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SIGDA NEWSLETTER

SPECIAL INTEREST GROUP ON DESIGN AUTOMATION

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SIG/SIC ACTIVITIES

1) Informal technical meetings at NCC.

2) Formal meeting during National ACM meeting + DA Workshop.

3) Joint sponsorship of annual Design Automation Workshop.

4) Quarterly newsletter.

5) Panel and/or technical sessions at other National meetings.

FIELD OF INTEREST OF SIGDA MEMBERS

Theoretic, analytic, and heuristic methods for:

1) performing design tasks,

2) assisting in design tasks,

3) optimizing designs through the use of computer techniques, algorithms and programs to:

1) facilitate communications between designers and design tasks,

2) provide design documentation,

3) evaluate design through simulation,

4) control manufacturing processes.

Chairman's Letter

The ACM '76 conference was held in Houston the week of October 19. The Special Interest Area on Technology SIG's met before the conference to discuss the future role of the SIA. The other SIG's in our SIA are Mini, Micro, Graph, Arch, and Comm.

The primary item of discussion was the possibility of a once-a-year technical newsletter which would include one paper or article chosen for inclusion by the editor of each SIG in the SIA. The article could have appeared in a previous issue of the SIG newsletter or it could be previously unpublished. The intent of the newsletter would be to promote technical interchange among SIG's having a common interest--in our case, technology. The SIG newsletter editor will be polled and if the response is favorable, the first issue will appear in the spring.

I have mailed the proposed bylaw change to Luther Abel, your secretary-treasurer who is in the process of preparing a ballot which you should be receiving soon.

Thus far, no members have indicated their interest in running for a SIGDA office next year. It is critical that we field a complete set of qualified candidates for all three elected offices. If you feel that a friend or colleague would make a good officer, and would like some help in convincing, let me know; I'll be happy to talk to anyone.

Remember the Symposium on Design Automation and Microprocessors in February. We need papers and interested attendees (see the call elsewhere in this issue).

Finally, I'd like to express my appreciation to Rob Smith for his continued excellent editing work on the Newsletter. As an officer, I receive a copy of all the SIG newsletters, and I can tell you that the SIGDA Newsletter is second to none. We must all remember, though, that Rob needs help. Articles and reviews must come from the membership. How about it?!?

FROM THE EDITOR

Several people at the 13th DAC were anxious to have some "real" PCB layout problems to experiment with in research and educational environments. The (longer than expected) result starts in this issue. Many thanks to Mel Breuer and Fred Krogh for contributing to an otherwise "all Livermore" issue. Heed your Chairman's plea -- contribute to the Newsletter! Nick Matelan recently left the LLL group to return to General Dynamics (Fort Worth), so perhaps his continuing contributions can be considered "outside work" now.

I encourage you to write to Fred Krogh concerning the place (now a lack thereof) of Design Automation in the proposed classification of computer programs. I'll start the ball rolling by suggesting --

- Z4A. Mechanical
- Z4B. Architectural
- Z4C. Electrical and Electronic
  - Z4*1 Analog Design
  - Z4*2 Digital Logic Design
  - Z4*3 Signal Processing
  - Z4*4 Physical Design
  - Z4*5 Documentation
  - Z4*6 Data Bases
  - Z4*7 Design Descriptions
  - Z4*8 Testing
  - Z4*9 Design Analysis
  - Z4*10 Magnetic Circuit Design
  - Z4*11 RF Systems
  - Z4*12 Multiservice DA Systems
- Z4D. Software

Any other suggestions?

Rob.

ROB SMITH
11/12/76

INCREMENTAL PROCESSING IN DESIGN AUTOMATION[†]

by

Melvin A. Breuer[‡]

ABSTRACT

In many design automation systems a substantial amount of computation deals with processing engineering changes. It is our belief that in many cases these changes can be processed more efficiently by using specialized routines rather than by re-executing a subset of the original set of programs used to process the original set of data. We refer to the new data which includes the engineering change, as an incremental problem, and the special routines used to process this data as incremental procedures. In this note we present the basic concepts related to an incremental processing design automation system, and illustrate some incremental processing algorithms.

1. Introduction

In the field of design automation we have seen a continual evolution in the design objectives of our systems. The first systems consisted of stand alone program modules and interfacing them was usually done manually. Recently the concept of a central data base and file management system has caught on, and now program modules can be interfaced into a true design automation system. Currently, interactive systems are being developed so that computer aided design is becoming a reality. Possibly the next step will be the development of incremental processing design automation systems so that engineering changes will be handled more efficiently. The incremental processing problems in this area are numerous, and unfortunately, most of them are quite hard.

[†]This work was supported by the National Science Foundation under Grant No. ENG 74-18647.

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In Section 2 we will illustrate some miscellaneous incremental processing algorithms; in Section 3 we will formally define an incremental processing problem; and in Section 4 we will illustrate the structure of a design automation system based upon incremental processing algorithms.

2. Example Incremental Processing Problems and Some Solutions

The field of incremental processing deals with the development of a procedure (algorithm or heuristic) P^* to solve a problem $\mathcal{P}$ on data D^* where the problem has previously been solved via procedure P on data D. We assume that the data D is very similar to the data D^*, i.e., D and D^* differ by a small amount Δ called the increment. The objective is that $P^*(D^*)$† executed more efficiently than $P(D^*)$.

The term incremental processing is being used here as a generic term covering a whole class of problems, known to some by terms such as updating, engineering change, design change, error recovery, etc. As such, incremental processing is a very common problem in design automation.

Next we will give a few examples where efficient incremental processing algorithm exists.

2.1 Sorting

Consider the problem $\mathcal{P}$ of sorting n numbers. Let P be a procedure which sorts a set D of N integers. The complexity of P is $n \log n$. Assume we execute P on D to obtain the result R. Now, assume for some reason we find that one of the numbers in D was in error. The corrected set of data is denoted by D^*, where $D^*=D-e+d$ (set operation). That is e is the element in D which was incorrect, and d is the correct value of this piece of data. The sorted form of D^* could be obtained by again employing procedure P, but this again is an $n \log n$ process. It is more efficient to operate on the result R, deleting e and inserting d. Since R is sorted, each of these operations is of complexity $\log n$. We see that the incremental processing procedure P^* for this simple Δ-problem consists of the process of element insertion and deletion in ordered sets.

† The notation P(D) stands for procedure P executing with respect to input data D.

2.2 Graph Problems

In this section we will briefly illustrate two incremental processing problems dealing with graph problems. The results are due mainly to Spira and Pan [1]. We first look at the problem of minimal spanning trees. Let G be an undirected weighted graph having n nodes, and let T be a minimal spanning tree of G. Prim's [2] procedure for constructing T is of order n^2, and more specifically the number of comparison operations required to construct T in a properly programmed algorithm is between $\frac{1}{2}(n-1)(n-2)$ and $(n-1)(n-2)$.

Assume the following Δ-problem occurs. A new node is added to G along with at least two arcs connecting this new node to G, forming the graph G^*. We now desire a minimal spanning tree for G^*. It turns out that a minimal spanning tree for G^* can be found from G and T via an algorithm of order n (Theorem 3.3 [1]). Hence a substantial reduction in computation can be achieved for this incremental processing problem.

Further results related to other incremental processing problems associated with computing the minimal spanning tree for G are summarized below:

(1) If the weight of an arc in T is increased, the new minimal spanning tree can be computed via algorithms of complexity $(n/4)$ for n even and $(n^2 - 4)/4$ for n odd.

(2) If the weight of an arc not in T is decreased, then the new minimal spanning tree can be found with just $(n-1)$ comparisons.

(3) If a node is deleted from G together with all its arcs, then an algorithm to compute the new minimal spanning tree is of complexity $O(n^2)$.

The latter result (3) shows that in the worst case it is necessary to recompute the minimal spanning tree without using any of the previous results.

In summary, we see that some incremental processing problems are amenable to solutions producing a significant reduction in computation, while others are not.

2.3 Matrix Operations

Let $C = A \times B$ be the product of two square matrices which are $n \times n$. Then to compute C requires n^3 multiplications. If one element in A is changed, then the new C matrix can be computed by just n multiplications. Also, the inverse A^{-1} of A requires the evaluation of n minors of rank (n-1). However, if one element in A is changed, the new A^{-1} can be determined by calculating only one minor.

3. Formal Definition of Incremental Processing (IPc)

Let D be a set of data. A unit data increment, denoted by δ, is the smallest unit of change that can be made to D. For example, if D is a graph, a unit data increment may be the deletion of an arc, or the change of an arc weight, or the addition of a node, etc. Let Δ be a set of unit data increments. Δ is said to be a macro increment. Let D and D^* be two sets of data which differ by Δ, denoted by $\Delta = D \oplus D^*$. D and D^* are said to define a Δ-problem. Note that D^* can be obtained from D via a series of unit data increments (transformations) defined by $\delta \in \Delta$.

Let P be a procedure which, operating on a data set D, solves a problem $\mathcal{P}$. Let the result produced be R, where we write $R = P(D)$. Let D^* represent a Δ-problem derived from D. Let T be a subset of intermediate results obtained when P(D) is executed. T is said to be a trace and may consist of from all to none of the intermediate results produced by P(D). Let P^* be a procedure such that $P(D^*) = P^*(D, \Delta, R, T)$. P^* is said to be an incremental procedure for $\mathcal{P}$. P^* is said to be an efficient incremental procedure if the complexity of P^* is significantly less than that of P in solving problem $\mathcal{P}$ on data D^*.

P^* is said to be complete if it is independent of R, i.e., it does not require the results of P(D). Note that our sorting procedure P^* can in principle sort D^* without knowledge of R, i.e., using $R = \varphi$, but then it is not efficient.

P^* is said to be traceless if it is independent of T. For example our sorting algorithm does not require trace information. However, a procedure P^* based on a symbolic result from P may require a trace, namely the symbolic expression itself.

Note that the efficiency of some procedures is a function of the complexity (size) of the Δ-problem. For example, if half the data in our original sorting problem was found to be erroneous and changed, then it is probably more efficient to sort D^* using P rather than P^*.

This example illustrates that, in general, we require a decision function $f(D, D^*)$ from which we can determine whether to solve the Δ-problem using P or P^*.

In summary, we see that the field of incremental processing deals with the development of procedures P^* and the related decision functions f, trace information T required of P, and identification of allowable unit data increments δ such that Δ-problems can be handled as efficiently as possible.

Note that when one procedure processes the results of another procedure, one must be concerned with the range of δ, i.e., the structure of $R \ominus R^*$, where $R^* = P^*(D, D^*, T, R) = P(D^*)$, and $D \oplus D^* = \delta$. Finally, it is important that the decision function f_d be not too complex, since a complex decision function would detract from the overall efficiency of using P^*.

4. A Simple Incremental Processing Design Automation System

Consider the processing of data as represented by the software system in Figure 1. Here P_i is a program module, D_i its input data and R_i its results. Note that the results R_i represent the input data D_{i+1} to module P_{i+1}. Looping is allowed.

For a simple computer hardware design automation system we may have: D_1 – logic design of circuit to be built; P_1 – partitioning module used to assign IC's to cards; P_2 – placement module used to assign IC's to slot locations on a card; P_3 – element assignment module used to reassign logic functions to different IC's; P_4 – pin assignment module used to assign signal names to card pins; P_5 – routing module used to interconnect all signals on each card; P_6 – output module; and R_6 – documentation, NC tapes, masks, etc.

Assume that such a system, as depicted in Figure 1, is used in processing a design. For such an environment it is quite plausible that the data D_i may undergo numerous changes due to one of several reasons, such as an engineering error has been uncovered or a design change is desired. We label this new data D_i^*. Assuming that the original data D_1 has already been processed to completion, i.e., R_n has been computed. The question we wish to deal with is how to compute the new R_n based on the change in D_i. If D_i^* differs by only a "small amount" from D_i, then we have an incremental processing problem.

There are two ways for processing D_i^*. The first is by entering it as data to P_i. The second is to have a special incremental processing module P_i^* process D_i^*, where P_i^* has access to D_i, R_i and possibly some intermediate results from P_i, labeled T_i. If P_i^* can process D_i^* much more efficiently than can P_i, then a significant savings in computation time can be achieved. Note that an incremental change in the data D_i may or may not produce an incremental change in R_i. If it does, then the new R_i, which is actually D_{i+1}^* can again be processed by an incremental processing module P_{i+1}^* if one exists. Our new system structure is shown in Figure 2.

Here the inputs to P_i^*, shown by dashed lines, represent D_i, T_i, and R_i. The module f_i, which also has inputs D_i and D_i^*, evaluates a decision function for determining whether or not D_i^* should be processed using P_{i+1} or P_{i+1}^*.

Note that in some cases either no P_i^* exists or else for some i, the decision function may select P_i over P_i^* for processing D_i^*. In any event, once P_i processes D_i^*, the result R_i^* may be sufficiently similar to R_i such that the decision function $f_{i+1}(D_{i+1}, D_{i+1}^*)$ selects P_{i+1}^* over P_i.

After processing an incremental problem Δ, a second incremental problem Δ' may occur. Therefore, after processing the first problem one should set $D \leftarrow D^*$ and $R \leftarrow R^*$. In addition, if P^* makes use of T, then T should also be updated to reflect the effects of D^*.

In summary, we believe that by incorporating incremental processing algorithms into a design automation system substantial cost benefits can be realized. At present we are attempting to develop incremental processing procedures for some of the well known algorithms use in partitioning, placement, routing, and test generation.

References

1. P. M. Spira and A. Pan, "On finding and updating spanning trees and shortest paths," SIAM J. Computer, vol. 4, pp. 375-380, September 1975.

2. R. C. Prim, "Shortest interconnection network and some generalizations," Bell System Tech. J., vol. 36, pp. 1389-1401, 1967.

3. E. W. Dijkstra, "A note on two problems in connection with graphs," Numer. Math., vol. 1, pp. 269-271, 1959.

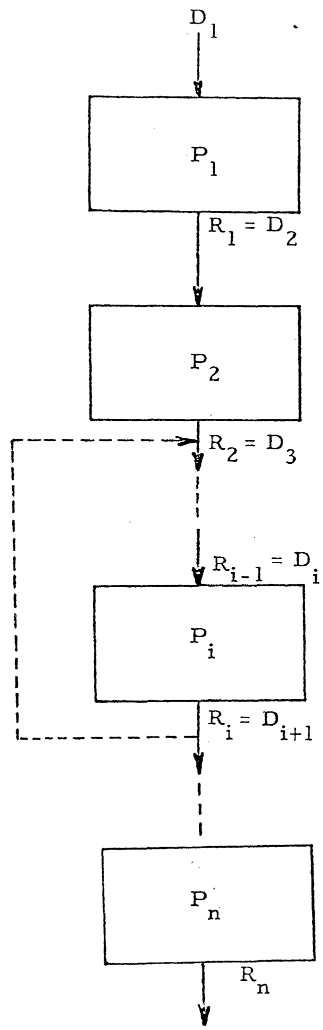

Figure 1: Flow through a conventional Design Automation System

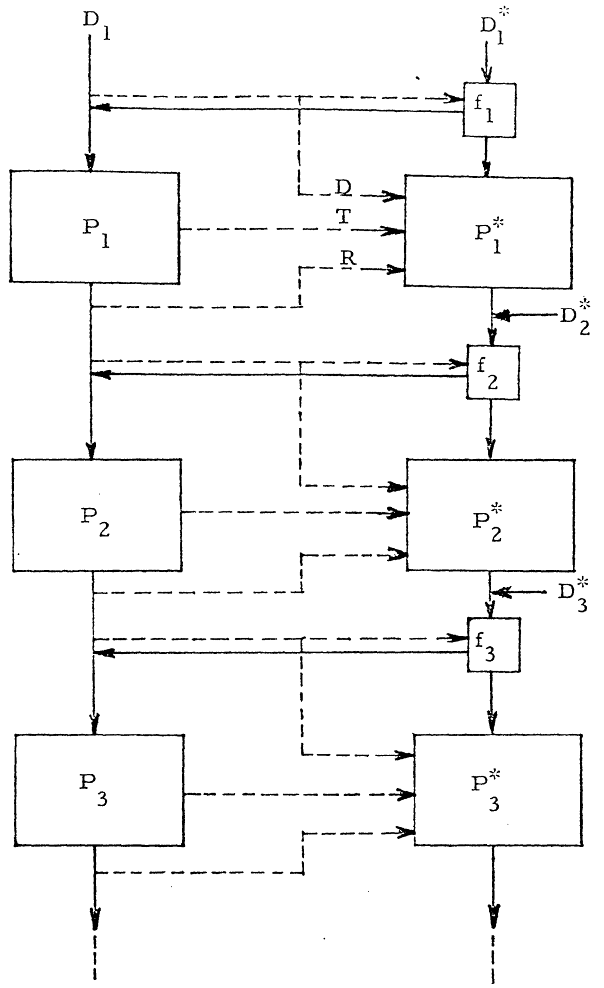

Figure 2: D.A. system with simple incremental processing structure

A CLASSIFICATION SCHEME FOR COMPUTER PROGRAM LIBRARIES

Fred T. Krogh

Section 366
Computing Memorandum #413
July 7, 1976
Revised August 16, 1976
Revised September 7, 1976

This note presents the results of one phase of research carried out at the Jet Propulsion Laboratory, California Institute of Technology, under Contract NAS 7-100, sponsored by the National Aeronautics and Space Administration.

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We hope to adopt a new classification scheme for the Collected Algorithms of the ACM and TOMS. The (incomplete) classification scheme given below indicates the direction of our thinking. Since this represents a radical departure from current schemes, it seems prudent to solicit opinions on the direction taken before proceeding further. We are also in dire need of assistance in classifications from I on. Some of these classifications will certainly be eliminated if no one thinks they are worth developing. Other classifications will be added if a good case for doing so can be made.

We would greatly appreciate comments and/or assistance from anyone reading this document. We hope to have a new classification scheme by about May 1977.

Much has been borrowed from John Bolstad's work, see "A Proposed Classification Scheme For Computer Program Libraries" in the SIGNUM Newsletter, Vol. 10 (Nov. 1975) pp. 32-39, and this paper is highly recommended as an example of a proposal which departs much less radically from the scheme most widely used at present.

The scheme proposed here has the advantage that procedures with code and usage that are closely related are close together in the classifications. For example, a program to evaluate a spline function is in a category very close to one which differentiates a spline function. It has the disadvantage that programs doing mathematically similar things can be classified in very different categories. Thus a subroutine for integrating a general function is classified in a category well removed from that for integrating a spline function generated from discrete data values.

We obviously feel there is some merit to the approach we have taken, but not fanatically so. We could be swayed to another approach, particularly by anyone inclined to write out the grubby details for an alternative.

A classification scheme should make it easy to find a program for a given task. Having found a program, it is frequently useful to know what other categories the program might be placed in and the categories of the procedures used by a given program. Such information can help to give a clearer idea of the programs characteristics. With these thoughts in mind, we suggest a listing of a program include the following kind of information.

We use the notation

c_i, d_i, $e_{i,j}$	are category calssifications
U	is an identifier to uniquely identify a program in a given category.
K_i	are keywords

A listing for a program P would take the form

c_0.U Title,author,etc.(Also c_1, c_2, ..., c_n)(Uses d_1, d_2, ..., d_m) (K_1, K_2, ..., K_j)

where c_0 is the primary category for P, and the c_i are secondary categories; the d_i indicate the categories used by P; and any of the items indicated in parentheses is optional. It is intended that the c_i and d_i only include categories that are not strongly implied by the fact that P is in c_0. At c_i, i=1,2,...,n there should be an entry of the form

c_i Also see $e_{i,1}$, $e_{i,2}$,...,$e_{i,k}$

where one of the $e_{i,j}$ is c_0 and the other $e_{i,j}$'s are referred to in a similar way.

In addition we hope to have a keyword index for the Collected Algorithms from ACM. James Lemme under the direction of John Rice has made such an index up to Algorithm 492.

Concerning the Revision Dated September 7, 1976.

I believe categories B to H are in reasonably good shape at this time, given the classification approach taken. All with whom I have discussed this in detail, either prefer a classification based primarily on the nature of the input to the software to one based on classical mathematical concepts, or are neutral on the question. I regard this as a central question to be resolved and welcome comments on the issue.

Ed Ng of JPL deserves most of the credit for the organization of category B. Categories G and H owe their present form to John Bolstad and Margaret Wright of Stanford. In addition to the major improvement in that area, John and Margaret have helped with a number of minor suggestions.

Assistance with any of the categories is most welcome. I suggest anyone interested in working on some category contact me first so that I can make them aware of any other work in that area. At present, John Bolstad has a revised version of his classification scheme with a greatly expanded statistics category, and less extensive extensions in graphics, utilities, data manipulation, and general applications. I believe the statistics in this proposal to be reasonably complete, but hope it is possible to organize statistics with more of the kind of structure found in the categories given here.

Finally, we would appreciate comments on the scheme used to label the categories, and suggestions for other labeling schemes.

A. ELEMENTARY OPERATIONS, INCLUDING INPUT/OUTPUT FOR STANDARD NUMERIC AND CHARACTER DATA TYPES
A1. INPUT/OUTPUT FOR STANDARD NUMERIC AND CHARACTER DATA TYPES
A2. DATA CONVERSION FOR STANDARD NUMERIC AND CHARACTER DATA TYPES
A2A. CONVERSION BETWEEN STANDARD DATA TYPES
A2B. DATA CONVERSION BETWEEN MACHINES
A2C. ENCRYPTION (CAN ANYONE SUGGEST A BETTER PLACE FOR THIS?)
A2Z. OTHER
A3. OPERATIONS ASSOCIATED WITH PARTIAL WORDS (INCLUDES I/O AND CONVERSION)
A3A. BIT HANDLING (SHIFTING, MASKING, LOGICAL OPERATIONS)
A3B. CHARACTER AND STRING HANDLING
A4. EXTENDED ARITHMETIC
SUBHEADINGS INCLUDE
A4A. RATIONAL OR INTEGER
A4B. REAL (E.G. MULTIPLE PRECISION)
A4C. COMPLEX (E.G. MULTIPLE PRECISION)
A4D. INTERVAL ARITHMETIC
A4Z. OTHER (E.G. SIGNIFICANT DIGIT, DECIMAL)
A4*1. INPUT/OUTPUT AND CONVERSION
A4*2. ELEMENTARY, SPECIAL AND STATISTICAL FUNCTIONS
A4*3. PROGRAMS WHICH WOULD BE CLASSED IN CATEGORIES C TO F FOR STANDARD FLOATING POINT ARITHMETIC
A4*4. PROGRAMS WHICH WOULD BE CLASSED IN CATEGORIES F TO H FOR STANDARD FLOATING POINT ARITHMETIC
A4*9. OTHER
A5. ARITHMETIC OPERATIONS ON POWER SERIES AND POLYNOMIALS
A8. OTHER (BUT SEE C1 FOR ELEMENTARY OPERATIONS ON MATRICES AND VECTORS)
A9. MODULES AND TOOLS (ERROR ANAYSIS, ENVIRONMENTAL INQUIRIES, ETC.)

B.	ELEMENTARY, SPECIAL, AND STATISTICAL FUNCTIONS
B1.	ELEMENTARY FUNCTIONS
B1A.	TRIGONOMETRIC FUNCTIONS AND INVERSES
B1B.	HYPERBOLIC FUNCTIONS AND INVERSES
B1C.	EXPONENTIAL AND LOGARITHM (INCLUDES A**X, A AND X REAL)
B1D.	INTEGER POWERS AND ROOTS
B2.	SPECIAL FUNCTIONS OF MATHEMATCAL PHYSICS
B2A.	EXPONENTIAL INTEGRAL AND RELATED FUNCTIONS
B2B.	GAMMA FUNCTION AND RELATED FUNCTIONS
B2C.	ERROR FUNCTION AND FRESNEL INTEGRALS
B2D.	LEGENDRE FUNCTIONS
B2E.	BESSEL FUNCTIONS
	THE FOLLOWING SUBHEADINGS ARE AVAILABLE (A * IS TO BE REPLACED BY 1, 2, 3, OR 4.)
B2E1.	J AND Y, CIRCULAR BESSEL FUNCTIONS OF FIRST AND SECOND KIND
B2E2.	I AND K, HYPERBOLIC (OR MODIFIED) BESSEL FUNCTIONS OF FIRST AND SECOND KIND
B2E3.	H, HANKEL FUNCTIONS
B2E4.	ZEROS OF BESSEL FUNCTIONS
B2E*A.	FUNCTIONS OF REAL ARGUMENT AND ORDER ZERO AND ONE
B2E*B.	FUNCTIONS OF REAL ARGUMENT AND INTEGER ORDER
B2E*C.	FUNCTIONS OF REAL ARGUMENT AND FRACTIONAL ORDER
B2E*D.	FUNCTIONS OF REAL ARGUMENT AND REAL ORDER
B2E*E.	FUNCTIONS OF COMPLEX ARGUMENT AND REAL ORDER
B2E*F.	FUNCTIONS OF COMPLEX ARGUMENT AND COMPLEX ORDER
B2F.	INTEGRALS OF BESSEL FUNCTIONS
B2G.	STRUVE FUNCTIONS, INCOMPLETE BESSEL FUNCTIONS, AND RELATED FUNCTIONS.
B2H.	CONFLUENT HYPERGEOMETRIC FUNCTIONS'
B2I.	COULOMB WAVE FUNCTIONS
B2J.	HYPERGEOMETRIC FUNCTIONS
B2K.	ELLIPTIC INTEGRALS AND ELLIPTIC FUNCTIONS
B2K1.	ELLIPTIC INTEGRALS
B2K2.	JACOBIAN ELLIPTIC FUNCTIONS AND THETA FUNCTIONS
B2K3.	WEIERSTASS ELLIPTIC AND RELATED FUNCTIONS
B2L.	PARABOLIC CYLINDER FUNCTIONS
B2M.	MATHIEU FUNCTIONS
B2N.	SPHEROIDAL WAVE FUNCTIONS
B2O.	ORTHOGONAL POLYNOMIALS
B2P.	BERNOULLI AND EULER POLYNOMIALS, RIEMANN ZETA FUNCTION
B2Z.	MISCELLANEOUS FUNCTIONS FROM MATHEMATICAL PHYSICS
B3.	FUNCTIONS FROM COMBINATORIAL ANALYSIS AND NUMBER THEORY
B4.	STATISTICAL FUNCTIONS
B9.	MODULES AND TOOLS FOR COMPUTING FUNCTIONS
C.	OPERATIONS ON FUNCTIONS DEFINED BY A GIVEN SET OF POINTS (INCLUDES INTERPOLATION, FITTING, INTEGRATION, DIFFERENTIATION, SUMMATION)
	AVAILABLE HEADINGS AND SUBHEADINGS ARE LISTED HERE. A HEADING MAY BE FOLLOWED BY ANY OF THE FIRST SUBHEADINGS, WHICH IN TURN MAY BE FOLLOWED BY ANY SUBHEADING FROM THE NEXT LOWER LEVEL, ETC. (THERE ARE TWO EXCEPTIONS NOTED BELOW.)
C1.	ONE DIMENSIONAL DATA
C2.	ONE DIMENSIONAL DATA -- DERIVATIVES GIVEN AT SOME DATA POINTS
C3.	ONE DIMENSIONAL DATA -- APPROXIMATING FUNCTION CONSTRAINED IN SOME WAY
C4.	ONE DIMENSIONAL DATA -- BOTH DERIVATIVES AND CONSTRAINTS
C5.	MULTI-DIMENSIONAL DATA
C6.	MULTI-DIMENSIONAL DATA -- DERIVATIVES GIVEN AT SOME DATA POINTS
C7.	MULTI-DIMENSIONAL DATA -- APPROXIMATING FUNCTION CONSTRAINED IN SOME WAY
C8.	MULTI-DIMENSIONAL DATA -- BOTH DERIVATIVES AND CONSTRAINTS
C9.	MODULES AND TOOLS FOR OPERATIONS USED IN C1.-C8.
C*A.	APPROXIMATING FUNCTION INTERPOLATES THE DATA POINTS
C*B.	APPROXIMATING FUNCTION FITS DATA IN A LEAST SQUARES SENSE
C*C.	MINIMAX FIT TO THE GIVEN DATA
C*D.	APPROXIMATE MINIMAX FIT TO THE DATA
C*E.	OTHER LP FITS
C*Z.	OTHER CRITERIA FOR SELECTING THE BEST APPROXIMATION
C**1.	APPROXIMATING FUNCTION IS A POLYNOMIAL
C**2.	APPROXIMATING FUNCTION IS A PIECEWISE POLYNOMIAL, EACH PIECE DEFINED BY LOCAL DATA
C**3.	APPROXIMATING FUNCTION IS A SPLINE, KNOTS GIVEN
C**4.	APPROXIMATING FUNCTION IS A SPLINE, KNOTS TO BE DETERMINED

C**5. APPROXIMATING FUNCTION IS A RATIONAL FUNCTION
C**6. APPROXIMATING FUNCTION IS A LINEAR COMBINATION OF EXPONENTIAL AND/OR TRIGONOMETRIC FUNCTIONS. (FOR TRIGONOMETRIC ALSO SEE J2.)
C**7. A CHOICE OF APPROXIMATING FUNCTIONS IS PROVIDED
C**8. AUTOMATIC SELECTION OF THE TYPE OF APPROXIMATING FUNCTIONS
C**9. OTHER APPROXIMATING FUNCTIONS
C***A. PROGRAM DOES TABLE LOOK UP (ONLY APPLIES TO APPROXIMATING FUNCTIONS DEFINED BY LOCAL DATA)
C***B. PROGRAM COMPUTES PARAMETERS FOR APPROXIMATING FUNCTION (LOWER LEVEL SUBHEADING DOES NOT APPLY)
C***C. PROGRAM USES PREVIOUSLY COMPUTED PARAMETERS TO GIVE RESULTS
C***D. PROGRAM DOES BOTH OF THE TWO ABOVE JOBS.
C****1. APPROXIMATING FUNCTION IS EVALUATED
C****2. APPROXIMATING FUNCTION IS DIFFERENTIATED
C****3. APPROXIMATING FUNCTION IS INTEGRATED
C****4. SOME CHOICE OF THE ABOVE
C****5. OTHER (INCLUDES SUMMATION)

D. OPERATIONS ON FUNCTIONS DEFINED BY USER PROVIDED SOFTWARE (INCLUDES APPROXIMATION, DIFFERENTIATON, INTEGRATION, SUMMATION)
D1. APPROXIMATION (SOLVE FOR PARAMETERS TO FIT A FUNCTION)
SUBHEADINGS ARE THE SAME AS INDICATED FOR C*A. TO C*Z. AND C**1. TO C**9., EXCEPT WITH C REPLACED BY D.
D2. DIFFERENTIATION
D2A. SINGLE VARIABLE FOR SCALAR FUNCTION
D2B. PARTIAL DERIVATIVES OF SCALAR FUNCTIONS
D2C. PARTIAL DERIVATIVES OF VECTOR FUNCTIONS
D2Z. OTHER
D3. INTEGRATION (QUADRATURE)
SUBHEADINGS INCLUDE
D3A. FINITE RANGE
D3B. SEMI-INFINITE RANGE
D3C. INFINITE RANGE
D3D. INDEFINITE INTEGRATION (ALSO SEE F2.)
D3E. MULTI-DIMENSIONAL INTEGRATION
D3*1. NO WEIGHT FUNCTION
D3*2. TRIGONOMETRIC WEIGHT FUNCTION
D3*9. OTHER WEIGHT FUNCTIONS
D3**A. AUTOMATIC, NO DERIVATIVES REQUIRED
D3**B. AUTOMATIC, USES EXTRA DERIVATIVES
D3**C. FIXED MESH, NO DERIVATIVES REQUIRED
D3**D. FIXED MESH, USES EXTRA DERIVATIVES
D4. SUMMATION AND CONVERGENCE ACCELERATION
D9. MODULES AND TOOLS USED IN D1.-D4. (E.G. PROGRAMS TO GET QUADRATURE FORMULAS.)

