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**JOERN BORK**

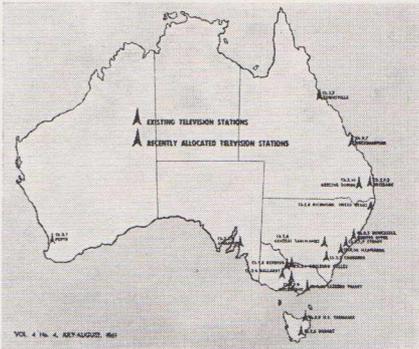
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The front cover map shows an amazing contrast in television station development compared to the 1961 map reproduced above. A comprehensive tabulation of television stations may be found in this issue.

**MULLARD-AUSTRALIA PTY. LTD.**

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**TECHNIQUES AND TACTICS**

Equipment designers using thermionic valves are rarely interested in valve manufacturing techniques or the materials used in valves—their only concern is that the valves meet specification, are uniform one with another, are reliable and good value.

In this supermarket and motel era, even the smaller semiconductor user became a discriminating purist, likely to debate at length the pros and cons of manufacturing techniques and materials, encouraged no less by the semiconductor principals extolling the virtues of a new manufacturing process; when some earlier process or basic material may have better suited a particular end application.

Complementary and to some measure analogous, valves and semiconductors are our business and from our preferred range for new equipment we recommend a particular type for a particular application, something of the Music Hall when the performers and the audience join in another spontaneous and jolly frolic through the data sheets and the “old time favourite” with a little of the atmosphere but right to the mood of today—for in this issue we announce important additions to our preferred range of silicon semiconductors.

**AMBASSADOR-EXTRAORDINARY**

The article on pages 68 and 69 tells its own hard hitting story, with perhaps a red face and a shifting in the seat. We believe a first rate and down to earth sequel to “A button or a piece of string” and “Knowing where to tap.”\* For this we are indebted to Mullard Outlook, United Kingdom Edition and we are preparing the message in colour, approximately 19” x 29” deep, for mounting—a *must* behind the scenes for every manufacturer, retailer, service organisation and service training school. Reserve your copy chaps—and round off your service reputation, by using only Mullard Long Life picture tubes and valves.

M.A.B.

\*Outlook, Issue Vol. 3, No. 1, Jan-Feb. 1960.  
Outlook, Issue Vol. 4, No. 1, Jan-Feb. 1961.

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<p><b>Victoria</b></p> <p>Carnegie (Australia) Pty. Ltd. Vere Street, Richmond. Phone: 42 2781</p>	<p><b>Western Australia</b></p> <p>Tedco Pty. Ltd. 579 Murray Street, Perth. Phone: 21 2561</p>	

and all leading wholesalers throughout the Commonwealth

# VIEWPOINT WITH MULLARD

## Papua and New Guinea Distributor

Mullard-Australia Pty. Ltd., have pleasure in announcing the appointment of Amalgamated Electronics Limited, as their distributor for the Territory of Papua and New Guinea.

Located in Port Moresby, Amalgamated Electronics have been established for over eight years, and are under the able leadership of Managing Director, Mr. W. Nicholson, who is assisted by a staff of six.

One of the major suppliers of telecommunications equipment in the Territory, Amalgamated Electronics offer a complete service for the installation and maintenance of HF and VHF communications systems for fixed, mobile or marine applications. In addition to these activities, they are wholesalers of electronic components and have also built up a strong business with AM receivers, tape recorders and household appliances. Servicing, which plays a major part in telecommunications, is also an important factor in the domestic field, due to the severe environmental conditions, such as high temperature and humidity, experienced in the Territory. An illustration of the arduous conditions under which domestic equipment is called upon to operate, is the extremely high incidence of service calls on electronic equipment, which is approximately 2½ times that carried out on the mainland, including the tropical areas in the Northern Territory and Queensland.

are not readily available. Our friends in the TV and radio service industry will appreciate just how frustrating this can be!

### Technical Staff

It is the policy of Amalgamated Electronics to encourage and assist the indigenous people to find useful employment and they are very proud of the fact that four of their technical staff are natives of the Territory. One of their best technicians, Korohi Morea, who comes from Pari village



Headquarters of Amalgamated Electronics Limited.

(about five miles from Port Moresby) is an acknowledged expert on record players and often succeeds where European technicians have given up! Another Amalgamated Electronics' employee, Naif Namis, is a New Guinean aged 17 years, who is the first private radio apprentice in the Territory. Naif comes from Nariawang Village which is about 20 miles from Lae and was



Korohi Morea and Naif Namis working in the Amalgamated Electronics' Service Department.

### Service the Keynote

A great deal of electronic equipment is imported from other countries and the extensive range of spare parts required creates quite a servicing problem. This is made all the more difficult because of the long delay in obtaining original spares from overseas, particularly Europe.

Quite often, a service call requires a jeep ride over a rough mountain track to a remote mission, the technician arriving only to find that the job involves a piece of imported equipment for which spare parts

educated at Lae High School up to Form 3. He has completed the first year of his apprenticeship and studies by correspondence with the Royal Melbourne Institute of Technology. A cousin of another indigenous member is Captain of Ipswich Grammar School.

We are confident that our readers in this rapidly developing Territory of Papua and New Guinea will obtain every assistance from the new Mullard distributor and, to our friends at Amalgamated Electronics Limited—ALL SUCCESS! ■

## FEASIBILITY OF UHF FM BROADCASTING

Following the recommendations of the Huxley Committee wherein only a few channels inadequate for a national service and sandwiched in between TV Channel 3 and 4 were left in the VHF band for FM broadcasting in Australia, we decided that the Applications Laboratory at Mullard-Australia should devote a reasoned study to the possibilities of UHF FM, bearing in mind that such a system had not been attempted in any other country. The basic requirement was the development of a low-cost stable oscillator and Mr. Z. Uzdy, B.E., Grad. I.R.E.E. (Aust.), Grad. I.E. Aust., head of the Microwave Section of the Applications Laboratory, undertook this development and the outcome was a paper read before the Institution of Radio & Electronics Engineers Aust., Radio & Electronic Engineering Convention at Canberra in March 1965, the paper "The Design of a Highly Stable Transistor Oscillator for the 500Mc/s Region".

The stability requirement of a local oscillator in an FM receiver with a bandwidth of 200kc/s is far more stringent than that for a UHF TV receiver with its bandwidth of 4500kc/s. The task originally set Mr. Uzdy, and as detailed in his first paper, was for an oscillator that must be cheap and simple in construction, readily reproducible and, just as important, that it be tunable over a range of about 20Mc/s. This would not only provide reception coverage of 100 separate channels, but also enormous flexibility in that, with the service area envisaged for each station, one could possibly stack 4000 or 5000 into an area the size of Australia still contained within the same 20Mc/s allocation. Not that one would envisage that quantity anyway.

Following the development of the stable oscillator, Mr. Uzdy went on with the feasibility study of a complete receiver and the outcome of this work will be the title of a paper that he will read before the Institution of Radio & Electronic Engineers, in Melbourne on November 16th and in Sydney on November 29th, entitled "The Feasibility of a Domestic FM Receiver Operating in the 500Mc/s Region".

Questioned on this development when it was recently announced, Mr. M. A. Brown our General Manager commented "I feel that any technological advantages that will provide better broadcast facilities, particularly in country areas, need the closest attention and investigation, hence our studies and it is hoped that the contribution might be helpful in decisions that might be taken towards the future broadcasting policy in Australia". He went on to say "There are certain factors to be considered such as an acceptable level of phase distortion due to propagation problems and it would be interesting to follow the test transmissions from UHF FM experimental stations soon to be operating in Sydney and Melbourne.

A precis of Mr. Uzdy's paper to be read before the November meetings of the I.R.E.E. will appear in the next issue of Outlook. ■

# THE SERVICE ENGINEER—AM

'A product is *everything* that the purchaser gets in exchange for his money.'

This modern definition means that while two products may be identical in function, appearance, performance—even in price—they may differ widely in terms of *total* value for money to the customer.

Where does the difference lie? Often in some form of buying incentive. It may be a special seasonal discount or an attractive insurance scheme. Perhaps a full-cover guarantee or free delivery with no limit on distance.

But by far the most valuable and lasting 'bonus' a customer can get with his purchase is the firm assurance of prompt, skilled and reliable after-sales service whenever he needs it.

And nowhere is this more important—or more readily expected—than in radio, TV and electrical trading.

## Expanding Service Function

In general a retailer's customers have a healthy respect—usually based on the

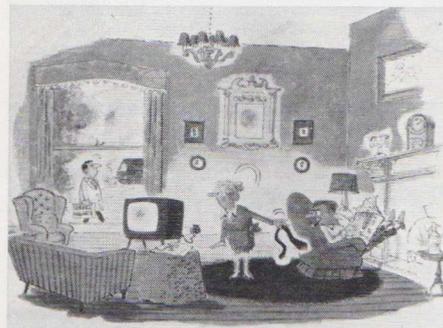


*This is how your customers see you. Do you use your influence to the best advantage?*

lack of any detailed knowledge—for any electrical or electronic. In particular they are mindful that today's home entertainment products—such as radio and TV receivers—are complicated precision-built instruments. They know that when things go wrong their correct course is to call in the retailer and his experts rather than attempt any amateur tinkering.

