Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	17 JANUARY 1997	MILITARY STANDARD

4. TITLE AND SUBTITLE
Minuteman Interface Control Program

5. FUNDING NUMBERS
SAMSO-STD-75-2A

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

DET 10, SPACE AND MISSILE SYSTEMS CENTER/SDC
1111 EAST MILL STREET
SAN BERNARDINO, CA 92408-1621

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

BMO-TR-94-20

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
A. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION IS UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This standard outlines the procedures to be followed in implementing the Minuteman Interface Control Program. It contains requirements for the preparation, revision and processing of all Interface Control Drawings (ICDs) authorized by the Space and Missile Systems Organization (SAMSO)for incorporation into SAMSO Report 62-46-1. Instructions for meeting specific Interface Control Drawing format and content requirements are provided, along with guidelines for documenting the various types of interfaces encountered in the Minuteman Weapon System.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Configuration Management, interface control practices, interface control drawings	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	

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SAMSO-STD 75-2A
17 January 1977
SUPERSEDING
SAMSO Exhibit 75-2
1 April 1975

SAMSO STANDARD
MINUTEMAN
INTERFACE CONTROL PROGRAM

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE SYSTEMS ORGANIZATION
AIR FORCE SYSTEMS COMMAND

DEPARTMENT OF THE AIR FORCE

Space and Missile Systems Organization

Air Force Systems Command

MINUTEMAN Interface Control Program SAMSO-STD 75-2A.

1. This SAMSO Standard has been approved for use by all agencies of the Space and Missile Systems Organization.

2. Recommended corrections, additions, or deletions should be addressed to:

SAMSO/MNBC
Norton AFB, CA 92409

FOREWORD

The purpose of this standard is to define requirements for the implementation of the Minuteman Interface Control Program, including the preparation and revision of Interface Control Drawings.

Revision "A" was prepared to accomplish the following:

(a) Include additional procedural requirements formerly regulated by SAMSO Exhibit 62-46A and SAMSO Exhibit 75-2.

(b) Standardize and clarify requirements for the preparation and revision of Interface Control Drawings.

CONTENTS

ILLUSTRATIONS

1. SCOPE

This standard outlines the procedures to be followed in implementing the Minuteman Interface Control Program. It contains requirements for the preparation, revision and processing of all Interface Control Drawings (ICDs) authorized by the Space and Missile Systems Organization (SAMSO) for incorporation into SAMSO Report 62-46-1. Instructions for meeting specific Interface Control Drawing format and content requirements are provided, along with guidelines for documenting the various types of interfaces encountered in the Minuteman Weapon System. Existing ICDs are not required to be updated to comply with this standard.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

Specifications

Military

MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-D-5480	Data, Engineering and Technical: Reproduction Requirements For

Standards

Military

MIL-STD-100	Engineering Drawing Practices
MIL-STD-483	Configuration Management Practices for Systems, Equipment, Munitions and Computer Programs
MIL-STD-1521	Technical Reviews and Audits For Systems, Equipment, and Computer Programs

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

ANSI Y14.5	Dimensioning and Tolerancing for Engineering Drawings
ANSI B46.1	Surface Texture
IEEE-315	Graphic Symbols for Electric and Electronics Diagrams (including

	Reference Class Designation Letters) (with ANSI Y32.2)
SAMSO Report 62-46-1	Minuteman Interface Control Drawings
SAMSO Report 62-46-3	Minuteman Interface Control Working Group Members and Interface Control Drawing Approval Signatures
D2-13781	Minuteman Interface Master Gage Control Document

2.3 Source of documents. Copies of listed specifications, standards, adopted industry association documents, SAMSO reports, and Minuteman control documents should be obtained from the purchasing office or as directed by the contracting officer.

3. THE MINUTEMAN INTERFACE CONTROL PROGRAM

3.1 Authorization. The Minuteman Interface Control Program is authorized and directed by SAMSO as provided in MIL-STD-483.

3.2 Purpose. The purpose of the Minuteman Interface Control Program is to develop and maintain a system of interface controls that will assure physical and functional compatibility between interfacing Associate contractor or government agency hardware/software/facility. The program also provides the means for identification and resolution of interface incompatibilities and for determining the interface impact of design changes.

3.3 Implementation. SAMSO has established the Interface Control Working Group (ICWG) and its chairmanship. Members of the ICWG are the ICWG chairman and those associate contractors and government agencies designated by SAMSO as Interface Control Program participants. The Minuteman Interface Control Program is implemented jointly by Minuteman associate contractors and government agencies. The basic functions of the ICWG are to facilitate the coordination of interface control activities and serve as the recognized communications link between the contractors and agencies. Detail requirements, procedures and responsibilities to be met or followed by participants in implementing the interface program are contained in paragraph 4 of this standard.

3.4 Documentation. Interface Control Drawings (ICDs) are used to document and control design requirements at selected interfaces. When approved (signed) by the participants and system released by the ICWG chairman (4.5.4), an ICD and revisions thereto represent agreement between the ICD participants and SAMSO that:

a. The interfacing designs will be within the requirements specified by the ICD.

b. The interfacing design requirements are physically and functionally compatible with one another.

c. No change which affects interface compatibility will be made to a design without coordination and agreement between the affected participants.

NOTE: ICDs are not to be used for manufacturing, assembly or quality control.

Requirements on the preparation of ICDs are contained in paragraphs 5 and 6 of this standard.

4. REQUIREMENTS – INTERFACE CONTROL PROGRAM PROCEDURES AND RESPONSIBILITIES

4.1 General. The purpose of paragraph 4 is to apply the interface control requirements and guidance of MIL-STD-483 to the administrative activities of the Minuteman Interface Control Program. Under the following topics it explains in detail the procedures and responsibilities for participants in the program.

a. Determining the required Interface Controls (4.2).

b. Scheduling Interface Control Activities and Monitoring Status (4.3).

c. Preparing ICDs and Interface Revisions (4.4).

d. Processing ICDs and IRs (4.5).

e. Other ICWG Procedures (4.6).

4.1.1 ICWG representatives. Each ICWG member organization shall appoint an ICWG representative to be that organizations single point of contact on interface matters. ICWG members participating in interface agreements shall authorize their ICWG representative and at least one other individual in their organization to approve ICDs on its behalf.

4.1.2 ICWG chairman. The individual appointed as the ICWG chairman is responsible for administering the Minuteman Interface Control Program on behalf of SAMSO and assuring that participants comply with the requirements of this standard.

4.1.3 ICWG member listing. ICWG member organizations, ICWG representatives, the ICWG chairman, individuals authorized to sign ICDs, and related addresses and phone numbers will be listed in SAMSO Report 62-46-3. The report is maintained by SAMSO.

4.2 Determining the required interface controls. The need for new or revised ICDs may be generated by the introduction of new hardware/software or by engineering changes to existing designs. Interfaces which are candidates for interface control will usually be identified through a review of the documentation leading to (1) introduction of new hardware/software (preliminary SRAs, system descriptions, meeting minutes, etc.); or (2) submittal of ECPs to implement hardware/software design changes (preliminary ECPs, directives, meeting minutes, etc.).

4.2.1 New hardware/software responsibilities – participants.

a. Notify the ICWG chairman whenever there is a potential interface impact due to new hardware/software.

b. Provide the chairman with a list of interfacing designs and recommend new ICDs or changes to existing ICDs. Also identify existing ICDs which are applicable without change, and master gage requirements, if any. (4.6.4) If new ICDs are indicated, the above recommendation shall include proposed "titles" and "scopes" (5.4.4 and 5.4.13, respectively) and preparation responsibilities. If Interface Revisions (IRs) are indicated, the above recommendation shall include affected ICD numbers and titles, a brief description of the nature of each change, and preparation responsibilities.

c. Support the ICWG chairman in coordinating a final list of recommended ICDs/IRs.

d. Provide the ICWG chairman with numbers for the IRs they will prepare.

e. Identify program milestones applicable to the new hardware/software.

4.2.2 Engineering change responsibilities – participants.

a. The participant responsible for initiating a change shall coordinate with other affected participants to determine the potential interface impact of the change.

b. He shall advise the ICWG chairman of the change and its potential interface impact, and request assignment of an Interface Control Working Group Action (ICWGA) sheet. (4.3.1)

c. He shall then assign the number(s) of the IR(s) he plans to originate to incorporate the effects of the change.

d. If new ICDs are also required, a recommendation for them shall be submitted to the chairman for action. (4.2.1)

4.2.3 New hardware/software and engineering change responsibilities – ICWG chairman.

a. Assign and distribute ICWGAs to program interface control activities as required.

b. Review ICD/IR recommendations with affected participants to develop coordinated ICD/IR lists, including the assignment of preparation responsibilities.

c. Assure that interface control plans are developed by the earliest applicable reviews (SDR, IPRs, etc.).

d. Assign ICD numbers.

e. Issue "blocks" of numbered IR forms to participants for their use as required.

f. Submit formal requests to SAMSO for new ICDs and for changes to the titles or scopes for existing ICDs. SAMSO

may authorize ICD requests as submitted, or recommend and coordinate changes thereto with the ICWG chairman and affected participants.

g. Upon receipt of SAMSO authorization, enter new ICDs into SAMSO Report 62-46-1.

h. Provide the necessary support to the associate contractors in the form of interface analysis, ICD/revision schedule dates, ICD/revision status or completed ICDs/revisions in support of their respective SDRs, PDRs, CDRs, FCAs, PCAs or other applicable program milestones.

i. Review each ECP to verify that: (1) the total interface impact has been identified; (2) the interface effects of the ECP have been adequately incorporated into the appropriate ICDs and IRs.

j. Define and coordinate resolution of interface problems.

4.3 Scheduling interface control activities and monitoring status. In general, ICDs and IRs shall be scheduled for system release to support the earliest appropriate SAMSO program milestone identified by the participants. The ICD/IR shall be fully approved and system released by the earliest applicable milestone (ref. MIL-STD-1521). Occasionally, it may be necessary to release an "incomplete ICD" (4.6.1) to support a given milestone.

4.3.1 Schedule documentation. ICWGAs shall be used to document and communicate, to affected participants and SAMSO, the plans of action and associated schedules required to prepare new ICDs, revise existing ICDs, resolve interface problems, etc. They shall include a written description of the subject/problem treated therein, and a record of related events (letters, meetings, telecons, etc.). A separate ICWGA shall be used to treat each subject, problem, etc. For accountability purposes, the ICWG chairman shall assign a number to each ICWGA. ICWGAs shall be prepared, maintained and distributed by the ICWG chairman.

4.3.2 Scheduling responsibilities – participants.

a. Identify ICD/IR program milestones to the ICWG chairman.

b. Support the ICWG chairman in establishing ICD/IR submittal/approval schedules to implement new hardware/software.

c. Provide the ICWG chairman with submittal/approval schedules for ICD/IRs resulting from change action. (When contractual and other considerations permit, IRs shall be scheduled for participant(s) approval in time to support Configuration Control Board (CCB) actions related to the change.)

d. Review current ICWGAs and comply with ICD/IR submittal/approval dates or other action items as scheduled.

e. Notify the ICWG chairman of potential schedule slides and cooperate in the rescheduling thereof.

4.3.3 Scheduling responsibilities – ICWG chairman.

a. Coordinate with affected participants to establish ICD/IR submittal/approval schedules in support of the earliest program milestone and record them on the applicable ICWGA.

b. Coordinate with affected participants to establish other ICWG action schedules such as data exchanges, problem resolutions, fit checks, etc., and record them on the applicable ICWGA.

c. Monitor ICWG actions to assure timely completion of scheduled items in support of program milestones.

d. Record actual ICD/IR submittal/approval dates on applicable ICWGAs.

e. Distribute ICWGA copies to affected participants and SAMSO on a maintained basis.

f. Prior to associate contractor milestones that require system released ICDs, advise affected participants and SAMSO of the status of all scheduled ICDs and/or IRs. (This shall be done through formal correspondence or by making it available at the applicable PDR, CDR, etc.) Indicate the extent of ICD/IR agreement reached to date and identify actions required to complete any outstanding ICDs/IRs. Also indicate if there will be any program impact due to outstanding ICDs/IRs.

g. Advise SAMSO of potential program impacts due to schedule slides and coordinate with affected participants to resolve the problem.

4.4 Preparing ICDs and interface revisions.

4.4.1 New ICDs. Upon receipt of SAMSO authorization for new ICDs, responsible participants may proceed with preparation activities. ICD preparation involves the combined efforts of the affected participants. Preparation responsibilities are outlined in paragraph 4.4.3.

4.4.2 Interface revisions.

4.4.2.1 Interface revisions – general. After an ICD has been system released, it can only be changed by preparing an Interface Revision (IR). Any participant to an ICD may originate IRs against that ICD. IRs shall be prepared whenever there is a need to change the information contained in an ICD. Separate IRs are required to revise each sheet of multi-sheet J-size ICDs and each volume of multi-volume book-form ICDs. In addition to making changes to ICDs due to the effects of new hardware/software of engineering changes (4.2), reasons for originating IRs include:

a. Correcting ICD drafting or typing errors.

b. Improving or expansing the interface definition.

c. Adding information to complete an "incomplete ICD".

d. Bringing ICD into accord with actual design or operation.

e. Incorporating design changes made in relation to resolving interface incompatibility problems prior to CDR.

4.4.2.2 Interface revisions – extensive. When a configuration changes extensively, an IR to sheet 1/volume I of an ICD may be used to add a new sheet/volume to define the new configuration. The old configuration will thereby be retained. On less complex changes, accountability of the old configuration may be retained by preparing IRs to either:

a. Add new views, paragraphs, etc., to describe the latest configuration while retaining old views, etc., or

b. Replace existing views or completely redraw the ICD (5.5.4). The old configuration then remains available through historical records of each ICD and IR.

4.4.3 ICD/IR preparation responsibilities – participants.

a. Prepare ICDs and IRs in accordance with requirements contained in paragraphs 5 and 6 of this standard. If extensive changes are required to an ICD, a "complete revision" shall be considered. (5.5.4)

b. Request that the chairman obtain SAMSO authorization for changes to ICD titles or scopes before preparing IRs to accomplish such changes.

c. Cooperate in the exchange of interface data needed for ICD/IR preparation. Notify the ICWG chairman whenever there is a problem in obtaining or providing such data which might impact program schedules.

d. Arrange, attend and participate in Technical Interchange (TI) meetings as required to support ICD/IR preparation.

4.5 Processing ICDs and IRs.

4.5.1 Submittal. Following preparation of an ICD or IR, the originating participant shall sign the original and submit it to the next participant as indicated on the applicable ICWGA. At the same time, he shall provide copies to other participants, the ICWG chairman and SAMSO as contractually specified. See Figure 1 for typical ICD/IR flow.

4.5.2 Approval routing. Routing and review will proceed according to the order of "action steps" recorded on the applicable ICWGA. Each affected participant shall review and approve the ICD/IR in his turn. Approval is indicated by an authorized signature in the ICD/IR approval block. After approval, each participant (except the last one) shall forward one copy of the ICD/IR to the ICWG chairman. The last approving participant shall forward the ICD/IR originals to the ICWG chairman for final review and system release.

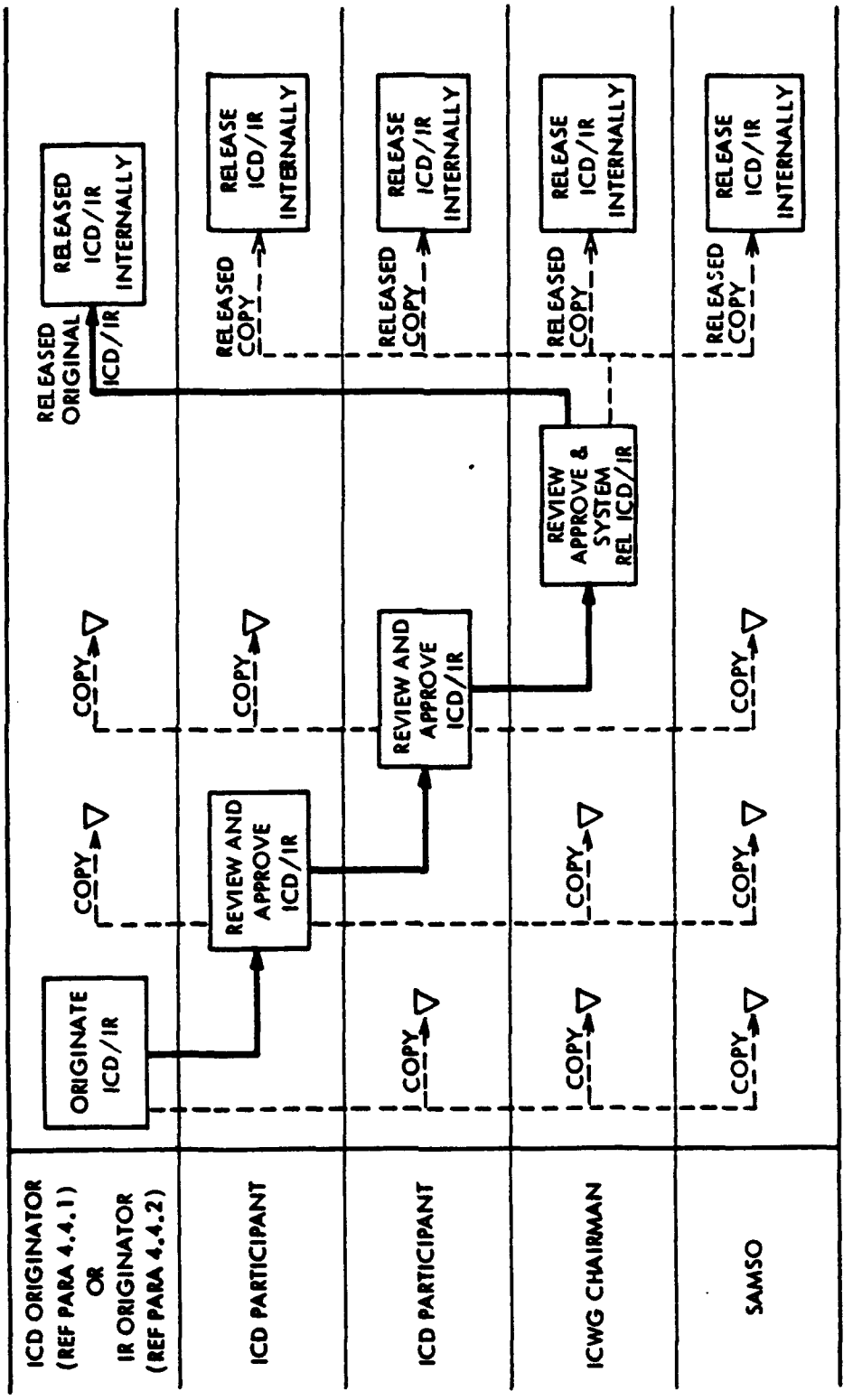


Figure 1. Typical ICD/IR Flow

4.5.3 Alterations. During approval routing, ICD/IR originals may not be altered without obtaining authorization from the originator and any participants who have already signed. Authorized alterations made after the originator's approval shall be documented by the affected participants and the ICWG chairman.

4.5.4 System release. System release of an ICD/IR means the ICD/IR, as signed by the participants, has been reviewed and signed by the ICWG chairman and is ready for distribution. Prior to system release, the ICWG chairman shall review each ICD/IR for compliance with the requirements of this standard. He may make corrections of an "administrative" nature. (Such corrections shall be coordinated with the participants.) If technical corrections are required, they shall be referred to the participants for action. ICDs/IRs reflecting the effects of Class I changes will not be approved by the ICWG chairman until directed by the procuring agency or the change is approved by the procuring agency.

4.5.5 Updating ICDs. The participant responsible for origination of an ICD shall "update" the ICD by incorporating outstanding IRs:

a. Any time subsequent to system release, but prior to the accumulation of six (6) IRs against a given ICD sheet/volume.

b. When one or more IRs have been outstanding against a given ICD sheet/volume for a period of six (6) months.

c. At the time of a "complete revision" to an ICD. (5.5.4)

d. Upon request by the ICWG chairman when deemed necessary, i.e., prior to the start of a major additive or block change, existence of large complex IRs, etc.

NOTE: A classified ICD, due to its special handling provisions, shall be updated when deemed necessary as concurred to by the originating participant and the ICWG chairman. Instructions for incorporating IRs are contained in 5.5.5.

4.5.6 Distribution.

a. System released ICDs and IRs. The ICWG chairman shall distribute copies of new ICDs/IRs, including "completely revised" ICDs (5.5.4), to the affected participants and SAMSO as contractually specified.

b. Updated ICDs. ICD originators shall distribute copies of "updated ICDs" (4.5.5) to affected participants, the ICWG chairman and SAMSO as contractually specified. Only the revised pages/sheets of book-form ICDs need be distributed unless otherwise contractually specified.

c. Special distribution. The ICWG chairman shall provide, on request, a contractor/agency with a maintained copy of an ICD (including outstanding IRs) in which they DO NOT participate if it is listed as a "Related ICD" on an

ICD in which they DO participate. All other special requests for ICD copies shall be directed to SAMSO. SAMSO may authorize the ICWG chairman to provide such copies on a "need" basis.

4.5.7 Custody. The ICWG chairman shall return system released ICD and IR originals to the ICD originator for custody.

4.6 Other ICWG procedures and requirements.

4.6.1 Incomplete ICDs. An "incomplete ICD" is one which has been system released without complete definition of, or agreement to, the interface requirements documented therein. Incomplete interface definitions may be due to temporary lack of interface data, or disagreement over the adequacy of data currently available. Incomplete interface agreements may be due to lack of contractual authority or SAMSO direction for certain aspects of the interfacing designs. "Incomplete" areas of an ICD may be noted on the ICD prior to, or during, approval routing. When release of an incomplete ICD becomes necessary, the following procedures apply:

a. The ICD originator and/or reviewing participants shall identify incomplete ICDs and incomplete items per instructions outlined in paragraph 5.4.16.2.c.

b. Prior to system release, the ICWG chairman shall coordinate with affected participants and/or SAMSO to establish an action plan for completion of the ICD and program it on the applicable ICWGA.

c. Incomplete items shall be "resolved" by preparing IRs against the ICD as soon as missing data is available, disagreements become resolved, or appropriate direction is received.

4.6.2 Second originals. In the event an ICD or IR becomes lost or destroyed a "second original" shall be prepared by the originating participant. This may be accomplished by completely redrawing the ICD/IR or by reproducing a new "original" from reproducible copies. In either case, the words,

"SECOND ORIGINAL – ORIGINAL LOST"

shall be entered in half-inch-high block letters on all second originals – directly over the title block on J-size ICDs or at the top of the first page/sheet of book-form ICDs and IRs.

4.6.3 ICD cancellation. All requests to cancel ICDs or individual ICD sheets/volumes shall be directed to the ICWG chairman for coordination and special instructions. Cancellation of a previously authorized ICD requires the approval of SAMSO. Individual sheets of multi-sheet (J-size) ICDs or individual volumes of multi-volume (book-form) ICDs may be cancelled with the concurrence of the ICWG chairman.

4.6.4 Master gage controls. Mechanical interfaces that require closely controlled fit to ensure their interchangeability may require interface master gages. The need for master gages to control these interfaces shall be identified as part of the overall interface control plan for a given CI and/or facility. The ICWG chairman shall coordinate all requests for master gages and obtain SAMSO approval for such tools. Master gage requirements and a listing of master tools are contained in the Minuteman Interface Master Gage Control Document, D2-13781.

4.6.5 Procuring agency signature prerogative. Under certain circumstances SAMSO or another agency with engineering responsibility for hardware involved in a given interface, may elect to accept responsibility for that interface. If this is done, SAMSO or the responsible agency signs all ICDs/IRs related to the interface in lieu of the "regular" contractor/agency.

4.6.6 ICWG meetings. In the course of administering the Interface Control Program, the ICWG chairman may call meetings involving ICWG representatives. ICWG meetings are used to develop interface control plans, resolve interface problems between participants, obtain sign-off of ICDs, and coordinate other interface control activities as required. The chairman shall provide an agenda to affected parties at least five (5) working days prior to a meeting. He is responsible for minutes of the meetings, including the recording of action items, commitment dates, etc.

4.6.7 Verification of interface design compatibility. The need may arise, under certain circumstances, to verify that interfacing designs are compatible or to assure that interface problems have been satisfactorily resolved. To accomplish such verification, fit checks and assembly reviews may be held. They will normally involve only the physical aspects of an interface. Functional verification will result from normal testing/demonstration procedures.

4.6.7.1 Developmental fit checks. During the early stages of hardware design, participants may hold developmental fit checks to identify or resolve interface problems by assembling the developmental hardware.

4.6.7.2 Confirmation fit checks. The ICWG chairman or SAMSO may request confirmation fit checks when the interfacing designs are complete, production equivalent hardware is available, and it is deemed necessary to confirm that the hardware can be satisfactorily assembled and is in conformance with applicable ICDs. Confirmation fit checks shall be conducted by the ICWG chairman at a site determined by hardware availability and program needs. It is the responsibility of the ICWG chairman to provide a plan for each fit check.

4.6.7.3 Assembly reviews. Assembly reviews may be requested by SAMSO, the ICWG chairman or participants to observe and review interface problems encountered during assembly of specific subsystems. The ICWG chairman may conduct these reviews at the assembly and checkout sites if required.

4.6.7.4 Documentation of fit check/assembly review interface problems. Each interface problem identified during fit checks/assembly

reviews shall be documented. Corrective action shall be established, along with the responsibility and schedule for implementing such action. Action assignments and schedules shall be programmed on the applicable ICWGA.

4.6.8 Resolving interface incompatibilities. Due to engineering errors, specification anomalies, manufacturing tolerance problems, etc., some interface incompatibilities may not be discovered until after interface agreements are complete. Incompatibilities may be detected during fit checks, breadboard or end-to-end testing, assembly and checkout, etc. All interface incompatibilities shall be brought to the attention of the ICWG chairman as soon as they are discovered. The chairman shall coordinate with affected participants in their development of a plan for resolution of the problem. The required solution may involve hardware/software redesign, interface revisions, etc. Interface problems, their program impacts and a schedule of ICWG actions for their resolution shall be recorded on appropriate ICWGAs. In the event that a problem cannot be resolved, the procedure specified in paragraph 4.6.11 shall be followed.

4.6.9 Change in hardware responsibility. Following release of an ICD, the engineering and/or manufacturing responsibility for an item (hardware/software) may be transferred from one contractor to another, or a second source manufacturer may be selected. When these occur, the method of handling transfer of interface responsibility shall be determined through coordination between the ICWG chairman, SAMSO/TRW and the affected contractors. The method may include:

a. Preparation of a new ICD(s).

b. Adding a new contractor to an existing ICD(s).

c. Replacing the former contractor with the new contractor on the appropriate ICD(s).

d. A combination of the above.

4.6.10 Discrepant hardware. A participant may find that a specific unit of his hardware does not comply with applicable ICDs. To provide assurance that the discrepant hardware can be assembled without interface impact, the participant may submit a formal request for assistance to the affected participant(s) and the ICWG chairman. The request shall identify the hardware, its unit/serial number, the discrepancies and the details of the recommended disposition (use as is, or rework and use). The ICWG chairman shall review the request with the affected participant(s) and provide a coordinated formal response to the request. The response may include a recommended disposition other than that contained on the request.

NOTE: The configuration of discrepant hardware shall not be documented on ICDs.

4.6.11 Disputes. In the event that ICWG members are unable to agree on interpretation of the procedures outlined in this standard or whether a given ICD/IR complies with the requirements of this standard, the problem shall be referred to the ICWG chairman. If resolution of the

problem cannot be achieved at that level, it shall be submitted to SAMSO for arbitration. SAMSO has final authority for the settlement of all disputes which arise in the Minuteman Interface Control Program. Formal notification of the resolution to a dispute shall be provided to the affected parties.

5. REQUIREMENTS - PREPARATION OF ICDs AND IRs

5.1 Interface types. The format and content of an ICD will vary depending upon the nature of the design requirements documented therein. For example, the interface between two electrical connectors may involve the mechanical aspects (connector size, pin/socket configuration, etc.) as well as the electrical aspects (signal levels, contact resistance, etc.) of the interface. Thus, an ICD for this interface would include both mechanical and electrical type interface design requirements. For purposes of this standard, interface design requirements are grouped into the following interface types:

Mechanical	Paragraph 6.3
Envelope	Paragraph 6.4
Environmental	Paragraph 6.5
Fluid	Paragraph 6.6
Electrical	Paragraph 6.7
Sequencing/Programming and Timing	Paragraph 6.8
Computer Programming	Paragraph 6.9

Additional subtypes of interfaces are included under the above paragraphs. General requirements for the technical description of each type and subtype of interface are contained in Section 6.

5.2 ICD/IR drawing standards. In general, ICDs and IRs shall be prepared in accordance with the drawing standards outlined in MIL-STD-100. However, in some areas, the requirements of this standard may deviate from MIL-STD-100 to satisfy unique aspects of the Minuteman Interface Control Program. Clarity and legibility of all ICDs and IRs must be sufficient to meet the reproducibility requirements of MIL-D-5480.

5.3 ICD formats. ICDs may be prepared using either of two basic formats: "J-size" drawings, or "book-form" drawings. The participant responsible for preparing an ICD will coordinate with the other participants to establish what format will be used. The requirements of this standard apply equally to both formats, except where noted otherwise.

5.3.1 J-size ICDs.

5.3.1.1 Application. J-size ICDs are usually used to document relatively complex mechanical/envelope interface design requirements. They may also be employed whenever the display of interface information best lends itself to a larger, sheet-type drawing.

5.3.1.2 Basic format. J-size ICDs shall be prepared in accordance with format requirements of Figures 2, 3 and 4 and MIL-STD-100. The ICDs shall be prepared on material per MIL-D-1000 with the exception that vellum paper shall not be used. Additional sheets may be added under the same ICD number if more space is required. Each sheet shall be independently zoned. Horizontal zoning shall begin with "1" as the first zone on the right and vertical zoning shall begin with "A" as the first zone from the bottom. Suggested zone sizes are 11-inch horizontal and 8-1/2-inch vertical. Each sheet shall contain, as a minimum, a complete title block, approval block, effectivity block, revision block, supplemental drawing number blocks in the border, and microfilm arrows. In addition, Sheet 1 shall always contain the SAMSO-approved scope, an equipment responsibility list, a list of related ICDs, and the applicable ICWGA number. Figures 2, 3 and 4 depict the "block" areas of a J-size ICD, identify the location of certain "standard information" and reference paragraphs of this standard wherein requirements for generation of this information are given.