E. COMPUTING FUNCTIONS DEFINED BY EQUATIONS (ROOT LOCI, DIFFERENTIAL, PARTIAL DIFFERENTIAL AND INTEGRAL EQUATIONS)
E1. ROOT LOCUS CALCULATIONS (FIND Y(X) GIVEN F(X,Y) = 0)
E2. INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS
SUBHEADINGS INCLUDE
E2A. METHODS WHICH ARE NOT ECONOMICAL FOR STIFF EQUATIONS
E2B. METHODS USEFUL FOR A RESTRICTED CLASS OF STIFF EQATIONS
E2C. METHODS FOR GENERAL STIFF EQUATIONS
E2D. METHODS WHICH ALLOW A SELECTION OF METHODS (SOME FOR STIFF, SOME NOT)
E2E. METHODS FOR DIFFERENTIAL EQUATIONS WITH DELAYS.
E2*1. AUTOMATIC SELECTION OF METHOD, ORDER, AND STEPSIZE IS AVAILABLE
E2*2. AUTOMATIC SELECTION OF ORDER AND STEPSIZE IS AVAILABLE
E2*3. AUTOMATIC SELECTION OF STEPSIZE IS AVAILABLE
E2*4. USER MUST COMPLETELY SPECIFY THE METHOD
E2**A. NO PARTIAL DERIVATIVES USED
E2**B. PARTIALS USED FOR STIFF EQS. IF AVAILABLE
E2**C. PARTIALS REQUIRED FOR STIFF EQS.
E2**D. PARTIALS USED FOR EQUATIONS EVEN IF NOT STIFF
E2**E. PARTIALS USED IF AVAILABLE, PROVISION MADE FOR STRUCTURE OR SPARSENESS
E2**F. PARTIALS REQUIRED FOR STIFF EQUATIONS, PROVISION MADE FOR STRUCTURE OR SPARSENESS
E2***1. RUNGE-KUTTA TYPE METHODS

E2***2. PREDICTOR-CORRECTOR TYPE METHODS
E2***3. EXTRAPOLATION TYPE METHOD
E2***4. METHODS WHICH REQUIRE EXTRA DERIVATIVES
E2***5. OTHER METHODS
E3. BOUNDARY VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS
SUBHEADINGS INCLUDE
E3A. LINEAR BOUNDARY VALUE PROBLEMS
E3B. NONLINEAR BOUNDARY VALUE PROBLEMS, PARTIALS NOT REQUIRED
E3C. NONLINEAR BOUNDARY VALUE PROBLEMS, PARTIALS REQUIRED
E3D. EIGENVALUE PROBLEMS (IF TREATED AS A SPECIAL CASE)
E3*1. METHODS BASED ON THOSE IN E2 ABOVE
E3*2. FINITE DIFFERENCE METHODS WITH AUTOMATIC MESH SELECTION
E3*3. OTHER METHODS WITH AUTOMATIC MESH SELECTION
E3*4. FINITE DIFFERENCE METHODS WITH USER SPECIFIED MESH
E3*5. OTHER METHODS WITH USER SPECIFIED MESH
E3*6. FINITE DIFFERENCE METHODS WITH CONSTANT MESH
E3*7. OTHER METHODS WITH CONSTANT MESH
E3**A. METHODS WHICH ITERATE BY SOLVING THE DIFFERENTIAL EQUATION, AND ATTEMPTING TO MATCH THE BOUNDARY CONDITIONS
E3**B. METHODS WHICH ITERATE BY SATISFYING THE BOUNDARY CONDITIONS, AND ATTEMPTING TO MATCH THE DIFFERENTIAL EQUATION
E4. INITIAL BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS
SUBHEADINGS INCLUDE
E4A. GENERAL METHODS BASED ON INITIAL VALUE METHODS IN E2.
E4B. OTHER GENERAL METHODS
E4C. METHODS WHICH APPLY ONLY TO PARABOLIC EQUATIONS
E4D. METHODS WHICH APPLY ONLY TO HYPERBOLIC EQUATIONS
E4*1. AUTOMATIC MESH SELECTION
E4*2. AUTOMATIC SELECTION OF TIME STEP SIZE, OTHER MESH IS SET BY USER
E4*3. AUTOMATIC SELECTION OF TIME STEP SIZE, OTHER MESH IS CONSTANT
E4*4. MESH IS USER SPECIFIED
E4*5. MESH MUST BE CONSTANT.
E4**A. MORE THAN TWO SPACE DIMENSIONS ALLOWED
E4**B. AT MOST TWO SPACE DIMENSIONS ALLOWED
E4**C. ONE SPACE DIMENSION ONLY
E5. BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS
SUBHEADINGS INCLUDE
E5A. LINEAR BOUNDARY VALUE PROBLEMS, DIRECT METHOD
E5B. LINEAR BOUNDARY VALUE PROBLEMS, ITERATIVE METHOD
E5C. NONLINEAR BOUNDARY VALUE PROBLEMS, PARTIALS NOT REQUIRED
E5D. NONLINEAR BOUNDARY VALUE PROBLEMS, PARTIALS REQUIRED
E5E. EIGENVALUE PROBLEMS
E5*1. RECTANGULAR BOUNDARY, MORE THAN TWO DIMENSIONS ALLOWED
E5*2. RECTANGULAR BOUNDARY, TWO DIMENSIONS (OR ONE)
E5*3. ALMOST RECTANGULAR BOUNDARY, MORE THAN TWO DIMENSIONS ALLOWED
E5*4. ALMOST RECTANGULAR BOUNDARY, TWO DIMENSIONS
E5*5. BOUNDARY WITH SOME OTHER SPECIAL CHARACTERISTIC, MORE THAN TWO DIM.
E5*6. BOUNDARY WITH SOME OTHER SPECIAL CHARACTERISTIC, TWO DIMENSIONS
E5*7. GENERAL BOUNDARIES, MORE THAN TWO DIMENSIONS ALLOWED
E5*8. GENERAL BOUNDARIES, TWO DIMENSIONS
E5**A. AUTOMATIC MESH SELECTION
E5**B. USER SET MESH
E5**C. CONSTANT MESH
E5***1. FINITE DIFFERENCE METHODS
E5***2. FINITE ELEMENT METHODS
E5***9. OTHER METHODS
E6. INTEGRAL EQUATIONS
SUBHEADINGS INCLUDE
E6A. LINEAR INTEGRAL EQUATIONS
E6B. NONLINEAR INTEGRAL EQUATIONS, PARTIALS NOT REQUIRED
E6C. NONLINEAR INTEGRAL EQUATIONS, PARTIALS REQUIRED
E6*1. FREDHOLM EQUATIONS
E6*2. VOLTERRA EQUATIONS
E8. OTHER TYPES OF EQUATIONS (E.G. DIFFERENTIAL EQUATIONS WITH DELAYS)
E9. MODULES AND TOOLS USED IN E1.-E8.

F. MATRIX ALGEBRA, EIGENVALUE PROBLEMS
THE FOLLOWING SUBHEADINGS ARE AVAILABLE THROUGHOUT THIS SECTION BUT ARE NOT EXPLICITLY LISTED. THE FIRST SUBHEADING CHARACTERIZES THE LOCATION OF NONZERO ELEMENTS IN THE INPUT MATRIX, THE NEXT SUBHEADING CHARACTERIZES SPECIAL RELATIONSHIPS AMONG THE ELEMENTS OF THE INPUT MATRIX, AND THE LAST SUBHEADING GIVES IMPLEMENTATION DETAILS.

F**1. GENERAL CASE
F**2. TRIANGULAR OR HESSENBERG
F**3. BAND (BUT NOT TRIDIAGONAL OR DIAGONAL)
F**4. TRIDIAGONAL
F**5. BLOCK BANDED (AS ARISE FROM PARTIAL DIFFERENTIAL EQUATIONS)
F**6. DIFFERING FROM ONE OF THE 5 JUST ABOVE ONLY SLIGHTLY
F**7. SPARSE WITH NO SPECIAL STRUCTURE
F**9. OTHER
F***A. GENERAL CASE
F***B. SYMMETRIC POSITIVE DEFINITE OR HERMITIAN
F***C. SYMMETRIC
F***D. ORTHOGONAL
F***Z. OTHER SPECIAL CASES
F****1. DIRECT METHOD (INCLUDES QR ALGORITHM AND INVERSE ITERATION)
F****2. ITERATIVE METHOD (INCLUDES CONJUGATE GRADIENT METHOD)
F****3. DIRECT METHOD USING AUXILIARY STORAGE
F****4. ITERATIVE METHOD USING AUXILIARY STORAGE
F1. ELEMENTARY OPERATIONS ON VECTORS AND MATRICES
F1A. INPUT/OUTPUT OF VECTORS AND MATRICES
F1B. ARITHMETIC OPERATIONS ON VECTORS (INCLUDES NORMS AND INNER PRODUCTS)
F1C. ARITHMETIC OPERATIONS ON MATRICES
F2. NONELEMENTARY OPERATIONS ON MATRICES
F2A. SIMILARITY TRANSFORMATIONS
F2B. MATRIX DECOMPOSITIONS (LU, SINGULAR VALUE, CHOLESKY, QR, ETC.)
F2C. UPDATES OF MATRIX DECOMPOSITIONS
F2D. BALANCING AND SCALING OF MATRICES
F2E. DETERMINANT OF A MATRIX
F2F. FUNCTIONS OF MATRICES (E.G. MATRIX EXPONENTIALS)
F3. STANDARD EIGENVALUE PROBLEM -- AX = LAMDA X
F3A. EIGENVALUES ONLY
F3B. ONLY SOME EIGENVALUES
F3C. EIGENVALUES AND EIGENVACTORS
F3D. EIGENVECTORS FOR GIVEN EIGENVALUES
F4. GENERAL EIGENVALUE PROBLEMS
F4A. EIGENVALUES ONLY
F4B. ONLY SOME EIGENVALUES
F4C. EIGENVALUES AND EIGENVECTORS
F4D. EIGENVECTORS FOR GIVEN EIGENVALUES

G. SOLUTION OF EQUATIONS AND APPROXIMATE SOLUTION OF OVERDETERMINED SYSTEMS AND CONSTRAINED SYSTEMS

G1. LINEAR SYSTEMS
FIRST LEVEL SUBHEADINGS ARE
G1A. N X N SYSTEMS (INCLUDES COMPUTING INVERSE)
G1B. LEAST SQUARES SOLUTION OF M X N SYSTEMS (INCLUDES COMPUTING PSEUDOINVERSE)
G1C. MINIMAX SOLUTION OF M X N SYSTEMS
G1D. OTHER LP SOLUTIONS OF M X N SYSTEMS
G1E. OTHER SOLUTIONS OF M X N SYSTEMS (E.G. ROBUST ESTIMATION)
G1F. SOLUTION OF UNDER DETERMINED SYSTEMS
ADDITIONAL SUBHEADINGS ARE AS GIVEN FOR F**1., ..., F****4., EXCEPT WITH F REPLACED BY G.
G2. ROOTS OF A SINGLE NONLINEAR EQUATION
G2A. ROOTS OF POLYNOMIALS
G2B. SOLUTION OF A SINGLE NONLINEAR EQUATION
G2B1. NO DERIVATIVES REQUIRED
G2B2. FIRST DERIVATIVE REQUIRED
G2B3. HIGHER DERIVATIVES REQUIRED
G3. NONLINEAR SYSTEMS
FIRST LEVEL SUBHEADINGS ARE THE SAME AS G1A. TO G1F., EXCEPT WITH THE REPLACED BY 3.
G3*1. NO PARTIAL DERIVATIVES REQUIRED
G3*2. JACOBIAN MATRIX REQUIRED
G3*3. OTHER DERIVATIVES REQUIRED
G3**A. PROBLEM HAS A DENSE JACOBIAN MATRIX (THE GENERAL CASE)
G3**B. PROBLEM HAS A SPARSE JACOBIAN MATRIX WITH SOME SPECIAL STRUCTURE
G3**C. PROBLEM HAS A SPARSE JACOBIAN MATRIX WITH NO SPECIAL STRUCTURE
G3**D. PROBLEM HAS DENSE JACOBIAN MATRIX, SECONDARY STORAGE IS USED
G3**E. PROBLEM HAS SPARSE JACOBIAN MATRIX WITH SPECIAL STRUCTURE, SECONDARY STORAGE IS USED
G3**F. PROBLEM HAS A SPARSE JACOBIAN MATRIX WITH NO SPECIAL STRUCTURE, SECONDARY STORAGE IS USED

G4. LINEAR SYSTEMS WITH LINEAR CONSTRAINTS
G4A. CONSTRAINED LEAST SQUARES (ALSO SEE H3A, QUADRATIC PROGRAMMING)
G4B. CONSTRAINED SOLUTIONS IN OTHER NORMS
G4*1. EQUALITY OR INEQUALITY CONSTRAINTS
G4*2. EQUALITY CONSTRAINTS ONLY
G4*3. UPPER AND/OR LOWER BOUNDS ONLY
G4*4. CONSTRAINTS OF TYPE G4*2. AND G4*3.
G4**A. DENSE CONSTRAINTS (GENERAL CASE)
G4**B. SPARSE CONSTRAINTS WITH SPECIAL STRUCTURE
G4**C. SPARSE CONSTRAINTS, NO SPECIAL STRUCTURE
G4**D. SAME AS G4**A., EXCEPT SECONDARY STORAGE IS USED
G4**E. SAME AS G4**B., EXCEPT SECONDARY STORAGE IS USED
G4**F. SAME AS G4**C., EXCEPT SECONDARY STORAGE IS USED
G4***1. SYSTEM HAS DENSE MATRIX (GENERAL CASE)
G4***2. SYSTEM HAS SPARSE MATRIX WITH SPECIAL STRUCTURE
G4***3. SYSTEM HAS SPARSE MATRIX WITH NO SPECIAL STRUCTURE
G5. NONLINEAR SYSTEMS WITH LINEAR CONSTRAINTS
G5A. CONSTRAINED NONLINEAR LEAST SQUARES (NO DERIVATIVES REQUIRED)
G5B. CONSTRAINED NONLINEAR LEAST SQUARES (PARTIAL DERIVATIVES REQUIRED)
G5C. CONSTRAINED SOLUTIONS IN OTHER NORMS (NO DERIVATIVES REQUIRED)
G5D. CONSTRAINED SOLUTIONS IN OTHER NORMS (PARTIAL DERIVATIVES REQUIRED)
SUBHEADINGS HERE ARE THE SAME AS THOSE FOR G4, EXCEPT THE 4 IS REPLACED BY 5, AND IN G5***1 TO G5***3 THE WORD MATRIX IN G4***1 TO G4***3 IS TO BE REPLACED BY JACOBIAN MATRIX
G6. NONLINEAR SYSTEMS WITH NONLINEAR CONSTRAINTS
G6A TO G6D ARE THE SAME AS G5A TO G5D
G6*1. EQUALITY OR INEQUALITY CONSTRAINTS (NO DERIVATIVES REQUIRED)
G6*2. EQUALITY OR INEQUALITY CONSTRAINTS (PARTIAL DERIVATIVES REQUIRED)
G6*3. EQUALITY CONSTRAINTS ONLY (NO DERIVATIVES REQUIRED)
G6*4. EQUALITY CONSTRAINTS ONLY (PARTIAL DERIVATIVES REQUIRED)
G6**A. JACOBIAN MATRIX OF CONSTRAINT FUNCTIONS IS DENSE (GENERAL CASE)
G6**B. JACOBIAN MATRIX OF CONSTRAINT FUNCTIONS HAS A SPECIAL STRUCTURE
G6**C. JACOBIAN MATRIX OF CONSTRAINT FUNCTIONS IS SPARSE, NO SPECIAL STRUCTURE
G6**D. SAME AS G6**A., EXCEPT SECONDARY STORAGE IS USED
G6**E. SAME AS G6**B., EXCEPT SECONDARY STORAGE IS USED
G6**F. SAME AS G6**C., EXCEPT SECONDARY STORAGE IS USED
G6***1 TO G6***3 ARE THE SAME AS G5***1 TO G5***3
H. OPTIMIZATION (INCLUDES LINEAR PROGRAMMING) NOTE -- TO MINIMIZE A SUM OF SQUARES SEE G1B, G3B, G4A, G5A, OR G6A.
H1. UNCONSTRAINED OPTIMIZATION
H1A. MAXIMA OR MINIMA OF A FUNCTION OF ONE VARIABLE
H1B. MAXIMA OR MINIMA OF A MULTIVARIATE FUNCTION
SUBHEADINGS INCLUDE
H1*1. NO DERIVATIVES REQUIRED
H1*2. FIRST DERIVATIVE (OR PARTIAL DERIVATIVES) REQUIRED
H1*3. HIGHER ORDER DERIVATIVES REQUIRED
H2. MAXIMA OR MINIMA OF A LINEAR FUNCTION WITH LINEAR CONSTRAINTS (LINEAR PROGRAMMING)
H2A. LINEAR PROGRAMMING
H2B. INTEGER LINEAR PROGRAMMING
H2C. MIXED INTEGER PROGRAMMING
ADDITIONAL SUBHEADINGS ARE THE SAME AS FOR G4*1 TO G4**F, EXCEPT WITH G4 REPLACED BY H2.
H3. MAXIMA OR MINIMA OF A NONLINEAR FUNCTION WITH LINEAR CONSTRAINTS
H3A. QUADRATIC PROGRAMMING (I.E. FUNCTION IS A QUADRATIC)
H3B. GENERAL CASE, NO DERIVATIVES REQUIRED
H3C. GENERAL CASE, FIRST ORDER PARTIAL DERIVATIVES REQUIRED
H3D. GENERAL CASE, HIGHER ORDER PARTIAL DERIVATIVES REQUIRED
SUBHEADINGS ARE THE SAME AS FOR G4*1 TO G4**F, EXCEPT WITH G4 REPLACED BY H3.
H4. MAXIMA OR MINIMA OF A NONLINEAR FUNCTION WITH NONLINEAR CONSTRAINTS
H4A. NO DERIVATIVES OF THE OBJECTIVE FUNCTION REQUIRED
H4B. FIRST ORDER PARTIAL DERIVATIVES OF THE OBJECTIVE FUNCTION REQUIRED
H4C. HIGHER ORDER PARTIAL DERIVATIVES OF THE OBJECTIVE FUNCTION REQUIRED
H4*1 TO H4***3 ARE THE SAME AS G6*1 TO G6***3

I. STATISTICAL ANALYSIS AND PROBABILITY
I****** NEED A VOLUNTEER -- AT PRESENT I PREFER MANY OPERATIONS ON TIME SERIES
I****** IN CATEGORY J, AND WOULD LIKE TO SEE MANY PROGRAMS WHICH A STATISTICIAN
I****** WOULD PUT UNDER REGRESSION CLASSIFIED UNDER VARIOUS LEAST SQUARES
CATEGORIES IN C AND G. CLEARLY A LOT OF CROSS REFERENCING IS GOING TO
I****** BE REQUIRED.

J. DISCRETE TRANSFORMS (INCLUDES SMOOTHING, FILTERING, DISCRETE FOURIER TRANSFORM, POWER SPECTRA, CONVOLUTIONS AND CORRELATIONS, ETC.)
J1. SMOOTHING AND FILTERING
J2. DISCRETE FOURIER TRANSFORMS
SUBHEADINGS INCLUDE
J2A. COMPLEX DATA
J2B REAL DATA
J2C. REAL ODD OR EVEN DATA
J2D COMPLEX DATA, SECONDARY STORAGE IS USED
J2E. REAL DATA, SECONDARY STORAGE IS USED
J2F. REAL ODD OR EVEN DATA, SECONDARY STORAGE IS USED
J2*1. ARBITRARY NUMBER OF POINTS OVER AN ENTIRE PERIOD
J2*2. NUMBER OF POINTS OVER AN ENTIRE INTERVAL MUST BE A POWER OF 2.
J2*3. SOME RESTRICTION ON THE NUMBER OF POINTS, BUT NOT J2*2.
J3. POWER SPECTRA AND CROSS SPECTRA
J4. CONVOLUTIONS AND CORRELATIONS
J8. DISCRETE ANALOGUES OF OTHER INTEGRAL TRANSFORMS
J9. MODULES AND TOOLS FOR USE IN SECTION J.

K. DATA HANDLING, COMBINATORIAL PROBLEMS
K******** NEEDS HELP
K1. SORTING
K2. MERGING
K3. SEARCHING AND COMPARING
K4. GRAPH THEORY
K5. COMBINATORIAL PROBLEMS IN OPERATIONS RESEARCH

L. GRAPHICS
L******** NEED A VOLUNTEER

M. SYMBOL MANIPULATION (PROGRAMS DOING OR USING SYMBOL MANIPULATION, COMPILERS FOR SYMBOL MANIPULATION GO IN O.)
M******** NEED A VOLUNTEER (IS SUCH A SECTION JUSTIFIED?)

N. LANGUAGE PROCESSORS (INCLUDES PREPROCESSORS, AND TEXT EDITORS)
N******** NEED A VOLUNTEER (SEE BOLSTAD FOR SOME IDEAS)

O. SYSTEM UTILITIES (FILE MANIPULATION, TIMERS, DATE AND TIME, DYNAMIC STORAGE, DUMPS AND TRACES, REPORT GENERATORS, ETC.)
O******** NEED A VOLUNTEER (IS SUCH A SECTION JUSTIFIED?)

Y. PROGRAMS NOT FITTING IN OTHER CATEGORIES

Z. APPLICATIONS
Z******** (NEEDS HELP)
Z1. PHYSICAL SCIENCES AND MATHEMATICS
Z1A. MATHEMATICS
Z1B. ASTRONOMY
Z1C. CHEMISTRY
Z1*. ETC.
Z2. BIOLOGICAL SCIENCES
Z3. SOCIAL SCIENCES
Z4. ENGINEERING
Z5. BUSINESS
Z*. ETC.

PRINTED CIRCUIT BOARD INTERCONNECTION ROUTING -- EXAMPLE PROBLEMS

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INTRODUCTION

The LLL Design Automation System is being used to produce layouts for a number of different types of printed circuit boards. This report contains detailed descriptions of several example layout problems, including solution layouts produced by earlier versions of the LLL router subsystems. The data representation used is first explained, then each example is shown and analyzed. If the authors receive requests to provide additional examples, later issues of the Newsletter will include similar example problems.

DATA BASE/DESIGN FILE OVERVIEW

The LLL Design Automation System data base is intended to be the central repository for information related to design components, formulation of design description materials, and certain processing functions of the DA system. The data base consists of a collection of information, the structures and conventions used to organize that information, and certain software modules used to access and manipulate the information.

Insofar as is practical, the data base is intended to be independent of host systems hardware and software characteristics. Processing economy has motivated the use of environmentally specialized features within a few software modules, but these routines could easily be replaced by functionally equivalent modules created for another host.

It is not possible to anticipate all of the ways that the data base will be used, so the organizational approach taken has emphasized flexibility and ease of extension to new, different applications. One of the most important features related to flexibility is the self-defining nature of data base contents. As explained below, information describing the name attributes and location of each item is also stored in the data base file.

The DASLL data base has five major features:

1) A data base manager (a software package called DB MGR) through which all access to data must be made;
2) A group of data management and access primitive commands which constitute the set (the only set) of commands which will elicit a valid response from the DB MGR;
3) Data base buffer areas (called DB user buffers) through which all communication between the DB MGR and the data base itself must occur;
4) A block of user related codes (e.g., access rights, update privileges, and priorities), one for each user (defaulted to new user values if user unknown). This is an activation block used in directing data flow and resolving contention.
5) A hierarchical data base structure, which will be referred as a group of rings or ring levels, which are depicted as concentric circles within a square. The square represents the user buffer area through which access occurs.

The Data Base Model

The validity of the stored data is of major importance in any data base. The use of inaccurate or outdated information can be very costly; thus, configuration control is a primary concern. Tight control on the data base contents is maintained by

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allowing access only through a small number of data base utility routines. Update to the data base is strictly controlled by the person responsible for the accuracy of data in the data base.

Centralized access allows underlying data base structures to be revised without fear of causing changes in design automation application program results. Further, all operating system interactions are removed from the DA application programmer because his only interface is through the utility programs. A set of concentric rings symbolizing the data area suggests the concepts of level and data resolution. Each ring represents a level of information, and each level has associated with it a characteristic resolution. Greater resolution is obtained by going deeper into the levels. General information and nomenclature needed to "home" in on a particular entity is contained on the outer levels. Thus, a starting point is established, specific data may be extracted directly. Inner rings may be accessed without stepping through intervening levels, depending on the type of data needed.

Accessing inner levels from outer levels implies a method of data association. Two general types of data may be accessed in each level; bound and unbound. Bound data exists in the data base in usable form. It can only be retrieved. Unbound information exists as symbolic references only; its final form (value) is dependent on both when and how it is used by an application program. Unbound data must be defined (bound) at the time of use. A datum is bound when the symbolic reference in the data base is replaced by a value usable in the application program. The point in an application process at which this occurs is called the binding time of the item. All data that is logically associated in the data base is connected by unbound (symbolic) references called pointers. Data may further be associated locally by their logical proximity. Such data, associated by being defined as a group, is called a data packet. Both bound and unbound data may be contained in a single packet. Pointers in data packets may point to other data packets. This is the way that resolution is increased, pointing (through level slots) to more detailed information. The packets pointed to must reside on the same or lower levels.

The concept of binding time leads to the need for a copy of the information used by the application program. The symbolic name of the data packet referenced by the pointer is replaced by a value at the binding time of the pointer. This value is the position in a list structure at which the symbolically referenced packet resides. This replacement must not occur in the data base. Therefore, a file is defined which contains all information from the data base that might be needed during the processing of a specific problem. This file is called the design file, and is essentially a local copy of those data packets relevant to a particular system activity, called a capability.

The specific information in the local copy of the data base that makes up the design file is directly dependent upon the application to be executed. A subsystem to route a printed circuit board requires a vastly different design file then a subsystem for microprocessor control programs. A routine called a preprocessor is responsible for selecting the specific data packets for an application program. The output from a preprocessor is always a design file, but the inputs may vary, because DA application problems may require several steps in their solutions. The example layout problems shown later in this report are described by design files.

Each worker has an associated loader routine which must access the design file and load tables from it in a format usable by its worker. This routine is usually a simple one. The rationale for separating the loader from the body of the worker is that many different worker routines may exist to perform a particular function (e.g., routing), all having common data needs. Each worker is written to conform to the common loader and design file, forcing informal consistency of the system.

Data representation is another aspect of system consistency. The DASLL data base is self-describing. Not only is each data item needed for various routines stored in the data base, but a specification for both its format and symbolic usage name is stored. It is most convenient if the same (symbolic) name is used to reference the data in worker and preprocessor code, and by the data base maintenance personnel to specify data entry and alteration. This format information is stored in special data packets and is always included as part of the design file for reference by loaders and following preprocessors. Therefore, all codes using the data base information must access it according to standardized formats. The result of this convention is that a data format may be easily changed in the data base, and all routines will automatically respond to the change with no programmatic changes. Another result is that since all users of the system reference data items by a data base defined symbolic reference name, everyone uses the same terminology for each particular item.

The basic structure of the data base is a reflection of the level concept. Each level may contain zero or more logical groupings of data packets called blocks. A block is marked by a block header consisting of a level number (the larger the number, the closer the level is to the center of the concentric rings), a block name, and level directory. The level directory lists the symbolic names of each block at the immediately lower level. Each block entry in the directory may optionally include associated data packets. Data packets may be defined at any level.

