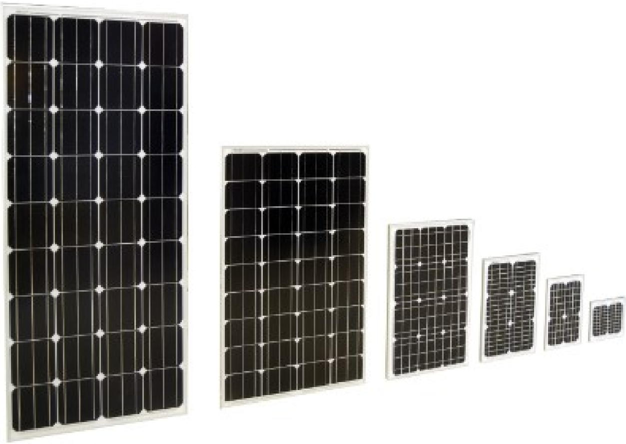
ANEXO I (Módulo Solar)

TECHNO SUN

Módulo fotovoltaicos Techno Sun
5 /10 / 20 / 40 / 100 / 150W



Módulos FV monocristalinos Techno Sun de alto rendimiento

Descripción

La gama de paneles solares de tecnología monocristalina de Techno Sun cuenta con una alta eficiencia de hasta el 17,96% de célula* y 15,92% del módulo*, tolerancia del ±3% y alta calidad de fabricación para proporcionar el mejor rendimiento.

Características destacadas

- Células solares de alta eficiencia con transmisión y cristal texturizado .
- Diodo de bypass para minimizar las pérdidas por sombras.
- Vidrio templado con encapsulado EVA y película de protección frente al medio ambiente, con marco de aluminio.
- Cumple las certificaciones internacionales (CE, TÜV NORD, ISO) y está incluido en el programa PV Cycle.

Aplicaciones

Sistemas de energía solar fotovoltaica para aplicaciones residenciales, comerciales o industriales aisladas de la red, de energía de respaldo o conectadas a red. .

* Valores de referencia del modelo de 150W, consultar tabla de valores para cada modelo.

TECHNO SUN

Módulo fotovoltaicos Techno Sun 5 /10 / 20 / 40 / 100 / 150W

Datos eléctricos						
Potencia máxima (W)	5	10	20	40	100	150
Tensión de potencia óptima (Vmp)	18,57	18,57	17,82	17,69	18,78	18.99
Corriente operativa óptima (Imp)	0,27	0,54	1,12	2,26	5,32	7.90
Tensión de circuito abierto (Voc)	22,64	22,64	22,54	22,54	22,64	22.42
Corriente de cortocircuito (Isc)	0,29	0,58	1,20	2,42	5,70	8.45
Eficiencia de célula (%)	17,96	17,96	16,76	16,56	17,88	17,96
Eficiencia de módulo (%)	9,16	10,83	11,45	12,74	14,90	15,12
Tolerancia (%)	±3%	±3%	±3%	±3%	±3%	±3%
NOCT	47°C +/-2°C	47°C +/-2°C	47°C +/-2°C	47°C +/-2°C	47°C +/-2°C	47°C +/-2°C

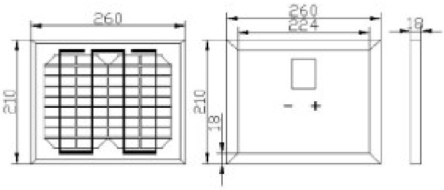
Coef. de temperatura						
Coef. de temperatura Isc (%)°C	+0.04	+0.04	+0.04	+0.04	+0.04	+0.04
Coef. de temperatura Voc (%)°C	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38
Coef. de temperatura Pm (%)°C	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47
Coef. de temperatura Im (%)°C	+0.04	+0.04	+0.04	+0.04	+0.04	+0.04
Coef. de temperatura Vm (%)°C	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38

Datos mecánicos						
Célula	52*15,3 (16,8)	52*30,6 (32,1)	156*21,9 (23,5)	156*44,3 (45,7)	156*104	156*156
Tecnología de célula	Monocristalina	Monocristalina	Monocristalina	Monocristalina	Monocristalina	Monocristalina
Número de células (pcs)	4*9	4*9	2*18	4*9	4*9	4*9
Tamaño del módulo (mm)	260*210*18	260*355*18	485*360*28	470*668*35	1005*668*35	1485*668*35
Grosor del cristal (mm)	3.2	3.2	3.2	3.2	3.2	3,2
Máx. carga de superficie	2400-5400Pa	2400-5400Pa	2400-5400Pa	2400-5400Pa	2400-5400Pa	2400-5400Pa
Resistencia al granizo	23m/s ,7.53g	23m/s ,7.53g	23m/s ,7.53g	23m/s ,7.53g	23m/s ,7.53g	23m/s ,7.53g
Peso de la unidad (Kg)	0,7	1,2	2,3	3,8	8	11,6
Corriente máxima del fusible (A)	-	-	-	10	10	10
Marco	18#	18#	28#	28#	35#	35#
Tipo de conector	MC4	MC4	MC4	MC4	MC4	MC4
Parte posterior	TPT	TPT	TPT	TPT	TPT	TPT
Rango de temperatura	-40°C / +85°C	-40°C / +85°C	-40°C / +85°C	-40°C / +85°C	-40°C / +85°C	-40°C / +85°C
FF (%)	70-76%	70-76%	70-76%	70-76%	70-76%	70-76%
Standard Test Conditions	AM1.5 1000W/m² 25°C					

