

APPLICATION NOTE

**A wide-band class-A linear
power amplifier
(174 – 230 MHz) with
2 transistors BLV33F**

ECO8005

**A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F**

**Application Note
ECO8005**

CONTENTS

1	ABSTRACT
2	INTRODUCTION
3	DESIGN OF THE AMPLIFIER
4	ADJUSTMENTS OF THE AMPLIFIER
5	ASSEMBLING OF THE AMPLIFIER AND MECHANICAL DATA
6	MEASURED RESULTS
7	CONCLUSION
8	REFERENCES

A wide-band class-A linear power amplifier (174 – 230 MHz) with 2 transistors BLV33F

Application Note
ECO8005

1 ABSTRACT

For application in driver or final stages of TV-transposers in Band III (174-230 MHz) a linear wideband power amplifier has been designed with 2 transistors BLV33F, coupled by means of 3 dB – 90° hybrids. Each transistor is adjusted in Class-A at $V_{CE} = 25$ V and $I_C = 3.25$ A. A demonstration model showed a peak sync. output power of 40 W at a 3-tone I.M. distortion between –52 and –53 dB. At this power level the cross-modulation varied from 15 to 18%. The power gain is between 13.3 and 13.6 dB. For natural convection cooling the heatsink temperature is 40 °C above ambient temperature.

2 INTRODUCTION

For application in T.V. transposers and transmitters for Band III a wideband linear power amplifier has been designed with 2 transistors BLV33F, coupled by means of 3 dB –90° hybrids. Each transistor is adjusted in Class-A at $V_{CE} = 25$ V and $I_C = 3.25$ A.

Note: The BLV33F is a high gain, internally matched, 1/2 inch 6 leads flange version of the BLV33.

3 DESIGN OF THE AMPLIFIER

For class-A operation the BLV33F is specified at $V_{CE} = 25$ V, $I_C = 3.25$ A. The corresponding typical gain, input and load impedance are given in Table 1:

Table 1

FREQ. (MHz)	GAIN (dB)	INPUT IMPEDANCE (Ω)	LOAD IMPEDANCE (Ω)
174	12.94	0.85 + j0.59	2.68 + j1.24
202	12.88	1.02 + j0.47	2.23 + j0.90
230	13.91	0.93 + j0.02	1.84 + j0.51

To obtain a high linear output and at the same time good input and output matching (V.S.W.R. ≤ 1.2) 3 dB –90° hybrids are used. The reflected input power will be absorbed in the 50 Ω resistor, matching the isolated port (see Fig.1). For detailed information on computer-aided design (carried out by Mr. Hilbers Central Application Laboratory) see Refs 1, 2 and 3. The transistors used in this particular amplifier are typical products, measured in a narrow band test amplifier and specified as follows:

$$V_{CE} = 25 \text{ V} - I_C = 3.25 \text{ A} - T_h = 70^\circ$$

Table 2

Transistor type	BLV33F	
Batch no.	MD 8-16 no.7	MD 8-16 no. 10
Vision frequency	224.25 MHz	
Output power (peak sync)	17.7 W	18 W
Intermod. product	–55 dB	–55 dB
Gain	14.2 dB	14.2 dB

4 ADJUSTMENTS OF THE AMPLIFIER

The amplifier consists of two equal BLV33F branches (see Fig.1) and both transistors are separately biased at $V_{CE} = 25$ V – $I_C = 3.25$ A. The printed circuit board of the 2 \times BLV33F wideband amplifier is given in Fig.2 and schematic diagram + lay-out of the bias unit is given in Fig.3. Figure 9 at the end of the report shows the lay-out of the amplifier with

A wide-band class-A linear power amplifier (174 – 230 MHz) with 2 transistors BLV33F

Application Note
ECO8005

the situation of the components. Each branch was adjusted for maximum and flat gain by means of a high power sweep with a frequency range from 170 – 230 MHz. The output of the amplifier was levelled at 40 W which means about 50% of the D.C. input power. After that, both branches are coupled by means of 3 dB –90° hybrids.

5 ASSEMBLING OF THE AMPLIFIER AND MECHANICAL DATA

Due to the dimensions of the printed circuit board (220 × 210 mm) 2 extruded blackened aluminium heat sinks (cat.no. 56293) are screwed on an aluminium plate (thickness 12 mm) which on its turn is screwed on the heat sink. Special attention has been paid to the surface finishing to keep the thermal resistance as low as possible.

Dimensions of the amplifier: l = 224 mm – w = 223 mm – h = 113 mm. Weight: 7.5 kg.

6 MEASURED RESULTS

In Fig.4 the typical results of crossmodulation and 3-tone intermod. product (from 170 – 230 MHz) have been given for peak sync output powers of 30 W and 40 W. Figure 5 shows peak sync output power as function of 3-tone intermod. products (measured on channel 12: Vision freq. 224.25 MHz – Sound freq. 229.75 MHz). In Figs 6 and 7 the forward and reverse transducer gain as well as input and output voltage standing wave ratio are given. The measuring test set-up is depicted in Fig.8.

Note:

Signal levels 3-tone measurements:

Vision carrier –8 dB; Sound carrier –7 dB;

Sideband –16 dB; 0 dB corresponds to peak sync.

Signals levels crossmodulation:

Vision carrier switched from –20 dB to 0 dB;

Sound carrier –7 dB; 0 dB = peak sync level

Crossmodulation is defined as the voltage variation (%) of the sound carrier.

7 CONCLUSION

Two transistors BLV33F, coupled by means of 3 dB –90° hybrids, can deliver an output power (peak sync) of typ. 40 W for –52 dB 3-tone intermodulation. At 40 W output the crossmodulation varied from 15% to 18% in Band III (170 – 230 MHz). The gain of the amplifier is typically 13.3 + 0.3 dB. The required D.C. input is approx. 165 W. Using a high power sweep with adjustable transistor output levelling provides a suitable method to adjust a linear wideband power amplifier.

