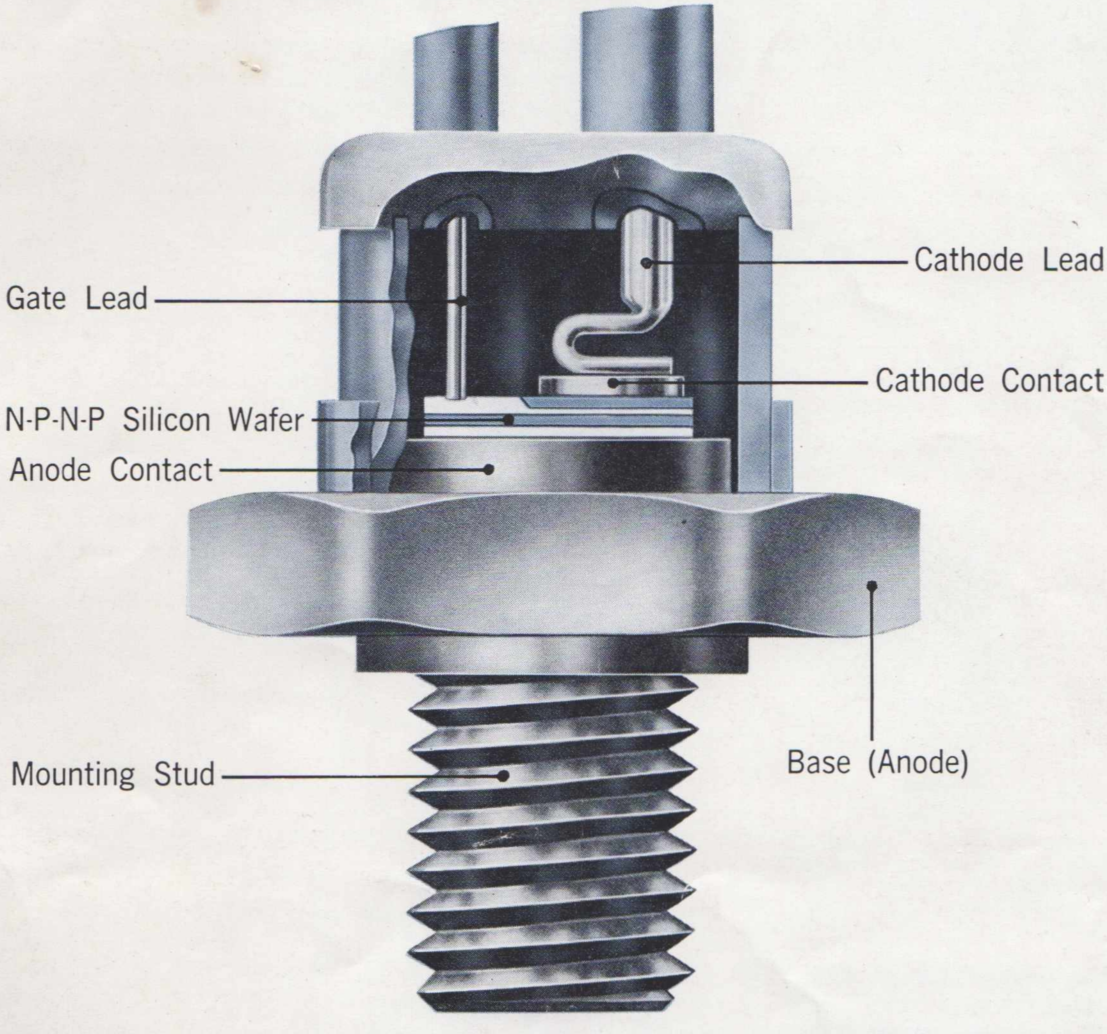
Mullard Outlook

AUSTRALIAN EDITION



VOL. 7, No. 2
MARCH-APRIL, 1964

MULLARD-AUSTRALIA PTY. LTD.

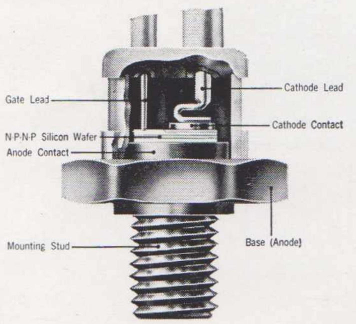
VOL. 7 — No. 2 MARCH-APRIL, 1964

Editorial Office:
35-43 Clarence Street, Sydney.
Telephone: 29 2006

Editor:
JOERN BORK

All rights reserved by Mullard-Australia Pty. Ltd., Sydney. Information given in this publication does not imply a licence under any patent. Original articles or illustrations reproduced in whole or in part must be accompanied by full acknowledgement: Mullard Outlook, Australian Edition.

TABLE OF CONTENTS



A cut-away view of a Mullard Thyristor from the BTY99 family. A tabulation of the Mullard Preferred Range of Thyristors may be found on page 17.

MULLARD-AUSTRALIA PTY. LTD.

35-43 CLARENCE STREET, SYDNEY
Phone: 29 2006

123-129 VICTORIA PDE., COLLINGWOOD, N.5
VICTORIA
Phone: 41 6644

Associated with
MULLARD LTD., LONDON

Excreta Tauri Sapientiam Fulgeat*

Such is the actual motto included in the crest of H.M.S. Aurochs, a R.N. submarine recently in Australian waters. No doubt the happy Silent Service cynic who designed it, inferred tactical manoeuvres and anticipated that at the launching, the dockyard manager's wife would understand.

The whims of salesmanship seem ever related to price emphasis and slick overstatement, consistently and conscientiously supported by the enthusiastic suckers—all of us at some time or another, knowingly or otherwise—and perhaps moreso where brains abound!

In the market place, baksheesh, gulli-gulli men and the waifs with "no mudder, no fadder", the pattern is legion and will remain so, for human failings are a warm experience.

Close to home the coming contests in automobile merchandising may well follow the past consumer products marketing excess and success. All credit then to the move for more creative selling, good customer relations and the dignity and satisfaction of sound selling.

Sell quality and service, sell Mullard.

Channel "Ought"

A handicap for some or unlimited scope for others—the O and its presentation.

For Melbourne retailer readers, the sales of new receivers, the re-sale of trade-ins, or the fidelity towards loyal and trusting customers—new Channel O biscuits in old receivers; and far be it that we mention how we harped on the advantages of turret tuners eight years ago—high quality, high performance turret tuners, standard, yet infinitely flexible.

M.A.B.

*The liberal translation of the Latin, without the four letter words, "Applesauce Baffles Brains".

