

AI Infrastructure and Liquid-cooled Controls Design based on EcoStruxure Building Operation

Design Overview

Data Center IT Capacity: 7,392 – 7,536 kW

Tier Availability: Tier III

Annualized PUE at 100% Load

San Francisco, CA: 1.12

Dallas, TX: 1.13 – 1.14

Singapore: 1.16 – 1.17

Paris: 1.09 – 1.10

Racks and Density

Total Racks: 96

Rack Power Density:

Networking racks up to 22 kW/rack

AI racks up to 142 kW/rack

Data Center Overall Space

NAM 37,774 ft²

IEC 3,509 m²

About this Control Design

- **BMS–Interoperability–** Enables real-time communication between the Building Management System (BMS) and cluster management software to protect servers and racks
- **Creation of a standardized format interface publishing EPMS/BMS data** for consumption by local applications and upstream data consumers and tools, Digital Twins, AI/ML and other Enterprise systems
- **Redundant controls design for cooling infrastructure**, including Coolant Distribution Units (CDUs), electrical distribution panels (RPPs), across white and grey space environments
- **AI Rack Power Profiling:** Includes new guidance for measuring AI rack power profiles, with a focus on Rack Peak Power and power quality monitoring

Introduction

AI factories and liquid cooling bring new challenges to data center design. Schneider Electric's data center reference designs help shorten the planning process by providing validated, proven, and documented AI infrastructure designs to address such challenges. This design focuses on the deployment of AI infrastructure for AI factories, specifically for *NVIDIA GB200 NVL72 and GB300 NVL72* based cluster such as NVIDIA DGX SuperPOD, in a single data hall. It will be extensible to NVIDIA Vera Rubin NVL72. The data hall is purpose-built and optimized using liquid-to-liquid CDUs and fluid coolers with adiabatic assist. Facility power and cooling design are optimized for capital cost, efficiency, and reliability.

Controls Reference Design CRD2 includes information on these technical areas: **EPMS/BMS** interoperability with NVIDIA Mission Control (AI factory operations and orchestration software, including Cluster and Workload Management features) and other local or enterprise applications, **Controls System** for cooling infrastructure, coolant distribution units (CDUs), electrical infrastructure as Remote Power Panels (RPPs), **end to end Electrical Distribution from high voltage to the low voltage power trains** feeding IT and mechanical loads, including new guidance for measuring AI rack power profiles.

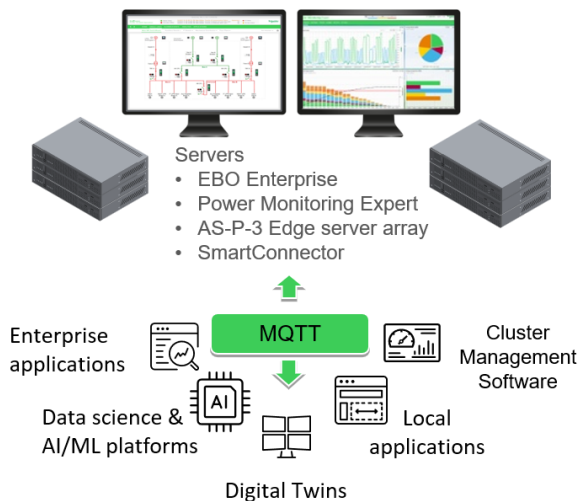


BMS and EPMS

EcoStruxure Building Operation (EBO) delivers a powerful, scalable platform that connects building management and electrical power monitoring systems into a unified, intelligent ecosystem.

EPMS and BMS Interfaces

EcoStruxure Platform: EBO + PME



EcoStruxure Building Operation will publish Mechanical and Electrical Power Monitoring System data in a standardized format for consumption by local applications and upstream data consumers and tools. Upstream systems may include NVIDIA Mission Control, Power Steering Algorithms, Digital Twins, AI/ML and other Local and Enterprise systems.

This “Data Catalog” publishing is designed to provide high quality and easily consumable data by these upstream systems. The design is flexible and decouples the naming convention of the Data Catalog publishing so that the system doesn’t dictate this naming convention but rather allows the local and upstream systems to set their own namespace requirements.

