M ELiSSA

Technical Note

Memorandum of Understanding
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TECHNICAL DATABASE OF MELISSA

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1. Preliminaries

1.1. Purpose

The purpose of this document is to establish a uniform means of designating instruments and instrumentation systems used for measurement and control of the MELISSA loop. To this end a designation standard is proposed.
The purpose of this standard is to establish:

- A system of graphic symbols for process displays. The system is intended to facilitate rapid comprehension and to establish uniformity of best practice.
- An identification code for each symbol
- A method of logic diagramming of binary interlock and sequencing systems for the start-up, operation, alarm, shutdown of equipment and processes
- A guideline for the preparation and use of instrument loop diagrams in the design, construction, start-up, operation, maintenance and modification of instrumentation systems.

Resulting benefits are intended to be as follows:

- A decrease in operator errors
- A shortening of operator training
- A better communication between the system users

2. Other information

2.1. Contacts

People in charge of:

- Pilot plant at UAB,
  - Joan ALBIOL for CII and CIVa (UAB)
  - Julio PEREZ for CIII (UAB)
- Software aspects
  - Jean-Louis TESTUD (consultant for UAB)

2.2. Reference documents

2.2.1. Data sources

- TN 78_71_01.doc
- Glossary MELISSA - Standard ISA S5.xls
- Table 1 - Identification letters.xls
- Table 2 - Typical letter combinations.xls
- Primary element symbol.vsd
- Instrument line symbols.vsd

2.2.2. Reference documents

- ESA Documents :
  - Standard ANSI/ISA S5.1 – 1984 (R1992)
  - Standard ANSI/ISA S5.2 – 1976 (R1992)
  - Standard ISA S5.3 – 1983
  - Standard ANSI/ISA S5.4 – 1991
  - Standard ISA S5.5 – 1985
- UAB Documents :
  - Inventory UAB.xls
  - TN 66_51
  - TN 66_52
- NTE Documents :
  - TN 72.1 Version 1 – Issue 0 – 31/07/2002
  - TN 72.2 Version 1 – Issue 1 – 31/07/2002
  - TN 72.3 Version Draft – 06/11/2002

3. Foreword

This document relies on the standard ISA S5. The authors advise the reader to consult the standard's documents for more information. ESA ESTEC has the pdf files of the standard ISA S5 [ESA ESTEC-IDC, 01477081 2005/1/5 13:33:15 GMT]

This document extracts the fundamental aspects of the standard useful for the technical data base of MELISSA.

4. Requirements

The main aims of this technical note are:

- To standardize the documentation of MELISSA
- To select within the standard ISA S5 the elements useful for MELISSA project
- To ease the consultation of the standard ISA S5 by explaining his organisation
- To offer a glossary for the technical terms
- To offer a standard for the identification of equipments
- To offer a standard for the graphical representation of the equipments
- To offer a standard for the representation of the different types of links (electric, pneumatic, sonic,..)
- To offer a temporary organisation for the structure of the technical database in order to collect information and before having chosen the right and final data base industrial software.
- To provide the relevant information in order to offer technical solutions for the design of the Technical Data Base of MELISSA.
- To define a homogeneous and standard database (technical and maintenance documents) and to check it by applying on the equipments
- To give the way update the database with the pilot evolutions (experimentation and technological evolutions).
- To ease the tracking of the experimentations on the pilot
- To industrialise the tracking process
- To insure the secure transmission of the collected information to MELISSA project existing and future partners
- To start the fulfilment of the database with the UAB available information at the TN writing date. To join together information on the existing equipment at that date
- To prepare the transmission of the data to an industrial relationship database software
- To define and to specify the next actions to be done

5. Who Is this document for ?

This document is intended to three kinds of users : creators and users of the ground pilot version and the users team of the final system.

First of all this document writes down the rules for all the users during the MELISSA process development.

Then the implemented rules need to allow the usage by the crew of the Life Support System in great working conditions.

Taking into account the planning of the project existing and long term norms need to be chosen that's why ISA S5 (famous standard for this type of process) has been selected.

5.1. For the designers

MELISSA process development (whose designers are in charge) is divided in several steps:

- Each compartment is set up in laboratory
- Progressive assembling of compartments
- Ground version pilot design
- On ground tests
- Ground version pilot in line with space requirements (space adaptation)
- On Earth staff training

Elements required by step:

- Linked elements for physical and chemical transformations necessary for the system
- Sensors and actuators necessary for the system
- Programmed calculators for the working system, malfunction identification, diagnosis and system reconfiguration

Identification of each produced element : defined and registered. Rules have to be set up:

- Standard graphics of the equipments
- Equipment identification standards (sticks,…)
- Standards to build the documentation relative to the equipments
  - Technical documentation
  - Maintenance documentation
  - Procedures (installation, calibration and dismantling…)

System working has to be controlled. Rules have to be established:

- Driving views standard presentation
- Color coding
- Circulating mode between views and information access code from the controlling screens

5.2. For users

5.2.1. In laboratory on Earth

Pilot users (ground version of MELISSA project) will make modifications. They need to access the technical documentation and necessarily to get the knowledge of its organisation.

They need to be able to update the technical documentation and insure the tracking of the technical evolutions made on the pilot

5.2.2. For the crew

It is not yet the right time to define final rules for them now but their needs have to be identified in order not to change the principles and the standards during the conception phase

The crew needs to make the life support system working by insuring:

- Drive the process during nominal working or failure working
- Which course of action is it necessary to take in case of fault detection ?
- Diagnosis validation
- Maintenance procedures

6. Content of the document

Definition of the process functions.

Design rules of technical drawings:

- Equipments symbols
- Links symbols
- Identification rules
- Color coding rules

Glossary of technical terms (See Excel file "Glossary MELISSA - Standard ISA S5.xls")

7. Organisation of standard ISA S5

7.1. Standard ISA S5.1 – Instrumentation symbol and identification

7.1.1. Content

- Outline of the identification system
- Functional identification
- Loop identification
- Symbols
- Table 1 – Identification letters
- Table 2 – Typical combination of letters
- Table 3 – Function blocks
- Instrument line symbols
- Examples

7.1.2. Use for MELISSA

Choice of standards for MELISSA:

- Identification system
- Instrument and function symbols
- Instrument line symbol

7.2. Standard ISA S5.2 – Binary Logic Diagrams for process operations

7.2.1. Content

- Method of logic diagramming or binary interlock and sequencing systems for the start-up, operation, alarm, and shutdown of equipment and processes
- Symbols
- Examples

7.2.2. Use for MELISSA

Standardized mean of symbolic and graphic description of the operating sequences of MELISSA pilot plant.

Note : This work has to be done after the standardisation of the static description of the MELISSA pilot plant.

7.3. Standard ISA S5.3 – Graphic symbols for control command

7.3.1. Content

The purpose of this section is to establish documentation for that class of instrumentation consisting of computers, programmable controllers, minicomputers and micro-processors based systems that have shared control, shared display or other interface features. Symbols are provided for interfacing field instrumentation, control room instrumentation and other hardware to the above. Terminology is defined in the broadest generic form to describe the various categories of these devices.

It contains:

Different type of Symbols

- Distributed control/shared display symbols
- Computer symbols
- Logic and sequential control symbols
- Internal system function symbols
- System links
- Alarms

7.3.2. Use for MELISSA

Useful to describe the control command system of each compartment of the pilot of MELISSA

7.4. Standard ISA S5.4 – Instrument loop diagram

7.4.1. Content

This standard will provide guidelines for the preparation and use of instrument loop diagrams in the design, construction, start-up, operation, maintenance and modification of instrumentation systems.

This standard will assist the understanding of instrument loop diagrams and improve communications among technical, non-technical, management, design, construction, operating and maintenance personnel.

7.4.2. Use for MELISSA

Useful to follow the evolutions of the pilot plant.

7.5. Standard ISA S5.5 – Graphic symbol for process display

7.5.1. Content

- Symbol usage
- Colour coding
- Grouping of symbols
- Structure of symbols

7.5.2. Use for MELISSA

- Choice of a colour coding mode (See § 9).
- Definition and description of the symbols for equipments present within MELISSA project.

