

## Annexe 1 – Modules photovoltaïques

# Sunmodule<sup>+</sup>

## SW 250 mono

### COMPORTEMENT LORS DE CONDITIONS DE TEST STANDARD (STC\*)

		SW 250
Puissance au point de puissance maximale	$P_{max}$	250 Wc
Tension à vide	$U_{oc}$	37,8 V
Tension au point de puissance maximale	$U_{mpp}$	31,1 V
Courant de court-circuit	$I_{sc}$	8,28 A
Courant au point de puissance maximale	$I_{mpp}$	8,05 A

\*STC: 1000W/m<sup>2</sup>, 25°C, AM 1.5

### COMPORTEMENT À 800W/m<sup>2</sup>, NOCT, AM 1.5

		SW 250
Puissance au point de puissance maximale	$P_{max}$	183,3 Wc
Tension à vide	$U_{oc}$	34,6 V
Tension au point de puissance maximale	$U_{mpp}$	28,5 V
Courant de court-circuit	$I_{sc}$	6,68 A
Courant au point de puissance maximale	$I_{mpp}$	6,44 A

Faible réduction du rendement en conditions de charge partielle à 25 °C: à 200 W/m<sup>2</sup>, la puissance est égale à 95 % (+/- 3 %) de la puissance en condition STC.

### MATÉRIAUX UTILISÉS

Cellules par panneau solaire	60
Type de cellules	monocristallin
Dimensions des cellules	156 mm x 156 mm
Vue de face	verre trempé (EN 12150)

### GRANDEURS CARACTÉRISTIQUES RELATIVES À INTÉGRATION OPTIMALE DANS LE SYSTÈME

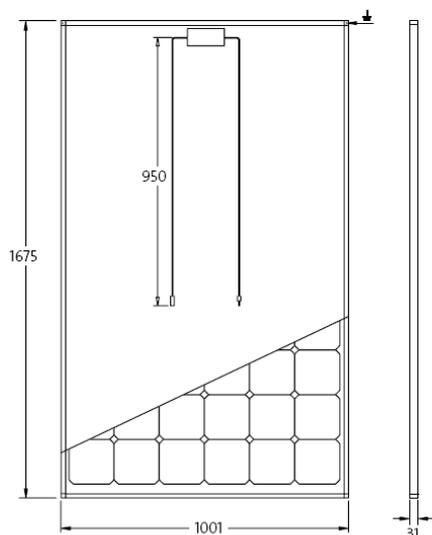
Tension de système maximale classe II	1000 V
Valeurs limites de courant inverse	16 A
Charge neige et vent selon IEC 61215	5,4 kN/m <sup>2</sup>
Nombre de diode bypass	3

### GRANDEURS CARACTÉRISTIQUES THERMIQUES

NOCT	47 °C
CT $I_{sc}$	0,042 %/K
CT $U_{oc}$	-0,33 %/K
CT $P_{mpp}$	-0,45 %/K

### AUTRES DONNÉES

Tolérance de mesure	+/- 3 %
Boîte de jonction	IP65
Connecteur	MC4
SolarWorld: tri Plus <sup>9)</sup>	$P_{Flash} \geq P_{max}$



- Qualified, IEC 61215
- Safety tested, IEC 61730
- Periodic Inspection
- Power Controlled



- 1) La puissance mesurée par SolarWorld ( $P_{Flash}$ ) est toujours supérieure à la puissance nominale ( $P_{max}$ ) du module.
- 2) Selon le marché.  
SolarWorld AG se réserve le droit de modifier des spécifications. Cette fiche technique correspond aux mentions de la norme EN 50380. Cette fiche technique est également disponible en anglais.

