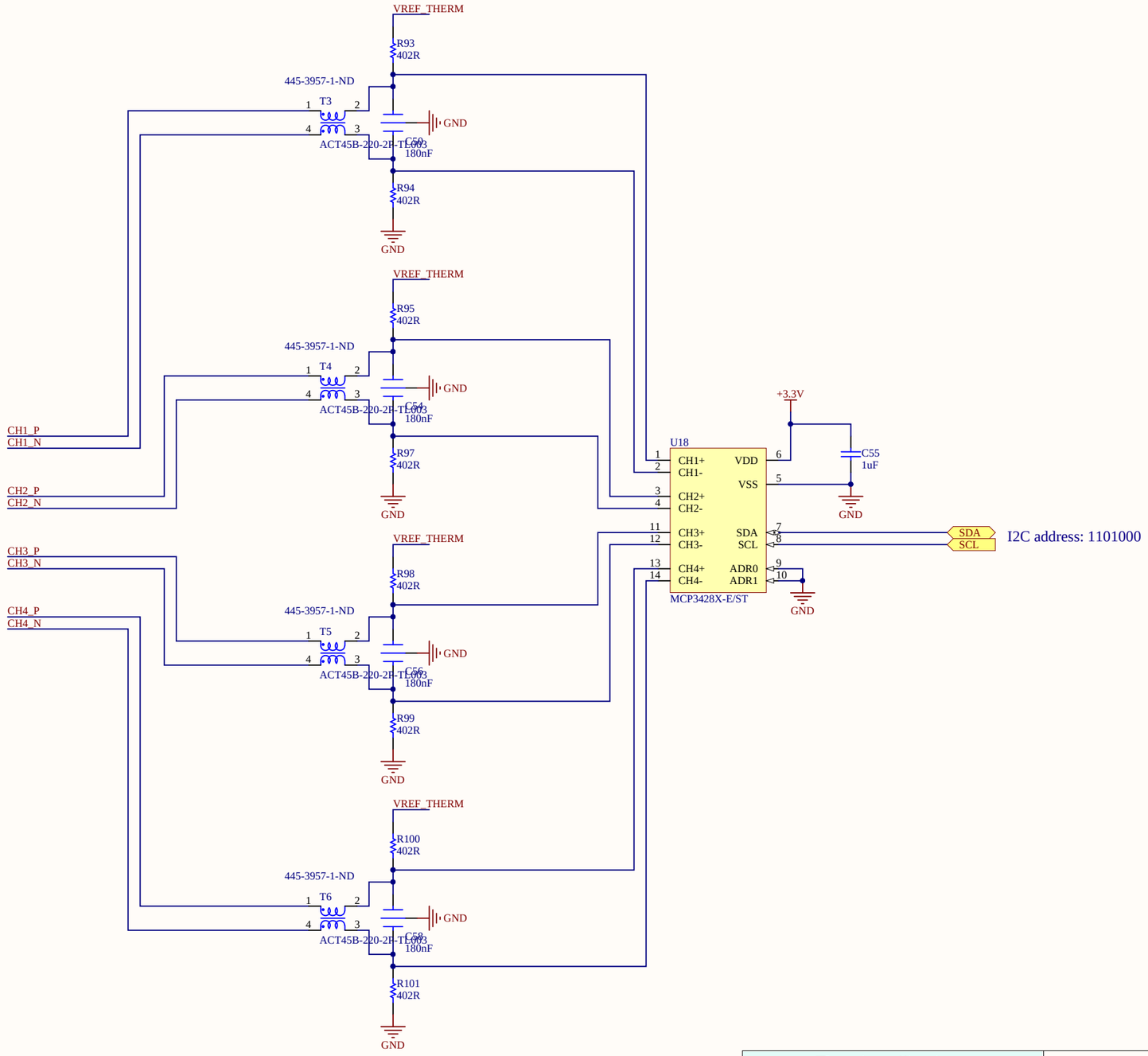
Sheet Title:	***Power_LV***		
Project Title:	***BMB-AIO-Carrier.PrjPCB***		
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:08 PM	Sheet * of *	
Author: *	File: Power_LV.SchDoc		

Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA

Thermistor Circuitry







Sheet Title: ***Thermistor-Circuitry***			***Makani Project*** *Google Inc. 2175 Monarch St. Alameda CA, 94501 USA*
Project Title: ***BMB-AIO-Carrier.PrjPCB***			
Size: Tabloid	Number:	Revision:	
Date: 5/10/2016	Time: 2:41:08 PM	Sheet * of *	
Author: *	File: Thermistor-Circuitry.SchDoc		

Battery Charge Circuitry

U_Battery-Charger
Battery-Charger.SchDoc

+LV_PRI
+12V
E3
5016
GND
VIN
+12V
GND
VOUT
SHDN
SWEN1
SWEN2
CHARGE+
GIOA2
N2HET1_16
N2HET1_14

Charge Current and Voltage Sensor

I2C address: 1101010
U_Current-Shunt-and-Bus-Sensor
Current-Shunt-and-Bus-Sensor.SchDoc

GND
VIN
GND
SENSE+
SENSE-
SDA
SCL
CHARGE+
PACK+
I2C_SDA
I2C_SCL

Battery Power Connectors

PACK+
F1
80V
50A
166.6885.5501
I2t rating: 25500
Interruption rating: 1000A at 80V
J1
PACK3 1
PACK2 2
CONN
DF22-2P-7.92DSA(06)
J3
PACK2 1
PACK1 2
CONN
DF22-2P-7.92DSA(06)
J4
PACK1 1
PACK- 2
CONN
DF22-2P-7.92DSA(06)

