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		I-IEN21003

Title	Enquiry No. I-IEN21003 dated 24.05.2021 for Development of PLC based slow control system for RF Source
Sub Title	PART-A (II): Scope of Supply, Work and Technical Specifications

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Abbreviations

AI - Analog Input
 AO - Analog Output
 BOM - Bill of Material
 cRIO - Compact Reconfigurable Input Output
 DI - Digital Input
 DO - Digital Output
 EMC - Electro Magnetic Compatibility
 EMI - Electro Magnetic Interference
 FAT - Factory Acceptance Test
 GA - General Assembly
 GUI - Graphical User Interface
 ICH&CD - Ion Cyclotron Heating & Current Drive
 II -ITER-India
 IO - ITER Organization
 LCU – Local Control Units
 LED - Light Emitting Diode
 MW - Megawatt
 PLC - Programmable Logic Controller
 PN+E - Phase Neutral Earth
 PON - Plant Operating Network
 REACH - Registration Evaluation Authorization and Restriction of Chemicals
 RF Source - Radio Frequency Source
 RFPS - Radio Frequency Power Source
 RoHS - Restrictions of Hazardous Substances
 SAT - Site Acceptance Test
 SMPS - Switch Mode Power Supply
 SSPA - Solid State Power Amplifier
 TB - Terminal Block
 XLPE - Cross linked Polyethylene
 ZHLS -Zero Halogen Low Smoke

Reference Documents:

1. IDM reference: 3QTLMD/version 1.0/13 Nov 2020 (for PLC hardware and software items)


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1 Introduction

This tender is for development of PLC based acquisition, monitoring and control system for RF source. It includes development of application program for Siemens PLC, procurement of relevant hardware and software, installation and commissioning of PLC system interfacing with cooling signals & tuning motors at prototype RF source test facility.

RF source generates MW level RF power in the frequency range of 35-65MHz. This RF source has tunable cavities to tune the amplifier at frequency of operation between 35-65MHz. There is a dedicated tuning mechanism in RF source to move tuning elements at a particular position corresponds to a particular operating frequency. Servo motor and drive controller is proposed to use for moving these elements at desired position precisely and accurately within a defined time period (180 seconds).

Being a MW RF source, thermal management is critical for the operation of system. Hence, water & air cooling is the necessary requirement. To monitor and control different cooling parameters, there are approximate 192 digital input channels, 96 digital output channels, 32 analog input channels and 2 analog output channels are required.

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2 Scope of Work

1. Bidder shall prepare Quality plan, Manufacturing & inspection plan, Packing & transportation plan, Activity schedule and submit the same at the time of kick off meeting for II approval.
2. Bidder shall develop application program for acquiring & monitoring different cooling parameters and to control the operation of blowers & valves using SIMATIC TIA portal software for Siemens PLC as described in section- 4.2, 4.1.1 & 4.1.2.
3. Bidder shall develop application program for precise control of moving element using motor & controller and develop proper control interface with Siemens PLC using SIMATIC TIA portal as described in section- 4.1.3 & 4.3.
4. Bidder shall procure relevant software licences for development of application program and has to supply the software with required licenses, user manuals & relevant certificates in USB drive as per Table 2 defined in section- 3.2.
5. Bidder shall provide one-week basic training at site for different software modules used for execution of this contract for 2 (Minimum) ITER-India Engineers.
6. Bidder shall prepare BOM and General assembly diagram (GA) of installation and submit the same for II approval.
7. Bidder shall procure all hardware components (Table 1), racks/cubicles (Table 3, Table 4), cables (Table 5) and all other accessories defined in sections - 3.1, 3.3, 3.4, 3.6.1 and 3.5.1 .
8. Bidder shall install all hardware components in racks/cubicles as per approved GA.
9. Bidder shall prepare wiring diagram as per defined in section - 3.7 and submit the same for II approval.
10. Bidder shall do complete internal wiring of the system as per approved wiring diagram.
11. Bidder shall conduct factory acceptance test as per defined in section- 5.1.
12. Bidder is responsible for packing and forwarding the system at II lab after getting dispatch clearance certificate from II. Bidder need to use adequate packing material for packaging the items for damage free transportation. Bidder is responsible for any damage to the items during transportation and the damaged item will be replaced by the bidder, free of cost within mutually agreed time.
13. Bidder shall carry out installation & commissioning of the system along with site acceptance test as per defined in section- 5.2.
14. Bidder shall prepare and submit the final version of documents considering all amendments during FAT & SAT listed in Table 10 defined in section-3.8.1.
15. Bidder shall provide standard warranty of 2 years after final acceptance of the system at ITER-India site.

3 Technical Specification

This section describes the detailed technical specification of hardware components, like PLC CPU, I/O modules, licenced version of PLC software, servo motors and drive controllers along with cables. It also describes the technical specification for I&C racks, cables and other components required for internal wiring.


3.1 PLC Hardware Technical Specification

The specifications for the PLC system which includes CPU, I/O modules & PS modules, servo motors along with controller mentioned in the Table 1. The component and accessories described in the Table 1 is minimal and not limited to items specified here. Bidder may include other accessories which require proper functioning of the system.

Table 1: Technical Specification for PLC hardware

Sr. No.	Item Description	Siemens Part number	Qty(Nos.)
1	SIMATIC PM 1507 24 V/8A stabilized power supply for SIMATIC S7-1500 - Input:120/230V AC - Output: 24 VDC /8A	6EP13334BA00	1
2	SIMATIC S7-1500, CPU 1516-3 PN/DP - Central processing unit (CPU) with working memory 1MB for program & 5MB for Data - 1.Interface: Profinet IRT with 2 port switches - 2. Interface: Profinet RT - 3.Interface: Profibus - 10ns Bit performance	6ES75163AN010AB0	1
4	SIMATIC S7-1500, Mounting rail 482 mm (approx..19 inch) - incl. grounding element - Integrated DIN rail for mounting of small components such as clamps, fuses, or relays	6ES75901AE800AA0	1
5	SIMATIC S7-1500, Mounting rail 830 mm - incl. grounding element - Integrated DIN rail for mounting of small components such as clamps, fuses, or relays	6ES75901AJ300AA0	1
6	SIMATIC ET 200MP, IM155-5 PN HF Profinet interface module - Integrated power supply - Maximum 30 I/O modules can be connected in one rack - Interface: RJ 45	6ES71555AA000AC0	1

	- No of ports: 2		
7	SIMATIC S7-1500, Digital input module, - 32 channels with 24V - Input delay 0.05 to 20ms configurable; - Diagnosis provided by LED indication for supply voltage, Error display, channel status	6ES75211BL000AB0	6
8	SIMATIC S7-1500, Digital output module, - 32 channels with 24VDC having 0.5A each channel - Diagnosis provided by LED indication for supply voltage, Error display, channel status	6ES75221BL010AB0	4
9	SIMATIC S7-1500, Analog input module, - 8 channels for current measurement - 8 channels for voltage measurement - 4 channels for RTD measurements - 8 channels for thermocouple measurements - Channels should be configurable for current/voltage/RTD/TC type connection - 16 bits of resolution of ADC - Basic conversion time including parameterizable integration time (ms): 9/23/27/107 ms - Linearity error (relative to input range): +/- 0.02% - Diagnosis for supply voltage monitoring, LED indication for channels status display	6ES75317KF000AB0	5
10	SIMATIC S7-1500, Analog output module, - 8 channels for voltage - 8 channels for current - 16 bits resolution of DAC - Linearity error (relative to output range = +/-0.15%) - Settling time: 30μs for resistive load - Conversion time per channel: 50μs (independent of number of activated channels) - Diagnosis for supply voltage monitoring, LED indication for channels status display	6ES75325HF000AB0	1
11	SIMATIC S7-1500, Front connector - screw-type terminal - 40-pin with 4 jumpers & cable straps	6ES75921AM000XB0	20
12	SIMATIC S7-Memory card for S7-1X00 CPUs/SINAMICS - 3.3V FLASH - 24 MB	6ES79548LF020AA0	1

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13	SIMOTICS S-1FK2 Servo motor - Static torque = 2.4 Nm @ 1000 rpm - Rated power = 0.75 kW - Rated Speed = 3000 rpm	1FK2204-5AF10-1MA0	10
14	SINAMICS S210 Servo drive controller - Suitable to drive motor specified in sr.no.13 - Communication: Profinet - Standard Digital Inputs: 5	6SL3210-5HB10-4UF0	10
15	MOTION-CONNECT 500, length = 20 m - Single prefabricated cable for servo motor and controller communication	6FX5002-8QN08-1CA0	10
16	IE FC TP Standard Cable GP2x2 sold by meter	6XV18402AH10	25
17	IE FC RJ45 Plug 145 (1 pack = 50 items)	6GK19011BB300AE0	1
18	PSU100S, 1Φ, 24VDC/20A	6EP13362BA10	1
20	SINAMICS SD card	6SL3054-4FC00-2BA0	1

3.2 PLC Software Technical Specification

This section describes the detailed technical specification for required software licences of the system.

