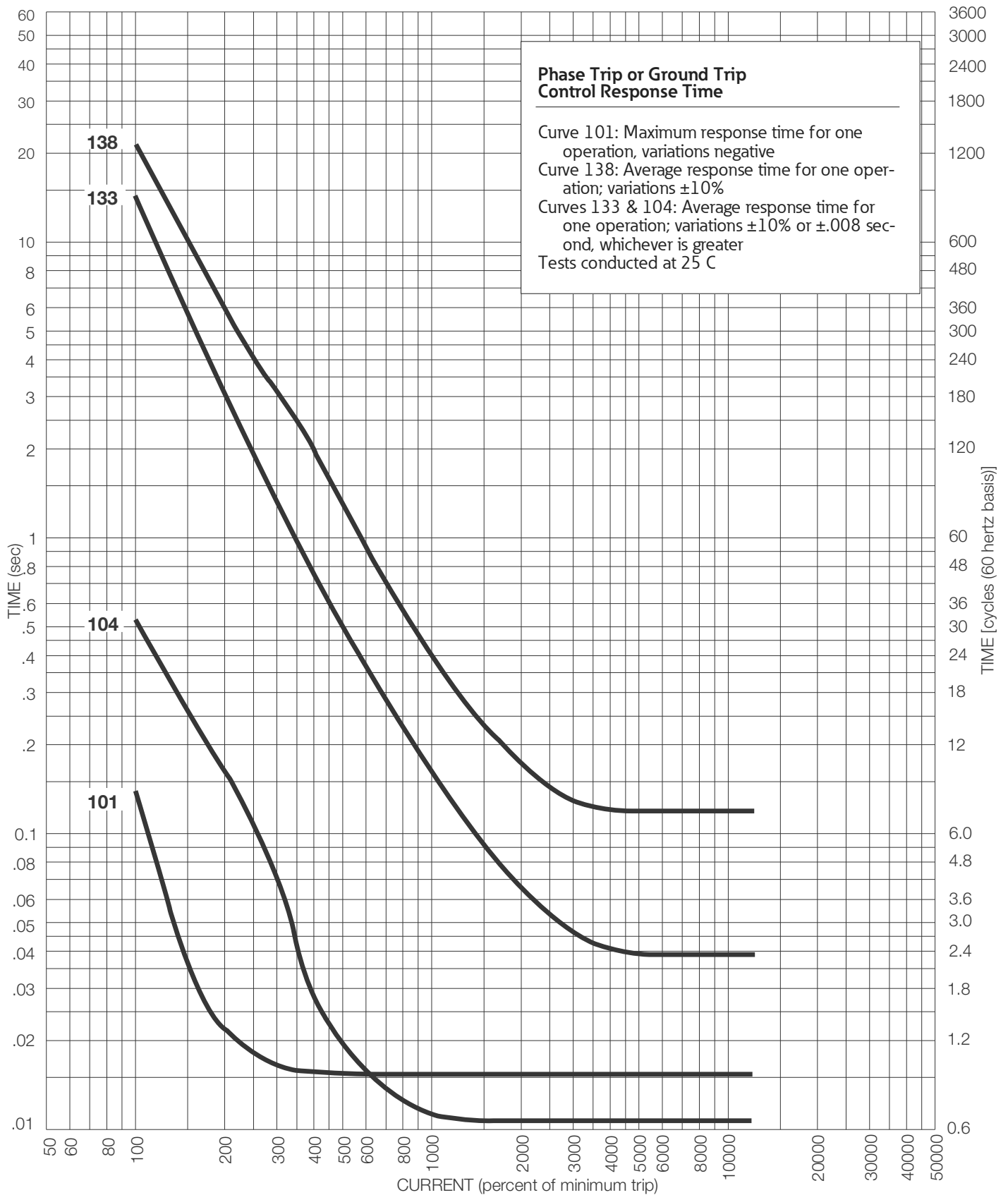
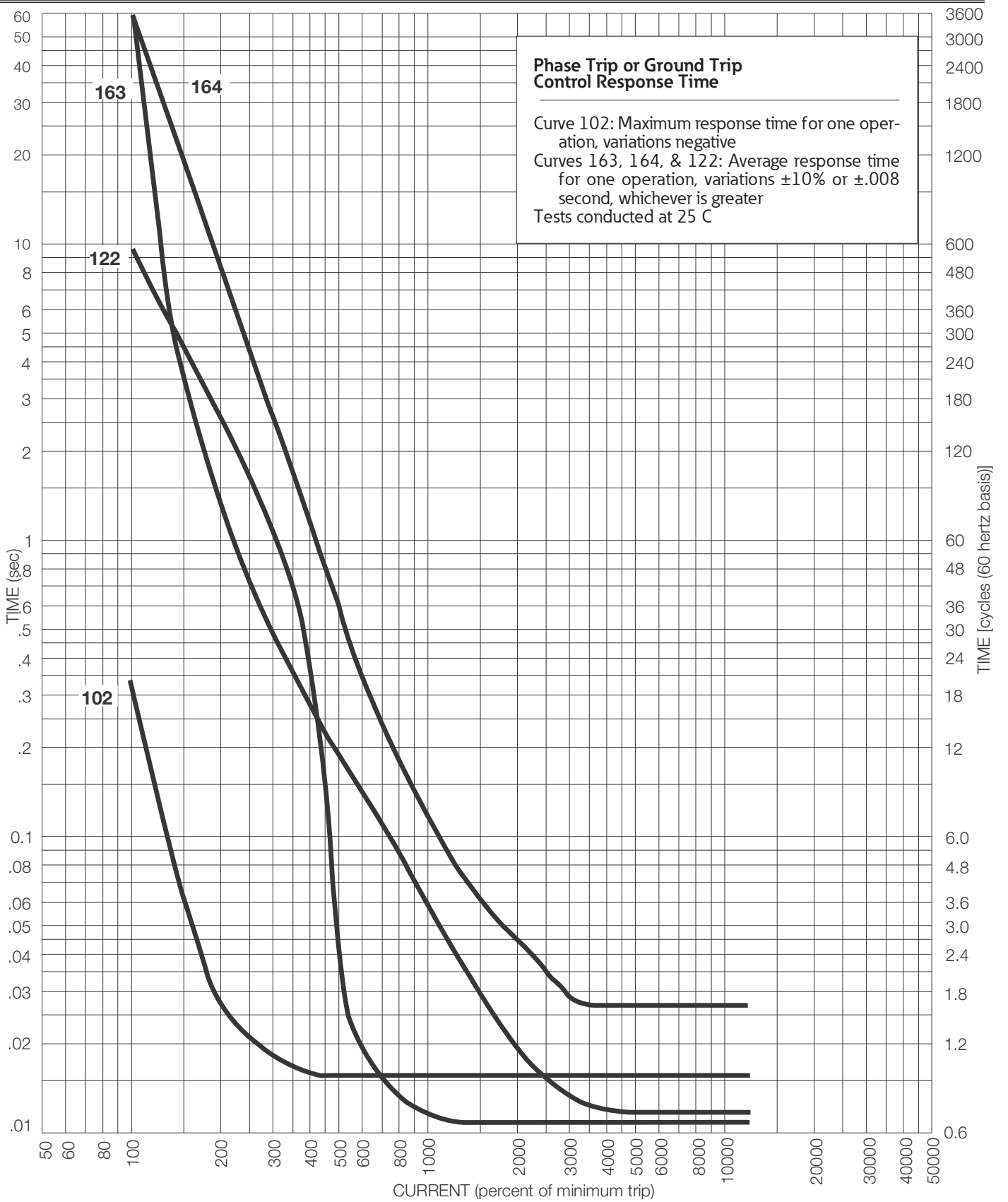
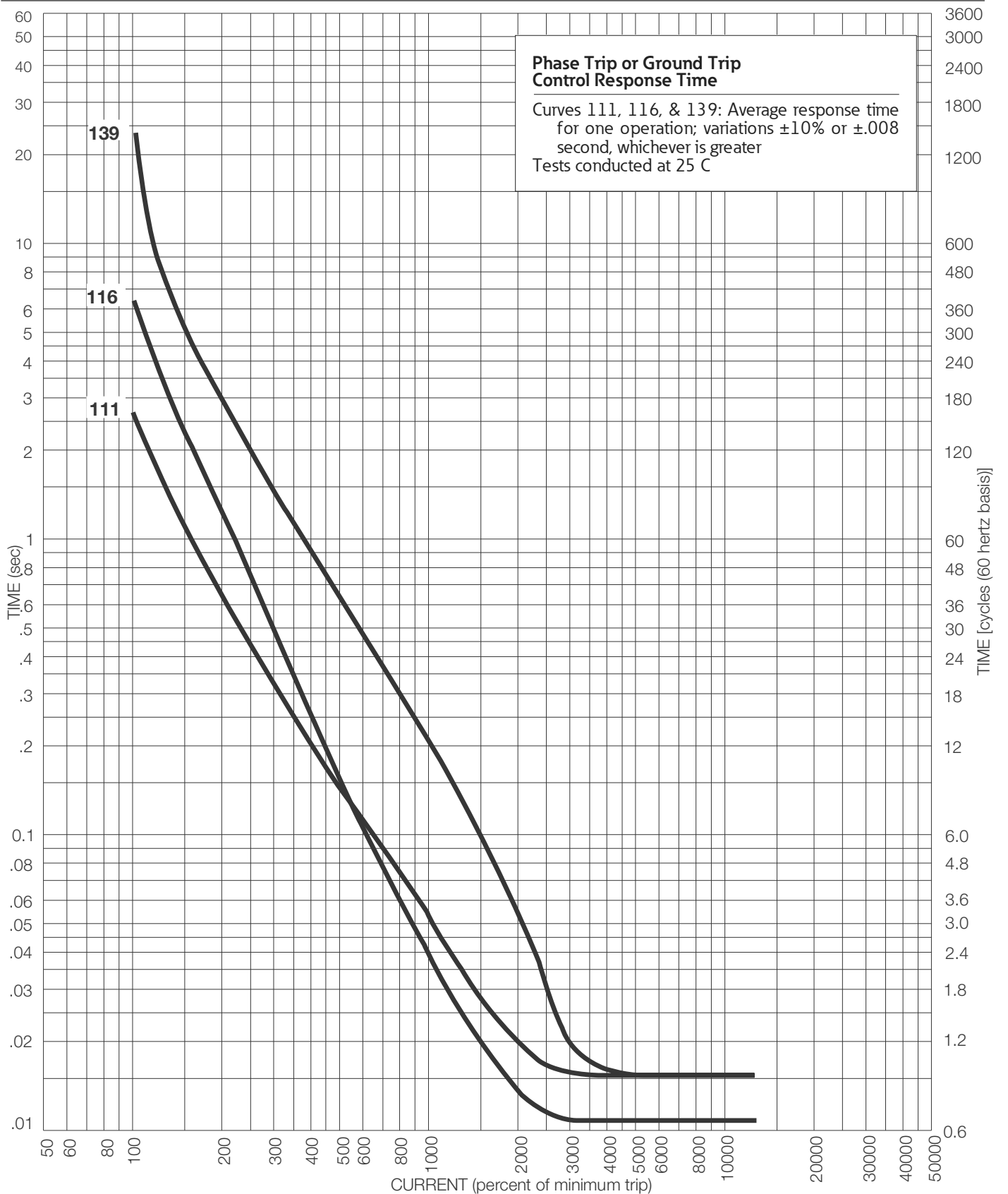
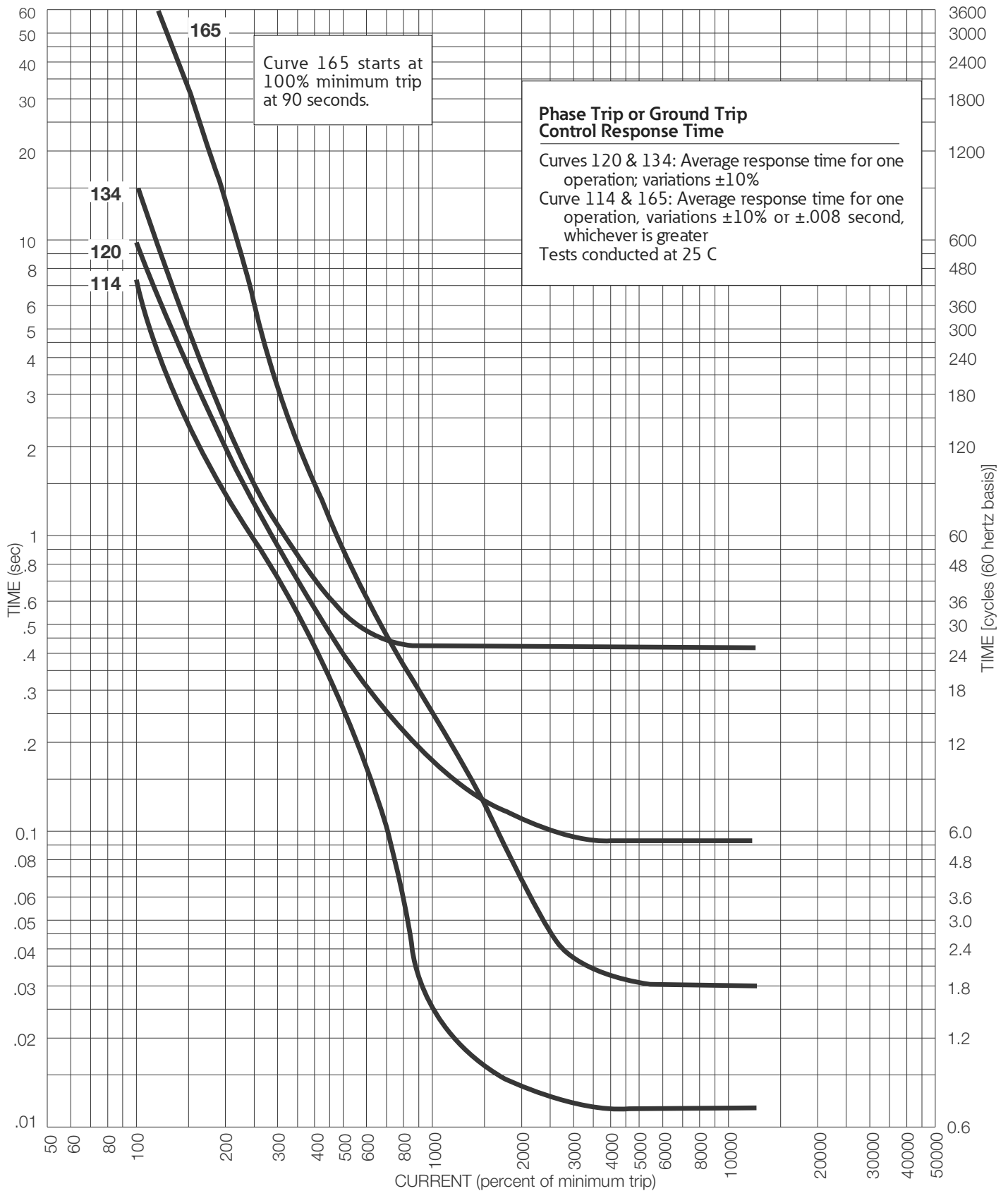


