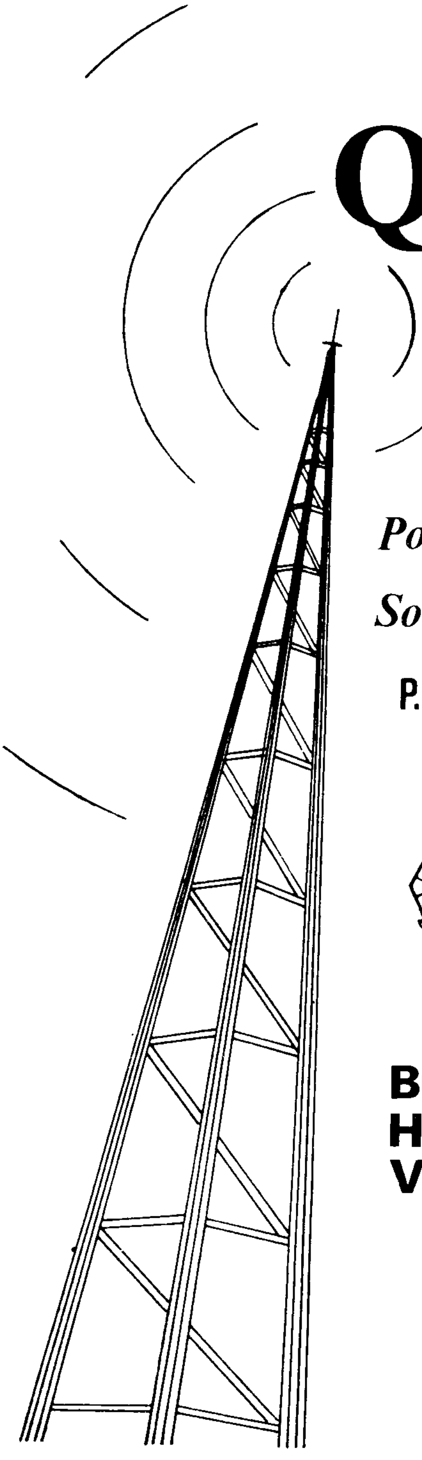

QSX PE

Port Elizabeth Branch of the South African Radio League

P.O.Box 462, Port Elizabeth. 6000.

National Call	145.5 Mhz
P.E. Repeater	145.05/65
Grahamstown	145.15/75
Lady's Slipper	145.10/70

ZS2PE

Bulletin: Sunday 08h40
HF: 40m – 7098 KHz
VHF: FM–145,700 MHz

Port Elizabeth Branch

NOTICE OF MONTHLY MEETING

THE MONTHLY MEETING OF THE PORT ELIZABETH BRANCH OF THE SOUTH AFRICAN RADIO LEAGUE WILL BE HELD AT THE SCOUT HALL, BROADWAY AVENUE, SUNRIDGE PARK ON FRIDAY 18th MAY, 1984 AT 8p.m. SEE YOU ALL THERE.

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Committee

CHAIRMAN:	Dick ZS2RS (32111)	VICE CHAIRMAN:	Trevor ZS2AE (321746)
SECRETARY:	Marge ZS2OB (303498)	TREASURER:	Brian ZS2AB (303498)
PROJECTS:	Lionel ZS2DD (321770)	SPECIAL EVENTS:	Colin ZS2AO (312471)
P.R.O.	Pete ZS2PJ (301493)	AWARDS:	Attie ZR2DY (611318)

QSX-PE - ZS2OB and ZS2AB.

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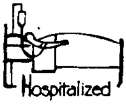
NEWS



We are sorry to hear that Lynn Crothall and Gordon Knapp will both be in hospital for a while undergoing operations and we all wish you both good luck and a speedy recovery.

GOOD LUCK to Gordon Knapp who wrote the P.M.G. examination on 10th May and we hope to hear that you will be on the air soon, Gordon.

Welcome A very warm welcome back to Andre ZS6UF ex ZS2BK and his xyl Reinette who have come back to live in Port Elizabeth and happy house hunting with lots of space for your antennas, Andre.

Back from a holiday in Div. 6 are Brian ZS2AB and Marge ZS2OB. The trip included an outing to Sun City (unfortunately they didn't come back as millionaires!) a visit to the Haartebeeshoek Satellite tracking station and dozens of shops looking for components!!! Evenings with Sel ZS6AXO and Doug ZS6MO were also enjoyed.

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Forthcoming Events

Hobbies Fair - Feathermarket Hall, July.
League contests - many new rules and operating sections. Full details will be published later.

