

Projet 3 - HS03 / Hacheur symétrique pour train.

Projet : PROJETS-TRAIN

Info : [DATA075], sujet de formation 1999/2000.

Révision : 1 du 26 novembre 1999

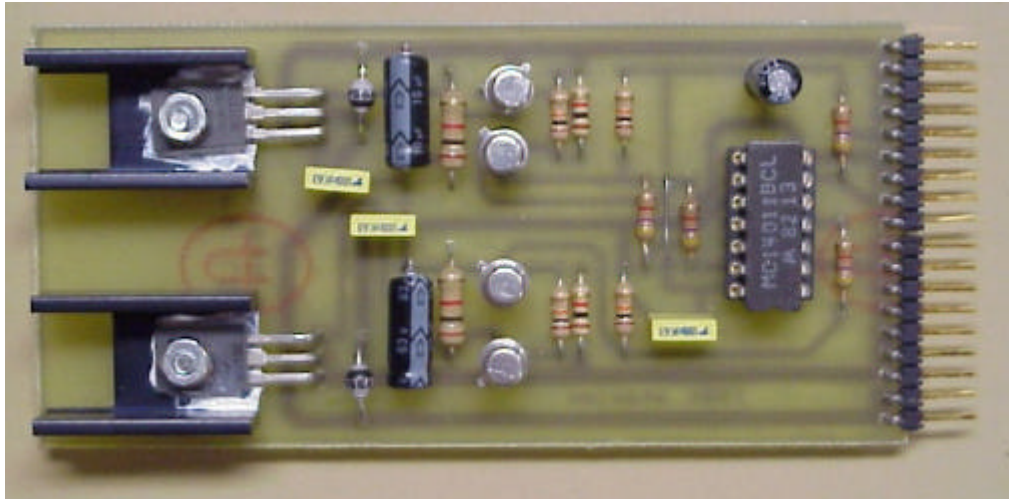


Figure 3.1. Hacheur symétrique pour train (images_maquettes\hs03-11.jpg).

3.1 Liste des documents

- Calculs des résistances
- Implantation du connecteur HE 13 18 points.
- Contraintes mécaniques.
- Liste des composants.
- Implantation des composants et circuit imprimé coté cuivre.
- Schéma électronique de la partie commande.
- Schéma électronique de la partie puissance.
- Documentations : HEF4011B, BD135, BD136, BYV95A, 2N2222A, 2N2907A.

3.2 Fonctionnement du montage

Tableau 3.1. Table de vérité du montage.

$\overline{\text{STOP}}$	AVAR	T1	T2	Q1	Q6	Q4	Q2	Q5	Q3	Vout
0	X	+5V	0V	ON	ON	ON	ON	OFF	OFF	HZ
1	0	0V	0V	OFF	ON	OFF	ON	ON	OFF	+E
1	1	+5V	+5V	ON	OFF	ON	OFF	OFF	ON	-E

3.3 Calculs des résistances

Soit I le courant maximal dans la charge. Soient β_3 et β_2 les gains en régime de saturation respectifs des transistors Q3 et Q2.

La résistance R4 est donnée par $R_4 \approx \frac{+E}{ib_3} = \frac{\beta_3 \cdot E}{I}$.

La puissance dissipée dans R4 vaut

$$P_{R4} = R_4 \cdot (ib_3)^2 = R_4 \cdot \left(\frac{\beta_3}{I}\right)^2.$$

La résistance R5 est donnée par R3 est prise 10 fois plus faible que R5.

$$R_5 \approx \frac{+E}{ib_2} = \frac{\beta_2 \cdot E}{ib_3} = \frac{\beta_2 \cdot \beta_3 \cdot E}{I}.$$

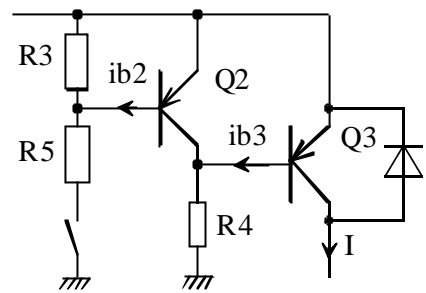


Figure 3.2. (orcad\train\hs03.drw).

Tableau 3.2. Calcul des résistances (projets-train.xls / HS03).

Tension E (en V)	5	9	12	15	18	24
Beta Q3 Q5	40	40	40	40	40	40
Beta Q2 Q4	80	80	80	80	80	80
I Q3 Q5 max (en A)	3	3	3	3	3	3
R4 - R12 (en ohms)	57	111	151	191	231	311
P dans R4-R12 en W	0.32	0.62	0.85	1.07	1.30	1.75
R5 (en ohms)	4587	8853	12053	15253	18453	24853
R3 (en ohms)	459	885	1205	1525	1845	2485
R10 (en ohms)	9920	14187	17387	20587	23787	30187
R11 (en ohms)	992	1419	1739	2059	2379	3019

Remarque : Les transistors TIP41C et TIP42C sont capable de conduire 6A pour une tension de 100V.

Tableau 3.3. Calcul des résistances (projets-train.xls / HS03).

Tension E (en V)	5	9	12	15	18	24
Beta Q3 Q5	40	40	40	40	40	40
Beta Q2 Q4	80	80	80	80	80	80
I Q3 Q5 max (en A)	1	1	1	1	1	1
R4 - R12 (en ohms)	172	332	452	572	692	932
P dans R4-R12 en W	0.1075	0.2075	0.2825	0.3575	0.4325	0.5825
R5 (en ohms)	13760	26560	36160	45760	55360	74560
R3 (en ohms)	1376	2656	3616	4576	5536	7456
R10 (en ohms)	29760	42560	52160	61760	71360	90560
R11 (en ohms)	2976	4256	5216	6176	7136	9056

Remarque : Les transistors BD135 et BD136 sont capable de conduire 1,5A pour une tension de 45V.

Remarque : Les transistors BD139 et BD140 sont capable de conduire 1,5A pour une tension de 80V.

3.4 Implantation du connecteur HE 13 18 points

Tableau 3.4. Implantation du connecteur.