Attachment No.1









Attachment No.2

Testing Procedure for Distribution

Management System Interface

Testing Procedure for Distribution Management System Interface

1. Testing for DNP 3.0 Interface

- a. Objective: For improved communication protocol of LRC Supplier.
- b. Testing Equipment: Follow by Configuration Fig. 1
- c. Location for Testing: At System Management Center (SMC) Building in PEA Head Office.

2. Testing for System Interface

- a. Objective: For improved System Performance in the Field (including Communication Equipment)
- b. Testing Equipment: Follow by Configuration Fig. 2 and/or Configuration Fig.3
- c. Location for Testing: At Area Distribution Dispatching Center Building (1 ADDC in DDC.1 Project and/or 1 ADDC in DDC.2 Project)

Detailed for Connector at Break-out Box (BOB)

RS-232 DESCRIPTION	RS-232 CIRCUIT	DB25 PIN	SIGNAL DIRECTION	SEE NOTE
Protective Ground	AA	1	-	1
Signal Ground	AB	7	-	-
Transmitted Data	BA	2	Out to DCE	-
Received Data	BB	3	In from DCE	-
Request To Send	CA	4	Out to DCE	-
Clear To Send	CB	5	In from DCE	-
Data Set Ready	CC	6	In from DCE	-
Data Terminal Ready	CD	20	Out to DCE	-
Received Line Signal Detect (DCD)	CF	8	In from DCE	-
Transmit Signal Element Timing (DTE)	DA	24	Out to DCE	-
Transmit Signal Element Timing (DCE)	DB	15	In from DCE	-
Receiver Signal Element Timing	DD	17	In from DCE	-

Note 1: DB25 connector pin 1 is connected to the DB25 connector body shell and to the metal enclosure

Note 2: DB25 connector is male type connector

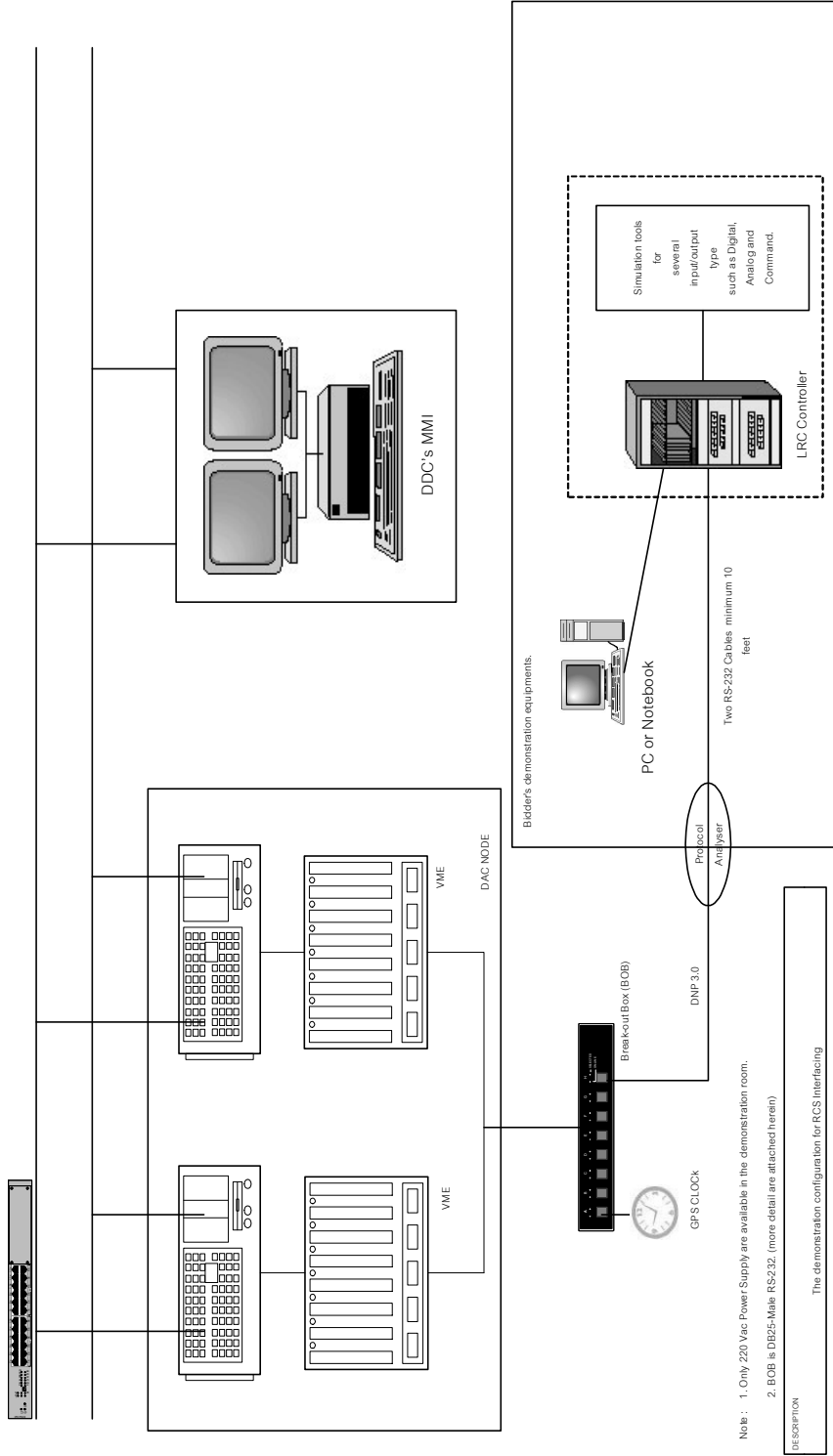
Remarks: DCD = Data Carrier Detector, DTE = Data Terminal Equipment, DCE = Data Circuit-terminating Equipment

Detailed for Connector at Telecontrol Gateway – Slave Unit (TCG-SU)

RS-232 DESCRIPTION	RS-232 CIRCUIT	RJ-45 PIN	SIGNAL DIRECTION	SEE NOTE
Protective Ground	AA		-	-
Signal Ground	AB	3	-	-
Transmitted Data	BA	4	Out to DCE	-
Received Data	BB	5	In from DCE	-
Request To Send	CA	-	-	-
Clear To Send	CB	-	-	-
Data Set Ready	CC	-	-	-
Data Terminal Ready	CD	-	-	-
Received Line Signal Detect (DCD)	CF	-	-	-
Transmit Signal Element Timing (DTE)	DA	-	-	-
Transmit Signal Element Timing (DCE)	DB	-	-	-
Receiver Signal Element Timing	DD	-	-	-

Remarks: DCD = Data Carrier Detector, DTE = Data Terminal Equipment, DCE = Data Circuit-terminating Equipment

Configuration for Preliminary Fig. 1

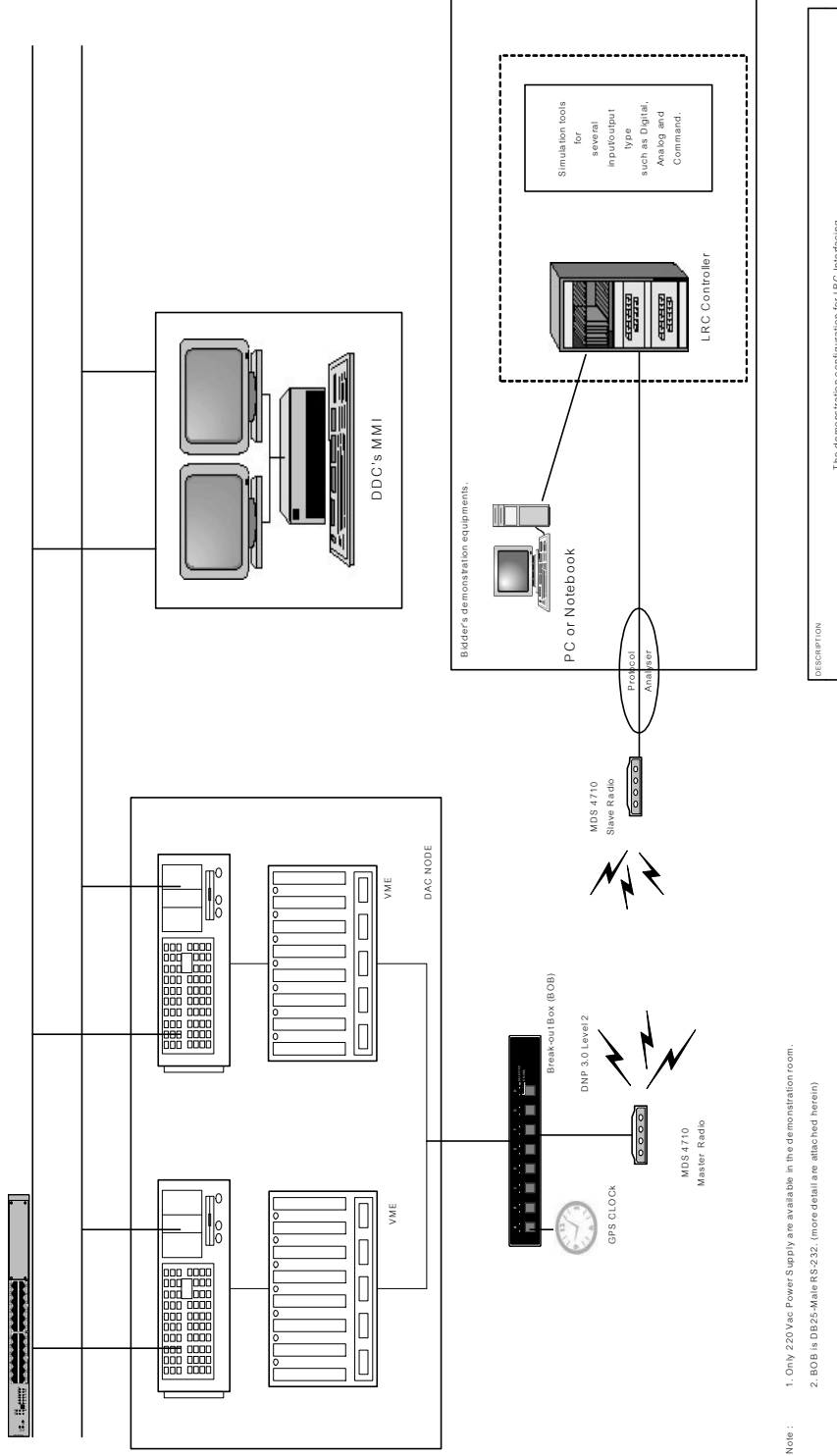


Note : 1. Only 220 Vac Power Supply are available in the demonstration room.
 2. BOB is DB25-Male, RS232. (more detail are attached herein)