8 REFERENCES

Ref.1:

G.L. Matthaei – Tables of Chebyshev

Impedance Transforming Network of Low-Pass Filter Form. Proceedings of the IEEE August 1964, pp 939 – 963.

Ref.2:

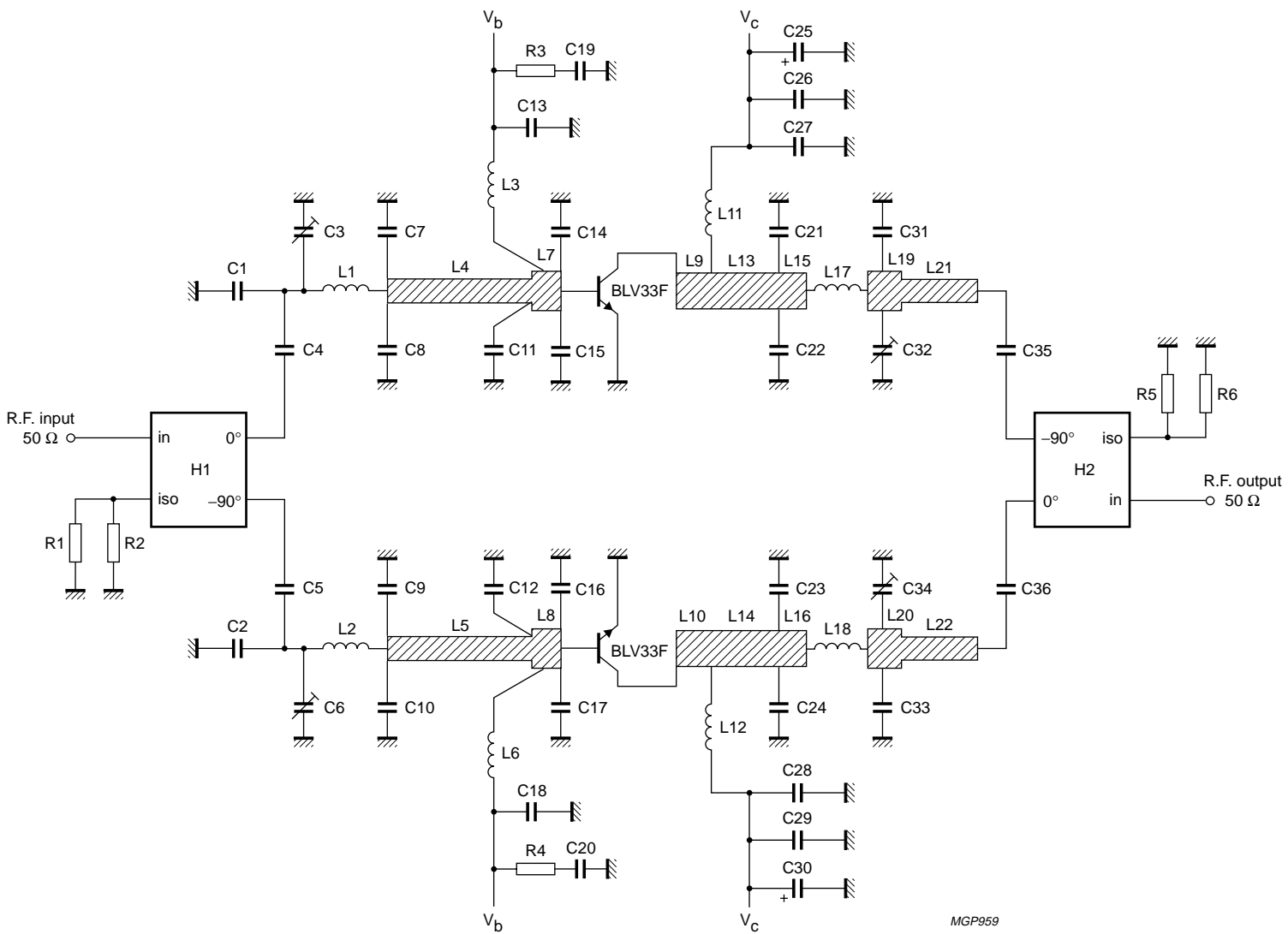
A.H. Hilbers and M.J. Köppen – A wideband linear power amplifier (470 – 860 MHz) with two transistors BLW34. C.A.B. report ECO7901.

Ref.3:

R.F.F. Zwanen – A wideband Class-A linear power amplifier (170 – 230 MHz) with two transistors BLV33. C.A.B. report ECO7904.

