DIGITAL LOAD CONTROLLER

(DLC)

FOR

INDUCTION GENERATOR (IGC)

&

SYNCHRONOUS GENERATOR (ELC)

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Patent No. P00200600394

LOAD CONTROLLER

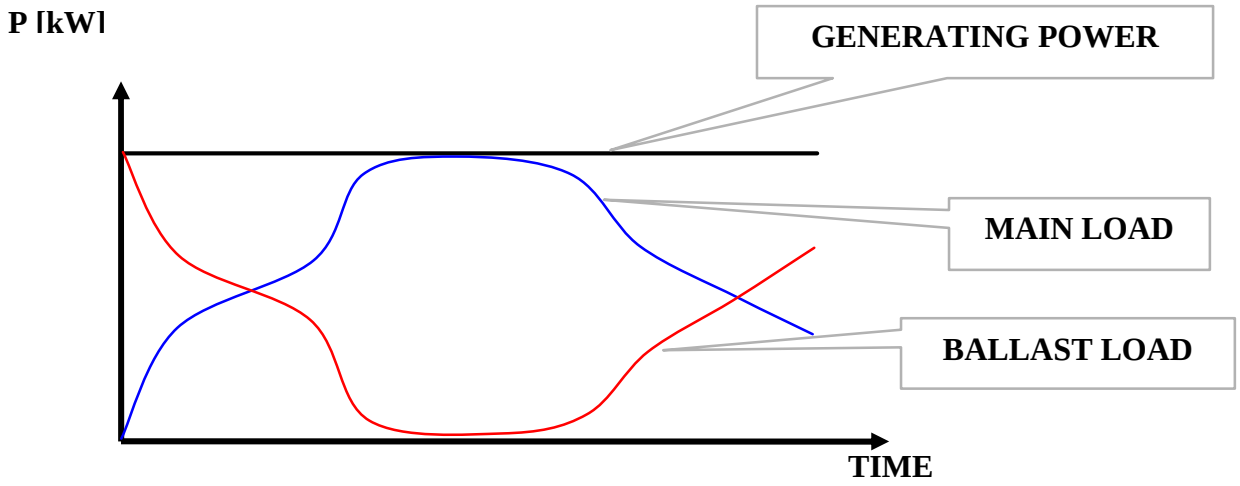
Electronics Load Control is an electronic governor that functions as a frequency and voltage regulator on a generator. Load control is suitable for a micro hydro power plant applied on rivers (with out a dam).

There are some advantages of load control:

1. Avoiding expensive mechanical/electrical tools.
2. Load control tools are relatively more simple and cheaper.
3. Load control is possible to accept very big load changes.
4. Simple maintenance.

Generating Power = Ballast Load + Main Load

The principal work of a load control is to balance a generator load towards main load changes. Therefore the output of the generator will be stable even though changes on the main load occur. Consequently, both the voltage and frequency are stable.



From the graphic above, it shows the generating power (the generated power is stable); the varying load is always balanced by the ballast load. Hence, the number of ballast load power and main load will always be equal with the generating power.

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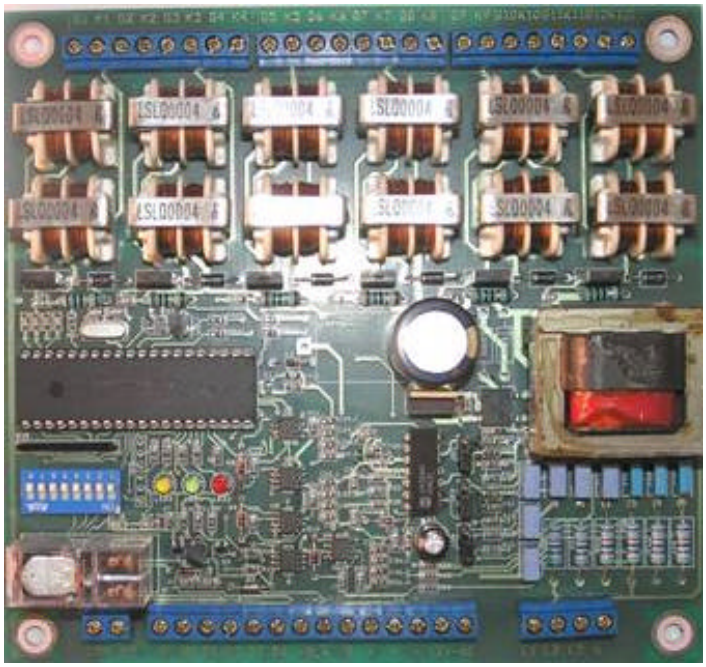
DLC DESCRIPTION