DESCRIPTION
 The demonstration configuration for RGS Interfacing

Remark: VME = Versa Module Eurocard, DAC = Data Acquisition and Control, MDS = Microwave Data System, GPS = Global Positioning System

Configuration for Preliminary Fig.2

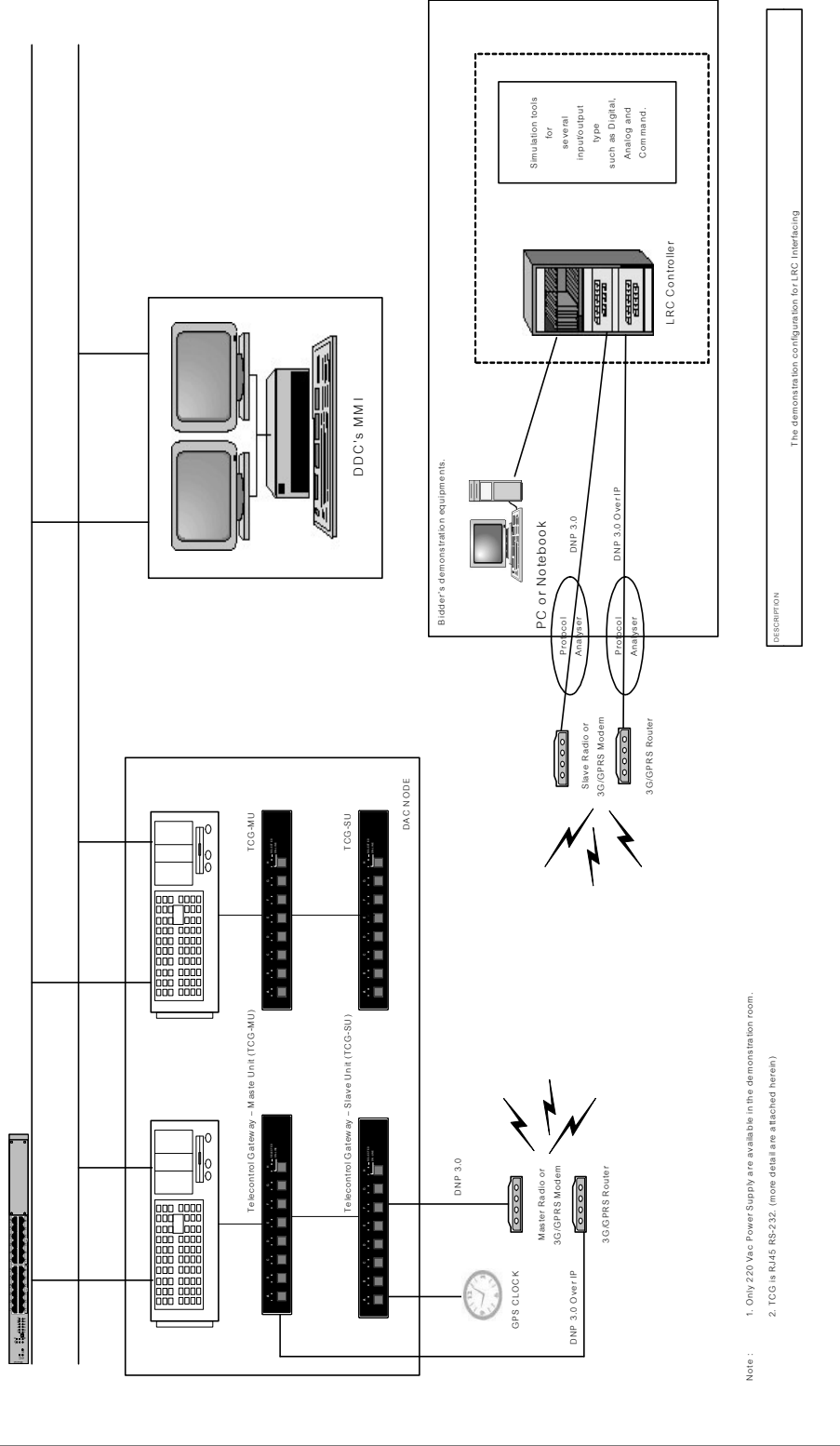


Note :
 1. Only 220Vac Power Supply are available in the demonstration room.
 2. BOB is DB25-Male RS-232. (more detail are attached herein)

DESCRIPTION
 The demonstration configuration for LRC Interfacing

Remark: VME = Versa Module Eurocard, DAC = Data Acquisition and Control, MDS = Microwave Data System, GPS = Global Positioning System

Configuration for Preliminary Fig.3



Note :
 1. Only 220 Vac Power Supply are available in the demonstration room.
 2. TCG is RJ45 RS-232. (more detail are attached herein)

Attachment No.3

Preliminary DMS inter facing Test Reports

I/O List for FRTU
TYPE :FRTU - LRC

LRC Voltage Level :
LRC Name (OP_ID) :
LRC Ref. Name (Site_ID) :
LRC DNP Address :
Control Outputs:

Item	CODE	Point Name (up to 50 chars)	State		Panel	Terminal Connection	Point Type	DMS (DNP Mapping)				Remark
			I (Close)	O (Trip)				Obj	Var	Qti	Class	
1	S/SNNR-XX	LRC Close/Open Command	Close	Open	FRTU-LRC		SBO	12	1	echo of request		0
2	S/SNNR-XX	LRC Reducing ON/OFF Command	On	Off	FRTU-LRC		SBO	12	1	echo of request		1
3	S/SNNR-XX	LRC Ground Trip Normal/Block Command	Normal	Block	FRTU-LRC		SBO	12	1	echo of request		2
4	S/SNNR-XX	LRC Hot Line Tag ON/OFF Command	On	Off	FRTU-LRC		SBO	12	1	echo of request		3
6	S/SNNR-XX	LRC Group Enable Command	GroupA	GroupB	FRTU-LRC		SBO	12	1	echo of request		4

Analog Points:

Item	CODE	Point Name (up to 50 chars)	Unit	Scale		Panel	Terminal Connection	Point Type	DMS (DNP Mapping)				Remark
				Actual Data	Raw Data				Obj	Var	Qti	Class	
1	S/SNNR-XX	LRC Current Phase A	A	0-600	0-600	FRTU-LRC		AI	32	2	17,28	2	0
2	S/SNNR-XX	LRC Current Phase B	A	0-600	0-600	FRTU-LRC		AI	32	2	17,28	2	1
3	S/SNNR-XX	LRC Current Phase C	A	0-600	0-600	FRTU-LRC		AI	32	2	17,28	2	2
4	S/SNNR-XX	LRC Fault Current Phase A	A	0-12000	0-12000	FRTU-LRC		AI	32	4	17,28	1	3
5	S/SNNR-XX	LRC Fault Current Phase B	A	0-12000	0-12000	FRTU-LRC		AI	32	4	17,28	1	4
6	S/SNNR-XX	LRC Fault Current Phase C	A	0-12000	0-12000	FRTU-LRC		AI	32	4	17,28	1	5
7	S/SNNR-XX	LRC Voltage Phase A-B	kV	0-40	0-4000	FRTU-LRC		AI	32	2	17,28	2	6
8	S/SNNR-XX	LRC Voltage Phase B-C	kV	0-40	0-4000	FRTU-LRC		AI	32	2	17,28	2	7
9	S/SNNR-XX	LRC Voltage Phase C-A	kV	0-40	0-4000	FRTU-LRC		AI	32	2	17,28	2	8
10	S/SNNR-XX	LRC Active Power	MW	-32.76+32.76	-3276-3276	FRTU-LRC		AI	32	2	17,28	2	9
11	S/SNNR-XX	LRC Reactive Power	MVAR	-32.76+32.76	-3276-3276	FRTU-LRC		AI	32	2	17,28	2	10
12	S/SNNR-XX	LRC Power Factor	%	-100+100	-10000+10000	FRTU-LRC		AI	32	2	17,28	2	11

S/SNNR-XX

SS : Substation Code, NN : Feeder No., R : Reducer, XX : Relocater No. of Feeder

SBO = Output Command (Select the line operate) , DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag) , SOE = MCD point (Digital input with time tag)

Note : The Meaning of Descriptor is before"/" is state "1" after "/" is state "0", " second line is state "1,0" for binary point; first line is state "0,1" for binary point.

Status Points:

Item	CODE	Point Name (up to 50 chars)	State			Panel	Terminal Connection	Point Type	DMS (DNP Mapping)				Remark
			0	1	2				3	Obj	Var	Qti	
1	S/SNNR-XX	LRC Recloser Status	Undefined	Close	Open	Fault	FRTU-LRC	SOE	2	2	17,28	1	0
	S/SNNR-XX						FRTU-LRC	SOE	2	2	17,28	1	1
2	S/SNNR-XX	LRC Control Mode	Undefined	Local	Remote	Fault	FRTU-LRC	DI	2	1	17,28	1	2
	S/SNNR-XX						FRTU-LRC	DI	2	1	17,28	1	3
3	S/SNNR-XX	LRC Power Status	Normal	Alarm			FRTU-LRC	DI	2	1	17,28	1	4
4	S/SNNR-XX	LRC Recloser Malfunction	Normal	Alarm			FRTU-LRC	DI	2	1	17,28	1	5
5	S/SNNR-XX	LRC Enduser Door Open	Normal	Alarm			FRTU-LRC	DI	2	1	17,28	1	6
6	S/SNNR-XX	LRC Ground Trip Block Status	Normal	Block			FRTU-LRC	DI	2	1	17,28	1	7
7	S/SNNR-XX	LRC Reclosing On/Off Status	Off	On			FRTU-LRC	DI	2	1	17,28	1	8
8	S/SNNR-XX	LRC AR Operate Status	Normal	Operate			FRTU-LRC	SOE	2	2	17,28	1	9
9	S/SNNR-XX	LRC AR Lockout Status	Normal	Lockout			FRTU-LRC	SOE	2	2	17,28	1	10
10	S/SNNR-XX	LRC Phase A Fault Detect	Normal	Trip			FRTU-LRC	SOE	2	2	17,28	1	11
11	S/SNNR-XX	LRC Phase B Fault Detect	Normal	Trip			FRTU-LRC	SOE	2	2	17,28	1	12
12	S/SNNR-XX	LRC Phase C Fault Detect	Normal	Trip			FRTU-LRC	SOE	2	2	17,28	1	13
13	S/SNNR-XX	LRC Earth Fault Detect	Normal	Trip			FRTU-LRC	SOE	2	2	17,28	1	14
14	S/SNNR-XX	LRC Protection Group B Trip	Normal	Trip			FRTU-LRC	SOE	2	2	17,28	1	15
15	S/SNNR-XX	LRC Voltage Sensor	Normal	Fail			FRTU-LRC	DI	2	1	17,28	1	16
16	S/SNNR-XX	LRC Battery Voltage Indicator	Normal	Fail			FRTU-LRC	DI	2	1	17,28	3	17
17	S/SNNR-XX	LRC Hot Line Tag On/Off Status	Off	On			FRTU-LRC	DI	2	1	17,28	1	18
18	S/SNNR-XX	LRC Recloser Group Setting	GroupA	GroupB			FRTU-LRC	DI	2	1	17,28	1	19

S/SNNR-XX

S/S: Substation Code, NN: Feeder No., R: Recloser, XX: Recloser No. of Feeder

SBO = Output Command (Select before operate), DOP = Output Command (Direct operate)

AI = Analog input (Measurement)

DI = Regular point (Digital input without time tag), SOE = MCD point (Digital input with time tag)

Note: The Meaning of Descriptor is before '/' is state '1' after '/' is state '0' for binary point; first line is state '0', 1st second line is state '1', 0th for ternary point.

