1. INTRODUCTION

1.1 Definition of Auxiliary Electrical Systems

- Electrical Auxiliary System, is a acronym used to describe a collection of related automotive Electrical components that interact with the main car systems and components to support his functionality.

- Electrical Auxiliary Systems are components related with Security Systems, Comfort Systems, Lighting Systems and Information Systems which are very important to help the main system to perform according the specifications.
1. INTRODUCTION

1.2 Taxonomy of Auxiliary Electrical Systems.

Auxiliary Electrical Systems

Security Systems
- Central locking door system
- Locking door with distance command
- Biometric system
- Anti steel system

Comfort and Safety Systems
- Seat adjustment
- Windows control
- Sun roof control
- Windshield wiper and window cleaning
- Compartment HVAC
- Control view mirrors

Lighting Systems
- Front Lighting
- Rear lighting
- Compartment lighting
- Signalization lighting

Information Systems
- Instruments panel
- Trip recorder
- Board computer
- Multimedia

Conclusion.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems - Central locking door system

- Either pneumatic or electric actuators can be used to power central locking systems
- Used for vehicle doors, luggage compartments and fuel-filler flaps.
- There are two types of locking systems:
  - Electrical / Pneumatic.
  - Electrical only actuation.

2.1 Security systems - Central locking door system (cont)

- In pneumatic systems, an electric motor drives the reversible dual-pressure pump.
- The pump provides the required system pressure (positive or vacuum).
- The system can be switched on and off by a central position switch inside the vehicle and by the ignition switch.
- As an optional feature, the system can be operated from a number of points (driver door, front-seat passenger door, and trunk lid).
- More widespread than the pneumatic systems are those which depend only from Electrical actuation.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems - Central locking door system (cont)

- **Electric motors** for central locking, although various technologies are used, according to function range and lock type, the basic principle remains constant: a small electric motor.

- The electric motor reduction-gear drive unit powers the actuating level responsible for opening and closing the lock.

- Provision must be made to ensure that the door can always be unlocked with the key and the interior handle in the event of a power failure.

- Central locking systems incorporating special theft-deterrence features must be designed to preclude deactivation of the security system using any means other than the vehicle key.

The Figure shows the block diagram for a general locking system.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems - Central door locking system (cont)

The figure shows a Electric locking system as explain.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems - Locking door with distance command

- The system is a variant of the Central door locking as it was seen on previous topic.

- The innovation is the possibility to integrate a remote hand command by infra red or by RF to give order for open/close the doors.

- This system has a receiver unit installed on the vehicle that receives the command from the hand transmitter.

- If the code in memory is the same as the received one then a signal that is connected in parallel with gear motors will actuate them and open/close the doors.

- The code can be modified and has about 59048 combinations (depends from the type of remote command).

- Generally the receivers can have a setup to receive more than one code, this happens when the vehicle will have several drivers. Each one has a hand command with a different code that will be recognized by the receiver unit.

- Nowadays, the car is equipped with anti steal system, the hand remote command can also activate the anti steal system by pressing two times the switch. In this case a red led start blinking, this confirms that the anti steal system is activated.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems -- Biometric system.

• The figures shows examples of applications of biometric sensors.

2.1 Security systems -- Biometric system (cont)

• Biometric system recognition has the main function to check and confirm the identity of the peoples based on biometric characteristics.

• At moment there are known about ten biometric processes, between them the most relevant are the following ones:
  – Identification of finger print.
  – Identification of face lines.
  – Identification of Iris.
  – Identification of voice.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems – Biometric system. (cont)

- For automotive vehicles it is used more frequently de finger print witch gives a more comprehensive differentiation of the identities.

- This technology gives more security compared with the car Key, that for instance could be lost. Note that de biometric characteristics are carried by the person.

- Also, the technology gives information about the identity of the person that drives the car.

- To Identify a finger print, first is necessary to register it. This is done by data acquisition of the finger print using a sensor with gray scale color and size (64000 to 96000 pixel with resolution of 8 bit/pixel).

2.1 Security systems – Biometric system. (cont)

- Digital finger print sensor based on direct optical scanning (DiOS).
  a. Image sensor CMOS with finger.
  b. Detail of information.
  1. Light.
  2. scene Finger lines.
  3. Led light from bottom.
  4. optical fiber beam.
  5. Sensitive sensor.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems — Biometric system (cont)

- The Access to the car, the sensors to identify the fingerprint needs to be installed on the doors outside.
- The main technologic challenge is to increase the mechanic hardness and protection of the sensor.
- The Sensor should be protected against bad weather conditions and crashes.

2.1 Security systems — Anti Steal system

- Car and alarm manufacturers are constantly fighting to improve security. Building the alarm system as an integral part of the vehicle electronics has made significant improvements. Even so, retrofit systems can still be very effective.
- Three main types of intruder alarm are used:
  - Switch operated on all entry points.
  - Battery voltage sensed.
  - Volumetric sensing.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems – Anti Steal system (cont)

- There are three main ways to disable the vehicle.
  - Ignition circuit cut off.
  - Starter circuit cut off.
  - Engine ECU (Electronic control unit) code lock.

- A separate switch or IR transmitter can be used to set an alarm system. Often, they are set automatically when the doors are locked.

- The following is an overview of the good alarm systems now available either as a retro-fit or factory fitted. Most are made for 12V.

- They have electronic sirens and give an audible signal when arming and disarming.

