Sistemas Energéticos

3º ano 6º semestre

Aula 24

Aula 24: Energia Solar Activa
Sistemas Fotovoltaicos

Tópicos

- ***Introdução***
- ***Determinação da energia diária a fornecer***
- ***Estimativa do factor de perdas***
- ***Estimativa da radiação solar incidente***
- ***Determinação da potência do gerador FV***
- ***Número de Módulos por Fileira***
- ***Capacidade da bateria de acumuladores***
- ***Regulador de Carga***
- ***Inversores DC/AC***

24 Introdução

O dimensionamento de sistemas autónomos para instalações domésticas, pode ser efectuado sem o recurso à utilização de software especifico, desde que não contemple um grande número de variáveis. Neste contexto, a aplicação de um conjunto de equações matemáticas simples permite executar o processo de dimensionamento de forma mais ou menos precisa.

24.0 Introdução

Um sistema fotovoltaico autónomo é fundamentalmente concebido para alimentar um conjunto de cargas que operam isoladas da rede eléctrica, durante todo o ano. Neste contexto, o dimensionamento de um sistema fotovoltaico autónomo é normalmente efectuado através do conhecimento prévio da intensidade da radiação solar disponível, correspondente ao mês com menor número de horas solares equivalentes. Este tipo de sistemas, para além de integrarem os painéis solares, deve também incluir os seguintes equipamentos:

24.0 Introdução

- **Baterias**: a sua principal função consiste em assegurar a alimentação dos consumos de energia eléctrica nos períodos em que o recurso solar não está disponível (período nocturno);

- **Controlador de carga**: a sua principal função consiste em efectuar a gestão da carga das baterias;

- **Inversor**: para o caso de haver cargas a alimentar em corrente alternada (CA), a sua principal função consiste em converter a tensão contínua em tensão alternada, com a frequência e amplitude da rede.

24.0 Introdução

Os sistemas autónomos para alimentação de instalações domésticas ou outras, podem ser utilizados de acordo com os seguintes tipos de aproveitamento:

- Instalações utilizadas para alimentar cargas de corrente contínua (12 V, 24 V ou 48 V, CC), sendo constituídas pela associação de módulos ou Painéis FV, regulador de carga e baterias, conforme mostrado esquematicamente na Figura 24.1. Nesta situação ***não*** existe a necessidade de se utilizem inversores (sistema muito mais económico e eficiente);

24.0 Introdução

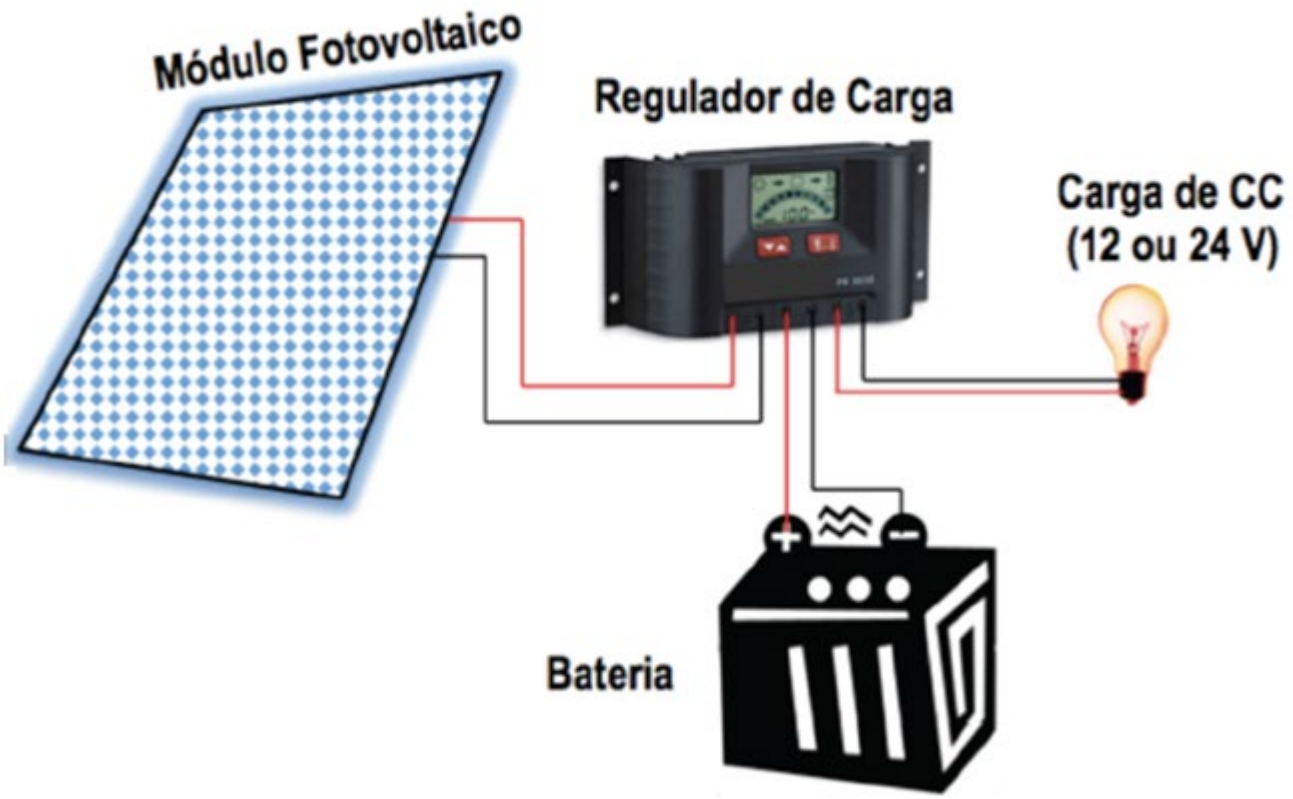


Figura 24.1 – Componentes do sistema solar fotovoltaico

24.0 Introdução

- Instalações utilizadas para alimentar cargas de corrente contínua (12 V, 24 V ou 48 V, CC) e cargas de corrente alternada (230 V, 50 Hz), sendo constituídas pela associação de módulos ou painéis FV, reguladores de carga, baterias e inversor, conforme mostrado esquematicamente na Figura 24.2.

É importante realçar que para ambas as situações (Figura 24.1 e Figura 24.2), o conjunto de baterias é colocado em paralelo com o fluxo de energia do sistema. Na verdade, este tipo de configuração encerra algumas vantagens em relação a uma eventual configuração em série. Com efeito, após ficar completamente carregado, o conjunto de baterias pode ser desligado do sistema de modo a que as cargas possam ser somente alimentadas pela energia que é gerada através dos painéis fotovoltaicos.

24.0 Introdução

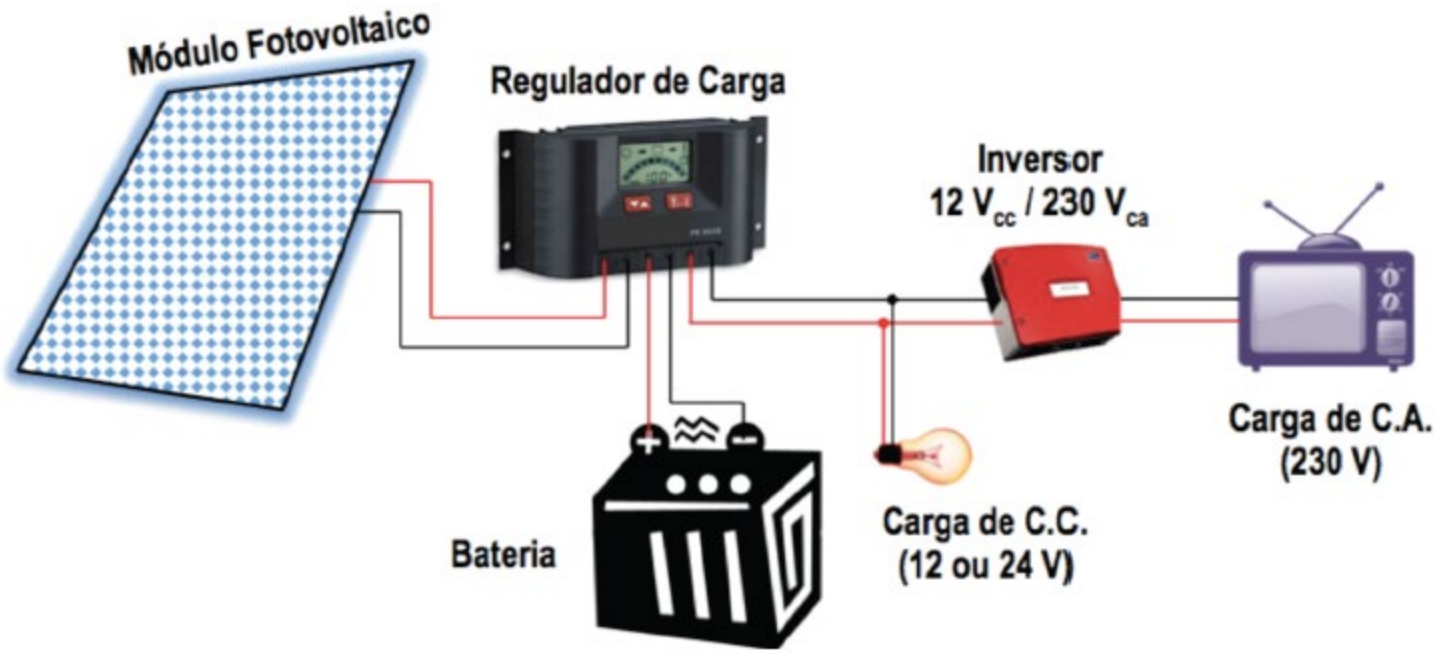


Figura 24.2 – Componentes do sistema solar fotovoltaico

24.0 Introdução

Se o sistema tiver algum grau de complexidade, é prudente que seja utilizado um software comercial específico. Por exemplo, esta última situação ocorre quando se pretende dimensionar um sistema FV autónomo para uma moradia familiar, constituída por cerca de 4 a 5 pessoas.

O processo de dimensionamento que se desenvolve em seguida, recorre a um dos métodos mais simples, entre os vários que ultimamente têm sido desenvolvidos.

24.1 Determinação da energia diária a fornecer aos consumos (Wh)

A primeira tarefa consiste em identificar o número, a potência e o tempo de funcionamento do conjunto de equipamentos que é necessário alimentar. A tabela a seguir configura um exemplo simples relativo ao procedimento que deverá ser executado para se efectuar o levantamento das necessidades diárias de consumo.

Tabela 24.1 – Estimativa de consumo diário de energia

Equipamentos	Número	Horas de uso/dia	Potência (W)	Energia diária (Wh/dia)
Lâmpadas de leitura				
Frigorifico				
Televisão				
Computador				
TOTAIS			ΣP_i	W_D

24.1 Determinação da energia diária a fornecer aos consumos (Wh)

A quantidade total de energia que é necessário prever para garantir a alimentação diária de todos os equipamentos, corresponde ao somatório das energias parciais consumidas pelos diferentes equipamentos utilizados:

$$W_D = \sum_{i=1}^{n} P_i \times t_i \left[\frac{kWh}{dia}\right] \qquad (24.1)$$

$$W_M = W_D \times dias\ do\ mês \left[\frac{kWh}{mês}\right]$$

Onde W_D representa a energia total consumida por dia, W_M representa a energia total consumida por mês, P_i indica a potência (W) de um determinado equipamento e t_i corresponde ao seu intervalo de tempo de funcionamento.

24.2 Estimativa do factor de perdas

A capacidade que um gerador fotovoltaico tem de alimentar as diversas cargas, está sujeita a algumas perdas inerentes ao sistema. Entre estas, aquelas que têm maior expressão são as que se referem às perdas nas cablagens e as perdas no inversor e regulador de carga:

- ⇒ Rendimento (cablagens): $\eta cabo = 0{,}97$
- ⇒ Rendimento (regulador+inversor): $\eta_{reg+inv} = 0{,}85$
- ⇒ Rendimento da bateria : $\eta_{bat} = 0{,}8$
- ⇒ Rendimento total dos sistema: $\eta_{sist} = \eta_{cabo} \times \eta_{reg+inv} \times \eta_{bat}$
- $= 0{,}97 \times 0{,}85 \times 0{,}8 = 0{,}67$

24.2 Estimativa do factor de perdas

Além destas perdas, existem outros factores que interferem no cálculo do sistema FV. Atendendo a que a radiação solar incidente é muito variável ao longo do ano, é necessário identificar o valor da intensidade da radiação solar incidente (**mês mais desfavorável**) para o qual se deve dimensionar o gerador FV.

24.3 Avaliação da radiação solar incidente

A consulta do site (https://re.jrc.ec.europa.eu/pvg_tools/en/) permite conhecer os I_M - Soma média mensal da irradiação global por metro quadrado, recebido pelos módulos do sistema dado [kWh/m²], a E_M - Produção média mensal de electricidade do sistema definido [kWh] por 1 KW de potência e o SD_M: Desvio padrão da produção mensal de electricidade devido à variação anual [kWh].para a cidade de Maputo.

25.3 AVALIAÇÃO DA RADIAÇÃO SOLAR INCIDENTE

Tabela 24.2 Produção média mensal de electricidade do sistema definido [kWh] e Soma média mensal da irradiação global por metro quadrado recebido pelos módulos do sistema dado [kWh/m²] para a cidade de Maputo

Mês	E_M [KWh/kW/mês]	H(i)m [KWh/m²]	SD_m
Janeiro	137,5	182,9	11,3
Fevereiro	113,1	152,0	6,0
Março	91,7	125,0	3,6
Abril	55,7	79,6	1,2
Maio	32,5	51,2	1,1
Junho	24,2	38,9	1,7
Julho	29,2	46,0	1,5
Agosto	48,5	70,9	1,3
Setembro	77,5	106,6	2,3
Outubro	111,2	147,8	4,5
Novembro	124,4	166,1	7,1
Dezembro	139,4	185,9	12,2

24.4 Estimativa da radiação solar incidente para uma superfície com inclinação óptima

É possível efectuar o cálculo da radiação solar em superfícies inclinadas, a partir dos valores registados para superfícies horizontais. A inclinação da superfície óptima, β_{opt} é habitualmente tomada como sendo igual à latitude do lugar, ϕ. Por outro lado, a radiação solar que incide sobre uma superfície com inclinação óptima, $I(\beta_{opt})$ é calculada de acordo com a seguinte equação:

$$I\left(\beta_{opt}\right) = \frac{I\left(0\right)}{\left(1 - 4,46\times10^{-4}\,\beta_{opt} - 1,19\times10^{-4}\,\beta_{opt}^{2}\right)} \qquad (24.2)$$

24.4 Estimativa da radiação solar incidente para uma superfície com inclinação óptima

Devido à exposição ao meio ambiente, a superfície frontal dos módulos fotovoltaicos pode, ao longo do tempo, acumular alguma sujidade (poeiras, compostos orgânicos acumulados, entre outros). Neste cenário, a acção da sujidade assim com o tipo de acabamento da superfície (vidros) dos módulos, contribuem negativamente no que concerne à capacidade que o gerador FV tem em absorver a radiação solar. A radiação solar que incide sobre uma superfície com inclinação qualquer, I (β,α) é calculada de acordo com a seguinte equação:

$$I(\beta,\alpha) = I(\beta_{opt}) \times \left[g_1 (\beta - \beta_{opt})^2 + g_2 (\beta - \beta_{opt}) + g_3 \right] \qquad (24.3)$$

24.4 Estimativa da radiação solar incidente para uma superfície com inclinação óptima

Onde: $$g_i = g_{i1}\left|\alpha\right|^2 + g_{i2}\left|\alpha\right| + g_{i3}; i = 1,2,3 \qquad (24.4)$$

α representa o azimute solar (ângulo de desvio em relação à direcção sul) da superfície receptora e β a sua inclinação relativamente à direcção horizontal, conforme esquematizado na figura abaixo

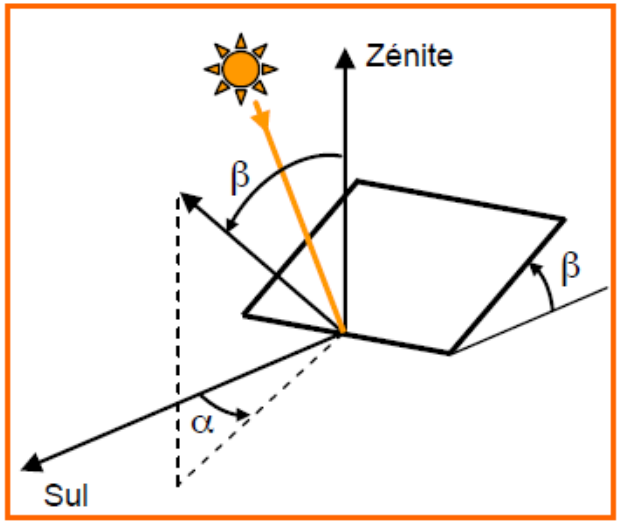


Figura 24.3 – Azimute solar

24.4 Estimativa da radiação solar incidente para uma superfície com inclinação óptima

A tabela seguinte apresenta os valores dos coeficientes g_i referentes a superfícies com um grau médio de sujidade, que se caracterizam por uma perda de transparência óptica com cerca de 3%.

