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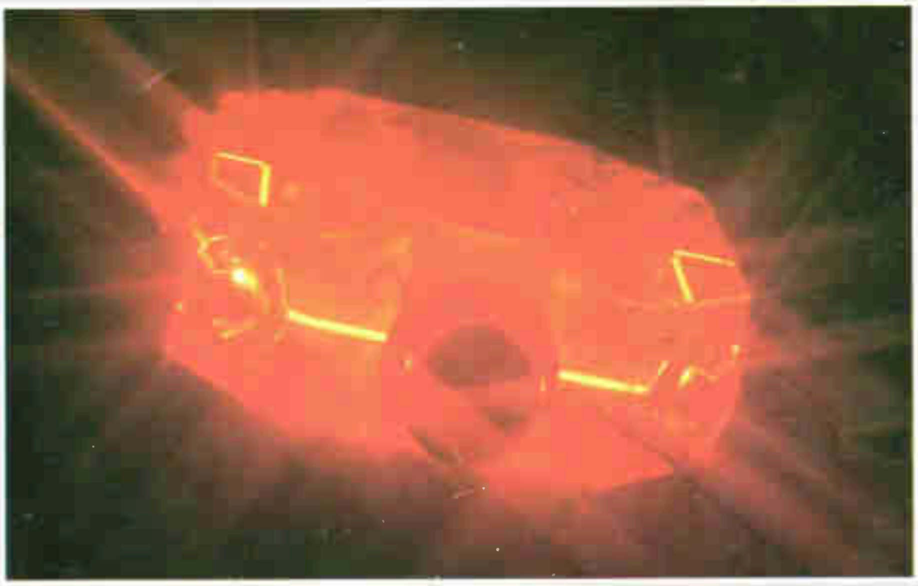
# Radio & Electronics World

The communications and electronics magazine

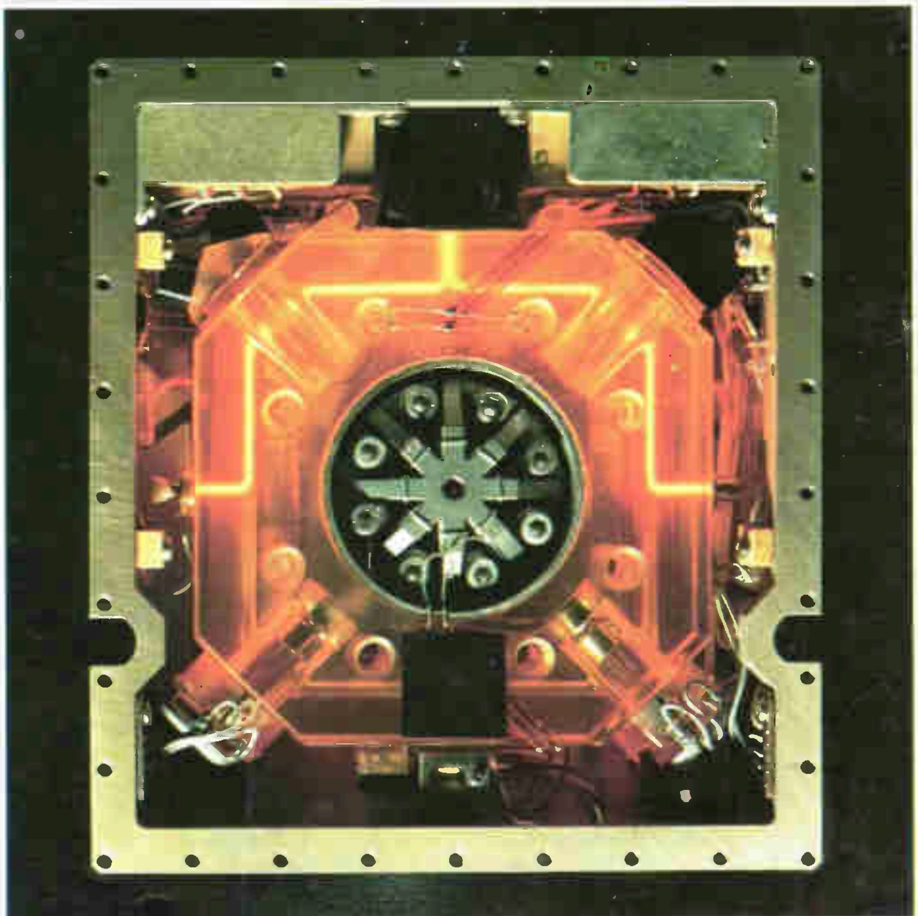


INERTIAL AND DOPPLER RADAR NAVIGATION SYSTEMS AND R-NAV

ELECTRONIC POWER CONTROL DEVICES AND PRINCIPLES

SPECTRUM WATCH

FREE CLASSIFIED ADS



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## ON THE COVER

This month's cover shows the Litton Laser Gyro (photographs courtesy of Litton Systems Canada Ltd).

**Publisher's Announcement**
Due to severe editorial production problems, we regret that this issue of ***R & EW*** has to be published with fewer pages than normal.


**Editorial**
Iain Mackenzie
Penny Phillips

**Advertisement Manager**
Marian Vidler

**Advertisement Executive**
Maria Smith

**Publisher**
Peter Williams

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**Safety in the shack**

Some of the constructional projects featured refer to additions or modifications to equipment; please note that such alterations may prevent the item from being used in its intended role, and also that its guarantee may be invalidated.

When building any constructional project, bear in mind that sometimes high voltages are involved. Avoid even the slightest risk – safety in the shack please, at all times.

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| E55L | 49.50 |
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| E81CC | 5.50 |
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| G180/2M | 6.95 |
| G240/2D | 9.00 |
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| GC10/4B | 17.50 |
| GC10/4E | 17.50 |
| GC12/4B | 17.50 |
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| GU20 | 35.00 |
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| KT67 | 9.00 |
| KT77 Gold lion | 11.95 |
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| KT88 USA | 10.95 |
| KT88 Selectron | 15.00 |
| KT88 GEC | 22.50 |
| KTW61 | 2.50 |
| KTW62 | 2.50 |
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| OB2WA | 2.50 |
| OC3 | 2.50 |
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| OM6 | 1.75 |
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| ORP50 | 3.95 |
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| P41 | 2.50 |
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| PC88 | 0.75 |
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| PC900 | 1.25 |
| PCC84 | 0.40 |
| PCC85 | 0.55 |
| PCC88 | 0.70 |
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| PCC189 | 0.70 |
| PCC805 | 0.70 |
| PCC806 | 0.80 |
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| PCF84 | 0.65 |
| PCF86 | 1.20 |
| PCF87 | 1.25 |
| PCF200 | 1.80 |
| PCF201 | 1.80 |
| PCF801 | 1.35 |
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| PCF806 | 1.00 |
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| QQV03-10 | 5.50 |
| QQV03-10 Mullard | 15.00 |
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| S30 2K | 8.50 |
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| S109/1K | 15.00 |
| S130P | 5.95 |
| SC1/800 | 5.00 |
| SC1/1100 | 6.00 |
| SC1/1200 | 5.00 |
| SC1/1300 | 6.00 |
| SC1/1400 | 6.00 |
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| TB2-5/300 | 95.00 |
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| TB3-750 | 115.00 |
| TB3-2000 | 450.00 |
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| TT11 | 1.50 |
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| TT100 | 69.00 |
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| TY4 400 | 85.00 |
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| U26 | 0.90 |
| U35 | 3.50 |
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| UF42 | 2.25 |
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| UU5 | 3.50 |
| UU6 | 6.00 |
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| UU8 | 9.00 |
| UY41 | 3.50 |
| UY85 | 0.70 |
| V235A/1K | 250.00 |
| V238A/1K | 295.00 |
| V246A/2K | 315.00 |
| V2406/1K | 225.00 |
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| V453 | 12.00 |
| VLS631 | 10.95 |
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| VP41 | 4.95 |
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| VR101 | 2.50 |

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| VU29 | 4.50 |
| VU39 | 2.50 |
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| W61 | 4.50 |
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| W81M | 4.50 |
| W729 | 1.00 |
| W739 | 1.50 |
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| X41 | 4.50 |
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| XC25 | 0.50 |
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| XR1-3200A | 79.50 |
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| YL1070 | 195.00 |
| YL1071 | 195.00 |
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| Z300T | 6.00 |
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| ZM1023 | 7.95 |
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| 1B27 | 55.00 |
| 1B35A | 45.00 |
| 1B63A | 75.00 |
| 1K3 | 2.50 |
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| 1P28 | 25.00 |
| 1R5 | 0.90 |
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| 1T4 | 1.00 |
| 1U4 | 1.75 |
| 1U5 | 1.00 |
| 1X2B | 2.50 |
| 2A3 | 16.50 |
| 2AS15A | 11.50 |
| 2B7 | 2.50 |
| 2B22 | 69.50 |
| 2C36 | 70.00 |
| 2C39A | 32.50 |
| 2C39BA | 39.50 |
| 2C40 | 37.00 |
| 2C42 | 29.50 |
| 2C43 | 60.00 |
| 2C51 | 2.50 |
| 2CY5 | 1.50 |
| 2D21 | 1.95 |
| 2D21W | 3.15 |
| 2E22 | 49.00 |
| 2E26 | 7.95 |
| 2J55 | 295.00 |
| 2K25 | 35.00 |
| 2K25 Raytheon | 75.00 |
| 2K26 | 95.00 |
| 2K29 | 250.00 |
| 2K48 | 140.00 |
| 2K56 | 250.00 |
| 2X2A | 5.00 |
| 3A/107B | 12.00 |
| 3A/108A | 9.00 |
| 3A/109B | 11.00 |
| 3A/110K | 12.00 |
| 3A/141K | 11.50 |
| 3A/146J | 7.50 |
| 3A/147J | 7.50 |
| 3A167M | 10.00 |
| 3A3A | 3.95 |
| 3A4 | 1.10 |
| 3A5 | 4.50 |
| 3AT2 | 3.35 |
| 3B22 | 25.00 |
| 3B24 | 12.00 |
| 3B26 | 24.00 |
| 3B28 | 15.00 |
| 3BZ6 | 1.50 |
| 3C45 | 39.50 |
| 3CX3000A7 | 650.00 |
| 3CY5 | 1.50 |
| 3D21A | 29.50 |
| 3E22 | 49.50 |
| 3E29 | 39.50 |
| 3EJ7 | 1.95 |
| 3H | 0.40 |
| 3J 170E | 1450.00 |
| 3L | 0.40 |
| 3Q4 | 2.50 |
| 4-65A | 75.00 |

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|---|---|
| 4-250A | 85.00 |
| 4-400A | 87.50 |
| 1000A | 425.00 |
| 4B32 | 35.00 |
| 4B/551B | 125.00 |
| 4BQ7A | 1.75 |
| 4BZ6 | 1.95 |
| 4C28 | 25.00 |
| 4C35 | 145.00 |
| 4CX125C Eimac | 150.00 |
| 4CX250B | 45.00 |
| 4CX250BM | 65.00 |
| 4CX250K | 115.00 |
| 4C250R | 125.00 |
| 4CX350A | 100.00 |
| 4CX350F | 95.00 |
| 4CX1000A | 425.00 |
| 4CX1500B | 475.00 |
| 4CX5000A | 1000.00 |
| 4D21/4-125A | 85.00 |
| 4D32 | 125.00 |
| 4GS7 | 2.25 |
| 4GV7 | 2.25 |
| 4JC6A | 2.95 |
| 4KT6 | 1.50 |
| 4X150A | 35.00 |
| 4X500A | 350.00 |
| 5A/102D | 9.50 |
| 5A152M | 9.00 |
| 5A163K | 10.00 |
| 5A170K | 6.25 |
| 5A-180M | 9.00 |
| 5A-206K | 10.00 |
| 5AM8 | 2.15 |
| 5AN8 | 1.20 |
| 5B-110M | 10.00 |
| 5B-254M | 14.50 |
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| 5B-256M | 15.00 |
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| 5C22 | 125.00 |
| 5CL8A | 2.50 |
| 5J180E | 1950.00 |
| 5LJ8 | 2.95 |
| 5R4GB | 5.50 |
| 5R4GY | 4.95 |
| 5TA | 5.95 |
| 5T8A | 1.95 |
| 5U4G | 4.50 |
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| 5V4G | 2.50 |
| 5X4 | 4.95 |
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| 5Z3 | 4.50 |
| 5Z4GT | 2.50 |
| 6/30L2 | 0.70 |
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| 6A8 | 1.50 |
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| 6AG7 | 1.95 |
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| 6AJ4 | 3.50 |
| 6AJ7 | 2.00 |
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| 6AK6 | 2.50 |
| 6AL5 | 0.85 |
| 6AM4 | 3.25 |
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| 6AT8 | 1.75 |
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| 6BS7 | 5.50 |
| 6BW6 | 5.35 |
| 6BW7 | 1.50 |
| 6BZ6 | 2.50 |
| 6BZ7 | 2.95 |
| 6C4 | 1.50 |
| 6C5 | 1.95 |
| 6C6 | 3.50 |
| 6C8G | 1.50 |
| 6C9 | 4.95 |
| 6CA4 | 4.95 |

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| 6CA7 | 3.50 |
| 6CB5 | 3.95 |
| 6CB6 | 1.95 |
| 6CD6GA | 4.50 |
| 6CF6 | 1.95 |
| 6CG7 | 4.50 |
| 6CH6 | 6.95 |
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| 6CM7 | 2.95 |
| 6CS6 | 0.75 |
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| 6CX8 | 2.50 |
| 6DC6 | 2.35 |
| 6DJ8 | 1.00 |
| 6DK6 | 1.50 |
| 6DQ5 | 8.50 |
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| 6DT6A | 1.50 |
| 6DW4B | 3.50 |
| 6E5 | 3.95 |
| 6EA7 | 2.50 |
| 6EA8 | 2.50 |
| 6EB8 | 1.75 |
| 6EJ7 | 0.85 |
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| 6EV8 | 1.75 |
| 6EV7 | 2.95 |
| 6EW6 | 1.50 |
| 6F1 | 2.00 |
| 6F5 | 5.50 |
| 6F6G | 2.50 |
| 6F7 | 5.50 |
| 6F13 | 3.00 |
| 6F14 | 1.00 |
| 6F17 | 2.75 |
| 6F23 | 0.60 |
| 6F24 | 1.25 |
| 6F25 | 1.25 |
| 6F28 | 1.25 |
| 6F32 | 1.25 |
| 6F33 | 12.50 |
| 6FH5 | 6.50 |
| 6FH8 | 5.95 |
| 6FL2 | 4.50 |
| 6FG7 | 4.50 |
| 6GE5 | 3.95 |
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| 6GK6 | 3.95 |
| 6GJ7 | 0.85 |
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| 6GS7 | 2.15 |
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| 6GW8 | 2.50 |
| 6GY5 | 4.95 |
| 6GY6 | 2.50 |
| 6H1 | 9.50 |
| 6H6 | 2.50 |
| 6H6GT | 1.95 |
| 6HB7 | 1.95 |
| 6HF8 | 2.50 |
| 6HM5 | 2.50 |
| 6HQ5 | 3.50 |
| 6HS6 | 4.95 |
| 6HS8 | 2.95 |
| 6HZ6 | 3.50 |
| 6J4 | 2.15 |
| 6JAWA | 3.15 |
| 6J5GT | 2.50 |
| 6J6 | 2.00 |
| 6J7 | 4.15 |
| 6J7G | 4.15 |
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| 6JE6C | 7.50 |
| 6JM6 | 7.50 |
| 6JU8A | 2.50 |
| 6JS6C | 8.50 |
| 6K7G | 2.00 |
| 6K8G | 3.00 |
| 6KD6 | 8.95 |
| 6KG6A | 6.95 |
| 6KM8 | 2.50 |
| 6L1 | 2.50 |
| 6L6GC | 2.95 |
| GL6GC USA | 6.50 |
| 6L6GT | 2.95 |
| 6L6WGC | 5.50 |
| 6L7 | 3.50 |
| 6L15 | 3.15 |
| 6L19 | 3.95 |
| 6LJ8 | 2.50 |
| 6LD20 | 1.15 |
| 6LF6 | 7.50 |
| 6LQ6 | 7.50 |
| 6P28 | 2.00 |
| 6Q7GT | 1.50 |
| 6R7 | 3.15 |
| 6RHH8 | 10.00 |
| 6S4A | 1.50 |
| 6SA7 | 1.35 |
| 6SC7 | 1.50 |
| 6SH7 | 1.35 |
| 6SJ7GT | 1.20 |
| 6SK7 | 1.35 |
| 6SL7GT | 1.95 |
| 6SN7GT | 1.95 |
| 6SQ7GT | 1.50 |
| 6SS7 | 1.95 |
| 6T8 | 1.50 |
| 6U6GT | 3.50 |
| 6U7G | 3.50 |
| 6U8A | 1.50 |
| 6V6G | 1.25 |
| 6V6GT | 1.95 |
| 6W4GT | 1.95 |
| 6Y6G | 3.95 |
| 6X2N | 1.00 |
| 6X4 | 1.50 |
| 6X5GT | 1.00 |
| 6X5GTY | 1.00 |
| 6X8A | 2.25 |
| 7A6 | 4.50 |
| 7AU7 | 1.50 |
| 7B6 | 3.50 |
| 7B7 | 2.50 |
| 7D8 | 4.50 |
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| 7K7 | 7.50 |
| 7L | 1.50 |
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| 7Y4 | 2.50 |
| 8B8 | 2.50 |
| 8B10 | 2.50 |
| 8BQ5 | 1.95 |
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| 8EB8 | 1.50 |
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| 10EW7 | 2.95 |
| 10F1 | 0.75 |
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| 10P14 | 2.50 |
| 11E3 | 55.00 |
| 11R3 | 5.50 |
| 12A6 | 3.95 |
| 12AD6 | 1.50 |
| 12AE6 | 5.50 |
| 12AH7GT | 4.95 |
| 12AL5 | 1.00 |
| 12AT6 | 1.25 |
| 12AT7 | 1.15 |
| 12AT7WA | 2.50 |
| 12AU6 | 1.50 |
| 12AU7 | 0.85 |
| 12AV6 | 1.95 |
| 12AV7 | 2.50 |
| 12AX4GTB | 1.50 |
| 12AX7 | 0.95 |
| 12AX7WA | 2.50 |
| 12AX7S | 7.95 |
| 12AY7 | 3.95 |
| 12B4A | 4.50 |
| 12BA6 | 2.50 |
| 12BE6 | 1.95 |
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| 12BL6 | 1.75 |
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| 12BY7A | 3.50 |
| 12C8 | 2.50 |
| 12CA5 | 1.95 |
| 12CX6 | 1.20 |
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| 12DW4A | 3.50 |
| 12DZ6 | 3.95 |
| 12E1 | 19.50 |
| 12E14 | 38.00 |
| 12FX5 | 1.95 |
| 12GN7 | 3.95 |
| 12HG7 | 3.95 |
| 12J5GT | 3.95 |
| 12J7GT | 3.50 |
| 12JZ8 | 2.95 |
| 12K7GT | 1.50 |
| 12K8Y | 1.95 |
| 12KU7 | 1.95 |
| 12PE13A | 53.00 |
| 12S7GT | 1.50 |
| 12SA7GT | 1.95 |
| 12SG7 | 4.75 |
| 12SK7 | 1.95 |
| 12SJ7 | 1.50 |
| 12SN7GT | 1.85 |
| 12SW7 | 3.50 |
| 12SY7 | 4.50 |
| 12X4 | 1.95 |
| 13D7 | 3.20 |
| 13D9 | 3.20 |
| 13DE7 | 2.50 |
| 13DR7 | 2.95 |
| 13E1 | 145.00 |
| 13EM7 | 3.50 |
| 14B6 | 4.50 |
| 14R7 | 3.50 |
| 15E | 5.50 |
| 16AQ3 | 1.95 |
| 16GY5 | 2.95 |
| 16H | 0.40 |
| 16L | 0.40 |
| 17A8 | 3.50 |
| 17AX4GTA | 1.95 |
| 17BE3 | 2.50 |
| 17DW4A | 2.95 |
| 17EW8 | 0.95 |
| 17JZ8 | 4.50 |
| 18D3 | 6.00 |
| 18GB5 | 3.50 |
| 19AQ5 | 3.50 |
| 19AU4GT | 2.50 |
| 19BG6 | 3.50 |
| 19G3 | 19.50 |
| 19G6 | 9.00 |
| 19H4 | 35.00 |
| 19H5 | 33.50 |
| 20CV | 9.50 |
| 20D1 | 0.70 |
| 20LF6 | 7.95 |
| 20L1 | 0.95 |
| 20P1 | 0.55 |
| 20P4 | 1.95 |
| 20P5 | 1.15 |
| 21JZ6 | 4.95 |
| 21KQ6 | 4.95 |
| 21LU8 | 3.75 |
| 24B1 | 39.50 |
| 24B9 | 39.50 |
| 25BQ6 | 1.75 |
| 25DQ6B | 2.95 |
| 25L6GT | 1.75 |
| 29C1 | 19.50 |
| 29KQ6 | 6.50 |
| 30C15 | 0.50 |
| 30C17 | 0.40 |
| 30C18 | 1.48 |
| 30FL2 | 1.35 |
| 30FL12 | 0.95 |
| 30FL13 | 1.10 |
| 30FL14 | 1.25 |
| 30L1 | 0.45 |
| 30L15 | 0.60 |
| 30L17 | 0.60 |
| 30P4MR | 1.00 |
| 30P12 | 1.00 |
| 30P18 | 0.60 |
| 30P19 | 1.00 |
| 30PL1 | 2.50 |
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| 30PL14 | 1.75 |
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| 33A 158M | 19.50 |

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| 35A3 | 3.95 |
| 35A5 | 4.50 |
| 35C5 | 4.50 |
| 35L6GT | 2.00 |
| 35Z3 | 1.95 |
| 35Z5GT | 3.50 |
| 38HE7 | 5.95 |
| 40KD6 | 5.50 |
| 42 | 6.95 |
| 47 | 6.00 |
| 50A5 | 1.50 |
| 50B5 | 1.95 |
| 50C5 | 0.95 |
| 50CD6G | 1.95 |
| 50EH5 | 1.50 |
| 50JY6 | 2.95 |
| 53KU | 4.50 |
| 75B1 | 3.50 |
| 75C1 | 4.50 |
| 80 | 4.50 |
| 83 | 8.50 |
| 83A1 | 7.50 |
| 85A1 | 6.50 |
| 85A2 | 2.95 |
| 90AV | 17.50 |
| 90C1 | 3.50 |
| 90CG | 17.50 |
| 90CV | 17.50 |
| 91AG | 9.00 |
| 92AG | 19.50 |
| 92AV | 19.50 |
| 95A1 | 6.50 |
| 100E1 | 10.00 |
| 108C1 | 2.50 |
| 150B2 | 6.50 |
| 150C1K | 9.00 |
| 150C2 | 2.50 |
| 150C4 | 2.50 |
| 185BT | 1.50 |
| 211 | 33.50 |
| 230D | 15.00 |
| 231D | 15.00 |
| 250TH | 150.00 |
| 307 | 5.00 |
| 328A | 15.00 |
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| 436A | 35.00 |
| 572B | 65.00 |
| 705A | 12.50 |
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| 723A/B | 75.00 |
| 724A | 275.00 |
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| 810 | 85.00 |
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| 813 Philips | 35.00 |
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| 2040 | 25.00 |
| 2050 | 5.95 |
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| 4313C | 4.00 |
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| 5727 | 2.50 |
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| 7527 | 85.00 |
| 7551 | 8.50 |
| 7558 | 9.45 |
| 7581A | 9.95 |
| 7586 | 15.00 |
| 7587 | 19.50 |
| 7591A | 6.95 |
| 7609 | 47.00 |
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| 7699 | 25.00 |
| 7788 | 25.00 |
| 7815 | 59.50 |
| 7868 | 7.50 |
| 7895 | 17.50 |
| 7963 | 7.95 |
| 8005 | 95.00 |
| 8020 | 45.00 |
| 8136 | 2.15 |
| 8156 | 7.95 |
| 8417 | 6.95 |
| 8844 | 25.00 |
| 8874 | 215.00 |
| 8950 | 10.50 |
| 9001 | 1.50 |
| 18042 | 10.50 |
| 18045 | 10.00 |
| 18046 | 11.50 |

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# INERTIAL AND DOPPLER RADAR NAVIGATION SYSTEMS AND R-NAV

## BY BRIAN KENDAL G3GDU

**AVIATION ELECTRONICS**

**Part Eight**

Before the days of radio navigation, the position of an aircraft or ship was determined by keeping a record of the track and estimated speed. These were plotted on a chart and, from this, an estimated present position was determined. Any errors were corrected by a star or sun sight or at the first landfall.