DNP3.0 Protocol Testing Check List

Date :
 Place :
 RTU Type :
 LRC Controll Unit Manufacturer : Model : Firmware Version :

Functional Check Detail	Result	Comments
1. Digital Input		
- Single bit (binary without time (DI) / binary with time (SOE))		
- Double bit (binary without time (DI) / binary with time (SOE))		
2. Digital Output (Command Control)		
- Select Before Operate (SBO)		
- Control Related Status Codes (i.e. code 0,2,7,12)		
3. Analog Input		
- 16 bit analog without time		
4. Class Scan		
- Class 1 (DI with Unsolicited)		
- Class 2 (Analog)		
- Class 3 (DI without Unsolicited)		
5. Time and Date Facility		
- GMT and Local Time Configuration(Local at Panel , GMT to SCADA)		
- Write Date and Time from SCADA/DMS		
6. Buffer Sending		
- SOE Buffer (512 events)		
7. Flag information		
- Online / Offline		
8. Internal Indication		
- Restart flag		
- Overflow		
- Need Time		
8. DNP Mapping and configuration		
Digital Input		
- Class assignment		
- Point Type (with/without time)		
Digital Output (Command Type)		
- SBO		
Analog Input		
- Class assignment		
- Point Type (with/without time)		
- Scaling		
- Deadband		
9. Unsolicited or retry Configuration		
- Number of retries		
- Retry delay time		
10. Communications Configuration		
- Baud Rate 300 - 19,200 bps		
- Via Radio (Delay time, DCD, CTS, RTS, Collision)		
- IP port Configuration (in case of DNP3 over IP Testing)		
- Diagnostic Port		
11. Fail Safe Design		

Remark :

- " / " = Yes , " x " = No , " -- " = Not be tested

- This is LRC - SCADA / DMS interface test , not included accuracy of analogue and full function test.

- Site Routine Test of the first LRC must be exercised before in service.

DNP3.0 Protocol Testing Check List

Date :			
Place :			
RTU Type :			
LRC Control Unit Manufacturer :	Model :	Firmware Version :	

Comment / Recommend :	

TESTED BY :
SIGNATURE :
COMPANY NAME :
DATE :

WITNESS BY :
SIGNATURE :
COMPANY NAME :
DATE :

WITNESS BY :
SIGNATURE :
COMPANY NAME :
DATE :

Appendix B : Specification สำหรับตู้ควบคุม LRR
(Specification no. RTRN-039/2561)





THREE-PHASE AUTOMATIC VOLTAGE REGULATORS (AVR) FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS

Specification No.: RTRN-039/2561

Approved date:22/05/2018

Rev. No.: 2

Form No. 02-3

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Invitation to Bid No.:

C Material, equipment, and specifications for THREE-PHASE AUTOMATIC VOLTAGE REGULATORS (AVR) FOR 22 kV AND 33 kV 50 Hz DISTRIBUTION SYSTEMS

C1 General material and packing instructions

Additional to the general instructions, the following shall be observed:

1a Scope

These specifications cover three-phase Automatic Voltage Regulators (AVR) and accessories for maintaining a constant output voltage and suitably designed for outdoor installation on distribution circuits, system voltages of 22 kV and 33 kV 50 Hz.

1b Standards

The three-phase automatic voltage regulators (hereinafter called the AVR) shall be manufactured and tested in accordance with the following standards:

Thailand Industrial Standard (TIS)

TIS 384: 2543 Power Transformers

International Electrotechnical Commission (IEC)

IEC 60076-1: 2011 Power transformers – Part 1: General

IEC 60076-2: 2011 Power transformers – Part 2: Temperature rise for liquid-immersed transformers

IEC 60076-3: 2013 Power transformers – Part 3: Insulation levels, dielectric tests and external clearance in air

IEC 60156: 1995 Insulating liquids – Determination of the breakdown voltage at power frequency – Test method

IEC 60214-1: 2004 Tap-changers – Part 1: Performance requirements and test methods

IEC 60296: 2012 Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear

And all other relevant standards, unless otherwise specified in these specifications.

PEA will accept the AVR tested in accordance with the later edition of the above standards.

PEA will also accept the type test report in accordance with the previous edition of the above standards, if there is no significant change in any test items or no additional test item(s) compared with the above standards. On the other hand, if there is significant change in any test items or there are any additional test items, the previous edition type test report with the additional test report(s) of the significant change test item(s) and/or additional test item(s) will be also accepted.



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1c Principal requirement

1c.1 Service conditions and installation

The AVR and accessories shall be designed and constructed for outdoor installation and operation under the following conditions:

Altitude	:	up to 1,000 m above sea level
Ambient air temperature	:	40 ^o C, maximum
	:	30 ^o C, monthly average, of the hottest month
Relative humidity	:	up to 94 %
Climate condition	:	tropical climate

1c.2 General

The AVR shall consist of three-phase auto-transformer, on-load tap-changer, current transformers, voltage transformers, auxiliary transformer, power supply, control and protecting equipment housing in a control cabinet, Distribution Management System (DMS) interface, and accessories.

The AVR shall be delivered with initial oil filling.

The AVR's tank and control cabinet shall be suitable for installation on concrete foundation (see drawing No.SA2-015/53004 attached).

1c.3 Three-phase auto-transformer

The three-phase auto-transformer shall be oil-immersed, star connected solidly grounded with neutral brought out, with delta connected tertiary windings of 1/3 of the total transformer capacity.

1c.3.1 Ratings and characteristics

The transformer shall have rating and minimum characteristics as specified in **Table 1**.

Table 1

Ratings and characteristics of three-phase auto-transformer

Ratings and characteristics	Unit	Requirements
Vector Group	-	YNa0d11
Rated frequency	Hz	50
Rated primary voltage	kV	Variation between + 4 x 1.25% and - 16 x 1.25% of the nominal system voltage
Rated secondary voltage with line drop compensation	kV	Constant at 105% of the nominal system voltage
Rated tertiary voltage	kV	6.6
Rated Power	MVA	As stated in "C3 Schedule of detailed requirement"
Rated Current	A	As stated in "C3 Schedule of detailed requirement"



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Ratings and characteristics	Unit	Requirements
Limit of temperature-rise		
- Winding	K	not exceed 55
- Top oil	K	not exceed 50

1c.3.2 Winding and tapping

The windings of the transformers shall be of copper, connected in star connection and provided with taps. The taps shall be arranged on series windings around neutral-point of the star connection and changed automatically by on-load tap-changer with full capacity tapping.

1c.3.3 Losses and short-circuit impedance

The specified or guaranteed losses plus positive tolerance on the principle tapping, for each transformer, shall not be more than the figures in the **Table 2**.

Short-circuit impedance shall be measured on the principle tapping at 75°C.

The short-circuit impedance of the offered transformer shall be as specified in the **Table 2** and have tolerance according to the relevant standard.

Table 2

Losses and short-circuit impedance of three-phase auto-transformer

System voltage (kV)	Rated power (MVA)	Rated current (A)	Losses plus positive tolerance		Short-circuit impedance (%)
			No-load loss (W)	Load loss (W)	
22	5.7	150	2,800	5,600	0.2
	8	200	3,000	6,000	0.2
	12	300	4,000	6,800	0.2
	16	400	5,000	8,400	0.2
33	12	200	4,200	6,800	0.2
	18	300	5,600	9,600	0.2

1c.4 On-load tap-changer (OLTC) and accessories

1c.4.1 Requirements

The OLTC shall be manufactured and tested in accordance with IEC 60214-1.

The OLTC shall be high speed resistor type and the technology of the OLTC shall be **vacuum technology**.

The OLTC shall be in-tank or tank mounted type.



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The OLTC manufacturer shall be:

- MASCHINENFABRIK REINHAUSEN (MR)/Germany; or
- ABB/Sweden

Removable bolted cover shall be provided for access to the arcing switch without opening the main tank or lowering the oil in the main tank.

The tap changer head shall be provided with an integrated pressure relief diaphragm (rupture disk) or other relief valve provided by OLTC manufacturer.

The protective relay and valve mounted into the oil pipe between the tap changer and oil conservator responding to the oil-flow from the OLTC oil compartment toward the oil conservator shall be provided. Overpressure relay for protection of load tap changer is also accepted.

1c.4.2 OLTC compartment

The contact life of the moving and fixed contacts of the on load tap selector switch, at the rated current shall be not less than 500,000 operations. Mechanical life shall be more than 1,000,000 operations.

The OLTC shall have an inspection interval, at the maximum rated current, of at least fifteen (15) years or not less than 150,000 tap change operations, whichever is earlier.

OLTC shall be able to be loaded up to 120% of transformer rated power.

The insulating oil for the OLTC shall be in a separate compartment, having separate oil level gauge and dehydrate breather.

The OLTC shall be provided with:

1. Pressure-relief device with a pressure control contact for tripping at a preset pressure
2. Protective relay or pressure relay with tripping contact
3. Oil conservator
4. Dehydrating breather with silica gel of not less than 1.5 kg
5. Drive shaft
6. Motor drive unit

1c.4.3 Operation

The OLTC shall be suitable for automatic and manual operation.

Automatic tap changing shall be operated by receiving signal from voltage regulating relay. Manually tap changing shall be operated either by electrical (push buttons) or mechanical (driving handle) operation.

When the OLTC is being driven by hand, the electrical system shall be automatically disconnected, hand crank or hand wheel shall be furnished.

When the OLTC is electrically operated, it can be either by remote operation performed by DMS or local operation (push buttons)



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The motor drive unit shall operated on three-phase 400 V AC 50 Hz and be provided with motor protection, i.e., open-phase, under voltage, overload, reverse rotating field, etc., and circuit-breaker to connect and disconnect the power supply to motor.

For in-tank OLTC, a manhole shall be installed on side of main tank and shall be provided for easy maintenance.

1c.4.4 Driving mechanism

OLTC driving mechanism housing shall be weatherproof type, IP 54 according to IEC 60529 with electrically heated to prevent from moisture mounted on the side of transformer, and equipped with at least following equipment:

1. Raise/Lower control switch
2. Transmitter for tap position
3. Operation counter
4. Local tap position indicator readable from outside without any obstruction
5. Limiting device to prevent from overreaching extreme tap positions
6. Equipment to operate remotely
7. Indicator when tap changer is in operation
8. Convenient outlet, for single-phase 230 V AC 50 Hz and lighting with door switch
9. Heater controlled by On-Auto-Off selector switch, hygrostat shall be used for auto mode.
10. Hand crank or hand wheel for manual operation, interlocked with motor control

1c.5 Bushing and terminal connector

The AVR shall have six (6) HV line terminal bushings, one (1) HV neutral terminal bushing, four (4) auxiliary transformer terminal bushings and two (2) voltage transformer terminal bushings.

The HV terminal bushing shall manufactured and tested according to DIN 42531 or 42532 and shall have full wave impulse withstand voltage as specified in **Table 3**.

Table 3

Full wave impulse withstand voltage of HV terminal bushings

Description	Unit	Line terminal bushings and neutral terminal bushing	
System voltage	kV	22	33
Full wave impulse withstand voltage, not less than	kV, Peak	125	170



The terminals of the HV bushings shall be equipped with 2-hole or 4-hole NEMA standard terminal pads, compression type terminal connectors (lugs) suitable for aluminium conductor diameter of 17.5 mm (cable size 185 mm²) and mounting hardware (bolts, nuts, washers, and lockwashers) of stainless steel.

