IDM UID
LAJF9S
VERSION CREATED ON / VERSION / STATUS
06 Mar 2015 / 1.1 / Approved
EXTERNAL REFERENCE

CODAC Architecture / Design Description Document

03_Functional Breakdown for Diagnostics Plant I&C

Functional Breakdown for Diagnostics Plant I&CDiagnostics functional breakdown will be used to identify each Plant I&C function. The functional breakdown is generated using several functional group types. These group types are identified based on device functionality, usage function, system management, operation procedure, Plant I&C interface, Data acquisition, Data Processing COTS etc. Functional breakdown is done upto level 5. In that Level 1 and Level 2 are the conceptual design while Level 3 to 5 is detailed design.

Approval Process			
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Document Security: Internal Use *RO: Simrock Stefan*			
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Change Log			
03_Functional Breakdown for Diagnostics Plant I&C (LAJF9S)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v1.1	Approved	06 Mar 2015	Updated Matrix
v1.0	Approved	22 Nov 2013	

Table of Contents

List of Figures

List of Tables

1 Introduction

The work flow for plant I&C design documentation with its PCDH deliverables is shown in figure 1. The designer starts with the description of the operational procedure of the relevant diagnostics. This is followed by a functional breakdown to level 2 for conceptual design and level 4 for detailed design. The functions have to support all operational needs with process variables and their attributes being defined for individual functions in the detailed design. Then he develops a hardware architecture in which all of the functions can be implemented. The allocation of functions to hardware will be also documented. Finally a state machine for automation will be defined, the cubicle layout with all cabling documentation developed and the interface sheets produced. All of these deliverables are documented in the design documents.

1.1 Acronyms

Table 1 : Acronyms

AVN	Audio Video network
CHD	CODAC & Information Technology, Heating & Current Drive, Diagnostics
CIN	Central Interlock network
CODAC	Control, Data Access and Communication
COS	Common Operating State
COTS	Commercial Off-The-Shelf
CSN	Central Safety network
DA	Domestic Agency
DAN	Dara Archiving Network
FAT	Factory Acceptance Test
FBS	Functional breakdown structure
FC	Fast Controller
I&C	Instrumentation and Control
I/O	Input / Output
IO	ITER Organization
PBS	Plant Breakdown structure
PCDH	Plant Control Design Handbook
PON	Plant operation network
PSH	Plant System Host
PSOS	Plant System Operating State
RO	Responsible Officer
SDN	Synchronous data bus network
TCN	Time communication network

1.2 References

Example Template - Functional Breakdown Structure for Diagnostics (KE685T)

2 Overview

Diagnostics functional breakdown will be used to identify each Plant I&C function. The functional breakdown is generated using several functional group types. These group types are identified based on device functionality, usage function, system management, operation procedure, Plant I&C interface, Data acquisition, Data Processing COTS etc. Functional breakdown is done upto level 5. In that Level 1 and Level 2 are the conceptual design while Level 3 to 5 is detailed design.

