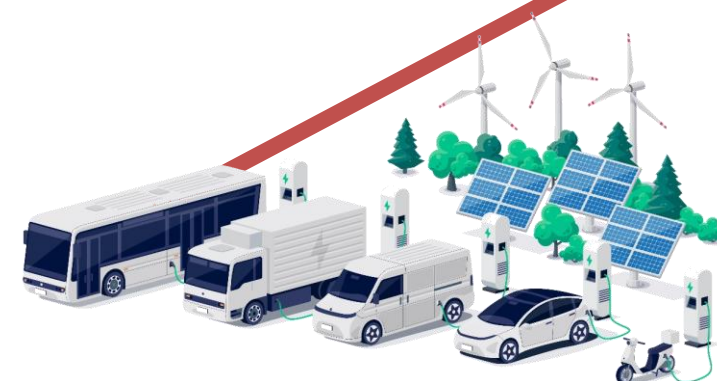




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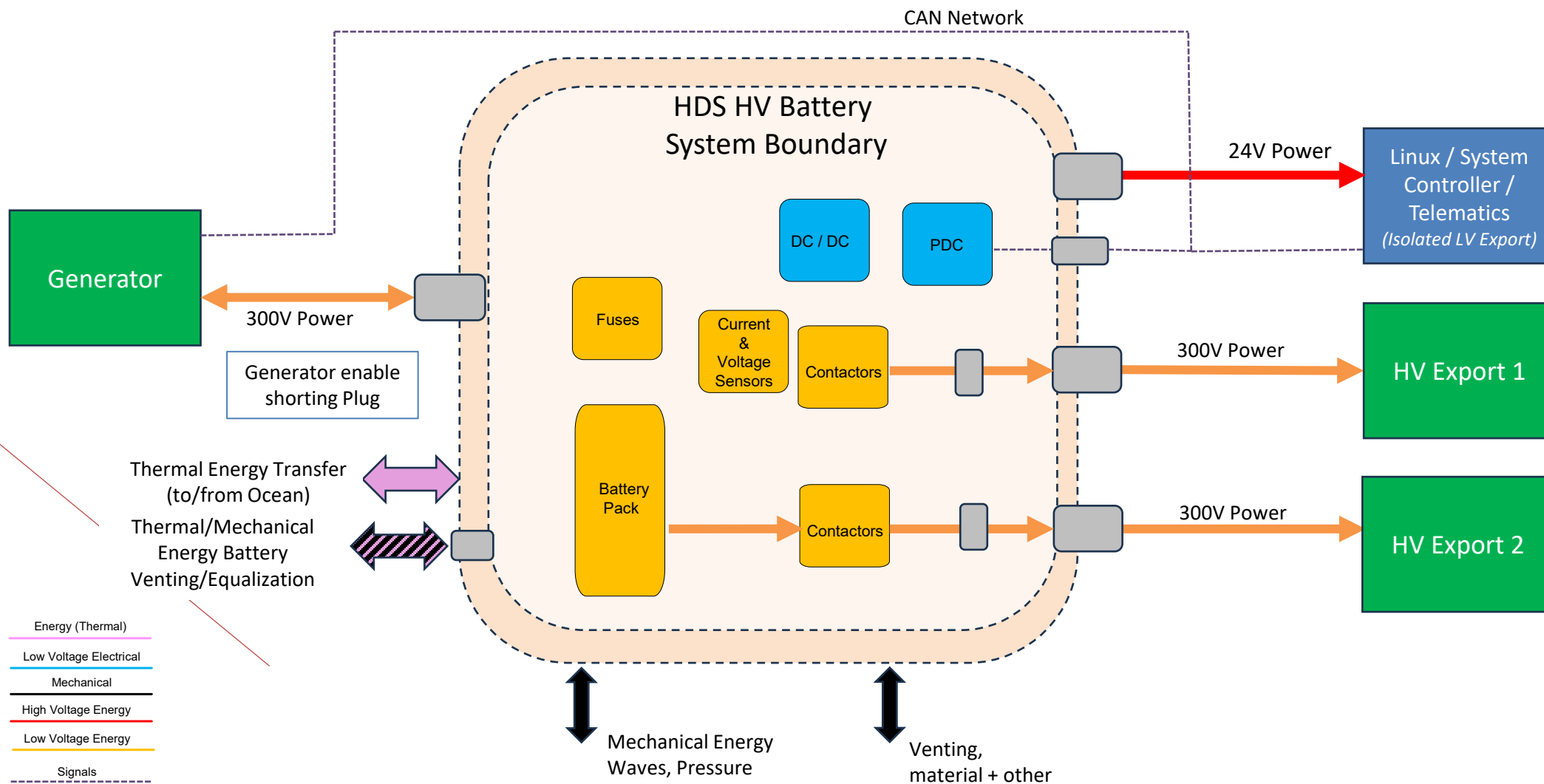
HARBOR Battery 07/29/2025



