MODUL DIGITAL

PRAKTIKUM

2019

ELEKTRONIKA DASAR

PADA PERMESINAN

JURUSAN TEKNIK MESIN

MODUL
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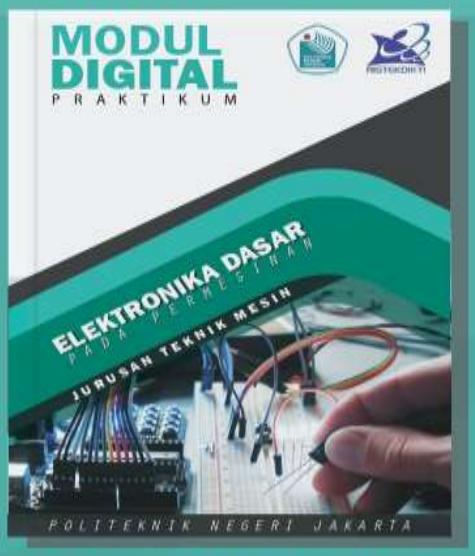

TIM PENGEMBANG INOVASI MODUL DIGITAL

PENANGGUNG JAWAB UMUM

ABDILLAH, S.E., M.Si. (Direktur PNJ)

PENANGGUNG JAWAB JURUSAN

1. Dr. Eng. Muslimin, S.T., M.T. (KaJur Teknik Mesin PNJ)
2. Dr. Tatun Hayatun Nufus, M.Si.

TIM PENGEMBANG

1. Haolia Rahman, M.T., Ph.D.
2. Hasvienda Moh. Ridlwan, S.T., M.T.
3. Devi Handaya, S.Pd., M.T.
4. Noor Hidayati, S.T., M.Sc.
5. Isnanda Nuriskasari, S.Si., M.T.
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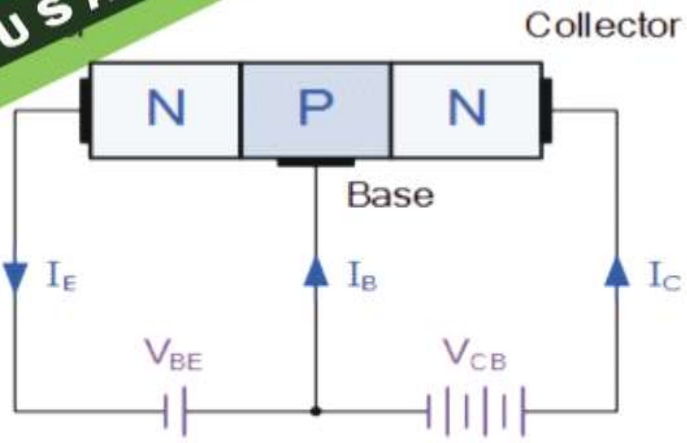
BAB IV

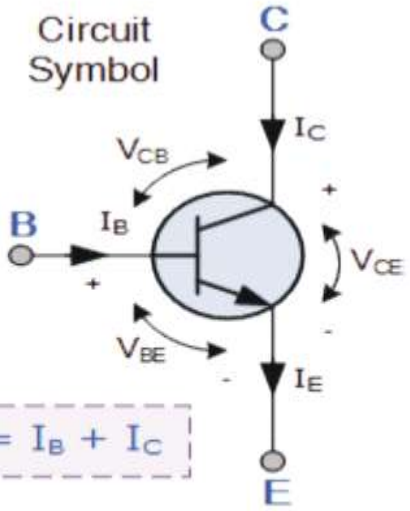
2019

KARAKTERISTIK DAN APLIKASI TRANSISTOR (BJT)

