POWER MANAGEMENT

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TECHNOLOGY FOCUS:

- SPACE PLATFORM IN LEO
- 250 kW (AVG.) CONTINUOUS LOAD POWER
- PRIME GENERATOR - SOLAR ARRAY
- MID-1980 TECHNOLOGY READINESS/LATE 1980 IOC
- TEN YEAR LIFE
- SHUTTLE LAUNCH
- ON-ORBIT MAINTENANCE/REPAIR/RETRIEVAL CAPABILITY
- LOW LIFE CYCLE ENERGY COST

OBJECTIVE/APPROACH

The objective of the multihundred kW power system management and distribution program is to develop the critical components, circuits and subsystems required to manage the generation, storage, and distribution of energy in large, orbital space systems. The approach taken to accomplish this objective is to design a reference system including the generation, energy storage, electrical power management and thermal energy management subsystems. This reference design is then used to assess at the system level the impact of changing various subsystem parameters. Based on the reference system design, a detailed design of the power management subsystem will be performed. The power management subsystem is autonomous and based on ground utility power systems concepts to the maximum extent possible. An agency power system breadboard is being developed for characterization and verification of the various component and subsystem technology developments.

OBJECTIVE:

- DEVELOP CRITICAL COMPONENTS, CIRCUITS, AND SUBSYSTEMS REQUIRED TO MANAGE THE GENERATION, STORAGE, AND DISTRIBUTION OF ENERGY IN LARGE SPACE SYSTEMS.

APPROACH:

- PERFORM REFERENCE SYSTEM DESIGN
  - GENERATION
  - ENERGY STORAGE
  - ELECTRICAL POWER MANAGEMENT
  - THERMAL ENERGY MANAGEMENT
- DEVELOP POWER MANAGEMENT AND DISTRIBUTION SUBSYSTEM FOR MULTI-100 kW ORBITAL POWER PLANT.
- PROVIDE AN AGENCY BREADBOARD FOR COMPONENT AND SUBSYSTEM CHARACTERIZATION AND VERIFICATION.

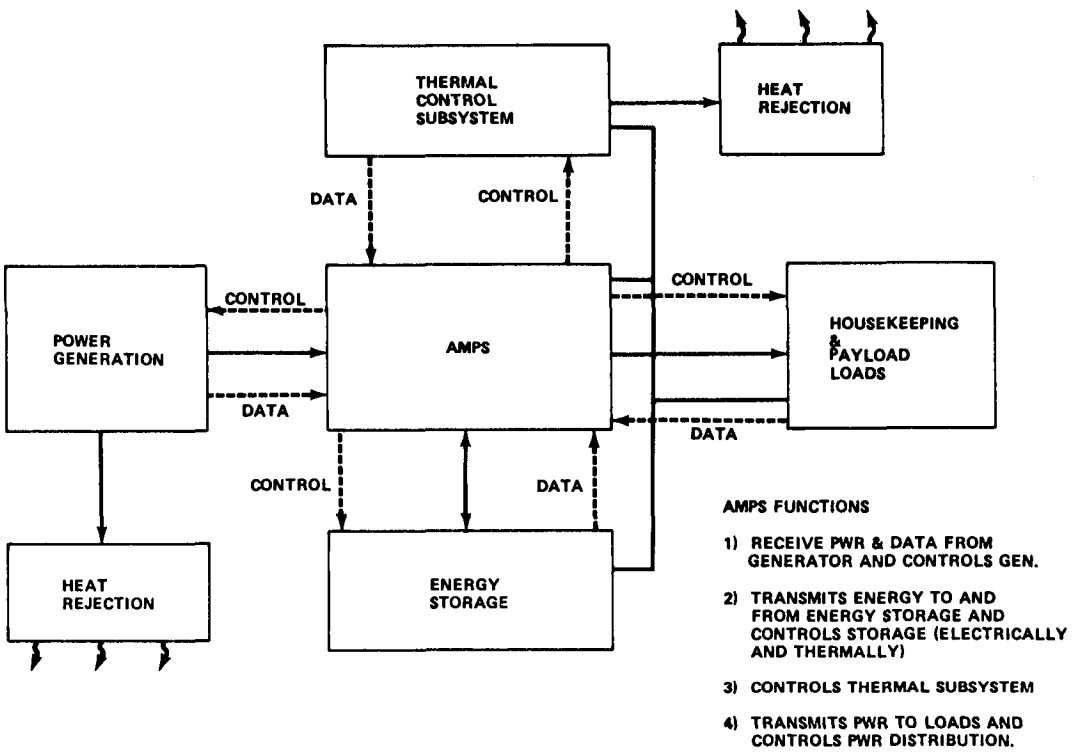
AMPS INTERFACES:

On this page is a block diagram depicting the major elements of the power system technology program and their key interfaces. As can be seen, the heart of the system is the power management and distribution element which is tilted the autonomously managed power system (amps). The various functions of the amps in relation to the other major elements are listed. For instance, the power generation system can be monitored and controlled to optimize its performance. For a photovoltaic system this might include solar pointing functions as well as on-array regulation and/or conditioning of power.

In the energy storage subsystem, capability will exist for utilization of various energy storage elements in direct proportion to their state-of-health. If secondary batteries are used, the generation of an appropriate signal can tell the amps control center that a different recharge fraction, different charge cutoff voltage, or different operating temperature for a particular battery (or battery module) would improve overall system performance.

Thermal control of the entire spacecraft is implemented by amps through appropriate sensing, logic, and control signal initiation.

AUTONOMOUSLY MANAGED POWER SYSTEM



SCHEDULE:

A BRIEF OVERVIEW OF THE PROGRAM SCHEDULE WITH SOME OF THE MAJOR MILESTONES LISTED IS SHOWN ON THE FACING PAGE. SPECIFIC PROGRAM TARGETS INCLUDE:

(1) COMPLETION OF REFERENCE SYSTEM BASELINE AND ESTABLISHMENT OF TECHNOLOGY RISK FOR THE VARIOUS OPTIONS IDENTIFIED BY MID-FY 1981.

(2) DEVELOPMENT OF CRITICAL CIRCUIT AND SUBSYSTEM TECHNOLOGIES REQUIRED FOR MANAGEMENT OF MULTI-100 KW POWER SYSTEMS BY THE END OF FY 1983.

(3) DEMONSTRATION OF AUTOMATED POWER SYSTEM MANAGEMENT BY THE END OF FY 1983.

