MICRO CONTROLLER BASED GOVERNOR(MCBG)

TYPE-MEG 601

Microprocessor Based Control System

TYPE-MEP 660

Types of Governors on Diesel Electric Locos

- Electro Hydraulic Governor Type-17MG8
  - GE & EDC
- Hydraulic Governor
  - Woodward
- Electronic Governor
  - Medha and BHEL.

Work of Governor

- Governor makes the correction of engine RPM by changing the amount of fuel supply into the engine- calling speed control.
  Governor helps reduce the excitation of M/Gen in engine over load to reduce the load demand-calling load control.

Basic functions of Governor

- Cranks the engine when operator demands.
- Increase / Decrease engine RPM as per the notch selection.
- Maintain the engine RPM from no load to full load.
- Provide load control signal to reduce over load on the engine to maintain constant engine RPM.
- Shuts down the engine on demand by operator or any safety device is operated.

Role of governor in Diesel Electric Locomotives

The diesel engine generates the power.

The mechanical power is converted in to electrical power by the Tr. Alternator.

The out HP from the Tr. Alt. connected to Tr. Motor and the locomotive moves.

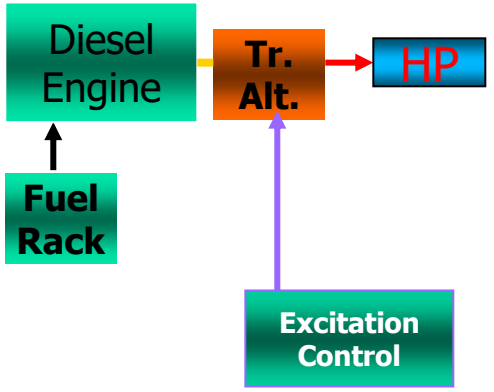
In a diesel engine the HP is proportional to its RPM.

The engine speed is selected by driver.

The governor should control the fuel rack to maintain constant engine RPM.

The governor should reduce the electrical load and maintain constant RPM

Governor



Working Principle of Governor

Advance the fuel rack during cranking

Control the fuel rack to maintain engine RPM at the set speed.

- To maintain engine RPM, the engine RPM signal is taken as an input.

Increase / Decrease the engine RPM as per the operator's request.

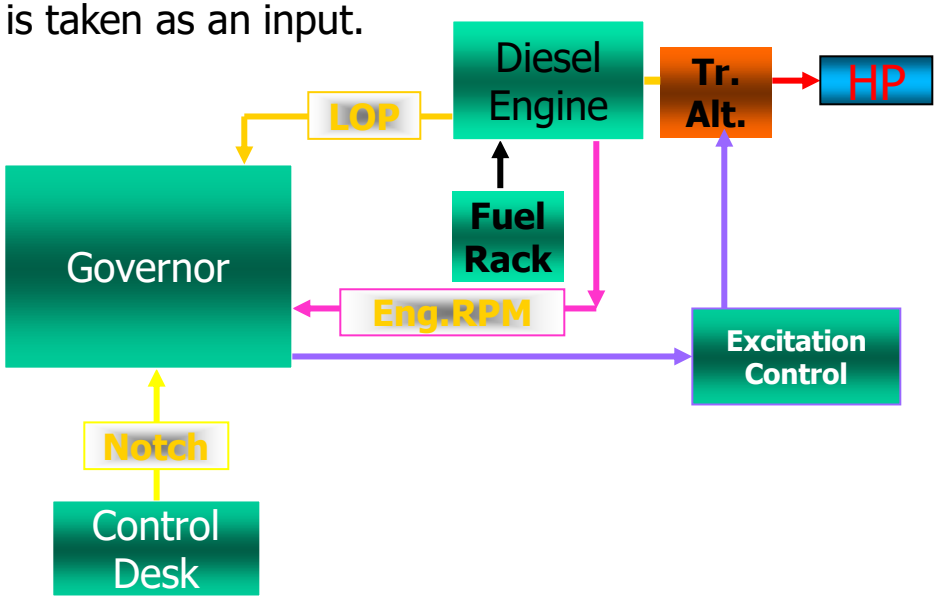
- Notch signal is taken as an input.

Withdraw fuel rack to Shut down the engine when lube oil pressure is dropped.

- Lube oil pressure signal is taken as an input.

Reduces the excitation under overload.

- Load control signal is given to Excitation control system.



Working Principle of Governor

With out sufficient quantity of air, all the fuel admitted does not burn

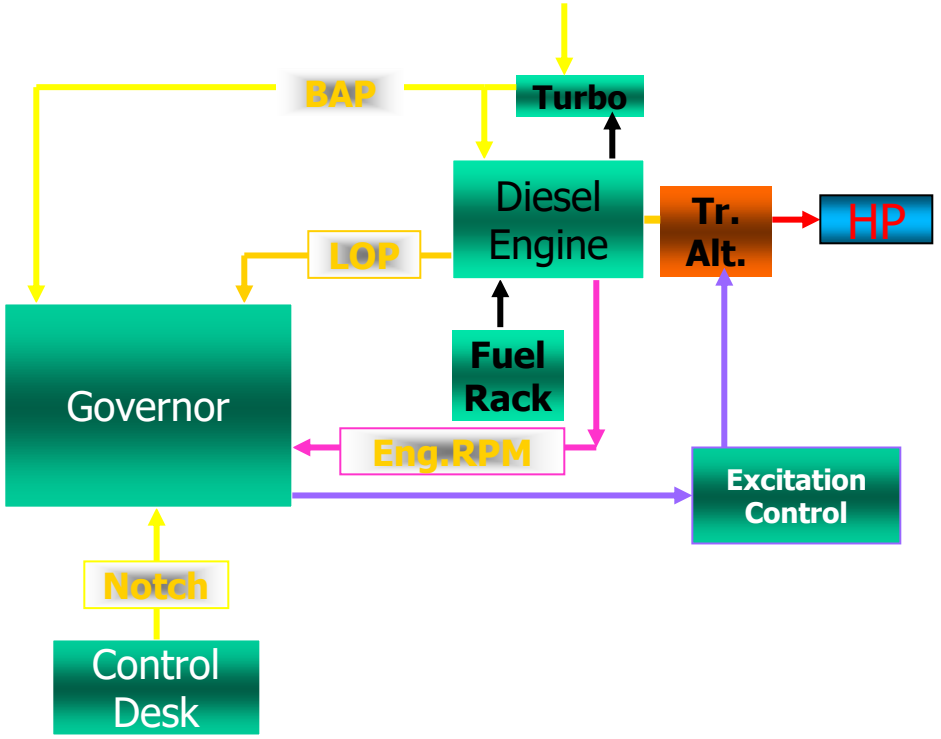
In the diesel engine, the inlet air pressure is boosted up by turbo (BAP).

If BAP is normal, sufficient air is available for complete burning of fuel.

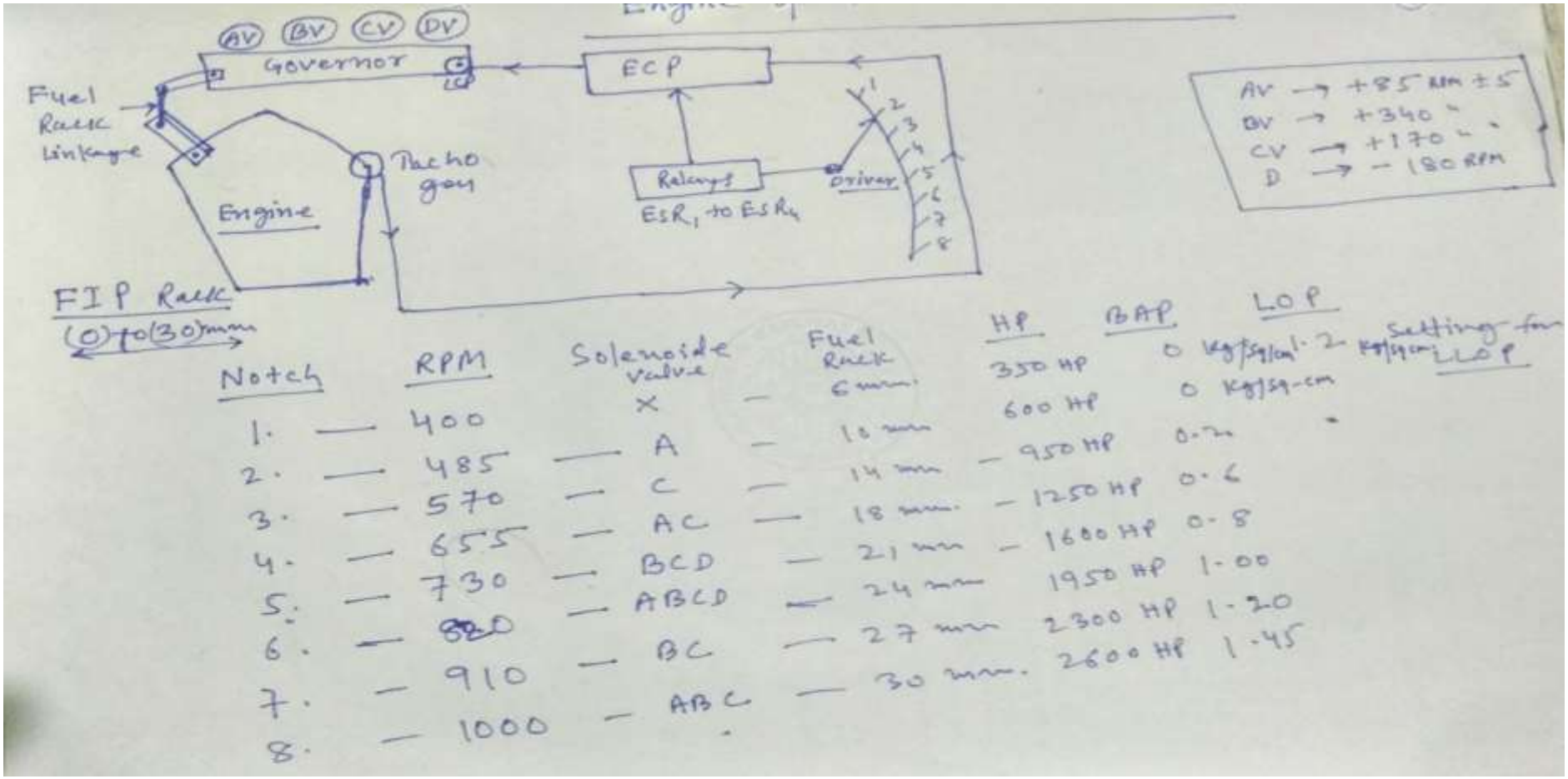
Less BAP means in-sufficient air and fuel is wasted.