Tabela 24.3 - Valores dos coeficientes *gi*

Coeficientes	*i = 1*	*i = 2*	*i = 3*
g_{1i}	8×10^{-9}	3.8×10^{-7}	-1.218×10^{-4}
g_{2i}	-4.27×10^{-7}	8.2×10^{-6}	2.892×10^{-4}
g_{3i}	-2.5×10^{-5}	-1.034×10^{-4}	0.9314

24.4 Estimativa da radiação solar incidente para uma superfície com inclinação óptima

Para módulos fotovoltaicos orientados a sul, o ângulo azimutal é nulo ($\alpha = 0$). Para esta situação, verifica-se:

$$\alpha = 0 \Rightarrow g_i = g_{i3}$$

$$g_1 = g_{13} = -1{,}218\times10\text{-}4$$

$$g_2 = g_{23} = 2{,}892\times10\text{-}4$$

$$g_3 = g_{33} = 0{,}9314$$

Nestas condições, a Equação 24.3 pode ser reescrita da seguinte maneira:

$$I(\beta) = I(\beta_{opt}) \times \left[-1.218\times10^{-4} \left(\beta - \beta_{opt}\right)^2 + 2.892\times10^{-4} \left(\beta - \beta_{opt}\right) + 0.9314 \right] \qquad (24.5)$$

24.4 Estimativa da radiação solar incidente para uma superfície com inclinação óptima

O painel deve ser instalado na direcção do Norte geográfico, para localidades que estão no hemisfério sul do nosso planeta.

Figura 24.4 – Orientação de painéis no hemisfério Sul

24.5 Determinação da potência do gerador FV

O gerador FV deverá ter uma potência (PFV) que deverá garantir a satisfação das necessidades de consumo diário de energia que constam na Tabela 24.1. Por outro lado, com os dados da Tabela 24.2, torna-se possível o cálculo da P_{FV} a instalar para cada dimensionamento feito (em que Ed é seleccionado como sendo o "pior" de todos os casos, ou seja, o valor mais baixo de produção energética).

$$P_{FV} = \frac{W_M}{\eta_{sistema} \times E_M} [kW] \qquad (24.6)$$

Onde:

η_{sist} – é o Rendimento do sistema

W_M - é a energia total consumida por dia mês (kWh/mês)

E_M - Produção de energia associada a 1 kW instalado (kWh/mês / kW)

24.6 Número de Módulos por Fileira

De forma geral, é recomendado que a tensão de funcionamento do sistema aumente com o aumento de carga diária consumida. Para cargas pequenas (até 1kWh diários) pode utilizar-se 12V como valor de VDC. Já para cargas intermédias (3 a 4 kWh por dia), recomenda-se os 24V. Para cargas diárias maiores (acima de 4 kWh diários), deverá adoptar-se VDC de 48V. Esta escolha leva a uma diminuição de perdas pelo sistema. (Sustainable Energy Industry Association of the Pacific Islands, 2012)

24.6 Número de Módulos por Fileira

A associação em série permite obter tensões mais elevadas, mantendo a corrente estipulada do módulo. O número de módulos por fileira, N_s é limitado pela tensão da bateria, V_{bat}. Contudo, a tensão máxima do sistema FV deve ser sempre igual ou superior à da bateria, já que o gerador tem que carregar a bateria. Deste modo, o número de módulos por fileira é calculado através da seguinte expressão:

$$N_S > \frac{V_{bat}}{V_{\max}} \qquad (24.7)$$

Onde:

V_{bat} Tensão em corrente contínua da bateria (V)

V_{max} corresponde à tensão máxima do módulo medida em condições padrão.

24.6 Número de Módulos por Fileira

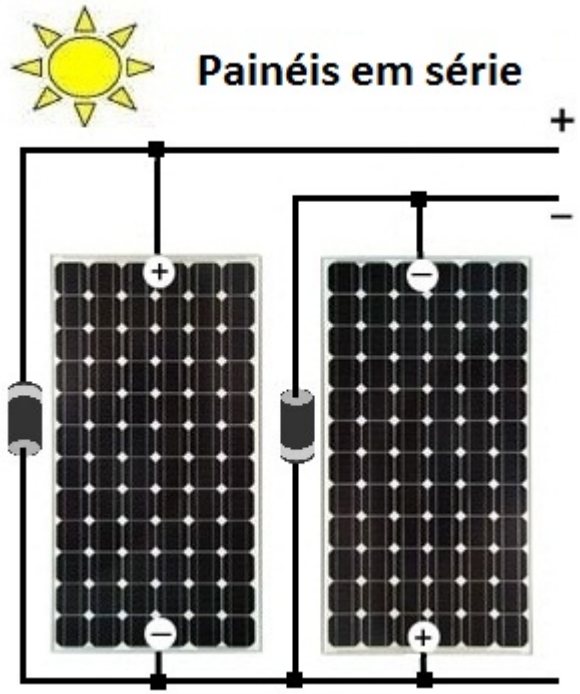


Figura 24.5 – Ligação de painéis em série

Se conectarmos um painel a outro em série (Figura 24.5) - (positivo de um painel com o negativo do outro), a cada painel adicionado a corrente se mantém e as tensões se somam.

24.6.1 Número de Fileiras em Paralelo

A ligação em paralelo entre módulos individuais é efectuada quando se pretende obter correntes mais elevadas e manter o nível de tensão estipulada do módulo. A corrente total, IT à saída do gerador fotovoltaico é calculada da seguinte forma:

$$I_T = N_F \times \mathrm{I}_{max} \Rightarrow N_F = \frac{I_T}{I_{\max}} \qquad (24.8)$$

onde N_F representa o número de fileiras ligadas em paralelo e I_{max} corresponde à corrente máxima do módulo medida em condições padrão. Por outro lado, a potência do gerador FV corresponde ao produto entre a tensão do gerador ($N_s \times V_{max}$) e a corrente total:

$$P_{FV} = \left(N_S \cdot V_{max}\right) \times I_T \Rightarrow I_T = \frac{P_{FV}}{N_S \times V_{\max}} \left[A\right] \qquad (24.9)$$

24.6.1 Número de Fileiras em Paralelo

Desta forma, o número de módulos por fileira é calculado através da seguinte expressão:

$$N_F = \frac{P_{FV}}{N_S \times V_{\max} \times \mathrm{I}_{\max}} = \frac{P_{FV}}{N_S \times P_m} \qquad (24.10)$$

Onde:

P_{FV} - Potência do gerador Foto Voltaico

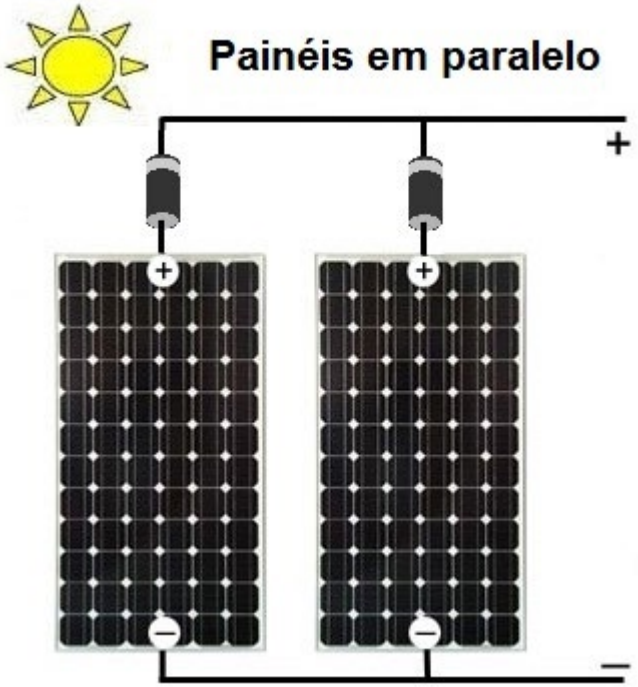
N_s – Número de módulos em série

V_{max} – Tensão máxima no ponto de potência máxima do painel a considerar, informação que se encontra disponível na ficha técnica do mesmo [V].

I_{max} – Corrente máxima no ponto de potência máxima do painel a considerar, informação que se encontra disponível na ficha técnica do mesmo [A].

P_m - corresponde à potência nominal do painel escolhido [W].

24.6.1 Número de Fileiras em Paralelo



Se conectarmos um painel a outro em paralelo (Figura 24.6) - (positivo com positivo e negativo com negativo), a cada painel adicionado, a tensão se mantém e as correntes se somam;

Figura 24.6 – Ligação de painéis em paralelo

24.7 Capacidade da bateria de acumuladores

No âmbito da utilização de sistemas fotovoltaicos autónomos para a alimentação de instalações domésticas, é normalmente comum acontecer que a produção e o consumo de energia não coincidem tanto ao longo do dia, quanto ao longo do ano.

Neste cenário, o armazenamento de energia eléctrica assume um vector absolutamente incontornável. Neste contexto, as baterias representam uma via pela qual é possível efectuar o armazenamento de energia, já que são capazes de transformar directamente a energia eléctrica em energia potencial química e posteriormente converter, directamente, a energia potencial química em energia eléctrica.

24.7 Capacidade da bateria de acumuladores

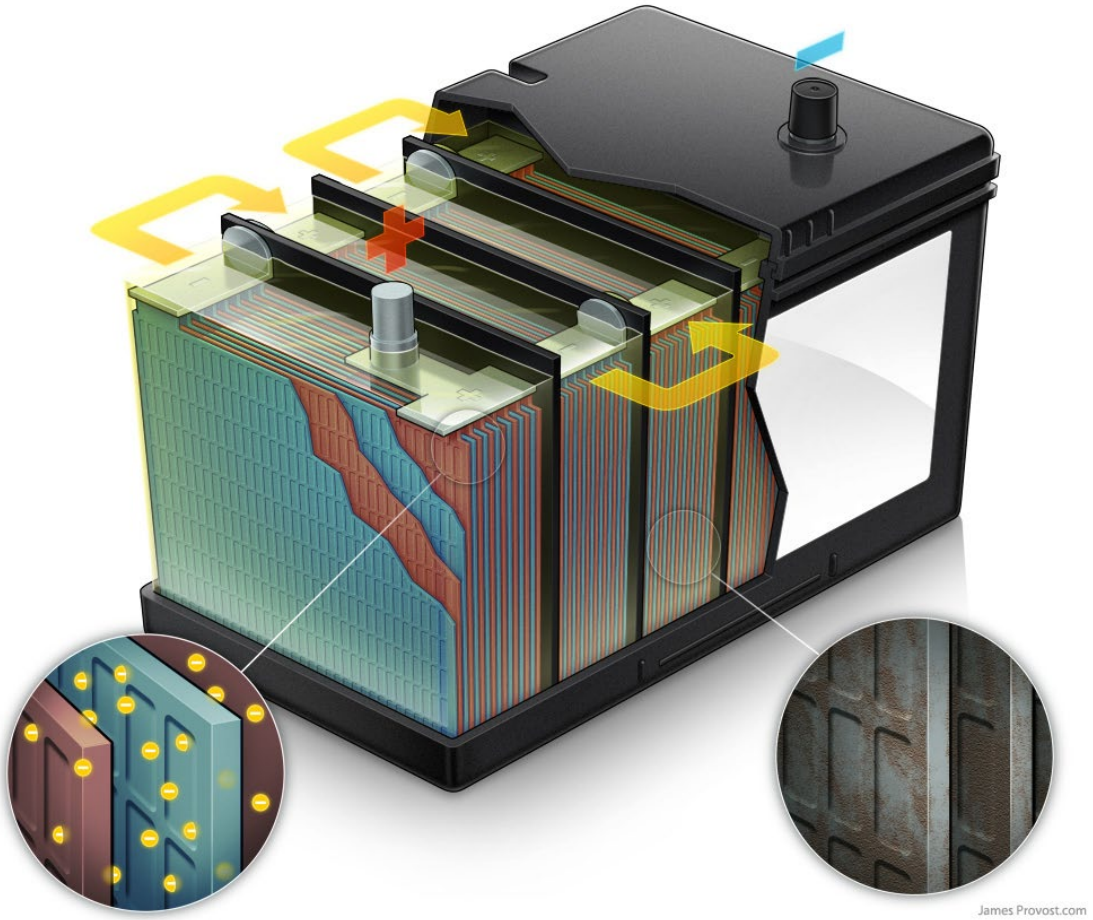


Figura 24.7 – bateria de acumuladores

24.7 Capacidade da bateria de acumuladores

Estado de Carga (State of charge – %): A quantidade de energia eléctrica armazenada pela bateria e um determinado tempo em relação a sua condição 100%. Essa medida depende de sua taxa de descarga;

Tensão de circuito aberto (Open circuit voltage – V): É a medição convencional de tensão da bateria livre de ligações com os circuitos.

Capacidade: Trata-se da corrente máxima que a bateria fornece em Ah(ampere hora), esse valor é reduzido a medida que a bateria se descarrega;

Capacidade nominal: É uma característica dependente dos componentes internos da bateria, estes influenciam na quantidade de carga que a bateria pode fornecer dentro de 20h, e até que a tensão de descarga seja 10,5V, e com corrente de descarga constante, além de temperatura ambiente de 25ºC.

Electrólito: É uma solução electrolítica composta de 34% de ácido sulfúrico e 66% de água destilada, com densidade ϱ igual a 1,20 g/cm^3 à 26ºC.

24.7 Capacidade da bateria de acumuladores

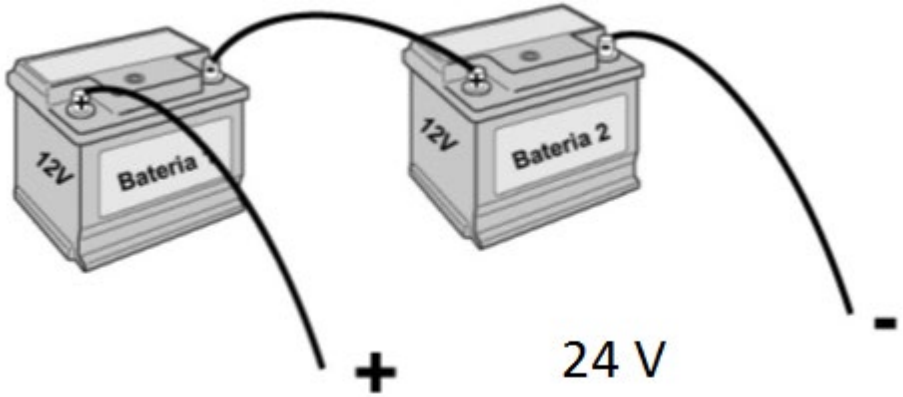


Figura 24.8 – Ligação de baterias em série

A ligação de baterias em série resulta numa capacidade constante, porém a tensão terminal aumenta. Como pode ser observado na Figura 24.8, o valor de tensão dobrou a capacidade manteve-se constante.

