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Analytical Thermal Analysis of the L-Band Transmitter Replacement

T. J. BENNETT
*Terrestrial Systems Branch
Space Systems and Technology Division*

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ANALYTICAL THERMAL ANALYSIS OF THE L-BAND TRANSMITTER REPLACEMENT

INTRODUCTION

The Terrestrial Systems Branch undertook a task to design an L-band transmitter to replace an existing unit with requirement of improving transmitter reliability by increasing the mean time between failures. A comprehensive, analytical thermal analysis was conducted on the L-band transmitter replacement to identify possible "hot spots." Early detection facilitates the use of proper thermal design to minimize the number and severity of hot spots.

The incorporation of proper thermal design with the electromechanical design will increase electronic component life by decreasing temperature rise. Furthermore, the allowable ambient operating temperature will increase due to improved heat transfer.

The analysis was conducted using several well-established thermal computer programs. Developed by the aerospace industries for the National Aeronautics and Space Administration (NASA), these thermal computer programs have proven successful through many space flight missions.

MECHANICAL DESIGN CONSIDERATIONS AND CONSTRAINTS

Special mechanical design considerations were included to meet the demands of anticipated future systems. Mechanical designs that directly impact the thermal design are detailed below.

To facilitate the replacement of the existing transmitter, the baseplate and mounting holes for the new design match those of the original unit. In addition, the locations of external connectors were maintained whenever possible. The only through holes permitted in the casing of the new design were the connector and pressure fitting holes. This limits the number of possible pressure leaks.

The casing was designed to be purged and pressurized with nitrogen or dry air when a protective radome is not provided. Also, whenever possible, the use and contact of dissimilar metals on and in the casing was avoided to limit electrochemical attack, primarily from rain and salt spray.

The casing walls were constructed of 3/8-in. aluminum plate. This allowed the insertion of number 8 and 10 locking threaded coils without rupturing the walls. The baseplate constructed of half-inch aluminum was the major heat sink of the casing.

The interior of the casing was designed using a modular concept so that each component was a separate entity (Figs. 1 and 2). Each component was attached to a mounting bracket, which in turn was attached to the transmitter casing by way of 10-32 threaded captive screws held to the mounting bracket by captive fasteners. Each modular unit was totally accessible to maintenance personnel for removal.

The mounting brackets are fabricated from quarter-inch aluminum plate, except for the power supplies which require half-inch plate for additional heat sinking. Quarter-inch plate was needed to bottom mount several components to mounting brackets with flathead screws. A thinner plate prohibits proper countersinking of mounting holes.

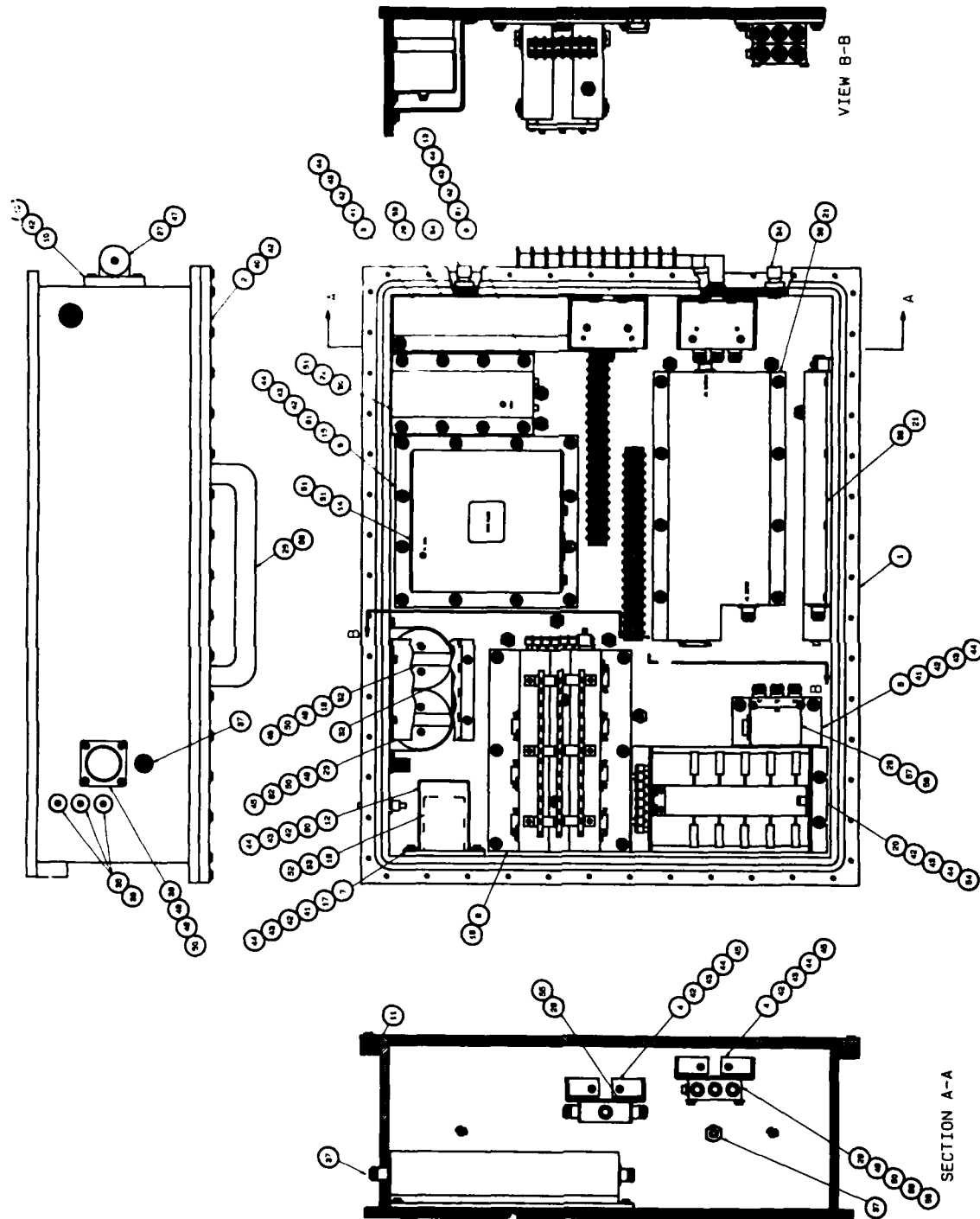


Fig. 1 - L-Band transmitter

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2	82				SCREW, PAN-HEAD, SLOTTED, #8-32UNC X .825	
20	81	08540	8238-SS-1032		CAPTIVE PANEL SCREW	
2	80	08540	8237-SS-1032		CAPTIVE PANEL SCREW	
4	58		MS35848-284		NUT, HEX	
4	58				SCREW, FLAT HEAD, SLOTTED, #2 ⁵ 25X20 X .825	CRES
2	57				SCREW, FLAT-HEAD, SLOTTED, #2 ⁵ #8-32UNC X 2.50	
2	56				SCREW, PAN-HEAD, SLOTTED, #8-32UNC X 1.375	
2	55				SCREW, PAN-HEAD, SLOTTED, #8-32UNC X .375	
4	54				SCREW, PAN-HEAD, SLOTTED, #10-32UNF X .500	
4	53				SCREW, FLAT-HEAD, SLOTTED, #2 ⁵ #10-32UNF X .50	
8	52				SCREW, PAN-HEAD, SLOTTED, #8-32UNC X .250	
8	51				SCREW, FLAT-HEAD, SLOTTED, #2 ⁵ #8-32UNF X .50	CRES
12	50		MS35338-137		WASHER, LOCK	
12	49		MS15785-807		WASHER, FLAT	
8	48				SCREW, PAN-HEAD, SLOTTED, #8-32UNC X .375	CRES
4	47				SCREW, PAN-HEAD, SLOTTED, #8-32UNC X 1.00	
4	46				SCREW, PAN-HEAD, SLOTTED, #10-32UNF X .750	
8	45				SCREW, PAN-HEAD, SLOTTED, #10-32UNF X .825	CRES
108	44		MS35338-138		WASHER, LOCK	
108	43		MS15785-808		WASHER, FLAT	
108	42	08540	2225-N184		NYLON WASHER, FLAT	
108	41	08540	8238-SS-1032		CAPTIVE PANEL SCREW	
54	40	08540	8240-SS-1032		CAPTIVE PANEL SCREW	
3	39	75815			FUSE	
2	38	50311	RF 1435C		SOLID STATE L-BAND POWER MODULE	
2	37	77820	UG-30D/U		RF CONNECTOR	
1	36	77820	MS3102E-32-8P		BOX-MOUNTING RECEPTACLE	
3	35	75815	340 287		3AG PANEL FUSE HOLDER	
2	34	02570	SS-800-1-DR		O-SEAL STRAIGHT THREAD CONNECTOR	
1	33	05245	MODEL 10SP1A		POWER LINE FILTER	
2	32	90201	CGS383U050X3L		CAPACITOR, 38000MFD, 50VDC	
1	31	04871	MODEL 1405		1400 SERIES POWER SUPPLY	
1	30	04871	MODEL 1101		1100 SERIES POWER SUPPLY	
1	29		MODEL 311		CIRCULATOR	
3	28	12588	MODEL S-3388		RF COAXIAL SWITCH	
1	27	12588	MODEL T-2171		TERMINATION	
1	26	50140	MS-1878/188-4/A		NARROW BAND FILTER	
2	25	51508	8578-A		HANDLE	
	24					
1	23	D	81885		COVER, CAPACITOR	
1	22	C	81885		GASKET, 1100 SERIES POWER SUPPLY	
2	21	D			GASKET, POWER MODULE	
1	20	D			CARD FILE ASSEMBLY	
1	19	C			STRAP, CAPACITOR	
1	18	D			GASKET, MODULATOR/REGULATOR	
1	17	C			GASKET, MOUNTING PLATE	
1	16	C			GASKET, POWER LINE FILTER	
1	15	D			GASKET, MOUNTING PLATE	
1	14	D			GASKET, 1400 SERIES POWER SUPPLY	
1	13	C			GASKET, MOUNTING PLATE	
1	12	D			COVER, POWER LINE FILTER	
1	11	D			O-RING	
1	10	C			MOUNTING PLATE, TERMINATION	
1	9	C			MOUNTING PLATE, 1100 SERIES POWER SUPPLY	
1	8	D			MOUNTING PLATE, 1400 SERIES POWER SUPPLY	
1	7	C			MOUNTING PLATE, POWER LINE FILTER	
1	6	E			MODULATOR/REGULATOR ASSY	
1	5	C			MOUNTING PLATE, RF COAXIAL SWITCH	
2	4	C			BRACKET, RF COAXIAL SWITCH & CIRCULATOR	
1	3	D			MOUNTING PLATE, NARROW BAND FILTER	
1	2	E			COVER	
1	1	E	81885		ENCLOSURE	

Fig. 2 - L-Band transmitter

Several mounting brackets and surfaces in the casing require a maximum waviness of 0.006 in. over a length of 4 in. This improves contact between heat-producing components, mounting brackets, and the casing. Improved surface tolerances are required on the modulator/regulator, power amplifiers, power supplies, and the RFI power filter mounting surfaces and brackets.

THERMAL DESIGN CONSIDERATIONS AND CONSTRAINTS

The thermal design of the transmitter allows effective operation during the worst case cycle time consisting of a period of 20 min on, followed by 20 min off. Coated with a low absorptivity-emissivity ratio paint, the exterior of the transmitter is designed to be cooled by natural convection. The ambient design condition consists of a sol-air temperature of 110°F (43°C) with zero wind speed. Interior heat is dissipated through passive design.

Components which generate heat, except the modulator/regulator assembly, have an upper operating temperature of 140°F (60°C). The modulator/regulator is limited by an upper temperature of 160°F (71°C). Thermostats, strategically located throughout the box, detect components that exceed maximum operating temperature and deactivate the power supplies for a minimum of 5 min.

The use of mounting brackets reduces the passive heat dissipation rate by decreasing the overall heat transfer coefficients. The decrease in heat transfer coefficients results from increased heat transfer path and additional contact resistance between surfaces (Fig. 3).

In place of silicone grease, a new thermal conductive product is being used to decrease contact resistance between mating surfaces. This product is a silicone elastomer binder with a thermal conductive filler that forms a flexible conductive pad which has a higher thermal conductivity than grease. The new thermal conductive product replaces silicone grease where modules require electrical isolation or high heat dissipation rates.

THERMAL DESIGN AND ANALYSIS APPROACH

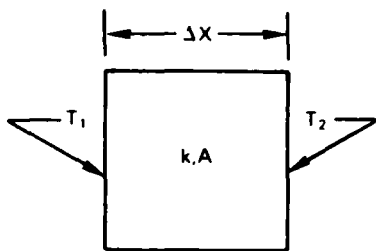
The L-band replacement transmitter is designed to improve the dissipation of heat. Heat dissipation, in turn, is improved by balancing the transfer of heat with short-term thermal storage, without exceeding component temperature limitations. Constraints on the design are large thermal gains over short periods of time, low-temperature gradient within the casing, and limited internal space.

Two design methods were analyzed to determine the most appropriate major form of heat dissipation for this design: the use of conduction heat transfer and thermal storage, and passive convection heat transfer using fin surfaces.