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bulletin roster

20th May	Trevor ZS2AE
27th May	Marge ZS2OB
3rd June	Brian ZS2AB
10th June	Lionel ZS2DD
17th June	Colin ZS2AO

****

A.G.M. '84: Full details of income and expenditure will be published in next month's Newsletter. It was your money and we are sure you would like to know how it was spent. MANY, MANY THANKS to all those who contributed so generously of their time, energy and money. Only another 10 years to the next one!!!

MINUTES OF THE GENERAL MEETING OF THE PORT ELIZABETH BRANCH OF THE SOUTH AFRICAN RADIO LEAGUE HELD AT THE SCOUT HALL, SUNRIDGE PARK, PORT ELIZABETH ON FRIDAY 16th MARCH, 1984.

PRESENT: 24 members and visitors.

APOLOGIES:ZS2RT

The Chairman apologised for the late start and welcomed all especially the ladies.

MINUTES: The Minutes of the General Meeting held 17th February, 1984 having been published and circulated in QSX-PE, were taken as read, proposed by Trevor ZS2AE and seconded by Lynn Crothall.

ARISING: Bill Browne ZS2BY referred to Motion 34 on which the Branch had decided to vote against. After very valid arguments put forward by Bill, Dick reminded members that the Branch had voted for the motion put forward by Council that the League should adhere to the I.A.R.U. Band Plan. Bill said there was no reason that the League should not do so, but that it would be against the interests of hams in South Africa for these to be gazetted into the Regulations. Various other members expressed their views and therefore it was decided that the Branch would vote for the motion.

FINANCE: The Treasurer said that several registration forms and cheques had arrived and several more donations to the A.G.M. fund.

CORRES: Council Minutes and Financial Statements.

ARISING: Dick read a portion of the Minutes to the meeting regarding Radio ZS. He made mention that several Branches had given donations to Radio ZS and these had been listed in the latest issue thereof. Why was it necessary to give donations and how do the branches know that money is required. Hanel Publications are contracted to Council who felt that the Branches might know something that Headquarters had not been informed about. However, if anyone made any suggestions for change then they should be able to make a viable counter-suggestion.

Dick said that the correspondence regarding the Hobbies Fair had been attended to.

With regard to the Navex Rally, Colin said he had struggled for helpers at the short notice given, but had also been assisted by members of the Algoa Branch.

Those who would be attending the Friday and Saturday functions were asked to give their names to the Secretary. There were still several souvenir pens for sale.

Bill Browne asked if there was any QRP operation in the Branch and it was suggested that he could set this in motion.

There being no further business, the meeting was closed and tea was taken. Thereafter the video of "The Silicon Factor" was shown for those who had missed it on TV and for those who wished to view it again.

sgd:
R.W. Schönborn ZS2RS
Chairman

sgd:
M.T. Weller ZS2OB
Secretary

WHO ? WHAT ? WATT!

JAMES WATT - "INVENTOR EXTRAORDINARY".

The basic unit which is used to measure electricity is the "watt" which can be defined as follows:
"A Watt is the rate at which energy is expended in a circuit when a current of one Amp flows at an applied voltage of one Volt".

James Watt, the British pioneer after whom the unit is named, was an extra-ordinary man. He was not a scientist nor was he concerned with experiments or attempts to prove any electrical theory. Notwithstanding this, the "watt" can be regarded as the "horsepower" unit of electronics with 746 watts equal to one horsepower.

The year is 1755, the place is Greenock on the Clyde. The 19 year old James Watt takes leave of his family going on horseback to London to look for work. His father was a trader who lost all his money and shop as a result of unfavourable speculation deals. The lack of money and ill health meant that James attended school very irregularly and was therefore largely self educated.

Arriving in London twelve days later, the young James obtained work from John Morgan, the instrument maker. After twelve months he returned to his home town but because he had not completed a full apprenticeship, The Glascow Guild prevented him from opening his own business as an instrument maker.

Watt accepted work in the Glasgow College in the section where models were made and repairs effected. The College requested that he repair their model of the Newcomen engine which had been discovered sixty years earlier and since that time had been used to pump water out of the coal mines.

When the model was once again in working order, Watt was surprised at the huge amount of steam required to drive the engine. He was of the opinion that he could develop an improved model and in 1765 built a large scale model which was erected at Kinneil near Linlithgow. This gave Watt the opportunity to go into the construction in more detail.

Extensive tests and patent rights used up the little money which Watt still possessed and he was obliged to give to Dr. John Roebuck, the founder of Carron Ironworks, two-thirds of the profit made by the patent in exchange for his carrying the running costs. The two partners could not agree and after a few years of uncomfortable partnership, they decided to split. Due to the lack of funds, Watt could still not bring his discovery to the public notice.