With the coming of radio navigational systems, such as I have described in earlier articles in this series, navigation became more precise. However, for wide coverage, these systems require large networks of ground stations which are subject to both natural and man-made interference.

Ideally, therefore, an aircraft or ship should carry a system which is capable of determining position without use of external reference sources.

In recent years, developments in radar; accelerometers; gyroscopes and particularly lightweight computers, have resulted in the introduction of two systems which require no external reference, yet are capable of accuracies comparable with the best of ground based systems.

These are Doppler radar, which determines the movement of the aircraft by means of a low power radar, and Inertial Navigation System (INS) which senses the movement of a gyroscopically stabilised platform by means of accelerometers. Both systems then integrate the movement with elapsed time and from these derive the current position of the aircraft.

These systems, in effect, provide a modern automatic version of the dead reckoning system.

### Inertial navigation

The basis of Inertial Navigation Systems lies in Newton's Laws of Motion which were originally postulated nearly three hundred years ago. They are:

1 A body continues in state of rest or uniform motion in a straight line unless acted upon by an external force.

2 Acceleration is proportional to the force acting and inversely proportional to the mass of the body.

3 To every action there is an equal and opposite reaction.

In order to determine movement, it is necessary to measure acceleration. The device which measures this is, not surprisingly, called an accelerometer.

### The accelerometer

In its most basic form this could comprise a section of tubing within which a piston is free to move but is retained in a central position by two springs.

If this device is accelerated along its axis, the piston will attempt to remain stationary but the retaining springs will apply a force to the piston and eventually cause it to move. A point of equilibrium will be reached at which a constant displacement will exist between case and piston, this being proportional to the acceleration of the piston, the tube and any object to which they are attached.

The movement of the piston is a measurement of the acceleration, and by comparing this with the elapsed time and the original velocity (which would be zero if the device was initially at rest), the present velocity and displacement of the accelerometer can be calculated.

When two accelerometers are fitted with their axes at right angles, then movement in any direction will produce proportional output from one or both devices.

If, therefore, one accelerometer were aligned North-South with the other East-West and the initial geographical position of the device held in the memory of a computer, then from the successive output signals from the accelerometers and the elapsed time, the computer can calculate the current position of the aircraft.

To achieve this, however, it would be necessary for the equipment assembly to remain at a constant bearing relative to geographical co-ordinates. In order to maintain this stability it is necessary to make use of the gyroscope.

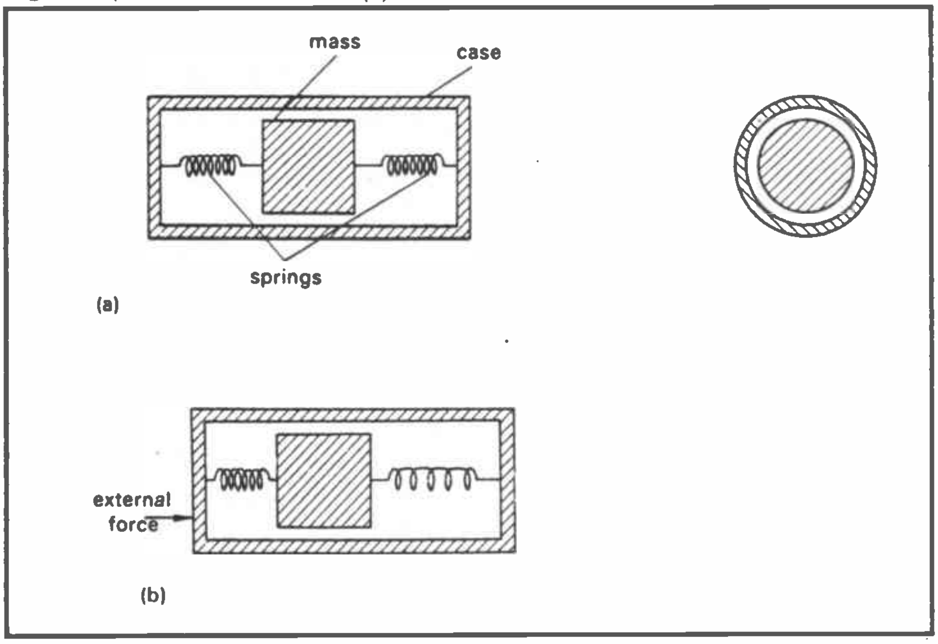
### The gyroscope

The basic principles of gyroscopes have been studied for over two hundred years. The first commercial application for navigation was in 1908, when Dr Kaempfe patented the gyrocompass.

A gyro may be described as a spinning mass, usually a wheel or disc, turning about an axis and supported by a gimbal which allows the mass to remain in the same alignment no matter what angular position is described by the support system.

To make use of the stability of the gyro, it is necessary to transfer this stability to some form of stable platform to which the accelerometer may be fixed. This is achieved by fitting the gimbal mount to a platform and transducers to register movement of the gyro inner gimbal. The output of the transducers is fed to a servo

*Fig 1: Simple accelerometer at rest (b) under acceleration*



amplifier and motor which maintains the platform which is, itself, mounted on gimbals in a position controlled by the gyro. By fitting the platform with two gyros mounted at right angles, its position is controlled and the requirement for a platform, which is stable in all axes, is met. To this can be fitted the accelerometers, the output of which is fed to the navigation computer for computation of the aircraft position.

### Strap down systems

In contrast to the basic system previously described, in recent years an alternative system has been developed in which the gyros and accelerometers are mounted directly on the aircraft frame and the reference table is, in effect, replaced by the computer.

This idea is not new. It was originally described in 1956, but until recently, sufficiently accurate computers were not available in a suitably compact form.

In this system, the gyros supply angular rate signals to a matrix which develops directional cosine signals used to indicate the aircraft attitude with reference to an inertial reference frame. The output from the accelerometers drives a co-ordinate converter, from which the matrix derives accelerations, along the inertial reference axes.

The signals are fed to a position computer for calculation of cartesian co-ordinates, representing the aircraft's position in inertial space, which are then summed to provide latitude and longitude readouts by a vector solver.

Inertial Navigation Systems are capable of indicating the displacement from the point of departure to a high degree of accuracy. However, to use this information for practical navigation it is necessary to relate this displacement to the geographical co-ordinates of the point of departure. It is, therefore, essential that the latitude and longitude of the aircraft are inserted during the pre-flight procedures and, thereafter, the equipment remains switched on. It is interesting to note that there is no necessity to insert any directional information, for the accelerometers sense the rotation of the earth and from this, stabilise the platform with respect to true north, from which all other angular measurements are derived.

### Ring Laser Gyros

Excellent though mechanical gyros may be, there would be many advantages if a non-mechanical equivalent could be developed. The Ring Laser Gyro is such a device.

The operation of this type of gyro depends upon the Doppler effect in which, if a source of a waveform is moved towards the observer, the frequency is apparently increased while it is reduced if the source is receding.

Consider first the case of a beam of coherent light (such as from a laser) which is directed around a track on a table by a series of mirrors. If the table should be rotated in the same direction as the light beam, then due to Doppler effect, the frequency of the light will be increased. Conversely, if the table were rotated in the opposite direction, the frequency will be lower. So, if the change in frequency in the light can be determined, this would provide a measure of the rotation of the table.

To make such a measurement directly would be virtually impossible, however, indirectly this can be achieved in a very simple way.

Considering the table just described, now pass a further beam of coherent light from the original source around the track in the opposite direction. When the table rotates, one beam will increase in frequency while the other decreases.

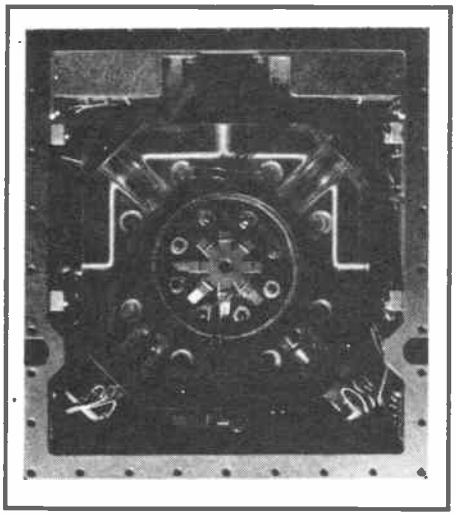


***Fig 2:*** *A Litton laser gyro*

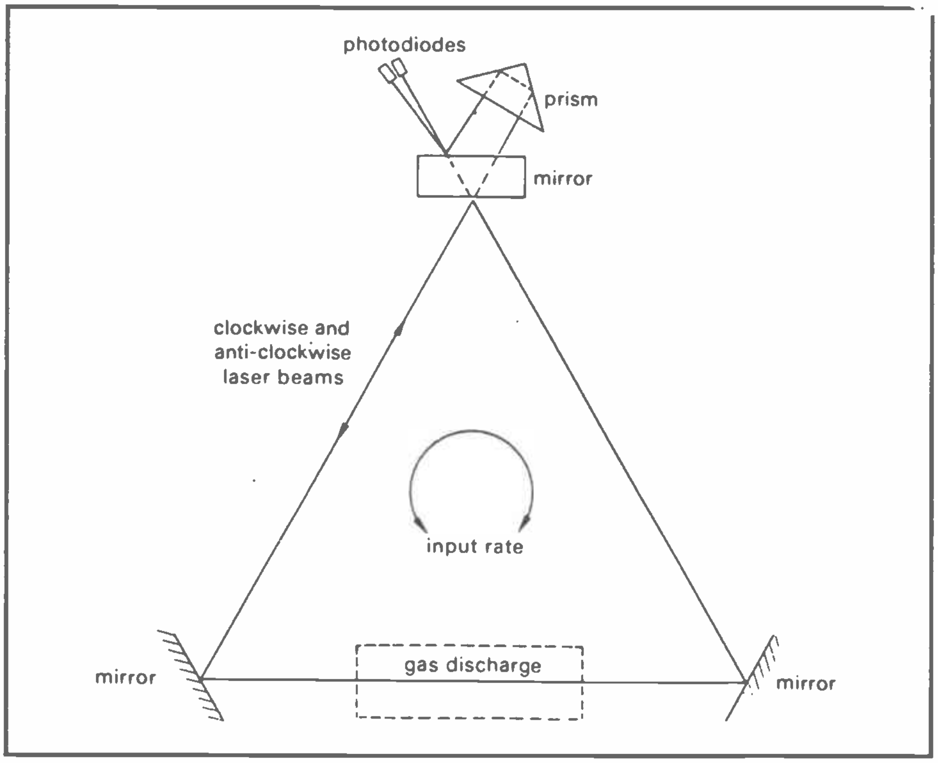



***Fig 3:*** *Principle of the laser gyro*

The frequency difference is measured by allowing a small percentage of the light to pass through one of the corner mirrors. A prism is used to reflect one of the beams so it crosses the other at a small angle, the effect of this being to generate an optical fringe pattern in the readout zone.

When the frequencies of the two beams are equal (ie when the table is at rest), the fringes will remain stationary. If the table is rotated, the difference in frequency between the two beams will cause the fringe pattern to move at a rate and direction proportional to the rate of rotation.

To detect the fringe movement, two photodiodes are mounted 90 degrees apart (in fringe space). As the fringes pass by the diodes, sinusoidal signals are generated whose frequency and relative phase indicate the speed and direction of rotation. These are then converted to digital form and fed to the computer.

Needless to say, the path length of a laser gyro must remain stable and, in order to achieve this, the gyro is machined from a solid block of a material of extremely low coefficient of expansion. A single structure contains the helium-neon gas, the lasing mirrors with electrodes forming the seals. A high voltage applied across the electrodes ionises the helium neon gas mixture,

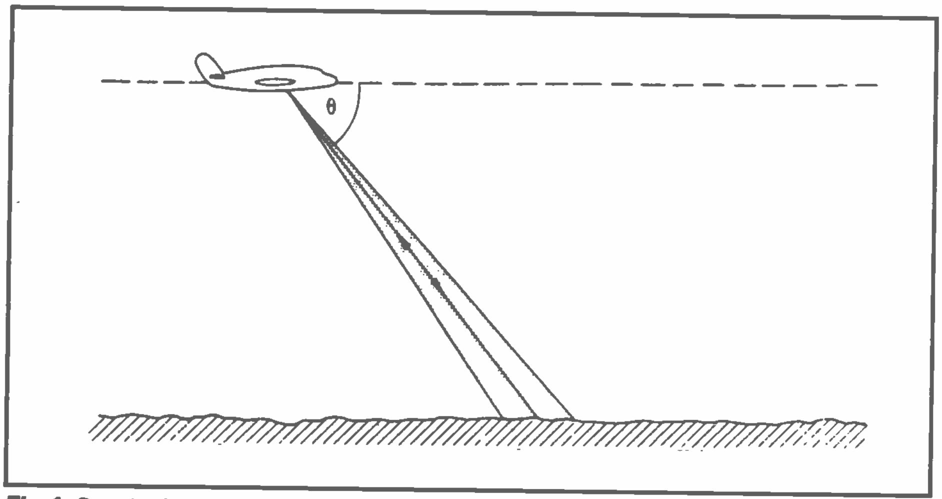



*Fig 4: Doppler forward beam depression angle*

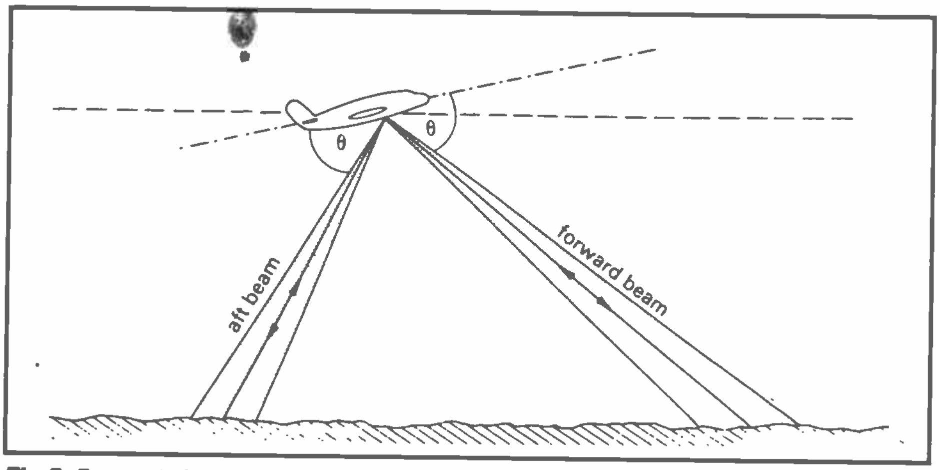



*Fig 5: Fore and aft beams to overcome pitch errors*

therefore, facilitating the lasing action to provide the coherent light.

Most manufacturers use a triangular light path but, unusually, Litton Industries (who provided the photographs accompanying this article) use a four sided light path.

Over the past ten years the laser gyro has proved both accurate and reliable. It is, therefore, conceivable that within the foreseeable future, laser gyros will totally replace mechanical gyros in aircraft inertial navigational systems.

## Doppler navigation

When the Austrian physicist Christian Doppler first documented the effect named after him, I am sure that he could not have imagined the diverse uses to which his work could be put.

So far in this series we have seen it used in VOR, to eliminate permanent echoes on radar and in gyroscopes (it has also been used in a microwave landing system). We now come to its use in a navigation system.

The Doppler navigation system is a self-contained dead reckoning system which obtains the desired information through a measurement of aircraft velocity (both forwards and sideways) by means of Doppler radar and a directional sensor, such as a magnetic compass or a gyro.

Doppler radar operates in a different manner to the pulse systems described in earlier articles. This radar transmits a continuous signal which impinges on the target and the reflected wave is received and compared in frequency with that transmitted.

If the target is stationary, then no frequency difference will be observed. If, however, the target is moving, a frequency difference will be observed, the variation being proportional to the relative velocity of the target. So, although Doppler radar will determine the velocity of the target, it provides no distance information. This is the principle on which Police radar operates when they tell you that you were driving at forty mph when you swear blind that you were doing precisely twenty-eight.

Conversely, if the target is stationary and the radar is moving, the velocity of the vehicle carrying the radar can be determined.

For use as a practical aircraft velocity sensor, a narrow beam is radiated so it will hit the ground a short distance ahead. On reaching the ground the energy will be scattered in all directions, but some will be returned in the direction of the aircraft.

As the aircraft is approaching in the direction of the signal path, the Doppler effect will ensure that the frequency of the signal is increased and on the return journey the effect will again be apparent. On reception, this frequency difference is measured and an apparent velocity calculated, which, after further allowance for the angle of depression of the beam, the true aircraft velocity can be derived.

As, however, the angle at which the beam is radiated is a vital component of the calculation, it follows that the calculation can only be accurate during straight and level flight.

To compensate for errors caused by the attitude of the aircraft, a second beam is radiated aft at the same angle of depression. By comparing the frequency shifts on the forward and aft facing beams, any errors due to aircraft pitch can be eliminated.

This technique of transmitting both fore and aft beams is called a 'Janus' configuration after the Roman god of doorways who was reputed to be able to face in both directions at the same time.

Radiating beams fore and aft will provide an accurate determination of the aircraft's forward motion but will not make any allowance for drift due to crosswinds. This determination can be obtained by radiating a third beam at right angles to the others to determine drift. This, however, would suffer from the same problems due to aircraft attitude as a single forward beam.

This problem is often overcome by rotating the beam configuration so that two beams are radiated forward symmetrically about the centre line of the aircraft, with the third to one side towards the rear. The Doppler shift on each beam will obviously be a result of both forward movement and drift, but as the three beam directions are accurately known, the necessary calculations can easily be performed in the computer.

Some equipment radiates a fourth rearward beam, which, although not strictly necessary for the computations, provides the advantage of redundancy which permits automatic monitoring.

Doppler airborne radar equipment operates either in X band (8.8-9.8GHz) or in Ke band (13.25-13.40GHz). Surprisingly, very little transmitted power is necessary, with most equipment operating at levels in the order of 20 to 100mW.

Although three or four beams may be used, it is common to use a single transmitter-receiver which is time shared between the three beams.

For transmission and reception, modern equipment uses microstrip aerials mounted on the underside of the main transmitter-receiver assembly which, in turn, is mounted in the belly of the

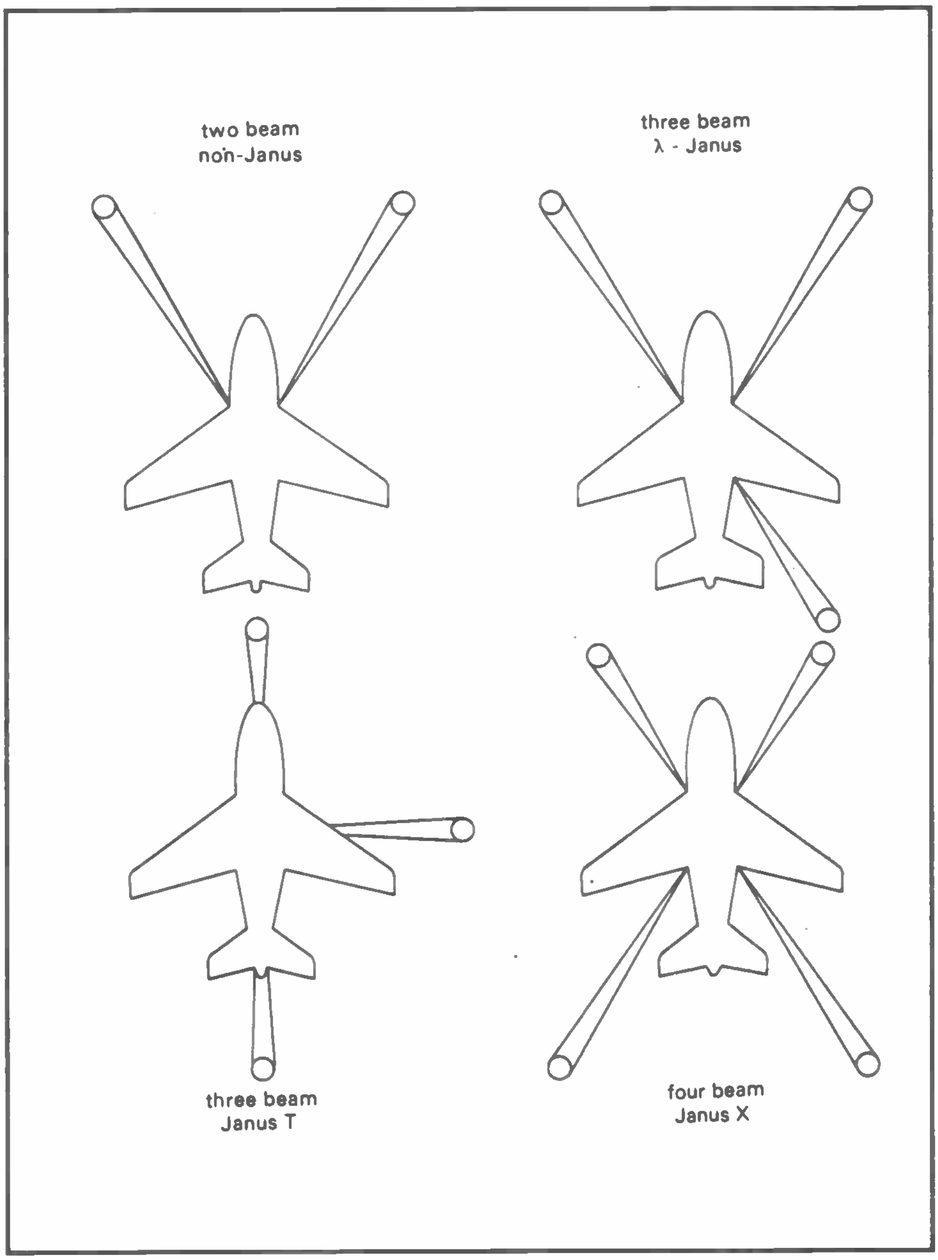



*Fig 6: Doppler radar beam configurations*

aircraft. Microwave switches in microstrip form produce switched three-beam configuration. The angle of depression of the beams is typically 67 degrees with a beamwidth of 5.5 degrees in the depression plane and 11 degrees broadside.

The accuracy of a Doppler radar navigation system is better than 0.5% in distance flown along track and within 0.5 degrees across track. These errors may be minimised, however, by updating the navigation computer from other, short distance aids, such as when overflying a VOR, etc.

**R-NAV**

Unlike all other systems described in this series, R-NAV is not a navigational aid with its own discrete sensors, but a computerised navigation management system accepting data from all available sources. These may include: DME, VOR, INS; Doppler, Omega, VLF, Loran or air data from the aircraft instruments.

As many of these aids are ground based, the database must hold positional information on all aids within the area of operation, from which a suitable selection may be made automatically. If a selected aid is not available, such as a DME being on the air for maintenance, an alternative selection is possible.

The aircraft position is computed from the available data which is displayed, together with the identification of the ground stations providing that information.

Prior to departure, if the flight plan is entered into the equipment, information such as: distance and/or time to next waypoint, crosstrack error, any necessary course corrections or even the necessary indicated air speed to ensure arrival at the next waypoint at a given time, may be displayed. The R-NAV equipment may also be interfaced with the aircraft's flight director system to automatically navigate the aircraft.

The accuracy of this system can be astounding as the author discovered a couple of years ago when he was invited to witness a demonstration of the Racal RNS 5000 equipment installed in the Racal Avionics Jetstream aircraft.

Taking off from the aircraft's home base at Biggin Hill, it was manually positioned to the west of London and the automatics were engaged. The aircraft then flew a predetermined triangular course some three hundred miles in length. It made use of about a dozen different DME beacons, positioning itself for a racetrack pattern around the Biggin Hill VOR with manual control being restored only for the final approach and landing.

Throughout the whole flight, the crosstrack error never exceeded 0.1 of a nautical mile (200 yards) and on the final approach the error was considerably less.

Typically, positional information on up to 5000 waypoints or navigational/aids together with 300 discrete routes may be stored within the navigation data bank of the system.

In operation, all necessary frequencies are automatically tuned. However, in the event of a total loss of data from ground based aids, and when air derived systems such as INS or Doppler are not available, the equipment will maintain a dead reckoning plot until data input is restored.

In addition to navigation functions, the R-NAV equipment may also provide assistance in fuel management by computing the present consumption, estimating fuel remaining at the destination, maintaining an engineering log and assisting in similar housekeeping duties.