MULLARD DISTRIBUTORS

New South Wales

Martin de Launay Pty. Ltd.
Cnr. Druitt & Clarence Sts., Sydney. Phone: 29 5834

Cnr. King & Darby Streets, Newcastle. Phone: 2 4741

144 Keira St., Wollongong. Phone: 2 6020

21 Bayliss Street, Wagga. Phone: 4644

Victoria

Carnegie (Australia) Pty. Ltd.
Vere Street, Richmond. Phone: 42 2781

Queensland

C. A. Pearce & Co. Pty. Ltd.
33 Bowen Street, Brisbane. Phone: 2 3201

Western Australia

Tedco Pty. Ltd.
7 Fitzgerald Street, Perth. Phone: 28 4921

South Australia

Agents:
Woollard & Crabbe Limited
180 Wright Street West, Adelaide. Phone: 51 4713

Tasmania

Medhursts Wholesale Ltd.
163 Collins Street, Hobart. Phone: 2 2911
136 Wellington Street, Launceston. Phone: 2 2091
106 Wilson Street, Burnie. Phone: 1919

and all leading wholesalers throughout the Commonwealth

VIEWPOINT WITH MULLARD

CONSUMER PRODUCTS SALES AND SERVICE

Let's Make Money

Many have tried but invariably get caught and we have all accepted a crook two bob from time to time. Above all, we must trade profitably and it is significant that the business transaction is far more than a cold cash deal—or terms. The customer knows and accepts that you are making a profit somehow and likes to feel that someone is benefiting who is taking an interest in him, with courtesy and service. How often, when we are buying shoes, furniture or pharmaceuticals do we wonder how much the retailer is making and what we might save if we knew somebody?

. . . taking an interest in him, with courtesy and service.

Honourable and Laudable Ambition

Please do not think it vulgar or indecent to harp on making money—it is the way one does it that counts; and the satisfaction of doing it, an honourable and laudable ambition indeed.

Public Relations No Fairy-Tale

To be sanctimonious with shades of the do-gooder is one thing, but drive, initiative and a sincere desire to please is vital in business relationships; something to be constantly and carefully nurtured in both a buyers' market and a sellers' market.

It could therefore be somewhat presumptuous of us to discuss it in Outlook. Nevertheless, as the Viewpoint page is devoted to selling, be it products or service, we touch on a few points that may be of interest to both non-technical and technical readers.

Customer Relations

The need for good CUSTOMER relations is self-evident and basic as good PUBLIC relations—the projecting of an image before, during and after you have landed the customer.

The Art

Customer relations has been defined "as the art of cultivating and perpetuating the goodwill of established customers".

Far be it that we set ourselves as paragons in the field, but in the next few issues of Outlook we shall endeavour to provide retailer (and servicemen) readers with a theme or two.

The Irritation

The difficulty of parking, sorting out the actual price, waiting for attention, a cluttered store, or just grit in the eye; the sales assistant has the important yet delicate task of cementing the relationship with customers, a variety of types with a variety of demands. For the attitude of the sales assistant reflects in what pleasure is derived from shopping and more particularly in your store, just as vital the attitude of your servicemen in the customers' homes, again a variety.

The Power of Your Local Press

As a retailer with goods to sell and a service to give, it is important that as many people as possible in your area know what you have to offer. One of the best ways of getting right into the homes of those people is through their local newspaper.

A vast number of households read their local weekly, in fact the publishers are so eager to distribute it, that one often receives two copies! One of the main reasons why local papers flourish is because people generally are far more interested in the familiar things around them than in happenings far away, what is more, they want to know what their local supermarket is offering in the way of cut-price foodstuffs and where last season's clothes are going for a song.

Do you make the best use of your local paper?

. . . as many people as possible in your area.

Direct Mailing

Next Viewpoint feature is a direct mailing scheme—the Mullard Direct Mailing Scheme—prepared in detail to help put you on personal friendly terms with every person in your area. To link up with your local press advertising—your image—and to sell them service and goods for you to build good customer relations with the minimum of irritation!

Of all the many forms of advertising and promotion a retailer can put to work to his advantage, none is more adaptable or capable of being so finely-focused as direct mail.

No matter whether your mailing shot is sent through the post or distributed by hand, you know EXACTLY where your message is being received. And you can be as selective as you like in order to meet the particular needs of your business and to reach those people whose interest you wish to arouse.

But how do you measure the success of your efforts? What means are there of linking your campaign DIRECTLY to the increased enquiries and sales which are likely to ensue?

We believe that direct mail allows for complete control over targets. The same control can appreciably help you in totting up the score.

Read the Viewpoint page in the next issue of Outlook (Vol. 7, No. 3) for details of the Mullard Direct Mailing Scheme.

MULLARD-AUSTRALIA PERSONALITIES

MR. M. F. JESSOP

With 14 years in the valve business, Merv Jessop keeps a close eye on our entertainment maintenance valve sales, stock movement and invoicing. Earlier associations were centred around stock and quality control in general engineering and aircraft engineering companies. There is something to "having a feel" for valves and, evidenced by his customer following, Merv certainly has the feel.

Much a family man, he has five children aged from 21 years to 12 years to occupy his interests, along with some fishing and gardening.

MULLARD AT THE A.S.E.E. EXHIBITION

A comprehensive range of power devices for applications in electrical engineering was shown by Mullard at the recent Association of Supervising Electrical Engineers Exhibition (A.S.E.E.) in London.

Amongst products shown for the first time were the new range of thyristors (silicon controlled rectifiers), silicon diodes, rectifier and thyristor stacks (in kit form or assembled) and a new 200kVA thyratron for resistance welders.

A thyristor bridge assembly and drive circuit was demonstrated controlling the speed of a 1 h.p. single-phase electric motor.* The unit represented an economic method of controlling loads of up to 1·5kW or 1 h.p. When controlling a 1 h.p. motor, the unit is able to cope with the difficult constant torque condition which produces high peak currents on the thyristors at very low conduction angles.

The basic unit provides a simple one-knob control of motor speed but optional circuits may be added to give various degrees of positive and negative feedback to achieve an improved speed-torque characteristic and compensation for variations in mains voltages, as well as the many other extra motor control facilities which are often required.

The unit represents the first of a range of Mullard bridges and drive circuits. With these units, it is possible to build equipment with the minimum of additional circuit design and without the necessity of going into elaborate detailed calculations to design circuits to provide adequate drive pulses for the thyristors.

NEW PRODUCTS

Thyristors

BTY80 and BTY81—These are inexpensive 4·7A thyristors intended for light industrial applications and for certain types of consumer electrical products. The minimum forward breakover voltage is 250V for the BTY80 and 400V for the BTY81. Both types are rated for 3·2A at a maximum mounting-base temperature of 85°C.

Thyristors rated for 4·7A, 10A, 16A, 20A, 30A, 50A and 70A are tabulated on page 17. Maximum junction temperature for all types is 125°C.

Silicon Diodes

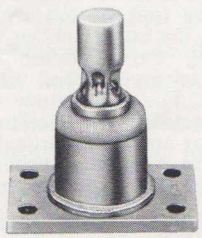
Silicon diodes for a wide variety of applications are now available in both conventional and reversed polarity versions for use at forward currents from 6A to 150A. Their high voltage ratings eliminate the use of costly protective circuitry in many applications.

BYZ10, BYZ11, BYZ12 and BYZ13—These comprise the 6A range and are rated for a maximum non-repetitive peak reverse voltage (V_{RSM}) of 1200V, 900V, 600V and 300V, respectively.

BYY22 and BYY24—Two diodes for use at forward currents up to 10A; their maximum non-repetitive peak reverse voltage is 400V and 800V respectively.

BYX13/400, BYX13/800, BYX13/1200 and BYX13/1600—The 20A range includes these four types which are rated for a maximum non-repetitive peak voltage (V_{RSM}) of 400V, 800V, 1200V and 1600V, respectively.

BYZ14, BYY15, BYY77 and BYX15—These four types are included in the range of 40A diodes, their maximum non-repetitive peak voltage being 400V, 800V, 1200V and 1600V, respectively.



150A silicon rectifier diode type BYX14.

