“HIGH POWER S-BAND TRANSISTORS FOR TELEMETRY”

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ABSTRACT

High power silicon bipolar devices have been developed for CW telemetry applications in low S-Band (1.7 - 1.85 GHz). To date, 50W CW has been obtained from a single device with 9dB gain and 45% efficiency with a simple, low cost structure. Continuing development work should soon result in a device capable of over 70W.

Telemetry systems span a diverse range of applications and missions. However all telemetry applications, by their very nature, require some form of compact transmitter. These transmitters are usually required to operate under conditions of high ambient temperature, heavy vibration and shock and variable system supply voltage. The transmitters must provide large amounts of RF output power while consuming as little prime power as possible. Finally, the transmitter must work properly after long periods of dormancy for the entire life of the mission, be it 10 minutes or 10 years.

Solid state devices have been used in telemetry applications for many years with excellent results. The primary advantage provided by solid state devices over their tube counterparts are small size and weight, low power consumption and excellent reliability.

In order to increase the range and signal-to-noise ratios of telemetry links, systems designers continue to specify more and more RF power, but often do not allow a great amount more physical room or heat sinking for the transmitter. To allow the transmitter designer to build larger transmitters in the same volume as previous transmitters, TRW has developed two new high power silicon bipolar telemetry transmitter transistors. These devices provide both more gain and more power than previously available devices in two important telemetry bands, 1700-1800 MHz and 2000-2300 MHz. These devices are configured in common-base and are suitable for operation in either class “B” or class “C”.

Both of these new devices incorporate internal matching circuits to allow for higher performance, greater bandwidth, and smaller simpler external matching circuits. A novel matching structure called a “direct return shunt inductor” is used to simplify the realization of an effective distributed shunt inductor element and to allow more effective parallel cell combining of very large devices. The shunt inductor element, a bond wire loop, is connected from the collector, through a dc blocking capacitor, directly to the base bonding pads of the transistor cells. This simple structure has proven to be both effective and manufacturable.

All of the wire bonds are formed with a semi-automatic gold wire bonder. This machine produces extremely consistent wire loops and allows excellent device consistency and very good manufacturing thru-put.

The transistor cells used for both of these devices are self-aligned interdigitated structures. They both employ gold refractory metallization. The 2000 MHz device further uses a 2-layer gold metallization system to reduce parasitics.

The 1700-1850 MHz device shown in Figure 1 will provide typically in excess of 50 watts CW at 28 volts with 9dB gain and 45% collector efficiency. The output power derates to about 35 watts at 100 degrees Centigrade heat sink temperature. This device consists of 12 cells of the LB-5 die, a device now used in large volumes in L-Band Radar applications. The transfer characteristics of this device are shown in Figure 2. The response of this part is smooth and continuous at all levels of RF drive. Further, the response is smooth and predictable as a function of power supply voltage, as shown in Figure 3. These two characteristics are very important in battery operated environments where the available voltage at or near the end of the mission life is decaying. A similar 22 volt device is in development for applications requiring lower system supply voltage. 16 cell devices are also in development to provide powers up to 70 watts CW.

The 2000-2300 MHz device, Figure 4, will provide typically 25 watts at 20 volts with 10dB gain and 40% collector efficiency. The power derates to about 15 watts at 100 degress Centigrade. This device uses 2 cells of the SB-15 die, which is also used in S-Band Radar applications. The power response and efficiency versus frequency of this device is shown in Figure 5. The transfer characteristic and response to supply voltage are similar to the 1700 MHz device.

These two new devices will provide the telemetry transmitter designer new degrees of freedom in his designs, and provide the end user with a higher performance telemetry link.