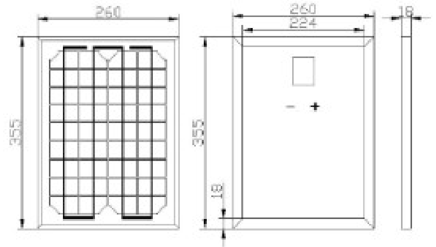
TECHNO SUN

Módulo fotovoltaicos Techno Sun
5 /10 / 20 / 40 / 100 / 150W

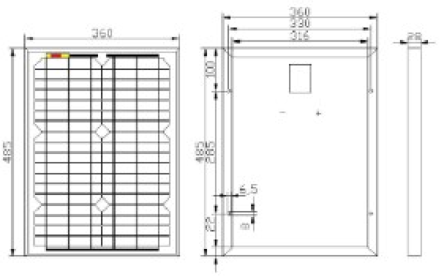
Panel solar 5W



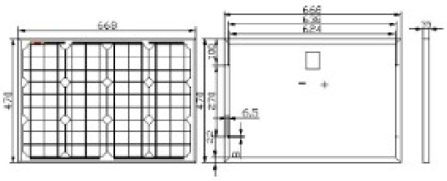
Panel solar 10W



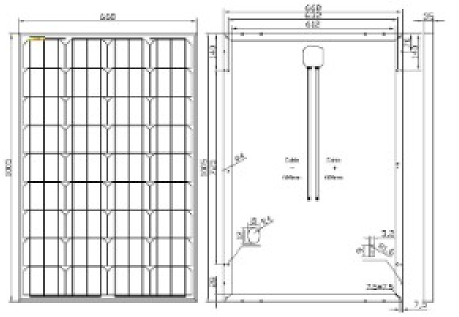
Panel solar 20W



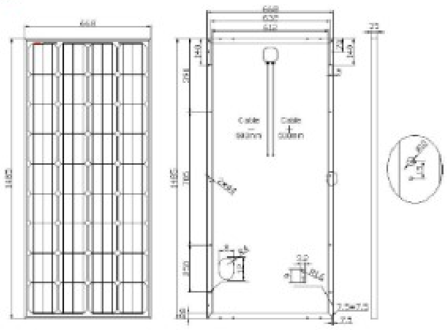
Panel solar 40W



Panel solar 100W



Panel solar 150W

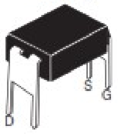


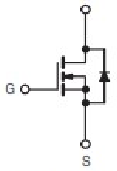
ANEXO II (Componentes Buck)

Power MOSFET

PRODUCT SUMMARY		
V_{DS} (V)	100	
$R_{DS(on)}$ (Ω)	V_{GS} = 10 V	0.27
Q_g (Max.) (nC)	16	
Q_{gs} (nC)	4.4	
Q_{gd} (nC)	7.7	
Configuration	Single	

HVMDIP





N-Channel MOSFET

FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- For Automatic Insertion
- End Stackable
- 175 °C Operating Temperature
- Fast Switching
- Ease of Paralleling
- Compliant to RoHS Directive 2002/95/EC

Pb Available RoHS* COMPLIANT

DESCRIPTION

Third generation Power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The 4 pin DIP package is a low cost machine-insertable case style which can be stacked in multiple combinations on standard 0.1" pin centers. The dual drain serves as a thermal link to the mounting surface for power dissipation levels up to 1 W.

ORDERING INFORMATION	
Package	HVMDIP
Lead (Pb)-free	IRFD123PbF
	SiHFD123-E3
SnPb	IRFD123
	SiHFD123

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)					
PARAMETER			SYMBOL	LIMIT	UNIT
Drain-Source Voltage			V_{DS}	100	V
Gate-Source Voltage			V_{GS}	± 20	
Continuous Drain Current	V_{GS} at 10 V	T_A = 25 °C	I_D	1.3	A
		T_A = 100 °C		0.94	
Pulsed Drain Current[a]			I_{DM}	10	
Linear Derating Factor				0.0083	W/°C
Single Pulse Avalanche Energy[b]			E_{AS}	100	mJ
Repetitive Avalanche Current[a]			I_{AR}	1.3	A
Repetitive Avalanche Energy[a]			E_{AR}	0.13	mJ
Maximum Power Dissipation	T_A = 25 °C		P_D	1.3	W
Peak Diode Recovery dV/dt[c]			dV/dt	5.5	V/ns
Operating Junction and Storage Temperature Range			T_J, T_{stg}	- 55 to + 175	°C
Soldering Recommendations (Peak Temperature)	for 10 s			300[d]	

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. V_{DD} = 25 V, starting T_J = 25 °C, L = 22 mH, R_g = 25 Ω, I_{AS} = 2.6 A (see fig. 12).
c. $I_{SD} \le 9.2$ A, dI/dt ≤ 110 A/μs, $V_{DD} \le V_{DS}$, $T_J \le 175$ °C.
d. 1.6 mm from case.