5.3.2 Book-form ICDs.

5.3.2.1 Application. Book-form ICDs are usually used to document "functional" design requirements (electrical, sequencing and timing, etc.) where extensive written information or tabular data must be presented. They may also be used for mechanical/envelope interface requirements, provided the information can be adequately displayed on 8-1/2 by 11-inch sheets or 11 by 17-inch (or longer) foldouts.

5.3.2.2 Basic format. Book-form ICDs are multi-sheet, 8-1/2 by 11-inch, typewritten documents, prepared on material per MIL-D-1000. Each page shall be the original typed or drawn page, except that larger drawings may be photo-reduced for incorporation into book-form ICDs. Every book-form ICD shall contain, as a minimum, a title page, revision page, table of contents, active page record, effectivity page, the SAMSO-approved scope, an equipment responsibility list, a related ICDs list, and a section for notes and abbreviations. Each page of the book-form ICD shall contain the ICD drawing number, page number and "Rev.__" in the upper right-hand corner.

Caution: Sufficient margin must be provided on all borders for reproduction purposes. All text, diagrams, ICD numbers, page numbers, etc., shall be within the following minimum margins:

Left hand - one inch margin

Right hand - one-half inch margin

Appendix A contains a sample book-form ICD which shows the order and format in which the above "standard information" is to appear. Detailed instructions for the generation of this information are contained in paragraph 5.4.

5.3.3 Combination ICDs. Occasionally it may be advantageous to use a combination of the two types of documentation just described. For example, a J-size mechanical ICD may have extensive amounts of tabular

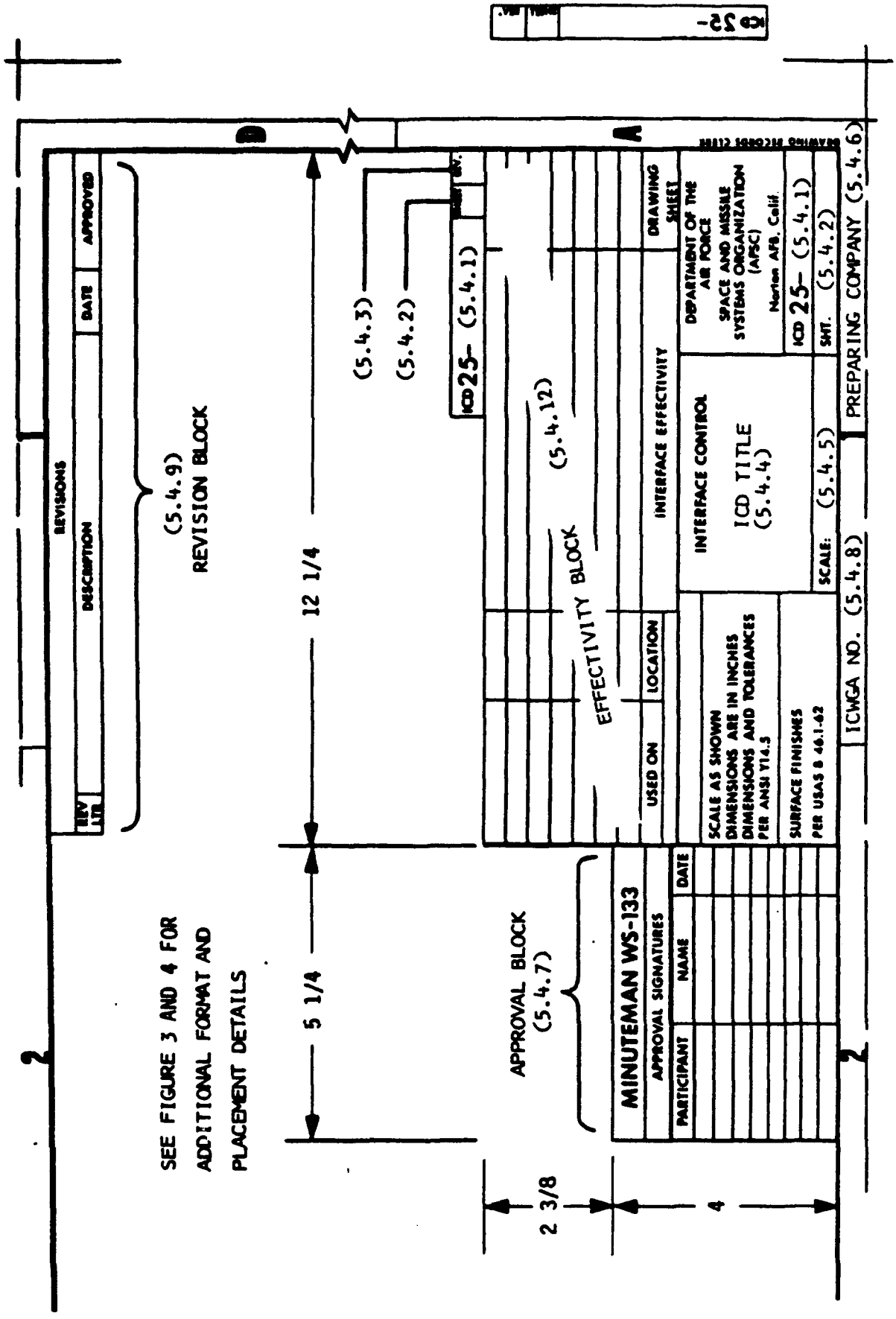


Figure 2. J-Size ICD Format Details

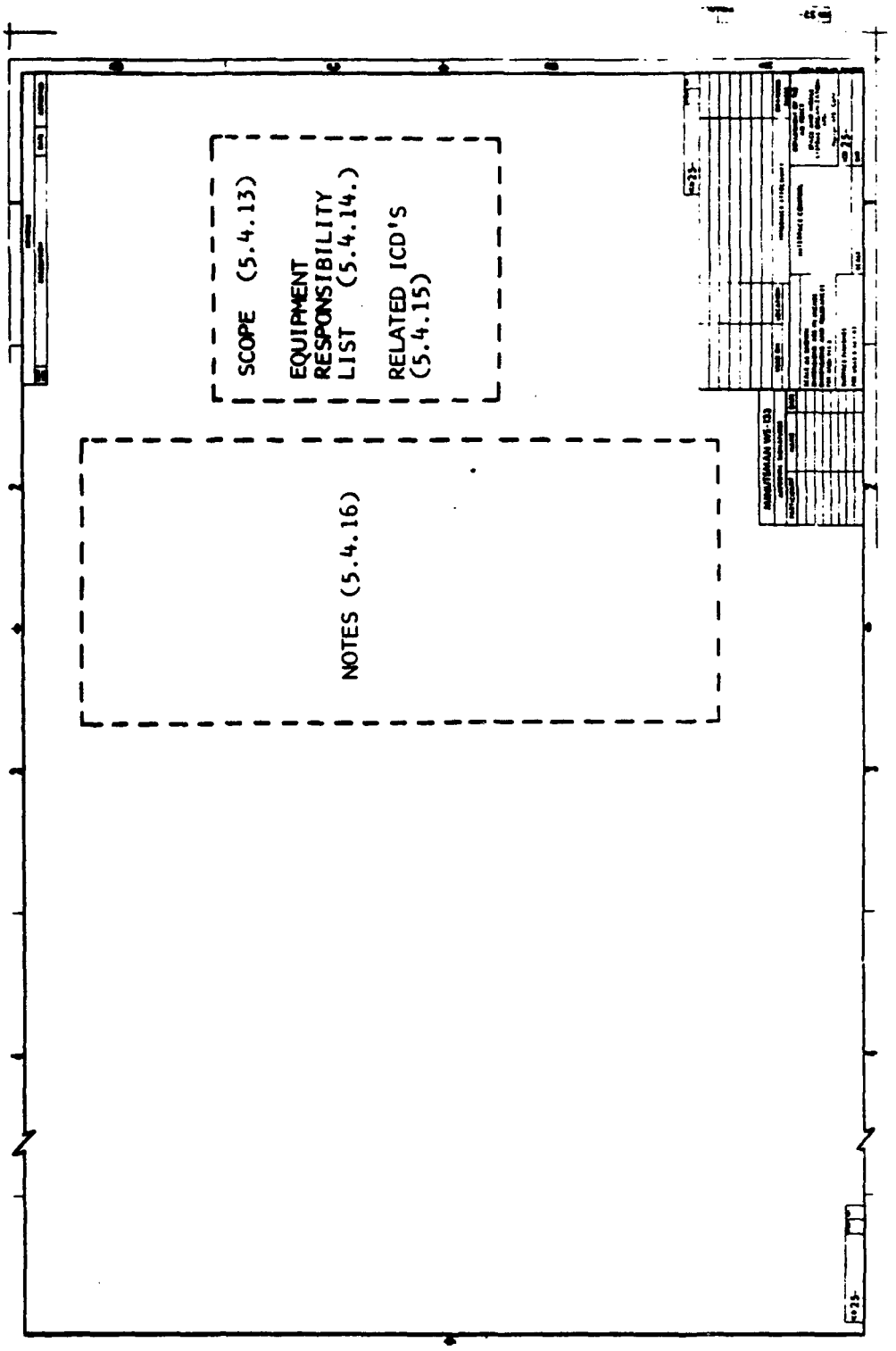


Figure 3. J-Size ICD Format

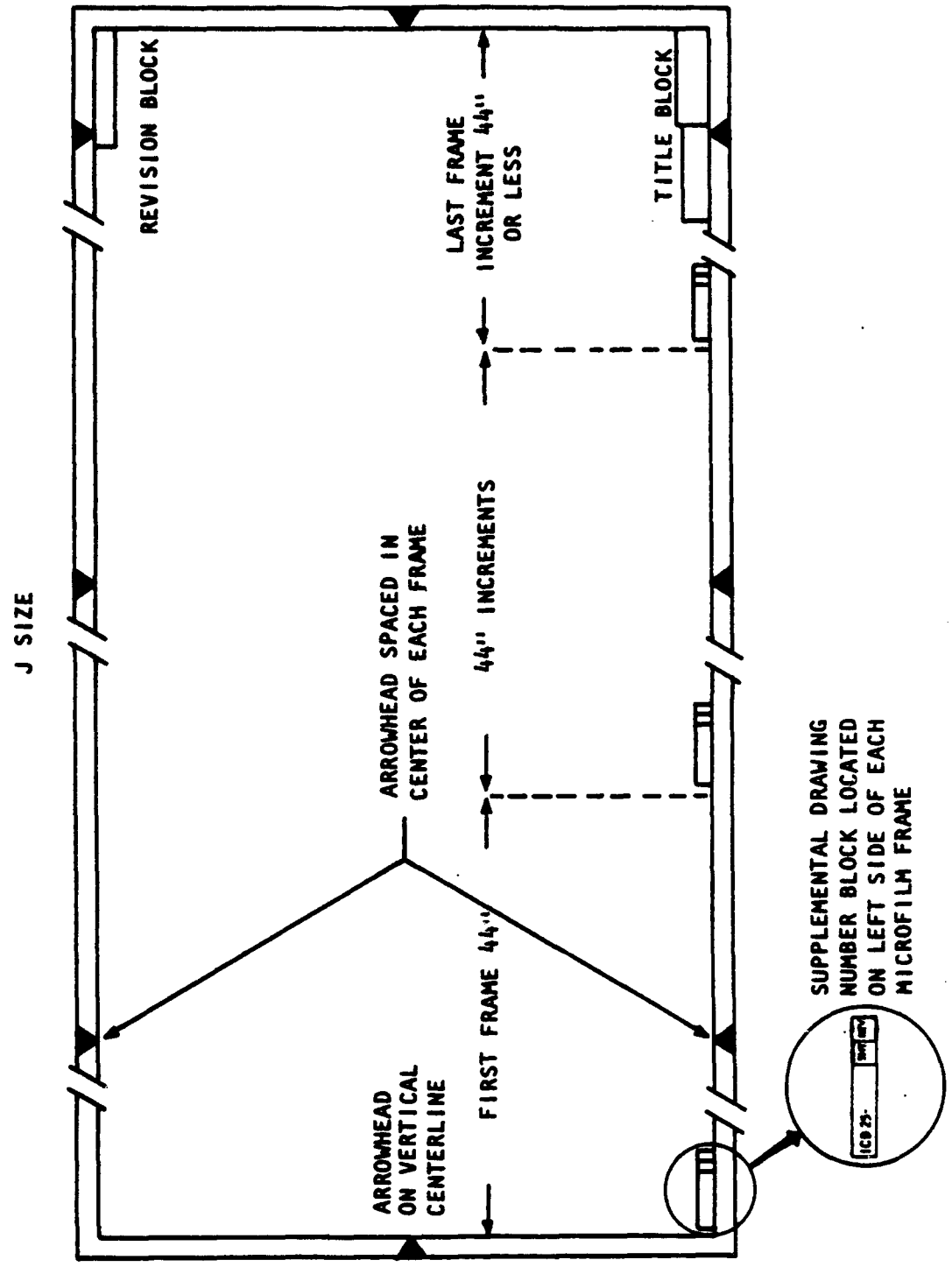


Figure 4. Microfilm Arrows and Supplemental Drawing Number Blocks

or written data. In this case a book-form ICD containing this data may be produced to supplement the J-size ICD. Such a supplemental book-form drawing is called a "D" document and the J-size which it supplements is called the "parent" ICD. When "D" documents are used, they shall carry the same number as the "parent" ICD, and shall be cross-referenced with the parent ICD by appropriate notations on sheet 1 of the parent and on the title page of the "D" document. The basic format and information content of a "D" document is the same as that required for a book-form ICD.

5.3.4 Paragraph/figure numbering.

a. Paragraphs. Book-form ICDs shall utilize the decimal system of paragraph numbering. For example:

1

1.1

1.2

2

2.1

2.1.1, etc.

Paragraph numbering should be limited to three sub-levels wherever possible. Itemization within a paragraph or subparagraph shall be accomplished by using lower-case letters, as opposed to numerals. When a paragraph must be continued on another page, the continuation page shall begin with the paragraph number, followed by "(Continued)". Use of the paragraph title is optional.

b. Figures. Figures, tables, charts, etc. shall be numbered with the same number as the paragraph in which they are referenced. If more than one figure applies to the same paragraph, they shall be identified with separate "dash" numbers (e.g., Figure 4.2-1, Figure 4.2-2, etc.).

5.4 Standard ICD information. In addition to the technical interface description, detailed in paragraph 6, all ICDs shall contain certain "standard information". This information is required for administrative purposes and shall have a uniform format and data content as outlined below. (Format and placement details for J-size ICDs are shown in Figures 2, 3 and 4. Format and placement details for book-form ICDs are shown in the sample document of Appendix A.)

5.4.1 ICD number. ICD numbers are issued by the ICWG chairman and shall appear on each ICD sheet/page. Additionally, on J-size ICDs the number will be entered in the border locations as shown in Figures 2, 3 and 4 and MIL-STD-100. Note that the entry beyond the right-hand border is printed on the back of the drawing. All ICD numbers shall be preceded by the letters "ICD".

Example: ICD 25-12345

Book-form drawings shall be further identified by placing the letter "D" between "ICD" and the number.

Example: ICD D25-23456

Additional volumes of the same number shall also show the appropriate volume number on each page.

5.4.2 Sheet/page numbers. On single sheet J-size ICDs, enter sheet 1 of 1. On multi-sheet ICDs, enter the total number of sheets on sheet 1 only. Enter only the individual sheet number for sheet 2 and on. The sheet number shall also be entered in the border blocks as shown in Figures 2, 3 and 4 and MIL-STD-100. On book-form ICDs, each page shall be numbered. Decimal page numbers may be used to add pages. Page 1 shall show the last page number used and total pages in the document (e.g., page 1 of 28, 30 pages total).

5.4.3 Revision letter. At the time of IR incorporation, the next revision letter for that sheet or volume (5.4.9) shall be entered:

a. In the border revision blocks of J-size ICDs (Figures 2, 3 and 4) or

b. On each book-form ICD page changed. (See Appendix A, page 4)

c. On the active page record of book-form ICDs next to the page number being revised.

5.4.4 ICD titles. ICD titles shall be as approved by SAMSO for inclusion in SAMSO Report 62-46-1. The first two words of all ICD titles shall be "Interface Control". The last words shall be the names of the participants, with the originator listed first. The title, when possible, should identify the interfacing items.

5.4.5 Drawing scale. Enter scale used (full size, 1/2 size, etc.), or enter "noted" or "none" as applicable.

5.4.6 Preparation responsibility. The name of the company (and division if applicable) that prepared the ICD shall be entered in the border directly below the ICD number.

5.4.7 Approval signatures. The "approval block" shall contain a printed list of applicable participants, each followed by an authorized signature (per SAMSO Report 62-46-3) and the date signed. The ICD originator shall be listed first. The ICWG chairman shall be listed last.

5.4.8 ICWGA number. The interface control working group action sheet (ICWGA) number under which the basic ICD was prepared shall be entered on:

a. Each sheet of a J-size ICD. (See figure 2)

b. The first page of every book-form ICD. (See page 2 of Appendix A)

c. New volumes of book-form ICDs or sheets of J-size ICDs added after the initial ICD release shall reflect the ICWGA number that programs their release.

5.4.9 Revision record. The revision block/page contains a record of system released interface revisions incorporated into the ICD. The "REV" column shall show the "revision letter" assigned at the time of each incorporation. The "description" column shall list the IR(s) incorporated (including released IRs cancelled by a subsequent IR) and the applicable ICWGA for each. In the "date" and "approved" columns, approval signatures shall be affixed and dated for each revision letter entry. (See page 3 of Appendix A and figure 2.)

5.4.10 Table of contents. (Not applicable to J-size ICDs.) Page 3 of book-form ICDs shall contain a table of contents. If more pages are required, they shall be numbered as decimal continuations of page 3 (i.e., 3.1, 3.2, etc.). The table of contents shall outline the ICD contents by major sections and paragraphs. Each section, paragraph, figure or table shall be listed in the order in which they appear in the document, starting with the title page. Their respective descriptions and page numbers shall be indicated in parallel columns. (See Appendix A, page 4.)

5.4.11 Active page record. (Not applicable to J-size ICDs.) Page 4 of book-form ICDs shall be the active page record. If more than one page is required, they shall be numbered as decimal continuations of page 4. The active page record shall consist of a list of all page numbers in the current revision of the ICD, followed by a column for the latest revision letter under which that page was revised. Also included on the active page record shall be columns to list "added pages" along with their respective revision letters. (See Appendix A, page 6.)

5.4.12 Effectivity information. "Effectivity" refers to the weapon system/missile designation, wing/base location, and interface location to which the ICD applies. Multi-sheet J-size ICDs shall include the effectivity for each sheet on sheet 1 only. All subsequent sheets shall state "see sheet 1 for effectivity". Sheets with a unique effectivity shall be listed separately, while those with a common effectivity shall be grouped together. Page 7 of book-form ICDs shall be the effectivity page. (See Appendix A, page 7.) Volume I of multi-volume ICDs shall summarize the effectivity of each volume. Each subsequent volume shall reflect only its own effectivity. Effectivities may be changed only with the concurrence of the ICWG chairman.

5.4.12.1 "Used on" column. SAMSO Report 62-46-1 shall be entered in the "used on" column for each line used in the effectivity block.

5.4.12.2 "Location" column. The "location" column indicates the general physical location of the interfacing hardware/software. Location shall be specified by facility (e.g., LF, LCF, etc.) for ground and missile to ground interfaces and by missile section (e.g., section 42) for missile interfaces. Typical interface locations on the Minuteman program include, but are not limited to, the following:

LF

LCF

Section 39

ALCC

SMSB

Plant 77

HETF I

5.4.12.3 "Interface effectivity" column. The "interface effectivity" column shall contain the applicable weapon system and/or missile designation followed by the corresponding wing/base location, if any.

Examples of weapon system designations are:

WS 133A-M

WS 133A-M Integrated

WS 133B

WS 133B Integrated

Examples of missile designations are:

LGM 30F

LGM 30G

JLGM 30G

Examples of wing/base locations are:

Wing I, Wing II, etc.

Wing I Collocated Squadron

AFWTR

Hill AFB

Examples of complete "interface effectivity" entries are:

WS 133A-M: Wing I-IV

LGM 30F

WS 133B Integrated: Wing VI, Wing I (Collocated Squadron) and AFWTR

LGM 30G: AFWTR

NOTE: Different missile designators or different weapon system designators shall not be combined in the same effectivity line entry (e.g., LGM 30F/LGM 30G).

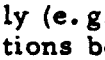
5.4.12.4 "Drawing sheet" column. (Applicable to J-size ICDs only.) This column shall reflect the ICD sheet(s) applicable to each effectivity entered.

5.4.13 Scope. All ICDs shall reflect the approved scope as it appears in the SAMSO letter of authorization. ICD scopes are the result of coordination between the participants involved and the ICWG chairman. The scope

may be altered through coordination with affected participants, the ICWG chairman and the procuring agency. The scope shall be a summary of the ICD contents and its intended purpose. If deemed important, the scope may also specify the methods employed by the ICD to document/verify interface design parameters, such as installation drawings, mated circuits, timing diagrams, etc. In a J-size ICD, the scope shall be located on sheet 1 in an area near the title and approval blocks (see Figure 3). In book-form ICDs, the scope shall be paragraph 1.1.

5.4.14 Equipment responsibility list. The "equipment responsibility list" shall appear immediately after the written scope. It shall consist of a list of interfacing hardware/software/facilities, along with their respective identification numbers (i.e., Figure A number, CI number, etc.), common name and the ICD participant responsible for their design. In book-form ICDs, the equipment responsibility list shall be paragraph 1.2. (See Appendix A, page 8.)

5.4.15 Related ICDs. All ICDs shall include a list of "related ICDs". A related ICD is one that may be directly impacted by and/or impacts the new/revised ICD and shall be listed by ICD number and complete title. Related ICDs shall be reviewed for impact whenever an interface design change is implemented or proposed. Related ICDs shall be listed as paragraph 1.3 in the book-form ICDs. If there are no related ICDs the word "none" shall be entered under the heading. (See Figure 3 and Appendix A, page 8.)

5.4.16 Notes. ICDs shall employ two basic types of notes: general notes and flagnotes. General notes and numbered flagnotes shall be defined in numerical order in the notes area of J-size ICDs, or in paragraph 2.1 of book-form ICDs. They may be intermixed, but shall be numbered consecutively (e.g., 1,  ,  , 4, etc.). Other notes shall be defined per instructions below. If there are no notes in a book-form ICD, enter "none" in paragraph 2.1. When a note is deleted, the remaining notes need not be renumbered.

5.4.16.1 General notes. General notes shall be used to explain or qualify information which applies to the ICD as a whole. Applicable military standards or special interface limitations are examples of information which may be conveyed by a general note.

5.4.16.2 Flagnotes.

a. Numbered flagnotes. Numbered flagnotes (e.g.,  ,  , etc.) shall be used to identify, explain or qualify information which applies to specific items or areas in an ICD. Flagnotes defined on sheet 1 of J-size ICDs may be used on any sheet to which they apply. Numbered flagnotes must be applied to some other location on the drawing or a general note shall be used instead.

b. Restricted flagnotes. Restricted flagnotes shall be used to identify, explain or qualify information which is peculiar to a given sheet/page of the ICD. For book-form ICDs, restricted flagnotes applicable to any one page shall start

with the letter "A" (e.g.,  ,  , etc.). They shall be defined by itemizing them in alphabetical order at the bottom of the page. (See figure 6.2 of Appendix A.) For J-size ICDs, restricted flagnotes applicable to any one sheet other than sheet 1 will use 3-digit numbers. The first digit shall identify the sheet to which the note applies, and the last two digits shall identify the note number for that page. Thus 401 would be note "1" appearing on sheet 4. J-size restricted flagnotes shall be defined by itemizing them in numerical order in the notes area of the sheet on which they are used.

c. Incomplete flagnotes. Incomplete ICDs (4.6.1) and incomplete items in an ICD shall be identified as follows:

1. An incomplete ICD shall be identified with the following note on the affected sheet of J-size ICDs or page 1 of book-form ICDs.

    This ICD is incomplete. Refer to ICWGA xxxx for actions and schedules for completion.

2. Incomplete items within an ICD shall be individually identified by the incomplete flagnote. The note shall be placed adjacent to the incomplete item, using subscripts of the incomplete flagnotes (e.g.,  , ) for each separate incomplete item.

3. Incomplete items shall be listed directly under the incomplete note on J-size ICDs. For book-form ICDs, the incomplete note shall be repeated in paragraph 2.1 and the incomplete items listed thereunder.

4. Incomplete item definitions shall include the location of the incomplete item, information or action required, and the responsible participant/agency. For example:

    Page 25, Associate "A" to provide mated circuit values.

    Page 32, SAMSO approval of ECP XYZ required before Associate "B" can agree to cable lengths.

5.4.17 Abbreviations. All unfamiliar abbreviations, acronyms, symbols, etc. used in an ICD shall be defined. Book-form ICDs shall include a list of abbreviations/symbols and their definitions in paragraph 2.2. If there are no abbreviations/symbols, enter "none" in paragraph 2.2. J-size ICDs shall define abbreviations/symbols on sheet 1.

5.5 Interface revisions (IRs).

5.5.1 IR format. Sheet 1 of an IR shall be an 8-1/2 by 11-inch vellum of the form shown in Figure 5-1. If additional IR sheets are needed to describe changes, the continuation form shown in Figure 5-2 shall be used.

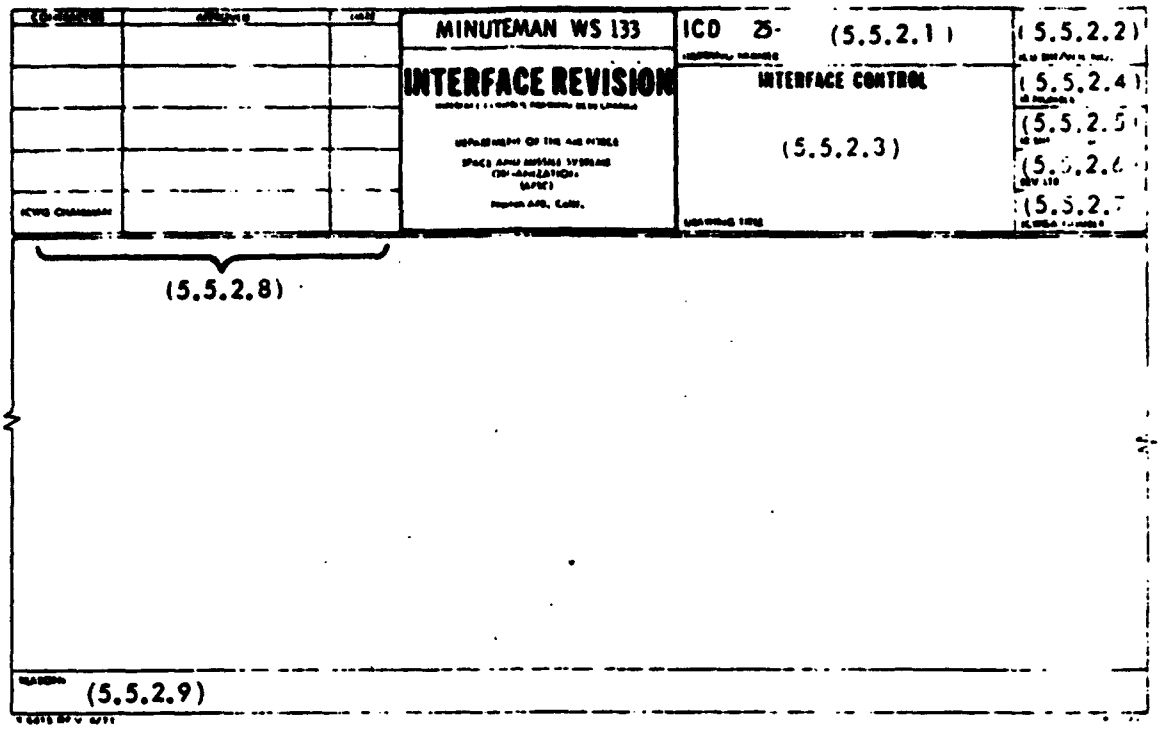


Figure 5-1. IR Sheet 1 Format

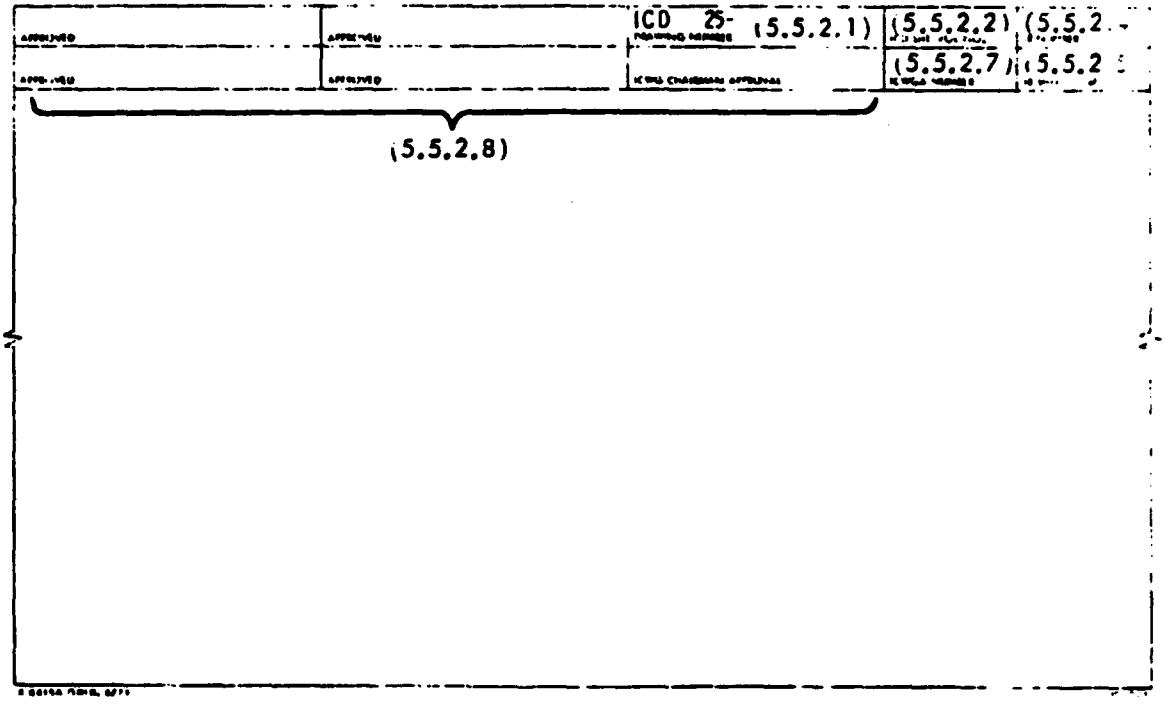


Figure 5-2. IR Continuation Sheet Format

Plain 8-1/2 by 11 or 11 by 17 and larger vellum may be used to replace complete ICD pages or change large pictorial areas. When plain vellum is used, as least 1/2-inch margin must be maintained on all sides. Numbered and unnumbered vellums for the IR forms shall be supplied by the ICWG chairman.

