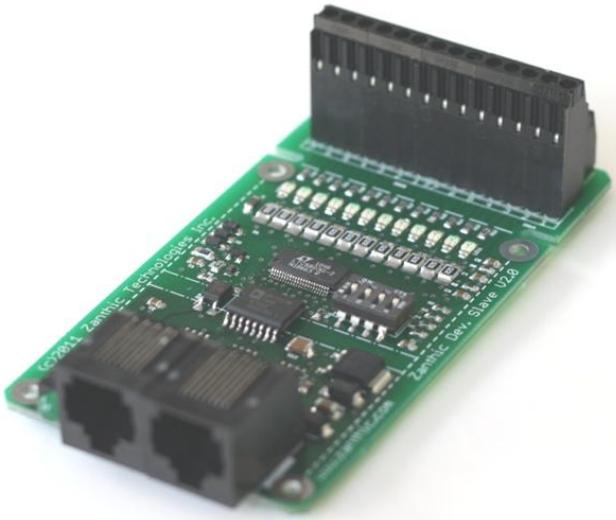
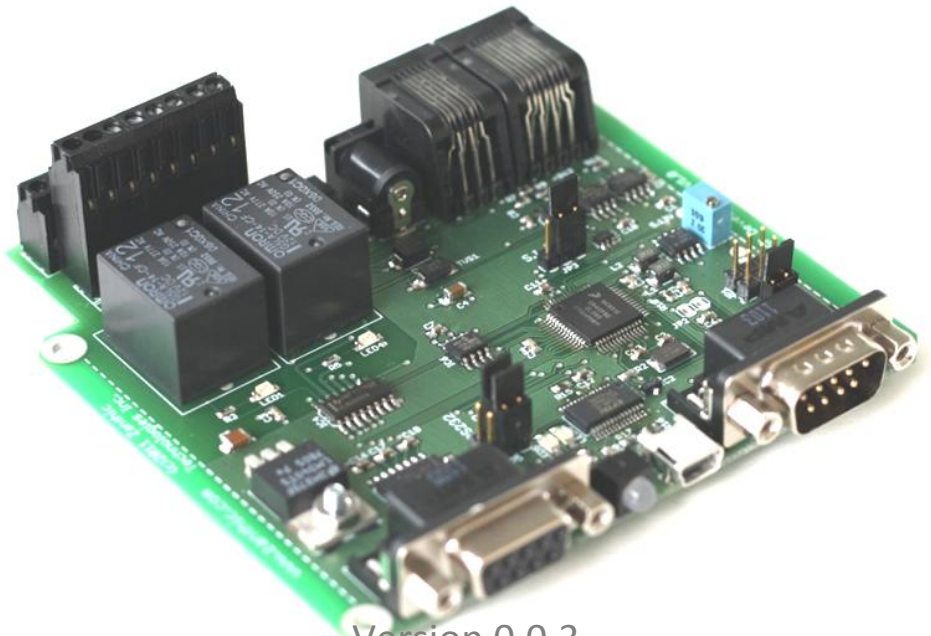


ZANTHIC TECHNOLOGIES INC.

Zanthic Cheetah64 processor with 6803 BMS Firmware for Lithium Ion Battery Management Demonstration Board Manual



Version 0.0.3

Version History

This document version history

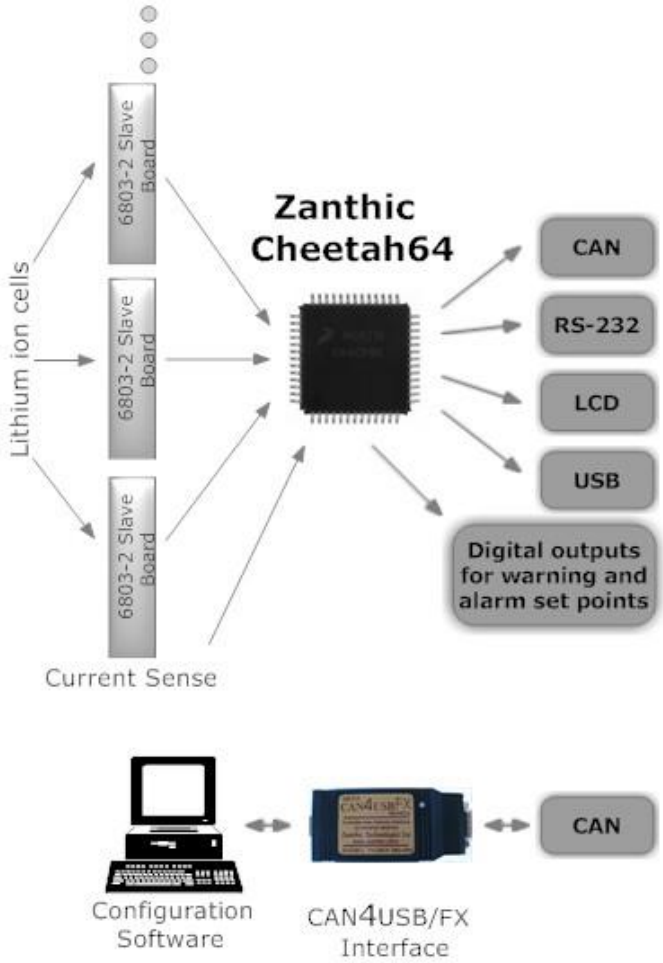
June 1, 2011	V 0.0.2 - Preliminary Version, internal use only
Aug 10,2011	V.0.0.3 – Updated with new slave board and example connections

Table of Contents

Contents

Introduction

This document was created to outline an example circuit to implement a master and slave configuration with the use of the Zanthic Technologies Inc. Cheetah64 processor running the 6803 battery management firmware. These boards are used as a technology demonstrator to show various features without being specific to any particular application.



Features

The demonstration board provides the following functionality

Master:

- CAN – Controller Area Network with standard male D9 connector
- RS232 (female D9) and USB option
- SPI Communications to Linear 6803-2 Slaves (simple, not used, and differential, used with this slave)
- Analog Input for current sensing
- Digital outputs with low side drivers
- Two relays for warning and error events
- LED for status and one LED for warning/error event
- 100mm design for fitting in extruded aluminum case