8. Outline of the identification system

[*Extracted from ISA S5-1*]

8.1. General

8.1.1. Tag number

Each instrument or function to be identified is designated by an alphanumeric code or tag number as shown in fig 1. The loop identification part of the tag number is generally common to all instruments or functions of the loop. A suffix or prefix may be added to complete the identification. Typical identification is shown in Figure 1.

		Typical tag number
TIC	103	- Instrument Identification or Tag Number
T	103	- Loop Identification
	103	- Loop Number
TIC		- Functional Identification
T		- First-Letter
IC		- Succeeding-Letters
		Expanded tag number
	10-PAH-5A	- Tag Number
	10	- Optional Prefix
	A	- Optional suffix
		Note: Hyphens are optional as separators

Panel 1 : Tag numbers

8.1.2. Loop number

The instrument loop number may include coded information, such as plant area designation. It is also possible to set aside specific series of numbers to designate special functions; for instance, the series 900 to 999 could be used for loops whose primary function is safety-related (See § 8.1.9)

8.1.3. Symbol

Each instrument may be represented on diagrams by a graphic symbol. The symbol may be accompanied by a tag number.

8.2. Functional identification

8.2.1. Article 1

The functional identification of an instrument or its functional equivalent consists of letters from Table 1 (See § 11.2.1) and includes one first-Letter (designating the measured or initiating variable) and one or more succeeding-Letters (identifying the functions performed).

8.2.2. Article 2

The functional identification of an instrument is made according to the function and not according to the construction. Thus, a differential-pressure recorder used for flow measurement is identified by FR; a pressure indicator and a pressure-actuated switch connected to the output of a pneumatic level transmitter are identified by LI and LS, respectively.

8.2.3. Article 3

In an instrument loop, the first-Letter of the functional identification is selected **according to the measured or initiating variable,** and not according to the manipulated variable. Thus, a control valve varying flow according to the dictates of a level controller is an LV, not an FV.

8.2.4. Article 4

The succeeding-Letters of the functional identification designate one or more readout or passive functions and/or output functions. A modifying-Letter may be used, if required, in addition to one or more other succeeding-Letters. Modifying-Letters may modify either a first-Letter or succeeding-Letters, as applicable. Thus, TDAL contains two modifiers. The letter D changes the measured variable T into a new variable, "differential temperature." The letter L restricts the readout function A, alarm, to represent a low alarm only.

8.2.5. Article 5

The sequence of identification letters begins with a first-Letter selected according to Table 1. Readout or passive functional letters follow in any order, and output functional letters follow these in any sequence, except that output letter C (control) precedes output letter V (valve), e.g., PCV, a self-actuated control valve. However, modifying-Letters, if used, are interposed so that they are placed immediately following the letters they modify.

8.2.6. Article 6

A multiple function device may be symbolised on a diagram by as many bubbles as there are measured variables, outputs, and/or functions. Thus, a temperature controller with a switch may be identified by two tangent bubbles - one inscribed TIC-3 and one inscribed TSH-3. The instrument would be designated TIC/TSH-3 for all uses in writing or reference.

8.2.7. Article 7

The number of functional letters grouped for one instrument should be kept to a minimum according to the judgment of the user. ***The total number of letters within one group should not exceed four.*** The number within a group may be kept to a minimum by:

- Arranging the functional letters into subgroups.

- Omitting the I (indicate) if an instrument both indicates and records the same measured variable.

8.2.8. Article 8

All letters of the functional identification are uppercase.

8.3. Loop identification

8.3.1. Article 9

The loop identification consists of a First-Letter and a number. Each instrument within a loop has assigned to it the same loop number and, in the case of parallel numbering, the same first-Letter. Each instrument loop has a unique loop identification. An instrument common to two or more loops should carry the identification of the loop which is considered predominant.

8.3.2. Article 10

Loop numbering may be parallel or serial. Parallel numbering involves starting a numerical sequence for each new first-Letter, e.g., TIC-100, FRC-100, LIC-100, AI-100, etc. Serial numbering involves using a single sequence of numbers for a project or for large sections of a project, regardless of the first-Letter of the loop identification, e.g., TIC-100, FRC-101, LIC-102, AI-103, etc. A loop numbering sequence may begin with 1 or any other convenient number, such as 001, 301 or 1201. The number may incorporate coded information; however, simplicity is recommended.

8.3.3. Article 11

If a given loop has more than one instrument with the same functional identification, a suffix may be appended to the loop number, e.g., FV-2A, FV-2B, FV-2C, etc., or TE-25-1, TE-25-2, etc. However, it may be more convenient or logical in a given instance to designate a pair of flow transmitters, for example, as FT-2 and FT-3 instead of FT-2A and FT-2B. The suffixes may be applied according to the following guidelines:

- An uppercase suffix letter should be used, i.e., A, B, C, etc.
- For an instrument such as a multipoint temperature recorder that prints numbers for point identification, the primary elements may be numbered TE-25-1, TE-25-2, TE25-3, etc., corresponding to the point identification number.
- Further subdivisions of a loop may be designated by serially alternating suffix letters and numbers.

8.3.4. Article 12

An instrument that performs two or more functions may be designated by all of its functions. For example, a flow recorder FR-2 with a pressure pen PR-4 may be designated FR-2/PR-4. A two-pen pressure recorder may be PR-7/B, and a common annunciator window for high and low temperature alarms may be TAHL -21. Note that the slash is not necessary when distinctly separate devices are not present.

8.3.5. Article 13

Instrument accessories such as purge meters, air sets, and seal pots that are not explicitly shown on a diagram but that need a designation for other purposes should be tagged individually according to their functions and should use the same loop identification as the instrument they directly serve. Application of such a designation does not imply that the accessory must be shown on the diagram. Alternatively, the accessories may use the identical tag number as their associated instrument, but with clarifying words added. Thus an orifice flange union associated with orifice plate FE-7 should be tagged FX-7, but may be designated FE-7 FLANGES. A purge meter associated with pressure gauge PI-8 may be tagged PI-8 PURGE. A thermowell used with thermometer TI-9 should be tagged TW-9, but may be tagged TI-9 THERMOWELL.

8.4. Symbols

8.4.1. Article 14

The examples in this standard illustrate the symbols that are intended to depict instrumentation on diagrams and drawings. Methods of symbolization and identification are demonstrated. The examples show identification that is typical for the pictured instrument or functional interrelationships. The symbols indicating the various instruments or functions have been applied in typical ways in the illustrations. However this usage does not imply that the applications or designations of the instruments or functions are restricted in any way. No inference should be drawn that the choice of any of the schemes for illustration constitutes a recommendation for the illustrated methods of measurement or control. Where alternative symbols are shown without a statement of preference, the relative sequence of symbols does not imply a preference.

8.4.2. Article 15

The bubble may be used to tag distinctive symbols, such as those for control valves, when such tagging is desired. In such instances, the line connecting the bubble to the instrument symbol is drawn close to, but not touching, the symbol. In other instances, the bubble serves to represent the instrument itself.

8.4.3. Article 16

A distinctive symbol whose relationship to the remainder of the loop is easily evident from a diagram need not be individually tagged on the diagram. For example, an orifice flange or a control valve that is part of a larger system need not be shown with a tag number on a diagram. Also, where there is a primary element connected to another instrument on a diagram, use of a symbol to represent the primary element on the diagram is optional.

8.4.4. Article 17

A brief explanatory notation may be added adjacent to a symbol or a line to clarify the function of an item. For instance, the notations 3-9 psig and 9-15 psig adjacent to the signal lines to two valves operating in split range, taken together with the symbols for the failure modes, allow complete understanding of the intent. Similarly, when two valves are operated in a diverting or mixing mode from a common signal, the notations 3-15 psig and 15-3 psig, together-with the failure modes, allow understanding of the function.

8.4.5. Article 18

The sizes of the tagging bubbles and the miscellaneous symbols shown in the examples are the sizes generally recommended; however, the optimum sizes may vary depending on whether or not the finished diagram is to be reduced in size and depending on the number of characters that are expected in the instrument tagging designation. The sizes of the other symbols may be selected as appropriate to accompany the symbols of other equipment on a diagram.