5.5.2 Standard IR information. In addition to the change description identified in paragraph 5.5.3, all IRs shall contain certain "standard information." Requirements for the generation of this information are outlined below. Each block in Figures 5-1 and 5-2 reflects the paragraph number of this standard that describes the entries to be made in that block.

5.5.2.1 Drawing number. This block shall contain the number of the ICD being revised. (5.4.1)

5.5.2.2 ICD sheet/volume number. This block shall contain the ICD sheet number (J-size) or volume number (book-form), as applicable. On single book-form ICDs enter "DOC".

5.5.2.3 Drawing title. This block shall contain the title of the ICD being revised. (5.4.4)

5.5.2.4 IR number. An IR number may be used only once. The same number shall appear on each sheet of the IR.

5.5.2.5 IR sheet number. This block shall show the sequence number of the IR sheet. On sheet 1 only, it will be followed by the total number of sheets in the IR. On single sheet IRs, enter 1 of 1.

5.5.2.6 Revision letter. This block shall be left blank. It is reserved for use by the ICD originator at the time of IR incorporation to identify the revision letter under which the IR was incorporated.

5.5.2.7 ICWGA number. Same as ICD requirements. (5.4.8)

5.5.2.8 Approval block. Same as ICD requirements (5.4.7) except IR originator shall be listed first. Remaining participants should be in the order specified in the ICWGA that programs the IR.

5.5.2.9 Reason. This block shall contain a concise description of the reason for the IR. If the change is the result of an ECP, the ECP number shall be referenced.

5.5.3 IR change description. The body of the IR shall contain a detailed description of the changes to be made to the ICD. Examples of change descriptions are shown in the sample of Appendix C. Each change shall be itemized, by number, on the IR form. The location of each change shall be specified: for book-form ICDs, the page and paragraph, figure, etc. shall be given; for J-size ICDs, the zone, detail, etc. shall be given. Previous unincorporated IRs shall be referenced if the change affects or cancels something added or changed by those IRs. Two examples of such referencing are:

a. Reference IR xxxxx

1. Change item 3 to read "The . . . at 4.0 amps".

2. Delete item 6.

b. This IR revises item 3 and cancels item 6 of IR xxxxx.

An accurate description of each change shall be given, along with any special instructions for its incorporation. Changes involving technical descriptions shall comply with the requirements outlined in paragraph 6 of this standard. If the change modifies an existing interface description, both the old and new configuration shall be shown and identified using the words "was" and "is", respectively. When an entire paragraph is to be changed, the words "revise paragraph to read as shown" may be used. If the change involves new information only, the instruction word "add" shall be used. If the change involves removing information only, the instruction word "delete" shall be used.

Flagnotes added by an IR shall not be numbered, but shall use a symbol such as ⟨x⟩. The number or letter shall be assigned at the time of IR incorporation in accordance with paragraph 5.5.5.

IR reference notes shall be used when it is necessary to include instructions or information on an IR other than the actual ICD change itself. The reference material shall be preceded by a symbol such as ▲, which shall be defined on the IR as "▲IR reference only." IR reference material is not to be incorporated into the ICD.

If a change involves most of an entire book-form ICD page, a replacement original page may be prepared and included as part of the IR. Each book-form replacement page shall be assigned a separate IR sheet number. The IR number and IR sheet number shall be penciled in at the top of the page (ref. page 4 of Appendix C). When replacement pages are provided, the instruction "replace page x with sheet y of this IR" shall be used in the IR change description.

If a change description for a J-size ICD requires more space than is available on the 8-1/2 by 11 IR form, larger sheets may be used to supplement the IR. Sheets used in this manner shall carry the IR number and an appropriate IR sheet number. Change descriptions made on supplemental IR sheets shall be referenced by appropriate instruction words on the basic IR form (e.g., "make changes as described on sheet 3 of this IR"). At least 1/2-inch margin must be maintained on all sides of supplemental IR sheets.

NOTE: When a hardware/software configuration and its effectivity are deleted by a change, accountability is maintained through microfilms of the ICD and IR's prior to the change.

5.5.4 Complete revisions. For changes that affect extensive portions of a J-size ICD sheet or many pages of a book-form ICD, a "complete revision" shall be made. Complete revisions are necessary to avoid the presence of large, unincorporated IRs in the system for long periods of time. When making complete revisions, the following procedure shall be followed:

a. Make a "second original" copy of the ICD or ICD sheet and retain it in a vault or preservation file until the ICD or sheet has been system releas d.

b. Make necessary changes to the ICD original. Completely redraw the ICD sheet or pages, if necessary.

c. Prepare an IR form (5.5.2) with the IR change description which shall read: "ICD (or ICD Sheet) COMPLETELY REVISED – ORIGINAL (OR PREVIOUS) RELEASE IS OBSOLETE". A brief summary of the areas changed shall also be given.

d. The revision block/page of the ICD shall be completed (5.4.9) with the next revision letter indicating that the IR has been, in effect, already "incorporated". A provision shall be made in the "approved" column for the ICWG chairman's signature.

e. Each page changed in a book-form ICD during a complete revision shall reflect the next revision letter penciled in the upper right-hand corner under the ICD/page number.

f. The new original of the completely revised ICD/ICD sheet shall be submitted along with the IR for approval routing.

NOTE: Outstanding system released IRs shall also be incorporated at the time of a complete revision to an ICD.

5.5.5 IR incorporation. System released IRs shall be incorporated by making changes to the original of the affected ICD, exactly as instructed by the IR. This process is called "updating" the ICD. (4.5.5) At the time of IR incorporation, the next revision letter shall be assigned and the revision block/page completed. (5.4.9) ICD updates are not routed for approval. (4.5.6.b) In addition, changes of an administrative nature are required at the time of IR incorporation. These include:

a. Numbers shall be assigned to new flagnotes. Incomplete flagnotes shall be removed as incomplete items are resolved. (The incomplete note itself shall not be removed until the last incomplete item has been resolved.)

b. IR numbers and IR sheet numbers shall be removed from any IR page that is to be used as the original for a replacement or additional page of a book-form ICD. The active page record and table of contents shall be updated, if affected.

c. On book-form ICDs, each page revised during a given update shall include the next revision letter penciled in the upper right-hand corner. This includes pages changed per an IR and pages changed for maintenance purposes such as table of contents, active page record, page/figure renumbering, etc.

5.5.6 IR cancellation. IRs may be cancelled at any time by mutual agreement of the participants involved.

a. System released IRs. System released IRs can only be cancelled by preparing another IR. The first entry on the cancelling IR shall be: "This IR cancels IR xxxxx" or "This IR cancels and supersedes IR xxxxx," whichever applies. Processing of a cancelling IR is the same as that described for any other IR.

b. Unreleased IRs. To cancel an IR prior to system release, return the original to the IR originator. The originator shall put a slash diagonally across the face of page 1 of the IR and write "CANCELLED" in bold letters. The reason for cancellation and an authorized signature and date shall be entered nearby. Distribution of a cancelled IR shall be the same as its initial distribution.

6. REQUIREMENTS – TECHNICAL DESCRIPTION OF INTERFACES

6.1 Basic approach. Interface requirements shall be documented by producing a pictorial and/or written description of the interface(s) involved and specifying those values/characteristics of a design which are considered "critical" to establishing interface compatibility.

6.1.1 Determination of values/characteristics to be controlled. The selection of the design characteristics/values to be controlled and the accuracy to which they are specified will be the responsibility of the participants in that particular ICD. The adequacy of the interface agreement is subject to the review of SAMSO and the ICWG chairman.

6.1.2 Common or redundant interface requirements. A participant's design requirements at an interface may be common to more than one place in an ICD, or to two or more ICDs (involving the same participants). Examples of such multiple application include driver or receiver circuits, connector/pin assignments, hardware input/output parameters, software routine, envelope requirements, etc. To avoid redundant control, these interfaces shall be documented only once. All other applications shall refer to the controlling view, paragraph or ICD for details of the requirement.

6.2 Use of military/contractor specifications or industry standards. In the paragraphs which follow, military or contractor specifications or industry standards are occasionally authorized as sources of interface requirements. Whenever such specifications are "called out" in an ICD, the information they contain becomes part of the ICD. The ICD shall record the standard or specification identification number, with the release date, or applicable revision letter and date in force at the time of ICD/IR preparation. This provides a baseline agreement. An ICD need not be updated to reflect subsequent revision levels of a specification unless the revision affects the interface. Military or contractor specifications may be reflected on an ICD for information or clarification. When this is done, the "callout" shall end with "(ref.)" and shall not

include the revision letter and date. Associates shall be responsible for transmitting copies of their specification sheets to the other ICD participants when the specification change results in an interface change.

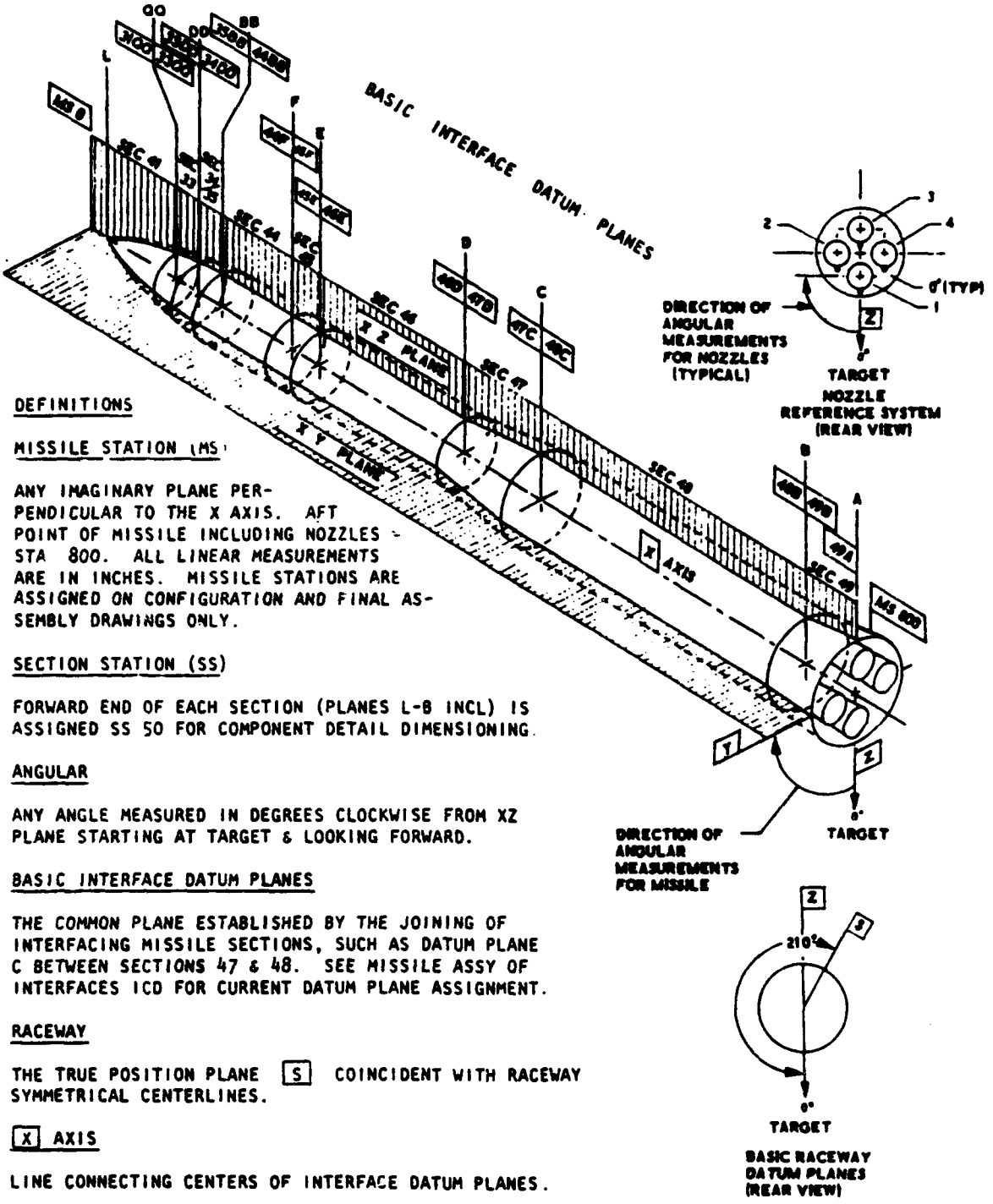
6.3 Mechanical interfaces.

6.3.1 Installations. Installation requirements shall be defined in ICDs by showing the interfacing configuration items/facilities in their installed (or "mated") condition. Figure 4.2 of Appendix A is a sample installation interface. Only that portion of the hardware applicable to the interface need be shown. A solid heavy line shall be used to indicate the interfacing surface areas in each appropriate view. Each component or part shall be identified along with the participant responsible for supplying it. Flagnotes or other means may be used to identify the supplier. In addition, the "halves" of the interface shall be separated and shown in detail views. Dimensioning and tolerancing of the various geometric (straightness, flatness, etc.) or location (position, concentricity, etc.) interface requirements shall be in accordance with ANSI Y14.5. Critical dimension tolerances affected by thermal or other special considerations shall be so noted. Design requirements in the following subparagraphs shall be documented as necessary to define mechanical installation interfaces.

6.3.1.1 Interchangeability. To allow for component interchangeability, the dimensions shown shall be such as to permit assembly with all parts built to their maximum or minimum tolerances. Assemblies requiring closely controlled fit to ensure interchangeability shall obtain that control through use of interface master gages. (4.6.4) The need for master gage controls shall be noted in the ICD, along with the name of the participant responsible for supplying the related master tooling. Dimensions controlled by master gages shall be so noted. Under worst case tolerance conditions it may occur that, technically, tolerance buildup prevents assembly of a combination of parts/assemblies. In these cases it may be possible to establish interface agreement on the basis of statistical analyses that provide adequate assurance the hardware can be satisfactorily assembled.

6.3.1.2 Surface finish. Two kinds of surface finish will be considered: "machine" and "protective". Machine finish requirements for interfacing surfaces shall be called out per ANSI B46-1. Protective finish requirements (e.g., painting, plating, etc.) shall be called out along with the materials and process specification which controls their application. If no specification is available, the necessary information shall be fully detailed in the ICD.

6.3.1.3 Location and orientation. Equipment and connectors shall be located with respect to recognized datum features or bench marks. Location shall be shown in two different views, and measurements shall follow the datum reference system outlined in ANSI Y14.5. When locating or orienting missile components and connectors, the applicable "missile drawing reference system" as defined by the missile integrating contractor, shall be used. Figure 6 shows a typical missile reference system, and defines the various datum features.



DEFINITIONS

MISSILE STATION (MS)

ANY IMAGINARY PLANE PERPENDICULAR TO THE X AXIS. AFT POINT OF MISSILE INCLUDING NOZZLES - STA 800. ALL LINEAR MEASUREMENTS ARE IN INCHES. MISSILE STATIONS ARE ASSIGNED ON CONFIGURATION AND FINAL ASSEMBLY DRAWINGS ONLY.

SECTION STATION (SS)

FORWARD END OF EACH SECTION (PLANES L-B INCL) IS ASSIGNED SS 50 FOR COMPONENT DETAIL DIMENSIONING.

ANGULAR

ANY ANGLE MEASURED IN DEGREES CLOCKWISE FROM XZ PLANE STARTING AT TARGET & LOOKING FORWARD.

BASIC INTERFACE DATUM PLANES

THE COMMON PLANE ESTABLISHED BY THE JOINING OF INTERFACING MISSILE SECTIONS, SUCH AS DATUM PLANE C BETWEEN SECTIONS 47 & 48. SEE MISSILE ASSY OF INTERFACES ICD FOR CURRENT DATUM PLANE ASSIGNMENT.

RACEWAY

THE TRUE POSITION PLANE [S] COINCIDENT WITH RACEWAY SYMMETRICAL CENTERLINES.

[X] AXIS

LINE CONNECTING CENTERS OF INTERFACE DATUM PLANES.

Figure 6. Typical/Missile Drawing Reference System and Basic Geometric Data

6.3.1.4 Holes. Hole callouts shall give all information necessary to assure compatible mating of interfacing components. Parameters to be considered include: datum references, diameter, depth, angularity counterbore, counter-sink, spotface chamfers, slotted holes, tolerances and protective finish.

6.3.1.5 Fasteners. Fastener callouts shall identify the type of fastener (e.g., nut, bolt, screw, etc.) used to assemble the interfacing components and the participant responsible for supplying it. All fastener characteristics pertinent to the interface shall be described. Characteristics to be considered include head type, size or diameter and tolerance, thread definition, length, material, protective finish and torque or installation requirements. If the fastener is a qualified military part, the corresponding military specification number (MS, AN, NAS, etc.) may be called out for this information. (See Appendix A, figure 5.2.2) Fasteners may also be described by calling out the applicable contractor specification, if it completely defines the required characteristics. If no specification is available, the ICD shall fully detail the fastener.

6.3.1.6 Bonding requirements. Bonding requirements relate to the interface with the electrical grounding and RF isolation system. The mechanical aspects of a bonding interface description shall consider factors such as stud or fastener types, washers or spacers, ground strap terminal characteristics, surface preparation, etc. (See figure 5.2.2 of Appendix A and paragraph 6.7.4 of this standard.) When appropriate, the points between which the impedance is measured will be defined.

6.3.1.7 *Weight and center of gravity (cg).* When required, the weights of interfacing items shall be recorded using appropriate units and the c.g. located with respect to known datum features.

6.3.1.8 Materials. Materials at interfacing surfaces shall be identified by calling out industry, military or contractor material specifications.

6.3.1.9 Markings. Hardware markings which affect interface relationships, such as orientation arrows or part identifiers, shall be shown on the ICD.

6.3.2 Electrical connectors (mechanical aspects). Electrical connectors shall be depicted in their mated condition. (This may be either a schematic representation or a fully detailed drawing.) Each connector shall be identified with its "P"/"J" code. If not obvious on the drawing, the cable assembly or equipment of which the connector is a part shall also be identified (e.g., W121, J2). The preferred method for documenting the mechanical interface requirements for electrical connectors will be to call out the military or contractor specification which applies. If no specification is available, each connector "half" shall be fully detailed in the ICD. Parameters to be considered include: connector size, pin/socket (contact) configuration, keyway indexing and tolerance, materials and finish, torque requirements, lockwire hole location and size, lockwiring requirements, etc. Connector halves defined by another ICD shall be noted as "reference" to avoid redundant control. (6.7.4 and Figure 5.2.1-1 of Appendix A)

6.3.3 Transportation and handling requirements. Transportation and handling requirements relate to the interface between configuration items and their shipping containers to ground handling equipment. They shall consider such things as support points, lift points, packaging materials, markings, etc. Transportation and handling interface descriptions shall comply with the requirements for installation as outlined. (6.3.1)

6.4 Envelope interfaces. When the space requirements of an item must be defined and controlled to assure compatibility with the space requirements of interfacing or adjacent items/facilities, an envelope interface exists. An ICD defining envelope interfaces shall include, when applicable, weight/cg of the hardware and reference to ICDs that control related mechanical and/or electrical interfaces. Envelope ICDs shall normally be prepared by the participant furnishing the item.

6.4.1 Hardware envelopes. Hardware envelopes (see figure 4.1 of Appendix A) will delineate the maximum (or minimum, as appropriate) space requirements of a configuration item using a single, heavy line. The nominal part outlined shall be shown (in phantom line) when such information is required to establish the relationship of the envelope to the hardware (i.e., clearance, tolerances, etc.). All critical dimensions shall be shown. The maximum envelope shall include variations due to environmental and other factors such as thermal expansion or contraction, motion or other effects of operation, deflection caused by static, flight, activation, shock, or handling loads, manufacturing tolerances, etc. Access areas required around or through hardware for installation or maintenance purposes shall also be identified and dimensioned. When the maximum envelope of crated equipment is a consideration, it shall be controlled.

6.4.2 Cable envelopes. Cable envelopes shall show the entire cable configuration (using breaks if necessary), including all connectors and keyways in relationship to cables. The true length of the cable shall be dimensioned, with tolerances. Critical cable diameters and allowable bend radii shall be shown. Also cable weight, clamp or support locations, maximum cable stretch/compression/rotation, handling and storage instructions shall be included when appropriate.

6.4.3 Missile assembly of interface envelopes. The "missile assembly of interface envelopes" ICD is a Minuteman-unique envelope drawing. The contractor responsible for missile assembly and test shall prepare one for each missile configuration. It shall be used to verify that missile components can be assembled and operated together under all expected conditions. "Missile assembly of interface envelope" ICDs shall utilize installation and envelope interface requirements documented in other ICDs for individual missile hardware items.

6.5 Environmental interfaces. Operating environmental requirements shall be considered during preparation of ICDs. Certain design requirements, such as "hardness" may result in environmental interface requirements which require documentation on the ICD. Environmental interfaces should not necessarily be restricted to physical interfaces between associates. Such interfaces should also define any indirect affect (i.e., radiation shielding) that one contractor's hardware, in an environmental

condition, may have on another associate contractor's hardware. Environmental interfaces that are described in weapon system specifications need not be controlled by ICDs. The following paragraphs contain examples of environmental interfaces which shall be documented within the constraints of this standard.

6.5.1 Thermal. Thermal interface requirements shall define details of the thermal environment that will affect, or are required for, hardware operation. The major thermal interface areas are: passive environment, forced air cooling and liquid cooling.

6.5.1.1 Heat transfer (passive). Heat transfer to the ambient environment or adjacent hardware shall be defined when considered critical to an item that generates heat, or to operation of heat sensitive hardware mating with or adjacent to the heat generating hardware. Factors to consider include operating temperature range, heat transfer rate and conduction, convection or radiation and allowable duration of maximum heat transfer.

6.5.1.2 Forced air cooling. Interface requirements for forced air cooling shall be identified for operation in both normal and emergency environmental control system (ECS) modes. Requirements shall include heat dissipation and rate, cooling air mass flow rate, temperature, relative humidity (maximum) and static pressure.

6.5.1.3 Liquid cooling. Interface requirements for liquid cooling shall consider the aspects of fluid interfaces (paragraph 6.6) as well as the chemical makeup of the interfacing coolant, amount and rate of heat dissipation, coolant temperature requirements and tolerances, pull down and recovery rates, flow direction and resistance, etc.

6.5.2 Dynamic. Dynamic interface requirements shall consider factors such as shock and vibration levels, damping, acoustics, debris, force transfer, acceleration, and deceleration.

6.5.3 Electromagnetic. If agreement is reached that certain electromagnetic characteristics require interface control, factors such as the following should be considered. Specify acceptable electromagnetic pulse (EMP) levels and/or acceptable values for electromagnetic interference (EMI) factors such as: pulse width versus amplitude curves, magnetic field susceptibilities, frequency dependent responses, modulation susceptibilities, continuous harmonic withstanding voltages, reference plane potential of quasi-differential drivers/receivers, as applicable.

6.5.4 Human. Control of human interface requirements shall be considered when operator to operating environment relationships are critical. Areas of human interface include, but are not limited to:

a. Reach envelope

b. Manipulation

c. Visual considerations

d. Audio message levels

e. Ambient noise

f. Input acceptance/handling rates

6.5.5 Special effects. If agreement is reached that certain special effects require interface control, factors such as the following should be considered:

a. Hardware/software circumvention – Specify interface effects due to circumvention resulting from hostile environments.

b. Hardware operating modes – Specify special modes of operation which may include: failure modes, out-of-tolerance parameters, data transmission interruption and recovery, etc.

c. Transients – Specify interface transient effects due to electrical power turn-on/turn-off, liquid coolant surges, thermal, etc.

6.5.6 Nuclear weapons effects. If agreement is reached that certain weapon effects requirements require interface control, factors such as the following should be considered.

a. Radiation – Types (alpha, beta, gamma, neutron, etc.), acceptable radiation levels.

b. Electromagnetic pulse – Specify appropriate EMP levels and characteristics.

c. Blast and shock – Overpressure levels and corresponding accelerations, velocities or displacements where appropriate.

d. Acoustics – Specify db level and resonant frequencies.

e. Thermal – Temperature versus time curves.

f. Debris – Static debris types and depth, impacting debris size, velocity and quantity.

6.6 Fluid interfaces. Fluid interface requirements shall consider factors such as hose and tubing characteristics, clamping pressures, fitting specifications and torque values, fluid types, operating and proof pressures including transients, flow rates, temperature, etc.

6.7 Electrical interfaces.

6.7.1 Interface block diagrams. Electrical interface descriptions shall employ interface block diagrams to depict the overall equipment/system/subsystem configuration. Multiple levels of block diagrams should be considered for complex interface relationships. At a minimum, the interface block diagram shall:

a. Identify the interfacing configuration items

b. Show their interconnecting relationship(s)

c. Locate the electrical interface(s)

They may also contain

d. Signal flow and cable routing

e. Cable and connector designation

f. Reference to related ICDs.

Each configuration item shall be identified by its title, CI (or Figure A) number, and the responsible participant. Interconnecting cables and connectors shall be identified with their reference numbers (e.g., W222, J2, etc.). Electrical interfaces shall be indicated by a "double arrow" symbol (), with the responsible participant noted on each side. If an indicated interface is covered by another ICD, the applicable ICD number shall be referenced on the block diagram. (See figure 3.1 of Appendix A)

6.7.2 Power and load. Power interfaces shall be defined by specifying the required output characteristics of the supply, the range(s) of loading over which they apply and tolerances. All modes of operation shall be considered: turn-on, turn-off, warmup, continuous, normal, load change, standby, emergency, etc. (See paragraph 5.1 of Appendix A) Power interface requirements to consider include:

Voltage and type

Frequency

Current (nominal, maximum and minimum)

Transients (including inrush, overshoot, and recovery time)

Ripple

Waveform

Polarity, phase rotation

Protection (over voltage, under voltage, current limiting)

Dynamic source impedance

Power factor

Load profiles

6.7.3 System/signal description. For complex system-level interface configurations, it may be desirable to supplement the block diagram with a written system description. A system description shall consist of a brief explanation of the overall purpose of the system, its basic nature, its operational requirements and the role of each interfacing configuration item/facility. System descriptions may also be expanded to include functional descriptions of critical interface signals, including their titles, mnemonics, their source and destination, and their functional significance to the system. (See paragraph 6.1 of Appendix A)

6.7.4 Connectivity. "Connectivity" refers to the electrical path between interfacing configuration items. It includes mated connectors and their interconnecting wires and/or cables for both power and signal.

Connectivity interfaces shall be described by means of connector wiring diagrams and schematics. Wiring diagrams, like figures 5.2.1-1 and 5.2.1-2 of Appendix A, shall be prepared for each electrical interface shown on the ICD block diagram. Each diagram shall show the connectors in their "mated" condition and the wiring configuration of each. Signal/function-to-pin assignments shall be defined for each connector half to assure proper connection of the circuits involved. In addition to the above, the following design requirements shall be documented as necessary.

a. Hookup. Show all connected wires including jumpers, splices, spares, etc. Identify all unconnected pins including uninstalled pins, etc.

b. Wire/cable characteristics. Specify wire type, conductor size (American Wire Gage number), conductor material, jacket material, color code, etc. Military or contractor specifications may be referenced for the above information, if available. Also record wire lengths, maximum resistances, cable capacitance, characteristic impedance, etc., as appropriate. When cable routing is critical to maintain electromagnetic compatibility (EMC) or EMP isolation, special notes, views, etc., shall be included.

c. Shielding. Show shield groupings within equipment and cables, shield treatment of connectors for referencing to structure (both overall cable shields and individual wire/pair shields) or for carrying shields through interfaces, shield tie points, ohmic requirements for terminating shields, etc.

d. Bonding and surface preparation. Specify bonding provisions and requirements including material, size, ohmic requirements for resistivity across the interface. Define any special surface characteristics or preparations such as flatness, stiffness, cleaning, coating, and/or plating requirements, etc. (See figures 4.2 and 5.2.2 of Appendix A)

e. Connectors. Provide the number of the military federal or contractor specification which applies. If no specification is available, the electrical interface requirements for the connector shall be fully defined in the ICD. Parameters to consider include: pin-to-pin isolation, breakdown voltages, contact resistance, dielectric properties, connector shell conductivity, bonding, etc., and shall consider the connector mechanical interface information of paragraph 6.3.2.

f. Electrical referencing (grounding). Use circuit schematics, connector wiring diagrams or interface electrical charts to show how each circuit is connected to the common electrical reference.