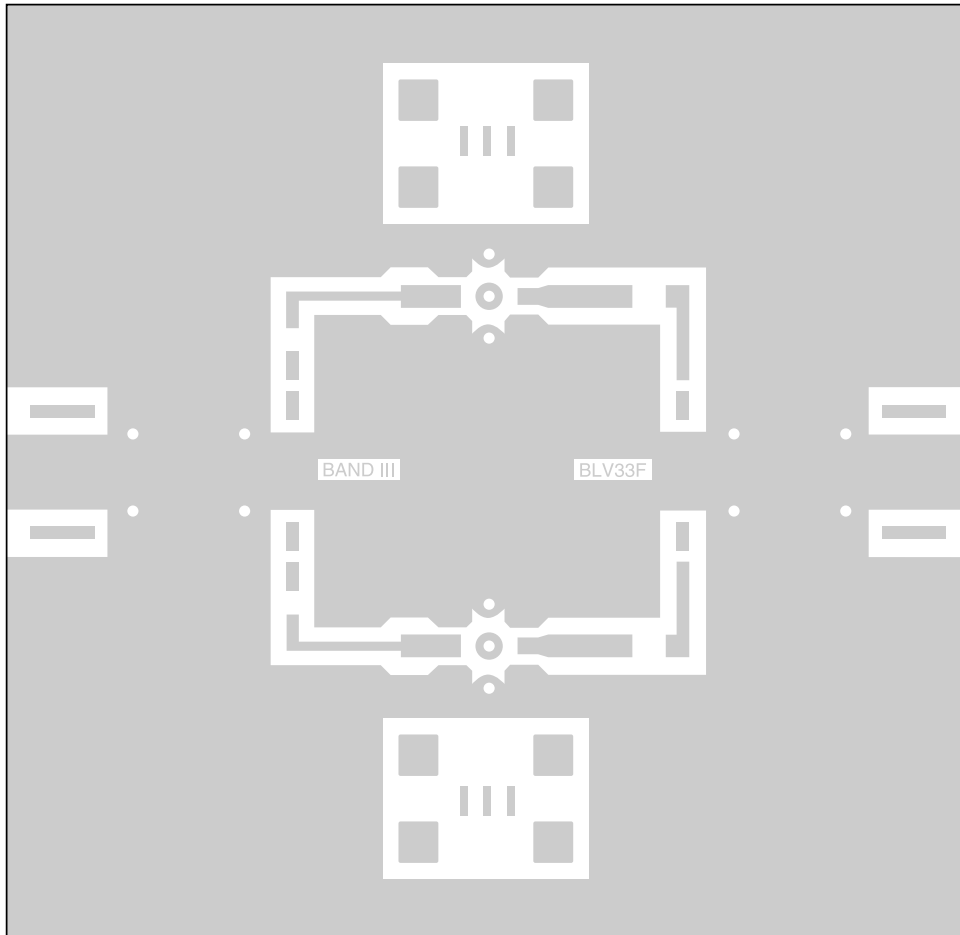
A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F

Application Note
ECO8005



MGP959

Fig.1 2x BLV33F Band III Class A linear power amplifier.



MGP986

Fig.2 Printed circuit board 2× BLV33F wideband power amplifier.

A wide-band class-A linear power amplifier (174 – 230 MHz) with 2 transistors BLV33F

Application Note
ECO8005

Table 3 Parts list: BLV33F Band III Class A linear power amplifier (170 – 230 MHz)

C1 = C2 = C7 = C9	10 pF	chip capacitor
C3 = C6 = C32 = C34	1.8 to 10 pF	film dielectric trimmer (cat. no. 222280905002)
C4 = C5 = C35 = C36	220 pF	chip capacitor
C8 = C10	39 pF	chip capacitor
C11 = C12	68 pF	chip capacitor
C13 = C18 = C27 = C28	1000 pF	chip capacitor
C14 = C15 = C16 = C17	120 pF	chip capacitor
C19 = C20 = C26 = C29	300 nF	metallized film capacitor (cat. no. 222235225334)
C21 = C22 = C23 = C24	56 pF	chip capacitor
C25 = C30	10 μ F (40 V)	electrolytic capacitor (cat. no. 222212117109)
C31 = C33	18 pF	chip capacitor (chip capacitors: ATC type 100B – C – MSX – 500)
R1 = R2 = R5 = R6	100 Ω	power metal film resistor PR52 type (cat. no. 232219231001)
R3 = R4	10 Ω	carbon resistor CR68 type
H1 = H2	3 dB -90°	coupler, model no. 10262 – 3, range 125 to 250 MHz, ANAREN MICROWAVE INC.
L1 = L2	25 nH	2 turns enamelled Cu wire (1 mm); int. diam. 5 mm; leads 2 \times 3 mm
L3 = L6	90 nH	5 turns closely wound enamelled Cu wire (1.5 mm) int. diam. 6.5 mm; length 5 mm; leads 2 \times 9 mm
L4 = L5		60 Ω stripline; w = 2 mm; length = 30 mm
L7 = L8		30 Ω stripline; w = 6 mm; length = 11 mm
L9 = L10		40 Ω stripline; w = 4 mm; length = 5 mm
L11 = L12	20 nH	Cu strip (1 mm); length = 17 mm; h = 5 mm; w = 4 mm
L13 = L14		30 Ω stripline; w = 6 mm; length = 17 mm
L15 = L16		30 Ω stripline; w = 6 mm; length = 4 mm
L17 = L18	28 nH	2 turns enamelled Cu wire (1.5 mm); int. diam. 6.5 mm; length 9 mm; leads 2 \times 3 mm
L19 = L20		30 Ω stripline; w = 6 mm; length = 6 mm
L21 = L22		50 Ω stripline; w = 3 mm; length = 15 mm

The striplines are printed on double Cu-clad printed circuit board with epoxy fibre-glass dielectric ($\epsilon_r = 4.5$); thickness 1/16 inch.

**A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F**

**Application Note
ECO8005****Table 4** Parts list: Class A bias circuit for a single transistor BLV33F

R1	150 Ω	carbon resistor CR25 type
R2	100 Ω	preset potentiometer CTP10 type
R3	10 Ω	carbon resistor CR25 type
R4	1000 Ω	carbon resistor CR25 type
R5 = R6 = R7	1.8 Ω	rectangular wirewound resistor EH707 type
R8 = R9	180 Ω	carbon resistor CR25 type
R10	33 Ω	carbon resistor CR25 type
C1 = C3	100 nF	metallized film capacitor
C2	100 pF	ceramic capacitor
C4	10 μ F	electrolytic capacitor
D1		BZY 88 (3V3)
D2		BY 206
T1		BD 136