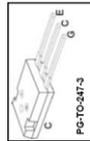
## Annexe 2 – Onduleurs photovoltaïques

Onduleurs		SunEzy 600E 3 entrées MPPT indépendantes	combinaison multi-onduleurs
			
références	onduleur	<b>PVSNV1600E</b>	▶ page A6
	extension de garantie 10 ans (1)	<b>PVS10ANS600E</b>	▶ page A6
entrée (CC)	puissance maximale du générateur photovoltaïque	5,4 kWc	
	plage tension MPP (2)	200 à 700 V	
	tension minimale de connexion réseau	150 V	
	tension maximale à vide	750 V	
	courant maximal	3 x 8,5 A	
	raccordement sur connecteurs MC3 Multi-contact*	3 paires	
sortie (CA)	puissance nominale ( <i>maximale</i> )	4,6 kW ( <i>5,1 kW</i> )	
	tension nominale	230 V	
	courant nominal ( <i>maximal</i> )	20 A ( <i>25 A</i> )	
	fréquence nominale	50 Hz	
normes et réglementations	conformité directive CEM	EN 50081, EN 50082, EN 61000-3-2	
	aux directives européennes (basse tension)	EN 50178	
	marquage	VDE GS	
	raccordement au réseau	VDE 0126-1-1 (2006.02)	
rendement maximal ( <i>euro péen</i> )		> 96 % ( <i>&gt; 94,5 %</i> )	
consommation propre en service		0 à 9 W	
paramètres disponibles sur l'écran rétro-éclairé à cristaux liquides		puissance CA instantanée, énergie produite depuis la mise en service, énergie produite durant la journée, courant / tension / fréquence CA, tension / courant CC.	
boîtier		Métallique	
température ambiante de fonctionnement		-20 °C à +55 °C	
humidité relative (HR)		0 % à 95 %	
indice de protection		IP 65	
ports de communication externe		RS232 (en standard)	
dimensions	longueur	430 mm	
	hauteur	530 mm	
	profondeur	130 mm	
masse		27 kg	

(2) MPP : Maximum Power Point, point de puissance maximum du générateur photovoltaïque.

**Low Loss DuoPack : IGBT in TrenchStop® and Fieldstop technology with soft, fast recovery anti-parallel EmCon HE diode**

- Short circuit withstand time – 10µs
- Designed for :
  - Soft Switching Applications
  - Induction Heating
- **TrenchStop®** and Fieldstop technology for 1200 V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - easy parallel switching capability due to positive temperature coefficient in  $V_{CE(sat)}$
- Very soft, fast recovery anti-parallel EmCon™ HE diode
- Low EMI
- Qualified according to JEDEC<sup>1</sup> for target applications
- Application specific optimisation of inverse diode
- •Pb-free lead plating: RoHS compliant



Type	$V_{CE}$	$I_C$	$V_{CE(sat)}$ , $T_J=25^\circ\text{C}$	$T_{Jmax}$	Marking	Package
IHW40T120	1200V	40A	1.8V	150°C	H40T120	PG-TO247-3

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CE}$	1200	V
DC collector current	$I_C$	40	A
$T_C = 25^\circ\text{C}$		75	
$T_C = 100^\circ\text{C}$		40	
Pulsed collector current, $t_p$ limited by $T_{Jmax}$	$I_{C(puls)}$	105	
Turn off safe operating area		105	
$V_{CE} \leq 1200\text{V}$ , $T_J \leq 150^\circ\text{C}$			
Diode forward current	$I_F$	31	
$T_C = 25^\circ\text{C}$		19.8	
$T_C = 100^\circ\text{C}$		47	
Diode pulsed current, $t_p$ limited by $T_{Jmax}$	$I_{F(puls)}$	47	
Diode surge non repetitive current, $t_p$ limited by $T_{Jmax}$	$I_{FSM}$	78	A
$T_C = 25^\circ\text{C}$ , $t_p = 10\text{ms}$ , sine halfwave		200	
$T_C = 25^\circ\text{C}$ , $t_p \leq 2.5\mu\text{s}$ , sine halfwave		160	
$T_C = 100^\circ\text{C}$ , $t_p \leq 2.5\mu\text{s}$ , sine halfwave		±20	
Gate-emitter voltage	$V_{GE}$	±20	V
Short circuit withstand time <sup>2)</sup>	$t_{SC}$	10	µs
$V_{GE} = 15\text{V}$ , $V_{CC} \leq 1200\text{V}$ , $T_J \leq 150^\circ\text{C}$			
Power dissipation, $T_C = 25^\circ\text{C}$	$P_{tot}$	270	W
Operating junction temperature	$T_J$	-40...+150	°C
Storage temperature	$T_{stg}$	-55...+150	

<sup>1</sup> J-STD-020 and JESD-022

<sup>2</sup> Allowed number of short circuits: <1000; time between short circuits: >1s.