N° de broche :	Désignation :
1	OUT
2	OUT
3	+E (+5V → +24V)
4	+E (+5V → +24V)
5	+E (+5V → +24V)
6	n. c.
7	n. c.
8	AVAR
9	n. c.
10	n. c.
11	$\overline{\text{STOP}}$
12	GND
13	GND
14	+5V
15	n.c.
16	-E (-5V → -24V)
17	-E (-5V → -24V)
18	-E (-5V → -24V)

3.5 Contraintes mécaniques

Les transistors de puissance seront montés sur des radiateurs de type RAWA 400 :

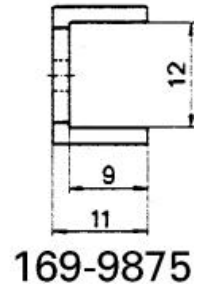
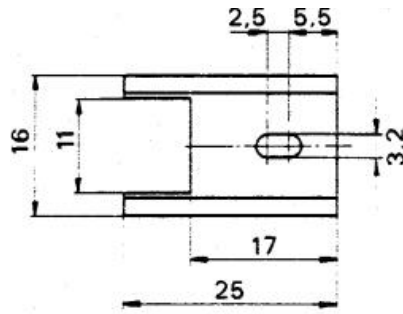


Figure 3.3. (images-composants\rawa400a.jpg).

Figure 3.4. (images-composants\rawa400b.gif).

La carte électronique fait 50 mm x 100 mm, afin d'avoir 12 circuits dans une plaque du commerce de 200 mm x 300 mm (référence 292-6932, Radiospares, 87^F40 HT, septembre 1999 - janvier 2000).

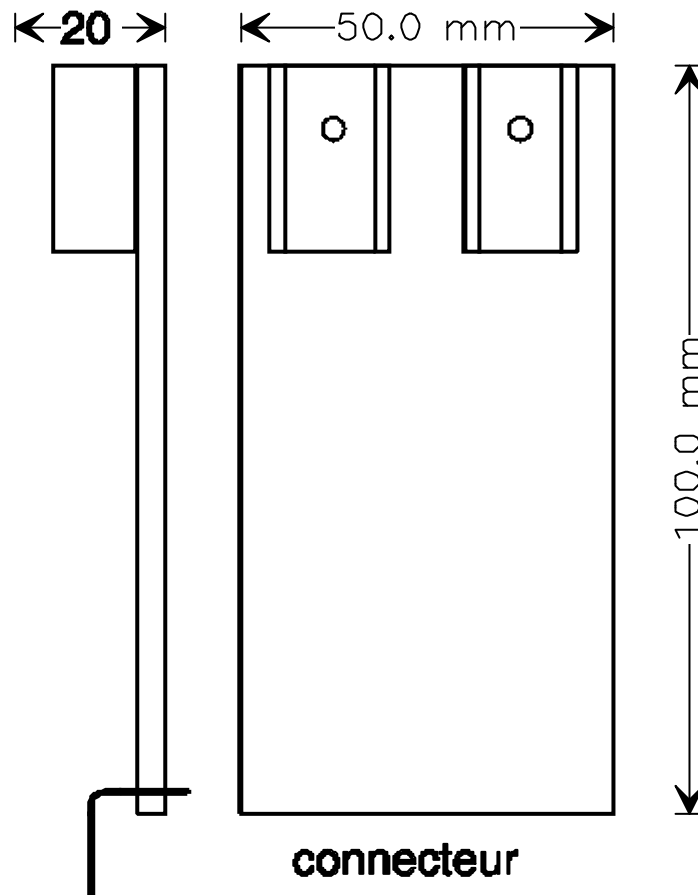
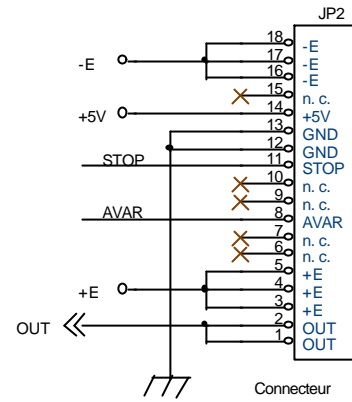
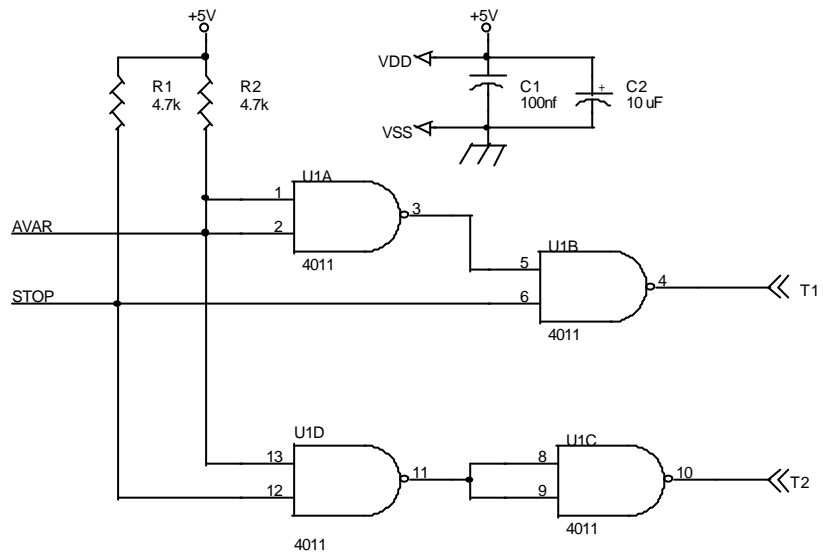