Table 2: Technical Specification for Software system

Sr.No.	Item Description	Siemens Part number	Qty(Nos.)
1	SIMATIC STEP 7 Prof. V16 - Floating License; - Engineering Software in TIA Portal; - SW and document on DVD; - License key on USB flash drive; - Executable in Windows 7 (64-bit), Windows 10 (64-bit), Windows Server 2012R2 (64-bit), Windows Server 2016/2019 (64); for configuration of SIMATIC S7-1200/1500, SIMATIC S7-300/400/WinAC, - SIMATIC Basic Panels Content: Set (4x DVD + 1x USB)	6ES78221AA060YA5	1
2	SIMATIC OPC UA S7-1500 medium (CPU-1515 / CPU-1516 (F)) - Single Runtime License, contains license certificate for OPC UA server and OPC UA client Class A	6ES78230BA001CA0	1

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	<ul style="list-style-type: none"> - Executable on all ET 200SP CPUs, S7-1500 up to CPU-1516 - Content: Certificate of License 		
3	SIMATIC WinCC Runtime Advanced 512 power tags V16 R-SW In TIA portal <ul style="list-style-type: none"> - Single Runtime Licence - Licence key on a USB flash drive; Class A - Executable in windows 10 (64 bit), windows server 2008 R2/2012 R2/2016 (64 bit) 	6AV21040DA060AA0	1
4	SIMATIC WinCC Advanced V16 Engineering software in TIA portal <ul style="list-style-type: none"> - Floating Licence - Licence key on a USB stick; Class A - Executable in windows 10 (64 bit), windows server 2008 R2/2012 R2/2016 (64 bit) for configuration of SIMATIC Panels, WinCC Runtime Advanced 	6AV21020AA060AA5	1

3.3 I&C Rack technical specification

This section describes the detail technical specification for PLC I&C rack and motor drive controller rack. Figure-1 shows interface between different components/equipment of slow controller. One rack is for PLC & I/O modules, ET200 PLC & I/O modules along with field signal termination. Second rack is used for mounting servo drive controllers. Table 3 describes the technical specification for PLC I&C rack and Table 4 describes the technical specification for servo drive controller rack. The component and accessories described in the Table 3 & Table 4 is minimal and not limited to items defined here. Bidder shall include other component and accessories which required for proper functioning of the system.

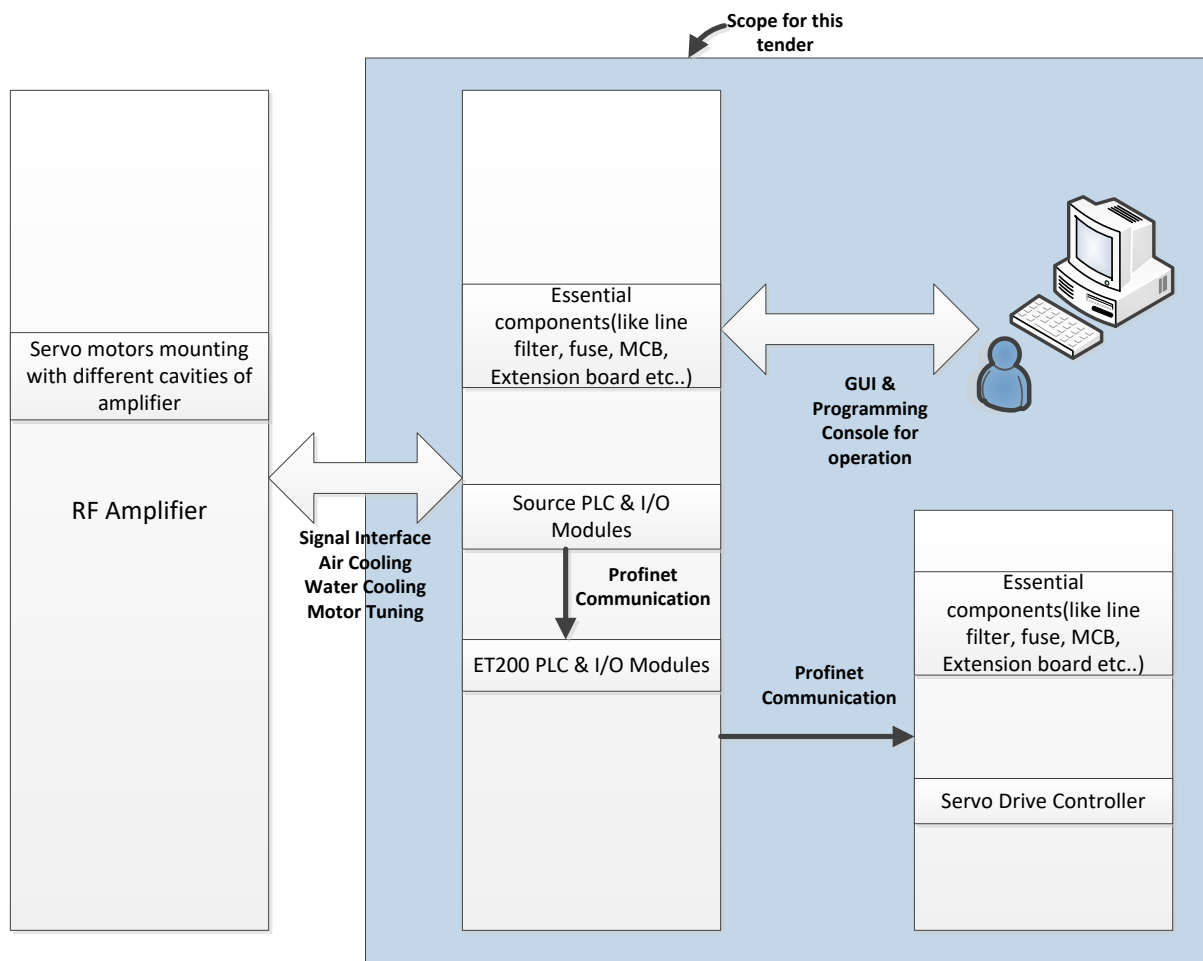


Figure 1: Slow controller interface block diagram

Table 3: Technical specification for PLC I&C Rack/cubicle

Sr. No.	Parameter Description	Specification	Remark
1	Environment	EMC protection	
2	Heat dissipation	1kW to 2kW	
3	Operation	Front and back doors-4X19" uprights 47U	
4	Dimensions (HXWXD)mm	H: 2200 X W: 800 X D: 800 mm	
5	Conformity standard	IEC62208	
6	Degree of protection	IP54 according to IEC60529	
7	Resistance to mechanical impacts	IK10 according to IEC 62262	

8	Compliance	RoHS and REACH	
9	Top & Bottom Frame	Vertical uprights	
10	Front door	Glazed door(4mm) with 180° hinges (right) and locking system by key	
11	Rear plain door	180° hinges (right) and locking system by key	
12	Removable roof	Made of sheet steel of Aluzinc 150 (or equivalent) mounted with specific cut-out, welded studs	
13	Side panels	2 nos. standard side panels, screwed on with captive screws & plugs	
14	Inverted roof	Single inverted roof made of sheet steel of ALUZINC 150(or equivalent) with dismountable plate mounted on the bottom of rack	
15	Foot and wheel kit for rack	<ul style="list-style-type: none"> - 2 castors without brakes & 2 castors with brakes and supports for accommodating the positioning feet. - Allows direct assembly on the base of the special SF frame. - Allows simultaneous assembly of the castors and levelling feet. - Use the levelling feet installed as standard on the rack. - Height of the castors: 105 mm. 	
16	Perforated mounting plate	Height 200mm mounted on top right side for cable fixing	
17	Earth points	2 earth points (front & rear) should require with marking	
18	Cable trays	2 metal cable trays should be mounted (1 at left side & 1 at right side)	
19	Pocket for document	Metal pocket for document should be mounted on Rear door	

