



SECTION – 2.19

PHASOR MEASUREMENT UNIT (PMU)

1.0.0 INTRODUCTION

This section covers the requirements of Phasor Measurement Unit for 132kV Substations (GICPL & GSS end).

2.0.0 SCOPE OF WORK

2.1.0 The scope of work shall include the following equipment.

- PMUs shall be complete in all respect including GPS receiver. The PMU shall be integrated with Phasor Data Concentrators (PDCs) installed at Control centres of SLDC/RLDC and NLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a- 2014 standard.
- The supplied PMUs shall be standalone or installed in the C&R panel being supplied by the bidder for respective substation package and with required interface cabling.
- Considering the limited quantity, the need for standardization across Owner's installations, existing availability of spares, ease of operation and maintenance, and proven compatibility with existing systems, as well as established approvals from competent statutory authorities based on prior use in RE projects of the Owner, the specified make and model are mandatory requirements.

Accordingly, the Bidder shall supply ABB / Hitachi Make Model RES670, VERSION 2.2 or higher (Article number/Manufacturer number: 1MNS500840-XSAA) with required accessories and communication ports (including memory card).

This PMUs (RES-670) shall have two sets of inputs (each set comprising a minimum of three-phase CT inputs and three-phase voltage inputs)

However, for general technical requirements, the Bidder shall comply in all respects with the specifications outlined in this section

- For PMU Bidder shall provide the **cost on an optional basis** for a quantity of two (02) numbers (each having two sets of inputs).
 - One (01) no. of PMU with two set of inputs one for Line-3 and one for Line-4 GIPCL end.
 - One (01) no. of PMU with two set of inputs one for Line-3 and one for Line-4 GETCO / GSS end.

GETCO end PMUs shall be installed within the existing system, subject to feasibility. In case integration within the existing system is not feasible, separate cubicles/panels shall be provided by the Bidder.

- Even if PMUs are not envisaged at present, provision for their future installation shall be mandatorily kept in scope. This shall include cut out in the panel, TTB, wiring up to terminal blocks (TBs), consideration of DC load, compliance with instrument transformer burden limits, provision of blanking plates, and all other associated works. These provisions shall form an integral part of the EPC Contractor's scope.
- The router with firewall shall be provided which shall interface PMUs on one side and communication equipment on the other side. The communication speed required for single PMU shall be less than 25 samples/second.



- PMU phasor data shall be integrated to SLDC/RLDC.
- PMU data shall also be integrated to substation SAS / SCADA / SAS system for monitoring and parametrisation.
- All software and associated licenses shall be provided on a perpetual basis, with no recurring or subscription-based costs to the Owner
- Auxiliary supply for the relay shall be universal (110 to 230 V AC/DC)

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS / IEC standards including amendments, if any, except where modified and / or supplemented by this specification. Bidder shall also consider / follow the requirements of PMU mentioned in the CEA "General Guidelines for 765/400/220/132kV substations and switchyard of Thermal / Hydro Power Projects" dated June, 2012.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Functional Requirements

- 4.1.1 The supplied PMUs shall be compliant to M class requirements of IEEE C37.118 Standards.
- 4.1.2 The PMUs shall communicate with PDC at Control centre over the communication link provided by the bidder. For this, PMU shall be provided with One Ethernet port of 10/100/1000 Base Tx and one optical fiber port of 10/100/1000 Mbps for streaming the data in TCP/IP unicast/multicast/broadcast in IEEE C37.118 format. The supplied PMUs shall be suitable to operate on unearthed 110 V DC (+10%, -15%) power supply as available in the substation.
- 4.1.3 The PMU shall support data 'Reporting Rates' of 10, 25, and 50 frames per seconds for 50 Hz System. The actual rate to be used shall be user selectable. All the PMU hardware and software shall be sized considering 50 frames per second.
- 4.1.4 PMUs shall be provided to measure Voltage and Current Phasors of 132 kV transmission lines. PMU shall also measure status of master protection and circuit breakers. The PMUs shall be able to measure/calculate following:
- 3-phase voltage Phasors (Phase to phase and Phase to Neutral),
 - 3-phase current Phasors,
 - Positive sequence voltage,
 - Positive sequence current,
 - Breaker Status
 - Main Protection Status
 - Frequency band of 45-55Hz
 - Rate of Change of Frequency (ROCOF) -df/dt

Provision shall be made for user/owner selection of measured value.