EBO with Power Monitoring Expert will deliver the BMS and EPMS through a single pane of glass. Power Monitoring Expert (PME) supporting advanced EPMS functions such as voltage dips, swells, and transient analysis. EBO and PME work together to provide energy consumption calculations, alarm notifications, trending data on equipment power profiles and facility power disturbances and PUE calculations.

To ensure accurate and granular monitoring, power quality meters with high resolution (samples per cycle), on-board data logging, and high precision will be distributed across the electrical infrastructure.

The system will publish both data point values & timestamp and its associated metadata describing those data points to upstream systems via a MQTT interface. This interface is assured through EBO communicating to a third-party MQTT broker.

This “Data Catalog” will be expanded to publish to DSX Exchange (Unified IT/OT) to integrate the BMS with DSX Boost.

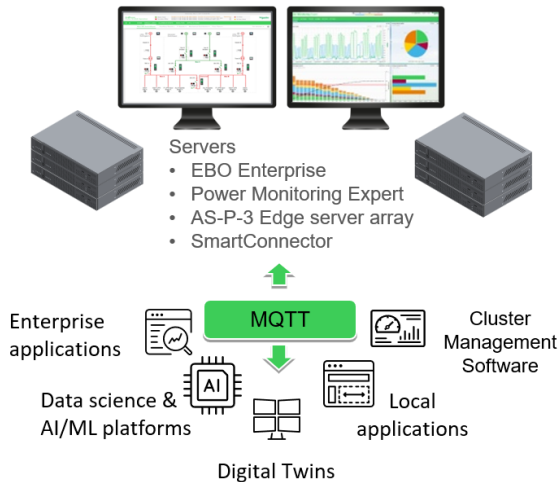
Data Catalog Publishing principles

- The format of the data publishing will consist of a Value and Timestamp for each data point published, and Metadata that describes each data point being published.
- The data point naming convention of this Value/Metadata combination will be flexible so customers can adopt their own namespace. This will decouple the design of the Data Catalog publishing so that the system doesn’t dictate the namespace of the naming convention but allows the consuming systems to set the publishing requirements.

Application Design for Data Catalog Publishing

MQTT Broker Interface

EcoStruxure Platform: EBO + PME



EBO uses a folder structure partnered with SmartConnector (a middleware service) to organize data. This:

1. Simplifies scaling
2. Creates an organized structure or “Namespace” for your runtime data managing system objects
 - a. Meta data is incorporated in system objects giving transparency
 - b. Leverages MQTT topics for system simplicity
3. It is a conforming BMS, able to integrate with NVIDIA Mission Control.

SmartConnector which is a middleware service coupled with the EBO folder structure and MQTT interface not only groups related functionality internally by Equipment and Area (e.g. Electrical, Mechanical, Generators, UPS, CDUs, Air Handlers, Building, Data Hall, Row, Rack etc.), but it also enables the ability to publish data upstream in a well-organized format.

The SmartConnector assembles the MQTT payload from Ecostruxure Building Operation then formats the data correctly before publishing it to the MQTT broker.

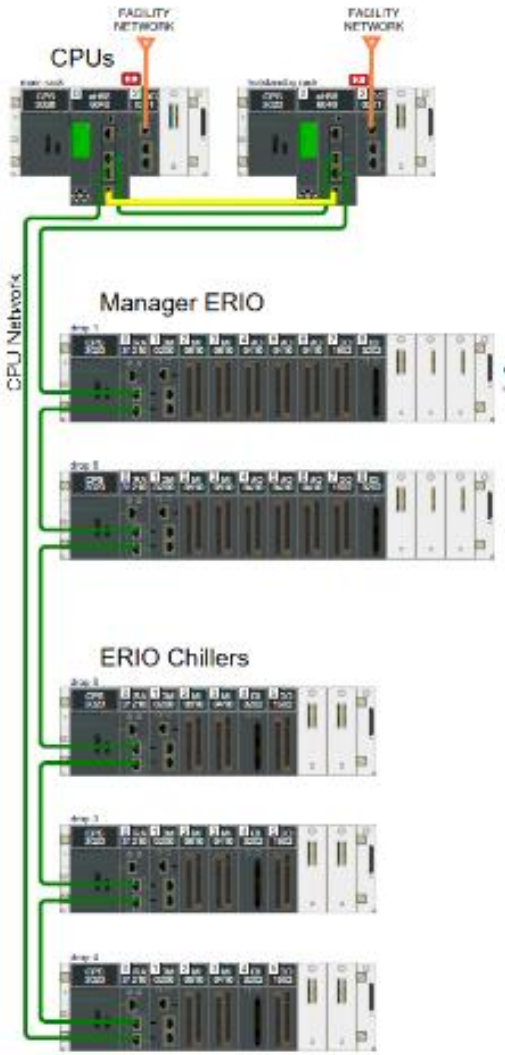
This also includes the data point real-time values as well as Metadata describing the data point (Point Type, Object Type, Engineering Unit, Rack Name, Rack ID etc.) which is a requirement for the local and upstream systems to consume that data. A well-defined structure makes publishing this data simple.

