Introduction

The Ten-D Energies PowerChest is a kit that provides backup AC power that is custom assembled by the customer. The customer selects an inverter that meets their needs, then selects batteries that meets the needs of the inverter and run time required. Then assembling the system with Ten-D BMS will enable monitoring and control of the system. As latest battery technologies rely on lithium chemistries, these batteries have to be aggressively monitored else damage can occur to the battery/equipment/etc. Using Ten-D battery management systems (BMS) will provides safety monitoring and management

for any lithium ion-based storage system. Active balancing technology combined with additional sensor(s) data allows the Ten-D Energies BMS to outperform many existing BMSs that are currently in use today. Gathering and analyzing the data using cloud computing gives Ten-D Energies unique insight into the conditions of the battery source, which then translates for a better algorithm for accurately calculating SoC and SoH for user pack. For better accuracy calculations, user data is feedback into the Ten-D Energies which is then uploaded to the customers BMS, note the customer can opt out of this feature.

http://www.tendenergies.com

Features and What's Included

1) Controlled Junction Box
- 48V compatible, 12s configuration
- 200A peak, 125A continuous
- Slow blow fuse
- Main contactor or relay array
- Pre-charge circuit
- Hall-effect current sensor
- Indoor rated

2) Interface, BMS master controller
- Raspberry Pi 3 based
- LCD, Touchscreen
- Wi-Fi or Ethernet connectivity*
- Wiring and connectors
- Enclosure (optional)
- Overcharge protection
- Undercharge protection
- Overcurrent protection
- Isolation fault detection
- Bad cell detection + audible alarm
- Displays battery status

3) Battery management boards (BMBs)
- Two (2) boards supporting 6s each
- Wire harness for common batteries
- Adapter for batteries in parallel
- Isolated CAN communication
- Active or passive balancing
- Two (2) external thermistors each
- Handles 3KWh or more, scalable

4) App, Cloud access
- iPhone compatible
- Up-to-date display
  - o Individual cell voltages
  - o Thermistors temperatures
  - o Overall current
- Show history of data
- BMS can be updated OTA*

*Requires Internet-connected Ethernet or Wi-Fi access point

Documentation
- Assembly and wiring how-to, links will be on Kickstarter.
- User Manual, links will be on Kickstarter.

POWERCHEST
BETA

Batteries Not Included: A list of what needs to be provided
- 12s Li-Ion based battery modules (e.g. Leaf cells, Fiat 500e batteries from sources like eBay)
- Inverter or Inverter/Charger compatible with 48V input (e.g. Magnum MS4448PAE)
    - If using the Magnum MS4448PAE, the remote-control is required P/N ME-RC50
- Charger (if inverter does not have it built-in)
- Ethernet cable (if not using Wi-Fi)
- Rack or some other enclosure is highly recommended
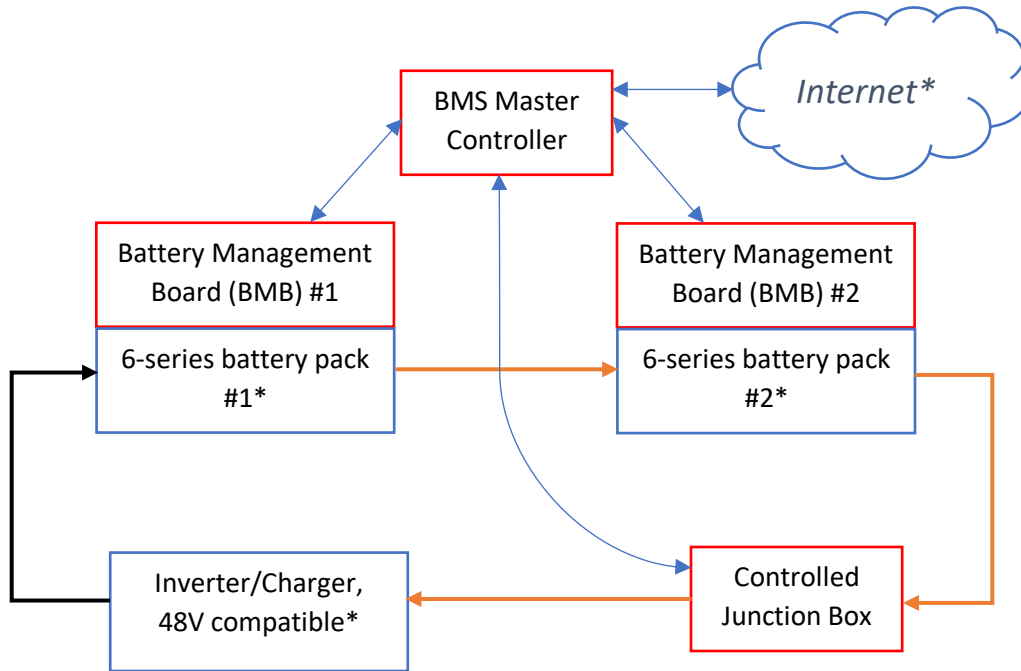- Simple tools and labor

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Inverter selection

- Magnum MS4448PAE 4KW output, (recommended, tested)
- Aims Power PICOGLF60W48V120V 6KW output (tested, but waveform distorts under higher load)

Typical Layout of PowerChest Assembly

* User provided component.