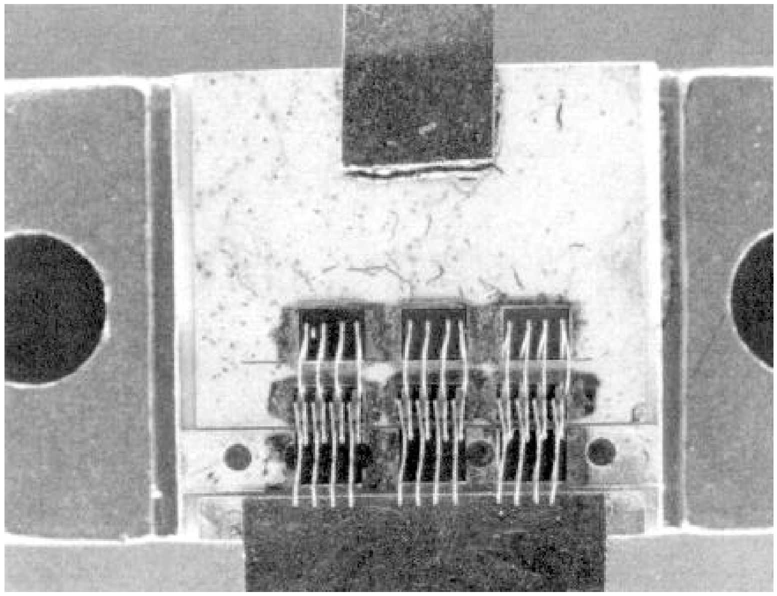

FIGURE 1. PHOTO OF 50W 1700-1850 MHz DEVICE

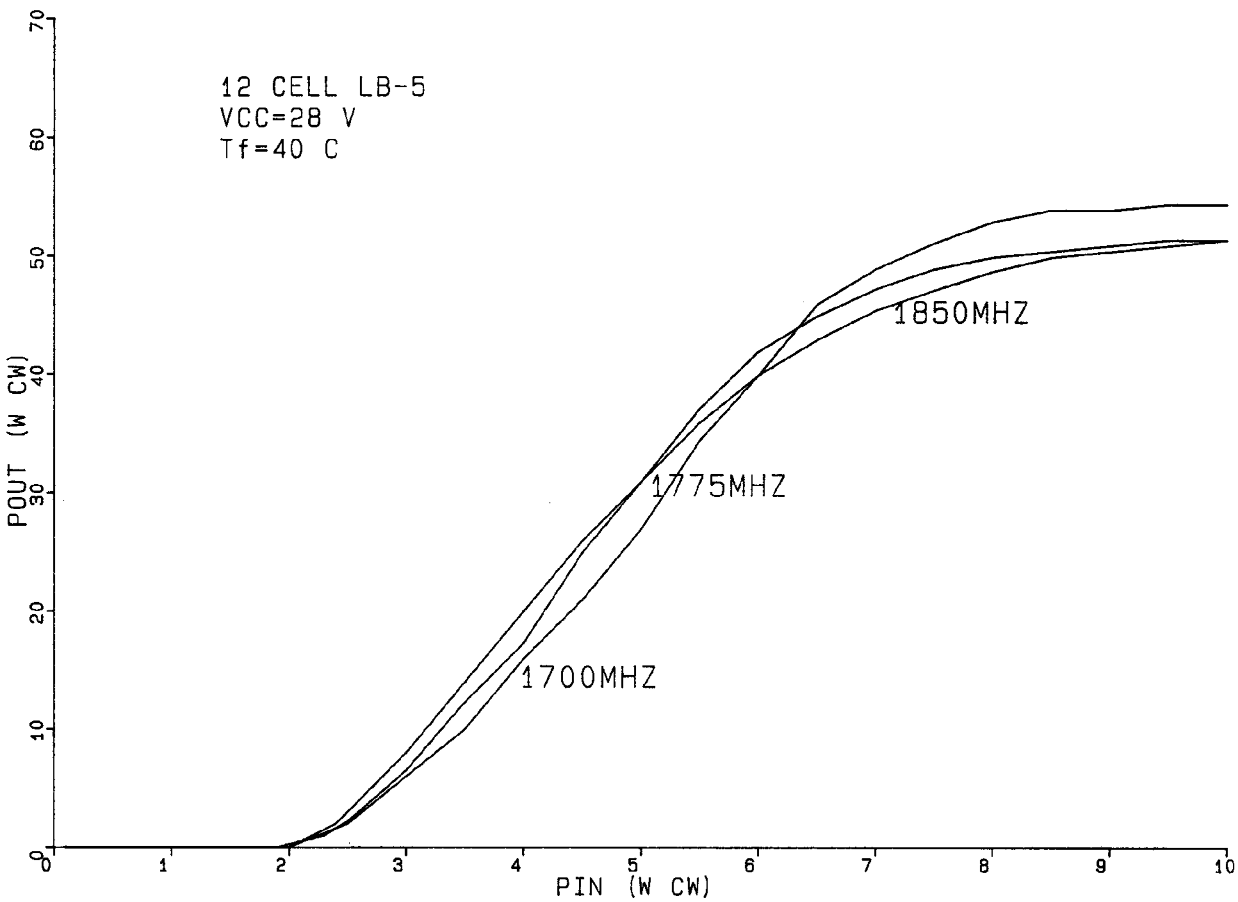

FIGURE 2 TRANSFR CHARACTERISTIC