Doosan Infracore

Service training: Generators

Product Service Manager

Christophe Vanderzielen

Doosan Infracore
Portable Power

Agenda

- A bit of history
- Generators Main Components
- What is Electricity
- Basic principles of current production
- How does an AC generator work ?
- Voltage regulation
- “Need to know” electrical concepts
- Generators controls types:
- Operation
- Testing and troubleshooting
- Programming the digital controller
- Digital controller improvements
- Maintenance
- Product Identification
-

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A Bit of History

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A bit of history

1986: E-Series
(only 3 Models)

2001: GenPower Series

2004: GenPower II

2005: PowerSource
launch in USA

Bauma 2007

A bit of history

Bauma 2007

Stage IIIA

From 2012 onwards

A bit of history

Stage II Models	Stage IIIA Models	Prime Power kVA	Stage II Models	Stage IIIA Models	Prime kVA
G20	G20 interim	20	G160	G150 SIIIA	150
G30	G30 interim	30	G200	G200 SIIIA	200
G40	G40 SIIIA	40	G250	G250 (was already SIIIA)	250
G60	G60 SIIIA	60	G400	Not released	400
G80	G80 SIIIA	80	G500	G500 SIIIA	500
G100	G100 SIIIA	100			

A bit of history

Stage II Models	Stage IIIA Models	Prime Power kVA	Stage II Models	Stage IIIA Models	Prime kVA
G20	G20 interim	20	G160	G150 SIIIA	150
G30	G30 interim	30	G200	G200 SIIIA	200
G40	G40 interim	40	G250	G250 (was already SIIIA)	250
G60	Not released	60	G400	Not released	400
G80	G80 SIIIA	80	G500	Not released	500
G100	G100 SIIIA	100			

A bit of history

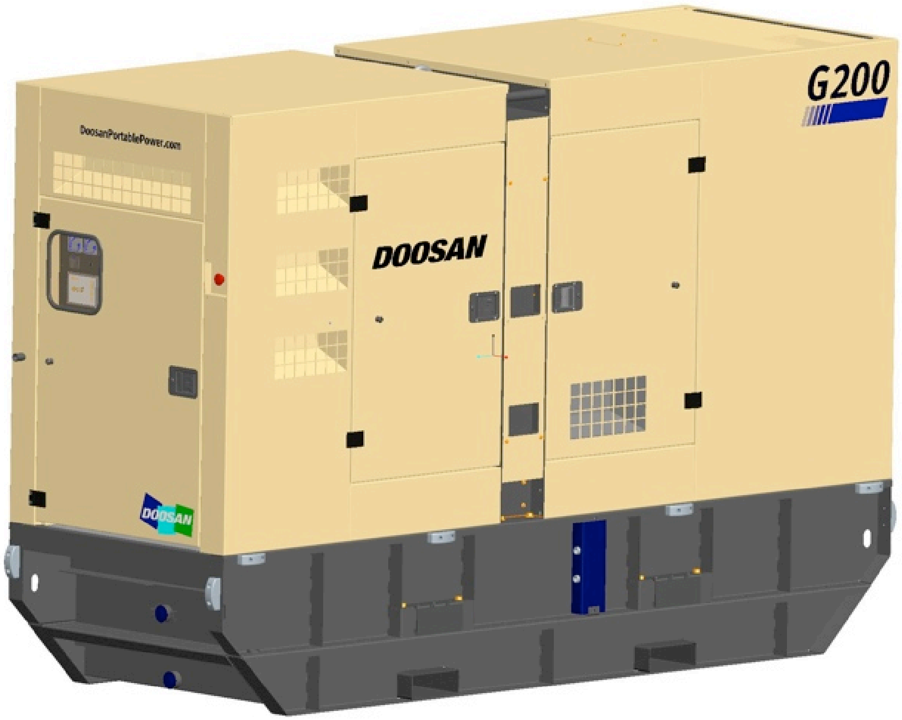
- GIIIA Project:

- Change engines from Stage II to Stage IIIA
- Opportunity to have a re-design

- Steps:

1. G150-SIIIA & G200-SIIIA – Released to production
2. G80-SIIIA & 100-SIIIA – Released to production
3. G400-SIIIA & G500-SIIIA – Under development
4. G60-SIIIA – under development
5. G20-30-40 – under development, already SIIIA engines fitted but re-design still to happen
6. G250 (Only re-design as the engine is already Stage IIIA compliant)

A bit of history



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Generators Main Components

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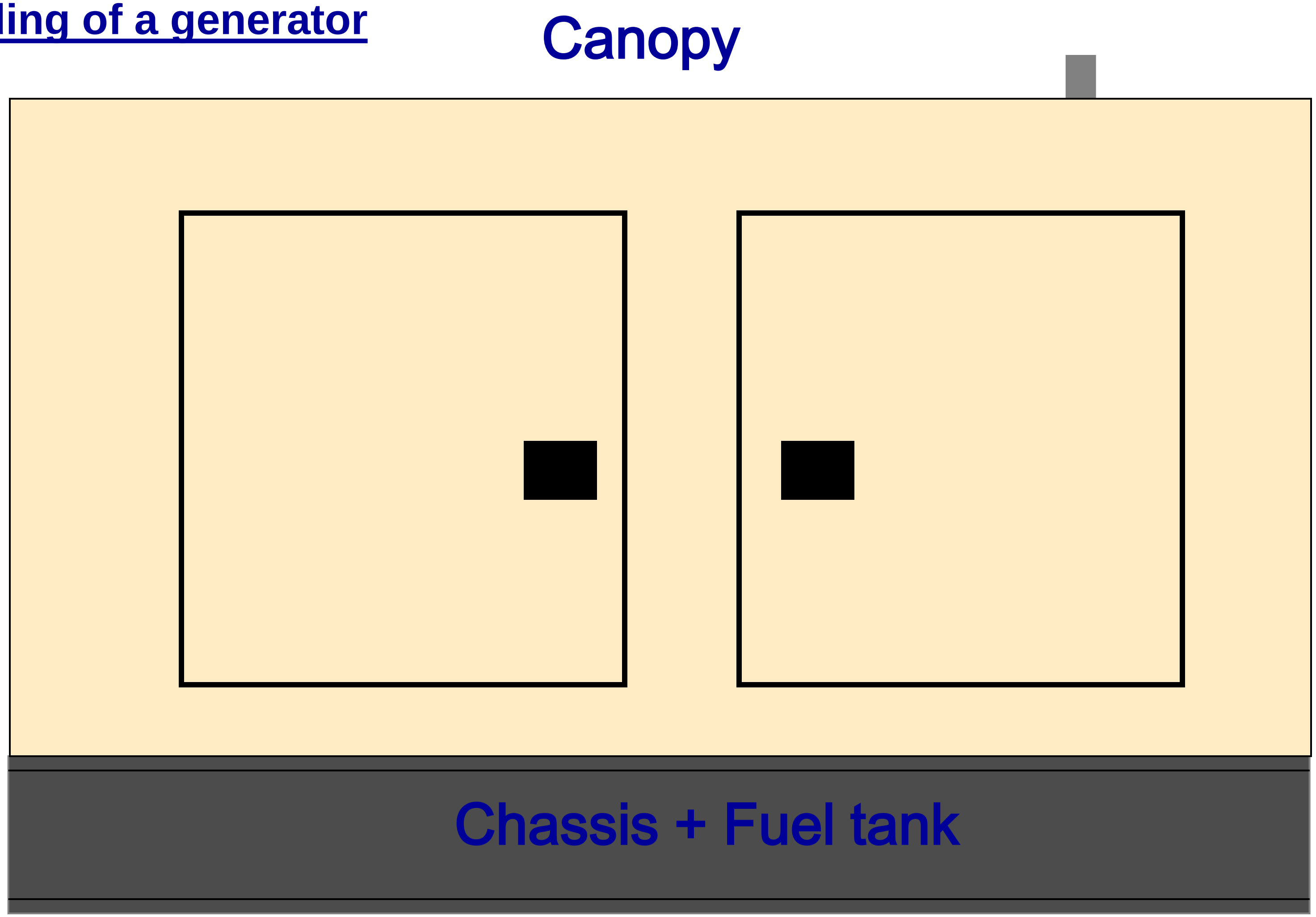
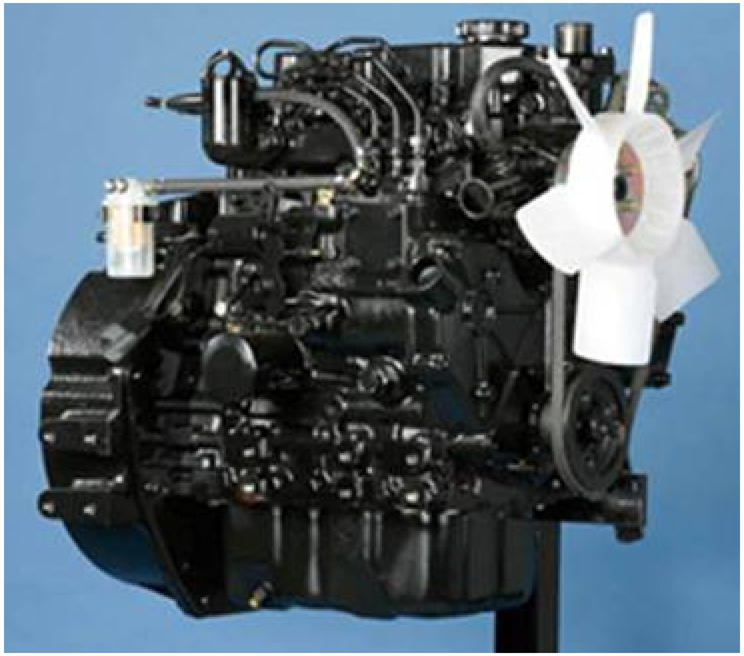
Generator's Main components

Building of a generator



Generator's Main components: engines



G10: Mitsubishi S3L2 (out of production):

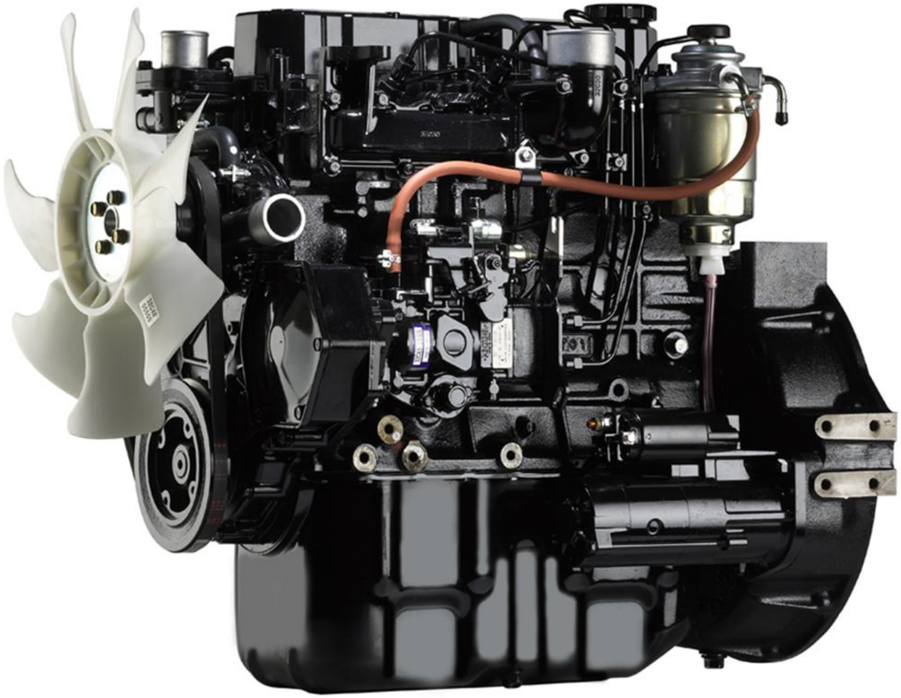
- 4-cycle, water-cooled, diesel
- Inline 3 Cylinders
- Total displacement: 1.318 Liters
- Natural-aspirated
- Prime output: 10 kW @ 1500 rpm

Generator's Main components: engines

G20: Mitsubishi S4Q2 – Y162SD (out of production):

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 2.505 Liters
- Natural-aspirated
- Prime output: 21 kW @ 1500 rpm
- Stage II compliant

Generator's Main components: engines



G20: Mitsubishi S4Q2 - Z361SD:

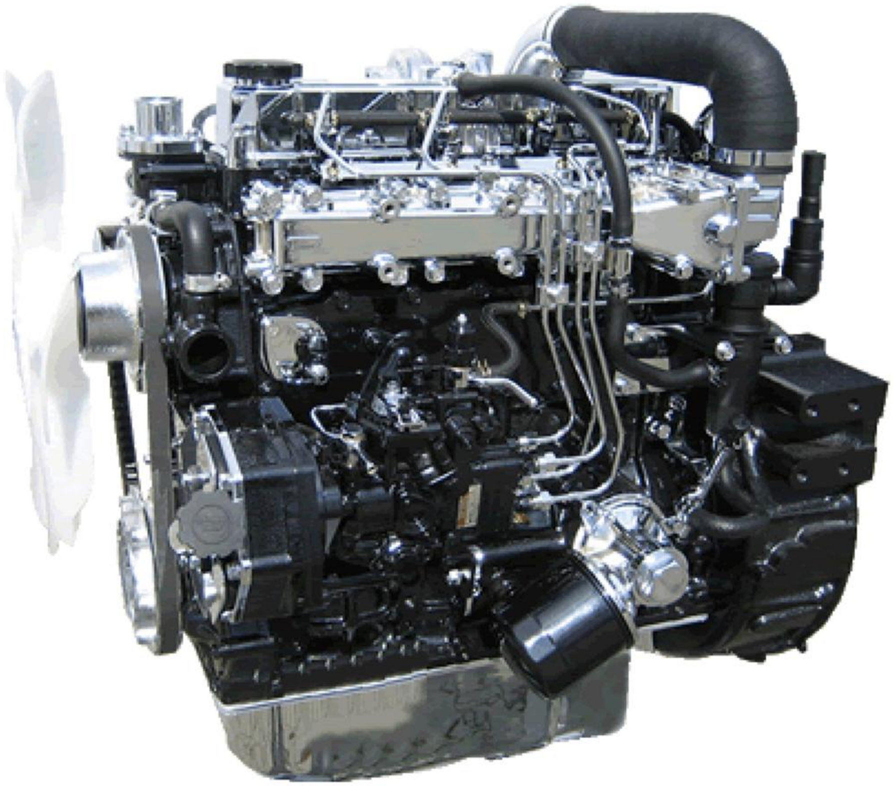
- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 2.505 Liters
- Natural-aspirated
- Prime output: 21 kW @ 1500 rpm
- Stage IIIA compliant

Generator’s Main components: engines

G30: Mitsubishi S4S – Y262SD (out of production):

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 3.331 Liters
- Natural-aspirated
- Prime output: 29 kW @ 1500 rpm
- Stage II compliant

Generator's Main components: engines



G30: Mitsubishi S4S - Z361SD:

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 3.331 Liters
- Natural-aspirated
- Prime output: 29 kW @ 1500 rpm
- Stage IIIA compliant

Generator’s Main components: engines

G40: Mitsubishi S4S – DT (out of production):

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 3.331 Liters
- Turbocharged
- Prime output: 38 kW @ 1500 rpm
- Stage II compliant

Generator’s Main components: engines

<u>G40: Mitsubishi S4S - Z3DT61SD:</u>

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 3.331 Liters
- Turbocharged
- Prime output: 38 kW @ 1500 rpm
- Stage IIIA compliant

Generator's Main components: engines

G60: John Deere 4045TF270

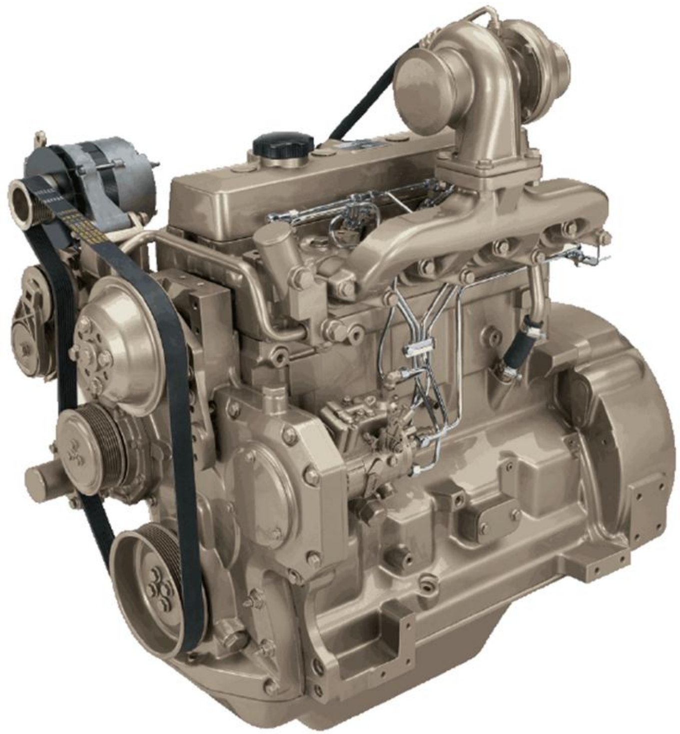
- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 4.5 Liters
- Turbocharged
- Prime output: 55 kW @ 1500 rpm
- Stage II Compliant

Generator’s Main components: engines

G80: John Deere 4045TF275 (out of production):

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 4.5 Liters
- Turbocharged
- Prime output: 75 kW @ 1500 rpm
- Stage II compliant

Generator's Main components: engines



<u>G80-SIIIA: John Deere 4045HFG82</u>

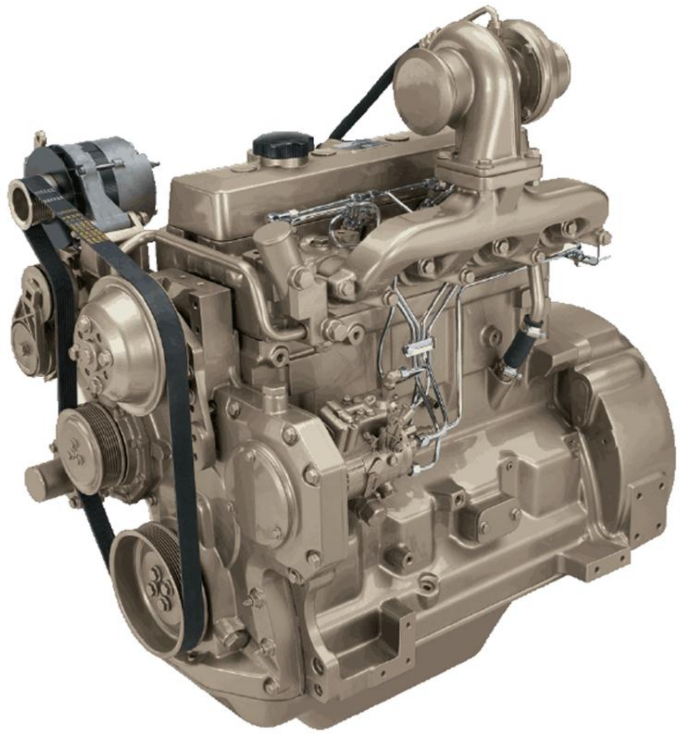
- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 4.5 Liters
- Turbocharged
- Prime output: 75 kW @ 1500 rpm
- Stage IIIA compliant

Generator's Main components: engines

<u>G100: John Deere 4045TF279 (out of production):</u>

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 4.5 Liters
- Turbocharged
- Prime output: 94 kW @ 1500 rpm
- Stage II compliant

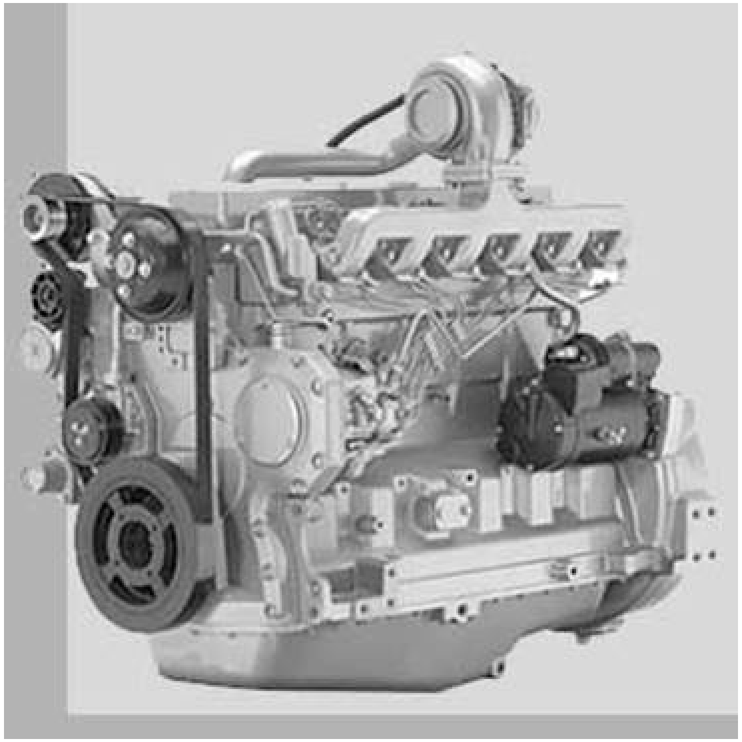
Generator's Main components: engines



G100-SIIIA: John Deere 4045HFG82

- 4-cycle, water-cooled, diesel
- Inline 4 Cylinders
- Total displacement: 4.5 Liters
- Turbocharged
- Prime output: 94 kW @ 1500 rpm
- Stage IIIA compliant

Generator's Main components: engines



G160: John Deere 6068HF279 (out of production):

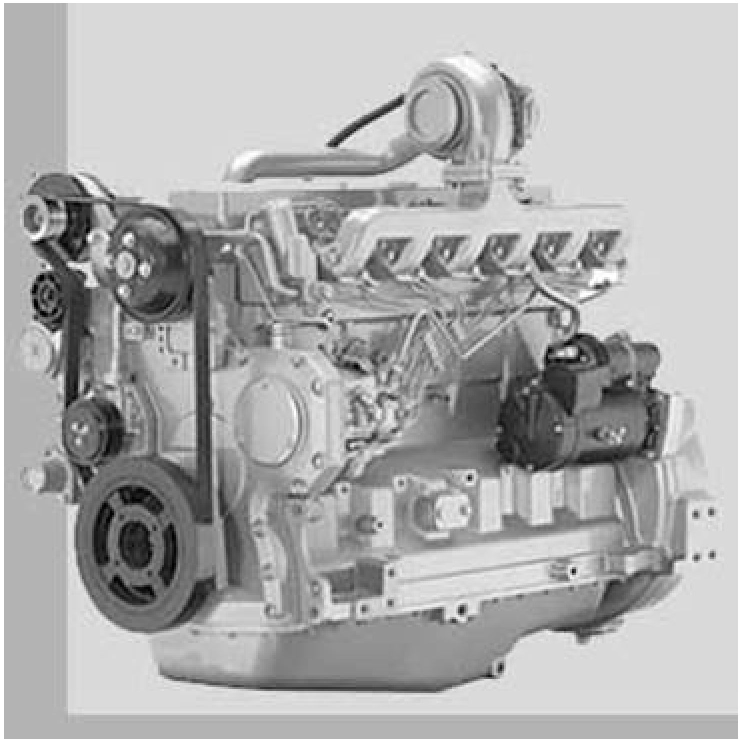
- 4-cycle, water-cooled, diesel
- Inline 6 Cylinders
- Total displacement: 6.8 Liters
- Turbocharged
- Prime output: 139 kW @ 1500 rpm
- Stage II compliant

Generator's Main components: engines

G150-SIIIA: John Deere 6068HFG82

- 4-cycle, water-cooled, diesel
- Inline 6 Cylinders
- Total displacement: 6.8 Liters
- Turbocharged
- Prime output: 139 kW @ 1500 rpm
- Stage IIIA compliant

Generator's Main components: engines



G200: John Deere 6068HF475 (out of production):

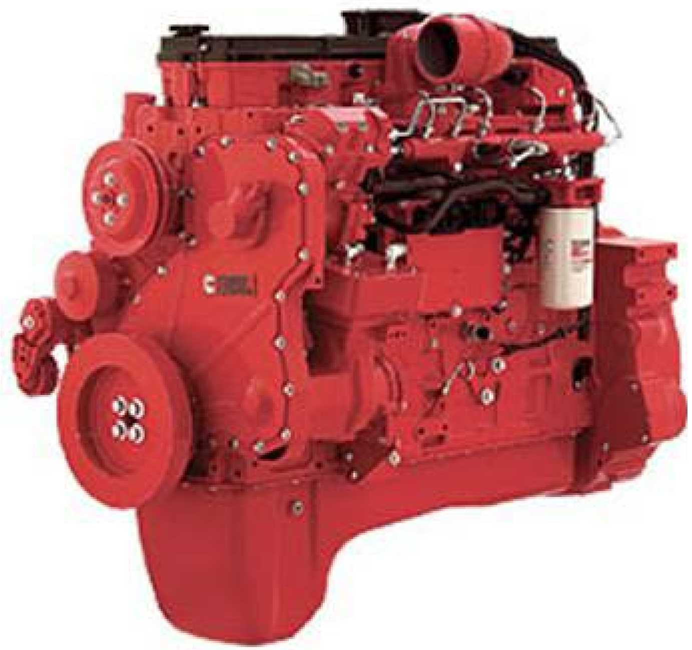
- 4-cycle, water-cooled, diesel
- Inline 6 Cylinders
- Total displacement: 6.8 Liters
- Turbocharged
- Prime output: 207 kW @ 1500 rpm
- Stage II compliant

Generator's Main components: engines

G200-SIIIA: John Deere 6068HFG82

- 4-cycle, water-cooled, diesel
- Inline 6 Cylinders
- Total displacement: 6.8 Liters
- Turbocharged
- Prime output: 207 kW @ 1500 rpm
- Stage IIIA compliant

Generator's Main components: engines



G250: Cummins QSL9-G3

- 4-cycle, water-cooled, diesel
- Inline 6 Cylinders
- Total displacement: 8.9 Liters
- Turbocharged - Aftercooled
- Prime output: 227 kW @ 1500 rpm
- Stage IIIA compliant

Generator's Main components: engines

G400: Cummins QSX15-G6

- 4-cycle, water-cooled, diesel
- Inline 6 Cylinders
- Total displacement: 15 Liters
- Turbocharged - Aftercooled
- Prime output: 358 kW @ 1500 rpm
- Stage II Compliant

Generator's Main components: engines

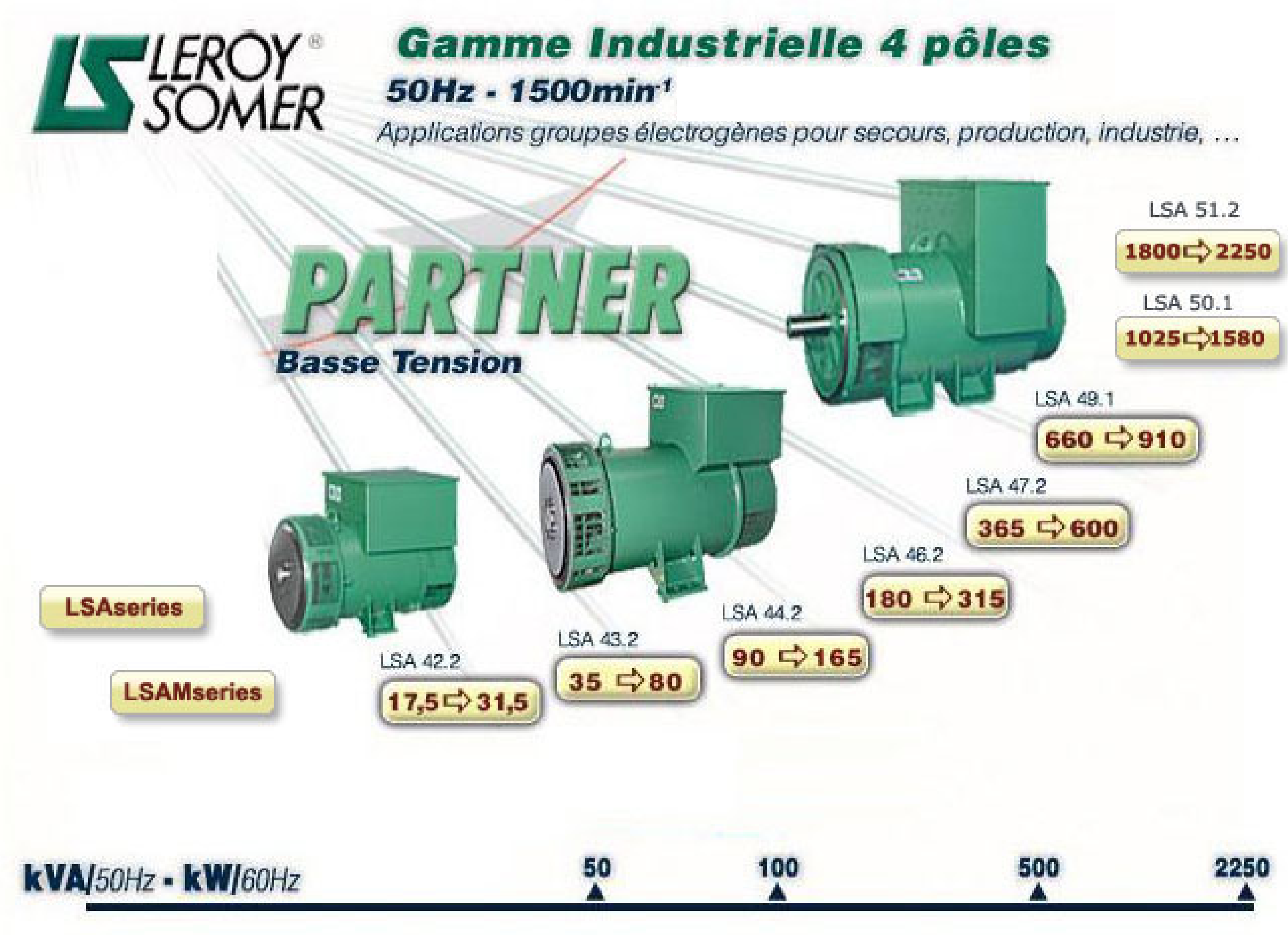
G500: Cummins QSX15-G9

- 4-cycle, water-cooled, diesel
- Inline 6 Cylinders
- Total displacement: 15 Liters
- Turbocharged - Aftercooled
- Prime output: 444 kW @ 1500 rpm
- Stage II Compliant

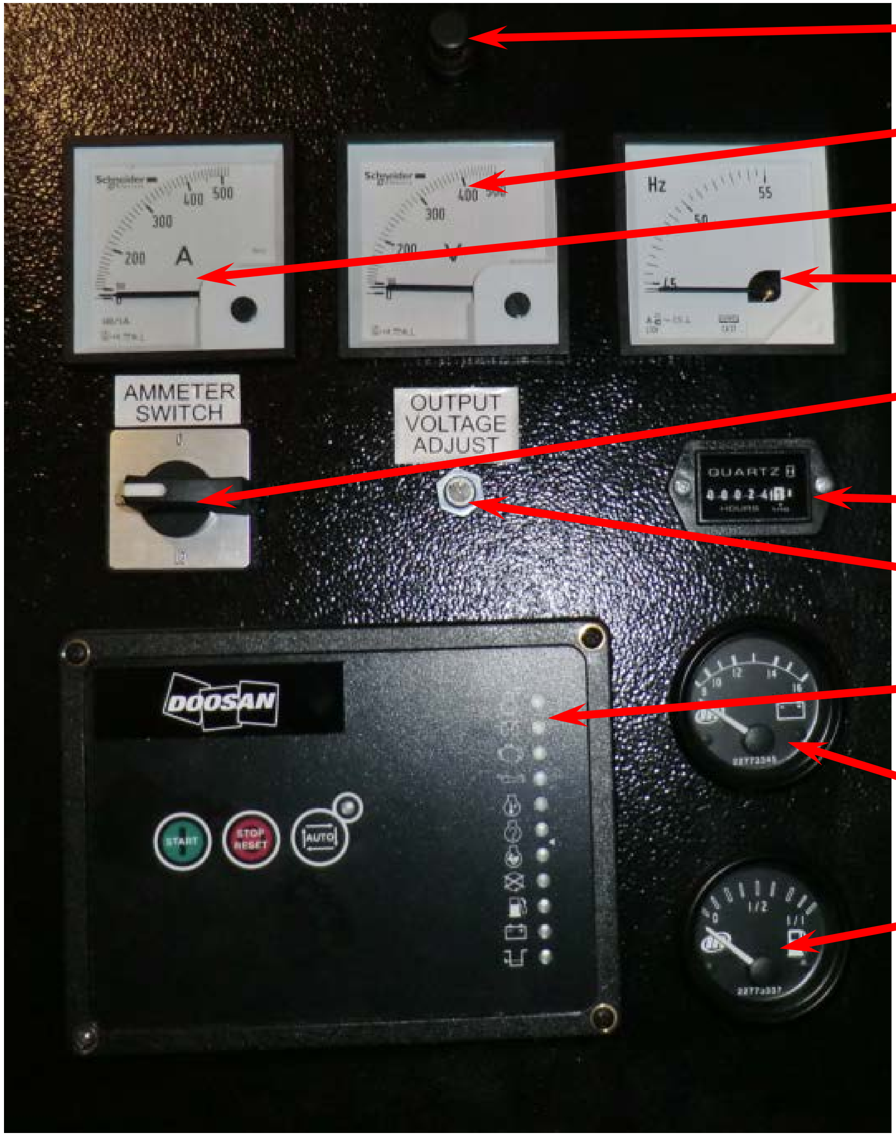
Generator's Main components: engines

Model	Make	Model	Emission level met	Rated speed rpm	Prime output @ rated speed kW
G20	Mitsubishi	S4Q2-Z361SD	E.U. Stage III A	1500	21
G30	Mitsubishi	S4S-Z361SD	E.U. Stage III A	1500	29
G40	Mitsubishi	S4S-Z3DT61SD	E.U. Stage III A	1500	38
G60	John Deere	4045TF270	E.U. Stage II	1500	55
G80-SIIIA	John Deere	4045HFG82	E.U. Stage III A	1500	75
G100-SIIIA	John Deere	4045HFG82	E.U. Stage III A	1500	93
G150-SIIIA	John Deere	6068HFG82	E.U. Stage III A	1500	139
G200-SIIIA	John Deere	6068HFG82	E.U. Stage III A	1500	188
G250	Cummins	QSL9-G3	E.U. Stage III A	1500	227
G400	Cummins	QSX15-G6	E.U. Stage II	1500	358
G500	Cummins	QSX15-G9	E.U. Stage II	1500	444

Generator's Main components: alternators



Generator's Main components: G20–G500 Analog Control



- Panel Lamp
- AC voltage phase-phase
- AC amperes per phase
- Frequency meter
- Ammeter selector switch
- Running hours
- Output Voltage Adjustment
- Indicators/Shutdown/Warnings Panel (see next slide)
- Battery voltage
- Fuel level

Generator's Main components: Control Panel

Engine running
Preglow
ECU status
Low oil pressure shutdown
High coolant temperature shutdown
Engine general alarm
Engine overspeed shutdown
Engine overcrank
Low fuel warning/shutdown
Battery charge fail warning
High containment level warning

Start Button
Stop/Reset Button
Auto start/stop Button
Auto On indicator

Generator's Main components: G20–G500 Digital Controller

Mode selection button

Start Button

Stop Button

Reset Button

Navigation buttons

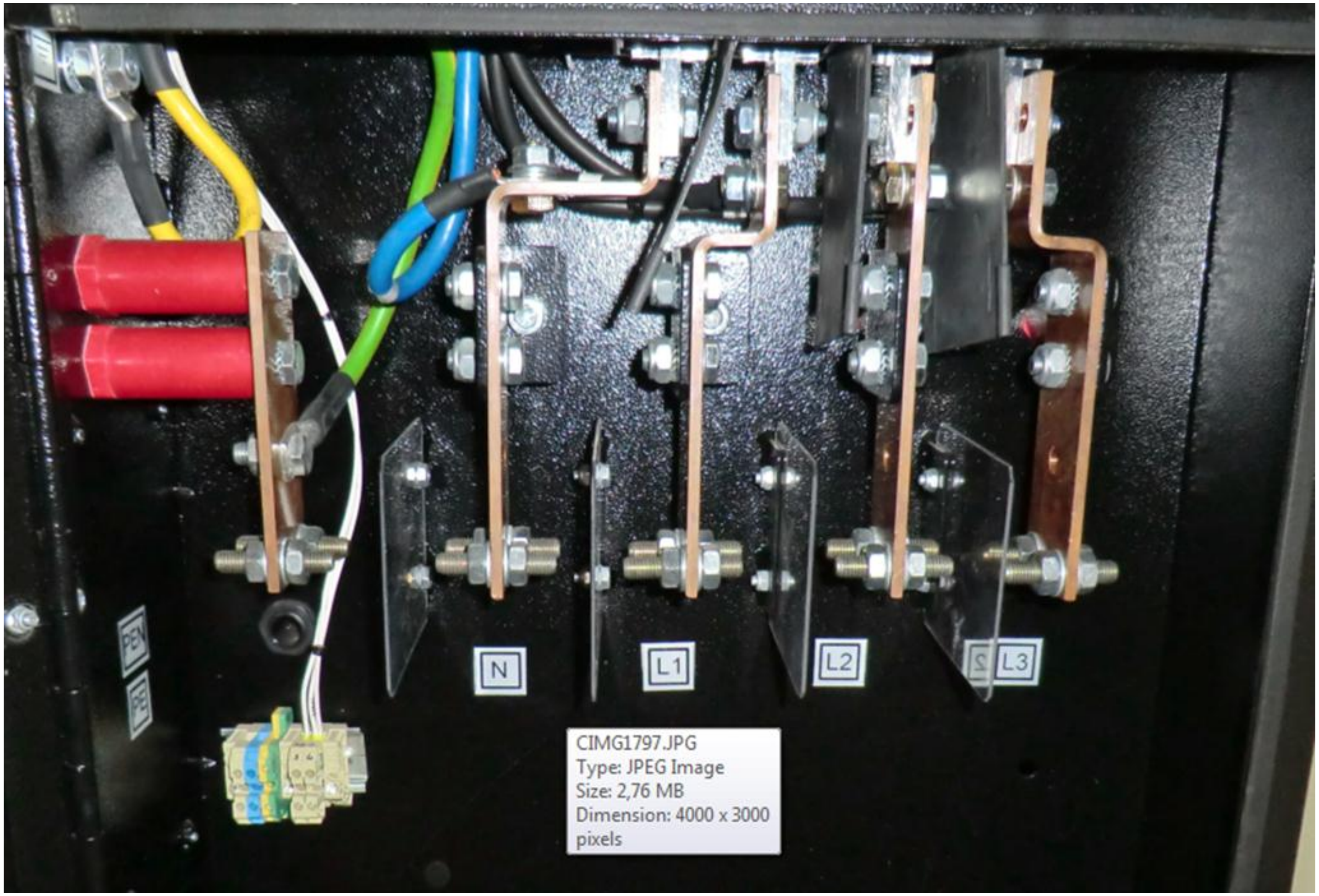
Generator’s Main components

Voltage adjusting potentiometer

4-pole circuit breaker

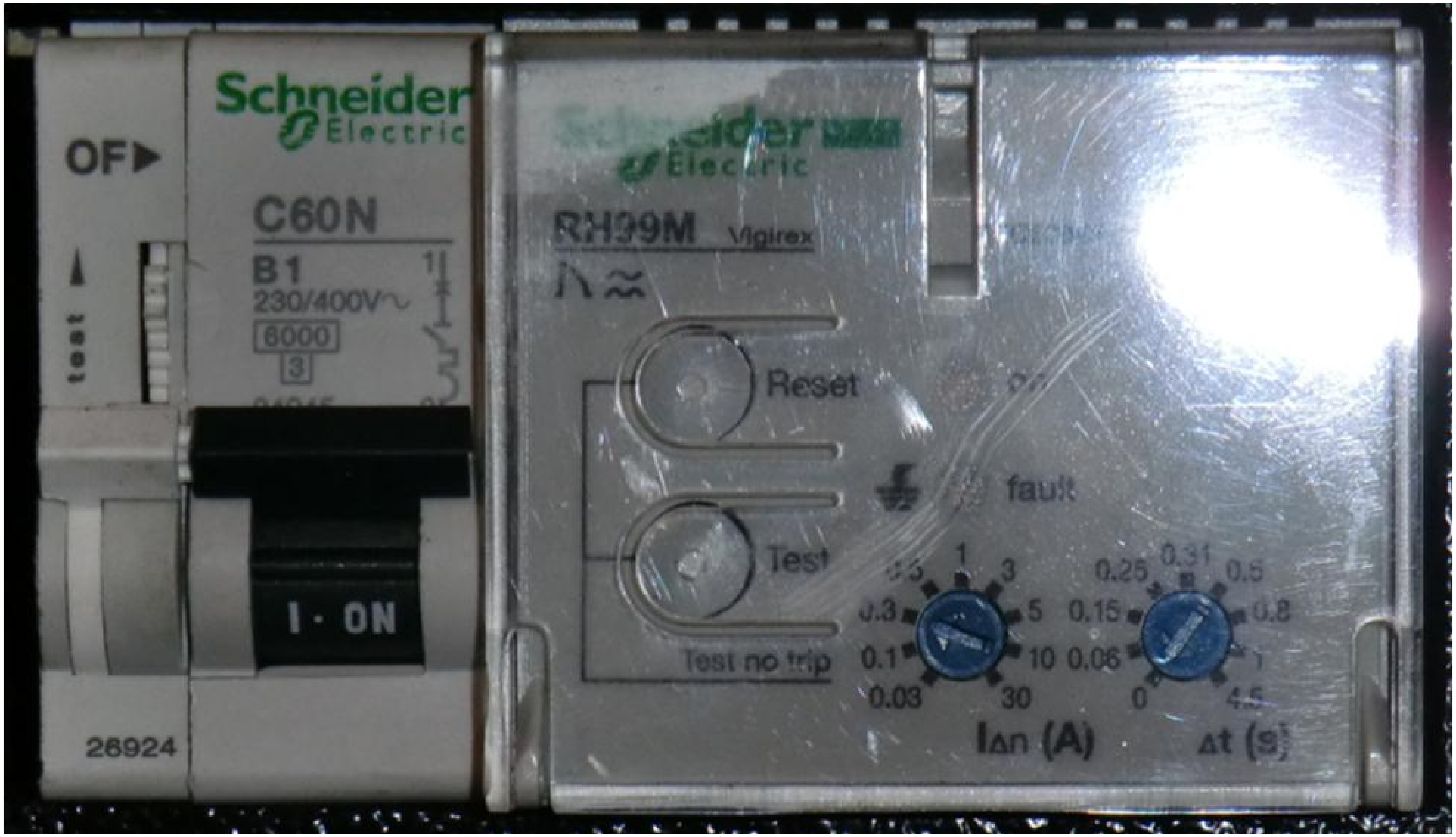
Generator’s Main components

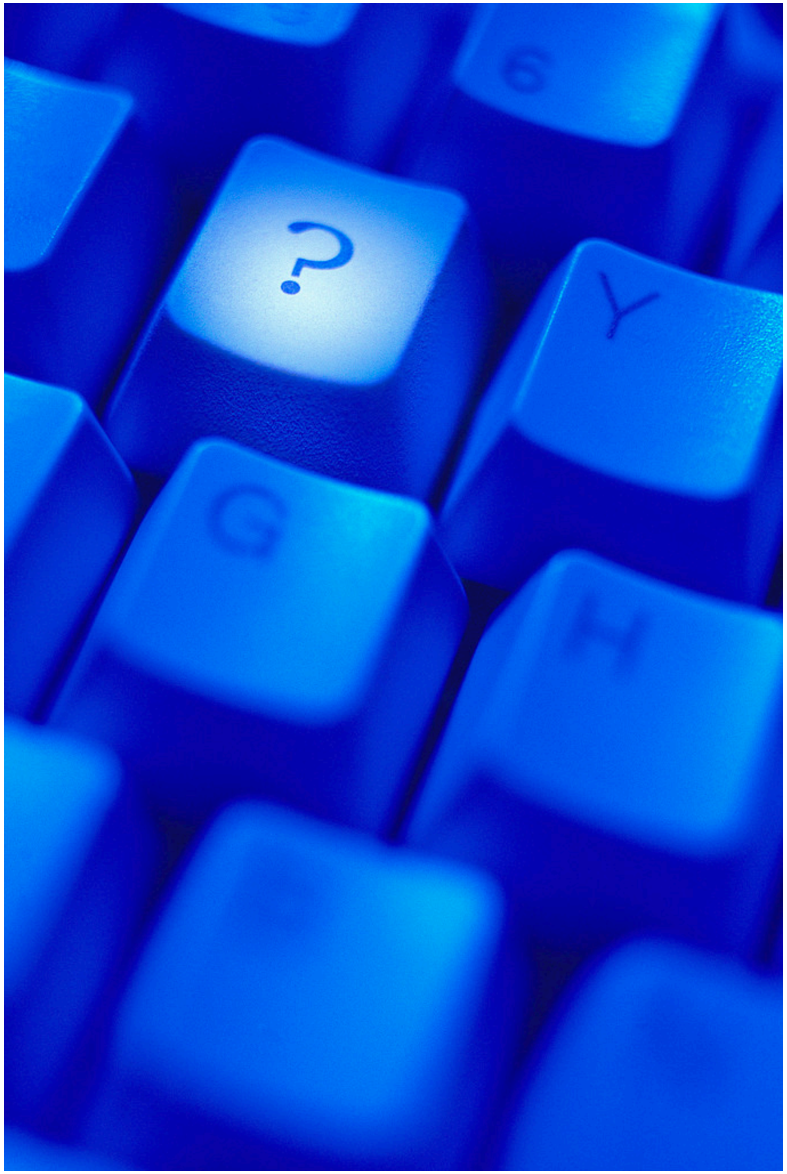
Rigid bus bar terminal (5 poles)



Generator's Main components

Adjustable Earth leakage protection
(Standard for G60 to G500)

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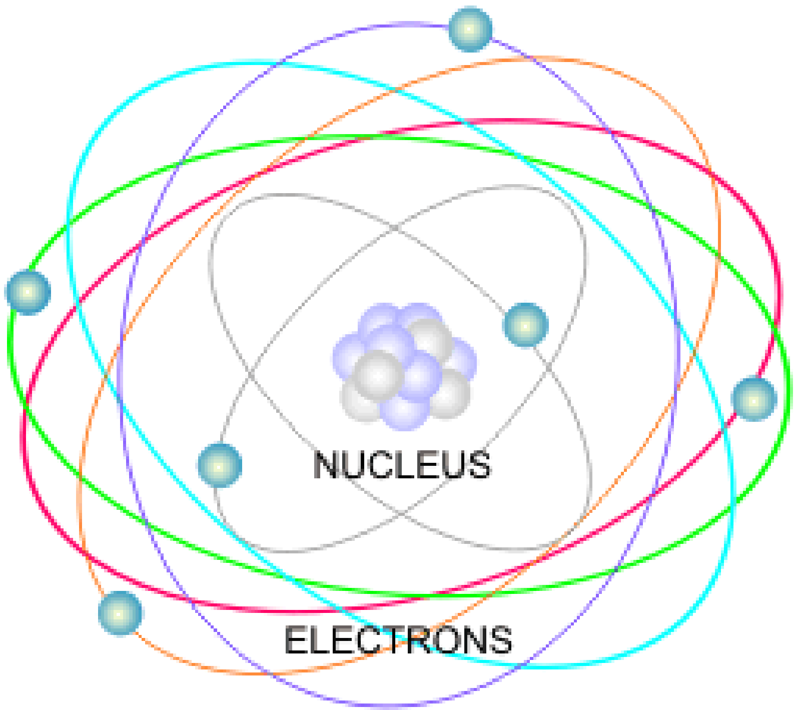
What is Electricity

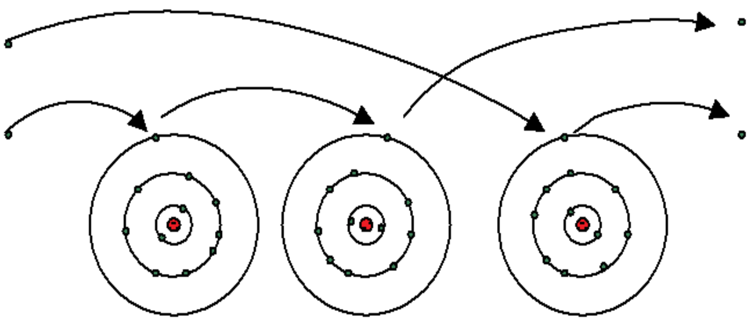
What is electricity?

- Every material on earth is made of electrons
- Every electron is made of a nucleus and electrons orbiting around the nucleus



What is electricity?

- Electricity is made of electrons freely travelling into a conductor
- Electrons are driven through a conductor by a potential difference – similar to a pressure difference in hydraulics

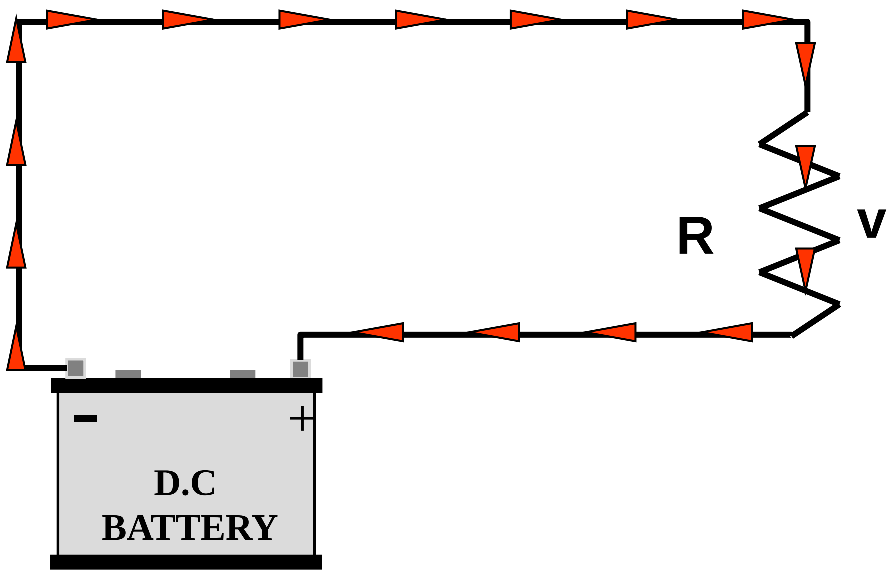


Single electrons in the outer, or valence, shell are free to move among similar atoms.

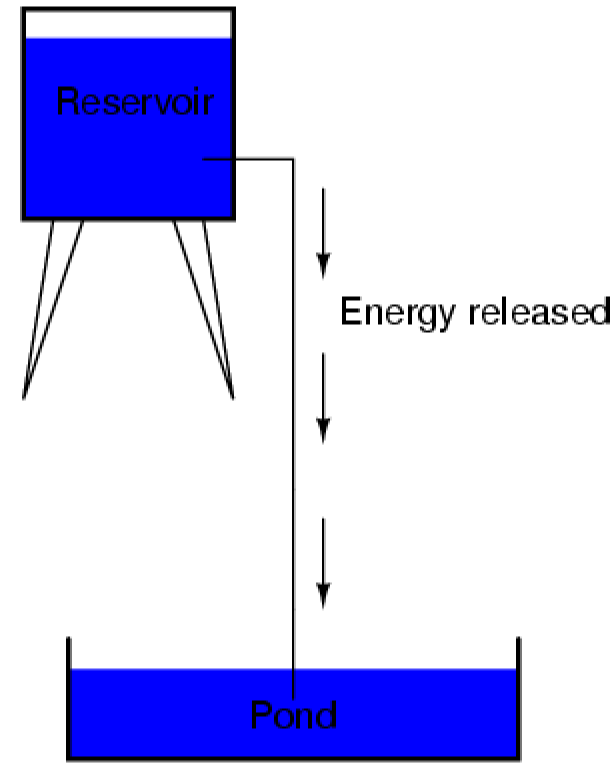
What is electricity?

- Electrons are driven through a conductor by a potential difference – similar to a pressure difference in hydraulics

Electrical potential difference



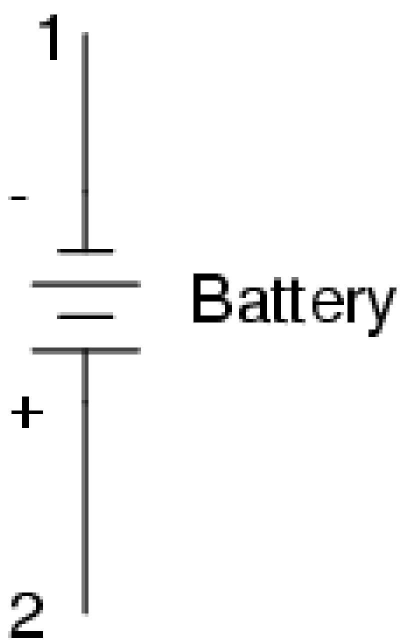
Potential difference water analogy



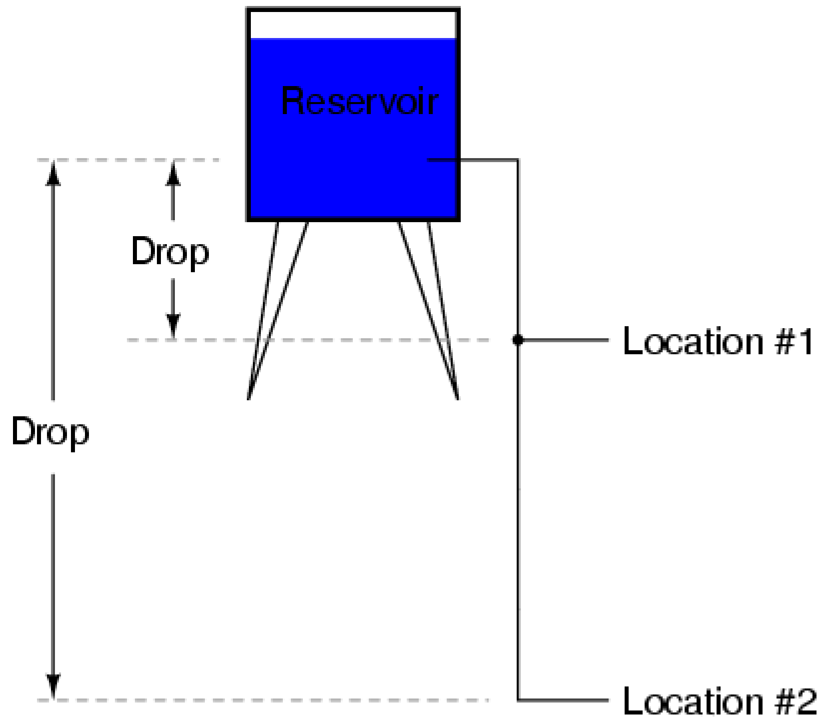
What is electricity?

- Voltage represents the potential difference – similar to the pressure difference in hydraulics

Electrical potential difference



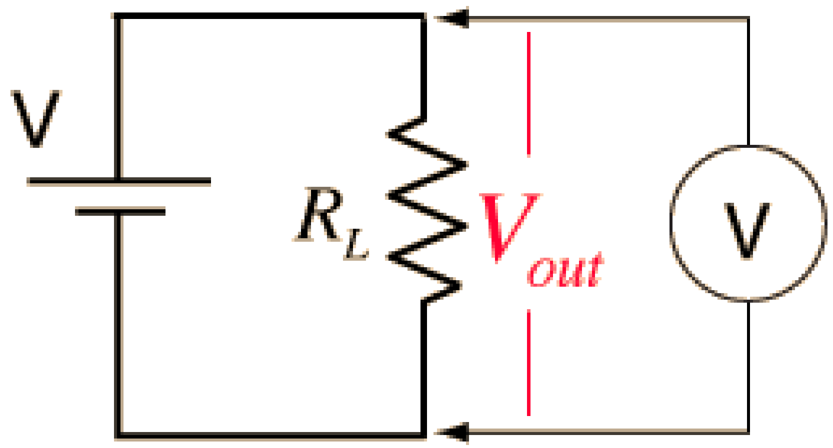
Potential difference water analogy



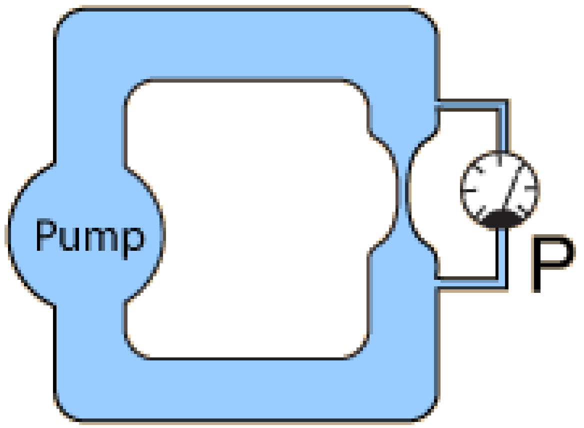
What is electricity?

Electrical potential difference: Volts

Hydraulics analogy: Pressure



A voltmeter is connected in parallel to measure the voltage change across a circuit element.



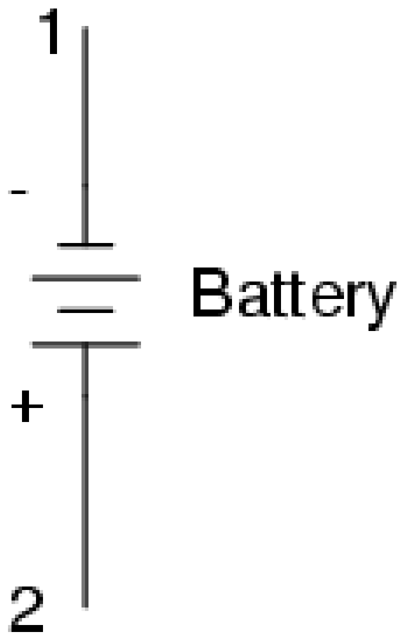
A pressure gauge is connected in parallel to measure the pressure drop across a region of resistance to flow.

A voltmeter is always connected in parallel with the part of the circuit for which you wish to measure voltage.

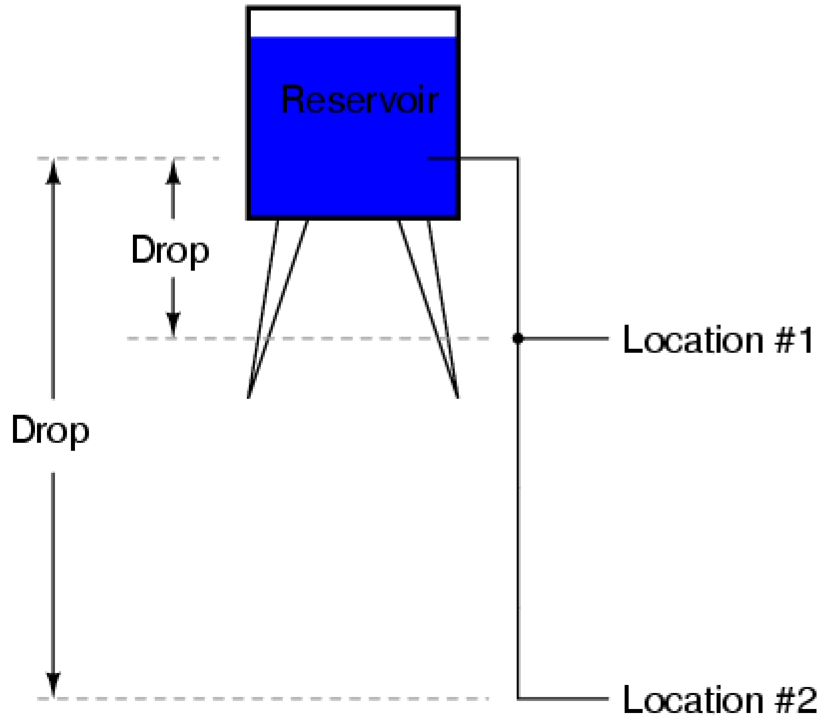
What is electricity?

Current represents the amount of electrons – similar to the flow in hydraulics

Electrical potential difference



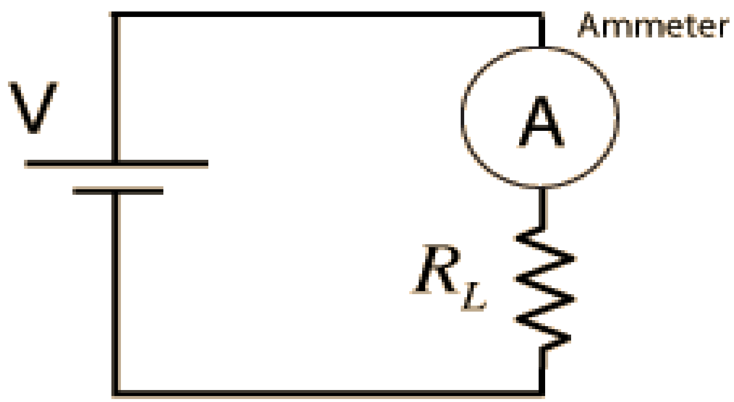
Potential difference water analogy



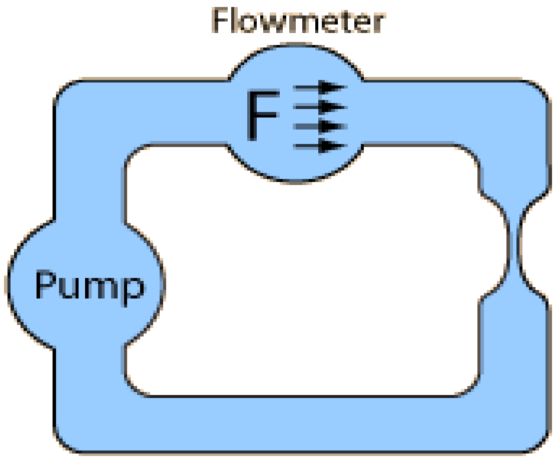
What is electricity?

Electrical flow: Amperes

Hydraulics Flow: liters/minute



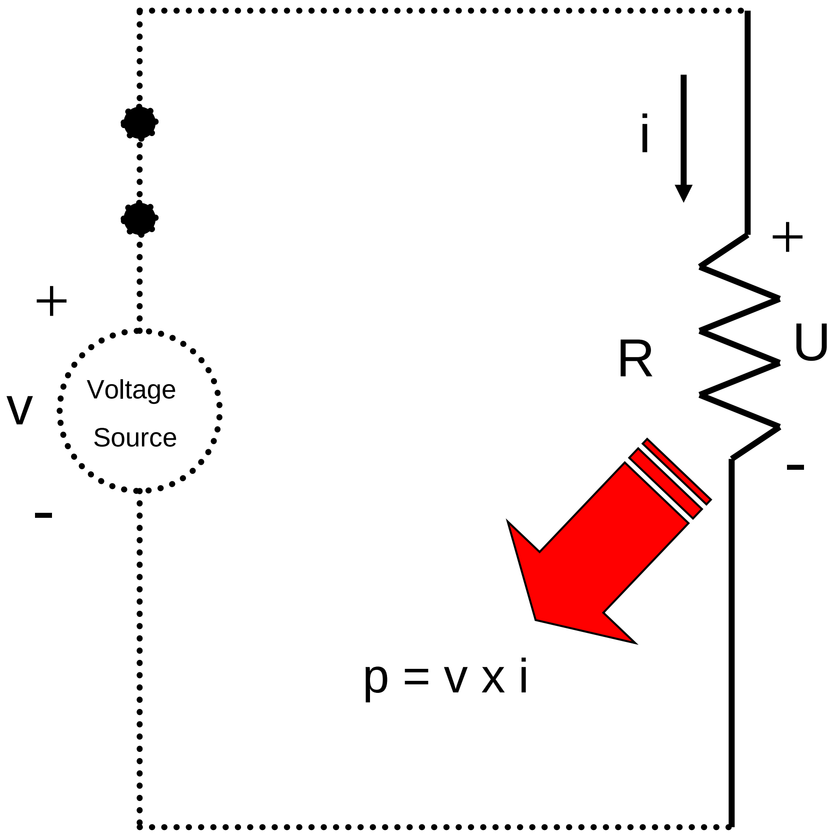
An ammeter is connected in series with a resistor to measure the current through the resistor.



A meter for volume flowrate must be in series to measure the flow, but must not appreciably affect the flow.

An ammeter is always connected in series with the part of the circuit in which you wish to measure current.

"Need to know" electrical concepts : Ohm's & power's law



Ohm's law

- Ohm's Law is the relationship between current, voltage and resistance, U = I x R
- Voltage drop across the resistor equals the product of the current and the resistance
- Voltage drop can be compared to pressure drop in a hydraulic circuit

Power's law

- P = U x I
- At any instant, power equals the product of the voltage and current
- Power in this example is said to be dissipated, implying energy consumption or use
- Power can be compared to pressure x flow in a hydraulic circuit

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Basic principles of current production

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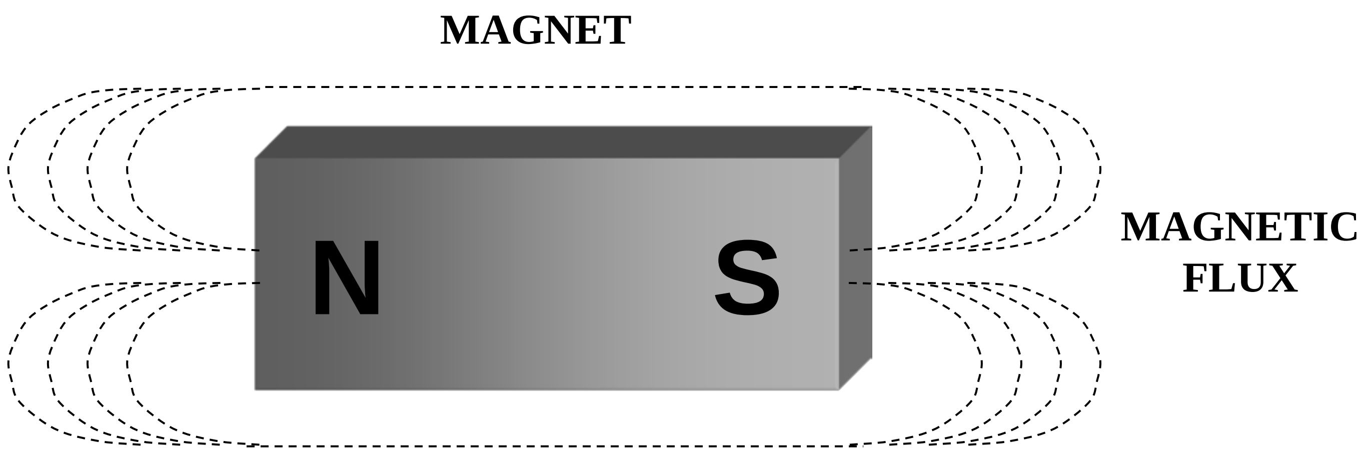
Course Objectives

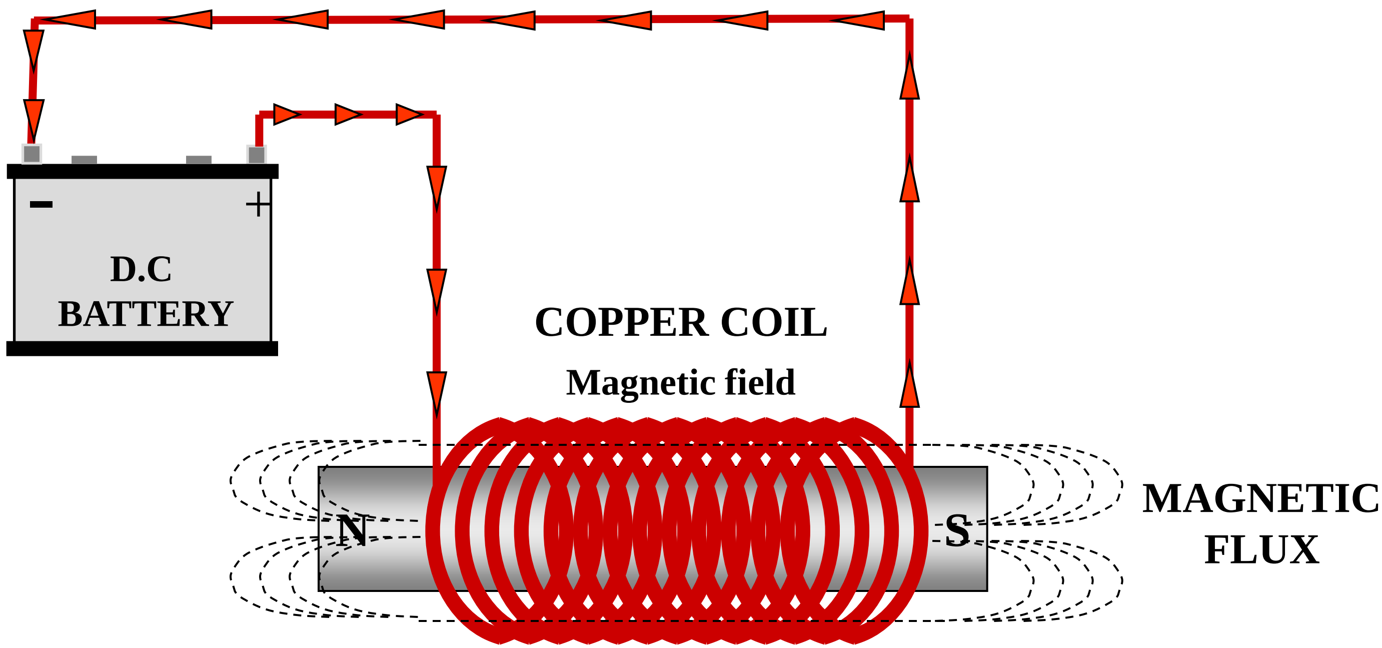
- **How is electricity created?**
- **How does a generator work?**

How is electricity created: Magnetism



Magnetism is the essential force which produces the *<u>electro motive force</u>* (EMF) in a Generator.

How is electricity created: Magnetism

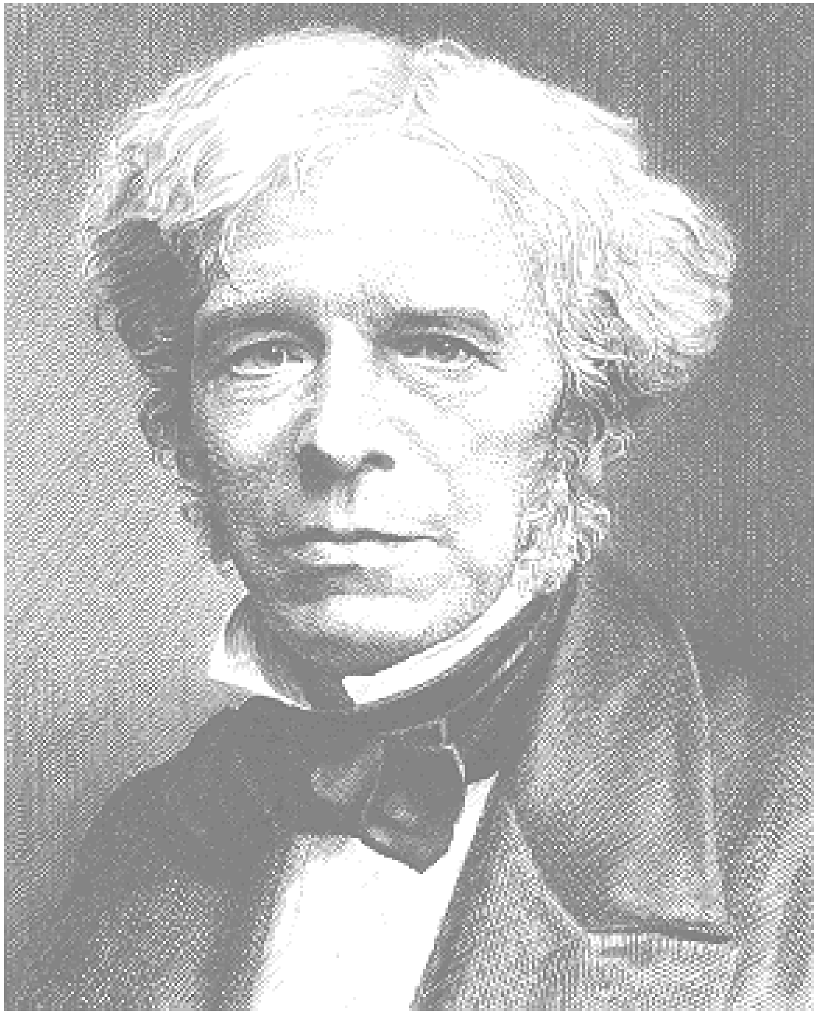


When a D.C supply is connected to a copper coil, current will flow (+ to -) through the coil, creating a magnetic field.
If an iron core is placed into the magnetic field, it will become magnetized.
The magnetic strength is determined by the D.C power in the coil.

This is the principle of ELECTRO-MAGNETISM, which is used to control the magnetic fields in an A.C Generators.

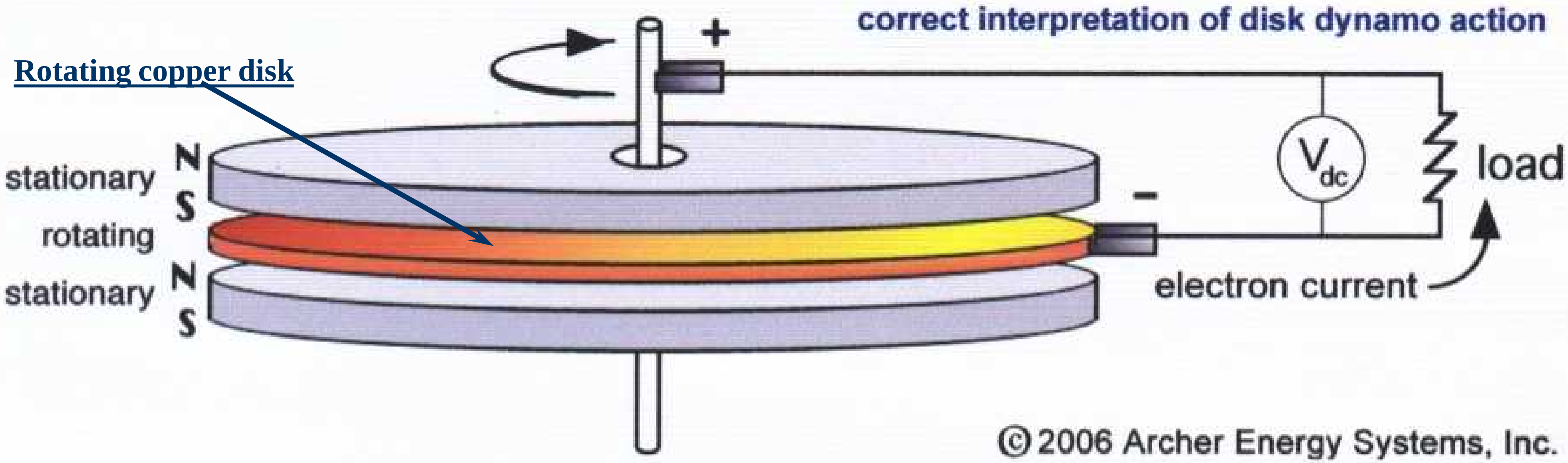
How is electricity created: Magnetism

<u>MICHAEL FARADAY 1791 - 1867</u>



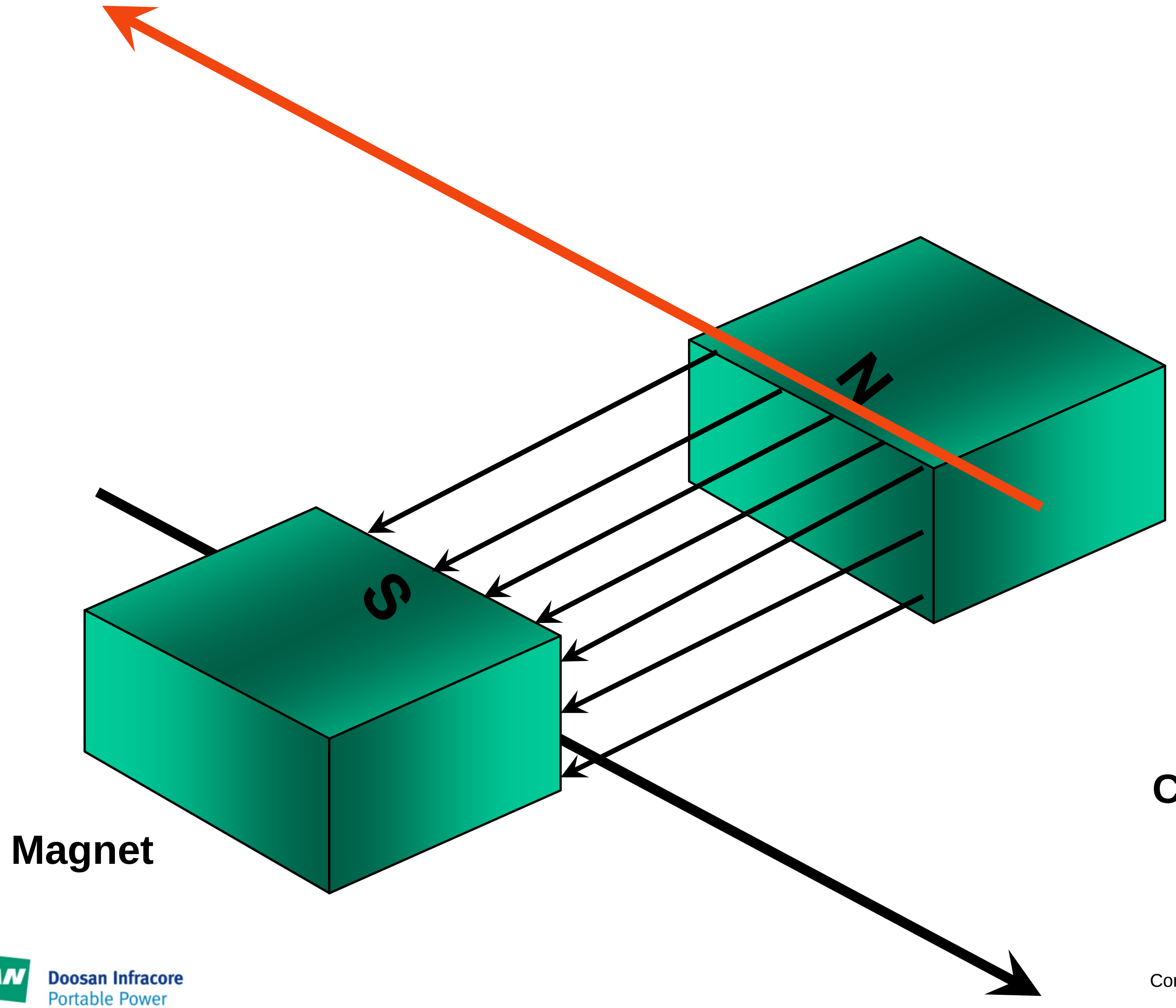
In 1831, Michael Faraday, using a simple magnet and a coil of wire, discovered that <u>mechanical energy</u> could be converted into <u>electrical energy</u>.