Hence to be fuel efficient, the governor should control the fuel rack based on the BAP.

- BAP signal is taken as an input.



Engine Speed Control system



MICRO CONTROLLER BASED GOVERNER (MCBG)

The MCBG has been divided into two parts –

1) Control unit

2) Actuator unit

Micro Controller Based Governor

Control unit

The control unit will be mounted on the wall on short Hood side just below the existing location of Lube oil, fuel oil and boost air pressure gauge in the driver’s cabin.

Display Parameters

- Displays the following Diesel Engine parameters:
  - LOP (Lube Oil pressure)
  - FOP (Fuel Oil Pressure)
  - BAP (Booster Air Pressure)
  - Notch (Notch position)
  - Engine RPM
  - LCP (Load Control Position)
- These parameters are continuously monitored and displayed on the screen.

The control unit is functionally divided into 6 cards.

1) Display Control Card

The main function of the card is to display the Diesel Engine parameters on display unit. The data received from Micro controller.

Display the following Diesel parameters:-

a) LOP (Lube oil pressure)

b) FOP (fuel oil pressure)

c) BAP (Booster Air Pressure)

d) Notch Position

e) Engine RPM

f) LCP (Load control Position)

2) Power Supply Card

The governor works on 72v DC. This card converts the 72 volts locomotive battery voltage to various low voltage supplies required by the system. 22v for all sensor, 12v stepper motor and load & clutch cards, 9v for all cards etc.

3) Motor Cards I & II

There are two stepper motor control cards. This card drives the stepper motor in the actuator unit.

The stepper motor cards communicates this drive signal to the stepper motor in the actuator unit.

4) Input card

This card is used for -

a) Monitoring and receiving notch signals from the locomotive throttle handle.
b) Receiving pressure signal from actuator unit.
c) Receiving engine speed signal from Techo generator.
d) Receiving cranking signal from Start button 43E wire no.
e) Receiving fuel rack position,BAP, LOP, FOP, LCP etc.

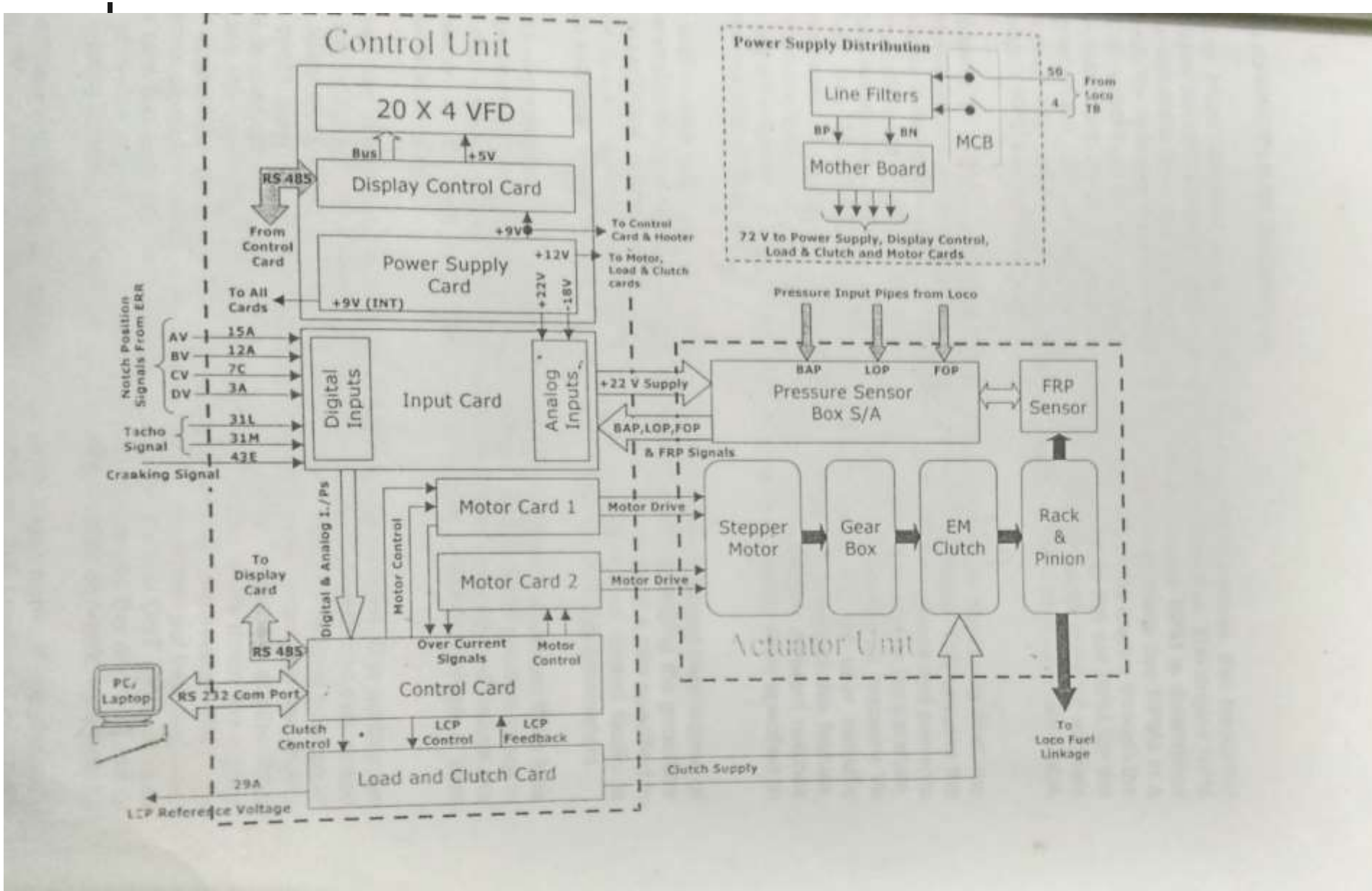
5) Control Card

- The control card consists a 16 bit micro controller.
- It receives various input signals like notch, engine speed, fuel rack position and Pressure signals etc from the input card.
- It communicates these parameters to display unit.
- The control card decides the engine RPM for the selected Notch.
- Existing RPM is compared with new RPM level.
- The control card computes the stepper motor direction and the angular movement required for new fuel rack position.
- It gives signal to the stepper motor cards to drive the motor.

6) Load and clutch card

This card is used for driving the clutch in the actuator unit and it also provides excitation voltage output for load control through an interface with E type excitation system.

Block diagram of MCBG (type MGE- 601)



Merits of MCBG

- Control of engine RPM without hunting.
- Load control interface with Excitation system for constant Horse power control.
- 16-bit micro controller based design.
- Stepper motor used for high precision position control of fuel rack.
- Continuous display of engine status parameters.
- Online fault diagnostic and fault message display.
- Error log with date and time stamp.
- Electronic and mechanical over speed trip testing through key lock switch.
- Fail safe shutting down of engine in case of power failure and any major malfunctioning of the equipment.
- No need for regular maintenance.

Merits of MCBG

- Defective sub-assembly can be replaced in position.
- Minimum internal wiring to increase reliability.
- Smooth control of fuel rack and no hunting.
- Electro-magnetic clutch for automatic shutdown.
- Failure of BAP sensor, the governor automatically disable the BAP based rack limitations.
- Zero running maintenance up to five years.
- No schedule maintenance up to 48 months.
- Low engine cranking time (5 to 10 seconds).
- Precise control of fuel rack through stepper motor.
- Independent Notch wise engine RPM Setting.
- Dry run test facility to test free travel of the fuel rack.
- Mechanical OSTA test facility.
- Electrical OST test facility .