This basic service function of the retailer is, however, expanding in its scope as domestic electrical and electronic equipment grows in complexity and range.

More and more customers are turning to their retailer not only for repairs, but also for informed guidance on the kind of equipment to buy and how best to use it. This trend is, in turn, beginning also to affect the function and standing of the retailer's outside service engineer.



*Are you a credit to your company?*

His ability to put life into a dead TV screen or coax music out of a silent radio set has always earned a certain grateful admiration. Now, with a greater public need for help in choosing and using electrical and electronic products, there are signs that he is finding a new place in the sun.

He is achieving the status of an authority who is frequently consulted by the customer he is visiting on matters which are often removed from the original subject of his call.



*Are you sure of your welcome?*

This extension of the part that the engineer plays in the retailer's business—and the new responsibilities and opportunities it creates—merits a fresh look at the way it ought best to be played.

## Overall Impact

As a travelling service engineer you are your employer's roving ambassador-extraordinary.

The whole organisation you represent may well be judged, not only on your technical competence, but also on the overall impact you make from the moment you knock on the customer's door.

How can the right impact be achieved?

Some of the following points-to-watch may be simple and obvious. Their observance may be standard practice so far as *you* are concerned. But although they weigh most heavily with the customer they are all too often overlooked.

Take the elementary subject of personal appearance.

Nobody expects a practical technician to be a walking fashion plate. But there's nothing to be gained (and a lot to be lost) by an unshaven chin, uncombed hair, unbrushed shoes or a dustcoat which is long overdue for a visit to the laundry.

Then there is your own personal conduct. A firm but dignified tap on the door wins friends more easily than an arrogant thump.

Nothing impresses the housewife more than to have a caller carefully wipe his feet on the mat before stepping onto the hall carpet.



# BASSADOR - EXTRAORDINARY

Often your work will take you into the sitting-room where the best furniture is normally to be found. Treat it with respect. Don't strew tools and components on every chair. Use a Mullard Drop Cloth or clean newspaper to protect floor coverings.

If you have to move ornaments to get to the job, treat them as though they were genuine Ming. Your reputation—and that of your employer—can be shattered just as quickly as that undistinguished but treasured bit of pottery.

Don't automatically light a cigarette while you're waiting for the circuit to warm up. Some people have a quite violent dislike of tobacco smoke. Ask permission first,



*It pays to finish the job properly. Do you?*

and hide your resentment if it's not forthcoming.

In conversation be interesting, interested and polite, without being overpowering. Keep off touchy subjects. Never criticise your employer. And resist being drawn into arguments, even if the customer mounts your favourite hobby-horse.

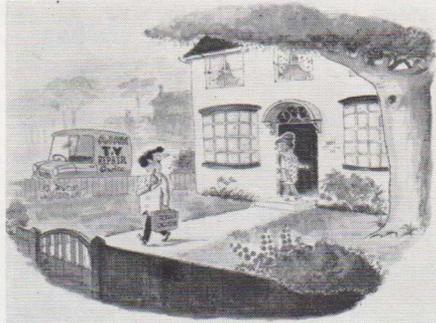
All these are commonsense lines of personal conduct which, as many engineers know from experience, are the safest to follow.

## "After-service Sales"

Remember, you start off with everything on your side. Unlike the door-to-door salesman you're there by the customer's express invitation. You are watched for, even welcomed. In fact there would be no end of a row if you didn't turn up as promised.

These favourable circumstances give you a head-start in building the customer-

confidence which is essential to your employer's prosperity—and ultimately to your own.



*Do you always remind your customers to come to your company for advice on any electrical products?*

More than that, this ideal situation opens the door for some really positive promotion of future business. Call it 'after-service sales'.

It's not suggested for a moment that you should take up the dual role of engineer and salesman. Not at all. Your contribution to the sales effort is of a much more subtle, long-term nature.

The following points about the firm you work for can often be put over easily and naturally in ordinary conversation. Indeed, the customer seeking advice may actually provide the openings without realising it.

- \*\*\* The firm's reputation and standing in the community.
- \*\*\* Its policy of selling only reputable products.



- \*\*\* The wide variety of the goods it stocks.
- \*\*\* The fact that it employs only fully-trained service personnel.
- \*\*\* The fact that it uses only the finest materials and components in its service work.
- \*\*\* Its willingness to provide, without obligation, any advice or assurance the customer needs on anything electrical or electronic.

And here's another confidence-building touch. Before you leave (and take a last look round to make sure everything is as you found it) explain in simple terms the nature of the repair you've just carried out on the customer's set.

## The Mental Picture

A great deal of money is spent in modern times by trade and industry on image-building. How does one define an image? One description is 'the mental picture and attitude created in a person's mind when the subject of the image is registered in his brain'.

The travelling service engineer, as we have seen, is in a very special position to influence for good or ill the 'mental picture and attitude' of his firm in the mind of the customer at whose home he calls.

By the efficiency with which he does his job, by the courteous way in which he deals with a customer's questions, by the lasting favourable impression he leaves behind, he immeasurably increases the probability of profitable 'after-service sales'.



*Do you create the right atmosphere?*

# TRANSISTOR STEREO PRE-AMPLIFIER

The pre-amplifier described is a low cost device having sufficient gain and adequate tone control facilities for use with all crystal and ceramic pick-up cartridges. The unit is suitable for use with the 5 watt transistor stereo amplifier described on pages 58 and 59 of Mullard Outlook, Vol. 8 No. 4 (July-August 1965) and will also prove quite useful in other, similar applications.

## Mullard Transistor BC109

The new Mullard silicon transistor type BC109 is used in the first stage, providing high gain and low noise performance. This transistor is particularly well suited for use in such applications where low noise and flexibility of input impedance in the pre-amplifier stage are required. The high gain of the device and the characteristics resulting from the use of the epitaxial layering technique in its manufacture, enables the BC109 to be used in higher level stages as may be seen elsewhere in this issue.

## Basic Circuit

From the basic circuit diagram, Fig. 1, it can be seen that the collector of the BC109 is directly coupled to the base of the OC44N. The emitter current of the BC109 (and hence that of the OC44N) is determined by the value of  $R_2$  and the collector voltage of the OC44N. This current is much less than the collector current of the OC44N whose collector voltage approaches half that of the supply. The value of  $R_2$  will therefore be several times that of  $R_3$ . By correct choice of the emitter currents of the two transistors a design can be achieved having low noise and high gain. The circuit action may be explained by considering an incremental negative potential change in the BC109 base. By transistor action in the BC109 its collector current falls, reducing the OC44N current considerably by the mechanism previously described. The collector current of the OC44N accordingly falls and its collector voltage moves negatively which causes the base to emitter voltage and collector current of the BC109 to rise. This movement tends to cancel the initial change, and negative feedback has therefore occurred. Due to the very large loop gain and heavy feedback

present, the stability of the circuit is quite high.

The AC gain can be restored without impairing the DC stability by reducing the AC feedback. This is achieved by

In order to accommodate the loss in signal level due to the bass and treble tone control network, a third transistor, in addition to the BC109 and OC44N mentioned earlier, is necessary. Since only a moderate amount of amplification is required, an