How is electricity created: Faraday generator

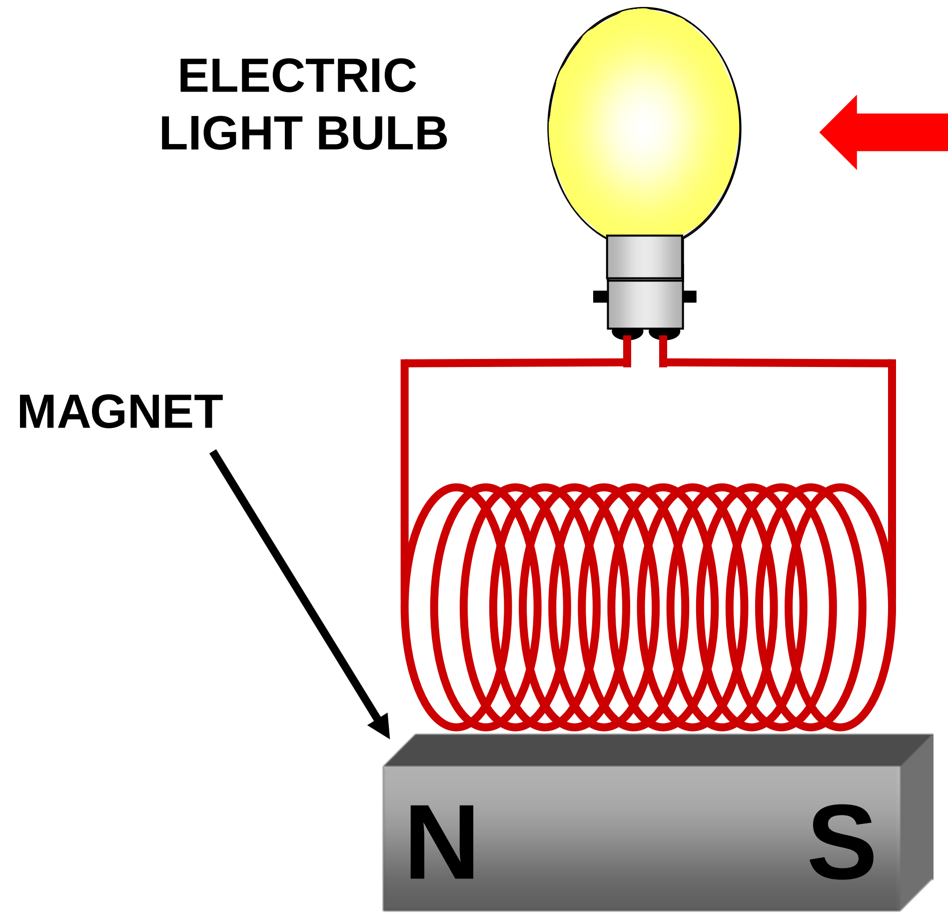


Faraday *induction dynamo* with a rotating conductive disk and stationary permanent magnet fields. Rotor back-torque proportional to load current is produced; rotating inertia is minimized, but motor power as shown is *not*. Magnets may be metallic (conductive) with very high residual induction.

How is electricity created: Magnetism



How is electricity created: Simple Faradey Generator



When the magnet is stationary, no action is being performed, so no electricity is generated.

When the magnet is moved passed the coil, this will generate the *electro motive force* (EMF or VOLTAGE) into the coil.

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How does an AC generator work ?

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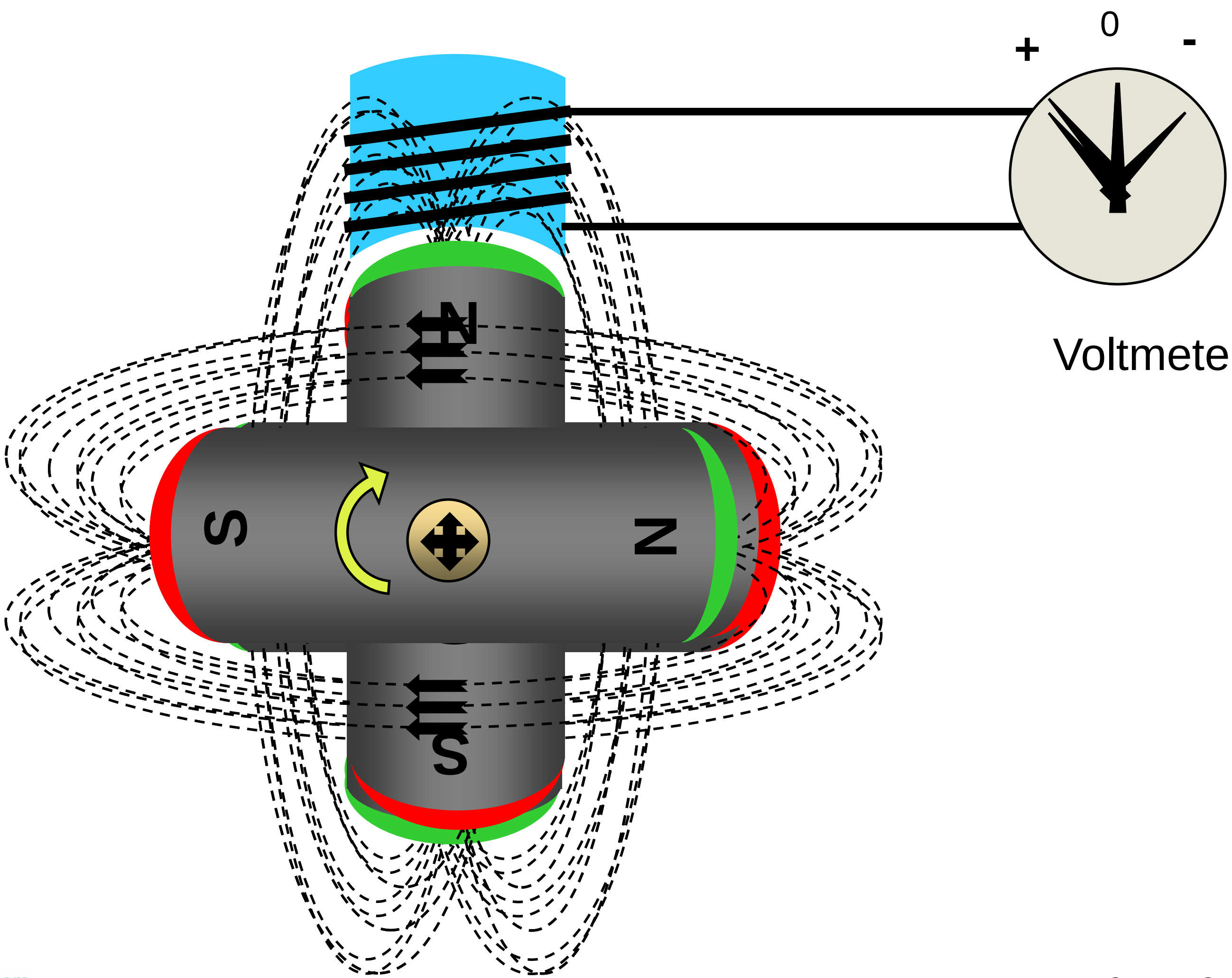
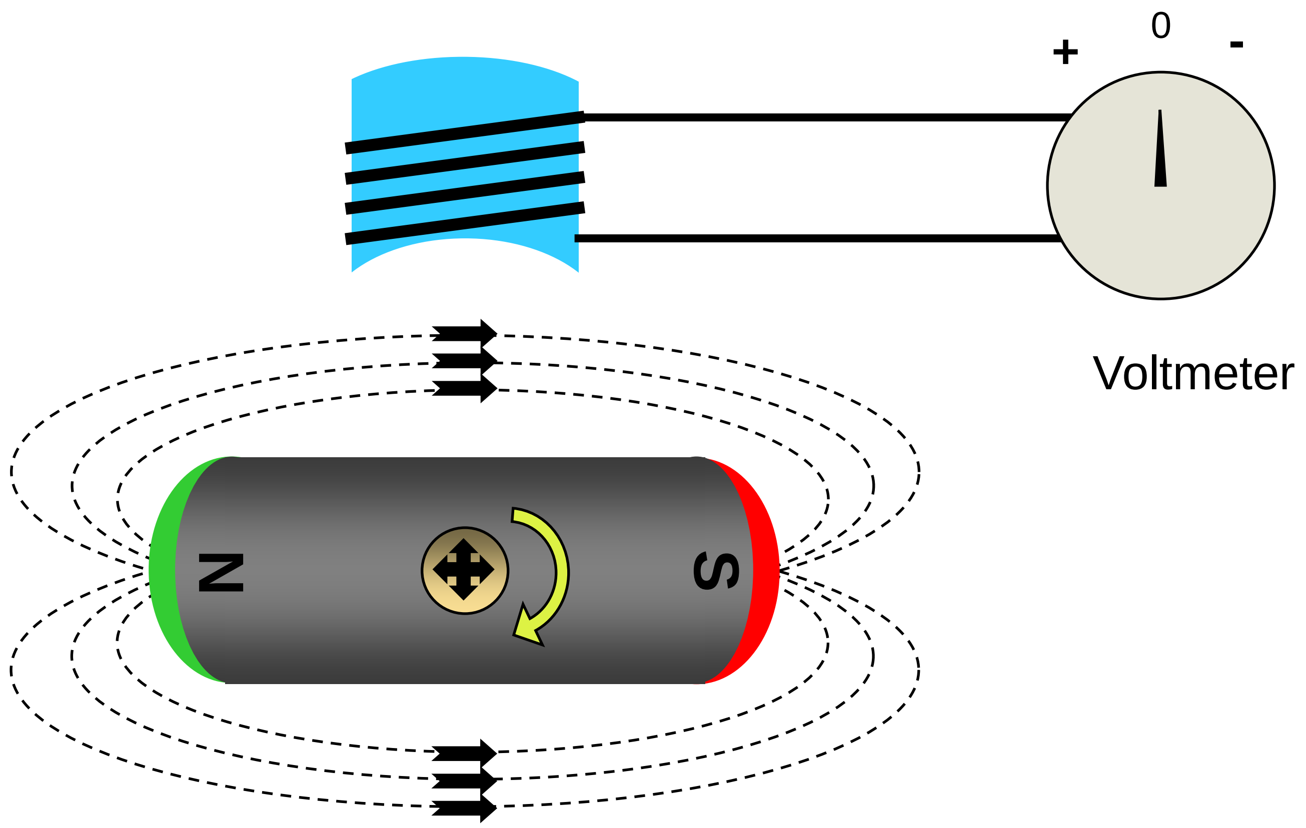
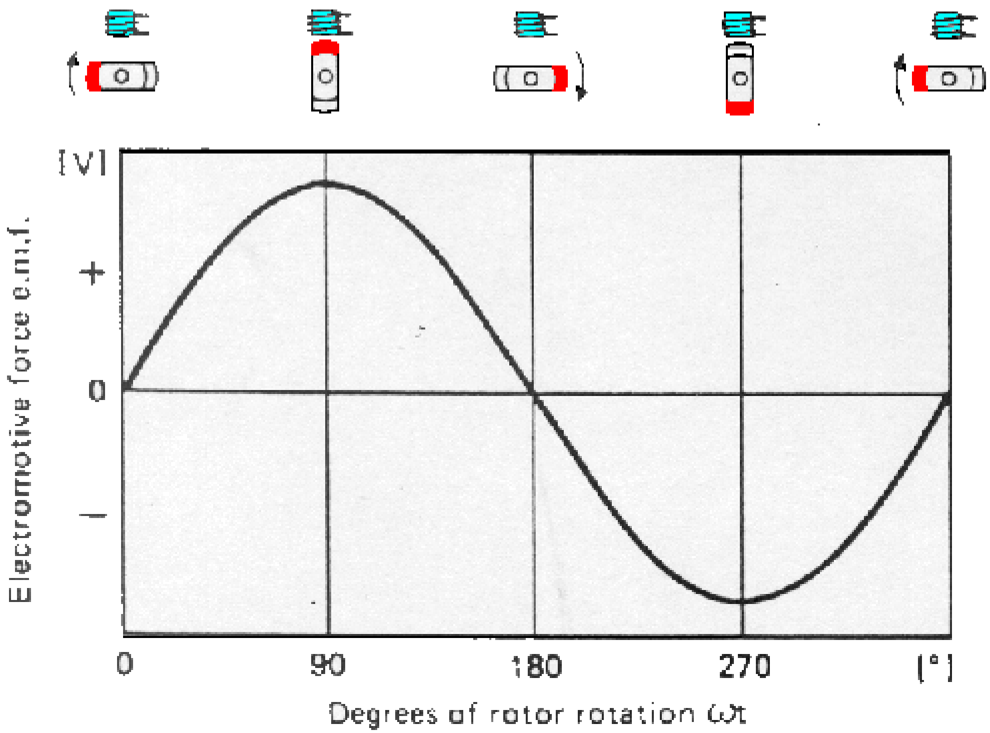
How does an AC generator work: basic principles



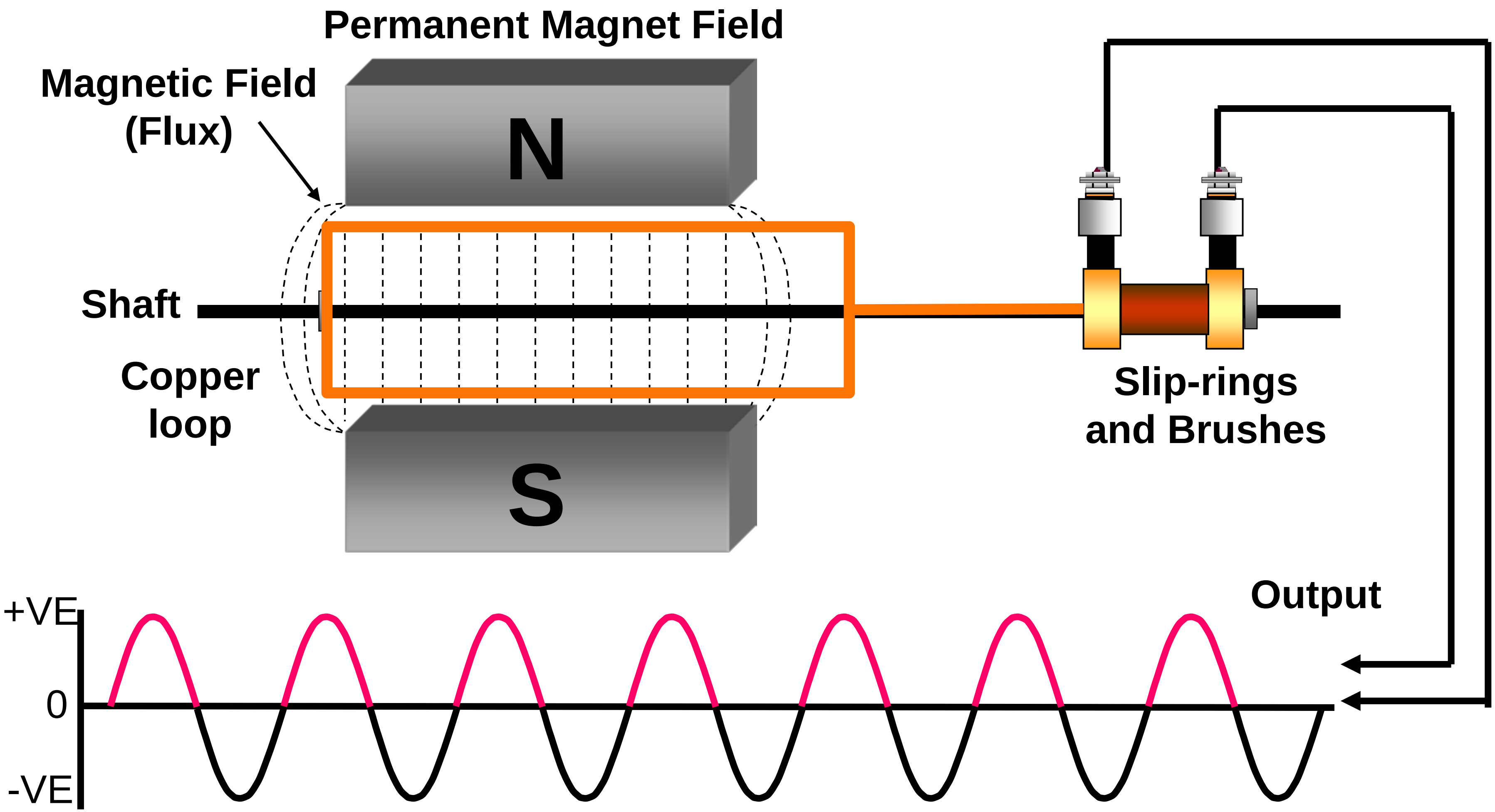
Refresh on electricity production principles



How does an AC generator work: basic principles

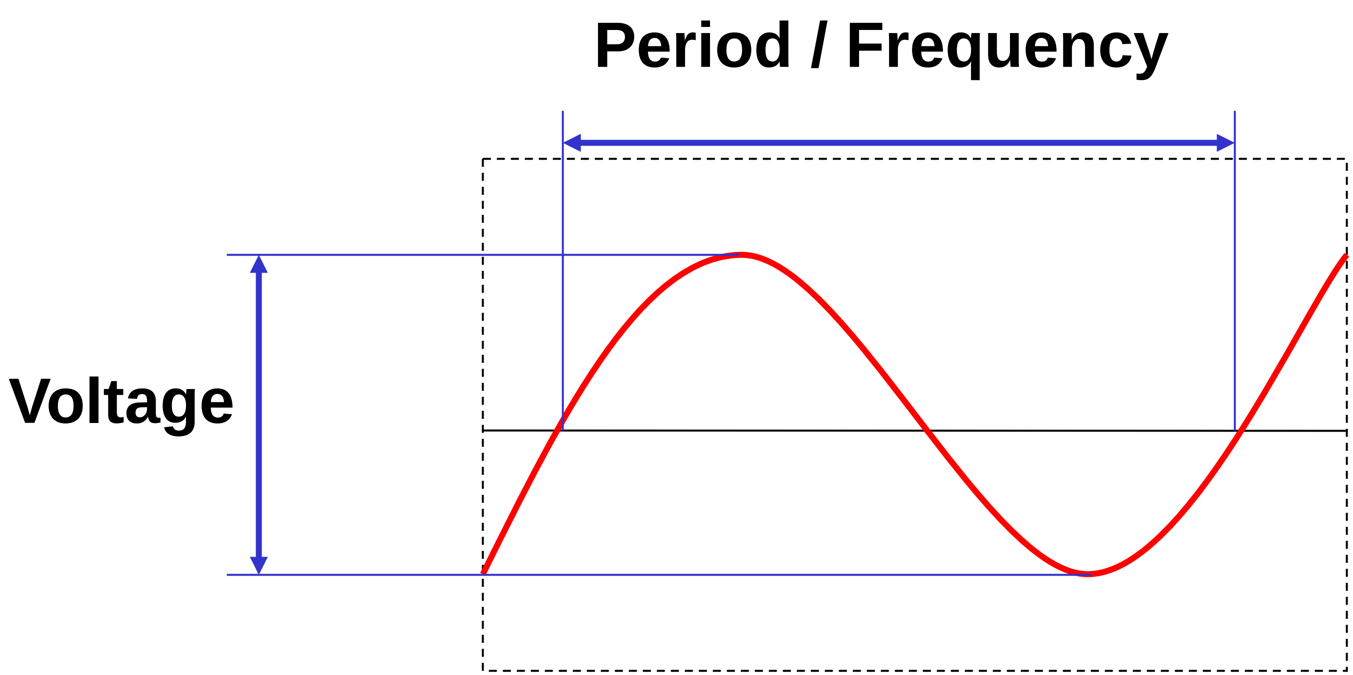


How does an AC generator work: basic principles



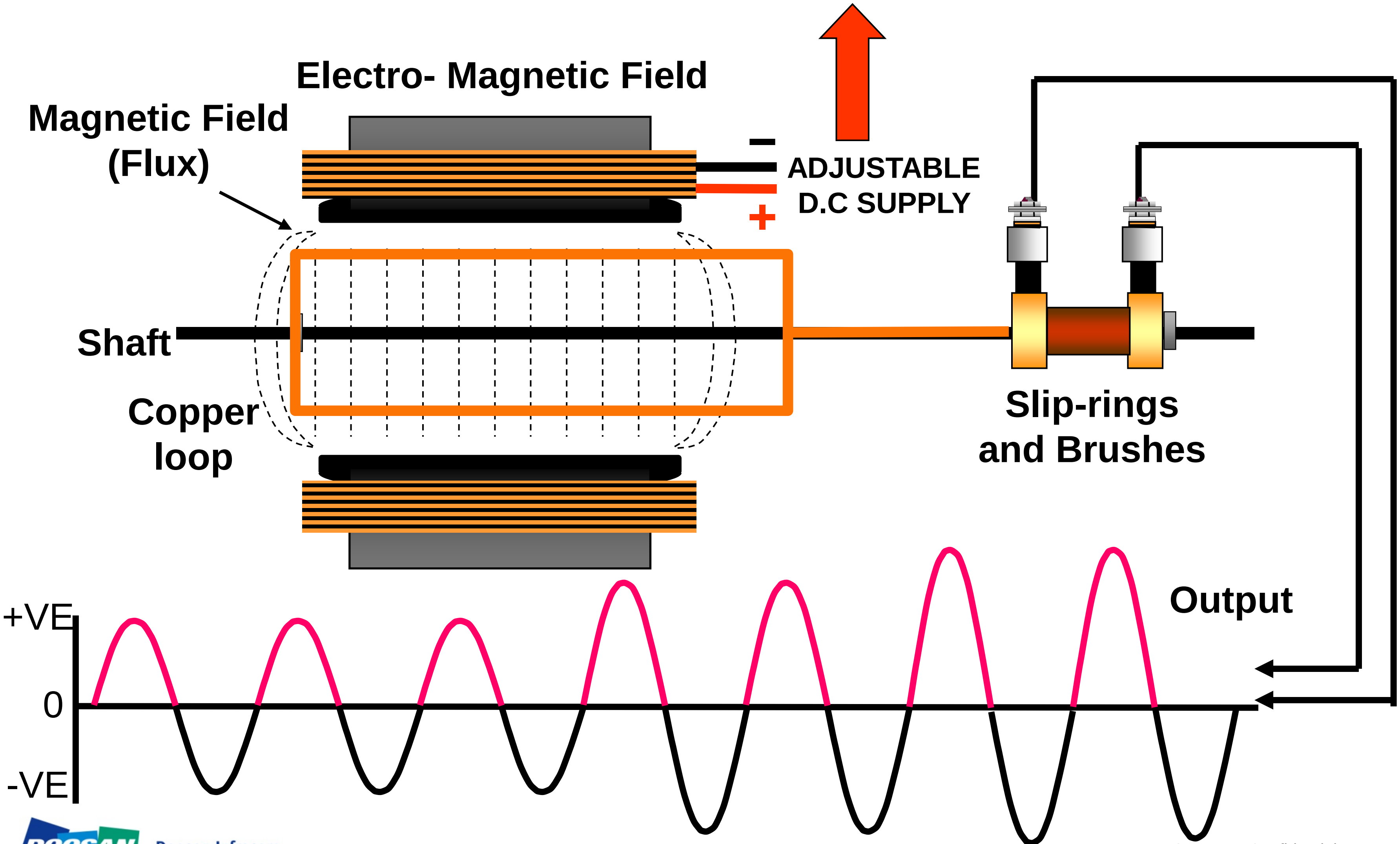
THE OUTPUT IS SINUSOIDAL, ALTERNATING CURRENT (A.C)

How does an AC generator work: basic principles

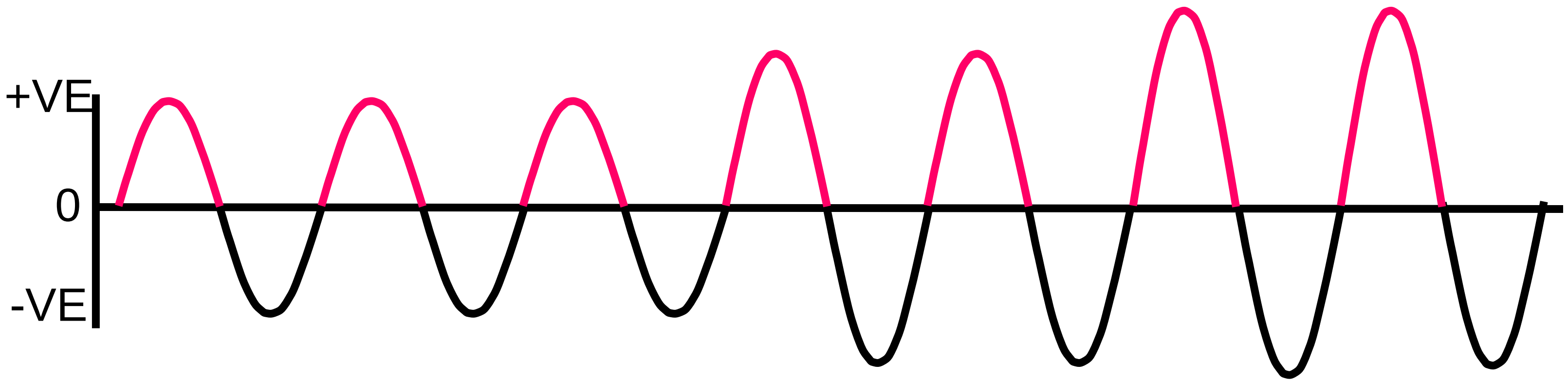


One Phase of a Generator

How does an AC generator work: basic principles



How does an AC generator work: basic principles



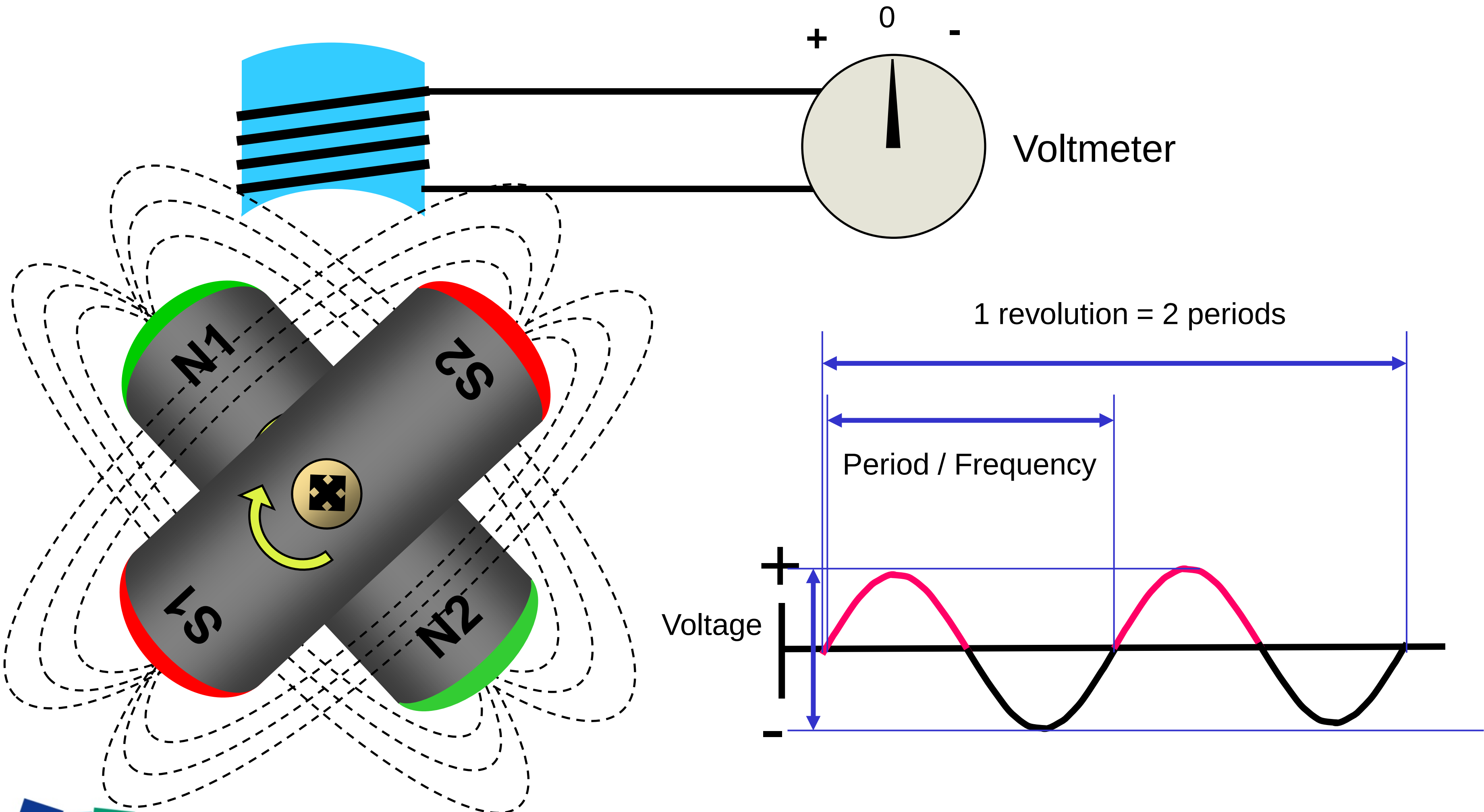
THE *__OUTPUT VOLTAGE__* CAN BE CONTROLLED BY ADJUSTING THE *__D.C. FIELD VOLTAGE__*

How does an AC generator work: Voltage

The output Voltage is a result of:

- **The strength of the magnetic field**
- **The length of conductors in the A.C armature**
- **The velocity (speed) of the conductors cutting the magnetic lines of force.**
- **The angle at which the conductor cuts the magnetic field**

How does an AC generator work: basic principles



How does an AC generator work: Frequency

- 50 Hz = 50 periods/second with 2poles rotor
  = 3000 periods / minute → 3000 rpm

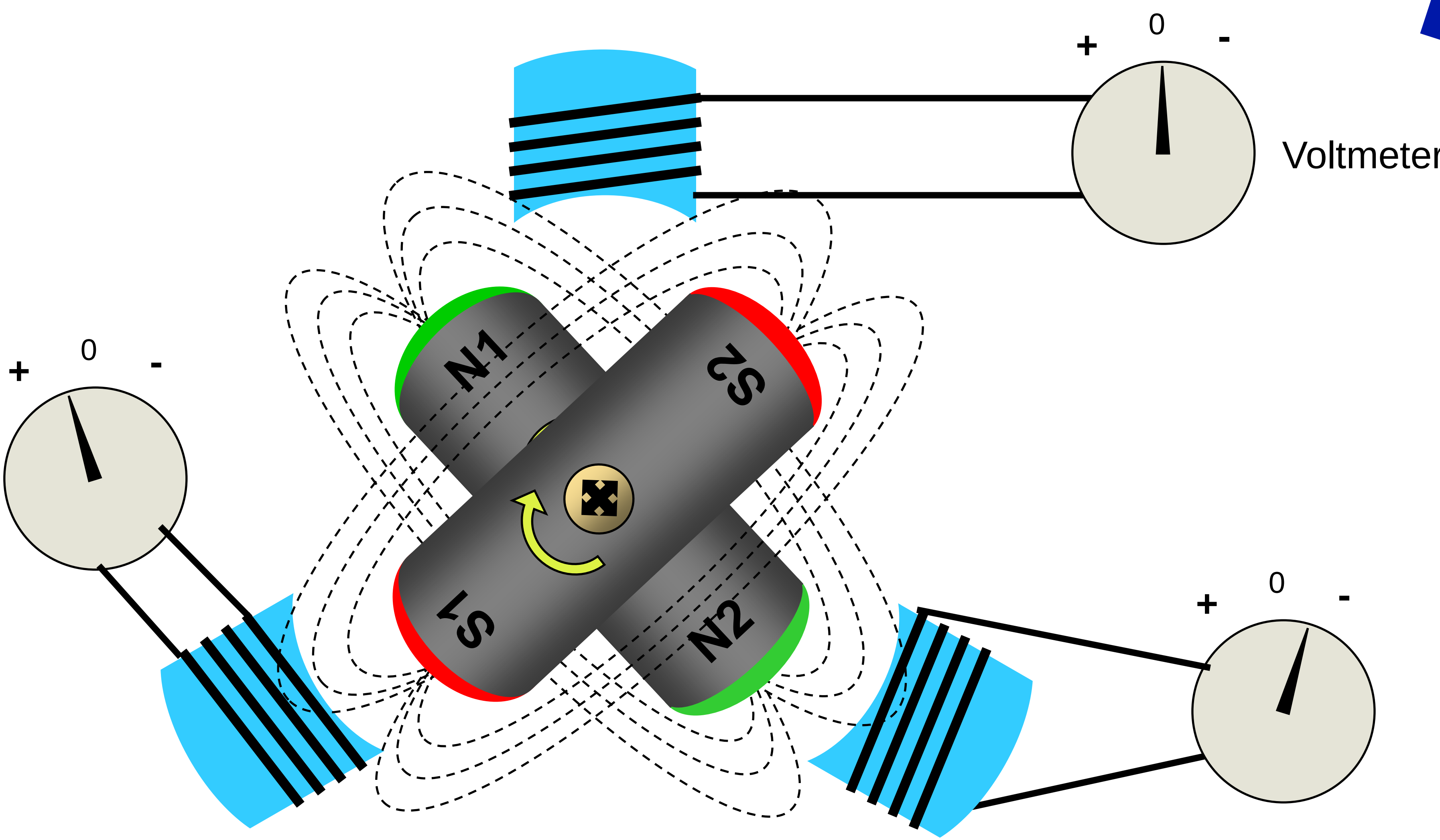
- 60 Hz = 60 periods/second with 2poles rotor
  = 3600 periods / minute → 3600 rpm

- Number of poles in our alternators = 4 → 2 periods / revolution

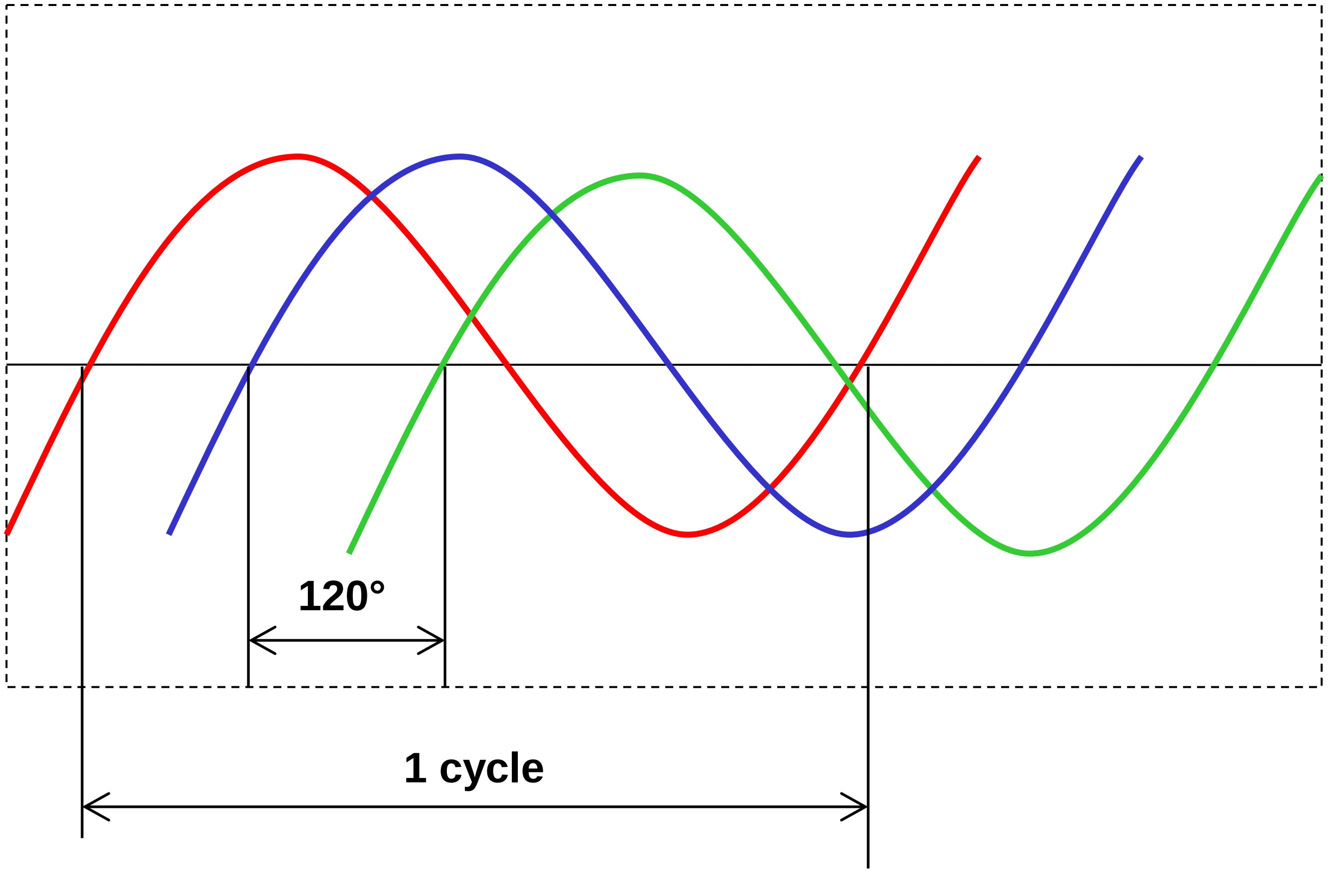
- Engine speed:

  - 50 Hz: 3000/2 = 1500 rpm
  - 60 Hz: 3600/2 = 1800 rpm

How does an AC generator work: 3 phases



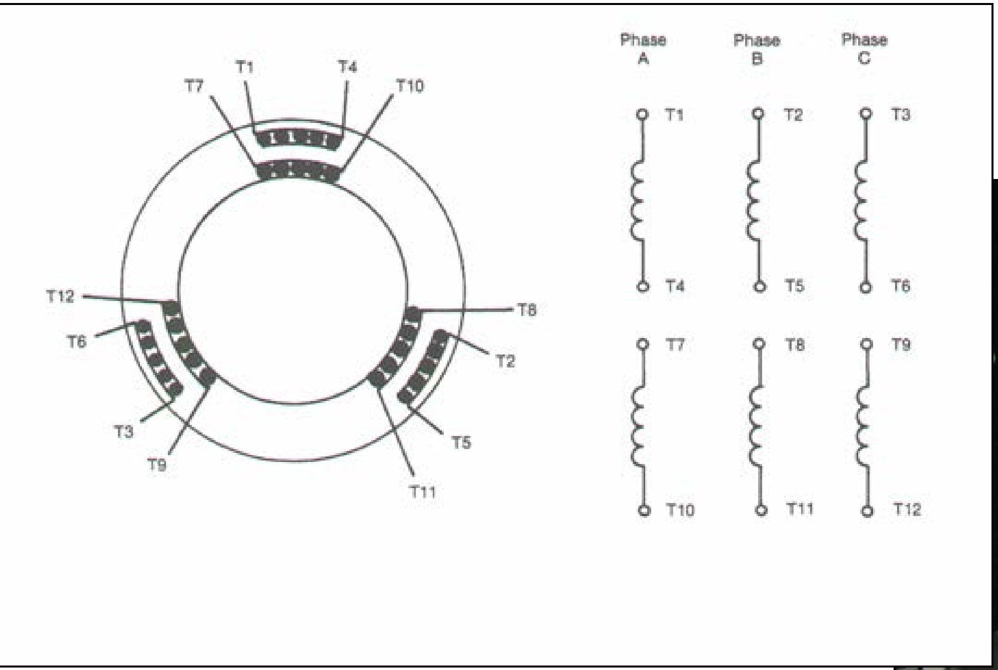
How does an AC generator work: basic principles

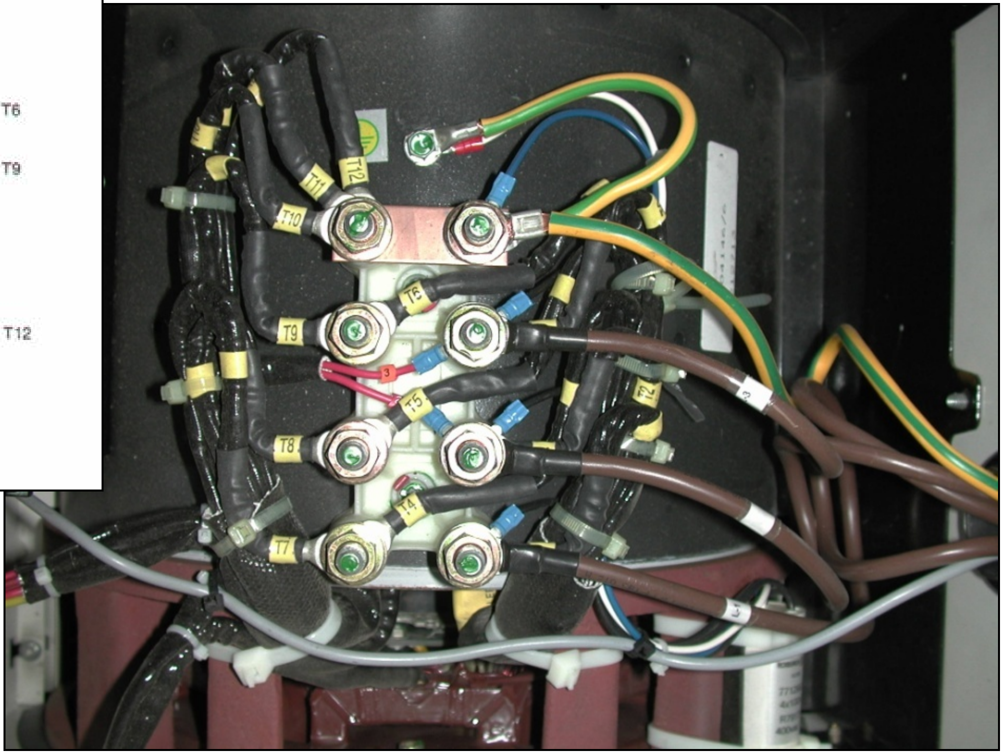


3 phase alternating current

How does an AC generator work: Stator windings

Standard generator alternator has a stator with a 6 windings & 12 wires re-connectable configuration allowing to configure 3-phases 230 or 400 VAC





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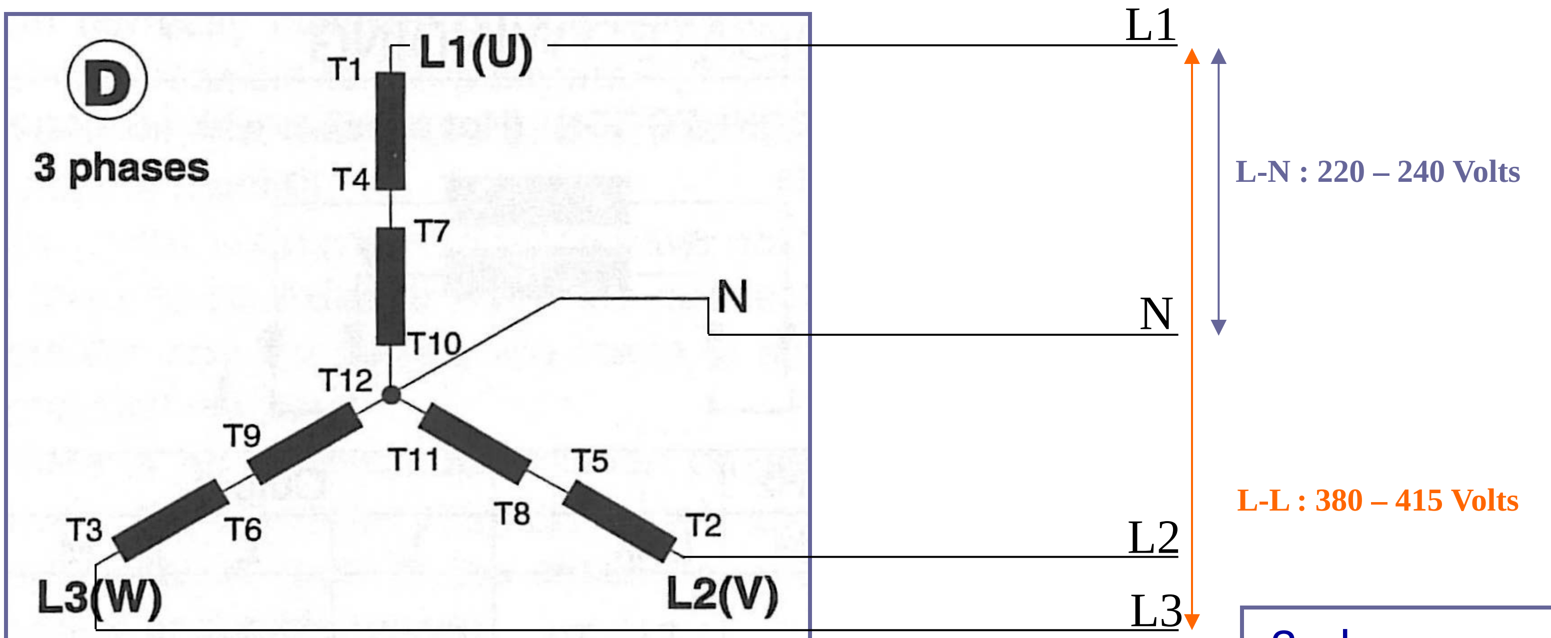
How does an AC generator work: Stator windings

Factory wye configuration : 380 – 415 Volts 3-phases connection



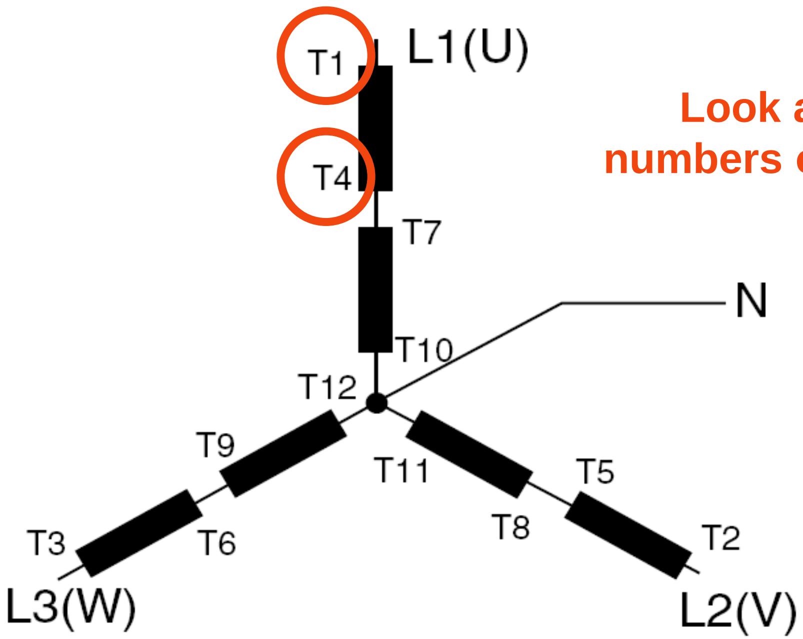
3-phases configuration

There are different ways to connect the neutral pole **(IT / TN-S / TN-C / TT)**

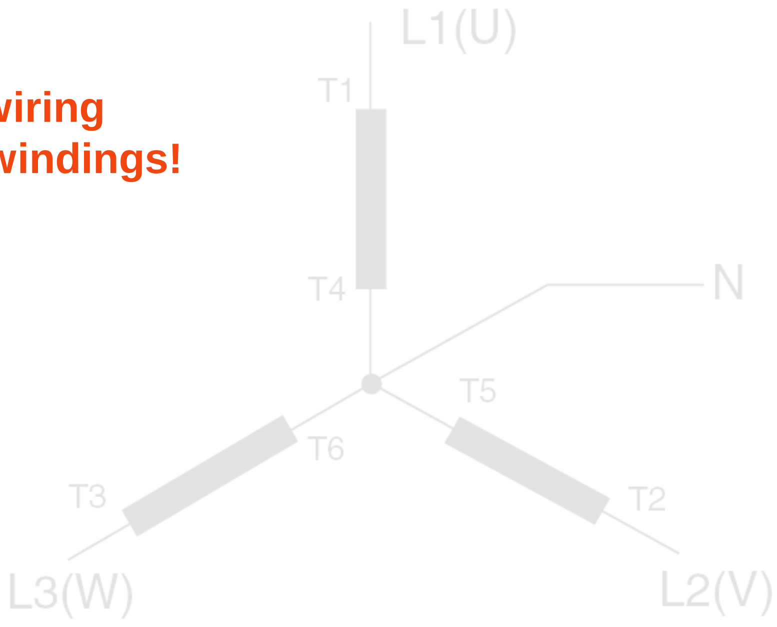
Factory configuration with
guaranteed operator protection

How does an AC generator work: Stator windings

Depending on the size and type of the generator, there are 3 or 6 windings



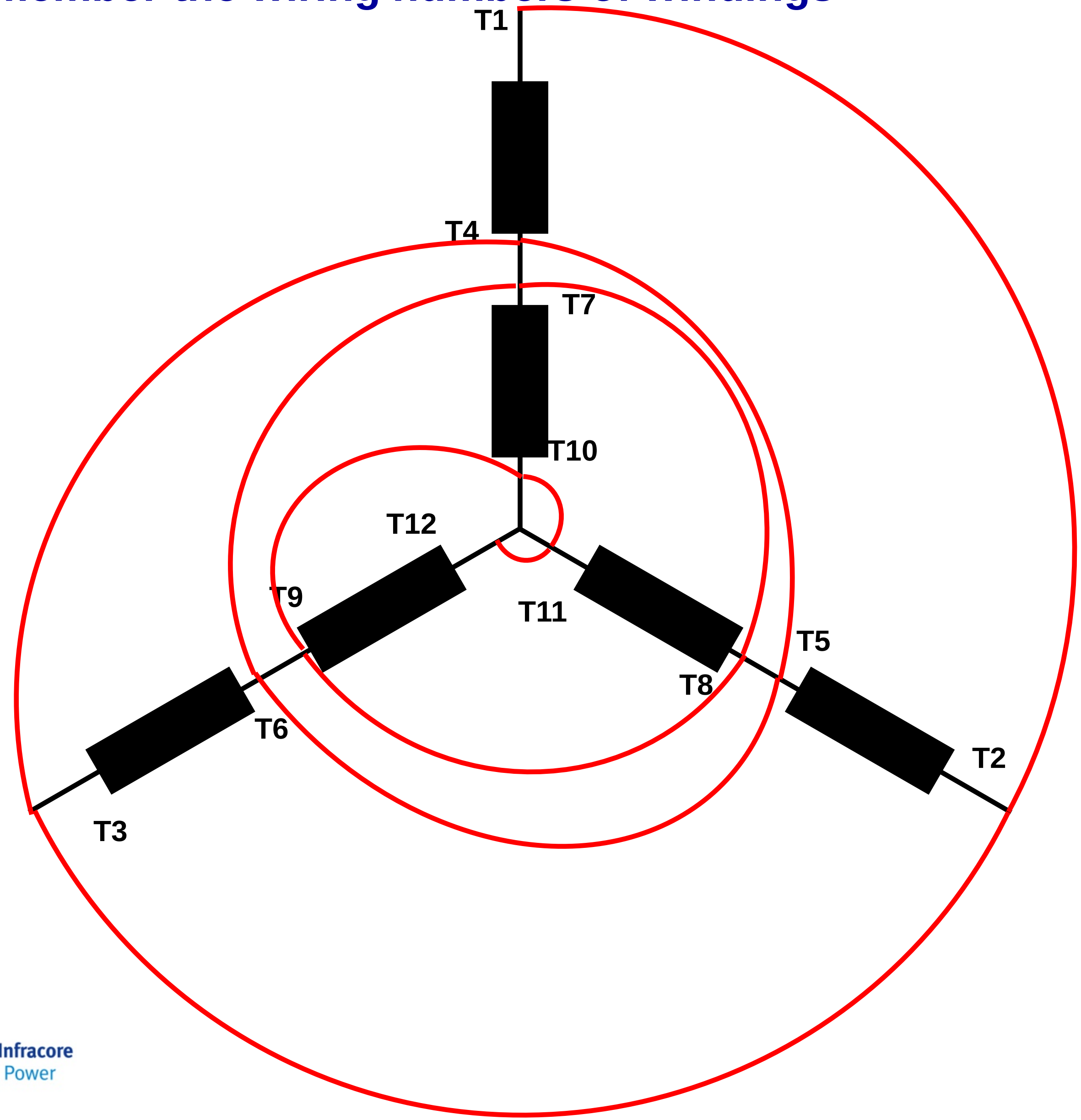
Look at the wiring numbers of the windings!



Doosan does not have any generators with 3 windings in his fleet!

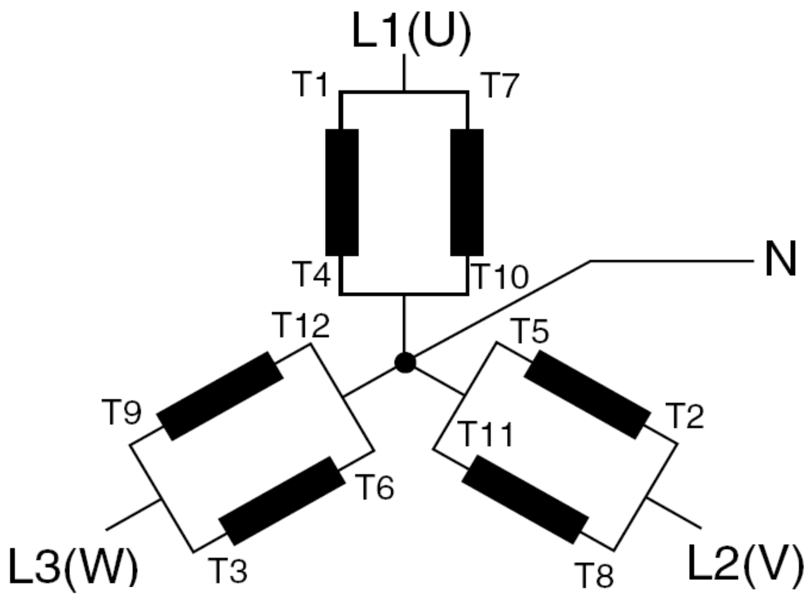
How does an AC generator work: Stator windings

• How to remember the wiring numbers of windings

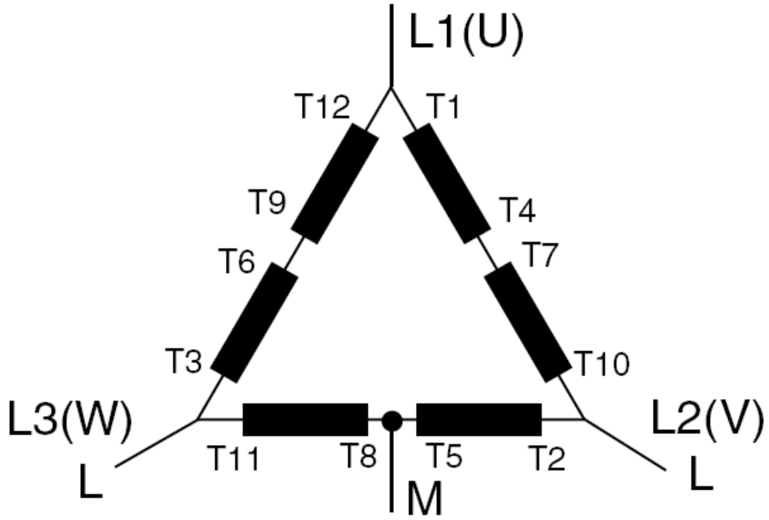


How does an AC generator work: Stator windings

With 6 windings (or 12 wire) generators we have the ability to change the output voltage by changing the configuration of the windings.



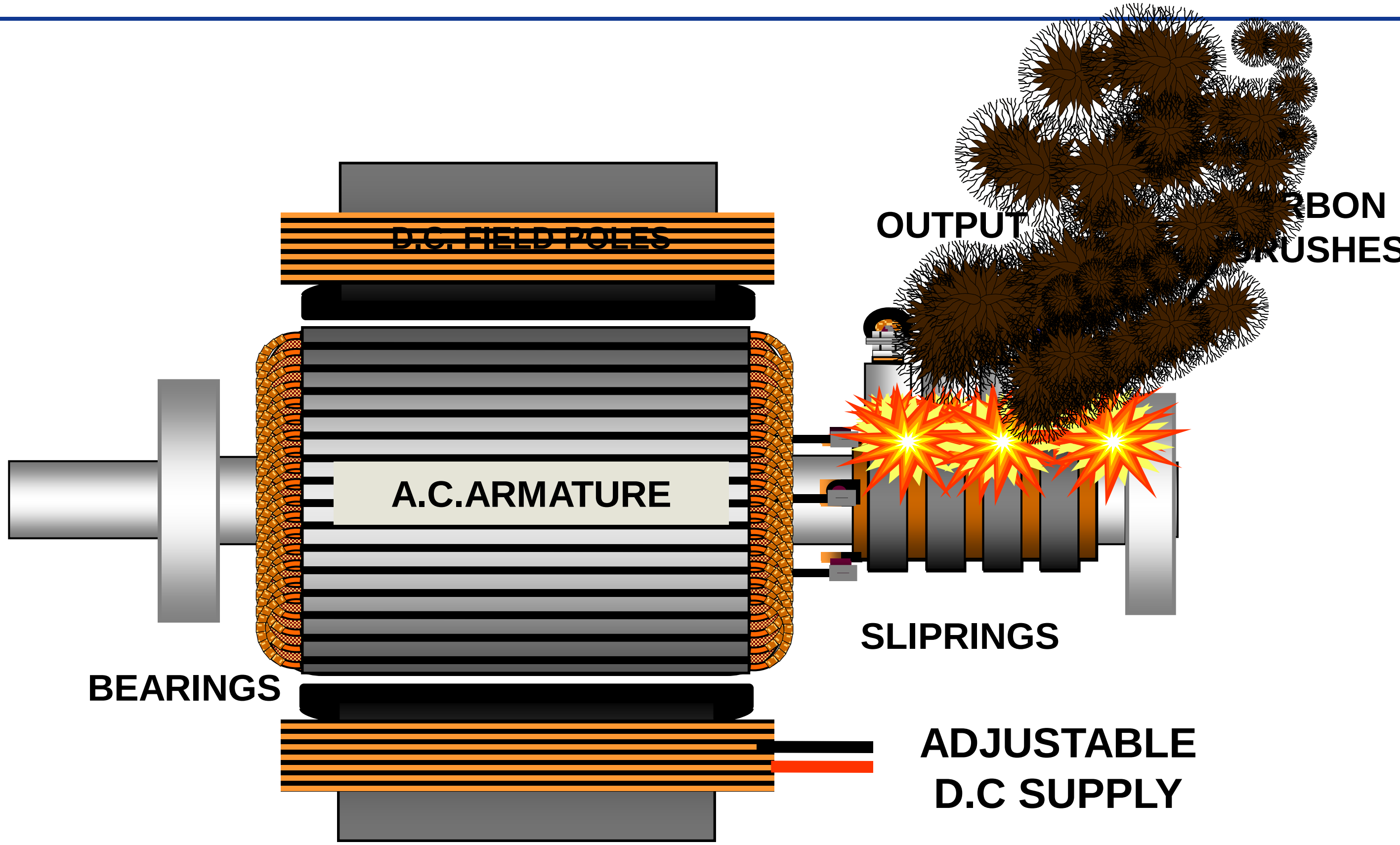
Parallel - Star



Delta

It 's advisable to choose the Delta-configuration because the max. voltage in Parallel-star is limited to 220 Volt!

How does an AC generator work: basic principles



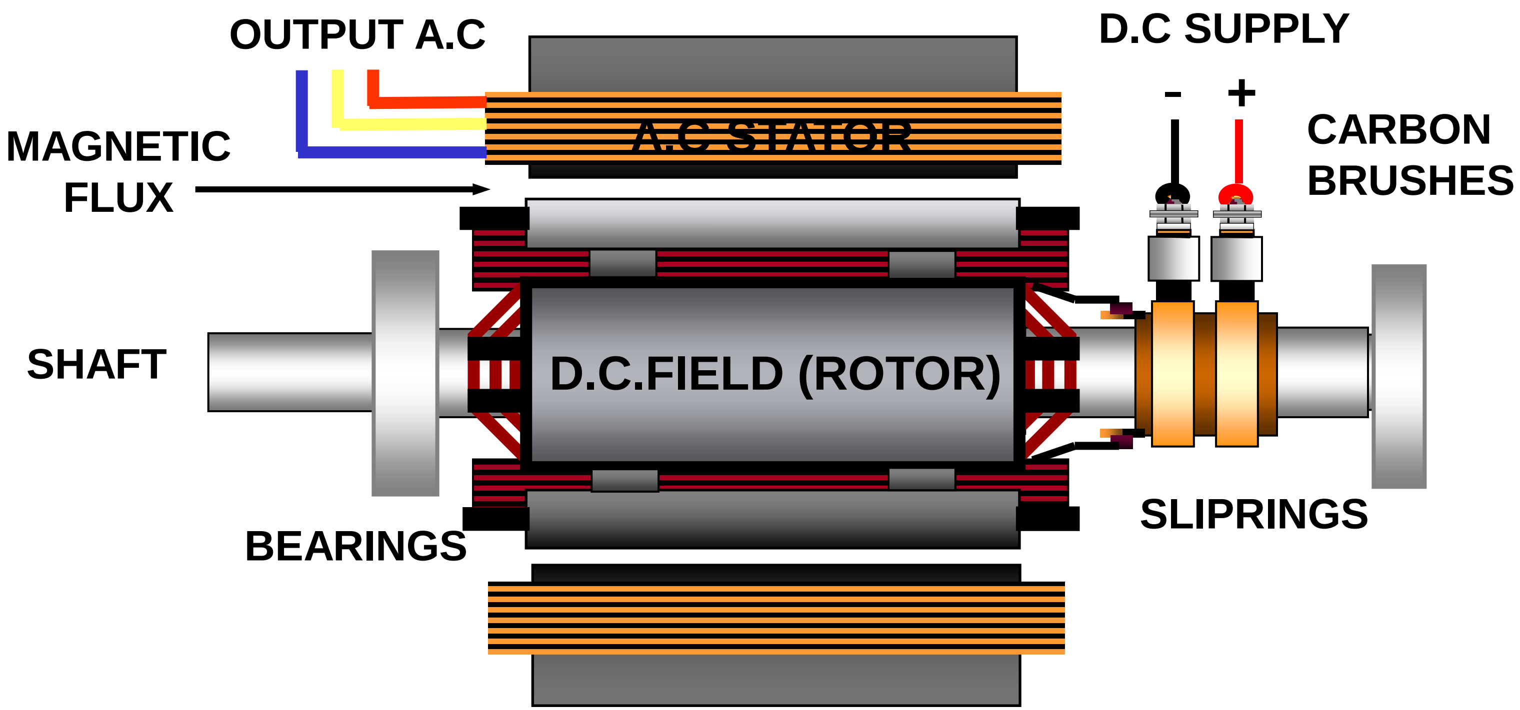
30 years ago, A.C Generators were designed with SLIPRINGS and CARBON BRUSHES

These had a tendency to wear out, and burn, with vibration or transient load currents.

Therefore Leroy Somer switched over to Brushless Generator design

How does an AC generator work: basic principles

How does an AC generator work: basic principles



- Generators were then equipped with a rotating field (rotor), which was supplied with D.C via two slip-rings.
- The output is taken from the static A.C windings (Stator),
- This design is still popular today, as the rotating field is easier to design and more economical to manufacture than a rotating armature.
- The 'BRUSHLESS GENERATOR' is similar in design, and became popular in the late 1960's, following the invention of the SILICON DIODE.

How does an AC generator work: basic principles

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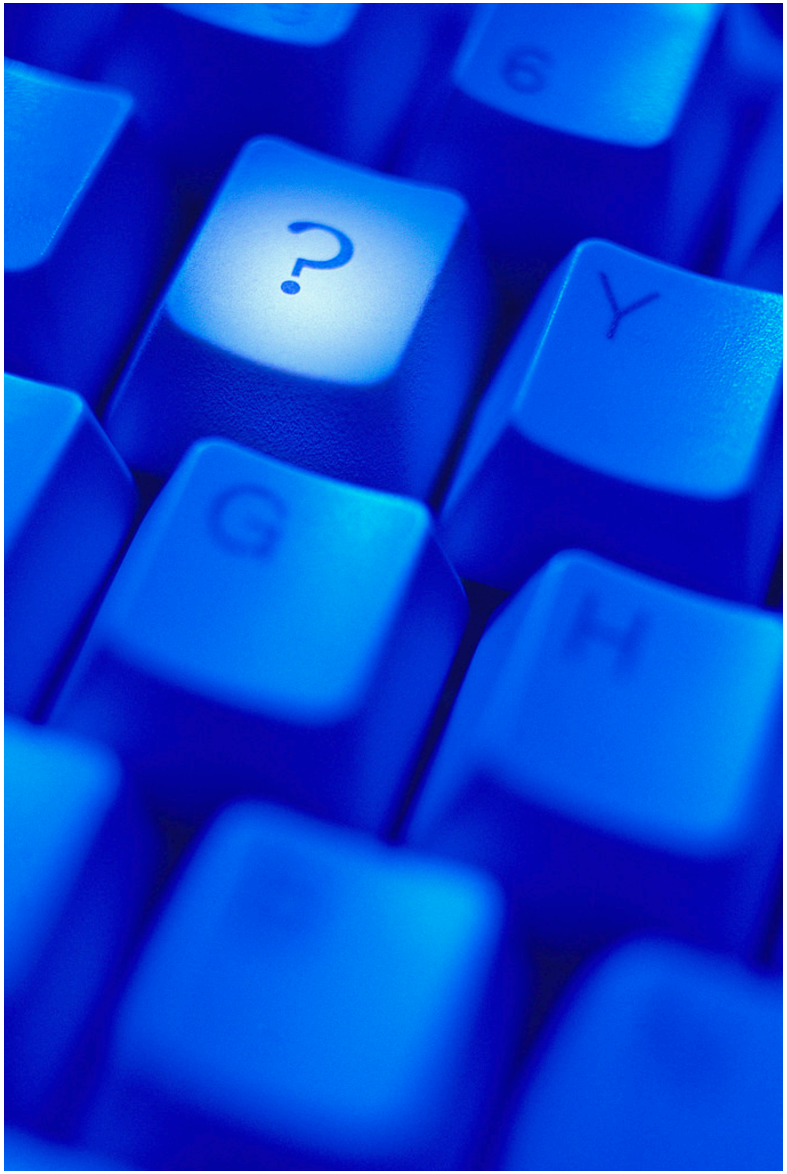
How does an AC generator work: basic principles



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Service training: Generators

How does an AC generator work: The excitation

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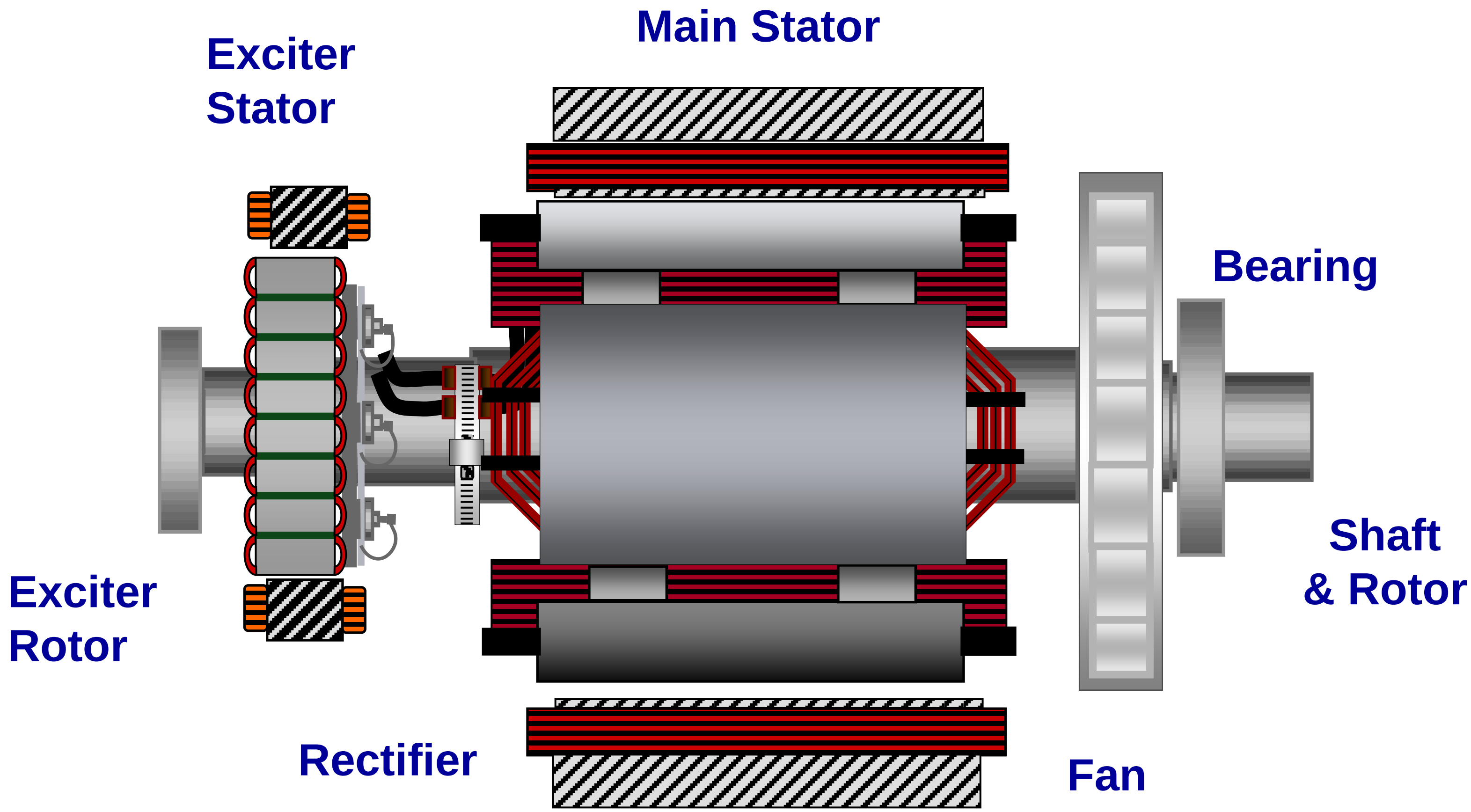
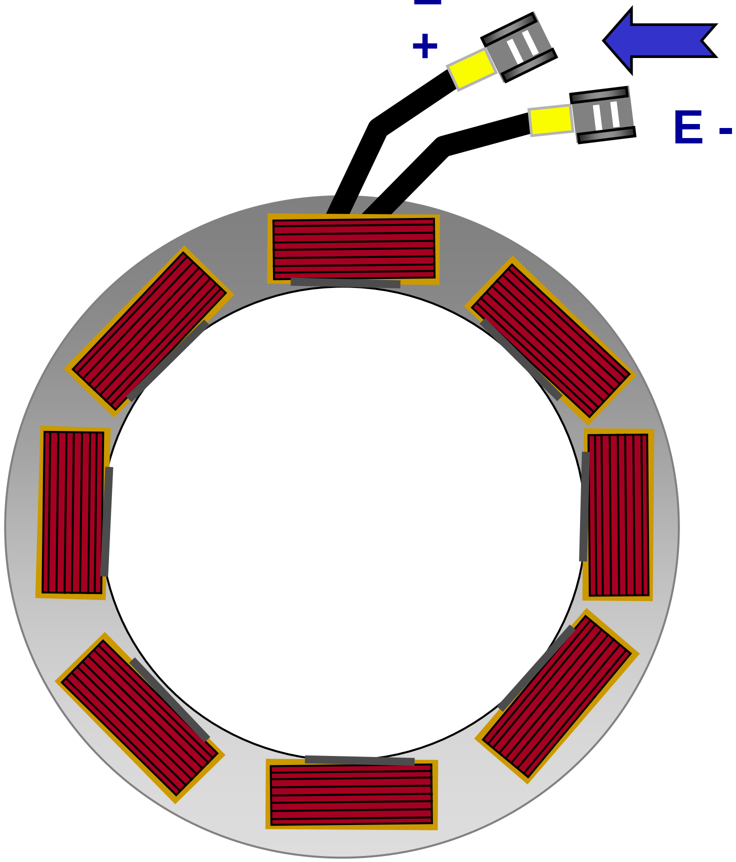
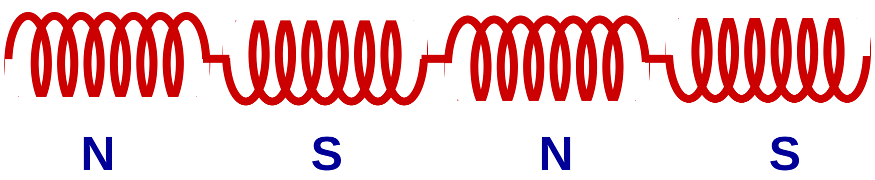
How does an AC generator work: Excitation System



How does an AC generator work: Excitor stator

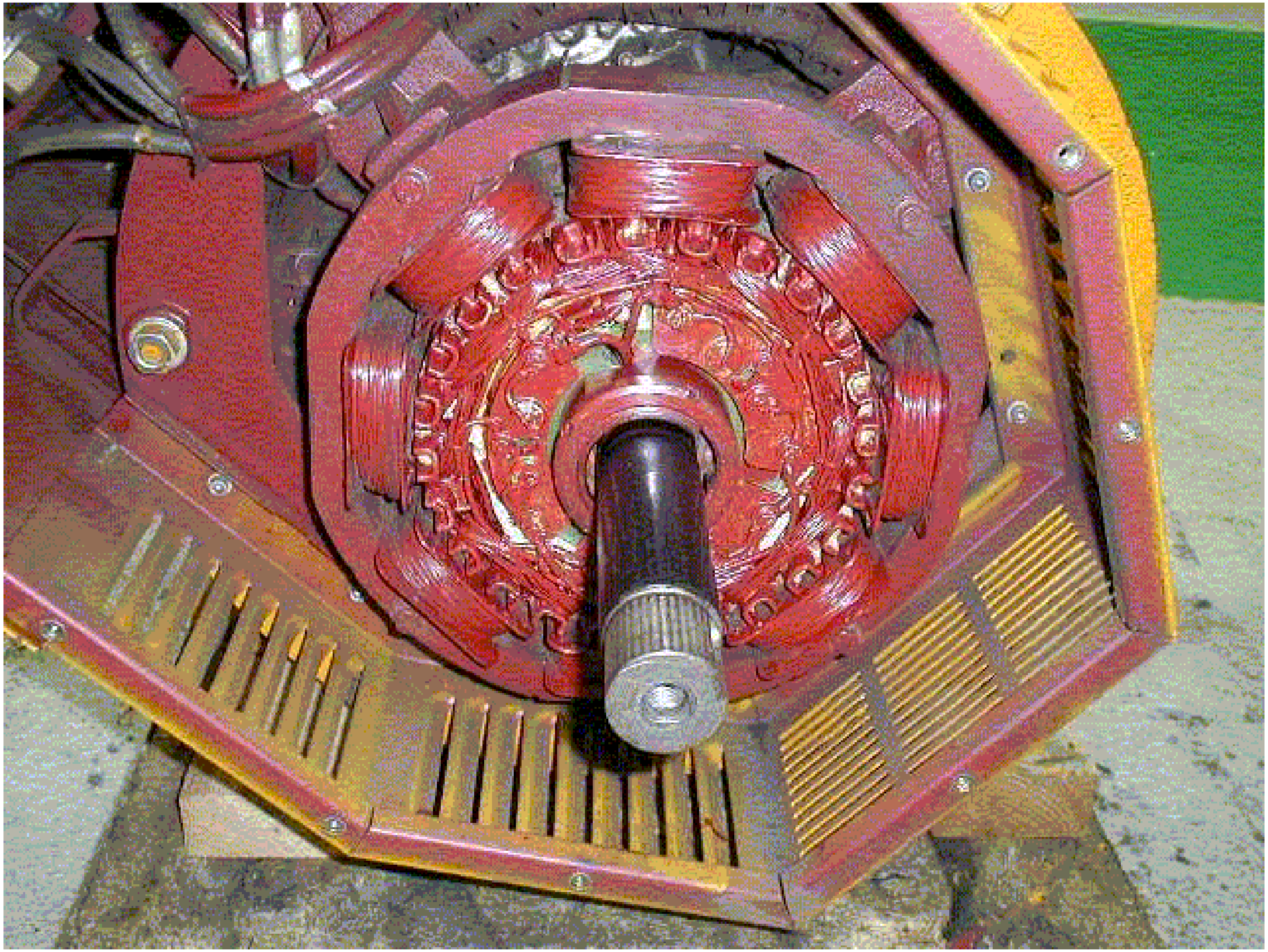


COIL CONNECTIONS

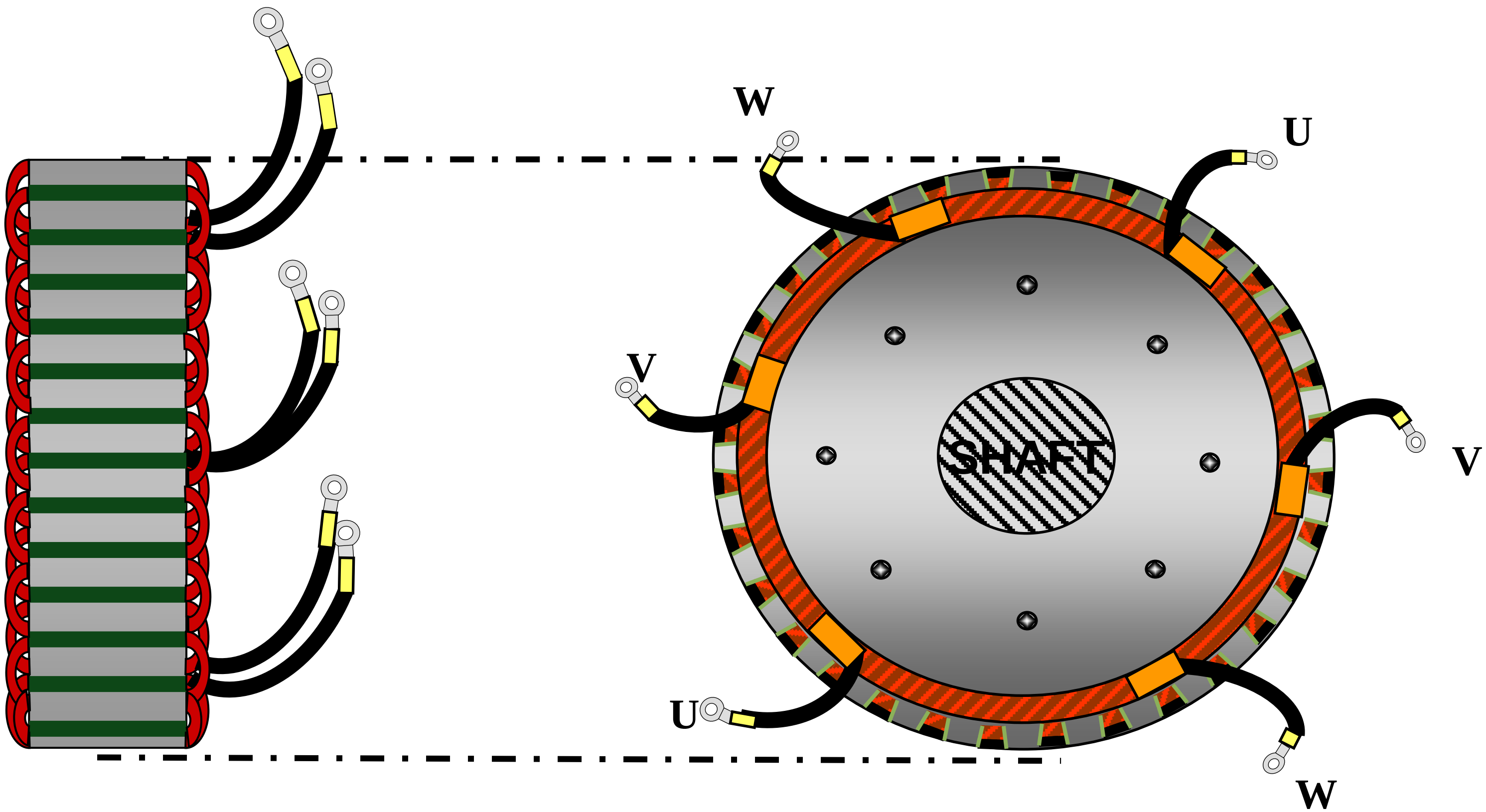


- High-remanence steel core
- Stores Residual Magnetism
- 8 pole magnet field
- High frequency Generator

How does an AC generator work: Excitor stator



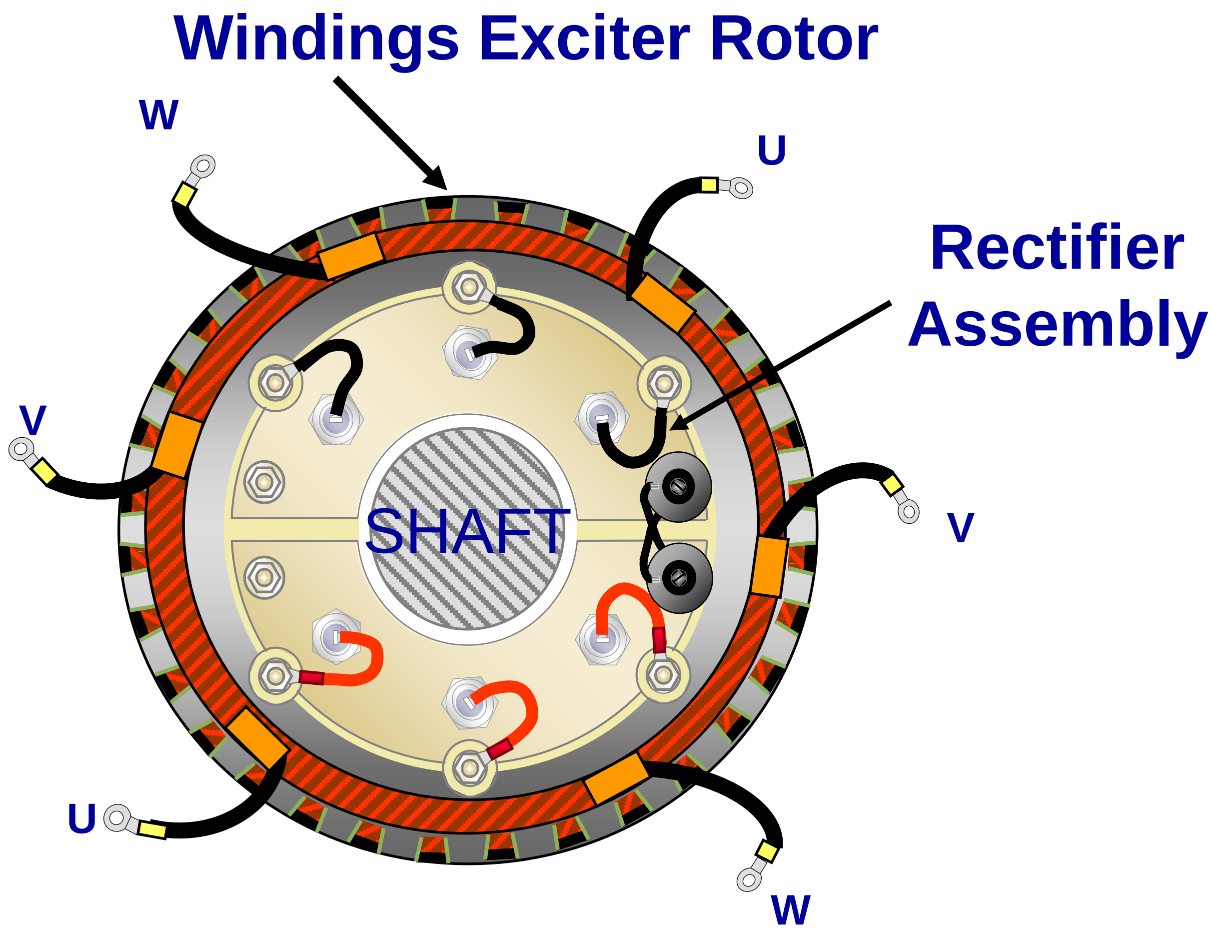
How does an AC generator work: Excitor rotor assembly



- 3 Phase A.C output, each Phase connected to 2 diodes on Main Rectifier.
- High Frequency output, (from 8 Pole Exciter Stator).
- An Exciter generator is a magnetic power amplifier for the main rotor current.