Application Object Model Design and MQTT Data

Data “Consumability” refers to the ease with which users and other applications can consume, interpret, and apply data from the system. This is not only important when working within the system, but also for when OT data (originating from the BMS) is sent to upstream data consumers and tools.

Objects in EBO can be easily modelled to align with the chosen Data Catalog by either applying a standardized folder structure or linking the Data Catalog reference within the object's additional property fields. This simple yet flexible approach supports application functionality and meets data publishing requirements, while greatly reducing complexity in configuration.

Facility Cooling Controls
Chilled Water Area -Grey Space



PLC Design distribution

This reference design powers seamless facility performance with intelligent control, resilient architecture, and future-ready automation-ensuring uptime, efficiency, and adaptability at every layer.

Facility Cooling, Data Hall, and Power Controls

AI factories introduce critical dependencies on facility cooling and rack-level safety systems. Any failure in monitoring or control—whether due to hardware faults, network interruptions, or manual override errors—can lead to unplanned downtime or equipment damage.

The building management system architecture implements a fully redundant control system based on *Modicon M580 PLCs* in a hot-standby configuration. The *Modicon M580* hot-standby control system provides a resilient, fault-tolerant backbone for managing the critical infrastructure of the NVIDIA NVL72-based AI factory. At the core of this design each system has a pair of *Modicon M580 PLCs* configured in a primary and hot-standby arrangement. Each PLC resides within its own dedicated manager panel, with full power and communication independence. These controllers form the heart of the facility's control strategy, providing continuous operation even during equipment or communication faults.

A Remote I/O (RIO) architecture connects remote I/O panels to the PLCs via an Ethernet/IP ring topology. Each RIO panel manages localized I/O for its assigned equipment group (e.g., chillers, fluid coolers, or pod), and includes its own power, communication, and I/O modules. The ring topology ensures that a single point of failure does not interrupt signal flow or I/O control.

This architecture provides fault isolation, supports secure operation, and maintains deterministic control in the event of a partial network failure.

Facility Network connected Devices

Connection	Device
Facility Network (White Space)	Coolant Distribution Units (CDU)
	Energy Valves (PCV)
	Leak Detectors
	NET RPDU rack PDU OUTLET
	RPP or busways
Facility Network (Grey Space)	IT Generator
	IT MV/LV Transformer
	IT UPS
	IT MAIN SWB
	IT UPS Batteries
	PDU
	Fan Walls controllers
	BMS / EPMS
	DX AC for Electrical Rooms
	Mech SWBD
	Mech UPS
	Mech Li Batteries
	Mech Generator
	Mech Tx MV/LV Transformer

Optimizing Chillers & Fluid Coolers for Efficient Heat Rejection

Facility Cooling Control Panels

Panel Name	Subsystem
Chilled Water and Adiabatic Dry Coolers (ADC) Manager Panels	Panel power and temperature
	Chilled water pumps VFD enable and speed signal
	Pumps VFD (Modbus RTU)
	Chilled water loop differential pressure.
	Chilled water supply and return temperature
	Expansion Tank
Chiller/Fluid Cooler and ADC ERIO Panel	Isolation and bypass valves
	Panel power and temperature
	Controller Units comms (Modbus RTU)
	Enable and supply temperature setpoint
	Supply and/or return line temperature and flow sensors
	Chiller supply and/or return isolation and bypass

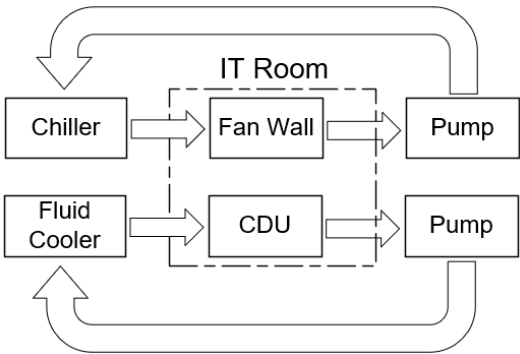
The Facility Cooling PLC Managers act as the central command center for mechanical cooling operations in the grey space. They coordinate chillers, fluid coolers, pumps, expansion tanks, and thermal storage to deliver resilient and energy-efficient cooling across the facility.