In 1768 Watt met Matthew Boulton, a man of vision who realised that steam engines should not be limited to the pumping of water and that they had a great future. Boulton was the owner of one of the most modern engineering firms in England. He took over Roebuck's share in the venture and a successful new partnership came about.

In 1769 Watt obtained his first patent. For its size, his engine gave more power than that of Newcomen and also used less fuel, but it was not suitable for anything other than steam-driven water pumps.

In 1781 Watt patented his second engine. This used the reciprocal movement of the piston to turn a wheel. This opened the way for new possibilities and indeed started the steam age. It placed England on the road to becoming a giant in the manufacturing industry.

-
-
-

The Watt family built Heathfield Hall, a stately home on Handsworth Heath on a 40 acre plot. Although by this time he was rich and famous Watt kept himself continually busy in his workshop and his restless brain thought up machines which could copy artwork, do drawings in perspective and also a press to copy manuscripts.

James Watt died on 19th August 1819 at Heathfield at the age of 83 years.

(Acknowledgments to Everyday Electronics September 1972).

for sale

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6809 Micro system Computer kit developed by the Cape Computer Club. Kit consists of a set of 5 unpopulated P.C. boards with full documentation. Boards are: CPU board, DRAM board (64K/256K), CRT controller, disk controller and parallel I/O board. Components, power supply, veroboard and connectors, keyboard in case available. Software available: 2 versions of Basic, 3 versions of Pascal and Forth, 3 disassemblers, text processors and cross-assemblers for 6502, etc, etc. Cost: 1st 4 boards, R35 each. P.S.U. R80. Veroboard and connectors R55. Components R80. Keyboard and case R80.
Contact Mike Pearton (515271 Home) or Lionel ZS2DD (321770 Home) or either at 424210 work.

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This is being published as a service to those newcomers to the Ham game in this branch who read the newsletter and are at a loss to understand our cryptic way of writing and talking. Just wait until they get onto cw!!!

QSO	conversation
sked	prearranged QSO
W.C.G.	White coated gentleman (i.e. doctor)
White House	hospital
Junior OP or) Harmonic)	child
RF	spirits, eg whisky
807's	beer (as in bottles)
OM	Old Man or husband.
Eyeball QSO	face to face QSO
Shack	a place where hams spend most of their lives.
Saltmine	place of work (where they spend the rest of their lives)
Handle-	your name (if you are a teapot, then it's the other end to the spout)
QTH	usually home location, but could be where you are at the moment.
YL	young lady, usually girlfriend
XYL	usually wife, although they don't appreciate being ex-young!
SW	Sweet wife or small woman in place of XYL
QRJ	Quick run to the John!
QRP	Ditto

Silent Key - passed away.
Modulate the mattress - sleep (what else?)
4 wheeler - anything from a Caddy to a Beetle.
Landline or twisted pair - telephone.

(Hope this helps, Linda and Dave - don't worry you'll learn it all!)

****

Psychologists say that people with hobbies are not likely to go crazy - but this does not apply to the people they live with!

Lecturer to Radio class: "One of the most efficient chokes I ever made was from a Ford Model T spark coil".
Pupil: "With an inductance of one Henry I suppose".

SOUTH AFRICAN RADIO LEAGUE SUID-AFRIKAANSE RADIOLIGA

TAK DURBAN BRANCH
POSBUS 1058 P.O. BOX
DURBAN
4000

22 April 1984

Mr. R. W. Schonborn
Chairman (Port Elizabeth Branch)
South African Radio League
P. O. Box 5329
WALMER
6065

Dear Dick,

Flight SA 612 touched down at Louis Botha Airport at 11h40 this morning, right on time and as we stepped off the aircraft we felt rather sad that the activities of a tremendous weekend had come to an end all too quickly.

Right from the outset, the transport to the Hotel in that limousine, the Cocktail function in the Drill Hall, the Annual General Meeting, the luncheon and dinner, the Cabaret, the VHF seminar, the Hotel accommodation, the outing the girls all enjoyed with Mitch, was all set in a most congenial atmosphere and added to it the fabulous weather was most impressive.

The total success of the entire weekend reflects the detailed planning, the organisation, the hard work and team effort that you, your committee, and the ladies obviously put into the venture.

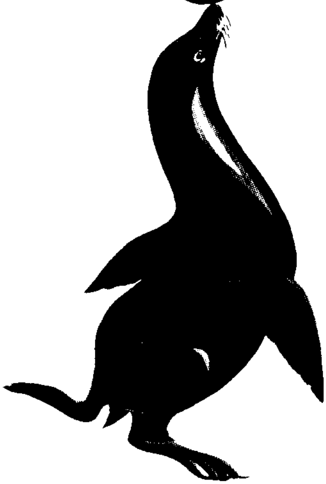
Congratulations on a job well done !