**Thermal Resistance**

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic IGBT thermal resistance, junction – case	$R_{th,jc}$		0.45	K/W
			1.1	
Diode thermal resistance, junction – case	$R_{th,jcd}$		40	
Thermal resistance, junction – ambient	$R_{th,ja}$		40	

**Electrical Characteristic, at  $T_J = 25^\circ\text{C}$ , unless otherwise specified**

Parameter	Symbol	Conditions	Value		Unit	
			min.	max.		
Static Characteristic	$V_{BR}(V_{CES})$	$V_{GE} = 0\text{V}$ , $I_C = 1.5\text{mA}$	1200	-	V	
			$V_{CE} = 15\text{V}$ , $I_C = 40\text{A}$			
Collector-emitter breakdown voltage	$V_{CE(sat)}$	$T_J = 25^\circ\text{C}$	1.8	2.3		
			$T_J = 125^\circ\text{C}$	2.1		-
			$T_J = 150^\circ\text{C}$	2.3		-
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}$ , $I_F = 18\text{A}$	1.65	2.15		
			$T_J = 25^\circ\text{C}$	1.7		
			$T_J = 125^\circ\text{C}$	1.7		
			$T_J = 150^\circ\text{C}$	1.7		
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 1.5\text{mA}$ , $V_{CE} = V_{GE}$	5.0	6.5	mA	
			$V_{CE} = 1200\text{V}$ , $V_{GE} = 0\text{V}$			
Zero gate voltage collector current	$I_{CES}$	$T_J = 25^\circ\text{C}$	-	0.4		
			$T_J = 150^\circ\text{C}$	-		4.0
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}$ , $V_{GE} = 20\text{V}$	-	600	nA	
			$V_{CE} = 20\text{V}$ , $I_C = 40\text{A}$	-		21
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}$ , $I_C = 40\text{A}$	-	6	S	
Integrated gate resistor	$R_{G(int)}$		-	6	$\Omega$	

**Dynamic Characteristic**

Dynamic Characteristic	Symbol	Conditions	Value	Unit
Input capacitance	$C_{iss}$	$V_{CE} = 25\text{V}$ , $V_{GE} = 0\text{V}$ , $f = 1\text{MHz}$	2500	pF
				130
Output capacitance	$C_{oss}$	$V_{CE} = 25\text{V}$ , $V_{GE} = 0\text{V}$ , $f = 1\text{MHz}$	110	nC
				203
Reverse transfer capacitance	$C_{riss}$	$V_{CE} = 25\text{V}$ , $V_{GE} = 0\text{V}$ , $f = 1\text{MHz}$	110	nC
				203
Gate charge	$Q_{gate}$	$V_{CE} = 960\text{V}$ , $I_C = 40\text{A}$ , $V_{GE} = 15\text{V}$	13	nH
				210
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$	$V_{GE} = 15\text{V}$ , $t_{SC} \leq 10\mu\text{s}$ , $V_{CC} = 600\text{V}$ , $T_J = 25^\circ\text{C}$	13	nH
				210
Short circuit collector current <sup>1)</sup>	$I_{C(SC)}$	$V_{GE} = 15\text{V}$ , $t_{SC} \leq 10\mu\text{s}$ , $V_{CC} = 600\text{V}$ , $T_J = 25^\circ\text{C}$	-	A

<sup>1)</sup> Allowed number of short circuits: <1000; time between short circuits: >1s.