While the individual cooling units are equipped with standalone controllers, the Facility Cooling Managers **orchestrate** the broader system, ensuring all components operate in sync to meet dynamic thermal loads and redundancy requirements.

Key Responsibilities:

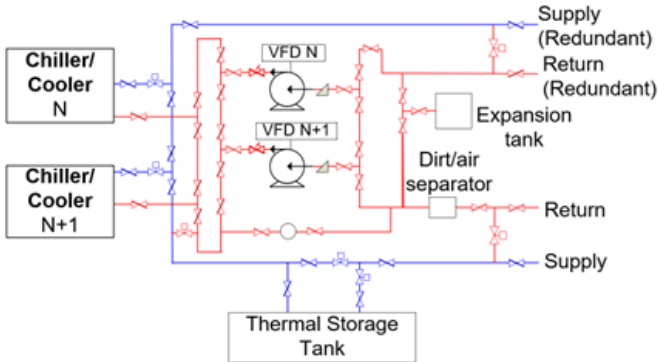
- **Staging & Load Balancing:** Dynamically stages chillers and fluid coolers based on real-time load using smart lead/lag logic to balance runtime and reduce energy consumption.
- **Rapid Response Cooling:** Overrides standard sequencing during thermal excursions to instantly deploy additional units for temperature control.
- **Chilled Water Pump Control:** Maintains loop differential pressure through PID-based staging and VFD control.
- **Thermal Storage Integration:** Manages transitions between Normal, Recharge, and Depleted modes of the TES tank to ensure uninterrupted cooling during outages.
- **Smart Valve & Chemical Control:** Controls isolation/bypass valves and chemical dosing units to maintain system reliability and water quality.

Facility Water System Flow



Facility Cooling Block Diagrams

Facility Piping Diagram



Similar piping architecture for chilled water loop and fluid cooler loop

Coordinated Monitoring, Leak Response & Environmental Control for AI-Optimized data halls

Data Hall Control Panels

Panel Name	Subsystem
Data Hall Manager Panels	Panel power and temperature
	Support areas environmental sensors
POD ERIO Panel	Panel power and temperature
	Environmental sensor, such as cold aisle temperature sensors
	Controls for rack return and supply
	Isolation valves actuators
	Rack energy valves (supplies power only)
	Rack electrical shunt trips
	Rack electrical POD trips
	Leak detection panel (supplies power and Facility network connection)

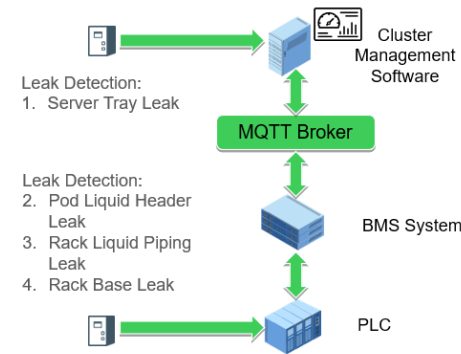
The Data Hall PLC Manager acts as the central orchestrator for NVIDIA’s liquid-cooled GB200 or GB300 NVL72 infrastructure—coordinating between independently controlled systems to ensure unified, efficient, and resilient thermal management across high-density IT environments.

Engineered for precision and operational continuity, the manager oversees air and liquid cooling systems, tracks environmental and equipment conditions, and executes intelligent, system-wide responses to thermal or safety events. Through deep integration with CDUs, fan walls, isolation valves, and leak detection systems, it delivers real-time insight and coordination across the entire white space.

Key Responsibilities:

- **Cooling Distribution Units (CDUs):** Supervises CDU staging and pump speed to maintain secondary supply temperatures and differential pressure based on real-time POD demand.
- **Rack Energy Valve Monitoring:** Continuously monitors rack-level flow, differential pressure, temperature, and energy data to support broader cooling optimization.
- **Fan Wall Unit Oversight:** Dynamically adjusts fan speeds and chilled water valve positions to stabilize aisle pressure and temperature across the data hall.