A final feature of the DASLL data base is the division of system personnel into three categories. The categories are based on the relative familiarity with the overall system that is required. The first level includes system staff who maintain the actual data base, preprocessors, and loaders. The second level includes all staff members who produce programs for the system (e.g., routers). The third level is that of the user, who needs the least overall familiarity with the system. This is not to say that the user can utilize the system in ignorance of organization, although this might be considered ideal. The primary reward of such a division is the isolation of the data transfer subsystem from the worker routine writers. The ready availability of data to these programmers in a conceptually simple format allows worker routines to be more rapidly developed using a consistent data acquisition method.

Data Base Manager Implementation

The generalities described above are implemented in the DASLL data base organization with three main features in mind: transportability, flexibility and extensibility. Each of these design goals is facilitated by isolating the data base from the operating systems, worker routines, and users through a manageable number of utilities which are accessed by preprocessors only. The concept of level allows flexibility in specifying a data relationship while allowing the use of transparency techniques to minimize loss or duplication of data. The use of a design file that is essentially an excerpt of the data base allows the use of data base modules for accessing it, lowering costs and system size. The major implementation decision, however, was the choice of the standard 80-column Hollerith card format as the conceptual basis of data representation. All data in the data base and on the design file are in strict character format, arranged as records referred to as card images. Each data packet is formed by one or more card images. Associated with each card image is a type code which is defined by a three-character mnemonic code in the first three columns of each card image of a packet. Information in a data packet resides in a fixed field format on a card image of the packet. Each packet may have one or more types of card images in it.

The inherent transportability and simplicity of this format made it a logical choice. The utilities required to access data in this format are read/write record and skip +-N records; capabilities associated with unit record equipment and available on practically every machine made. The wide variety of machines at LLL make transportability a vital concern even at the cost of sacrificing some efficiency, However, efficiency is enhanced in this system through the use of directories and local data accessing practices in the preprocessor code. Further, all data in the data base and design file is in user readable form, an aid in debug and development.

The self-descriptive feature of this model is implemented by defining a group of system data packets specifically for that task. Skeleton data packets (ZSK) define (in position sensitive form) the starting column, the total character count, the data type (such as alphanumeric, integer, pointer) and other flags for each field in all other data packet types. Similarly, template (ZTM) data packets are used to define mnemonic tags for each data field of each packet type. The descriptions of data packet contents are used in many ways.

The packet type and field information is used to access data from a program at run time and to specify fields to be altered in the data base update. Skeleton position and data type information is used at data base update time to automatically place supplied data packets (a reason fixed fields are not considered too inconvenient). Skeleton data is also used to build the data transfer formats which are put in the design file to allow system I/O routines (in the host system) to access design file data, decreasing conversion overhead for bound data. Since all data is stored in character format in the data base and design file, conversion must be made before the worker routines can process them. Data bound in the data base (such as dimensions of an IC package) are never altered in worker routines, so formats constructed from skeleton information (ZTM) are used in reading such data through the loaders. This method is also applicable to unbound (symbolic) references (pointers) because they are simply read as character fields. When data values are finally resolved, the numerical information is replaced on the design file and information in the design file is changed to reflect that they have been bound. Conversions necessary before pointers are finally bound are done in the preprocessor using data base utilities.

Data Base Utilities

The DB access utilities are those routines which must use the kernel routine calls to perform their functions. They basically fetch and store data for manipulation routines; they, therefore, consist of bookkeeping code and calls on the kernel primitives. This scheme concentrates calls to the kernel in a relatively small number of routines, making update due to kernel changes minimal.

The access utilities are:

1) FNDLEV (LEVEL, LEVTAG)

   186

   Locates the record in receiver buffer with ring level of <LEVEL> and header of LEVTAG

2) FNDTAG (TAG, TAGTYP)

   187

   Locates the record in receiver buffer with tag name of <TAG> in the current level

3) FNDTYP (TYPNAM)

   188

   Locates the record in receiver buffer with type of <TYPNAM >

4) GETSKL (TYPE)

   192

   Process skeleton codes for record type of <TYPE>

5) BLDFMT (TYPE)

   193

   Build an ANSI FORTRAN IV format for skeleton of <TYPE>.

The DB manipulation utilities are those routines which are most commonly accessed by routines logically referencing the data base. That is, the manipulation routines provide the primary interface between users and worker routines and the stored design information. These routines use DB access utilities to acquire information (passed through a buffer) so it can be transformed according to the needs of the worker routine. Manipulation routines are completely isolated from the host machine (and the kernel). They often assume data to be fetched and operate directly on a copy of the data base information in the internal manipulation or "Receiver" buffer.

The DB manipulation utilities are:

1) USEDB (CPBLTY, OPTION)

   181

   Preset pointers to reference capability < CPBLTY >

2) SETDB (TYPE, TAG, OPTION, SETMOD)

   182

   Cause fetch of skeleton, and setup of records of type <TYPE> under tag of <TAG>

3) RETRV (DATA, FLDNBR, OPTION)

   184

Retrieves information from output buffer according to current skeleton at field number <FLDNBR>

4) Insert (DATA, FLDNBR, OPTION)

183

Inserts data into output buffer according to current skeleton at field number <FLDNBR>

5) Flush (OPTION)

185

Empty output buffer to the active output file (usually the design file).

There are four main buffers used to hold data during a data base transaction. They are the receiver buffer, the output buffer, the skeleton buffer, and the template buffer. The receiver buffer holds information that has been found by FNDLEV, FNDTYP, and FNDTAG. SETDB causes data found in the receiver buffer to be copied to output buffer, for use by INSERT, RETRV, and FLUSH. The skeleton buffer holds the skeleton information for the current record type. The template buffer serves a similar purpose for template information. This is used by RETRV and INSERT to perform data format conversions for internal use by worker routines. The information in these buffers is also used by SETDB to build run-time formats for the design file.

Data Base File Contents

Each item of information stored in the data base is stored in a field, which has a conventional (standard) name, a current value, a format code, and a location. The current value is always expressed as a string of characters, which is interpreted in a way specified by the format code.

Fields are usually collected into meaningful sets of related information. Each set of one or more items has its corresponding set of current value character strings recorded in a record. Each record has a type, which is indicated by the value of the first field (card type code) of the record. Each record is always 80 characters long, even if some parts are not used.

A list of information (e.g., signal set mode list) may be continued on successive records of the same type. Continuation is implied in this situation by order of appearance. In general, position of various occurrences of record types in this data base is of significance.

A collection of related records of one or more record types may be grouped together in a packet. Each packet consists of records of a particular set of types, which appear within the packet in a specific order. (Examples appear in the contents section). Each packet has a tag (or name) which appears on the first record of the packet. For example, a packet tagged 14PINDIP contains a detailed physical description of package type 14 pin dual inline pack.

Packets are organized into levels which reflect the degree of detail or information resolution contained in each packet. Each level has a name reflecting the class of information stored at that level; for example the level named USERS contains packets which describe attributes of system users.

The data base file is sequentially organized, with a fixed record length of 80 characters. A host-system-independent internal organization using symbolic references (pointers) and record types is maintained in the file. Each major application of the data base uses a section of the file which has a name and a level number two. Within each level (here one) are found subcollections of information each having a level name and a level number one greater than the containing level. For example, at one time the DASLLDB level structure looked like--

```
                  I----  2.  SYSTYPE
                  I
                  I----  2.  SYSDEFN
                  I
                  I----  2.  SYSDOC
                  I
1.  DBSYSDATA --  I----  2.  USERS
                  I
                  I----  2.  ROUTELIB

                  I----  3.  PROMPTS
                  I
                  I----  3.  BOARD
                  I
                  I----  3.  DEVICETYPE
                  I
                  I----  3.  PACKAGES
                  I
                  I----  3.  WIRULES
                  I
                  I----  3.  CONNECT
```

Within each level definition, one might find packets of information and/or definitions of subsidary levels. As will be explained later, the order in which things appear in the file is critical.

Each type of utilization of the data base supports a specific DA system capability (e.g., PCB routing), and requires certain predefinable data base services. Within the DB file is kept a list of record types associated with each capability, so that data base access software can predetermine access requirements. Each capability is described by a packet of records referenced by the capability name (packet tag). The packet contains a set of records which list the subsidary capabilities and/or record types needed to support an application.

Each record consists of 80 characters, the first three of which identify a particular record type. Positions 3 thru 69 contain characters representing stored values of fields associated with the record. Record character 70 contains a plus symbol if information stored on the record is to be continued onto a succeeding record of the same type.

Certain records used to organize the data base file use distinguishing characters in the record type code field---

```
$X   Level X Header Record
*Y   Packet Y Header Record
 (   Commentary Text Record--Ignored in all
     Processing
```

Each packet consists of a packet header and a packet body. The header record specifies the packet tag (name), and may contain other location or information source items. The packet body consists of an ordered set of records of specific types and meanings.

Each record type used in the data base is itself defined by a descriptive packet found in level 1 = DBSYSDATA, Level 2 = SYSDEFN. The packet tag is the name (3-character code) of the subject record type. ZRD records explain the purpose of the subject. ZDC records explain the purpose of the fields found on the subject record. A set of template (ZTM) records list the standard reference names of the fields, in the left-to-right order they appear on the subject. A set of skeleton records (ZSK) describe the contents of each field. Each field descriptor is 10 characters long and is found on a ZSK card in the same relative position as the field name on the ZTM record.

A group of (one or more) fields may be repeated on a data base data record type specification out to a limit of one card image (Col 70). A shorthand method for specifying that a group of fields is to be repeated in a record type skeleton is the use of the repetition description field on the skeleton (ZSK) card. The repetition description has the general form

IIJJZDKKK

where II is the field number of the first field in the group to be repeated, JJ counts the number of times the group (II to last field defined) is to be repeated, including II = first, the character positions between successive groups. KKK blank or zero means no separation interval.

For example---

```
ZSK0404I         0802A      1002I      0202ZD001
   Field 1       Field 2    Field 3    Field 4
is equivalent to
ZSK0404I         0802A      1002I      1302A    1502I
```

Card Format Descriptions

Appendix I reproduces documentation on the card types found in the example design files and in Appendix I. A brief commentary on this material may help to explain it. Consider the packet which describes type RLL cards, which begins with the packet header card (*RLL) sequenced DB 127. Two ZSK cards describe the field positions and content represesentations of type RLL records, with two ZTM cards in the packet describing corresponding field standard reference names. Three ZRD cards summarize the purpose of the RLL record, and then the purpose each field is briefly explained. For example, the third field of each type RLL record begins in character position 19, is 5 characters long, and contains an integer number. It is called LEGY, and is the Y-ordinate of the reference point for the legal location (or component site) described by an RLL record.

LAYOUT PROBLEMS

To illustrate the use of design files for printed circuit board layouts, a simple two-integrated-circuit problem is presented in some detail. Figure 1 shows several descriptive reports extracted from the design file listed in Figure 2. The checkprints shown in Figure 3 were generated on an 11" electrostatic plotter using the design file of Figure 2. The wiring paths shown were generated during testing of an unoptimized Lee router. A production processing run using this problem would result in a somewhat higher quality layout. Figure 4 shows the data which would be supplied by a user to initiate the creation of the two chip example problem.

Figure 5 shows the design file (most wire segments deleted for brevity) for another relatively small problem whose etch artwork is shown in Figure 6.

Figure 7 shows a slightly more complicated checkprint, followed by the design file.

The layout problems described by these examples represent only a few of the boards which could be made available in this Newsletter. Please write to the editor if you would like to see more layout problems made available.

```
**********************************
*                                *
*  B O A R D   S U M M A R Y     *
*                                *
**********************************

OARD NUMBER  LEA68-907004                           BOARD TYPE   CLI1
EPORT GENERATION TIME, MACHINE, AND DATE          10:57:24 U 10/29/76
SER NUMBER                                                    129075
OARD TITLE                             DASLL TEST EXAMPLE.
UMBER OF SIGNAL SETS                         7
UMBER OF FROMTOS                            13
UMBER OF WIRED FROMTOS        13.  100.0 PCT
UMBER OF FROMTOS NOT WIRED     0.     0.  PCT
UMBER OF DEVICES                            54
UMBER OF DEVICE TYPES                        4
UMBER OF PADS                               80
UMBER OF UNUSED PADS                        60
UMBER OF PIN VIAS                           36
UMBER OF FEEDTHRU VIAS                       0
```

```
**************************
*                        *
*   P A R T   L I S T    *
*                        *
**************************

OARD NUMBER  LEA68-907004                            BOARD TYPE   CLI1
EPORT GENERATION TIME, MACHINE, AND DATE          10:57:24 U 10/29/76
SER NUMBER                                                    129075

ART  NAME          QUANTITY        PACKAGE NAME          DEVICE LIST
4PINDIP                1                                  IC2

'ART  NAME         QUANTITY        PACKAGE NAME          DEVICE LIST
N7400N                 1                                  IC1
 7    2    1   40    1 LOADING ROUTE PRB   1 STOPAT=33023
 0    1    0    1   16 NORMAL COMPLETION OF PROCESSING          0
```

```
**********************************
*                                *
*   D E V I C E   R E P O R T    *
*                                *
**********************************

)ARD NUMBER  LEA68-907004                           BOARD TYPE   CLI1
:PORT GENERATION TIME, MACHINE, AND DATE          10:57:24 U 10/29/76
SER NUMBER                                                    129075

EVICE NAME   DEVICE TYPE   DEVICE LOCATION   BOARD LAYER   ROTATION
:1           SN7400N         2.000    2.500        1             0.
                                      PIN   1   SIGNAL SET +5V
                                            2              IN1
                                            3              IN2
                                            4              OUT1
                                            5              UNUSED
                                            6              UNUSED
                                            7              UNUSED
                                            8              UNUSED
                                            9              UNUSED
                                           10              UNUSED
                                           11              UNUSED
                                           12              UNUSED
                                           13              UNUSED
                                           14              GND

EVICE NAME   DEVICE TYPE   DEVICE LOCATION   BOARD LAYER   ROTATION
C2           14PINDIP        2.000    4.000        1             0.
                                      PIN   1   SIGNAL SET +5V
                                            2              IN1
                                            3              IN2
                                            4              OUT2
                                            5              UNUSED
                                            6              UNUSED
                                            7              UNUSED
                                            8              UNUSED
                                            9              UNUSED
                                           10              OUT9
                                           11              UNUSED
                                           12              UNUSED
                                           13              UNUSED
                                           14              GND
```

```
*****************************************************
*                                                   *
*   S I G N A L   S T R I N G   R E P O R T         *
*                                                   *
*****************************************************

BOARD NUMBER  LEA68-907004                          BOARD TYPE   CLI
REPORT GENERATION TIME, MACHINE, AND DATE        10:57:24 U 10/29/7
USER NUMBER                                                  12907

+5V        (  5)  FOIL .066  MIN SEPARATION .016  VIA  9    NO WIRE
                                        DEVICE IC1          PIN   1
                                               IC2                1
                                               +EC44 +21          1

GND        (  1)  FOIL .066  MIN SEPARATION .016  VIA  9    NO WIRE
                                        DEVICE IC1          PIN  14
                                               IC2               14
                                               +EC44 +22          1

IN1        (  3)  FOIL .036  MIN SEPARATION .016  VIA  9    NO WIRE
                                        DEVICE IC1          PIN   2
                                               IC2                2
                                               +EC44 +1           1

IN2        (  2)  FOIL .036  MIN SEPARATION .016  VIA  9    NO WIRE
                                        DEVICE IC1          PIN   3
                                               IC2                3
                                               +EC44 +2           1
                                               +EC44 +3           1

OUT1       (  7)  FOIL .036  MIN SEPARATION .016  VIA  9    NO WIRE
                                        DEVICE IC1          PIN   4
                                               +TP8  +1           1

OUT2       (  6)  FOIL .036  MIN SEPARATION .016  VIA  9    NO WIRE
                                        DEVICE IC2          PIN   4
                                               +EC44 +4           1
                                               +TP3  +2           1

OUT9       (  4)  FOIL .036  MIN SEPARATION .016  VIA  9    NO WIRE
                                        DEVICE IC2          PIN  10
                                               +EC44 +C           1

UNUSED     (  8)                                            NO WIRE
                                        DEVICE IC1          PIN   5
                                               IC1                6
                                               IC1                7
                                               IC1                8
                                               IC1                9
                                               IC1               10
                                               IC1               11
                                               IC1               12
                                               IC1               13
                                               IC2                5
                                               IC2                6
                                               IC2                7
                                               IC2                8
                                               IC2                9
                                               IC2               11
                                               IC2               12
                                               IC2               13
                                               +TP8  +3           1
                                               +TP8  +4           1
                                               +TP8  +5           1
                                               +TP8  +6           1
                                               +TP8  +7           1
                                               +TP8  +8           1
```

{Land Lower Left Corner

{Land Upper Right Corner

{Name of Wire Segment

{Wire Segment Centerline

{Layer on which Segment Routed

{Feedthru via Pad is Layer Zero

WIRE SEGMENTS BY SIGNAL SET

LINKX	LINKY	LINKZ	LINKX	LINKY	LINKZ	NAME	C/L-X1	C/L-Y1	C/L-X2	C/L-Y2
WIRE SEGMENTS FOR SIGSET 1 GND										
2647	3877	0	2723	3953	0	005	2685	3915	2685	3915
2647	2467	0	2723	2543	0	007	2685	2505	2685	2505
2567	1647	0	2643	1723	0	00C	2605	1685	2605	1685
1350	1582	1	1466	1632	1	001	1350	1607	1466	1607
2575	3915	1	2625	4000	1	002	2600	3915	2600	4000
2600	3890	1	2685	3940	1	003	2600	3915	2685	3915
2600	2480	1	2685	2530	1	006	2600	2505	2685	2505
2575	2500	1	2625	2505	1	008	2600	2500	2600	2505
1441	1607	1	1491	1685	1	009	1466	1607	1466	1685
1466	1660	1	2605	1710	1	00A	1466	1685	2605	1685
2660	2505	2	2710	3915	2	004	2685	2505	2685	3915
2580	1685	2	2630	2500	2	00B	2605	1685	2605	2500
2600	2475	2	2605	2525	2	00D	2600	2500	2605	2500
WIRE SEGMENTS FOR SIGSET 2 IN2										
2362	4472	0	2438	4548	0	013	2400	4510	2400	4510
2362	4122	0	2438	4198	0	016	2400	4160	2400	4160
2772	4122	0	2848	4198	0	018	2810	4160	2810	4160
2772	2892	0	2848	2968	0	01A	2810	2930	2810	2930
2362	2892	0	2438	2968	0	01C	2400	2930	2400	2930
1340	4571	1	1360	4727	1	00E	1350	4571	1350	4727
1350	4561	1	1466	4581	1	00F	1350	4571	1466	4571
1456	4510	1	1476	4571	1	010	1466	4510	1466	4571
1466	4500	1	2400	4520	1	011	1466	4510	2400	4510
2400	4150	1	2810	4170	1	015	2400	4160	2810	4160
2400	2920	1	2810	2940	1	019	2400	2930	2810	2930
2390	4300	2	2410	4510	2	012	2400	4300	2400	4510
2390	4160	2	2410	4300	2	014	2400	4160	2400	4300
2800	2930	2	2820	4160	2	017	2810	2930	2810	4160
2390	2800	2	2410	2930	2	01B	2400	2800	2400	2930
WIRE SEGMENTS FOR SIGSET 3 IN1										
2462	4042	0	2538	4118	0	020	2500	4080	2500	4080
2712	4042	0	2788	4118	0	022	2750	4080	2750	4080
2712	2822	0	2788	2898	0	024	2750	2860	2750	2860
2462	2822	0	2538	2898	0	026	2500	2860	2500	2860
2462	4782	0	2538	4858	0	02A	2500	4820	2500	4820
1350	4873	1	1466	4893	1	01D	1350	4883	1466	4883
2500	4070	1	2750	4090	1	01F	2500	4080	2750	4080
2500	2850	1	2750	2870	1	023	2500	2860	2750	2860
1456	4820	1	1476	4883	1	027	1466	4920	1466	4883
1466	4810	1	2500	4830	1	028	1466	4920	2500	4820
2490	4080	2	2510	4300	2	01E	2500	4080	2500	4300
2740	2860	2	2760	4080	2	021	2750	2860	2750	4080
2490	2800	2	2510	2860	2	025	2500	2800	2500	2860
2490	4300	2	2510	4820	2	029	2500	4300	2500	4820
WIRE SEGMENTS FOR SIGSET 4 OUT9										
1428	4611	0	1504	4687	0	02D	1466	4649	1466	4649
1492	4027	0	1568	4103	0	031	1530	4065	1530	4065
2162	4027	0	2238	4103	0	033	2200	4065	2200	4065
1530	4055	1	2200	4075	1	030	1530	4065	2200	4065
1350	4561	2	1466	4581	2	02B	1350	4571	1466	4571
1456	4571	2	1476	4649	2	02C	1466	4571	1466	4649
1466	4639	2	1530	4659	2	02E	1466	4649	1530	4649
1520	4065	2	1540	4649	2	02F	1530	4065	1530	4649
2190	4000	2	2210	4065	2	032	2200	4000	2200	4065
WIRE SEGMENTS FOR SIGSET 5 +5V										
2647	4197	0	2723	4273	0	038	2685	4235	2685	4235
2857	4197	0	2933	4273	0	03A	2895	4235	2895	4235
2857	2977	0	2933	3053	0	03C	2895	3015	2895	3015
2567	2977	0	2643	3053	0	03E	2605	3015	2605	3015
1877	1807	0	1953	1883	0	043	1915	1845	1915	1845
1877	2677	0	1953	2753	0	045	1915	2715	1915	2715
2567	2677	0	2643	2753	0	047	2605	2715	2605	2715
1350	1738	1	1466	1788	1	034	1350	1763	1466	1763
2685	4210	1	2895	4260	1	037	2685	4235	2895	4235
2605	2990	1	2895	3040	1	03B	2605	3015	2895	3015
1441	1763	1	1491	1845	1	040	1466	1763	1466	1845
1466	1820	1	1915	1870	1	041	1466	1845	1915	1845
1915	2690	1	2605	2740	1	044	1915	2715	2605	2715
2600	4275	2	2685	4325	2	035	2600	4300	2685	4300
2660	4235	2	2710	4300	2	036	2685	4235	2685	4300
2870	3015	2	2920	4235	2	039	2895	3015	2895	4235
2580	2800	2	2630	3015	2	03D	2605	2800	2605	3015
2600	2775	2	2605	2825	2	03F	2600	2800	2605	2800
1890	1845	2	1940	2715	2	042	1915	1845	1915	2715
2580	2715	2	2630	2800	2	046	2605	2715	2605	2800
2600	2775	2	2605	2825	2	048	2600	2800	2605	2800
WIRE SEGMENTS FOR SIGSET 6 OUT2										
1872	4317	0	1948	4393	0	04D	1910	4355	1910	4355
1872	4327	0	1948	4403	0	04F	1910	4365	1910	4365
2262	4327	0	2338	4403	0	051	2300	4365	2300	4365
2932	4162	0	3008	4238	0	055	2970	4200	2970	4200
2932	4322	0	3008	4398	0	057	2970	4360	2970	4360
2262	4322	0	2338	4398	0	059	2300	4360	2300	4360
1350	4405	1	1466	4425	1	049	1350	4415	1466	4415
1456	4355	1	1476	4415	1	04A	1466	4355	1466	4415
1466	4345	1	1910	4365	1	04B	1466	4355	1910	4355
1910	4355	1	2300	4375	1	04E	1910	4365	2300	4365
3890	4100	1	3910	4200	1	052	3900	4100	3900	4200
2970	4190	1	3900	4210	1	053	2970	4200	3900	4200
2300	4350	1	2970	4370	1	056	2300	4360	2970	4360
1900	4355	2	1920	4365	2	04C	1910	4355	1910	4365
2290	4300	2	2310	4365	2	050	2300	4300	2300	4365
2960	4200	2	2980	4360	2	054	2970	4200	2970	4360
2290	4300	2	2310	4360	2	058	2300	4300	2300	4360

```
WIRE SEGMENTS FOR SIGSET   7 OUT1
        3002   4362      0          3078   4438      0  050   3040   4400   3040   4400
        3002   3032      0          3078   3108      0  05F   3040   3070   3940   3070
        2262   3032      0          2330   3100      0  061   2300   3070   2300   3070
        3890   4400      1          3910   4500      1  054   3900   4400   3900   4500
        3040   4390      1          3900   4410      1  058   3040   4400   3900   4400
        2300   3060      1          3040   3080      1  05E   2300   3070   3040   3070
        3030   3070      2          3030   4400      2  05C   3040   3070   3040   4400
        2290   2800      2          2310   3070      2  066   2300   2800   2300   3070
```

FROM-TO LIST
-------- ----

NBR	FMX	FMY	Z	TOX	TOY	Z	SIGSET	SIGNAME	STATUS
1	1350	4571	1	1350	4727	1	2	IN2	ROUTED
2	2300	4300	0	1350	4415	1	6	OUT2	ROUTED
3	2400	4300	0	1350	4571	1	2	IN2	ROUTED
4	2200	4000	0	1350	4571	2	4	OUT9	ROUTED
5	2600	2500	0	2600	4000	0	1	GND	ROUTED
6	2500	2800	0	2500	4300	0	3	IN1	ROUTED
7	2400	2800	0	2400	4300	0	2	IN2	ROUTED
8	2600	2800	0	2600	4300	0	5	+5V	ROUTED
9	2500	4300	0	1350	4883	1	3	IN1	ROUTED
10	2300	4300	0	3900	4100	0	6	OUT2	ROUTED
11	2600	2500	0	1350	1607	1	1	GND	ROUTED
12	2600	2800	0	1350	1763	1	5	+5V	ROUTED
13	2300	2800	0	3900	4500	0	7	OUT1	ROUTED