ELC function as speed turbine regulator (governor) for power plan system by synchronous generator. While IGC function as voltage regulator (AVR) for power plan by asynchronous generator (IMAG). With balancing between turbine power (input power) with consumer load by balancing the number of power that thrown to ballast load. This ELC/IGC is the new generation where control system based on MicroPocessor/ Microcontroller that able to control power plan with very high precision. By this system, generator frequency can be controlled easily and accurately. Though it is based on Microprocessor but the components of DLC are resist to the spike voltage / thunder. By this system the application of the installation and the commissioning will be simpler, because we don't need any adjustment on the DLC. Frequency application nominal are 50 Hz or 60 Hz, depend on the setting of the switch. DLC storage on the box according to the capacity, completed by Circuit Breaker, contactor/ motorized circuit breaker and metering. For capacity under 35kW, the size of the box is 50cm wide, 70 cm height, and 25 cm thickness. For capacity from 40kW to 60kW the box size is 60 cm wide, 80 cm height, and 30 cm thickness. While for the capacity 70 to150 kW the box size is 70 cm wide, 120 height, and 50 cm thickness.

The DLC can be applied for Mini Hydro Power (MHP) with off-grid / on-grid operation. DLC as turbine governor is operating simpler than flow control. DLC not use flow control and fly wheel to control the turbine speed during synchronizing. By added one unit synchronizer with the protection so the power plan can work Isolated or Parallel/ Interconnection ways.



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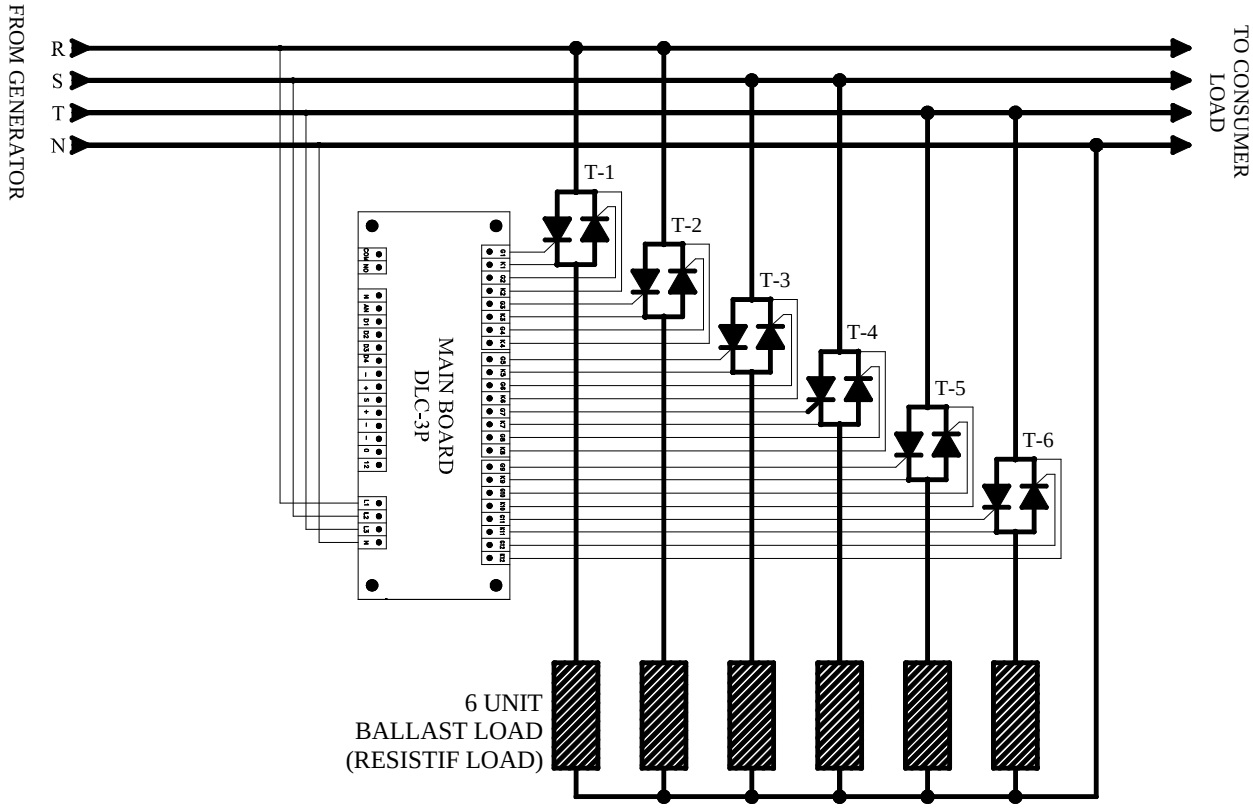
MAINBOARD OF DIGITAL LOAD CONTROLLER (DLC)