- 4.1.5 A time synchronization system (GPS receiver) shall be provided with PMU. The PMU shall have internal clock with time accuracy of at least 1 microsecond, which shall be synchronized with GPS time master clock. Upon loss of signal from the GPS source, the PMU shall detect a loss-of-signal and generate an alarm which will be transferred to PDC. Upon loss of signal, the PMU time facility shall revert to an internal time base. The internal clock shall have minimum stability of 1 ppm. Time synchronization shall be carried out by NTP, and it shall be synchronized with the master time clock. Necessary hardware and software shall be provided for the same.



- 4.1.6 PMU shall have HMI (Human Machine Interface), portable configuration device to perform setting changes. The HMI shall also display the real time measured values. Alternatively Portable configuration device for PMUs can be provided for configuring the PMUs. Testing & configuration accessories such as test switch, connector, software, hardware etc., which are required for testing and configuration changes locally, shall be supplied.
- 4.1.7 The PMUs shall have continuous self-monitoring, diagnostic feature and capable to identify & communicate problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC also.
- 4.1.8 The PMU shall fully comply to the requirement of SLDC / RLDC and First Time Charging (FTC) process.
- 4.1.9 The dispersedly located PMUs shall communicate with Phasor Data Concentrators (PDCs) installed at certain strategic location at State, Regional and National levels. Integration of PMU to PDC shall conform to IEEE C37.118, for communication.
- 4.1.10 PDC shall be equipped with Historian for data storage. Various analytical tools, visualization software package available at PDC levels shall be used for monitoring the entire inter-connected grid on real time basis, which are useful in monitoring safety and security of the grid as well enable in taking control/corrective action in the new regime of grid management.
- 4.1.11 As per the Central Electricity Regulatory Commission (Communication System for inter-State transmission of electricity) Regulations, 2017 the Regional Load Despatch Centre shall be nodal agency for integration and supervision of Communication System of the ISTS, ISGS, SLDCs and IPPs at RLDC end for monitoring, supervision and control of Power System and adequate data availability in real time. The Regional Load Despatch Centre (RLDC) shall collect and furnish data related to Communication System of various users, CTU, RLDC, STU and SLDC to RPCs. RLDCs shall provide operational feedback to CTU.
- 4.1.12 Remote configuration facility shall be provided in PMU and the bidder shall supply the software for remote configuration of PMU.
- 4.1.13 Remote firmware upgrade feature shall be made available.
- 4.1.14 PMU shall be capable of sending data in Unicast, Multicast and broadcast.
- 4.2.0 Time Facility (GPS)**
- 4.2.1 The PMU requires time reference to UTC. A GPS based time facility to synchronize each PMU clock with Coordinated Universal Time (UTC), shall be provided except in case of in-built GPS in each PMU. The GPS receivers to be offered shall meet the supplied PMUs interface and accuracy requirements.
- 4.2.2 The time receiver shall include propagation delay compensation and shall also include an offset to permit correction to local time to achieve time accuracy of at least ± 0.2 microseconds (μ s). Within one minutes of reacquisition of signal, the time shall return to within 0.2 micro-second of UTC. Proper correction of leap second shall be provided. The signal sent to PMU from the GPS receiver shall be UTC or provide information to the PMU to correct the time to UTC by using the IRIG-B time profile as per IEEE Standard C37.118. The supplied GPS shall be IEEE1588v2.0 (PTP) compliant.
- 4.2.3 The time receiver shall detect the loss of signal from the UTC source and a loss of signal event shall be sent to the PMU which will be transferred to PDC & SAS and shall result in an alarm at PDC & SAS. Upon loss of signal, the PMU time facility shall revert to an internal time base. The internal time base shall have minimum stability of 1 PPS.



