TVET CERTIFICATE V in AUTO ELECTRICITY AND ELECTRONICS SYSTEM

REPAIRING VEHICLE INFOTAINMENT SYSTEMS

AEEVI501

Repair vehicle Infotainment Systems

Competence

LEVEL : 5

Credits: 10

Learning hours: 100

Sector: Transportation and logistics

Sub-sector: Automobile

Module Note Issue date: November, 2020

Purpose statement

This module describes the skills and knowledge required to repair vehicle infotainment system. The knowledge acquired from this module will allow the learner to describe vehicle infotainment system.

The module will allow the participant to perform Diagnose, maintain and repair vehicle infotainment system components and test vehicle infotainment system in order to keep comfortable conditioning vehicle.

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LEARNING UNIT 1 – DESCRIBE INFOTAINMENT SYSTEM SCRIBE INFOTAINMENT SYSTEM

LO1.1 Identify infotainment subsystem

- **Content/Topic1 Design of infotainment subsystem**

In vehicle infotainment or in car entertainment is a technology collecting hardware and software in automobiles that provides sound system includes audio or video entertainment with radio and cassette or CD players. Nowadays, the vehicle's entertainments are originated with automotive navigation systems, video players, USB, Bluetooth connectivity, computer, in-car internet and Wi-Fi. Once controlled by simple dashboard knobs.

The infotainment system can be described as a distributed, heterogeneous hardware/software system, which provides entertainment functionalities and information services to the drivers and passengers in the vehicle through the interaction of several connected devices. It mainly comprises of a head unit along with a combination of components such as a control panel, telematics device, and head-up display. The hardware components are interconnected with certain standardized communication protocols such as **CAN network (**CAN network or controller area network is a robust vehicle bus standard and is designed to allow microcontrollers and devices to communicate with each other in applications without the host computer.) and some wireless communication channels like Bluetooth. (Erjavec, 2010)

1. **Instrument cluster**

The instrument panel cluster (IPC) or Vehicle Dashboard is one of the few devices with which the vehicle communicate to the driver. Devices such as driver information centre and heads up display are considered sub system add-on devices to the IPC. Even though from technology and complexity perspectives, the IPC is simpler than other modules, it is important to the driver, since it is one of the few modules the driver sees.
The IPC modules take signals from various sensors and communicate with almost all the other modules in the vehicle to get the relevant information and status about the vehicle. The IPC processes data and provides information in appropriate form to the driver. (Erjavec, 2010)

2. **Navigation System**

Navigation systems use global positioning satellites to help drivers make travel decisions. These global positioning systems (GPSs) set up a mathematical grid between the satellites and radio stations on the ground. The exact position of a vehicle can be plotted on the grid; therefore, the system knows exactly where the vehicle is located. GPS can display traffic and travel information on a display screen. It can display a road map marking the exact location of the vehicle. It can plot out the best way of getting to a destination and can also tell the driver how many miles have been travelled and how many remain before reaching a destination. It can also

display traffic information, regarding traffic backups due to congestion, roadwork, and/or accidents, then display alternative routes so travel is not delayed. (Erjavec, 2010)
GPS is an important device in navigation system that may also have additional capabilities as listed below:

- ✓ Maps, including street maps, displayed in human readable format via text or in a graphical format,
- ✓ Turn-by-turn navigation directions to a human in charge of a vehicle or vessel via text or speech,
- ✓ Directions fed directly to an autonomous vehicle such as a robotic probe,
- ✓ Traffic Congestion Maps (depicting either historical or real time data) and suggested alternative directions,
- ✓ Information on nearby amenities such as restaurants, fuelling stations, tourist attraction, Etc.

3. Mobile phones

These allow call to be made and taken in the vehicle. Permanently-installed mobile phones consist of a transmitter and receiver (up to 8W) and a handset, including hands free system with microphone and loudspeaker. On hands free systems, there is a risk of feedback if the echoes from the electronic voice are not suppressed. Therefore, complicated echo compensating solutions have to be realised that enable simultaneous talking and listening of the people at each end of the line. This occurs on the basis of digital signal of the processors. In addition, measures are necessary to suppress the driving noise in the microphone signal. (SAXENA, 2012)

4. Audio/TV

Vehicle audio/TV is equipment installed in a car or other vehicle to provide in car entertainment and information for the vehicle occupants. Until in the 1950s it consisted of a simple AM radio. Additional since then have included FN radio (1952), 8 track players cassette players, record players, CD and DVD players. One of the things you will need to consider before even thinking about how to install a car DVD player is what tools you will need for the job. While each car and each car DVD system is different there are still some basic items you will probably need to complete the installation process. For most projects you will need a flat-head and Philips-head screwdriver, pliers and a wire striping/crimping tool at the very least. You may also need a socket and ratchet set, utility knife, panel tool, drill and bit set and torque driver set as well. Again, this is a list of only the more basic tools and you are likely to need several other items as well.

While it is well established that "real men" don't read instruction manuals, most real men don't do a really good job of installing their car DVD players either. Read the instructions carefully and study any schematics supplied with the DVD player to make sure you completely understand the process in installing that specific car DVD player correctly. (SAXENA, 2012)

While each system is different and unique it is usually made up of three components:

- ✓ the DVD player itself;
- ✓ the car video monitor;
- ✓ the sound system;

LO 1.2.Describe infotainment subs systems.

- **Content /Topic1: Design of infotainment subsystems.**

1. Design of Instrument cluster

An instrument cluster displays the status of a vehicles' systems.

The speedometer is usually situated in a prominent position. It has a pointer that lines up with numerical values, which indicate vehicle speed in miles per hour (MPH).The speedometer also has an odometer to measure distance traveled. The tachometer displays engine speed in revolutions per minute (RPM).The rev limit (red area) indicates the maximum engine speed allowed, before damage can occur.

It is designd with different components as shown on figure below .

Figure 1. Typical Instrument Cluster Construction

2. Design of Navigation systems

An automotive navigation system is part of automobile controls or a third party adds on used to find direction in an automobile. It typically uses a satellite navigation device to get its position data which is then correlated to a position on a road. When directions are needed routing can be calculated.

TYPES OF DESIGN OF NAVIGATION SYSTEM

- **Navigation system with permanently installed monitor**: this system is permanently installed in the vehicle and offers full functionality
- **Car radio navigation system**: this is also installed in the car and due to the small dimensions of the displays, a map cannot be shown. Instructions are given acoustically and visually by way of the arrow. The systems use the GPS and speedometer Yaw rate sensor signals for calculation of the route.
- **Navigation system with PDA**: On this system a small pocket computer (Personal Digital Assistant) is mounted in the vehicle. And it displays serve as the monitor. The computer receives the signal from a GPS antenna. The map details are transferred from a PC. PDA systems are not very accurate because they only refer to a GPS signal. (Erjavec, 2010)

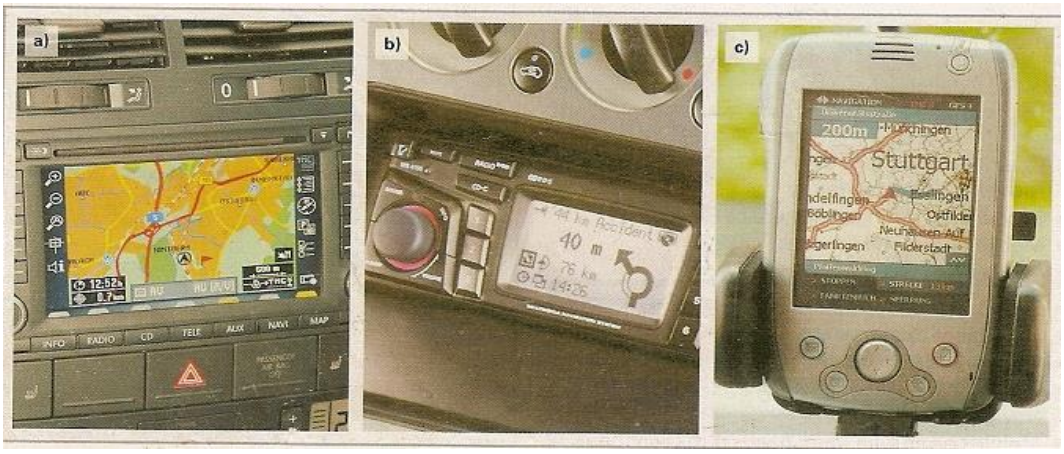

Figure 2: a) with permanently installed monitor, b) with car radio, c) with PDA system

3. Design of Mobile phones

These are mobile units not primarily intended for automotive use. The main components of a GSM cell phone are a 2 watt transceiver, a digital signal processor for channel and voice coding and a control circuit to co-ordinate communications with the rest of the network. In addition, there are a microphone, speaker, antenna, keypad, display, rechargeable battery and SIM Card reader. Installation kits for the vehicle consist of cradle with power supply, microphone and antenna connection.