In the last article in this series, I shall be describing the use of satellites for navigation, search and rescue and the system which will shortly be introduced that will enable passengers to telephone subscribers worldwide. REW

# SPECTRUM WATCH

by John Andrews

Radio Nova International, a satellite-delivered radio channel (as opposed to the Mediterranean 'pirate' of the same name), has started broadcasting English-language music programmes to a potential thirty million listeners in Europe. These lucky people are those who are connected to a TVRO or cable network, while the programmes are also being offered as a sustaining service, gratis, to small radio stations. It is supported financially by advertisements and is the brainchild of Chris Carey, one time owner of computer and satellite hobbyist shops and possibly better remembered as loonabout Spangles Muldoon on Radio Caroline.

Similar services are reportedly promised by the Branson group and Radio Luxembourg, whose name has been mentioned in connection with Radio Tara, a high-powered commercial station to be run jointly with state broadcaster RTE of Ireland.

### Pan-European paging announced

A European-wide paging service, with users being able to be paged in any country on the same 'bleeper', is now a reality following an agreement between six British paging companies and the French and German authorities. This Euro-page service, operating on 466MHz in the UHF band, is due to start next year, with Spain and Italy joining shortly after. The six British companies will share the work and cost of setting up transmitters to cover the UK.

### Private TV transmitter approved

The Department of Trade and Industry (DTI) has granted type approval to a television transmitter made by Microwave Modules Ltd of Liverpool. It transmits colour TV pictures and sound up to a distance of 5km, in the 22GHz waveband. The company says this is the first time that private organisations have been able to transmit TV pictures in the UK; the unit is intended for video surveillance operations, either rooftop or pole-mounted. A price is not quoted but it will probably sell for more than MM's 70cm ATV jobs!

### ... and more microwave television

Microwave TV as a substitute for (or forerunner to) cable TV has been mentioned several times in this column, and now the first British demonstration has been made of this technique. According to Marconi Communication Systems, at their presentation in Chelmsford, up to thirty channels could be provided to between 80 and 90% of the population at relatively moderate cost in this way.

The low-power transmitter shown operates in the 2.5GHz band and has a range of up to 30km. Receivers would sell for £50 or less (far cheaper than home satellite receivers), making microwave TV an attractive prospect. The only snag is that the 2.5GHz band is currently used for TV outside broadcast links and the broadcasters are highly unlikely to release the frequency to rival organisations. The Government is understood to be considering an interim trial of microwave TV for five years which, if it goes ahead, will almost certainly be on higher (and more expensive) frequencies. But watch this space . . .

### Europe's first

Meanwhile the Irish Department of Communications has invited applications for installing and operating what would be Europe's first multi-channel microwave TV network. Up to £250,000 is to be spent on acquiring and erecting transmitters. Eleven channels are to be provided and receivers will have to be able to cope with decoding scrambled signals. No doubt 'unofficial' models will also be sold!

The microwave network will carry a new commercial service to be set up along the lines of Channel Four in Britain. Programmes will be sourced from independent production companies and will be subject to the same legal constraints as the state-run RTE service.

### Aerial TV deflated

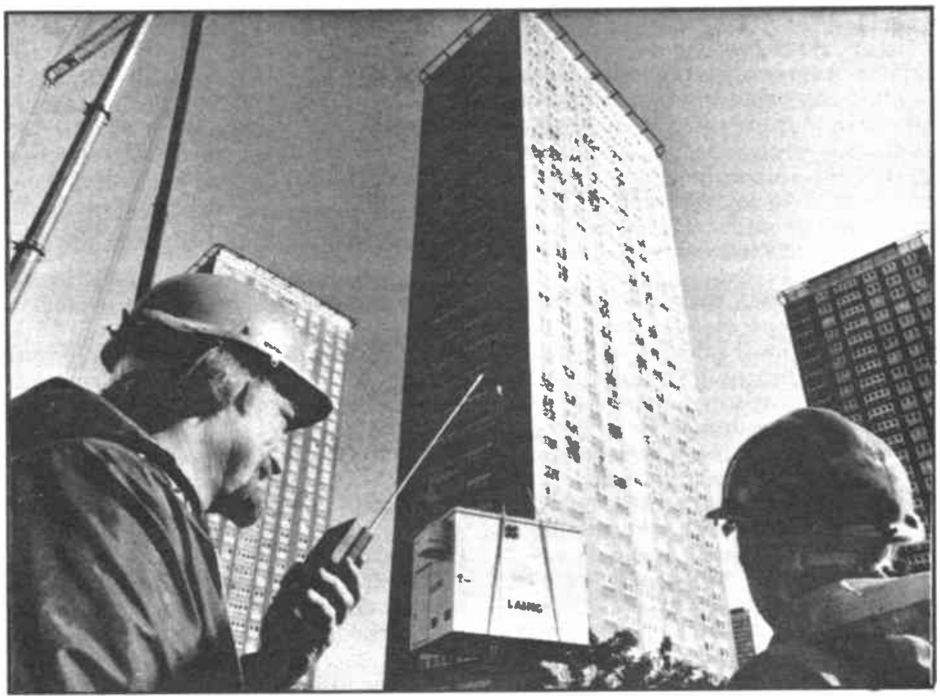
Over the years there have been several schemes to provide television broadcasting from the air – and I don't mean satellites. Shortly after the last war it was calculated that most of the USA could be provided with TV programming from circling Stratocruisers, and it is said that this technique was actually used for armed forces TV in Vietnam. Radio Caroline also intended doing this for their own vision service during the late 1960s but this scheme never left the ground.

In Nigeria a different proposal was developed – a large balloon known as an Aerostat. In 1977 the Nigerian Television Authority announced that six channels would be provided in this way. The equivalent of $41 million was spent on the project, which involved a balloon suspended 10,000 feet above the ground, before the idea was abandoned as a failure.

### More money aloft

If balloon TV is not to be, then airship-based radar stations are a reality. Following the loss of the *USS Stark* to an Iraqi Exocet missile, the United States Navy has awarded a long-delayed contract to develop airships as over-the-horizon radar platforms. Two contracts, totalling $168 million, for the development phase of these blimps have gone to a joint venture consortium of Baltimore-based Westinghouse Electric of the United States and our own Airship Industries of Britain. The contract will last five years and at least one craft is to be constructed.

*A 450 ton crane with long boom raises a Cellnet cellular radio base station 360 feet on to the roof of the David Naysmith Tower in Glasgow, the tallest block of flats in Europe. The result is a car telephone system which can make and receive calls to and from anywhere in the world*



# DATA FILE

## Ray Marston looks at solid-state power control devices in the second part of his mini-series on power control circuits

In last month's edition of Data File we opened this new Power Control mini-series by first looking at basic electrical/electronic power control principles and then at practical electro-mechanical power control devices such as switches, relays and reed relays. This month we continue the theme by surveying the available range of solid-state power control devices, briefly describing their main operating features and characteristics.

### Transistor devices

The simplest type of solid-state power control device is the discrete bipolar transistor. In most practical power control applications this device is used in the switching mode. *Figures 1a* and *1b* show how to use npn and pnp transistors as electronic switches. In the case of the npn transistor, the switch load is wired between supply positive and Q1 collector and in the case of the pnp device the load is wired between Q1 collector and the zero-volts rail. In both cases the switch driving signal is applied to Q1 base via R1, which has a typical resistance of about twenty times greater than the load resistance value.

In the npn circuit, Q1 is cut off (acting like an open switch) with zero driving signal applied; under this condition its output (collector) voltage equals the positive supply voltage value. Q1 can be driven to saturation, so that it acts like a closed switch and passes current from collector to emitter, by applying a large positive input driving voltage. Under this condition, the output equals the saturation voltage value of the transistor (typically 200mV to 600mV).

The action of the pnp circuit (*Figure 1b*) is the reverse of that described above and the transistor is driven to saturation (with its output a few hundred mV below the supply voltage value) and passes current from the emitter to collector with zero input drive voltage applied. This is cut off (with its output at zero volts) when the input equals the positive supply rail value.

A useful variation of the transistor switch is the optocoupler, which comprises an infra-red LED (Light-Emitting Diode) and a matching photo-transistor, mounted close together (optically coupled) within a light-excluding package, as shown in the basic application circuit of *Figure 2*. Here, when SW1 is open, zero current flows through the LED, so Q1 is in darkness and passes zero current (it acts like an open switch). Zero output voltage appears across R2. When SW1 is closed the current flows through the LED via R1, illuminating Q1 and causing it to act like a closed switch generating an R2 output voltage. The R2 output voltage can be controlled via the R1 input current, even though R1 and R2 are fully isolated electrically. In practice, the device can be used to optocouple either digital (switching) or analogue signals, providing many hundreds of volts of isolation between the input and output circuits.

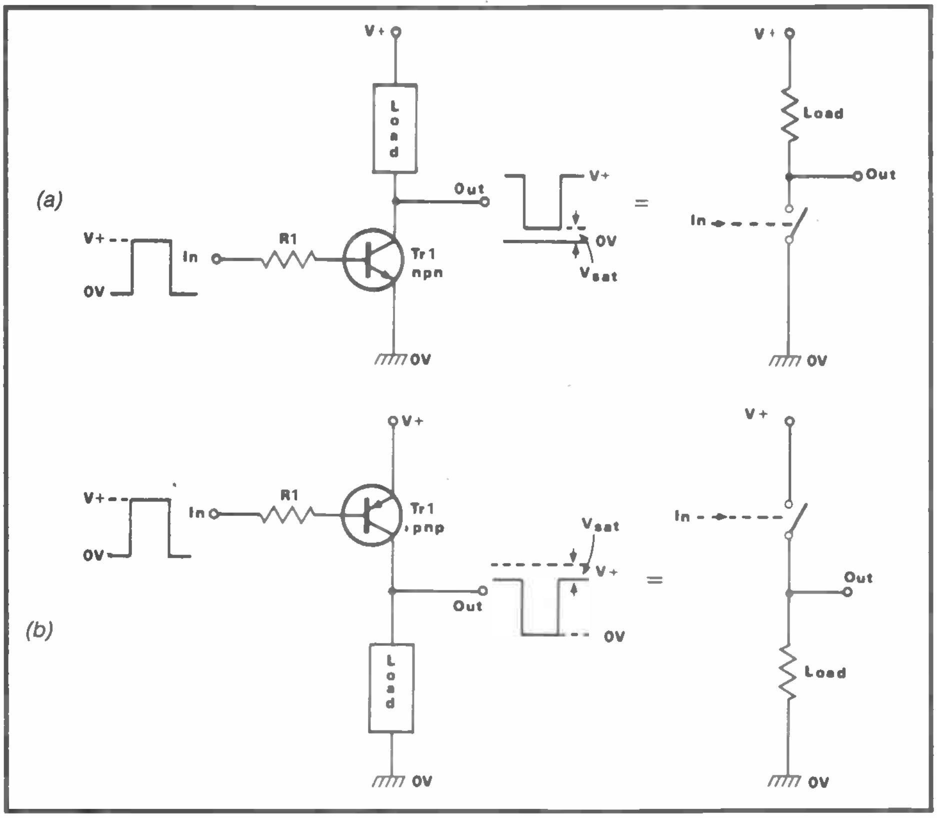



**Fig 1(a):** *Bipolar npn transistor switch circuit,* **(b)** *bipolar pnp transistor switch circuit*

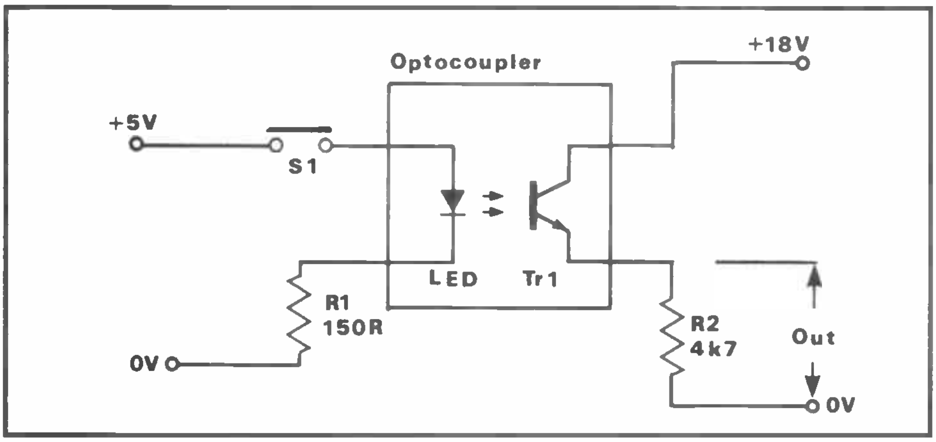



**Fig 2:** *Basic optocoupler switching circuit*

### FET devices

Field-Effect Transistors are 3-terminal voltage-controlled current generators that present a near-infinite impedance on their input or gate terminal. They are available in two basic versions, giving either an 'enhancement' or a 'depletion' mode of operation. Enhancement mode devices pass zero current when the gate voltage is zero and the current rises (is enhanced) when the gate is forward biased. Depletion mode devices give the reverse of this action. They pass a maximum current when the gate voltage is zero and the current falls (depletes) when the gate is forward biased. In the remainder of this article we will consider enhancement mode FETs only.

FETs are available under a variety of exotic names that relate to details of

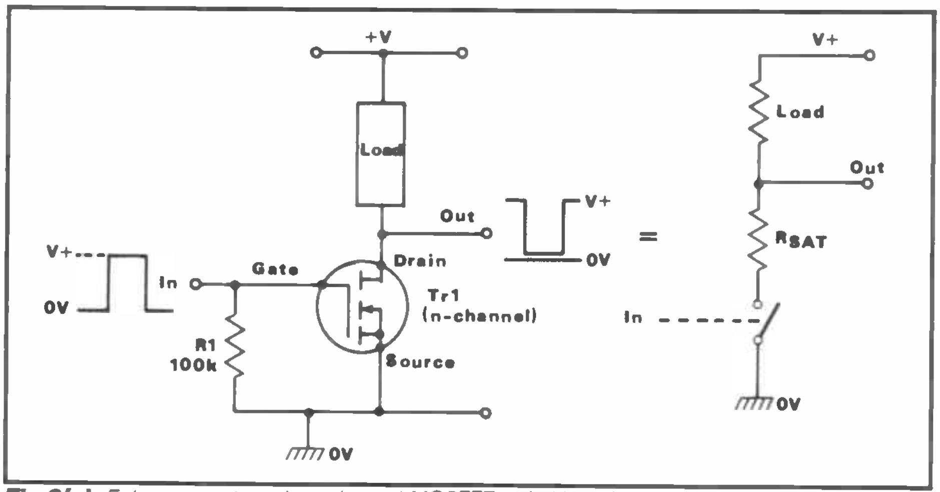



*Fig 3(a):* Enhancement-mode n-channel MOSFET switching circuit

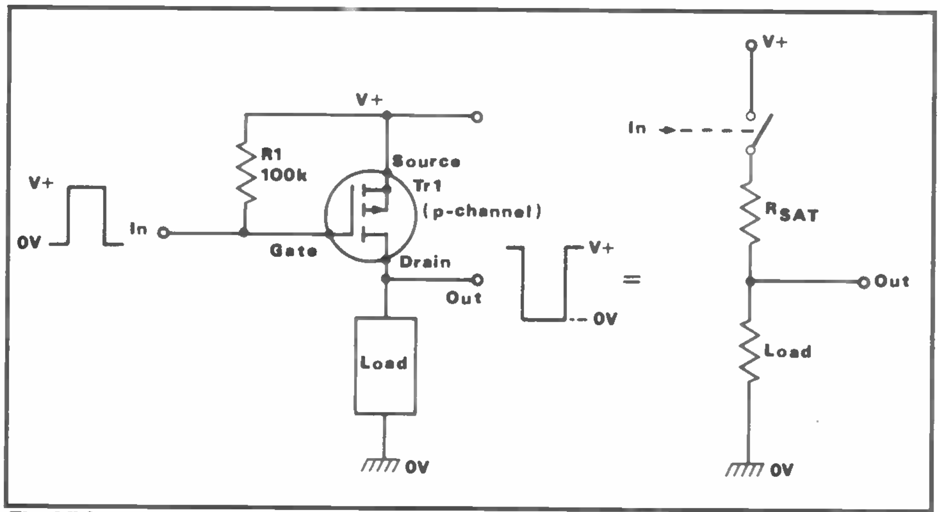



*Fig 3(b):* Enhancement-mode p-channel MOSFET switching circuit

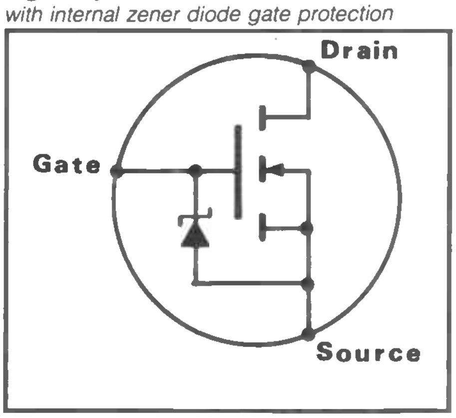
their construction. Names such as IGFET (Insulated Gate FET) and MOSFET (Metal Oxide Silicon FET) are widely used amongst low-power devices, while names like VMOS, HMOS and HEXFET are common among high-power devices.

FETs are available in two basic types, being either n-channel or p-channel types, which are analogous to npn and pnp transistors respectively. *Figures 3a* and *3b* show how to use n-channel and p-channel enhancement-mode MOSFETs as simple electronic switches. In the case of the n-channel device, the MOSFET acts like an open switch when the gate voltage is zero and like a closed switch (in series with a saturation resistance) which passes current from drain to source when the gate is at the positive supply rail value. The p-channel circuit gives the reverse of this action, acting like a closed switch (plus saturation resistance) which passes current from source to drain when the gate voltage is zero and as an open switch when the gate is at the positive supply rail value.

Note that the closed switch saturation resistance of a MOSFET may vary from a few hundred ohms in a low-power device to a fraction of an ohm in a high-power device. This gives a voltage-divider action with the load resistor which determines the closed-state output voltage of the circuit. Thus, if the *Figure 3a* circuit has a 10V supply and a 900 ohm load, it will give a closed output of 1V at an $R_{sat}$ value of 100 ohms, or 10mV at an $R_{sat}$ value of 0.9 ohms.

Also note that the gate terminal of a

*Fig 4:* Symbol of MOSFET n-channel device with internal zener diode gate protection




MOSFET device presents a near-infinite input resistance. If the terminal is allowed to 'float' the device can easily be damaged by accumulated electrostatic charges. Some MOSFETs have a built-in zener diode to give some degree of protection against this danger (see *Figure 4*).

## Basic CMOS switch

One of the most important of all digital IC families is the CMOS. This entire family is based on the simple Complementary MOSFET digital inverter circuit, shown in *Figure 5*. This circuit comprises nothing more than a p-channel and an n-channel enhancement-mode MOSFET wired in series between the two supply lines, with the MOSFET gates tied together at the input terminal and the output taken from the junction of the two devices. In use, the input is at either zero volts (logic-0) or full positive supply rail voltage (logic-1).

*Figure 6a* shows the digital equivalent of the above circuit with a logic-0 input. Under this condition, Q1 acts like a closed switch in series with an $R_{sat}$ resistance of 400Ω and Q2 acts as an open switch. The circuit draws zero quiescent current but can source fairly large drive currents into an external output-to-ground load via the 400Ω output resistance (R1) of the inverter.

*Figure 6b* shows the equivalent of the inverter circuit with a logic-1 input. In this case, Q1 acts like an open switch but Q2 acts like a closed switch in series with an $R_{sat}$ of 400Ω. This circuit draws zero quiescent current, but can sink fairly large currents via an external supply-to-output load via its internal 400Ω output resistance (R2).

The basic CMOS digital inverter stage has a near-infinite input impedance which draws near-zero (typically 0.01 uA) quiescent current with a logic-0 or logic-1 input. This can source or sink substantial output currents, having an output that is made inherently short-circuit proof via the 400Ω output impedance of the device. It gives an excellent low-power switching action.

## CMOS bilateral switches

One very important member of the CMOS family is the so-called bilateral switch or transmission gate, which is shown in basic form in *Figure 7a* and in symbolic form in *Figure 7b*. The importance of this device is that (just like an ordinary mechanical switch or set of relay contacts) it can conduct current in either direction (bilaterally), whereas an ordinary transistor or FET switch can conduct current in one direction only (from collector or emitter in the case of an npn device, or from emitter to collector in a pnp device).

The operation of the *Figure 7a* circuit is fairly simple. The device comprises an n-channel and a p-channel MOSFET wired in inverse parallel (drain-to-source and source-to-drain), but with their gate signals applied in anti-phase via a pair of CMOS inverter stages to give the bilateral switching action. Thus when the control signal is at the logic-0 level, the gate of Q2 is driven to logic-1 and the gate of Q1 is driven to logic-0. Under this condition both MOSFETs act as open switches between the X and Y points of the circuit. When, on the other hand, the control signal is set at the logic-1 level, the gate of Q2 is driven to logic-0 and the gate of Q1 is driven to logic-1. As a result of this, both MOSFETs act as closed switches and a low resistance (equal to the $R_{SAT}$ value exists between the X and Y points of the circuit.

When the control input is at logic-1, signal currents can flow in either direction between the X and Y terminals (via Q1 in one direction, or Q2 in the other), provided that the signal voltages are between the two logic-level voltage limits. Each of the X and Y terminals can be used as either an IN or OUT terminal.

Practical CMOS bilateral switch circuits are usually a bit more complex than shown in *Figure 7*, giving typical ON resistances of only 100Ω or so. All these types of practical CMOS ICs house several bilateral switches. The 4016B and 4066B ICs, for example, each house four such switches configured as independent SPST switches (see *Figure 8*). The 4051B acts as a single-pole eight-way bilateral switch (see *Figure 9*).

### SCR basics

All of the solid-state power control devices that we have looked at so far, are intended for use with low to medium voltage dc supplies. SCRs and Triacs, by contrast, are solid-state power control devices that are intended for use with medium to high voltage ac supplies. *Figure 10* shows the symbol and basic 'power switch' application circuit of an SCR, or Silicon Controlled Rectifier. Note in this and other circuits that follow, that alternative component values are given for use with 120V and 240V power lines, the 240V values being noted in parentheses.

The SCR can (as implied by its name and symbol) be regarded as a 3-terminal silicon rectifier that can be controlled via its gate terminal. Normally, it acts as an open switch, but if its anode is positive (relative to its cathode) it can be made to switch on and act like a forward biased rectifier by applying a modest input 'trigger' current to its gate terminal. If the resulting anode-to-cathode current exceeds a minimum 'holding' value (typically a few mA) the SCR will then self-latch into the ON state and will remain there until the anode-to-cathode current falls below the minimum holding value. At this point, the SCR automatically switches back to the open-switch state.

