Bridging the Gap to Full Electrification in Ports

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Growth of Port Electrification

Port Electrification is expanding

Ports expanding use of battery powered equipment

- Legislation is accelerating the transition
- Government funding is available to support

Bespoke interfaces depending on power

- Reduces interoperability and scalability
- Ports will not accept closed ecosystems
- Difficult to scale solutions

Grid power availability

- Grid infrastructure expansion is moving slow
- Some ports with poor power availability

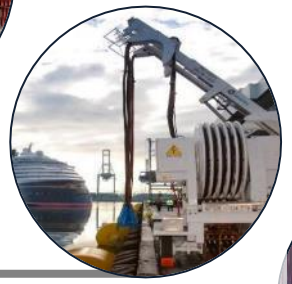
Information Classification: General

Electrification Landscape in Ports

Well on the way

STS Cranes — Cable Reel

RTGs / RMGs — Cable Reel / Busbar



Shore Power — Cable Reel

AGVs — Battery Swapping / QCC

Reach Stackers / Strads / Yard Tractors — Battery Powered (CCS / MCS)

Information Classification: General

What are the Roadblocks?

Not as many…

Machinery Uptime

- 24/7 operation
- Charging time -> downtime

Grid Availability

- Grid expansion takes a long time
- Agreement on who will take the bill

Information Classification: General

Picture source: Chris Hunkeler 510-621-3391

What is MCS?

Megawatt Charging System – A key part of the solution

CHARIN

A standard high power connection interface

Developed jointly by a multi-industry taskforce through CharIn

Facilitate high power charging with a connector light enough to connect by hand

Bring economies of scale into niche industries

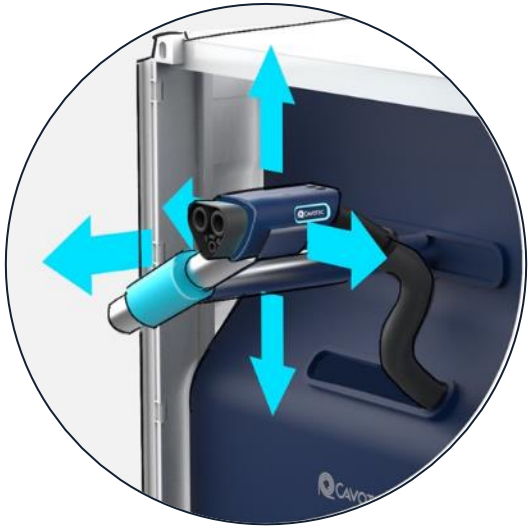
Information Classification: General

What does MCS Solve

Making scalability accessible

Compact / Lightweight

- light enough to connect by hand
- Can also be automated
- Small size for high power charging



Increased Uptime

- Fast Charging
  (high power charging)
- Fast connect / disconnect
- Scalable and Interoperable

Green Solution

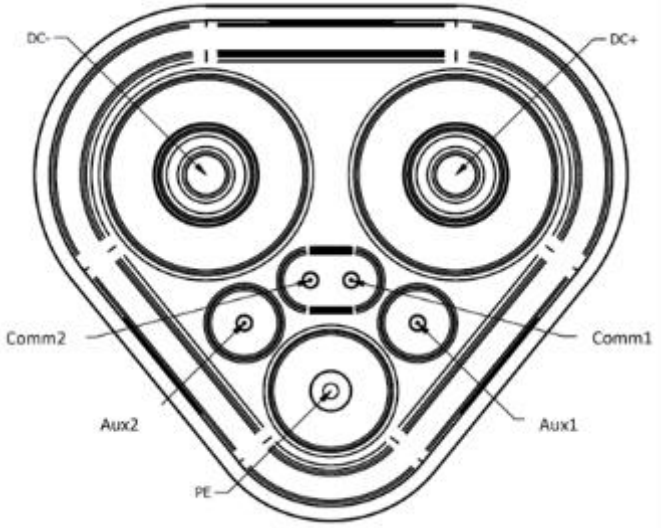
- CO2 Emission Reduction
- Noise Reduction

Information Classification: General

MCS - A Standard Specification

That meets industry needs

Voltage (DC):	1.500VDC max.
Amperage:	3.000A max.
Total Power:	4.5MW max. (@1500VDC)
Cycles:	10.000 (target)
Dedicated Power Levels:	
Level 1	Up to 350kW (no cooling)
Level 2	Up to 1MW (liquid-cooled cable and connector)
Level 3	Up to 4.5MW (liquid-cooled cable, connector & inlet)
Communication Protocol to BMS:	ISO 15118 – Ethernet (CANBUS possible)
Locking:	Solenoid operated interlock
Insertion Force:	100N
Additional Features:	Replaceable pins from front (Cavotec standard for industrial connectors)
	Aluminium outer housing
	On-board temperature sensing for cable & pins



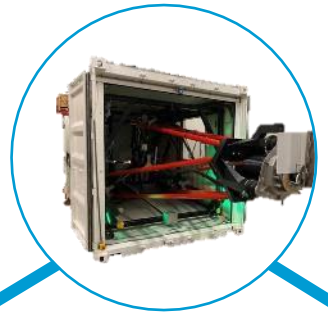
Information Classification: General

Charging System in Modules

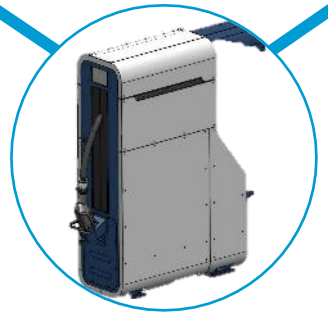
Transformer

Power Electronics

Cooling

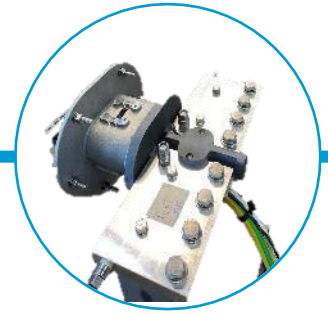


ACS



Manual Dispenser

MCS cooled cable and connector



Inlet

	Transformer	Power Electronics	Cooling	ACS / Manual Dispenser	MCS cooled cable and connector	Inlet
Cavotec scope	☑	☑	☑	☑	☑	☑
Comments	Flexible to local power supply Stand-alone or Integrated in PEC Mobile	Mobile solution Modular, scalable from 1MW to 6MW	Cooling container, possibility to combine PEC and MCS cable cooling	Manual or Automated Connection System for autonomous mine operation	First global MCS L3 cooled cable and connector serial supplier Robust aluminum design	MCS interoperability Small footprint for easy integration Cooled busbar design Dust cap

Information Classification: General

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