# Litton Magnetrons

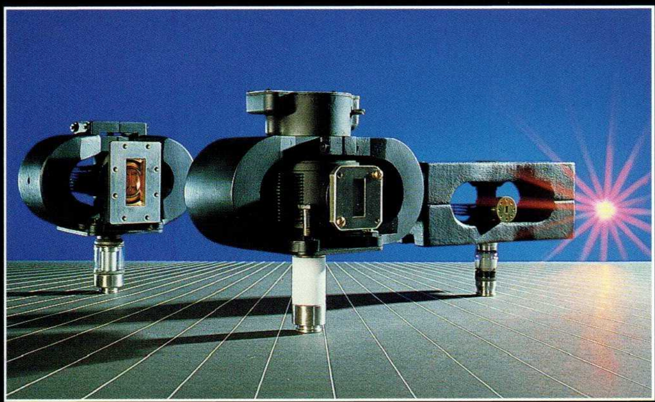
Litton Systems is one of the country's leading manufacturers of microwave power tubes. It is the only U.S. manufacturer that has a complete, diverse line of generic magnetrons including coaxial, vane and strap, and rising sun types.

All generic classes of magnetrons start out equal. They all use the same basic equations to generate dimensional parameters inside the magnetron, where electron interaction takes place. However, no single type of magnetron satisfies all systems' criteria. Certain performance parameters are inherent in a generic glass that make them suitable for a particular application.

**VANE AND STRAP**

With roots going back to World War II, the vane and strap circuit is the first modern day magnetron circuit. It was the next evolution from the hole and slot configuration, which was less efficient and suffered from mode instability problems.

The vane and strap magnetron accomplishes its mode selection, as the name implies, by strapping or connecting alternate vanes together with circular bits of wire called straps. Unstrapped, the resonator structure looks like many half-wave resonator circuits in series which would have multiple possible modes of oscillation. Connecting every other vane with an independent strap (two are required) effectively places the resonators in parallel so that for one frequency only, every vane is 180 electrical degrees out of phase from its neighboring wave, hence the term "PI mode."



Connecting the vanes in this fashion allows no undesirable modes of operation close to the intended operating frequency. So the dominant mode is the PI mode or intended operating mode. For this reason, the vane and strap circuit has a very reliable starting region, which produces extremely low jitter values of .5 to 1 nanosecond RMS. All of the stored energy is contained in the resonator circuit and is coupled to the waveguide through a single aperture or loop from one resonator section. The vane length and interstrap capacity therefore determines the exact operating frequency of the tube.