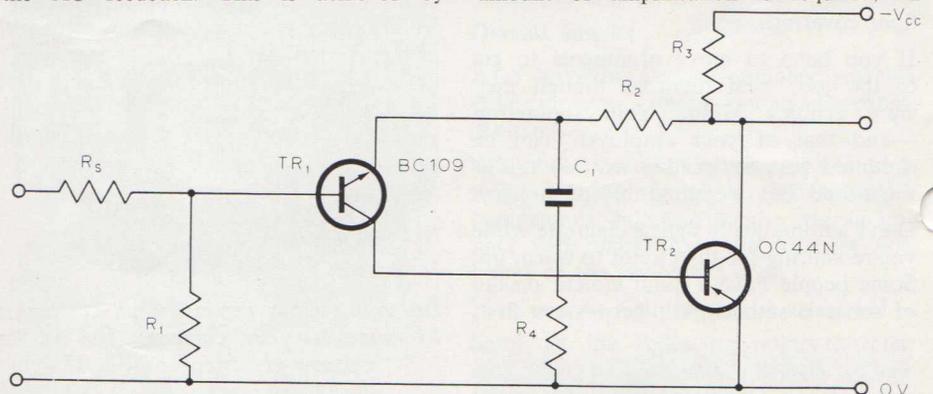


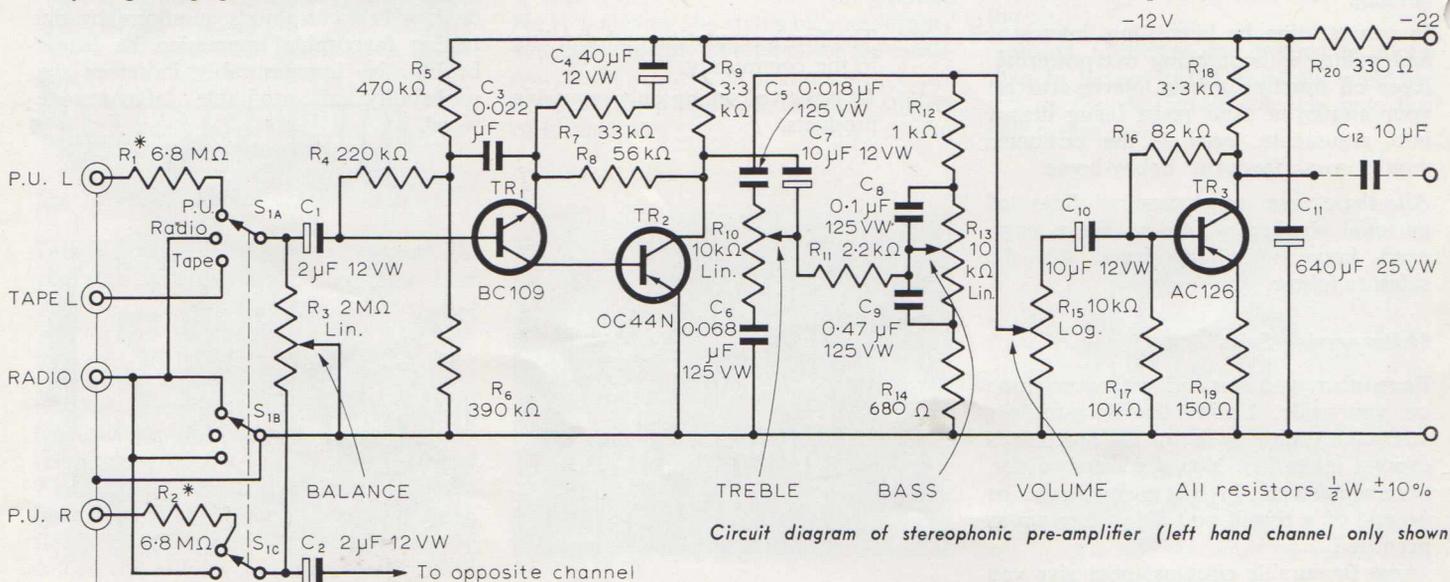
Fig. 1 Basic circuit diagram.

the addition of the capacitor  $C_1$ . It is now possible to control gain, frequency response and "roll off" of the circuit by selecting suitable values for  $C_1$  and  $R_4$ . The component values in the complete circuit diagram represent a compromise for matching the input impedance of the pre-amplifier to high and low output ceramic and crystal pick-ups, with due regard to pick-up compensation.

AC126 with an un-bypassed emitter resistor provides the desired gain. Where the pre-amplifier is used with the 5W transistor stereo amplifier referred to earlier, the coupling capacitor  $C_{12}$  is already fitted to the main amplifier board. In other cases home constructors should ensure that a coupling capacitor is fitted to the output of each pre-amplifier channel. Performance specifications are tabulated below:

## 5W AMPLIFIER PERFORMANCE SPECIFICATIONS

Frequency response ( $\pm 1$ dB)	20c/s to 13 kc/s	Sensitivity 70mV for an output of 5W
Bass cut (at 30c/s)	- 3 dB	Total distortion 0.7% at 5W (measured overall i.e. pre-amplifier and 5W amplifier)
Bass boost (at 30c/s)	+ 3 dB	
Treble cut (at 10kc/s)	- 6 dB	
Treble boost (at 10kc/s)	+ 6 dB	



Circuit diagram of stereophonic pre-amplifier (left hand channel only shown)

\*The values of resistors  $R_1$  and  $R_2$  are typical for a medium output crystal pick-up. An attenuating network as shown in Fig. 2 may be substituted to suit other requirements.

### Constructional Details

The layout of individual components is catered for by the provision of a printed wiring board\* with the position of each component indicated by an identification number. This code is supplied with the printed wiring board and will serve to simplify construction. The pre-amplifier is designed for stereo operation from a 22V power supply rail. However, by changing the values of decoupling resistors and capacitors, operation from other power supplies is possible. Each channel of the pre-amplifier is provided with its own decoupling network in order to achieve adequate filtering. Facilities are provided for radio and tape inputs and it can be seen from the circuit diagram that the radio input is earthed when the pre-amplifier is

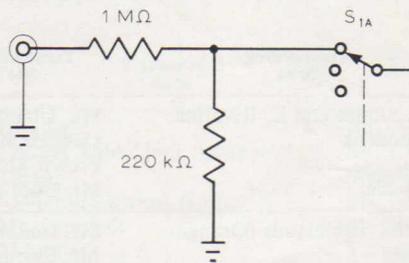


Fig. 2. Input attenuating network.

switched to either the pick-up or tape position. This is done to prevent individual channels interfering with each other. If stereo operation is not required on tape, the inputs to both channels may be connected in parallel (i.e. monophonic).

Fig. 2 shows a voltage divider, for which provision is made on the printed wiring board, to reduce the possibility of overloading the input stage when a high output pick-up is used. If desired, this can be tailored to suit the individual's requirements. ■

\* Printed wiring boards and complete kit sets are available from:

R.C.S. Radio Pty. Ltd.,  
651 Forest Road,  
BEXLEY. N.S.W.



Printed wiring board with components of both channels inserted.

## ELECTRONIC TACHOMETER

An article entitled "Design for an Electronic Tachometer" was first published in Outlook, Vol. 6 No. 5. The simplicity and flexibility of design together with good accuracy has prompted many home constructors to duplicate the tachometer with success.

Ferrier Electrical Instruments have made available a 260° meter movement for use with the original tachometer circuit. Principal dimensions of the case are 3.8" diameter and 2.6" total depth. Mounting is facilitated by a U bracket and the non-parallax illuminated scale has green tinted graduations and figures to match most commonly used motor car instrumentation. The movement has a full scale deflection of 1mA and may be obtained calibrated in either 5,000 or 10,000 rev/min.

The meter, as well as complete kit sets may be ordered from:

Ferrier Electrical Instruments,  
45 Albany Street,  
CROWS NEST, N.S.W.  
PHONE 43 5596

or their interstate distributors. ■



### VARIABLE POWER SUPPLY

"The Variable Power Supply for Service", which was described in Outlook Vol. 8 No. 1 on page 6, was constructed by a number of servicemen and home constructors largely because of the "fail safe" feature when the output is accidentally short circuited, as well as its good regulation.

Heating Systems Pty. Ltd. recommend

their model MC82AP cabinet and chassis unit which is designed to accommodate all the components of the variable power supply and to provide adequate ventilation for the heatsink mounted silicon diodes and power output transistor.

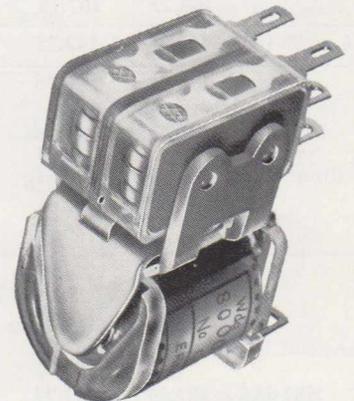
Heating Systems Pty. Ltd. are located at:  
24-32 O'Riordan Street,  
ALEXANDRIA, N.S.W.

and have branches throughout the Commonwealth. ■

### ERNI RELAY AND THE STREET LIGHTING CONTROLLER

Enquiries have been made regarding the ERNI relay as used in the Street Lighting Controller described in Outlook, Vol. 8 No. 4.

The type numbers of the relay used in the prototype were only developmental numbers. When enquiring, please quote type numbers 20KW (single changeover contact) or 20KWW (two changeover contacts).



If the type 20KWW relay is to be used, the extra operating current required would only affect the lowest operating voltage. Reliable operation would take place at the normal and higher supply line voltages. ■