Leak Detection System Data Flow



Integrated Leak Detection & Isolation:

The manager is tightly integrated with the Cluster Management Software and Leak Detection System (LDS) to automatically detect and isolate both server-level and infrastructure-level leaks:

- Server tray leaks are detected by the Cluster Management Software and communicated to the PLC via BMS.
- Rack and POD leaks are detected by the PLC through sensors placed in manifolds, piping, and rack bases.

Depending on the leak location, the system automatically initiates targeted isolation actions—such as closing valves, disconnecting power, and disabling cooling units to contain risk and protect equipment.

Power System

The electrical distribution design from the low voltage power trains to feed the IT and mechanical loads up to secondary and primary medium voltage distribution and high voltage substation connection architecture.

This design complements the Schneider Electric Reference design 108,110 (IEC) and 109,111 (ANSI) that focus on the deployment of AI factories, specifically NVIDIA GB200 and GB300 NVL72 racks in a single data hall. The data hall is purpose-built and optimized with Motivair liquid-to-liquid CDUs and fluid coolers with adiabatic assist or high-temperature chillers.

The controls architecture can be paired with scaling of the power capacity through multiplying data halls with HV or MV electrical distribution. At the same time, it describes the Electrical Power Monitor System (EPMS) with an emphasis of Power Quality Monitoring needs. The Data Center power quality monitoring is a crucial aspect of the electrical distribution to assure good accuracy, on-board data logging and high resolution (sample/cycle). The distribution of power meters in the electrical system shall consider a good granularity to obtain an efficient measurement.

Power Quality Monitoring

Power Quality Meters distribution

Panel Name	ION9000T	PM8000	HDPM6000
IT Main SWBD	ATS Incomers (Utility, GEN)		
IT Critical SWBD		Busbar between incomers and feeders	
PDU	Incomers		Feeders
RPP or busways	Incomers		Feeders
Mech Main SWBD	ATS Incomers (Utility, GEN)		
Mech Critical SWBD		Busbar between incomers and feeders	

Traditionally it was sufficient to achieve a power quality measurement in the grid and generators connection points of the electrical distribution to measure and evaluate the compliance in terms of voltage and current disturbance on those.

With today's new AI rack's power profiles, the power peak is now significantly more than the rated nominal capacity of the rack for a very short duration, called an Electrical Design Point (EDP) peak.

While a portion of the power peaks are addressed by rack's power supply units and their bulk capacitance, the remainder – called Rack Peak Power will propagate up through the AC line cord to the power distribution system to the uninterruptible power supply (UPS) units, and to the electric grid or generator. These power peaks can occur as frequently as several times a second, depending on the AI workload.

This new profile requires deploying power quality meters differently and implementing them within the data halls for the same target, measuring compliance and the potential disturbances created.

This Power quality measurement will help to implement a safe operated set-up during the life cycle of the data center, since the commissioning to the operation and maintenance

The table on the left summarizes the recommended Power Quality Meters per Switchboard in the different rooms, for more details refer to Electrical one lines of the Reference design 108 and 109. The design can be adjusted as needed by specific requirements and constraints. *PowerLogic PM8000* power meters are placed to aggregate for energy management while the *PowerLogic ION9000T* are used to capture transient waveforms, especially at row-level.

Lifecycle Software

AI factories push the limits of data center facility infrastructure, so it's critical to leverage advanced planning and operation tools to ensure safe and reliable operations.

Planning & Design

Electrical Safety and Reliability: Due to the high amount of power supplied to an AI cluster, design specifications such as available fault current, arc flash hazards and breaker selectivity must be analyzed in the design phase. Applications like *Ecodial* and *ETAP* simulate the electrical design and reduce the chance of costly mistakes or even worse, injury.