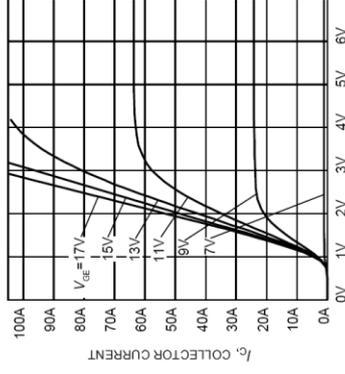
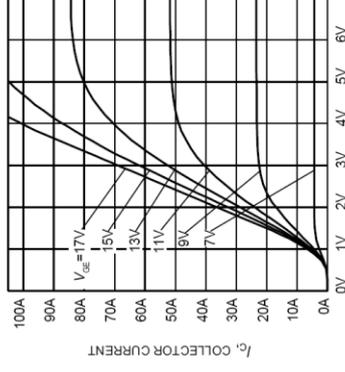
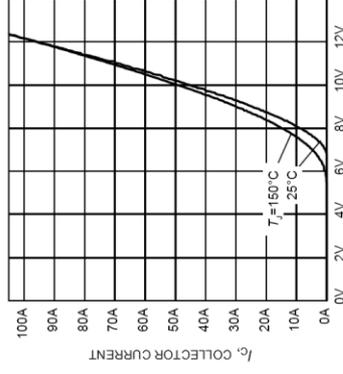
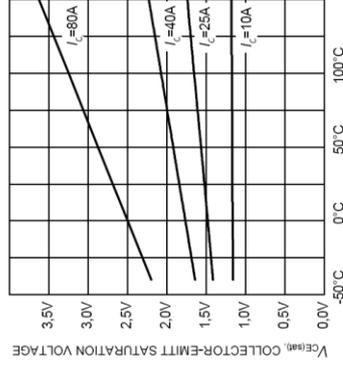
**Switching Characteristic, Inductive Load, at  $T_J=25^\circ\text{C}$** 

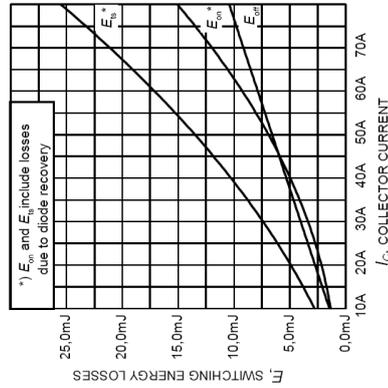
Parameter	Symbol	Conditions	Value		Unit
			min.	typ. max.	
<b>IGBT Characteristic</b>					
Turn-on delay time	$t_{d(on)}$	$T_J=25^\circ\text{C}$ , $V_{CC}=600\text{V}$ , $I_C=40\text{A}$ ,	-	48	ns
Rise time	$t_r$	$V_{GE}=0/15\text{V}$ ,	-	34	-
Turn-off delay time	$t_{d(off)}$	$R_G=15\Omega$ ,	-	480	-
Fall time	$t_f$	$L_{\sigma'}=180\text{nH}$ ,	-	70	-
Turn-on energy	$E_{on}$	$C_{\sigma'}=39\text{pF}$	-	3.3	mJ
Turn-off energy	$E_{off}$	Energy losses include "tail" and diode reverse recovery.	-	3.2	-
Total switching energy	$E_{is}$		-	6.5	-
<b>Anti-Parallel Diode Characteristic</b>					
Diode reverse recovery time	$t_{rr}$	$T_J=25^\circ\text{C}$ ,	-	195	ns
Diode reverse recovery charge	$Q_{rr}$	$V_R=800\text{V}$ , $I_F=18\text{A}$ ,	-	1880	nC
Diode peak reverse recovery current	$I_{rrm}$	$di_F/dt=800\text{A}/\mu\text{s}$	-	20.2	A

