

ANEXO V: SELECCIÓN DE EQUIPOS

HIBRIDACIÓN DE ENERGÍA FOTOVOLTAICA Y BATERÍAS EN UNA CENTRAL
HIDROELÉCTRICA REVERSIBLE EXISTENTE

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1. INTRODUCCIÓN

1.1. Objetivo del anexo

El objetivo del anexo de la selección de equipos para el proyecto de estudio es un documento complementario que describe la tecnología y dispositivos que se integrarán en el sistema.

Es decir, el objetivo es la descripción de los equipos que permitirán llevar a cabo la hibridación a la central hidroeléctrica reversible ya existente.

1.2. Alcance de la selección del equipo

Una vez identificadas las necesidades del sistema en el anexo 3 como la energía que necesitamos almacenar o la potencia se pueden seleccionar los equipos principales como los módulos fotovoltaicos, los inversores fotovoltaicos y sistemas de almacenamiento en baterías.

1.3. Resumen de la arquitectura del sistema híbrido

La arquitectura del sistema híbrido propuesto tiene tres elementos principales: la planta fotovoltaica flotante, la central hidroeléctrica reversible existente y el sistema de almacenamiento en baterías.

El sistema fotovoltaico y de almacenamiento convergen en un centro de reparto de media tensión que se encuentra equipado de celdas de media tensión de 24 kV libres de SF6 que agrupan ambas tecnologías. Esto actúa de nodo de conexión y se conecta directamente al embarrado de media tensión (15,5 kV) de la turbina reversible de Moralets que se va a alimentar.

2. SISTEMA FOTOVOLTAICO

2.1. Módulos solares

Los módulos solares son los elementos principales del sistema solar. Se ha hecho una búsqueda de los paneles solares más utilizados a nivel europea como son JinkoSolar, Trina Solar, Longi, JA Solar y Canadian Solar.

Entre todas las alternativas disponibles en el mercado, se ha seleccionado el módulo Longi LR7-72H7H 630 M que pertenece a la serie Hi-MO X6 Max (Paneles Solares Anti-Polvo Hi-MO X6 Guardian: Durabilidad y Eficiencia En un Solo Producto, s. f.). Está fabricado con células de silicio monocristalino HPBC (Hybrid Passivated Back Contact).

Estos permiten alcanzar eficiencias de hasta el 23%, reduciendo las pérdidas eléctricas y maximiza la generación energética en superficies limitadas. Dicho panel se encuentra certificado para sistemas de hasta 1500 V en corriente continua garantizando su integración en plantas híbridas de gran escala. (Hybrid Passivated Back Contact) (Solo Producto, s. f.). A continuación, se adjunta la tabla 1 con las características de los paneles solares seleccionados.

Panel seleccionado	LR7-72HTHF
País del fabricante	China
Potencia Wp STC [W]	630
Potencia Wp NOCT [W]	470,8
Eficiencia STC [%]	23,3
Voltaje a potencia máxima (Vmp) STC [V]	53,02
Voltaje a potencia máxima (Vmp) NOCT [V]	49,78
Amperaje a potencia máxima (Imp) STC [A]	15,07
Amperaje a potencia máxima (Imp) NOCT [A]	12,17
Tensión Circuito Abierto (Voc) STC [V]	44,78
Tensión Circuito Abierto (Voc) NOCT [V]	40,87
Corriente Cortocircuito (Isc) STC [A]	14,07
Corriente Cortocircuito (Isc) NOCT [A]	11,52
Temperatura de operación (°C)	-40°C a +85°C
NOCT [°C operación células]	45±2°C
Coeficiente Pmax [%/°C]	-0.280
Coeficiente Voc [%/°C]	-0.230
Coeficiente Isc [%/°C]	+0.050
Voltaje máximo del sistema [V]	1500
Garantía producto potencia [años]	25
Garantía producto materiales [años]	15
Rendimiento a 25 años [%]	89,4
Dimensión (Lxaxe) [mm]	2382×1134×30
Peso [kg]	28.5

Tabla 1 Tabla de características Longi LR7-72HTHF 605~ 630 M. Fuente: Elaboración propia

2.2 Estructura de montaje

2.2.1. Plataformas flotantes y estructura para los módulos.

En el mercado destacan soluciones como Isigenere, Sungrow, Hydrelío, SolarDock y Nautical SUNRISE. Los dos últimos son los que ofrecen soluciones offshore de gran escala.

De las opciones disponibles, las plataformas flotantes SolarDock de HSB Marine (Hsbmarine, s. f.) son las que se han seleccionado en este proyecto. Se usan para la instalación de sistemas solares en embalses y cuerpos de agua. Están fabricadas de fibra de poliéster reforzado (FRP) ofreciendo una mayor resistencia y garantizando una larga vida útil.

Los paneles solares se situarán a una altura mínima de 60 centímetros sobre el nivel del agua evitando los efectos de la humedad, abrasión y acumulación de la sal. Su diseño permite el ajuste de las distancias entre filas y el ángulo de inclinación de los paneles optimizando la producción de energía.

El diseño de las plataformas flotantes SolarDock es resistente frente a los fuertes vientos o incendios. Además, dispone de pasarelas de servicio para permitir el acceso al personal para realizar el mantenimiento, inspecciones y reparaciones.

Este tipo de estructuras pueden albergar hasta 150 paneles. A continuación, se adjunta la Figura 1 de las plataformas SolarDock y la tabla 2 con sus características principales. (HSB Marine, s. f.).

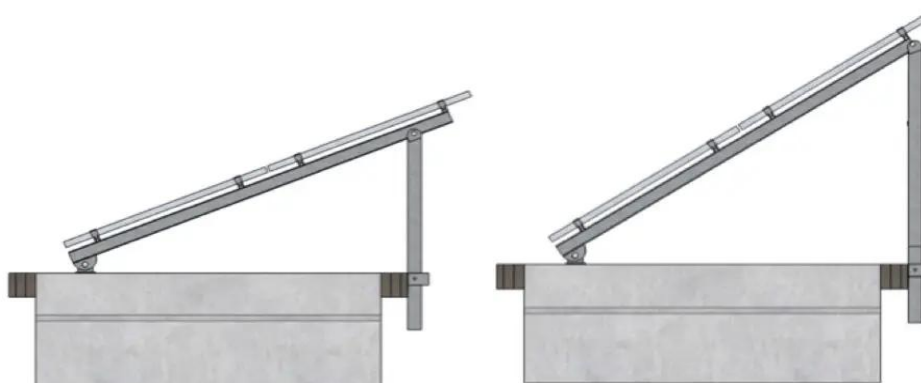


Figura 1: Plataforma flotante SolarDock de HSB Marine. Fuente: HSB Marine, s. f.

Plataformas flotantes	SolarDock de HSB Marine
Altura del panel sobre el agua (cm)	60
Eficiencia energética	8% más electricidad por m ²
Material estructural	Plataformas de FRP (polímero reforzado con fibra)
Altura de los flotadores de plástico del agua (cm)	60
Vida útil (años)	20

Tabla 2: Tabla de características plataformas flotantes SolarDock de HSB Marine. Fuente: Elaboración propia

Cada módulo de la estructura tiene un armazón metálico donde se fija el módulo solar. En el caso de nuestra plataforma flotante SolarDock de HSB Marine se compone de acero galvanizado o aluminio, anodizado.

Los paneles son fijados al bastidor mediante abrazaderas y perfiles de aluminio anticorrosivos. Este tipo de fijaciones permiten una fácil y rápida instalación.

Los flotadores son conectados entre sí formando bloques modulares para asegurar su rigidez estructural. Por otra parte, la estructura portante de cada módulo se integra en el sistema de unión haciendo que la plataforma sea estable.

2.2.3. Sistemas de anclaje y amarre.

Existen tres tipos de anclajes: en el fondo, en la costa o pilotes.

Los anclajes en el fondo son los más empleados en la actualidad y los elegidos en esta ocasión. Son las más maduras gracias a la ingeniería oceánica y que se han empleado en otros sectores. (HSB Marine, s. f.).



Figura 2: Anclajes en el fondo. Fuente: HSB Marine, s. f.

El tipo de anclaje utilizado serán los hincados helicoidales con alas en espiral que proporcionan una mejor y mayor sujeción, para soportar cargas muy elevadas, tanto verticales como horizontales.

2.2.4. Conexiones eléctricas.

Las conexiones eléctricas deben ser las adecuadas para un ambiente húmedo y tener una cubierta resistente al agua y rayos UV. Por otra parte, la canalización debe estar protegida para minimizar la abrasión de los materiales ya que se encuentran en contacto con el agua.

Además, los transformadores e inversores deben ser ubicados en tierra firme o en plataformas auxiliares flotantes.

2.3 Inversores

En la actualidad, existen dos modalidades de inversores, inversores string e inversores centrales. En el mercado destacan marcas como SMA y Power electronics para las soluciones centrales mientras que en string Huawei, Sungrow y Goodwe. (Energético, 2025). Todos ellos son capaces de adaptarse a los diferentes proyectos fotovoltaicos.

Tras analizar las opciones del mercado y los requerimientos específicos de una planta flotante, se han descartado los inversores string ya que este tipo de inversor tendría que estar sobre la plataforma flotante junto con los paneles fotovoltaicos y todavía no hay soluciones que se adapte a este tipo de ambientes. Optando por inversor central se ha elegido la marca power electronics inversor Multi PCSK FP4390K4 Power Electronics FP4390K4 de 4390 kVA (PCSK & Multi PCSK | Power Electronics, s. f.) que representa una solución avanzada y compacta.

A continuación, se adjunta la tabla 3 con las características del inversor seleccionado.

INVERSOR SELECCIONADO	INVERSOR MULTI PCSK FP4390K4 DE POWER ELECTRONICS
POTENCIA DE SALIDA (KVA/KW) @40°C	4390
TENSIÓN DE RED DE FUNCIONAMIENTO (VCA)	690±10%
TENSIÓN MÁXIMA (V)	1500
NÚMERO DE ENTRADAS INDEPENDIENTES	4
EFICIENCIA (%)	98,93

Tabla 3: Tabla de características del inversor Multi PCSK FP4390K4. Fuente: Elaboración propia

2.4. Monitorización y protecciones

2.4.1. Protecciones.

Todos los elementos eléctricos deben tener medidas de protección cumpliendo con el reglamento de baja y alta tensión con el fin de proteger los equipos frente a cortocircuitos, sobretensiones y contactos directos e indirectos.

2.4.2. Estación meteorológica y sensores.

Las estaciones meteorológicas y sensores son necesarias para la obtención de los datos sobre la irradiación y las condiciones climáticas. Normalmente se cuenta con piranómetros para la lectura de irradiancia, junto con sensores de temperatura ambiente, temperatura de panel y detector de ensuciamiento de paneles. También se añadirán unas Weather Station para medir factores

climáticos como humedad relativa, y mediante veleta y anemómetro el comportamiento del viento, además de pluviómetros para medir las precipitaciones.

2.4.3. Cables de baja y media tensión.

Los cables de baja y media tensión son necesarios el transporte de la energía eléctrica que es generada por los paneles fotovoltaicos.

2.4.4. Cajas de conexión.

Las cajas de conexión permiten unir los ramales de un generador fotovoltaico facilitando las operaciones de control y mantenimiento. También se incorporan dispositivos para medir las corrientes y comprobar el correcto funcionamiento del sistema a nivel de string.

3. SISTEMA DE ALMACENAMIENTO DE BATERIAS

3.1. Tecnología seleccionada

En la actualidad, el mercado dispone de diversas soluciones de almacenamiento para sistemas fotovoltaicos que nos ofrecen un alto rendimiento, durabilidad y tecnología avanzada. Entre las opciones más reconocidas se encuentra Tesla, Huawei, Risen, Mars y Sungrow (Casas, 2025).

La tecnología del sistema de almacenamiento energético que se ha seleccionado es LUNA2000-2.0MWH-2H1 de Huawei. Esta solución nos ofrece una energía nominal de 2,032 kWh y potencia nominal de 1,016 kW. Tiene integrado los sistemas de enfriamiento inteligente por aire, supresión de incendios con FM-200 o Novec 1230, protocolos de comunicación RS485 y protección IP55.

A continuación, en la Tabla 4 se añaden las características principales.

MODELO	LUNA2000-2.0MWH-2H1
TENSIÓN NOMINAL (V)	1,250
TENSIÓN MÁXIMA (V)	1,500
CAPACIDAD ENERGÉTICA NOMINAL (KWH)	2,032
TASA DE CARGA Y DESCARGA (C)	≤ 0.5
POTENCIA NOMINAL (KW)	1,016
DIMENSIONES (MM)	6,058 x 2,896 x 2,438
PESO DEL CONTENEDOR (T)	≤ 30
RANGO DE TEMPERATURA DE FUNCIONAMIENTO (°C)	-30 ~ 55
RANGO DE TEMPERATURA DE ALMACENAMIENTO (°C)	-40 ~ 60

HUMEDAD RELATIVA (%)	0 ~ 100
ALTITUD MÁXIMA DE FUNCIONAMIENTO (M)	4,000
MÉTODO DE ENFRIAMIENTO	Refrigeración inteligente
CONFIGURACIÓN DE HVAC	6 o 4
AGENTE EXTINTOR DE INCENDIOS	FM-200 / Novec 1230™
INTERFAZ DE COMUNICACIÓN	Ethernet / SFP
PROTOCOLO DE COMUNICACIÓN	Modbus TCP / IEC 104
GRADO DE PROTECCIÓN	IP55
GRADO DE ANTICORROSIÓN	C5-Medium
ARRANQUE AUTÓGENO	Opcional

Tabla 4: Tabla de características de las baterías LUNA2000-2.0MWH-2H1. Fuente: Elaboración propia

3.2. EMS

Se trata de un sistema que nos permite gestionar o coordinar el funcionamiento de nuestra planta fotovoltaica junto con las baterías y la central hidroeléctrica reversible. Huawei lo tiene incorporado dentro de su contenedor junto con sus servicios auxiliares incluida la UPS y el transformador auxiliar que alimente estos servicios.