Figure 1

DC Characteristics of the BMS

Table 1: **Absolute Maximum Ratings**

Symbol	Description	Min	Max	Units
Battery Management Board (BMB)				
V_{CELL}	Individual cell voltage.	2.0	4.2	V
V_{SERIES}	Voltage of all cells in series.	8.0	35.0	V
V_{CANH}, V_{CANL}	CAN signal line voltage with reference to CAN ground**	-36	36	V
V_{ABR*}	Voltage between the positive and negative lines of the active balancing rails.	-0.5	12.0	V
V_{TEMP}	Temperature sensor input	-0.5	6.0	V
I_{CELL1}	Single cell discharge current during passive balancing.	0.83	1.75	A
I_{CELL2}	Single cell charging current during active balancing.	0.3	1.75	A
I_{SERIES}	Current draw from all cells in series.	3	400	mA
I_{ABR*}	Current flow over active balancing rails.	0.0	0.6	A
T_{STG}	Storage temperature (ambient)	-65	150	°C
T_{OP}	Operational temperature (ambient)	-40	125	°C
Battery Management System (BMS) Master Controller				
V_{INPUT}	Operational voltage	9.1	40	V
P_{INPUT}	Power consumption	6	10	W
I_{INPUT}	Current draw	0.125	0.2	A
I_{SENSE}	Current sensor LEM HO 50-S	-300	300	A
T_{STG}	Storage temperature (ambient)	-65	150	°C
T_{OP}	Operational temperature (ambient)	-40	125	°C

    * Do **not** connect active balancing rails to external power source or load.
    **CAN ground is isolated from all other ground references.

Table 2: **Recommended Operating Conditions**

Symbol	Description	Min	Max	Units
Battery Management Board (BMB)				
V_{CELL}	Individual cell voltage.	2.7	4.1	V
V_{SERIES}	Voltage of all cells in series.	9.0	33.6	V
V_{CANH}, V_{CANL}	CAN signal line voltage with reference to CAN ground**	0.0	5.0	V
V_{TEMP}	Temperature sensor input	0.0	2.56	V
T_{STG}	Storage temperature (ambient)	-40	125	°C
T_{OP}	Operational temperature (ambient)	-10	85	°C
Battery Management System (BMS) Master Controller				
V_{INPUT}	Operational voltage	10	36	V
P_{INPUT}	Power consumption	tba	10	W
I_{INPUT}	Current draw	tba	1.1	A
I_{SENSE}	Current sensor LEM HO 250-S	-200	200	A
T_{STG}	Storage temperature (ambient)	-40	125	°C
T_{OP}	Operational temperature (ambient)	-10	85	°C

    **CAN ground is isolated from all other ground references.

Inverter (recommend Magnum MS4448PAE) Specifications

Output Power	4,400W
Peak Watts	8,500W
Output Voltage	120 / 240 VAC
Output Peak	70amps
Output Current	35amps
Output Waveform	Pure Sine
Output Frequency	60 Hz
Input Voltage	48 VDC
Continuous Output Amps	35amps
Operating Temp	-20° C to +60° C (-4° F to 140° F)
Efficiency	94%
Weight	55 lb (24.9 kg)
Dimensions	13.75"x12.65"x8.0" (34.9 cm x 32.1 cm x 20.3 cm)
UL Certified	Yes
Phase	Single
Topology	Low Frequency
Input Battery Voltage Range	36.0 - 64.0 VDC
Battery Side Fuse	200amp ANL

Specifications for Controlled Junction Box

Electrical and Communications
- Supports 12s configuration   36-50V DC input range   12V compatible GPIO signals   - No reverse protection   - Slow blow fuse rated at 200A
Mechanical
- Physical overall dimensions: W:21" X D: 23.5" X H: 40.5"   - Mounting type: Free standing   - Connectors: - Main contactor input, 00 gauge with ring terminal   - Main contactor output, 00 gauge with ring terminal   - Current sensor signal cable, 5-pin is **JST PHR-5**   - Contactor control line, flying lead   - Pre-charge circuit control line, flying lead   - Ground wire, flying lead   - Indoor use only   - Weight: 5kg   - Temperature range: 10c – 50c
Certifications
RoHS compliant

Specifications for BMS Master Controller

Electrical and Communications
- CAN baud rate: 500 kbps   - CAN channel isolation: Yes   - RF specs: WiFi 802.11 b/g/n   - Computing System: Raspberry Pi 3   - Processor: ARM Cortex-A53   - Ethernet: Gigabit-compatible   - OS: Windows IoT   - Input voltage range: 36-67V DC

Electro-mechanical
- Physical overall dimensions: 121mm x 219mm x 80mm   - Mechanical mounting type: panel/screw.   - Connector types: - Molex for CAN and BMB enable P/N 0430451021   - Current sensor connector **JST PHR-5**   - Contactor on/off signal, block terminal   - Pre-charge on/off, block terminal   - Power, block terminal   - Ethernet   - LCD touchscreen: Capacitive   - Indoor use only   - Weight: 2kg   - Temperature range: 10c – 50c

Safety
- Overcharge protection   - If a cell exceeds maximum cell voltage, unit will shut off. 1s max delay.   - Undercharge protection   - If a cell drops below a min cell voltage, unit will shut off. 1s max delay.   - Overcurrent protection   - If the system draws more than +/-125A for over 6s, unit will shut off.   - Temperature monitoring   - If the external thermistor temp sensors exceed safe limits, unit will stop charging.   - Isolation fault detection   - If any cell short-circuits to the chassis (rack or other enclosure), unit will shut off. 1s max delay.   - Bad cell detection + audible alarm   - If any cell voltage or temperature is out of bounds, alarm will sound. No delay.

Certifications
RoHS compliant