MIL-STD-1399 (NAVY) SECTION 702
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1 DECEMBER 1970

MILITARY STANDARD

INTERFACE STANDARD FOR SHIPBOARD SYSTEMS

SECTION 702

SYNCHRO DATA TRANSMISSION

FSC MISC

DEPARTMENT OF THE NAVY

WASHINGTON, D.C. 20360

Interface Standard for Shipboard Systems,
Synchro Data Transmission
MIL-STD-1399(NAVY) SECTION 702

1. This Military Standard is mandatory for use by Commands of the Navy in the technical development plans, design, and procurement specifications for new ship acquisitions and systems/ equipments for installation therein.

2. Recommended corrections, additions, or deletions should be addressed to the Naval Ship Engineering Center, Center Building, Prince George's Center, Hyattsville, Maryland 20782.

FOREWORD

The purpose of this section is to define the standard interface requirements for and constraints on the design of shipboard systems/equipments which will transmit or utilize synchro data.

CONTENTS

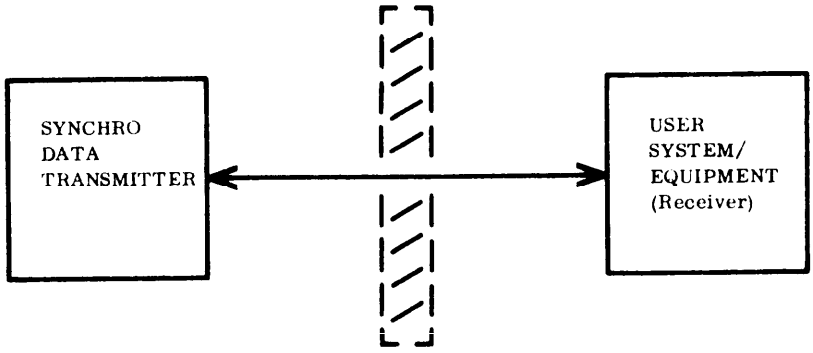
1. GENERAL, SCOPE AND INTERFACE

1.1 General. This section is an integral part of MIL-STD-1399. When the interface between a ship synchro data transmitter and the user system/equipment is under consideration, this section and the standard must be viewed as a single document. The policies and procedures established by MIL-STD-1399 are mandatory.

1.2 Scope. This section establishes interface requirements for shipboard systems/equipments transmitting or utilizing synchro data to ensure compatibility between such systems/equipments.

1.3 Interface. The interface which is the concern of this section is shown symbolically on figure 1 (see paragraph "Definitions" of MIL-STD-1399):

INTERFACE[1/]



CHARACTERISTICS: (of the data transmitted)	Signal function Signal parameters Signal accuracy
CONSTRAINTS: (on transmitting and utilizing equipment)	Impedance Power factor correction Circuit configuration System loading

1/ The interface is between the output terminals of the synchro data transmitter and the input terminals of the user system/equipment (receiver). The associated electrical circuitry internal to the user system/equipment which represents a load on the transmitter is a part of the interface.

Figure 1 - Interface.

2. REFERENCED DOCUMENTS

2.1 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.

GOVERNMENTAL

SPECIFICATION

MILITARY
MIL-D-1000 - Drawings, Engineering and Associated Lists.
MIL-S-20708 - Synchros, General Specification for.

STANDARD

MILITARY
MIL-STD-710 - Synchros, 60 and 400 Cycle.

DRAWING

MILITARY
815-1853311 - Synchro System Loading Tabulation Form

PUBLICATION

NAVAL SHIP ENGINEERING CENTER
DDS 9650-2 - Procedure for Determining Synchro System Load Capacity.

(Copies of specifications, standards, drawings and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. DEFINITIONS

3.1 Synchro data transmitter. A synchro data transmitter is a device which converts angular displacement into a proportional electrical signal.