24.7 Capacidade da bateria de acumuladores

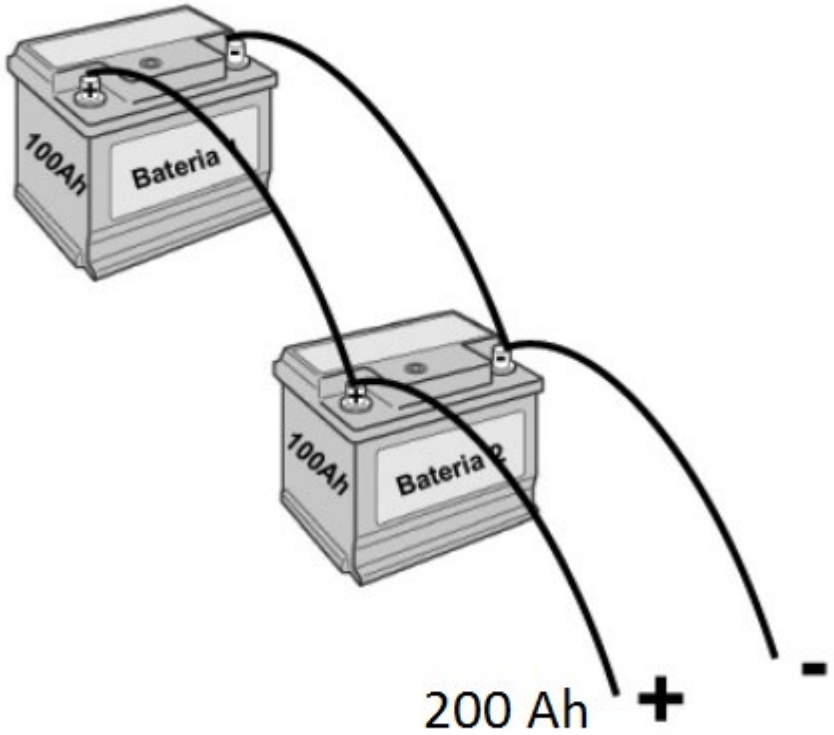


Figura 24.9 – Ligação de baterias em paralelo

A ligação de baterias em paralelo resulta no aumento da capacidade do sistema, porém a tensão terminal continua a mesma. Como pode ser observado na Figura 24.9, o valor de tensão não muda, supondo que a capacidade de uma bateria seja 100Ah, o sistema total teria uma capacidade de 200Ah.

24.7 Capacidade da bateria de acumuladores

A bateria é um dos elementos mais dispendiosos dos actuais sistemas fotovoltaicos. O seu eventual sobredimensionamento incrementa muito os custos de instalação dos sistemas FV. A utilização de baterias subentende que estes equipamentos são utilizados para fornecer a energia que é necessária para satisfazer necessidades diárias de consumo (energia das cargas) na eventualidade de não haver sol (dias de chuva), ou então dias muito nublados. Se fosse possível utilizar-se uma bateria ideal, a sua eficiência, K_{Bat} seria igual a 100% e a profundidade de descarga, KD seria também igual a 100% (ou seja, seria possível descarregar completamente a bateria sem a danificar).

24.7 Capacidade da bateria de acumuladores

Se esta hipotética bateria ideal fosse utilizada durante um dia, então a quantidade de carga eléctrica fornecida (expressa em Ah) da bateria, W(Ah) seria calculada através da seguinte expressão:

$$W_{(Ah)} = \frac{Energia\ diária\ de\ consumo}{Tensão\ da\ bateria} = \frac{W_D(Wh)}{U}[Ah] \qquad (24.11)$$

Contudo, em situações reais a eficiência da bateria nunca atinge 100% (por exemplo, para baterias de chumbo – ácido, os valores correntes são de 80%, e a profundidade de descarga máxima de segurança (para não se danificar a bateria) é normalmente de 60%.

24.7 Capacidade da bateria de acumuladores

Por outro lado, o número de dias, N_d cuja probabilidade de uma bateria ser utilizada de modo a substituir totalmente o gerador FV, corresponde normalmente a 3 ou 4 dias – céu encoberto ou chuva. Deste modo, o cálculo da capacidade de uma bateria real, CB (Ah) é efectuado através da seguinte equação:

$$C_{(Ah)} = W_{(Ah)} \frac{N_d}{\eta_{sist}} \Leftrightarrow C_{(Ah)} = \frac{W_D(Ah) \times N_d}{U \times \eta_{sist}} [Ah] \qquad (24.12)$$

24.8 Regulador de Carga

Nos sistemas fotovoltaicos autónomos a tensão nos terminais do painel fotovoltaico deverá ser compatível com a tensão nominal da bateria; na verdade, a tensão do painel deve ser superior à tensão da bateria. Com efeito, atendendo a tensão aos terminais do painel FV depende do valor da temperatura, é importante garantir que para temperaturas elevadas a tensão gerada seja suficientemente alta para acautelar o carregamento das baterias.

24.8 Regulador de Carga

Por outro lado, para valores baixos de temperatura é necessário garantir que a tensão do painel fotovoltaico não supere a tensão de carga da bateria. Deste modo, a utilização de um regulador de carga tem como principal função a medição da tensão da bateria e, por conseguinte, a sua protecção contra ocorrência de sobrecargas.

Na eventualidade de a tensão no painel ser inferior à tensão da bateria, o regulador de carga evita que a bateria descarregue através do painel, através da utilização de díodos de bloqueio que evitam a passagem de corrente inversa a ocorrência de sobrecargas.

24.8 Regulador de Carga

As principais funções atribuídas aos reguladores de carga das baterias são as seguintes:

- Assegurar o carregamento da bateria;
- Evitar a sobrecarga da bateria;
- Bloquear a corrente inversa entre a bateria e o painel;
- Prevenir a ocorrência de descargas profundas (no caso de baterias chumbo - ácido).

24.8.1 Selecção do regulador de carga MPP

A selecção do regulador de carga MPP é prevista para cumprir o seu valor de corrente máxima DC, $I_{max\ DC}$. Por isso deverá ser limitada pela corrente total, IT à saída do gerador fotovoltaico:

$$I_{maxDC} > I_T \Leftrightarrow I_{maxDC} > \left(N_F \times I_T\right) \qquad (24.13)$$

Sendo que a corrente a considerar é calculada por:

$$I_T = \frac{P_{FV}}{V_{DC}}[A] \qquad (24.14)$$

24.8.1 Selecção do regulador de carga MPP

Pode ser necessária a colocação de mais que um controlador, dependendo da corrente máxima do escolhido ($Imax$). Assim, o número de controladores de carga a colocar em paralelo, pode ser calculado através da equação

$$\text{Número de Controladores} = \frac{I_T}{I_{\max DC}} \qquad (24.15)$$

24.9 Inversores DC/AC

Por imperativo de fabrico dos equipamentos eléctricos, é normalmente utilizado a tensão de 230 V (ou 230/400 V), que corresponde à tensão nominal das redes eléctricas de distribuição de Moçambique. É importante realçar que apesar de existirem no mercado equipamentos domésticos que são fabricados de modo a funcionarem à tensão de 12 V ou 24 V (televisões, frigoríficos, etc.), a sua utilização pêlos consumidores é muito reduzida já que, o seu preço é na maioria dos casos relativamente elevado. Afim de se poder dispor de uma tensão de 230 V (ou 230/400 V), em sistemas fotovoltaicos que produzem energia eléctrica em corrente continua (DC), é necessário inserir no sistema os designados inversores de corrente.

24.9 Inversores DC/AC

A principal função de um inversor de corrente consiste em estabelecer a ligação entre o gerador fotovoltaico e a rede eléctrica de corrente alternada (AC) ou a carga AC. Neste contexto, a sua principal tarefa consiste em converter o sinal eléctrico DC do gerador fotovoltaico num sinal eléctrico AC, e ajustá-lo para a frequência e o nível de tensão da rede a que ficará ligado.

24.9.1 Selecção do inversor

Por outro lado, na eventualidade de os aparelhos (cargas) a alimentar funcionarem em corrente alternada, o inversor deve ser escolhido de modo a garantir a potência máxima simultânea (soma das potências de cada aparelho), ΣP_i dos equipamentos utilizados. Neste sentido, a potência mínima requerida para o inversor, P_{inv} é calculada de acordo com a seguinte equação:

$$P_{inv} > \sum P_i \qquad (24.16)$$

PowerSafe®

Sustainable solutions

PowerSafe® TS

La gama PowerSafe® TS ofrece una solución de alto rendimiento y larga vida útil para aplicaciones de energía renovable.

Las celdas PowerSafe® TS se basan en una tecnología convencional, ventilada y diseñada para aplicaciones de energía renovable que requieren la máxima duración con el mayor nivel de fiabilidad, y son especialmente adecuadas para uso en instalaciones de energía solar, garantizando un suministro eléctrico continuo durante las horas de oscuridad o periodos con menos luz solar.

El mantenimiento puede reducirse utilizando electrolitos adicionales, lo que significa que las celdas sólo se rellenan una vez al año. Esto ayuda a mantener bajos los costes de mantenimiento y las convierte en una solución ideal para muchos lugares remotos o automatizados.

Las placas positivas tubulares se usan ampliamente en baterías para aplicaciones especialmente exigentes. En la gama TS, las placas se han optimizado para ofrecer una duración más amplia y una mayor capacidad.

Ventajas principales

- Capacidades de 300 a 4580Ah en régimen de 120 horas (C120)
- Productos disponibles en versiones con carga llena o seca
- 5200 ciclos de funcionamiento hasta que la batería se descargue un 25%
- Rellenado requerido una vez al año
- Mínimo mantenimiento requerido
- Excelente seguridad de funcionamiento: conectores y terminales totalmente aislados, tapón de bloqueo de llama a prueba de ácido para cada celda, protección de polaridades durante el transporte

EnerSys®

Power/Full Solutions

Especificaciones generales			Capacidad nominal (Ah)		Dimensiones nominales													
Tipo	Tensión nominal (V)	Número de termi-nales	Régimen de 10h a 1,80Vpc @20°C	Régimen de 120h a 1,85Vpc @25°C	Longitud mm	Longitud pulg	Anchura mm	Anchura pulg	Altura mm	Altura pulg	Peso típico carga seca kg	Peso típico carga seca lbs	Peso típico carga llena kg	Peso típico carga llena lbs	Volumen de electrolito litros	Volumen de electrolito US Gal	Corriente de corto-circuito (A)	Resistancia interna (mΩ)
TLS 4	2	2	220	300	103	4.06	206	8.12	389	15.33	13.0	28.6	18.0	39.8	3.9	1.0	2059	1.02
TLS 5	2	2	270	367	124	4.89	206	8.12	389	15.33	15.5	34.2	21.9	48.2	4.9	1.3	2625	0.8
TLS 6	2	2	323	440	145	5.71	206	8.12	389	15.33	18.1	39.8	25.6	56.5	5.8	1.5	3000	0.7
TVS 4	2	2	340	460	124	4.89	206	8.12	505	19.9	18.4	40.6	27.3	60.3	6.9	1.8	2838	0.74
TVS 5	2	2	390	530	124	4.89	206	8.12	505	19.9	21.5	47.3	30.0	66.2	6.6	1.7	3281	0.64
TVS 6	2	2	470	640	145	5.71	206	8.12	505	19.9	25.1	55.3	35.4	78.0	7.9	2.1	3750	0.56
TVS 7	2	2	550	745	166	6.54	206	8.12	505	19.9	28.7	63.2	40.7	89.7	9.2	2.4	4200	0.5
TYS 5	2	2	590	802	145	5.71	206	8.12	684	26.95	29.8	65.8	44.6	98.3	11.3	3.0	3621	0.58
TYS 6	2	2	670	912	145	5.71	206	8.12	684	26.95	34.0	75.0	48.4	106.7	11.0	2.9	4200	0.5
TYS 7	2	2	816	1120	191	7.53	210	8.27	684	26.95	40.5	89.2	59.6	131.3	14.8	3.9	5147	0.41
TYS 8	2	2	900	1220	191	7.53	210	8.27	684	26.95	44.6	98.4	63.2	139.4	14.5	3.8	5676	0.37
TYS 9	2	2	1040	1415	233	9.18	210	8.27	684	26.95	50.2	110.8	73.9	163.0	18.3	4.8	6625	0.32
TYS 10	2	2	1120	1523	233	9.18	210	8.27	684	26.95	54.4	119.9	77.8	171.6	18.0	4.8	7000	0.3
TYS 11	2	2	1260	1714	275	10.84	210	8.27	684	26.95	60.0	132.2	88.4	194.8	21.9	5.8	8108	0.26
TYS 12	2	2	1340	1825	275	10.84	210	8.27	684	26.95	64.1	141.4	92.3	203.5	21.6	5.7	8824	0.24
TZS 11	2	4	1560	2130	275	10.84	210	8.27	829	32.66	76.5	168.6	112.3	247.6	27.5	7.3	7554	0.28
TZS 12	2	4	1710	2335	275	10.84	210	8.27	829	32.66	81.7	180.0	117.0	257.9	27.1	7.2	8400	0.25
TZS 13	2	6	1940	2640	399	15.72	214	8.43	813	32.03	94.9	209.2	146.6	323.2	39.7	10.5	8936	0.24
TZS 14	2	6	2040	2775	399	15.72	214	8.43	813	32.03	101.8	224.5	153.4	338.2	39.6	10.5	9589	0.22
TZS 15	2	6	2150	2925	399	15.72	214	8.43	813	32.03	105.4	232.4	156.0	343.9	38.9	10.3	10294	0.2
TZS 16	2	6	2240	3050	399	15.72	214	8.43	813	32.03	110.3	243.2	160.9	354.7	38.9	10.3	11053	0.19
TZS 17	2	8	2430	3310	487	19.19	212	8.35	813	32.03	122.0	269.0	182.2	401.6	48.5	12.8	11667	0.18
TZS 18	2	8	2555	3480	487	19.19	212	8.35	813	32.03	127.6	281.3	186.7	411.7	47.8	12.6	12353	0.17
TZS 20	2	8	2800	3810	487	19.19	212	8.35	813	32.03	137.8	303.8	199.8	440.5	47.6	12.6	14000	0.15
TZS 22	2	8	3090	4210	576	22.69	212	8.35	813	32.03	151.9	335.0	223.5	492.7	57.7	15.2	11053	0.14
TZS 24	2	8	3360	4580	576	22.69	212	8.35	813	32.03	162.6	358.4	235.8	519.9	56.3	14.9	16154	0.13

Notas: Los valores eléctricos mostrados en la tabla hacen referencia al rendimiento a plena carga y temperatura ambiente de + 25°C.
La altura mostrada es la altura total, incluidos conectores y recubrimientos

Instalación y funcionamiento

- Rango de temperatura recomendado: 10°C/+50°F a +40°C/+86°F (valor preferido: 25°C/68°F)
- Se puede instalar en racks de acero o madera.

Normas

- Conforme con la norma internacional IEC 60896-11
- Conforme con la norma internacional IEC 61427:2005.
- Fabricada en plantas de producción EnerSys® con certificado ISO 9001.

Estructura

Electrodo positivo: Placa tubular fundida a presión con combinación óptima de plomo-antimonio.

Electrodo negativo: Placa plana empastada con rejilla de aleación de de plomo-antimonio.

Separadores: Material microporoso de baja resistencia.

Carcasa: Moldeada en acrilonitrilo estireno (SAN) duradero y transparente para permitir el control visual del nivel de electrolito y el estado de la celda.

Tapa: Acabada en acrilonitrilo butadieno estireno (ABS).

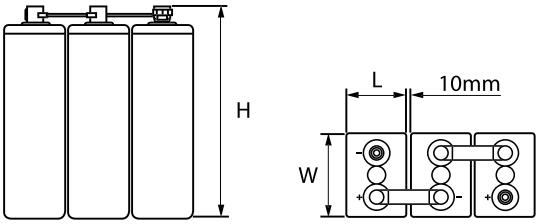
Tapones de ventilación: Tapones de seguridad equipados con bloqueos de llama. Bajo demanda, existen tapones de ventilación especiales que permiten el relleno y la lectura de la gravedad específica sin necesidad de quitarse.

