

PHASE CONTROL SYSTEM CONCEPTS AND SIMULATIONS

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This short paper provides a summary overview of the Solar Power Satellite (SPS) reference phase control system as defined in a three phase study effort under contract to the Johnson Space Center (see Refs. 1-5). It serves to summarize key results pertinent to the SPS reference phase control system design. These results are a consequence of extensive system engineering tradeoffs provided via mathematical modeling, optimization, analysis and the development/utilization of a computer simulation tool called SOLARSIM.

Figure 1 shows the system engineering viewpoint of the SPS transmitting system using the retrodirective phased array concept consisting of three major systems; viz., (1) The Reference Phase Distribution System, (2) The Beam Forming and Microwave Power Generating System and (3) The Solar Power to Electrical Power Conversion System. Figure 2 illustrates the Reference Phase Distribution and Beam Forming System.

The reference phase control system concept was presented in detail in Ref. 3; its major features are illustrated here. Based upon earlier study efforts (Refs. 3, 4), a phase control system concept has been proposed which partitions the system into three major levels. Figure 2 demonstrates the partitioning and represents an expanded version of Figure 1. The first level of phase control illustrated in Figure 2 consists of a reference phase distribution system implemented in the form of phase distribution tree structure. The major purpose of the tree structure is to electronically compensate for the phase shift due to the transition path lengths from the center of the spacetenna to each phase control center (PCC) located in each subarray. In the reference system, this is accomplished using the Master Slave Returnable Timing System (MSRTS) technique. The detailed mathematical modeling and analysis of the MSRTS technique is provided in Ref. 4. Based upon extensive tradeoffs using SOLARSIM and appropriate analysis during the Phase II study, a four level tree is selected to be the reference phase distribution system configuration.

The second level of phase control consists of the Beam Steering and Microwave Power Generating System which houses the SPS Power Transponders. This transponder consists of a set of phase conjugation multipliers driven by the reference phase distribution system output and the output of a pilot spread spectrum receiver (SS RCVR) which accepts the received pilot via a diplexer connected to a separate receive horn or the subarray itself. The output of the phase conjugation circuits serve as inputs to the third level of the phase control system. The third level of phase control is associated with maintaining an equal and constant phase shift through the microwave power amplifier devices while minimizing the associated phase noise effects (SPS RFI potential) on the generated power beam. This is accomplished by providing a phase-locked loop around each high power amplifier, Figure 2.

REFERENCES

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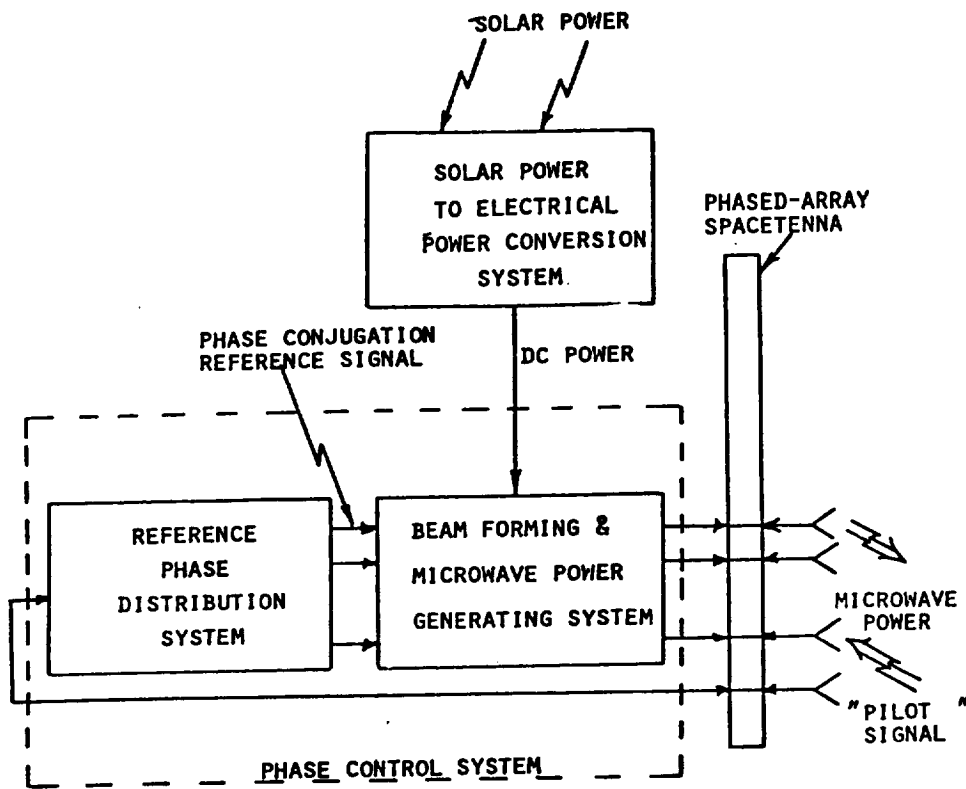


Figure 1. Solar Power Satellite (SPS) Transmission System (Phase Conjugation).

