

- 5.20.4** Paint shade for indoor electrical equipment shall be 631 & for outdoor electrical equipment shall be 632 as per IS 5.
- 5.20.5** Suitability of cable terminal boxes/chambers for the respective cables sizes / runs as per the final cable schedule shall be ensured by the contractor.
- 5.20.6** All JB's for lighting installation shall be with minimum IP-65 enclosure protection. The terminal block for these shall be bolted type.
- 5.20.7** Reacceleration scheme shall be provided for all drives of GTG. For balance loads/drives reacceleration scheme shall be provided by CONTRACTOR as per Process requirement.
- 5.20.8** All out door electrical equipments shall be provided with FRP canopy.
- 5.20.9** Suitability of cable terminal boxes/chambers for the respective cables sizes / runs as per the final cable schedule shall be ensured by the CONTRACTOR.
- 5.20.10** FCS (9 Nos. approx.) for plant communication and MCPs (3 Nos. approx.) for fire alarm system shall be free issued to contractor. However exact quantity shall be informed during detailed engineering and the same shall be installed by the contractor without any time and cost implication to the owner
- 5.20.11** All nuts, bolts, washers wherever used shall be of stainless steel SS304. External hardware for lighting fixture, CG boxes, junction boxes, welding receptacles, 230V receptacles, LCS lighting panel, local control panel shall be of stainless steel.

6.0 ECS I/O LIST

- 6.1.1** A micro-processor based Electrical Control System (ECS) for Ramagundam Fertilizer Complex is being procured separately by Owner. ECS shall be a HMI supported distributed supervisory system provided to permit remote monitoring of breaker operation and remote metering. Under envisaged ECS it is proposed to cover all feeders of EHV system, all HV switchboards of the project for centralized monitoring. It is also proposed to cover the incomers, bus couplers and the buses of all 415V PCCs/ PMCCs, battery charger and UPS. ECS interface panels and HMI shall be located at each substation. Upper level ECS including ECS OWS and EWS for centralized control and monitoring of all the feeders shall be located at steam and power generation control room.
- 6.1.2** For the purpose of data acquisition, it is proposed to locate Data Acquisition Units in the form of Remote Terminal Unit (RTUs), ECS interface panels with suitable I/O interfaces at various substations. These will be connected to the human-machine interface by a suitable data highway. Refer system architecture (doc. No. A747-400-16-50-SK-0007) for details.
- 6.1.3** CONTRACTOR shall be required to provide facilities and I/O signal interface from the equipment in his battery limit as per details below. The overall plant ECS is to be supplied and commissioned by Others after integrating with the signal interface provided by CONTRACTOR.
- 6.1.4** This is only a typical I/O list to meet monitoring and various application software requirements of ECS. Requirement of signals for plant performance and operational requirement shall be developed by Vendor keeping all ECS requirements in view.
- 6.1.5** As per Owner's requirements, wherever a process signal is utilized for different purposes (such as DCS, SCAP and ECS) the signal shall be multiplied and separate terminals for the same shall be provided.
- 6.1.6** Contractor shall provide signals for Contractor supplied switchboards as per below as a minimum at ECS interface panels (consisting of hardwired DI, AO & AI (4-20 mA) signals and interposing relays for hardwired DO signals) free-issued by Owner and to be located in Contractor's substation. Supply of all cables from Field transmitter/ CONTRACTOR supplied equipments to ECS interface panels (located in substation) is in the scope of Contractor. Contractor shall provide interconnection diagram for terminals at Contractor's side of the free-issued ECS interface panels.
- 6.1.7** The following miscellaneous requirements shall be considered:
- All digital I/Os indicated as "hard-wired" in ECS I/O list shall be made available as potential-free contacts.

- ii). As per Owner's requirements, wherever a process signal is utilized for different purposes (such as ECS and DCS) the signal shall be multiplied and separate terminals for the same shall be provided.
- iii). All ECS hardwired I/Os shall be wired by the CONTRACTOR from the equipment and panels up to the ECS interface panel.
- iv). All other I/Os indicated as "signals required over numerical relay and metering LAN" in the ECS I/O list shall be made available by CONTRACTOR at the SAS.
- v). For signals acquired over relay/metering LAN, the CONTRACTOR shall be required to supply a suitable relay LAN interface device (referred as Ethernet switches). CONTRACTOR shall ensure that the two ports at the Ethernet switches for communication to ECS shall have two separate device addresses for accessing them.
- vi). I/O cables shall have at least one spare pair.
- vii). Suitable PVC engraved labels for module identification, non-insulated type lugs for wire termination and printed number ferrules shall be used for the assembly.