BYX14/400, BYX14/800 and BYX14/1200—These are 150A high voltage diodes for power rectification purposes. Their maximum crest reverse working voltage (V_{RWM}) is 200V, 400V and 600V, respectively; the maximum non-repetitive peak voltage (V_{RSM}) is indicated by the figure after the type number (i.e. BYX14/**400**) and the maximum junction temperature is 190°C.

Aluminium Heatsinks**

An extensive range of die-cast and extruded heatsinks, together with all the necessary components to meet the varied heat dissipation requirements of silicon diodes and thyristors were shown. Heatsinks with thermal resistances of 0·5°C/W to 12°C/W are available. They can be supplied in standard lengths or as continuous extrusion and are designed for either natural or forced air cooling. By reference to comprehensive technical data and performance curves produced for each heatsink, users can determine both quickly and accurately the most suitable heatsink for a particular requirement.

A typical example of an extruded heatsink is the type 40D. This heavy duty extrusion is designed for convection cooling and has a very low thermal resistance. A specially designed range of die-cast heatsinks is available for use with the BYZ10, BYY22 and BYZ14 series of diodes.

Thyristor and Diode Rectifier Stacks and Assemblies

A range of heavy duty and light duty rectifier stacks for applications ranging from instrumentation to electrical traction and control installations were also shown in London at the A.S.E.E. Exhibition. The stacks are of rugged construction with high electrical safety factors. Non-tracking insulators permit operation in damp atmospheres and the stacks may be mounted on either a horizontal or vertical surface without restricting the ventilation below the heatsink. The aluminium heatsinks are protected against corrosion and their generous finned areas give a high safety factor against possible over-heating caused by fluff and dust collection.

Ignitrons

Water-cooled and air-cooled types were shown for resistance welding or similar AC control applications at power ratings from 60kVA to 2400 kVA.

The latest addition to the types displayed is ZX1000 which is an air-cooled ignitron for single-phase resistance welding applications at peak powers of up to 200kVA.

As the ZX1000 incorporates a fast-response, low energy ignitor, it may be fired by a low-cost miniature thyratron. A fast ignition time of 10μsec, independent of variations in load impedance, is achieved by using a suitable capacitor firing system.

The ZX1000 is rated for a maximum peak voltage (forward and inverse) of 800V and a maximum surge current of 2·8 times the maximum demand current (T = 0·15sec). It may be operated over a frequency range of 25c/s to 60c/s.

The ignitron can be supplied with air-cooling fins or with a slip-on water jacket. Peak power output with either method of cooling is unchanged. For more detailed information, data sheets may be obtained from the Mullard Technical Service Department.

Mullard compact air-cooled ignitron type ZX1000 for use at peak powers up to 200kVA. Right: Cooling-fin assembly. Left: Alternative water-cooling jacket.

Thyratrons

Eight large thyratrons, primarily intended for use in motor control equipment were displayed. Current ratings vary from 2·5A to 25A and types were exhibited with negative and positive control characteristics.

---

* A similar unit is described in Outlook, Vol. 6 No. 2, page 25 and was shown at the 1963 I.R.E. Convention in Melbourne.

**The local range of heatsinks was tabulated in Outlook Vol. 6 No. 6, page 77. Forward a stamped, self-addressed foolscap envelope, endorsed "Heatsink" and receive a leaflet detailing mechanical dimensions and thermal characteristics.

MULLARD THYRISTORS PREFERRED RANGE

Max repetitive peak reverse voltage V	Max non-repetitive peak reverse voltage (<5mS) V	$I_{f(av)max}$ **4.7A**	$I_{f(av)max}$ **10A**	$I_{f(av)max}$ **16A**	$I_{f(av)max}$ **20A**	$I_{f(av)max}$ **30A**	$I_{f(av)max}$ **50A**	$I_{f(av)max}$ **70A**
100	**150**	—	**BTY87-100R**	**BTY91-100R**	**BTX12-100R**	**BTX13-100R**	**BTY95-100R**	**BTY99-100R**
150	**225**	**BTY79**	—	—	—	—	—	—
200	**300**	—	**BTY87-200R**	**BTY91-200R**	**BTX12-200R**	**BTX13-200R**	**BTY95-200R**	**BTY99-200R**
250	—	**BTY80**	—	—	—	—	—	—
300	**400**	—	**BTY87-300R**	**BTY91-300R**	**BTX12-300R**	**BTX13-300R**	**BTY95-300R**	**BTY99-300R**
400	**500**	**BTY81**	**BTY87-400R**	**BTY91-400R**	**BTX12-400R**	**BTX13-400R**	**BTY95-400R**	**BTY99-400R**
500	**600**	—	**BTY87-500R**	**BTY91-500R**	**BTX12-500R**	**BTX13-500R**	**BTY95-500R**	**BTY99-500R**
600	**700**	—	**BTY87-600R**	**BTY91-600R**	**BTX12-600R**	**BTX13-600R**	**BTY95-600R**	**BTY99-600R**
700	**800**	—	**BTY87-700R**	**BTY91-700R**	**BTX12-700R**	**BTX13-700R**	**BTY95-700R**	**BTY99-700R**
Maximum Average Forward Current (A)		**4·7**	**10**	**16**	**20**	**30**	**50**	**70**
Maximum Recurrent Peak Current (A)		**20**	**40**	**60**	**100**	**250**	**450**	**500**
Maximum Junction Temperature (°C)		**125**	**100**	**125**	**125**	**125**	**125**	**125**

THYRISTOR AND DIODE RECTIFIER STACKS

Single-phase stacks

	Rectifier Stack OSH240A	Thyristor Stack OTH23-403
Max. DC output voltage	250V	250V
Max average DC output current*	20A	23A
Max. applied AC voltage	280V rms; 400V pk	280V rms; 400V pk
Max. non-repetitive peak reverse voltage	800V	800V
Max. recurrent peak current	50A	60A

Three-phase thyristor stack

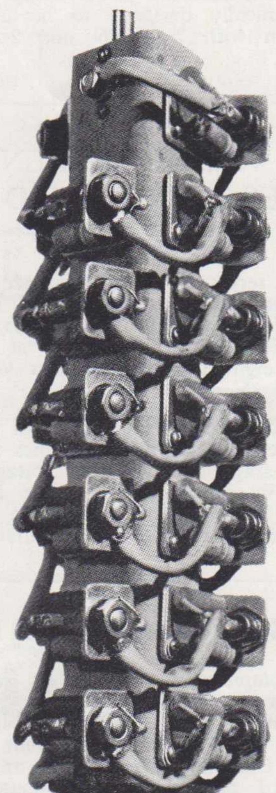
	OTK117-1206
Max. DC output voltage	1050V
Max. average DC output current*	117A
Max. applied AC voltage	1100V
Max. non-repetitive peak reverse voltage	2200V
Max. recurrent peak current	350A

*with resistive or inductive load.

EHT Rectifier Modules

Two types were shown, one a basic module for connecting in series and the other a high voltage assembly rated for a maximum transient voltage of 16kV. These assemblies are designed to operate under arduous conditions and built to withstand heavy overload and surge currents.

	OSS4300 (basic module for series connection)	OSS8300/20 (high voltage assembly)
Output voltage	360V	7·2kV
Output current (T_{amb} 55°C)	3·5A	3·5A
Surge current	300A for 10msec	300A for 10msec
Overall dimensions	110m x 25·4mm	



High voltage rectifier unit type OSS8300/20.