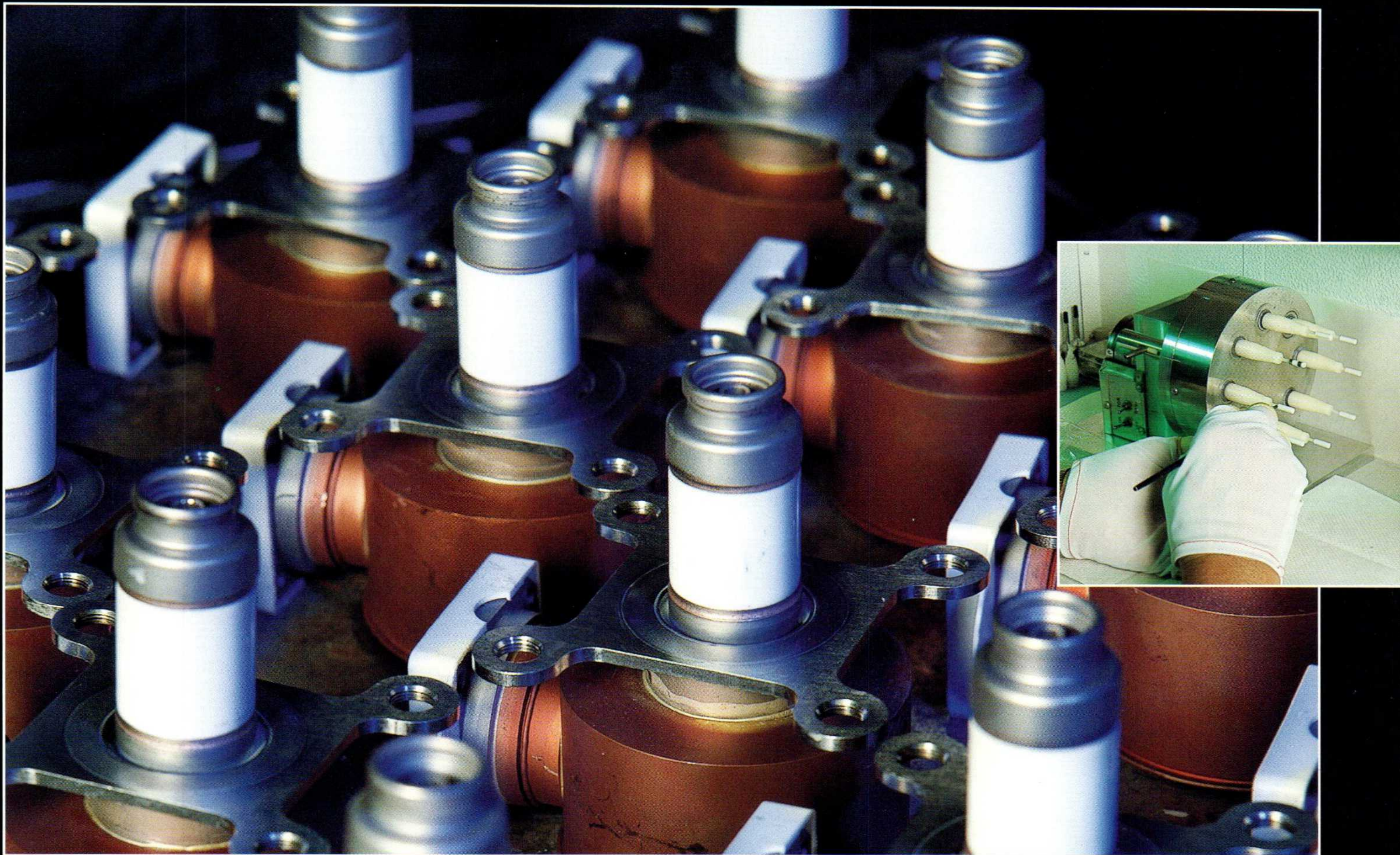
The unsymmetrical loading of the resonator causes this circuit to be unbalanced and thus more sensitive to modulator and antenna variations than the coaxial magnetron. it also begins to be nonproductive above 12 GHz as the efficiency falls off. Normally, this can be offset by increasing the number of resonators, but mechanical assembly problems and electrical design limitations begin to restrict the number of resonators that can be successfully strapped. Below 10 GHz the vane and strap structure is very attractive. Its simplicity provokes a lower-cost tube, with efficiencies that rival the coaxial structure. In addition, resonator vanes are attached directly to a large anode block tied in turn to the external heat sinking mechanism to provide a smaller package for a given power input level.

A positive anode magnetron is another form of a vane and strap magnetron; however, the anode is modulated rather than the cathode. Operating characteristics are similar to the vane and strap. The positive anode magnetron has a greatly reduced magnetic reluctance path; hence it requires approximately one-quarter the magnetic material of a conventional magnetron. The single disadvantage is that the anode must dissipate through an insulation medium, which restricts the heat transfer and limits its applications to low power levels (below 10 kW) and low duty factors.

**COAXIAL**

The coaxial circuit is the most recent development in pulsed magnetrons. Developed in the early 1960s, it consists of a one-half wavelength circular cavity mounted coaxially around the resonator structure. This configuration offers an improvement in some performance features over the vane and strap and rising sun structures, especially pushing and pulling. Mode selection is accomplished by closely coupling this resonant cavity to every other resonator section via small coupling apertures in the resonator back wall. The PI mode is selected because the coupling apertures are 360 electrical degrees apart and equal to the resonant frequency of the cavity, only at one frequency. Every vane tip is 180 degrees out of phase with its neighbor. The coupling is adjusted to store approximately 75 percent of the energy in the coaxial cylinder. Effects from antenna loading changes (pulling) are one-quarter as much as the vane and strap or rising sun structures. The high Q of a coaxial cylinder, coupled to the resonator structure, yields an overall Q of 8000 compared with 2000 for a vane and strap or rising sun. High Q has a stabilizing effect on the frequency when pulling conditions exist. The principal effect is on frequency deviations caused by current changes through the tube (pushing); changes are about one-quarter as great as in vane and strap or rising sun types.