Electrolito: Acido sulfúrico diluido con una gravedad específica de 1,240 ±0.010 (nivel máximo) a 25°C para una celda totalmente cargada. La gran reserva de electrolito restringe el relleno a una vez al año.

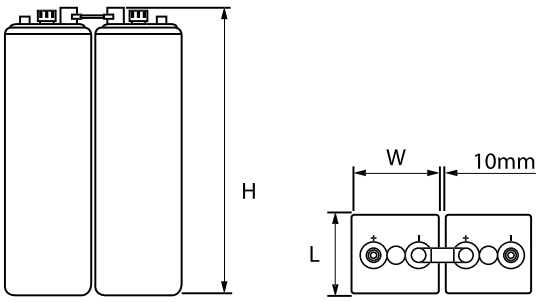
Terminales: Polo de aleación de plomo a prueba de fugas con inserto de latón diseñado para ofrecer una resistencia mínima y un flujo de corriente máximo.

Conectores: Conectores interceldas de cobre resistente y totalmente aislados, los cuales permiten mediciones de tensión.

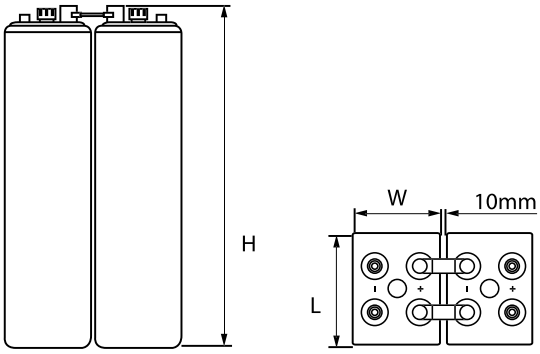
TLS, TVS, TYS 5 - TYS 6



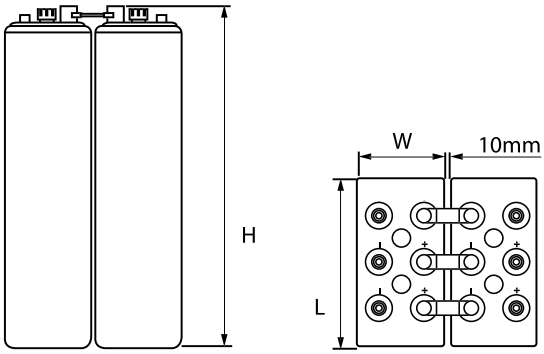
TYS 7 - TYS 12



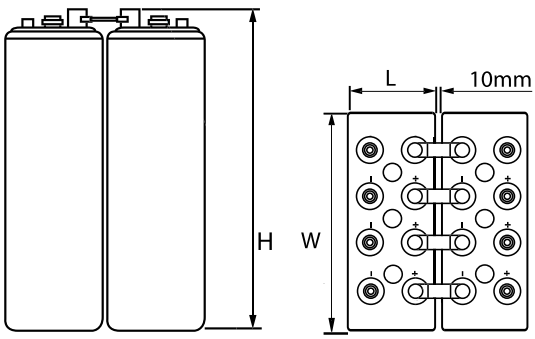
TZS 11, TZS 12



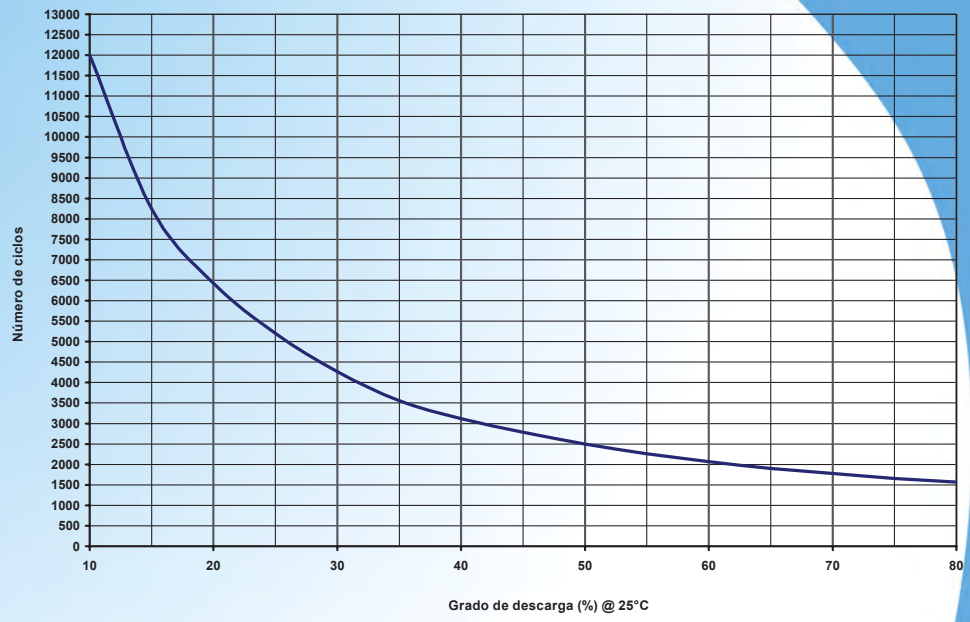
TZS 13 - TZS 16



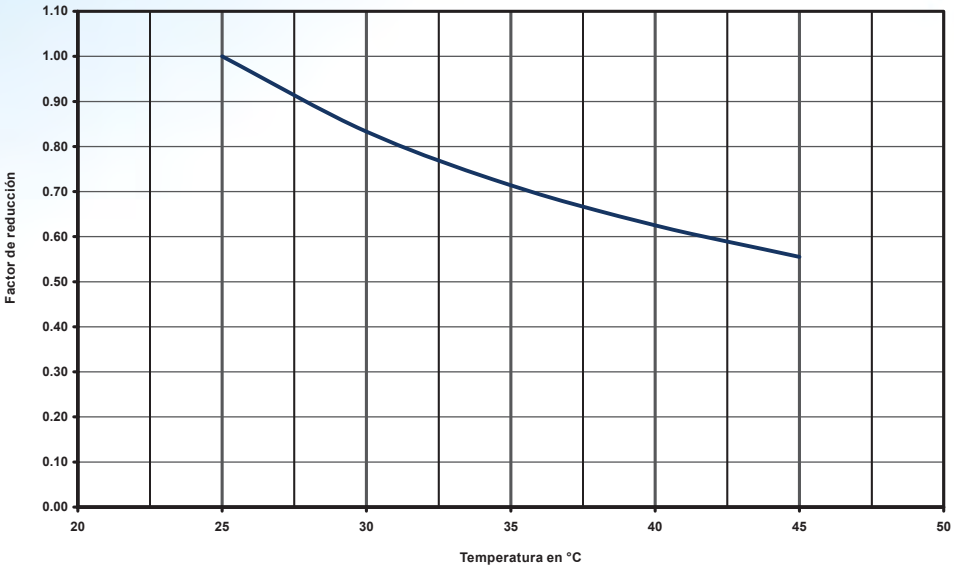
TZS 17 - TZS 24



PowerSafe® TS - Aplicaciones de energía renovable
Número de ciclos vs grado de descarga (25°C)



Baterías para aplicaciones de energía renovable
Factor de reducción de número de ciclos vs temperatura media de celda



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EnerSys
Power/Full Solutions
www.enersys.com

Global & Americas Headquarters

EnerSys
2366 Bernville Road
Reading
PA 19605
USA
Tel. +1-610-208-1991
Fax +1 610-372-8457

Regional Headquarters

EnerSys Europe (EMEA)
Löwenstrasse 32
8001 Zürich
Switzerland
www.enersys-emea.com

EnerSys Asia
152 Beach Road
Gateway East Building
Level 11
189721 Singapore
Tel: +65 6508 1780
Fax +65 6292 4380

Por favor refiérase a la dirección del sitio web para más detalles sobre la oficina más cercana de EnerSys: www.enersys-emea.com

PYLONTECH

LOW VOLTAGE ENERGY STORAGE SYSTEM
-FOR RESIDENTIAL AND SME

Pylon Technologies Co., Ltd.

As the leading vertically integrated manufacturer of lithium iron phosphate battery systems,Pylontech has provided various battery solutions for nearly all kinds of ESS applications.
Thanks to our self-developed core technology in cells/BMS/system design, Pylontech has delivered more than 2.0GWH batteries serving 120,000+ users.

Vertical industry integration chain

Material Cell Battery Module Battery Module

Advantage

- Developed with our own LFP (lithium iron phosphate) cell to ensure the highest safety
- Self-designed BMS protects the cell in all angels such as abnormal temperature, current, voltage, SoC, SoH
- Vertical industry integration ensures more than 6000 cycles with 95% DoD
- Modular design gives the end customers the power of choice of capacity
- Compatible with most of the available Hybrid inverters
- Simple buckle fixing minimize the installation time and cost
- Backward compatibility with existing US series product
- Pre-charge function to protect ESS system from surge current

UN38.3

Specification

Basic Parameters	US2000C	US3000C	Phantom-S
Nominal Voltage（V）	48	48	48
Nominal Capacity (Wh)	2400	3552	2400
Usable Capacity (Wh)	2280	3374.4	2200
Dimension（mm）	442*410*89	442*420*132	440*440*88.5
Weight（Kg）	24	32	24
Discharge Voltage（V）	44.5 ~ 53.5	44.5 ~ 53.5	44.5 ~ 53.5
Charge Voltage（V）	52.5 ~ 53.5	52.5~53.5	52.5~53.5
Charge / Discharge Current（A）	25(Recommend)	37 (Recommend)	25(Recommend)
	50 (Max@60s)	74 (Max@60s)	50 (Max@60s)
	90 (Peak@15s)	90 (Peak@15s)	100（Peak@15s）
Communication Port	RS485，CAN	RS485，CAN	RS485，CAN
Single string quantity(pcs)	16	16	8
Working Temperature/℃	0~50	0~50	0~50
Shelf Temperature/℃	-20~60	-20~60	-20~60
Humidity	5%~95%	5%~95%	5%~95%
Altitude (m)	<2000	<2000	<2000
Design life	15^{+} Years（25℃/77℉）	15^{+} Years（25℃/77℉）	15^{+} Years（25℃/77℉）
Cycle Life	>6000, 25℃	>6000, 25℃	>6000, 25℃
Authentication Level	IEC62619/CE /UN38.3	VDE2510-50/IEC62619/UL1973 UL9540A/CE/UN38.3	IEC62619/CE /UN38.3
Feature	Pre-Charge Dual-active protection Flexible current steps Dry contact wake up	Pre-Charge Dual-active protection Flexible current steps Dry contact wake up	

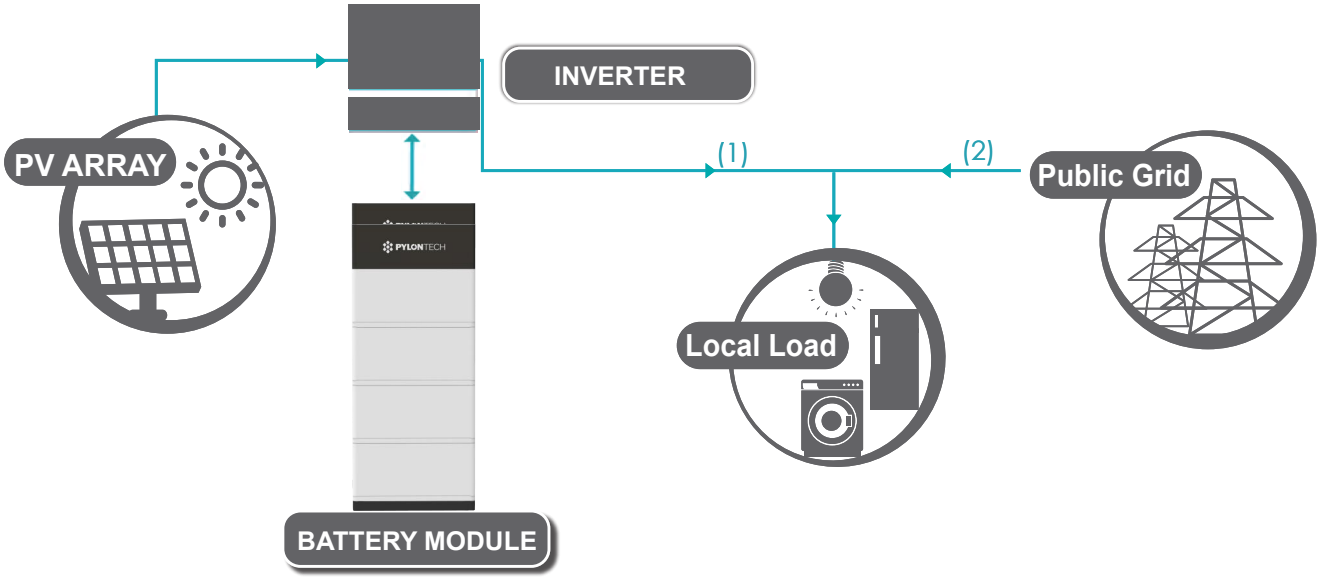
PYLONTECH FORCE SERIES

Pylontech Force L1 is the latest version of HESS (home energy storage system), inherit with our modular design concept, combined wih easy installation, simple connectors and outdoor compatibility, the furniture type of equipment is your ideal place to hold your valuable force - the electricity.

Advantages

1. Modular design gives highest flexibility
2. LFP cell inside enable longest life and highest safety
3. Quick connector to save installation time
4. Furniture like design suits both indoor and outdoor installation
5. Proven BMS with widest compatiblities with inverters

Solution of ESS



Technical Specification

FORCE L1

Battery Module		2	3	4	5	6	7
Battery System Capacity (kWh)		7.10	10.65	14.21	17.76	21.31	24.86
Voltage Range (V)		44.5~54					
Dimension (W*D*H mm)		600*380*530	600*380*700	600*380*870	600*380*1040	600*380*1210	600*380*1380
Weight (kg)		84	119	154	189	224	259
Depth of Discharge		90%					
Charge/Discharge Current(A)	(Recommend)	30	45	60	75	90	100
	(Continuous)	75	100	100	100	100	100
	(Peak@15s)	105	105	105	105	105	105
Communication		CAN,RS485					
Protection Class		IP55					
Working Temperature(℃)		0~50					
Storage Temperature(℃)		-20~60					
Humidity		5%-95%					
Altitude (M)		＜2000					
Design Life		15+ Years (25℃/°F)					
Cycle Life		＞6000，25℃					
Authentication Level		VDE/IEC62619/CE/UN38.3					

Technical Specification

FORCE L2

Battery Module		2	3	4
Battery System Capacity (kWh)		7.10	10.65	14.21
Voltage Range (V)			44.5~54	
Dimension (W*D*H mm)		450*300*820	450*300*1120	450*300*1410
Weight (kg)		83	119	155
Depth of Discharge			90%	
Charge/Discharge Current(A)	(Recommend)	30	45	60
	(Continuous)	75	100	100
	(Peak@15s)	105	105	105
Communication			CAN,RS485	
Protection Class			IP55	
Working Temperature(℃)			0~50	
Storage Temperature(℃)			-20~60	
Humidity			5%-95%	
Altitude (M)			＜2000	
Design Life			15 $^{+}$Years (25℃/°F)	
Cycle Life			＞6000, 25℃	
Authentication Level			VDE/IEC62619/CE/UN38.3	

Cube the Force | PYLONTECH

sales@pylontech.com.cn www.pylontech.com.cn

20LV030904

DATASHEET

ENERGY CUBE

ECS4100-H2/H3/H4/H5/H6/H7

FOX ENERGY CUBE
BATTERY STORAGE SYSTEM

HIGH VOLTAGE BATTERY FROM FOX

The Energy cube is a high-performance, scalable battery storage system. The modular design allows for maximum flexibility, making it suitable for a broad range of storage applications.

Additional batteries can be installed in series, allowing for a maximum storage capacity of 28.21 kWh. Installation is easy, with a plug and play solution that can save valuable time for installers.