TEMPERATURE COMPENSATION PROLONGS EFFECTIVE BATTERY LIFE

OA675 Bias Stabilising Diode

The Mullard junction diode OA675, is being used in the latest transistor radios and amplifiers to provide compensation for changes in battery voltage and operating temperature.

The crossover distortion of an output stage will increase as the battery supply voltage deteriorates and this effect is accentuated as the operating temperature falls. To ensure good battery life, it is desirable that the receivers be designed to give acceptable performance when the voltage falls to about 50% of the nominal value and, if the OA675 is incorporated in the base-bias network of the output stage of the equipment, the necessary compensation can be achieved. With such an arrangement the voltage can fall well below the 50% limit without the performance deteriorating even at extremely low temperatures. Use of the Mullard bias stabilising diode thus ensures less variation in performance with battery voltage decay and considerably prolongs the useful life of the batteries in transistorised equipment featuring Class 'B' output stages.

Although the OA675 may be used in most medium transistor power output stages, it is specifically designed to be used in conjunction with 2-OC74N and 2-AC128 transistors.

NEW RANGE OF ZENER DIODES INTRODUCED BY MULLARD

A new series of close tolerance zener diodes has recently been added to the existing Mullard range. These diodes, which have a dissipation of 400mW at 25°C, comprise eight types with zener voltages between 4·7V and 9·1V.

The diodes are suitable for use in voltage reference circuits, coupling and bias circuits for DC amplifiers, and as voltage-shift elements in digital circuits. The BZY88 family of zener diodes is available in all-glass sub-miniature DO-7 encapsulation.

TABLE OF CONTENTS

The Comprehensive Table of Contents was prepared to assist readers with the location of technical articles contained in Volume 1 to Volume 6 of Outlook. This Table of Contents also contains an index of Mullard product type numbers most frequently required.

We are pleased to inform those readers who have enquired, that further reprints are now available. To secure your copy please forward your remittance of 1/6d to Mullard-Australia Pty. Ltd., G.P.O. Box 2118, Sydney, N.S.W. Cheques, Postal Notes and Money Orders should be made payable to "Mullard-Australia Pty. Ltd.".

MULLARD INTRODUCE FOUR NEW POWER TRANSISTORS

Fourteen Low-Cost Germanium and Silicon Types Provide a Wide Range

The introduction of four power transistors extends the Mullard range to fourteen types, forming a wide and economic range. The four new devices consist of two high-current, low-frequency germanium power transistors —types 2N1100 and ADY26—and two high-power n-p-n double-diffused silicon types BDY10 and BDY11.

This range meets the requirements of industrial control and switching, communications and DC converter applications, producing power outputs of up to 130W. The important characteristics and applications of the Mullard transistor range are given in the table (right).

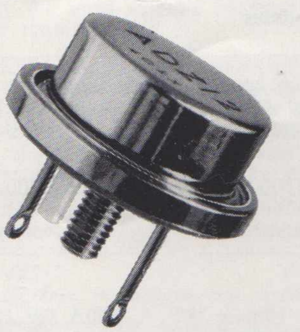
Four Groups

The fourteen types have specific applications but can be classified into four groups of similar overall characteristics. The "general purpose" group consisting of the OC20, OC28, OC29, OC35 and OC36 is intended for switching, amplifying and control applications in the industrial and communications fields. The higher-current germanium devices 2N1100, ADY26, ADZ11 and ADZ12 are used for audio frequency, DC converter and series regulation applications. The high-frequency devices OC22, OC23 and OC24, form a group with particular use in high speed switching, wideband audio and ultrasonic applications. The silicon transistors, BDY10 and BDY11, are used where higher powers and operating temperatures are required.

Advanced Performance In Silicon

The double-diffusion technique used in the manufacture of the silicon power transistors gives a low bottoming voltage and a high voltage performance, the voltage rating of the BDY11 being 100V, together with an adequate frequency performance and maintained gain to collector currents of 4A. The typical f_1 value of these two transistors is 2 Mc/s. The silicon transistors can be used with the OC28 p-n-p germanium transistor in high-power, complementary n-p-n and p-n-p circuits.

More detailed information on the Mullard power transistor range may be obtained from the Mullard Technical Service Departments.



ADZ12 Power Transistor in TO-36 encapsulation.

MULLARD INDUSTRIAL POWER TRANSISTOR RANGE *

Important Characteristics and Applications

2N1100	High voltage, high power, high current; intended for general industrial converter and series regulator applications.
ADY26	High voltage, high power, high current; with maintained gain. For high-power DC converter and series regulator applications.
ADZ11	High power, high current; for AF applications.
ADZ12	High power, high current; for AF applications.
BDY10	Medium voltage, high frequency, high power, n-p-n silicon double-diffused; intended for general industrial applications.
BDY11	High voltage, high frequency, high power, n-p-n silicon double-diffused; intended for general industrial applications.
OC20	Medium gain; very high voltage and high-current switching applications.
OC22	High-speed switching, also suitable for high-quality audio output stages.
OC23	High-speed switching; specially designed as pulse amplifier for driving Ferroxcube cores.
OC24	High-speed switching, medium-frequency transmitter and carrier telephony applications.
OC28	Close tolerance, high voltage, high current; particularly suitable for DC converters.
OC29	High gain, medium voltage, high current; suitable for industrial switching, control applications and high-power industrial applications.
OC35	Medium voltage, high current; general purpose and control applications (for example, stabilised power supply units).
OC36	High voltage, medium gain, high current; general purpose and control applications.

* A tabulation of Mullard entertainment semiconductors may be found on pages 23 and 24.

Stabilised Transistor Power Supply Unit

With the ever increasing use of semiconductors—devices which may require currents as low as 1mA and as high as 3A or more—the need for stabilised low voltage power supply units has now become more necessary and this article describes such a unit. This unit was originally designed for use in the Mullard Educational Service but it is believed that service organisations and home constructors will also be interested in the circuit details.

General Specification

The unit operates from conventional mains supplies and can give a number of different stabilised output voltages over a current range from zero to 3A. For an output current of 2A, for example, the unit can supply +12·75V and −12·75V (with respect to a common terminal). Alternatively it can supply 25V. For zero output current these potentials rise to 13·5V and 27V respectively.

The maximum continuous current which can be drawn from either of the 13V terminals is 3A and from the 25V supply is 4A. If both 13V supplies are in continuous operation, the total current drawn must not exceed 4A.

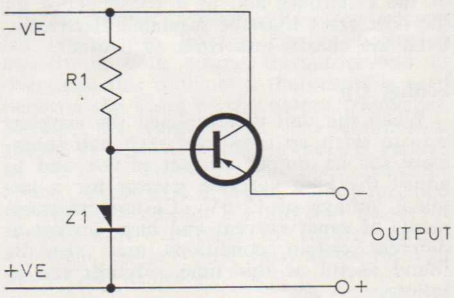


FIG. 1

Stabilisation

A number of stabiliser circuits were tried and rejected before the final prototype was accepted. Some of these circuits were too complex and too expensive—others failed to operate successfully over the desired current range. It was decided finally that a transistor should be used in an emitter follower circuit with voltage stabilisation on the base. Such a circuit is shown in Fig. 1. In broad terms, the circuit operates in the following manner. The output voltage between transistor emitter and positive rail is a function partly of the potential drop across the transistor and partly of the potential difference between base and emitter terminals (V_{be}).

