PLC Specification

Revision 06 – 07/05/2021

Contents

1 HARDWARE REQUIREMENTS

All PLC hardware that would be required to meet the I/O and philosophy requirements. Architecture and Bill of Materials provided as reference. When specified in the tender document, provision shall be made for mounting the PLC hardware in the motor control centre. All PLC components will be supplied by the contractor. Details of the equipment to be installed and the required arrangement of such equipment will be included in the tender document.

In general, the manufacturer shall allow 1 or more compartments or tiers in the MCC for rack assemblies which shall accommodate ONLY the PLC hardware, including the input and output modules. Where special power supplies such as a CVT, UPS or DC supplies are specified, these shall be regarded as part of the hardware and shall be mounted in the same compartment as the other equipment. The power circuit drawings and the control schematics relating to each MCC will include all connections to the PLC hardware. All such connections shall be made by the MCC manufacturer via the marshalling compartment.

In addition to the general power earth bar specified elsewhere, an “Instrument Earth 0 Volt Bar” and an “Instrument Screen Earth Bar” shall be provided in each compartment housing PLC Hardware and these shall be used only for instrumentation Earthing connections. They shall be electrically isolated from the power earth. Particular attention shall be paid to the provision of cabling facilities to the modules. Adequate PVC cable trunking shall be installed and separate trunking shall be provided for analogue and digital circuits. Wiring to and from analogue input and output modules shall be carried out using cables equal to Contronics DEKORON control cable Type 1751, with 0.5mm² conductors.

Each analogue control cable shall be individually earthed to the instrument earth bar by means of its tined copper drain wire AT ONE END ONLY. The wiring between each starter panel and the digital input and output modules in the PLC panel shall be as indicated on the circuit diagrams and shall be installed in adequately sized PVC trunking with provision for 50% spare capacity. With the exception of the PLC output to the starter or relay coil, no power circuits may be run in this PVC trunking.

Each end of each core shall be terminated in a spade or pin type pre-insulated lug and marked with its respective wire number by means of interlocking plastic ferrules as detailed in the circuit diagram or termination schedule. Where connections are to be made between the PLC I/O modules and field cabling, the MCC manufacturer shall wire the I/O module terminal to the marshalling compartment.

2 PROGRAMMING

The PLC shall be coded using IEC-61131-3 standards (Ladder Logic). There should the no block locked, as the program is the asset of eThekwini municipality after handover.

3 STRUCTURE

All Tags should follow a detailed IO list and conform to a standard structure in naming conventions. All Networks are to be commented and defined. Tag naming conventions to be defined and documented.

4 KNOWLEDGE TRANSFER

The PLC programmer should ensure Knowledge transfer in terms of PLC Programming. This should be done at the PLC programmer's office and the Program should be clearly defined in terms of structure and method.

5 CERTIFICATIONS

Must be a Recognized Certified System Integrator with either one of Siemens, Schneider or Allen Bradly.

Please Note: Schneider is used on Waste Water Treatment Works and on Water Treatment Works and Pump Stations Siemens PLC is used.

6 TRAINING

Training - The contractor should provision for Training for eThekwini staff members as per PC Sum specified in BOQ.

7 LICENCES

Licenses - The contractor should provision for 2 of Latest Version of Licenses with at least 5 minimum of user license. Professional License is preferable.

8 TYPE

PLC Type – Siemens S 7 1200 for small pump station and S7 1500 for Water Treatment works or big pump station with more than 3 pump sets

9 CONFIGURATION

Software Blocks**:** A modular software design shall be adopted. Standard software blocks shall be used for common control equipment such as motors, valves, actuators, measured values, alarms, totalizers, sequence and closed loop controllers.

10 INTEGRATION

The PLC will need to integrate with the RTU by means of the Modbus TCP/ RTU protocol over RS 485 or Ethernet IP. The PLC will act as the Modbus Slave. Where there are VSD's or Softstarters, then the PLC would integrate by means of Ethernet IP. Where there are Universal Motor Controllers, the PLC would integrate by means of Ethernet IP.

11 CONTRACTUAL

Existing Code and Documentation- In certain instances eThekwini Water and Sanitation may provide existing code and QC documentation for re-use, therefore all aspects relating to the PLC coding and quality control should be priced but noted as an option, as only partial services may be utilized. A provisional sum should also be included to cater for instances where the PLC Engineers services are required for Technical assistance and/or for commissioning purposes.

12 PLC QUALITY CONTROL

The Contractor shall prepare and submit (Hard and Soft copy) for approval, a Functional Design Specification explaining how the PLC software will be implemented and how the required control philosophy will be programmed. The Functional Design Specification shall include the following as a minimum:

- Software structural breakdown and description
- Equipment modes of operation description
- Tag numbering system (equipment and software)
- Complete device list (sensors, actuators etc.)
- Complete input and output list with physical addresses
- Logic diagrams for control of all devices
- Complete list of all alarms generated within the PLC
- Equipment start-up and shutdown sequences (including flow charts)
- List of registers and timers with default settings
- Complete data communications structure with tags (for HMI and/or SCADA systems)

The FDS shall be approved by the Engineer prior to bulk software configuration.