20	Fan	473 m ³ /h mounted on the bottom of the rear door	
21	Outlet grill	Outlet grill should be mounted on the top of the rear door	
22	Cable support	Cable support on the lateral framework	
23	Screws & nuts	Set of 50 screws, washers and nuts (for 19" uprights)	
24	DIN rail	3U 19" plate required	
25	Lighting arrangement	<ul style="list-style-type: none"> - Should be mounted on front and rear upright side - One light should be mounted at terminal block side 	
26	Earth braids	For claddings (mounted on welded earth studs on removable claddings)	
27	Door contact	1 contact should be mounted at front door & 1 contact should be mounted at rear door	
28	Ground bar with threaded holes	2 ground bars (1 at front bottom side & 1 at rear bottom side) should be mounted	
29	Support angle for Equipment	14 Nos.	

Table 4: Technical specification for Servo drive controller rack

Sr. No.	Parameter Description	Specification	Remark
1	Environment	EMC protection	
2	Heat dissipation	1kW	
3	Operation	Front door- Fixed 19"	
4	Dimensions (HXWXD)mm	H: 1200 X W: 800 X D: 500 mm	
5	Conformity standard	IEC62208	
6	Degree of protection	IP54 according to IEC60529	
7	Resistance to mechanical impacts	IK10 according to IEC 62262	

8	Compliance	RoHS and REACH	
9	Structure	Single-piece body, folded and welded	
10	Gasket	Special body-door gasket (IP+EMC)	
11	Locking system	2 locks with key and earth continuity	
12	Lugs and lifting eyes	4 wall fixing lugs and set of 4 lifting eyes	
13	Earth braid	Earth braid for claddings (mounted on welded earth studs on removable claddings)	
14	Cable trays	cable trays should be mounted as required for complete the wiring	
15	Door contact	1 door contact should be mounted	
16	Pilot lights	Red & green pilot lights should be mounted for indication of POWER ON condition	
17	Outlet grille	Outlet grille should be mounted on the bottom of lateral side (right)	
18	Fan	Minimum 130 m ³ /h mounted on the top lateral side (left) or as per requirement	
19	Screws, washers & nuts	Set of 30 screws, washers and nuts	
20	Cable support	Cable support on the lateral framework	
21	Ground bar	1 ground bar should be mounted at bottom side of the panel	
22	Mounting plate	Plain galvanized mounting plate is required for component mounting	
23	Pocket	Document pocket is required	

3.4 Cables Technical Specification

Bidder shall be responsible for procurement of cables used for internal wiring of PLC I&C rack and servo controller rack. The technical specification of cables is defined as per Table 5. The required cables should be according to the standards as defined in Table 6.


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Table 5: Technical specification for cable

Sr.No.	Parameter Description	Specification	Remark
1	Core material	Copper	
2	Insulation	XLPE (ZHLS type) where applicable	
3	Nominal Voltage	1100V	
4	Size	As per requirements	
5	Types	Multicore or single core	
6	Compliance	CE	

Table 6: Standards applicable for cables

Sr.No.	Parameter Description	Applicable Standard	Remark
1	Reduced flame propagation	IEC 60332-3	
2	Flame retardant	IEC 60332-1	
3	Low smoke	IEC 61034	
4	Zero halogen	IEC 60754-1	
5	Non-toxicity	IEC 60754-2	
6	Insulated cables sizes	IEC 60228 class 6	
7	Identification of cores of cables	IEC 60445	

3.5 Details of PLC rack

3.5.1 Components for PLC rack

Bidder shall be responsible to procure the following components as defined in Table 7 for PLC I&C rack. The component and accessories described in the Table 7 is minimal and not limited to items defined here. Bidder shall include other component and accessories which required for proper functioning of the system.

Table 7: Procurement & mounting of Components in PLC I&C rack

Sr. No	Description	Specifications	Compliance
1	AC Mains	230V +/-10%,50 Hz, 1 Phase AC	
2	Type of wiring	PN+E	
3	Major components		
3.1	Power on Indicator	Shall be provided at front side.	
3.2	Input mains circuit breaker	As per load requirement (~1 Nos) with breaking capacity of 10 kA	
3.3	Cable entry and exit arrangement	Suitable removable gland plate at top and bottom side of rack as per requirements	
3.4	Circuit Breaker	As per requirements at input side	
3.5	Line filter (1- phase)	<ul style="list-style-type: none"> - Current rating as required at input line - Filter shall achieve >40dB (or more) attenuation of CM (asymmetric) from 100kHz to 30MHz and DM (symmetric) over the frequency range from 100kHz (or less) to 10MHz (or more) 	
3.6	SMPS	Minimum: 24V/5A (make: Meanwell, siemens, Schneider)	
3.7	Network switch up to 1Gbps	Qty :1 (Make: Cisco, TP-link, D-Link)	
3.8	Vertical Extension board	10 point with 5A& 16A dual compatibility	
3.9	Terminal blocks for field signal termination	As required (Preferred make: Phoenix, Schneider electric, TE connectivity) with CE marking	
3.10	Minimum cross-sectional area of wire used for internal wiring	0.5 Sq.mm	
3.11	Cable tray for internal wiring	As per requirement	
3.12	Mounting of PLC S7-1516 with SMPS & I/O modules,	--	

	ET-200 & I/O Modules which are procured as per Table-1		
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3.6 Details of Motor Control cubicle

The Motor control cubicle rack shall be designed to accommodate 18 servo drive controllers. Bidder shall carried out installation of all required component and internal wiring for 18 servo drive controllers. Out of 18, 10 servo drive controllers shall be mounted and provision for additional space for remaining 8 drive controllers shall be kept for future use.

3.6.1 Components for cubicle

Bidder shall be responsible to procure the required components for servo drive controller rack as defined in Table 8. The component and accessories described in the Table 8 is minimal and not limited to items defined here. Bidder shall include other component and accessories which required for proper functioning of the system.

Table 8: Procurement & mounting of components in servo drive controller cubicle

Sr. No	Description	Specifications	Compliance
1	AC Mains	400V +/-10%,50 Hz, 3 Phase AC	
2	Type of wiring	TN-S	
3	Power requirements	25 kW All controller load shall be distributed over 3 phases to make 3 phase balance system	
4	Major components		
4.1	Power On Indicator	Shall be provided at front side.	
4.2	Input mains circuit breaker (QA1)	As per load requirement (~1 Nos) with breaking capacity of 10 kA	
4.3	Circuit breakers (QA2 to QA20)	As per load requirement (~ 19 Nos) with breaking capacity of 10 kA	
4.4	Distribution bus (B1)	As per load requirement with protective Earth bus With 10 kA (Short circuit) Isc Rating	

4.5	Input cable connection TB	As per requirements	
4.6	Input cable Gland arrangement on cubicle	Metallic gland as per cable requirements (1 Nos)	
4.7	Output cable gland arrangement on cubicle	Suitable metallic gland as per requirements for servo motor MOTION-CONNECT 500 cables (~ 18 Nos)	
4.8	Cable entry point for Profinet cable	As per requirements for servo controller interface	
4.9	Cable tray for internal wiring	As per requirement	
5	Additional items		
5.1	Cooling Fan with filters	As per requirements	
5.2	Cubicle internal light with door switch interlock	Shall be provided as per requirement	
6	Minimum cross-sectional area of wire used for internal wiring	0.5 Sq.mm	
7	Line filter (3- phase)	<ul style="list-style-type: none"> - Current rating as required at input line - Filter shall achieve >40dB (or more) attenuation of CM (asymmetric) from 100kHz to 30MHz and DM (symmetric) over the frequency range from 100kHz (or less) to 10MHz (or more) 	
8	Mounting of Servo drive controllers which are procured as per Table-1	--	

3.6.2 Tentative single line diagram for Motor drive controller cubicle

Figure-2 shows the tentative single line diagram for servo drive controller rack. Table 9 describes the symbol used in single line diagram.

