FIPS PUB 61

FEDERAL INFORMATION
PROCESSING STANDARDS PUBLICATION

1979 February 16

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

CHANNEL LEVEL POWER CONTROL INTERFACE

CATEGORY: HARDWARE STANDARD
SUBCATEGORY: INTERFACE

U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, *Secretary*
Luther H. Hodges, Jr., *Under Secretary*
Jordan J. Baruch, *Assistant Secretary* for Science and Technology
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

Foreword

Federal Information Processing Standards Publications of the National Bureau of Standards are adopted and promulgated under the provisions of Public Law 89-306, and Part 6 of Title 15 Code of Federal Regulations. The standards are required for implementation by Federal agencies in the acquisition, development and use of automated information systems and in the interchange of data between and among agencies and with the public. The use of such standards which are adopted after extensive review by Federal agencies, industry and the public is intended to reduce Government Costs and improve the effectiveness of Government Services.

Comments concerning Federal Information Processing Standards Publications are welcomed, and should be addressed to the Director, Institute for Computer Sciences and Technology, National Bureau of Standards, Washington, D.C. 20234.

Ernest Ambler, *Director*

Abstract

This standard defines the functional, electrical, and mechanical interface specifications for a power control interface for use in connecting computer peripheral equipment as a part of automatic data processing (ADP) systems. This standard, together with a companion standard for I/O Channel Interface, defines the hardware characteristics for the I/O channel level interface.

The Government's intent in employing this Channel Level Power Control Interface standard is to reduce the cost of satisfying the Government's data processing requirements through increasing its available alternative sources of supply for computer system components at the time of initial system acquisition, as well as in system replacement and augmentation and in system component replacement. This standard is also expected to lead to improved reutilization of system components.

When acquiring ADP systems and system components, Federal agencies shall cite this standard in specifying the power control interface for connecting computer peripheral equipment as a part of ADP systems.

Key Words: Automatic data processing (ADP); Channel level power control interface; Computer peripherals; Computers; Federal Information Processing Standard; Input/Output; Interfaces.

Nat. Bur. Stand. (U.S.) Fed. Info Process. Stand. Publ. (FIPS PUB) 61, 17 pages.

(1980)

CODEN:FIPPAT

For sale by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.

Federal Information
Processing Standards Publication 61

1979 February 16

ANNOUNCING THE STANDARD FOR

CHANNEL LEVEL POWER CONTROL INTERFACE

Federal Information Processing Standards Publications are issued by the National Bureau of Standards pursuant to the Federal Property and Administration Services Act of 1949, as amended, Public Law 89-306 (79 Stat. 1127), Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 Code of Federal Regulations (CFR).

Name of Standard. Channel Level Power Control Interface (FIPS PUB 61).

Category of Standard. Hardware Standard, Interface.

Explanation. This standard defines the functional, electrical, and mechanical interface specifications for a power control interface for use in connecting computer peripheral equipment as a part of automatic data processing (ADP) systems. This standard, together with a companion standard for I/O Channel Interface, defines the hardware characteristics for the I/O channel level interface.

The Government's intent in employing this Channel Level Power Control Interface standard is to reduce the cost of satisfying the Government's data processing requirements through increasing its available alternative sources of supply for computer system components at the time of initial system acquisition, as well as in system replacement and augmentation and in system component replacement. This standard is also expected to lead to improved reutilization of system components.

When acquiring ADP systems and system components, Federal agencies shall cite this standard in specifying the power control interface for connecting computer peripheral equipment as a part of ADP systems.

Approving Authority. Secretary of Commerce.

Maintenance Agency. Department of Commerce, National Bureau of Standards (Institute for Computer Sciences and Technology).

Cross Index. American National Standards Institute document X3T9/666, Rev. 2, Draft Proposed American National Standard Specifications for Power Control Interface.

Applicability. This standard is applicable whenever use of Federal Information Processing Standard I/O Channel Interface (NBS-FIPS-PUB-60) is required.

Verification of the correct operation of all interfaces that are required to conform to this standard shall, through demonstration of other means acceptable to the Government, be provided prior to the acceptance of all applicable ADP equipment.

Specifications. This standard incorporates by reference the technical specifications of ANSI document number X3T9/666, Rev. 2. Copies of the technical specifications section of the standard will be available from the National Technical Information Service as described in the *Where to Obtain Copies* section below.

Implementation. The provisions of this standard are effective June 23, 1980. All applicable equipment ordered on or after the effective date, or procurement actions for which solicitation documents have not been issued by that date, must conform to the provisions of this standard unless a waiver has been granted in accordance with the procedure described elsewhere in this standard.

Regulations concerning the specific use of this standard in the Federal procurement will be issued by the General Services Administration to be a part of the Federal Property Management Regulations.

This standard shall be reviewed by NBS within three years after its effective date, taking into account technological trends and other factors, to determine whether the standard should be reaffirmed, revised or withdrawn.

Waivers. Heads of agencies desiring a waiver from the requirements stated in this standard so as to acquire ADP equipment that does not conform to this standard, shall submit a request for such a waiver to the Secretary of Commerce for review and approval. Approval will be granted if, in the judgment of the Secretary based on all available information, including that provided in the waiver request, a major adverse economic or operational impact would occur through conformance with this standard.

A request for waiver shall include: (1) a description of the existing or planned ADP system for which the waiver is being requested, (2) a description of the system configuration, identifying those items for which the waiver is being requested, and including a description of planned expansion of the system configuration at any time during its life cycle, and (3) a justification for the waiver, including a description and discussion of the major adverse economic or operational impact that would result through conformance to this standard as compared to the alternative for which the waiver is requested.