73's
Yours in Amateur Radio,

ZS5RJ

PHIL F. UNTERHORST
CHAIRMAN (DURBAN BRANCH)
SOUTH AFRICAN RADIO LEAGUE

A Question of Balance



Balance is an important quality for ice skaters, bicycle riders or football players. It is no less important in audio output circuits.

Vivian Capel

IF you have ever attempted to ride a bicycle, or received a bank statement with the last figures in red, or maybe been the unfortunate recipient of a plate of soup from a careless waiter's tray, you will appreciate something they all lack — balance!

Indeed, as it is a desirable quality in so many aspects of life, balance is no less important in many electronic circuits, particularly amplifier output stages.

One of the most common types of circuit is the complementary push-pull arrangement, shown in **Figure 1**, although there are many variations on it. The two transistors, one PNP (Q2) and the other NPN (Q1), are connected, apparently, in series across the supply. Both are driven from the collector circuit if the driver transistor Q3, hence the phase of the driving signal is the same for both of the output devices. However, as these are of opposite polarity, one is driven further into conduction, while the other is cut off. On the next half-cycle the situation is reversed. Output is taken from the junction of their emitters via a coupling capacitor, C1.

Now many folk, including some technicians of my acquaintance seem to have difficulty in understanding just how this circuit can work. In a series circuit, the current must be equal in all parts, so as the output pair are in series, how can one be passing a heavy current while the other is passing none at all?

The answer is that they are in series only as regards the steady quiescent supply current through them. The situation is quite different when the signal comes along, because now, the output capacitor puts them virtually in a parallel configuration.

Current Paths

Let's see what happens (**Figure 2**). If say Q2 conducts first while Q1 is cut off, current is drawn through the loudspeaker from the positive supply to increase the charge in the capacitor (it is already partly charged, to half the supply rail voltage).

However, as the capacitance is very large, the half-cycle finishes before it can be fully charged. Now, Q2 is cut off and Q1 conducts (**Figure 3**). This completes a circuit back to the positive rail through which the capacitor begins to discharge. The discharge current also flows through the loudspeaker.

So, one transistor keeps charging the capacitor and the other keeps discharging it, and the ebb and flow passes through the speaker which thereby responds to both half-cycles.

If the capacitance is insufficient, the capacitor will fully charge or discharge before the end of the half-cycle. This means that the long wave-length low frequencies will not be reproduced, and those in the mid-region, which utilise a significant proportion of the capacitance, will be distorted. This is because the rate at which a capacitor charges and discharges is not linear. Comparative linearity is obtained only by restricting the charging to a small portion of the total capacity.

Problems of this nature are rare, unless due to faulty components, as electrolytics of sufficiently high value are readily available.

Transistor Gain

In the days of valve push-pull circuits it was always the practice to match a pair of output valves to achieve balance, as the mutual conductance of new valves of the same type differed over a certain range. A characteristic of transistors that has not yet been beaten by the makers is a spread of gain values which is far wider than that of valves. The spread can be up to eight times between minimum and maximum h_{FE} specifications, which can be quite a headache for the designer. In some cases, the range is narrowed by the suffix letters A, B, or C which denotes bands of increasing gain values, but only a few devices are so identified.

What, then, is the effect of unmatched transistors in a complementary output circuit? Much will depend on the precise form the circuit takes, and its refinements, but there are certain general observations that can be made. Firstly we note that the devices are operating as emitter followers, the load being in their respective emitter circuits, and the collectors being taken to +VE and 0V.

Now the voltage gain of an emitter follower is always less than one, its virtue lying in its amplification of current, which is what is required for an output stage. The internal resistance of output transistors is always much less than the load, around a fraction of an ohm, so the maximum current available is never taken. Hence ▶

variations in the maximum current available caused by differences in the current gains of the two transistors, would have no effect.

Any difference in voltage would though, as these would produce differences of current through the load, hence power variations.

Formulae

So what effect does discrepancies in transistor h_{FE} have on the voltage applied to the loudspeaker? Voltage gain for an emitter follower is

$$(V = Z_L/(Z_L = (Z_S/Z_L))$$

where Z_L is the total load and Z_S is the source impedance.

It can be seen that the source impedance, which is the output impedance of the driver stage, affects the result. In accordance with the basic law governing the coupling of audio stages, the input impedance of one stage should be fed from an output impedance of the preceding stage that is much lower. This poses the question as to what is the input impedance of each of the output transistors. The formula is:

$$Z_{in} = h_{FE} \times Z_L$$

Let us put some values to these expressions. The speaker impedance is eight ohms, say, but added to this is the reactance of the series capacitor, and also the value of the emitter resistor. Reactance will change with frequency, but we can reckon a nominal value of two ohms for reactance and resistance, thus giving a total load of ten ohms.