Table 9: Symbol description of single line diagram of motor control cubicle

QA1	Main incoming circuit breaker
-----	-------------------------------

QA2 to QA20	Output circuit breakers
CA1	Incomer cable
WA1 to WA20	Internal wiring
	Servo motor controller 1 to servo motor controller-18
B1	Distribution bus
A1	Motor control cubicle

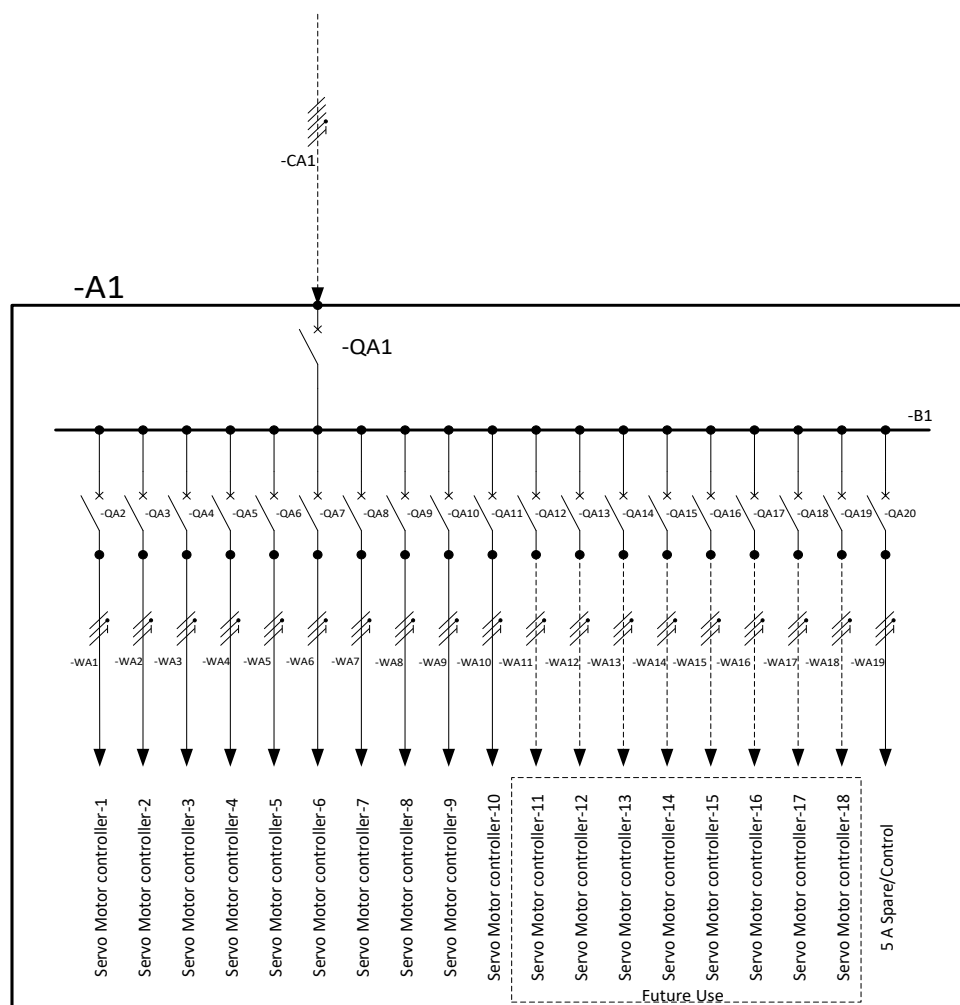



Figure 2: Proposed Single line diagram for distribution of Motor control cubicle

Note: Dotted line shown in figure-2 is not the scope of bidder, however space for mounting the additional drive controller shall be kept for future use.

3.7 Rack wiring guidelines

Bidder shall comply following standards where ever applicable.

- Standard industrial practice for internal cubicle wiring for both racks.

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- All components should be tagged properly as per approved wiring/schematic diagram.
- Standard IEC 60204-1 for internal cubicle wiring.
- Standards IEC 60947-1, IEC 60947-2 for circuit breakers.
- Standards IEC 61439 for cabling


3.8 List of Deliverables

3.8.1 Documents

Bidder shall be responsible to generate necessary required documents as defined in Table 10. Bidder needs to submit the same for review and approval from II. Final copy of the documents shall be submitted in softcopy as per specified format along with hardcopy (where applicable).

Table 10: List of deliverable documents

Sr. No	Description	Details	Format for document	Remarks
1	Quality related documents	Quality plan, Manufacturing & inspection plan, Packing & transportation plan, and Activity schedule in softcopy as well as one hardcopy.	PDF	In USB drive
2	Wiring Diagrams	Detailed wiring diagram for PLC I&C rack and servo controller rack with editable file in softcopy as well as one hardcopy. - As per IEC 60617 for Symbols	PDF and DXF	In USB drive
3	BOM along with make and supplier	Bill of material for PLC I&C rack and servo controller rack in softcopy as well as one hardcopy.	XLSX (MS-Excel)	In USB drive
4	Technical Documentation	Requirement Document, Engineering Document, Installation & Configuration Manual, Operational Manual, Maintenance Manual in softcopy as well as one hardcopy.	DOCX & PDF	In USB drive

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5	Standard compliance certificates and test certificate	Standard compliance certificate & test reports provided by OEM with proper sign and stamp shall be provided.	PDF	Hardcopy
6	FAT & SAT	Factory Acceptance Test report and Site Acceptance Test report in softcopy as well as one hardcopy.	DOCX & PDF	In USB drive

3.8.2 Hardware items

Bidder shall be responsible for delivering the hardware listed in Table 11.

Table 11: List of Hardware items

Sr. No	Description	Qty	Remarks
1	PLC I&C rack with all mounting hardware components defined in Table 3 & Table 7.	1 set	
2	Servo drive controller rack with all mounting hardware components defined in Table 4 & Table 8	1 set	

3.8.3 Software items

Bidder shall be responsible for software items delivery as per Table 12.

Table 12: List of software items

Sr. No	Description	Qty	Remarks
1	Editable final copy of Software code with comments shall be delivered (In USB drive).	2 Nos.	
2	Licences softwares defined in Table 2	1 set	