* Pb containing terminations are not RoHS compliant, exemptions may apply

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	120	°C/W

SPECIFICATIONS (T_J = 25 °C, unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Static						
Drain-Source Breakdown Voltage	V_{DS}	V_{GS} = 0 V, I_D = 250 μA	100	-	-	V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = 1 mA	-	0.13	-	V/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$, I_D = 250 μA	2.0	-	4.0	V
Gate-Source Leakage	I_{GSS}	V_{GS} = ± 20 V	-	-	± 100	nA
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = 100 V, V_{GS} = 0 V	-	-	25	μA
		V_{DS} = 80 V, V_{GS} = 0 V, T_J = 150 °C	-	-	250	
Drain-Source On-State Resistance	$R_{DS(on)}$	V_{GS} = 10 V; I_D = 0.78 A[b]	-	-	0.27	Ω
Forward Transconductance	g_{fs}	V_{DS} = 50 V, I_D = 0.78 A[b]	0.80	-	-	S
Dynamic						
Input Capacitance	C_{iss}	V_{GS} = 0 V V_{DS} = 25 V f = 1.0 MHz, see fig. 5	-	360	-	pF
Output Capacitance	C_{oss}		-	150	-	
Reverse Transfer Capacitance	C_{rss}		-	34	-	
Total Gate Charge	Q_g	V_{GS} = 10 V; I_D = 9.2 A, V_{DS} = 80 V see fig. 6 and 13[b]	-	-	16	nC
Gate-Source Charge	Q_{gs}		-	-	4.4	
Gate-Drain Charge	Q_{gd}		-	-	7.7	
Turn-On Delay Time	$t_{d(on)}$	V_{DD} = 50 V, I_D = 9.2 A R_g = 18 Ω, R_D = 5.2 Ω, see fig. 10[b]	-	6.8	-	ns
Rise Time	t_r		-	27	-	
Turn-Off Delay Time	$t_{d(off)}$		-	18	-	
Fall Time	t_f		-	17	-	
Internal Drain Inductance	L_D	Between lead, 6 mm (0.25") from package and center of die contact 	-	4.0	-	nH
Internal Source Inductance	L_S		-	6.0	-	
Drain-Source Body Diode Characteristics						
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	1.3	A
Pulsed Diode Forward Current[a]	I_{SM}		-	-	10	
Body Diode Voltage	V_{SD}	T_J = 25 °C, I_S = 1.3 A, V_{GS} = 0 V[b]	-	-	2.5	V
Body Diode Reverse Recovery Time	t_{rr}	T_J = 25 °C, I_F = 9.2 A, dI/dt = 100 A/μs[b]	-	130	260	ns
Body Diode Reverse Recovery Charge	Q_{rr}		-	0.65	1.3	μC
Forward Turn-On Time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)				

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. Pulse width ≤ 300 μs; duty cycle ≤ 2 %.