# AUSTRALIAN TELEVISION CHANNELS – 1965

Channel Number	Band Mc/s	Vision Mc/s	Sound Mc/s	Aerial Polarisation	Transmitting Area	Transmitting Site	National Stations	Commercial Stations	
0	45-52	46.24	51.74	H	S.W. Slopes and E. Riverina	Mt. Ulandra	ABMNO	ATVO	
		46.26	51.76	H		Melbourne			
		—	—	V		Bega			
		—	—	H		Brisbane			ABSNO
1	56-63	57.258	62.758	V	Central Tablelands (Orange)	Mt. Canobolas	ABCN1	*	
		57.25	62.75	H		Albury	ABAV1		
		57.26	62.76	V		Bendigo	ABEV1		
		—	—	H		Mt. Gambier	ABGS1		
		57.25	62.75	V		Pt. Pirie	ABNS1		
		—	—	H		Warwick	ABSQ1		
—	—	V	Taree	ABTN1					
2	63-70	—	—	V	S.W. Slopes and E. Riverina	Mt. Barker	ABAW2	*	
		64.26	69.76	H		Grafton-Kempsey	ABDN2		
		—	—	V		Broken Hill	ABLN2		
		64.25	69.75	H		Sydney	ABN2		
		64.24	69.74	H		Brisbane	ABQ2		
		64.26	69.76	H		Adelaide	ABS2		
		—	—	V		Swan Hill	ABSV2		
		64.24	69.74	H		Hobart	ABT2		
		64.25	69.75	H		Melbourne	ABV2		
		64.25	69.75	H		Perth	ABW2		
64.24	69.74	H	S.W. Slopes and E. Riverina	Mt. Ulandra	RVN2				
3	85-92	86.24	91.74	V	S.W. Slopes and E. Riverina	Black Mountain	ABC3	*	
		86.252	91.752	H		Darling Downs (Toowoomba)	ABDQ3		
		86.23	91.73	V		Goulburn Valley (Shepparton)	ABGV3		
		86.20	91.70	H		N.E. Tasmania	ABNT3		
		—	—	V		Dubbo	ABQN3		
		86.26	91.76	H		Rockhampton	ABRQ3		
		86.238	91.738	H		Ballarat	ABRV3		
		87.27	92.77	H		Townsville	ABTQ3		
		—	—	H		Bunbury	ABTQ3		
		86.25	91.75	H		Newcastle	ABTQ3		
—	—	V	Pt. Pirie	The Bluff	BTW3	NBN3			
4	94-101	—	—	H	S.W. Slopes and E. Riverina	Mawson Trig Point	ABCW4	*	
		95.24	100.74	H		Latrobe Valley (Traralgon)	ABLV4		
		—	—	H		Mackay	ABMQ4		
		—	—	H		Mildura	ABMV4		
		95.26	100.76	H		Upper Murray (Vic.)	Goschen	AMV4	
		—	—	H		Warwick	Passchendale Ridge	SDQ4	
95.25	100.75	H	Illawarra (Wollongong)	Knight's Hill	WIN4				
5	101-108	102.258	107.758	H	S.W. Slopes and E. Riverina	Great Sugarloaf	ABHN5	*	
		102.25	107.75	H		Bunbury	ABSW5		
5A	137-144	138.25	143.75	H	Illawarra (Wollongong)	Knight's Hill	ABWN5A		
6	174-181	175.26	180.76	H	S.W. Slopes and E. Riverina	Mt. Nardi	ABRN6	*	
		—	—	V		Wide Bay (Q'land)	ABWQ6		
		175.248	180.748	H		Ballarat	Lookout Hill		BTV6
		—	—	V		Dubbo	Mt. Cenn Cruaich		CWN6
		175.256	180.756	V		Goulburn Valley (Shepparton)	Mt. Major		GMV6
—	—	H	Mackay	Mt. Blackwood	MVQ6				
175.25	180.75	H	Hobart	Mt. Wellington	TVT6				
7	181-188	—	—	H	S.W. Slopes and E. Riverina	Griffith	ABGN7	*	
		—	—	H		Upper Namoi, N.S.W. (Tamworth)	Mt. Dowe nr. Mt. Kaputar	ABUN7	*
		182.26	187.76	H		Adelaide	Mt. Lofty	ADS7	
		182.25	187.75	H		Sydney	Artarmon	ATN7	
		—	—	V		Broken Hill	Rocky Hill	BKN7	
		182.25	187.75	H		Brisbane	Mt. Coot-tha	BTQ7	
		182.258	187.758	V		Canberra	Black Mountain	CTC7	
		182.25	187.75	H		Melbourne	Dandenong	HSV7	
		182.26	187.76	H		Rockhampton	Mt. Hopeful	RTQ7	
		182.25	187.75	H		Townsville	Mt. Stuart	TNQ7	
182.25	187.75	H	Perth	Bickley	TVW7				

# AUSTRALIAN TELEVISION CHANNELS – 1965

Channel Number	Band Mc/s	Vision Mc/s	Sound Mc/s	Aerial Polarisation	Transmitting Area	Transmitting Site	National Stations	Commercial Stations	
8	188-195	189.25	194.75	V	Bendigo	Mt. Alexander		BCV8	
		189.258	194.758	V	Central Tablelands (Orange)	Mt. Canobolas		CBN8	
		—	—	V	Taree	Middle Brother		ECN8 *	
		189.25	194.75	H	Richmond-Tweed (Lismore)	Mt. Nardi		RTN8	
		—	—	H	Mt. Gambier	Mt. Burr		SES8 *	
		—	—	H	Mildura	Yatpool		STV8 *	
		189.24	194.74	V	Wide Bay (Q'land)	Maryborough		WBQ8	
9	195-202	—	—	H	Cairns	Mt. Bartle Frere	ABNQ9	*	
		196.248	201.748	H	Melbourne	Dandenong		GTV9	
		—	—	H	Griffith	Mt. Bingar		MTN9 *	
		196.24	201.74	H	Upper Namoi, N.S.W. (Tamworth)	Mt. Dowe nr. Mt. Kaputar		NEN9	
		196.26	201.76	H	Adelaide	Mt. Lofty		NWS9	
		196.25	201.75	H	Brisbane	Mt. Coot-tha		QTQ9	
		196.25	201.75	H	Perth	Bickley		STW9	
		196.25	201.75	H	Sydney	Willoughby		TCN9	
		196.238	201.738	H	N.E. Tasmania	Mt. Barrow		TNT9	
—	—	V	Albany	—		—	φ		
10	208-215	209.26	214.76	H	Darling Downs (Toowoomba)	Mt. Mowbullin		DDQ10	
		—	—	H	Cairns	Mt. Bartle Frere		FNQ10 *	
		209.246	214.746	H	Latrobe Valley (Traralgon)	Mt. Tassie		GLV10	
		209.24	214.74	H	Grafton-Kempsey	Mt. Moombil		NRN10	
		—	—	H	Adelaide	Mt. Lofty		SAS10	
		209.25	214.75	H	Sydney	Artarmon		TEN10	
		—	—	V	Swan Hill	Goschen		—	φ
—	—	H	Northam	Mawson Trig Point		—	φ		
11	215-222	—	—	V	Bega-Cooma	Brown Mountain		—	φ

\* Due to commence shortly.  
 φ Call signs not yet allocated.

## TELEVISION REPEATER / TRANSLATOR STATIONS

Transmitting Area	Parent Station		Radiated Power (W)		Channels		Polarisation	Site of Translator
	National	Commercial	National	Commercial	National	Commercial		
Khancoban, N.S.W.	—	AMV4	—	5	—	10	H	Mount Youngal
Various S.M.A. Camps, N.S.W.	—	AMV4	—	5	—	6	H	Twins Peak
Lithgow, N.S.W.	ABCN1	CBN8	5	5	5	6	V	Reservoir Hill
• Mudgee, N.S.W.	—	CBN8	—	1	—	11	V	Bombira, 1.6 miles north of Mudgee
Kyogle, N.S.W.	ABRN6	RTN8	1	1	3	5	V	Mudgee
Bonalbo, N.S.W.	—	RTN8	—	1	—	5	V	Geneva Hill
Warrnambool-Port Fairy, Vic.	ABRV3	BTV6	50	50	2	9	V	Brown's Hill
Queenstown-Zeehan, Tas.	ABT2	TVT6	50	50	4	8	H	Tower Hill
Rosebery-Renison Bell, Tas.	ABT2	TVT6	5	5	1	10	H	Mount Owen
Taroona, Tas.	—	TVT6	—	3	—	8	V	Mount Read
Swansea-Bicheno, Tas.	—	TVT6	—	50	—	8	■ H	Tranmere Point
Smithton-Stanley, Tas.	ABNT3	TNT9	50	50	1	6	V	0.5 miles south of Bicheno
Gowrie Park, Tas.	—	TNT9	—	1	—	1	H	The Nut
								1.5 miles north-west of Gowrie Park

- The station at Mudgee is to be established on a temporary basis and the matter will be reviewed when the commercial television station in the Central Western Slopes area commences operation in the light of the service provided to Mudgee by that station.
- Horizontal to serve Swansea and vertical to serve Bicheno.

# The New Range of Mullard Silicon Planar Transistors

Several of a new range of silicon planar transistors designed to provide optimum performance in audio and RF amplifier applications are now available from Australian manufacture. These types BF115 (RF amplifier) and BC107, BC108 and BC109 (audio pre-amplifiers) will find wide applications for car radio, radiograms, record players and tape recorders.

## Planar Construction

These transistors are n-p-n silicon manufactured by the planar epitaxial technique. In the planar construction the surface of the crystal of 'N' type silicon, forming the collector region of the transistor, is coated with silicon oxide. This coating is etched to form a window through which the 'P' type base diffusion takes place. When the diffusion of the base material is completed the window is closed by further oxidation of the surface. A second small window is now etched in the oxide layer defining the region to be occupied by the emitter of the transistor, through which the 'N' type diffusion takes place.

Before the first oxide layer is produced on the collector crystal, an epitaxial layer of high resistivity 'N' type crystal is formed on the main low resistivity material. It is important that the major part of the collector region has a low resistance to ensure a low voltage drop across the collector. However it is essential, for good transistor performance, that the resistivity of the collector material in the region of the junction should be high. Hence, by epitaxial growth, these conflicting requirements are resolved.

## Encapsulation

This entire family of silicon planar transistors are mounted in TO-18 cases providing complete hermetic sealing, a good dissipation characteristic and low interelectrode capacitance.

