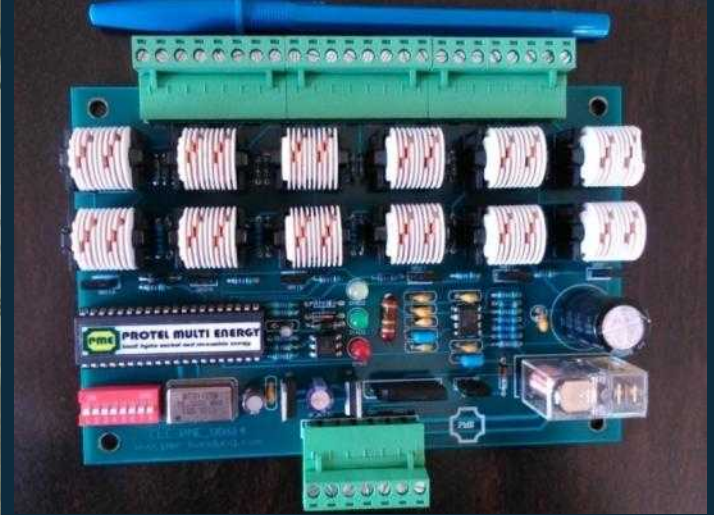


ELECTRONIC LOAD CONTROLLER (ELC) DIGITAL SYSTEM TECHNOLOGY



STATE OF THE ART CONTROL SYSTEM
FOR SMALL HYDRO POWER



PROTEL MULTI ENERGY

Jl. Awibitung No.40 Ciawitali Selatan
Cimahi 40512 Jawa Barat, Indonesia

Telp/fax : +62 22 6631608

admin@pme-bandung.com

www.pme-bandung.com

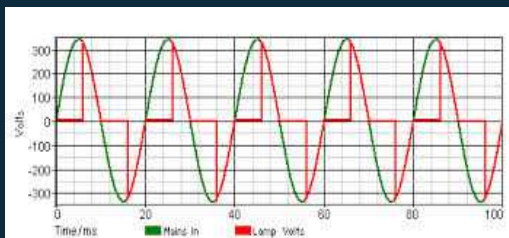
ADVANTAGE OF ELC

1. Constant frequency and voltage, thus avoid damage on electronic appliances
2. Preventing generator from runaway speed
3. No water hammer risk on the penstock, since no need of sudden flow closing on turbine
4. No frequent turbine opening adjustment, thus unintended operation are possible
5. Easy in installation & operation, even by villagers with limited technical background
6. Long life time & maintenance free
7. Competitive price compared to any other control systems type
8. ELC is integrated with standard protection & metering, no more panel required
9. Customized metering and protection, based on customer requirements
10. Suitable for synchronous generator, on/off grid application and can be integrated with existing control system as back up.
11. Suitable for remote data monitoring system (RMS) integration

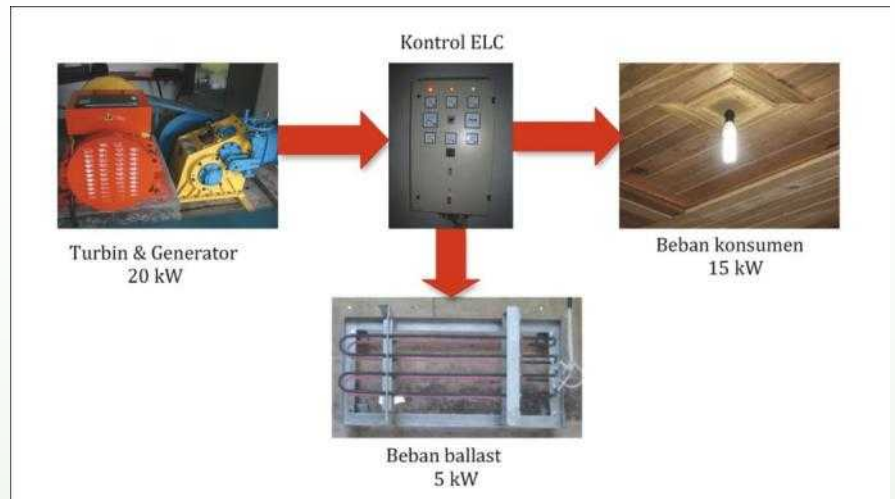
ELC WORKING PRINCIPLES

ELC Protel Multi Energy uses micro controller technology (digital system) with all the parameter are programmed into a chip, thus no more setting required during commissioning or normal operation.