SCHEDULE

SYSTEM DEFINITION

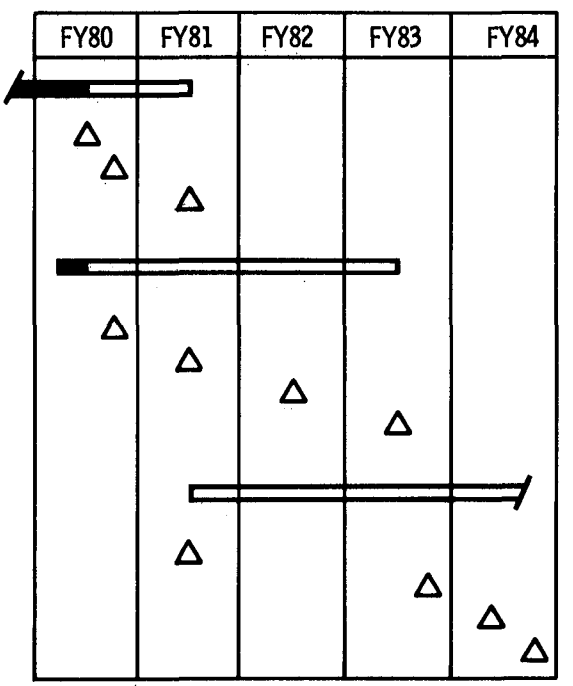
- TRADES COMPLETE
- REFERENCE EPS COMPLETE
- ROI COMPLETE

AMPS DEVELOPMENT

- COMPONENT TECHNOLOGY ASSESSMENT
- ESTABLISH THERMAL MGMT. REQTS.
- COMPLETE DESIGN
- AMPS BREADBOARD ASSEMBLY COMPLETE

BREADBOARD DEMONSTRATION

- COMPLETE SYSTEM BREADBOARD MODS.
- AMPS INTEGRATION COMPLETE
- VERIFICATION COMPLETE
- AMPS TECHNOLOGY READINESS



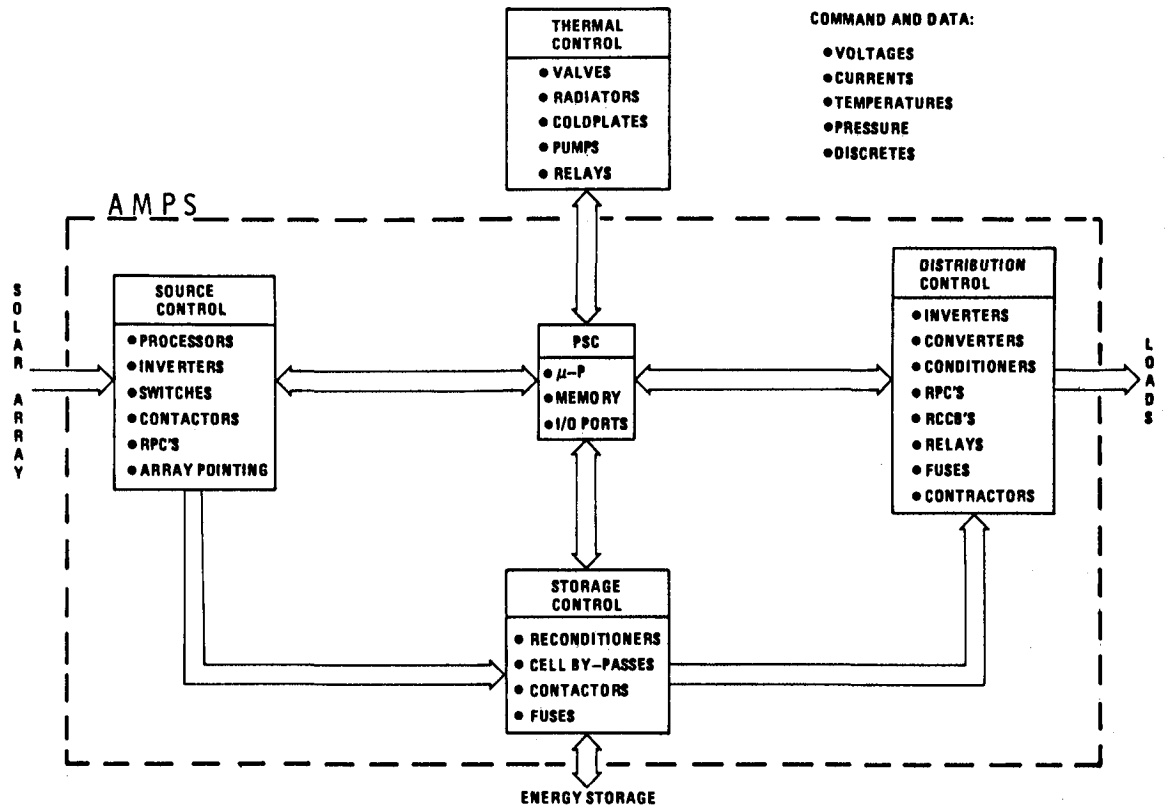
AMPS FUNCTIONS

As depicted on the facing page, the amps performs five basic functions:

(1) Total power system management
(2) Source control
(3) Energy storage control
(4) Thermal system management
(5) Distribution control

The components and equipment required to accomplish the implementation of each function is listed. Based on the reference power system concept selected, detailed design requirements for each component or piece of equipment will be generated, and the required technology developments identified.