6.7.5 Circuits. All interface circuits (with the exception of power circuits) shall be classified either as "drivers" or "receivers." In general, electrical interface descriptions will be concerned with defining the electrical requirements for the signals associated with each driver-receiver combination (mated circuit). (See figures 5.3.2-1 and 5.3.2-2 of Appendix A)

6.7.5.1 Interface control – electrical charts. Interface control – electrical charts or their equivalent shall be prepared to provide details for each interface signal. A connector interface is generally selected as the reference point for itemizing the signals in a distinct group. A chart may be comprised of several pages to accommodate all signals on a given connector. At the top of each chart the mating connectors (and related cable numbers when applicable) shall be identified, along with the responsible associates. (See Appendix A, chart 5.3.1 for sample format.) The following information shall be provided for each signal:

a. Signal name or title. In design of new equipment, every attempt should be made to establish signal names such that the name denotes its function when the signal is in its true logic state. Wherever possible, the same nomenclature shall be used on each side of an interface. If a signal must go by more than one name, each name (and mnemonic when applicable) shall be listed. Participants shall avoid the use of generic notations such as "prime", "bar", or "not" by careful selection of names.

b. Pin assignment. The pin number associated with each signal and signal return shall be recorded. Each pin shall be accounted for, including grounds, spares, etc.

c. Source and destination. The "ultimate source" and "ultimate destination" of each signal shall be identified and coded "S" or "D," respectively. The source and destination will be considered to be the configuration item which contains the respective driver or receiver circuit for the signal in question, excluding any "connectivity" circuitry. Signal returns will be assumed to have the same source and destination as their "active" counterparts, unless specified otherwise. When driver output or receiver input termination is to other than another circuit, such as unused outputs, any special termination requirements to avoid noise or reliability problems shall be defined.

d. Signal characteristics. Specify the values, ranges, etc., of signal parameters required to define the interface. If space does not permit, the applicable ICD paragraph, mated circuit, waveform diagram, etc., may be referenced.

NOTE: These charts contain much of the same information that is in connector wiring diagrams. The two may be combined to avoid duplication of interface data.

6.7.5.2 Driver/receiver identification. Driver and receiver circuits shall be assigned "type codes" to facilitate their handling and identification during the documentation process. The basic "type code" shall consist of a number followed by two letters. For example:

The number identifies the responsible participant. Numbers currently assigned to Minuteman program participants are as follows:

Autonetics	1	Avco	5	Bell	10
Sylvania East	2	Aerojet	6	Ogden ALC	11
Boeing	3	General Electric	7	Logicon	12
Sylvania West	4	Univac	8	Bendix	13
		Honeywell	9		

The first letter shall be either a "D" (for Driver) or an "R" (for Receiver). The second letter shall be assigned by the ICD originator to identify each circuit within a series of circuits. Thus, in the above example, a "2DB" would be Sylvania East Driver "B". If the occasion arises whereby a participant has more than 26 different driver or receiver circuits in a single ICD, a double letter shall be used for the last designator. Thus, a "2DAA" would be Sylvania East Driver "AA."

6.7.5.3 Mated circuits. Mated circuits are used to verify compatibility between co-functioning drivers and receivers. They shall be prepared for all interface circuits considered critical by the participants. The method for documenting mated circuits involves the following basic steps (for each driver and receiver):

a. Prepare circuit schematics

b. Calculate equivalent circuit parameters*

c. Determine allowable circuit operating limits

d. Mate and compare

NOTE: The requirements outlined in this paragraph and defined in the following sub paragraphs apply to discrete component and hybrid circuits only. Interfacing integrated circuits of the same or related series, which are designed and specified by the manufacturer(s) to be compatible, need not be subjected to the same rigorous analysis.

Also, the requirements set forth in the following sub paragraphs are oriented to discrete signal circuits. Analog, frequency dependent and other "specialized" circuits vary in nature to a degree that does not permit definition herein of specific interface documentation

* Equivalent circuits may, or may not be required, depending upon the simplicity of the circuit and the analytical approach taken.

requirements. Such requirements may include, but not be limited to: preparing circuit schematics, circuit mating and documentation of parameters such as signal level, frequency response, load impedance, transient response, noise sensitivity, cross talk, band pass characteristics and critical, time dependent wave-forms.

6.7.5.3.1 Schematics. Schematic diagrams shall be prepared for each interfacing driver and receiver circuit. Schematics will be drafted per MIL-STD-100 using the electrical/electronic symbols shown in IEEE-315. All components used as discretes shall be defined: passive devices (resistors, capacitors, etc.) with their values and tolerances; active devices (diodes, transistors, ICs, etc.) with their military or contractor specification/part numbers. Integrated circuits may be detailed in schematic form at the option of the preparing participant. Otherwise, they shall be defined by showing their functional symbol (i.e., inverter amplifier, NAND gate, etc.) and labeling them with the appropriate specification/part number.

a. Drivers. Driver schematics shall contain all information necessary to permit a detailed analysis of the output circuit characteristics. They shall include all circuitry in the last (or output) stage and show all supply voltages (with tolerances), drive signals, signal commons, etc., pertinent to the interface. Driver schematics shall be laid out so that signal flow is generally from left to right, with the output terminals clearly defined at the right-hand side of the diagram. (See figure 5.3.3-1 of Appendix A and figure 1 of Appendix B)

b. Receivers. Receiver schematics shall contain all information necessary to permit a detailed analysis of the input circuit characteristics. They shall include all circuitry in the first (or input)stage and show all supply voltages, (with tolerances) secondary loads, signal commons, etc., pertinent to the interface. Receiver schematics shall be laid out so that signal flow is generally from left to right, with the input terminals clearly defined at the left-hand side of the diagram. (See figure 5.3.3-3 and 5.3.3-4 of Appendix A and figure 5 of Appendix B)

6.7.5.3.2 Equivalent circuits. When required, driver/receiver circuits shall be reduced to their potential-source equivalent (Thevenin), or current-source equivalent (Norton), depending upon analytical convenience. Equivalent circuit parameter values (nominal or worst case as required) shall be calculated for the steady-state operating condition of each logic state. If circuit operation is nonlinear, separate sets of circuit parameters shall be derived for each region within a logic state over which linear behavior can be assumed. Equivalent circuits and schematics for a given circuit should be shown on the same page. Equivalent circuit parameters to be considered are E_r(max) E_{rs}, E_{thresh}, E_{to}, I_r, I_t, Z_r, Z_t (see paragraph 6.7.5.5 for definitions). Equivalent circuit

parameter values shall normally be displayed in tabular form on the same page as the equivalent circuit and schematic. A graphic display may be used for ease in interpreting more complex circuits. (See figure 3 of Appendix B) Parameter values are shown in tabular form at the bottom of each page. (See figures 5.3.3-1 and 5.3.3-2 of Appendix A) The logic state headings for the tabular data are normally assigned in the following manner:

a. If all signals relating to a given circuit are of the same logic type (positive or negative), the terms True and False and/or High and Low may be used.

b. If the signals related to a given circuit are of mixed logic type, only the terms High and Low (relating to voltage) shall be used.

A correlation between High/Low operating states and True/False logic states shall be provided for each signal. For a mated circuit where all signals employ the same logic type, this may be accomplished via the headings for mated circuit tabular values (See figure 5.3.2-1 of Appendix A). For a mating involving mixed logic types, a table correlating all signals in the ICD should be considered.

6.7.5.3.3 Allowable operating limits. Allowable circuit operating limits (e.g., maximum voltage, current, etc.) shall be determined using component specification/data sheets. In some cases, interpolation/extrapolation may be required to define interface requirements. Allowable limits may be recorded along with the equivalent circuit data described above. (See Figure 5.3.3-3 and 5.3.3-4 of Appendix A)

6.7.5.3.4 Mating. Circuit mating involves the calculation of the interface parameters which will result when each driver/receiver set is functioning together. The mating is normally done by the participant responsible for the receiver circuit. A separate mating analysis shall be made for all steady-state operating conditions of the mated circuits, using parameter values obtained from the equivalent circuits. The results of these calculations shall then be compared with the allowable operating limits of each circuit to establish that interface compatibility exists. Interface parameters normally determined through circuit mating are:

a. Voltage and current levels for each state with ± tolerance or maximum/minimum limit values. All voltages shall be in relation to signal common unless otherwise noted.

b. Noise margins (dc) for high and low states.

c. Logic fault states due to major electrical faults as detailed in paragraph 6.7.5.4.

d. Maximum and/or minimum rise and fall times (when critical) from 10 to 90% of the voltage change at the receiver circuit input.

e. Impedances (see figure 5 of Appendix B).

The results of mated circuit calculations shall be displayed on a mated circuit figure. One such figure shall be prepared for each driver/receiver combination. (See figures 5.3.2-1 and 5.3.2-2 of Appendix A and figures 6 through 8 of Appendix B.) Each figure shall include a simple block diagram which shows each driver and receiver and their interconnecting relationship(s). Drivers and receivers shall be identified with their "type codes" (ref. paragraph 6.7.5.2 and the electrical interfaces between them indicated by "double arrow" symbols. All connectivity parameters (e.g., line resistance, cable capacitance, etc.) of the interconnecting wires, both upstream and downstream of the interface shall be considered in mated circuit calculations, and reflected in the mated circuit figure when used. All interface signals related to a given driver/receiver pair shall be listed on the applicable mated circuit figure.

Mated circuit parameter values may be displayed in tabular or graphic form. Driver/receiver circuit graphical overlay diagrams may be prepared to depict worst case operating regions, performance envelopes and noise margins. Figure 5.3.2-1 of Appendix A shows an example of a "graphical mating" that displays dc noise margins as derived from mating with a receiver containing hysteresis. Where applicable, pulse level, pulse shape, duration and repetition rate shall be defined. A separate diagram may be prepared to depict critical pulse parameters or timing relationship to other signal or clock pulses.

6.7.5.4 Fault conditions. In addition to the above considerations, interface descriptions involving logic circuits shall also record the receiver interface logic states ("true" or "false") which would exist during the occurrence of major electrical faults. These fault conditions are:

Fault A – Open circuit; an impedance between the signal and signal common much higher than normal (as seen by the receiver, looking into the interface).

Fault B – Short circuit; an impedance between the signal and signal common much lower than normal (as seen by the receiver, looking into the interface).

Fault C – Power off; the state of the input to the receiver circuit (looking into the driver circuit) resulting from loss of power to the driver circuit.

Logic states for the above faults shall be recorded in a separate table on the applicable mated circuit figure. (See figures 5.3.2-1 and 5.3.2-2 of Appendix A)

6.7.5.5 Electrical abbreviations. Abbreviations for the most common parameters used in interface circuit descriptions are defined as follows and need not be repeated in ICDs.

E_r Voltage that receiver circuit requires to operate

$E_{r(max)}$ Absolute maximum continuous voltage level for receiver circuit

E_{rs}	Receiver circuit source voltage (Thevenin equivalent)
E_{thresh}	Receiver circuit switching level (E_r): True value indicates worst case limit for true-to-false transition; false value indicates worst case limit for false-to-true transition.
E_{to}	Driver open circuit voltage (Thevenin equivalent)
E_1	Voltage at interface with circuits mated
I_r	Current that receiver circuit requires to operate
I_t	Current that driver circuit can supply
I_1	Current at interface with circuits mated
Z_r	Receiver circuit input impedance (Thevenin equivalent)
Z_t	Driver circuit output impedance (Thevenin equivalent)
Max	Maximum - most positive or least negative value
Min	Minimum - most negative or least positive value
DCNM	Direct Current Noise Margin (logic circuits)

$\left(DCNM_{HIGH} = E_{1\,min} - E_{th\,(high)} \text{ and } DCNM_{LOW} = E_{th\,(low)} - E_{1\,max}\right)$

Other parameter abbreviations shall be defined in ICDs as they are required.

6.8 Sequencing/programming and timing interfaces. Sequencing/programming and timing interfaces include those factors that control the signals and/or transfer/processing of information (data and messages) across an interface. The requirements of these interfaces shall be specified to the level needed to ensure compatibility of the interfacing designs with overall hardware, software and system performance requirements. The signals and/or transfer/processing of information may be controlled by hardware, software or a combination of the two. Hardware is defined as the usage of an equipment's mechanical, magnetic, electrical, or other interfacing media that affect or effect signal or information transfer/processing at an interface. Software control is defined as a computer program which establishes routines for the control of interface signals and/or information transfer/processing with the system constraints.

Elements of control common to hardware and software are the sequence and timing of signals/information across the interface and the characteristics of the information to be transferred or processed. The

requirements for defining these two elements are included in paragraphs 6.8.1 and 6.8.2. Requirements for defining the interaction of two or more software programs involved in signal/information transfer are included in paragraph 6.8.3.

6.8.1 Sequence and timing interfaces. Sequencing and timing interfaces are concerned with the order of signals, messages or data transferred across an interface and their relationship to each other or to some time-based reference such as a computer clock, 24-hour clock, etc. Paragraphs 6.8.1.1 through 6.8.1.4 are oriented toward signal sequencing and timing, but may also be applied to message sequencing, data transfer timing, computer time sharing, synchronization and mode control, etc. Data transfer timing diagrams, and the like, shall have the same basic format and signal status representation as described below for signals.

6.8.1.1 Interface signal diagrams. Interface signal diagrams shall be prepared to depict the overall system configuration. Requirements for these diagrams are essentially the same as those for interface block diagrams (6.7.1) with one addition; each interface signal in each interconnecting cable will be listed, along with the "sequence/timing" number(s) on which the signal appears.

NOTE: The interface block diagram for an ICD having both electrical and information transfer interfaces may be expanded to include the above information.

6.8.1.2 System/signal descriptions. For complex system-level interface configurations, it may be desirable to supplement the interface signal diagram with a written system description (6.7.3).

6.8.1.3 Signal sequence and timing diagrams. Signal sequence and timing requirements will be described by means of signal sequence and/or timing diagrams. These diagrams will be prepared for each critical functional sequence. These diagrams shall have a format similar to that shown in figure 6.2 of Appendix A. Message/data sequencing diagrams and flow charts shall have a format similar to figures 9 and 10 of Appendix B, respectively. Each signal involved in the sequence shall be listed down the left side of the diagram. (The number of the ICD paragraph which gives their functional description shall also be recorded.) Major system events will be indicated across the top (and/or bottom) using "event designators" (T_0, T_1, etc.) to show their relative occurrence. Moving horizontally across the diagram, the status of each signal as a function of time shall be indicated. Critical signal timing, time durations, time delays, etc. shall be dimensioned on the diagram, using appropriate units of time. Signal sequences or timing subject to computer program control shall be so identified. Two different methods for representing signal status are recognized: "single-line" and "dual-level".

a. Single-line representation. Single-lines are usually used to represent discrete command and control signals or serial trains of digital data. With single-line representation, the state of a signal is indicated by the presence (or absence) of a solid, horizontal line. The presence of the line shall denote an "active" state; the absence of

the line shall denote an "inactive" state. A dashed line shall indicate that the state of the signal is optional - that it may or may not be active. An interface signal is in the active state when the function, as described by the signal description, is occurring. (See figure 11 of Appendix B)

b. Dual-level representation. Dual-levels are usually used to represent digital data bits or binary logic states. (See figure 6.2 of Appendix A) With dual-level representation, the state of a signal is indicated by the level (upper or lower) of a solid horizontal line. The upper line shall denote an active state. The lower line shall denote an inactive state. The presence of both lines at the same time shall be used to denote the following conditions, as indicated:


Denotes that the signal may be either active or inactive, but shall not change state during the time interval.


Denotes that the state of the signal is optional - that it may be either active or inactive during the time interval.


Denotes the allowable time tolerance, including delay time, for signal to change state.

The logic values 1 or 0 may be shown for both levels of each signal with the value following the signal name indicating the active state. Use of such annotation is generally reserved for interfaces where a direct correlation is required between software and logic states. (See figure 6.2 of Appendix A)

6.8.1.4 Logic/voltage level correlation. A chart or explanation shall be included to correlate the logical significance (i.e., "true"/"false", "1"/"0", "active"/"inactive", etc.) of the represented signal with the voltage at the interface. (See figure 12 of Appendix B)

6.8.1.5 "Event designator" cross referencing. "Event designators" (T_0, T_1, etc.) common to different timing diagrams shall be cross-referenced for ICD continuity.

6.8.2 Message/data communication interfaces. Message/data (information) interfaces are primarily concerned with defining the format of "words" used to communicate the information (command and control messages, digital data, etc.) across an interface. Other message/data interface characteristics to be considered for documentation include message acceptance criteria, message density and bit rates, priority rules and data formats. Interface block diagrams and system/functional descriptions shall be prepared for message/data interfaces in accordance with requirements specified in paragraphs 6.8.1.1 and 6.8.1.2. Message/data interfaces are normally presented in conjunction with sequencing and timing interfaces, therefore, common block diagrams and descriptions shall be prepared.

6.8.2.1 Word formats for messages/data. Word formats shall be documented by diagramming the "bit pattern" of each word, word-segment, or word-sequence which compose the message or data. Written descriptions may be used to explain each format diagram. On these diagrams, time runs from left to right (assuming serial data); bit "0" shall be the first to cross the interface. The purpose of each bit position shall be noted and the binary codes specified. Figure 7 shows an example of a word format diagram.

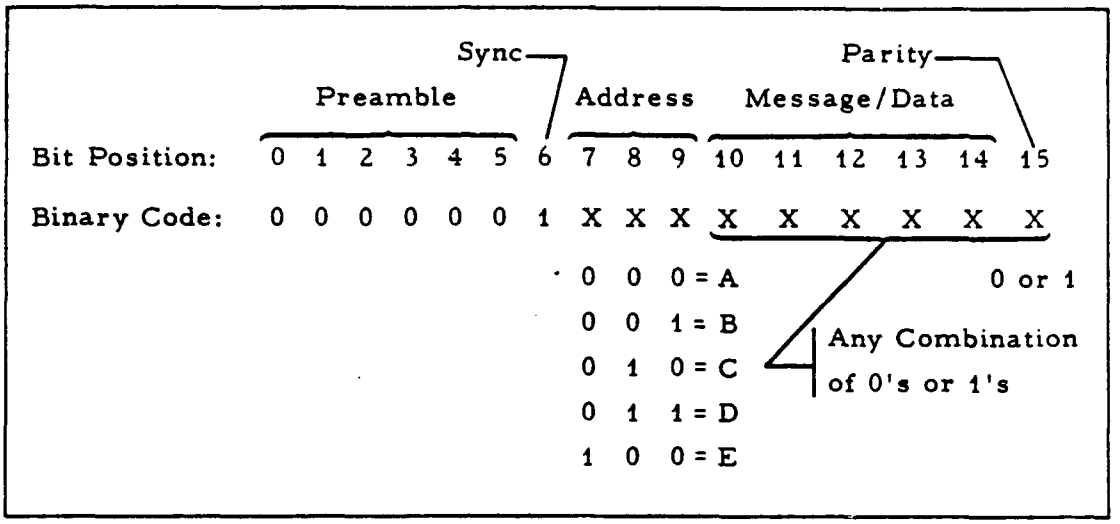


Figure 7. Typical Word Format Diagram

6.8.2.2 Message acceptance criteria. Specify the system criteria which must be met for message acceptance, including operating modes, format checks, flag setting, command line status, sequencing order, etc. (See figure 13 of Appendix B)

6.8.2.3 Message density and bit rates. Specify the allocation of messages into time slots and give the maximum and minimum message/data/bit rates for each mode of communication. (See figure 14 of Appendix B)

6.8.2.4 Priority rules. Specify the order of priority for transmitting, accepting, rejecting, or responding to various messages and data.

6.8.2.5 Data formats. (Telemetry data, message formats, etc.) Specify sync and data word positions as a function of time. Specify the number and type of words or word-segments allocated to each data frame or data cycle and the relative positions of each. (See figures 15-1 and 15-2 of Appendix B)

6.8.3 Software to software. For a system program which is made up of functions supplied by two or more contractors, software to software interfaces (linkages for information transfer) shall be defined. This shall include entry and exit addresses, any system timing constraints, and how

the linkage operation is initiated, e.g., interrupt or program control, etc. Additional considerations include:

a. Subprogram associations – Utilization of software subroutines shared by different software programs for the same computer.

b. Data transfer/transmission – Block and word data transmission formats, coding requirements, and register access. (See figure 16 of Appendix B)

c. Software to software flows – Input/output flows and format between software programs, signals and/or messages associated with programmed data transfer.

d. Special programming – Identification of unique and/or critical programming techniques for software executive/subsystem.

e. Memory allocations – Memory address limits for programmable devices and/or storage devices, shall be defined when two or more contractors are sharing a device. Memory address constraints shall be identified for each major function (subroutine or complete program) which is sharing the device with one or more other major functions. For functions which time-share memory locations, the timing and control parameters shall be identified and quantified.

6.9 Computer programming interfaces. Computer programming interfaces are the means by which application guidelines for computers (or any programmable device) may be defined and controlled. The interface definition shall provide the necessary information to help the programmer translate software requirements into a code recognizable by the computer, e.g., assembly language or machine language. Further, computer operation and performance data shall be defined. Functional requirements imposed on a program by other end items shall not be included in the definition of computer programming interfaces. Such requirements may be part of the same ICD when software to software or software to hardware interfaces are included. Computer programming interfaces shall be presented in book form and shall contain, as applicable, a detailed discussion of the following:

a. Basic architecture

b. Operating modes

c. Execution sequences

d. Interrupt structure

e. Accessible registers

f. Use of index registers

g. Memory size and access

h. Clock timing and control

i. Instruction repetoire:
   - Format
   - Execution time (with tolerances)
   - Operation performed (to the bit level)

j. Input/output characteristics:
   - Signal names (or identifiers)
   - Channel selection
   - Timing and control
   - Special formats

k. Resident programs

l. Arithmetic algorithms

m. Capabilities for program testing

n. Operation under required adverse conditions

o. Special programming constraints.

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Appendix A

Sample Book-form ICD

This Appendix is a mandatory part of SAMSO Standard 75-2A regarding format and placement details for "standard" ICD information (5.4). It is a sample of a complete, hypothetical book-form ICD that includes examples of design descriptions for several different types of interfaces. These examples are provided as guidelines only, for the documentation of interface design requirements. The information contained in the examples form a part of the requirements of this Standard only to the extent specifically referenced by the test of the basic standard.

NOTE: Even though the examples are shown in book-form, the same principles for producing "standard" ICD information and interface design descriptions are applicable to J-size ICDs.

Additional examples of specific interface types may be obtained from the ICWG chairman in the form of released ICDs.

SAMPLE

ICD D25-1234
Page 1 of 30
31 Pages Total
Rev A

INTERFACE CONTROL - BLACK BOX NO. 1 TO SUB-SYSTEM X, MECHANICAL, ENVELOPE, ELECTRICAL, SEQUENCING AND TIMING

CONTRACTOR A/CONTRACTOR B

DEPARTMENT OF THE AIR FORCE
SPACE AND MISSILE SYSTEM ORGANIZATION
(AFSC)
NORTON AFB, CALIF.

MINUTEMAN WS-133		
APPROVAL SIGNATURES		
PARTICIPANT	NAME	DATE
CONTRACTOR A	John C. Doe	11/18/7X
CONTRACTOR B	A. B. Brown	12-14-7X
ICWG CHAIRMAN	L. M. Chairman	1-17-7X

ICWGA 10001

SAMPLE

SAMPLE

REVISION RECORD			
REV. LTR	DESCRIPTION	DATE	APPROVED
A	Incorporated IR 72222 (ICWGA 20002) (IR 72202 cancelled by IR 72222)	2/6/7X	J. C. X.

SAMPLE

SAMPLE

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SAMPLE

ICD D25-12345
Page 4
Rev A

ACTIVE PAGE RECORD

ORIG. REL. PAGE NO.	REV. SYM.	ADDED PAGES						ORIG. REL. PAGE NO.	REV. SYM.	ADDED PAGES					
		PAGE NO.	REV. SYM.	PAGE NO.	REV. SYM.	PAGE NO.	REV. SYM.			PAGE NO.	REV. SYM.	PAGE NO.	REV. SYM.	PAGE NO.	REV. SYM.
1	A							23							
2	A							24							
3								25							
3.1	A							26							
4	A							27							
5	A							28	A	DELETED					
6								29							
7								30	A						
8															
9															
10															
11															
12															
13	A														
14															
15															
16															
17															
18															
19															
20															
21	A	21.1	A												
22															

SAMPLE

SAMPLE

EFFECTIVITY		
USED ON	LOCATION	INTERFACE EFFECTIVITY
SAMSO Report 62-46-1	LCF	WS-133B: Wing VI, Wing I (Collocated Squadron), and AFWTR

SAMPLE

SAMPLE

1 General

1.1 Scope

This ICD specifies mechanical, envelope, electrical and sequencing and timing requirements for the interface between Black Box No. 1 and Subsystem X. It contains mechanical installation and electrical power requirements for Box No. 1 and defines the electrical characteristics (levels, timing, etc.) for interface signals between it and the Remote Control Unit. Included are Mated Circuits and Timing Diagrams for critical interface signals, an Envelope drawing for Box No. 1 and Wiring Diagrams for each connector interface.

1.2 Equipment and Responsibility List

Identification No.	Nomenclature	Responsible Participant
CI 666	Black Box Set	Contractor B
Fig. A 7777	Equipment Mount A	Contractor A
Fig. A 555	Power Supply	Contractor A
Fig. A 888	Remote Control Unit	Contractor A

1.3 Related ICDs

The following ICDs may be impacted by changes to this ICD:

Number	Title
ICD 25-11111	Remote Control Unit to Sub-system Y, Electrical, Sequencing and Timing - Contractor A/Contractor C
ICD 25-22222	Power Supply to Sub-system Y, Electrical - Contractor A/Contractor C
ICD 25-33333	Black Box Set to Equipment Mount A, Installation - Contractor B/AF Agency Z

SAMPLE

2 Notes and Abbreviations

2.1 Notes

1. Not applicable to facilities where Sub-system Y is not installed.
2. Clean surface and brush cad. Plate noted area per BAC 5849.
3. Surfaces in this area to be flat and parallel within 0.01 inch TIR.
4. Dimensions are in inches.
   Dimensions and tolerances per ANSI Y14.5.
5. Surface finishes per USAS B46.1-62.
6. Contractor A Connector Specification 73-266123-0100 Rev. G. dated 6 June 1972.
7. Contractor B Connector Specification BACC45DS20C07P Rev. F. dated 2 April 1973.

2.2 Abbreviations

BPS	Bits Per Second
IC	Integrated Circuit
I_n	Receiver short circuit current (Norton equivalent)
NC	No Connection
P/N	Part Number
Typ	Typical
Y_n	Receiver Circuit input admittance (Norton equivalent)

SAMPLE

3 Interface Block Diagram and System Description

3.1 Interface Block Diagram

Figure 3.1 shows the interface configuration for Subsystem X. It depicts Black Box No. 1 installed on Equipment Mount A and shows the interconnections with the Power Supply and Remote Control Unit. Also identified are the electrical and mechanical interfaces described in this ICD.

3.2 System Description

No system description is provided in this sample ICD. It does, however, contain examples of interface signal descriptions in paragraph 6.1.