However, the base-emitter voltage is the difference between the output voltage (V_o) and the zener voltage (V_z). If the zener diode Z1 maintains a constant voltage the base-emitter voltage increases as the output voltage decreases ($V_{be} = V_z - V_o$). Consequently any tendency for the output voltage to drop, causes an increase in V_{be} which increases the output voltage again. Under normal conditions, therefore, the output voltage remains substantially constant for large changes in output conditions.

Resistor R1 has a critical value which depends upon the parameters of the zener diode and of the transistor. In practice, therefore, it is usually semi-variable and is adjusted to suit any individual combination of semiconductors.

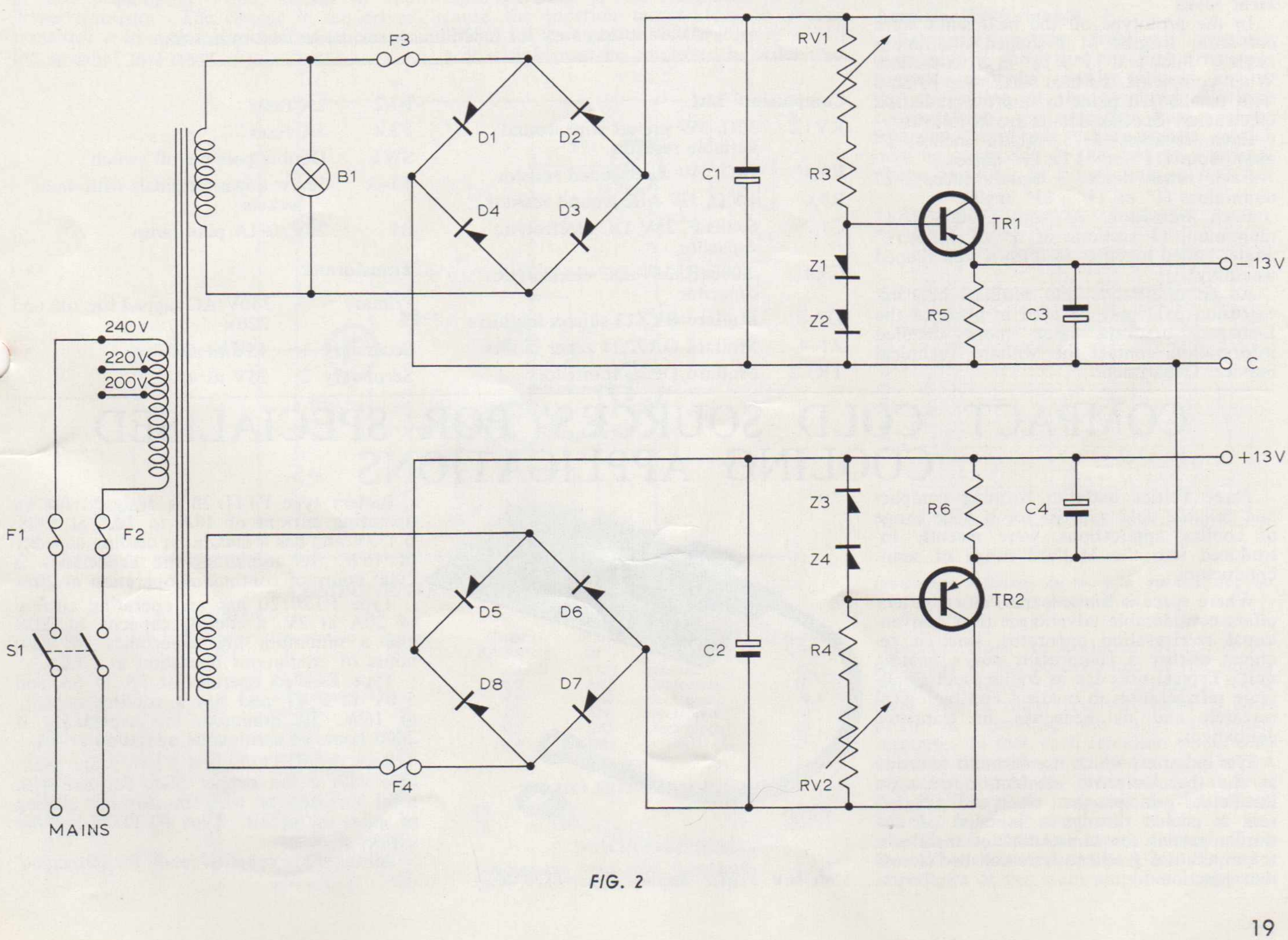


FIG. 2

Circuit Description

Fig. 2 illustrates the complete circuit of the final prototype. It will be realised that the upper and lower halves of the circuit are identical and the unit is, to all intents and purposes, two separate power packs using a common transformer primary. Taking the top half of the diagram, rectifier diodes D5 to D8 form a full wave bridge circuit with reservoir capacitor C1. Z2 and Z4 are zener diodes which, in conjunction with resistors RV2 and R4 and transistor TR1, form a stabilisation circuit. Capacitor C3, in conjunction with the ohmic resistance of the transistor, gives additional smoothing of the DC output.

The outputs from both halves of the unit are cross-connected so that voltages of either polarity with respect to a common point can be obtained. It should be noted that there is no common earth in the circuit and a real earth may be connected to any one of the three output terminals.

Finally, the need for the fuses F3 and F4 should be noted. These fuses protect the diodes and transistors from overload.

Construction

The prototype unit was constructed in a metal box $9'' \times 9'' \times 3''$. No great difficulty in layout was experienced although it is, of course, essential that the rectifiers, zener diodes and transistors be mounted on separate heat sinks of adequate dimensions. In the prototype the heat sinks were themselves mounted on a large section of insulating material such as paxolin or formica. The sections were then bolted one either side of the mains transformer.

Heat Sinks

In the prototype all the heat sinks were cut from lengths of L-shaped aluminium angle $\frac{1}{8}''$ thick and $1\frac{1}{2}'' \times 1\frac{1}{2}''$ in cross section. When completed, the heat sinks were painted with blackboard paint to improve radiation efficiencies. Specific details are as follows:

Each rectifier, 3·75 square inches, $\frac{1}{8}''$ aluminium ($1\frac{1}{4}''$ of $1\frac{1}{2}'' \times 1\frac{1}{2}''$ angle).

Each zener diode, 3 square inches, $\frac{1}{8}''$ aluminium ($1''$ of $1\frac{1}{2}'' \times 1\frac{1}{2}''$ angle).

Each transistor, 22 square inches, $\frac{1}{8}''$ aluminium (3 sections of $5''$ of $1\frac{1}{2}'' \times 1\frac{1}{2}''$ angle, bolted together to form a step shaped assembly).

As an alternative, the Mullard heatsink extrusion 35D may be used in place of the L-shaped brackets. For more detailed information, contact the Mullard Technical Service Department.

In the prototype unit a 30V, 4A centre tapped secondary transformer was used. The windings to the centre tap were unsoldered and brought out to spare tags.

Connections to Semiconductors

Fig. 3 shows the terminal connections to the various semiconductors used in the circuit. Note that in all these devices the actual casing is connected internally to one of the electrodes and as a consequence all the heat sinks must be insulated electrically from the chassis and from each other.