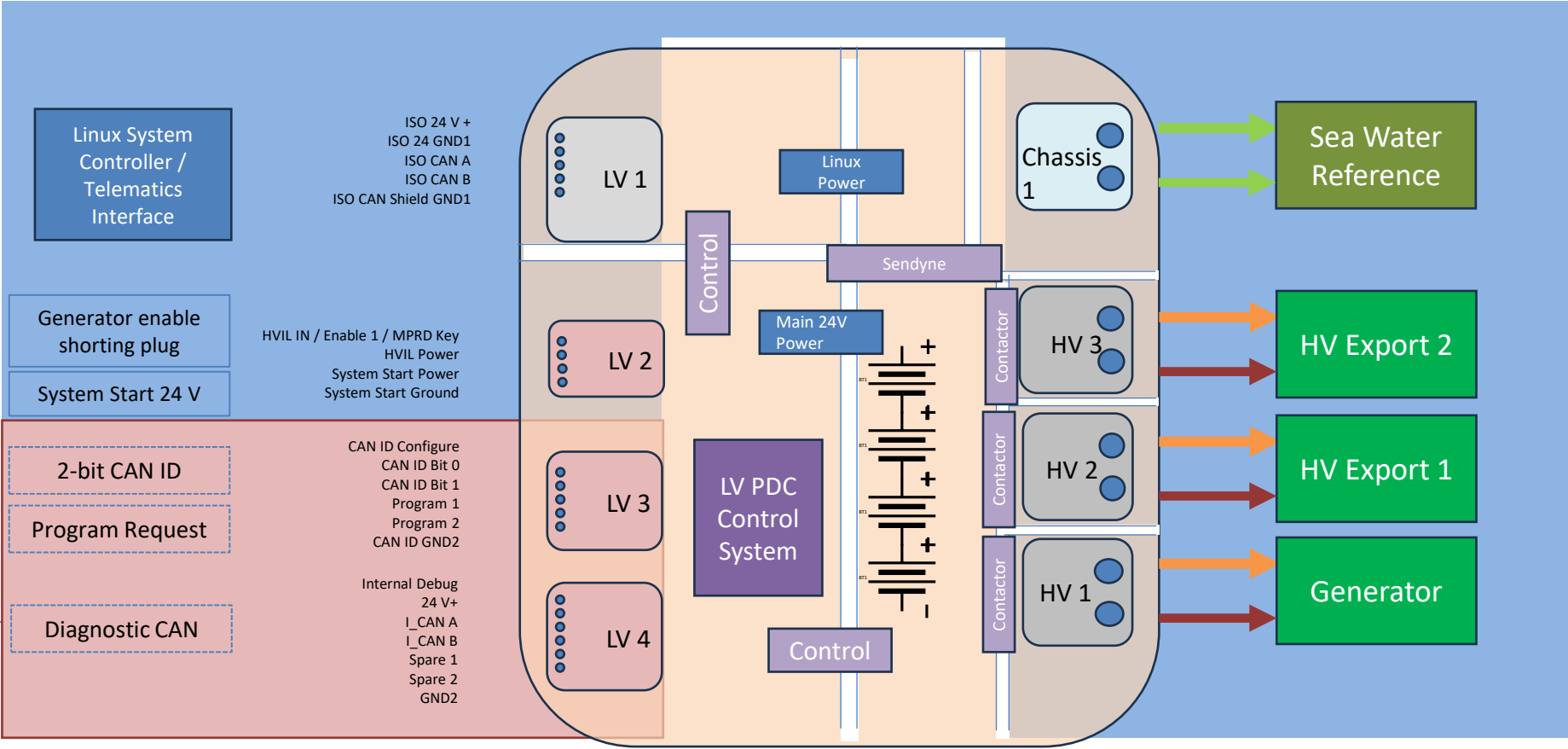
Agenda

- Status / Review
 - System Implementation
 - System Operating Detail
 - System Power Draw
 - System Faults and Reactions
- Parts Status
 - Battery End Caps tooled and received – starting battery module build
 - Power Supplies, Off the shelf components and PDU parts selected
 - Controller Selection
 - Complete Milestone 2: Design Freeze and Procurement of Long Lead Parts Freeze
- Next Steps
 - Finalize CAN Database

