

An External Oscillator Is Substituted for the internal quartz-crystal oscillator of a common battery-powered wall clock.

hour hand (one 24-“hour” cycle) during a Martial sidereal day, the required frequency is 15,973.568 Hz.

It is worthwhile to note that for the 24-hour or for any of the 24-“hour” clock speeds, the minute hand would complete a revolution in 2 hours or “hours”. Therefore, it could be desirable to remove the minute hand to prevent confusion. In addition, in that case, the 12-hour faceplate must be replaced by a 24-hour faceplate.

It is also worthwhile to note that the precision of the clock display depends on the precision of the external oscillator, which can be cheap or expensive, as needed to obtain the precision required for a specific application. For example, the external oscillator could be a battery-powered, fixed-frequency quartz oscillator; a commercially available programmable integrated-circuit frequency synthesizer; or a programmable frequency synthesizer locked to highly stable reference oscillator (e.g., a hydrogen maser).

*This work was done by James Lux of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-40845*

## Efficient Switching Arrangement for $(N + 1)/N$ Redundancy

This arrangement can be generalized beyond its initial application.

NASA’s Jet Propulsion Laboratory, Pasadena, California

An efficient arrangement of four switches has been conceived for coupling, to four output ports, the output powers of any subset of four devices that are members of a redundant set of five devices. In normal operation, the output power of each of four of the devices would be coupled to one of the four output ports. The remaining device would be kept as a spare: normally, its output power would be coupled to a load, wherein that power would be dissipated. In the event of failure of one of the four normally used devices, that device would be disconnected from its output port and connected to the load, and the spare device would be connected to the output from which the failed device was disconnected. Alternatively or in addition, the outputs of one or more devices could be sent to ports other than the ones originally assigned to them.

In the original intended application, the devices would be microwave amplifiers and the switches would be mechan-

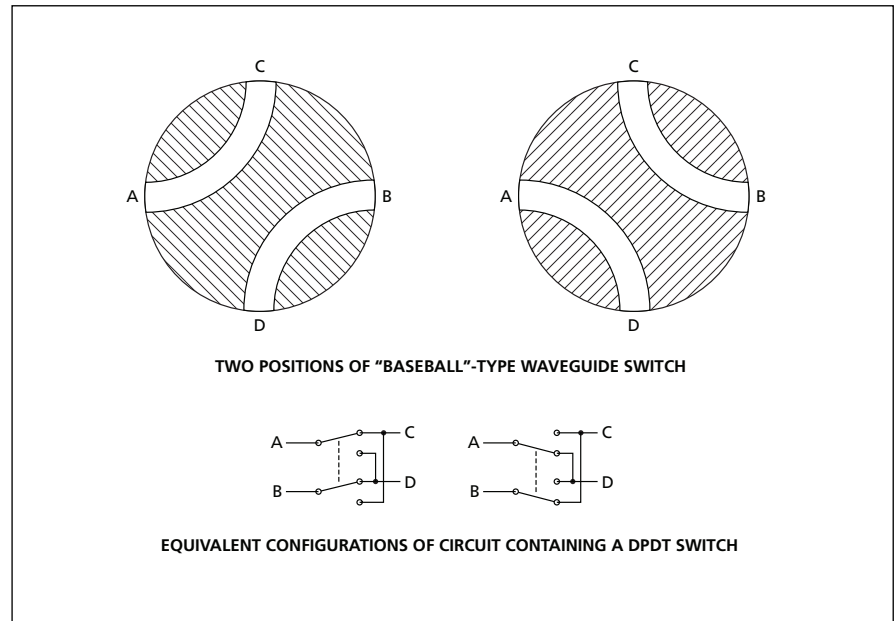


Figure 1. Ports A, B, C, and D can be connected in either of two different combinations of pairs, depending on the setting of a waveguide switch of the “baseball” type. Nominally equivalent switching could be effected by use of an electric circuit containing a DPDT switch.