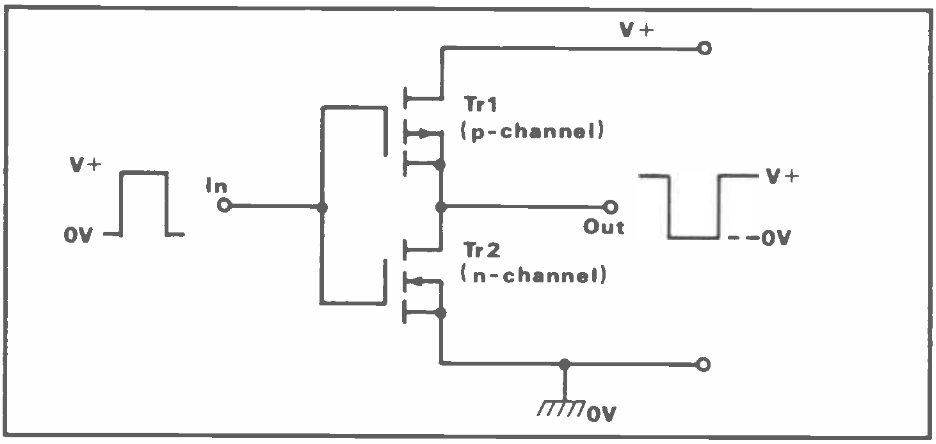



**Fig 5:** *Basic CMOS digital inverter circuit*

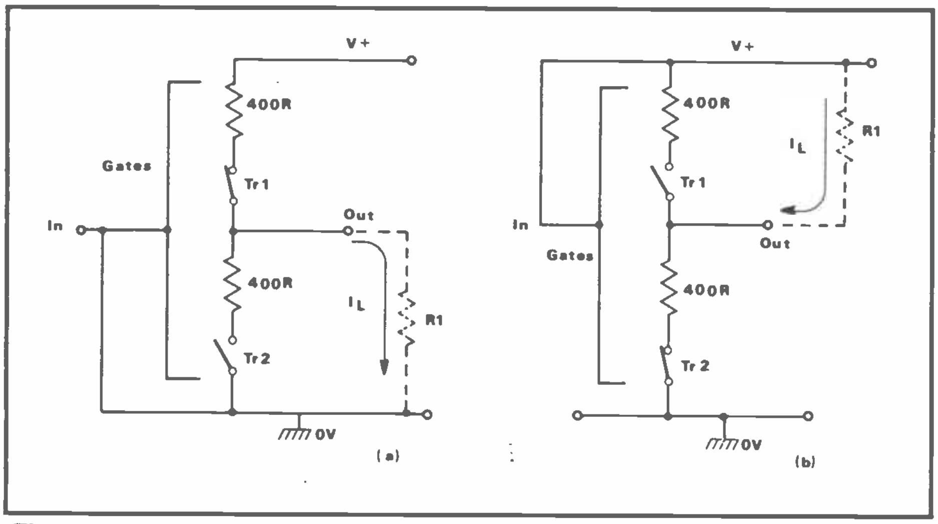



**Fig 6:** *Equivalent circuits of the CMOS digital inverter with* **(a)** *logic-0 and* **(b)** *logic-1 inputs*

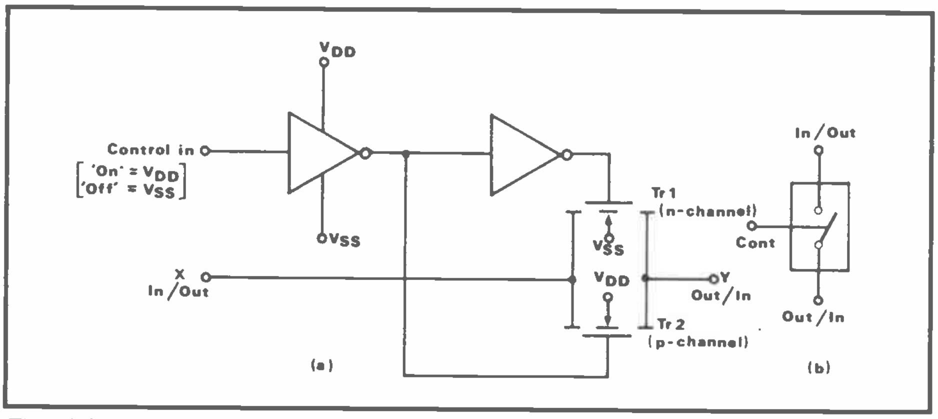



**Fig 7(a):** *Basic circuit and* **(b)** *symbol of simple CMOS bilateral switch or transmission gate*

The *Figure 10* circuit acts as follows. The ac power line signal is full-wave rectified via D1-D4 and converted into a waveform that rises from zero to maximum and then drops back to zero again in each ac half-cycle and is applied to the SCR anode via lamp-load LP1. If the S1 switch is open, zero gate drive is applied to the SCR. When this happens, the SCR acts like an open switch and the lamp is off. If S1 is closed, however, gate drive is applied to the SCR via R1-R2 (just after the start of each half-cycle), causing the SCR to turn on and self-latch until the end of the half-cycle. At this point, it automatically turns off again as its forward current falls below the minimum holding value. This process repeats itself in each half-cycle and, thus, the lamp operates at almost full power.

Note in the above circuit that the SCR anode voltage drops to only a few

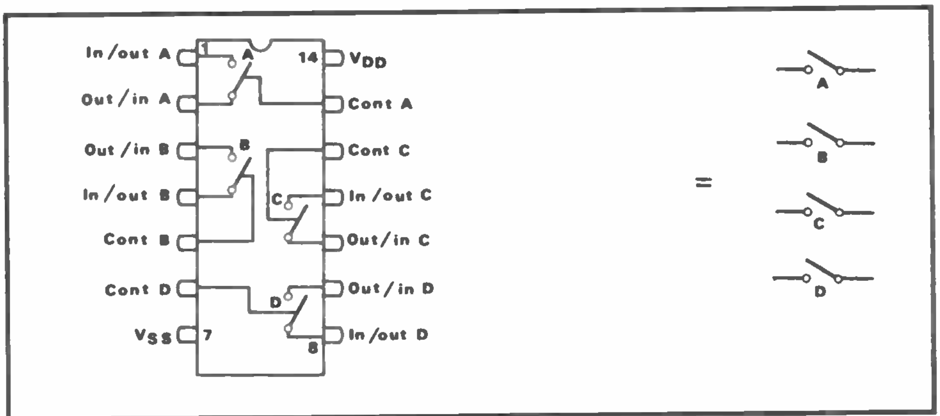



**Fig 8:** *The 4016B and 4066B quad bilateral switches each act as four independent SPST switches*

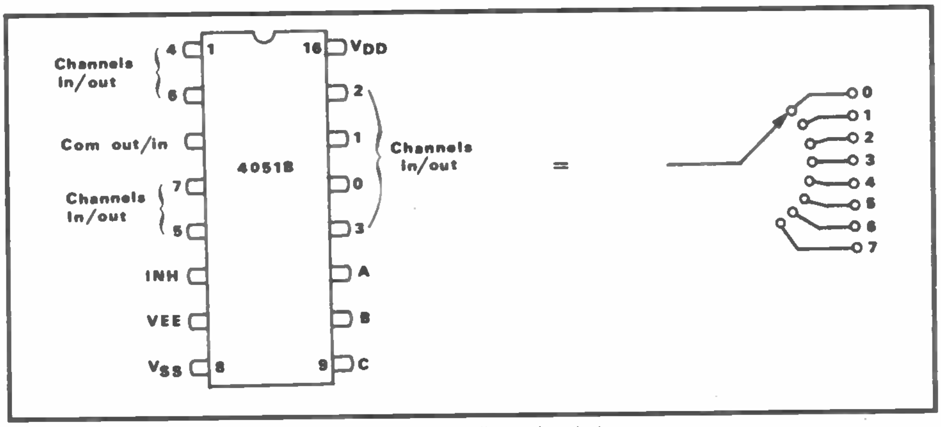



**Fig 9:** *The 4051B acts as a single-pole 8-way bilateral switch*

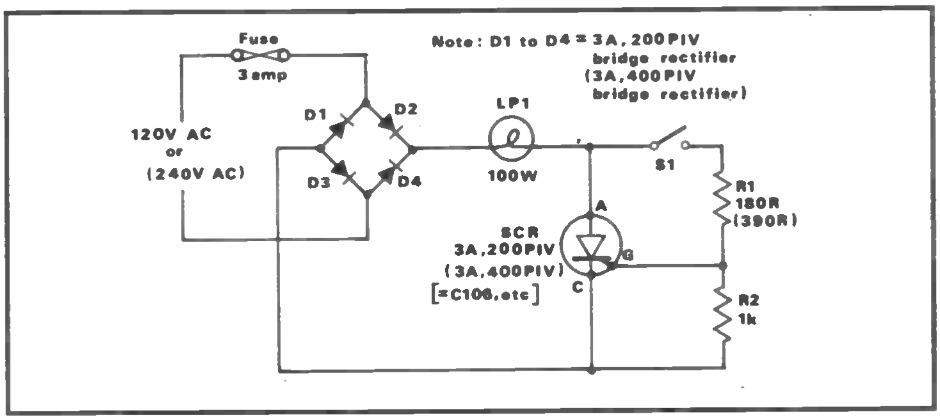



**Fig 10:** *Full-wave ON/OFF SCR circuit with dc power load*

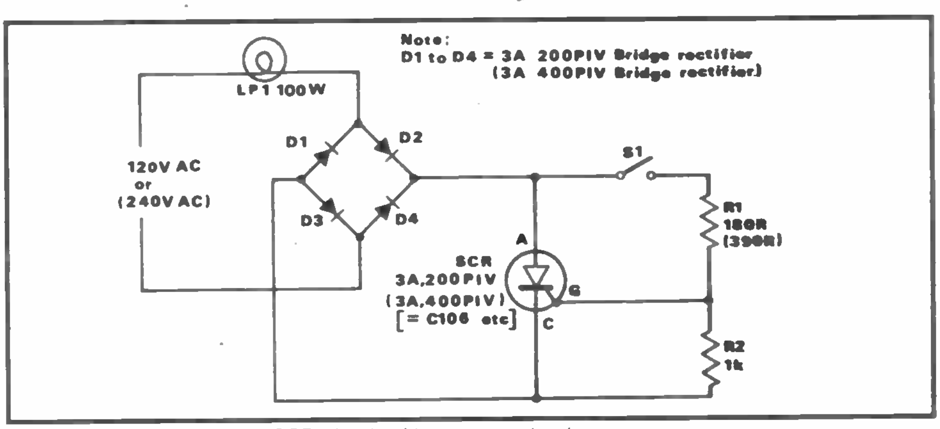



**Fig 11:** *Full-wave ON/OFF SCR circuit with ac power load*

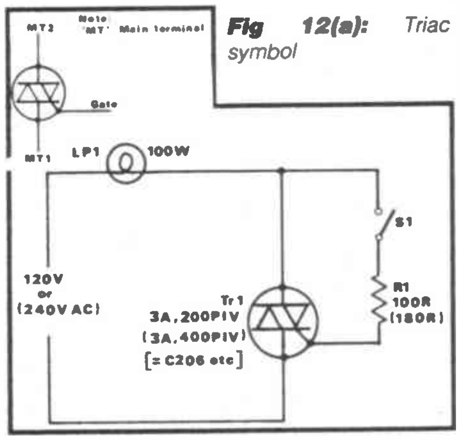



**Fig 12(a):** *Triac symbol*

**Fig 12(b):** *Simple Triac ac power switch circuit*

hundred mV as soon as the SCR turns on, so S1 and R1-R2 consume very little mean power, but S1 can be used (via the SCR) to control very large power loads. Also note that the lamp load is shown placed on the dc side of the bridge rectifier; this circuit is shown for use with dc loads. However, the circuit can be modified for use with ac loads by simply placing the load on the ac side of the bridge (see *Figure 11*).

## Triac basics

The SCR can only conduct current from anode to cathode; a Triac, on the other hand, is a device that can conduct current in either direction between its two main terminals (MT1 and MT2). It can thus be used to directly control ac power. *Figure 12a* shows the standard symbol of the Triac, while *Figure 12b* shows how it can be used as a simple ac power switch that can be used to replace the *Figure 11* SCR-based design.

The Triac can, for most practical purposes, be simply regarded as a pair of SCRs wired in inverse parallel (so that they can conduct MT2 currents in either direction) and sharing a common gate terminal. The device's action can be triggered by either positive or negative gate currents, irrespective of the polarity of the MT2 current. It has four possible triggering modes or 'quadrants'. The trigger current sensitivity is greatest when the MT2 and gate currents are both of the same polarity (either both positive or both negative) and is about half as great when they are of opposite polarity.

The operation of the *Figure 12b* circuit is quite simple. When S1 is open, the Triac acts like an open switch and the lamp passes zero current, but when S1 is closed the Triac is gated on via R1 and self-latches shortly after the start of each half-cycle, thus switching full power to the lamp load.

Finally, note that SCRs and Triacs can be used to apply variable power to dc or ac loads by using either the burst-fire or the phase-triggered techniques described last month. We'll show you how in next month's edition of Data File. R&EW

# DX-TV RECEPTION REPORTS

**Compiled by Keith Hamer and Garry Smith**

An accurate way to sum up long-distance television reception conditions throughout June would be to call them 'mega-spectacular'! Sporadic E DX reigned supreme between Saturday 4th and Tuesday 7th creating extremely high MUFS and signals from almost everywhere. Needless to say Band I was, at times, so choc-a-bloc that indentification was a formidable task. DX-TV records were broken during that particular period when transatlantic signals were noted as high as 80MHz. Much higher MUFS were encountered from the African continent when sustained Band III sporadic E reception occurred from at least three countries on the north coast.

All the old favourites such as Italy, Russia and Spain were frequently received throughout the month often at extremely high signal levels. Iceland has been a regular visitor so far but Portugal seems to be suffering from severe shyness this season!

Tropospheric reception between the 10th and 20th held a few surprises too, as we will see later. Without a doubt a good month for newcomers to the hobby with lots of prolonged openings and a variety of things to see. Although we've said it before about other spectacular months, June 1988 must rate as the best so far and deserves a place in DX-TV history. Hopefully history will repeat itself!

### DX-TV log for June

This month, a bumper crop of reception reports has arrived indicating that exotics have been received all over the UK. As a consequence, we have attempted to produce a combined log featuring the highlights of the month. Some of these, for instance the Italian private transmitters, are perhaps more of a novelty rather than rare examples of reception. The same applies to the low-power Greek transmitter on channel E3. So, if you are a newcomer to DX-TV and you haven't logged any of the following don't be too discouraged – exotics will eventually come your way. Experience will allow you to recognise the more unusual openings which produce exotics.

Our thanks to the following enthusiasts for sending log reports: Mark Dent (MD), Kevin Jackson (KJ), Paul Davies (PD) – all of Leeds; Gösta van der Linden (GvL), Netherlands; Garry Smith (GS), Keith Hamer (KH) – both Derby; Simon Hamer (SH), New Radnor; Bob Brooks (BB), South Wirral; Bertrand Prince (BP), France; Marc Vissers (MV), Belgium; Vince Richardson (VR), Conwy; David Glenday (DG), Arbroath; Chris Howles (CH), Lichfield.

The combined log should be reasonably self-explanatory. The contributor's initials have also been included.

**01/06/88:**
Arabic preaching on E4 at 2306 – Morocco or Tunisia? (MV).

**03/06/88:**
Unidentified E3 Arab woman newsreader at 1920 (SH).
EPT (Greece) E3 with subtitle programme (SH).
Unidentified IA 'TELE NOVA' caption at 1920 (SH).
RTS (Albania) IC (SH).
DDR: F1 (East Germany) E4 – it's still on air! (SH).
TELEMARKET E2 – Italian private station on programmes at 1944 (MD).

**04/06/88:**
Unid FuBK E3 with clock or writing below at 0745 (GS).
EPT E3 'EPT' PM5534 floating with above (GS).
TELEMARKET E2 – Italian private station on programmes at 0911 (MD).

**05/06/88:**
TSS (Russia) R1, R2, R3, R4 and R5 (SH).
RTS (Albania) IC (SH).
TELEMARKET E2 – Italian private station (SH).
TELE UNO IA – Italian private station on caption at 1110 (CH).
Unid E2 GTE test card from south-east 0945-1020 (CH).
Unid vertical stripes pattern on R1 at 0715 (BP).
RUV (Iceland) E2 'RUV ISLAND' PM5544 at 1220 (SH).
Band III SpE- RUV E6 and E7 at 1220 (SH).

**06/06/88:**
JTV (Jordan) E3 'JTV SUWEILEH' PM5534 (BB).
Unid vertical stripes pattern on R1 at 1110 (BP).
TSS R2 with clock at 1759 showing +6h (BB).
Unid Arabic programme E3 at 1845 (GS).
WTKR A3 (CBS Norfolk, Virginia) programmes 2258-0156 (MD, PD).
WWAY A3 (ABC Wilmington, N Carolina) programmes 2258-0156 (MD).
Unid CBS A2 (–10kHz offset) possibly WFMY-TV N Carolina (MD, PD).
Unit ABC A2 (+10kHz offset) possibly WCBD-TV S Carolina (MD, PD).
CJCN-TV (Grand Falls, Newfoundland) A4 programmes 2230-0115 (CH, GS, KH).
Unid 525-line programmes A2, A3 and A4 (BB, SH, GS, KH).
Unid 525-line pictures Ch A5 (R3) (GS).

**07/06/88:**
PM5544 E2 without identification at 0727 (VR).
FuBK E3 with 'BRUDD PROGRAMME 1' (?) identification at 1045 (VR).
Unidentified A2 and A3 programmes at 0831 (MD).
Band III SpE
RTA (Algeria) E5 (M Cid) programmes 1310-1430 (KJ, GS, CH).
RTA (Algeria) E7 (Constantine) programmes 1310-1325 (GS).
RTT (Tunisia) E6 with FuBK at 1320 approximately (GS).
Libya E6 (20kW Tripoli Tx) FuBK + clock at 1324 approximately (GS).
RTS (Albania) IC with the PM5534 test pattern at 1600 (CH).

**08/06/88:**
EPT (Greece) E3 on 'EPT' PM5534 at 0803 (KJ).
SRT (Syria) E3 with 'ORTAS DAMAS' PM5534 (SH).

**10/06/88:**
Unidentified E3 Koran reader with logo top right at 1450 (GvL).
AFN TV Soesterberg A80 at 2111 - tropospherics (MD, CH, SH, KJ).

**12/06/88:**
'DR, DANMARK' PM5534 on new E30 channel (Vejle) at 2250 (DG).
AFN TV Soesterberg A80 at 2300 - tropospherics (DG).

**14/06/88:**
DBP Düsseldorf-Burscheid Tx on E36 (SAT-1 relay?) – tropospherics (MD, KJ, GS).
WDR-1 (West Germany) E8 of FuBK at 0807 – tropospherics (MD, GS, CH).
AFN TV Soesterberg A80 at 0825 – tropospherics (MD, KJ).
DR E31 and TV2 E53 – new Danish transmitters at Copenhagen (MV).

**21/06/88:**
TELE UNO IA test pattern at 1451 (MD, VR).

**22/06/88:**
TELE RADIO ERCOLANO caption E2 (Unid Italian station) (GS).

**25/06/88:**
Unidentified USA/Canadian Tx A2 at 2315 (MD, SH).
Unidentified USA/Canadian Tx A3 at 2335 (MD, SH).
Unidentified USA/Canadian Tx A4 towards midnight (SH).
Arabic programme on E4 at 1700 (MV).

**28/06/88:**
RTBF-1 E3 PM5544 via SpE at 1528 (MD).
Arabic programme on E4 at 1830 (MV).

### Mystery test cards

On June 4th a weak FuBK with a clock or white lettering below was alternating with the Greek PM5534 test card on E3 at 0745. Unfortunately, the Greek PM5534 won the battle before further clues could be obtained.

The Spanish-type GTE test pattern was resolved from 0945-1015 on June 5th by

Chris Howles from a south-easterly direction on channel E2. Sporadic E signals can arrive from a different direction to their true one. It is most likely to be TVE-2 but could there be a more interesting explanation?

On June 7th at 1045, during an opening to Scandinavia, Vince Richardson noticed an FuBK with an identification resembling 'BRUDD PROGRAMME 1'. Earlier, on E2 at 0727, Vince saw a PM5544 without any form of identification. This sounds like Sweden before switching over to the 'KANAL 1 SVERIGE' pattern.

### Greater distance

Several DXers used scanners to monitor the various sound channels. On A3, Mark Dent and Paul Davies heard the callsign of WTKR-TV (CBS network) in Norfolk, Virginia and WWAY (ABC) A3 from Wilmington in North Carolina. Paul also heard the weather forecast for South Carolina on A2 from the WCBD-TV outlet of the ABC network. On A3 there was a reference to 'News 3' and local events in Georgia – possibly WRBL-TV (CBS) Columbus or WSAV-TV (NBC) Savannah. Paul is certain that other A2 signals originated from WSB-TV (NBC) Atlanta, Georgia; WCBD-TV (ABC) Charleston, South Carolina or WFMY-TV (CBS) Greensboro, North Carolina.

In some cases the stations could be identified by their offset frequencies which, in the USA, are zero, −10kHz or +10kHz. Fortunately Paul had access to a list of offset frequencies for the various transmitters.

Reception continued until well into the early hours but, according to the logs, most of us switched off around 0100 as the signals weakened.

Whether the opening continued throughout the night we can't be sure but the following morning at 0830, Mark Dent noted weak 525-line signals on channels A2 and A3.

### Middle East reception

On June 6th, Bob Brooks of South Wirral resolved the 'JTV SUWEILEH' PM5534 test pattern from Jordan while on the 8th, Simon Hamer logged the Syrian PM5534 displaying 'ORTAS DAMAS' identification in the lower black block. Gösta van der Linden of Rotterdam queries a striped logo forming a quadrant seen in the top right-hand corner of the picture on two separate occasions on E3. It was first seen on May 30th at 1930 with a second sighting on June 10th at 1450 accompanying an Arab reading the Koran. The logo he sketched looks similar to that of Egypt. Unidentified Arabic signals on E4 were picked up several times by Marc Vissers of Belgium. On June 1st signals were seen towards midnight which suggests that these were from the south rather than the Middle East.

Another mystery occurred at 1759 on June 6th when Bob Brooks saw the Russian clock caption six hours ahead on channel R2. On R1 it showed the usual three hours' difference.

### Reception reports

A tropospheric lift between June 10th and 20th provided a little relief (!) from the exotics in Band I. Even so, a variety of unusual signals managed to creep into Band III and UHF.

David Glenday (Arbroath) saw the 'DR DANMARK' PM5534 from the new UHF outlet at Vejle on channel E30 at 2250 on June 12th while Marc Vissers noted the new Copenhagen DR (E31) and TV2 (E53) transmitters on PM5534 test pattern on the 14th.

The American Forces Network at Soesterberg in the Netherlands on A80 (E71/72) was seen over a wide area of the UK between the 10th and 14th. David Glenday, Chris Howles, Simon Hamer, Kevin Jackson and Mark Dent were all lucky enough to see it.

### Highlights

Other tropospheric highlights included Sender Freies Berlin on E7 (SFB-1) and E39 (SFB-3), Switzerland (+PTT TSI) E34 and the SAT-1 relay on E36 from Düsseldorf.

There were a few reports of a 'WDR-1' FuBK on channel E8 early on June 14th. According to Mark Dent, the only WDR-1 outlet on E8 is Ibbenbueren (1kW) but we noted the 'WDR-1 Mü 32' FuBK on this channel. Obviously this was a switching error because this identification originates from the Münster E32 outlet. An FuBK of similar strength was later seen carrying 'hrl' identification.

### Band III sporadic E spectacular

A more sustained and dramatic example of Band III sporadic E occurred on the 7th from at least three neighbouring countries on the north coast of Africa. The opening lasted for about 90 minutes. The build-up was particularly interesting.

Due to the absence of French TV signals Chris Howles became suspicious of French FM stations on 89.6, 92.0, 93.0, 93.9, 98.2, 99.2, 99.50 and 101.8MHz. Selective fading was considered at first but all became clear when the stations were identified as Tunisia.

Examining Band III revealed an Arabic programme on E5. There was only a very noisy signal when monitored in Derby but a strong signal was located on channel E7 with Arabic sound. At 1320 on E6 the Tunisian FuBK test card with tone gradually emerged but soon faded. However, the Libyan FuBK rapidly appeared with a digital clock below accompanied by music! A process of elimination soon suggested that the E7 signal was RTA Algeria from the Constantine outlet. The E5 signal had by now increased in strength but the E6 and E7 signals soon deteriorated.

On E5 there were various news items including live coverage of the Syrian President arriving in Algeria. A circular logo was regularly shown, the centre of which depicted the shape of all the united north African countries. The same logo was also incorporated in the top right of the news reports and seemed to imply some form of programme link-up between the Arab countries.

### African mystery

The E5 signal is thought to have originated from the Algerian M Cid transmitter which is situated close to the Tunisian border. At times the same programme was detected roughly halfway between E5 and E6. This corresponds to Moroccan channel M6. However, the fading on this channel was not in sympathy with E5. Despite frequent attempts, no activity could be resolved on M4 and M5 which might have cleared up the mystery. Unfortunately, colour could not be resolved on E5 – a pity really since Algeria uses PAL and Morocco uses SECAM.

A further mystery is evidence of a co-channel signal on E5 during part of the news report. This wasn't noticed until a video recording was later scrutinised.

### Italian private stations

Quite a few private stations have been spotted this season, usually on channels E2 and IA. Although on-screen signature is included throughout the transmissions, this is still causing problems with identification.

At times, Tele Uno (formerly Radio-Tele-Uno) is relaying programmes from the Canale 5 network which accounts for the '5' logo. The word 'TELE' in tiny lettering has also been seen above a large on-screen '5' logo on channel IA recently. Could this be from the same network?

Similarly TELEMARKET, which usually broadcasts just below E2, sometimes relays Super Channel programmes with 'SUPER' as the on-screen logo. The American CNN news is also shown.

A new station called Tele Ercolano uses channel E2. A caption 'TELE RADIO ERCOLANO' is mostly shown and sometimes a message and telephone number are included below, such as 'Tele Ercolano buona domenica con Carlo e Lind Tel 739 4028'. There are reports of a 'Canale 3 Tele Ercolano' caption – obviously the wrong channel number!

A 'Tele Nova' caption has also been spotted on channel IA. Perhaps this simply implies it is a new channel or it could be a relay of Tele Nova which used channel E21 in the Milan area. So, watch out for the PM5534!