A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F

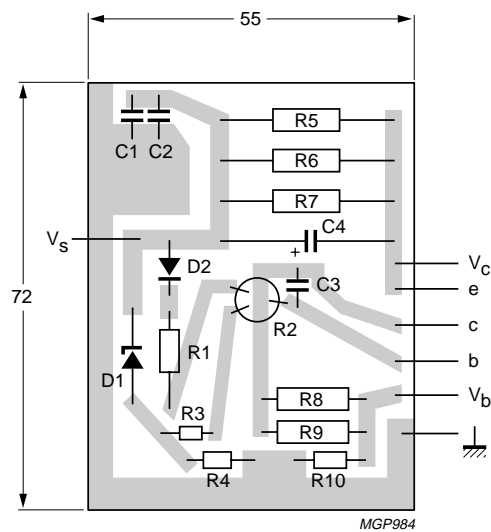
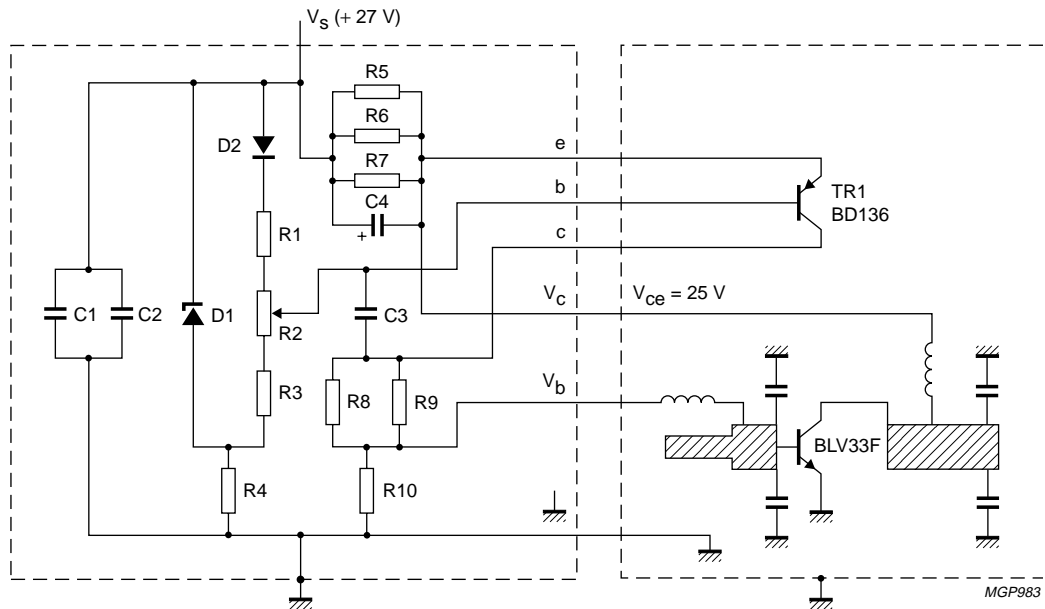
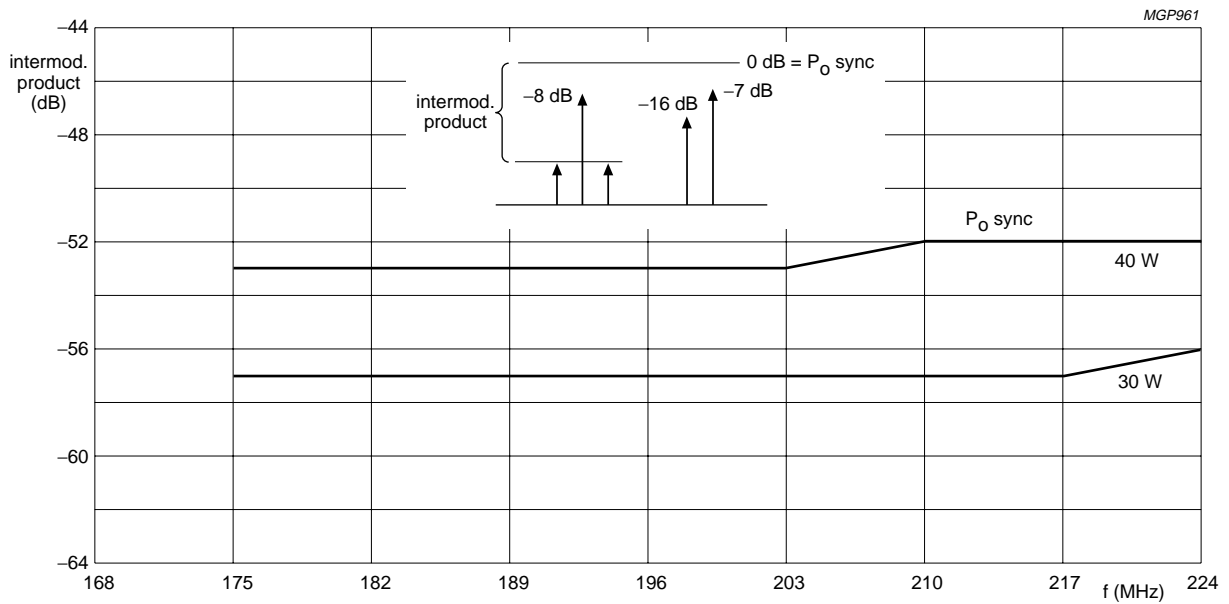
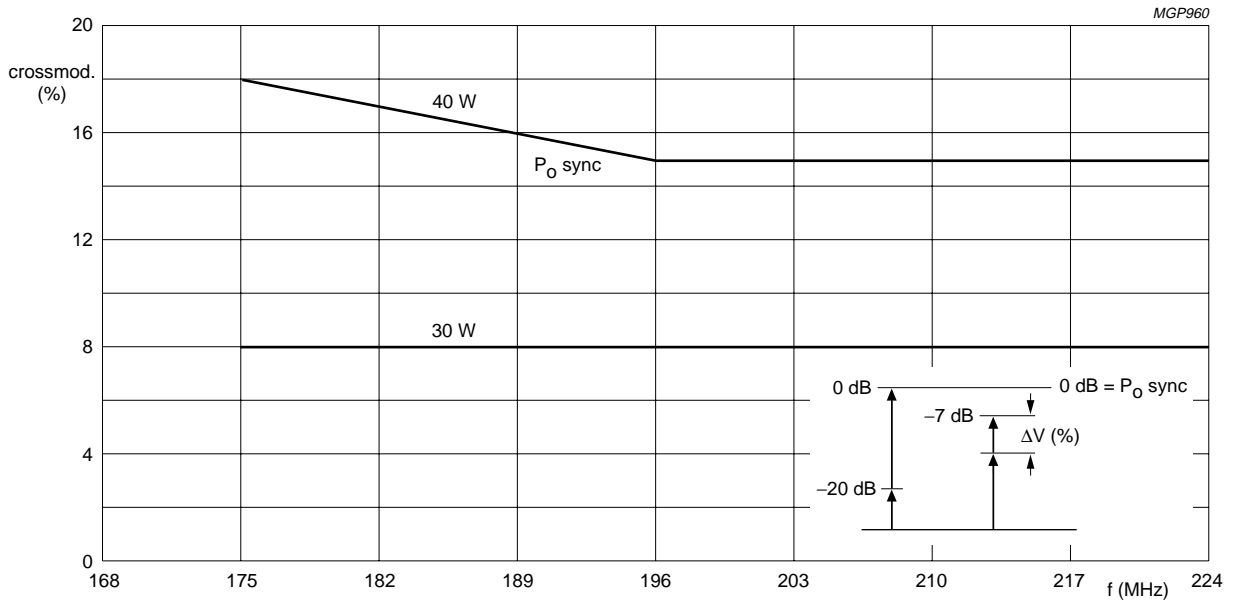