Since the use of phone while driving is banned, most the systems feature a hands free devices or headphones. Because the inside of the vehicle works like a faraday cage a shielded cable leads to an externally mounted antenna. (SAXENA, 2012)

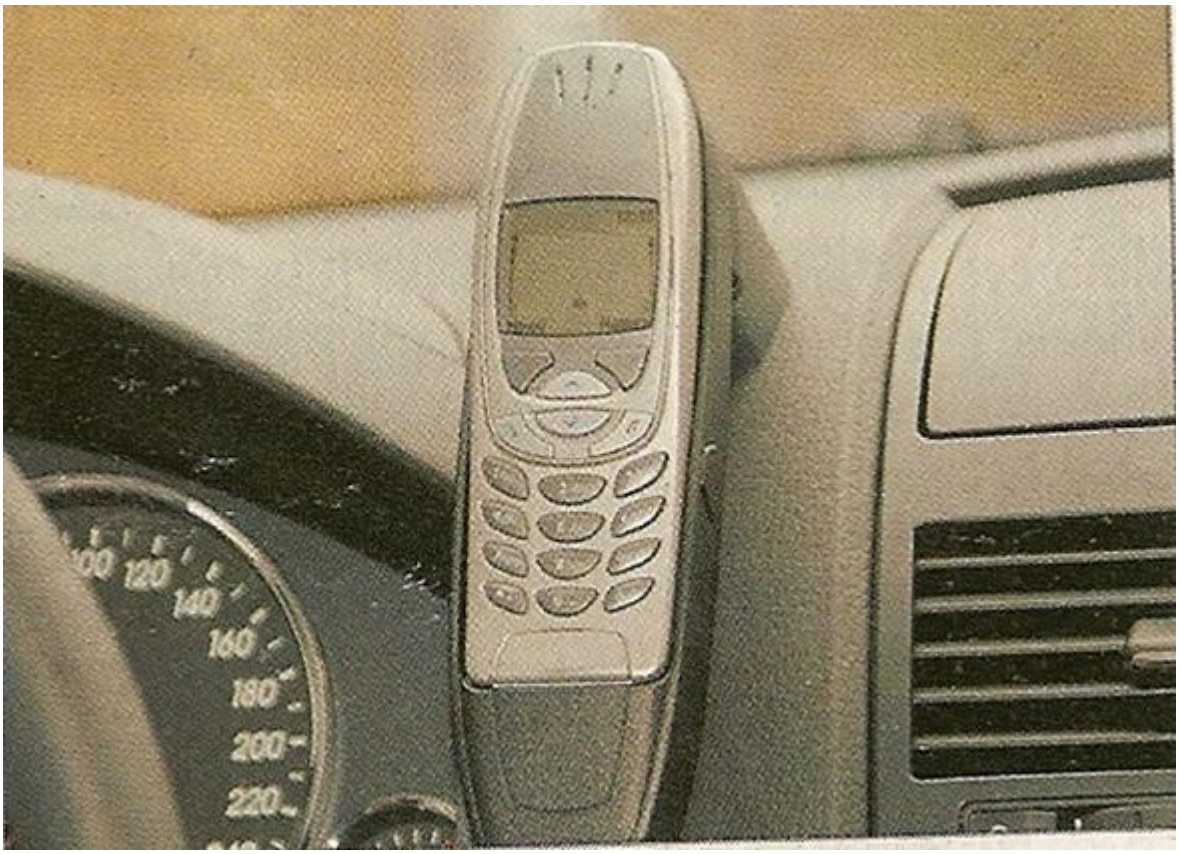

Figure 3: In vehicle mobile phones

4. Design of Audio/TV

Sound systems are available in a wide variety of models. The complexity of the system varies significantly from the basic AM radio to more complex stereo systems **(Figure below)** that include an AM/FM radio receiver, a stereo amplifier, compact disc (CD) player, cassette player, equalizer, several speakers, and power antenna system. A radio receives signals (radio waves) that are broadcast from radio station towers or antennas. Amplitude modulation (AM) waves travel far but cannot be used to broadcast in stereo. Also, AM does not have as good sound quality as frequency modulation (FM). Nearly all FM broadcasts are in stereo, but the distance range for good reception is limited. Sound quality depends on the basic system, but especially on the quality of the speakers and their placement. Many sound systems are equipped with

several speakers, each designed to produce a different range of sound. Matching speakers to the system is done by selecting and wiring speakers so they have the same impedance as the rest of the sound system. (James E, 2006)

Figure4: An AM/FM radio with CD player.

- **Content /Topic2 Operating principle of vehicle infotainment subsystem.**

1. Operating principle of Instrument cluster

The instrument cluster, the most important information is displayed for the driver.

Example of these displays are road speed, engine speed, engine temperature, oil pressure, alternator warning lamp or lighting and self- diagnosis error message. The instrument cluster is in the central field of vision of the driver. Using on-board computer, which evaluates data and sensor signals and communicates them to other control units (e.g. engine, gear box, ABS), further information can be displayed. (James E, 2006)

Examples are:

- ✓ Trip data, such as average fuel consumption and cruising range.
- ✓ Inspection and service intervals
- ✓ Wear limits, e.g. brake pads
- ✓ Fluid levels, e.g. fuel and oil
- ✓ Bulb function check

2. Operating principle of navigation system

These offer help in finding the right route to the target destination and orientation in unfamiliar areas. Navigation systems can take on the following tasks:

- ✓ Vehicle positioning
- ✓ Position data transfer
- ✓ Calculation of optimum route based on current traffic conditions.
- ✓ Guidance to destination with route recommendations

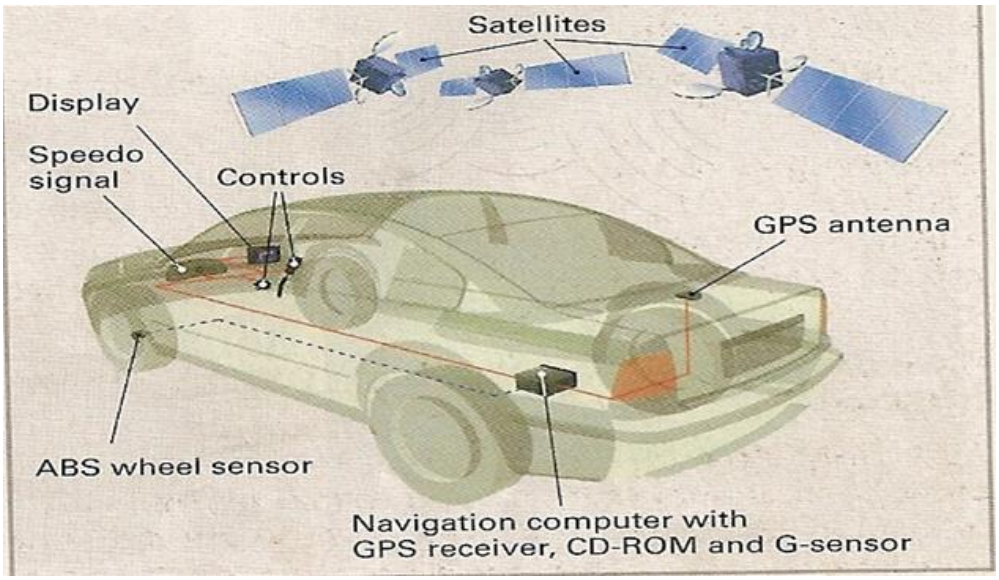

Figure 6: **Operating principle of navigation system**

As showed on figure above are all components and subsystems involved. The input signals are processed by the navigation computer. Output is visual on the display and vocal.

Position data transfer: This serves as means of sending the location of vehicle to rescue services in the event of an accident, or breakdown. Furthermore, the vehicle can be located more quickly in the event of theft.

Optimum route calculation. When the driver enters his or her target destination using the control elements or voice input, the navigation equipment determines the vehicles current location. From this point the navigation computer can calculate the optimum route to the target destination using data from the map memory. The navigation computer can calculate distances and angles on curving stretches of road based on data supplied by the speedometer signal and the yaw rate sensor. The details recorded from the sensors over distance travelled are compared with data from the CD-ROM, DVD or software in the map memory and adjusted as necessary (map matching). In this way, the actual position of the vehicle over a set route can be determined with great accuracy. If the GPS signal is available, the position can also be verified.

Dynamic route guidance: The latest traffic situations, e.g. congestion, road maintenance sites, road blocks, from communication sources such as TIM (Traffic Information System), RDS (Radio Data System) or the Internet can be considered in the route calculation. (James E, 2006)

Guidance to destination by recommendations on where to turn. The navigation system guides the vehicle with recommendations on where to turn on the calculated route to the target destination. Normally, these recommendations are given vocally by a computer so the driver is not distracted. A route map or direction arrows on a display can also be shown as a supplement. The system responds to wrong turns by issuing immediate instructions guiding the user to an alternate route.

Types of design. The following systems can be found;

- ✓ Navigation systems with permanently installed monitor

- ✓ Car radio navigation system
- ✓ Navigation system with PDA

Navigation system with permanently installed monitor: This offer full functionality as previously described. It is often offered as optional equipment in the new vehicles.

Figure 7.types of navigation system a) permanently installed monitor b) with car radio) with PDA

Car radio navigation system: A map can not be shown due to the small dimensions of the displays. The instructions for calculated route on these units are given acoustically and visually by way of arrows. The systems use GPS and speedometer and yaw rate sensor signals for calculation of the route.