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
SCAP Panel					
DI	S	ECS (Auto)/ SCAP (Manual) selector switch in ECS Position	ECS	SCAP	Hardwired
DI	S	ECS (Auto)/ SCAP (Manual) selector switch in SCAP Position	SCAP	ECS	Hardwired
Gas Turbine Generator & Generator Transformer (Typical for each GTG)					
AI	S	Ambient Temperature of GTG Skid (4-20mA Signal)			Hardwired
DI	D	GTG Winding Temperature (From GT Temp. Monitoring System)	Alarm	Normal	Hardwired
DI	D	GTG Bearing Temperature (From GT Temp. Monitoring System)	Alarm	Normal	Hardwired
DI	D	Rotor earth fault operated	True	False	Relay LAN
DI	D	Relay 80 operated	True	False	
DI	D	Relay 59G operated	True	False	
DI	D	Relay 27G operated	True	False	
DI	D	Relay 32 Alarm operated	True	False	
DI	D	Relay 81 1 st stage operated	True	False	
DI	D	Relay 81 2 nd stage operated	True	False	
DI	D	Relay 51/ 51V operated	True	False	
DI	D	Relay Field Failure Protection (40G) Operated	True	False	
DI	D	Relay Negative Phase sequence (46) Operated	True	False	
DI	D	Stator Earth Fault – 95% (64G1) operated	True	False	
DI	D	Stator Earth Fault – 100% (64G2) operated	True	False	
DI	D	Dead Machine Protection 50G Operated	True	False	
DI	D	Backup impedance 21G Operated	True	False	
DI	D	Local breaker backup protection 50LBB operated	True	False	

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DI	D	Pole slipping relay (78G) operated	True	False	
DI	D	Low forward power protection (37G) relay operated	True	False	
DI	D	Fuse Failure Relay Operated	True	False	
DI	D	Under frequency relay (81U) operated	True	False	
DI	D	Generator Differential relay (87G) operated	True	False	
DI	D	Transformer differential relay (87T) operated	True	False	
DI	D	Generator transformer combined differential relay (87GT) operated	True	False	Relay LAN
DI	D	Generator Transformer REF (64R) Operated	True	False	
DI	D	Transformer Trouble (63TX) Function relay operated	True	False	
DI	D	Generator Transformer Standby Earth Fault (51G) Operated	True	False	
DI	D	GTG Excitation failure operated	True	False	
DI	D	GTG Over fluxing relay (99T) operated	True	False	
DI	D	Numerical Relay Unhealthy (For each type of relay)	Unhealthy	Healthy	
AI	S	Turbine speed			Hardwired
DI	D	Tripping relay 1 (86-1) Operated	True	False	Hardwired
DI	D	Tripping relay 2 (86-2) Operated	True	False	Hardwired
AI	A	GTG R-Phase Current			Hardwired
AI	A	GTG Y-Phase Current			
AI	A	GTG B-Phase Current			
AI	V	GTG RY-Line Voltage			
AI	V	GTG YB-Line Voltage			
AI	V	GTG BR-Line Voltage			
DO	C	GTG Voltage Raise contact	Operated	Not Operated	Hardwired
DO	C	GTG Voltage Lower contact	Operated	Not Operated	Hardwired
AI	S	GTG MW (11 kV)			Hardwired
DO	C	Governor MW Raise contact	Operated	Not Operated	Hardwired
DO	C	Governor MW Lower contact	Operated	Not Operated	Hardwired
AI	S	GTG MVAR (11 kV)			Hardwired
DO	C	AVR MVAR Raise	Operated	Not Operated	Hardwired
DO	C	AVR MVAR Lower	Operated	Not Operated	Hardwired
AI	S	GTG Frequency			Hardwired
DO	C	GTG Frequency Raise	Operated	Not Operated	Hardwired
DO	C	GTG Frequency Lower	Operated	Not Operated	Hardwired
DI	S	GTG Running in Droop Mode	True	False	Hardwired
DI	S	GTG Running in Isochronous Mode	True	False	Hardwired
DI	S	GTG Running in Constant MW Mode	True	False	Hardwired
DO	C	Set GTG Run Mode to Droop Mode Contact	Operated	Not Operated	Hardwired
DO	C	Set GTG Run Mode to Isochronous Mode Contact	Operated	Not Operated	Hardwired