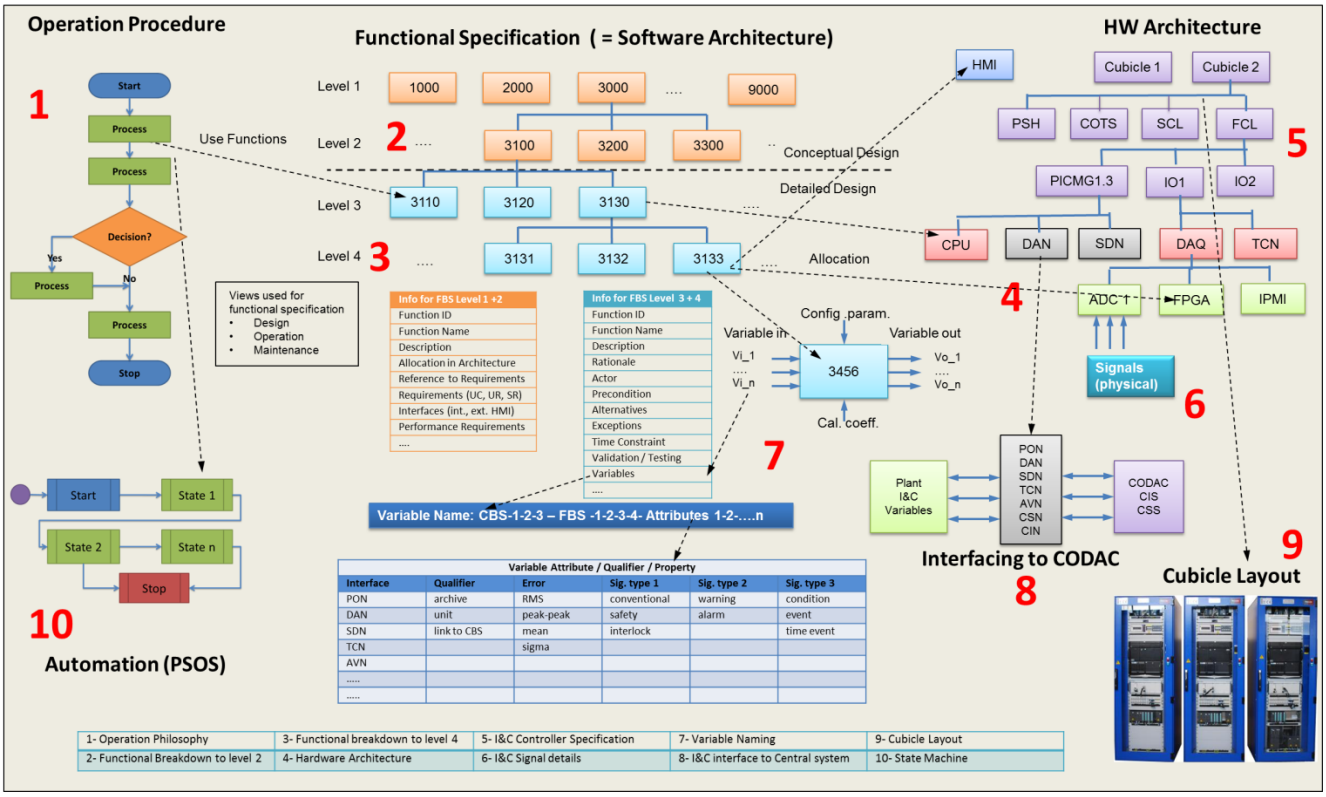

Figure 1: I&C Design Workflow

3 Functional Breakdown

3.1 Rationale for Functional Breakdown

1. Breakdown based on compromise of different functional needs in plant I&C life-cycle
    - Specification
    - Design
    - Implementation
    - Acceptance Testing
    - Commissioning
    - Operation
    - Maintenance
2. Functional views sorted in about 22 groups
    - Around 13 generic main groups
        i. Plant operators global vi
        ii. Operation procedure
        iii. Instrumentation (Measurement) and Control
        iv. (System) Management
        v. (System) Usage
        vi. (Subsystem) Usage
        vii. (Device) Usage
        viii. (Component) Usage
        ix. Commercial control
        x. Plant system (other PBS)
        xi. Signal conditioning
        xii. Data acquisition / data processing
        xiii. Interface
    - Around 9 function specific groups
        i. Meas./Ctrl/ related
        ii. Interface related
        iii. Signal conditioning specific (filtering)
        iv. Data acquisition specific (data types)
        v. Data processing specific (math functions)
        vi. COTS specific
        vii. System management specific
        viii. Machine protection specific
        ix. Occupational safety specific
3. Functional breakdown to level 2 describes conceptual design in hierarchical structure
    - Attempt of generic breakdown since all diagnostics serve same goal and common concept
    - Level 1 takes into account
        i. Global and local functionality

ii. Signal chain from producer (sensor/actuator) to consumers (applications)
iii. Standard (see signal chain) and commercial controllers
iv. Conventional, protection, safety
v. Usage (operation) and (system) management

- Level 2 take into account
  i. Functional view groups matching level 1 needs
  ii. Instrumentation and Control view

4. Functional breakdown to level 4 (and 5) describes detailed design in non-hierarchical structure but operationally preferred structure
   - Generic usage and management functional view groups
   - Specific usage and management functional view groups
   - Preferred structure can be re-arranged if beneficial for plant I&C development and deployment.

3.2 Group Types

3.2.1 Group Type 1 – Level 1 Functions

- **Global** – This level 1 function which will be used to define I&C interface with other PBS (eg. PBS 31, PBS 17 etc.)
- **Signal Conditioning** - This level 1 function will be used to define signal conditioning function within the Plant I&C.
- **Data Acquisition** – This level 1 function will be used to define data acquisition function within plant I&C
- **Data Processing** – This level 1 function will be used to define data Processing function within plant I&C
- **System Management** – This level 1 function will be used to define system management (Cubicle, Fast controller etc) within plant I&C
- **Operation** – This level 1 function will be used to define operation (Plant automation, Plant configuration)
- **Machine Protection** – This level 1 function will be used to define machine protection functions used in Plant I&C
- **Occupational safety** - This level 1function will be used to define safety functions
- **Commercial controllers (COTS)** – This level 1 function will be used to define and identify COTS device functions in Plant I&C
- **Interface** – This level 1 function will be used to define interfaces in plant I&C