Fig.3 Class A bias circuit for a single transistor BLV33F.

A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F

Application Note
ECO8005

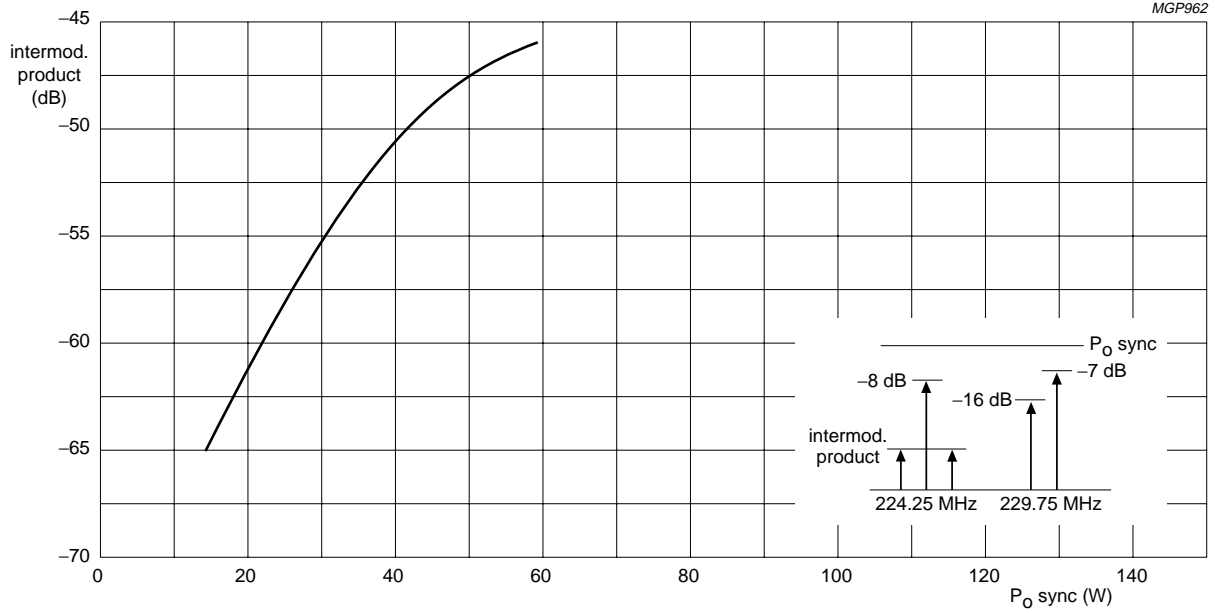


2× BLV33F Class A linear power amplifier.
 $V_{CE} = 25\text{ V} - I_C = 2 \times 3.25\text{ A} - T_{amb} = 23\text{ }^\circ\text{C} - T_h = 65\text{ }^\circ\text{C}.$

Fig.4 Crossmodulation and intermodulation products of the 2× BLV33F wideband Band III linear power amplifier.

