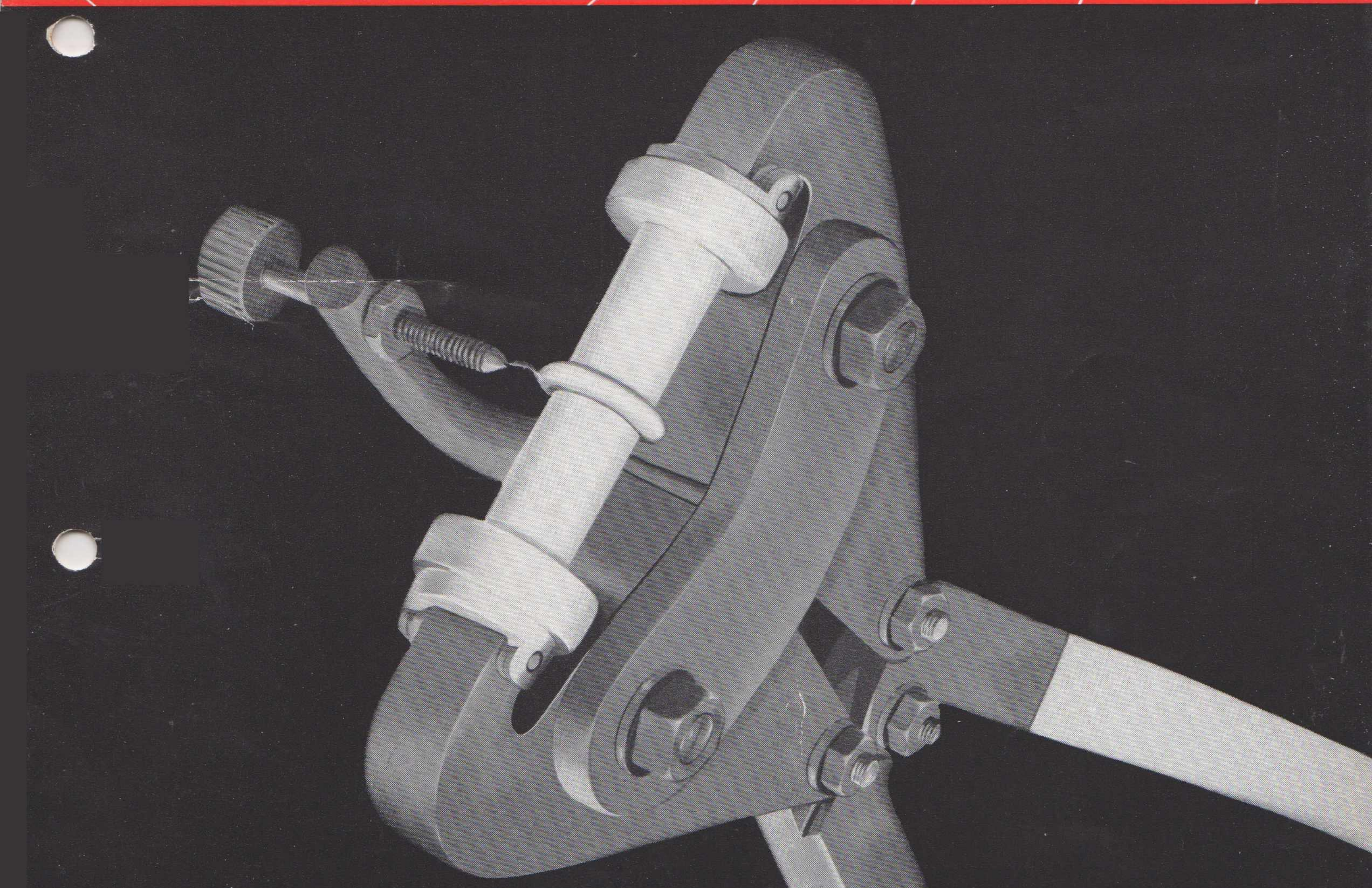
# Mullard Outlook

AUSTRALIAN EDITION



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MULLARD-AUSTRALIA PTY. LTD.

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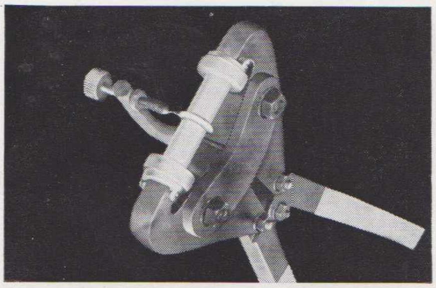

*High voltage is developed when pressure is exerted by way of the jaws onto the two cylinders of Piezoxide. These cylinders are mechanically in series and electrically in parallel: the high energy discharge voltage thus obtained, visible between the sharp tip of the adjustable screw and the metal ring, may well serve to ignite gases, fire explosives or be used for high sensitivity industrial transducers. The properties of Piezoxide, a new ceramic material introduced by Mullard, are discussed on Page 29.*

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VICTORIA
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## PRESSURE

In basic electrical theory, voltage has almost invariably been described as pressure and as the wondrous simplicity of Ohm's Law unfolded it sparked the ambition, the enthusiasm and study tenacity for many trainee engineers. The analogy of pressure and small pipes, pressure in boilers, pressure and insulation breakdown, all left their mark.

The device shown on the front cover that looks like a cross between a praying mantis* and an emasculator is the classic relationship of pressure and voltage—5,000 to 10,000 of it!

Something that would have shattered the alchemists, St. Elmo, the Devil himself and all the witches on Walpurgisnacht; far removed from the mundane stroking of a cat's fur, briskly rubbing amber on a dry cloth and their modern counterpart, the electrostatic discharges on removing a terylene shirt.

We are serious about Piezoxide—please join us on Page 29.

## THE GOLDEN ACCOLADE

With great pleasure and humility we salute and say thank you to our good friends Martin de Launay Pty. Limited, our New South Wales distributors for as long as most remember. Achievement enough—50 years of growth, strength, durability and service, may this continue and a little of its inherent respect and stability rub off on the Industry.

M.A.B.

* Mantidae, orthodera ministralis.

# VIEWPOINT WITH MULLARD

# 50 YEARS OF SERVICE

*May 16th, 1966 was the Golden Anniversary of our New South Wales distributors Martin de Launay Pty. Limited and we are glad in this issue to pay tribute to their progress, their support and their contribution to electrical and electronic goods merchandising in this State.*

On this anniversary occasion, the Martin de Launay Managing Director, Eric Reeve, modestly stated: "For 50 years Martin de Launay has concentrated all its energy on

**Eric Reeve,**
Managing Director

**George Mitchell,**
General Manager & Director

giving service second to none, as we believe that this commodity is one that is all important to our customers. Although it is an intangible, we know that it is in fact the concrete foundation of our business.

"We are able to give this service because our staff operates as a team. Most of us have served Martin de Launay and the trade together for a very long period; 20 years service with the company being commonplace among our executive staff.

"It is to the team spirit and loyalty of our senior staff that we owe a great deal of our success."

With branches now in Sydney, Newcastle, Wollongong and Wagga, Mr. Reeve pointed out that promptness and thorough supervision of all orders was the keynote of their business, ably administered by General Manager and Director George Mitchell, Bob Broughton, Director and Manager Newcastle, Jack Muldoon, Wollongong and Jack Boomer, Wagga.

A very human feature of their achievement is the extremely long periods of unbroken service by their employees which only reflects continuity of customer relationships and the detailed knowledge of customer needs, looking both ways—to their customers and to the companies they represent.

For us it has been a most happy relationship, almost of one family with a subtle difference in that we are given our relations but are allowed to choose our friends. In this merchandising field, if the distribution is worth anything and likewise the distributor, the outcome is a strong team with a great measure of loyalty and a mutually instinctive feeling towards sales presentation and growth—and self-defence. With this understanding there develops trust of the individual and the product for the true wholesaler and distributor is not an indent or commission agent, but a partner who undertakes to distribute the manufacturer's goods, has confidence selling them and sells them from the bulk stock he carries. Martin de Launay is a fine example of a

**"Bob" Broughton,**
Director & Manager, Newcastle

**John Donahoo,**
Asst. Manager, Newcastle Branch

wholesaler-distributor fulfilling its true purpose, and in this case, with good business economies and a tenacious determination.

50 years of successful trading and cautious expansion reflects confidence and stability and such organisations in turn subconsciously inject something back into the Industry, if even for the privilege of taking something out!