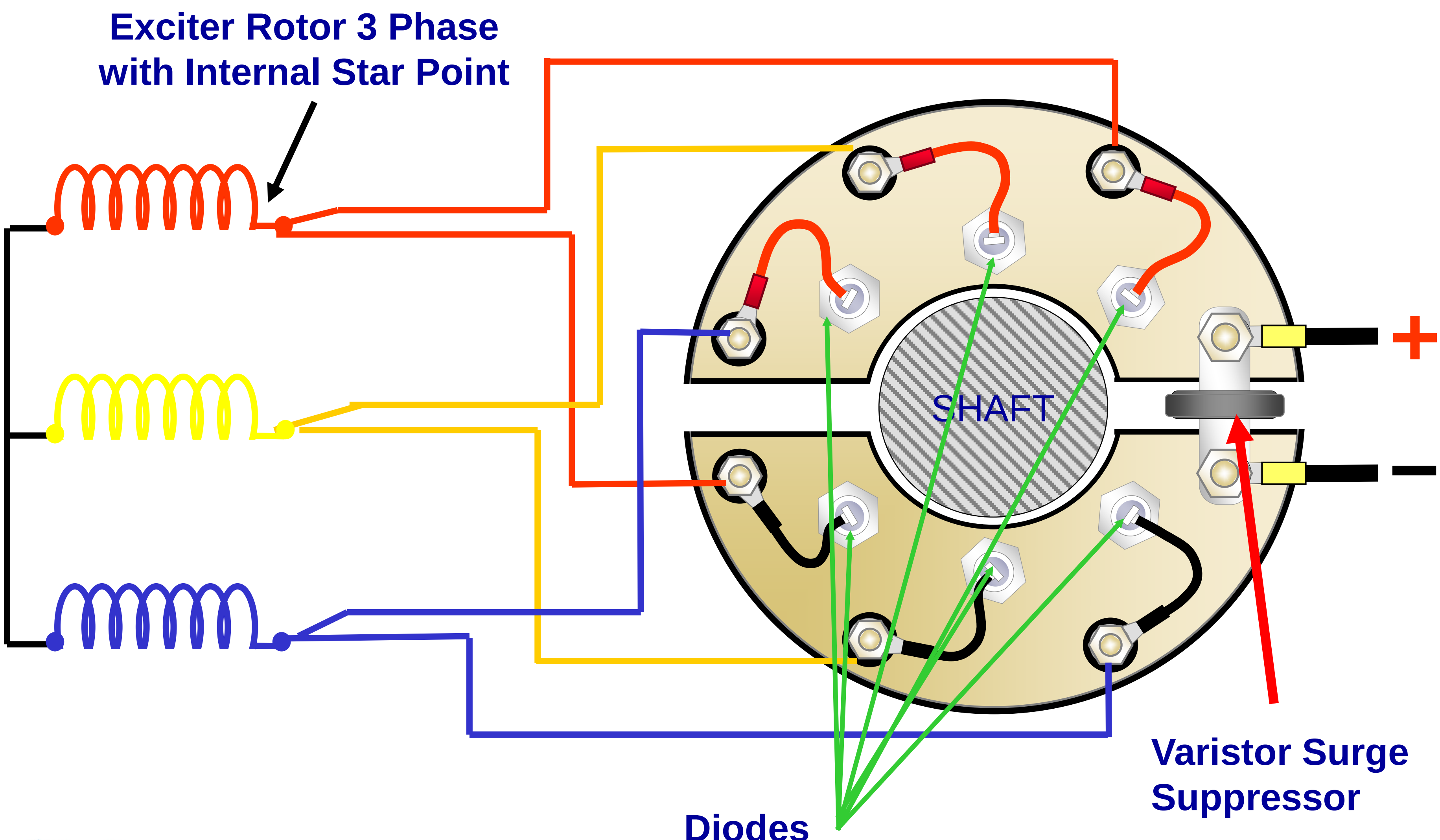
How does an AC generator work: Excitor rotor assembly

How does an AC generator work: Excitor rotor & rectifier

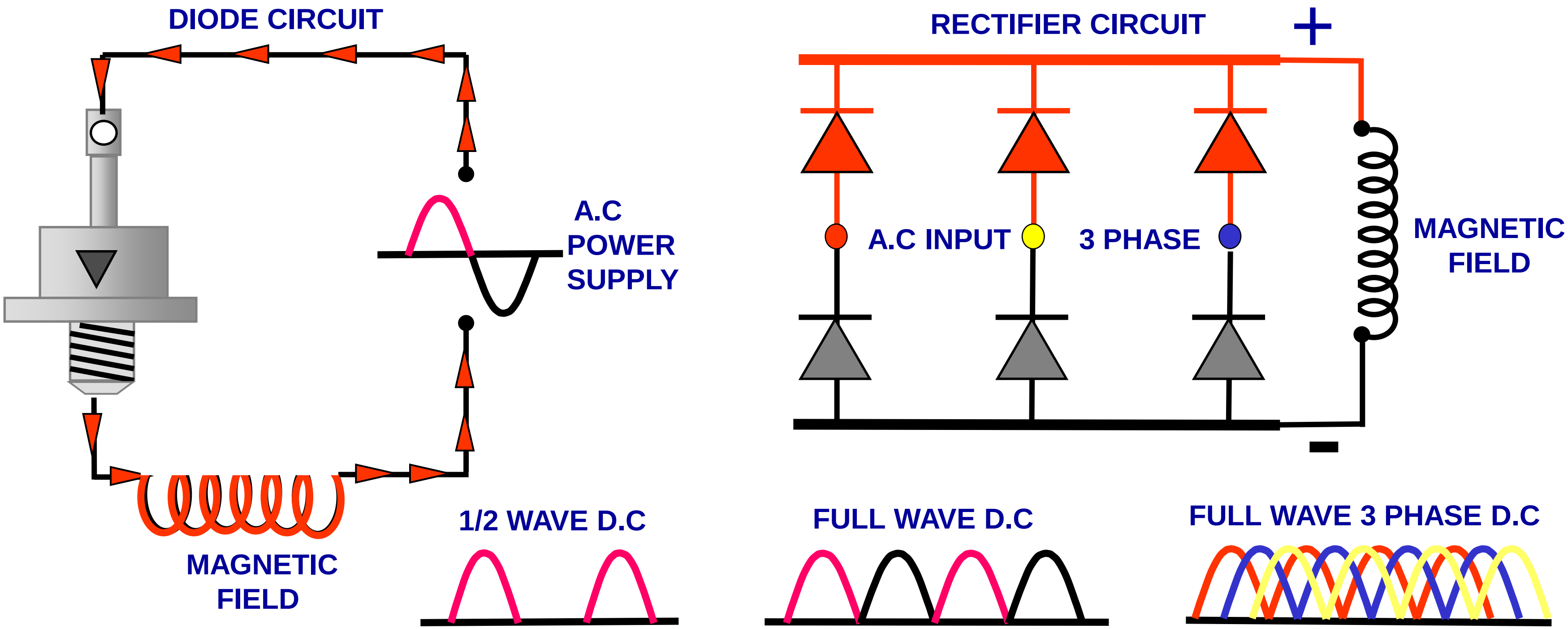


Rectifier Assembly Mounted on Exciter Rotor.

How does an AC generator work: Diode bridge assembly



How does an AC generator work: The silicone diode

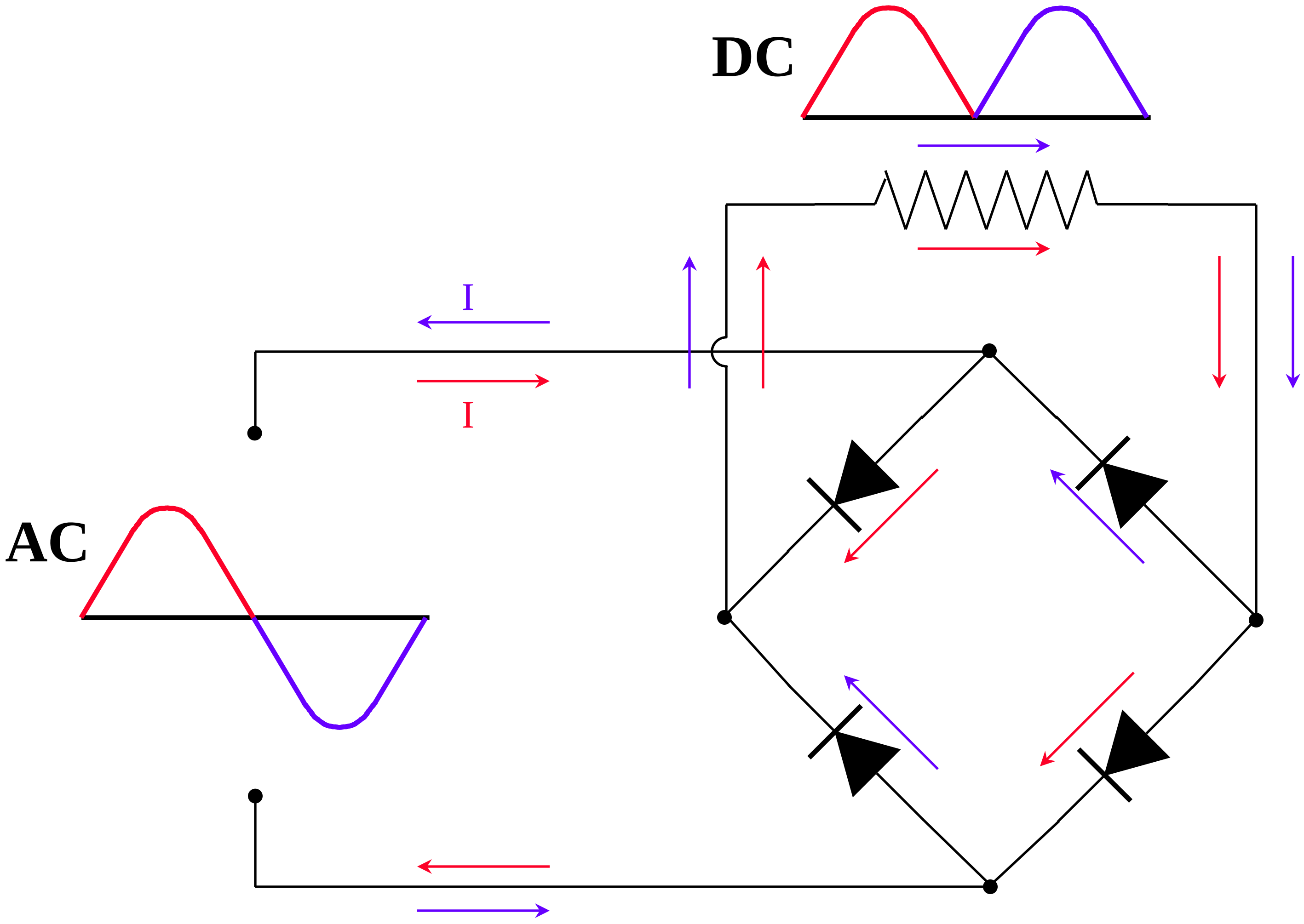


The SILICON DIODE acts as an ELECTRONIC 'ONE WAY VALVE' to A.C.

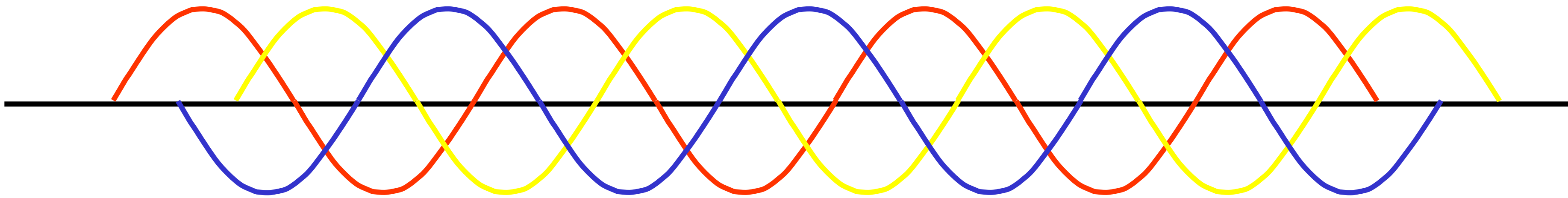
A SINGLE SILICON DIODE will allow ONLY ONE HALF OF THE A.C CYCLE to pass through to the magnetic field.

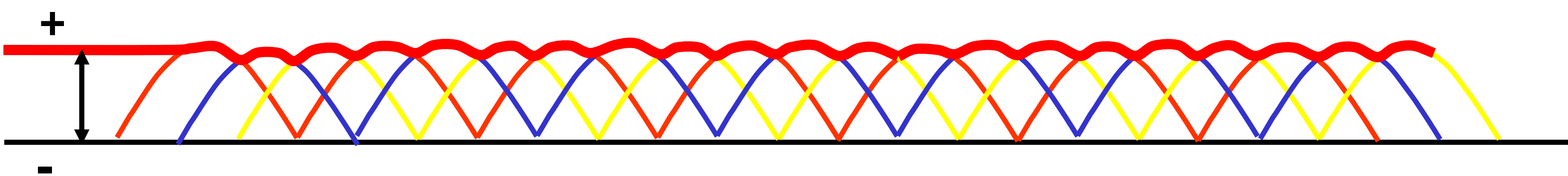
A FULL WAVE RECTIFIER converts BOTH HALVES of the cycle into DIRECT CURRENT, (D.C).

How does an AC generator work: The diode bridge



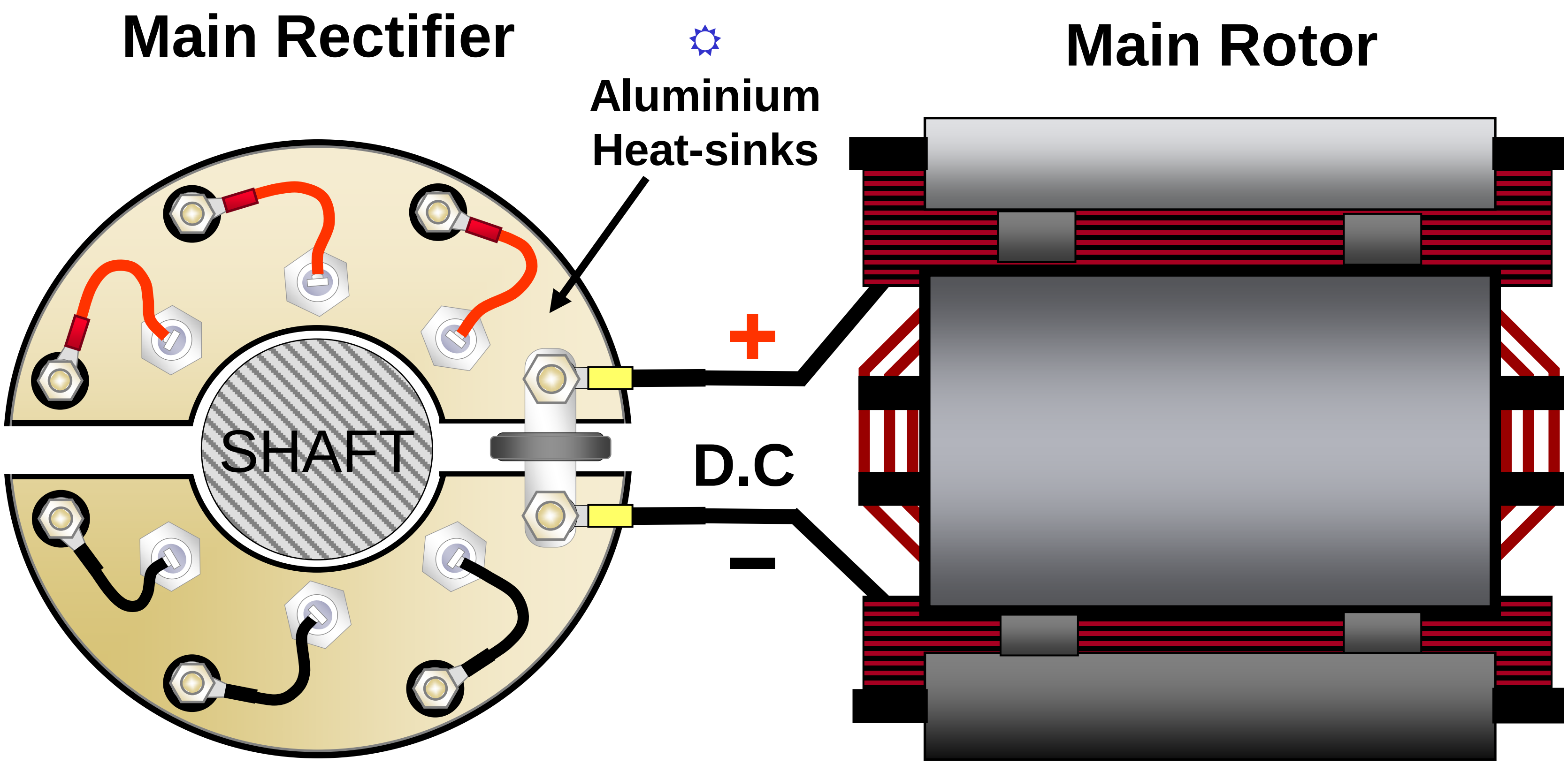
How does an AC generator work: Operation of a diode





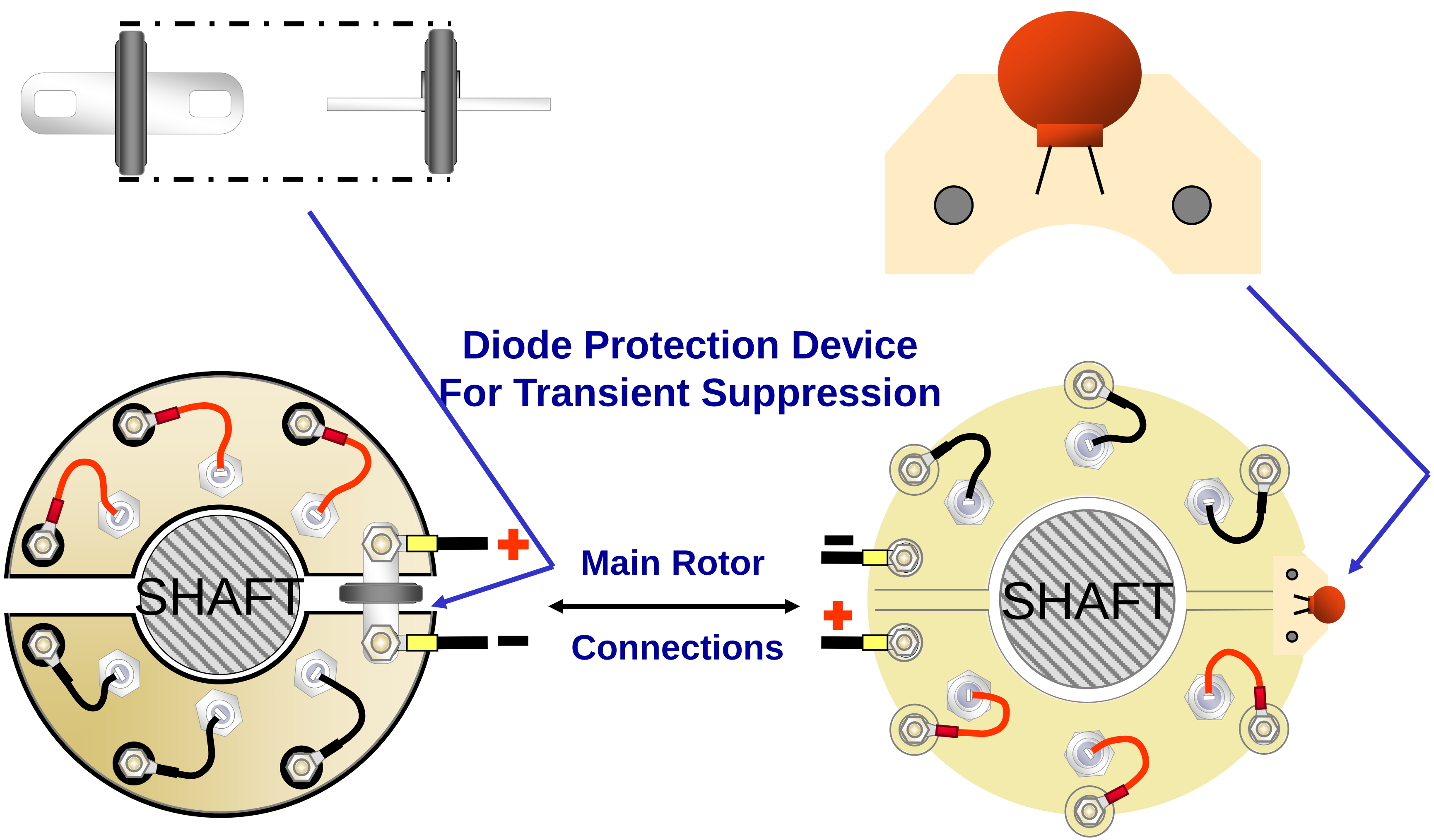
Full wave 3 Phase rectification will produce a D.C. output of 1,35 time A.C input voltage

How does an AC generator work: Main rectifier connections to main Rotor

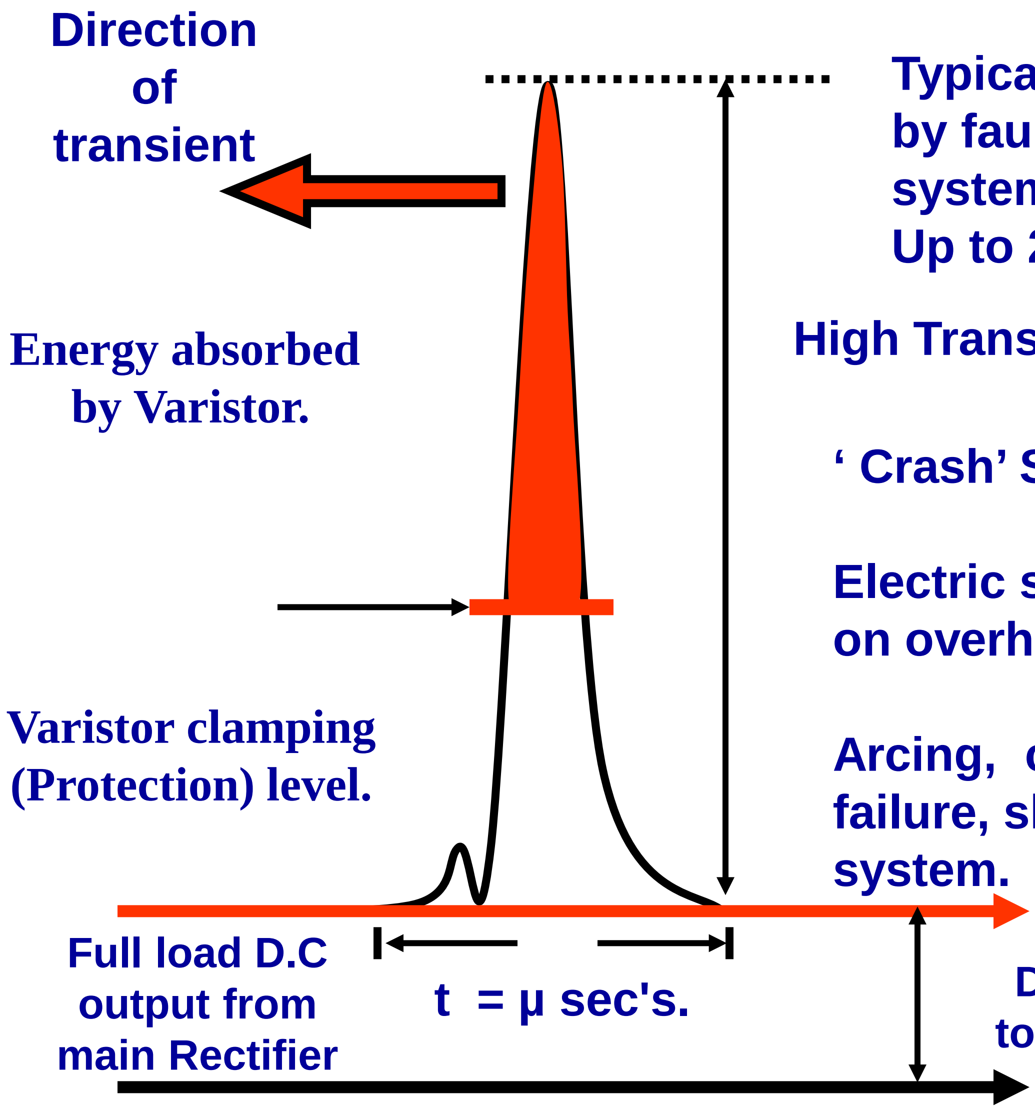


The Rectifier Output is a smooth D.C Supply across the Aluminium Heat Sinks
This is fed to the Main Rotor windings

How does an AC generator work: Metal Oxide Varistor (Surge Suppressor)



How does an AC generator work: Metal Oxide Varistor (Surge Suppressor)



Typical high voltage transient created by fault condition in the distribution system.
Up to 2- 3000V (peak voltage)

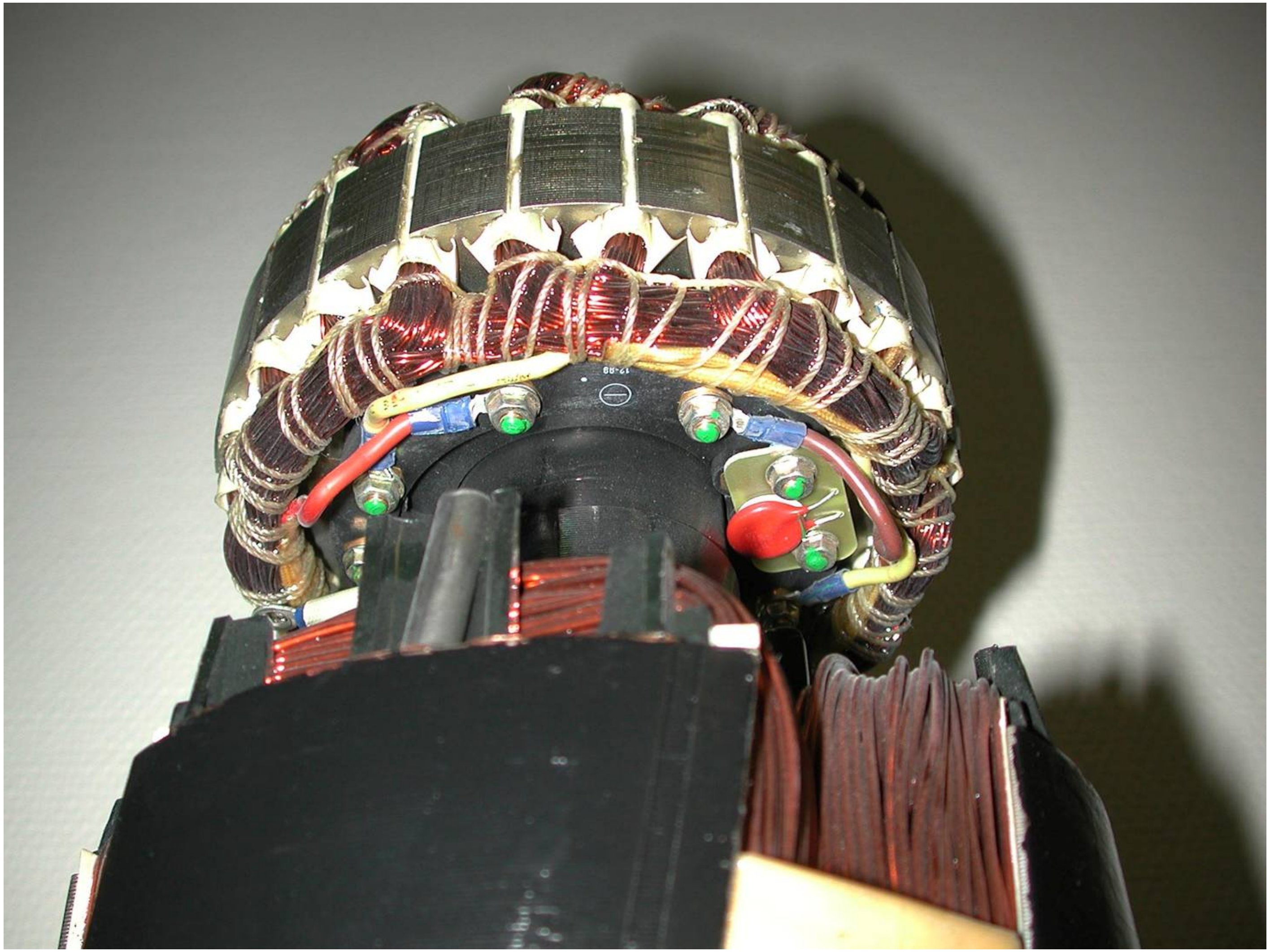
High Transient surges can be created by:-

‘ Crash’ Synchronising onto live bus-bars.

Electric storm, (lightning), and field effects on overhead lines (distribution systems).

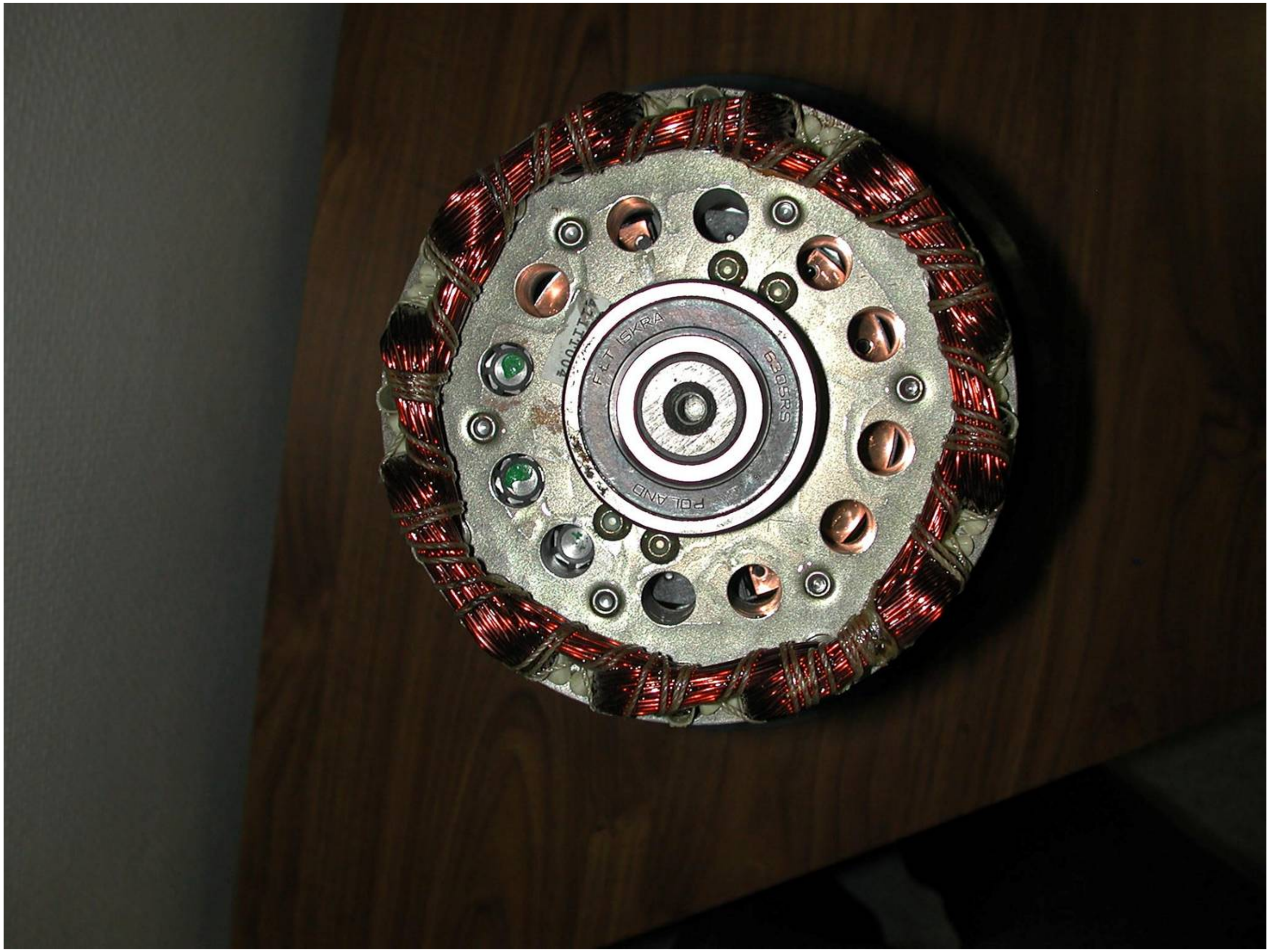
Arcing, caused by faulty switching, motor failure, short circuits in the distribution system.

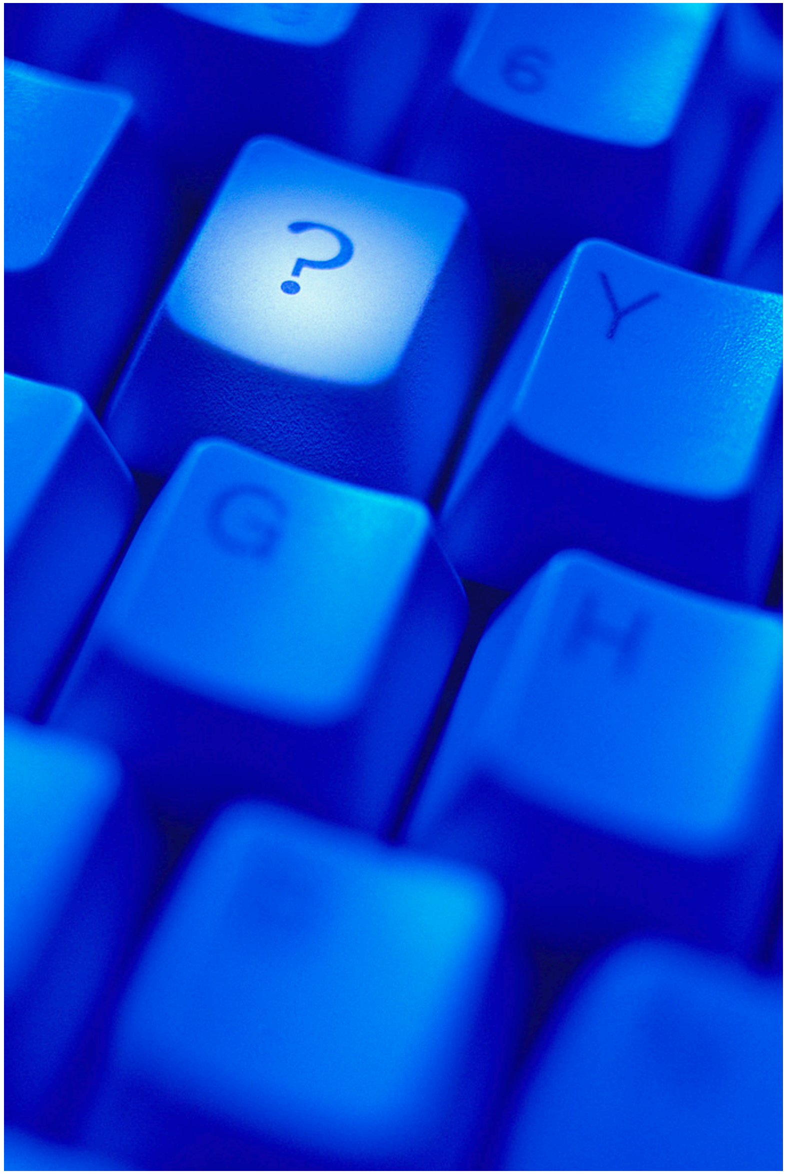
How does an AC generator work: Diode bridge assembly



How does an AC generator work: Rotor assembly

How does an AC generator work: Rotor assembly: excitation end





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Service training: Generators

Voltage regulation

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Portable Power

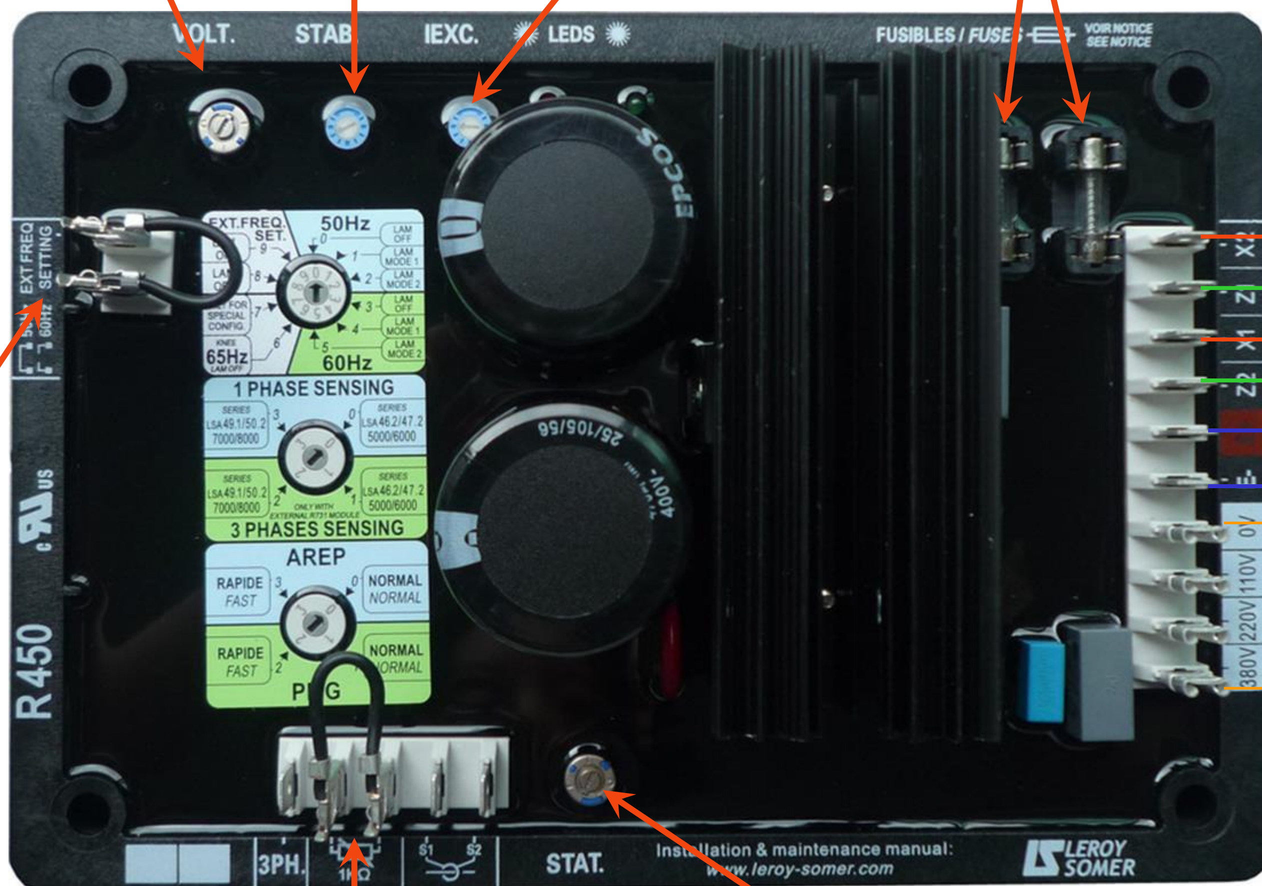
Course Objectives

- **Description of the Automatic Voltage Regulator (AVR)**
- **How is the produced voltage regulated?**
- **Shunt and AREP regulation**

Description of the Automatic Voltage Regulator (AVR)

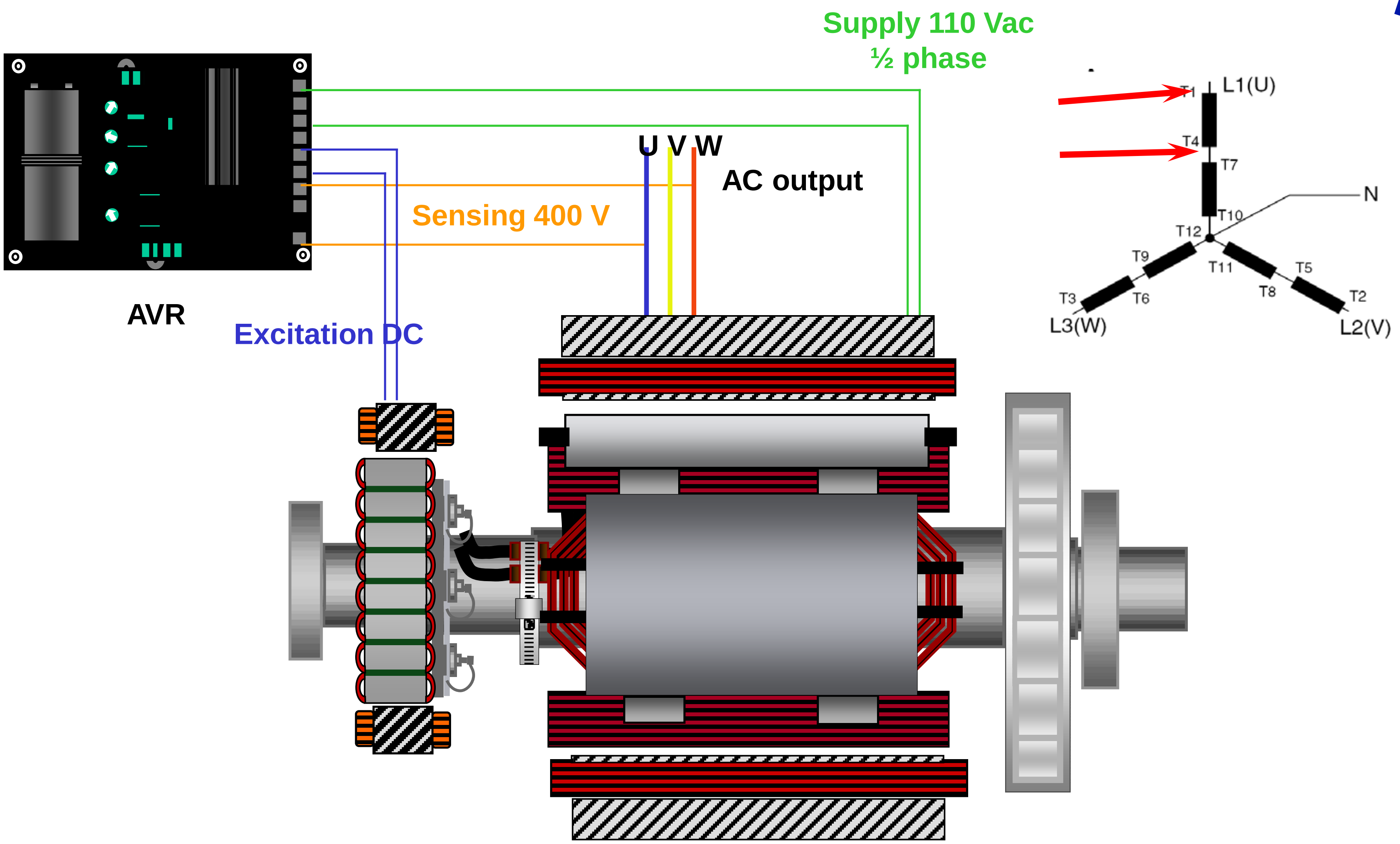
Automatic Voltage regulator

Description of the Automatic Voltage Regulator (AVR)



Shunt & AREP

Voltage regulation (shunt)



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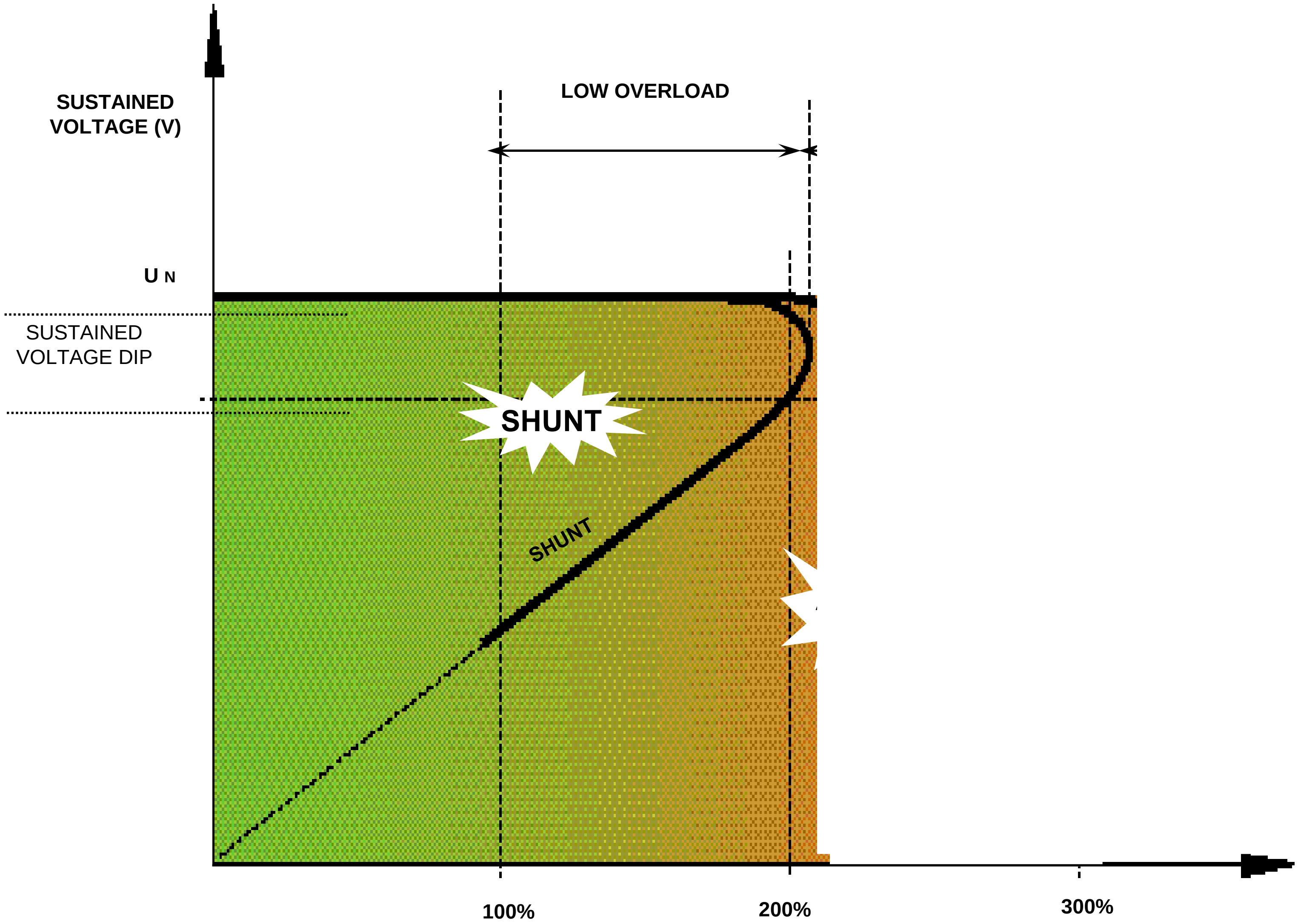
Overload Characteristics Shunt



AREP

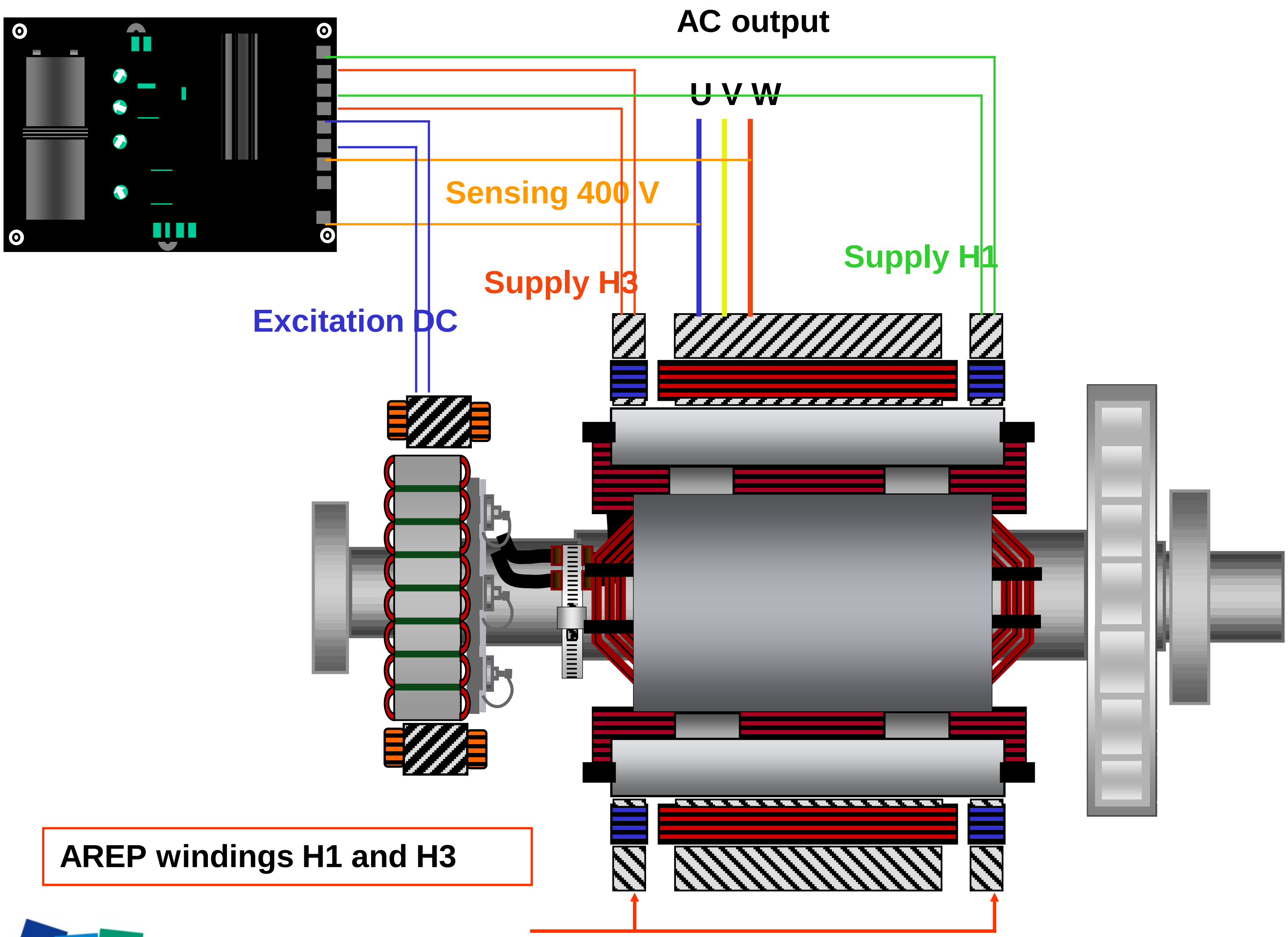
Auxiliary winding

Regulation

Excitation

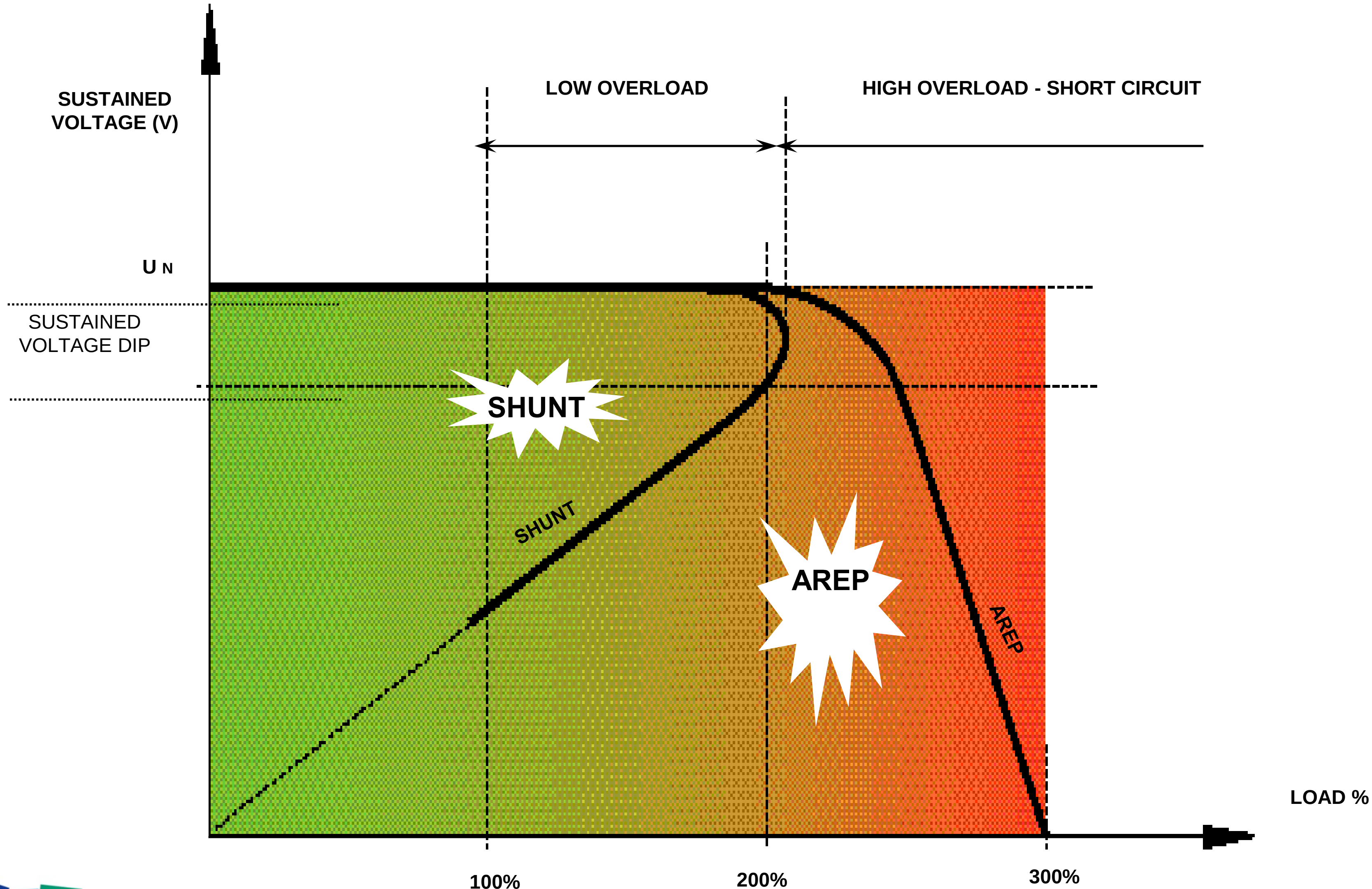
Principle

Voltage regulation (AREP)

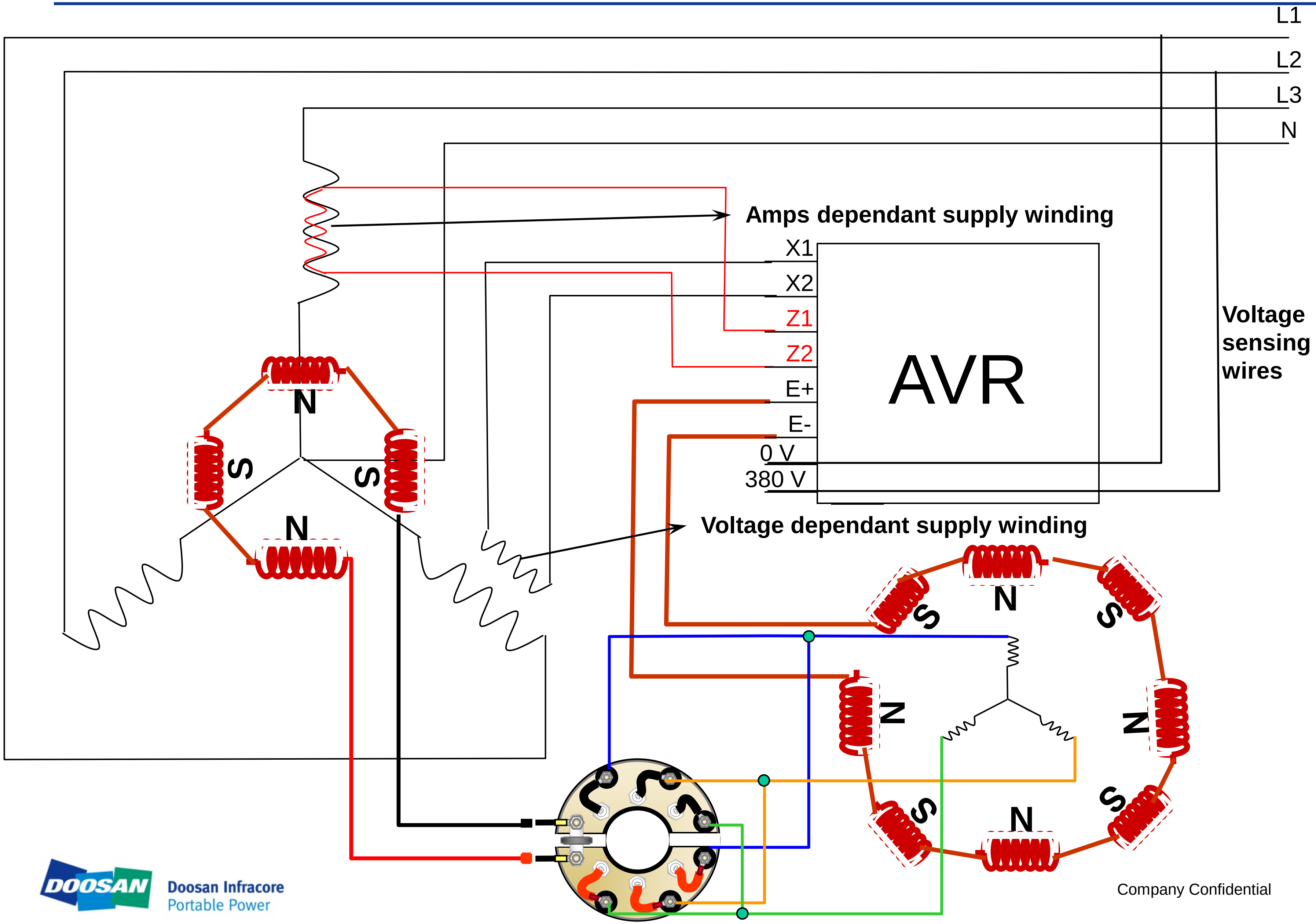


AREP windings H1 and H3

Overload Characteristics AREP



Voltage regulation (AREP)

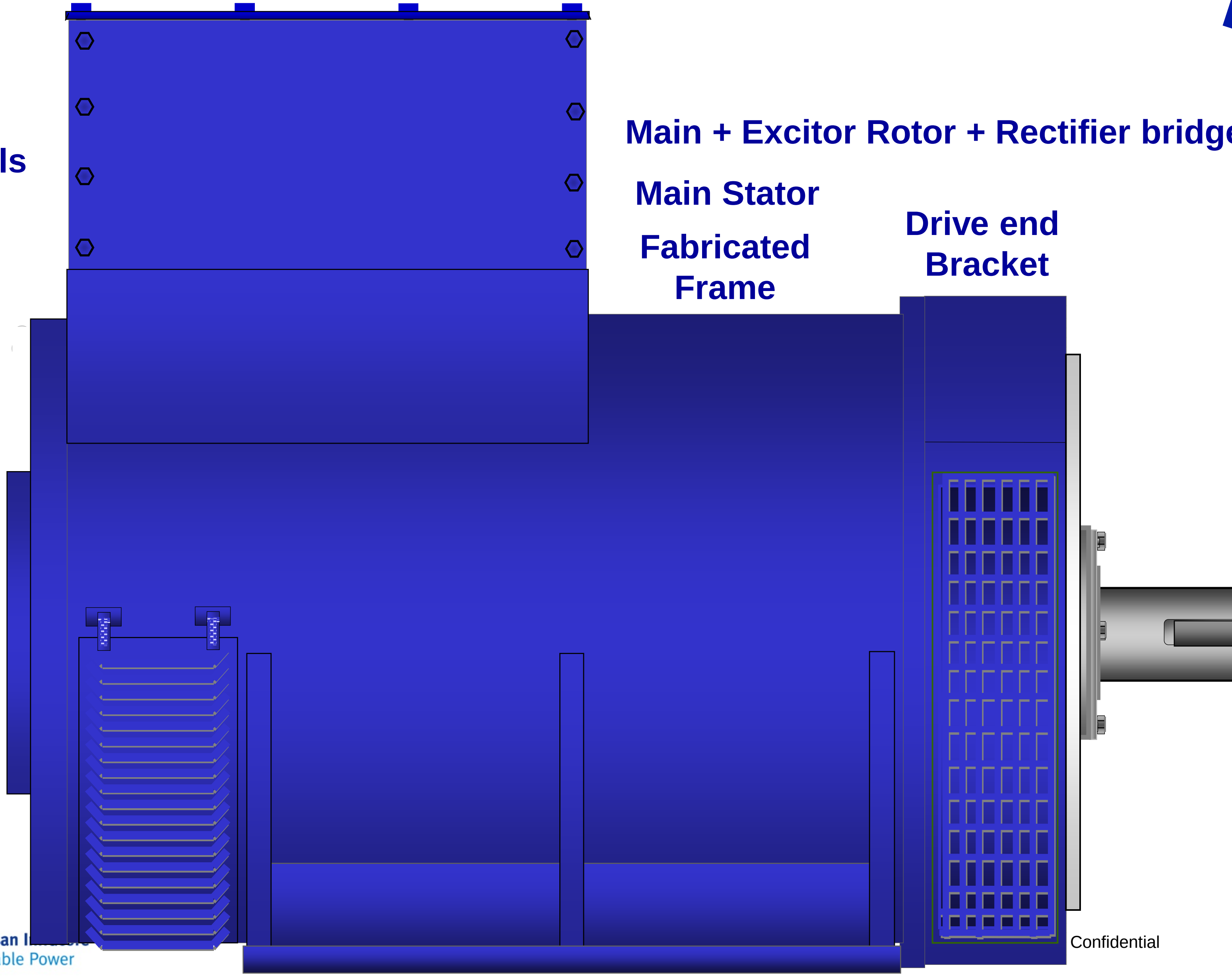


Construction summary

Main Terminals

A.V.R.

Non drive end Bracket & Exciter Stator assy

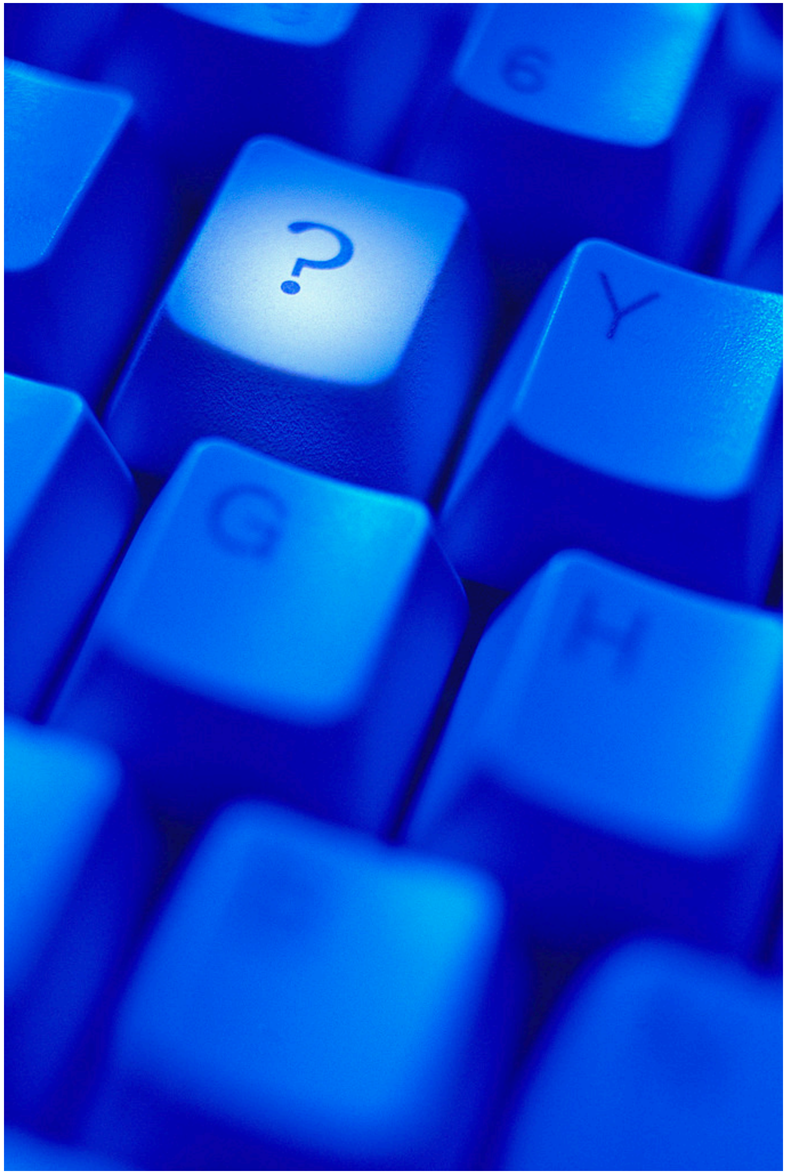


Main + Excitor Rotor + Rectifier bridge

Main Stator

Fabricated Frame

Drive end Bracket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Doosan Infracore

Service training: Generators

“Need to know” electrical concepts : Voltage, Current, active/reactive power

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Portable Power

“Need to know” electrical concepts : Voltage, Current

We have seen that the Power is the product of voltage and current:
P = U x I

<u>3 phases configuration :</u>

P in VA = U x I x √3
√3 is the 3 phase multiplication factor.

Therefore, the theoretical power in kVA = $\dfrac{U \times I \times \sqrt{3}}{1000}$

“Need to know” electrical concepts : active/reactive power

Many electrical circuits induce a delay in the current sinusoid versus the voltage, they are called the INDUCTIVE circuits

Others induce a advance in the current sinusoid versus the voltage, they are called the CAPACITIVE circuits

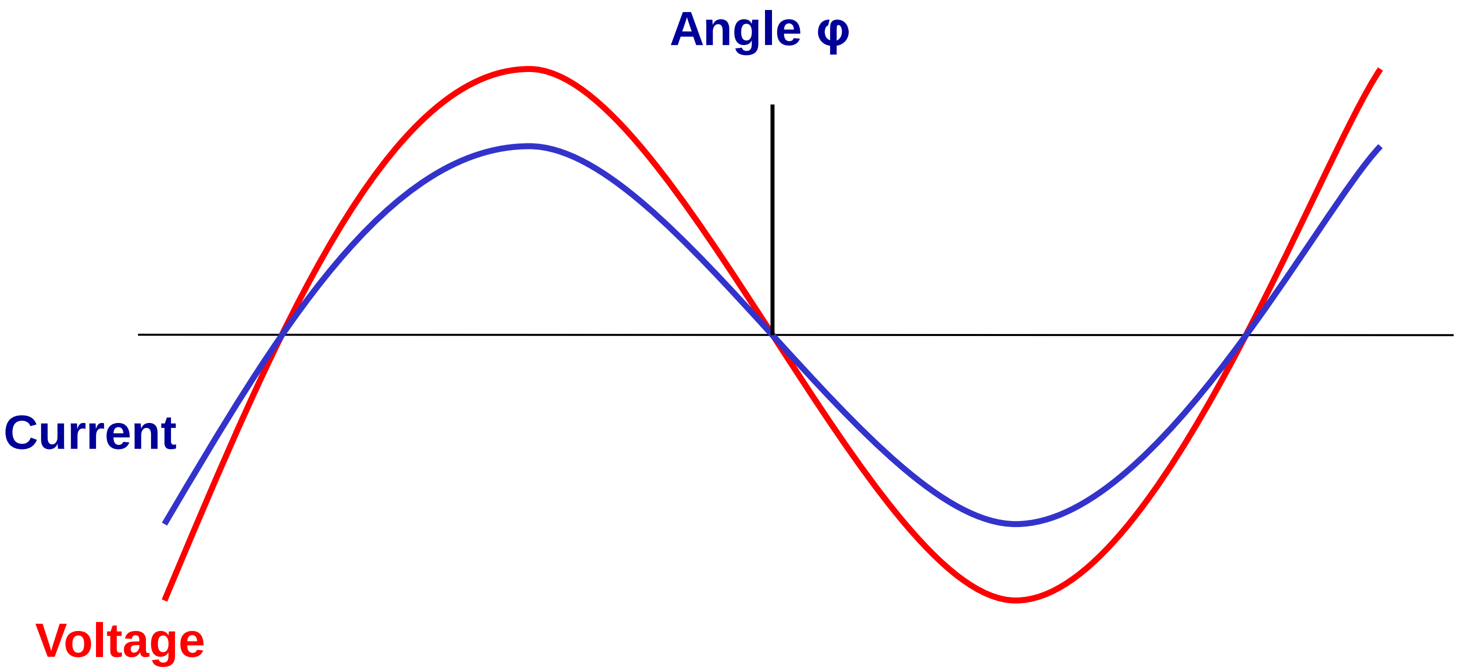
The angle between the voltage and the current sinusoids is called φ (Phi)

This angle influences the power required to power up an application, the Cosinus of the angle φ is called the POWER FACTOR and is involved in the power calculation

“Need to know” electrical concepts : active/reactive power

When the angle φ equals 0, the Cosinus φ equals 1.
This is what happens in pure resistive loads, for example, glowing lamps, or a load bank

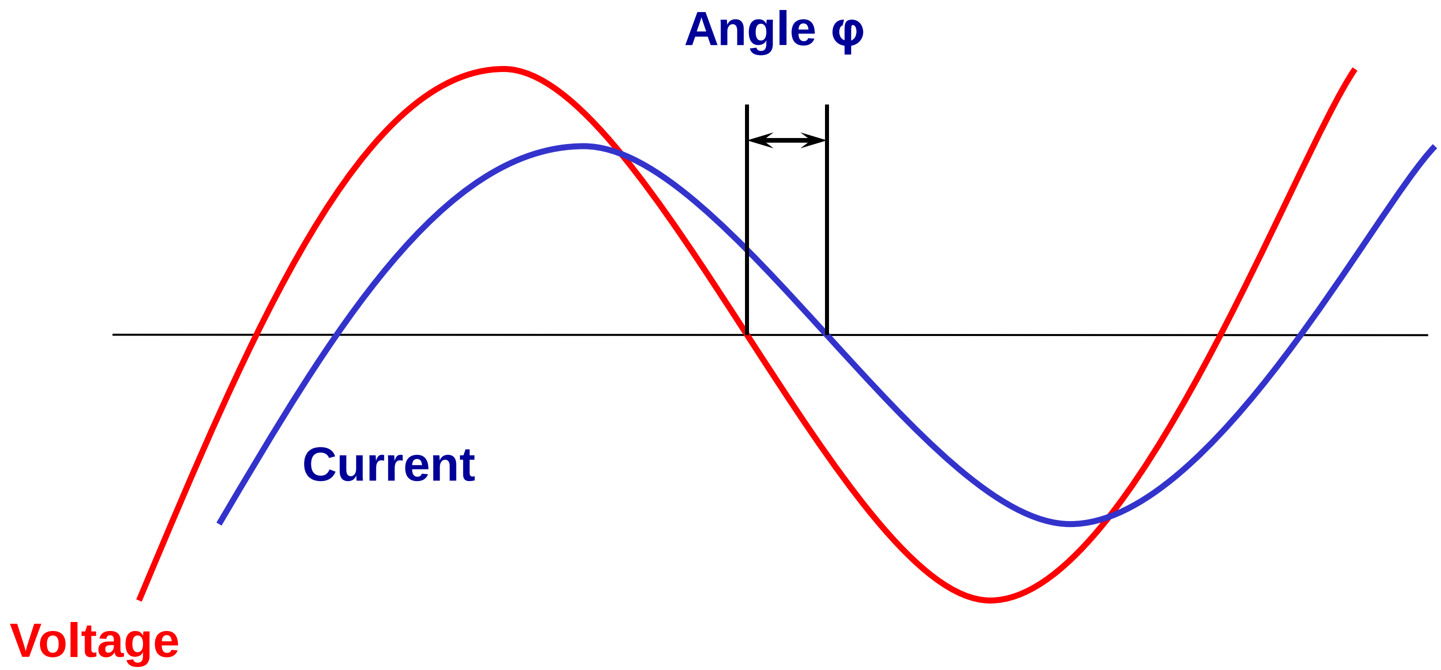
The power calculation then equals $P = U \times I \times \sqrt{3}$



"Need to know" electrical concepts : active/reactive power

When the angle φ equals, for exemple, 28°, the Cosinus φ equals 0.88.