The coaxial structure is more tolerant of poor pulse shapes, especially at long pulse conditions. In addition, effects of the cavity reduce the inherent amount of random frequency modulation during the pulse period compared with vane and strap and rising sun types. There are, however, some compromises to consider. Because there are two coupling schemes, one between the resonator and the cavity and the other between the cavity and the output, undesirable modes occur above and below the intended mode of operation. Such modes are usually damped internally with dissipative absorbers. Their effects, however, are still present, and because of their close proximity to the PI mode, the circuit does not oscillate consistently. Leading edge time jitter variations are approximately four times greater than the vane and strap or rising sun. Care must be exercised in designing the starting characteristics of the modulator in order to minimize starting mode phenomena. The modulator voltage rise rate must be contained within certain prescribed limits to prevent mode skipping. Short pulse operation below 200 nanoseconds at frequency bands below Ku is not recommended. Cost also increases because of the addition of the cavity and the necessary increase in magnet size required to encircle the cavity, especially at lower frequencies.



From an environmental standpoint, the coaxial circuit is much easier to temperature compensate than the vane and strap or rising sun. On the other hand, frequency deviations caused by vibration are magnified in tunable versions because of the cantilevered, suspended tuning disk in the ceiling of the cavity. Isolation type tube mounting supports will, however, eliminate vibration effects. The coaxial circuit has an inherent thermal impedance situation which imposes duty factor limits and high average power levels. More vanes can be added to reduce tip temperatures. High dissipation values, however, are limited by the restricted heat transfer mechanism between the anode resonator and the external heat sink.

**RISING SUN**

The rising sun circuit derives its name from the appearance of its resonator cross section. Resonators are alternately large and small with a common inner diameter. The geometry results from the electrical design, which is a closely coupled dual resonant system. Every other resonator is resonant to F1, while the interposing resonators are resonant to F2. Because the resonators are closely coupled, a single PI mode F3 frequency becomes outstanding, with the competing modes becoming widely separate. Mechanically it can be thought of as an extension of the vane and strap circuit. As the frequency of the magnetron increases, the geometry becomes smaller and the straps more difficult to fabricate. Ultimately, it becomes easier to foreshorten the back wall of the resonator section to coincide with the equivalent RF position of the straps.

Although rising sun structures are about 40 years old, they have never enjoyed the popularity of coaxial or vane and strap magnetrons because market interest in millimeter bands has not been high. Rising sun structures are a low-cost extension of the vane and strap circuit into the 100 GHz region. They tolerate very high rates of voltage rise because of relatively low Qs and wide mode separation, so short pulse operation is very practical.

As the frequency increases above 35 GHz, rising sun magnetrons approach a mechanical limitation in the number of vanes that can be used. Coaxial circuits offer the ability to use a larger number of vanes, allowing them to operate at power levels with slightly improved efficiencies. Coaxial circuits have been developed to 70 GHz and rising sun circuits to 95 GHz.

**INJECTION-LOCKED**

Injection-locked magnetrons are emerging as a viable alternative to traveling-wave tubes (TWTs) and klystrons in applications where coherency is needed. These magnetrons offer greater cost-effectiveness than linear beam tubes, along with the rare combination of compact size and good performance.

The concept of injection locking is fairly simple. A low-level coherent signal is applied directly to the resonant circuit of a free-running, high-power oscillator. If the coherent source frequency is close enough to the oscillator free-running frequency and the signal amplitude is large enough, the high-power device will assume the frequency and phase stability of the coherent source over a certain bandwidth. In the case of an injection-locked magnetron, the energy is coupled into the anode through a circulator.