System specifications

- Operating supply voltage: 40 to 90 volt DC.

Can accept a voltage deep if 22volt DC for 0.8 second during cranking.

- Load control

From maximum to minimum field position change in8.5 to 11 second
From minimum to maximum field position change in 25 to 30 second

- Pressure sensor

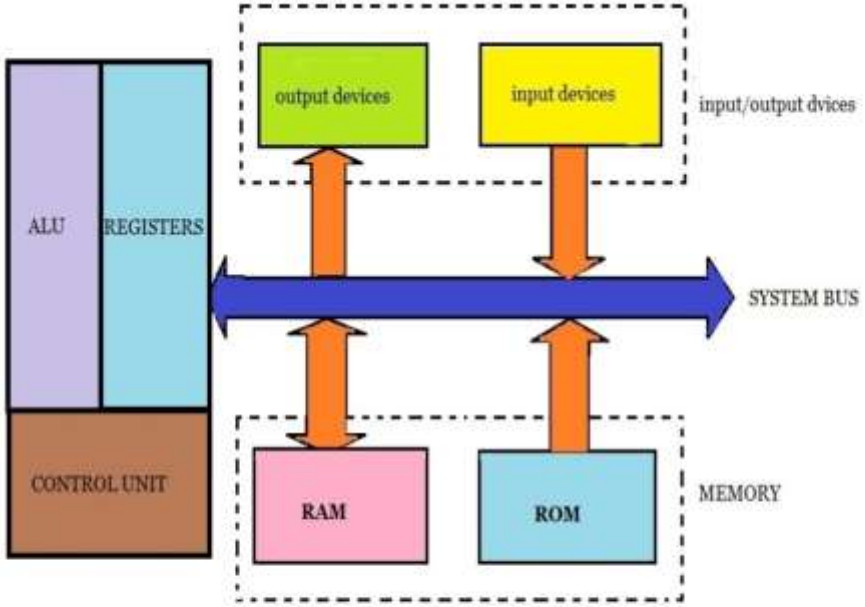
Boost air pressure sensor range from 0 to 3 kg/sq cm.
Fuel oil sensor range from 0 to 6 kg/sq cm.
Lube oil pressure range from 0 to10 kg/sq cm.

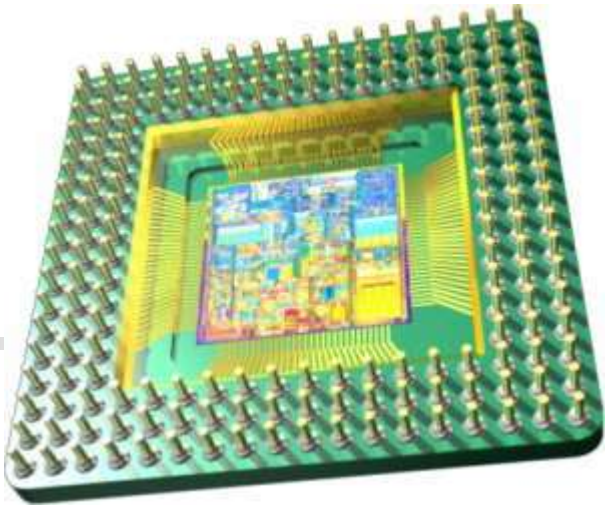
- Actuator unit

Working capacity (in torque) > 16.3 N m
Rack travel 0 to 30 mm

Microprocessor Based Control System

Microprocessor





The microprocessor is a multipurpose, programmable device that accepts digital data as input, processes it according to instructions stored in its memory, and provides results as output.

Medha Excitation & Propulsion Control System - MEP-660

- MEP-660 loco control system is designed to replaces the existing propulsion and E-type Excitation system.
- MEP660 is totally a new concept in Diesel Loco Control which:
  - Eliminates mechanical interlocking.
  - Uses microprocessor to control the locomotive through a software logics.
- The system is designed maintenance free, by eliminating the draw backs in the existing control system.

MEP-660 LOCOMOTIVE CONTROL SYSTEM

- Additional features like
  - Superior control over wheel slip,
  - Optimum utilization of HP.
  - Fault diagnostics.
  - Event recorder.
    - Internal & External recording
    - Both short term and long term recording.
  - Multi reset Vigilance control system
  - Auto emergency brake system @ preset locomotive speed.
  - Self Load testing.
  - Built in Auto flasher light system

Types of Locomotives Fitted with MEP-660

- Type : WDG3A
- Built @ : DLW
- GHP : 3100 HP
- NLV :1100 V
- Transitions : Single
  - 2S-3P to 6P @ 41.5 KMPH
- Type of Tr. Motors : 4907BZ
- Gear Ratio : 18:74
  - TM : Bull gear
- Governor : WW/MCBG
- Rectifier : Self cooled / Conventional

- Type : WDM3A
- Built @ : DMW
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- NLV :1100 V
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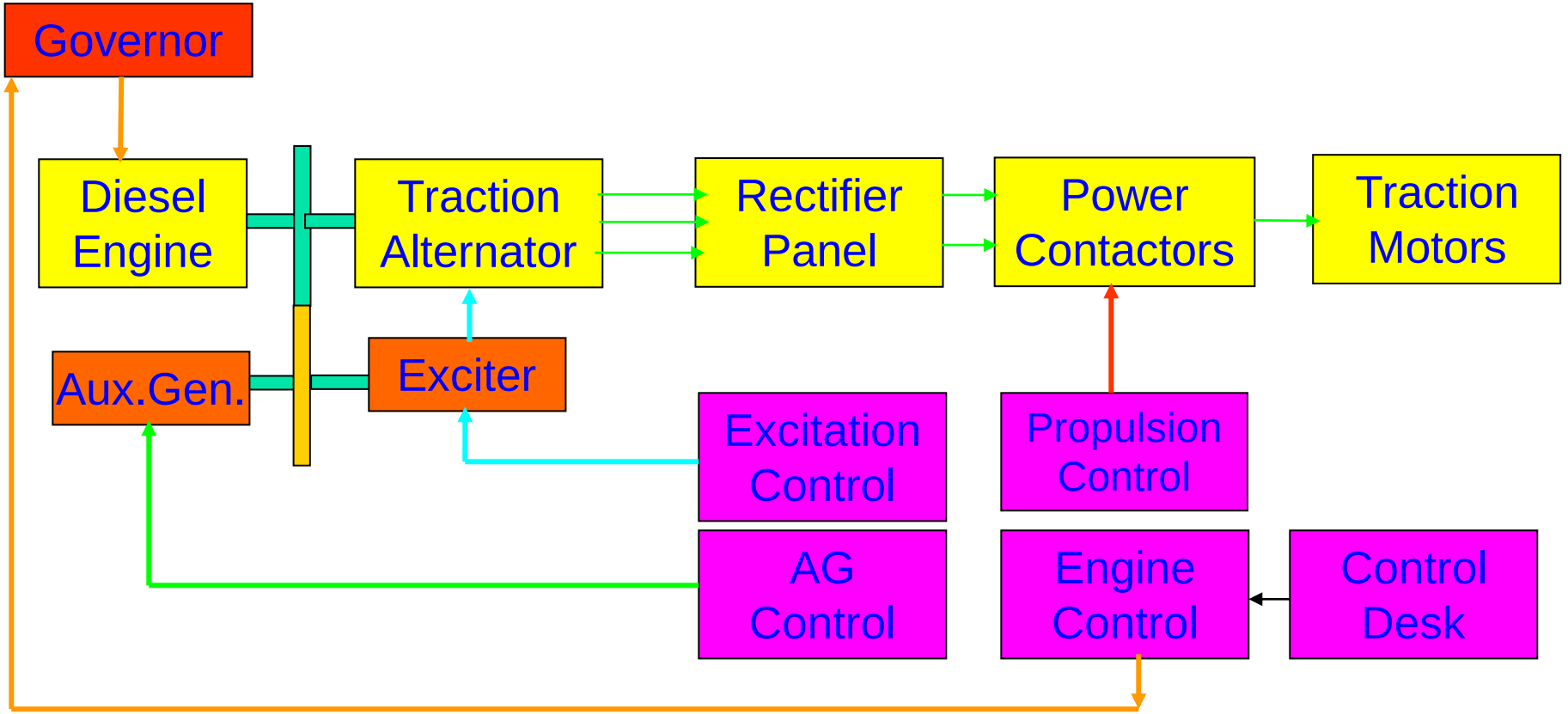
- Gear Ratio : 18:65
  - TM : Bull gear
- Governor : WW/MCBG
- Rectifier : Self cooled