4.2.4 The supplied GPS shall have "one IRIG-port plus 1 PPS port" and one Ethernet port as minimum.

4.2.5 In some of the locations, GPS shall be installed in switchyard along with PMU. GPS must be suitable to work in such Electrical environment.

4.3.0 Industrial Grade Layer-3 LAN Switch

4.3.1 The PMUs at Substations/Power Plants shall be connected to the communication equipment through an industrial grade Layer-3 LAN switch.

4.3.2 The industrial grade LAN switch shall interface PMUs on one side and communication equipment on the other side.

4.3.3 The LAN switch shall operate on 110V DC (+10%, -15%) supply voltage of station.

4.3.4 For detailed specifications of networking components including Ethernet switches, the Bidder shall refer to the relevant section of the tender document.

4.4.0 Armoured Fibre Optic Cables

4.4.1 Fibre optic cables within the control room shall be of armoured type for protection against rodents and physical stresses. fibre optic cables, required to be laid in the switchyard shall also be of armoured type. The technical details of Fibre optic cables is mentioned in section 2-21.

4.4.2 The characteristics of the fibre optic shall be as per the IEC 60870-5-103 standard. The fibre optic cables shall be run in GI conduit pipes while passing through cable trenches / cable racks outside the control room building. The fibre optic cables inside the panel shall be neatly laid and tied.

4.5.0 Cabling & Interconnections

4.5.1 All cabling between component units of the PMU, PMU to GPS along with antenna and to the control and relay panels (located in the control building) shall be supplied and installed by the bidder and shall be shown on bidder supplied drawings. Plug-type connectors with captive fasteners or compression type connectors shall be used for all internal interconnections. The connectors shall be polarized to prevent improper assembly. Each end of interconnection cables shall be identified by a marker which includes the cable number and the identifying number and location of each of the cable's terminations. This information shall match with the Contractor's drawings.

4.5.2 Adequate space and hardware shall be provided for routing of the field wiring within the enclosures. Wiring within enclosures shall be neatly arranged and shall not be directly fastened to the enclosure frame. All internal interconnection wiring and cables shall be routed separately from field wiring to the PMU terminals & power wiring. All wiring shall use copper conductors and have flame retardant insulation. Conductors in multi-conductor cables shall be individually colour coded.

4.5.3 The use of non-flammable, self-extinguishing, plastic wire troughs is permissible. Metal clamps must have insulating inserts between the clamps and the wiring. Wiring between stationary and movable components, such as wiring across door hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wiring.

4.5.4 The bidder shall be responsible for laying and termination of all cables required under the project which includes interconnections among bidder supplied equipment and their



interconnection with panels. Testing and commissioning of these interconnections shall also be done by the bidder.

4.6.0 Wiring/Cabling Requirements

4.6.1 Shielded (screened) cables shall be used for external Cabling from the PMU/ SIC panels. These external cables (except communication cables) shall have the following characteristics:

- a. All cables shall have stranded copper conductor.
- b. Minimum core cross-section of 2.5 sq.mm for PT cables, 4 sq.mm for CT cables and 2.5 sq.mm for Power & Control outputs and 1.5 sq.mm for Digital
- c. Status inputs, transducer mA current output
- d. Rated voltage U_0/U of 0.65/1.1KV
- e. External sheathing of cable shall have oxygen index not less than 29 & temperature index not less than 250. Cable sheath shall meet fire resistance test as per IS 1554 Part- I.
- f. Shielding, longitudinally laid with overlap.
- g. Dielectric withstand 2.5 kV at 50 Hz for 5 minutes
- h. External marking with manufacture's name, type, core quantity, cross-section, and year of manufacture.

4.6.2 The Communication cable shall be of shielded, twisted pairs and of minimum 0.22 sq. mm size Copper cable or Fibre optic cable.

4.7.0 Secondary Injection Test Facility

4.7.1 Relay test Block shall be provided for online testing of all numerical relays.

4.7.2 Test block shall have facility of CT, PT, Trip Circuit, auxiliary supply, logical inputs and output contacts. Test block shall be mounted below and in front of the panel.