12.1 INSPECTIONS

The minimum inspection of the PLC, by the Engineer, shall include the following:

- Correct choice of PLC CPU and power supply (calculations to be presented)
- Correct configuration of all Input and Output Cards (drawings to be presented)
- Correct wiring of all expansion/ remote modules (drawings)
- Correct wiring of all input and outputs to marshalling strips (drawings)
- Code review of all PLC Control Logic (logic diagrams, flowcharts and software printouts to be presented)
- Review of the Contractor's Quality Control Documentation (checklists to be presented)

12.2 TESTING

The minimum testing of the PLC system, by the Engineer, shall include the following:

- Thin slice testing and acceptance of all software control blocks
- Correct operation of all control logic
- Correct operation of all modes of operation
- Correct detection and annunciation of simulated faults
- Correct inter PLC/ RTU data communication
- PLC cycle time measurement

The compulsory method of testing shall be using the actual PLC that will be delivered to site and be simulated within the same MCC.

The Contractor shall carry out a full functional test to prove the correct operation of the PLC Program, including interlocking, remote control and the simulation of all protection devices. All other circuits external to the PLC shall be simulated and shall be tested accordingly. No PLC code manipulation shall be utilized to achieve the simulations.

The proposed testing procedure shall be documented by the Contractor and approved by EWS before testing takes place. The tests shall be witnessed by the Employer's Representative and shall be recorded in triplicate on an approved test form before shipment to site.

12.3 DOCUMENTATION

The following documentation shall be provided by the Contractor at the various project phases listed below: (Hard and Soft copy)

12.4 DURING CONSTRUCTION

- Control system architecture drawing
- PLC I/O list
- PLC loading calculations
- PLC panel General Arrangement drawing

- PLC panel schematic/wiring drawings
- PLC Functional Design Specification (FDS)
- Point to point wiring check certificates
- PLC panel IP certificate
- PLC panel Quality Control Documentation certificates
- PLC panel Certificate of Compliance and test report

12.5 AS BUILT

- Control system architecture drawing
- PLC I/O list
- PLC loading calculations
- PLC panel General Arrangement drawing
- PLC panel schematic/wiring drawings
- PLC I/O loop drawings
- PLC Functional Design Specification (FDS)
- PLC Trip and Alarm Matrix
- PLC Control Logic (logic diagrams, flowcharts and software)

13 HMI QUALITY CONTROL

The HMI shall be inspected by the Engineer and tested by the Contractor (which tests shall be witnessed by the Engineer) prior to delivery, installation and switch-on at site.

13.1 INSPECTIONS

The minimum inspection of the HMI, by the Engineer, shall include the following:

- Correct choice of HMI and power supply
- Correct configuration of all HMI graphics, alarms and trend pages (drawings to be presented)
- Correct wiring (drawings)
- Review of the Contractor's Quality Control Documentation (checklists to be presented).

13.2 TESTS

The minimum testing of the HMI system, by the Engineer, shall include the following:

- Correct operation of equipment
- Correct operation of all modes of operation
- Correct graphics, alarm and trend operation
- Correct inter PLC/ SCADA data communication
- PLC cycle time measurement with HMI connected

- PLC/ SCADA data communications response time measurement
- Correct trends setup
- Correct alarms setup
- Correct user access level setup

13.3 DOCUMENTATION

This following documentation shall be provided by the Contractor at the various project phases listed below:

13.4 DURING CONSTRUCTION

- Control system architecture drawing
- HMI panel General Arrangement drawing
- HMI panel schematic/wiring drawings
- Functional Design Specification (FDS)
- Point to Point wiring check certificates
- HMI panel IP certificate
- HMI panel Quality Control Documentation certificates · HMI panel Certificate of Compliance and test report

13.5 AS BUILT

- Control system architecture drawing
- HMI panel schematic/wiring drawings
- Functional Design Specification (FDS)
- Point to point wiring check certificates
- HMI panel IP certificate
- HMI panel Quality Control Documentation certificates
- HMI panel Certificate of Compliance and test report

14 TYPICAL HARDWARE LIST

PLC Hardware

The below list of hardware is current installed within the PLC cubicle of the MCC;

Item	Description	Tag Name (Ref. to DWG)	Supplier	Part Number	Quantities

1	PLC Controller	CPU	Siemens	6ES7214-1AG40-0XB0	1
2	Digital Input Module	Digital Input Card	Siemens	6ES7221-1BH32-0XB0	2
3	Digital Output Card	Digital Output Card	Siemens	6ES7222-1HH32-0XBO	2
4	Analog Input Card	Analog Input Card	Siemens	6ES7231-4HF32-0XB0	2
5	HMI	HMI TP1500	Siemens	6AV2124-0QC02-0AX0	1
6	Ethernet Switch	8 PORT EHERNET SWITCH	DELTA	DVS-008I00	1