The terminal bushings for the voltage transformers and the auxiliary transformer shall be manufactured and tested according to DIN 42530.

The bushings of the AVR shall locate as shown in the sketch in the **Figure 1**.

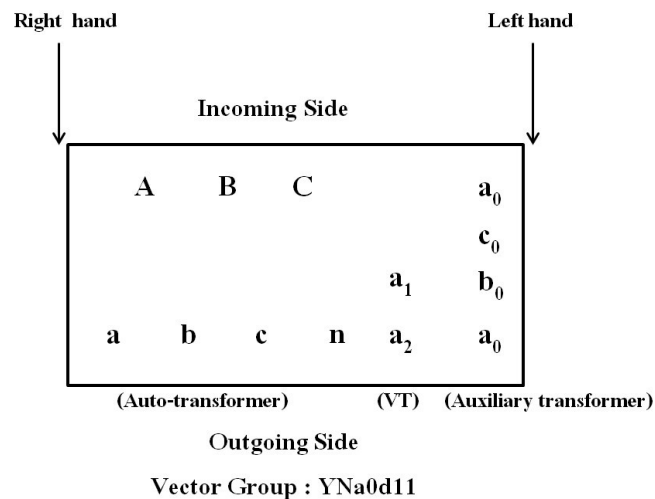


Figure 1: Preliminary bushings arrangement of the AVR

1c.6 Tank finish

Tank of the AVR shall be capable of withstanding, without leakage or permanent distortion, an internal gas pressure of 101,325 Pa and a vacuum of 76 cm of mercury, and shall be designed and constructed for vacuum filling in the field.

Cover shall be welded to the tank to avoid oil leakage.

The tank shall be designed without pockets wherein gas may collect.

All valves, fittings, and piping shall be designed and constructed for vacuum filling.

The tank shall also have suitable jacking pads and pulling lugs. The tank shall be provided with a fabricated or structural steel base designed and built to allow skidding or moving on rollers in either direction.

Flat base plates are not acceptable.

The tank shall be equipped with manholes and/or hand holes of suitable size to make installation and maintenance easy. Cover for inspection openings bushings, hand holes etc. located directly on the tank cover shall be provided with adequate gas stoppers.

The main tank shall be separated from the OLTC tank for prevent the electric arc in same oil tank.

It must be possible to remove any bushing without removing the tank cover.



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In order to prevent tank deformation during operation, pressure relief devices with manually reset and visual indicator shall be mounted directly on the tank cover for pressure release static pressure adjustment of such devices shall be less than hydraulic test pressure.

Surfaces in contact with transformer oil shall be finished with oil-resistant paint. Other surfaces shall be painted with a primer coat and not less than two (2) finish weather resistant coats, or better the final coat color shall be grey color (Code RAL 7036).

1c.7 Current transformers

The Current Transformers (CT), for adapting the current by Line Drop Compensator (LDC), shall depend on the influence of the designed value and shall be installed in the auto-transformer tank at the secondary side of the auto-transformer.

The secondary terminal bushings of the CT shall be installed in cable box mounted on the auto-transformer tank.

The CT for instantaneous overcurrent relay(s) shall be according to manufacturer's design.

The CT shall have rating and minimum characteristics as specified in **Table 4**.

Table 4

Ratings and characteristics of the current transformers

Ratings and characteristics	Unit	Requirements	
		22 kV	33 kV
Type	-	Oil immersed self cooled	
Number of phases	-	1 - phase - 3 units	
Class of insulation	-	A	
Rated frequency	Hz	50	
Rated primary current	A	Equal to rated current of the AVR As stated in "C3 Schedule of detailed requirement"	
Rated secondary current	A	1	
Burden	VA	20	
Number of cores	-	2	
Accuracy class			
- for metering	-	0.5FS5	
- for protection	-	5P20	
Power frequency test voltage, 1 minute	kV r.m.s.	50	70
Full wave impulse withstand voltage	kV peak	125	170



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1c.8 Voltage transformers

The voltage transformers (VT) for sensing secondary voltage of the auto-transformer shall be installed in the tank near its secondary bushings in the cable box.

The terminals of the voltage transformers shall be equipped with solderless clamp type connectors (using bolts and nuts), suitable for Al conductor size 25 mm² - 50 mm² (diameter 6.4 mm - 9.0 mm).

The VT shall have rating and minimum characteristics as specified in **Table 5**.

Table 5

Ratings and characteristics of the voltage transformers

Ratings and characteristics	Unit	Requirements	
		22 kV	33 kV
Type	-	Oil immersed self cooled	
Number of phase	-	1 - phase - 1 unit	
Class of insulation	-	A	
Rated frequency	Hz	50	
Rated primary voltage	kV	13.34	20
Rated secondary voltage	V	110	110
Rated output	VA	50	
Number of cores	-	1	
Accuracy class	-	0.5	
Voltage factor at 30 second	-	1.9	
Power frequency test voltage, 1 minute	kV r.m.s.	50	70
Full wave impulse withstand voltage	kV peak	125	170

1c.9 Auxiliary transformer

The auxiliary transformer for supplying power to control devices and the motor drive unit shall be provide

The primary voltage of the auxiliary transformer is from the tertiary winding of the auto-transformer.

The auxiliary transformer shall be installed in the auto-transformer tank near its secondary bushings in the cable box.

The auxiliary transformer shall have rating and minimum characteristics as specified in **Table 6**.



Table 6

Ratings and characteristics of the auxiliary transformers

Ratings and characteristics	Unit	Requirements
Type	-	Oil immersed self cooled
Number of phase	-	3 - phase
Connection symbol	-	Dyn11
Class of insulation	-	A
Rated frequency	Hz	50
Rated primary voltage	kV	6.6
Rated secondary voltage	V	400/230
Rated power	VA	3,000
Power frequency test voltage, 1 minute	kV r.m.s.	20
Full wave impulse withstand voltage	kV peak	60

The terminals of the auxiliary transformer shall be equipped with solderless clamp type connectors (using bolts and nuts), suitable for Al conductor size 25 mm^2 - 50 mm^2 (diameter 6.4 mm - 9.0 mm).

1c.10 Power Supply

Each set of the AVR shall be provided with a power supply for supplying AC/DC power to the operating mechanism, the local control cabinet, and the local control cabinet heater.

In addition, the power supply shall supply $12_{-5\%}^{+15\%}$ V DC, 5 A, regulation $\pm 0.5\%$, THD $\leq 3\%$ at rated terminal voltage power to the terminal blocks for the radio (provided by PEA).

For bidding purposes, the bidders shall assume that the radio together will require approximately 45 watts ($13.8 \text{ V} \times 3 \text{ A}$) while the radio is in transmit mode and approximately 5 watts ($13.8 \text{ V} \times 0.3 \text{ A}$) while the radio is in receive mode.

Under normal condition, the power supply shall be powered from the **auxiliary transformer** (in Clause 1c.9). In case of AC power failure, the power supply shall provide DC power to the AVR and associated equipment from a backup power supply system integrated in the power supply.

The bidder shall be supply cable for connecting between the **auxiliary transformer** (in **Clause 1c.9**) and the control cabinet. The end side of the cable shall be furnished with 2-contact connectors (male), according to MIL-C-5015 series.

The backup power supply system shall be of maintenance free rechargeable sealed lead acid battery pack. The battery shall be of gelled electrolyte type and shall be designed and tested according to relevant publication of IEC 60896-21, DIN 43534, BS 6290 part 4, or equivalent. The nominal voltage of the battery shall be 24 V DC.

The bidder shall design the capacity of the battery system, using appropriate temperature correction factor, design margin and ageing factor, as shown in **Appendix 1** attached.



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The battery shall have a minimum lifetime of not less than twelve (12) years at 20°C.

The battery shall have sufficient capacity to sustain operation of the equipment including control unit and radio for not less than twelve (12) hours if the AC power supply failed.

For bidding purposes, the bidders shall assume that the DMS radio will be transmit mode for at least 20% of the time during this period.

The tray used for supporting the battery shall be made of corrosion resistant material.

The minimum space between batteries shall be 10 mm.

The battery charger shall be fully temperature compensated and have the facilities to select input voltage between 110 V AC and 230 V AC and shall be supplied via isolation transformer.

The battery charger shall be automatic switched to charging mode when the battery voltage drops below the preset value and shall be automatic switched to trigger mode (do not charge) in the following cases:

- Battery voltage over the preset value
- Ambient temperature is more than 70°C
- Charging time is more than twenty-four (24) hours

The battery charger shall have over current, over voltage and surge protection.

The battery charger shall be grounded isolated from the power supply.

To prevent deep discharge of the batteries on loss of AC power source, the battery charger shall automatically disconnect all circuitry fed by the batteries following a user-adjustable time period or when the battery voltage falls below a preset value. If the battery voltage discharged below the preset value, the time to fully recharge the whole batteries shall not exceed twenty-four (24) hours.

In order to prevent serious batteries discharging, the direct current power will be cut off when voltage stays under the minimum preset value (as specified on previous paragraph).

The automatic battery checking device shall be provided to check battery's health and initiate battery failed alarm signal in case of deterioration detected. The deterioration detecting could be the comparative method between the measurement values and setting values (i.e. internal resistance, voltage, etc.).

Each set of battery charger shall be provided with at least the following alarms:

- Low battery voltage alarm
- High battery voltage alarm
- Battery failed alarm
- Battery charger overvoltage alarm
- Others according to manufacturer's design

Each alarm indicator shall be displayed on the local control panel with super bright LED pilot lamps in red color. The lamp diameter shall be not less than 3 mm.



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1c.11 Local control cabinet

The local control cabinet shall be weatherproof, outdoor type, and separated from the tank. The equipment in the control cabinet shall be factory-assembled, readily wired and tested so that only the supply cables are to be connected at site.

The local control cabinet shall be primary coated with rust resistant paint and finished with grey color (Code RAL 7036).

Each control cabinet shall be equipped with the following equipment:

1. Voltmeter for reading the output voltage of the regulator
2. Ammeter for reading the output current of the regulator
3. Electro-mechanical indicators, for showing of at least ten (10) alarm and trip functions
4. Tap position lamp indicators
5. A Remote/Local switch. While this switch is in the “Local” position, control shall be permitted only from the local control panel (i.e. remote control shall be prohibited). While the Switch is in “Remote” position, control shall be permitted from the DMS (i.e. local control shall be prohibited)
6. Manual- automatic transfer switch
7. Manual raise-lower control switch
8. Siren off switch
9. Power Supply (in Clause 1c.10)
10. Line drop compensator
11. Voltage regulating relay having regulating output voltage range of at least 95% to 110% of nominal value of the voltage to be regulated
12. Instantaneous overcurrent relay(s), three phase, to prevent the tap changer operation during short-circuit
13. Heater and adjustable thermostat
14. Other equipment according to manufacturer’s design

1c.12 Distribution Management System (DMS) interface

The control unit shall be capable of interoperation with DMS over serial and IP network. The control unit shall be provided with both two serial RS-232 port for serial network and two (2) Ethernet ports for IP network. The control unit shall be selectable the active port. And other port shall be provided for local diagnostic and test purposes without interfacing with normal DMS data traffic.

The serial RS-232 data port shall be selectable for operation at 1,200 to 19,200 bits per second asynchronous data formats. The serial RS-232 data port shall be provided hardware handshake and configurable for disable/enable handshake signal. The RS-232 data port shall support, as minimum, the DNP 3.0 communication protocol using the MARS radio communication system.

The Ethernet data port shall support, as minimum, the DNP 3.0 over IP communication protocol using the MARS radio communication system or GPRS/EDGE/3G router or other IP network equipments.



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The message security features of the protocol shall be fully implemented (i.e. DNP 3.0 secure).

This capability shall be demonstrated successfully as part of factory acceptance testing.

All of communication equipment shall be provided by others.

The testing procedure for DMS interface is according to **Appendix 2**

1c.12.1 Analog signals

The analog signal shall include quantities specified in **Table 7**.