PDA navigation system: On this system a small pocket computer (Personal Digital Assistant) is mounted in the vehicle. Its display serves as the monitor. The computer receives the signal from a GPS antena. The map details are transferred from a PC. PDA systems are not very accurate as they only refer to the GPS signal.

Additional functions. With the navigation system an electronic road atlas can be carried onboard. Features such as voice guidance, voice information, folding monitor, touchscreen or information about speed limits for the the road the vehicle is on are available as options. (James E, 2006)

3. Operating principle of mobile phones

Internet: With the aid of a cell phone (UMTS) or PDA with integrated cell phone (GPRS), a wireless connection to the internet can be created. With Bluetooth technology, networking of these mobile units is possible with communication systems, such as Personal Digital Assistant

(PDA), Car radio, CD changer or navigation system in the car. Each Bluetooth-compatible units features a unique equipment code, with means it can be identified clearly among others.
Additional mobile equipment, such as a computer, notebook, PDA, Can thereby be connected to each other without cables and without complex configuration. This opens a wide range of opportunities, for example transfer of addresses and maps to the navigation system or downloading of music or videos from the internet.

4. Operating principle of Audio /TV

One of the things you will need to consider before even thinking about how to install a car DVD player is what tools you will need for the job. While each car and each car DVD system is different there are still some basic items you will probably need to complete the installation process. For most projects you will need a flat-head and Philips-head screwdriver, pliers and a wire striping/crimping tool at the very least. You may also need a socket and ratchet set, utility knife, panel tool, drill and bit set and torque driver set as well. Again, this is a list of only the more basic tools and you are likely to need several other items as well.

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While each system is different and unique it is usually made up of three components:

- ✓ the DVD player itself;
- ✓ the car video monitor;
- ✓ the sound system;

And there are four main different types of installation that will present you with four different degrees of difficulty.

Safety Note

Make sure to distinguish the anode and the cathode when connecting the power. For secure package transportation the CD/DVD reader module is firmly fixed with a screw. Before the installations of the unit, please remove the screws from the top. If the screws are not removed, you cannot insert any CD/DVD disk.

Car DVD players come with a safety function that is connected to the handbrake. This feature prevents users from watching videos or TV shows while driving.

If you so choose, you can permanently disable this function by connecting the brake control cable to GND. It is the end-users responsibility to install and operate this unit in a manner in accordance with local, state and federal laws. (James E, 2006)

Wiring

The wiring diagram includes plenty of strange acronyms. See what these cables are and where to connect them:

- ✓ GND: It's a power wire that needs to connect to ground (notice the negative sign →-).
- ✓ BATT or B+: A power cable that should be connected to the permanent +12V power. It is used for memory backup to keep the settings stored. The 12V permanent battery wire will always offer electricity whether the vehicle is on or off.
- ✓ ACC or IGN SW: The ACC wire offers power only when you insert car key into ignition switch and turn it to ACC position. This way the device can detect the ignition switch state.
- ✓ BRAKE or BRAKE- CON: Handbrake connection cable that needs to be connected to a handbrake signal wire (GND) in order to comply with several local, state and national laws that prohibit watching videos while driving.
- ✓ BACK or REVERSE-CON: This cable connects to the reverse signal. It is used to trigger the rear-view camera mode.
- ✓ ANT-CON or PWR ANT: Antenna amplifier output control.
- ✓ MUTE-CON or MUTE-TEL: The mute control wire is used to interface with a factory hands-free system. It can mute the car DVD player while the hands-free system receives a call.
- ✓ AMP or AMP-CON: Amplifier output control. This control cable can trigger the external audio amplifier to turn on automatically when the car DVD player is powered on.
- ✓ ILLUM: Illumination control cable, which is wire that can detect the headlight switch state and dim the light accordingly.
- ✓ KEY: Usually, KEY1 and KEY2 are wires used for controlling analogy steering.
- ✓ CAN BUS, CAN RX/TX: It's a special connection for CAN BUS system. Typically, the car model's specific head units come with the required CAN BUS adapter.
- ✓ RL+-/RR+-/FL+-/FR+-: These are the acronyms for the rear left, rear right, front left and front right sound output channels. Each channels have + and – poles.
- ✓ SUB or WOOFER: It's usually a mono output, and often has a crossover circuit so that it only plays bass. It can be connected to amplifier or active sub-woofer.
- ✓ AUX and AUX VIDEO-IN: Aux (usually RCA type) ports are used to connect external audio and video signals. It enables you to connect other audio/video players to the head unit.
- ✓ VIDEO OUT: analogy video signal output for external monitor.
- ✓ CAM-IN or CAMERA-IN: rear-view camera video signal input.
- ✓ IPOD: A special Apple device port is used to connect an iPod to play music.
- ✓ USB: Depending on the model, it can support audio/video playback from USB flash drive, or support WIFI/3G dongle.
- ✓ SD or Micro-SD: SD and Micro-SD are memory card types. Usually if you insert a card with songs of videos pre-loaded, they will play. (James E, 2006)

Glossary

AUX: The auxiliary port is also known as an auxiliary jack or auxiliary input. Aux allows you to use and external audio/video source and play it through the car audio system. It's often used for iPods and MP3 players, cell phones, tablets and media players. Typically, it only requires an inexpensive cable that connects to a headphone output on your phone, mp3 player, etc. to the input on the car stereo.

Bluetooth: Bluetooth is a wireless technology standard for exchanging data over short distances. In cars Bluetooth is generally used for hands free calls and streaming music from phones to the car stereo system through what's called an A2DP profile.

WIFI: Wi-Fi, also spelled Wi-Fi or Wi-Fi, is a popular technology that allows an electronic device to exchange data or connect to the internet wirelessly using UHF radio waves.

2 DIN systems

DIN is an international standard for Car stereo / in-dash car entertainment units: 2 DIN simply means a standard double decker slot size.

This system is mounted in the car dashboard and will probably pose you the most difficulty, especially if you are installing it from scratch. But since double DIN car DVD systems also look the coolest, it is definitely worth the effort...

Two DIN car DVD systems are usually made up of a screen and DVD player, with the amplifier being built into the dashboard unit. You may find that you will need unit mounts andconnectors to get the DVD player to be seated properly. Installation of this type of system requires a lot of re-wiring and,if the edges of the DVD player is too big or too small for a non-standard stereo space, you may even need to remodel the dash to make sure the unit fits snugly. Check the dimensions of your dashboard slot before buying your new car DVD! (James E, 2006)

figure 7.Double-Sized In-Dash Car DVD Players

You are probably going to need to run wires from the player to the speakers, any auxiliary input devices you might want to run (such as rear cameras or car kits) as well as running a wire to both ends of the emergency break cable as it may be illegal in your country to be able to operate the screen when the car is in motion, unless it's using a rear view camera. You will also need to wire the car DVD player to the power supply.

1 DIN systems

This type of DVD player is similar to the 2 DIN in that it is mounted in the dash and is requires a great deal of wiring to get it installed. However, the player only takes up half the space of the 2 DIN model and you may need to remodel the stereo port in the dash to make the DVD player fit snugly. Like the 2 DIN system it is made up of screen (often retractable), amplifier and DVD player. Connections, wires and mounting brackets are always needed, but not always included.

Figure 8. Installation of this system is similar to that of the 2 DIN player.

Alternative Design Car DVD Players

This type of system is easier to install than the one, or two DIN DVD player but will still present you with some unique problems. While you won't have to fit the new electrical components to existing parts of the car you will still have to do a substantial amount of wiring to get the system hooked up to a power supply and/or stereo system. To install this type of car DVD player you will probably need wire, screws, glue or some other adhesive.

Car Headrest Monitor / DVD Player

Car Roof (Ceiling) Monitor

Car Sun Visor DVD Player

To install a headrest monitor you will need to remove the fitted headrest and run power and connection wires down through the hole... with most cars you should be able to take the cover off the bottom of the seat and put an unwound clothes hanger, or some other kind of wire, up through the slot to find the cable and fish it out... It then can be run under the carpet to the main car unitin the dash, or to another connection box in another location.

If you want to install a sun visor DVD player or overhead car DVD player you will need to consider two things: how to fix the player to the roof, and how to wire the DVD player so that the cables remain hidden. When mounting the overhead monitor you will need to install it in the middle of the car for ultimate strength. You will then need to conceal the wires wires underneath roof panels, running them from the player to the dashboard or power supply. This will require a lot of work as panels, the car's kick plate and even sometimes the seatbelt will have to be removed. Sun visor DVD players are little easier to mount, as wires don't have to go so far to get to the power source/main adaptor. However they will still require some careful work removing Andre-attaching panels.

Clip-on Car DVD players

This type of car DVD player is the easiest to install by far, and most flexible when it comes to moving from place to place. Clip-on car DVD players usually include sun visor DVD players, headrest DVD players and arm rest DVD players. You should be able to plug them into the cigarette lighter and strap them on to the allotted location.