It was with much regret that we learned a few weeks ago of the sudden passing of co-founder Mr. E. A. de Launay in his 82nd year, indeed within a week of this 50 year anniversary. He could be justly proud of the business that he started and the fellows who have followed, the late Frank Heskett, and as stated elsewhere: "The sturdy belief in the need of wholesaler service impregnates the whole of Martin de Launay policy, has done so throughout 50 years and will continue to do so as long as

**Jack Muldoon,**
Manager, Wollongong Branch

**Jack Boomer,**
Manager, Wagga Branch

**Denny Fitzgerald,**
Tech. Rep., Newcastle Branch & Nn. N.S.W.

**Dennis Woolgar,**
Purchasing Officer

**Bill Devey,**
Technical Sales, Newcastle Branch

**Don Lindsay,**
Representative, Newcastle & Nn. Coalfields

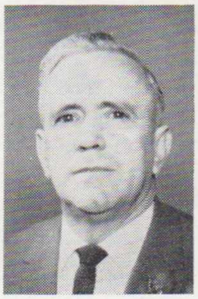
**Eric Beames,**
Section Manager, Country Orders

**Laurie Nagle,**
Radio, TV & Elect. Sales Supervisor

**Neville Mills,**
Western Representative

**Jeff Rutledge,**
South-West Representative

**Neville Piper,**
Metropolitan Representative



**Dick Whittington,**
Metropolitan Representative

men like Eric Reeve and George Mitchell are at the helm, and the staff continues to have every faith in that belief." ■

# MULLARD MINI SPEAKER UNITS

## A DESIGN FOR SMALL LOUDSPEAKER HOUSINGS

*High fidelity sound reproduction is a field where subjective evaluation plays a large part in forming an opinion and equally there is a considerable margin for differences of opinion. The Mullard Mini Loudspeaker Box however was without exception praised by even the most devoted audio enthusiasts for its smoothness over the whole frequency spectrum and the broad sound dispersion factor as well as its compact physical size and form factor.*

**Mitred Corner Lock and Colan Cloth**

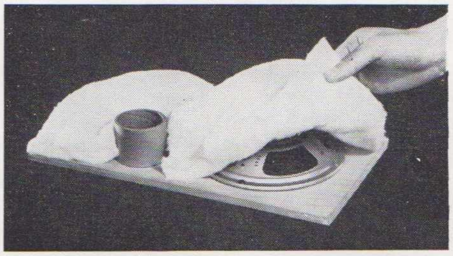
The frequency response curve shown below is an improved version of the one discussed in Outlook Volume 9, No. 2, Page 16. The improved response is due to a special mitred corner lock which was used on the initial pre-production batch and which considerably stiffens the loudspeaker box, thereby avoiding unwanted resonances and equalizing the response curve. When examining the improved response curve it will be noticed that the high frequency end is considerably extended, and this is largely due to the acoustically transparent speaker cloth material used. This cloth is manufactured by:

Tygan (Aust.) Pty. Ltd.,
2 Donald St.,
Guildford, N.S.W.

and distributed under the trade name "Colan" by major electronic parts distributors throughout Australia. It is available in a range of colours and designs to enable most decors to be matched. Approved Type numbers are: AP 337 (plain dark brown); AP 334 (brown/beige check weave); TS 5394 (cream/brown mini-check weave).

**Damping and Filling**

During evaluation tests it was found that the overall frequency response curve could be evened out somewhat by increasing the size of the "Innerbond" material used to 17" x 8" and affixing it to the front panel of the speaker unit as shown in the picture. The "Innerbond" material may be fastened to the timber by gluing or stapling, ensuring that the vent is left unobstructed as shown.



*Method of affixing "Innerbond" to the front panel of the unit by either gluing or stapling. One corner of the "Innerbond" padding is lifted temporarily to show part of the 6WR speaker. NOTE: The vent should NOT be covered.*

The "Innerbond" used with initial prototypes was the 16 oz/sq. yd. 1" thick

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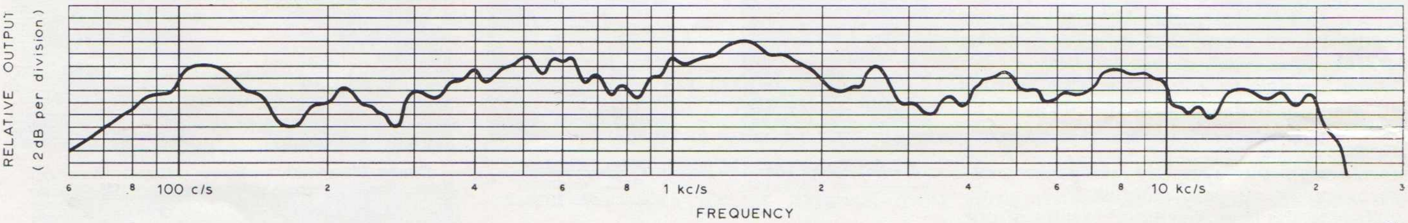
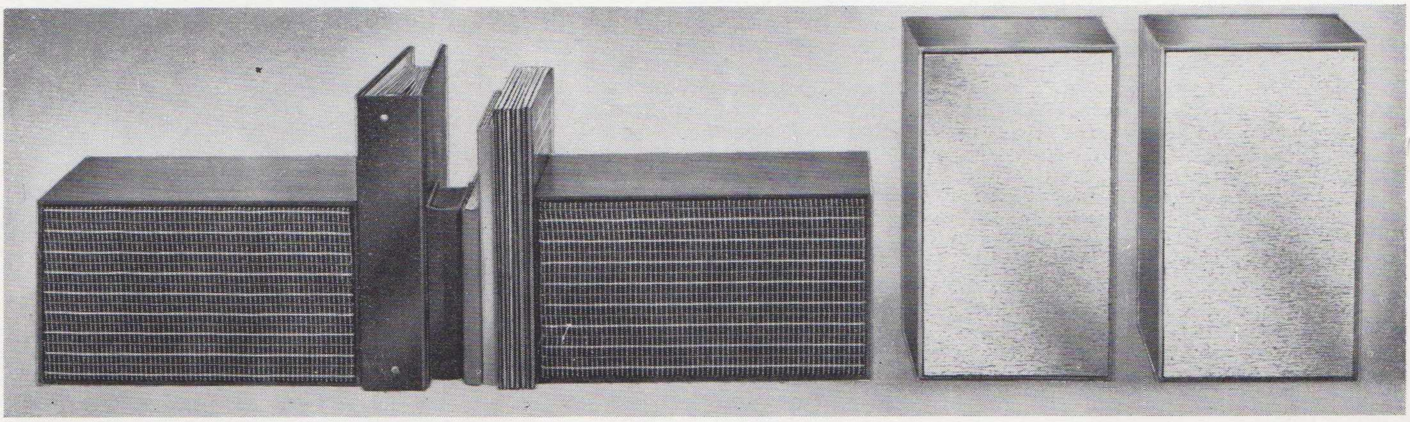



*This response curve of the improved Mullard Mini Speaker unit as discussed was measured with the microphone on the tweeter axis 18" away from the front of the enclosure.*



*Prototypes of the enclosure, available from suppliers tabulated below, following the outline drawing published in OUTLOOK Volume 9, No. 2, Page 17, incorporating the mitred corner lock as discussed.*

## COMMERCIALLY AVAILABLE MULLARD MINI SPEAKER UNITS

**STOP PRESS:** As this issue goes to press it is brought to our notice that the Mullard Mini Speaker Units are already being made available commercially as shown below. Several exterior treatments are available, such as maple or walnut veneer polished finish or for a slight extra charge teak veneer oiled finish.

**E. W. Goulding Pty. Ltd.**
433 Liverpool Rd.,
Ashfield, N.S.W.

Loudspeaker housing only (For Loudspeakers see Magnavox)

**Magnavox (Aust.) Pty. Ltd.**
6-8 O'Riordan St.,
Alexandria, N.S.W.
(or their distributors.)

6WR and 3TC Mark II Loudspeakers

**Classic Radio Service,**
245 Parramatta Rd.,
Haberfield, N.S.W.

Mini Speaker Units completely assembled and tested with cross-over capacitor and back cover sealed into place.

**T.O.S.C.A.**
Electronic Sales & Rentals,
180 Lyons Rd.,
Drummoyne, N.S.W.

Mini Speaker Units completely assembled and tested with cross-over capacitor and back cover sealed into place.

# CERAMIC PIEZOELECTRIC MATERIAL 'PIEZOXIDE'

*When certain materials are subjected to electrical stresses, related mechanical stresses will occur in the material. Conversely, mechanical stresses applied to the material will generate related electrical stresses. This phenomenon is termed the piezoelectric effect. • Piezoelectricity occurs in various natural crystalline materials, but a new fabricated ceramic material which exhibits the same effect has now been introduced by Mullard. This new material—Piezoxide—is based mainly on lead zirconate-titanate. • Piezoxide combines high permittivity, a high coupling factor and good mechanical strength. It is available in four grades which cover applications as varied as ultrasonic generators, ignition systems, filter networks and gramophone pick-up elements.*

Piezoelectricity is observed in various ferroelectric crystals and polycrystalline materials which have non-centrosymmetrical properties. It is 'pressure' electricity and thus it is found that when electrically polar materials are geometrically deformed by mechanical pressures, then charges of opposite signs are developed on their parallel surfaces. Moreover, it is found that if an element is strained only within its elastic limit, then the magnitude of the charge densities obtained is directly proportional to the applied mechanical stress.