IDENTIFIKASI KARAKTERISTIK TRANSISTOR(BJT) DAN APLIKASINYA SEBAGAI SAKLAR ELEKTRONIS

JURUSAN TEKNIK MESIN





POLITEKNIK NEGERI JAKARTA

BAB IV

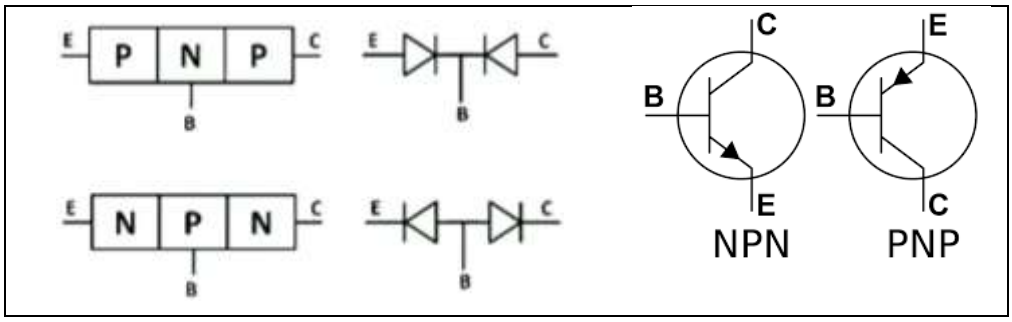
KARAKTERISTIK DAN APLIKASI TRANSISTOR (BJT)

4.1 TUJUAN

Pada akhir sesi, mahasiswa akan dapat mengidentifikasi karakteristik Transistor (BJT) dan aplikasinya sebagai saklar elektronis.

4.2 TEORI PENGANTAR

Transistor merupakan komponen elektronika yang terbuat dari material semikonduktor yang mempunyai 3 terminal. Pada dasarnya Transistor merupakan penggabungan dari dua buah dioda dengan kutub yang sama saling menjadi satu sehingga akan mendapatkan tiga lapis semikonduktor. Struktur transistor seperti Gambar 4. 1berikut.

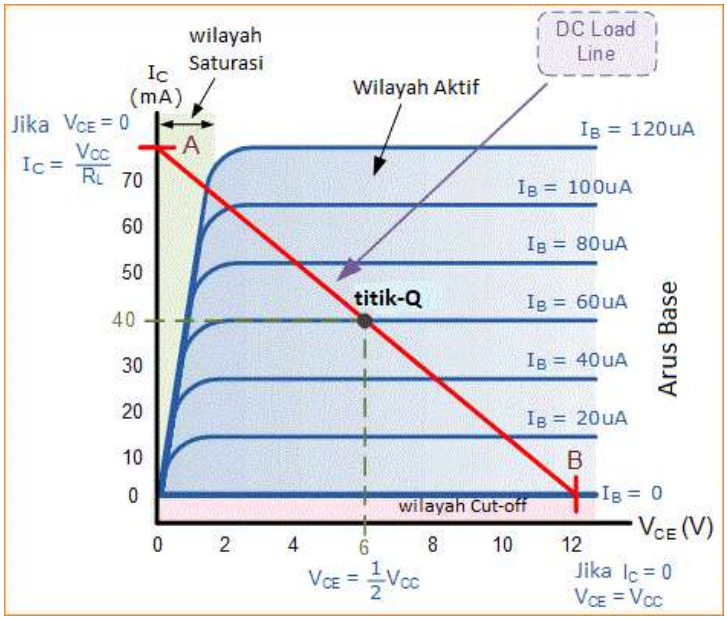


Gambar 4. 1 Konfigurasi transistor NPN dan PNP

sumber :https://belajarelektronika.net/wp-content/uploads/2016/01/transistor-npn-dan-pnp-768x432.jpg
https://abi-blog.com/transistor-jenis-fungsi-dan-karakternya/

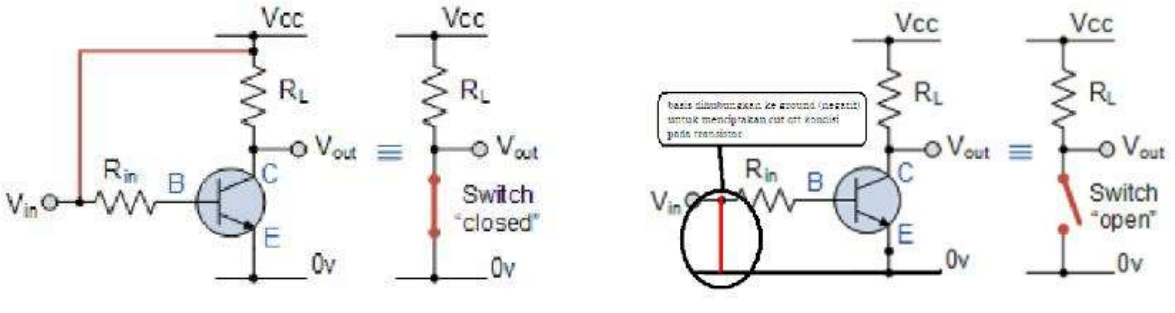
Karakteristik Transistor

Kurva karakteristik transistor merupakan daerah operasi yang digambarkan pada grafik berikut.