Arm Rest Car DVD Player

Some Things To Consider

The information above is only a snippet of the material that you will need to help you through the installation process. Installing a car DVD player is not something to be undertaken lightly, especially when installing 1DIN or 2 DIN car DVD players and overhead DVD players, which can be quite complicated to place and wire.

If you are serious about installing the DVD player and have the resources to do it. It is important that you work methodically and carefully to avoid confusion or delays. Here are some things you might want to consider doing:

1. Research the project:
   Read and make sure you understand instructions for the components you are going to install. It might even be agood idea to go onlineand see if anybody has done any wiring plans for your particular car model.
2. Prepare for the task before you start:
   If you're taking on amajor task, like installing a 1 DIN, 2 DIN or overhead DVD player, you will needto ensure you have all the necessary tools, accessories and cables. You will also need to give yourself at least a day without distractions to complete the job.
3. Remove existing components carefully and methodically:
   It is important that you don't lose or damage the old stereo unless you want your brand new unit to go with the car when you sell it. Laying out panels and parts in relation to their location on the car with all their screws on the panel will also prevent a 30-minute game of hunt the screw.
4. Make your work tidy:
   Try to make wires as tight as possible and prevent them from coiling up.

Do-It-Yourselves who rush into car DVD installation projects might well find they are left with a time-consuming project which ends with an ugly and sometimes unsafe result.

There's nothing worse than a car with wires scattered all the way through it. A professional installer would make sure wires were tidied away somewhere behind the panelling of the carin nice neat straight lines. And, by taking time when installing the car DVD player yourself you can achieve similar results. It is also important to be aware of audio and visual problems that could come up from an hastily-assembled system. These might include flickering screens, black holes in sound, or rattling components amongst other things.

Incorrectly installed systems can, at their worst, be a hazard to the system, the car and yourself. If two wires are exposed they can short, creating a short-circuit that will, at the very least, turn your new stereo into an expensive brick and, at worst, fry the electrical circuit in your car. However, this is minor compared to the possibility of a car fire. Wire that has been piled too closely together for too long will fuse generating a temperature so hot it can combust causing a car fire. (Zhao, Liang, & Chen, (2018-01-02).)

Car DVD Installation Glossary

- ✓ **Changer**
  = a CD changer; a device which holds several CDs and plays them on demand without having to eject or manually sort discs. Needless to say you can now get DVD changers too.

- ✓ **Crossover**
  = a device that limits the range of frequencies sent to different speakers.
- ✓ **DIN**
  = just stands for "Detaches Institut für Normung" (DIN, the GermanInstitute for Standardization), similar to ISO. The relevance for car DVDs ystems is that DIN means a standard sized dashboard slot, so 1 DIN meansthe device takes up one slot, and 2 DIN means the unit is ‘double-decker ‘and uses the space of two slots.
- ✓ **DTS**
  = "Digital Theatre Systems “multichannel audio - basically another surround-sound standard like DolbyDigital 5.1.
- ✓ **DVD-A**
  = DVD audio - just like a music CD, except more features and higher quality.
- ✓ **RF**
  = Radio Frequency - probably talking about the wireless headphones. RF isgenerally better than Infra Red because you don’t have to be in the 'line ofsight' of the transmitter.
- ✓ **Inverter**
  = A power supply device you can plug into your dashboard cigarette lighter to supply AC to power-hungry devices.
- ✓ **In-dash**
  = a device such as a DVD player installed in your dashboard, typically in the place of your old car radio.
- ✓ **GPS**
  = Global Positioning System - in your this means navigation / map display software linking to a signal receiver and a readout on your screen.
- ✓ **GUI**
  = Graphical User Interface - i.e. you can control the device using on-screen menus, often with a touchscreen
- ✓ **Headliner**
  = the coverings that make the ceiling inside your car.

Car Headlining Diagram

- ✓ **Modulator**
  = An FM transmitter that turns an audio input source, e.g. an MP3 player or audio line-in, into a radio signal for you to tune into using your car stereo.

- ✓ **Monitor**
  = a screen that receives a signal from e.g. a DVD player or TV tuner - if product is described as a Monitor it typically means it does NOT include the actual input player, e.g. DVD player unit. This is fine if you are buying that separately or you are building an in-car PC.
- ✓ **Motorized**
  = where the TFT screen of a display, usually in a dashboard unit, automatically folds and slides inside its housing when not in use.
- ✓ **Power port**
  = a grand name for the little dashboard cigarette lighter socket
- ✓ **RCA**
  = those red and white (for audio) and yellow (for video) connectors used fore.g. connecting your DVD player to your home TV
- ✓ **RDS**
  = Radio Display (/Data) System - the function where your radio can displayrich data such as the name of the station or the track name, for FM radio signals.
- ✓ **Receiver**
  =(confusingly enough) the device that transmits your video signal to screen, e.g. a car DVD player
- ✓ **S-Video**
  = high quality video connector often included on graphics cards, monitors ,dvd players, and consoles as an alternative to RCA or VGA + Audio.

- ✓ **Sub**
  = subwoofer
- ✓ **Versatile**
  = a vague term that generally just means "feature rich", e.g. a car DVD player that also has a built-in GPS and connects with external storage devices.

LO 1.3. IDENTIFY INFOTAINMENTS SUBSYSTEM COMPONENTS

- **Content/Topic 1 Instrument cluster system display**

1. Road speed

The speedometer is a gauge that indicates the current speed the vehicle is traveling. Speedometers can be digital, like a digital clock, clearly indicating the speed, or mechanical using a needle to indicate the speed of the vehicle. Speedometers reflect the speed of the vehicle from the transmission output shaft speed sensor, which is then converted by the vehicle's computer via an algorithm to display the proper speed. The old days the vehicles used a speedometer cable instead of a sensor. Pro Tip: Drivers should always monitor their speed for safety purposes and to avoid speeding tickets.

2. Engine speed

The tachometer's job is to display the speed of the engine in revolutions per minute or RPMs. Because transmissions have many gears, the speed of the car does not match engine speed and transmission gears are designed to convert the speed of the engine into acceleration and performance. A tachometer is helpful while pulling a trailer or going up and down steep grades. However, they're most often used with manual transmissions to indicate to the driver when to shift gears. This function is of no use for drivers of automatic transmissions, as the vehicle will shift gears as needed.

3. Engine temperature

A thermistor, attached to the engine block or thermostat housing, provides the information that is then displayed on your dashboard. While many vehicle dashboard gauges are analog or use needles to display the approximate temperature, some cars are able to provide a live, digital display of the temperature. The average temperature of a vehicle's engine, while running, is about 195 – 220 degrees Fahrenheit. Many newer vehicles temperature reading are done by the vehicle's computer and often triggers a warning light to illuminate if trouble is detected. Pro Tip: Pay close attention to your vehicle's temperature gauge. An overheating engine can cause serious and permanent damage to the engine which could result in costly repairs or result in complete replacement.

4. Oil pressure

Contrary to popular belief, the oil pressure gauge does not monitor the level of oil in the engine but instead the pressure of the oil being pushed through the engine. Similar to how blood pressure is monitored, the oil pressure gauge monitors the force pushing the oil through the engine using a sensor. A normal oil pressure, while the vehicle is in motion on the road, should be between 20 to 50 PSI (pounds per square inch) and can be significantly less when the vehicle is at an idle state. Pro Tip: Oil pressure will vary and can change based on the engine's RPMs. If the oil pressure gauge drops or doesn't read any pressure, turn the vehicle off immediately.

5. Alternator warning lamp or light

The **alternator light does work** by a balance. When you turn on the key, 12 volts is supplied to the **alternator's** field windings through the idiot **light**. This gives an indication that the **alternator's** field circuit is intact, and it also provides the current to start the **alternator charging**.

6. Self-diagnosis error

When entering the self-diagnostic mode, the following indicators blink:ABS indicator, brake system indicator, A/T gear position indicator, charging system indicator, cruise control indicator, cruise main indicator, EPS indicator, high beam indicator, high temperature indicator, immobilizer indicator, lights-on indicator, low temperature indicator, low oil pressure indicator, low fuel indicator, malfunction indicator lamp (MIL), seat belt indicator, security indicator, side airbag cutoff indicator, sequential sportshift mode shift indicator, safety indicators, SRS indicator.

- **Content/Topic 2 Navigation system components**

1. Display

Sound quality depends on the basic system but especially on the quality of the speakers and their placement. Many sound systems are equipped with several speakers, each designed to produce a different range of sound. Matching speakers to the system is done by selecting and wiring speakers so they have the same impedance as the rest of the sound system. Impedance

requirements are typically noted on the rear of the sound unit and/or in the installation instructions. The placement of the speakers is critical to good clean sound. Sound waves from the speaker will bounce off anything they hit, including other sound waves. This bouncing of sound can cause noise or distortion. To achieve a high-quality sound system, the speakers must be placed so that all bouncing is anticipated.

2. Speedo signal

Electronic Speedometers rely on the Vehicle's Speed Sensor to Display Travelling Speed. Electronic speedometers use a vehicle speed sensor rather than a drive cable to compute the speed of the vehicle. The sensor consists of a toothed metal disk, a stationary detector and a magnetic coil**.**

3. ABS wheel sensor

Without wheel speed sensors, your ABS and TCS will not work. These systems rely on information from the wheel speed sensors; the sensors tell the ABS when to unlock the brakes to avoid sliding, and they tell the TCS when to distribute power to different wheels so that you stay in control of your vehicle. Without wheel speed sensors, the ABS and TCS do not have the information they need, and so they shut off, leaving your car without two primary safety features.