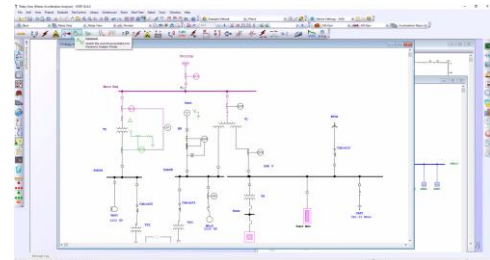
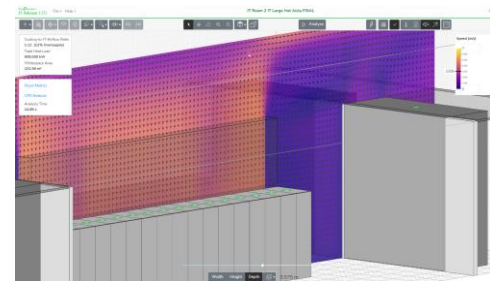
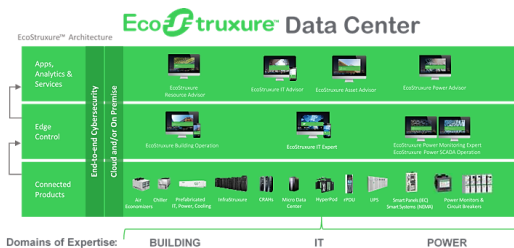
Cooling: AI clusters are pushing the limits of what can be done with air-cooling. Modeling the IT space with computational fluid dynamics (CFD) helps spot issues including high pressure areas, rack recirculation, and hot spots. This is especially true when retrofitting an existing data center with an AI cluster. Schneider Electric's *EcoStruxure IT Design CFD* can quickly model airflow, allowing rapid iteration to find the best design and layout.

Operations

EcoStruxure™ is Schneider Electric's open, interoperable, integrated Internet of Things (IOT)-enabled system architecture and platform. It consists of three layers: connected products, edge control, and applications, analytics, and services.

EcoStruxure Data Center is a combination of three domains of *EcoStruxure*: Power, Building, and IT. Each domain is focused on a subsystem of the data center: power, cooling, and IT. These three domains combined will reduce risks, increase efficiencies, and speed operations across the entire facility.

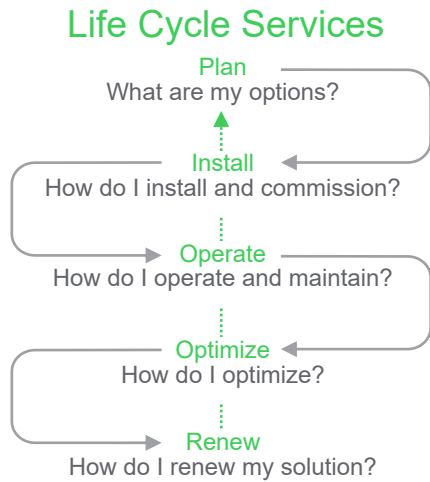
- *EcoStruxure Power Operation* monitors power quality, generates alerts, while protecting and controlling the electrical distribution system of the data center from the MV level to the LV level. It uses any device for monitoring and alerting, uses predictive analytics for increased safety, availability, and efficiency, while lowering maintenance costs.
- *EcoStruxure Building Operation* controls cooling effectively while driving reliability, efficiency, and safety of building management, security, and fire systems. It performs data analytics on assets, energy use, and operational performance.
- *EcoStruxure IT* makes IT infrastructure more reliable and efficient while simplifying management by offering complete visibility, alerting and modelling tools. It receives data, generates alerts, predictive analytics, and system advice on any device to optimize availability and efficiency in the IT space.



Visit [EcoStruxure for Data Center](#) for more details.

There are several options for supervisory visibility and control. *AVEVA Unified Operations Center* can provide visibility at a site or across an entire enterprise.

Schneider Electric Life-Cycle Services



- 1** Team of **over 7,000 trained specialists** covering every phase and system in the data center
- 2** Standardized, documented, and validated **methodology** leveraging automation tools and repeatable processes **developed over 45 years**
- 3** **Complete portfolio of services** to solve your technical or business challenge, simplify your life, and reduce costs

Get more information for the Electrical and Cooling design:



Electrical and Cooling References Designs

NVIDIA GB200 NVL72 Reference Design 109 (ANSI) can be downloaded [here](#)
NVIDIA GB200 NVL72 Reference Design 108 (IEC) can be downloaded [here](#)
NVIDIA GB300 NVL72 Reference Design 111 (ANSI) can be downloaded [here](#)
NVIDIA GB300 NVL72 Reference Design 110 (IEC) can be downloaded [here](#)