The power calculation then equals $P = U \times I \times \sqrt{3} \times 0.88$



“Need to know” electrical concepts : active/reactive power

The APPARENT power is the product of voltage and current, not taking into account the POWER FACTOR.

The APPARENT power unit is Volt-Amps, or VA, or kVA for easier use and is noted with the letter “S”

$$S\ (kVA) = \frac{U\ (Volts) \times I\ (Amps) \times \sqrt{3}\ (3\ phase\ factor)}{1000\ (for\ \underline{k}VA)}$$

This is the number we use for our model names, i.e. a 100 kVA machine is named G100.
It is also the only value with which you can compare generators powers without the application influence.

“Need to know” electrical concepts : active/reactive power

The ACTIVE power is the product of voltage and current and taking into account the POWER FACTOR.

The ACTIVE power unit is Watts, or W, or kW for easier use and is noted with the letter “P”

$$P\ (kW) = \frac{U\ (Volts) \times I\ (Amps) \times \sqrt{3}\ (3\ phase\ factor) \times \cos\varphi}{1000\ (for\ \underline{k}W)}$$

“Need to know” electrical concepts : active/reactive power

The REACTIVE power is the product of voltage and current and taking into account the Reactive part of the power.

The REACTIVE power unit is Volt-Amps Reactive, or VAR, or kVAR for easier use and is noted with the letter “Q”

$$Q\ (\text{kVAR}) = \frac{U\ (\text{Volts}) \times I\ (\text{Amps}) \times \sqrt{3}\ (\text{3 phase factor}) \times \sin\varphi}{1000\ (\text{for } \underline{\text{k}}\text{VAR})}$$

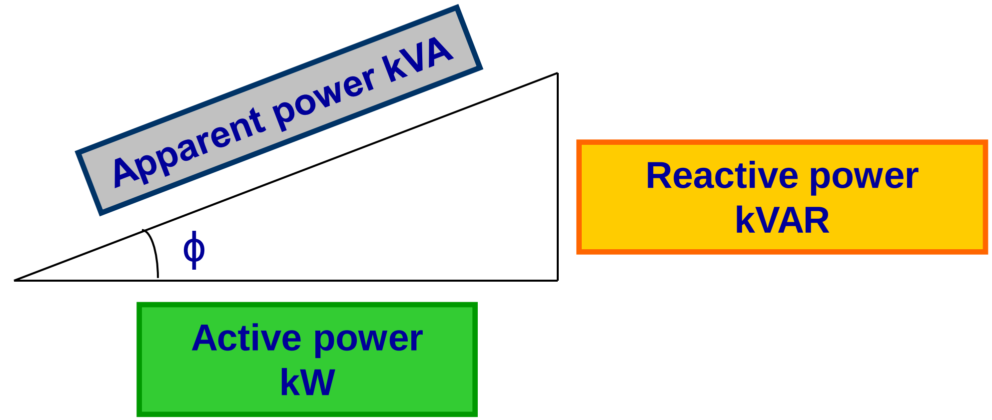
"Need to know" electrical concepts : active/reactive power

How to express the relation between Apparent, Active and Reactive power : 3 equations

$$\boxed{kW} = \boxed{kVA} \times \cos\phi$$

$$\boxed{kVAR} = \boxed{kVA} \times \sin\phi$$

$$kVA = \sqrt{(kW^2 + kVAR^2)}$$



In industrial reality **Power Factor COS ϕ = 0,8** or close to this value for most of the loads

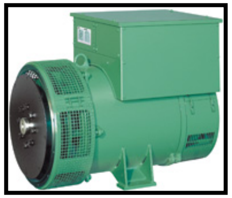
Alternators are rated as follows : **500 kVA** under **400Volts** with a **Power Factor COS ϕ = 0,8**

$$\boxed{kW} = 500kVA \times 0{,}8 = \boxed{400\ kW}$$

Limited by engine output and stator current

$$\boxed{kVAR} = 500kVA \times 0{,}6 = \boxed{300\ kVAR}$$

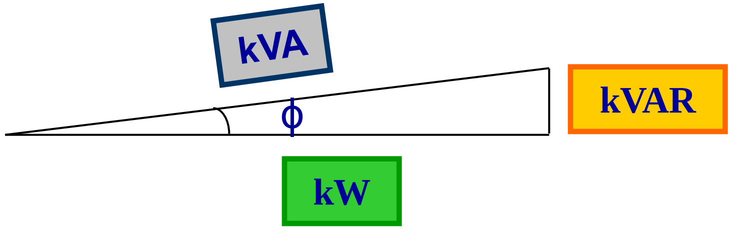
Limited by rotor excitation current



“Need to know” electrical concepts : active/reactive power

- The reactive power is used in the reactive elements such as:
  - Coils in motor stators, solenoids, and transformers
  - Capacitive elements such as capacitors used in variable frequency drives and un-interruptible power systems
- The reactive power is used by the reactive component and returned to the electrical power source.

Close to purely resistive / ϕ close to 0°

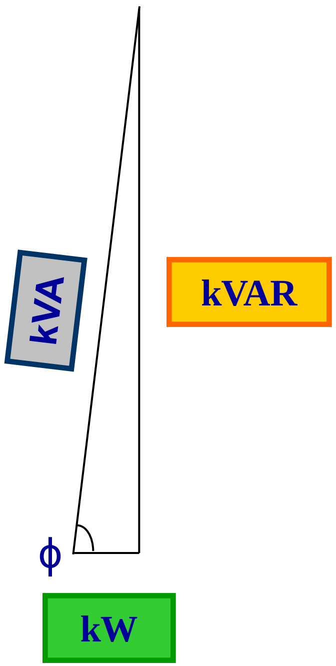


COS ϕ close to 1

For purely *resistive loads*
Phase angle, ϕ = 0°.
Power Factor = Cos ϕ = cos 0° = 1
kW = kVA x PF = kVA x 1
kW = kVA and Reactive Power (kVAR) = 0

Close to purely inductive / ϕ close to 90°

COS ϕ close to 0



For purely *inductive loads*
Phase angle, ϕ = 90°
Power Factor = Cos ϕ = cos 90° = 0
kW = kVA x PF = kVA x 0
kVA = kVAR and Active Power (kW) = 0

“Need to know” electrical concepts : active/reactive power

G500 engine is rated 444 kW, you will not be able to supply more than 420 kW pure resistive load even if alternator is able to supply 500 kW (η alt = 94,5% = alternator’s efficiency)

If load real power is 400 kW with power factor COS ϕ = 0,6 you will need an alternator sized like follows :

$$\text{kVA} = \frac{\text{kW}}{\text{COS } \phi} = \frac{400 \text{ kW}}{0,6} = 670 \text{ kVA} \longrightarrow 700 \text{ kVA alternator}$$

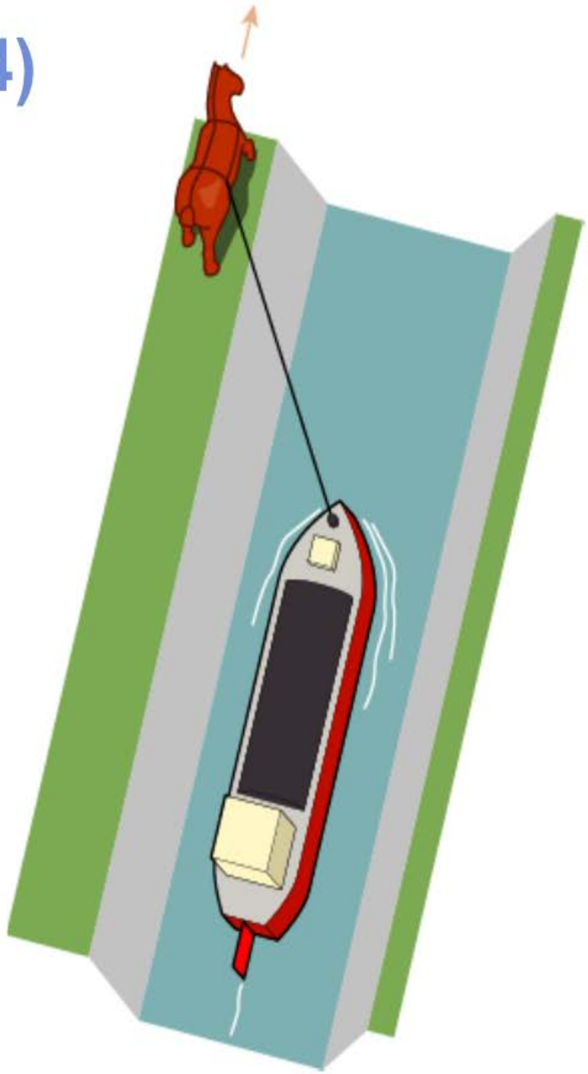
COS ϕ impact must be considered seriously when sizing a generator → $$$

Considering a wrong load COS ϕ → alternator overload → breakdowns

Analogies to explain reactive power

II. The horse-and-boat analogy (1/4)

Take a boat on a canal, pulled by a horse at the bank



Analogies to explain reactive power

II. The horse-and-boat analogy (2/4)

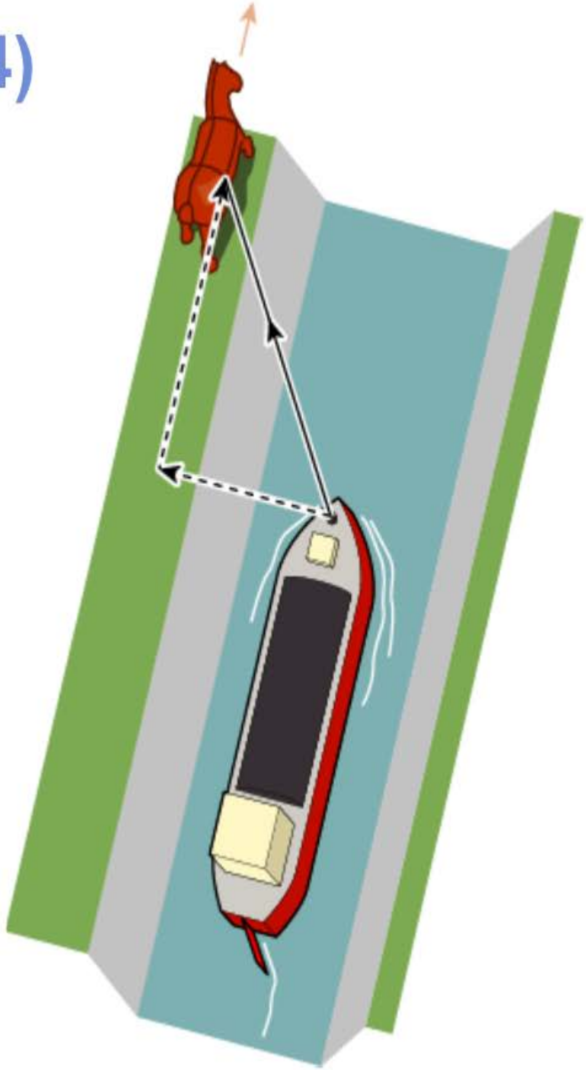
The fact that the horse is not walking straight in front of the boat, does not influence the work it has to do to pull the boat. But without compensation by the rudder, the boat will be pulled towards the bank of the canal.

Consequences:

- The turned rudder leads to extra losses
- The fact that the rope is pulling at the flank of the horse and not straight behind it, limit's the horse's capacity to deliver work

Analogies to explain reactive power

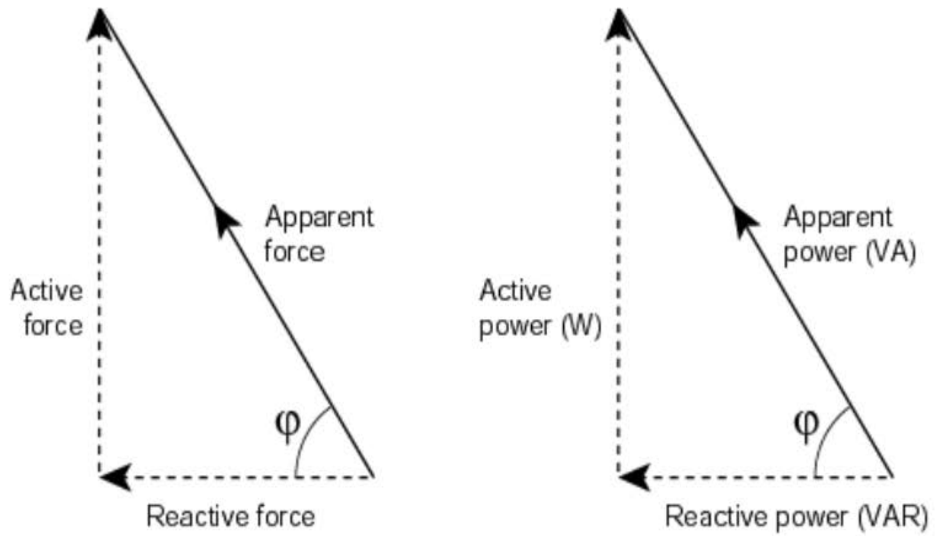
II. The horse-and-boat analogy (3/4)

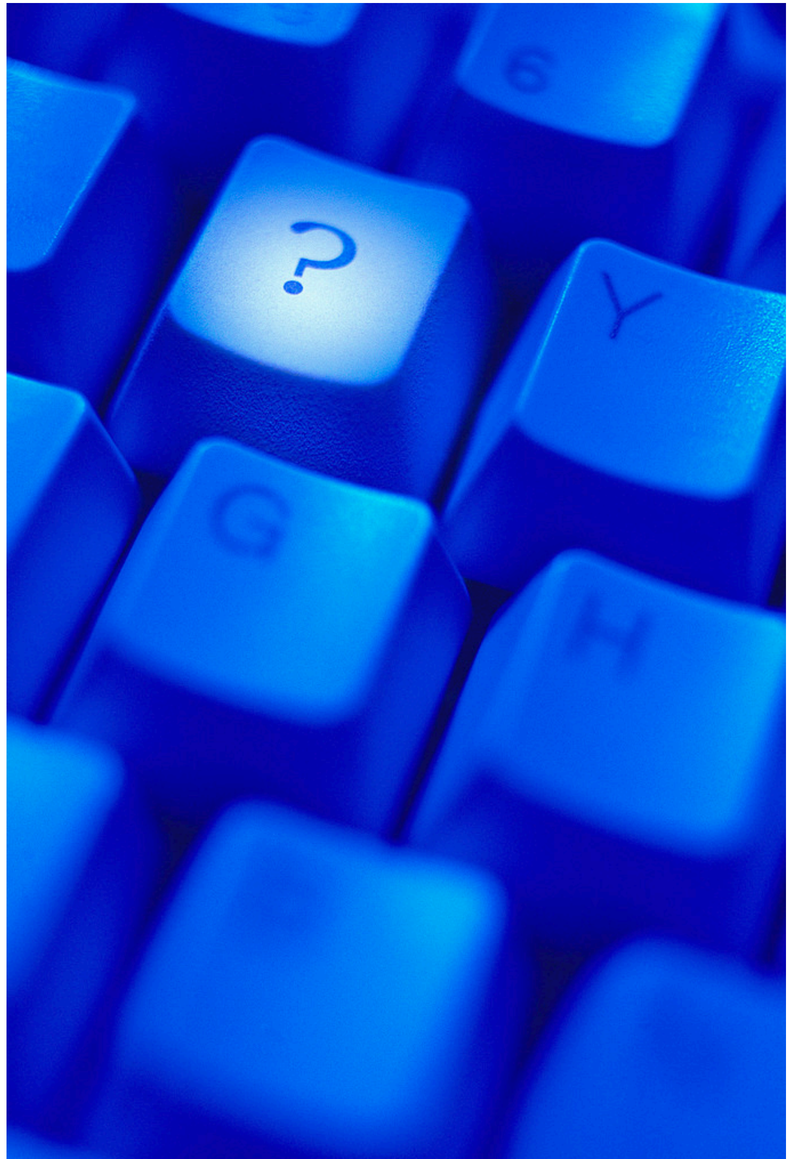


Analogies to explain reactive power

II. The horse-and-boat analogy (4/4)

The vector representation of the force to pull the boat, is similar to the vector representation of power in an electric system:





Doosan Infracore

Service training: Generators

Generators controls types: Analog controls

Doosan Infracore
Portable Power

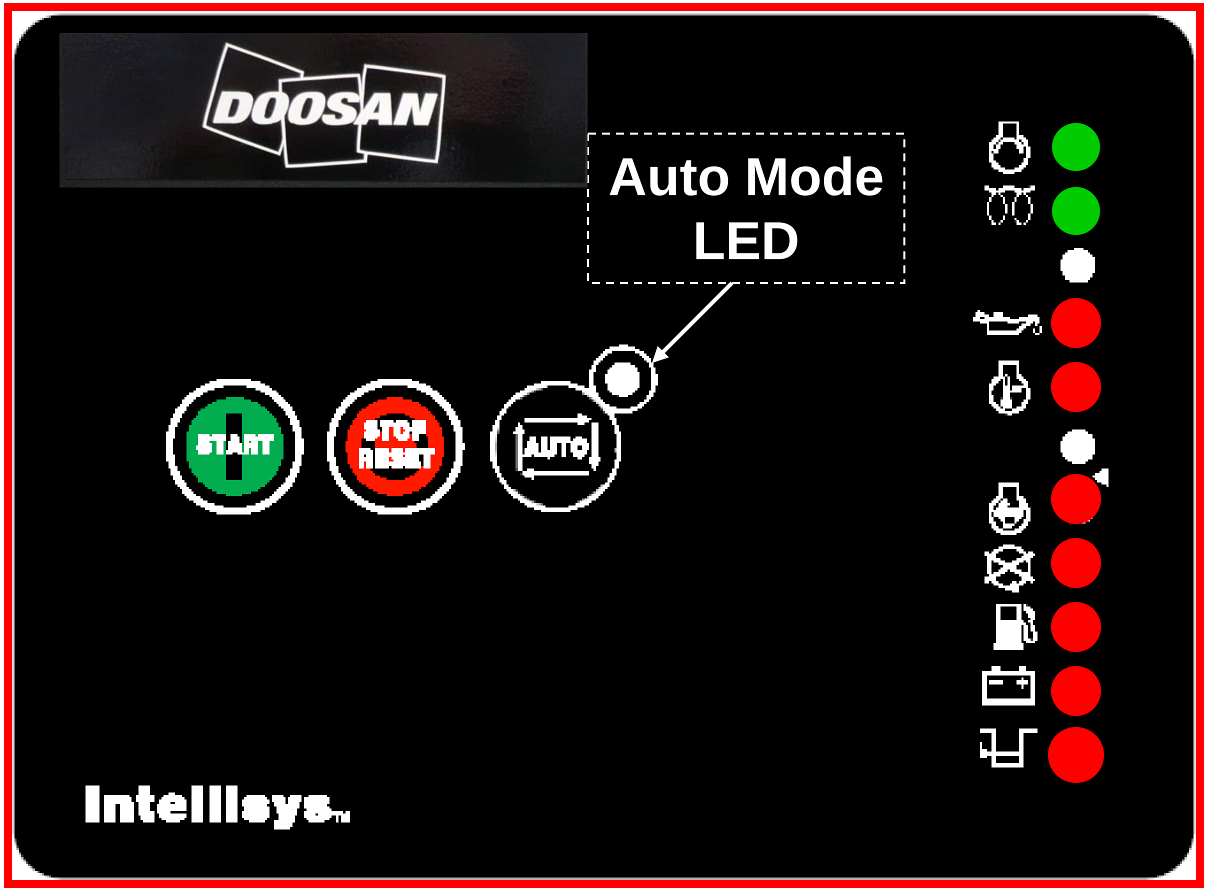
Course Objectives

- **Functions description**
- **Operation**

Analog AutoStart Controls

- The AutoStart controls come in two versions:
  - “Mechanical” for the G10 up to the G60
  - “Electronic” for G80 and larger

Analog AutoStart Panel – Mechanical Engine

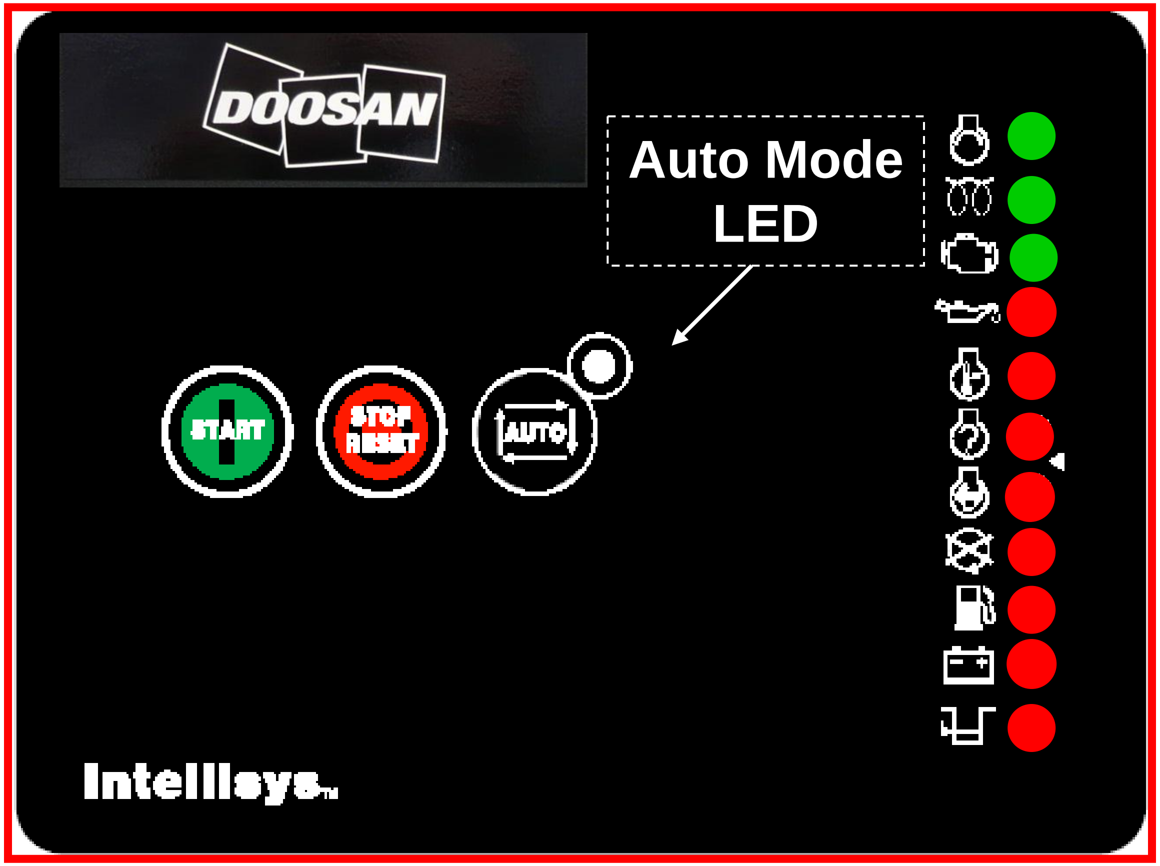


Engine Running
Preheat

Low Oil Pressure
High Eng Temp

Overspeed
Overcrank/Start Fail
Low Fuel
Charge Fail
High Containment Level

Analog Autostart Panel – Electronic Engine



Engine Running
Preheat
ECU Status
Low Oil Pressure
High Eng Temp
Eng Fault
Overspeed
Overcrank/Start Fail
Low Fuel
Charge Fail
High Containment Level

Analog AutoStart Operations

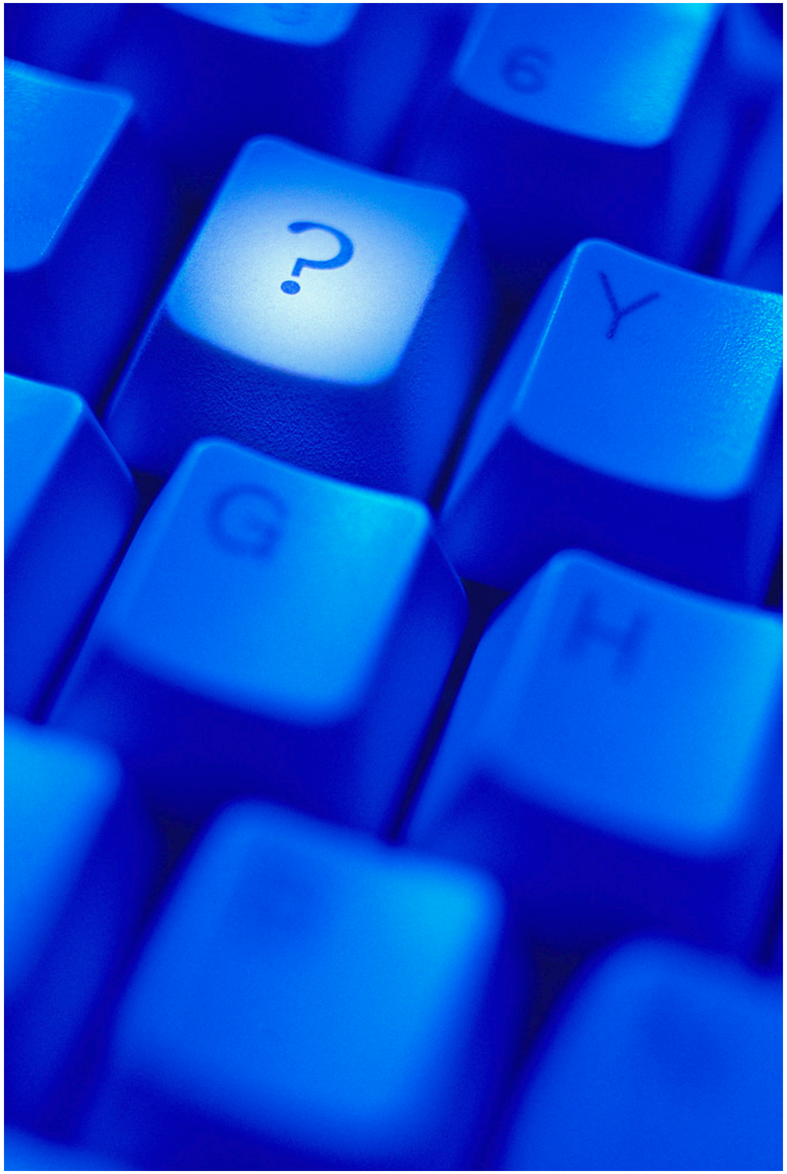
- **Operations**
  - **The panel powers up in the manual mode only.**
  - **Press start to initiate the start sequence**
  - **Press stop to stop the generator set**
  - **Press Auto to place the generator set in the Auto / Standby mode and the LED by the Auto Button will be lit.**

Analog AutoStart Setpoints

- Crank Attempts – 3
- Crank timer – 10 seconds
- Crank Rest Timer – 15 seconds
- Start Delay Timer (Auto Mode Only) – 10 seconds
- Preheat Timer – 10 seconds
- Oil Pressure By Pass Timer – 10 seconds
- Energize To Stop Timer – 5 Seconds
- Overspeed – 110%
- Underspeed – 80%
- Low Battery Voltage Setpoint – 10.5 VDC
- High Battery Voltage Setpoint – 14.5 VDC

Sensing

- The AutoStart Controller for the mechanical engines senses speed from the charging alternator.
- While the AutoStart Controller for the electronic engines senses speed from the ECU.
- High Engine Coolant Temperature opens at 104° C and increasing.
- Low Oil Pressure switch opens at 0,85 Bars and decreasing.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Doosan Infracore

Service training: Generators

Generators controls types: Digital controls

Doosan Infracore
Portable Power

Course Objectives

- **How to display menus**
- **How to view and edit settings**
- **Functions description**

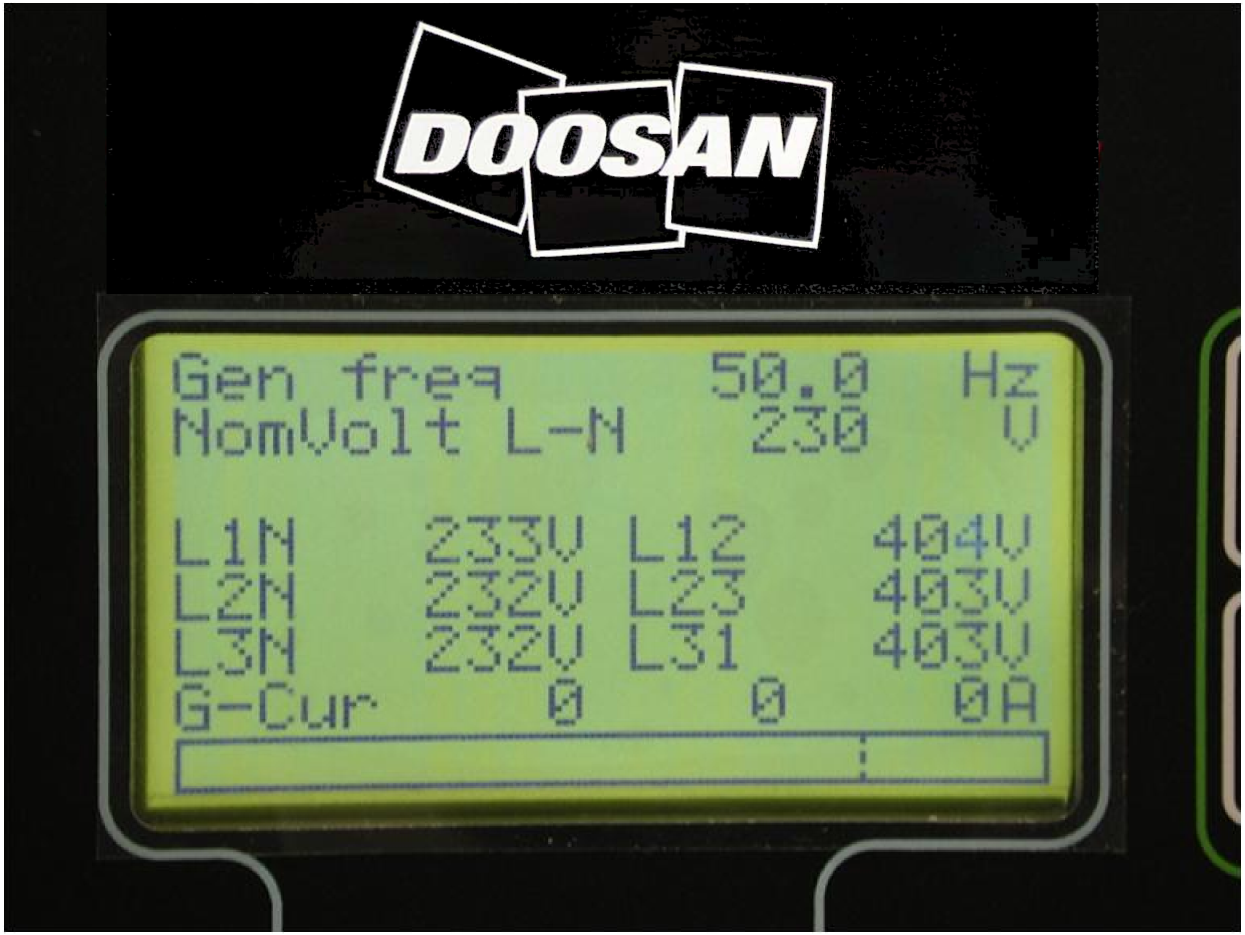
Basic Digital Controls Operation

- Doosan's Digital Controller is a comprehensive generator set controller that is used as the primary interface between the operator and the generator set. It provides a high degree of engine and generator protection. Multiple real-time parameters can also be viewed. The parameters include, but are not limited to kW, KVA, kVAr, power factor, oil pressure, coolant temperature, engine speed, and diagnostic history.

Operator interface

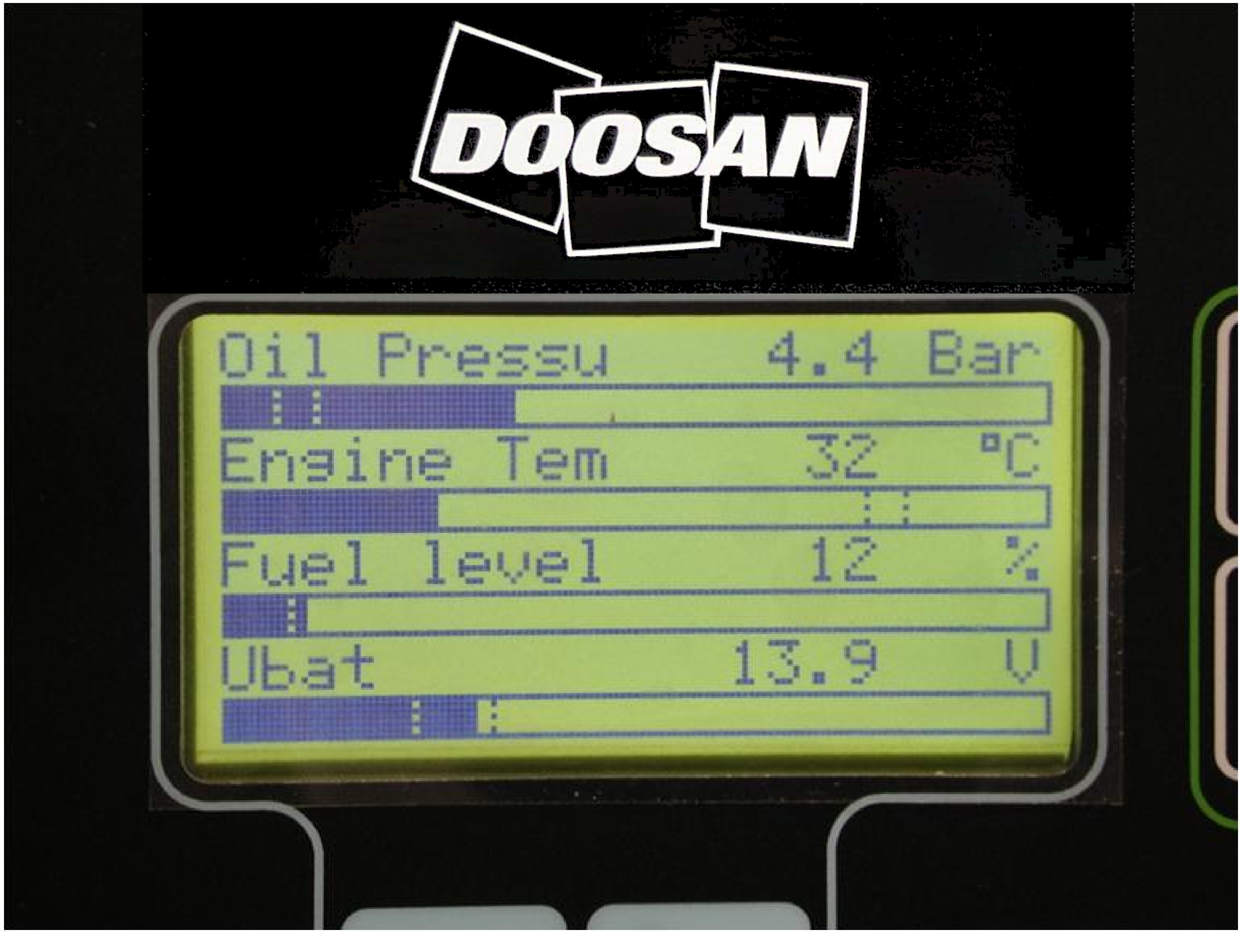
How to display menus?

1. Use repeatedly PAGE button to select the MEASUREMENT menu.
2. Use ↓and ↑to select the screen with requested data.



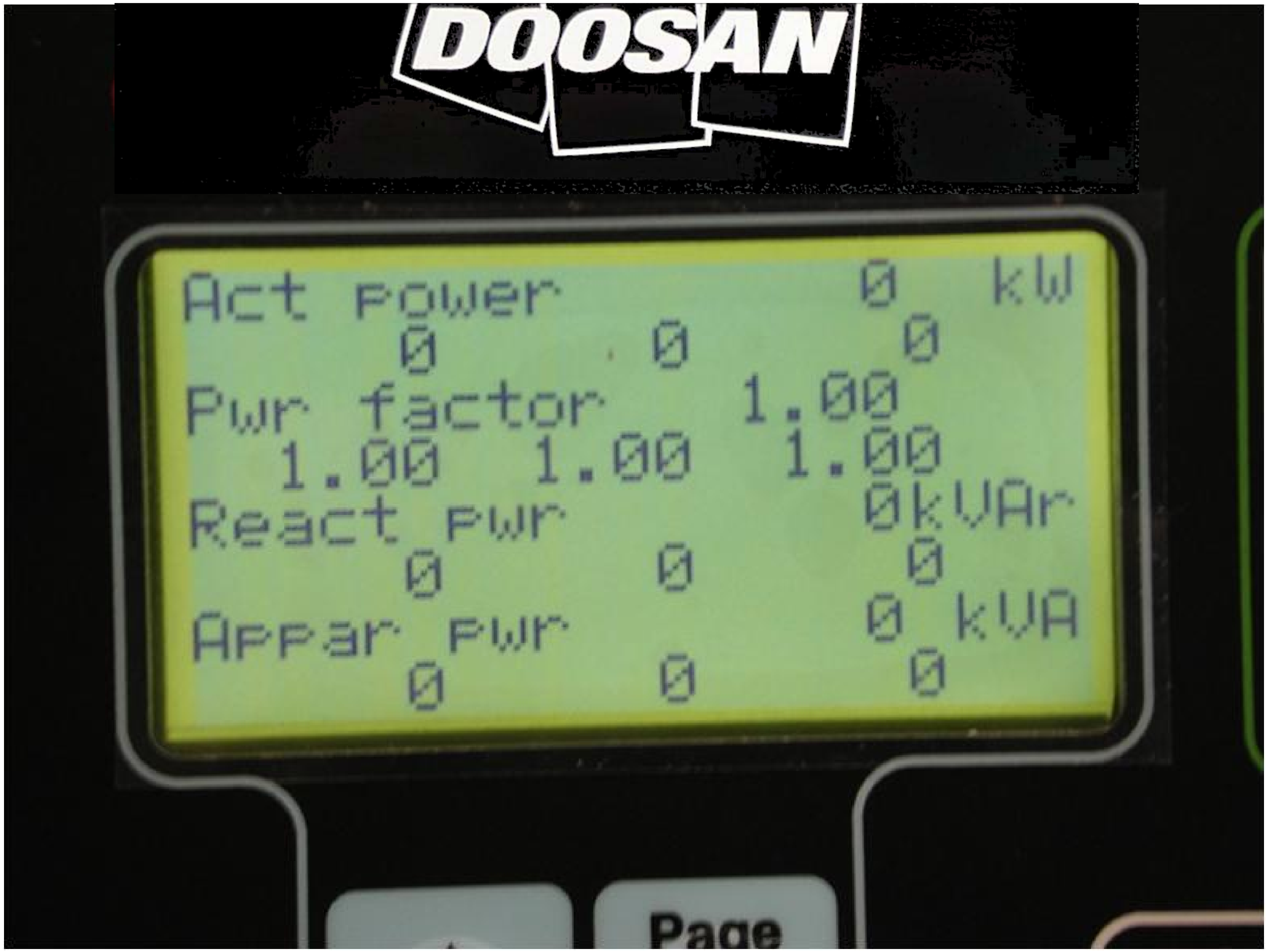
Frequency, voltage and current phase to neutral and phase to phase

How to display menus?



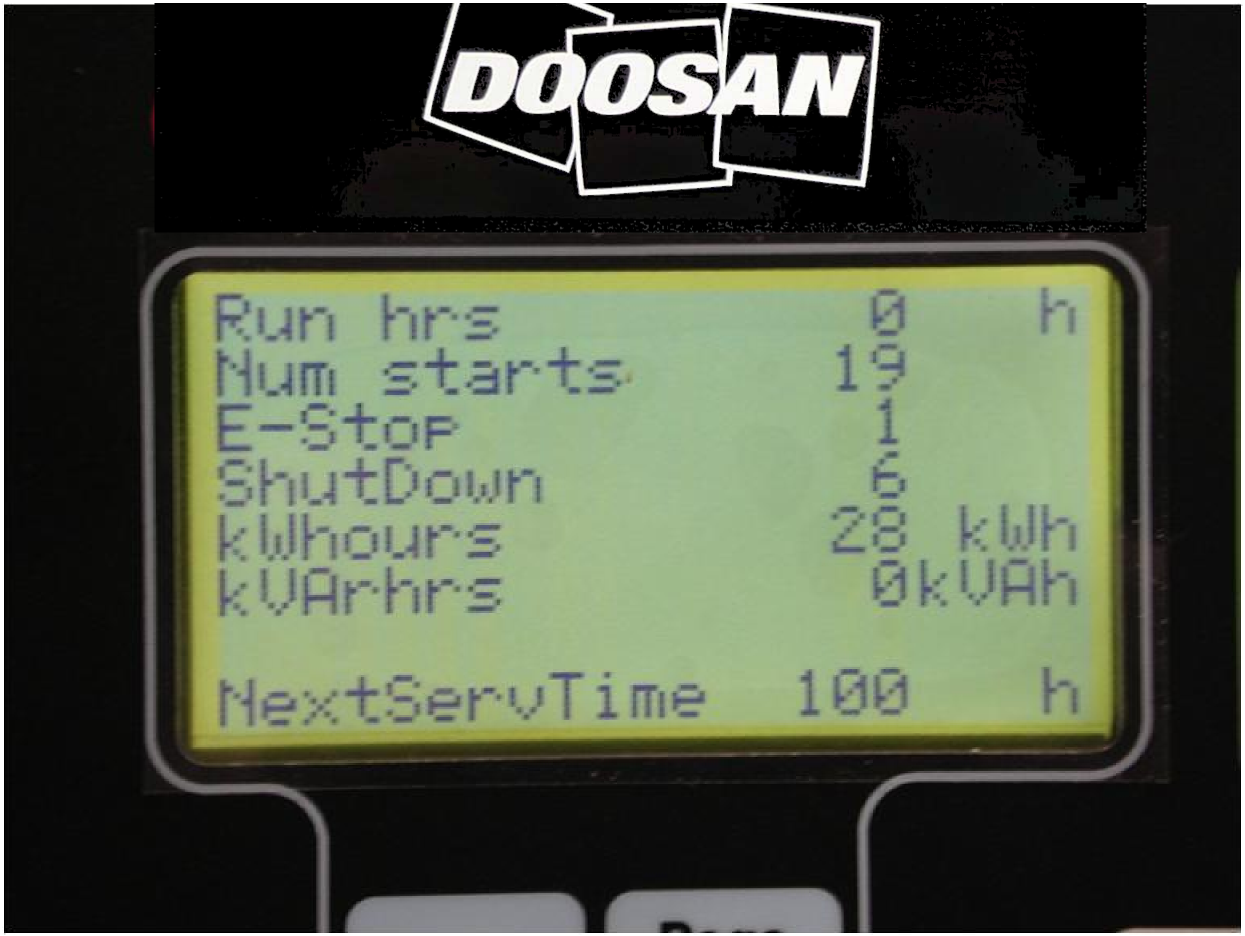
Engine oil pressure, water temperature, fuel level and battery voltage

How to display menus?



Active and reactive power, power factor

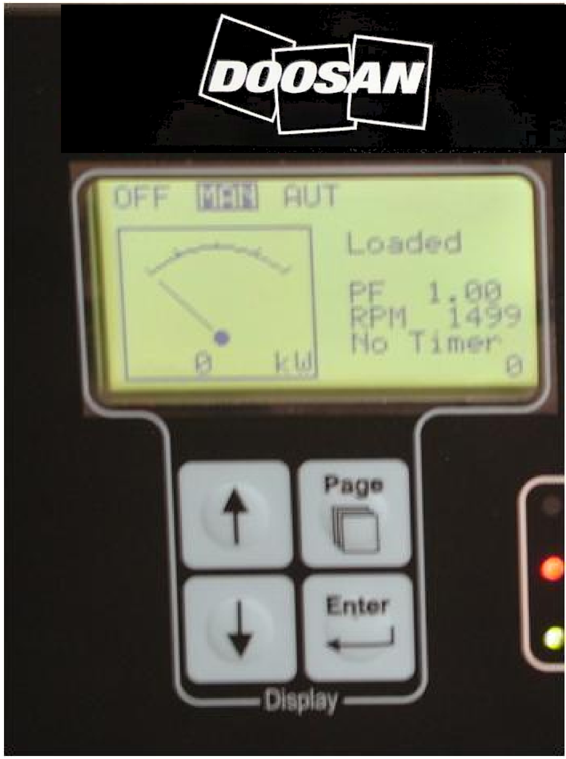
How to display menus?



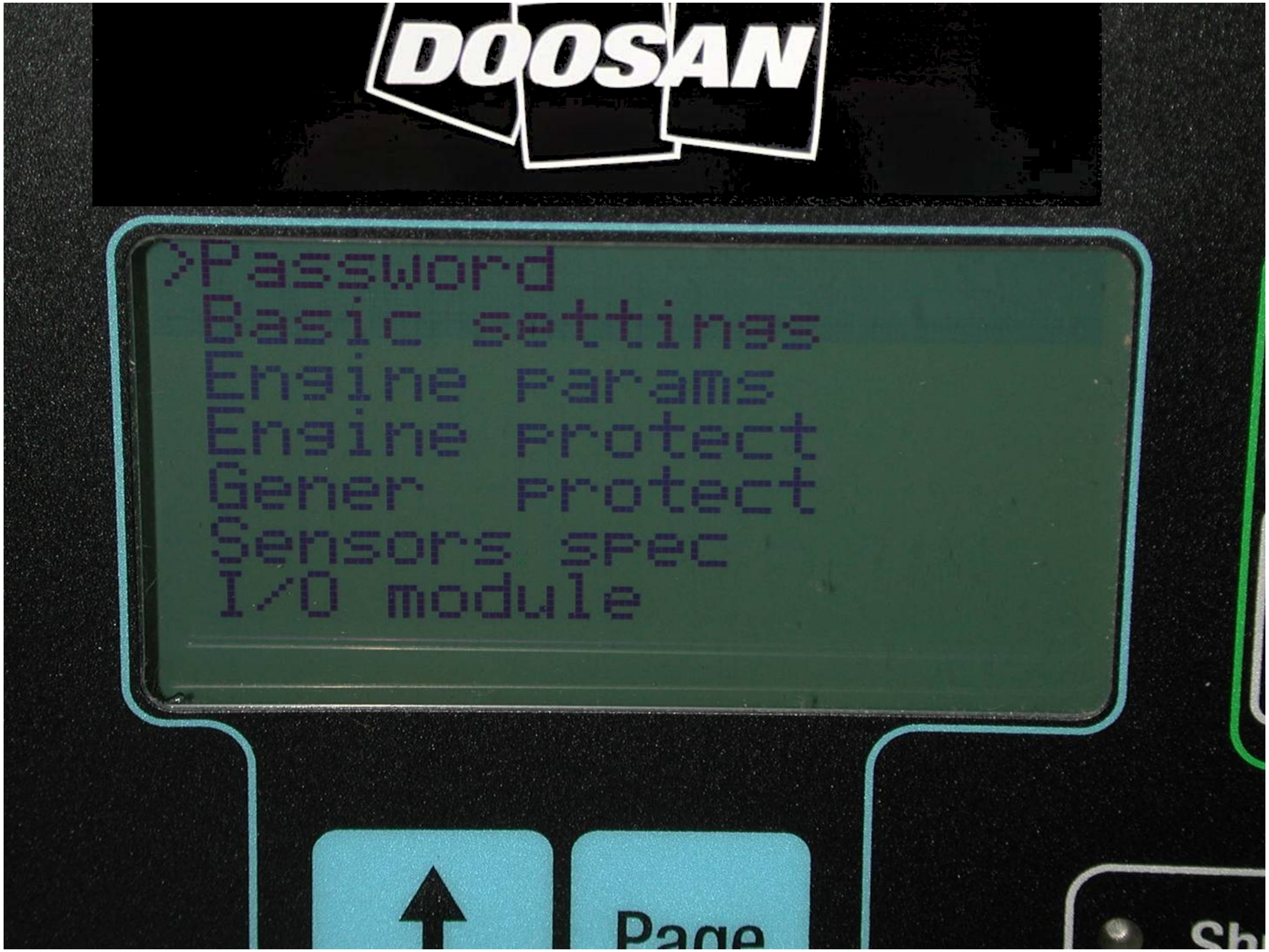
Running hours and service time

How to view and edit settings?

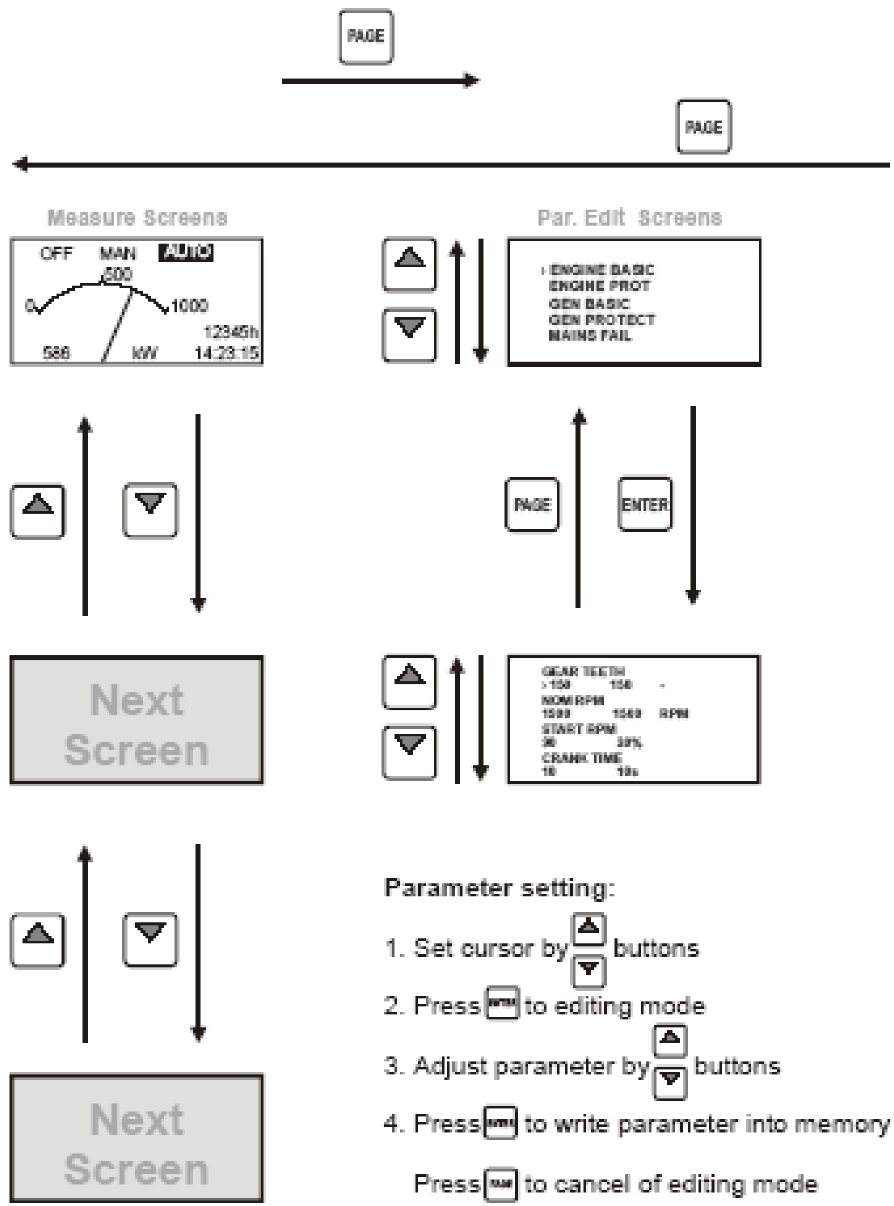
1. Use repeatedly PAGE button to select the ADJUSTMENT menu.
2. Use ↑ or ↓ to select requested set points group.
3. Press ENTER to confirm.
4. Use ↑ or ↓ to select requested set point.
5. Set points marked "*" are password protected.
6. Press ENTER to edit.
7. Use ↑ or ↓ to modify the set point. When ↑ or ↓ is pressed for 2 sec, auto repeat function is activated.
8. Press ENTER to confirm or PAGE to leave without change.
9. Press PAGE to leave selected set points group.



How to view and edit settings?



Summary


PAGE
PAGE
Measure Screens
OFF MAN AUTO
500
0
1000
12345h
586 kW 14:23:15
Par. Edit Screens
ENGINE BASIC
ENGINE PROT
GEN BASIC
GEN PROTECT
MAINS FAIL
PAGE
ENTER
Next Screen
GEAR TEETH
NOM RPM
START RPM
CRANK TIME
Next Screen
Parameter setting:
1. Set cursor by buttons
2. Press to editing mode
3. Adjust parameter by buttons
4. Press to write parameter into memory
Press to cancel of editing mode

How to view and edit settings?

The following sub-menus are available in the controller

Basic settings	Engine params	Engine protect
Gen-set name	Starting RPM	Eng prot del
Nomin power 1	Starting POil	Alarm Horn
Nomin power 2	Preheat time	Overspeed
Nomin current1	MaxCrank time	Oil Pressu Wrn
Nomin current2	CrnkFail pause	Oil Pressur Sd
CT ratio	Crank attempts	Oil Pressu Del
PT ratio	Idle time	Engine Temp Sd
Nomin Volt1	Min stab time	Engine Tem Wrn
Nomin Volt2	Max stab time	Wrn EngTempLow
Nominal freq 1	Cooling speed	Engine Tem Del
Nominal freq 2	Cooling time	Wrn FuelLevel
Gear teeth	AfterCool time	Sd FuelLevel
AlternatorFreq	Stop time	Fuel Level del
Nominal RPM 1	Fuel solenoid	Batt overvolt
Nominal RPM 2	Fuel PullCoil	Batt undervolt
ControllerMode	D+ function	Batt volt del
FltResGoToMAN	ECU FreqSelect	NextServTime
DispBaklightTO	ECU SpeedAdj	
IL Power Off	WtBfAcceptRPM	
Contr. addr		
COM1 Mode		
COM2 Mode		
ModemIniString		
ModbusComSpeed		

How to view and edit settings?

The following sub-menus are available in the controller (continued)

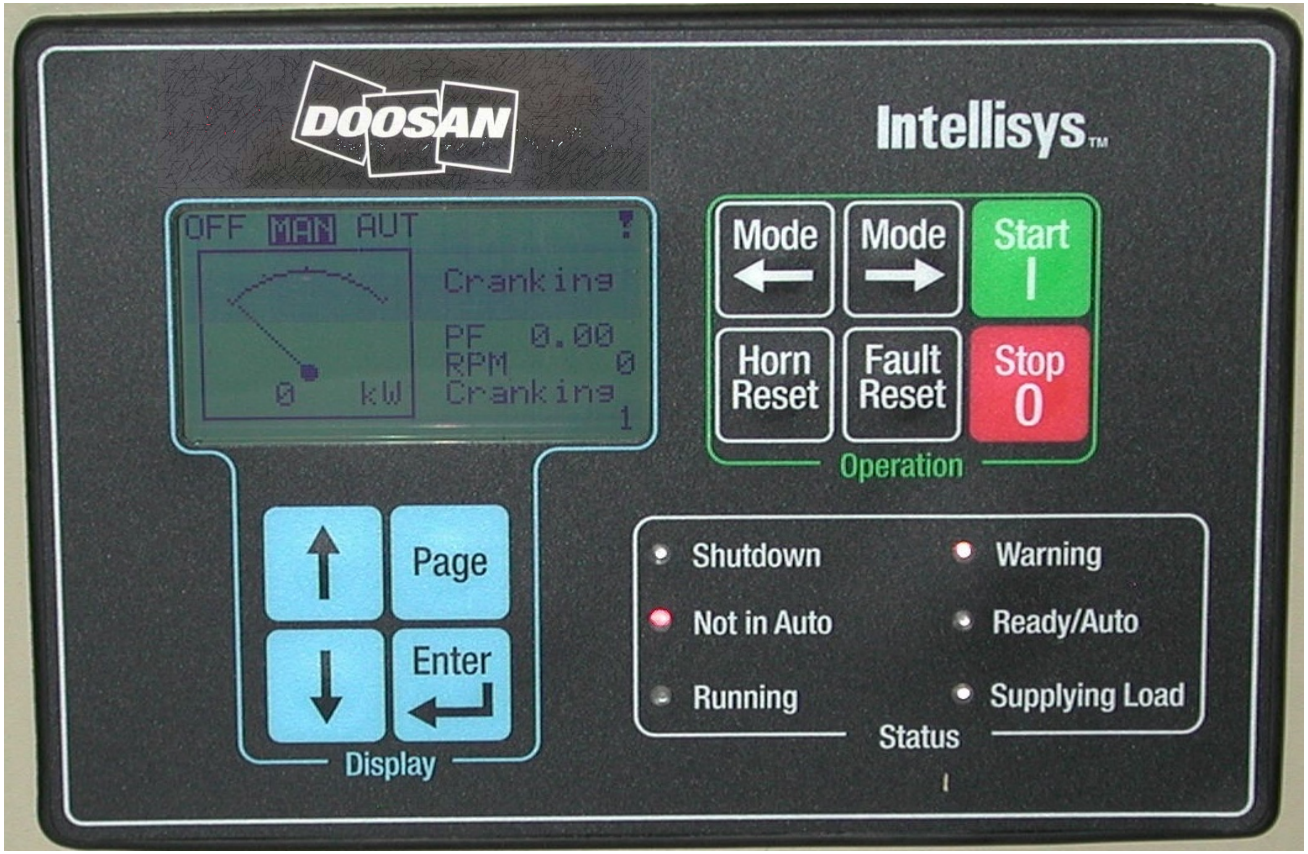
Gener protect	Date/Time	Sensors spec
Overload	Time stamp per	Calibr AI 1
Overload Wrn	#SummerTimeMod	Calibr AI 2
Overload del	#Time	Calibr AI 3
Ishort	#Date	CalibrAInIOM 1
Ishort del	Timer1 repeat	CalibrAInIOM 2
2Inom del	Timer1 ON time	CalibrAInIOM 3
Curr unbal	Timer1Duration	CalibrAInIOM 4
Curr unbal del	Timer1OFF time	
Gen >V Sd	Timer2 repeat	
Gen >V Wrn	Timer2 ON time	
Gen <V Wrn	Timer2Duration	
Gen <V SD	Timer2OFF time	
Gen V del		
Volt unbal		
Volt unbal del		
Gen >f		
Gen >f Wrn		
Gen <f Wrn		
Gen <f		
Gen f del		

Function description

1. **OFF mode: No start of the gen-set is possible. Outputs STARTER, and FUEL SOLENOID are not energized. No reaction if buttons START,STOP are pressed.**

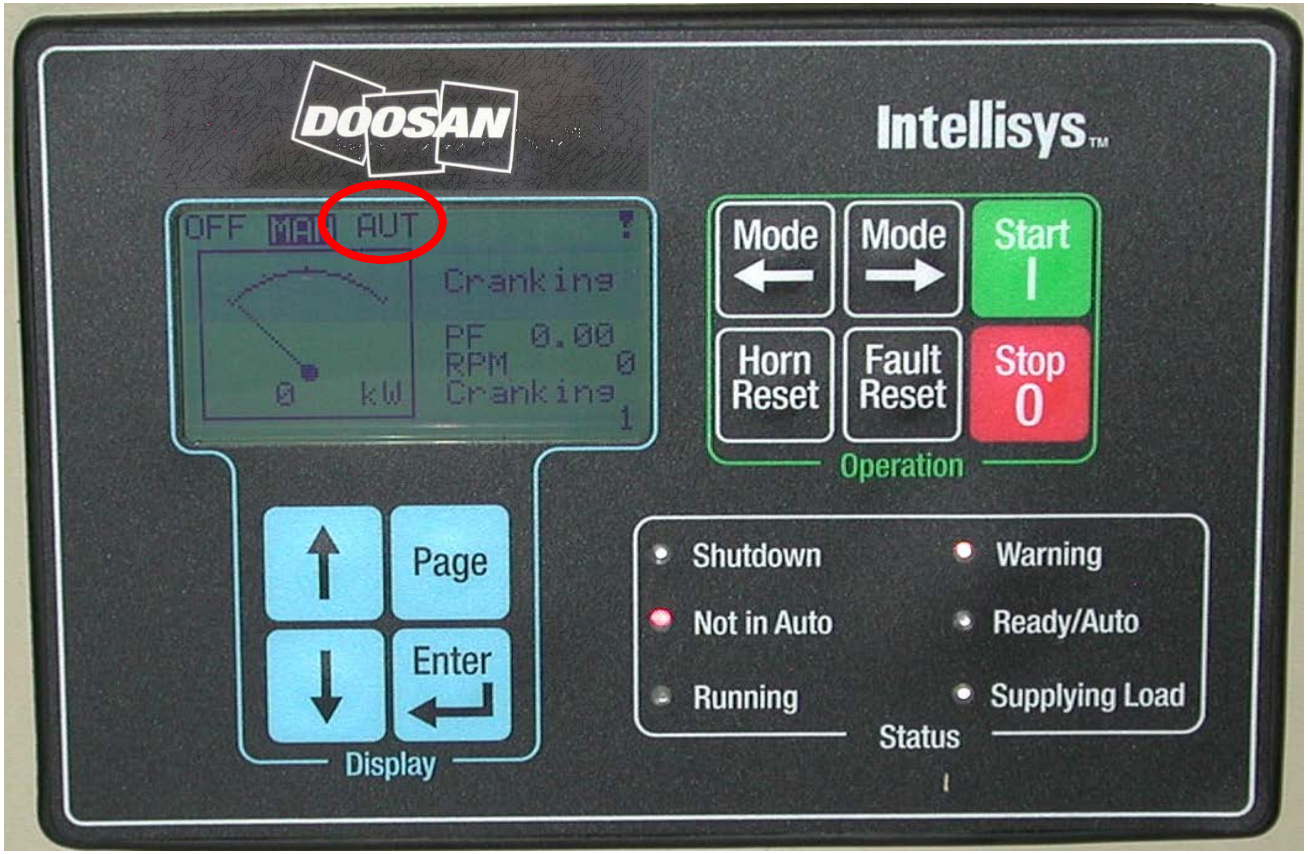
Function description

2. MAN mode: START. - starts the gen-set. STOP stops the gen-set.



Function description

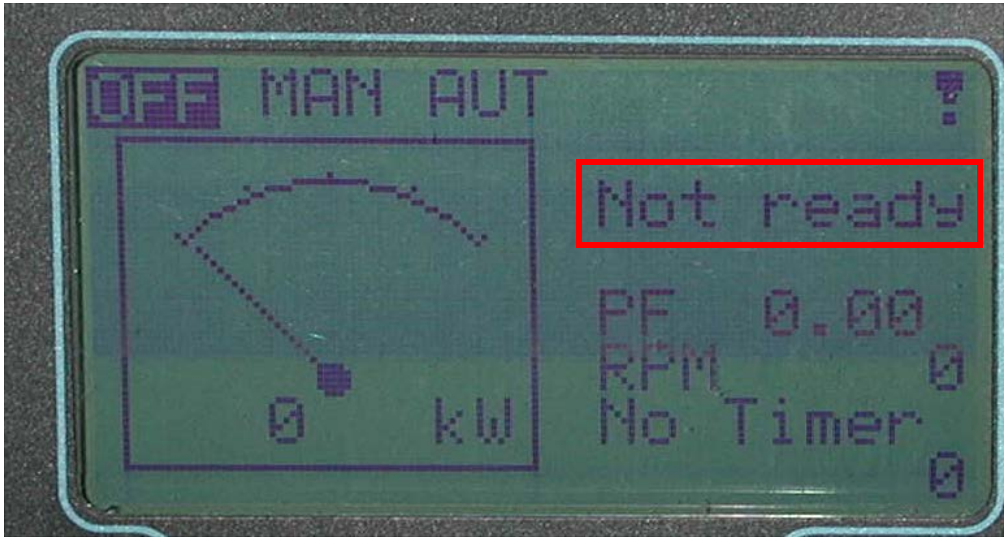
3. **AUTO mode: The controller does not respond to buttons START, STOP. Engine start/stop request is given by binary input REM START/STOP.**



Gen-set operation states

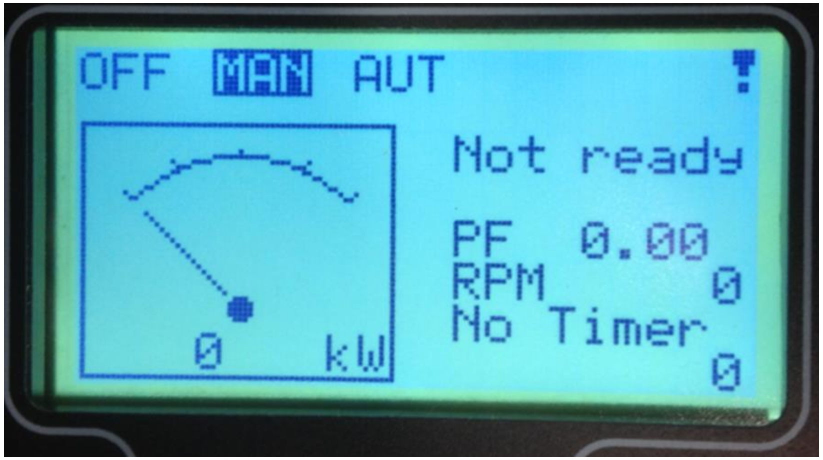
Engine state machine

Init	Autotest during controller power on
Not ready	Genset is not ready to start
Preheat	Preheat sequence in process, Preheat output is closed
Cranking	Engine is cranking
Pause	Pause between start attempts
Starting	Starting speed is reached and the *Idle timer* is running
Running	Genset is running at nominal speed
Loaded	Genset is running at nominal speed and GCB OPEN/CLOSE is closed
Stop	Stop
Shutdown	Shut-down alarm activated
Ready	Genset is ready to run
Cooling	Genset is cooling before stop

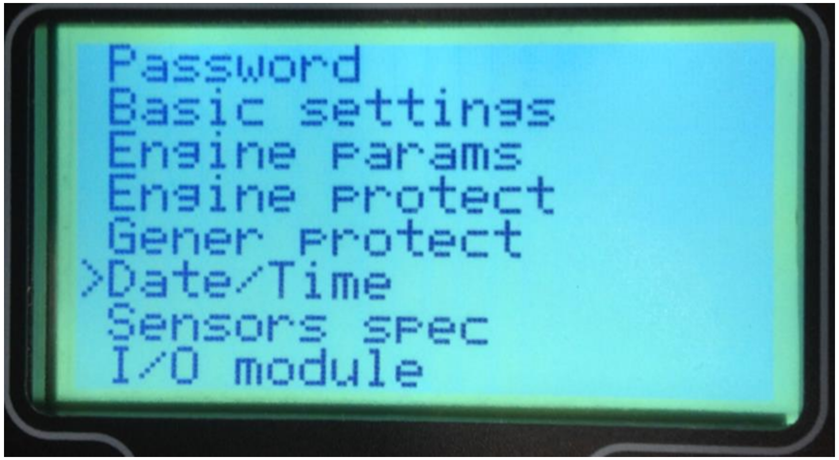


Digital controller clock start setting: time setup

1. From the start page press the “PAGE” button

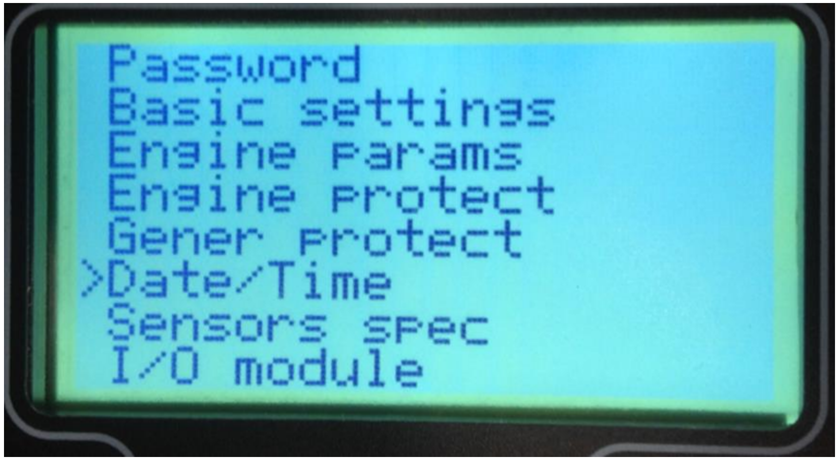


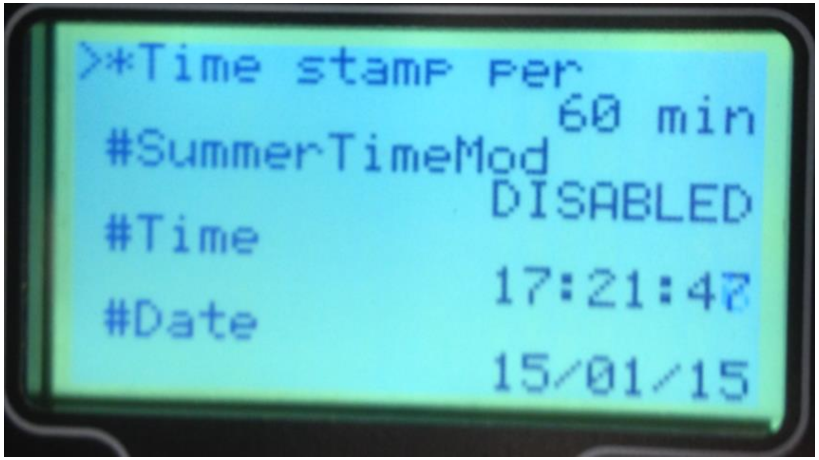
2. You get to the sub-menus list



Digital controller clock start setting: time setup

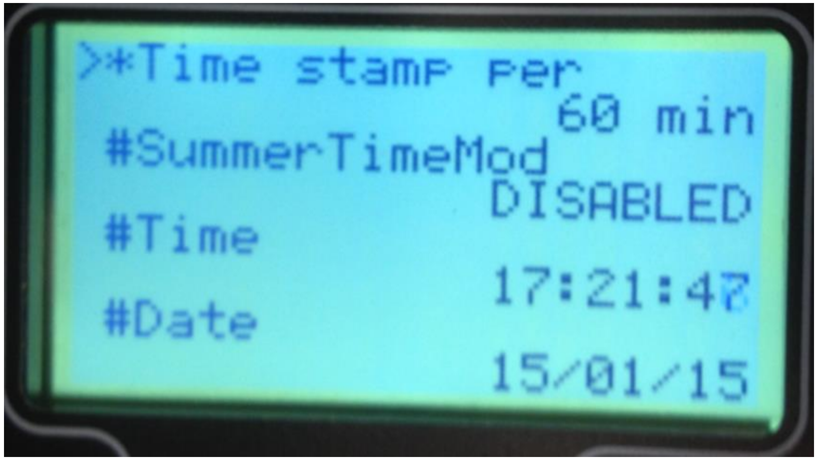
3. **By using the down arrow, select the "Date/Time" menu, then press "ENTER"**

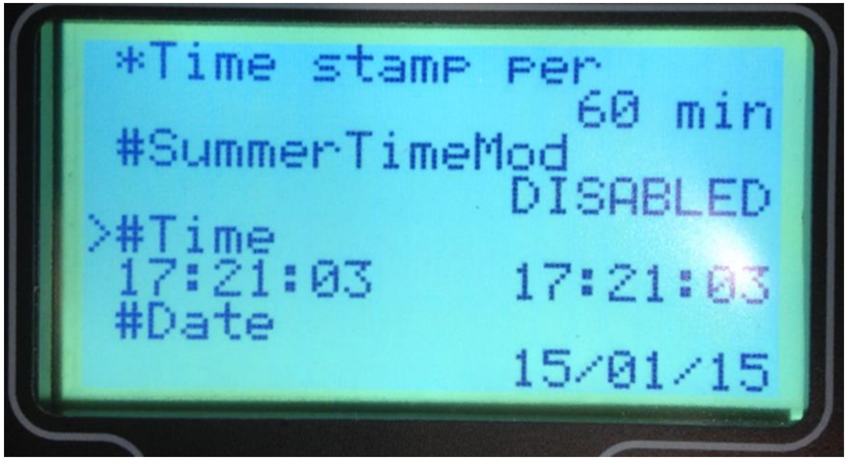




Digital controller clock start setting: time setup

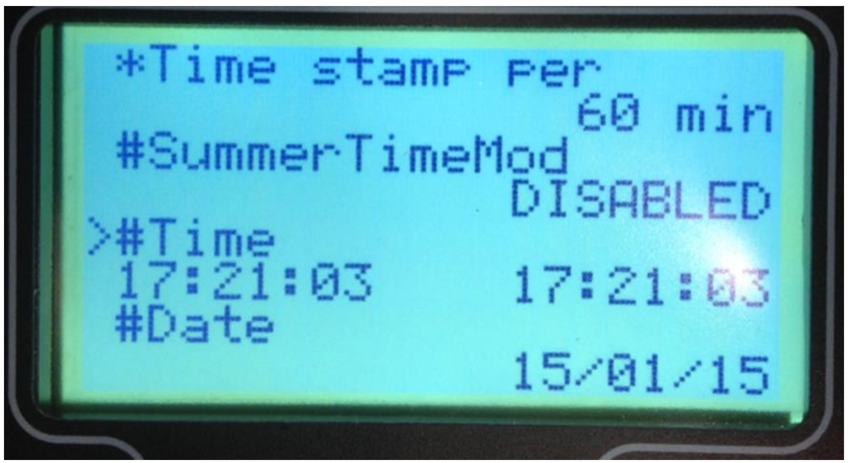
4. **By using the down arrow, select the "#Time" menu, then press "ENTER". A "duplicate" time appears**





Digital controller clock start setting: time setup

5. By using the up or down arrow, adjust the “duplicate” time to your local time. Press “ENTER”, the time set in the controller adjusts accordingly. Use the same procedure for the date, if adjustment is needed.



Digital controller clock start setting: start time setup

6. Using the same principle, select the “Timer1 repeat” menu, press “ENTER” and adjust the days you need the machine to start. Choices are day by day, Monday to Friday, Monday to Saturday, Monday to Sunday, Saturday to Sunday. Press “ENTER” to validate your choice.

Digital controller clock start setting: start time setup

7. Using the same principle, select the “Timer1 ON time” menu, press “ENTER” and adjust the hour you need the machine to start at. Press “ENTER” to validate your choice. Same procedure for “Timer1 OFF time

Digital controller clock start setting: start time setup

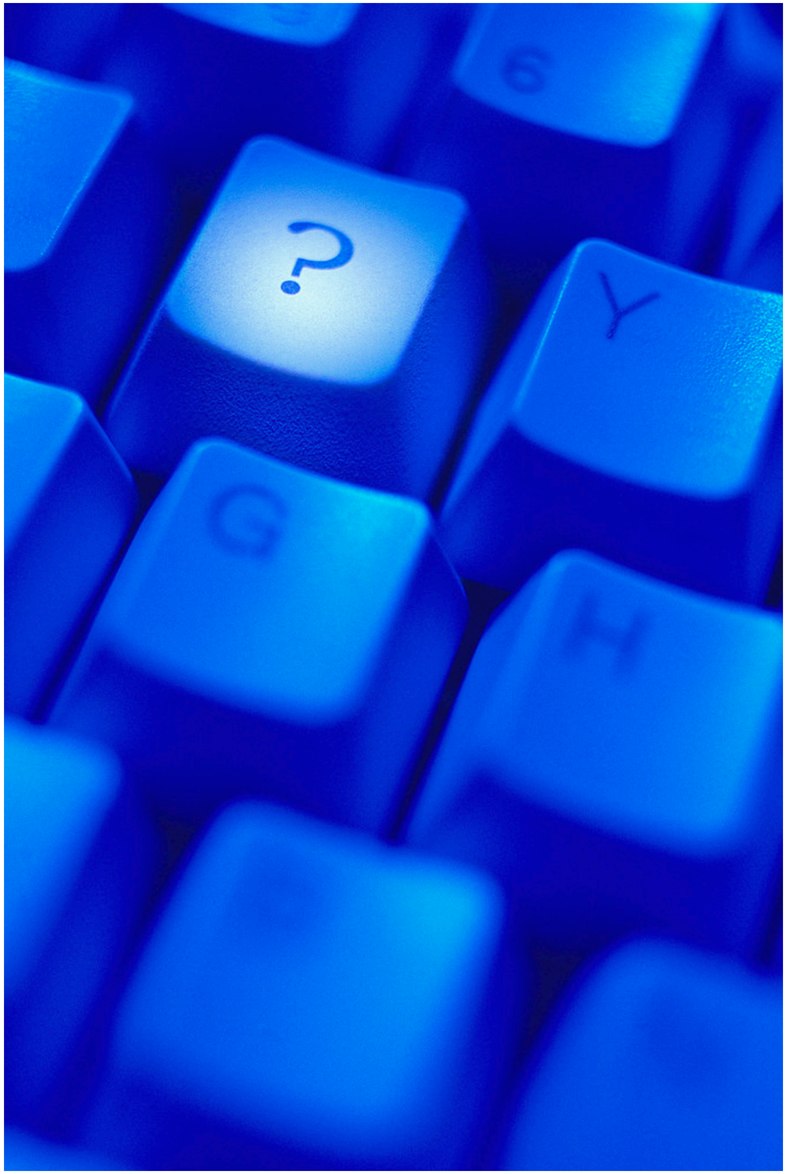
8. Your timer is now all set up. It will apply whenever you set the controller in “AUTO” mode.

How to use the controller software

Connect your PC through the RS232 port to the back of the controller and start the Comap software.

If your PC doesn't have a RS232 connection, you can source a USB to RS232 converter from Doosan, CPN is 46551205 , to be used together with a female – female RS232 DB9 NULL cable.

Switch the controller on (green button) and get connected.
Save the history file using the generator's serial number and date number as file name.