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

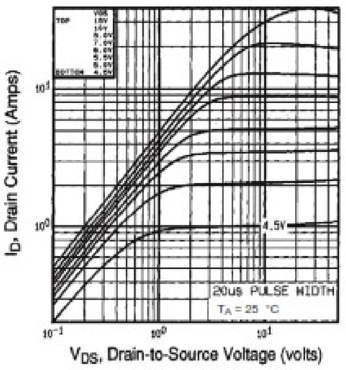


Fig. 1 - Typical Output Characteristics, T_A = 25 °C

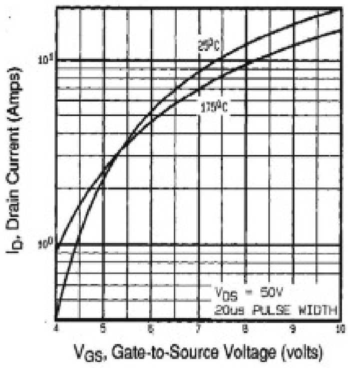


Fig. 3 - Typical Transfer Characteristics

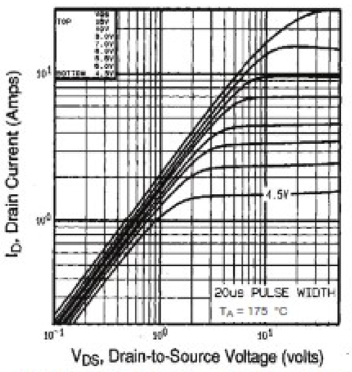


Fig. 2 - Typical Output Characteristics, T_A = 175 °C

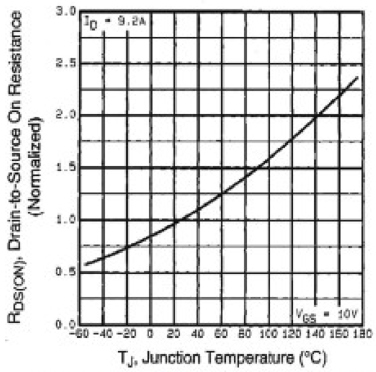


Fig. 4 - Normalized On-Resistance vs. Temperature

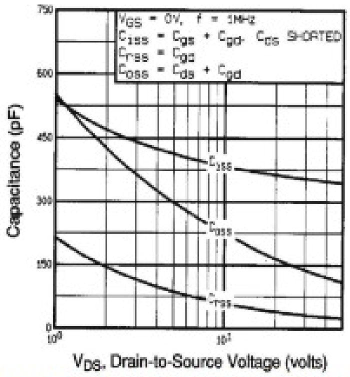


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

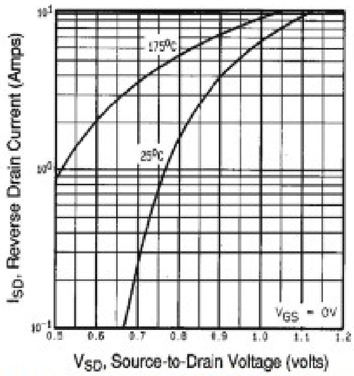


Fig. 7 - Typical Source-Drain Diode Forward Voltage

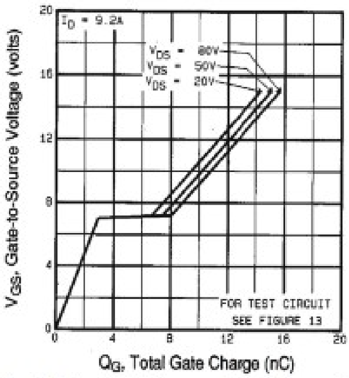


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

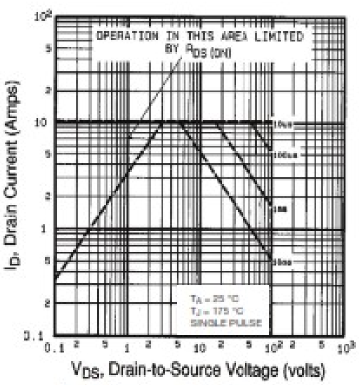


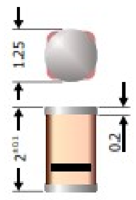
Fig. 8 - Maximum Safe Operating Area

Diotec Semiconductor

MCL103B, MCL103C

Surface Mount Small Signal Diodes
Kleinsignal-Dioden für die Oberflächenmontage

Version 2006-10-30



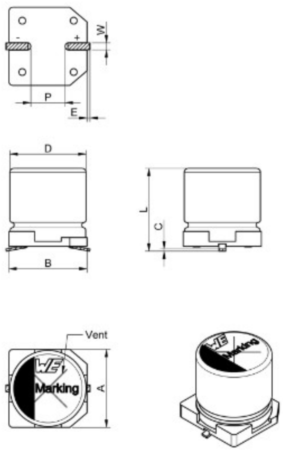
Dimensions - Maße [mm]

Power dissipation Verlustleistung	400 mW
Repetitive peak reverse voltage Periodische Spitzensperrspannung	20...30 V
Glass case Quadro-MicroMELF Glasgehäuse Quadro-MicroMELF	(LS-31)
Weight approx. – Gewicht ca.	0.01 g
Standard packaging taped and reeled Standard Lieferform gegurtet auf Rolle	

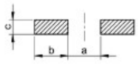
Maximum ratings and characteristics — **Grenz- und Kennwerte**

			MCL103B	MCL103C
Repetitive peak reverse voltage Periodische Spitzensperrspannung		V_{RRM}	30 V	20 V
Leakage current, T_j = 25°C Sperrstrom, T_j = 25°C	V_R = 20 V	I_R	5 µA	–
	V_R = 10 V	I_R	–	5 µA
Forward voltage, T_j = 25°C Durchlass-Spannung, T_j = 25°C	I_F = 20 mA	V_F	< 0.37 V	
	I_F = 200 mA	V_F	< 0.6 V	
Power dissipation – Verlustleistung	T_A = 25°C	P_{tot}	400 mW [1])	
Peak forward surge current, 10 µs square pulse Stoßstrom für einen 10 µs Rechteckimpuls	T_A = 25°C	I_{FSM}	15 A	
Max. junction capacitance – Max. Sperrschichtkapazität V_R = 0 V, f = 1 MHz		C_j	typ. 50 pF	
Reverse recovery time – Sperrverzug I_F = 200 mA über/through I_R = 200 mA bis/to I_R = 20 mA		t_{rr}	typ. 10 ns	
Junction temperature – Sperrschichttemperatur Storage temperature – Lagerungstemperatur		T_j T_S	-55...+175°C -55...+175°C	
Thermal resistance junction to ambient air Wärmewiderstand Sperrschicht – umgebende Luft		R_{thA}	< 300 K/W [1])	

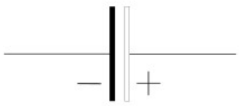
A Dimensions: [mm]



B Recommended hole pattern: [mm]



C Schematic:



WÜRTH ELEKTRONIK

D1 Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Capacitance	0.25V; 120Hz	C	27	µF	± 20%
Rated voltage		U_R	25	V (DC)	max.
Leakage current	after 2 min.	I_{Leak}	6.75	µA	max.
Dissipation factor	120 Hz	DF	14	%	typ.
Ripple current	100kHz @105°C	I_{ripple}	200	mA	max.
Impedance	100kHz @20°C	Z	0.62	Ω	max.

E General information:

Aluminium Electrolytic Capacitors

Storage Conditions:	35°C, <45% RH
Operating Temperature:	-55 °C up to +105 °C
Load Life:	2000 h @ +105°C / 25 V (DC)
Test conditions of Electrical Properties:	20°C, 33% RH; if not specified differently
FIT according to	separate documentation

L max.	**5.5**		
D ±0.5	6.3		
A ±0.2	6.6		
B ±0.2	6.6		
C max.	0.15		
W ±0.1	0.65	a	2.1
E ±0.05	0.35	b	3.5
P ±0.2	2.2	c	1.6

REV	DATE	BY	CHECKED
1.0	2014-11-11	SSt	PSL

Projection

Würth Elektronik eiSos GmbH & Co. KG
EMC & Inductive Solutions
Max-Eyth-Str. 1
74638 Waldenburg
Germany
Tel. +49 (0) 79 42 945 - 0
www.we-online.com
eiSos@we-online.com

DESCRIPTION

WCAP-ASLI Aluminum Electrolytic Capacitors

Order.- No.