Finally, has the Italian Breakfast TV programme 'Uno Mattina' been abandoned? The 'RAI-1' PM5544 has been received regularly around 0800. REW

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# MEDIUM WAVE DXING

by Steve Whitt

This month it seems that the radio world is conducting a major exercise in self-publicity since two significant radio shows will be with us very shortly.

### Show time

Twenty-first birthday parties are always special but this autumn the BBC is planning a special party to celebrate the coming of age of the national radio networks and BBC local radio. The party which is open to the public, will be staged at Earl's Court in London from 1st till 9th October. During this time Earl's Court will become virtually a second Broadcasting House as many programmes switch from their normal studios to the complex outside broadcast facilities at the *BBC Radio Show*.

The show is being staged by BBC Enterprises and is aimed at providing fun for all the family. There will be exhibits depicting the story of radio, the latest in hi-fi and radio technology, and many aspects of music and radio. Two working studios will be used for live programming; one exclusively for Radio 4 and the World Service, the other reserved for local stations. In fact 32 BBC local stations will be producing more than 100 hours of programming direct from Earl's Court, including the newest station to take to the air, BBC Radio Gloucestershire. A complete sound theatre has even been constructed seating 450 people specially for live programmes such as *Any Questions* and *Gardeners' Question Time*.

The show is unique, dealing as it does with radio only, and the DXer has not been forgotten since the European DX Council will have a stand at the show promoting all aspects of the radio listening hobby. They are anticipating 100,000 visitors over the nine days and are preparing publicity material to introduce the hobby to the casual radio listener.

For more information (there is a glossy 12 page booklet available) contact the organisers before 27th September at: BBC Radio Show, PO Box 100, Chatham, Kent ME5 8LJ. Tickets can be ordered in advance provided orders are received by 16th September; otherwise entry at the door on the day is possible. Further instant information will be available on *Ceefax* page 297 and by phone on the Radio Show Hotline (0898) 654318.

In a similar vein, don't forget the Communicate 88 Convention being held soon. If you're interested in offshore/independent radio then this show is for you. It is a free radio convention being held on 24th September in the Spanish Hall at the Wintergardens in Blackpool. There will be numerous stands and exhibits on show and many personalities from the free radio world past and present will be on hand. This date coincides with the Blackpool illuminations so accommodation in the town for this event might be difficult to find at this late stage. I'm led to believe that the cost will be about £10. If this interests you, more information is available if you send an SAE to: Anoraks-UK, PO Box 539, Blackpool FY1 4RE, or since time is short call Anoraks during office hours at (0253) 882017.

### Club news

Recently the Medium Wave Circle has been publicising the fact that their publication *Medium Wave News* has been revamped. As regular readers will know, the Medium Wave Circle has been mentioned in this column before because it is the only UK based specialist radio club for medium (and long) wave enthusiasts. Now in its 33rd year, the club newsletter has been substantially expanded and now is published in an A5 style pamphlet. From just eight pages per issue in 1987, it now boasts a total of 20 pages per issue devoted to news, loggings and feature articles. In the August issue, for example, it included articles on summertime, a MW loop project, and a complete list of all North American stations logged in the past year.

According to the Circle, membership subscription rates have not been increased despite the greater number of pages. The club offers a free sample copy of *Medium Wave News* to anyone interested. To obtain one and full subscription details write to: Harold Emblem (Club Secretary), 137A Hampton Road, Southport, Merseyside PR8 5DY, England. An SAE or IRC would be appreciated to help cover postage costs.

### Newsdesk

**Eire:** New broadcasting legislation which will increase fines from £50 to a possible £20,000 will come into effect on 1st January 1989 effectively ending the present unregulated situation in which over 100 independents are operating. Some stations (eg Sunshine in Dublin) have already stated that they will close down at 2359 on 31st December 1988 unless they are granted an official licence. There isn't much time left to hear the majority of Irish independents since the proposed licensing arrangements will cut back the total number of licensed independents to somewhere around the 50 mark. Recent developments include a new station on 1611kHz relaying (temporarily?) Boyneside Radio. The station has been heard daily after about 2100 throughout the UK and as far away as Scandinavia.

**West Germany:** DLF Köln (1269kHz) has dropped DX Circle for the summer. The weekly DX programme presented by Alan Thompson will return in the autumn.

**St Kitts:** 895 Voice of Nevis is a *new* station using 10kW, owned and managed by Nevis Broadcasting Co Ltd, and should be an interesting target for the serious MW DXer.

**United Kingdom:** BBC Radio Gloucestershire has been testing and relaying BBC R2 on 603kHz since May. Local programmes are due to start at 0600 on 3rd October but the station will have an official opening ceremony with Princess Anne on the 11th. Their address is: London Road, Gloucester GL1 1SW.

Southern Sound currently based in Brighton has won the IBA franchise for Eastbourne/Hastings beating two other consortia to the prize. Meanwhile Hereward Radio based in Peterborough has been awarded the Cambridge franchise.

Two MW pirates are operating in London compared with about 30-40 on the VHF-FM band. Radio Memphis, a Rock 'n Roll station featuring music from the 50s and 60s, operates on 1260kHz on Sunday mornings for a couple of hours and Swinging Radio England has been using 1611kHz (just off the top end of the band) at night. Outside London, UK Radio (1413kHz) is operative in the Midlands, and Sunshine Radio (1017kHz) in Shropshire has been noted. On Merseyside Storeton Community Radio (1026kHz) has been reactivated.

**USA:** In contrast to the UK the current line up across the Atlantic looks like this; by the end of May the FCC had licensed 5078 AM stations of which 170 are still in a construction permit (CP) state. There are about 550 stations in AM stereo of which most (450) use the Motorola C-QUAM system. The remainder use the Kahn system. One of the pioneer users (WTIC located in Hartford, CT) of the Kahn system has reluctantly defected to the C-QUAM camp, probably due to commercial pressure. Despite this, WTIC Director of Engineering insists that the Kahn system is superior under night-time skywave conditions.

**Clandestine:** According to the *Times of India* Sikh Pirate Radio, Sikh extremists have taken equipment from Britain to the Indo-Pakistan border in order to set up at least three stations with estimated coverage of 200 miles. This plan has been linked to Sikh broadcasting activity from Radio Luxembourg two years ago.

### Across the pond

By the time you read this column the start of the winter MW DX season will be with us. Even for the experienced DXer, the Atlantic Ocean can form a formidable barrier, yet for most UK-based listeners the first taste of really long distance reception will be a station in the Americas. Often many sleepless nights and much perseverance are needed to hear your first transatlantic signal. However, having surmounted this hurdle you may wonder why it has proved to be so difficult to hear such stations before! Here are a few tips to help you catch signals from across the pond.

The vast majority of stations in the Americas operate on frequencies that are a multiple of 10kHz whereas European stations are separated by 9kHz. This means that the two frequency plans are not coincident and certain window frequencies exist where there is less interference from European stations, making transatlantic reception more likely.

Reception can occur at any time there is a complete path of darkness between the transmitter and receiver and for the Americas this usually implies listening after midnight (UK time). Reception can take place as early as 8 or 9pm in mid-winter but is usually better later when European interference is reduced by stations closing down for the night. In the morning good reception is possible up till local sunrise in Europe; even as late as 10am in mid-winter.

Reception depends not just on darkness but on suitable ionospheric conditions which vary in a fairly unpredictable manner. For this reason the medium wave band may be dead one night, when just a few days earlier reception of Canadian stations was possible using just a simple portable radio!

Most stations from the Americas regularly identify themselves with call-signs or slogans, so identifying a station is not too difficult even if it is not in English.

To get you started try looking for these popular and fairly regular visitors from across the Atlantic:

**590kHz** VOCM St Johns Newfoundland, Canada; Top 40 music, commercials and news on the half-hour.

**930kHz** CJYQ St Johns Newfoundland, Canada; Top 40 music, commercials and news on the half-hour. Uses 'Q Radio' slogan. This is probably the easiest station to hear.

**1050kHz** WFAN New York, USA; continuous talk and news about sport. Heard after BBC Radio 1 leaves 1053kHz at midnight UK local time.

**1220kHz** Radio Globo, Rio de Janeiro, Brazil; often a strong signal despite being nearly 10,000km from the UK. Reception is best after BBC Radio 3 closes down at midnight. Programming in Portuguese a mix of news, music and *futbol*. This has to be heard to be believed!

**1510kHz** WSSH Boston Ma, USA; specialises in easy listening, popular music with commercials and news. Reception is often possible after BRT Brussels vacates 1512kHz around 9pm.

**1570kHz** CKLM Laval, Quebec, Canada; a French language station with easy listening or country music. Commercial format. Often best heard in the hours around UK dawn.

**1610kHz** Caribbean Beacon, Anguilla; used to be the easiest signal to hear from the Caribbean since there was little interference on this channel. However, recent pirate activity in the UK and Holland on 1611kHz could make things trickier. Look for English language religious programmes with identification usually on the hour or half-hour.

These are just a few of the most likely transatlantic stations. Last winter over 150 different stations from the USA and Canada were logged in the UK and a similar number from Central and South America were also heard! Good listening and good luck. REW

# AMATEUR RADIO WORLD

## Compiled by Arthur C Gee G2UK

There has been talk of a complete revision of the amateur radio licence for quite a long time. Way back in September 1987, the RSGB set out its ideas on the revision needed in its journal *Radio Communication* and we commented on these proposals in our December 1987 instalment. Negotiations have been going on for several months between the various interested parties. Signs were beginning to appear that the DTI was anxious to get the matter settled.

In the July 1988 issue of *Radio and Electronics World* we quoted some remarks made by Mr Nigel Heriz-Smith, who said at a public meeting of radio amateurs in Leeds that: 'after the present review of the amateur licence, the next priority item was the introduction of some form of novice licence. Nigel Heriz-Smith is the head of the DTI's amateur radio section. We concluded our comments with the words: 'So it seems something along these lines (referring to the possibility of a review of the licence) is forthcoming in the very near future'.

Speculation was afoot that a Novice Licence or a Student's Licence was to be announced at the RSGB's 75th Anniversary Celebrations at the NEC, Birmingham. This did not happen, instead the Licence Review suddenly appeared! Speculators should have taken more notice of the priority indicated by Mr Heriz-Smith's remarks!

So, the draft of the new licence is now officially out and it is proposed that the licence should come into effect on the 1st January 1989. A great deal of space is devoted to this topic in the RSGB's August edition of *Radio Communication*. Those who are interested in this subject and are not RSGB members should try to get a copy to read about the new licence in detail. The RSGB proposes running a series of articles in future issues of *Radcom*, which will set out the rationale behind some of the changes. Some of the more interesting changes they have listed are as follows.

There will be an annually renewed, single sheet licence validation document, with a separate booklet setting out the terms and conditions of the licence. There will only be one type of licence, covering all previous types. Activities such as 'maritime mobile' etc will be included in the standard licence. Restrictions on emergency operation will be relaxed. The requirements for keeping a log will be tightened up, for instance, a note in the schedule re log keeping, states that 'CQ calls must be entered, whether answered or not.' Restrictions on recording and retransmitting of messages will be relaxed. Data and RTTY will be permitted on Top Band, and cross-band contacts will be allowed with stations on frequencies legally available to them, but not to us, eg 220MHz.

The RSGB article in the August issue of *Radcom* has an interesting account of what they proposed for the new licence and what was finally granted by the Licensing Authority. The impression one gets is that the RSGB did well, even if they did not get all they asked for. One or two particularly interesting requests which did not get through, included an aeronautical mobile licence. Apparently, a number of RSGB members had asked for this. It seems some countries do include this facility in their amateur radio licences.

A useful information sheet on the new licence is available from the Radio Amateur Licensing Unit, Post Office Counters Ltd, Chetwynd House, Chesterfield, Derbyshire S49 1PF. Tel: 0246 217555/217699. Ask for Information Sheet No7 *New Amateur Radio Licences*. A booklet giving the full text of the terms and limitations of the new licence, including the Schedule and the Notes, may be obtained on request from the same address from December. However, it should be noted that all licensees will automatically be sent a copy of the booklet when they renew their licence. For students of the RAE, the booklet is also reproduced in *How to become a Radio Amateur*, which is available from the Radio Amateur Licensing Unit.

### AMSAT-UK's Colloquium

The Colloquium held in conjunction with the University of Surrey's Space Engineering Dept at Guildford from July 29th to 31st was an outstanding success. Some 187 delegates from 16 countries attended to hear a very diverse series of lectures by Dr Martin Sweeting, Director of the University's Space Centre and Ron Broadbent, Secretary of AMSAT-UK. Topics covered everything from the recent launch of Oscar 13, planned amateur radio satellites for the immediate future from the American delegation, to a most superb presentation by Geoffery Perry, the well known author and TV space commentator, on the Chinese space scene.

Readers will remember that Geoff Perry headed the team of scholars at the Kettering School, who devoted their spare time to setting up a monitoring service which was able to spot Russian Spacecraft launches before they were officially announced! He has now been able to establish a similar project covering Chinese space activities and his lecture was illustrated with superb photos and recordings of the data signals transmitted by Chinese spacecraft. His lecture received well deserved applause from the enthralled audience.

Deserving of much praise too, was the film presented by the Japanese delegation on the construction and launching of their first amateur radio satellite JAS-1. The quality and professionalism of this was first class, as was the English commentary on the film.

Jan King, W3EGY, Vice President (Engineering) of the North American AMSAT-NA Group, presented a prototype of the Microsat Satellite, a miniaturised (18in) satellite of a cubic structure, which it proposes to sell in quantity for less sophisticated satellite systems. This was a delightful piece of miniaturised spacecraft engineering, the success of which will be followed with great interest.

Social activities gave delegates the opportunity to meet folk they had only previously corresponded with or had met 'on the air'. A particularly welcome guest was Dr Leonid Labutin, the radio organiser of the Russian-Canadian Skitrek Polar Expedition who joined the Colloquium on the final afternoon.

The University of Surrey is to be congratulated on the way the Colloquium was run and the excellent facilities it provided. The event was well summed up by a casual remark I overheard, made by one of the overseas' delegates from the Middle East who said that AMSAT-UK's Surrey University Colloquium has become the 'Mecca of amateur radio satellite enthusiasts!' This was the third event of this nature and was the best so far.

### Young Amateur of the Year Award

Readers will recall that we gave details of the Young Amateur of the Year Award in this column recently. This award was made by the DTI in recognition of a major contribution made by a radio amateur to the art of radio communication. The award was linked to the RSGB's 75th Anniversary celebrations. It consisted of a prize of £250 and a day out looking at some of the aspects of the work being done by its Radio Communications Division. It was to be awarded to a person judged to have made an individual contribution of outstanding merit in the area of amateur radio, who had not reached the age of eighteen by the closing date of March 31st 1988. The objectives of the award were to demonstrate the DTI's interest in promoting technological awareness and education and to draw attention to the many aspects of amateur radio in the minds of the public, with a view to encouraging more young people to take advantage of the privileges and benefits of this unique activity.

It was won by fifteen year old Andrew Keeble of Old Catton, Norfolk and was presented to him at the RSGB's exhibition at the NEC in Birmingham. This year's exhibition was a special event being part of their 75th Anniversary celebrations, and was opened by the Duke of Edinburgh on 15th July. Andrew believes he won the award through his efforts in setting up a special event station at the Sprowston High School, with the help of his classmates.

With this station he was able to contact other amateur radio stations in Australia and New Zealand, a particularly commendable performance from a fifteen year old, within a week of getting his amateur radio transmitting licence! He hopes ultimately to work in radio communications.

### Health risks

Possible health risks from electromagnetic radiation have been in the news lately and we considered some aspects of this recently in this column. We reported that the Central Electricity Generating Board was to spend a million pounds on research into the question of whether electromagnetic fields can cause ill health, cancer or even birth defects in embryos. We quoted a report from Dr Samuel Milham of the Washington USA State Health Service, in which he said that some types of cancer are about twice as high in radio amateurs as they are in the rest of the community.

In this country, the National Radiological Protection Board has recently issued a report dealing with this subject. The report comments on recommendations from the International Radiation Protection Association (IRPA) on electromagnetic fields generated by radio and power stations. Studios in the USA have suggested a link between electromagnetic fields and leukaemia in children. The Board's report is based on evidence which was presented at a public enquiry into a proposed 254kHz radio transmission aerial mast to be erected in Co Meath, Ireland.

The report states that it is improbable that there is a risk of cancer or birth defects at exposure levels similar to those suggested by the IRPA. If there is, it is still much less than the risk presented by cancer producing agents which are already present in the environment.

### UoSAT-C update

The UoSAT-C spacecraft which is the successor to UoSAT-1 and 2 is progressing well. The design is proceeding at high speed, with many designs complete and circuits being laid out using computer-aided printed circuit layout facilities. Major items of activity are centred on the fabrication of a new modular structure using module boxes milled from solid aluminium billets, using a computer controlled machine situated in the Mechanical Engineering Department adjacent to the Space laboratories of Surrey University. GaAs solar cells are being fabricated in Japan, together with etched optical detectors for attitude sun sensors. The objectives for UoSAT-C will be similar to those of UoSAT-1 and 2; to carry engineering, science and satellite communications experiments. It is hoped to have a launch date set for the spacecraft early in 1989. NEW

# Short Wave News for DX Listeners

**by Frank A Baldwin** All titles in UTC, **bold** figures indicate the frequency in kHz

African stations often prove to be interesting to both short wave listeners and DXers alike. This contribution, the first of a two part series, deals with transmitters on the 60m Tropical Band (**4750** to **5050** ) located in that continent and exhibiting relatively high power ratings. Those stations listed here are rated at 100kW or more, therefore presenting good opportunities for reception by beginner DXers. In the next issue, African transmitters rated at 50kW and less will be featured.

The signals emanating from African based transmitters may be heard here in the UK throughout the year, the prime times being at the start of individual schedules and additionally during our evening periods.

Programmes in English, French and Portuguese accord to the former colonial situation, while those in Arabic conform to the territorial limits of Islam. Additionally, there are many African language programmes in Afrikaans, Hausa, Somali, Swahili and dialects/vernaculars such as Afar, Rendille, Turkana and Boran etc.

Experienced DXers are not only able to aurally recognise the languages, as distinct from individual dialects/ vernaculars, which they report simply as a vernacular but can instantly recognise the African style of locally inspired musical material and presentation.

The sounds of African drums are commonplace, as are those produced by various other local instruments. Often described by DXers as 'tribal chants' are those vocals of a solo performer, the following chorus being rendered by many voices, with the sequence being repeated again and again. Then there are the fast and very rhythmic orchestral musical selections described in DXers' terms as 'hi-life music'. Equatorial Guinea is particularly noted for that very distinctive musical style.

Africa can provide the listener with many differing types and styles of both language and musical presentation, offering a whole range of interesting transmissions to those roving over the 60m band.

## Start here

For those about to commence their African Safari on the band under discussion here, one of the most often heard and reported stations is Radio Yaounde (Radio Diffusion Nationale du Cameroun) in Cameroon. At 100kW, it is scheduled in French and English with the National Service from 0400 to 0700 and from 1630 to 2400. There are news bulletins in English at 0530, 1800, 2100 and programmes at 0505 (Sunday at 0645 and 1705). The frequency is **48540.**

Nouakchott in Mauritania is another station often appearing in the SWL press. With a power of 100kW, it transmits programmes in the Home Service on **4845** in vernaculars, French and Arabic from 0600 to 0830 and from 1800 to 2400, the French language being used from 1700 onwards.

## Continue from here

Another frequently heard station is the 100kW Maseru in Lesotho on **4800.** Programmes in the Home Service are radiated from 0300 to 2200 in Sesotho but with English newscasts timed at 0430 and at 0500 (0527 Monday to Friday inclusive) and daily at 1130 and 1600. I should add that I have often heard them with religious programmes in English on Sunday at 2100.

A South African repeatedly logged is the 100kW SABC (South African Broadcasting Corporation) Johannesburg, featuring Radio 5 programmes from 0300 to 0505 and from 1625 to 2200 in English and Afrikaans on **4880.**

The **4885** frequency is the Voice of Kenya, Nairobi. It carries programmes in vernaculars and Somali from 0200 (Sunday from 0330) to 0600 and from 1430 to 2115 daily, being heard here recently when closing with the station identification in Somali and a choral rendition of the National Anthem. The power is 100kW.

The 100kW Dakar in Senegal is on the air with the National Service in French, vernaculars and English from 0600 (Sunday from 0700) to 0900 and from 1600 to 2400 (varying to 0100) on **4890.** However, for some time now, it has been relaying the RFI (Paris) African Service, this being heard in English from 0400.

The Voice of Kenya, Nairobi, appears again on **4915** , on which channel it radiates programmes in the National Service entirely in Swahili from 0200 (Sunday from 0230) to 0630 and from 1330 to 2010 (Saturday until 2110) with a power of 100kW.

Libreville in Gabon radiates National Network programmes in French and vernaculars from 0430 (Sunday from 0530) to 0630 and from 1600 to 2400 on **4777.** The power is 100kW, but Libreville is rarely heard in the clear, owing to adjacent channel activity and utility interference. Libreville is only reported from time to time by UK DXers because of this.

Undoubtedly, the easiest African station to hear is Africa Number One on **4830.** With a power of 250kW this transmitter, located at Moyabi-Moanda in Gabon, operates from 0500 to 0530 and from 1700 to 2300. An English programme is timed from 1900 to 1930.

Often heard are the signals of Radio Garoua, Cameroon on **5010.** At 100kW, Garoua transmits the Home Service programmes in French, vernaculars and English from 0425 to 0700 and from 1630 to 2315. Relays of the Yaounde English newscasts are timed at 0500, 1800 and 2100, making reception of the station identification easy for DXer beginners.

The 100kW signals from Niamey, Niger may be heard on **5020.** The Home Service 2 is on the air from 0530 to 0700 (Saturday until 2300, Sunday until 2200) and from 1700 (Saturday, Sunday and holidays from 1630) to 2200 (holidays until 2300). There is a newscast in English at 2000.

The transmissions from Bangui, capital of the Central African Republic, can often be heard on **5035.** With the Home Service in French and Sango. Bangui operates with a power of 100kW from 0430 to 0700 and from 1630 to 2300.

Carrying the Home Service in French and vernaculars, the 100kW Togblekope in Togo is on **5047** from 0530 to 0800 and from 1700 to 0005. There is a ten minute English news bulletin at 1950.

## ON THE AIR

The interested reader is invited to align the receiver on some of the frequencies at the times specified, for possible reception of signals from some of the stations indicated below.

## AFRICA

### Botswana

Gaborone on **3356** at 1820, a talk followed by songs and local style music. The Home Service in Setswana is on the air from 0400 to 0700 and from 1500 to 2100 with newscasts in English at 0510, 1610 (Monday to Friday) and at 1910. The power is 50kW.

### Burundi

Bujumbura on **3300** at 2023, songs with music of the locality, YL with some announcements then a male choir, all in Swahili. The Home Service in French, Kirundi and Swahili is on this channel from 0300 to 0700 (Sunday until 1000) and from 1600 to 2100 with an English news bulletin at 1645. The power is 25kW. The frequency is usually subject to commercial interference, but this was fortunately absent on this reported occasion.

### Central African Republic

Bangui on **5035** at 2005, OM with a talk in French. Bangui operates from 0430 to 0700 and from 1630 to 2300 carrying the Home Service in French and Sango, the power being 100kW.

### Ghana

Accra on **3366** at 2118, announcements, songs and local pops in English. GBC2 radiates entirely in English from 0525 to 0905 and from 1700 to 2305, the power being 50kW.

### Rwanda

Kigali on **3330** at 1832, OMs shouting, then a talk in vernacular. This 5kW transmitter carries the Home Service in Kinyarwanda, Swahili and French from 0300 to 0600 (Sunday until 2100) from 0900 to 1200 (Saturday until 2100) and from 1300 to 2100.

**South Africa**
RSA (Radio South Africa) Johannesburg on **17755** at 1505, OM with a newscast of both local and world events. This English programme directed to the UK and West Africa is scheduled from 1400 to 1556 daily.

**Transkei**
Radio Capital, Umtata, on **3927.3** at 0322, with pop songs and music, OM with announcements which included local temperatures then more pops. Radio Capital is on the air with programmes in English from 1700 to 2200 and from 0300 to 0530 at 20kW.

**Zaire**
Radio Candip, Bunia on **3389.3** at 1837, OMs with a discussion in French. The Home Service in French, Swahili and vernaculars is on this frequency from 0330 to 0600 and from 1530 to close at around 1915.