DLC OPERATION

Principally, control with DLC aimed to make power that generate from generator equal with the output power, so the voltage and frequency will be stable. To stabilizing the voltage and frequency by throw the unused power to the ballast load. Ballast load is a part of DLC that is not used for the consumer but it must be a resistive load. The working principle of DLC simplify will be explained as follow. When power accepted by consumer change it will be detected by DLC and convert the input power to ballast load immediately. The system of ballast load on each phase divided into two ballast step. First ballast will fully load and then the second ballast is loaded. In vice versa, when the consumers need power, the second ballast will be reduced first, and after the second ballast is empty, than the first ballast will be reduced. To control the ballast power SCR is used. It is an electronic switch that can control the number of power that throw to the ballast load, where SCR is automatically controlled by DLC. Basic diagram of DLC can be seen on the attachment.



Basic diagram of wiring system Digital Load Control with 2 step ballast load

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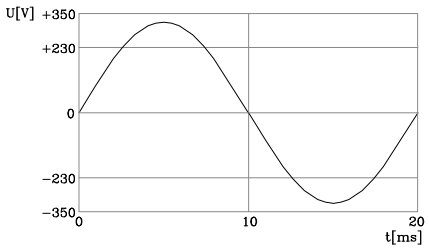
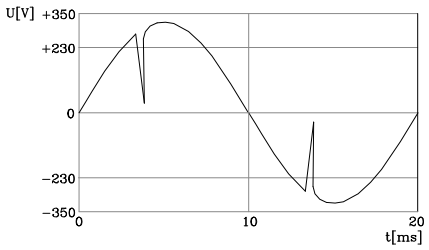
LOW DISTORSION

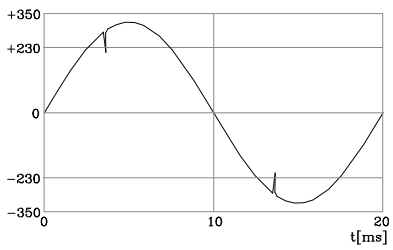
High distortion on line will disturb even destruct the electronic devices. Does the mechanical or generator will make vibration that will disturb the devices. This DLC has less distortion than other ELC. Different from other ELC that only use one step ballast load. DLC designed with two step ballast load. It is used to reduce the distortion (harmonic) on line voltage/ generator. One step ballast load ELC has very high voltage distortion on the line that will destruct several electronic components which cannot resist on the high distortion / harmonic. While, with two step ballast load, voltage distortion/harmonic will be reduce very high. No conflict with modern AVR. The different of the line voltage between other ELC (one step) to DLC (two step) can be illustrated as follows.



Picture a.



Picture b.



Picture c.

Explanation:

a. Line voltage without distortion/ harmonic, if use flow control/ without ballast load.
b. Line voltage with other ELC (one step ballast load). Very high distortion on the line / voltage.
c. Line voltage with DLC (two step ballast load). Very low distortion on the line/ voltage.