8.4.6. Article 19

Aside from the general drafting requirements for clearness and legibility, symbols may be drawn with any orientation. Likewise, signal lines may be drawn on a diagram entering or leaving the appropriate part of a symbol at any angle. However, the function block designators and the tag numbers should always be drawn with a horizontal orientation. Directional arrowheads should be added to signal lines when needed to clarify the direction of flow of information. The judicious use of such arrowheads, especially on complex drawings, will often facilitate understanding of the system.

8.4.7. Article 20

The electrical, pneumatic, or other power supply to an instrument is not expected to be shown unless it is essential to the understanding of the operation of the instrument or the loop.

8.4.8. Article 21

In general, one signal line will be enough to represent the interconnections between two instruments on flow diagrams even though they may be connected physically by more than one line.

8.4.9. Article 22

The sequence in which the instruments or functions of a loop are connected on a diagram should reflect the functional logic or information flow, although this arrangement will not necessarily correspond to the signal connection sequence. Thus, an electronic loop using analog voltage signals requires parallel wiring, while a loop using analog current signals requires series interconnections. However, the diagram in both instances should be drawn as though ail the wiring were parallel, to show the functional inter-relationships clearly white keeping the presentation independent of the type of instrumentation finally installed. The correct interconnections are expected to be shown on a suitable diagram.

8.4.10. Article 23

The degree of detail to be applied to each document or sketch is entirely at the discretion of the user of the standard. The symbols and designations in this standard can depict both hardware and function. Sketches and technical papers will usually contain highly simplified symbolism and identification. Process flow diagrams will usually be less detailed than engineering flow diagrams. Engineering flow diagrams may show ail in-line components, but may differ from user to user in the amount of off-line detail shown. in any case, consistency should be established for each application. The terms simplified, conceptual, and detailed as applied to the diagrams of 6.12 were chosen to represent a crass section of typical usage. Each user must establish the degree of detail that fulfils the purposes of the specific document or sketch being generated.

8.4.11. Article 24

It is common practice for engineering flow diagrams to omit the symbols of interlock - hardware components that are actually necessary for a working system, particularly when symbolizing electric interlock systems. For example, a level switch may be shown as tripping a pump, or separate flow and pressure switches may be shown as actuating a solenoid valve or other interlock devices. In both instances, auxiliary electrical relays and other components may be considered details to be shown elsewhere. By the same token, a current transformer sometimes will be omitted and its receiver shown connected directly to the process - in this case the electric motor.

8.4.12. Article 25

Because the distinctions between shared display/shared control and computer functions are sometimes blurred, in choosing symbols to represent them the user must rely on manufacturers' definitions, usage in a particular industry, and personal judgment.

9. System organisation

9.1. MELISSA project

Melissa project (Microbiological Ecological Life Support System Alternative) is developed by the European Space Agency (ESA) for an ecosystem mainly based on the micro-organisms. It claims to be a tool for artificial ecosystem understanding and for a next support system of the biological life for long spatial flights (Mergeay and al, 1988).

The Melissa project is based on the eatable biomass recovery from wastage, CO_2 and minerals and using the light as energy source for photosynthesis.

The process is composed of 5 sub-systems (called compartments) strongly interconnected through liquid, solid or gas exchanges. These material exchanges are shown on graphic representation in order to materialize existing links between sub-systems. The crew compartment (CV) mainly consists of human staff that consumes oxygen and biomass and produces waste and CO_2. Other compartments are made with the necessary elements for the waste reprocessing and the production of nutritive elements and oxygen (bioreactors, separators …)
The diagrams below describe the main loop and links organization.

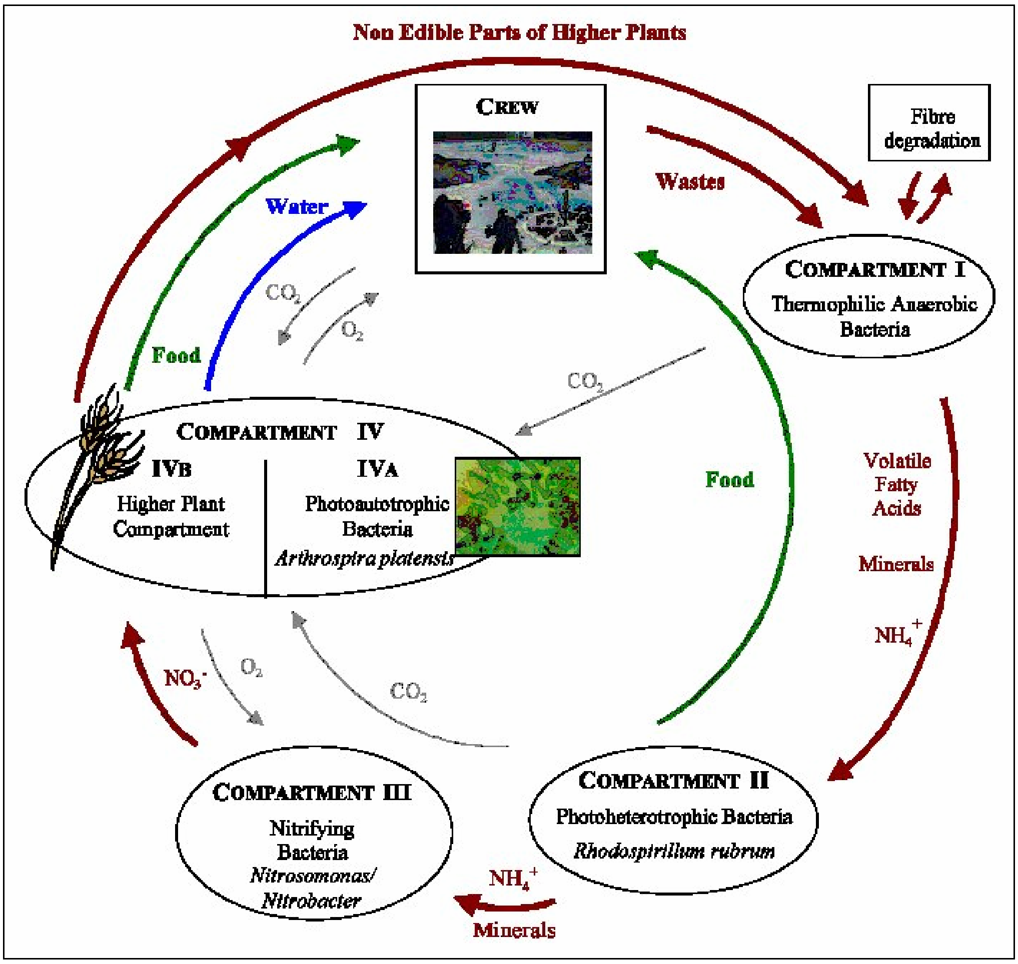

Figure 1 : MELISSA advanced concept loop (source: ESA)

9.1.1. Compartment's loops

The list of the loops is extracted from TN 72.1 Version 1 Issue 0 (NTE). The loops of the compartment are numbered according to the following rules:

9.1.2. Article 26

The hundreds number corresponds to the number of the compartment

- Compartment CI from 100 to 199,
- Compartment CII from 200 to 299
- Compartment CIII from 300 to 399
- Compartment CIVa from 400 to 449

- Compartment CIVb from 450 to 499
- Compartment CV from 500 to 599

9.1.3. Article 27 :

The first ten functions of each hundred are dedicated to control loops

9.1.4. Article 28 :

The series 1 to 99 are free

9.1.5. Article 29 :

The series 600 to 699 are free

9.1.6. Article 30 :

The series 700 to 799 are free

9.1.7. Article 31 :

The series 800 to 899 are used for loops whose primary function is maintenance-related.

9.1.8. Article 32

The series 900 to 999 are used for loops whose primary function is safety-related.