**Switching Characteristic, Inductive Load, at  $T_J=150^\circ\text{C}$** 

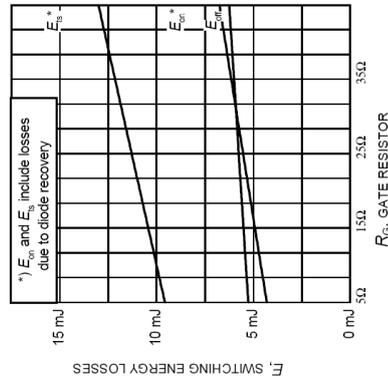
Parameter	Symbol	Conditions	Value		Unit
			min.	typ. max.	
<b>IGBT Characteristic</b>					
Turn-on delay time	$t_{d(on)}$	$T_J=150^\circ\text{C}$	-	52	ns
Rise time	$t_r$	$V_{CC}=600\text{V}$ , $I_C=40\text{A}$ ,	-	40	-
Turn-off delay time	$t_{d(off)}$	$V_{GE}=0/15\text{V}$ ,	-	580	-
Fall time	$t_f$	$R_G=15\Omega$ ,	-	120	-
Turn-on energy	$E_{on}$	$L_{\sigma'}=180\text{nH}$ ,	-	5.0	mJ
Turn-off energy	$E_{off}$	$C_{\sigma'}=39\text{pF}$	-	5.4	-
Total switching energy	$E_{is}$	Energy losses include "tail" and diode reverse recovery.	-	10.4	-
<b>Anti-Parallel Diode Characteristic</b>					
Diode reverse recovery time	$t_{rr}$	$T_J=150^\circ\text{C}$	-	300	ns
Diode reverse recovery charge	$Q_{rr}$	$V_R=800\text{V}$ , $I_F=18\text{A}$ ,	-	3540	nC
Diode peak reverse recovery current	$I_{rrm}$	$di_F/dt=800\text{A}/\mu\text{s}$	-	25.3	A

<sup>2)</sup> Leakage inductance  $L_{\sigma}$  and Stray capacity  $C_{\sigma}$  due to dynamic test circuit in Figure E.  
<sup>1)</sup> Leakage inductance  $L_{\sigma}$  and Stray capacity  $C_{\sigma}$  due to dynamic test circuit in Figure E.

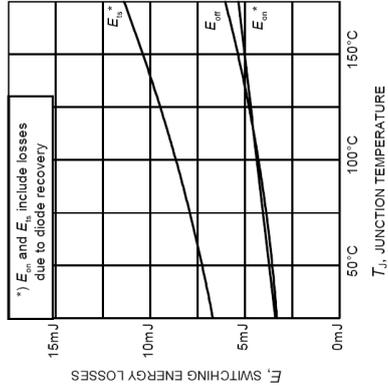

**Figure 5. Typical output characteristic ( $T_J=25^\circ\text{C}$ )**

**Figure 6. Typical output characteristic ( $T_J=150^\circ\text{C}$ )**

**Figure 7. Typical transfer characteristic ( $T_J=150^\circ\text{C}$ ,  $V_{CE}=20\text{V}$ )**

**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature ( $V_{GE}=15\text{V}$ )**



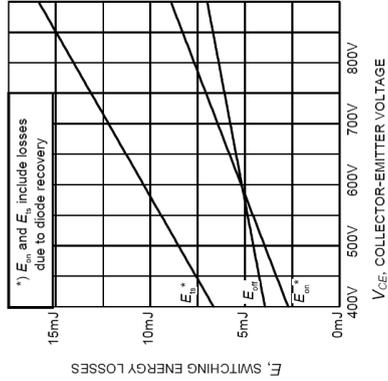
**Figure 13. Typical switching energy losses as a function of collector current**  
(inductive load,  $T_j=150^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_{\theta C}=15\Omega$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_{\theta E}=15\Omega$ , Dynamic test circuit in Figure E)



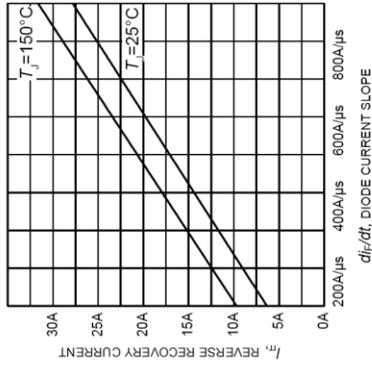
**Figure 14. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_j=150^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_{\theta C}=15\Omega$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_{\theta E}=15\Omega$ , Dynamic test circuit in Figure E)



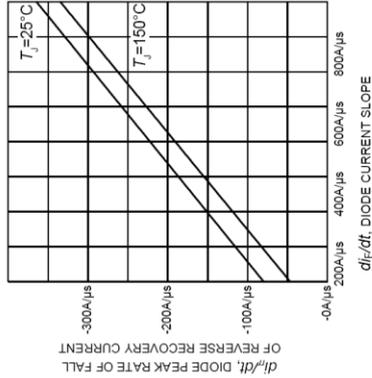
**Figure 15. Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_{\theta C}=15\Omega$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_{\theta E}=15\Omega$ , Dynamic test circuit in Figure E)