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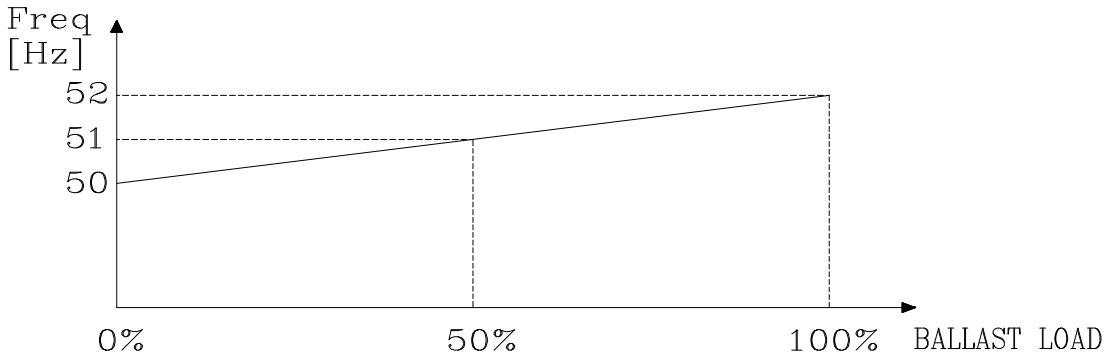
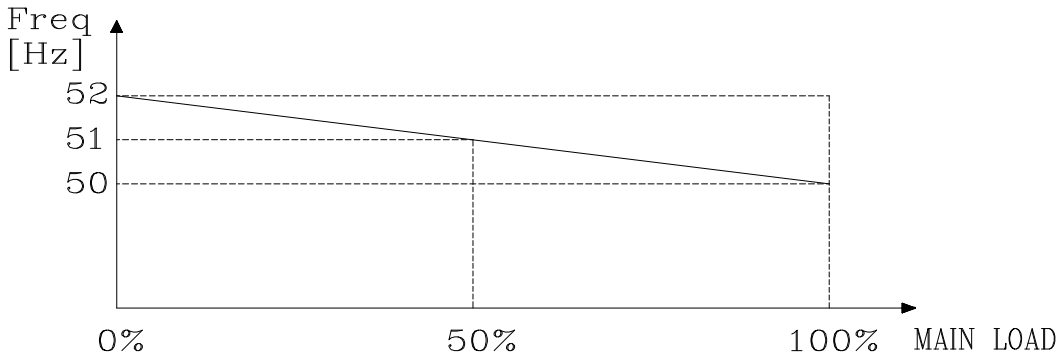
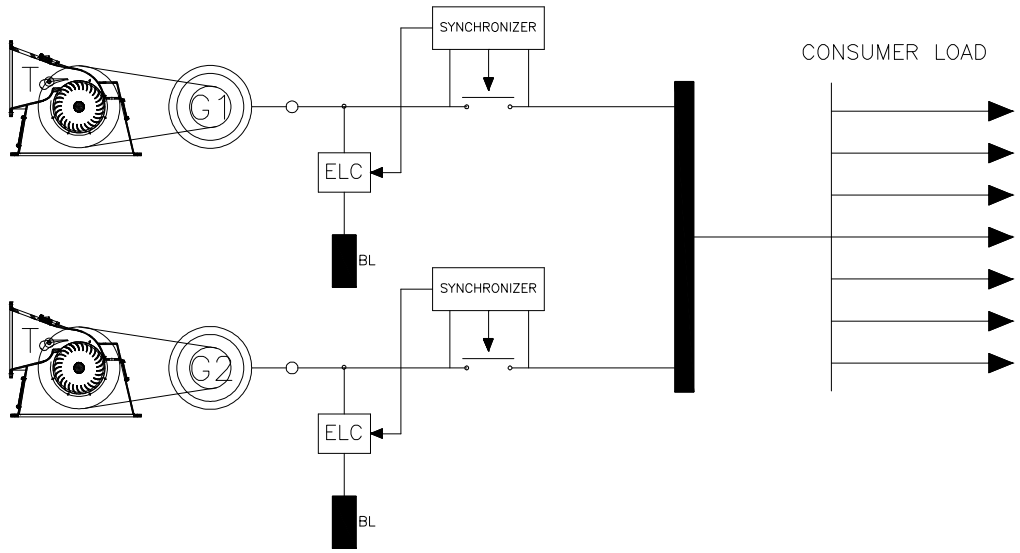
DROOP

DLC completed by droop. Through the existence of droop, DLC is able to be operating parallel with other mini hydro power plant. By droop as well, the input power to ballast load can be monitor from the distance by using remote percentage ballast load. So that, the energy from power plan can be optimally used. Droop can be activated or not from the set of the switch.







DROOP APLICATION FOR PARALLEL OPERATION

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ACCURATION FREQUENCY CONTROLLER

The accuracy of DLC for long term is 0.01 Hz. While for the short term, the changes of frequency to 100% load between 1 to 5 Hz is depend on the setup switch. The maximum return frequency time to the first position is 0.45 sec. The frequency will be maintain steady to maximum input power. When droop activated, frequency will increase equal with ballast power.