- They are all triggered when the car door opens and will automatically reset after a period of time, often 1 or 2 minutes.

- The alarms are triggered instantly when an entry point is breached.

- Most systems can be considered as two pieces, with a separate control unit and siren.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems - Anti Steal system (cont)

- Most systems have the control unit in the passenger compartment and the siren under the bonnet.

- Most systems now come with two infrared remote ‘keys’ that use small button-type batteries and have an LED that shows when the signal is being send.

- Intrusion sensors such as car movement and volumetric sensing can be adjusted for sensitivity.

- When operating with flashing lights most systems draw about 5 A. Without flashing lights (siren only) the current drawn is less than 1 A.

- The sirens produce a sound level of about 95 dB, when measured 2 m in front of the vehicle.

- Next slide shows a block diagram of an alarm system. The system, as is usual, can be considered as a series of inputs and outputs signals.
2. ELECTRICAL AUXILIARY SYSTEMS

2.1 Security systems - Anti Steal system (cont)

Inputs

- Ignition supply.
- Engine crank signal.
- Volumetric sensor.
- Bonnet switch.
- Trembler switch.
- IR/RF remote (Figure 16.27).
- Doors switches.
- Control switch.

Outputs

- Volumetric transmitter.
- System LED.
- Horn or siren.
- Hazard lights.
- Ignition immobilizer.
- Loop circuit.
- Electric windows, sunroof and door locks.

A security code in the engine electronic control unit is a powerful protection. This can only be ‘unlocked’ to allow the engine to start when it receives a coded signal.

Ford and other manufacturers use a special ignition key that is programmed with the required information. Even the correct ‘cut’ key will not start the engine.

Citroën, for example, have used a similar idea but the code has to be entered via a numerical keypad.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Seat adjustment

Seats and control switches

• Fundamentally, the mentioned system operate using one or several permanent magnet motors, together with a supply reversing circuit.

• When the switch is moved, one of the relays will operate and this changes the polarity of the supply to one side of the motor.

• If the switch is moved the other way, then the polarity of the other side of the motor is changed.

• When at rest, both sides of the motor are at the same potential. This has the effect of regenerative braking so that when the motor stops it will do so instantly.

• Further refinements are used to enhance the operation of these systems. Limit switches, position memories and force limitations are the most common.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Seat adjustment (cont).

1- Power Battery.
2- Power connection box.
3- Fuse Box.
4- Command switches for backs inclination motor.
5- Command switches for up/down movement motor.
6- Command Switches for Slide front/rear seat motor.
7- Motor seat slider front/rear.
8- Motor seat up/down position movement.
9- Motor for back inclination.
10- Block for de passenger.

A typical electrically controlled seat is shown previous slide. This system uses four positioning motors, two for each motor.

When the seat position is set, some vehicles have set position memories to allow automatic re-positioning if the seat has been moved.

This is often combined with electric mirror adjustment.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windows control.

- Power windows control have mechanisms that are driven by electric motors. There are two types of system in use.

- The available installation space assumes a prominent place among the criteria applied in determining which system to install.

- An electric-motor driven spur pinion transmits the force to a conventional window regulator.

- The electric motor transfers the force through a Bowden cable.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windows control (cont)

Command panel for windows control.

Electric windows control block diagram
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windows control (cont)

Example of a simple control circuit.

Control window location on doors
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windows control (cont)

- Window operation is controlled manually by means of a rocker switch. For greater convenience, power windows can be linked to a central or decentralized closing system.

- When the vehicle is locked, closes the windows automatically or sets them to a predefined partially-open position for ventilation purposes.

- During closing, a force-limitation device (anti-squeeze or finger protection) is in operation. The device serves to prevent human appendages from being caught by the closing window.

- The window drive units include integral Hall sensors to monitor motor speed during operation. If a reduction in speed is detected, the motor’s direction of rotation is immediately reversed. The window closing force must not exceed 100 N at a spring rate of 10 N/mm.

- The unit automatically overrides the anti-squeeze protection immediately before the window enters the door seal, allowing the motor to run to its end position and permitting complete closure of the window.

- At the same time, the final window position is signaled back to the control unit. Electronic control may be concentrated in a central control unit, or the control elements may be dispersed among the individual window motors in order to reduce the complexity of the wiring.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Sun roof control

- An electronic control unit featuring integral force limitation provides benefits if the sunroof is incorporated in a central-locking system.
- The electronic control system includes a microcomputer responsible for evaluating incoming signals and monitoring sunroof position.
- The closed and maximum opening positions for the sliding action of the sunroof are monitored with the aid of micro switches or Hall-effect sensors.
2. **ELECTRICAL AUXILIARY SYSTEMS**

### 2.2 Comfort and Safety systems

Sun roof control (cont).

- Supplementary functions such as:
  - preset position control,
  - closing via rain sensor,
  - motor-speed control,
  - electronic motor protection,

The operation of an electric sun-roof is similar to the motor reverse circuit discussed earlier in the windows control.

However, further components and circuitry are needed to allow the roof to slide, tilt and stop in the closed position.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Sun roof electric control (cont).

1- motor with reduction speed.
2- slider car.
3- command cable.
4- roof panel.
5- base for roof panel.
6- Slide base for the roof panel.
10 – Guide for slide the base for roof panel.
7,9,11 – Base for slide the system.