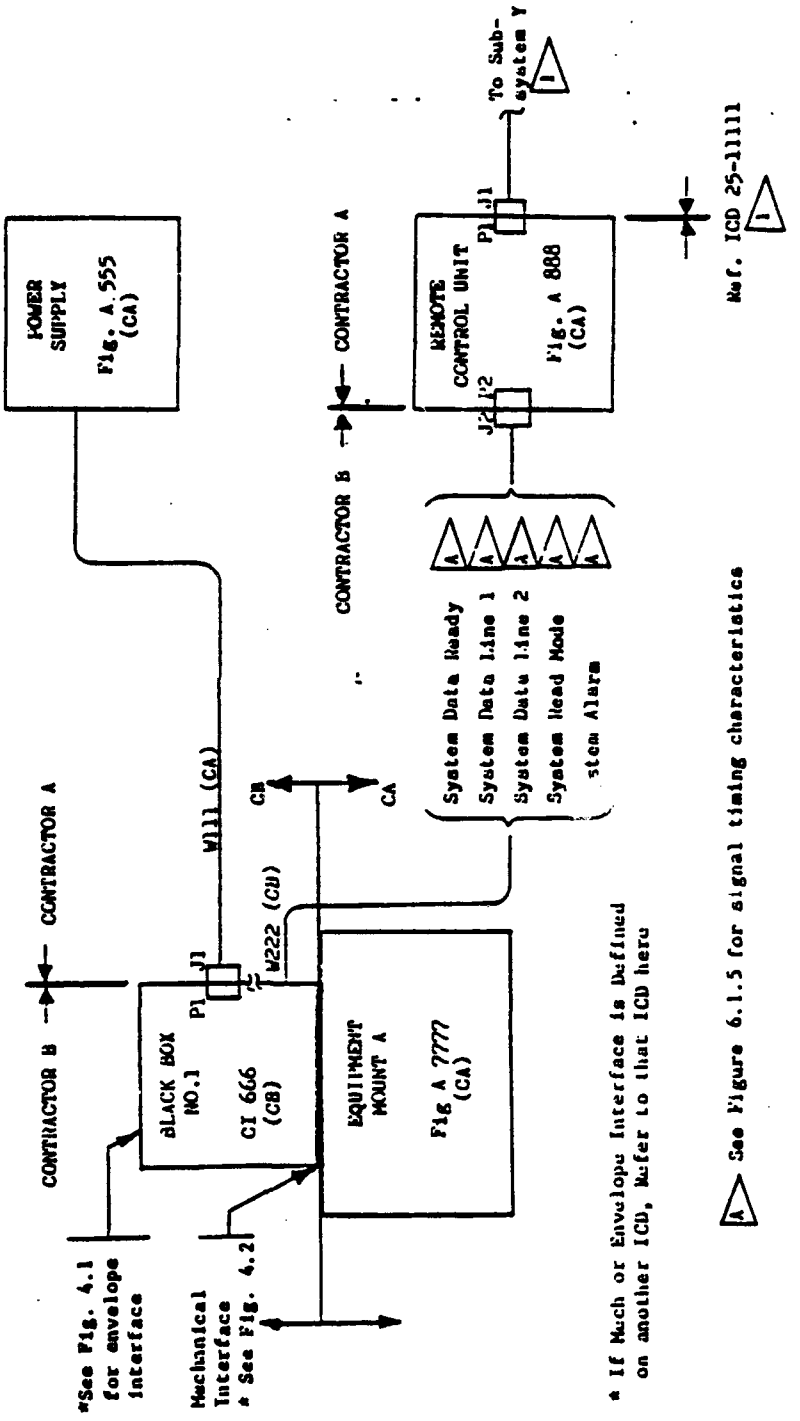


Figure 3.1. Sub-System X Interface Block Diagram

SAMPLE

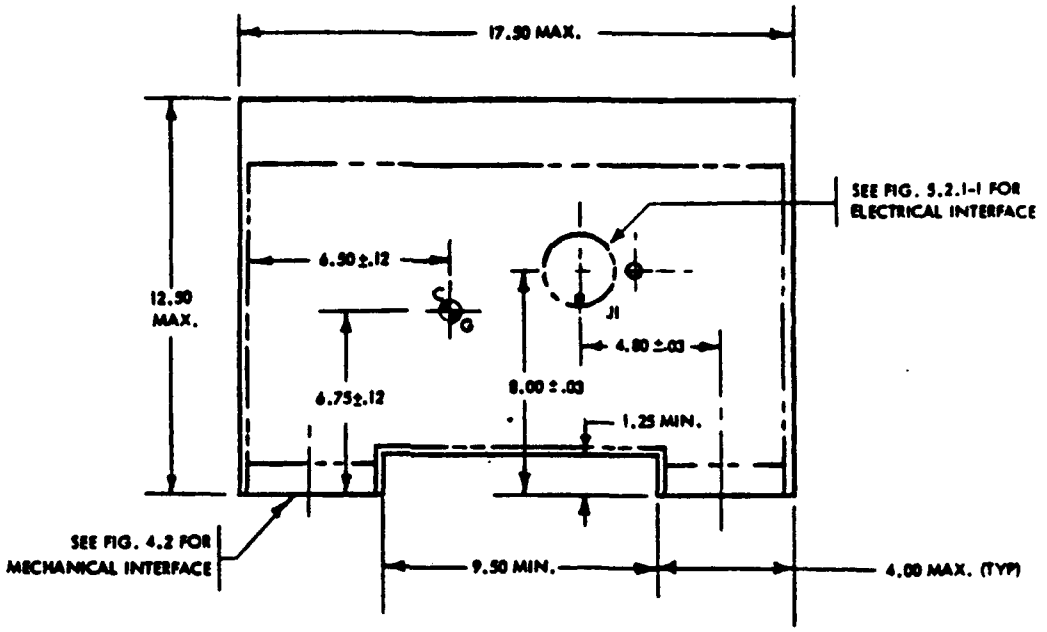
4 Mechanical Interface

4.1 Envelope

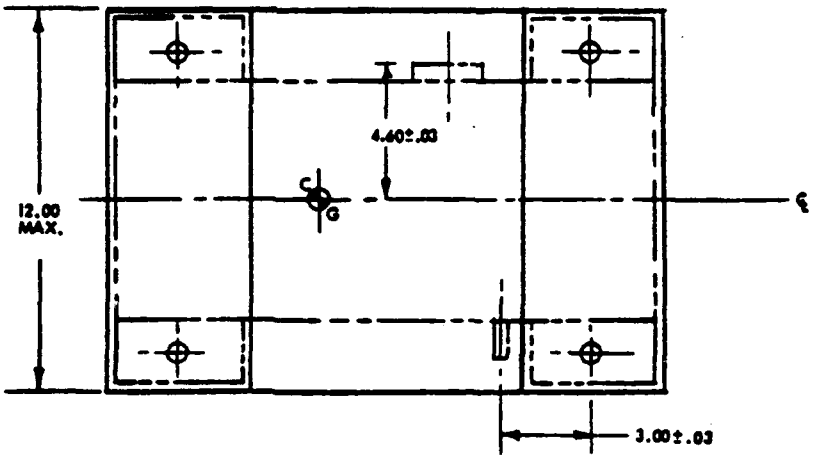
The equipment envelope for Black Box No. 1 is shown in Figure 4.1.

4.2 Installation

Mechanical interface requirements for installation of Black Box No. 1 onto Equipment Mount A are shown in Figure 4.2.



FRONT VIEW



BOTTOM VIEW

Figure 4.1 Envelope Drawing - Black Box No. 1

SAMPLE

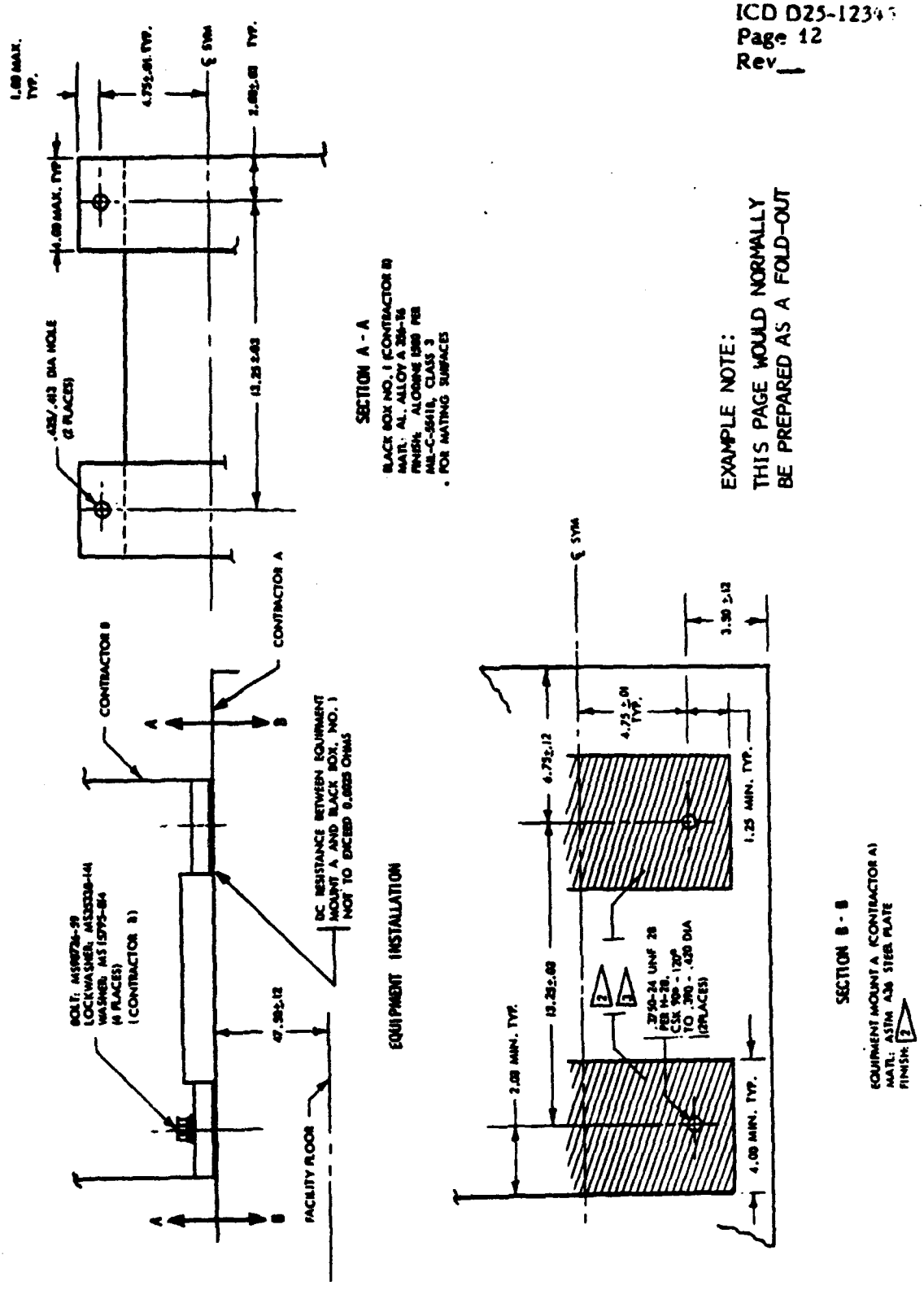


Figure 4.2 Installation Drawing

SAMPLE

5 Electrical Interface

5.1 Power and Load

5.1.1 Voltage

The voltage at the input terminals of Black Box No. 1 will be 28 ± 2 VDC within 1.5 seconds following power turn-on. During power line transients lasting up to 3.0 seconds maximum, the input voltage will not exceed 35 VDC.

5.1.2 Current

The continuous current rating of Black Box No. 1 will be 5.5 Amps maximum. Surge currents up to 10 Amps may be experienced during the first 1.5 seconds following power turn-on.

5.1.3 Ripple

The ripple voltage will be less than 320 mv peak-to-peak, riding on the D.C. levels of paragraph 5.1.1.

5.1.4 Overvoltage Protection

Input voltages in excess of 35 VDC for 0.6 ± 0.6 seconds will cause the Power Supply to shut down completely.

5.2 Connectivity

5.2.1 Wiring Diagrams

Wiring Diagrams for the power connector interface (P1/J1) on Black Box No. 1 and the signal connector interface (J2/P2) on the Remote Control Unit are shown in Figures 5.2.1-1 and 5.2.1-2, respectively.

5.2.2 Bonding

The bonding interface for the ground strap from Black Box No. 1 to Equipment Mount A is shown in Figure 4.2.

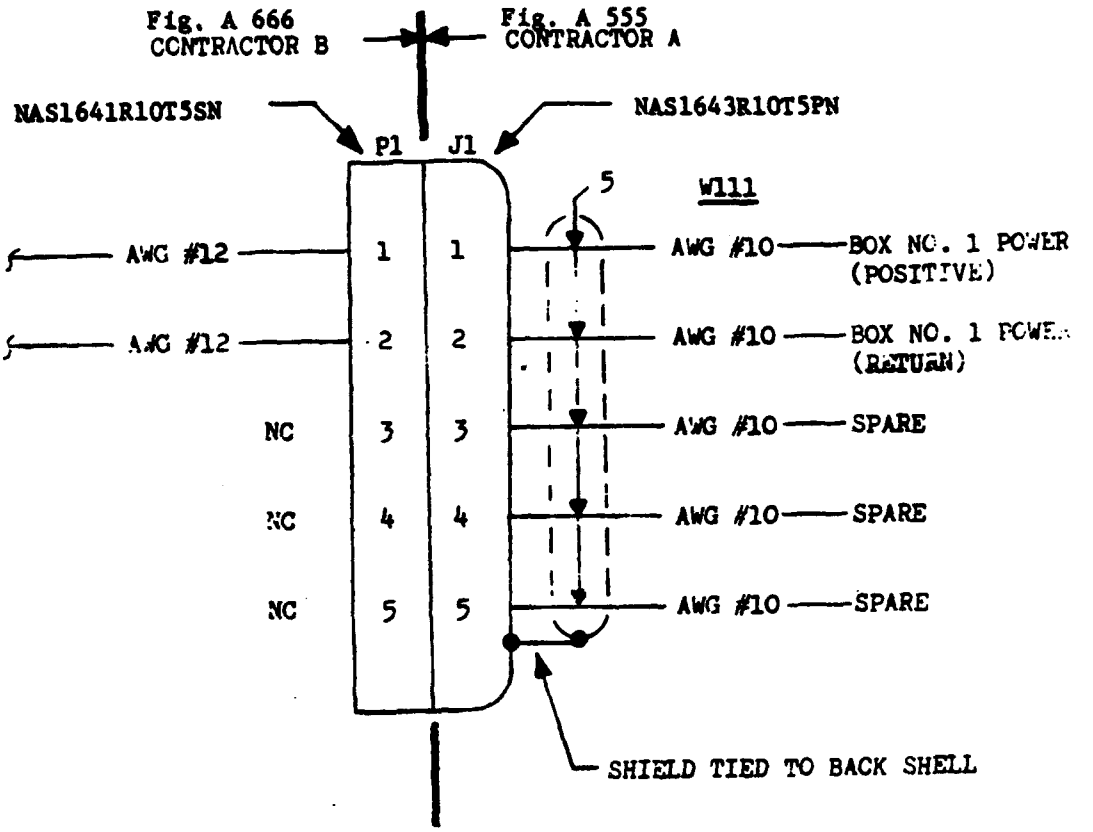


Figure 5.2.1-1. Connector Wiring Diagram - P1/J1 (W111)

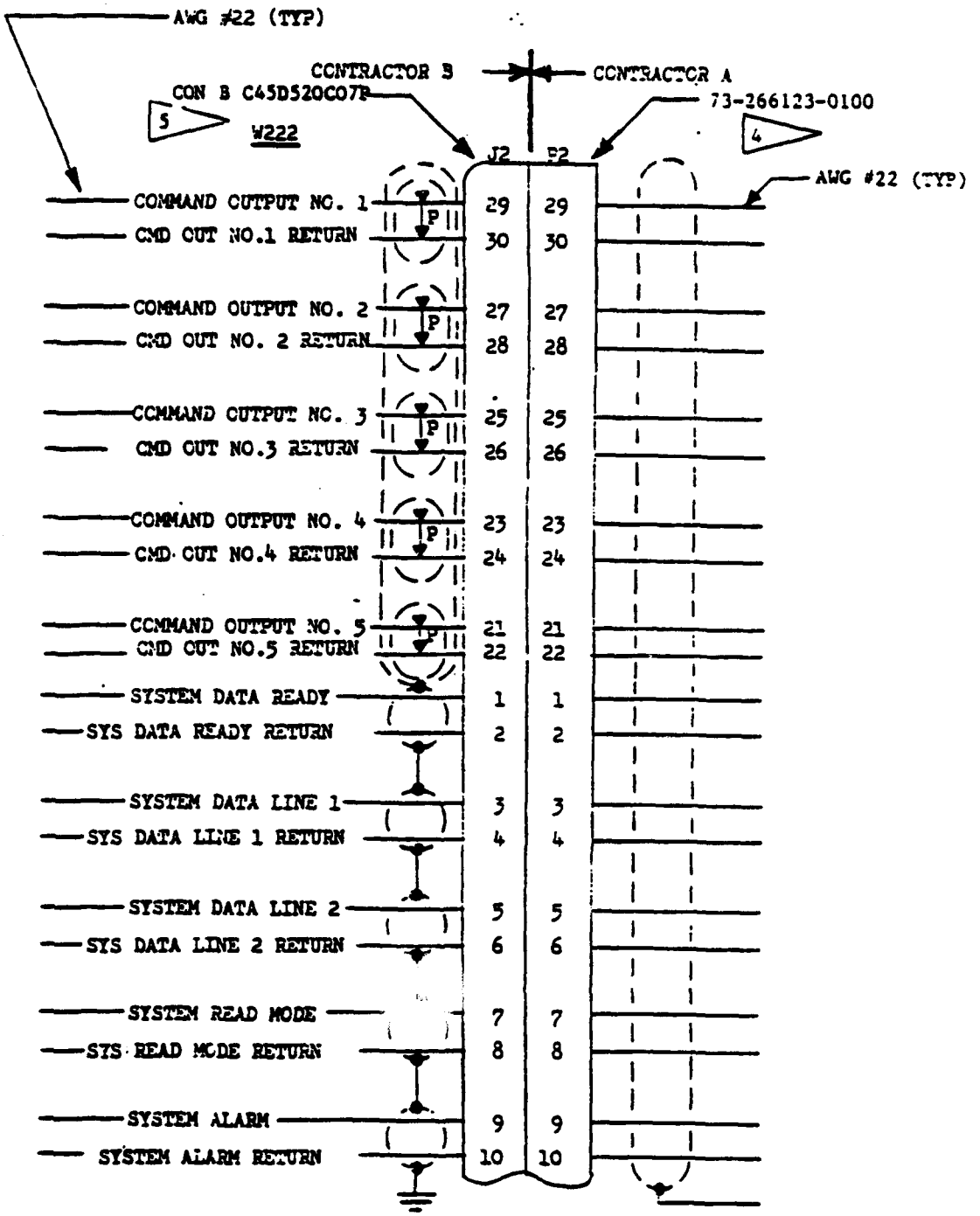


Figure 5.2.1-2. Connector Wiring Diagram J2/P2 (W222)

5.3 Circuits

5.3.1 Interface Control - Electrical Chart

Electrical interface characteristics for Subsystem X signals are defined on Chart 5.3.1.

5.3.2 Mated Circuits

Mated circuits for the above signals are shown in Figures 5.3.2-1 and 5.3.2-2.

5.3.3 Schematics and Equivalent Circuits

Schematic diagrams and equivalent circuits for Subsystem X drivers and receivers are shown in Figures 5.3.3-1 through 5.3.3-4.

CHART 5.3.1 INTERFACE CONTROL - ELECTRICAL

CONTRACTOR B TO CONTRACTOR A

CABLE W222 CONNECTOR J2 MATES WITH REMOTE CONTROL UNIT CONNECTOR P2

REF	SIGNAL SOURCE OR DESTINATION	S OR D	COMMON SIGNAL DESCRIPTIONS NAME	PIN NO.	SIGNAL AND INTERFACE CHARACTERISTICS	SIGNAL SOURCE OR DESTINATION	S OR D
	CI 666	S	COMMAND OUTPUT NO. 1	29	Ref. ICD 25-11111	SUBSYSTEM	D
			COMMAND OUTPUT NO. 1 RETURN	30			
	CI 666	S	COMMAND OUTPUT NO. 2	27	Ref. ICD 25-11111	SUBSYSTEM	D
			COMMAND OUTPUT NO. 2 RETURN	28			
	CI 666	S	COMMAND OUTPUT NO. 3	25	Ref. ICD 25-11111	SUBSYSTEM	D
			COMMAND OUTPUT NO. 3 RETURN	26			
	CI 666	S	COMMAND OUTPUT NO. 4	23	Ref. ICD 25-11111	SUBSYSTEM	D
			COMMAND OUTPUT NO. 4 RETURN	24			
	CI 666	S	COMMAND OUTPUT NO. 5	21	Ref. ICD 25-11111	SUBSYSTEM	D
			COMMAND OUTPUT NO. 5 RETURN	22			
	CI 666	S	SYSTEM DATA READY	1	3DA - 5RA	FIG. A 888	D
			SYSTEM DATA READY RETURN	2			

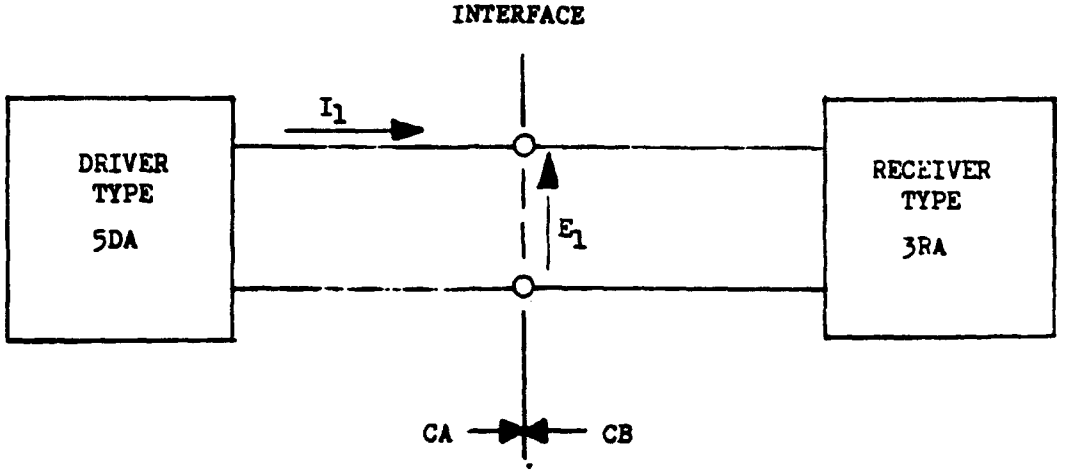
CHART 5.3.1 (cont'd) INTERFACE CONTROL - ELECTRICAL

CONTRACTOR B TO CONTRACTOR A

CABLE W222 CONNECTOR J2 MATES WITH REMOTE CONTROL UNIT CONNECTOR P2

REF	SIGNAL SOURCE OR DESTINATION	S OR D	COMMON SIGNAL DESCRIPTIONS NAME	PIN NO.	SIGNAL AND INTERFACE CHARACTERISTICS	SIGNAL SOURCE OR DESTINATION	S OR D
	CI 666	S	SYSTEM DATA LINE 1	3	3DA - 5RA	FIG. A 888	D
			SYSTEM DATA LINE 1 RETURN	4			
	CI 666	S	SYSTEM DATA LINE 2	5	3DA - 5RA 1	FIG. A 888	D
			SYSTEM DATA LINE 2 RETURN	6			
	CI 666	S	SYSTEM READ MODE	7	3DA - 5RA	FIG. A 888	D
			SYSTEM READ MODE RETURN	8			
	CI 666	D	SYSTEM ALARM	9	5DA - 3RA	FIG. A 888	S
			SYSTEM ALARM RETURN	10			

SAMPLE



	TRUE (low)		FALSE (high)	
	MAX.	MIN.	MAX.	MIN.
E_1	-9.85 VDC	-10.9 VDC	+5.47 VDC	+4.9 VDC
I_1	-0.26 MA	-0.32 MA	+0.16 MA	+0.13 MA
DCNM	6.39 to 98.5 VDC from E_1 MAX (True)		9.9 to 11.9 VDC from E_1 MIN (False)	

FAULT	INTERFACE LOGIC STATE
A	FALSE
B	FALSE
C	FALSE

INTERFACE SIGNAL(S): SYSTEM ALARM

NOTE:

See the next three pages for plots of the mated circuits in the true & false states showing

(a) Pulse width vs amplitude
(b) DCNM relative to threshold

Figure 5.3.2-1. Mated Circuit Type 5DA - 3RA

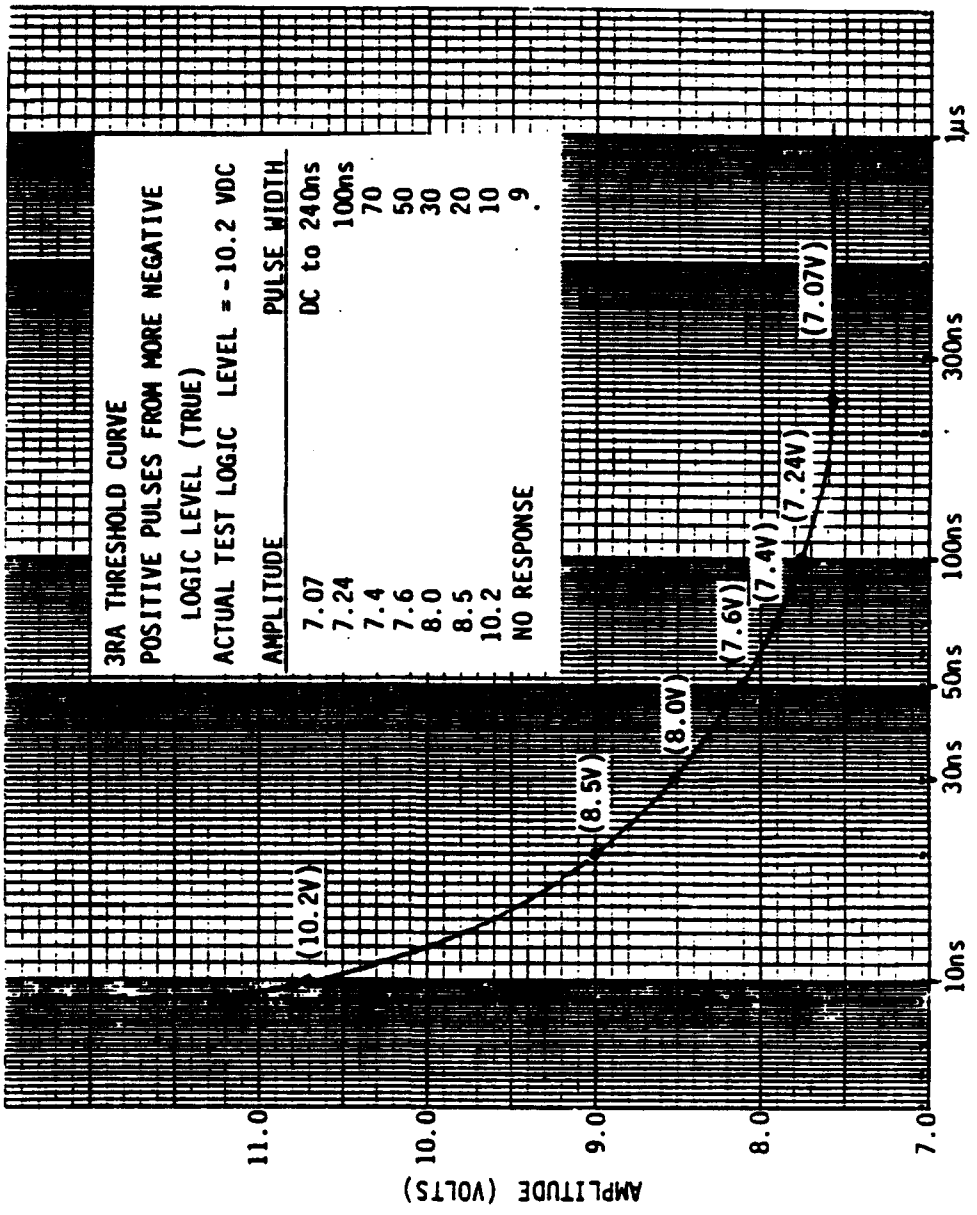


Figure 5.3.2-1.1 Mated Circuit Type 5DA-3RA (Continued)

SAMPLE

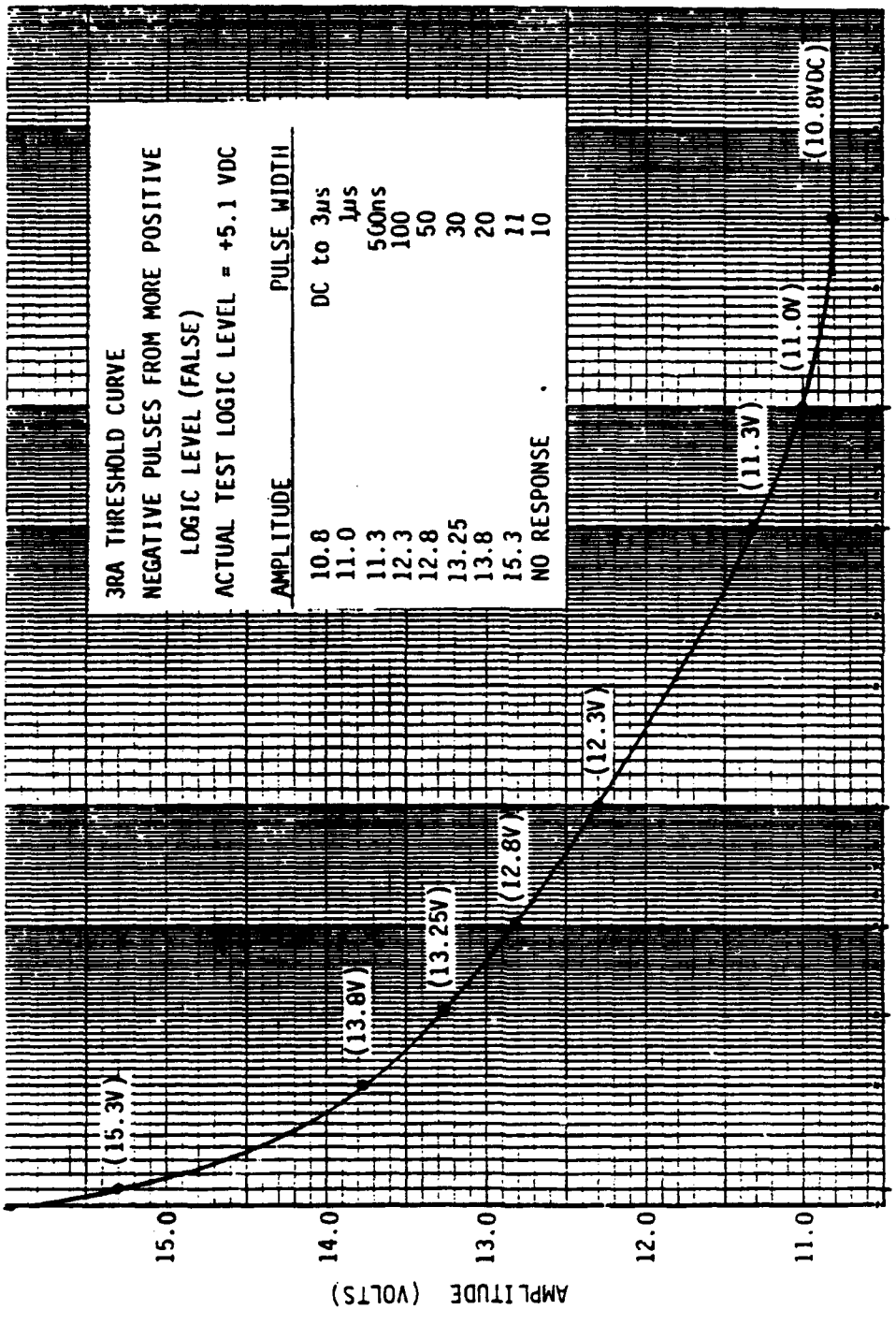


Figure 5.3.2-1.2 Mated Circuit Type 5DA-3RA (Continued)

