Report No. FAA-RD-74-109

ANA-64

FAA PRINTED CIRCUIT BOARD ANALYSIS-COMPREHENSIVE ANALYSIS

Gerald L. Ginsberg

December 1973

Final Report

Document is available to the public through the
National Technical Information Service,
Springfield, Virginia 22151.

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

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Administration Printed Circuit
omprehensive Analysis, by Gerald
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2. Electronic Circuit
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Philco-Ford Corporation, Communication Systems Division
Federal Aviation Administration Printed Circuit Board Analysis - Comprehensive Analysis, by Gerald L. Ginsberg. Final report, Task IC. Willow Grove, Penna., December 1973.

81 p. (RD-74-109)
Contract No. FA72WA-3000

1. Printed Circuit Boards. 2. Electronic Circuit Boards--Analysis. I. Ginsberg, Gerald L.

Technical Report Documentation Page

1. Report No. FAA-RD-74-109	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Federal Aviation Administration Printed Circuit Board Analysis - Comprehensive Analysis		5. Report Date December 1973
		6. Performing Organization Code
7. Author(s) Gerald L. Ginsberg		8. Performing Organization Report No.
9. Performing Organization Name and Address Philco-Ford Corporation Communication Systems Division 3900 Welsh Road Willow Grove, PA 19090		10. Work Unit No. (TRAIS) 36317
		11. Contract or Grant No. DOT-FA72WA-3000
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D. C. 20590		13. Type of Report and Period Covered Final Report Task IC
		14. Sponsoring Agency Code ARD-650 (215-607)
15. Supplementary Notes		

16. Abstract

Based on the results of the data collected on FAA printed circuit boards (previous report), this report contains a comprehensive analysis to determine the effect standard printed circuit board size requirements would have on existing FAA equipment. The analysis takes into account FAA maintenance and logistic systems. Significant benefits can be accrued if parameters, in addition to the board size, are properly standardized and applied.

A Categorization and Data Collection study and a Cost Vs. Benefit study are contained in separate reports.

17. Key Words Printed Circuit Boards	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	81	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

Federal Aviation Administration Engineering Requirement FAA-ER-650-013 (July 30, 1971) provides for a comprehensive program to analyze the present use of printed circuit boards by the FAA and to establish the standards for future control and application of printed circuit boards in FAA electronic equipment.

The resulting Printed Circuit Board Survey (PCBS) to implement this effort is divided into two tasks, namely:

Task I - Analysis of existing printed circuit board status

Task II - Standards for future equipment utilizing printed circuit cards

For efficient analysis and reporting purposes both Tasks have been subdivided as follows:

Task Ia - Categorization , FAA-RD-74-108

Task Ib - Data Collection , FAA-RD-74-108

Task Ic - Comprehensive Analysis , FAA-RD-74-109

Task IIa - Cost versus Benefit Study , FAA-RD-74-111

This report covers the Comprehensive Analysis portion of the Printed Circuit Board Survey.

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1.0 COMPREHENSIVE ANALYSIS

In accordance with the requirements of FAA-ER-650-013 (July 30, 1971) and based on the results of the Data Collection task of the FAA Printed Circuit Board Survey, Philco-Ford has performed a Comprehensive Analysis to determine the effects (benefits) that could have accrued to the FAA if a standard size printed circuit board restriction had been in effect at the time the equipment listed in Table 1-1 was designed. In addition, the analysis takes into account current FAA maintenance and logistics system and practices.

1.1 GENERAL CONSIDERATIONS

The positive effects (benefits) to be derived from the imposition of a standard size printed circuit board restriction is greatest when the optimum specific size restriction is considered. However, the optimum size restriction has yet to be determined and hopefully will be a result of the Cost vs. Benefits Study which is to follow this Comprehensive Analysis. Therefore, this Analysis considers the effects on printed wiring boards for a board size change in the General Analysis (Section 2.0), and considers the overall effect of a board size restriction for the optimum standard size board(s) for each of the equipments considered in the Detailed Analysis (Section 3.0).

It should be noted that a requirement which governs printed wiring board configurations does not directly limit printed wiring complexity and density. These can be indirectly controlled by specifying minimum line widths, spaces, hole sizes, annular rings, etc., and by restricting the manufacturing and assembly techniques to insure performance and quality. This is evident in the numerous printed wiring boards photographed and analysed by Philco-Ford where boards vary from very "loose" to extremely "tight" even though the design was governed by MIL-STD-275B in most cases.

Table 1-1. FAA EQUIPMENT

FAA	Nomenclature	Contractor	Title
2449	RBDE-5	Raytheon	Radar Brite Display Equipment
6400	RTC-3	Raytheon	Test Monitor Control Equipment
7200	ATCBI-3	Whitaker	Air Traffic Control Beacon
	ATCBI-4	Tasker	Air Traffic Control Beacon
7280		Airborne Inst. Lab	ATCBI-3 Storage Tube Defruiter
7847	BRITE-1	ITT Aerospace	Bright Radar Indicator Tower Eqpt.
7861	RVR	Solid State Rads.	Runway Visual Range System
7900	CDC	Raytheon	Computer Display Channel
7919	CUE	Raytheon	Computer Update Equipment
7951		Electronic Labs	Coded Time Source
8000	Mark IA	Wilcox	Instrument Landing System
8049		Texas Instruments	Video Mapper Group
8100		Cutler-Hammer	Beacon Video Defruiting Eqpt.
8142		Chain Lakes Res.	Doppler VOR Sideband Ant. Monitor
8144		Leach	Five Channel Recorder
8150	ASRDS-3	ITT Aerospace	Airport Surveillance Radar Display
8165		GRM	Radio Channel Control Equipment
8178	BRITE-2	ITT Aerospace	Bright Radar Indicator Tower Eqpt.
8195	BUEC	ITT Aerospace	Back-Up Emergency Communications
8200	ASR-7	Texas Instruments	Airborne Surveillance Radar
8300	ARTS-III	Univac/Texas Inst.	Automated Radar Terminal System
8400	RBDE-6	Westinghouse	Radar Brite Display Equipment
8451	RML-6	Collins Radio	Radio Microwave Link
8610	Mark IB	Cutler-Hammer	Instrument Landing System
8886		Stelma	Eight Channel Data Terminal
	FDEP	I.B.M.	Flight Data Entry and Printout
	WFMU		Weather and Fixed Map Unit
	MX-8757	Cardion	Navy Beacon Video Defruiting Eqpt.
	TU-9	Collins Radio	Fifty-Watt UHF Transmitter
	TV-35	Wilcox	VHF Eight-Watt Transmitter
	TV-36	Collins	Fifty-Watt VHF Transmitter
	CCC	I.B.M.	Central Computer Complex
	AN/FYQ-47		Common Digitizer

1.1.1 INITIAL PROCUREMENT

Vendors of existing FAA equipment did not generally have any specific printed wiring board size restrictions imposed either through FAA or in-house guidelines. For the most part, equipment requirements such as configuration, volume, accessibility, fault isolation, performance, and environmental capability, as well as in-house design, manufacturing, and testing capability, determined printed wiring board size (including density and complexity).

It must be assumed that these vendors had the capability and incentive to determine the optimum printed wiring board size(s) to best meet all requirements consistent with the lowest cost for development, and in most cases, the initial procurement of the equipment. Therefore, the imposition of just a printed wiring board size restriction will, in most cases, result in the use of less than an optimum printed wiring board size from the vendor's standpoint. The vendor is highly motivated to develop an equipment which meets performance requirements at minimum cost while meeting delivery schedules - and usually they are all "tight".

The incentives which would allow or cause a vendor to optimize the overall development of an equipment while using some printed wiring board size standard, other than his own, are all tied-in to quantity and continuity of production. FAA vendors either develop and manufacture one type of equipment for the FAA or, if they are involved with several types, there is usually a significant time interval between procurements. Therefore, FAA equipment and spares procurements appear to the vendor as individual "buys" with no printed wiring hardware similarities or continuity of design/production from one procurement to another. This justifies neither the purchase of large quantities of material and components to obtain quantity benefit, nor the standardization of production tools and automatic or semi-automatic test facilities for the inherent benefits thereof.

Therefore, the imposition of only a standard printed wiring board size restriction would not result in any benefit to the FAA from an initial procurement standpoint considering current competitive procurement policies. In many cases, the result would be negative resulting in higher procurement cost and other undesirable effects as discussed above.

1.1.2 MAINTAINABILITY

Most FAA facilities do not have automatic or semi-automatic printed wiring board performance and diagnostic test equipment, except for a few equipments which have specialized test equipment for only use with a particular equipment. Since the vast majority of printed wiring boards are not plugged into any universal device for bench testing and fault location, a standard size board by itself would be of little or no benefit. A standard connector(s) would aid the technicians by allowing the use of fewer connector interface setups for test and diagnostic work, however this Analysis is primarily concerned with a standard size restriction. Standard connectors will be considered in the Cost vs. Benefit Study which follows this Analysis.

Circuit partitioning, density, complexity, and the manufacturing and assembly techniques would be influenced by a board size restrition and,depending on their application to specific circuits, could be most beneficial to testing and repair. However, a size restriction would merely influence, and not govern, these parameters and would not ensure the application of these parameters in such a way as to benefit test and repair.

Therefore, the imposition of a printed wiring board size restriction alone would not necessarily result in any benefit from a maintenance standpoint. Only if the vendor chose to optimize the application of the factors discussed above within the printed wiring board sizes allowed would benefits result, since in some cases a large printed wiring board would be beneficial and in others a small printed wiring board would be advantageous.

Although a printed wiring board size restriction alone would not necessarily result in maintenance benefits, many other parameters were brought to light during the Data Collection effort and this Analysis which give every indication of providing maintenance benefits if properly specified and applied. Consideration of these parameters will be covered in the Cost vs. Benefit Study which is the next phase of the FAA Printed Circuit Board Survey.

1.2 APPROACH

The 779 printed wiring boards inspected and photographed during Data Collection were analysed and a density and complexity factor was determined for each by means of computer analysis. Printed wiring board type, population, and usage was reviewed for each equipment and based on this review, and information obtained from the FAA Library, and various Towers and Centers visited, typical FAA equipment types were selected. For pracitcal reasons, these equipments were analysed in more detail than the others to determine the overall effect (benefit) which would have occurred if the printed wiring board sizes had been reduced or made larger, whichever would have been most beneficial, to same standard size, while maintaining the same components and circuitry on each printed wiring board. The complexity and density of the printed wiring boards were the most significant factors to consider, and the values derived by the computer analysis, as well as insights gained by inspection of the printed wiring board photographs were all considered in the analysis. Printed wiring board usage in the typical equipments was analysed to determine the effect on the equipment configuration.

For all equipments other than those selected as "typical", the effect on the printed wiring boards if the board size had been smaller or larger was analysed in the same manner.

1.3 RESULTS

The effect on printed wiring boards if a board size restriction had been imposed is analyzed in Section 2.0 for each equipment (other than those considered typical and covered in Section 3.0 "Detailed Analysis") considered in this Program.

The overall effect (benefit) if a board size restriction had been imposed is analysed in detail in Section 3.0 for those selected equipments deemed "typical" of FAA equipment.

A summary of the results of this analysis and the conclusions reached are given in Section 4.0.

Table 2-1 defines the data format for the Data Collection columns (#1 through #60) of the computer analysis.

TABLE 1-2

Columns 1-3: Sequence number
Columns 4-10: Equipment title
Columns 11-17: PW assembly number
Columns 18-20: Board length in 0.1 inch units
Columns 21-23: Board width in 0.1 inch units
Column 24: Number of wiring lavers
Column 25: Input-output connector designator
Columns 26-28: Input-output pin usage
Columns 29, 33, 37, 41, 45, 49, 53: Component size code
Columns 30, 34, 38, 42, 46, 50, 54: Component terminal code
Columns 31-32, 35-36, 39-40, 43-44, 47-48, 51-52, 55-56: Component quantity
Column 57: Digital-analog designator
Column 58: Routing constant for conductors
Column 59: Busing constant for ground and voltage
Column 60: Grid size designator

Appendix "A", Computer Analysis Derivation, lists information necessary to interpret the various alpha-numeric codes and other factors utilized, as well as the derivation of Density, Complexity, and Magnitude as calculated by the computer analysis.

Appendix "B" contains selected portions of the computer print-out the computed values for Density, Complexity, and Magnitude for the 779 printed wiring boards covered by the Data Collection phase of this Study.

1.3.1 ANALYSIS OF COMPUTER RESULTS

1.3.1.1 DENSITY

"Density" is a measure of how much of the available printed wiring board area is used for components, including terminal areas, without consideration for interconnection wiring. A density value of 0.800 (80%) for large components and 0.700 (70%) for small components is considered "tight" and it would normally be difficult to reduce board size.

1.3.1.2 COMPLEXITY

"Complexity" is a measure of how difficult it is to include all interconnecting and input/output circuit runs within the area available. A complexity value of 0.500 (50%) is considered low (easy to interconnect) value of 0.800 (80%) is considered high (very difficult). Complexity values of 0.800 (80%) and higher normally require manual layout, as opposed to computer layout, to accomplish the required interconnections with the computer programs on hand and within reasonable computer usage times.

The Complexity value is the ratio of Hook-up Area (required) to Usable Wiring Area (available).

A. Hook-up Area

Hook-up Area takes into account the following printed wiring design parameters:

1. Component Density.

2. Number of terminal areas used.

3. Layout and interconnection wiring gird size.

4. Degree of interconnection wiring busing with large conductor widths.

5. The number of interconnection wiring layers on the printed wiring board.

6. A hook-up factor which approximates the length of an average interconnection wiring conductor for the type of circuit involved.

The manner in which these parameters are determined and used is defined in detail in Appendix A.

B. Usable Wiring Area

Usable Wiring Area takes into account the the following printed wiring design parameters:

1. Usable Area for interconnection wiring.

2. Size of terminal areas required.

3. Area required for input-output wiring interconnections.

These values are, in turn, dependent on the following:

Usable Area - printed wiring board length, width, number of wiring layers, and provisions for input-output and mounting.

Terminal Areas - number of terminal areas, size of terminal areas, number of wiring layers, and a routing constant which represents the basic guidelines for conductor routing.

Input-Output Area (if any) - type of input-output connector, connector size, number of contacts available, number of contacts required, grid size and ratio of connector width to board width.

The manner in which these parameters are determined and used is defined in detail in Appendix A.

1.3.1.3 Magnitude

"Magnitude" is the product of "complexity" and the available printed wiring board area. This value represents the magnitude of effort required for the entire printed wiring board design for a specific assembly.

For more details concerning magnitude see Appendix A.

2.0 GENERAL ANALYSIS - CONFIGURATION AND USAGE

2.1 GENERAL

All printed wiring board assemblies for twenty-one Federal Aviation Administration equipments were photographed at various FAA facilities.[1] It was assumed that optimum circuit partitioning was attempted, and in most cases accomplished by the vendors who developed the various equipments studied. Therefore, this portion of the Analysis considered the affect on printed wiring boards if a board size restriction with the same circuit partitioning had been mandatory at the time of development.

2.1.1 SIZE RESTRICTION

If a board size were increased to meet the size restriction, it is obvious that component density and layout/interconnection complexity would be reduced. Therefore, the affect of board size reduction will be considered herein.

Parameters analyzed include:

a. Number of printed wiring board types

b. Sizes of printed wiring boards

c. Single-, double-sided or multilayer

d. Input/output connector type

e. Connector pin usage

f. Integrated circuit component usage

g. Complexity (computer calculated)

h. Density (computer calculated)

i. Actual board configuration (color photographs)

j. Affect of board size reduction.

---

1. Six "typical" printed wiring assemblies of the Central Computer Complex equipment were also photographed.

2.2 EQUIPMENT

2.2.1 RADAR BRITE DISPLAY EQUIPMENT

Nomenclature: RBDE-5

FAA Type: FA-2449

Contract: Raytheon, Lexington, Mass.

This equipment contains ninety-nine different printed circuit board types, each 6-inches long, 5-inches wide, and 1-1/16-inch thick. All of the boards are either single- and double-sided. The connector used is an AMP (Blade) with 29 contacts on 0.1-inch centers. Pin usage varies from 5 to 29 with approximately half of the assemblies using from 23 to 29 pins. Conventional circuit components are used throughout.

Except for six printed wiring boards, the complexity was less than 0.500, with the majority less than 0.300. Densities of the majority of the assemblies are less than 0.600. This indicates that most of the printed wiring boards could be somewhat smaller without undue crowding, and since the connector is shorter than the board width, the board width and length could be reduced.

2.2.2 TEST MONITOR CONTROL EQUIPMENT

Nomenclature: RTC-3

FAA Type: FA-6400

Contractor: Raytheon, Wayland, Mass.

This equipment contains thirty-three different printed wiring board types, all 1/16-inch thick. Twenty-nine are 6.0 inches long, 5.2-inches wide; three are 3.3-inches long, 4.3 inches wide; and one is 10.5 inches long, 7.0 inches wide. All are single- and double-sided. The three connectors used are all card-edge type with contacts on 0.156-inch centers; 15- and 22-pin one-sided and 44-pin two-sided types are used. Pin usage is 50% for the majority of the printed wiring boards with a few using nearly 100%. Fifteen of the printed wiring boards use 14-lead dual-in-line packages (DIPs).

Except for nine printed wiring boards, the complexities are less than 0.500, with the majority less than 0.400. All but six have densities less than 0.600, indicating that, except for a few, the printed wiring boards could be smaller without undue crowding. Pin usage is generally low and the connector does not extend to the board edges, thus the width and length could be reduced.

2.2.3 AIR TRAFFIC CONTROL BEACON GROUND STATION VIDEO DEFRUITING EQUIPMENT GROUP

Nomenclature: ATCBI-4

FAA Type: FA-7200

Contractor: Whitaker Corporation, North Hollywood, Calif.

This equipment contains seventeen different printed wiring board types, each 2.5-inches long, 4.0-inches wide, 1/16-inch thick, and double-sided. A double-sided card-edge connector with 60 contacts on 0.125-inch centers is used. Five printed circuit boards use all 60 pins; three use more than 40 pins; and approximately half of the balance use 50% of the pins. Twelve of the printed wiring boards use 14-lead DIP's.

The complexity of seven of the printed wiring boards is greater than 0.600, and the balance varies between 0.300 and 0.600. The densities of nine assemblies are 0.600 or higher, indicating that the majority of these boards are quite crowded and any size reduction would result in higher development costs and make maintenance more difficult.

2.2.4 ATCBI-3 STORAGE TUBE DEFRUITER

FAA Type: FA-7280

Contractor: Airborne Instruments Lab, Long Island, N.Y.

This equipment contains three different printed wiring board types, each 11.8-inches long, 8.3-inches wide, 1/16-inch thick and one-sided. A two-part connector with 23 contacts on 0.150-inch centers is used. Pin usage is 12, 14, and 22 pins for the three printed wiring boards. Conventional circuit components are used throughout.

