ANSI/ISA-TR88.00.02-2015

A Technical Report prepared by ISA and registered with ANSI

Machine and Unit States: An implementation example of ANSI/ISA-88.00.01

Approved 26 October 2015

ANSI/ISA-TR88.00.02-2015, Machine and Unit States: An implementation example of ANSI/ISA-88.00.01

ISBN: 978-1-941546-65-9

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Foreword

The ISA88 committee has defined a series of standards addressing the batch industry and providing terminology and a consistent set of concepts and models for batch manufacturing plants and batch control. These standards, however, were not defined in the context of packaging machines, or machines that perform discrete operations. As the ANSI/ISA88 batch standard continues to evolve, the context of the standard models may be extended to include the entire plant, integrating the software definitions of batch, packaging, converting and warehousing. Currently, as noted in this report there is a need to begin consideration of the ANSI/ISA88 standard in the context of differing automated machinery.

This is an informative document. This document contains implementation guidelines in order to establish a common presentation and high level software architecture or layout. The terms and definitions used in this document are harmonized, as much as possible, with ANSI/ISA-88.00.01; the document is not definitive in this respect. The models used, and applied, in this document are an extension of the models presented in ANSI/ISA-88.00.01 and are shown how they are applied to differing machine functionality. Discrete machine functionality is expressed graphically in several situations and described. The intent of this document is proposing specific implementation options and indicates a preference for a specific set of machine types.

In 2013 this document was updated for three reasons: to simplify the document and enable easier adoption, to clarify existing materials and make them easier to apply and to make it more complete, including the best approaches being used to implement. Major changes include addition of a minimum set of PackTags, a minimum set of states and removal of examples and MES definitions not central to the document's purpose. Other changes addressed in this revision are: improved definition of suspending and holding, transition between modes, blocked and starved tags, stop reasons, and warnings.

Publication of this technical report that has been registered with ANSI has been approved by ISA, 67 Alexander Drive, Research Triangle Park, NC 27709. This document is registered as a technical report according to the Procedures for the Registration of Technical Reports with ANSI. This document is not an American National Standard and the material contained herein is not normative in nature. Comments on the content of this document should be sent to ISA, 67 Alexander Drive, Research Triangle Park, NC 27709.

Abstract

The approaches used in programming discrete machines today are generally considered to be solely dependent on the machine and the software engineer, or control systems programmer. This constant change offers little additional value and generally increases the total costs, from the designing and building of the process to operating and maintaining the system by the end user. This technical report on the implementation of ANSI/ISA-88.00.01 in discrete machines breaks this paradigm and demonstrates how to apply the ANSI/ISA-88.00.01 standard concepts to automated machine states and modes. This technical report gives examples of general and specific machine state models and procedural methods. The report cites real control examples as implementations, and provides specific tag naming conventions; it also cites a number of common terms that are consistent with batch processing and ANSI/ISA-88.00.01.

Key words

state machine, state model, mode manager, machine state, unit control mode, PackML, state commands, command tags, status tags, administration tags, base state model, functional programming, modular programming, machine control software, discrete machine software, PackTags, Weihenstephan, Production Data Acquisition, PDA, ISA88, TR88.

Introduction

When the ANSI/ISA-88.00.01 standard is applied to applications across a plant, there is a need to align the terminologies, models and key definitions between different process types: continuous, batch, and discrete processes. Discrete processes involve machines found in the packaging, converting, and material handling applications. The operation of these machines is typically defined by the OEM, system integrator, end user, or is industry specific.

A task group with members from technology providers, OEMs, system integrators, and end users was chartered by the OMAC (Organization for Machine Automation and Control) Packaging Workgroup. The task group generated the PackML guidelines as a method to show how the ANSI/ISA-88.00.01 concepts could be extended into packaging machinery. This technical report is intended to build upon and formalize the concepts of the PackML guidelines and to show application examples.

The purpose of the technical report is to:

- Define a standard state-based model for automated machines.
- Identify definitions for common terminology.
- Explain to practitioners how to use state programming for automated machines.
- Provide references to actual implementation examples and templates from automation and control vendors.
- Identify a common tag structure for automated machines in order to:
  - Provide for “connect & pack” functionality
  - Provide functional interoperability and a consistent look and feel across the plant floor.
  - Provide consistent tag structure for connection to plant MES and enterprise systems.

Machine and Unit States
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1 Scope

Since its inception, the OMAC Packaging Machine Language (PackML) group has been using a variety of information sources and technical documents to define a common approach, or machine language, for automated machines. The primary goals are to encourage a common “look and feel” across a plant floor, and to enable and encourage industry innovation. The PackML group is recognized globally and consists of control vendors, OEM’s, system integrators, universities, and end users, which collaborate on definitions that endeavour to be consistent with the ISA88 standards and consistent with the technology and the changing needs of a majority of automated machinery. The term “machine” used in this report is equivalent to an ISA88 “unit”.

This has led to the following:
1. A definition of machine/unit state types
2. A definition of machine/unit control modes
3. A definition of unit control mode management
4. State models, state descriptions, and mode and state transitions
5. A definition of the minimum PackTags required for performance monitoring

2 References

The following documents contain provisions that are referenced in this text. At the time of publication the editions indicated were valid. All documents are subject to revision, and parties to agreements based on this technical report are encouraged to investigate the possibility of applying the most recent editions of the reference documents indicated below.

— ANSI/ISA-88.00.01-2010, Batch Control - Part 1: Models and Terminologies

— ISA-88.00.02-2001, Batch Control - Part 2: Data Structures and Guidelines for Languages

— ANSI/ISA-88.00.03-2003, Batch Control - Part 3: General and Site Recipe Models and Representation

— ANSI/ISA-88.00.04-2006, Batch Control - Part 4: Batch Production Records

— ISA Draft 88.00.05 Batch Control - Part 5: Implementation Models & Terminology for Modular Equipment Control

— IEC 61131-1 Programmable controllers – Part 1: General Information

— IEC 61131-3 Programmable controllers - Part 3: Programming Languages

— IEC TR61131-4 Programmable controllers - Part 4: User Guidelines

— PLCopen TC5 Safety Software

— Weihenstephan Standard – Part 2 Version 2005 www.weihenstephaner-standards.de/index.php?id=2&L=1

— ANSI/ISA-95.00.01-2010 (IEC 62264-1 Mod) Enterprise – Control System Integration - Part 1: Models and Terminologies

— ANSI/ISA-95.00.02-2010 (IEC 62264-2 Mod) Enterprise – Control System Integration - Part 2: Object Model Attributes

— ANSI/ISA-95.00.05-2013, Enterprise - Control System Integration - Part 5: Business-to-Manufacturing Transactions

— DIN 8782, Beverage Packaging Technology; Terminology Associated with Filling Plants and their Constituent Machines