ELC works to control frequency based on phase angle control switching. ELC main board will continuously check the system frequency every 10 ms and will trigger the thyristor to dump the power at certain phase angle according to the error. Frequency control uses PI algorithm with adjustable PI response through dip switch on main board. Frequency error maximum ± 0.2 Hz with recovery time ± 3 seconds. We use two step method dumping to reduce harmonic, where every step will hold 50% of dumped power. All generated power can be diverted 100% to dummy load safely.



ELC DEFINITION



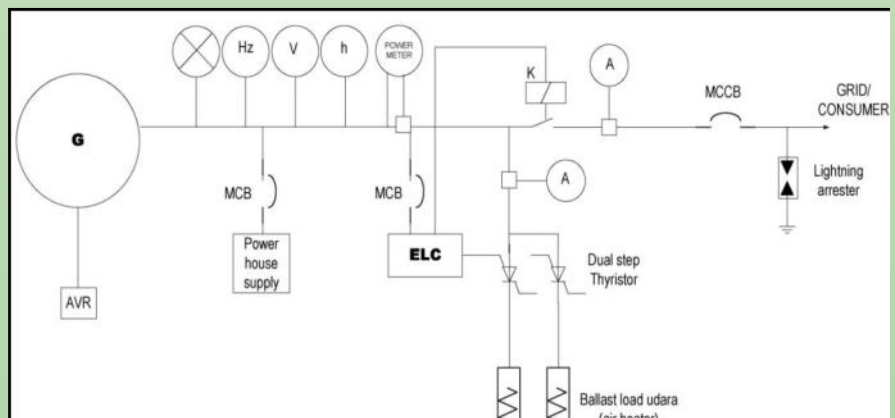
Electronic Load Controller (ELC) is a controller used in small hydro power generation to control the **frequency** of generator by diverting excess power to dummy/ballast load, thus the speed, frequency and voltage of generator will be maintained.

Excess power normally happened during low power consumption on main load/villagers during day or midnight. On the plant without ELC or appropriate governor, this condition will lead to higher generator speed, high frequency and voltage which will destroy most of electrical appliances and even generator it self due to runaway speed. In most large hydro power generation, control is done by adjusting flow entering turbine through guide vane to match the power output required and maintain the speed (flow control). This will be too complicated and costly for small hydro power, especially for rural electrification that required simple and affordable system and ELC is the appropriate solution for this situation.

Power diversion to dummy load is done electronically through **thyristor** as electronic switch which controlled by ELC main board. It will keep the frequency at set point with smooth and steady operation without the need of operator interferences. Our ELC panel is integrated with standard protection for main load and generator and metering to monitor the plant operation at real time.

$$P_{\text{generator}} = P_{\text{load}} + P_{\text{ballast}}$$

$$20.000 \text{ Watt} = 15.000 \text{ Watt} + 5.000 \text{ Watt}$$



STANDARD ELC METERING



STANDARD ELC PROTECTION



AIR HEATER BALLAST LOAD



WATER HEATER BALLAST LOAD



UNDER FREQUENCY & VOLTAGE CONTROL

Under/Over frequency relay can be added to switch off main load automatically when system frequency falls below minimum threshold (47.5 Hz). This is to prevent damaged on generator and electronic appliances due to low frequency for long time. Nevertheless most villagers do not need this protection due to operational reason, thus under frequency relay are only provided if requested.

Voltage on generator is regulated with Automatic Voltage Regulator which normally integrated on generator. Some generator type without AVR might have voltage fluctuation upon load change although the frequency is stable. Thus it is suggested to use synchronous generator with AVR to get better electricity quality and stable operation.

METERING AND PROTECTION

ELC panel is provided with standard analog metering to monitor the electrical output and electrical consumption, thus no additional panel required. Customer can request additional metering system if standard version is not sufficient. Digital or analog version is available on request. Following is our standard ELC metering:

NO	METERING	PROTECTION
1	Pilot lamps, 3P	MCCB consumer
2	Ampere meter ballast, 3P	Contactor consumer
3	Ampere meter consumer, 3P	MCB/Fuse protection
4	Voltmeter generator, 1P	Lightning arrester (optional)
5	Hour counter, 1P	Under/over freq (optional)
6	Frequency generator, 1P	Under/over volt (optional)

BALLAST LOAD

Ballast load is resistance load to dump the excess power. We use industrial standard resistance to ensure quality and lifetime. The standard resistance type is tubular air heater while some customer can request to use water heater type resistance as well. It is not recommended to use standard electrical load for dummy load for safety reason. The capacity of ballast load is about 20-30% higher than generated power to ensure safety and life time.