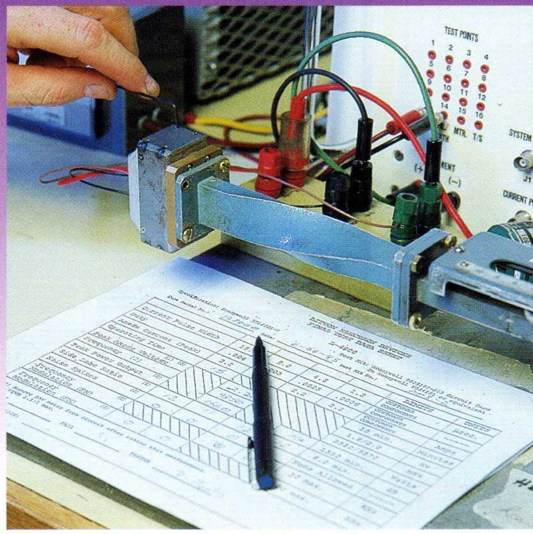
(continued on page 5)

# VANE AND STRAP MAGNETRONS

| TYPE Dimen. | BAND | FREQUENCY (GHz) | PEAK POWER (kW) | DUTY CYCLE | NOM. ANODE VOLTAGE (kV) | PEAK ANODE CURRENT (A) | CODE |
|---|---|---|---|---|---|---|---|
| L-3858 | S | 2.45 | 2.5 | CONTINUOUS | 7.2 | 0.56 | FSZE |
| L-4933 | S | 2.72 | 480 | 0.0007 | 26 | 50 | FCYK |
| L-4932 | S | 2.76 | 480 | 0.0007 | 26 | 50 | FCYK |
| L-4931 | S | 2.80 | 480 | 0.0007 | 26 | 50 | FCYK |
| L-4919 | S | 2.805 | 4500 | 0.001 | 70 | 130 | FWZB |
| L-4930 | S | 2.84 | 480 | 0.0007 | 26 | 50 | FCYK |
| L-4929 | S | 2.88 | 480 | 0.0007 | 26 | 50 | FCYK |
| L-4928 | S | 2.9-3.1 | 1000 | 0.001 | 45 | 50 | MWYB |
| L-4678 | C | 3.9-4.1 | 350 | 0.001 | 25.5 | 27.0 | MWYB |
| L-4820 | C | 4.5-5.1 | 250 | 0.00125 | 25.0 | 25.0 | MWYB |
| L-4727 | C | 5.4 | 85 | 0.0012 | 15.0 | 13.5 | FWYB |
| 7156B | C | 5.45-5.825 | 250 | 0.0006 | 26.0 | 24.0 | MWYB |
| 6344A | C | 5.45-5.825 | 175 | 0.00085 | 21.5 | 22.0 | MWYB |
| L-5080 | C | 5.45-5.825 | 250 | 0.001 | 25.0 | 24.0 | MWYB |
| 7156A | C | 5.45-5.825 | 225 | 0.0009 | 24.0 | 24.5 | MWYB |
| L-4701 | C | 6.8-7.3 | 300 | 0.001 | 24.5 | 27.0 | MWYB |
| L-3106A | X | 8.5-9.6 | 65 | 0.001 | 15.0 | 15.0 | MWYB |
| 6543 | X | 8.5-9.6 | 65 | 0.001 | 15.0 | 15.0 | MWYB |
| 6543A | X | 8.5-9.6 | 65 | 0.001 | 15.0 | 15.0 | MWYB |
| L-4193A | X | 8.5-9.6 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| 7008 | X | 8.5-9.6 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L-4193K | X | 8.5-9.6 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L-4193H | X | 8.5-9.6 | 210 | 0.001 | 22.0 | 27.5 | MWYB |