3.2 User system/equipment. A user system/equipment is a system or equipment which receives an input signal from a synchro data transmitter and uses this input to perform the intended system/equipment functions.

3.3 Synchro data receiver. A synchro data receiver is a device which converts the synchro data signal to a proportional angular displacement or to a proportional analog electrical signal in a form acceptable to the user system/equipment.

3.4 Synchro data transmission system. A synchro data transmission system is a system composed of a transmitter, switches, fuses and other accessories required to transmit a synchro data signal to the synchro data receivers located within the user systems/equipments. Synchro data transmission systems can be categorized into the two following basic systems:

(a) Torque system. A torque system is one in which the synchro data receivers are self-positioning without any servomechanism assist. Torque synchro data receivers are normally used to position pointers, dials, or in other applications in which a low powered mechanical output is required.

(b) Control system. A control system is one in which the synchro data receivers are not self-positioning. They require a servomechanism to provide the required mechanical output. Since control synchro data receivers appear as high impedance loads to the synchro data transmitter, high impedance non-standard synchro data receivers used for the conversion of the synchro data signal to a proportional analog electrical signal are considered to be control synchro data receivers.

3.5 Signal flow diagram. A signal flow diagram, as shown on Drawing 815-1853311, is a diagram which gives the synchro signal distribution for a particular system, and which illustrates the maximum synchro loading condition for that system. It utilizes signal distribution and equipment data as inputs.

3.6 Synchro system load summary. A synchro system load summary is a tabulation, as shown on Drawing 815-1853311, which is designed in a form to facilitate the recording of values necessary to indicate the extent of loading of a particular synchro system.

4. REQUIREMENTS

4.1 The interface requirements and constraints established herein are mandatory (see paragraph "Requirements" of MIL-STD-1399).

5. INTERFACE CHARACTERISTICS AND CONSTRAINTS

5.1 Synchro data transmission systems - general considerations. The number of discrete synchro data transmission systems installed on any particular ship will vary with the input requirements of the user systems/equipment. The configuration of synchro data transmission systems may vary from a simple system, consisting of a transmitter and a receiver, to an extremely complex system consisting of a transmitter and multiple receivers. The complexity of the synchro data transmission systems installed will be directly related to the ships mission as determined by ships characteristics. Consequently, ships requiring sophisticated electronic and weapons installations for mission accomplishment will reflect the maximum need for synchro data transmission. Since the quantity and the electrical characteristics

of synchro data receivers vary through a wide range, it is necessary to analyze each system individually to determine the capability of the system, as shown on the signal flow diagram, to function within predetermined limits of accuracy. This analysis is accomplished and documented by completing a synchro system load summary for each installed synchro data transmission system.

5.2 Interface characteristics. The interface characteristics of shipboard synchro data transmission systems are given below. Each such system will contain a synchro data signal with the applicable characteristics of 5.2.1 through 5.2.4 at various system/equipment interfaces.

5.2.1 Signal function. The standard synchro data signal contains the following functional information:

(a) Signal function description - defines the system use of the transmitted signal, expressed as own ship heading, own ship speed, target range, etc.
(b) Signal function quantity - relates the transmitted signal to the proportional angular displacement, expressed in degrees/revolution, knots/revolution, yards/revolution, etc.

The signal functions of the various standard synchro systems currently in use onboard U.S. Navy ships are given in the Appendix.

5.2.2 System parameters. System parameters are as follows:

(a) Voltage. All synchro data transmission systems shall be designed to operate at 115 volts alternating current (a.c.).
(b) Frequency. All synchro data transmission systems shall be either 60 Hertz (Hz) or 400 Hz.

5.2.3 System/equipment accuracy requirements. The required accuracy of the input synchro data signal to allow the user system/equipment to operate within its designed limits shall be defined on both the category B and category G drawings. For synchro data signal generating systems/equipment the design accuracy of the output signal shall be defined on both the category B and category G drawings. These signal accuracies shall be delineated in minutes of arc for both static and dynamic operations.

