

April 2001

Volume 1, Issue 10

# ANODE

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A complex impedance bridge.

## Mark Up Your Calendar!

Its getting near to the end of term for the present committee. All members are hereby notified that the AGM will be held at the clubhouse on the 23rd of June at 13:30 hours.

On the social calendar we have a 'bring and braai' on the 21st April at 13:00. Ladies will you please bring a salad. (Whoops! If any of you guys are 90's guys, will you

bring a salad?)

We - the technical committee - are still researching the most favoured club project. The list/table of projects has grown over the last month or two. Any suggestions for suitable technical electronic construction projects will be welcomed.

The Lions are holding a cycle race and fun ride on the 22nd April,

starting at 07:30 hours. The communications is being supplied by us - the West Rand Club Members and other hams - in support of the Lions and the marshals. See OM Dirk ZS6AU if you are able to assist.

## EAST TO ZANZIBAR

THE VQ1JO  
EXPEDITION  
M. Geddes,  
ZE3JO (ex G2SO)

[NOTE: this took place in 1957]

WITH the prospect of a six weeks' holiday and a desire to try the effect of operating under the influence of an exotic call-sign, three interesting possibilities were considered by the writer early this year: It could be either the Seychelles (VQ9), Mauritius (VQ8) or Zanzibar (VQ1).

For various reasons, the latter was decided upon. With the experienced advice of VQ4RF, who had been to Zanzibar as VQ1RF during 1951, an immediate application was made to the Public Works Dept. there for an amateur licence. This was granted without delay under the requested call-sign of VQ1JO, no charge being made because of the short stay proposed, but the limitation was the 14 mc band and CW only. With 150 watts input. Having arranged the li-

cence, the hotel booking, boat passages and the necessary import-export permits from the Rhodesian Government, the next thing was the gear.

### Apparatus and Location

ZE2KV was good enough to make available a B2Mk. III Tx/Rx, capable of running 20 watts on 14 mc, and ZE6JL loaned a number of crystals for it. For those who may not be familiar with this ver-

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### Special points of interest:

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- Contact details on back page

## A Complex Impedance Bridge

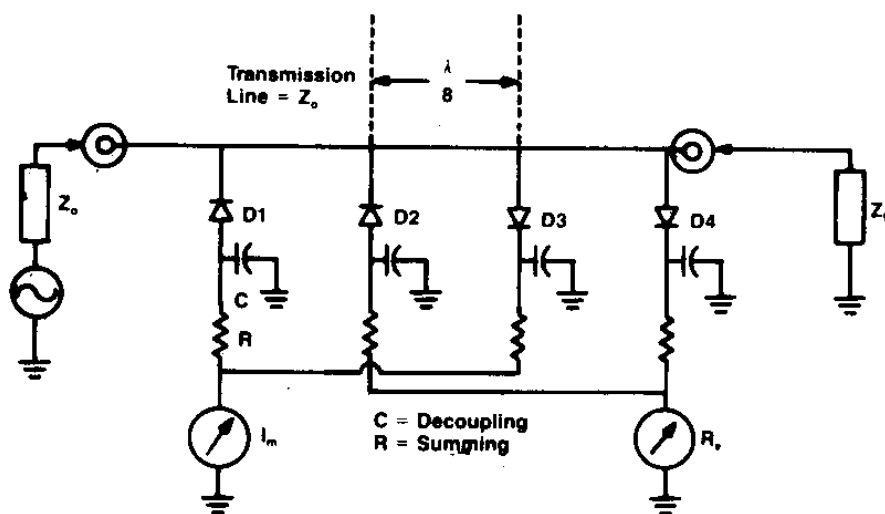
By Carl G. Lodstrdm Dow-Key Microwave Corp.

The voltage-current relationships along a transmission line are well known. The author has taken these principles and developed a very simple means of indicating the complex nature of an RF load, with an X-Y oscilloscope display that approximates a Smith chart. One of the entries in the First Annual RF Design Contest, the enthusiasm of the author for his idea comes through clearly as he describes the instrument!