The following heat transfer and capacitance equations were used to evaluate the methods:

Conduction;

$$Q_k = -kA \frac{\Delta T}{\Delta x} \text{ (Btu/h)} \tag{1}$$



$$T_k = T_2 - T_1$$

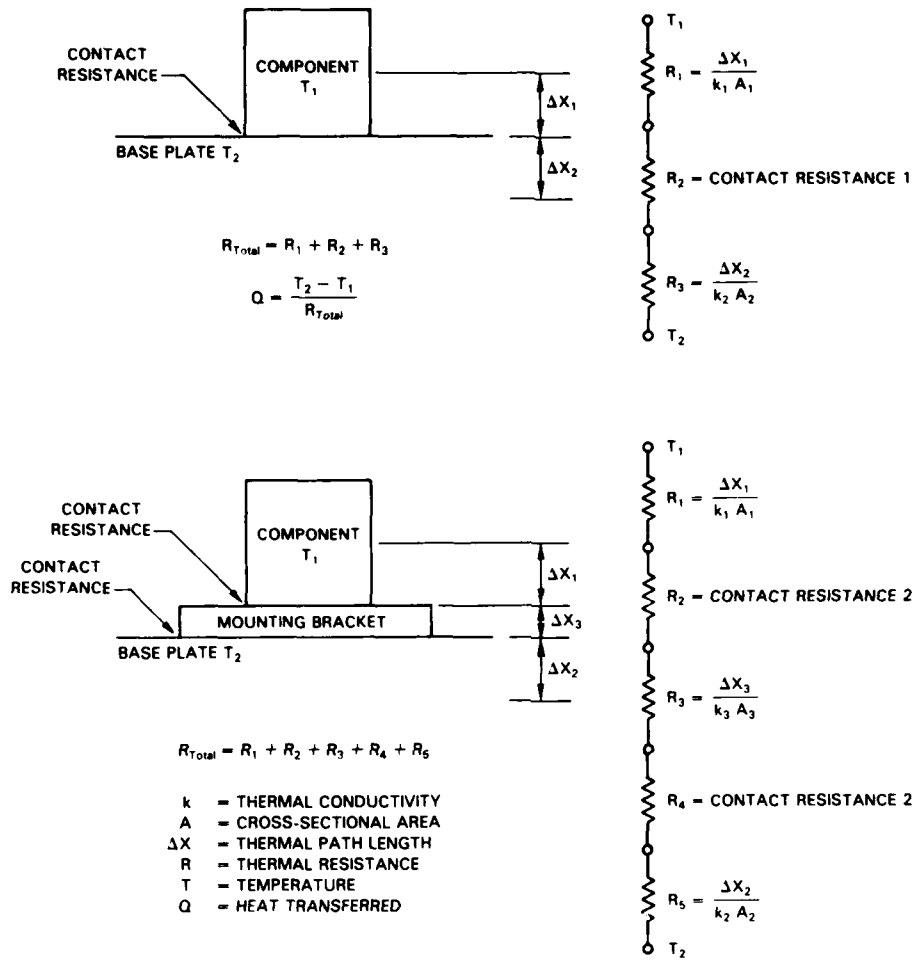
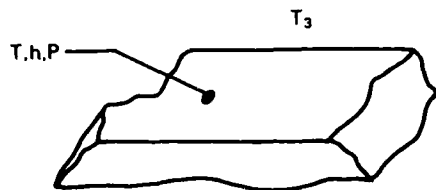


Fig. 3 — Effect of mounting brackets on total thermal resistance

Convection;

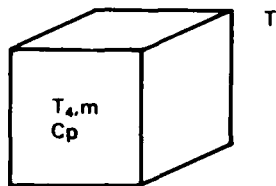
$$Q_h = hP\Delta T_h \text{ (Btu/h)} \quad (2)$$



$$\Delta T_h = T - T_3$$

Capacitance;

$$C = mC_p\Delta T_c \text{ (Btu)} \quad (3)$$



$$\Delta T_c = T_5 - T_4$$

where

- k is the conductive heat transfer coefficient (Btu/h · ft · °F)
- A is the cross-sectional area in the direction of heat flow (ft²)
- Δx is the heat transfer distance (ft)
- ΔT_k is the temperature difference for heat transfer (°F).
- h is the convective heat transfer coefficient (Btu/h · ft² · °F)
- P is the heat transfer surface area or perimeter (ft²)
- ΔT_h is the temperature difference for heat transfer (°F)
- m is the mass (lbm)
- C_p is the specific heat (BTM/lbm · °F)
- ΔT_c is the temperature difference for thermal storage (°F).

For this design, k , h , and C_p are fixed, and the temperature differences ΔT_k , ΔT_h , and ΔT_c are relatively small. The only coefficients which can be varied to improve heat transfer and storage are A , Δx , P , and m . An increase in A and decrease in Δx improves heat conduction by enlarging the contact area and decreasing the heat transfer path. Increasing P improves convection by increasing the surface area. Increasing m improves the thermal storage capability.

Finned surfaces are recommended when convective heat transfer is the limiting factor in the total dissipation of heat and when $2/k(b \cdot h) > 5$, where b is the fin thickness (Fig. 4). Fins are added to the surface P to increase the overall surface area until an optimum solution is reached, where the convective and conductive heat transfer rates are balanced:

$$kA \frac{\Delta T_k}{\Delta x} = hP \Delta T_h \quad (4)$$

For this design, the convective heat transfer rate needs to be at least equivalent to conductive heat transfer rate to the baseplate to be the more attractive solution.

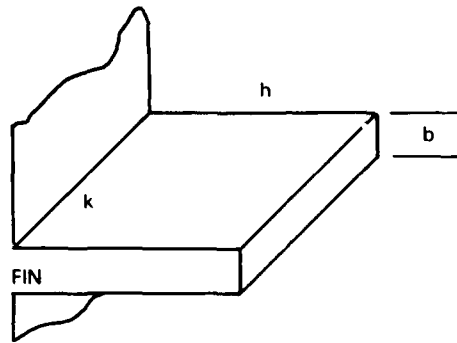


Fig. 4 - Fin surface

The value for ΔT_k and ΔT_h are approximately equal and can be eliminated from the equation. After rearranging terms, the equation for the required convective heat transfer surface, P , becomes:

$$P = \frac{kA}{h\Delta x} \quad (5)$$

Using the conductive coefficient values for the modulator/regulator,

$$\frac{kA}{\Delta X} = 8.9 \frac{\text{Btu}}{h^\circ F}$$

and the convective heat transfer coefficient,

$$h = 0.4 \frac{\text{Btu}}{h^\circ F \cdot ft^2}$$

To calculate the required surface area for equivalent heat transfer, P is equal to 22.25 ft². The present surface area is 2.06 ft²; thus P requires 10.8 times more surface area. With internal space at a premium, the use of fin surfaces as the major form of heat transfer is prohibitive. Fins are used as a secondary source for additional cooling on particular components.

In developing thermal models there are two standard approaches to handling purchased components. The first is to introduce the component as a heat source applied to a surface; the second is to incorporate the component as a physical part of the model. The first approach assumes that the component is not critical to the operation of the design, or that the possibility of thermal failure from this component is minute. The second approach assumes the opposite. This second approach was used throughout the analysis.

Accurate incorporation of component into the system requires the use of detailed manufacturer information. Where manufacturer information was not available or did not exist, visual inspection and available data were used to estimate heat transfer coefficient and capacitance.

THERMAL COMPUTER PROGRAMS

Two main computer programs were used to analyze the thermal characteristics of the transmitter: Radiation View Factor (RAVFAC) and System Improved Numerical Differencing Analyzer (SINDA). These programs were developed for NASA by Lockheed and TRW Corporations, respectively, to analyze space flight equipment. Currently, both programs are recognized and used within the aerospace industry. The programs use finite difference, contour integrals, and other matrix techniques to formulate thermal and general solutions.

RAVFAC develops the blackbody radiation view factor, f_{ij} , to determine radiation exchange between objects. Radiation view factor is defined as the percent of radiation emitted by surface i that

impinges on surface j (Fig. 5). The accuracy of the results are dependent on the number of elements per node and nodes per surface, and the distance between the two surfaces, i and j , relative to the size of the surfaces.

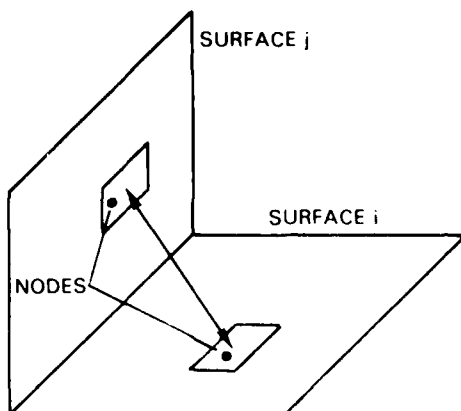


Fig. 5 - Radiation exchange

SINDA uses a resistor-capacitor (R-C) network to represent a thermal system. Each component is represented as a nodal point (s), interconnected to other nodal points by resistors, i.e., conduction, convection, and radiation conductance (Fig. 6). Associated with each node is a thermal capacitance for energy storage. The accuracy of the results are dependent on the number of nodal points used to describe a component and by the accuracy of the heat transfer coefficient and thermal capacitance.

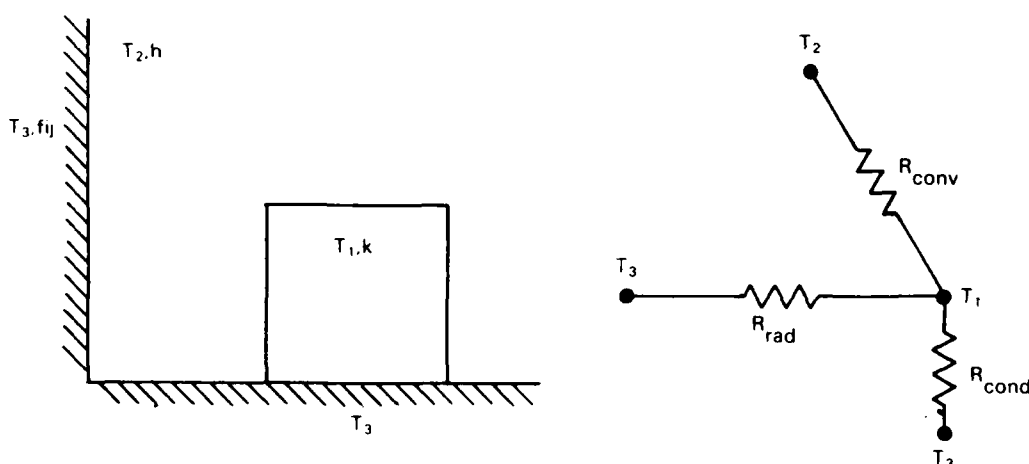


Fig. 6 - R-C network

Several other computer programs are required to generate view factors and to arrange them into a format acceptable to SINDA: Ravplot-three-dimensional plotting program, Copaps-data reduction program, and Script f-data conversion program.

THERMAL MODEL DEVELOPMENT

The RAVFAC data deck for this model is constructed of two-dimensional rectangular and circular plates, and three-dimensional cylinders. Rectangular components are made up of six rectangular plates

to represent the six sides of a box. The capacitors are the only nonrectangular components and are constructed by combining a cylinder with two circular plates. Flat objects such as printed circuit boards are constructed of two rectangular plates facing opposite directions. The walls of the casing are made up of rectangular plates facing into the casing. Appendix A includes a RAVFAC deck.

Each plate is constructed of one node which is subdivided into rectangular elements with the length of each element varying from 1 to 2 in. on a side.

The plotting program Ravplot is used to assure correct orientation of surfaces and components before RAVFAC is executed. Figures 7 and 8 are examples of Ravplot drawings. Appendix B includes Ravplot deck.

The execution of RAVFAC generates view factors for each surface, i.e., six sets of view factors for each box. The program Colaps is used to reduce the data to a more manageable form. Colaps reduces sets of view factors to a single set, i.e., each component becomes a single set. Appendix C shows a Colaps deck.

Script *f* uses surface emissivities, the blackbody view factor and area data from Colaps to generate greybody conductance values. Appendix D includes a Script *F* data deck.

SINDA requires capacitance, conductor, and source data to generate steady state or transient temperatures profiles. Appendix E includes a complete SINDA data deck.

The capacitance (thermal storage) *C* is specified in units of Btu per °F and is calculated by using either Eq. (6) or (7). The capacitance values are located in the Node Data block.

$$C = mC_p \tag{6}$$

$$C = VC_p \tag{7}$$

where

<i>C</i> is the capacitance	(Btu/°F)
<i>m</i> is the mass	(lbm)
<i>C_p</i> is the specific heat	(Btu/lbm · °F)
<i>ρ</i> is the density	(lbm/ft ³)
<i>V</i> is the volume	(ft ³).

The conductance uses the format of Eq. (8). The convective and conductive conductors are input as linear conductors into the network solution using Eqs. (9) and (10), respectively.

$$\dot{Q} = G \cdot (T_2 - T_1) \tag{8}$$

where

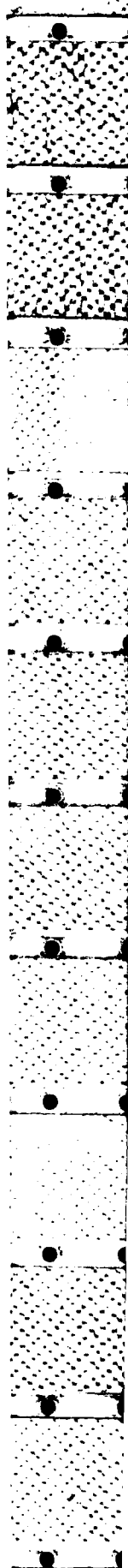
\dot{Q} is the heat rate	(Btu/h)
<i>G</i> is the conductance	(Btu/h · °F)
<i>T</i> is the temperature	(°F)

$$G = h \cdot P \tag{9}$$

$$G = k \cdot \frac{A}{x} \tag{10}$$

where

<i>h</i> is the convective film coefficient	(Btu/ft ² · h · °F)
<i>P</i> is the surface area	(ft ²)
<i>k</i> is the thermal conductivity of the material	(Btu/ft · h · °F)
<i>A</i> is the cross-sectional area of the conductive	(ft ²)
<i>x</i> is the length of the conductive path	(ft).