9.1.9. *List of the loops of CI (See Excel file "list of loops.xls")*

Number of loops 33

Loop Number	Description	Code TN 72-1			
100	BIOMASS control loop				
101	FLOW control loop				
102	CI Pressure control	2	1	4	4
103	CI Level control	2	1	4	5
104	Liquefying CI Temperature control	2	1	4	1
105	CI Microbial activity control	2	1	4	3
106	CI pH control	2	1	4	2
107					
108					
109					
110	Liquefying	2	1	1	
111	Provide mechanical containtment	2	1	2	
112	Input mixer	2	1	3	1
113	Pumping	2	1	3	2
114	Reactor stirring	2	1	3	3
115	Biological Oxygen Demand (BOD) monitoring	2	1	5	1
116	Chemical Oxygen Demand (COD) monitoring	2	1	5	2
117	Dry Weight monitoring	2	1	5	3
118	Cellulose / Faeces ratio monitoring	2	1	5	4
119	Ethanol monitoring	2	1	6	1
120	Fatty Acids monitoring	2	1	6	2
121	NH4 monitoring	2	1	6	3
122	CO2 monitoring	2	1	6	4
123	H2S monitoring	2	1	6	5
124	H2 monitoring	2	1	6	6
125	Indigestible nutrients monitoring	2	1	6	7
126	Kjeldahl-N monitoring	2	1	6	8
127	Gas filtering processing	2	1	7	1
128	Gas pumping processing	2	1	7	2
129	Liquid pumping from CI reactor processing	2	1	7	3
130	Liquid solid separation processing	2	1	7	4
131	Liquid pumping from S2 solid separator processing	2	1	7	5
132	Liquid sterilisation processing	2	1	7	6
133	Liquid filtering processing	2	1	7	7
134	Liquid buffering processing	2	1	7	8
135	Solid waste buffering	2	1	8	1

Panel 2 : List of the loops of CI

9.1.10. *List of the loops of CII*

Number of loops 22

Loop Number	Description	Code TN 72-1			
200	CII Biomass control	2	2	4	4
201	FLOW control loop				
202	PRESSURE control loop				
203	CII Level control	2	2	5	1
204	CII Temperature control	2	2	4	1
205	CII Light control	2	2	4	3
206	CII pH control	2	2	4	2
207					
208					
209					
210	VFA degradation	2	2	1	
211	Provide containment	2	2	2	
212	Provide homogeneous growth substrate	2	2	3	
213	Ammonium NH4 monitoring	2	2	5	2
214	CO2	2	2	5	3
215	Active Biomass	2	2	5	4
216	Kjeldahl-N	2	2	5	5
217	CO2 filtering	2	2	6	1
218	CO2 Analyser	2	2	6	2
219	CO2 pumping to CIVb	2	2	6	3
220	Liquid separation	2	2	6	4
221	Liquid filtering	2	2	6	5
222	Liquid analysis	2	2	6	6
223	Liquid buffering	2	2	6	7
224	Solid waste buffering	2	2	7	1
225					

Panel 3 : List of the loops of CII

9.1.11. *List of the loops of CIII*

Number of loops 23

Loop Number	Description	Code TN 72-1			
300	BIOMASS control loop				
301	FLOW control loop				
302	CIII Pressure control	2	3	4	5
303	CIII Level control	2	3	4	4
304	CIII Temperature control	2	3	4	1
305					
306	CIII pH control	2	3	4	2
307					
308	CII dissolved oxygen (DO) control	2	3	4	3
309	CIII Ammonium control	2	3	4	6
310	Nitrification	2	3	1	
311	Provide containment	2	3	2	
312	Provide packed-bed substrat	2	3	3	
313	Liquid filtering	2	3	5	1
314	Liquid analysis	2	3	5	2
315	Liquid pumping	2	3	5	3
316	Gas analysis	2	3	5	4
317	Gas filtering	2	3	5	5
318	CO2 filtering	2	3	6	1
319	CO2 pumping to CIVb	2	3	6	2
320	Liquid pumping	2	3	6	3
321	Liquid solid separation	2	3	6	4
322	Liquid bufering	2	3	6	5
323	Liquid analysis	2	3	6	6
324	Solid buffering	2	3	7	1
325					

Panel 4 : List of the loops of CIII

9.1.12. *List of the loops of CIV*

Number of loops 25

Loop Number	Description	Code TN 72-1			
400	CIVa Biomass control	2	4	4	3
401	CIVa Gas flow control	2	4	4	5
402	CIVa Pressure control	2	4	4	4
403	LEVEL control loop				
404	CIVa Temperature control	2	4	4	1
405	CIVa Light control	2	4	4	2
406					
407					
408					
409					
410	Biomass production	2	4	1	
411	Provide containment	2	4	2	
412	Provide homogeneous substrate	2	4	3	
413	Liquid filtering	2	4	5	1
414	Liquid buffering	2	4	5	2
415	Liquid pumping	2	4	5	3
416	Gas buffering	2	4	5	4
417	Gas mixing	2	4	5	5
418	Gas analysis	2	4	5	6
419	Gas pumping	2	4	5	7
420	Gas filtering	2	4	5	8
421	Gas filtering	2	4	6	1
422	Gas pumping	2	4	6	2
423	Gas buffering	2	4	6	3
424	Liquid buffering	2	4	6	4
425	Liquid solid separation	2	4	6	5
426	Liquid filtering	2	4	6	6
427	Liquid buffering	2	4	6	7
428	Solid buffering	2	4	7	1

Panel 5 : List of the loops of CIVa

Number of loops 16

Loop Number	Description	Code TN 72-1			
450					
451					
452	PRESSURE control loop				
453					
454	TEMPERATURE control loop				
455	LIGHT intensity control loop				
456	pH nutrients control loop				
457					
458	Air HUMIDITY conttrol loop				
459	NUTRIENT delivery control loop				
460	Higher plants cultivation	2	5	1	
461	Provide containment	2	5	2	
462	Provid eplats substrat	2	5	3	
463	Ensure adequate environment	2	5	4	
464	Gas filtering	2	5	6	1
465	Gas pumping	2	5	6	2
466	Water vapour condensation	2	5	6	3
467	O2 distribution	2	5	6	4
468	Edible biomass treatment	2	5	6	5
469	Non edible biomass grinding	2	5	6	6

Panel 6 : List of the loops of CIVb

9.1.13. *List of the loops of CV*

Number of loops 11

Loop Number	Description	Code TN 72-1			
500					
501					
502					
503					
504					
505					
506					
507					
508					
509					
510	Consuming O2	5	1		
511	Consuming edible biomass	5	2		
512	Producing faeces	5	3		
513	Producing CO2	5	4		
514	Drying	3	1		
515	Waste handling	3	2		
516	Edible biomass supply	3	1		
517	O2 supply	3	2		
518	Traitment of cabin air	1	1		
519	Urine and Faeces collection	1	2		
520	Organic components collection	1	3		

Panel 7 : List of the loops of CV

9.1.14. *List of alarms*

List of the alarm loops of all compartments

Number of loops 17 **November 2005**

	Loop Number	Description	Code TN 72-1				Comment
CI	900						
	906	Detection of H2					
	907	Detection of small amount of H2S					
	909						
CII	910						
CIII	920	Temperature detection loop					
	921						
	924	Biomass exceeding range detection					
	925	Pressure detection loop					
	926						
CIVa	930	Temperature detection loop					Over temperature - In case of over temperature or lack of gas flow, the system changes to a safety conditions. This basically means to stop the liquid flow operation and to decrease the light intensity to a minimum. In both cases cooling capacity is related to light energy input and proper agitation by the air.
	931	Light detection loop					
	932	Gas flow detection loop					Lack of gas flow - See comment of loop 930
	933						
	934	Biomass exceeding range detection					
	935	Pressure detection loop					Gas over pressure - If the internal pressure surpasses a high pressure limit a safety valve is opened. This is done at the PLC level.
	936						
	938	Flow detection loop					
	939						
CIVb	940	Temperature detection loop					
	941	Light detection loop					
	942	Gas flow detection loop					
	943	Nutrient delivery detection loop					
	944						
	945	Pressure detection loop					
	946						
	948						
	949	Contaminant detection					
CV	950						

Panel 8 : List of the alarm loops

10. Instrument line symbols

[Extracted from ISA S5.1]

10.1. General recommendations

- All lines to be fine in relation to process piping lines (recommended value "line size 1" (VISIO software)
- The most important lines should be kept solid with the secondary lines being broken. If all lines are of equal importance, a usual convention is to break the vertical line;
- An arrow shows the fluid or information direction
- A colour coding of the lines could be defined to make easy the interpretation of a diagram
- The identification characters of a line are consistent for the same project (recommended type for MELISSA could be "character font Arial size 6")
- The line symbols are defined according to the nature of the fluid (See § 8.4)

10.2. Piping line symbol

Piping lines represent the links between the equipments within the loops. Recommended line thickness for MELISSA could be "line size 5" (VISIO Software). The fluids within the pipes are liquid, solid or gas.