A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F

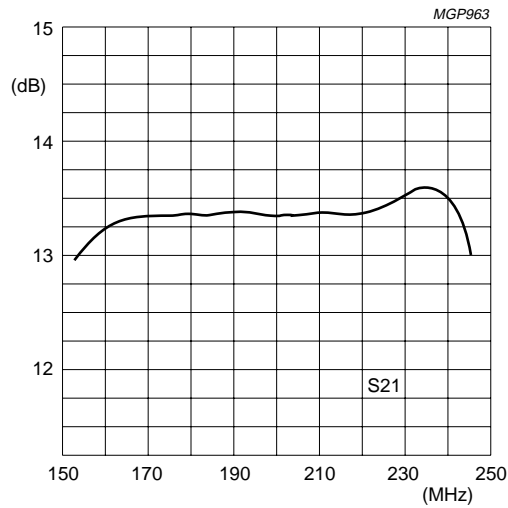
Application Note
ECO8005



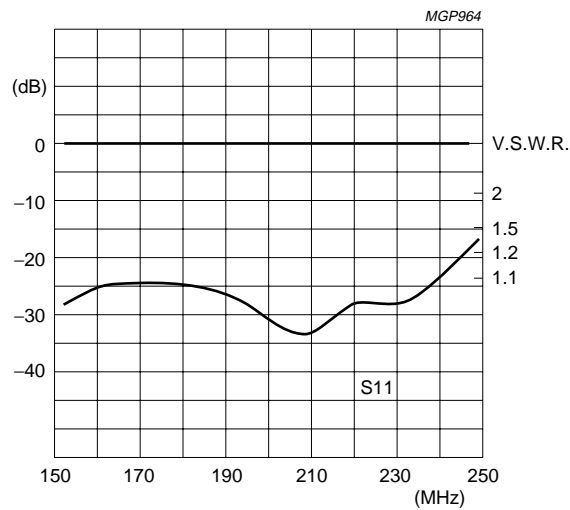
2x BLV33F Band III amplifier.
 $V_{CE} = 25$ V; $I_C = 2 \times 3.25$ A; $T_{amb} = 23$ °C; $T_h = 65$ °C.

Fig.5 3-tone intermodulation product as function of P_o sync. Vision freq. 224 MHz; sound freq 229.5 MHz.

A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F



a. Forward transducer gain.

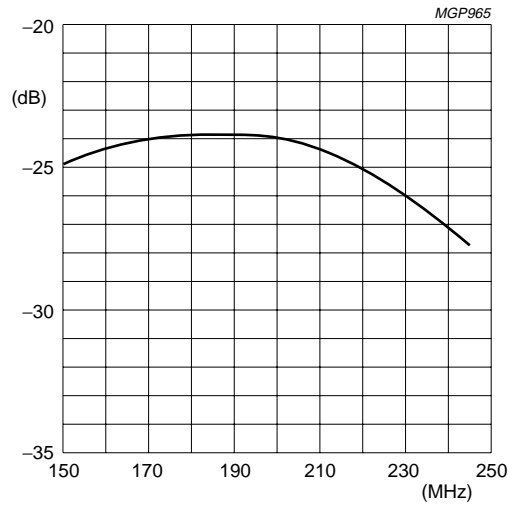


b. Input voltage standing wave ratio.

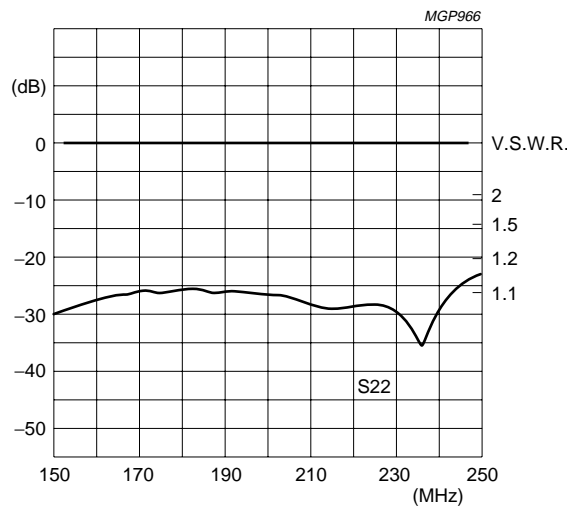
Fig.6 2× BLV33F wideband Band III power amplifier.

A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F

Application Note
ECO8005



a. Reverse transducer gain.