Table 7

Typical list of the input/output points of the analog signals

Item	Point name	Units	Type of analog input		
			Current	Voltage	Others
1	Line Current	A	1	-	-
2	Line Voltage A-B	kV	-	1	-
3	Tap Position	-	-	-	1
4	Winding Temperature B	°C	-	-	1
5	Oil Temperature	°C	-	-	1
Total		-	1	1	3

1c.12.2 Status signals

The status points shall include quantities specified in **Table 8**.

Table 8

Typical list of the input/output points of the status signals.

Item	Point name	Descriptor	Contact/Status Type	Point Type
1	AVR Control Set Mode	Local/Remote	DC-2S	DI
2	AVR Auto/Manual Status	Auto/Manual	DC-2S	DI
3	Buchholz Warning	Normal/Alarm	SC-2S	DI
4	Buchholz Tripping	Normal/Trip	SC-2S	SOE
5	Tap Changer Protection	Normal/Trip	SC-2S	SOE
6	Transformer Oil Level Max.	Normal/Alarm	SC-2S	DI
7	Transformer Oil Level Min.	Normal/Alarm	SC-2S	DI
8	Tap Changer Oil Level Max.	Normal/Alarm	SC-2S	DI
9	Tap Changer Oil Level Min.	Normal/Alarm	SC-2S	DI
10	Temperature Warning	Normal/Alarm	SC-2S	DI
11	Temperature Tripping	Normal/Trip	SC-2S	SOE



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Item	Point name	Descriptor	Contact/Status Type	Point Type
12	Transformer Pressure Relief	Normal/Trip	SC-2S	SOE
13	OLTC Pressure Relief	Normal/Trip	SC-2S	SOE
14	OLTC Over current Block	Normal/Block	SC-2S	SOE
15	Tap Change Delay	Normal/Alarm	SC-2S	DI
16	MCB Trip for Motor Drive Unit	Normal/Alarm	SC-2S	DI
17	AC Supply Failure	Normal/Alarm	SC-2S	DI
Total		-	17	-

Remark:

- 1) SC-2S (**Single Contact, Two-State Status**) – Two possible position of single contact used in such a way that one position indicates an alarm or failure state and the other indicates the normal state.
- 2) DC-2S (**Double Contact, Two-State Status**) – Two separate contact used as a complimentary pair in such a way that one contact indicates an open state and the other indicates a closed state with conflicting indications representing a state that is considered INVALID.
- 3) SOE – Digital Input with time tagging
- 4) DI – Digital Input without time tagging

1c.12.3 Control signals

The control points shall include quantities specified in **Table9**.

Table 9

Typical list of the output points of the control signals

Item	Point name	Digital Output	Control Point Type
1	OLTC Control Set Auto/Manual Command	1	SBO
2	OLTC Raise/Lower Command	1	DOP
Total		2	-

Remark:

- 1) SBO – Output Command (Select-Checkback-Before-Operate)
- 2) DOP – Output Command (Direct Operate)

1c.12.4 Facility for radio

The control cabinet of AVR shall be provided some facilities to install the radio and accessories (in the future by PEA). These facilities shall include these following:

1c.12.4.1 Ample space for radio

A minimum contiguous space of 200 mm (height) x 450 mm (width) x 300 mm (depth) shall be provided for mounting the radio in the control cabinet.



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1c.12.4.2 Antenna support

For radio communication, the antenna support shall be provided for clamping the antenna's pole (1"- 2" in diameter) at the appropriated position without modification in future.

1c.13 Electric surge protection

All power supplies, measuring and controlling equipment installed in the control cabinet and connected to the external equipment shall be taken to ensure proper functions and component safety from switching and lightning voltage transient and all regular atmospheric, electrical, and magnetic disturbances, whether induced or directly coupled.

In particular, the equipment shall be constructed and tested to meet the latest applicable standards of IEC 60255-5, or ANSI/IEEE C37.90.1 and ANSI/IEEE C37.1 and be capable of withstanding the tests described in these standards without damage, false control output, or loss of internally stored data and parameters.

All AC and DC power supply incoming and outgoing circuit shall be provide with suitable surge protective devices according to IEC 61643-1 or 61643-11.

1c.14 Earthing

The exposed noncurrent-carrying parts of the AVR and metal frames of instrument used, which can be accessible to persons and can become under tension when fault is occurring in the AVR, shall be earthed. Earthing terminals shall be provided for the AVR tank and control cabinet. The terminals shall be equipped with solderless clamp type connectors for steel stranded wire size 50 mm² (diameter 9.0 mm). Earthing bridges shall be provided between tank and tank cover, conservator and tank cover, head of the OLTC and tank cover. All earthing bridges shall have a suitable cross-section and be painted.

1c.15 Terminal blocks

Terminal blocks shall be provide in the control cabinet for connecting power cables and control cables for all input and output signals between AVR's equipment, control panel and DMS interface specified **in Clause 1c.12** and between DMS interface and radio. The terminal block shall be vibration and shock proof, maintenance-free of screw or screwless spring type.

The terminal block for CT circuit shall be designed to provide and automatic short circuiting of the transformer secondary winding before opening the transformer circuit when the disconnect link is moved into the "test" or "shorting" position.

The terminal blocks for DC power supply shall be of heavy-duty, 600 VDC moulded block type with moulded insulating barrier between terminals. Each terminal block and individual terminal shall have removable white marking strip for marking circuit designation.

No more than two (2) wires shall be connected to any terminal. Adequate space and hardware shall be provided for routing of the field wiring within the control cabinet.

All terminal blocks shall provide 10% spare terminal for PEA's future use.



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1c.16 Electrical wiring and piping

All equipment which require wiring shall be completely wired and tested ready for terminating at site. All control cables which are wired on the AVR's tank shall be enclosed in metal conduits, and shall be wired to a weatherproof type junction box mounted on the tank. The junction box shall be provided with a terminal panel.

All power cables and control cables used for wiring shall be manufactured and tested in accordance with relevant TIS standards.

1c.17 Accessories

Each AVR shall be equipped with the following accessories:

1. Oil conservator(s) for main tank and OLTC compartment
2. Dehydrating breather(s) which shall provide a clear observation and easy replacement
3. Magnetic oil level gauge(s) with alarm contacts(s)
4. Lifting lugs
5. Dial type thermometer(s) with trip contact for measuring oil temperature and winding temperature
6. Double float Buchholz relay with alarm and trip contacts
7. Sudden oil flow relay (protective relay) with trip contact
8. Pressure relief devices with alarm contacts, for main tank and OLTC compartment
9. HV bushings equipped with terminal connectors
10. Bird guard cap (bushing cover), ultra-violet and track resistant material, e.g. polypropylene, neoprene, etc; which is suitable for exposure to sunlight
11. Oil sampling valves, for main tank and OLTC compartment
12. Oil drain valves with plugs or caps
13. Sludge drain plugs, for main tank and OLTC compartment
14. Earth terminals with solderless clamp type connectors
15. Nameplate with connection diagram
16. Siren or horn
17. Other accessories according to manufacturer's design

1c.18 Spare parts and special tools

The bidders have to quote recommended spare parts and special tools for installation and maintenance with separate price for each item offered.



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1d Test and test reports

1d.1 Routine tests

Each AVR shall pass the manufacturer's standard routine tests, and also pass the following test items in accordance with the relevant standards:

1. Measurement of winding resistance
2. Measurement of voltage ratio, and check of phase displacement
3. Measurement of short-circuit impedance
4. Measurement of load loss
5. Measurement of no-load loss
6. Induced overvoltage withstand test
7. Separate-source voltage-withstand test
8. Oil dielectric strength test

1d.2 Type tests

The following type tests shall be in accordance with the relevant standards:

1. Temperature-rise test
2. Impulse withstand voltage test

Type test shall be made on only one (1) unit of each rating. (See conditions of submitting the type test report and other document in **1d.2.2**)

The costs of all tests and reports shall be borne by the Manufacturer/Bidder/Contractor.

1d.2.1 Acknowledged testing laboratories/institutes

The type tests shall be conducted or inspected by the acknowledged testing laboratories/institutes as following:

- (1) Independent laboratories/institutes which are members of the Short-circuit Testing Liaison (STL) or independent laboratories/institutes which are accredited according to TIS 17025 or ISO/IEC 17025 with the scope of accreditation covered the relevant test items, standards and equipment. The certification and scope of accreditation of the independent laboratories/institutes shall be submitted with the bid for consideration.
- (2) Thailand's national laboratories, institutes, universities and electric utilities, as follows:
 - National Metal and Materials Technology Center (MTEC)
 - Electrical and Electronic Products Testing Center (PTEC)
 - Thai Industrial Standards Institute (TISI)
 - Electrical and Electronics Institute (EEI)
 - Department of Science Service (DSS)



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- Testing Laboratory, Electrical Engineering Department, Faculty of Engineering, Chulalongkorn University
- Electricity Generating Authority of Thailand (EGAT)
- Metropolitan Electricity Authority (MEA)
- Provincial Electricity Authority (PEA)
- Other laboratories, institutes, universities or electric utilities approved by PEA

In case of the foreign manufacturers having experience of more than twenty (20) years in design, manufacture and sell the AVR, PEA will accept type test report(s) conducted by the manufacturer's laboratory or other independent laboratories without qualification mentioned in (1) or (2). Documents showing the manufacturer's experience such as reference list shall be submitted with the bid for consideration.

The type test report done by the laboratories in Thailand or local manufacturers shall be valid within five (5) years counted from the issued date in the test report to the bid closing date.

1d.2.2 Type test report and other document shall be submitted

The type test reports and/or other document shall be submitted with the bid for consideration in each case as the following:

Case 1: The proposed AVR has a complete type test report of the identical unit (same type/model, dimensions and all ratings) and the tests conducted by the testing laboratories in **1d.2.1**, in this case the bidders shall submit:

- (1) The complete type test report, or
- (2) If the proposed AVR has been supplied to PEA and get the order from PEA's Procurement Department (PEA's head office), the Purchase Order (PO) or copy of the contract can be submitted, or
- (3) If the proposed AVR has been registered for PEA's Product Acceptance, the non-expired registration certificate counted to the bid closing date can be submitted, or
- (4) If the proposed AVR has been registered for PEA's Product list for substation turnkey project, the non-expired registration certificate counted to the bid closing date can be submitted.

However the document in (2), (3) and (4) shall be proved that the AVR specified in the PO, Contract or registration certificate shall be the same product, type/model, dimension and all ratings as



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the proposed AVR for this bid and the document in (2) and (3) shall be also proved that the submitted document is based on PEA's same **Specification No.** as this bid.

Case 2: The proposed AVR has no a type test report, in this case the manufacturer shall have an experience in design and manufacture an AVR or power transformer with On-load Tap-Changer (OLTC) with voltage rating 22 kV or above, a supplied record, PO or Contract showing experience of the manufacturer shall be submitted with the following:

- (1) The design review of the proposed AVR such as drawing, calculation etc., and
- (2) Test plan for type testing of the proposed AVR including information i.e. testing laboratory as specified in **1d.2.1**, testing procedure and test date.
- (3) Manufacturing plan for the proposed AVR such as manufacturing schedule

The design review will be sent to Engineering department for approval.

In this case the Contractor (the bidder who wins the bid) shall submit the complete type test report of the proposed AVR for approval before shipment.

1e Packing

The AVR, control cabinets, and accessories shall be seaworthy packed in wooden packages which will not be returned.

If the wooden package is made of rubber wood (Yang-para), the wooden parts shall be treated with wood preservative. The details of wood treatment shall be described.



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C2 Material and packing data of the Three-phase automatic voltage regulators (AVR) for 22 kV and 33 kV 50 Hz distribution systems

The following data and details shall be submitted with the bid

2a Critical documents of the proposed three-phase Automatic Voltage Regulator (AVR) (see pages 26 of 26)

2b Performance data and guarantee of three-phase Automatic Voltage Regulator (AVR) (see pages 21 of 26 to 25 of 26)

2c Drawings of overall AVR and control cabinet, with dimensions in mm, showing of particulars of normal construction details.