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DO	C	Set GTG Run Mode to Constant MW Mode Contact	Operated	Not Operated	Hardwired
DI	S	GTG Excitation in Constant PF Mode	True	False	Hardwired
DI	S	GTG Excitation in Constant VAR Mode	True	False	Hardwired
DI	S	GTG Excitation in VAR Control Mode	True	False	Hardwired
DO	C	Set GTG Excitation to Constant PF Mode contact	Operated	Not Operated	Hardwired
DO	C	Set GTG Excitation to Constant VAR Mode contact	Operated	Not Operated	Hardwired
DO	C	Set GTG Excitation to VAR Control Mode contact	Operated	Not Operated	Hardwired
DO	C	GTG Excitation ON	Operated	Not Operated	Hardwired
DO	C	GTG Excitation OFF	Operated	Not Operated	Hardwired
DI	S	GTG Excitation ON	True	False	Hardwired
DI	S	GTG Excitation OFF	True	False	Hardwired
AI	S	Generator Transformer Oil Temperature			Hardwired
AI	S	Generator Transformer Winding Temperature			Hardwired
DI	S	GTG Exciter Trip	Operated	Not Operated	Hardwired
DI	S	GTG Generator Trip	Operated	Not Operated	Hardwired
DI	S	GTG Unit Trip	Operated	Not Operated	Hardwired
DI	S	GTG Control from Mark VI	Mark VI	Not Mark VI	Hardwired
DI	S	GTG Control from Remote	Remote	Not Remote	Hardwired
DO	C	GTG in parallel with Tie Line From ECS to MarkVI, If required	True	False	Hardwired
DI	S	AVR in local	Local	Remote	Hardwired
DI	S	AVR in remote	Remote	Local	Hardwired
AO	C	GTG MW Set Point			Hardwired
AO	C	GTG Frequency Set Point			Hardwired
Miscellaneous (Typical for Each DC system).					
DI	A	DC Charger-I	Failure	Normal	Hardwired
DI	A	DC Charger-II	Failure	Normal	Hardwired
DI	A	DC Battery	Discharged	Normal	Hardwired
DI	A	DC Battery	Isolated	Normal	Hardwired
PMCC/EPMC					
Line PT I/O signals					
AI	V	R-Y line voltage			These signals are required over numerical relay and metering LAN (see note 1)
AI	V	Y-B line voltage			
AI	V	B-R line voltage			
DI	D	Line VT MCB	Open	Closed	Hardwired
Incomer from other switchboards I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN (see note 1)
AI	A	Y phase current			
AI	A	B phase current			
AI	W	3-phase real power			
AI	R	3-phase reactive power			
AI	A	Power factor			
DI	S	CB in service & Closed	Closed	Not closed	Hardwired
DI	S	CB in service & Open	Open	Not open	Hardwired

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DI	D	Relay 95	Operated	Reset	These signals are required over numerical relay and metering LAN (see note 1)
DI	D	Trip on under-voltage	Activated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DI	D	Relay 86	Operated	Reset	Hardwired
DO	C	Trip from ECS	Activated	reset	Hardwired
Bus coupler I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN (see note 1)
AI	A	Y phase current			
AI	A	B phase current			
AI	W	3-phase Real power			
AI	R	3-phase Reactive power			
AI	A	Power factor			
DI	S	CB in service & Closed	Closed	Not closed	Hardwired
DI	S	CB in service & Open	Open	Not open	Hardwired
DI	D	Relay 95	Operated	Reset	These signals are required over numerical relay and metering LAN (see note 1)
DI	D	Auto-changeover	Blocked	Not blocked	
DI	D	Numerical Relay	Unhealthy	Healthy	
DI	S	Switchboard (A-I-M selector switch)	In auto mode	Not in auto mode	Hardwired
DI	S	Switchboard (A-I-M selector switch)	In independent mode	Not in indep mode	Hardwired
DI	S	Switchboard (A-I-M selector switch)	In manual mode	Not in manual mode	Hardwired
DI	D	DC control supply #1	Failed	Healthy	Hardwired
DI	D	DC control supply #2	Failed	Healthy	Hardwired
DI	D	AC space heater supply #1	Failed	Healthy	Hardwired
DI	D	AC space heater supply #2	Failed	Healthy	Hardwired
DO	C	Trip from ECS	Activated	reset	Hardwired
DI	D	Relay 86	Operated	Reset	Hardwired
Bus PT I/O signals					
AI	V	R-Y bus voltage			These signals are required over numerical relay and metering LAN (see note 1)
AI	V	Y-B bus voltage			
AI	V	B-R bus voltage			
DI	D	Bus VT MCB	Open	Closed	Hardwired
Outgoing ACB feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN (see note 1)
AI	A	Y phase current			
AI	A	B phase current			
AI	W	Real power			
AI	R	Reactive Power			
AI	A	Power factor			
DI	S	CB in service & Closed	Closed	Not closed	Hardwired
DI	S	CB in service & Open	Open	Not open	Hardwired
DI	D	Relay 95	Operated	Reset	These signals are required over numerical relay and metering LAN (see note 1)
DI	D	Trip on under-voltage	Activated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DI	D	Relay 86	Operated	Reset	Hardwired
DO	C	Trip from ECS	Activated	reset	Hardwired
DO	C	Close inhibit	Activated	reset	Hardwired
Outgoing ACB motor feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN (see note 1)
AI	A	Y phase current			
AI	A	B phase current			
AI	W	Real power			
AI	R	Reactive power			
AI	A	Power factor			
DI	S	CB in service & Closed	Closed	Not closed	Hardwired
DI	S	CB in service & Open	Open	Not open	Hardwired
DI	D	Relay 95	Operated	Reset	These signals are required over numerical relay and metering LAN (see note 1)
DI	D	Trip on under-voltage	Activated	Reset	
DI	D	Motor Trip from Process	Activated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DI	D	Relay 86	Operated	Reset	Hardwired
DO	C	Trip from ECS	Activated	reset	Hardwired