MODELO	PPC PRO
CONSUMO MÁXIMO (W)	350
ENTRADA AC (VAC)	230 o 120
ENTRADA DC (VDC)	120-290
FRECUENCIA (HZ)	50
PESO (KG)	34
DIMENSIONES (MM)	641 x 847 x 357
RANGO DE TEMPERATURA DE FUNCIONAMIENTO (°C)	-20 a + 50
PROTECCIÓN	IP54 (NEMA 3R)

Tabla 5: Tabla de características del sistema de control. Fuente: Elaboración propia

4. CENTRO DE TRANSFORMACIÓN

En la hibridación existirán dos modelos de centro de transformación dado que se utilizan diferentes marcas para la parte de los inversores centrales para la solar flotante y la parte de almacenamiento de la parte de BESS. Para los inversores centrales de Power electronics se utilizará un centro de transformación doble que puede incorporar en su skid dos inversores de estos, también de power electronics, mientras que de la parte de BESS se utilizará el centro de transformación de Huawei de 6 MVA.

4.1. Especificaciones del centro de transformación para la planta solar flotante

El sistema Twin Skid Compact, desarrollado por Power Electronics, es una solución de diseño compacto y llave en mano, es decir, esta solución lleva incorporado en el mismo skid de la parte de media tensión los dos inversores con todas sus conexiones realizadas en fábrica. Esto hace que la fase de instalación y la puesta en marcha sean más simple, es una solución *plug-and-play* que permite reducir los tiempos de activación sin comprometer la densidad de potencia ni la eficiencia operativa. (PCSK & Multi PCSK | Power Electronics, s. f.). A continuación, en la Tabla 6 se adjunta un resumen de las características principales:

CENTRO DE TRANSFORMACIÓN PARA LA PLANTA SOLAR FLOTANTE	TWIN SKID COMPACT
INVERSORES DISPONIBLES	V Skid Compact
RANGO DE POTENCIA @ 40 °C	3820 - 8780
RANGO DE POTENCIA @ 50 °C	3550 - 8150
RANGO DE MEDIA TENSIÓN (KV)	34,50
TENSIÓN NOMINAL DE ENTRADA (V)	690
TENSIÓN DE SALIDA NOMINAL (KV)	15
FRECUENCIA (HZ)	50
REFRIGERACIÓN DEL TRANSFORMADOR	ONAN
DEPÓSITO DE RETENCIÓN DE ACEITE	Acero galvanizado. Integrado con filtro de hidrocarburos. Opcional.
CONEXIONES DE MEDIA Y BAJA TENSIÓN	Solución de acoplamiento cercano (plug & play)
PROTECCIÓN CONTRA SOBRETENSIÓN	Interruptor motorizado incluido en el inversor.
RANGO DE TEMPERATURA DE FUNCIONAMIENTO (°C)	-25°C ~ 50°C
GRADO DE PROTECCIÓN DE LA SALA DE MEDIA Y BAJA TENSIÓN	IP 54
ALTITUD MÁXIMA (M)	Hasta 1000
HUMEDAD RELATIVA (%)	4 - 95
SISTEMA DE EXTINCIÓN DE INCENDIOS	Accesorio de retención del tanque de aceite del transformador. Opcional.
NORMATIVA	IEC 62271-212, IEC 62271-200, IEC 60076, IEC 61439-1

Tabla 6: Inversor MVSKID Power Electronics. Fuente: Elaboración propia

4.2. Especificaciones del centro de transformación para BESS

El sistema JUPITER-6000K-H1 (Solución Almacenamiento y Fotovoltaica A Gran Escala | FusionSolar España, s. f.) de Huawei es un centro de transformación prefabricado y preensamblado en contenedor de 20 HC (High Cube) que está diseñado para las aplicaciones de generación y almacenamiento de energía. En él se encuentran integrado los elementos como el transformador de potencia, celdas de media tensión (RMU) y paneles de baja tensión (LV panel).

Para nuestra instalación se necesitará cinco contenedores de JUPITER-6000K-H1 ya que necesitamos cubrir una demanda de 27 MW.

El modelo seleccionado es una estación inteligente de transformación de alta eficiencia, que reduce los costes de montaje y tiempos de implementación ofreciendo una integración con sistemas de monitores y control remoto. Esto lo hace una solución para las aplicaciones industriales. (Solución Almacenamiento y Fotovoltaica A Gran Escala | FusionSolar España, s. f.)

En la Tabla 8 se muestran las características del centro de transformación para BESS.

CENTRO DE TRANSFORMACIÓN PARA BESS	JUPITER-6000K-H1
BATERÍAS DISPONIBLES	LUNA2000-200KTL-H1
MÁXIMA CANTIDAD DE VOLTAJE Y AMPERAJE DE CORRIENTE ALTERNA	22
TENSIÓN NOMINAL DE ENTRADA (V)	800
TENSIÓN DE SALIDA NOMINAL (KV)	15
FRECUENCIA (HZ)	50
TIPO DE REFRIGERACIÓN DEL TRANSFORMADOR	ONAN
TOMAS DEL TRANSFORMADOR	$\pm 2 \times 2.5\%$
TRANSFORMADOR AUXILIAR	Transformador de tipo seco, 5 kVA, monofásico, li0
TENSIÓN DE SALIDA DEL TRANSFORMADOR AUXILIAR (VAC)	230 / 127
RANGO DE TEMPERATURA DE FUNCIONAMIENTO (°C)	-25 ~ 60
DIMENSIONES (MM)	6,058 x 2,896 x 2,438
PESO (T)	< 23
GRADO DE PROTECCIÓN DE LA SALA DE MEDIA Y BAJA TENSIÓN	IP 54
HUMEDAD RELATIVA (%)	0 ~ 95
ALTITUD MÁXIMA DE FUNCIONAMIENTO (M)	1,000
NORMATIVA	IEC 62271-202, EN 50588-1, IEC 60076, IEC 62271-200, IEC 61439-1

Tabla 7: Centro de transformación para BESS. Fuente: Elaboración propia

4.3 Celdas.

La tensión de las turbinas en este caso es de 15,5 KV por lo tanto dado que la hibridación se llevará a cabo a nivel de media tensión todas las celdas instaladas en el sistema serán de SIEMENS modelo 8DJH de 24 kV BLUE GIS (8DJH 24 - Blue GIS, s. f.). Se trata de celdas libres de SF6 cumpliendo con la normativa europea que entra en vigor a partir de 2026 respecto a la prohibición de nuevos equipos de media tensión que utilicen este gas.

En la Tabla 8 se muestran las características de la celda Siemens 8DJH 24kV seleccionada.

TIPO CELDA	8DJH 24 – BLUE GIS.
TENSIÓN NOMINAL (KV)	15
FRECUENCIA NOMINAL (HZ)	50
TENSIÓN SOPORTADA NOMINAL DE CORTA DURACIÓN A FRECUENCIA INDUSTRIAL (KV)	36
TENSIÓN NOMINAL DE IMPULSO DE RELÁMPAGO SOPORTADA (KV)	95
CORRIENTE MÁXIMA SOPORTADA NOMINAL (KA)	50/52.5
CORRIENTE ADMISIBLE NOMINAL DURANTE UN BREVE PERIODO DE TIEMPO 3 S (KA)	20/21
CORRIENTE NOMINAL SOPORTADA DURANTE UN BREVE PERIODO DE TIEMPO 1 S (KA)	20/21
CORRIENTE CONTINUA NOMINAL DE LA BARRA COLECTORA (KA)	630
CORRIENTE CONTINUA NOMINAL DE LOS ALIMENTADORES (A)	630
ANCHO (ALIMENTADORES)	350/450/550
PROFUNDIDAD SIN CONDUCTO DE ALIVIO DE PRESIÓN (MM)	775
PROFUNDIDAD CON CONDUCTO DE ALIVIO DE PRESIÓN (MM)	890
RANGO DE TEMPERATURA DE FUNCIONAMIENTO (°C)	-25 to +55

Tabla 8: Tabla de características de las celdas 8DJH 24 – blue GIS. Fuente: Elaboración propia

5. INTEGRACIÓN CON LA CENTRAL HIDROELECTRICA EXISTENTE

5.1. Puntos de conexión y esquema funcional

La planta fotovoltaica será de tipo flotante en el embalse superior de la central hidroeléctrica, en este caso, Llauset. Por otro lado, el sistema de almacenamiento mediante baterías se instalará junto a la central hidroeléctrica de Moralets. Allí se dispondrá el correspondiente centro de transformación de la tecnología BESS, encargado de elevar la tensión desde el nivel de baja tensión de las baterías hasta la tensión de operación de la turbina, 15,5 kV.

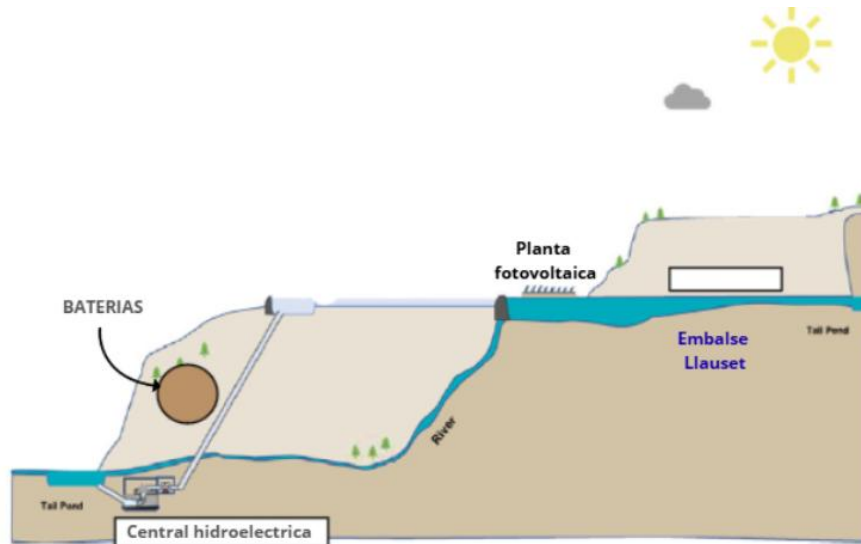


Figura 3: Esquema de funcionamiento de la hibridación en la central hidroeléctrica de Moralets. Fuente: Elaboración propia

La hibridación del sistema se realizará a nivel de media tensión, en la tensión correspondiente a la turbina, a 15.5 kV. La planta solar y las baterías contarán con sus propios centros de transformación conectados en serie que eleva la tensión hasta un centro de reparto equipado con celdas de media tensión de 24 kV libres de SF6. Un controlador central gestionará el modo de operación del sistema, determinando cuándo usar la energía solar, cuándo cargar o descargar las baterías, y cómo coordinar la producción y almacenamiento de la hidroeléctrica reversible. Finalmente, este centro de reparto se conecta al embarrado de media tensión de la turbina seleccionada en la central hidroeléctrica reversible de Moralets, integrando todas las fuentes en un único sistema híbrido gestionado de forma coordinada.

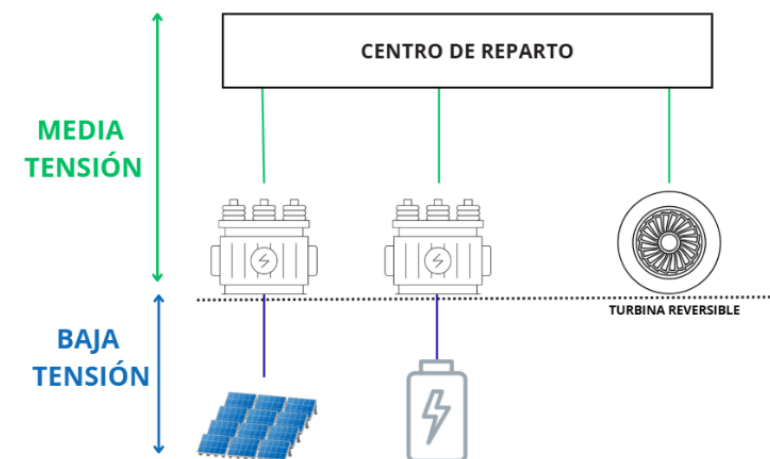


Figura 4: Esquema de la hibridación del estudio. Fuente: Elaboración propia

5.2. Compatibilidad de tensión y frecuencia

5.2.1. Tensión.

La tensión de trabajo de los inversores será a 690 V mientras que la de las baterías será a 400 V. Cada tecnología se conectará a su respectivo centro de transformación que elevará la tensión hasta 15,5 kV

5.2.2. Frecuencia.

El sistema es compatible con 50 Hz.