2d Details, catalogue and/or drawings of the following equipment:

1. On-load tap-changer, and motor drive unit
2. Dehydrating breather
3. Oil level gauge
4. Thermometer
5. Buchholz relay
6. Sudden oil flow relay
7. Pressure relief devices
8. Bushings
9. Bird guard cap (bushing cover), ultra-violet and track resistant material, e.g. polypropylene, neoprene, etc; which is suitable for exposure to sunlight
10. Terminal bushing connectors, with description of material use for the component parts
11. Oil sampling valves
12. Oil drain valves with plugs or caps
13. Sludge drain plugs
14. Earth terminal connectors
15. Nameplate with connection diagram
16. Current transformers
17. Voltage transformers
18. Auxiliary transformer
19. Power Supply
20. Voltage regulating relay
21. Instantaneous overcurrent relay
22. Line drop compensator
23. Accessories according to manufacturer's design



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2e Electrical wiring diagrams of operating and control circuits

2f List of routine test

2g Type test report and/or test certificate or test plan

2h List of spare parts with itemized prices (if any)

2i List of special tools with itemized prices (if any)

2j Packing details

Packing method (shown by drawing(s), and describe packing material)

Number of units, pieces, or sets in each package

Dimensions (L x W x H) of each package in cm

Volume of each package in m³

Gross weight of each package in kg

Number of packages



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Invitation to Bid No.:

2a Performance data and guarantee of three-phase Automatic Voltage Regulator (AVR)

2a.1 Three-phase auto-transformer

Ratings and characteristics	Unit	Proposed data
Make and country of origin	-	
Type or Model	-	
Vector Group	-	
Rated frequency	Hz	
Rated primary voltage	kV	
Rated secondary voltage, without line drop compensation	kV	
Rated tertiary voltage	V	
Rated power	MVA	
Rated power of tertiary winding	MVA	
Rated primary current at tap No. 1	A	
Rated secondary current in all tap positions	A	
Rated tertiary current	A	
Operation duty: continuous operation (Type DB)	Yes/No	
Full load maximum temperature rise of winding	K	
Full load maximum temperature rise of top oil	K	
Losses on the principle tapping:		
No-load loss	kW	
Load loss	kW	
Tolerances of losses:		
No-load loss	%	
Load loss	%	
Short-circuit impedance on the principle tapping at 75°C	%	
Tolerance of the short-circuit impedance	%	
HV Bushings:		Line and neutral
Standards	-	
Current rating	A	
Power-frequency test voltage, 1 minute	kV r.m.s.	
Full wave impulse withstand voltage	kV peak	
Protection class	-	
Colour of glazing	-	
Neutral point brought out	Yes/No	



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Ratings and characteristics	Unit	Proposed data
Windings:		
Construction of windings	-	
Power-frequency test voltage, 1 minute	kV r.m.s.	
Full wave impulse withstand voltage	kV peak	
Class of insulation	-	
Construction of core	-	
Method of cooling	-	
Total cooling surface	cm ²	
Brand of insulating oil used for initial filling	-	
Weight of core	kg	
Weight of winding	kg	
Weight of oil filling	kg	
Weight of the part liftable from tank	kg	
Weight of complete transformer with OLTC and oil	kg	
Protection class for transformer tank	-	
Colour of tank: grey (Code RAL 7036)	Yes/No	
Tank finish conforms to PEA's requirement	Yes/No	

2a.2 On-load tap-changer

Ratings and characteristics	Unit	Proposed data
Make and country of origin	-	
Type or Model	-	
Contact life time	operations	
Number of steps	steps	
Step voltage	V	
Rated voltage	kV	
Rated current	kA	



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2a.3 Current transformers

Ratings and characteristics	Unit	Proposed data
Make and country of origin	-	
Type	-	
Number of phases	-	
Class of insulation	-	
System voltage	kV	
Rated frequency	Hz	
Ratio	-	
Burden	VA	
Number of cores	-	
Accuracy class		
- for metering	-	
- for protection	-	
Power frequency test voltage, 1 minute	kV r.m.s.	
Full wave impulse withstand voltage	kV peak	
Short-time thermal current, 1 second	kA	
Dynamic current	kA	

2a.4 Voltage transformers

Ratings and characteristics	Unit	Proposed data
Make and country of origin	-	
Type	-	
Number of phases	-	
Class of insulation	-	
Rated frequency	Hz	
Rated primary voltage	kV	
Rated secondary voltage	V	
Rated output	VA	
Number of cores	-	
Accuracy class	-	
Voltage factor at 30 second	-	
Power frequency test voltage, 1 minute	kV r.m.s.	
Full wave impulse withstand voltage	kV peak	



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2a.5 Auxiliary transformer

Ratings and characteristics	Unit	Proposed data
Make and country of origin	-	
Type	-	
Number of phases	-	
Connection symbol	-	
Class of insulation	-	
Rated frequency	Hz	
Rated primary voltage	kV	
Rated secondary voltage	V	
Rated output	VA	
Power frequency test voltage, 1 minute	kV r.m.s.	
Full wave impulse withstand voltage	kV peak	

2a.6 Battery Charger

Ratings and characteristics	Unit	Proposed data
Make and country of origin	-	
Rated input voltage	V	
Rated output voltage DC	V	
Rated output current DC	A	
Rated frequency	Hz	
Rated capacity	VA	

2a.7 Battery

Ratings and characteristics	Unit	Proposed data
Make and country of origin	-	
Model/Type or Catalogue No.	-	
Rated voltage DC	V	
Rated capacity	Ah	
Number of cells	-	
Operating voltage per cell	V	
Time to completely charge from total discharge	hr	



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Note: Conditions for documentation and consideration

1. The Contractor has to supply the following documents in English and/or Thai, before shipment/delivery, for each ordered AVR:
 - 1.1 Three (3) sets of instruction book for installation, operation and maintenance shall be packed together with each package in **Thai**.
 - 1.2 Three (3) sets of control schematic diagrams
 - 1.3 Three (3) sets of foundation drawings
 - 1.4 Type test certificate or test report and routine test report of the proposed AVR
 - 1.5 Number of turns of each winding, each coil, and each tap position
 - 1.6 Type of enamel, temperature class, and size of the enameled wire.

The above documents shall be sent to the following address:

Transformer Division

Provincial Electricity Authority

200 Ngam Wong Wan Road, Chatuchak

Bangkok Metropolis 10900 Thailand

2. The Contractor has to guarantee the quality of the AVR and accessories for **Three (3) years** from the date of issuance of the notice of acceptance. During the guarantee period, bidder of supplier will be bound to pay in amount equal to the exact purchasing value for the defective parts of the AVR.
3. Prices of spare parts and special tools are important factors to be consider



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Critical documents of the proposed three-phase Automatic Voltage Regulator (AVR)

Item	Required technical documents	Proposed technical document	Reference document (page/folder)
1	Performance data and guarantee of three-phase Automatic Voltage Regulator (AVR)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
2	Drawings of overall AVR and control cabinet, with dimensions in mm, showing of particulars of normal construction details.	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3	Details, catalogue and/or drawings of the equipment, according to 2d	<input type="checkbox"/> Yes <input type="checkbox"/> No	
4	Electrical wiring diagrams of operating and control circuits	<input type="checkbox"/> Yes <input type="checkbox"/> No	
5	Type test report and/or test certificate (if any), or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	The purchase order (PO) or copy of the contract (if any), or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	Product lists certificate (if any), or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	PEA Product Acceptance certificate (if any), or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	Supplied record, PO or Contract showing experience of the manufacturer an AVR or power transformer with On-load Tap-Changer (if any) , or	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	Documents showing the design review of the proposed AVR with manufacturing plan and test plan (if any)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
6	List of routine test	<input type="checkbox"/> Yes <input type="checkbox"/> No	
7	List of spare parts with itemized prices (if any)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
8	List of special tools with itemized prices (if any)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
9	Packing detail(s)	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Note: The bidders who do not submit all critical documents mentioned in the above table with the bid shall be rejected.



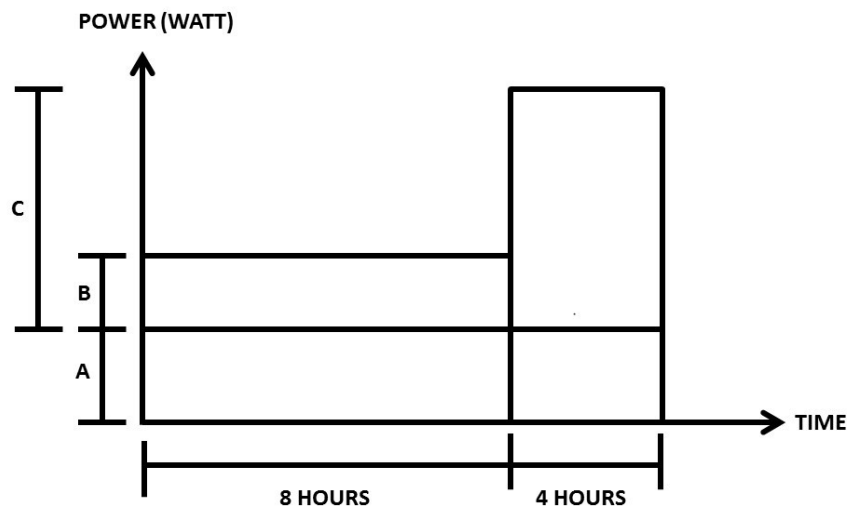
APPENDIX 1

DESIGN CALCULATION OF BATTERY SIZING AND BATTERY CHARGER RATING

A. Battery Sizing Calculation

A.1 DC Load Profile

The DC load consumption shall be calculated as the itemize lists according to manufacturer’s design. The calculation shall be performed by using standard DC load profile as below.



Where:

A : Continuous DC load control system and FRTU

B : Five (5) watt while the radio is in receive mode (8 hours)

C : Forty-five (45) watts while the radio is in transmit mode (4 hours)

A.2 Battery Sizing Calculation

Battery sizing shall be calculated in accordance with the latest version of IEEE 485: Recommended practice for sizing lead – acid battery for station applications.

B. Battery Charger Rating Calculation

1. Battery charger has to be able to supply recharging current for battery and supply the continuous load current.
2. Current demand from battery charger is given by formula , as per in IEEE 946: Recommended practice for the design of dc auxiliary power systems for generating station.

$$\begin{aligned}
 I \text{ charger} &= I \text{ load} + I \text{ recharge} \\
 &= I \text{ load} + (Ah \times 1.1) / T \quad \text{Ampere}
 \end{aligned}$$



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Where,

- I_{load} : Continuous DC load (A)
 $I_{recharge}$: Charging current (A)
Ah : Ampere-hours discharged from battery
T : Time to re-charge the battery to approximately 95% of capacity
1.1 : Constant that compensates for the battery loss



APPENDIX 2

Testing Procedure for Distribution Management System Interface

1. Testing for DNP 3.0 Interface

- a. Objective : For improved communication protocol of AVR Supplier
- b. Testing Equipment : Follow by **Configuration Fig. 1**
- c. Location for Testing : At System Management Center (SMC) Building in PEA Head Office

2. Testing for System Interface

- a. Objective : For improved system performance in the field (Including communication equipment)
- b. Testing Equipment : Follow by **Configuration Fig. 2** and/or **Configuration Fig.3**
- c. Location for Testing : At Area Distribution Dispatching Center Building

Detailed for Connector at Break-out Box (BOB)

RS-232 DESCRIPTION	RS-232 CIRCUIT	DB25 PIN	SIGNAL DIRECTION	SEE NOTE
Protective Ground	AA	1	-	1
Signal Ground	AB	7	-	-
Transmitted Data	BA	2	Out to DCE	-
Received Data	BB	3	In from DCE	-
Request To Send	CA	4	Out to DCE	-
Clear To Send	CB	5	In from DCE	-
Data Set Ready	CC	6	In from DCE	-
Data Terminal Ready	CD	20	Out to DCE	-
Received Line Signal Detect (DCD)	CF	8	In from DCE	-
Transmit Signal Element Timing (DTE)	DA	24	Out to DCE	-
Transmit Signal Element Timing (DCE)	DB	15	In from DCE	-
Receiver Signal Element Timing	DD	17	In from DCE	-

Note 1: DB25 connector pin 1 is connected to the DB25 connector body shell and to the metal enclosure