Gambar 4. 2 Kurva Karakteristik Transistor
sumber :https://abdulelektro.blogspot.com/2019/07/karakteristik-transistor-npn.html

Transistor sebagai saklar akan On jika berada di daerah saturasi dan akan Off jika berada di daerah cut off. Pada kondisi On, kaki basis perlu diberikan tegangan positif, hal ini dilakukan agar arus mengalir dari kolektor ke emitter. Sedangkan pada kondisi Off, kaki basis transistor perlu dihubungkan ke ground. Ilustrasi gambar ditunjukkan pada gambar berikut.



Transistor On Transistor Off

Gambar 4. 3 Transistor On dan Transistor Off

Penguatan arus transistor (β) ditentukan oleh persamaan berikut.

$$\beta = \frac{I_C}{I_B}$$

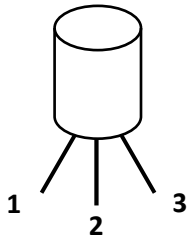
dengan nilai I_B bisa didapatkan dengan persamaan berikut.

$$I_B = \frac{V_{BB} - V_{BE}}{R_B}$$

Menentukan Tipe Transistor NPN dan PNP

Untuk dapat menentukan bahwa tipe transistor merupakan tipe NPN atau PNP, maka perlu diketahui terlebihdahulu kaki basis, kolektor, dan emitter. Berikut langkah-langkahnya.

1. Atur selector pemilih pada multimeter di Ohmmeter x100.
2. Tempelkan probe pada setiap kaki dengan ilustrasi sebagai berikut dan amati pergerakan jarum multimeter.



   a. Menentukan kaki **Basis**
      1) Jika probe ditempelkan pada kaki 3 dan probe lainnya ditempelkan pada kaki 1 dan 2 menyebabkan jarum bergerak, maka kaki 3 merupakan **kaki basis**.
      2) Jika probe positif yang berada pada kaki 3, maka transistor bertipe **NPN**.
      3) Jika probe negatif yang berada pada kaki 3, maka transistor bertipe **PNP**.
   b. Menentukan kaki **Kolektor** dan **Emitter** (Asumsi tipe **NPN**)
      Jika probe positif ditempelkan pada kaki 1 dan probe negatif pada kaki 2 menyebabkan jarum bergerak ke kanan, maka kaki 1 adalah emitter dan kaki 2 adalah kolektor. Berlaku sebaliknya.

4.3 ALAT DAN BAHAN PRAKTIKUM

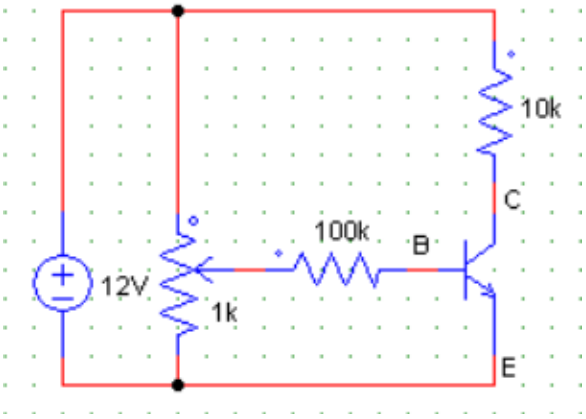
1. Multimeter
2. Protoboard
3. Resistor 22Ω, 1kΩ, 10kΩ dan 100kΩ

4. Resistor variabel 1kΩ
5. Kabel penghubung
6. Sumber tegangan DC
7. Transistor BD139 dan BD140

4.4. METODE PRAKTIKUM

1. Karakteristik Transistor

a. Buatlah rangkaian sesuai dengan Gambar 4. 4berikut pada protoboard.



Gambar 4. 4 Rangkaian Karakteristik Transistor

b. Atur R_{var} agar V_{BE} memiliki nilai 0-12 V

c. Ukurlah V_{BE} dan V_{CE} dengan menggunakan multimeter dan catat hasilnya, Kemudian tentukan nilai β !