## CENTRAL AMERICA

**Costa Rica**
Faro del Caribe (Lighthouse of the Caribbean), San Jose on **5055** at 0542. OM with announcements in Spanish, a religious talk, some appropriate music and then off without the National Anthem at 0614. Faro del Caribe is on the air from 1000 to 1800 and from 2300 to 0500 (Saturday and Sunday to around 0630) with a power of 5kW. There is an English programme timed from 0300 to 0400.

## SOUTH AMERICA

**Bolivia**
Radio Abaroa, Riberalta on **4712** at 0305, OM with a talk in Spanish followed by some folk songs and music. The schedule of this 0.5kW transmitter is from 1030 to 0400.

**Brazil**
Radio Nacional Brasil, Brasilia on **15265** at 1823, OM with a talk about Brazilian exports of coffee and sugar. This English transmission is directed to Europe from 1800 to 1900 daily.

**Ecuador**
Radio Rio Amazonas, Macuma on **4870** at 0305, a talk in Spanish with mentions of Bolivia, then some announcements including a promotion; followed by a programme of songs with guitar accompaniment. This station operates from 1100 to 1600 and from 0000 to 0400 varying to 0500. The power is 5kW.

**Venezuela**
La Voz de Carabobo, Valencia on **4780** at 0322, announcements, many promotions, folk songs and music, OM with the station identification in Spanish. The schedule is from 0900 (Sunday from 1000) to 0400 (Sunday until 0300) with a power of 1kW.

## ASIA

**China**
Xinjiang PBS, Urumqi on **4735** at 0013, local style music and songs in Uigher. The Home Service in Uigher is on this frequency from 2300 to 0200, from 0330 to 0730 and from 1030 to 1700. There are relays of the Radio Beijing Minority Language Service from 0030 to 0056, 1100 to 1126 and from 1330 to 1356. The power is 50kW.

Radio Beijing on **11600** at 1435, announcements, pop songs and music in the English programme for South Asia, timed from 1400 to 1555.

**Bangladesh**
Dhaka on **7505** at 1732, local orchestral music and songs during the Bengali transmission to the Middle East, scheduled from 1630 to 1800.

**India**
AIR (All India Radio) Delhi on **9910** at 2025, OM with a talk about Indian political life and current home policies. This English programme is directed to Europe from 2000 to 2230.

**Pakistan**
Islamabad on **17660** at 0543, songs and music in the Urdu presentation to the Middle East, timed from 0430 to 0645.

**United Arab Emirates**
Abu Dhabi on **9630** at 1742, Arabic music and songs, announcements, the station identification being followed by recitations from the Holy Koran.

## SOUTH EAST ASIA

**N Korea**
Pyongyang on **9325** at 1515, news and comment of local events during an English programme for Europe and the Middle East, timed from 1500 to 1600.

## PACIFIC

**Australia**
Shepparton on **11720** at 0730, OM with the station identification, then a talk about travelling facilities in Australia. This English programme is directed to the Central Pacific area from 0730 to 0930.

Shepparton on **15160** at 0540, folk songs and music, announcements in the English programme for the South Pacific region, scheduled from 0300 to 0730.

## CLANDESTINE

Iran's Flag of Freedom Radio on **9045** at 1735, OM with a talk in Farsi, also being heard on the parallel channel of **7080.** The organisation concerned is 'The Front for the Liberation of Iran' which is headed by former Prime Minister Ami Amini. The policy is one of pro-monarchy and hostility to the present Iranian authority, the transmitter being located in Egypt.

## NOW HEAR THESE

Radio Zaracay, Santo Domingo de los Colorados, Ecuador on **3394.8** at 0248, OM announcements and promotions followed by a political talk in Spanish. With a power of 10kW, Radio Zaracay is on the air in Spanish and Quechua from 1000 to 1400 and from 1900 to a sign off varying from 0330 to 0600.

Radio Nueva America, La Paz, Bolivia on **4795** at 0357, OM with announcements. The station identification is in Spanish, they then sign off without the National Anthem at 0359.

## NOW LOG THESE

Radio Tawantinsuyo, Cuzco, Peru on **4910** at 0250, folk song recordings, announcements in Spanish, poor modulation, off without the National Anthem at 0302. The schedule, using Spanish and Quechua, is from 0900 to 0300 with a power of 5kW. The frequency varies to **4909** on occasions.

La Voz de Cutervo, Cutervo, Peru on **5661.2** at 0132, YL with a talk in Spanish, then some folkloric songs and music. At 0.6kW; this one is operational in Spanish from 1100 (Sunday from 1000) to closing at any time from 0300 to 0400.

## THE ISWL

The International Short Wave League '87 produce a monthly journal entitled *Monitor,* which regularly includes sections on both broadcast and amateur bands. Contributors to the former feature receive a special edition of The Broadcast Bands in advance of the journal. This unexpurgated edition proved to be an informative guide to current activity with schedules, target areas etc.

Amateur and broadcast band contests are frequently held, with an award going to the participant with the highest total score in any one year; the trophy becoming a permanent possession of the winner.

ISWL CW (Morse code) nets may be heard on Monday at 2030 on **3535**, and on Saturday at 1000 on **3550**, the controller being G2WQ. SSB nets are held on Tuesday at 1900 on **3700**, controller GW4UZL, and on Saturday at 1030 on **3685**, controller G2BRR; sometimes using the Club callsign G4BJC. All times stated are UK clock times (not UTC) and all frequencies are plus or minus QRM (interference).

A whole range of attractively designed awards are free to members attaining the required number of QSL cards, as specified in the rules appertaining to the respective certificates.

ISWL '87 is affiliated to the Radio Society of Great Britain and the European DX Council.

Details of membership are available from the Hon Secretary, J May G1GWG, 10 Clyde Crescent, Wharton, Winsford, Cheshire CW7 3LA.

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| DAF70 | 1.75 | EC92 | 1.85 | EF39 | 1.10 | EL91 | 6.80 | GZ34★ | 4.40 | PL83 | 0.90 | UY85 | 0.85 |
| DAF96 | 0.90 | ECC81 | 1.25 | EF80 | 0.65 | EL95 | 1.80 | GZ37 | 3.95 | PL84 | 0.90 | VR105/30 | 2.45 |
| DET22 | 32.80 | ECC82 | 0.95 | EF83 | 3.90 | EL504 | 2.70 | KT77★★ | 14.00 | PL504 | 1.25 | VR150/30 | 2.45 |
| DF92 | 0.65 | ECC83 | 1.10 | EF85 | 0.90 | EL509 | 5.65 | KT88★★ | 25.00 | PL508 | 2.00 | X66 | 4.95 |
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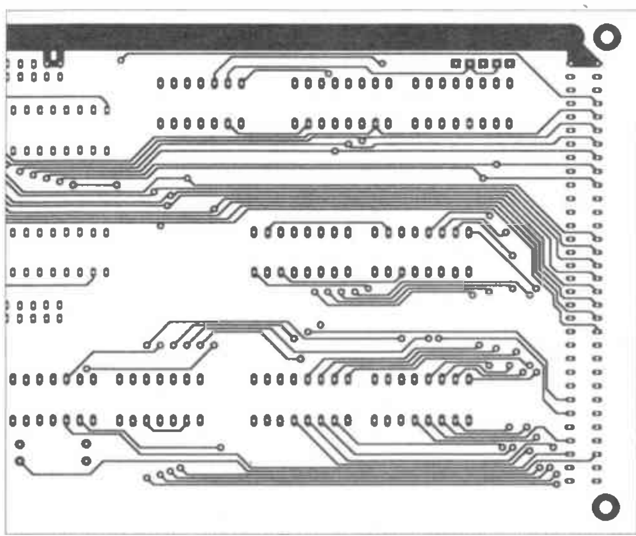

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# ATV ON THE AIR

## Andy Emmerson G8PTH puts you in the picture

**Slots revisited**

A couple of months back I included details of an Alford slot for 70cm ATV designed by Merle, W9DNT. Since then Merle has corrected one dimension on the drawing and come up with two other designs: one is for 70cm and the other for 900MHz (this is discussed in Network 934). But first the correction.

At the tip of the drawing a circumference of 4in was mistakenly shown. The 4in represents the diameter across the slot, not the circumference (which is closer to 12in). Apologies for this. Since then Merle has altered the design and come up with something which is both smaller and easier to work with.

Unlike the previously published 4in diameter slot antenna, which used a ¾in slotted aperture, this one is 3.5in across and has a narrower ½in opening. The approximate impedance is 200 ohms, so a coaxial matching balun is needed to reduce this to the 50 ohms we know and love. The balun is shown in the RSGB and ARRL handbooks and is the familiar loop of coaxial cable; it's an electrical half wavelength long and folded in half, with all the braids connected together. One end of the balun loop's inner conductor is joined to the end of the feedline and connected to one terminal of the 200 ohm antenna. The antenna's other terminal is connected to the other end of the balun's inner conductor.

To determine the length of the cable used for the 4:1 balun you use this formula: 492 divided by the frequency times 12 (inch conversion) times the cable's velocity factor. These are 'under braiding' measurements, so you should allow extra for trimming. An example for (American) ATV use on 439MHz works out as follows: $492 \div 439\text{MHz} = 1.1207 \times 12 = 13.449\text{in} \times$ velocity factor of .78 (RG-8) = 10.490021in. So let's call it 10.5in. At 421MHz it works out closer to 11in. I hope you're not using RG-8 cable in this day and age, so check if what you're using has a different velocity factor – in fact, many don't.

The material for the Alford slot is galvanised steel, sometimes referred to as gutter pipe or stove pipe. An alternative, which W7KPW of the Central Texas ATV Group is experimenting with, is aluminium irrigation tubing. No doubt copper central heating pipe could be used just as well. PVC ring support pieces may be placed and attached anywhere along the length of the antenna where it is felt necessary. I have a dimensioned sketch of this antenna and will happily pass it on to anyone who sends an SAE to the Editorial Department of *Radio and Electronics World*.

**What are SATV and NBTV?**

Slow-scan TV is familiar to most ATVers but some folk are uncertain about SATV and NBTV. SATV is now a rather dated German concept which was only used in Germany. The S stands for 'schmalband' or narrowband and relates to normal fast-scan operation on 70cm and 23cm.

The idea was to reduce the transmitted bandwidth to 1MHz, thus giving two advantages. Together with the use of matching narrow-band receivers it gave a considerable boost or 'punch' to signals, enabling them to be seen where normal ATV would not get through (as TV DXers know – reducing the bandwidth of the TV receiver appears to sharpen up the picture no end). Interference to other band users is also reduced. Depending on circumstances, we might see a comeback of SATV one day!

NBTV or Narrow Band television is generally taken to mean (intentionally) low-definition television. There is a speciality interest group for NB people, called the Narrow Bandwidth Television Association. It was founded in 1975 and exists to promote the 'development, study and widespread use of low definition and mechanical television'. Membership is open to anyone with an interest in its aims at a modest annual subscription. Rather like the G-QRP club, it has a faithful following and a high reputation in its field.

The Association holds an annual exhibition and conference in April or May and members receive quarterly newsletters of about 12 pages containing technical articles, details of constructional projects and so on. There are also some special services for members. Activities include the building of experimental cameras, monitors, closed circuit demonstrations, tape correspondence (using audio tape recorders) and transmissions on the amateur wavebands; 10 and 2m being favoured.

NBTV is genuine television, along the lines of the BBC/Baird transmissions of the 1930s. With improved techniques, the system gives moving half-tone pictures within a bandwidth of some 7kHz. It must not be confused with slow-scan TV which provides only still pictures, though with higher definition. Technical standards are well established with 32 lines, vertical (upward) scanning and 12.5 pictures per second with a 3:2 ratio.

Membership enquiries should be addressed to: N Reynolds, 6A Collingbourne Road, London W12 0JQ. For information on amateur band NBTV contact: J Sumner, 20 Woodlands Way, Southwater, Horsham, Sussex RH13 7HZ. If you want to know about other technical matters write to: D B Pitt, 1 Burnwood Drive, Wollaton, Nottingham NG8 2DJ.

**Sign-off**

That's all for this month. Next time it will be our quarterly activity round-up, plus the continuing controversy over SSTVers versus the phone patchers on 14MHz. I am hearing fascinating things about the Philips video graphics computer and hope to report on this shortly. Don't forget to send in your reports to me. NEW

# NETWORK 934

## Andy Emmerson G9BUP

**A horizontal omni**

Several times recently we have been discussing the advantages (and disadvantages) of horizontal polarisation for 934MHz. One of the biggest drawbacks was the lack of a 'gain' antenna with omnidirectional characteristics. There is no problem sending and receiving horizontal polarisation in just one direction – you just mount your yagi with the elements horizontally. However, if you want all round (omnidirectional) coverage, you are limited to very low gain devices like the Halo.

But not any more. Our amateur colleagues in the States have developed a dual Alford slot antenna, with an estimated gain of between 5 and 7dB. Is it a miracle or what? How does it work?

There is no trickery involved. Quite a few years ago a British antenna designer called Andrew Alford came up with a scheme for a vertical pipe-like aerial which had horizontally polarised omnidirectional coverage, but it was some while before people believed it could work and started to adopt the design. In the non-professional radio field this was partly because most users (amateurs) opted for vertical polarisation and it was the amateur television enthusiasts who first started to try out Alford Slots. This is because amateur television (ATV) is generally horizontally polarised and once the ATV enthusiasts started building repeaters they needed horizontal omnidirectional antennas for the repeater sites. Taking this one stage further, the Americans and Canadians have an amateur television band allocation at 902-928MHz (very close to our 934MHz band) and have built Alford slots for this band.

The result is a horizontal omni which looks like a five foot length of drainpipe. Although the antenna has horizontal polarisation, it is mounted vertically, just like a collinear.

This is not the place to explain all the theory but you can find it in the standard antenna textbooks. The aerial is made from 2in diameter pipe, either copper, aluminium or steel and the dimensions are not desperately critical, in other words they don't have to be made to the nearest millimetre.

The credit for making a working slot on the 900MHz band goes to Merle Reynolds W9DNT of Moline, Illinois. I have a dimensioned drawing which is not really suitable for reproduction but I will be happy to send a photocopy to anyone who provides me with an SAE, care of the Editorial staff at *Radio and Electronics World*.

The antenna's impedance is around 200ohms, which means you need to build a balun (from coaxial cable) to match the antenna to the normal 50ohms used. Merle made his slot from normal steel stovepipe material, but aluminium or copper tubing would be just as good (and possibly better). Bandwidth is calculated at 20MHz with Standing Wave Ratio at 1.5:1 or less, so there will be no problem in making this design perform just as well at 934MHz.

### 1001 uses for a power meter

No, I cannot think of 1001 uses either, but here are a few. The most obvious is to measure the power from your rig into the antenna system. In a base station situation, this is a good idea, because although the nominal power of your rig may be the customary 5W it is always worth keeping an eye on the reading. If it changes you can be pretty certain that either the transceiver is unwell (not especially likely) or something has changed in the antenna system (much more likely). We will come back to this.

### The dreaded SWR

Probably the most important aim when installing a radio system is getting the SWR (Standing Wave Ratio) to a minimum. Many people have only a hazy idea of this, so it is worth studying a little more closely. The goal is to transfer all the power output from the transmitter to the aerial and radiate it effectively. The objective is also to receive as much signal on the antenna and bring all of this back to the receiver. In our case, the transmitter and receiver are in the same box, which simplifies things.

What might go wrong? Unsuitable or ageing coaxial cable (it deteriorates over the years); poorly made joints in the connectors and 'unmatched' antennas can all lead to signal loss, and we cannot afford to lose much of our valuable signal, either on transmit or receive. The signal does not disappear as such but gets trapped in the system as, what are called, standing waves, which never get transmitted or received. This is where a good power meter can detect and measure these standing waves. They are compared to the signal which is actually getting out, enabling us to calculate the SWR.

The L-Wave meter makes this very easy. First you measure the forward power (that is the power leaving the transmitter for the receiver), and then you flick the switch and measure the reflected power (power which cannot 'get out' for one of the reasons mentioned earlier). Then relate the forward power to reflected, which you can do with the aid of a pocket calculator. If you have a computer, your task will be easier as the basic program shown will work on most home computers.

Obviously you want the reflected power to be as little as possible and a VSWR of up to 1.5:1 is fine. Up to 2:1 is not too bad. The ideal figure is a 'perfect match' of 1:1 but this is difficult to achieve. If you do get something approaching this, it is most likely to be due to inaccuracies in your measurements. No power meter on the amateur market is 100% accurate – you would need to use professional equipment costing hundreds of pounds for that.

However, even the cheapest meter gives good relative results, in other words, you can see when things are getting better (or if they are getting worse). There is a lot more to VSWR, cable loss and antenna matching than this and if the subject fascinates you there are many books on the subject. Check out the amateur radio books section at your public library.

That is it for this month. Let me know if you are building an unusual antenna or would like to have a go at building your own slot antenna as I can supply all the literature. Let's have some activity reports, too.

### Trade news

We do not seem to have reviewed many accessories lately, and I was reminded recently that L-Wave are still producing their In-line power meter. This is a well-built item, largely produced from a die-cast case and finished in light grey. The power meter is calibrated from 200mW to 10W and has two power sensors to allow forward and reverse power measurements to be made at the flick of a switch. Rubber feet enable it to be used 'standing up' or 'lying down' and professional quality N type connectors are fitted. If you prefer, BNC types can be supplied to order, but I would recommend the N types as these are less likely to come undone, they also make a better, more stable joint.

L-Wave is run by Les Wicks G3ZUD and is based at: West Winds, The Fosse Way, Kinoulton, Notts NG12 3ES. Telephone Les on Kinoulton 81502 for the latest price. He is a keen microwave enthusiast and supplies similar meters for the 23cm band, as well as all kinds of dipole feeds for dish aerials and polarisation switching units for yagi antennas.

```
10 CLS
20 PRINT : PRINT : PRINT
30 PRINT TAB(2) "VOLTAGE STANDING WAVE RATIO"
40 PRINT : PRINT
50 PRINT "REFLECTED POWER";
55 INPUT PR
60 PRINT
70 PRINT "INCIDENT POWER";
75 INPUT IP
80 IF PR>IP THEN GOTO 220
85 IF PR=IP THEN GOTO 135
90 A=1+SQR(PR/IP)
100 B=1-SQR(PR/IP)
110 C=A/B
115 LET C=INT(C*10+.5)/10
120 PRINT : PRINT
130 PRINT "THE VSWR IS " C " TO 1"
131 GOTO 140
135 PRINT : PRINT : PRINT "THE VSWR IS INFINITY"
140 PRINT : PRINT
150 FOR W=1 TO 5000 : NEXT
160 PRINT "DO YOU WANT TO MAKE ANOTHER"
170 PRINT "CALCULATION? YES (Y)   OR NO (N)"
180 A$=INKEY$ : IF A$="" THEN 180
190 IF A$="Y" THEN 10
200 IF A$="N" THEN 280
210 END
220 PRINT : PRINT
230 PRINT TAB(7) "**** ERROR ****"
240 PRINT : PRINT "REFLECTED WAVE GREATER"
250 PRINT 'THAN INCIDENT WAVE'
260 FOR Q=1 TO 50000 : NEXT
270 GOTO 10
280 CLS
290 PRINT "PROGRAM BY G4NVT"
```

*The basic computer program for calculating SWR*

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■ Yaesu FT227R 2m FM mobile transceiver. Very good condition. 1W/10W switchable, memory, repeater shift, mobile mount, mike and manual, £140. Tel: 061-748 1704

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■ Aerial boot mounts, two £5 each. Philips push button car radio, £10. Maplin keyboard plus metal case, £20. Service manuals TR3200, TR3500, TR2500, TR2400, TR9500, TR9000, £8 each. Operating manual TR3200 £3. Heathkit R-C bridge C-3U plus manual, £30. Yaesu speaker case, 11in x 8in x 6in fitted two speakers, £11. Assorted miniature valves, meters, switches, rotary cases, send requirements magazines, PW, R&EW, RadComm, offers? Carriage extra. Des Thompson G8SBU. Tel: (0385) 265059

■ TS430, AT230, SP430 and CD600 RTTY CW decoder. 6 months old, mint condition. Not used for Tx, offers over £550. Will not split. Please write to Gary Gammer, 9 Speedwell Close, Spital's Cross, Edenbridge, Kent TN8 6BU

■ Philips RF meter GM 6025 10mV VHF, offers. Phillips, 33 Henry Road, Gloucester GL1 3DY

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■ Slow scan TV transmit and receive program, no hardware needed, for Spectrum computer, £5.95. Morse tutor for BBC Micro computer program on 40/80 track disc, £10. Brilliant program to learn Morse with! BBC roms for sale, send for list. All roms £10 each. Amanda Hearle, Thornleigh, West Winch Road, West Winch, King's Lynn, Norfolk. Tel: (0366) 388615

■ Matsui MR4099 SW VHF stereo, gen coverage, £80, brand new. Sony 7600D, same, £120. Sony air 7, £150. Scanner – Yaesu FT203R hand-held, 2m transceiver with loads of extras, £170, vgc. Yaesu FT290R Mutek front-end case, two sets nicads, strap, £290, all items in perfect condition and working order. Will swap all above for R7000 with antenna. Tel: Peter G8UFK, Derby (0332) 768048

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■ ZM PLL VFO, home brewed WPO kit, cased, 10mW out, xtals for WEA-SAT bands included. Also, only needs AR spaced (365+365p) capacitor to get it going, £30.00 inc postage. 2m 'talkbox' transmitter, also home brewed, cased, 1.5W out, xtals for 143.975 144.975 and an xtal for Rx included, £40.00 including postage. PW 'Blenheim' VHF to HF converter, worker, only needs xtal (116.000MHz) and case to get it going, £20.00 inc postage. Write only to Borkhataria, 24 York Rd, London W5 4SG

■ Ranger AR3500 26-30MHz tuning steps 100Hz 1kHz 10kHz 100kHz 1MHz LSB USB FM AM CW 8 watts FM 30 watts SSB. Programmer scanner Ranger split frequency. Tel: (0283) 221870

■ Pye PF2UB xtaled, SU8, RB13, RB4, RB0, RB6, £40. Both with carrycase and 3 NiCads. Pye Westminster FM 6 channel xtaled: 70.260-70.450, £50. Cirkit 2m PA, 25W out/3W in, £25. 2 Pye PF1 Rxs, RB4, RB13, with 6 NiCads, £20. G Tillett, 43 Chippenham Road, Harold Hill, Essex RM3 8HJ. Tel: 04023 49890

■ Eddystone EC10 0.5-30MHz in 5 bands, solid state Rx, complete with Eddystone power pack or batteries, headphones and manual, vgc £45.00. Thermion 13.8V dc 20A linear PSU (power supply unit). Overvolts/current protection, twin meters, air cooled, £35.00. 13.8V dc 15A linear PSU £15.00. 24V 20A transformer, £6.00. Heathkit 0-300V ac/dc voltmeter. Bench type with large scale. Ideal mains monitor, £5.00. Heathkit field strength meter with adj sensitivity, £5.00. Racal (army) headphones with pads, £5.00. Racal variable Tx sidetone/practice Morse oscillator with tape rec o/p, £5.00. Advance 'Advac' wideband VVM with manual, £10.00. 4 off marine quality ribbed AE insulators, £3.00 the lot. Box of assorted Tx/Rx components, transformers, tuning cond's, hi volts, caps, etc, £5.00 the lot. G4FZG QTHR. Tel: (0242) 580329

## WANTED

■ 12V-6V dc converter. Tel: Peter Wilson, Coleshill Birmingham, 62308

■ 934 transceiver in good condition. Tel: (0283) 221870

■ Nato 2000. Must be in perfect condition. £90 paid. Tel: (0283) 221870

■ *Radio & Electronics World* June and July 1986. To comply with local exchange control regulations please send a quote including the cost of airmail postage to: S Shaw, PO Box 1404, Randfontein, 1760, South Africa

■ Yaesu FRG7000 or FRG7700. M H Wilkes, The Elms, 3 Bescot Rd, Walsall WS2 9AD

■ Cash paid for very early types of germanium transistors – any condition considered. Tell me what you have or write for my wanted list. Reply guaranteed. Pre-1960 transistor data books and sheets also wanted. Dr Andrew Wylie, 2E Welbeck Mansions, Inglewood Road, London NW6 1QX

■ MacDonald Radio and TV servicing volumes 81/82, 82/83, 83/84 in good condition. £20 offered each. Meil, St Clair Cottage, Holm, Orkney KW17 2RZ

■ RTTY decoder together with monitor and leads etc required for connection to Trio R2000 communication receiver. Sensible price. Mr H M Carroll, Flat No3, 135 Newbridge Rd, Bath, Avon BA2 3HG

■ Circuit diagram and operation details of Stentor FC1500 transceiver, so I can see IF conversion to channel for ATC use. A R Greenfield, 20 Church Meadow, Lilleshall, Newport, Shropshire TF10 9HD. Tel: (0952) 604302

■ Nordmende Galaxy mesa 9000ST radio receiver, 17 bands with RFO FM stereo, 6 pre-sets (memories are not pre-sets), 4W output solid state. Is there anything like it on the market today? If so, name and address please, all expenses paid. Tel: (0472) 358896 anytime

■ Author of 'ABC Air Traffic Control' requires information from readers on high frequency aeronautical radio for a new edition of his book. Please send details of your experience of receivers, antenna, messages etc, and any helpful comments to Graham Duke, 4 Ridgeway Grove, Newport, Gwent NP9 5AN. All replies will be answered and postage refunded

■ Grandstand 934MHz transverter, preferably working. Tel: Paul (08444) 237131

■ ATU, KW or Drake. Must have built-in power SWR meter, and be rated at 1kW. Also KW1000 linear or similar. Tel: Coventry (0203) 450476

■ Early valve radios and components. Tel: Reading (0734) 883799

■ Sony CRF-330K Rx. Must be mint. Good price paid. Tel: 061-743 1570

■ General coverage receiver 550kHz to 30MHz. Will swap Amstrad CPC 464 micro in good working order. TV modulator, power supply, but no monitor. Or cash for receiver up to £70.00, but must be in good working order. What have you? Also wanted the ARRL 1986 handbook: £5.00 offered plus postage. Or what price do you require? All letters answered. Mike Day, 39 Valnord Lane, St Peter Port, Guernsey, Channel Islands. Tel: (0481) 26168

■ Circuit diagrams or service sheets for Amplion 'Delegate' HU-610 valve receiver. Age of unit unknown – possibly forty years old. Mark Glover, 9 Church Square, Basingstoke, Hampshire

■ OK so I picked it up at a car boot sale. Seavoice Seafarer range type RT-100; can anyone help with information on this Tx/Rx, as I would like to use it as a monitor, the xtal selector is marked 6-8-12-14-16-11-25-26-27-18-20-22; what is on these channels? What in the way of an antenna do I need? Should it work without the microphone? Or on receive which is missing, could it be converted to other VHF bands? Any help much appreciated, postage refunded. Mike Evans, 120 Loughton Way, Buckhurst Hill, Essex IG9 6AR. Telephone: 01-505 6303

## FREE CLASSIFIED ADS

### FREE CLASSIFIED ADS CAN WORK FOR YOU

We are pleased to be able to offer readers the opportunity to sell your unwanted equipment or advertise your 'wants'.