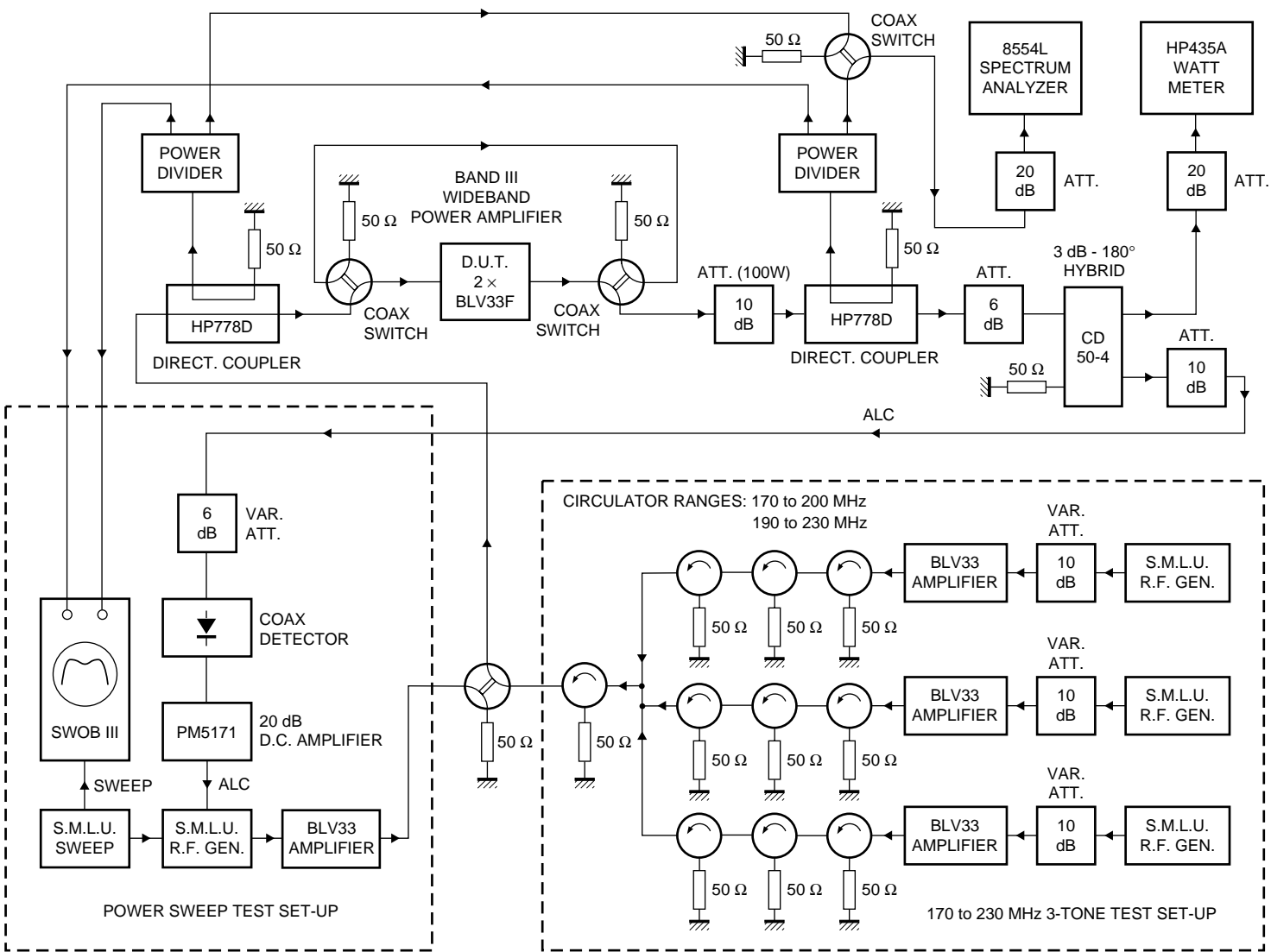


b. Output voltage standing wave ratio.

Fig.7 2× BLV33F wideband power amplifier.

A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F

Application Note
ECO8005



MGP985

Fig.8 Test set up 2x BLV33F Band III power amplifier.

**A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F**

**Application Note
ECO8005**

Unfortunately the numbers in the lay-out of Fig.9 do not correspond with those of the schematic diagram of Fig.1. The reader is referred to the translation Table 5.

Table 5

NUMBER IN LAY-OUT (see Fig.9)	NUMBER OF SCHEMATIC DIAGRAM (see Fig.1)
R1	R3
R2	R5
R3	R6
C2	C1
C3	C3
C4	C4
C5	C7
C6	C8
C7	C11
C8	C14
C9	C15
C10	C19
C11	C13
C12	C21
C13	C22
C14	C25
C15	C26
C16	C27
C17	C31
C18	C32
C19	C35
L1	L1
L3	L3
L6	L11
L9	L17

A wide-band class-A linear power amplifier
(174 – 230 MHz) with 2 transistors BLV33F