10.3. Types of power supply

These designations may also be applied to purge fluid supplies.

Abbreviation	Description
AS	Air Supply
PA	Plant Air
GS	Instrument Air
GA	Gas Supply
ES	Electric Supply
HS	Hydraulic Supply
NS	Nitrogen Supply
SS	Steam Supply
WS	Water Supply

Panel 9 : Types of power supply

10.4. Instrument line symbol [Instrument line symbol.vsd]

ES - 24DC	Instrument supply or connection to process: AS - Air Supply ES - Electric Supply GS - Gas Supply HS - Hydraulic Supply NS - Nitrogen Supply SS - Steam Supply WS - Water Supply The supply level may be added to the instrument supply line, e.g. ES - 24DC a 24 Volt direct current power supply *Note Visio : Hydraulic link in « Instruments gabarit »*
S-15	Undefined signal *Note Visio : Signal link in « Instruments gabarit »*
S-16	Pneumatic signal. (If a gas other rthan air is used, the gas may be identified by a note onthe signal symbol) *Note Visio : Pneumatic link in « Instruments gabarit »*
S-17	Electric signal *Note Visio : Electric link in « Instruments gabarit »*
S-18	Hydraulic signal *Note Visio : Hydraulic link in « Instruments gabarit »*
S-19	Capillary tube *Note Visio : Capillary link in « Instruments gabarit »*
S-20	Electromagnetic or sonic signal (guided) Electromagnetic phenomena include: Heat Radio waves Nuclear Radiation Light *Note Visio : Electromagnetic link in « Instr. gabarit »*
S-21	Electronic or sonic signal (NOT guided) . Electromagnetic phenomena include: Heat Radio waves Nuclear Radiation Light *Note Visio : Electromagnetic link in « Instr. gabarit »*
S-22	Software or data link *Note Visio : Software link in « Instr. gabarit »*
S-23	Mechanical link *Note Visio : Mechanical link in « Instr. gabarit »*
S-26	Electric binary signal *Note Visio : Electric binary link in « Instr. gabarit »*
S-27	Pneumatic binary signal *Note Visio : Pneumatic binary link in « Instr. gabarit »*

Panel 10 : Instrument line symbol

These normalized line symbols exist within VISIO software

10.5. Examples

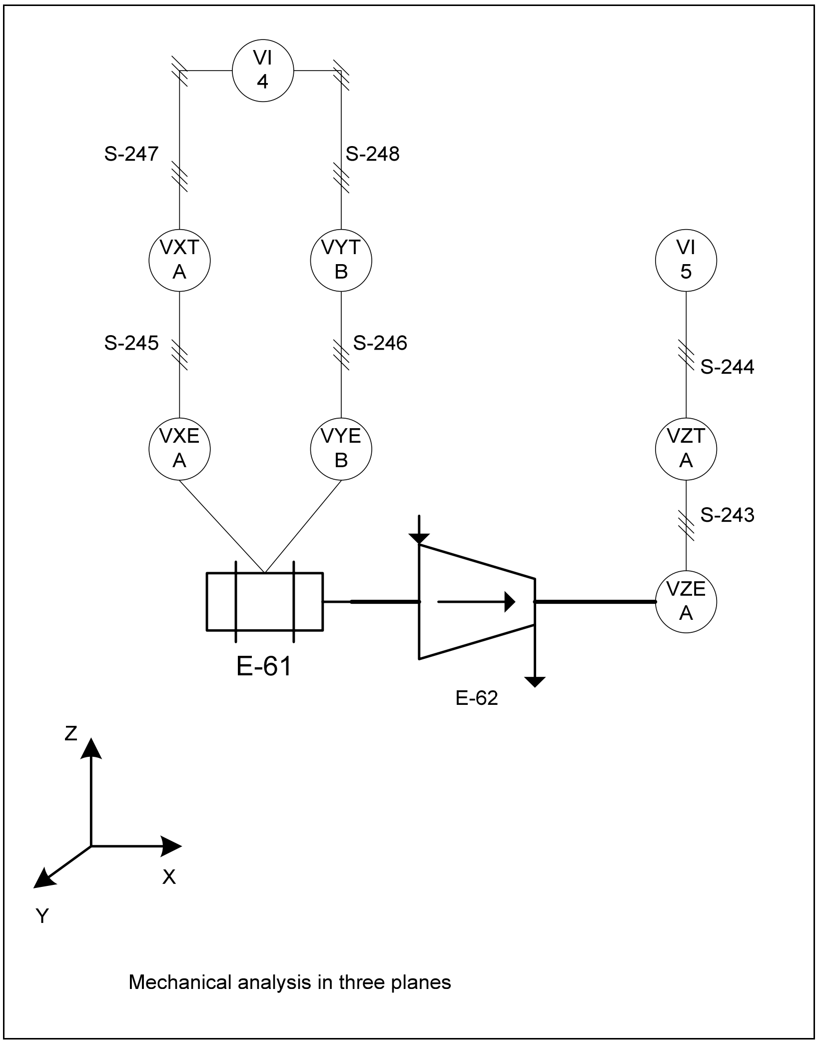

Figure 2 : Example of drawing (VISIO Software)

11. Graphic symbols

[Extracted from ISA S5.3]

11.1. Symbol usage

1. The graphic symbols in this standard are intended for use on Virtual Device Units (VDUs).
2. Because size variations of symbols representing the various pieces of equipment are anticipated, no scale is indicated on the graphic symbol sketches. The integrity of the defined symbols should be preserved by maintaining the aspect ratio depicted.
3. Color coding to improve the perception of information and ease of interpretation of the displayed image is anticipated.
4. Graphic symbols should be arranged to depict spatial relationships, energy, material and data flows in a consistent manner (e.g., left to right, top to bottom, etc.). Equipment outlines and piping lines may be differentiated by colour, intensity, or width.
5. Symbols may be rotated in any orientation on a VDU in order to represent the process in the most effective manner.
6. Arrows may be used on process lines to indicate direction of flow.
7. Symbols should be shown only when they are important to understanding the operation or are an integral part of the process depicted. Symbol qualities, such as luminance, size, color, fill, and contrast should be considered collectively and judiciously in order to avoid any psycho physiological masking of adjacent display targets, such as measurement values, alarm messages, labels, etc.
8. Numeric values and text may be included to enhance comprehension. The values may be either static or dynamic.
9. Graphic displays may contain both static and dynamic symbols and data. The symbol set, white intended for color displays, is also usable on monochromatic displays.
10. Special characteristics of displays should be used to enhance the understanding of process symbols. These characteristics can be used for both static and dynamic symbol applications. These characteristics may be used to indicate the status of process devices:
    - Reverse video
    - Blinking
    - Intensity variation
    - Colour coding
11. Status designation by use of solid or outline forms are particularly applicable to the Rotating Equipment and Valves and Actuators groups of symbols. Prudence in

judgment should be used when adhering to this practice as some symbols should not change from their outline form. In depicting valve position, use solid to show open (material flowing or active) and outline to show closed (material stopped or no active). Another usage is solid/outline to represent a pump running/stopped as the generally accepted practice. Some industries, such as the power industry, use solid/outline to show closed (active or unit energized)/open (no *active or unit deenergized). In these special cases, the explicit uses of these conventions are* to be made clear to the operator and noted in operation manuals. The use of outline and solid (filled) forms to indicate status is as follows:

- An outline symbol form indicates an off, stopped, or no active state.
- A solid (filled) symbol form indicates an on, running, or active state.