Types of Locomotives Fitted with MEP-660

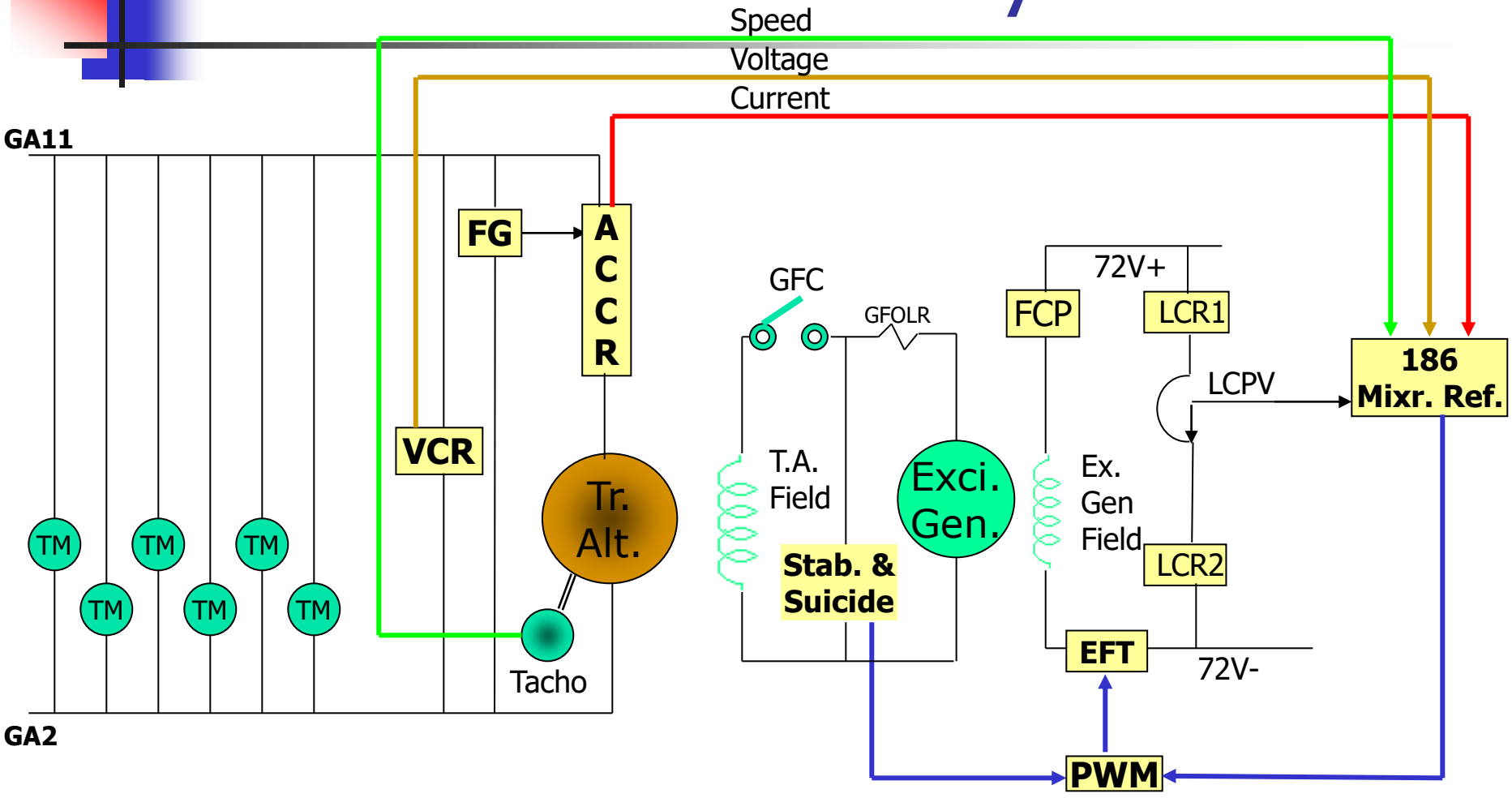
- **Type : WDM3D**
- **Built @ : DLW**
- **GHP : 3300 HP**
- **NLV :1075 V**
- **Transitions : Two**
  - 2S-3P-FF to 2S-3P-WF @ 42 KMPH
  - 2S-3P-WF to 6P @ 52 KMPH
- **Tr. Motors : 5002BY**
- **Gear ratio :18:65**
  - TM : Bull gear
- **Governor : WW/MCBG**
- **Rectifier : Alternator Mounted**

- **Type : WDG3D**
- **Built @ : DLW**
- **GHP : 3300 HP**
- **NLV :1100 V**
- **Transitions : Two**
  - 2S-3P-FF to 2S-3P-WF @ 36 KMPH
  - 2S-3P-WF to 6P @ 43 KMPH
- **Tr. Motors : 4907BZ**
- **Gear Ratio : 18:74**
  - TM : Bull gear
- **Governor : WW/MCBG**
- **Rectifier : Alternator Mounted**

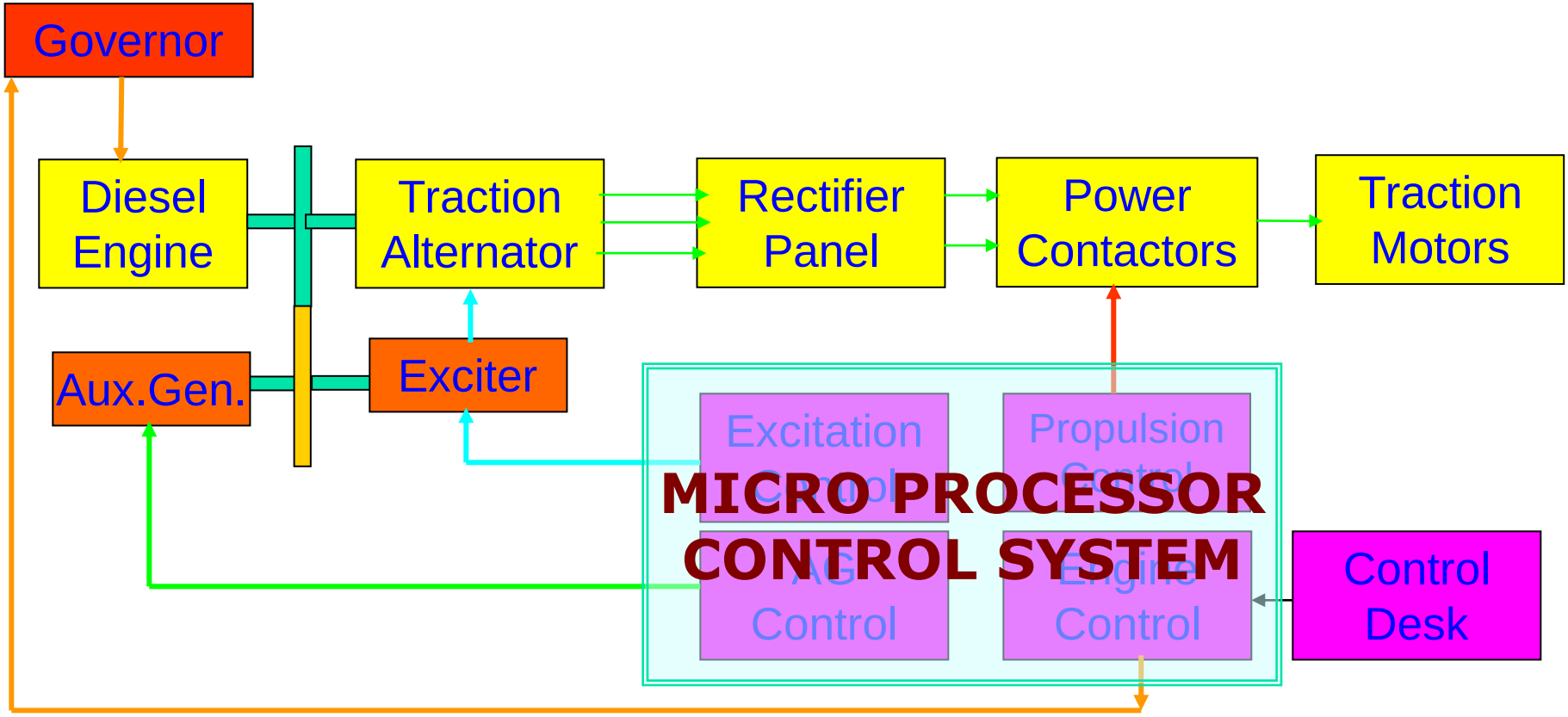
Diesel Electric Locomotive with E-type Excitation system.