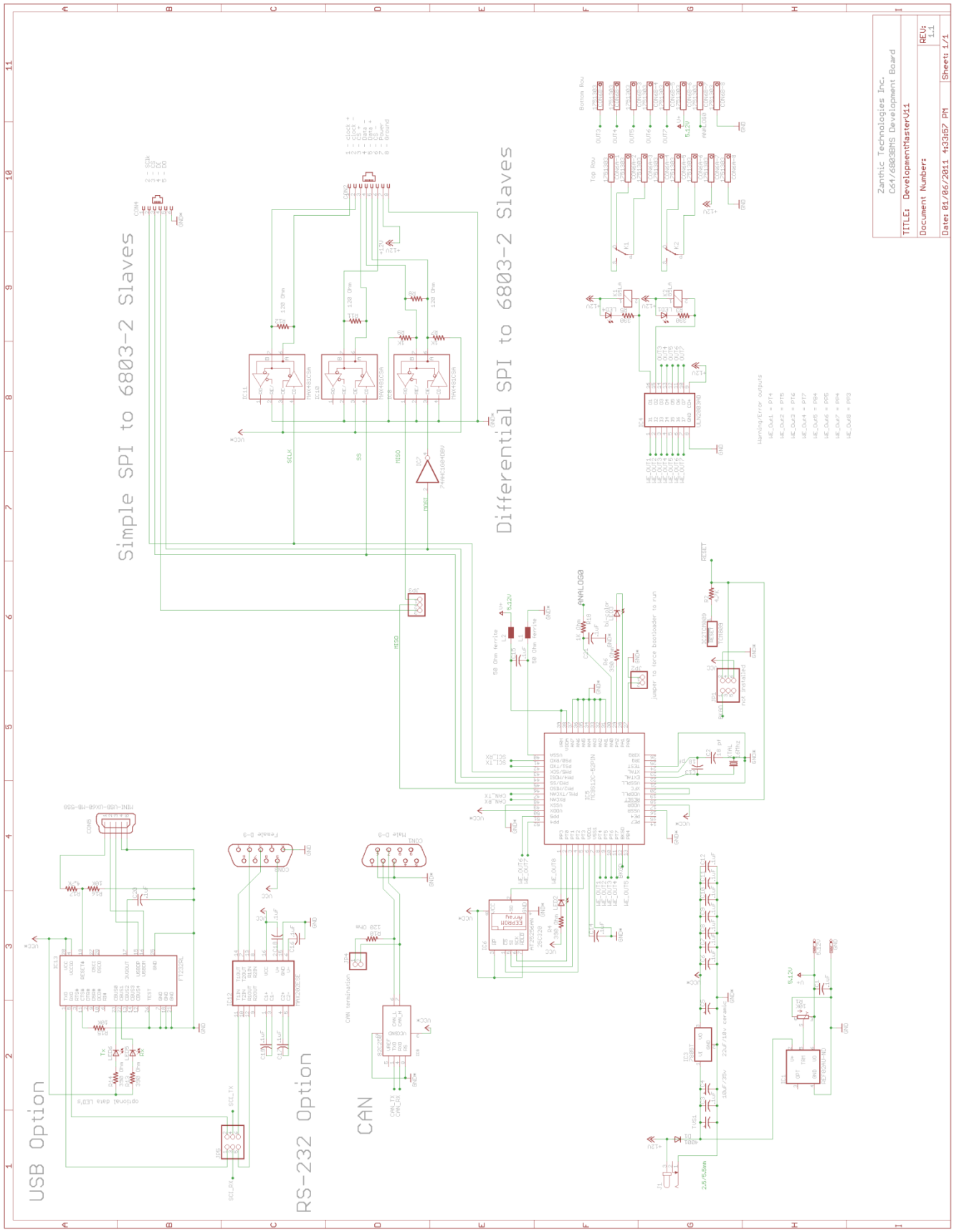
Slave:

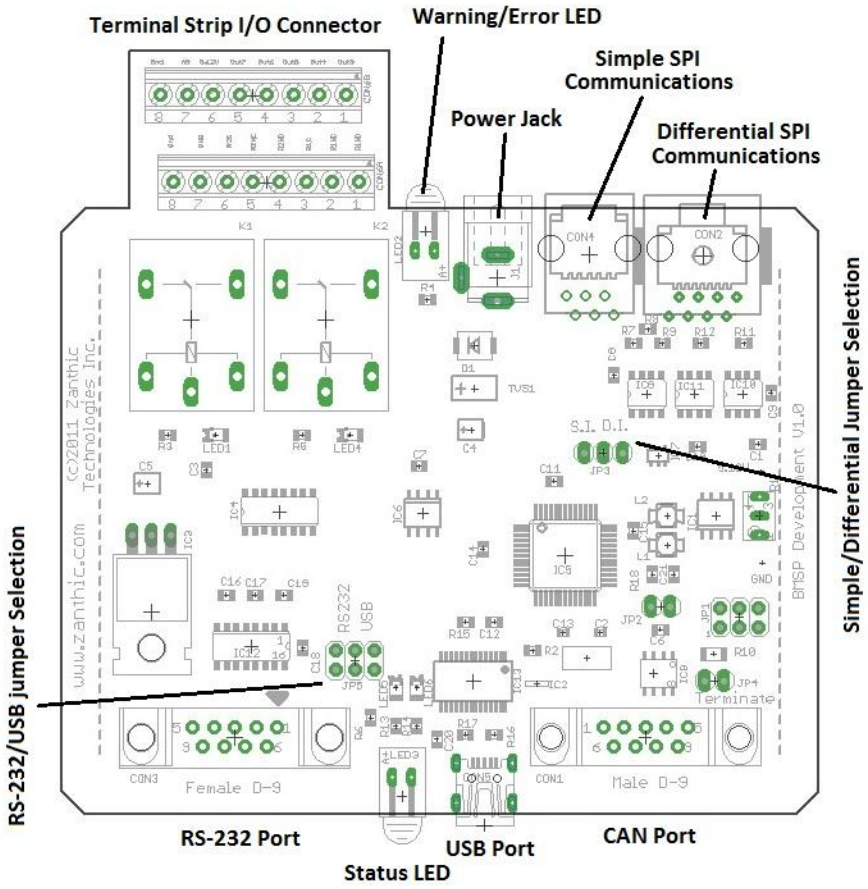
- Isolated communication bus with differential SPI communications
- Newest member of the LTC6803-2 family
- Power down feature to reduce cell current draw when not in use
- Each slave of 12 cells can be used in any combination of series or parallel because of isolated communications bus

Master Demo Board Details

The master board is build around the Zanthic Cheetah64 processor running the 6803BMS firmware for lithium ion battery management which is built on a Freescale 9S12C64 microprocessor with the Cheetah bootloader and BMS firmware programmed into it. Referring to the schematic on the following page (and provided in higher detail in a separate file), the following should be noted:

- Two different SPI communications to the Linear Technologies 6803-2 slave is shown with straight (simple) SPI going through the CON4 - RJ11 (6 pin) connector or the better differential version of the SPI circuitry going through the CON2 - RJ45 (8 pin) The Slave board is designed to work with the differential connection and the simple connection is provided on the master for experimentation use should you want to implement a simpler interface to the 6803-2 device.
- The SPI controlled external memory, IC6, is required to contain all of the configuration data for the microcontroller. The processor will not work properly without this IC present.
- There are 8 warning/error outputs with 3 of them connected on board, two relays and one LED. The other 5 outputs are brought out to the terminal strip as low side driver outputs and should be limited to 50mA each even though the individual channels are rated higher, the overall driver's (IC4) ability to dissipate heat must be taken into consideration
- The RS232 (SCI) port is connected to both the RS-232 driver and the USB driver and can be selected through jumpers on the JP5 pin header.
- A 5.12v reference IC (IC1) is used to provide a 5.12v reference voltage to the A/D circuitry which will allow an even 5mV per bit reading on the 10 bit A/D channel. This voltage can be adjusted using the R1 trim pot.


Simple SPI to 6803-2 Slaves
Differential SPI to 6803-2 Slaves
USB Option
RS-232 Option
CAN
Zanthic Technologies Inc.
C64/6803BMS Development Board
TITLE: DevelopmentMasterV11
Document Number:
REV: 1.1
Date: 01/06/2011 1:33:57 PM
Sheets 1/1



Board Layout

Pinouts:

Power: 2.5mm/5.5mm barrel power jack, center positive, 12vDC input

RS-232: The RS-232 port is wired in such a way that the connection to a standard PC RS-232 port will require a "null modem" connection, that is, pins 2 and 3 will be flipped. Connection to the Matrix Orbital, model LK204-25 will be done in a straight through manner. There is a separate document for the use of the Matrix LCD unit for more information.

Pin Number	Name	Description
2	Receive Data	Data received into this board
3	Transmit Data	Data transmitted from this board
5	Ground	Board ground
9	+5v Power Out	The board's +5v regulated output is provided on Pin 9 to power the Matrix LCD

USB: A standard mini USB connector is provided that is used in conjunction with the FTDI FT232RL interface that converts the SCI port to USB. FTDI provides (on their website) virtual Com port drivers that allow the USB data to be accessed through a virtual Com port on your Windows PC.

CAN: The CAN port is wired as a standard male D-9 with the following pin out. A fixed rate of 500kbps is used and a termination jumper is provided on board (JP4)

Pin Number	Name	Description
2	CAN Low	CAN Low
7	CAN High	CAN High
3	Ground	Board ground
6	Ground	Board ground

SPI Simple for Slave Communications: This 6 pin RJ11 connector (CON4 on schematic) is provided as a direct connection to the SPI port but is not used for the slave circuitry that is included in this package.