Complexity varies from 0.140 to 0.209, however density varies from 0.347 to 0.459 and the board photographs show moderate density, therefore the boards could be made slightly smaller without undue crowding, and since the connector does not extend to the board edges, the boards width could be reduced as well as its length. Since many jumpers are now used, it is likely that a two-sided board would be required if size were reduced.

2.2.5 RUNWAY VISUAL RANGE SYSTEM

Nomenclature: RVR

FAA Type: FA-7861

Contractor: Solid State Radiations, Inc., Los Angles, Calif.

This equipment contains seventeen different printed wiring board types, all 1/16 inch thick: 14 are 5.3-inches long x 4.5-inches wide and three are 5.6-inches long, 15.0-inches wide, and single- or double-sided. A two-part connector with 35 pins on 0.100-inch centers is used. The large boards have three tangs and use three of these connectors. Pin usage varies from 17 to 35 pins per connector with the average approximately 27. Conventional circuit components are used throughout.

Four printed wiring boards have complexities from 0.355 to 0.501, with the balance less than 0.355. Approximately half of these printed wiring boards have densities higher than 0.400 with a maximum of 0.573, indicating that components are not overly crowded. Therefore the majority of these printed wiring boards could be made smaller without undue crowding and since the connector does not extend to the board edges the boards width could be reduced as well as its length. Certain printed wiring boards were obviously matrix boards used for various circuit configurations and therefore their density is low, as expected, and as indicated by the very low complexity values for these boards.

2.2.6 CODED TIME SOURCE

FAA Type: FA-7951

Contractor: Electronic Laboratories, Inc.
Houston, Texas

The equipment contains thirty-six different printed wiring board types, each 4.1-inches long, 4.5-inches wide, 1/16-inch thick, and double-sided. The connector used is card-edge with 44 pins on 0.156 inch centers. Four printed wiring boards use 44 pins, eleven use from 30 to 43 pins, and the balance less than 30. DIPs with 14-leads are used on nineteen of the printed wiring boards.

Complexity is greater than 0.500 for thirteen types, with the balance varying from 0.131 to 0.500. Only seven printed wiring boards have densities over 0.550, and this indicates that the printed wiring boards could be smaller without undue crowding, and since the connector does not extend to the board edges, the board width and length could be reduced.

The results of a questionaire completed by Electronic Labs Inc., the vendor for this equipment, indicate that the original contract specification which dictated the available volume configuration and subdivision of the system, had a direct effect on the printed wiring board size(s). Vendor standards were used for board sizes. The connector selection was based on circuit complexity and I/O access requirements, and together with the card rack and guide system used, had additional direct affect on the final board size determination. It should be noted that no new tooling (fabrication and/or test) was required for the manufacture of these board assemblies - most likely due to the use of the vendor's own board size standards. It would appear that the imposition of a board size restriction would have caused the vendor additional effort and/or time in the development of this equipment.

2.2.7 LOCALIZER STATION (INSTRUMENT LANDING SYSTEM)

Nomenclature: Mark IA

FAA Type: FA-8000

Contractor: Wilcos (American Standard), Kansas City, Missouri

This equipment contains twenty-one different printed wiring board types. There are ten different size boards 1/16-inch thick ranging from 3.5-inches long x 4.0-inches wide to 5.5-inches long x 7.8-inches wide. All are single- and double-sided. All three connectors used are two-part; 29 contacts on 0.100 inch centers, 23 contacts on 0.150-inch centers, and 17 contacts on 0.100-inch centers. Pin usage is high for the 23 and 29-contact connectors; and half of the 17-contact connectors use from 13 to 17 pins. Conventional circuit components are used throughout.

All boards have complexities of less than 0.300 except for three. Only six assemblies have densities over 0.500, indicating that most boards could be somewhat smaller without undue crowding, and since the connector is shorter than the board width, the board width and length could be reduced. However, with the large number of different size boards, it is most probable that an equipment volume reduction could not be realized by reducing board sizes.

2.2.8 VIDEO MAPPER (See Detailed Analysis Section 3.0)

2.2.9 BEACON VIDEO DEFRUITING EQUIPMENT (STORAGE TUBE)

FAA Type: FA-8100

Contractor: Cutler-Hammer, Deer Park, N.Y.

This equipment contains eight different printed wiring board types, each 3.3-inches long, 7.8-inches wide, 1/16-inch thick, and double-sided. A card-edge connector with 44 contacts on 0.156-inch centers is used. Pin usage is 17 to 29 except for one board which uses 42 pins. DIP's with 14-leads are used on five printed wiring boards.

Complexities range from 0.503 to 0.993 for all except two printed wiring boards, which have lower values. Calculated densities range from 0.334 to 0.812 with four above 0.600. The board photographs show high density on at least half the printed wiring boards. This indicates that a printed wiring board size reduction would result in undue crowding for at least 4 of the boards and examination of the board photographs confirms this.

2.2.10 COMPUTER DISPLAY CHANNEL COMPUTER UPDATE EQUIPMENT NON-RADAR KEYBOARD MULTIPLEXER

Nomenclature: CDC and CUE

FAA Type: FA-7900 and FA-7919

Contractor: Raytheon, Lexington, Mass.

This equipment contains at least one hundred and twenty-seven different printed wiring board types. There are thirty different size boards, 1/16-inch thick, ranging from 2-inches high x 2-inches wide to 8-inches high x 12.5-inches wide. All are double-sided. There are eleven different connectors used. Ten of the connectors are card-edge with the number of contacts ranging from 22 to 100, and one printed wiring board had individual staked forked contacts. Pin usage is approximately 60 to 65% with a few printed wiring boards utilizing most, if not all, of the pins. Thirty-four assemblies used 14-lead DIP's.

Complexity ranges from 0.031 to 0.972. Of one-hundred and twenty-seven printed wiring boards, only twenty-nine were over 0.500. Thirty-two assemblies had densities over 0.400, indicating that some size reduction could be accomplished. A review of the board photographs shows that most printed wiring boards could be reduced somewhat in size, however, due to the vast number of sizes of printed wiring boards and their locations in many areas of the equipment, a slight printed wiring board size reduction would most probably not allow for a reduction in overall equipment volume.

2.2.11 DOPPLER VOR SIDEBAND ANTENNA MONITOR

FAA Type: FA-8142

Contractor: Chain Lakes Research Corp., Detroit, Mich.

This equipment contains five different printed wiring board types. Four are 5-inches long x 5-inches wide, and one is 2.5-inches long x 5-inches wide. All are 1/16 inch thick and single-sided. A card-edge connector with 15 contacts on 0.156-inch centers is used. Pin usage ranges from 12 to 14 pins. Conventional circuit components are used throughout.

Complexities range from 0.089 to 0.183 and densities from 0.351 to 0.458. This indicates that some board size reduction is possible with the component sizes most likely being the limiting factor. Since the connector is as long as the board is wide, all reduction would have to be accomplished by shortening the board, unless a new connector is used with closer contact spacing.

The results of a questionaire completed by Chain Lakes Research Corporation, the vendor for this equipment, confirms the results of the computer analysis. Some size reduction would be possible for some boards, however components are crowded and component density would be the limiting factor. Also, the connector spans the full width of the boards and pin usage is high, therefore a smaller connector with contact centers less than the 0.156 inch now used would be required if the width were reduced. The vendor indicates that it would be required to reduce conductor widths from the 0.062 inch actually used and that descrete parts layout would be impossible, however this is based on his consideration of reducing the current 5 inches long x 5 inches wide board to 4-1/2 inches long x 3 inches wide with the same circuitry and components. Such an area reduction is not feasible and the questionaire did not propose to limit the number of boards to the current number in the equipment, but rather to restrict the size of all boards (any number) to 4-1/2 inches long x 3 inches wide.

The vendor indicates that the original contract specification which dictated the cabinet size, and the requirement for a configuration which facilitated maintenance, had a direct effect on board size determination.

Since vendor standards were not used for board size(s) and further since the boards were made by a subcontractor who tooled as required for these board size(s), it would appear that the imposition of a board size restriction would not have caused the vendor additional effort and/or time from a manufacturing standpoint.

2.2.12 5-CHANNEL RECORDER

FAA Type: FA-8144

Contractor: Leach Corporation
Azusa, California

This equipment contains eleven different printed wiring board types. All are 1/16-inch thick, single- or double-sided, and the three sizes range from 2.5-inches long x 4.5-inches wide to 8.0-inches long x 8.0-inches wide. Two of the three connectors used are card-edge with contacts on 0.156 inch centers and 15 or 18 contacts. The third is a card-edge connector with 86 contacts on 0.125 inch centers. Pin usage is quite high for most connectors with approximately 2 unused pins per connector. Conventional circuit components are used throughout.

Complexities range from 0.065 to 0.525 (fairly low values). Densities range from 0.240 to 0.595 with only one above 0.500. This indicates that most of the boards could be reduced somewhat in size without undue crowding. Since all connectors are shorter than the board width, the board width and length could be reduced.

2.2.13 AIRPORT SURVEILLANCE RADAR DISPLAY SYSTEM
(See Detailed Analysis Section 3.0)

2.2.14 BRIGHT RADAR INDICATOR TOWER EQUIPMENT

Nomenclature: BRITE-Z

FAA Type: FA-8178

Contractor: ITT-Aerospace/Optical Division, Fort Wayne, Ind.

This equipment contains thirty-two different printed wiring board types. All are 1/16-inch thick, double-sided boards, and the four sizes range from 6.3-inches long x 4.5-inches wide to 6.1-inches long x 9.0-inches wide. The three connector types used are card-edge with 18, 36, and 44 contacts on 0.156 inch centers. Pin usage is high for the 18 and 36-contact connectors and less than 50% for the 44-contact connector. Conventional circuit components are used throughout except for a few boards which have 14-lead DIP's.

Complexity is less than 0.300 for all but five boards (quite low). However, only ten boards had densities less than 0.400 and the balance ranged up to 0.723, moderately dense from a component standpoint. To reduce the size of most boards would cause undue crowding of components.

2.2.15 BACK-UP EMERGENCY COMMUNICATIONS

Nomenclature: BUEC

FAA Type: FA-8195

Contractor: ITT-Aerospace/Optical Division, Fort Wayne, Ind.

This equipment contains sixteen different printed wiring board types. All are 1/16-inch thick, single- and double-sided. The eight sizes range from 1.7-inches long x 8.0-inches wide to 6.6-inches long x 10.0-inches wide. Six of the seven connector types used are card-edge with 10, 15, 30, 44, 60, and 72 contacts on 0.156 inch centers. Three board types use individual fork-type contacts staked to the board. Pin usage is low on most boards utilizing connectors with approximately 60% average usage. DIPs with 14-leads are used on eight of the printed wiring boards.

Complexities are all below 0.400 except for four boards and densities are all below 0.500 except for five boards. This indicates that most boards could be reduced in size without undue crowding and inspection of the board photographs confirms this. Most of the connectors are shorter than the width of the board and in these cases, the width as well as the length of the board could be reduced.

2.2.16 AUTOMATED RADAR TERMINAL SYSTEM DATA ENTRY DISPLAY SUBSYSTEM

Nomenclature: ARTS-III

FAA Type: FA-8300

This equipment contains at least one hundred and fifty-two different printed wiring board types. All are 1/16-inch thick, single- and double-sided, except for seven types which are multilayer. The sixteen different sizes range from 3.0-inches long x 3.2-inches wide to 8.6-inches long x 14.2-inches wide. There are nine types of connectors; five are card-edge with 15, 22, 30, 44, and 72 contacts on 0.156 inch centers, two are card-edge with 29 and 47 contacts on 0.100 inch centers, and two are 2-part connectors with 17 and 56 contacts on 0.100 inch centers. Pin usage on four types, which make up approximately 80% of the total, ranges from 65% to 100% on most of these connectors. Nineteen assemblies utilize flat-packs and seventy-two utilize 14-lead DIP's.

Reviewing the complexities and densities of all the boards indicates that approximately one-third of the boards are loosely packaged, one-third are moderately dense and the remaining one-third are quite dense. Therefore approximately half of the boards could be reduced somewhat in size without undue crowding.

The results of a questionaire completed by Univac Defense Systems Division, the vendor for this equipment indicate that the original contract specification which dictated the cabinet size and imposed MIL-STD-275, together with heat dissipation considerations and the fact that the vendor's standard connector was used, were responsible for the board size selected. Consideration for moutning up to twenty 14-lead flat packs on a single board for certain types was also an influential factor.

Since vendor standards were not used for board size(s), and new tooling was required for these board size(s), it would appear that the imposition of a board size restriction would not have caused the vendor additional effort and/or time from a manufacturing standpoint. However, the fact that there are sixteen different board sizes implies that board sizes were optimized for each board area in the equipment considering all parameters involved, and thus the imposition of a board size restriction would, in most cases, have resulted in less than an optimum situation for one or more of the factors involved.

2.2.17 RADAR BRIGHT DISPLAY EQUIPMENT (CONTROL RACK ASSEMBLY)

Nomenclature: RBDE-6

FAA Type: FA-8400

Contractor: Westinghouse Electric, Baltimore, Md.

This equipment contains seventeen different printed wiring board types. All are 1/16-inch thick double-sided boards. There are two sizes of boards; 6.0-inches long x 7.0-inches wide and 12.0-inches long x 9.5-inches wide. Fourteen boards have card-edge connectors with 36 contacts on 0.156 inch centers. The other three boards are not plug-in and interface with cable connectors. Pin usage is low and only four boards use more than 22 pins. Conventional circuit components are used throughout.

Only two boards have complexities above 0.252, however densities are rather high and range from 0.409 to 0.792. A review of the board photographs confirms that component density is high on most boards, therefore any reduction in size would cause undue crowding.

2.2.18 INSTRUMENT LADNING SYSTEM

Nomenclature: MARK IB

FAA Type: FA-8610

Contractor: Cutler-Hammer

This equipment contains fourteen different printed wiring board types. All are 1/16-inch thick and double-sided boards. There are six different size boards ranging from 3.0-inches long x 6.0-inches wide to 10.1-inches long x 5.8-inches wide. Of the five different connectors, two are 2-part and have 29 and 35 contacts on 0.100 inch centers, and three are card-edge and have 28, 30, and 50 contacts on 0.156 inch centers. One assembly has fork-type contacts individually staked to the board. Pin usage is approximately 90% on two connector types and 40% on the balance. Conventional circuit components are used throughout.

Complexities are low with only two boards over 0.290. Densities are low to moderate and inspection of the board photographs confirms that most board sizes could be somewhat reduced without undeu crowding. Length and width could be reduced on most boards since the connector length is less than the board width.

2.2.19 WEATHER AND FIXED MAP UNIT

Nomenclature: WFMU

This equipment has fifteen different printed wiring board types, 1/16-inch thick double-sided. All are 2.5-inches long, 4.0-inches wide, except one which is 2.5-inches long, 8.8-inches wide. All connectors are card-edge with 60 contacts on 0.125 inch centers, except for one board, which has 136 contacts on 0.125 inch centers. Pin usage is generally low and only five boards use over 53 pins with the 60-contact connector. The larger connector uses 128 pins. DIPs with 14-leads are used on ten of the boards.

Most boards have relatively high complexities with only seven boards less than 0.568. Densities range from 0.240 to 0.754 and inspection of the board photographs shows that half the boards are dense and half could be reduced in size from a component standpoint except for the large number of interconnections required. Therefore, these boards could not be made smaller without undue crowding.

2.2.20 COMMON DIGITIZER

Nomenclature: AN/FYQ-47/49

This equipment contains fifty-six different printed wiring board types. All are 1/16-inch thick, double-sided, 5-5-inches long, and 6.0-inches wide. A single type card-edge connector with 50 contacts on 0.200 inch centers is used. Pin usage is high with thirty boards using from 45 to 50 pins. All but eleven boards use 14-lead DIP's.

Complexities are quite low with only thirteen boards over 0.200. Densities are low with only eighteen boards over 0.300. Complexity and density figures indicate that size reduction might be feasible, however due to the large number of inputs-outputs from the many DIP's used, running circuit paths to the connectors would get difficult without a reduction in line widths and spacings for most boards. A few boards are blank on one end and could be shortened.

2.2.21 AIRPORT SURVEILLANCE RADAR

Nomenclature: ASR-7

FAA Type: FA-8200

This equipment conta9ns thirty-nine different printed wiring board types. All are 1/16-inch thick, double-sided, except one which is single-sided. Five boards are 4.5-inches long x 4.0-inches wide and the balance are 6.4-inches long x 8.0-inches wide. The two connectors used are two-part with 17 and 47 contact on 0.100 inch centers. Pin usage averages 10 for the 17 contact-connector and varies from 5 to 44 for the 47-contact type, with very low usage for mahy. DIPs with 14-leads are used on twenty-three boards.

Complexities range from 0.027 to 0.668 and densities from 0.136 to 0.811 (a wide range). Inspection of the board photographs confirms that many boards are "tight", however many are "loose" enough to allow a substantial reduction in size without undue crowding and since the connector is shorter than the board width, the length and/or the width could be reduced.

2.2.22 CENTRAL COMPUTER COMPLEX

Nomenclature: CCC

Contractor: I.B.M.

The Central Computer Complex consists of a vast array of equipment cabinets, consoles, and ancillary equipment which utilize thousands of printed wiring boards of various types and sizes. These boards represent the contractor's product line printed wiring assemblies which are highly standardized as regards mechanical configuration, circuit function, and performance parameters. The contractor has extensive automated facilities for the manufacturing and testing of these assemblies, which also accomodate repair/retest when required. The attendant economies which result from such facilities are reflected in the end-product equipment usage and spares procurement.

It is doubtful that an attempt to further standardize, or to change to some other standardized board size/configuration, would result in a significant benefit to the F. A. A. in future procurements of equipment of this type, considering the high degree of standardization and complexity these units exhibit.

For background information for this Study six typical CCC boards were photographed and analyzed. Four of these were single-sided, 1/16-inch thick, 4.7-inches long, and either 2.5-inches or 5.2-inches wide. One is double-sided, 1/16-inch thick, 3.0-inches long and 7.0-inches wide. The sixth board analyzed is a three-layer (multilayer) board, 1.8-inches long and 1.8-inches wide.

The four single-sided boards use a card-edge connector with sixteen contacts on 0.125-inch centers. The other two boards use a custom two-part connector with twenty-four contacts on 0.125-inch centers. Pin usage was not recorded.

The "complexities" of the single- and double-sided boards ranged from 0.046 to 0.168, and densities from 0.402 to 0.776. The multilayer board has a complexity of 0.692 and a density of 0.533. All of the boards use conventional circuit components, except the multilayer board which uses special "in-house modules.

The single-sided board assemblies are moderately "loose" and their generous component spacing is ideal for automated insertion.