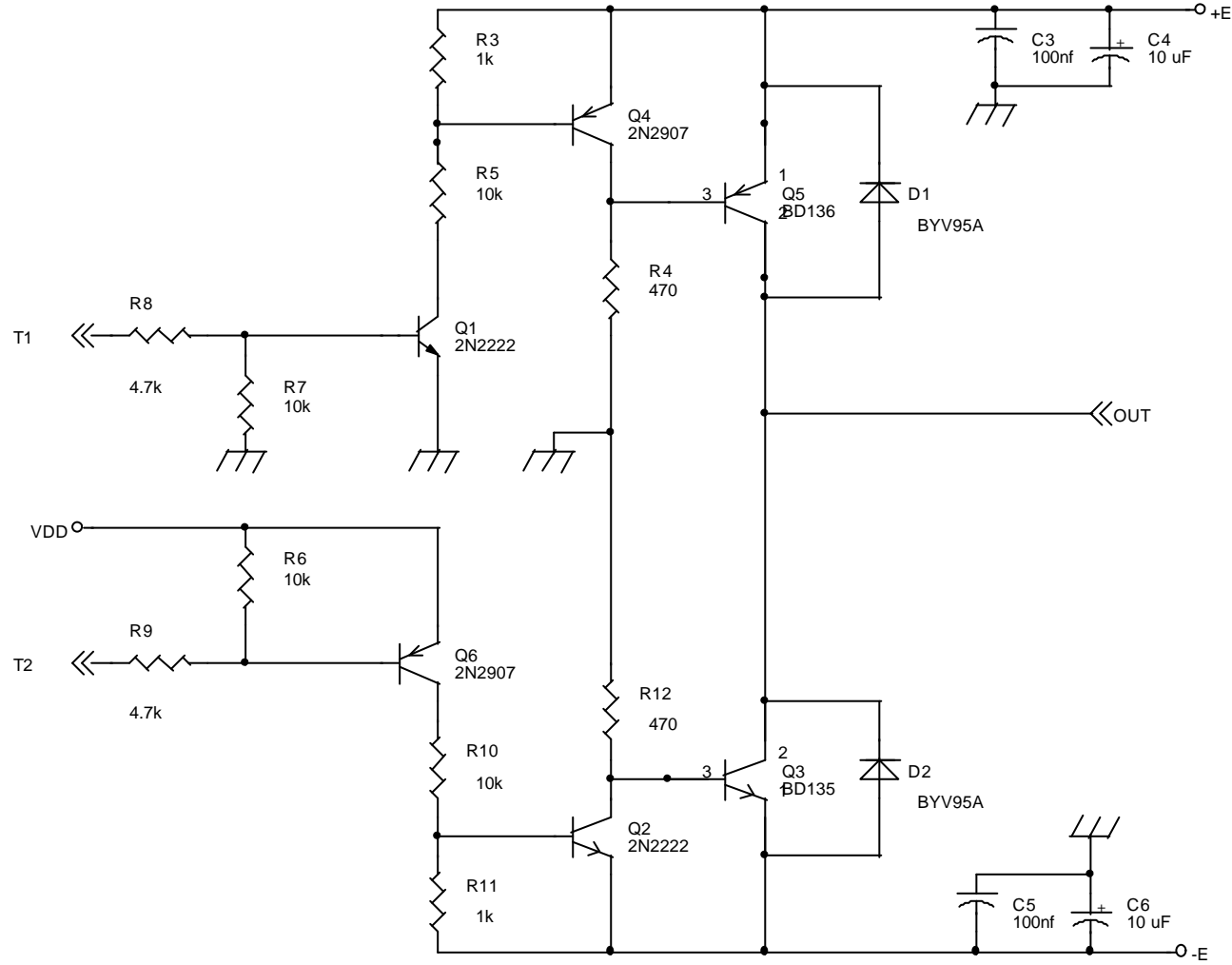
Figure 3.5. Dimensions de la carte (orcad\train\hs03.drw).

Référence	Qu.	Désignation	Fournisseur	Code Cde.	Page :	U.D.V.	Prix	Prix U.	Prix T.
JP1	0.5	Connecteur en barrette HE13 36 pts	Radiospare 2000	189-9665	1-289	1	49.06 F	49.06 F	24.53 F
C1,C3,C5	3	100nF MKT 63V	Radiospare 2000	166-8348	1-755	10	13.90 F	1.39 F	4.17 F
C2	1	10 uF 25V radial chimique	Radiospare 2000			5	7.00 F	1.40 F	1.40 F
C4,C6	2	10 uF 25V axial chimique	Radiospare 2000	108-5254	1-742	5	7.00 F	1.40 F	2.80 F
D1,D2	2	BYV95A	Radiospare 2000	196-1007	1-937	5	11.50 F	2.30 F	4.60 F
Q2,Q1	2	2N2222A	Radiospare 2000	295-028	1-957	1	3.00 F	3.00 F	6.00 F
Q3	1	BD135				1	7.50 F	7.50 F	7.50 F
Q4,Q6	2	2N2907A	Radiospare 2000	296-166	1-957	1	4.50 F	4.50 F	9.00 F
Q5	1	BD136				1	7.30 F	7.30 F	7.30 F
R1,R2,R8,R9	4	4.7k	IUT GEII			1	0.20 F	0.20 F	0.80 F
R3, R11	2	1k	IUT GEII			1	0.20 F	0.20 F	0.40 F
R4,R12	2	470	IUT GEII			1	0.20 F	0.20 F	0.40 F
R5,R6,R7,R10	4	10k	IUT GEII			1	0.20 F	0.20 F	0.80 F
U1	1	HEF4011BP	Radiospare 2000	306-544	1-1091	5	21.06 F	4.21 F	4.21 F
Divers	2	Dissipateur RAWA 400 11P	Radiospare 2000	169-9875		1	5.25 F	5.25 F	10.50 F
Divers	1	Support 14 broches tulipe	Radiospare 2000	100-9941	1-396	10	48.45 F	4.85 F	4.85 F
Divers	50	Circuit imprimé SF50x100 mm	IUT GEII			1	0.20 F	0.20 F	10.00 F