## Application

The audio amplifier range consists of three types having characteristics carefully

chosen to satisfy all needs. The BC107 has a high collector voltage rating intended for driver stage application in "hi-fi" equipment, the BC108 is intended as a general purpose pre-amplifier providing high gain and the BC109 is primarily intended for low noise, high gain, input stages in tape recorders and other audio equipment. The BF115 has been designed to provide low noise and high gain, and with its controlled AGC characteristics provides all the charac-

ters is only 100mV, it is able to exhibit normal transistor action despite the unusual voltage relationship.

Consider an incremental negative potential change at the BC109 base; by transistor action the BC109 collector current will fall, thus causing the OC44N collector current to fall and its collector voltage to move in a negative direction, resulting in a rise of the base to emitter voltage and emitter current of the BC109.

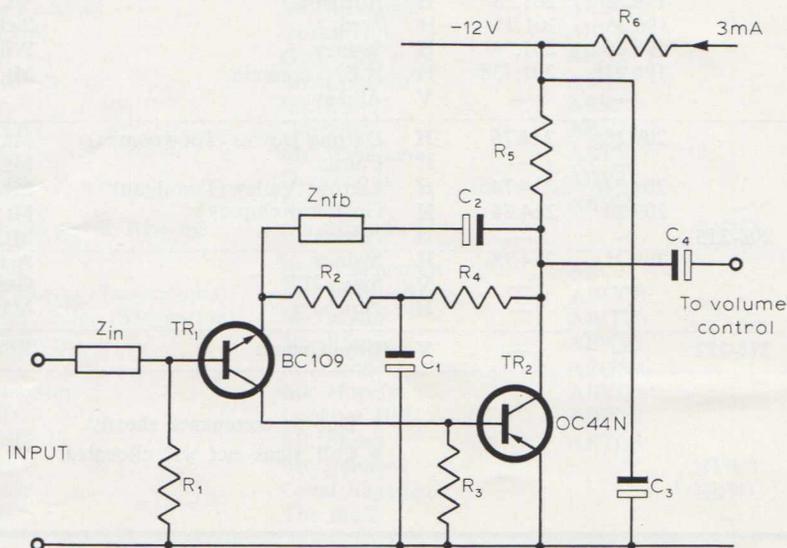


Fig. 1. Complementary amplifier using silicon and germanium transistors.

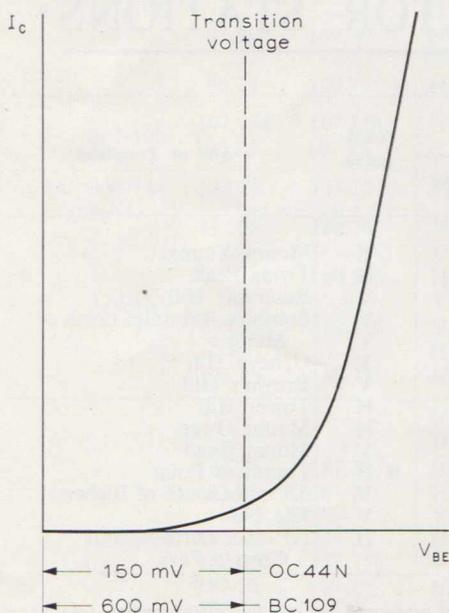


Fig. 2. Transition point on  $I_C$ - $V_{BE}$  characteristic curve.

teristics necessary for RF and IF amplifiers to 30Mc/s.

## Choosing the Transistor for the Task

It is not necessary to know the various manufacturing processes of transistors but simply remember that certain processes provide characteristics ideal for certain applications. The low resistivity of germanium can be used to advantage in low voltage power amplifiers, and provides the lowest noise figure in UHF amplifiers—the mesa construction offers distinct advantages for high voltage amplifiers. In many cases, such as complementary amplifiers, silicon and germanium transistors can be combined to best advantage as illustrated in Fig. 1.

## Audio Pre-amplifier

The circuit constants are so arranged that the  $V_{BE}$  of the OC44N is set at the transition point of 150mV and the base of the BC109 is set to a potential only a few millivolts above ground via the input circuit.

Because of the low emitter current of the BC109 and owing to the fact that this transistor is operating at its transition point, it follows that the emitter potential will only be about 600mV above ground. Since the bottoming voltage of the BC109

As this opposes the initial change, negative feedback has occurred. Due to the high loop gain and heavy feedback, the circuit stability is excellent. The AC gain is restored by simply short circuiting the AC feedback path and by choice of circuit constants,  $Z_{in}$  and  $Z_{nfb}$  both sensitivity control and equalization can be achieved.

## RF Amplifiers

The BF115 is intended as an RF amplifier for all those applications where previously the AF115/116/117 were used and due to its good linearity and excellent temperature characteristic, is particularly suited to car radio application. This transistor offers the following features:—

1. A low value of feedback capacitance (not greater than 0.7pF at a collector to emitter voltage of 10V), enabling high gain to be achieved.
2. A low knee voltage enabling a large voltage swing in IF stages.
3. A good noise performance (3.5dB at 1Mc/s).
4. An improved protection to voltage surges.
5. A very low value of collector base leakage current providing good high temperature performance.

## SUGGESTED CAR RADIO CIRCUIT

The maximum feedback capacitance of the BF115 is 0.7pF whereas that of the AF117 is 2.4pF. It is therefore theoretically possible to achieve a gain improvement of 5.4dB with the same stability factor. A further increase in gain of 1.7dB may be obtained by raising the collector loading providing a stability factor of 4 instead of the usual 6 as with the AF117. In practice however, the improvement is obtained only if the stage gain is not determined by the AGC line damping, which limits the collector loading in the IF stage. In the past this limitation has necessitated a rather high base source impedance but has always had the disadvantage of considerable spreads which could only be overcome by some sacrifice in gain.

With the BF115 it is possible to realise this increase in gain simply by using a high value pre-set potentiometer as one of the bias resistors. This allows a high collector load to be used in the IF stage. The temperature effects with the BF115

are small and virtually the only requirement of the stabilisation is that the spread in quiescent current should be small. An increase in gain of 7dB together with a reduction in spreads is therefore possible with the BF115.

If a BC108 is used as an audio driver the input impedance may be considerably greater than 10kΩ and it is therefore possible to use a higher value of detector load resulting in increased diode efficiency and a further improvement in sensitivity of 2-3dB. A further gain improvement is possible in the mixer stage thus providing an overall sensitivity from a receiver fitted with one IF stage, only 8dB less than a conventional receiver employing two IF stages.

The problem now arising is to find a satisfactory means of controlling gain when only one IF stage is used, as two IF stages are required in order to achieve an adequate AGC characteristic. In car radios, an RF stage is desirable because of the require-

ments of good selectivity, image rejection and freedom from cross-modulation. With this in mind, it is suggested that a receiver of this type should have a controlled RF stage and only one IF stage.

Unfortunately the design of the RF stage is necessarily one of compromise between such factors as gain, noise performance, signal handling and freedom from mixer blocking. In order to overcome the problem of mixer blocking it is necessary to limit the maximum input to the mixer by choice of tapping ratio between the RF transistor collector and the mixer base, and also by reducing the RF transistor collector voltage. These requirements limit the RF gain to a value considerably lower than can otherwise be achieved with the BF115. In any case it is felt that the performance attainable from the circuit in Fig. 3 should be adequate for all requirements and should provide the following typical performance. (For performance specifications see table below.)