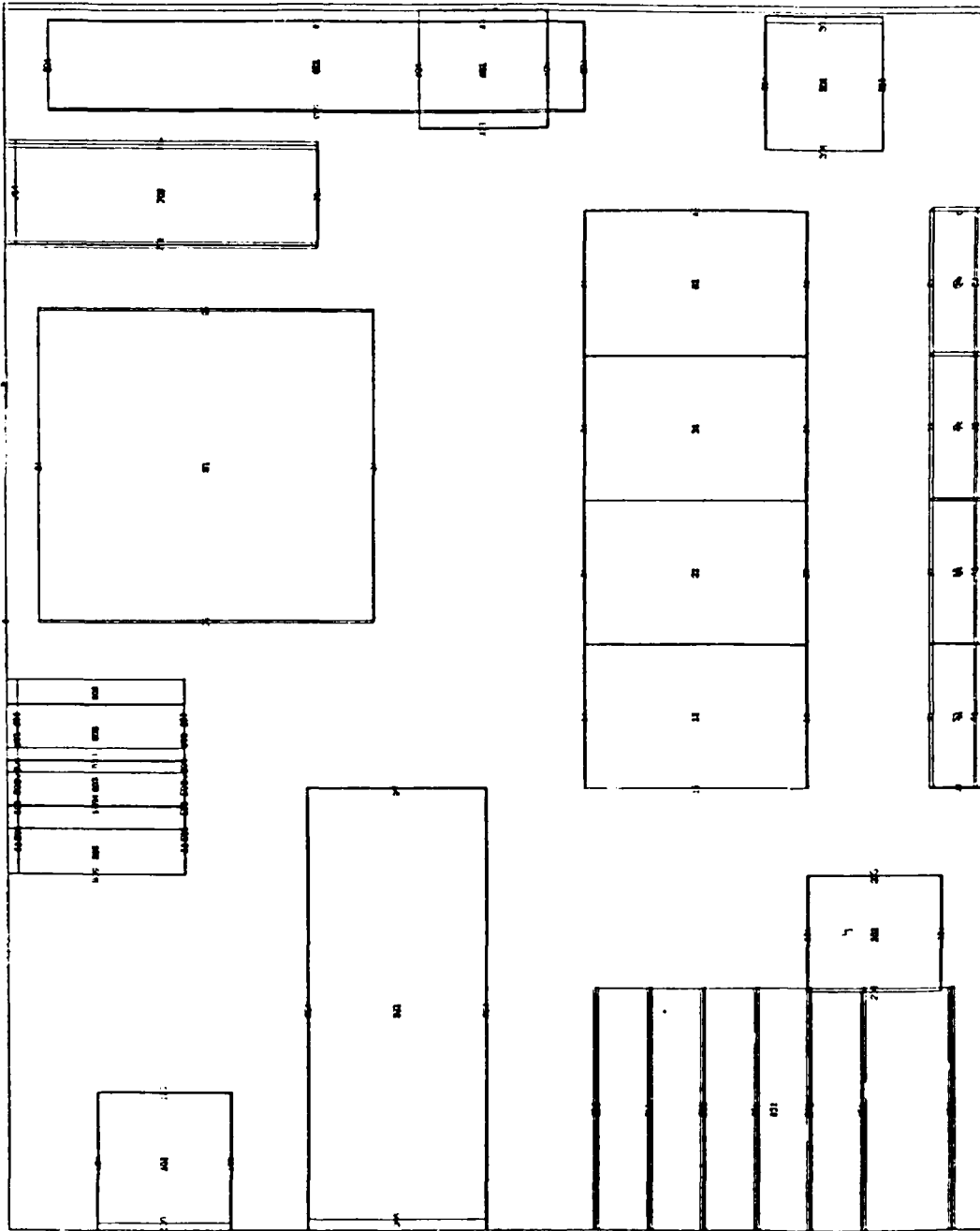


Fig. 7 - RAVPLOT of L-band transmitter

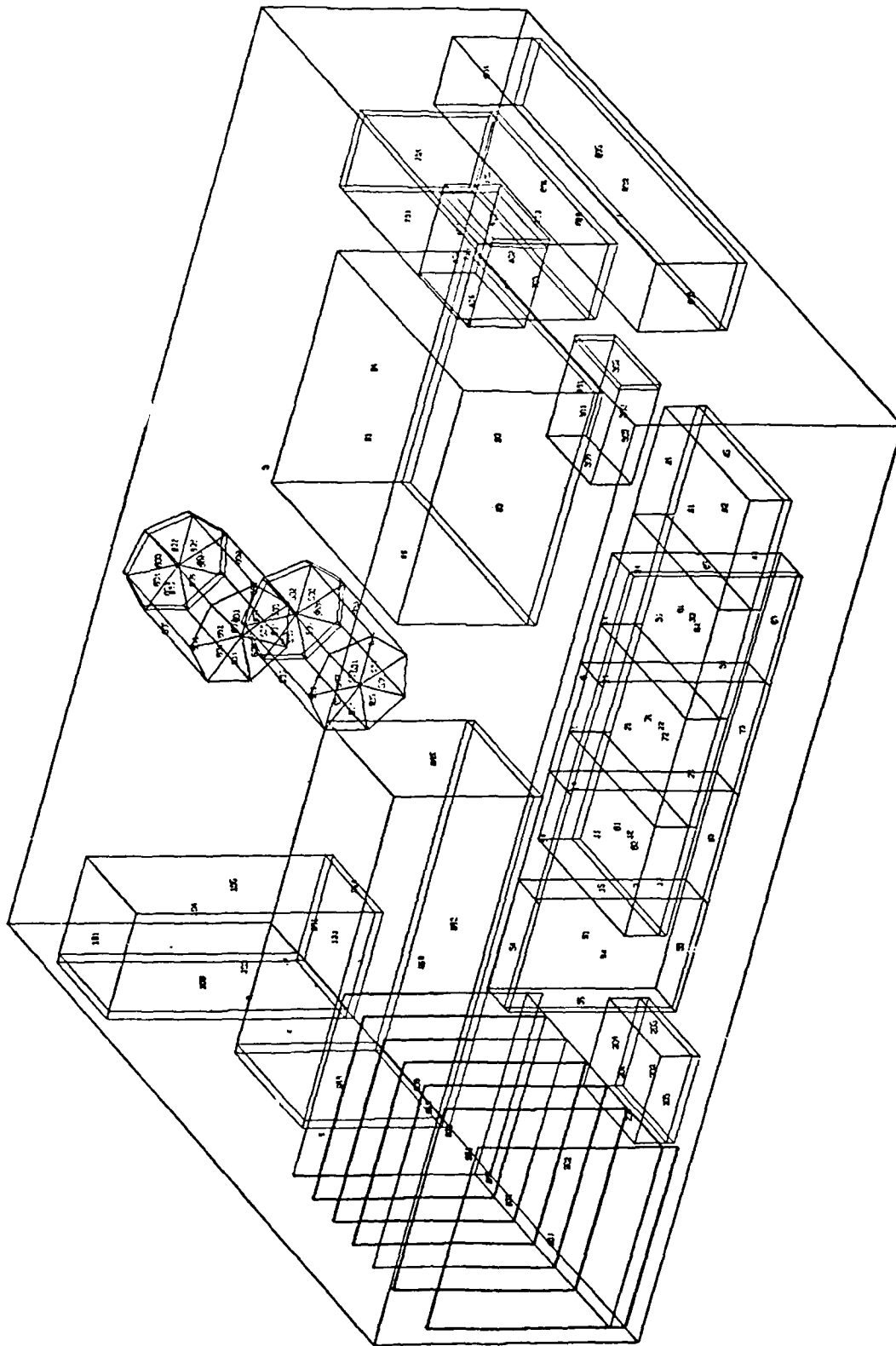


Fig. 8 -- RAVPLOT of L-band transmitter

To account for contact resistance between surfaces where the conductive pad is used, the contact area is assumed to be half the plate area. Where the pad is not used, the mounting screw area is assumed to be the contact area.

The radiation conductor is input as a nonlinear conductor using the format of Eq. (11).

$$G = \epsilon \sigma FA ((T + 460)) ((T + 460)^2 + (T + 460)^2) \quad (11)$$

where

σ is the Stefan-Boltzman constant 0.1714×10^{-8} (Btu/ft² h · R⁴)

ϵ is the emissivity

FA is Script f (ft²).

The conductors are located in the Conductor Data block.

Heat sources are redefined in each iteration of the analysis. The heat source values are listed in the Constants Data block and redefined in the Variables 1 block.

Time between iterations is 0.5 min with output every 5 min. The cycle time for the first 250 min is 5 min on, followed by 20 min off to stabilize the transmitter cycle temperature. This is followed by a 20 min on, 20 min off worst condition cycle. The final 150 min returns to the original 5 min on, 20 min off cycle. The cycle scheduling is listed in the Execution block.

OBSERVATIONS AND DESIGN MODIFICATIONS

Preliminary results revealed one major and two minor localized hot spots, and three areas of concern with insufficient manufacturer's data.

The modulator/regulator is the most likely component to exceed its temperature limit. Heat is difficult to dissipate due to the small surface area relative to the amount of heat generated by the regulator. A high thermal resistance also exists between the interior of the regulator and its conducting surface. To utilize the available surface area, the regulators are attached to large aluminum blocks. In addition, each regulator is finned for additional heat dissipation. The size and shape of the heat sink/mounting bracket was determined by the available space within the casing (Fig. 9).

The output sections of the power amplifiers are minor areas of concern. The analysis shows that the amplifiers approach their maximum temperature limits as the modulator/regulator reaches its limit. There is sufficient temperature gradient difference between the amplifiers and their limit to allow the modulator/regulator to deactivate the power supplies before the amplifiers reach their maximum temperature. Therefore, no revisions were required in the design.

The three areas of possible concern due to insufficient manufacturer's data were the two power supplies and the RFI power filter. The analysis indicated the three components are operating below their respective critical temperature limits, but due to limited manufacturer's data, the coefficients are of questionable value. The smaller of the two power supplies was opened for visual inspection, and all heat generating components appeared to be well heat sunk. When the unit was bench-tested, it appeared to operate near ambient conditions. The power supplies arrived from the manufacturer with a label requesting adequate heat sinking. To assure proper operation of the two supplies, the mounting bracket thickness was increased to a half inch instead of the quarter inch used on all other brackets.

The RFI power filter is hermetically sealed, which eliminates visual inspection, and requires the manufacturer's limited information be used to calculate the coefficients. The filter was bench-tested and appeared to remain cool. Due to the high electrical efficiency of the filter, the mounting bracket will follow the design of other components until a full-scale test of the transmitter is conducted.

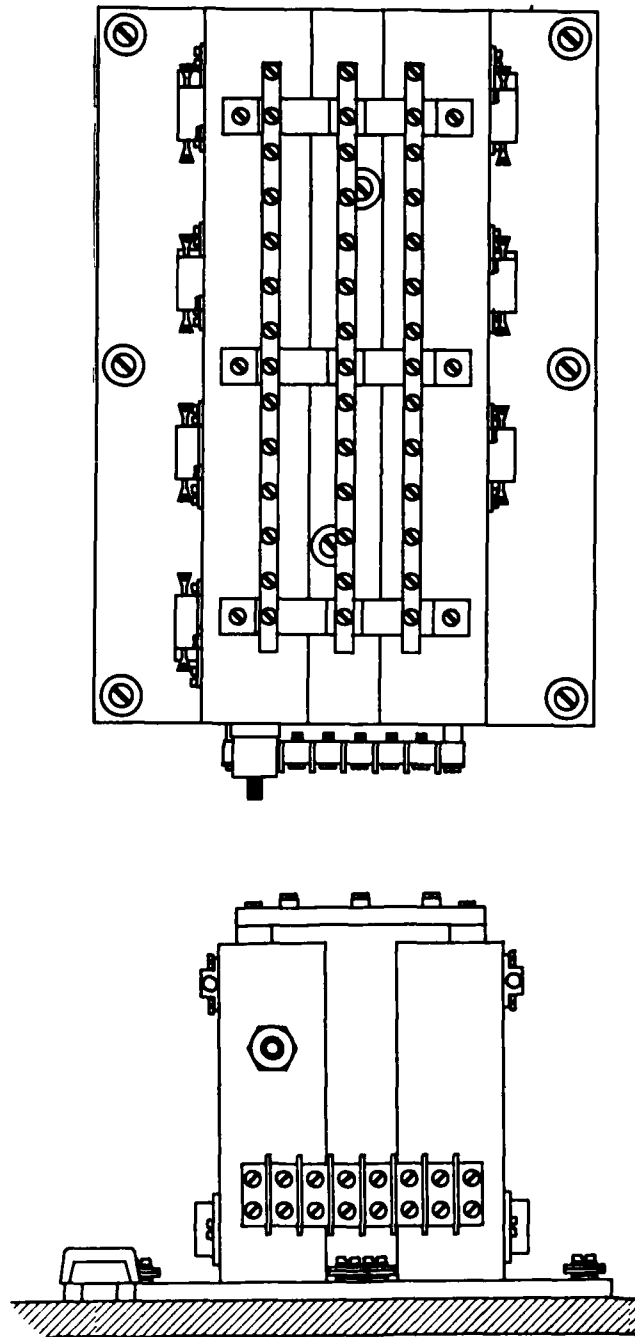


Fig. 9 - Modulator/regulator

CONCLUSION

The thermal analysis predicts that the transmitter is capable of withstanding an ambient sol-air temperature of 110°F (43°C), with no wind, and will operate effectively. The transmitter is also able to withstand extreme environmental conditions without malfunctioning.

During normal operations the interior of the transmitter is designed to minimize component temperature rise. This is accomplished by spreading out the heat generated by the components into the mounting bracket/heat sink. Lower temperature rise will increase the life expectancy of the electronic components.

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Appendix A

RAVFAC

T. J. BENNETT

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/ J73 BENNETT,776126P4,BENNT2,CPT=(C,P),CAT=23
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/ ASG LRAVFAC,MY/PAVFAC/LRAVFAC,USE=SHR
/ EXQT CO=LRAVFAC,CPTIME=400000,PT=(7,A)
L RAND 1 TRANSMITTE RADIATION ANALYSIS

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	1	0	2	2		
10133	1	1	1	2	30.0	0.0
	0				0.75	6.0
10233	-1	1	1	2	30.0	0.0
	0				0.75	3.5
10333	-1	1	1	2	30.0	0.0
	0				3.1875	0.75
10433	1	1	1	2	30.0	0.0
	0				0.25	0.75
10533	-1	1	1	2	20.0	0.0
	0				0.0	8.25
10633	1	1	1	2	20.0	0.0
	0				0.0	0.75
20133	1	1	1	2	20.0	0.0
	0				18.0	6.25
20233	-1	1	1	2	20.0	0.0
	0				18.0	6.25
20333	-1	1	1	2	10.0	0.0
	0				21.015	6.25
20433	1	1	1	2	10.0	0.0
	0				18.0	6.25
20533	-1	1	1	1	20.0	0.0
	0				18.0	8.875
20633	1	1	1	1	20.0	0.0
	0				18.0	6.25
30133	1	1	1	2	20.0	0.0
	0				17.0	24.385
30233	-1	1	1	2	20.0	0.0
	0				17.0	24.385
30333	-1	1	1	2	10.0	0.0
	0				19.625	24.385
30433	1	1	1	2	10.0	0.0
	0				17.0	24.385
30533	-1	1	1	1	20.0	0.0
	0				17.0	27.25
30633	1	1	1	1	20.0	0.0
	0				17.0	24.385