Setting Up

When the unit is completed the simplest way to set it up is to load each half separately for an output current of 3A and to adjust the base variable resistor for a terminal voltage of 12·5V. Certain measurements of zener current and base current at different output conditions may also be found useful at this time. Details are as follows:

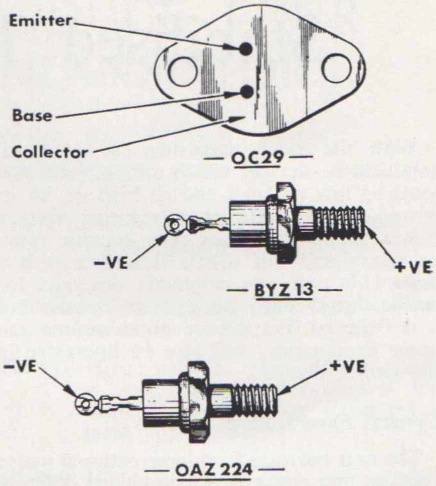


FIG. 3

OUTPUT CURRENT (A)	OUTPUT VOLTAGE (V)	ZENER CURRENT* (mA)	BASE CURRENT* (mA)
–	13·5	150	negligible
1	13·25	100	4
2	12·75	45	14
3	12·5	14	24

*Values may vary for individual zener diodes and transistors.

Components List

RV1,2	50Ω, 3W pre-set wire wound variable resistor
R3,4	20Ω, 3W wire wound resistor
R5,6	100Ω, 5W wire wound resistor
C1,2	6,400μF, 25V DC electrolytic capacitor
C3,4	2,000μF, 25V DC electrolytic capacitor
D1–8	Mullard BYZ13 silicon rectifiers
Z1–4	Mullard OAZ224 zener diodes
TR1,2	Mullard OC29 transistors
F1,2	2A fuses
F3,4	3A fuses
SW1	Double pole on/off switch
T1–3	Screw down terminals with 4mm sockets
B1	20V, 0·1A pilot lamp

Transformer

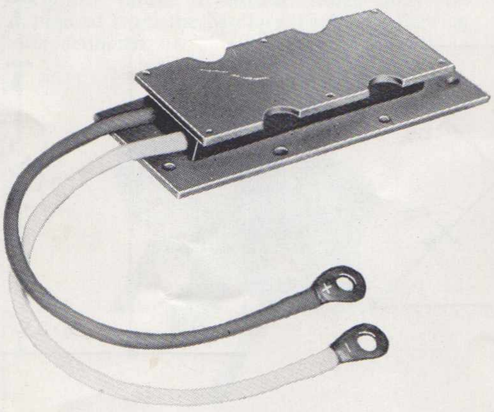
Primary	240V AC tapped for 200 and 220V
Secondary 1	15V at 4A
Secondary 2	15V at 4A

COMPACT 'COLD SOURCES' FOR SPECIALISED COOLING APPLICATIONS

Three Peltier batteries forming compact and reliable cold sources for a wide range of cooling applications, were recently introduced into the Mullard range of semiconductors.

Where space is limited, the Peltier battery offers considerable advantages over conventional refrigeration apparatus, since it requires neither a compressor nor a heating unit. Typical uses are in cooling and small-scale refrigeration in medical and biological research and as heatsinks in transistor equipment.

The batteries, which use bismuth telluride as the thermoelectric element, operate on the Peltier principle that, when a direct current is passed through a junction of dissimilar metals, or semiconductor materials, a temperature gradient is established across that junction.



Mullard Peltier Battery Type PT20/20.

Battery type PT11/20 is designed for an operating current of 18A to 22A at 1·0V o 1·2V and has a maximum cooling capacity of 16W. Its minimum life expectancy is 2000 hours of continuous operation at 20A.

Type PT20/20 has an operating current of 20A at 2V, a cooling capacity of 23W and a minimum life expectancy of 2000 hours of continuous operation at 20A.

Type PT47/5 operates at 5A to 6A and 5·0V to 5·4V and has a cooling capacity of 16W. Its minimum life expectancy is 2000 hours of continuous operation at 5A.

Both the PT11/20 and PT47/5 are available with a flat copper plate for use with solid surfaces, or with fins for the cooling of gases or liquids. Type PT20/20 has flat copper plates.

All three are supplied ready for immediate use.

Increased Power Output from Complementary Symmetry Amplifier

Using Mullard Transistors AC127/AC128

As a result of extended life tests, the AC127 transistor peak collector current rating has been increased from 200mA to 500mA and, consequently, the preferred complementary pair is now the AC127/AC128. These transistors are capable of producing much higher audio powers than the previous AC127/AC132 combination.

The amplifier described in this article delivers 750mW to a 7·5Ω loudspeaker when operated from a 9V source and the use of DC coupling throughout results in considerable component economy, without sacrificing any of the advantages normally associated with complementary symmetry amplifiers.

The drift problems usually encountered in DC coupled amplifiers have been minimised by the use of an n-p-n transistor as a pre-amplifier. This transistor, acting as a difference amplifier, compares the voltage at the junction of the output transistors with the voltage provided by the voltage divider R_3, R_4 and, since the latter is fixed, any change in the mid-point voltage of the output transistors causes a change of current in the pre-amplifier—and, hence in the driver transistor. The change in the driver transistor is in such a direction as to correct the original mid-point displacement.

This feedback system does not correct for changes in leakage current occurring equally in both output transistors and to overcome this problem a thermistor is used between the bases of the output transistors. Ideally, the response of this component should be such as to reduce the DC voltage by 5mV/°C between the output transistor bases. Although a figure of 82Ω is specified for the shunt resistor R_{10}, this may be varied between 68Ω and 100Ω to ensure that a quiescent current of 2·5mA flows through the AC127 collector.

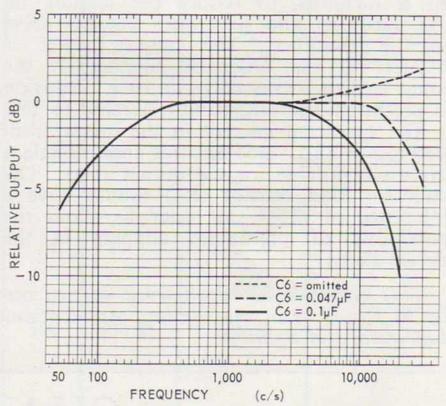
Transistor Ratings

The peak current through the output transistors is 440mA which is somewhat below the permissible maximum. The power output, however, is limited to the quoted figure, by the collector dissipation limit of the transistor and the need to employ a speaker with a conventional voice coil impedance. The maximum collector dissipation of the AC127 is 280mW which occurs when the amplifier supplies 300mW. Reference to the data will show that this is an absolute limiting value. If this dissipation is not to cause the junction temperature to exceed 100°C for an ambient temperature of 45°C, a heat sink must be employed in order that the thermal resistance of the transistor will be less than 0·2°C/mW. In practice, the output transistors were both attached to a piece of 16 gauge aluminium 1½" x 2½", which gave the AC127 a thermal resistance of 0·16°C/mW. Preliminary calculations indicate that, under the same dissipation and temperature limitations a 12V supply and 15Ω speaker combination can produce an output power of 950mW.