The idea of this instrument was conceived through the better understanding of the Smith chart that I was able to receive in the late '70s. It took a few years, until around

1980, to get around to building one, verifying the concept. I remember that it was an antenna that defied tuning, and a 2-meter (145 MHz) version of the instrument was built.

chart, all mismatches reflect power. At an open end of a transmission line a voltage maximum will occur. This corresponds to a point at the right edge of a Smith chart. At a shorted end there will be a voltage minimum (the left



As is apparent in the Smith

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## EAST TO ZANZIBAR

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sion of the B2, the transmitter is a two-stage CO-PA, using EL32 into 6L6, integral with a seven-stage superhet receiver, which certainly pulls in the stations, though it suffers by reason of lack of bandspread on 14 mc. The transmitter section will load into any aerial over about 100 ft. long, and the power unit can be adjusted to work from AC supply voltages over a wide range.

It was possible to have the B2 at ZE3J0 for a few weeks before leaving; during this "period of indoctrination" it

was thoroughly tried out so that the writer could become familiar with its operation and capabilities, and get *au fait* with the rather critical receiver adjustment on 20 metres. Using the large home-station aerial system, good reports were obtained throughout the world.

The trip to Zanzibar was via Beira in Portuguese East Africa where ZE3JJ, CR7DQ and CR7LU were met and the gear was checked by the Portuguese Customs authorities there. The journey to Zanzibar itself from the home QTH in Rhodesia took about four

days, by train and boat.

From the hotel room, the best aerial that could be arranged was a 100 ft. wire 60 ft. high at the station end, sloping down to a height of only 12 feet at the far end. The first call under VQ1JO was put out at 1130 GMT on August 14 and was answered by a welter of stations, of which W5BNO was the most readable; he gave an RST-579 report, which seemed reasonable in view of the location and power. In this first session of about three hours, some 60 DX stations were knocked off, which was very encouraging.

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## A Complex Impedance Bridge

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edge), and in the case of a perfect match, there will be equal voltage along the line (chart center).

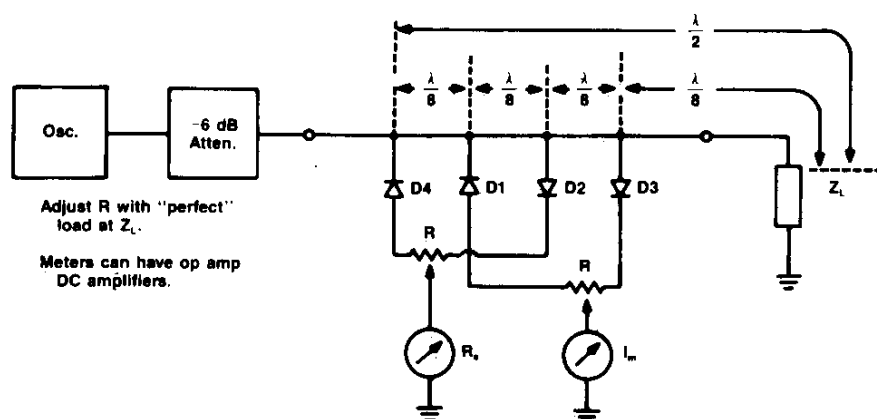
tors up and capacitors down. They will not move on a straight line, like their resistive counterparts, but along some resistive circle, the unity circle if the resistive

tions, then?

A wise man, Magnus Koch at the Chalmers U. of Technology, Goteborg, Sweden, once told me, "if you can measure something with a bridge, do it!" As the years have gone by, I have found them to be words of wisdom, and they certainly apply here. A bridge, how to make a bridge that can detect in what direction something takes off on a Smith chart?