Harbor – Boundary Diagram

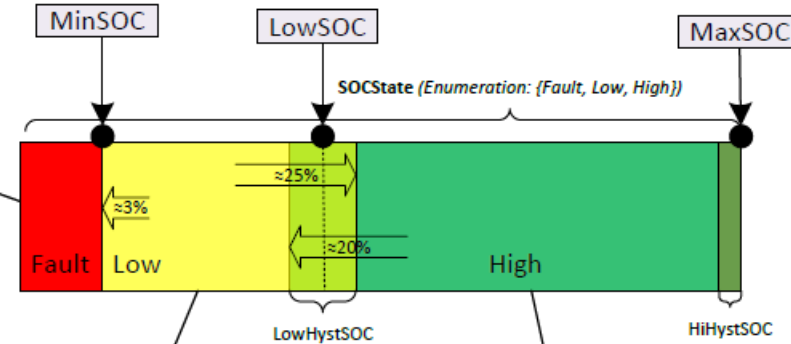


Harbor – Electrical I/O Concept



SOC Based Operating Modes

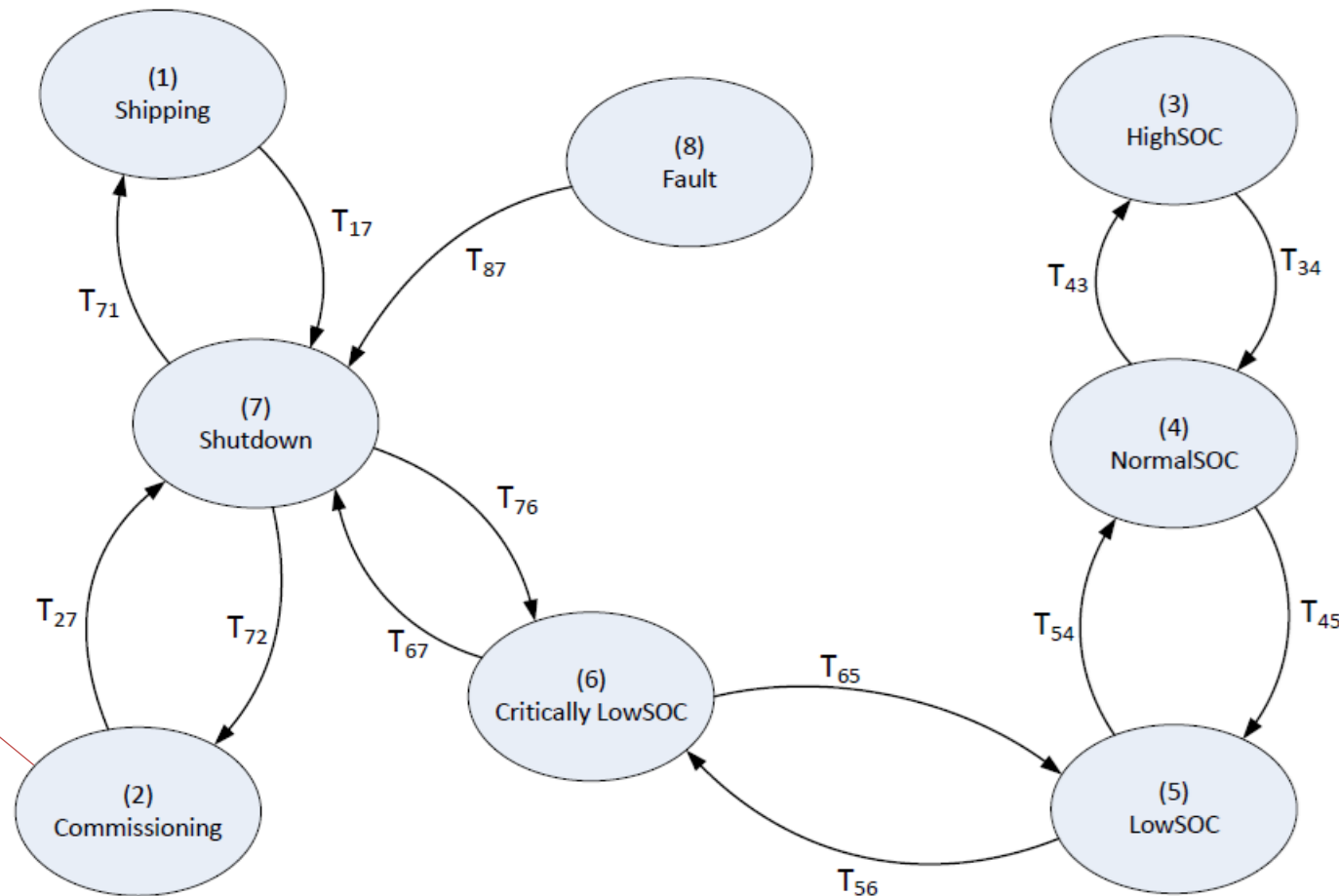
- **"SysEnable = false"**
- **"DisChgEnable = false"**
- **"ChgEnable = false"**
- Damage to cells is possible
- Human intervention required inspect and recover pack.
- BSA will wake PDC at "MinSOC" PDC will then fully disconnect ALL loads from the pack except for CMUs



- **"SysEnable = true"**
- **"DisChgEnable = false"**
- **"ChgEnable = true"**
- PDC de-energizes all loads except genset contactors to minimize parasitic loads. PDC puts itself to sleep
- BSA will wake the PDC if the pack voltage goes higher than "LowSOC"
- System is designed using existing load case data such that "SOCState=Low" is rarely entered. The compromise is usable system capacity

- **"SysEnable = true"**
- **"DisChgEnable = false"**
- **"ChgEnable = true"**
- All systems are fully awake and operational.
- System is available to provide power to export circuits
- PDC will de-energize Genset contactors at "MaxSOC"

System Operation Diagram



- System Faults
- Loss of communication (Generator, Linux)
 - Isolation Fault (Generator, Export 1, Export 2)
 - Stuck Contactor
 - Battery Failure
 - Battery SOC
 - Temperature
 - Internal Failure

System Operating Detail

Power Mode	Shipping	Comission	High SOC	Normal SOC	Low SOC	Critical Low SOC	Shutdown	Linux CAN Fault	GEN CAN Fault
Battery Draw without Generator					8 W	8 W			
HV Export 1									
HV Export 2									
Linux DCDC									
Main 24 V Power									
System Start 24 V									
Isolation Monitor									
Battery Safety Sensor									
Generator Contactors									
Power Distribution Controller (PDC)									
BMS									

No Effect	
Active	
External Control	
Sleep / Intermittent	
Not Powered	

Feature will operate correctly based SOC and operating mode even with the fault.