Battery Connection Switch

U_Battery-Connection-Switch
Battery-Connection-Switch.SchDoc

PACK+
BAT_SWITCH_MID
GND
VIN
SWITCH_MID
GND
VOUT
SWEN1
SWEN2
PACK+_S
GIOA6
GIOA7

Relay Connection Point

J2
CONN
1
2
3
4
BAT_SWITCH_MID
PACK+
39-29-6048

Hall Effect Sensor

U_Hall-Effect-Current-Sensor
Hall-Effect-Current-Sensor.SchDoc

PACK+_S
+3.3V
GND
IP+
IP-
+3.3V
GND
OUTPUT
SUPPLY_DIV2
+LV_SEC
E2
5015
HALL_OUTPUT_MON
HALL_SUPPLY_MON
5015
E5

Coulomb Counter

I2C address: 1010101
U_Coulomb-Counter
Coulomb-Counter.SchDoc

I2C
+3.3V
GND
I2C
+3.3V
GND
PACK+
SRP
SRN
PACK+
PACK-

Thermistor Circuitry

I2C address: 1101000
U_Thermistor-Circuitry
Thermistor-Circuitry.SchDoc

+3.3V
E9
5016
GND
+3.3V
GND
SDA
SCL
I2C_SDA
I2C_SCL

Cell Balancing

U_Cell-Balancing
Cell-Balancing.SchDoc

+3.3V
GND
+3.3V
GND
SCK
MISO
MOSI
CSB
SPI3_CLK
SPI3_MISO
SPI3_MOSI
SPI3_NCS0

Serialization EEPROM

I2C address: 1010XXX (gets entire address space)
U_MMS-I2C-EEPROM
MMS-I2C-EEPROM.SchDoc

I2C
EEPROM_WP
I2C
WP
+3.3V
GND
+3.3V
GND

Power_LV

U_Power_LV
Power_LV.SchDoc

+LV_PRI
+LV_SEC
+5V
GND
+LV_PRI
+LV_SEC
+5V
GND
+LV_OR
+LV_PRI_MON
+LV_SEC_MON
+LV_OR_VMON
+LV_OR_IMON
+LV_OR
+LV_PRI_MON
+LV_SEC_MON
+LV_OR_VMON
+LV_OR_IMON

Power_12V

U_Power_12V
Power_12V.SchDoc

+LV_OR
+12V_DISABLE
GND
+LV_OR
+12V_DISABLE
GND
+12V
+5V
+12V_MON
+5V_MON
+12V
+5V
+12V_MON
+5V_MON

AIO Node Interface

U_Ground_Test_Interface
Ground_Test_Interface.SchDoc

+12V
+12V
+5V
+3.3V
+1.2V
GND
+12V_GTI
+12V
+5V
+3.3V
+1.2V
GND
CAN1
AIO_GTI
+12V_DISABLE
+12V_DISABLE

U_MMS-AIO-Module-Interface
MMS-AIO-Module-Interface.SchDoc

CAN1
AIO_GTI
SPI1_NCS4
GPIO
N2HET1
CAN2
CAN3
SPI3
SCI
LIN
PORT4
+12V_AIO
+12V_CARRIER
+3.3V
+2.5V
+1.2V
CARRIER_ID
I2C
ADC
AGND
GND

CARRIER_ID
CARRIER_ID0
CARRIER_ID1
CARRIER_ID2
CARRIER_ID3
GND
BOARD_ID = 1000 (Battery management)

I2C
I2C_SCL
I2C_SDA
I2C_SCL
I2C_SDA

GPIO_TMS
GIOA2
GIOA6
GIOA7
GIOA2
GIOA6
GIOA7

H2HET1
N2HET1_22
N2HET1_14
N2HET1_16
N2HET1_22
N2HET1_4
N2HET1_14
N2HET1_16
N2HET1_18
N2HET1_20
N2HET1_PIN_NDIS

SPI3_TMS
SPI3_CLK
SPI3_MOSI
SPI3_MISO
SPI3_NCS0
SPI3_CLK
SPI3_MOSI
SPI3_MISO
SPI3_NCS0
SPI3_NCS1
SPI3_NCS4
SPI3_NCS5

J7
1
R1
DNL
SMTSO-116-8-ET
J11
1
R3
DNL
SMTSO-116-8-ET
R2
DNL
1
J8
SMTSO-116-8-ET
R4
DNL
1
J12
SMTSO-116-8-ET
GND

TMS_ADC_14_23
ADC14
ADC15
ADC16
ADC17
ADC18
ADC19
ADC20
ADC21
ADC22
ADC23
+LV_PRI_MON
+LV_SEC_MON
+LV_OR_VMON
+LV_OR_IMON
+12V_MON
+5V_MON
HALL_SUPPLY_MON
HALL_OUTPUT_MON
EEPROM_WP

The AIO module standoff height should be 0.250 inches (6.35 mm).

M3 chassis mount holes should be used for non-captured hardware.

SMTSO-632-8ET PemNuts have 6-32 thread for direct mounting (but uses non-metric screws).

SMTSO-143-8ET PemNuts have clearance holes for use with an M3 stacked standoff on the bottom.

Amphenol Connections

J5
CONNECTOR
1 +LV_SEC
2
3
4
5
6
7
8
9
10
11
12
13
14
39-29-6148
GND

J6
CONN
1 +LV_PRI
2 GND
39-29-6028

Makani Logo
Fiducial
Fiducial
Fiducial
Fiducial
Fiducial
Fiducial

Sheet Title: *Top-Level*		
Project Title: *BMB-AIO-Carrier.PrjPCB*		
Size: Tabloid	Number:	Revision:
Date: 5/10/2016	Time: 2:41:08 PM	Sheet * of *
Author: *	File: Top-Level.SchDoc	

Makani Project
Google Inc.
2175 Monarch St.
Alameda CA, 94501
USA