The request for waiver shall be submitted to the Secretary of Commerce, Washington, D.C. 20230, and labeled as a Request for Waiver to a Federal Information Processing Standard. Waiver requests will normally be processed within 45 days of receipt by the Secretary. No action shall be taken to issue solicitation documents or to order equipment for which this standard is applicable and which does not conform to this standard prior to receipt of a waiver approval response from the Secretary.

Where to Obtain Copies. Either paper or microfiche copies of this Federal Information Processing Standard, including the technical specifications, may be purchased from the National Technical Information Service (NTIS) by ordering Federal Information Processing Standard Publication 61 (NBS-FIPS-PUB-61), Channel Level Power Control Interface. Ordering information, including prices and delivery alternatives, may be obtained by contacting the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, Virginia 22161, Telephone: (703) 557-4650.

TECHNICAL SPECIFICATIONS

FOR

CHANNEL LEVEL POWER CONTROL INTERFACE

X3T9/666 Rev. 2
1976 August 18

Draft Proposed

AMERICAN NATIONAL STANDARD SPECIFICATIONS FOR POWER CONTROL INTERFACE

ABSTRACT

The functional and mechanical specifications are defined for a Power Control Interface which provides a sequential and interlocked means of controlling the power supplied by a computer system power control circuit to attached control units, I/O devices, channel frames, or free-standing storage frames (operating in a REMOTE status) without affecting the power on the rest of the system. By stepping the power (on or off) in discrete system components, the overall power requirements and power surge noise generation are decreased.

Several levels of power may exist, depending on the system configuration. Each (Central Processing Unit) sequentially provides power, via the Power Control Interface, to each stand-alone frame attached to the CPU. Each stand-alone frame (directly attached to the CPU) having units attached (i.e., a channel with a control unit) sequentially controls the power to each attached unit by means of the Power Control Interface.

The Power Control Interface permits the removal of any frame from the system without affecting the power on the rest of the system unless that frame is controlling other frames not shared with other control units. It also provides System Emergency Power Off capability.

FOREWORD

(This Foreword is not a part of the Standard, Specifications for Power Control Interface.)

This Standard provides the specifications for the functional and mechanical characteristics of a Power Control Interface for a general purpose computer system. The Power Control Interface provides a means of controlling the power supplied by a computer system power control circuit to attached frames (operating in a remote status) without affecting the power on the rest of the system. These attached frames include control units, I/O devices, channel frames, or free-standing storage frames.

The Interface provides power-on, power-off, and emergency-power-off control to discrete systems in steps, thereby decreasing the overall power requirements and the power surge noise generation.

The design of this interface includes the following features:

1. Several levels of power depending on the system configuration.
2. Sequential power control from each Central Processing Unit (CPU) to each stand-alone frame attached to that CPU.
3. Sequential power control from each stand-alone frame (directly attached to the CPU) to each unit attached to it.
4. Provides System Emergency Power Off (EPO) capability.

Included in the Standard is a description of the interconnections of all lines, the functional descriptions of each of these lines, and the sequence of signals on the lines for power control of connected units for both LOCAL and REMOTE operation. Implementation of the Power Control Interface also permits the removal of any control unit, I/O device, channel frame, or free-standing storage frame from the system without affecting the power on the rest of the system unless the unit removed controls other frames not shared with other control units.

The Mechanical Specification of the Interface is defined in chapter 3 of the Standard. The mechanical specification describes two system and multi-system interconnection with interlocking of the EPO circuits.

Subcommittee X3T9 on I/O Interface, which developed this Standard, had the following members:

D.L. Shoemaker, Chairman

D.L. Anderson
J.M. Bakshi
R. Bender
J. Biddle
W.H. Bridge
G.E. Clark
R. Derby
R.E. Douglas
J.R. Easling
T.E. Gardner
J.W. Greenleaf
R.L. Hendrickson
H. Kirby
D.E. Knoblock
C. Klueber
P. Lannan
D.H. Lee
M.H. Lohrenz
D.C. Loughry
H.T. Meyer
W.J. McClain
D.L. Nelson
K.S. Oakes
R. Patel
J. Rapoza
N.J. Ream
K. Spiro
H.W. Swanson
W. Topercer
G.E. Williams
R.A. Whitcomb

Table of Contents

CHAPTER 1.

Introduction

1.1 Scope. This document provides the description of a Power Control Interface which will enable manufacturers to design equipment which is compatible in its power sequencing and controls. Included in this document are definitions and descriptions of the power control interface lines in addition to emergency power off operations.

CHAPTER 2.

Functional Specification

2.1 Power Control Interface General Description. The Power Control Interface provides a sequential and interlocked means for systems powering. Stepping power in discrete systems components (sections) decreases overall power requirements and lessens power surge noise generation. All systems operating in remote control status have their powering controlled by the system power control circuit.

Several levels of power may exist, depending on the system configuration. Each central processing unit (CPU) sequentially provides power, via the power control interface, to each stand-alone frame attached to that CPU. Each stand-alone frame (directly attached to the CPU) which has units attached (a channel with a control unit), requires controls to sequentially power each such attached unit by means of the power control interface. (See figure 1 for multiple applications of the power control interface.)