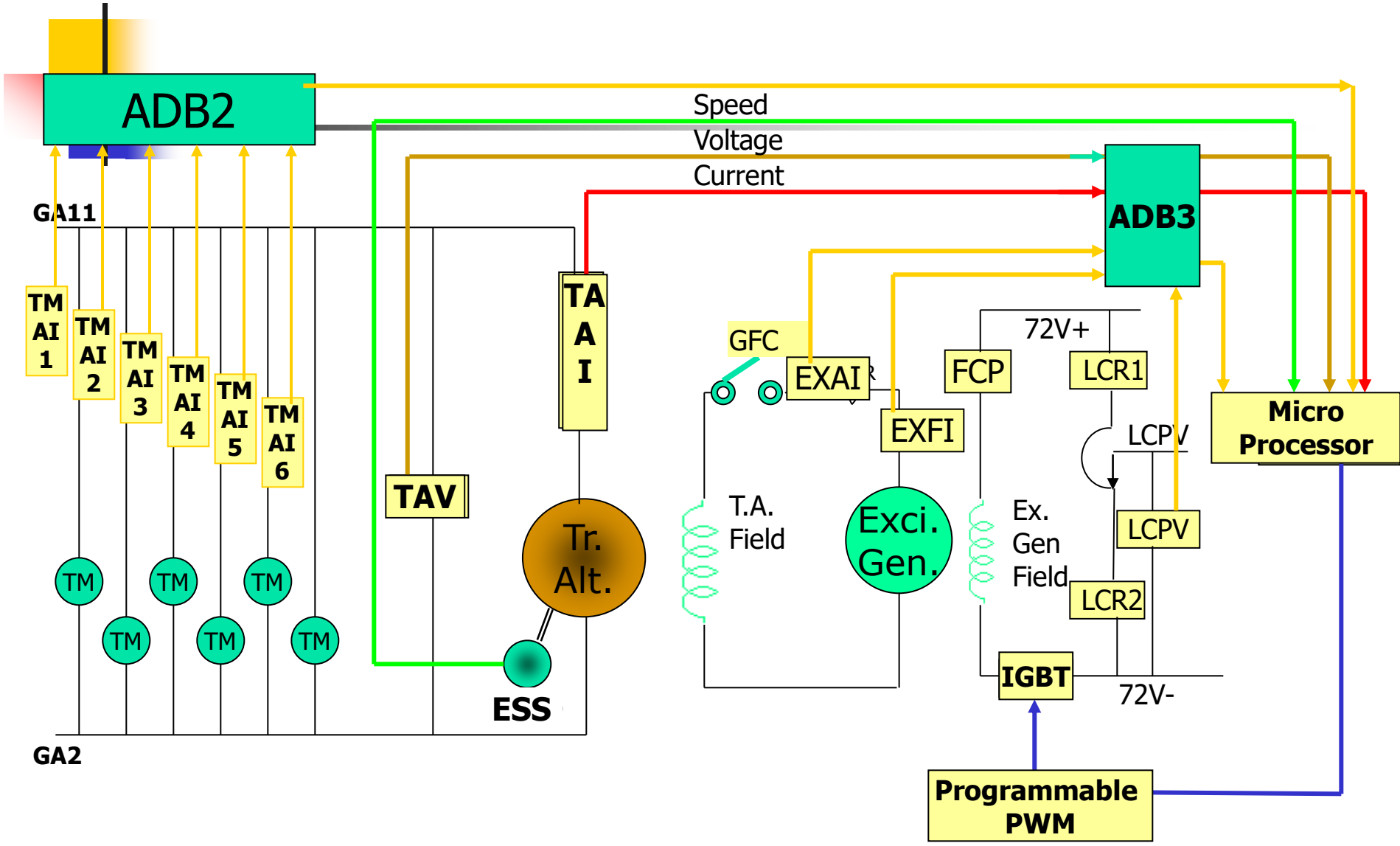
Block diagram of E-type Excitation control system.



Diesel Electric Locomotive with MEP-660



Block diagram of MEP-660 Excitation control system.



CONTROL systems required For operating a locomotive

- **Auxiliary Generator Control for charging the on board batteries and supplying power to other equipments**

- **Propulsion Control to run the locomotive in Traction / Braking mode,Forward/Reverse direction, etc**

- **Excitation Control to run locomotive at different power levels as per requirement**

- **Wheel Slip Control to detect the slipping of wheels and taking corrective action**

Dynamic Braking Control during the Dynamic braking

MEP-660 LOCOMOTIVE CONTROL SYSTEM

- The MEP-660 continuously monitors all the input signal in a cyclic maner. If any change in the digital inputs is noticed by the system, the MEP performs the following activities:
  - It selects the output devices to be energised as per the software logic.
  - It verifies the related feed back signals from safety point weather the devices can be energised.
  - It verifies various analog signals like pressures, temperatures etc. whether they are in the limits.
- After all verifications, MEP energises the required output devices for that input command.

MEP-660 LOCOMOTIVE CONTROL SYSTEM

- The MEP-660 has got two programmable PWM outputs. These PWM outputs are controlled through a set of instructions stored in the microprocessor. These variable PWMs are connected to two IGBTs.
- One IGBT is connected in the Auxiliary Generator field circuit to regulate Auxiliary Generator Voltage at the set limit.
- The (AGAI) A.G armature current sensor and (BATI) Battery Charge Current sensors continuously monitor the AG armature and battery charging currents.

MEP-660 LOCOMOTIVE CONTROL SYSTEM

- The second IGBT is connected in Exciter Field circuit to control the Exciter voltage.
- Based on the operating requests by the driver, the MEP-660 computes required output power from various inputs and accordingly generates PWM signal which drives the Exciter Field current.
- Exciter voltage changes accordingly and in turn Tr. Alternator Voltage. Thus traction output power is controlled by MEP-660 to the required constant HP at each notch.
- Tr. Alternator Voltage and current are continuously monitored by TAV and TAAI sensors.

MEP-660 LOCOMOTIVE CONTROL SYSTEM

- During Dynamic Brake operation the MEP-660 controls the Tr. Motor field current to limit the traction motor armature current which is decided by the master handle position and speed of the locomotive.
- The limits of TM armature and Field currents are user settable parameters and the limit values can be entered directly.

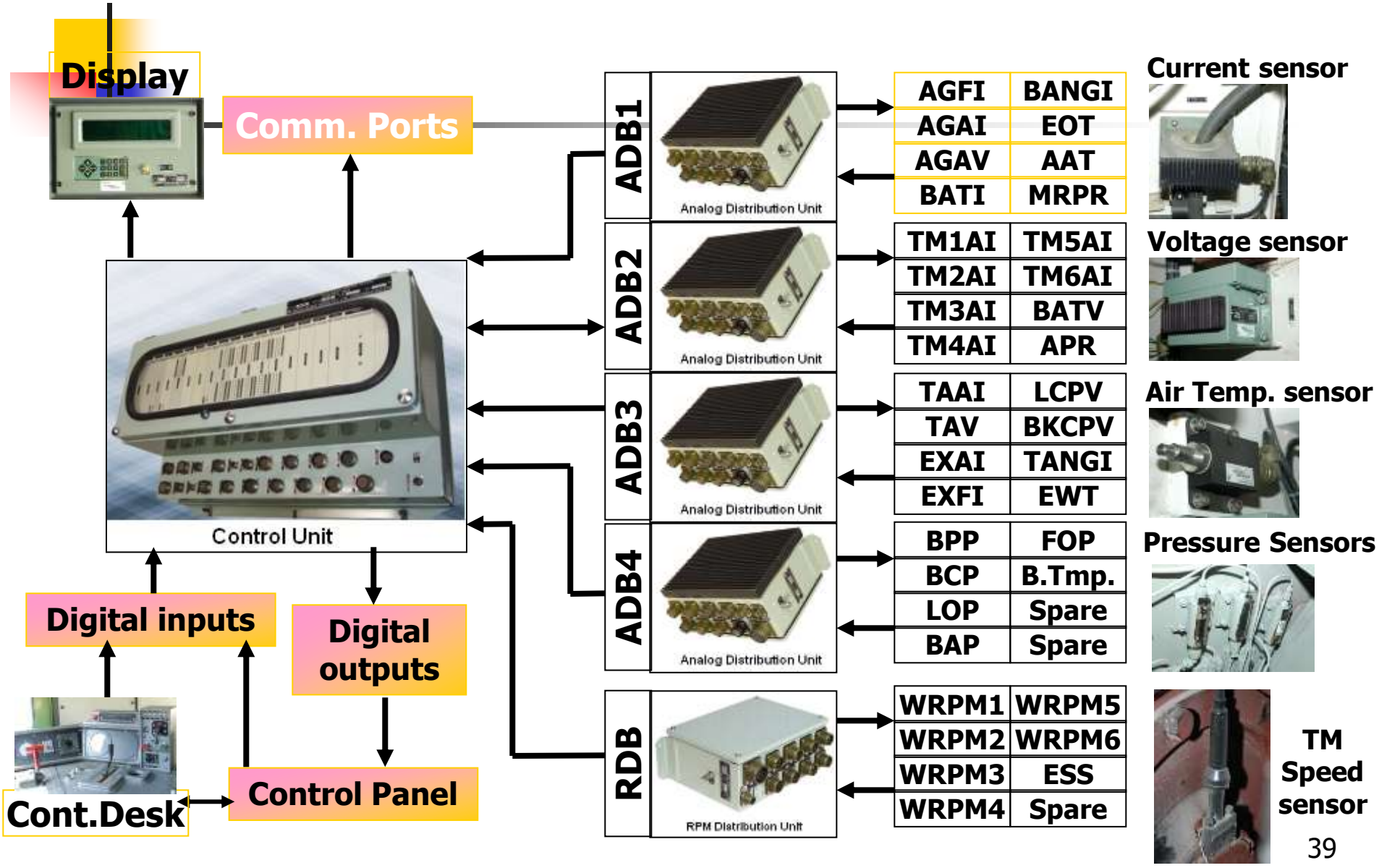
Uncommon Items of MEP-660 system

- Current Sensors
- Voltage Sensors
- Temperature Sensors
- Pressure Sensors
- Speed Sensors
- Analog Distribution Unit (MDB-701)
- RPM Distribution Unit (MDB-702)
- Control unit (MEP-660)
- Display unit (MDS-733)
- Memory Freeze Unit (MMF-705)
- MCOS Unit (MSP-707)
- Resistor Unit (MRP-703)
- Alerter Magnet Valve