SAMPLE

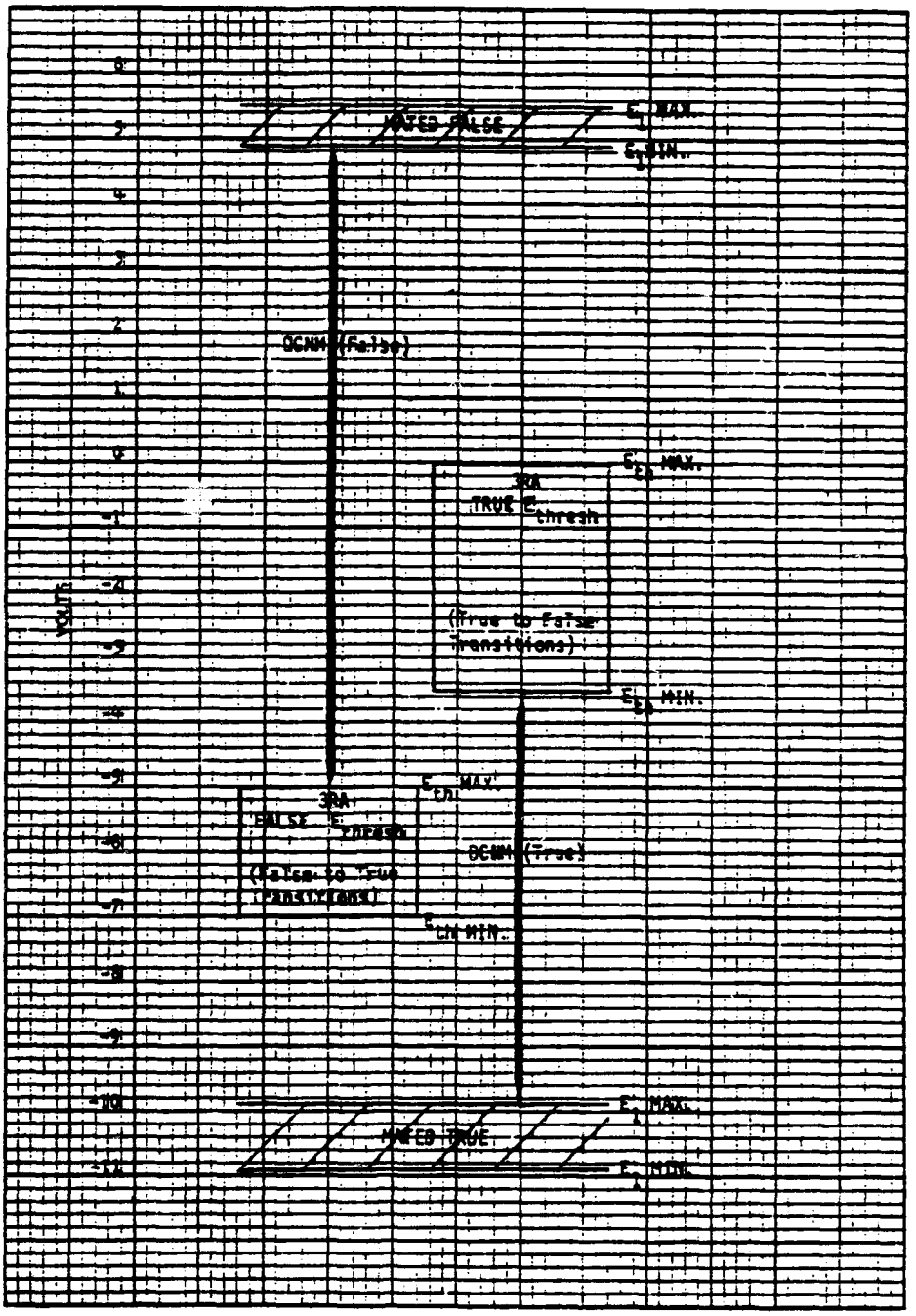
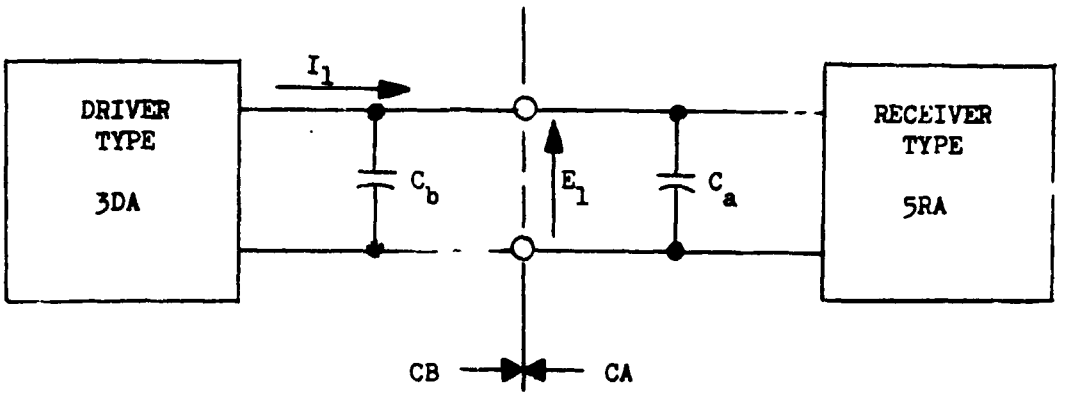


Figure 5.3.2-1.3 Mated Circuit Type 5DA-3RA (Continued)



C_b = 7900 pF MAX C_a = 200 pF MAX

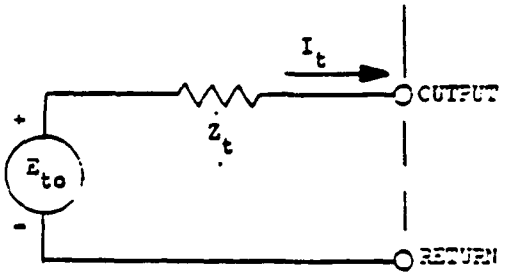
	TRUE (low)		FALSE (high)	
	MAX.	MIN.	MAX.	MIN.
E_1	-5.17 VDC	-11.9 VDC	+12.6 VDC	+10.1 VDC
I_1	-.08 MA	-1.6 MA	46 A	0
DCNM	6.27 VDC		8.8 VDC	

FAULT	INTERFACE LOGIC STATE
A	FALSE
B	TRUE
C	INDETERMINATE

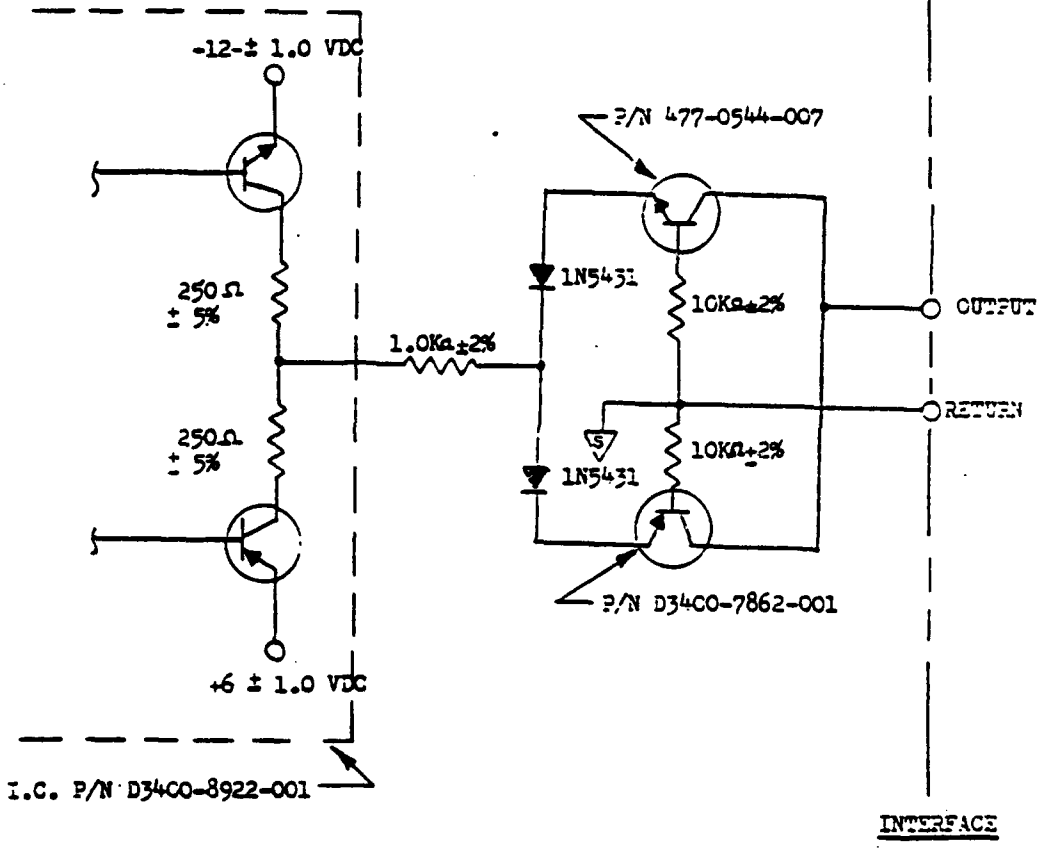
INTERFACE SIGNAL(S): SYSTEM DATA LINE 1
SYSTEM DATA LINE 2 1
SYSTEM READ MODE
SYSTEM DATA READY

Figure 5.3.2-2. Mated Circuit Type 3DA - 5RA

EQUIVALENT CIRCUIT



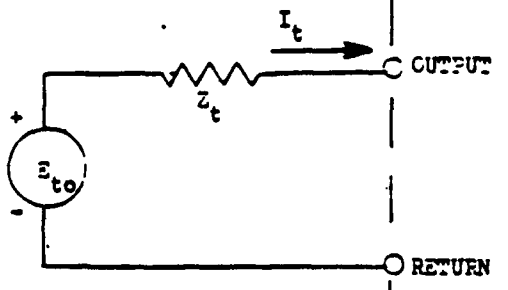
SCHEMATIC DIAGRAM (Ref.)



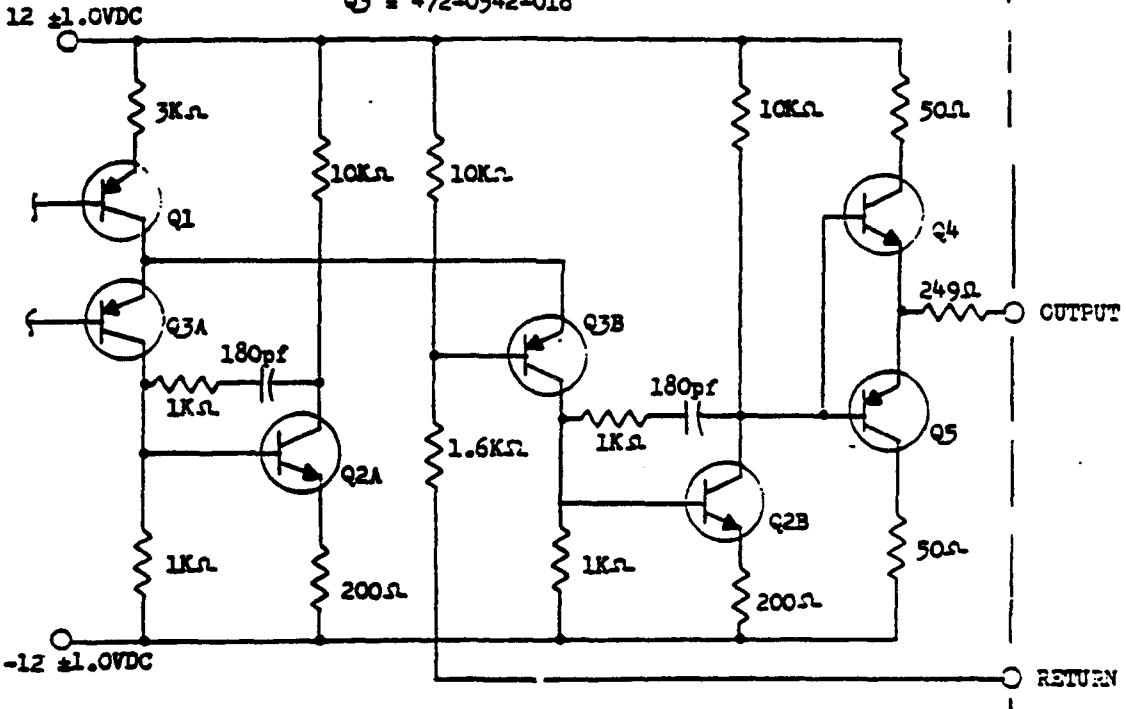
	TRUE (low)		FALSE (high)	
	MAX	MIN	MAX	MIN
E_{to}	-9.7VDC	-11.2VDC	+5.6VDC	+4.9VDC
I_t	0	-5MA	4.2MA	0
Z_t	1.33KΩ	1.05KΩ	1.33KΩ	1.05KΩ

Figure 5.3.3-1. Driver Type 5DA

EQUIVALENT CIRCUIT



SCHEMATIC DIAGRAM (Ref.)
Q1 = 472-0542-017
Q2 = 472-0544-017
Q3 = 472-0542-018
Q4 = 472-0543-007
Q5 = 472-0545-007

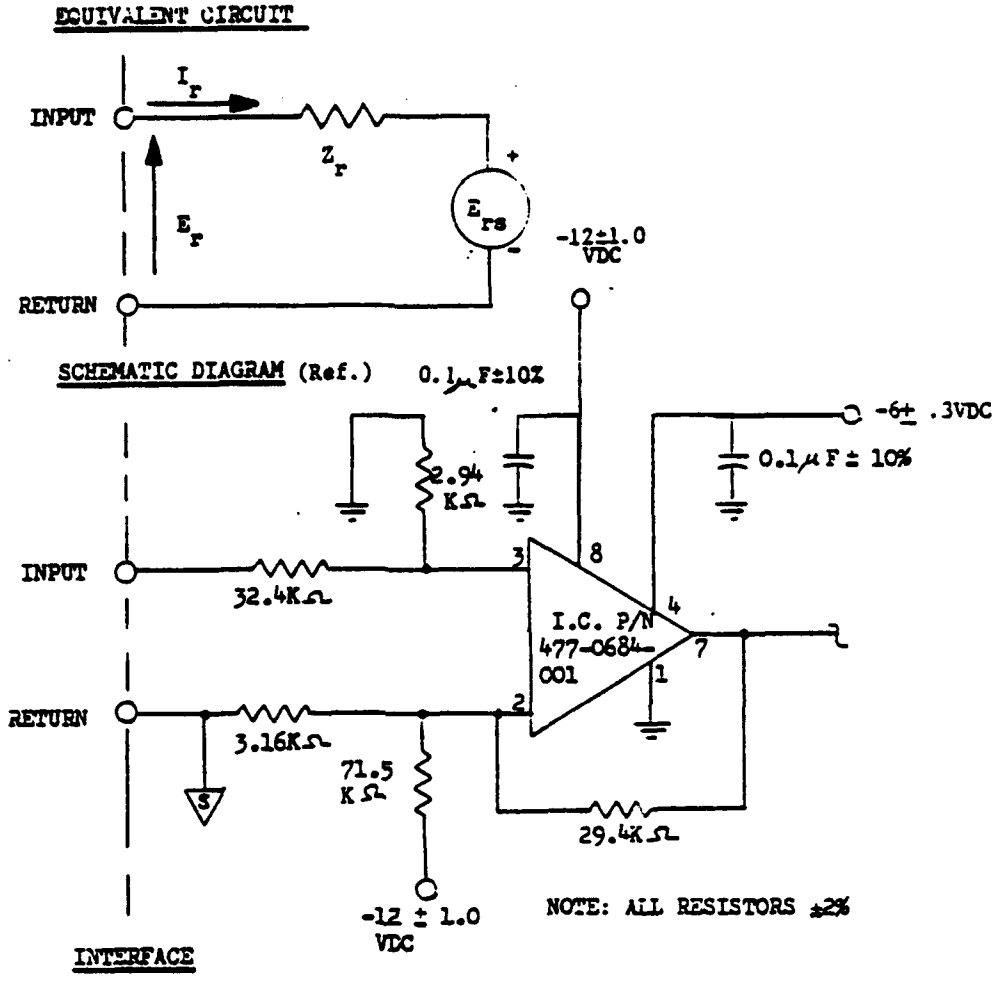


NOTE: ALL RESISTORS ARE ± 4%; CAPACITORS, ± 10%.

INTERFACE

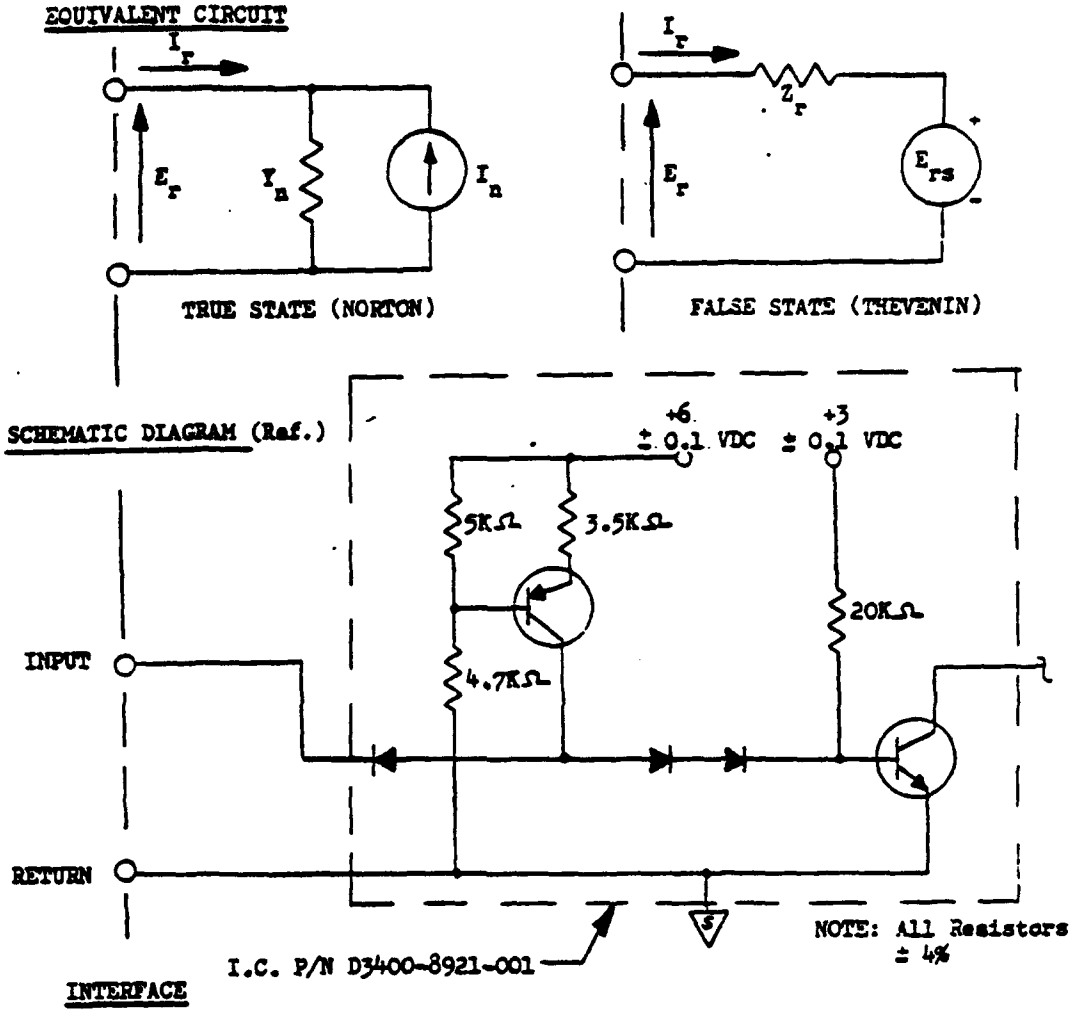
	TRUE (low)		FALSE (high)	
	MAX	MIN	MAX	MIN
E_{to}	-6.54VDC	-12.0VDC	12.6VDC	10.2VDC
Z_t	910Ω	230Ω	2KΩ	470Ω
I_t	-3.1MA	—	2.8MA	—

Figure 5.3.3-2. Driver Type 3DA



	TRUE (low)		FALSE (high)	
	MAX	MIN	MAX	MIN
E_{rs}	0	0	0	0
Z_r	35.87K	34.81K	35.87K	34.81K
I_r	-100 A	-1.1 MA	+1.1MA	+220 A
E_r MAX	-38VDC		+38VDC	
E_{thresh}	-0.36VDC	-3.46VDC	-5.21VDC	-7.27VDC

Figure 5.3.3-3. Receiver Type 3RA



INTERFACE

	TRUE (low)		FALSE (high)	
	MAX	MIN	MAX	MIN
I_n	+1.5MA	+0.08MA	N/A	N/A
$1/Y_n$		100K	N/A	N/A
I_r	-0.35MA	-1.5MA	80 A	0
Z_r	N/A	N/A		250K
E_{rs}	N/A	N/A	+20VDC	+4VDC
E_r MAX	-38VDC		+25VDC	
E_{thresh}	+1.1VDC		+1.3VDC	

Figure 5.3.3-4. Receiver Type 5RA

6 Sequencing and Timing Interface

6.1 Signal Descriptions

6.1.1 System Data Ready

The System Data Ready signal is issued by Black Box No. 1 to the Remote Control Unit whenever Subsystem X is put into the "test" mode. It alerts the Remote Unit to prepare for receiving data on System Data Lines 1 and 2.

6.1.2 System Data Lines 1 and 2

System Data Lines 1 and 2 carry a serial train of split-phase digital code at a bit rate of 1300 bps. During test, the code consists of a series of alternating 1's and 0's which continue as long as the System Read Mode is "true" (ref. 6.1.3).

6.1.3 System Read Mode

The System Read Mode signal is issued by Black Box No. 1 to the Remote Unit whenever system data is ready for transfer. It causes the Remote Unit to gate in data on lines 1 and 2 as long as it is "true".

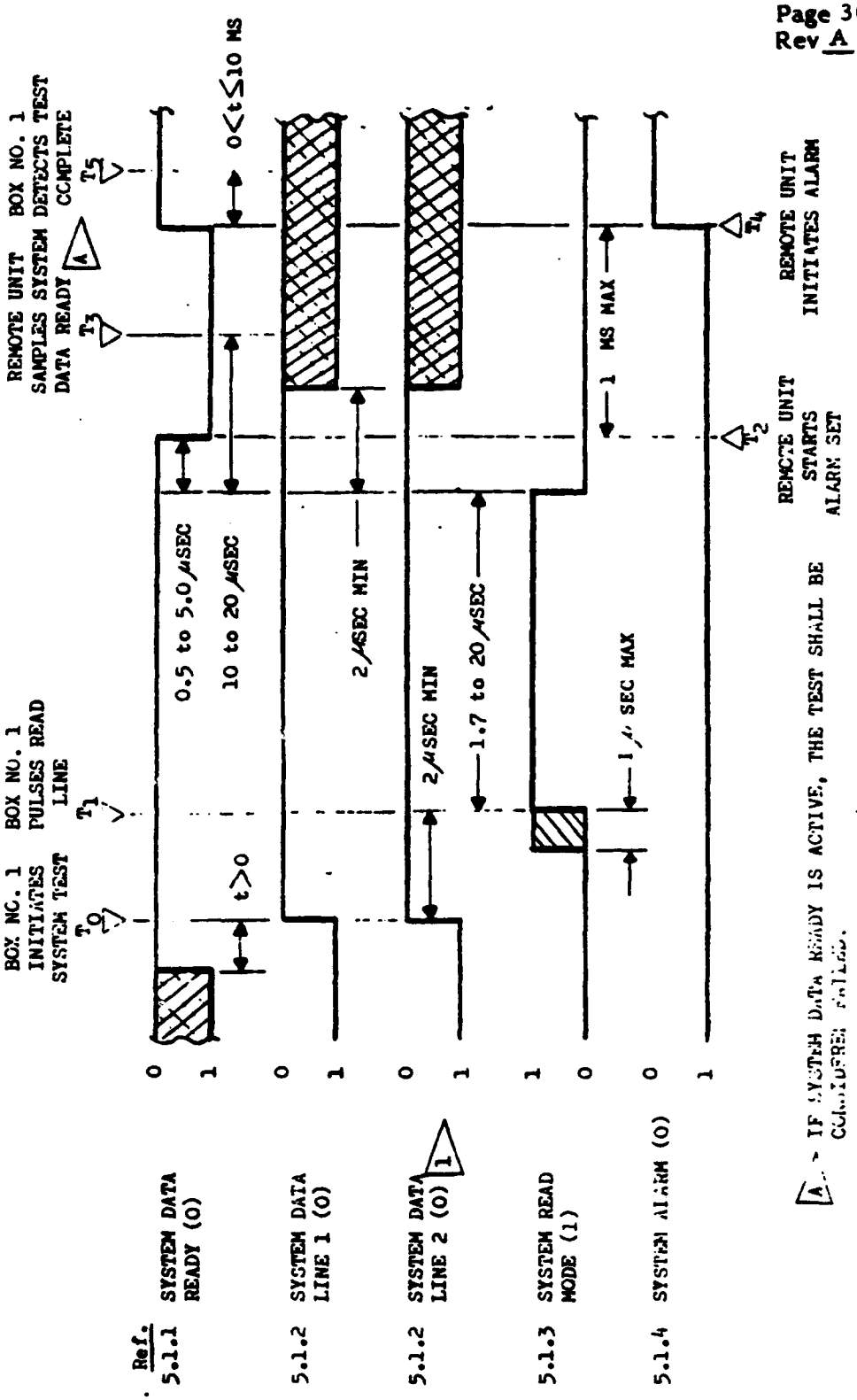
6.1.4 System Alarm

The System Alarm signal is issued by the Remote Unit to Black Box No. 1 whenever it fails to detect the test data train on either Data Line 1 or Data Line 2. 1

6.2 Subsystem X Test Sequence

Signal sequencing and timing during the Subsystem X Test Mode is shown in the Timing Diagram of Figure 6.2.

SAMPLE



1 - IF SYSTEM DATA READY IS ACTIVE, THE TEST SHALL BE CONSIDERED FAILED.

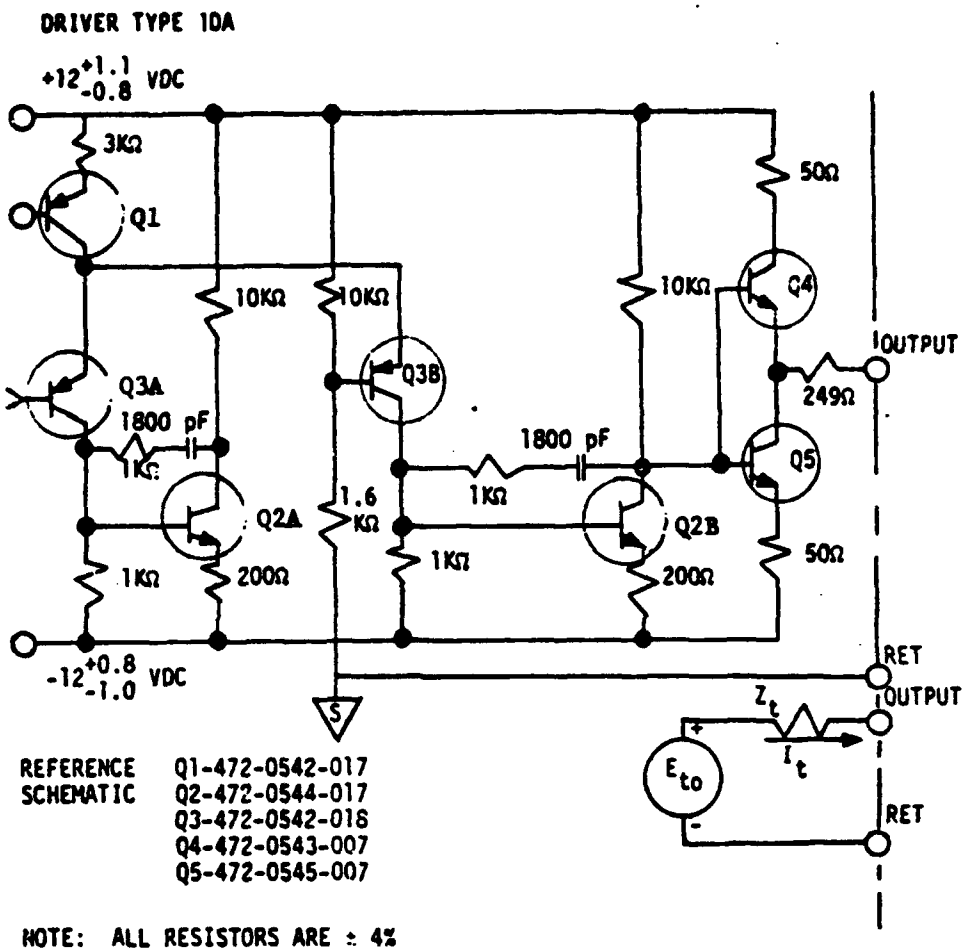
Figure 6.2. Timing Diagram - Sub-System X Test Sequence

SAMPLE

Appendix B

(Sample Interface Documentation)

This appendix contains examples of interface documentation not adapted for inclusion in Appendix A. These examples form part of the requirements of this Standard only to the extent stated in the text of the basic Standard.