Remarks: - DCD = Data Carrier Detector, DTE = Data Terminal Equipment, DCE = Data Circuit-terminating Equipment
- DB25 connector is male type connector



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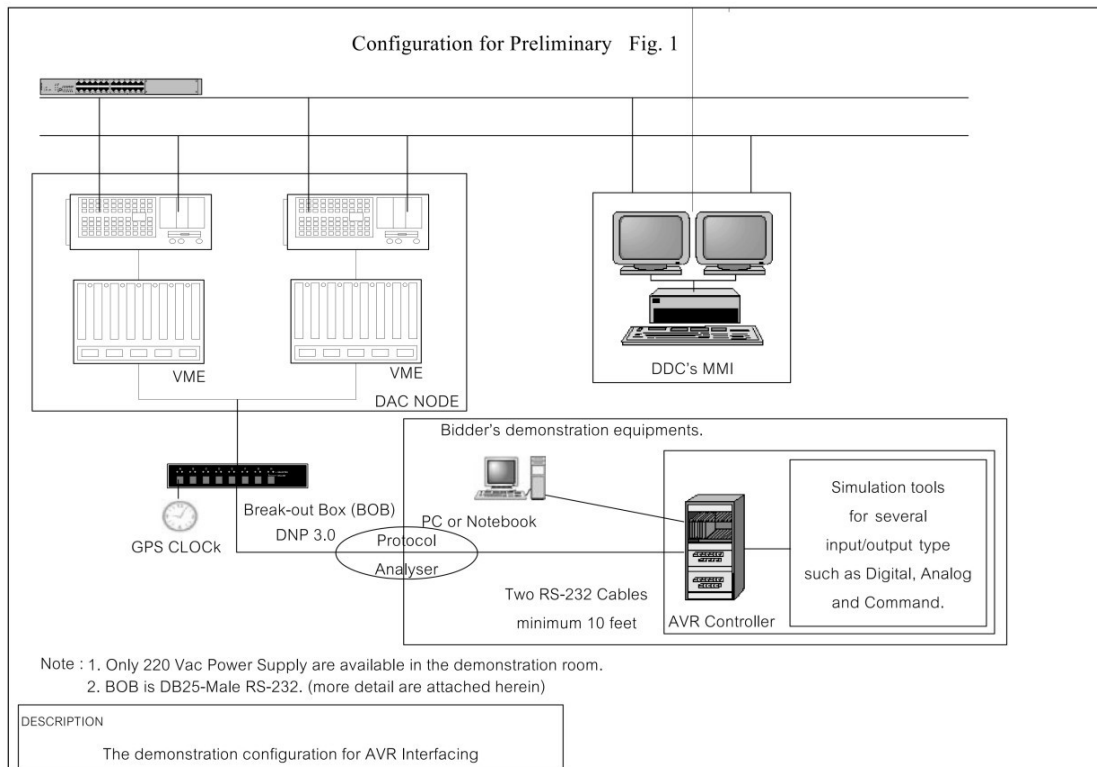
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Detailed for Connector at Telecontrol Gateway – Slave Unit (TCG-SU)

RS-232 DESCRIPTION	RS-232 CIRCUIT	RJ-45 PIN	SIGNAL DIRECTION	SEE NOTE
Protective Ground	AA	-	-	-
Signal Ground	AB	3	-	-
Transmitted Data	BA	4	Out to DCE	-
Received Data	BB	5	In from DCE	-
Request To Send	CA	-	-	-
Clear To Send	CB	-	-	-
Data Set Ready	CC	-	-	-
Data Terminal Ready	CD	-	-	-
Received Line Signal Detect (DCD)	CF	-	-	-
Transmit Signal Element Timing (DTE)	DA	-	-	-
Transmit Signal Element Timing (DCE)	DB	-	-	-
Receiver Signal Element Timing	DD	-	-	-

Remarks: DCD = Data Carrier Detector, DTE = Data Terminal Equipment, DCE = Data Circuit-terminating Equipment



Remark: VME = Versa Module Eurocard, DAC = Data Acquisition and Control, MDS = Microwave Data System, GPS = Global Positioning System



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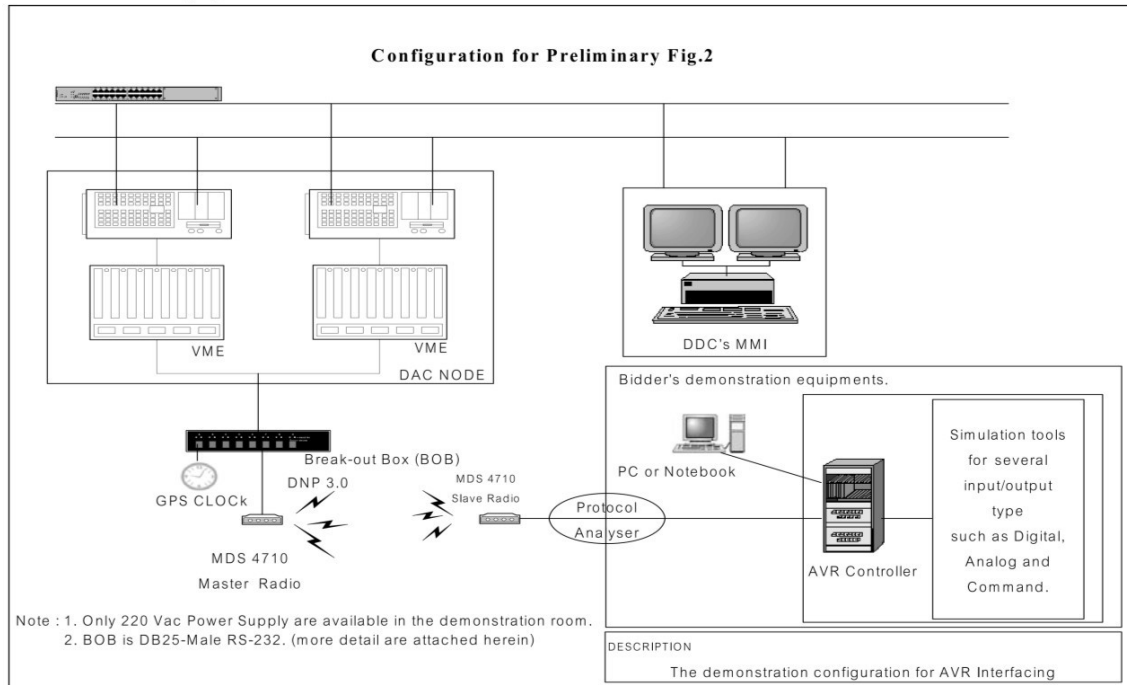
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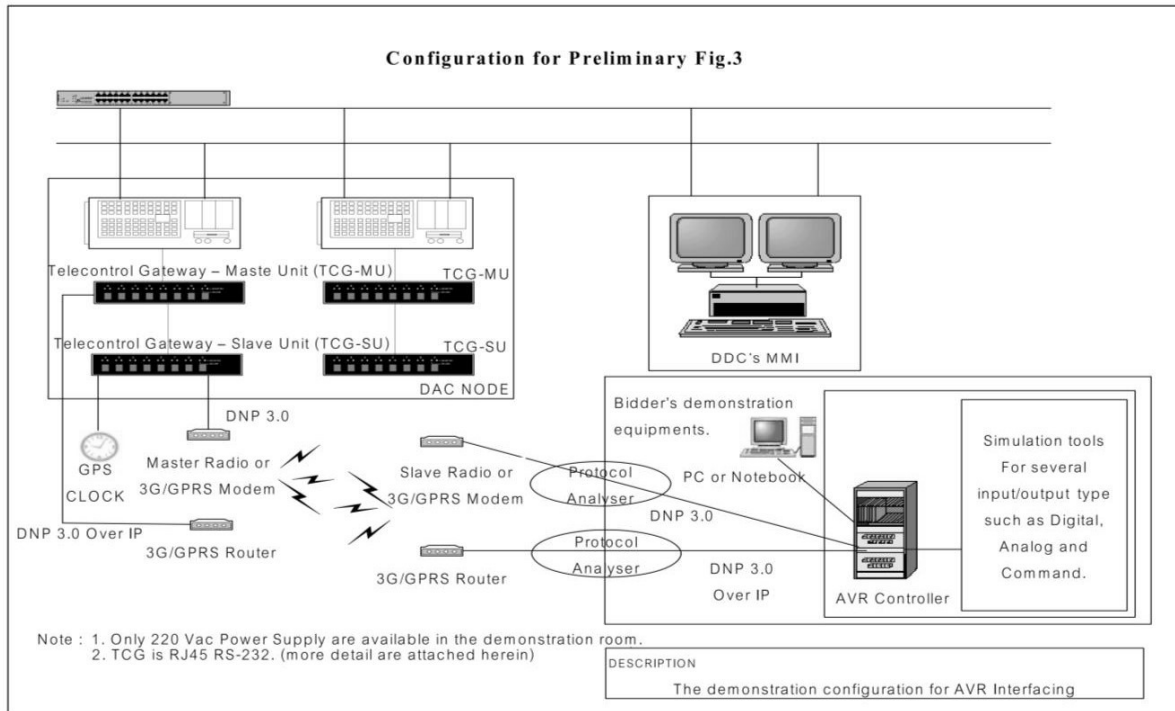
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Remark: VME = Versa Module Eurocard, DAC = Data Acquisition and Control, MDS = Microwave Data System, GPS = Global Positioning System





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DNP3.0 Protocol Testing Check List

Date :
 Place :
 RTU Type :
 AVR Control Unit Manufacturer :

Functional Check Detail	Result	Comments
1. Digital Input	
<ul style="list-style-type: none"> - Single bit (binary without time (DI) / binary with time (SOE)) 	
<ul style="list-style-type: none"> - Double bit (binary without time (DI) / binary with time (SOE)) 	
2. Digital Output (Command Control)	
<ul style="list-style-type: none"> - Select Before Operate (SBO) 	
<ul style="list-style-type: none"> - Control Related Status Codes (i.e. code 0,2,7,12) 		Ref. to Table 58- Control related status codes in DNP3 Doc
3. Analog Input	
<ul style="list-style-type: none"> - 16 bit analog without time 	
4. Class Scan	
<ul style="list-style-type: none"> - Class 1 (DI with Unsolicited) 	
<ul style="list-style-type: none"> - Class 2 (Analog) 	
<ul style="list-style-type: none"> - Class 3 (DI without Unsolicited) 	
5. Time and Date Facility	
<ul style="list-style-type: none"> - GMT and Local Time Configuration(Local at Panel , GMT to SCADA) 	
<ul style="list-style-type: none"> - Write Date and Time from SCADA/DMS 	
<ul style="list-style-type: none"> - Time diff 	
6. Buffer Sending	
<ul style="list-style-type: none"> - SOE Buffer (512 events) 	
7. Flag information	
<ul style="list-style-type: none"> - Online / Offline 	
8. Internal Indication	
<ul style="list-style-type: none"> - Restart flag 	
<ul style="list-style-type: none"> - Overflow 	
<ul style="list-style-type: none"> - Need Time 	
9. DNP Mapping and configuration	
Digital Input	
<ul style="list-style-type: none"> - Class assignment 	
<ul style="list-style-type: none"> - Point Type (with/without time) 	
Digital Output (Command Type)	
<ul style="list-style-type: none"> - SBO 	
Analog Input	
<ul style="list-style-type: none"> - Class assignment 	
10. Unsolicited or retry Configuration	
<ul style="list-style-type: none"> - Number of retries 	
<ul style="list-style-type: none"> - Retry delay time 	
11. Communications Configuration	
<ul style="list-style-type: none"> - Baud Rate 300 - 19,200 bps 	
<ul style="list-style-type: none"> - Via Radio (Delay time, DCD, CTS, RTS, Collision) 	
<ul style="list-style-type: none"> - IP port Configuration (in case of DNP3 over IP Testing) 	
<ul style="list-style-type: none"> - Diagnostic Port 	
12. Fail Safe Design	

Remark : - "/" = Yes , " x " = No , "--" = Not be tested
 - This is RCS - SCADA / DMS interface test , not included accuracy of analogue and full function test.
 - Site Routine Test of the first rcs must be exercised before in service.

