

APPENDIX

INTEGRATED STANDARDS STRUCTURE FOR AUTOMATED MANUFACTURING

In planning the development of this model, the first and second divisions of a work breakdown structure (WBS) were formulated to describe frequently occurring gaps that must be bridged before automation is fully integrated throughout the plant. There were seven major divisions. Next, the standards that are useful when integrating automated equipment in a computerized plant were identified. Over 400 organizations within the United States prepare standards, but it is a select few (ASTM, CCITT, EIA, IEEE, and ISA) that write most of the standards related to industrial automation. Only those standards concerned with integration of the automated equipment (instead of the equipment itself) were considered. Standards inapplicable to the integration process were not considered. The standards thus identified as being useful when integrating automated equipment were then placed into one or more of the WBS divisions. The end result was this Appendix, an Integrated Standards Structure for Automated Manufacturing. The listing of the standards in the chart is not intended to be complete, but it is a necessary beginning. One may see there are very few standards listed in certain divisions. This serves to identify those areas where standards need to be developed.

Standards are referred to in this Appendix by a short generic content description and number. The standardizing organization and committee responsible for each standard may be identified by the abbreviation associated with the standard number as follows:

American National Standards Institute	ANSI
Instrument Society of America	ISA
Institute of Electrical and Electronics Engineers	IEEE
Electronic Industries Association	EIA
Federal Information Processing Standard	FIPS
Military Standard	MIL
National Bureau of Standards	NBS
National Fire Protection Association	NFPA
Comité Consultatif Internationale de Télégraphique et Téléphonique	CCITT
International Organization for Standardization	ISO

Other abbreviations used are as follows:

ACU	Adaptive Control Unit
ATE	Automated Test Equipment
CAMAC	Computer Automated Measurements and Control
CPPP	Computerized Production Process Planning
CRP	Capacity Requirements Planning

DBS	Data Base System
DCE	Data Communication Equipment
DTE	Data Terminal Equipment
HDLC	High Level Data Link Control
IPWICS	International Purdue Workshop on Industrial Computer Systems
MRP	Materials Requirements Planning
MRPII	Manufacturing Resource Planning
NC	Numerical Control
PCM	Pulse Code Modulation
PROWAY	Process Highway (i.e., a particular local area network being developed for manufacturing)

Please supply corrections or additions and request further information from:

Dr. Leonard B. Gardner
P.O. Box 1523
Spring Valley, California 92077

SYSTEMS TRAINING

Operators

Maintenance

Programmers

Quality Assurance

Business

Employee Development

Simulation for Trainers

Management

General

ASTM E 625

COMPUTER AND COMMUNICATION SYSTEMS

Computer

- Vocabulary Project 26 & 27, ANSI X3K5
- Data transmission vocabulary Project 248, ANSI X3S3.2
- Software engineering terminology IEEE 729

ADP Systems—Formats

- Optional command and format for NC EIA RS-447
- ASCII ANSI X3.4
- ASCII extensions ANSI X3.41
- Numeric value representation ANSI X3.42
- Additional ASCII controls ANSI X3.64
- OCR-A character set ANSI X3.17
- OCR-B character set ANSI X3.49
- Hollerith code FIPS-14; ANSI X3.26
- Magnetic tape labels and files ANSI X3.27

- Structure for magnetic headers ANSI X3.57
- EBCDIC (267 character)
- Information interchange formats FIPS-20

Terminals

- Odd parity for flexowriters EIA RS-244
- Subset for NC punched tapes EIA RS-358B
- DTE and NC equipment EIA RS-408
- DTE and DCE packet mode PCM ISO X.25
- DTE and DCE for synchronous PCM ISO X.21
- ACU and DTE EIA RS-366
- DTE and DCE 37 position connections EIA RS-449
- DTE and DCE 25 position connections EIA RS-232