POWER SYSTEM MANAGEMENT
AND DISTRIBUTION



COMPONENT TECHNOLOGY DEVELOPMENTS:

A preliminary list of component technology developments based on proposed concepts and assessments made to date is shown. A list of component developments required for the selected eps concept and reference design will be an output of the component technology assessment task.

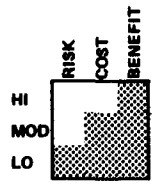
COMPONENT TECHNOLOGY DEVELOPMENTS:

DEVELOPMENT ITEM	PRIMARY CHARACTERISTICS
RPC	300 VDC, 100 A
SOLID STATE CKT. BREAKER	300 V, 1 - 20 A 300 V, 50 - 200 A
VACUUM SWITCH	300 V, 200 A
ON-ARRAY SWITCHING DEVICES	XSISTOR - 300 V, 10 A MICROPROCESSOR DATA BUS
SLIP RINGS ROTARY TRANSFORMER	300 V, 400 A
CONNECTORS	300 V, 200 A

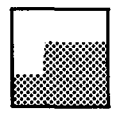
AMPS BREADBOARD VERIFICATION OBJECTIVES:

- Establish transient response to load switching
- Verify fault detection and clearing
- Measure system efficiencies for various operating modes
- Estabish and verify power quality standards
- Demonstrate utility power management and distribution concept
- Evaluate new component technologies in a realistic environment

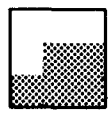
DEVELOPMENT RECOMMENDATIONS*



- HIGH VOLTAGE BUS AND COMPONENTS (100 - 300 V)



- AUTOMATED POWER SYSTEM UTILIZING ON-BOARD FAULT DETECTION AND CORRECTION TO MINIMIZE GROUND SYSTEM COST



- HIGH VOLTAGE BUS AND COMPONENTS (300 V - 1 KV) IN WHICH USE OF ALTERNATING CURRENT MAY BE ATTRACTIVE

*SOURCE: SYMPOSIUM ON POWER TECHNOLOGY FOR FUTURE SYNCHORONOUS SATELLITES AND PLATFORMS, MAY 1979.

CONCLUSION

- The amps program for LEO technology in the 250 kW category includes all specific technology and development activities recommended by the "power technology for future synchronous satellites and platforms symposium" of May 1979 except fiber optics

RECOMMENDATION

- The amps program be augmented to the extent that breadboard testing include GEO mission profiles and unique operating parameters.

TECHNOLOGY RECOMMENDATIONS*

- DEVELOP RELAYS, FUSES, AND SOLID STATE SWITCHES TO DISTRIBUTE POWER TO MULTI-KW LOADS IN 100 TO 400 VOLT SYSTEMS WITH CURRENTS IN THE 100 AMPERE RANGE.
- DEVELOP AND QUALIFY A RADIATION HARDENED POWER SUBSYSTEM CENTRAL PROCESSOR INCLUDING SOFTWARE IMPLEMENTATION OR BATTERY CHARGE CONTROL, LOAD MANAGEMENT, POWER SYSTEM STATE OF HEALTH MONITORS AND CONTROL AND TELEMETRY CONDITIONING.
- REDUCE CABLING WEIGHT BY FLIGHT QUALIFICATION OF 100 - 500 V SOLAR ARRAYS AND 100 - 300 V BATTERIES.
- REDUCE RF AND SIGNAL CABLING WEIGHT THROUGH THE USE OF FIBER OPTICS.
- REDUCE POWER CONDITIONING AND DISTRIBUTION EQUIPMENT WEIGHT BY ADVANCING THE STATE OF THE ART OF HIGH FREQUENCY/HIGH VOLTAGE/HIGH POWER CONVERSION AND CONTROL EQUIPMENT.

*SOURCE: SYMPOSIUM ON POWER TECHNOLOGY FOR FUTURE SYNCHRONOUS SATELLITES AND PLATFORM, MAY 1979.