3.0 DETAILED ANALYSIS - TYPICAL EQUIPMENT

The following equipment has been selected as typical of the various FAA equipments listed in Table 1-1 which were all investigated.

a. FA-8049 Video Mapper Group

b. FA-8150 Airport Surveillance Radar Display System (ASRDS-3)

These typical equipments each contain a significant number and a wide variety of board types which ensures that the analysis and conclusions reached are valid and that they are representative of all of the FAA equipment investigated in regards to printed wiring board assemblies and their usage in equipment. For the same reasons, the validity of maintenance considerations is assured.

It was assumed that optimum circuit partitioning was attempted, and in most cases accomplished by the vendors who developed the various equipments studied. Therefore, this portion of the Analysis considered the affect on printed wiring boards if a board size restriction with the same circuit partitioning had been mandatory at the time of development.

3.1 BOARD SIZE RESTRICTION

If a board size were increased to meet the size restriction, component density and layout/interconnection complexity would be reduced. If a board size were reduced, component density and layout/interconnection complexity may or may not be increased, depending upon the amount of available or unused board area. Therefore, the effect of both a board size increase and reduction are considered herein.

Parameters analyzed include:

a. Number of printed wiring board types

b. Sizes or printed wiring boards

c. Single-, double-sided or multilayer

d. Input/output connector type

e. Connector pin usage

f. Integrated circuit component usage

g. Complexity (computer calculated)

h. Density (computer calculated)

i. Actual board configuration (color photographs)

j. Affect on assembly configuration

k. Affect on equipment configuration

3.2 VIDEO MAPPER GROUP

Nomenclature: None

FAA Type: FA-8049

Contractor: Texas Instrument, Dallas, Texas

All elements of the Video Mapper Group equipment which utilize printed wiring boards are contained in a single cabinet enclosure. The effects (benefit) of the imposition of a board size restriction at the time of equipment development will first be analyzed for the individual assemblies which contain printed wiring boards within the equipment, and then from an overall equipment viewpoint.

The assemblies are:

a. Distribution Assembly

b. Map Module Assembly

c. Azimuth Processor Assembly

d. Power Supply Assembly

3.2.1 Distribution Assembly

This assembly is essentially a printed wiring card pod contained within a module which also has input/output connectors for interfacing with the cabinet interconnection wiring. The card pod contains 13 printed wiring boards of two types. 1A3A1 thru A12 are one type and 1A3A13 is the other type. All are 8 inches long x 6.8 inches wide, 1/16 inch thick, and double-sided. Two part 47-pin Elco 7023 Varicon Connectors with pins on 0.100 inch centers are used for all boards. Pin usage is 29 pins for the 12 similar boards and 19 pins for the other board. These 12 boards use 14 lead DIP's as well as conventional components while the other board uses conventional components only. Complexity is 0.191 and density 0.295 for the 12 boards, while the other board has a complexity of only 0.007 and a density of 0.097.

This indicates that a board size reduction is possible without undue crowding. The single Common Distribution Amplifier Assembly board is quite "loose" and could assume any reduced size configuration determined optimum for the other 12 similar Distribution Amplifier Assembly boards. Since only 29 of the 47 pins available are used, a shorter connector together with a narrower board could be used. The board length could also be decreased as can be seen by inspection of the board photograph.

Decreasing the board size together with rearrangement of the other components in the Distribution Assembly could result in a narrower and/or lower assembly. Since there is only one of these assemblies in the equipment and further since it occupies one half of the cabinet width as mounted alongside a Map Module Assembly, the effect of reducing the width and/or height of the Distribution Assembly must be considered together with possible size reductions of the other assemblies within the cabinet. This will be discussed in Section 3.2.1.5, Overall Equipment.

3.2.2 Map Module Assembly

This assembly is tightly packaged with the Photomultiplier Tube Housing Assembly mounted adjacent to the Map Scanner Assembly as required for operation. The overall "L" shapted configuration of these two assemblies determines and dominates the Map Module Assembly size and shape. All other components are contained in the remaining open internal corner of the "L". A printed wiring board card pod is located in this area and contains seven printed wiring boards, 1A4A4 thru A10. All boards are 8.5 inches x 4.9 inches wide, 1/16 inch thick, and double-sided.

Two-part 29 pin Elco 7023 Varicon connectors with pins on 0.100 inch centers are used for all boards. Pin usage ranges from 18 to 29 pins for five of the boards and 8 and 10 pins for the other two. One board uses 14 lead DIP's and conventional components while all others use conventional components. Although complexities range only from 0.139 to 0.397, densities range from 0.398 to 0.610, and the board photographs show small components tightly packaged on five of the seven boards. The remaining two boards are also moderately dense.

This indicates that a board size reduction is not feasible. The board size could not be increased either in length or width within the confines of the Map Module Assembly due to the tight packaging, however, the existing board configurations do provide the minimum required space for the replacement of components with proper tools and normal care.

The Map Module Assembly configuration will not permit a printed wiring board size change.

3.2.3 Azimuth Processor Assembly

This assembly contains 14 printed wiring boards, 1A9A1 thru A14, which are all mounted in a single card pad running the full width of the assembly. There are 8 different types of boards, each being 7.4 inches long x 8.0 inches wide, 1/16 inch thick, and double sided. Two-part Elco 47 pin 7023 Varicon connectors with pins on 0.100 inch centers are used for all the boards. Pin usage ranges from 13 to 43 pins for 13 of the board types and 7 pins for the other board type. Five of the board types use 14 lead DIP's and conventional components while all others use conventional components. Complexities range from 0.016 to 0.593 and densities from 0.095 to 0.708. The board photographs show that one board type is very dense, three are moderately dense, three are moderately loose, and two are very loose.

Considering the board densities, there would be no particular advantage to increasing board size since existing board configurations do provide the minimum required space for the replacement of components with proper tools and normal care. A reduction of board sizes is not feasible for at least 4 of the 8 board types. Reducing the size of the remaining 4 types would necessitate having a card pod which would accommodate two different sizes of boards. This added complexity is not warranted considering the slight reduction in volume which would result. The card pod has unused spaces for at least three additional boards and the Azimuth Processor Assembly could be reduced in width by approximately three inches if these unused board spaces were eliminated.

3.2.4 Power Supply Assembly

This assembly is tightly packaged with a mixture of large components, high heat producing components with finned heat dissipators, and scattered printed wiring boards - typical of large cabinet power supplies. The assembly runs the full width of the equipment cabinet. The boards are plugged-in from the top and are mounted individually or in small groups adjacent to, or as a part of, the various voltage assemblies. There are seven boards consisting of four different types. Although mounted in various locations, all boards are 4.0 inches long x 6.0 inches wide, 1/16 inch thick, and double-sided. Two board types use two-part 17 pin Elco 7023 Varicon connectors with pins or 0.100 inch centers and pin usage is 8 and 13 pins. The other two board types use the same type of connector with 35 pins, and pin usage is 11 and 15 pins. All boards use conventional components only. Complexity ranges from 0.016 to 0.593, and density ranges from 0.095 to 0.708 and the board photographs confirm that the boards range from moderately loose to moderately tight.

Considering the nature, and tight packaging, of the Power Supply Assembly, and the fact that the printed wiring boards are located and nested-in at various locations throughout the assembly, no benefit would result if the boards were made smaller. The tight packaging precludes making the boards larger, however, the existing board configuration does provide adequate space for component replacement with proper tools and normal care.

3.2.5 Overall Equipment

Of the four assemblies which contain printed wiring boards, it is not feasible to reduce board size for three, namely the Map Module Assembly, Azimuth Processor Assembly, and Power Supply Assembly. The overall width of the Azimuth Processor Assembly could be reduced approximately three inches by eliminating the unused board spaces in the card pod, however, such a slight width reduction would merely leave an unused gap at one side of the equipment cabinet at that level which could not be used effectively for mounting anything contained in this cabinet.

The Distribution Assembly could be reduced in width and/or height due to a printed wiring board size reduction. However, this assembly is mounted next to a Map Assembly, and together they utilize the full cabinet width. Reducing either height or width would merely leave a gap, not readily utilized by any other element in the cabinet.

There is approximately seven inches of open area at the rear of the cabinet for the full cabinet height above the blower assembly which could be reduced since only cables and terminal blocks occupy this area. With this inefficient utilization of cabinet volume at the rear, there would be no benefit gained by minor reductions in subassembly sizes without a complete reconfiguration of the cabinet with volumetric packaging efficiency as a design goal.

3.3 AIRPORT SURVEILLANCE RADAR DISPLAY SYSTEM

Nomenclature:	ASRDS-3
FAA Type:	FA-8150
Contractor:	ITT Aerospace/Optical Division, Fort Wayne, Indiana

All elements of the Airport Surveillance Radar Display System which utilize printed wiring boards are contained in either the Common Equipment Cabinet or the PPI Display Console. The effects (benefit) of the imposition of a board size restriction at the time of equipment development will first be analyzed for the individual assemblies which contain printed wiring boards within the Common Equipment Cabinet and PPI Display Console, and then from an overall Cabinet and Console equipment viewpoint.

The assemblies are:

Common Equipment Cabinet

a. Video/Trigger Distribution Assembly

b. Line Compensation Amplifier Assembly

c. Azimuth Data Converter Assembly

d. ACP/ARP Distribution Assembly

e. Power Supply Drawer

PPI Display Console

a. CRT Chassis

b. Card Nest Assembly

3.3.1 Common Equipment Cabinet

3.3.1.1 Video/Trigger Distribution

This assembly consists of a full width 19 inch front panel with card guides and connectors mounted behind and directly to the panel. Provision is made for the vertical mounting of seven printed wiring boards, however, only five are utilized for this equipment configuration. The five boards are all the same type and are 7-3/8 inches long x 4-1/2 inches wide, 1/16 inch thick, and double-sided. Two-sided 44 pin card edge connectors with pins on 0.156 inch centers are used for all boards. All boards use 18 pins and have conventional components only. These boards were not available for photographing during examination of the actual equipment, however complexity and density are estimated to be only moderately dense from the equipment manual illustrations.

The board size could be reduced somewhat without undue crowding and since only 18 of the 44 pins available are used, a shorter connector together with a narrower board could be used and/or the board could be made shorter. However, considering that there are two unused board spaces in this assembly and further that board center distances are excessive, there would be no particular benefit to reducing board sizes without reconfiguring this assembly to take advantage of the reduced board size and closer center distances. This assembly could then be made lower and/or shorter and/or narrower.

3.3.1.2 Line Compensation Amplifier

This assembly consists of a full width 19 inch front panel with card guides and connectors mounted behind, and directly to, the panel. Provision is made for the vertical mounting of ten printed wiring boards, however, only eight are utilized for this equipment configuration. There are three types of boards, each being 6.2 inches long x 4.5 inches wide, 1/16 inch thick, and double-sided. Forty-four pin two-sided card edge connectors with pins on 0.156 inch centers are used for all boards. Pin usage ranges from 7 to 14 pins. One of the board types uses 14-lead DIP's and the others use conventional components only. Complexities range from 0.161 to 0.323 and densities from 0.270 to 0.577. The board photographs confirm that the three board types are loose, moderately dense, and dense.

Considering that only two of the eight boards could be reduced in size (either length and/or width), and the fact that there are two unused board spaces in this assembly, there would be no particular benefit to reducing the size of two boards. Board center spacing is large, however metal shields are provided between boards and this spacing is required to prevent "shorts".

3.3.1.3 Azimuth Data Converter

This assembly consists of a full width 19 inch front panel with card guides and connectors mounted behind, and directly to, the panel. Provision is made for the horizontal mounting of ten printed wiring boards, however, only seven are utilized for this equipment configuration. There are six types of boards, each being 6.2 inches long x 4.5 inches wide, 1/16 inch thick, and double-sided. Forty-four pin two-sided card edge connectors with pins on 0.156 inch centers are used for all boards. Pin usage ranges from 6 to 13 pins. Three of the board types use 14-lead DIP's and the others use conventional components only. Complexities range from 0.026 to 0.592 and densities from 0.175 to 0.355. The board photographs confirm that three board types are loose and three are moderately loose.

The board size could be reduced somewhat without undue crowding and since only 13 pins maximum are used of the 44 available, a shorter connector together with a narrower board could be used and/or the board could be made shorter. However, considering that there are three unused board spaces provided in this assembly, there would be no particular benefit to reducing board sizes without reconfiguring this assembly to take advantage of the reduced board size. This assembly could then be made lower and/or shorter.

3.3.1.4 ACP/ARP Distribution

This assembly consists of a full width 19 inch front panel with card guides and connectors mounted behind, and directly to, the panel. Provision is made for the horizontal mounting, side-by-side, of the two printed wiring boards. These two boards are the same type and are 7.0 inches long x 4.8 inches wide, 1/16 inch thick, and double-sided. Forty-four pin two-sided card edge connectors with pins on 0.156 inch centers are used for both boards. Pin usage is 18 pins. This board type uses conventional components only. This board was not available for photographing during examination of the actual equipment, however, the component density is loose as can be seen in the equipment manual illustration.

The board size could be reduced without undue crowding and since only 18 of the 44 pins available are used, a shorter connector together with a narrower board could be used and/or the board could be made shorter. However, since only two boards are used in a very low panel assembly which also has many other components, it would not be practical to reduce the size of the assembly except for shortening it somewhat.

3.3.1.5 Power Supply Drawer

This assembly is a single large drawer, running the full width of the cabinet, tightly packaged, with the major part consisting of two similar power supply assemblies. Each of these power supply assemblies contain a mixture of large components, high heat producing components with finned heat dissipators, and two printed wiring boards mounted vertically adjacent to each other. The boards plug-in from the top. There are two types of boards, each used by each power supply assembly. The boards are 6.2 inches long x 4.5 inches wide, 1/16 inch thick, and double sided. Two-sided 44 pin card-edge connectors with pins on 0.156 inch centers are used for all boards. Pin usage is 7 and 13 pins. These boards are voltage regulator circuits and use conventional components only. Complexities are 0.010 and 0.032 and densities 0.154 and 0.226. The board photographs confirm that one board type is very loose and the other moderately loose.

The boards could be made somewhat smaller, however, considering the nature, and tight packaging, of the power supply assemblies, and the fact that the printed wiring boards are nested-in among other larger components and heat sinks, no benefit would result if the boards were made smaller. The tight assembly packaging precludes making the boards larger, however, the boards are loosely packaged now and no benefit would result from an increased board size either.

3.3.1.6 Overall Common Equipment Cabinet

Of the five assemblies which contain printed wiring boards, it is not feasible to reduce the ACP/ARP Distribution Assembly and Power Supply Drawer size by reducing the printed wiring board size or reconfiguring the boards, due to the unique configuration of these assemblies.

The Video/Trigger Distribution Assembly height and/or width could be reduced by making the boards narrower, reducing the board center-to-center spacing, and eliminating the two unused board spaces. The height reduction would reduce cabinet height requirements, however, a width reduction would leave an unused gap at one side of the equipment cabinet at that level which could not be used effectively for mounting anything contained in this cabinet. Splitting other functional assemblies merely to fill such a gap would mean that such assemblies would then be difficult to test and maintain and their possible use in other equipment configurations as a complete function would not be possible. Therefore, only a height reduction of approximately 1-3/4 inches is considered feasible for this assembly.

The Line Compensation Amplifier Assembly height could be reduced a maximum of 1-3/4 inches by reconfiguring the printed wiring boards (same size - not smaller) to be narrower, and reducing excessive vertical clearances in the assembly.

The Azimuth Data Converter Assembly printed wiring boards could be reduced in size and/or made narrower, however, if the boards remained horizontally mounted, the resultant width reduction would leave an unused gap at one side of the equipment cabinet at that level - a space not reaily usable by other components. If the boards were mounted vertically, the maximum board width reduction deemed feasible would not be sufficient to reduce assembly height. Therefore, a size reduction for this assembly is not considered feasible.

Of the five assemblies considered, only two could have the height reduced 1-3/4 inches each, or a total of 3-1/2 inches due to printed wiring board size reduction and/or configuration change. Considering the inefficient utilization of cabinet volume at the rear, there would be no benefit gained by an overall cabinet height reduction of 3 inches without a complete reconfiguration of the cabinet with volumetric packaging efficiency as a design goal.

3.3.2 PPI Display Console

3.3.2.1 CRT Chassis

This assembly makes up the entire top section of the PPI Display Console, including the CRT display front panel and associated controls. There is one each of five types of plug-in printed wiring boards in this assembly. Three are mounted in a small card nest integrated within the chassis, and the other two are contained in another small card nest attached to the rear of the chassis. All boards are 6.2 inches long x 4.5 inches wide, 1/16 inch thick, and double-sided. Two-sided 44 pin card-edge connectors with pins on 0.156 inch centers are used for all boards. Pin usage ranges from 12 to 30 pins. All boards use conventional components only. These boards were not available for photographing during examination of the actual equipment, however, equipment manual illustrations gave an indication of complexity and density. Four of the boards are moderately dense while the other is moderately loose.

Considering the highly integrated packaging configuration of this chassis assembly and the fact that the only board which could be reduced in size with undue crowding is contained in a card nest whose minimum size is dictated by the other two boards it contains, it is obvious that no particular benefit would result from reducing the size of this board. Board sizes could be increased somewhat, however, the present board configuration is not unduly crowded and sufficient room exists for test and repair with normal maintenance procedures and care.

3.3.2.2 Card Nest Assembly

This assembly is mounted in the lower section of the PPI Display Console and is withdrawn from the front with the printed wiring boards mounted vertically and plugged-in from the side. This card nest has provision for mounting 24 boards but contains only 18 boards for this equipment configuration. There are 13 types of boards, all 6.2 inches long x 4.5 inches wide, 1/16 inch thick, and double sided. Forty-four pin two-sided card-edge connectors with pins on 0.156 inch centers are used for all boards. Pin usage ranges from 8 to 37 pins. Complexities range from 0.032 to 0.883, and densities from 0.139 to 0.517. The board photographs confirm that six boards are dense, two are moderately dense, four are moderately loose, and one is loose.

Considering that there are six unused card slots in this assembly and that eight of the eighteen boards cannot be reduced in size without undue crowding, and further that the lower section of the PPI Console is not crowded, the reduction in size of the five boards where this is possibe would not result in any particular benefit. The minimum size and shape of the PPI Console is governed by the CRT display with associated controls as well as human factor considerations such as the height of the display panel, therefore a slight reduction in volume of the card nest would not result in a reduction in the size of the PPI Console.

3.3.2.3 Overall PPI Console

The reduction of the size of the single printed wiring board where this is possible in the CRT chassis would not result in a size reduction, or any other particular benefit to the CRT chassis assembly.

The reduction of the size of the five printed wiring boards where this is possible and/or elimination of the siz unused card slots could result in a somewhat smaller Card Nest Assembly. However, considering that there is adequate room without crowding in the lower section of the PPI console for the present card nest, and further that the minimum size of the PPI console is governed by the CRT display and other human factor considerations, no particular benefit would result from a reduction in the size of the Card Nest Assembly.