Pin Number	Name	Description
1	N/C	Not connected
2	SClk	S-Clock from SPI system (output)
3	CS	Chip Select from SPI system (output)
4	DI	Data input into SPI system (MISO)
5	DO	Data output from SPI system (MOSI)
6	Gnd	Board ground

SPI Differential Communications to Slave boards: This 8 pin RJ45 connector (CON2 on schematic) provides the main connection to the external 6803-2 slave boards through a differential method of communicating SPI data for improved noise immunity

Pin Number	Name	Description
1	Clock +	Differential + clock signal
2	Clock -	Differential + clock signal
3	CS +	Differential + Chip Select signal
4	Data -	Differential - Data signal
5	Data +	Differential + Data signal
6	CS -	Differential - Chip Select signal
7	+ Power	Power to the master board is provided here to power the remote slave boards
8	Ground	Board ground

Note: Each slave board contains two RJ45 connectors so they can be ‘daisy chained’ from the master board.

Terminal Strip – Upper Row: Looking towards the connector, with connection 1 starting from the left,

Pin Number	Name	Description
1	Relay 1 – N.O.	Relay 1 is connected to warning/error output 1 and will energize when there is NO warnings/errors in effect. This acts as a failsafe that if the processor resets or the power is removed, the relay contacts are in a warning/error state
2	Relay 1 – N.C.	
3	Relay 1 - Common	
4	Relay 2 – N.O.	Connected to warning/error output 2
5	Relay 2 – N.C.	
6	Relay 2 - Common	
7	+ 12v Power	12v power fed into the barrel jack is provided here
8	Ground	Board ground

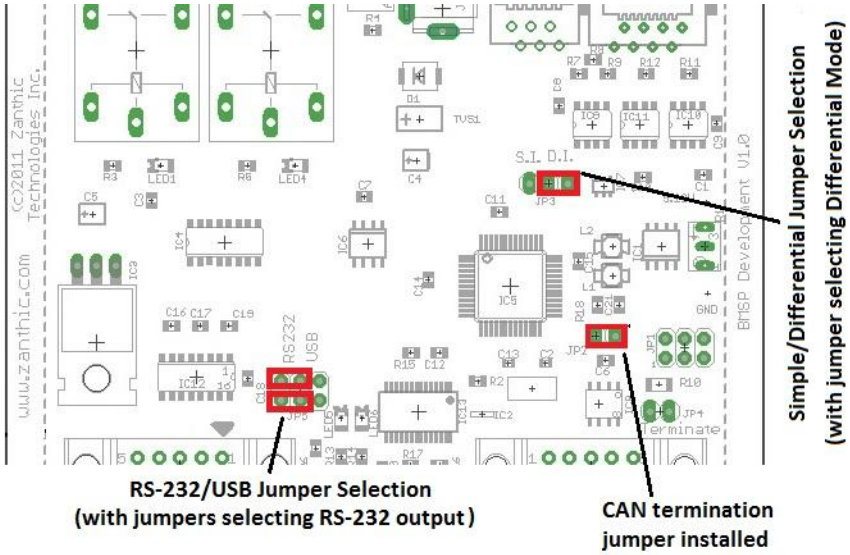
Note: Current through the relay contacts should be limited to under 2 Amps as the pcb trace width and thickness are a limiting factor.

Terminal Strip – Lower Row: Looking towards the connector, with connection 1 starting from the left,

Pin Number	Name	Description
1	Out 3	Warning/Error output 3-7. These outputs are low side drivers that will be normally activated (pulled to ground) when there is no warning/error activated for that output. Not to exceed 50mA on each of these. Build in suppression diode to board power for SMALL inductive loads like low coil current external relays
2	Out 4	
3	Out 5	
4	Out 6	
5	Out 7	
6	+5.12v ref	External connection for 5.12v reference voltage for external current sensor. Do not exceed 20mA draw
7	Analog 0	Analog input to master for current sensing. Do not exceed 0-5v DC.
8	Ground	Board ground

Jumper Settings:

Please refer to the following picture for jumper settings



Bill of Materials:

The following pages contain a bill of materials for the master demo board and options as well as sample pricing as of May, 2011 in Canadian funds.

Development Master Board V1.1 - last modified June 1, 2011										
						sample pricing from Digikey in Cdn$				
Qty.	**Board Ref**	**Value**	**Description**	**Manufacturer #**	**Digikey #**	**Qty 1 $**	**Q1 Total**	**Qty 100 $**	**Q100 total**	**Comments**
12	C1,C3,C6-C12,C14,C15,C21	.1uF	805 size, 16volt			$0.07	$0.84	$0.04	$0.48	
2	C3,C13	18pF	603 size			$0.07	$0.14	$0.04	$0.08	
1	C4	10uF/35v	ceramic	GMK316F106ZL-T	587-1352-1-ND	$0.46	$0.46	$0.19	$0.19	
1	C5	22uF/16v	ceramic	C3225Y5V1A226Z/1.15	445-1596-1-ND	$0.49	$0.49	$0.23	$0.23	
1	CON1	DB9 male		AMP 1734351-1	A35105-ND	$1.13	$1.13	$0.75	$0.75	
1	D1	4001 diode	sma	CGRA4001-G	641-1016-1-ND	$0.43	$0.43	$0.14	$0.14	
1	IC1	REF02	5.12v reference	TI REF02AU	REF02AU-ND	$4.80	$4.80	$3.51	$3.51	
1	IC2	TCM809	reset IC	TCM809LENB713	TCM809LENB713CT-ND	$0.42	$0.42	$0.27	$0.27	
1	IC3	7805	regulator	LM7805CT	LM7805CT-ND	$0.67	$0.67	$0.42	$0.42	
1	IC4	ULN2003	driver	ULN2003ADR	296-1368-1-ND	$0.68	$0.68	$0.41	$0.41	
1	IC5	Cheetah64	micro-controller	Zanthic		$35.00	$35.00	$13.00	$13.00	
1	IC6	AT25256	memory	25LC256-I/SN	25LC256-I/SN-ND	$1.76	$1.76	$1.17	$1.17	
1	IC9	CAN	CAN driver	AMIS42671ICAB1RG	766-1007-1-ND	$2.68	$2.68	$1.87	$1.87	
1	J1	barrel	power jack 2.5/5.5mm	PJ-102A	CP-102A-ND	$0.83	$0.83	$0.39	$0.39	
1	JP1,JP5	header	2x3 pin header			$0.57	$0.57	$0.23	$0.23	JP1 not installed as it is not needed
2	JP2,JP4	header	1x2 pin header			$0.25	$0.50	$0.15	$0.30	
1	JP3	header	1x3 pin header			$0.27	$0.27	$0.12	$0.12	
2	K1,K2	relay		G5LA-14-CF DC12	Z2576-ND	$1.54	$3.08	$1.10	$2.20	
2	L1,L2	ferrite	1206 ferrite	BLM31PG500SN1L	490-1055-1-ND	$0.51	$1.02	$0.30	$0.60	
4	LED1,LED4	1206 size	relay on LED's		green=754-1141-1-ND	$0.19	$0.76	$0.11	$0.44	