So, for an h_{FE} of 20, the input impedance is 200, for 40 it is 400, for 60 it is 600 and so on. Thus a low h_{FE} means a corresponsingly low input impedance, and the output impedance of the driver stage must be lower still.

Let us see how the source of impedance affects the voltage gain of the output transistor at different values of h_{FE}. Although the two output transistor inputs are in parallel, they can be regarded as a single transistor because one is only conducting at a time.

For a source impedance of 40 ohms and a h_{FE} of 40, the voltage gain will be:

$$10/(10 + (40/40) = 0.9$$

If the h_{FE} is halved, namely 20, the gain becomes:

$$10/(10 + (40/20)) = 0.83$$

Thus the drop is to 92 per cent of the former value, which is not as bad as may have been anticipated.

If the source impedance if 100 ohms, with the same 10 ohm load, the gain with an h_{FE} of 40 is:

$$10/(10 + (100/40)) + 0.8.$$

Halving the h_{FE} in this case produces a gain of:

$$(10/(10 + (10/20)) = 0.66$$

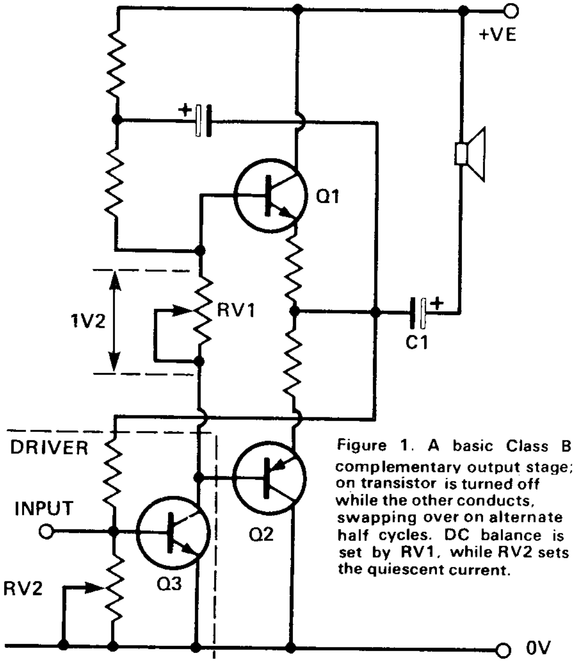


Figure 1. A basic Class B complementary output stage; on transistor is turned off while the other conducts, swapping over on alternate half cycles. DC balance is set by RV1, while RV2 sets the quiescent current.

So the reduction becomes 82.5 per cent of the previous figure. It can be seen from this that the effect of variations of h_{FE} on output voltage, hence on balance between the two outputs transistors, increases withan increase in source impedance.

Another factor already shown is that the input impedance of the output transistor drops in proportion to the decrease in h_{FE}. Should the h_{FE} be much below the parameter designed for, it could load the driver stage to the extent of increasing distortion there. While a good design should take into account the h_{FE} spread lowest value, not all do, and in addition, individual transistors are not uncommonly found to be below the specified spread.

One method often used to keep the gain of each output device high so as to minimise effects of h_{FE} variations and to present a high loading impedance to the driver stage, is to use a darlington pair for each output device.

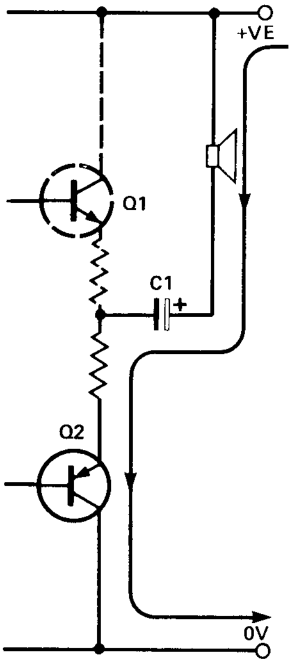
DC Balancing

The effects we have so far discussed are of the amplitude of each half of the signal waveform. There is also the effect on the quiescent DC current through the output stage to consider.

Bias is provided by direct connection to the collector of the driver transistor, but the two bases are separated in the potential divider chain from supply to driver collector by some 1V2, to overcome the base/emitter 0V6 potentials. If this potential is increased by increasing the resistance between the bases, the emitter/base voltage of both transistors will be greater and the quiescent current through both will rise. A preset resistor RV1 thus makes a convenient control for adjusting the output current.