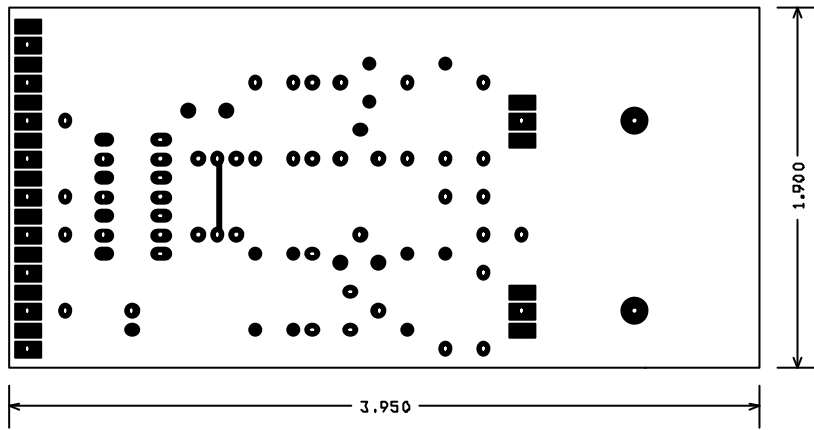
TOTAL H.T. :	99.26 F
dont TVA : 20.60%	20.45 F
TOTAL T.T.C. :	119.70 F

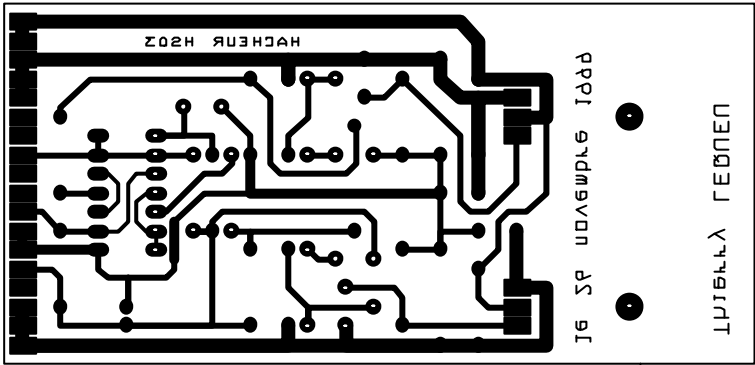


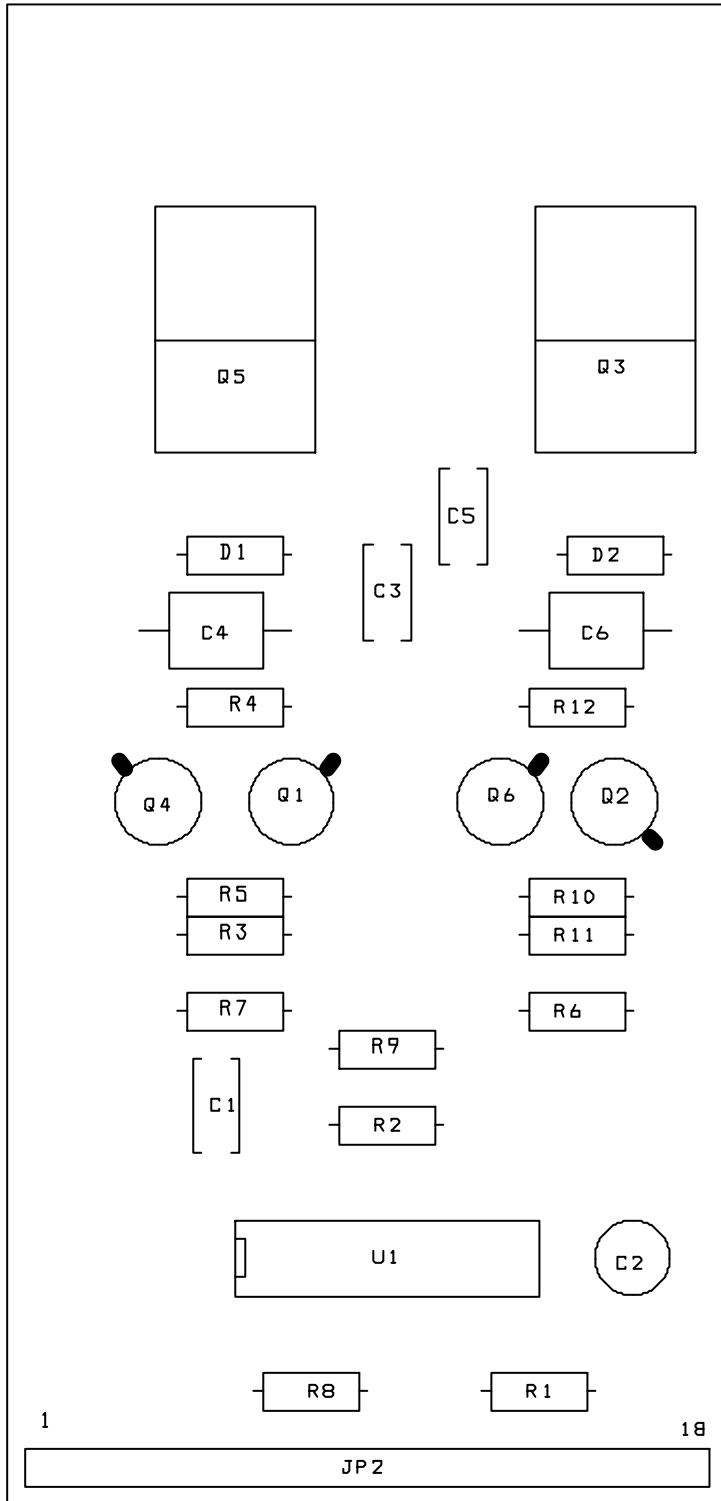
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Thierry LEQUEU		
Size	Document Number	Rev
A4	EEP - TL - HACHEUR SYMETRIQUE	1
Date:	Friday, November 26, 1999	Sheet 1 of 2