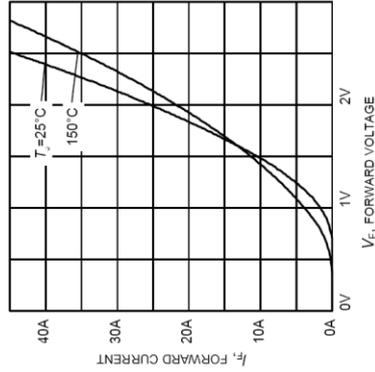
**Figure 16. Typical switching energy losses as a function of collector-emitter voltage**  
(inductive load,  $T_j=150^\circ\text{C}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_{\theta C}=15\Omega$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_{\theta E}=15\Omega$ , Dynamic test circuit in Figure E)



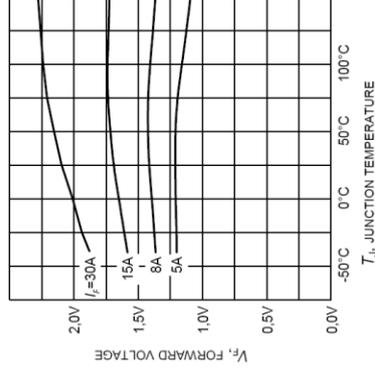
**Figure 25. Typical reverse recovery current as a function of diode current slope**  
( $V_{CE}=600\text{V}$ ,  $I_F=15\text{A}$ , Dynamic test circuit in Figure E)



**Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**  
( $V_{CE}=600\text{V}$ ,  $I_F=15\text{A}$ , Dynamic test circuit in Figure E)



**Figure 27. Typical diode forward current as a function of forward voltage**

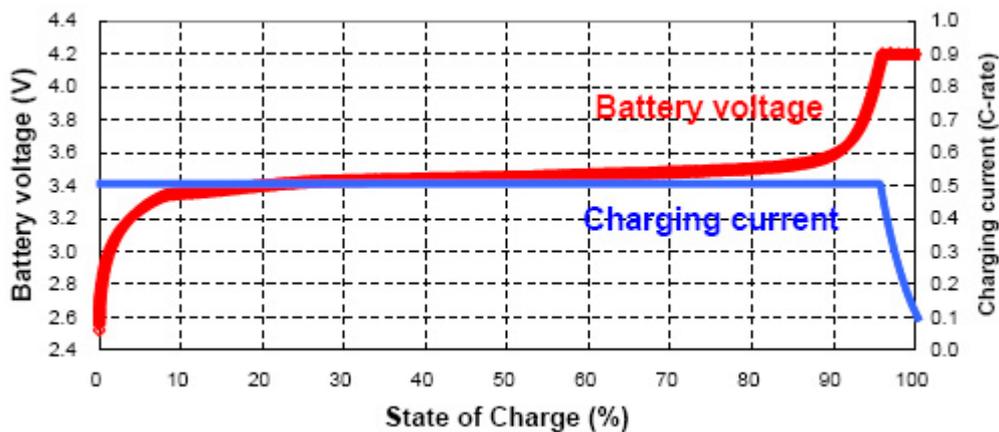


**Figure 28. Typical diode forward voltage as a function of junction temperature**



Annexe 4 : Caractéristiques de éléments LiFePo4

Model : SE100AHA		
Nominal Capacity (Ah)	100	
Nominal Voltage(v)	3.2	
Internal Impedance(1khz AC ,mΩ)	≤0.9	
Charging Cut-off Voltage(CCCV Model,V)	3.6	
Discharging Cut-off Voltage(v)	2.5	
Recommend Charging-Discharging Current(0.3C,A)	30	
Maximum short-tine Discharging Current (period≤10s,A)	800	
Life Cycle(0.3C Charging-discharging,80%DDC)	2000	
Operating Thermal Ambient	Charging	0°C~45°C
	Discharging	-20°C~55°C
Storage Thermal Ambient	-20°C~45°C	
Weight(kg)	3.2±0.1kg	
Shell Material	Plastic	



Caractéristique de charge d'un élément LiFePo4 sous un courant de 0,5C

Nota : On considèrera que le State of Charge évolue proportionnellement avec le temps.