The reduction in size and/or reconfiguration of the few printed wiring boards where this is possible would not result in any particular benefit to the PPI console equipment.

4.0 SUMMARY, CONCLUSIONS and RECOMMENDATIONS

4.1 SUMMARY

The imposition of a printed wiring board size restriction for a given circuit partitioning at the time of initial equipment procurement would have resulted in the following effects for the equipment covered by this Study:

Twenty equipments analyzed in Section 2.0 -

6 - No board size reduction feasible.
5 - Slight board size reduction feasible.
8 - Moderate board size reduction feasible.
1 - No board size change considered due to the highly standardized nature of this large complex of product-line equipment.

Two equipments analyzed in Section 3.0 -

Video Mapper Group:

4 assemblies - Slight board size reduction is feasible for most boards.
1 assembly - No board size reduction feasible.

Airport Surveillance Radar Display System:

6 assemblies - Slight board size reduction is feasible for most boards.
1 assembly - No board size reduction is feasible.

4.2 CONCLUSIONS

4.2.1 INITIAL PROCUREMENT

It must be assumed that the FAA equipment contractors had the capability and incentive to determine the optimum printed wiring board sizes to, in their opinion, best meet the lowest cost for development, and in most cases, the initial procurement of the equipment. Therefore, the imposition of only a printed wiring board size restriction will in most instances result in the use of a less than optimum printed wiring board size from the contractor's standpoint.

Considering current competitive procurement practices, the imposition of only a standard printed wiring board size would thereby not result in any significant benefit to the FAA from an initial procurement viewpoint. In many instances the result would be negative with higher procurement costs and other undesirable effects discussed in paragraph 1.1.1.

4.2.2 MAINTAINABILITY

With existing FAA maintenance facilities and procedures for their use the vast majority of the printed wiring boards are not plugged into any universal device for troubleshooting and fault location testing. Thus, a standard size printed wiring board would presently be of little or no benefit in this area. A standard connector would aid the technicians by allowing the use of fewer connector interface setups for this type of work, but this was not a parameter of the Comprehensive Analalysis.

4.2.3 EQUIPMENT PACKAGING

4.2.3.1 Sub-Assemblies

Most sub-assemblies that perform relatively simple electrical functions could have been somewhat reduced in size in proportion to the slight-to-moderate printed wiring board size reductions possible. However, the major portion of the sub-assembly size reductions possible would have been due to the reduction of unused board area and, in general, due to more efficient sub-assembly packaging.

The sub-assemblies that contain relatively complex and self-contained circuit functions, such as power supplies, are generally densely packaged and board size reductions possible would be insignificant or have little effect on the overall equipment configuration.

Therefore, the reduction of printed wiring board size by itself, where possible, would not have resulted in highly significant benefits in reducing sub-assembly/equipment sizes in most of the FAA equipment covered by this Study.

4.2.3.2 Major Assemblies

The most common equipment assemblies, such as complete cabinets, have not been densely packaged from a volumetric efficiency standpoint. Considering the low efficiency of cabinet volume utilization, there would not be gained highly significant benefits by minor reductions in sub-assembly sizes without a complete reconfiguration of the cabinet in order to improve packaging efficiency.

Certain specialized major equipment assemblies, such as PPI consoles, have their configuration and minimum size governed by human factors considerations, such as the use of a CRT display. The minor sub-assembly size reductions that could be obtained by printed wiring board size reductions in these areas would not result in any significant benefit.

Therefore, the reduction of printed wiring board size alone, where possible, would not have resulted in highly significant benefits in reducing major equipment assembly sizes in most of the FAA equipment covered by this Study.

4.3 RECOMMENDATIONS

As noted above, printed wiring board size standardization alone is not sufficient to obtain significant benefits. However, work done on the Data Collection and Comprehensive Analysis tasks indicate that significant benefits can be accrued by the FAA if additional parameters are also properly standardized and applied.

It is recommended that additional analysis be performed to determine the optimum FAA printed wiring board size(s) in conjunction with associated elements of equipment packaging suitable for standardization in order for the FAA to derive increased benefits from future equipment procurements. The areas of standardization, in addition to board size, which should be evaluated are, as a minimum, the following:

1. State-of-the-art and potential development.
2. Types of input/output sub-assembly connectors.
3. Thermal aspects.
4. Backplane interconnection wiring arrangements.
5. Maintenance -
    a. facilities
    b. testing (circuit complexity)
    c. repairability
    d. logistics.
6. Reliability.

More significant benefits can be accrued by extending the analysis beyond the immediate printed wiring area, namely, into the area of packaging hardware, such as cabinets, racks, drawers, etc.

APPENDIX A

DATA FORMAT AND ANALYSIS DERIVATION

1.0 COMPONENT DENSITY (CD)

CD = CA/UA (NOTE: if CD greater than 1 - STOP)

where: CA = Component Area - see par. 1.2
UA = Usable Area (@ Nw=1) - see par. 1.1

1.1 USABLE AREA (UA)

UA = (L-5) (W-5) (Nw) units of 0.01 square inches

where: L = board length in 0.1 inch units (columns 18-20)
W = board width in 0.1 inch units (columns 21-23)
Nw = number of wiring layers (column 24)

1.2 COMPONENT AREA (CA) - from 1 to 7 component types

$$CA = \sum_{1}^{7} (Qc)\,(Sc)$$ units of 0.01 square inches

where: Qc = quantity of a component (columns 31-32, 35-36,39-40,43-44,47-48, 51-52,55-56)
Sc = size of a component in 0.01 inch units (columns 29,33,37,41,45,49,53) - see Table 1.

2.0 COMPLEXITY (C)

C = HU / UW (NOTE: if C greater than 1 - STOP)

where: HU = Hook-Up Area - see par. 2.3
UW = Usable Wiring Area - see par. 2.1

2.1 USABLE WIRING AREA (UW)

UW = UA - TA - IØ units of 0.01 square inches

where: UA = Usable Area - see par. 1.1
TA = Termination Area - see par. 2.1.1
IØ = Input-Output Area - see par. 2.2

Table 1.
(columns 29,33,37,41,45,49,53)

COMPONENT SIZE (S)

A	0.08 square inches
B	0.18
C	0.30
D	0.40
E	0.50
F	0.60
G	0.70
H	0.80
I	0.90
J	1.00
K	1.25
L	1.50
M	1.75
N	2.00
Ø	0.03
P	2.25
Q	2.50
R	0.05
S	3.00
T	4.00
U	5.00
V	7.50
W	8.00
X	10.00
Y	15.00
Z	20.00

Table 2.
(columns 30,34,38,42,46,50,54)

COMPONENT TERMINALS (T)

A	1
B	2
C	3
D	4
E	5
F	6
G	7
H	8
J	10
K	11
L	12
M	14
N	16
Ø	0
P	24
Q	68

EXAMPLES:

CM = 14-lead DIP
BC = TO-5 can transistor
AC = TO-18 can transistor
AB = RC07 resistor
AB = DO3 diode
BM = 14-lead Flatpack

Table 3.

ROUTING CONSTANT (column 58)

0 = no conductor routing restrictions.
1 = no conductors routed on layer #1.

2 = no conductors routed under any components on layer #1.
3 = no conductors routed between any component terminals - all layers.

4 = no conductors routed under any digital components on layer #1.
5 = no conductors routed between digital component terminals - all layers.

6 = no conductors routed under any analog components on layer #1.
7 = no conductors routed between analog component terminals - all layers.

Table 4.

A-D CONSTANT (Column 57)

0 = 1.0 (special circuits)
1 = 1.0(100% analog or simply wired circuits)
2 = 0.8
3 = 0.7
4 = 0.6
5 = 0.5
6 = 0.4
7 = 0.3
8 = 0.2
9 = 0.0 (circuits with complex interconnections)

2.1.1 TERMINATION AREA (TA)

A. Quantity of Terminals (QT) - from 1 to 7 component types

$$QT = \sum_{1}^{7} (Qc)(Tc)$$

where: Qc = quantity of a component (columns 31-32,35-36,39-40,43-44,47-48,51-52,55-56)
Tc = number of a component's terminals (columns 30,34,38,42,46,50,54) - see Table 2.

2.1.1.1 ROUTING CONSTANT (RC) = 0 or = 7 - see Table 3.

$$TA = (.025)(Nw)(QT)(\%A + 0.2)$$

where: Nw = number of wiring layers (column 24)
QT = quantity of terminals - see par. 2.1.1 A
%A = percent analog (100% = 1.0) - see Table 4

2.1.1.2 ROUTING CONSTANT (RC) = 1 - see Table 3.

$$TA = UA @ Nw=1 + (Nw-1)(TA @ RC=3)$$

where: UA = usable area - see par. 1.1
Nw = number of wiring layers (column 24)
TA = termination area - see par. 2.1.1.4

2.1.1.3 ROUTING CONSTANT (RC) = 2 - see Table 3.

$$TA = CA + (0.02)(Nw-1)(QT)(\%A + 0.5)$$

where: CA = component area - see par. 1.2
Nw = number of wiring layers (column 24)
QT = quantity of terminals - see par. 2.1.1 A
%A = percent analog (100%=1.0) - see Table 4

2.1.1.4 ROUTING CONSTANT (RC) = 3 or = 5 - see Table 3

$$TA = (0.02)(Nw)(QT)(\%A + 0.5)$$

where: Nw = number of wiring layers (column 24)
QT = quantity of terminals - see par. 2.1.1 A
%A = percent analog (100%=1.0) - see Table 4

2.1.1.5 ROUTING CONSTANT (RC) = 4 - see Table 4.

$$TA = (0.03)(QT)(\%A) + (CA)(1-\%A) + (0.02)(Nw-1)(QT)(\%A + 0.5)$$

where:
QT = quantity of terminals - see par. 2.1.1 A
%A = percent analog (100%=1.0) - see Table 4.
CA = component area - see par. 1.2
Nw = number of wiring layers (column 24)

2.1.1.6 ROUTING CONSTANT (RC) = 6 - see Table 4.

$$TA = (0.005)(QT)(1-\%A) + (\%A)(CA) + (0.02)(Nw-1)(QT)(\%A + 0.5)$$

where:
QT = quantity of terminals - see par. 2.1.1 A
%A = percent analog (100%=1.0) - see Table 4.
CA = component area - see par. 1.2
Nw = number of wiring layers (column 24)

2.2 INPUT-OUTPUT AREA (IØ)

IØ = (IØM) (Fn) (Fu)

where:
IØM = maximum IØ area - see par. 2.2.1
Fn = necking factor - see par. 2.2.2
Fu = usage factor - see par. 2.2.3

2.2.1 INPUT-OUTPUT MAXIMUM AREA (IØM)

IØM = (0.5) (IØU) (IØW) (G)

where:
IØU = IØ usage (columns 26-28)
IØW = IØ width - see Table 5.
G = grid size - see Table 6.

2.2.2 NECKING FACTOR (Fn) - from Curve 1.

A. Necking Ratio (NR)

NR = IØW / (W-5)

where:
IØW = IØ width - see Table 5.
W = board width (columns 21-23)

(NOTE: if NR greater than 1.0 use NR = 1.0 for calculation purposes.)

CURVE #1.

Necking Ratio (NR)
versus
Necking Factor (Fn)

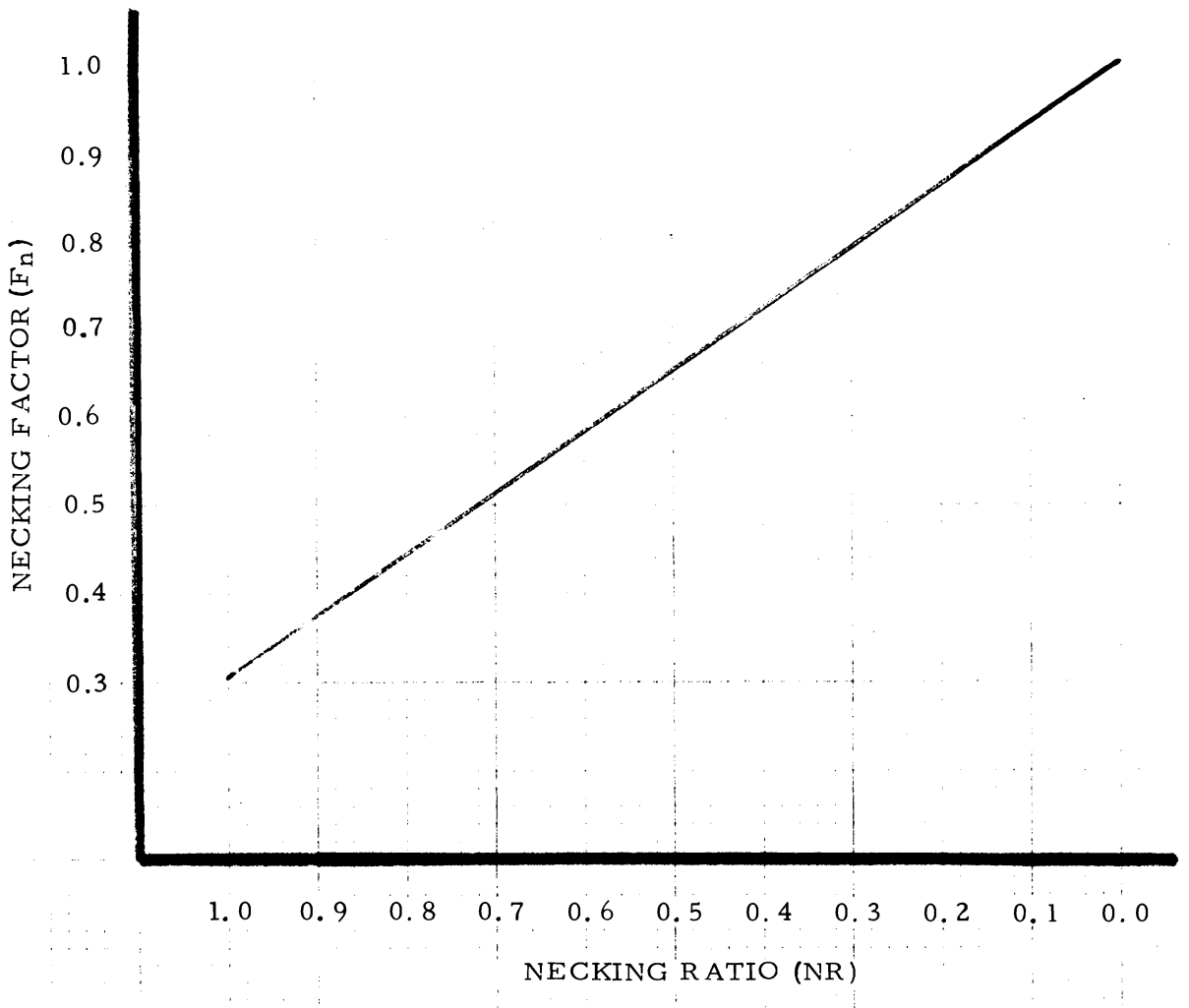

Table 5.

INPUT-OUTPUT CATEGORY (column 25)

	Centers	IOA (available)	IOW (width)
A	.100	29 2-part	3.0 inches
B	.156	15 one-sided	2.4
C	.156	22 one-sided	3.5
D	.156	44 two-sided	3.5
E	.125	60 two-sided	3.8
F	.150	23 2-part	3.5
G	.100	35 Elco	3.5
H	.100	105 Elco (3-tang)	10.5
J	.100	17 2-part	1.7
K	.100	86 two-sided	4.3
L	.200	32 two-sided	3.2
M	.200	44 two-sided	4.4
N	.200	100 two-sided	10.0
Ø	.156	72 two-sided	5.6
P	.156	10 one-sided	1.6
Q	.100	IOA=IOU	(W-5)
R	.100	43 one-side	4.3
S	.156	36 two-sided	2.7
T	----	NOT PLUG-IN	(W-5)
U	.100	47 Elco (7023)	4.7
W	.156	18 one-sided	2.7
X	.125	86 two-sided	5.4
Y	.156	60 two-sided	4.7
Z	.156	30 two-sided	2.4
I	.100	56 two-part	2.8
0	.200	50 two-sided	5.0
1	.100	12 two-part	1.2
2	.200	18 two-part (perp.)	3.6
3	.100	4ea. 47 two-part	(W-5)
4	.156	28 one-sided	4.4
5	.156	50 two-sided	3.9
6	.125	136 two-sided	8.5
8	.125	16 one-sided	2.0
9	.125	24 two-part	3.0

Table 6.

GRID CONSTANT (column 60)

0 = 0.025 inch
1 = 0.050 inch
2 = 0.100 inch
3 = 0.200 inch

Table 7.

BUSING CONSTANT (column 59)

0 = all conductors of same width
1 = 10% one grid wider (1.1)
2 = 20% one grid wider (1.2)
3 = 30% one grid wider (1.3)
4 = 40% one grid wider (1.4)
5 = 50% one grid wider (1.5)
6 = 60% one grid wider (1.6)
7 = 70% one grid wider (1.7)
8 = 80% one grid wider (1.8)
9 = 90% one grid wider (1.9)

(NOTE:
"2" can also equal having 10% of the conductors two grid units larger in width, for example.)

Curve #2.