865080443005

COMPLIANT RoHS&REACh WÜRTH ELEKTRONIK

SIZE: A4

Size: 6.3 x 5.5

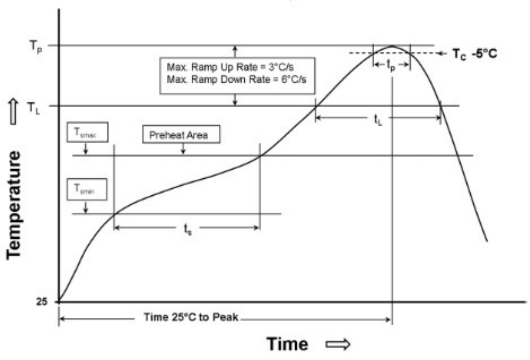
Component Marking:

Print	Description
1st Line	Capacitance value: 27 µF
2nd Line	Rated Voltage: 25
3rd Line	WCAP-ASLI & datecode: YWW

D2 Multiplier for Ripple Current vs. Frequency:

C [µF]/ Frequency [Hz]	60 (50)	120	400	1000	10000	50000-100000
C ≤ 10	0.47	0.59	0.76	0.85	0.97	1.00
10 < C	0.52	0.65	0.80	0.85	0.97	1.00

H1: Classification Reflow Profile for SMT components:



H2: Classification Reflow Profiles

Profile Feature	Pb-Free Assembly
Preheat - Temperature Min (T_{smin}) - Temperature Max (T_{smax}) - Time (t_s) from (T_{smin} to T_{smax})	 150°C 200°C 60-120 seconds
Ramp-up rate (T_L to T_P)	3°C/ second max.
Liquidous temperature (T_L) Time (t_L) maintained above T_L	217°C 60-150 seconds
Peak package body temperature (T_p)	See Table H3
Time within 5°C of actual peak temperature (t_p)	20-30 seconds
Ramp-down rate (T_P to T_L)	6°C/ second max.
Time 25°C to peak temperature	8 minutes max.

refer to IPC/JEDEC J-STD-020D

H3: Package Classification Reflow Temperature

	Package Thickness	Volume mm³ <350	Volume mm³ 350 - 2000	Volume mm³ >2000
PB-Free Assembly	< 1.6 mm	260°C	260°C	260°C
PB-Free Assembly	1.6 - 2.5 mm	260°C	250°C	245°C
PB-Free Assembly	≥ 2.5 mm	250°C	245°C	245°C

refer to IPC/JEDEC J-STD-020D

ANEXO III (Buck + ACC)

Buck ACC.xmcd

Módulo BP 4165. Condiciones de trabajo: Ta = 34ºC, G = 70 mW/cm2

Datos:

Carga: $R := 6\Omega$

$e_e := 1.602 \cdot 10^{-19} C$ $\quad m_m := 1$ $\quad k := 1.381 \cdot 10^{-23} J \cdot K^{-1}$ $\quad V_t := 0.026V$

Condiciones estándar: $T_a := 25$ $\quad G_{STC} := 1 \frac{kW}{m^2}$

Condiciones de trabajo: $G_{ct} := 700 \frac{W}{m^2}$ $\quad T_{a\_ct} := 34$ $\quad T_{ct} := (273 + T_{a\_ct})K$

Datos módulos (STC):

$P_{M\_MOD} := 5W$ $\quad V_{M\_MOD\_STC} := 18.57V$ $\quad I_{M\_MOD\_STC} := 0.54A$

$V_{OC\_MOD\_STC} := 22.64V$ $\quad I_{SC\_MOD\_STC} := 0.58A$

$NOCT := 47$ $\quad N_{S\_MOD} := 36$ $\quad N_{P\_MOD} := 1$

$K_{OC\_T} := -0.38mV$ Coeficiente de temperatura de Voc de las células

Células: $R_{S\_MOD} := \frac{(V_{OC\_MOD\_STC} - V_{M\_MOD\_STC})}{I_{M\_MOD\_STC}} = 7.537\Omega$

a) Punto de funcionamiento del módulo en condiciones de trabajo:

$C_1 := \frac{I_{SC\_MOD\_STC}}{100 \frac{mW}{cm^2}}$ $\quad C_1 = 5.8 \times 10^{-3} \cdot \frac{A \cdot cm^2}{mW}$

$I_{SC\_MOD} := C_1 \cdot G_{ct}$ $\quad I_{SC\_MOD} = 0.406A$

$C_2 := \frac{NOCT - 20}{80 \frac{mW}{cm^2}}$ $\quad C_2 = 0.0338 \cdot \frac{m^2}{W}$ $\quad e^1 = 2.718$

En condiciones estándar:

$T_{c\_STC} := 25 + C_2 \cdot G_{STC}$ $\quad T_{c\_STC} = 58.75 °C$

En las condiciones de trabajo:

$T_c := T_{a\_ct} + C_2 \cdot G_{ct}$ $\quad T_c = 57.625$ ºC

$V_{OC\_MOD} := V_{OC\_MOD\_STC} + K_{OC\_T} \cdot (T_c - T_{c\_STC}) \cdot N_{S\_MOD}$ $\quad V_{OC\_MOD} = 22.655V$

b) Punto de funcionamiento del módulo sin MPPT:

$$I_{MOD}(V_{MOD}) := I_{SC\_MOD}\cdot\left(1 - e^{\frac{V_{MOD} - V_{OC\_MOD} + I_{SC\_MOD}\cdot R_{S\_MOD}}{N_{S\_MOD}\cdot V_t}}\right)$$

$$V_R := 5V$$

$$I_{MOD\_Q} := I_{SC\_MOD}\cdot\left(1 - e^{\frac{V_R - V_{OC\_MOD} + I_{SC\_MOD}\cdot R_{S\_MOD}}{N_{S\_MOD}\cdot V_t}}\right) = 0.406A$$

$$V_{MOD\_Q} := V_R$$

$$P_{MOD\_Q} := V_{MOD\_Q}\cdot I_{MOD\_Q} = 2.03W$$

c) Punto de máxima potencia del módulo:

$$P_{MOD}(V_{MOD}) := I_{MOD}(V_{MOD})\cdot V_{MOD}$$

$$\frac{d}{dV_{MOD}}P_{MOD}(V_{MOD}) = I_{MOD}(V_{MOD}) + \frac{d}{dV_{MOD}}I_{MOD}(V_{MOD})\cdot V_{MOD}$$

$$0 = I_{SC\_MOD} - \left(I_{SC\_MOD} + \frac{V_{M\_MOD}\cdot I_{SC\_MOD}}{N_{S\_MOD}\cdot V_t}\right)\cdot e^{\frac{V_{M\_MOD} - V_{OC\_MOD} + I_{SC\_MOD}\cdot R_{S\_MOD}}{N_{S\_MOD}\cdot V_t}}$$