Doosan Infracore

Service training: Generators

Operation

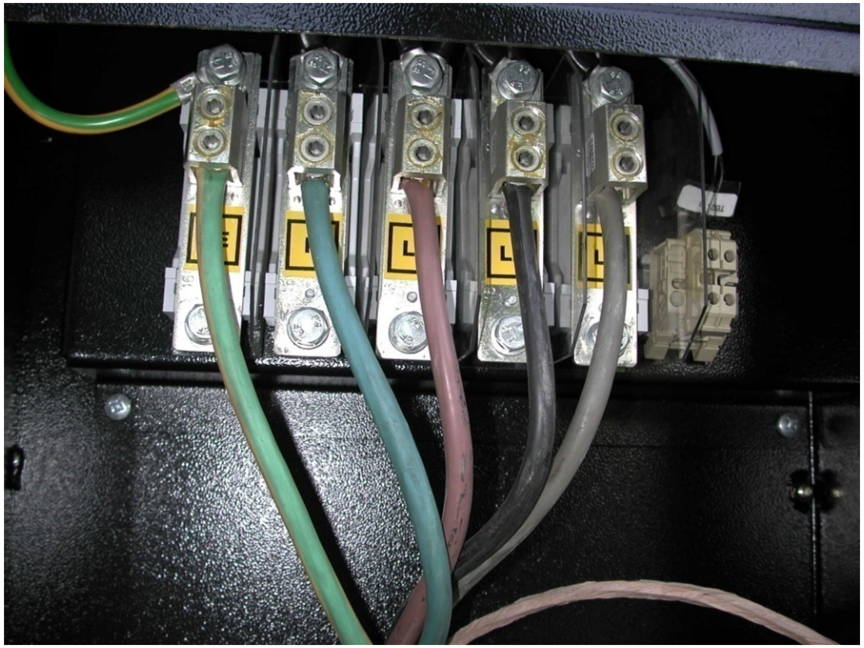
Doosan Infracore
Portable Power

Course Objectives

- Connecting the load
- Pre-start checks
- Starting the generator
- Stopping the generator

Connecting the load

- Make sure the wires are not cracked or damaged in any way
- Connect the proper phase wire to its corresponding bar L1–L2–L3. Mixing phases connections can result in equipment damage, accidents causing injuries or even death
- Always use the 5 connections, 3 phases, neutral and ground

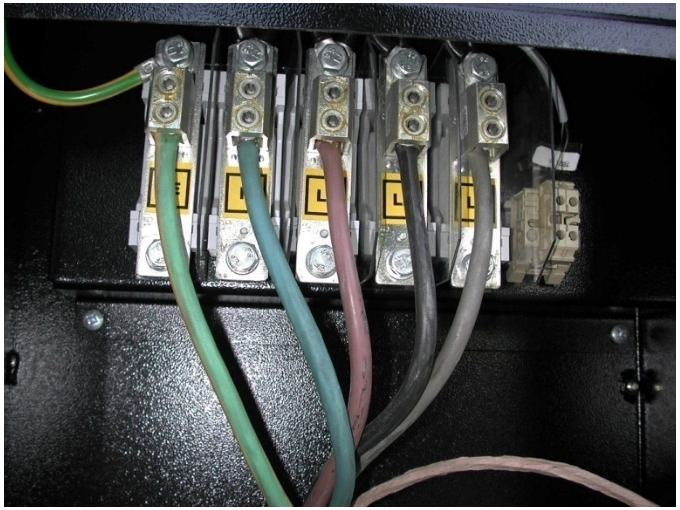


Pre-start checks

Before starting:

- Ensure load wiring connections are tight
- Check for fluid leaks
- Check for fluid level in container base
- Check engine oil and coolant level
- Check proper grounding circuit. Refer to Safety-Grounding.
- Check for frayed or loose fan belts, hoses or wiring insulation
- Check for leaves, paper, debris in air vents
- Check Fuel Level. Add CLEAN diesel fuel.

Pre-start checks



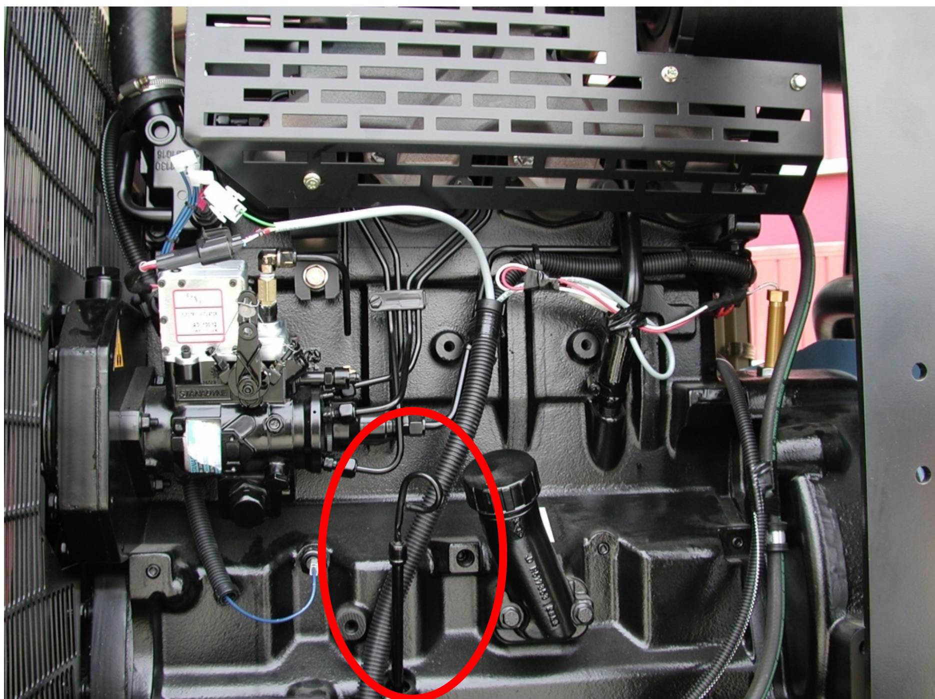
Before starting:

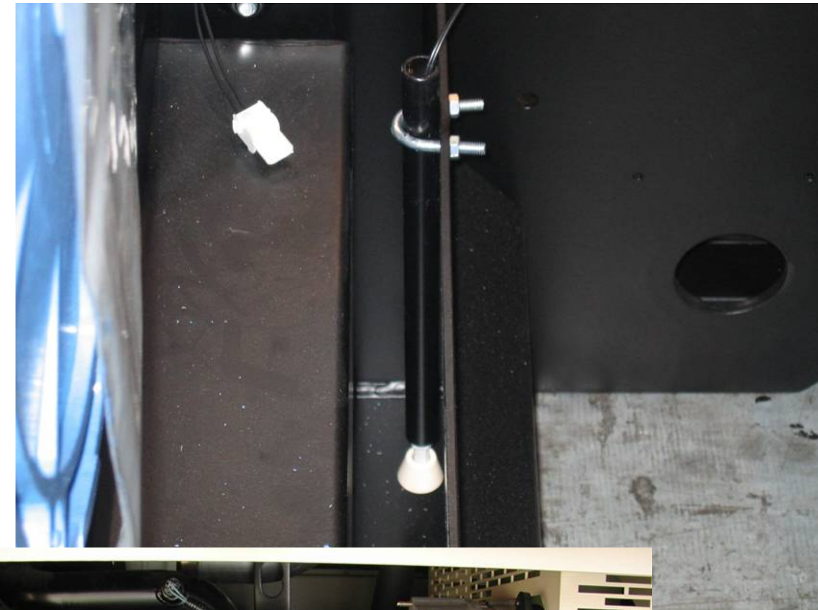
- Ensure load wiring connections are tight
- Check for fluid leaks

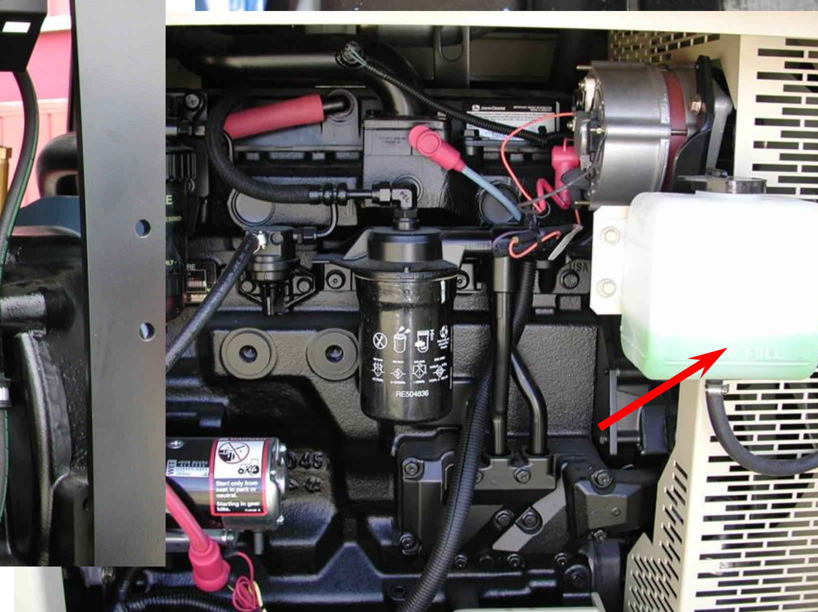
Pre-start checks

Before starting:

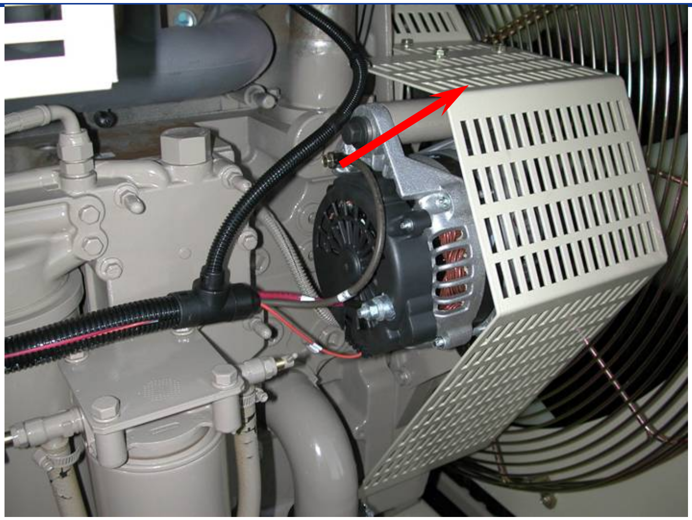
- Check for fluid level in container base
- Check engine oil and coolant level





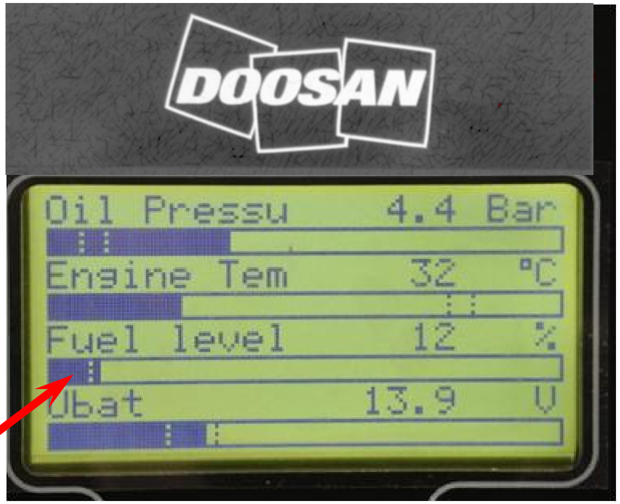


Pre-start checks



Before starting:

- Check for frayed or loose fan belts, hoses or wiring insulation
- Check for leaves, paper, debris in air vents
- Check Fuel Level.

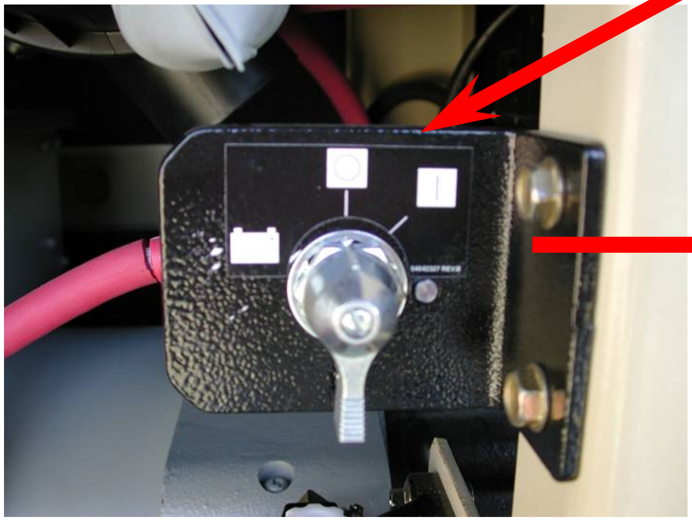


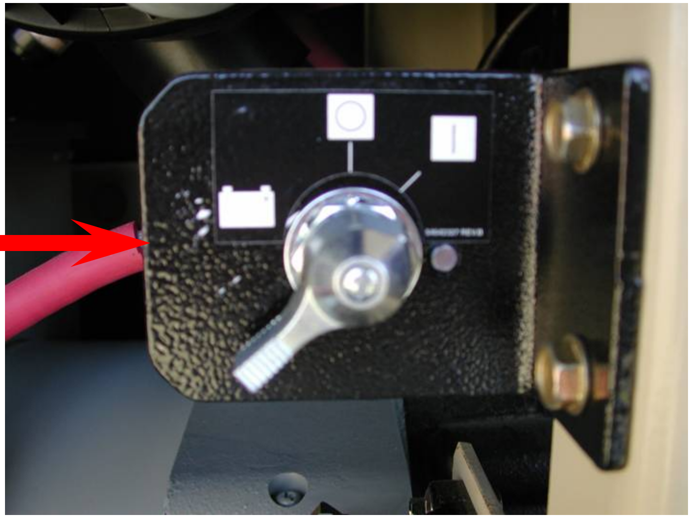
Pre-start checks

- Check Fuel Level. Add CLEAN diesel fuel if necessary.

Starting

- Switch the battery switch on





Starting

- On G10, turn the starting key to the position “I”
- Move it on to the pre-heating position and keep it there for a few seconds – 5 to 10 seconds during summer time – up to 1 ½ minute during winter time while freezing.
- If the engine doesn’t start after 15 seconds cranking, wait 1 minute before trying again.
- If the engine doesn’t start after 3 attempts, go through the troubleshooting procedure

Starting

- On G20 to G500, push the start button – the control will do the pre-heat and start procedure on its own.
- If the engine didn't start after 3 attempts, the control will show the overcranking alarm → go through the troubleshooting procedure.

Generator operation recommendations

Engine duty cycle:

Running the generator at low loads for an extended period of time will result in:

- **Fuel Dilution of the lubricating oil**
- **Carbon build up in the cylinder and turbocharger**
- **Cylinder head valve sticking**
- **Reduced performance**

The average load should not be below 40 % of the generator nominal power

Generator operation recommendations

Load unbalance:

Load unbalance between phases should not exceed 30% of the nominal load

Power factor:

- **The closer PF is to 1.0, the closer apparent power is to real power**
- **IMPORTANT!!!! The smaller the PF is, the larger the current must be to produce the same amount of real power. The alternator must be capable of providing excess current.**
- **Generators are designed for and rated at 0.8 PF to give them the capability to withstand higher current demand from loads with 0.8 PF.**

Generator operation recommendations

Power factor example:

185 kW load at 400 volts.

- **Remember 3 phase kW = Volts x Amps x PF x √3/1000, and Amps = kW x 1000 / Volts / PF**
- **If the load's PF = 1.0, the current that the load demands is: Amps = 185kW x 1000 / 400 volts / √3 / 1.0 = 267 amps**
- **A G200 can do the job**

- **If the load's PF = 0.8, the current that the load demands is: Amps = 185kW x 1000 / 400 volts / √3 / 0.8 = 334 amps to get the same 185kW of real power!**
- **A G250 is required to do this job**

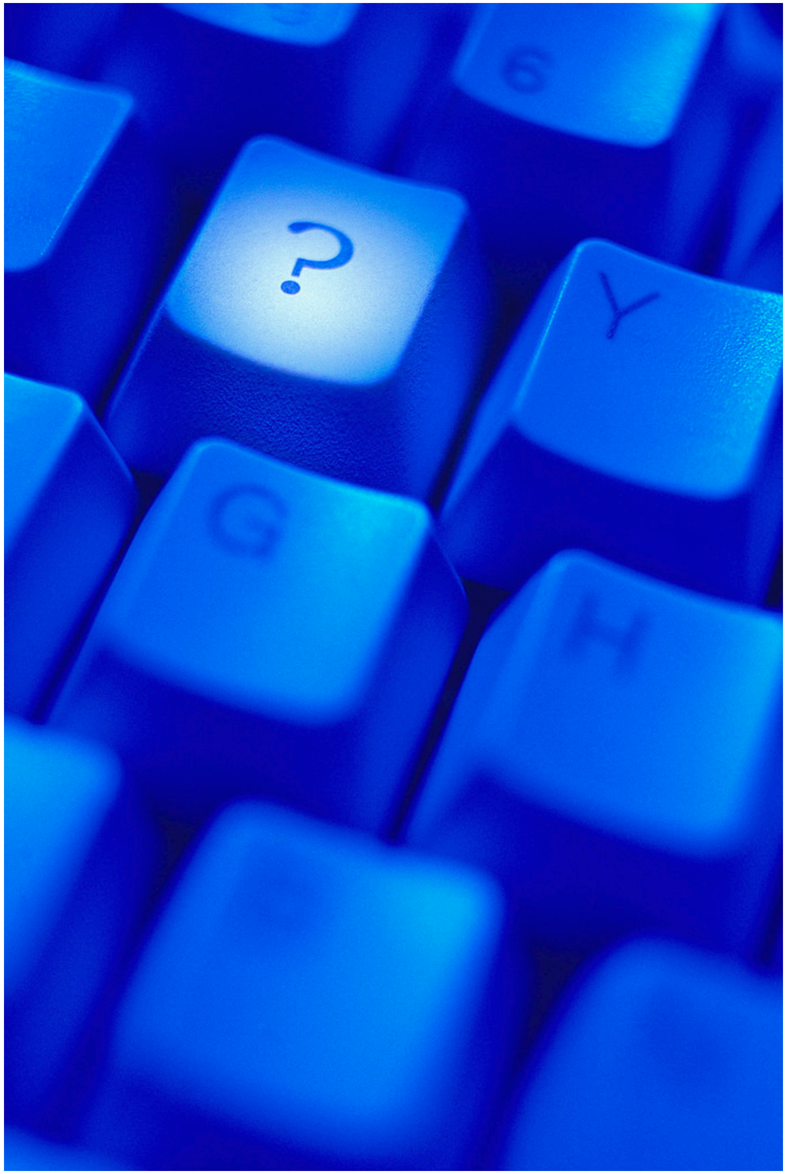
Generator operation recommendations

Power factor example Continued):

The alternator must be capable of delivering even more current than this for limited amounts of time

It is crucial to take the power factor into account before selecting the right generator for the job

When troubleshooting a generator performance problem, this also needs to be checked upfront to clearly know what the generator is really facing.



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Doosan Infracore

Service training: Generators

Testing and troubleshooting

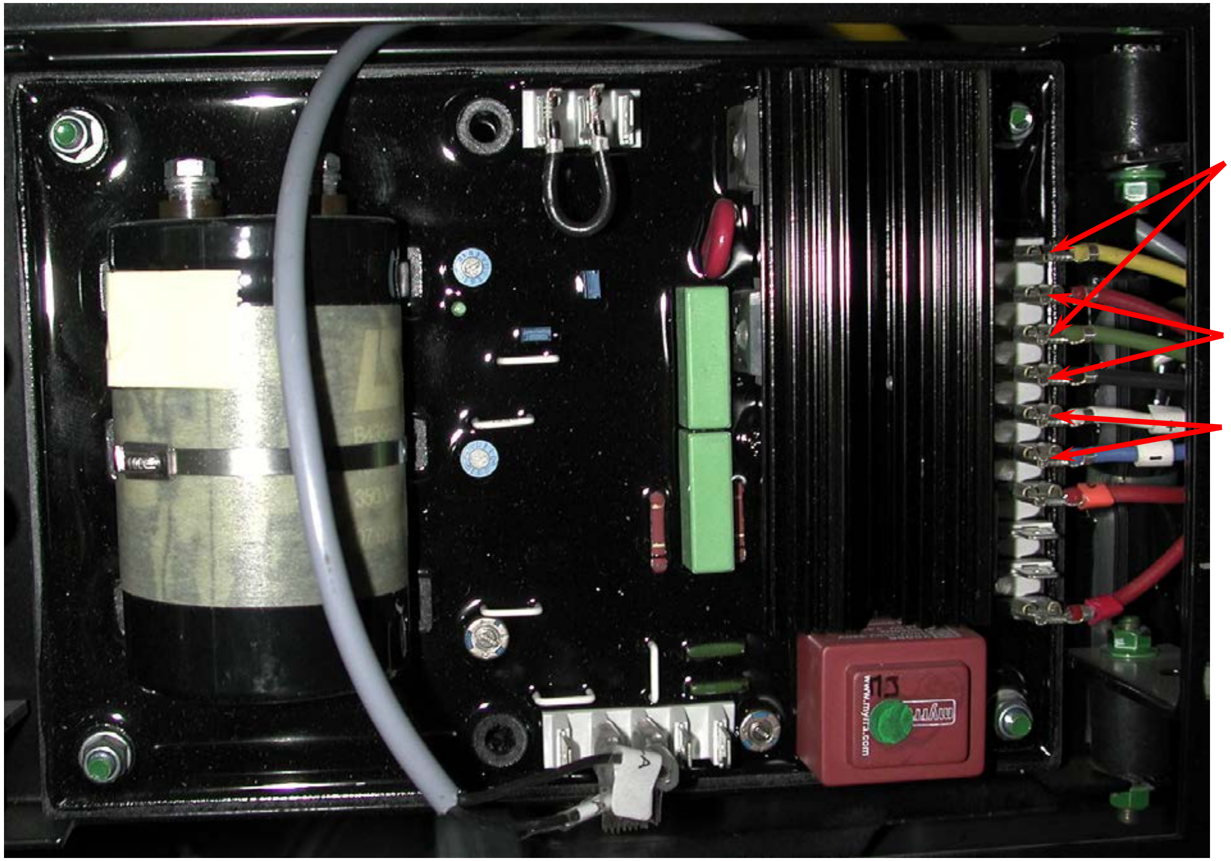
Doosan Infracore
Portable Power

Course Objectives

- Testing the AVR
- How to check the windings Integrity
- How to check diodes
- No voltage, what can be the cause?
- The control’s alarms
- Troubleshooting and fixes

AVR (Auto Voltage Regulator) testing

Disconnect the AVR wires, engine at stop, and test the auxiliary windings and field resistances



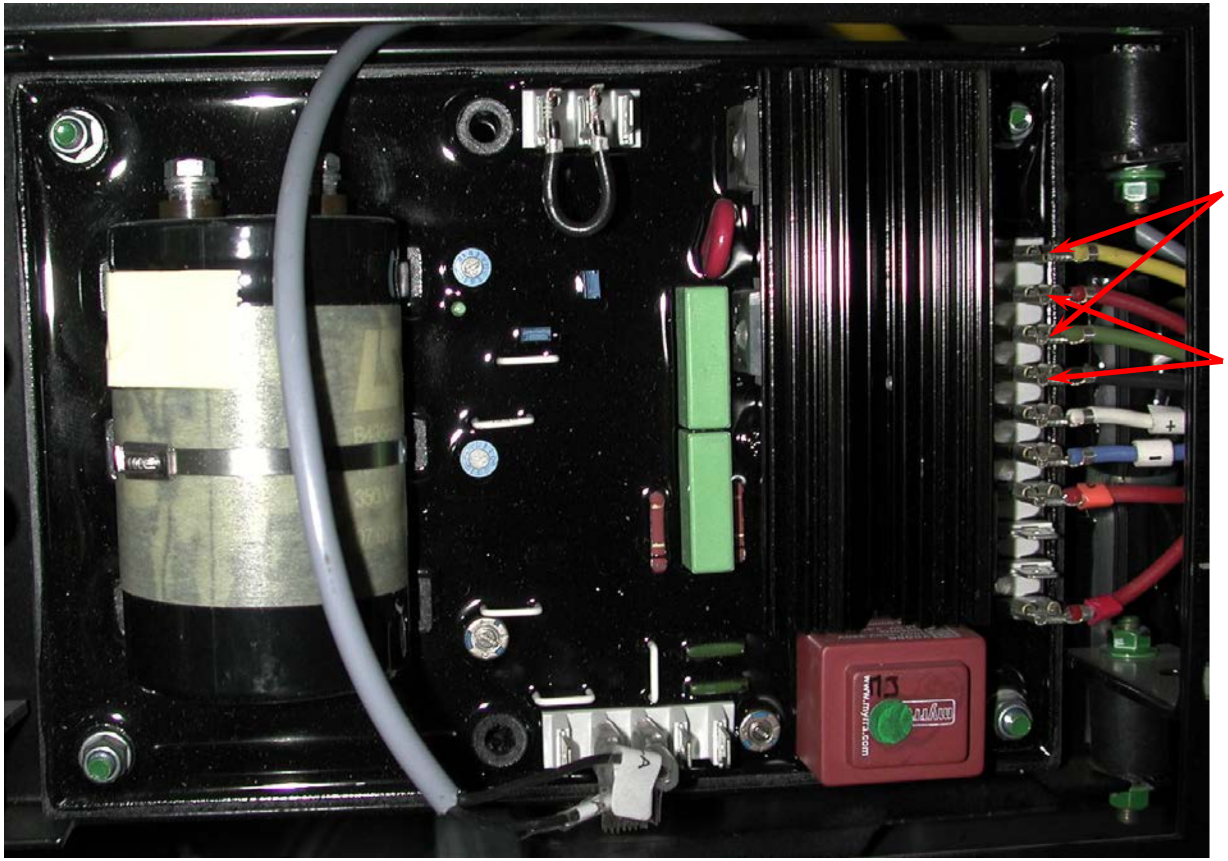
X1 – X2 connections (Ω)

Z1 – Z2 connections (Ω)

E+ – E- (Field) (Ω)

AVR (Auto Voltage Regulator) testing

With the AVR wires connected, engine running, test the auxiliary windings voltage



X1 – X2 connections: U (VAC) at no load

Z1 – Z2 connections: U (VAC) at no load

Testing of a Generator

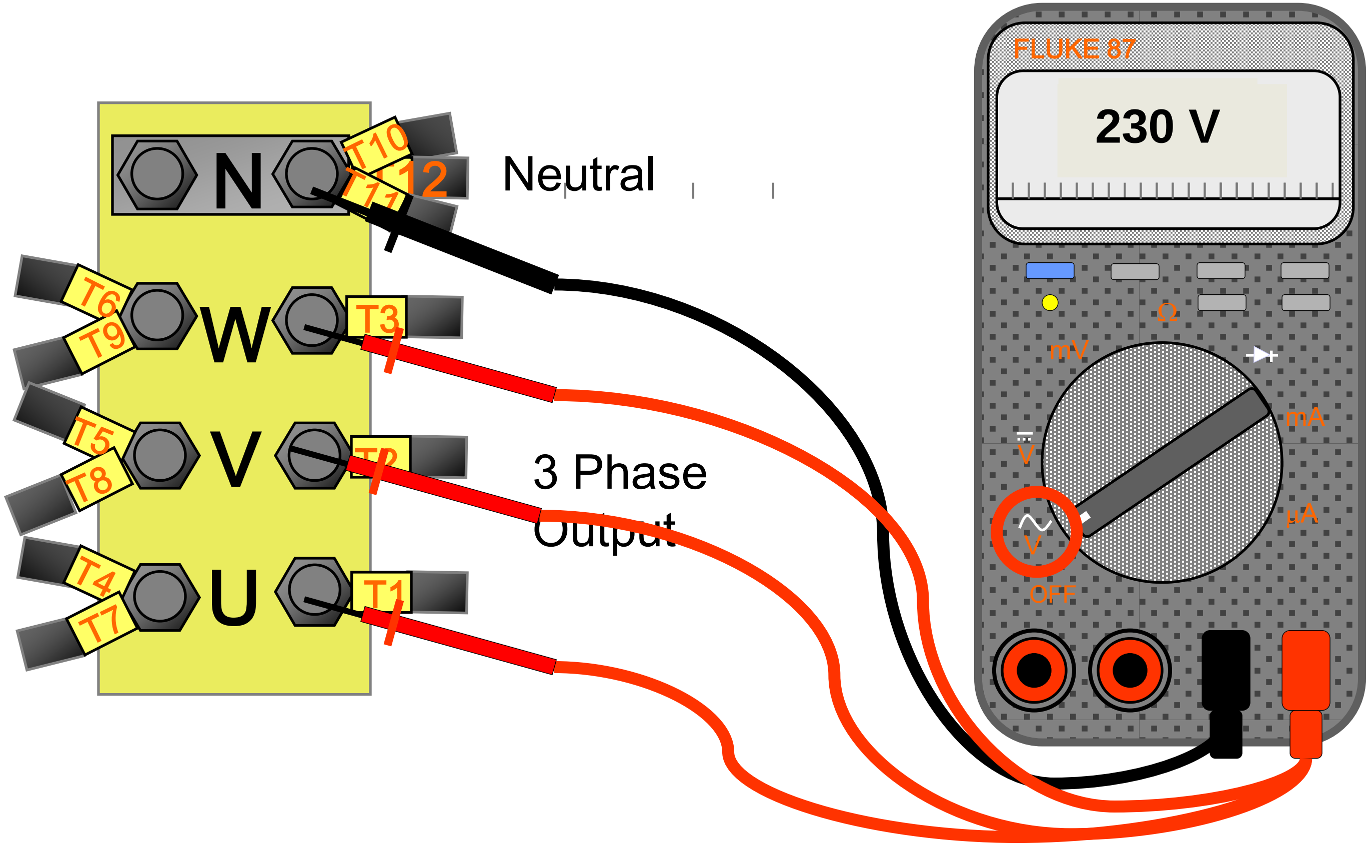
Be careful!

Use certified protection equipment rubber soles shoes, rubber gloves.

And more than never, ………..

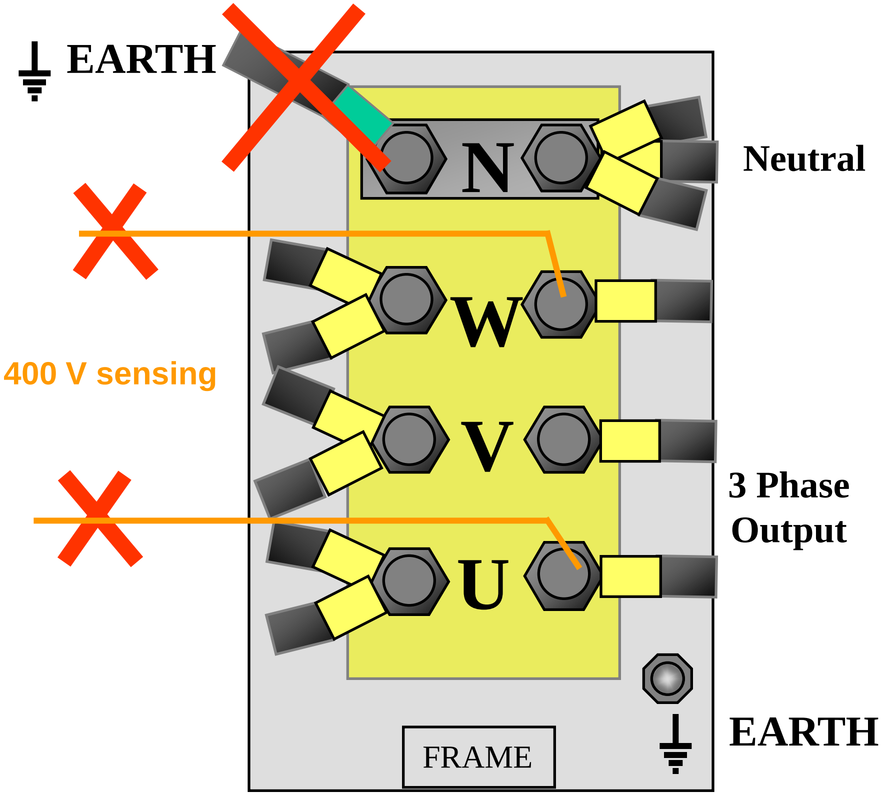
Testing of a Generator

Checking windings integrity



1. Check the voltage between U/N – V/N – W/N with a Multi-meter
2. The voltage should be 3 x the same: Max. voltage difference: 1 to 2 Volt
3. If the difference is more than 1 to 2 Volt, perform the following test:

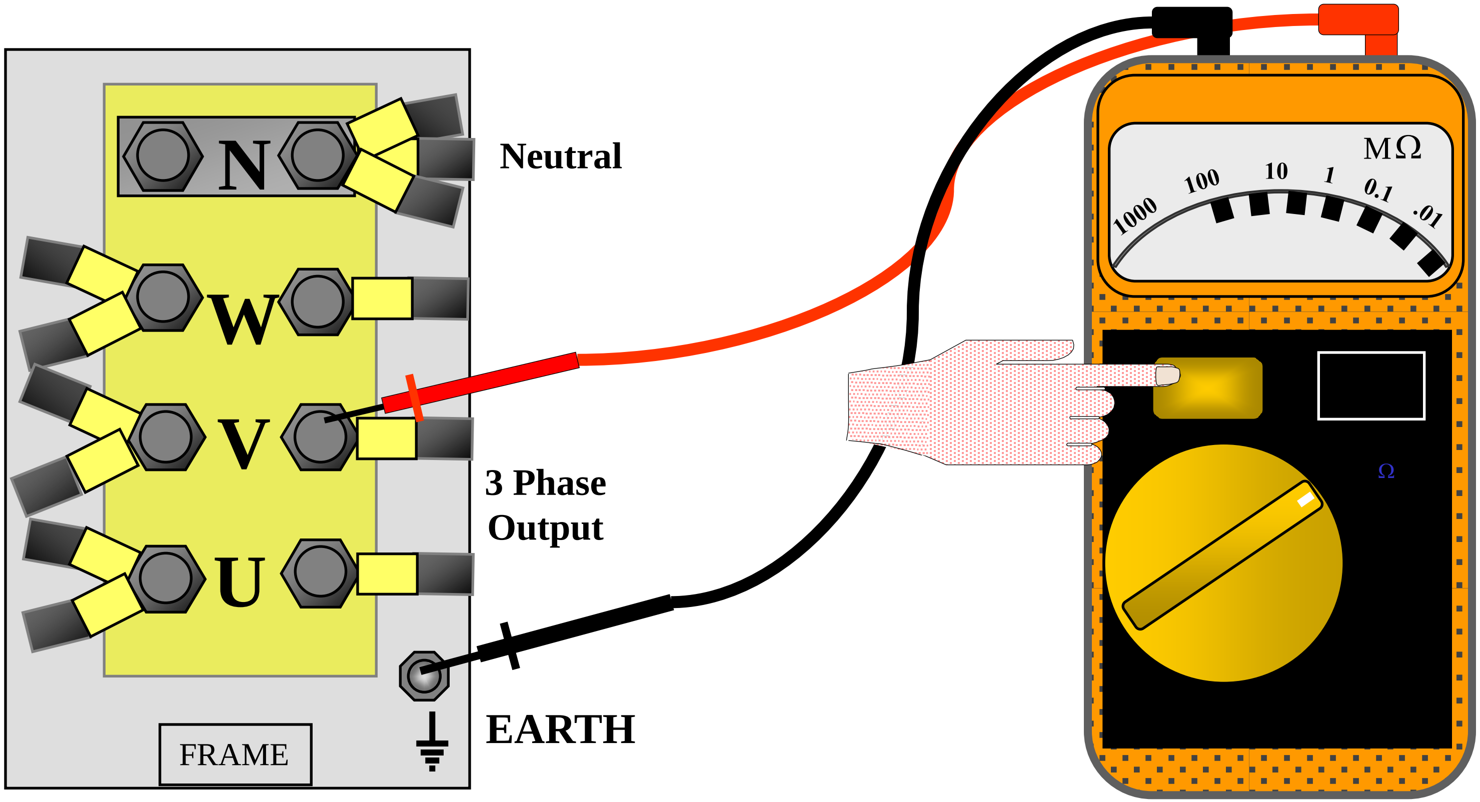
Checking windings integrity



1. Disconnect the sensing wires of the AVR before you carry out this test.

2. Disconnect the connections from Neutral to Earth.

Checking windings integrity

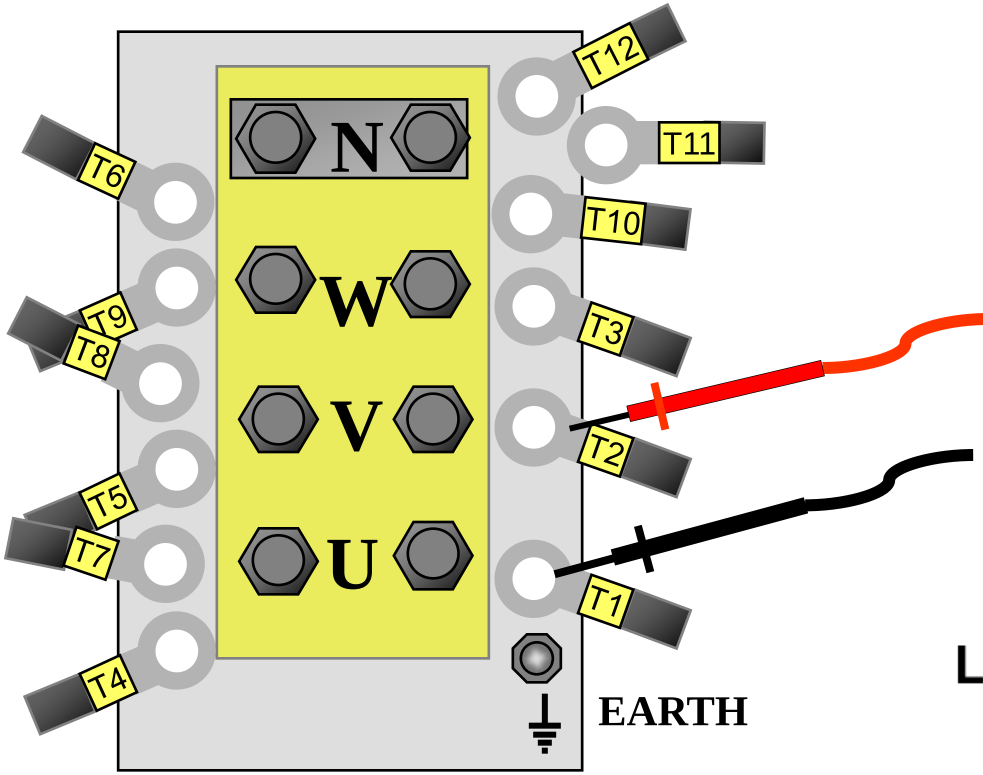


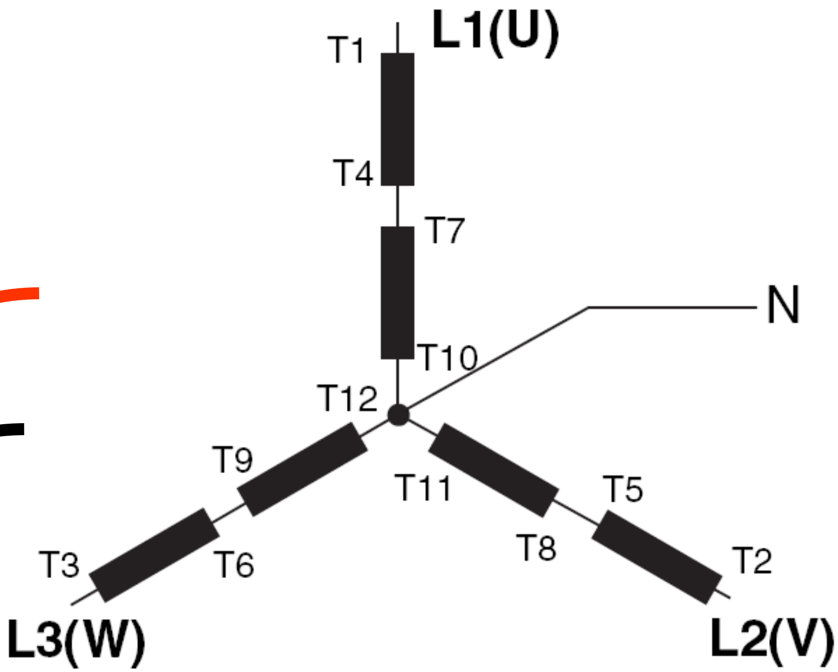
3. Test the Stator insulation (One phase – earth) with an Insulation tester.
4. The MINIMUM insulation value is 1.0 Meg-Ohm to Earth.

   Windings must be dried out if below 1 Meg-Ohm

5. If after drying, the value is good, there is still a possible fault (phase to phase)

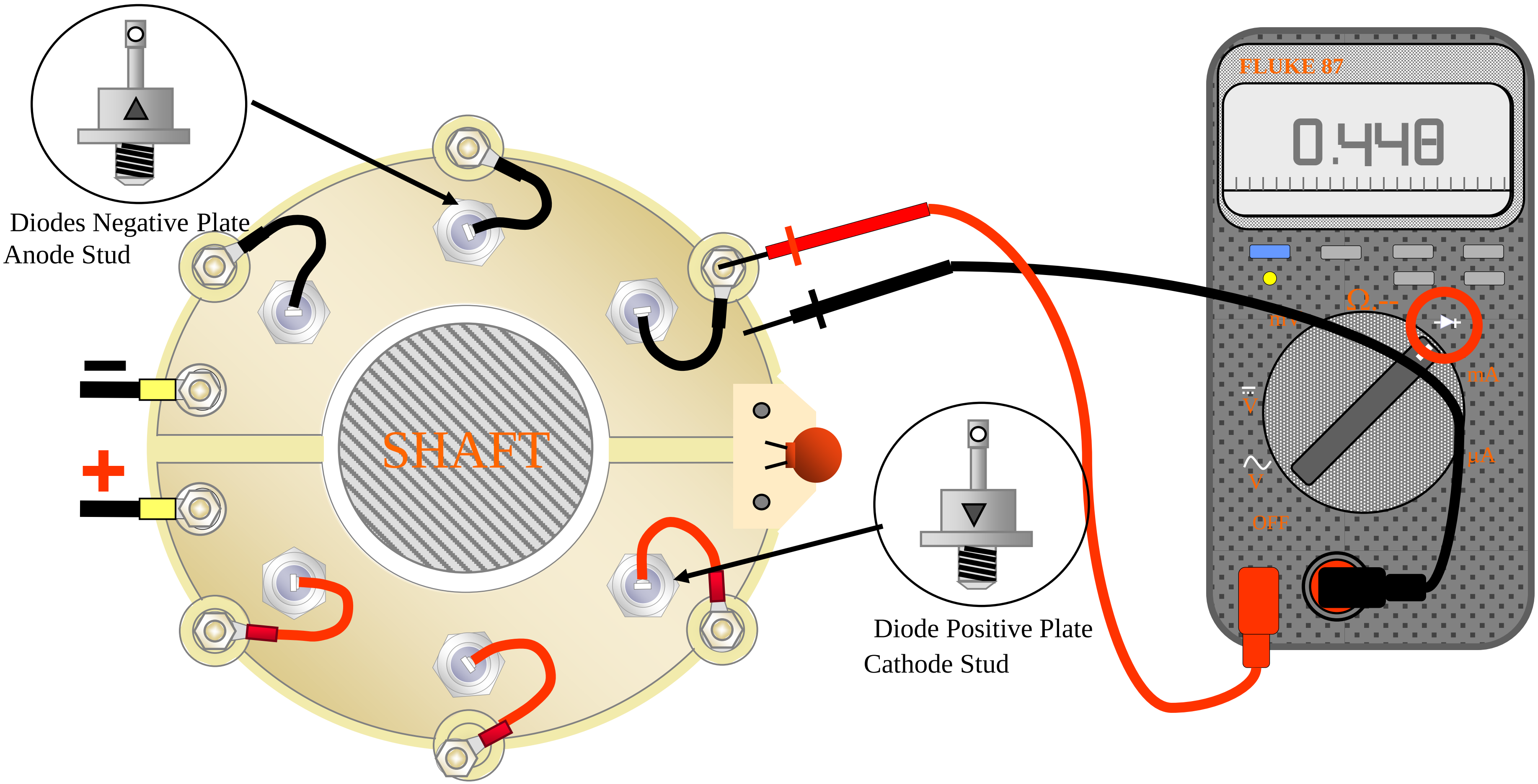
Checking windings integrity





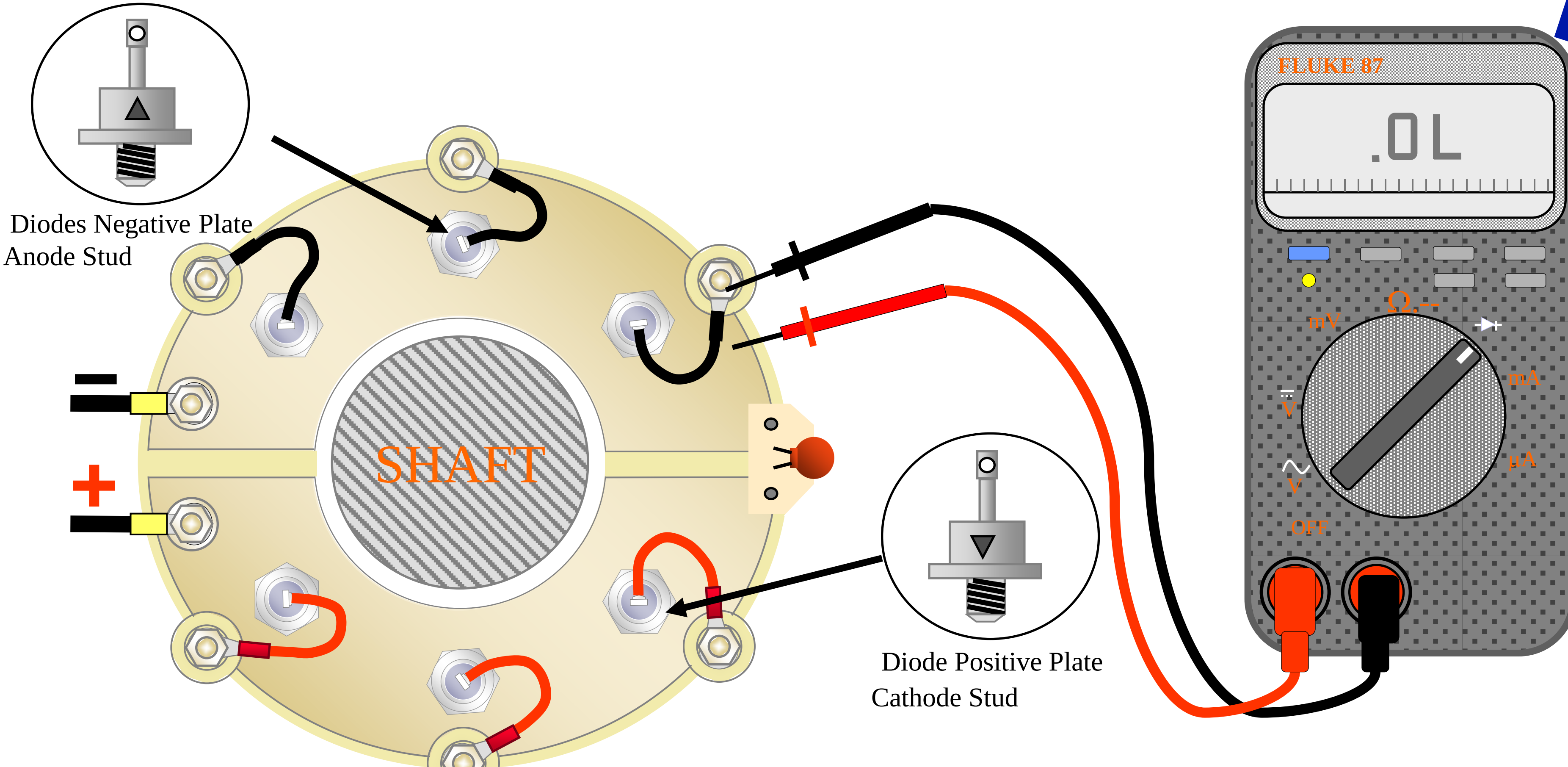
Disconnect ALL wire-ends and isolate them from each other.
Measure the windings mutual.
T1 against all others (except T4 which must be 0 meg ohm)
Value must be above 1 Meg Ohm

Checking diodes



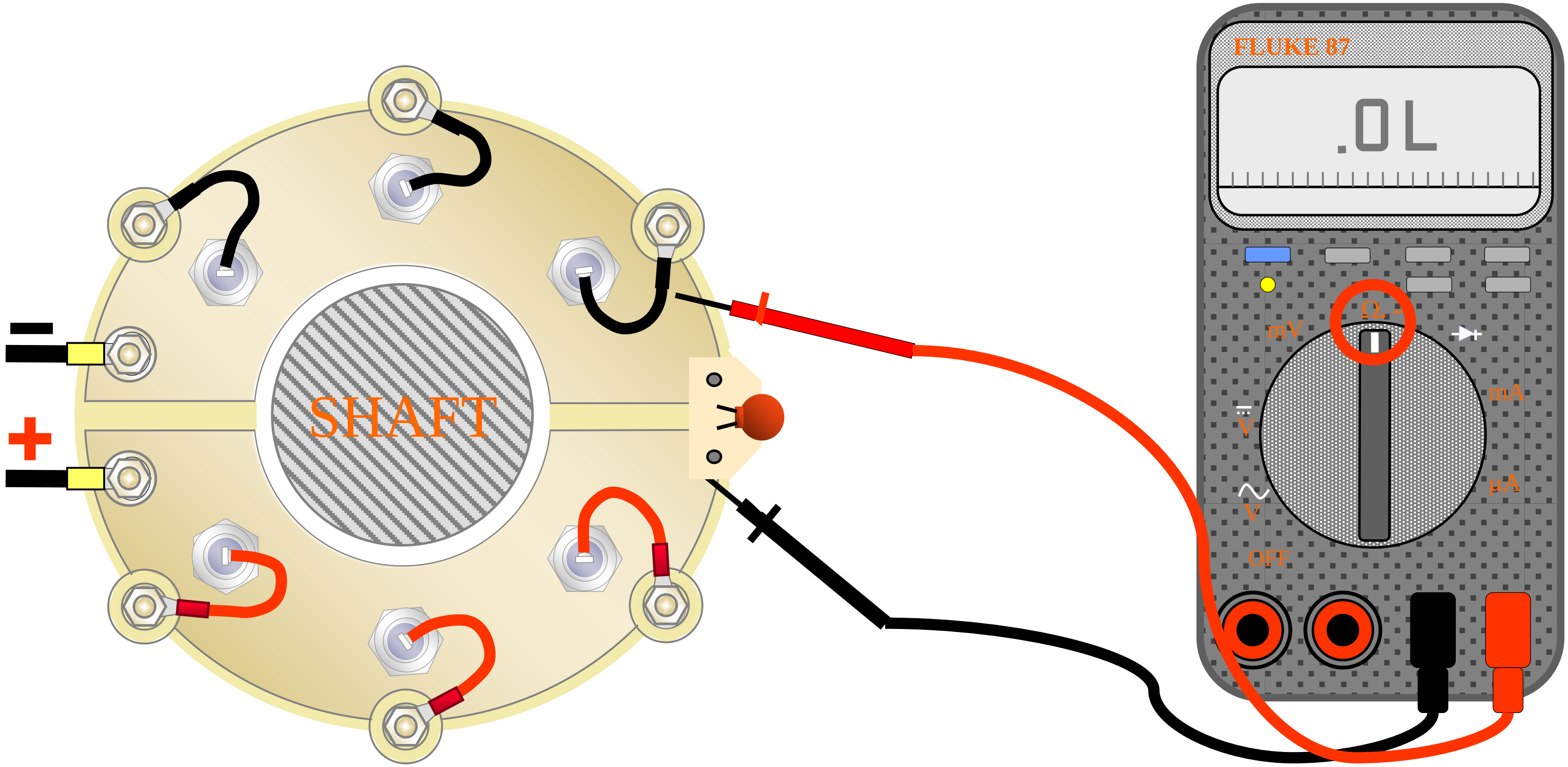
Switch the Multi-meter to the position indicating ‘diode’ test position. With the Positive test lead on the Anode side of the diode, the meter should give a reading, indicating electron flow

Checking diodes



Reverse the Multimeter leads, so that the Positive lead is on the Anode side of the diode; the Multimeter should now read OL, (Over Load - no electron flow). A faulty diode will give a short circuit reading in both directions, or an open circuit reading in both directions.

Checking the varistor



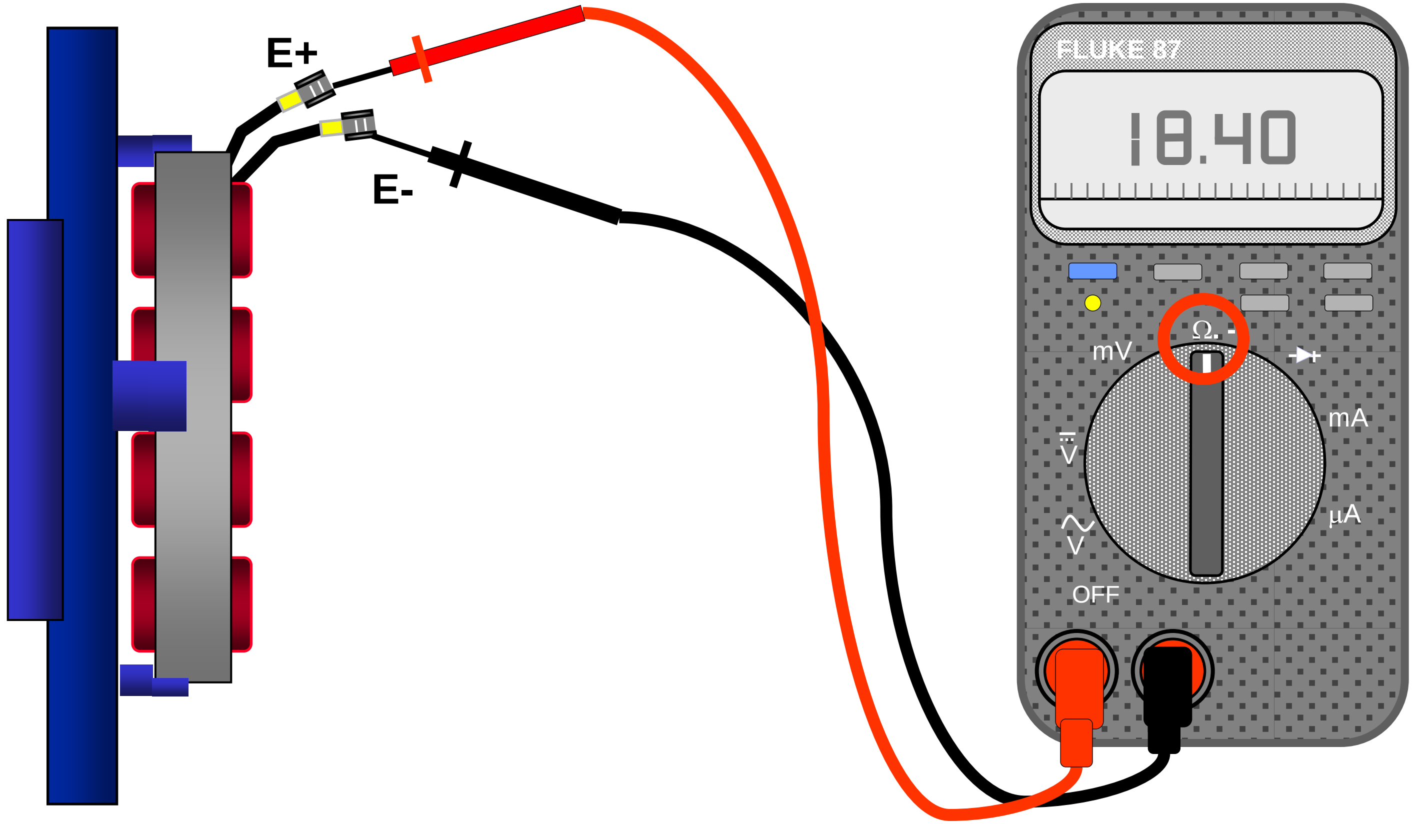
Switch the Multimeter to the position indicated for resistance 'Ω' testing

The Varistor should read Infinity in both directions, and has no polarity

A faulty Varistor will be short circuit, or burnt ('blown') by fault current

A blown Varistor will not affect the operation of the generator!

Testing of Excitation Stator



Check the Exciter Stator resistance across E+ & E- with a multi-meter set on the Ω range.

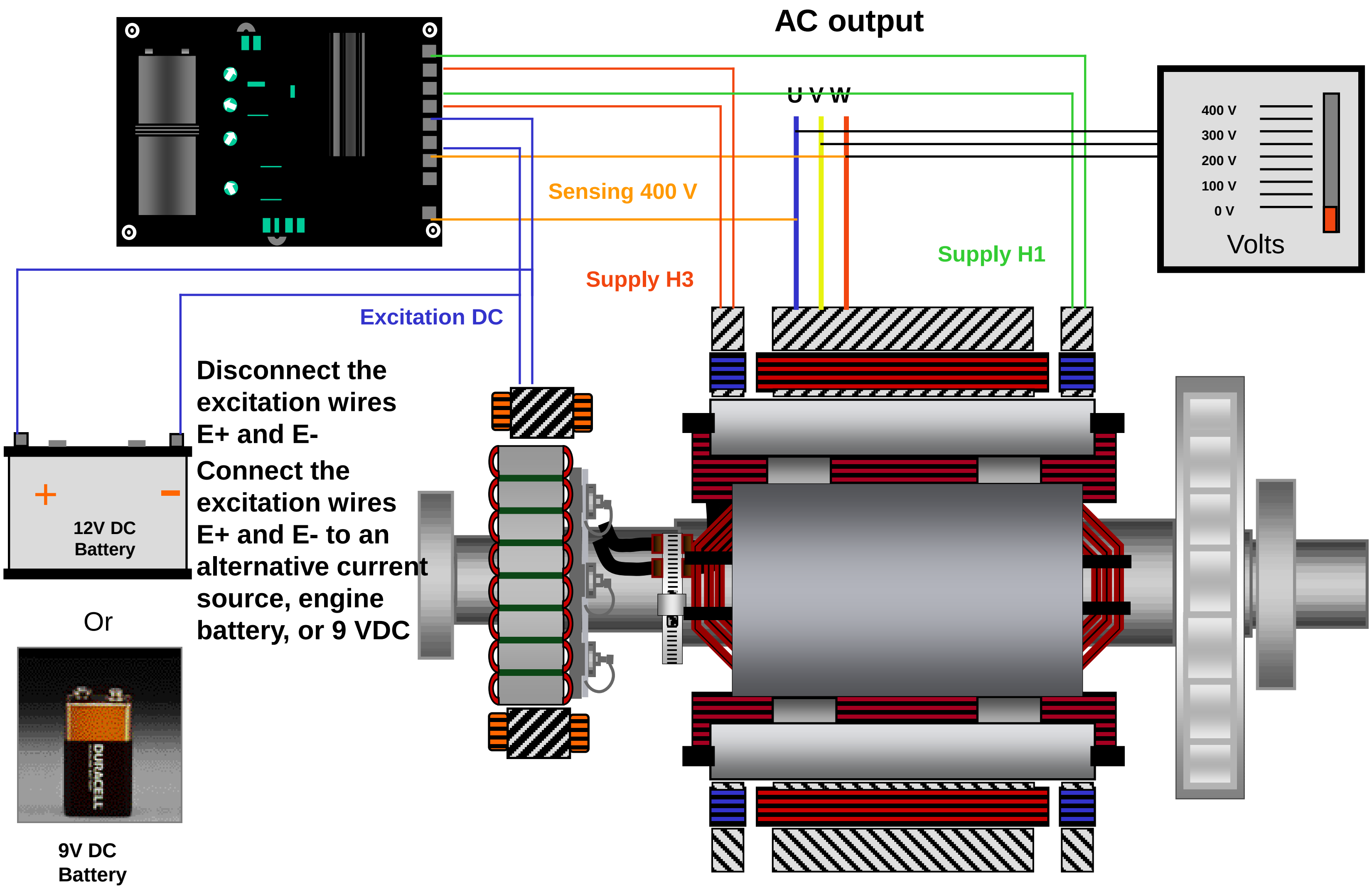
The correct resistance figures are given in the Operation and Maintenance Manual supplied with the Generator.

Loss of remnant magnetism

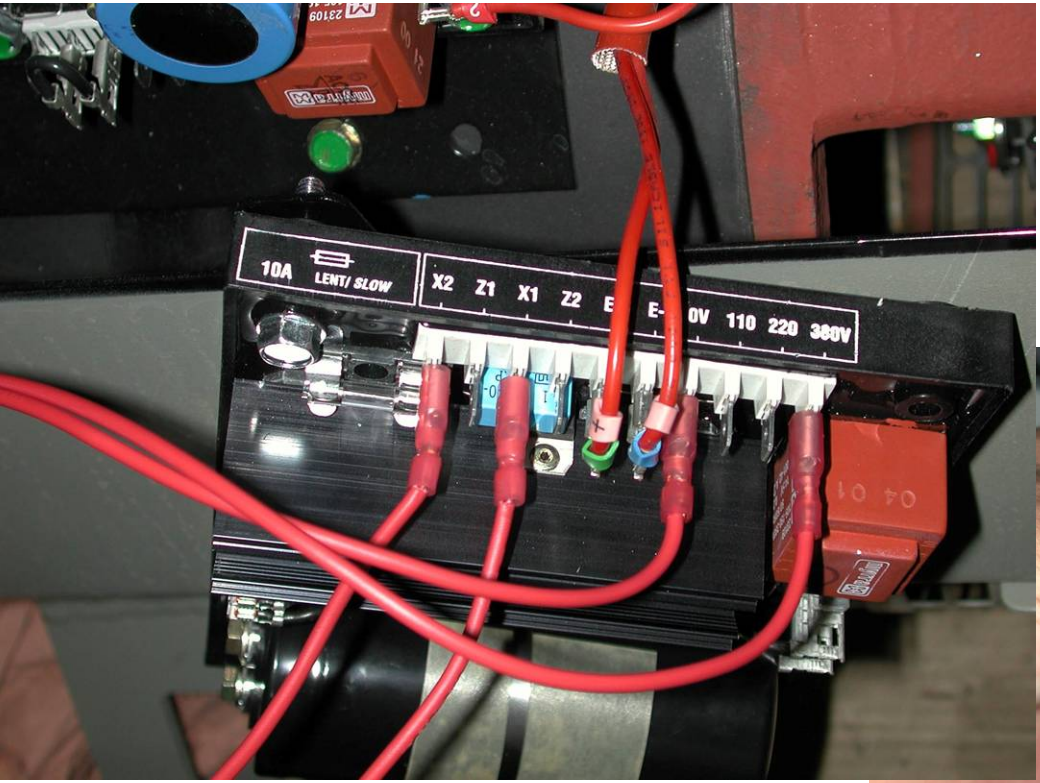
Engine runs but:

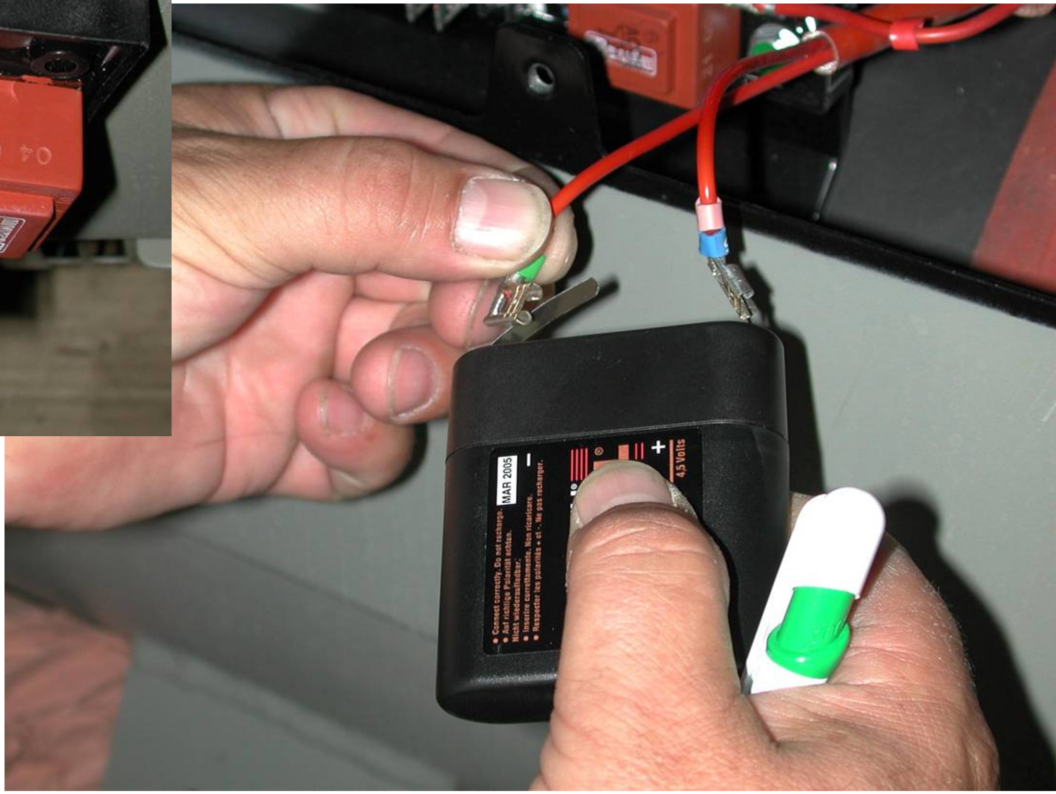
No Voltage!!

Loss of remnant magnetism



Loss of remnant magnetism





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Loss of remnant magnetism

If we disconnect the battery, connect the AVR again, start the engine and….

We have normal voltage:
this indicates that the remnant magnetism was lost in the excitor.

We have still no voltage:
this indicates that the AVR is probably broken and needs to be changed.

Reading the analog control's information

Engine Running
Preheat
ECU Status (for electronic engines)

Reading the analog control's alarms

- Low oil pressure alarm
- Shuts down the engine

Reading the analog control's alarms

- High water temperature alarm
- Shuts down the engine

Reading the analog control's alarms

- **Engine fault alarm**
- **Have the engine dealer reading the ECU to check what the fault is**

Reading the analog control's alarms

- Engine overspeed alarm
- Can be caused by a sudden load drop
- Start the engine again and check the engine speed stability
- If the alarm goes off again, or if the engine runs erratically, check the fuel line for air
- If the problem persists have the engine ECU checked.
- If the ECU is OK, change the generator controller

Reading the analog control's alarms

- **Overcrancking alarm: the engine didn't start after 3 attempts and the controller gave up**

Reading the analog control's alarms

- Low fuel level alarm: the fuel level in the tank is lower than 10 % of total volume
- Shuts down the engine

Reading the analog control's alarms

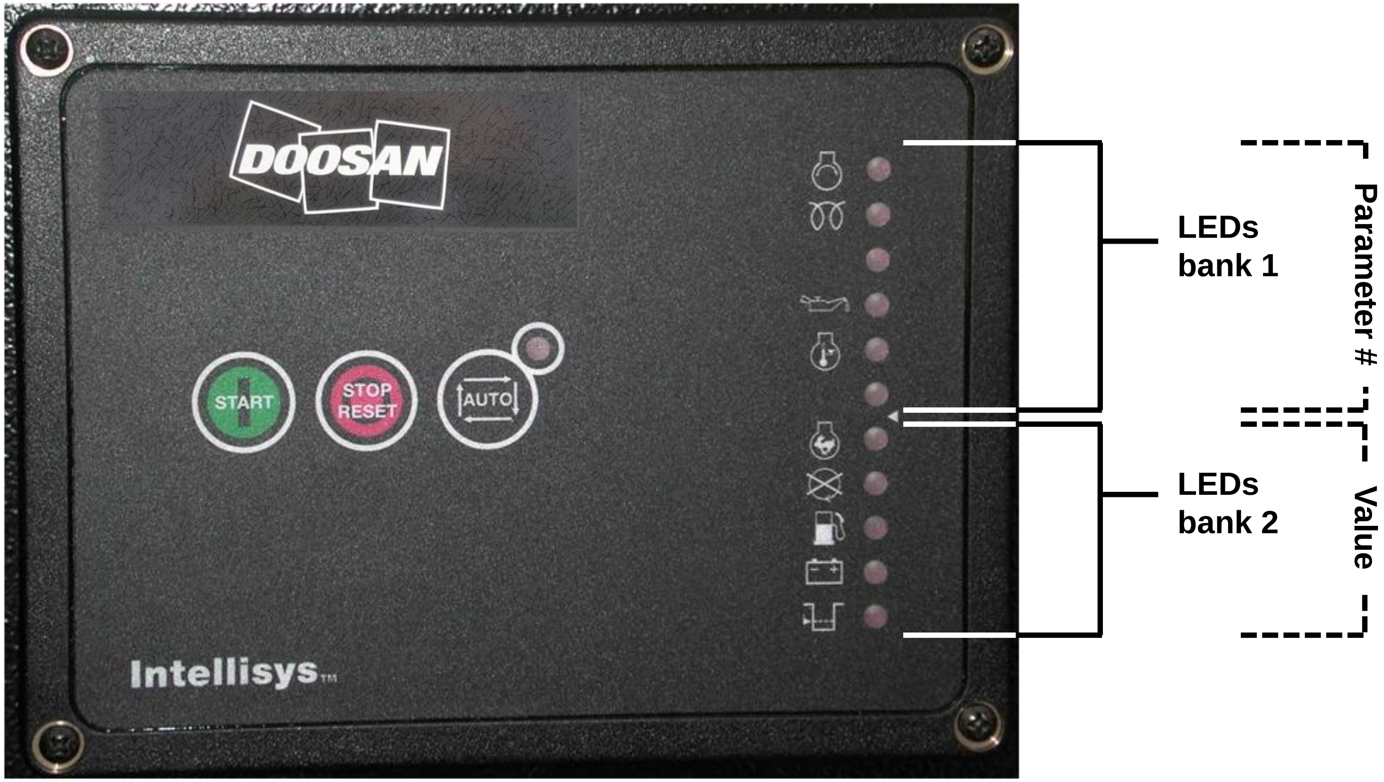
- Battery charge fail: Indicates battery voltage is low or not being charged.
- Does not shut down the engine

Reading the analog control's alarms

- Full bunded base alarm
- Indicates the bunded base is close to full
- Does not shuts down the engine

Setting up the analog controller

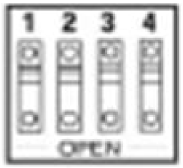
- Eleven LEDs separated into two banks (see below) are provided on the faceplate.
- The LEDs Bank 1 includes 6 LEDs and Bank 2 includes 5.
- In Setup mode, these banks form a binary code to indicate either the controller setup configuration or error status, which is indicated by the last 8 (red) LEDs



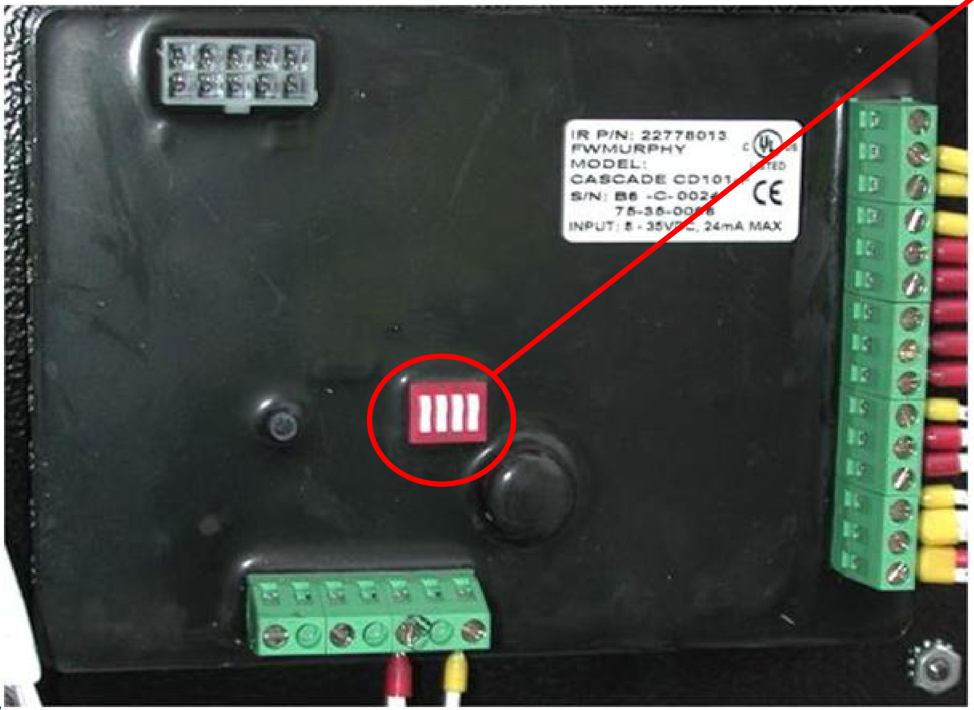
Setting up the analog controller

- To enter the SETUP MODE, first remove DC power to the controller (Battery switch) and wait until the controller is completely switched off. Use the start and stop buttons to check if the controller still reacts, and also to speed-up the discharge of its internal capacitor.
- On the back of the controller are four DIP switches, set switch #1 to ON (see schematic at right) then restore DC power.

Move Switch toward the numbers to Turn On

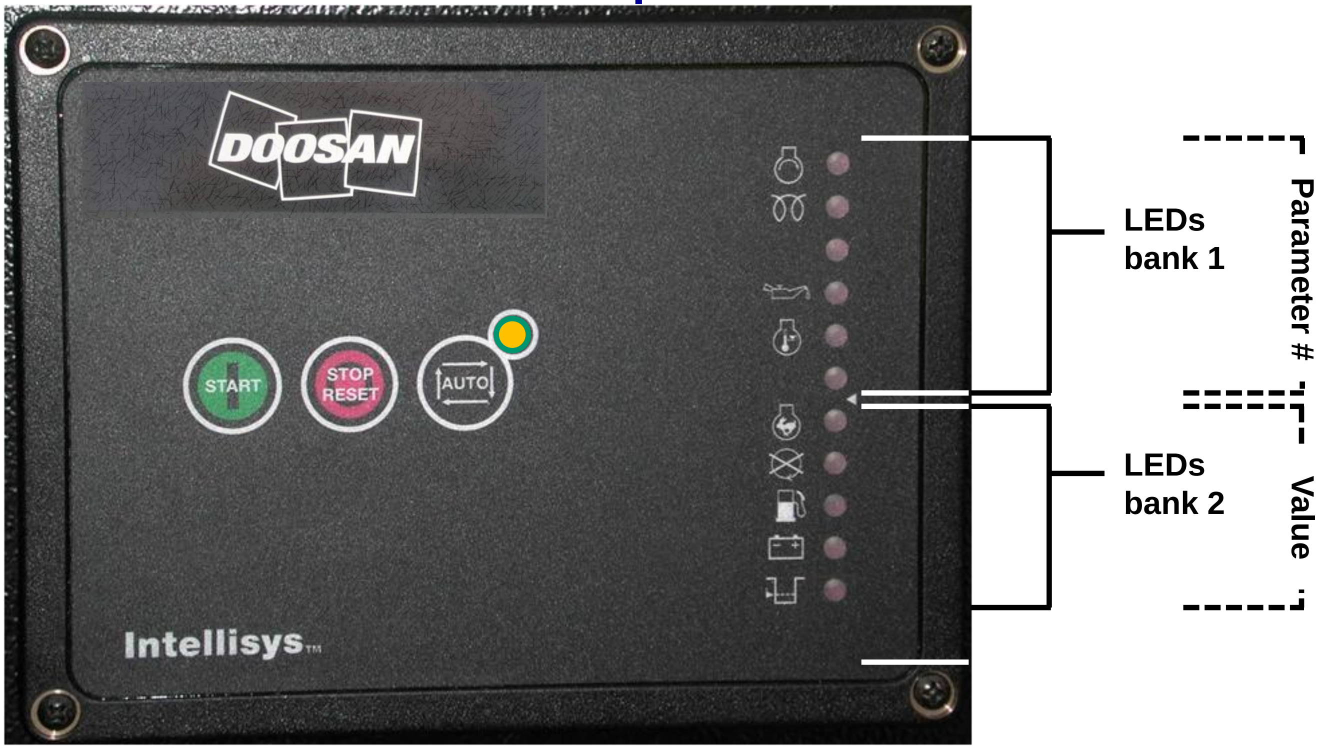


NOTE: Switch settings are read at Power Up only.



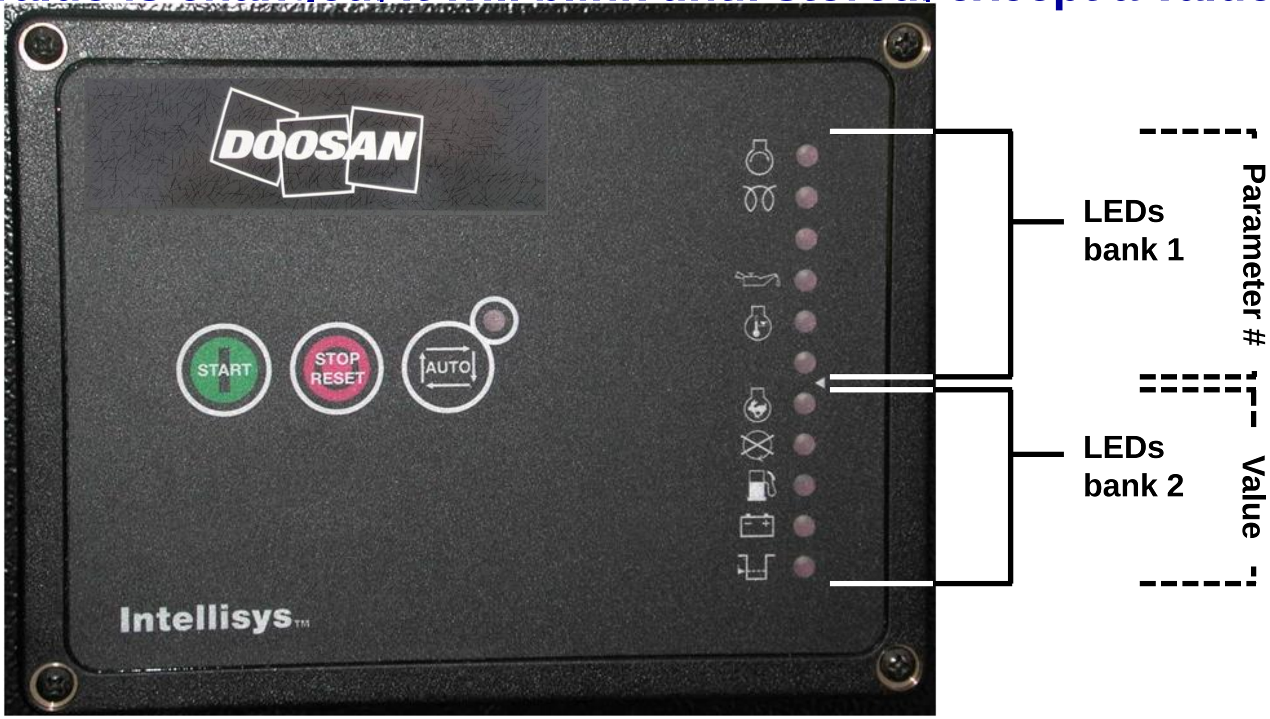
Setting up the analog controller

- The AUTO mode LED will blink to indicate that the controller is in the SETUP MODE.
- When in the SETUP MODE, pressing the "START" button steps up thru the entire list of parameters. The pattern of the LEDs Bank 1 (see below), is used to indicate which parameter is selected. The pattern will change once each time the "START" button is pressed.