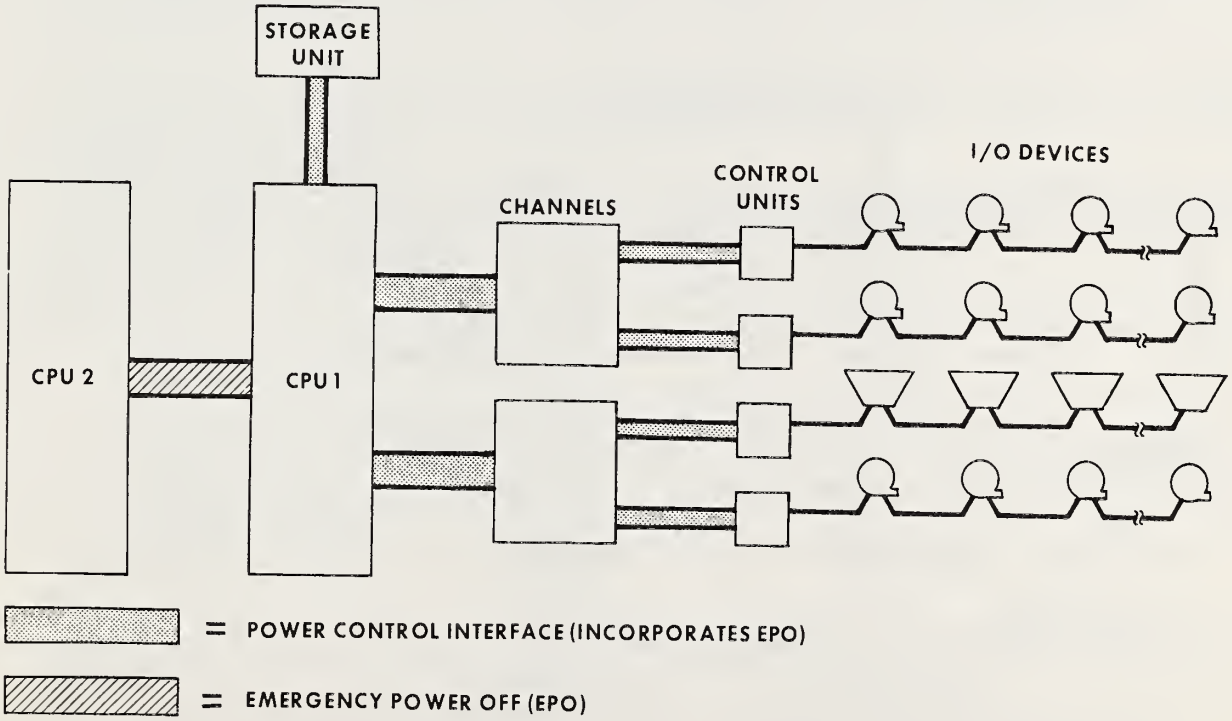

FIGURE 1. Power control interface-system application

For purposes of discussion in this publication, the controlling element will be referred to as the *system* and the controlled element as the *unit.*

2.2 Interface Line Descriptions. The power control interface lines are shown in figure 2.

These lines are assigned as follows:

Power Connector Block Pin Number	Line Name	Line Abbreviation
1	Unit Source	Unit Source
2	*EPO Control	EPO Ctrl
3	System Source	Sys Source
4	Powering Complete	Pwr Compl
5	Power Hold	Pwr Hold
6	Power Pick	Pwr Pick

* EPO = Emergency Power Off

The time relationships of the signals on these lines are shown in figure 3.

2.2.1 Unit Source. The 'unit source' line provides a power source from the unit being sequenced on. The power source supplies the power required by the unit for the 'EPO control,' 'power pick,' and 'power hold' functions. This 'unit source' line should not be loaded by the system.

The maximum allowable current drawn through the 'unit source' line is 500 milliamperes at 24 volts. The minimum allowable current drawn while energizing a coil or coils is 30 milliamperes.