- 4.03 kWh Capacity
- Scalable to 28.21 kWh
- 90% Depth of Discharge
- Wide Temperature Tolerance
- Easy Installation
- CAN/RS485 Communication
- High Voltage

High Voltage | **Easy Installation** | **High Efficiency** | **Expandable System** | **90% DoD**

FOX

ENERGY CUBE
ECS4100-H2/H3/H4/H5/H6/H7

Model	ECS4100-H2	ECS4100-H3	ECS4100-H4	ECS4100-H5	ECS4100-H6	ECS4100-H7
ELECTRICAL CHARACTERISTICS						
Battery Type	LiFePO4 Prismatic Cell					
Battery Module	1*CM4100 1*CS4100	1*CM4100 2*CS4100	1*CM4100 3*CS4100	1*CM4100 4*CS4100	1*CM4100 5*CS4100	1*CM4100 6*CS4100
Nominal Capacity [Wh]	8060	12090	16120	20150	24180	28210
Nominal Voltage [V]	115.2	172.8	230.4	288	345.6	403.2
Operating Voltage [V]	97.2 - 131.4	145.8 - 197.1	194.4 - 262.8	243 - 328.5	291.6 - 394.2	340.2 - 459.9
Recommend Discharge Current [A]	25					
Max.Charge/Discharge Current [A]	50					
Peak Discharge Current [A]	65A @30sec					
Battery Pack Round-Trip Efficiency	>95%					
Depth of discharge	90%					
Cycle Life	≥6000*1					
Communication	CAN, RS485					
Display	CS: LED*1, CM: LED*7					
Scalability	Max. 7 Modules in Series					
OPERATING CONDITIONS						
Installation Location	Outdoor/ Indoor (Stand)					
Operating Temperature [°C]	-10 - 55					
Storage Temperature [°C]	-20 - 55					
Cooling method	Natural Convection					
Humidity	0% to 100% (No Condensing)					
Altitude [m]	Max. 2,000					
Mechanical Characteristics						
Dimensions (W*H*D) [mm]	570*350*380	570*470*380	570*590*380	570*710*380	570*830*380	570*950*380
Weight [kg]	74.3	110.3	146.3	182 .3	218.3	254.3
Certificates						
Safety	IEC 62619					
EMC	EN IEC 61000-6-1/2/3/4					
Transportation	UN38.3					
Ingress Protection	IP65					

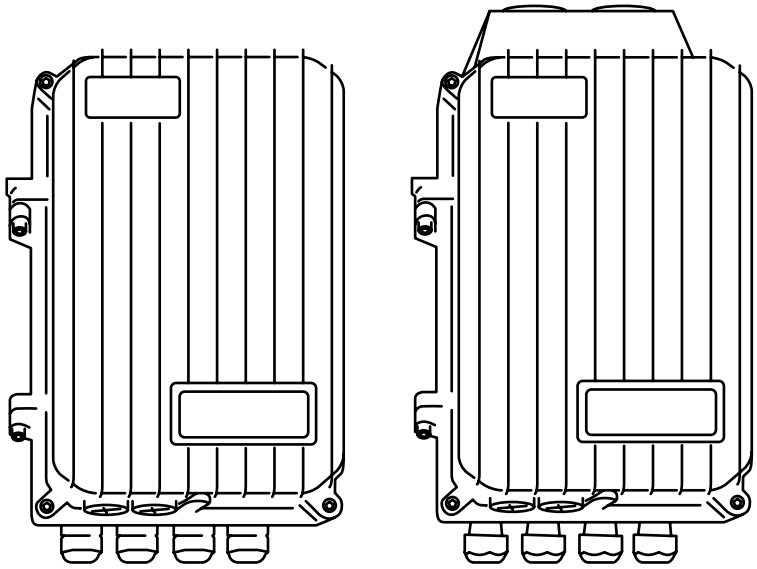
*1 25℃, @90% DOD, 0.5C charging/discharging

VarioString
VS-70

Model	VS-70
Electrical characteristics PV array side	MPPT
Maximum solar power recommended (@STC)	4200 W
Maximum current	13 A
Maximum solar open circuit voltage	600 V
Minimum solar functional circuit voltage	200 V
Recommended MPPT voltage	250-500 V
Electrical characteristics battery side	
Maximum output current	70 A
Nominal battery voltages	48 V
Operating voltage range	38 - 68 V
Battery grounding possibility	Battery + or battery -
Performances of the device	
Maximum efficiency	> 98 %
MPPT efficiency	> 99.8 %
Maximum stand-by self-consumption (48 V)	< 20 mA (1 W)
Charging stages	4 stages: Bulk, Absorption, Float, Equalization
Battery temperature compensation (with accessory BTS-01)	–3 mV / °C / cell (25°C ref) default value adjustable -8 to 0 mV /°C
Electronic protections	
PV reverse polarity	•
Battery overvoltage	Up to max 80 V
Over temperature	•
Reverse current at night	•
Galvanic isolation	•
PV grounding possibility	PV + , PV - , floating
Ground fault Protection	Programmable
Environment	
Operating ambient temperature range	–20 to 55°C
Humidity	100 %
Ingress protection of enclosures	IP54
Mounting location	indoor
General data	
Warranty	5 years
ISO Certification	9001:2008 / 14001:2004
Weight	5.51 kg
Dimensions h/w/l [mm]	120 / 220 / 350
Solar generation connection (6mm^2)	SUNCLIX™ (Phoenix Contact Tool Free)
Parallel operation (separated PV arrays)	Up to 15 devices
Max wire size	35 mm^2
Glands	M 20 x 1,5
Communication	
Network cabling	STUDER communication BUS
Remote control & Communication	RCC-02/-03, Xcom-232i / Xcom-LAN / Xcom-GSM / Xcom-SMS
Menu languages	English / French / German / Spanish
Data logging	With RCC-02/03, Xcom-232i on SD card · One point every minute
Accordance to standards	
EU declaration of conformity	**Low Voltage Directive (LVD) 2014/35/EU:** - EN 62109-1:2010 **Electromagnetic Compliance (EMC) Directive 2014/30/EU:** - EN 61000-6-2:2005, - EN 61000-6-4:2007/A1:2011
Accessories	
Remote control RCC-02 or RCC-03	•
Module Xcom-232i	•
Communication sets Xcom-LAN / Xcom-GSM / Xcom-SMS	•
Battery Status Processor BSP	•
2 aux. contacts module ARM-02	•
Battery temp. sensor BTS-01 (3 m)	•
Communication cable CAB-RJ45-8-2	•

Data may change without any notice

EN

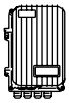


variotrack

The **variotrack** MPPT solar charge controller maximizes the energy generated by charging the batteries in an optimal way. The accuracy of the Maximum Power Point Tracking (MPPT) algorithm, the high peak efficiency and low internal consumption ensure an optimal valorisation of the energy produced by the PV modules to all types of battery technology. The **variotrack** is 100% manufactured in Switzerland and has a 10-year warranty.

swiss made power

Technical data



variotrack

	VT-40			VT-65		
Electrical characteristics PV array side at nominal battery voltage	12 V	24 V	48 V	12 V	24 V	48 V
Maximum solar power recommended (@STC)	625 W	1250 W	2500 W	1000 W	2000 W	4000 W
Maximum solar open circuit voltage	75 V	150 V		75 V	150 V	
Maximum solar functional circuit voltage	75 V	145 V		75 V	145 V	
Minimum solar functional circuit voltage	Above battery voltage					
Electrical characteristics battery side						
Maximum output current	40 A			65 A		
Nominal battery voltages	Automatic / manual set to 12, 24 or 48 V					
Operating voltage range	7 - 68 V					
Performances of the device						
Tracking efficiency	> 99 %					
European weighted efficiency	> 97 %					
Maximum stand-by self-consumption (48 V)	< 25 mA (1.2 W)					
Maximum stand-by self-consumption (24 V)	< 30 mA (0.8 W)					
Maximum stand-by self-consumption (12 V)	< 35 mA (0.5 W)					
Charging stages*	4 stages: Bulk, Absorption, Floating, Equalization					
Battery temperature compensation (available with accessory BTS-01/BSP)	-3 mV / °C /cell (25°C ref) default value adjustable -8 to 0 mV / °C					
Electronic protections						
PV reverse polarity	✓					
Battery reverse polarity	✓					
Battery overvoltage	✓					
Over temperature	✓					
Reverse current at night	✓					
Environment						
Operating ambient temperature range	-20 to 55°C					
Humidity	100%					
Ingress protection of enclosures	IP54					
Mounting location	indoor					
General data						
Weight	3.8 kg			5.2 kg		
Dimensions h/w/l [mm]	120 / 220 / 310					
Parallel operation (separated PV arrays)	Up to 15 devices					
Max wire size	35 mm^2					
Glands	M 20 × 1,5					
Communication						
Network cabling	STUDER communication BUS (included)					
Configuration	RCC-02/-03, Internal DIP switches for basic settings					
Data logging	With RCC-02/03, Xcom-232i on SD card · One point every minute					
Accordance to standards						
Conformity	Low Voltage Directive (LVD) 2014/35/EU: EN/IEC 62109-1 Electromagnetic Compliance (EMC) Directive 2014/30/EU: EN/IEC 61000-6-2, 61000-6-4					

variotrack

	VT-80		
Electrical characteristics PV array side at nominal battery voltage	12 V	24 V	48 V
Maximum solar power recommended (@STC)	1250 W	2500 W	5000 W
Maximum solar open circuit voltage	75 V	150 V	
Maximum solar functional circuit voltage	75 V	145 V	
Minimum solar functional circuit voltage	Above battery voltage		
Electrical characteristics battery side			
Maximum output current	80 A		
Nominal battery voltages	Automatic / manual set to 12, 24 or 48 V		
Operating voltage range	7 - 68 V		
Performances of the device			
Tracking efficiency	> 99 %		
European weighted efficiency	> 97 %		
Maximum stand-by self-consumption (48 V)	< 25 mA (1.2 W)		
Maximum stand-by self-consumption (24 V)	< 30 mA (0.8 W)		
Maximum stand-by self-consumption (12 V)	< 35 mA (0.5 W)		
Charging stages*	4 stages: Bulk, Absorption, Floating, Equalization		
Battery temperature compensation (available with accessory BTS-01/BSP)	-3 mV / °C /cell (25°C ref) default value adjustable -8 to 0 mV / °C		
Electronic protections			
PV reverse polarity	✓		
Battery reverse polarity	✓		
Battery overvoltage	✓		
Over temperature	✓		
Reverse current at night	✓		
Environment			
Operating ambient temperature range	-20 to 55°C		
Humidity	100%		
Ingress protection of enclosures	IP54		
Mounting location	indoor		
General data			
Weight	5.5 kg		
Dimensions h/w/l [mm]	120 / 220 / 350		
Parallel operation (separated PV arrays)	Up to 15 devices		
Max wire size	35 mm²		
Glands	M 20 × 1,5		
Communication			
Network cabling	STUDER communication BUS (included)		
Configuration	RCC-02/-03, Internal DIP switches for basic settings		
Data logging	With RCC-02/03, Xcom-232i on SD card · One point every minute		
Accordance to standards			
Conformity	Low Voltage Directive (LVD) 2014/35/EU: EN/IEC 62109-1 Electromagnetic Compliance (EMC) Directive 2014/30/EU: EN/IEC 61000-6-2, 61000-6-4		

Efficient, robust and flexible

- Easy and safe commissioning with full protection against incorrect wiring
- Rugged and durable, this device is designed to perform in harsh environmental conditions (IP54)
- High tracking efficiency >99%
- Up to 15 VarioTrack in parallel on the same communication bus (75kW)
- 4 step charger fully programmable for longer battery life
- Low self-consumption: <1W in night time mode
- Display with 7 LEDs showing status and current
- Suitable for any solar and battery system
- Optimal usage in an Xtender system with synchronized battery management

Combine with a range of accessories

- Display, programming and data logging remote control **(RCC-02/-03)**
- Communication sets **(Xcom-LAN/Xcom-GSM)**
- Communication module **(Xcom-232i/Xcom-CAN)**
- Battery temperature sensor **(BTS-01)**
- Battery Status Processor **(BSP)**
- Communication with lithium battery BMS **(Xcom-CAN)**
- 2 additional auxiliary contacts **(ARM-02)**

Certifications & Warranty

100% manufactured and tested in Switzerland (Europe). ISO certified factory 9001:2020/14001:2020. All our products include a 10-year warranty (5+5).

STC = Standard Test Conditions
Data may change without any notice

* Number of steps, thresholds, end current and times adjustable with the RCC-02/-03

4K3I

Call our specialists **+41 27 205 60 80** or visit **studer-innotec.com.**

Studer Innotec SA, rue des Casernes 57, 1950 Sion, Switzerland,
info@studer-innotec.com, fax +41 27 205 60 88.

BlueSolar Charge Controllers
MPPT 75/10, 75/15, 100/15, 100/20 & 100/20-48V

Solar Charge Controller
MPPT 75/15

Ultra-fast Maximum Power Point Tracking (MPPT)
Especially in case of a clouded sky, when light intensity is changing continuously, an ultra-fast MPPT controller will improve energy harvest by up to 30% compared to PWM charge controllers and by up to 10% compared to slower MPPT controllers.

Load output
Over-discharge of the battery can be prevented by connecting all loads to the load output. The load output will disconnect the load when the battery has been discharged to a pre-set voltage.
Alternatively, an intelligent battery management algorithm can be chosen: see Battery Life.
The load output is short circuit proof.
Some loads (especially inverters) can best be connected directly to the battery, and the inverter remote control connected to the load output. A special interface cable may be needed, please see the manual.

Battery Life: intelligent battery management
When a solar charge controller is not able to recharge the battery to its full capacity within one day, the result is often that the battery will continually be cycled between a 'partially charged' state and the 'end of discharge' state. This mode of operation (no regular full recharge) will destroy a lead-acid battery within weeks or months.
The Battery Life algorithm will monitor the state of charge of the battery and, if needed, day by day slightly increase the load disconnect level (i.e. disconnect the load earlier) until the harvested solar energy is sufficient to recharge the battery to nearly the full 100%. From that point onwards the load disconnect level will be modulated so that a nearly 100% recharge is achieved about once every week.

Programmable battery charge algorithm
See the software section on our website for details

Day/night timing and light dimming option
See the software section on our website for details

Programming, real-time data and history display options
- Color Control GX or other GX devices: see the **Venus** documents on our website.
- A smartphone or other Bluetooth-enabled device: VE.Direct Bluetooth Smart dongle needed.

VE.Direct Bluetooth Smart dongle needed to enable Bluetooth

BlueSolar Charge Controller	MPPT 75/10	MPPT 75/15	MPPT 100/15	MPPT 100/20	MPPT100/20-48V
Battery voltage (auto select)	12/24V				12/24/48V
Rated charge current	10A	15A	15A	20A	20A
Nominal PV power, 12V 1a,b)	145W	220W	220W	290W	290W
Nominal PV power, 24V 1a,b)	290W	440W	440W	580W	580W
Nominal PV power, 48V 1a,b)	n. a.	n. a.	n. a.	n. a.	1160W
Max. PV short circuit current 2)	13A	15A	15A	20A	20A
Automatic load disconnect	Yes				
Max. PV open circuit voltage	75V		100V		
Peak efficiency	98%				
Self-consumption	12V: 25 mA 24V: 15 mA				25 / 15 / 10 mA
Charge voltage 'absorption'	14,4V / 28,8V (adjustable)				14,4V / 28,8V / 57,6V (adj.)
Charge voltage 'float'	13,8V / 27,6V (adjustable)				13,8V / 27,6V / 55,2V (adj.)
Charge algorithm	multi-stage adaptive				
Temperature compensation	-16 mV / °C resp. -32 mV / °C				
Max. continuous load current	15A			20A	20A / 20A / 1A
Low voltage load disconnect	11,1V / 22,2V / 44,4V or 11,8V / 23,6V / 47,2V or Battery Life algorithm				
Low voltage load reconnect	13,1V / 26,2V / 52,4V or 14V / 28V / 56V or Battery Life algorithm				
Protection	Output short circuit / Over temperature				
Operating temperature	-30 to +60°C (full rated output up to 40°C)				
Humidity	95%, non-condensing				
Data communication port	VE.Direct (see the data communication white paper on our website)				
ENCLOSURE					
Colour	Blue (RAL 5012)				
Power terminals	6 mm² / AWG10				
Protection category	IP43 (electronic components), IP22 (connection area)				
Weight	0,5 kg		0,6 kg	0,65 kg	
Dimensions (h x w x d)	100 x 113 x 40 mm		100 x 113 x 50 mm	100 x 113 x 60 mm	
STANDARDS					
Safety	EN/IEC 62109-1, UL 1741, CSA C22.2				

1a) If more PV power is connected, the controller will limit input power.
1b) The PV voltage must exceed Vbat + 5V for the controller to start.
Thereafter the minimum PV voltage is Vbat + 1V
2) A PV array with a higher short circuit current may damage the controller.