One does not have to! As you go along a transmission line away from, say a shorted end, you start at the leftmost end, and we all know that after  $\lambda/8$ , looking back, we will see an inductance with  $j\text{col} = Z_0$ . After another  $\lambda/8$ , making  $\lambda/4$

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Correspondingly, loads with some imaginary part, inductors and capacitors combined with the load, will move vertically from the center, induc-

part is a match. In the vicinity of the center, this vertical movement is approximately a straight line. How do we detect and indicate these devia-

## EAST TO ZANZIBAR

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### Operating Results

For about five days until August 20, DX conditions were quite good and many contacts were being made in spite of the awful pile-ups on the frequency, which continued despite repeated requests to QSY. Another particular annoyance was the tendency for some of the waiting operators to keep calling continuously, thus breaking up a QSO already going on, making it difficult to exchange reports and sometimes even to get a call-sign. It became a matter, every time, of picking out

only the best R5 signal after each call—anything less was certain to be lost in the QRM. In fact, it can be said that VQ1JO experienced to the full all the sensations of a wanted DX station! After August 20, conditions on 20 metres deteriorated sharply, and from then until the 30th, when the VQ1JO visit came to an end, it was hard; going to raise anything. Subsequent checks with other stations after the return to Rhodesia confirmed that conditions generally were poor during this ten day period—which was a pity, because it coincided with what would have been VQ1JO's

spell of maximum activity.

However, the log shows that VQ1JO worked 45 countries and 350 stations during August 14-30; for 52 of them, it was a first contact with VQ1, the only U.K. station in this category being G3JKF. Eight W call areas were worked for first contacts, the missing two being W1 and W0.

For the record, it should be explained that the very first amateur station operated from Zanzibar was VQ1RF, who was followed by VQ1RO (G2RO), but for a short time only, with VQ1JO on the present occasion as the eighth inhabitant.

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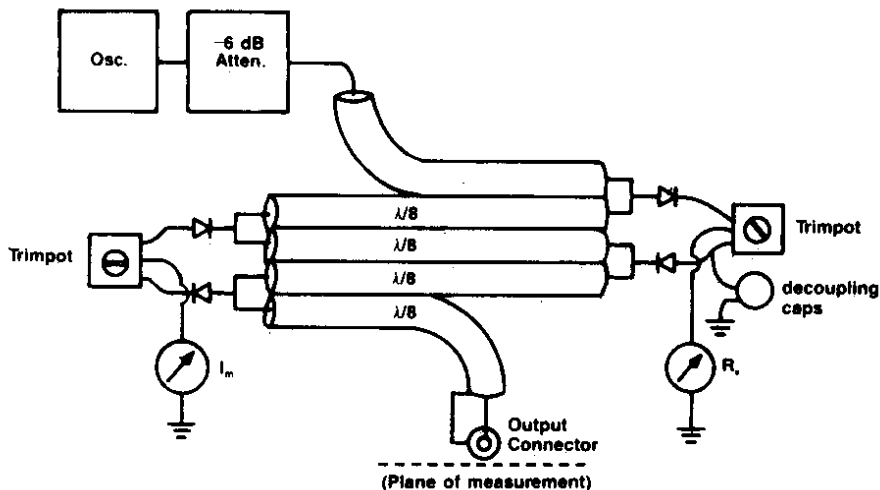
## A Complex Impedance Bridge

(Continued from page 3)

total, it looks like an open circuit, and so on. After one turn around the chart we have

detect, but D2 will get twice the normal. D3 and D1 will not see any change. Due to the way D2 and D4 are

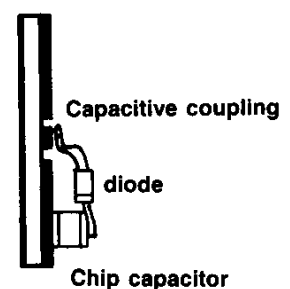
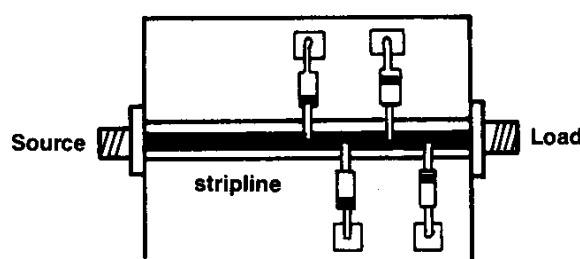
served is this apparatus. It is the fact that near perfect loads will be treated especially carefully and accurately. Also, the concept is clearly not limited to 50 ohm lines. One can imagine the use of perhaps a 5 ohm line in a test fixture for measuring transistor input impedances.



traveled  $\lambda/2$  along the line. Let us now put four little detector diodes, monitoring the voltage on the line, spaced  $\lambda/8$  apart, one in each "compass direction" around the chart. Well, you say, you can not do that! It introduces a mismatch! True, but all four diodes do the same. Since they are mutually cancelling, at that frequency, plus a little line loss, it does not matter.

turned, a negative voltage will appear at their summing point. An open circuit will produce the opposite effect, with a positive voltage from D4 and no voltage from D2.