Feature is un-equivocally on or active.

Externally commanded operation or externally supported.

Feature in low current mode with wake up based on SOC and system voltage.

Feature is not powered

System Power Draw

Description	Current		Operating Mode													
	Data Sheet Values		Shipping		Comissioning / Diag		Normal SOC / ON		High SOC		Low SOC		Critical Low SOC / External Power		Shutdown	
	Active	Sleep/STDBy	Qty	Total	Qty	Total	Qty	Total	Qty	Total	Qty	Total	Qty	Total	Qty	Total
All at 24VDC																
Controller current	1.0000	0.0010	0	0.00	1	1.00	1	1.00	1	1.00	1	0.0010	1	1.00	0	0.00
Contactor Generator	0.0700	0.0700	0	0.00	2	0.14	2	0.14	0	0.00	2	0.1400	2	0.14	0	0.00
CVT Generator	0.1000	0.0200	0	0.00	1	0.10	1	0.10	1	0.10	0	0.0000	0	0.00	0	0.00
SSPC / SSPC Relay Generator	0.0655	0.0655	0	0.00	1	0.07	1	0.07	0	0.00	0	0.0000	0	0.00	0	0.00
Contactor Export 1/2	0.0833	0.0833	0	0.00	4	0.33	4	0.33	4	0.33	0	0.0000	0	0.00	0	0.00
CVT Export 1 / 2	0.1000	0.0200	0	0.00	1	0.10	1	0.10	1	0.10	0	0.0000	0	0.00	0	0.00
SSPC / SSPC Relay Export	0.0655	0.0655	0	0.00	1	0.07	1	0.07	1	0.07	0	0.0000	0	0.00	0	0.00
DC/DC 1 Stand By Main + Relay	0.0291	0.0000	0	0.00	1	0.03	1	0.03	1	0.03	1	0.0291	0	0.00	0	0.00
DC/DC 2 Stand By LV Export + Relay	0.0291	0.0000	0	0.00	1	0.03	1	0.03	1	0.03	0	0.0000	0	0.00	0	0.00
Isolated CAN Repeater	0.0833	0.0000	0	0.00	1	0.08	1	0.08	1	0.08	0	0.0000	1	0.08	0	0.00
Wake Circuit	0.0100	0.0100	0	0.00	1	0.01	1	0.01	1	0.01	0	0.0000	1	0.01	0	0.00
Relay MPRD/LV	0.0083	0.0083	0	0.00	1	0.01	1	0.01	1	0.01	0	0.0000	0	0.00	0	0.00
BES	0.0200	0.0090	0	0.00	1	0.02	1	0.02	1	0.02	0	0.0000	1	0.02	0	0.00
IMD	0.0198	0.0000	0	0.00	1	0.02	1	0.02	1	0.02	0	0.0000	1	0.02	0	0.00
CMU	0.0136	0.000012	6	0.00	6	0.08	6	0.08	6	0.08	6	0.0041	6	0.08	6	0.00
BMS	0.1458	0.0004	0	0.00	1	0.15	1	0.15	1	0.15	0	0.0000	1	0.15	0	0.00
Total Current				0.00		2.23		2.23		2.03		0.17		1.50		0.00
Fudge Factor	120%															
DCDC Efficiency	80%															
HV Battery Output Power	Watts			0.0027				80.3		72.9		6.3				0.0027
20% to 5% SOC Duration	Days											6				
External Power	Watts					64.26								43.21		