| 5780 | X | 8.5-9.6 | 250 | 0.001 | 33.0 | 32.0 | MWYB |
| L-4773 | X | 8.9 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L-4731 | X | 9.0-9.5 | 200 | 0.00016 | 22.0 | 27.5 | MWYB |
| 7006 | X | 9.0-9.6 | 190 | 0.0013 | 21.0 | 27.5 | MWYB |
| L-4951 | X | 9.050 | 40 | 0.0011 | 14 | 14 | FWYB |
| L-4498 | X | 9.15-9.45 | 65 | 0.001 | 15.0 | 15.0 | MWYB |
| L-4193B | X | 9.2-9.55 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L5145 | X | 9.275-9.295 | 1.0 | 0.0033 | 2.8 | 1.33 | MWXB |
| L-3028D | X | 9.28-9.33 | 0.10 | 0.027 | 0.8 | 0.55 | MWXB |
| L-3225 | X | 9.31-9.35 | 1.0 | 0.0033 | 2.8 | 1.33 | MWXB |
| L-4706 | X | 9.345 | 1.1 | 0.002 | 2.0 | 2.2 | MWXB |
| L-4698B | X | 9.345 | 1.3 | 0.0027 | 2.0 | 2.2 | MWXB |
| L-4800 | X | 9.345 | 1.3 | 0.0042 | 2.0 | 2.2 | MWXB |
| L-4697 | X | 9.345 | 5.0 | 0.001 | 4.4 | 4.5 | MWXB |
| L-4651 | X | 9.375 | 5.0 | 0.001 | 4.4 | 4.5 | MWXB |
| L-4702 | X | 9.375 | 6.5 | 0.00035 | 4.5 | 4.85 | MWXB |
| L-4942 | X | 9.375 | 7.0 | 0.002 | 5.5 | 4.5 | FWCB |
| L-4943 | X | 9.375 | 7.0 | 0.002 | 5.5 | 4.5 | FWCB |
| L-4601C | X | 9.375 | 9.5 | 0.00035 | 5.7 | 5.70 | MWXB |
| L-3431A | X | 9.375 | 18 | 0.001 | 7.0 | 7.0 | MWXB |
| L-3654A | X | 9.375 | 24 | 0.001 | 8.0 | 8.25 | MWXB |
| L-3890 | X | 9.375 | 24 | 0.001 | 8.0 | 8.25 | MWXB |
| 4J52A | X | 9.375 | 70 | 0.001 | 15.0 | 14.0 | MWYB |
| 4J52B | X | 9.375 | 70 | 0.0012 | 15.0 | 15.0 | MWYB |
| 4J50A | X | 9.375 | 225 | 0.001 | 21.5 | 27.5 | MWYB |
| L-4801 | X | 9.4-9.6 | 8.0 | 0.001 | 5.8 | 5.0 | MWXB |
| L-4685 | X | 9.41 | 70 | 0.001 | 15.0 | 15.0 | MWXB |
| L-3101A | Ku | 16.0-17.0 | 60 | 0.001 | 16.5 | 16.0 | MWYB |