	2	-1
RFI POWER FILTER TSP	7.5	0.0
	0.0	0.0
RFI POWER FILTER BOTTOM	7.5	0.0
	0.0	0.0
RFI POWER FILTER FRONT	7.5	0.0
	0.0	90.0
RFI POWER FILTER BACK	7.5	0.0
	0.0	90.0
RFI POWER FILTER RIGHT SIDE	2.5	0.0
	0.0	90.0
RFI POWER FILTER LEFT SIDE	2.5	0.0
	0.0	90.0
COAX SWITCH 1 TOP	2.625	0.0
	0.0	0.0
COAX SWITCH 1 BOTTOM	2.625	0.0
	0.0	0.0
COAX SWITCH 1 FRONT	2.625	0.0
	0.0	90.0
COAX SWITCH 1 BACK	2.625	0.0
	0.0	90.0
COAX SWITCH 1 RIGHT SIDE	1.1875	0.0
	0.0	0.0
COAX SWITCH 1 LEFT SIDE	1.1875	0.0
	0.0	0.0
COAX SWITCH 2 TOP	3.015	0.0
	0.0	0.0
COAX SWITCH 2 BOTTOM	3.015	0.0
	0.0	0.0
COAX SWITCH 2 FRONT	3.015	0.0
	0.0	90.0
COAX SWITCH 2 BACK	3.015	0.0
	0.0	90.0
COAX SWITCH 2 RIGHT SIDE	1.1875	0.0
	0.0	0.0
COAX SWITCH 2 LEFT SIDE	1.1875	0.0
	0.0	0.0

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40133	1	1	1	2	20.0	0.0	CIRCULATOR TOP			
	0				9.25	24.875	5.1875	2.625	0.0	2.875
40233	-1	1	1	2	20.0	0.0	CIRCULATOR BOTTOM			
	0				9.25	24.875	3.5	2.625	0.0	2.875
40333	-1	1	1	2	10.0	0.0	CIRCULATOR FRONT			
	0				12.125	24.875	3.5	2.625	0.0	1.6875
40433	1	1	1	2	10.0	0.0	CIRCULATOR BACK			
	0				9.25	24.875	3.5	2.625	0.0	1.6875
40533	-1	1	1	1	20.0	0.0	CIRCULATOR RIGHT SIDE			
	0				9.25	27.25	3.5	1.6875	0.0	2.875
40633	1	1	1	1	20.0	0.0	CIRCULATOR LEFT SIDE			
	0				9.25	24.875	3.5	1.6875	0.0	2.875
50133	2	1	7	2	10.0	0.0	CAPACITOR 1 TOP			
	0				5.25	3.00	4.0	1.5	0.1	360.0
50233	-2	1	7	2	10.0	0.0	CAPACITOR 1 BOTTOM			
	0				5.25	3.00	0.250	1.5	0.1	360.0
50333	4	1	7	2	31.5	0.0	CAPACITOR 1 SIDE			
	0				5.25	3.00	0.0	4.0	0.1	360.0
60133	2	1	7	2	10.0	0.0	CAPACITOR 2 TOP			
	0				5.25	6.50	4.0	1.5	0.1	360.0
60233	-2	1	7	2	10.0	0.0	CAPACITOR 2 BOTTOM			
	0				5.25	6.50	0.250	1.5	0.1	360.0
60333	4	1	7	2	31.5	0.0	CAPACITOR 2 SIDE			
	0				5.25	6.50	0.0	4.0	0.1	360.0
70133	1	1	1	2	30.0	0.0	POWER SUPPLY 1100 TOP			
	0				9.25	18.25	4.1875	2.25	0.0	7.0
70233	-1	1	1	2	30.0	0.0	POWER SUPPLY 1100 BOTTOM			
	0				9.25	18.25	0.25	2.25	0.0	7.0
70333	-1	1	1	2	40.0	0.0	POWER SUPPLY 1100 FRONT			
	0				9.25	11.25	0.0	2.25	0.0	4.1875
70433	1	1	1	2	40.0	0.0	POWER SUPPLY 1100 BACK			
	0				9.25	18.25	0.0	2.25	0.0	4.1875
70533	-1	1	1	1	30.0	0.0	POWER SUPPLY 1100 RIGHT SIDE			
	0				11.5	18.25	0.0	4.1875	0.0	7.0
70633	1	1	1	1	30.0	0.0	POWER SUPPLY 1100 LEFT SIDE			
	0				9.25	18.25	0.0	4.1875	0.0	7.0
80133	1	1	1	1	60.0	0.0	FILTER TOP			
	0				0.0	25.0	2.6875	2.5	0.0	12.125
80233	-1	1	1	1	60.0	0.0	FILTER BOTTOM			
	0				0.25	25.0	0.250	2.25	0.0	11.875
80333	-1	1	1	2	70.0	0.0	FILTER FRONT			
	0				12.125	25.0	0.0	2.5	0.0	2.6875
80433	1	1	1	2	20.0	0.0	FILTER BACK			
	0				0.250	25.0	0.0	2.5	0.0	2.6875

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80533	-1	1	1	1	60.0	0.0	FILTER RIGHT SIDE
	0			0.0	27.25	0.0	2.6875 0.0 12.125
80633	1	1	1	1	60.0	0.0	0.0 0.0 90.0
	0			0.0	25.0	0.0	FILTER LEFT SIDE
90133	-1	1	1	6	30.0	0.0	2.6875 0.0 12.125
	0			13.25	5.5	0.48	0.0 0.0 90.0
90233	1	1	1	6	30.0	0.0	CARD BUCKET BOTTOM DOWN
	0			13.25	5.5	0.49	8.0 0.0 5.5
90333	-1	1	1	3	30.0	0.0	90.0 0.0 0.0
	0			21.25	5.5	0.0	CARD BUCKET BOTTOM UP
90433	1	1	1	3	30.0	0.0	8.0 0.0 5.5
	0			21.2	5.5	0.0	90.0 0.0 0.0
90533	1	1	1	3	30.0	0.0	CARD BUCKET RIGHT SIDE OUT
	0			13.2	5.5	0.0	6.0 0.0 5.5
90633	-1	1	1	3	30.0	0.0	90.0 0.0 90.0
	0			13.25	5.5	0.0	CARD BUCKET RIGHT SIDE IN
91133	1	1	1	3	30.0	0.0	6.0 0.0 5.5
	0			14.4	5.5	0.5	90.0 0.0 90.0
91233	-1	1	1	3	30.0	0.0	CARD BUCKET LEFT SIDE OUT
	0			14.45	5.5	0.5	6.0 0.0 5.5
92133	1	1	1	3	30.0	0.0	90.0 0.0 90.0
	0			15.6	5.5	0.5	CARD BUCKET LEFT SIDE IN
92233	-1	1	1	3	30.0	0.0	6.0 0.0 5.5
	0			15.65	5.5	0.5	90.0 0.0 90.0
93133	1	1	1	3	30.0	0.0	CARD 1 LEFT FACE
	0			16.8	5.5	0.5	5.5 0.0 5.5
93233	-1	1	1	3	30.0	0.0	90.0 0.0 90.0
	0			16.45	5.5	0.5	CARD 1 RIGHT FACE
94133	1	1	1	3	30.0	0.0	5.5 0.0 5.5
	0			18.0	5.5	0.5	90.0 0.0 90.0
94233	-1	1	1	3	30.0	0.0	CARD 2 LEFT FACE
	0			18.05	5.5	0.5	5.5 0.0 5.5
95133	1	1	1	3	30.0	0.0	90.0 0.0 90.0
	0			19.2	5.5	0.5	CARD 2 RIGHT FACE
95233	-1	1	1	3	30.0	0.0	5.5 0.0 5.5
	0			19.25	5.5	0.5	90.0 0.0 90.0
96133	1	1	1	1	30.0	0.0	CARD 3 LEFT FACE
	0			6.5	0.0	6.0	5.5 0.0 5.5
96333	-1	1	1	1	30.0	0.0	90.0 0.0 90.0
	0			12.0	0.0	0.0	CARD 3 RIGHT FACE
96433	1	1	1	1	30.0	0.0	5.5 0.0 5.5
	0			6.5	0.0	0.0	90.0 0.0 90.0
96533	-1	1	1	3	30.0	0.0	CARD 4 LEFT FACE
	0			6.5	0.75	0.0	5.5 0.0 5.5
					0.0	0.0	90.0 0.0 90.0
					0.75	0.0	CARD 4 RIGHT FACE
					0.0	0.0	5.5 0.0 5.5
					0.0	0.0	90.0 0.0 90.0
					0.75	0.0	CARD 5 LEFT FACE
					0.0	0.0	5.5 0.0 5.5
					0.0	0.0	90.0 0.0 90.0
					0.75	0.0	CARD 5 RIGHT FACE
					0.0	0.0	5.5 0.0 5.5
					0.0	0.0	90.0 0.0 90.0
					0.75	0.0	REGULATOR TOP
					0.0	0.0	0.0 0.0 0.0
					0.75	0.0	REGULATOR FRONT
					0.0	0.0	0.0 90.0 0.0
					0.75	0.0	REGULATOR RACK
					0.0	0.0	0.0 90.0 0.0
					0.75	0.0	REGULATOR RIGHT SIDE
					0.0	0.0	6.0 0.0 5.5
					0.0	0.0	0.0 0.0 90.0

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							REGULATOR LEFT SIDE		
	1	1	1	3	30.0	0.0	5.75	0.0	5.5
	0		6.5		0.25	0.25	0.0	90.0	
1133	1	1	1	2	30.0	0.0	AMP 1 TOP #1		
	0		13.0		10.0	1.25	3.25	0.0	
1233	-1	1	1	2	30.0	0.0	0.0	5.0	
	0		13.0		10.0	0.250	0.0	0.0	
1333	-1	1	1	2	10.0	0.0	AMP 1 BOTTOM #1		
	0		18.0		10.0	0.0	3.25	0.0	
1433	1	1	1	2	10.0	0.0	0.0	1.25	
	0		13.0		10.0	0.0	0.0	90.0	
1533	1	1	1	2	10.0	0.0	AMP 1 BACK #1		
	0		13.0		10.0	0.0	3.25	0.0	
1633	1	1	1	1	30.0	0.0	0.0	90.0	
	0		13.0		10.0	0.0	AMP 1 LEFT SIDE #1		
2133	1	1	1	2	30.0	0.0	1.25	5.0	
	0		13.0		13.25	1.25	0.0	90.0	
2233	-1	1	1	2	30.0	0.0	AMP 1 TOP #2		
	0		13.0		13.25	0.250	3.25	0.0	
2333	-1	1	1	2	10.0	0.0	0.0	5.0	
	0		18.0		13.25	0.0	3.25	0.0	
2433	1	1	1	2	10.0	0.0	0.0	1.25	
	0		13.0		13.25	0.0	0.0	90.0	
3133	1	1	1	2	30.0	0.0	AMP 1 BACK #2		
	0		13.0		16.5	1.25	3.25	0.0	
3233	-1	1	1	2	30.0	0.0	0.0	5.0	
	0		13.0		16.5	0.250	3.25	0.0	
3333	-1	1	1	2	10.0	0.0	0.0	1.25	
	0		18.0		16.5	0.0	0.0	90.0	
3433	1	1	1	2	10.0	0.0	AMP 1 FRONT #3		
	0		13.0		16.5	0.0	3.25	0.0	
4133	1	1	1	2	30.0	0.0	0.0	1.25	
	0		13.0		19.75	1.25	0.0	90.0	
4233	-1	1	1	2	30.0	0.0	AMP 1 TOP #4		
	0		13.0		19.75	0.250	3.25	0.0	
4333	-1	1	1	2	10.0	0.0	0.0	5.0	
	0		18.0		19.75	0.0	3.25	0.0	
4433	1	1	1	2	10.0	0.0	AMP 1 BOTTOM #4		
	0		13.0		19.75	0.0	3.25	0.0	
4533	-1	1	1	1	30.0	0.0	0.0	1.25	
	0		13.0		23.00	0.0	0.0	90.0	
5133	1	1	1	2	30.0	0.0	AMP 1 FRONT #4		
	0		20.75		10.0	0.75	3.25	0.0	
5233	-1	1	1	2	30.0	0.0	0.0	5.0	
	0		21.75		10.0	0.75	0.0	90.0	
5333	-1	1	1	2	10.0	0.0	AMP 2 TOP #1		
	0		20.75		10.0	0.75	3.25	0.0	
							0.0	90.0	

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5433	1	1	1	2	10.0	0.0	AMP 2 BACK #1		
	0				20.75	10.0	3.25	0.0	1.25
5533	-1	1	1	1	30.0	0.0	0.0	0.0	0.0
	0				20.75	10.0	1.25	0.0	5.0
6133	1	1	1	2	30.0	0.0	90.0	90.0	0.0
	0				20.75	13.25	AMP 2 TOP #2		
6233	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0				21.75	13.25	0.0	90.0	0.0
6333	-1	1	1	2	30.0	0.0	AMP 2 BOTTOM #2		
	0				21.75	13.25	3.25	0.0	5.0
6433	-1	1	1	2	10.0	0.0	0.0	90.0	0.0
	0				20.75	13.25	AMP 2 FRONT #2		
7133	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0				20.75	13.25	0.0	0.0	0.0
7233	1	1	1	2	30.0	0.0	AMP 2 RACK #2		
	0				20.75	16.5	3.25	0.0	1.25
7333	-1	1	1	2	30.0	0.0	0.0	90.0	0.0
	0				21.75	16.5	AMP 2 TOP #3		
7433	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0				20.75	16.5	0.0	0.0	0.0
8133	1	1	1	2	10.0	0.0	AMP 2 BACK #3		
	0				20.75	16.5	3.25	0.0	1.25
8233	1	1	1	2	30.0	0.0	0.0	0.0	0.0
	0				20.75	19.75	AMP 2 TOP #4		
8333	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0				21.75	19.75	0.0	90.0	0.0
8433	-1	1	1	2	10.0	0.0	AMP 2 BOTTOM #4		
	0				20.75	19.75	3.25	0.0	5.0
8533	-1	1	1	2	10.0	0.0	0.0	90.0	0.0
	0				20.75	19.75	AMP 2 FRONT #4		
9133	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0				20.75	19.75	0.0	0.0	0.0
9233	1	1	1	3	30.0	0.0	AMP 2 BACK #4		
	0				0.750	23.0	3.25	0.0	1.25
9333	-1	1	1	3	50.0	0.0	0.0	0.0	0.0
	0				0.750	23.0	AMP 2 RIGHT SIDE #4		
9433	-1	1	1	3	20.0	0.0	1.25	0.0	5.0
	0				0.750	23.0	90.0	90.0	0.0
9533	1	1	1	3	20.0	0.0	POWER SUPPLY 1400 TOP		
	0				0.750	12.0	7.0	0.0	11.0
9633	-1	1	1	2	50.0	0.0	90.0	0.0	0.0
	0				0.750	23.0	POWER SUPPLY 1400 BOTTOM		
133	-1	1	1	7	60.0	0.0	7.0	0.0	11.0
	0				0.0	0.0	90.0	0.0	90.0
							POWER SUPPLY 1400 FRONT		
							7.0	0.0	4.1875
							90.0	90.0	0.0
							POWER SUPPLY 1400 BACK		
							7.0	0.0	4.1875
							90.0	90.0	0.0
							POWER SUPPLY 1400 RIGHT SIDE		
							4.1875	0.0	11.0
							90.0	0.0	90.0
							POWER SUPPLY 1400 LEFT SIDE		
							4.1875	0.0	11.0
							90.0	0.0	90.0
							CASING TOP		
							27.5	0.0	22.0
							0.0	0.0	0.0