4 Development of Application program

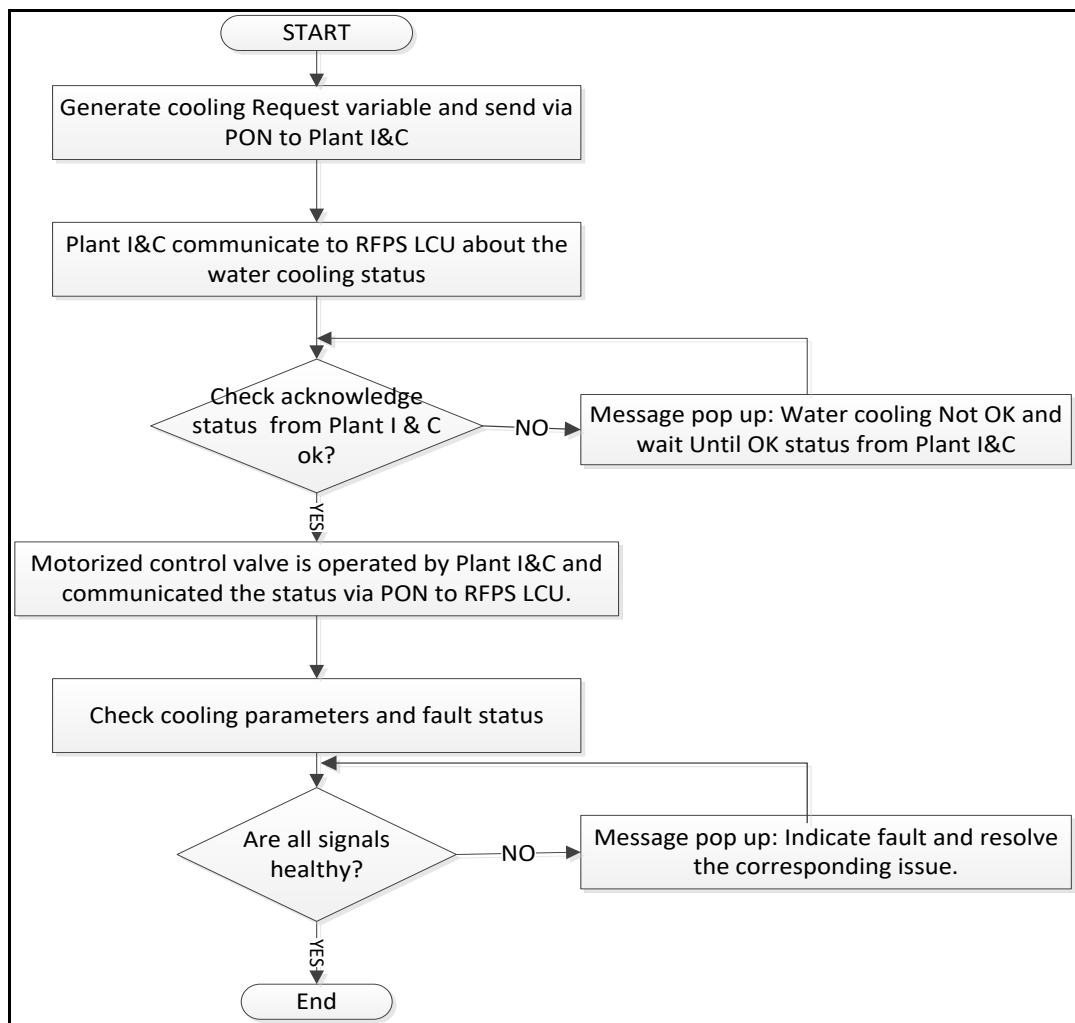
4.1 Functional Description of different software modules

4.1.1 Water cooling system

This function ensures healthy status of different water-cooling parameters for proper operation of RF source. It controls and monitors the different sensors & actuators connected in the field and update the status on corresponding GUI. The variable corresponding to “water cooling start request” is generated from PLC and communicated to plant I&C via PON network. Plant I&C check the necessary inputs and operate the motorized control valve to start the cooling. This function monitor and control different sensors & actuators for the checking of healthiness of cooling requirement in different parts of RF source. If each parameter is ok, then PLC will generate digital output “Water cooling ok” for different stage of amplifier and it will be given as input to internal protection function, which will be implemented on cRIO.

This is the overview of the logic. However, finalization of logic will be carried out after mutual discussion between II and bidder. Figure 3 shows the flowchart of water cooling.

Figure 3: Flowchart for water cooling system



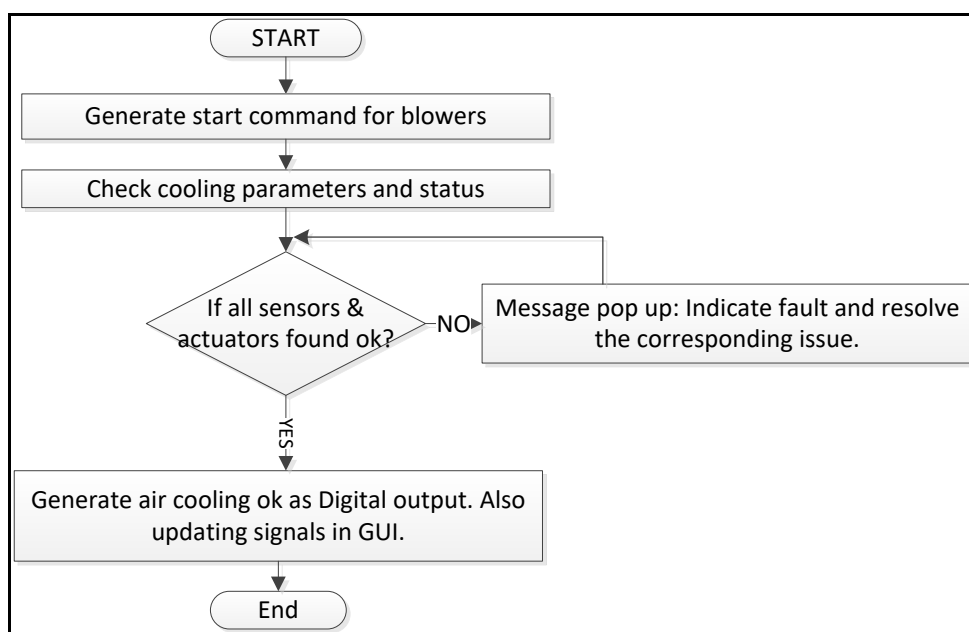
In scope of this tender, Bidder shall generate DO for “Start water cooling request” & “Water cooling ok”. Also, control and monitors different sensors and actuators parameters mounted at different locations of RF source. List of Tentative signals are defined in Table 13.

4.1.2 Air cooling system

This function ensures proper air cooling of different part of RF source. It controls and monitors the different sensors & actuators connected in the field and update the status in the corresponding GUI. After checking healthiness of water cooling, “start command” for blowers will be generated. The blowers will be started sequentially one by one to avoid high inrush current. Once blower runs at proper speed, air flow at different location of RF source will be monitored and updated the status of each in respected GUI. If all sensors and actuators found healthy then variable corresponding to “Air cooling ok” will be generated and PLC will generate digital output “Air cooling ok” for different stage of amplifier and it will be given as input to internal protection function, which is implemented on cRIO.

This is the overview of the logic. However, finalization of logic will be carried out after mutual discussion between II and bidder. Figure 4 shows flowchart of the air cooling.

Figure 4: Flow chart for air cooling system



In scope of this tender, Bidder shall generate DO for “Start Blower” sequentially to avoid high inrush current & “Air cooling ok”. Also, control and monitor different sensor and actuator parameters mounted at different locations of RF source. List of Tentative signals are defined in Table 13.