Victron Energy B.V. | De Paal 35 | 1351 JG Almere | The Netherlands
General phone: +31 (0)36 535 97 00 | E-mail: sales@victronenergy.com
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BlueSolar Charge Controllers with screw connection

MPPT 250/70-Tr VE.Can, MPPT 150/100-Tr VE.Can & MPPT 250/100-Tr VE.Can

BlueSolar Charge Controller MPPT 250/100-Tr VE.Can with optional display

BlueSolar Charge Controller MPPT 250/100-Tr VE.Can without display

VE.Direct Bluetooth Smart Dongle

Bluetooth sensing: Smart Battery Sense

Bluetooth sensing: BMV-712 Smart Battery Monitor or SmartShunt

Ultra-fast Maximum Power Point Tracking (MPPT)

Especially in case of a clouded sky, when light intensity is changing continuously, an ultra-fast MPPT controller will improve energy harvest by up to 30% compared to PWM charge controllers and by up to 10% compared to slower MPPT controllers.

Advanced Maximum Power Point Detection in case of partial shading conditions

If partial shading occurs, two or more maximum power points (MPP) may be present on the power-voltage curve.
Conventional MPPTs tend to lock to a local MPP, which may not be the optimum MPP.
The innovative BlueSolar algorithm will always maximize energy harvest by locking to the optimum MPP.

Outstanding conversion efficiency

No cooling fan. Maximum efficiency exceeds 99%.

Flexible charge algorithm

Fully programmable charge algorithm (see the software page on our website), and eight pre-programmed algorithms, selectable with a rotary switch (see manual for details).

Extensive electronic protection

Over-temperature protection and power derating when temperature is high.
PV short circuit and PV reverse polarity protection.
PV reverse current protection.

Internal temperature sensor

Compensates absorption and float charge voltage for temperature.

Optional external battery voltage, temperature and current sensing via Bluetooth

A Smart Battery Sense or a BMV-712 Smart Battery Monitor can be used to communicate battery voltage and temperature (and current, in case of a BMV 712 or a SmartShunt) to one or more BlueSolar Charge Controllers. (VE.Direct Bluetooth Smart dongle needed)

VE.Can: the multiple controller solution

Up to 25 units can be synchronised with VE.Can

VE.Direct or VE.Can

For a wired data connection to a Color Control GX, other GX products, PC or other devices

Remote on-off

To connect for example to a VE.BUS BMS.

Programmable relay

Can be programmed to trip on an alarm, or other events.

Optional: SmartSolar pluggable LCD display

Simply remove the rubber seal that protects the plug on the front of the controller, and plug-in the display.

SmartSolar pluggable display

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BlueSolar Charge Controller	250/70-Tr VE.Can	150/100-Tr VE.Can	250/100-Tr VE.Can
Battery voltage	12 / 24 / 48V Auto Select (software tool needed to select 36V)		
Rated charge current	70A	100A	
Nominal PV power, 12V 1a,b)	1000W	1450W	
Nominal PV power, 24V 1a,b)	2000W	2900W	
Nominal PV power, 36V 1a,b)	3000W	4350W	
Nominal PV power, 48V 1a,b)	4000W	5800W	
Max. PV short circuit current 2)	35A	70A	
Maximum PV open circuit voltage	150V resp. 250V absolute maximum coldest conditions 145V resp. 245V start-up and operating maximum		
Maximum efficiency	99%	98%	99%
Self-consumption	Less than 35mA @ 12V / 20mA @ 48V		
Charge voltage 'absorption'	Default setting: 14,4 / 28,8 / 43,2 / 57,6V (adjustable with: rotary switch, display, VE.Direct or Bluetooth)		
Charge voltage 'float'	Default setting: 13,8 / 27,6 / 41,4 / 55,2V (adjustable: rotary switch, display, VE.Direct or Bluetooth)		
Charge voltage 'equalization'	Default setting: 16,2V / 32,4V / 48,6V / 64,8V (adjustable)		
Charge algorithm	multi-stage adaptive (eight preprogrammed algorithms) or user defined algorithm		
Temperature compensation	-16 mV / -32 mV / -64 mV / °C		
Protection	PV reverse polarity / Output short circuit / Over temperature		
Operating temperature	-30 to +60°C (full rated output up to 40°C)		
Humidity	95%, non-condensing		
Maximum altitude	5000m (full rated output up to 2000m)		
Environmental condition	Indoor, unconditioned		
Pollution degree	PD3		
Data communication port	VE.Direct and VE.Can		
Remote on/off	Yes (2 pole connector)		
Programmable relay	DPST AC rating: 240VAC / 4A DC rating: 4A up to 35VDC, 1A up to 60VDC		
Parallel operation	Yes, parallel synchronised operation with VE.Can (max. 25 units)		
ENCLOSURE			
Colour	Blue (RAL 5012)		
PV terminals	35 mm² / AWG2	35 mm² / AWG2	
Battery terminals	35mm² / AWG2		
Protection category	IP43 (electronic components), IP22 (connection area)		
Weight	3 kg	4,5 kg	
Dimensions (h x w x d)	185 x 250 x 95 mm	Tr models: 216 x 295 x 103 mm	
STANDARDS			
Safety	EN/IEC 62109-1, UL 1741, CSA C22.2		

1a) If more PV power is connected, the controller will limit input power.
1b) The PV voltage must exceed Vbat + 5V for the controller to start. Thereafter the minimum PV voltage is Vbat + 1V.
2) A PV array with a higher short circuit current may damage the controller.

With VE.Can up to 25 Charge Controllers can be daisy-chained and connected to a Color Control GX or other GX device
Each Controller can be monitored individually, for example on a Color Control GX and on the VRM website

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General phone: +31 (0)36 535 97 00 | E-mail: sales@victronenergy.com
www.victronenergy.com

AJ
275-400VA

Model		AJ 275-12	AJ 350-24	AJ 400-48
Inverter				
Nominal battery voltage		12 Vdc	24 Vdc	48 Vdc
Input voltage range		10.5 – 16 Vdc	21 – 32 Vdc	42 – 64 Vdc
Continuous power @ 25°C		200 VA	300 VA	300 VA
Power 30 min. @ 25°C		275 VA	350 VA	400 VA
Power 5 min. @ 25°C		350 VA	500 VA	600 VA
Power 5 sec. @ 25°C		450 VA	650 VA	1000 VA
Asymmetric load		150 VA	150 VA	200 VA
Max. efficiency (%)		93 %	94 %	94 %
Cos φ max.		0.1 – 1 up to 200 VA	0.1 – 1 up to 300 VA	0.1 – 1 up to 300 VA
Detection of the load		2 W only with the solar option -S		
Short-circuit current AC 2 sec.		2.3 Aac (4.6 Aac*)	3.2 Aac (6.4 Aac*)	4.6 Aac (9.2 Aac*)
Output voltage		Sine wave 230 Vac (120 Vac*) ±5 %		
Frequency		50 Hz (60 Hz*) ± 0.05 % (crystal controlled)		
Distortion THD (resistive load)		< 3 % (@ Pnom.)		
Consumption Stand-by		0.3 W**	0.5 W**	1.1 W**
Consumption «ON» no load		2.4 W	3.5 W	5.2 W
Overheat protection (±5°C)		Shut down @ 75°C - Auto-restart @ 70°C		
Overload and short circuit protection		Automatic disconnection with 2 time restart attempt		
Reverse polarity protection as internal fuse		60 A	40 A	25A
Deep discharge battery protection		Shut off @ 0.87 x Unom - Automatic restart @ Unom		
Max. battery voltage		Shut off @ > 1.33 x Unom - Automatic restart @ < Umax		
Acoustic alarm		Before low battery or overheating disconnection		
General data				
Weight		2.4 kg	2.6 kg	
Dimensions h/w/l [mm]		142 / 163 / 84		
Protection index IP		IP 30 conforms to DIN 40050		
Certification ECE-R 10 (E24)		•	•	Not available
EU declaration of conformity		**Low Voltage Directive (LVD) 2014/35/EU:** - EN 62109-1:2010 **Electromagnetic Compliance (EMC) Directive 2014/30/EU:** - EN 61000-6-2:2005, EN 61000-6-4:2007 / A1:2011		
Operating temperature		-20°C to + 50°C		
Relative humidity in operation		95 % without condensation		
Ventilation forced		From 45°C ± 5°C		
Acoustic level		< 45 dB (with ventilation)		
Warranty		5 years		
ISO Certification		9001:2008 / 14001:2004		
Approximate correction of Pnom		-1.5 % / °C since + 25°C		
Recommended battery capacity		> 5 x Pnom/Unom (recommended value in Ah)		
Length cables (Battery/AC out)		1.2 m / 1 m		
Options		**AJ 275-12-S**	**AJ 350-24-S**	**AJ 400-48-S**
Solar regulator	Voltage max.	25 Vdc	45 Vdc	90 Vdc
	Current max.	10 Adc		
	Principle	Floating 3 stages (I/U/UO)		
	Absorption voltage	14.4 Vdc	28.8 Vdc	57.6 Vdc
	Floating voltage	13.6 Vdc	27.2 Vdc	54.4 Vdc
Plug for remote control (RCM)		•	•	•

* 120Vac/60Hz on request
** Standby with solar option -S

Data may change without any notice

AJ
500-700VA

Model		AJ 500-12	AJ 600-24	AJ 700-48
Inverter				
Nominal battery voltage		12 Vdc	24 Vdc	48 Vdc
Input voltage range		10.5 – 16 Vdc	21 –32 Vdc	42 –64 Vdc
Continuous power @ 25°C		400 VA	500 VA	500 VA
Power 30 min. @ 25°C		500 VA	600 VA	700 VA
Power 5 min. @ 25°C		575 VA	675 VA	900 VA
Power 5 sec. @ 25°C		1000 VA	1200 VA	1400 VA
Asymmetric load		250 VA	300 VA	300V A
Max. efficiency (%)		93 %	94 %	94 %
Cos φ max.		0.1 – 1 up to 400 VA	0.1 – 1 up to 500 VA	0.1 – 1 up to 500 VA
Detection of the load		Adjustable: 1 to 20 W		
Short-circuit current AC 2 sec.		5.2 Aac (10.4 Aac*)	5.7 Aac (11.4 Aac*)	7 Aac (14 Aac*)
Output voltage		Sine wave 230 Vac (120 Vac*) ± 5%		
Frequency		50 Hz (60 Hz*) ± 0.05 % (crystal controlled)		
Distortion THD (resistive load)		< 3 % (@ Pnom.)		
Consumption Stand-by		0.4 W	0.6 W	1.5 W
Consumption «ON» no load		4.6 W	7.2 W	12 W
Overheat protection (±5°C)		Shut down @ 75°C - Auto-restart @ 70°C		
Overload and short circuit protection		Automatic disconnection with 2 time restart attempt		
Reverse polarity protection as internal fuse		120 A	90 A	60 A
Deep discharge battery protection		Shut off @ 0.87 x Unom - Automatic restart @ Unom		
Max. battery voltage		Shut off @ >1.33 x Unom - Automatic restart @ < Umax		
Acoustic alarm		Before low battery or overheating disconnection		
General data				
Weight		4.5 kg		
Dimensions h/w/l [mm]		142 / 240 / 84		
Protection index IP		IP 30 conforms to DIN 40050		
Certification ECE-R 10 (E24)		•	•	Not available
EU declaration of conformity		**Low Voltage Directive (LVD) 2014/35/EU:** - EN 62109-1:2010 **Electromagnetic Compliance (EMC) Directive 2014/30/EU:** - EN 61000-6-2:2005, EN 61000-6-4:2007 / A1:2011		
Operating temperature		-20°C to + 50°C		
Relative humidity in operation		95 % without condensation		
Ventilation forced		From 45°C ± 5°C		
Acoustic level		< 45 dB (with ventilation)		
Warranty		5 years		
ISO Certification		9001:2008 / 14001:2004		
Approximate correction of Pnom		-1.5 % / °C since +25°C		
Recommended battery capacity		> 5 x Pnom/Unom (recommended value in Ah)		
Length cables (Battery/AC out)		1.5 m / 1 m		
Options		**AJ 500-12-S**	**AJ 600-24-S**	**AJ 700-48-S**
Solar regulator	Voltage max.	25 Vdc	45 Vdc	90 Vdc
	Current max.	15 Adc		
	Principle	Floating 3 stages (I/U/UO)		
	Absorption voltage	14.4 Vdc	28.8 Vdc	57.6 Vdc
	Floating voltage	13.6 Vdc	27.2 Vdc	54.4 Vdc
Plug for remote control (RCM)		•	•	•

* 120Vac/60Hz on request
** Standby with solar option -S

Data may change without any notice

AJ
2100-2400VA

Model		AJ 2100-12	AJ 2400-24
Inverter			
Nominal battery voltage		12 Vdc	24 Vdc
Input voltage range		10.5 – 16 Vdc	21–32 Vdc
Continuous power @ 25°C		2000 VA	2000 VA
Power 30 min. @ 25°C		2100 VA	2400 VA
Power 5 min. @ 25°C		2450 VA	2800 VA
Power 5 sec. @ 25°C		5000 VA	5200 VA
Asymmetric load		1000 VA	1200 VA
Max. efficiency (%)		92 %	94%
Cos φ max.		0.1 – 1 up to 2000 VA	0.1 – 1 up to 2000 VA
Detection of the load		Adjustable: 1 → 20 W	
Short-circuit current AC 2 sec.		26 Aac (52 Aac*)	30 Aac (60 Aac*)
Output voltage		Sine wave 230 Vac (120 Vac*) ±5 %	
Frequency		50 Hz (60 Hz*) ± 0.05 % (crystal controlled)	
Distortion THD (resistive load)		< 3 % (@ Pnom. & Uin nom.)	< 3% (@ Pnom & Uin nom.)
Consumption Stand-by		0.7 W	1.2 W
Consumption «ON» no load		16 W	16 W
Overheat protection (±5°C)		Shut down @ 75°C - Auto-restart @ 70°C	
Short circuit protection		Automatic disconnection with 2 time restart attempt	
Reverse polarity protection by internal fuse		Not protected	150 A
Deep discharge battery protection		Shut off @ 0.87 x Unom - Automatic restart @ Unom	
Max. battery voltage		Shut off @ >1.33 x Unom - Automatic restart @ < Umax	
Acoustic alarm		Before low battery or overheating disconnection	
General data			
Weight		19 kg	18 kg
Dimensions h/w/l [mm]		273 / 399 / 117	
Protection index IP		IP 20 conforms to DIN 40050	
Certification ECE-R 10 (E24)		•	•
EU declaration of conformity		**Low Voltage Directive (LVD) 2014/35/EU:** - EN 62109-1:2010 **Electromagnetic Compliance (EMC) Directive 2014/30/EU:** - EN 61000-6-2:2005, EN 61000-6-4:2007 / A1:2011	
Operating temperature		-20°C to +50°C	
Relative humidity in operation		95 % without condensation	
Ventilation forced		From 45°C ± 5°C	
Acoustic level		< 45 dB (with ventilation)	
Warranty		5 years	
ISO Certification		9001:2008 / 14001:2004	
Approximate correction of Pnom		-1.5 % / °C since + 25°C	
Recommended battery capacity		> 5 x Pnom/Unom (recommended value in Ah)	
Length cables (Battery/AC out)		1.7m / 1m	
Options		**AJ 2100-12-S**	**AJ 2400-24-S**
Solar regulator	Voltage max.	25 Vdc	45 Vdc
	Current max.	30 Adc	
	Principle	Floating 3 stages (I/U/UO)	
	Absorption voltage	14.4 Vdc	28.8 Vdc
	Floating voltage	13.6 Vdc	27.2 Vdc
Accessories			
JT8 Remote control		•	

* 120Vac/60Hz on request
** Standby with solar option -S

Data may change without any notice

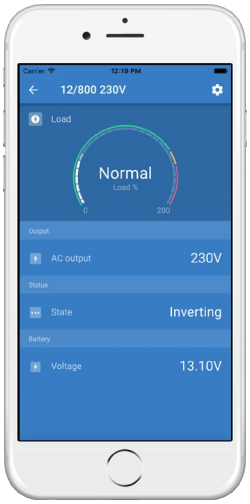
Phoenix Inverters

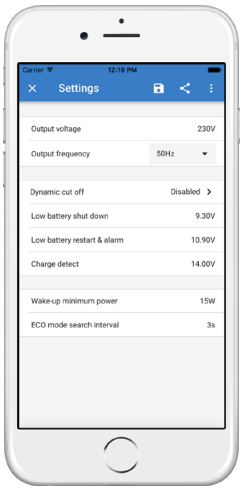
250VA – 1200VA 230V and 120V, 50Hz or 60Hz

www.victronenergy.com

Phoenix 12/375 VE.Direct

Phoenix 12/375 VE.Direct





VE.Direct communication port

The VE.Direct port can be connected to:

- A computer (VE.Direct to USB interface cable needed)
- Apple and Android smartphones, tablets, MacBook's and other devices (VE.Direct Bluetooth Smart dongle needed)

Fully configurable:

- Low battery voltage alarm trip and reset levels
- Low battery voltage cut-off and restart levels
- Dynamic cut-off: load dependent cut-off level
- Output voltage 210 - 245V
- Frequency 50 Hz or 60 Hz
- ECO mode on/off and ECO mode sense level

Monitoring:

- In- and output voltage, % load and alarms

Proven reliability

The full bridge plus toroidal transformer topology has proven its reliability over many years.
The inverters are short circuit proof and protected against overheating, whether due to overload or high ambient temperature.