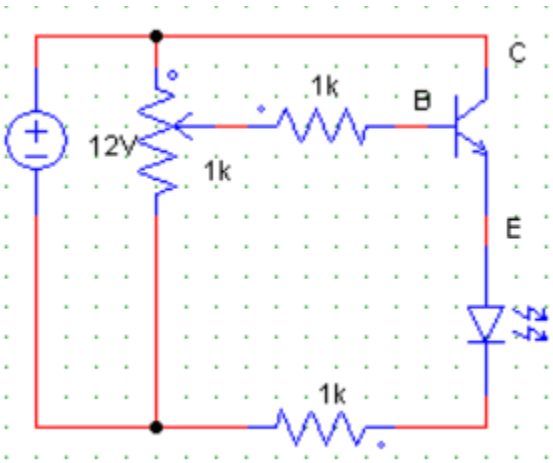
Tabel 4. 1Hasil Pengukuran V_{BE} dan V_{CE} untuk Penentuan Nilai β

R_{var} (Ω)		V_{in} (V)	V_{BE} (V)	V_{CE} (V)	β
		0			
		1			
		2			
		3			
		4			
		5			
		6			
		7			
		8			
		9			
		10			
		11			
		12			

2. Aplikasi Transistor

a. Rangkaian Transistor Sebagai Saklar

1) Buatlah rangkaian sesuai dengan gambar berikut pada protoboard.



Gambar 4. 5 Rangkaian Transistor Sebagai Saklar

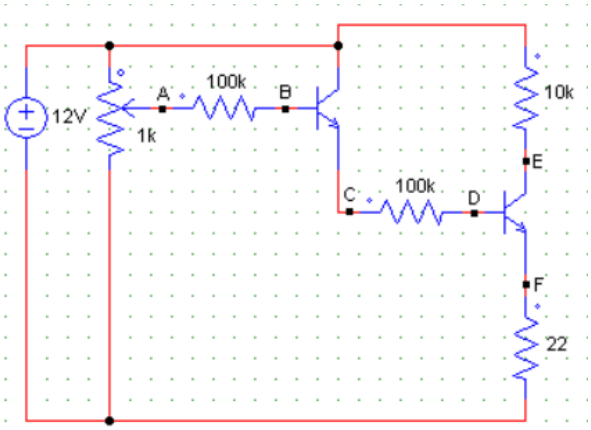
2) Atur R_{var} agar V_{in} memiliki nilai 0-12 V
3) Ukurlah V_{LED} dengan menggunakan multimeter, amati nyala lampu LED dan catat hasilnya!

Tabel 4. 2 Hasil Pengukuran V_{LED}

R_{var} (Ω)	V_{in} (V)	V_{LED} (V)	Nyala Lampu
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12		

b. Rangkaian Darlington

1) Buatlah rangkaian sesuai dengan gambar berikut pada protoboard.



Gambar 4. 6 Rangkaian Darlington

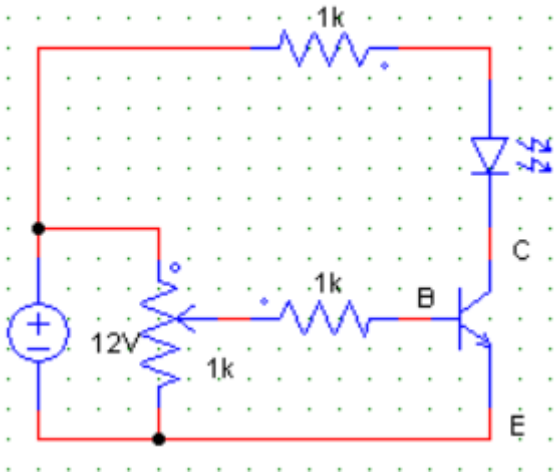
2) Atur R_{var} agar V_A memiliki nilai 0-5 V
3) Ukurlah V_B, V_C, V_D, V_E, dan V_F dengan menggunakan multimeter dan catat hasilnya!

Tabel 4. 3 Hasil Pengukuran V_B, V_C, V_D, V_E, dan V_F

R_{var} (Ω)	V_A (V)	V_B (V)	V_C (V)	V_D (V)	V_E (V)	V_F (V)
	0					
	0,5					
	1					
	1,5					
	2					
	2,5					
	3					
	3,5					
	4					
	4,5					
	5					

4.5 EVALUASI

1) Buatlah rangkaian sesuai dengan gambar berikut pada protoboard.