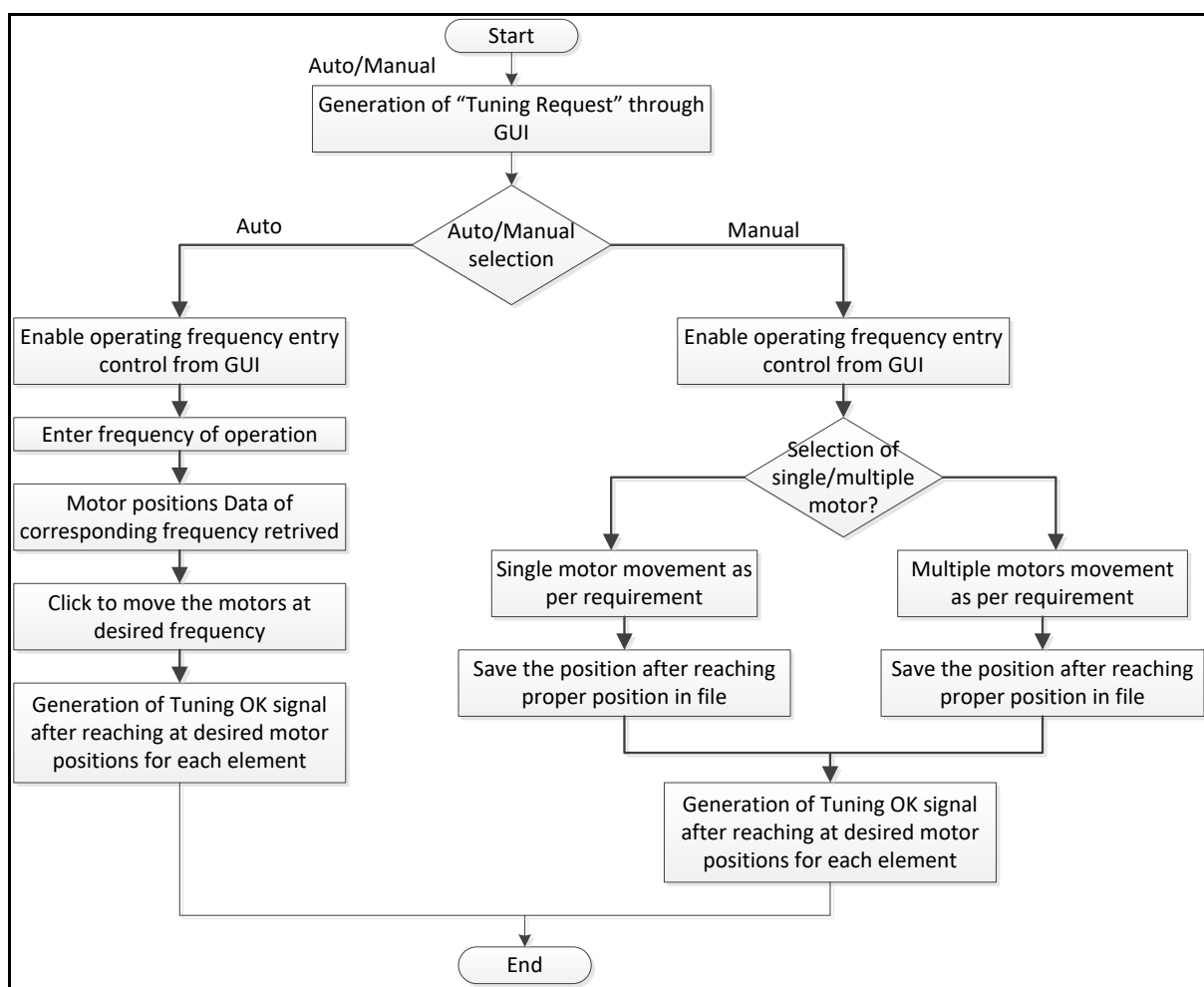
4.1.3 Motor Tuning system

This function ensures the proper positions of each tuning element according to the operating frequency of RF Source. Bidder shall generate variable corresponding to “Tuning request”. Motor tuning function receives the variable along with operating frequency

information and accordingly position of various tuning element is passed to motor controller. Once position of various tuning elements reached at proper position, motor controller informs tuning completed status to PLC and PLC generates variable corresponding to “Tuning OK”.

This is the overview of the logic. However, finalization of logic will be carried out after mutual discussion between II and bidder.

Figure 5: Flowchart of Motor Tuning system



4.2 Acquisition, monitoring & control for water and air cooling system

Bidder has to develop application program in TIA portal and Graphical User interface in WinCC for air cooling and water cooling system for RF amplifier. There are approximate 192 digital inputs channels, 96 digital output channels, 32 analog input channels and 2 analog output channels.


All the channels are acquired at 100ms rate and archived as file in the Host system. Masking function for group of channels shall be incorporated and finalized through mutual discussion with II.

Final signal list with signal name & variable name and proper location for programming will be communicated at the time of kick of meeting with bidder after PO placement. Tentative signals are mentioned in the below Table-13.

Table 13: Tentative sensors and signals description for air & water cooling

Sr. No.	Sensors	Signal levels	Type of signal
1	Status & command generation for communication with cRIO	24V	DO
2	Arc test signals	24V	DO
3	Start and stop command for blowers	24V	DO
4	Differential pressure switch low status monitoring	24V	DI
5	Fault generation for air cooling in case of unhealthy status for interlock purpose	24V	DO
6	Control valve status monitoring (High/Low)	24V	DI
7	Inlet & Outlet temperature transmitter monitoring	0-20mA	AI
8	Flow transmitter monitoring	0-20mA	AI
9	Flow alarm Status (High/Low)	24V	DI
10	Pressure switch status monitoring (High/Low)	24V	DI
11	Fault generation for water cooling in case of unhealthy status or crossing the threshold in case of analog input for interlock purpose	24V	DO
12	SSPA set voltage	0-10V	AO

4.3 Monitoring & control of Motor tuning system

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RF amplifier having different tuning elements which should be moved at predefined positions for particular operating frequency. II shall provide position of different tuning elements for different operating frequency to bidder for development of application program. Bidder shall tune the motors in such a way that movement of all tuning elements are smooth, precise and travel full stroke length within 180 seconds. There should be indication of time duration of motors movement in seconds.

4.4 Development of Graphical User Interface

Bidder shall finalise Graphical User Interface (GUI) after mutual discussion with II, within 3 months after placing of contract. Bidder shall be responsible for development of GUI to operate & monitor different elements of cooling and motor tuning system for the RF amplifier, as follows:

- All commands and status will be arranged on GUI screen for monitoring and control purpose.
- Calibration table should be developed for particular analog input and analog output from field signal to actual parameter.
- Prepare files containing Maximum and minimum threshold limits as per requirement of different channels for generating fault signals. These fault signals act as interlock and interface with main control system.
- Logging of state-change for each command & status with time stamping shall be carried out, saved in a file and display as message when clicked on appropriate button defined on the screen.

GUI for motor tuning system is described below:

Pictorial GUI shall be compatible for displaying status & position of total 36 motors, used for single RF source. However, in this tender 10 motors & drive controllers will be used.

There is two mode of operation: Auto or Manual. User has to select the mode of operation. In manual mode, individual motor can be moved forward or reverse through control button. Also, GUI provides facility to enter fixed position for any selected motor and by clicking on “GO” control button, motor shall move at required position. Final position for each individual motor shall be saved in predefined file format for future use.

In auto mode, selection of desired frequency of operation shall be provided on the screen for tuning purpose. The position of all motors from the stored file (corresponding to desired frequency) can be retrieved and move the motor at particular position. Motors shall not be allowed to move beyond the defined software limits for each moving element. After successful completion of movement of each tuning element, digital output signal corresponds to “Tuning OK” shall be generated.

After reaching the desired position, indication of healthy status should be displayed on the screen for each motor. Otherwise error message should be displayed on the screen for easy trouble shooting in case of fault occurred during movement of each motor. Reset button should be provided to reset motor faults to start operation again.

5 Acceptance Criteria

5.1 Factory Acceptance Test

The following tests will be done at factory site.

- PLC I&C rack and Servo drive controller rack wiring and component mounting will be verified and checked according to the approved wiring diagram.
- Application program and GUI of air & water cooling system will be tested with simulated signals as per mutually agreed logic between II & Bidder.
- Application program and GUI of motor tuning system will be tested as per mutually agreed logic between II & Bidder.

Note: Bidder shall prepare and submit the FAT report for II review & approval.

5.2 Site Acceptance Test

The following tasks will be carried out by the bidder at II lab, IPR during SAT:


- Bidder shall unpack and install the racks at II ICH&CD lab.
- Bidder has to complete the interface wiring between PLC I&C rack and servo drive controller rack.
- Bidder has to install all SIMATIC TIA portal and WinCC as defined in Table 2 licenced software in operational computer.
- Bidder has to install application program in operational computer located in control room at II lab and interface with PLC I&C rack.

The following tests will be carried out during SAT:

- All hardware components should be visually checked and verified.
- II will check and verify wiring as per approved wiring diagram.
- Application program and Graphical user interface testing shall be carried out with dummy/field signals as per defined in section- 4.2, 4.3 & 4.4.
- The movement of motor will be checked as per defined in section- 4.3.
- Bidder shall prepare and submit the SAT report for II review & approval.
- Compliance certificate, Test report and warranty certificate for each item shall be checked & verified by II.

Note:

1. All required instruments, accessories, cables and other than deliverable bill of materials for satisfactory demonstration of the system for SAT is to be listed and submitted to II before SAT. Those items not listed shall be provided by the Bidder towards conduct successful SAT of the system.
2. Final acceptance shall be given for all the items after the Bidder performing the Site Acceptance test successfully by bidder at II lab, IPR.

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6 General Instructions for Bidder

1. Bidder shall inform ITER-India about used software for preparation of wiring diagram, schedule and component layout for the project.
2. All documentation shall be in English language only.
3. Internal technical review meeting shall generally be held bi-weekly between ITER-India members and Bidder personnel in form of remote participation.
4. Progress meeting shall be held in-person/remote on regular monthly basis to discuss different technical issue between ITER-India and Bidder.
5. Progress report shall be submitted on monthly basis to ITER-India by the bidder.
6. Access to Bidder's premises for ITER-INDIA deputed representative shall be allowed by bidder during the execution of the project.
7. ITER-India Quality officer may visit the factory where work is carried out and he/she may inspect all/any related document.