OF 1700 - 1850 MHZ DEVICE

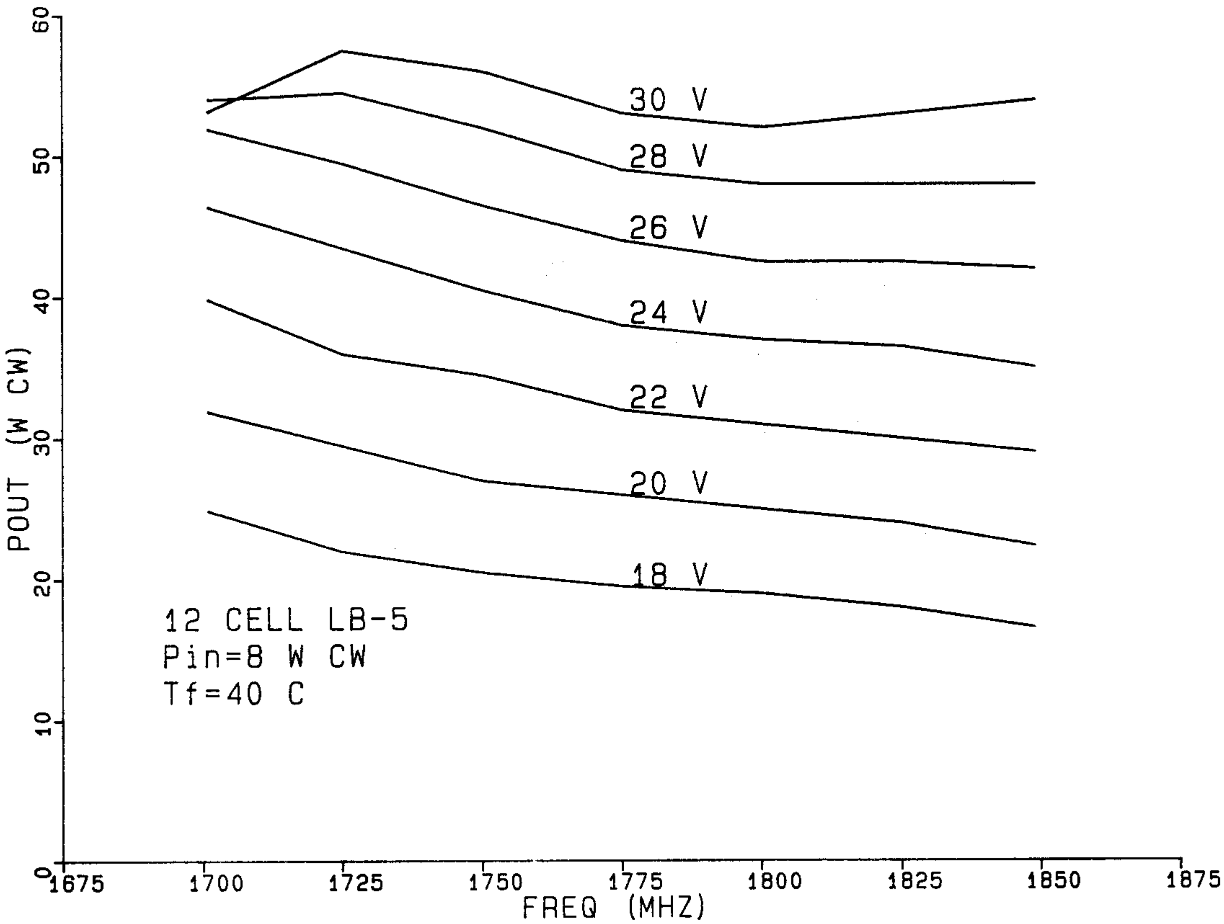

FIGURE 3 VCC RESPONSE OF 1700 - 11850 MHZ DEVICE

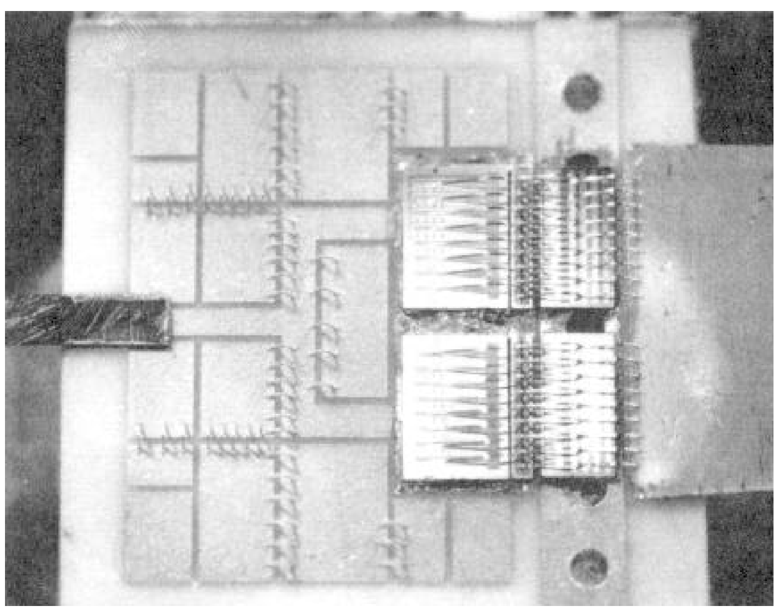