Figure 1. Two Chip CLI Board Sample Report

```
ZFMRSG(A3,120, 2A10,I6, 2A10)                    {Board Number and Title
RSG                     WGH
***
ZFMRDS(A3, 2A10,A1,A6, 3A10)
RDSLEAG3-90/004         A12/15/DASLL TEST EXAMPLE.
***
ZFMRDT(A3, 6A10)                                 {Commentary Remarks
RDTTWO 14-PIN DIPS AND SIX SIGNAL SETS.
***
ZFMRBG(A3,I2,I1,I1,I1,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5)
RBG 1112 1000 1000 4000 5500 1350 1100 3975 5540 1350 1100 3975 5400
***
ZFMRLL(A3,A10,I5,I5,I2,I2,I10,I10, 2X, 1X,10X,A3)
RLL←TP8   ←1    3900 4500 0 1          4          1  0   {Board
RLL←TP8   ←4    3900 3300 0 1          4          2  0   {Geometry
RLL←EC44  ←18   1350 2231 1 1          3          3  0
RLL←EC44  ←10   1350 3479 1 1          3          4  0
RLL←EC44  ←1    1350 4903 1 1          3          5  0   {Legal
RLL←EC44  ←F    1350 4103 2 1          3          6  0   {Locations
RLLIC2          2000 4000 1 1          2          7  1
RLL←TP8   ←3    3900 3700 0 1          4          8  0
RLL←EC44  ←E    1350 4259 2 1          3          9  0
RLL←TP8   ←2    3900 4100 0 1          4         10  0
RLL←EC44  ←Z    1350 1607 2 1          3         11  0
RLL←EC44  ←D    1350 4415 2 1          3         12  0
RLL←EC44  ←17   1350 2387 1 1          3         13  0
RLL←EC44  ←Y    1350 1763 2 1          3         14  0
RLL←EC44  ←C    1350 4571 2 1          3         15  0
RLL←EC44  ←X    1350 1919 2 1          3         16  0
RLL←EC44  ←B    1350 4727 2 1          3         17  0
RLL←EC44  ←W    1350 2075 2 1          3         18  0
RLL←EC44  ←16   1350 2546 1 1          3         19  0
RLLIC1          2000 2500 1 1          1         20  1
RLL←EC44  ←A    1350 4883 2 1          3         21  0
RLL←EC44  ←V    1350 2231 2 1          3         22  0
RLL←EC44  ←U    1350 2387 2 1          3         23  0
RLL←EC44  ←T    1350 2546 2 1          3         24  0
RLL←EC44  ←15   1350 2699 1 1          3         25  0
RLL←EC44  ←S    1350 2699 2 1          3         26  0
RLL←EC44  ←R    1350 2855 2 1          3         27  0
RLL←EC44  ←14   1350 2855 1 1          3         28  0
RLL←EC44  ←P    1350 3011 2 1          3         29  0
RLL←EC44  ←13   1350 3011 1 1          3         30  0
RLL←EC44  ←9    1350 3635 1 1          3         31  0
RLL←EC44  ←N    1350 3167 2 1          3         32  0
RLL←EC44  ←8    1350 3791 1 1          3         33  0
RLL←EC44  ←M    1350 3323 2 1          3         34  0
RLL←EC44  ←22   1350 1607 1 1          3         35  0
RLL←EC44  ←7    1350 3947 1 1          3         36  0
RLL←EC44  ←L    1350 3479 2 1          3         37  0
RLL←EC44  ←12   1350 3167 1 1          3         38  0
RLL←EC44  ←6    1350 4103 1 1          3         39  0
RLL←EC44  ←K    1350 3635 2 1          3         40  0
RLL←TP8   ←8    3900 1700 0 1          4         41  0
RLL←EC44  ←5    1350 4259 1 1          3         42  0
RLL←EC44  ←21   1350 1763 1 1          3         43  0
RLL←EC44  ←J    1350 3791 2 1          3         44  0
RLL←TP8   ←7    3900 2100 0 1          4         45  0
RLL←EC44  ←19   1350 2075 1 1          3         46  0
RLL←EC44  ←4    1350 4415 1 1          3         47  0
RLL←EC44  ←11   1350 3323 1 1          3         48  0
RLL←TP8   ←6    3900 2500 0 1          4         49  0
RLL←EC44  ←3    1350 4571 1 1          3         50  0
RLL←EC44  ←H    1350 3947 2 1          3         51  0
RLL←TP8   ←5    3900 2900 0 1          4         52  0
RLL←EC44  ←20   1350 1919 1 1          3         53  0
RLL←EC44  ←2    1350 4727 1 1          3         54  0
***
ZFMRRV(A3, 2(I2,I5,I5,I5,I5))
RRV 0 1250 1100 1350 1500 0 1250 5000 1350 5400
RRV 0 3825 4050 4000 5400                        {Routing
***                                              {Barriers
ZFMRDV(A3,A10,I10, 1X, 1X,10X)
RDV←TP8   ←1          4
RDV←TP8   ←4          4
RDV←EC44  ←18         3
RDV←EC44  ←10         3
RDV←EC44  ←1          3
RDV←EC44  ←F          3
RDVIC2                2
RDV←TP8   ←3          4                          {Device
RDV←EC44  ←E          3                          {Descriptions
RDV←TP8   ←2          4
RDV←EC44  ←Z          3
RDV←EC44  ←D          3
RDV←EC44  ←17         3
RDV←EC44  ←Y          3
RDV←EC44  ←C          3
RDV←EC44  ←X          3
RDV←EC44  ←B          3
RDV←EC44  ←W          3
RDV←EC44  ←16         3
RDVIC1                1
RDV←EC44  ←A          3
RDV←EC44  ←V          3
RDV←EC44  ←U          3
RDV←EC44  ←T          3
RDV←EC44  ←15         3
RDV←EC44  ←S          3
RDV←EC44  ←R          3
RDV←EC44  ←14         3
RDV←EC44  ←P          3
RDV←EC44  ←13         3
RDV←EC44  ←9          3
RDV←EC44  ←N          3
RDV←EC44  ←8          3
RDV←EC44  ←M          3
RDV←EC44  ←22         3
RDV←EC44  ←7          3
RDV←EC44  ←L          3
RDV←EC44  ←12         3
RDV←EC44  ←6          3
RDV←EC44  ←K          3
RDV←TP8   ←8          4
RDV←EC44  ←5          3
RDV←EC44  ←21         3
RDV←EC44  ←J          3
RDV←TP8   ←7          4
RDV←EC44  ←19         3
RDV←EC44  ←4          3
```

```
RDV←EC44 ←11        3
RDV←TP8  ←6         4
RDV←EC44 ←3         3
RDV←EC44 ←0         3
RDV←TP8  ←5         4
RDV←EC44 ←20        3
RDV←EC44 ←2         3
***
ZFMRTD(A3.A10.I10.I3.I3)
RTDSN1400N            1005  1
RTD14PINDIP           1005  1
RTDCLIEDGECON         2001 44
RTDCLITESTPT          3002  8
***
ZFMRPK(A3.I2.I10.I10.I3.I4.I3.I3.I16.A10. 5X)
RPK14      0          00020005000002000000007700300
RPKA1      A          0000   10000009025902500250025EDGECON
RPK01      0          0000   20000029063906300630063CLITESTPT
***
ZFMRPF(A3. 4(I4.I4.I2.I2. 2X. 1X))
RPF 600 300 8 0 8  500 300 8 0 8  400 300 8 0 8  300 300 8 0 8
RPF 200 300 8 0 8  100 300 8 0 8    0 300 8 0 8    0   0 8 0 8
RPF 100   0 8 0 8  200   0 8 0 8  300   0 8 0 8  400   0 8 0 8
RPF 500   0 8 0 8  600   0 8 0 8
RPF000000000010100
RPF000000000020002
***
ZFMRPE(A3. 3(I2.I4.I4.I4.I4. 1X))
RPE 0004590045 645  45  09045 255 645 345
***
ZFMRRU(A3. I4.I2.I2.I2.I1.I2.I2.I4. 4X. 4X. 2X. 2X. 2X)
RRU0200016000230092000
RFU0250015000230092000
RRU0500016000239090000
***
ZFMRSD(A3.A10.I10.I10.I3. 1X. 5X. 3X. 5X. 3X)
RSDGND              3            1  3
RSDIN2              1            4  4
RSDIN1              1            8  3
RSDOUT9             1           11  2
RSD+5V              3           13  3
RSDOUT2             1           16  3
RSDOUT1             1           19  2
RSDUNUSED           1           21  0
***
ZFMRSN(A3.10(I3.I3))
RSN  20 14   2 14  35   1 39   3  7   3 54   1 50   1 20   2  7   2  5   1
RSN   2 10  15   1 20   1  7   1 45   1  7   4 47   1 10   1 20   4  1   1
***
ZFMRCT(A3.I4.I4.I4.I4.I4.I4.I4.I4.I4)
RCT   54  54    3    4    3    8   20    3    1
***
ZFMFLT(A3.A10.A10.A10.A10)
FLT14420610I26    129:75          010-21-76
***
ZFMRLH(A3.16(I4))
RLH
***
ZFMRFT(A3. 9(I5))
RFT 1350 4571    1 1350 4727    1    2    0    0
RFT 2300 4300    0 1350 4415    1    6    0    0
RFT 2400 4300    0 1350 4571    1    2    0    0
RFT 2200 4000    0 1350 4571    2    4    0    0
RFT 2600 2500    0 2600 4000    0    1    0    0
RFT 2500 2800    0 2500 4300    0    3    0    0
RFT 2400 2800    0 2400 4300    0    2    0    0
RFT 2000 2000    0 2000 4500    0    5    0    0
RFT 2500 4500    0 1350 4883    1    3    0    0
RFT 2500 4500    0 3900 4100    0    6    0    0
RFT 2000 2500    0 1350 1607    1    1    0    0
RFT 2600 2000    0 1350 1763    1    5    0    0
RFT 2300 2800    0 3900 4500    0    7    0    0
***
ZFMRWS(A3.12(I5))
RWS 1350 1607    1    0    1    0  116   50   66    0    1    0
RWS 2600 4000    1    0    4  270   85   50   66    0    1    0
RWS 2600 3915    1    0    1    0   85   50   66    0    1    0
RWS 2685 3915    2    9    4  270 1410   50   66    0    1    1
RWS 2685 2505    1    9    3  180   85   50   66    0    1    1
RWS 2600 2505    1    0    4  270    5   50   66    0    1    0
RWS 1466 1607    1    0    2   90   78   50   66    0    1    0
RWS 1466 1685    1    0    1    0 1139   50   66    0    1    0
RWS 2605 1685    2    9    2   90  815   50   66    0    1    1
RWS 2605 2500    2    0    3  180    5   50   66    0    1    0
RWS 1250 4571    1    0    2   90  155   20   36    0    2    0
RWS 1350 4571    1    0    1    0  116   20   36    0    2    0
RWS 1466 4571    1    0    4  270   61   20   36    0    2    0
RWS 1466 4510    1    0    1    0  934   20   36    0    2    0
RWS 2400 4510    2    9    4  270  210   20   36    0    2    1
RWS 2400 4300    2    0    4  270  140   20   36    0    2    0
RWS 2400 4160    1    9    1    0  410   20   36    0    2    1
RWS 2810 4160    2    9    4  270 1230   20   36    0    2    1
RWS 2810 2930    1    9    3  180  410   20   36    0    2    1
RWS 2400 2930    2    9    4  270  130   20   36    0    2    1
RWS 1350 4883    1    0    1    0  116   20   36    0    3    0
RWS 2500 4300    2    0    4  270  220   20   36    0    3    0
RWS 2500 4080    1    9    1    0  250   20   36    0    3    1
RWS 2750 4080    2    9    4  270 1220   20   36    0    3    1
RWS 2750 2860    1    9    3  180  250   20   36    0    3    1
RWS 2500 2060    2    9    4  270   60   20   36    0    3    1
RWS 1466 4883    1    0    4  270   63   20   36    0    3    0
RWS 1466 4820    1    0    1    0 1034   20   36    0    3    0
RWS 2500 4020    2    9    4  270  520   20   36    0    3    1
RWS 1350 4571    2    0    1    0  116   20   36    0    4    0
RWS 1465 4571    2    0    2   90   78   20   36    0    4    0
RWS 1466 4649    2    9    1    0    0   20   36    0    4    1
RWS 1466 4649    2    0    1    0   64   20   36    0    4    0
RWS 1530 4649    2    0    4  270  584   20   36    0    4    0
RWS 1530 4065    1    9    1    0  670   20   36    0    4    1
RWS 2200 4065    2    9    4  270   65   20   36    0    4    1
RWS 1350 1763    1    0    1    0  116   50   66    0    5    0
RWS 2600 4300    2    0    1    0   85   50   66    0    5    0
RWS 2685 4300    2    0    4  270   65   50   66    0    5    0
RWS 2685 4235    1    9    1    0  210   50   66    0    5    1
RWS 2895 4235    2    9    4  270 1220   50   66    0    5    1
RWS 2895 3015    1    9    3  180  290   50   66    0    5    1
RWS 2605 3015    2    9    4  270  215   50   66    0    5    1
RWS 2605 2800    2    0    3  180    5   50   66    0    5    0
RWS 1466 1763    1    0    2   90   82   50   66    0    5    0
RWS 1466 1845    1    0    1    0  449   50   66    0    5    0
RWS 1915 1845    2    9    2   90  870   50   66    0    5    1
RWS 1915 2715    1    9    1    0  690   50   66    0    5    1
RWS 2605 2715    2    9    2   90   85   50   66    0    5    1
RWS 2605 2800    2    0    3  180    5   50   66    0    5    0
RWS 1350 4415    1    0    1    0  116   20   36    0    6    0
RWS 1465 4415    1    0    4  270   60   20   36    0    6    0
RWS 1460 4355    1    0    1    0  444   20   36    0    6    0
RWS 1910 4355    2    9    2   90   10   20   36    0    6    1
RWS 1910 4365    1    9    1    0  390   20   36    0    6    1
RWS 2300 4365    2    9    4  270   65   20   36    0    6    1
RWS 3900 4100    1    0    2   90  100   20   36    0    6    0
RWS 3900 4200    1    0    3  180  930   20   36    0    6    0
RWS 2970 4200    2    9    2   90  160   20   36    0    6    1
RWS 2970 4360    1    9    3  180  670   20   36    0    6    1
RWS 2300 4360    2    9    4  270   60   20   36    0    6    1
RWS 3900 4500    1    0    4  270  100   20   36    0    7    0
RWS 3900 4400    1    0    3  180  860   20   36    0    7    0
RWS 3040 4400    2    9    4  270 1330   20   36    0    7    1
RWS 3040 3070    1    9    3  180  740   20   36    0    7    1
RWS 2300 3070    2    9    4  270  270   20   36    0    7    1
***
```

Device Types

Package Descriptions

Footprints

Pad Envelopes

Wiring Rules

Signal Sets

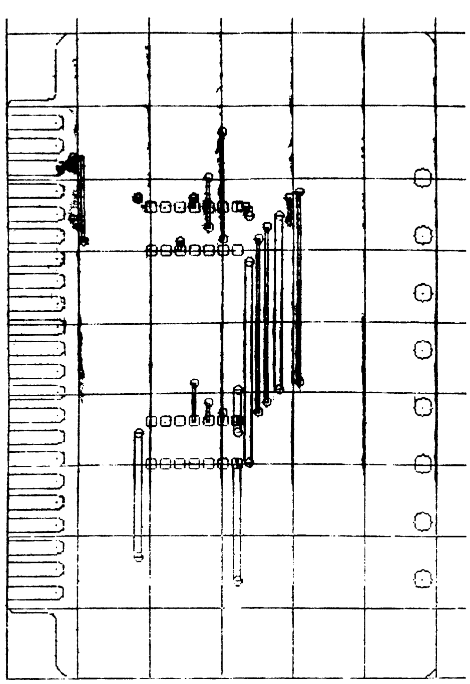
Node Lists

Count Summary

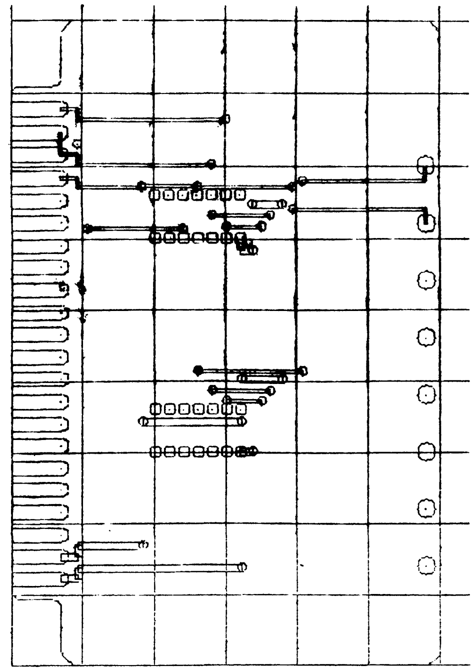
FromTo List

Wire Segments and Vias

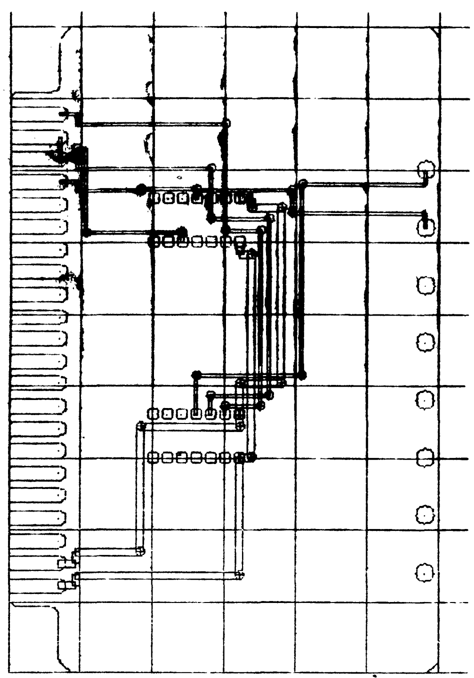
Figure 2. Two Chip CLI Board Design File



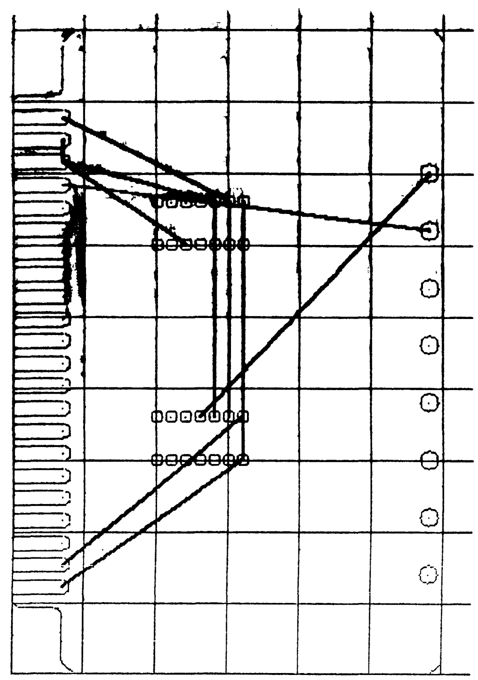
a. Top Conductor Layer



b. Bottom Conductor Layer



c. Both Layers Superimposed (Unoptimized)



d. Connections (Fromtos) to be wired.

Figure 3. Two Chip CLI Checkprints

```
$ID SECTION
ORIGINATOR      - WGM
BOARD NUMBER    - LEA68-907004
REVISION LETTER - A
REVISION DATE   - 12/15/75
TITLE           - DASLL TEST EXAMPLE.
DESCRIPTION     - TWO 14-PIN DIPS AND SIX SIGNAL SETS.
$WIRING RULE SECTION
POWER       +5V       GND
$COMPONENTS SECTION
IC1         SN7400N   2.0        2.5        1        0.
IC2         14PINDIP  2.0        4.0        1        0.
EC44        CLIEDGECON
TP8         CLITESTPT
```

```
$SIGNAL SECTION
IC1      01 +5V      02 IN1      03 IN2      04 OUT1      +
         14 GND
IC2      01 +5V      02 IN1      03 IN2      04 OUT2      +
         14 GND      10 OUT9
EC44     01 IN1      02 IN2      03 IN2      04 OUT2      +
         21 +5V      22 GND       C OUT9
TP8      01 OUT1     02 OUT2
END DATA
TTY INPUT
```

Figure 4. 2-Chip User Input Deck

```
ZFMRSG(A3,I20, 2A10,I6, 2A10)
RSG                          N. HOWARD
***
ZFMRDS(A3, 2A10,A1,A6, 3A10)
RDS75-2110-11              -6-4-76CURSOR CONTROL PRINTED CIRCUIT
***
ZFMRDT(A3, 6A10)
RDT-INCLUDES ENGINEERING CHANGES
***
ZFMRDG(A3,I2,I1,I1,I1,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5)
RDG 3112 1000 1000 675011125 1100 1100 665011025 1100 1100 665011025
***
ZFMRLL(A3,A10,I5,I5,I2,I2,I10,I10, 2X, 1X,10X,A3)
RLLR13         1500 4090 1 1          15           1  1
RLLCR7         3000 2090 1 1           9           2  1
RLLQ1          6000 7000 1 1          14           3  1
RLLIC3         2250 7000 1 1           1           4  1
RLLR52         3000 9700 1 3          15           5  1
RLLR1          1500 9090 1 1          15           6  1
RLLR43         5250 3000 1 1          15           7  1
RLLR34         1500 7300 1 1          15           8  1
RLLR2          1500 9000 1 1          15           9  1
RLLCR3         3000 6090 1 1           9          10  1
RLLR25         1500 2210 1 1          15          11  1
RLLR16         1500 3000 1 1          15          12  1
RLLPWRINGND    400010750 1 1          17          13  1
RLLIC17        5550 5000 1 1           2          14  1
RLLIC16        4000 7000 1 1           8          15  1
RLLR24         1500 2300 1 1          15          16  1
RLLIC6         2250 4000 1 1           1          17  1
RLLR5          1500 7090 1 1          15          18  1
RLLIC15        6000 2000 1 1           7          19  1
RLLIC14        4000 8000 1 1           6          20  1
RLLR46         5250 2000 1 1          15          21  1
RLLIC13        4000 3000 1 1           5          22  1
RLLR37         1500 8210 1 1          15          23  1
RLLR30         1500 5300 1 1          15          24  1
RLLIC12        4000 4000 1 1           5          25  1
RLLR28         1500 4300 1 1          15          26  1
RLLR21         245010490 1 1          16          27  1
RLLR8          1500 6000 1 1          15          28  1
RLLIC11        4000 6000 1 1           4          29  1
RLLR19         3000 3300 1 1          15          30  1
RLLR12         3000 6300 1 1          15          31  1
RLLR18         1500 2000 1 1          15          32  1
RLLIC10        4000 5000 1 1           3          33  1
RLLIC9         4000 9000 1 1           2          34  1
RLLIC2         2250 6000 1 1           1          35  1
RLLR51         3000 9800 1 3          15          36  1
RLLR49         5250 4900 1 3          15          37  1
RLLR42         5250 4000 1 1          15          38  1
RLLPWRIN-15    205010750 1 1          17          39  1
RLLC2          5250 2300 1 3          13          40  1
RLLCR11        525010135 1 3          11          41  1
RLLCR10        125010300 1 1          10          42  1
RLLQ2          6000 6000 1 1          14          43  1
RLLQ3          6000 4000 1 1          14          44  1
RLLR15         1500 [illegible]090 1 1          15          45  1
RLLCR9         24501[illegible]600 1 3          10          46  1
RLLCR2         3000 [illegible]000 1 1           9          47  1

RLLIC5         2250 5000 1 1           1          48  1
RLLR54         3000 9500 1 3          15          49  1
RLLR4          1500 8000 1 1          15          50  1
RLLR45         5250 3090 1 1          15          51  1
RLLR36         1500 8300 1 1          15          52  1
RLLR27         1500 3210 1 1          15          53  1
RLLR20         3000 2300 1 1          15          54  1
RLLQ4          6000 3000 1 1          14          55  1
RLLR11         1500 5000 1 1          15          56  1
RLLR7          1500 6090 1 1          15          57  1
RLLCR5         3000 3090 1 1           9          58  1
RLLIC8         2250 2000 1 1           1          59  1
RLLIC1         2250 9000 1 1           1          60  1
RLLR50         5250 4800 1 3          15          61  1
RLLR48         5250 2090 1 1          15          62  1
RLLR41         5250 6000 1 1          15          63  1
RLLR39         1500 9210 1 1          15          64  1
RLLR32         1500 6300 1 1          15          65  1
RLLC1          400010055 1 3          12          66  1
RLLR23         150010055 1 1          16          67  1
RLLPWRIN+5     470010750 1 1          17          68  1
RLLR33         1500 6210 1 1          15          69  1
RLLR14         1500 4000 1 1          15          70  1
RLLCR8         3000 2000 1 1           9          71  1
RLLCR1         3000 7090 1 1           9          72  1
RLLPWRIN+15    350010750 1 1          17          73  1
RLLCR6         3000 3000 1 1           9          74  1
RLLIC4         2250 6000 1 1           1          75  1
RLLR53         3000 9600 1 3          15          76  1
RLLR44         5250 3300 1 1          15          77  1
RLLR3          1500 8090 1 1          15          78  1
RLLR35         1500 7210 1 1          15          79  1
RLLR26         1500 3300 1 1          15          80  1
RLLR17         1500 2090 1 1          15          81  1
RLLR10         1500 5090 1 1          15          82  1
RLLCR4         3000 6000 1 1           9          83  1
RLLR6          1500 7000 1 1          15          84  1
RLLIC7         2250 3000 1 1           1          65  1
RLLR47         525010045 1 3          15          86  1
RLLR40         5250 7000 1 1          15          87  1
RLLR38         1500 9300 1 1          15          88  1
RLLR31         1500 5210 1 1          15          89  1
RLLR9          3000 7300 1 1          15          90  1
RLLR29         1500 4210 1 1          15          91  1
RLLR22         245010055 1 1          16          92  1
***
ZFMRRV(A3, 2(I2,I5,I5,I5,I5))
RRV 0 3700 1300 4050 1700 0 150010675 200010875
RRV 0 575010675 625010875
***
ZFMRDV(A3,A10,I10, 1X, 1X,10X)
RDVR13            15
RDVCR7             9
RDVQ1             14
RDVIC3             1
RDVR52            15
RDVR1             15
RDVR43            15
RDVR34            15
RDVR2             15

RDVCR3             9
RDVR25            15
RDVR16            15
RDVPWRINGND       17
RDVIC17            2
RDVIC16            8
RDVR24            15
RDVIC6             1
RDVR5             15
RDVIC15            7
RDVIC14            6
RDVR46            15
RDVIC13            5
RDVR37            15
RDVR30            15
RDVIC12            5
RDVR28            15
RDVR21            16
RDVR8             15
RDVIC11            4
RDVR19            15
RDVR12            15
RDVR18            15
RDVIC10            3
RDVIC9             2
RDVIC2             1
RDVR51            15
RDVR49            15
RDVR42            15
RDVPWRIN-15       17
RDVC2             13
RDVCR11           11
RDVCR10           10
RDVQ2             14
RDVQ3             14
RDVR15            15
RDVCR9            10
RDVCR2             9
RDVIC5             1
RDVR54            15
RDVR4             15
RDVR45            15
RDVR36            15
RDVR27            15
RDVR20            15
RDVQ4             14
RDVR11            15
RDVR7             15
RDVCR5             9
RDVIC8             1
RDVIC1             1
RDVR50            15
RDVR48            15
RDVR41            15
RDVR39            15
RDVR32            15
RDVC1             12
RDVR23            16
RDVPWRIN+5        17
RDVR33            15
RDVR14            15
RDVCR8             9
RDVCR1             9
RDVPWRIN+15       17
RDVCR6             9
RDVIC4             1
RDVR53            15
RDVR44            15
RDVR3             15
RDVR35            15
RDVR26            15
RDVR17            15
RDVR10            15
RDVCR4             9
RDVR6             15
RDVIC7             1
```

```
RDVR47                   15
RDVR40                   15
RDVR38                   15
RDVR31                   15
RDVR9                    15
RDVR29                   15
RDVR22                   16
***
ZFMRTD(A3,A10,I10,I3,I3)
RTDLM386P2               1 27  8
RTDSOCKET14              2  5  2
RTDSN7432                2  5  1
RTDCD4023AE              2  5  1
RTDCD4048AD              3  7  2
RTDSN7473                2 05  1
RTDNE555                 1 26  1
RTDSN7408                2 05  1
RTD1N4148P2              4 28  8
RTD1N758AP2              4 28  2
RTD1N748AP2              4 28  1
RTDCAPTANTB              5 16  1
RTDCAPTANTA              4 28  1
RTD2N2905AP2             6 27  4
RTDRSTR1/4W              4 28 51
RTDRSTR1W                7 21  3
RTDLUG200                8  4  4
***
ZFMRPK(A3,I2,I10,I10,I3,I4,I3,I3,I16,A10, 5X)
RPK 8          0         0  2  27 27  2
RPK14          0         000200050000020000000007700300
RPK16          0         0  2   7  0  2   0   0 770 300
RPK 2          0         0  0  28 28
RPK 2          0         0  0  16 16
RPK 3          0         0  2  27 27  2
RPK 2          0         0  0  21 21
RPK 1          0         0  0   4
***
ZFMRPF(A3, 4(I4,I4,I2,I2, 2X, 1X))
RPF 300 300 8 0 8  200 300 8 0 8  100 300 8 0 8    0 300 8 0 8
RPF   0   0 8 0 8  100   0 0 0 0  200   0 8 0 8  300   0 8 0 8
RPF 700 300 0 0 8  600 300 8 0 6  500 300 0 0 8  400 300 8 0 8
RPF 300 300 8 0 8  200 300 8 0 8  100 300 8 0 8  100 000 8 0 8
RPF 200 000 8 0 8  300 000 8 0 8  400 000 8 0 8  500 000 8 0 8
RPF 600 000 8 0 8  700 000 8 0 8
RPF 700 300 8 0 8  600 300 8 0 8  500 300 8 0 8  400 300 8 0 8
RPF 300 300 8 0 8  200 300 8 0 8  100 300 8 0 8    0 300 8 0 8
RPF   0   0 8 0 8  100   0 8 0 8  200   0 8 0 8  300   0 8 0 8
RPF 400   0 8 0 8  500   0 8 0 8  600   0 8 0 8  700   0 8 0 8
RPF   0   0 8 0 8  400   0 8 0 8
RPF   0   0 8 0 8  700   0 8 0 8
RPF   0 300 8 0 8    0   0 8 0 8  300   0 8 0 8
RPF   0   012 012  800   012 012
RPF   0   0 4 0 4
***
ZFMRPE(A3, 3(I2,I4,I4,I4,I4, 1X))
RPE 090459045 345  45  09045 255 345 345
RPE 0  559045 745  45  0  55 255 745 345
RPE 090459045 745  45  09045 255 745 345
RPE 090459045 345  45  09045 255 345 345
***
ZFMRRU(A3,I3,I3,I2,I2,I1,I2,I2,I4, 4X, 4X, 2X, 2X, 2X)
RRU0200160900230992000
RRU0250150900230992000
RRU0500160900399993000
***
ZFMRSD(A3,A10,I10,I10,I3, 1X, 3X, 3X, 5X, 3X)
RSDHH                    1         1  4
RSDBF1                   1         5  7
RSD3.7VP                 3        12  6
RSDRR                    1        18  3
RSDC0                    1        21  4
RSDGND                   3        25 28
RSD03B                   1        53  2
RSDAD                    1        55  2
RSDS0                    1        57  3
RSDAN                    1        60  2
RSDY5                    1        62  2
RSDAX                    1        64  4
RSDSS                    1        68  3
RSDX4                    1        71  4
RSDJJ                    1        75  3
RSDTT                    1        78  3
RSDAJ                    1        81  2
RSDAA                    1        83  3
RSDAF                    1        86  2
RSDS2                    1        88  3
RSDAK                    1        91  3
RSDAP                    1        94  3
RSDAU                    1        97  3
RSDUU                    1       100  2
RSDC1-                   1       102  4
RSDBB                    1       106  3
RSDY4                    1       109  2
RSD01B                   1       111  2
RSDLL                    1       113  4
RSDVV                    1       117  4
RSD02B                   1       121  2
RSDAC                    1       123  2
RSDCC                    1       125  2
RSDAM                    1       127  2
RSDAM                    1       129  2
RSDAF1                   1       131  7
RSDY2                    1       138  2
RSDAW                    1       140  3
RSD15V-                  3       143  2
RSD10V-                  3       145 19
RSDWW                    1       164  4
RSDAB                    1       168  2
RSDDD                    1       170  2
RSDNN                    1       172  4
RSDC1                    1       176  4
RSDXX                    1       180  2
RSD04B                   1       182  2
RSDAE                    1       184  2
RSDS1                    1       186  2
RSDEE                    1       188  3
RSDA0                    1       191  2
RSD5VP                   3       193 18
RSDY6                    1       211  2
RSD00                    1       213  3
RSDC0-                   1       216  4
RSDYY                    1       220  4
RSDFF                    1       224  3
RSDX2                    1       227  6
RSDPP                    1       233  3
RSDZZ                    1       236  4
RSD15VP                  3       240  3
RSD10VP                  3       243 22
RSDAG                    1       265  2
RSDS3                    1       267  2
RSDAL                    1       269  2
RSDGG                    1       271  4
RSDAQ                    1       275  3
RSDAV                    1       278  6
RSDQQ                    1       284  3
RSDUNUSED                1       287  0
***
ZFMRSN(A3,10(I3,I3))
RSN 75  7 28  2 83  1 33 13 34  2 82  1  1  1 12  1 81  1 76  2
RSN 49  2 41  2 86  2  3  3 43  1 44  3 55  1 17  2  1  2 70  1
RSN 20  7 20 12 15  4 15 13 46  1 42  2 16  1 80  1 26  1 24  1
RSN 65  1  8  1 52  1 88  1 33  7 20 11 19  1 15  7 41  1 66  2
RSN 40  2 29  3 29  4 29  5 29  7 25  9 25 15 25  8 22  9 22 15
RSN 22  8 13  1 38  2 44  2 31  2 10  2 25  5 25 12 15  3 29  9
RSN 87  1 44  1 14  3 19  6 19  2 62  2 40  1 17  7 70  2 33  9
RSN 25 11 22 11 61  2 14  7 35  3 52  2 23  2 17  3 26  2 91  2
RSN  2  1 71  2  6  2  9  1 60  2 30  2 58  2 22  5 22 12 15  8
RSN 60  3 88  2 64  2 25  1 38  1 77  1 20  5 20  1 19  3 85  3
RSN 12  2 20  8 20 14 15  2 15  5 78  2 50  1 35  2 55  3 14  2
RSN 87  2  3  2  4  2 90  1  8  2 79  2 85  7 45  2 74  1 22  6
RSN 63  2 43  2 72  1 47  2 18  2  4  3 54  2  2  2 33  8 29 11
RSN 34  1  6  1 78  1 18  1 57  1 36  2  5  2 43  3 14  8 19  7
RSN 21  1 62  1 67  2 39  1 34  7 42  1 67  1 11  1 53  1 69  1
RSN 79  1 37  1 61  1 36  1 76  1 60  4 35  4  4  4 75  4 48  4
RSN 17  4 85  4 59  4 85  2 30  1 00  2 53  2 90  2 72  2 57  2
RSN 75  3 75  2 31  1 65  2 69  2 20  9 20  3 15 10 15 12 59  3
RSN 81  2  7  2 55  2 10  1 83  2 29  1 15  6  9  2 60  7 25  6
RSN 29 10 63  1 33 14 20  4 15 14 06  1 25 15 22 10 29 14 25  2
RSN 25  3 25  7 25 10 25 14 22  2 22  3 22  7 22 10 22 14 68  1
RSN  3  1 14  4 48  2 82  2 56  1 20 10 20 13 15  1 15  9 33  7
RSN 32  2 71  1 33 10 50  2 35  7 33 12 29  8 29 13 25  4 22  4
RSN 37  2 14  6 48  7 56  2 22 13 59  2 54  1 16  2 11  2 27  2
RSN 92  2 73  1 34  6 60  8 35  0  4  8 75  8 40  8 17  8 85  8
RSN 59  8 84  1 28  1 45  1 32  1 27  1 92  1 45  2 91  1 69  1
RSN 23  1 64  1  5  1 49  1 58  1 74  2 29 12 15 11 33 11 29  2
RSN  4  7 84  2 47  1 25 13 22  1  7  1 51  1 19  4 19  8 77  2
RSN 51  2 21  2 66  1 48  3 24  2 89  2
***
ZFMRCT(A3,I4,I4,I4,I4,I4,I4,I4,I4,I4)
RCT  92  92   8  17   3  70 286   8   4
***
ZFMRLI(A3,A10,A10,A10,A10)
RLI1637R60812     280303              07-03-76
***
ZFMRLH(A3,16(I4))
RLH
***
ZFMRFT(A3, 9(I5))
RFT 525010135     0 525010045    0     3     0     0
RFT 1900 8300     0 1900 8210    0    15     0     0
RFT 1900 4300     0 1900 4210    0    16     0     0
RFT 1900 9300     0 1900 9210    0    21     0     0
RFT 1900 7300     0 1900 7210    0    29     0     0
RFT 5250 2000     0 5250 2090    0    38     0     0
RFT 1900 3300     0 1900 3210    0    41     0     0
RFT 1900 6300     0 1900 6210    0    44     0     0
RFT 1900 2300     0 1900 2210    0    60     0     0
RFT 5250 3090     0 5250 3000    0    67     0     0
RFT 1900 5300     0 1900 5210    0    69     0     0
RFT 4300 6300     0 4400 6300    0     6     0     0
RFT 4400 6300     0 4500 6300    0     6     0     0
RFT 3000 9500     0 3000 9600    0     2     0     0
RFT 3000 9700     0 3000 9800    0    36     0     0
RFT 5650 4900     0 5650 4800    0    40     0     0
RFT 4600 4300     0 4500 4300    0    52     0     0
RFT 4500 3300     0 4600 3300    0    52     0     0
```