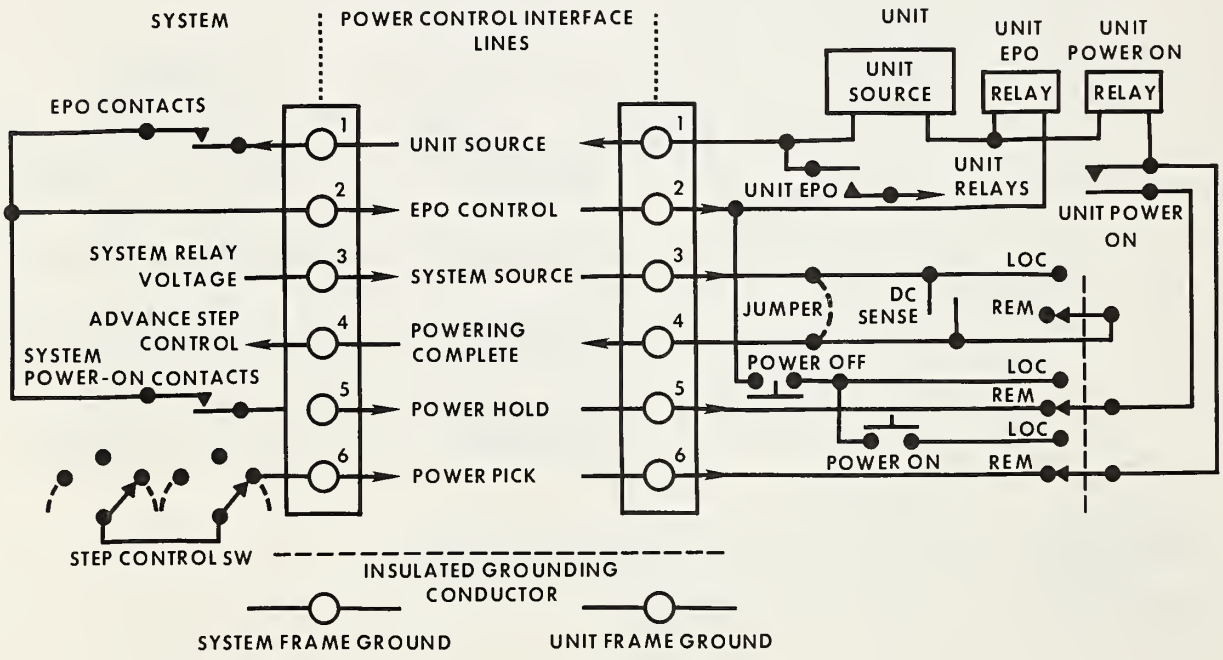

FIGURE 2. Typical power control

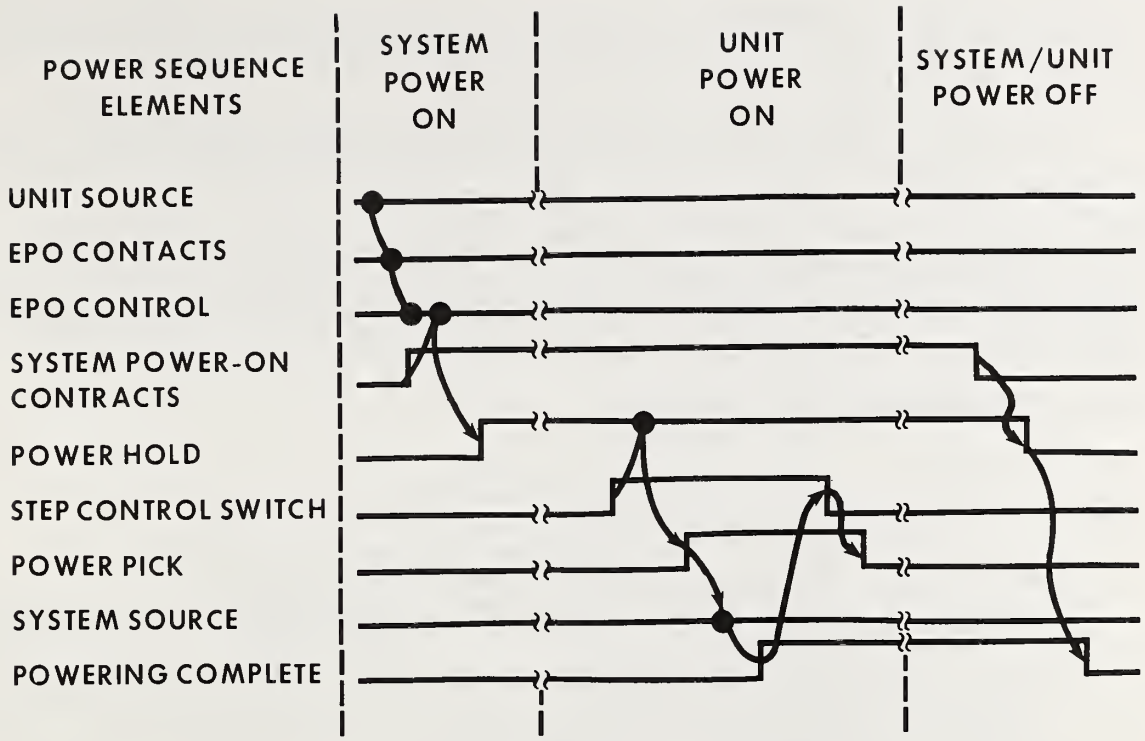

FIGURE 3. Typical power sequencing conditions

2.2.2 Emergency Power Off Control. The 'emergency power off (EPO) control' line is connected to the 'unit source' line when the EPO relay contacts are closed. In the event of an EPO condition, this line opens.

2.2.3 System Source. The 'system source' line provides a power source from the system controlling the sequencing. This source supplies the power to advance the system step control circuit. This source should not be loaded by the unit.

The maximum allowable current drawn through the 'system source' line is 500 milliamperes at 24 volts. The minimum allowable current drawn while energizing a coil or coils is 30 milliamperes.

2.2.4 Powering Complete. The 'powering complete' line is connected to the 'system source' line when one of three conditions exist:

1. Local/remote switch is set to LOCAL.
2. Local/remote switch is set to REMOTE and the unit-power sequence is complete. This connection need be maintained only as long as the 'power pick' line is energized. (See section 2.2.6 "Power Pick.")
3. Power for the unit is not controlled by the system and a jumper is placed between the two lines.

2.2.5 Power Hold. The 'power hold' line is connected to the 'unit source' line when the system has power on. 'Power hold' causes unit power to remain on (after once being turned on) until either:

1. System power is dropped with the unit local remote switch set to REMOTE, or
2. Unit power is locally turned off by the unit power off switch. (Refer to section 2.3.2 "Power Off.")

2.2.6 Power Pick. The 'power pick' line is connected to the 'power hold' line when the step control switch closes the contacts for the unit to be powered. It is shorted, in this manner, until the step control senses a signal on the 'powering complete' line.

'Power pick' initiates the power-on sequence in the unit (providing the unit is in remote status). The maximum allowable current drawn through the 'power pick' line is 500 milliamperes at 24 volts.

A possible implementation would be for 'power pick' to be connected to the unit-power-on relay coil. Energizing this relay with 'power pick' causes one of its contact sets to short power hold to the coil, thus keeping the relay energized after 'power pick' drops and as long as 'power hold' remains energized. (See figure 2).

2.3 Normal Power Sequencing Conditions

2.3.1 Power On.

Refer to figure 2 for the following:

1. With the EPO switch reset, the system power-on switch is closed.
2. 'System source' voltage is sent to all units. (Or, it may already be on before the system power-on switch is closed.)
3. 'Unit source' voltage is sent from each unit and is returned to each unit (after passing through the EPO relay and power on/off switch contacts for that unit) as the 'EPO control' and 'power hole' lines.
4. The step control switch advances to the first position.
5. A path from 'power hold' to 'power pick' is completed for the unit connected to the first step position.
6. If the unit local/remote switch is set to LOCAL, no unit power-on sequence takes place due to making 'power pick' active. Instead, the path from 'system source' to 'powering complete' is completed through the local/remote switch.