H. S. WATSON,  
Applications Laboratory Sydney.

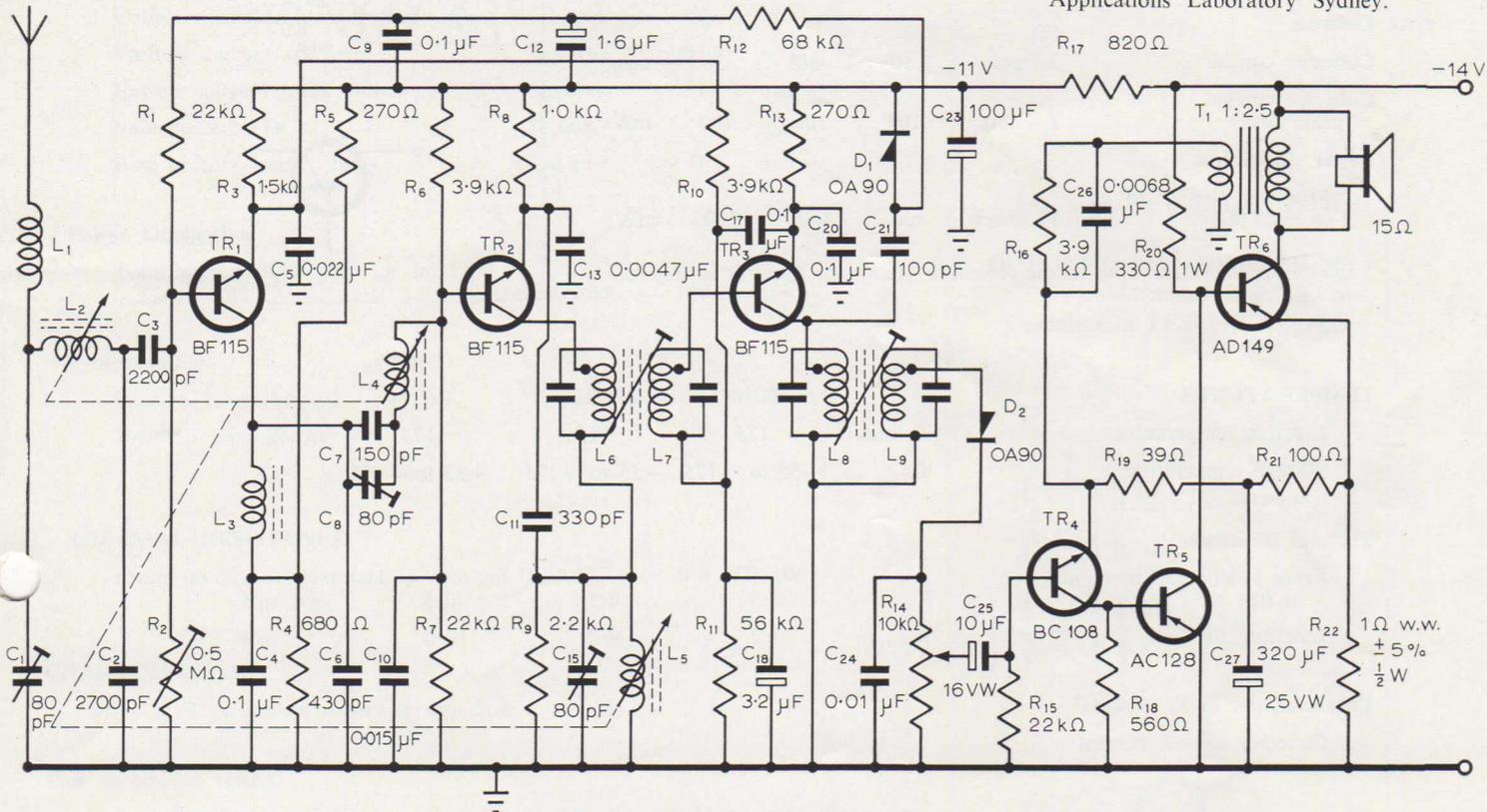


Fig. 3. Suggested car radio circuit.

### CAR RADIO PERFORMANCE SPECIFICATIONS

Receiver		Audio Amplifier	
Sensitivity at 1Mc/s with 30% modulation for 50mW output power	< 1 $\mu$ V	Power output into load at 10% distortion before clipping	5.5 W 4.5 W
Signal-to-noise ratio at 1 $\mu$ V aerial e.m.f.	3 dB	Sensitivity for 4.5W output	55 mV
at 10 $\mu$ V aerial e.m.f.	20 dB	Negative feedback	9 dB
AGC range for 10dB change in output	95 dB	Input resistance	15 kΩ
Maximum signal handling 30% modulation	2 V	Bandwidth (-3dB)	40c/s to 7kc/s
80% modulation	1 V	Distortion at 4.5W	~ 3 %



# SILICON N-P-N PLANAR EPITAXIAL TRANSISTORS

## BC107 BC108 BC109

The BC107 is a high voltage n-p-n silicon transistor primarily intended for audio applications.

The BC108 is a general purpose n-p-n silicon transistor primarily intended for audio applications.

The BC109 is a low noise n-p-n silicon transistor primarily intended for audio applications.

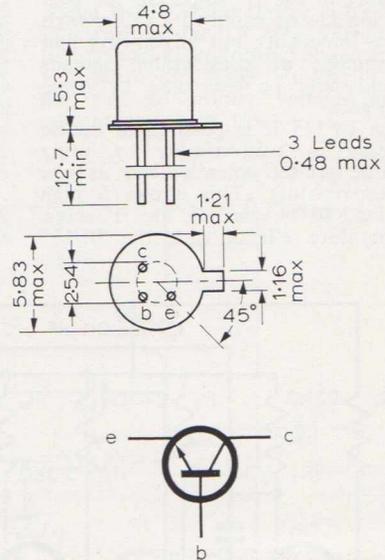
### ABRIDGED PRELIMINARY CHARACTERISTICS

RATINGS (limiting values)*		BC107	BC108	BC109	
<b>Voltages</b>					
Collector to base voltage (open emitter)	$V_{CB0}$ max.	45	20	20	V
Collector to emitter voltage (open base)	$V_{CE0}$ max.	45	20	20	V
Emitter to base voltage (open collector)	$V_{EB0}$ max.	5	5	5	V
<b>Currents</b>					
Collector current	$I_C$ max.	50	50	50	mA
Collector current (peak value)	$I_{CM}$ max.	100	100	100	mA
<b>Power dissipation</b>					
Total power dissipation at $T_{amb} = 25^\circ\text{C}$	$P_{tot}$ max.	300	300	300	mW

\* Limiting values according to the Absolute Maximum Systems as defined in I.E.C. publication 134.

### OUTLINES AND DIMENSIONS

Conforms to J.E.D.E.C. TO-18.



TEMPERATURES		BC107	BC108	BC109	
Junction temperature	$T_j$ max.	175	175	175	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to +175	-55 to +175	-55 to +175	$^\circ\text{C}$
<b>Thermal Resistance</b>					
From junction to ambient in free air	$R_{th j-a}$	0.5	0.5	0.5	$^\circ\text{C}/\text{mW}$
Junction to case	$R_{th j-c}$	0.2	0.2	0.2	$^\circ\text{C}/\text{mW}$
<b>Characteristics at <math>T_j = 25^\circ\text{C}</math></b>					
Collector cut-off current $V_{CB} = -20\text{V}; I_E = 0\text{mA}$	$I_{CB0}$ typ.	1	1	1	nA
<b>Collector to emitter knee voltage</b>					
$I_C = 10\text{mA}; V_{CE}$ reference = 1V	$V_{CEK}$ typ.	0.4	0.4	0.4	V
<b>Transition frequency</b>					
$I_C = 0.5\text{mA}; V_{CE} = 5\text{V}$	$f_T$ typ.	85	85	95	Mc/s
<b>Collector capacitance</b>					
$V_{CB} = 5\text{V}; I_E = 0; f = 1\text{Mc/s}$	$C_C$ typ.	4.5	4.5	4.5	pF

NOTE: Data sheets for the BC107, BC108 and BC109 are contained in Vol. 4 of the Mullard Technical Handbook.

# SILICON N-P-N PLANAR EPITAXIAL TRANSISTOR BF115

The BF115 is a n-p-n silicon planar epitaxial high frequency transistor primarily intended for RF amplifiers and mixer/oscillators ( $f_T = 230\text{Mc/s}$ ).

## CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

$T_j = 25^\circ\text{C}$  unless otherwise specified

### RATINGS (limiting values)<sup>1</sup>

#### Voltages

Collector to base voltage (open emitter)	$V_{CBO}$ max.	50	V
Collector to emitter voltage (resistive termination of the base)	$V_{CER}$ max.	50	V <sup>2</sup>
Emitter to base voltage (open collector)	$V_{EBO}$ max.	5	V

#### Currents

Collector current (DC)	$I_C$ max.	30	mA
Collector current (peak value)	$I_{CM}$ max.	30	mA
Emitter current (DC)	$I_E$ max.	31	mA
Emitter current (peak value)	$I_{EM}$ max.	31	mA
Base current (DC)	$I_B$ max.	1	mA
Base current (peak value)	$I_{BM}$ max.	1	mA

#### Power Dissipation

Total power dissipation up to $T_{amb} = 45^\circ\text{C}$	$P_{tot}$ max.	140	mW
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#### Temperatures

Storage temperature	$T_{stg}$	-55 to +175	$^\circ\text{C}$
Junction temperature	$T_j$ max.	175	$^\circ\text{C}$

#### THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	0.9	$^\circ\text{C}/\text{mW}$
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### CHARACTERISTICS

$T_j = 25^\circ\text{C}$  unless otherwise specified

#### Base to emitter voltage

$I_C = 20\text{mA}; V_{CE} = 2\text{V}$	$V_{BE}$	<	1.1	V
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#### DC current gain

$I_C = 1\text{mA}; V_{CE} = 10\text{V}$	$h_{fe}$	45 to 165
$I_C = 20\text{mA}; V_{CE} = 2\text{V}$	$h_{fe}$	> 40

#### Base to emitter voltage<sup>2</sup>

$I_C = 1\text{mA}$ $V_{CE} = 10\text{V}$	$V_{BE}$	0.65 to 0.74	V
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#### Feedback capacitance at

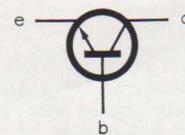
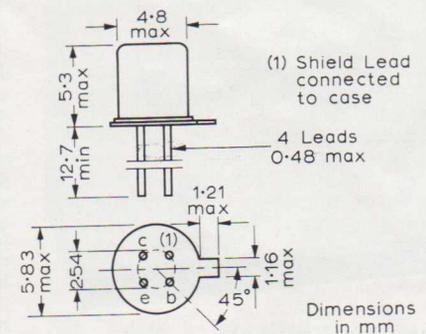
$f = 0.45\text{Mc/s}$ $I_C = 1\text{mA}$ $V_{CE} = 10\text{V}$	$c_{re}$	typ. <	0.6 0.7	pF pF
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#### Transition frequency

$I_C = 1\text{mA}$ $V_{CE} = 10\text{V}$	$f_T$ typ.	230	Mc/s
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### OUTLINES AND DIMENSIONS

Conforms to J.E.D.E.C. TO-18.