The piezoelectric effect was predicted and shown experimentally by Pierre and Jacques Curie in 1880. It was also shown, just a year later, that when an electric field was applied to an element between its opposite surfaces, then the boundaries were geometrically displaced. So piezoelectricity is dual in the sense that it is 'caused' either by electrical or mechanical stresses which 'effect' either mechanical or electrical displacements respectively. The interaction of the elastic and electrical properties of ferroelectric materials within a single element provides a simple and convenient method of obtaining electro-mechanical and mechano-electrical energy transformations which are analogous to 'motor' and 'generator' actions respectively. Early practical applications of piezoelectricity with natural and water-soluble crystals were necessarily limited by the difficulties in matching the intrinsic fixed properties of these materials with those the designer needs for a particular device. Electrical ceramic techniques have, however, produced several interesting ferroelectric materials with pronounced electrostrictive properties. These materials have large values of remanent polarisation and may be permanently polarised. In this state, their behaviour resembles that of a piezoelectric crystal and therefore, by analogy, they are usually referred to as piezoelectric. The range of ceramic piezoelectric materials introduced by Mullard is known also as 'Piezoxide'.

Because of the ceramic nature of these materials, elements may be pre-shaped and their piezoelectric properties may be formed and controlled during the manufacturing process. This now provides the device designer with a certain freedom of choice for the element shape and its properties for a particular device requirement. A non-polar and unstressed element of these materials has isotropic properties, and the crystallographic reference axes may be chosen freely. They exhibit piezoelectricity only when polarised, the direction of polarisation also being chosen freely and made permanent in the process.

**Piezoxide Materials and Grades**

Piezoxide materials are composed of polycrystalline chemical compounds having the general formula $ABO_3$, where A and B may be cations such as Ba, Pb, Zr, Ti; specific examples are $BaTiO_3$ or the solid solutions of $Pb(Ti,Zr)O_3$. These materials stem from the family of chemical compounds with perovskite-type structures which have continuous ranges of composition and in which a number of different crystal phases may occur either with ferroelectric or antiferroelectric properties. Modified forms of these materials are used which may be derived by small atomic disturbances, displacements or substitutions to obtain the permanent ferroelectric phase condition in which the material will be useful for piezoelectric applications.

Physically, Piezoxide is a hard whitish-brown non-porous material of a ceramic nature, chemically inert and unaffected by humidity or other atmospheric conditions. It has mechanical properties similar to the more common insulation ceramics, and the manufacturing process is not unlike the preparation of these although more careful control is taken in the formation of the electrical properties. Piezoxide is not easily broken but it should be handled with some care. These materials are, however, extremely 'stiff'; that is, they are capable of exerting or sustaining very large forces.

A wide range of material properties is required to give complete coverage for all applications, and four grades are introduced, each having characteristics suitable for particular applications.

**PXE 1**

Grade PXE 1 is a material developed for transducer applications operating at mechanical resonance such as ultrasonic power transducers or narrow-band filters. It has a high mechanical Q-factor but a fairly low coupling factor.

**PXE 3**

Grade PXE 3 has a high sensitivity for mechano-electrical conversions, as shown by its high piezoelectric voltage constant. It is therefore suitable for ignition and delay-line applications. It has a low dielectric constant.

**PXE 4**

Grade PXE 4 is most suitable for high-quality resonance applications such as those described for PXE 1; that is, for power electro-mechanical transducers. Its sensitivity and operating temperature range are greater than those of PXE 1.

**PXE 5**

Grade PXE 5 has a low mechanical Q-factor and high sensitivity and dielectric constant. It is therefore ideal for all non-resonance applications such as pick-up elements, feedback plates and ignition applications.

**Piezoxide and Piezoelectricity**

Piezoxide materials are polycrystalline dielectric materials which before they have been made electrically polar or are mechanically stressed have properties which are isotropic. A Piezoxide element is formed from smaller crystallites and each of these may be considered to consist of permanent electrostatic dipoles. The orientations of these dipoles can be displaced when they are placed in an electric field. A field increasing in the opposite sense to that of the dipole will give a reversal of the dipole at some value of the field strength, and a hysteresis effect may be obtained in this way. This dielectric hysteresis effect implies that the material has spontaneous polarisation or a dipole moment per unit volume. These materials are called ferroelectric materials since the dielectric hysteresis (Fig. 1) is analogous to magnetic hysteresis and the spontaneous polarisation corresponds to the intrinsic magnetisation of a ferromagnetic material. Within an isotropic element, the orientations and magnitudes of all its constituent dipoles are such that

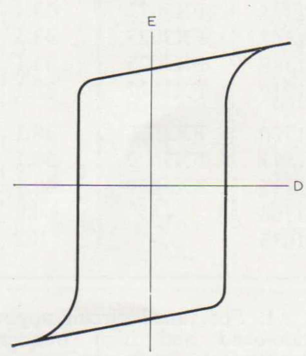



*Fig. 1—Hysteresis Effect*

the total net dipole moment is zero. During the manufacture of Piezoxide, the material is cooled from above its Curie temperature in a strong electric field. The dipoles

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# MULLARD RANGE OF F

*The response to the article entitled "Ferroxcube" Toro necessary a more comprehensive tabulation. • Ferroxcube for inductors and transformers. Mullard Ferroxcube materi Zinc Ferrites and Nickel Zinc Ferrites, and depending on different frequencies. • Important parameters for design and tolerances. More detailed information on Ferroxcu may be found in Vol. 6 of the Mullard Technical Mullard offices throughout Australia is always availabl*