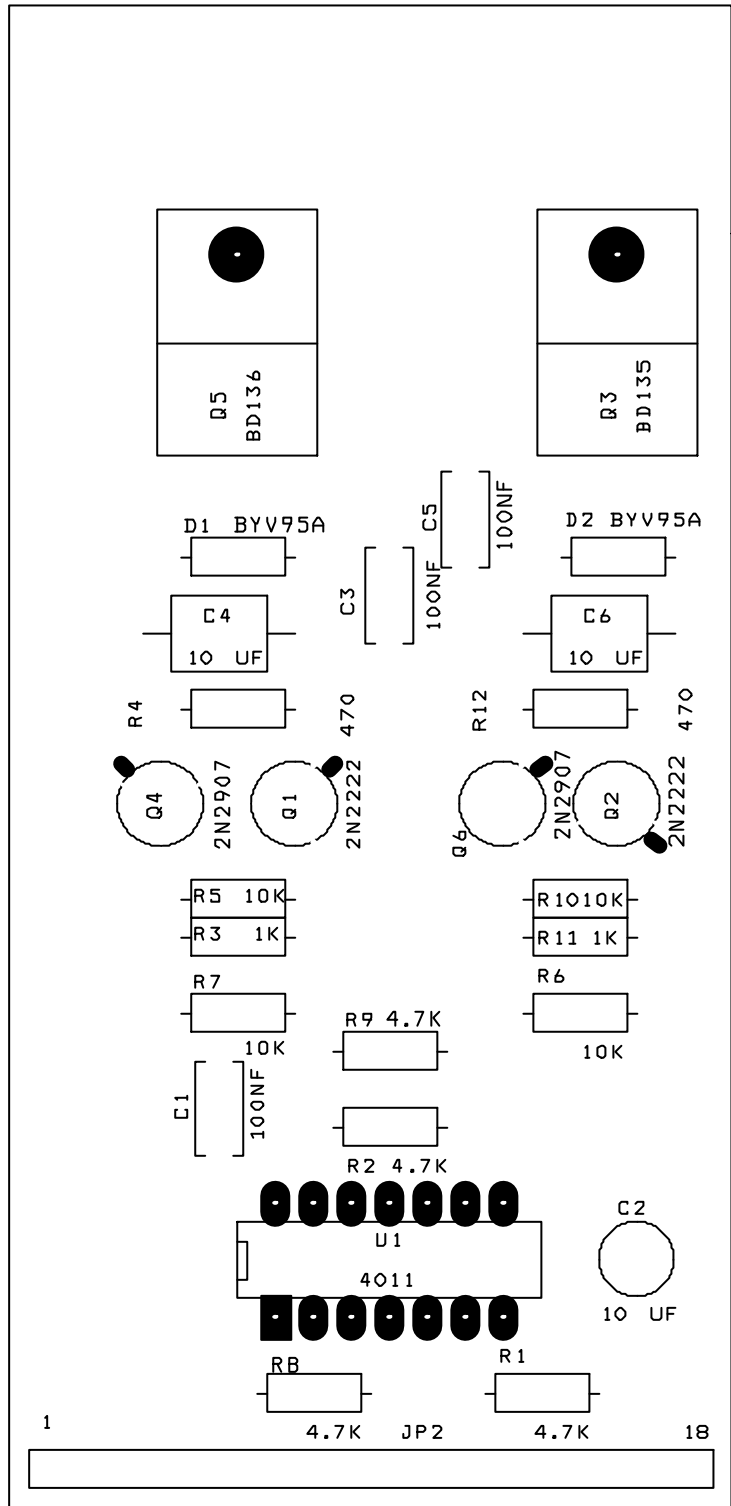
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Thierry LEQUEU		
Size	Document Number	Rev
A	EPP - TL - HACHEUR SYMETRIQUE	1
Date:	Friday, November 26, 1999	Sheet 2 of 2