6. FICHAS TÉCNICAS

Hi-MO X6 Max Guardian Anti-Dust

LR7-72HTHF 605~630M

- Equipped with HPBC Cell, continuing the high efficiency gene
- Unique border design effectively reduces the impact of dust accumulation and improves power generation gain throughout the entire lifecycle
- High reliability, stable operation under harsh testing conditions
- More suitable for industrial and commercial colored steel tile roofs and small angle installation scenarios



15-year Warranty for
Materials and Processing



25-year Warranty for Extra
Linear Power Output

Complete System and Product Certifications

IEC 61215, IEC 61730

ISO9001:2015: ISO Quality Management System

ISO14001: 2015: ISO Environment Management System

ISO45001: 2018: Occupational Health and Safety

IEC62941: Guideline for module design qualification and type approval

LONGi



23.3%
MAX MODULE
EFFICIENCY

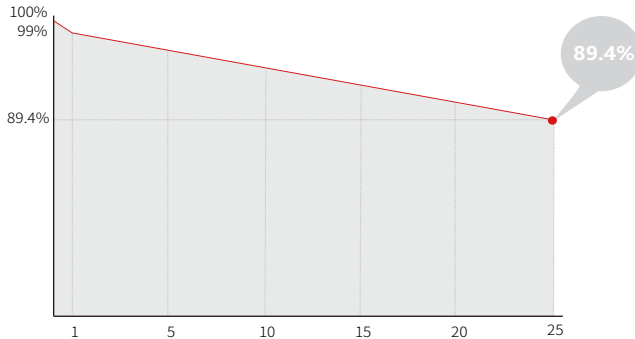
0~3%
POWER
TOLERANCE

<1%
FIRST YEAR
POWER DEGRADATION

0.40%
YEAR 2-25
POWER DEGRADATION

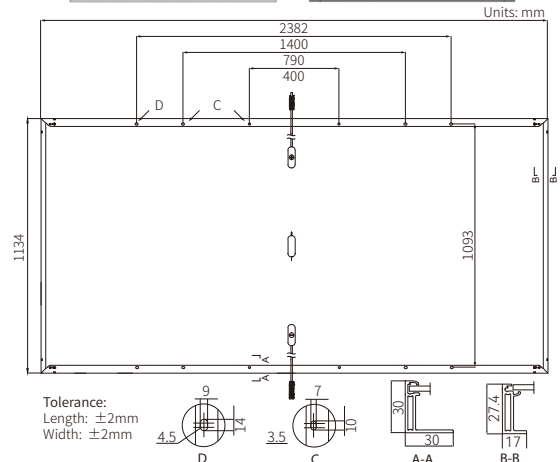
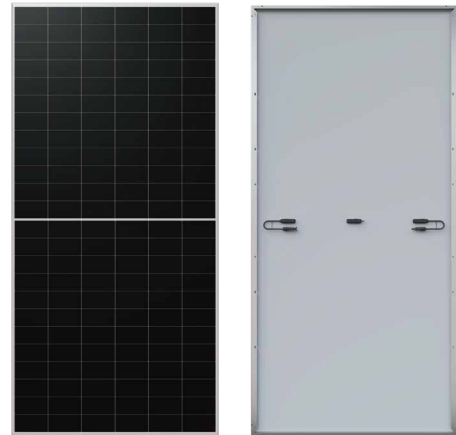
Additional Value

25-Year Power Warranty



Mechanical Parameters

Cell Orientation	144 (6×24)
Junction Box	IP68
Output Cable	4mm ² , +400, -200mm/±1400mm length can be customized
Glass	Single glass, 3.2mm coated tempered glass
Frame	Anodized aluminum alloy frame
Weight	28.5kg
Dimension	2382×1134×30mm
Packaging	36pcs per pallet / 144pcs per 20' GP / 720pcs per 40' HC



Electrical Characteristics

 STC: AM1.5 1000W/m² 25°C

 NOCT: AM1.5 800W/m² 20°C 1m/s

 Test uncertainty for P_{max}: ±3%

Module Type	LR7-72HTHF-605M		LR7-72HTHF-610M		LR7-72HTHF-615M		LR7-72HTHF-620M		LR7-72HTHF-625M		LR7-72HTHF-630M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (P _{max} /W)	605	452.1	610	455.9	615	459.6	620	463.4	625	467.1	630	470.8
Open Circuit Voltage (V _{oc} /V)	52.27	49.17	52.42	49.22	52.57	49.36	52.72	49.59	52.87	49.64	53.02	49.78
Short Circuit Current (I _{sc} /A)	14.74	11.91	14.80	11.95	14.87	12.01	14.93	12.06	15.01	12.12	15.07	12.17
Voltage at Maximum Power (V _{mp} /V)	44.03	40.18	44.18	40.32	44.33	40.46	44.48	40.59	44.63	40.73	44.78	40.87
Current at Maximum Power (I _{mp} /A)	13.75	11.26	13.81	11.31	13.88	11.36	13.94	11.42	14.01	11.47	14.07	11.52
Module Efficiency(%)	22.4		22.6		22.8		23.0		23.1		23.3	

Operating Parameters

Operational Temperature	-40°C ~ +85°C
Power Output Tolerance	0 ~ 3%
Maximum System Voltage	DC1500V (IEC)
Maximum Series Fuse Rating	25A
Nominal Operating Cell Temperature	45±2°C
Protection Class	Class II
Fire Rating	IEC Class C

Mechanical Loading

Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

Temperature Ratings (STC)

Temperature Coefficient of I _{sc}	+0.050%/°C
Temperature Coefficient of V _{oc}	-0.230%/°C
Temperature Coefficient of P _{max}	-0.280%/°C

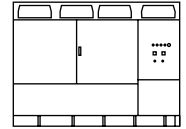
Multi PCSK

V_01

Modularity.
Easy maintenance.
Up to 4 independent DC inputs.
Advanced grid support.
Compatible with all battery technologies.



Freemaq Multi PCSK



COMMON FEATURES MULTI PCSK		FRAME 2	FRAME 3	FRAME 4	
AC	Max. AC Output Current (A) @40°C	1837	2756	3674	
	Operating Grid Frequency (Hz)	50/60Hz			
	Current Harmonic Distortion (THDi)	< 3% per IEEE519			
	Power Factor (cosine phi) ^[1]	0.5 leading ... 0.5 lagging			
	Reactive Power Compensation	Four quadrant operation			
DC	DC Voltage Ripple	< 3%			
	Max. DC Continuous Current per Input (A)	1148	1148	2295	1148
	Max. DC Short Circuit Current per Input (kA)	250 kA with a time constant of 3ms			
	Battery Technology	All type of batteries (BMS required)			
	Number of Separate DC Inputs	2	3	2	4
CABINET	Dimensions [WxDxH] (ft)	9.8 x 6.5 x 7.2			
	Dimensions [WxDxH] (m)	3.0 x 2.0 x 2.2			
	Weight (lbs)	11465	11795	12125	
	Weight (kg)	5200	5350	5500	
	Type of Ventilation	Forced air cooling			
ENVIRONMENT	Degree of Protection	NEMA 3R / IP55			
	Operating Temperature Range ^[2]	From -25°C to +60°C, >50°C power derating			
	Operating Relative Humidity Range	From 4% to 100% non-condensing			
	Storage Temperature Range	From -15°C to +40°C			
	Max. Altitude (above sea level)	2000m / >2000m power derating (Max. 4000m)			
CONTROL INTERFACE	Communication Protocol	Modbus TCP			
	Power Plant Controller	Optional. Third party SCADA systems supported			
	Keyed ON/OFF Switch	Standard			
PROTECTIONS	Ground Fault Protection	Insulation monitoring device			
	Humidity Control	Active heating			
	General AC Protection & Disconn	Circuit breaker			
	General DC Protection & Disconn	DC switch-disconnectors ^[3]			
	Overvoltage Protection	Type II for AC and Type I+II for DC			
CERTIFICATIONS & STANDARDS	Safety	UL 1741 / CSA 22.2 No.107.1-16 / IEC 62109-1 / IEC 62109-2			
	Installation	NEC 2020			
	Utility Interconnect ^[4]	UL 1741 SA & SB / RULE 21 / RULE 14H / IEEE 1547.1 2020 / IEC 62116:2014			

NOTES

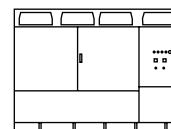
[1] Consult P-Q charts available: $Q(kVar) = \sqrt{(S(kVA))^2 - P(kW)^2}$.

[2] Optional available for temperatures down to -35°C.

[3] Battery short circuit disconnection has to be done on the battery side.

[4] Consult Power Electronics for other applicable standards/grid codes.

Freemaq Multi PCSK



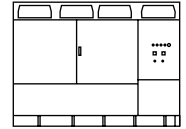
690 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP2195K2	FP3290K3	FP4390K2	FP4390K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	2195	3290	4390	
	AC Output Power (kVA/kW) @50°C ^[1]	2035	3055	4075	
	Operating Grid Voltage (VAC)	690V ±10%			
DC	DC Voltage Range ^[2]	976V - 1500V			
	Maximum DC Voltage	1500V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.84%	98.87%	98.93%	
	Euroeta (η) (preliminary)	98.45%	98.48%	98.65%	
660 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP2101K2	FP3151K3	FP4200K2	FP4200K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	2100	3150	4200	
	AC Output Power (kVA/kW) @50°C ^[1]	1950	2925	3900	
	Operating Grid Voltage (VAC)	660V ±10%			
DC	DC Voltage Range ^[2]	934V - 1500V			
	Maximum DC Voltage	1500V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.81%	98.84%	98.90%	
	Euroeta (η) (preliminary)	98.45%	98.48%	98.65%	
645 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP2055K2	FP3080K3	FP4105K2	FP4105K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	2055	3080	4105	
	AC Output Power (kVA/kW) @50°C ^[1]	1905	2855	3810	
	Operating Grid Voltage (VAC)	645V ±10%			
DC	DC Voltage Range ^[2]	913V - 1500V			
	Maximum DC Voltage	1500V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.78%	98.87%	98.87%	
	Euroeta (η) (preliminary)	98.40%	98.60%	98.60%	
630 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP2005K2	FP3005K3	FP4010K2	FP4010K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	2005	3005	4010	
	AC Output Power (kVA/kW) @50°C ^[1]	1860	2790	3720	
	Operating Grid Voltage (VAC)	630V ±10%			
DC	DC Voltage Range ^[2]	891V - 1500V			
	Maximum DC Voltage	1500V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.76%	98.79%	98.85%	
	Euroeta (η) (preliminary)	98.39%	98.42%	98.59%	
615 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP1955K2	FP2935K3	FP3915K2	FP3915K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	1955	2935	3915	
	AC Output Power (kVA/kW) @50°C ^[1]	1815	2725	3635	
	Operating Grid Voltage (VAC)	615V ±10%			
DC	DC Voltage Range ^[2]	870V - 1500V			
	Maximum DC Voltage	1500V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.76%	98.79%	98.84%	
	Euroeta (η) (preliminary)	98.38%	98.41%	98.57%	

NOTES

[1] Values at 1.00-Vac nom and cosφ=1. Consult Power Electronics for derating curves.
The maximum AC output power must be limited to meet the P-Q capability requirement at the inverter level of some grid codes.

[2] Consult Power Electronics for derating curves.

Freemaq Multi PCSK



600 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP1910K2	FP2865K3	FP3820K2	FP3820K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	1910	2865	3820	
	AC Output Power (kVA/kW) @50°C ^[1]	1775	2660	3545	
	Operating Grid Voltage (VAC)	600V ±10%			
DC	DC Voltage Range ^[2]	849V - 1500V			
	Maximum DC Voltage	1500V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.76%	98.78%	98.94%	
	Euroeta (η) (preliminary)	98.37%	98.39%	98.56%	
530 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP1685K2	FP2530K3	FP3370K2	FP3370K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	1685	2530	3370	
	AC Output Power (kVA/kW) @50°C ^[1]	1565	2350	3130	
	Operating Grid Voltage (VAC)	530V ±10%			
DC	DC Voltage Range ^[2]	750V - 1300V			
	Maximum DC Voltage	1300V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.76%	98.78%	98.94%	
	Euroeta (η) (preliminary)	98.37%	98.39%	98.56%	
500 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP1590K2	FP2385K3	FP3180K2	FP3180K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	1590	2385	3180	
	AC Output Power (kVA/kW) @50°C ^[1]	1475	2215	2955	
	Operating Grid Voltage (VAC)	500V ±10%			
DC	DC Voltage Range ^[2]	708V - 1250V			
	Maximum DC Voltage	1250V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.76%	98.78%	98.94%	
	Euroeta (η) (preliminary)	98.37%	98.39%	98.56%	
480 V		FRAME 2	FRAME 3	FRAME 4	
REFERENCES		FP1525K2	FP2290K3	FP3055K2	FP3055K4
AC	AC Output Power (kVA/kW) @40°C ^[1]	1525	2290	3055	
	AC Output Power (kVA/kW) @50°C ^[1]	1415	2125	2840	
	Operating Grid Voltage (VAC)	480V ±10%			
DC	DC Voltage Range ^[2]	679V - 1200V			
	Maximum DC Voltage	1200V			
	Number of Separate DC Inputs	2	3	2	4
EFFICIENCY	Efficiency (Max) (η) (preliminary)	98.76%	98.78%	98.84%	
	Euroeta (η) (preliminary)	98.37%	98.39%	98.56%	

NOTES

- [1] Values at 1.00-Vac nom and cosφ=1. Consult Power Electronics for and derating curves.
 [2] Consult Power Electronics for derating curves.