A limitation is the bandwidth. I would say that the function is very satisfying within a 10 percent band centered around the design frequency. That is certainly more than enough for most "band" operations, be it ham radio, cellular mobile, radar, microwave link or CB. An exception from the bandwidth limitation is, of course, the well-matched load, which will appear as such no matter what the frequency.



Let us excite the line and try various loads at the other end. The last diode is to be positioned where the loads will be applied, or an integer multiple of  $\lambda/8$ , in which case the indicators will change sign and label.

Referring to the basic schematic (Figure 1), let us look at a short circuit. D4 will obviously get no voltage at all to

In both cases, D1 and D3 will detect equally strong signals, but of opposite signs, so their sum is zero. In a similar way it works for imaginary deviations. Just imagine the chart rotated 90 degrees!

The beauty of the Smith chart, or at least one of them, is pre-

The maximum possible frequency of operation that can be achieved remains to be determined. The diodes have to be operating, of course, and can always be spread by multiples of  $\lambda/8$  if physically necessary, but the bandwidth will suffer. Hew-

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## A Complex Impedance Bridge

*(Continued from page 4)*

lett-Packard has been kind enough to supply me with some zero bias diodes good to 10 GHz, but in spite of a lot of care, they got damaged by static electricity. Using regular "hot carrier" diodes will work to at least 1GHz, but a signal level of at least -15 dBm is necessary for good signals. A possible method

of building the instrument for microwave frequencies is shown in Figure 2.

### Practical Aspects

It may be more desirable to have the test plane outside the connector, as opposed to just behind it. This is possible by just adding some line

after the last diode. This may actually be the preferred

method, since all the diodes then will be mounted in an identical manner on the line, thereby balancing each other better. They will then have to be permuted, changing the order from 1-2-3-4 to 4-1-2-3.

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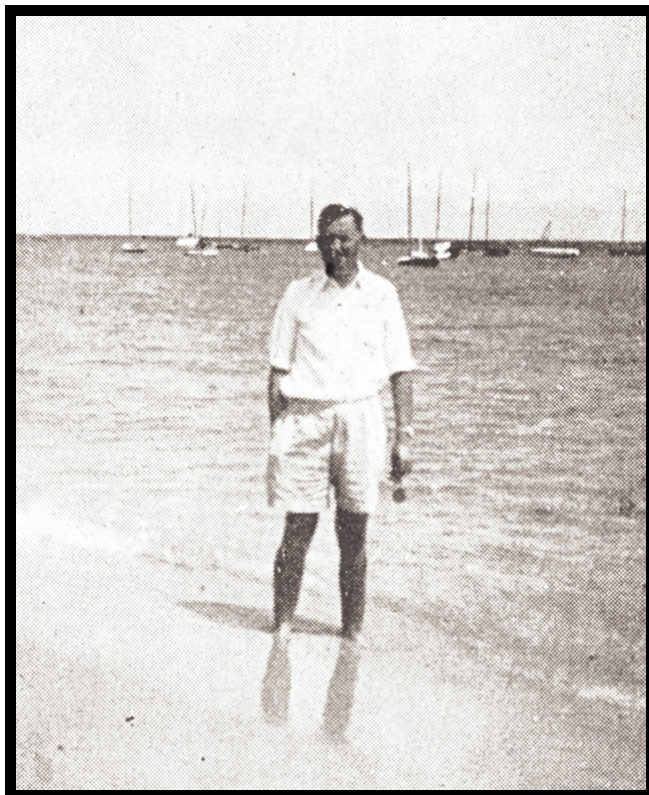
## EAST TO ZANZIBAR