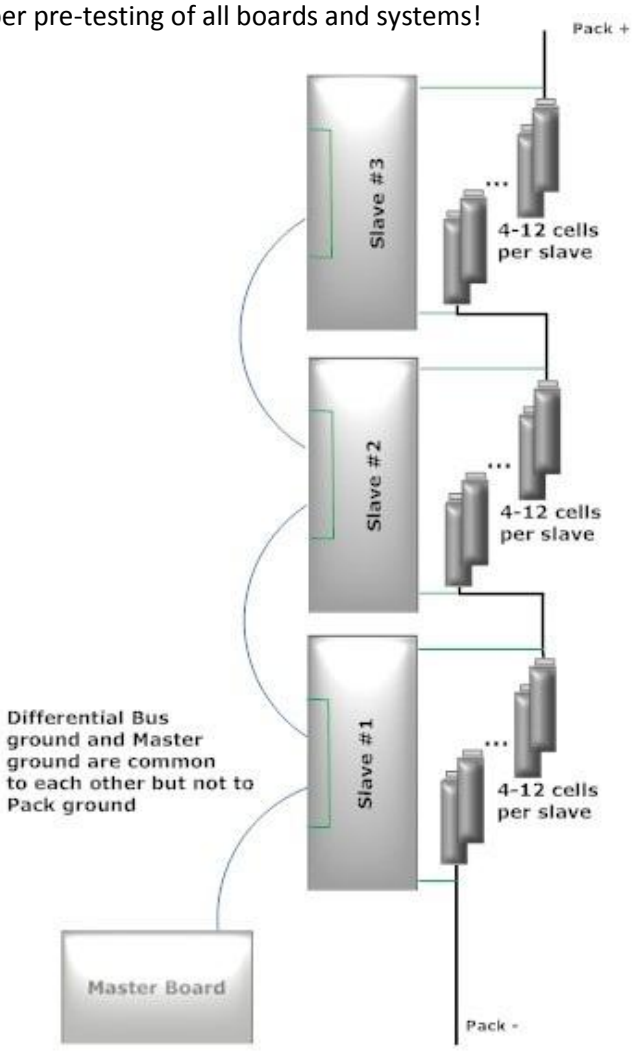
1	LED2	panel led - red		SSF-LXH100ID	67-1217-ND	$0.70	$0.70	$0.38	$0.38	
1	LED3	panel led - bicolor	bi-color status LED	SSF-LXH100HGW	67-1221-ND	$1.12	$1.12	$0.62	$0.62	
1	R1	10k pot		PV37Y103C01B00	490-3008-ND	$2.46	$2.46	$1.52	$1.52	
1	R2	4.7K Ohm	805 size			$0.05	$0.05	$0.02	$0.02	
4	R3-R6	390 Ohm	805 size			$0.05	$0.20	$0.02	$0.08	
3	R7,R9,R18	1K Ohm	805 size			$0.05	$0.15	$0.02	$0.06	
4	R8,R10,R11,R12	120 Ohm	1206 size			$0.05	$0.20	$0.02	$0.08	
0						$0.00	$0.00	$0.00	$0.00	
1	TVS1	transorb	SMA size, 20volt	SMAJ20CA-13-F	SMAJ20CA-FDICT-ND	$0.68	$0.68	$0.36	$0.36	
1	CON6	connector	16 pos terminal block	1720060000	281-1675-ND	$10.37	$10.37	$8.04	$8.04	
1	Xtal	16 Mhz crystal		ABM3-16.000MHZ-B2-T	535-9103-1-ND	$1.57	$1.57	$0.94	$0.94	
1	PCB					$20.00	$20.00	$8.00	$8.00	based on $1.25in^2 for proto and $.50in^2 Qty 100
					Total		**$94.03**		**$46.90**	
	Simple SPI Communications									
1	CON4			5520470-3	A31417-ND	$1.67	$1.67	$1.14	$1.14	
					Total		**$1.67**		**$1.14**	
	Differential SPI Communications									
1	CON2			5555164-1	A31416-ND	$1.23	$1.23	$0.83	$0.83	
1	IC7	inverter	single inverter	SN74LVC1G04DBVR	296-11599-1-ND	$0.55	$0.55	$0.26	$0.26	
3	IC8,IC10,IC11	RS485	low current driver	ADM485JRZ	ADM485JRZ-ND	$2.76	$8.28	$1.99	$5.97	
					Total		**$10.06**		**$7.06**	

	RS232 Option									
1	CON3	DB9 female		AMP 1734354-1	A35107-ND	$2.03	$2.03	$1.35	$1.35	
4	C16-C19	.1uF	805 size, 16volt			$0.07	$0.28	$0.04	$0.16	
1	IC12	Max202	RS232 driver	MAX202CSE+	MAX202CSE+-ND	$3.99	$3.99	$1.92	$1.92	
2	LED5,LED6	1206 size			green=754-1141-1-ND	$0.19	$0.38	$0.11	$0.22	
					Total		**$6.68**		**$3.65**	
	USB Option									
1	C20	.1uF	805 size, 16volt			$0.07	$0.07	$0.04	$0.04	
1	IC13	FT232	USB interface	FTDI FT232RL	768-1007-1-ND	$4.65	$4.65	$3.77	$3.77	
2	R13,R14	390 Ohm	805 size			$0.05	$0.10	$0.02	$0.04	
2	R15,R16	10 K	805 size			$0.05	$0.10	$0.02	$0.04	
1	R17	4.7K	805 size			$0.05	$0.05	$0.02	$0.02	
1	CON5	usb	mini usb 2.0	UX60-MB-5S8	H2960CT-ND	$1.22	$1.22	$0.72	$0.72	
					Total		**$6.19**		**$4.63**	

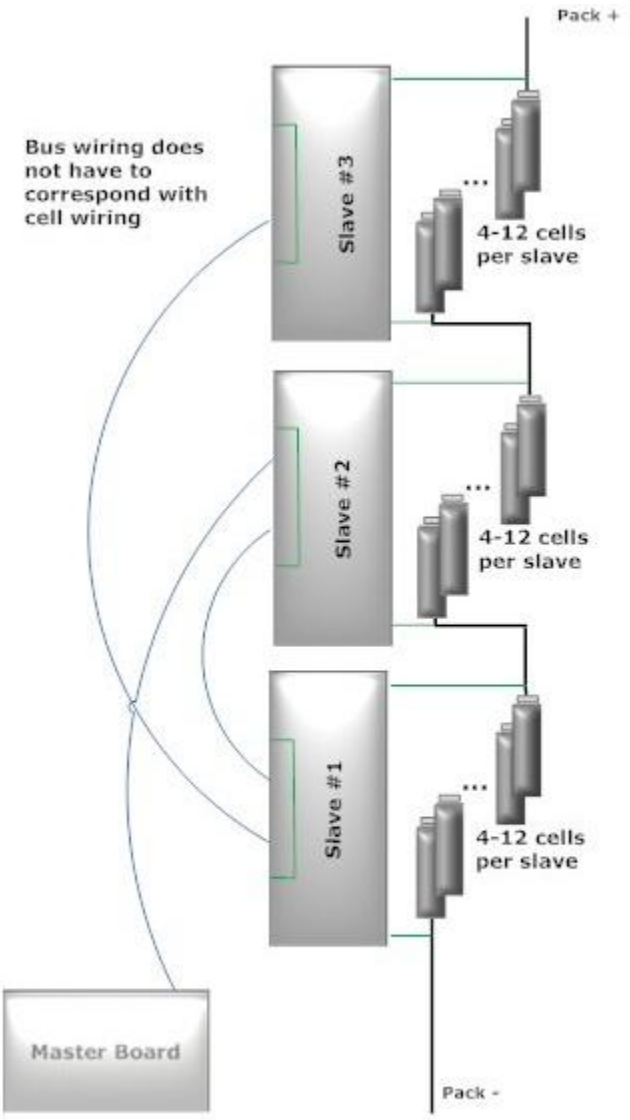
Slave Demo Board Details

The slave board presented here is the more complex board with fully isolated and differential data signals. The advantage with this scheme is that each group of cells that are attached to this board are in isolation with the data bus (and therefore the master) as well as in isolation with any other slave board. This means that the actual power terminals for this group of cells can be connected to other slave boards in different manners including series/ parallel and combinations of the two.