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233	1	1	1	14	30.0	0.0	CASING FRONT		
	0			22.0	0.0	0.0	27.5	0.0	6.5
333	-1	1	1	14	30.0	0.0	0.0	90.0	0.0
	0			0.0	0.0	0.0	CASING BACK		
433	1	1	1	6	220.0	0.0	27.5	0.0	6.5
	0			0.0	27.5	0.0	0.0	90.0	0.0
533	-1	1	1	3	110.0	0.0	CASING RIGHT SIDE		
	0			0.0	0.0	0.0	6.5	0.0	22.
633	1	1	1	14	110.0	0.0	0.0	0.0	90.
	0			0.0	0.0	0.0	CASING LEFT SIDE		
							6.5	0.0	22.
							0.0	0.0	90.
							CASING BOTTOM		
							27.5	0.0	22.
							0.0	0.0	0.0

-1

ENC
 / CATV MY/LRANG2/PAVFAC/RAVOUT,ACNM=FT07F001
 / FMSYS FT07F001
 / FSJ

Appendix B

RAV PLOT

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/ JOB DE WNETT, 77012534, WNETT2, OPT=(C,D), CAT=17
 / LIMIT MIN=5, MAX=150
 / PC=HIS, USEFCAT/077/021/WNETT2
 / FC=FC06-071, LAA0=5/40/75
 / ASG LRVPLT2, HIS/LRVPLT2, USE=SHR
 / EXOT 00=LRVPLT2

LEAF 1 TRANSMITTER RADIATION ANALYSIS

1	2	3	4	5	6	7	8	9
10133	1	1	1	2	30.0	0.0	RFI POWER FILTER TOP	
	0		0.75	0.75	0.0	0.0	3.1875	0.0
10233	-1	1	1	2	30.0	0.0	RFI POWER FILTER BOTTOM	
	0		0.75	4.0	0.0	0.0	3.1875	0.0
10333	-1	1	1	2	20.0	0.0	RFI POWER FILTER FRONT	
	0		0.25	0.75	0.0	0.0	3.75	0.0
10433	1	1	1	2	20.0	0.0	RFI POWER FILTER BACK	
	0		0.75	0.75	0.0	0.0	3.75	0.0
10533	-1	1	1	2	30.0	0.0	RFI POWER FILTER RIGHT SIDE	
	0		0.75	0.75	0.0	3.1875	3.75	0.0
10633	1	1	1	2	30.0	0.0	RFI POWER FILTER LEFT SIDE	
	0		0.75	0.75	0.0	0.0	3.75	0.0
20133	1	1	1	2	20.0	0.0	CMAX SWITCH 1 TOP	
	0		0.0	8.5	0.0	4.1875	2.625	0.0
20233	-1	1	1	2	20.0	0.0	CMAX SWITCH 1 BOTTOM	
	0		0.0	8.5	0.0	3.0	2.625	0.0
20333	-1	1	1	2	10.0	0.0	CMAX SWITCH 1 FRONT	
	0		0.0	5.485	0.0	3.0	2.625	0.0
20433	1	1	1	2	10.0	0.0	CMAX SWITCH 1 BACK	
	0		0.0	8.5	0.0	3.0	2.625	0.0
20533	-1	1	1	1	20.0	0.0	CMAX SWITCH 1 RIGHT SIDE	
	0		0.025	8.5	0.0	3.0	1.1875	0.0
20633	1	1	1	1	20.0	0.0	CMAX SWITCH 1 LEFT SIDE	
	0		0.025	8.5	0.0	3.0	1.1875	0.0
30133	1	1	1	2	20.0	0.0	CMAX SWITCH 2 TOP	
	0		2.0	25.485	0.0	5.1875	3.015	0.0
30233	-1	1	1	2	20.0	0.0	CMAX SWITCH 2 BOTTOM	
	0		2.0	25.485	0.0	4.0	3.015	0.0
30333	-1	1	1	2	10.0	0.0	CMAX SWITCH 2 FRONT	
	0		4.025	25.485	0.0	4.0	3.015	0.0
30433	1	1	1	2	10.0	0.0	CMAX SWITCH 2 BACK	
	0		2.0	25.485	0.0	4.0	3.015	0.0
30533	-1	1	1	1	20.0	0.0	CMAX SWITCH 2 RIGHT SIDE	
	0		2.0	29.25	0.0	4.0	1.1875	0.0
30633	1	1	1	1	20.0	0.0	CMAX SWITCH 2 LEFT SIDE	
	0		2.0	25.485	0.0	4.0	1.1875	0.0
40133	1	1	1	2	20.0	0.0	CIRCULATOR TOP	
	0						2.625	0.0

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40233	0		9.25	25.875	5.1875	0.0	0.0	0.0	CIRCULATOR BOTTOM
	-1	1	1	2	20.0	0.0	2.625	0.0	2.675
	0		9.25	25.875	3.5	0.0	0.0	0.0	0.0
40333									CIRCULATOR FRONT
	-1	1	1	2	10.0	0.0	2.625	0.0	1.6875
	0		12.125	25.875	3.5	0.0	0.0	90.0	0.0
40433									CIRCULATOR BACK
	1	1	1	2	10.0	0.0	2.625	0.0	1.6875
	0		9.25	25.875	3.5	0.0	0.0	90.0	0.0
40533									CIRCULATOR RIGHT SIDE
	-1	1	1	1	20.0	0.0	1.6875	0.0	2.675
	0		9.25	28.25	3.5	0.0	0.0	0.0	90.0
40633									CIRCULATOR LEFT SIDE
	1	1	1	1	20.0	0.0	1.6875	0.0	2.675
	0		9.25	25.875	3.5	0.0	0.0	0.0	90.0
50133									CAPACITOR 1 TOP
	2	1	7	2	10.0	0.0	1.5	0.1	360.0
	0		16.25	14.5	4.0	0.0	0.0	0.0	0.0
50233									CAPACITOR 1 BOTTOM
	-2	1	7	2	10.0	0.0	1.5	0.1	360.0
	0		16.25	14.5	0.250	0.0	0.0	0.0	0.0
50333									CAPACITOR 1 SIDE
	4	1	7	2	31.5	0.0	4.0	0.1	360.0
	0		16.25	14.5	0.0	0.0	0.0	0.0	0.0
60133									CAPACITOR 2 TOP
	2	1	7	2	10.0	0.0	1.5	0.1	360.0
	0		20.25	14.5	4.0	0.0	0.0	0.0	0.0
60233									CAPACITOR 2 BOTTOM
	-2	1	7	2	10.0	0.0	1.5	0.1	360.0
	0		20.25	14.5	0.250	0.0	0.0	0.0	0.0
60333									CAPACITOR 2 SIDE
	4	1	7	2	31.5	0.0	4.0	0.1	360.0
	0		20.25	14.5	0.0	0.0	0.0	0.0	0.0
70133									POWER SUPPLY 1100 TOP
	1	1	1	2	30.0	0.0	2.25	0.0	7.0
	0		15.0	9.25	4.1875	0.0	0.0	0.0	0.0
70233									POWER SUPPLY 1100 BOTTOM
	-1	1	1	2	30.0	0.0	2.25	0.0	6.75
	0		15.0	9.25	0.250	0.0	0.0	0.0	0.0
70333									POWER SUPPLY 1100 FRONT
	-1	1	1	2	40.0	0.0	2.25	0.0	4.1875
	0		21.75	9.25	0.0	0.0	0.0	90.0	0.0
70433									POWER SUPPLY 1100 BACK
	1	1	1	2	40.0	0.0	2.25	0.0	4.1875
	0		15.0	9.25	0.0	0.0	0.0	90.0	0.0
70533									POWER SUPPLY 1100 RIGHT SIDE
	-1	1	1	1	30.0	0.0	4.1875	0.0	7.0
	0		15.0	11.50	0.0	0.0	0.0	0.0	90.0
70633									POWER SUPPLY 1100 LEFT SIDE
	1	1	1	1	30.0	0.0	4.1875	0.0	7.0
	0		15.0	9.25	0.0	0.0	0.0	0.0	90.0
80133									FILTER TOP
	1	1	1	1	60.0	0.0	2.5	0.0	12.125
	0		0.0	26.0	2.6875	0.0	0.0	0.0	0.0
80233									FILTER BOTTOM
	-1	1	1	1	60.0	0.0	2.25	0.0	11.875
	0		0.25	26.0	0.250	0.0	0.0	0.0	0.0
80333									FILTER FRONT
	-1	1	1	2	20.0	0.0	2.5	0.0	2.6875
	0		12.125	26.0	0.0	0.0	0.0	90.0	0.0
80433									FILTER BACK
	1	1	1	2	20.0	0.0	2.25	0.0	2.6875
	0		0.250	26.0	0.0	0.0	0.0	90.0	0.0
80533									FILTER RIGHT SIDE
	-1	1	1	1	60.0	0.0	2.6875	0.0	12.125

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80633	0			0.0	28.25	0.0	0.0	0.0	90.0
	1	1	1	1	60.0	0.0	2.6875	0.0	12.125
	0				0.0	0.0	0.0	0.0	90.0
90133	-1	1	1	0	30.0	0.0	CARD BUCKET BOTTOM DOWN		
	0				16.5	17.0	11.5	0.0	5.5
90233	1	1	1	6	30.0	0.0	CARD BUCKET BOTTOM UP		
	0				16.5	17.7	0.0	0.0	0.0
90333	-1	1	1	3	30.0	0.0	CARD BUCKET RIGHT SIDE OUT		
	0				16.5	23.45	0.0	0.0	5.5
90433	1	1	1	3	30.0	0.0	CARD BUCKET RIGHT SIDE IN		
	0				16.5	23.4	0.0	0.0	30.0
90533	1	1	1	3	30.0	0.0	CARD BUCKET LEFT SIDE OUT		
	0				16.5	17.0	0.0	0.0	5.5
90633	-1	1	1	3	30.0	0.0	CARD BUCKET LEFT SIDE IN		
	0				16.5	17.05	0.0	0.0	5.5
91133	1	1	1	3	30.0	0.0	CARD 1 LEFT FACE		
	0				16.5	18.41	0.0	0.0	5.5
91233	-1	1	1	3	30.0	0.0	CARD 1 RIGHT FACE		
	0				16.5	13.43	0.0	0.0	5.5
92133	1	1	1	3	30.0	0.0	CARD 2 LEFT FACE		
	0				16.5	19.84	0.0	0.0	5.5
92233	-1	1	1	3	30.0	0.0	CARD 2 RIGHT FACE		
	0				16.5	19.86	0.0	0.0	5.5
93133	1	1	1	3	30.0	0.0	CARD 3 LEFT FACE		
	0				16.5	21.27	0.0	0.0	5.5
93233	-1	1	1	3	30.0	0.0	CARD 3 RIGHT FACE		
	0				16.5	21.29	0.0	0.0	5.5
94133	1	1	1	3	30.0	0.0	CARD 4 LEFT FACE		
	0				16.5	22.7	0.0	0.0	5.5
94233	-1	1	1	3	30.0	0.0	CARD 4 RIGHT FACE		
	0				16.5	22.72	0.0	0.0	5.5
95133	1	1	1	3	30.0	0.0	CARD 5 LEFT FACE		
	0				16.5	24.13	0.0	0.0	5.5
95233	-1	1	1	3	30.0	0.0	CARD 5 RIGHT FACE		
	0				16.5	24.15	0.0	0.0	5.5
96133	1	1	1	3	30.0	0.0	CARD 6 LEFT FACE		
	0				16.5	25.56	0.0	0.0	5.5
96233	-1	1	1	3	30.0	0.0	CARD 6 RIGHT FACE		
	0				16.5	25.58	0.0	0.0	5.5
97133	1	1	1	3	30.0	0.0	CARD 7 LEFT FACE		
	0				16.5	27.0	0.0	0.0	5.5
97233	-1	1	1	3	30.0	0.0	CARD 7 RIGHT FACE		
	0				16.5	27.02	0.0	0.0	5.5
1133	1	1	1	2	30.0	0.0	CARD 1 TOP #1		
							3.25	0.0	5.0

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1233	0			7.25	10.0	1.25	0.0	0.0	0.0
	-1	1	1	2	30.0	0.0	AMP 1 BOTTOM #1	0.0	0.0
	0			7.25	10.0	0.250	3.25	0.0	5.0
1333							0.0	0.0	0.0
	-1	1	1	2	10.0	0.0	AMP 1 FRONT #1	0.0	1.25
	0			12.25	10.0	0.0	0.0	90.0	0.0
1433							AMP 1 BACK #1	0.0	0.0
	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			7.25	10.0	0.0	0.0	90.0	0.0
1533							AMP 1 LEFT SIDE #1	0.0	0.0
	1	1	1	1	30.0	0.0	1.25	0.0	5.0
	0			7.25	10.0	0.0	0.0	0.0	90.0
2133							AMP 1 TOP #2	0.0	0.0
	1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			7.25	13.25	1.25	0.0	0.0	0.0
2233							AMP 1 BOTTOM #2	0.0	0.0
	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			7.25	13.25	0.250	0.0	0.0	0.0
2333							AMP 1 FRONT #2	0.0	0.0
	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			12.25	13.25	0.0	0.0	90.0	0.0
2433							AMP 1 BACK #2	0.0	0.0
	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			7.25	13.25	0.0	0.0	90.0	0.0
3133							AMP 1 TOP #3	0.0	0.0
	1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			7.25	16.5	1.25	0.0	0.0	0.0
3233							AMP 1 BOTTOM #3	0.0	0.0
	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			7.25	16.5	0.250	0.0	0.0	0.0
3333							AMP 1 FRONT #3	0.0	0.0
	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			12.25	16.5	0.0	0.0	90.0	0.0
3433							AMP 1 BACK #3	0.0	0.0
	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			7.25	16.5	0.0	0.0	90.0	0.0
4133							AMP 1 TOP #4	0.0	0.0
	1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			7.25	19.75	1.25	0.0	0.0	0.0
4233							AMP 1 BOTTOM #4	0.0	0.0
	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			7.25	19.75	0.250	0.0	0.0	0.0
4333							AMP 1 FRONT #4	0.0	0.0
	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			12.25	19.75	0.0	0.0	90.0	0.0
4433							AMP 1 BACK #4	0.0	0.0
	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			7.25	19.75	0.0	0.0	90.0	0.0
4533							AMP 1 RIGHT SIDE #4	0.0	0.0
	-1	1	1	1	30.0	0.0	1.25	0.0	5.0
	0			7.25	23.00	0.0	0.0	0.0	90.0
5133							AMP 2 TOP #1	0.0	0.0
	1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			0.75	10.0	1.25	0.0	0.0	0.0
5233							AMP 2 BOTTOM #1	0.0	0.0
	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			0.75	10.0	0.250	0.0	0.0	0.0
5333							AMP 2 FRONT #1	0.0	0.0
	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			5.75	10.0	0.0	0.0	90.0	0.0
5433							AMP 2 BACK #1	0.0	0.0
	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			0.75	10.0	0.0	0.0	90.0	0.0
5533							AMP 2 LEFT SIDE #1	0.0	0.0
	1	1	1	1	30.0	0.0	1.25	0.0	5.0