LUNA2000-2.0MWH Series Smart String ESS



More Energy



Optimal Investment



Simple O&M



Safe & Reliable

Battery Container			
Model	LUNA2000-2.0MWH-1H0	LUNA2000-2.0MWH-1H1	LUNA2000-2.0MWH-2H1
DC Rated Voltage	1,200 V	1,250 V	1,250 V
DC Max. Voltage	1,500 V	1,500 V	1,500 V
Nominal Energy Capacity	2,064 kWh	2,032 kWh	2,032 kWh
Charge & Discharge Rate	≤ 1 C	≤ 1 C	≤ 0.5 C
Rated Power	2,064 kW	2,032 kW	1,016 kW
Container Configuration (W x H x D)	6,058 x 2,896 x 2,438 mm	6,058 x 2,896 x 2,438 mm	6,058 x 2,896 x 2,438 mm
Container Weight	≤ 30 t	≤ 30 t	≤ 30 t
Operation Temperature Range	-30°C ~ 55°C	-30°C ~ 55°C	-30°C ~ 55°C
Storage Temperature Range	-40°C ~ 60°C	-40°C ~ 60°C	-40°C ~ 60°C
Relative Humidity	0 ~ 100% (Non-condensing)	0 ~ 100% (Non-condensing)	0 ~ 100% (Non-condensing)
Max. Operating Altitude	4,000 m	4,000 m	4,000 m
Cooling Method	Smart Air Cooling	Smart Air Cooling	Smart Air Cooling
Configuration of HVAC	8 HVACs ¹	8 or 6 HVACs ¹	6 or 4 HVACs ¹
Fire Suppression Agent	FM-200	FM-200 / Novec 1230™	FM-200 / Novec 1230™
Communication Interface	Ethernet / SFP	Ethernet / SFP	Ethernet / SFP
Communication Protocol	Modbus TCP / IEC 104	Modbus TCP / IEC 104	Modbus TCP / IEC 104
Protection Degree	IP55	IP55	IP55
Anti-corrosion Degree	C5-Medium	C5-Medium	C5-Medium
Black Start	-	Optional	Optional

Standards Compliance

RoHS, IEC62477-1, IEC62040-1, IEC61000-6-2, EN55011, UL9540A, IEC62619, UN3536, etc.

¹ - The quantity of HVACs depends on C rate and application scenario

PPC PRO

For Solar, Storage & Hybrid Plants.
Maximum Flexibility.
Modular and Programmable.
O&M diagnosis.





MECHANICAL DATA	Material	Polyester
	Installation	Wall or rack mounted
	Flammability	Halogen-free, self-extinguishing enclosure material (UL94-5V)
	Cable entry	Bottom in & out
	Maintenance	Front
	Cooling	Forced ventilation
	Weight ^[1]	34 kg / 75 lbs
ELECTRICAL DATA	Dimensions (H X W X D) ^[1]	641 X 847 X 357 (mm) / 26 x 34 x 14 (inches)
	Maximum consumption	350 W
	AC Voltage input	230 Vac (IEC) [±10%], 120 Vac (UL) [±10%]
	DC Voltage input	120-290 Vdc
	Frequency input:	50/60 Hz
COMMUNICATIONS	Compatible inverters	HEM, HEMK, PCSM, PCSK, Freemaq Statcom
	Communication protocols	Modbus TCP/ ADS for inverter control / DNP3 with Grid Operators. ^[2]
	Communication Switch	6 RJ45 Ports + 2 FO Multi Mode SC connectors
ENVIRONMENTAL CONDITIONS	Temperature range	From -20 to +50°C
	Humidity	From 5 to 95 % (5 to 95 % non-condensing).
	Protection degree	IP 54 / NEMA 3R
	Pollution degree	Type III
	Maximum altitude	3000 m / 9840 ft
CERTIFICATIONS	Marking	CE
	Standards	UL 916
FUNCTIONALITIES ^[3]	Active power control	Open & closed loop active power control, frequency response (with /without reserve), ramp rate. Negative and positive active power setpoints, SoC Balancing (storage applications)
	Reactive power control	Reactive power control, power factor control, voltage control, Q(V) curve, cosphi(P) curve, ramp rate, statcom control, capacitor bank control, night mode, SQD.
	Diagnosis functions	Warning / fault messages real-time data monitoring, plant phasor operation diagrams.
	Others	Internal measurement and compatibility with power analyzers, P/Q plant limitations, hot standby redundancy, controlled plant start, individual inverter control, line drop compensation, communication loss security process.
OTHERS	Web server	For local and remote monitoring / control.
	Customizable solution	Flexible solution based on a powerful modular and programmable controller

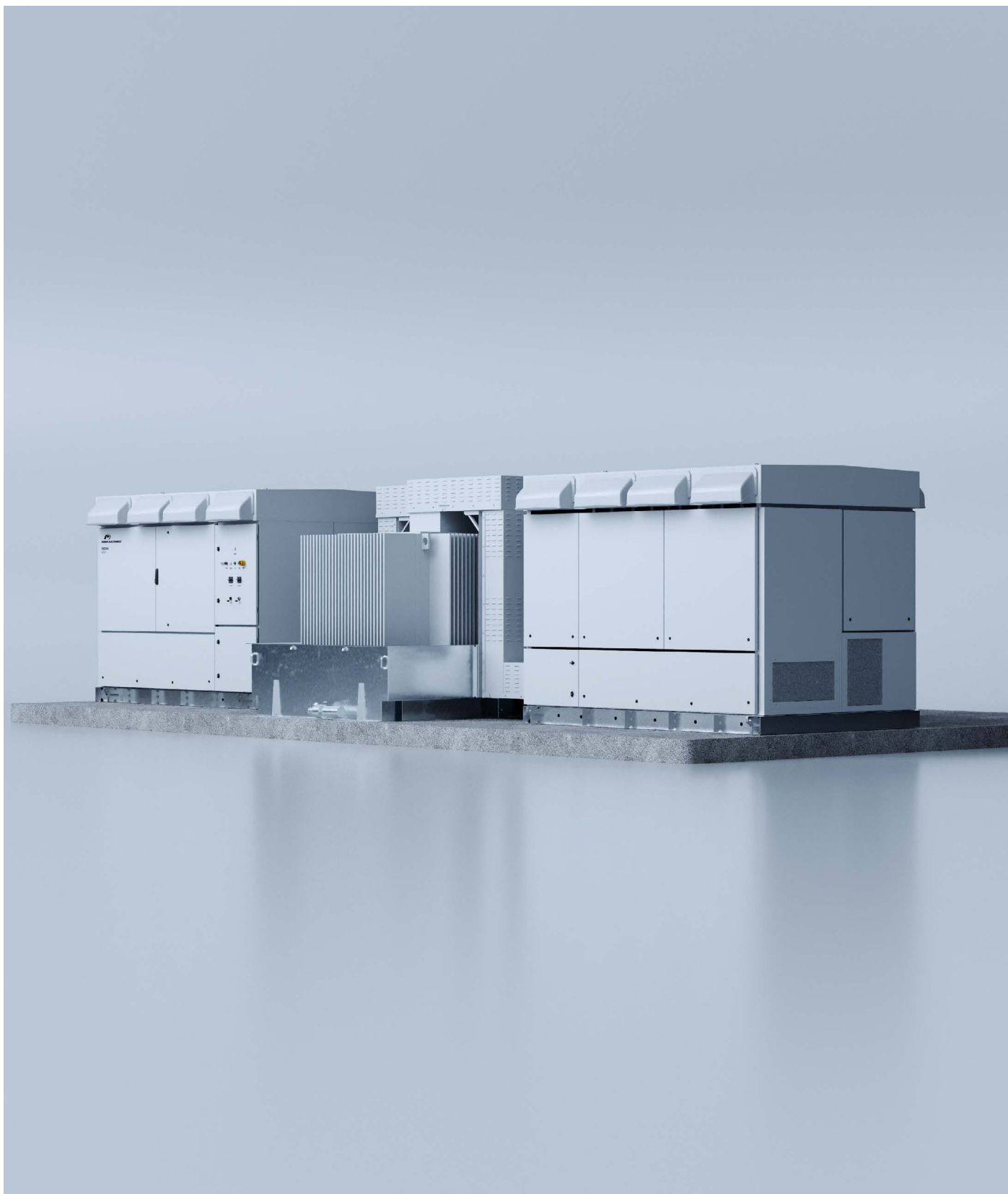
Twin Skid Compact

Turn-key solution.

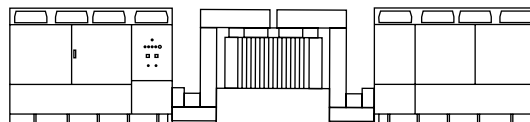
Fastest connection with two HEMK.

Compact design reducing space requirements.

Installation cost reduction.



Twin Skid Compact



RATINGS	Power range @ 40 °C	3820 kVA - 8780 kVA
	Power range @ 50 °C	3550 kVA - 8150 kVA
MEDIUM VOLTAGE EQUIPMENT	MV voltage range	11 kV / 13.2 kV/ 13.8 kV/ 15 kV / 20 kV / 22 kV / 23 kV / 25 kV / 30 kV / 33 kV / 34.5 kV
	LV voltage range	600 V /615 V /630 V / 645 V / 660 V / 690 V
	Transformer cooling	ONAN / KNAN
	Transformer vector group	Dy11y11
	Transformer protection	Protection relay for pressure, temperature (two levels) and gassing.
		Monitoring of dielectric level decrease
	Transformer index of protection	PT100 optional
		IP54
	Transformer losses	IEC standard or IEC Tier-2
	Oil retention tank	Galvanized steel. Integrated with hydrocarbon filter. Optional
	Switchgear configuration	Double feeder (2L)
	Switchgear protection	Circuit breaker (V)
	Switchgear short circuit rating ^[1]	16 kA 1 s (optionally 20 kA or 25 kA)
	Switchgear IAC ^[1]	A FLR 16 kA 1 s
CONNECTIONS	LV-MV connections	Close coupled solution (plug & play)
	LV protection	Motorized circuit breaker included in the inverter
	HV AC wiring	MV bridge between transformer and protection switchgear prewired
ENVIRONMENT	Ambient temperature range ^[2]	-25 °C... +50 °C (T > 50 °C power derating)
	Maximum altitude (above sea level) ^[1]	Up to 1000 m
	Relative humidity	4% to 95% non condensing
AUXILIARY SERVICES	User cabinet	Integrated in the inverter (by default). Optionally, LV cabinet in the skid
	UPS system ^[1]	1 kVA/1 kW (12 minutes). Optional
OTHER EQUIPMENT	Safety mechanism	Interlocking system
	Fire suppression system	Transformer oil tank retention accessory. Optional
STANDARDS	Compliance	IEC 62271-212, IEC 62271-200, IEC 60076, IEC 61439-1

NOTES

[1] Consult with Power Electronics for other options.

[2] For lower temperatures, consult with Power Electronics.

► JUPITER-9000K/6000K/3000K-H1
Smart Transformer Station



Simple

Prefabricated and pre-tested,
no Internal cabling needed onsite
Compact 20' HC container design for easy transportation



Efficient

High efficiency transformer for higher yields
Lower self-consumption for higher yields



Smart

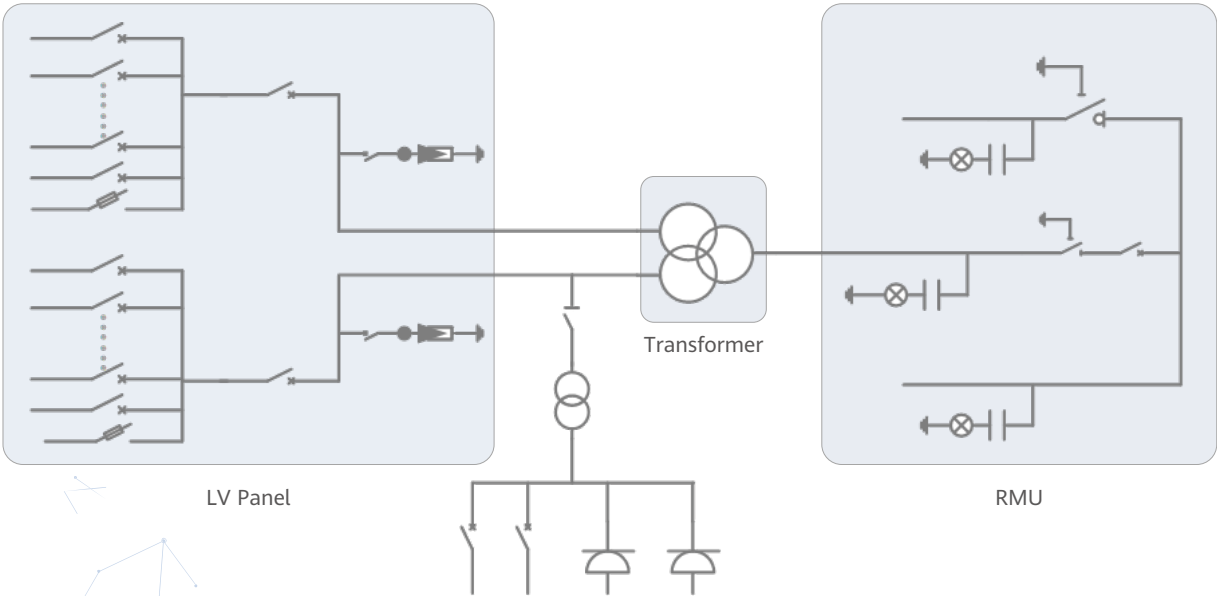
Real-time detection of transformer,
LV panel and RMU high precision sensor
of LV electricity parameters
Remote control of ACB and MV circuit breaker