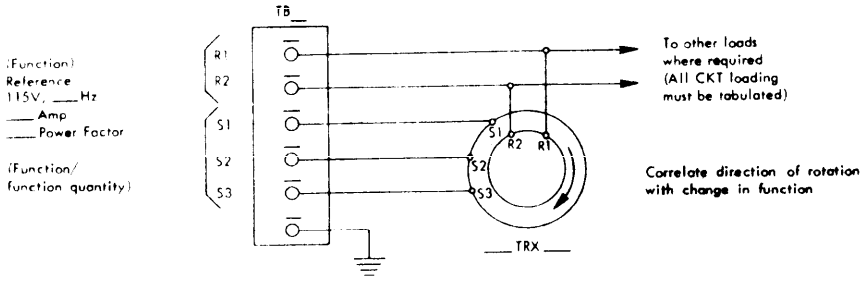
5.2.4 Component/interface identification. The total electrical distribution of the interfacing synchro data signal internal to the generating or user system/equipment shall be delineated on category B and category G drawings. All components shall be identified by their military designation. Resistors, capacitors, inductors, and semiconductors shall be identified also by their electrical values. When non-standard components are used, the electrical characteristics of the non-standard component shall be included on the drawing. Figure 2, details A, B, and C, illustrates typical methods of interface presentation.

5.3 Interface constraints. The interface characteristics of shipboard synchro data transmission systems impose certain constraints on the configuration of each system/equipment involved. These constraints are necessary to insure compatibility between systems/equipment when they are interconnected.

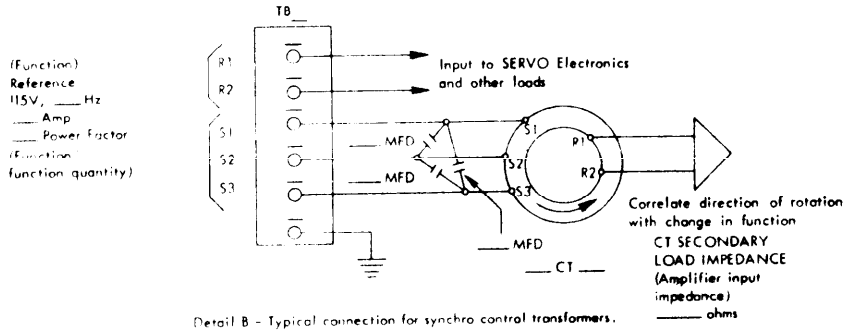
5.3.1 Component selection. Synchro data transmitters and synchro data receivers shall be selected from components listed in MIL-STD-710 which comply with MIL-S-20708 unless specific deviation approval is granted. When non-standard data transmitters, data receivers or other devices are selected for use in synchro data systems, they shall be electrically compatible with the synchro signal characteristics specified in MIL-S-20708. The characteristics of non-standard components shall be defined in the same form and categories as used by MIL-S-20708.

5.3.2 Load impedance. When control transformers built in accordance with MIL-S-20708 are used in equipment design, the impedance of the load impressed on the secondary of the control transformers shall be a minimum of 30,000 ohms. When electrically compatible non-standard components are selected in lieu of MIL-S-20708 control transformers, the load impedance reflected by an interface containing such a component shall be a minimum of 50,000 ohms. Load impedance shall be delineated on category B and G drawings.

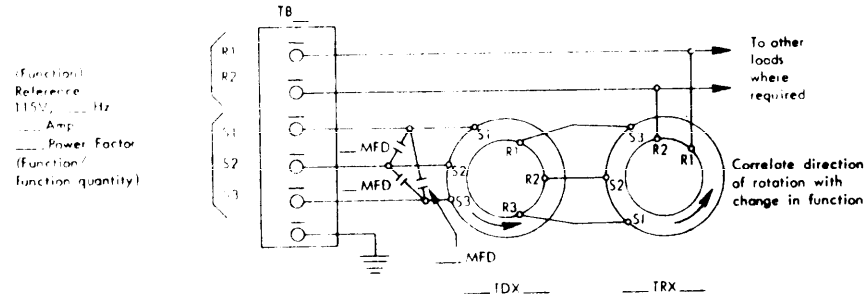
Typical Synchro Circuit Connections



Detail A - Typical connection for synchro Transmitters and torque receivers.