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6133	0			0.75	10.0	0.0	0.0	0.0	9.0
	1	1	1		30.0	0.0	3.25	0.0	5.0
	0			0.75	13.25	1.25	0.0	0.0	0.0
6233	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			0.75	13.25	0.25	0.0	0.0	0.0
6333	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			0.75	13.25	0.0	0.0	90.0	0.0
6433	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			0.75	13.25	0.0	0.0	90.0	0.0
7133	1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			0.75	16.5	1.25	0.0	0.0	0.0
7233	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			0.75	16.5	0.25	0.0	0.0	0.0
7333	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			0.75	16.5	0.0	0.0	90.0	0.0
7433	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			0.75	16.5	0.0	0.0	90.0	0.0
8133	1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			0.75	19.75	1.25	0.0	0.0	0.0
8233	-1	1	1	2	30.0	0.0	3.25	0.0	5.0
	0			0.75	19.75	0.25	0.0	0.0	0.0
8333	-1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			0.75	19.75	0.0	0.0	90.0	0.0
8433	1	1	1	2	10.0	0.0	3.25	0.0	1.25
	0			0.75	19.75	0.0	0.0	90.0	0.0
8533	-1	1	1	1	30.0	0.0	1.25	0.0	5.0
	0			0.75	23.00	0.0	0.0	0.0	90.0
9133	1	1	1	3	50.0	0.0	7.0	0.0	11.0
	0			10.75	0.75	4.1875	0.0	0.0	0.0
9233	-1	1	1	3	50.0	0.0	7.0	0.0	11.0
	0			10.75	0.75	0.25	0.0	0.0	0.0
9333	-1	1	1	3	20.0	0.0	7.0	0.0	4.1875
	0			21.75	0.75	0.0	0.0	90.0	0.0
9433	1	1	1	3	20.0	0.0	7.0	0.0	4.1875
	0			10.75	0.75	0.0	0.0	90.0	0.0
9533	-1	1	1	2	50.0	0.0	4.1875	0.0	11.0
	0			10.75	7.75	0.0	0.0	0.0	90.0
9633	1	1	1	2	50.0	0.0	4.1875	0.0	11.0
	0			10.75	0.75	0.0	0.0	0.0	90.0
133	-1	1	1	7	60.0	0.0	28.5	0.0	22.0
	0			0.0	0.0	6.5	0.0	0.0	0.0
233	1	1	1	14	30.0	0.0	28.5	0.0	6.5
	0			22.0	0.0	0.0	0.0	90.0	0.0
333	-1	1	1	14	30.0	0.0	28.5	0.0	6.5

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	0		0.0	0.0	0.0	0.0	90.0	0.0
433	1	1	1	6	220.0	0.0	CASING RIGHT SIDE	27.0
	0		0.0		23.5	0.0	6.5	0.0
533	-1	1	1	3	110.0	0.0	CASING LEFT SIDE	90.0
	0		0.0		0.0	0.0	0.5	0.0
633	1	1	1	14	110.0	0.0	CASING BOTTOM	22.0
	-		0.0		0.0	0.0	28.5	0.0
-1							0.0	0.0
30.0	-30.0							
L BAND TRANSMITTER								
30.0	-30.0							
BENNETT								
0.0	0.0							
L BAND TRANSMITTER								
0.0	0.0							
BENNETT								
0.0	-90.0							
L BAND TRANSMITTER								
0.0	-90.0							
BENNETT								
END								
/ FOSYS FT18F001,TYPE=PLUT								
/ EQU								

Appendix C
COLAPS

T. J. BENNETT

/ JOB BENNETT,77G12634,9ENNT2,OPT=(C,R),CAT=22
/ LIMIT MIN=15,RAND=150
/ FC MY,USERCAT/077/020/5ENNT2
/ FD FT14F001,BAND=5/20/5
/ FD FT07F001,BAND=5/20/5
/ FD FT06F001,BAND=5/20/5
/ ASG LCOLAPS,MY/COLAPS/LCOLAPS,USE=SMR
/ FXQT GO=LCOLAPS,CPTIME=400000,OPT=(Z,A)
L BAND 1 TRANSMITTER COLAPS 2 DATA
32 0 5

- 1 1
- 2 2
- 3 3
- 4 4
- 5 5 6
- 6 7 8
- 7 9
- 8 10
- 9 11
- 10 12
- 11 13
- 12 14
- 13 15
- 14 16
- 15 17
- 16 18
- 17 19
- 18 20
- 19 21
- 20 22
- 21 23
- 22 24
- 23 25
- 24 26
- 25 27
- 26 28
- 27 29
- 28 30
- 29 31
- 30 32
- 0

L BAND 1 TRANSMITTER COLAPS DATA
0.1280E 030.5950E 010.5259E-010.6602E-010.0000E 000.2032E 000.0000E 000.6297E-01
0.1130E 020.2654E 000.0000E 000.0000E 000.0000E 000.0000E 000.0000E 000.0000E 00
0.1909E-010.6011E 000.6819E-010.3242E-010.1782E-010.8574E 000.1652E 000.8079E-01
0.4601E-010.0000E 000.5914E 010.7865E 010.2200E 000.1489E 020.3864E 000.2466E 02
0.2922E 020.1414E-010.8563E-020.0000E 000.1966E-010.0000E 000.5295E-020.9430E 00
0.2301E-010.0000E 000.0000E 000.0000E 000.0000E 000.0000E 000.0000E 000.1044E 00
0.5769E 000.6387E-020.2031E-020.9917E-030.6874E 000.1497E 000.5182E-010.1465E-01
0.0000E 000.6726E 010.1236E 020.2294E 000.2781E 010.7081E-010.0000E 00
0.2922E 020.2244E 000.1013E-020.1753E 000.7095E-020.2235E 000.5829E-010.4708E 01
0.5619E-010.8390E-020.1211E-010.1576E-010.8604E-020.7005E-010.2630E-010.3113E-01
0.6710E-010.1744E 000.6365E 000.1692E-010.3091E-010.1193E 000.9496E 000.9334E-02
0.8685E 010.2260E 010.1739E 000.2742E 010.7545E 010.1392E 00
0.3366E 020.1391E-010.7232E-010.1363E 000.1415E 010.3822E-010.6065E 010.2587E-01
0.3432E-020.8699E-020.1017E-010.5851E-020.1645E-010.5871E-010.3123E-010.7546E-01
0.2104E 000.7444E 000.7367E-010.1237E 000.1999E 000.3293E 000.1209E 000.1018E 02
0.6000E 000.8930E 000.2785E 000.1137E 020.2100E 00
0.7070E 010.0000E 000.0000E 000.0000E 000.0000E 000.0000E 000.0000E 000.0000E 00
0.0000E 000.0000E 000.0000E 000.0000E 000.7451E-020.0000E 000.0000E 000.0000E 00
0.0000E 000.7105E-020.7174E-020.7097E-020.7054E-020.0000E 000.6756E 010.0000E 00
0.1161E 000.1695E-010.1589E 000.2103E-01
0.4475E 020.0000E 000.9138E 010.2944E 000.5570E 000.3522E 000.4887E-010.1410E 00

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0.2238E 000.1138E 000.1951E 000.4316E 000.2670E 000.9054E 000.2387E 010.1126E 01
 0.2834E 000.3923E 000.4394E 000.3885E 000.0000E 000.8542E 010.1504E 020.6340E 00
 0.6676E 000.6753E 000.7419E 00
 0.7070E 010.0000E 000.0000E 000.0000E 000.0000E 000.0000E 000.0000E 000.0000E 00
 0.0000E 000.0000E 000.4206E 020.0000E 000.0000E 000.0000E 000.0000E 000.0000E 00
 0.5080E 020.7042E 020.6998E 020.0000E 000.6499E 010.0000E 000.1131E 000.1081E 01
 0.2198E 000.1043E 01
 0.4476E 020.8753E 020.4411E 010.2290E 020.1275E 020.9904E 020.4628E 020.0000E 00
 0.0000E 000.0000E 000.3115E 010.1189E 000.7531E 000.2373E 010.1818E 000.2727E 00
 0.3714E 000.4302E 000.0000E 000.5579E 010.1279E 020.0000E 000.5511E 000.5771E 01
 0.1882E 00
 0.1084E 030.3070E 000.1713E 020.0000E 000.0000E 000.0000E 000.0000E 000.0000E 00
 0.6581E 000.1240E 010.1155E 000.4755E 010.2519E 010.8596E 000.5372E 000.2798E 00
 0.1521E 000.0000E 000.2200E 020.2789E 020.1540E 010.2757E 010.4132E 000.1971E 02
 0.1350E 030.1601E 000.4914E 010.6435E 010.6347E 010.2587E 010.6333E 010.0000E 00
 0.2050E 010.5878E 010.1701E 000.4195E 010.2255E 000.4009E 000.7516E 000.3258E 01
 0.0000E 000.1842E 020.3829E 020.8583E 010.9745E 010.4182E 020.7603E 00
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 0.1322E 000.7950E 010.3239E 010.1949E 000.2142E 000.1513E 000.1429E 000.2004E 01
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 0.6050E 020.2134E 020.0000E 000.0000E 000.0000E 000.2062E 000.8170E 010.2820E 01
 0.1649E 010.1066E 010.0000E 000.2029E 010.4193E 010.2560E 010.5789E 020.2726E 01
 0.1447E 010.3722E 000.8531E 020.8450E 010.3757E 01
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 0.1335E 010.0000E 000.0000E 000.6521E 010.4167E 010.3576E 020.3493E 010.1641E 01
 0.3134E 000.1446E 010.1040E 000.3627E 01
 0.6050E 020.2148E 020.0000E 000.1145E 010.7737E 010.5238E 010.2791E 010.1580E 01
 0.0000E 000.0000E 000.7517E 010.4981E 010.5414E 020.2013E 010.2097E 010.3046E 00
 0.4551E 010.1114E 000.1613E 01
 0.6050E 020.2494E 020.5156E 000.1722E 010.2769E 010.1713E 010.3821E 020.0000E 00
 0.0000E 000.1843E 010.2809E 010.1815E 020.2385E 010.9902E 000.1298E 000.2643E 01
 0.5097E 010.7377E 01
 0.6050E 020.6478E 000.3556E 010.6343E 010.4321E 010.9601E 020.0000E 000.0000E 00
 0.4634E 010.7062E 010.6471E 020.3789E 010.1976E 010.2769E 010.6632E 010.1196E 00
 0.6209E 01
 0.7150E 020.3536E 000.3037E 000.1558E 000.3207E 020.3944E 000.3746E 000.3238E 00
 0.2023E 000.1235E 000.1564E 020.1317E 020.3404E 020.9230E 000.2511E 000.1136E 00
 0.4687E 020.0000E 000.0000E 000.0000E 000.1345E 010.7260E 000.2135E 000.7041E 01
 0.0000E 000.1505E 020.2279E 020.7070E 000.1509E 010.1165E 000.6983E 00
 0.4067E 020.0000E 000.0000E 000.7373E 000.1398E 010.7366E 000.2167E 000.0000E 00
 0.1419E 020.1998E 020.5546E 000.3513E 000.1962E 000.2096E 00
 0.4062E 020.0000E 000.2189E 000.7475E 000.1398E 010.7351E 000.0000E 000.1331E 02
 0.1911E 020.1812E 000.2706E 000.3907E 000.1317E 00
 0.4687E 020.7340E 010.2231E 000.7413E 000.1377E 010.0000E 000.1249E 020.2106E 02
 0.1913E 010.7846E 000.8022E 000.9016E 01
 0.4687E 020.0000E 000.0000E 000.0000E 000.1111E 010.1036E 020.8931E 010.9901E 00
 0.1699E 020.2721E 000.1173E 01
 0.4062E 020.0000E 000.0000E 000.1495E 010.9610E 010.7341E 010.9120E 000.1625E 02
 0.3797E 000.3096E 00
 0.4062E 020.0000E 000.1349E 010.9463E 010.7201E 010.8490E 000.1625E 020.5380E 00
 0.1939E 00
 0.4687E 020.1746E 010.9768E 010.6001E 010.6421E 000.1812E 020.1654E 010.1309E 00
 0.3047E 030.5809E 020.7700E 020.1161E 020.4368E 010.2479E 020.1069E 00
 0.6050E 030.1705E 030.4974E 020.2873E 020.2355E 020.3190E 02
 0.6050E 030.2280E 020.1753E 020.3609E 010.1046E 02
 0.1787E 030.3091E 010.9711E 010.6199E 00
 0.1787E 030.5202E 010.1463E 02
 0.1430E 030.2298E 01
 0.1430E 03
 -99.0
 / CATV MY/L3AND1/COLAPS/COLOUT,ACAP=FT07F001
 / FOSYS FT07F001
 / F0J

Appendix D

SCRIPT f

/ JCB BENNETT,77G12684,BENNT2,OPT=(C,2),CAT=17
 / LIMIT MIN=9,LAN=150
 / PD NY,USRCAT/D77/32C/BENNT2
 / FD FT07F001,LAN=5/20/5
 / FD FT06F001,LAN=5/20/5
 / ASG LSCRPTF,NY/SCRIPTE/LSCRPTF,USE=SHR
 / FXQT G0=LSCRPTF