15 TYPICAL IO LIST

Input and Output Schedule

Digital Input Signals:

TAG NAME	DESCRIPTION	PLC TAG NAME	PHYSICAL INPUT
XX_MIC_001_AUTO	Pump No. 1 - Auto	Local:1:I.Data.0	Module:1.0
XX_MIC_001_HAND	Pump No. 1 - Hand	Local:1:I.Data.1	Module:1.1
XX_MIC_001_RUN	Pump No. 1 - Run	Local:1:I.Data.2	Module:1.2
XX_MIC_001_OLOAD	Pump No. 1 - Overload Trip	Local:1:I.Data.3	Module:1.3
XX_MIC_001_ELF	Pump No. 1 - Earth Fault Trip	Local:1:I.Data.4	Module:1.4
XX_MIC_001_CURRENT	Pump No. 1 - Under Current Trip	Local:1:I.Data.5	Module:1.5
XX_MIC_001_SPARE_01	Pump No. 1 - Spare	Local:1:I.Data.6	Module:1.6
XX_MIC_001_SPARE_02	Pump No. 1 - Spare	Local:1:I.Data.7	Module:1.7
XX_MIC_002_AUTO	Pump No. 2 - Auto	Local:1:I.Data.8	Module:1.8
XX_MIC_002_HAND	Pump No. 2 - Hand	Local:1:I.Data.9	Module:1.9
XX_MIC_002_RUN	Pump No. 2 - Run	Local:1:I.Data.10	Module:1.10
XX_MIC_002_OLOAD	Pump No. 2 - Overload Trip	Local:1:I.Data.11	Module:1.11
XX_MIC_002_ELF	Pump No. 2 - Earth Fault Trip	Local:1:I.Data.12	Module:1.12
XX_MIC_002_CURRENT	Pump No. 2 - Under Current Trip	Local:1:I.Data.13	Module:1.13

XX_MIC_002_SPARE_01	Pump No. 2 - Spare	Local:1:I.Data.14	Module:1.14
XX_MIC_002_SPARE_02	Pump No. 2 - Spare	Local:1:I.Data.15	Module:1.15
XX_MIC_003_SPARE_01	Pump No. 3 - Spare	Local:2:I.Data.0	Module:2.0
XX_MIC_003_SPARE_02	Pump No. 3 - Spare	Local:2:I.Data.1	Module:2.1
XX_MIC_003_SPARE_03	Pump No. 3 - Spare	Local:2:I.Data.2	Module:2.2
XX_MIC_003_SPARE_04	Pump No. 3 - Spare	Local:2:I.Data.3	Module:2.3
XX_MIC_003_SPARE_05	Pump No. 3 - Spare	Local:2:I.Data.4	Module:2.4
XX_MIC_003_SPARE_06	Pump No. 3 - Spare	Local:2:I.Data.5	Module:2.5
XX_MIC_003_SPARE_07	Pump No. 3 - Spare	Local:2:I.Data.6	Module:2.6
XX_MIC_003_SPARE_08	Pump No. 3 - Spare	Local:2:I.Data.7	Module:2.7
XX_GNRL_FF	General – Fuse Fail	Local:3:I.Data.0	Module:3.0
XX_GNRL_LS_A	General – Reservoir “A” Low Level	Local:3:I.Data.1	Module:3.1
XX_GNRL_LS_B	General – Reservoir “B” Low Level	Local:3:I.Data.2	Module:3.2
XX_GNRL_INT_AL	General – Intruder Alarm	Local:3:I.Data.3	Module:3.3
XX_GNRL_FIRE_AL	General – Fire Alarm	Local:3:I.Data.4	Module:3.4
XX_GNRL_NFS_001	General – No Flow Pump No. 1	Local:3:I.Data.5	Module:3.5
XX_GNRL_NFS_002	General – No Flow Pump No. 2	Local:3:I.Data.6	Module:3.6
XX_GNRL_PLC_ZS	General – PLC & UPS Limit Switch	Local:3:I.Data.7	Module:3.7

Digital Output Signals:

TAG NAME	**DESCRIPTION**	**PLC TAG NAME**	**PHYSICAL OUTPUT**
XX_MIC_001_CMD	Pump No. 1 – Start	Local:1:O.Data.0	Module:1.0
XX_MIC_002_CMD	Pump No. 2 – Start	Local:1:O.Data.1	Module:1.1
XX_MIC_003_SPARE	Pump No. 3 – Spare	Local:1:O.Data.2	Module:1.2
XX_MIC_001_INHIBIT	Pump No. 1 – Inhibit	Local:1:O.Data.3	Module:1.3
XX_MIC_002_INHIBIT	Pump No. 2 – Inhibit	Local:1:O.Data.4	Module:1.4
XX_MIC_003_INHIBIT	Pump No. 3 – Spare	Local:1:O.Data.5	Module:1.5