Detail B - Typical connection for synchro control transformers.



Detail C - Typical connections for synchro circuits containing synchro differential units.

NOTE: The degree of detail shown in the above examples is the minimum data required by the system designer. Synchro rotations and wiring terminations indicated are illustrative examples only. Precise synchro rotation, wiring terminations, and the other information shown in the examples must be furnished. The above details can be mixed to suit various synchro configurations and the concept can be applied to any servo mechanism.

Figure 2 - Typical Synchro Circuit Connections

5.3.3 Power factor correction. All control transformers (CT's) and differential transmitters (CDX's and TDX's) shall be compensated by power factor correction capacitors. Each synchro capacitor shall be mounted as close as possible to the control transformer or differential transmitter with which it is used. Switching shall not be permitted to isolate a synchro data receiver from its associated power factor correcting capacitors. The values of such capacitors shall be calculated in accordance with Design Data Sheet, DDS 9650-2.

5.3.4 Component alignment requirements. All alignment requirements unique to the system/equipment shall be defined on category G drawings. Recommended alignment tolerances necessary to achieve the specific system/equipment accuracy shall be included on category G drawings.

5.3.5 Standard connections. Synchro transmitters and receivers shall be installed with synchro terminals R1, R2, S1, S2, S3 connected in consecutive order to adjacent terminals in a single row on one equipment terminal board (see figure 2). Terminal boards and terminals shall be numerically identified with signal function and signal parameter data also identified adjacent to the respective terminal on the category B and G drawings and in the equipment. The direction of rotation and a precise correlation of the direction of rotation with respect to the function shall be indicated on category B and G drawings.

5.3.6 Circuit configuration. Sixty Hz components shall not be installed in 400 Hz synchro data distribution systems or vice versa unless such units are specifically designed to operate effectively at either frequency. Torque synchro data receivers shall never be installed in control synchro systems. Transmitter reference power shall be common throughout each particular system. Internal uses of the reference power supplied as a part of the interfacing synchro data signal shall be limited to associated torque synchro receiver reference, indicator lights, control relays and servomechanism control excitation. The synchro reference power shall be electrically independent and isolated from the user system/equipment main power circuits and non-associated signal function circuits. In all cases the resultant power requirements imposed on the synchro data signal reference power by the user systems/equipment shall be restricted to an absolute minimum.

5.3.7 System design and loading. Each shipboard synchro data transmission system shall be designed for interface compatibility with the characteristics given in 5.2 and shall be within the allowable tolerances specified in Design Data Sheet, DDS 9650-2. System loading calculations shall be tabulated for each system using Drawing 815-1853311 as a guide.

5.3.7.1 Should the calculations reveal that the allowable tolerances at any interface are exceeded, alternate methods of supporting the required signal distribution, such as component substitution, load relocation, synchro signal amplifier installation, etc., shall be thoroughly investigated. A proposed method of eliminating the out-of-tolerance conditions shall be submitted in accordance with section 7.

6. DOCUMENTATION REQUIREMENTS

6.1 DD form 1423. The documentation listed in 6.1.1 and 6.1.2 shall be specified by the PDA on DD Form 1423 - Contract Data Requirements List. The Naval Ship Engineering Center, Interior Communication and Navigation System Design Section, shall be included in the distribution listed in block 14 of DD Form 1423 for all category B and G drawings displaying synchro data and for all load summaries.