STRT

L BAND 2 TRANSMITTER SCRIPT F DATA
 30 465

0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0							
0							
0							
0.1280E	030.8414E	-010.1975E	-010.0000E	000.1279E	020.9763E	010.2097E	010.0000E 00
0.6857E	010.0000E	000.0000E	000.0000E	000.0000E	000.0000E	000.5551E	010.3745E 00
0.4519E	-010.3755E	-020.1859E	-020.4127E	000.1910E	000.9640E	-010.5818E	-010.0000E 00
0.7936E	010.1440E	020.1953E	020.2765E	020.5693E	-010.4021E	02	
0.2922E	020.3570E	-010.2094E	-010.0000E	000.1347E	000.1139E	000.0000E	000.1461E 01
0.8902E	-010.2045E	000.6491E	000.3795E	000.7307E	000.0000E	000.7867E	000.4436E -01
0.1236E	-010.5866E	-020.1299E	-010.1496E	000.4954E	-010.1996E	-010.0000E	000.5701E 01
0.1100E	020.5329E	010.1484E	000.2024E	000.5726E	00		
0.2922E	020.2272E	000.0000E	000.3025E	-020.2843E	000.3949E	000.7217E	-010.1325E -01
0.9709E	-020.6404E	-020.1512E	-020.4787E	-020.4651E	-010.3495E	-010.7816E	-010.2149E 00
0.9699E	000.2215E	-010.5433E	-010.1607E	000.1016E	010.3063E	-010.8567E	010.4612E 01
0.3563E	010.1673E	000.8436E	010.1740E	00			
0.3366E	020.0000E	000.1344E	-010.4039E	000.6546E	010.9404E	-010.6985E	-020.2503E -01
0.2971E	-010.1782E	-010.4379E	-010.2161E	-010.4914E	-010.1153E	000.2583E	000.7544E 00
0.7853E	-010.1300E	000.2074E	000.3184E	000.1059E	000.9407E	010.2423E	010.4869E 00
0.9317E	000.1093E	020.1111E	00				
0.5163E	020.3738E	010.2944E	010.0000E	000.4491E	000.0000E	000.0000E	000.0000E 00
0.0000E	000.0000E	000.1703E	000.9811E	-010.8924E	-030.0000E	000.0000E	000.7665E -01
0.6642E	-010.0000E	000.0000E	000.0000E	000.9937E	010.1171E	020.1675E	-010.8958E 01
0.1282E	-010.8692E	00					
0.5183E	020.3621E	010.6499E	-010.2652E	010.0000E	000.0000E	000.0000E	000.0000E 00
0.0000E	000.1318E	010.6932E	000.5410E	-010.6217E	-020.0000E	000.3452E	000.2109E 00
0.1385E	000.6361E	-010.0000E	000.1239E	020.1430E	020.6330E	000.1252E	010.7543E -01
0.1360E	01						
0.1090E	030.1750E	010.1072E	010.2017E	000.3155E	000.3370E	000.2016E	000.3736E 00
0.5304E	000.3351E	010.6050E	010.3395E	010.9527E	000.1135E	010.1383E	010.1184E 01
0.6373E	000.0000E	000.3063E	020.3638E	020.2462E	010.4212E	010.2103E	010.6763E 00
0.1350E	030.1712E	000.1576E	-010.3752E	-010.7086E	-010.5293E	-010.9950E	-010.0000E 00
0.2083E	-010.1534E	000.4770E	000.1885E	010.2675E	000.4663E	000.6189E	000.7592E 00
0.0000E	000.2212E	020.3825E	020.8273E	000.1493E	020.4492E	020.1168E	00
0.2200E	030.3246E	020.7006E	010.8667E	010.2949E	010.2193E	020.6681E	010.9169E 00
0.1533E	000.7357E	-010.3638E	-010.7905E	000.2940E	000.1189E	000.8081E	-010.9940E -01
0.2165E	020.5298E	020.3907E	020.2286E	010.6680E	000.9361E	01	
0.6150E	020.2058E	020.0000E	000.0000E	000.0000E	000.0000E	000.1962E	000.1931E -01
0.7986E	-020.3741E	-020.2473E	000.1004E	000.5508E	-010.3576E	-010.1349E	-010.2268E 01
0.8061E	000.0000E	000.3322E	-010.1040E	000.3242E	01		
0.6050E	020.2329E	020.0000E	000.0000E	000.0000E	000.2027E	000.1738E	-010.6676E -02
0.3291E	-020.3863E	000.1054E	000.5677E	-010.3045E	-010.1739E	-010.3308E	010.1084E 01
0.0000E	000.3585E	-010.1280E	000.3653E	01			
0.6050E	020.2133E	020.0000E	000.0000E	000.2414E	000.2474E	-010.1092E	-010.4588E -02
0.5860E	000.1378E	000.6912E	-010.3135E	-010.1607E	-010.1715E	010.7451E	000.9236E 00
0.3241E	-010.1569E	000.1435E	01				
0.6050E	020.2462E	020.0000E	000.1602E	000.2049E	-010.8666E	-020.4293E	-020.2765E 00
0.4579E	-010.1771E	-010.8371E	-020.7155E	-020.2263E	010.3716E	000.4675E	000.1098E -01
0.8362E	-010.7309E	01					
0.6050E	020.0000E	000.3251E	000.5935E	-010.2787E	-010.1304E	-010.2764E	000.1525E -01

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0.6007E-02J.2556E-02J.1306E-C10.2899E 010.5903E 000.2661E 010.2492E-010.1939E 00
0.5594E 01
0.5275E 020.3213E 000.1107E 000.5311E-010.2606E-010.900JE 000.4946E-010.6488E-01
0.4632E-010.6736E-010.8975E 010.4854E 010.5639E-010.1078E 010.4489E 000.2239E 02
0.4687E 020.0000E 000.0000E 000.0000E 000.1687E 010.870JE 000.2404E 000.7787E-01
0.0000E 000.1315E 020.2034E 020.1731E 010.2829E 000.1652E 000.5489E 00
0.4062E 020.0000E 000.0000E 000.8587E 000.1840E 010.9117E 000.2447E 000.0000E 00
0.1199E 020.1696E 020.3799E 000.2813E-020.3365E 000.1520E 00
0.4062E 020.0000E 000.2366E 000.9159E 000.1993E 010.9207E 000.0000E 000.1276E 02
0.1812E 020.3796E 000.4314E-020.7491E 000.8507E-01
0.4687E 020.7555E-010.2430E 000.9023E 000.1820E 010.000JE 000.1299E 020.2049E 02
0.1641E 010.1817E 000.3935E 010.6427E-01
0.4687E 020.0000E 000.0000E 000.0000E 000.4163E-010.9585E 010.6370E 010.2042E 02
0.7896E 000.3874E 000.2235E 00
0.4062E 020.0000E 000.0000E 000.5095E-010.9249E 010.6091E 010.1660E 020.5456E 00
0.6103E 000.2124E 00
0.4062E 020.0000E 000.5406E-010.9245E 010.6239E 010.1662E 020.5888E 000.9222E 00
0.1555E 00
0.4687E 020.4878E-010.9517E 010.7622E 010.1936E 020.7131E 000.3104E 010.1309E 00
0.3047E 030.1345E 030.1477E 030.1775E 000.1931E 020.1988E 010.3874E 00
0.6050E 030.1112E 030.2066E 020.5067E 020.2695E 020.7286E 02
0.6050E 030.1176E 020.1808E 020.1509E 020.4386E 01
0.1787E 030.2512E 010.1069E 020.8200E-01
0.1787E 030.8116E 010.1497E 02
0.1430E 030.1670E 01
0.1430E 03
END
/ CATV MY/LBAND2/SCRIPT,ACNP=FT07F001
/ FOSYS FT07F001
/ FCJ

Appendix E

SINDA

T. J. BENNETT

```

100
200
300
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500
600
700
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900
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1100
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4700
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5200
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5400
5500
5600
5700
5800
5900
6000
6100

```

SERIAL LPCS
 LEAD TRANSITTER
 SHUT STUDY
 CONDUCTION DATA

1,120,0.689	\$ RF POWER FILTER (RTU/R)
2,120,0.325	\$ COAXIAL SWITCH 1
3,120,0.354	\$ COAXIAL SWITCH 2
4,120,0.376	\$ CIRCULATOR
5,120,0.195	\$ CAPACITOR 1
6,120,0.195	\$ CAPACITOR 2
7,120,0.466	\$ SERIES 1100 POWER SUPPLY
8,120,0.410	\$ FILTER
9,120,0.512	\$ CARD BUCKET
10,120,0.051	\$ CARD 1
11,120,0.051	\$ CARD 2
12,120,0.051	\$ CARD 3
13,120,0.051	\$ CARD 4
14,120,0.051	\$ CARD 5
15,120,0.051	\$ CARD 6
16,120,0.051	\$ CARD 7
17,120,0.258	\$ AMP 1 #1
18,120,0.277	\$ AMP 1 #2
19,120,0.277	\$ AMP 1 #3
20,120,0.306	\$ AMP 1 #4
21,120,0.258	\$ AMP 2 #1
22,120,0.277	\$ AMP 2 #2
23,120,0.277	\$ AMP 2 #3
24,120,0.306	\$ AMP 2 #4
25,120,1.628	\$ 1400 SERIES POWER SUPPLY
26,120,7.938	\$ CASING TOP
27,120,7.938	\$ CASING BOTTOM
28,120,1.964	\$ CASING FRONT
29,120,1.964	\$ CASING BACK
30,120,1.519	\$ CASING RIGHT SIDE
31,120,1.519	\$ CASING LEFT SIDE
32,120,0.051	\$ AIR INSIDE THE CASING
33,120,19.887	\$ HEAT SINK PLATE
-34,112,1.0	\$ TOP BOUNDARY
-35,112,1.0	\$ BOTTOM BOUNDARY
-36,112,1.0	\$ FRONT BOUNDARY
-37,112,1.0	\$ BACK BOUNDARY
-38,112,1.0	\$ RIGHT SIDE BOUNDARY
-39,112,1.0	\$ LEFT SIDE BOUNDARY

CONDUCTION DATA

1,1,31,169.245	\$ RF FILTER TO LEFT SIDE
2,1,32,0.200	\$ AIR- ²
-3,1,2,1.714E-11	\$ COAXIAL SWITCH 1
-4,1,25,5.142E-11	\$ 1400 POWER SUPPLY
-5,1,26,2.057E-10	\$ CASING TOP
-6,1,27,2.057E-10	\$ CASING BOTTOM
-7,1,29,1.200E-10	\$ CASING BACK
-8,1,31,2.228E-10	\$ CASING LEFT SIDE
9,2,27,51.414	\$ COAXIAL SWITCH 1 TO CASING BOTTOM
10,2,32,0.038	\$ AIR
-11,2,26,6.856E-11	\$ CASING TOP
-12,2,27,1.200E-10	\$ CASING BOTTOM
-13,2,29,6.856E-11	\$ CASING BACK
-14,2,31,1.714E-11	\$ LEFT SIDE

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6200	15,3,30,4.166	\$ COAXIAL SWITCH 2 TO CASING BOTTOM
6300	16,3,32,0.034	\$ AIR
6400	-17,3,8,5.142E-11	\$ FILTER
6500	-18,3,26,8.570E-11	\$ CASING TOP
6600	-19,3,27,1.714E-11	\$ CASING BOTTOM
6700	-20,3,29,3.428E-11	\$ CASING BACK
6800	-21,3,30,6.856E-11	\$ RIGHT SIDE
6900	22,4,30,3.954	\$ CIRCULATOR TO CASING RIGHT SIDE
7000	23,4,32,0.074	\$ AIR
7100	-24,4,8,5.142E-11	\$ FILTER
7200	-25,4,9,1.714E-11	\$ CARD BUCKET
7300	-26,4,26,1.028E-10	\$ CASING TOP
7400	-27,4,27,3.428E-11	\$ CASING BOTTOM
7500	-28,4,29,1.714E-11	\$ CASING BACK
7600	-29,4,30,1.028E-10	\$ CASING RIGHT SIDE
7700	30,5,27,5.923	\$ CAPACITOR 1 TO CASING BOTTOM
7800	31,5,32,0.129	\$ AIR
7900	-32,5,6,5.142E-11	\$ CAPACITOR 2
8000	-33,5,7,6.856E-11	\$ 1100 SERIES POWER
8100	-34,5,9,6.856E-11	\$ CARD BUCKET
8200	-35,5,25,1.714E-11	\$ 1400 SERIES POWER
8300	-36,5,26,1.371E-10	\$ CASING TOP
8400	-37,5,27,1.200E-10	\$ CASING BOTTOM
8500	-38,5,28,1.714E-11	\$ CASING FRONT
8600	-39,5,29,1.714E-11	\$ CASING BACK
8700	-40,5,30,1.714E-11	\$ CASING RIGHT SIDE
8800	41,5,27,5.923	\$ CAPACITOR 2 TO CASING BOTTOM
8900	42,6,32,0.129	\$ AIR
9000	-43,6,7,8.570E-11	\$ 1100 SERIES POWER
9100	-44,6,9,1.200E-10	\$ CARD BUCKET
9200	-45,6,26,6.856E-11	\$ CASING TOP
9300	-46,6,27,8.570E-11	\$ CASING BOTTOM
9400	-47,6,28,1.371E-10	\$ CASING FRONT
9500	48,7,27,70.205	\$ 1100 SERIES POWER TO CASING BOTTOM
9600	49,7,32,0.234	\$ AIR
9700	-51,7,9,1.714E-11	\$ CARD BUCKET
9800	-52,7,17,1.714E-11	\$ AMP 1 #1
9900	-53,7,25,2.228E-10	\$ 1400 SERIES
10000	-54,7,26,2.571E-10	\$ CASING TOP
10100	-55,7,27,2.228E-11	\$ CASING BOTTOM
10200	-56,7,28,2.057E-10	\$ CASING FRONT
10300	-57,7,29,1.714E-11	\$ CASING BACK
10400	58,8,27,474.735	\$ FILTER TO CASING BOTTOM
10500	61,8,32,0.180	\$ AIR
10600	-62,8,9,1.714E-11	\$ CARD BUCKET
10700	-63,8,20,3.428E-11	\$ AMP 1 #4
10800	-64,8,24,3.428E-11	\$ AMP 2 #4
10900	-65,8,25,1.714E-11	\$ 1400 SERIES POWER SUPPLY
11000	-66,8,26,2.228E-11	\$ CASING TOP
11100	-67,8,27,4.114E-10	\$ CASING BOTTOM
11200	-68,8,29,1.371E-10	\$ CASING BACK
11300	-69,8,30,3.942E-10	\$ CASING RIGHT SIDE
11400	-70,8,31,1.714E-11	\$ CASING LEFT SIDE
11500	71,9,27,1.810	\$ CARD BUCKET TO BOTTOM
11600	72,9,32,0.257	\$ AIR
11700	-73,9,10,2.400E-10	\$ CARD 1
11800	-74,9,11,5.142E-11	\$ CARD 2
11900	-75,9,12,8.570E-11	\$ CARD 3
12000	-76,9,13,8.570E-11	\$ CARD 4
12100	-77,9,14,5.142E-11	\$ CARD 5
12200	-78,9,15,5.142E-11	\$ CARD 6