2) Atur R_{var} agar V_{in} memiliki nilai 0-12 V
3) Ukurlah V_{LED} dengan menggunakan multimeter, amati nyala lampu LED dan catat hasilnya!

R_{var} (Ω)	V_{in} (V)	V_{LED} (V)	Nyala Lampu
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12		

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Albert, M., & David, B. 2015. Electronic Principles. McGraw-Hill Education. New York.

Modul Praktikum Listrik dan Elektronika. 2012. Jurusan Teknik Mesin. Politeknik Negeri Jakarta.

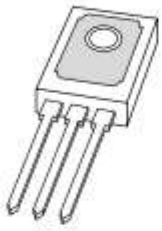
Modul Praktikum Elektronika Dasar. 2014. FKIP, Universitas Sriwijaya.

Buku Penuntun Praktikum Elektronika 1. 2018. FMIPA, Universitas Indonesia

LAMPIRAN

1. Datasheet BD139 NPN Transistor
2. Datasheet BD140 PNP Transistor

DATA SHEET



BD135; BD137; BD139
NPN power transistors

Product specification
Supersedes data of 1997 Mar 04

1999 Apr 12

Philips
Semiconductors

PHILIPS

NPN power transistors BD135; BD137; BD139

FEATURES

- High current (max. 1.5 A)
- Low voltage (max. 80 V).

APPLICATIONS

- Driver stages in hi-fi amplifiers and television circuits.

DESCRIPTION

NPN power transistor in a TO-126; SOT32 plastic package. PNP complements: BD136, BD138 and BD140.

PINNING

PIN	DESCRIPTION
1	emitter
2	collector, connected to metal part of mounting surface
3	base

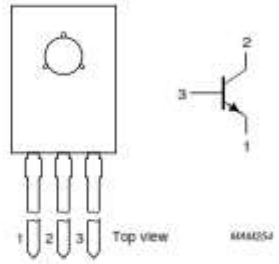


Fig.1 Simplified outline (TO-126; SOT32) and symbol.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	BD135		–	45	V
	BD137		–	60	V
	BD139		–	100	V
V_{CEO}	collector-emitter voltage	open base			
	BD135		–	45	V
	BD137		–	60	V
	BD139		–	80	V
V_{EBO}	emitter-base voltage	open collector	–	5	V
I_C	collector current (DC)		–	1.5	A
I_{CM}	peak collector current		–	2	A
I_{BM}	peak base current		–	1	A
P_{tot}	total power dissipation	$T_{mb} \leq 70$ °C	–	8	W
T_{stg}	storage temperature		−65	+150	°C
T_j	junction temperature		–	150	°C
T_{amb}	operating ambient temperature		−65	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j-a}$	thermal resistance from junction to ambient	note 1	100	K/W
$R_{th\ j-mb}$	thermal resistance from junction to mounting base		10	K/W

Note

1. Refer to TO-126; SOT32 standard mounting conditions.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	I_E = 0; V_{CB} = 30 V	–	–	100	nA
		I_E = 0; V_{CB} = 30 V; T_j = 125 °C	–	–	10	μA
I_{EBO}	emitter cut-off current	I_C = 0; V_{EB} = 5 V	–	–	100	nA
h_{FE}	DC current gain	V_{CE} = 2 V; (see Fig.2)				
		I_C = 5 mA	40	–	–	
		I_C = 150 mA	63	–	250	
		I_C = 500 mA	25	–	–	
	DC current gain	I_C = 150 mA; V_{CE} = 2 V;				
	BD135-10; BD137-10; BD139-10	(see Fig.2)	63	–	160	
	BD135-16; BD137-16; BD139-16		100	–	250	
V_{CEsat}	collector-emitter saturation voltage	I_C = 500 mA; I_B = 50 mA	–	–	0.5	V
V_{BE}	base-emitter voltage	I_C = 500 mA; V_{CE} = 2 V	–	–	1	V
f_T	transition frequency	I_C = 50 mA; V_{CE} = 5 V; f = 100 MHz	–	190	–	MHz
$\frac{h_{FE1}}{h_{FE2}}$	DC current gain ratio of the complementary pairs	$\lvert I_C \rvert$ = 150 mA; $\lvert V_{CE} \rvert$ = 2 V	–	1.3	1.6	