*(Continued from page 3)*

### Some General Impressions

Zanzibar is a large island some 23 miles off the East African coast, 53 miles long by 24 wide. It is part of a British Protectorate, which comprises Zanzibar itself and the neighbouring island of Pemba, with all the islets within their territorial waters. Of the total population of over a quarter of a million, only some 500 are Europeans, engaged mainly in the spice trade. The Protectorate is a prolific producer of coconuts and cloves, and one can get the scent of cloves on the off-shore breeze when miles away at sea. The Island has good roads, and the swimming and fishing are excellent. As there is no indigenous amateur population, Zanzibar would indeed be a DX paradise for a permanent VQ1 resident!

Both as a holiday trip with the XYL and as a DXpedition, the whole experience was cer-



tainly well worth while. By the time this appears in print, all VQ1JO QSL's will have been sent off direct to every station worked. If anyone should not have received the expected card, write ZE3JO, Box 2462, Salisbury, Southern Rhodesia.

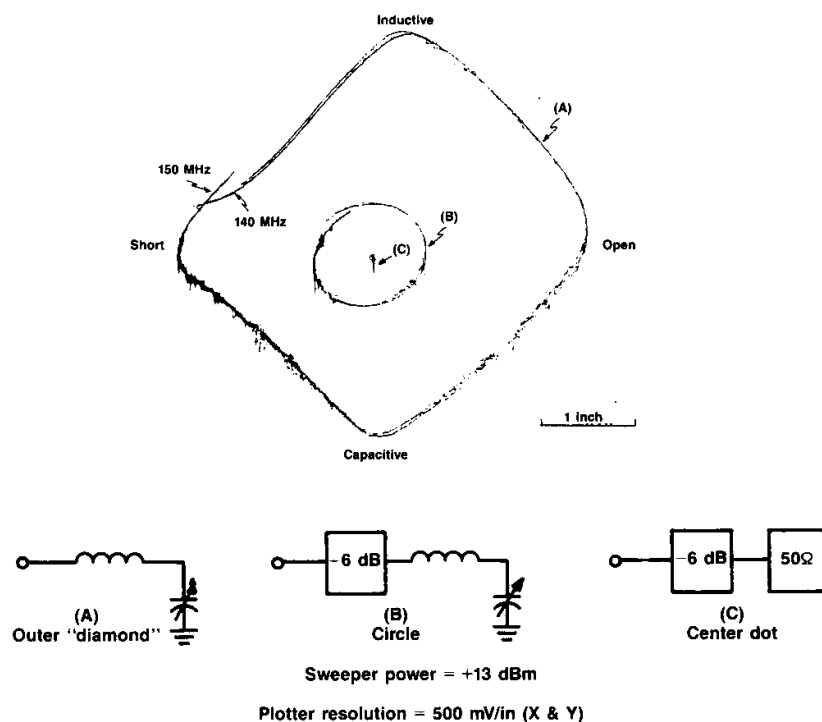
**VQ1JO (ZE3JO ex-G2SO) cooling his ankles during**

**his convalescing holiday at Zanzibar during August this year, when he made 350 contacts in 45 countries in 16 days under the temporary VQ1JO call.**

*[ MAL later became Z23JO and went silent key on the 1st April 1997. His elder son*

*(Continued on page 7)*

## A Complex Impedance Bridge



(Continued from page 5)

It is also possible to measure remote ( $100\lambda$ ) objects. By leaving the end of the line open, one can determine to what extent the chart is rotated, and either change the frequency slightly to get the open located on the right, or add some cable, or just remember the position. The insertion loss of the cable limits the sensitivity, of course, but I have derived useful information about a load with a 20 dB attenuator in line and +10 dBm excitation. This corresponds to a VSWR of 1.02:1 or 40 dB return loss. With the same level of excitation I can detect the difference between a "perfect" load and one of 70 dB reflection. To observe that mis-

match on a Smith chart, you would have to use a microscope, since it corresponds to a distance from the center of half the thickness of a human hair.