12. A symbol may be partially filled or shaded to represent the characteristic of the contents of a vessel, e.g., level, temperature, etc.
13. Properties of physical or chemical states, as measured by primary elements or instruments, can be represented on a VDU by symbolic characters. It is not normal to display these characters on a process display, but they are available if required.
14. Example of the moisture recorder MR 2 if there is a separate primary element, it should be tagged ME 2
15. Use of a user's choice letter to be defined in user's legend

11.2. Grouping of symbols

The graphic symbols for process displays have been divided into related groups. The ISA norm defines 13 groups and their contents are as follows:

Group N°	**Group**	**Symbol**
1	***Connectors***	
2	***Containers and Vessels***	
	Process	Distillation Tower
		Jacketed Vessel
		Reactor
		Vessel
	Storage	Atmospheric Tank Bin Floating Roof Tank Gas Holder Pressure Storage Vessel Weigh Hopper
3	***Electrical***	Circuit Breaker

		Manual Contactor Delta Connection Fuse Motor State Indicator Transformer Wye Connection
4	***Filters***	Liquid Filter Vacuum Filter
5	***Heat Transfer Devices***	Ex changer Forced Air Exchanger Furnace Rotary Kiln
6	***HVAC*** (Heating Ventilating and Air Conditioning)	Cooling tower Evaporator Finned Exchanger
7	***Material Handling***	Conveyor Mill Roll Stand Rotary Feeder Screw Conveyor
8	***Mixing***	Agitator Inline Mixer
9	***Reciprocating Equipment***	Reciprocating Compressor or Pump
10	***Rotating Equipment***	Blower Compressor Pump Turbine
11	***Scrubbers and Precipitators***	Electrostatic precipitator Scrubber
12	***Separators***	Cyclone separator Rotary separator Spray driver
13	***Valves and Actuators*** Actuators	 Actuator Throttling actuator

		Valves	Manual actuator Valve 3-Way Valve Butterfly Valve Check Valve Relief Valve

The symbols will be presented in the TN 78-72. The symbols are categorized into their respective groups and are presented in alphabetical order. Each symbol is described in a Visio file with the following information:

Group	An associated classification of similar symbols
Subgroup	Represents further division within a group
Symbol Name	The name of the process symbol
Symbol Mnemonic	A four-character name given to the symbol to be used as its reference name in a computer system
Description	A brief description of what the symbol represents
Symbol Drawing	The actual drawing of the symbol itself. The shape that is drawn corresponds to a VISIO shape. Process connections and flow directions have been included with some symbols for functional clarity.

11.2.1. Action to be done

To update the control view of MELISSA (see TN 66-52) and complete them with more detailed standardized process views.

12. Equipment identification

12.1. Practical identification rules

- The total number of letters within one group should not exceed 4.
- To reduce the number of letters, it is possible to use sub-grouping letters or “user’s choice”
- All letters of the functional identification are uppercase (recommended size for MELISSA “Arial size 6”)
- Symbols may be drawn with any orientation.
- Signal lines may be drawn on a diagram entering or leaving the appropriate part of a symbol at any angle.

See Excel Files:

- ”Table 1 – Identification letters.xls”
- “Table 2 - A – B – C – Typical letter combinations.xls”
- “Primary element symbol.vsd”

12.2. Identification letters

[Extracted from ISA S5.1]

12.2.1. Table 1 - Identification letters

For easier consultation see Excel file “Table 1 – Identification letters.xls”

	FIRST LETTER (4)		SUCCEEDING LETTERS (3)		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	Analysis (5,19)	-	Alarm	-	Auto / Stop (23)
B	Burner, Combustion	-	User's choice (1)	User's choice (1)	User's choice (1)
C	User's choice (1)	-	-	Control (13)	-
D	User's choice (1)	Différential (4)	-	-	-
E	Voltage	-	Sensor (Primary element)	-	-
F	Flow rate	Ratio (fraction) (4)		-	Avant (Forward) (24)
G	User's choice (1)	-	Glass, viewing device (9)	-	-
H	Hand	-	-	-	High, (7,15,16)
I	Current (electrical)	-	Indicate (10)	-	-
J	Power	Scrutation (scan) (7)	-	-	-
K	Time, Time schedule	Time Rate of Change (4,21)	-	Control station (22)	-
L	Level	-	Light (11)	-	Low (7,15,16)
M	User's choice (1)	Momentané (4)	-	-	Middle, Intermediate (7,15), Hand mode (23)
N	User's choice (1)	-	User's choice (1)	User's choice (1)	User's choice (1)
O	User's choice (1)	-	Orifice, Restriction	-	-
P	Pressure, Vacuum	-	Point test connection	-	-
Q	Quantity	Integrate - Totalize (4)	-	-	-
R	Radiation	-	Record (17)	-	Rearming (25)
S	Speed, Frequency	Safety (4,8)	-	Switch (13)	-
T	Temperature	-	-	Transmitter (18)	Maintenance or test mode (23)
U	Multivariable (6)	-	Multi-fonction (12)	Multi-fonction (12)	Multi-fonction (12)
V	Vibration, Mechanical Analysis (19)	-	-	Valve, Damper, Louver (13)	-
W	Weight, Force	-	Well	-	-
X	Unclassified (2)	X Axis	Unclassified (2)	Unclassified (2)	Unclassified (2)
Y	Event State or Presence (20)	Y Axis	-	Relay, Compute, Convert (13,14,18)	-
Z	Position, Dimension	Z Axis	-	Driver, Actuator, Unclassified final control element	-

Panel 11 : Table 1 - Identification letters

12.2.2. Notes for Table 1

1. A "user's choice" letter is intended to cover unlisted meanings that will be used repetitively in particular project. If used, the letter may have one meaning as a first

letter and another meaning as succeeding letter. The meanings need to be defined only once in a legend for that project.

2. The unclassified letter X is intended to cover unlisted meanings that will be used only once or used to a limited extent. If used, the letter may have any number of meanings as a first-letter and any number of meanings as a succeeding-letter.
3. The grammatical form of the succeeding-letter meanings may be modified as required. For example, “indicate” may be applied as “indicator” or “indicating”, “transmit” as “transmitter” or “transmitting”, etc…
4. Any first-letter, if used in combination with modifying letters D (differential), F (ratio), M (momentary), K (time rate of change), Q (integrate or totalize), or any combination of these intended to represent a new and separate measured variable, and the combination is treated as a first-letter entity. Thus, instruments TDI and TI indicate two different variables.
5. First-letter A (analysis) covers all analyses not described by a user’s choice letter. It is expected that the type of analysis will be defined outside a tagging bubble.
6. Use of first-letter U for multivariable instead of a combination of first-letters is optional.
7. The use of modifying terms “high”, “low”, “middle” or “intermediate” and “scan” is optional
8. The term safety applies to emergency protective primary elements and emergency protective final control elements only. Thus, a self-actuated valve that prevents operation of a fluid system as a higher-than-desired pressure by bleeding fluid from the system is back-pressure-type PCV, even if the valve is non intended to be used normally. However, this valve is designated as a PSV if it is intended to protect against emergency conditions, i.e., conditions that are hazardous to personnel and/or equipment and that are not expected to arise normally. The designation PSV applies to all valves intended to protect against emergency pressure conditions regardless of whether the valve construction and mode of operation place them in the category of the safety valve, relief valve, or safety relief valve. A rupture disc is designated PSE.
9. The passive function G applies to instruments or devices that provide an uncalibrated view, such as sight glasses and television monitors.
10. “Indicate” normally applies to the readout – analog or digital – of an actual measurement. In the case of a manual loader, it may be used for the dial or setting indication, i.e., for the value of the initiating variable.
11. A pilot light that is part of an instrument loop should be designated by a first-letter followed by the succeeding-letters L. For example, a pilot light that indicates an expired time period should be tagged KQL; If it is desired to tag a pilot light that is not part of an instrument loop, the light is designated in the same way. For example, a running light for an electric motor may be tagged EL, assuming voltage to be the appropriate measured variable, or YL, assuming the operating status is being

monitored. The unclassified variable X should not be used for applications which are limited in extent. The designation XL should not be used for motor running lights, as these are commonly numerous. It is permissible to use the user's choice letters M, N or O for a motor running light when the meaning is previously defined. If M is used, it must be clear that the letter does not stand for the word "motor", but for a monitored state.