PLEASE NOTE: *Most toroids may be obtained coated or uncoated*

| Type Number | | Size | Minimum Apparent Permeability | Maximum Number of Turns per 1 mH | Maximum Residual plus Eddy Current Dissipation Factor | Minimum Saturation Magnetization | | Measuring Frequency | $\Sigma(I/A)$ | Effective Magnetic Path Length le |
|---|---|---|---|---|---|---|---|---|---|---|
| Uncoated | Coated ♦ | | | | | 20°C | 100°C | | | |
| — | — | (mm) | ($\mu_a$) | α | $\left(\frac{\tan\delta_{r+e}}{\mu_a}\right)$ | (ampere turns) | (ampere turns) | (Mc/s) | (cm⁻¹) | (cm) |
| FX1969 | — | 2 | 1000 | 130 | $12 \times 10^{-6}$ | 1.51 | 0.794 | 0.1 | 211 | 0.499 |
| FX2073 | — | 5 | 1000 | 89.1 | $12 \times 10^{-6}$ | 3.56 | 1.88 | 0.1 | 100 | 1.18 |
| FX2270 | — | 5.2 | 40 | 491 | $300 \times 10^{-6}$ | 59.7 | 179 | 10 | 121 | 1.25 |
| FX1886 | — | 5.2 | 10 | 981 | $3000 \times 10^{-6}$ | 49.7 | 169 | 50 | 121 | 1.25 |
| FX2072 | — | 8.4 | 1000 | 93.1 | $12 \times 10^{-6}$ | 6.86 | 3.61 | 0.1 | 109 | 2.27 |
| FX2691 | FX3009 | 12.7 | 1800 | 35.6 | $120 \times 10^{-6}$ | 4.64 | 2.44 | 0.45 | 28.6 | 2.76 |
| FX1593 | FX3008 | 12.7 | 1200 | 43.6 | $120 \times 10^{-6}$ | 6.95 | 3.21 | 0.45 | 28.6 | 2.76 |
| FX1322 | FX3007 | 12.7 | 700 | 57 | $50 \times 10^{-6}$ | 11.3 | 6.95 | 0.45 | 28.6 | 2.76 |
| FX1594 | FX3011 | 12.7 | 500 | 67.5 | $120 \times 10^{-6}$ | 11.9 | 4.39 | 0.5 | 28.6 | 2.76 |
| FX1595 | FX3012 | 12.7 | 200 | 107 | $200 \times 10^{-6}$ | 33 | 21.1 | 2 | 28.6 | 2.76 |
| FX1596 | FX3013 | 12.7 | 130 | 132 | $200 \times 10^{-6}$ | 50.7 | 35.2 | 5 | 28.6 | 2.76 |
| FX1597 | FX3014 | 12.7 | 40 | 239 | $300 \times 10^{-6}$ | 132 | 110 | 10 | 28.6 | 2.76 |
| FX1598 | FX3015 | 12.7 | 10 | 478 | $3 \times 10^{-3}$ | 395 | 373 | 50 | 28.6 | 2.76 |
| FX1582 | FX3017 | 25.4 | 1050 | 58.9 | $120 \times 10^{-6}$ | 19.8 | 10.5 | 0.45 | 45.8 | 6.89 |
| FX1230 | FX3016 | 25.4 | 700 | 72.1 | $50 \times 10^{-6}$ | 28.2 | 15.7 | 0.45 | 45.8 | 6.89 |
| FX1583 | FX3018 | 25.4 | 500 | 85.4 | $120 \times 10^{-6}$ | 29.6 | 11.5 | 0.5 | 45.8 | 6 89 |
| FX1231 | FX3019 | 25.4 | 200 | 135 | $140 \times 10^{-6}$ | 82 | 52.6 | 2 | 45.8 | 6.89 |
| FX1299 | FX3020 | 25.4 | 100 | 191 | $200 \times 10^{-6}$ | 164 | 114 | 5 | 45.8 | 6.89 |
| FX1358 | FX3021 | 25.4 | 40 | 302 | $300 \times 10^{-6}$ | 329 | 274 | 10 | 45.8 | 6.89 |
| FX1584 | FX3022 | 25.4 | 10 | 604 | $3 \times 10^{-3}$ | 986 | 932 | 50 | 45.8 | 6.89 |
| FX1586 | FX3024 | 38.1 | 1050 | 43 | $120 \times 10^{-6}$ | 28 | 14.7 | 0.45 | 24.4 | 9.71 |
| FX1585 | FX3023 | 38.1 | 700 | 52.7 | $50 \times 10^{-6}$ | 39.8 | 22.1 | 0.45 | 24.4 | 9.71 |
| FX1587 | FX3025 | 38.1 | 500 | 62.6 | $120 \times 10^{-6}$ | 41.7 | 15.5 | 0.5 | 24.4 | 9.71 |
| FX1588 | FX3026 | 38.1 | 200 | 98.5 | $140 \times 10^{-6}$ | 116 | 74.2 | 2 | 24.4 | 9.71 |
| FX1589 | FX3027 | 38.1 | 100 | 139 | $200 \times 10^{-6}$ | 232 | 161 | 5 | 24.4 | 9.71 |
| FX1590 | FX3028 | 38.1 | 40 | 220 | $300 \times 10^{-6}$ | 464 | 386 | 10 | 24.4 | 9.71 |
| FX1591 | FX3029 | 38.1 | 10 | 441 | $3 \times 10^{-3}$ | 1390 | 1310 | 50 | 24.4 | 9.71 |
| FX2395 | FX3030 | 38.1 | 1400 | 21.5 | $120 \times 10^{-6}$ | 21 | 11 | 0.45 | 8.14 | 9.71 |
| FX1108 | — | 89 | 200 | 76.5 | $175 \times 10^{-6}$ | 280 | 180 | 2 | 14.7 | 23.5 |
| FX1076 | — | 108 | 1050 | 29.4 | $200 \times 10^{-6}$ | 78 | 41.1 | 0.5 | 11.4 | 27.1 |

Grade A1. For tuned circuit applications up to 500 kc/s and for wide-band and high frequency transformers when lowest frequency to be transmitted is greater than about 1Mc/s.

Grade A4. For tuned circuit applications up to 500kc/s and for high flux density applications, wide-band low power transformers (10kc/s to 20Mc/s) and low power pulse applications.

Grade A5. For tuned circuit applications up to 200kc/s and for communication transformers up to approximately 1Mc/s.

Grade B1. For tuned circuit applications over the range of 0.5 to 1Mc/s and for wide-band and high frequency transformers over the range 1 to 20Mc/s.

Grade B2. For tuned circuit applications over the range 0.5 to 2Mc/s and for wide-band and high frequency transformers over the range 1 to 50Mc/s.

All parameters measured at $B_{max} \leqslant 0.5$ gauss. A1, A4 and A5 materials—Manganese Zinc Ferrite. B1, B2, B3, B4 and B5

# FERROXCUBE TOROIDS

*Toroids in OUTLOOK Vol. 9/1, page 11 has made
xcube toroids are widely used in industry as a core material
material may be broadly divided into two groups, Manganese
ng on its composition optimum results are obtained from
esign are tabulated together with mechanical dimensions
roxcube toroids as well as Mullard magnetic components
nical Handbook. The Technical Service Department in
ailable for technical assistance with any special problem.*

*ated and different type numbers have to be quoted when ordering.*

| ...tive ...etic ...ength | Effective Flux Area Ae | Effective Volume Ve | Approximate Weight | Material | Colour Code | | Dimensions | | | Max. Coating Thickness ♦ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Body | Peripheral Mark | A | B | C | |
| ) | (cm²) | (cm³) | (g) | — | — | — | (mm) | (mm) | (mm) | (mm) |
| 99 | $0.237 \times 10^{-2}$ | $1.18 \times 10^{-3}$ | 0.01 | A5 | — | — | 1.27 ± 0.1 | 2.03 ± 0.1 | 0.64 ± 0.1 | — |
| 8 | $1.18 \times 10^{-2}$ | $13.9 \times 10^{-3}$ | 0.05 | A5 | — | — | 2.9 ± 0.2 | 5 ± 0.2 | 1.15 ± 0.1 | — |
| 5 | $1.03 \times 10^{-2}$ | $12.9 \times 10^{-3}$ | 0.05 | B4 | — | — | 3.1 ± 0.2 | 5.18 ± 0.2 | 1.02 ± 0.1 | — |
| 5 | $1.03 \times 10^{-2}$ | $12.9 \times 10^{-3}$ | 0.05 | B5 | — | — | 3.1 ± 0.2 | 5.18 ± 0.2 | 1.02 ± 0.1 | — |
| 7 | $2.1 \times 10^{-2}$ | $47.6 \times 10^{-3}$ | 0.8 | A5 | — | — | 6.3 ± 0.2 | 8.38 ± 0.2 | 2.03 ± 0.1 | — |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.45 | A5 | Dark green | — | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.45 | A4 | Red | — | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.45 | A1 | Grey | — | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.45 | B1 | White | Brown | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.4 | B2 | White | Red | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.35 | B3 | White | Orange | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.3 | B4 | White | Yellow | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 5 | $9.68 \times 10^{-2}$ | 0.268 | 1.15 | B5 | White | Green | 6.35 ± 0.5 | 12.7 ± 0.5 | 3.17 ± 0.46 | 0.25 |
| 9 | 0.15 | 1.04 | 5.1 | A4 | Red | — | 19 ± 1.1 | 25.4 ± 1.3 | 4.78 ± 0.46 | 0.3 |
| 9 | 0.15 | 1.04 | 5.1 | A1 | Grey | — | 19 ± 1.1 | 25.4 ± 1.3 | 4.78 ± 0.46 | 0.3 |
| 9 | 0.15 | 1.04 | 5.1 | B1 | White | Brown | 19 ± 1.1 | 25.4 ± 1.3 | 4.78 ± 0.46 | 0.3 |
| 9 | 0.15 | 1.04 | 4.8 | B2 | White | Red | 19 ± 1.1 | 25.4 ± 1.3 | 4.78 ± 0.46 | 0.3 |
| 9 | 0.15 | 1.04 | 4.6 | B3 | White | Orange | 19 ± 1.1 | 25.4 ± 1.3 | 4.78 ± 0.46 | 0.3 |
| 9 | 0.15 | 1.04 | 4.5 | B4 | White | Yellow | 19 ± 1.1 | 25.4 ± 1.3 | 4.78 ± 0.46 | 0.3 |
| 9 | 0.1[illegible] | 1.04 | 3.9 | B5 | White | Green | 19 ± 1.1 | 25.4 ± 1.3 | 4.78 ± 0.46 | 0.3 |
| 1 | 0.[illegible]8 | 3.86 | 19.5 | A4 | Red | — | 25.4 ± 1.2 | 38.1 ± 1.9 | 6.35 ± 0.5 | 0.3 |
| 1 | 0.398 | 3.86 | 19.5 | A1 | Grey | — | 25.4 ± 1.2 | 38.1 ± 1.9 | 6.35 ± 0.5 | 0.3 |
| 1 | 0.398 | 3.86 | 19.5 | B1 | White | Brown | 25.4 ± 1.2 | 38.1 ± 1.9 | 6.35 ± 0.5 | 0.3 |
| 1 | 0.398 | 3.86 | 18.5 | B2 | White | Red | 25.4 ± 1.2 | 38.1 ± 1.9 | 6.35 ± 0.5 | 0.3 |
| 1 | 0.398 | 3.86 | 18 | B3 | White | Orange | 25.4 ± 1.2 | 38.1 ± 1.9 | 6.35 ± 0.5 | 0.3 |
| 1 | 0.398 | 3.86 | 17 | B4 | White | Yellow | 25.4 ± 1.2 | 38.1 ± 1.9 | 6.35 ± 0.5 | 0.3 |
| 1 | 0.398 | 3.86 | 15 | B5 | White | Green | 25.4 ± 1.2 | 38.1 ± 1.9 | 6.35 ± 0.5 | 0.3 |
| 1 | 1.19 | 11.6 | 58 | A4 | Red | — | 25.4 ± 0.5 | 38.1 ± 0.8 | 19.05 ± 0.05 | 0.3 |
| | 1.6 | 37.5 | 178 | B2 | — | — | 63.5 ± 3.1 | 88.9 ± 4.4 | 12.7 ± 0.05 | — |
| | 2.38 | 64.4 | 324 | A4 | — | — | 69.9 ± 3.6 | 108 ± 5.3 | 12.7 ± 0.05 | — |