DIP SWITCH SETTING

ELC Main board ELC is equipped with dip switch to adjust certain parameter externally. In most cases dip switch default setting are suitable for most of plant characteristic, but in case special requirements are required it is possible to adjust it. Following are dip switch function:

DIP SWITCH NO	FUNCTION	DEFAULT POSITION	STATUS	VALUE
DIP 1	Proportional Value		OFF	3
DIP 2			OFF	
DIP 3	Integral Value		OFF	3
DIP 4			OFF	
DIP 5	Set Point -1 = 49 Hz		OFF	50 Hz
DIP 6	Set Point +1 = 51 Hz		OFF	50 Hz
DIP 7	System freq. (50/60 Hz)		OFF	50 Hz
DIP 8	Droop setting (52Hz)		OFF	Disable

Detailed dip switch setting can be found on ELC operation manual

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PROJECTS REFERENCES

Since year 2011 – 2015 ELC PME have been operating in more than 450 MHP sites all over the world ranging from 3-200 kW with total installed capacity ± 7.5 MW. ELC spread all over Indonesia archipelago and exported to several countries such as: Malaysia, Philippine, Thailand, Australia, Turkey, Switzerland, Iran, France, Pakistan, South Africa, Kenya, Mozambique, Ethiopia, Nigeria.

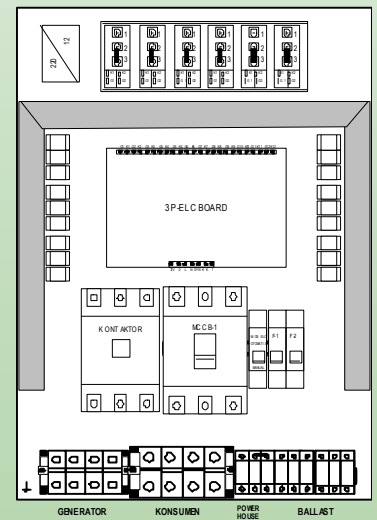
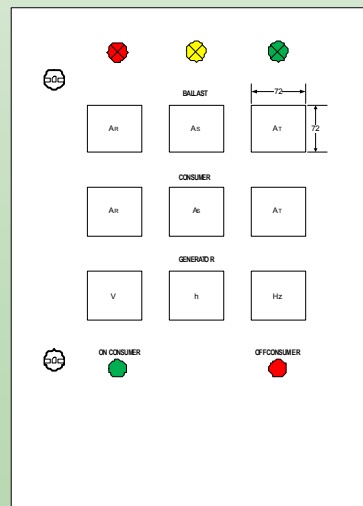
We always try to improve our product quality and services. We are dynamically improved to follow the last technology and requirements to meet the customer need. We are very welcome to advice and input from the customer to improve our product quality and services.



ELC SPECIFICATION

1. ELC Type : Digital system with microcontroller
2. Control method : Phase angle control with PI algorithm, two steps.
3. Switching method : Double Thyristor (SCR), 3 or 6 units
4. Power : 1 – 500 kW
5. Voltage : 220/380 V, 230/400 Volt
6. Phase : 1 and 3 Phase
7. Frequency : 50 / 60 Hz
8. Freq. accuracy : $< \pm 0.2$
9. Freq. sensing : every 10 ms or 100 times/s at 50 Hz
10. Recovery time : ± 3 seconds
11. Standard protection
 - Main load MCCB
 - Main load contactor
 - Fuse/ MCB protection
 - Over/Under Frequency relay (optional)
 - Lightning arrester (optional)
12. Standard metering (analog)
 - Pilot lamps generator, 3 phase
 - Amperemeter ballast, 3 phase
 - Amperemeter consumer, 3 phase
 - Voltmeter generator, 1 Phase
 - Hour counter, 1 Phase
 - Frequency generator, 1 Phase
13. Ballast load : Tubular air heater

STANDARD ELC LAYOUT



REMARKS :

1. Specification are subject to change if required
2. Metering and protection are custom made as request
3. Cable and component size have been calculated based on capacity.