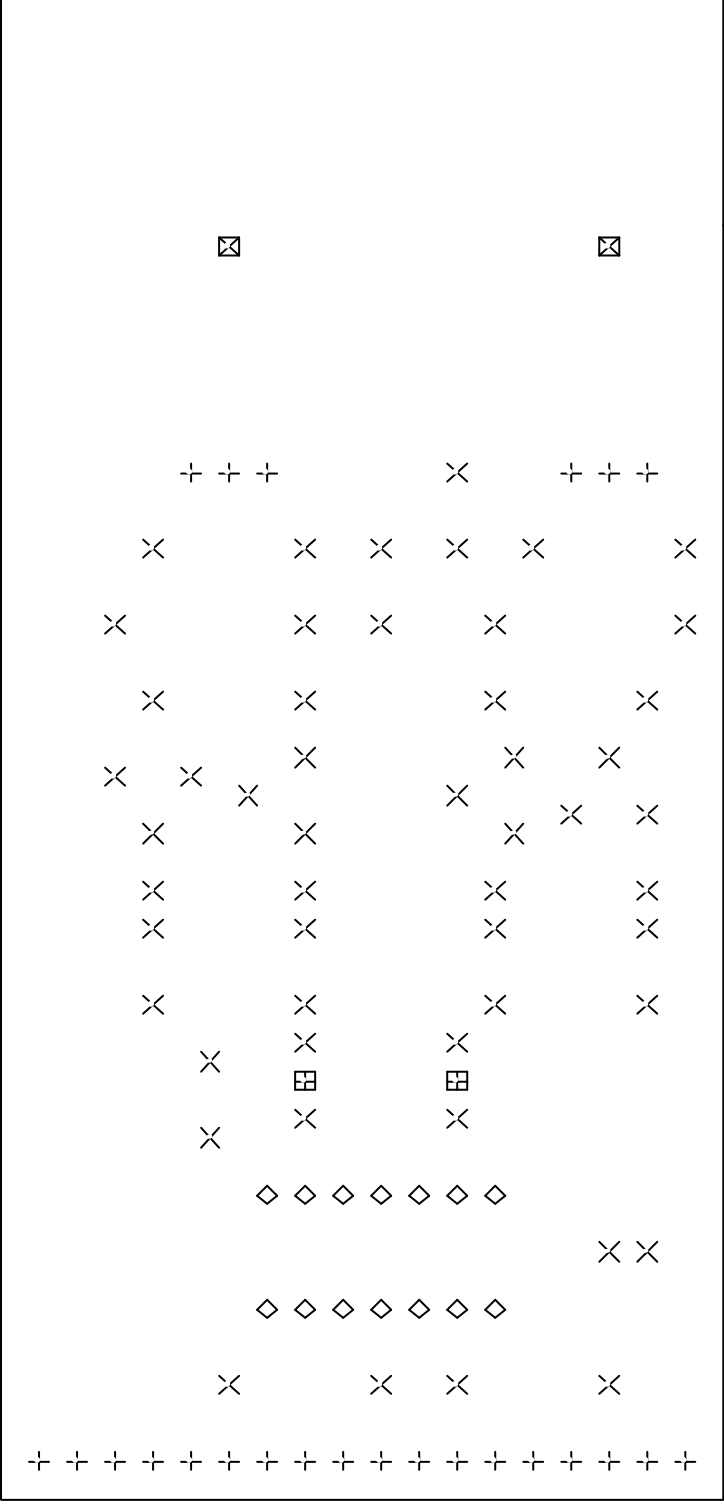




48.26



100.33



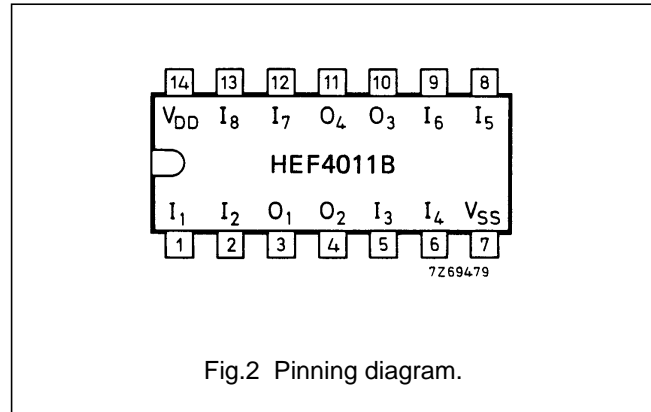
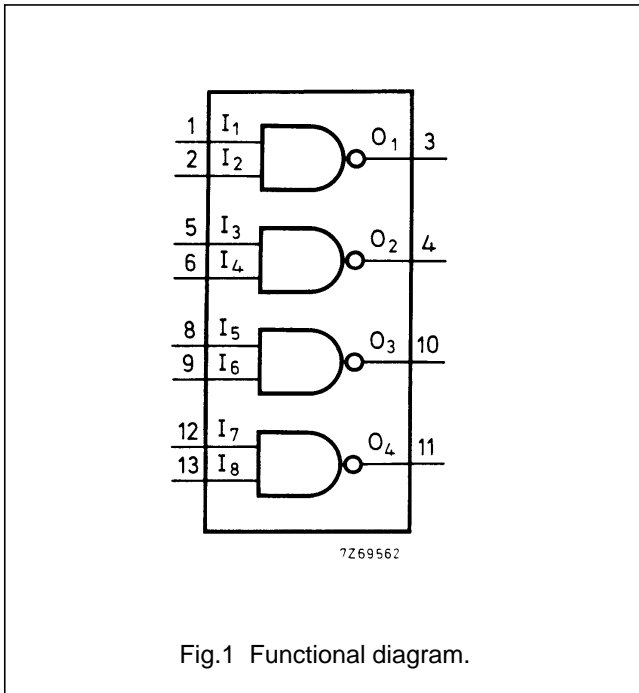
DRILL CHART				
SYM	DIAM	TOL	QTY	NOTE
+	0.010		24	NON-PLATED
x	0.020		52	NON-PLATED
◇	0.020		14	
⊕	0.028		2	
⊠	0.147		2	
TOTAL			94	

Quadruple 2-input NAND gate

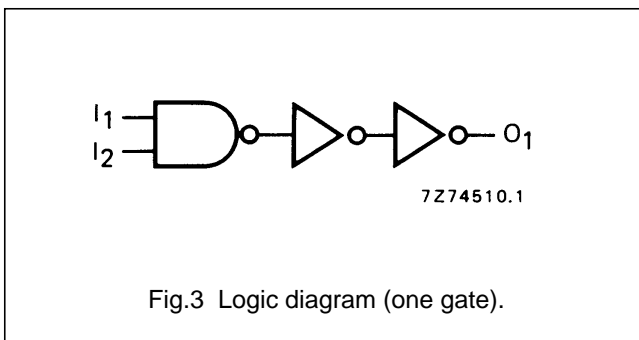
HEF4011B gates

DESCRIPTION

The HEF4011B provides the positive quadruple 2-input NAND function. The outputs are fully buffered for highest noise immunity and pattern insensitivity of output impedance.



- HEF4011BP(N): 14-lead DIL; plastic (SOT27-1)
 - HEF4011BD(F): 14-lead DIL; ceramic (cerdip) (SOT73)
 - HEF4011BT(D): 14-lead SO; plastic (SOT108-1)
- (): Package Designator North America



FAMILY DATA, I_{DD} LIMITS category GATES

See Family Specifications

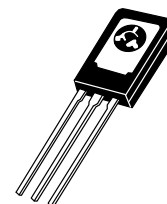
Plastic Medium Power Silicon NPN Transistor

BD135
BD137
BD139

... designed for use as audio amplifiers and drivers utilizing complementary or quasi complementary circuits.

- DC Current Gain — $h_{FE} = 40$ (Min) @ $I_C = 0.15$ Adc
- BD 135, 137, 139 are complementary with BD 136, 138, 140

1.5 AMPERE
POWER TRANSISTORS
NPN SILICON
45, 60, 80 VOLTS
10 WATTS



CASE 77-08
TO-225AA TYPE

MAXIMUM RATINGS

Rating	Symbol	Type	Value	Unit
Collector-Emitter Voltage	V_{CEO}	BD 135 BD 137 BD 139	45 60 80	Vdc
Collector-Base Voltage	V_{CBO}	BD 135 BD 137 BD 139	45 60 100	Vdc
Emitter-Base Voltage	V_{EBO}		5	Vdc
Collector Current	I_C		1.5	Adc
Base Current	I_B		0.5	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D		1.25 10	Watts mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D		12.5 100	Watt mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}		-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	10	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Ambient	θ_{JA}	100	$^\circ\text{C}/\text{W}$

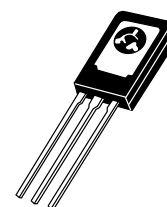
Plastic Medium Power Silicon PNP Transistor

... designed for use as audio amplifiers and drivers utilizing complementary or quasi complementary circuits.