High start-up power

Needed to start loads such as power converters for LED lamps, halogen lamps or electric tools.

ECO mode

When in ECO mode, the inverter will switch to standby when the load decreases below a preset value (min load: 15W). Once in standby the inverter will switch on for a short period (adjustable, default: every 2,5 seconds). If the load exceeds a preset level, the inverter will remain on.

Remote on/off

A remote on/off switch can be connected to a two-pole connector, or between battery plus and the left-hand contact of the two-pole connector.

LED diagnosis

Please see manual for a description.

To transfer the load to another AC source: the automatic transfer switch

For our low power inverters, we recommend our Filax Automatic Transfer Switch. The Filax features a very short switchover time (less than 20 milliseconds) so that computers and other electronic equipment will continue to operate without disruption.

Available with different output sockets

Schuko

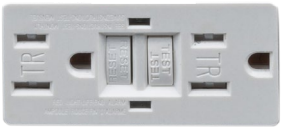
UK

AU/NZ

IEC-320
(male plug included)

Nema 5-15R

GFCI



DC connection with screw terminals

No special tools needed for installation

Phoenix Inverter	12 Volt 24 Volt 48 Volt	12/250 24/250 48/250	12/375 24/375 48/375	12/500 24/500 48/500	12/800 24/800 48/800	12/1200 24/1200 48/1200
Cont. power at 25°C (1)		250VA	375VA	500VA	800VA	1200VA
Cont. power at 25°C / 40°C		200 / 175W	300 / 260W	400 / 350W	650 / 560W	1000 / 850W
Peak power		400W	700W	900W	1500W	2200W
Output AC voltage / frequency (adjustable)		230VAC or 120VAC +/- 3% 50Hz or 60Hz +/- 0,1%				
Input voltage range		9,2 - 17 / 18,4 - 34,0 / 36,8 - 62,0V				
DC low shut down (adjustable)		9,3 / 18,6 / 37,2V				
Dynamic (load dependent) DC low shut down (fully configurable)		Dynamic cut-off, see https://www.victronenergy.com/live/ve.direct:phoenix-inverters-dynamic-cutoff				
DC low restart and alarm (adjustable)		10,9 / 21,8 / 43,6V				
Battery charged detect (adjustable)		14,0 / 28,0 / 56,0V				
Max. efficiency		87 / 88 / 88%	89 / 89 / 90%	90 / 90 / 91%	90 / 90 / 91%	91 / 91 / 92%
Zero-load power		4,2 / 5,2 / 7,9W	5,6 / 6,1 / 8,5W	6 / 6,5 / 9W	6,5 / 7 / 9,5W	7 / 8 / 10W
Default zero-load power in ECO mode (default retry interval: 2,5 s, adjustable)		0,8 / 1,3 / 2,5W	0,9 / 1,4 / 2,6W	1 / 1,5 / 3,0W	1 / 1,5 / 3,0W	1 / 1,5 / 3,0W
ECO mode stop and start power setting		Adjustable				
Protection (2)		a - f				
Operating temperature range		-40 to +65°C (fan assisted cooling) Derate 1,25% per °C above 40°C				
Humidity (non-condensing)		max 95%				
ENCLOSURE						
Material & Colour		Steel chassis and plastic cover (blue Ral 5012)				
Battery-connection		Screw terminals				
Maximum cable cross-section		10mm² / AWG8	10mm² / AWG8	10mm² / AWG8	25 / 10 / 10mm² / AWG4 / 8 / 8	35 / 25 / 25mm² / AWG2 / 4 / 4
Standard AC outlets		230V: Schuko (CEE 7/4), IEC-320 (male plug included) UK (BS 1363), AU/NZ (AS/NZS 3112) 120V: Nema 5-15R, GFCI				
Protection category		IP 21				
Weight		2,4kg / 5,3lbs	3,0kg / 6,6lbs	3,9kg / 8.5lbs	5,5kg / 12lbs	7,4kg / 16,3lbs
Dimensions (h x w x d, mm) (h x w x d, inch)		86 x 165 x 260 3.4 x 6.5 x 10.2	86 x 165 x 260 3.4 x 6.5 x 10.2	86 x 172 x 275 3,4 x 6,8 x 10,8	105 x 216 x 305 4.1 x 8.5 x 12.1 (12V model: 105 x 230 x 325)	117 x 232 x 327 4.6 x 9.1 x 12.9 (12V model: 117 x 232 x 362)
ACCESSORIES						
Remote on-off		Yes				
Automatic transfer switch		Filax				
STANDARDS						
Safety		EN-IEC 60335-1 / EN-IEC 62109-1				
EMC		EN 55014-1 / EN 55014-2 / IEC 61000-6-1 / IEC 61000-6-2 / IEC 61000-6-3				
Automotive Directive		ECE R10-4				

1) Nonlinear load, crest factor 3:1
2) Protection key:
   a) output short circuit
   b) overload
   c) battery voltage too high
   d) battery voltage too low
   e) temperature too high
   f) DC ripple too high

Battery Alarm
An excessively high or low battery voltage is indicated by an audible and visual alarm, and a relay for remote signalling.

VE.Direct Bluetooth Smart dongle (must be ordered separately)

BMV Battery Monitor
The BMV Battery Monitor features an advanced microprocessor control system combined with high resolution measuring systems for battery voltage and charge/discharge current. Besides this, the software includes complex calculation algorithms to exactly determine the state of charge of the battery. The BMV selectively displays battery voltage, current, consumed Ah or time to go. The monitor also stores a host of data regarding performance and use of the battery.

Victron Energy B.V. | De Paal 35 | 1351 JG Almere | The Netherlands
General phone: +31 (0)36 535 97 00 | E-mail: sales@victronenergy.com
www.victronenergy.com

NEW

CanadianSolar

HiKu7 Mono PERC

640 W ~ 665 W

CS7N-640|645|650|655|660|665MS

MORE POWER

665 W
Module power up to 665 W
Module efficiency up to 21.4 %

Up to 3.5 % lower LCOE
Up to 5.7 % lower system cost

Comprehensive LID / LeTID mitigation technology, up to 50% lower degradation

Compatible with mainstream trackers, cost effective product for utility power plant

Better shading tolerance

MORE RELIABLE

40 °C lower hot spot temperature, greatly reduce module failure rate

Minimizes micro-crack impacts

Heavy snow load up to 5400 Pa, wind load up to 2400 Pa*

12 Years **Enhanced Product Warranty on Materials and Workmanship***

25 Years **Linear Power Performance Warranty***

1st year power degradation no more than 2%
Subsequent annual power degradation no more than 0.55%

*According to the applicable Canadian Solar Limited Warranty Statement.

MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
ISO 45001: 2018 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730 / INMETRO
UL 61730 / IEC 61701 / IEC 62716
Take-e-way

* The specific certificates applicable to different module types and markets will vary, and therefore not all of the certifications listed herein will simultaneously apply to the products you order or use. Please contact your local Canadian Solar sales representative to confirm the specific certificates available for your Product and applicable in the regions in which the products will be used.

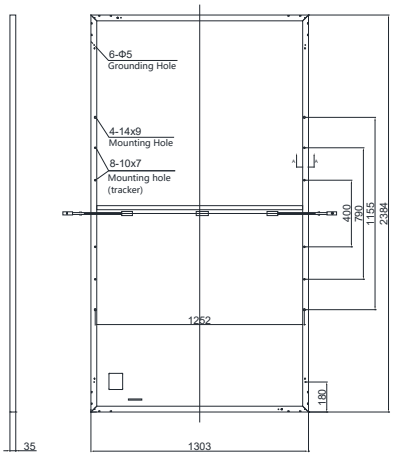
CSI Solar Co., Ltd. is committed to providing high quality solar products, solar system solutions and services to customers around the world. Canadian Solar was recognized as the No. 1 module supplier for quality and performance/price ratio in the IHS Module Customer Insight Survey, and is a leading PV project developer and manufacturer of solar modules, with over 52 GW deployed around the world since 2001.

* For detailed information, please refer to the Installation Manual.

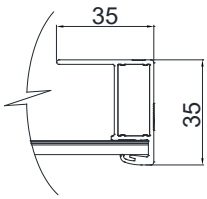
CSI Solar Co., Ltd.
199 Lushan Road, SND, Suzhou, Jiangsu, China, 215129, www.csisolar.com, support@csisolar.com

ENGINEERING DRAWING (mm)

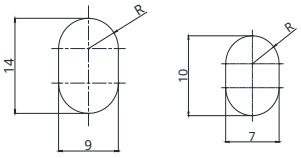
Rear View



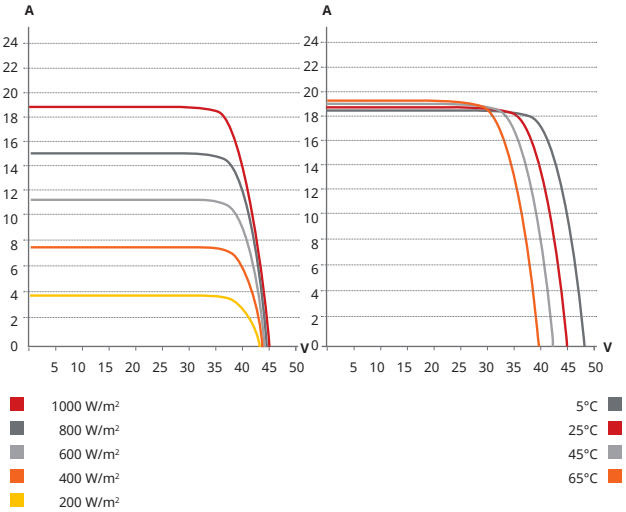
Frame Cross Section A-A



Mounting Hole



CS7N-650MS / I-V CURVES



ELECTRICAL DATA | STC*

CS7N	640MS	645MS	650MS	655MS	660MS	665MS
Nominal Max. Power (Pmax)	640 W	645 W	650 W	655 W	660 W	665 W
Opt. Operating Voltage (Vmp)	37.5 V	37.7 V	37.9 V	38.1 V	38.3 V	38.5 V
Opt. Operating Current (Imp)	17.07 A	17.11 A	17.16 A	17.20 A	17.24 A	17.28 A
Open Circuit Voltage (Voc)	44.6 V	44.8 V	45.0 V	45.2 V	45.4 V	45.6 V
Short Circuit Current (Isc)	18.31 A	18.35 A	18.39 A	18.43 A	18.47 A	18.51 A
Module Efficiency	20.6%	20.8%	20.9%	21.1%	21.2%	21.4%
Operating Temperature	-40°C ~ +85°C					
Max. System Voltage	1500V (IEC) or 1000V (IEC)					
Module Fire Performance	CLASS C (IEC 61730)					
Max. Series Fuse Rating	30 A					
Application Classification	Class A					
Power Tolerance	0 ~ + 10 W					

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

ELECTRICAL DATA | NMOT*

CS7N	640MS	645MS	650MS	655MS	660MS	665MS
Nominal Max. Power (Pmax)	478 W	482 W	486 W	489 W	493 W	497 W
Opt. Operating Voltage (Vmp)	35.0 V	35.2 V	35.4 V	35.6 V	35.8 V	36.0 V
Opt. Operating Current (Imp)	13.66 A	13.70 A	13.73 A	13.75 A	13.78 A	13.81 A
Open Circuit Voltage (Voc)	42.0 V	42.2 V	42.4 V	42.6 V	42.8 V	43.0 V
Short Circuit Current (Isc)	14.77 A	14.80 A	14.84 A	14.87 A	14.90 A	14.93 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	132 [2 x (11 x 6)]
Dimensions	2384 × 1303 × 35 mm (93.9 × 51.3 × 1.38 in)
Weight	34.4 kg (75.8 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy, crossbar enhanced
J-Box	IP68, 3 bypass diodes
Cable	4 mm² (IEC)
Cable Length (Including Connector)	460 mm (18.1 in) (+) / 340 mm (13.4 in) (-) or customized length*
Connector	T4 series or H4 UTX or MC4-EVO2
Per Pallet	31 pieces
Per Container (40' HQ)	527 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.34 % / °C
Temperature Coefficient (Voc)	-0.26 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	42 ± 3°C

PARTNER SECTION

* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. CSI Solar Co., Ltd. reserves the right to make necessary adjustment to the information described herein at any time without further notice.
Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

CSI Solar Co., Ltd.
199 Lushan Road, SND, Suzhou, Jiangsu, China, 215129, www.csisolar.com, support@csisolar.com

Q.PEAK DUO XL-G11.7
570-590

EXCELLENT RELIABILITY AND OUTSTANDING YIELDS

BREAKING THE 21% EFFICIENCY BARRIER
PERC Technology with zero gap cell layout boosts module efficiency up to 21.7%.

LOW ELECTRICITY GENERATION COSTS
Higher yield per surface area, lower BOS costs and up to 175 watts more module power than standard 144 half-cell modules.

ENDURING HIGH PERFORMANCE
Long-term yield security thanks to regular PID and Hot-Spot tests according to IEC requirements.

EXTREME WEATHER RATING
High-tech aluminium alloy frame, certified for high snow (5400 Pa) and wind loads (2400 Pa).

A RELIABLE INVESTMENT
Inclusive 12-year product warranty and 25-year linear performance warranty[1].

[1] See data sheet on rear for further information.