4. Controller

Many optional sound systems have very a high wattage output and use several amplifiers. Some even have automatic sound level systems that discreetly adjust the volume to compensate for changes in ambient noise and vehicle speed. An amplifier increases the volume of a sound without distorting it. Amplifiers are typically rated by the maximum power (watts) they can put out. In order to take advantage of the power output, speakers must be chosen that match the output.

5. Satellite

To provide high-quality radio that is not interrupted by distance, some vehicles can be purchased with satellite radio. Satellite radios are also available as add-on items. These radios pick up sound waves from satellites many miles above the earth. Since the radio waves are transmitted by more than one satellite at all times, and each in their own orbit or place within the orbit, the same radio station can be heard from coast to coast Although distance does not hamper the reception, the radio waves cannot penetrate buildings, tunnels, or large groupings of trees. Therefore, to enjoy satellite radio, stay on the open road.

6. GPS Antenna

Power Antennas Many vehicles are equipped with electrically operated antennas that extend when the radio is turned on and lower when it is turned off. These antennas are powered by a small reversible electric motor. The motors are turned off by limit switches that open when the mast has extended or lowered to its desired height. Power antennas (even black-colored

antennas) need to be cleaned with chrome polish on a regular basis to keep them working properly. Often when there is a problem with a power antenna, it is caused by dirt or a lack of lubricant on the telescoping mast. When there is a problem with the power unit, it is normally replaced as a unit.

7. Navigation computer with GPS receiver, CD ROM and G sensor

Entertainment and navigation are the most used applications of infotainment systems

Application of in-vehicle infotainment system differs vehicle to vehicle; more premium the car is, more advanced is the infotainment system. Applications of an in-vehicle infotainment system are infotainment, navigation, communication and connectivity, remote services, and telematics services. In developed markets people use infotainment systems even for accessing social media and mails, checking the availability of parking spots across the city, and streaming high definition video and audio.

However, the main application of in-vehicle infotainment systems has been limited to entertainment and navigation in most of the markets. This is primarily due to the limitations in the connectivity infrastructure in developing countries. In these regions, the lack of high-speed internet connection limits the use of infotainment applications. (Zhao, Liang, & Chen, (2018-01-02).)

Going forward, the infotainment system will act as the control center for the vehicle where the display unit and the instrument cluster will integrate into one big display and will be a common feature in the cars of the future. The integration of augmented and virtual reality with in-vehicle infotainment systems will be the next level in driving experience and comfort. A majority of these innovations are in pre-development stages; however, the day is not far when these technologies will start penetrating the automotive infotainment landscape.

- **Content/Topic 3 Mobile phones components**

1. Transmitter

Radio transmitters and receivers are electronic devices that manipulate electricity resulting in the transmission of useful information through the atmosphere or space. Transmitters. A transmitter consists of a precise oscillating circuit or oscillator that creates an AC carrier wave frequency.

2. Receiver

A radio receiver, also known as a receiver, a wireless or simply a radio, is an electronic device that receives radio waves and converts the information carried by them to a usable form. It is used with an antenna. The antenna intercepts radio waves (electromagnetic waves) and converts them to tiny alternating currents which are applied to the receiver, and the receiver extracts the desired information. The receiver uses electronic filters to separate the desired radio frequency signal from all the other signals picked up by the antenna, an electronic amplifier to increase the power of the signal for further processing, and finally recovers the desired information through demodulation.

3. Hand set

In-vehicle infotainment works in integration with many other in-vehicle and external systems to deliver entertainment and information to the driver and passengers.

- ✓ The main components of an in-vehicle infotainment systems are:
- ✓ **Integrated Head-Unit:** In-vehicle infotainment head unit is a touch screen based, tablet-like device, mounted on the vehicle's dashboard. With user friendly HMI, the head unit acts as a perfectly connected control center for the infotainment system.
- ✓ **Heads-Up Display:** Automotive heads-up display is an integral part of high-end infotainment systems, which displays the vehicle's real-time information on the transparent screen integrated with the vehicle's windshield. Heads-up display helps in reducing the driver's distraction while driving and assists him with key details like speed, navigation maps, electronic digital cluster (information from vehicle's OBD port-II), climate, multimedia options, etc.
- ✓ **High-end DSPs and GPUs to support multiple displays**: New age infotainment systems are powered by powerful automotive processors designed for advanced IVI systems. These automotive processors are capable of displaying content on multiple displays (e.g. Head-up Display or Windshield, Connected smartphones, Head Unit, and more) and delivers an enhanced in-vehicle experience to drivers and passengers.
- ✓ **Connectivity Modules:** Infotainment systems encompass GPS, Wi-Fi, and Bluetooth modules to provide connectivity with external networks and devices. These modules help in establishing services like navigation, internet connectivity and smartphone integration with the infotainment system. (Zhao, Liang, & Chen, (2018-01-02).)
- ✓ **Automotive Sensors Integration**: Proximity sensors, gesture recognition sensors for detecting ambient light, camera sensors and many other in-vehicle sensors integrate with infotainment systems to provide safety-related information to the driver and passengers.

LO 1.4. DESCRIBE INFOTAINMENT SUBSYSTEM COMPONENTS

- **Content/Topic 1.Design and operating principles of Instrument cluster system displays**

1. Road speed

The **speedometer** is usually situated in a prominent position.

It has a pointer that lines up with numerical values, which indicate vehicle speed in miles per hour (MPH). The speedometer also has an odometer to measure distance travelled. The speedometer cable links between the speedometer head and the transmission housing. It has an inner cable that is a flexible wire with a drive gear on one end. It moves within a stationary outer housing. At the speedometer head in the instrument cluster, a small magnet rotates. The resulting magnetic force moves the speedometer pointer.

2. **Engine speed**

The tachometer's job is to display the speed of the engine in revolutions per minute or RPMs. Because transmissions have many gears, the speed of the car does not match engine speed and transmission gears are designed to convert the speed of the engine into acceleration and performance. A tachometer is helpful while pulling a trailer or going up and down steep grades. However, they're most often used with manual transmissions to indicate to the driver when to shift gears. This function is of no use for drivers of automatic transmissions, as the vehicle will shift gears as needed.

3. **Engine temperature**

Warning lamps are usually positioned around the perimeter of an instrument cluster. They may have red, green, blue or orange lenses. They are used to indicate system information such as oil pressure, parking brake, battery status, direction indication, hi beam, ABS, choke, etc.

4. **Oil pressure**

oil pressure should be between 25 to 65 psi when the **oil** is warm. A **reading** of 80 psi or higher means that there is a serious issue that needs to be resolved.

5. **Alternator warning lamp or lighting**

When you start the engine, the car will check to make sure the alternator is outputting the correct voltage. This warning light will shut off after a few seconds if the computer has determined that the alternator is functional. When the light stays on, it indicates that the computer has detected an issue with the charging system.

If this light illuminates, try to use only necessary accessories like windshield wipers or headlights so as to avoid excessively draining out the battery. An alternator that is on its way out may cause this warning light to flash when there is a high demand on the battery. You can always save yourself a lot of trouble by paying attention to warning signs like this and trying to conserve your car's battery.

6. **Self-diagnosis error**

The fuel gauge displays the amount of fuel that is left in a fuel tank. Fuel quantity is measure in gallons. The temperature gauge displays engine coolant temperature.

When a vehicle is moving, it transfers motion through a gear linkage and rotates the speedometer inner cable.At the speedometer head in the instrument cluster, a small magnet rotates. The resulting magnetic force moves the speedometer pointer.

Electronically Driven Speedometer

The transmission housing contains an output shaft with a trigger wheel.A vehicle speed sensor is positioned next to the trigger wheel.When a vehicle is moving, the sensor produces a signal that relates to vehicle speed.The computer (ECU / BCM) processes the input signal and converts the information into drive signals, for either analog or digital speedometers.

(www.fitaudio.com/)

Some analog systems do not use a computer. The frequency of the incoming signal is converted to a voltage, which is used to drive a stepper motor that deflects the pointer.

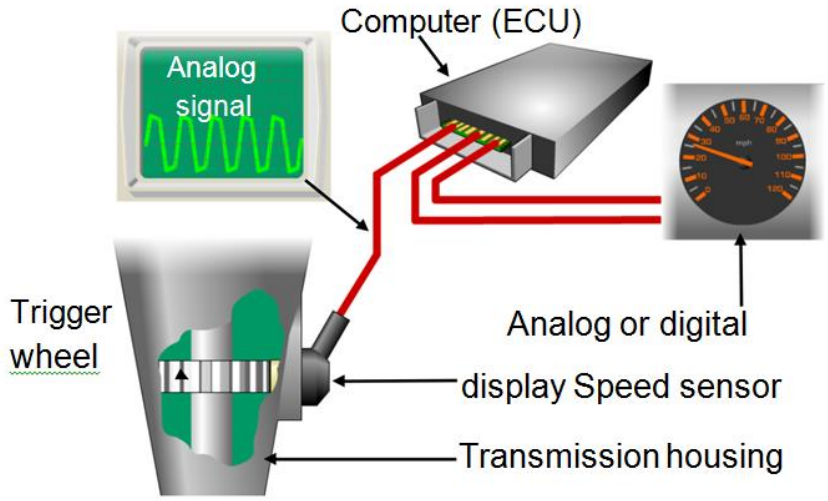


Figure 9. **Electronically Driven Speedometer**

Typical Digital Instrument Cluster

The digital instrument cluster is lightweight and easy to read.