Input-Output Usage Ratio (UR)
versus
Usage Factor (Fu)

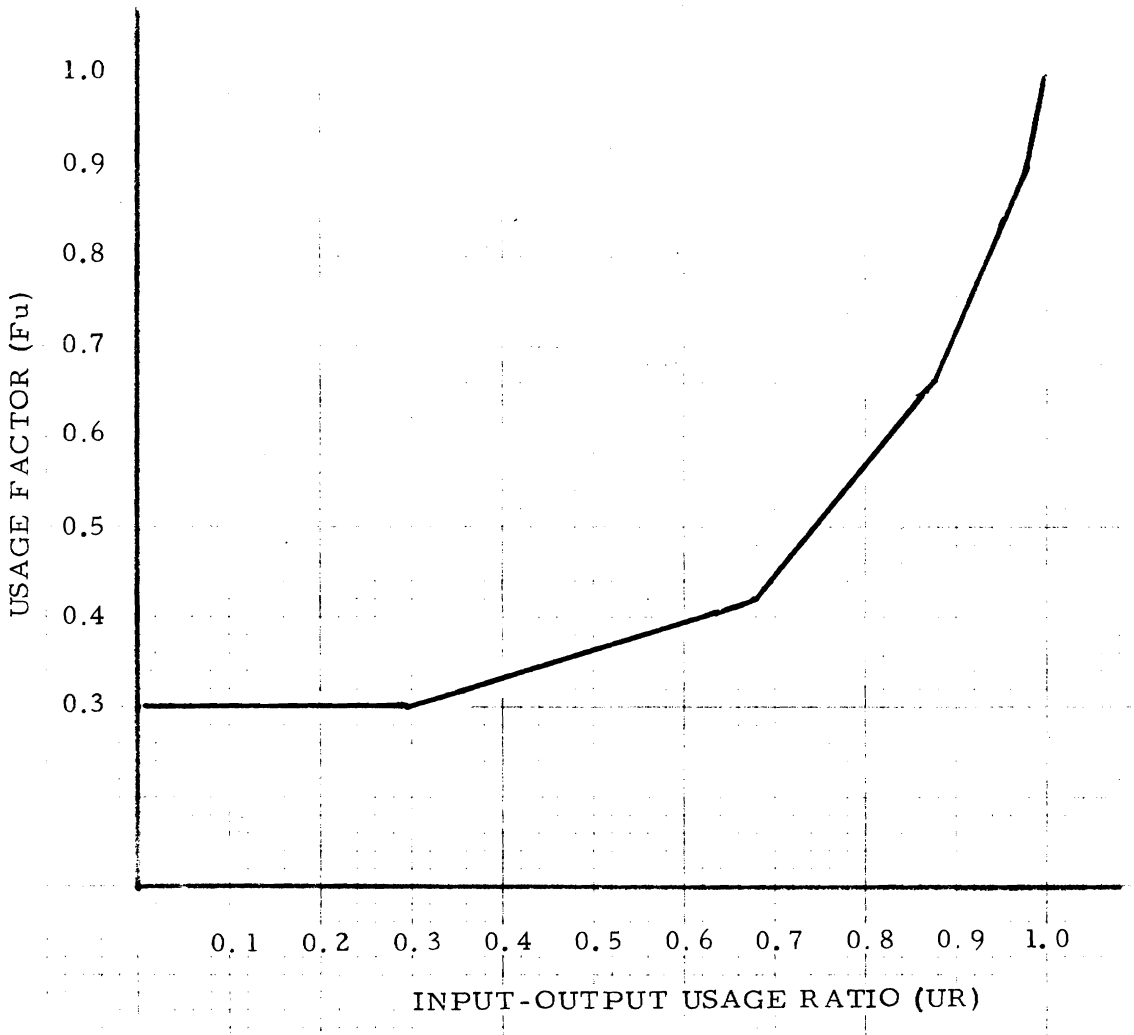

Table 8.

HOOKUP FACTOR (HU)

	ROUTING CONSTANT			
	0	3,5,7	2,4,6	for layer #1.
D-A	0	1 thru 7	-	for all other layers
0-1	0.5	0.6	0.7	
2	0.7	0.9	1.1	
3	0.9	1.2	1.5	
4	1.1	1.6	2.0	
5	1.3	1.9	3.0	
6	1.5	2.4	3.0	
7	1.7	2.9	3.6	
8	1.9	3.4	4.3	
9	2.1	4.0	5.0	

2.2.3 USAGE FACTOR (Fu) - from Curve 2.

A. Usage Ratio (UR)

UR = IØU / IØA

where:

IØU = IØ used (columns 26-28)
IØA = IØ available - see Table 5.

2.3 HOOK-UP AREA (HU) - from 1 to Nw wiring layers

$$HU = (CD)\ (TU)\ (G)\ (BC)\ (1/Nw) \sum_{1}^{Nw} F_h$$

where:

CD = Component Density - see par. 1.0
TU = terminals used - see par. 2.3.1
G = grid size in inches - see Table 6.
BC = busing constant - see Table 7.
Nw = number of wiring layers (column 24)
F_h = hook-up factor - see Table 8.

(NOTE: for the first layer when RC=1,
HU = UA @Nw=1 , see par. 1.1)

2.3.1 Terminals Used (TU)

TU = QU + IØU

where:

QU = QT (T=A thru L) + 0.6 QT (T=M thru Q)- see par. 2.1.1.A and Table 2.
IØU = IØ used (columns 26-28)

3.0 MAGNITUDE (M)

M = (C) (UA)

where:

C = Complexity - see par. 2.0
UA = Usable Area - see par. 1.1

APPENDIX B

DATA TABULATION AND COMPUTER ANALYSIS

PRINTED CIRCUIT BOARD EVALUATION

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
001	REDE-5	PB 1	6.0	5.0	1	A	9	0.435	0.247	6.122
002	REDE-5	PB 2	6.0	5.0	2	A	11	0.389	0.395	19.533
003	REDE-5	PB 3	6.0	5.0	2	A	16	0.467	0.208	10.285
004	REDE-5	PB 4	6.0	5.0	1	A	14	0.223	0.102	2.526
005	REDE-5	PB 5	6.0	5.0	1	A	12	0.088	0.015	0.376
006	REDE-5	PB 6	6.0	5.0	2	A	19	0.260	0.071	3.491
007	REDE-5	PB 7	6.0	5.0	1	A	16	0.177	0.072	1.772
008	REDE-5	PB 8	6.0	5.0	1	A	11	0.667	0.169	4.171
009	REDE-5	PB 9	6.0	5.0	1	A	14	0.600	0.291	7.194
010	REDE-5	PB 10	6.0	5.0	2	A	20	0.659	0.484	23.979
011	REDE-5	PB 11	6.0	5.0	1	A	5	0.103	0.007	0.179
012	REDE-5	PB 12	6.0	5.0	1	A	6	0.321	0.139	3.451
013	REDE-5	PB 13	6.0	5.0	1	A	7	0.339	0.147	3.635
014	REDE-5	PB 14	6.0	5.0	2	A	13	0.722	0.342	16.936
015	REDE-5	PB 15	6.0	5.0	2	A	20	0.576	0.315	15.613
016	REDE-5	PB 16	6.0	5.0	2	A	29	0.861	0.862	42.683
017	REDE-5	PB 17	6.0	5.0	2	A	5	0.508	0.205	10.129
018	REDE-5	PB 18	6.0	5.0	1	A	17	0.377	0.279	6.909
019	REDE-5	PB 19	6.0	5.0	1	A	25	0.270	0.101	2.502
020	REDE-5	PB 20	6.0	5.0	1	A	29	0.509	0.534	13.227
021	REDE-5	PB 21	6.0	5.0	1	A	26	0.088	0.017	0.414
022	REDE-5	PB 22	6.0	5.0	1	A	27	0.072	0.012	0.297
023	REDE-5	PB 23	6.0	5.0	2	A	29	0.409	0.179	8.860
024	REDE-5	PB 24	6.0	5.0	2	A	29	0.424	0.212	10.509
025	REDE-5	PB 25	6.0	5.0	2	A	25	0.600	0.246	12.152
026	REDE-5	PB 26	6.0	5.0	2	A	20	0.343	0.105	5.195
027	REDE-5	PB 27	6.0	5.0	2	A	24	0.421	0.377	18.676
028	REDE-5	PB 28	6.0	5.0	2	A	29	0.272	0.056	2.756
029	REDE-5	PB 29	6.0	5.0	1	A	23	0.517	0.406	10.052
030	REDE-5	PB 30	6.0	5.0	2	A	25	0.469	0.465	23.019
031	REDE-5	PB 31	6.0	5.0	1	A	27	0.271	0.095	2.357
032	REDE-5	PB 32	6.0	5.0	2	A	29	0.571	0.581	28.742
033	REDE-5	PB 33	6.0	5.0	2	A	21	0.375	0.244	12.060
034	REDE-5	PB 34	6.0	5.0	1	A	24	0.270	0.103	2.548
035	REDE-5	PB 35	6.0	5.0	1	A	29	0.268	0.215	5.328
036	REDE-5	PB 36	6.0	5.0	2	A	29	0.388	0.161	7.963
037	REDE-5	PB 40	6.0	5.0	2	A	29	0.447	0.200	9.885
038	REDE-5	PB 41	6.0	5.0	1	A	24	0.244	0.128	3.174
039	REDE-5	PB 42	6.0	5.0	1	A	18	0.251	0.093	2.302
040	REDE-5	PB 44	6.0	5.0	2	A	24	0.707	0.592	29.325

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPUTED: COMPLEXITY	COMPUTED: MAGNITUDE
041	REDE-5	PB 45	6.0	5.0	2	A	16	0.475	0.221	10.928
042	REDE-5	PB 46	6.0	5.0	1	A	21	0.402	0.330	8.180
043	REDE-5	PB 48	6.0	5.0	2	A	29	0.421	0.187	9.243
044	REDE-5	PB 49	6.0	5.0	2	A	29	0.417	0.203	10.070
045	REDE-5	PB 50	6.0	5.0	1	A	27	0.093	0.018	0.443
046	REDE-5	PB 51	6.0	5.0	1	A	27	0.086	0.016	0.389
047	REDE-5	PB 60	6.0	5.0	1	A	6	0.562	0.023	0.575
048	REDE-5	PB 61	6.0	5.0	2	A	26	0.501	0.243	12.033
049	REDE-5	PB 62	6.0	5.0	1	A	16	0.222	0.027	0.668
050	REDE-5	PB 63	6.0	5.0	2	A	9	0.355	0.046	2.296
051	REDE-5	PB 64	6.0	5.0	2	A	16	0.346	0.156	7.743
052	REDE-5	PB 65	6.0	5.0	1	A	16	0.482	0.177	4.379
053	REDE-5	PB 66	6.0	5.0	1	A	13	0.630	0.298	7.380
054	REDE-5	PB 67	6.0	5.0	2	A	11	0.547	0.200	9.910
055	REDE-5	PB 68	6.0	5.0	1	A	14	0.331	0.169	4.172
056	REDE-5	PB 69	6.0	5.0	1	A	8	0.323	0.077	1.906
057	REDE-5	PB 70	6.0	5.0	1	A	9	0.497	0.235	5.817
058	REDE-5	PB 71	6.0	5.0	1	A	16	0.430	0.138	3.416
059	REDE-5	PB 72	6.0	5.0	1	A	18	0.527	0.295	7.298
060	REDE-5	PB 73	6.0	5.0	1	A	12	0.320	0.085	2.104
061	REDE-5	PB 74	6.0	5.0	1	A	10	0.288	0.067	1.658
062	REDE-5	PB 75	6.0	5.0	1	A	25	0.414	0.111	2.740
063	REDE-5	PB 76	6.0	5.0	2	A	13	0.788	0.370	18.322
064	REDE-5	PB 77	6.0	5.0	1	A	14	0.612	0.229	5.659
065	REDE-5	PB 78	6.0	5.0	1	A	5	0.874	0.062	1.527
066	REDE-5	PB 79	6.0	5.0	2	A	11	0.600	0.481	23.806
067	REDE-5	PB 80	6.0	5.0	1	A	22	0.438	0.178	4.411
068	REDE-5	PB 81	6.0	5.0	2	A	7	0.352	0.138	6.853
069	REDE-5	PB 82	6.0	5.0	1	A	14	0.556	0.358	8.854
070	REDE-5	PB 83	6.0	5.0	1	A	9	0.886	0.091	2.254
071	REDE-5	PB 84	6.0	5.0	2	A	27	0.676	0.324	16.054
072	REDE-5	PB 85	6.0	5.0	2	A	25	0.614	0.566	28.031
073	REDE-5	PB 86	6.0	5.0	1	A	20	0.493	0.309	7.640
074	REDE-5	PB 87	6.0	5.0	1	A	17	0.557	0.271	6.713
075	REDE-5	PB 88	6.0	5.0	1	A	19	0.414	0.272	6.732
076	REDE-5	PB 89	6.0	5.0	1	A	19	0.859	0.431	10.665
077	REDE-5	PB 90	6.0	5.0	1	A	19	0.538	0.297	7.345
078	REDE-5	PB 91	6.0	5.0	1	A	13	0.438	0.121	3.000
079	REDE-5	PB 92	6.0	5.0	1	A	11	0.369	0.119	2.955
080	REDE-5	PB 93	6.0	5.0	1	A	9	0.370	0.292	7.226

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
081	REDE-5	PB 94	6.0	5.0	2	A	11	0.437	0.099	4.909
082	REDE-5	PB 95	6.0	5.0	1	A	21	0.210	0.029	0.709
083	REDE-5	PB 96	6.0	5.0	1	A	21	0.399	0.139	3.429
084	REDE-5	PB110	6.0	5.0	1	A	9	0.947	0.097	2.408
085	REDE-5	PB111	6.0	5.0	2	A	15	0.657	0.167	8.287
086	REDE-5	PB112	6.0	5.0	1	A	9	0.348	0.119	2.952
087	REDE-5	PB114	6.0	5.0	2	A	23	0.581	0.212	10.469
088	REDE-5	PB115	6.0	5.0	2	A	17	0.677	0.523	25.882
089	REDE-5	PB117	6.0	5.0	2	A	11	0.454	0.109	5.395
090	REDE-5	PB118	6.0	5.0	1	A	10	0.335	0.110	2.730
091	REDE-5	PB119	6.0	5.0	1	A	10	0.245	0.052	1.283
092	REDE-5	PB120	6.0	5.0	1	A	7	0.284	0.096	2.388
093	REDE-5	PB121	4.2	5.0	1	A	21	0.792	0.265	4.417
094	REDE-5	PB131	6.0	5.0	1	A	12	0.325	0.052	1.281
095	REDE-5	PB133	6.0	5.0	1	A	8	0.419	0.123	3.051
096	REDE-5	PB134	6.0	5.0	1	A	11	0.419	0.121	2.988
097	REDE-5	PB138	6.0	5.0	1	A	15	0.664	0.387	9.567
098	REDE-5	PB151	6.0	5.0	1	A	17	0.472	0.238	5.896
099	REDE-5	PB152	6.0	5.0	1	A	19	0.516	0.273	6.752

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED DENSITY	COMPLEXITY	MAGNITUDE
100	RTC-3	1903637	3.3	4.3	1	B	8	0.628	0.394	4.190
101	RTC-3	1903638	3.3	4.3	1	B	8	0.628	0.394	4.190
102	RTC-3	1903639	3.3	4.3	1	B	14	0.833	0.464	4.940
103	RTC-3	328752	6.0	5.2	1	C	8	0.476	0.163	4.208
104	RTC-3	328865	6.0	5.2	2	D	10	0.202	0.059	3.034
105	RTC-3	329106	6.0	5.2	1	C	11	0.472	0.214	5.522
106	RTC-3	329107	6.0	5.2	2	D	15	0.448	0.292	15.095
107	RTC-3	329244	6.0	5.2	1	C	13	0.481	0.207	5.338
108	RTC-3	331376	6.0	5.2	2	D	39	0.239	0.605	31.295
109	RTC-3	331449	6.0	5.2	2	D	23	0.720	0.614	31.734
110	RTC-3	331482	6.0	5.2	2	C	12	0.255	0.537	27.770
111	RTC-3	331662	6.0	5.2	2	D	12	0.264	0.301	15.576
112	RTC-3	331663	6.0	5.2	2	D	10	0.467	0.352	18.183
113	RTC-3	331664	6.0	5.2	2	D	9	0.402	0.117	6.049
114	RTC-3	331702	6.0	5.2	2	D	34	0.426	0.526	27.212
115	RTC-3	331703	6.0	5.2	2	D	21	0.531	0.636	32.881
116	RTC-3	331770	6.0	5.2	2	D	14	0.595	0.104	5.357
117	RTC-3	331785	6.0	5.2	2	D	28	0.526	0.134	6.936
118	RTC-3	332013	6.0	5.2	2	D	16	0.283	0.410	21.212
119	RTC-3	332014	6.0	5.2	2	D	20	0.284	0.591	30.532
120	RTC-3	332049	6.0	5.2	2	D	17	0.525	0.181	9.367
121	RTC-3	332125	6.0	5.2	2	D	15	0.525	0.680	35.143
122	RTC-3	332170	6.0	5.2	2	D	13	0.550	0.159	8.228
123	RTC-3	332194	6.0	5.2	2	D	20	0.421	0.312	16.141
124	RTC-3	332207	6.0	5.2	1	C	8	0.523	0.242	6.257
125	RTC-3	332268	6.0	5.2	2	D	15	0.592	0.155	7.995
126	RTC-3	332288	6.0	5.2	2	D	14	0.603	0.197	10.170
127	RTC-3	332293	6.0	5.2	2	D	28	0.323	0.286	14.776
128	RTC-3	343096	10.5	7.0	2	D	26	0.353	0.031	4.020
129	RTC-3	343317	6.0	5.2	2	D	6	0.660	0.150	7.737
130	RTC-3	349051	6.0	5.2	2	D	11	0.554	0.248	12.812
131	RTC-3	388185	6.0	5.2	1	C	6	0.768	0.552	14.263
132	RTC-3	496375	6.0	5.2	2	D	33	0.351	0.864	44.675

PRINTED CIRCUIT BOARD EVALUATION

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
133	ATCBI-4	707075	2.5	4.0	2	E	26	0.766	0.885	12.397
134	ATCBI-4	707077	2.5	4.0	2	E	6	0.661	0.670	9.376
135	ATCBI-4	707079	2.5	4.0	2	E	37	0.821	0.646	9.049
136	ATCBI-4	707082	2.5	4.0	2	E	7	0.617	0.227	3.174
137	ATCBI-4	707096	2.5	4.0	2	E	25	0.634	0.547	7.663
138	ATCBI-4	707098	2.5	4.0	2	E	44	0.451	0.729	10.199
139	ATCBI-4	707235	2.5	4.0	2	E	60	0.457	0.868	12.152
140	ATCBI-4	707237	2.5	4.0	2	E	60	0.251	0.478	6.689
141	ATCBI-4	707239	2.5	4.0	2	E	60	0.266	0.505	7.070
142	ATCBI-4	707241	2.5	4.0	2	E	60	0.343	0.205	2.875
143	ATCBI-4	707243	2.5	4.0	2	E	60	0.266	0.277	3.883
144	ATCBI-4	707245	2.5	4.0	2	E	28	0.644	0.770	10.776
145	ATCBI-4	707247	2.5	4.0	2	E	27	0.889	0.142	1.985
146	ATCBI-4	707249	2.5	4.0	2	E	36	0.560	0.467	6.534
147	ATCBI-4	707253	2.5	4.0	2	E	45	0.683	0.646	9.044
148	ATCBI-4	707255	2.5	4.0	2	E	46	0.511	0.619	8.670
149	ATCBI-4	707314	2.5	4.0	2	E	20	0.914	0.369	5.171

PRINTED CIRCUIT BOARD EVALUATION

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
150	FA-7280	P4109	11.8	8.3	1	F	14	0.458	0.182	16.085
151	FA-7280	P4110	11.8	8.3	1	F	22	0.459	0.209	18.398
152	FA-7280	P4111	11.8	8.3	1	F	12	0.347	0.140	12.383