7 Technical Compliance Matrix

Bidder should be filling the following tables for understanding of technical requirement of this tender.

Table 14: Technical compliance for PLC hardware

Sr. No	Item Description	Siemens Part number	Qty (Nos.)	Bidder Compliance
1	SIMATIC PM 1507 24 V/8A stabilized power supply for SIMATIC S7-1500 - Input:120/230V AC - Output: 24 VDC /8A	6EP13334BA00	1	
2	SIMATIC S7-1500, CPU 1516-3 PN/DP - Central processing unit (CPU) with working memory 1MB for program & 5MB for Data - 1.Interface: Profinet IRT with 2 port switches - 2. Interface: Profinet RT - 3.Interface: Profibus - 10ns Bit performance	6ES75163AN010AB0	1	
4	SIMATIC S7-1500, Mounting rail 482 mm (approx..19 inch) - incl. grounding element - Integrated DIN rail for mounting of small components such as clamps, fuses or relays	6ES75901AE800AA0	1	
5	SIMATIC S7-1500, Mounting rail 830 mm - incl. grounding element - Integrated DIN rail for mounting of small components such as clamps, fuses or relays	6ES75901AJ300AA0	1	
6	SIMATIC ET 200MP, IM155-5 PN HF Profinet interface module - Integrated power supply - Maximum 30 I/O modules can be connected in one rack - Interface: RJ 45 - No of ports: 2	6ES71555AA000AC0	1	
7	SIMATIC S7-1500, Digital input module, - 32 channels with 24V - Input delay 0.05 to 20ms configurable;	6ES75211BL000AB0	6	

	<ul style="list-style-type: none"> - Diagnosis provided by LED indication for supply voltage, Error display, channel status 			
8	SIMATIC S7-1500, Digital output module, <ul style="list-style-type: none"> - 32 channels with 24VDC having 0.5A each channel - Diagnosis provided by LED indication for supply voltage, Error display, channel status 	6ES75221BL010AB0	4	
9	SIMATIC S7-1500, Analog input module, <ul style="list-style-type: none"> - 8 channels for current measurement - 8 channels for voltage measurement - 4 channels for RTD measurements - 8 channels for thermocouple measurements - Channels should be configurable for current/voltage/RTD/TC type connection - 16 bits of resolution of ADC - Basic conversion time including parameterizable integration time (ms): 9/23/27/107 ms - Linearity error (relative to input range): +/- 0.02% - Diagnosis for supply voltage monitoring, LED indication for channels status display 	6ES75317KF000AB0	5	
10	SIMATIC S7-1500, Analog output module, <ul style="list-style-type: none"> - 8 channels for voltage - 8 channels for current - 16 bits resolution of DAC - Linearity error (relative to output range = +/-0.15%) - Settling time: 30μs for resistive load - Conversion time per channel: 50μs (independent of number of activated channels) - Diagnosis for supply voltage monitoring, LED indication for channels status display 	6ES75325HF000AB0	1	
11	SIMATIC S7-1500, Front connector <ul style="list-style-type: none"> - screw-type terminal - 40-pin with 4 jumpers & cable straps 	6ES75921AM000XB0	20	

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12	SIMATIC S7-Memory card for S7-1X00 CPUs/SINAMICS - 3.3V FLASH - 24 MB	6ES79548LF020AA0	1	
13	SIMOTICS S-1FK2 Servo motor - Static torque = 2.4 Nm @ 1000 rpm - Rated power = 0.75 kW - Rated Speed = 3000 rpm	1FK2204-5AF10-1MA0	10	
14	SINAMICS S210 Servo drive controller - Suitable to drive motor specified in sr.no.13 - Communication: Profinet - Standard Digital Inputs: 5	6SL3210-5HB10-4UF0	10	
15	MOTION-CONNECT 500, length = 20 m - Single prefabricated cable for servo motor and controller communication	6FX5002-8QN08-1CA0	10	
16	IE FC TP Standard Cable GP2x2 sold by meter	6XV18402AH10	25	
17	IE FC RJ45 Plug 145 (1 pack = 50 items)	6GK19011BB300AE0	1	
18	PSU100S, 1Φ, 24VDC/20A	6EP13362BA10	1	
20	SINAMICS SD card	6SL3054-4FC00-2BA0	1	

Table 15: Technical compliance for PLC software

Sr. No	Item Description	Siemens Part number	Qty (Nos.)	Bidder Compliance
2	SIMATIC STEP 7 Prof. V16 - Floating License; - Engineering Software in TIA Portal; - SW and document on DVD; - License key on USB flash drive; - Executable in Windows 7 (64-bit), Windows 10 (64-bit), Windows Server 2012R2 (64-bit), Windows Server 2016/2019 (64); for configuration of SIMATIC S7-1200/1500, SIMATIC S7-300/400/WinAC, - SIMATIC Basic Panels Content: Set (4x DVD + 1x USB)	6ES78221AA060YA5	1	
3	SIMATIC OPC UA S7-1500 medium (CPU-1515 / CPU-1516 (F))	6ES78230BA001CA0	1	

	<ul style="list-style-type: none"> - Single Runtime License, contains license certificate for OPC UA server and OPC UA client Class A - Executable on all ET 200SP CPUs, S7-1500 up to CPU-1516 - Content: Certificate of License 			
4	SIMATIC WinCC Runtime Advanced 512 power tags V16 R-SW In TIA portal <ul style="list-style-type: none"> - Single Runtime Licence - Licence key on a USB flash drive; Class A - Executable in windows 10 (64 bit), windows server 2008 R2/2012 R2/2016 (64 bit) 	6AV21040DA060AA0	1	
5	SIMATIC WinCC Advanced V16 Engineering software in TIA portal <ul style="list-style-type: none"> - Floating Licence - Licence key on a USB stick; Class A - Executable in windows 10 (64 bit), windows server 2008 R2/2012 R2/2016 (64 bit) for configuration of SIMATIC Panels, WinCC Runtime Advanced 	6AV21020AA060AA5	1	

Table 16: Technical Compliance for PLC I&C rack

Sr. No.	Parameter Description	Specification	Bidder Compliance
1	Environment	EMC protection	
2	Heat dissipation	1kW to 2kW	
3	Operation	Front and back doors- 4X19" uprights 47U	
4	Dimensions (HXWXD)mm	H: 2200 X W: 800 X D: 800 mm	
5	Conformity standard	IEC62208	
6	Degree of protection	IP54 according to IEC60529	
7	Resistance to mechanical impacts	IK10 according to IEC 62262	
8	Compliance	RoHS and REACH	


9	Top & Bottom Frame	Vertical uprights	
10	Front door	Glazed door(4mm) with 180° hinges (right) and locking system by key	
11	Rear plain door	180° hinges (right) and locking system by key	
12	Removable roof	Made of sheet steel of Aluzinc 150 (or equivalent) mounted with specific cut-out, welded studs	
13	Side panels	2 nos. standard side panels, screwed on with captive screws & plugs	
14	Inverted roof	Single inverted roof made of sheet steel of ALUZINC 150(or equivalent) with dismountable plate mounted on the bottom of rack	
15	Foot and wheel kit for rack	<ul style="list-style-type: none"> - 2 castors without brakes & 2 castors with brakes and supports for accommodating the positioning feet. - Allows direct assembly on the base of the special SF frame. - Allows simultaneous assembly of the castors and levelling feet. - Use the levelling feet installed as standard on the rack. - Height of the castors: 105 mm. 	
16	Perforated mounting plate	Height 200mm mounted on top right side for cable fixing	
17	Earth points	2 earth points (front & rear) should require with marking	

18	Cable trays	2 metal cable trays should be mounted (1 at left side & 1 at right side)	
19	Pocket for document	Metal pocket for document should be mounted on Rear door	
20	Fan	473 m ³ /h mounted on the bottom of the rear door	
21	Outlet grill	Outlet grill should be mounted on the top of the rear door	
22	Cable support	Cable support on the lateral framework	
23	Screws & nuts	Set of 50 screws, washers and nuts (for 19" uprights)	
24	DIN rail	3U 19" plate required	
25	Lighting arrangement	<ul style="list-style-type: none"> - Should be mounted on front and rear upright side - One light should be mounted at terminal block side 	
26	Earth braids	For claddings (mounted on welded earth studs on removable claddings)	
27	Door contact	1 contact should be mounted at front door & 1 contact should be mounted at rear door	
28	Ground bar with threaded holes	2 ground bars (1 at front bottom side & 1 at rear bottom side) should be mounted	
29	Support angle for Equipment	14 Nos.	