Note: Speed is 10 to 12 m/s.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems — Sun roof electric control (cont).

1 – motor.
2 – actuator to move manually the rotation in case motor does not work.
3 – part to indicate the position of open and close.
4 – rotation for the actuator 3.
5 – micro switch receives information position from 3.
OFF – roof closed.
ON – roof all others positions of work.
6 – relay of the motor.
7 – Wires for relay command.

2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems — Windshield Wiper systems and window cleaning.

- Systems for cleaning the vehicle’s windshield, headlamps, and rear window are needed in order to comply with legal stipulations for good visibility at all times.

- The requirements of the wiper system are simple. The windscreen must be clean enough to provide suitable visibility at all times.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

- To do this, the wiper system must meet the following requirements.
- Efficient removal of water and snow.
- Efficient removal of dirt.
- Operate at temperatures from -30 to 80 °C.
- Pass the stall and snow load test.
- Service life in the region of 1500 000 wipe cycles.

Such systems can be subdivided as follows:
- Windshield wiper systems,
- Rear-window wiper systems,
- Headlamp wiper systems,
- Headlamp washer systems,
- Combination wiper-washer (wipe/wash) systems.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

- The windshield wiper system must meet the following requirements:
  - Removal of water and snow.
  - Removal of dirt (mineral, organic or biological).
  - Operation at high temperature (+ 80 °C) and low temperature (– 30 °C).
  - Corrosion resistance against acids, alkalis, salts (240 h), ozone (72 h).

2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

- Types of windshield cleaning systems.

![Diagram of windshield cleaning systems]
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

- Mechanical wiper mechanism.

Principle of the mechanical wiper mechanism:
1. Oscillating crank 1
2. Oscillating crank 2
3. Crank 1
4. Crank 2
5. Couple rod 1
6. Couple rod 2

- Tandem wiper mechanical system.

Tandem wiper system (series coupled)
Right hand part of wiper mechanism designed as:
1. Oscillating crank;
2. Crank;
3. Couple rod.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

- **Wiper motors.**
  - DC motors are used as wiper motors.
  - For normal use in windshield wiper systems, they incorporate a worm-gear unit.
  - but when used in rear window and headlamp cleaning systems, they often incorporate an additional gear unit for translating rotary motion into oscillating motion (four-bar linkage, rack-and pinion mechanism or crank-wheel mechanism).
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

- Wiper motors.

Wiper motor speeds

- Typical specifications for wiper motor speed and hence wipe frequency are 45 rev/min at normal speed
- The speed of 65 rev/min at fast speed.
- The motor must be able to overcome the starting friction of each blade at a minimum speed of 5 rev/min.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

Wiper motors.

- Characteristics curves for two wiper motor speeds (fast and Low speed).

![Characteristics of a wiper motor: speed, current, power output, efficiency, and torque.]

To ensure good visibility in the wiped areas, it is imperative that the wiper system is backed by a washing system.

- Electrical centrifugal pumps of simple design are used (characteristic pump curve) to pump the water through 2 to 4 nozzles and onto the windshield in a narrow spray pattern.

- The water, to which a cleaning additive is added, is contained in a reservoir of 1.5...2 l capacity. If the same water is used also to clean the headlamps, a larger volume of up to 7 l is necessary.

- A separate reservoir can be provided for the rear-window cleaning system.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

Window cleaning.

- The washing system is often coupled to the corresponding wiper system by means of an electronic control.
- The water is sprayed onto the window or windshield while a pushbutton is pressed,
- The wiper system continuing to operate for several additional cycles after the pushbutton is released.

Example of a pump for washing.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont)

Window cleaning

- Three types: Gear type, Squeeze type, and centrifugal type.

Rear window cleaning

- These systems perform similar to windshield cleaning systems.

- However, service life is limited to 0.5 \( \cdot \) 106 wipe cycles. In right-hand traffic vehicles, the wiped area is preferred with parking position on the right-hand side (as viewed in the direction of travel).

- The 180° system is used when rear-window dimensions permit.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Windshield wiper systems and window cleaning (cont).

Rear window cleaning

- The cleaning and washing of rear window could have a designated reservoir as mentioned on previous information.

- The Electronic control unit only gives order to send the cleaning liquid during the actuation of correlated function button.

- After release the button the rear wiper still running during several seconds.

- Anti fog heater on rear window.
  - The system includes a heating resistance in crystal that avoids the condensation effect of humidity in the glass window.
  - The resistance is composed of a very thin wire inserted in the crystal, which is powered by the battery.
  - The temperature achieved in the window eliminates the ice, snow and condensation during winter.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems - Windshield wiper systems and window cleaning (cont).

Heater resistance inside rear window

Electric circuit of heating resistor on rear window
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Compartment HVAC.

- The vehicle’s climate-control system provides the following:
  - A comfortable climate for all passengers,
  - An environment calculated to minimize driver stress and fatigue,
  - More recent units use filters to remove particulate matter (pollen, dust) and even
  - Odors from the air,
  - Good visibility through all windows, and windshield.

- On vehicles with liquid-cooled engines, the engine heat (by-product of the combustion process) contained in the coolant is used to warm the passenger compartment.

- With air-cooled engines, engine heat is taken from the exhaust or, in some cases, from the engine’s lubrication circuit.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Compartment HVAC. (cont)

Air Condition

- The heater unit alone is not capable of providing a comfortable environment at all times. When the outside temperature climbs beyond 20 °C, the air must be cooled to achieve the required interior temperatures.