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
153	RVR	M01 UFF	5.3	4.5	1	G	35	0.475	0.501	9.623
154	RVR	M02 UFF	5.3	4.5	1	G	35	0.400	0.355	6.813
155	RVR	M03 XMT	5.3	4.5	2	G	33	0.474	0.286	10.990
156	RVR	M04 5BB	5.3	4.5	2	G	27	0.573	0.376	14.449
157	RVR	M06 LST	5.3	4.5	1	G	15	0.303	0.148	2.834
158	RVR	M07 CPG	5.3	4.5	2	G	22	0.367	0.123	4.732
159	RVR	M08 22S	5.3	4.5	2	G	34	0.360	0.161	6.197
160	RVR	M10 HDC	5.3	4.5	2	G	27	0.483	0.273	10.489
161	RVR	M11 OCC	5.3	4.5	2	G	30	0.213	0.048	1.853
162	RVR	M12 FDC	5.3	4.5	1	G	10	0.272	0.102	1.968
163	RVR	M13 LSR	5.3	4.5	2	G	20	0.439	0.187	7.197
164	RVR	M18 TBL	5.6	15.0	2	H	52	0.214	0.040	5.950
165	RVR	M19 TBL	5.6	15.0	2	H	52	0.229	0.045	6.671
166	RVR	M20 TBL	5.6	15.0	2	H	52	0.214	0.040	5.950
167	RVR	M21 STS	5.3	4.5	1	G	13	0.320	0.154	2.960
168	RVR	M25 CLC	5.3	4.5	1	G	35	0.462	0.407	7.810
169	RVR	M26 SCC	5.3	4.5	1	G	23	0.420	0.335	6.433

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
170	CCDEDTS	ATT1153	4.1	4.5	2	D	27	0.214	0.322	9.282
171	CCDEDTS	DCL1156	4.1	4.5	2	D	21	0.214	0.352	10.142
172	CCDEDTS	ATT1162	4.1	4.5	2	D	23	0.410	0.064	1.847
173	CCDEDTS	ATT1168	4.1	4.5	2	D	5	0.717	0.266	7.675
174	CCDEDTS	1171	4.1	4.5	2	D	30	0.353	0.876	25.236
175	CCDEDTS	DCL1172	4.1	4.5	2	D	41	0.151	0.188	5.429
176	CCDEDTS	ATT1180	4.1	4.5	2	D	28	0.314	0.525	15.115
177	CCDEDTS	ATT1186	4.1	4.5	2	D	42	0.376	0.878	25.276
178	CCDEDTS	ATT1189	4.1	4.5	2	D	44	0.151	0.243	6.990
179	CCDEDTS	DCL1192	4.1	4.5	2	D	42	0.151	0.231	6.648
180	CCDEDTS	ATT1195	4.1	4.5	2	D	39	0.374	1.000	28.791
181	CCDEDTS	CLI1198	4.1	4.5	2	D	38	0.318	0.752	21.671
182	CCDEDTS	CLI1201	4.1	4.5	2	D	39	0.376	0.837	24.095
183	CCDEDTS	1204	4.1	4.5	2	D	8	0.511	0.136	3.917
184	CCDEDTS	ATT1207	4.1	4.5	2	D	21	0.625	0.550	15.849
185	CCDEDTS	1252	4.1	4.5	2	D	18	0.506	0.174	5.023
186	CCDEDTS	1255	4.1	4.5	2	D	15	0.529	0.543	15.633
187	CCDEDTS	CLI1258	4.1	4.5	2	D	10	0.597	0.439	12.649
188	CCDEDTS	1261	4.1	4.5	2	D	13	0.894	0.366	10.554
189	CCDEDTS	1264	4.1	4.5	2	D	7	0.847	0.334	9.616
190	CCDEDTS	EDS1265	4.1	4.5	2	D	8	0.571	0.213	6.143
191	CCDEDTS	EDS1269	4.1	4.5	2	D	8	0.667	0.195	5.628
192	CCDEDTS	CLI1279	4.1	4.5	2	D	4	0.500	0.102	2.947
193	CCDEDTS	DCL1282	4.1	4.5	2	D	9	0.721	0.374	10.771
194	CCDEDTS	ATT1293	4.1	4.5	2	D	44	0.131	0.185	5.338
195	CCDEDTS	1324	4.1	4.5	2	D	6	0.444	0.342	9.864
196	CCDEDTS	CLI1336	4.1	4.5	2	D	23	0.549	0.153	4.412
197	CCDEDTS	DCL1401	4.1	4.5	2	D	9	0.632	0.323	9.311
198	CCDEDTS	BPS1417	4.1	4.5	2	D	8	0.222	0.051	1.474
199	CCDEDTS	PSLVD	4.1	4.5	2	D	17	0.465	0.098	2.823
200	CCDEDTS	BPFI	4.1	4.5	2	D	11	0.349	0.059	1.712
201	CCDEDTS	DCL2IN	4.1	4.5	2	D	44	0.151	0.202	5.819
202	CCDEDTS	DCLJKFF	4.1	4.5	2	D	38	0.206	0.233	6.722
203	CCDEDTS	JKFF	4.1	4.5	2	D	28	0.206	0.195	5.624
204	CCDEDTS	ATTIN	4.1	4.5	2	D	44	0.151	0.202	5.819
205	CCDEDTS	ATT4IN	4.1	4.5	2	D	42	0.151	0.192	5.543

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
206	MARK-IA	GS 2A1	4.5	5.8	2	A	26	0.481	0.112	4.750
207	MARK-IA	GS 3A4	5.0	4.0	1	F	17	0.273	0.066	1.043
208	MARK-IA	MRK 2A2	4.4	6.7	2	J	17	0.581	0.151	7.322
209	MARK-IA	LOC 3A5	5.0	4.3	2	J	10	0.537	0.155	5.296
210	MARK-IA	TEL 3A1	5.0	6.0	2	F	21	0.397	0.107	5.307
211	MARK-IA	MRK 2A5	4.4	6.7	1	J	16	0.422	0.172	4.167
212	MARK-IA	LG7A1A1	3.5	4.0	1	J	13	0.705	0.571	5.996
213	MARK-IA	L 6A1A1	5.5	7.8	1	J	9	0.351	0.153	5.582
214	MARK-IA	L 6A1A2	5.5	7.8	2	J	13	0.351	0.080	5.853
215	MARK-IA	L 6A1A3	5.5	7.8	2	J	6	0.290	0.037	2.675
216	MARK-IA	L 6A1A4	5.5	7.8	2	F	21	0.330	0.128	9.352
217	MARK-IA	L 6A1A5	5.5	7.8	2	J	9	0.359	0.062	4.498
218	MARK-IA	S C 1A1	3.3	6.5	2	A	26	0.476	0.342	11.481
219	MARK-IA	LOC 2A1	4.5	5.8	2	A	28	0.578	0.146	6.175
220	MARK-IA	STAT2A1	3.3	6.5	2	A	26	0.648	0.333	11.175
221	MARK-IA	MRK 2A3	4.4	6.7	2	J	7	0.414	0.106	5.118
222	MARK-IA	MRK 3A1	6.5	3.0	1	J	17	0.412	0.137	2.061
223	MARK-IA	TEL 3A2	4.0	4.8	2	F	23	0.319	0.035	1.039
224	MARK-IA	S C 1A2	3.3	6.5	2	A	27	0.406	0.174	5.856
225	MARK-IA	L G 3A1	4.0	4.8	1	F	13	0.373	0.125	1.882
226	MARK-IA	3A2/3A3	5.0	6.0	2	A	23	0.536	0.210	10.381

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
227	MX-8757	101496	3.3	7.8	2	D	27	0.669	0.726	29.662
228	MX-8757	101497	3.3	7.8	2	D	26	0.469	0.503	20.548
229	MX-8757	101498	3.3	7.8	2	D	29	0.470	0.670	27.387
230	MX-8757	101499	3.3	7.8	2	D	18	0.334	0.321	13.113
231	MX-8757	101501	3.3	7.8	2	D	21	0.712	0.993	40.588
232	MX-8757	1015	3.3	7.8	2	D	26	0.651	0.719	29.374
233	MX-8757	101503	3.3	7.8	2	D	17	0.812	0.597	24.401
234	MX-8757	101504	3.3	7.8	2	D	42	0.412	0.036	1.451

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
235	CDC/CUE	451625	5.0	3.6	2	L	12	0.220	0.277	7,739
236	CDC/CUE	463346	5.0	5.0	2	T		0.572	0.154	6,250
237	CDC/CUE	451594	6.0	5.3	2	M	23	0.407	0.485	25,634
238	CDC/CUE	451998	6.0	6.0	2	K	31	0.197	0.181	10,954
239	CDC/CUE	385950	6.0	5.3	2	M	37	0.294	0.185	9,747
240	CDC/CUE	5041029	5.8	4.8	2	D	11	0.423	0.062	2,811
241	CDC/CUE	409559	6.0	6.0	2	K	23	0.393	0.546	33,008
242	CDC/CUE	409616	6.0	6.0	2	K	48	0.346	0.814	49,217
243	CDC/CUE	409546	6.0	5.3	2	M	24	0.278	0.040	2,086
244	CDC/CUE	409547	6.0	5.3	2	M	34	0.500	0.972	51,322
245	CDC/CUE	409397	8.0	4.4	2	T		0.641	0.332	19,426
246	CDC/CUE	405916	6.0	5.3	2	M	17	0.312	0.652	34,410
247	CDC/CUE	409621	6.0	6.0	2	K	67	0.419	0.908	54,935
248	CDC/CUE	405715	6.0	6.0	2	K	43	0.180	0.237	14,336
249	CDC/CUE	LOG SD	6.0	6.0	2	K	59	0.128	0.167	10,108
250	CDC/CUE	COM DL	6.0	6.0	2	K	52	0.234	0.480	29,014
251	CDC/CUE	409856	6.0	5.3	2	M	10	0.286	0.281	14,811
252	CDC/CUE	450269	6.0	5.3	2	M	44	0.217	0.159	8,391
253	CDC/CUE	450271	6.6	3.8	2	L	29	0.089	0.078	3,137
254	CDC/CUE	451963	6.6	3.8	2	L	22	0.268	0.579	23,320
255	CDC/CUE	XMT DA	6.0	6.0	2	K	28	0.393	0.821	49,658
256	CDC/CUE	452486	6.0	6.0	2	R	21	0.498	0.291	17,630
257	CDC/CUE	451999	6.0	6.0	2	K	46	0.140	0.179	10,836
258	CDC/CUE	405558	6.0	5.3	2	M	28	0.474	0.790	41,715
259	CDC/CUE	405915	6.0	5.3	2	M	13	0.648	0.311	16,427
260	CDC/CUE	405662	4.4	2.4	2	T		0.672	0.221	3,282
261	CDC/CUE	405694	6.0	6.0	2	R	12	0.331	0.118	7,149
262	CDC/CUE	405462	8.0	8.0	2	K	46	0.289	0.287	32,266
263	CDC/CUE	405465	8.0	8.0	2	K	59	0.255	0.404	45,394
264	CDC/CUE	405550	9.0	8.0	2	K	38	0.328	0.433	55,249
265	CDC/CUE	405331	3.2	5.0	2	R	8	0.388	0.174	4,220
266	CDC/CUE	405545	6.8	10.8	2	N	89	0.249	0.237	30,767
267	CDC/CUE	405869	6.0	5.3	2	M	19	0.407	0.182	9,598
268	CDC/CUE	462970	6.8	10.8	2	N	41	0.245	0.115	14,910
269	CDC/CUE	385235	6.0	6.0	2	R	22	0.197	0.317	19,156
270	CDC/CUE	405557	6.0	5.3	2	M	16	0.186	0.283	14,968
271	CDC/CUE	462979	6.8	10.8	2	N	45	0.241	0.158	20,473
272	CDC/CUE	462976	6.8	10.8	2	N	83	0.263	0.228	29,587
273	CDC/CUE	576839	8.0	8.0	2	K	57	0.128	0.042	4,684
274	CDC/CUE	PVD HV	5.8	4.8	2	D	15	0.513	0.073	3,311
275	CDC/CUE	5041028	5.8	4.8	2	D	18	0.757	0.113	5,151

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED DENSITY	COMPLEXITY	MAGNITUDE
276	CDC/CUE	5041027	5.8	4.8	2	D	20	0.315	0.046	2.088
277	CDC/CUE	385991	6.0	5.3	2	D	29	0.282	0.391	20.626
278	CDC/CUE	385239	6.0	6.0	2	R	14	0.340	0.623	37.711
279	CDC/CUE	1385028	2.0	3.2	2	T		0.526	0.906	7.340
280	CDC/CUE	2385028	2.0	3.2	2	T		0.479	0.388	3.141
281	CDC/CUE	3385028	2.0	3.2	2	T		0.553	0.798	6.463
282	CDC/CUE	405461	8.0	8.0	2	K	51	0.206	0.139	15.638
283	CDC/CUE	405326	9.0	8.0	2	R	38	0.226	0.118	15.098
284	CDC/CUE	405130	9.0	8.0	2	R	37	0.391	0.466	59.439
285	CDC/CUE	405329	9.0	8.0	2	R	37	0.272	0.371	47.259
286	CDC/CUE	405242	6.8	10.8	2	N	88	0.305	0.316	40.966
287	CDC/CUE	463101	6.8	10.8	2	N	67	0.333	0.261	33.809
288	CDC/CUE	364614	5.4	10.8	2	N	69	0.171	0.054	5.484
289	CDC/CUE	450688	6.0	6.0	2	K	54	0.445	0.138	8.345
290	CDC/CUE	385828	6.0	6.0	2	M	41	0.220	0.165	9.977
291	CDC/CUE	462968	8.0	12.5	2	N	84	0.392	0.124	22.370
292	CDC/CUE	482936	6.8	10.8	2	N	82	0.265	0.190	24.677
293	CDC/CUE	462859	6.8	10.8	2	N	40	0.245	0.179	23.178
294	CDC/CUE	405219	6.8	10.8	2	N	82	0.245	0.222	28.825
295	CDC/CUE	405327	9.0	8.0	2	K	37	0.175	0.083	10.545
296	CDC/CUE	453161	9.0	8.0	2	K	56	0.271	0.127	16.144
297	CDC/CUE	450559	9.0	8.0	2	K	38	0.151	0.197	25.164
298	CDC/CUE	428011	7.5	8.0	2	K	70	0.181	0.055	5.775
299	CDC/CUE	453180	7.5	8.0	2	K	76	0.237	0.166	17.437
300	CDC/CUE	EP1208	7.0	11.0	2	N	30	0.316	0.040	5.437
301	CDC/CUE	454073	6.0	5.2	2	M	43	0.242	0.557	28.795
302	CDC/CUE	409868	6.0	6.0	2	K	69	0.230	0.388	23.444
303	CDC/CUE	454070	6.0	5.2	2	M	25	0.182	0.265	13.700
304	CDC/CUE	385993	5.2	6.0	2	M	42	0.195	0.086	4.464
305	CDC/CUE	385540	5.2	6.0	2	M	37	0.227	0.311	16.076
306	CDC/CUE	405104	6.0	6.0	2	K	52	0.342	0.839	50.749
307	CDC/CUE	385995	5.2	6.0	2	M	37	0.340	0.370	19.104
308	CDC/CUE	454066	5.2	6.0	2	M	18	0.239	0.358	18.517
309	CDC/CUE	385956	5.2	6.0	2	M	31	0.242	0.117	6.067
310	CDC/CUE	385934	5.2	6.0	2	M	38	0.200	0.270	13.983
311	CDC/CUE	405114	6.0	6.0	2	K	52	0.475	0.658	39.827
312	CDC/CUE	405766	6.0	6.0	2	K	30	0.238	0.167	10.087
313	CDC/CUE	385976	6.6	5.2	2	M	17	0.236	0.333	19.105
314	CDC/CUE	385929	5.5	3.8	2	S	21	0.539	0.284	9.362
315	CDC/CUE	385975	6.0	5.2	2	M	38	0.303	0.562	29.065

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
316	CDC/CUE	385931	5.2	3.8	2	S	30	0.542	0.334	10,350
317	CDC/CUE	385986	6.0	5.2	2	M	31	0.287	0.360	18,615
318	CDC/CUE	405134	6.0	6.0	2	K	21	0.190	0.067	4,043
319	CDC/CUE	385967	6.0	5.2	2	M	40	0.296	0.568	29,377
320	CDC/CUE	405332	6.0	6.0	2	K	5	0.056	0.012	0.717
321	CDC/CUE	409156	10.5	8.0	2	T		0.317	0.075	11,301
322	CDC/CUE	453179	7.5	8.0	2	K	58	0.265	0.051	5,349
323	CDC/CUE	453161	8.8	8.0	2	K	66	0.349	0.518	64,527
324	CDC/CUE	405805	7.0	11.0	2	N	94	0.262	0.243	33,129
325	CDC/CUE	462835	7.0	11.0	2	N	86	0.232	0.178	24,291
326	CDC/CUE	405806	7.0	11.0	2	N	74	0.291	0.277	37,819
327	CDC/CUE	385847	5.8	5.2	2	M	28	0.346	0.299	14,883
328	CDC/CUE	385928	5.5	3.8	2	S	23	0.499	0.196	6,468
329	CDC/CUE	385530	7.0	5.2	2	M	29	0.349	0.682	41,665
330	CDC/CUE	385895	5.5	3.8	2	S	14	0.419	0.104	3,425
331	CDC/CUE	462969	8.0	11.0	2	N	23	0.323	0.031	4,931
332	CDC/CUE	385056	5.0	10.0	2	T		0.362	0.546	46,713
333	CDC/CUE	385154	8.0	10.0	2	T		0.268	0.101	14,331
334	CDC/CUE	462977	6.8	11.0	2	N	97	0.413	0.389	51,462
335	CDC/CUE	462278	6.8	11.0	2	N	95	0.265	0.238	31,526
336	CDC/CUE	405466	7.5	7.8	2	K	54	0.133	0.143	14,617
337	CDC/CUE	405777	6.0	5.2	2	M	32	0.220	0.401	20,716
338	CDC/CUE	385982	6.0	5.2	2	M	37	0.160	0.161	8,318
339	CDC/CUE	385930	5.2	3.8	2	S	20	0.613	0.284	8,797
340	CDC/CUE	385987	6.0	5.2	2	M	35	0.278	0.458	23,671
341	CDC/CUE	450687	6.0	6.0	2	K	15	0.319	0.066	4,012
342	CDC/CUE	451592	6.0	5.2	2	M	24	0.429	0.549	28,407
343	CDC/CUE	450288	6.5	3.8	2	L	15	0.304	0.717	28,395
344	CDC/CUE	451591	6.0	5.2	2	M	28	0.309	0.430	22,247
345	CDC/CUE	451593	6.0	5.2	2	M	16	0.333	0.567	29,335
346	CDC/CUE	450270	6.0	5.2	2	M	29	0.207	0.292	15,075
347	CDC/CUE	450284	6.0	5.2	2	M	37	0.417	0.611	31,602
348	CDC/CUE	450353	3.0	3.6	2	C	4	0.470	0.730	11,314
349	CDC/CUE	450378	6.5	3.8	2	L	26	0.247	0.605	23,957
350	CDC/CUE	451208	6.0	5.2	2	M	16	0.208	0.112	5,790
351	CDC/CUE	405257	5.5	3.5	2	E	47	0.432	0.705	21,161
352	CDC/CUE	409606	5.5	3.5	2	E	28	0.516	0.772	23,170
353	CDC/CUE	405320	5.5	3.5	2	E	24	0.353	0.466	13,979
354	CDC/CUE	405256	5.5	3.5	2	E	39	0.265	0.545	16,356
355	CDC/CUE	405498	5.5	3.5	2	E	12	0.367	0.413	12,383