RFT 4100 6300	0 4300 6300	0	6	0	0
RFT 3400 9600	0 3400 9800	0	40	0	0
RFT 4300 7000	0 4500 7000	0	45	0	0
RFT 4500 4000	0 4700 4000	0	52	0	0
RFT 4500 3000	0 4700 3000	0	52	0	0
RFT 3400 9500	0 3400 9700	0	62	0	0
RFT 245010400	0 245010600	0	62	0	0
RFT 3400 6300	0 3400 6090	0	8	0	0
RFT 5650 2090	0 5650 2300	0	12	0	0
RFT 3400 3300	0 3400 3090	0	19	0	0
RFT 3400 2300	0 3400 2090	0	34	0	0
RFT 3400 7300	0 3400 7090	0	42	0	0
RFT 5650 3090	0 5650 3300	0	68	0	0
RFT 4000 4300	0 4000 4000	0	6	0	0
RFT 4000 3300	0 4000 3000	0	6	0	0
RFT 4300 4300	0 4300 4000	0	9	0	0
RFT 4300 3300	0 4300 3000	0	20	0	0
RFT 4600 7300	0 4300 7300	0	25	0	0
RFT 4500 4300	0 4500 4000	0	52	0	0
RFT 4100 4000	0 4100 4300	0	52	0	0
RFT 4500 3300	0 4500 3000	0	52	0	0
RFT 4100 3000	0 4100 3300	0	52	0	0
RFT 4300 8000	0 4600 8000	0	55	0	0
RFT 325010400	0 325010055	0	61	0	0
RFT 245010055	0 245010400	0	62	0	0
RFT 5650 4000	0 6000 4000	0	7	0	0
RFT 5650 7000	0 6000 7000	0	28	0	0
RFT 5650 6000	0 6000 6000	0	31	0	0
RFT 5650 3000	0 6000 3000	0	47	0	0
RFT 6100 2000	0 6200 2300	0	12	0	0
RFT 4300 8300	0 4700 8300	0	23	0	0
RFT 4500 4000	0 4100 4000	0	52	0	0
RFT 4500 3000	0 4100 3000	0	52	0	0
RFT 2350 8300	0 1900 8300	0	15	0	0
RFT 2350 4300	0 1900 4300	0	16	0	0
RFT 2350 9300	0 1900 9300	0	21	0	0
RFT 2350 5300	0 1900 5300	0	69	0	0
RFT 3000 2090	0 3400 2000	0	17	0	0
RFT 1900 9090	0 1500 9000	0	18	0	0
RFT 1900 8090	0 1500 8000	0	26	0	0
RFT 3000 7090	0 3400 7000	0	32	0	0
RFT 1900 4090	0 1500 4000	0	4	0	0
RFT 3000 6090	0 3400 6000	0	48	0	0
RFT 1900 5090	0 1500 5000	0	54	0	0
RFT 3000 3090	0 3400 3000	0	63	0	0
RFT 150010055	0 125010300	0	40	0	0
RFT 4400 7300	0 4600 7000	0	5	0	0
RFT 4100 6000	0 4600 6000	0	58	0	0
RFT 6100 2000	0 5650 2090	0	12	0	0
RFT 2450 4000	0 1900 4000	0	13	0	0
RFT 2450 7300	0 1900 7300	0	29	0	0
RFT 2450 7300	0 3000 7300	0	29	0	0
RFT 2450 3000	0 3000 3000	0	30	0	0
RFT 2450 3300	0 1900 3300	0	41	0	0
RFT 2450 3300	0 3000 3300	0	41	0	0
RFT 2450 6300	0 1900 6300	0	44	0	0
RFT 2450 6300	0 3000 6300	0	44	0	0
RFT 1900 9000	0 2450 9000	0	50	0	0
RFT 2450 6000	0 3000 6000	0	1	0	0
RFT 2450 2000	0 1900 2000	0	56	0	0
RFT 2450 2000	0 3000 2000	0	56	0	0
RFT 1900 8000	0 2450 8000	0	57	0	0
RFT 2450 5000	0 1900 5000	0	59	0	0
RFT 2450 2300	0 1900 2300	0	60	0	0
RFT 2450 2300	0 3000 2300	0	60	0	0
RFT 2450 7000	0 1900 7000	0	66	0	0
RFT 2450 7000	0 3000 7000	0	66	0	0
RFT 2450 6000	0 1900 6000	0	1	0	0
RFT 4200 8000	0 4500 8300	0	45	0	0
RFT 4000 3000	0 4600 3000	0	6	0	0
RFT 4000 4000	0 4600 4000	0	6	0	0
RFT 4100 8000	0 4700 8000	0	25	0	0
RFT 325010400	0 350010750	0	61	0	0
RFT 6000 2300	0 6300 2000	0	68	0	0
RFT 2450 3000	0 1900 3090	0	30	0	0
RFT 6300 2000	0 5650 2000	0	68	0	0
RFT 1900 6090	0 2350 6300	0	43	0	0
RFT 2350 2300	0 1900 2090	0	46	0	0
RFT 1900 7090	0 2350 7300	0	33	0	0
RFT 400010750	0 400010055	0	6	0	0
RFT 5250 4000	0 5250 3300	0	22	0	0
RFT 4100 8300	0 4500 8000	0	5	0	0
RFT 4500 4000	0 4500 3300	0	52	0	0
RFT 4000 4000	0 4000 3300	0	6	0	0
RFT 2350 3300	0 1900 3000	0	24	0	0
RFT 1900 9090	0 2450 9300	0	18	0	0
RFT 2450 5300	0 1900 5090	0	54	0	0
RFT 2450 4300	0 1900 4090	0	4	0	0
RFT 1900 8090	0 2450 8300	0	26	0	0
RFT 4700 3300	0 5250 3090	0	67	0	0
RFT 1500 6000	0 1500 5210	0	62	0	0
RFT 4700 5000	0 4600 4300	0	52	0	0
RFT 4500 8000	0 4400 7300	0	5	0	0
RFT 4600 8000	0 4700 7300	0	55	0	0
RFT 4700 7300	0 4200 7000	0	55	0	0
RFT 4700 8000	0 4600 7300	0	25	0	0
RFT 2250 3300	0 1500 3210	0	40	0	0
RFT 1500 2210	0 2250 2300	0	40	0	0

RFT 2250 7300	0 1500 7210	0	40	0	0
RFT 1500 6210	0 2250 6300	0	40	0	0
RFT 4700 4300	0 5250 4000	0	22	0	0
RFT 5250 4800	0 5650 5300	0	14	0	0
RFT 5250 4900	0 5750 5300	0	58	0	0
RFT 1500 3000	0 1500 2090	0	2	0	0
RFT 230010055	0 205010750	0	39	0	0
RFT 4300 6000	0 5250 6000	0	51	0	0
RFT 6200 2000	0 5250 2000	0	38	0	0
RFT 2250 4300	0 2250 3300	0	40	0	0
RFT 1500 3300	0 1500 2300	0	6	0	0
RFT 1500 9090	0 1500 8090	0	36	0	0
RFT 4100 7300	0 4100 6300	0	6	0	0
RFT 2250 8300	0 2250 7300	0	40	0	0
RFT 1500 8090	0 1500 7090	0	36	0	0
RFT 4100 6300	0 4100 5300	0	6	0	0
RFT 1500 7090	0 1500 6090	0	36	0	0
RFT 2250 5300	0 2250 4300	0	40	0	0
RFT 4700 5000	0 4700 6000	0	52	0	0
RFT 4700 6000	0 4700 7000	0	52	0	0
RFT 1500 5090	0 1500 4090	0	2	0	0
RFT 4100 9300	0 3400 9600	0	40	0	0
RFT 1500 7210	0 1500 6210	0	40	0	0
RFT 1500 3210	0 1500 2210	0	40	0	0
RFT 2250 6300	0 2250 5300	0	40	0	0
RFT 6300 7000	0 6000 6300	0	3	0	0
RFT 4400 4300	0 4400 3300	0	58	0	0
RFT 4200 4000	0 4200 3000	0	14	0	0
RFT 4200 9300	0 3400 9500	0	62	0	0
RFT 1500 9300	0 1500 8300	0	6	0	0
RFT 4400 8000	0 4100 7300	0	6	0	0
RFT 1500 8300	0 1500 7300	0	6	0	0
RFT 2550 9000	0 2550 8000	0	62	0	0
RFT 2550 8000	0 2550 7000	0	62	0	0
RFT 2550 7000	0 2550 6000	0	62	0	0
RFT 2550 6000	0 2550 5000	0	62	0	0
RFT 2550 5000	0 2550 4000	0	62	0	0
RFT 2550 4000	0 2550 3000	0	62	0	0
RFT 2550 3000	0 2550 2000	0	62	0	0
RFT 1500 7000	0 1500 6000	0	62	0	0
RFT 2250 9300	0 2250 8300	0	40	0	0
RFT 1500 5210	0 1500 4210	0	62	0	0
RFT 1500 8210	0 1500 9210	0	62	0	0
RFT 1500 7300	0 1500 6300	0	6	0	0
RFT 1500 5300	0 1500 4300	0	6	0	0
RFT 6300 4000	0 6000 3300	0	3	0	0
RFT 1500 4300	0 1500 3300	0	6	0	0
RFT 1500 6300	0 1500 5300	0	6	0	0
RFT 5250 2300	0 6300 2300	0	6	0	0
RFT 2550 2000	0 1500 2000	0	62	0	0
RFT 2550 7000	0 1500 7000	0	62	0	0
RFT 6000 4300	0 6050 5300	0	11	0	0
RFT 1500 2000	0 1500 3090	0	62	0	0
RFT 1500 4090	0 1500 3000	0	2	0	0
RFT 5650 2000	0 5650 3090	0	68	0	0
RFT 4200 8000	0 4300 7000	0	45	0	0
RFT 4100 5300	0 4000 4300	0	6	0	0
RFT 4500 6000	0 4400 7000	0	64	0	0
RFT 165010300	0 1500 9300	0	6	0	0
RFT 245010055	0 2550 9000	0	62	0	0
RFT 1500 7000	0 1500 8210	0	62	0	0
RFT 285010600	0 400010750	0	6	0	0
RFT 4100 5000	0 4400 6000	0	35	0	0
RFT 3400 9700	0 245010055	0	62	0	0
RFT 4600 3000	0 5250 2300	0	6	0	0
RFT 5250 4900	0 4400 4300	0	58	0	0
RFT 3400 9600	0 2250 9300	0	40	0	0
RFT 285010600	0 165010300	0	6	0	0
RFT 4400 5000	0 4600 6300	0	65	0	0
RFT 3000 3000	0 4200 3300	0	30	0	0
RFT 4700 6300	0 4200 7300	0	49	0	0
RFT 2250 9300	0 150010055	0	40	0	0
RFT 4700 7000	0 4400 8300	0	52	0	0
RFT 6300 6000	0 5650 5000	0	37	0	0
RFT 470010750	0 565010045	0	52	0	0
RFT 400010055	0 565010135	0	6	0	0
RFT 4600 6000	0 5250 4900	0	58	0	0
RFT 4600 9300	0 3000 9500	0	2	0	0
RFT 4200 4000	0 5250 4800	0	14	0	0
RFT 4200 6000	0 5250 7000	0	10	0	0
RFT 6000 7300	0 5950 5300	0	53	0	0
RFT 4700 9300	0 3000 9700	0	36	0	0
RFT 3000 9700	0 1500 9090	0	36	0	0
RFT 6300 3000	0 6150 5300	0	27	0	0
RFT 400010055	0 4400 8000	0	6	0	0
RFT 6000 6300	0 6300 4000	0	3	0	0
RFT 3000 6000	0 4600 5000	0	1	0	0
RFT 2450 4000	0 4200 5000	0	13	0	0
RFT 4400 8300	0 470010750	0	52	0	0
RFT 4300 4300	0 4500 7300	0	9	0	0
RFT 2250 5300	0 5650 4900	0	40	0	0
RFT 4300 3300	0 4100 7000	0	20	0	0
RFT 2450 5000	0 4400 3000	0	59	0	0
RFT 525010045	0 6300 7000	0	3	0	0
RFT 3000 2000	0 4300 5000	0	56	0	0
RFT 3000 7000	0 4400 4000	0	66	0	0
RFT 2450 8000	0 4500 5000	0	57	0	0
RFT 3000 9500	0 1500 5090	0	2	0	0
RFT 2450 9000	0 4200 4300	0	50	0	0

```
RFT 4700 8300     0 6100 2300    0    23    0    0
RFT 5650 3300     0 470016055    0    60    0    0
***
ZFMRWS(A3,12(I5))
RWS 2450 5438     0    9    1    0    0   20   36    0    1    1
RWS 3000 5438     0    9    1    0    0   20   36    0    1    1
RWS 3000 5210     0    9    1    0    0   20   36    0    1    1
RWS 4000 5210     0    9    1    0    0   20   36    0    1    1
RWS 2450 6000     1    0    2   90   90   20   36    0    1    0
RWS 1900 6000     1    0    1    0  209   20   36    0    1    0
RWS 2450 5438     1    0    1    0  550   20   36    0    1    0
```