Details of System

- Digital Inputs….. 80
- Digital Output….. 64 (32 LOW +16 High)
- Analog Inputs….. 32
  - Voltage ……. TAV, BATV, AGAV, BKCPV, LCPV
  - Current ……. TAAI, TM1AI-TM6AI, BATI, AGAI, EXAI, AGFI, EXFI, TANGI, BANGI
  - Temperature……. EWT, EOT, AAT
  - Pressure ……. MRPR, BP, BCP, LOP, FOP, BAP
  - Altitude ……. APR
- Frequency Inputs: WH1RPM to WH6RPM & ESS

Inter connections of MEP-660 sub assemblies



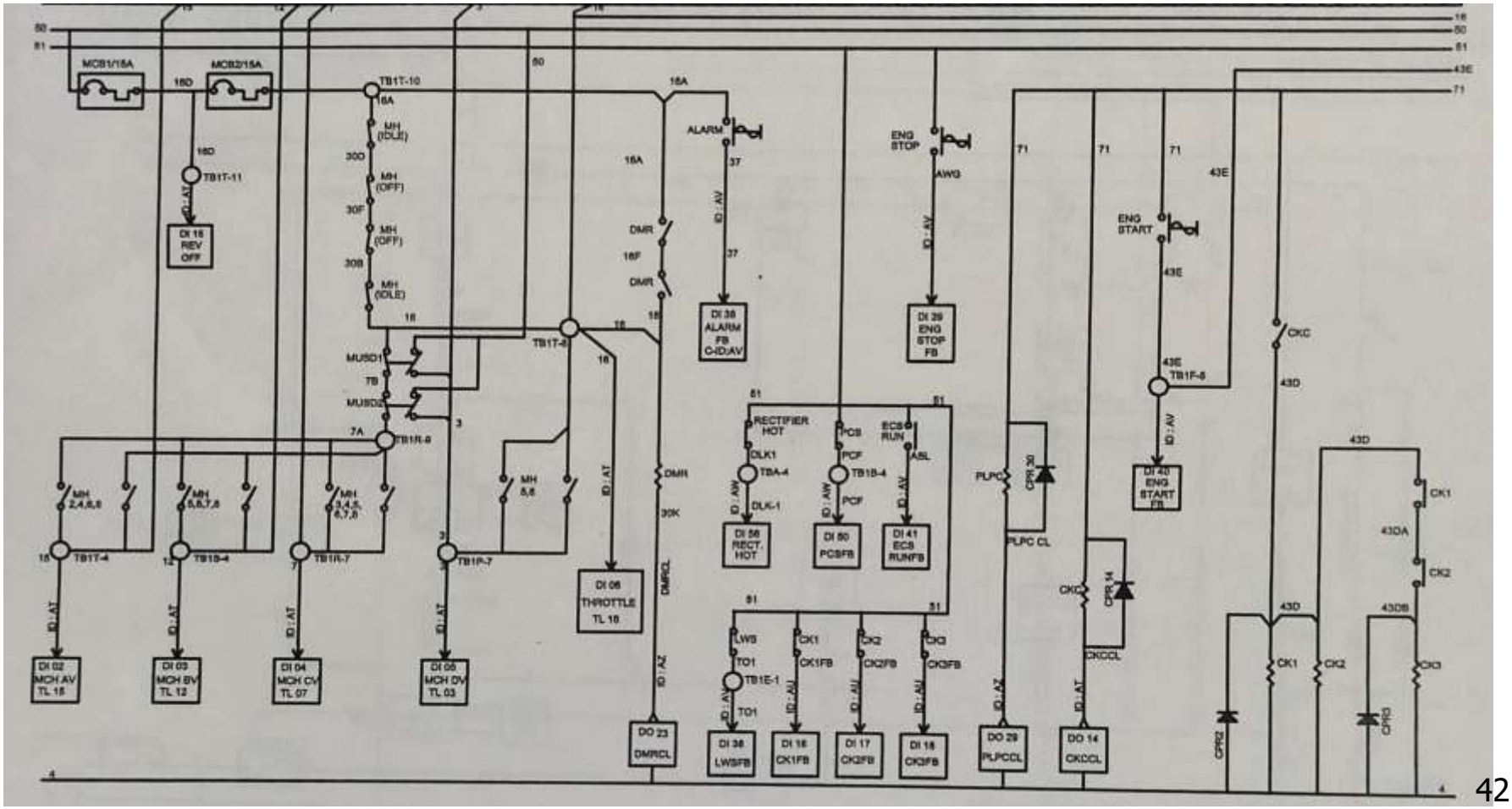
MEP 660 Components

1. Control unit
2. Display unit
3. Analog distribution unit
4. RPM distribution unit
5. Engine speed sensor
6. Voltage sensor
7. Current sensor
8. Temperature sensor
9. TM speed sensor
10. Pressure sensor

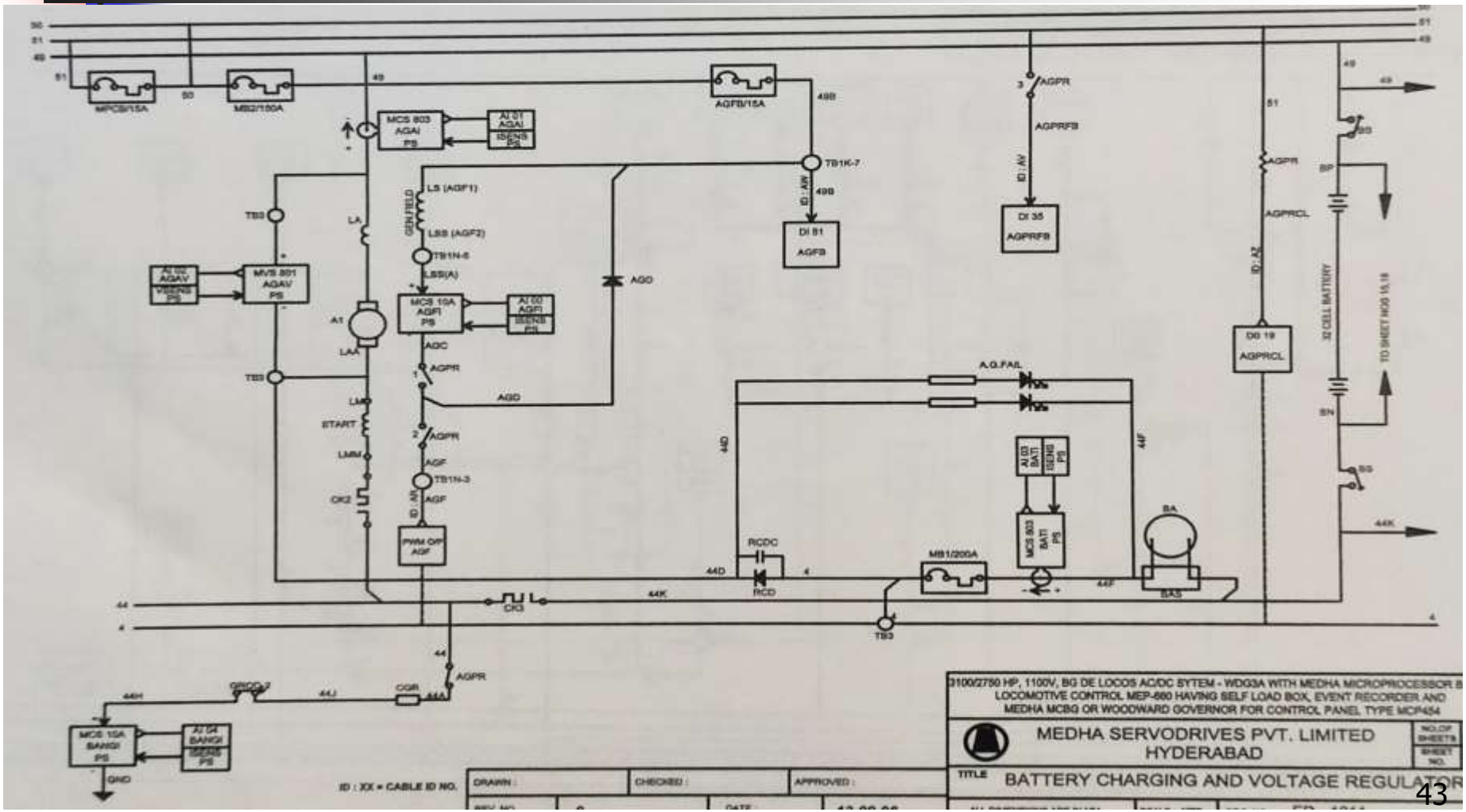
Description of Activity

1. Starting the Engine
2. Battery charging circuit
3. Engine speed control circuit
4. Power circuit
    a) Alternator rectifier circuit
    b) Exciter field control circuit
    c) Traction motor circuit
5. Loco propulsion circuit
    a) Motor cut-out circuit
    b) Transition control circuit
6. Dynamic brake control circuit
7. Engine shutdown circuit
8. Protection and alarm circuit