# COAXIAL MAGNETRONS

| TUBE Dimen. | BAND | FREQUENCY (GHz) | PEAK POWER (kW) | DUTY CYCLE | NOM. ANODE VOLTAGE (kV) | PEAK ANODE CURRENT (A) | CODE |
|---|---|---|---|---|---|---|---|
| L-4570 | C | 5.4-5.88 | 250 | 0.0013 | 25.0 | 20.0 | MWYB |
| L-4469 | X | 8.5-9.6 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L-4936 | X | 7.8-8.5 | 20 | 0.0012 | 8.0 | 8.25 | MWXB |
| L-4972 | X | 8.5-9.6 | 20 | 0.0012 | 8.0 | 8.25 | MWXB |
| L-4575 | X | 8.5-9.6 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L-4593 | X | 8.5-9.6 | 250 | 0.0005 | 25.0 | 27.5 | MWYB |
| L-4590 | X | 8.7-9.4 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L-4770 | X | 9.0-9.16 | 70 | 0.00066 | 14.5 | 14.0 | MWYB |
| L-4791 | X | 9.0-9.2 | 80 | 0.0011 | 14.8 | 16.0 | MWYB |
| L-4581 | X | 9.0-9.6 | 220 | 0.001 | 21.5 | 27.5 | MWYB |
| L-4979 | X | 9.05-10.0 | 100 | 0.001 | 17.7 | 18 | MWYB |
| L-4666 | X | 9.16-9.34 | 350 | 0.001 | 26.5 | 30.0 | MWYB |
| L-4583A | X | 9.2-9.55 | 200 | 0.001 | 22.0 | 27.5 | MWYB |
| L-5190 | X | 9.240 | 90 | 0.001 | 15.0 | 13.5 | FWXB |
| L-5362B | X | 9.345 | 10 | 0.001 | 5.0 | 5.0 | FWXB |
| L-5274B | X | 9.345 | 7.5 | 0.001 | 4.3 | 4.5 | FWXB |
| L-4652B | X | 9.345 | 8.7 | 0.001 | 4.35 | 4.76 | FWXB |
| L-4704 | X | 9.345 | 8.7 | 0.001 | 4.35 | 4.76 | FWXB |
| L-5191 | X | 9.345 | 78 | 0.0012 | 13.0 | 12.0 | FWYB |
| L-5359 | X | 9.375 | 7.0 | 0.001 | 4.25 | 4.50 | FWXB |
| L-4495 | X | 9.375 | 8.0 | 0.0025 | 5.5 | 4.5 | FWXB |
| L-4667A | X | 9.375 | 8.7 | 0.001 | 4.7 | 4.7 | FWXB |
| L-4642A | X | 9.375 | 9.0 | 0.00047 | 5.0 | 5.0 | FWXB |
| L-3990 | X | 9.375 | 24 | 0.0015 | 8.0 | 8.25 | FWXB |
| L-5211 | X | 9.375 | 24 | 0.0015 | 8.0 | 8.25 | FWXB |
| L-4824 | X | 9.375 | 25 | 0.0006 | 8.0 | 8.2 | FWXB |
| L-5543 | X | 9.375 | 40 | 0.0002 | 13.0 | 8.0 | FWXB |
| L-4693 | X | 9.375 | 65 | 0.001 | 13.0 | 12.0 | FWXB |
| L-5047 | X | 9.375 | 65 | 0.001 | 13.0 | 12.0 | FWXB |
| L-4553 | X | 9.375 | 70 | 0.001 | 15.0 | 15.0 | FWYB |
| L-4711 | X | 9.375 | 100 | 0.001 | 14.0 | 17.0 | FWYB |
| L-4679A | X | 9.375 | 120 | 0.001 | 15.5 | 17.0 | FWYB |
| L-5448B | X | 9.500 | 90 | 0.001 | 15.0 | 13.5 | FWXB |
| L-4753 | X | 9.5-10.5 | 7.5 | 0.0013 | 4.5 | 4.75 | MWXB |
| L-4973 | Ku | 14.0-15.2 | 20 | 0.0012 | 8.0 | 8.25 | MWXB |
| L-4721A | Ku | 14.5-15.2 | 180 | 0.00078 | 19.0 | 25.0 | MWYB |
| L-4689 | Ku | 14.5-15.5 | 125 | 0.001 | 18.5 | 18.0 | MWYB |
| l-4747 | Ku | 14.85 | 23 | 0.00125 | 8.0 | 8.25 | FWXB |
| L-5328 | Ku | 15.4-15.7 | 2.5 | 0.003 | 3.6 | 3.0 | MWYB |
| L-5409 | Ku | 15.4-15.7 | 2.5 | 0.0031 | 3.6 | 3.0 | MWXB |
| L-5112 | Ku | 15.4-15.7 | 3.0 | 0.005 | 3.6 | 3.1 | MWXB |
| L-4743 | Ku | 15.46 | 2.5 | 0.0001 | 3.5 | 3.0 | FWXB |
| L-4605 | Ku | 15.5-17.5 | 100 | 0.001 | 17.5 | 19.0 | MWYB |
| L-3496B | Ku | 16.0-16.5 | 1.0 | 0.001 | 3.0 | 1.6 | MWXB |
| L-4714 | Ku | 16.0-17.0 | 55 | 0.001 | 14.7 | 15.0 | MWXB |
| L-4725 | Ku | 16.0-17.0 | 60 | 0.001 | 16.5 | 16.0 | MWXB |
| L-7208B | Ku | 16.0-17.0 | 125 | 0.001 | 17.0 | 19.0 | MWYB |
| L-5271 | Ku | 16.2-16.3 | 0.4 | 0.0005 | 2.9 | 1.5 | MWXB |
| L-4419 | Ku | 16.5 | 65 | 0.00072 | 16.0 | 16.0 | FWYB |
| L-4451 | Ku | 16.6-17.1 | 35 | 0.001 | 12.0 | 9.5 | MWYB |
| L-4555 | Ka | 32.1-33.1 | 65 | 0.001 | 16.0 | 16.2 | MWYB |
| L-4524 | Ka | 34.0-35.0 | 130 | 0.0005 | 22.0 | 20.0 | MWYB |
| L-4768 | Ka | 34.5-35.4 | 26 | 0.002 | 13.5 | 9.5 | MWYB |