   If the local/remote switch on the unit is set to REMOTE, unit power on takes place. When the sequence is complete, the unit closes the path from 'system source' to 'powering complete'. If the unit has a sequential powering circuit to supply power to units attached to it (i.e., the "unit" actually serves as a "system" as well), bringing up 'powering complete' will be delayed until all units have been powered.
7. Upon receipt of 'powering complete' at the system, the step control switch advances to the next position and opens 'power pick' to the unit just powered.
8. Steps 5, 6, and 7 are repeated until all power sequencing is complete.

2.3.2 Power Off.

1. The system power-on contacts open.
2. The 'power hold' line opens.
3. If the unit is in remote status, the power on the unit drops ('unit source' remains up) and the 'powering complete' line opens.
4. If the unit is in local status, no change in the power status occurs.

2.3.3 Emergency Power Off. Emergency power off control is accomplished by contact point control (normally open points that close after reset of the EPO switch). All units in the equipment configuration are under the control of EPO regardless of whether in local or remote status.

2.4 Local Power Controls. Certain power controls may be included in a unit (or device) for local control of power, depending on the use and design of the unit.

A unit designed for customers use in an offline mode must make the on/offline, local/remote, power-on, and power-off switches available to the operator.

2.4.1 Local/Remote Switch. Stand-alone frames may have a local/remote switch to permit switching that unit to system power control or to its own power control.

The effect of the setting of this switch, with various combinations of unit and system power, is shown in the table, "Local/Remote Switch Effects." The normal procedure for Case 2 is to bring up unit power before switching to remote. The switching would then have no effects (Case 4).

When in local status, the unit does not respond to any system power control except EPO. The 'powering complete' line for the unit is connected to the 'system source' line via the local/remote switch.

Local/Remote Switch Effects

Case	Switching From:	Unit Power	System Power	Effect
1	Local to Remote	Off	Off	None
2	Local to Remote	Off	On	None*
3	Local to Remote	On	Off	Unit drops power
4	Local to Remote	On	On	None
5	Remote to Local	Either	Either	None

* A unit may be designed to automatically cause power to be turned on in this case, but this is optional.

2.4.2 Online/Offline Switch. Normal use of the local/remote switch for changing the power state of a unit requires the use of the online/offline switch. Transitions in power are then made while in offline mode.

2.4.3 Power-on Switch. The power-on switch must be under the control of the local/remote switch and is active only if the local/remote switch is set to LOCAL.

If power-on switch is not exposed (unit is not to be used by the operator in an offline mode), a pushbutton or toggle switch for power-on condition must be provided. This switch should be readily accessible to maintenance personnel and should be active only in the local position.

2.4.4 Power-off Switch. If the unit is designed for use in an offline mode, the power-off switch must be a red pushbutton (or toggle switch) readily accessible to the operator. If it is to turn off power without regard to the local/remote switch, it must be labeled POWER OFF. If it turns off power only in local, the power-off pushbutton must be labeled PWR OFF IF IN LOCAL.

A power-off switch is not normally exposed on a unit designed for system power sequencing only. However, if it is exposed, and the local/remote switch is also exposed, the rules stated in the preceding paragraph apply. When the power-off switch is exposed, but the local/remote switch is not, the power-off switch must be labeled PWR OFF IF IN LOCAL.

Each unit must have a supply disconnect switch (circuit breaker) readily accessible to maintenance personnel. This switch is not interlocked by the local/remote switch.

2.5 Unit Removal. It is possible to physically remove any control unit, I/O device, channel frame, or free-standing storage frame from the system, without affecting the power on the rest of the system, with the following two exceptions:

1. Removing a channel frame physically from the system deactivates all control units and devices controlled from that channel frame, unless they are being shared with other channel frames.
2. Removing a control unit physically from the system deactivates all devices controlled from that control unit, unless they are being shared with other control units. In the case of a shared I/O device, the device is deactivated only if its primary power is supplied through the control unit removed from the system.

2.6 Shared Units. When a unit is shared between systems multiple power control interfaces are required, one for each system. Cabling within the unit is as shown in figure 4.