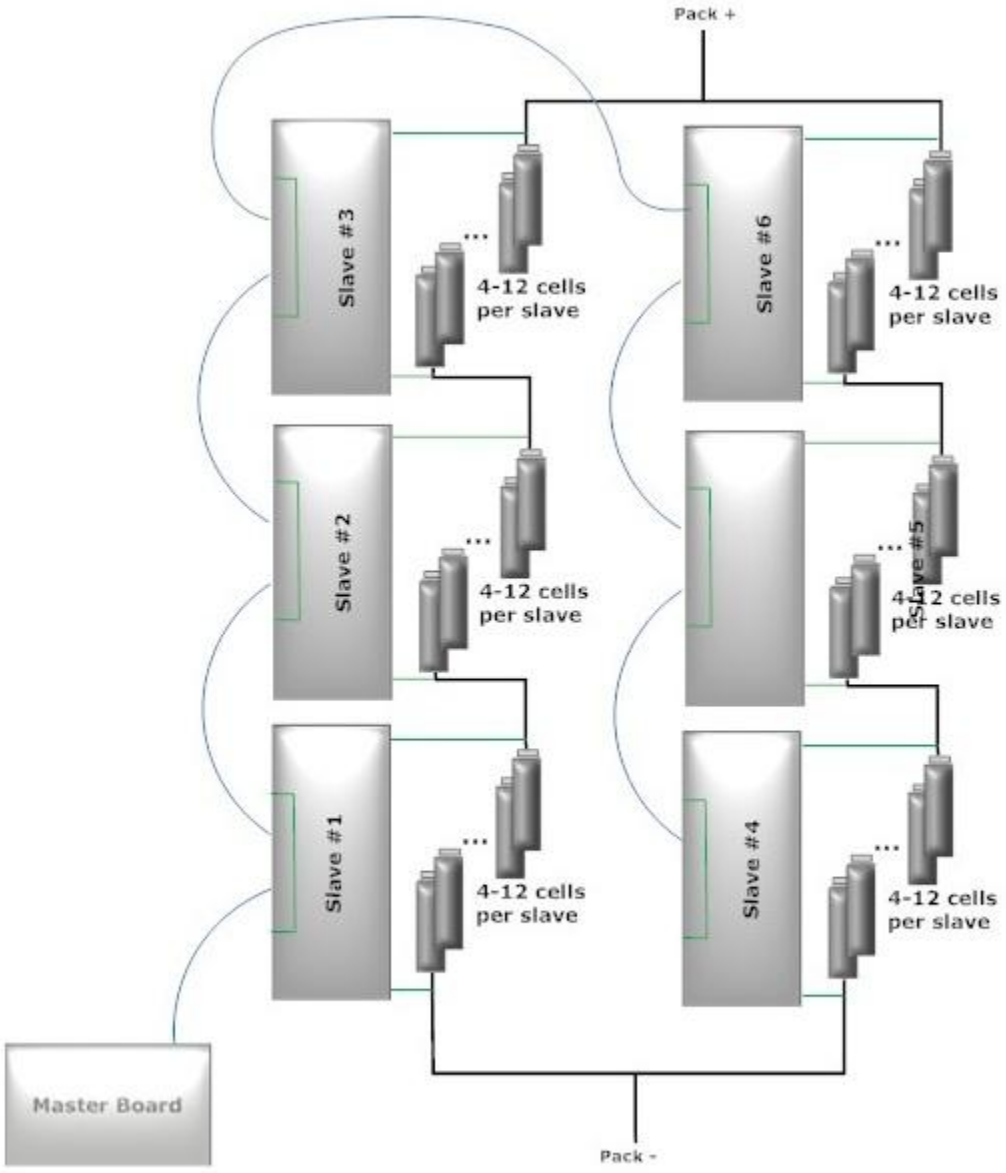
NOTE: please do not continue with any connections until you have a perfect understanding of how your system works and where the potential ground and power issues are. Each slave board will have voltages of up to 60 volts and can be deadly! You are ultimately responsible for implementing all safety protocols including the proper pre-testing of all boards and systems!



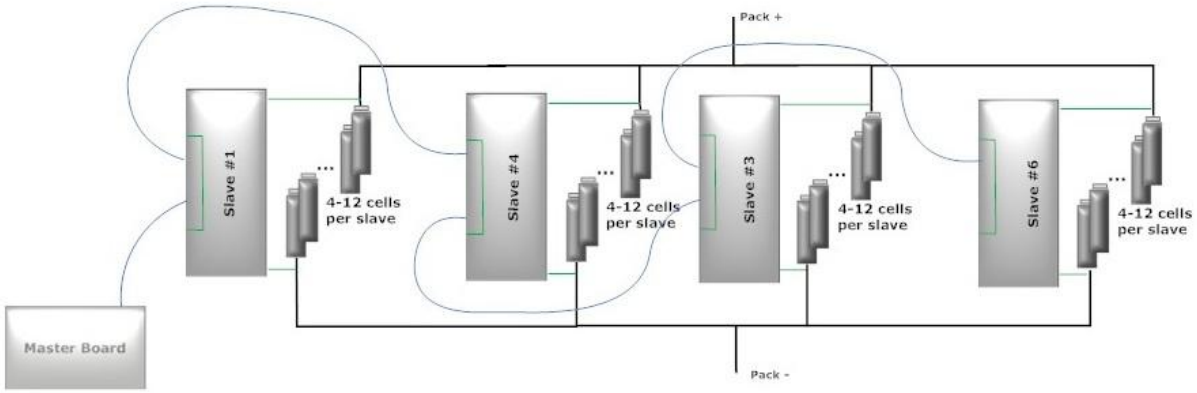
The above diagram shows one potential method of connection. Note that because the differential communications bus is isolated from each slave board, the master board ground is not connected to the pack ground.



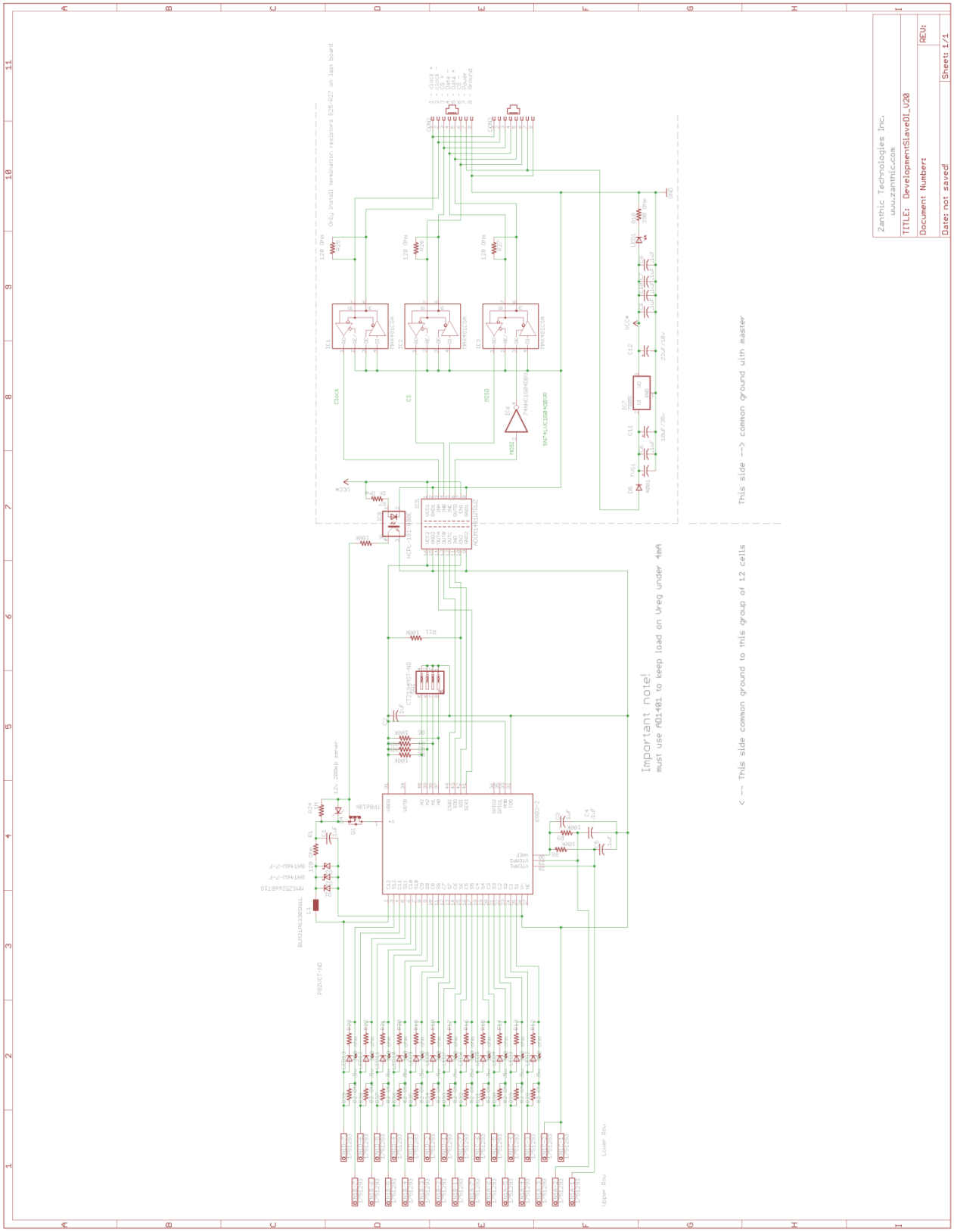
In the above diagram the communications bus does not necessarily have to go from slave to slave in the same order as the actual power wiring. Note that this is only true in this example where we are using isolated slave communications! Also note that each slave board has dip switches that will set its address and this does not have to correspond to either the communication wiring order or the power wiring order (although it would make sense to set them in some logical manner)