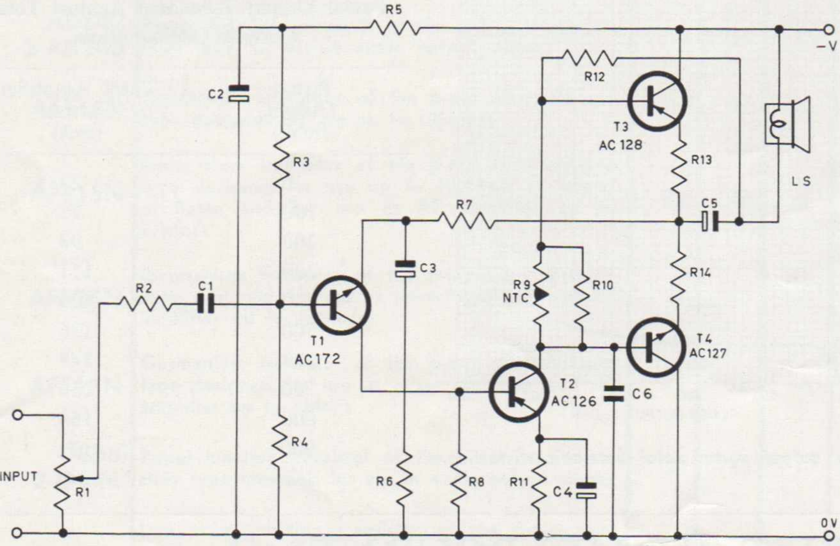
When designing an amplifier using this configuration, considerable care must be taken in choosing the emitter resistors for the output stage. As in all Class 'B' stages, if the resistors are too low, the amplifier will be thermally unstable and may "run away" at high temperatures. If, however, the resistors are too high, not only will too much audio power be wasted but the quiescent current in the driver transistor will rise unduly. As an example, in the amplifier described, should the emitter resistors be raised from 0·47Ω to 2·2Ω the driver-collector-current would have to be increased from 10mA to 30mA—such an increase would, of course, have a drastic effect on battery life.

Amplifier Performance

Reference to the frequency response diagram will show that the high frequency response may be readily tailored to suit the application of the amplifier. Without compensation, the amplifier has a rising frequency/amplitude characteristic which may be controlled in the case of a gramophone amplifier by connecting an 0·047µF capacitor from the collector of the driver transistor to the positive side of the supply voltage (ground). If the amplifier is to be used with a radio receiver, there is little point in retaining the high frequency response. In fact, such retention would only increase the noise level and so the bypass capacitor should be increased to at least 0·1µF. The bass response is determined by the level of feedback which, in this amplifier, is 12dB and this is determined by R_6. When this resistor is 8·2Ω, the input impedance of the main amplifier is approxi-



Frequency response curve with various degrees of compensation.



COMPONENTS PARTS LIST

RESISTORS

Circuit Reference	Value		Tolerance (±%)	Description	Rating (W)
R1	1	MΩ	—	log taper potentiometer	
R2	120	kΩ	10	carbon	½
R3	10	kΩ	5	carbon	½
R4	8.2	kΩ	5	carbon	½
R5	1.8	kΩ	10	carbon	½
R6	8.2	Ω	5	wire wound	½
R7	1	kΩ	10	carbon	½
R8	470	Ω	10	carbon	½
R9	33	Ω	10	N.T.C.	
*R10	82	Ω	5	carbon	
R11	27	Ω	10	carbon	½
R12	430	Ω	5	carbon	½
R13	0.47	Ω	5	wire wound	½
R14	0.47	Ω	5	wire wound	½

CAPACITORS

Circuit Reference	Value (µF)	Description	Rating (V)
C1	0.027	ceramic	25
C2	100	electrolytic	10
C3	200	electrolytic	6.4
C4	100	electrolytic	4
C5	500	electrolytic	10
*C6	.047	ceramic	25
	(see text)		

MULLARD TRANSISTORS

T1	AC172	T3	AC128
T2	AC126	T4	AC127

MISCELLANEOUS

Loudspeaker voice coil impedance	7.5 Ω
Battery (such as Eveready 2761)	9 V

Mullard Transistors for Complementary Symmetry Applications

N-P-N TRANSISTOR AC127

Abridged Preliminary Data**

Collector voltage

V_{CEM} max.	+32	V
*$V_{CE(AV)}$ max.	+32	V

Collector current

I_{CM} max.	500	mA

Reverse emitter-base voltage

V_{EBM} max.	+10	V

Base current

I_{BM} max.	10	mA

Total dissipation

$$\left(p_{tot}\ \text{max.} = \frac{T_j\ \text{max.} - T_{amb.}}{\theta}\right)$$

Temperature Ratings

Storage temperature limits	−55 to +75	°C
Maximum junction temperature	90	°C
*Maximum junction temperature	100	°C
Junction temperature rise above ambient θ		
(1) without cooling clip in free air	0·37	°C/mW
(2) with cooling clip in free air	0·22	°C/mW
(3) with standard cooling clip on a heat sink of at least 12·5cm²	0·16	°C/mW

*Total duration max. 200 hours.

**For more detailed information see Volume 4 of the Mullard Technical Handbook.

P-N-P TRANSISTOR AC128

Abridged Preliminary Data**

Collector voltage

V_{CB} max.	−32	V
V_{CE} max.	−32	V

Collector current

I_{CM} max.	1	A

Reverse emitter-base voltage

V_{EB} max.	−10	V

Base current

I_{BM} max.	40	mA

Total dissipation

$$\left(p_{tot}\ \text{max.} = \frac{T_j\ \text{max.} - T_{amb.}}{\theta}\right)$$

Temperature ratings

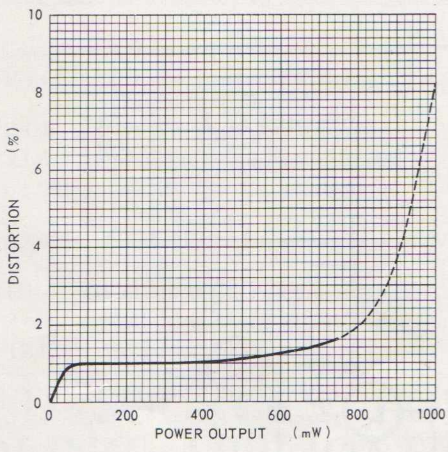
Storage temperature limits	−55 to +75	°C
*Maximum junction temperature	100	°C
Junction temperature rise above ambient θ		
(1) without cooling clip in free air	0·3	°C/mW
(2) with cooling clip in free air	0·15	°C/mW
(3) with standard cooling clip on a heat sink of at least 12·5cm²	0·09	°C/mW

(Continued from page 21)

mately 3kΩ and 25mV input is required to produce full output. Since the input impedance of the amplifier is low, it is not desirable to connect the amplifier directly to a crystal pick-up cartridge. Consequently, R_2 is included, to reduce the loading on the cartridge and to ensure current drive to the amplifier. The output power is 750mW at the onset of clipping; if the input is then increased until 10% distortion is produced, the output will increase to 1W.

The quiescent current in the driver transistor is 10mA—this ensures that sufficient drive is available for the output stage. The collector load resistor (R_{12}) should have a tolerance of ±5% in order to avoid the possibility of premature clipping in the driver stage.

This article is based on work carried out by R. Donohoe of the Mullard Applications Laboratory in Sydney.



Power output versus total harmonic distortion.