Given

$$V_{M\_MOD} := 2V$$

$$0 = I_{SC\_MOD} - \left(I_{SC\_MOD} + \frac{V_{M\_MOD}\cdot I_{SC\_MOD}}{N_{S\_MOD}\cdot V_t}\right)\cdot e^{\frac{V_{M\_MOD} - V_{OC\_MOD} + I_{SC\_MOD}\cdot R_{S\_MOD}}{N_{S\_MOD}\cdot V_t}}$$

$$V_{M\_mod} := Find(V_{M\_MOD}) \qquad V_{M\_MOD} := V_{M\_mod} \qquad V_{M\_MOD} = 16.84V$$

$$I_{M\_MOD} := I_{MOD}(V_{M\_mod}) \qquad I_{M\_MOD} = 0.385A$$

$$P_{M\_MOD} := I_{M\_MOD}\cdot V_{M\_MOD} \qquad P_{M\_MOD} = 6.477W$$

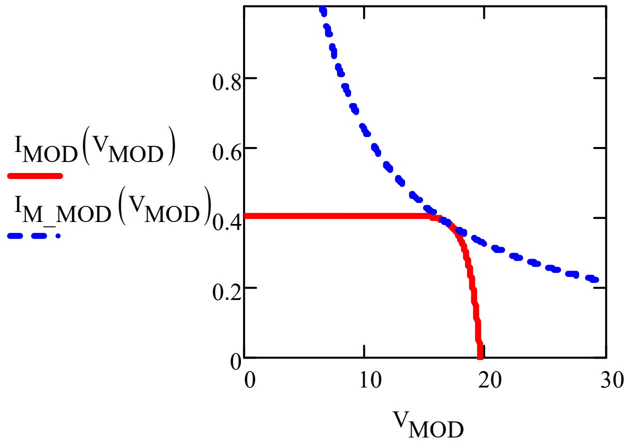
$$I_R := \frac{P_{M\_MOD}}{5V} = 1.295A$$

d) Con MPPT (ideal):
- Punto de funcionamiento del módulo: Punto de máxima potencia

Hipérbola de potencia constante (= máxima):

$I_{M\_MOD}(V_{MOD}) \cdot V_{MOD} = P_{M\_MOD}$

$I_{M\_MOD}(V_{MOD}) := \frac{P_{M\_MOD}}{V_{MOD}}$



$V_{M\_MOD} = 16.84V$

$I_{MOD}(V_{M\_MOD}) = 0.385A$

$P_{MOD}(V_{M\_MOD}) = 6.477W$

- Convertidor (ideal): VR < VMOD: Reductor

$V_o := 5V$

$V_R = \delta \cdot V_{M\_MOD}$ $\delta := \frac{V_R}{V_{M\_MOD}}$ $\delta = 0.297$

$I_o := \frac{P_{MOD}(V_{M\_MOD})}{V_o} = 1.295A$

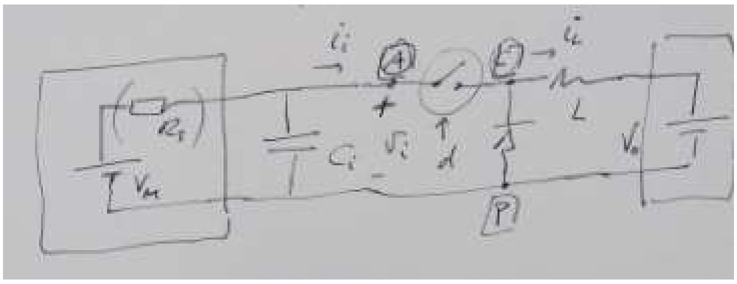
Convertidor Buck:

$V_i := V_{M\_MOD}$ $D := 0.29($ $f_s := 50kHz$

$L := 372\mu H$ $R_C := 0.1\Omega$ $C := 25\mu F$

(0 < t < DTc) $V_{in} - V_o = L \cdot \frac{di}{dt}$

Control modo corriente media ACC:
Consideraciones:
- Modelo del módulo fotovoltaico: Fuente de tensión continua de valor V_{M_MOD}
- Modelo de la batería: Fuente de tensión continua Vo = 5 V
- Condensador Ci entre el módulo y la entrada del buck
- Rendiemiento del buck = 1



Especificaciones: fc < 0.1 - 0.2 fs $f_{ci} := 10kHz$ $MF_i := 75°$

$V_m := 0.33V$

$\omega_{ci} := 2 \cdot \pi \cdot f_{ci} = 62.832 \frac{krad}{s}$ $F_m := \frac{1}{V_m} = 3.03 \frac{1}{V}$