Cranking and Engine speed Control Circuit



Battery Charging Circuit



Question Bank

1. MCBG stands for micro controller base governor.– True
2. MCBG stands for microprocessor base governor.
3. In MCBG, load and clutch control card to reduce the excitation under engine overload conditions –True
4. The control card de- energize EM clutch coil under emergency shutdown in MCBG locomotive – True
5. In MCBG the torque is transmitted to the rack and pinion through an electromagnetic clutch – True
6. In MCBG the rack and pinion converts the rotary motion to vertical motion –True
7. Working capacity of MCBG (in torque) is greater than 16.3 Nm – True
8. The fuel rack travel range of MCBG is-

   a) 0 to 30 mm b) 5 to 30 mm c) 0 to 25 mm d) 25 to 30 mm

   option a is correct.

Question Bank

18. In MCBG loco, control of engine RPM without fuel rack travelling – False
19. In MCBG loco, control of engine RPM through fuel rack travelling – True
20. In MCBG defective sub assembly can be replaced in position – True
21. Merits of MCBG, smooth control of fuel rack with hunting – False
22. Merits of MCBG, smooth control of fuel rack without hunting – True
23. In MCBG, electromagnetic clutch provided for automatic shutdown – True
24. In MCBG, Dry run test facility to test free movement of LCR - False

Question Bank

25. In MCBG, Dry run test facility to test free travel of the fuel rack – True

26. Mechanical OST test facility and electrical OST test facility are available in MCBG – True

28. How many cards are fitted in MCBG control unit.

A) 6. B) 7. C) 3. D) 2

Option B is correct.

29. In MCBG, display control card to display the diesel engine parameters on display unit – True

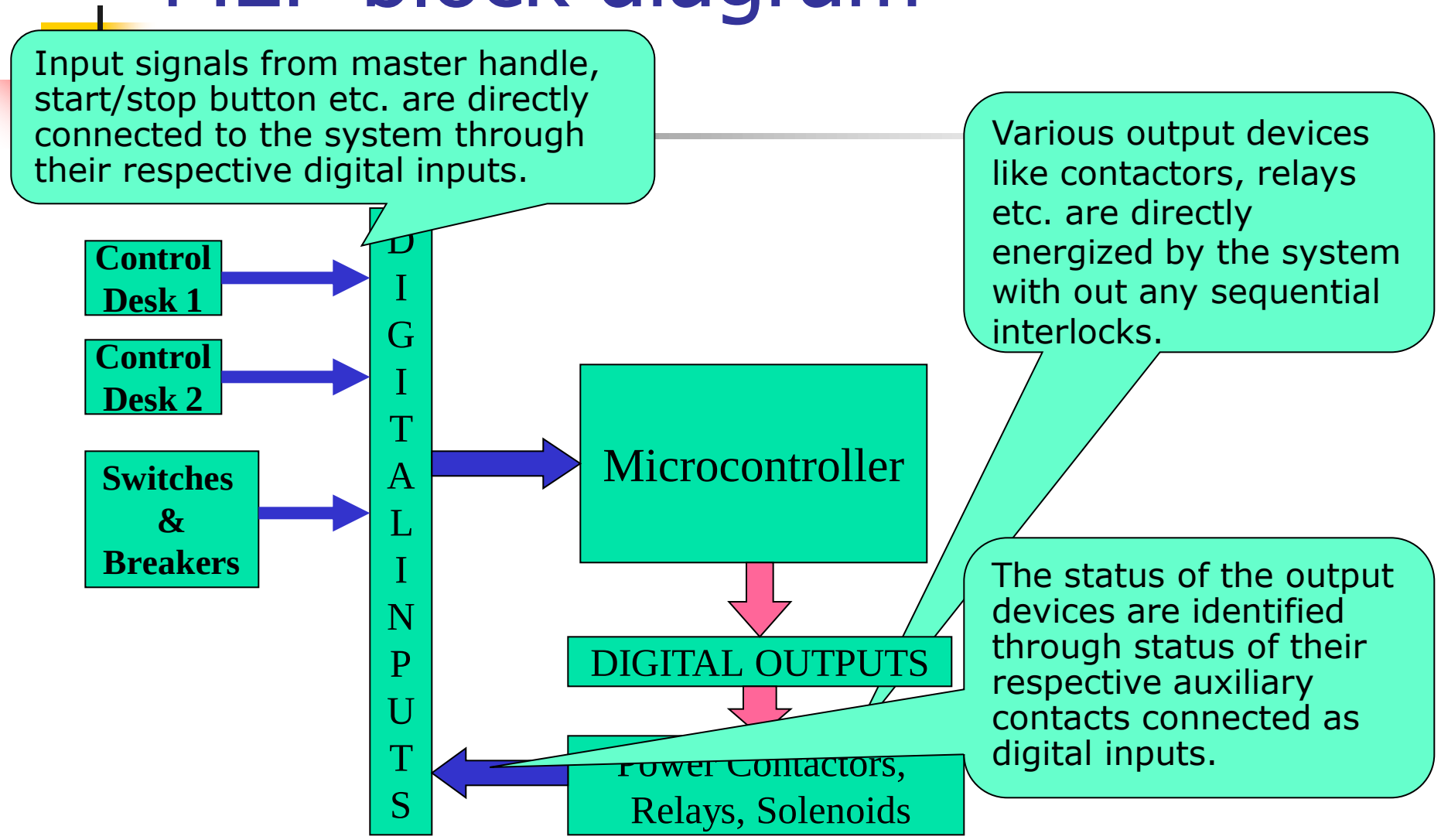
30. How many motor cards are fitted in MCBG control unit –.

A) 6. B) 2 C) 0. D) 1.

Option B is correct.

32. The control card consists a 16 bit micro controller in MCBG – True

MEP block diagram



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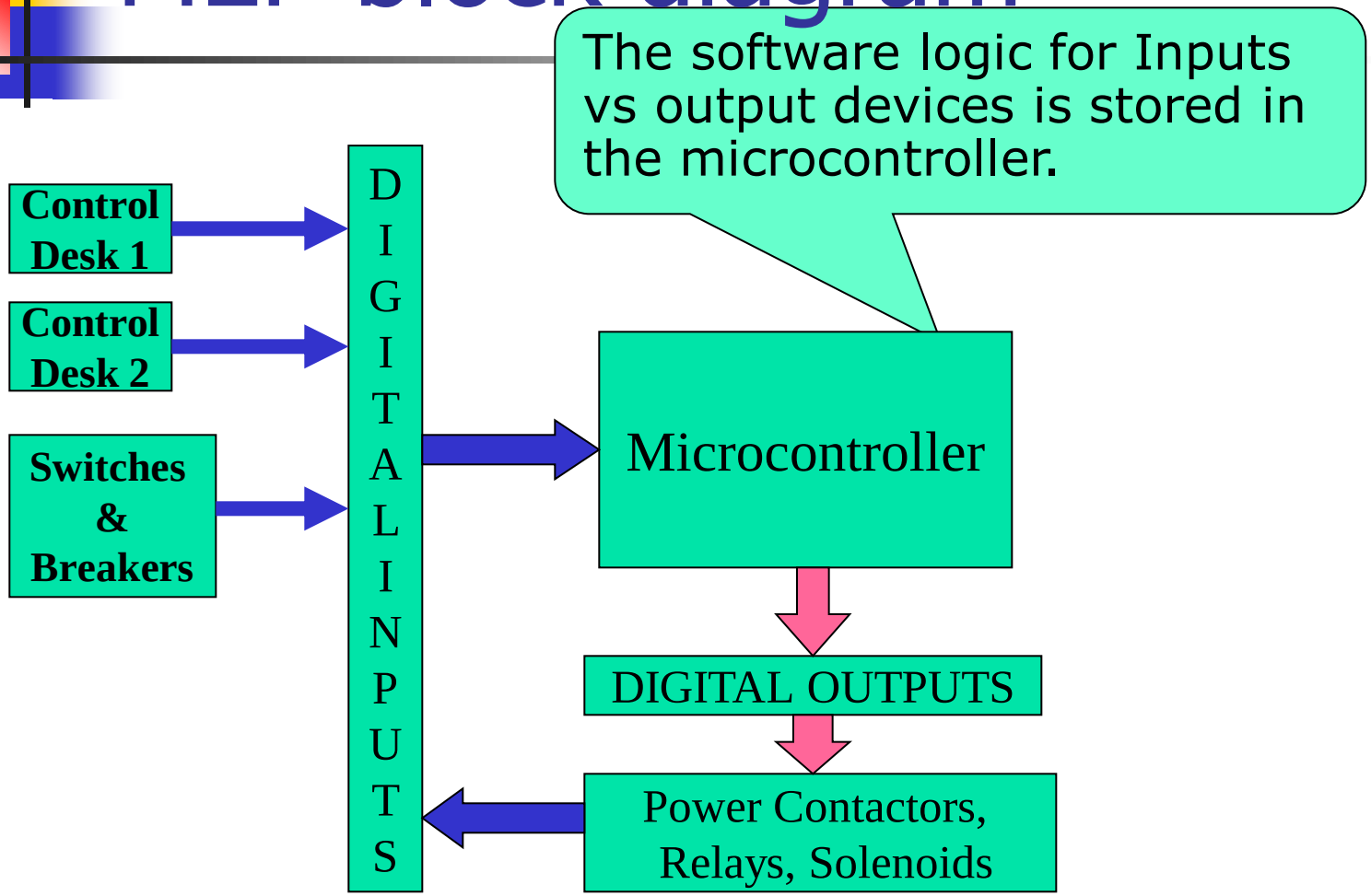