3.2.2 Group Type 2 – Plant Break Down structure

In this group type all PBS are mentioned which has I&C interface with diagnostics Plant I&C. Initially following PBS are identified

- PBS 31 – Vacuum
- PBS 17 – Diverter
- PBS 47 – Plasma Control System

- PBS 65 – Liquid and Gas Distribution
- PBS 55 - Diagnostics Port plug instrumentation
- PBS 26 – Cooling water system
- PBS XX – (As per plant I&C interface)

3.2.3 Group Type 3 – Operation Procedure

In this group type functions associated with the operation procedure are mentioned.

- Automate
- Configure
- Initialise
- Control
- Monitor
- Diagnose
- Calibrate
- Condition
- Test

3.2.3.1 Group Type 3-A – State machine parameters

In this group type, following functions associated with the State Machine view

- Evaluate Conditions
- Evaluate Events
- Automation Status

3.2.4 Group Type 4 – Instrumentation and Control

In this group type, following functions associated with the instrumentation and control view

- Measurement
- Control
- Calibrate
- Quality Tag
- Production state
- Filters
- Measurement Analysis

3.2.4.1 Group Type 4-A – Application Measurement and Control

- Measurement
- Control

Group Type 4-B -

3.2.5 Group Type 5 – System Management Functions

- Configure
- Command
- Control
- Status

- Monitor
- Automation
- Health
- Timing

3.2.5.1 Group Type 5-A – Standard device management

- Cubicle
- Fast Controller
    - Fast Controller CPU
    - Fast Controller IO Chassis
- DAQ devices
- Slow Controller
- PSH
- Master Controller
- Network Switch

3.2.5.2 Group Type 5-B – System Parameters

- Power
- Temperature
- FAN Speed
- Health Status
- Serial No
- Manufacturer
- Fan Voltage
- FAN On/Off

3.2.6 Group Type 6 – Commercial Controls (COTS)

- Laser
- HV – Power supply
- LV – Power Supply
- Mass Spectrometer
  Optical Spectrometer
- Vacuum Controller
- Camera
- Signal Generator
- Microwave generator
- RF Power Amplifier
- Pre Amplifier

3.2.7 Group Type 7 – Data Acquisition

- Condition Signal
- Acquire Raw Data
- Process Data
- Provide Measurement
- Time Stamp Data

- Measurement
- Synchronization
- DAQ Component

3.2.7.1 Group Type 7-A – DAQ Component

- A/D Conversion
- D/A Conversion
- Frame Grabbing
- Digital Input Output
- Pre-Processing

3.2.7.2 Group Type 7-B – DAQ Devices

- ADC Card
- DAC Card
- Frame Grabbing Card
- Digital IO Card
- Timing Card

3.2.7.3 Group Type 7-C – DAQ Channels

- Analog Channels
- Digital Channels

3.2.7.4 Group Type 7-D – Timing Specific Functions

- Clock
- Trigger
- Time Stamp
- Epics Time Stamp
- Clock Jitter

3.2.8 Group Type 8 – Signal Conditioning functions

- Signal Interface
- Amplification Drive
- Filters
- Attenuation
- Isolation
- Multiplexing
- Digital Signal Processing

3.2.8.1 Group Type 8-A – Signal Conditioning Specific functions

- Impedance
- Bandwidth
- Coupling
- Gain
- Offset
- Voltage Divide
- Buffer Voltage Divide

- High voltage divider
- Balanced differential divider
- Optical isolation
- Magnetic isolation
- Digital isolation

3.2.9 Group Type 9 – Data Processing Functions

- Measurement
- Control
- Calibrate
- Filters
- Analysis

3.2.9.1 Group Type 9-A – Measurement functions

- Events
- Alarm
- Measurement Data
- Measurement Error
- Quality Tag
- Timestamp Data

3.2.9.2 Group Type 9-B- Control Functions

- PID Control
- Control Shutter
- Control Actuators
- Control Heater

3.2.9.3 Group Type 9-C – Calibration

- In-Situ Calibration
- Energy Calibration
- Electronic Calibration

3.2.9.4 Group Type 9-D – Filter Function

- Low Pass Filet
- High Pass Filter
- Band Pass Filter
- Band Stop Filter

3.2.9.5 Group Type 9-E – Mathematical functions

- Integral
- Derivative
- Polynomial Evaluation
- Linear Evaluation
- Filters
- Statistics
    - Mean