4.7.3 For measuring instruments (MFM, PQM, PMU etc.), separate / dedicated TTB and shall be connected in such a way that it facilitates testing / checking / removal / replacement activates without affecting other measuring instruments connected to same core of CT/PT. TTB shall be of 3 phase-4 wire type. TTB shall be mounted below and in front of the panel. TTB shall be of large size and shall be of SCREW type. (e.g. Dev industries model no 4SF)

4.8.0 Constructional Requirements

Relay panels shall be of simplex type design preferably with front glass door. It shall consist of CRCA sheet steel with thickness not less than 3mm for weight bearing panels and 2mm for other panels and shall provide a degree of protection not less than IP 31 in accordance with IS: 2147

Panels shall be free standing, floor-mounting type. All doors and removable covers of panels shall be gasketed all around. Anti-vibration pads shall be placed between panel and base frame. Cable entries to the panels shall be from the bottom. Each panel shall be provided with a minimum of 300 thick removable gland plate and each panel shall be powder coated with painting thickness shall not be less than 85 micron

5.0.0 DRAWINGS, DATA AND MANUAL

5.1.0 **To Be Submitted After Award of Contract:**

- Technical data sheets
- Dimensional general arrangement drawing
- Interconnection / wiring diagram
- Catalogues / drawings.
- Quality plan



- Test certificates
- O&M manual

6.0.0 TESTS

a. Type Tests

The list of Type tests applicable on the PMU is mentioned in Table-1 & type test requirements are mentioned in Table-2. The contractor may optionally submit type test reports for all the tests conducted at accredited laboratory for review & approval by Customer/Client. However, in the event, the type test reports are not meeting the specification requirement, Customer/Client may ask for the type testing above tests (EMI/EMC, Environmental & Functional tests) as required at no additional cost.

b. Routine Tests

Each complete unit shall undergo routine testing. The list of Routine tests to be performed in the factory is mentioned in Table-1. Few samples of PMUs from each Package shall be tested at the PMU Test Lab before taking up mass production.

c. Field Tests

The Contractor shall carry out the field-testing of PMUs after installation and integration with C&R panels. The list of field tests is mentioned in **Table-1**.

Table-1: List of Tests on PMU:

Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
	FUNCTIONAL TESTS FOR PMU			
1.	Check for BOQ, Technical details, Construction & Wiring as per PMU drawings		√	√
2.	Check for PMU database & configuration settings		√	√
3.	Check the operation of all Analog inputs, Digital and Status input points of PMU		√	√
4.	Check operation of all communication ports of PMU	√	√	√
5.	Check for communication between PMU and PDC	√		√
6.	Test for PMU time synchronization from GPS	√		√
7.	Test Power Supply Voltage Margin, Ripple Levels and Short Circuit Protection	√		
8.	Test for PMU operation with DC power supply voltage variation	√		
9.	Check for auto restoration of PMU on DC power recovery after its failure	√	√	√
10.	Test for PMU diagnostic feature	√		
11.	Accuracy tests as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard	√		
12.	Test for PMU internal Clock stability	√		
13.	End to end test (between PMU&PDC) for all I/O points			√
14.	Testing and Configuration of PMU from HMI or Portable Configuration tool	√	√	√
	EMI/EMC IMMUNITY TESTS FOR PMU			



Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
15.	Surge Immunity Test as per IEC 61000-4-5& IEC 60255-22-5	√		
16.	Electrical Fast Transient Burst Test as per IEC 61000-4-4 & IEC 60255-22-4	√		
17.	Damped Oscillatory Wave Test as per IEC 61000-4-18 & IEC 60255-22-1	√		
18.	Electrostatic Discharge test as per IEC 61000-4-2 & IEC 60255-22-2	√		
19.	Radiated Electromagnetic Field Test as per IEC 61000-4-3 & IEC 60255-22-3	√		
20.	Damped Oscillatory magnetic Field Test as per IEC 61000-4-10	√		
21.	Power Frequency magnetic Field Test as per IEC 61000-4-8	√		
	INSULATION TEST FOR PMU			
22.	Power frequency voltage withstand Test as per IEC 60255-22-5	√		
23.	1.2/50 μs Impulse voltage withstand Test as per IEC 60255-22-5	√		