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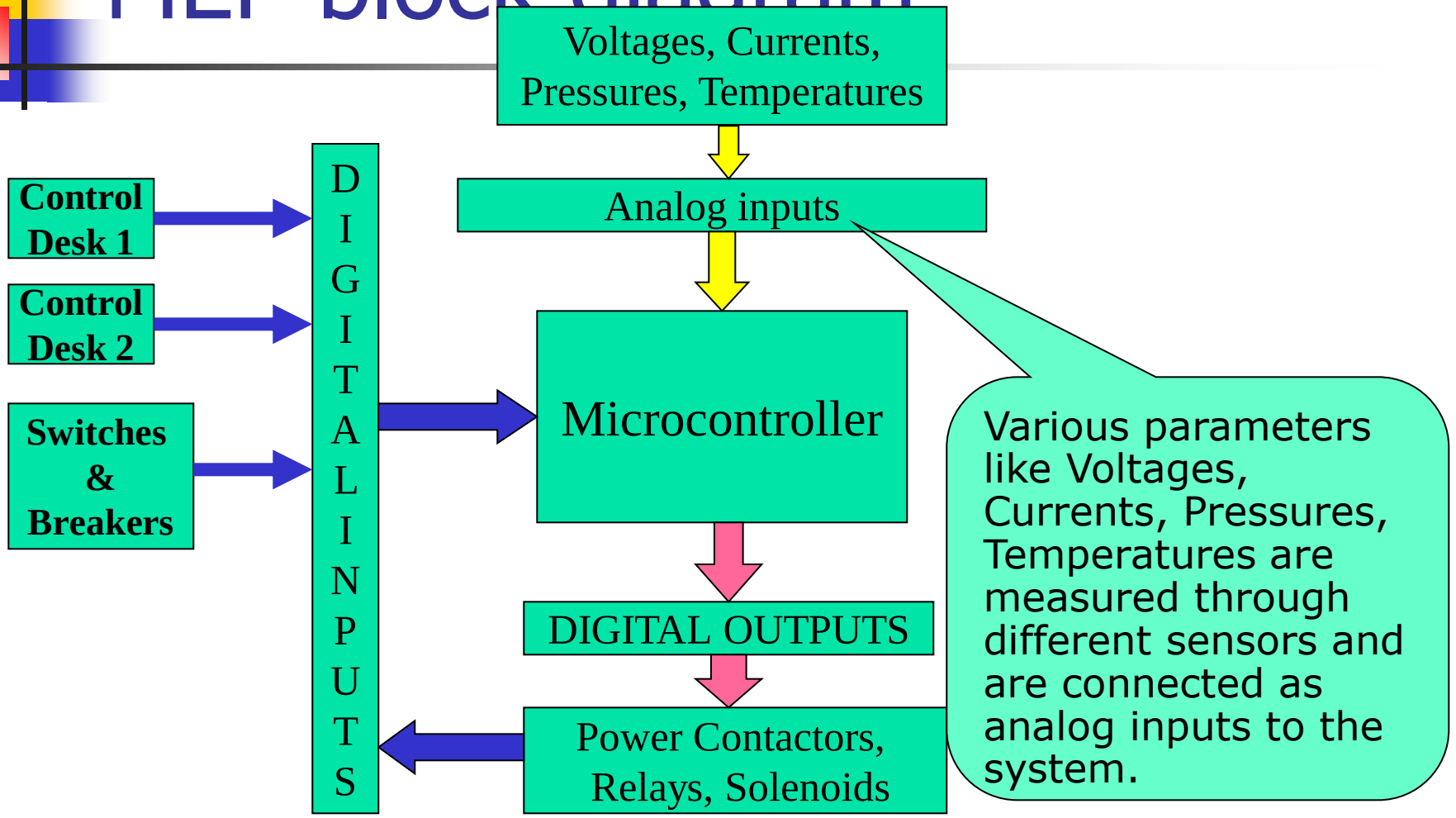

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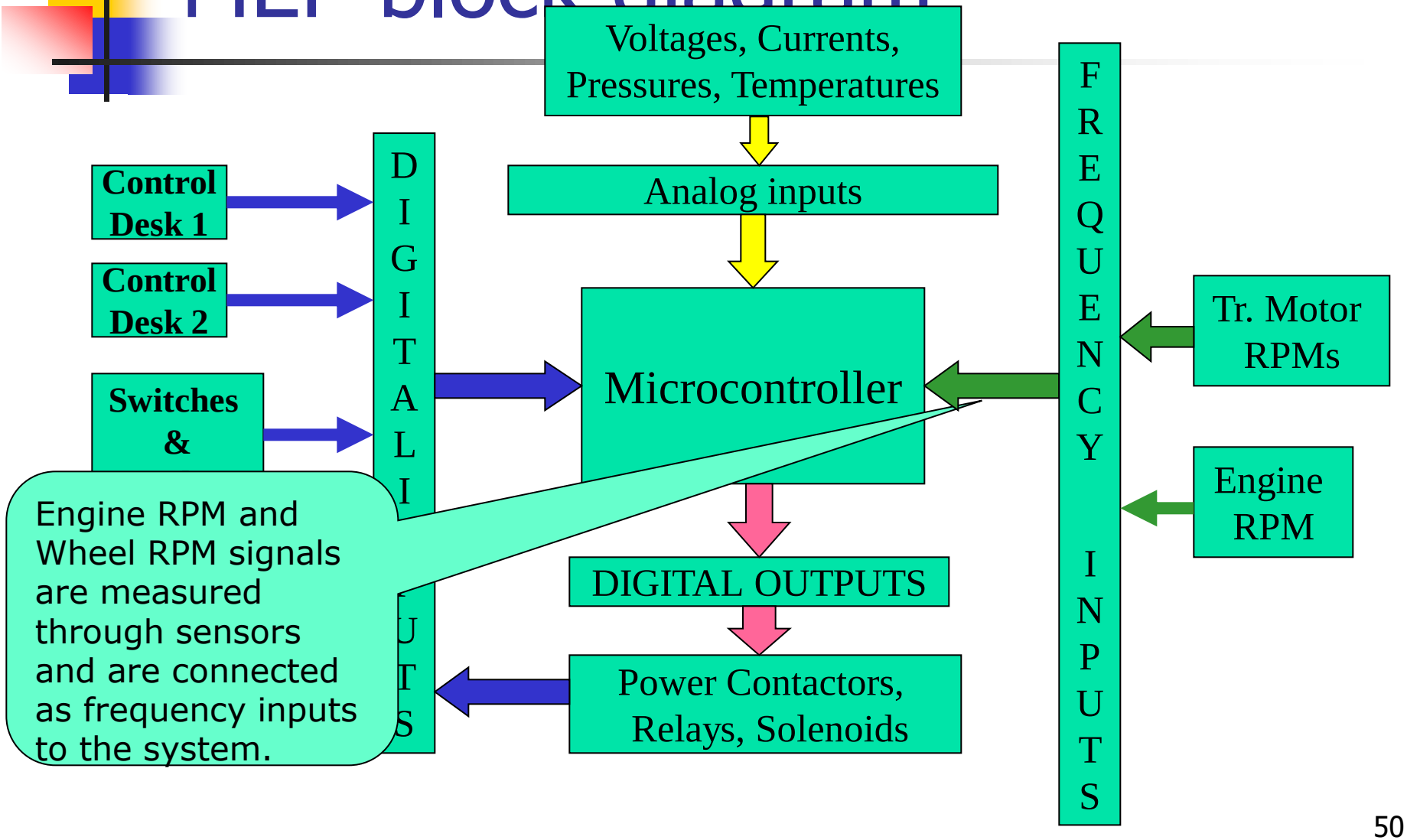

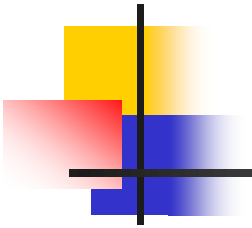

THANK YOU