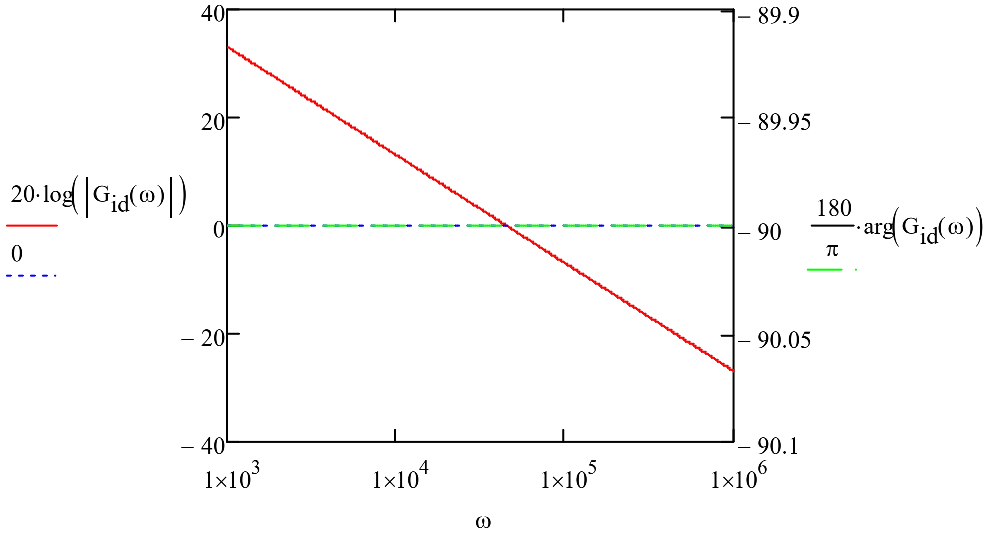
DC) $\frac{1}{D} = \frac{V_{M\_MOD}}{V_o}$ $D := \frac{V_o}{V_{M\_MOD}} = 0.297$

$\frac{1}{D} = \frac{I_o}{I_i}$ $I_i := I_{MOD}(V_{M\_MOD}) = 0.385A$

$I_o := \frac{I_i}{D} = 1.295A$

ac) $G_{id}(\omega) = \frac{i_L}{d}$ $v_i = i'_o = 0$

$d \cdot V_{M\_MOD} = j \cdot L \cdot \omega \cdot i_L$ $G_{id}(\omega) := \frac{V_{M\_MOD}}{(j \cdot L \cdot \omega)}$



$\arg(G_{id}(\omega_{ci})) = -90 \cdot ^{\circ}$

Compensador de tipo 2

$$G_i(\omega) = \frac{\omega_{p0c}}{j \cdot \omega} \cdot \frac{1 + j \cdot \frac{\omega}{\omega_{zc}}}{1 + j \cdot \frac{\omega}{\omega_{pc}}}$$

$$\arg(G_{id}(\omega_{ci})) - 90^{\circ} + AUFA_i = -180^{\circ} + MF_i$$

$$AUFA_i := -180^{\circ} + MF_i - (\arg(G_{id}(\omega_{ci})) - 90^{\circ}) = 75 \cdot ^{\circ}$$

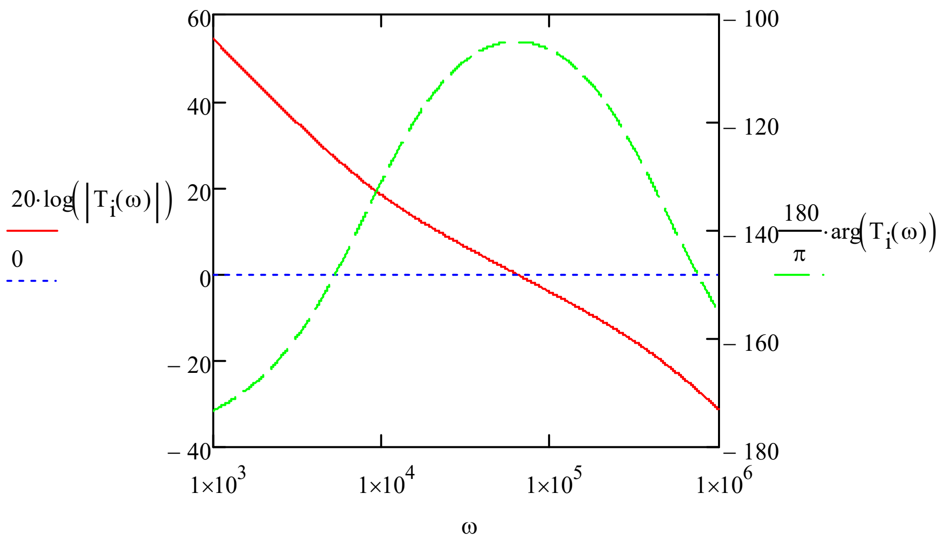
$$K := \tan\left(\frac{AUFA_i}{2} + 45^{\circ}\right) = 7.596$$

$$\omega_{zc} := \frac{\omega_{ci}}{K} = 8.272 \frac{krad}{s} \qquad \omega_{pc} := \omega_{ci} \cdot K = 477.255 \frac{krad}{s}$$

$$|G_{id}(\omega_{ci})| \cdot \frac{\omega_{p0c}}{|\omega_{ci}|} \cdot \frac{\left|1 + j \cdot \frac{\omega_{ci}}{\omega_{zc}}\right|}{\left|1 + j \cdot \frac{\omega_{ci}}{\omega_{pc}}\right|} \cdot F_m = 1$$

$$\omega_{p0c} := \frac{\left|\frac{j \cdot \omega_{ci}}{\omega_{pc}} + 1\right| \cdot |\omega_{ci}|}{\left|\frac{j \cdot \omega_{ci}}{\omega_{zc}} + 1\right| \cdot |G_{id}(\omega_{ci})| \cdot F_m \cdot \Omega} = 3.789 \frac{krad}{s}$$

$$G_i(\omega) := \frac{\omega_{p0c}}{j \cdot \omega} \cdot \frac{1 + j \cdot \frac{\omega}{\omega_{zc}}}{1 + j \cdot \frac{\omega}{\omega_{pc}}} \qquad T_i(\omega) := G_{id}(\omega) \cdot G_i(\omega) \cdot F_m \cdot \Omega$$