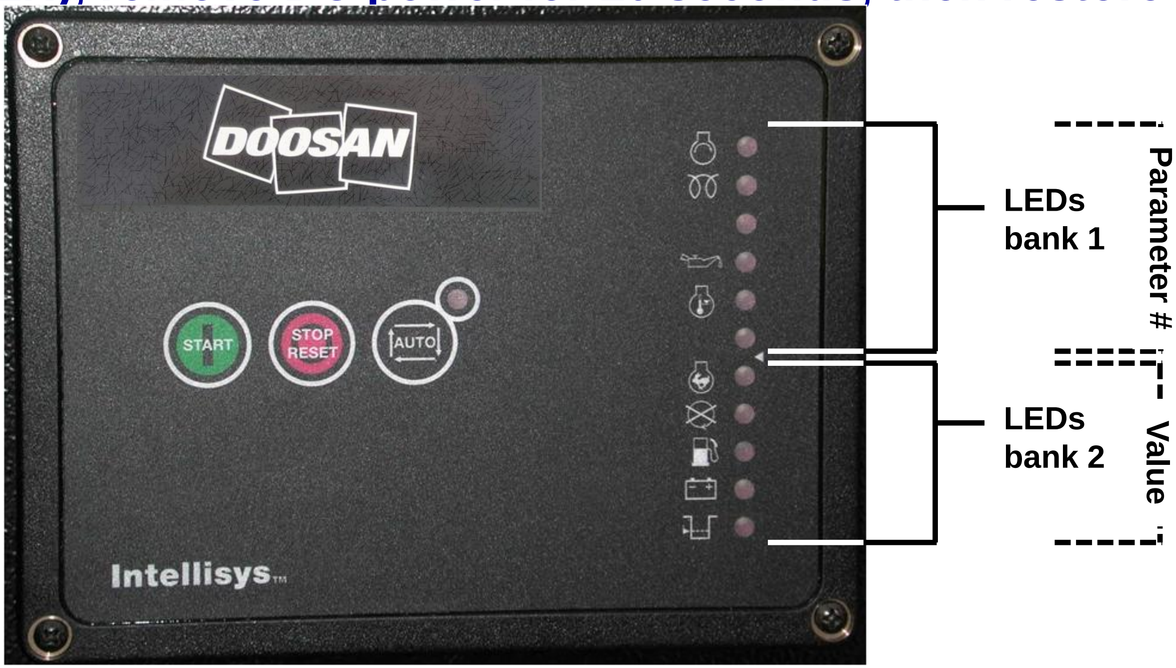
Setting up the analog controller

•Pressing the "STOP" button steps up thru all the available values for each parameter.
•The pattern of the LEDs Bank 2 (see below), is used to indicate which value is selected. The pattern will change once each time the OFF button is pushed.
•Pressing the "AUTO" button stores the displayed value.
•If any value is changed, it will blink until stored, except a value of zero.



Setting up the analog controller

- If any value is changed but not stored, and then the parameter is changed, the value will still be what was shown originally.
- If you accidentally go past a desired parameter or value, you can step back by pressing the down arrow button.
- The parameter/value list and corresponding LED indication are shown on Table 1 – Parameter Values and Corresponding LED Indication.
- When you are finished with setup, set switch #1 to in the Normal Operating Position (OPEN), remove DC power for 10 seconds, then restore DC power.



Setting up the analog controller

•Required values for G20 to G60:

	CONFIGURATION PARAMETER	LED BANK 1	VALUE	LED BANK 2
1	ENGINE SPEED SOURCE	○○○○○●	GENERATOR AC	○○○○●
2	CRANK ATTEMPTS	○○○○●○	3*	○○○○○
3	CRANK TIMER	○○○○●●	10 SEC	○○○○●
4	CRANK REST TIMER	○○○●○○	15 SEC*	○○○●○
5	START DELAY TIMER (AUTO MODE ONLY)	○○○●○●	10 SEC	○○○●○
6	STOP DELAY TIMER (AUTO MODE ONLY)	○○○●●○	0 SEC*	○○○○○
7	PREHEAT TIMER	○○○●●●	10 SEC	○○○●○
8	EXTENDED PREHEAT DURING CRANK	○○●○○○	0 SEC*	○○○○○
9	WARMUP TIMER	○○●○○●	0 MIN*	○○○○○
10	COOLDOWN TIMER	○○●○●○	0 MIN*	○○○○○
11	BYPASS TIMER	○○●○●●	10 SEC*	○○○●○
12	ENERGIZE TO STOP TIMER	○○●●○○	10 SEC	○○○●●
13	AUXILIARY INPUT BYPASS TIMER	○○●●○●	30 SEC*	○○○○○
14	STARTER MOTOR ABUTMENT PROTECTION DELAY	○○●●●○	DISABLED*	○○○○○
15	REMOTE START SIGNAL TYPE	○○●●●●	MAINTAINED*	○○○○○
16	DIGITAL INPUT 1	○●○○○○	LOW OIL PRESSURE (OPEN ON FAULT)	○○○○○
17	DIGITAL INPUT 2	○●○○○●	HIGH ENGINE TEMP (OPEN ON FAULT)	○○○○○
18	DIG INP 3 (AUX IN 1) LOW FUEL	○●○○●○	DELAYED SHUTDOWN	○○●○●
19	DIG INP 4 (AUX IN 2) HIGH CONT	○●○○●●	DELAYED WARNING	○○○●●
20	(RESERVED FOR FUTURE USE)	○●○●○○	(RESERVED FOR FUTURE USE)	
21	(RESERVED FOR FUTURE USE)	○●○●○●	(RESERVED FOR FUTURE USE)	
22	FUEL RELAY CONTROL (NON ECU ENG)	○●○●●○	ENERGIZED TO RUN*	○○○○○
23	AUX OUT 1 FUEL SOL PULL-IN	○●○●●●	SOLENOID ENERGIZE	●○●○○
24	AUXILIARY OUTPUT 2 PRECRANK ALARM	○●●○○○	START DELAY	●○○●●
25	AUX OUT 3	○●●○○●	ENGINE RUNNING	○○●○●
26	AUXILIARY OUTPUT 4	○●●○●○	PREHEAT	○○●○○
27	(RESERVED FOR FUTURE USE)	○●●○●●	(RESERVED FOR FUTURE USE)	
28	INITIAL POWER-UP MODE	○●●●○○	POWER UP IN MANUAL MODE*	○○○○○
29	OIL PRESS CRANK DISCONNECT DELAY	○●●●○●	NOT USED*	○○○○○

Setting up the analog controller

•Required values for G20 to G60 (Continued):

	CONFIGURATION PARAMETER	LED BANK 1	VALUE	LED BANK 2
30**	NOMINAL GENERATOR FREQUENCY	○●●●●○	50HZ	○○○○○
31	CRANK DISCONNECT FREQUENCY (10'S DIGIT)	○●●●●●	1	○○○○●
32	CRANK DISCONNECT FREQUENCY (1'S DIGIT)	●○○○○○	6	○○●●○
33	CRANK DISCONNECT RPM (1000'S DIGIT)	●○○○○●	0*	○○○○○
34	CRANK DISCONNECT RPM (100'S DIGIT)	●○○○●○	5*	○○●○●
35	CRANK DISCONNECT RPM (10'S DIGIT)	●○○○●●	4*	○○●○○
36	CRANK DISCONNECT RPM (1'S DIGIT)	●○○●○○	0*	○○○○○
37	OVERSPEED SETPOINT (% ABOVE RUN SPEED)	●○○●○●	10%*	○○○○●
38	UNDERSPEED SETPOINT (% BELOW RUN SPEED)	●○○●●○	20%*	○○○●●
39	UNDERSPEED RESPONSE	●○○●●●	NONE	○○○○○
40	LOW OIL PRESSURE SHUTDOWN SETPOINT	●○●○○○	10 PSI	○○○●●
41	HIGH ENGINE TEMP SHUTDOWN SETPOINT	●○●○○●	230 DEG F*	○●○○●
42	LOW BATTERY VOLTAGE SETPOINT	●○●○●○	10.5 V*	○○●○●
43	HIGH BATTERY VOLTAGE SETPOINT	●○●○●●	15.0 V*	○○●●○
44	WEAK BATTERY VOLTAGE SETPOINT	●○●●○○	WARNING DISABLED	○○○○○
45	SOLENOID ENERGIZE TIMER	●○●●○●	1.0 S	○○●●●
46	LED PROFILE SELECT	●○●●●○	IR	○○○○●
47	MANUAL LAMP TEST	●○●●●●	IN USE	○○○○●
48	FLYWHEEL TOOTH COUNT (100'S DIGIT)	●●○○○○	0	○○○○○
49	FLYWHEEL TOOTH COUNT (10'S DIGIT)	●●○○○●	1	○○○○●
50	FLYWHEEL TOOTH COUNT (1'S DIGIT)	●●○○●○	8	○●○○○
51	RUN SPEED (1000'S DIGIT)	●●○○●●	1*	○○○○●
52**	RUN SPEED (100'S DIGIT)	●●○●○○	5	○○●○●
53	RUN SPEED (10'S DIGIT)	●●○●○●	0*	○○○○○
54	RUN SPEED (1'S DIGIT)	●●○●●○	0*	○○○○○
55	ALTERNATOR EXCITE DURING CRANK	●●○●●●	ENABLED	○○○○●
56	(RESERVED FOR FUTURE USE)	●●●○○○	(RESERVED FOR FUTURE USE)	
57	(RESERVED FOR FUTURE USE)	●●●○○●	(RESERVED FOR FUTURE USE)	
58	(RESERVED FOR FUTURE USE)	●●●○●○	(RESERVED FOR FUTURE USE)	
59	FAULT CODE SPN CONVERSION METHOD	●●●○●●	VERSIONS 1 AND 4 SUPPORTED*	○○○○○

Setting up the analog controller

•Required values for G80 to G200:

	CONFIGURATION PARAMETER	LED BANK 1	VALUE	LED BANK 2
1	ENGINE SPEED SOURCE	○○○○○●	J1939 (ECU)	○○○●○
2	CRANK ATTEMPTS	○○○○●○	3*	○○○○○
3	CRANK TIMER	○○○○●●	10 SEC	○○○○●
4	CRANK REST TIMER	○○○●○○	15 SEC*	○○○●○
5	START DELAY TIMER (AUTO MODE ONLY)	○○○●○●	10 SEC	○○○●○
6	STOP DELAY TIMER (AUTO MODE ONLY)	○○○●●○	0 SEC*	○○○○○
7	PREHEAT TIMER	○○○●●●	10 SEC	○○○●○
8	EXTENDED PREHEAT DURING CRANK	○○●○○○	0 SEC*	○○○○○
9	WARMUP TIMER	○○●○○●	0 MIN.*	○○○○○
10	COOLDOWN TIMER	○○●○●○	0 MIN.*	○○○○○
11	BYPASS TIMER	○○●○●●	10 SEC*	○○○●○
12	ENERGIZE TO STOP TIMER	○○●●○○	10 SEC	○○○●●
13	AUXILIARY INPUT BYPASS TIMER	○○●●○●	30 SEC*	○○○○○
14	STARTER MOTOR ABUTMENT PROTECTION DELAY	○○●●●○	DISABLED*	○○○○○
15	REMOTE START SIGNAL TYPE	○○●●●●	MAINTAINED*	○○○○○
16	DIGITAL INPUT 1	○●○○○○	LOW OIL PRESSURE (CLOSE ON FAULT)	○○○○●
17	DIGITAL INPUT 2	○●○○○●	HIGH ENGINE TEMP (CLOSE ON FAULT)*	○○○○●
18	DIG INP 3 (AUX IN 1) LOW FUEL	○●○○●○	DELAYED SHUTDOWN	○○●○●
19	DIG INP 4 (AUX IN 2) HIGH CONT	○●○○●●	DELAYED WARNING	○○○●●
20	(RESERVED FOR FUTURE USE)	○●○●○○	(RESERVED FOR FUTURE USE)	
21	(RESERVED FOR FUTURE USE)	○●○●○●	(RESERVED FOR FUTURE USE)	
22	FUEL RELAY CONTROL (NON ECU ENG)	○●○●●○	ENERGIZED TO RUN*	○○○○○
23	AUX OUT 1 FUEL SOL PULL-IN	○●○●●●	SOLENOID ENERGIZE	●○●○○
24	AUXILIARY OUTPUT 2 PRECRANK ALARM	○●●○○○	START DELAY	●○○●●
25	AUX OUT 3	○●●○○●	ENGINE RUNNING	○○●○●
26	AUXILIARY OUTPUT 4	○●●○●○	PREHEAT	○○●○○
27	(RESERVED FOR FUTURE USE)	○●●○●●	(RESERVED FOR FUTURE USE)	
28	INITIAL POWER-UP MODE	○●●●○○	POWER UP IN MANUAL MODE*	○○○○○
29	OIL PRESS CRANK DISCONNECT DELAY	○●●●○●	NOT USED*	○○○○○

Setting up the analog controller

•Required values for G80 to G200 (Continued):

	CONFIGURATION PARAMETER	LED BANK 1	VALUE	LED BANK 2
30**	NOMINAL GENERATOR FREQUENCY	○●●●●○	50HZ	○○○○○
31	CRANK DISCONNECT FREQUENCY (10'S DIGIT)	○●●●●●	1	○○○○●
32	CRANK DISCONNECT FREQUENCY (1'S DIGIT)	●○○○○○	6	○○●●○
33	CRANK DISCONNECT RPM (1000'S DIGIT)	●○○○○●	0*	○○○○○
34	CRANK DISCONNECT RPM (100'S DIGIT)	●○○○●○	5*	○○●○●
35	CRANK DISCONNECT RPM (10'S DIGIT)	●○○○●●	4*	○○●○○
36	CRANK DISCONNECT RPM (1'S DIGIT)	●○○●○○	0*	○○○○○
37	OVERSPEED SETPOINT (% ABOVE RUN SPEED)	●○○●○●	10%*	○○○○●
38	UNDERSPEED SETPOINT (% BELOW RUN SPEED)	●○○●●○	20%*	○○○●●
39	UNDERSPEED RESPONSE	●○○●●●	NONE	○○○○○
40	LOW OIL PRESSURE SHUTDOWN SETPOINT	●○●○○○	10 PSI	○○○●●
41	HIGH ENGINE TEMP SHUTDOWN SETPOINT	●○●○○●	230 DEG F*	○●○○●
42	LOW BATTERY VOLTAGE SETPOINT	●○●○●○	10.5 V*	○○●○●
43	HIGH BATTERY VOLTAGE SETPOINT	●○●○●●	15.0 V*	○○●●○
44	WEAK BATTERY VOLTAGE SETPOINT	●○●●○○	WARNING DISABLED	○○○○○
45	SOLENOID ENERGIZE TIMER	●○●●○●	1.0 S	○○●●●
46	LED PROFILE SELECT	●○●●●○	IR	○○○○●
47	MANUAL LAMP TEST	●○●●●●	IN USE	○○○○●
48	FLYWHEEL TOOTH COUNT (100'S DIGIT)	●●○○○○	0	○○○○○
49	FLYWHEEL TOOTH COUNT (10'S DIGIT)	●●○○○●	1	○○○○●
50	FLYWHEEL TOOTH COUNT (1'S DIGIT)	●●○○●○	8	○●○○○
51	RUN SPEED (1000'S DIGIT)	●●○○●●	1*	○○○○●
52**	RUN SPEED (100'S DIGIT)	●●○●○○	5	○○●○●
53	RUN SPEED (10'S DIGIT)	●●○●○●	0*	○○○○○
54	RUN SPEED (1'S DIGIT)	●●○●●○	0*	○○○○○
55	ALTERNATOR EXCITE DURING CRANK	●●○●●●	NOT USED*	○○○○○
56	(RESERVED FOR FUTURE USE)	●●●○○○	(RESERVED FOR FUTURE USE)	
57	(RESERVED FOR FUTURE USE)	●●●○○●	(RESERVED FOR FUTURE USE)	
58	(RESERVED FOR FUTURE USE)	●●●○●○	(RESERVED FOR FUTURE USE)	
59	FAULT CODE SPN CONVERSION METHOD	●●●○●●	VERSIONS 1 AND 4 SUPPORTED*	○○○○○

Setting up the analog controller

•Required values for G250 to G500:

	CONFIGURATION PARAMETER	LED BANK 1	VALUE	LED BANK 2
1	ENGINE SPEED SOURCE	○○○○○●	J1939 (ECU)	○○○●○
2	CRANK ATTEMPTS	○○○○●○	3*	○○○○○
3	CRANK TIMER	○○○○●●	10 SEC	○○○○●
4	CRANK REST TIMER	○○○●○○	15 SEC*	○○○●○
5	START DELAY TIMER (AUTO MODE ONLY)	○○○●○●	10 SEC	○○○●○
6	STOP DELAY TIMER (AUTO MODE ONLY)	○○○●●○	0 SEC*	○○○○○
7	PREHEAT TIMER	○○○●●●	10 SEC	○○○●○
8	EXTENDED PREHEAT DURING CRANK	○○●○○○	0 SEC*	○○○○○
9	WARMUP TIMER	○○●○○●	0 MIN.*	○○○○○
10	COOLDOWN TIMER	○○●○●○	0 MIN.*	○○○○○
11	BYPASS TIMER	○○●○●●	10 SEC*	○○○●○
12	ENERGIZE TO STOP TIMER	○○●●○○	15 SEC*	○○○○○
13	AUXILIARY INPUT BYPASS TIMER	○○●●○●	30 SEC*	○○○○○
14	STARTER MOTOR ABUTMENT PROTECTION DELAY	○○●●●○	DISABLED*	○○○○○
15	REMOTE START SIGNAL TYPE	○○●●●●	MAINTAINED*	○○○○○
16	DIGITAL INPUT 1	○●○○○○	LOW OIL PRESSURE (CLOSE ON FAULT)	○○○○●
17	DIGITAL INPUT 2	○●○○○●	HIGH ENGINE TEMP (CLOSE ON FAULT)*	○○○○●
18	DIG INP 3 (AUX IN 1) LOW FUEL	○●○○●○	DELAYED SHUTDOWN	○○●○●
19	DIG INP 4 (AUX IN 2) HIGH CONT	○●○○●●	DELAYED WARNING	○○○●●
20	(RESERVED FOR FUTURE USE)	○●○●○○	(RESERVED FOR FUTURE USE)	
21	(RESERVED FOR FUTURE USE)	○●○●○●	(RESERVED FOR FUTURE USE)	
22	FUEL RELAY CONTROL (NON ECU ENG)	○●○●●○	ENERGIZED TO RUN*	○○○○○
23	AUX OUT 1 FUEL SOL PULL-IN	○●○●●●	SOLENOID ENERGIZE	●○●○○
24	AUXILIARY OUTPUT 2 PRECRANK ALARM	○●●○○○	START DELAY	●○○●●
25	AUX OUT 3	○●●○○●	ENGINE RUNNING	○○●○●
26	AUXILIARY OUTPUT 4	○●●○●○	PREHEAT	○○●○○
27	(RESERVED FOR FUTURE USE)	○●●○●●	(RESERVED FOR FUTURE USE)	
28	INITIAL POWER-UP MODE	○●●●○○	POWER UP IN MANUAL MODE*	○○○○○
29	OIL PRESS CRANK DISCONNECT DELAY	○●●●○●	NOT USED*	○○○○○

Setting up the analog controller

•Required values for G250 to G500 (Continued):

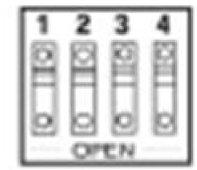
	CONFIGURATION PARAMETER	LED BANK 1	VALUE	LED BANK 2
30**	NOMINAL GENERATOR FREQUENCY	○●●●●○	QSX15 COMM	○○○●○
31	CRANK DISCONNECT FREQUENCY (10'S DIGIT)	○●●●●●	1	○○○○●
32	CRANK DISCONNECT FREQUENCY (1'S DIGIT)	●○○○○○	6	○○●●○
33	CRANK DISCONNECT RPM (1000'S DIGIT)	●○○○○●	0*	○○○○○
34	CRANK DISCONNECT RPM (100'S DIGIT)	●○○○●○	5*	○○●○●
35	CRANK DISCONNECT RPM (10'S DIGIT)	●○○○●●	4*	○○●○○
36	CRANK DISCONNECT RPM (1'S DIGIT)	●○○●○○	0*	○○○○○
37	OVERSPEED SETPOINT (% ABOVE RUN SPEED)	●○○●○●	10%*	○○○○●
38	UNDERSPEED SETPOINT (% BELOW RUN SPEED)	●○○●●○	20%*	○○○●●
39	UNDERSPEED RESPONSE	●○○●●●	NONE	○○○○○
40	LOW OIL PRESSURE SHUTDOWN SETPOINT	●○●○○○	10 PSI	○○○●●
41	HIGH ENGINE TEMP SHUTDOWN SETPOINT	●○●○○●	230 DEG F*	○●○○●
42	LOW BATTERY VOLTAGE SETPOINT	●○●○●○	21.0 V*	○●○●●
43	HIGH BATTERY VOLTAGE SETPOINT	●○●○●●	30.0 V*	●○○○○
44	WEAK BATTERY VOLTAGE SETPOINT	●○●●○○	WARNING DISABLED	○○○○○
45	SOLENOID ENERGIZE TIMER	●○●●○●	1.0 S	○○●●●
46	LED PROFILE SELECT	●○●●●○	IR	○○○○●
47	MANUAL LAMP TEST	●○●●●●	IN USE	○○○○●
48	FLYWHEEL TOOTH COUNT (100'S DIGIT)	●●○○○○	0	○○○○○
49	FLYWHEEL TOOTH COUNT (10'S DIGIT)	●●○○○●	1	○○○○●
50	FLYWHEEL TOOTH COUNT (1'S DIGIT)	●●○○●○	8	○●○○○
51	RUN SPEED (1000'S DIGIT)	●●○○●●	1*	○○○○●
52**	RUN SPEED (100'S DIGIT)	●●○●○○	5	○○●○●
53	RUN SPEED (10'S DIGIT)	●●○●○●	0*	○○○○○
54	RUN SPEED (1'S DIGIT)	●●○●●○	0*	○○○○○
55	ALTERNATOR EXCITE DURING CRANK	●●○●●●	NOT USED*	○○○○○
56	(RESERVED FOR FUTURE USE)	●●●○○○	(RESERVED FOR FUTURE USE)	
57	(RESERVED FOR FUTURE USE)	●●●○○●	(RESERVED FOR FUTURE USE)	
58	(RESERVED FOR FUTURE USE)	●●●○●○	(RESERVED FOR FUTURE USE)	
59	FAULT CODE SPN CONVERSION METHOD	●●●○●●	VERSIONS 1 AND 4 SUPPORTED*	○○○○○

Setting up the analog controller

• To exit SETUP MODE, first remove DC power to the controller (Battery switch) and wait until the controller is completely switched off. Wait until the AUTO mode LED has completely stopped to blink.

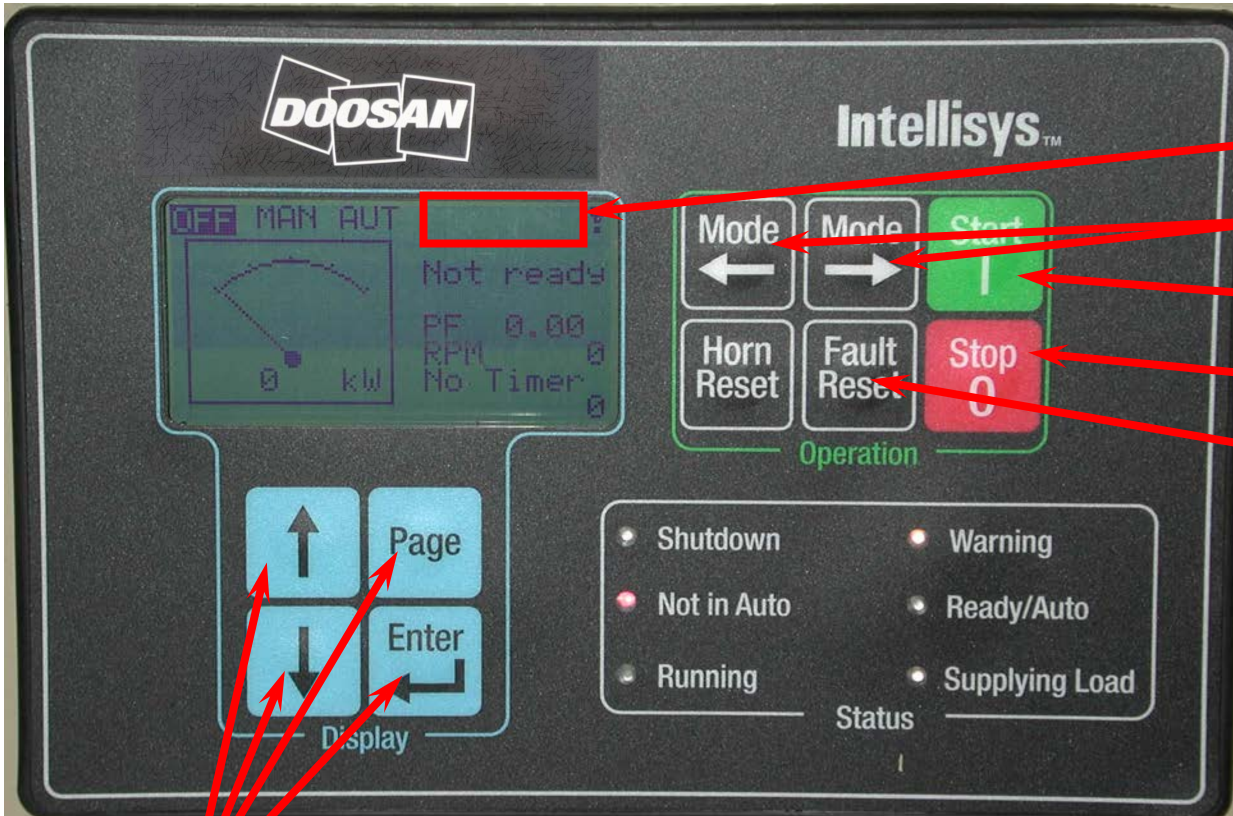
• On the back of the controller, set back switch #1 to its original position then restore DC power.

Move Switch toward the numbers to Turn On



NOTE: Switch settings are read at Power Up only.

Reading the digital control's alarms



Alarms display location

Mode selection button

Start Button

Stop Button

Reset Button

Navigation buttons

Reading the digital control's alarms

Events specification	Protection type	Information on binary output available (See list of Binary outputs)	Description
Wrn Oil Press	WRN	YES	Oil pressure is smaller than *Wrn Oil press* setpoint.
Sd Oil Press	SD	NO	Oil pressure is smaller than *Sd Oil press* setpoint.
Wrn Water Temp	WRN	YES	Water temperature is greater than *Wrn Water temp* setpoint.
Sd Water Temp	SD	NO	Water temperature is greater than *Sd Water temp* setpoint.
Wrn Fuel Level	WRN	YES	Fuel level is smaller than *Wrn Fuel Level* setpoint.
Sd Fuel Level	SD	NO	Fuel level is smaller than *Sd Fuel Level* setpoint.
Analog inp IOM/PTM - Wrn	WRN	YES	Warning alarm configurable on the input of IG-IOM/IGS-PTM.
Analog inp IOM/PTM - Sd	SD	YES	Shutdown alarm configurable on the input of IG-IOM/IGS-PTM.
Binary input	Configurable	YES	Configurable Warning/Shutdown alarms on the inputs of IL-NT.
Battery voltage <, >	WRN	YES	Battery voltage is out of limits given by *Batt overvolt* and *Batt undervolt* setpoints.
Battery flat	SD	YES	If the controller switches off during starting sequence due to bad battery condition it doesn't try to start again and activates this protection.

Reading the digital control's alarms

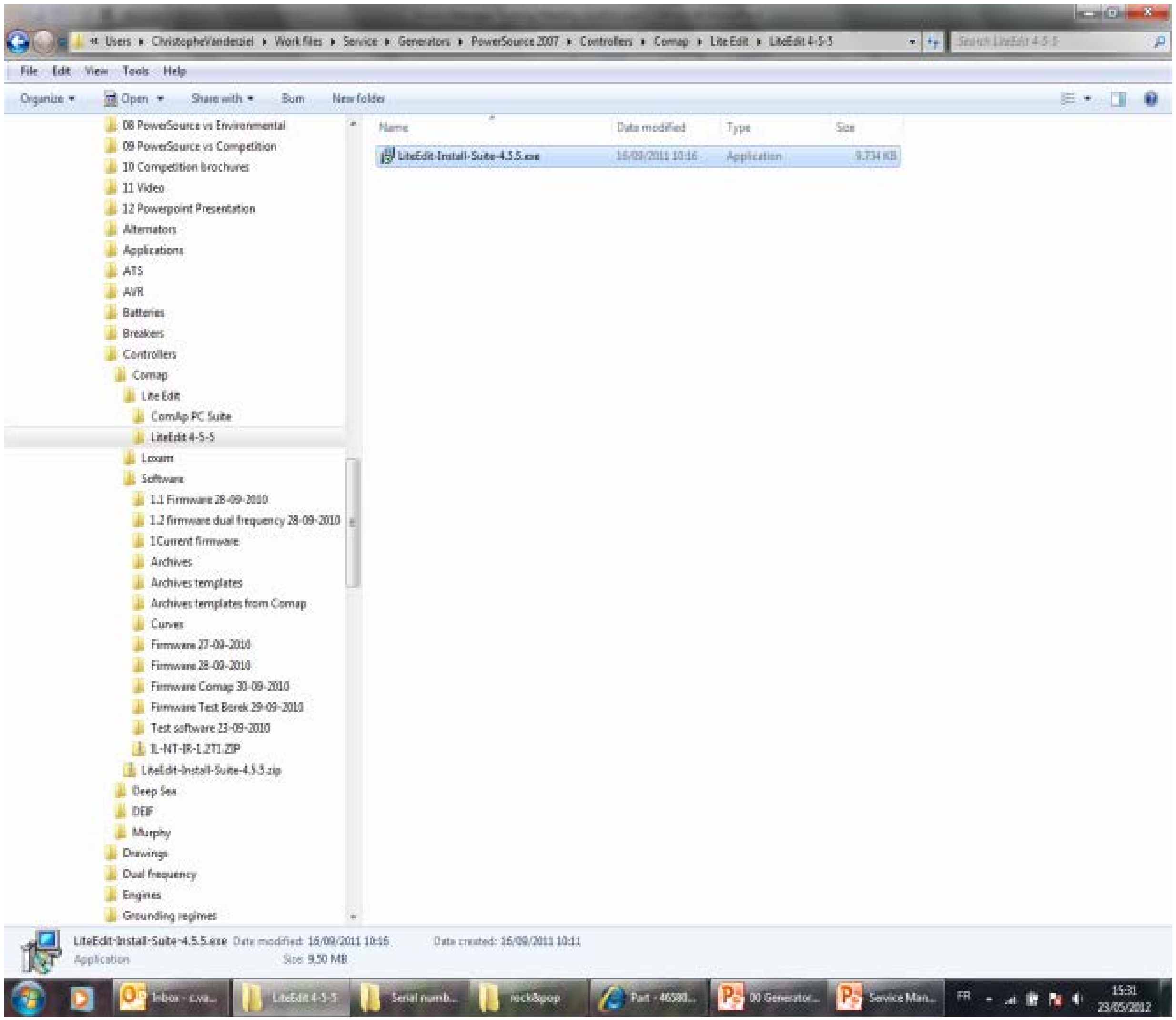
Events specification	Protection type	Information on binary output available (See list of Binary outputs)	Description
Start failed	SD	YES	Gen-set start failed.
ParamFail	NONE	NO	Wrong checksum of parameters. Happends typically after downloading new firmware or changing of the parameter. The controller stays in INIT mode. Check all parameters, write at least one new parameter.
Vgen <, >	SD	YES	The generator voltage is out of limits given by *Gen <V* and *Gen >V* setpoints.
Vgen <, >	WRN	YES	
Vgen unbl	SD	NO	The generator voltage is unbalanced more than the value of *Volt unbal* setpoint.
Fgen <,>	SD	YES	The generator frequency is out of limits given by *Gen >f* and *Gen <f* setpoints.
			The generator frequency is out of limits given by *Gen >f* and *Gen <f* setpoints.
Igen unbl	SD	NO	The generator current is unbalanced.
Overload	SD	YES	The load is greater than the value given by *Overload* setpoint.
Overspeed	SD	YES	The protection comes active if the speed is greater than *Overspeed* setpoint.

Reading the digital control's alarms

Events specification	Protection type	Information on binary output available (See list of Binary outputs)	Description
Underspeed	SD	YES	During starting of the engine when the RPM reache the value of *Starting RPM* setpoint the starter is switched off and the speed of the engine can drop under *Start RPM* again. Then the Underspeed protection becomes active. Protection evaluation starts 5 seconds after reaching *StartingRPM*.
EmergencyStop	SD	NO	If the input *Emergency stop* is opened shutdown is immediately activated.
PickupFault	SD	NO	Failure of magnetic pick-up sensor for speed measurement.
Stop fail	SD	YES	Gen-set stop failed.
WrnServiceTime	WRN	NO	The period for servicing is set by the *NextServTime* setpoint. The protection comes active if the running hours of the engine reach this value.
ChrgAlternFail	WRN	YES	Failure of alternator for charging the battery.

Reading the digital control’s alarms using the computer

- **Install the LiteEdit software by double-clicking the application – follow the instructions**

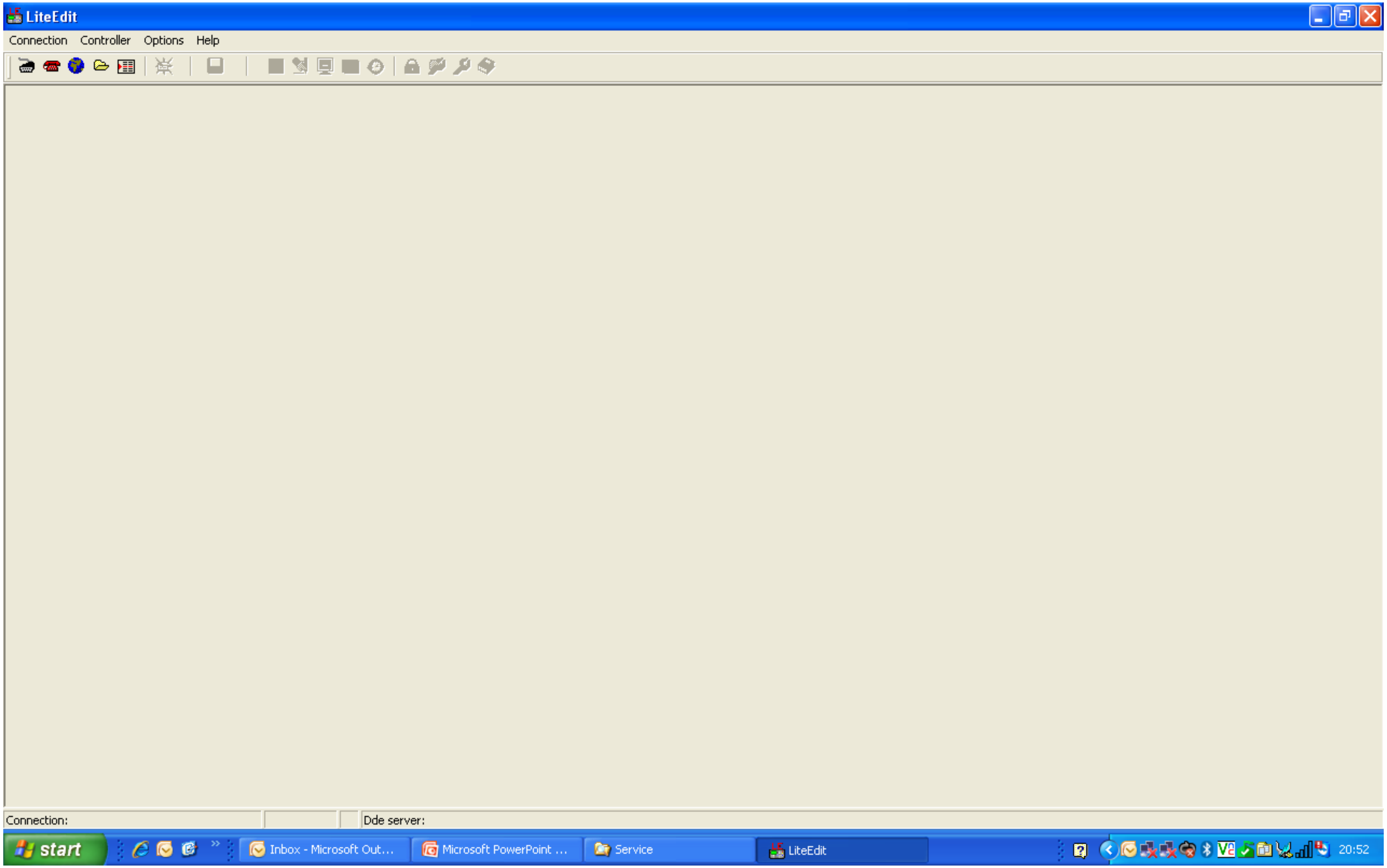


Reading the digital controller using the computer

- **Connect the computer to the controller**

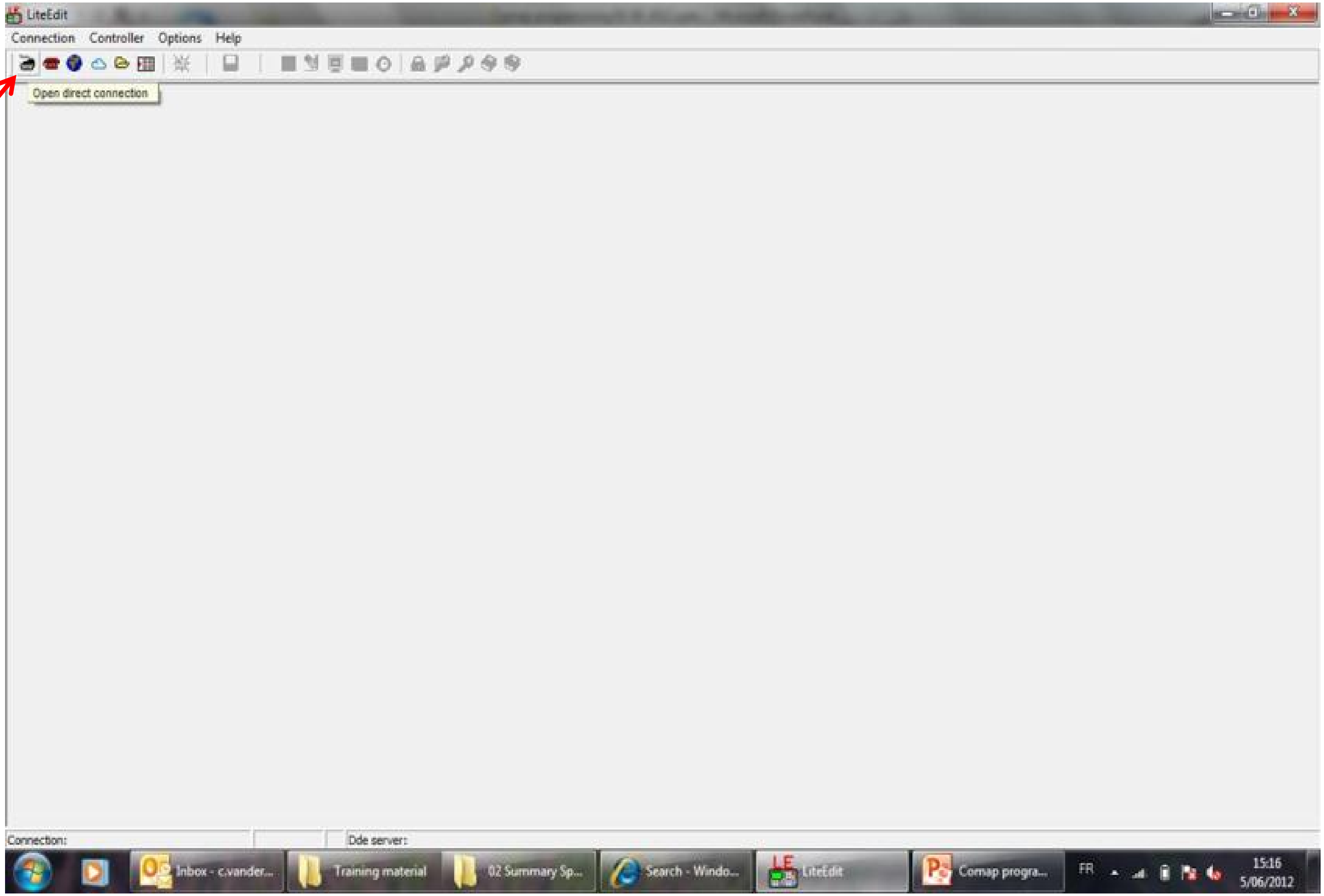
Reading the digital controller using the computer

- **Open the LiteEdit software**



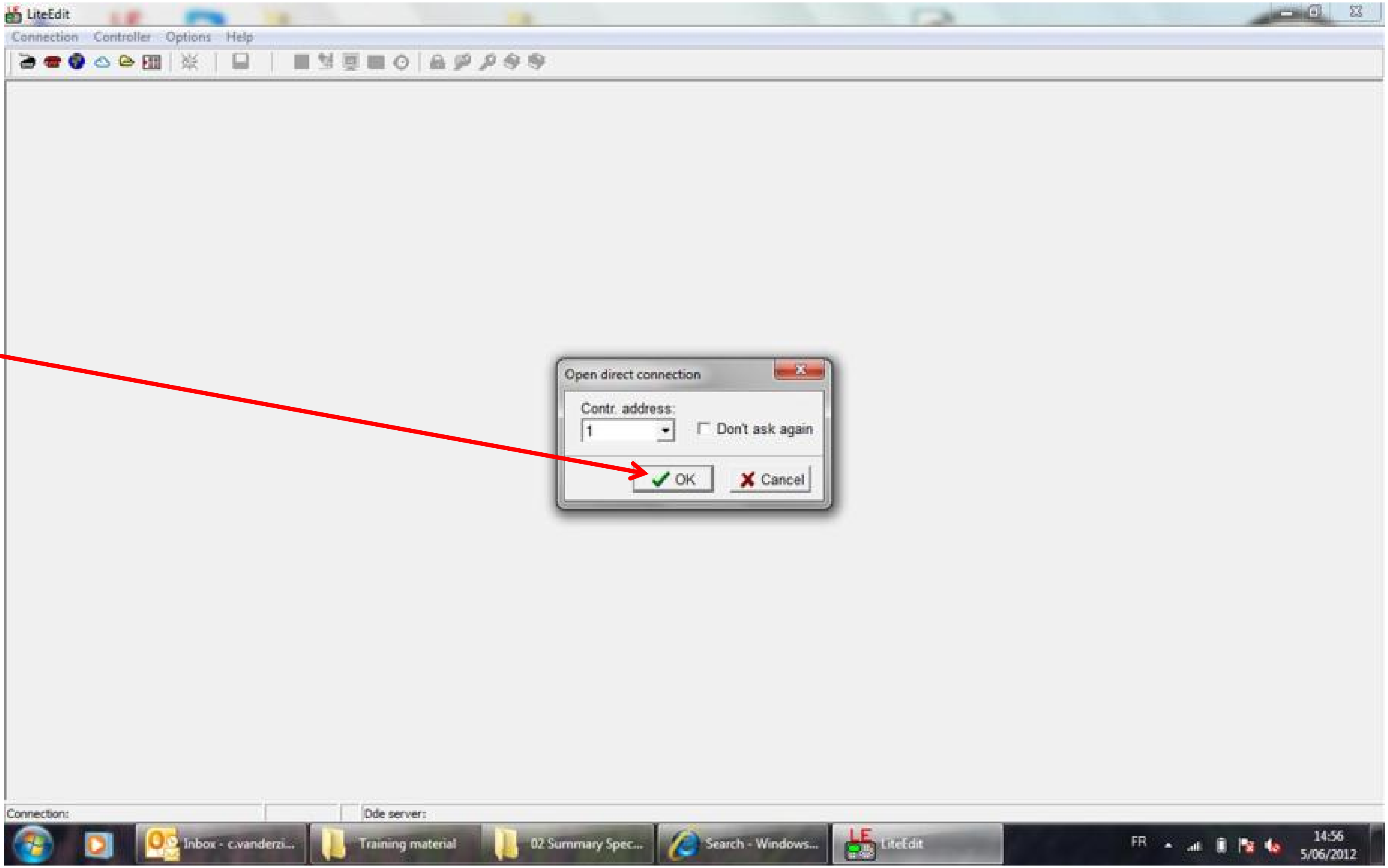
Reading the digital controller using the computer

- **Open direct communication to the controller**



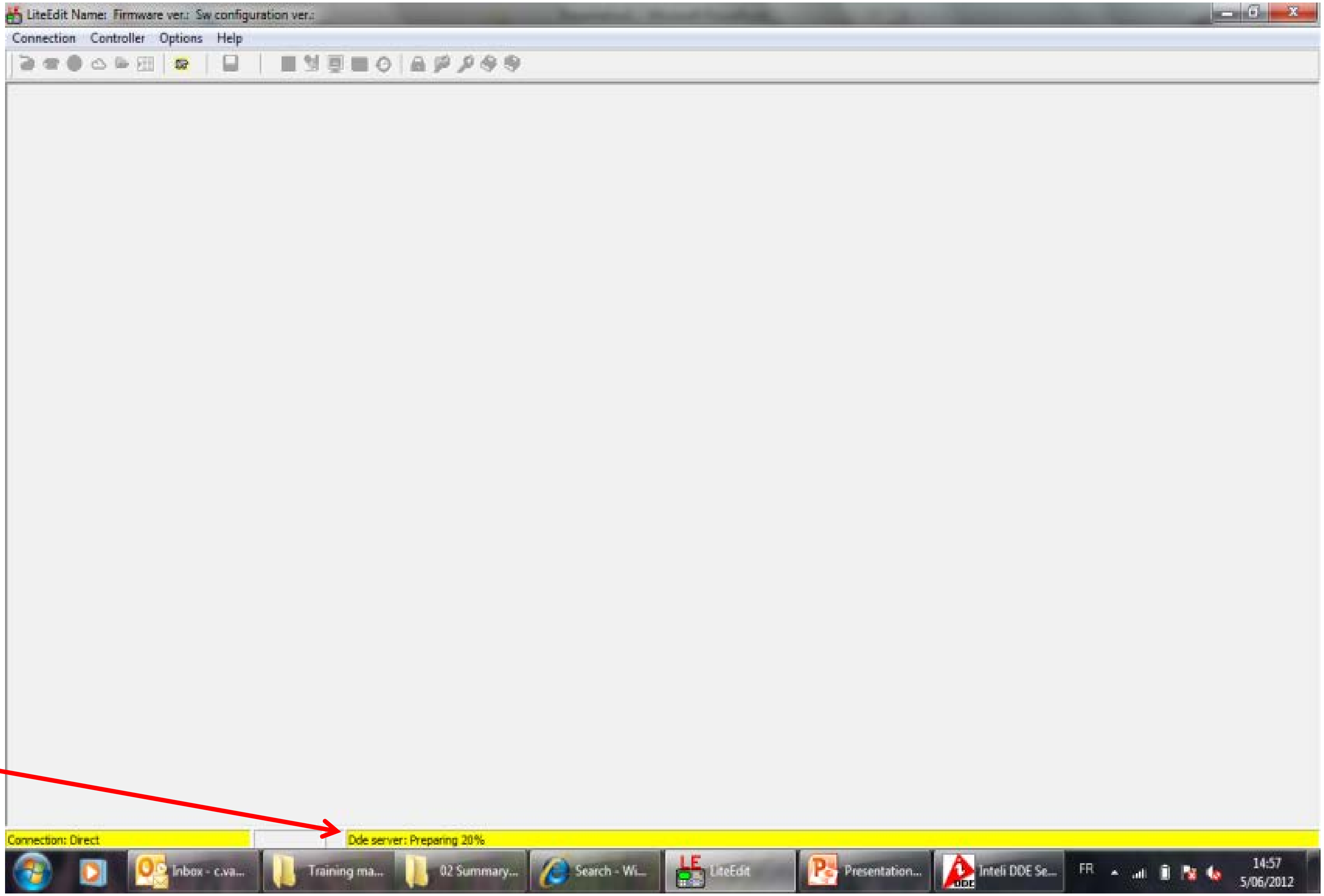
Reading the digital controller using the computer

- **Open direct communication to the controller**



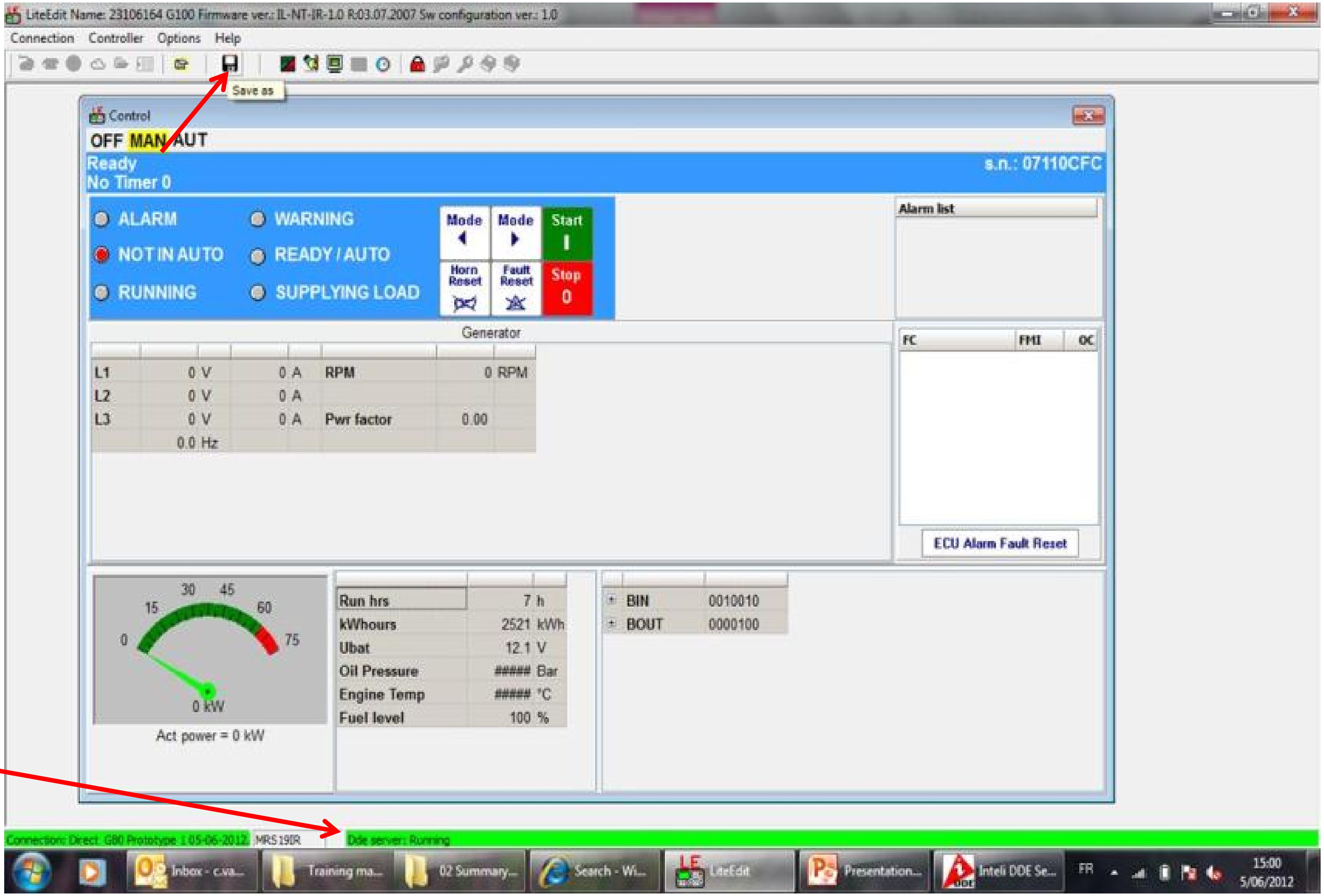
Reading the digital controller using the computer

- **Open direct communication to the controller**



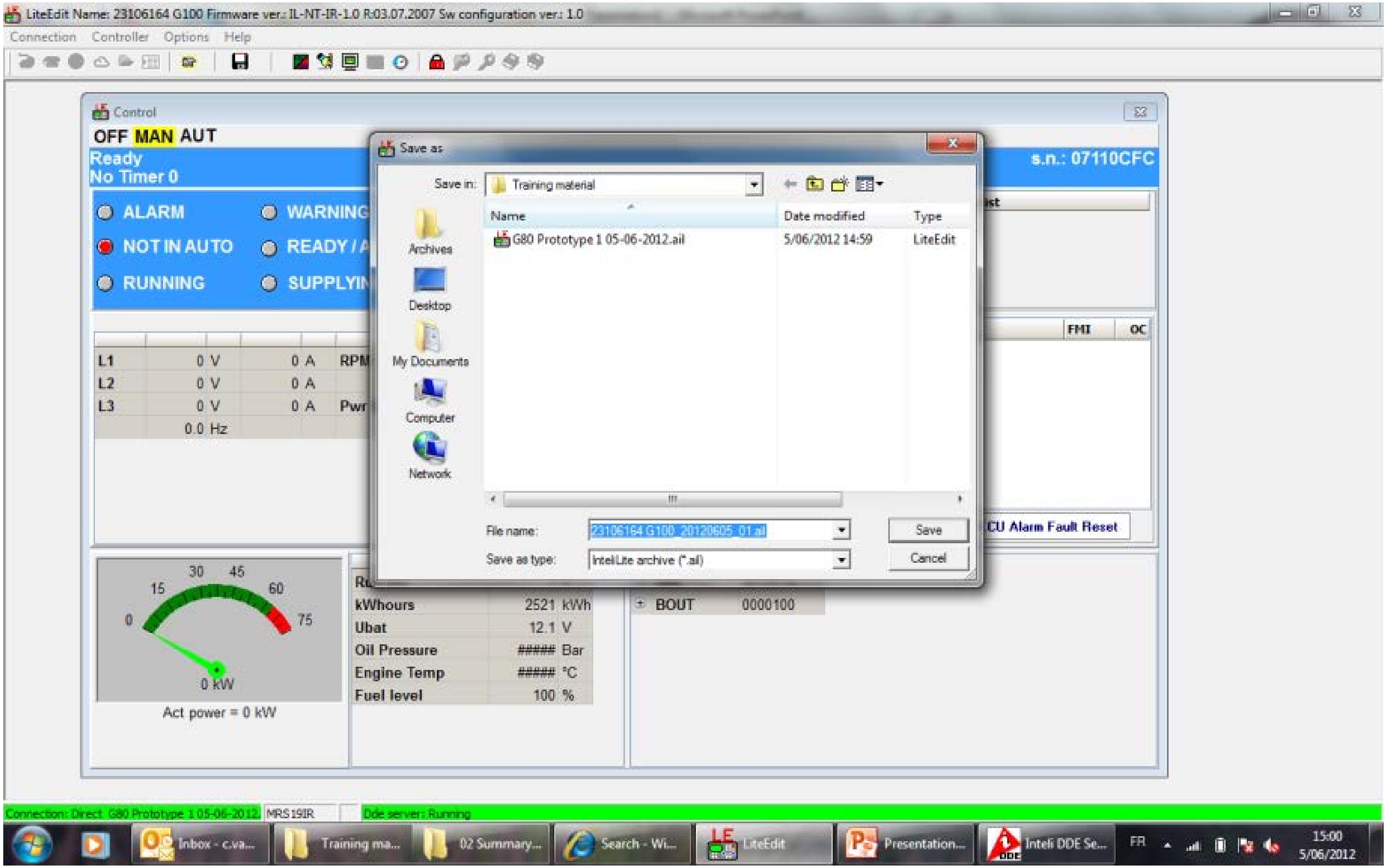
Reading the digital controller using the computer

- **IMPORTANT : Save the controller's archive before any other action**



Reading the digital controller using the computer

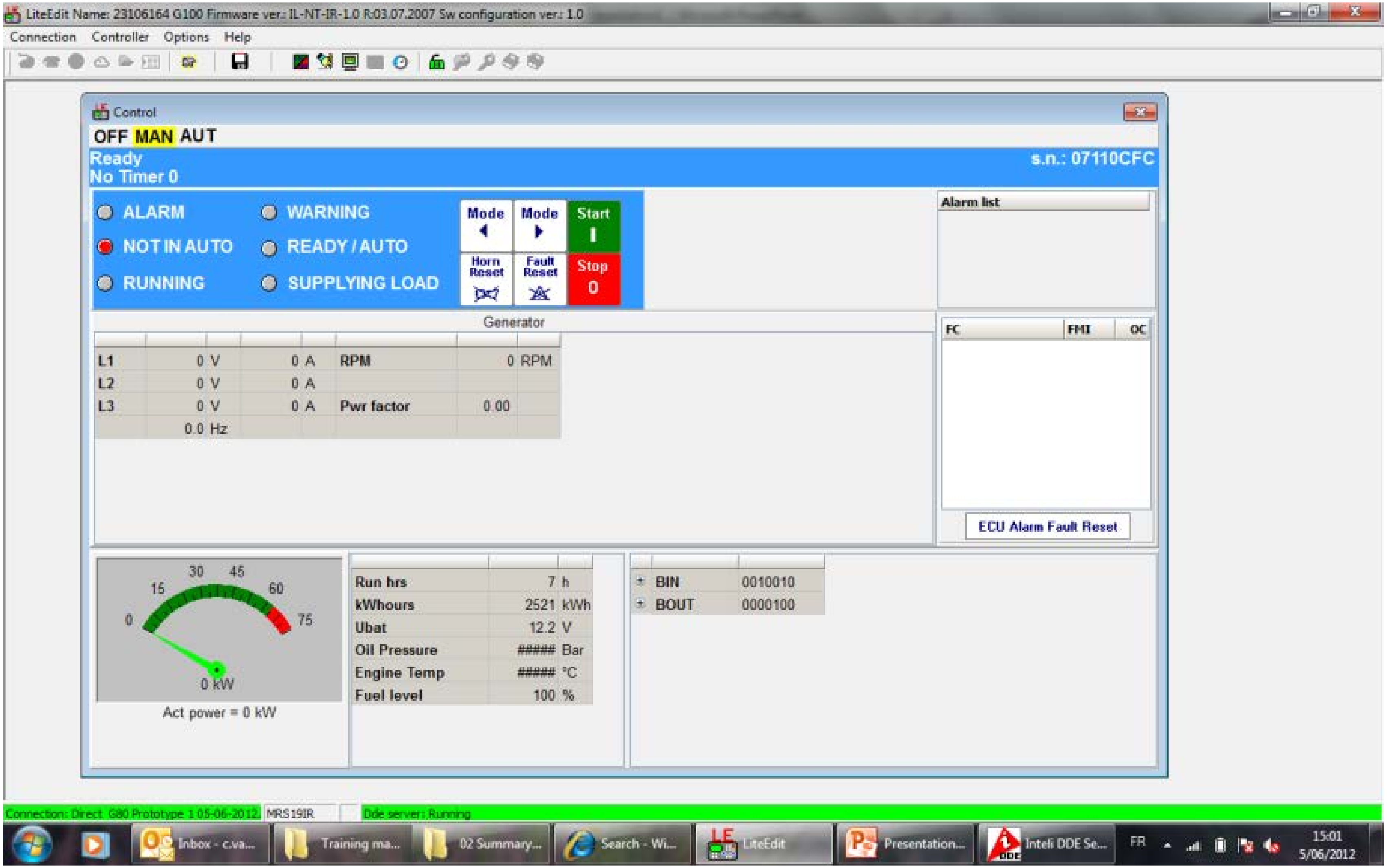
- **IMPORTANT : Save the controller's archive before any other action**



DOOSAN

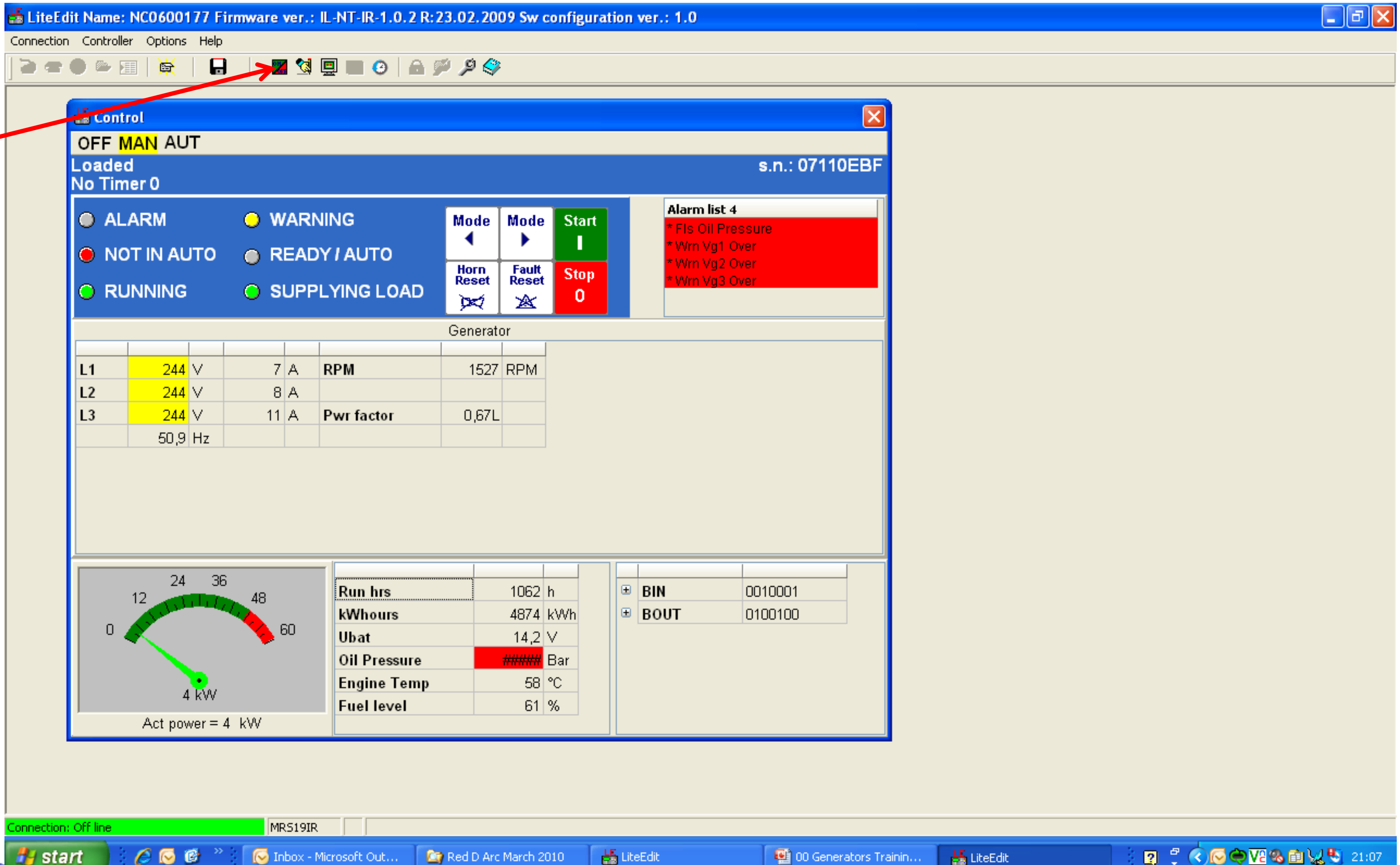
Reading the digital controller using the computer

- **IMPORTANT : Save the controller's archive before any other action**



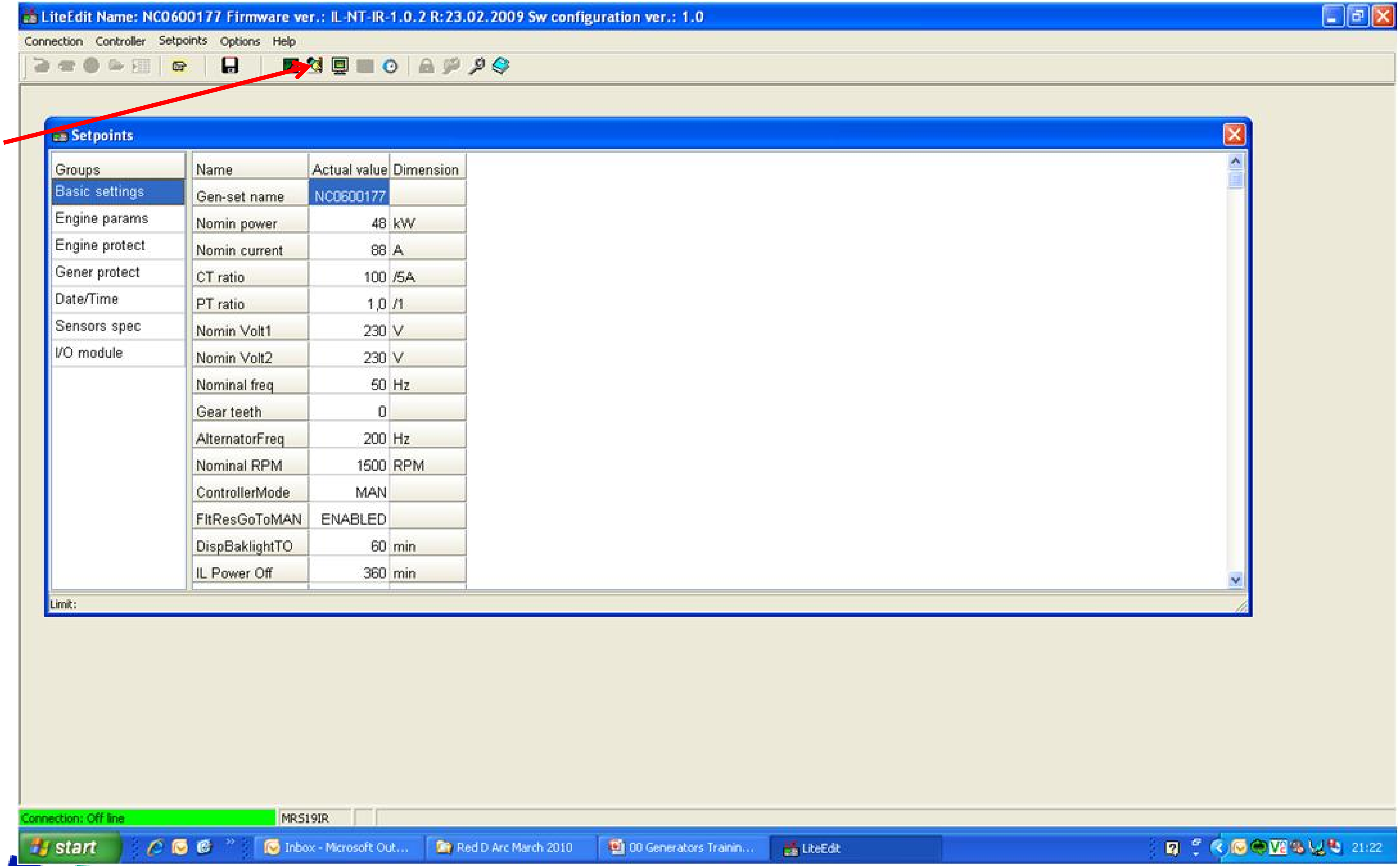
Reading the digital controller using the computer

• Control menu



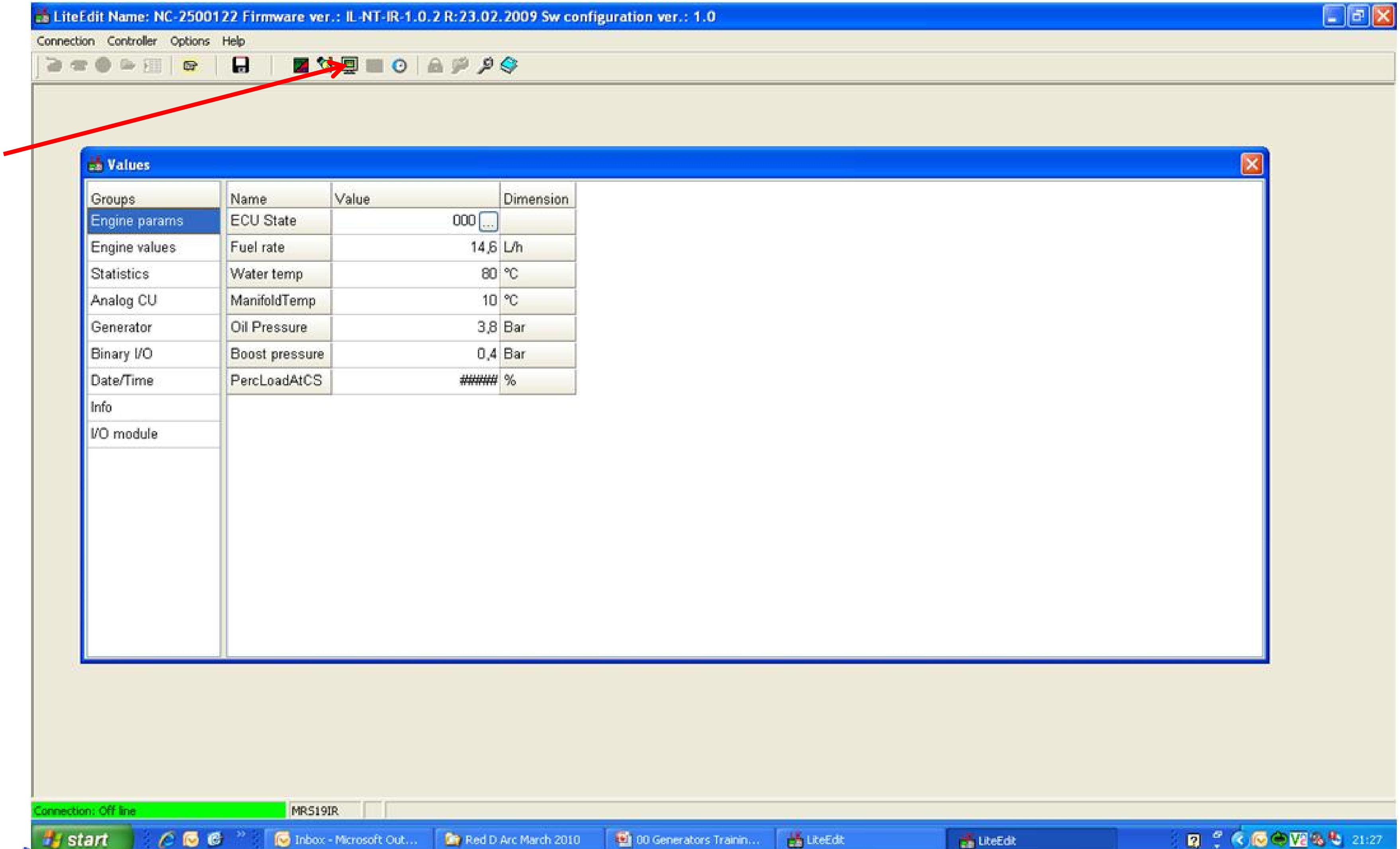
Reading the digital controller using the computer

- **Set points menu**



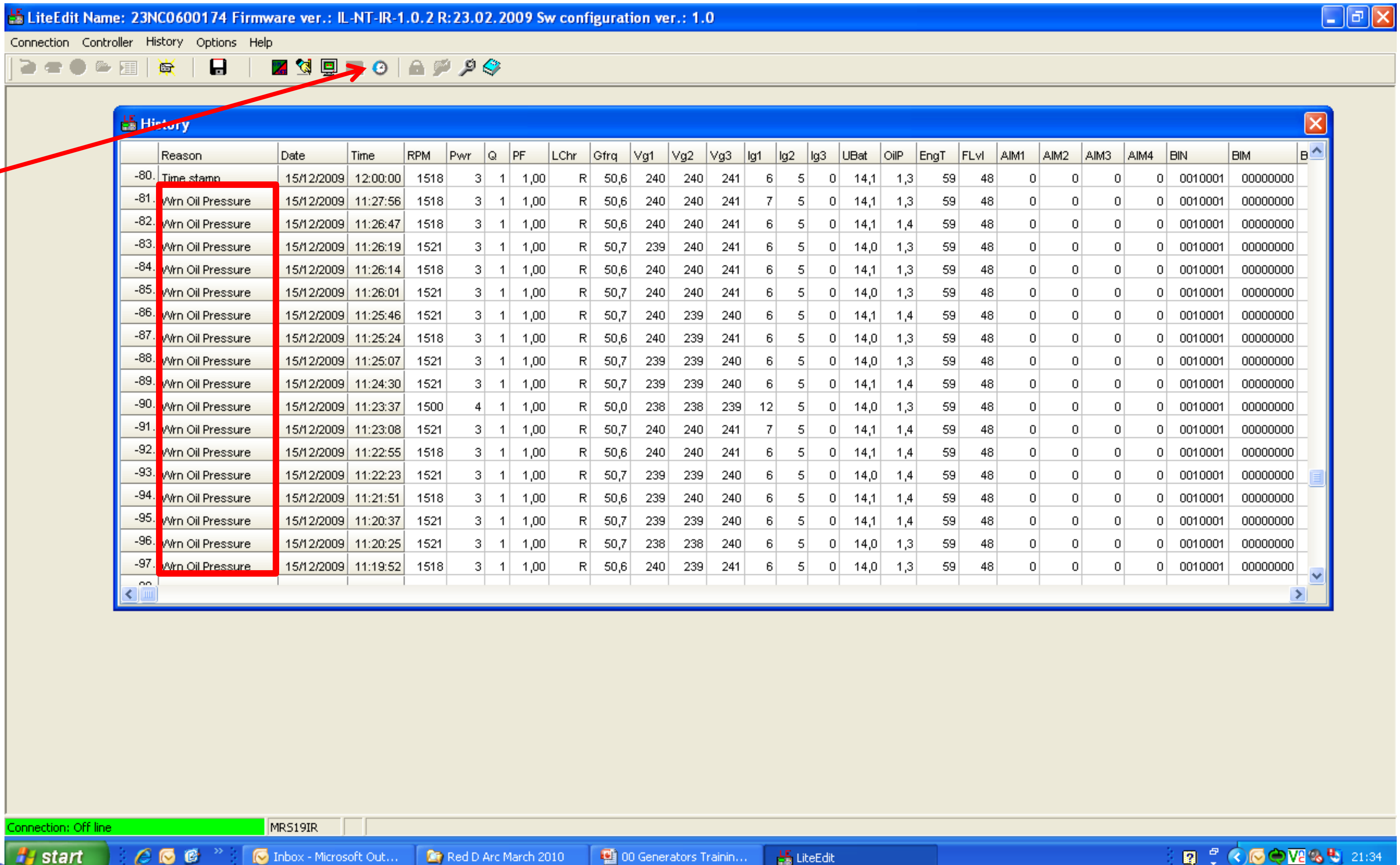
Reading the digital controller using the computer