In the above diagram there are 6 slaves in two parallel groups of 3 slaves each. Note that before the power connection is made, attention has to be given to whether the two groups are at the same potential to avoid massive current flowing from the higher group to the lower. Additional protection between the two groups may also be in order as this diagram is showing one possible method of communications wiring and not necessarily the best overall power wiring.



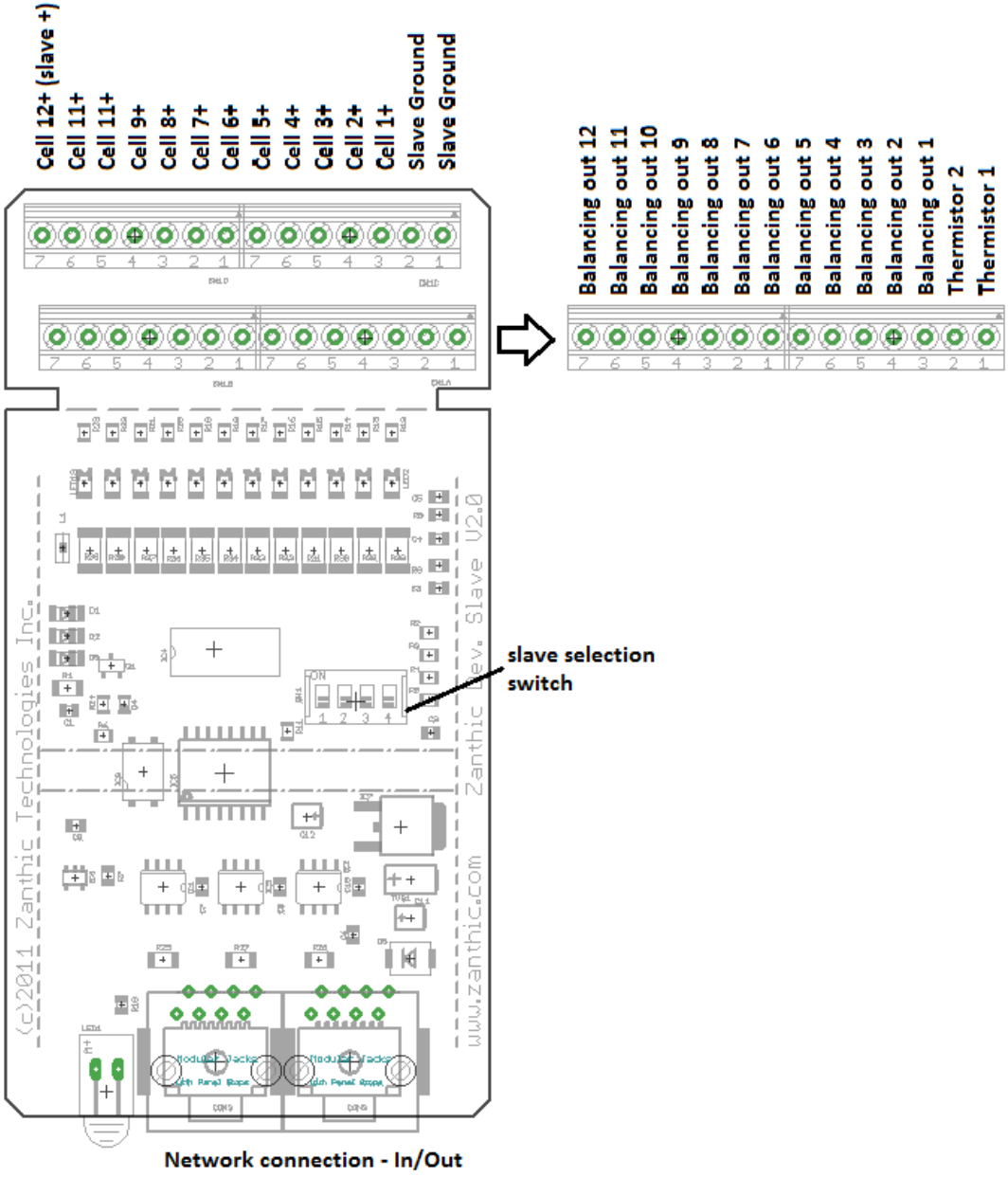
The above diagram shows 4 save boards in parallel and again, attention must be given to each board's initial voltage so as to not discharge a higher one to a lower one.


Zanthic Technologies Inc.
www.zanthic.com
TITLE: DevelopmentSlaveUI_V20
Document Number:
REV:
Date: not saved!
Sheet: 1/1
This side --> common ground with master
< -- This side common ground to this group of 12 cells
Important note!
must use MD1401 to keep load on Vreg under 4mA

Slave Board Notes:

It should be noted that this particular version of the slave schematic shows that the 6803-2 device and part of the interface circuitry is being powered from the cells themselves but is only active while there is power on the communications side. When power is present at the RJ-45 from the master, the opto-coupler IC8 will activate the Q1 mosfet and apply cell power to the 6803-2 which will in turn supply 5 volts to the rest of the interface circuitry.

This particular slave board includes 82 ohm resistors for balancing and also brings out the balancing signal to the upper row of the connectors. Both internal and external balancing circuitry can co-exist for testing purposes. For this value of resistor the intent is for demonstration is with small cell balancing with the approximate current being around 50mA. This would obviously have little effect on a larger cell where external balancing would be required.



Slave Selector Switch: Note that with all of the switches in their 'On' position, the slave will be set to be the lowest (#1) slave on the differential network. The above diagram would indicate this particular node is addressed to be the highest (#16) on the network. Slave #2 would have switch #1 in the 'off' position with all other switches set to 'on'.

Connection of Slave board to cells:

Great care must be taken during the connection of the slave board to the actual cells as a single wrong connection or the correct connection in the wrong order can mean the end of the slave board and very possibly other significant damage and fire hazard. Ideally, the slave board would utilize a break away connector that could be wired as a separate step, thoroughly checked and verified and then plugged into the slave board with the ground connections being made first and each cell connection, 1,2,3... being made after that. Because that would be difficult to achieve, another suggestion is that the slave board actually be equipped with a dip style switch that allows each connection to be made through the switch. Because the slave board is only reading the voltages and only handle small balancing currents, the switch does not have to be high current. The proper order for turning on would be during connection, ground, cell 1 +, cell 2+... until cell 12+. During a disconnect, the reverse would occur, that is, switch off cell 12+, cell 11+...