- Here, compressor-driven refrigeration units with R 134a refrigerant are in use (until 1992, R12 refrigerant).

- The engine-driven compressor compresses the vaporous refrigerant, which heats up in the process and is then directed to the condenser where it cools and liquefies.

- The energy supplied in the compressor and the heat absorbed in the evaporator are dissipated to the environment here.

- An expansion valve sprays the cooled liquid into the evaporator where the evaporation process extracts the required evaporation heat from the incoming stream of fresh air, thereby cooling the air.

- Moisture is extracted from the cooled air as condensation, and the air’s humidity is reduced to the desired level.

- Evaporators and condensers are generally designed as tube-and-fin heat exchangers.

- The evaporator is located before the heater core in the fresh-air stream and cools the air

- to approx. 3...5 °C. The dehumidified air is reheated in the heater core to the desired temperature.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Compartment HVAC (cont)

Automatic Climate control

- Automatic climate control is particularly useful for vehicles in which both air conditioner and heater are installed, because the constant monitoring and adjustment required to maintain a temperate climate presents the occupants with a complicated task.

- An automatic climate control system incorporating a pre selection feature can automatically maintain the correct Passenger-compartment heating, ventilation and air conditioning (HVAC).
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Compartment HVAC. (cont)

- These parameters are mutually interdependent, and changes to one will affect the others. At the center of the system is a temperature-control circuit for interior temperature.

- The control unit continuously monitors both the preselected temperature and all essential variables which affect the system, using this information to calculate a Set point $t_i$.

- The set point is compared with the actual temperature, and the control unit uses the difference between the two as the basis for determining the required heating, refrigeration, and air-flow rate.

- Another function controls the position of the air-distribution flaps with reference to the program which the occupants have selected. Meanwhile, all control circuits continue to respond to manual inputs.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Compartment HVAC. (cont)

- The set point temperature determined by the control unit is achieved by means of water or air-side adjustments. Infinitely-variable or graduated blower control is used to adjust the air flow to the specified level.

- There is generally no set point processing involved in this operation. This type of arrangement is inadequate for dealing with the increases in flow rate caused by aerodynamic pressure at high speeds.

- Here, a special control function can compensate by responding to increasing vehicle speeds, initially by reducing the blower speed to zero, and then, should the flow continue to rise, by using a restriction flap to throttle the stream of incoming air.
2. ELECTRICAL AUXILIARY SYSTEMS

2.2 Comfort and Safety systems – Control rear view mirrors (cont)

- It is the main propose of the system move the rear view mirrors in all directions, so that the driver can adjust his rear view to the seat position.
- For each mirror (Left and right side), the system has two motors.
- One motor moves horizontal direction and the second moves inclination.
- The two mirrors is a safety device for the driver, seeing the rear traffic therefore the mirrors are controlled by the driver.

1. Left mirror.
2. Right mirror.
3. Control switch block.
4. Power box.
5. Fuse.
7. Mirror right connector.
8. External temperature sensor.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Front Lighting

- The primary function of the headlamps at the vehicle front end is to illuminate the roadway so that the driver can register the traffic conditions and recognize any obstacles and hazards in good time.
- They also serve to identify and mark out the vehicle to oncoming traffic.
- The turn-signal lamps serve to show the driver’s intention to change direction or to indicate a hazardous situation.

2.3 Lighting systems – Front Lighting (cont)

The headlamps and lights at the front end include the following:

- Low-/high-beam headlamps.
- Fog lamps.
- Auxiliary driving lamps.
- Turn-signal lamps.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Front Lighting (cont)

Main head beam lamps

- The high traffic density on modern roads severely restricts the use of high-beam headlamps. Under most standard conditions, the low beams are the actual driving lamps. Basic design modifications have allowed substantial improvements in low-beam performance. These include:
  - Introduction of the asymmetrical low-beam pattern, characterized by an extended visual range along the right side of the road. Official approval for various types of halogen lamps, making it possible to enhance the luminous intensity at the road surface by 50 ... 80 %.
  - Introduction of innovative headlamp systems featuring complex geometrical configurations designed to improve efficiency levels by up to 50 %.
  - The "Litronic" gaseous-discharge headlamp (with luminous arc) supplies more than twice the light generated by comparable halogen units.

- Modern headlamps are electrically operated, positioned in pairs, one or two on each side of the front of a vehicle.

- A headlamp system is required to produce a low and a high beam, (Low-beam used according legislation) which may be achieved either by an individual lamp for each function or by a single multifunction lamp.

- High beams (called "main beams" or "full beams" or "driving beams" in some countries) cast most of their light straight ahead, maximizing seeing distance, but producing too much glare for safe use when other vehicles are present on the road.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Front Lighting (cont)

- Because there is no special control of upward light, high beams also cause back dazzle from fog, rain and snow due to the retro reflection of the water droplets.

- **Low beams** (called "dipped beams" in some countries) have stricter control of upward light, and direct most of their light downward and either rightward (in right-traffic countries) or leftward (in left-traffic countries), to provide safe forward visibility without excessive glare or back dazzle.

- **Low beam** (dipped beam, passing beam, meeting beam) headlamps provide a distribution of light designed to provide adequate forward and lateral illumination with limits on light directed towards the eyes of other road users, to control glare.