        - Min
        - Max
        - RMS
        - Standard Deviation
        - Averaging
        - Moving Average
        - Median
        - Variance
    - Signal Operation
    - Transform
        - Fast Fourier Transform
        - Fast Hilbert Transform
        - fast Hartley transform (FHT)
        - Laplace Transform
        - Inverse FFT

3.2.10 Group Type 10 – Interface

- DAN
- SDN
- TCN
- PON
- AVN
- CIN
- CSN
- PCIe
- GbE

3.2.10.1 Group Type 10-A – Interface specific function

- Buffer Data
- Stream Data
- Interface
- Archive Data
- Real time streaming
- Timing
- Audio-Video streaming

3.2.11 Group Type 11 – Machine Protection

- Plant protection
- Interlock

3.2.12 Group Type 12 – Occupational Safety

- COTS Devices

4 Functional Breakdown for Diagnostics Plant I&C

Following table help to generate functional breakdown structure for diagnostics pant I&C

Table 2 : FBS Matrix

Level 1	Level 2	Level 3	Level 4	Level 5
FBS 1 (Global)	GT 2	GT 4	GT 4-A	
FBS 1 (Signal Conditioning)	GT 8	GT 5	GT 8-A, GT 9-D	
FBS 1 (Data Acquisition)	GT 7-A	GT 7, GT 9-E	GT 7-B	GT 7-C
FBS 1 (Data Processing)	GT 9	GT 4-A, GT 9-B, GT 9-C, GT 9-D, GT 9-E	GT 9-A	
FBS 1 (System Management)	GT 5-A	GT -5	GT 5-B	
FBS 1 (Operation)	GT 3	GT 3A		
FBS 1 (Machine Protection)	GT 11	GT6		
FBS 1 (Occ. Safety)	GT 6			
FBS 1 (COTS)	GT 6	GT 3, GT 4, GT 5, GT 9	GT 4-A, GT 5-B, GT 9-A, GT 9-E, GT 9-D	
FBS 1 (Interface)	GT 10	GT 3	GT 10-A	

Preferred functional breakdown for Diagnostics (Example)

Example Template - Functional Breakdown Structure for Diagnostics (KE685T)

This template is live document.

5 Attributes for Diagnostics Plant I&C

6 Variable Naming for Diagnostics Plant I&C

The plant system function identifier shall be based upon a Control Breakdown Structure (CBS) and satisfy the following naming convention:
- Within each hierarchical CBS level, a plant system function is identified by an alphanumeric string of maximum 4 characters: FFFF. This string identifier shall be unique within the CBS level concerned.
- The full plant system function name consists of all required function identifiers separated by the separator (hyphen "-").

Therefore the plant system function format is: FFFF-FFFF-FFFF for a level 3 control function.

The variable name format is: **Control Function Identifier: Variable Identifier**

The variable identifier is a free string of 16 characters maximum VV…VV, provided the full name including the function identifier is unique within the whole ITER plant.
Therefore, the variable name format is:
FFFF-…….FFFF: VV….VV
Since the FBS has a limited number of levels (typically 4) and we are constructing the FBS from functional groups, we cannot always cover all functional information in them. Additional information will the attribute groups (around 20-30) which may include functional groups if needed.

Finally variable can be only distinguished by different attributes; this information needs to get into the name (very cryptic like 1 (or 2) characters per attribute group).

The naming concept is therefore

CBS1-CBS2-CBS3 FBS1-FBS2FBS3FBS4(FBS5)-An-Am-Ao-Ap-(....)
Where n,m,o,p identify the attribute groups 01...-30(or more) in which the variables are different
The attribute groups should be only used in the naming where required to differentiate variable.

Example

Example 1 – Read Time Stamp Data for micro fission chamber

CBS 1 – **D1**
CBS 2 – **I3**
CBS 3 – **B3A0**
Level 1 Function – **Data Processing (DP)**
Level 2 Function – **Measurement (ME)**
Level 3 Function – **Measurement 1 (M1)** It may be actual measurement function
Level 4 Function – **Time Stamp Data (TD)**
Level 5 Function – **There no Function**
Attributes
Attribute 1 – **Read**
Attribute 2 – **Error**
Attribute 3 – **No Attribute**
Attribute 4 – **No Attribute**
Attribute 5 – **No Attribute**
Then the variable Name is

***D1-I3-B3A0*:DPMEM1TD00-RE000**