- DC Current Gain — $h_{FE} = 40$ (Min) @ $I_C = 0.15$ Adc
- BD 136, 138, 140 are complementary with BD 135, 137, 139

BD136
BD138
BD140
BD140-10

1.5 AMPERE
POWER TRANSISTORS
PNP SILICON
45, 60, 80 VOLTS
10 WATTS



CASE 77-08
TO-225AA TYPE

MAXIMUM RATINGS

Rating	Symbol	Type	Value	Unit
Collector-Emitter Voltage	V_{CEO}	BD 136 BD 138 BD 140	45 60 80	Vdc
Collector-Base Voltage	V_{CBO}	BD 136 BD 138 BD 140	45 60 100	Vdc
Emitter-Base Voltage	V_{EBO}		5	Vdc
Collector Current	I_C		1.5	Adc
Base Current	I_B		0.5	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D		1.25 10	Watts mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D		12.5 100	Watt mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}		-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	10	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Ambient	θ_{JA}	100	$^\circ\text{C}/\text{W}$

Fast soft-recovery controlled avalanche rectifiers

BYV95 series

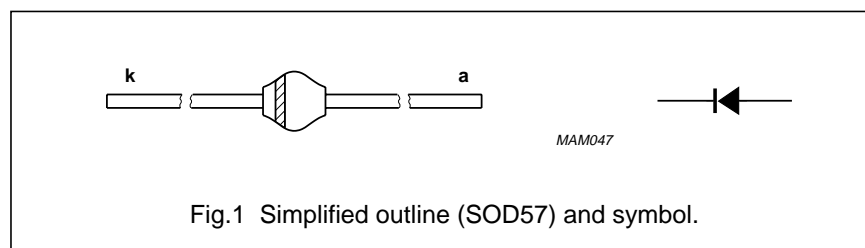
FEATURES

- Glass passivated
- High maximum operating temperature
- Low leakage current
- Excellent stability
- Guaranteed avalanche energy absorption capability
- Available in ammo-pack.

DESCRIPTION

Rugged glass SOD57 package, using a high temperature alloyed construction. This package is

hermetically sealed and fatigue free as coefficients of expansion of all used parts are matched.



LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

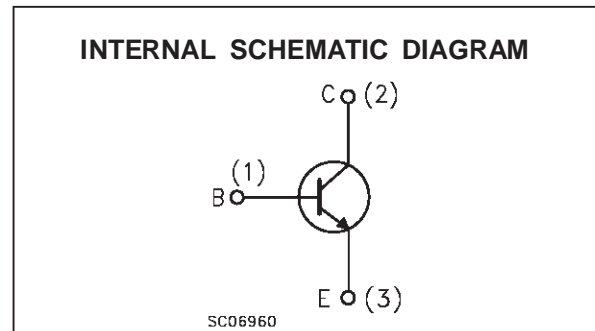
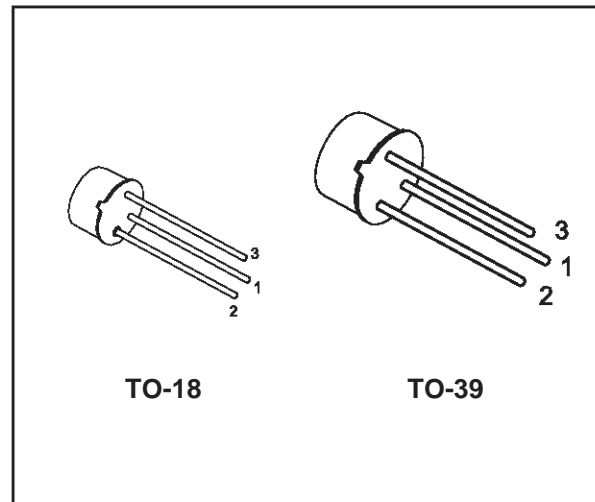
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{RRM}	repetitive peak reverse voltage				
	BYV95A		–	200	V
	BYV95B		–	400	V
	BYV95C		–	600	V
V_R	continuous reverse voltage				
	BYV95A		–	200	V
	BYV95B		–	400	V
	BYV95C		–	600	V
$I_{F(AV)}$	average forward current	$T_{tp} = 65\text{ °C}$; lead length = 10 mm see Fig. 2; averaged over any 20 ms period; see also Fig. 6	–	1.5	A
		$T_{amb} = 65\text{ °C}$; PCB mounting (see Fig.11); see Fig. 3; averaged over any 20 ms period; see also Fig. 6	–	0.8	A
I_{FRM}	repetitive peak forward current	$T_{tp} = 65\text{ °C}$; see Fig. 4	–	17	A
		$T_{amb} = 65\text{ °C}$; see Fig. 5	–	9	A
I_{FSM}	non-repetitive peak forward current	$t = 10\text{ ms}$ half sine wave; $T_j = T_{j\text{ max}}$ prior to surge; $V_R = V_{RRM\text{ max}}$	–	35	A
E_{RSM}	non-repetitive peak reverse avalanche energy	$L = 120\text{ mH}$; $T_j = T_{j\text{ max}}$ prior to surge; inductive load switched off	–	10	mJ
T_{stg}	storage temperature		–65	+175	°C
T_j	junction temperature	see Fig. 7	–65	+175	°C

HIGH SPEED SWITCHES

DESCRIPTION

The 2N2219A and 2N2222A are silicon planar epitaxial NPN transistors in Jedec TO-39 (for 2N2219A) and in Jedec TO-18 (for 2N2222A) metal case. They are designed for high speed switching application at collector current up to 500mA, and feature useful current gain over a wide range of collector current, low leakage currents and low saturation voltage.

☞ 2N2219A approved to CECC 50002-100,
2N2222A approved to CECC 50002-101
available on request.