It can have digital displays for speed, fuel level, climate control, distance travelled etc.

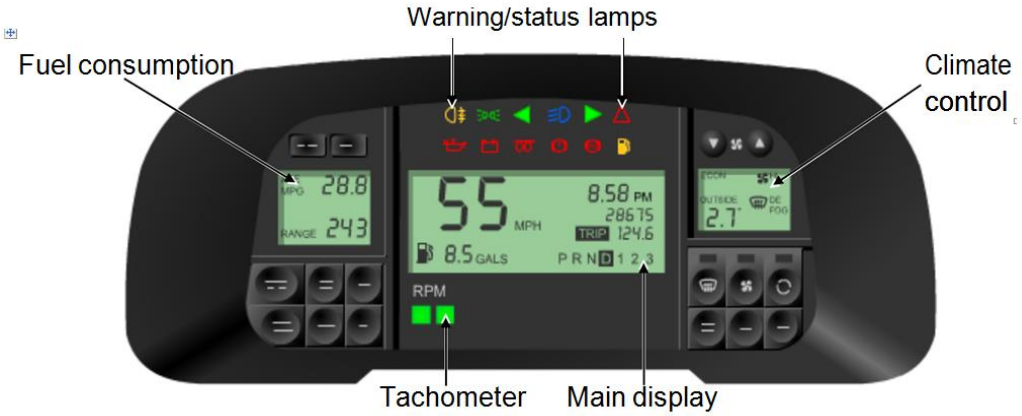


Figure 10. **Digital Instrument Cluster**

There will also be lamps for warning / vehicle status, and direction indication. The displays may be LCD, LED, or vacuum fluorescent. Incoming data is processed by the Body Computer Module (BCM).

Typical Instrument / Body Computer (BCM)

The instrument computer has

three main stages of operation:

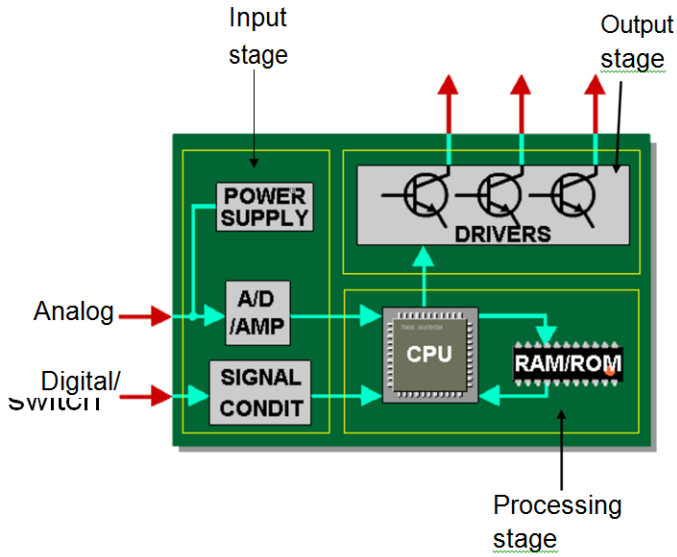
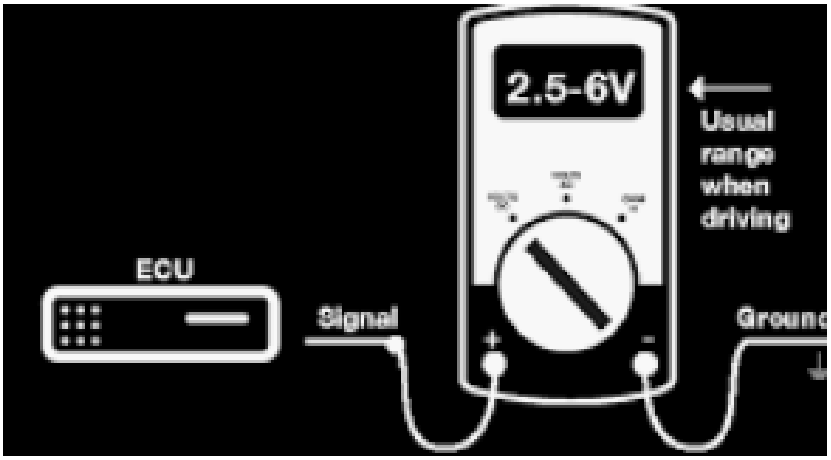


Figure 11. **Body Computer (BCM)**

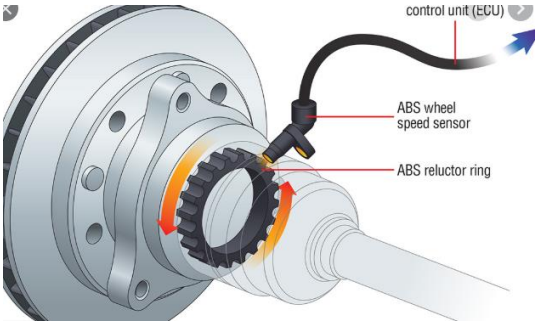
- **Content/Topic 2 Design and operating principle of Navigation system components**

1. **Display**

2. **Speedo signal**



3. **ABS wheel sensor**



4. Controller

Drivers don't care about other components other than the car module. The car module generally named as a navigation system or briefly navigation. The driver pushes, scroll or rotate the button to activate the navigation system. A map appears on the screen and the driver makes his/her selections to calculate a new route, inputs the destination which is wanted to be reached and the navigation system asks the driver to decide which path to follow. After this process, the navigation system describes the route the driver, leads the driver to reach the destination. Maps are updated regularly according to the changes and also some software updates are promulgated by the seller of the navigation system.

5. Satellite

6. GPS antenna

7. Navigation computer with GPS receiver,CD-ROM and Gsensor

When it comes to cars, there are three main GPS **navigation system** options. You **can** opt for a factory-**installed system** on a new car, a dealer-**installed system** on a new or used vehicle or get a portable **device** that requires little or no installation.

- **Content/Topic 3. Design and operating principle of Mobile phones components**

1. Transmitter

A radio transmitter design has to meet certain requirements. These include the frequency of operation, the type of modulation, the stability and purity of the resulting signal, the efficiency of power use, and the power level required to meet the system design objectives.[1] High-power transmitters may have additional constraints with respect to radiation safety, generation of X-rays, and protection from high voltages.[2]

Typically a transmitter design includes generation of a carrier signal, which is normally sinusoidal, optionally one or more frequency multiplication stages, a modulator, a power amplifier, and a filter and matching network to connect to an antenna. A very simple transmitter might contain only a continuously running oscillator coupled to some antenna system. More elaborate transmitters allow better control over the modulation of the emitted signal and improve the stability of the transmitted frequency. For example, the Master Oscillator-Power Amplifier (MOPA) configuration inserts an amplifier stage between the oscillator and the antenna. This prevents changes in the loading presented by the antenna from altering the frequency of the oscillator

2. **Receiver**

When most people think about a "**car stereo**," they're actually thinking about the **receiver**. Also known as the head unit or deck, the **receiver** is both the brain and heart of your **car** audio system and the bit that you'll directly interact with from behind the wheel

3. **Handset**

Car Phones are **still available** as a luxury item now though. World leaders tend to all have a satellite **phone** directly installed on board their limo. ... Motorola even provides US customers with the m800 and m900 **car phones**, for use with such networks as well networks respectively.

LEARNING UNIT 2- PERFORM REPAIRING OF INFOTAINMENT SYSTEM

LO2.1 : Select tools, materials and equipment

- **Content/Topic 1 Selection of Tools**

1. Power tools
   Tools like grinder, air sander and pneumatic wrench
2. Measuring tools
   You have to select measuring tools for measuring
3. Hand tools

Examples of Tools are:

- Spanners(8,9,10,12,14,17 and 19)
- Screw drives: star and flat
- Allen keys 8,9 and 10
- Pliers such as long nose, universal and cutting pliers

- **Content/Topic 2. Selection of Materials**

1. Fuse
2. Relay
3. Grease
4. Lubricants
5. Brushes
6. Wires
7. Insulator tips
8. Bulbs and sockets

Example of Materials are:

- Fuel(Diesel or petrol)
- Sand paper
- Glease
- Engine oil
- Water
- Liquid soap
- Wires and soldering accessories
- Lamps and other electronic devices ready to replace.