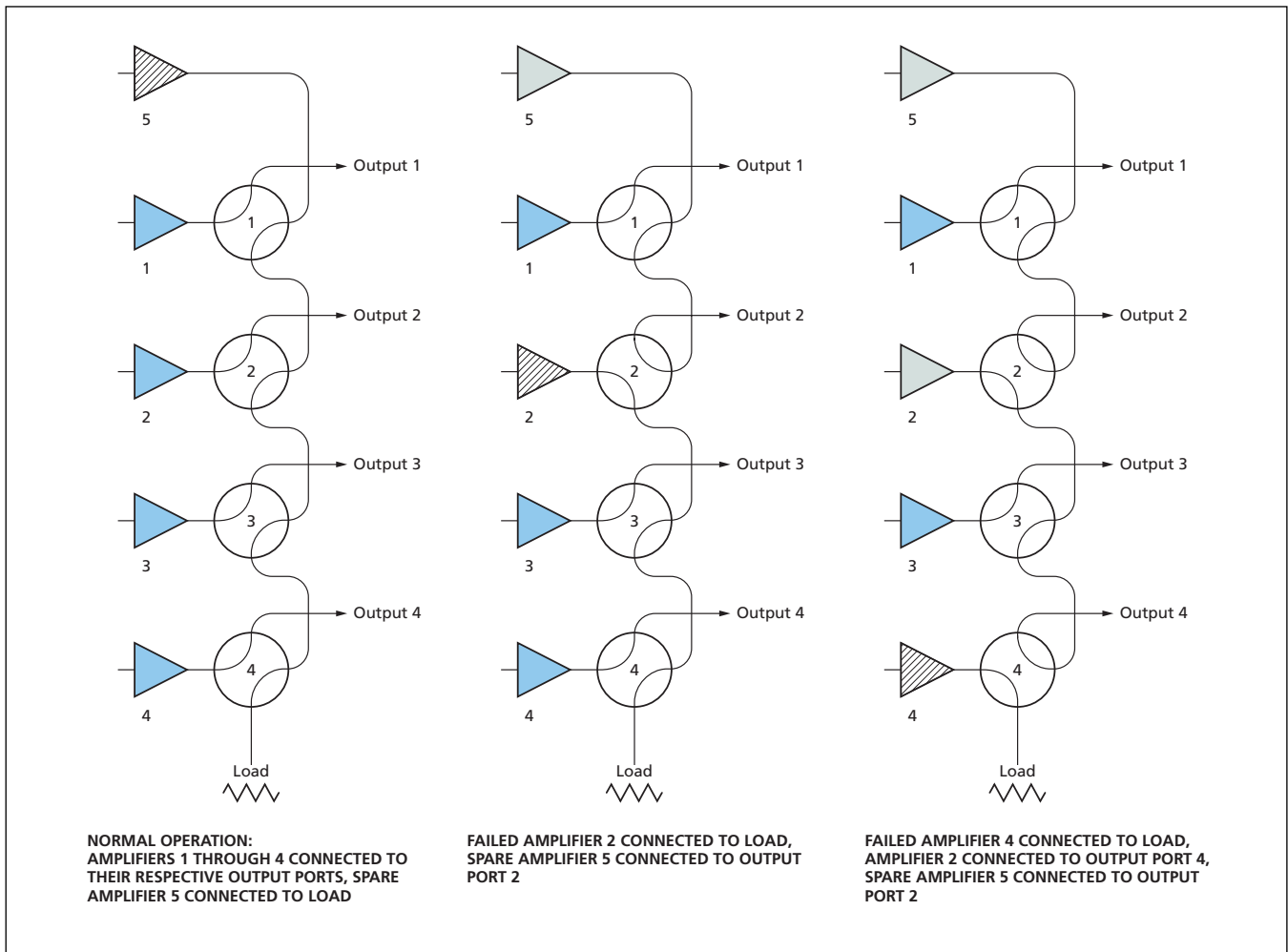


Figure 2. These **Three Switching Configurations** are a few examples of the larger number of allowable configurations for directing the outputs of four of the five amplifiers to the four output ports.

ically actuated waveguide switches. The arrangement could also be generalized to devices other than microwave amplifiers, to switches other than mechanically actuated microwave switches, and to greater numbers of switches, ports, and devices ( $N$ ,  $N$ , and  $N + 1$ , respectively, where  $N > 4$ ).

The mechanically actuated microwave switches in the original application would be two-position, four-port switches of a type known in the art as “baseball switches” because of the resemblance between their

waveguide cross sections and the patterns of stitches on baseballs. Figure 1 depicts the two positions of a baseball switch and the corresponding positions of a nominally equivalent circuit containing a double-pole, double-throw (DPDT) switch.

Figure 2 depicts three examples of useable switching configurations representative of the modes of operation described above. It should be apparent from casual inspection that any of those modes can be attained by actuation of one or more switches. In the original ap-

plication and perhaps in other potential applications, safety considerations dictate that switching configurations be limited to those in which every amplifier is connected to either an output port or to the load; non-connection of an amplifier or connection of an amplifier to another amplifier is not allowed.

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## Lightweight Reflectarray Antenna for 7.115 and 32 GHz

Reflectarrays for two different frequency bands share the same aperture.

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A lightweight reflectarray antenna that would enable simultaneous operation at frequencies near 7.115 GHz and frequencies near 32 GHz is undergoing development. More precisely,

what is being developed is a combination of two reflectarray antennas — one for each frequency band — that share the same aperture. (A single reflectarray cannot work in both frequency

bands.) The main advantage of the single dual-band reflectarray is that it would weigh less and occupy less space than do two single-band reflectarray antennas.