Usually, a nearly saturated transistor Q4 takes the place of this preset resistor between the bases, as this offers a means of stabilising the current (**Figure 4**). Should the voltage across it rise for any reason and thereby increase the output transistor current, its own bias will be increased, turning it harder on and so lowering the voltage drop across it. Thus it self-compensates and keeps the output base voltages steady. It only does this of course, relative to each of the transistors Q1 and Q2, not relative to the negative supply, otherwise it would remove the incoming signal. A preset RV1 in the base circuit sets the conduction level and thereby the output stage current just as in the case of the simple base/base resistor.

If the output pair are unmatched, say Q1 has a higher h_{FE} than Q2, this preset can do nothing to balance things up as it adjusts the bias on both transistors at the same time. In such a case, the voltage appearing at



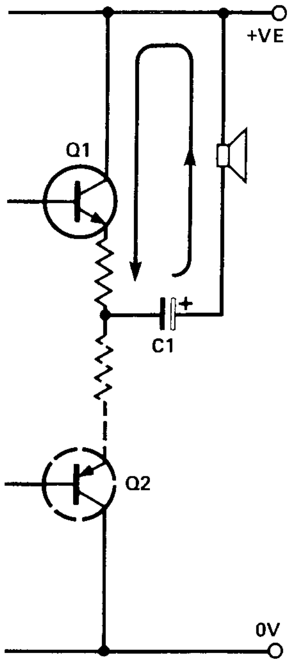


Figure 2 (left). When Q2 conducts (Q1 cut off), C1 charges through the loudspeaker and Q2.
Figure 3 (middle). When Q1 conducts and Q2 is cut off, C1 discharges through the loudspeaker and Q1. The two transistors are in series for DC, but not for AC.

the junction of the emitters, which should be a half that of the supply, will be higher because the upper transistor is turned on harder and so has a smaller voltage drop across it.

The lower emitter/collector voltage results in reduced power handling before clipping of the output commences. This is made worse by the higher voltage gain of this transistor, which drives the output into overload conditions sooner. Hence, one half wave is clipped long before the other and the total power without distortion is reduced.

Fortunately this can be adjusted without much difficulty. The output-pair bases are tied to the driver collector, and the output emitters are at the usual 0V6. Thus the junction voltage is partly governed by that of the driver collection. In addition to this, the biasing of the output transistors is affected. When the driver collector is low, that is, near to zero volts the bottom transistor base is more negative, hence the transistor, which is a PNP device, is turned harder on and the voltage across it decreases. At the same time, the upper transistor, an NPN type, has its base also made more negative which reduces its conduction so increasing the voltage across it.

The driver collector voltage can be readily adjusted by a preset in its base circuit, RV2. So, it should be remembered that this preset, or maybe one in an earlier DC coupled stage, sets the mid-point output voltage, while the one associated with the circuitry between the two output bases sets the output current.

There is a snag here, though. If the unbalance of the output pair is such as to necessitate a very low voltage on the driver collector to compensate, and bring the mid-point voltage right, it could impair its own power handling abilities. The driver must supply power to provide that low source impedance that we saw was so desirable, and it could easily be overloaded if its collector voltage was taken too low.

A further point is that wide discrepancies in h_{FE} of the output pair makes adjustment critical and tricky. It is also likely to change as the transistors warm up, by more than the usual amount. In any case such adjustments should be made after a short run at normal operating volume/levels.

Negative Feedback

It may be argued that the differences in amplitude of negative and positive cycles due to transistor unbalance can be corrected by amounts of negative feedback. True, negative feedback will reduce the discrepancies by a significant amount, but by its nature, distortion can never be completely eliminated. It is increasingly being found that a high negative feedback level brings its own problems.

Phase shift over the feedback loop can turn negative into positive feedbacks at high frequencies, with disasterous results; it also renders the amplifier vulnerable to transient distortion. When large values of feedback are employed, the gain of earlier stages must be made greater to compensate for the loss produced by it. If a sudden large amplitude transient arrives, the negative feedback signal appears too late to reduce the leading pulse, so it overloads the stage, thereby generating severe distortion.

The maxim for good amplifier design is to get it as near perfect as possible without negative feedback, then apply a moderate amount to improve performance still further. Some makers use it as wallpaper to cover the cracks, but this is never satisfactory.

So, it is highly desirable to use matched transistors in the output stage. Small differences may have no noticeable effect, but with the large spreads common with some types of transistor, you may get a pair from the top and bottom of the range. A pair of 2N3772s I obtained recently for a public address amplifier of which the specified h_{FE} was 15—60, actually measured 12 and 17, hardly a useable combination.