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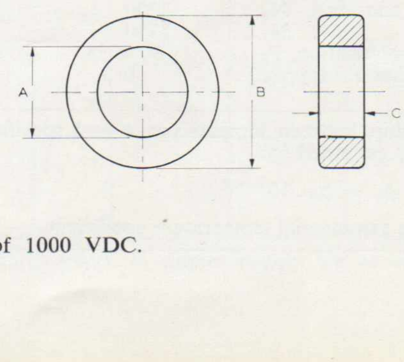
Grade B3. For tuned circuit applications over the range 2.0 to 5Mc/s and for wide-band and high frequency applications over the range 1 to 50Mc/s.

Grade B4. For tuned circuit applications over the range 5 to 20Mc/s and for wide-band and high frequency applications over the range 20 to 100Mc/s.

Grade B5. For tuned circuit applications over the range 20 to 50Mc/s and for wide-band and high frequency applications over the range 20 to 100Mc/s.




and B5 materials—Nickel Zinc Ferrite.

♦ Nylon coating will withstand test voltage of 1000 VDC.

← Page 29

become re-orientated so that they are fixed-direction dipoles and are aligned parallel to the field. This leads to the symmetry condition of a polar axis and all planes perpendicular to and intersecting this axis. If the element is now compressed, stretched or twisted by mechanical pressures, the average location of the positive and negative charges which make up the dipoles is altered and net surface charges are obtained. The material therefore exhibits a piezoelectric effect in which the properties of the polar plane predominate.

**Range of Applications for Piezoxide**

Piezoelectric elements can perform either of two functions. They may be used where mechanical energy is available and is required to be transformed into a source of electrical energy, or they may be used where electrical energy is available to be transformed into a source of mechanical energy. That such transformations are produced within single solid-state elements offers a wide field of application. That these elements can be pre-shaped in a moulded ceramic whose properties can also be controlled gives a wide degree of flexibility in the adaptation to a particular design.

Some of the applications of Piezoxide will be found in the following list:

*Ultrasonic generators*

*Echo, asdic and sonar transducers*

*Ignition of gases and fuels by spark sources*

*Projectile detonation*

*Accelerometers, vibration and pressure gauges*

*Electro-acoustic elements for gramophone pick-up heads and microphones*

*Filter and delay networks*

*Feedback control systems*

*Resonance transformers*

*Remote control of alarms and switches*

*Relays*

Modern piezoelectric ceramics are of continually increasing importance and use to device and equipment designers throughout industry. In general, most of these applications use elements operating in conditions similar to those of the foregoing analysis. However, two types of application that are included above are described in the following paragraphs.

**Ignition and Detonating Systems**

The mechano-electrical transformation obtainable from Piezoxide elements operated in piston-like vibration are also used to provide electrical impulses and spark sources. Such impulses and spark sources are often required for the ignition of gases, fuels or explosives. For a particular element operating in open-circuit conditions, the piezoelectric relationship, $E = gT$, holds, and thus the magnitude of the voltage obtained is directly proportional to the applied stress. This voltage may be built up and discharged between the electrodes of a spark gap. If the piezoelectric material used is chosen to have a large voltage constant g, then the element will transform small forces to large electrical outputs. The resulting output can also be improved if the mechanical forces available are amplified

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**TECHNICAL DATA**

| | PXE1 | PXE3 | PXE4 | PXE5 | |
|---|---|---|---|---|---|
| 1. MECHANICAL DATA | | | | | |
| Density, $\rho_m$ | 5·7 | 7·8 | 7·55 | 7·65 | $\times 10^3$kg/m$^3$ |
| Curie temperature, $T_c$ | 130 | > 350 | > 320 | 300 | °C |
| Modulus of elasticity, $Y^E_{11}$ | 1·25 | 0·85 | 0·86 | 0·65 | $\times 10^{11}$N/m$^2$ |
| $Y^E_{33}$ | 1·21 | 0·69 | 0·73 | 0·53 | $\times 10^{11}$N/m$^2$ |
| Max. working pressure | 5·0 | 5·0 | 5·0 | 5·0 | kg/mm$^2$ |
| 2. ELECTRICAL DATA | | | | | |
| Dielectric constant of free space, $\varepsilon_0$ | 8·85 | 8·85 | 8·85 | 8·85 | pF/m |
| Relative dielectric constant, $\varepsilon^T_{33}/\varepsilon_0 = \varepsilon_r$ | 900 | 570 | 1200 | 1750 | |
| Specific resistance, $\rho_{el}$ at 25°C | 0·1 | > 1 | > 1 | > 10 | $\times 10^{10}\Omega$.m |
| Time constant, $\tau = RC$ | 0·5 | > 30 | > 30 | > 200 | min |
| Dielectric dissipation factor, tan $\delta$ | 1·7 | 0·5 | 0·6 | 1·8 | $\times 10^{-2}$ |
| 3. ELECTRO-MECHANICAL DATA | | | | | |
| Coupling factors, $k_p$ | 0·23 | 0·47 | 0·5 | 0·6 | |
| $k_{31}$ | 0·13 | 0·28 | 0·3 | 0·35 | |
| $k_{33}$ | 0·33 | 0·62 | 0·6 | 0·7 | |
| Piezoelectric charge constants, $d_{31}$ | 34 | 67 | 104 | 171 | $\times 10^{-12}$C/N |
| $d_{33}$ | 85 | 169 | 233 | 376 | $\times 10^{-12}$C/N |
| Piezoelectric voltage constants, $g_{31}$ | 4·3 | 13·3 | 9·8 | 11·0 | $\times 10^{-3}$V.m/N |
| $g_{33}$ | 10·6 | 33·4 | 21·8 | 24·2 | $\times 10^{-3}$V.m/N |
| Quality factor, $Q_p$ | 1000 | > 500 | > 500 | 50 | |
| Frequency constants, $N_p$ | 3200 | 2260 | 2300 | 2000 | c/s.m |
| $N_1$ | 2330 | 1550 | 1620 | 1390 | c/s.m |
| Remanent polarisation, $P_R$ | 30 to 35 | 30 to 35 | 30 to 35 | 30 to 35 | C/cm$^2$ |
| Poisson constant (approx.) | 0·3 | 0·3 | 0·3 | 0·3 | |

The relationship between temperature $\theta$ and specific resistance $\rho_e$ at that temperature is approximately governed by:

$$\rho_e = \rho_{25} \cdot 10^{\alpha(\theta-25)},$$

where $\alpha$ is the exponential temperature coefficient.

← Page 32

before applying them to the piezoelectric element. The forces must be applied over the whole of the end surface of an element and since it is usually more convenient to do this on small areas, two smaller elements are often used connected in parallel. The maximum pressure which can be exerted on the material has to be less than 7000lb/in$^2$ (or approximately 5kg/mm$^2$) for applications requiring continuous operations, such as combustion engines. Where the forces are to be applied only once, then they may be much larger. For compression forces, an element will provide two electric charges of opposite polarity on each compression-release cycle. With Piezoxide, a high efficiency of energy conversion is obtained and the output may be up to 70% of the input.

**Flexure Systems**

The energy transformations provided by piezoelectric elements which are operated in a flexural mode are often used for electro-acoustic and some ultrasonic applications. The method of fabrication of Piezoxide is particularly suitable for constructing series- or parallel-connected flexure elements. These consist essentially of the ceramic piezo-electrical material which has two outer electroded surfaces and a common centre electrode. The element is permanently polarised so that the directions of polarisation between the two outer and the inner electrodes are opposite in sense. Then the manner of operation is somewhat analogous to that of a heated bi-metal strip. When the element is connected to an alternating field, the part of it which is polarised in the same sense as the applied field expands, and the part which is polarised in the opposite sense contracts. Piezoxide has a very good compliance and as an example, a bar mounted as a cantilever will give a displacement of approximately 1/16 inch at a distance of 1 inch from the clamped position for an applied field of 100V. The resonance frequency $f_r$ of a cantilever-mounted flexure bar of thickness t and whose free length is l is given by:

$$f_r = \frac{1\cdot72t}{l^2}\left(\frac{Y}{\rho}\right)^{\frac{1}{2}}.$$

A parallel-connected bar has the advantage that it has a lower operating impedance than the dimensionally equivalent series system.