- **Actual values menu**



Reading the digital controller using the computer

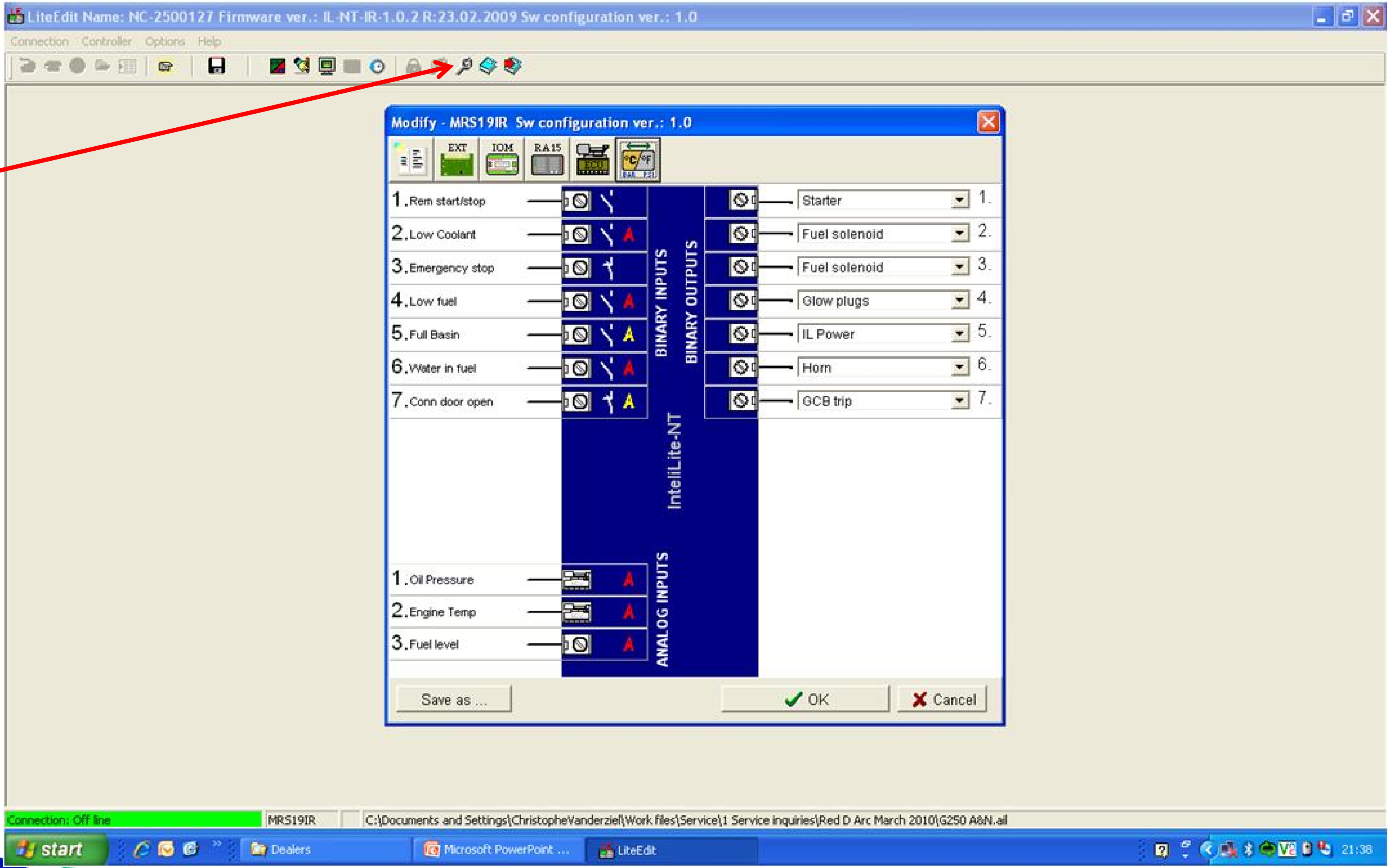
- **History menu**



	Reason	Date	Time	RPM	Pwr	Q	PF	LChr	Gfrq	Vg1	Vg2	Vg3	Ig1	Ig2	Ig3	UBat	OilP	EngT	FLvl	AIM1	AIM2	AIM3	AIM4	BIN	BIM
-80.	Time stamp	15/12/2009	12:00:00	1518	3	1	1,00	R	50,6	240	240	241	6	5	0	14,1	1,3	59	48	0	0	0	0	0010001	00000000
-81.	Wrn Oil Pressure	15/12/2009	11:27:56	1518	3	1	1,00	R	50,6	240	240	241	7	5	0	14,1	1,3	59	48	0	0	0	0	0010001	00000000
-82.	Wrn Oil Pressure	15/12/2009	11:26:47	1518	3	1	1,00	R	50,6	240	240	241	6	5	0	14,1	1,4	59	48	0	0	0	0	0010001	00000000
-83.	Wrn Oil Pressure	15/12/2009	11:26:19	1521	3	1	1,00	R	50,7	239	240	241	6	5	0	14,0	1,3	59	48	0	0	0	0	0010001	00000000
-84.	Wrn Oil Pressure	15/12/2009	11:26:14	1518	3	1	1,00	R	50,6	240	240	241	6	5	0	14,1	1,3	59	48	0	0	0	0	0010001	00000000
-85.	Wrn Oil Pressure	15/12/2009	11:26:01	1521	3	1	1,00	R	50,7	240	240	241	6	5	0	14,0	1,3	59	48	0	0	0	0	0010001	00000000
-86.	Wrn Oil Pressure	15/12/2009	11:25:46	1521	3	1	1,00	R	50,7	240	239	240	6	5	0	14,1	1,4	59	48	0	0	0	0	0010001	00000000
-87.	Wrn Oil Pressure	15/12/2009	11:25:24	1518	3	1	1,00	R	50,6	240	239	241	6	5	0	14,0	1,3	59	48	0	0	0	0	0010001	00000000
-88.	Wrn Oil Pressure	15/12/2009	11:25:07	1521	3	1	1,00	R	50,7	239	239	240	6	5	0	14,0	1,3	59	48	0	0	0	0	0010001	00000000
-89.	Wrn Oil Pressure	15/12/2009	11:24:30	1521	3	1	1,00	R	50,7	239	239	240	6	5	0	14,1	1,4	59	48	0	0	0	0	0010001	00000000
-90.	Wrn Oil Pressure	15/12/2009	11:23:37	1500	4	1	1,00	R	50,0	238	238	239	12	5	0	14,0	1,3	59	48	0	0	0	0	0010001	00000000
-91.	Wrn Oil Pressure	15/12/2009	11:23:08	1521	3	1	1,00	R	50,7	240	240	241	7	5	0	14,1	1,4	59	48	0	0	0	0	0010001	00000000
-92.	Wrn Oil Pressure	15/12/2009	11:22:55	1518	3	1	1,00	R	50,6	240	240	241	6	5	0	14,1	1,4	59	48	0	0	0	0	0010001	00000000
-93.	Wrn Oil Pressure	15/12/2009	11:22:23	1521	3	1	1,00	R	50,7	239	239	240	6	5	0	14,0	1,4	59	48	0	0	0	0	0010001	00000000
-94.	Wrn Oil Pressure	15/12/2009	11:21:51	1518	3	1	1,00	R	50,6	239	240	240	6	5	0	14,1	1,4	59	48	0	0	0	0	0010001	00000000
-95.	Wrn Oil Pressure	15/12/2009	11:20:37	1521	3	1	1,00	R	50,7	239	239	240	6	5	0	14,1	1,4	59	48	0	0	0	0	0010001	00000000
-96.	Wrn Oil Pressure	15/12/2009	11:20:25	1521	3	1	1,00	R	50,7	238	238	240	6	5	0	14,0	1,3	59	48	0	0	0	0	0010001	00000000
-97.	Wrn Oil Pressure	15/12/2009	11:19:52	1518	3	1	1,00	R	50,6	240	239	241	6	5	0	14,0	1,3	59	48	0	0	0	0	0010001	00000000

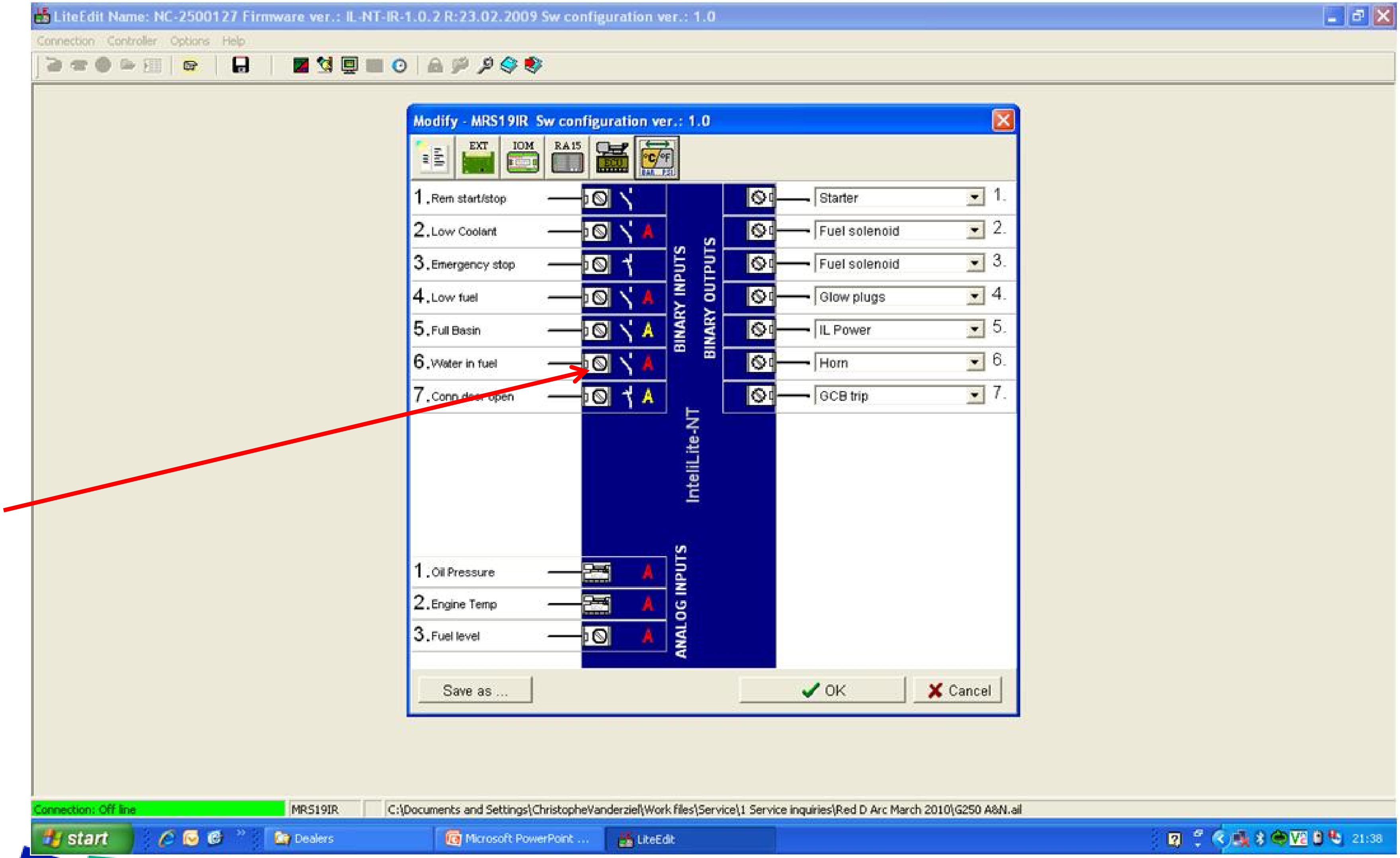
Reading the digital controller using the computer

- **Configuration menu**



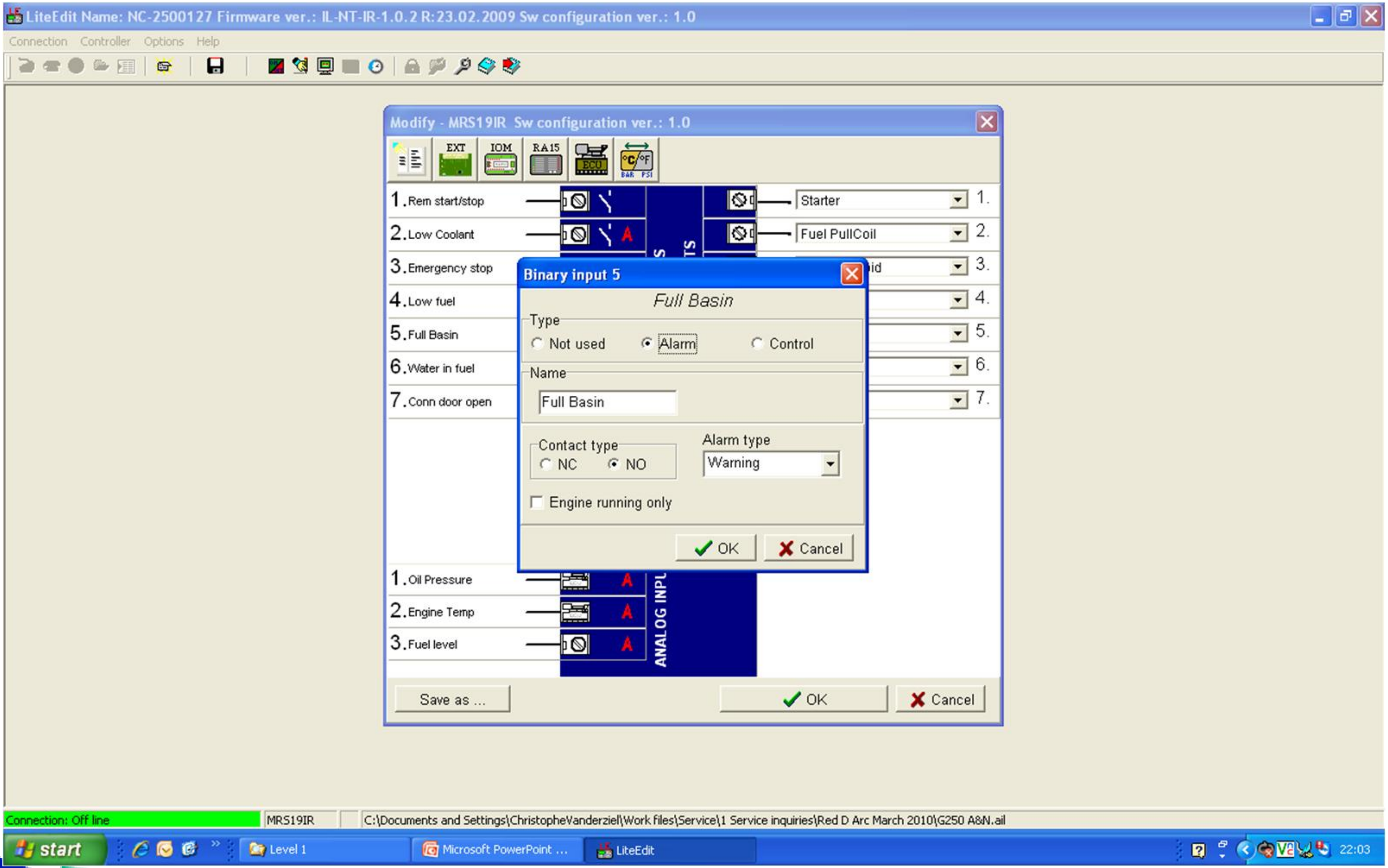
Reading the digital controller using the computer

- **Inputs / outputs configuration menu**



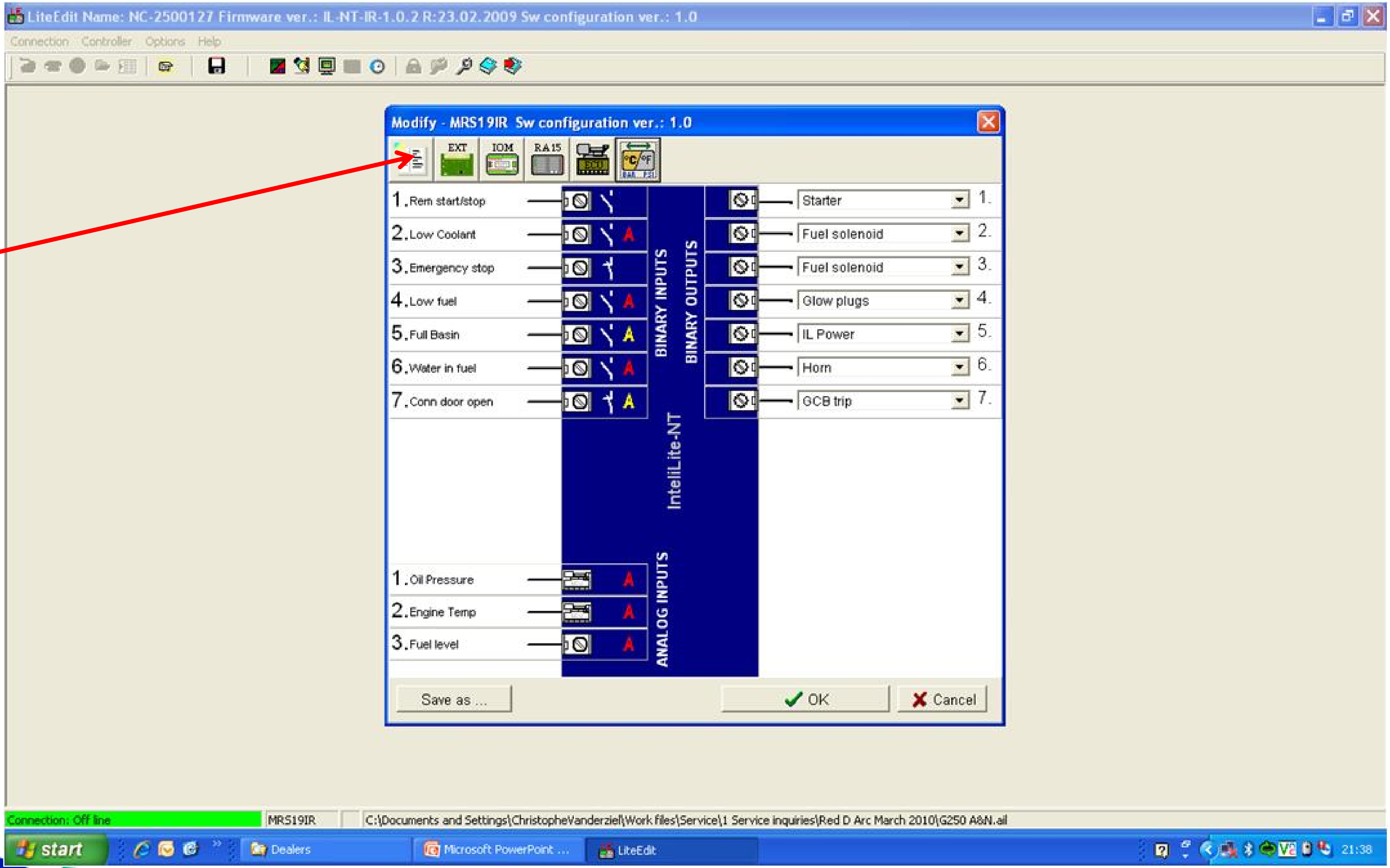
Reading the digital controller using the computer

- **Inputs / outputs configuration menu**



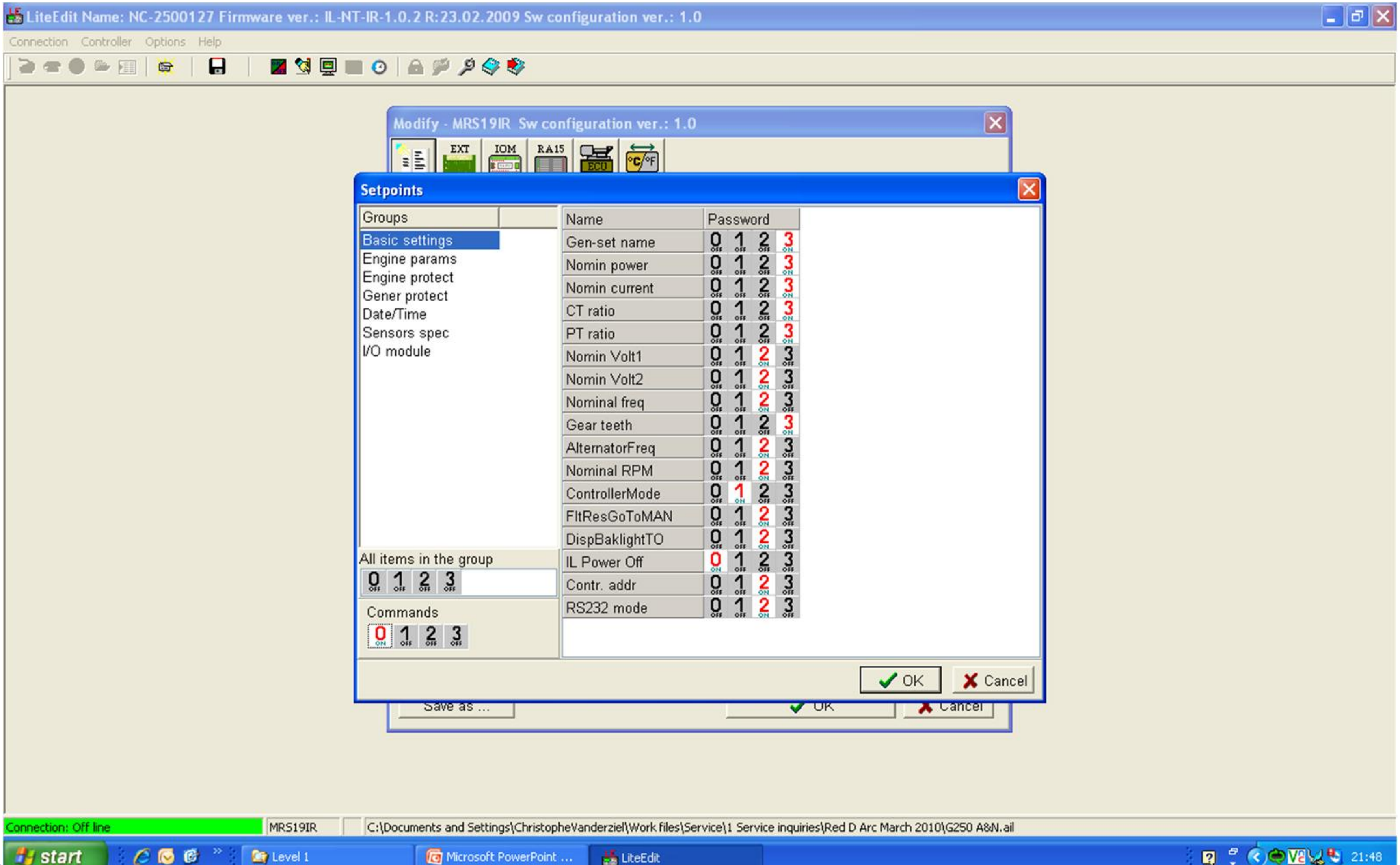
Reading the digital controller using the computer

- **Password set points menu**



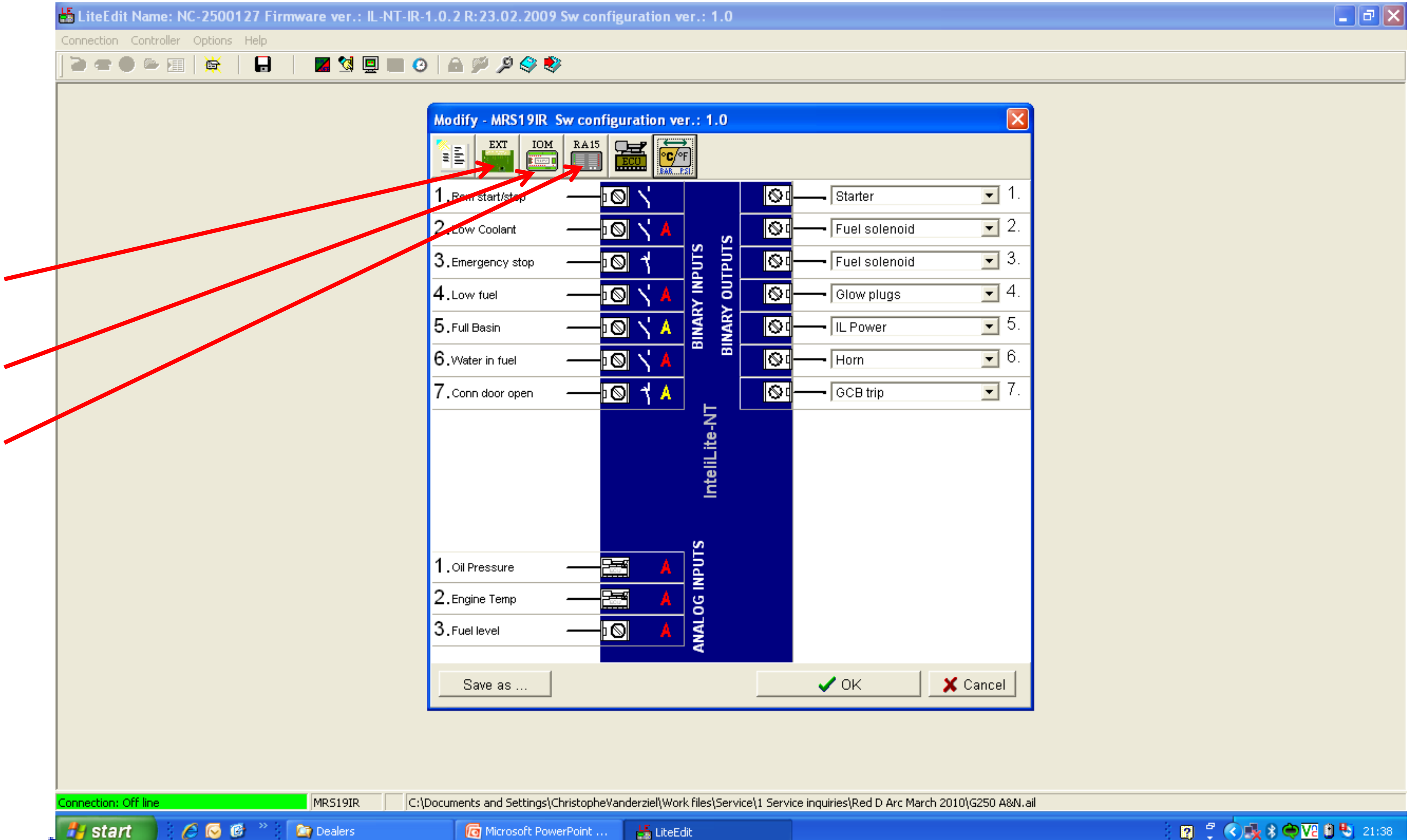
Reading the digital controller using the computer

- **Password set points menu**



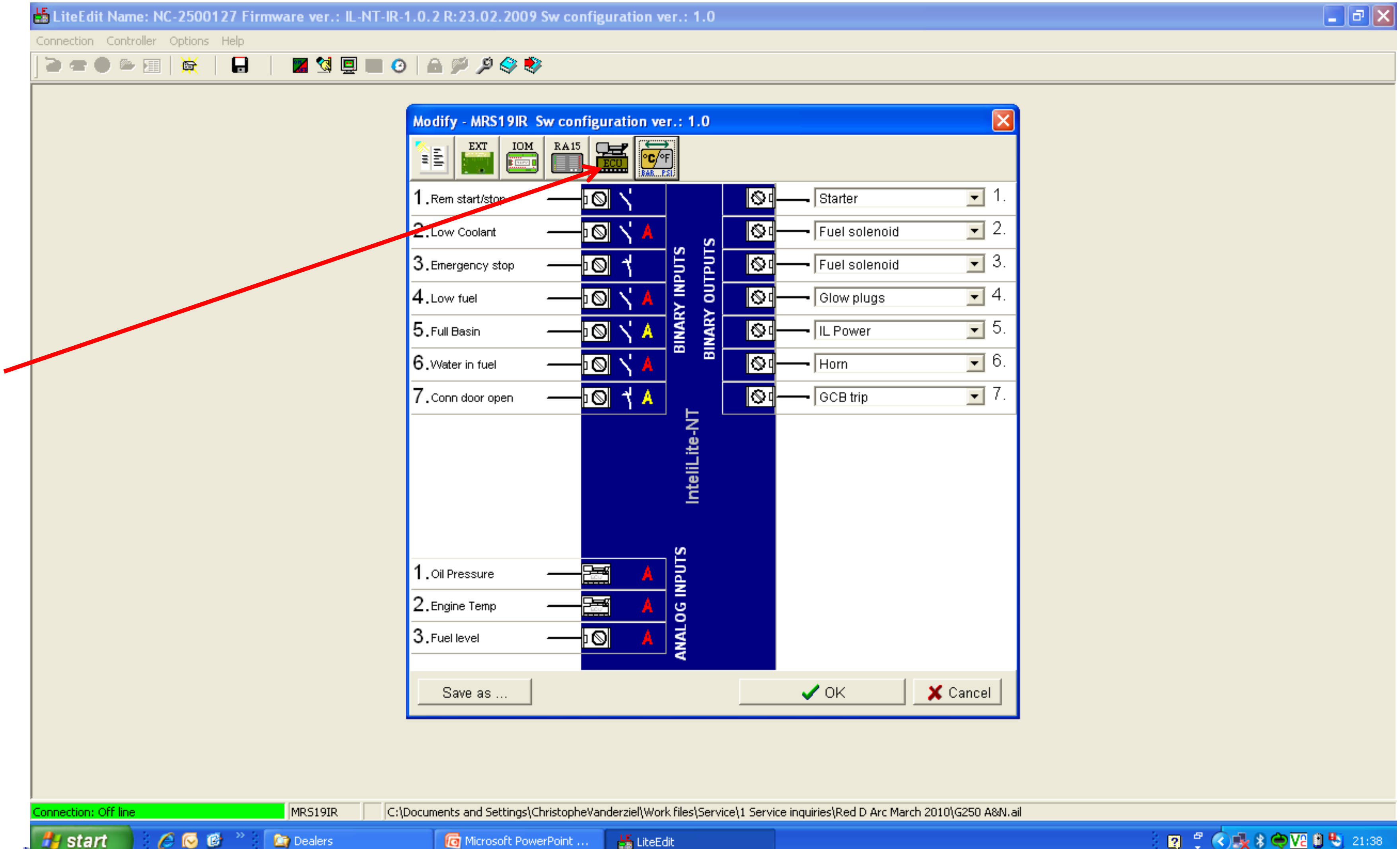
Reading the digital controller using the computer

- Not used



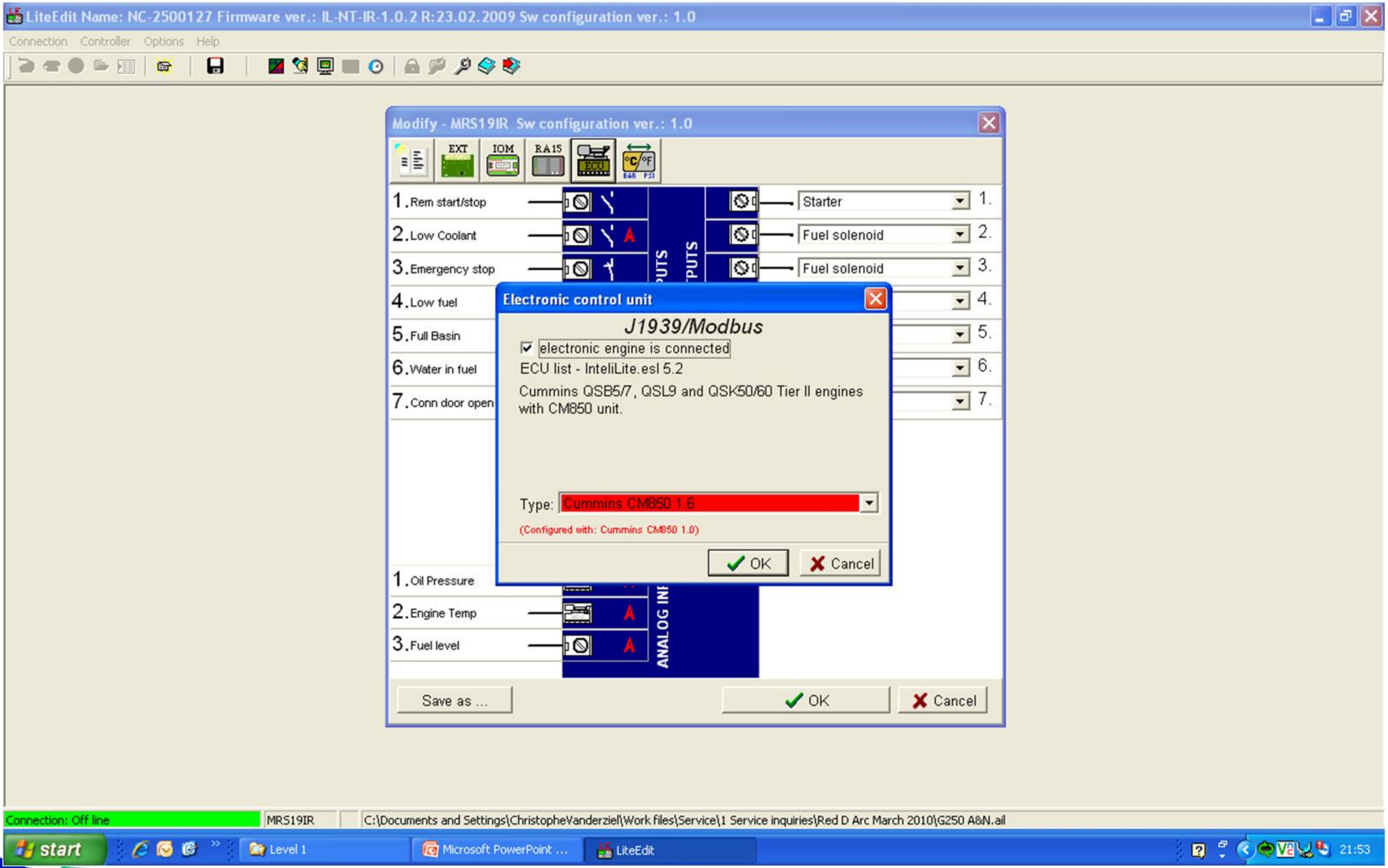
Reading the digital controller using the computer

- **Engine ECU configuration menu**



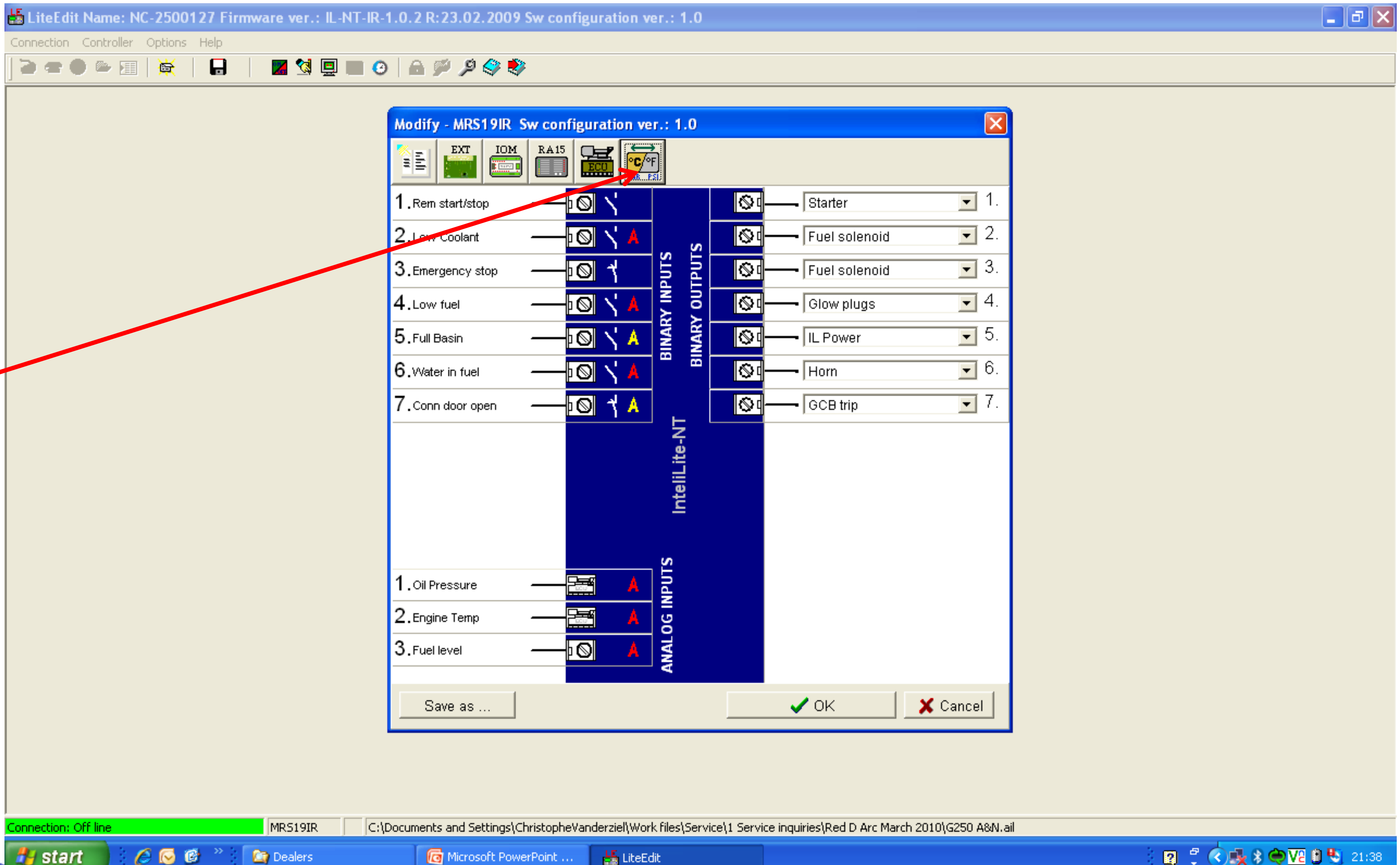
Reading the digital controller using the computer

- **Engine ECU configuration menu**



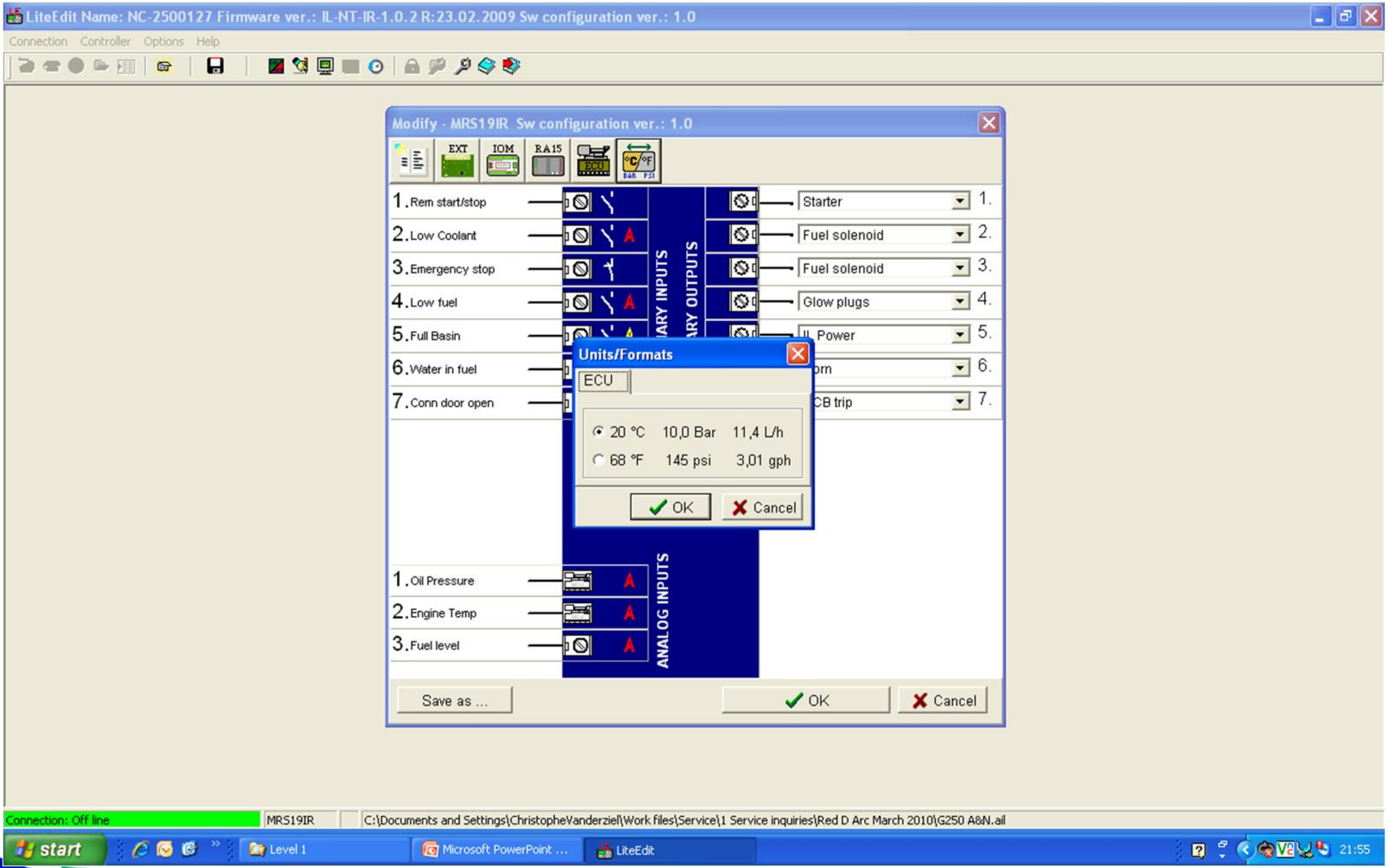
Reading the digital controller using the computer

• Units choice menu



Reading the digital controller using the computer

- **Units choice menu**



Doosan Infracore

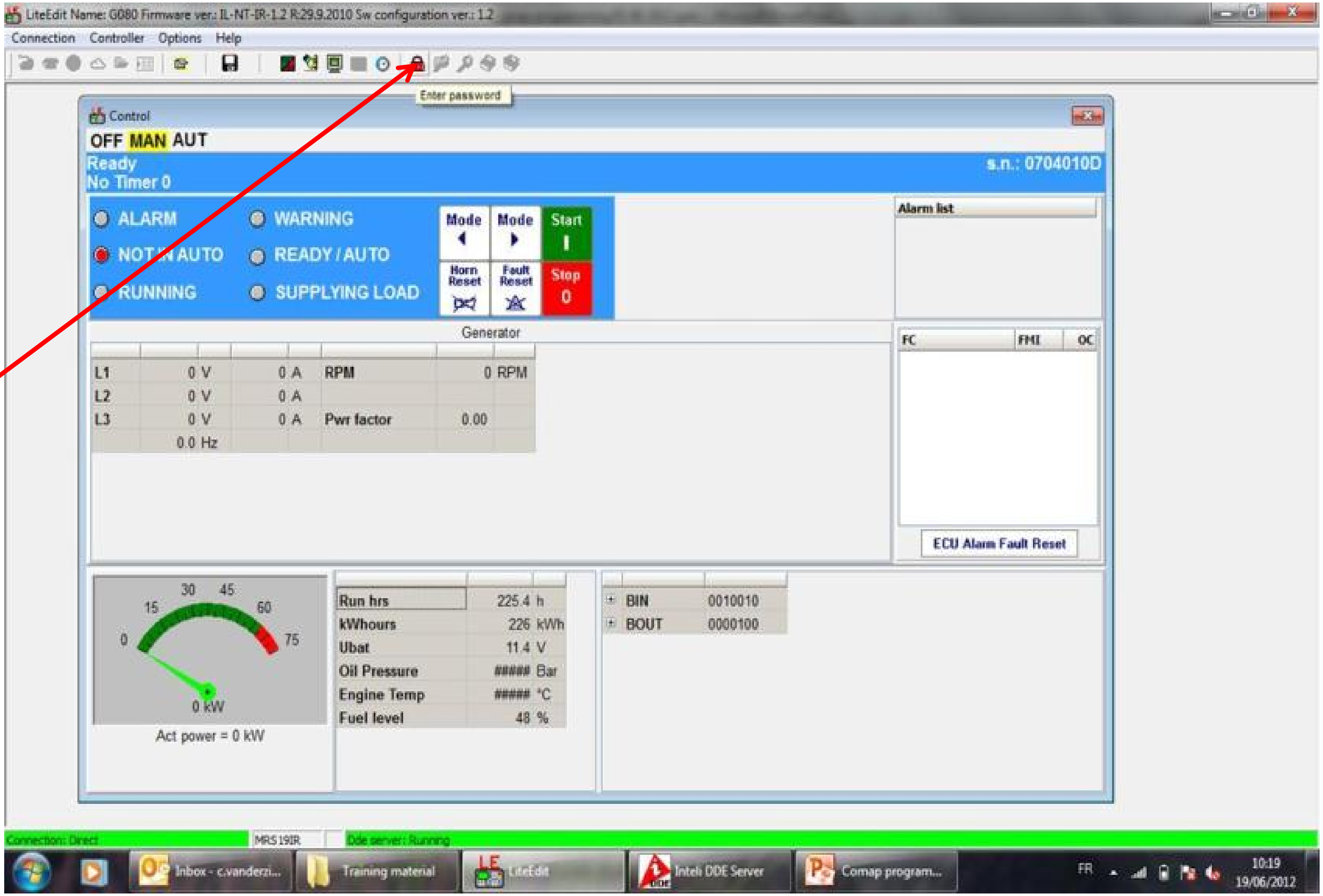
Service training: Generators

Programming the digital controller

Doosan Infracore
Portable Power

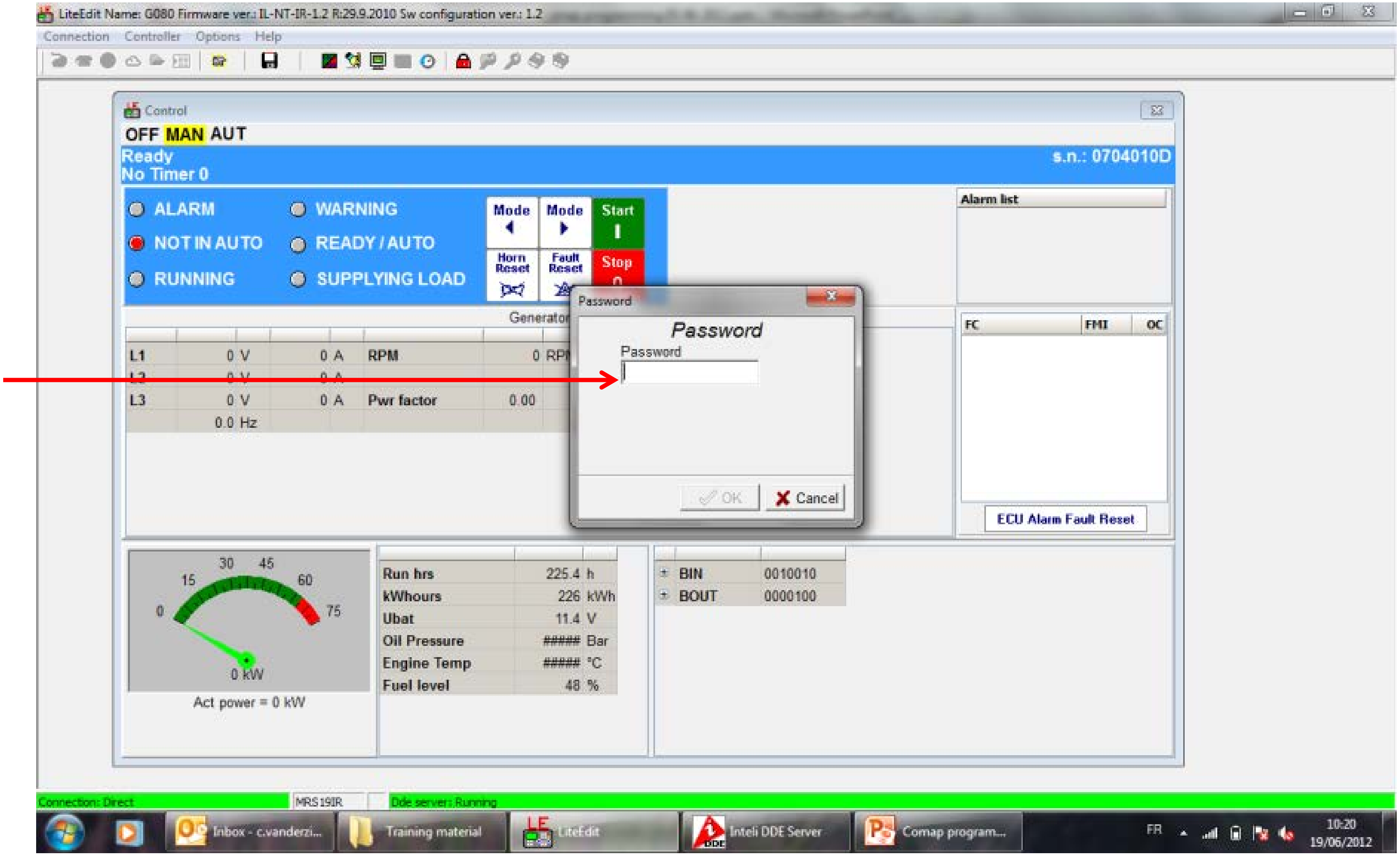
Programming the digital controller using the computer

- Unlock the controller using the master password



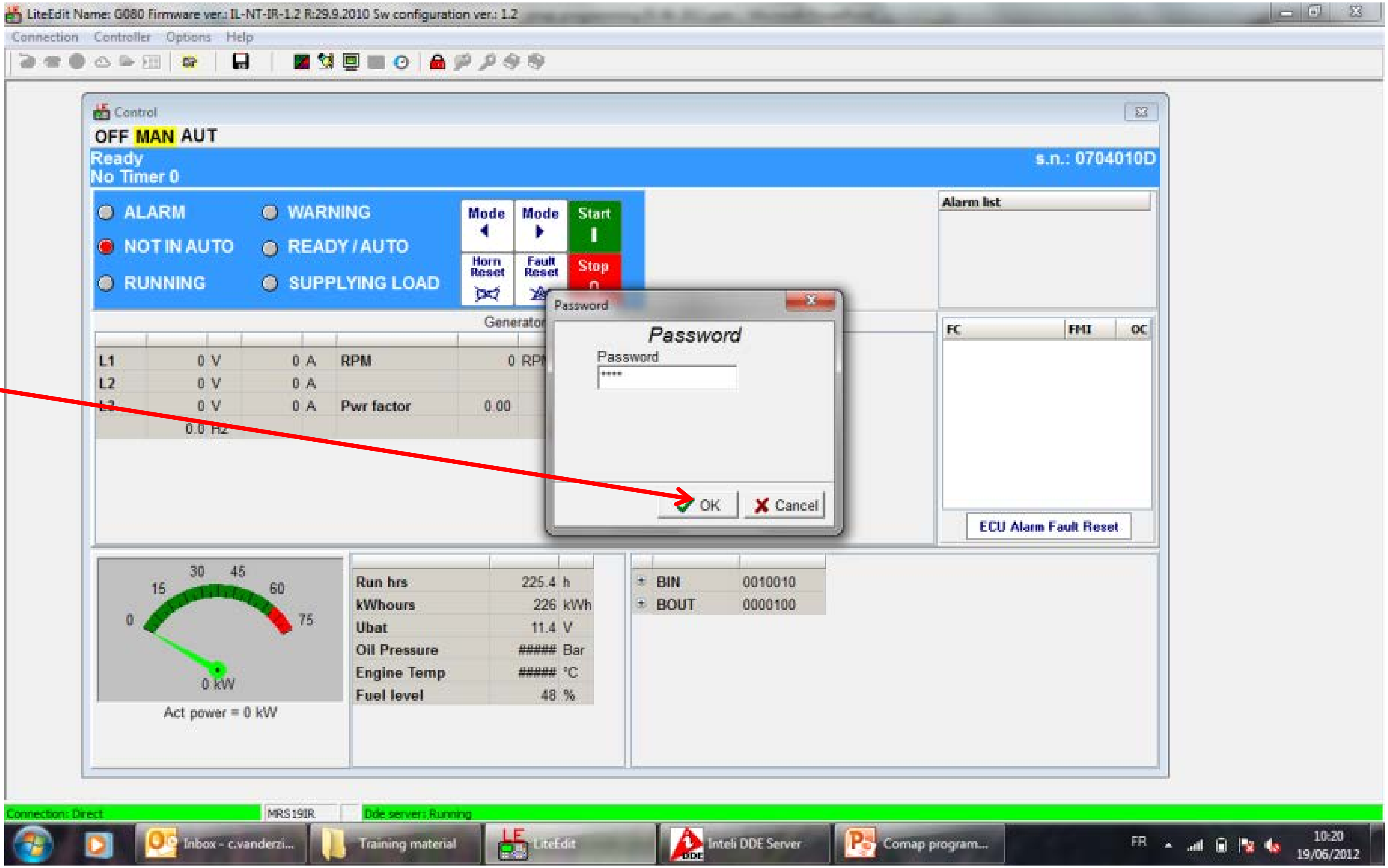
Programming the digital controller using the computer

- Unlock the controller using the master password



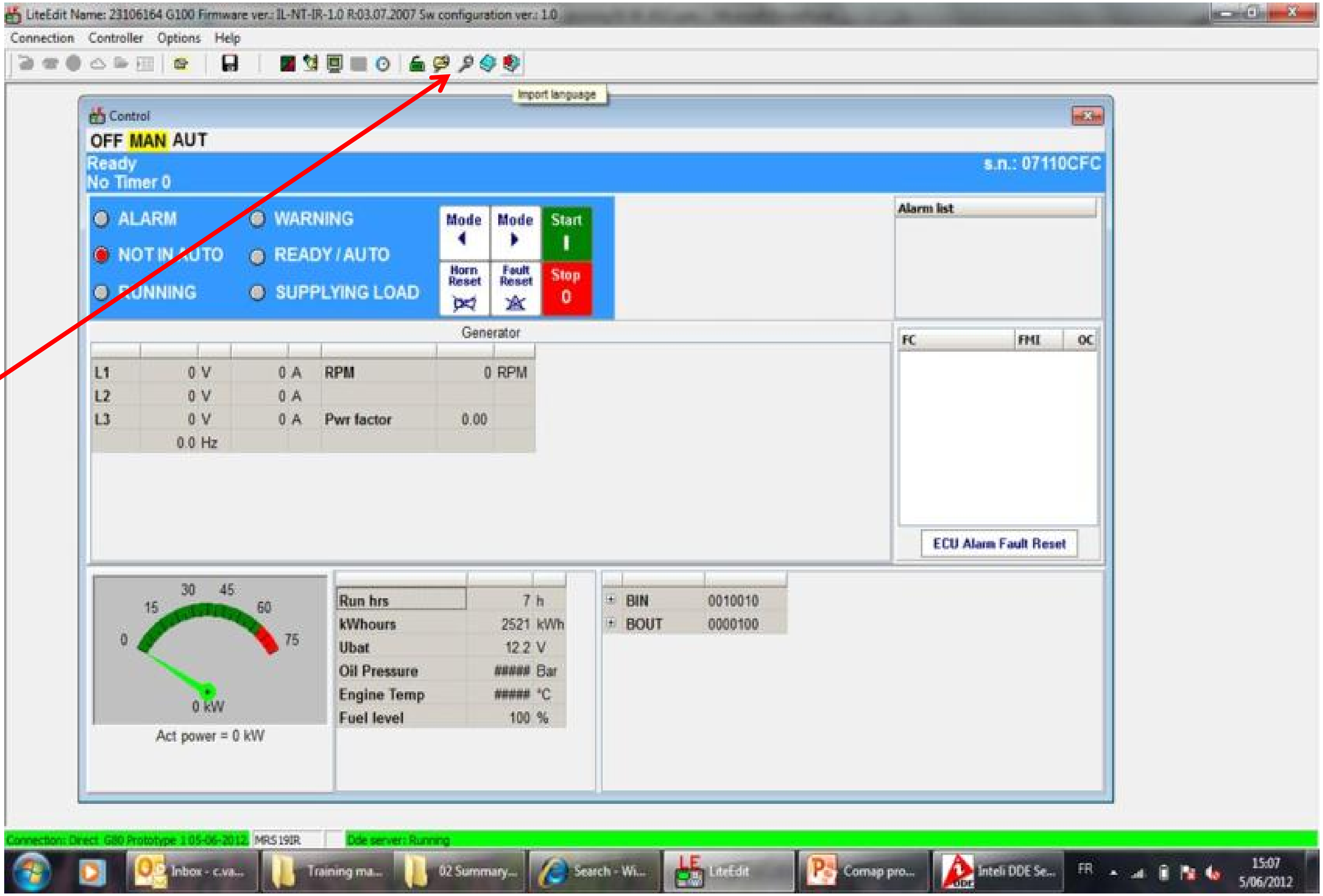
Programming the digital controller using the computer

- **Unlock the controller using the master password**



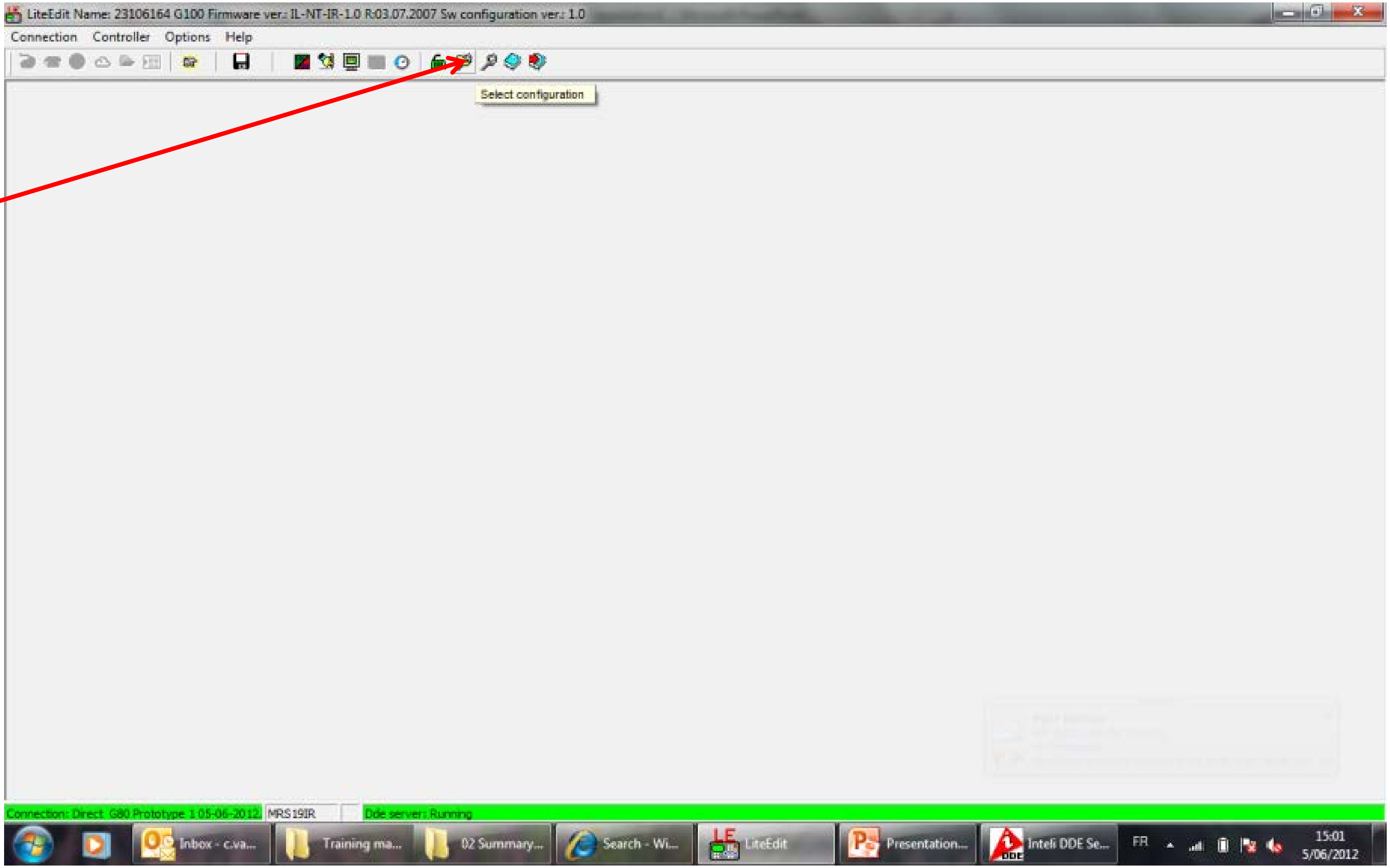
Programming the digital controller using the computer

- Unlock the controller using the master password



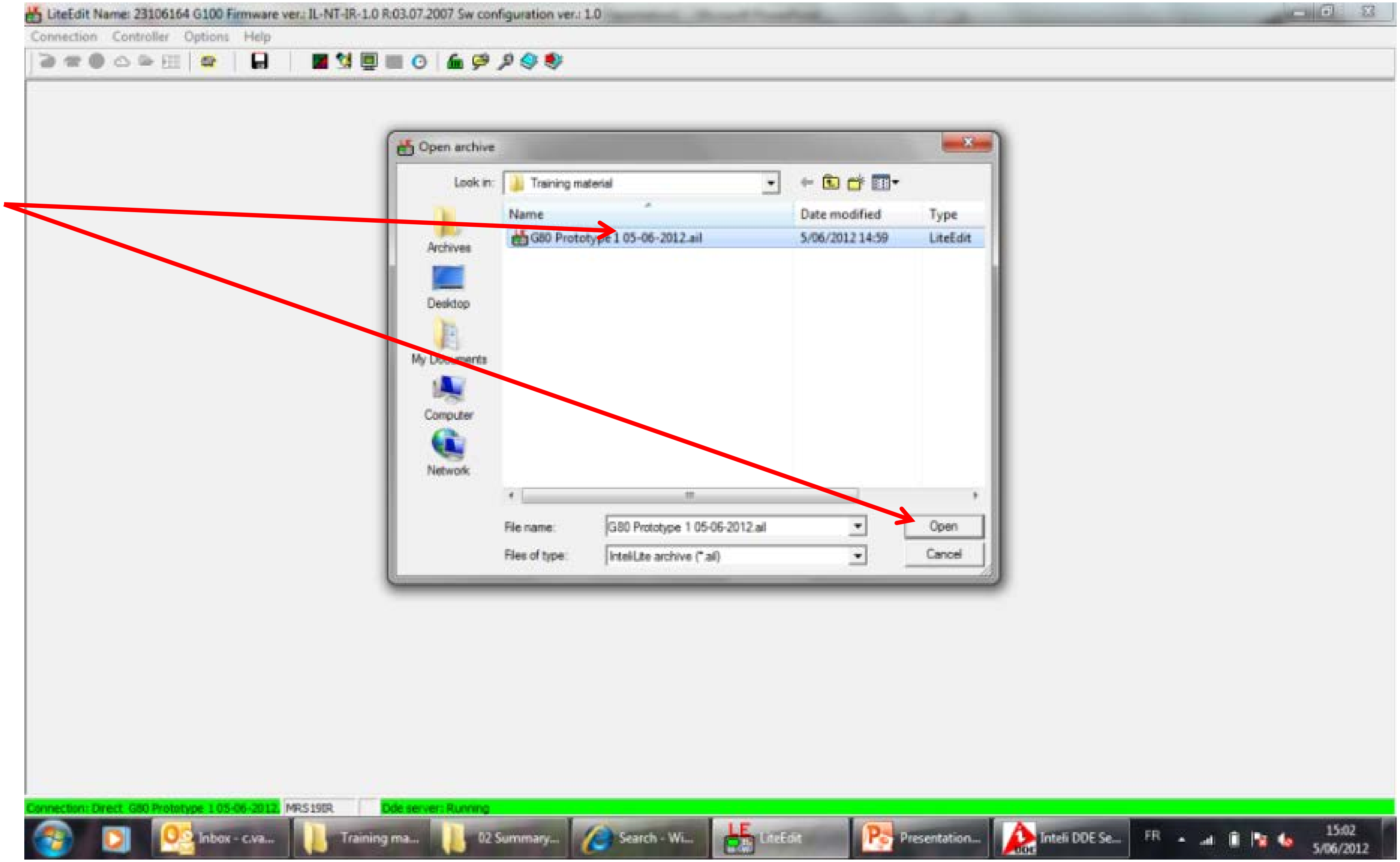
Programming the digital controller using the computer

- **Select the Configuration**



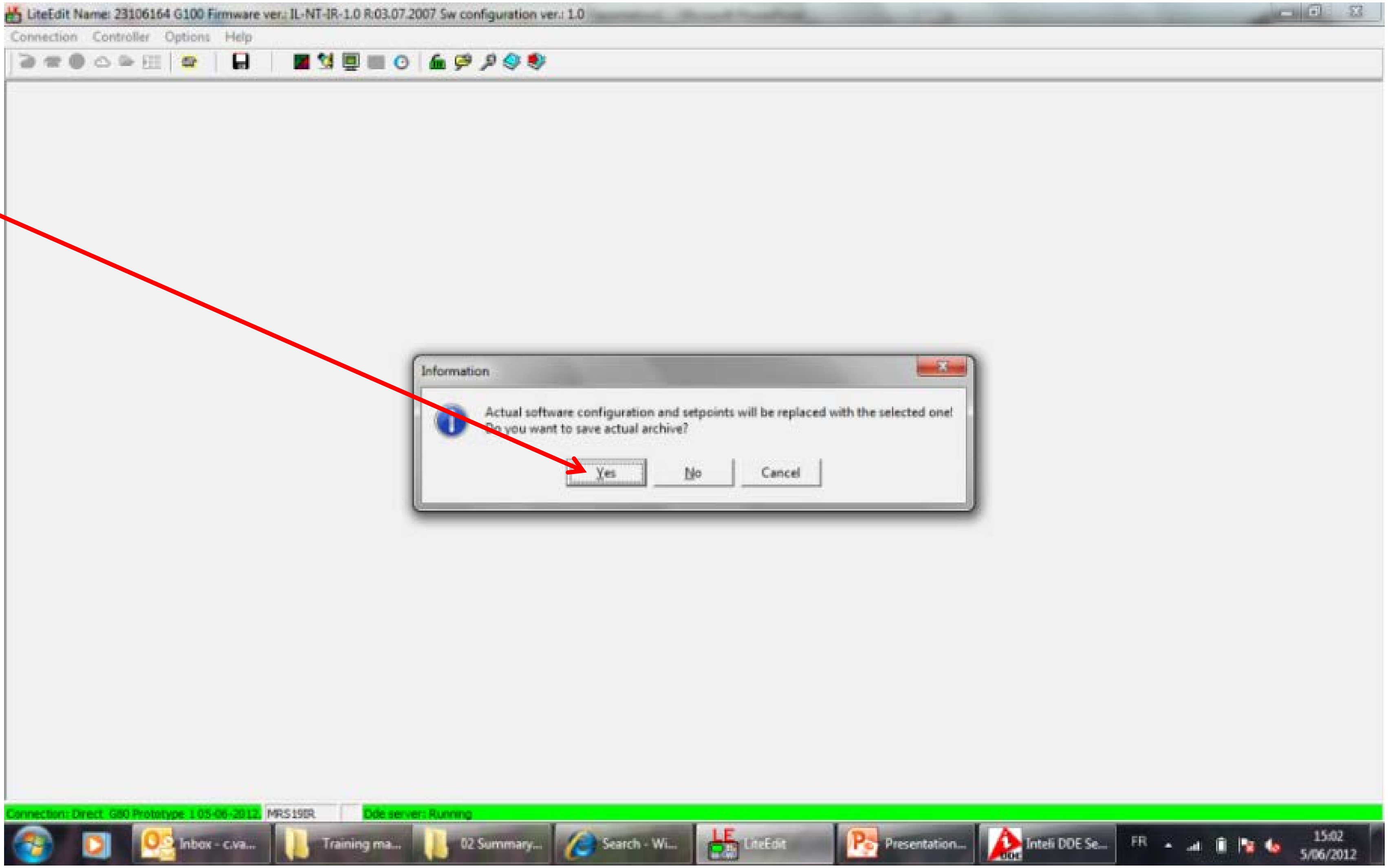
Programming the digital controller using the computer

- **Select the Configuration file**



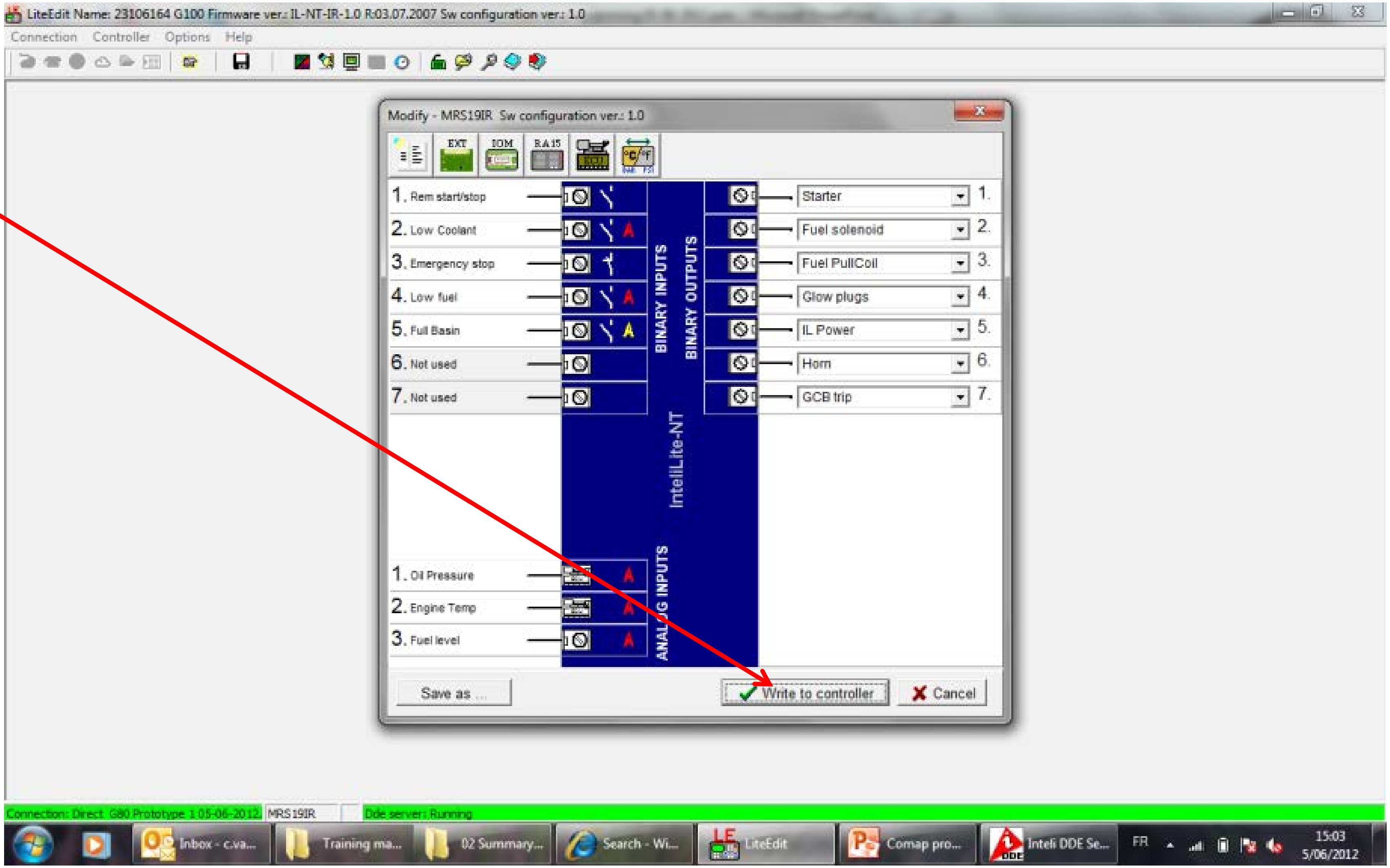
Programming the digital controller using the computer

- Confirm the Configuration selection



Programming the digital controller using the computer

- **Write to the controller**



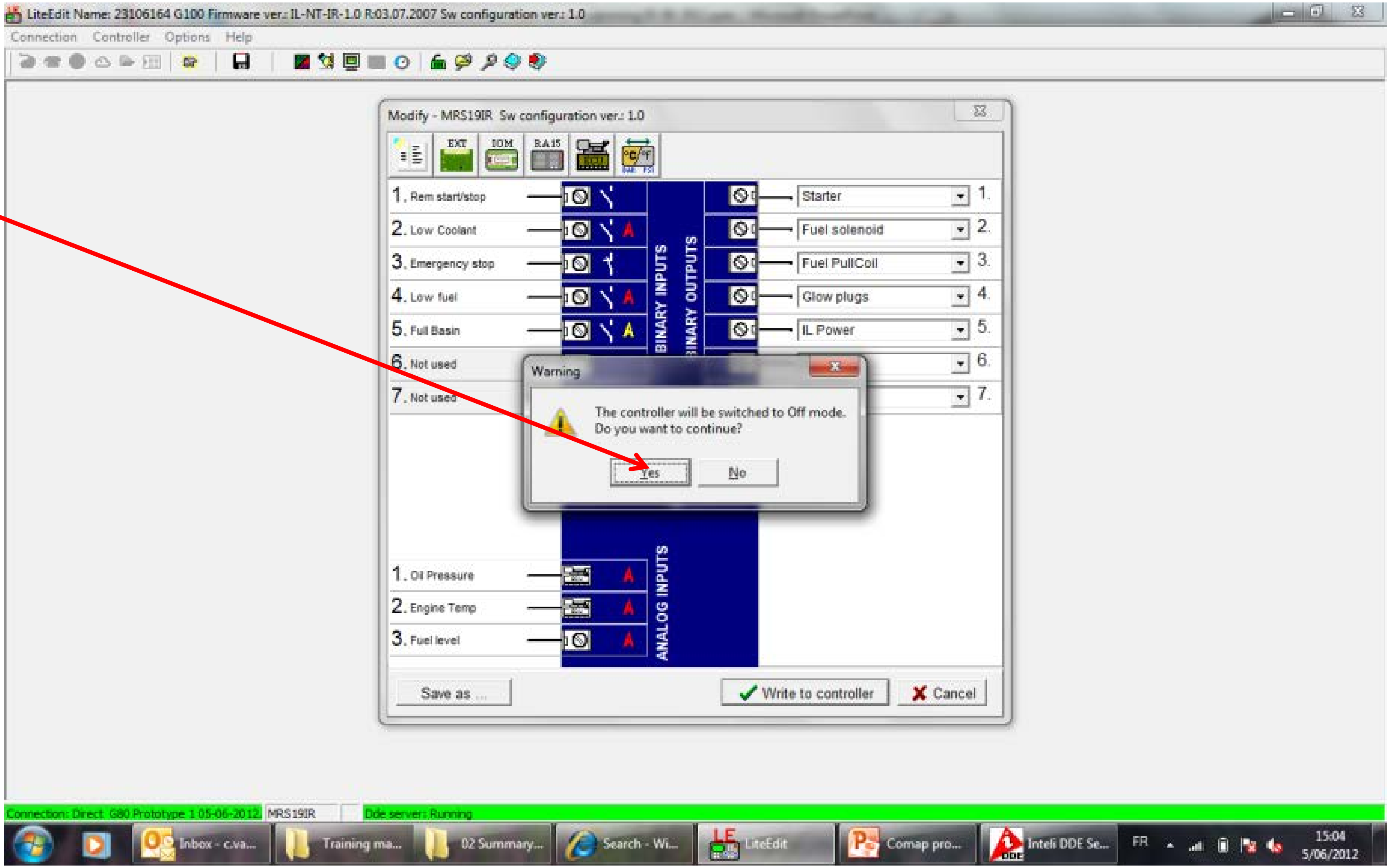
Programming the digital controller using the computer

- **IMPORTANT : The controller will be switched off during programming, therefore the controller power hold will be released.**
- **To avoid power shut off and loss of controller data:**
  - **It is compulsory to power-up the controller from an external source**
  - **An alternative is to keep the power-up green button pushed in during the programming time**

- **Failing to keep the controller powered-up will cause programming interruption and may cause the controller firmware to be corrupted. The controller can then become unusable and will need to be replaced**

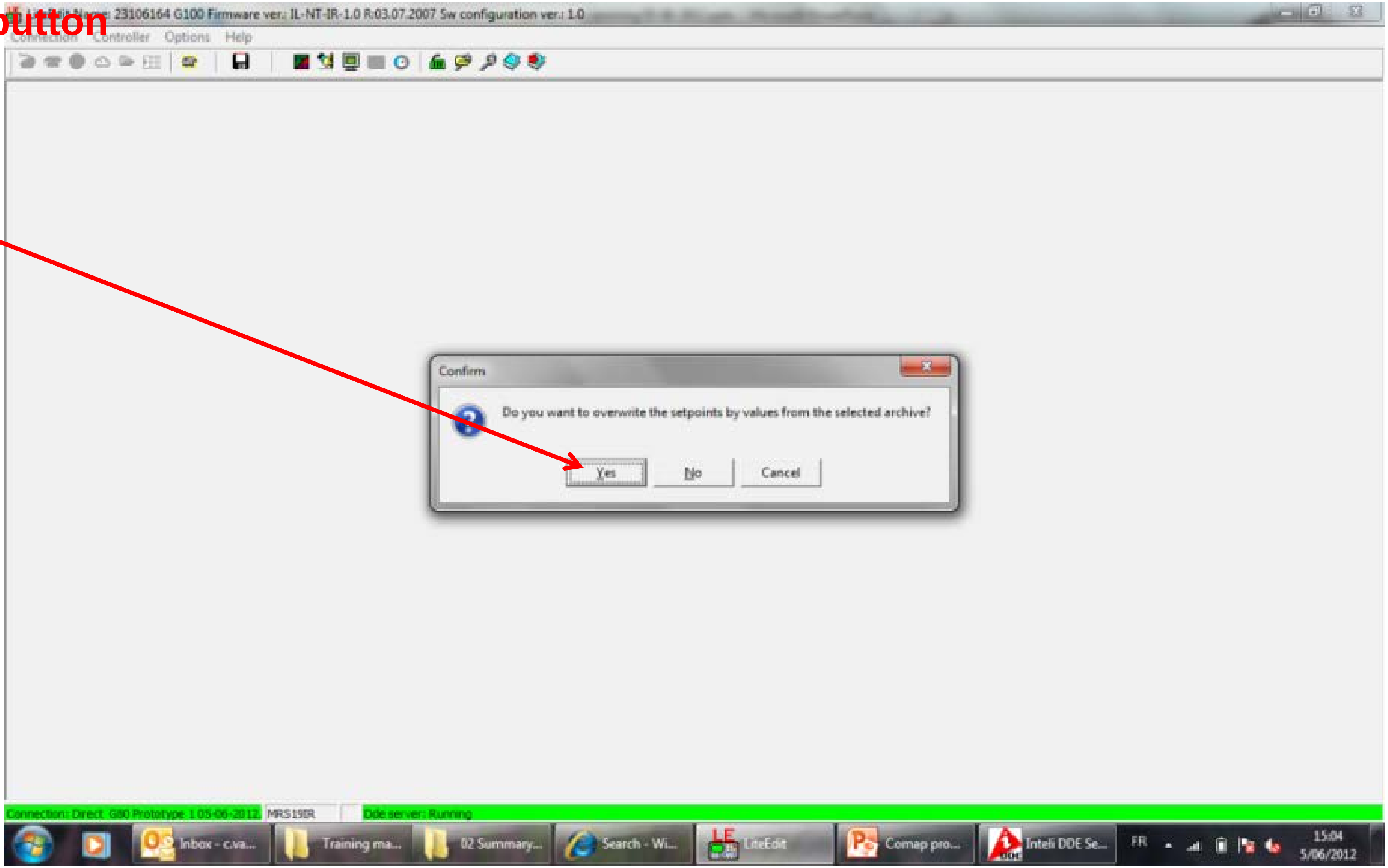
Programming the digital controller using the computer