12. Use of a succeeded-letter U for "multifunction" instead of a combination of other functional letters is optional. This non-specific function designator should be used sparingly.
13. A device that connects, disconnects or transfers one or more circuits may be either a switch, a relay, an ON-OFF controller, or a control valve, depending on the application. If the device manipulates a fluid process stream and is not a hand-actuated ON-OFF block valve, it is designated as a control valve. For all applications to use the succeeding-letters CV for anything other than a self-actuated control valve. For all applications other than fluid process streams, the device is designated as follows:
    - A switch, if it is actuated by hand.
    - A switch or an ON-OFF controller, if it is automatic and if it is the first such device in a loop. The term "switch" is generally used if the device is used for alarm, pilot light, selection, interlock or safety.
    - The term "controller" is generally used if the device is used for normal operating control.
    - A relay, if it is automatic and if it is not the first such device in a loop, i.e., it is actuated by a switch or an ON-OFF controller.
14. It is expected that the functions associated with the use of succeeding-letters Y will b defined outside a bubble on a diagram when further definition is considered necessary. This definition need to be made when the function is self-evident, as for a solenoid valve in a fluid signal line.
15. The modifying terms "high", "low" , "middle" or "intermediate" correspond to values of the measured variable, not to values of the signal, unless otherwise noted. For example, a high-level alarm derived from a reverse-acting level transmitter signal should be an LAH, even though the alarm is actuated when the signal falls to a low value. The terms may be used in combinations appropriate.
16. The terms "high" and "low", when applied to positions of valves and other open-close devices, are defined as follows:
    - "high" denotes that the valve is in or approaching the fully open position.
    - "low" denotes that it is in or approaching the fully closed position.

17. The word “record” applies to ,any form of permanent storage of information that permits retrieval by any means.
18. For use of the “transmitter” versus “converter”, see the definition in the glossary.
19. First-letter V, “vibration or mechanical analysis” is intended to perform the duties in machinery monitoring that the letter A performs in more general analyses. Except for vibration, it is expected that the variable of interest will be defined outside the tagging bubble.
20. First-letter Y is intended for use when control or monitoring responses are event-driven as opposed to time or time schedule-driven. The letter Y , in this position, can also signify presence or state.
21. Modifying-letter K, in combination with a first-letter such as L, T or W signifies a time rate of change of the measured or initiating variable. The variable WKIC, for instance, may represent a rate of weight loss controller.
22. Succeeding-letter K is a user’s option for designating a control station, while the succeeding-letter C is used for describing automatic or manual controllers.
23. The Succeeding-Letters A and/or M and/or T could be used to clear the description of commands : A for Automatic mode, M for Manual mode and T for Test mode.
24. The Succeeding-letter F could be used to clear the description of command : F for Forward
25. The Succeeding-Letter R could be used to clear the description of command : R for Rearming.

12.3. Typical letter combination

[Extracted from ISA S5.1]

12.3.1. Section A – Controllers and readout devices

First Letter	Initiating or measured variable	Controllers				Readout devices	
		Recording	Indicating	Blind	Self actuated control valve	Recording	Indicating
A	Analysis	ARC	AIC	AC	-	AR	AI
B	Burner/Combustion	BRC	BIC	BC	-	BR	BI
C	User's Choice	-	-	-	-	-	-
D	User's Choice	DRC	DIC	DC	-	DR	DI
E	Voltage	ERC	EIC	EC	-	ER	EI
F	Flow rate	FRC	FIC	FC	FCV, FICV	FR	FI
FQ	Flow quantity	FQRC	FQIC	-	-	FQR	FQI
FF	Flow ratio	FFRC	FFIC	FFC	-	FFR	FFI
G	User's Choice	-	-	-	-	-	-
H	Hand	-	HIC	HC	-	-	-
I	Current	IRC	IIC	-	-	IR	II
J	Power	JRC	JIC	-	-	JR	JI
K	Time	KRC	KIC	KC	KCV	KR	KI
L	Level	LRC	LIC	LC	LCV	LR	LI
M	User's Choice	MRC	MIC	MC	-	MR	MI
N	User's Choice	-	-	NC	-	-	-
O	User's Choice	-	-	-	-	-	-
P	Pressure/Vacuum	PRC	PIC	PC	PCV	PR	PI
PD	Pressure differential	PDRC	PDIC	PDC	PDCV	PDR	PDI
Q	Quantity	QRC	QIC	-	-	QR	QI
R	Radiation	RRC	RIC	RC	-	RR	RI
S	Speed/Frequency	SRC	SIC	SC	SCV	SR	SI
T	Temperature	TRC	TIC	TC	TCV	TR	TI
TD	Temperature differential	TDRC	TDIC	TDC	TDCV	TDR	TDI
U	Multivariable	-	-	-	-	UR	UI
V	Vibration/Machinery analysis	-	-	-	-	VR	VI
W	Weight/Force	WRC	WIC	WC	WCV	WR	WI
WD	Weight/Force differential	WDRC	WDIC	WDC	WDCV	WDR	WDI
X	Unclassified	-	-	-	-	-	-
Y	Event/State/Presence	-	YIC	YC	-	YR	YI
Z	Position/Dimension	ZRC	ZIC	ZC	ZCV	ZR	ZI
ZD	Gauging/Deviation	ZDRC	ZDIC	ZDC	ZDCV	ZDR	ZDI

Panel 12 : Typical letters combination (A)

12.3.2. Section B – Switches and transmitters

First Letter	Initiating or measured variable	Switches and alarm devices			Transmitters		
		High	Low	Combined	Recording	Indicating	Blind
A	Analysis	ASH	ASL	ASHL	ART	AIT	AT
B	Burner/Combustion	BSH	BSL	BSHL	BRT	BIT	BT
C	User's Choice	-	-	-	-	-	-
D	User's Choice	DSH	DSL	DSHL	DRT	DIT	DT
E	Voltage	ESH	ESL	ESHL	ERT	EIT	ET
F	Flow rate	FSH	FSL	FSHL	FRT	FIT	FT
FQ	Flow quantity	FQSH	FQSL	-	-	FQIT	FQT
FF	Flow ratio	FFSH	FFSL	-	-	-	-
G	User's Choice	-	-	-	-	-	-
H	Hand	-	-	HS	-	-	-
I	Current	ISH	ISL	ISHL	IRT	IIT	IT
J	Power	JSH	JSL	JSHL	JRT	JIT	JT
K	Time	KSH	KSL	KSHL	KRT	KIT	KT
L	Level	LSH	LSL	LSHL	LRT	LIT	LT
M	User's Choice	MSH	MSL	MSHL	MRT	MIT	MT
N	User's Choice	NSH	NSL	-	-	-	-
O	User's Choice	-	-	-	-	-	-
P	Pressure/Vacuum	PSH	PSL	PSHL	PRT	PIT	PT
PD	Pressure differential	PDSH	PDSL	-	PDRT	PDIT	PDT
Q	Quantity	QSH	QSL	QSHL	QRT	QIT	QT
R	Radiation	RSH	RSL	RSHL	RRT	RIT	RT
S	Speed/Frequency	SSH	SSL	SSHL	SRT	SIT	ST
T	Temperature	TSH	TSL	TSHL	TRT	TIT	TT
TD	Temperature differential	TDSH	TDSL	-	TDRT	TDIT	TDT
U	Multivariable	-	-	-	-	-	-
V	Vibration/Machinery analysis	VSH	VSL	VSHL	VRT	VIT	VT
W	Weight/Force	WSH	WSL	WSHL	WRT	WIT	WT
WD	Weight/Force differential	WDSH	WDSL	-	WDRT	WDIT	WDT
X	Unclassified	-	-	-	-	-	-
Y	Event/State/Presence	YSH	YSL	-	-	-	YT
Z	Position/Dimension	ZSH	ZSL	ZSHL	ZRT	ZIT	ZDT
ZD	Gauging/Deviation	ZDSH	ZDSL	-	ZDRT	ZDIT	ZDT