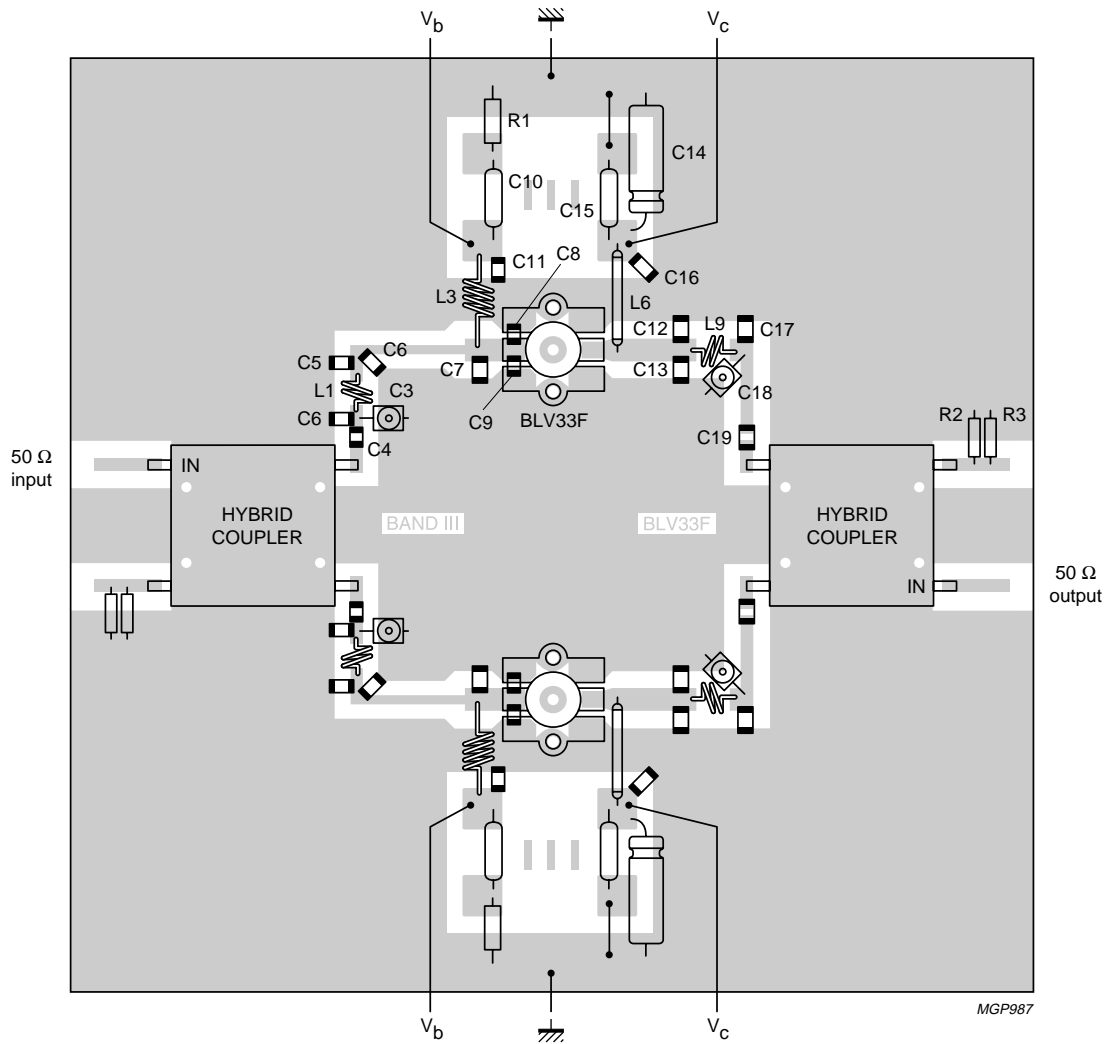


Fig.9 Lay-out of amplifier with situation of components.

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. +43 160 1010,
Fax. +43 160 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 689 211, Fax. +359 2 689 102

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

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: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +45 32 88 2636, Fax. +45 31 57 0044

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615800, Fax. +358 9 61580920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

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: see Singapore

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,
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

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

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 1231,
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 3 301 6312, Fax. +34 3 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 632 2000, Fax. +46 8 632 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2686, Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2865, 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

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 625 344, Fax. +381 11 635 777

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>

© Philips Electronics N.V. 1998

SCA57

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands

Date of release: 1998 Mar 23

Let's make things better.

**Philips
Semiconductors**



PHILIPS

SUNSTAR 商斯达实业集团是集研发、生产、工程、销售、代理经销、技术咨询、信息服务等为一体的高科技企业，是专业高科技电子产品生产厂家，是具有 10 多年历史的专业电子元器件供应商，是中国最早和最大的仓储式连锁规模经营大型综合电子零部件代理分销商之一，是一家专业代理和分销世界各大品牌 IC 芯片和电子元器件的连锁经营综合性国际公司，专业经营进口、国产名厂名牌电子元件，型号、种类齐全。在香港、北京、深圳、上海、西安、成都等全国主要电子市场设有直属分公司和产品展示展销窗口门市部专卖店及代理分销商，已在全国范围内建成强大统一的供货和代理分销网络。我们专业代理经销、开发生产电子元器件、集成电路、传感器、微波光电元器件、工控机/DOC/DOM 电子盘、专用电路、单片机开发、MCU/DSP/ARM/FPGA 软件硬件、二极管、三极管、模块等，是您可靠的一站式现货配套供应商、方案提供商、部件功能模块开发配套商。商斯达实业公司拥有庞大的资料库，有数位毕业于著名高校——有中国电子工业摇篮之称的西安电子科技大学（西军电）并长期从事国防尖端科技研究的高级工程师为您精挑细选、量身订做各种高科技电子元器件，并解决各种技术问题。

微波光电部专业代理经销高频、微波、光纤、光电元器件、组件、部件、模块、整机；电磁兼容元器件、材料、设备；微波 CAD、EDA 软件、开发测试仿真工具；微波、光纤仪器仪表。欢迎国外高科技微波、光纤厂商将优秀产品介绍到中国、共同开拓市场。长期大量现货专业批发高频、微波、卫星、光纤、电视、CATV 器件：晶振、VCO、连接器、PIN 开关、变容二极管、开关二极管、低噪晶体管、功率电阻及电容、放大器、功率管、MMIC、混频器、耦合器、功分器、振荡器、合成器、衰减器、滤波器、隔离器、环行器、移相器、调制解调器；光电子元件和组件：红外发射管、红外接收管、光电开关、光敏管、发光二极管和发光二极管组件、半导体激光二极管和激光器组件、光电探测器和光接收组件、光发射接收模块、光纤激光器和光放大器、光调制器、光开关、DWDM 用光发射和接收器件、用户接入系统光收发器件与模块、光纤连接器、光纤跳线/尾纤、光衰减器、光纤适配器、光隔离器、光耦合器、光环行器、光复用器/转换器；无线收发芯片和模组、蓝牙芯片和模组。

更多产品请看本公司产品专用销售网站：

商斯达中国传感器科技信息网：<http://www.sensor-ic.com/>

商斯达工控安防网：<http://www.pc-ps.net/>

商斯达电子元器件网：<http://www.sunstare.com/>

商斯达微波光电产品网：[HTTP://www.rfoe.net/](http://www.rfoe.net/)

商斯达消费电子产品网：<http://www.icasic.com/>

商斯达实业科技产品网：<http://www.sunstars.cn/> 微波元器件销售热线：

地址：深圳市福田区福华路福庆街鸿图大厦 1602 室

电话：0755-82884100 83397033 83396822 83398585

传真：0755-83376182 (0) 13823648918 MSN: SUNS8888@hotmail.com

邮编：518033 E-mail:szss20@163.com QQ: 195847376

深圳赛格展销部：深圳华强北路赛格电子市场 2583 号 电话：0755-83665529 25059422

技术支持：0755-83394033 13501568376

欢迎索取免费详细资料、设计指南和光盘；产品凡多，未能尽录，欢迎来电查询。

北京分公司：北京海淀区知春路 132 号中发电子大厦 3097 号

TEL: 010-81159046 82615020 13501189838 FAX: 010-62543996

上海分公司：上海市北京东路 668 号上海赛格电子市场 D125 号

TEL: 021-28311762 56703037 13701955389 FAX: 021-56703037

西安分公司：西安高新开发区 20 所(中国电子科技集团导航技术研究所)

西安劳动南路 88 号电子商城二楼 D23 号

TEL: 029-81022619 13072977981 FAX:029-88789382