Bill of Materials:

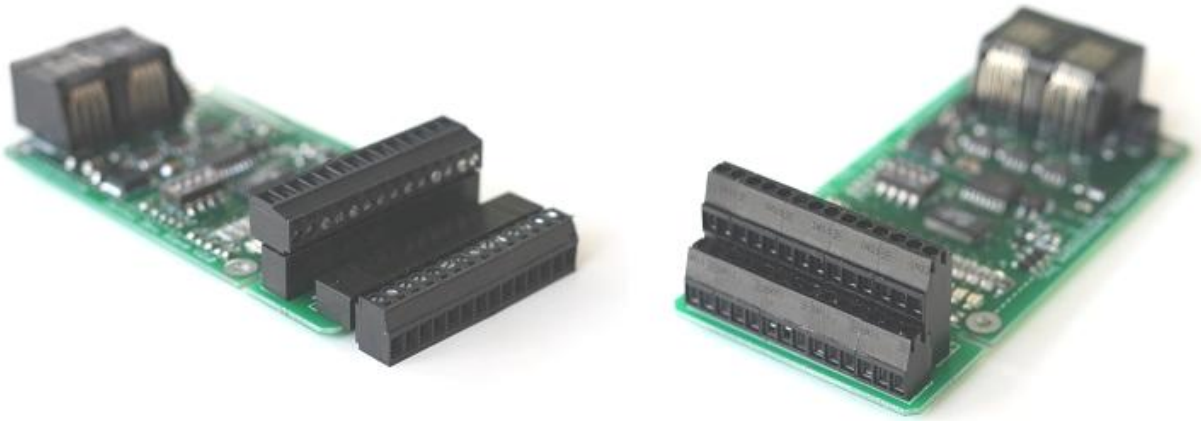
The following pages contain a bill of materials for the slave demo board and options as well as sample pricing as of May, 2011 in Canadian funds.

Development Slave Board V2.0 - last modified June 16, 2011										
						sample pricing from Digikey in Cdn$				
Qty	**Board Ref**	**Value**	**Description**	**Manufacturer #**	**Digikey #**	**Qty 1 $**	**Q1 Total**	**Qty 100 $**	**Q100 total**	
3	C1-C3	1uF	805 size, 16volt			$0.07	$0.21	$0.04	$0.12	
7	C4-C10	.1uF	805 size, 16volt			$0.07	$0.49	$0.04	$0.28	
1	C11	10uF/35v	ceramic	GMK316F106ZL-T	587-1352-1-ND	$0.46	$0.46	$0.19	$0.19	
1	C12	22uF/16v	ceramic	C3225Y5V1A226Z/1.15	445-1596-1-ND	$0.49	$0.49	$0.23	$0.23	
1	CON1-AB	Terminal strip	3.5mm spacing	1720040000	281-1674-ND	$9.55	$9.55	$6.64	$6.64	other connector options are available, see below
1	CON1-CD	Terminal strip	3.5mm spacing	1720060000	281-1675-ND	$11.07	$11.07	$8.58	$8.58	
2	CON2, CON3	Connector	RJ45	5555164-1	A31416-ND	$1.23	$1.23	$0.83	$0.83	
2	D1	68v zener	500mW, SOD123	MMSZ5266BT1G	MMSZ5266BT1GOSCT-ND	$0.54	$1.08	$0.17	$0.34	
1	D2,D3	Schottky diode	SOD123	BAT46W-7-F	BAT46W-7-FDICT-ND	$0.50	$1.00	$0.23	$0.46	
1	D4	Zener diode	12V, SOD-323F	MM3Z12VC	MM3Z12VCCT-ND	$0.45	$0.45	$0.13	$0.13	
3	D5	4001 diode	sma	CGRA4001-G	641-1016-1-ND	$0.68	$0.68	$0.41	$0.41	
1	IC1-IC3	RS485	low current driver	ADM485JRZ	ADM485JRZ-ND	$2.76	$8.28	$1.99	$5.97	
1	IC4	LTC6803-2	Linear Technology	LTC6803G-2		$15.53	$15.53	$12.98	$12.98	Pricing from Linear.com also available from Digikey but more expensive
1	IC5	isolator	Analog Devices	ADUM1401WTRWZ	ADUM1401WTRWZ-ND	$9.69	$9.69	$7.16	$7.16	do not substitute without careful look at current consumption. Must not exceed 4mA
1	IC6	inverter	single inverter	SN74LVC1G04DBVR	296-11599-1-ND	$0.55	$0.55	$0.26	$0.26	
1	IC7	7805	5 volt reg, TO252-3	AP1117D50G-13	AP1117D50GCT-ND	$0.65	$0.65	$0.35	$0.35	
1	IC8	optocoupler		HCPL-181-000E	516-1646-1-ND	$0.52	$0.52	$0.31	$0.31	NOT 425-2116-1-ND or 425-2114-1-ND
1	L1	50 Ohm Ferrite Bead	1206 size	BLM31PG500SN1L	490-1055-1-ND	$0.22	$0.22	$0.18	$0.18	

1	LED1	Green LED	panel LED	SSF-LXH100GD	67-1218-ND	$0.71	$0.71	$0.39	$0.39	
12	LED2-LED13	Green LED	smt LED	APT3216SGC	754-1141-1-ND	$0.18	$0.18	$0.09	$0.09	
1	Q1	Mosfet	P-channel, SOT23-3	TP0610K-T1-E3	TP0610K-T1-E3CT-ND	$0.57	$6.84	$0.34	$4.08	
1	R1	120 Ohm	1206 size			$0.05	$0.05	$0.02	$0.02	
1	R2-R6,R8,R9,R11	100K	805 size			$0.05	$0.05	$0.02	$0.02	
1	R7	1K Ohm	805 size			$0.05	$0.05	$0.02	$0.02	
13	R10, R12-R23	390 Ohm	805 size			$0.05	$0.05	$0.02	$0.02	
3	R25-R27	120 Ohm	1206 size			$0.05	$0.65	$0.02	$0.26	only required for last board on network
12	R28-R39	82 Ohm/ .5w	2010 size	ERJ-14YJ820U	P82VCT-ND	$0.36	$1.08	$0.11	$0.33	small cell balancing. For external balancing, see other examples
1	R24	1 Meg Ohm	805 size			$0.05	$0.60	$0.02	$0.24	
1	SW1	4 pos switch		219-4MST	CT2194MST-ND	$0.75	$0.75	$0.62	$0.62	
1	TVS1	transorb	SMA size, 20volt	SMAJ20CA-13-F	SMAJ20CA-FDICT-ND	$0.68	$0.68	$0.36	$0.36	
2	not shown	100K NTC Thermistor		MF52A1104J3950	317-1264-ND	$0.39	$0.39	$0.19	$0.19	
	PCB					$8.50	$17.00	$3.40	$6.80	based on $1.25in^2 for proto and $.50in^2 Qty 100
					Total		**$91.23**		**$58.86**	includes $16 connector CON1 so this price could be lowered with other selection

Connector options

The following two options are shown for the connections to the cells.