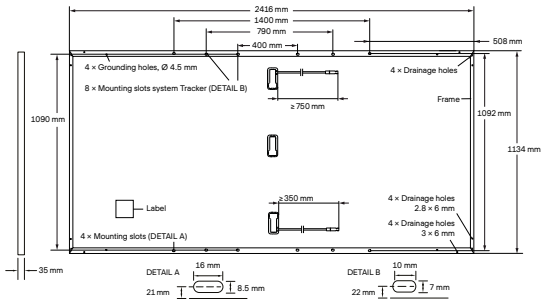
THE IDEAL SOLUTION FOR:

Ground-mounted solar power plants

Engineered in Germany

MECHANICAL SPECIFICATION

Format	2416 mm × 1134 mm × 35 mm (including frame)
Weight	30.7 kg
Front Cover	3.2 mm thermally pre-stressed glass with anti-reflection technology
Back Cover	Composite film
Frame	Anodised aluminium
Cell	6 × 26 monocrystalline PERC solar half cells
Junction box	53-101 mm × 32-60 mm × 15-18 mm Protection class IP67, with bypass diodes
Cable	4 mm² Solar cable; (+) ≥ 750 mm, (−) ≥ 350 mm
Connector	Stäubli MC4-Evo2, Hanwha Q CELLS HQC4; IP68



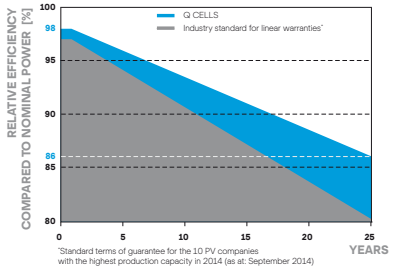
Drawing not to scale

ELECTRICAL CHARACTERISTICS

POWER CLASS				570	575	580	585	590
MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / −0 W)								
Minimum	Power at MPP[1]	P_{MPP}	[W]	570	575	580	585	590
	Short Circuit Current[1]	I_{SC}	[A]	13.49	13.51	13.54	13.57	13.59
	Open Circuit Voltage[1]	V_{OC}	[V]	53.59	53.62	53.64	53.67	53.70
	Current at MPP	I_{MPP}	[A]	12.82	12.87	12.92	12.97	13.01
	Voltage at MPP	V_{MPP}	[V]	44.46	44.68	44.90	45.12	45.33
	Efficiency[1]	η	[%]	≥ 20.8	≥ 21.0	≥ 21.2	≥ 21.4	≥ 21.5
MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NMOT[2]								
Minimum	Power at MPP	P_{MPP}	[W]	427.6	431.4	435.1	438.9	442.6
	Short Circuit Current	I_{SC}	[A]	10.87	10.89	10.91	10.93	10.95
	Open Circuit Voltage	V_{OC}	[V]	50.54	50.56	50.59	50.62	50.64
	Current at MPP	I_{MPP}	[A]	10.09	10.13	10.17	10.22	10.26
	Voltage at MPP	V_{MPP}	[V]	42.39	42.58	42.77	42.96	43.14

[1]Measurement tolerances P_{MPP} ±3%; I_{SC}; V_{OC} ±5% at STC: 1000 W/m², 25±2 °C, AM 1.5 according to IEC 60904-3 • [2]800 W/m², NMOT, spectrum AM 1.5

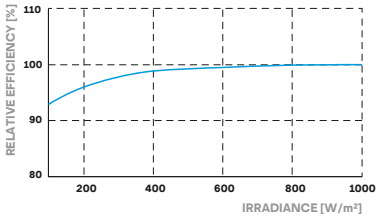
Q CELLS PERFORMANCE WARRANTY



At least 98 % of nominal power during first year. Thereafter max. 0.5 % degradation per year. At least 93.5 % of nominal power up to 10 years. At least 86 % of nominal power up to 25 years.

All data within measurement tolerances. Full warranties in accordance with the warranty terms of the Q CELLS sales organisation of your respective country.

PERFORMANCE AT LOW IRRADIANCE



Typical module performance under low irradiance conditions in comparison to STC conditions (25 °C, 1000 W/m²).

TEMPERATURE COEFFICIENTS							
Temperature Coefficient of I_{SC}	α	[%/K]	+0.04	Temperature Coefficient of V_{OC}	β	[%/K]	−0.27
Temperature Coefficient of P_{MPP}	γ	[%/K]	−0.34	Nominal Module Operating Temperature	NMOT	[°C]	43±3

PROPERTIES FOR SYSTEM DESIGN

Maximum System Voltage	V_{SYS}	[V]	1500	PV module classification	Class II
Maximum Reverse Current	I_R	[A]	25	Fire Rating	C
Max. Design Load, Push / Pull		[Pa]	3600 / 1600	Permitted Module Temperature on Continuous Duty	−40 °C - +85 °C
Max. Test Load, Push / Pull		[Pa]	5400 / 2400		

QUALIFICATIONS AND CERTIFICATES

IEC 61215:2016, IEC 61730:2016.
This data sheet complies with DIN EN 50380.

TÜVRheinland CERTIFIED
www.tuv.com
ID 1111220277

CE

PACKAGING INFORMATION

Vertical packaging	2458 mm	1134 mm	1270 mm	1000 kg	20 pallets	16 pallets	31 modules

Note: Installation instructions must be followed. See the installation and operating manual or contact our technical service department for further information on approved installation and use of this product.

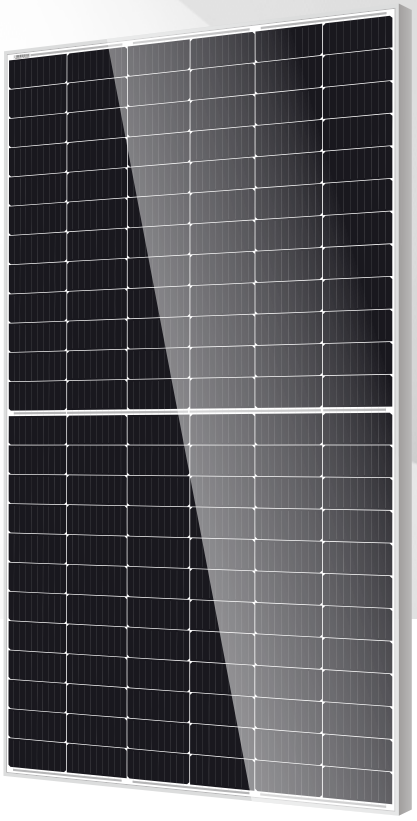
Hanwha Q CELLS GmbH
Sonnenallee 17-21, 06766 Bitterfeld-Wolfen, Germany | **TEL** +49 (0)3494 66 99-23444 | **FAX** +49 (0)3494 66 99-23000 | **EMAIL** sales@q-cells.com | **WEB** www.q-cells.com

Engineered in Germany

DMEGC *Quality. Performance. Value.*

445 / 450 / 455 / 460

DM460M6-72HSW/-V



Technology

High module conversion efficiency
through superior manufacturing technology

DMEGC cell inside

Over decade cell production experience
Qualified by most of module manufacturers
5G enhanced manufactory

PID Free

Excellent PID resistance according to
IEC TS 62804-1

Performance

High performance under low light conditions
(Cloudy days, mornings and evenings)

Quality

Manufactured according to International Quality, Health and Safety, Environmental Management Systems(ISO9001, ISO14001, ISO45001)

Value

Assured by the manufacturer who is the very most healthy PV provider

Social responsibility

SA8000 certified by TüV Nord
Low carbon footprint traceable

Service

Local office support, immediate response

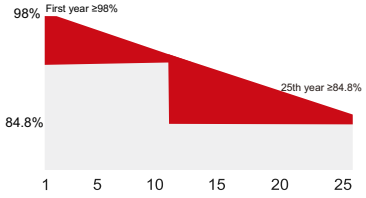
Superior Manufacturing-Quality Assurance

- TQC & SPC quality control systems
- Advanced cell sorting to avoid electric mismatch
- 100% twice EL tests

Visible Quality

- Durable,high-quality
- Rigid construction：5400Pa & 2400Pa rated assembly

Warranty



- 12 Years product warranty
- 25 Years power output warranty

A Member of the Hengdian Group

Ver:20220314A2

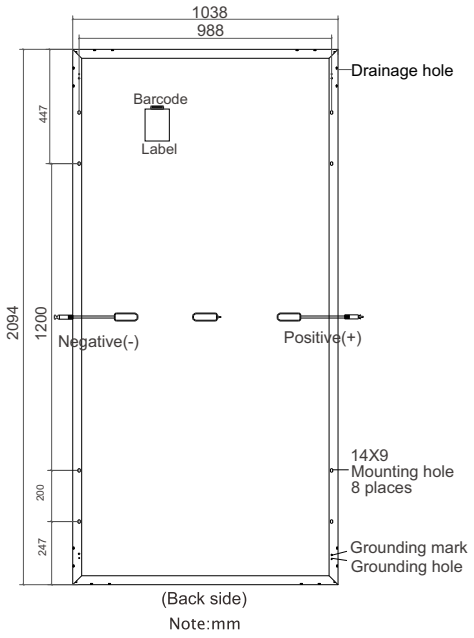
Electrical Specifications

* STC irradiance of 1000W/m^2 spectrum AM 1.5 and cell temperature of 25°C

Module Type	Pm(W)	Tolerance	Imp(A)	Vmp(V)	Isc(A)	Voc (V)	Module Efficiency
DM445M6-72HSW/-V	445	0/+3%	10.92	40.77	11.35	50.12	20.47%
DM450M6-72HSW/-V	450	0/+3%	11.01	40.91	11.43	50.27	20.70%
DM455M6-72HSW/-V	455	0/+3%	11.10	41.04	11.51	50.42	20.93%
DM460M6-72HSW/-V	460	0/+3%	11.18	41.17	11.59	50.57	21.16%

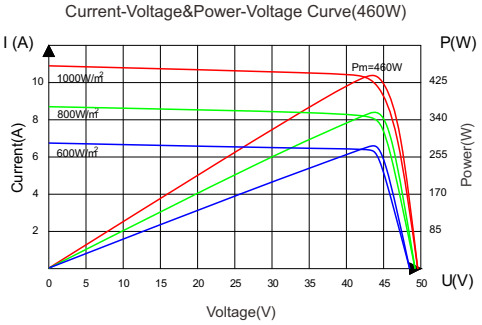
Mechanical Data

Cell Type	P type Mono-crystalline
Cell Arrangement	144(6x24)
Module Structure	Glass/Encapsulant/Backsheet
Glass Thickness	3.2mm
PV module classification	Class II
Junction Box Rating	IP67/IP68
Cables	4mm²/1300mm or Customized Length
Connector Type	MC4/MC4 Compatible(1000V) EVO2/EVO2 Compatible(1500V)
Fire Rating Class	Class C



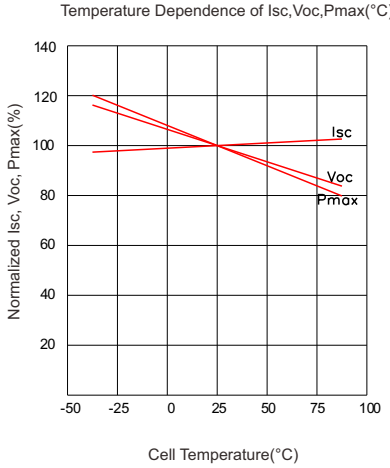
Maximum Ratings

Operating Temperature	-40°C to +85°C
Maximum System Voltage	1000V/1500V DC(IEC)
Maximum Series Fuse Rating	20A
Number of Diodes	3



Packaging

Module Dimensions	2094x1038x35mm
Weight	24.3kg
Container	40' HQ
Pieces per Pallet	31
Pieces per Container	682



Temperature Characteristics

Temperature Coefficient of Isc	+0.0487%/°C
Temperature Coefficient of Voc	-0.256%/°C
Temperature Coefficient of Pmax	-0.328%/°C

statement: Due to technological progress, product parameters will be adjusted accordingly; When signing the contract, the latest data of the company shall prevail.

DMEGC

Hengdian Group DMEGC Magnetics Co., Ltd.
Hengdian Industrial Zone, Dongyang City
Zhejiang Province, China 322118

Tel: 0086-579-8658-8825 Fax: 0086-579-8655-4845
Email: solar@dmegc.com.cn
www.chinadmegc.com www.dmegc.solar

BlueSolar Polycrystalline Panels

www.victronenergy.com

BlueSolar Polycrystalline 175W

- Low voltage-temperature coefficient enhances high-temperature operation.
- Exceptional low-light performance and high sensitivity to light across the entire solar spectrum.
- 25-Year limited warranty on power output and performance.
- 5-Year limited warranty on materials and workmanship.
- Sealed, waterproof, multi-functional junction box gives high level of safety.
- High performance bypass diodes minimize the power drop caused by shade.
- Advanced EVA (Ethylene Vinyl Acetate) encapsulation system with triple-layer back sheet meets the most stringent safety requirements for high-voltage operation.
- A sturdy, anodized aluminium frame allows modules to be easily roof-mounted with a variety of standard mounting systems.
- Highest quality, high-transmission tempered glass provides enhanced stiffness and impact resistance.
- High power models with pre-wired quick-connect system with MC4 (PV-ST01) connectors.

MC4 connectors

Article Number	Description	Net weight	Electrical data under STC (1)				
			Nominal Power	Max-Power Voltage	Max-Power Current	Open-Circuit Voltage	Short-Circuit Current
			P_{MPP}	V_{MPP}	I_{MPP}	Voc	Isc
		Kg	W	V	A	V	A
SPP040201200	20W-12V Poly 440 x 350 x 25mm series 4a	1.9	20	18.4	1.09	21.96	1.18
SPP040301200	30W-12V Poly 655 x 350 x 25mm series 4a	2.8	30	18.2	1.66	21.80	1.80
SPP040451200	45W-12V Poly 425 x 668 x 25mm series 4a	3.1	45	19.1	2.36	22.90	2.55
SPP040601200	60W-12V Poly 545 x 668 x 25mm series 4a	4	60	19.3	3.12	23.10	3.37
SPP040901200	90W-12V Poly 780 x 668 x 30mm series 4a	6.1	90	19.5	4.61	23.44	4.98
SPP041151200	115W-12V Poly 1015 x 668 x 30mm series 4a	8	115	18.94	6.08	22.73	6.56
SPP041751200	175W-12V Poly 1485 x 668 x 30mm series 4a	12	175	18,3	9.56	21.9	10.24
SPP032602000	260W-20V Poly 1640 x 992 x 40mm series 3a	17	260	30	8.66	36.75	9.30
SPP042702000	270W-20V Poly 1640 x 992 x 35mm series 4a	18.4	270	31.7	8.52	38.04	9.21
SPP043302400	330W-24V Poly 1956 x 992 x 40mm series 4a	22.5	330	37.3	8.86	44.72	9.57

Module	SPP 040201200	SPP 040301200	SPP 040451200	SPP 040601200	SPP 040901200	SPP 041151200	SPP 041751200	SPP 032601200	SPP 042702000	SPP 043302400
Nominal Power (± 3% tolerance)	20W	30W	45W	60W	90W	115W	175W	260W	270W	330W
Cell type	Polycrystalline									
Number of cells in series	36							60	60	72
Maximum system voltage (V)	1000V									
Temperature coefficient of PMPP (%)	-0.45/°C	-0.45/°C	-0.45/°C	-0.45/°C	-0.45/°C	-0.45/°C	-0.45/°C	-0.45/°C	-0.47/°C	-0.45/°C
Temperature coefficient of Voc (%)	-0.35/°C	-0.35/°C	-0.35/°C	-0.35/°C	-0.35/°C	-0.35/°C	-0.35/°C	-0.35/°C	-0.34/°C	-0.35/°C
Temperature coefficient of Isc (%)	+0.04/°C	+0.04/°C	+0.04/°C	+0.04/°C	+0.04/°C	+0.04/°C	+0.04/°C	+0.04/°C	+0.045/°C	+0.04/°C
Temperature Range	-40°C to +85°C									
Surface Maximum Load Capacity	200 kg/m²									
Allowable Hail Load	23 m/s, 7.53 g									
Junction Box Type	PV-LH0805	PV-LH0806			PV-LH0801	PV-LH0808			PV-JB002	
Length of Cable / connector	No cable				900 mm / MC4					
Output tolerance	+/-3%									
Frame	Aluminium									
Product warranty	5 years									
Warranty on electrical performance	10 years 90% + 25 years 80% of power output									
Smallest packaging unit	1 panel									
Quantity per pallet	380	240	180	140	90	80	36	20	32	37

1) STC (Standard Test Conditions): 1000 W/m², 25°C, AM (Air Mass) 1.5

Victron Energy B.V. | De Paal 35 | 1351 JG Almere | The Netherlands
General phone: +31 (0)36 535 97 00 | E-mail: sales@victronenergy.com
www.victronenergy.com