Power Output Tabulated Against Total Current Consumption

Power Output (mW)	Total Amplifier Current (mA)
0	23·5
100	73
200	94
300	111
400	124
500	136
600	148
700	156
800	164
900	171
1W	180

CHANNEL 0 IN MELBOURNE*

In order to convert existing tuners in the field for Channel 0 reception, Mullard have available an additional range of biscuits. These are tabulated below against their relevant tuner type numbers.

In the re-tuning of Channel 1 biscuits to cover the frequency of Channel 0 between 45Mc/s to 52Mc/s, the 30dB relationship between sound and vision carriers on the overall IF response cannot be maintained and the result may be distortion on both vision and sound. For this reason it is recommended that new Channel 0 biscuits be obtained.

CHANNEL 0

Tuner Type Number	*Biscuit Type Aerial*	*Number RF & Osc.*
AT7580	CZ.320.104	CZ.321.078
NT3001	CZ.320.097	CZ.321.070
NT3006	CZ.320.084	CZ.321.057
NT3009	A3.178.70	
NT3011	CZ.320.160	

CHANNEL 3

NT3009	CZ.322.034	
NT3011	CZ.322.031	

Special Channel 3 Biscuits

In some isolated fringe areas, communications services around 160Mc/s cause interference with Channel 3 reception. Redesigned Channel 3 biscuits which have an image rejection better than 80dB and which may be used in these areas, are also available. These type numbers, to be used as replacements for the conventional Channel 3 biscuits (vision = 86·25Mc/s; sound = 91·75Mc/s), are also listed in the Table.

* *See also page 14.*

MULLARD PREFERRED RANGE OF TRANSISTORS
For Entertainment Applications in Australia

When approaching the maximum limiting values, either electrically or thermally, the comprehensive data and curves, as contained in Volume 4 of the Mullard Technical Handbook, should be consulted.

Type Number	Description and Application	$-V_{CB}$ max (V)	$-V_{CE}$ max (V)	$-V_{EB}$ max (V)	$-I_C$ max (mA)	$-I_B$ max (mA)	T_j max (°C)	P_{tot} max T_{amb} 25°C (mW)	Outlines and Dimensions
AC125	General purpose audio pre-amplifier and driver of the p-n-p alloy junction type	32	32	10	200	10	90 ■	500 ●	TO-1
AC126	High gain audio pre-amplifier and driver of the p-n-p alloy junction type	32	32	10	200	10	90 ■	500 ●	TO-1
AC127	**n-p-n** germanium alloy junction transistor for use in complementary Class 'B' output stages	+32	+32	+10	500	10	100 ■	280 ●	TO-1
AC128 **2-AC128**	High gain germanium alloy junction transistor of the p-n-p type designed for use in Class 'B' output stages	32	32	10	1A	20	90 ■	550 ●	TO-1
AC132	Germanium alloy junction transistor of the p-n-p type for use in complementary Class 'B' output stages	32	32	10	200	10	90 ■	550 ●	TO-1
AC172	**n-p-n** low noise junction transistor of the germanium alloy type intended for use as audio pre-amplifier	+32	+32	+10	10★	10	100 ■	280 ●	TO-1
AD139 **2-AD139**	Medium power junction transistor of the p-n-p germanium alloy type for use in audio output stages	32	32	10	2A	200	90 ■	13W ●	MD-11
AD140 **2-AD140**	Power junction transistor of the p-n-p germanium alloy type for use in audio output stages	55	55	10	3A	500	100 ■	35W ●	TO-3
AF114N	Germanium transistor of the p-n-p alloy diffused type designed for use up to 100Mc/s	32	32	—	10	1	75	50 ▼	TO-44
AF115N	Germanium transistor of the p-n-p alloy diffused type designed for use up to 100Mc/s as mixer/oscillator and for use as RF amplifier up to 27Mc/s	32	32	—	10	1	75	50 ▼	TO-44
AF116N	Germanium transistor of the p-n-p alloy diffused type designed for use as mixer/oscillator and RF amplifier up to 16Mc/s	32	32	—	10	1	75	50 ▼	TO-44
AF117N	Germanium transistor of the p-n-p alloy diffused type designed for use as mixer/oscillator and RF amplifier up to 6Mc/s	32	32	—	10	1	75	50 ▼	TO-44
OC26 **2-OC26**	Power junction transistor of the p-n-p germanium alloy type intended for use in audio output stages	32	32	10	3·5A	500	100 ■	12·5W ●	TO-3
OC44N	Low noise junction transistor of the p-n-p germanium alloy type for use in early stages of audio amplifiers and as mixer/oscillator in broadcast receivers	15	15	12	10	1	90 ■	43 ▼	TO-1
OC45N	Low noise junction transistor of the p-n-p germanium alloy type intended for use in early stages of audio amplifiers and in IF stages in broadcast receivers	15	15	12	10	1	90 ■	43 ▼	TO-1
OC74N **2-OC74N**	High gain germanium alloy junction transistor of the p-n-p type designed for use in Class 'B' output stages	20	20	6	300	—	90 ■	550 ●	TO-1

▼ T_{amb} = 45°C ● with suitable heat sink ■ 200 hours operation ★ Typical

Mullard

MULLARD PREFERRED RANGE OF DIODES

For Entertainment Applications in Australia

When approaching the maximum limiting values, either electrically or thermally, the comprehensive data and curves, as contained in Volume 4 of the Mullard Technical Handbook, should be consulted.

Type Number	Description and Application	Max PIV (V)	I_{FM} (mA)	$I_{F (AV)}$ (mA)	$I_{F (surge)}$ (A)	T_{amb} max (°C)	Outlines and Dimensions
AA119 **2-AA119**	AM/FM detector diode	45	100	15	0·2	60	SO-6
BA100	General purpose, small-signal point contact diode	60	100	90	0·2	90	SO-6
BA114	General purpose, small-signal point contact diode suitable for voltage stabilisation	—	—	20	—	90	SO-6
BA122	General purpose, small-signal point contact diode suitable for AFC	100	100	90	0·2	90	SO-6
BY100	Silicon junction power rectifier	800	5A	450	55 ■	70	SO-16
OA90	Sub-miniature HF detector diode	30	45	10	0·2	75	SO-6
OA91	Sub-miniature high-voltage general purpose diode	115	150	50	0·5	75	SO-6
OA95	Sub-miniature high-voltage general purpose diode	115	150	50	0·5	75	SO-6
OA200	General purpose, small-signal point contact diode	50	250	160	—	125	SO-6
OA210	Silicon junction power rectifier	400	5A	500	25	70	SO-16
OA605	Silicon junction, low current medium power rectifier	50	5A	500	25	70	SO-16
OA610	Silicon junction, low current medium power rectifier	100	5A	500	25	70	SO-16
OA620	Silicon junction, low current medium power rectifier	200	5A	500	25	70	SO-16
OA630	Silicon junction, low current medium power rectifier	300	5A	500	25	70	SO-16
OA650	Silicon junction power rectifier	500	5A	500	25	70	SO-16
OA660	Silicon junction power rectifier	600	5A	500	25	70	SO-16
OA670	Silicon junction power rectifier	700	5A	500	25	70	SO-16
OA675	Compensation diode for Class 'B' output stages	1 ●	10	—	—	75	TO-1

■ sine wave = 10msec

● although the reverse break-down voltage is normally much higher than 1V, this device is not intended to be used in the reverse direction

STAR PRINTERY