Figure 5. The ARAC Problem Design File

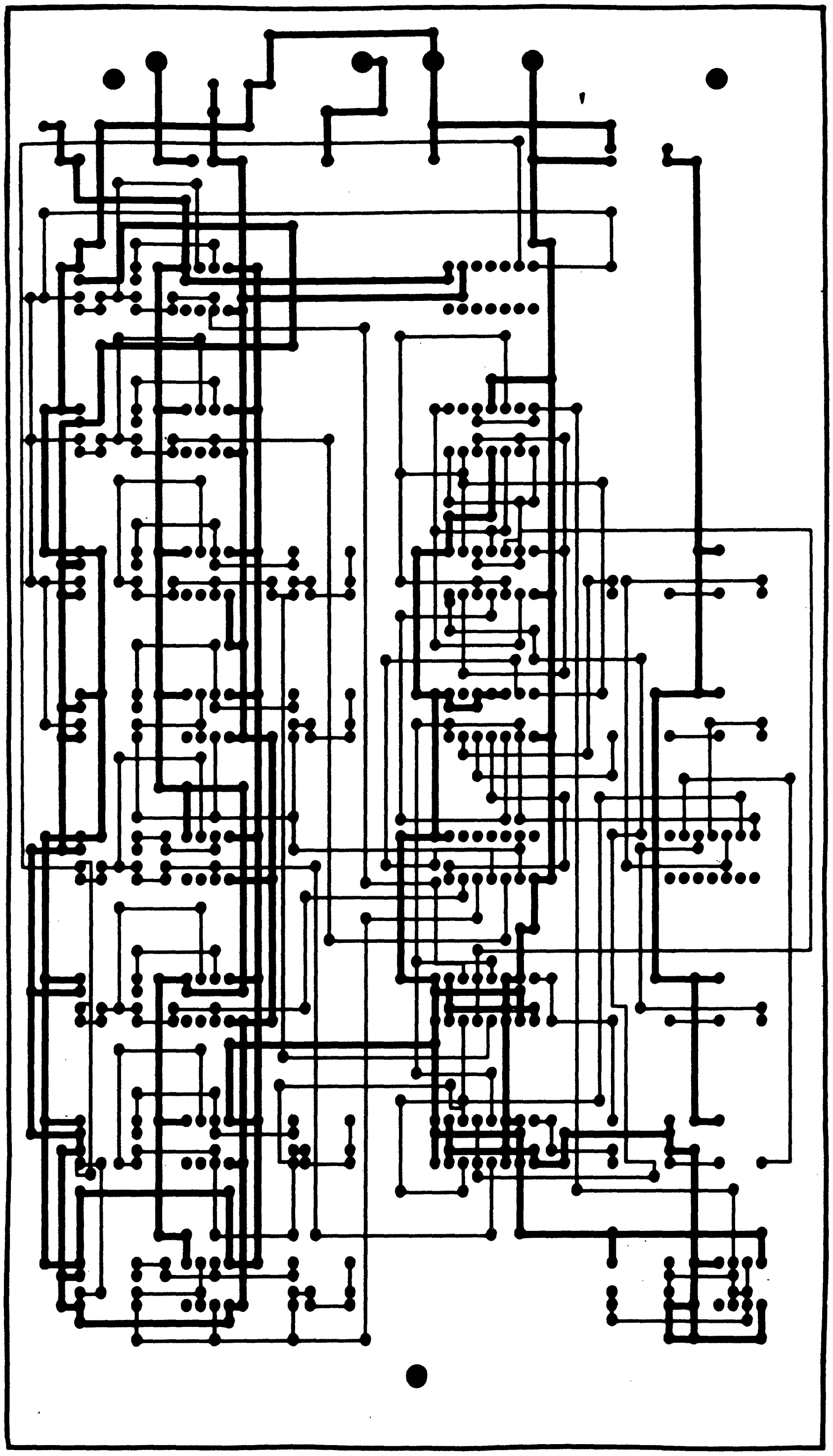


Figure 6. Etch Artwork for the ARAC Problem

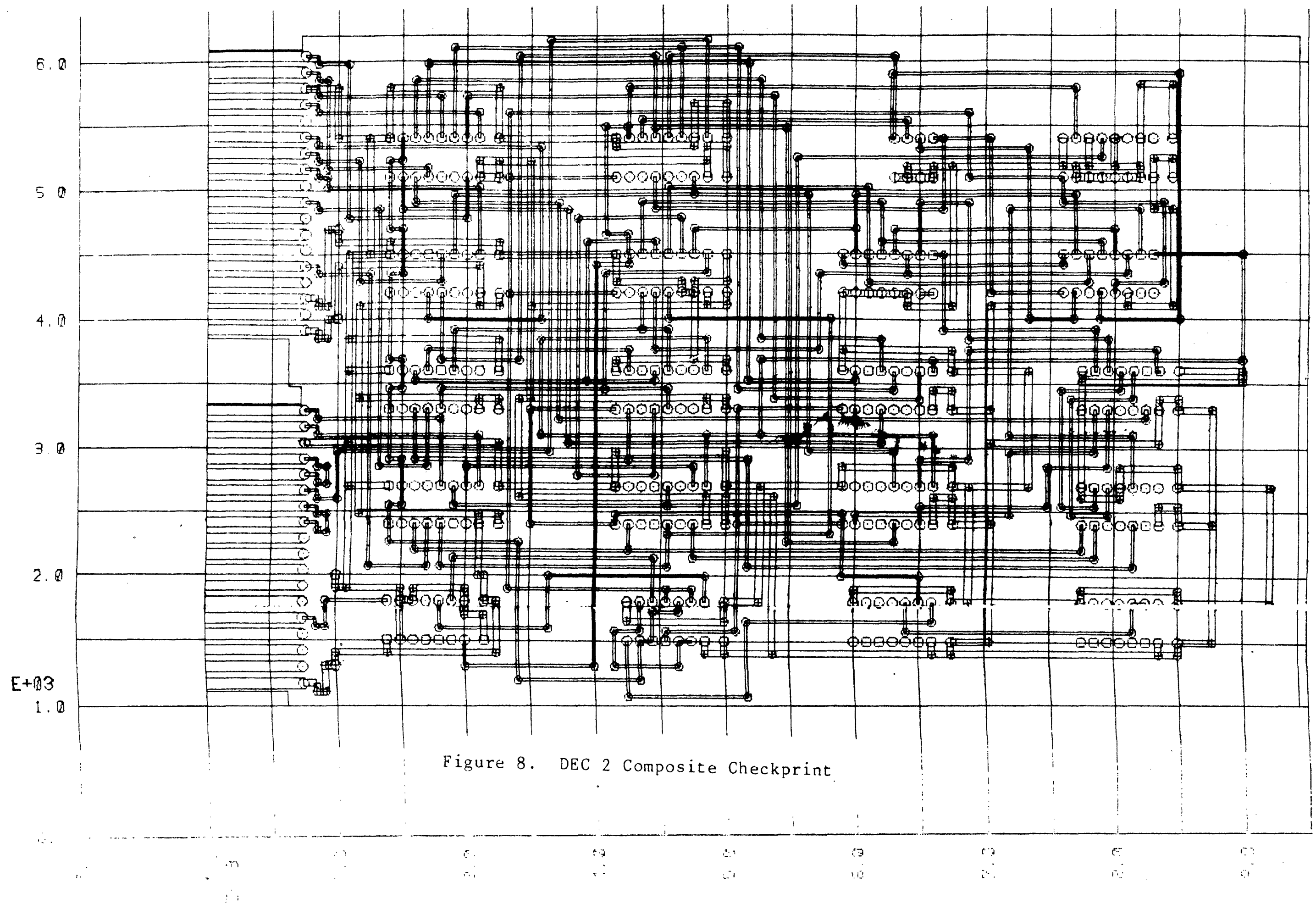


Figure 8. DEC 2 Composite Checkprint

```
ZFMRSG(A3,I20, 2A10,I6, 2A10)
RSG                    MYLES W. SPANN JR. I
***
ZFMRDS(A3, 2A10,A1,A6, 3A10)
RDSLEA76-2005-21S      07-13-7PARITY GEN,LSI 11,BOARD
***
ZFMRDT(A3, 6A10)
RDTDOUBLE HEIGHT ,EXTENDED LENGTH
***
ZFMRBG(A3,I2,I1,I1,I1,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5,I5)
RBG 6112 1000 1000 9430 6190 1900 1200 9000 5990 1750 1000 9430 6190
***
ZFMRLL(A3,A10,I5,I5,I2,I2,I10,I10, 2X, 1X,10X,A3)
RLL←ECON ←BS2 1750 5665 2 1        12        1  0
RLLIC16       7600 4200 0 1        10        2  1
RLL←ECON ←BK2 1750 4915 2 1        12        3  0
RLL←ECON ←BK1 1750 4915 1 1        12        4  0
RLL←ECON ←BC2 1750 4165 2 1        12        5  0
RLL←ECON ←BC1 1750 4165 1 1        12        6  0
RLLIC2        4250 1500 0 1         2        7  1
RLL←ECON ←AS2 1750 2915 2 1        12        8  0
RLL←ECON ←AS1 1750 2915 1 1        12        9  0
RLL←ECON ←AK2 1750 2165 2 1        12       10  0
RLL←ECON ←AK1 1750 2165 1 1        12       11  0
RLL←ECON ←AC2 1750 1415 2 1        12       12  0
RLL←ECON ←AC1 1750 1415 1 1        12       13  0
RLLC18        2000 1300 0 2        13       14  1
RLLIC6        4150 2400 0 1         6       15  1
RLL←ECON ←BR2 1750 5540 2 1        12       16  0
RLL←ECON ←BR1 1750 5540 1 1        12       17  0
RLL←ECON ←BJ2 1750 4790 2 1        12       18  0
RLL←ECON ←BJ1 1750 4790 1 1        12       19  0
RLL←ECON ←BB2 1750 4040 2 1        12       20  0
RLL←ECON ←BB1 1750 4040 1 1        12       21  0
RLLIC12       7750 3300 0 1         7       22  1
RLLIC19       6300 5100 0 1        11       23  1
RLL←ECON ←AR2 1750 2790 2 1        12       24  0
RLL←ECON ←AR1 1750 2790 1 1        12       25  0
RLL←ECON ←AJ2 1750 2040 2 1        12       26  0
RLL←ECON ←AJ1 1750 2040 1 1        12       27  0
RLL←ECON ←AB2 1750 1290 2 1        12       28  0
RLL←ECON ←AB1 1750 1290 1 1        12       29  0
RLL←ECON ←BA2 1750 3915 2 1        12       30  0
RLL←ÈCON ←BA1 1750 3915 1 1        12       31  0
RLLIC1        2400 1500 0 1         1       32  1
RLLIC15       5900 4200 0 1         9       33  1
RLL←ECON ←BS1 1750 5665 1 1        12       34  0
RLL←ECON ←AA2 1750 1165 2 1        12       35  0
RLL←ECON ←AA1 1750 1165 1 1        12       36  0
RLLIC5        2400 2400 0 1         5       37  1
RLL←ECON ←BU1 1750 5915 1 1        12       38  0
RLL←ECON ←BP2 1750 5415 2 1        12       39  0
RLL←ECON ←BP1 1750 5415 1 1        12       40  0
RLL←ECON ←BH2 1750 4665 2 1        12       41  0
RLL←ECON ←BH1 1750 4665 1 1        12       42  0
RLLIC9        2400 3300 0 1         5       43  1
RLL←ECON ←AP2 1750 2665 2 1        12       44  0
RLLIC11       5900 3300 0 1         6       45  1
RLL←ECON ←AH2 1750 1915 2 1        12       46  0
RLLIC18       4150 5100 0 1         8       47  1

RLLIC20       7600 5100 0 1         8       48  1
RLLC19        2000 4000 0 2        13       49  1
RLLIC14       4150 4200 0 1         8       50  1
RLLIC4        7750 1500 0 1         4       51  1
RLL←ECON ←BV2 1750 6040 2 1        12       52  0
RLL←ECON ←BV1 1750 6040 1 1        12       53  0
RLL←ECON ←BN2 1750 5290 2 1        12       54  0
RLL←ECON ←BN1 1750 5290 1 1        12       55  0
RLL←ECON ←BF2 1750 4540 2 1        12       56  0
RLL←ECON ←BF1 1750 4540 1 1        12       57  0
RLLIC8        7750 2400 0 1         7       58  1
RLL←ECON ←AV2 1750 3290 2 1        12       59  0
RLL←ECON ←AV1 1750 3290 1 1        12       60  0
RLL←ECON ←AN2 1750 2540 2 1        12       61  0
RLL←ECON ←AN1 1750 2540 1 1        12       62  0
RLL←ECON ←AF2 1750 1790 2 1        12       63  0
RLL←ECON ←AF1 1750 1790 1 1        12       64  0
RLLIC10       4150 3300 0 1         6       65  1
RLLIC17       2400 5100 0 1         5       66  1
RLL←ECON ←AP1 1750 2665 1 1        12       67  0
RLL←ECON ←BU2 1750 5915 2 1        12       68  0
RLL←ECON ←AH1 1750 1915 1 1        12       69  0
RLL←ECON ←BM2 1750 5165 2 1        12       70  0
RLL←ECON ←BM1 1750 5165 1 1        12       71  0
RLL←ECON ←BE2 1750 4415 2 1        12       72  0
RLL←ECON ←BE1 1750 4415 1 1        12       73  0
RLL←ECON ←AU2 1750 3165 2 1        12       74  0
```

```
RLL←ECON ←AU1 1750 3165 1 1           12           75  0
RLL←ECON ←AM2 1750 2415 2 1           12           76  0
RLL←ECON ←AM1 1750 2415 1 1           12           77  0
RLLIC3        6000 1500 0 1            3           78  1
RLL←ECON ←AE2 1750 1665 2 1           12           79  0
RLL←ECON ←AE1 1750 1665 1 1           12           80  0
RLLIC13       2400 4200 0 1            5           81  1
RLL←ECON ←BT2 1750 5790 2 1           12           82  0
RLL←ECON ←BT1 1750 5790 1 1           12           83  0
RLLIC7        5900 2400 0 1            6           84  1
RLL←ECON ←BL2 1750 5040 2 1           12           85  0
RLL←ECON ←BL1 1750 5040 1 1           12           86  0
RLL←ECON ←BD2 1750 4290 2 1           12           87  0
RLL←ECON ←BD1 1750 4290 1 1           12           88  0
RLL←ECON ←AT2 1750 3040 2 1           12           89  0
RLL←ECON ←AT1 1750 3040 1 1           12           90  0
RLL←ECON ←AL2 1750 2290 2 1           12           91  0
RLL←ECON ←AL1 1750 2290 1 1           12           92  0
RLL←ECON ←AD2 1750 1540 2 1           12           93  0
RLL←ECON ←AD1 1750 1540 1 1           12           94  0
***
ZFMRRV(A3, 2(I2,I5,I5,I5,I5))
RRV 0 1000 1000 1625 1100 0 1000 3340 1725 3480
RRV 0 1000 3480 1625 3850 0 1000 6050 1725 6190
***
ZFMRDV(A3,A10,I10, 1X, 1X,10X)
RDV←ECON ←BS2        12
RDVIC16              10
RDV←ECON ←BK2        12
RDV←ECON ←BK1        12
RDV←ECON ←BC2        12
RDV←ECON ←BC1        12
RDVIC2                2

RDV←ECON ←AS2        12
RDV←ECON ←AS1        12
RDV←ECON ←AK2        12
RDV←ECON ←AK1        12
RDV←ECON ←AC2        12
RDV←ECON ←AC1        12
RDVC18               13
RDVIC6                6
RDV←ECON ←BR2        12
RDV←ECON ←BR1        12
RDV←ECON ←BJ2        12
RDV←ECON ←BJ1        12
RDV←ECON ←BB2        12
RDV←ECON ←BB1        12
RDVIC12               7
RDVIC19              11
RDV←ECON ←AR2        12
RDV←ECON ←AR1        12
RDV←ECON ←AJ2        12
RDV←ECON ←AJ1        12
RDV←ECON ←AB2        12
RDV←ECON ←AB1        12
RDV←ECON ←BA2        12
RDV←ECON ←BA1        12
RDVIC1                1
RDVIC15               9
RDV←ECON ←BS1        12
RDV←ECON ←AA2        12
RDV←ECON ←AA1        12
RDVIC5                5
RDV←ECON ←BU1        12
RDV←ECON ←BP2        12
RDV←ECON ←BP1        12
RDV←ECON ←BH2        12
RDV←ECON ←BH1        12
RDVIC9                5
RDV←ECON ←AP2        12
RDVIC11               6
RDV←ECON ←AH2        12
RDVIC18               8
RDVIC20               8
RDVC19               13
RDVIC14               8
RDVIC4                4
RDV←ECON ←BV2        12
RDV←ECON ←BV1        12
RDV←ECON ←BN2        12
RDV←ECON ←BN1        12
RDV←ECON ←BF2        12
RDV←ECON ←BF1        12
RDVIC8                7
RDV←ECON ←AV2        12
RDV←ECON ←AV1        12
RDV←ECON ←AN2        12
RDV←ECON ←AN1        12
RDV←ECON ←AF2        12
RDV←ECON ←AF1        12
RDVIC10               6
RDVIC17               5
RDV←ECON ←AP1        12

RDV←ECON ←BU2        12
RDV←ECON ←AH1        12
RDV←ECON ←BM2        12
RDV←ECON ←BM1        12
RDV←ECON ←BE2        12
RDV←ECON ←BE1        12
RDV←ECON ←AU2        12
RDV←ECON ←AU1        12
RDV←ECON ←AM2        12
RDV←ECON ←AM1        12
RDVIC3                3
RDV←ECON ←AE2        12
RDV←ECON ←AE1        12
RDVIC13               5
RDV←ECON ←BT2        12
RDV←ECON ←BT1        12
RDVIC7                6
RDV←ECON ←BL2        12
RDV←ECON ←BL1        12
RDV←ECON ←BD2        12
RDV←ECON ←BD1        12
RDV←ECON ←AT2        12
RDV←ECON ←AT1        12
RDV←ECON ←AL2        12
RDV←ECON ←AL1        12
RDV←ECON ←AD2        12
RDV←ECON ←AD1        12
***
ZFMRTD(A3,A10,I10,I3,I3)
RTDSN8T380WC          1031  1
RTDSN7400AWC          1031  1
RTDSN7432NWC          1031  1
RTDSN8801AWC          1031  1
RTDDM8838NWC          2032  4
RTDSN74175NWC         2032  4
RTDSN74180NWC         1031  2
RTDDM8136NWC          2032  3
RTDSWDIP16            3007  1
RTDRDIP16680          3007  1
RTDSWDIP8             4027  1
RTDDECEDGECON         5  1 72
RTDCAPTANTB           6 16  2
***
ZFMRPK(A3,I2,I10,I10,I3,I4,I3,I3,I16,A10, 5X)
RPK16        0          0  2  31     2
RPK18        0          0  2  32     2
RPK16        0          0  2   7  0  2    0    0 770 300
RPK 8        0          0  2  27 27  2
RPK01        0          0000   1                          EDGECON
RPK 2        0          0  0  16 16
***
ZFMRPF(A3, 4(I4,I4,I2,I2, 2X, 1X))
RPF 600 300 8 0 8  500 200 8 0 8  400 300 8 0 8  300 300 8 0 8
RPF 200 300 8 0 8  100 300 8 0 8    0 300 8 0 8    0   0 8 0 8
RPF 100   0 0 0 8  200   0 8 0 8  300   0 8 0 8  400   0 8 0 8
RPF 500   0 0 0 8  600   0 8 0 8  750   0 8 0 8  750 300 8 0 8
RPF 700 300 8 0 8  600 300 8 0 8  500 300 8 0 8  400 300 8 0 8
RPF 300 300 8 0 8  200 300 8 0 8  100 300 8 0 8    0 300 8 0 8
RPF   0   0 8 0 8  100   0 8 0 8  200   0 8 0 8  300   0 8 0 8
RPF 400   0 8 0 8  500   0 8 0 8  600   0 8 0 8  700   0 8 0 8

RPF 850   0 8 0 8  850 300 8 0 8
RPF 700 300 8 0 8  600 300 8 0 8  500 300 8 0 8  400 300 8 0 8
RPF 300 300 8 0 8  200 300 8 0 8  100 300 8 0 8    0 300 8 0 8
RPF   0   0 8 0 8  100   0 8 0 8  200   0 8 0 8  300   0 8 0 8
RPF 400   0 8 0 8  500   0 8 0 8  600   0 8 0 8  700   0 8 0 8
RPF 300 300 8 0 8  200 300 8 0 8  100 300 8 0 8    0 300 8 0 8
RPF   0   0 8 0 8  100   0 8 0 8  200   0 8 0 8  300   0 8 0 8
RPF   0   016 1
RPF   0   0 8 0 8  700   0 8 0 8
***
ZFMRPE(A3, 3(I2,I4,I4,I4,I4, 1X))
RPE 090459045 795  45  09045 255 795 345
RPE 090459045 895  45  09045 255 895 345
RPE 090459045 745  45  09045 255 745 345
RPE 090459045 345  45  09045 255 345 345
***
ZFMRRU(A3,I3,I3,I2,I2,I1,I2,I2,I4, 4X, 4X, 2X, 2X, 2X)
RRU02001609002309920000
RRU02501509002309920000
RRU05001609003999930000
***
ZFMRSD(A3,A10,I10,I10,I3, 1X, 3X, 3X, 5X, 3X)
RSDBDAL02L              1          1  2
RSDRDA03                1          3  3
RSDBDAL13L              1          6  2
RSDBGILBGOL             1          8  2
RSDBKILBKOL             1         10  2
RSDDIN                  1         12  2
RSD6S113R1111           1         14  3
RSDGND                  3         17 67
RSD14P2S77R77           1         84  3
RSD671011P1R1           1         87  5
RSDBDAL06L              1         92  2
RSDP12S91R99            1         94  3
RSDBDINL                1         97  2
RSDP12S33R33            1         99  3
RSDRDA08                1        102  3
RSD8P512P3              1        105  2
RSDRDA14                1        107  2
RSDP10S44R44            1        109  3
RSDBDAL01L              1        112  2
RSDBDAL12L              1        114  2
RSDRPLY                 1        116  3
RSDRDA04                1        119  3
RSDDEVSEL               1        122  6
RSDRDA10                1        128  3
RSD8P612P4              1        131  2
RSDRDA00                1        133  3
RSDWD12                 1        136  3
```

```
RSDS102R1010         1        139  3
RSDDAL05L            1        142  2
RSD14S08R08          1        144  3
RSDRDA09             1        147  3
RSDPDA15             1        150  2
RSDBDAL06L           1        152  2
RSDSYP               3        154 39
RSDBDAL11L           1        193  2
RSD4S16R2            1        195  2
RSDPDA05             1        197  3
RSDDS7L              1        200  2

RSDRDA11             1        202  3
RSDBDAL09L           1        205  2
RSDWD09              1        207  3
RSD4S124R1212        1        210  3
RSDPDA01             1        213  3
RSDWD08              1        216  3
RSDBDAL04L           1        219  2
RSDBDAL15L           1        221  2
RSDSYNC              1        223  4
RSDWD07              1        227  3
RSDWD15              1        230  3
RSD14P6S55R55        1        233  3
RSDWD06              1        236  3
RSDLSR               1        239  6
RSDWD14              1        245  3
RSDDDAL10L           1        248  2
RSDDDAL08L           1        250  2
RSDWD05              1        252  3
RSDPDA06             1        255  3
RSDSYNCL             1        258  2
RSDWD13              1        260  3
RSDBDOUTL            1        263  2
RSDRDA12             1        265  3
RSD12P6S11           1        268  2
RSDWRTLYL            1        270  2
RSDPDA04             1        272  3
RSDDOUT              1        275  2
RSDWENBL             1        277 11
RSDRDA02             1        288  3
RSDDDAL03L           1        291  2
RSDWD03              1        293  3
RSDBDAL14L           1        296  2
RSDWD11              1        298  3
RSDWD02              1        301  3
RSDWD10              1        304  3
RSD14P4S66R66        1        307  3
RSD2P62P1213         1        310  3
RSDWD01              1        313  3
RSD2P83P1            1        316  2
RSDBDAL07L           1        318  2
RSD12P5S22           1        320  2
RSDRDA07             1        322  3
RSDWD09              1        325  3
RSDRDA13             1        328  2
RSDUNUSED            1        330 58
***
ZFMRSN(A3 10(I3,I3))
RSN 37 12 72  1 37 13 15 13 50 13 66  4 82  1 24  1  8  1 76  1
RSN 61  1 32  3  7  1  2 11 47  6 23  3 32  1 32  5 32  6 32  9
RSN 32 15  7  7  7 16 78  7 78 16 51  7 51 16 37  8 37 18 15  8
RSN 15 10 84  8 84 18 58  4 58  7 58 16 43  8 43 18 65  8 65 18
RSN 45  8 45 18 22  7 22  8 22 16 81  8 81 18 50  8 50 14 50 15
RSN 50 18 33  9 33 10 33 11 33 12 33 13 33 14 66  8 66 18 47  2
RSN 47  8 47 18 23  5 23  6 23  7 23  8 48  2 48  4 48  6 48  8
RSN 48 10 48 11 48 12 49 13 48 14 49 15 48 18 14  2 49  2 12  1
RSN  5  1 90  1 83  1 50  2 33  7  2  7 15  1 84  1 65  1 45  1
RSN  2  1 43 12  3  1  2  9 47 12 23  1 32  4 46  1 50 12 33  3
RSN  2  3 84  4 81  3 47 15 58  5 22  3 45 12 66 10 50 10 33  4
RSN  2  4 37  4 59  1 66  1  1  1 78  3 51  2 51  3 43  3 65  4
RSN 50 11  7  2  7  4 50  9  2 13 47  9 48  9 84 12 81 10 47 11

RSN 58  6 22  4 37  3 15  4 48  5 45  2 22 11 66  2  2 10 47 10
RSN 23  2 43  4 18  1 33  8  2  8 47 14 84  5 81  5 47 13 45 13
RSN 66 13 37  1 74  1 32  8 32 16  7 14  7 15 78 14 78 15 51 14
RSN 51 15 37 16 37 17 15 16 15 17 84 16 84 17 58 14 58 15 43 16
RSN 43 17 65 16 65 17 45 16 45 17 22 14 22 15 81 16 81 17 50 16
RSN 50 17  2 14 66 16 66 17 47 16 47 17 48 16 48 17 14  1 49  1
RSN 35  1 30  1 81 15 16  1 58  3  2  2 43  6 65  5 50  5 47  1
RSN 44  1 84 13 81 13 47  5 81  4 54  1 84  7 22  2 81  5  2 12
RSN 47  4 23  4 37  6 15  5 48  3 84  2 22  1 81  2 43  1 41  1
RSN 66 15 52  1 32 14 50  7 47  7 48  7 58 13 43 14 65 15 33 15
RSN 33 16 66 14 50  6 33  5  2  5 58 12 43 11 65 10  7 11 78  2
RSN 15  9 84  9 65  9 45  9 45 10 22 13 66 11 81 12 39  1 81  1
RSN 70  1 58 11 43  5 65  7 43 10 65 12 50  3 32 10 26  1 45  7
RSN 22 12 66  5 32  7 79  1 45  4 66  3 47  3 22  6 33  1 51  1
RSN 63  1 58 10 43  2 65  2 32  2  7  5  7  3  7  9  7 10 37  7
RSN 37  9 43  7 43  9 81  7 81  9 66  7 66  9 37 10 15 12 48  1
RSN 37 15 56  1 37 14 15 15 58  9 66 12 68  1 84 15 22 10 81 14
RSN 37 11 15 10 58  8 84 10 22  9 81 11 50  4 33  6  2  6  7  6
RSN  7 12  7 13 37  3 15  7 58  2  7  8 78  1 43 15 85  1 22  5
RSN 33  2 43 13 65 13 50  1 37  2 15  2 58  1 45  3 66  6 32 11
RSN 32 12 32 13 78  4 78  5 78  6 78  8 78  9 78 10 78 11 78 12
RSN 78 13 51  4 51  5 51  6 51  8 51  9 51 10 51 11 51 12 51 13
RSN 15  3 15  6 15 11 15 14 84  3 84  6 84 11 84 14 65  3 65  6
RSN 65 11 65 14 45  3 45  6 45 11 45 14 45 15
***
ZFMRCT(A3,I4,I4,I4,I4,I4,I4,I4,I4,I4)
RCT   94   94    6   13    3   83  367    6    4
***
```

```
ZFMRLI(A3,A10,A10,A10,A10)
RLI2049Z60726    604500            07-03-76
***
ZFMRLH(A3,16(I4))
RLH
***
ZFMRFT(A3, 9(I5))
RFT 2600 1800    0 2500 1800    0    8    0    0
RFT 4650 4200    0 4750 4200    0    8    0    0
RFT 5900 4200    0 6000 4200    0    8    0    0
RFT 6000 4200    0 6100 4200    0    8    0    0
RFT 6100 4200    0 6200 4200    0    8    0    0
RFT 6200 4200    0 6300 4200    0    8    0    0
RFT 6300 4200    0 6400 4200    0    8    0    0
RFT 6400 5100    0 6500 5100    0    8    0    0
RFT 6500 5100    0 6600 5100    0    8    0    0
RFT 6400 5100    0 6300 5100    0    8    0    0
RFT 7700 5100    0 7800 5100    0    8    0    0
RFT 7800 5100    0 7900 5100    0    8    0    0
RFT 7900 5100    0 8000 5100    0    8    0    0
RFT 8000 5100    0 8100 5100    0    8    0    0
RFT 8100 5100    0 8200 5100    0    8    0    0
RFT 8150 1800    0 8250 1800    0   21    0    0
RFT 6500 4200    0 6600 4200    0   49    0    0
RFT 4450 1500    0 4350 1500    0   66    0    0
RFT 4650 1500    0 4750 1500    0   75    0    0
RFT 1750 2790    2 1750 2915    2    4    0    0
RFT 1750 2415    2 1750 2540    2    5    0    0
RFT 3100 2400    0 3250 2400    0   34    0    0
RFT 3100 3300    0 3250 3300    0   34    0    0
RFT 3100 4200    0 3250 4200    0   34    0    0
RFT 3100 5100    0 3250 5100    0   34    0    0

RFT 4850 5100    0 5000 5100    0   34    0    0
RFT 4850 4200    0 5000 4200    0   34    0    0
RFT 4850 3300    0 5000 3300    0   34    0    0
RFT 4850 2400    0 5000 2400    0   34    0    0
RFT 4850 1500    0 5000 1500    0   34    0    0
RFT 6600 1500    0 6750 1500    0   34    0    0
RFT 6750 2400    0 6600 2400    0   34    0    0
RFT 6750 3300    0 6600 3300    0   34    0    0
RFT 8350 1500    0 8500 1500    0   34    0    0
RFT 8500 2400    0 8350 2400    0   34    0    0
RFT 8500 3300    0 8350 3300    0   34    0    0
RFT 8300 5100    0 8450 5100    0   34    0    0
RFT 8200 5400    0 8000 5400    0    8    0    0
RFT 8000 5400    0 7800 5400    0    8    0    0
RFT 7800 5400    0 7600 5400    0    8    0    0
RFT 4750 1800    0 4550 1800    0   23    0    0
RFT 8200 5400    0 8450 5400    0    8    0    0
RFT 4750 5400    0 5000 5400    0    8    0    0
RFT 8050 2700    0 7750 2700    0    8    0    0
RFT 7750 3300    0 7750 3600    0    8    0    0
RFT 2500 1800    0 2500 1500    0    8    0    0
RFT 8200 5100    0 8200 5400    0    8    0    0
RFT 2000 4000    0 1750 3915    2   34    0    0
RFT 2000 1300    0 1750 1165    2   34    0    0
RFT 3000 1800    0 2600 1800    0    8    0    0
RFT 2400 2400    0 2500 2700    0   66    0    0
RFT 2400 3300    0 2500 3600    0   66    0    0
RFT 2400 4200    0 2500 4500    0   66    0    0
RFT 2400 5100    0 2500 5400    0   66    0    0
RFT 8500 2700    0 8050 2700    0    8    0    0
RFT 3000 1800    0 3150 1500    0    8    0    0
RFT 4650 1800    0 4450 1500    0   66    0    0
RFT 4750 4200    0 5000 4500    0    8    0    0
RFT 7750 2700    0 7750 3300    0    8    0    0
RFT 5900 3600    0 5900 4200    0    8    0    0
RFT 2400 1500    0 2000 1300    0   34    0    0
RFT 2400 4500    0 2000 4700    0    8    0    0
RFT 4150 5400    0 4750 5400    0    8    0    0
RFT 4350 1800    0 4650 1500    0   75    0    0
RFT 3150 1800    0 3100 2400    0   34    0    0
RFT 2500 1800    0 2000 2000    0    8    0    0
RFT 2500 2700    0 2400 3300    0   66    0    0
RFT 2500 3600    0 2400 4200    0   66    0    0
RFT 2500 4500    0 2400 5100    0   66    0    0
RFT 5000 1800    0 4250 1800    0    8    0    0
RFT 6750 1800    0 6000 1800    0    8    0    0
RFT 7750 3600    0 8500 3600    0    8    0    0
RFT 7750 1800    0 8500 1800    0    8    0    0
RFT 2000 4700    0 1750 4165    2    8    0    0
RFT 2400 1800    0 1750 1665    2   60    0    0
RFT 4550 3600    0 4350 4200    0   22    0    0
RFT 4150 4500    0 4650 4200    0    8    0    0
RFT 1750 1415    2 2500 1500    0    8    1    0
RFT 6750 3600    0 5900 3600    0    8    0    0
RFT 5900 2700    0 6750 2700    0    8    0    0
RFT 2400 4500    0 3250 4500    0    8    0    0
RFT 2400 5400    0 3250 5400    0    8    0    0
RFT 4750 4200    0 5000 3600    0    8    0    0
RFT 5000 3600    0 4150 3600    0    8    0    0
RFT 4150 2700    0 5000 2700    0    8    0    0

RFT 2400 2700    0 3250 2700    0    8    0    0
RFT 2400 3600    0 3250 3600    0    8    0    0
RFT 6750 2700    0 6750 1800    0    8    0    0
RFT 4150 4200    0 4150 5100    0   23    0    0
RFT 6600 2700    0 6600 3600    0   10    0    0
RFT 3100 2400    0 3100 3300    0   34    0    0
RFT 3100 3300    0 3100 4200    0   34    0    0
RFT 2400 4500    0 2400 5400    0    8    0    0
```

```
RFT 3100 4200    0 3100 5100    0   34    0    0
RFT 2400 3600    0 2400 4500    0    8    0    0
RFT 3250 5400    0 4150 5400    0    8    0    0
RFT 4850 5100    0 4850 4200    0   34    0    0
RFT 4850 2700    0 4850 3600    0   10    0    0
RFT 4850 4200    0 4850 3300    0   34    0    0
RFT 6750 2700    0 6750 3600    0    8    0    0
RFT 4850 3300    0 4850 2400    0   34    0    0
RFT 3250 4500    0 4150 4500    0    8    0    0
RFT 4850 2400    0 4850 1500    0   34    0    0
RFT 6750 1500    0 6750 2400    0   34    0    0
RFT 8500 1800    0 8500 2700    0    8    0    0
RFT 6750 2400    0 6750 3300    0   34    0    0
RFT 8500 1500    0 8500 2400    0   34    0    0
RFT 3250 2700    0 4150 2700    0    8    0    0
RFT 8500 2400    0 8500 3300    0   34    0    0
RFT 5000 2700    0 5000 1800    0    8    0    0
RFT 4450 3600    0 4450 4500    0   37    0    0
RFT 4250 4500    0 4250 5400    0   47    0    0
RFT 4150 2400    0 4150 3300    0   52    0    0
RFT 5900 2400    0 5900 3300    0   52    0    0
RFT 5000 2700    0 5900 2700    0    8    0    0
RFT 2400 2700    0 2400 3600    0    8    0    0
RFT 6400 4200    0 6400 5100    0    8    0    0
RFT 2400 2700    0 1750 3040    1    8    0    0
RFT 2500 1800    0 2400 2700    0    8    0    0
RFT 6750 1800    0 7750 1800    0    8    0    0
RFT 2400 5400    0 1750 5790    1    8    0    0
RFT 2400 1500    0 3150 1800    0   34    0    0
RFT 1750 1915    2 2700 1800    0   13    1    0
RFT 6600 5100    0 7700 5100    0    8    0    0
RFT 7950 2700    0 8150 3600    0   16    0    0
RFT 7850 2700    0 8050 3600    0   25    0    0
RFT 8100 4200    0 8300 5100    0   34    0    0
RFT 8350 3300    0 8100 4200    0   34    0    0
RFT 5900 2400    0 6500 1800    0   52    0    0
RFT 4750 4500    0 6000 4500    0    9    0    0
RFT 3100 4200    0 2000 4000    0   34    0    0
RFT 7600 5100    0 8000 4200    0   23    0    0
RFT 4550 1500    0 4150 2400    0   52    0    0
RFT 1750 2040    2 2600 1500    0   58    1    0
RFT 4450 3300    0 4650 4500    0   57    0    0
RFT 2800 5400    0 1750 5790    2    3    0    0
RFT 4550 3300    0 4850 4500    0   80    0    0
RFT 4250 3600    0 2700 3600    0   56    0    0
RFT 2900 1800    0 4450 1800    0   65    0    0
RFT 4550 4500    0 6100 4500    0   74    0    0
RFT 2700 2700    0 4250 2700    0   76    1    0
RFT 5000 1500    0 6600 1500    0   34    0    0
RFT 6750 1500    0 8350 1500    0   34    0    0
RFT 3250 5100    0 4850 5100    0   34    0    0
RFT 3100 5400    0 1750 5665    2   20    0    0

RFT 2800 2700    0 1750 3290    2   19    0    0
RFT 2900 2700    0 4550 2700    0   26    0    0
RFT 4250 3300    0 2600 3300    0   51    0    0
RFT 2600 2400    0 4250 2400    0   72    0    0
RFT 2900 3600    0 4550 3600    0   22    0    0
RFT 6200 4500    0 7900 4500    0   50    0    0
RFT 6300 4500    0 8000 4500    0   18    0    0
RFT 5900 4500    0 7600 4500    0   30    0    0
RFT 6100 4500    0 7800 4500    0   74    0    0
RFT 6400 4500    0 8100 4500    0   14    0    0
RFT 6000 4500    0 7700 4500    0    9    0    0
RFT 6300 5400    0 4550 5400    0   42    0    0
RFT 2800 2400    0 4550 2400    0    2    0    0
RFT 4150 2400    0 5900 2400    0   52    0    0
RFT 6400 1800    0 8150 1800    0   21    0    0
RFT 4650 5400    0 2900 5400    0   61    0    0
RFT 4750 3600    0 3000 3600    0   64    1    0
RFT 4850 2700    0 6600 2700    0   10    0    0
RFT 2800 3300    0 4550 3300    0   80    0    0
RFT 3000 2700    0 4750 2700    0   81    0    0
RFT 2700 5100    0 1750 5915    2   70    0    0
RFT 4550 2400    0 4550 4200    0    2    0    0
RFT 3100 2700    0 1750 3165    2   33    0    0
RFT 2800 4500    0 1750 5290    2   40    0    0
RFT 2600 2700    0 4450 2700    0   43    1    0
RFT 4750 3300    0 2900 3300    0   48    1    0
RFT 4350 4500    0 6200 4500    0   50    0    0
RFT 6500 3600    0 8050 3300    0   27    1    0
RFT 8150 2700    0 8200 4500    0   36    0    0
RFT 2600 3600    0 4450 3600    0   37    0    0
RFT 5900 4500    0 4650 5100    0   30    1    0
RFT 2900 2400    0 4750 2400    0   69    1    0
RFT 2500 3300    0 4450 3300    0   57    1    0
RFT 2500 2400    0 4450 2400    0   67    1    0
RFT 3100 4500    0 1750 5165    2   55    0    0
RFT 6400 5400    0 4350 5400    0    7    0    0
RFT 2800 1800    0 4850 1800    0    6    0    0
RFT 7850 3600    0 6600 4500    0   62    0    0
RFT 2700 4200    0 1750 5415    2   54    0    0
RFT 3000 5100    0 1750 6040    2   46    0    0
RFT 7600 4200    0 6600 5400    0   12    0    0
RFT 1750 4790    2 2800 3600    0   29    1    0
RFT 6000 3300    0 8250 3300    0   53    0    0
RFT 4450 4200    0 6400 4500    0   14    0    0

RFT 6500 2400    0 7950 3300    0   71    0    0
RFT 7950 3600    0 6500 4500    0   79    0    0
RFT 4250 4200    0 6300 4500    0   18    1    0
RFT 7700 4200    0 6500 5400    0   28    0    0
RFT 1750 4665    2 3100 3600    0   45    1    0
RFT 6000 3600    0 8150 3300    0   59    1    0
RFT 6600 5400    0 4450 5100    0   12    0    0
RFT 4750 5100    0 2900 4500    0   15    0    0
RFT 6500 5400    0 4250 5100    0   28    1    0
RFT 4550 5100    0 2600 4500    0   31    1    0
RFT 2700 3300    0 1750 4915    2   11    0    0
RFT 1750 5540    2 3000 4200    0   35    1    0
RFT 7800 4200    0 6400 5400    0    7    1    0
RFT 6600 3600    0 8300 4500    0   10    0    0
RFT 4250 1500    0 6600 1800    0   77    0    0
RFT 6000 2400    0 7850 3300    0   73    0    0

RFT 6500 2700    0 8350 3600    0   44    0    0
RFT 4350 5100    0 2500 4200    0   24    1    0
RFT 7900 4200    0 6300 5400    0   42    0    0
RFT 4550 1800    0 4150 4200    0   23    0    0
RFT 4350 1500    0 2400 2400    0   66    0    0
RFT 4450 5400    0 2800 4200    0   39    0    0
RFT 2700 2400    0 1750 4415    2    1    0    0
RFT 1750 5040    2 3000 3300    0   78    1    0
RFT 4750 2400    0 7850 2400    0   69    0    0
RFT 6000 2700    0 8250 3600    0   41    1    0
RFT 1750 4540    2 3000 2400    0   68    1    0
RFT 4250 5400    0 7700 5400    0   47    0    0
RFT 4150 5100    0 7600 5100    0   23    0    0
RFT 6300 3600    0 4650 5400    0   61    0    0
RFT 4250 2400    0 7750 2400    0   72    0    0
RFT 4750 2700    0 8350 2700    0   81    1    0
RFT 6300 2700    0 4750 5100    0   15    0    0
RFT 4250 2700    0 8250 2700    0   76    1    0
RFT 6200 2700    0 4550 5100    0   31    1    0
RFT 3000 1500    0 4250 4500    0   47    0    0
RFT 7950 2400    0 4750 3600    0   64    1    0
RFT 8250 2400    0 4750 3300    0   48    1    0
RFT 6500 4200    0 2900 5100    0   49    1    0
RFT 6200 2400    0 4350 5100    0   24    1    0
RFT 8150 2400    0 4250 3300    0   51    0    0
RFT 6300 2400    0 4450 5400    0   39    0    0
RFT 8050 2400    0 4250 3600    0   56    1    0
RFT 6000 3600    0 2700 5400    0   59    0    0
RFT 6000 2700    0 2700 4500    0   41    1    0
RFT 6000 3300    0 2600 5100    0   53    0    0
RFT 6000 2400    0 2600 4200    0   73    1    0
RFT 6300 3300    0 2800 5100    0   32    1    0
RFT 6500 3600    0 3000 5400    0   27    0    0
RFT 6500 2700    0 3000 4500    0   44    1    0
RFT 6500 2400    0 2900 4200    0   71    1    0
RFT 6200 3600    0 2600 5400    0   82    0    0
RFT 6200 3300    0 2500 5100    0   17    0    0
RFT 4850 5400    0 1750 2665    2   38    0    0
RFT 4550 2700    0 7900 5400    0   26    0    0
RFT 4450 2700    0 8100 5400    0   43    1    0
RFT 1750 1790    2 8350 1800    0   63    1    0
RFT 4450 2400    0 8300 5400    0   67    1    0
***
ZFMRWS(A3,12(I5))
RWS 1750 4415    2    0    1    0   99   20   36    0    1    0
RWS 1849 4415    2    0    4  270   62   20   36    0    1    0
RWS 1849 4353    2    9    1    0    0   20   36    0    1    1
RWS 2700 2400    2    0    4  270  324   20   36    0    1    0
RWS 2700 2076    1    9    3  180  450   20   36    0    1    1
RWS 2250 2076    2    9    2   90 2276   20   36    0    1    1
RWS 2250 4352    1    9    3  180  400   20   36    0    1    1
RWS 2800 2400    2    0    4  270  324   20   36    0    2    0
RWS 2800 2076    1    9    1    0 1750   20   36    0    2    1
RWS 4550 2076    2    9    2   90  324   20   36    0    2    1
RWS 4550 2400    2    0    4  270   76   20   36    0    2    0
RWS 4550 2324    1    9    1    0 1253   20   36    0    2    1
RWS 5803 2324    2    9    2   90 1676   20   36    0    2    1
RWS 5803 4000    1    9    3  180 1253   20   36    0    2    1
RWS 4550 4000    2    9    2   90  200   20   36    0    2    1
RWS 1750 5790    2    0    1    0   99   20   36    0    3    0
RWS 1849 5790    2    0    4  270   62   20   36    0    3    0
RWS 1849 5728    2    9    1    0    0   20   36    0    3    1
RWS 2800 5400    2    0    2   90  327   20   36    0    3    0
RWS 2800 5727    1    9    3  180  950   20   36    0    3    1
RWS [illegible] 2727    1    0    4  270   10   20   36    0    4    0
RWS [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] 4 [illegible]
RWS 1849 2790    2    0    4  270   62   20   36    0    4    0
RWS 1849 2728    2    9    1    0    0   20   36    0    4    1
RWS 1750 2915    2    0    1    0   99   20   36    0    4    0
RWS 1849 2915    2    0    4  270   62   20   36    0    4    0
RWS 1849 2853    2    9    1    0    0   20   36    0    4    1
RWS 1850 2717    1    0    1    0   71   20   36    0    4    0
RWS 1921 2717    2    9    2   90  135   20   36    0    4    1
RWS 1921 2852    1    9    3  180   71   20   36    0    4    1
RWS 1850 2352    1    0    4  270   17   20   36    0    5    0
RWS 1850 2477    1    0    2   90    2   20   36    0    5    0
RWS 1750 2415    2    0    1    0   99   20   36    0    5    0
RWS 1849 2415    2    0    4  270   62   20   36    0    5    0
RWS 1849 2353    2    9    1    0    0   20   36    0    5    1
RWS 1750 2540    2    0    1    0   99   20   36    0    5    0
RWS 1849 2540    2    0    4  270   62   20   36    0    5    0
RWS 1849 2478    2    9    1    0    0   20   36    0    5    1
RWS 1850 2335    1    0    1    0   71   20   36    0    5    0
```