METERING

Volt meter, frequency meter, hour meter, ampere meter to each phase for consumer load, ampere meter for ballast load and lamp indicator.

PROTECTION

Over/Under frequency, Over/Under Voltage Protection, Over Load Protection, Main Load Short Circuit and Ballast Load Short Circuit.

DLC TECHNICAL SPECIFICATION

1. Phase : 3 Phase 4 wire / 1 Phase 2 wire
2. Voltage : 230/400 Volt / 277/480V
3. Nominal Frequency : 50 Hertz / 60 Hertz
4. Frequency deviation : 1 s/d 5 Hertz
5. Max time Constance : 0.45 second
6. Number ballast : 2 step (6 unit for 3 Phase)
7. Droop : 5 %
8. Capacity : 3 – 500 kW

INPUT ADDITIONAL

1. Analog Signal input (0.10Vdc) - setting frequency for synchronization process with grid ± 2 Hz from nominal frequency.
2. Digital input, enable external setting frequency – setting frequency from analog input for auto-synchronizer.
3. Digital input, shift frequency reference 2Hz – switch off ballast load when Synchronic switch close for auto-synchronizer.
4. Digital input, enable DROOP.

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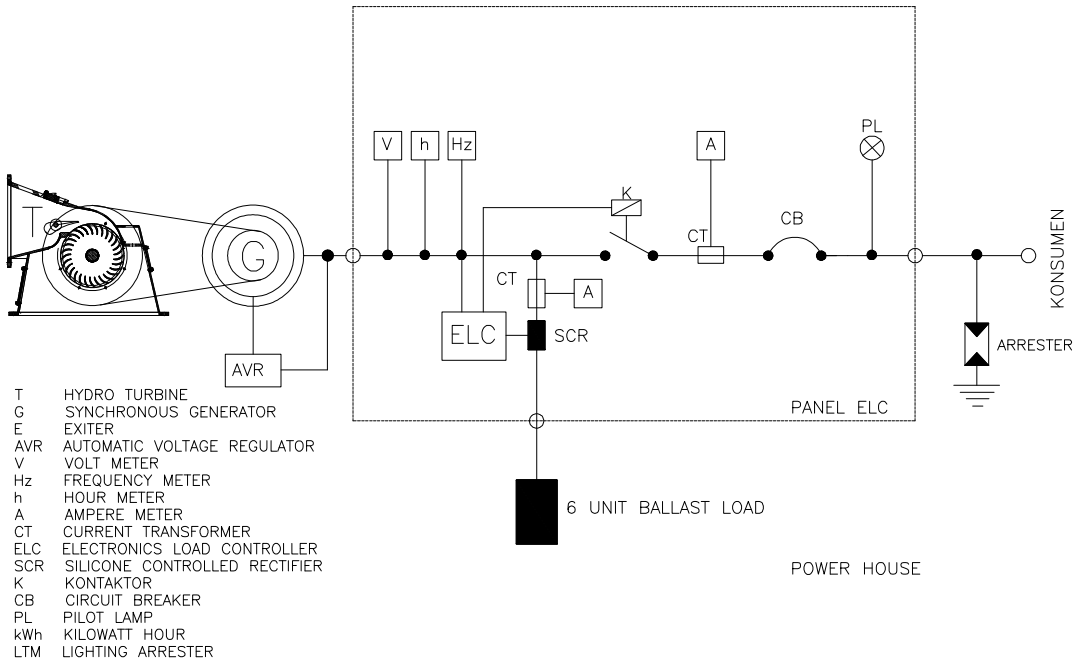
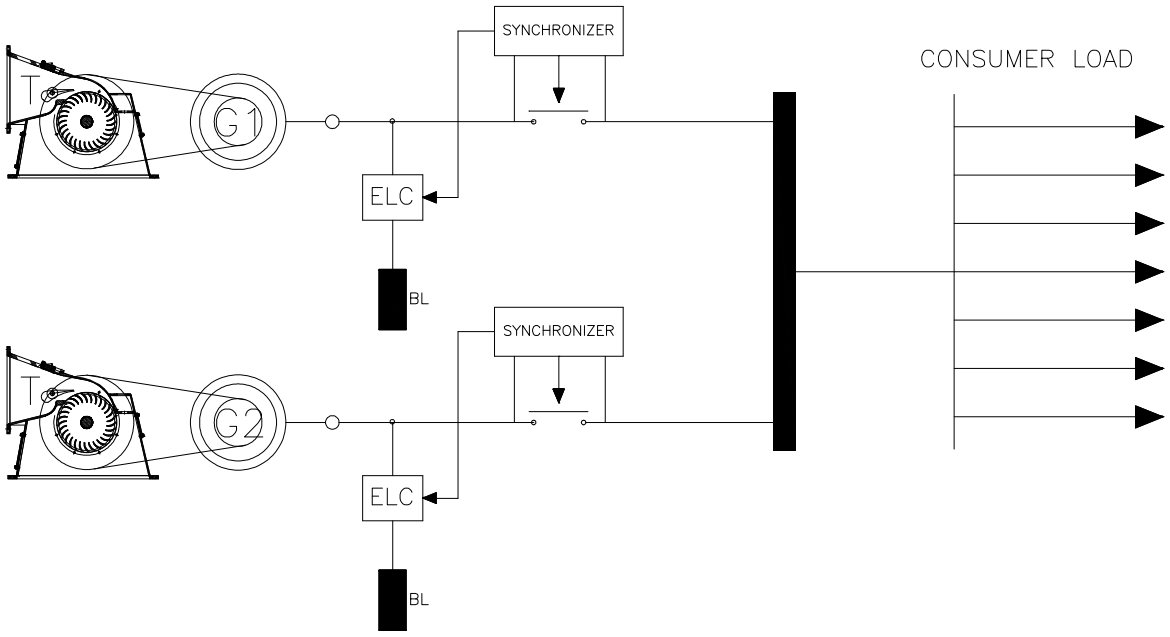
TYPICAL APLICATION