<sup>1</sup> Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

<sup>2</sup>  $R_B < 1.1k\Omega$

<sup>3</sup>  $V_{BE}$  decreases with about  $1.7\text{mV}/^\circ\text{C}$  at increasing temperatures.

NOTE: Comprehensive information and design curves for the BF115 may be found in Vol. 4 of the Mullard Technical Handbook.

# MICROWAVE COOKING - PART III

Following the article entitled "Microwave Cooking—Part II", Vol. 8 No. 4, in this issue photographs of the prototype oven showing the actual layout of the oven components are included.

Microwave "cooking" includes the thawing of frozen foods and the final preparation of pre-cooked meals. It will perhaps be a long time before there is a magnetron in most homes, to introduce a note of variety into the life of the service engineer! However, in canteens and restaurants there are definite and substantial advantages in microwave cooking and a number of installations have already proved their worth.

The greatest advantage is that thawing and cooking can be performed very rapidly, the heat being generated inside the substance to be heated, thus where there are large and sudden variations in the demand for particular dishes these can be met with comparative ease and the customer need not be kept waiting or told that a dish is "off the menu".

In most cases the flavour of the food is enhanced since no water is used: there is evidence that the retention of vitamins and so on is not lessened and may be increased since the cooking time is short. One disadvantage is that as foods are cooked from the inside the surface may be unconventional and perhaps unacceptable (crustless loaves, for example); but this can be easily remedied by a short period of external heating.

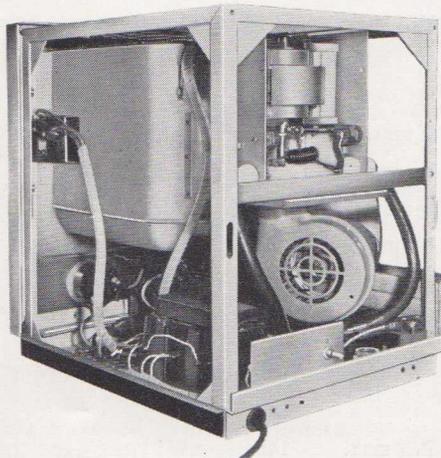


The 10" x 10" x 10" cooking cavity, near the top may be seen the coupling loop discussed below.

## Cooking Cavity

The stainless steel cooking cavity in this particular model measures 10" x 10" x 10" though other aspect ratios are possible. Near the top of the cavity may be seen the coupling loop which "couples" the microwave energy from the magnetron "into" the cavity. The orientation of this loop being chosen to provide minimum reflected energy under all possible working conditions. Part of the roof of the cavity can be seen to be perforated to allow the cooling air from the magnetron to enter and expel the moist air through a similar perforated plate in the oven door (seen partially on the left of the photograph). An interesting feature of the door is the quarter wave stub, not

seen in the illustration as it is hidden from view by sealing tape, which is necessary to prevent accumulation of food particles. The continuous stub is situated around the inside of the door, and at the operating



The microwave oven with covers removed.

frequency, effectively presents a high impedance to the unwanted stray radiation. This method of shielding is far superior to the hitherto used "bronze finger" strips, since it cannot be interfered with by poor contacts or dirty surfaces.

## Energy Coverage Pattern

The object of these three articles in Outlook is to cover some of the fundamental points where microwave energy can be applied effectively in the food preparation field. The simplicity of the particular magnetron, power supply arrangements and so on relate to the basic techniques just as much as oven configuration, in that the particular oven described and illustrated does not have any ancillary wave-guide coupling between the magnetron and oven, the magnetron being directly coupled into the oven by the small loop. The oven itself behaves as a cavity and one must picture multiple reflections of energy criss-crossing the oven and the work saturated by an energy coverage pattern. Where there can be certain heat transfer from one part of the food being prepared to another, the cooking or pre-heating will be uniform, however for particular foods, especially where the cooking cycle is from the beginning, depending upon its position in the oven, some parts may be subject to a higher level of energy than others and again this is covered by the multiple reflections from the walls of the oven and these might change with a mass of food.

## Field Stirrer

To provide a more uniform energy distribution, where costs allow, a small rotating vane is usually placed near the coupling loop or at the aperture of a wave-guide this vane is continuously rotated and has been termed a "field stirrer". Some ovens have the stirrers driven from separate motors, whilst others are air-driven from the magnetron cooling ducts.

## Demonstration Oven Available

The oven illustrated is set up in the Applications Laboratory at our Head Office, 35-43 Clarence Street, Sydney, and whilst work proceeds on other ovens, demonstrations can be arranged by contacting Mullard offices throughout the Commonwealth. ■

## IMPROVED DIODE PERFORMANCE

A new gold-bonded subminiature medium speed switching diode released by Mullard gives substantially improved performance over the existing established type OA47 which, however, will continue to be available.

The construction of the diode AAY30, resulting in an improved reverse voltage rating of 50V with a close control of stored charge of 500pC, features close control of the forward voltage drop.

These all-round improvements will considerably ease the design problems in computer and control logic switching applications; the device is also suitable for use in telecommunication, instrumentation and general industrial applications.

## Abridged Advanced Data:

$V_{BM}$ max.	50	V
$V_F$ max. (at $I_F = 150\text{mA}$ )	1.0	V
$I_{FM}$ max.	400	mA
$I_R$ max. (at $V_R=30\text{V}$ , $T_{amb}=25^\circ\text{C}$ )	50	$\mu\text{A}$
$T_j$ max.	75	$^\circ\text{C}$

The AAY30 is a gold-bonded germanium device contained in a subminiature all-glass construction with DO-7 encapsulation.

Further data on this new addition to the range of Mullard switching diodes may be found in Volume 4 of the Mullard Technical Handbook. ■

## Latest Vinkors Simplify Resonant-Circuit Design

*Designers of LC resonant circuits will find their work much simplified and the use of padding capacitors generally unnecessary as a result of the availability of the Vinkor range of ferrite pot cores with temperature coefficients controlled to be compatible with polystyrene capacitors—irrespective of the effective permeability of the pot core.*

Initially, part of the "yellow"\* range of Vinkors is offered with this closely controlled temperature coefficient; eventually all the "yellow" range and also the "violet" range will be available. To differentiate between types of Vinkors with this close control and those without, the marking on the core will be yellow instead of silver; type numbers will not be altered.

### Tighter Control

In the design of LC resonant circuits the problem of predicting and counteracting the change of resonant frequency with change of ambient temperature is significant. This change is primarily due to the temperature coefficient of reactance of the constituents of the circuit. Many resonant circuits include inductors based on Vinkor ferrite pot cores and polystyrene capacitors. The temperature coefficients of these two components are compensatory in sign but until now have been mainly incompatible in

value. New manufacturing control techniques in the Mullard factories have overcome this.

The temperature coefficients are now based on a nominal of +130 ppm/°C with a tolerance of ±60 ppm/°C over the temperature range of 20 to 50°C. This has been achieved by maintaining tighter control limits in the production process.

### Higher Q Values

In some applications, pot cores with higher effective permeabilities can now be used as the temperature coefficient is no longer prohibitive and thus higher Q values can be realised due to the reduction of the DC resistance of the winding. For example, using a Vinkor with an effective permeability of 250 the temperature coefficient is now between +70 and +190 ppm/°C whereas previously it was +125 to +375 ppm/°C.

In view of the fact that the temperature coefficient of a complete inductor is influenced, to a certain degree, by the particular winding that is used, the relationship

$$TC = \mu_e \times TF$$

may not hold strictly true—where TC is inductor temperature coefficient,  $\mu_e$  the effective permeability of the Vinkor and TF is the temperature factor

$$TF = \frac{\Delta\mu_i}{\mu_i^2\Delta T}$$

of the constituent pot cores. However, due allowance is made in the production process of Vinkors for the effects of a typical winding on the overall temperature coefficient. ■

\* The yellow range of Vinkors as designed for inductors up to 300kc/s. More detailed design information on all available Vinkors may be found in the Mullard Vinkor Manual and Vol. 6 of the Mullard Technical Handbook.

## The Matching and Equalisation of Piezo-Electric Pick-ups

*Design engineers are constantly grappling with the problem of matching a high impedance pick-up to the low input impedance of a transistor amplifier. Because piezo-electric pick-ups are predominantly capacitive, an impedance matching may be achieved by connecting a much larger capacitor in series with the pick-up, thus forming a capacitive voltage divider part of which is used to match the base impedance of the input transistor, without the additional noise contributed by current carrying resistive voltage dividers.*

The internal impedance of piezo-electric pick-ups is predominantly capacitive, ( $C_s$ ) and approximately 500pF. They are usually designed so that when the output is loaded by a specified high resistance ( $R_L$ ) full equalisation is obtained. This equalisation is done partly mechanically and partly electrically. Any network which has the same effect as the specified load on the frequency response of the pick-up will give the same overall (and therefore correct) equalisation. With valves there is no point in departing from resistive equalisation and it is, of course, possible to use this also with transistor-input circuits. The recommended load resistance is then put in series with the pick-up and the transistor input terminal.