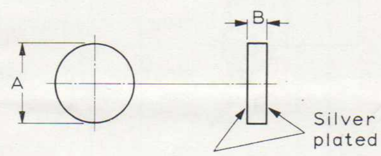
**Standard Shapes**

Piezoxide elements are supplied polarised and provided with flat electrodes on the end surfaces. Feedback plates have special electrodes which are not symmetrical. The direction of polarisation is marked by colour spots where applicable, negative being green and positive red.

Standard sizes are available, and these are indicated in Table 1. Other sizes can be supplied as required. ■

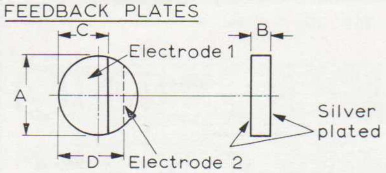
**TABLE 1—DIMENSIONS OF STANDARD PIEZOXIDE COMPONENTS**

DISCS



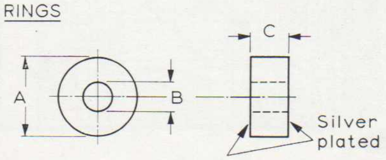

| A | B | PXE1 | PXE3 | PXE4 | PXE5 |
|---|---|---|---|---|---|
| 16 | 1·1 | MB1004 | MB1005 | MB1006 | MB1007 |
| 16 | 3 | — | MB1008 | MB1009 | MB1010 |
| 20 | 0·6 | — | MB1011 | — | MB1012 |
| 25·4 | 6·35 | MB1013 | MB1014 | MB1015 | MB1016 |
| 50 | 6 | MB1017 | — | MB1018 | MB1019 |
| 50 | 12·5 | MB1020 | — | MB1021 | MB1022 |
| 50 | 18 | MB1023 | — | MB1024 | MB1025 |

FEEDBACK PLATES



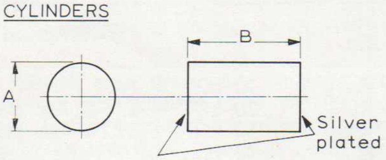

| A | B | C | D | Electrode polarity 1 | Electrode polarity 2 | PXE1 | PXE3 | PXE4 | PXE5 |
|---|---|---|---|---|---|---|---|---|---|
| 16 | 1·1 | 10 | 13 | − | + | — | — | — | MB1000 |
| 16 | 1·1 | 10 | 13 | + | − | — | — | — | MB1001 |

RINGS



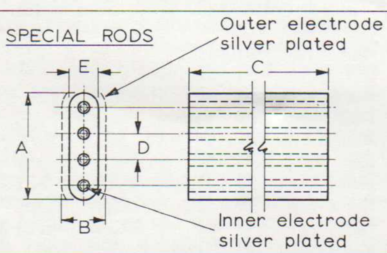

| A | B | C | PXE1 | PXE3 | PXE4 | PXE5 |
|---|---|---|---|---|---|---|
| 30 | 15 | 5 | MB2000 | — | MB2001 | MB2002 |
| 12·7 | 9·5 | 19·05 | MB2003 | — | — | MB2004 |
| 38·1 | 31·75 | 38·1 | — | — | — | MB2005 |

CYLINDERS




| A | B | PXE1 | PXE3 | PXE4 | PXE5 |
|---|---|---|---|---|---|
| 10 | 18 | — | MB1026 | — | MB1027 |
| 25·4 | 76 | MB1028 | — | — | MB1029 |

SPECIAL RODS




| A | B | C | D | E | Electrode polarity Inner | Electrode polarity Outer | PXE1 | PXE3 | PXE4 | PXE5 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1·6 | 0·67 | 15·5 | 0·35 | 0·4 | + | − | — | — | — | MB8000 |
| 1·6 | 0·67 | 12·7 | 0·35 | 0·4 | + | − | — | — | — | MB8001 |
| 1·6 | 0·67 | 15·5 | 0·35 | 0·4 | − | + | — | — | — | MB8002 |
| 1·6 | 0·67 | 12·7 | 0·35 | 0·4 | − | + | — | — | — | MB8003 |

Dimensions in mm. Available in materials: PXE1, PXE3, PXE4, PXE5.

NOTE:—Piezoxide will be available in developmental quantities from Mullard offices in approximately six to eight weeks' time.

Mullard

# THREE WATT TRANSISTOR STEREO POWER AMPLIFIER WITH TONE CONTROL FACILITIES

*A complementary pair of medium power output transistors in an encapsulation no bigger than that commonly employed for small signal transistors provides high output power and a low level of distortion. Although it will be a month or two until these transistors are available through trade channels, manufacturers are already examining the very favourable watt/cent ratio for the AC187/AC188 complementary output pair. An output power level of 3W is ideal for car radios, record players and cord transistor mantel radios. The amplifier described below was designed for a commercial stereo home entertainment centre working into efficient vented enclosures* and the 6W of output power thus available will suffice for the medium to large home, for instance.*

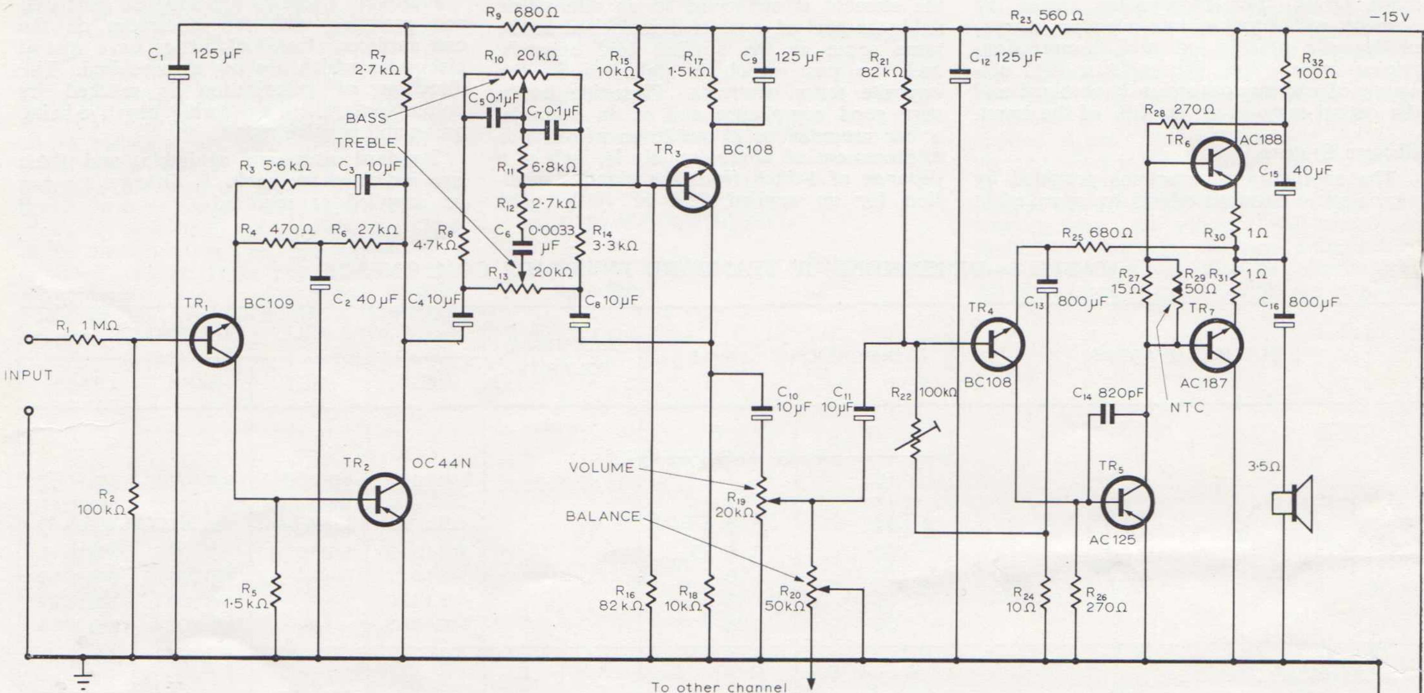
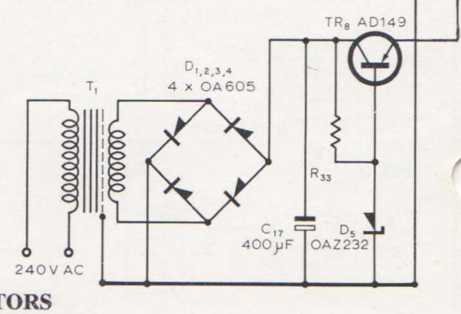



*Fig. 1. Circuit diagram of one channel of the three watt transistor stereo power amplifier.*

* See Page 28 Mullard Mini Speaker Units, a Design for Small Loudspeaker Housings.