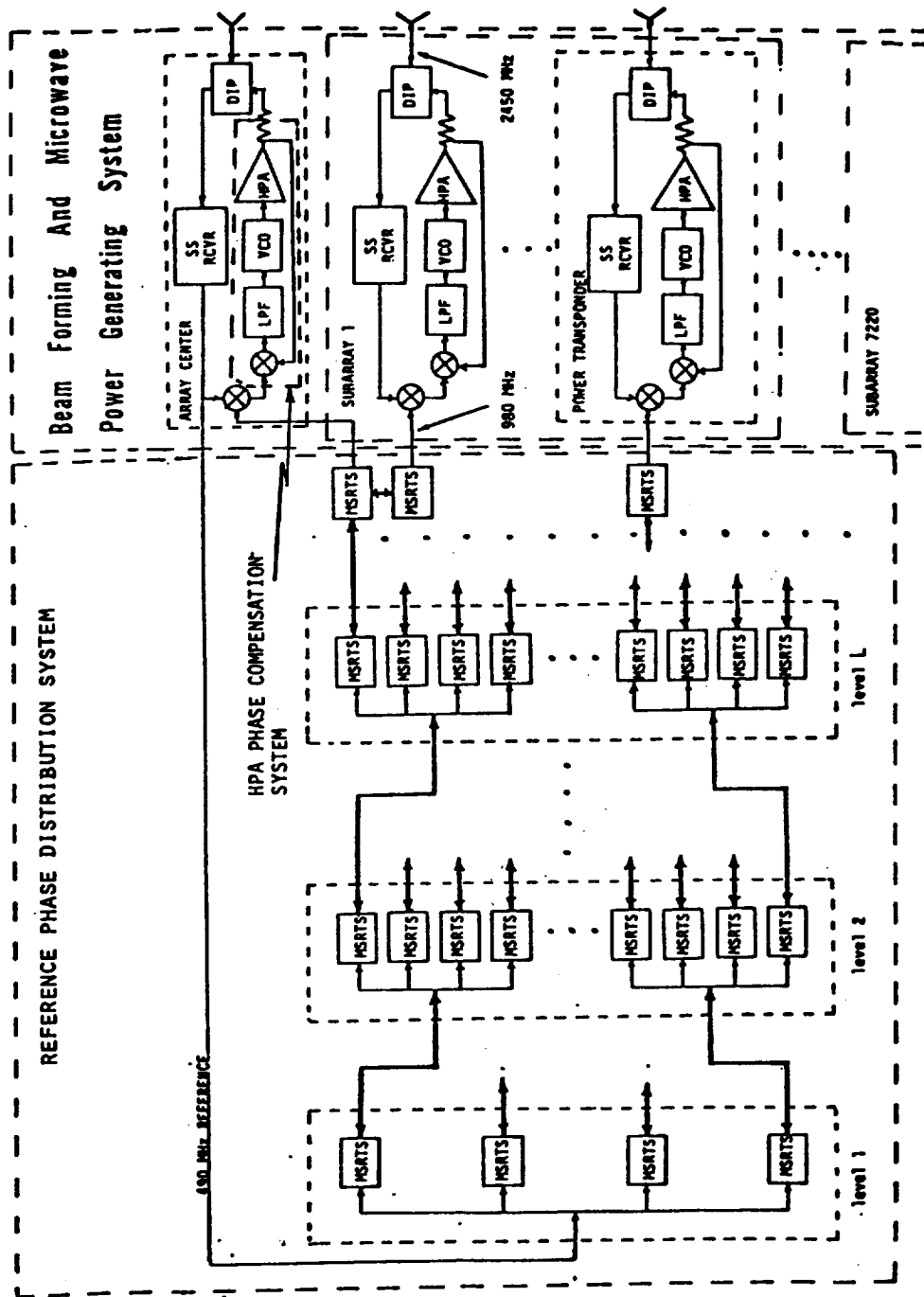


Figure 2. Reference Solar Power Satellite Transmission System.