



TECHNICAL REPORT

EIARS431™

Issued 1976-09
Stabilized 2015-07

Electrical Interface Between Numerical Control and Machine Tools

NOTICE

This document has been taken directly from the original TechAmerica document and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE Technical Standards. The release of this document is intended to replace the original with the SAE International document. Any numbers established by the original document remain unchanged.

The original document was adopted as an SAE publication under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of specifications and standards. TSB rules provide for (a) the publication of portions of unrevised specifications and standards without consensus voting at the SAE committee level, and (b) the use of the existing specification or standard format.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2015 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: SAE EIARS431

SAE values your input. To provide feedback on this Technical Report, please visit <http://www.sae.org/technical/standards/EIARS431>

Documents

Document Sharing Hub



Reproduced By GLOBAL
ENGINEERING DOCUMENTS
With The Permission of EIA
Under Royalty Agreement



ANSI/EIA RS-431-78
Approved December 6, 1978

EIA RS-431

EIA STANDARD

*Electrical Interface
Between Numerical Control
and Machine Tools*

RS-431



September 1976

Engineering Department
ELECTRONIC INDUSTRIES ASSOCIATION

NOTICE

EIA engineering standards are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such standards shall not in any respect preclude any member or non-member of EIA from manufacturing or selling products not conforming to such standards, nor shall the existence of such standards preclude their voluntary use by those other than EIA members whether the standard is to be used either domestically or internationally.

Recommended standards are adopted by EIA without regard to whether or not their adoption may involve patents on articles, materials, or processes. By such action, EIA does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the recommended standards.

Published by

ELECTRONIC INDUSTRIES ASSOCIATION

Engineering Department

2001 Eye Street, N.W., Washington, D. C. 20006

© Electronic Industries Association 1976

All rights reserved

Printed in U S A.

ELECTRICAL INTERFACE BETWEEN NUMERICAL CONTROL AND MACHINE TOOLS

(From Standards Proposal No. 1181 formulated under the cognizance of EIA Engineering Committee IE-31 on Numerical Control Systems and Equipment)

FOREWORD

The widespread use of Numerically Controlled Machine Tools has necessitated a standard whereby a variety of numerical controls can be used on the same machine tool with minimum changes to the interface.

The Electronic Industries Association has long sponsored the work of Committee IE-31 on Numerical Control Systems and Equipment. This committee, made up of representatives of control systems builders, machine builders, and users, has prepared this standard for use by people building and using Numerical Machine Controls.

1. GENERAL

1.1 Purpose

This standard is intended to serve as a guide in the design of an electrical interface between Numerical Control systems and electrical equipment associated with machine tools so as to promote:

- 1.1.1 Compatability between machine tool electrical equipment and Numerical Control systems.
- 1.1.2 Reliable operation of the machine/control combination.
- 1.1.3 Uniform operation and definition of on/off signals.
- 1.1.4 Safety to personnel, consistent with provisions of NFPA-79 Electrical Standard for Metal Working Machine Tools.

1.2 Scope

This standard covers both active and passive aspects of the electrical interface between the Numerical Control (NC) and the machine power and logic control, motor drive equipment, and other electrical apparatus on or associated with the machine tool. It covers:

- 1.2.1 Identification, grouping and wiring methods for signal and current-carrying conductors, grounding conductors, shields, and electrical transient suppression apparatus.
- 1.2.2 Voltage and current ratings and timing for on/off signals to and from the NC.
- 1.2.3 Voltage and current ratings for analog velocity reference signals to drive apparatus for axis motions and spindle or table rotation.

1.3 Definitions

For the purposes of this standard, definitions of terms are given in EIA Automation Bulletin 3-C entitled "Glossary of Terms for Numerically Controlled Machines" and in NFPA-79 entitled "Electrical Standard for Metalworking Machine Tools."

2. INTERFACE

2.1 The physical interface consists of the electrical connections between NC and machine power and logic control, motor drive equipment, and other electrical apparatus on or associated with the machine tool. Figure 1 shows the functional areas that are included in the definition of the interface.

2.2 The interface connections are divided into four groups; I, II, III and IV. (See Fig. 1). The composition of the groups does not depend upon the arrangement of enclosures; machine logic and motor drives may be physically separated or either one or both may be in the NC enclosure.

2.3 Group I – Drive Velocity Commands

2.3.1 Connections commanding velocity or indicating servo-error, and connections of the NC to variable-speed drives (See Fig. 2).