Given $\qquad \omega_1 := 1000 \frac{rad}{s} \qquad |T_i(\omega_1)| = 1 \qquad f_{ci} := \frac{Find(\omega_1)}{2\pi} = 10 \cdot kHz$

$$MF_i := \arg(T_i(2 \cdot \pi \cdot f_{ci})) + 180^{\circ} = 75 \cdot ^{\circ}$$

Por tanto, confirmamos que a la frecuencia de cruce tenemos el MF deseado

ANEXO IV (Script Compensador)

```
clc;
clear all;
close all;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                              %
%  CALCULO DE LAS FUNCIONES DE TRASNSFERENCIA Y REGULADORES  %
%                  PARA CONTROL MODO ACC                       %
%                                                              %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 1 - Definición de especificaciones
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


    % Tensión de entrada
        Vi = 16.71;
        Ii=0.387;
    % Tensión de salida y carga R
        Vo_rms = 5;
        Vom= Vo_rms*sqrt(2);

       % R =  2  ;%%%%

    % Filtro (la notación científica es la más cómoda utilizar)
        L = 362e-6;
        C = 26e-6;
        Rc = 15e-3;

    % Modulación Bipolar
        Fsw =50e3; % Frecuencia de conmutación
        V_tri = 0.33;  % Amplitud de la triangular
        Fm=1/V_tri; %  --> 3.03V


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 2 - FDT del filtro LC con carga R
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

   s = tf('s');  %Definición de la variable s para utilizarla en las
fdt

   Zl = L*s; % Impedancia de la bobina sin considerar su resistencia
RL

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%
%   3 - Diseño del lazo de corriente con Control ACC
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%
```

```
%Función de transferencia  de control de corriente en el indcutor

Gid=  Vi/Zl ; %%%%%

figure(2);
bode(Gid); % Respuesta en frecuencia

%Ganancia del lazo de corriente con regulador Gi = 1:

Ti = Gid*Fm  ; %%%%%

hold on;
bode(Ti);
grid on;


% Diseño del regulador mediante el método K de Venables %


% Frecuencia de cruce y margen de fase deseados

Fci = 10000  ; %%%% Frecuencia de cruce de Ti
wci =  Fci*2*pi ; %%%%     "       en rad/s
MFi =  75 ; %%%% Margen de fase deseado

% Modulo y fase de Gid a la frecuencia de cruce deseada

[M_wci,F_wci]=bode(Gid,wci); % (El módulo no está en dB)

%Determinación del tipo de regulador a partir de la fase.


if F_wci<(-90)    % si la fase está entre -90 y -180 Tipo 3


%     Fase_objetivo = -180 + MFi;
%
%     AUFA =  abs(-90-abs(F_wci)-Fase_objetivo)  ;%%%% Aumento de fase
necesario
%
%     K  = tand((AUFA/2)+45)    ; %%%% Calculamos el factor K.
%                %%%% Ojo la función tan() da la tanjente en radianes
%                %%%% para trabajar en grados utilizar tand()
%
%    % y determinamos las frecuencias de polos y ceros
%
%     wzi = wci/K   ; %%%% Frecuencia de los ceros
%
%     wpi = wci*K   ; %%%% Frecuencia de los polos
%
%     Ki = (wci/(M_wci*Ri*Fm))*(1+(wci/wpi)/(1+(wci/wzi)))    ; %%%%
Ganancia del regulador
%
%
%     % Implementación del regulador
%
%     Gi = (Ki/s)*(1+(s/wzi))^2/(1+(s/wpi))^2;
```

```
%
%     figure(3);
%     bode(Gi); % Respuesta en frecuencia
%     grid on;


elseif ((F_wci>=-90) && (F_wci<-30)) % Regulador Tipo 2

    Fase_objetivo = -180 + MFi;

    AUFA = +90-F_wci+Fase_objetivo   ;%%%% Aumento de fase necesario

    K  =  tand((AUFA/2)+45)   ; %%%% Calculamos el factor K

    % y determinamos las frecuencias de polos y ceros

    wzi = wci/K   ; %%%% Frecuencia de los ceros

    wpi =  wci*K   ; %%%% Frecuencia de los polos

    Ki = wci/(M_wci*Fm)*sqrt(1+(wci/wpi)^2)/sqrt(1+(wci/wzi)^2)    ;
%%%% Ganancia del regulador



    % Implementación del regulador

    Gi = (Ki*(1+(s/wzi)))/(s*(1+(s/wpi)));

    figure(3);
    bode(Gi); % Respuesta en frecuencia
    grid on;

else  % Tipo 1

    %%% No va a ser el caso

end


%Ganancia del lazo de corriente con el regulador calculado:

Ti = Gid*Gi*Fm    ; %%%%%

figure(4);
margin(Ti); % Respuesta en frecuencia con la función margin que ofrece
grid on;    % la frecuencia de cruce y el margen de fase.


% FDT del lazo cerrado de corriente

Ti_LC = (Ti/(1+Ti))    ; %%%%%
```

```
figure(4);
bode(Ti_LC); % Respuesta en frecuencia en lazo cerrado
hold on;
margin(Ti); % añadimos la de lazo abierto en la misma figura para
comparar
grid on;


%%% Respuesta del lazo cerrado a 50 Hz;
[Mod_50,F_wci]=bode(Ti_LC,50*2*pi);

Mod_dB_50=20*log10(Mod_50); %Módulo en dB





%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Fin del Archivo
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```