6.1.1 Drawings, category B and G. Category B and G drawings in accordance with MIL-D-1000 shall indicate the following data:

(a) System/equipment accuracy (see 5.2.3).
(b) Component/interface identification (see 5.2.4).
(c) Load impedance (see 5.3.2).
(d) Component alignment - Category G only (see 5.3.4).

6.1.2 Load summary. Synchro system load summaries for all separate synchro systems shall be developed using Drawing 815-1853311, as a guide (see 5.3.7).

7. DEVIATIONS

7.1 Conditions. In achieving the purpose of this section it is recognized that there must be some flexibility of application. During the early design stage of onboard synchro data transmission systems/equipment it may become apparent that significant advantages in the overall design/operation of such systems/equipment can be achieved by deviating from the standard characteristics specified herein. In such instance, the provisions of the "Deviations" paragraph of MIL-STD-1399 shall apply.

7.2 Deviation procedure. When invoking deviations to this section, reports shall be made in accordance with 8.1.

8. REPORTS AND CORRESPONDENCE

8.1 Reports, correspondence and similar information shall be submitted by the procuring activity to NAVSHIPS for action with copies to:

(a) NAVSEC 6170
(b) Program manager

Review activities:
AS, OS, EC

Preparing activity:
Navy - SH
(Project Misc-N694-9)

DRES | COTTER PINS CONTACTING CORROSION RESISTANT STEEL | | | | | CORROSION RESISTANT | AMBIENT TEMPERAT

APPENDIX

STANDARD SYNCHRO FUNCTIONS

10. Standard synchro functions.

10.1 This appendix lists standard synchro systems functions currently in use onboard U.S. Navy ships. In addition to the synchro functions, system frequency and function quantity are also provided. All system voltages are 115 volts a.c.

Synchro function	System frequency	Function quantity	See note
Own ship heading	400	360°/rev	--
	400	10°/rev	--
	60	360°/rev	--
	60	10°/rev	--
Roll	400	180°/rev	--
	400	10°/rev	--
	60	180°/rev	1
	60	10°/rev	1
Pitch	400	180°/rev	--
	400	10°/rev	--
	60	180°/rev	1
	60	10°/rev	1
Own ship speed	400	100 knots/rev	--
	400	40 knots/rev	2
	400	10 knots/rev	--
	60	100 knots/rev	2
	60	40 knots/rev	--
Latitude	400	360°/rev	--
	400	10°/rev	--
	400	1°/rev	2
Longitude	400	360°/rev	--
	400	10°/rev	--
	400	1°/rev	2
Keel depth	400	6480'/rev	3
	400	180'/rev	3
Shaft revolution (varies with ship type)	60	200 rpm/rev	--
	60	400 rpm/rev	1
Rudder angle	60	90°/rev	--
Plane angle	60	180°/rev	3
Engine order/motor order	60	360°/rev	--
Propeller pitch angle	60	40°/rev	2
Own ship distance	60	360°/nautical mile	--
Own ship speed component (E-W & N-S)	400	100 knots/rev	--
	400	10 knots/rev	--
Wind speed (apparent)	400	100 knots/rev	1
	60	100 knots/rev	1
Wind speed (raw)	400	1.9 rev/knot	1
Wind direction	400	360°/rev	1
	60	360°/rev	1

Synchro function	System frequency	Function quantity	See note
Bearing	400	360°/rev	--
	400	10°/rev	--
	60	360°/rev	1
	60	10°/rev	1
Range	400	1296 Kyds/rev	--
	400	72 Kyds/rev	--
	400	2 Kyds/rev	--
	60	1296 Kyds/rev	1
	60	72 Kyds/rev	1
	60	2 Kyds/rev	1
Depression angle	400	360°/rev	--
		10°/rev	--
Elevation angle	400	360°/rev	1
		10°/rev	1

NOTES:
1. Not available onboard submarines.
2. Available only for specific applications.
3. Not available onboard surface ships.

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

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(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
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b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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