Table-2: PMU Type Test Requirements

Test Nos	Test Name	EUT Status	Test Level	Power Supply Points		I/O Points	Passing Criteria
				CM	DM	CM	
1	Surge Immunity Test	ON	Level 3	2 kV	1 kV	2 kV	A
2	Electrical Fast Transient Burst Test	ON	Level 3	2 kV	-	1 kV	A
3	Damped Oscillatory Wave Test	ON	Level 3	2.5 kV	1 kV	2.5 kV	A
4	Electrostatic Discharge Test	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode			A
5	Radiated Electromagnetic Field Test	ON	Level 3	10 V/m electric field strength			A
6	Damped Oscillatory Magnetic Field Test	ON	Level 3	10 A/m at 1MHz of magnetic field strength			A
7	Power frequency magnetic field	ON	Level 3	30 A/m of magnetic field strength (Continuous duration sine wave)			A



Test Nos	Test Name	EUT Status	Test Level	Power Supply Points		I/O Points	Passing Criteria
				CM	DM	CM	
8	Power frequency voltage withstand	OFF	-	1 kV rms for 1 minute			No break down or flashover shall occur
9	1.2/50µs impulse voltage withstand	OFF	-	2 kVp			No break down or flashover shall occur
10	DC Voltage Dips & Interruptions / Variation as per IEC 61000-4-29	ON	-	-			-
11	Insulation Resistance Test	OFF	-	Measure Insulation resistance using 500 VDC Megger before & after Power Freq & Impulse voltage withstand tests			As per manufacturer standard
12	Dry heat test	ON	-	Continuous operation at 550 C for 16 hrs			0
13	Damp heat test	ON	-	at 95% RH and 400 C for 16 hrs			0
14	Cold test	ON	-	Continuous operation at 00 C for 96 hrs			0

Note: -

1. EUT - Equipment Under Test
2. CM - Common Mode; DM - Differential mode
3. I/O points do not include Communication ports
4. Passing Criteria
0 - no failure: normal performance within the specified limits
A: minor failure: temporary degradation or loss of function or performance which is self-recoverable

Typical Datasheets

Phasor Measurement Unit

S. No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
1.	Device	Phasor Measurement Unit (PMU)	
2.	Manufacturer		
3.	Model No.		



S. No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
4.	Country of origin		
	Inputs		
5.	Minimum Analog Channel	as per project requirement and tender specifications.	
6.	Minimum Digital Channels	8	
7.	CT core	Capable for Metering Core	
8.	Auxiliary Power Supply Source	110 V DC or 48V DC (+10%, -15%) power supply source	
9.	Communication ports	One Ethernet port of 10/100 Base Tx and one optical fiber port of 100 Mbps	
10.	Interface ports for Time synchronization	IRIG-B interface port for either a standard or high-accuracy demodulated IRIG-B time-synchronization input signal or Ethernet port on IEEE 1588v2.0 (PTP)	
11.	Communication Protocols	Both Multicast and Unicast	
	Measurement Output		
12.	Performance Class	M class	
13.	Test Compliance as per IEEE 37.118	Bidder to fill the values as per test conducted in the lab for each individual values both in steady state and Dynamic State as per IEEE C37.118 Standard	
14.	Environmental Condition During testing	Bidder to fill the environmental condition during testing for each test.	
15.	Reporting rates (Frame per second)	25 and communication port wise	
	Environmental condition		
16.	Temperature	-10 to 50 degree Celsius	
17.	Humidity	10% to 95%	
18.	Corrosivity	C5-M zone as per ISO 12944	
19.	Configuration tool		
20.	HMI facility	Yes	
21.	Remote Configuration Change Facility	Yes	

GPS Based Time Facility



S. No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Country of origin		
4.	Time stability of internal time base	Minimum 1 ppm	
5.	Propagation delay compensation	Yes	
6.	Include an offset to permit correction to local time	Yes	
7.	Reverting to internal time base upon loss of signal from UTC source	Yes	
8.	Resynchronization Delay	Not more than 5 Minutes.	
9.	Accuracy of resynchronization	< 1.5 Micro Sec	
10.	Interfaces	Minimum one Ethernet port and One IRIG-B port & 1 PPS port.	