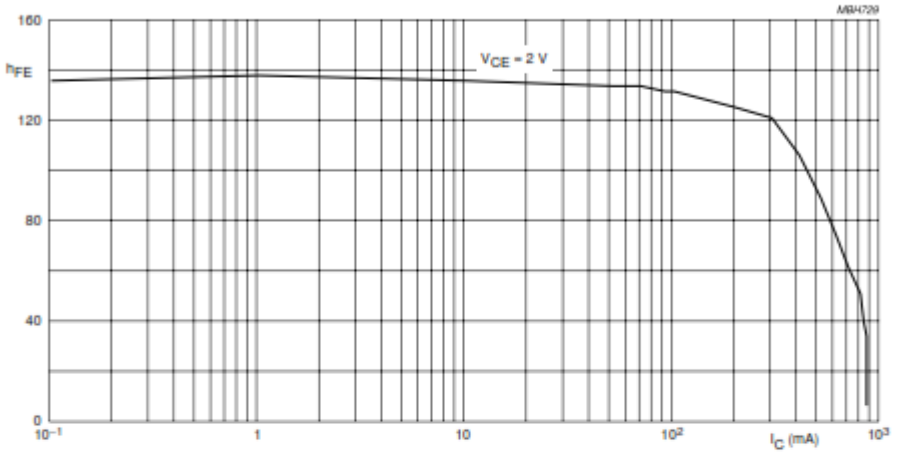
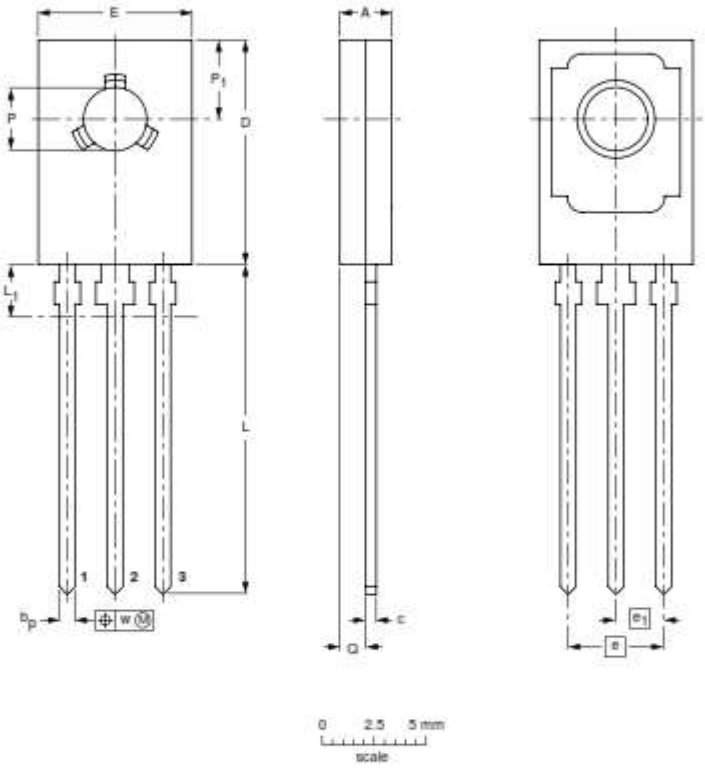


Fig.2 DC current gain; typical values.

PACKAGE OUTLINE

Plastic single-ended leaded (through hole) package; mountable to heatsink, 1 mounting hole; 3 leads SOT32



DIMENSIONS (mm are the original dimensions)

UNIT	A	b_p	c	D	E	e	e_1	L	$L_1^{(1)}$ max	Q	P	P_1	w
mm	2.7 2.3	0.88 0.65	0.60 0.45	11.1 10.5	7.8 7.2	4.58	2.29	16.5 15.3	2.54	1.5 0.9	3.2 3.0	3.9 3.6	0.254

Note

1. Terminal dimensions within this zone are uncontrolled to allow for flow of plastic and terminal irregularities.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT32		TO-126				97-03-04

DEFINITIONS

Data Sheet Status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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NOTES