Reliable

Robust design against harsh environments optimal cooling
Design for high availability and easy O&M
Comprehensive tests from components, device to solution

Schematic Diagram



Technical Specifications

Model	JUPITER-9000K-H1	JUPITER-6000K-H1	JUPITER-3000K-H1
Input			
Available Inverters / PCS	SUN2000-330KTL-H1 / SUN2000-330KTL-H2 / LUNA2000-200KTL-H1		
Max. LV AC Inputs	30	22	11
AC Power	9,000 kVA @40°C ¹	6,600 kVA @40°C ¹	3,300 kVA @40°C ¹
Rated Input Voltage	800 V		
LV Panel Segregation	Form 2b		
LV Main Switches	ACB (4,000 A, 2 x 1 pcs)	ACB (2,900 A, 2 x 1 pcs)	ACB (2,900 A, 1 x 1 pcs)
LV Main Switches for Inverters / PCS	MCCB (400 A, 2 x 15 pcs)	MCCB (400 A, 2 x 11 pcs)	MCCB (400 A, 11 pcs)
Output			
Rated Output Voltage	10~35 kV ²		
Frequency	50 Hz or 60 Hz		
Transformer Type	Oil-immersed, Conservator Type		
Transformer Cooling Type	ONAN		
Transformer Tappings	± 2 x 2.5%		
Transformer Oil Type	Mineral Oil (PCB Free)		
Transformer Vector Group	Dy11-y11	Dy11	
Transformer Min. Peak Efficiency Index	Tier 1 or Tier 2 In Accordance with EN 50588-1		
RMU Type	SF ₆ Gas Insulated		
RMU Transformer Protection Unit	MV Vacuum Circuit Breaker Unit		
RMU Cable Incoming / Outgoing Unit	Direct Cable Unit or Cable Load Break Switch Unit		
Auxiliary Transformer	Dry Type Transformer, 5 kVA, Single-phase, li0		
Output Voltage of Auxiliary Transformer	230 / 127 Vac		
Protection			
Transformer Detection & Protection	Oil Level, Oil Temperature, Oil Pressure and Buchholz		
Protection Degree of MV & LV Room	IP 54		
Internal Arcing Fault of STS	IAC A 20 kA 1s		
MV Relay Protection	50/51, 50N/51N		
LV Overvoltage Protection	Type I+II		
Anti-rodent Protection	C5-Medium		
Features			
2 kVA UPS	Optional ³		
MV Surge Arrester for Transformer	Optional ³		
General			
Dimensions (W x H x D)	6,058 x 2,896 x 2,438 mm (20' HC ISO Container)		
Weight	< 28 t	< 23 t	< 15 t
Operating Temperature Range	-25°C ~ 60°C ⁴		
Relative Humidity	0% ~ 95% (Non-condensing)		
Max. Operating Altitude	1,000 m ⁵		
MV-LV AC Connections	Prewired and Pretested, No Internal Cabling Onsite		
LV & MV Room Cooling	Smart Cooling without Air-across for Higher Availability		
Communication	Modbus TCP, Preconfigured with SmartACU2000D		
Standards Compliance			
IEC 62271-202, EN 50588-1, IEC 60076, IEC 62271-200, IEC 61439-1			

1: More detailed AC power of STS, please refer to the de-rating curve.
2: Rated output voltage from 10 kV to 35 kV, more available upon request
3: Extra expense needed for optional features which standard product doesn't contain, more options upon request.
4: When ambient temperature ≥55 °C, awning shall be equipped for STS on site by customer.
5: For higher operating altitude, pls consult with Huawei.

Application

Versions



R_HA406_004.tif



R_HA406_004.png

Individual circuit-breaker panel 450 mm

RRT block

Application

Typical uses, ratings, standards

8DJH 24 switchgear is a factory-assembled, type-tested, 3-pole metal-enclosed single-busbar switchgear for indoor installation.

8DJH 24 switchgear is used in public and industrial energy systems of the secondary distribution level, e.g. in

- Secondary transformer substations of power supply system operators
- Utilities transfer substations for business enterprises
- Installations of building supply technologies
- Water and sewage treatment plants
- Underground railway stations, railway stations, airports
- Charging stations for electric vehicles
- Generating plants for renewable energies (biomass, hydro power, wind turbines, solar parks).

Electrical data (maximum values) and dimensions

Rated voltage	kV	7.2	12	15	17.5	24
Rated frequency	Hz	50	50	50	50	50
Rated short-duration power-frequency withstand voltage	kV	20	28	36	38	50
Rated lightning impulse withstand voltage	kV	60	75	95	95	125
Rated peak withstand current	kA	50/52.5	50/52.5	50/52.5	50/52.5	50/52.5
Rated short-time withstand current 3 s	kA	20/21	20/21	20/21	20/21	20/21
Rated short-time withstand current 1 s	kA	20/21	20/21	20/21	20/21	20/21
Rated continuous current of the busbar	A	630	630	630	630	630
Rated continuous current of feeders	up to A	630 ¹⁾	630 ¹⁾	630 ¹⁾	630 ¹⁾	630 ¹⁾
Width (feeders)	mm	350/450/550 ¹⁾ →				
Depth						
– without pressure relief duct	mm	775	775	775	775	775
– with pressure relief duct	mm	890	890	890	890	890
Height without low-voltage compartment and pressure relief duct	mm	optionally 1200/1400/1700 →				

1) Depending on the feeder function and the selected design options

Standards

		IEC standard/ EN standard
Switchgear		62271-1
		62271-200
Switching devices	Circuit-breakers	62271-100
	Disconnectors and earthing switches	62271-102
	Switch-disconnectors	62271-103
	Switch-fuse combination	62271-105
Voltage detecting systems		62271-213
HV HRC fuses		60282
Surge arresters / surge limiters		60099
Degree of protection		60529
		62262
Insulation		60071
Instrument transformers	General requirements	61869-1
	Current transformers	61869-2
	Inductive voltage transformers	61869-3
	Low-power current transformers	61869-6
		61869-10
	Low-power voltage transformers	61869-6
		61869-11
Insulating gas		62271-4
Installation		61936-1 / EN 50522
Environmental conditions		60721-3-3
Operation		EN 50110

Requirements

Features

Environmental independence

Hermetically tight, welded switchgear vessels made of stainless steel as well as single-pole solid insulation make the parts of the primary circuit under high voltage of 8DJH 24 switchgear

- Insensitive to certain aggressive ambient conditions, such as:
 - Saline air
 - Air humidity
 - Dust
 - Condensation
- Tight to ingress of foreign objects, such as:
 - Dust
 - Pollution
 - Small animals
 - Humidity.

Compact design

Thanks to the use of an insulation of natural gases (Clean Air), compact dimensions are possible.

Thus:

- Existing switchgear rooms and substation rooms can be used effectively
- New constructions cost little
- Costly city-area space is saved.

Maintenance-free design

Switchgear vessels designed as sealed pressure systems, maintenance-free switching devices and enclosed cable plugs ensure:

- Maximum supply reliability
- Personnel safety
- Sealed-for-life design according to IEC 62271-200 (sealed pressure system)
- Installation, operation, extension and replacement without gas work
- Reduced operating costs
- Cost-efficient investment
- No maintenance cycles.

Innovation

The use of digital secondary systems and combined protection and control devices ensures:

- Clear integration in process control systems
- Flexible and highly simplified adaptation to new system conditions and thus to cost-efficient operation.

Service life

Under normal service conditions, the expected service life of gas-insulated switchgear 8DJH 24 is at least 40 years, taking the tightness of the hermetically welded switchgear vessel into account. The service life is limited by the maximum number of operating cycles of the switchgear devices installed:

- For circuit-breakers, according to the endurance class defined in IEC 62271-100
- For three-position disconnectors and earthing switches, according to the endurance class defined in IEC 62271-102
- For three-position switch-disconnectors, according to the endurance class defined in IEC 62271-103.

Safety

Personal safety

- Safe-to-touch and hermetically sealed primary enclosure
- Standard degree of protection IP65 for all high-voltage parts in the switchgear vessel, at least IP2X for the switchgear enclosure according to IEC 60529
- All high-voltage parts including the cable terminations, busbars and voltage transformers are metal-enclosed and / or provided with earthed layers
- Panels tested for resistance to internal faults up to 21 kA
- Capacitive voltage detecting system to verify safe isolation from supply
- Logical mechanical interlocks prevent maloperation
- HV HRC fuses and cable compartments are only accessible when outgoing feeders are earthed
- Feeder earthing via make-proof earthing switches.

Security of operation

- Hermetically sealed primary enclosure independent of environmental effects (pollution, humidity and small animals)
- Welded switchgear vessels, sealed for life
- Maintenance-free in an indoor environment (IEC 62271-1)
- Operating mechanisms of switching devices and auxiliary switches accessible outside the primary enclosure (switchgear vessel)
- Metal-coated, plug-in inductive voltage transformers mounted outside the switchgear vessel
- Current transformers as ring-core current transformers mounted outside the switchgear vessel
- Complete switchgear interlocking system with logical interlocks
- Mechanical position indicators integrated in the mimic diagram
- Minimum fire load
- Option: Resistance against earthquakes.

Reliability

- Type and routine-tested
- Standardized and manufactured using numerically controlled machines
- Quality assurance in accordance with DIN EN ISO 9001
- More than 1,500,000 switchgear panels of Siemens in operation worldwide for many years.

General

- Panels 3-pole metal-enclosed
- High-voltage compartments with metal partitions
- Hermetically tight, welded switchgear vessel made of stainless steel, with welded-in bushings for electrical connections and mechanical components
- Frame made of sendzimir-galvanized sheet steel
- Front covers and doors of low-voltage compartments powder-coated in color RAL 7035 (light gray)
- Functions as individual panels or combined in a panel block with up to four functions in a common switchgear vessel
- Switching devices 3-pole, fixed-mounted, depending on the function
 - Three-position switch-disconnector
 - Three-position switch-disconnector/fuse combination
 - Vacuum circuit-breaker with three-position disconnector
 - Make-proof earthing switch
- Cable connection with outside-cone plug-in system according to DIN EN 50181
 - In ring-main and circuit-breaker feeders with bolted contact (M16)
 - In transformer feeders with plug-in contact or optionally with bolted contact (M16)
- Wall-standing or free-standing arrangement
- Pressure relief downwards, optionally upwards via pressure absorber systems.

Interlocks

- According to IEC 62271-200
- Logical mechanical interlocks and the constructive features of the three-position switches prevent maloperation as well as access to the cable connection of the feeders and HV HRC fuses under voltage
- Impermissible and undesired operations can be prevented by means of locking devices provided at the switching devices.

Modular design

- Individual panels and panel blocks can be lined up and optionally extended – without gas work on site
- Option: Low-voltage compartment available in 3 overall heights. Installation and removal possible on site, wiring to the panel via plug connections.

Instrument transformers

- Ring-core current transformers not subjected to dielectric stress
- Metal-coated voltage transformers, plug-in type
- In the air-insulated metering panel:
Cast-resin insulated block-type current and voltage transformers (narrow design according to DIN 42600 Part 8 or Part 9)
- Replacement of instrument transformers without gas work, as they are located outside the switchgear vessel.

Sensors

- Current sensor as inductive current transformer in combination with precision shunt (voltage signal)
- Voltage sensor as resistor divider
- In combination with secondary devices such as
 - SICAM FCM
 - 7SJ81.

Vacuum circuit-breaker

- Maintenance-free under normal ambient conditions according to IEC 62271-1
- No relubrication or readjustment
- Up to 10,000 operating cycles
- Vacuum-tight for life.

Secondary systems

- Customary protection, measuring and control equipment
- Option: Numerical multifunction protection relay with integrated protection, control, communication, operating and monitoring functions
- Can be integrated in process control systems.

Digitalization, condition monitoring

Siemens Xcelerator, available monitoring functionalities

Siemens Xcelerator

Siemens Xcelerator is an open digital business platform that enables customers to accelerate their digital transformation more easily, quickly, and at scale.

Addressing key challenges in the energy sector and beyond

Maintaining grid stability – Increasing energy demands often clash with fluctuating generation. Balancing both is crucial for tomorrow's grid stability.

Our smart energy solutions simplify management, align OT and IT, and ensure a resilient, scalable, and adaptable grid.

Maximizing cyber and asset security – Power grids can be a target for cyberattacks, which may cause power outages and unpredictable results.

Our solutions incorporate security measures to remove vulnerabilities in IT components, control devices, as well as transformer substation and switchgear systems.

Reducing expenditures – Our solutions enhance competitiveness through optimized CAPEX and OPEX with asset optimization, digital planning, simulation, and flexible financing options.

Integrating distributed energy resources (DERs) – DERs are at the heart of a clean and resilient energy future. Nevertheless, a greater system flexibility is needed to consistently balance supply and demand.

Our solution offering covers the entire spectrum: from consulting through technical applications and services to tailored financing and business models.