- **Write to the controller**



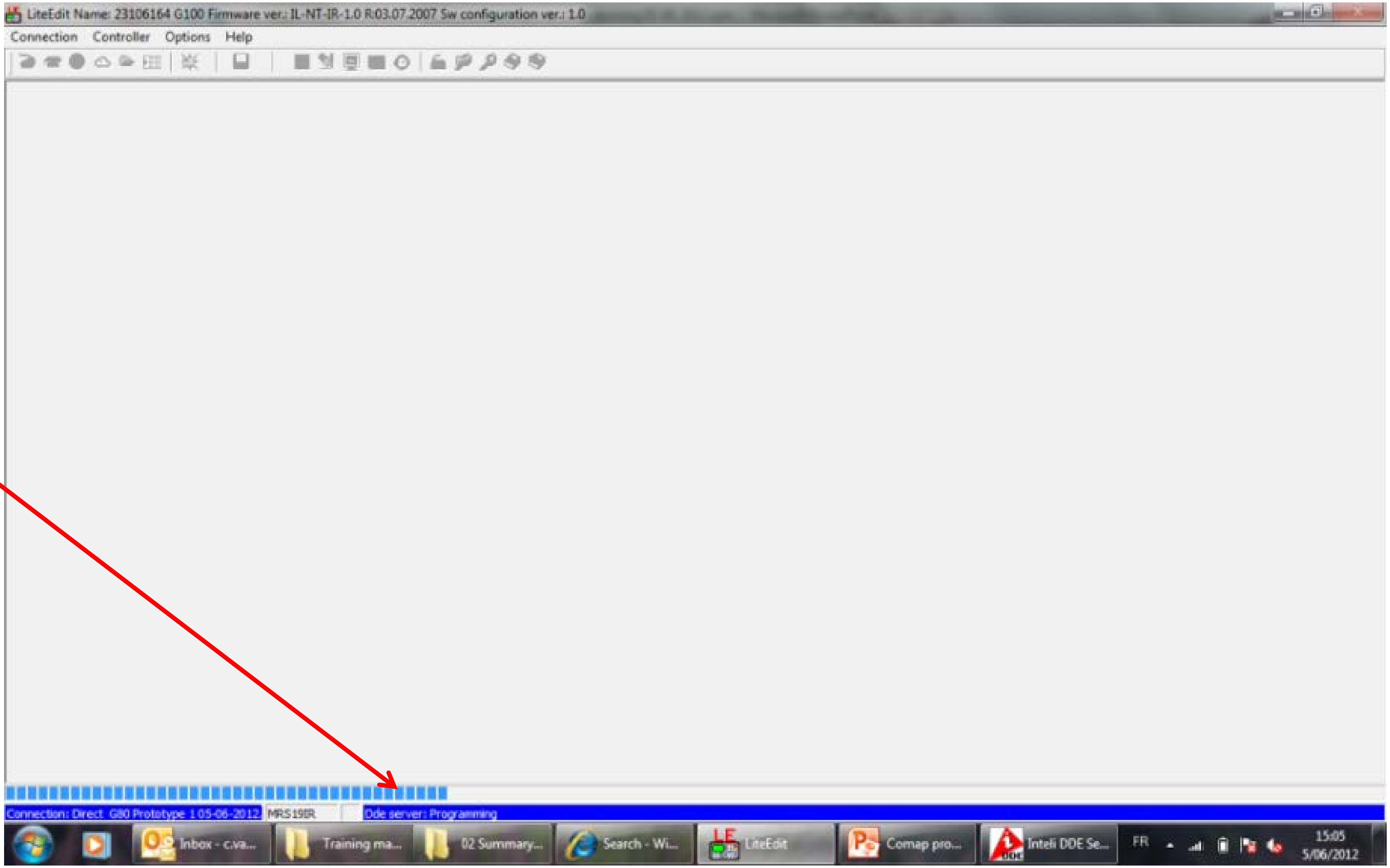
Programming the digital controller using the computer

- Write to the controller – push the green power button before hitting "Yes" button



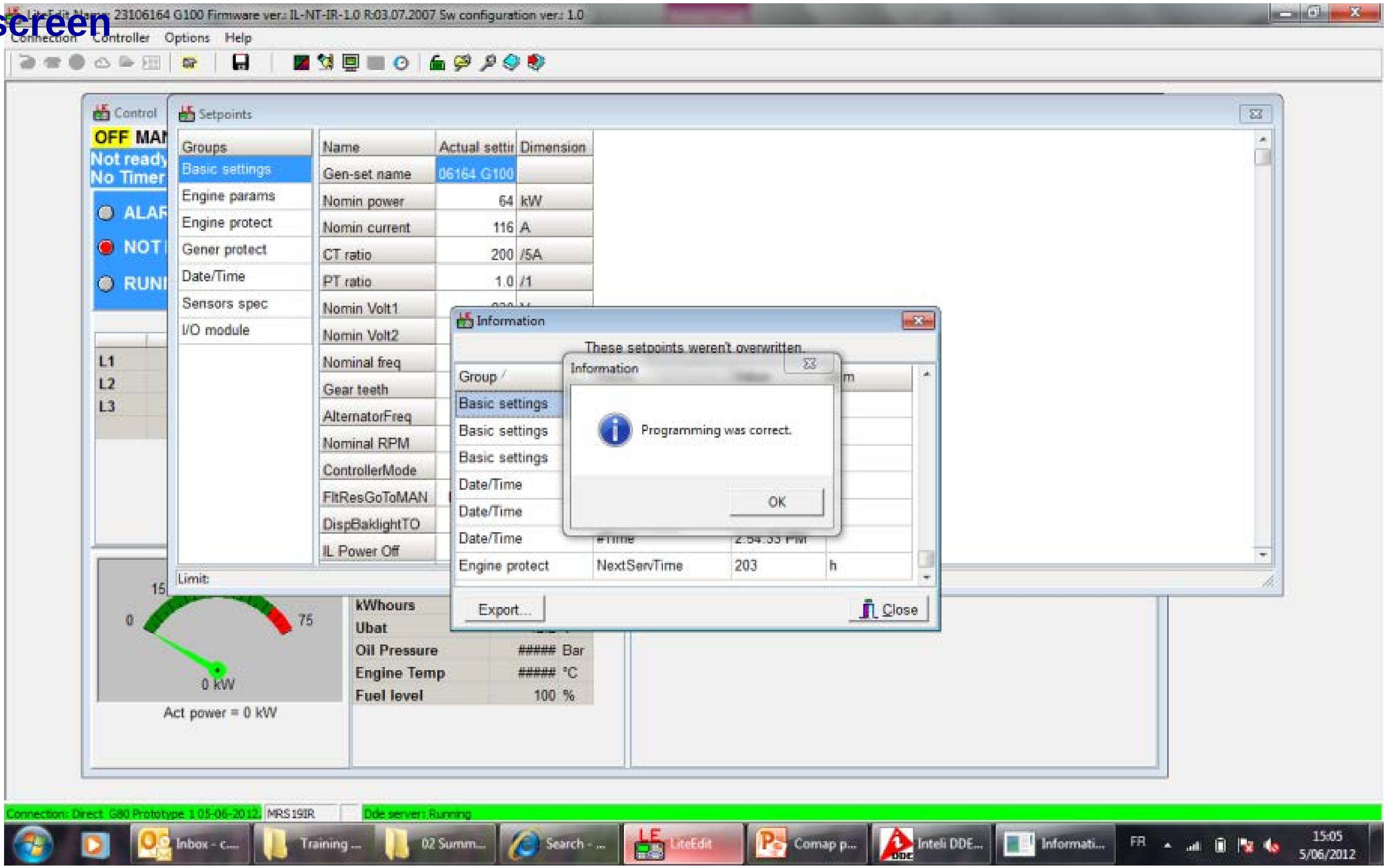
Programming the digital controller using the computer

- **Write to the controller: the controller shows the writing progress**



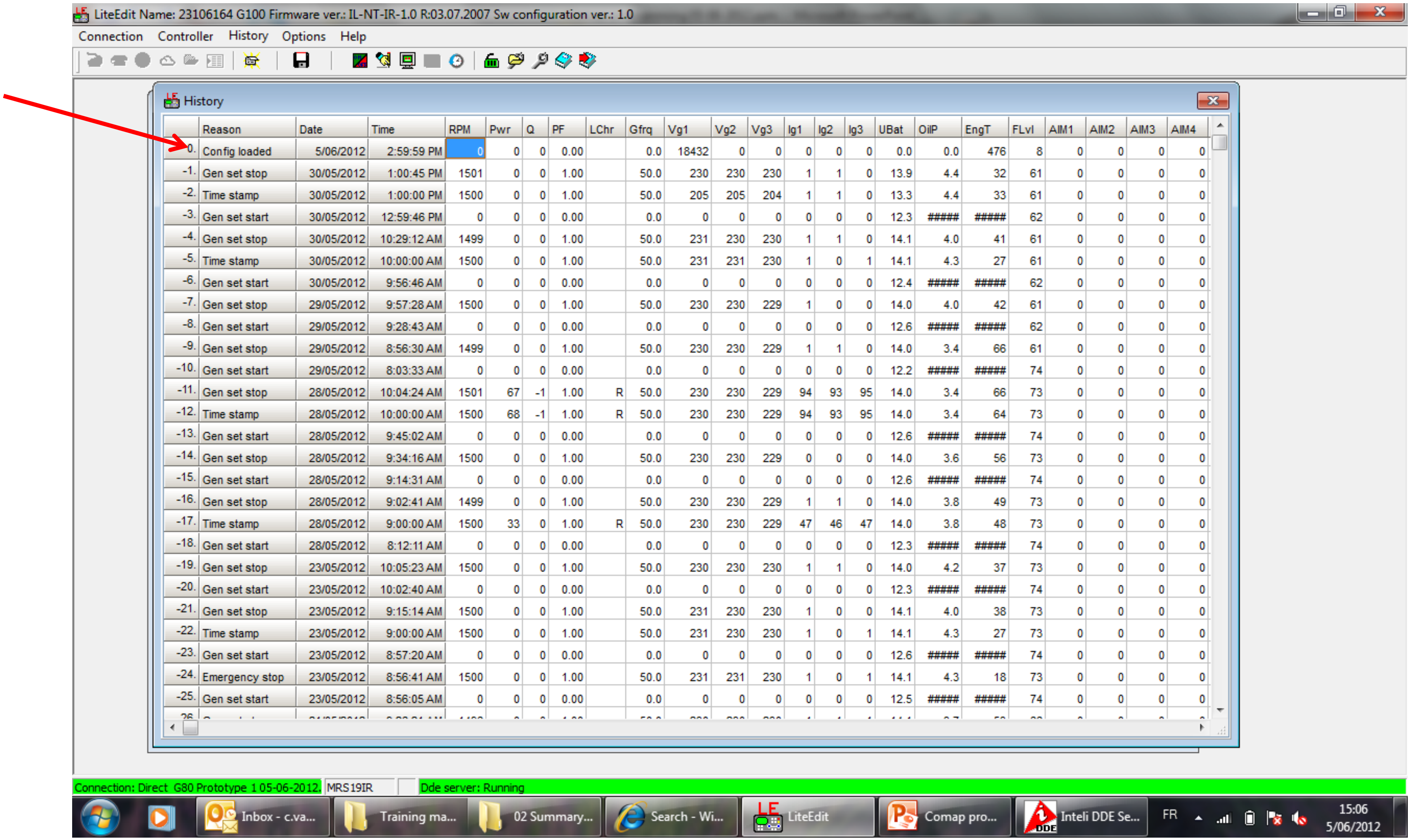
Programming the digital controller using the computer

- Write to the controller: the programming is complete when seeing this screen



Programming the digital controller using the computer

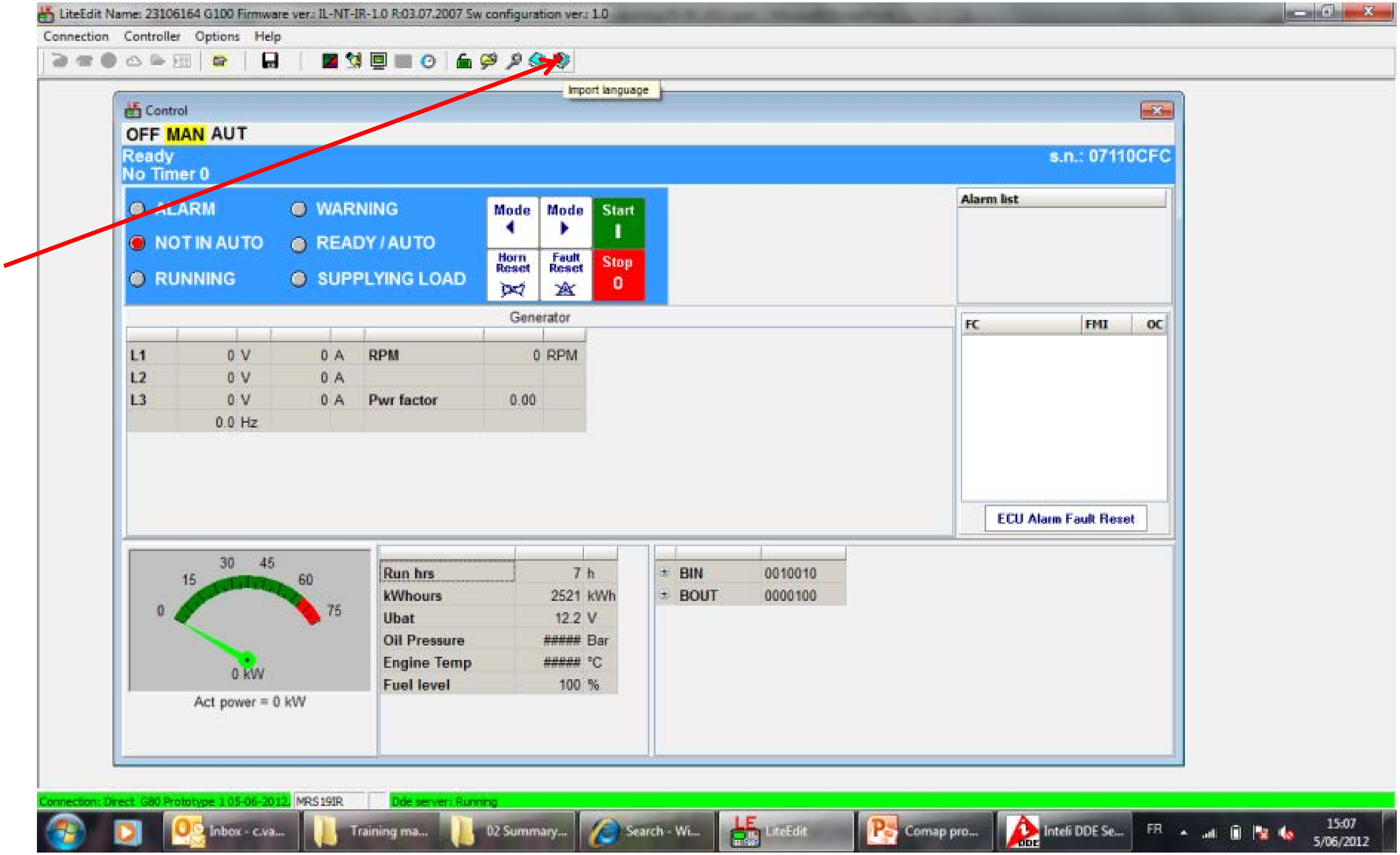
- **Write to the controller: The history keeps track of programming**



	Reason	Date	Time	RPM	Pwr	Q	PF	LChr	Gfrq	Vg1	Vg2	Vg3	Ig1	Ig2	Ig3	UBat	OilP	EngT	FLvl	AIM1	AIM2	AIM3	AIM4
0.	Config loaded	5/06/2012	2:59:59 PM	0	0	0	0.00		0.0	18432	0	0	0	0	0	0.0	0.0	476	8	0	0	0	0
-1.	Gen set stop	30/05/2012	1:00:45 PM	1501	0	0	1.00		50.0	230	230	230	1	1	0	13.9	4.4	32	61	0	0	0	0
-2.	Time stamp	30/05/2012	1:00:00 PM	1500	0	0	1.00		50.0	205	205	204	1	1	0	13.3	4.4	33	61	0	0	0	0
-3.	Gen set start	30/05/2012	12:59:46 PM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.3	#####	#####	62	0	0	0	0
-4.	Gen set stop	30/05/2012	10:29:12 AM	1499	0	0	1.00		50.0	231	230	230	1	1	0	14.1	4.0	41	61	0	0	0	0
-5.	Time stamp	30/05/2012	10:00:00 AM	1500	0	0	1.00		50.0	231	231	230	1	0	1	14.1	4.3	27	61	0	0	0	0
-6.	Gen set start	30/05/2012	9:56:46 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.4	#####	#####	62	0	0	0	0
-7.	Gen set stop	29/05/2012	9:57:28 AM	1500	0	0	1.00		50.0	230	230	229	1	0	0	14.0	4.0	42	61	0	0	0	0
-8.	Gen set start	29/05/2012	9:28:43 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.6	#####	#####	62	0	0	0	0
-9.	Gen set stop	29/05/2012	8:56:30 AM	1499	0	0	1.00		50.0	230	230	229	1	1	0	14.0	3.4	66	61	0	0	0	0
-10.	Gen set start	29/05/2012	8:03:33 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.2	#####	#####	74	0	0	0	0
-11.	Gen set stop	28/05/2012	10:04:24 AM	1501	67	-1	1.00	R	50.0	230	230	229	94	93	95	14.0	3.4	66	73	0	0	0	0
-12.	Time stamp	28/05/2012	10:00:00 AM	1500	68	-1	1.00	R	50.0	230	230	229	94	93	95	14.0	3.4	64	73	0	0	0	0
-13.	Gen set start	28/05/2012	9:45:02 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.6	#####	#####	74	0	0	0	0
-14.	Gen set stop	28/05/2012	9:34:16 AM	1500	0	0	1.00		50.0	230	230	229	0	0	0	14.0	3.6	56	73	0	0	0	0
-15.	Gen set start	28/05/2012	9:14:31 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.6	#####	#####	74	0	0	0	0
-16.	Gen set stop	28/05/2012	9:02:41 AM	1499	0	0	1.00		50.0	230	230	229	1	1	0	14.0	3.8	49	73	0	0	0	0
-17.	Time stamp	28/05/2012	9:00:00 AM	1500	33	0	1.00	R	50.0	230	230	229	47	46	47	14.0	3.8	48	73	0	0	0	0
-18.	Gen set start	28/05/2012	8:12:11 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.3	#####	#####	74	0	0	0	0
-19.	Gen set stop	23/05/2012	10:05:23 AM	1500	0	0	1.00		50.0	230	230	230	1	1	0	14.0	4.2	37	73	0	0	0	0
-20.	Gen set start	23/05/2012	10:02:40 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.3	#####	#####	74	0	0	0	0
-21.	Gen set stop	23/05/2012	9:15:14 AM	1500	0	0	1.00		50.0	231	230	230	1	0	0	14.1	4.0	38	73	0	0	0	0
-22.	Time stamp	23/05/2012	9:00:00 AM	1500	0	0	1.00		50.0	231	230	230	1	0	1	14.1	4.3	27	73	0	0	0	0
-23.	Gen set start	23/05/2012	8:57:20 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.6	#####	#####	74	0	0	0	0
-24.	Emergency stop	23/05/2012	8:56:41 AM	1500	0	0	1.00		50.0	231	231	230	1	0	1	14.1	4.3	18	73	0	0	0	0
-25.	Gen set start	23/05/2012	8:56:05 AM	0	0	0	0.00		0.0	0	0	0	0	0	0	12.5	#####	#####	74	0	0	0	0

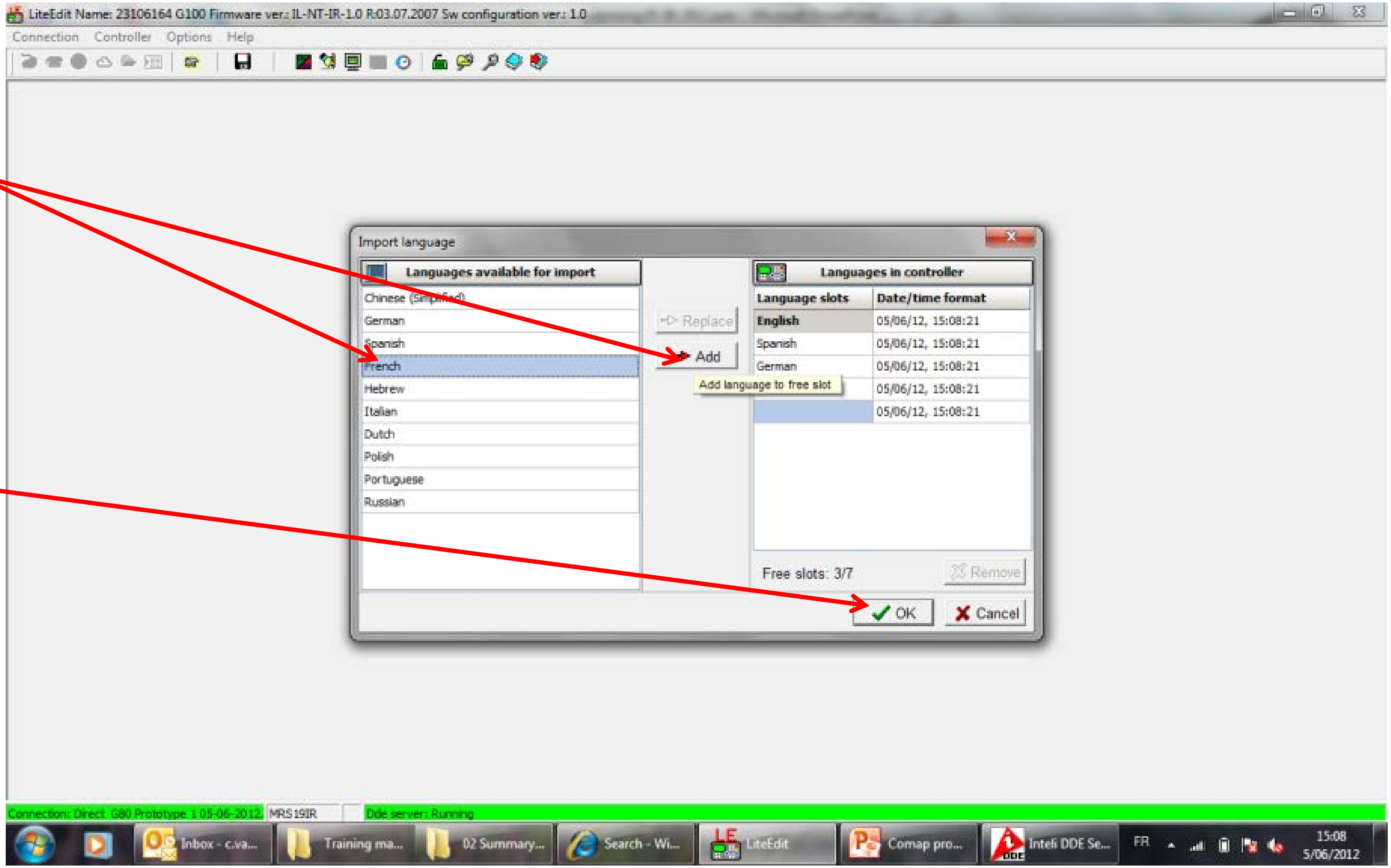
Programming the digital controller using the computer

- **Importing a language**



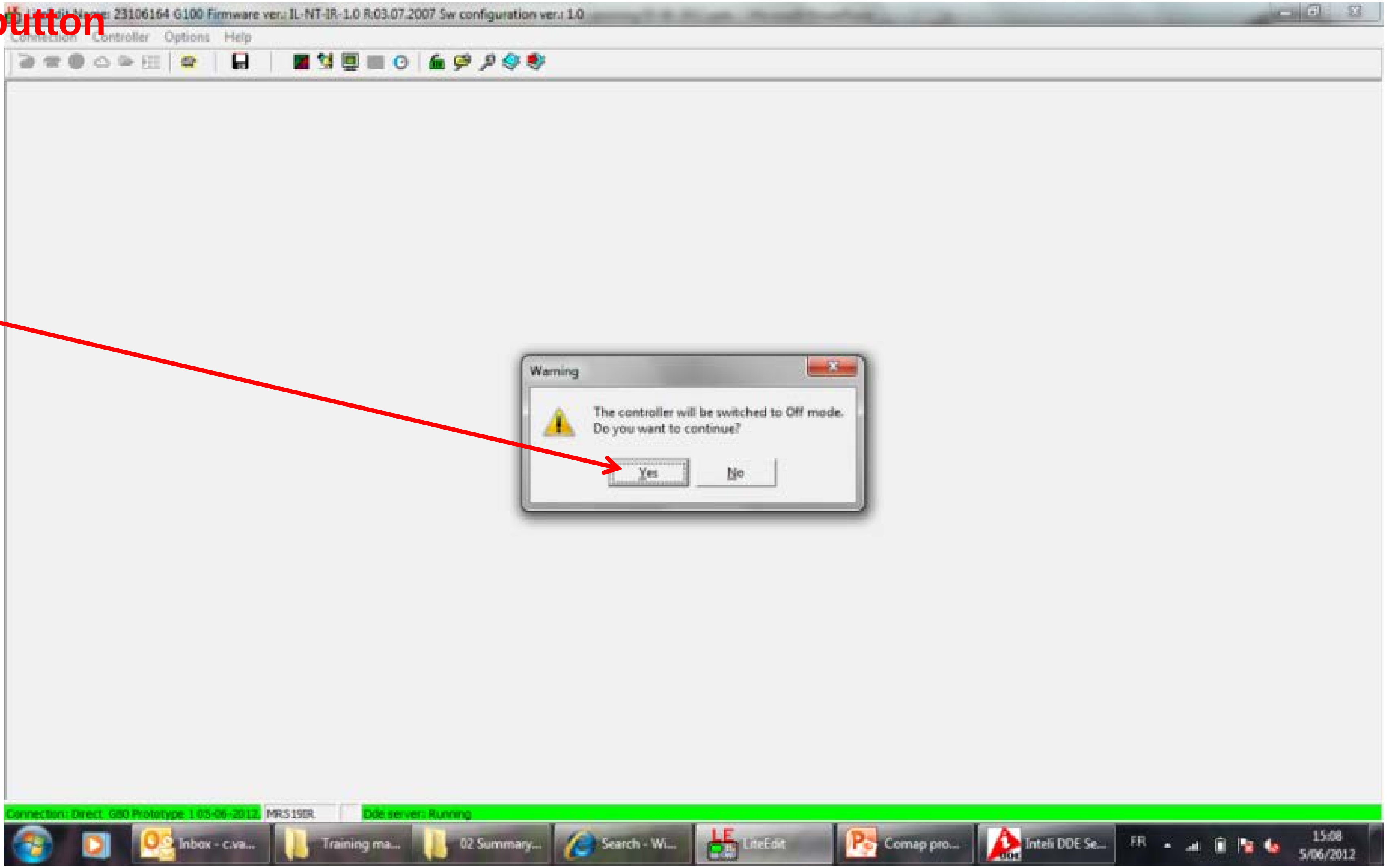
Programming the digital controller using the computer

- **Importing a language: select the language you want import**



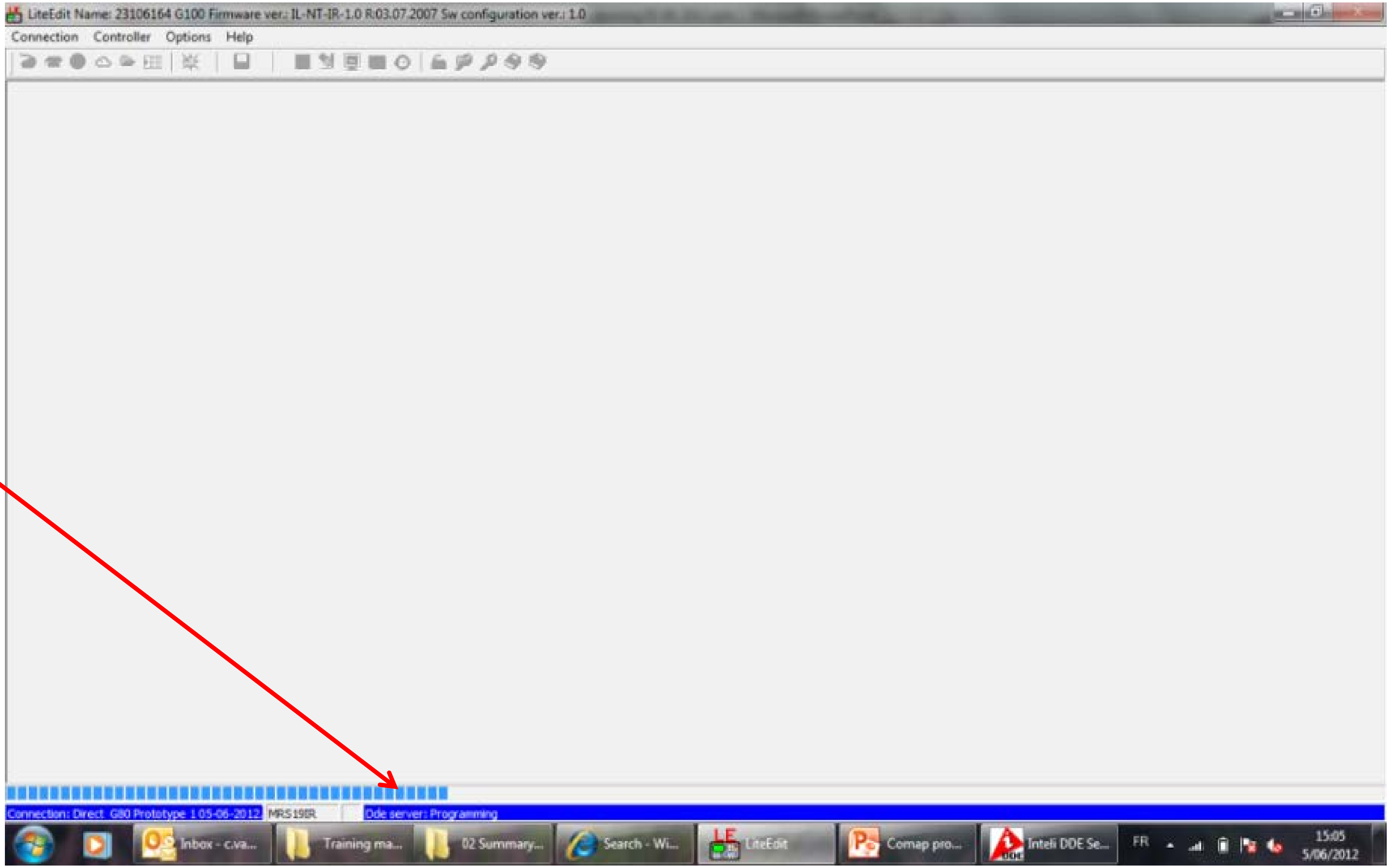
Programming the digital controller using the computer

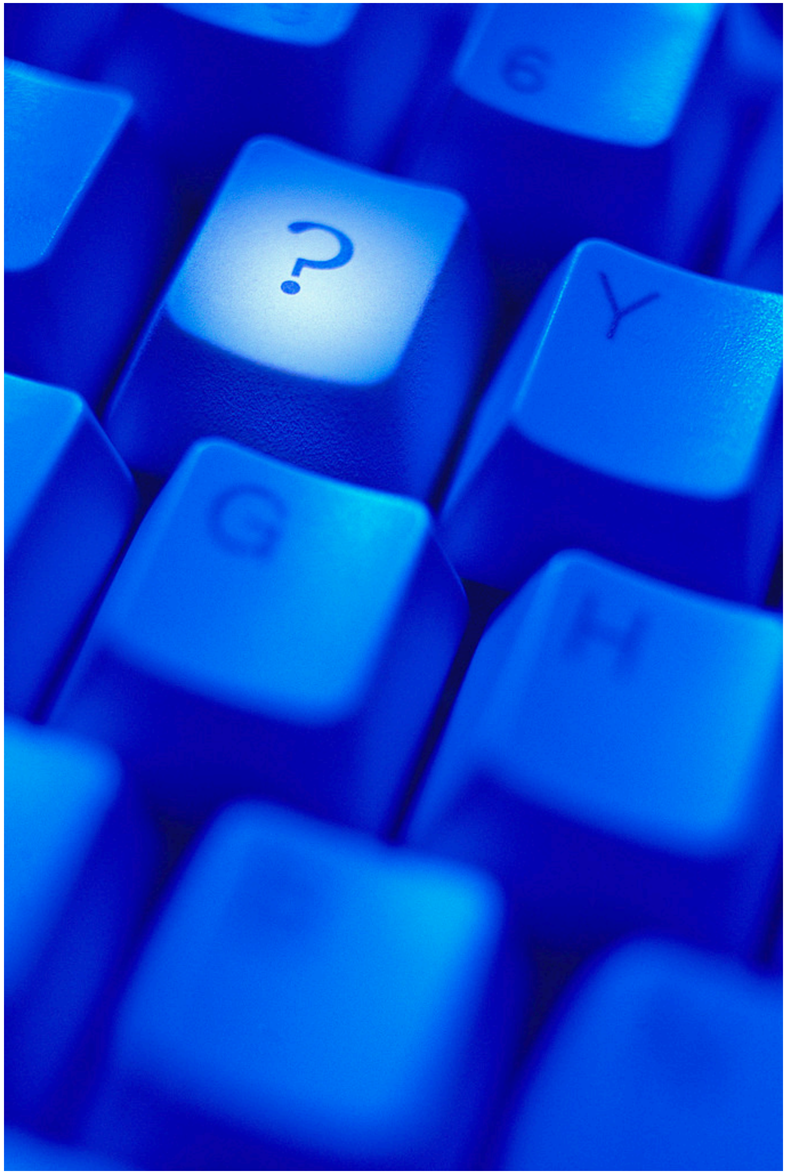
• **Write to the controller – push the green power button before hitting "Yes" button**



Programming the digital controller using the computer

- **Write to the controller: the controller shows the writing progress**

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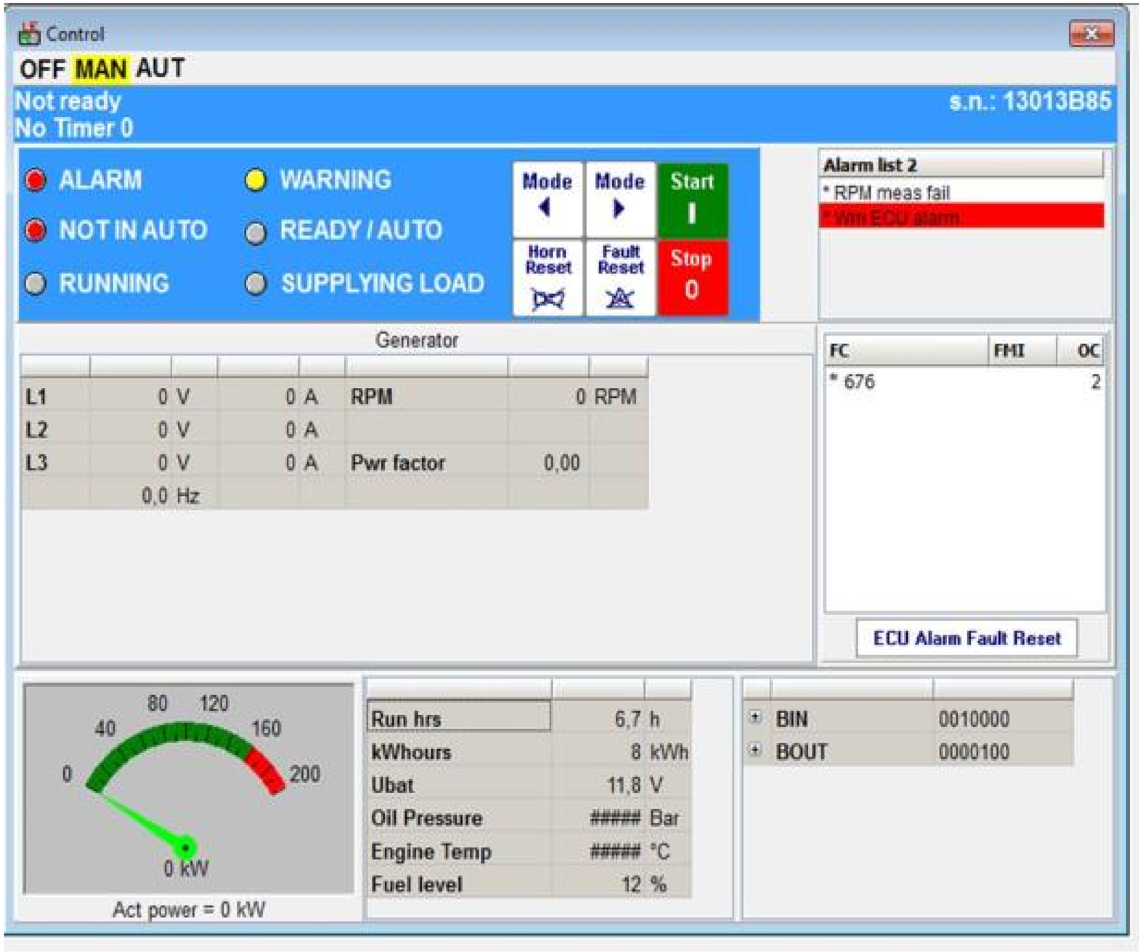
Service training: Generators

Digital controller improvements

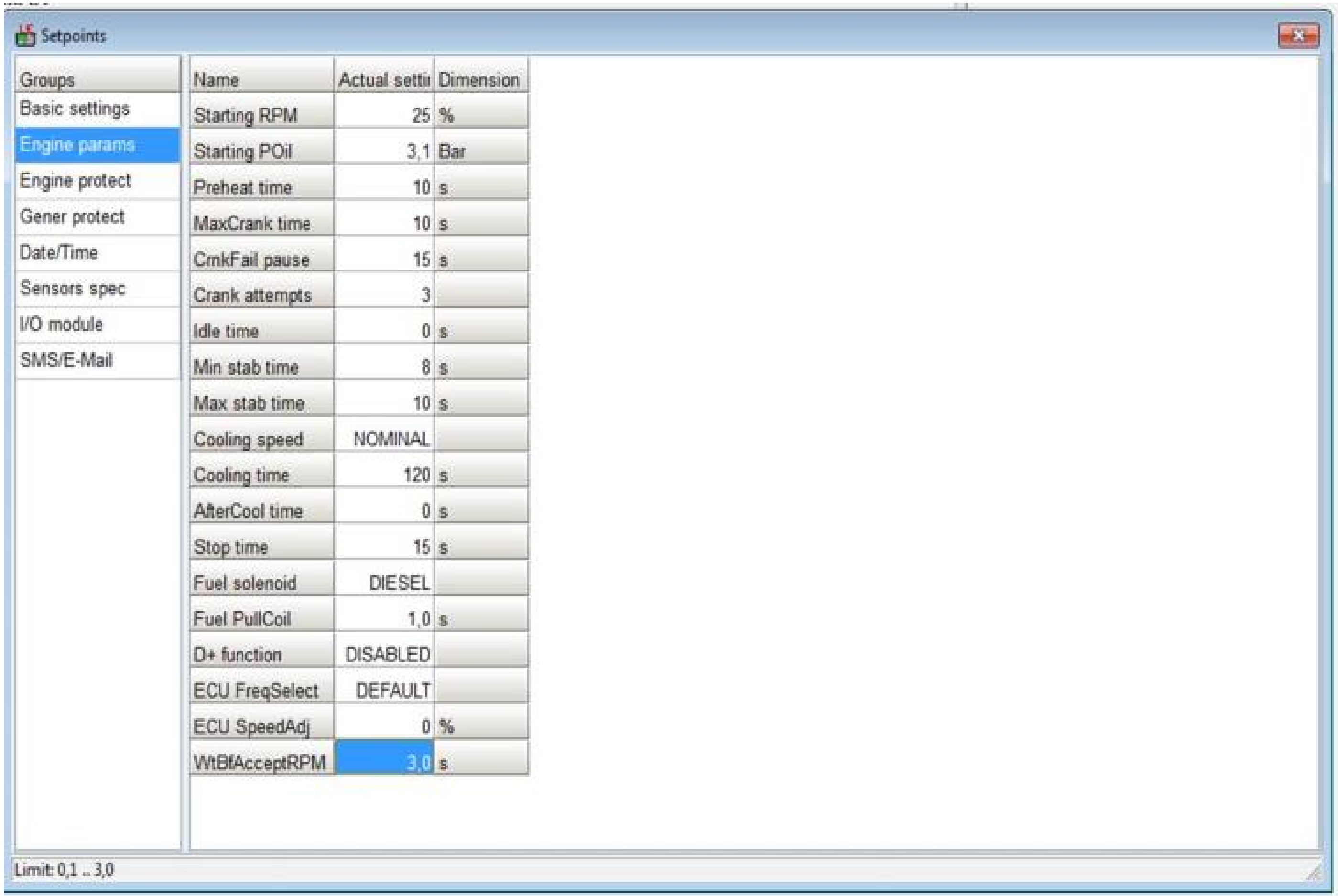
Digital controller improvements

When starting up a generator equipped with an electronically governed John Deere engine and the digital controller, we have experienced issues with the engine speed information communication from the ECU to the controller.



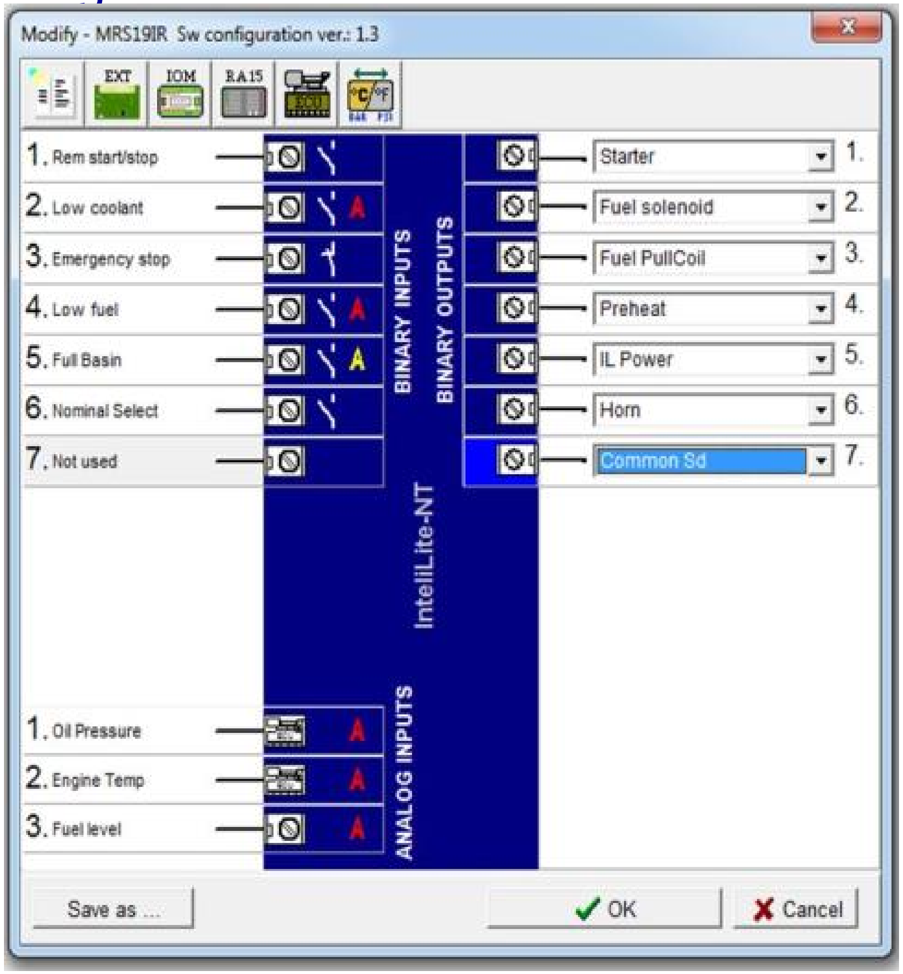
Digital controller improvements

Upon our request, the manufacturer recommended a solution involving a temporization holding the engine RPM measurement for 3 seconds



Digital controller improvements

While the firmware had to be modified, we also asked for a modification to trip the main breaker on emergency shutdowns, meaning any detected fault which would trigger a generator shutdown.



Summary

- While the firmware had to be modified, we also asked for a modification to trip the main breaker on emergency shutdowns, meaning any detected fault which would trigger a generator shutdown.

- These features are included in the latest firmware 1.3

- Firmware 1.3 and new settings files can be implemented in all digital controllers with Hardware version 1.2 and higher

Doosan Infracore

Service training: Generators

Maintenance

Doosan Infracore
Portable Power

Course Objectives

- Inspections
- Maintenance
  - Break-in, 100 hours
  - 250 hours
  - 500 hours
  - 1000 hours
  - 1500 hours
  - 2000 hours

Inspections

WARNING!

Before attempting any repair service, disconnect engine battery Cables and all leads to electrical power requirements. Failure to do so can result in severe personal injury, death or damage to the equipment.

Inspections

General:

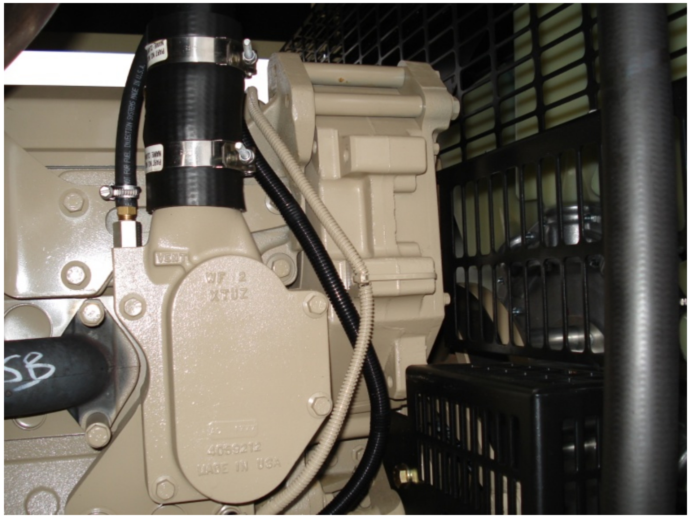
In addition to periodic inspections, many of the components in this unit requires periodic servicing to provide maximum output and performance. Servicing may consist of pre-operation and post-operation procedures to be performed by the operating or maintenance personnel. The primary function of preventive maintenance is to prevent failure and consequently, the need for repair. Preventive maintenance is the easiest and the least expensive type of maintenance. Maintaining your unit and keeping it clean at all times will facilitate servicing.

Inspections

Hoses:

Each month it is recommended that the intake hoses from the air cleaner and all flexible hoses used for water and fuel be inspected for the following:

1. All rubber hose joints and the screw type hose clamps must be tight and the hoses showing no signs of wear, abrasion or deterioration
2. All flexible hoses must be free of wear, deterioration and vibration abrasion. Routing clamps must be secure and properly mounted.



Inspections

Fuel/Water Separator:

Daily check for water in the fuel filter/water separator unit. Some engines have a translucent bowl for visual indication, and others have a drain valve below the primary element. Every six months or 500 hours, or less if fuel is of poor quality or contaminated, replace the bowl element(s).

Inspections

Air Vents

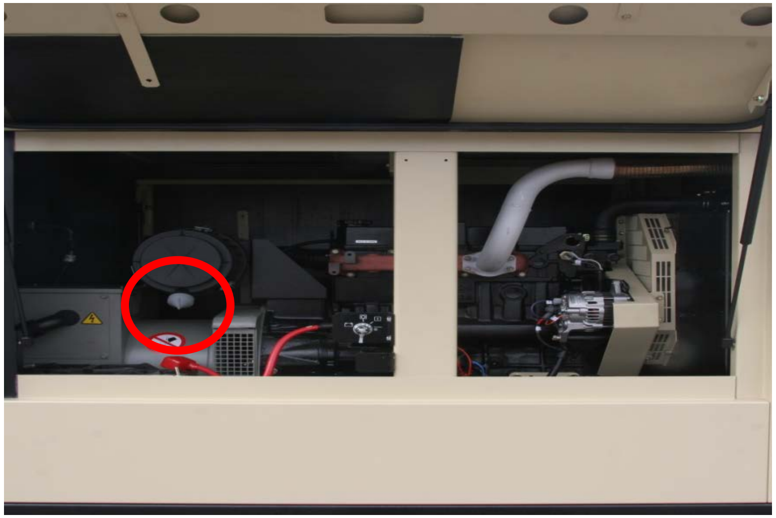
Daily clean the air vents of any obstruction or debris.

Inspections

Air Cleaner

Proper maintenance of the air cleaner provides maximum protection against airborne dust.

Squeeze the rubber valve (precleaner dirt dump) periodically to ensure that it is not clogged).



Maintenance

Scheduled Maintenance

The maintenance schedule is based on normal operation of the unit. In the event unusual environmental operating conditions exist, the schedule should be adjusted accordingly.

Break-in, 100 hours – G10 up to G40

Change the oil and filter after the first 100 hours of operation of a new or rebuilt engine.

These diesel engines must be used with heavy duty lubricating oil in compliance with the requirements of the standards API CC, DEF2101D, Mil-I-2104C or Mil-L-46152A/B for L.E. + S.L + S.Q engines and API CD for S.S engines. Straight mineral oils are not suitable, neither are oils of less detergency than specified.

Oil Viscosities	Ambient Temperature Range
SAE 30	-5°C to 40°C (23°F to 104°F)
SAE 5W-20	-30°C to -5°C (-22°F to 23°F)
SAE 10W-30	-25°C to 40°C (-13°F to 104°F)
SAE 15W-40	-20°C to 50°C (-4°F to 122°F)

Maintenance

Break-in, 100 hours – G60 up to G200

Change the oil and filter after the first 100 hours of operation of a new or rebuilt engine.

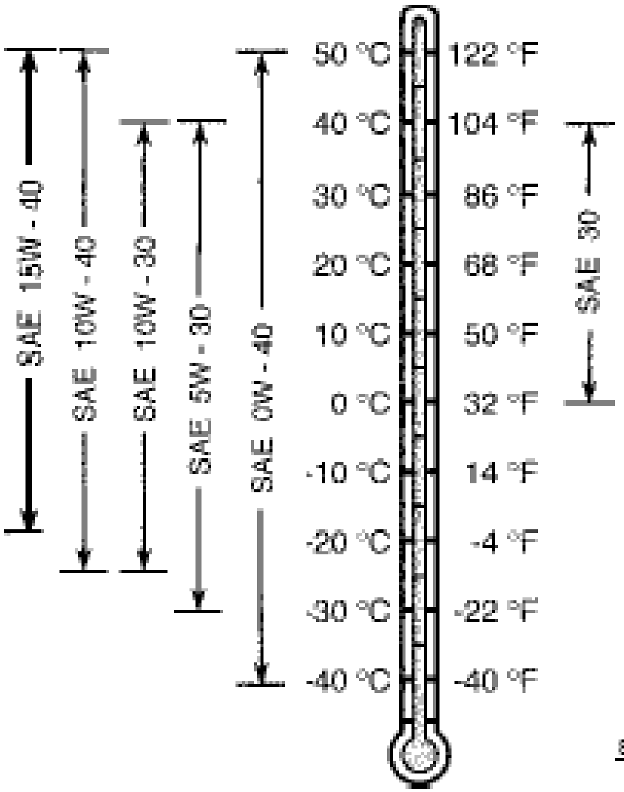
Use oil viscosity based on the expected air temperature range during the period between oil changes. The following oil is preferred:

Oils meeting ACEA Specification E4/E5

Other oils may be used if they meet one or more of the following:

- API Service Classification CI-4
- API Service Classification CH-4
- ACEA Specification E3

Multi-viscosity diesel engine oils are preferred.



Maintenance

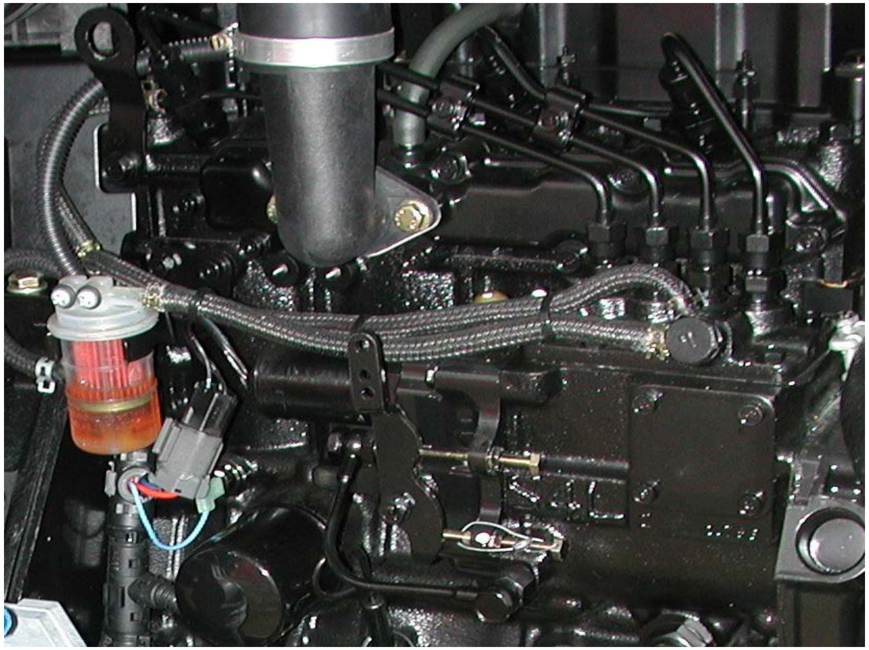
Break-in, 100 hours – G250 up to G500

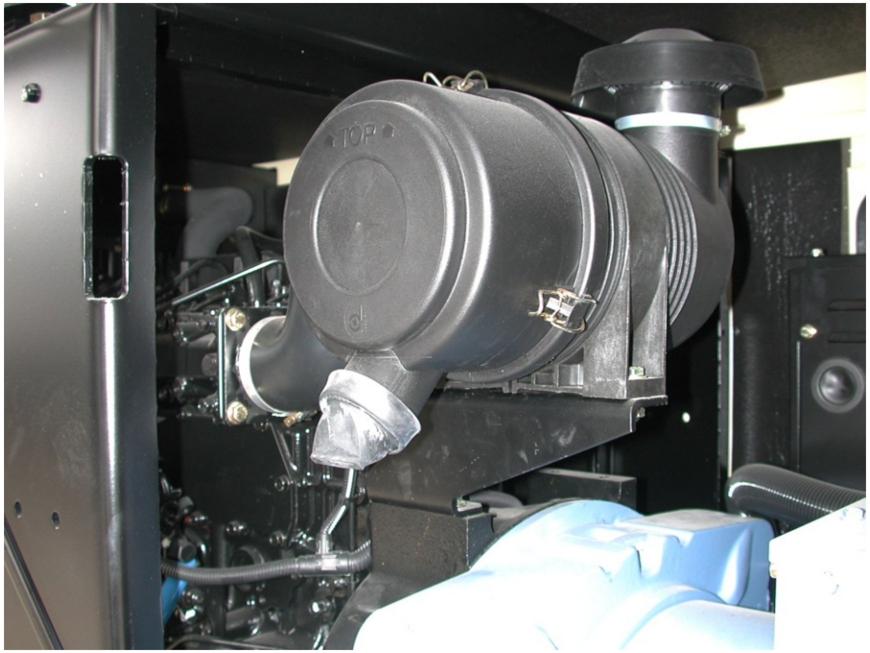
No break-in maintenance for these models

Maintenance

250 hours or 3 months G10 to G40

- Change the engine oil and filter
- Change the fuel filter element
- Change the air filter element





Maintenance

500 hours or 1 year G60 to G200

- Change the engine oil and filter
- Change the fuel filter element
- Change the air filter element

Maintenance

500 hours or 6 months G250 to G500

- Change the engine oil and filter
- Change the fuel filter element
- Check the Cooling System
- Replace the Coolant Filter
- Check the Batteries
- Check the Battery Cables and Connections

Maintenance

500 hours or 6 months G250 to G500

Engine oil requirements:

A sulfated ash limit of 1.85 percent has been placed on all engine lubricating oils recommended for use in Cummins engines. Higher ash oils can cause valve and/or piston damage and lead to excessive Oil consumption.

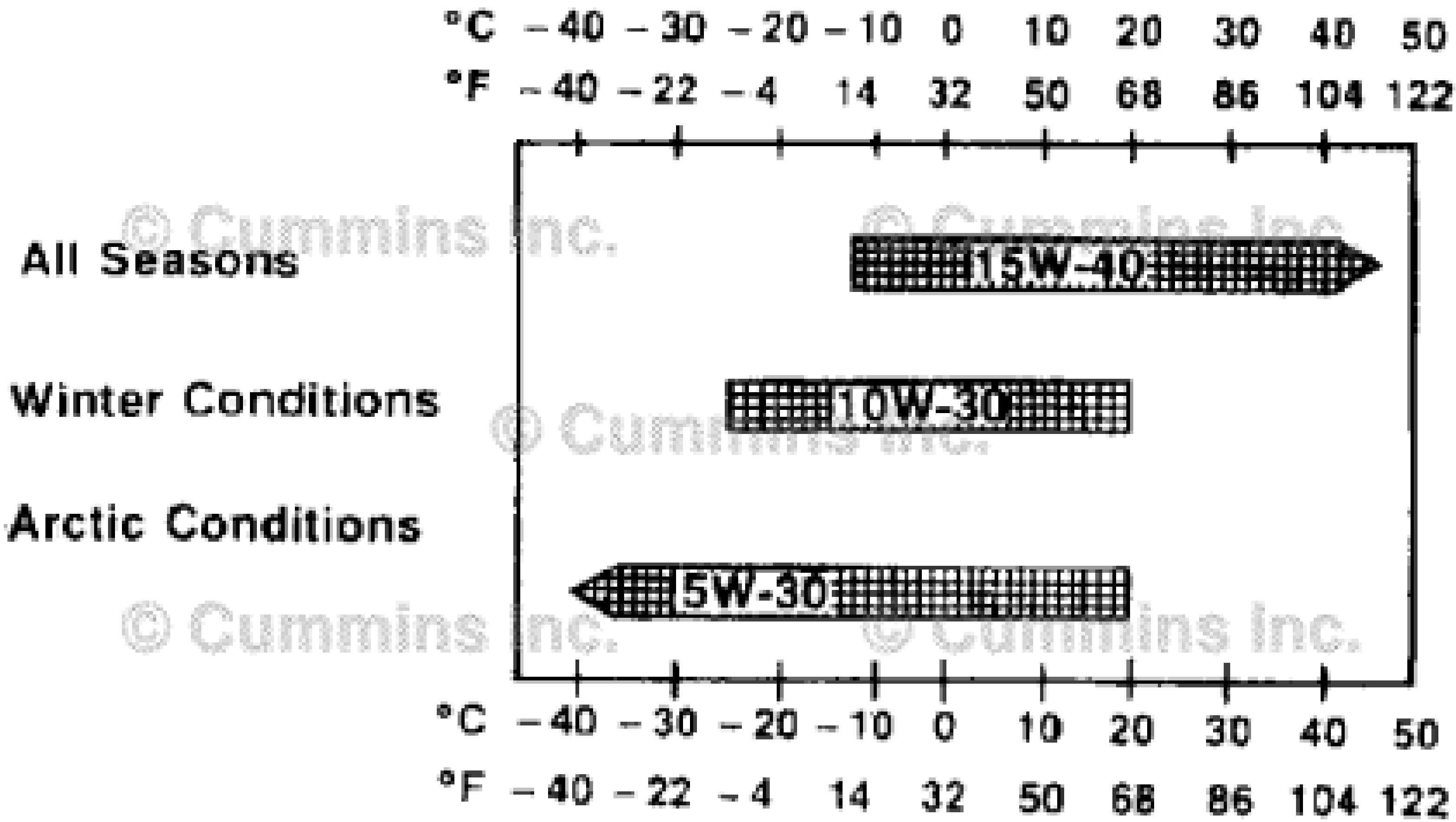
The use of quality engine lubricating oils, combined with appropriate oil drain and filter change intervals, is a critical factor in maintaining engine performance and durability.

Cummins Inc. recommends the use of high-quality SAE 15W-40 heavy-duty engine oil, such as Valvoline® Premium Blue®, which meets performance specifications as listed below.

NOTE: In areas where CH-4/SJ or CG-4/SH oils are not available, refer to Oil Drain Intervals in Section 2.

Maintenance

500 hours or 6 months G250 to G500: oil specifications



Maintenance

500 hours or 6 months G250 to G500: oil specifications

Cummins Engineering Standard Classification (CES)	American Petroleum Institute Classification (API)	International Classifications	Comments
	API CD API CE API CG-4/SH	ACEA E-1	**OBSOLETE. DO NOT USE.**
CES-20075	API CF-4/SG	ACEA E-2 ACEA E-3 JAMA DH-1	~~Minimum acceptable oil classification for midrange engines.~~
CES-20071 CES-20076	API CH-4/SJ API CH-4	Global DHD-1	Acceptable oil classification for midrange engines.
CES-20072 CES-20077	API CH-4	ACEA E-5 Global DHD-1	Similar in performance to CES-20071 but validated under European test standards. Excellent oil for midrange engines.
CES-20078	API CI-4/SK API CI-4		Excellent oil for midrange engines.

Maintenance

1000 hours or 1 year G10 to G40

(On top of 250 hours maintenance)

- Check the starter and charge alternator
- Clean the radiator
- Have the injection pump checked by a certified engine dealer
- Clean the generator set
- Retighten the nuts and bolts

Maintenance

1000 hours or 1 year G60 to G200

Same as 500 hours maintenance

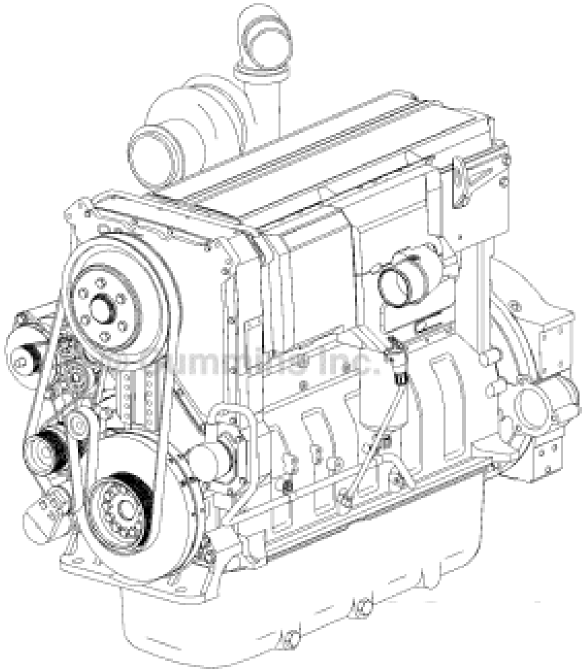
- Change the engine oil and filter
- Change the fuel filter element
- Change the air filter element

Maintenance

1000 hours or 1 year G250 to G500

(On top of 500 hours maintenance)

- Drive Belts - check
- Fan Hub Belt Driven - check
- Cooling Fan Belt Tensioner - check



Maintenance

2 year G10 to G40

- Flush and Refill Cooling System

Maintenance

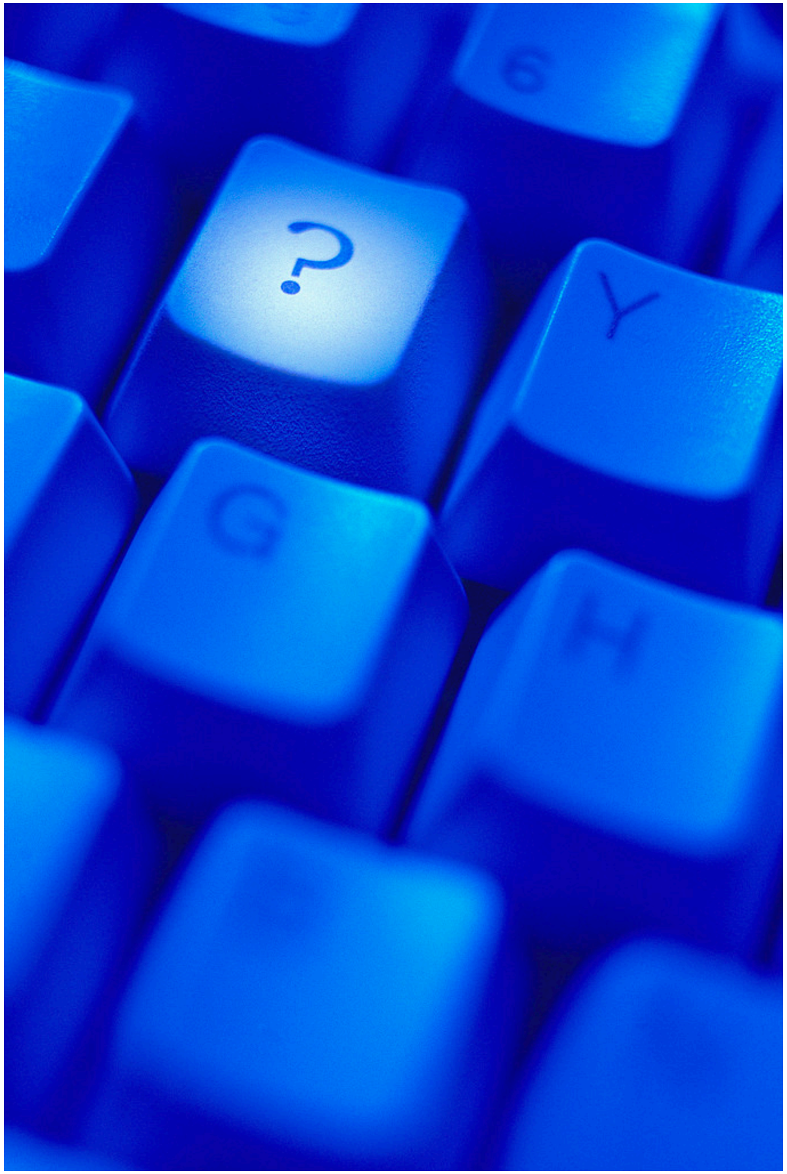
2000 hours or 2 years G60 to G200

- Flush and Refill Cooling System
- Test Thermostats
- Check and Adjust Valve Clearance

Maintenance

2000 hours or 2 year G250 to G500

- Flush and Refill Cooling System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Product Identification

- It is critical to properly identify the machine you're considering before any inquiry on service or parts.

- Over the years, more than 1 machines has carried the same name, which leads to confusion when advising the right part or the right service action to perform.

- Also, the serial number informs us of which specification the machine was built to, including the factory fitted options.

DOOSAN

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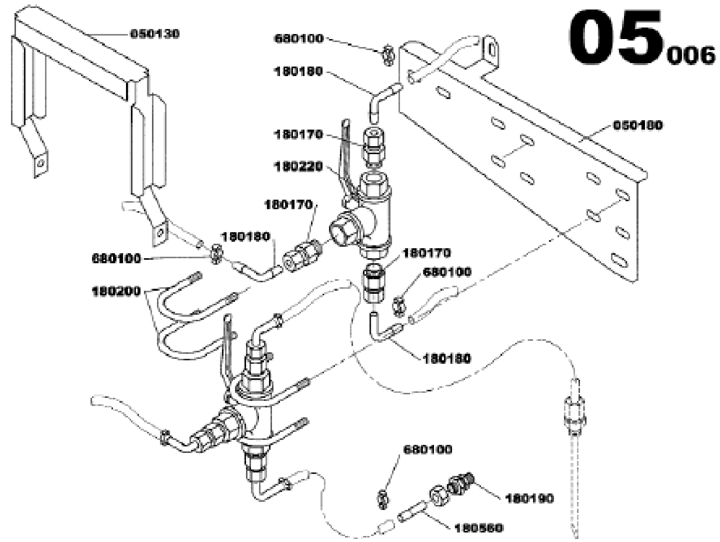
Service training: Generators

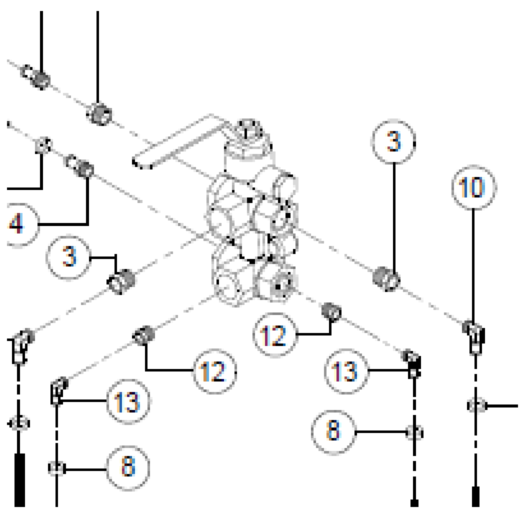
Product Identification

Product Identification

As an example, a 3 way fuel valve for a G200 looks like this:

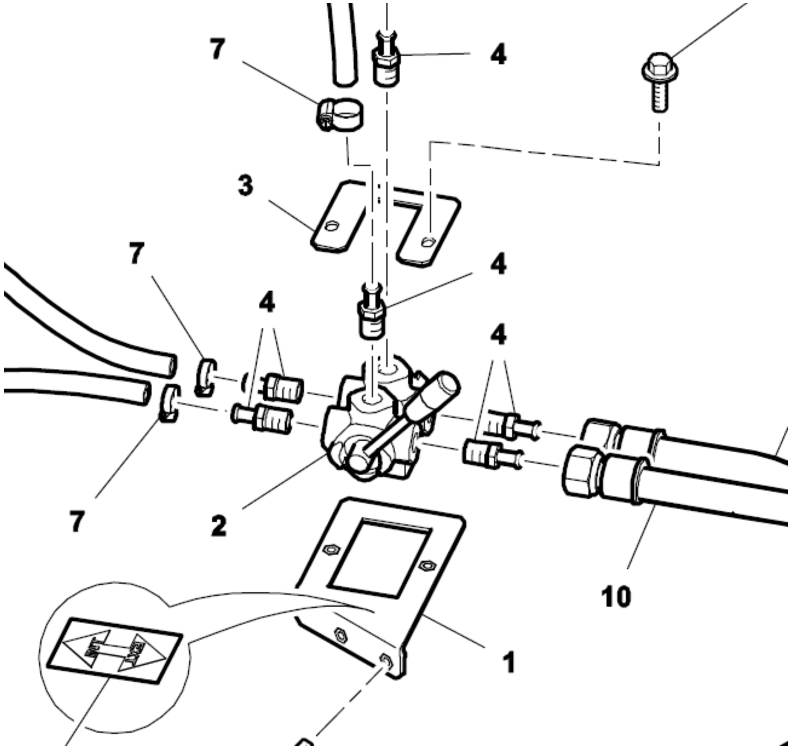


….. Or like this:



Product Identification

….. Or like this:



Just depending on the serial number of the machine

Product Identification

Generators

- Genpower Range (2001 to 2007): $\underbrace{\text{XXX}}_{\text{Model}}\ \underbrace{\text{XXXXXXXX}}_{\text{8 digits}}$

- Example: 55001003886

- PowerSource from Unicov (2007 to 2008): $\underbrace{\text{XX}}_{\text{Year}}\text{G}\underbrace{\text{XXX}}_{\text{Model}}\ \underbrace{\text{XXXX}}_{\text{4 digits}}$

- Example: 07G2500001

Product Identification

<u>Generators</u>

- PowerSource from Airpower: $G\underbrace{XXX}_{\text{Model}}\underbrace{X1XX}_{\text{4 digits}}$
- Example: $G25\underbrace{0101}_{\text{Range starting at 101 for differentiation}}$

- Stage IIIA PowerSource from Airpower: $G\underbrace{XXX}_{\text{Model}}3\underbrace{XXXX}_{\text{4 digits}}$

  "3" digit for "Stage IIIA"

- Example: G15030002

Doosan Infracore
Portable Power

Product Identification

Light Towers

- EMEA Light Towers: use the latest 6 digits:
  - LT6K 366XXX or 367XXX
  - V9: 368XXX

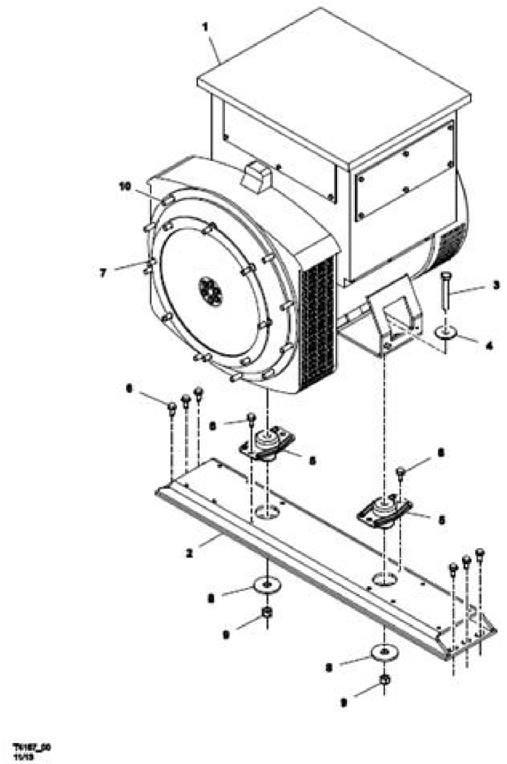
Product Identification

- Another important point on product identification is on specification changes within a same range.
- <u>Example:</u> G20, G30 and G40 engines were changed to Stage IIIA engines as we ran out of engines before the new model was ready.
- Also, Leroy-Somer is changing their alternators design and discontinuing the supply of the old design

Product Identification

A serial number has been recorded for the first machine affected by the change and reflected in a parts manual revision, as shown below:

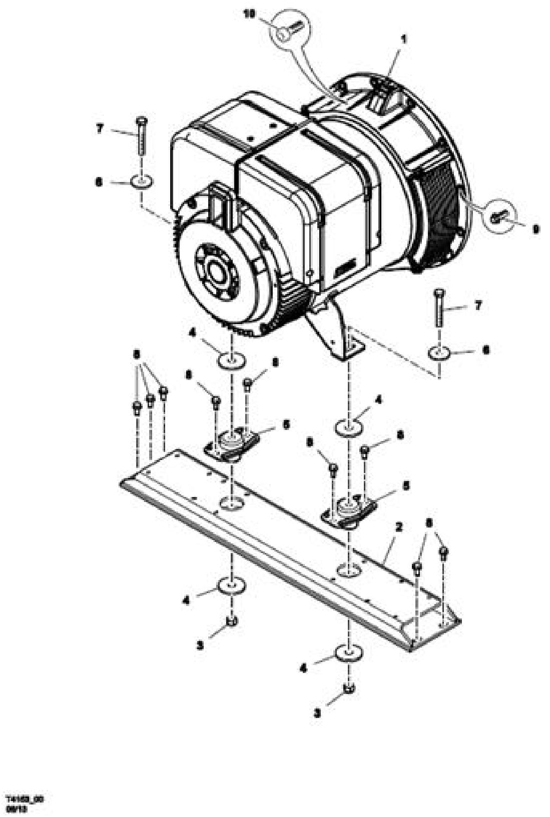
ALTERNATOR MOUNTING
(Serial no. -> G0400329)



12

G40 23078314 G 12/14
ELECTRICAL SYSTEM

ALTERNATOR MOUNTING
(Serial no. G0400330 ->)

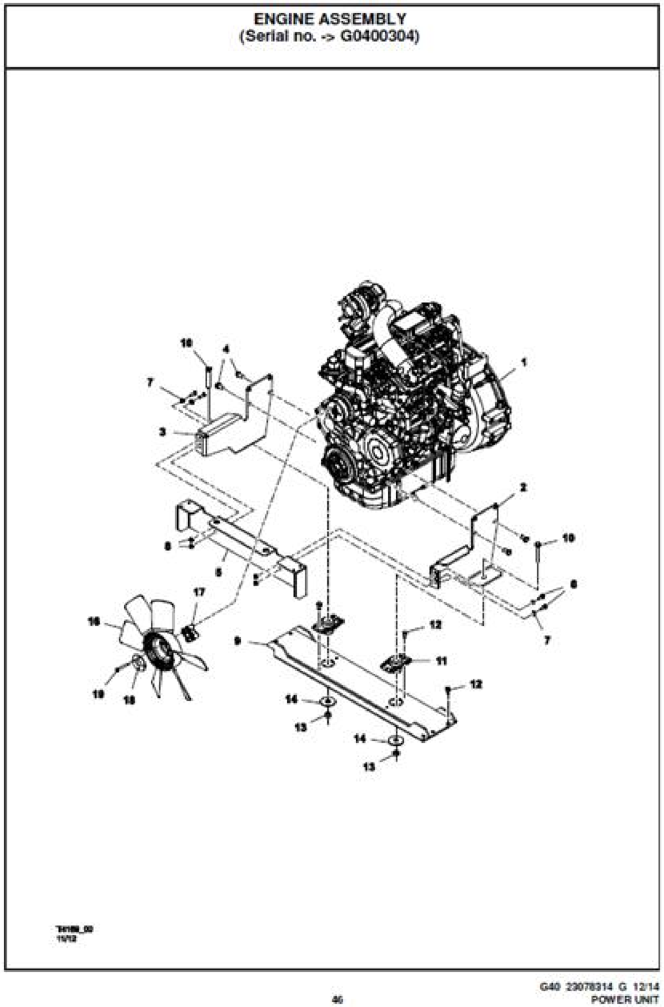


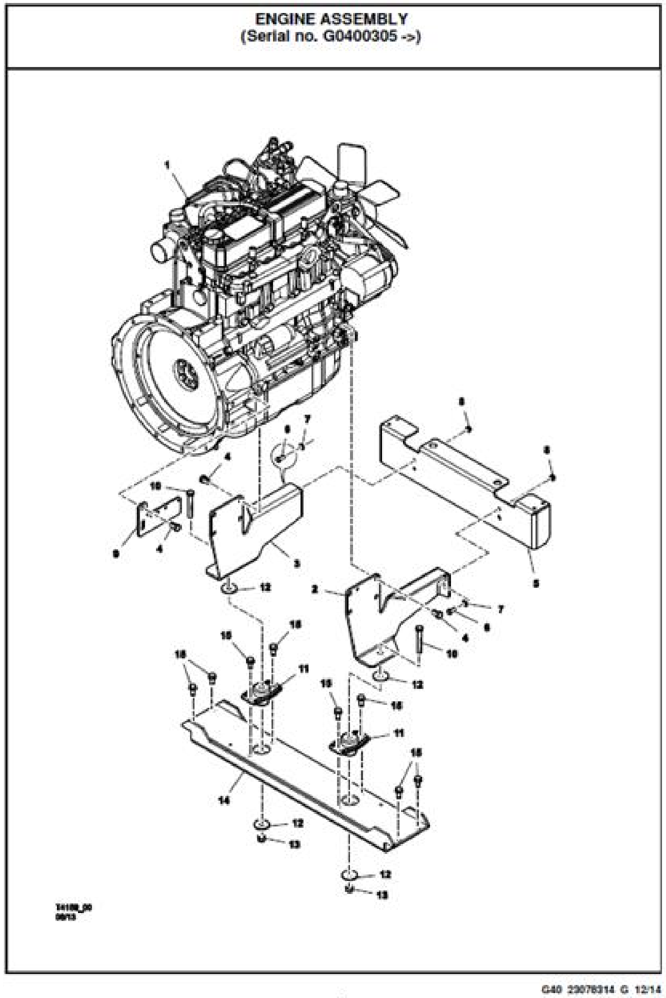
14

G40 23078314 G 12/14
ELECTRICAL SYSTEM

Product Identification

A serial number has been recorded for the first machine affected by the change and reflected in a parts manual revision, as shown below:





Thank you very much for your kind attention

Doosan Infracore
Portable Power