- **Content/Topic 3. Selection of Equipment**

1. PPE
   Personal protective equipment
2. Multi-meter

Used for measuring voltage and current

3. Hand scanner

Example Equipment are:

- Hand scanner OBD1 and OBD2
- Wireless printer
- Car lift
- And other required equipment according to the faults identified

LO2.2. Diagnose infotainment systems

- **Content/Topic 1 .Visual inspection of infotainment system**

1. **Loosen wires**

Unplug the electrical wire from the electrical outlet. Make sure to grab a covered portion of the cord. Locate all the areas on the electrical cord with exposed wires.

2. **Broken devises**

Use .Visual inspection for checking if any devices are in good conditions

3. **Burned wires**

Because it's hard to spot a **burned wire**, here are some **signs** to look for: As you walk by an outlet you smell smoke. There is a **burned** smell in a particular room that gets heavier with time.

- **Content/Topic 2.Verify the fault with scan tool**

1. **Readout the fault code**

OBD-II Diagnostic Tool: This will allow you to read the onboard diagnostic codes your car generates when it detects a problem. Some scanners are also listed as "OBD2 scanners."

2. **Collect further information**

Record the data. After the scan has completed, typically within a few seconds, it will display any specific trouble or error codes it reads. Take note of these codes if the scanner doesn't give you a detailed explanation of what the code means.

- Some scanners will store the codes for you, download them to a computer/website, or give you an explanation right from the screen.
- Most scanner apps for Bluetooth-capable scanners connect to a diagnostic service that will give you more information.

3. **Clear fault code**

Clear the codes. If you don't want to keep the Check Engine light on, use the diagnostic tool to clear the warning light if possible.

4. **Actuation test**

Fix the problem yourself. If you have some skill and experience with automotive repair, the trouble codes/descriptions you have should offer a good starting point to find and fix the issue.

- Keep in mind, trouble-code alerts aren't always related to the problematic part and may be a symptom of another issue instead.
- Basic diagnostic tools aren't the best way to fix issues on your own. Mechanics have access to higher-quality diagnostic tools that monitor more systems and information.

- **Content/Topic 3.Check Infotainment systems**

1. Open circuits

Maintain the first test probe at the hot wire terminal of the circuit. Remove the second probe from the neutral terminal then place it on the ground terminal for the circuit. Once more the multimeter will read "OL" or infinity if the circuit is open or zero if the circuit is functioning.

2. High resistance circuits

To measure resistance:

1. Turn power to circuit OFF.

- If a circuit includes a capacitor, discharge the capacitor before taking any resistance reading.

2. Turn digital multimeter dial to resistance, or ohms, which often shares a spot on the dial with one or more other test/measurement modes

3. Short circuits

Once you've identified a potential short, use your multimeter to confirm the voltage by setting it to resistance or continuity setting. If you notice a lower-than-expected resistance, then that's a clear indication that current is being diverted away from the area, and there's a short circuit.

4. Damaged insulation

A cable insulation resistance test is a test that is performed by applying 500 V or more between the conductor and ground and measuring the resulting leakage current.

An insulation resistance tester is a test instrument that measures current that leaks through the insulation into ground.

5. Burnt wiring Connector damaged Terminal

Brush the metal pins with the toothbrush. Apply a quick spray of

the electrical contact cleaner to remove any dry dust or corrosion. Use vinegar to clean the pins if contact cleaner is not available. Brush the pins again to remove any left over debris.

6. **Damaged Frayed wires Water and moisture**

In-vehicle entertainment is flourishing and is integrated with automotive navigation system. This constitutes a complete “in vehicle infotainment”. The present day radio in the automobile has advance features like the traditional Tuner sources - FM, AM. Media Sources like CD/DVD, USB Audio, Picture, Video, SD Card support, iPod, Pair a phone and listen to Music and access the Phone book and make or accept calls, configure the Radio and so much more like Navigation etc. In such In-vehicle entertainment systems, status of different modules and their connections becomes important for a technician who is performing its evaluation. In this scenario diagnostics comes into picture. Diagnostics refers to a vehicle's self-diagnostic and reporting capability. This paper presents implementation of Diagnostics in Car Radio which is done using three tests viz., Speaker Test, Display test, Connection Test and System Version Information test.

With the advances in technology, the auto motive industry is moving towards the radios with more integrated features in them. The present day radio in the automobile has features like (www.fitaudio.com/)

- ✓ Tuner sources - FM, AM.
- ✓ Media Sources like USB Audio, Picture, Video, SD Card support, iPod, AUX.
- ✓ Wireless connectivity: Bluetooth, Hands-free, Phone book, Internet, Phone app access
- ✓ Telematics: GPS, Modem
- ✓ Speech Recognition
- ✓ Reconfigurable displays
- ✓ Rear-seat entertainment
- ✓ Rear View Camera

In such an infotainment system, status of different modules becomes important to know whether they are working up to the expectation and also to prevent any malfunction in future. Here diagnostics comes in to picture. Diagnostics is an automotive term referring to a vehicle's self-diagnostic and reporting capability. It gives the vehicle owner or repair technician access to the status of the various vehicle sub-systems. In this paper three tests of diagnostics are implemented namely Speaker test which tests the audio output from four speakers Left front, Rear Left, Right Front and Rear Right. Display test is used to test the display quality. Connection test shows the connection status of different components. System Vesrion Information test gives the version information of different components. (www.popularmechanics.com/technology/how-to/3380301)

LO 2.3: Repair infotainment system components.

- **Content/Topic 1 Procedures of Dismounting and checking infotainment subsystem.**

1. **Navigation system components**

Describe shipboard electronic navigation equipment as related to:

a. Safety
b. Physical characteristics
c. Purpose
d. Limitations
e. Maintenance
f. Installation
g. Components
h. Operations
i. Interfacing
j. Other electronic subsystems
k. Technical documentation
l. Material condition

2. Instrument cluster system displays

These strange hieroglyphics vary from vehicle to vehicle, so be sure to **check your owner's manual** for specific information about your vehicle. In many cars, the warning lights will illuminate briefly when the engine is turned on to check the bulb. If warning lights remain illuminated, however, you should take your vehicle in for service.

Red, Yellow/Orange, Green, and Blue Lights
As with most things, there are levels to this. A **red** warning light demands immediate attention (don't drive any further), while **yellow/orange** warning lights indicate a problem that needs to be serviced soon.
If you see a **green or blue** light, this normally indicates that a certain car function is on or currently in use. Standard Dashboard Warning Lights

1. Check Engine Light

What it looks like: A yellow submarine
What it is: The Check Engine Light
I'm sure we've all seen this one before. It's one of the more serious lights to pay attention to and normally indicates an emissions or general engine running problem. Sometimes the word "check" appears near the engine symbol, sometimes not at all. Older vehicles may not have a symbol at all, just the text "Check Engine" or "Service Engine Soon." (www.popularmechanics.com/technology/how-to/3380301)
In many vehicles, the check engine light illuminates whenever the engine is turned on to check the bulb. If the light stays illuminated, the car's diagnostic systems have detected a malfunction that needs to be investigated. If the check engine light begins to flash or blink, this may indicate an engine misfire is occurring.

What to do: If the check engine light stays on, take the vehicle in to be serviced as soon as you can.
If the check engine light is blinking, drive delicately at moderate speeds (slow acceleration and deceleration) until you can get your car to a mechanic. It can be very dangerous and damaging to drive while the check engine light is flashing! Click here for more reasons why your check engine light might be on.

2. Battery Light

What it looks like: A winking robot
What it is: The Battery/Charging System Light
The battery light indicates that the car's charging system is short of power or is not charging properly. This can lead to electrical problems involving your power steering, braking, lights, and engine. It normally indicates a problem with the battery itself or the alternator.**What to do:** Take your vehicle in to get serviced as soon as you can. Most likely, you just need to replace your battery. Other causes may include wiring problems, a faulty alternator, or a faulty battery.

3. Temperature Warning Light

What it looks like: A pirate ship or a key submerged in water **What it is:** The Engine/Coolant Temperature Warning Light The temperature warning light means that the engine is, or is very close to overheating. Some cars may not have a specific engine warning light. You may only have a temperature gauge with a red section (H) at the highest end of the gauge. If the needle enters the red section, the engine is overheating and should be stopped as soon as safely possible. Other times, an "engine overheating" or "temp" message will illuminate, sometimes alternating with a flashing radiator or fan icon. **What to do:** Never drive with an overheating engine! Stop driving as soon as you possibly can and switch off the engine to allow the engine to cool.
If the engine temperature warning light comes on again, you probably have a problem with your coolant, radiator, or water pump. Drive the car at a low speed to your local mechanic. **WARNING:** NEVER open the coolant reservoir cap while the engine is hot or running.

4. Oil Pressure Warning

What it looks like: A magic genie lamp or a Neti pot **What it is:** The Engine Oil Pressure Indicator Light The oil pressure warning light indicates a loss of oil pressure, meaning

lubrication is low or lost completely. **What to do:** Do not drive while this light is illuminated! If you see this light come on while driving, stop the car as soon as it is safe to do so.You should check your motor oil level and pressure as soon as you can. If that doesn't get the light to turn off, have your vehicle checked out by a professional mechanic before you do any more damage to your vehicle.