Displaying the voltages on an X-Y oscilloscope (or a plotter for swept signals) is very convenient. It then becomes apparent that the outline of the displayed field, corresponding to the circular border of the Smith chart, is not really circular, but somewhat diamond shaped. Should this be disturbing, a 6 dB attenuator can be left on the measurement port. It is "transparent" enough to make good measurements through. It also provides the necessary DC return path for the diode cur-

rents, which may not be present in the load or source.

The matching impedance of the source is not critical at all. A mismatch there reflects part of the power back to the source, but what travels down the line is what counts. With zero bias diodes it should be possible to use a regular signal generator for the source, with levels of 1 mV (-47 dBm), and measure receiver inputs without driving them into non-linear regions.

Substituting the "perfect" load with a resonant circuit opens up a few interesting applications. The output from the  $jX$  detector becomes very sensitive to changes in frequency, being zero at resonance. This can be used to measure deviation, modulation, PLL step response and maybe even phase noise. The higher the Q of the attached resonant circuit, the more sensitivity a VCO can be locked to a cavity or a stub, by feeding back the DC signal.

Another application could be a distance meter, connecting both outputs to an UP/ DOWN counter, with an antenna for a load. The sinelcosine information in the reflected signal will run the counter up or down, and one count for every half wavelength will be gathered. This may be a good detector for doppler radar burglar alarms, eliminating false alarms from objects that are just swinging back and forth in the wind.

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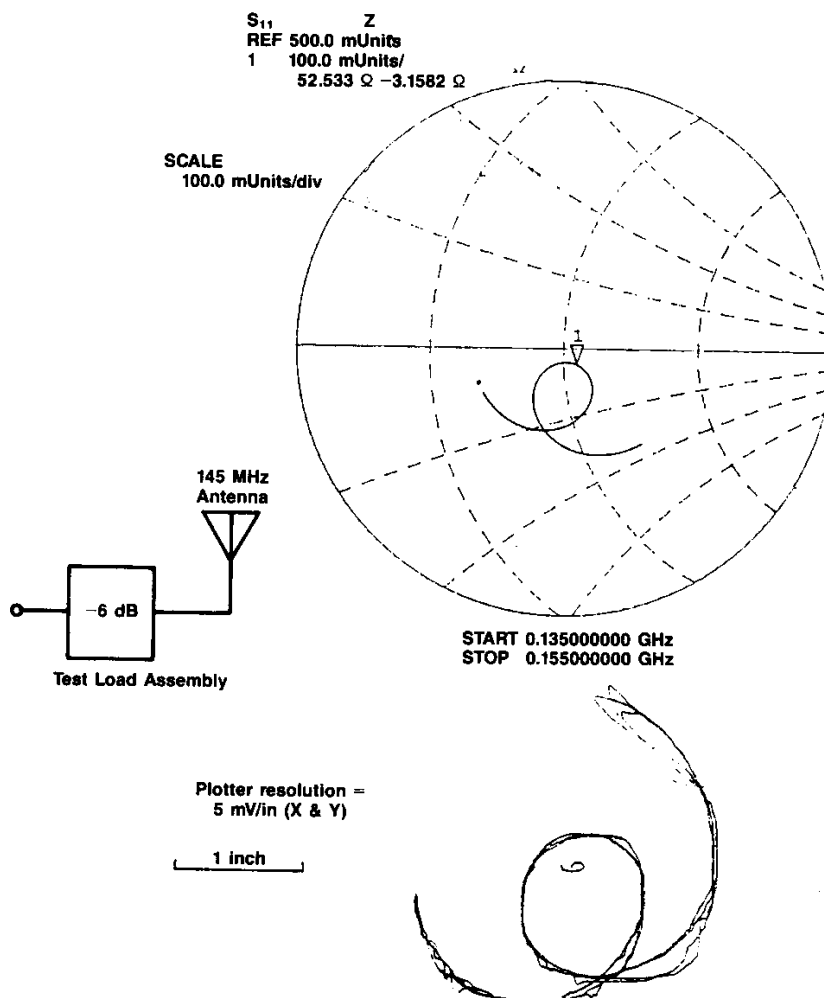
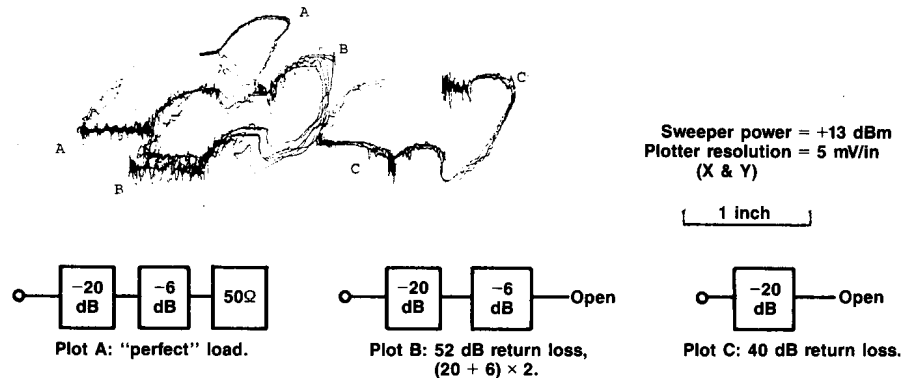
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To conclude, a detector has been described that in sensitivity far exceeds the common VSWR meter and furthermore provides information about the complex nature of the load, while still being of the same simplicity as a VSWR meter. The trade-off is bandwidth. Also, it has other potential uses, as outlined, that a VSWR meter has not.