Class A

In order to avoid the troublesome crossover distortion of inherent with class B designs, many constructors and makers are going back to class A operation. There is no doubt that these are much superior for quality work, but have the disadvantage of taking high current through the output stage. This is less of a drawback now that transistors are avilable which have very large current ratings unheard of a few years ago.

The main difficulty now is getting rid of the excess heat, but large heatsinks are also obtainable that can handle the power. There are though, limitations when it comes to the very high powers, and for these, class B or a derivative is the most practical solution.

A typical class A circuit is shown in **Figure 5**, and at first glance it seems hopelessly unbalanced. The transistors are not complementary but both NPN types. The configuration is similar to the class B circuit, but whereas the top transistor is operating as an emitter follower, the bottom one is working as a normal grounded emitter. Thus while the voltage gain of the upper devices is less than unity, that of the lower one is proportional to its h_{FE}.

Balance is established by the way

the driver is connected. Notice that its emitter is taken directly to the base of the lower output transistor, hence its base/emitter input current flows also through the base/emitter junction of the output transistor in addition to the collector/emitter current. Thus, with respect to the lower output transistor, the driver behaves as an emitter follower giving a low-voltage gain.

For the upper transistor, this is not the case, and it is driven by the grounded emitter driver stage consisting of Q2 and Q3 with none of the driver's input current affecting its base/emitter junction. Thus the balance is neatly attained. As with the class B circuit, the voltage at the junction between the two transistors can be set to half the supply voltage by adjusting the bias on the driver using RV2.

The preset for setting the current through the output pair RV1, is connected not between their bases, as with the class B complimentary circuit, but in the collector feed to the driver. This is because the bases of both transistors, being of the same polarity, need to be made either more positive or negative to increase or decrease the collector respectively. With the complementary circuit one had to be made more positive while the other was made more negative.

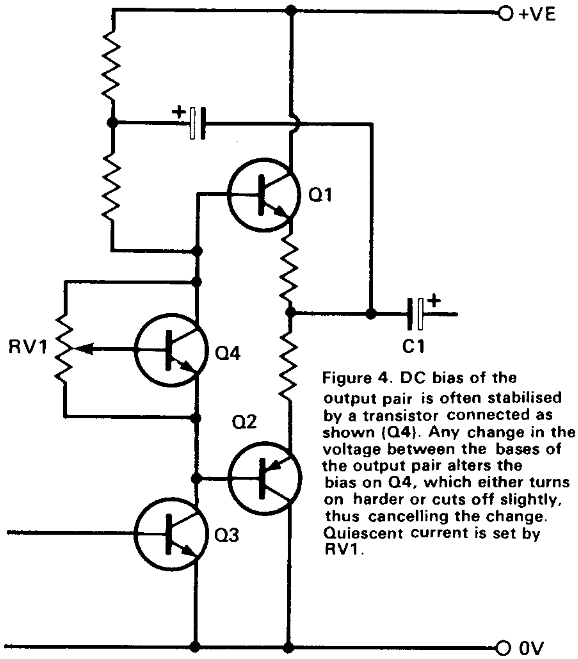


Figure 4. DC bias of the output pair is often stabilised by a transistor connected as shown (Q4). Any change in the voltage between the bases of the output pair alters the bias on Q4, which either turns on harder or cuts off slightly, thus cancelling the change. Quiescent current is set by RV1.

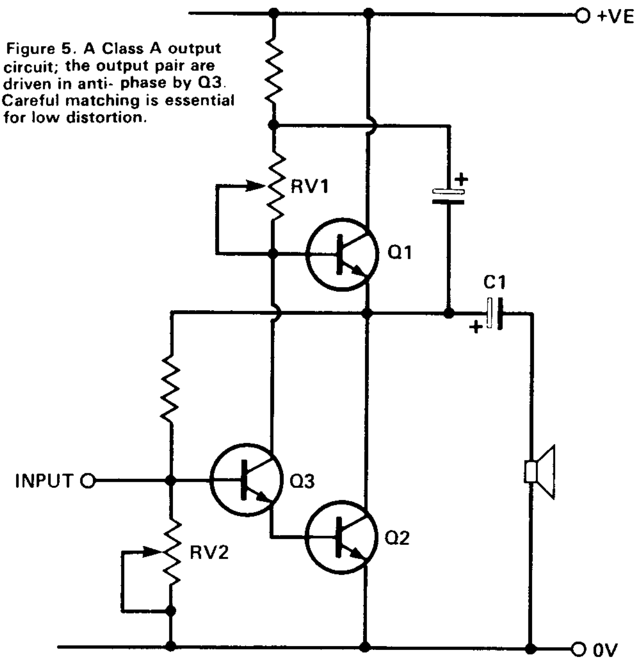
Matched Pairs

While a matched pair of output transistors is, as we have seen, desirable in a class B complementary circuit, it is *essential* with a circuit using class A operation. Any difference will have a greater effect on the distortion, and could also result in one transistor getting hotter than the other. Having a high quiescent current, they are likely to be running close to their limits anyway, and the ratings of one could easily be exceeded.