Panel 13 : Typical letters combination (B)

12.3.3. Section C – Other devices

First letter	Initiating or measured variable	Solenoids, relays, computing devices	Primary element	Test Point	Well or Probe	Viewing device, glass	Safety device	Fianl element
A	Analysis	AY	AE	AP	AW	-	-	AV
B	Burner/Combustion	BY	BE	-	BW	BG	-	BZ
C	User's Choice	-	-	-	-	-	-	-
D	User's Choice	DY	DE	DP	-	-	-	DZ
E	Voltage	EY	EE	-	-	-	-	EZ
F	Flow rate	FY	FE	FP	-	FG	-	FV
FQ	Flow quantity	FQY	FQE	-	-	-	-	FQV
FF	Flow ratio	-	FE	-	-	-	-	FFV
G	User's Choice	-	-	-	-	-	-	-
H	Hand	-	-	-	-	-	-	HV
I	Current	IY	IE	-	-	-	-	IZ
J	Power	JY	JE	-	-	-	-	JV
K	Time	KY	KE	-	-	-	-	KV
L	Level	LY	LE	-	LW	LG	-	LV
M	User's Choice	-	-	-	-	-	-	-
N	User's Choice	NY	-	-	-	-	-	NV
O	User's Choice	-	-	-	-	-	-	-
P	Pressure/Vacuum	PY	PE	PP	-	-	PSV	PV
PD	Pressure differential	PDY	PE	PP	-	-	-	PDV
Q	Quantity	QY	QE	-	-	-	-	QZ
R	Radiation	RY	RE	-	RW	-	-	RZ
S	Speed/Frequency	SY	SE	-	-	-	-	SV
T	Temperature	TY	TE	TP	TW	-	TSE	TV
TD	Temperature differential	TDY	TE	TP	TW	-	-	TDV
U	Multivariable	UY	-	-	-	-	-	UV
V	Vibration/Machinery analysis	VY	VE	-	-	-	-	VZ
W	Weight/Force	WY	WE	-	-	-	-	WZ
WD	Weight/Force differential	WDY	WE	-	-	-	-	WDZ
X	Unclassified	-	-	-	-	-	-	-
Y	Event/State/Presence	YY	YE	-	-	-	-	YZ
Z	Position/Dimension	ZY	ZE	-	-	-	-	ZV
ZD	Gauging/Deviation	ZDY	ZDE	-	-	-	-	ZDV

Panel 14 : Typical letters combination (C)

13. Colour coding

13.1. Guidelines

1. Information-bearing color schemes should be simple, consistent, and unambiguous.
2. ***Number of colors*** : The most common color technology is the CRT using the raster display scheme and an additive color generation technique based on the three primaries: red, blue, and green. The number of selectable colors can range from six plus black and white to the thousands. The number of colors in one display should be limited to the minimum necessary to satisfy the process interface objectives of the display. Color is an effective coding technique for dynamic identification and classification of display elements. Used judiciously, it can improve operator performance, e.g., reduce search time, improve element identification, etc. Conversely, irrelevant color can act as visual noise and negate the positive effects of color coding. Typically, six colors (plus black and white) can accommodate the dynamic coding requirements of process displays.

Figure 3 : Color limitation

3. ***Background color*** : Large background areas should be black. In situations where the black background results in a high task/surround illumination ratio, a brighter background may be used, preferably blue or brown.
4. ***Compatible color combinations*** : those with high chromaticity contrast, should be used. Some good combinations include: black-on-yellow, red-on-white, blue-on-white, and green-on-white. Combinations to avoid include: yellow-on-white, yellow-on-green, red-on-magenta, and cyan-on-green. In each case, the weight or size of the foreground element must also be considered. Certain combinations like blue-on-black can be acceptable only when the blue element is sufficiently large. These generalizations neglect the effects of illumination levels and ambient lighting. Each pair should be evaluated on a per-case basis.

All combinations

Letters colour \ Background colour	white	black	red	blue	green	yellow	cyan	magenta
white		TEXT 12	TEXT 13	TEXT 14	TEXT 15	TEXT 16	TEXT 17	TEXT 18
black	TEXT 21		TEXT 23	TEXT 24	TEXT 25	TEXT 26	TEXT 27	TEXT 28
red	TEXT 31	TEXT 32		TEXT 34	TEXT 35	TEXT 36	TEXT 37	TEXT 38
blue	TEXT 41	TEXT 42	TEXT 43		TEXT 45	TEXT 46	TEXT 47	TEXT 48
green	TEXT 51	TEXT 52	TEXT 53	TEXT54		TEXT 56	TEXT 57	TEXT 58
yellow	TEXT 61	TEXT 62	TEXT 63	TEXT 64	TEXT 65	TEXT 66	TEXT 67	TEXT 68
cyan	TEXT 71	TEXT 72	TEXT 73	TEXT 74	TEXT 75	TEXT 76		TEXT 78
magenta	TEXT 81	TEXT 82	TEXT 83	TEXT 84	TEXT 85	TEXT 86	TEXT 87	

Panel 15 : All color combination

Good Choices

Letters colour \ Background colour	white	black	red	blue	green	yellow	cyan	magenta
white		TEXT 12	TEXT 13	TEXT 14	TEXT 15		TEXT 17	TEXT 18
black	TEXT 21		TEXT 23			TEXT 26	TEXT 27	TEXT 28
red	TEXT 31	TEXT 32				TEXT 36		
blue	TEXT 41					TEXT 46		TEXT 48
green	TEXT 51							
yellow		TEXT 62	TEXT 63	TEXT 64				
cyan								
magenta		TEXT 82						

Panel 16 : Good color combination

5. Use color as a redundant indicator along with text, symbol, shape, size, reverse video, blinking, and intensity coding to preserve communications of critical process state and quality information with individuals having limited color perception.
6. To insure fast operator response, use highly saturated colors such as red or yellow.
7. Colors should not be used to indicate quantitative value.
8. The display designer should establish a project-related set of generic color meanings before developing a list of specific color-to-display-element associations. Each project may have its unique set of generic definitions; e.g., Project A uses red to indicate closed or inactive states, while Project B uses green. In some special cases, such as the power industry, red may indicate closed and active or unit energized. This is suitable as long as the color meanings are defined as such for the particular project. Listed below is an example of a unique project-related color plan:

13.1.1. Colour plan example

Color	**Generic meaning**	**Element association**
BLACK	BACKGROUND	
RED	EMERGENCY	1- STOP 2- HIGHEST PRIORITY ALARM 3- CLOSED 4- OFF
YELLOW	CAUTION	1- ABNORMAL CONDITION 2- SECOND PRIORITY ALARM
GREEN	SAFE	1- NORMAL OPERATION 2- START 3- OPEN 4- ON
CYAN (LIGHT BLUE)	STATIC & SIGNIFICANT	1- PROCESS EQUIPMENT IN SERVICE 2- MAJOR LABELS
BLUE	NONESSENTIAL	1- STANDBY PROCESS EQUIPMENT 2- LABELS, TAGS, ETC.
MAGENTA (PURPLE)	RADIATION	1- RADIATION ALARMS 2- QUESTIONABLE VALUES
WHITE	DYNAMIC DATA	1- MEASUREMENTS & STATE INFORMATION 2- SYSTEM MESSAGES 3- TREND 4- ACTIVE SEQUENTIAL STEP

14. UNITS

The ISA Standards and Practice Department is aware of growing need for attention to the metric system of units in general, and the international system of units (SI) in particular, in the preparation of instrumentation standards. The “Metric Practice Guide”, which has been published by the American Society for Testing and Materials as ANSI designation Z210.1 (ASTM E380-76 IEEE Std 268-1975), and the future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

15. Glossary of technical terms

See Excel File ”Glossary MELISSA – Standard ISA S5.xls”