Figure 7. DEC 2-hi (Double Width) Design File

APPENDIX I. RECORD DESCRIPTION EXCERPTS FROM THE

```
                                                                        DB     1
                                                                        DB     2
(
(     D A S L L   DATA BASE
(
(
(    VERSION 9-7-76 WGC
(
(                                                                       DB     3
(                                                                       DB     4
(                                                                       DB     5
(                                                                       DB     6
$1DBSYSDATA                                                             DB     7
*SYSTYPE                                                                DB     8
*SYSDEFN                                                                DB     9
*SYSDOC                                                                 DB    10
*USERS                                                                  DB    33
$2SYSDEFN                                                               DB    34
(                                                                       DB    35
(  SYSTEM SELF-DEFINITION                                               DB    36
(                                                                       DB    37
(  EACH PACKET BELOW DEFINES A RECORD TYPE FOUND IN THE DATA BASE       DB    38
(  INCLUDING PURPOSE OF RECORD (ZRD). FIELD LOCATIONS (ZSK). FIELD      DB    39
(  NAMES (ZTM) AND PURPOSE OF EACH FILED (ZRD).                         DB    40
(                                                                       DB    41
(-------------------------------------------------------------------
(
*RBG        :DASLLDB   ROUTELIB  BOARD                                  DB    57
ZSK0402N     0601S     0701S     0801S     0905N     1405N     +
ZSK1905N     2405N     2905N     3405N     3905N     4405N     +
ZSK4905N     5405N     5905N     6405N


ZTMBTYPE     BSHAPE    BORENT    BLAYER    BXMIN     BYMIN     +  DB     6
ZTMBXMAX     BYMAX     PXMIN     PYMIN     PXMAX     PYMAX     +  DB    62
ZTMRXMIN     RYMIN     RXMAX     RYMAX                            DB    63
ZRD            RBG      BOARD GEOMETRY DEFINITION                 DB    64
ZDC BTYPE      RBG  1   BOARD TYPE CODE - IMPLIES BOARD GRAPHICS FOR  DB    65
ZDC                 1   STANDARD TYPES.                           DB    66
ZDC BSHAPE     RBG  2   BOARD SHAPE CODE                          DB    67
ZDC BORENT     RBG  3   BOARD ORIENTATION                         DB    68
ZDC BLAYER     RBG  4   NUMBER OF CONDUCTOR FOIL LAYERS           DB    69
ZDC BXMIN      RBG  5   DIMENSIONS OF THE RECTANGLE               DB    70
ZDC BYMIN      RBG  6   WHICH CONTAINS THE OUTERMOST              DB    71
ZDC BXMAX      RBG  7   GRID SQUARES OF THE PHYSICAL              DB    72
ZDC BYMAX      RBG  8   BOARD.                                    DB    73
ZDC PXMIN      RBG  9   DIMENSIONS OF THE PERIPHERY               DB    74
ZDC PYMIN      RBG 10   OF THE PLACEMENT RECTANGLE                DB    75
ZDC PXMAX      RBG 11   (AREA WITHIN WHICH DEVICES                DB    76
ZDC PYMAX      RBG 12   CAN BE PLACED).                           DB    77
ZDC RXMIN      RBG 13   DIMENSIONS OF THE PERIPHERY OF            DB    78
ZDC RYMIN      RBG 14   THE INTERCONNECTION RECTANGLE             DB    79
ZDC RXMAX      RBG 15   (AREA WITHIN WHICH FOIL PATHS CAN         DB    80
ZDC RYMAX      RBG 16   BE ROUTED).                               DB    81
(-------------------------------------------------------------------
(
*RCT        :DASLLDB   ROUTELIB  ACCOUNTING*UNBOUND               DB    82
ZSK0404N     0804N     1204N     1604N     2004N     2404N     +  DB    83
ZSK2804N     3204N     3604N                                      DB    84
ZTMCTLEGAL   CTDEV     CTPKG     CTDTYPE   CTRSET    CTSIGST   +  DB    85
ZTMCTNODES   PFCT      PECT                                       DB    86
ZRD            RCT      THIS IS THE READIN OF THE COUNTS OF THE LEGAL  DB    87
ZRD            RCT      LOCATIONS AND OF THE PACKAGE TYPES AND OF THE  DB    88
ZRD            RCT      DEVICE TYPES, ETC.                        DB    89
ZDC CTLEGAL    RCT  1   NUMBER OF LEGAL LOCATIONS                 DB    90
ZDC CTDEV      RCT  2   NUMBER OF DEVICES                         DB    91
ZDC CTPKG      RCT  3   NUMBER OF DIFFERENT PACKAGE TYPES         DB    92
ZDC CTDTYP     RCT  4   NUMBER OF DIFFERENT DEVICE TYPES          DB    93
ZDC CTRSET     RCT  5   NUMBER OF WIRING-RULE SETS                DB    94
ZDC CTSIGST    RCT  6   NUMBER OF SIGNAL SETS                     DB    95
ZDC CTNODES    RCT  7   NUMBER OF NODES IN ALL SIGSETS            DB    96
ZDC PFCT       RCT  8   NUMBER OF FOOTPRINTS                      DB    97
ZDC PECT       RCT  9   NUMBER OF PAD ENVELOPES FOR ALL DEVICE TYPES  DB    98
(-------------------------------------------------------------------
(
*RDS        :DASLLDB   ROUTELIB  BOARD     *UNBOUND               DB    99
ZSK0420A     2401A     2506A     3130A
ZTMBNUMBER   BREV      BREVDAT   ONAM                             DB   101
ZRD            RDS      PROBLEM IDENTIFICATION ENTRIES            DB   106
ZDC BNUMBER    RDS  1   BOARD NUMBER                              DB   107
ZDC BREV       RDS  2   REVISION LETTER                           DB   108
ZDC BREVDAT    RDS  3   REVISION DATE  MMDDYY                     DB   109
ZDC ONAM       RDS  4   DRAWING TITLE                             DB   110
(-------------------------------------------------------------------
(
*RDT        :DASLLDB   ROUTELIB  BOARD     *UNBOUND               DB   111
ZSK0460A
ZTMDTEXT                                                          DB   113
ZRD            RDT      PART OF BOARD IDENTIFICATION              DB   114
ZDC DTEXT      RDT  1   DESCRIPTIVE TEXT SUPPLIED BY USER         DB   115
(-------------------------------------------------------------------
(
*RDV        :DASLLDB   ROUTELIB  DEVICE    *UNBOUND               DB   116
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ZSK0410A      1410NPRTD 2401N    X2501N    X2610N    X                        DB   117
ZTMDNAME      DEVPTR    DWUNDER   DRLUNDR   DELIST                            DB   118
ZRD             RDV      DEVICE TABLE ENTRIES                                 DB   119
ZDC DNAME       RDV  1   DEVICE REFERENCE NAME (10 CHARACTERS)                DB   120
ZDC DEVPTR      RDV  2   POINTER TO DEVICE TYPE TABLE ENTRY                   DB   121
ZDC DWUNDER     RDV  3   CODE WHICH INDICATES IF ROUTING IS ALLOWED           DB   122
ZDC             RDV  3   UNDER DEVICE                                         DB   123
ZDC DRLUNDR     RDV  4   CURRENTLY UNDEFINED                                  DB   124
ZDC DELIST      RDV  5   POINTER TO 8 OR LESS LOGICAL OR ELECTRICAL           DB   125
ZDC             RDV  5   ELEMENTS PER DEVICE                                  DB   126
(--------------------------------------------------------------------
(
*RES         :DASLLDB   ROUTELIB  WIREPATH  *UNBOUND
ZSK04[illegible]
ZTMEVL[illegible]
ZRD             RES      ROUTED LAYOUT EVALUATION SUMMARY
(--------------------------------------------------------------------
(
*RFT         :DASLLDB   ROUTELIB  WIREPATH  *UNBOUND
ZSK0405I      0109ZD000
ZTMFROMX      FROMY     FROMZ     TOX       TOY       TOZ
ZTMFTSIGSET   FTSTATUS
ZRD             RFT      FROMTO POINT-TO-POINT INTERCONNECTION DSCR
ZDC FROMX       RFT  1   FROM POINT X LOCATION
ZDC FROMY       RFT  2   FROM POINT Y LOCATION
ZDC FROMZ       RFT  3   FROM POINT Z LOCATION
ZDC TOX         RFT  4   TO   POINT X LOCATION
ZDC TOY         RFT  5   TO   POINT Y LOCATION
ZDC TOZ         RFT  6   TO   POINT Z LOCATION
ZDC FTSIGSET    RFT  7   FROM-TO SIGNAL SET NUMBER
ZDC FTSTATUS    RFT  8   STATUS CODE FOR FROMTO  0 -- ROUTED
ZDC             RFT                              1 -- UNROUTED
ZDC             RFT                              2 -- DECOMPOSED
ZDC FTPOINT     RFT  9   A POINTER TO ANOTHER FROMTO:  FIRST FROMTO OF
ZDC             RFT      DECOMPOSITION CHAIN IF FTSTATUS=2.  NEXT
ZDC             RFT      DERIVATIVE FROMTO IN A DECOMPOSITION CHAIN IF
ZDC             RFT      FTSTATUS=0 OR 1.  IF FTPOINT=0. THEN THIS FROMTO
ZDC             RFT      IS THE END LINK IN A DECOMPOSITION CHAIN OR
ZDC             RFT      THERE IS NO DECOMPOSITION OF THIS FROMTO.
(--------------------------------------------------------------------
(
*RLH         :DASLLDB   ROUTELIB  WIREPATH  *UNBOUND
ZSK0404I      0116ZD000
ZTMHIST
ZRD             RLH      ROUTED LAYOUT HISTORY
ZDC HIST        RLH  1   A LIST OF UP TO 15 MODULE NUMBERS. EACH OF
ZDC             RLH      WHICH REPRESENTS A SUPERVISOR ROUTINE WHICH
ZDC             RLH      HAS PROCESSED THE DESIGN FILE DATA AS THIS
ZDC             RLH      DATA WAS RECEIVED FROM THE PREVIOUSLY LISTED
ZDC             RLH      SUPERVISOR.  THESE MODULE NUMBERS ARE LISTED
ZDC             RLH      IN THE ORDER OF APPLICATION OF THE
ZDC             RLH      ASSOCIATED SUPERVISOR ROUTINES.
(--------------------------------------------------------------------
(
*RLI         :DASLLDB   ROUTELIB  WIREPATH  *UNBOUND
ZSK0410A      1410A     2410A     3410A
ZTMWHENDON    WHODID    RTMETHD
ZRD             RLI      ROUTED LAYOUT IDENTIFICATION
ZDC WHENDON     RLI  1   WHEN THIS PCB ROUTED LAYOUT DESCRIPTION WAS  +
ZDC             RLI      ADDED TO THE DESIGN FILE. THIS IS THE REF    +


ZDC             RLI      DESIGNATOR FOR THE LAYOUT.  CHARACTER STRING +
ZDC             RLI      OBTAINED FROM ORDERLIB ROUTINE CLOCK1 WITH   +
ZDC             RLI      MACHINE DESIGNATOR ADDED ---                 +
ZDC             RLI                        HH TIME IN HOURS           +
ZDC             RLI          HHMMXYNNDD    X  MACHINE DESIGNATOR      +
ZDC             RLI                        MM TIME IN MINUTES         +
ZDC             RLI                        NN MONTH OF YEAR           +
ZDC             RLI                        DD DAY OF MONTH
ZDC             RLI                        Y  LAST DIGIT OF YEAR
ZDC WHODID      RLI  2   USER NUMBER OF PERSON WHO RAN THIS LAYOUT
ZDC RTMETHD     RLI  3   METHOD USED TO CREATE THIS LAYOUT (0 --> UNK)
ZDC VERSION     RLI  4   A 10 CHARACTER STRING CONTAINING THE DATE OF THE
ZDC             RLI      SYSTEM RELEASE WHICH WAS USED TO CALCULATE THIS
ZDC             RLI      DESIGN FILE SECTION UPDATE.
(------------------------------------------------------------------
(
(
*RLL         :DASLLDB   ROUTELIB  BOARD                                       DB   127
ZSK0410A      1405N     1905N     2402S     2602S     2810NPRPK      +
ZSK3810NPRDVR4802N      X5001N    X5110I    X6103A
ZTMLLNAME     LEGX      LEGY      LEGLYRC   LORENT    LPKGTYP        +    DB   130
ZTMLOCCUPY    LDEVCOD   LOCSTAT   LSPARE    PINTAG                        DB   131
ZRD             RLL      LEGAL LOCATION DESCRIPTION--WHERE IS SITE   +    DB   132
ZRD             RLL      THAT COULD BE OCCUPIED BY A DEVICE, AND WHAT +   DB   133
ZRD             RLL      OCCUPIES THAT SITE NOW.                     +    DB   134
ZDC LLNAME      RLL  1   SYMBOLLIC NAME USED TO REFERENCE THIS LEGAL +    DB   135
ZDC                      LOCATION                                         DB   136
ZDC LEGX        RLL  2   X ORDINATE OF REFERENCE POINT FOR LEGAL     +    DB   137
ZDC                      LOCATION(MILS)                                   DB   138
ZDC LEGY        RLL  3   Y ORDINATE OF REFERENCE POINT FOR LEGAL     +    DB   139
ZDC                      LOCATION(MILS)                                   DB   140
ZDC LEGLYRC     RLL  4   LAYER ON WHICH LEGAL LOCATION OCCURS (0=>ALL)    DB   141
ZDC LORENT      RLL  5   ROTATIONAL ORIENTATION CODE FOR LEGAL LOC        DB   142
ZDC LPKGTYP     RLL  6   DEVICE TYPE CODE SPECIFYING WHAT PACKAGE
ZDC                      TYPE OR TYPES ALLOWED TO OCCUPY THIS LEGAL  +    DB   144
ZDC                      LOCATION (REF TO PACKAGE TYPE )                  DB   145
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ZDC LOCCUPY     RLL  7   REFERENCE TO DEVICE CURRENTLY ASSIGNED TO     +  DB   146
ZDC                      OCCUPY THIS LEGAL LOCATION                       DB   147
ZDC LDEVCOD     RLL  8   FUNCTION CODE FOR DEVICE ASSIGNED THIS LOC    +
ZDC                      (EG CAP. RESISTOR. DIODE. ETC)                        149
ZDC LOCSTAT          9   OCCUPANCY STATUS OF DEVICE PRESENTLY ASSIGNED+   DB   150
ZDC                      TO THIS LEGAL LOCATION. (PERMANENCY OF PLACE-+   DB   151
ZDC                      MENT--CAN DEVICE BE RELOCATED)                   DB   152
ZDC LSPARE          10   PRESENTLY UNUSED FIELD
ZDC PINTAG      RLL 11
(
(
*RPE         :DASLLDB   ROUTELIB  PACKAGES                                DB   155
ZSK0402S      0604N      1004N     1404N      1004N     0103ZD001         DB   156
ZTMTENVZ      TEVXMIN    TEVYMIN   TEVXMAX    TEVYMAX                     DB   157
ZRD             RPE       PAD ENVELOPE LOCATIONS FOR A PACKAGE TYPE    +  DB   158
ZRD             RPE       LOCATION OF CORNERS OF RECTANGLE(S) CONTAIN- +  DB   159
ZRD             RPE       ING PADS                                        DB   160
(    ********   RPE       NOTE THAT UP TO  3  PAD ENVELOPE DESCRIPTIONS   DB   161
(               RPE       MAY APPEAR ON AN RPE CARD                       DB   162
ZDC TENVZ       RPE  1    PAD ENVELOPE LAYER NUMBER                       DB   163
ZDC TEVXMIN     RPE  2    OFFSET OF LOWER LEFT CORNER OF PAD ENVELOPE  +  DB   164
ZDC                       FROM PACKAGE TYPE REFERENCE POINT ASSUMING NO+  DB   165
ZDC                       ROTATION.  (MILS)  NEGATIVE ENCODED VALUE IF +  DB   166

ZDC                       .GT. 9000.  TO FIND SUCH NEGATIVE OFFSETS--  +  DB   167
ZDC                       TRUEOFF = 9000 - TEVXMN                         DB   168
ZDC TEVYMIN     RPE  3    VERTICAL OFFSET OF LLC OF PAD ENVELOPE          DB   169
ZDC TEVXMAX     RPE  4    HORIZONTAL OFFSET OF UPPER RIGHT CORNER OF PE   DB   170
ZDC TEVYMAX     RPE  5    VERTICAL   OFFSET OF UPPER RIGHT CORNER OF PE   DB   171
(------------------------------------------------------------------
(
(
*RPF         :DASLLDB   ROUTELIB  PACKAGES                                DB   172
ZSK0404N      0804N      1202N     1402N      1602N    X0104ZD001         DB   173
ZTMPFX        PFY        PFPADEX   PLAYER     PFPADIN                     DB   174
ZRD             RPF       DETAILED PAD INFORMATION                        DB   175
ZDC PFX         RPF  1    X-OFFSET OF PAD FROM PACKAGE REFERENCE POINT    DB   176
ZDC PFY         RPF  2    Y-OFFSET OF PAD FROM PACKAGE REFERENCE POINT    DB   177
ZDC PFPADEX     RPF  3    EXTERIOR PAD SHAPE CODE                         DB   178
ZDC PLAYER      RPF  4    PAD LAYER CODE                                  DB   179
ZDC PFPADIN     RPF  5    INTERIOR PAD CODE (IF ANY)                      DB   180
(------------------------------------------------------------------
(
(
*RPI         :DASLLDB   ROUTELIB  PROMPTS                                 DB   181
ZSK0403A      0702I      0110ZD001                                        DB   182
ZTMOUTTYP     FLDPSN                                                      DB   183
ZRD             RPI       DEFINES A TABLE OF DESCRIPTIVE RECORD TYPES     DB   184
ZRD             RPI       FOR $ID SECTION OF ROUTE INPUT FORM             DB   185
ZDC OUTTYP      RPI  1    RECORD TYPE TO RECEIVE PROMPT INPUT DATA        DB   186
ZDC FLDPSN      RPI  2    FIELD POSITION IN OUTTYP RECORD FOR DATA        DB   187
(------------------------------------------------------------------
(
(
*RPK         :DASLLDB   ROUTELIB  PACKAGES                                DB   188
ZSK0402N      0610NPRPF 1610NPRPE 2603N      2904N      3303N          +  DB   18
ZSK3603N      3916N      5510APRLL 6505I      X                           DB   190
ZTMPFOOTCT    PFOOTPT    PENVPTR   PENVCT     PKGCODE    PSILK         +
ZTMPDRILL     PSHADOW    AGRGAT    PSPARE                                 DB   192
ZRD             RPK       PACKAGE TYPE TABLE ENTRIES                      DB   193
ZDC PFOOTCT     RPK  1    NUMBER OF FOOTPRINTS FOR THIS PACKAGE TYPE      DB   194
ZDC PFOOTPT     RPK  2    POINTER TO FIRST FOOTPRINT DESCRIPTOR IN        DB   195
ZDC             RPK  2    FOOTPRINT LIST                                  DB   196
ZDC PENVPTR     RPK  3    POINTER TO 1ST PAD ENVELOPE FOR THIS PACKAGE    DB   197
ZDC             RPK  3    TYPE                                            DB   198
ZDC PENVCT      RPK  4    PAD ENVELOPE COUNT******ALSO ON RTD AS SDEVCT*  DB   199
ZDC             RPK  4    ********                                        DB   200
ZDC PKGCODE     RPK  5    PACKAGE TYPE NUMERIC DESIGNATION CODE
ZDC PSILK       RPK  6    SILK SCREEN SYMBOL CODE
ZDC PDRILL      RPK  7    DRILL CODE FOR HOLE
ZDC PSHADOW     RPK  8    RECTANGLE CORNERS OF SHADOW CAST BY PART******  DB   203
ZDC             RPK       SHOULD BE 4 SEPARATE VARIABLES*****
ZDC AGRGAT      RPK  9    SYMBOLLIC REFERENCE TO AGGREGATED DEVICE TYPE   DB
ZDC             RPK       GROUP IN RLL RECORDS
ZDC PSPARE      RPK 10    SPARE GRAPHICS POINTERS
(------------------------------------------------------------------
(
(
*RPL         :DASLLDB   ROUTELIB  PACKAGES
ZSK0410A      1410PRPK
ZTMPKNAME     PKPNTR
ZRD             RPL       SUPPLEMENTARY INFORMATION TO RPK PACKAGE TYPES
ZDC PKNAME      RPL  1    GENERIC NAME OF PACKAGE REFERENCED BY PKPNTR
ZDC PKPNTR      RPL  2    POINTER TO RPK RECORD NAMED BY PKNAME
(------------------------------------------------------------------
(
*RPN         :DASLLDB   ROUTELIB  PROMPTS                                 DB   208
ZSK0402I      0602A      0113ZD001                                        DB   209
TMPPINNO      PINLTR                                                      DB   210
ZRD             RPN       DEFINES A TABLE OF MNEMONIC PIN NAMES AND       DB   211
ZRD             RPN       CORRESPONDING INTERNAL NUMERIC REPRESENTATION   DB   212
ZDC PINNO       RPN  1    STANDARD PIN NUMERIC DESIGNATOR - USED IN       DB   213
ZDC             RPN  1    DESIGN FILE                                     DB   214
ZDC PINLTR      RPN, 2    CONVENTIONAL PIN LETTER REFERENCE - NON         DB   215
ZDC             RPN  2    NUMERIC                                         DB   216
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(------------------------------------------------------------------
(
*RPR        :DASLLDB   ROUTELIB  PROMPTS                                DB   217
ZSK0401I     0501I      0602I      0801I      0962A                     DB   218
ZTMPRESPC    PSTSPC     LNGTH      PMTFLG     MESSAG                    DB   219
ZRD            RPR       DEFINES A SINGLE LINE OF AN OUTPUT PROMPT      DB   220
ZRD            RPR       MESSAGE                                        DB   221
ZDC PRESPC     RPR  1    COUNT OF LINES SPACED BEFORE MESSAGE IS OUTPUT DB   222
ZDC PSTSPC     RPR  2    COUNT OF LINES SPACED AFTER MESSAGE IS OUTPUT  DB   223
ZDC LNGTH      RPR  3    NUMBER OF CHARACTERS IN MESSAGE                DB   224
ZDC PMTFLG     RPR  4    A NUMERIC CODE WHICH DETERMINES USE OF PROMPT  DB   225
ZDC            RPR  4    MESSAGE (HEADER OR DATA INPUT PROMPT)          DB   226
ZDC MESSAG     RPR  5    MESSAGE TEXT                                   DB   227
(------------------------------------------------------------------
(
*RPV        :DASLLDB   ROUTELIB  BOARD                                  DB   228
ZSK0405N     0112ZD001
ZTMPVOID                                                                DB   230
ZRD            RPV       DEFINES AREAS OF A PC BOARD IN WHICH PLACEMENT DB   231
ZRD            RPV       IS NOT ALLOWED                                 DB   232
ZDC PVOID      RPV  1    DESCRIBES PLACEMENT VOID                       DB   233
(-----------------------------------------------------------------
(
(
*RRU        :DASLLDB   ROUTELIB  WIRERULES                              DB   234
ZSK0403N     0703N      1002N      1202N      1401S      1502N       +
ZSK1702N     1904N      2304N     X2704N     X3102N     X3302N    X  +
ZSK3502N   X    N     X  04N     X    N     X    S     X    S    X
ZTMRLANDW    RSEPMIN    RXTVIA     RINVIA     RICON      RVIAMAX     +  DB   238
ZTMRTURN     RCONMAX    RCONMIN    RPARAL     RSEPAR     RVDRILL     +  DB   239
ZTMRBPINS    RUNDER     RVIASEP    RGROUND    RWIREIT    RMLTSOU        DB   240
ZRD            RRU       WIRING RULE TABLE ENTRIES                      DB   241
ZDC RLANDW     RRU  1    LAND WIDTH IN .001 INCHES                      DB   242
ZDC RSEPMIN    RRU  2    MIN SEPARATION BETWEEN ADJACENT LANDS IN .001  DB   243
ZDC            RRU  2    INCHES                                         DB   244
ZDC RXTVIA     RRU  3    VIA SHAPE CODE FOR EXTERIOR BOARD SURFACES     DB   245
ZDC RINVIA     RRU  4    VIA SHAPE CODE FOR INTERIOR BOARD SURFACES     DB   246
ZDC RICON      RRU  5    INTERCONNECTION RULE CODE                      DB   247
ZDC RVIAMAX    RRU  6    MAXIMUM NUMBER OF VIAS IN THE SIGNAL SET       DB   248
ZDC RTURN      RRU  7    TURN COUNT LIMIT FOR ENTIRE SIGNAL SET         DB   249
ZDC RCONMAX    RRU  8    MAX LENGTH OF FOIL BETWEEN NODE PAIRS          DB   250
ZDC RCONMIN    RRU  9    MIN FOIL LENGTH BETWEEN NODES                  DB   251
ZDC RPARAL     RRU 10    LENGTH OF MAX PARALLEL RUN AT MIN SEPARATION   DB   252
ZDC RSEPAR     RRU 11    POST-ROUTE SEPARATION CODE FOR ARTWORK         DB   253
ZDC            RRU 11    OPTIMIZATION                                   DB   254
ZDC RVDRILL    RRU 12    DRILL CODE FOR SIGNAL VIAS                     DB   255
ZDC RBPINS     RRU 13    BETWEEN PIN ROUTING DISTANCE--MIN SEPARATION   DB   256
ZDC            RRU 13    OF PINS                                        DB   257
ZDC RUNDER     RRU 14    RELATIVE UNDESIRABILITY OF ROUTING UNDER       DB   258


ZDC            RRU 14    DEVICES                                        DB   259
ZDC RVIASEP    RRU 15    MINIMUM VIA SEPARATION, MILS                   DB   260
ZDC RGROUND    RRU 16    MAXIMIZE AREA OF BOARD CONNECTED TO THIS NET   DB   261
ZDC RWIREIT    RRU 17    UNROUTABLE WIRES ON BOARD CAN BE CONNECTED     DB   262
ZDC            RRU 17    USING DISCRETE WIRES                           DB   263
ZDC RMLTSOU    RRU 18    MULTIPLE SOURCE GATES ALLOWED                  DB   264
(-----------------------------------------------------------------
(
(
*RRV        :DASLLDB   ROUTELIB  BOARD                                  DB   265
ZSK0402S     0605N      1105N      1605N      2105N      0102ZD000
ZTMBARZ      BARXMIN    BARYMIN    BARXMAX    BARYMAX                   DB   267
ZRD            RRV       ROUTING VOIDS.  AREAS OF BOARD THROUGH WHICH + DB   268
ZRD            RRV       NO CONDUCTING PATHS ARE TO BE DEFINED.       + DB   269
ZRD            RRV       LOCATION OF CORNERS OF RECTANGULAR AREAS.      DB   270
(   *******    RRV       NOTE THAT UP TO 3 BARRIERS CAN BE DESCRIBED    DB   271
(              RRV       ON AN RRV CARD                                 DB   272
ZDC BARZ       RRV  1    LAYER ON WHICH BARRIER OCCURS (0 ==> ALL)      DB   273
ZDC BARXMIN    RRV  2    LOCATION IN MILS BARRIER LOWER LEFT X          DB   274
ZDC BARYMIN    RRV  3    LOCATION IN MILS BARRIER LOWER LEFT Y          DB   275
ZDC BARXMAX    RRV  4    LOCATION IN MILS BARRIER UPPER RIGHT X         DB   276
ZDC BARYMAX    RRV  5    LOCATION IN MILS BARRIER UPPER RIGHT Y         DB   277
(-----------------------------------------------------------------
(
(
*RSD        :DASLLDB   ROUTELIB  CONNECT   *UNBOUND                     DB   278
ZSK0410A     1410NPRRU 2410NPRSN 3403N      3701N     X3803N    X    +  DB   279
ZSK4103N    X4405N     X4903N     X                                     DB   280
ZTMSIGNAM    SRULE      SFIRSTN    SNODECT    SNODCOD    SPREWIR     +  DB   281
ZTMSPWIRCT   SLENGTH    SVIACT                                          DB   282
ZRD            RSD       ENTRIES TO SIGNAL SET TABLES                   DB   283
ZDC SIGNAM     RSD  1    SIGNAL SET ALPHA/NUMERIC NAME                  DB   284
ZDC SRULE      RSD  2    POINTER TO WIRING RULE SET APPLICABLE TO THIS  DB   285
ZDC            RSD  2    SIGSET                                         DB   286
ZDC SFIRSTN    RSD  3    POINTER TO 1ST NODE IN LIST                    DB   287
ZDC SNODECT    RSD  4    NBR OF CONSECUTIVE NODES IN NODE LIST FOR THIS DB   288
ZDC            RSD  4    SIGSET                                         DB   289
ZDC SNODCOD    RSD  5    NODE LIST REPRESENTATION CODE                  DB   290
ZDC SPREWIR    RSD  6    FIRST PREDETERMINED WIRE IN THE WIRE SEGMENT   DB   291
ZDC            RSD  6    TABLE                                          DB   292
ZDC SPWIRCT    RSD  7    PRE-WIRED SEGMENT COUNT                        DB   293
ZDC SLENGTH    RSD  8    TOTAL CONDUCTING PATH LENGTH FOR THIS SIGSET   DB   294
ZDC SVIACT     RSD  9    VIA COUNT FOR THIS SIGSET                      DB   295
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(---------------------------------------------------------------------
(
(
*RSG        :DASLLDB   ROUTELIB  CONNECT   *UNBOUND                        DB   296
ZSK0420I     2420A      4406I     5020A
ZTMODATE     DRAWBY     DWGDATE   CHECKER                                  DB   298
ZRD             RSG      SIGNATURE DATA FOR DRAWING                        DB   299
ZDC ODATE       RSG  1   DATE OF ORIGINATION                               DB   300
ZDC DRAWBY      RSG  2   DRAFTSMAN NAME                                    DB   301
ZDC DWGDATE     RSG  3   DATE DRAWN                                        DB   302
ZDC CHECKER     RSG  4   NAME OF CHECKER                                   DB   303
(---------------------------------------------------------------------
(
(
*RSN        :DASLLDB   ROUTELIB  CONNECT   *UNBOUND                        DB   304
ZSK0403N RDV 0703N     0110ZD000
ZTMSDEVICE    SPINBR                                                       DB   306