Simply complete the order form at the end of these ads – feel free to use an extra sheet of paper if there is not enough space. We will accept ads not on our order form. Send to ***Radio & Electronics World***, Classified Ads, Sovereign House, Brentwood, Essex CM14 4SE.

# FREE CLASSIFIED AD ORDER FORM

**Send to:** Radio & Electronics World Classified Ads·Sovereign House · Brentwood · Essex · CM14 4SE

**Classification:** (tick appropriate box) If you want to insert ads under more than one classification use separate sheets for second and subsequent ads

For Sale ...................................................... ☐ Wanted ........................................................ ☐

**USE BLOCK CAPITALS** (One word per box)

To avoid mistakes please write clearly and punctuate your ad

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| Name/Address Postcode/Telephone | | | | | | | |
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**USE SEPARATE SHEET FOR MORE WORDS**

**Ensure that you have included your name and address, and/or telephone number**

**CONDITIONS:** Your ad will be published in the first available issue. We will not accept trade advertisements. We reserve the right to exclude any advertisement.

# SMALL ADS

**TV Dx only £65.99**
Inclucing Binatone 4.5 screen covers. VHF band 1×3 and UHF, excellent value. Send cheque or postal order to:
**S M ENTERPRISES**
**28 Preston, Enfield EN3 6EP**
*Goods usually dispatched within 7 days*

## AMATEUR TELEVISION
IS TELEVISION YOUR INTEREST? Then you need the BRITISH AMATEUR TELEVISION CLUB, only £6 per year – super magazine. Send SAE to:
**'Grenehurst', Pinewood Road**
**High Wycombe, Bucks HP12 4DD**

## TURN YOUR SURPLUS
IC's TRANSISTORS etc, into cash, immediate settlement. We also welcome the opportunity to quote for complete factory clearance.
**CONTACT:**
**COLES-HARDING & CO**
**103 South Brink, Wisbech, Cambs**
**TEL: 0945 584188/Fax. No. 0945-588844**
Est Over 10 years

## WORKSHOP SERVICE MANUALS
Any Colour/Mono TV, Amateur Radio, Military Surplus, Music System, Vintage Valve Wireless etc, etc...... **£5.00 plus LASE**
Any Video Recorder....... **£10.00 plus LSAE**

**FREE** Catalogue Unique Repair and Data Guides for LSAE.
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**Oxon OX9 4QY**

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| SWG | 1lb | 8oz | 4oz | 2oz |
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| 8 to 34 | 3.63 | 2 09 | 1 10 | 0.88 |
| 35 to 39 | 3.82 | 2.31 | 1.27 | 0.93 |
| 40 to 43 | 6.00 | 3.20 | 2 25 | 1 61 |
| 44 to 47 | 8.67 | 5.80 | 3 49 | 2.75 |
| 48 | 15 96 | 9.58 | 6 38 | 3 69 |
| **SILVER PLATED COPPER WIRE** | | | | |
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| **TINNED COPPER WIRE** | | | | |
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Please add 15% VAT. Orders under £3 add 50p.
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## ELECTRO DISPOSALS
2000 sq ft of surplus equipment and components
**UNIT 31, LONLAS WORKSHOPS**
**SKEWEN, NEATH**
**Tel: 0792 818451**

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## 0277 219876

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**ICOM-BUSINESS/AMATEUR/ MARINE/AIR**
**UK AND EXPORT**
**MRZ COMMUNICATIONS LTD**
**NEWCASTLE UNDER LYME**
ICOM
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**7 DAY SERVICE**

## BRENT ELECTRONICS & COMMS
**49 Seaview Street, Cleethorpes**
**South Humberside DN35 8EU**
**Tel: 0472 690383**

Pye M296 UHF mobiles........... **POA**
Pye A200 linear amp, 148/174MHz..................... **£35 each**

Airlight 62 headset EM mic.... **£35**
X-Band 20 inch dish and feed EL/AZ mount inc motor drives and syncros.............................. **£50**

Solid State indicator units ex. "Red Steer" radar .................. **£65**

Helical antennas BNC fitting, 2 metres......................... **£5.50 each**

All + 15% VAT
Cheque with order – carriage included

## USED AMATEUR EQUIPMENT?
**I buy, sell and exchange**
For the deal you've been looking for, phone Dave, G4TNY, anytime on Hornchurch (040 24) 57722 or (0836) 201530
9am-7pm Mon-Sat or send SAE
Personal callers by appointment please
**G4TNY Amateur Radio**
**132 Albany Road, Hornchurch, Essex RM12 4AG**

## Radio & Electronics World
The communications and electronics magazine

## SMALL ADS

This method of advertising is available in multiples of a single column centimetres — (minimum 2cms). Copy can be changed every month.

**RATES**
per single column centimetre:
1 insertion £9.65, 3 — £9.15, 6 — £8.65, 12 — £7.75.

### RADIO & ELECTRONICS WORLD SMALL AD ORDER FORM
**TO:** Radio & Electronics World · Sovereign House
Brentwood · Essex CM14 4SE · England · (0277) 219876

**PLEASE RESERVE**..............centimetres by..............columns

**FOR A PERIOD OF** 1 issue........☐ 3 issues........☐ 6 issues........☐ 12 issues........☐

**COPY** enclosed........☐ to follow........☐

**PAYMENT ENCLOSED:**........ £ —

Cheques should be made payable to Radio & Electronics World Overseas payments by International Money Order Credit Card

**CHARGE TO MY ACCOUNT**........☐

CREOIT CARD EXPIRY OATE

COMPANY ................................................................

ADDRESS ................................................................

SIGNATURE .......................................... TELEPHONE..........................

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C P I

24v ni-cad battery contains twenty XD type cells, used condition, some cells may be faulty .......... **£12.00**
Spring tension gauges, set of 3. 0-4 ounce, 0-16 ounce, 0-6lb .......... **£8.00**
Ex Vulcan bomber hitch and roll assembly, contains gears, shafts, bearings etc .......... **£15.00**
Range and bearing marker unit, contains bevel gears, servos, shafts etc .......... **£15.00**
Radar drive unit, contains 2 ex 24v motors, gears, components etc .......... **£15.00**
Eddystone type 770R VHF receiver, 19-155 MHz .......... **£120.00**
Type R210 receiver 2-15 MHz, complete with plug and headphones .......... **£55.00**
ITT UHF TX-RX base station .......... **£40.00**
ITT 149 MHz VHF transmitter .......... **£40.00**
Collins R390A receiver, poor condition **£150.00** Ring for details
Readyphone 100 watt, LIN, amplifier, complete with ATU .......... **£75.00**

*Prices include postage and packing*

**A C ELECTRONIC SERVICE**
**17 APPLETON GROVE, LEEDS LS9 9EN**
**TELEPHONE: 0532 496048**

**JAPANESE Ic's (PART OF OUR RANGE)**

AN7178 £2.95, BA5406 £2.20, HA1377 £2.20, HA1392 £2.50, HA1394 £2.95, HA1397 £2.75, HA1398 £2.75, HA13001 £2.95, LA4460 £1.80, LA4461 £1.80, LA4507 £4.25, LC7137 £4.50, M51517 £2.80, MB3705 £1.80, MB3712 £1.50, MB3722 £3.50, MB3730 £2.50, MB3731 £3.50, STK461 £7.50, STK463 £8.40, TA7205AP £1.00, TA7222AP £1.30, TA7240 £2.95, TA7241 £2.95, TA7270 £2.75, TA7271 £2.75, TA7274 £2.95, TA7280 £3.50, TA7281 £2.95, TA7282 £2.95, TA7283 £2.95, TA7288 £2.95, TA7611 £3.20, UPC575 £1.00, UPC1156 £2.95, UPC1181 £1.10, UPC1182 £1.10, UPC1185 £2.50, UPC1188 £2.75, UPC1230 £2.50, UPC1263 £2.50, UP1277 £2.75, UPC1278 £2.75, UPC1365 £3.60, UPC1394 £1.95.
ADD 60p POST AND PACKING AND THEN ADD 15% VAT TO TOTAL

**T POWELL 16 PADDINGTON GREEN LONDON W2 1LG**
**OPEN MON-FRI 10AM-5PM, SAT 9AM-12 NOON.**
**TELEPHONE: 01 723 9246**
**ACCESS/VISA. TELEPHONE ORDERS ACCEPTED OVER £5.00**

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**Crystal Controlled Micro Transmitters, Telephone Transmitters and Covert Body Transmitters**
High Grade, Superb Stability
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Portable and Pocket Bug Detectors and the Unique CS420 Tap Defeat System which will Nullify the Effect of *ANY* Telephone Interceptions
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**01-866 3300. FAX: 01 429 0950**

***ETESON ELECTRONICS***

**E•E•**
***15B Lower Green, Poulton-le-Fylde, Blackpool***
***Tel: (0253) 885107***

*Open: 9.30am - 12.30, 1.30 - 5.30. Closed Wed & Sun.*
*Electronic Component Specialists.*
*A wide range of electronic components, IC's, capacitors, transistors, resistors, plugs and sockets etc.*

**IAN FISHER COMMUNICATIONS OF STANHOPE**

**CB Works, The Market Shop, Market Place, Stanhope, County Durham**
**☎ (0388) 528464**

Main Distributors of 27MHz CB radios and the NEW CEPT models including UNIDEN and DNT.
Including U.K. and CEPT walkie talkies.
Large stocks of coaxial cable, plugs, sockets and adaptors.
Stockists of the new UNIDEN 28/30 Multimode Transmitter reciever
All available via mail order. Retail/Wholesale

OPEN: MON-SAT 10.30am-6.00pm
SUN 2.30 - 4.30
RING FOR DETAILS (0388) 528464

**JAYCEE ELECTRONICS LTD**
JOHN GM3OPW
**20 Woodside Way, Glenrothes, Fife KY7 5DP**
**Tel: 0592 756962**
Open: Tues-Sat 9-5
Quality secondhand equipment in stock. Full range of TRIO goodies. Jaybeam – Microwave Modules – LAR.

**AGRIMOTORS**
**MERTON CB AND RADIO CENTRE**
**MERTON GARAGE AND POST OFFICE, MERTON.**
**Nr OAKHAMPTON, DEVON EX20 3DZ**
OPEN 6 DAYS 9-6 LUNCH 1-2pm
EARLY CLOSING THURSDAY 1.00pm
(SUNDAYS BY APPOINTMENT)
SPECIALIST IN 934 MHz
SUPPLIERS OF ALL 27MHz AND 934 MHz EQUIPMENT
AMATEUR ACCESSORIES CATERED FOR
08053 200

**MORSE CODE PREPARATION**
Cassette A: 1-12 wpm for amateur.
Cassette B: 12-25 wpm for professional examination preparation.
Each cassette is type C90.
Price of each cassette (including booklets) £3.95.
Morse key with separate batter (PP3) – driven solid-state oscillator and sound transducer produces clear tone for sending practice.
Price of key with electronic unit £8.95.
Price includes postage etc. Europe only
**MH ELECTRONICS (Dept RE)**
**12 Longshore Way, Milton, Portsmouth PO4 8LS**

# COUNTY GUIDE

**RATES**
**BOXES ad sizes**
**20mm x 59mm single**
**40mm x 59mm double**

| Total prepayment rates | Ad space | 3 issues | 6 issues | 12 issues |
|---|---|---|---|---|
| | single | £47.00 | £88.00 | £158.00 |
| | double | £94.00 | £176.00 | £316.00 |

**ON OFFER:** IBM 5110 Mainframe. Printer + Diskette. BBC computer with side ram + Disc Drive. New range of 39 Element 23/24cm aerials **£60.00**. 23/24cm valve cavity amplifiers. Single valve amplifier **£110.00** Two valve **£200.00** complete with base. BIAS circuit + blower. 432MHz dual range converters. 70cm + Satellite 2 metre IF **£40.00.** EMI 2001. TV EQUIPMENT

MICROMAX R.F.SYSTEMS.
TEL 0902 343746. ALL ITEMS + P&P

**RADIO & ELECTRONICS WORLD COUNTY GUIDE ORDER FORM**

**TO:** Radio & Electronics World · Sovereign House · Brentwood · Essex CM14 4SE · England · (0277) 219876

print your copy here ..........

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**NUMBER OF INSERTIONS REQUIRED**

| | | | |
|---|---|---|---|
| Single County Guide | 3 .......... £47.00 ☐ | 6 .......... £88.00 ☐ | 12 .......... £158.00 ☐ |
| Double County Guide | 3 .......... £94.00 ☐ | 6 .......... £176.00 ☐ | 12 .......... £316.00 ☐ |

**PAYMENT ENCLOSED** £ —

Cheques should be made payable to Radio & Electronics World. Overseas payments by International Money Order

Conditions — Payment must be sent with order form. No copy changes allowed. Ads accepted subject to our standard conditions, available on request.

Registered No 2307667 (England)

C P I

Please mention **Radio & Electronics World** when replying to any advertisements

Radio & Electronics World
The communications and electronics magazine

# ADVERTISING RATES & INFORMATION

## DISPLAY AD RATES

| depth mm x width mm | ad space | 1 issue | 3 issues | 6 issues | 12 issues |
|---|---|---|---|---|---|
| | | | series rates for consecutive insertions | | |
| 61 x 90 | ⅛page | £91.00 | £86.00 | £82.00 | £73.00 |
| 128 x 90 or 61 x 186 | ¼ page | £160.00 | £150.00 | £145.00 | £125.00 |
| 128 x 186 or 263 x 90 | ½ page | £305.00 | £290.00 | £275.00 | £245.00 |
| 263 x 186 | 1 page | £590.00 | £560.00 | £530.00 | £475.00 |
| 263 x 394 | double page | £1140.00 | £1070.00 | £1020.00 | £910.00 |

## COLOUR AD RATES

| depth mm x width mm | ad space | 1 issue | 3 issues | 6 issues | 12 issues |
|---|---|---|---|---|---|
| | | colour rates exclude cost of separations | series rates for consecutive insertions | | |
| 128 x 186 or 263 x 90 | ½ page | £420.00 | £395.00 | £375.00 | £335.00 |
| 297 x 210 | 1 page | £810.00 | £760.00 | £730.00 | £650.00 |

## SPECIAL POSITIONS

| | |
|---|---|
| Covers: | Outside back cover 20% extra, inside covers 10% extra |
| Bleed: | 10% extra [Bleed area = 307 x 220] |
| Facing Matter: | 15% extra |

## DEADLINES

*Dates affected by public holidays

| issue | colour & mono proof ad | mono no proof and small ad | mono artwork | on sale thurs |
|---|---|---|---|---|
| Sep 88 | 14 Jul 88 | 20 Jul 88 | 22 Jul 88 | 11 Aug 88 |
| Oct 88 | 11 Aug 88 | 17 Aug 88 | 19 Aug 88 | 8 Sep 88 |
| Nov 88 | 15 Sep 88 | 21 Sep 88 | 23 Sep 88 | 13 Oct 88 |
| Dec 88 | 13 Oct 88 | 19 Oct 88 | 21 Oct 88 | 10 Nov 88 |

## CONDITIONS & INFORMATION

**SERIES RATES**
Series rates also apply when larger or additional space to that initially booked is taken.
An ad of at least the minimum space must appear in consecutive issues to qualify for series rates.
Previous copy will automatically be repeated if no further copy is received.
A 'hold ad' is acceptable for maintaining your series rate contract. This will automatically be inserted if no further copy is received.
Display Ad and Small Ad series rate contracts are not interchangeable.
If series rate contract is cancelled, the advertiser will be liable to pay the unearned series discount already taken.

**COPY**
Except for County Guides copy may be changed monthly.
No additional charges for typesetting or illustrations (except for colour separations).
For illustrations just send photograph or artwork.
Colour Ad rates do not include the cost of separations.

Printed — web-offset.

**PAYMENT**
Above rates exclude VAT.
All single insertion ads are accepted on a prepayment basis only, unless an account is held.
Accounts will be opened for series rate advertisers subject to satisfactory credit references.
Accounts are strictly net and must be settled by publication date.

**FOR FURTHER INFORMATION CONTACT**
Radio & Electronics World, Sovereign House, Brentwood, Essex CM14 4SE.
(0277) 219876

Overseas payments by International Money Order.
Commission to approved advertising agencies is 10%.

**CONDITIONS**
10% discount if advertising in both Radio & Electronics World and Amateur Radio. A voucher copy will be sent to Display and Colour advertisers only.
Ads accepted subject to our standard conditions, available on request.

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## No. 1 LIST BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD1 5 13A junction boxes for adding extra points to your ring main circuit.
BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD7 4 In flex switches with neon on/off lights, saves leaving things switched on.
BD9 2 6V 1A mains transformers upright mounting with fixed clamps.
BD11 1 6½in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
BD13 12 30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.
BD22 2 25 watt loudspeaker two unit crossovers.
BD29 1 B.O.A.C. stereo unit is wonderful value.
BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD34 48 2 meter length of connecting wire all colour coded.
BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. original cost £40 each.
BD49 10 Neon valves, with series resistor, these make good night lights.
BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD59 2 Flat solenoids—you could make your multi-tester read AC amps with this.
BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD91 2 Mains operated motors with gearbox. Final speed 16 rpm, 2 watt rated.
BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD122 10m Twin screened flex with white pvc cover.
BD128 10 Very fine drills for pcb boards etc. Normal cost about 80p each.
BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
BD139 6 Microphone inserts—magnetic 400 ohm also act as speakers.
BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149 6 Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.
BD180 6 Neon indicators in panel mounting holders with lens.
BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD196 1 in flex simmerstat—keeps your soldering iron etc. always at the ready.
BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201 8 Keyboard switches—made for computers but have many other applications.
BD210 4 Transistors type 2N3055, probably the most useful power transistor.
BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD242 2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
BD246 2 Tacho generators, generate one volt per 100 revs.
BD252 1 Panostat, controls output of boiling ring from simmer up boil.
BD259 50 Leads with push-on ¼in tags—a must for hook-ups—mains connections etc.
BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
BD275 1 Guitar mic—clip-on type suits most amps.
BD283 3 Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
BD293 50 Mixed silicon diodes.
BD296 3 Car plugs with lead, fit into lighter socket.
BD305 1 Tubular dynamic mic with optional table rest.

Most other packs still available and you can choose any as your free one.

**VERY POWERFUL 12 VOLT MOTORS—⅓rd HORSEPOWER** Made to drive the Sinclair C5 electric car but equally adapable to power a go-cart, a mower, a rail car, model railway, etc. Brand new. Price £15.00 plus £2.00 postage. Our ref 15P1.

### OVER 400 GIFTS YOU CAN CHOOSE FROM

**There is a total of over 400 packs in our Baker's Dozen range and you become entitled to a free gift with each dozen packs.**
**A classified list of these packs and our latest "News Letter" will be enclosed with your goods, and you will automatically receive our next news letter.**

## NEWLY ADVERTISED ITEMS

**LASER TUBE**
Made by Phillips Electrical. New and unsued. This is helium-neon and has a typical power rating of .9mW. It emits random polarised light and is completley safe provided you do not look directly into the beam when eye damage could result. Do not use in the present of children unless a diverging lens is fitted. DON'T MISS THIS SPECIAL BARGAIN—£29.95 plus £3 insured delivery.

**MUSIC CENTRE PANEL**
Top section is the radio which is Long, Medium FM and Stereo, with calibrated scale and edgewise tuning control. Below this are the main function controls. To the left, :- Bass, Treble, Vol and Bal. These are all slider controls. In the centre section are the press button function switches:-CD/AUX, Tape, Disc, AFC, FM, LW and MW, and on the right a socket for stereo headphones. Below this are twin cassette decks. Again stereo, giving standard playback and record, also tape copying, editing etc. Finally the tape controls:- Record, Play, Rewind, Forward, Stop, Eject and Pause. There is also lead and plug for a Compact Disc Player. Requires only a mains transformer and a pair of speakers. The unit is beautifully made on a panel, size approx. 14½"×10½". Designed originally for a very expensive HiFi or Midi equipment it is "lovely to look at". Coincidentally, it is almost the identical width of the Akai midi racks we are offering and you could easily fit it into this rack. Price £15. Our ref 15P12

**Ex GPO MULTI-RANGE TEST METER 12/C1**
Complete in real leather case with carrying handle—this is a 20,000 OPU instrument, with 19 ranges including AC and DC volts—dc current 5mA to 1A, 4ohms ranges up to 20meg—the low ohms range is particularly useful, you will be able to read right down to one ohm and below. This meter also has provision for reading dc current 0-5 amp and 0-25 amp. Meter size 6" long × 3" wide ×2" deep. Leather case has compartment for test leads, prods, and croc clips all of which are included. Can be used in the case. Not new but are in first class condition—tested and guaranteed. Price is £7.00. Order ref 7P5. Leather case available separately £3.00 ref 3P47.

**RE-CHARGEABLE NICADS 'D' SIZE**
These are tagged for easy joining together but tags, being spot welded, are easy to remove. Virtually unused, tested and guaranteed. £2.00 ref 2P141 or 6 wired together for £10.00 ref 10P47.

**8 TRACK CASSETTE DECK**
Complete with cassette holder. In fact, if you have any 8 track cassettes, then with the addition of 2 speakers this unit would play them. As 8 track cassettes are no longer made the units have become surplus, however, they do contain lots of useful parts: motor, tape head and drive, pulley wheels, etc. and a stereo amplifier. Mains operated. Brand new in makers packing. Only £3.00 each plus £1.00 additional postage. Order ref 3P46.

**COMPUTER BARGAIN—MEMOTECH MTX 512 64K RAM**
Full size QWERTY keyboard with 57 professional keys and additional 12 dual function keys arranged as a separate key pad with cursor control and editing keys. Auto repeat is standard on all keys. This is a very superior home computer and comes complete with power supply, cassette lead, TV lead and 3 cassette programmes. Brand new in manufacturer's original packing with 250 page Operator's Manual. Price £45.00 plus £4.00 postage.

**STEREO SPEAKERS**
Each 10 watts 8 ohm and twin speakers mounted in Walnut-finish cabinets, size 16" high × 10" wide × 6" deep. Front is black Dacron and the finish is very pleasing. Price £7.00 per pair. Extra postage and packing £3.00

**STABILISED 15v 2a PSU**
A kit which mounts on a SRB panel. Mains operated. Ideal to drive monitor, etc. Price only £5.00.

