Battery Management

Antenna Size

Question No. 4 (Ch 3) - Exercise Problem

4. Batteries make up a significant part of the in-orbit weight of a communications satellite but are needed to keep the communications system operating during eclipses. A direct broadcast TV satellite requires 500 W of electrical power to operate the housekeeping functions of the satellite and 5 kW to operate its 16 high-power transponders. The longest duration of an eclipse is 70 min, during which time the batteries must provide power to keep the satellite operating, but the batteries must not discharge below 70% of their capacity. The satellite bus operates at 48 V.

a. What is the current that must be supplied by the power conditioning unit to keep the satellite operating normally?

b. Battery capacity is rated in ampere hours, the product of the current (in amps) that the battery can supply multiplied by the length of time that this current can be supplied before the battery is fully discharged. The satellite batteries must not discharge beyond 70% of their rated capacity during eclipse. Find the battery capacity required for this DBS-TV satellite.

c. If batteries weigh 1.25 kg per ampere-hour of capacity, how much weight on this satellite is devoted to batteries?

d. If half of the transponders are shut down during eclipse, what saving in battery weight is achieved?

https://chatgpt.com/share/c8d16a8c-18fc-4bc0-bfd3-b3ba1bf88b36

48 V → Battery

70 % only could be used

70 Mins

Total Power consumption = 5.5 kW

0.5 kW (House keeping) + 5 kW (Transponders)

ⓐ Total Current Supplied = $\frac{5500}{48}$ = 114.58 A

ⓑ Capacity = $114.58 \times \frac{100}{60}$ (100 Min → Per hour)

= 190.9666666667 A-h

© Capacity x Weight

= 238.7083333334

(d) Half of Transponders stopped working:

$$P = \frac{5000}{2} = 2500\ W$$

$$P_T = 500 + 2500 = 3000\ W = 3\ kW$$

A geostationary satellite provides service to a region which can be covered by the beam of an antenna on the satellite with a beamwidth of 1.8°. The satellite carries transponders for Ku band and Ka band,
with separate antennas for transmit and receive. For center frequencies of 14.0-11.5 GHz and 30.0-
20.0 GHz, determine the diameters of the four antennas on the satellite.
a. Find the diameters of the two transmitting antennas. Specify the diameter and calculate the gain at
each frequency.
b. Find the diameters of the two receiving antennas. Specify the diameter and calculate the gain at each frequency.