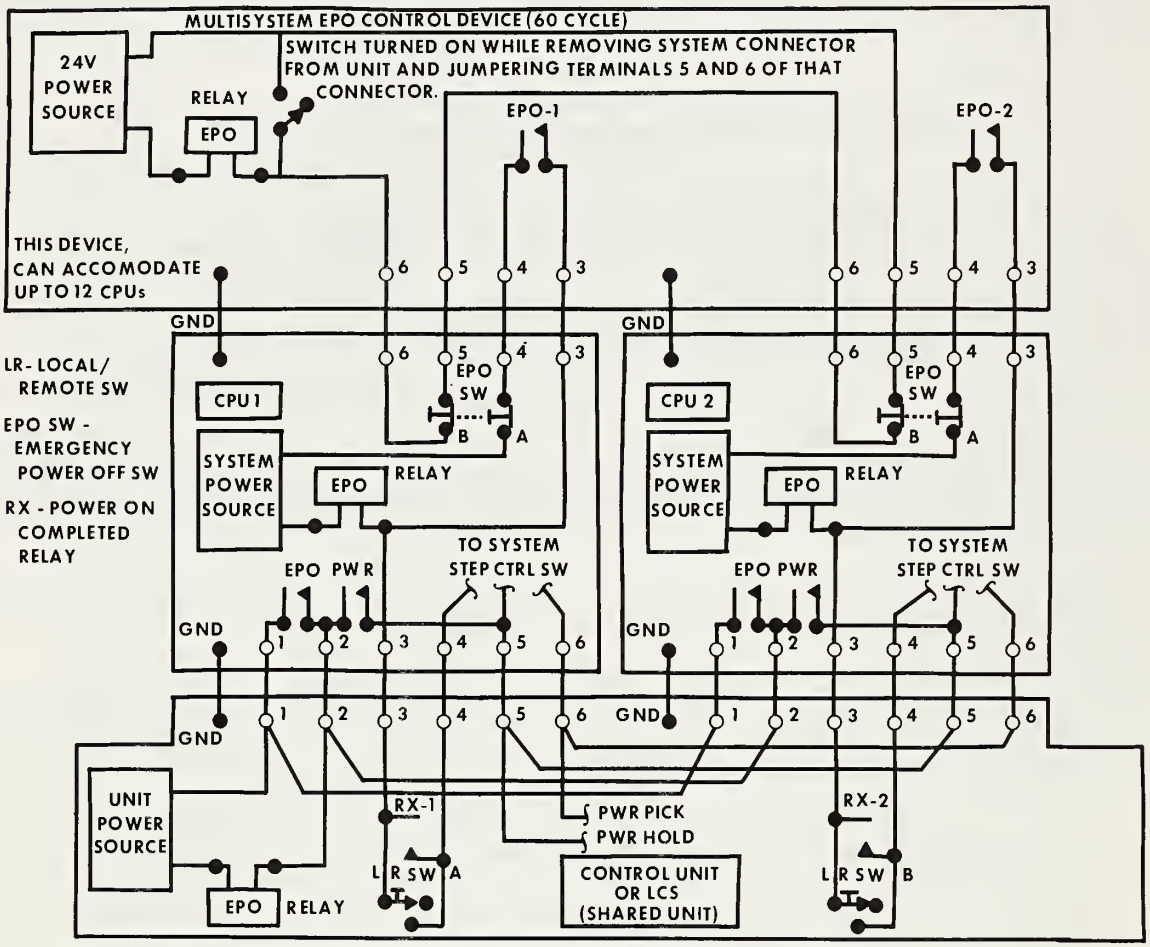

FIGURE 4. Shared unit configuration

Unit power is brought up when the first system powers up and is dropped when the last system drops power, unless an EPO condition occurs. An EPO condition on both systems causes the attached unit to drop its power.

2.7 Multisystem Emergency Power Off. When a system configuration includes more than one CPU, interlocking of the EPO circuits of the related CPUs may be desired, EPO interlocking is required when units are shared between the CPUs. This interlocking must be such that an EPO condition detected in one of the CPUs will cause the EPO circuits of all connected CPUs to open, thus dropping power.

Each CPU may then power up after resetting the EPO circuit that caused the overall EPO condition.

To accomplish interlocking, each CPU must provide a multisystem EPO control interface connector and associated circuitry. The interface is shown in figure 5 and a typical implementation is shown in figure 4.

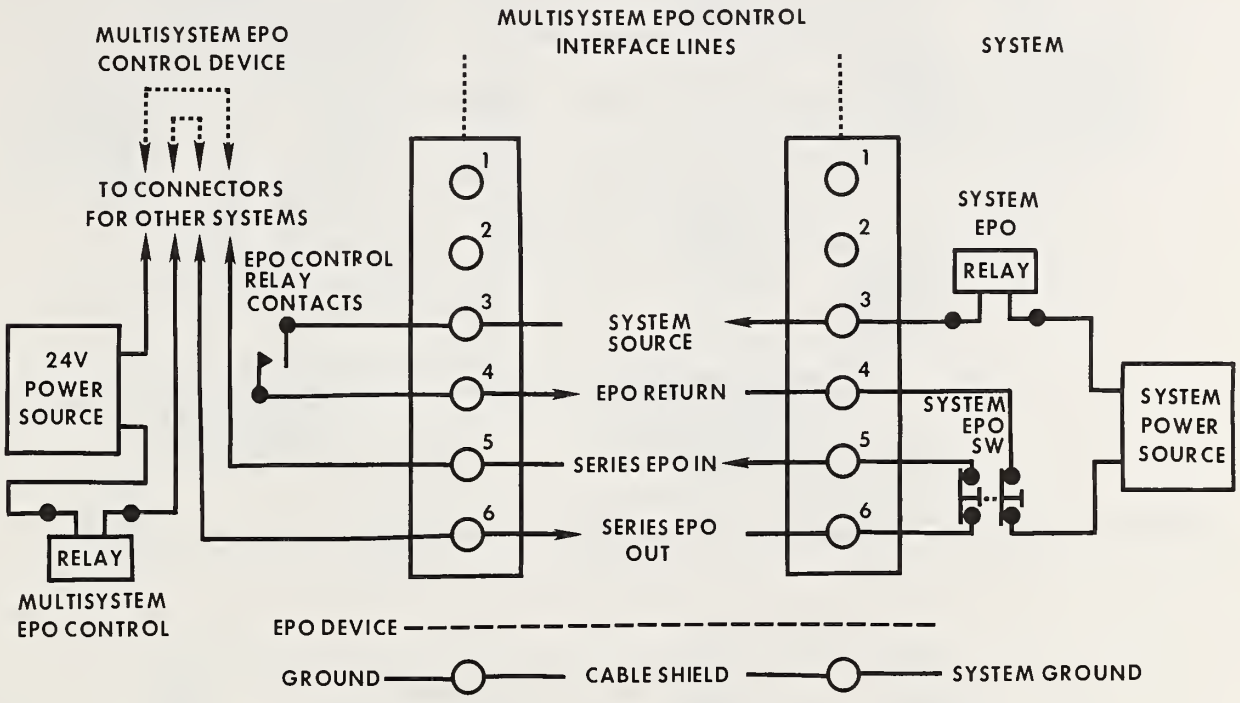

FIGURE 5. Multisystem EPO control interface

CHAPTER 3.