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12300	-79,9,16,2,914E-10	\$	CARD 7
12400	-80,9,25,1,714E-11	\$	1400 SERIES POWER
12500	-81,9,26,2,914E-10	\$	CASING TOP
12600	-82,9,27,6,856E-10	\$	CASING BOTTOM
12700	-83,9,28,2,057E-10	\$	CASING FRONT
12800	-84,9,29,1,714E-11	\$	CASING BACK
12900	-85,9,30,3,428E-10	\$	CASING RIGHT SIDE
13000	-86,9,31,1,714E-11	\$	CASING LEFT SIDE
13100	87,10,9,2,1A3	\$	CARD 1 TO CARD RACKET
13200	88,10,32,0,229	\$	AIR
13300	-89,10,11,2,057E-10	\$	CARD 2
13400	-90,10,26,1,714E-11	\$	CASING TOP
13500	-91,10,27,1,714E-11	\$	CASING BOTTOM
13600	-92,10,28,1,028E-10	\$	CASING FRONT
13700	93,11,9,2,1B5	\$	CARD 2 TO CARD RACKET
13800	94,11,32,0,229	\$	AIR
13900	-95,11,12,2,228E-10	\$	CARD 3
14000	-96,11,26,5,142E-11	\$	CASING TOP
14100	-97,11,27,1,714E-11	\$	CASING BOTTOM
14200	-98,11,28,3,428E-11	\$	CASING FRONT
14300	99,12,9,2,1A3	\$	CARD 3 TO CARD RACKET
14400	100,12,32,0,229	\$	AIR
14500	-101,12,13,1,8A5E-10	\$	CARD 4
14600	-102,12,26,5,142E-11	\$	CASING TOP
14700	-103,12,27,1,714E-11	\$	CASING BOTTOM
14800	-105,12,28,1,714E-11	\$	CASING FRONT
14900	107,13,9,2,1A3	\$	CARD 4 TO CARD RACKET
15000	108,13,32,0,229	\$	AIR
15100	-109,13,14,1,8A5E-10	\$	CARD 5
15200	-110,13,26,1,714E-11	\$	CASING TOP
15300	-111,13,27,1,714E-11	\$	CASING BOTTOM
15400	-112,13,28,1,028E-10	\$	CASING FRONT
15500	113,14,9,2,1A3	\$	CARD 5 TO CARD RACKET
15600	114,14,32,0,229	\$	AIR
15700	-115,14,15,1,8A5E-10	\$	CARD 6
15800	-116,14,26,3,428E-11	\$	CASING TOP
15900	-117,14,27,1,714E-11	\$	CASING BOTTOM
16000	-118,14,28,6,856E-11	\$	CASING FRONT
16100	119,15,9,2,1A3	\$	CARD 6 TO CARD RACKET
16200	120,15,32,0,229	\$	AIR
16300	-121,15,16,2,057E-10	\$	CARD 7
16400	-122,15,26,3,428E-11	\$	CASING TOP
16500	-123,15,27,1,714E-11	\$	CASING BOTTOM
16600	-124,15,28,1,714E-11	\$	CASING FRONT
16700	-125,15,30,1,714E-11	\$	CASING RIGHT SIDE
16800	126,16,9,2,1A3	\$	CARD 7 TO CARD RACKET
16900	127,16,32,0,229	\$	AIR
17000	-128,16,26,3,428E-11	\$	CASING TOP
17100	-129,16,27,1,714E-11	\$	CASING BOTTOM
17200	-130,16,28,1,714E-11	\$	CASING FRONT
17300	-131,16,30,1,714E-11	\$	CASING RIGHT SIDE
17400	132,17,18,21,260	\$	AMP 1 #1 TO AMP 1 #2
17500	133,17,27,0,864	\$	CASING BOTTOM
17600	134,17,32,0,081	\$	AIR
17700	-135,17,21,1,714E-11	\$	AMP 2 #2
17800	-136,17,25,3,428E-11	\$	1400 SERIES POWER SUP.
17900	-137,17,26,1,543E-11	\$	CASING TOP
18000	-138,17,27,2,228E-10	\$	CASING BOTTOM
18100	-139,17,29,1,714E-11	\$	CASING BACK
18200	-140,17,31,1,714E-11	\$	CASING LEFT SIDE
18300	141,18,19,21,260	\$	AMP 1 #2 TO AMP 1 #3

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18400	142,18,27,3.456	\$	CASING BOTTOM
18500	143,18,32,0.089	\$	AIR
18600	-144,18,22,1.714E-11	\$	AMP 2 #2
18700	-145,18,26,1.543E-10	\$	CASING TOP
18800	-146,18,27,1.885E-10	\$	CASING BOTTOM
18900	-147,18,29,1.714E-11	\$	CASING BACK
19000	148,19,20,21.260	\$	AMP 1 #3 TO AMP 1 #4
19100	149,19,27,3.456	\$	CASING BOTTOM
19200	150,19,32,0.089	\$	AIR
19300	-151,19,23,1.714E-11	\$	AMP 2 #3
19400	-152,19,26,1.543E-10	\$	CASING TOP
19500	-153,19,27,1.885E-11	\$	CASING BOTTOM
19600	-154,19,29,1.714E-11	\$	CASING BACK
19700	155,20,27,3.456	\$	AMP 1 #4 TO CASING BOTTOM
19800	156,20,32,0.094	\$	AIR
19900	-157,20,24,1.714E-11	\$	AMP 2 #4
20000	-158,20,26,1.543E-10	\$	CASING TOP
20100	-159,20,27,2.057E-10	\$	CASING BOTTOM
20200	-160,20,29,1.714E-11	\$	CASING BACK
20300	-161,20,30,1.714E-11	\$	CASING RIGHT SIDE
20400	162,21,22,21.260	\$	AMP 2 #1 TO AMP 2 #2
20500	163,21,27,0.864	\$	CASING BOTTOM
20600	164,21,32,0.081	\$	AIR
20700	-165,21,25,1.714E-11	\$	1400 SERIES POWER SUP.
20800	-166,21,26,1.371E-10	\$	CASING TOP
20900	-167,21,27,2.057E-10	\$	CASING BOTTOM
21000	-168,21,29,8.570E-11	\$	CASING BACK
21100	-169,21,31,1.714E-11	\$	CASING LEFT SIDE
21200	170,22,23,21.260	\$	AMP 2 #2 TO AMP 2 #3
21300	171,22,27,3.456	\$	CASING BOTTOM
21400	172,22,32,0.089	\$	AIR
21500	-173,22,26,1.371E-10	\$	CASING TOP
21600	-174,22,27,1.714E-10	\$	CASING BOTTOM
21700	-175,22,29,6.856E-11	\$	CASING BACK
21800	176,23,24,21.260	\$	AMP 2 #3 TO AMP 2 #4
21900	177,23,27,3.456	\$	CASING BOTTOM
22000	178,23,32,0.089	\$	AIR
22100	-179,23,26,1.371E-10	\$	CASING TOP
22200	-180,23,27,1.714E-10	\$	CASING BOTTOM
22300	-181,23,29,6.856E-11	\$	CASING BACK
22400	182,24,27,3.456	\$	AMP 2 #4 TO CASING BOTTOM
22500	183,24,32,0.094	\$	AIR
22600	-184,24,26,1.371E-10	\$	CASING TOP
22700	-185,24,27,1.885E-10	\$	CASING BOTTOM
22800	-186,24,29,8.570E-11	\$	CASING BACK
22900	-187,24,30,1.714E-11	\$	CASING RIGHT SIDE
23000	188,25,27,386.150	\$	1400 SERIES POWER TO CASING BOTTOM
23100	189,25,32,0.697	\$	AIR
23200	-190,25,26,8.056E-10	\$	CASING TOP
23300	-191,25,27,9.770E-10	\$	CASING BOTTOM
23400	-192,25,28,3.771E-10	\$	CASING FRONT
23500	-193,25,29,6.856E-11	\$	CASING BACK
23600	-194,25,30,1.714E-11	\$	RIGHT SIDE
23700	-195,25,31,5.495E-10	\$	LEFT SIDE
23800	196,26,28,4.435	\$	CASING TOP TO CASING FRONT
23900	197,26,29,4.435	\$	CASING BACK
24000	198,26,30,3.423	\$	CASING RIGHT SIDE
24100	199,26,31,3.423	\$	CASING LEFT SIDE
24200	200,26,32,2.003	\$	AIR
24300	-201,26,27,1.371E-09	\$	CASING BOTTOM
24400	-202,26,28,3.942E-10	\$	CASING FRONT

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24500	-203,26,29,6,170E-10	\$	CASING BACK
24600	-204,26,30,2,228E-10	\$	CASING RIGHT SIDE
24700	-205,26,31,3,085E-10	\$	CASING LEFT SIDE
24800	206,27,28,4,435	\$	CASING BOTTOM TO CASING FRONT
24900	207,27,29,4,435	\$	CASING BACK
25000	208,27,30,3,423	\$	CASING RIGHT SIDE
25100	209,27,31,3,423	\$	CASING LEFT SIDE
25200	210,27,32,1,001	\$	AIR
25300	211,27,33,1000	\$	HEAT-SINK PLATE
25400	-212,27,28,8,570E-11	\$	CASING FRONT
25500	-213,27,29,2,571E-10	\$	CASING BACK
25600	-214,27,30,1,200E-10	\$	RIGHT SIDE
25700	-215,27,31,1,543E-10	\$	LEFT SIDE
25800	216,28,30,2,033	\$	CASING FRONT TO RIGHT SIDE
25900	217,28,31,2,033	\$	LEFT SIDE
26000	218,28,32,0,395	\$	AIR
26100	-219,28,29,5,142E-11	\$	CASING BACK
26200	-220,28,30,1,714E-11	\$	RIGHT SIDE
26300	-221,28,31,8,570E-11	\$	LEFT SIDE
26400	222,29,30,2,033	\$	CASING BACK TO RIGHT SIDE
26500	223,29,31,2,033	\$	LEFT SIDE
26600	224,29,32,0,434	\$	AIR
26700	-225,29,30,6,856E-11	\$	RIGHT SIDE
26800	-226,29,31,6,856E-11	\$	LEFT SIDE
26900	227,30,32,0,149	\$	CASING RIGHT SIDE TO AIR
27000	-228,30,31,1,714E-11	\$	LEFT SIDE
27100	229,31,32,0,263	\$	CASING LEFT SIDE TO AIR
27200	230,26,34,3,843	\$	CASING TOP TO BOUNDARY
27300	231,33,35,100,00	\$	HEAT SINK TO BOUNDARY
27400	232,28,36,0,953	\$	CASING FRONT TO BOUNDARY
27500	233,29,37,0,953	\$	CASING BACK TO BOUNDARY
27600	234,30,38,0,403	\$	CASING RIGHT SIDE TO BOUNDARY
27700	235,31,39,0,368	\$	CASING LEFT SIDE TO BOUNDARY
27800	236,33,34,0,971	\$	HEAT SINK TO TOP BOUNDARY
27900			
28000	RCO		
28100	3CONSTANTS DATA		
28200	TIME0,0.0		
28300	UTIME1,0.0083333		
28400	ORLXCA,0.25		
28500	ORLXCA,0.25		
28600	TIME0,0.999996	\$	30 MINUTE CYCLE TIME
28700	OUTPUT,0.083333	\$	OUTPUT EVERY 5 MINUTES
28800	NLOOP,500	\$	MAXIMUM ITERATIONS
28900	1,68.24	\$	RF POWER FILTER (BTU/HR)
29000	2,0.0	\$	COAXIAL SWITCH 1
29100	3,0.0	\$	COAXIAL SWITCH 2
29200	4,16.29	\$	CIRCULATOR (BTU/HR)
29300	5,0.0	\$	CAPACITOR 1
29400	6,0.0	\$	CAPACITOR 2
29500	7,61.42	\$	1100 SERIES POWER SUPPLY
29600	8,20.47	\$	FILTER
29700	9,0.0	\$	CARD HOCKET
29800	10,0.0	\$	CARD 1
29900	11,85.30	\$	CARD 2
30000	12,85.30	\$	CARD 3
30100	13,85.30	\$	CARD 4
30200	14,85.30	\$	CARD 5
30300	15,0.0	\$	CARD 6
30400	16,17.06	\$	CARD 7
30500	17,17.06	\$	AMP 1 #1
	18,34.12	\$	AMP 1 #2

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30600          19,170.60          $ AMP 1 #3
30700          20,272.97          $ AMP 1 #4
30800          21,17.06           $ AMP 2 #1
30900          22,34.12           $ AMP 2 #2
31000          23,170.60          $ AMP 2 #3
31100          24,272.97          $ AMP 2 #4
31200          25,759.53          $ 1400 SERIES POWER SUPPLY (KTIJ/HR)
31300          26,0.0             $ USED TO ZERO OUT HEAT SOURCES
31400          END
31500          RCN 3ARRAY DATA
31600          1                   $ TIME ARRAY
31700          0.000,0.008,0.017,0.025,0.033,0.042,0.050,0.058,0.067,0.075
31800          0.083,0.092,0.100,0.108,0.117,0.125,0.133,0.142,0.150,0.158
31900          0.167,0.175,0.183,0.192,0.200,0.208,0.217,0.225,0.233,0.242
32000          0.250,0.258,0.267,0.275,0.283,0.292,0.300,0.308,0.317,0.325
32100          0.333,0.342,0.350,0.358,0.367,0.375,0.383,0.392,0.400,0.408
32200          END $ TIME TO HOURS BY 1/2 MINUTE INCREMENTS
32300          END
32400          RCN 3EXECUTION
32500          F DIMENSION X(2000)
32600          F SDI=2000
32700          F WTR=0
32800          F GO TO IC00=1,5
32900          F WRDCK
33000          M TIME=0.0
33100          F10 CONTINUE
33200          END
33300          RCN 3VARIABLES 1
33400          M IF(TIME.GT.0.084.AND.TIME.LE.0.5)GO TO 10
33500          M IF(TIME.GT.0.583333)GO TO 10
33600          SHFTV(25,K1,R1)      ! SHIFT HEAT SOURCE INTO COMPONENTS
33700          F GO TO 20
33800          F10 CONTINUE
33900          ARYNY(25,R1,K26,R1)  ! ZERO OUT HEAT SOURCES
33950          SHFTV(1,K16,G16)    ! A/D LOGIC CARD ALWAYS 0
34000          F20 CONTINUE
34100          END
34200          RCN 3VARIABLES 2
34300          END
34400          RCN 3OUTPUT CALLS
34500          TPRINT
34600          END
34700          RCN 3END OF DATA

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END

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