2.3.2 This group includes, in particular, the connections to hydraulic servo-valves and velocity signals to motor drives where these are used for driving NC axes and/or machine spindles.

2.3.3 This group includes the connections for outputs to motors where the NC includes armature and/or field power supplies.

2.4 Group II – Interconnections with Measurement System and Measuring Transducers

Connections for measurement of position and/or velocity on linear and rotary axes and of spindle orientation; other measuring transducers associated with the NC, such as adaptive control signals. This group includes the connections for associated excitation and supply voltages and tachometer signals where these are connected directly to the NC. (See Fig. 1).

2.5 Group III – Power and Grounding Conductors

Connections to the grounding conductor and to the main power supply system.

2.6 Group IV – On/Off Signals

Connections for on/off signals, both mandatory and optional, interchanged between the NC and machine (See Fig. 3).

3. GENERAL CONSIDERATIONS OF INTERFACE CONNECTIONS

3.1 Separation and Shielding

3.1.1 Where conductors from different groups run parallel to each other in the same raceway and/or at their points of connection to the NC, they shall be separated by a sufficient distance and/or shielding for mutual interference effects to be insignificant. Alternatively, every group shall have its own shield. It shall be the responsibility of the NC builder to provide the necessary advice to fulfill this requirement.

3.1.2 Refer to sections 4, 5, 6 and 7 for requirements for separation and shielding for specific groups.

3.2 Connection of Shielding

3.2.1 Cable shields shall be connected to the grounding conductor at the NC. The NC builder shall be responsible for these connections. If this connection must be made outside the NC, as an exception, the NC builder shall indicate its location.

3.2.2 The user shall not connect the shielding at any other point to any metallic structure, nor by any alternative route to the frame or grounding conductor, except by agreement of the NC builder.

3.2.3 Shielding shall have electrical continuity from the NC to the remote termination with a minimum of unshielded length.

3.2.4 Shielding shall not be used as a connection nor a current-carrying element between the devices at each end of the cable.

3.2.5 All shielded cables shall be externally insulated to prevent accidental contact with any other metallic parts. This outer insulation shall either afford mechanical protection of the cable or it shall be additionally covered with a mechanically protective outer layer or layers.

3.3 Cable Specifications

The NC builder shall recommend types of shielded cable suitable for use with the NC.

4. RECOMMENDATIONS AND REQUIREMENTS FOR GROUP I INTERFACE (Fig. 2)

4.1 Shielding of Connections

Group I connections for each drive velocity command output circuit from the NC shall be shielded separately.

4.2 Isolation Between NC and Electric Motor Drives

4.2.1 Where electric motor control circuits are used, there shall be no electrically conductive connection (except for grounding conductor) between the power circuit of the motor and the NC, except as specified in 4.5. Connections to the grounding conductor shall be in accordance with 6.5.

4.2.2 Connections for the velocity command signals from the NC to electric drives for axis motors may or may not comprise a zero-reference potential connection (See Figs. 2a and 2b). The electric drives shall always be insensitive to common-mode inputs between its input terminals and the frame or cabinet.

4.2.3 Group I connections for each output from the NC to dc motor armatures and/or field excitation should be installed as twisted pairs of conductors.

4.3 Hydraulic Servo-valves

The NC builder should provide output currents proportional to machine velocity or alternatively advise the machine builder of appropriate voltage to current conversion devices.

4.4 Velocity Command Voltages and Currents

4.4.1 The motor speed signal should be chosen so that the velocity command voltage for maximum motor rpm under the conditions of use should lie between $\pm 7V$ and $\pm 10V$. The NC shall provide an output that is linearly proportional to the speed commanded with polarity indicating direction, in the range of velocity corresponding to contouring on axis drives, and throughout the range on spindle drives. The manufacturer of the motor drive shall make appropriate provision for control of field energization where required.

4.4.2 Output impedance of the NC for voltage signals shall be less than 100 ohm.

4.4.3 The resultant input impedance of one or more motor controllers for voltage signals shall be greater than 5K ohm.

4.5 Connections Between NC and Power Circuits

The builder of the motor drive shall ensure that no direct electrical path (except for grounding conductor) under 20K ohm exists between the NC and power circuits. This includes any means of measuring motor armature current.

4.6 Servo Energization

The NC builder shall state whether the servo loops for the machine axis drives remain fully excited when the axes are in position.