Available monitoring functionalities for gas-insulated switchgear

Condition monitoring

Condition monitoring serves to continuously improve the resilience, reliability, and availability of maintenance-free, gas-insulated medium-voltage switchgear with an expected service life of 40 years. These values are based on the design and empirical data for switchgear assemblies, as well as on the intended use of the switchgear under normal service conditions according to IEC 62271-1.

To protect the investment (CAPEX) and reduce operational expenditures (OPEX), the extension of switchgear functions with a condition monitoring system is the appropriate way for early indication of irregularities at the switchgear and its peripheral components. This is the premise for condition-based inspection.

Temperature monitoring of the cable connections

Temperature monitoring of the cable connections ensures that the maximum permissible thermal service conditions of the gas-insulated switchgear and the cable connection set are not exceeded during operation. With the help of an intelligent correlation between the ambient air temperature, the cable connection temperature, and the switchgear utilization, anomalies can already be detected and indicated before the limit temperature is reached, based also on low-load scenarios.

Temperature and humidity monitoring of the environment (dew-point monitoring)

Ongoing condensation would lead to corrosion at the switchgear, and reduce its service life. Specific countermeasures after strong humidity at the switchgear assembly, as well as the prevention of further condensation, can remedy the situation.

Partial discharge monitoring

Partial discharges arise if the electrical insulation is damaged or insufficient. Partial discharge monitoring offers a pre-alarming in case of a possibly insufficient electrical insulation. In most cases, partial discharges are a long-term effect of thermal overstressing or of defective or incorrectly installed peripheral components.

Digital gas density monitoring

For perfect operation of a gas-insulated switchgear, the correct gas density inside the switchgear vessel is crucial. To maintain the full scope of functions of the switchgear, immediate action is required if the gas density falls below the necessary values.

Circuit-breaker monitoring

Continuous monitoring of circuit-breaker functions enables an evaluation of the actual health status of the circuit-breaker, based on both mechanical and electrical parameters. The evaluation of performed mechanical and electrical switching operations, as well as the monitoring of other components, allows to indicate at an early stage if servicing work is necessary, or if a suitable replacement switchgear should be procured.

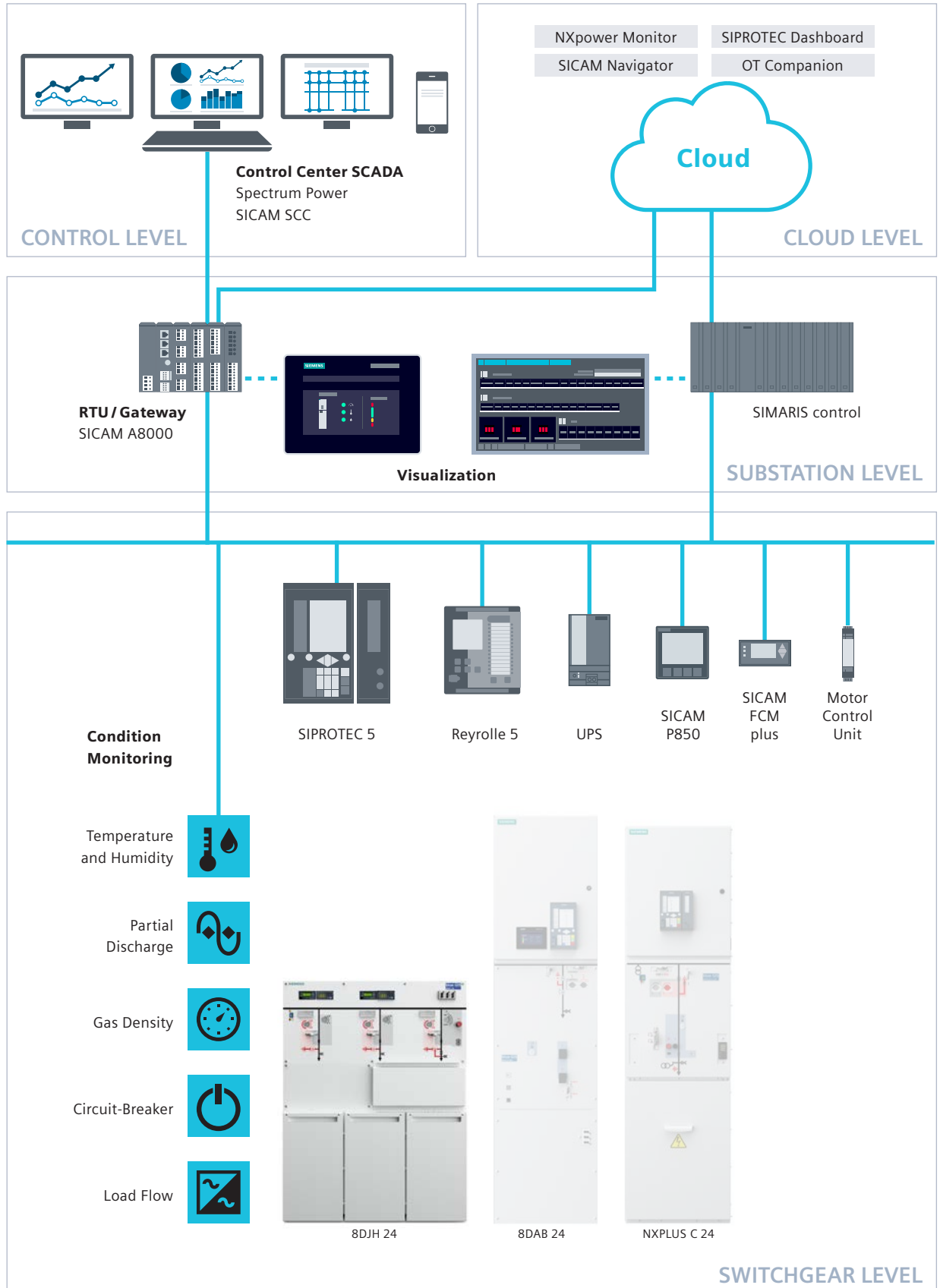
Load flow monitoring

An increasing number of distributed energy resources and the growing share of e-mobility lead to ever more volatile load flows in the distribution grids. Capturing this data is an important element for identifying hotspots in the grid, and it offers planning security for the operator.

Digitalization, condition monitoring

Digitalization solutions from a single source

End-to-End-Cybersecurity



Technical data

Switchgear

Electrical data of the switchgear

Rated insulation level	Rated voltage U_r	kV	7.2	12	15	17.5	24
	Rated short-duration power-frequency withstand voltage U_d :						
	– phase-to-phase, phase-to-earth, open contact gap	kV	20	28	36	38	50
	– across the isolating distance	kV	23	32	39	45	60
	Rated lightning impulse withstand voltage U_p :						
	– phase-to-phase, phase-to-earth, open contact gap	kV	60	75	95	95	125
	– across the isolating distance	kV	70	85	110	110	145
Rated frequency f_r		Hz	50	50	50	50	50
Rated continuous current I_r ²⁾	for busbar	A	630	630	630	630	630
	for ring-main and cable feeders	A	630	630	630	630	630
	for circuit-breaker feeders	A	630	630	630	630	630
	for transformer feeders	A	Depending on the HV HRC fuse-link →				
50 Hz	Rated short-time withstand current I_k	for switchgear with $t_k = 1$ or 3 s ¹⁾	up to kA	20/21 ¹⁾			→
	Rated peak withstand current I_p		up to kA	50/52.5 ¹⁾			→
Filling level (pressure values at 20 °C)	Rated filling level p_{re} (absolute)	kPa	190	190	190	190	190
	Minimum functional level p_{me} (absolute)	kPa	180	180	180	180	180
Ambient air temperature T ³⁾	Operation	standard	°C	–25 to +55			→
		on request	°C	–40 to +70			→
	Storage / transport	standard	°C	–25 to +55			→
		on request	°C	–40 to +70			→
Degree of protection	for gas-filled switchgear vessel		IP65	IP65	IP65	IP65	IP65
	for switchgear enclosure		IP2X/IP3X ¹⁾ →				
	for low-voltage compartment		IP3X/IP4X ¹⁾ →				
Partition class			PM	PM	PM	PM	PM
Loss of service continuity category	Feeder panels with (switch-)disconnecter		LSC2	LSC2	LSC2	LSC2	LSC2
	Billing metering panel M, cable feeder K		LSC1	LSC1	LSC1	LSC1	LSC1
Accessibility to compartments (enclosure)	Busbar compartment		Non-accessible →				
	Switching-device compartment		Non-accessible →				
	Cable compartment / HV HRC fuse compartment						
	– Feeder panels with switching device		Interlock-controlled →				
Internal arc classification ⁴⁾ (option)	– Billing metering panel M, cable feeder K		Tool-based →				
	IAC A						
	Accessibility FL or FLR						
	Arc test current I_A	up to kA	21	21	21	21	21
	Test duration t_A	s	1	1	1	1	1

1) Design option

2) The rated continuous currents apply to ambient air temperatures of max. 40 °C.

The 24-hour mean value is max. 35 °C (according to IEC 62271-1)

3) Minimum and maximum permissible ambient air temperature depending on the secondary equipment used

4) Description of the design options as of page 33

Three-position switch-disconnector

Rated voltage U_r		kV	7.2	12	15	17.5	24
General-purpose switch function	Rated mainly active load breaking current I_{load}	A	630	630	630	630	630
	Rated short-circuit making current I_{ma} 50 Hz	up to kA	50/52.5 ¹⁾				→
	Electrical endurance	Class	E3	E3	E3	E3	E3
	Number of electrical operating cycles with I_{load}	n	100	100	100	100	100
	Number of short-circuit making operations with I_{ma}	n	5	5	5	5	5
	Capacitive switching	Class	C2	C2	C2	C2	C2
	Mechanical endurance	Class	M1	M1	M1	M1	M1
	Number of mechanical operating cycles	n	1000	1000	1000	1000	1000
Disconnecter function	Mechanical endurance	Class	M0	M0	M0	M0	M0
	Number of mechanical operating cycles	n	1000	1000	1000	1000	1000
Make-proof earthing switch function	Rated short-circuit making current I_{ma} 50 Hz	up to kA	50/52.5 ¹⁾				→
	Number of short-circuit making operations with I_{ma}	n	5	5	5	5	5
	Mechanical endurance	Class	M0	M0	M0	M0	M0
	Number of mechanical operating cycles	n	1000	1000	1000	1000	1000

Three-position switch-disconnector/fuse combination

Rated voltage U_r		kV	7.2	12	15	17.5	24
Switch function	Rated mainly active load breaking current I_{load}	A	200	200	200	200	200
	Rated short-circuit making current I_{ma} 50 Hz	up to kA	50/52.5 ¹⁾				→
	Number of electrical operating cycles with I_{load}	n	100	100	100	100	100
	Number of short-circuit making operations with I_{ma}	n	5	5	5	5	5
	Mechanical endurance	Class	M1	M1	M1	M1	M1
	Number of mechanical operating cycles	n	1000	1000	1000	1000	1000
Switch-fuse combination function	Rated transfer current $I_{transfer}$	A	1400	1400	1400	1400	1400
	Maximum permissible rated power S_r of the transformer ²⁾	up to kVA	250 to 630	1250	1250	1250	2000
Disconnecter function	Mechanical endurance	Class	M0	M0	M0	M0	M0
	Number of mechanical operating cycles	n	1000	1000	1000	1000	1000
Make-proof earthing switch function	Rated short-circuit making current I_{ma} 50 Hz	up to kA	6.3	6.3	6.3	6.3	6.3
	Number of short-circuit making operations with I_{ma}	n	5	5	5	5	5
	Mechanical endurance	Class	M1	M1	M1	M1	M1
	Number of mechanical operating cycles	n	1000	1000	1000	1000	1000

Vacuum circuit-breaker with three-position disconnector

Rated voltage U_r		kV	7.2	12	15	17.5	24	
Circuit-breaker type 1 function	Rated operating sequence		O – 0.3 s – CO – 3 min – CO					→
		Option	O – 0.3 s – CO – 15 s – CO					→
	Rated short-circuit breaking current I_{sc}	up to kA	20/21 ¹⁾					→
	Electrical endurance	Class	E2	E2	E2	E2	E2	
	Number of short-circuit breaking operations with I_{sc}	n	50	50	50	50	50	
	Capacitive switching	Class	C2	C2	C2	C2	C2	
	Switching of cable systems	Class	S1	S1	S1	S1	S1	
	Mechanical endurance	Class	M2	M2	M2	M2	M2	
	Number of mechanical operating cycles	n	10000	10000	10000	10000	10000	
	Disconnecter function	Mechanical endurance	Class	M0	M0	M0	M0	M0
Number of mechanical operating cycles		n	1000	1000	1000	1000	1000	
Make-proof earthing switch function	Rated short-circuit making current I_{ma} 50 Hz	up to kA	50/52.5 ¹⁾					→
	Number of short-circuit making operations with I_{ma}	n	5	5	5	5	5	
	Mechanical endurance	Class	M0	M0	M0	M0	M0	
	Number of mechanical operating cycles	n	1000	1000	1000	1000	1000	