**SMOOTHING CAPACITOR**
2,350uf 63v 10 amp at 50°C. Can type with mounting bracket. Price £2.00. Our ref 2P206.

**SMOOTHING CAPACITOR**
2,200uf 63v 5.8 amp at 50°C. Can type with mounting bracket. Price £1.00. Our ref BO644.

**10 amp 100v BRIDGE RECTIFIER ASSEMBLY**
This comprises of 4 diodes mounted on two 4"×3" sinks with bottom insulators. Price £2.00. Our ref 2P207.

**BRIGHT LIGHT SWITCH**
This will control mains circuits up to 10amps, gets it switch pulses from car headlights, sun, bright daylight, etc., so it does not use batteries and it's sensor is completely isolated from the mains. With full instructions supplied. Price £10.00. Order ref 10P46.

**UNUSUAL MAINS MOTOR**
Quite small, measures only 2"×2"×1" approx., but is surprisingly powerful. it revs at 3,000rpm and is reversible. It has good length ⅛" diameter spindle. Price £1.00. Our order ref BO640.

**RUBBER 13amp EXTENTION LEAD SOCKET**
Virtually unbreakable, made by Duraplug. £1.00 each. Order ref BO641.

**PAPST AXIAL FAN—MANUFACTURERS REF NO. TYP4580N.**
This is mains operated. 15 watt rating and in a metal frame with metal blades so OK in high temperatures. Body size approx. 4¾" square x 1⅝" thick. £6.00 each, plus £1.00 postage. Our ref 6P6.

**PRICE REDUCTION FOR THAT MODEM CONNECTOR**
Standard BT flat plug and 3 metre lead. Price now reduced to 50p, 2 for £1.00. Ref BO552.

**VERY POWERFUL MAGNETS**
Although only less than 1" long and not much thicker than a pencil these are very difficult to pull apart. Could be used to operate embedded reed switches, etc. Price 50p each, 2 for £1.00. Ref BO642.

**AC GENERATOR**
This is really a motor with a permanent magnetic rotor. You would have to make a handle. The voltage out could be up to 100v and the frequency would depend upon the speed of rotation. One use could be to trigger our SS relay 2P183. Another use could be for ringing a bell in a 2 wire telephone circuit. Price £1.00. Our ref BO640.

**FLIP-OVER DIGITAL CLOCK**
Quite an eyecatcher, this is mains operated. The figures flip-over per minute and per hour and give a larger than usual visual display. Supplied complete with front and perspex panels to glue together to make its case. £2.00 each. Our ref 2P205.

**MOTOR TO WORK OFF SOLAR CELLS**
Could drive a fan or other device. Speed would depend upon the number of cells used. Six of our BO631's in series would cause it to rev at a reasonable speed. With twelve it would be quite fast and current would be 25-30mA depending on load. Price of the motor is £1.00. Our ref BO643.

## J & N BULL ELECTRICAL
**Dept REW, 250 PORTLAND ROAD, HOVE BRIGHTON, SUSSEX BN3 5QT**

**MAIL ORDER TERMS:** Cash, PO or cheque with order. Orders under £20 add £1.50 service charge. Monthly account orders accepted from schools and public companies. Access and B/card orders accepted. **Brighton (0273) 734648 or 203500**

## POPULAR ITEMS
### Some of the many items described in our current list which you will receive if you request it

**3½in FDD CHINON** 80 track 500k. Shugart compatible interface. Standard connections, interchangeable with most other 3½in and 5¼in drives. Brand new. £28.50 plus £3 insured post.

**3in FDD HITACHI HFD305SXA** Shugart compatible interface. 500k on 3in disc. Recommended for many Amstrads but interchangeable with most drives. £29.50 plus £3 insured post.

**FDD CASE AND POWER SUPPLY KIT** for the 3in or 3½in. £11.00. Ref 11P2 for the Chinon, 11P3 for the Hitachi.

**9in MONITOR** made for ICL, uses Phillips black and white tube. Brand new and complete but uncased. £16.00 plus £5.00 post.

**ACORN COMPUTER DATA RECORDER REF ALF03** Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. Ref 10P44.

**POWERFUL IONISER** Uses mains transformer. Generates approx. 10 times more ions than the normal diode/cap ladder circuits. Complete kit £11.50 plus £3.00 post.

**3 INCH FDD** Hitachi ref. HFD 305SXA. Ideal replacement or second drive in most computers, especially Amstrad 6128, etc. Price £30 plus £3 post.

**FREE POWER!** Can be yours if you use our solar cells—sturdily made modules with new system bubble magnifiers to concentrate the light and so eliminate the need for actual sunshine—they work just as well in bright light. Voltage input is .45—you join in series to get desired voltage—and in parallel for more amps. **Module A** gives 100mA, Price £1, Our ref. BO631. **Module C** gives 400mA, Price £2, Our ref. 2P199. **Module D** gives 700mA, Price £3, Our ref. 3P42.

**SOLAR POWERED NI-CAD CHARGER** 4 Ni-Cad batteries AA (HP7) charged in eight hours or two in only 4 hours. It is a complete, boxed ready to use unit. Price £6. Our ref. 6P3.

**50V 20A TRANSFORMER** 'C' Core construction so quite easy to adapt for other outputs—tapped mains input. Only £25 but very heavy so please add £5 if not collecting. Order Ref. 25P4.

**15A PANEL METER** These have been stripped from Government surplus battery charger units made originally for army use. Unused, tested but of course rather old, diameter 2in can be surface or flush mounted. £3 each. Our Ref. 3P40.

**SWITCH AC LOADS WITH YOUR COMPUTER** This is easy and reliable if you use our solid state relay. This has no moving parts, has high input resistance and acts as a noise barrier and provides 4kW isolation between logic terminals. The turn-on voltage is not critical, anything between 3 and 30V, internal resistance is about 1K ohm. AC loads up to 10A can be switched. Price is £2 each. Ref. 2P183.

**METAL PROJECT BOX** Ideal size for battery charger, power supply etc.; sprayed grey, size 8in x 4¼in x 4in high, ends are louvred for ventilation other sides are flat and undrilled. Order Ref. 2P191. Price £2.

**BIG SMOOTHING CAPACITOR**. Sprague powerlytic 39,000uF at 50V. £3. Our ref. 3P41.

**HEAVY DUTY CURLY MAINS LEAD.** Can be loaded up to 13A, stretces to almost 3 metres fitted with 13A plug. £3. Order ref. 3P42.

**4-CORE FLEX CABLE.** Cores separately insulated and grey PVC covered overall. Each copper core size 7/0.2mm. Ideal for long telephone runs or similar applications even at mains' voltage. 20 metres £2. Our ref.2P196 or 100 metres coil £8. Order ref. 8P19.

**6-CORE FLEX CABLE.** Description same as the 4-core above. Price 15 metres for £2. Our ref. 2P197 or 100 metres £9. Our ref. 9P1.

**BULK-HEAD MOUNTING LOUDSPEAKER.** Metal case with chrome grill front and with mounting lugs for screwing to ceiling, 8in. speaker. £10 each. Order ref. 10P43 add £2 post.

**TWIN GANG TUNING CAPACITOR.** Each section is .0005uF with trimmers and good length ¼in spindle. Old but unuse3d and in very good condition. £1 each. Our ref. BO630.

**13A PLUGS** Good British make complete with fuse, parcel of 5 for £2. Order ref. 2P185.

**13A ADAPTERS** Takes 2 13A plugs, packet of 3 for £2. Order ref. 2P187.

**20V-0-20V** Mains transformers 2½ amp (100 watt) loading, tapped primary. 200-245 upright mountings £4. Order ref. 4P24.

**BURGLAR ALARM BELL**—6" gong OK for outside use if protected from rain. 12V battery operated. Price £8. Ref. 8P2.

**24 HOUR TIME SWITCH**—16A changeover contacts, up to 6 on/offs per day. Nicely cased, intebnded for wall mounting. Price £8. Ref. 8P6.

**CAPACITOR BARGAIN**—axial ended, 4700$\mu$F at 25V. Jap made, normally 50p each, you get 4 for £1. Our ref. 613.

**PIEZO ELECTRIC FAN**—An unusual fan, more like the one used by Madame Butterfly than the conventional type, it does not rotate. The air movement is caused by two vibrating arms. It is American made, mains operated, very economical and causes no interference, so is ideal for computer and instrument cooling. Price is only £1 each. Ref. BO598.

**SPRING LOADED TEST PRODS**—Heavy duty, made by the famous Bulgin company. very good quality. Price 4 for £1. Ref. BO597.

**CURLY LEAD**—Four core, standard replacement for telephone handset, extends to nearly 2 metres. Price £1 each. Ref. BO599.

**ASTEC P.S.U.**—Switch mode type. Input set for +230V. Output 3.5 amps at +5V, 1.5 amps at +12V, and 3 amps at +5V. Should be OK for floppy disc drives. Regular price £30. Our price only £10. Ref. 10T34. Brand new and unused.

**APPLIANCE THERMOSTATS**—Spindle adjust type suitable for convector heaters or similar. Price ? for £1. Ref. BO582.

**3-CORE FLEX BARGAIN No. 1**—Core size 5mm so ideal for long extension leads carrying up to 5 amps or short leads up to 10 amps. 15mm for £2. ref. 2P189.

**3-CORE FLEX BARGAIN No. 2**—Core size 1.25mm so suitable for long extension leads carrying up to 13 amps, or short leads up to 25A. 10m for £2 Ref. 2P190.

**ALPHA-NUMERIC KEYBOARD**—This keyboard has 73 keys giving trouble free life and no contact bounce. The keys are arranged in two groups, the main area is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13" x 4"—brand new but offered at only a fraction of its cost, namely £3, plus £1 post. Ref. 3P27.

**WIRE BARGAIN**—500 metres 0.7mm solid copper tinned and p.v.c. covered. Only £3 plus £1 post. Ref. 3P31—that's well under 1p per metre, and this wire is ideal for push on connections.

**INTERRUPTED BEAM KIT**—This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components—relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price £2. Ref. 2P15.

**3-30V VARIABLE VOLTAGE POWER SUPPLY UNIT**—with 1 amp DC output. Intended for use on the bench for experimenters, students, inventors, service engineers etc. This is probably the most important piece of equipment you can own (after a multi range test meter). It gives a variable output from 3-30 volts and has an automatic short circuit and overload protection, which operaes at 1.1 amp approximately. Other features are very low ripple output, a typical ripple is 3mV pk-pk, 1mV rms. Mounted in a metal fronted plastic case, this has a voltmeter on the front panel in addition to the output control knob and the output terminals. Price for complete kit with full instructions is £15. Ref. 15P7.

## ELMASET INSTRUMENT CASE

300x133x217mm deep ........ £10.00 ea (£2.20)

## REGULATORS

LM317T Plastic T0220 variable ........ £1
LM317 Metal ........ £2
7812 Metal 12v 1A ........ £1.00
CA3085 T099 Variable regulator ........ £1
LM338 5A variable ........ £5

## COMPUTER ICS

8741 Micro Ex equipment ........ £1.30
8039 Ex equipment ........ £1.00
4164-15 Ex Eqpt ........ £1
27128 250n[S] NEW ........ £3.00
68008 Processor Ex-Equip ........ £5
27256-30 ex-eqpt ........ £3.00
2764-30 2176 USED ........ £2
1702 EPROM ex equip ........ £5.00
2732-45 2716 USED £2 ........ 100 | £1.50
2114 EX EQPT 60p 4116 EX EQPT ........ 70p
4416 RAM ........ £3.50
D446C (TC5517AP) ........ £1.50
ZN427E-8 ........ £4.00
ZN428E-8 ........ £4.00

## CRYSTAL OSCILLATOR

1.8342MHz ........ 2/£1.50

## SIL RESISTOR NETWORKS

8 pin 10K 22K ........ 5/£1.00
9 pin 22K ........ 5/£1.00
10 pin 68R 180R 22K ........ 5/£1.00

## SURFACE MOUNTED TRANSISTORS

BCW31 BCW72 NTAV70 1S2836 min 50/type ........ 100 £2.50

## TRANSISTORS

BC107 BCY70. Pre formed leads full spec
20/£1 100/£4 1000/£30

## POWER TRANSISTORS

POWER FET IRF9531 8A 60V P channel to 220 ........ 2/£1
2N3055H RCA House numbered ........ 5/£2
2SC1520 sim BF259 ........ 3/£1 100/£22
TIP141, 142/146, £1 ea, TIP110, 125, 42B ........ 2/£1
TIP35B £1.30 TIP35C ........ £1.50
SE9302 100V 10A DARL SIM TIP121 ........ 2/£1
2N3055 Ex eqpt tested ........ 4/£1
Plastic 3055 or 2955 equiv 50p ........ 100/£35
2N3773 NPN 25A 160V £1.80 ........ 10/£16
BD132 ........ 5/£1

## QUARTZ HALOGEN LAMPS

A1/216 24v 150w ........ £2.25
H1 12v 55w (car spot) ........ £1.50

## NICKEL CADMIUM BATTERIES

7.2 Volts 1.8 A/hr C Cells in packs of 6 ........ £5 P&P £1

## ZIF SOCKETS

TEXTOOL single inline 32 way. Can be ganged for use with any dual inline devices ........ 2/£1.50

## MISCELLANEOUS

BNC to croc clips lead 1 metre ........ £1
Small Microwave Diodes AEI DC1028A ........ 2/£1
Moulded inductor 470uH size of a 1 watt film resistor ... 5/£1
To-220 Heat Sink sim RS 403-162 ........ 10/2.50
D.I.L. Switches 10 Way £1 8 Way 80p. 4/5/6 Way 50p
180 Volt 1 watt ZENERS ALSO 12V ........ 20/£1
Olivetti logos calculator keyboard (27) key plus 12 Digit flourescent display on driver boad (ie calculator less case, transformer and printer) ........ £1.30
Plastic Equipment case 9x6x1.25" with front and rear panels containing PCB with eprom 2764 -30 and ICS 7417 LS30 LS32 LS74 LS367 LM311 7805 Reg. 9 way D plug, push button switch, din socket ........ £1.90
VNIOLM 60V 1/2 5ohm TO-92 mosfet ........ 4/£1. 100/£20
MIN GLASS NEONS ........ 10/£1
RELAY 5v 2 pole changeover looks like RS 355-741 marked STC 47WBO5T ........ 2/£1
MINIATURE CO-AX FREE PLUG RS 456-071 ........ 2/£1
MINIATURE CO-AX FREE SKT RS 456-273 ........ 2/£1.50
STRAIN GAUGES 40 ohm Foil type polyester backed balco grid alloy ........ £1.50 ea 10+ £1
DIL REED RELAY 2 POLE n/o CONTACTS ........ £1
ELECTRET MICROPHONE INSERT ........ £0.90
Linear Hall effect IC Micro Switch no 613 SS4 sim RS 304-267 ........ £2.50 100+ £1.50
Hall Effect IC UGS3040 + MAGNET ........ £1.00
OSCILLOSCOPE PROBE SWITCHED X1X10 £10

CHEAP PHONO PLUGS ........ 100 £2 1000/£18
1 pole 12 way rotary switch ........ 4/£1
AUDIO ICS LM380 LM336 ........ £1 ea
555 Timer 5/£1 741 Op AMP ........ 5/£1
COAX PLUGS nice ones ........ 4/£1
4 x 4 MEMBRANE KEYBOARD ........ £1.50
15,000uF 40V SPRAGUE ........ £2.50 (£1.25)
INDUCTOR 20uH 1.5A ........ 5/£1
NEW BT PLUG + LEAD ........ £1.50
1.25" PANEL FUSEHOLDERS ........ 5/£1
CHROMED HINGES 14.5 x 1" OPEN ........ £1 ea
TOK KEY SWITCH 2 POLE 3 KEYS ideal for car/home alarms ........ £3
12v 1.2W small wire ended 1 amps fit AUDI VW TR7 SAAB VOLVO ........ 10/£1
12V MES LAMPS ........ 10/£1
STEREO CASSETTE HEAD ........ £2
MONO CASS. HEAD ........ £1 ERASE HEAD 50p
THERMAL CUT OUTS 50 77 85 120C ........ £1 ea
THERMAL FUSE 121C 240V 15A ........ 5/£1
TRANSISTOR MOUNTING PADS TO-5/TO-18 ........ £3/1000
TO-3 TRANSISTOR COVERS ........ 10/£1
STICK ON CABINET FEET ........ 30/£1
PCB PINS FIT 0.1" VERO ........ 200/£1
TO-220 micas + bushes ........ 10/50p 100/£2
TO-3 micas + bushes ........ 20/£1
PTFE min screen cable ........ 10m/£1
Large heat shrink sleeving pack ........ £2
CERAMIC FILTERS 6M/9M/10.7M ........ 50p 100/£20
TOKIN MAINS RFI FILTER 250v 15A ........ £3
IEC chassis plug rfi filter 10A ........ £3
Potentiometers short spindles values 2k5 10k 25k 1M 2M5 new value ........ 5/£1
500k lin 500k log ........ 4/£1
40Khz ULTRASONIC TRANSDUCERS EX-EQPT NO DATA ........ £1/pr
PLESSEY INVERTER TRANSFORMER 11.5-0-11.5V to 240v 200VA ........ £6 (£3)

## ZENERS

5.6V IW3 Semikron 49K available ........ £25/1000
Supressor OF606 120V BI Directional Zener in 3 amp W/E package ........ 5/£1.00

## DIODES & RECTIFIERS

BAW76 Equiv IN4148 ........ £60/10,000
1N4148 ........ 100/£1.50
1N4004/SD4 1A 300V ........ 100/£3
1N5401 3A 100V ........ 10/£1
BA158 1A 400V fast recovery ........ 100/£3
BA159 1A 1000V fast recovery ........ 100/£4
120v 35A stud ........ 65p
12 FL10 12A 200V small stud
........ 4/£1.50 100/£25
BY127 1200V 1.2A ........ 10/£1
BY254 800v 3A ........ 8/£1
BY255 1300v 3A ........ 6/£1
6A 100V Similar MR751 ........ 4/£1
1A 800v bridge rectifier ........ 4/£1
4A 100V bridge ........ 3/£1
6A 100v bridge ........ 50p
8A 200V Bridge ........ 2/£1.25
10A 200v bridge ........ £1.50
25A 200v bridge £2 ea ........ 10/£18
25A 400v bridge £2.50 ........ 10/£22

## SCRs

2P4M equiv C106D ........ 3/£1 100/£20
MCR72-6 10A 600v SCR ........ £1
35A 600v stud ........ £2
TICV106D .8A 400v SCR 3/£1 ........ 100/£15
MEU21 Prog. unijunction ........ 3/£1

## TRIACS — diacs 25p

NEC Triac ACO8F 600V TO 220
........ 5/£2 100/£30
Diacs ........ 4/£1
TXAL225 8A 400V 5mA gate 2/£1 ........ 100/£35
TRAL 2230D 30A 400V isolated stud ........ £4 each

## CONNECTORS

DIN 41612 96way socket (3row) right angle pcb pins SIM RS 470-443 ........ £1.20 each
DIN 41612 64 way a/c plug right angle pcb pins SIM RS 470-465 ........ £1.00 each
34 way card edge IDC connector (disk drive type) ... £1.25
Centronics BBC Printer lead ........ £3.50
Centronics 36way IDC plug ........ £2.50
Centronics 36way IDC skt ........ £4
Centronics 36way plug (solder type) ........ £4
USED Centronics 36W plug & socket ........ £3

D 9-way £1, 15-way £1.50; 25-way ........ £2
37-way £2, 50-way £3.50; covers 50p ea

## WIRE WOUND RESISTORS

**W21 or Sim 2.5W 27R ........ 10 of one value £1**
R10 0R15 0R22 2R0 4R7 5R0 5R6 8R2 10R 12R 15R 18R 20R 22R 27R 33R 36R 47R 56R 62R 75R 3R9 91R 100R 120R 180R 390R 430R 470R 560R 680R 820R 910R 1K15 1K2 1K5 1K8 2K4 2K7 3K3 3K0 5K0 10K
**R05 (50 milli-ohm) 1% 3W ........ 4 for £1**
**W22 or Sim 6W ........ 7 of one value £1**
R47 1R0 1R5 3R3 6R8 9R1 10R 20R 27R 33R 51R 56R 62R 68R 100R 120R 180R 390R 500R 560R 620R 910R 1K0 1K2 1K5 1K8 2K7 3K3 3K9 4K7 10K
**W23 or Sim 9W ........ 6 of one value £1**
R22 R47 1R0 1R1 15R 56R 62R 68R 100R 120R 180R 220R 300R 390R 680R 1K0 1K5 5K1 10K
**W24 or Sim 12W ........ 4 of one value £1**
R50 1R0 2R0 6R8 9R1 10R 18R 22R 27R 56R 68R 75R 82R 100R 150R 200R 220R 270R 400R 620R 6K8 8K2 1K0 10K 15K

## WIRE WOUND RESISTORS — BOLT ON HEATSINK TYPE

10 watt 39R, 180R ........ 40p each
25 watt R33, 1R2, 1R5, 4R7, 25R, 100R ........ 50p each
50 watt 3R3, 5R1, 18R, 27R ........ 60p each

## PHOTO DEVICES

BPW50 Infra red photo Diode ........ 3/£1
Slotted opto-switch OPCOA OPB815 ........ £1.30
2N5777 ........ 50p only
TIL81 T018 Photo transistor ........ £1
TIL38 Infra red LED ........ 5/£1
OP12252 Opto isolator ........ 50p
Photo diode 50p ........ 6/£2
MEL12 (Photo darlington base n/c) ........ 50p
RPY58A LDR 50p ORP12 LDR ........ 70p
GREEN or YELLOW 3 or 5mm 10/£1 ........ 100/£6.50
FLASHING RED OR GREEN LED 5mm 50p ........ 100/£35
LEDS assorted RD/GN/YW + INFRE/RED ........ 200/£5

## SUB MIN PRESETS HORIZONTAL

1K 4K7 10K 22K 47K 1M 10M ........ 15/£1 100/£5

## CERMET MULTI TURN PRESETS 3/4"

10R 20R 100R 200R 250R 500R ........ 50p
2K 5K 10K 22K 50K 100K 200K 2K2 2K5 47K 500K 2M2

## IC SOCKETS

6-pin 15/£1 8-pin 12/£1; 14-pin 10/£1.00; 18/20-pin 7/£1; 22/24/28 pin 4/£1 40 pin 30p

## TRIMMER CAPACITORS — 5/50p

Grey larger type 2 to 25pF Transistors 2N4427 ........ 60p
Feed Thru Ceramic Caps 1000pF ........ 10/£1

## SOLID STATE RELAYS NEW 10A 250v AC

Zero voltage switching Control voltage 8-28v DC ........ £2.50
40A 250V AC Solid State relays ........ £18

## POLYESTER/POLYCARB CAPS

1uF 100v 10mm SIEMENS block polycarb 10k available
1000/£80
1n/3n3/5n6/8n2/10n 1% 63v 10mm ........ 100/£6
2µ2 160v rad 22mm ........ 100/£10
33n/47n 250v AC X rated rad 15mm ........ 10/£1.00
1µ 600V Mixed dielectric ........ 50p ea

## STC NTC BEAD THERMISTORS

G22 220R G13 1K G23 2K G54 50K G25 200K G16 1M Res@ 20'c directly heated type ........ £1 each
FS22BW NTC Bead inside end of 1" glass probe res @ 20'c 200R ........ £1.00

## BEAD TANTALUM CAPS

6UB 25V, 47U 3V, 2U2 20V, 10U 10V ........ 12/£1 100/£6

## MONOLOTHIC CERAMIC CAPS

10n 50V 2.5mm ........ 100/£4.50
100n 50v ........ 2.5mm or 5mm 100/£6
100N 50V axial Shortleads ........ 100/£3
100n ax long leads ........ 100/£6
100n 50v RAD 0.3" centres ........ 100/£10

## STEPPER MOTOR 4 PHASE 2 9v WINDINGS

£3.50 ........ 10/£30

# KEYTRONICS

**MAIL ORDER ONLY**

**P.o. Box 634**
**Bishops Stortford, Herts, CM23 2RX**
**☎ 0279 505543 : FAX 0279-757656**

MIN CASH ORDER £3.00 OFFICIAL ORDERS WELCOME
UNIVERSITIES COLLEGES SCHOOLS GOVT DEPARTMENTS
MIN. ACCOUNT ORDER £10.00

P&P AS SHOWN IN BRACKETS (HEAVY ITEMS)
65p OTHERWISE (LIGHT ITEMS)

**ADD 15% VAT TO TOTAL**

**ELECTRONIC COMPONENTS BOUGHT FOR CASH**

Access