Notes:

- Acquisition of input/output (I/O) signals as hardwired or software:
 - Relay & control panels shall have numerical relays. All signals of I/O list that are to be acquired on the relay LAN have been indicated as such. All other I/Os shall be acquired hardwired. In case any of these data cannot be acquired over the relay LAN, these signals have to be provided as hardwired.
 - All other I/Os shall be acquired hardwired and have been indicated as "hardwired" in the typical I/O list above.
 - In case any of these data can not be acquired over the relay LAN, these signals have to be provided as hardwired. For requirement of numerical relays, refer Electrical part of contract document.
- This I/O list is indicative only. Any other I/O required to meet the contract requirements shall be identified and provided by CONTRACTOR.

6.1.8 Guidelines for ECS I/O Interface Design:

Analogue Input (AI) Signals:

For all measurements for I, V, MW, MVAR, Hz, PF, , obtained on the relay and metering LAN, maximum possible accuracy shall be ensured.

Digital Input (DI) Signals:

Alarm (D)

Alarm is a signal which requires operator to be alerted such as PT circuit MCB (closed, open), relays 86 & 95 (operated, reset), under-voltage trip etc. This shall be hardwired / on relay LAN as specified.

For hardwired signal, potential free contacts of rating 0.5 A, 220 V DC or 240 V AC, make to alarm (NO) preferred.

Generally a hardwired alarm point is put under "sequence of event" monitoring.

Status (S) For hardwired signal, potential free contacts of rating 0.5 A, 220 V DC or 240 V AC, make to alarm (NO) required.

Digital Output (DO) Signals:
Command (C) Hardwired through potential free changeover type contact of interposing relay, contact rating 5 A, 240 V AC and/or 2 A, 220 V DC.

Relay/Metering LAN ECS Interface Specification

i.	LAN link type	FO
ii.	Communication protocol	IEC-61850
iii.	Communication speed	100 Mbps
iv.	Link configuration	Point to point
v.	Qty of relays/meters on a LAN link	To suit response requirement
vi.	Response requirement	As per specification.
vii.	Link medium	FO
viii.	LAN cabling	From Ethernet switches to ECS RTU panels including supply and termination,

7.0 SPARES

7.1 Commissioning Spares

Commissioning spares for all electrical equipments are included in CONTRACTOR's scope of supply and shall be included in the base price.

7.2 Two Years Operation & Maintenance Spares:

CONTRACTOR shall submit a list with unit prices of recommended spares for two years of normal operation for all electrical equipment along with their bid.

7.3 Mandatory Spares:

Mandatory spares as per the document attached, A747-400-16-50-SL-7810 are included in the scope of supply of CONTRACTOR.

8.0 INSPECTION AND TESTING AT MANUFACTURER'S WORKS

All major electrical equipment and material shall be subject to inspection by Owner/ EIL/ authorized representative at manufacturers' works. CONTRACTOR/ Supplier shall furnish all necessary information concerning the supply to Owner/ EIL.

Contractor shall ensure that the HV/MV switchboard procured have type test certificates. Type test certificates for short circuit withstand and heat run tests for switchboards shall not be more than five years old. In those cases, where the short circuit withstand and heat run tests type test certificates are more than five years old, contractor/ manufacturer shall carry out the type tests at CPRI or any authorized testing lab prior to dispatch of equipment with no commercial & delivery time implication. All other type tests shall be valid until there is a design change, in that case contractor/ manufacturer shall carry out all the type tests at CPRI/CMRI/CIMFR or any authorized testing lab prior to dispatch of equipment with no commercial & delivery time implication. In the absence of specific confirmation to this stipulation, offered equipment shall be summarily rejected.

Contractor/ Supplier shall ensure that type test certificates for other electrical equipments shall not be more than five years old. In those cases where type test certificates are more than five years old, Contractor/ Supplier shall carry out the type tests at CPRI/CMRI/CIMFR or any