1) Design option

2) Depending on the primary voltage of the transformer and the HV HRC fuses used

Product range

Individual panels



Three-position disconnector



Vacuum circuit-breaker



Three-position switch-disconnector



Capacitive voltage detecting system



Surge arrester or limiter



Current transformer



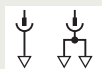
Voltage transformer



Voltage sensor



Current sensor

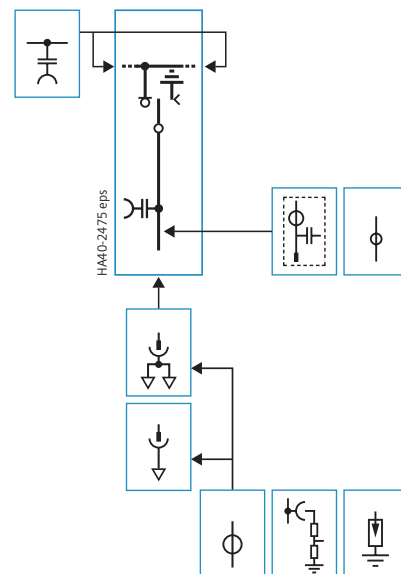


Cable connection with outside cone (not included in scope of supply)

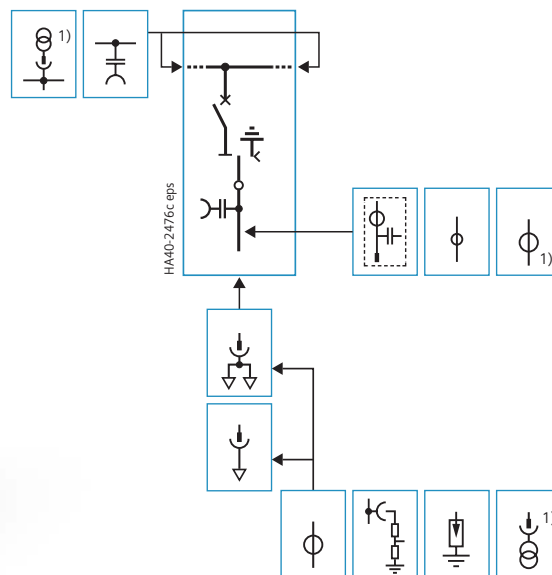


SiBushing (integrated measurement of current, voltage, and temperature)

Ring-main feeder (R)



Circuit-breaker feeder (L)



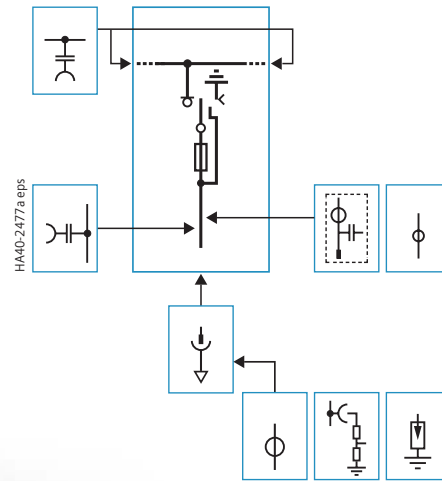
1) Only for panels with a width of 550 mm

All dimensions in mm.

Product range

Individual panels

Transformer feeder (T)



Three-position
switch-disconnector



Capacitive voltage
detecting system



Surge arrester
or limiter



Current transformer



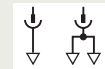
HV HRC fuse



Voltage sensor



Current sensor



Cable connection
with outside cone
(not included in scope of
supply)



SIBushing (integrated
measurement of current,
voltage, and temperature)

All dimensions in mm.

Product range

Individual panels



Three-position disconnecter



Vacuum circuit-breaker



Three-position switch-disconnector



Capacitive voltage detecting system



Surge arrester or limiter



Current transformer



HV HRC fuse



Voltage transformer



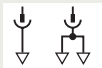
Voltage sensor



Current sensor



Fixed earthing points for busbar earthing



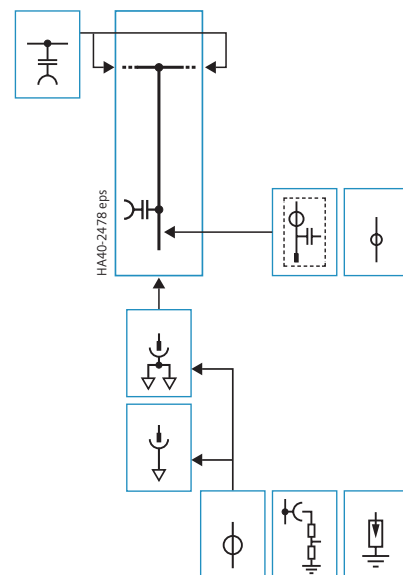
Cable connection with outside cone (not included in scope of supply)



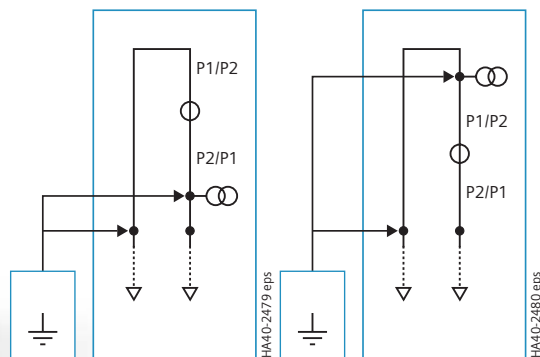
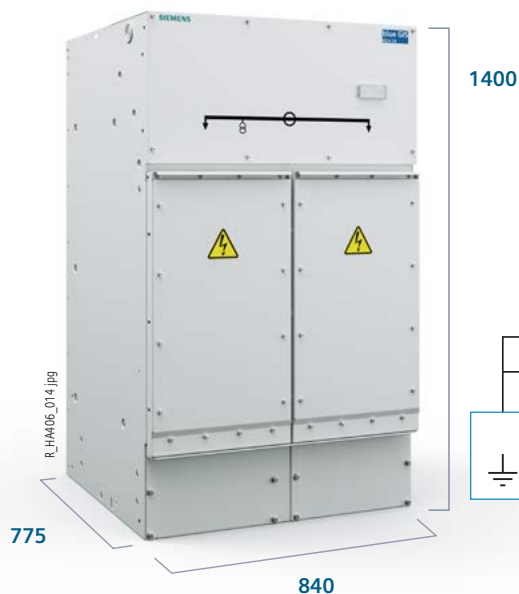
SiBushing (integrated measurement of current, voltage, and temperature)

P1 and P2 are terminal designations of the current transformer

Cable feeder (K)



Billing metering panel (M)



All dimensions in mm.

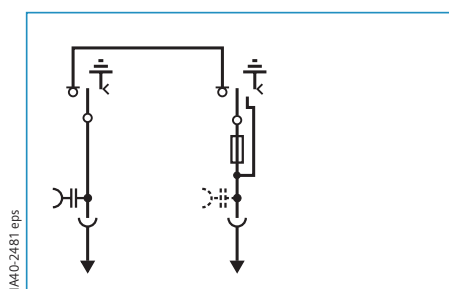
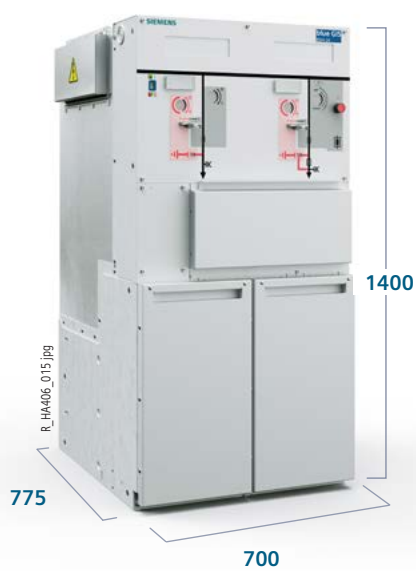
Product range

Panel blocks (excerpt)

Panel blocks for 8DJH 24, 2-panel design, optionally with busbar extension

Components shown in dotted lines can be used optionally.

RT 1 ring-main feeder, 1 transformer feeder



Three-position
disconnecter



Vacuum circuit-breaker



Three-position
switch-disconnector



Capacitive voltage
detecting system

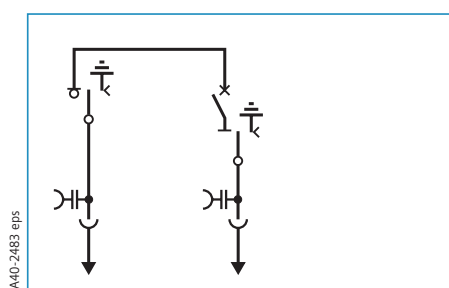


Cable connection
with outside cone
(not included in scope of
supply)



HV HRC fuse

RL 1 ring-main feeder, 1 circuit-breaker feeder



All dimensions in mm.

Product range

Panel blocks (excerpt)



Three-position
disconnector



Vacuum circuit-breaker



Three-position
switch-disconnector



Capacitive voltage
detecting system



Cable connection
with outside cone
(not included in scope of
supply)

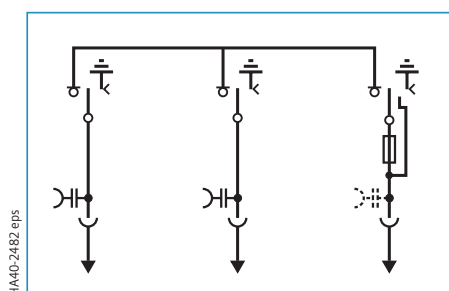


HV HRC fuse

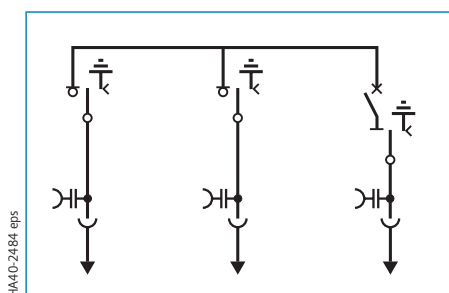
Panel blocks for 8DJH 24, 3-panel design, optionally with busbar extension

Components shown in dotted lines can be used optionally.

RRT 2 ring-main feeders, 1 transformer feeder



RRL 2 ring-main feeders, 1 circuit-breaker feeder



All dimensions in mm.

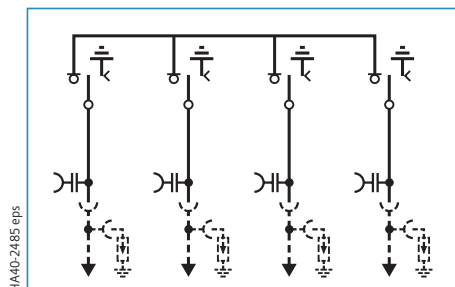
Product range

Panel blocks (excerpt)

Panel blocks for 8DJH 24, 4-panel design, optionally with busbar extension

Components shown in dotted lines can be used optionally.

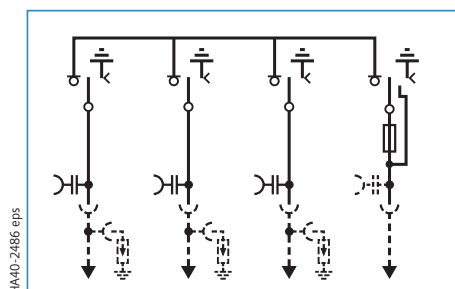
RRRR 4 ring-main feeders



Dimensions in mm

Width	Depth	Height
1400	775	1200
		1400
		1700

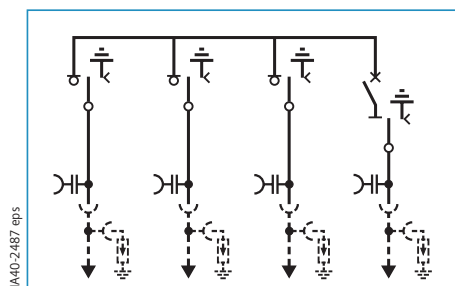
RRRT 3 ring-main feeders, 1 transformer feeder



Dimensions in mm

Width	Depth	Height
1400	775	1200
		1400
		1700

RRRL 3 ring-main feeders, 1 circuit-breaker feeder



Dimensions in mm

Width	Depth	Height
1400	775	1200
		1400
		1700



Vacuum circuit-breaker



Three-position
disconnecter



Three-position
switch-disconnector



HV HRC fuse



Capacitive voltage
detecting system



Cable connection
with outside cone
(not included in scope of
supply)



Surge arrester

SR20-D2

Digital secondary standard pyranometer with Modbus RTU and 4-20 mA output

SR20-D2 is a solar radiation sensor of the highest category in the ISO 9060 classification system: secondary standard. SR20-D2 is designed for the solar PV industry, offering two types of commonly used irradiance outputs: digital via Modbus RTU over RS-485 and analogue 4-20 mA (current loop). Individually tested for temperature and directional response, SR20-D2 is the most accurate digital secondary standard pyranometer available.



Figure 1 SR20-D2 digital secondary standard pyranometer



Figure 2 state-of-the-art electronics inside the SR20-D2

Introduction

SR20-D2 measures the solar radiation received by a plane surface, in W/m^2 , from a 180° field of view angle. It is employed where the highest measurement accuracy is required. SR20-D2 offers two types of outputs commonly used in the solar PV industry: digital via Modbus RTU over RS-485 and analogue 4-20 mA (current loop). These industry standards allow for easy data acquisition, easy read-out and error-free instrument exchange when using SR20-D2.

The best pyranometer for the PV industry

SR20-D2 is the most accurate digital secondary standard pyranometer available. Its benefits:

- Digital output: easy implementation & servicing
- Best-in-class temperature response
< $\pm 0.4\%$ (-30 to $+50\text{ }^\circ\text{C}$), best "zero offset a" and best calibration uncertainty
- Test certificates for temperature- and directional response included as required by ISO 9060
- Re-calibration registers fully accessible to users

Best measurement accuracy

In order to improve overall measurement accuracy, Hukseflux effectively targeted two major sources of measurement uncertainty: calibration and “zero offset a”.