Mechanical Specification

3.1 Interconnection.

3.1.1 Two-System Interconnection. In a system configuration containing only two CPUs, interlocking of the EPO circuits can be accomplished by a single, special cable.

3.1.2 Multisystem Interconnection. When the system configuration includes up to 12 CPUs, the interlocking of the EPO circuits can be accomplished by the multisystem EPO control device shown in figures 4 and 5. This control device continually senses the EPO circuits of all connected CPUs.

The multisystem EPO control device is a self-contained device, which obtains its primary power independently of any of the associated CPUs.

3.2 Dual System EPO Control. Dual systems EPO control can be provided as shown in figure 6. The interlocking of the EPO circuits can be accomplished by a single, special cable.

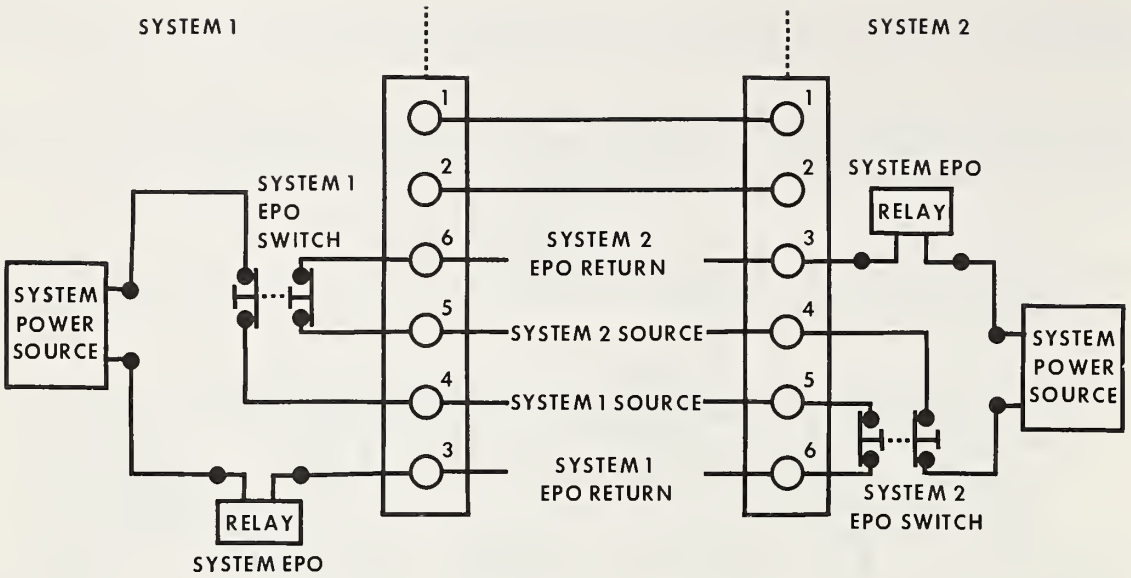

FIGURE 6. Dual system EPO control interface

3.3 Power Cables and Connectors. The maximum cable length shall not exceed 150 feet.

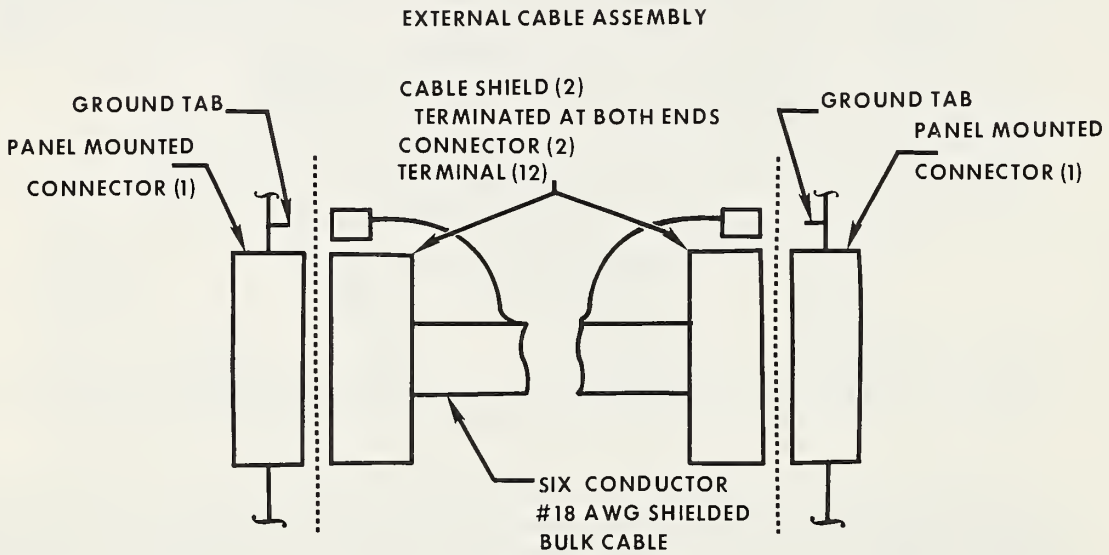

FIGURE 7. Power control and cable connector

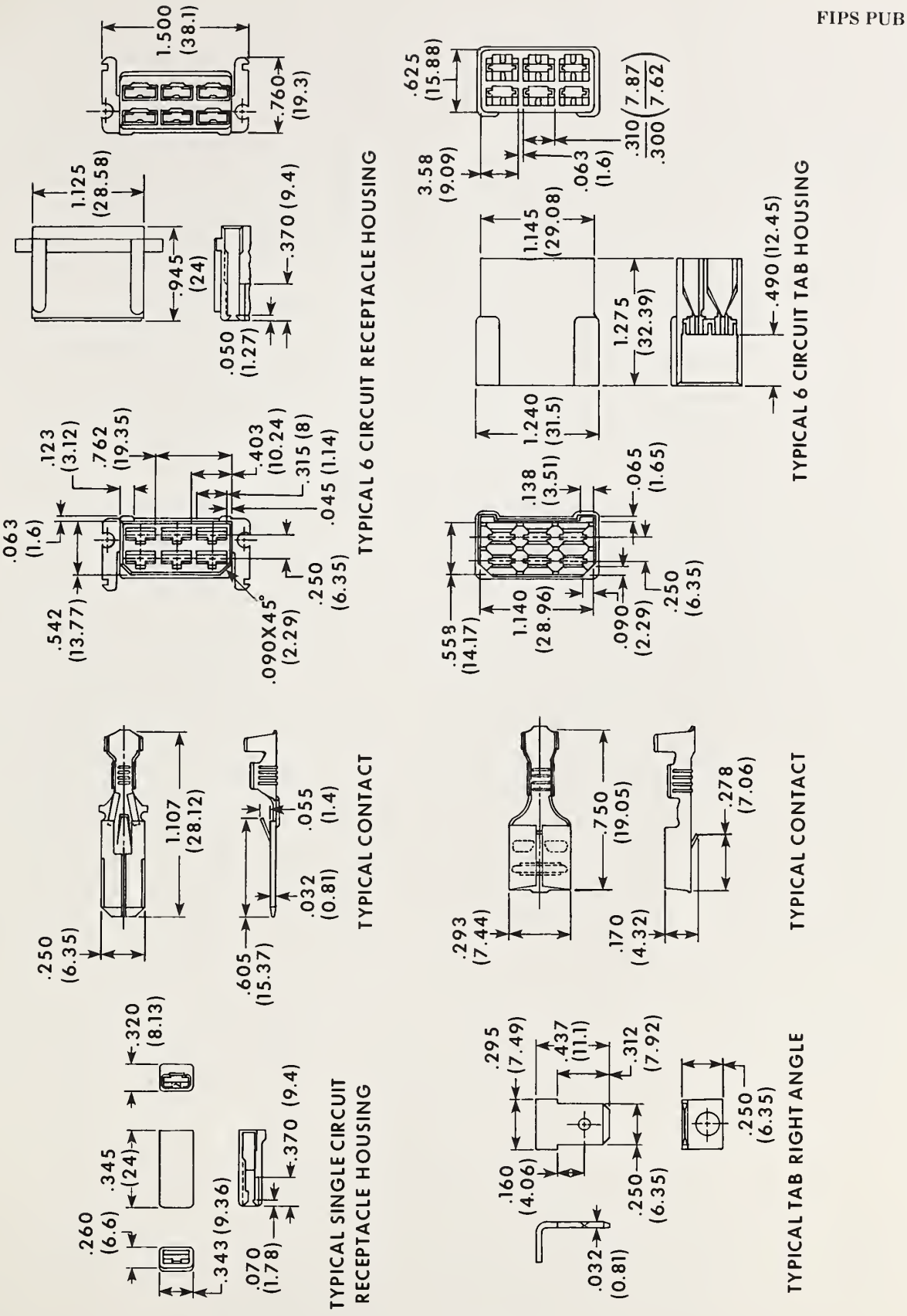

FIGURE 8. Power control connector

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980 O—303-125

NBS TECHNICAL PUBLICATIONS

PERIODICALS

JOURNAL OF RESEARCH—The Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent Bureau publications in both NBS and non-NBS media. Issued six times a year. Annual subscription: domestic $17; foreign $21.25. Single copy, $3 domestic; $3.75 foreign.

NOTE: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

DIMENSIONS/NBS—This monthly magazine is published to inform scientists, engineers, business and industry leaders, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on work at NBS. The magazine highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, it reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing. Annual subscription: domestic $11; foreign $13.75.

NONPERIODICALS

Monographs—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NBS, NBS annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

Applied Mathematics Series—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NBS under the authority of the National Standard Data Act (Public Law 90-396).

NOTE: The principal publication outlet for the foregoing data is the Journal of Physical and Chemical Reference Data (JPCRD) published quarterly for NBS by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

Building Science Series—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NBS administers this program as a supplement to the activities of the private sector standardizing organizations.

Consumer Information Series—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

Order the **above** *NBS publications from: Superintendent of Documents, Government Printing Office, Washington, DC 20402.*

Order the **following** *NBS publications—FIPS and NBSIR's—from the National Technical Information Services, Springfield, VA 22161.*

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NBS Interagency Reports (NBSIR)—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Services, Springfield, VA 22161, in paper copy or microfiche form.

BIBLIOGRAPHIC SUBSCRIPTION SERVICES

The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:

Cryogenic Data Center Current Awareness Service. A literature survey issued biweekly. Annual subscription: domestic $25; foreign $30.

Liquefied Natural Gas. A literature survey issued quarterly. Annual subscription: $20.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: $30. Please send subscription orders and remittances for the preceding bibliographic services to the National Bureau of Standards, Cryogenic Data Center (736) Boulder, CO 80303.