Table 17: Technical compliance for Servo drive controller rack

Sr. No.	Parameter Description	Specification	Bidder Compliance
1	Environment	EMC protection	
2	Heat dissipation	1kW	

3	Operation	Front door- Fixed 19"	
4	Dimensions (HXWXD)mm	H: 1200 X W: 800 X D: 500 mm	
5	Conformity standard	IEC62208	
6	Degree of protection	IP54 according to IEC60529	
7	Resistance to mechanical impacts	IK10 according to IEC 62262	
8	Compliance	RoHS and REACH	
9	Structure	Single-piece body, folded and welded	
10	Gasket	Special body-door gasket (IP+EMC)	
11	Locking system	2 locks with key and earth continuity	
12	Lugs and lifting eyes	4 wall fixing lugs and set of 4 lifting eyes	
13	Earth braid	Earth braid for claddings (mounted on welded earth studs on removable claddings)	
14	Cable trays	cable trays should be mounted as required for complete the wiring	
15	Door contact	1 door contact should be mounted	
16	Pilot lights	Red & green pilot lights should be mounted for indication of POWER ON condition	
17	Outlet grille	Outlet grille should be mounted on the bottom of lateral side (right)	
18	Fan	Minimum 130 m ³ /h mounted on the top lateral side (left) or as per requirement	
19	Screws, washers & nuts	Set of 30 screws, washers and nuts	
20	Cable support	Cable support on the lateral framework	
21	Ground bar	1 ground bar should be mounted at bottom side of the panel	

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22	Mounting plate	Plain galvanized mounting plate is required for component mounting	
23	Pocket	Document pocket is required	

Table 18: Technical compliance for Cable specification

Sr. No.	Parameter Description	Specification	Bidder Compliance
1	Core material	Copper	
2	Insulation	XLPE (ZHLS type) where applicable	
3	Nominal Voltage	1100V	
4	Size	As per requirements	
5	Types	Multicore or single core	
6	Compliance	CE	

Table 19: Technical Compliance for standards

Sr. No.	Parameter Description	Applicable Standard	Bidder Compliance
1	Reduced flame propagation	IEC 60332-3	
2	Flame retardant	IEC 60332-1	
3	Low smoke	IEC 61034	
4	Zero halogen	IEC 60754-1	
5	Non-toxicity	IEC 60754-2	
6	Insulated cables sizes	IEC 60228 class 6	
7	Identification of cores of cables	IEC 60445	

Table 20: Technical compliance for Servo controller rack components

Sr. No	Description	Specifications	Bidder Compliance
1	AC Mains	400V +/-10%,50 Hz, 3 Phase AC	
2	Type of wiring	TN-S	
3	Power requirements	25 kW All controller load shall be distributed over 3 phases to make 3 phase balance system	
4	Major components		
4.1	Power on Indicator	Shall be provided at front side.	
4.2	Input mains circuit breaker (QA1)	As per load requirement (~1 Nos) with breaking capacity of 10 kA	
4.3	Circuit breakers (QA2 to QA20)	As per load requirement (~ 19 Nos) with breaking capacity of 10 kA	
4.4	Distribution bus (B1)	As per load requirement with protective Earth bus With 10 kA (Short circuit) I _{sc} Rating	
4.5	Input cable connection TB	As per requirements	
4.6	Input cable Gland arrangement on cubicle	Metallic gland as per cable requirements (1 No)	
4.7	Output cable gland arrangement on cubicle	Suitable metallic gland as per requirements for servo motor MOTION-CONNECT 500 cables (~ 18 Nos.)	
4.8	Cable entry point for Profinet cable	As per requirements for servo controller interface	
4.9	Cable tray for internal wiring	As per requirement	
5	Additional items		

5.1	Cooling Fan with filters	As per requirements	
5.2	Cubicle internal light with door switch interlock	Shall be provided as per requirement	
6	Minimum cross-sectional area of wire used for internal wiring	0.5 Sq.mm	
7	Line filter (3- phase)	As required at input line	

Table 21: Technical compliance for PLC I&C rack

Sr. No	Description	Specifications	Bidder Compliance
1	AC Mains	230V +/-10%,50 Hz, 1 Phase AC	
2	Type of wiring	PN+E	
3	Major components		
3.1	Power on Indicator	Shall be provided at front side.	
3.2	Input mains circuit breaker	As per load requirement (~1 Nos) with breaking capacity of 10 kA	
3.3	Cable entry and exit arrangement	Suitable removable gland plate at top and bottom side of rack as per requirements	
3.4	Circuit Breaker	As per requirements at input side	
3.5	Line filter (1- phase)	As required at input line	
3.6	SMPS	Minimum: 24V/5A (make: Meanwell, siemens, Schneider)	
3.7	Network switch up to 1Gbps	Qty :1 (Make: Cisco, TP-link, D-Link)	
3.8	Vertical Extension board	10 point with 5A& 16A dual compatibility	
3.9	PLC S7-1516 with SMPS & I/O modules	To be mounted	
3.10	ET-200 with SMPS & I/O modules	To be mounted	


3.11	Terminal blocks for field signal termination	As required (Preferred make: Phoenix, Schneider electric, TE connectivity)	
3.12	Minimum cross-sectional area of wire used for internal wiring	0.5 Sq.mm	
3.13	Cable tray for internal wiring	As per requirement	

Table 22: Technical compliance for wiring guidelines

Sr. No.	Description for wiring guidelines	Bidder compliance
1	<ul style="list-style-type: none"> - Standard industrial practice for internal cubicle wiring for both racks. - All components should be tagged properly as per approved wiring/schematic diagram. - Standard IEC 60204-1 for internal cubicle wiring. - Standards IEC 60947-1, IEC 60947-2 for circuit breakers. - IEC 61439 for cabling. 	

Table 23: Technical compliance against documents deliverables

Sr. No	Description	Details	Format for document	Remarks	Bidder compliance
1	Wiring Diagrams	Detailed wiring diagram for PLC I&C rack and servo controller rack with editable file in softcopy as well as hardcopy. - As per IEC 60617 for Symbols	PDF and DXF	In USB drive	
2	BOM	Bill of material for PLC I&C rack and servo controller rack	XLSX (MS-Excel)	In USB drive	
3	Technical Documentation	Requirement Document, Engineering Document, Installation & Configuration Manual,	DOCX & PDF	In USB drive	

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		Operational Manual, Maintenance Manual			
4	FAT & SAT	Factory Acceptance Test report and Site Acceptance Test report	DOCX & PDF	In USB drive	

Table 24: Technical compliance for Hardware deliverables

Sr. No	Description	Qty	Bidder Compliance
1	PLC I&C rack with all mounting hardware components defined in Table 3 & Table 7.	1 set	
2	Servo drive controller rack with all mounting hardware components defined in Table 4 & Table 8.	1 set	

Table 25: Technical compliance for software deliverables

Sr. No	Description	Qty	Bidder Compliance
1	Editable final copy of Software code with comments shall be delivered (In USB drive).	2 Nos.	
2	Licences software defined in Table 2	1 set	

Table 26 Compliance for Scope understanding

Sr. No.	Requirement as per enquiry	Compliance statement by Bidder	Remarks
1	Scope of work as defined in section - 2		
2	Application program development as defined in section - 4		
3	Factory Acceptance test as defined in section - 5.1		
4	Site Acceptance test as defined in section - 5.2		

Authorized Signature by Bidder along with seal and date