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
356	CDC/CUE	405319	5.5	3.5	2	E	20	0.344	0.089	2.663
357	CDC/CUE	405318	5.5	3.5	2	E	42	0.491	0.840	25.208
358	CDC/CUE	450225	5.5	3.5	2	E	45	0.209	0.345	10.350
359	CDC/CUE	705000	4.0	4.5	2	G	28	0.489	0.255	7.131
360	CDC/CUE	ROUND	2.0	2.0	2	T		0.898	0.941	4.234
361	CDC/CUE	CHARGEN	7.4	11.5	2	N		0.863	0.132	20.110

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
362	VID MAP	3A1/4A1	4.0	6.0	2	G	15	0.383	0.114	4.371
363	VID MAP	1A10A3	4.0	6.0	2	J	13	0.293	0.074	2.861
364	VID MAP	2A1/6AU	4.0	6.0	2	G	11	0.386	0.071	2.736
365	VID MAP	1A10A1	4.0	6.0	2	J	8	0.616	0.248	9.529
366	VID MAP	1A9A6	7.4	8.0	2	U	33	0.708	0.593	61.341
367	VID MAP	A4/5/11	7.4	8.0	2	U	27	0.209	0.320	33.156
368	VID MAP	A9	7.4	8.0	2	U	42	0.125	0.064	6.587
369	VID MAP	A1/A2	7.4	8.0	2	U	7	0.578	0.128	13.254
370	VID MAP	AP/DDA	7.4	8.0	2	U	28	0.213	0.331	34.271
371	VID MAP	A3/A10	7.4	8.0	2	U	13	0.166	0.096	9.941
372	VID MAP	1A914	7.4	8.0	2	U	43	0.095	0.016	1.617
373	VID MAP	1A9A7	7.4	8.0	2	U	17	0.218	0.094	9.779
374	VID MAP	1A9A8	7.4	8.0	2	U	14	0.284	0.051	5.323
375	VID MAP	A1-A12	8.0	6.8	2	U	29	0.295	0.191	18.089
376	VID MAP	A13	8.0	6.8	2	U	19	0.097	0.007	0.692
377	VID MAP	693411	8.5	4.9	2	A	25	0.478	0.211	14.836
378	VID MAP	693414	8.5	4.9	2	A	18	0.595	0.186	13.118
379	VID MAP	693417	8.5	4.9	2	A	8	0.607	0.231	16.281
380	VID MAP	693420	8.5	4.9	2	A	21	0.602	0.213	15.019
381	VID MAP	693423	8.5	4.9	2	A	10	0.610	0.205	14.402
382	VID MAP	693426	8.5	4.9	2	A	29	0.594	0.397	27.953
383	VID MAP	712469	8.5	4.9	2	A	25	0.398	0.139	9.790

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
384	DCPPLER	PC1	5.0	5.0	1	B	12	0.458	0.128	2.587
385	DCPPLER	PC2	5.0	5.0	1	B	13	0.457	0.183	3.700
386	DCPPLER	PC3	5.0	5.0	1	B	12	0.351	0.134	2.714
387	DCPPLER	PC4	5.0	5.0	1	B	12	0.390	0.161	3.261
388	DCPPLER	PC5	2.5	5.0	1	B	14	0.442	0.089	0.805

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
389	5-CHANN	200008	5.1	4.9	1	W	18	0.326	0.278	5.627
390	5-CHANN	200001	5.1	4.9	1	W	17	0.426	0.268	5.431
391	5-CHANN	200006	5.1	4.9	1	W	18	0.308	0.158	3.197
392	5-CHANN	200004	5.1	4.9	1	W	18	0.401	0.256	5.182
393	5-CHANN	200009	8.0	8.0	2	X	83	0.351	0.080	8.955
394	5-CHANN	200003	5.1	4.9	2	W	16	0.595	0.281	11.389
395	5-CHANN	200007	5.1	4.9	1	W	8	0.240	0.065	1.309
396	5-CHANN	200002	5.1	4.9	1	W	17	0.337	0.174	3.516
397	5-CHANN	200005	5.1	4.9	1	W	10	0.448	0.061	1.234
398	5-CHANN	524633	2.5	4.5	1	B	8	0.425	0.525	4.202
399	5-CHANN	524634	2.5	4.5	1	B	13	0.401	0.521	4.170

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
400	ASRDS-3	8113183	6.2	4.5	2	D	10	0.270	0.161	7.323
401	ASRDS-3	8113191	6.2	4.5	2	D	7	0.154	0.010	0.473
402	ASRDS-3	8113195	6.2	4.5	2	D	13	0.226	0.032	1.449
403	ASRDS-3	8113207	6.2	4.5	2	D	32	0.139	0.168	7.646
404	ASRDS-3	8113211	6.2	4.5	2	D	8	0.180	0.219	9.966
405	ASRDS-3	8113215	6.2	4.5	2	D	37	0.252	0.557	25.401
406	ASRDS-3	8113219	6.2	4.5	2	D	24	0.517	0.208	9.465
407	ASRDS-3	8113223	6.2	4.5	2	D	30	0.229	0.446	20.339
408	ASRDS-3	8113227	6.2	4.5	2	D	12	0.420	0.883	40.253
409	ASRDS-3	8113243	6.2	4.5	2	D	9	0.333	0.111	5.062
410	ASRDS-3	8113263	6.2	4.5	2	D	23	0.446	0.494	22.541
411	ASRDS-3	8113267	6.2	4.5	2	D	9	0.439	0.183	8.327
412	ASRDS-3	8113420	6.2	4.5	2	D	14	0.419	0.105	4.787
413	ASRDS-3	8113428	6.2	4.5	2	D	7	0.577	0.323	14.744
414	ASRDS-3	8113439	6.2	4.5	2	D	18	0.433	0.220	10.050
415	ASRDS-3	8114385	6.2	4.5	2	D	7	0.312	0.372	16.965
416	ASRDS-3	8114389	6.2	4.5	2	D	11	0.355	0.068	3.110
417	ASRDS-3	8114393	6.2	4.5	2	D	11	0.175	0.026	1.193
418	ASRDS-3	8114401	6.2	4.5	2	D	13	0.346	0.592	26.978
419	ASRDS-3	8114405	6.2	4.5	2	D	6	0.217	0.280	12.750
420	ASRDS-3	IND DOG	6.2	4.5	2	D	17	0.319	0.103	4.705

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
422	BRITE-2	A1	6.1	9.0	2	S	29	0.471	0.100	9.528
423	BRITE-2	A2	6.1	9.0	2	S	32	0.540	0.144	13.706
424	BRITE-2	A5	6.1	9.0	2	S	26	0.607	0.172	16.387
425	BRITE-2	A6	6.1	9.0	2	S	31	0.533	0.120	11.454
426	BRITE-2	306455	10.0	4.0	2	W	16	0.297	0.409	27.211
427	BRITE-2	504856	7.3	4.0	2	W	8	0.304	0.065	3.078
428	BRITE-2	504858	7.3	4.0	2	W	16	0.413	0.083	3.936
429	BRITE-2	504863	7.3	4.0	2	W	14	0.215	0.028	1.348
430	BRITE-2	506451	10.0	4.0	2	W	17	0.494	0.678	45.077
431	BRITE-2	0928900	6.1	9.0	2	S	33	0.616	0.321	30.579
432	BRITE-2	8114137	6.3	4.5	2	D	12	0.417	0.102	4.730
433	BRITE-2	8114141	6.3	4.5	2	D	12	0.420	0.134	6.231
434	BRITE-2	8114145	6.3	4.5	2	D	24	0.594	0.225	10.424
435	BRITE-2	8114149	6.3	4.5	2	D	20	0.575	0.234	10.845
436	BRITE-2	8114153	6.3	4.5	2	D	14	0.345	0.341	15.821
437	BRITE-2	8114157	6.3	4.5	2	D	30	0.633	0.262	12.174
438	BRITE-2	8114161	6.3	4.5	2	D	18	0.709	0.294	13.654
439	BRITE-2	8114165	6.3	4.5	2	D	16	0.528	0.215	9.988
440	BRITE-2	8114169	6.3	4.5	2	D	11	0.386	0.748	34.701
441	BRITE-2	8114173	6.3	4.5	2	D	9	0.422	0.138	6.382
442	BRITE-2	8114177	6.3	4.5	2	D	9	0.571	0.233	10.815
443	BRITE-2	8114181	6.3	4.5	2	D	11	0.454	0.546	25.320
444	BRITE-2	8114185	6.3	4.5	2	D	22	0.507	0.095	4.387
445	BRITE-2	8114189	6.3	4.5	2	D	6	0.398	0.046	2.147
446	BRITE-2	8114193	3.8	4.5	2	D	12	0.530	0.105	2.771
447	BRITE-2	8114201	6.3	4.5	2	D	10	0.305	0.032	1.507
448	BRITE-2	8114205	6.3	4.5	2	D	14	0.453	0.079	3.666
449	BRITE-2	8114209	6.3	4.5	2	D	15	0.180	0.019	0.860
450	BRITE-2	8114213	6.3	4.5	2	D	9	0.254	0.072	3.337
451	BRITE-2	8114217	6.3	4.5	2	D	8	0.409	0.142	6.567
452	BRITE-2	8114276	6.3	4.5	2	D	10	0.265	0.305	14.162
453	BRITE-2	VIDEO	10.0	4.0	2	W	17	0.723	0.383	25.497

SEQ NO.	EQPMT TITLE	ASS.Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
457	BLEC	8003017	4.2	4.0	2	Z	12	0.604	0.203	5.266
458	BLEC	8005330	1.7	7.0	2	T		0.685	3.170	49.444
459	BLEC	8115023	6.4	4.6	2	D	10	0.193	0.310	14.984
460	BLEC	8115054	6.6	10.0	2	D	28	0.357	0.632	73.286
461	BLEC	8115089	6.4	6.8	2	O	58	0.150	0.118	8.740
462	BLEC	8115097	6.4	6.8	2	O	26	0.122	0.065	4.806
463	BLEC	8115102	6.4	4.6	2	D	29	0.156	0.255	12.328
464	BLEC	8115110	6.4	6.8	2	O	33	0.201	0.176	13.083
465	BLEC	8115141	14.0	7.8	2	Y	43	0.342	0.351	69.119
466	BLEC	8115162	4.2	4.0	1	B	9	0.550	0.503	6.515
467	BLEC	8115272	4.2	4.0	2	B	13	0.710	0.416	10.774
468	BLEC	8115301	6.6	10.2	2	O	63	0.150	0.210	24.886
469	BLEC	8115323	8.0	8.0	2	Y	30	0.259	0.498	56.066
470	BLEC	8115366	4.2	4.0	1	P	6	0.423	0.313	4.053
471	BLEC	DECODER	1.7	8.0	2	T		0.440	0.667	12.000
472	BLEC	PHASECO	1.7	8.0	2	T		0.550	0.840	15.125

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
476	ARTSIII	A42	6.0	8.0	2	U	37	0.267	0.588	48.536
477	ARTSIII	A24	6.0	8.0	2	U	46	0.421	0.367	30.260
478	ARTSIII	A23	6.0	8.0	2	U	26	0.401	0.364	30.034
479	ARTSIII	A21-2	6.0	8.0	2	U	41	0.173	0.238	19.667
480	ARTSIII	A20-2	6.0	8.0	2	U	40	0.181	0.247	20.411
481	ARTSIII	A20/1-1	6.0	8.0	2	U	43	0.448	0.299	24.662
482	ARTSIII	A19	6.0	8.0	2	U	42	0.178	0.233	19.252
483	ARTSIII	A18	6.0	8.0	2	U	43	0.140	0.148	12.209
484	ARTSIII	A17-2	6.0	8.0	2	U	27	0.476	0.557	45.927
485	ARTSIII	A17-1	6.0	8.0	2	U	47	0.109	0.098	8.096
486	ARTSIII	A16	6.0	8.0	2	U	44	0.241	0.438	36.120
487	ARTSIII	A15	6.0	8.0	2	U	40	0.195	0.321	26.489
488	ARTSIII	A14-2	6.0	8.0	2	U	37	0.194	0.257	21.232
489	ARTSIII	A13-2	6.0	8.0	2	U	44	0.155	0.177	14.580
490	ARTSIII	A13-1	6.0	8.0	2	U	47	0.400	0.968	79.884
491	ARTSIII	A12-3	6.0	8.0	2	U	41	0.170	0.311	25.664
492	ARTSIII	A12-2	6.0	8.0	2	U	46	0.177	0.230	18.995
493	ARTSIII	A11-1	6.0	8.0	2	U	45	0.162	0.196	16.140
494	ARTSIII	A14-1	6.0	8.0	2	U	22	0.132	0.118	9.764
495	ARTSIII	A10-2	6.0	8.0	2	U	39	0.298	0.626	51.680
496	ARTSIII	A8	6.0	8.0	2	U	16	0.258	0.381	31.443
497	ARTSIII	A7-2	6.0	8.0	2	U	9	0.196	0.235	19.401
498	ARTSIII	A7-1	6.0	8.0	2	U	43	0.212	0.344	28.421
499	ARTSIII	A6-2	6.0	8.0	2	U	16	0.245	0.134	11.064
500	ARTSIII	A5-3	6.0	8.0	2	U	41	0.354	0.458	37.756
501	ARTSIII	A5-2	6.0	8.0	2	U	45	0.315	0.454	37.426
502	ARTSIII	A4/A6-1	6.0	8.0	2	U	29	0.230	0.356	29.401
503	ARTSIII	A3	6.0	8.0	2	U	47	0.294	0.675	55.674
504	ARTSIII	A3	6.0	8.0	2	U	13	0.196	0.226	18.622
505	ARTSIII	MSN46	6.0	8.0	2	U	29	0.351	0.423	34.894
506	ARTSIII	MSN58	6.0	8.0	2	U	30	0.445	0.683	56.329
507	ARTSIII	MSN204	6.0	8.0	2	U	38	0.347	0.472	38.975
508	ARTSIII	6866521	6.0	8.0	2	U	46	0.536	0.893	73.650
509	ARTSIII	6866852	6.0	8.0	2	U	45	0.277	0.591	48.718
510	ARTSIII	6867061	6.0	8.0	2	U	38	0.318	0.756	62.343
511	ARTSIII	A2	6.0	8.0	3	U	39	0.378	0.375	46.397
512	ARTSIII	750020	3.0	3.2	2	I	56	0.357	0.710	9.586
513	ARTSIII	750140	3.0	3.2	2	I	56	0.372	0.520	7.020
514	ARTSIII	750120	3.0	3.2	2	I	56	0.354	0.800	10.794
515	ARTSIII	7500110	3.0	3.2	2	I	56	0.209	0.569	7.678

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPUTED: COMPLEXITY	COMPUTED: MAGNITUDE
526	ARTSIII	750150	3.0	3.2	2	I	56	0.452	0.780	10.524
527	ARTSIII	750050	5.0	3.0	2	I	42	0.125	0.026	0.583
528	ARTSIII	750170	3.0	3.2	2	I	56	0.262	0.227	3.070
529	ARTSIII	750350	3.0	3.2	2	I	56	0.452	0.612	8.269
531	ARTSIII	750990	3.0	3.2	2	I	18	0.656	0.176	2.379
533	ARTSIII	751245	3.0	3.2	3	I	31	0.556	0.956	19.349
534	ARTSIII	751230	3.0	3.2	3	I	56	0.687	0.669	13.545
535	ARTSIII	750030	3.0	3.2	2	I	36	0.182	0.168	2.271
536	ARTSIII	750080	3.0	3.2	3	I	56	0.603	0.970	19.644
537	ARTSIII	751295	3.0	3.2	3	I	56	0.378	0.604	12.236
538	ARTSIII	751275	3.0	3.2	2	I	56	0.404	0.444	5.989
539	ARTSIII	751325	3.0	3.2	3	I	26	0.772	0.591	11.962
540	ARTSIII	751320	3.0	3.2	3	I	15	0.729	0.447	9.046
541	ARTSIII	751315	3.0	3.2	2	I	56	0.182	0.217	2.924
542	ARTSIII	751310	3.0	3.2	2	I	56	0.428	0.429	5.794
545	ARTSIII	751220	3.0	3.2	2	I	56	0.209	0.622	8.402
546	ARTSIII	751225	3.0	3.2	2	I	56	0.446	0.737	9.943
549	ARTSIII	750490	3.0	3.2	2	I	56	0.345	0.342	4.617
553	ARTSIII	750300	3.0	3.2	2	I	21	0.652	0.478	6.456
555	ARTSIII	F21	5.4	6.8	2	0	50	0.101	0.044	2.692
556	ARTSIII	INV-1	5.4	6.8	2	0	50	0.072	0.027	1.668
557	ARTSIII	G22-1	5.4	6.8	2	0	50	0.072	0.027	1.668
558	ARTSIII	REG-1	5.4	6.8	2	0	50	0.303	0.374	23.088
559	ARTSIII	SRL-1	5.4	6.8	2	0	50	0.272	0.307	18.928
560	ARTSIII	GB1	5.4	6.8	2	0	50	0.091	0.085	5.233
561	ARTSIII	G2A-1	5.4	6.8	2	0	50	0.082	0.070	4.325
562	ARTSIII	G21	5.4	6.8	2	0	50	0.062	0.045	2.770
563	ARTSIII	RO-1	5.4	6.8	2	0	34	0.259	0.374	23.109
564	ARTSIII	GA1	5.4	6.8	2	0	50	0.062	0.045	2.770
565	ARTSIII	DEC-1	5.4	6.8	2	0	50	0.293	0.320	19.763
566	ARTSIII	CTR-1	5.4	6.8	2	0	50	0.243	0.243	15.011
567	ARTSIII	CMP	5.4	6.8	2	0	50	0.210	0.193	11.910
568	ARTSIII	BO-1	5.4	6.8	2	0	41	0.318	0.363	22.401
569	ARTSIII	SRS-1	5.4	6.8	2	0	50	0.323	0.462	28.525
570	ARTSIII	RDS-1	5.4	6.8	2	0	38	0.360	0.306	18.894
572	ARTSIII	IND	5.4	6.8	2	0	48	0.197	0.068	4.171
574	ARTSIII	SW	5.4	6.8	2	0	50	0.204	0.046	2.842
575	ARTSIII	BQ2-1	5.4	6.8	2	0	12	0.303	0.201	12.406