FIGURE 4. PHOTO OF 25W 2000 - 2300 MHZ DEVICE

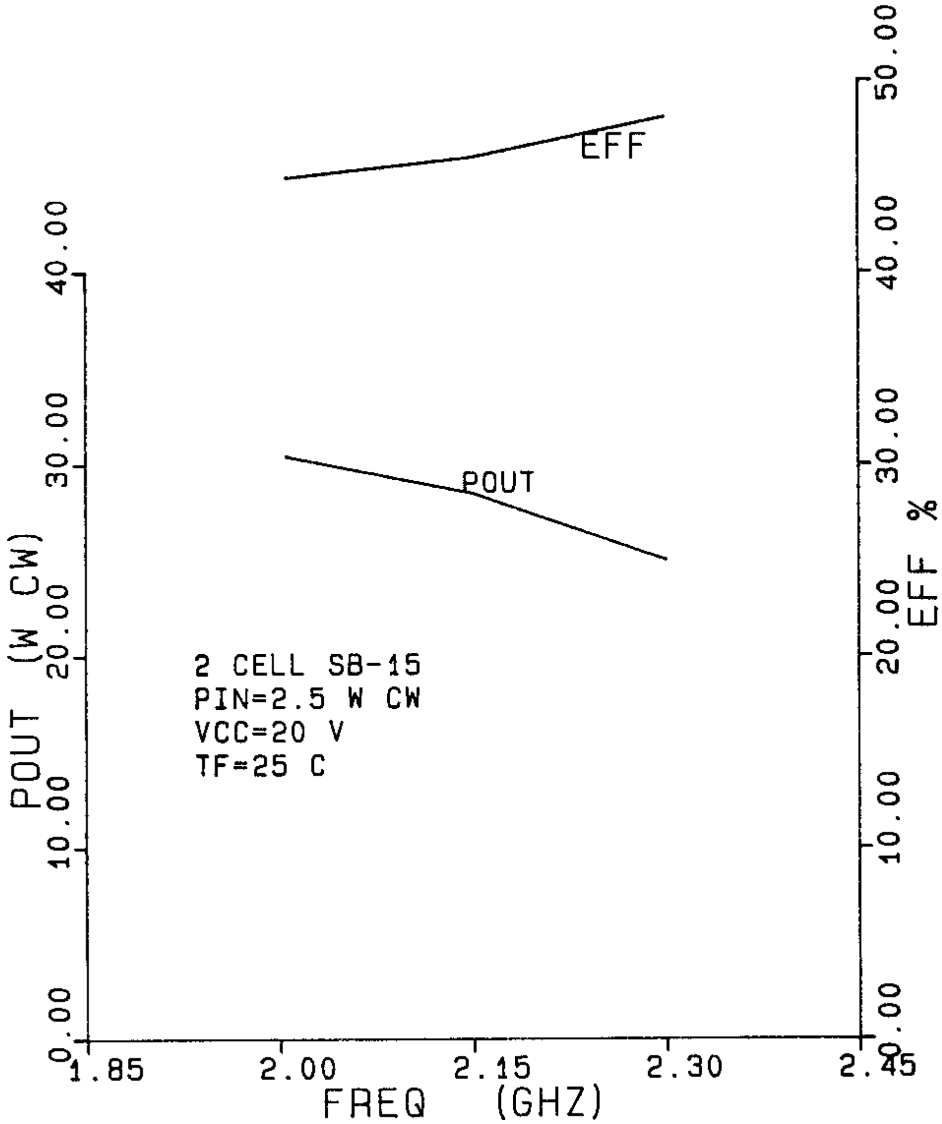

FIGURE 5 POWER OUTPUT AND EFFICIENCY OF 2000 - 2300 MHZ DEVICE