## LIST OF COMPONENTS

### CAPACITORS

All capacitors in μF, 10% unless otherwise stated

| Circuit Ref. | Value | Description | Rating |
|---|---|---|---|
| $C_1$ | 125 | Electrolytic | 16VW |
| $C_2$ | 40 | Electrolytic | 10VW |
| $C_3$ | 10 | Electrolytic | 16VW |
| $C_4$ | 10 | Electrolytic | 16VW |
| $C_5$ | 0.1 | Polyester | 125V |
| $C_6$ | 0.0033 | Polyester | 125V |
| $C_7$ | 0.1 | Polyester | 125V |
| $C_8$ | 10 | Electrolytic | 16VW |
| $C_9$ | 125 | Electrolytic | 2.5VW |
| $C_{10}$ | 10 | Electrolytic | 16VW |
| $C_{11}$ | 10 | Electrolytic | 16VW |
| $C_{12}$ | 125 | Electrolytic | 16VW |
| $C_{13}$ | 800 | Electrolytic | 10VW |
| $C_{14}$ | 820pF | Ceramic | 500V |
| $C_{15}$ | 40 | Electrolytic | 16VW |
| $C_{16}$ | 800 | Electrolytic | 16VW |
| $C_{17}$ | 400 | Electrolytic | 25VW |

### RESISTORS

All resistors 1/2W, 10% unless otherwise stated

| Circuit Ref. | Value | Description | Circuit Ref. | Value | Description |
|---|---|---|---|---|---|
| $R_1$ | 1 MΩ | | $R_{18}$ | 10 kΩ | |
| $R_2$ | 100 kΩ | | $R_{19}$ | 20 kΩ | 1/4W log. pot. |
| $R_3$ | 5.6 kΩ | | $R_{20}$ | 50 kΩ | 1/2W lin. pot. |
| $R_4$ | 470 Ω | | $R_{21}$ | 82 kΩ | |
| $R_5$ | 1.5 kΩ | | $R_{22}$ | 100 kΩ | 50mW lin. |
| $R_6$ | 27 kΩ | | | | pre-set pot. |
| $R_7$ | 2.7 kΩ | | $R_{23}$ | 560 Ω | |
| $R_8$ | 4.7 kΩ | | $R_{24}$ | 10 Ω | |
| $R_9$ | 680 Ω | | $R_{25}$ | 680 Ω | |
| $R_{10}$ | 20 kΩ | 1/2W lin. pot. | $R_{26}$ | 270 Ω | |
| $R_{11}$ | 6.8 kΩ | | $R_{27}$ | 15 Ω | |
| $R_{12}$ | 2.7 kΩ | | $R_{28}$ | 270 Ω | |
| $R_{13}$ | 20 kΩ | 1/2W lin. pot. | $R_{29}$ | 50 Ω | VA1034 NTC |
| $R_{14}$ | 3.3 kΩ | | $R_{30}$ | 1 Ω | 1/2W Wire W. |
| $R_{15}$ | 10 kΩ | | $R_{31}$ | 1 Ω | 1/2W Wire W. |
| $R_{16}$ | 82 kΩ | | $R_{32}$ | 100 Ω | |
| $R_{17}$ | 1.5 kΩ | | $R_{33}$ | 120 Ω | 1W |

**LIST OF COMPONENTS,** Continued.

**MULLARD SEMICONDUCTORS**

Transistors

| | |
|---|---|
| $TR_1$ | BC109 |
| $TR_2$ | OC44N |
| $TR_3$ | BC108 |
| $TR_4$ | BC108 |
| $TR_5$ | AC125 |
| $TR_6$ | AC188 |
| $TR_7$ | AC187 |
| $TR_8$ | AD149 |

Diodes

| | |
|---|---|
| $D_1$ | OA605 |
| $D_2$ | OA605 |
| $D_3$ | OA605 |
| $D_4$ | OA605 |
| $D_5$ | OAZ232 |

**TRANSFORMER $T_1$**

| | |
|---|---|
| Ferguson Transformers Pty. Ltd. | PX482 |
| Special Transformers Pty. Ltd. | ST3618 |
| A. & R. Transformers Pty. Ltd. | PT5990 |

Transformer $T_1$ ratings:
Primary, 240V; 50c/s.
Secondary, 17V; 1A.

**Summary of Amplifier Performance**

| | | |
|---|---|---|
| Output at onset of clipping | 3 | W |
| Distortion at 3W output | 2.6 | % |
| Sensitivity for 3W output | 100 | mV |
| Frequency response, 3dB points | 40c/s 25 | kc/s |
| Tone control range at 100c/s and 10kc/s | ± 10 | dB |

**CIRCUIT DESCRIPTION**

The circuit diagram of one channel of a stereophonic system is shown in Fig. 1.

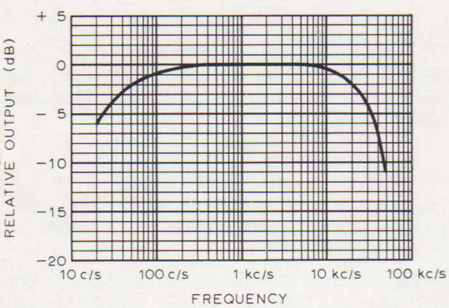



*Fig. 2. Frequency response curve of amplifier measured at the base of $TR_4$.*

As may be seen the circuit employs seven transistors per channel. The BC109 n-p-n silicon planar epitaxial low noise transistor ensures an excellent signal to noise ratio. By using a silicon transistor directly strapped to a germanium transistor, thus forming a complementary pair, a number of advantages are gained and discussion of these may be found in Outlook Volume 8, No. 5, Page 74. The complementary pair is followed by another silicon transistor, BC108, used in a feedback tone control stage. A further silicon transistor, BC108, is used as a driver pre-amplifier, followed by an AC125 driver transistor. As may be seen from Fig. 4, an AC187-AC188 complementary germanium medium power output transistor pair develops in excess of 3W output across a 3.5Ω load.

The pre-amplifier stage has been designed to provide sufficient sensitivity and equalisation for ceramic cartridges, resulting in a stage gain of approximately 10 times. Magnetic cartridges may be used with this amplifier circuit by employing a modified equalisation feedback circuit. The modifications required to provide sufficient sensitivity for magnetic cartridges are as follows:

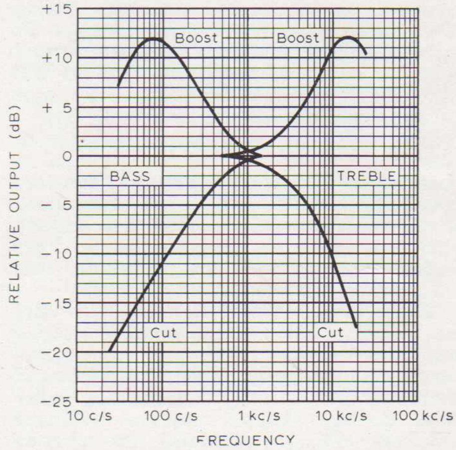



*Fig. 3. Tone-control characteristics for the three watt transistor stereo power amplifier.*

1. Replace the input resistor $R_1$ with a capacitor of 2μF.
2. Replace the equalisation network $R_3$ and C3 with a series-parallel combination: a capacitor of 0.047μF in series with a parallel combination of a resistor of 4.7kΩ and a capacitor of 0.015μF.

The tone control circuit shown, as mentioned previously, is a feedback system with a total range of approximately 20dB at 100c/s and 10kc/s respectively, as may be seen in Fig. 3.

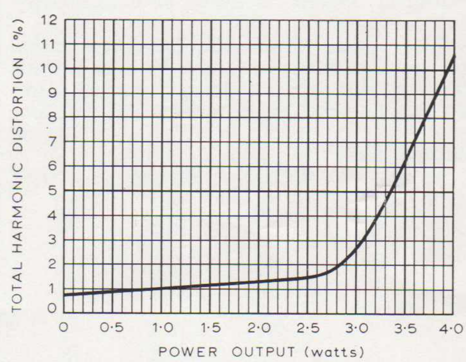



*Fig. 4. Power output tabulated against total harmonic distortion.*

The output amplifier stage consists of four transistors providing in excess of 3W into a 3.5Ω loudspeaker load before the onset of clipping. The bias for symmetrical clipping is initially adjusted by the variable pre-set resistor, $R_{22}$ in Fig. 1.