- This beam is intended for use whenever other vehicles are present ahead. The international **ECE Regulations** for filament headlamps and for high-intensity discharge headlamps specify a beam with a sharp, asymmetric cutoff preventing significant amounts of light from being cast into the eyes of drivers of preceding or oncoming cars.

- Control of glare is less strict in the North American **SAE** beam standard.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems — Front Lighting (cont)

- **High beam** (main beam, driving beam, full beam) headlamps provide a bright, centre-weighted distribution of light with no particular control of light directed towards other road users’ eyes.

- As such, they are only suitable for use when alone on the road, as the glare they produce will dazzle other drivers. International ECE Regulations permit higher-intensity high-beam headlamps than are allowed under North American regulations.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Front Lighting (cont)

Fog Lights

- Fog lamps are intended to improve road-surface illumination in fog, snow, heavy rain and dust.

- A parabolic reflector featuring a light source located at the focal point reflects light along a parallel axis (as with the high-beam lamp) and the lens extends this beam to form a horizontal band.

- A special screen prevents the beam from being projected upward.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems — Front Lighting (cont)

- In fog, this technology minimizes the glare reflected back to the driver. The screen, the image of which is projected onto the road surface by the lens, furnishes maximum contrast at the light/dark cutoff line.

- Two white- or yellow-light fog lamps are permitted. The control circuit for switching the fog lamps must be independent of that used for high and low beams.

- The (German) law allows fog-lamp installation in positions more than 400 mm from the widest point of the vehicle's periphery provided that the switching circuit is designed to ensure that they operate only in conjunction with the low beams.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Front Lighting (cont)

Auxiliary driving lamps

- Auxiliary driving lamps enhance the high-beam visibility provided by dual, quad and six-headlamp systems.

- The basic optical principles are similar to those used for fog lamps. The only difference being the lens, which is specifically designed to furnish an extended beam. Auxiliary driving lamps are often identical to fog lamps in shape and size.

- Auxiliary driving lamps are mounted and aimed in the same way as standard headlamps, and the underlying lighting concepts are the same.

- Auxiliary driving lamps are also subject to the cited regulations governing maximum luminous intensity in vehicular lighting systems, according to which the sum of all reference numbers is not to exceed 75. For older lamps without approval number, the number 10 is used for general assessment purposes.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Front Lighting (cont)

Turning Lights

- Group 1 (front-mounted), Group 2 (rear-mounted) and Group 5 (side) turn-signal

- lamps are required on dual-track vehicles. Group 2 turn-signal lamps are sufficient

- for motorcycles and mopeds. The instrument cluster indicator lamp may be in any

- desired color. The flash frequency is defined as 90 ± 30 cycles per minute.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Rear Lighting

- Lights are turned on at the vehicle's rear end in accordance with the weather conditions and indicate the vehicle’s position.

- They also indicate how the vehicle is moving and in which direction, e.g. whether it is traveling un-braked straight ahead, or whether the brakes are applied or the driver is intending to change direction, or whether a hazardous situation exists.

- The backup lamps illuminate the roadway while the vehicle is backing up/reversing.

2.3 Lighting systems – Rear Lighting (cont)

The lamps/lights at the rear end include the following:

- Stop lamps.
- Tail lamps.
- Fog warning lamps.
- Turn-signal lamps.
- Parking lamps.
- License-plate lamps and Back-up lamps.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems — Rear Lighting (cont)

Stop Lamps

- For each passenger car, two category S1 or S2 stop lamps and one category S3

- Stop lamp are prescribed as mandatory. When a nested design with the stop and tail lamps is used, the luminous-intensity ratio between individual functions must be at least 5:1.

- The category S3 stop lamp (central high-mounted stop lamp) must not be incorporated in a nested design with another lamp.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Rear Lighting

Rear fog lamps

- The European Union nations have mandated that one or two red-light fog warning lamps (rear fog lamps) will be installed on all new vehicles.

- They must be distanced at least 100 mm from the stop lamp. The visible illuminated area along the reference axis is not to exceed 140 cm².

- The electrical switching must be designed to ensure that the fog warning lamp operates only in conjunction with the low beam, high beam and/or front fog lamp.

- It must also be possible to switch off the fog warning lamps independently of the front fog lamps.

Rear fog lamps
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Rear Lighting (cont)

Rear turn signal lamps

• Two yellow turn-signal lamps are stipulated. An indicator is required inside the vehicle.

Parking lamps

• The vehicle may be equipped with either two parking lamps front and rear or one parking lamp on each side. White light is prescribed at the front and red at the rear.

• Yellow may also be used at the rear if the parking lamps have been designed as single units with the side turn-signal lamps.

• The parking lamps must be designed to operate even when no other vehicle lights (headlamps) are on. The parking-lamp function is usually assumed by the tail and side-marker lamps.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems – Rear Lighting (cont)

License-plate lamps and Back-up lamps.

- The rear license-plate lamp(s) must be designed to ensure that the rear license plate remains legible up to a distance of at least 25 m by night.

- Approved are the minimum luminance at all points on the surface of the license plate is 2.5 cd/m².

- The luminance gradient of 2 x Bmin/cm should not be exceeded between any of the test points distributed across the surface of the test plate.

- Bmin is defined as the smallest luminance measured at the test point.

One or a maximum of two white-light lamps are approved.