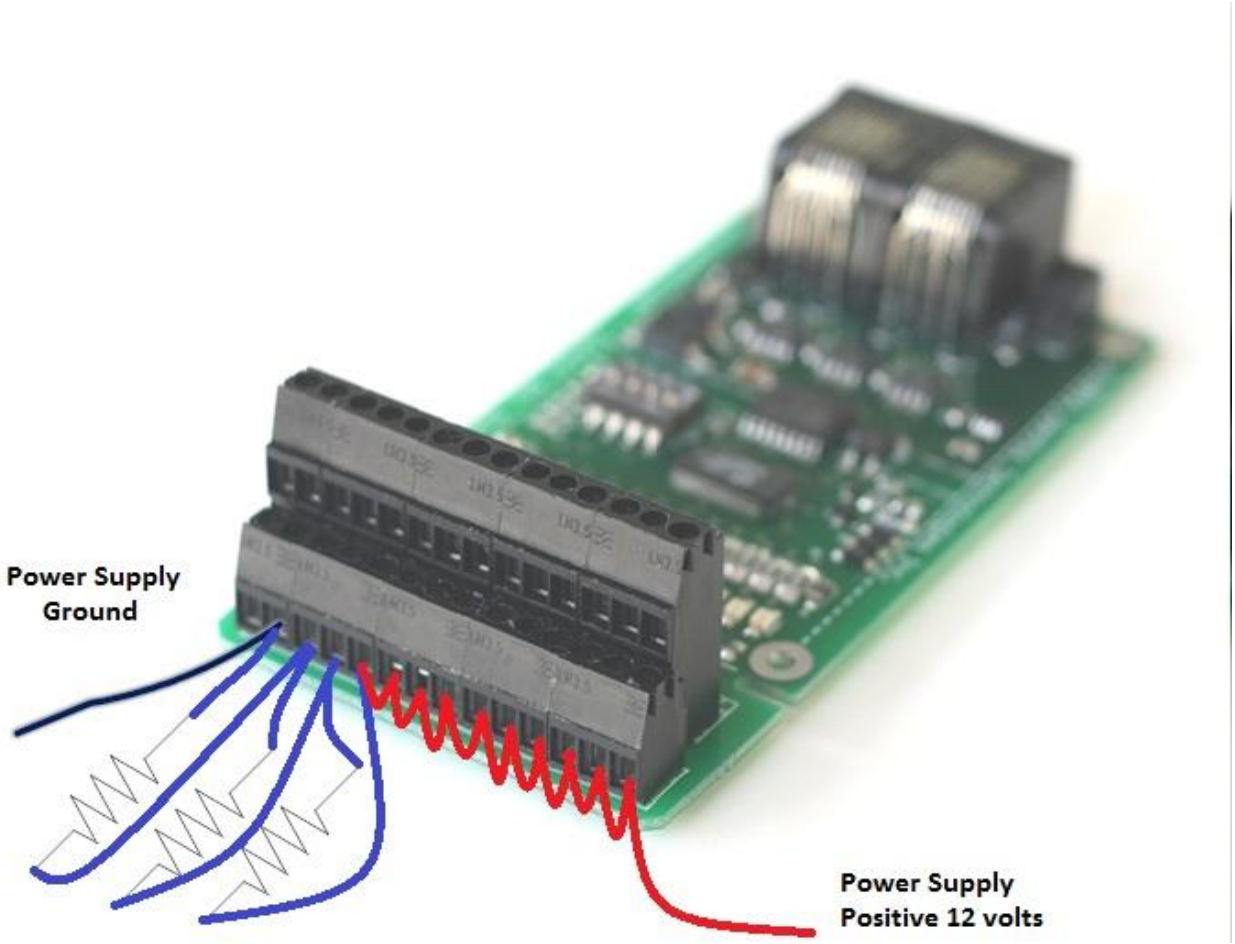


The connector shown on the left is a break- away connector made from the base parts
Molex 39501-1014 vertical socket (Digikey WM7763-ND)
Molex 39502-1014 right angle (Digikey WM7782-ND)
And two Molex 39500-0014 terminal blocks (Digikey WM7744-ND)

The connector on the right does not separate and is made from Weidmuller parts 1720040000 and 1720060000 (Digikey 281-1674-ND and 281-1675-ND) With other combinations also possible.

Initial Testing of Slave board

It is recommended that you test the slave board with resistors and a power supply before connecting to your cells. Note that because the slave board gets its power on the LTC6803-3 side from the cell connections, there will be no communications to the master board until there is power available on the cell connections with a minimum voltage of approximately 10v.

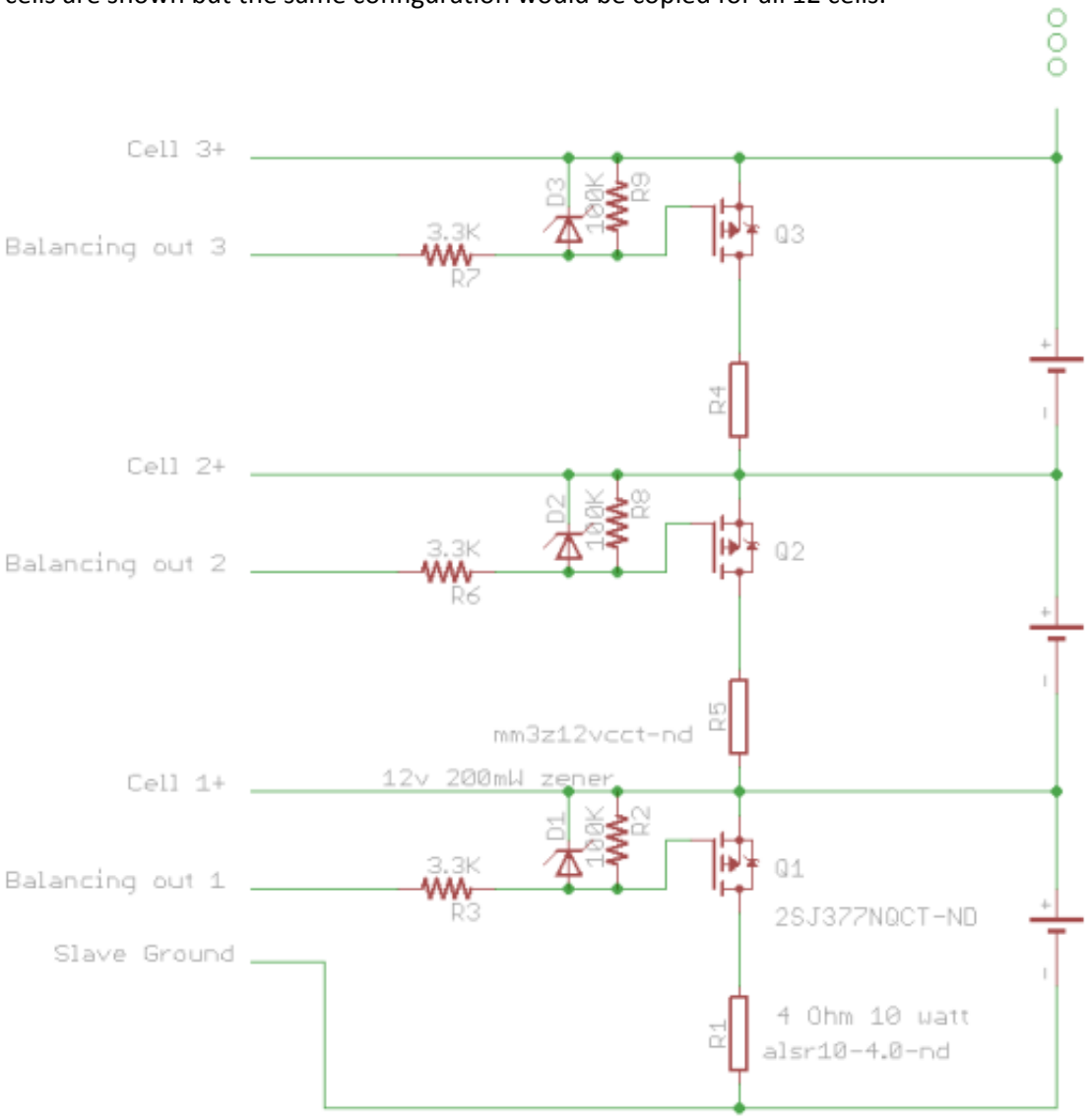


The three resistors can have the value of 1000 ohms or whatever is available without drawing too much current. The red wire in the picture shows a jumper connecting the third resistor to each of the upper cell connections so that the 12 volts will power the board through the top connection.

Note that the thermistors are not shown connected and will therefore show a false reading.

External cell balancing circuitry

The following circuit shows a higher current mosfet being used to externally balance a cell. Only the first three cells are shown but the same configuration would be copied for all 12 cells.



The 4 ohm balancing resistor sets the current around 1 amp with the mosfet rated for 5 amps.

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