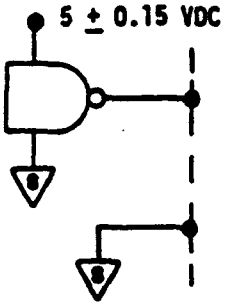
	LOW		HIGH	
	MAX	MIN	MAX	MIN
E_{to}	-6.54V	-12.0V	12.6V	10.2V
Z_t	910 Ω	230 Ω	2000 Ω	470 Ω
I_t	-3.1 MA	--	2.8 MA	--

Figure 1. Driver Circuit Schematic (Discrete Component) Example

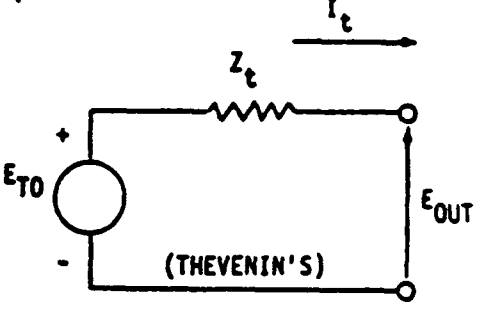
DRIVER TYPE: 1 DB OR 1 DG

P/N 1 DB: 7902961 (TI SN5400)
1 DG: 7902963 (TI SN5920)

LOGICAL REPRESENTATION



EQUIVALENT CIRCUIT



	PARAM-ETER	HIGH			LOW		
		NOTE	MIN	MAX	NOTE	MIN	MAX
Region 1	E_{to} / Z_t	2	2.8 VDC / 175Ω	5.15 VDC / 2.5 KΩ	2.4	0 VDC / 0Ω	0.20 VDC / 12.5 KΩ
	I_t	3	0	0.4 ma	3	16 ma	0 ma
Region 2	E_{to} / Z_t	2	2.8 VDC / 175Ω	4.2 VDC / 86Ω			
	I_t	3	0.4 ma	16 ma			
Region 3	E_{to} / Z_t	1,2,4	-0.25 ma / 100MΩ	0 / 0			
	E_{out}	3	2.8 VDC	5.5 VDC			
MAX RATINGS	E_{OX}	5	2.4 VDC	5.5 VDC			
	I_{OX}	6	-16 ma	-0.25 ma			
	I_T				7	-16 ma	0

DRIVER CIRCUIT TRUTH TABLE

Figure 2. Driver Circuit Data (Microcircuit or Integrated Circuit) Example

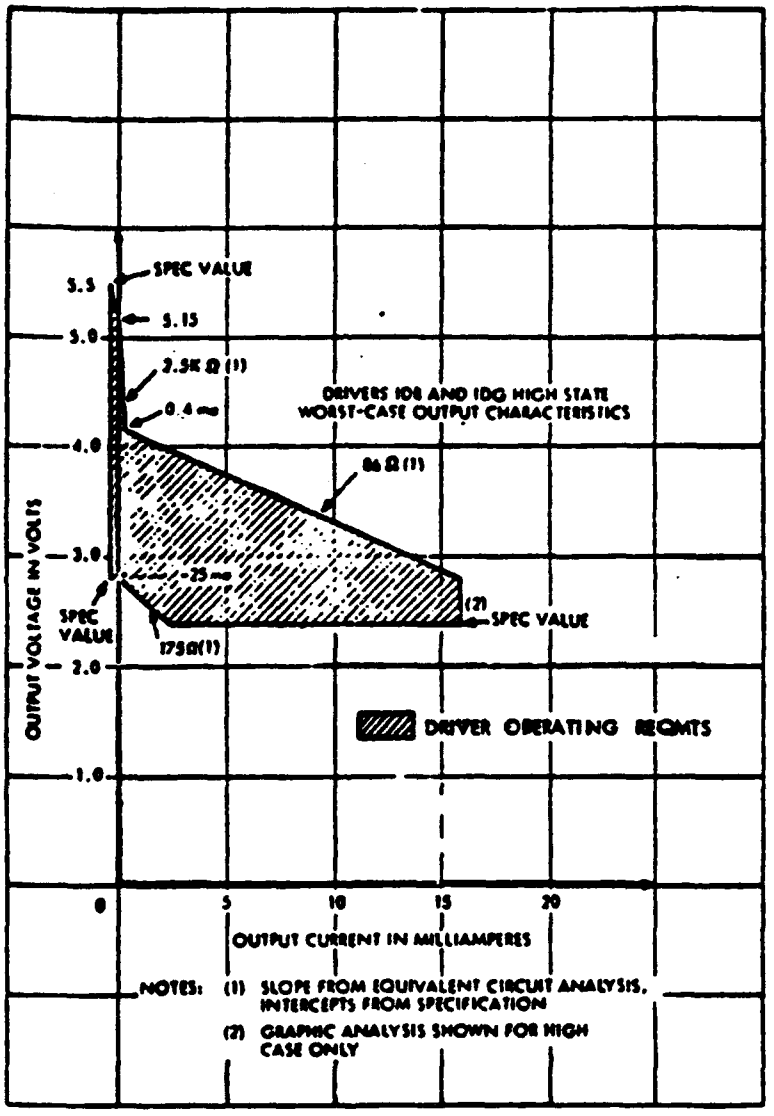
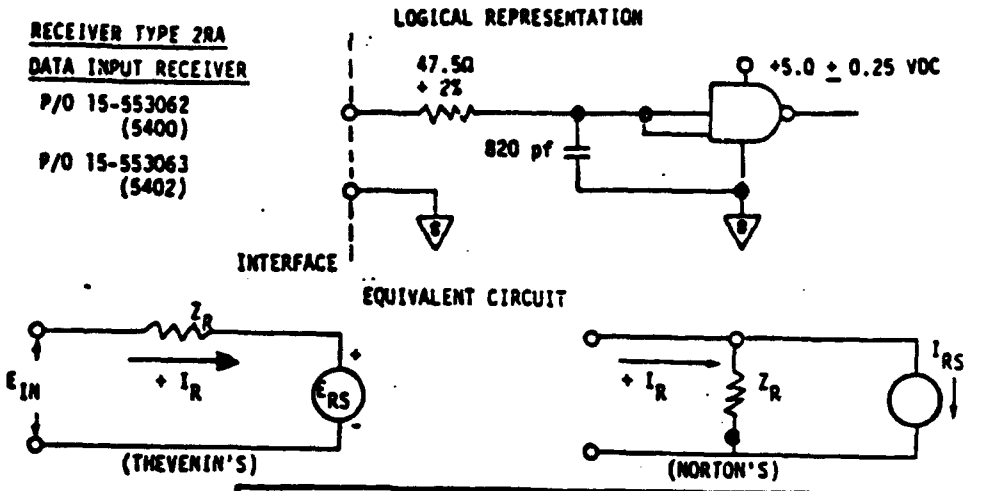


Figure 3. Driver Circuit Characteristics Graphical Data Example



		HIGH			LOW		
		CONSTRAINT	MIN	MAX	CONSTRAINT	MIN	MAX
Region 1 (5)	I_R/Z_R	$1.8<E_{IN}<2.4$ VDC	0 ma/-	80u /-			
	E_{R_S}	↓	0 VDC	-			
Region 2	E_{RS}/Z_R	$2.4<E_{IN}<5.5$ VDC	-10.0 VDC/ 155K	0 VDC/-	$0<E_{IN}<0.85$ VDC	0.92V / 1.347 KΩ	4.86V/ (2) 2.85 KΩ
	I_R	↓	0 ma	0.1 ma		-1.71 ma	-0.05 ma
Region 3	E_{RS}/Z_R				$-0.5<E_{IN}<0$ VDC	3.57 V/ 5.25 KΩ	4.88 V/ 2.95 KΩ
	I_R					-1.91 ma	-0.68 ma
Region 4	E_{RS}/Z_R				$-1.55<E_{IN}<-0.5$ VDC	3.57 V/ 5.25 KΩ	-0.41 V/ 96Ω
	I_R					-22 ma	-0.8 ma
	$E_{THRESHOLD}$		1.80 VDC MIN			0.85 VDC MAX	
	E_R MAX		5.5 VDC			-0.5 VDC	

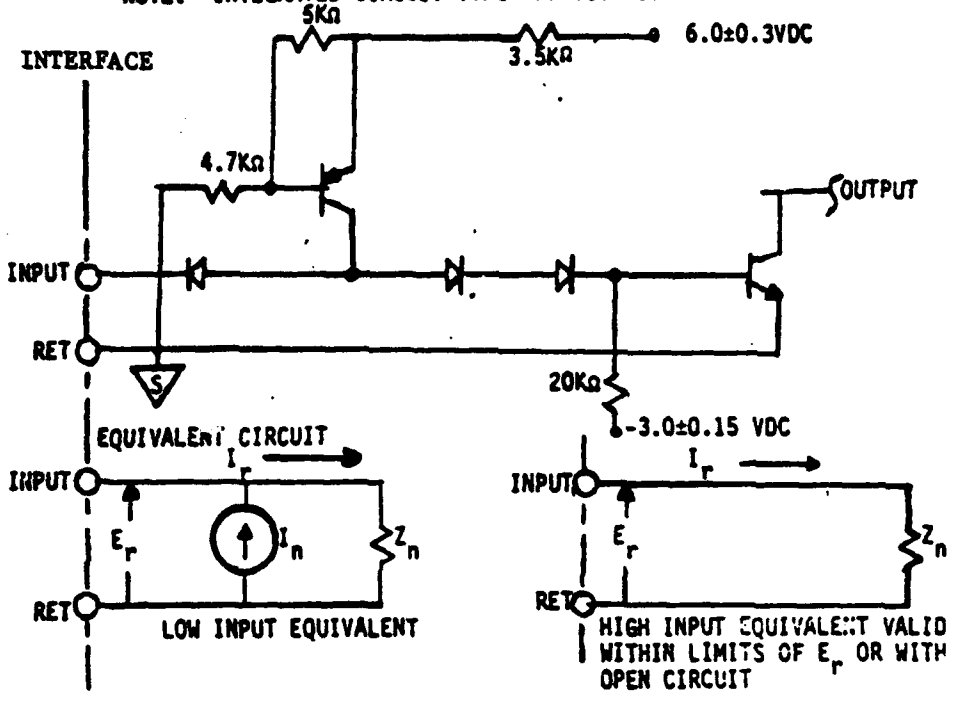
NOTES:
(1) RESTRICTIONS ON E_{IN} -1.55 VDC<E_{IN}<5.5VDC.
(2) TRUNCATE ABOVE +1.8 VDC PLOTTING THIS LINE ON A GRAPH.
(3) E_{IN} OF +0.85V TO +1.80V IS INVALID OPERATING RANGE.
(4) RESISTOR TOLERANCES ARE WORST CASE.
(5) USE NORTON EQUIVALENT FOR CONSTANT CURRENT REGION.

Figure 4. Receiver Circuit Data (Hybrid Integrated or Microcircuit) Example

RECEIVER TYPE 3RG

REFERENCE SCHEMATIC

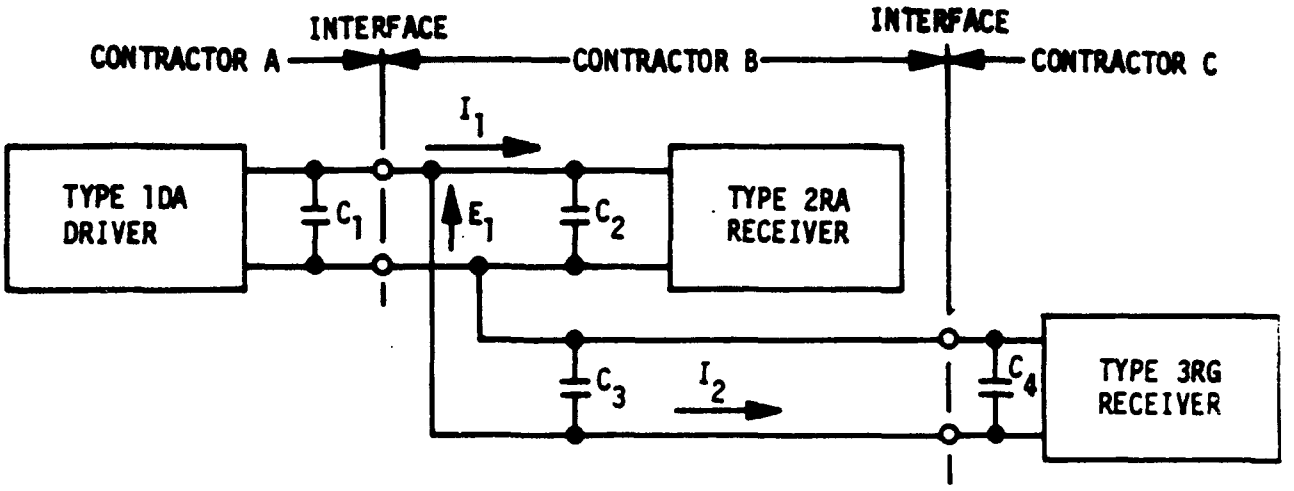
NOTE: INTEGRATED CIRCUIT TYPE 477-0537-001



	LOW		HIGH	
	MAX	MIN	MAX	MIN
E_r	-4 VDC	-27 VDC	OPEN CKT	OR 4 TO 20VDC
Z_n		100KΩ		100KΩ
I_n	1.5MA	.35MA	--	--
$E_{r(MAX)}$	-27 VDC		+20 VDC	
E_{THRESH}	+1.1 VDC		+1.3 VDC	
I_r	-.35MA	-1.5MA	- -	- -

Figure 5. Receiver Circuit Data (Integrated Circuit) Example

MATED CIRCUIT TYPE
1DA TO 2RA & 3RG



	MAX
C_1	.32 μF
C_2	.121 μF
C_3	.018 μF
C_4	650 pf

	MIN	MAX
T_r	1 μs	2 μs
T_f	.85 μs	2 μs

	TRUE (LOW)		FALSE (HIGH)	
	MAX	MIN	MAX	MIN
E_1	-9.3 V	-12.7 V	+5.8 V	+3.4 V
I_1	0	-50 μa	3.9 μa	1.4 μa
I_2	-1.0 μa	-3.9 μa	50 μa	0
DCNM	2RA=2.1	3RG=1.6	2RA=1.2	3RG=.93

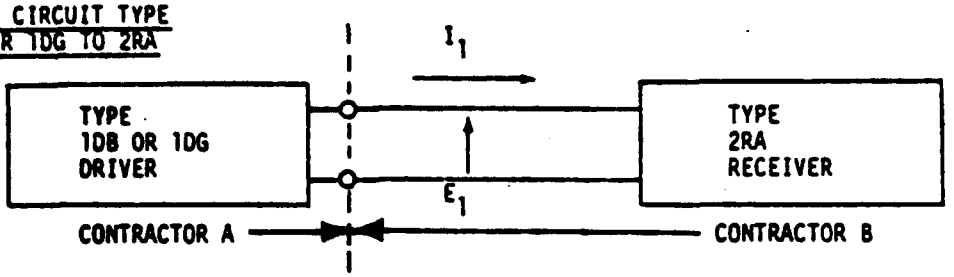
FAULT	INTERFACE LOGIC STATE	
	2RA	3RG
A	FALSE	TRUE
B	FALSE	TRUE
C	FALSE	TRUE

FUNCTION: INPUT-OUTPUT DATA TEST

Figure 6. Mated Circuits Data Example

INTERFACE

MATED CIRCUIT TYPE
1DB OR 1DG TO 2RA



CABLE CHARACTERISTICS

1) EE #24 TW PR
   Z_0 = 147 ± 21Ω
   R_{DC} = 27m Ω/FT MAX
   C = 30 PF/FT MAX
   MAX L = 3.5 ft

2) EE #24 SHLD TW PR
   Z_0 80 ± 10Ω
   R_{DC} = 27 MΩ/FT MAX
   C = 60 Pf/FT MAX
   MAX L = 3.5 ft

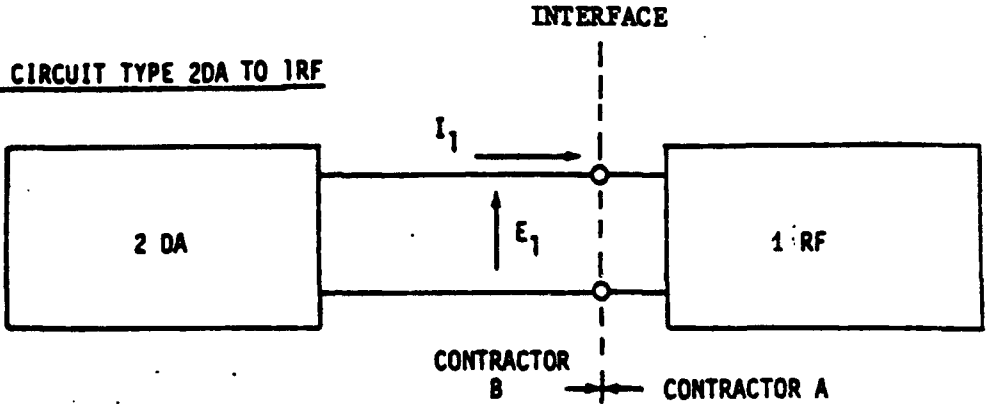
	MIN	MAX
T_r	2 µs	15 µs
T_f	2 µs	12 µs

	FALSE (HIGH)		TRUE (LOW)	
	MAX	MIN	MAX	MIN
E_1	5.15 VDC	2.7 VDC	0.22 VDC	0 VDC
I_1	0.1 ma	0 ma	-0.53 ma	-1.7 ma
UCNM	-	0.99 V	-	0.63 V

FAULT	INTERFACE LOGIC STATE
A	FALSE (HIGH)
B	TRUE (LOW)
C	FALSE (HIGH)

FUNCTION: MCG INPUT ACKNOWLEDGE

Figure 7. Mated Circuits (with Cable Parameters) Data Example



	MIN	MAX
T_r	5 ns	250 ns
T_f	5 ns	250 ns

	FALSE (HIGH)		TRUE (LOW)	
	MAX	MIN	MAX	MIN
E_1	5.25 VDC	2.73 VDC	0.36 VDC	0.071 VDC
I_1	0.173 ma	0 ma	-1.23 ma	-3.13 ma
DC NM	0.88 VDC		0.62 VDC	

FAULT	INTERFACE LOGIC STATE
A	FALSE (HIGH)
B	TRUE (LOW)
C	FALSE (HIGH)

FUNCTION: MCG EXTERNAL INTERRUPT REQUEST

Figure 8. Mated Circuits Data Example

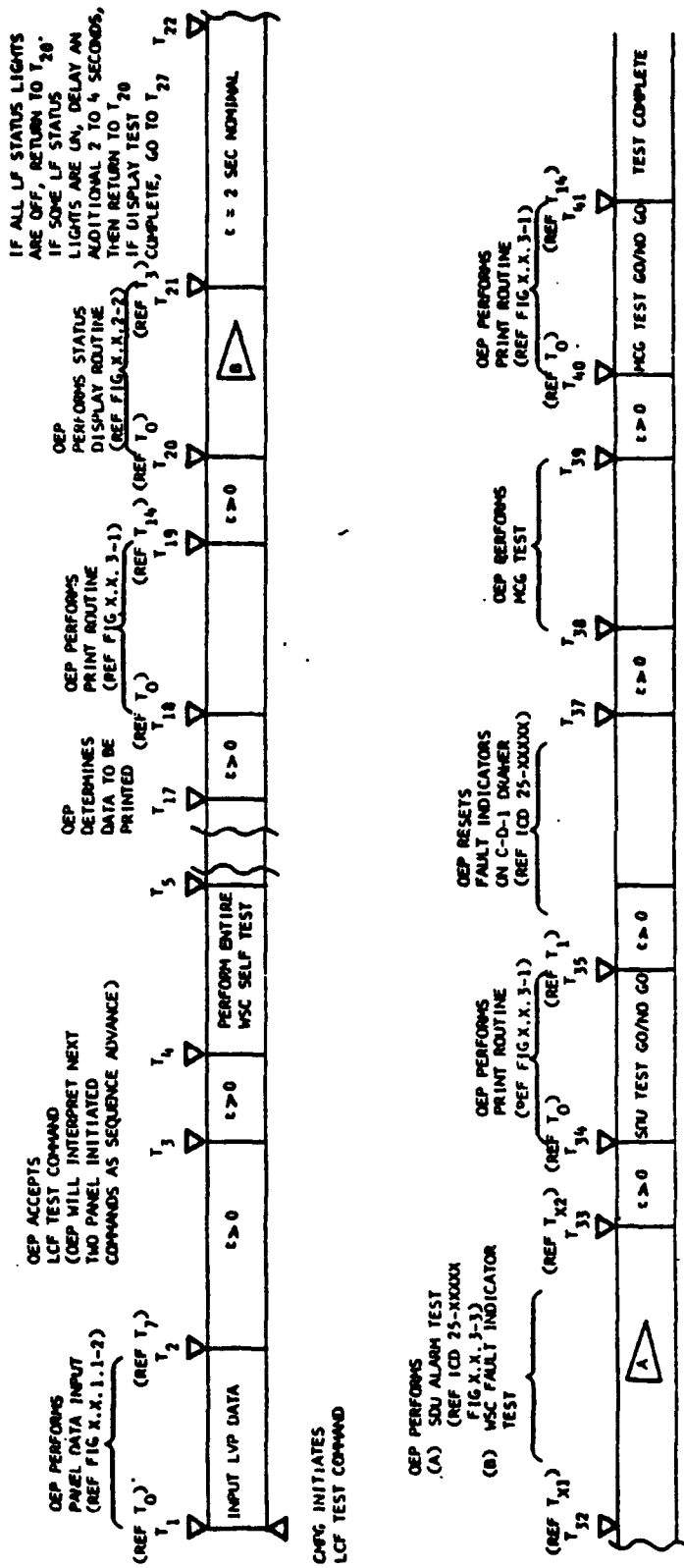


Figure 9. Sequence Diagram Example

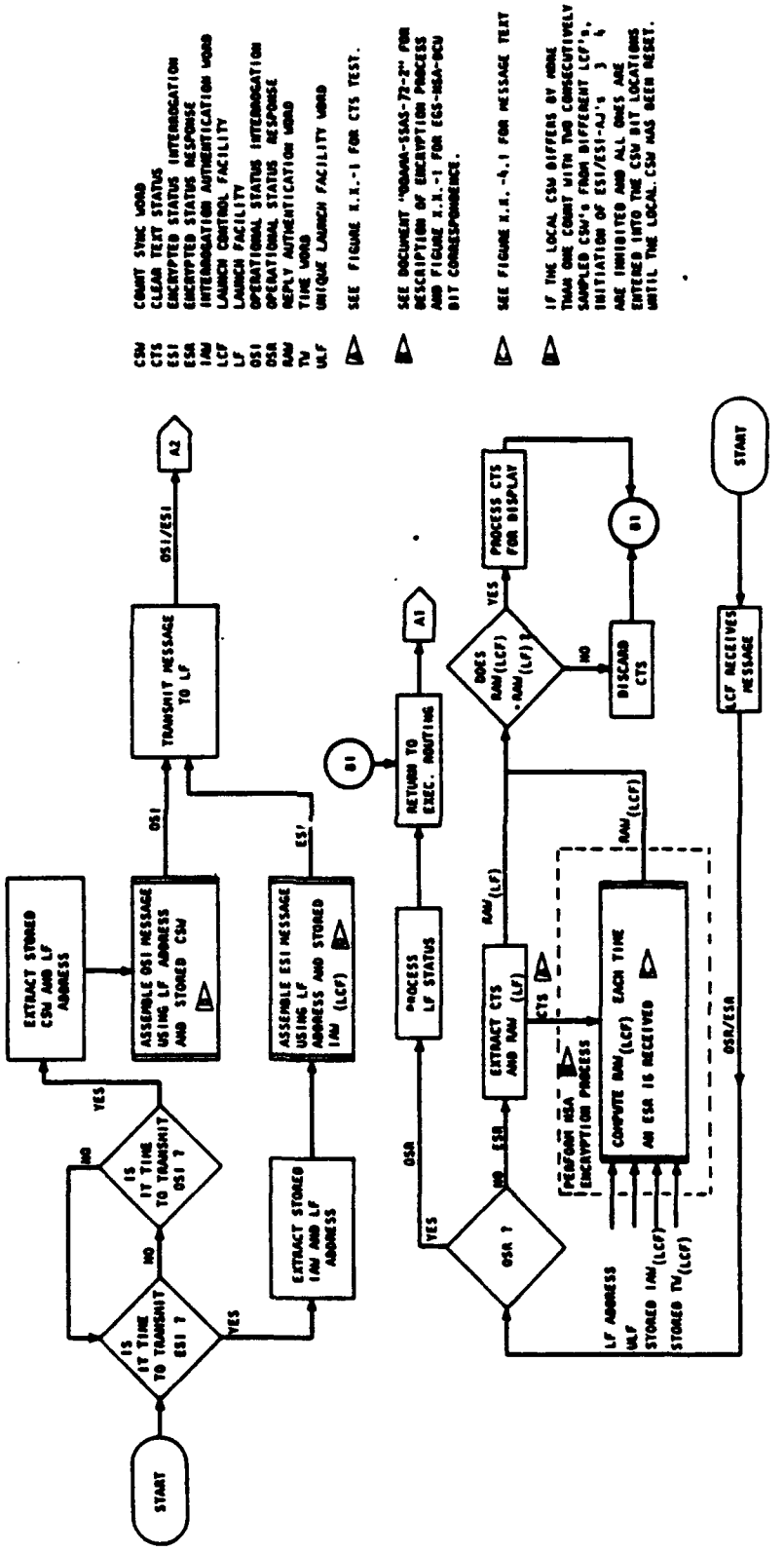
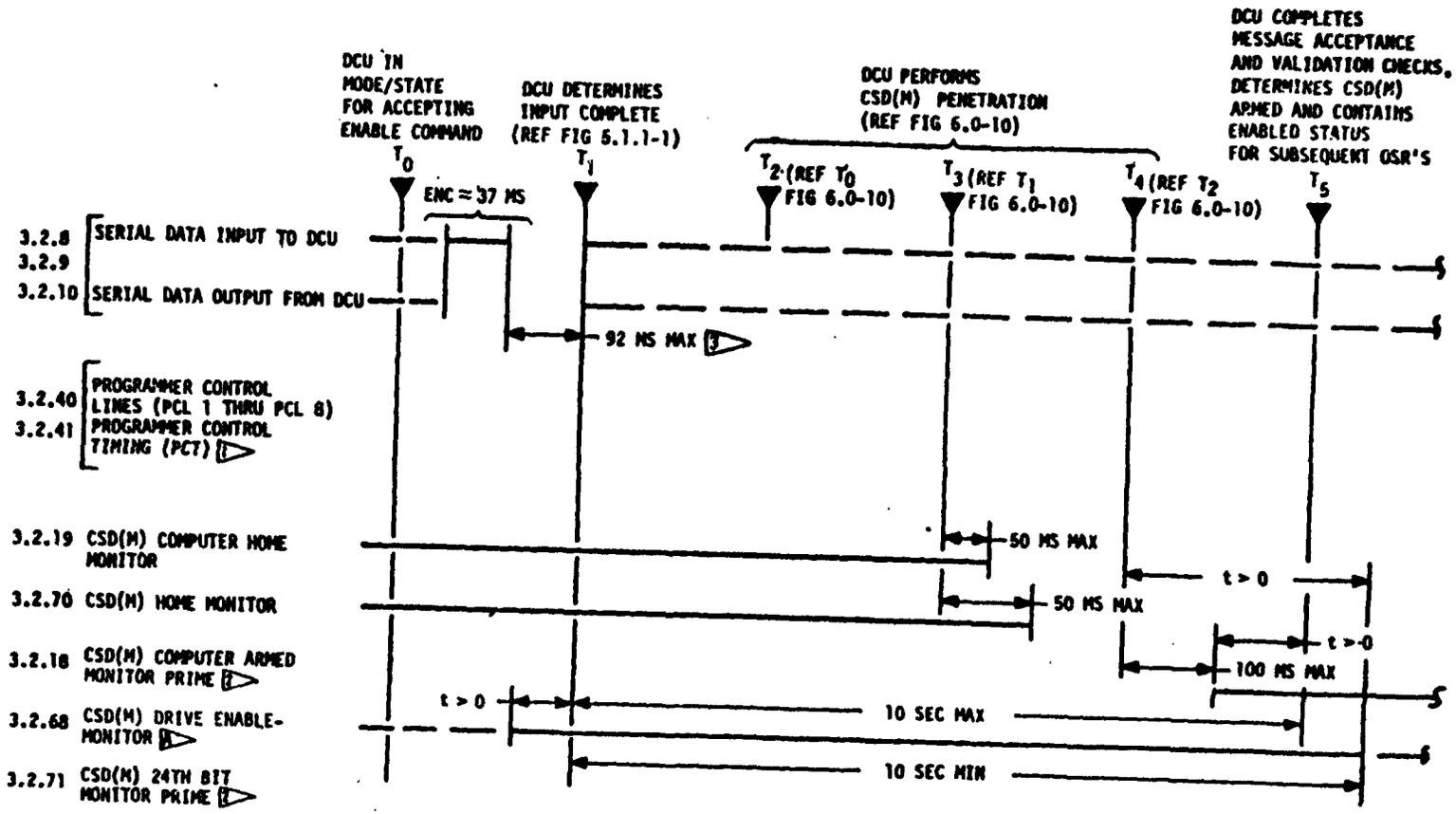


Figure 10. Signal/Message Flow Example



Example Note.
A timing diagram of this type may be a foldout page.

THE CSD(M) DRIVE ENABLE-MONITOR SIGNAL MAY BE CONTINUOUS FOR EXTENDED PERIODS DURING ENABLE OPERATION SUCH AS SELECTIVE ENABLING OF LF'S IN PREPARATION FOR LAUNCH. THE EGS EXTENDS/SETS TRUE THE CSD(M) DRIVE ENABLE-MONITOR SIGNAL FOR A MINIMUM PERIOD OF 10 SECONDS EACH TIME AN ENABLE OR ENABLE TEST COMMAND IS RECEIVED.

Figure 11. Single Line Timing Diagram Example

INTERFACE SIGNALS	WSC TERMINOLOGY	LOGIC STATES	WSC SOFTWARE ANNOTATION (BINARY VALUE)	WSC & SDU INTERFACE (VOLTAGE)	LOGIC LEVELS	
					WSC	SDU
SDU Alarm SDU Mode 1 SDU Mode 2 SDU Data Ready	D128-b6 D[illegible]-b6 D[illegible]-b2 D[illegible]-b3 D128-b1	Active	"0"	High	F	T
		Inactive	"1"	Low	T	F
SDU Read Mode	D[illegible]-15	Active	"1"	Low	T	T
		Inactive	"0"	High	F	F
SDU Data In SDU Data Out	SOIR SDU Data Out	Not Applicable	Data "1" Data "0"	Low High	Data "1" Data "0"	Data "1" Data "0"

SOFTWARE TO HARDWARE CONVERSION TABLE

INTERFACE SIGNAL	WSC - SDU INTERFACE		
	QUIESCENT STATE	SHIFT BY WSC	SHIFT BY SDU
SDU Data Shift Pulse	3V (High)	3 V to 0 V (High to Low)	0 V to 3 V (Low to High)

Figure 12. Software to Hardware Conversion Table and Data Shift Table Example

	AHC	TOTI	RSR	RDT	RDH	RDA	RDI	RDW	RDC	SCNT	CLIP (LCF)	CLIP (ALCC)	SATCC	MOSI	ENTC	TVI	OSI/OSI-AJ	MTC	MSC	TOTC	PLC (LCF)	PLC (ALCC)	ENC (LCF)	ENC (ALCC)	INC	ELC	CNV	PGLC	TPDC/TPDH	OWC/OWT
Must be encrypted			X	X	X	X	X	X	X		X		(1)														X	X		X
If in clear text, then clear text mode must be established (See 5.5)		X								X			X	X	X	X	X	X	X	X	X		X						X	
If encrypted, then crypto sync must be established (See 5.4.3)	X			X	X	X		X	X	X	X		X		X			X	X	X	X		X		X	X	X	X	X	X
If clear text, then accepted even if crypto sync is established (See 5.4.3).																									X	X				
If ALCC, then must be clear text and ALCC access must be established (See 5.6)												X										X		X	X	X				
Two consecutive radio designated commands must compare. They may be separated by any length of time. Any LCF messages will not affect this rule except the radio designated command will be rejected if ENC/ENTC's or PLC's which pass the address and function code checks are received.																						X		X						

(1) During Strategic Alert PIGA Leveling.