Programs/Languages

- Software engineering terminology IEEE 729
- Guide to the use of ATLAS IEEE 771
- APT remarks ANSI X3TR
- Guide for the use of Ada® IEEE P990
- Software taxonomy IEEE P1002
- ATLAS IEEE 416
- C/ATLAS IEEE 716
- C/ATLAS syntax IEEE 717
- FORTRAN I/O and EX industrial extension ISA S61.2
- FORTRAN ANSI X3.9
- COBOL ANSI X3.23
- PL/1 ANSI X3.53
- PL/S general purpose subset ANSI X3.74
- PL/M
- BCPL
- APT ANSI X3.37
- APT post-processor interface ANSI X3TR
- BASIC ANSI X3.60
- RT BASIC extensions IEEE 726
- Subroutines for CAMAC IEEE 758
- COMPACT/ACTION/SPLIT Project 253, BSR X3.94
- Text processing Project 203, ANSI X3J6
- APL Project 331, ANSI X3J10
- PASCAL ANSI X3.97; IEEE 770
- Extended PASCAL Project 345, ANSI X3J9
- Ada real-time multi-tasking MIL 1815
- Software quality assurance plans IEEE 730
- BLISS
- SAIL/PLANNER/CONIVER
- QLISP/INTERLISP/POPLER/POP-2/LISP-2
- MUMPS XII.1
- IMACS—integrated family for RT control

Networks

- S-100 asynchronous nonmultiplexed IEEE 696
- Asynchronous 5 MHz IEEE 795

- VME bus supports 68000 family IEEE 896
- PROWAY high reliability IPWICS project
- ETHERNET XEROX/Intel
- Local area networks IEEE P902.3D
- Serial data highway IEEE 595
- Parallel data highway IEEE 596

Displays

- Graphics for ASCII controls FIPS 36, ANSI X3.32
- Digital representation of physical ANSI Y14.26 M
- Graphical symbols for process displays ISA RP5.5
- Graphical subsets ANSI X3.64

Systems

- Design documentation IEEE P1016
- Verification IEEE P1012
- Reliability measurement IEEE P982
- COPICS—production information control
- PC/DBS—process control data base system

Protocols

- Synchronous data rates EIA RS-269B
- Serial data bit sequence ANSI X3.15
- Character structure and parity ANSI X3.16
- High-speed data rates ANSI X3.31
- ASCII communication control ANSI X3.25
- Physical layer ANSI Project 324 and CCITT X.21
- Data link layer ANSI Project 325 and CCITT X.25
- Network layer ANSI Project 326 and CCITT X.25
- Transport layer ANSI Project 332
- Session layer ANSI Project 333
- Presentation layer ANSI Project 335
- Application layer ANSI Project 334
- Model for open system interconnection ISO
- DDCCMP digital data communications protocol
- ADCCP adv. data communication control ANSI X3.66
- HDLC frame structure

PLANT ENVIRONMENT

Security System

Power

Services

Warehousing

HVAC

Energy Conversion/Reclamation

Fire Protection

Waste Control Treatment

Vents and Hoods

Interior Communications

Timing Standards

Motors and Trucks (for transportation and loading)

Noise Control

Layaway

PRODUCTION SYSTEM SPARES AND REPAIRS

Spares

Repairs

Parts

Repair Systems

PRODUCTION SYSTEM TEST AND SUPPORT

Integration and Assembly

Auxiliary Equipment

System ATE

Alarm Systems

- Test and evaluation of excitation control
- Hardware test of digital computers

IEEE 421 A
ISA RP 55.1

Calibration

Test Sets

Test Line

Preventative Maintenance

Clean Room

PRODUCTION EQUIPMENT

Machine Tools

- Intrinsically safe apparatus
- Electrical and construction
- Electrical and construction for NC
- Exchangeable CLDATA
- NC equipment for asynchronous circuits
- NC machine tools
- DTE and NC equipment
- DTE and DCE packet mode PCM
- DTE and DCE for synchronous PCM

NFPA 4913
EIA RS-281B
EIA RS-281B
EIA RS-494
EIA RS-491
EIA RS-431
EIA RS-408
ISO X.25
ISO X.21

- ACU and DTE EIA RS-366
- DTE and DCE 37 and 9 position connections EIA RS-449
- DTE and DCE 25 position connections EIA RS-232