However, this method of equalisation does not give the best results when used with transistor circuits, because it gives a relatively poor signal-to-noise ratio and it also does nothing to minimise gain spreads. Its use is therefore likely to be confined to low gain circuits for use with high output crystal pick-ups.

When less sensitive pick-ups are used a preferable arrangement is to load the pick-up output with a capacitor so that the pick-up is in series with a much larger capacitor  $C_p$ , thus forming a capacitive voltage divider. The common point of this capacitive voltage divider is connected to the base

of the input transistor. The input resistance of this transistor stage ( $R_{in}$ ), thus appears across the lower capacitor. The time constant of the input resistance of this stage which is formed by the two capacitances in parallel is equal to the time constant formed in the recommended valve equalising circuit by the load resistance and the internal capacitance of the pick-up, exactly the same equalising results will be obtained. This gives us the matching condition.

$$C_p = C_s \left( \frac{R_L}{R_{in}} - 1 \right) \approx C_s \frac{R_L}{R_{in}}$$

However, as the transistor now sees a source of very much lower impedance, much better signal-to-noise ratio is obtained. In addition, over most of the frequency band it is voltage driven, and the gain of the circuit will be independent of the  $h_{re}$  of the particular transistor used. The only spread then to be expected is in the bass region where some loss, or gain, of bass frequencies may be expected, depending on the gain of the particular transistor used. In general, with transistor circuits, this type of equalisation is preferred to any attempt to produce a high series resistance.

A variant of this capacitive equalising technique exists. In this, instead of connecting a large capacitance between transistor base and ground, an equivalent large input capacitance is obtained by con-

necting a much smaller capacitor from base to the collector of the input transistor, so that its capacity is effectively multiplied by the voltage gain of the transistor stage. This gives an even better signal-to-noise ratio but its proper operation depends on having a well defined voltage gain from the input stage. Thus, it may be difficult to combine this with volume or tone controls in the collector circuit of this transistor.

It should be noted that the equivalent circuit of some crystal pick-ups includes a resistance in series with the crystal capacitance. When capacitive voltage-divider input circuits are used, this series resistance can result in a substantial treble loss. It is, however, easy to compensate for this effect by the use of a small resistance such that this resistance has the same ratio to the internal series resistance as has the internal crystal capacitance to the external capacitance. If this resistance is made higher than necessary to compensate for the series pick-up resistance, a useful degree of treble boost can be obtained.

Another practical point is that the noise contributed by current-carrying resistors often greatly exceeds that of the transistors. This is particularly noticeable when the low-noise BC109 is used. Careful attention is thus required in the selection of the resistor types used in low-level stages. ■



## Silicon Avalanche Power Rectifier BYX25

*A solid-state general-purpose diode with a wide field of applications, the Mullard silicon avalanche power rectifier diode—BYX25 series— is the first device of its size with an avalanche power of 18 kW.*

Contained in a casing conforming to the JEDEC DO-4 (VASCA SO-10) outline, this diode has been developed as a high-class all-round industrial device with an insulation path of 6mm, and is the first of a new range of Mullard solid-state avalanche power rectifiers.

### NUMEROUS APPLICATIONS

Besides possessing an extremely good reverse avalanche power rating it is also capable of a 240A peak one-cycle surge (50c/s). These factors make it particularly suitable for high-voltage power supplies, without necessitating the use of sharing-components, in transmitters and similar equipment where voltage and current outputs of the order of 20kV and 15A are common—the adequate surge rating enabling the overload contactors to drop out before the device is damaged.

The diode may be used directly connected to 3-phase industrial supplies, making it ideal for use in conjunction with thyristors in motor control, temperature control and numerous other applications where reliable

DC power is required. Other applications include voltage spike suppression for the protection of semiconductor devices or equipment.

### TWO VOLTAGES—TWO POLARITIES

The diode is offered in two different voltage grades, 600V (type BYX25/600) and 800V (type BYX25/800), and in both normal (cathode stud) and reverse polarity versions.

A simple system has been devised to cater for the repetitive use of the device in the avalanche mode. This enables the equipment designer—starting from the forward current rating, the repetitive reverse avalanche power or from the heat-sink size—to establish quickly the capability of the device once any two of these parameters are known.

For example, the repetitive or non-repetitive avalanche power permitted when the device is mounted on a given heat sink can be easily found provided the ambient temperature and forward current are known.

### Abridged Advance Data

	BYX25-600	BYX25-800
Crest Working Voltage	600 V	800 V
Min. Avalanche Voltage	750 V	1000 V
Max. Avalanche Voltage	1050 V	1320 V
$I_{CAV}$ at $T_s = 125^\circ\text{C}$		12 A
Peak one-cycle surge		240 A
Avalanche Power $T_j = 25^\circ\text{C}$		18 kW
$T_{jmax}$		175 °C

## NEW VHF QUICK-HEATING VALVE

Designers of mobile UHF transmitting equipment will find the Mullard YL1190 quick-heating valve of considerable advantage in mobile applications where consumption must be kept to an absolute minimum, space is at a premium, temperature of the equipment is limited, but immediate operation after 'switch-on' is required.

Designed for use in mobile transmitter output and frequency multiplier stages, the YL1190 is a double tetrode capable of operating efficiently at frequencies up to 500M/cs, and is a useful UHF addition to the popular range of Mullard quick-heating valves.

### Circuit Design Simplified

The YL1190, now available in development sample quantities, gives 70% output in less than half a second after switching on. It is of single-ended construction, thus simplifying in-line circuit design. Filament ratings of the YL1190 are 1.1V at 3.8A.

### Typical Class "C" FM Operating Conditions

	200Mc/s	500Mc/s
$V_a$	350V	260V
$I_a$	$2 \times 70\text{mA}$	$2 \times 70\text{mA}$
$P_{drive}$	1W	2.5W
$P_{out}$	33W	20.5W
$P_{load}$	26W	14.5W

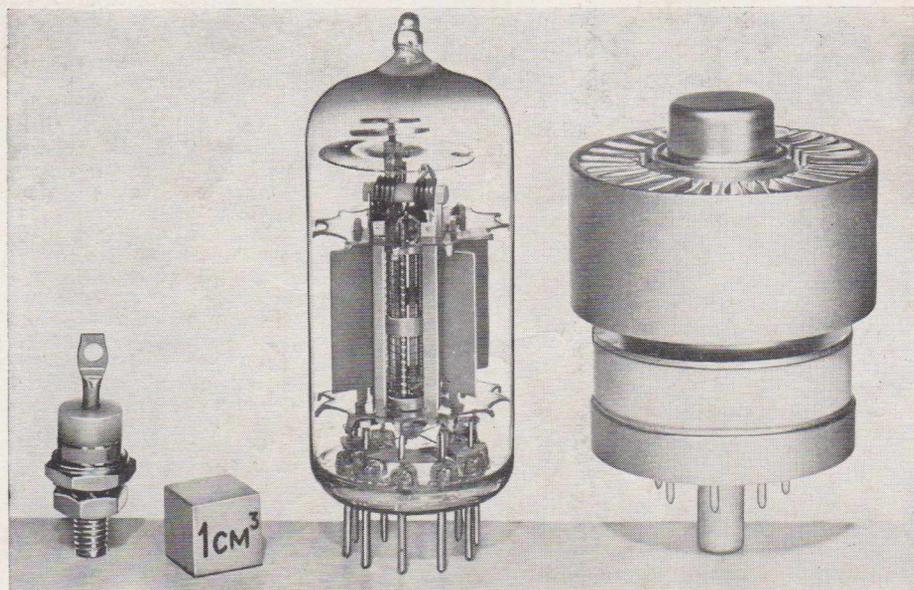
A Mullard quick-heating valve is now available for all applications in VHF and UHF "mobile-band" transmitters designed for "on-the-move" operation. This is the result of continual additions to the quick-heating valve range.

Mullard quick-heating valves virtually eliminate current consumption during stand-by periods. Other advantages include much greater useful life and large reductions in heat dissipation within the unit—the latter being a very important factor in the design of compact transistorised units. ■

## ALL-CERAMIC TETRODE

A forced air-cooled power tetrode, type QV2-250C, is now available from Mullard. This valve is of all-ceramic construction, which gives it a higher working temperature compared with previous types incorporating glass seals. The increased base seal temperature permitted, 250°C instead of 175°C, allows greater flexibility for equipment design when operating it at UHF.

At 175Mc/s output powers of 390W can be obtained and at 500Mc/s, 225W can be obtained. The valve operates at a maximum  $V_a$  of 2kV and maximum  $P_a$  of 250W. It is a direct equivalent to the 4CX250B. ■



The new products shown in the picture and discussed on this page are from left to right: Avalanche silicon power rectifier BYX25; Centre: YL1190 quick heating valve for 500Mc/s mobile operation next to the QV2-250C, all ceramic tetrode for a maximum power output of 390W at 175Mc/s. A 1cm cube is also shown for size reference.