The switching circuit must be designed to ensure that the backup lamps operate only with reverse gear engaged and the ignition on.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems - Compartment Lighting

- Most cars have lights located in or near the ceiling of the passenger compartment, to provide illumination by which to fasten seatbelts and enter or exit the car.

- These often have an option to switch on when the front (or all) passenger doors are opened. Many vehicles have expanded this feature, causing the overhead interior light to remain on after all doors are closed, allowing passengers to fasten seat belts with added illumination.

- The extended lighting cycle usually ends when the vehicle’s ignition has begun, or a gradual reduction in light emitted after a couple of minutes if the car isn’t started. Interior lighting has been added on some vehicles at the bottom edge of the dashboard, which illuminate the floor for front passengers, or underneath the front seats at the rear, to illuminate the floor for rear seat passengers.

- This type of convenience lighting approach is also sometimes used to illuminate interior or exterior door handles, exterior step running boards, or electric window switches.

2.3 Lighting systems - Compartment Lighting (cont)

- LED light sources are beginning to appear increasingly as interior convenience lights in various locations as the technology becomes more widely used, especially with finely focused lighting on console control surfaces and in cabin storage areas.

- There may be additional map lights that are aimed at specific passenger positions, that allow for reading without particular glare distraction to the driver.

- Some vehicles have approach lighting (puddle lights) integrated into the exterior mirrors or lower edges of the doors, as well as activating interior lighting, that is activated via key. Many cars have lights in the trunk, the engine compartment, and the glove box and other storage compartments.

- Most instruments and controls on a dashboard in modern vehicles are illuminated in some fashion when the headlamps are turned on, and the intensity of light can be adjusted by the driver for comfort.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems - Signalization Lighting

Identification lamps

- Identification lamps must be visible through 360 degrees from the vehicle, and should be perceived as flashing when viewed from any particular location.

- The flashing frequency $f$ lies between 2 and 5 Hz. Blue identification lamps are intended for installation on official vehicles. Yellow identification lamps are designed to warn of dangers or dangerous transport.

Spot Lights

- Spot lamps generate a narrow beam of light of high luminous intensity, making it possible to illuminate a small area from a substantial distance.

Lights for work services.

- On a moving vehicle, lights for work services may be switched on only when the vehicle's motion represents an integral part of the operation being performed.

- For instance, when tractors are used in agriculture and forestry, on self-propelled machinery, on rescue vehicles, etc.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Lighting systems - Signalization Lighting (cont)

Convenience lamps

- Lamps use inside compartment are expanding very fast, as they can help the passengers to have indication of specific actuation components as switches, close /open status of doors, indication of exit doors, trunk, etc.

- These lamps are low consumption, normally they are Led technology, specially for indication and signalization of switches or actuators.

2.4 Information systems – Information panel

- Drivers have to process a permanently increasing stream of information originating from their own and other vehicles, from roads and from telecommunications equipment.

- All this information must be conveyed to drivers in the information and communications areas of their vehicles with suitable display and indicating equipment and in compliance with ergonomic requirements.

- In future, it will increasingly become the norm for cellular phones, navigation systems and ranging systems to join radios and vehicle monitoring systems as standard features in motor vehicles.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel (cont)

Information and communications areas

- In any vehicle, there are four information and communications areas, which must satisfy different requirements in terms of their display features:
  - the instrument cluster,
  - the windshield,
  - the center console,
  - the vehicle rear compartment.

- The display features of these areas are determined by the available range of information and the necessary, useful or desirable information for the occupants concerned.

- Dynamic information and monitoring information (e.g. fuel level) to which the driver should respond is indicated in the instrument cluster (i.e. as near as possible to the primary field of vision).

- A head-up display (HUD), which reflects the information in the windshield, is especially suited to engaging the driver’s attention (e.g. in the case of warnings from a ranging warning radar (ACC) or route directions).

- The display is supplemented acoustically by voice output.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel (cont)

- Status information or dialog prompts are mainly displayed in the vicinity of the operator unit in the center console.

- Information of an entertainment nature is featured in the vehicle rear compartment, away from the primary field of vision. This is also the ideal location for the mobile office.

- The backrest of the front passenger seat is a suitable installation location for the monitor and operator terminal of a laptop computer.

Individual and combined instruments

- Conventional individual instruments for the optical output of information were initially superseded by more cost-effective instrument clusters (combination of several information units in a single housing) with good illumination and antireflection qualities.

- The passage of time, with the continual increase in information, saw the creation in the existing space available of the modern instrument cluster with several needle instruments and numerous tell-tale lamps.

- Next slide shows instrument panel example for the car driver.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel (cont)

Digital displays – Digital instruments

- The first digital instruments used on a large, worldwide scale featuring vacuum fluorescent displays (VFDs) and later liquid-crystal displays (LCDs) can now mainly be found in Japan and the USA in luxury-class cars.

- These instruments found little favor in Europe and have now virtually disappeared from use. Here the trend towards needle instruments has continued uninterrupted but with a radical technical change in the way in which they are activated (see Fig., no. 2 on previous slide).
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems - Information panel (cont)

Digital displays – Central display and operator unit center console

- The introduction of navigation and driver information systems has seen the incorporation of a display monitor and a keypad in the center console. Such systems combine all the additional information from functional units and information components (e.g. cellular phone, car radio/CD, controls for heating/air conditioning (HVAC)).

- In a central display and operator unit. The components are interconnected in a network and are capable of interactive communication.