Manufacturing Systems

- Intrinsically safe apparatus NFPA 4913
- Electrical and construction EIA RS-281B

Process Systems

- Intrinsically safe instruments ISA RP 12.6
- Electrical and construction EIA RS-281B
- Programmable instruments IEEE 488
- DTE and NC equipment EIA RS-408
- DTE and DCE packet mode PCM CCITT X.25
- DTE and DCE for synchronous PCM CCITT X.21
- ACU and DTE EIA RS-366
- DTE and DCE 37 position connections EIA RS-449
- DTE and DCE 25 position connections EIA RS-232

Material Handling

- Intrinsically safe instruments ISA RP 12.6
- Electrical and construction EIA RS-281B

Sensors

- Electrical transducers ISA S 37.1
- Automatic control ANSI MC 85.1M
- Fluid measurement ANSI MCF-IM
- Process instrumentation ISA S 51.1
- Thermocouples ANSI MC 96.1
- Potentiometric displacement ANSI S 37.12
- Potentiometric pressure ANSI S 37.6
- Piezoelectric ANSI S 37.10
- Strain gage pressure ANSI S 37.3
- Strain gage force ANSI S 37.8
- Strain gage accelerometer ANSI S 37.5
- Turbine flow meters ISA RP 31.1
- Instrument air ISA S 7.3
- Dynamic response ISA S 26
- Analog signal compatability ISA S 50.1

Interfaces

- DTE and DCE serial data ANSI X3.24
- DTE and nonsynchronous equipment EIA RS-404
- DTE and NC equipment EIA RS-408
- DTE and DCE packet mode PCM CCITT X.25
- DTE and DCE for synchronous PCM CCITT X.21
- ACU and DTE EIA RS-366
- DTE and DCE 37 and 9 position connections EIA RS-449
- DTE and DCE 25 position connections EIA RS-232
- Balanced lines EIA RS-422

- Unbalanced lines
- CAMAC modular instrument
- I/O channel
- Power control

EIA RS-423
IEEE 583

Transmitters/Receivers

Modems

- Single current contact closure
- Unbalanced double current

CCITT V.31
CCITT V.28

Cryptographic Systems

Peripherals

- Flexible disk and controller

EIA RS-474

PRODUCTION AND PLANT MANAGEMENT

Sales and Marketing

Production Design and Engineering

- Production line
- Production cell
- Flexible manufacturing system
- Group technology
- MICLASS

Manufacturing Engineering

Industrial Engineering

- Installation of safe instruments—Class 1

ISA RP 12.6

Production and Plant Control

- CPPP
- CRP
- MRP
- MRPII

Manufacturing

Quality Assurance

- Guide for quality assurance
- Quality assurance

IEEE P983
IEEE 730

Shipping and Inventory Control

Personnel Management

Logistics

Configuration Control

- Configuration management
- Configuration management audits

IEEE P828
EIA CMB 3

- Configuration management for software EIA CMB 4A
- Configuration management and technical data requirements EIA CMB 5
- Configuration identification for software EIA CMB 4-2
- Computer software libraries EIA CMB 4-3

Hazardous Material Control

Software Quality Assurance Management

- Verification IEEE P1012
- Reliability measurements IEEE P982

Systems

- Test documentation IEEE P829
- Requirements specification IEEE P830
- Design documentation IEEE
- Project documentation Project 16, ANSI X3K1
- Generic guide ASTM E 622
- Functional requirements ASTM E 623
- Implementation design ASTM E 624
- Evaluation ASTM E 626
- Functional designs ASTM E 730
- Procurement of turnkey system ASTM E 731
- Procurement of manufacturing system ASTM Subcom. E31.08,
Project No. E31.0801
- Documenting programs and systems FIPS 38
- Documenting ASTM E 627
- Software documentation ASTM E 919
- Considering user needs ANSI 10.5