System Faults

- Loss of Communication
 - With LINUX / External controller
 - Not able to turn on Export Power
 - Disable Export Power
 - With Generator
 - Generator operates with a default table based on voltage

- Proposed:

Generator Output Power		
Voltage	Corresponding SOC	Max Output Power
< 260 V	5% to 35%	300 W
260 V to 285 V	35% to 85%	5kW
285 V to 295 V	85% to 95%	200 W
>295 V	>95%	0 W

- Battery System – No change in operation

System Faults

- Export Faults
 - Stuck contactor, Unable to close contactor
 - Disable individual power export
 - Provide a warning message
 - Overcurrent
 - Turn off export until request to turn off followed by a request to turn on
 - Provide a warning message
 - Open Fuse
 - Disable individual power export
 - Provide a warning message
 - Unable to Pre-Charge
 - Disable individual power export
 - Provide a warning message
 - Pre-Charge too fast – TBD Open Load
 - No effect
 - Provide a warning message

System Faults

- Generator Contactor Faults
 - Stuck contactor, Unable to close contactor
 - Provide a warning
 - Overcurrent
 - Provide a warning
 - Open Fuse
 - Disable generator
 - Provide a warning
 - Unable to Pre-Charge / Shorted output
 - Turn off
 - Provide a warning
 - Pre-Charge too fast – TBD Open Load
 - No effect

System Faults

- Isolation Faults
 - Isolation Fault Level
 - Typical 500 Ohm / Volt @300 V = 150K (2 mA)
 - Provide a Warning message
 - If isolated to the exports, disable export for that operation cycle
 - If isolated to the generator – disable the generator input
 - Isolation Warning
 - TBD 2 x Fault Level = 300 K (1.0 mA)
 - Provide a Warning message
 - If isolated to the exports, disable export for that operation cycle
 - If isolated to the generator – warning only

System Faults

- Battery Faults
 - Critical Faults
 - Over temperature
 - Bad Cell / under voltage
 - Cell vent detection
 - Provide warning message and shut down system
 - Warning Faults
 - Cell Temp High or Low
 - Low SOC
 - Low SOH
 - Provide warning message

Controller Selection

TTControl
HYDAC INTERNATIONAL

TTC 2000 – TTControl's new ECU Series Key benefits of family concept

In production	In Concept Phase	In production	In Concept Phase	SOP 2025
				
TTC 2030 32 I/Os	TTC 2100 48 I/Os	TTC 2300 62 I/Os	TTC 2500 98 I/Os	TTC 2700 132 I/Os

Functional Safety	Cybersecurity	Scalability & Flexibility	Complex Automation	Faster time to market
Various certifications	Secure boot	Family concept	High speed interfaces	Full MATCH Integration
Safe libraries	Secure communication	Software building blocks	New interfaces such as SENT, fast outputs, ...	Seamless re-use of code
Mixed criticality	Secure tools	High configurability of I/Os	High performance with multi-cores	Simulation and Testing

TTC ACADEMY

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Controller I/O

- **8 x PWM/Digital Outputs** (high-side, up to 4 A, configurable as analog inputs or timer inputs)
- **6 x Digital Outputs** (high-side, up to 4 A, configurable as PVG, analog, or emergency stop outputs)
- **2 x PWM Outputs** (low-side, up to 4 A, configurable as analog or timer inputs)
- **8 x Analog Inputs** (0–5 V, 12-bit, with configurable pull-up/down)
- **2 x Analog Inputs** (0–32 V, 12-bit, with configurable pull-up/down or emergency stop IN)
- **6 x Digital Timer Inputs** (0.1 Hz – 20 kHz, encoder support, configurable as analog or SENT)
- **4 x SENT Interfaces** (with SPC support)
- **2 x CAN FD Interfaces** (one with ISOBUS support)
- **1 x LIN Interface**
- **Sensor Supply:** 5 V, max 250 mA