- Positioning this terminal, which is of universal use to driver and passenger, in the center console is effective and necessary from both ergonomic and technical standpoints. The optical information appears in a graphics display.

- The demands placed by TV reproduction and the navigation system on the image/map display determine the resolution and color reproduction.

Graphics modules

- The tendency results in instrumentation featuring a classical needle instrument but supplemented by a graphics display. Even the central display monitor is located at the height of the instrument cluster.

- What is important to all optical displays is that they can be easily read inside the driver’s primary field of vision or in its immediate vicinity without the driver having to divert his eyes from the road for long periods.

- This is the case for instance when the displays are positioned in the lower area of the center console (see Fig., no. 3 on previous slide).
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel (cont)

Graphics modules

- The graphics modules in the instrument cluster permit mainly the display of driver and vehicle-related functions such as e.g. service intervals, check functions covering the vehicle’s operating state and also vehicle diagnostics as needed for the work.

- They can also show route-direction information from the navigation system (no digitized map excerpts, only route-direction symbols such as arrows as turn-off instructions or intersection symbols).

- It is to be expected that the initially monochrome modules will be succeeded in a second stage by color displays whose reading speed and reliability are increased by color reproduction.

Individual module with computer monitor

- By roughly 2003, the remaining mechanical measuring instruments had tendency to disappear.

- The entire area of the instrument cluster has been replaced by a freely addressable graphics monitor (provided the price of LCD computer monitors develops economically).

- Such a unit module offers an array of information display options. It is conceivable to have an individually selectable form of display which is geared to the specific needs of individual user groups (see Fig., no. 4 on previous slide).
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel (cont)

Instrument clusters

- Microcontroller technology and the ongoing networking of motor vehicles have in the meantime transformed instrument clusters from precision-mechanical instruments to electronically dominated devices.

- A typical instrument cluster (LED-illuminated) is a very flat component (electronics, flat stepping motors) and virtually all the components are directly contacted on a printed-circuit board.

Instrument cluster design

1. Tall-tail lamp, 2. Printed-circuit board,
10. Optical waveguide, 11. LCD.
2. ELECTRICAL AUXILIARY SYSTEMS

2.3 Information systems – Information panel (cont)

- While the basic functions are the same in most instrument clusters, the partitioning of the function blocks into (partly application-specific) microcontrollers, ASICs and standard peripherals sometimes differs significantly (product range, display scope, display types).

- Electronic instrument clusters indicate measured variables with high accuracy thanks to stepping-motor technology, and also take over “intelligent” functions such as engine-speed-dependent oil-pressure warning, prioritized fault indication in matrix displays, or service-interval indicator.

- Even online diagnostic functions are standard and take up a significant part of the program memory. Because instrument clusters are standard features on all vehicle types and all the bus systems merge here anyway, the former are becoming increasingly established as gateways, i.e. bridges between the different bus systems in the motor vehicle (e.g. engine CAN, body CAN and diagnostic bus).

2.4 Information systems – Information panel (cont)

![Diagram of instrument cluster block diagram]
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel (cont)

Display Types- TN-LCD

- With its high status of development, TN-LCD technology ("Twisted Nematic-Liquid Crystal Display") is the most commonly used form of display.

- The term stems from the twisted arrangement of the elongated liquid-crystal molecules between the locating glass plates with transparent electrodes. A layer of this type forms a "light valve", which blocks or passes polarized light depending on whether voltage is applied to it or not. The switching times are relatively long at low temperatures on account of the high viscosity of the liquid-crystal material.

- TN LCDs can be operated in positive contrast (dark characters on a light background) or negative contrast (light characters on a dark background). Positive contrast cells are suitable for front- and backlighting while negative-contrast cells can only be read with satisfactory reading contrast when strongly lit from the rear.

- TN technology is suitable not only for smaller display modules but also for larger display areas in modular or even full-size LCD instrument clusters.

Display Types- Graphics displays for instrument clusters

- Dot-matrix displays with graphics capabilities are needed to display infinitely variable information. They are activated by line scanning and therefore require multiplex characteristics.

- Under the conditions prevailing in a motor vehicle, conventional TN LCDs can today produce multiplex rates of up to 1 : 4 with good contrast and up to 1 : 8 with moderate contrast. Other LCD display technologies are needed to achieve higher multiplex rates.

- STN and DSTN technologies are now being used for modules with moderate resolution. DSTN technology can be implemented to provide monochrome or color displays.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel

Display Types - STN LCD and DSTN LCD

- The molecule structure of an STN (Super Twisted Nematic) display is more heavily twisted inside the cell than in a conventional TN display. STN LCDs permit only monochrome displays; usually in blue-yellow contrast. Neutral color can be obtained by applying "retarder film", but this is not effective throughout the entire temperature range encountered in the vehicle.

- DSTN LCDs (Double-layer STN) feature considerably improved characteristics, which permit neutral black-and-white reproduction over wide temperature ranges with negative and positive contrast. Color is created by backlighting with colored LEDs. Multicolor reproduction is created by incorporating red, green and blue thin film color filters on one of the two glass substrates. Under automotive conditions.

Display Types - AMLCD

- The task of the visually sophisticated and rapidly changing display of complex information in the area of the instrument cluster and the center console with high resolution liquid-crystal monitors with video capabilities can only effectively be performed by an AMLCD (Active-Matrix Liquid-Crystal Display).

- The best developed and mostly widely used are the TFT LCDs (Thin Film Transistor LCDs) addressed with thin-film transistors.