1. STAND ALONE OPERATION



T HYDRO TURBINE
G SYNCHRONOUS GENERATOR
E EXITER
AVR AUTOMATIC VOLTAGE REGULATOR
V VOLT METER
Hz FREQUENCY METER
h HOUR METER
A AMPERE METER
CT CURRENT TRANSFORMER
ELC ELECTRONICS LOAD CONTROLLER
SCR SILICONE CONTROLLED RECTIFIER
K KONTAKTOR
CB CIRCUIT BREAKER
PL PILOT LAMP
kWh KILOWATT HOUR
LTM LIGHTING ARRESTER

2. PARALLEL 2 UNIT GENERATORS



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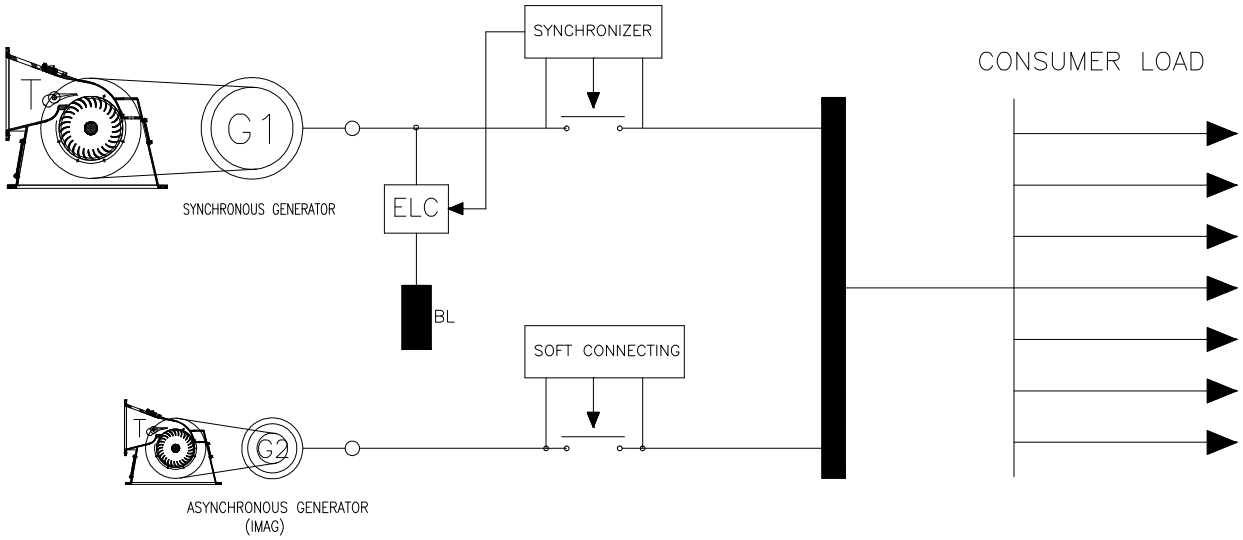
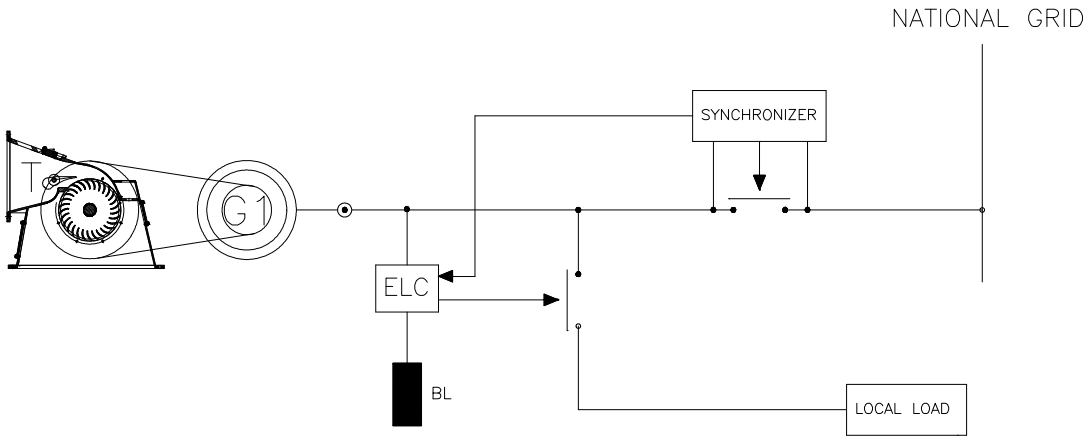
3. PARALLEL SYNCHRONOUS GENERATOR & ASYNCHRONOUS GENERATOR (IMAG)