Industrial grade Layer-3 LAN Switch (Substation LAN Switch) and Router

S. No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Country of origin		
4.	Performance	Minimum 5 Gbps Switching Capacity	
	Processing Capacity	Minimum 2Mbps	
5.	Functions	High performance routing for Data Exchange between PMU and PDC	
	IPSec VPN Tunnels	Minimum 10	
	Minimum number of concurrent TCP sessions	10	
6.	Layer-2 & Layer-3 features required	Static & Dynamic Routing for IPv4 and Ipv6	
		RIP for IPv4 (RIPv1/v2) and IPv6 (RIPng)	
		OSPF for IPv4 (OSPFv2) and IPv6 (OSPFv3)	



S. No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
		Border Gateway Protocol 4 with support for IPv6 addressing wherever applicable.	
		Policy-based routing	
		IPv6 tunneling to allow IPv6 packets to traverse IPv4-only networks by encapsulating the IPv6 packet into a standard IPv4 packet.	
		Dynamic Host Configuration Protocol (DHCP) Client, Relay and server.	
		Support for Multicast VLAN	
		Support for Jumbo frames	
		Should provide for 32K MAC Address Table	
		Should have facilities such as IPv6 to IPv4 tunneling, DHCPv6, ICMPv6	
7.	Features to support	Support IEEE 802.3u: Auto-negotiation on TP, IEEE 802.3x, 802.1p: flow control and prioritization, IEEE 802.1Q: VLANs, maximum 32 VLANs, IEEE 802.1d, 802.1w: Spanning Tree, Rapid Spanning Tree including QoS, MPLS, Security, Broadband, Multiservice, Voice, IP to IP Gateway, RSTP 2004 extensions providing sub-second hop on rings, IEEE 802.1p: Diff Serv, traffic prioritization for routed IP flows/ports Shall support Multicast and Unicast. Shall be PTP enabled as per IEEE1588v2.0 (Power Profile)	
8.	Routing Protocols	EIGRP, IGRP, IS-IS, OSPF, BGP, ARP, IPCP, IP forwarding, VLAN & MPLS etc.	
9.	Network Protocols	TCP/IP, IPv4, IPv6, OSI, Telnet, UDP, DHCP	
10.	Network management	<ul style="list-style-type: none"> • Console port for configuration of software features • Shall able to manage the switch through Command-line interface; Web browser; SNMP etc. 	
11.	Security	a. Access Control Lists for both IPv4 and IPv6 for filtering traffic to prevent unauthorized users from accessing the network	
		b. Port-based rate limiting and access control list (ACL) based rate limiting	
		c. IEEE 802.1x to provide port-based user authentication with multiple 802.1x authentication sessions per port	
		d. Media access control (MAC) authentication to provide simple authentication based on a user's MAC address	
		e. Dynamic Host Configuration Protocol (DHCP) snooping to prevent unauthorized DHCP servers	
		f. Port security and port isolation	
12.	Minimum inbuilt software firewall features required	a) Data encryption supported DES (56 BITS) 3 DES (168 bis) and hashing algorithm like MD5 and SHA-1 b) Filtering of packets based on sources address,	



S. No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
		destination address, protocol types, user, port number, URL c) Filtering of protocols such as FTP, SMTP, HTTP, SNMP, UDP, ICMP, RPC, DNS, DHCP, ARP d) Detailed system logging	
13.	Speed configurability at each port	WAN ports optional 64kbps to 2Mbps	
14.	Interface ports	a) For connecting to communication equipment on 1Gbps Ethernet port or G.703 port b) 1 Gbps Ethernet port for each PMU Shall be finalized during detail engineering.	
15.	Mounting	Rack mountable	
16.	Environmental Compliance	IEC61850-3, EMS-IEC61000, EMI: FCC part15 A	
17.	Operating Temperature	- 10 to 75°C, no force cooling.	