Figure 13. Message Acceptance Criteria Example

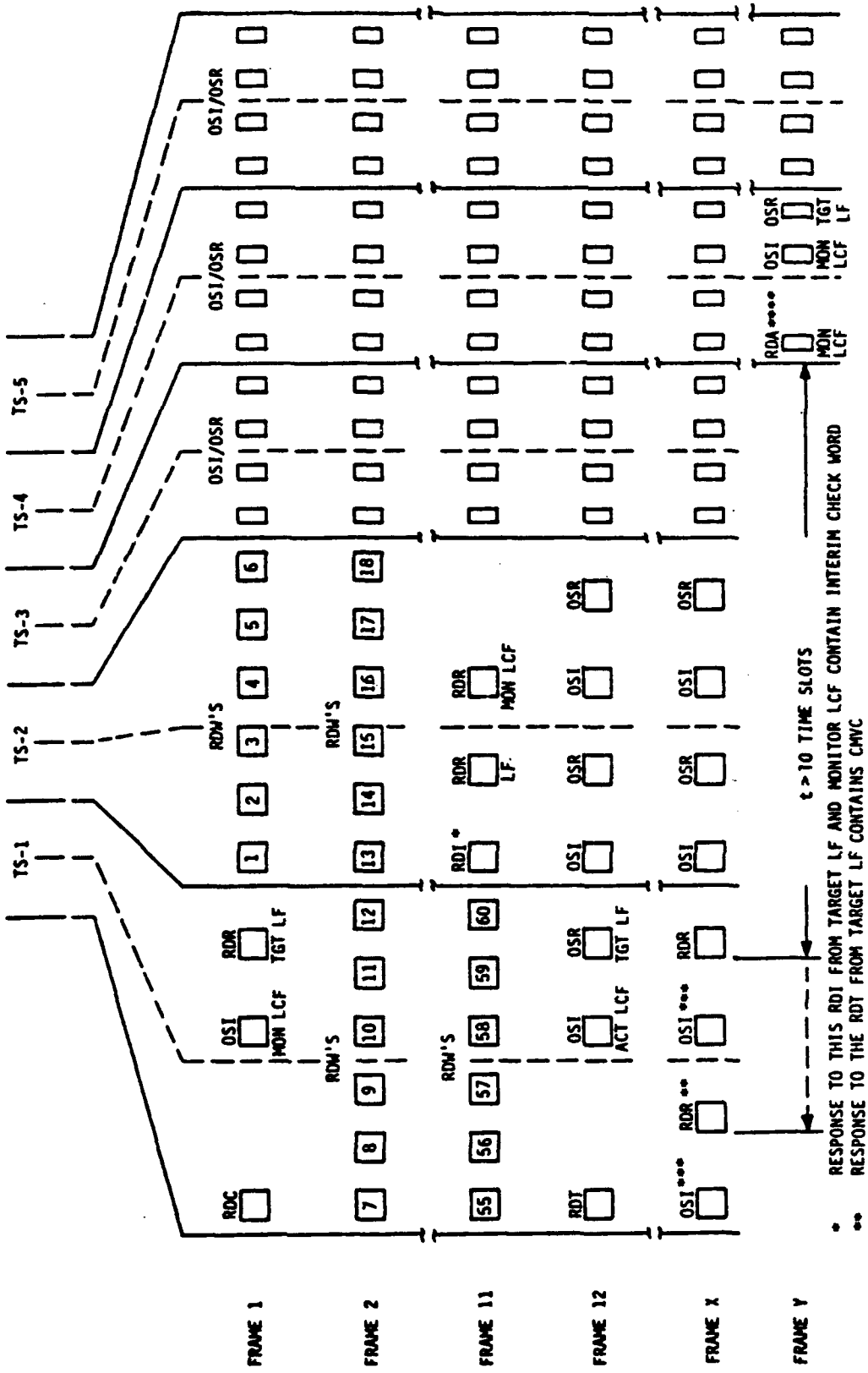
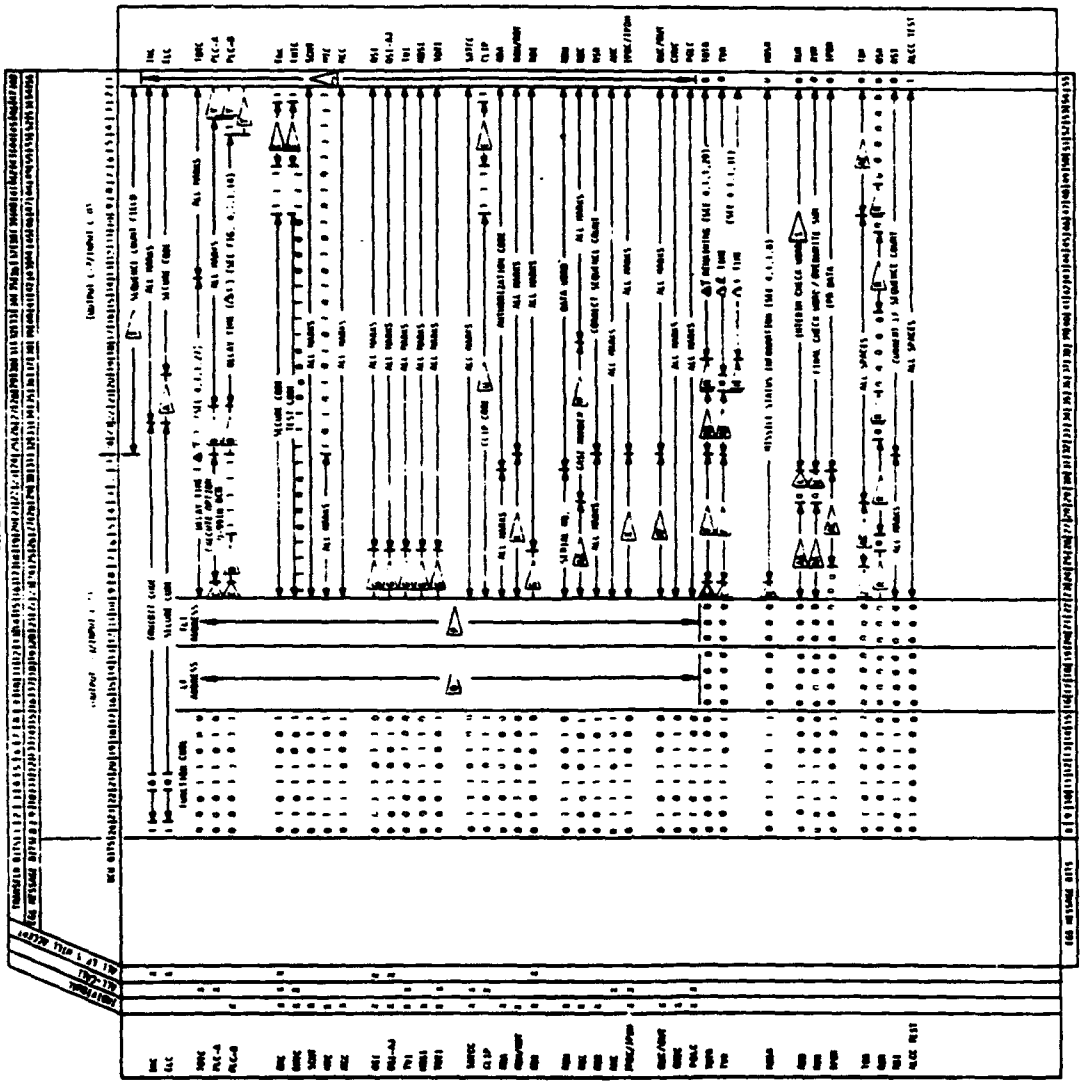


Figure 14. Message Density Example



EXAMPLE NOTE:
Fig. 15-1 & 15-2 would normally be combined into a single foldout page.

Figure 15-1. Data/Message Format Example

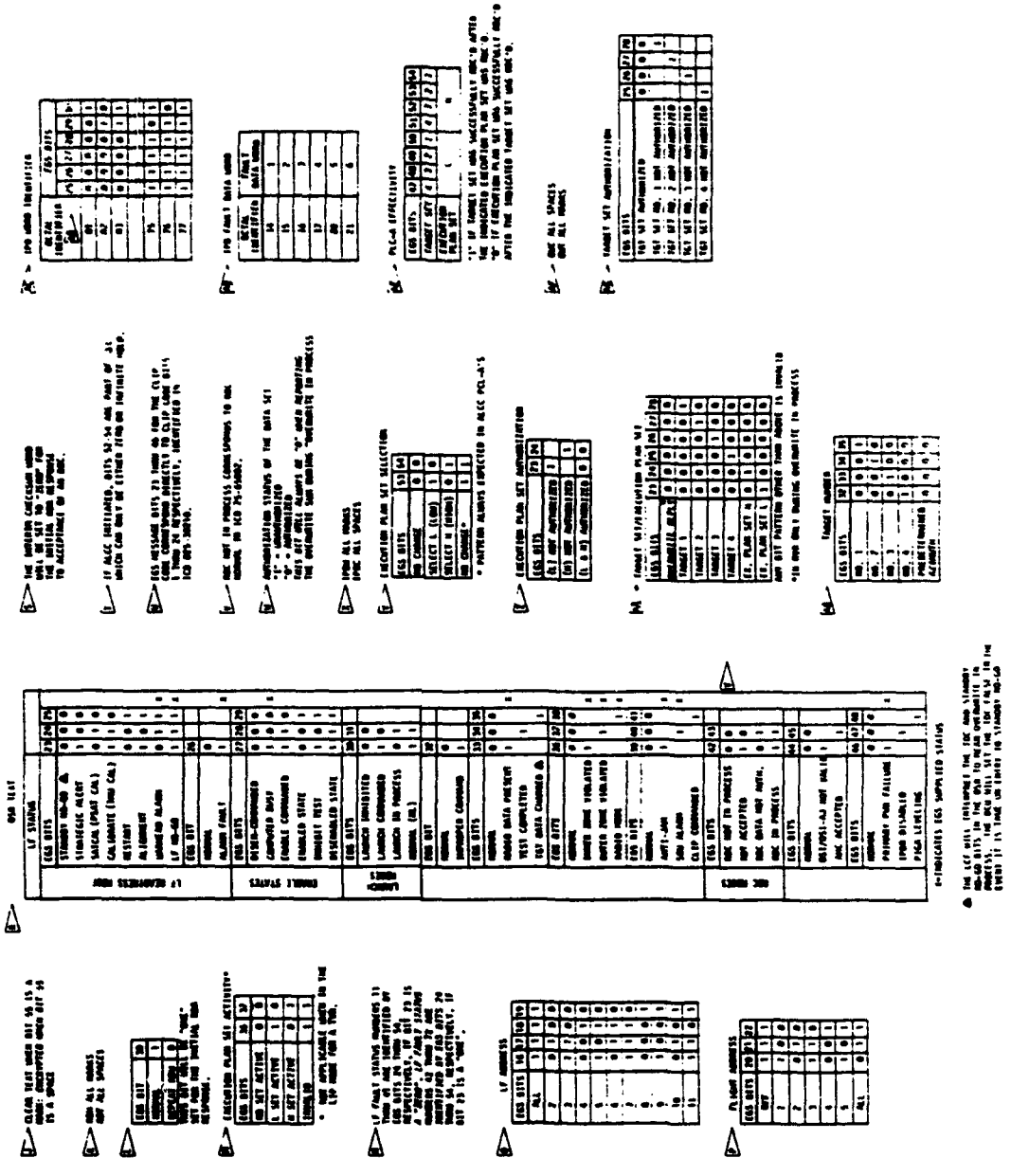


Figure 15-2. Data/Message Format Example

FRAME	CHANNEL 5 4 3 2 1 0	5 4 3 2 1 0	5 4 3 2 1 0
1	0 0 0 1 0 1	31	61 1 0 0 0 0 0
2	0 0 0 0 0 0	32 S_s	62 1 0 0 0 0 0
3	0 1 1 0 1 1	33	63 1 0 0 0 0 0
4		34	64 X X X X X X
5	ZEROS	35 S_f	65 1 0 1 1 0 1
6		36	66 Y Y Y Y Y Y
7		37	67 1 0 0 0 0 0
8		38 C_a	68 0 1 1 1 0 0
9		39	69 0 1 1 1 0 1
10	PENETRATION	40	70
11		41 C_b	71 ZEROS
12	CHANGE	42	72
13		43	73
14	CODE	44 ZEROS	74 ZEROS
15		45	75
16		46	76 MCG
17		47 ZEROS	77 TRANSFER
18		48	78 CHECKSUM
19		49	79 BLOCK
20	ZEROS	50 ZEROS	80 CHECKSUM
21		51	81
22		52 MCG	
23	ZEROS	53 TRANSFER	
24		54 CHECKSUM	
25		55 1 0 0 0 0 0	
26	ZEROS	56 1 0 0 0 0 0	
27		57 1 0 0 0 0 0	
28	MCG	58 0 0 1 1 0 0	
29	TRANSFER	59 0 0 0 0 1 1	
30	CHECKSUM	60 0 0 0 1 1 0	

Note: The tape shall contain a Fill and a Verify Record, each having the format shown.

X = code for Wing

Y = code for Flight

Figure 16. Block and Word Data Transmission Format Example

Appendix C

(Sample Interface Revision)

This appendix contains a sample three page IR comprised of a page one form, continuation page form and replacement page for a book-type ICD. The changes described in the IR pertain to the sample ICD in Appendix A. The methods of describing the changes depict those described in paragraph 5.5.3 of the basic Standard.

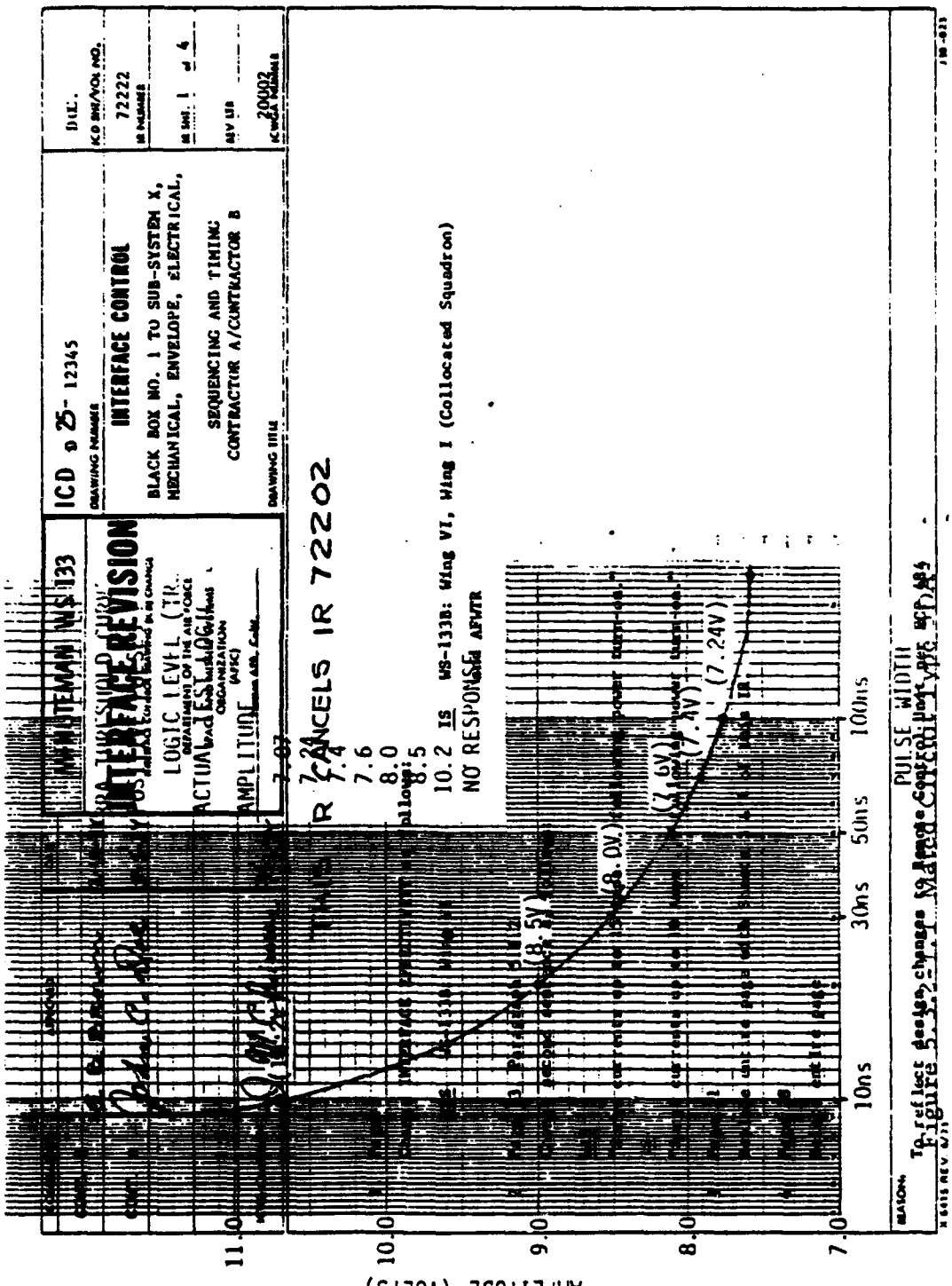


Figure 1. IR Page 1 Sample

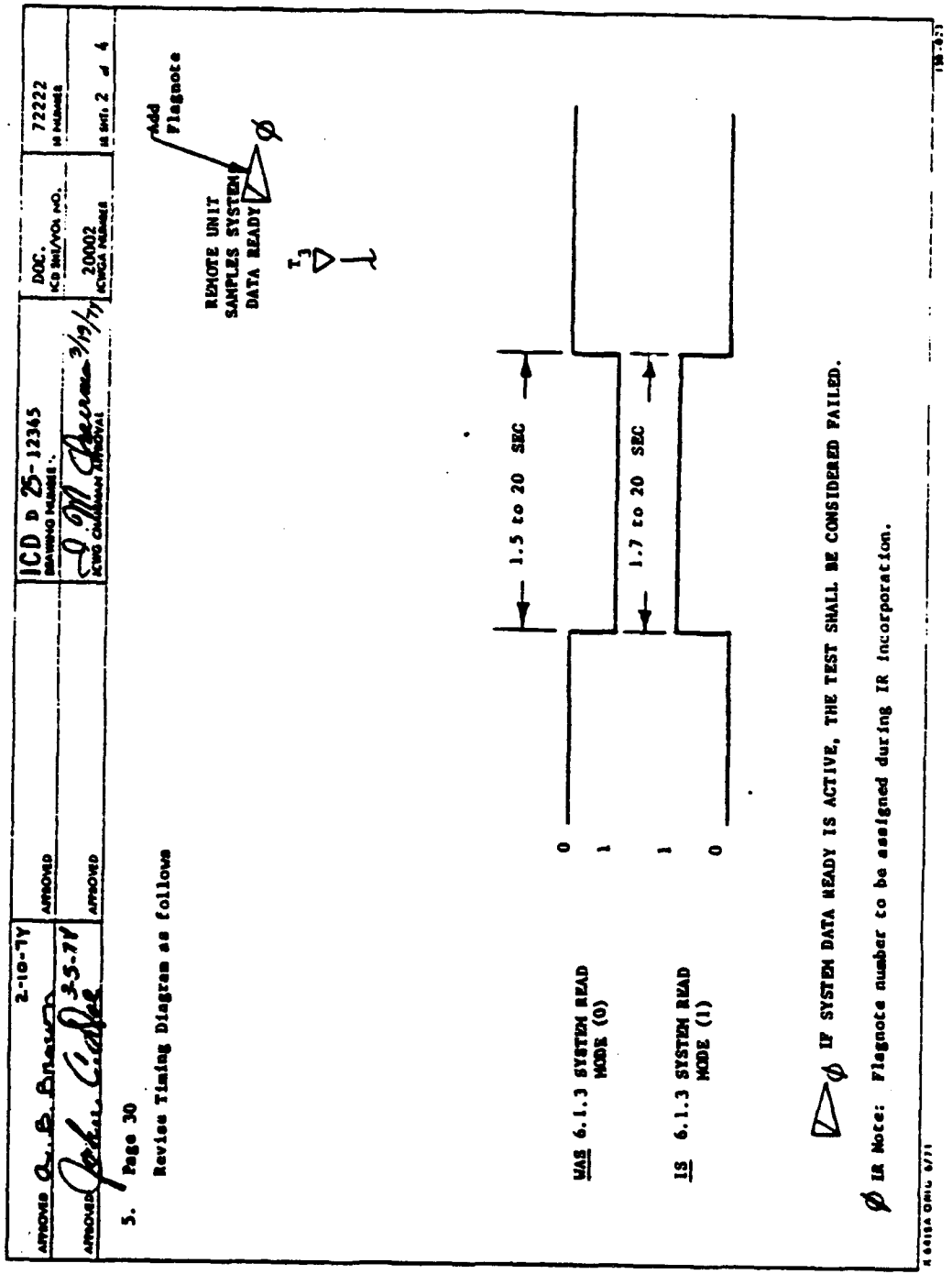


Figure 2. IR Continuation Page Sample

SAMPLE

IR 7222.2
SHEET 4

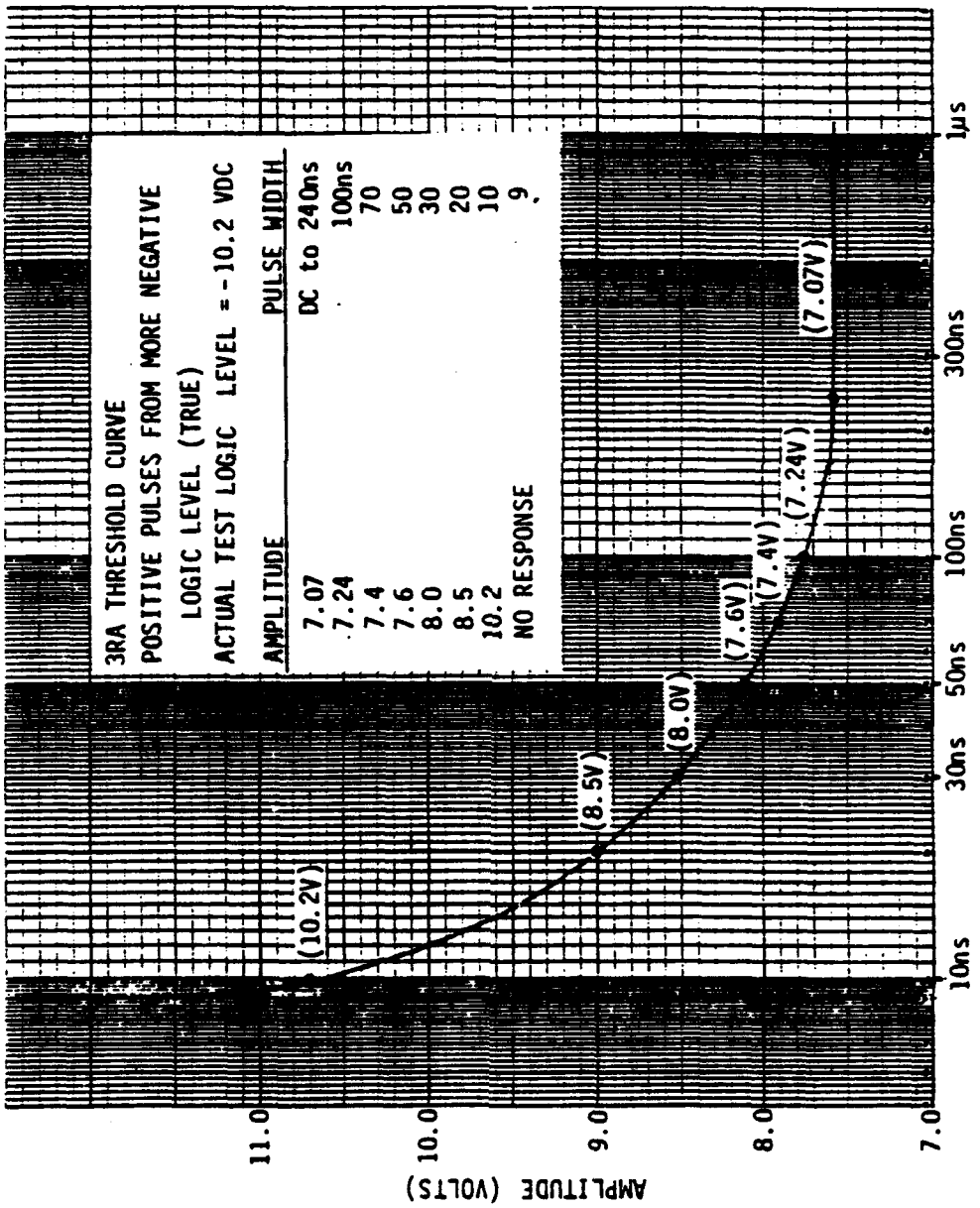


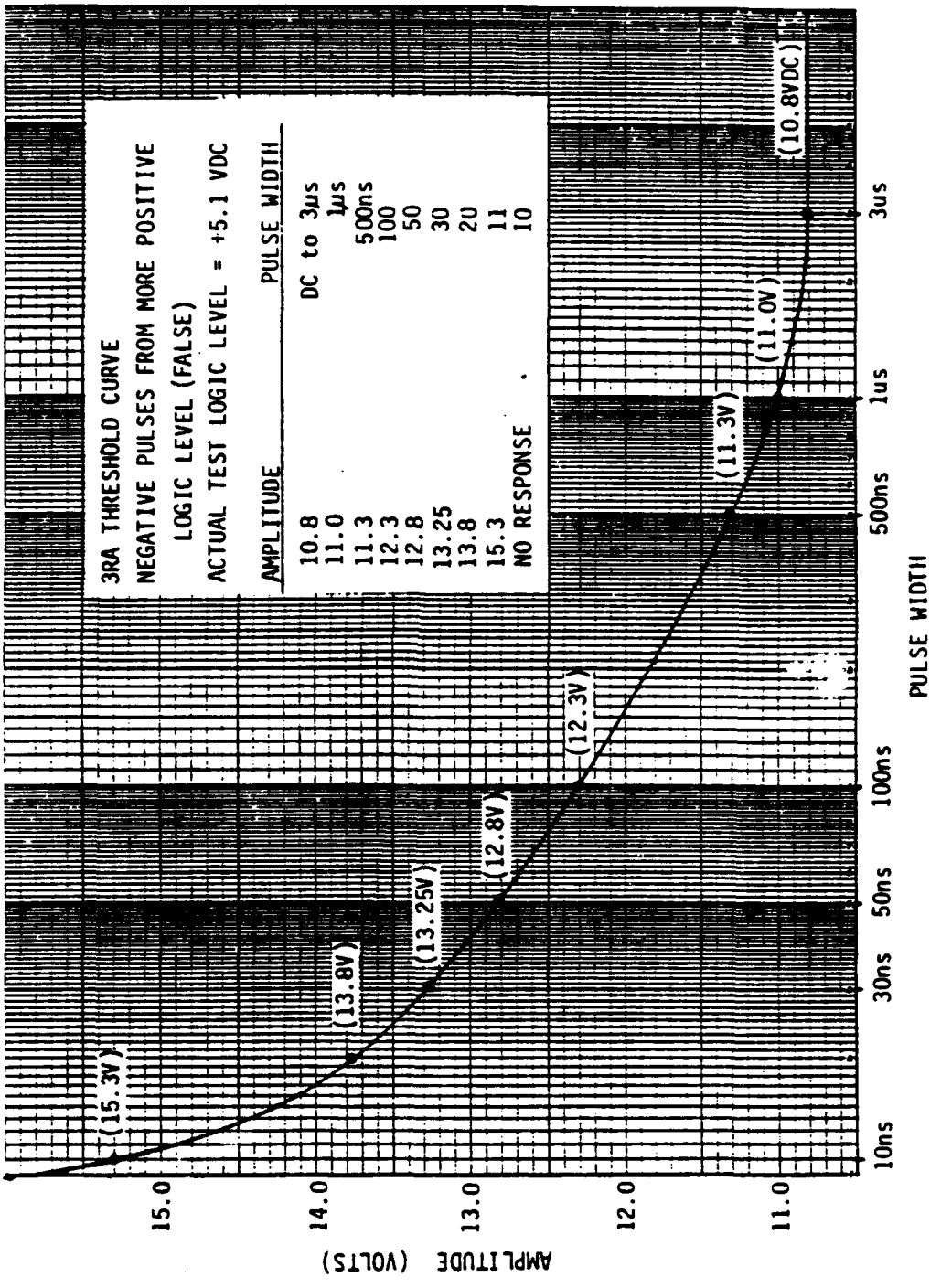
Figure 5.3.2-1.1 Mated Circuit Type 5DA-3RA (Continued)

SAMPLE

SAMPLE

IR 72-2-

ICD D25-12345
Page 21.1
Rev __



SAMPLE

INDEX

INDEX (Continued)

INDEX (Continued)

INDEX (Continued)