- Display monitors with diagonals of 4”...7” in the center-console area. Formats of 10”...14” with are planned for programmable instrument clusters.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Information panel (cont)

- TFT LCDs consist of the "active" glass substrate and the opposing plate with the color-filter structures. The active substrate accommodates the pixel electrodes made from tin-indium oxide, the metallic row and column circuits and the semiconductor structures.

- At each intersecting point of the row and column circuits, there is a field effect transistor which is etched in several masking steps from a previously applied sequence of layers. A capacitor is likewise generated at each pixel.

- The opposite glass plate accommodates the color filters and a "black-matrix" structure, which improves the contrast of the display. These structures are applied to the glass in a sequence of photolithographic processes.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Trip recorder

- These devices record the vehicle speed, the distance covered (odometer), and the time. They also incorporate a warning lamp which is triggered when vehicles exceed a preset speed (such as the legally permitted limit, or the maximum speed commensurate with economical operation).

- The following data is also recorded on the tachograph chart along with the corresponding clock time: Road-speed curve, wheel time and pauses and distance covered.

2.4 Information systems – Trip recorder (cont)

Mode of operation

- The EC tachograph is a special form of trip recorder which incorporates an auxiliary feature allowing differentiated recording of wheel time and test periods (time-group monitor); different versions are available, for either one driver or two.

- EC tachograph charts serve as the driver’s official daily record. Within the countries of the European Union, the EC tachograph is obligatory equipment on specific types of vehicle.

- The supplementary features on the EC tachograph include a clock-function display and an LED which confirms to the driver that the charts are installed and that all styluses are functioning properly.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Trip recorder (cont)

Tachograph chart

Within the framework of a fleet management system, tachograph charts can also be subjected to semi- or fully automatic evaluation and the data processed in a computer.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – board computer system

- The electronic control units (ECU) were developed for use in automotive. The structure can be divided in signal condition, of input channels, logic processing of these signals, microcomputer and output channels with regulation and command.

- A modern car has about 20 until 60 ECUs for real time control of each module function.

- As the electronic control is distributed by many ECUs, this means that these modules are interconnected by serial networks for information transmission between them.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – board computer system (cont)

• The structural blocks use identical electronic components which are in all module platforms of hardware or modules.

• To implement the structural architecture there are two essential elements:
  – Concept for structure the functionality of the car (CARTRONIC).
  – Communication networks, with the function is exchange information between ECUs.

• A integrated system that controls the system of the car, where information is exchanged use a network as the Control area network (CAN).

CARTRONIC – Connecting Network Modules
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Multimedia

- **Multimedia** means combination of different medias. All medias are interconnected by network the media devices could be communication systems, mobile information systems, radio, CD readers, phone, telematics, computer with video and TV.

Multimedia audio system with radio

2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Multimedia (cont)

**Navigation systems**

- Navigation systems have become extremely popular in recent years. Initially, the available systems were mainly intended for retrofitting.

- Since then, navigation systems are mainly fitted as optional extras on new cars and are no longer the sole preserve of a few luxury-sedan models. This development has enabled such systems to be better integrated in the vehicle.

- Sensors can be jointly used by various vehicle systems. Displays in the instrument cluster place important route-guidance information in the driver’s primary field of vision.

- Some vehicle manufacturers have even incorporated navigation as part of a complete driver information system with audio and telephone functions.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems — Multimedia (cont)

- This development will continue. Simple systems which offer the driver no more than a mere indication of his/her position on a card and a straight-line direction to destination, have for the most part disappeared from the market.

- Common to all systems is the combination of the basic functions of "positioning", "destination selection", "route computation" and "route guidance".

- Systems in the upper performance spectrum also offer a color map display. All the functions require a digital map of the road network and this is generally stored on a CD-ROM.

Traffic telematics

- The word "telematics" is derived from the contraction of the words "telecommunications" and "informatics".

- Accordingly, the transmission of traffic related information from and to motor vehicles, and its subsequent, mostly automatic evaluation is combined under the term “traffic telematics”.

- Today, the main transmission paths for telecommunications are provided by radio

- and mobile radio communications networks.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Multimedia (cont)

- Radio only allows a path into the vehicle and does not serve to communicate individual messages. With GSM, information can be exchanged in both directions between vehicles and control centers run by service providers.

- The amount of information exchanged is restricted in each case by the bandwidth of the available transmission channels.

- It is therefore essential that the coding of standardized message content is as free as possible of redundant information.

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Auto PC

- A revolution in the use of information technology in vehicles is taking place! Advanced computing, communications and positioning developments are being introduced in even the most basic vehicles.

- Next slide shows an Auto PC/Car Multimedia system. However, there were several barriers to the widespread use of such new technology.

- Not robust enough, too costly, difficult to install, lack of common standards, difficult to operate.
2. ELECTRICAL AUXILIARY SYSTEMS

2.4 Information systems – Multimedia (cont)

- Most of these problems either have been resolved or are about to be, and other developments are also
- beneficial: Computers have become smaller and prices reduced.

3. Conclusions

- Auxiliary automotive systems are an important part of the car giving more security, safety, comfort.
- They are very important in the automotive Industry, special in component Industry that supplies the big car manufactures.
- With evolution of automotive Industry, more auxiliary systems are integrated as series components, not as option parts. Because, the competition between brands is more aggressive.
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