If the total output power of 3W is not required or a 3.5Ω speaker load not conveniently provided, the pre-amplifier and tone control stages could readily be used with the four transistor 2.5W main amplifier of the Medium Power Amplifier described in OUTLOOK Volume 9, No. 2, Page 22.

The curve in Fig. 4 shows the low level of distortion tabulated against power output and it may also be seen that for an output power of 2.8W the distortion figure is 2%.

In the power supply shown in Fig. 1, the transistor Zener diode combination provides excellent filtering. The power transformer in size and regulation, as well as the capacitor value, were chosen with cost consideration to provide 3W per channel. The sensitivity must therefore be arranged to suit the particular pick-up cartridge so that gross overloading of the amplifier will not occur.

The value of resistor $R_3$ is 5.6kΩ for a cartridge of 100mV output and must be reduced for higher output pick-ups.

Under full bass boost and overload conditions the power supply has been specifically designed to starve the output pair and also provide protection for these transistors against severe overload and accidental short-circuiting of the output. ■

R. E. BROWN

Applications Laboratory, Sydney

# NEW REFERENCE MANUAL

## MULLARD VOLTAGE REGULATOR (ZENER) DIODES

This booklet is the latest addition to the range of Mullard technical publications. It discusses the physics of voltage regulator diodes and design procedures, enabling the reader to calculate component values for circuits to suit particular requirements.

A number of basic circuits are provided wherein the voltage regulator diode is used to control stabilised power supply output voltages using series transistors together with error detectors and amplifiers. In all, six chapters provide a condensed, easy to read discussion on the subject and conclude with a multi-coloured chart providing an easy reference to the preferred range of Mullard voltage regulator diodes.

The publication is available from Mullard offices throughout the Commonwealth, priced at 85c plus 7c postage. Cheques, money orders and postal notes should be made payable to "Mullard-Australia Pty. Ltd." The publication may also be obtained from major booksellers. ■

# MAILING LIST

If you change your location, don't forget to let us know in good time, otherwise your Outlook may reach you late or never. And please, when you change, quote both your old and your new address. We can then be sure of destroying the obsolete mailing plate. ■

# MULLARD ANNOUNCES NEW PLANS FOR MICROCIRCUIT PRODUCTION

## MANY NEW TYPES OF CIRCUIT INTRODUCED

Continuing the build-up of its microcircuit activity, Mullard has announced that its production staff making semiconductor integrated circuits will be more than doubled during the next eighteen months. This expansion is taking place at the Southampton plant which is the company's main semiconductor production unit.

Mullard is already Britain's biggest supplier of semiconductors and through Associated Semiconductor Manufacturers Limited—the company it set up jointly with G.E.C. in 1962—it can point to over 4,000 people engaged in the development and manufacture of transistors, diodes and allied devices.

The build-up of microcircuit facilities is based on the company's own substantial research, development and production experience in this field extending over ten years. But it has been given an additional impetus through an agreement to exchange microcircuit technology with the American Westinghouse Company, which has been heavily involved in U.S. space and military projects.

Selected types from the wide range of Westinghouse integrated circuits are to be marketed in Britain by Mullard and will be manufactured in the U.K. company's Southampton plant.

Conversely, a series of Mullard-designed fast computing circuits which operate at the exceptionally high speed of 1.5 nano seconds are to be produced in the Westinghouse factory in the U.S.A. Mullard will market these circuits in Britain and experimental samples of them were shown at the 1966 Instruments, Electronics and Automation Exhibition in London.

**Thirty New Linear and Digital Circuits**

The exhibition was also used to preview nearly thirty other new types of semiconductor integrated circuit that will become available in commercial quantities during 1966. With these new circuits added to its existing ranges, together with yet further types to be introduced soon, Mullard will have one of the most comprehensive ranges of integrated circuits available in Britain.

The new types will include a range of twenty digital circuits that are expected to meet most of the industry's standard requirements for devices in computers, instruments, control systems and military equipment over the next few years. They include two circuits that consume only micro-watts of power.

Eight new linear circuits will also be added. This range contains several advanced devices including operational amplifiers and very high-gain differential amplifiers for use in instruments and industrial control systems, and a wideband amplifier (DC to 100Mc/s) for telecommunications equipment.

All the new circuits are in ¼" x ⅛" or ¼" x ¼" "flat-pack" encapsulation to give high packing densities. By late 1966 most will be available in dual-in-line packaging, which allows automatic soldering on to printed wiring boards.

**Digital Circuits**

Comprising seventeen types of DTL digital circuits for use in computers, instruments, control systems and military equipment, this series contains single and multiple gates, monostables, bistables, expanders and a flip-flop.

Outstanding features common to all the circuits include a propagation delay time of only 20 nano seconds; high noise-margins; high fan-outs; operation from a simple 6V DC power supply.

There are also a bistable circuit and a dual gate which, while of similar performance, consume only a few hundred micro-watts of power. Additionally, an experimental dual gate and a flip-flop are available. From these will be derived a family of saturated-logic elements characterized by high noise-margins and high speeds.

The above types are in addition to the 1.5 nano second current-steered logic circuits mentioned earlier.

**Linear Circuits**

These include two audio amplifiers, three differential amplifiers, two operational amplifiers and a wideband amplifier.

The audio amplifiers give power outputs of 10mW and 45mW respectively and are principally intended for use as audio amplifiers in communications receivers.

Two of the differential amplifiers give minimum gains of 1000 and 1500; the other has a controlled gain of 250 $\pm$ 30. All three have high common-mode rejection and low drift (typically 10$\mu$V/°C).

High input-impedance, low-drift and high reliability are the salient features of the operational amplifiers, both of which are intended for use in instrumentation and control systems.

The wideband amplifier has a frequency response from DC to 100 Mc/s. In telecommunications equipment, it can be used as a 60Mc/s wideband IF amplifier, a 455kc/s oscillator/mixer stage, and, as a general purpose amplifier with externally adjustable bandwidth. ■

# BRIDGE RECTIFIERS — BY122 AND BY123

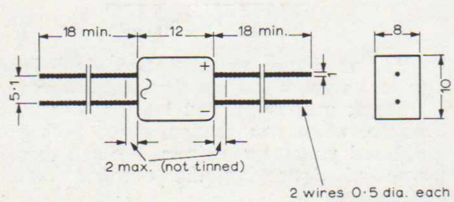
The BY122 and BY123 are two new medium-current bridge rectifier assemblies intended for a wide variety of power supply applications. Each type consists of four double-diffused silicon rectifiers connected in a bridge configuration and encapsulated in a 12mm x 10mm x 8mm epoxy case. This new epoxy case provides simplicity in mounting and space economy over the conventional discrete rectifiers now commonly used by equipment manufacturers.

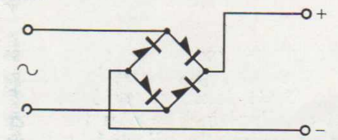
The repetitive peak input voltages for the BY122 and BY123 are 120V and 800V respectively, and repetitive peak currents of 3A and 2A respectively can be drawn from the two bridges. These two devices are suitable for power supplies for most transistorized industrial equipment and the BY123 especially can be used as an economical "off-the-line" rectifier assembly. ■

**Abridged Preliminary Data**

| | BY122 | BY123 | |
|---|---|---|---|
| Input voltage r.m.s. (max.) | 42 | 280 | V |
| Input repetitive peak voltage (max.) | 120 | 800 | V |
| Continuous output voltage | | | |
| with C load | 60 | 400 | V |
| with R and L load | 38 | 255 | V |
| Average output current with R and L load (up to 35°C) (max.) | 0.8 | 0.6 | A |
| Repetitive peak current (max.) | 3 | 2 | A |
| Thermal resistance from junction to ambient | 55 | 55 | °C/W |

**Outlines and Dimensions**




Plastic envelope with polarity indications at both sides
The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles)

# MINI SPEAKER UNITS

← From page 28

grade, which proved to have the best absorption coefficient for this application. This material is manufactured by:

Wonder Wool Pty. Ltd.,
87b James St.,
Leichhardt, N.S.W.

and is obtainable from major electronic parts distributors throughout Australia.

**Calk Strip**

Plasticine was used as a temporary seal for the back cover during initial testing. A more permanent sealing material should be used when the unit is finally assembled, and a semi-setting mastic gasket is recommended, such as Strip Calk "G" ⅛" round, which is manufactured by:

Selleys Chemicals Ltd.
1 Gow Street,
Bankstown, N.S.W.

and may be obtained from their distributors throughout Australia. It must be stressed that it is essential that the whole enclosure is completely airtight; indeed the ultimate performance will depend almost entirely on this factor. The Strip Calk "G" is a permanently plastic material with a tacky surface which will provide adequate adhesion to timber and it is important that the strip is applied under compression to promote adhesion. Once the surfaces have made adequate contact with the calking compound the back cover may be skew-screwed (or pinned) into place. ■



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