4. INTERCONNECTION TO NATIONAL GRID WITH STAND ALONE FACILITY



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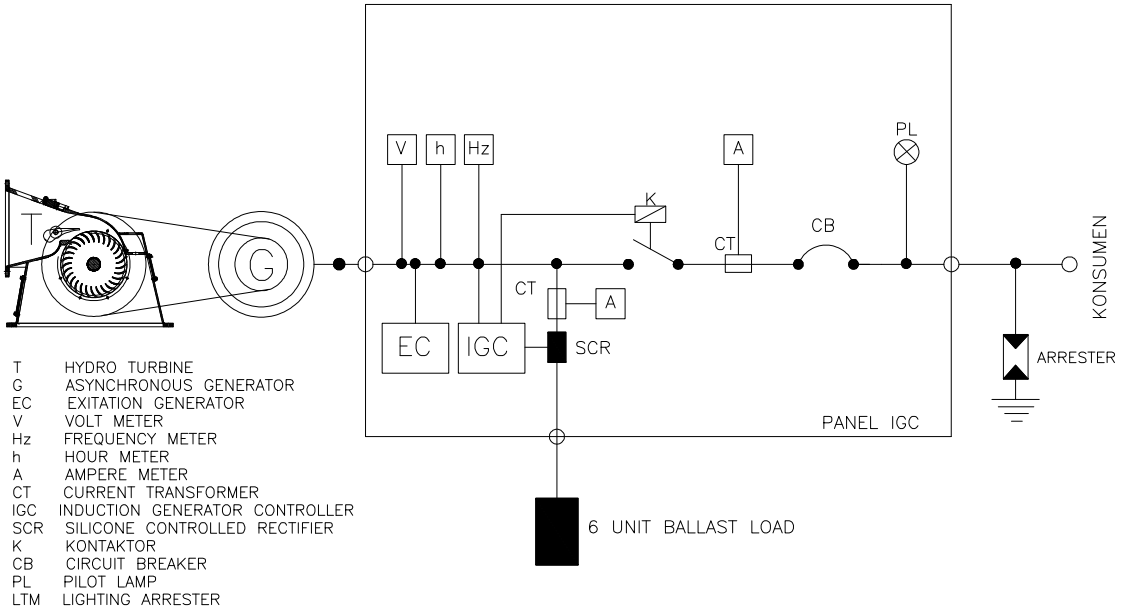
5. APLICATION FOR INDUCTION MOTOR AS GENERATOR (IMAG)



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