## RISING SUN MAGNETRONS

| TYPE Dimen. | BAND | FREQUENCY (GHz) | PEAK POWER (kW) | DUTY CYCLE | NOM. ANODE VOLTAGE (kV) | PEAK ANODE CURRENT (A) | CODE |
|---|---|---|---|---|---|---|---|
| L-4154B | Ka | 24.25 | 40 | 0.0003 | 14.0 | 13.3 | FWYB |
| L-4064A* | Ka | 34.85 | 68 | 0.0008 | 19.0 | 13.8 | FWYB |
| | Ka | 34.85 | 124 | 0.000364 | 19.5 | 26.0 | FWYB |
| L-4064E | Ka | 34.85 | 125 | 0.000364 | 19.0 | 27.5 | FWYB |
| L-4516A* | Ka | 34.7-34.93 | 70 | 0.0007 | 19.0 | 14.3 | MWYB |
| | Ka | 34.7-34.93 | 125 | 0.0003 | 19.5 | 28.3 | MWYB |

* Multiple specifications of peak power, duty cycle, anode voltage, and peak anode current indicate two modes of operation.

## FREQUENCY AGILE MAGNETRONS

| TYPE Dimen. | BAND | FREQUENCY (GHz) | AGILITY RATE (Hz) | AGILITY RANGE (MHz) | PEAK POWER (kW) | DUTY CYCLE | NOM. ANODE VOLTAGE (kV) | PEAK ANODE CURRENT (A) | CODE |
|---|---|---|---|---|---|---|---|---|---|
| L-4771 | X | 9.05 | 25 | ±215 | 200 | 0.001 | 21.5 | 27.5 | _WYB |
| L-4736 | X | 9.1-9.5 | 75 | ±30 | 75 | 0.001 | 15.0 | 15.0 | _WYB |
| L-4683 | X | 9.35 | * | ±250 | 250 | 0.001 | 25.5 | 25.0 | _WYB |
| L-4798 | X | 9.375 | 75 | ±40 | 100 | 0.001 | 15.5 | 16.0 | _WYB |
| L-4799 | X | 9.375 | 75 | ±40 | 100 | 0.001 | 15.5 | 16.0 | _WYB |
| L-4528 | Ku | 15.6 | * | ±100 | 100 | 0.001 | 17.3 | 19.0 | _WYB |
| L-4752B | Ku | 16.85 | 50 | ±80 | 50 | 0.0007 | 13.0 | 11.0 | _WXB |
| L-4525 | Ku | 16.2 | * | ±250 | 76 | 0.0008 | 16.0 | 16.0 | _WYB |
| L-4740 | Ku | 16.0-17.0 | 200 | ±25 | 55 | 0.001 | 14.7 | 15.0 | _WXB |
| L-4754 | Ku | 16.0-17.0 | 200 | ±25 | 55 | 0.001 | 14.7 | 15.0 | _WXB |
| L-4527 | Ku | 16.5 | * | ±300 | 65 | 0.00072 | 14.0 | 13.9 | _WYB |

* Electromagnetically tuned. The agility rate is dependent on the input tuning frequency and specific design parameters of the device.