### Acknowledgements

To Magnus Koch, as mentioned above, and to Ingvar Svensson, my teacher at TGG, Goteborg, who had the ability of explaining the Smith chart

so vividly that this concept surfaced in one of his more absent-minded students' mind! If all teachers were like him, this world would be a much better place.



### About the Author

Cari Lodstrdm is applications engineer at Dow-Key Microwave Corp., 1110 Mark Avenue, Carpinteria, CA 930132918. He has an Electronics Engineering degree from the Technical Gymnasium of Goteborg, Sweden, and is amateur radio operator SM6MOM/W6.

### East to Zanzibar

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*Dirk, then got his licence and was Z23JO/R from April 1999 to May 2000. Dirk has now relocated to South Africa and is ZR6DMG, residing in Newlands (Jhb) with his daughter and family.]*

## The West Rand Amateur Radio Club

26.14122 South - 27.91870 East

P.O. Box 562  
Roodepoort  
1725

Phone: +27 11 726 6892  
Email: [john.brock@pixie.co.za](mailto:john.brock@pixie.co.za)

**Bulletins** (Sundays at ...)  
11h15 Start call in of stations  
11h30 Main bulletin start

**Frequencies**  
145,625 MHz (West Rand Repeater)  
10,135 MHz (HF Relay)  
14,160 MHz

## Radio Amateurs do it with more frequency!



**We are going on the  
Web**

**[www.zs6wr.org.za](http://www.zs6wr.org.za)**

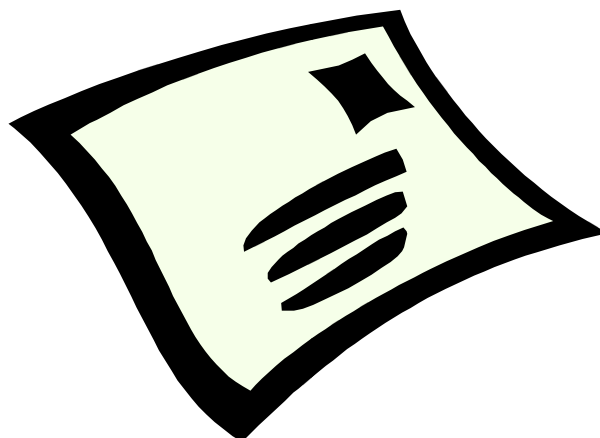
Please note this has been just been registered. Our site will be up in the new year.

Chairman	Bill	ZS6REV	726 6892	---
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To make this the best ham radio magazine in South Africa we need your input. Please submit articles, comments, suggestions etc.

Please send plain text with no formatting to the email address



**We need your input! Email us articles,  
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