ZRD             RSN      SIGNAL SET TO DEVICE INFORMATION                  DB   307
ZDC SDEVICE     RSN  1   DEVICE TO WHICH SIGSET IS CONNECTED               DB   308
ZDC SPINBR      RSN  2   PIN ON DEVICE WHICH IS IN SIGSET                  DB   309
(---------------------------------------------------------------------
(
(
*RTD        :DASLLDB   ROUTELIB  DEVICE                                    DB   310
ZSK0410A     1410NPRPK 2403N     2703N                                     DB   311
ZTMDTNAME     DTPACK     DTCODE    SDEVCT     DTELEM     DTPINCT       +  DB   312
ZTMDRATA      DUNITA     DRATB     DUNITB     PINTYPE    PINLOAD       +  DB   313
ZTMDELTYPE    DELTIME    DELPGCT   DELPINS    DISSIP                       DB   314
ZRD             RTD      DEVICE TYPE TABLE ENTRIES                         DB   315
ZDC DTNAME      RTD  1   DEVICE TYPE NAME-10 CHAR MAX                      DB   316
ZDC DTPACK      RTD  2   PACKAGE TYPE TABLE REF POINTER                    DB   317
ZDC DTCODE      RTD  3   DEVICE PACKAGE TYPE NUMERIC CODE
ZDC SDEVCT      RTD  4   PAD ENVELOPE COUNT FOR DEVICE TYPE*******SEE      DB   319
ZDC             RTD  4   RPK PENVCT******                                  DB   320
ZDC DTELEM      RTD  5   NUMBER OF ELEMENTS IN DEVICE                      DB   321
ZDC DTPINCT     RTD  6   NUMBER OF PINS IN DEVICE                          DB   322
ZDC DRATA       RTD  7   DEVICE RATING PRIMARY                             DB   323
ZDC DUNITA      RTD  8   DEVICE RATING UNITS PRIMARY                       DB   324
ZDC DRATB       RTD  9   SECONDARY RATING                                  DB   325
ZDC DUNITB      RTD 10   SECONDARY RATING--UNITS                           DB   326
ZDC PINTYPE     RTD 11   PIN TYPE CODE                                     DB   327
ZDC PINLOAD     RTD 12   PIN LOADING IN STANDARD TTL (1.6 MA) LOAD         DB   328
ZDC             RTD 12   UNITS                                             DB   329
ZDC DELTYPE     RTD 13   ELEMENT TYPE CODE (FUNCTION)                      DB   330
ZDC DELTIME     RTD 14   PRESENTLY UNUSED ELEMENT TIMING FIELDS            DB   331
ZDC DELPGCT     RTD 15   NUMBER OF PIN GROUPS PER ELEMENT                  DB   332
ZDC DELPINS     RTD 16   PINS IN EACH GROUP                                DB   333
ZDC DISSIP      RTD 17   POWER DISSIPATION OF DEVICE, NOMINAL IN           DB   334
ZDC             RTD 17   MILLIWATTS                                        DB   335
(---------------------------------------------------------------------
(
(
*RWS        :DASLLDB   ROUTELIB  WIREPATH  *UNBOUND
ZSK0405I     0112ZD000
ZTMWENDX      WENDY      WENDZ     VIAHERE    ORNTCOD    ORNTDRG
ZTMSEGLGH     COPRWID    TRAKWID   CHANFLG    SIGSET
ZTM           TRAKWID    CHANFLG   SIGSET
ZRD             RWS      STRAIGHT LINE WIRE SEGMENT DESCRIPTION
ZDC WENDX       RWS  1   SEGMENT CENTERLINE REFERENCE END X LOCATION
ZDC WENDY       RWS  2   SEGMENT CENTERLINE REFERENCE END Y LOCATION
ZDC WENDZ       RWS  3   SEGMENT CENTERLINE REFERENCE END Z LOCATION
ZDC PADCODE     RWS  4   VIA PAD CODE FOR REFERENCE POINT (0 IF NO VIA)
ZDC ORNTCOD     RWS  5   ORIENTATION CODE FOR WIRE SEGMENT --- 0 NONE,
ZDC             RWS      1 RIGHT, 2 UP, 3 LEFT, 4 DOWN, 9 USE ORNTDRG
ZDC ORNTDRG     RWS  6   WIRE SEGMENT DIRECTION IN DEGREES
    SEGLGH           7   SEGMENT CENTERLINE LENGTH
ZDC COPRWID     RWS  8   WIDTH OF COPPER FOIL CONDUCTING PATH
ZDC TRAKWID     RWS  9   WIDTH OF TRACK (COPPER PLUS SEPARATION
ZDC             RWS      ASSOCIATED WITH THIS LAND)
ZDC CHANFLG     RWS 10   CHAIN FLAG WHEN 1 MEANS NEXT WIRE REF END
ZDC             RWS      COINCIDES WITH NON-REF END THIS SEGMENT.
ZDC             RWS      IF 0, THE END POINTS OF THE NEXT WIRE SEGMENT
ZDC             RWS      IN THE DESIGN FILE DO NOT COINCIDE WITH
ZDC             RWS      EITHER END OF THE CURRENT SEGMENT.
ZDC SIGSET      RWS 11   SIGNAL SET NBR FOR THIS SEGMENT
ZDC VIAHERE     RWS 12   A FLAG WHICH INDICATES A VIA AT (WENDX,WENDY)
ZDC             RWS      WHEN 1.  NO VIA IF =0.



(---------------------------------------------------------------------
(
(
*USR        :DBSYSDATA USERS                                               DB   336
ZSK0420A     2402I      2602I     2802I                                    DB   337
ZTMUSERNAM    USERACC    UNAMLGH   USRPROC                                 DB   338
ZRD             USR      DEFINES USER NAME AND SYSTEM PARAMETERS           DB   339
ZRD             USR      SPECIFIC TO USER                                  DB   340
ZDC USERNAM     USR  1   10 CHAR NAME BY WHICH USER IS KNOWN TO THE DA     DB   341
ZDC             USR  1   SYSTEM                                            DB   342
ZDC USERACC     USR  2   MAX COMMAND ACCESS FOR CURRENT USER               DB   343
ZDC UNAMLGH     USR  3   LENGTH OF USER NAME IN CHARACTERS                 DB   344
ZDC USRPROC     USR  4   NUMERIC USER CODE FOR COMMAND MACRO PROCEDURES    DB   345
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(-----------------------------------------------------------------
(
(
*ZCH        :DBSYSDATA SYSTYPE                                      DB   346
ZSK0410A     0107ZD000                                              DB   347
ZTMCPBLTY                                                           DB   348
ZRD              ZCH      DEFINES A LIST OF SUBCAPABILITIES FOR A MAJOR   DB   349
ZRD              ZCH      SYSTEM CAPABILITY (FOR EXAMPLE: THE LAYOUT      DB   350
ZRD              ZCH      CAPABILITY IS MADE UP OF PLACE, ROUTE, AND      DB   351
ZRD              ZCH      GRAPHICS)                                       DB   352
ZDC CPBLTY       ZCH   1  NAME OF A DATA BASE CAPABILITY                  DB   353
(-----------------------------------------------------------------
*ZDC        :DBSYSDATA SYSDEFN                                      DB   354
ZSK0510A     1603A      2002I      2599A                            DB   355
ZTMFLDNAM    PACKET     FLDNBR     REMARKS                          DB   356
ZDC FLDNAM       ZDC   1  NAME OF FIELD TO BE DESCRIBED                   DB   357
ZDC PACKET       ZDC   2  CARD TYPE CODE OF RECORD CONTAINING FIELD       DB   358
ZDC FLDNBR       ZDC   3  NUMBER OF FIELD ON RECORD, LEFTMOST IS FIRST    DB   359
ZDC REMARKS      ZDC   4  REMARKS DESCRIBING ITEM RECORDED IN THIS FIELD  DB   360
(-----------------------------------------------------------------
*ZFM        :*NONSPEC                                               DB   361
ZSK0499A                                                            DB   362
ZTMFORMAT                                                           DB   363
(-----------------------------------------------------------------
*ZRD        :DBSYSDATA SYSDEFN                                      DB   364
ZSK0510A     1603A      2002I      2599A                            DB   365
ZTMUNUSED1   RECODE     UNUSED2    REMARKS                          DB   366
ZRD              ZRD      DOCUMENTARY DESCRIPTION OF RECORD TYPE          DB   367
ZDC UNUSED1      ZRD   1  UNUSED FIELD                                    DB   368
ZDC RECODE       ZRD   2  CARD TYPE CODE FOR RECORD DESCRIBED             DB   369
ZDC UNUSED2      ZRD   3  UNUSED FIELD                                    DB   370
ZDC REMARKS      ZRD   4  DESCRIPTIVE REMARKS EXPLAINING PURPOSE OF     + DB   371
ZDC              ZRD      RECORD TYPE OF THIS PACKET                      DB   372
ZRD              ZDC      DOCUMENTARY DESCRIPTION OF FIELD ON RECORD      DB   373
(-----------------------------------------------------------------
*ZRQ        :DBSYSDATA SYSTYPE                                      DB   374
ZSK0403A     0117ZD001                                              DB   375
ZTMDATATYP                                                          DB   376
(-----------------------------------------------------------------
*ZSK        :DBSYSDATA SYSDEFN                                      DB   377
ZSK0402I     0602I      0701A      0801A      0903A      1201A      DB   378
ZSK0606SD000                                                        DB   379
ZTMSTRTCL    FLDLNG     FLDFMT     USECOD     LOCNAM     RESCOD     DB   380
ZRD              ZSK      SKELETON DESCRIBING USE AND CONTENTS OF ALL   + DB   381
ZRD              ZSK      RECORD TYPES IN THE DATA BASE.  EACH RECORD   + DB   382
ZRD              ZSK      LISTED IN THE SYSTEM SELF-DEFINITION (THIS)   + DB   383
ZRD              ZSK      SECTION MUST HAVE A ZSK RECORD IMMEDIATELY    + DB   384


ZRD              ZSK      FOLLOWING THE TAG HEADER (EG, *USR)             DB   385
ZDC STRTCL       ZSK   1  STARTING CHARACTER POSITION                     DB   386
ZDC FLDLNG       ZSK   2  LENGTH OF FIELD IN CHARACTERS                   DB   387
ZDC USECOD       ZSK   4  CODE DEFINING USE OF DATA                       DB   388
ZDC LOCNAM       ZSK   5  RECORD TYPE NEEDED IF USECOD IS A POINTER TYPE  DB   389
ZDC RECOD        ZSK   6  STATUS CODE (DETERMINES RESOLUTION)             DB   390
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REPORT ON THE SIXTH INTERNATIONAL SYMPOSIUM ON MULTIPLE-VALUED LOGIC

Stephen Y. H. Su
Symposium Chairman
Dept. of Electrical Engineering
Utah State University

and

Richard Spillman
Symposium Committee Member
Dept. of Electrical Engineering
Utah State University

The Sixth International Symposium on Multiple-Valued Logic was held at Utah State University, Logan, Utah, May 25-28, 1976, under the co-sponsorship of the IEEE Computer Society, Association for Computing Machinery, Office of Naval Research and Utah State University. Professor Stephen Y. H. Su of Utah State University served as the symposium chairman and Professor Zvonko Vranesic of the University of Toronto was the technical program chairman. The symposium included two invited talks, eight parallel technical sessions, five tutorial sessions, and a panel discussion. Five tutorial papers and 40 technical papers were presented. The last session reported recent results as well as ideas which were not fully developed.

In his opening remarks to the 79 participants from nine countries, Dr. Su outlined some of the reasons why interest in multiple-valued logic has been growing for several years. He pointed out that multiple-valued logic offers a means of overcoming the pin limitation problem of MSI and LSI, since it allows each input pin to accept and each output pin to deliver more information. In addition, he indicated that the wide range of applications of the concepts of multiple-valued logic in the areas of digital systems, software, artificial intelligence, plant disease diagnostic rules and human movement control were represented by some of the papers presented at the symposium. When a 10-valued logic system is eventually developed the conversion from decimal to binary and back again will be eliminated. Su also noted the increased reliability and reduced cost of multiple-valued circuit elements.

Dr. David Rine, formally at West Virginia University, now at the University of Texas, presented the first tutorial paper entitled, "A Survey of Mulitple-Valued Algorithmic Logics: From a Practical Point of View." Rine noted several basic differences between theoretical and actual programming models. He then suggested a number of changes in the current models utilizing multiple-valued logic which would reduce these differences.

In the second tutorial session, Dr. I. Rosenberg of the University of Montreal, discussed the algebraic and combinatorial aspects of multiple-valued circuits. He outlined the results of the last five symposia dealing with the mathematical development of multiple-valued logics. Among the topics which Rosenberg briefly covered were discrete functions, Post algebras and threshold logic.

Dr. Stephen Su of Utah State University and Mr. Peter Cheung of Packard Instrument Company in the third tutorial session, reviewed the development of a cubical notation for multiple-valued switching functions and pointed out that it is a compact notation which is easily stored and processed by a digital computer. They defined a number of basic operators and their algebraic properties which could be used to manipulate the cubes to detect symmetrical functions and to minimize switching functions. Su and Cheung defined a general "don't care" condition and indicated that the diagnosis of colon cancer is one of the several possible applications of such a new definition.

Dr. K. C. Smith of the University of Toronto outlined the development of circuits for multiple-valued logic in the fourth tutorial session. He suggested that more development of multiple-valued circuits for practical applications will be seen in the near future. He developed a notation for drawing multiple-valued circuits and then offered several examples of multiple-valued logic elements, such as a ternary NAND using T^2L and a current-mode five-valued storage element.

The final tutorial paper was given by Dr. U. Strasilla of Reticon Corporation who described discrete-time analog devices. He demonstrated how such devices could be used to implement multi-level logic operations.

The panel discussion centered on possible future applications of multiple-valued logic. In addition to hardware applications, several unique areas of application, such as, in social systems, medical systems, and philosophical systems were discussed. Specifically, among the many examples mentioned were:

1) Time series multiple-valued logic

2) Systems modeling of interpersonal interaction

3) Diagnosis of disease

4) Programming systems

5) Proving the independence of axioms

The general conclusion of the panel discussion was that the concept of multiple-valued logic has a broad range of applications in a number of diverse disciplines.

While the 40 papers presented in the technical sessions reflected the theme of the panel discussion with their wide range of interest, the majority of the papers addressed the issue of the design, construction, and analysis of digital multiple-valued systems. In technical session 1A, four papers dealing with multiple-valued networks and arrays were presented. While in the parallel session 1B, four papers developing the algebraic properties of various multiple-valued logic's were discussed.

Session 2 consisted of an invited paper by Dr. Y. H. Pao, and Mr. J. Altman of Case Western Reserve University, entitled "Use of Associative Memory Techniques in Implementation of Multiple-Valued Logic Systems." They outlined a pattern recongition technique closely related to a fuzzy logic recognition system.

A paper developing techniques of fault detection in multiple-valued systems was presented in session 3A. A modified form of the D-Algorithm for fault detection was suggested, which would handle the problems of fault detection introduced by the multiple-valued nature of the circuit. In the parallel session 3B, two papers on the philosophical applications of multiple-valued logic were discussed.

Session 4A consisted of three papers on the applications of three-valued logic to digital systems. In this session a COS/MOS implementation of three-valued logic was proposed, as well as a static hazard-free three-valued T-gate, and a three-valued positional control system. In session 4B, three related papers were presented. One applied Venn diagrams to multiple-valued systems. The second paper developed a many-valued propositional calculus. The final paper in this session applied multiple-valued logic to hypothesis generation and medical diagnosis.

The mathematical aspects of multiple-valued circuit implementation were discussed in the four papers of session 5A. The synthesis of multiple-valued circuits, the development of multiple-valued codes, a discussion of noise margins in multiple-valued circuits, and an analysis of circuit complexity were among the specific topics presented. Session 5B included four papers on fuzzy logic and its applications. Fuzzy maps and applications of fuzzy logic to linguistics and to a logic of uncertainty were developed.

The second invited paper entitled "Semantic Influence from Fuzzy Premises" was presented in session six, by Dr. L. A. Zadeh of the University of California, at Berkeley. Dr. Zadeh translated fuzzy statements into relational assignment equations and illustrated their solution with several examples.

The various applications of multiple-valued logic was illustrated by the three papers of session 7A. In this session, multiple-valued logic was applied to univeral decision elements, human movement control, and plant disease diagnostic rules. In session 7B, three papers developing multiple-valued minimization techniques and procedures for the generation of multiple-valued prime implicants were presented.

The final session reported the results of recent research efforts. The subject matter of this session ranged from fuzzy logic and network theory to circuit realization of three-valued systems.

Two general principals may be derived from this symposium: (1) multiple-valued logic presents some real advantages in the future development of digital systems; and (2) the concepts of multiple-valued logic may be used to solve some important problems in computer science, engineering, medical diagnostics and mathematics, etc. The overall conclusion of the symposium is that multiple-valued logic offers an exiting new frontier which is clearly worthy of a concentrated research effort.

14TH DESIGN AUTOMATION CONFERENCE

REQUIREMENTS FOR SUBMITTING PAPERS

If you plan to submit a paper, you should send three copies of the paper (rough drafts are acceptable) to the program chairman no later than December 15, 1976. Please include a title for the paper plus an abstract (less than 25 words).

Accompanying the draft should be the full name, affiliation address, and telephone number of the principal author, with whom all further direct communication will be conducted.

Notification of acceptance will be sent to you during the first week of March 1977. After notification of acceptance, you will receive detailed instructions on the format to be observed in typing the final copy. To insure the availability of Proceedings at the Workshop, your final manuscript will be due April 20, 1977.

Final papers should be no longer than 5000 words, and the presentation should be limited to 20 minutes. Projection equipment for 35mm slides and viewgraph (overhead projector) foils will be available for every talk. Please indicate what, if any, additional audio-visual aids you require.

Rough drafts are to be sent to the Program Chairman:

Program Chairman

David W. Hightower
Texas Instruments, Inc.
P. O. Box 5012 MS907
Dallas, Texas 75222
214-238-3492

Computer Aided Artwork Contest

Any useful, viewable output from a CAD system can be entered in the Design Automation Conference Artwork contest. A letter to the contest chairman stating title and display area required is due by April 20, 1977.

Contest Chairman:

Paul Losleben
R 154
9800 Savage Rd.
Fort Meade, Maryland 20755
301-688-7815

General Chairman

Judith G. Brinsfield
Bell Laboratories
Room 3B-323
Whippany Road
Whippany, NJ 07981
201-386-3169

Sponsors

The sponsors of the Design Automation Workshop are the ACM (Association for Computing Machinery) Special Interest Group on Design Automation and IEEE (Institute of Electrical and Electronics Engineers) Computer Society Design Automation Technical Committee.

Design Automation

Design Automation implies the use of computers as aids to the design process.

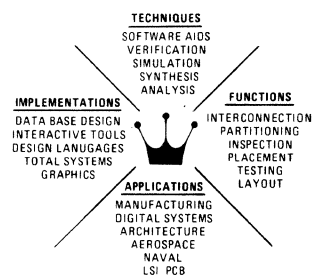
In the broadest sense, the design process includes everything from specifying the characteristics of a product to meet a marketing objective to enumerating the details of how it is to be manufactured and tested.

Thus design automation embraces applications from one end of the design process to the other.

Site of the 14th DAC

International Hotel
300 Canal Street
New Orleans, Louisiana
June 20, 21, 22, 1977

TOPICS OF INTEREST



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SYMPOSIUM ON DESIGN AUTOMATION AND MICROPROCESSORS ISSUES CALL FOR PAPERS

The IEEE Technical Committee on Design Automation and the ACM Special Interest Group on Design Automation are co-sponsoring a Symposium on Design Aids for the Design of Microprocessors and Microprocessor-based Systems.

This two-day symposium is scheduled for February 24-25, 1977, in Palo Alto, California, just prior to the COMPCON 77 Spring meeting.

In addition to refereed papers and invited talks, which will be published in a proceedings, the symposium will include a number of informal sessions. In order to stimulate open discussion, these will not be recorded in the proceedings.

If you wish to submit a paper, send three (3) copies of a rough draft (no more than 5000 words) to the general chairman:

W. M. vanCleemput
Digital Systems Laboratory
Stanford University
Stanford, CA 94305
(415) 497-1270

If you intend to participate by speaking at an informal session, or just by attending, please contact the general chairman.

Important Deadlines:

Rough draft: November 15, 1976
Notification of acceptance: December 15, 1976
Final manuscript: January 31, 1977
Request for participation in informal sessions: December 31, 1976

Topics

Papers are invited on any topic which falls within the general area of c.a.d. education. Some questions that might be considered could be: Where should c.a.d. be taught, on the job or in an educational establishment? At what educational level should c.a.d. be introduced? Should c.a.d. be considered as an interdisciplinary subject in its own right or should it be integrated into existing subjects and courses? What are the requirements in equipment and software for a viable teaching effort in c.a.d.? Should c.a.d. be taught as such, or is it really advanced computer science.?

Dates

CAD Ed is scheduled for 13-15 July 1977.

Venue

CAD Ed will be held at Teesside Polytechnic, Middlesbrough, Cleveland, England. The Polytechnic has modern buildings with good conference facilities. Residential accommodation in halls is available for delegates within a few minutes walk from the Polytechnic. Train services from all parts of the country are convenient and frequent, and there are several flights a day from Heathrow Airport, London, to Teesside Airport.

Organisation

CAD ED is organised by Teesside Polytechnic with support from:

Whessoe Ltd, Darlington
CAD Centre, Cambridge
Computer Aided Design Journal, IPC Press

The International Planning Panel is composed of leading authorities in this field and will supervise such activities as the selection of papers and the planning of sessions.

Exhibition

During the conference period there will be an exhibition at which manufacturers of equipment and suppliers of software or c.a.d. services will be displaying their facilities.

Deadline Dates

As soon as possible
Intention to submit - see form

1 November 1976
800 word summary required.
These will be assessed by referees for final selection.

25 April 1977
Final versions of papers required.

Conference Format

A feature of the conference will be the presentation of a number of papers by invited speakers from Europe and North America. These will be concerned with current developments in the general field of c.a.d., or specifically with the teaching of c.a.d. These keynote addresses given by leading authorities in their field, together with all the contributed papers, will occupy most of the conference time, but towards the end of the conference there will be a general discussion, led by a panel of experts, dealing with issues raised during the conference.

Proceedings

The full Proceedings of CAD Ed will be published.

Enquiries and correspondence to:—

Conference Secretary,
CAD Ed,
Teesside Polytechnic,
Middlesbrough,
Cleveland,
England.

Telephone: Middlesbrough 44176

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1977 International Symposium on Fault-Tolerant Computing FTCS-7

University Hilton Hotel (Adjacent to the USC campus)
LOS ANGELES, CALIFORNIA JUNE 28-30, 1977

CALL FOR PAPERS

This is the seventh annual international symposium sponsored by the Technical Committee on Fault-Tolerant Computing of the IEEE Computer Society.

Papers are solicited on any subject dealing with the general topic of fault-tolerant computing. A list of the topics considered relevant to the theme of this symposium is given below.

- *Fault-Tolerant System Architecture*
- *Operating Systems for Fault-Tolerant Systems*
- *Fault Diagnosis, Reconfiguration, and Recovery*
- *Fault-Tolerant Software Systems*
- *Error Control in Computers and Computer Networks*
- *Measures of Availability, Reliability, and Fault Tolerance*
- *System Testing and Diagnosis*
- *Applications of Error Coding Techniques*
- *Modeling of Fault-Tolerant Systems*
- *Verification of Hardware/Firmware/Software Design*
- *Analysis of Test Generation Methods*

Four copies of a complete paper of digest length (4000 words maximum) should be sent so as to be received by the Program Chairman no later than December 1, 1976. Each paper should include an abstract of no more than one page.

Authors will be notified of the disposition of their papers by March 1, 1977.

GENERAL CHAIRMAN
Professor Arthur D. Friedman
Dept. of Electrical Engineering & Computer Science
University of Southern California
Los Angeles, CA 90007

PROGRAM CHAIRMAN
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Call for Papers

ACM 77

October 17-19, 1977

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PARTICIPATE

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You are encouraged and invited to submit a paper on any aspect of computer research, development or application. Papers may be theoretical, state-of-the-art reports, reviews or tutorials. Papers must not have been previously published or presented, and they must not exceed 15 pages, including a 125 word abstract, bibliography and illustrations. Five copies of the draft paper should be received by February 15, 1977.

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