ABSOLUTE MAXIMUM RATINGS

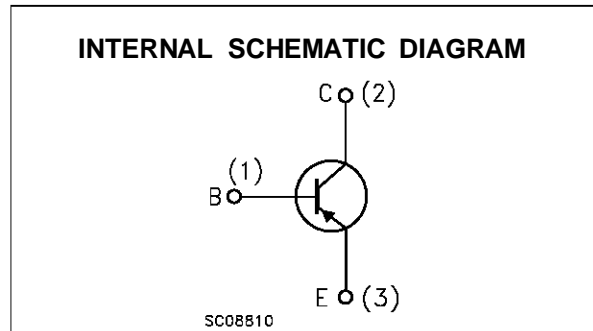
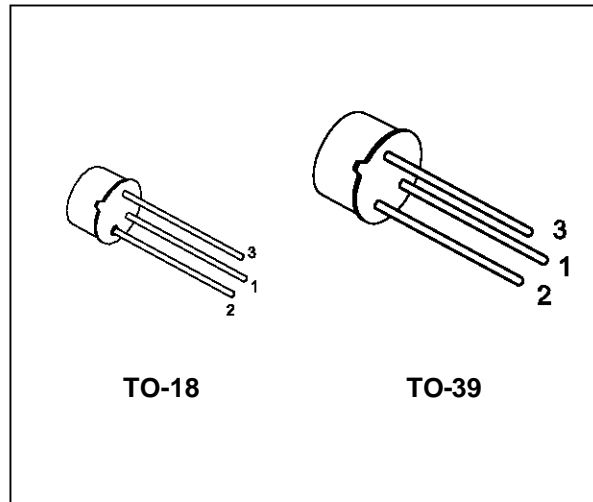
Symbol	Parameter	Value	Unit
V_{CBO}	Collector-Base Voltage ($I_E = 0$)	75	V
V_{CEO}	Collector-Emitter Voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-Base Voltage ($I_C = 0$)	6	V
I_C	Collector Current	0.8	A
P_{tot}	Total Dissipation at $T_{amb} \leq 25\text{ }^\circ\text{C}$ for 2N2219A for 2N2222A at $T_{case} \leq 25\text{ }^\circ\text{C}$ for 2N2219A for 2N2222A	0.8	W
		0.5	W
		3	W
		1.8	W
T_{stg}	Storage Temperature	-65 to 200	$^\circ\text{C}$
T_j	Max. Operating Junction Temperature	175	$^\circ\text{C}$

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

DESCRIPTION

The 2N2905A and 2N2907A are silicon planar epitaxial PNP transistors in Jedec TO-39 (for 2N2905A) and in Jedec TO-18 (for 2N2907A) metal case. They are designed for high speed saturated switching and general purpose applications.

- ☰ 2N2905A approved to CECC 50002-100, 2N2906A approved to CECC 50002-103 available on request.

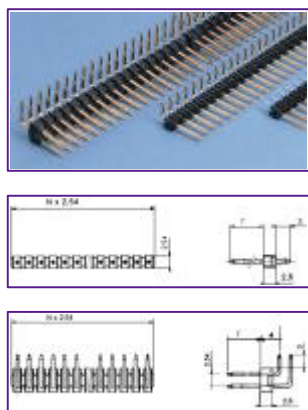


ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CBO}	Collector-Base Voltage ($I_E = 0$)	-60	V
V_{CEO}	Collector-Emitter Voltage ($I_B = 0$)	-60	V
V_{EBO}	Emitter-Base Voltage ($I_C = 0$)	-5	V
I_C	Collector Current	-0.6	A
P_{tot}	Total Dissipation at $T_{amb} \leq 25\text{ }^\circ\text{C}$ for 2N2905A for 2N2907A at $T_{case} \leq 25\text{ }^\circ\text{C}$ for 2N2905A for 2N2907A	0.6	W
		0.4	W
		3	W
		1.8	W
T_{stg}	Storage Temperature	-65 to 200	$^\circ\text{C}$
T_j	Max. Operating Junction Temperature	200	$^\circ\text{C}$

Barrettes simple et double rangée au pas de 2,54 mm

FCI



- Embases mâles HE 13 destinées au raccordement carte à carte, compatibles avec les fiches femelles de la série 6160 et toute autre fiche HE 13/HE 14.
- Ces connecteurs sont équipés de 1 ou 2 rangées de 36 contacts chacune qui peuvent être sectionnées manuellement. Un pied de lavage permet le nettoyage après soudure.
- Cette série est conforme à la norme NFC 93401, les contacts sont dorés.

Spécifications techniques

Pas: 2,54 mm

Section des broches: 0,63 x 0,63 mm

Résistance d'isolement: $\geq 10^3 \text{ M}\Omega$

Résistance de contact: $\leq 20 \text{ m}\Omega$

Intensité admissible: 3 A à 20°C

Tension de tenue: 1000 V eff.

Tenue en température: -55°C à +125°C

Endurance mécanique: 400 cycles

Isolant auto-extinguible: UL 94-V0

Matière des contacts: laiton

Revêtement des contacts: dorure sur nickel

réf. nombre
FCI de rangées

Version droite Version coudée

6170 36 1D1201 6170 36 1C1201 1

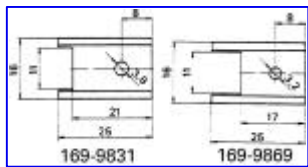
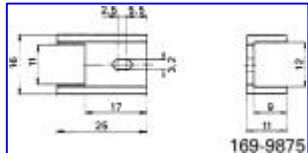
6170 36 2D1201 6170 36 2C1201 2

U.D.V.=5

réf. FCI	code commande	prix de l'U.D.V.		
		1-9	10-24	25+
Version droite				
6170 36 1D1201	189-9643	45.67 Fr	43.39 Fr	38.82 Fr
6170 36 2D1201	189-9659	88.39 Fr	83.97 Fr	75.13 Fr
Version coudée				
6170 36 1C1201	189-9665	49.06 Fr	46.61 Fr	41.70 Fr
6170 36 2C1201	189-9687	97.37 Fr	92.50 Fr	82.76 Fr

Dissipateurs thermiques type RAWA 400

Seifert



- Dissipateurs pour moyennes puissances.

Spécifications techniques

Résistance thermique: 18°C / W

U.D.V.=1

réf. Seifert	code			
	commande	prix de l'U.D.V.		
		1-99	100-249	250+
RAWA 400 8P	169-9831	5.25 Fr	4.73 Fr	4.20 Fr
RAWA 400 9P	169-9869	5.25 Fr	4.73 Fr	4.20 Fr
RAWA 400 11P	169-9875	5.25 Fr	4.73 Fr	4.20 Fr