**CODES**

| TUNING | OUTPUT | COOLING | MAGNET |
|---|---|---|---|
| F FIXED | C COAXIAL | X CONVECTION/CONDUCTION | K PERMANENT SEPARATE |
| M MECHANICAL | W WAVE GUIDE | Y FORCED AIR | B PERMANENT INTEGRAL |
| | S ANTENNA STUB | Z LIQUID | E ELECTRO SEPARATE |

## BEACON MAGNETRONS

| TYPE | BAND | FREQUENCY (GHz) | PEAK POWER (watts) | DUTY CYCLE | NOM. ANODE VOLTAGE (kV) | PEAK ANODE CURRENT (A) |
|---|---|---|---|---|---|---|
| L-4850 | C | 4.4-4.8 | 900 | 0.002 | 3.0 | 2.0 |
| L-4846 | C | 5.4-5.9 | 350 | 0.002 | 2.4 | 1.0 |
| L-4847 | C | 5.4-5.9 | 540 | 0.0003 | 2.4 | 1.2 |
| L-4844 | C | 5.4-5.9 | 600 | 0.002 | 2.2 | 1.1 |
| L-4848 | C | 5.4-5.9 | 600 | 0.002 | 2.7 | 1.2 |
| L-4855 | C | 5.4-5.9 | 600 | 0.0005 | 2.7 | 1.2 |
| L-4841 | C | 5.4-5.9 | 900 | 0.001 | 3.0 | 1.8 |
| L-4854 | C | 5.4-5.9 | 900 | 0.001 | 3.2 | 1.8 |
| L-4851 | C | 5.4-5.9 | 1500 | 0.0003 | 3.1 | 1.8 |
| L-4843 | C | 5.4-5.9 | 4500 | 0.001 | 5.1 | 4.5 |
| L-4832 | X | 8.8-9.5 | 400 | 0.0003 | 2.2 | 1.4 |
| L-4834 | X | 8.8-9.5 | 475 | 0.0003 | 2.2 | 1.4 |
| L-4839 | X | 8.8-9.5 | 400 | 0.0012 | 2.2 | 1.1 |
| L-4833 | X | 8.8-9.5 | 700 | 0.0003 | 2.6 | 1.4 |
| L-4831 | X | 9.2-9.5 | 500 | 0.0005 | 2.7 | 1.2 |
| L-4837 | X | 9.2-9.55 | 550 | 0.002 | 2.5 | 1.3 |
| L-4766 | Ku | 16.2-16.3 | 550 | 0.00035 | 2.4 | 1.6 |

All Beacon Magnetrons are conduction cooled, SMA connector output, mechanically tunable, and have integral magnets.

(continued from page 1)

In the past, injection locking was an add-on feature for off-the-shelf, standard magnetrons. Consequently, the design of the magnetron used was in no way optimized to give the best possible injection-locked performance. Litton has developed a number of magnetrons specifically for injection locking to meet several requirements. These requirements have been for both individual magnetrons and two-tube chains. Since these tubes were designed to be operated as injection-locked amplifiers, rather than free-running magnetrons, the result has been injection-locked performance far superior to that obtained with standard tubes.

The key to effective injection-locked performance is in the anode circuit. Classical anode circuits can be only moderately coupled before the tube will no longer operate stably as a free-running oscillator. In order to achieve larger locking bandwidths, new types of circuits are required. Litton has developed three anode circuits for use with injection-locked magnetrons: interdigital, modified vane and strap, and modified rising sun. The modifications are proprietary, and they result in a dramatic improvement in the gain/bandwidth that is achievable. One tube system at Litton involves a locking bandwidth of 1% at 12 dB gain, and individual tubes have been produced with a locking bandwidth of 2% at 12dB gain. These tubes all run as free oscillators in the absence of a locking signal. This is important in order to be able to obtain good noise performance across the locking band. Experience has shown that if a tube will not free run without a locking signal, then it will also drop out of oscillation towards the edge of the locking band, causing a substantial increase in the measured noise level.

Injection-locked magnetrons will never provide the gains available from klystrons or offer the gain/bandwidth combinations from TWTs. However, magnetrons can easily attain functional bandwidths of up to 2% at gains of 10 to 12dB per stage. This performance along with the magnetrons' compact size, efficiency, and simplicity of power supply make it an attractive choice for many applications.

## SALES OFFICES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