In addition, SR20-D2 has a negligible temperature response. All are best in class. The temperature response of every individual instrument is tested and corrected onboard by the instrument electronics, using a second degree polynomial.

Demanding applications

SR20-D2's low temperature dependence makes it the ideal candidate for use under very cold and very hot conditions.

SR20-D2 design

SR20-D2 pyranometer employs a state-of-the-art thermopile sensor with black coated surface, two domes and an anodised aluminium body. The connector, desiccant holder and sun screen fixation are very robust and designed for long term industrial use. SR20-D2 uses a high-end 24-bit A/D converter. All parts are specified for use across SR20-D2's entire rated operating temperature range. SR20-D2 offers two types of outputs commonly used in the solar PV industry: digital output via Modbus RTU over 2-wire RS-485 and analogue 4-20 mA output (current loop).

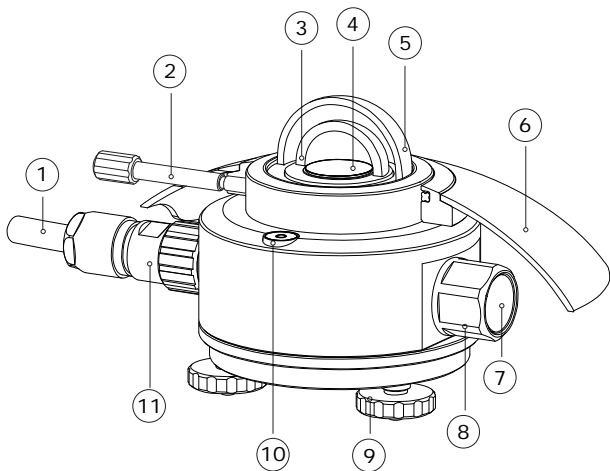


Figure 3 overview of SR20-D2:

(1) cable, (2) fixation of sun screen, (3) inner dome, (4) thermal sensor with black coating, (5) outer dome, (6) sun screen, (7) humidity indicator, (8) desiccant holder, (9) levelling feet, (10) bubble level, (11) connector

Standards

Applicable instrument classification standards are ISO 9060 and WMO-No. 8.

Re-calibration: accessible registers

The recommended calibration interval of pyranometers is 2 years. The registers containing the applied sensitivity and the calibration history of SR20-D2 are fully accessible for users. This allows the user to choose his own local calibration service. The same feature may be used for remotely controlled re-calibration of pyranometers in the field. Ask Hukseflux for information on this feature and on ISO and ASTM standardised procedures for field calibration.



Figure 4 SR20-D2 secondary standard pyranometers with digital output for GHI (global horizontal irradiance) and POA (plane of array) measurements

Choosing the right instrument

Pyranometers are subject to classification in three classes according to ISO 9060. From second class to first class and from first class to secondary standard, the achievable accuracy improves by a factor 2. Measurement accuracy does not only depend on instrument properties, but also on measurement conditions. A very accurate instrument will quickly underperform without a regular schedule of maintenance. Our pyranometer [selection guide](#) assists you in choosing the right instrument. Whatever your application is: Hukseflux offers the highest accuracy in every class at the most attractive price level.

Hukseflux Sensor Manager software

For communication between a PC and SR20-D2, the Hukseflux Sensor Manager software is included. It allows the user to plot and export data, and change the SR20-D2 Modbus address and its communication settings.



Figure 5 user interface of the Sensor Manager

Suggested use

- PV system performance monitoring
- all networks with regular instrument exchange
- scientific meteorological observations
- reference instrument for comparison
- extreme climates (tropical / polar)



Figure 6 SR20-D2 side view

See also

- **SR20** secondary standard pyranometer with analogue millivolt output
- **SR25** secondary standard pyranometer with sapphire outer dome
- alternative instruments: **SR11** and **LP02** for lower accuracy measurements
- **SR12** first class pyranometer for solar energy testing applications
- the making of SR20 **documented**
- view our complete **range of solar sensors**

SR20-D2 specifications

Measurand	hemispherical solar radiation
ISO classification	secondary standard pyranometer
Calibration uncertainty	< 1.2 % (k = 2)
Zero offset a	5 W/m ² unventilated 2.5 W/m ² ventilated
Calibration traceability	to WRR
Calibration registers	accessible to users
Spectral range	285 to 3000 x 10 ⁻⁹ m
Rated operating temperature range	-40 to +80 °C
Temperature response	< ± 0.4 % (-30 to +50 °C)
Heater	no heating
Temperature response test of individual instrument	report included
Directional response test of individual instrument	report included
Standard cable length	5 m
Backwards compatibility	SR20-D1

Digital output

Output	-irradiance in W/m ² -instrument body temperature in °C
Communication protocol	Modbus / over 2-wire RS-485
Transmission mode	RTU
Rated operating voltage range	5 to 30 VDC
Power consumption	< 75 x 10 ⁻³ W at 12 VDC

4-20 mA output

Output	irradiance in W/m ²
Transmitted range of 4-20 mA output	0 to 1600 W/m ²
Rated operating voltage range of 4-20 mA output	5.5 to 40 VDC
Power consumption	
- main supply	< 75 x 10 ⁻³ W at 12 VDC
- 4-20 mA current loop	< 40 x 10 ⁻³ W at 12 VDC, with recommended 100 Ω shunt resistor

Options

- longer cable, in multiples of 5 metres
- adapted transmitted range for 4-20 mA output
- ventilated with **VU01** ventilation unit

About Hukseflux

Hukseflux sensors, systems and services are offered worldwide via our office in Delft, the Netherlands and local distributors.

Are you interested in this product?
E-mail us at: info@hukseflux.com

SR20-D2 digital secondary standard pyranometer

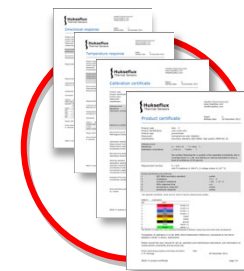
Nowadays, the best pyranometers are made by Hukseflux Thermal Sensors. This overview of features and benefits of SR20-D2 gives you some of the reasons why! Whatever your application is, Hukseflux offers the highest accuracy in every class at the most attractive price level.



Best measurement accuracy

- lowest zero offsets
- lowest calibration uncertainty
- best temperature dependence

- only Hukseflux includes all ISO required reports with every individual sensor
 - temperature response testing from -30 to 50 °C
 - full directional response testing



Best paperwork



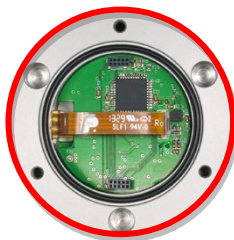
Best connector

- interchangeable cables
- IP67 grade
- for industrial use



Best desiccant cartridge

- visible indicator of instrument health
- rugged aluminium design
- serviceable by user

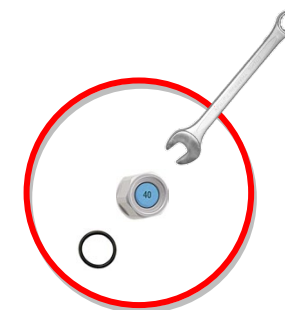


Best digital interface

- industry standard output types
- Modbus RTU over 2-wire RS-485
- registers for re-calibration accessible to users

Best humidity protection

- wrench-operated
- o-ring compressed to spec
- desiccant service interval > 2 years





Medición por remoto de la Temperatura en módulos Fotovoltaicos.

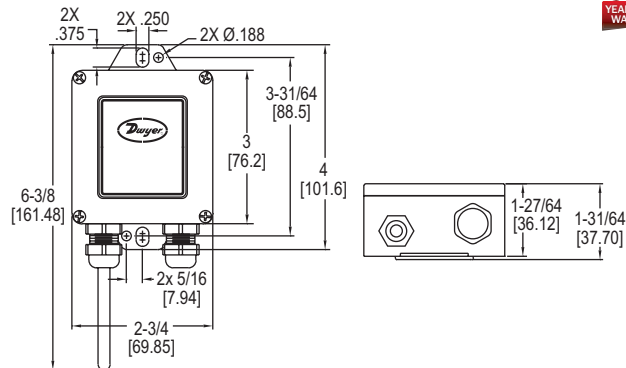
Los sensores Todo-en-Uno de Lufft ofrecen una entrada adicional para conectar sensores externos, como la sonda de temperatura externa WT1. Este sensor de temperatura remoto se puede combinar con cualquier miembro de la familia WS. Una aplicación típica es el uso como sensor de referencia para monitorear la eficiencia de un sistema solar.

Descripción	Valor
Longitud del Cable	5m. (Preguntar otras medidas)
Temperatura de Trabajo	-40°C ... 125°C
Tipo de Protección	IP68
Peso	300gr Aprox.
Dimensiones	Ø30mm, altura 8mm
Tolerancia de la Resistencia de 0°C a 70°C	±0.1°C
Temperatura Máxima de Exposición	150°C
Tiempo de Respuesta	~ 10s
Tipo de Sonda	PT1000

Dwyer**SERIES O-4**

OUTSIDE AIR TEMPERATURE SENSOR

NEMA 4X, Removable Terminal Block



The **Series O-4 Outside Air Temperature Sensor** is great for monitoring ambient air temperatures in outdoor applications. The temperature sensors are mounted in a NEMA 4X enclosure with integral mounting tabs.

FEATURES/BENEFITS

- NEMA 4X weatherproof housing
- Surface or suspension mount

APPLICATIONS

- Agricultural house ventilation
- HVAC and building automation

MODEL CHART			
Model	Sensor Type	Model	Sensor Type
O-4A	10k Ω type III thermistor	O-4D	Pt100 Ω RTD
O-4B	10k Ω type II thermistor	O-4E	Pt1000 Ω RTD
O-4C	3k Ω thermistor	O-4F	20k Ω thermistor

SPECIFICATIONS

Accuracy: Thermistor temperature sensor: $\pm 0.22^{\circ}\text{C}$ @ 25°C ($\pm 0.4^{\circ}\text{F}$ @ 77°F); RTD temperature sensor: DIN class B: $\pm 0.3^{\circ}\text{C}$ @ 0°C ($\pm 0.54^{\circ}\text{F}$ @ 32°F).

Operating Temperature: -40 to 250°F .

Probe Diameter: 0.235" (5.97 mm).

Probe Length: 3.5".

Probe Material: 304 SS.

Mounting: Suspension or surface.

Enclosure Rating: NEMA 4X (IP66).

Weight: 3 oz (85 g).

Agency Approvals: Meets the technical requirements of EU Directive 2011/65/EU (RoHS II).



Compact all-in-one weather sensor with measurement of temperature, relative humidity, precipitation intensity, precipitation type, precipitation quantity, air pressure, wind direction and wind speed.

- **Parameters measured**

Temperature, relative humidity, precipitation intensity, precipitation type, precipitation quantity, air pressure, wind direction, wind speed

- **Measurement technology**

Ultrasonic/Wind, NTC/T, Capacitive/RH, MEMS capacitive/Pressure, 24 GHz Doppler radar/Precipitation

- **Product highlights**

Compact all-in-one weather sensor, low power, heater, aspirated radiation shield, maintenance-free operation, open communication protocol

- **Interfaces**

RS485 with supported protocols UMB-Binary, UMB-ASCII, Modbus-RTU, Modbus-ASCII, XDR and SDI-12

- **Article number**

8370.U01, 8370.U02

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications. Integrated design with ventilated radiation protection for measuring: Air temperature, relative humidity, precipitation intensity, precipitation type, precipitation quantity, air pressure, wind direction and wind speed. One external temperature sensor is connectable.

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General	
Dimensions	Ø approx. 150 mm, height approx. 343 mm
Weight	Approx. 1.5 kg
Interface	RS485, 2 - wire, half - duplex
Power supply	4...32 VDC
Operating temperature	-50...60 °C
Operating rel. humidity	0...100 % RH
Heating	40 VA at 24 VDC
Cable length	10 m
Protection level housing	IP66
Mast mounting suitable for	Mast diameter 60 - 76 mm

Temperature	
Principle	NTC
Measuring range	-50 ... 60 °C
Unit	°C
Accuracy	±0.2 °C (-20...50 °C), otherwise ±0.5 °C (>-30 °C)

Relative humidity	
Principle	Capacitive
Measuring range	0 ... 100 % RH
Unit	% RH
Accuracy	±2 % RH

Air pressure	
Principle	MEMS capacitive
Measuring range	300 ... 1200 hPa
Unit	hPa
Accuracy	±0.5 hPa (0...40 °C)

Wind direction	
Principle	Ultrasonic
Measuring range	0 ... 359.9 °
Unit	°
Accuracy	< 3 ° RMSE > 1.0 m/s

Wind speed	
Principle	Ultrasonic
Measuring range	0 ... 75 m/s
Unit	m/s
Accuracy	±0.3 m/s or ±3 % (0...35 m/s) ±5 % (>35 m/s) RMS
Resolution	0.1 m/s

Precipitation intensity	
Resolution	0.1 mm/h

Precipitation quantity

Resolution	0.01 mm
Reproducibility	Typical >90 %
Measuring range drop size	0.3...5 mm
Type of precipitation	Rain/snow