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101 1248, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 68 9211, Fax. +359 2 68 9102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Sydhavnsgade 23, 1780 COPENHAGEN V,
Tel. +45 33 29 3333, Fax. +45 33 29 3905

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615 800, Fax. +358 9 6158 0920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 2353 60, Fax. +49 40 2353 6300

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku,
TOKYO 108-8507, Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381, Fax +9-5 800 943 0087

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Pakistan: see Singapore

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 319762,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2886, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 62 5344, Fax.+381 11 63 5777

For all other countries apply to: Philips Semiconductors,
International Marketing & Sales Communications, Building BE-p, P.O. Box 218,
5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: http://www.semiconductors.philips.com

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PHILIPS

SGS-THOMSON MICROELECTRONICS

BD136
BD138/BD140

PNP SILICON TRANSISTORS

- SGS-THOMSON PREFERRED SALESTYPES
- PNP TRANSISTOR

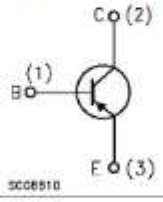
DESCRIPTION

The BD136, BD138 and BD140 are silicon epitaxial planar PNP transistors in Jedec SOT-32 plastic package, designed for audio amplifiers and drivers utilizing complementary or quasi compementary circuits.

The complementary NPN types are the BD135 BD137 and BD139.

SOT-32

INTERNAL SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value			Unit
		BD136	BD138	BD140	
V_{CBO}	Collector-Base Voltage (I_E = 0)	-45	-60	-80	V
V_{CEO}	Collector-Emitter Voltage (I_B = 0)	-45	-60	-80	V
V_{EBO}	Emitter-Base Voltage (I_C = 0)	-5			V
I_C	Collector Current	-1.5			A
I_{CM}	Collector Peak Current	-3			A
I_B	Base Current	-0.5			A
P_{tot}	Total Dissipation at $T_c \leq 25$ °C	12.5			W
P_{tot}	Total Dissipation at $T_{amb} \leq 25$ °C	1.25			W
T_{stg}	Storage Temperature	-65 to 150			°C
T_j	Max. Operating Junction Temperature	150			°C

THERMAL DATA

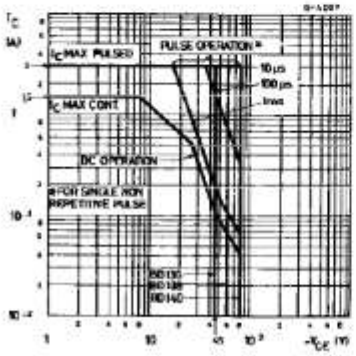
$R_{thj\text{-}case}$	Thermal Resistance Junction-case	Max	10	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector Cut-off Current (I_E = 0)	V_{CB} = -30 V V_{CB} = -30 V T_C = 125 °C			-0.1 -10	µA µA
I_{EBO}	Emitter Cut-off Current (I_C = 0)	V_{EB} = -5 V			-10	µA
$V_{CEO(sus)}$*	Collector-Emitter Sustaining Voltage	I_C = -30 mA for **BD136** for **BD138** for **BD140**	 -45 -60 -80			 V V V
$V_{CE(sat)}$*	Collector-Emitter Saturation Voltage	I_C = -0.5 A I_B = -0.05 A			-0.5	V
V_{BE}*	Base-Emitter Voltage	I_C = -0.5 A V_{CE} = -2 V			-1	V
h_{FE}*	DC Current Gain	I_C = -5 mA V_{CE} = -2 V I_C = -0.5 A V_{CE} = -2 V I_C = -150 mA V_{CE} = -2 V	25 25 40		 250	
h_{FE}	h_{FE} Groups	I_C = -150 mA V_{CE} = -2 V for BD140 group 10	 63		 160	

* Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %

Safe Operating Areas



SOT-32 (TO-126) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	7.4		7.8	0.291		0.307
B	10.5		10.8	0.413		0.445
b	0.7		0.9	0.028		0.035
b1	0.49		0.75	0.019		0.030
C	2.4		2.7	0.040		0.106
c1	1.0		1.3	0.039		0.050
D	15.4		16.0	0.606		0.629
e		2.2			0.087	
e3	4.15		4.65	0.163		0.183
F		3.8			0.150	
G	3		3.2	0.118		0.126
H			2.54			0.100
H2		2.15			0.084