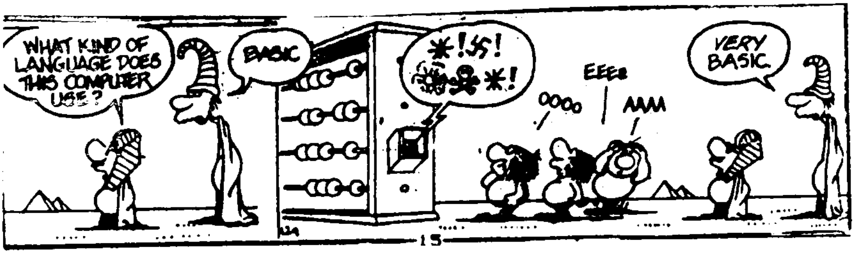
Now here we are faced with a major problem. Have you ever tried to purchase a matched pair? Apart from a few types which are supplied matched by the makers, they are just not generally available for the majority of suppliers. For the benefit of HE readers (as well as my own), I carried out a survey of mail order suppliers to find one who was prepared to match up pairs, even at a little extra cost. Of those contacted, only one expressed willingness to do so, and one well-known firm suggested that I order a quantity, say 25, match up a pair and return the others for credit (not a refund)!

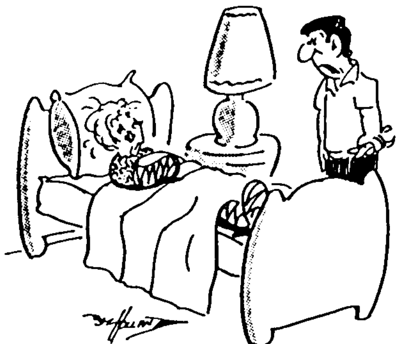
The firm that will supply matched pairs (with h_{FE} values matched), is **Comtech Electronics, 205 Studes Rd., Leicester LE2 9FY**. I ordered two pairs of 2N3772s and received them a couple of days later. No extra charge was made, and on checking them found them very closely matched. In fact it would have been difficult to get closer! Their prices, in general, seem quite reasonable compared to many others too.

Figure 5. A Class A output circuit; the output pair are driven in anti- phase by Q3. Careful matching is essential for low distortion.

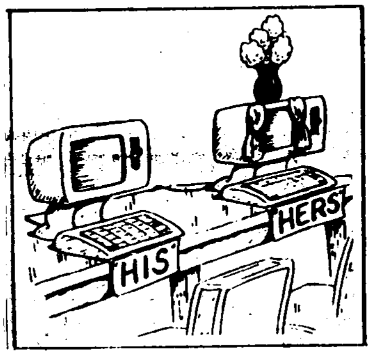


HE





"Don't beat around the bush, Fransie. If you don't want to help with my antenna again today, why don't you just come right out and say so?"

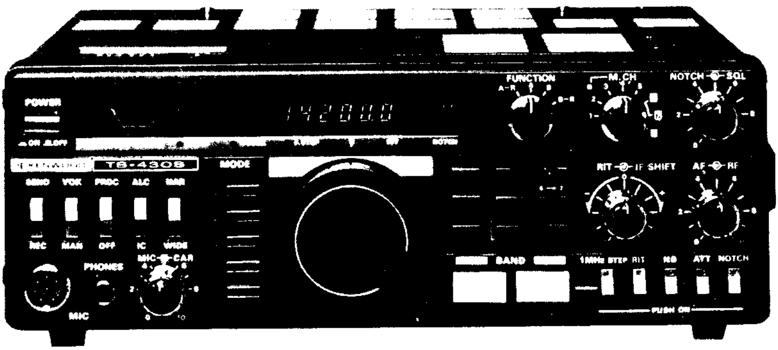


KENWOOD

TS-430S

HF TRANSCEIVER

The D'XERS Choice



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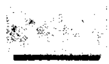
* Notch filter.
* Speech processor.
* All mode squelch circuit.
* Noise blanker
* R.F. Attenuator.
* Vox circuit.

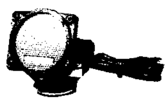
OPTIONAL ACCESSORIES

PS-430
DC Power Supply



SP-430
External Speaker

SP-40
Mobile Speaker



AT-130
Antenna Tuner

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