

TECHNICAL REPORT
ISA-TR5.1.01/ISA-TR77.40.01-2012
Functional Diagram Usage

Approved 10 August 2012

ISA-TR5.1.01/ISA-TR77.40.01-2012
Functional Diagram Usage

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ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

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Foreword

Functional diagrams were first employed when discrete and electric analog control systems were designed. Associations and professional societies, such as Scientific Apparatus Makers Association (SAMA), ISA, and ISO, provided guidelines as to industry use of functional diagrams. SAMA has ceased to exist, but its popular standard, PMC 22.1-1981, *Functional Diagramming of Instrument and Control Systems*, is currently available through The Measurement, Control and Automation Association as well as ISA. Current ISA standards available for industry use include ANSI/ISA-5.1-2009, *Instrument Symbols and Identification*, and ISA-5.2-1976 (R1992), *Binary Logic Diagrams for Process Operations*. Symbols from SAMA PMC 22.1-1981, *Functional Diagramming of Instrument and Control Systems*, have been incorporated into ANSI/ISA-5.1-2009. The work within this technical report maintains historical practices of the previous and current documents and expands on new algorithms and practices.

Abstract

This technical report is an extension of ANSI/ISA-5.1-2009. The intent of this report is to provide further information and practical examples on the usage of functional diagrams for documenting application software. It is hoped that this report will be a handy reference to design engineers who are directly involved in the generation or review of functional diagrams.

Key words

functional diagram, function block symbols, application software, control algorithm, cascade controller, multiple input multiple output controller, symbol legend, PID controller

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1 Scope

The scope of this technical report is to expand on and illustrate usage of function block symbols and functions and to prepare examples in development of complex function block symbols and functions.

2 Purpose

The purpose of this technical report is to provide advice and guidance in documenting application software through functional diagrams.

3 Definitions

3.1 alarm:

an audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a response [ANSI/ISA-18.2-2009]

3.2 application software:

software specific to a user application that is configurable and in general contains logic sequences, permissive and limit expressions, control algorithms, and other codes required to control the appropriate input, output, calculations, and decisions

3.3 binary:

a term applied to a signal or device that has only two discrete positions or states. When used in its simplest form, as in binary signal (as opposed to analog signal), the term denotes an on-off or high-low state, i.e., one which does not represent continuously varying quantities.

3.4 controller:

a device having an output that varies to regulate a controlled variable in a specified manner. A controller may be a self-contained analog or digital instrument, or it may be the equivalent of such an instrument in a shared control system. An automatic controller varies its output automatically in response to a direct or indirect input of a measured process variable. A manual controller is a manual loading station, and its output is not dependent on a measured process variable but can be varied only by manual adjustment. A controller may be integral with other functional elements of a control loop.

3.5 control station:

a manual loading station that provides control-loop switching between manual and automatic control mode. It is also known as an auto-manual station. In addition, the operator interface of a distributed control system may be regarded as a control station.

3.6 converter:

a device that receives instrument signal information in one form and transmits an output signal in another form. An instrument that changes a sensor's output to a standard signal is properly designated as a transmitter, not a converter. Typically, a temperature element (TE) may connect to a transmitter (TT), not to a converter (TY).

3.7 digital:

a term applied to a signal or device that uses binary digits to represent continuous values or discrete states

3.8 distributed control system:

a system that, while being functionally integrated, consists of subsystems that may be physically separate and remotely located from one another

3.9 function:

the purpose of or an action performed by a device

3.10 functional diagram:

the practice of diagramming application software in its basic functional form, exclusive of its operating media or specific equipment detail

3.11 legend sheet:

a sheet of the individual symbols and identification with explanation

3.12 logic signal:

representation of information by a set of discrete values in accordance with a prescribed law. These values are represented by numbers. [ISA-51.1-1979 (R1993)]

3.13 logic system:

decision-making and translation elements of a control system; provides outputs in response to external inputs and internal logic (NFPA 85: Boiler and Combustion Systems Hazards Code, 2011 Edition)

3.14 macro:

a set of functions combined as a specific program to be run as a single task. The task is a subset of the controller's program but executes repeatedly for similar devices or applications with unique inputs and outputs.

3.15 measurement:

the determination of the existence or the magnitude of a variable [ISA-51.1-1979 (R1993)]

3.16 multiple input multiple output:

an algorithm/program, such as model predictive control, neural net, expert system, etc., that computes one or more output demands, biases, or setpoints based on multiple inputs

3.17 process:

any operation or sequence of operations involving a change of energy, state, composition, dimension, or other properties that may be defined with respect to a datum [ISA-51.1-1979 (R1993)]

3.18 process measurement:

the acquisition of information that establishes the magnitude of process qualities. [ISA-51.1-1979 (R1993)]

3.19 process variable:

any variable property of a process; used in this standard to apply to all variables other than instrument signals [ISA-51.1-1979 (R1993)]

3.20 program:

a repeatable sequence of actions that defines the status of outputs as a fixed relationship to a set of inputs

3.21 setpoint:

an input variable that sets the desired value of the controlled variable; may be manually set, automatically set, or programmed. Its value is expressed in the same units as the controlled variable.

4 Abbreviations (Acronyms)

HMI – human machine interface

I/O – input/output

MIMO – multiple input multiple output

MOV – motor operated valve

PID - proportional integral derivative