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
576	ARTSIII	BQ1	5.4	6.8	2	0	11	0.363	0.134	8.286
577	ARTSIII	RD4	5.4	6.8	2	0	36	0.150	0.022	1.376
578	ARTSIII	326523	4.1	5.7	2	0	35	0.583	0.928	34.762
579	ARTSIII	326509	4.1	5.7	2	0	33	0.281	0.294	11.013
580	ARTSIII	326520	4.1	5.7	2	0	34	0.540	0.926	34.669
581	ARTSIII	326521	4.1	5.7	2	0	8	0.373	0.462	17.279
582	ARTSIII	326526	4.1	5.7	2	0	35	0.499	0.548	20.519
583	ARTSIII	326530	4.1	5.7	1	0	32	0.494	0.785	14.704
584	ARTSIII	326532	4.1	5.7	2	0	27	0.557	0.760	28.437
585	ARTSIII	326536	4.1	5.7	2	0	32	0.540	0.739	27.668
586	ARTSIII	326537	4.1	5.7	2	0	36	0.451	0.659	24.665
587	ARTSIII	DCM-1	6.0	6.0	2	0	69	0.649	0.559	33.820
588	ARTSIII	ADS	6.0	6.0	2	0	64	0.525	0.981	59.335
589	ARTSIII	CSM	6.0	6.0	2	0	55	0.558	0.164	9.920
590	ARTSIII	DCM	6.0	6.0	2	0	69	0.629	0.800	48.383
591	ARTSIII	DCM-2	6.0	6.0	2	0	69	0.613	0.811	49.040
592	ARTSIII	MTC	6.0	6.0	2	0	70	0.468	0.763	46.135
593	ARTSIII	UCM	6.0	6.0	2	0	68	0.282	0.348	21.082
594	ARTSIII	A1-1	4.4	4.0	2	J	10	0.545	0.208	5.690
595	ARTSIII	686572	4.4	4.0	2	J	9	0.618	0.194	5.292
596	ARTSIII	6865711	4.4	4.0	2	J	8	0.464	0.177	4.831
597	ARTSIII	A11-2	4.4	4.0	2	J	14	0.558	0.435	11.883
598	ARTSIII	686577	4.4	4.0	2	J	9	0.665	0.237	6.465
599	ARTSIII	7117500	3.0	5.0	2	I	44	0.628	0.365	8.205
601	ARTSIII	A3	4.0	8.0	2	U	31	0.566	0.186	9.772
602	ARTSIII	A1-2	5.8	5.0	2	A	19	0.786	0.283	13.517
603	ARTSIII	4334 04C	11.0	6.0	2	D	20	0.285	0.028	3.196
605	ARTSIII	32235	4.5	4.0	1	2	17	0.467	0.305	4.266
606	ARTSIII	326510	3.5	5.1	2	C	12	0.194	0.212	5.860
607	ARTSIII	DISRECV	8.6	14.2	2	3	146	0.198	0.371	82.399
608	ARTSIII	EC149	4.0	2.5	1	B	10	0.551	0.577	4.037
609	ARTSIII	XZ4 05	4.0	2.5	1	C	14	0.526	0.395	2.766
610	ARTSIII	A5-1	3.2	3.8	2	A	25	0.456	0.870	15.506
611	ARTSIII	SPECIAL	6.5	5.0	2	I	34	0.633	0.472	25.483
612	ARTSIII	2050	2.2	5.3	2	C	12	0.350	0.484	7.896
613	ARTSIII	2330	2.2	5.3	2	C	14	0.374	0.566	9.243
614	ARTSIII	2030	2.2	5.3	2	C	14	0.751	0.996	16.249
615	ARTSIII	2880	2.2	5.3	2	C	7	0.864	0.844	13.771
616	ARTSIII	2270	2.2	5.3	2	C	18	0.629	0.719	11.740
617	ARTSIII	2010	2.2	5.3	2	D	13	0.752	0.507	8.274
618	ARTSIII	2020	2.2	5.3	2	D	21	0.706	0.374	6.104
619	ARTSIII	2260	2.2	5.3	2	C	14	0.912	0.401	6.550
620	ARTSIII	2140	2.2	5.3	2	C	21	0.885	0.319	5.208

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
621	ARTSIII	2060	2.2	5.3	2	C	20	0.593	0.654	10.679
622	ARTSIII	2040	2.2	5.3	2	C	17	0.542	0.859	14.027
623	ARTSIII	2130	2.2	5.3	2	C	18	0.288	0.424	6.918
624	ARTSIII	2180	2.2	5.3	2	C	13	0.855	0.831	13.564
625	ARTSIII	2230	2.2	5.3	2	C	13	0.327	0.460	7.505
626	ARTSIII	2320	2.2	5.3	2	C	6	0.502	0.570	9.296
627	ARTSIII	2150	2.2	5.3	2	C	9	0.716	0.978	15.954

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	WDTH	# L	INOUT C	#TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
629	REDE-6	WDF1	6.0	7.0	2	S	12	0.616	0.153	10.938
630	REDE-6	WVP1	6.0	7.0	2	S	29	0.606	0.339	24.260
631	REDE-6	WIR1	6.0	7.0	2	S	26	0.478	0.191	13.634
632	REDE-6	WVP2	6.0	7.0	2	S	27	0.529	0.252	18.002
633	REDE-6	WSG1	6.0	7.0	2	S	17	0.409	0.107	7.632
634	REDE-6	SSC1	6.0	7.0	2	S	11	0.481	0.134	9.589
635	REDE-6	RDF1	6.0	7.0	2	S	11	0.708	0.213	15.248
636	REDE-6	WDA1	6.0	7.0	2	S	13	0.674	0.097	6.957
637	REDE-6	SPM1	6.0	7.0	2	S	20	0.422	0.125	8.912
638	REDE-6	SFA1	6.0	7.0	2	S	22	0.583	0.113	8.114
639	REDE-6	SRD1	6.0	7.0	2	S	8	0.676	0.126	8.985
640	REDE-6	RVD1	6.0	7.0	2	S	13	0.792	0.185	13.202
641	REDE-6	RMG1	6.0	7.0	2	S	26	0.497	0.434	31.041
642	REDE-6	RHD1	6.0	7.0	2	S	13	0.716	0.195	13.938
643	REDE-6	8903HB2	12.4	9.5	2	T		0.433	0.031	6.533
644	REDE-6	8937127	12.0	9.5	2	T		0.410	0.162	33.599
645	REDE-6	8937128	12.0	9.5	2	T		0.780	0.153	31.681

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
646	MARKIB	KEYER	6.8	5.8	2	A	10	0.338	0.029	1.931
647	MARKIB	DCC 2-7	6.8	5.8	2	A	19	0.613	0.106	7.105
648	MARKIB	MONITER	6.8	5.8	2	A	6	0.506	0.255	17.052
649	MARKIB	IF/AGC	6.8	5.8	2	A	11	0.389	0.096	6.414
650	MARKIB	ALARM	6.8	5.8	2	A	14	0.378	0.082	5.499
651	MARKIB	A1A3AFC	6.2	4.4	2	G	30	0.231	0.061	2.718
652	MARKIB	A1A2MOD	6.2	4.4	2	G	31	0.318	0.097	4.320
653	MARKIB	A1A1MON	6.2	4.4	2	G	33	0.462	0.200	8.899
654	MARKIB	MIXERIF	6.2	4.4	2	G	30	0.194	0.043	1.925
655	MARKIB	A2A1	5.7	5.0	2	3	28	0.692	0.863	40.377
656	MARKIB	BEACON	10.1	5.8	2	5	24	0.442	0.672	68.375
657	MARKIB	1A1A2	10.1	5.8	2	Z	13	0.309	0.054	5.509
658	MARKIB	A6A1	7.0	6.0	2	Q	8	0.515	0.290	20.758
659	MARKIB	A6A2	3.0	6.0	2	Q	13	0.521	0.190	5.220

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
661	WFMU	706499	2.5	8.8	2	6	128	0.540	0.798	26.509
662	WFMU	706540	2.5	4.0	2	E	30	0.369	0.454	6.354
663	WFMU	706526	2.5	4.0	2	E	59	0.283	0.568	7.949
664	WFMU	706530	2.5	4.0	2	E	60	0.283	0.581	8.138
665	WFMU	706528	2.5	4.0	2	E	60	0.240	0.446	6.240
666	WFMU	706551	2.5	4.0	2	E	23	0.754	0.610	8.539
667	WFMU	706549	2.5	4.0	2	E	44	0.363	0.703	9.838
668	WFMU	706607	2.5	4.0	2	E	14	0.266	0.248	3.477
669	WFMU	706542	2.5	4.0	2	E	55	0.237	0.117	1.637
670	WFMU	706534	2.5	4.0	2	E	19	0.614	0.492	6.883
671	WFMU	706532	2.5	4.0	2	E	14	0.400	0.249	3.485
672	WFMU	706538	2.5	4.0	2	E	16	0.691	0.774	10.841
673	WFMU	706536	2.5	4.0	2	E	17	0.686	0.661	9.260
674	WFMU	706544	2.5	4.0	2	E	20	0.257	0.060	0.844
675	WFMU	706546	2.5	4.0	2	E	60	0.520	0.830	11.619

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	# C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
676	DIGITIZ	SRS	5.5	6.0	2	0	50	0.275	0.175	9,640
677	DIGITIZ	DEC	5.5	6.0	2	0	49	0.286	0.187	10,276
678	DIGITIZ	BFC	5.5	6.0	2	0	41	0.332	0.195	10,746
679	DIGITIZ	BO	5.5	6.0	2	0	26	0.266	0.144	7,910
680	DIGITIZ	ADDER	5.5	6.0	2	0	50	0.297	0.219	12.062
681	DIGITIZ	BU	5.5	6.0	2	0	50	0.127	0.087	4,774
682	DIGITIZ	REG	5.5	6.0	2	0	50	0.196	0.102	5,594
683	DIGITIZ	CMP	5.5	6.0	2	0	50	0.297	0.202	11,134
684	DIGITIZ	SRC	5.5	6.0	2	0	50	0.297	0.202	11.134
685	DIGITIZ	INV	5.5	6.0	2	0	50	0.066	0.030	1,673
686	DIGITIZ	FGM	5.5	6.0	2	0	32	0.099	0.044	2,393
687	DIGITIZ	F21	5.5	6.0	2	0	50	0.099	0.058	3,165
688	DIGITIZ	HA	5.5	6.0	2	0	11	0.066	0.018	0.967
689	DIGITIZ	G2A	5.5	6.0	2	0	50	0.077	0.039	2.120
690	DIGITIZ	EDT	5.5	6.0	2	0	50	0.250	0.147	8,092
691	DIGITIZ	DM	5.5	6.0	2	0	43	0.364	0.261	14,328
692	DIGITIZ	CUD	5.5	6.0	2	0	50	0.297	0.202	11,134
693	DIGITIZ	WS	5.5	6.0	2	0	49	0.012	0.001	0.040
694	DIGITIZ	C23	5.5	6.0	2	0	50	0.127	0.080	4.376
695	DIGITIZ	TL	5.5	6.0	2	0	50	0.187	0.157	8,647
696	DIGITIZ	CTR	5.5	6.0	2	0	50	0.236	0.133	7,292
697	DIGITIZ	C27	5.5	6.0	2	0	50	0.099	0.053	2,901
698	DIGITIZ	SRL	5.5	6.0	2	0	50	0.272	0.172	9,458
699	DIGITIZ	R6021	5.5	6.0	2	0	11	0.023	0.003	0.148
700	DIGITIZ	G22	5.5	6.0	2	0	50	0.066	0.030	1,673
701	DIGITIZ	G21	5.5	6.0	2	0	50	0.055	0.023	1,276
702	DIGITIZ	GB1	5.5	6.0	2	0	50	0.088	0.048	2,617
703	DIGITIZ	GA1	5.5	6.0	2	0	50	0.055	0.023	1,276
704	DIGITIZ	IRP	5.5	6.0	2	0	50	0.207	0.112	6.170
705	DIGITIZ	MLD	5.5	6.0	2	0	41	0.176	0.078	4,312
706	DIGITIZ	OPT	5.5	6.0	2	0	48	0.190	0.087	4,811
707	DIGITIZ	SYN	5.5	6.0	2	0	40	0.231	0.128	7,052
708	DIGITIZ	ST	5.5	6.0	2	0	49	0.137	0.011	0,624
709	DIGITIZ	DL	5.5	6.0	2	0	50	0.841	0.395	21,722
710	DIGITIZ	DC2	5.5	6.0	2	0	16	0.327	0.052	2,874
711	DIGITIZ	BQ2	5.5	6.0	2	0	12	0.275	0.094	5,172
712	DIGITIZ	BQ1	5.5	6.0	2	0	11	0.361	0.053	2,938
713	DIGITIZ	BAM	5.5	6.0	2	0	15	0.587	0.193	10,613
714	DIGITIZ	DAR	5.5	6.0	2	0	8	0.196	0.032	1,778
715	DIGITIZ	CCS	5.5	6.0	2	0	26	0.472	0.169	9,319

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	# C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
716	DIGITIZ	RD1	5.5	6.0	2	0	25	0.302	0.103	5,682
717	DIGITIZ	LPD	5.5	6.0	2	0	46	0.111	0.020	1,096
718	DIGITIZ	IND	5.5	6.0	2	0	48	0.512	0.219	12,026
719	DIGITIZ	EG	5.5	6.0	2	0	11	0.308	0.129	7,121
720	DIGITIZ	XYS	5.5	6.0	2	0	42	0.584	0.763	41,984
721	DIGITIZ	V_R	5.5	6.0	2	0	46	0.595	0.171	9,392
722	DIGITIZ	DIG	5.5	6.0	2	0	43	0.527	0.377	20,747
723	DIGITIZ	DAS	5.5	6.0	2	0	29	0.400	0.246	13,509
724	DIGITIZ	RO	5.5	6.0	2	0	34	0.425	0.411	22,615
725	DIGITIZ	RA	5.5	6.0	2	0	17	0.210	0.053	2,908
726	DIGITIZ	SQ	5.5	6.0	2	0	24	0.421	0.218	12,008
727	DIGITIZ	RD2	5.5	6.0	2	0	36	0.285	0.107	5,864
728	DIGITIZ	RD3	5.5	6.0	2	0	18	0.393	0.102	5,600
729	DIGITIZ	SW	5.5	6.0	2	0	50	0.229	0.095	5,227
730	DIGITIZ	ID	5.5	6.0	2	0	29	0.375	0.168	9,228
731	DIGITIZ	HOS	5.5	6.0	2	0	30	0.283	0.303	16,667

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	# C	INOUT #TU	COMPUTED: DENSITY	COMPLEXITY	MAGNITUDE
732	IEM	SMS1	4.7	2.5	1	8	9	0.776	0.168	1,415
733	IEM	SMS2	4.7	2.5	1	8		0.417	0.161	1,355
734	IEM	SMS3	4.7	2.5	1	8		0.402	0.046	0.389
735	IEM	SMS4	4.7	5.2	1	8		0.418	0.103	2,032
736	IEM	SLT2	1.8	1.8	3	9		0.533	0.692	3,510
737	IEM	SLT5	3.0	7.0	2	9		0.650	0.098	3,169

SEQ NO.	EQPMT TITLE	ASS'Y NO.	BOARD LGTH"	BOARD WDTH	# L	INOUT C	INOUT #T	COMPUTED: DENSITY	COMPUTED: COMPLEXITY	COMPUTED: MAGNITUDE
741	ASR-7	651683	4.5	4.0	2	J	11	0.660	0.505	14.144
742	ASR-7	651686	4.5	4.0	2	J	14	0.304	0.147	4.112
743	ASR-7	651692	6.4	8.0	2	U	22	0.179	0.215	18.998
744	ASR-7	651695	6.4	8.0	2	U	39	0.442	0.446	39.467
745	ASR-7	651698	6.4	8.0	2	U	16	0.309	0.423	37.470
746	ASR-7	651701	6.4	8.0	2	U	29	0.136	0.123	10.899
747	ASR-7	651704	6.4	8.0	2	U	43	0.212	0.321	28.386
748	ASR-7	651707	6.4	8.0	2	U	19	0.428	0.661	58.486
749	ASR-7	651716	6.4	8.0	2	U	8	0.280	0.091	8.020
750	ASR-7	651719	6.4	8.0	2	U	31	0.171	0.131	11.606
751	ASR-7	651728	6.4	8.0	2	U	38	0.155	0.175	15.472
752	ASR-7	651731	6.4	8.0	2	U	35	0.196	0.255	22.591
753	ASR-7	651734	6.4	8.0	2	U	10	0.174	0.035	3.091
754	ASR-7	651737	6.4	8.0	2	U	16	0.242	0.137	12.116
755	ASR-7	651740	6.4	8.0	2	U	12	0.295	0.093	8.207
756	ASR-7	651743	6.4	8.0	2	U	13	0.431	0.522	46.177
757	ASR-7	651749	6.4	8.0	2	U	31	0.191	0.245	21.703
758	ASR-7	651833	4.5	4.0	2	J	11	0.811	0.652	18.259
759	ASR-7	651848	6.4	8.0	2	U	17	0.451	0.235	20.799
760	ASR-7	651863	6.4	8.0	2	U	14	0.504	0.466	41.200
761	ASR-7	651878	6.4	8.0	2	U	29	0.336	0.584	51.659
762	ASR-7	651904	6.4	8.0	2	U	10	0.386	0.162	14.372
763	ASR-7	651907	6.4	8.0	2	U	10	0.438	0.274	24.265
764	ASR-7	651910	6.4	8.0	2	U	11	0.427	0.238	21.065
765	ASR-7	651938	6.4	8.0	2	U	13	0.368	0.116	10.260
766	ASR-7	669430	6.4	8.0	2	U	22	0.166	0.132	11.640
767	ASR-7	669439	6.4	8.0	2	U	10	0.337	0.158	13.946
768	ASR-7	669442	6.4	8.0	2	U	7	0.273	0.061	5.357
769	ASR-7	669444	6.4	8.0	2	U	17	0.202	0.230	20.341
770	ASR-7	669445	6.4	8.0	2	U	22	0.569	0.668	59.080
771	ASR-7	669448	6.4	8.0	2	U	5	0.388	0.118	10.411
772	ASR-7	664518	6.4	8.0	1	U	5	0.221	0.027	1.195
773	ASR-7	664454	6.4	8.0	2	U	43	0.239	0.251	22.239
774	ASR-7	664457	6.4	8.0	2	U	44	0.230	0.302	26.739
775	ASR-7	664460	6.4	8.0	2	U	26	0.169	0.175	15.486
776	ASR-7	664463	6.4	8.0	2	U	5	0.402	0.126	11.189
777	ASR-7	664564	4.5	4.0	2	J	11	0.427	0.117	3.270
778	ASR-7	664707	4.5	4.0	2	J	5	0.481	0.098	2.733
779	ASR-7	707116	6.4	8.0	2	U	22	0.569	0.668	59.080