5. ABS Warning

What it looks like: An abs workout reminder **What it is:** The **A**ntilock **B**rake **S**ystem (if equipped)The antilock brake system regulates brake pressure to prevent wheels from locking during braking. If the ABS is not working properly, the wheels may lock up and cause a dangerous driving situation. If the ABS light remains on, the antilock brake system needs professional diagnosis. Sometimes the warning light is only text, such as "Antilock" or "ABS." In some vehicles, the ABS warning is red. In others, it is yellow or orange. In some vehicles, the ABS turns on when the antilock brake system is active. If it remains on, however, ABS safety features have been turned off. **What to do:** If the ABS light stays lit, a malfunction in your antilock brake system has been detected. Have your vehicle professionally serviced as soon as you can.

6. Airbag Indicator

What it looks like: A meteor is heading your way **What it is:** The Airbag Indicator, a.k.a. Supplemental Restraint System (SRS) The airbag warning light indicates something wrong with your airbag system. For the safety of you and your passengers, take the vehicle in for service as soon as possible. **What to do:** If the airbag light does not illuminate when you turn the ignition, continues to flash, or stays illuminated, one or more of your airbags are malfunctioning. Take the vehicle in for service immediately.

7. Safety Belt Reminder

What it looks like: An obese child wearing a bandolier **what it is:** The Seat Belt Reminder Light Chiming or beeping usually accompanies the seat belt reminder light. **What to do:** Fasten your seat belt! If your seat belt is fastened, the warning light may come on if you have a lot of weight on one of the seats. Either remove the weight or buckle the seat belt on the corresponding seat.

8. Brake System Warning

What it looks like: A Pokémon gym is nearby **What it is:** The Brake System Warning Light
This warning light illuminates when there is a problem with your brakes. You may also see a light that says “Brake.” This can indicate that the parking brake is applied, there is low brake fluid, or the brake system needs to be inspected immediately .If the light only comes on when you pressing down on the brake pedal, you may have a problem with your hydraulic circuits (bad hose, leaky disk caliber, or something else). If the pedal feels loose or goes to the floor, pull the vehicle over as soon as safely possible. **What to do:** Check the brake fluid and make sure the parking brake isn’t on. If adding brake fluid and releasing the parking brake doesn’t turn the light off, have the brake system inspected immediately .If both the ABS and Brake Light Warning lights come on, you could have a seriously dangerous problem with your brakes. Stop the car as soon as safely possible and get your brake system inspected.

9. TPMS (Tire Pressure Monitoring System)

What it looks like: A boiling cauldron **what it is:** The Tire Pressure Warning Light (if equipped)
Some vehicles come with a tire pressure monitoring system. The light comes on when one or more of your tires have low pressure. It is usually red or yellow. **What to do:** Check the tire pressure on all of your tires. Refer to your owner’s manual for recommended PSI levels.

10. Check Gas Cap

What it looks like: A big screw is stuck in your car. **What it is:** The Gas Cap Warning Light
If the gas/fuel cap is not properly tightened, the gas cap warning light will come on. Some vehicles display text instead, such as “Check Gas Cap.” The gas cap prevents fuel from evaporating out of the tank and keeps rain, dust, and other things from entering the tank. If left unattended, the check engine light will illuminate.

3. Mobile phones components and Audio/TV Sources

The most important part of the system. Get a good head unit from a name brand. If you skimp here, your whole system will suffer. For people that are on a budget: Get good quality head unit without all the bells and whistles. A flip down face with a colorful display looks great, but it won't necessarily sound better that a regular plain head unit. If you are planning to get

amplifiers in the future, get a head unit with RCA outputs.

Speakers

The second most important part of the system. If you are on a budget, just get a nice set of speakers up front and don't even worry about the rear speakers, amplifiers, etc until you have some more money later on.

Speaker installation is definitely the most important aspect that determines how your whole system sounds. No equalizer or processor can compensate for poorly installed speakers.

Factory locations are usually not acceptable for audiophile quality sound. Speakers should ideally be pointing straight at you.

Speakers on each side should be as close to each other as possible with no obstructions. Speakers should be mounted on a good baffle (preferably an enclosure). Difference between left and right speaker distances to your ears should be as small as possible. The front speakers should also play as low as possible in frequency (ideally 60Hz or less), being able to handle full power. This is where crossovers with high slopes come in to protect the speakers.

Amplifiers

Amplifiers do not only make a system sound louder, they make it sound BETTER. The morepower you get, the cleaner the signal going into the speakers. A common misconception is that if a 100 watt amplifier is used on 50 watt speakers, the speakers will burn. This is not true, as long as there is no distortion and the speakers are properly protected with crossovers. More power is always better. For systems with a lot of power, you might also have to upgrade the car's electrical system, by getting a high output alternator, capacitors, etc.

Subwoofers

Subwoofers cover low frequencies in the audio spectrum. Subwoofers need to be installed in a box designed specifically for them. Put a subwoofer in the wrong type or size box and it will not perform as it should and could be destroyed. Subwoofers need a lot of power to play at acceptable levels without distortion.

4. Audio/TV Components

Matching subs (and speakers) to amplifiers

This is a very important aspect of system planning that is often overlooked. Amplifiers are designed to provide maximum power at a certain impedance. An amplifier at this maximum level will be under more stress and produce more heat, so mounting location also becomes important.

Professional installers wire subs (and speakers) in parallel and/or series combinations to obtain a load that will make the amplifier perform at full power.

Processors

Many people believe that they need to have an equalizer, center channels, rear speakers, etc for better sound and compromise by buying cheaper components. A properly designed system will sound great without the need for all this other components. If you have the money and are an audiophile or into competition, then this "extra" components can become important.

Upgrading

Always keep in mind future upgrades when buying audio gear. For example, let's say you are low on funds and want to add two subwoofers and an amplifier. Since powerful amplifiers are expensive, you can get a 2-channel amplifier to drive the subwoofers at acceptable levels. Later on, when you have more money, you can buy an identical amplifier and power each sub with an amplifier in bridged mode for more bass. If you planned carefully, the impedance's of your subwoofers will match the amplifiers for maximum output in the bridged configuration.

Cheap Components

Buying better quality components will definitely increase system performance. Although name brands are more expensive, they are more reliable (read: will last longer). For people on tight budgets, it is better to save for a better component and take longer building a better system one component at a time.

- **Content/Topic 2. Cleaning of infotainment system components**

1. **Instrument cluster**

- ✓ Remove debris and dirt from cracks and crevices with a soft-bristle brush.
- ✓ Remove dust by gently spraying a can of compressed air.
- ✓ Lightly mist a microfiber towel with water/plastic cleaner and gently wipe buttons.
- ✓ Use short-hair microfiber towels or specialized touchscreen wipes to clean the screen.

2. **Navigation system**

- ✓ Remove debris and dirt from cracks and crevices with a soft-bristle brush.
- ✓ Remove dust by gently spraying a can of compressed air.
- ✓ Lightly mist a microfiber towel with water/plastic cleaner and gently wipe buttons.
- ✓ Use short-hair microfiber towels or specialized touchscreen wipes to clean the screen.

3. **Mobile phones**

- ✓ Remove debris and dirt from cracks and crevices with a soft-bristle brush.
- ✓ Remove dust by gently spraying a can of compressed air.

- ✓ Lightly mist a microfiber towel with water/plastic cleaner and gently wipe buttons.
- ✓ Use short-hair microfiber towels or specialized touchscreen wipes to clean the screen.

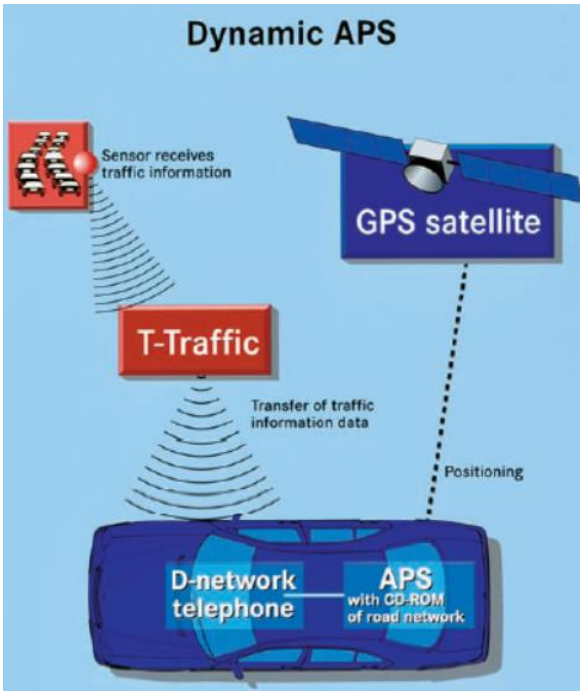
4. Audio/TV

- ✓ Clean speakers with compressed air

- **Content/Topic 3. Procedures of mounting infotainment subsystem**

1. Navigation system components

Navigation systems use global positioning satellites to help drivers make travel decisions. These global positioning systems (GPSs) set up a mathematical grid between the satellites and radio stations on the ground. The exact position of a vehicle can be plotted on the grid; therefore, the system knows exactly where the vehicle is. GPS can display traffic and travel information on a display screen It can display a road map marking the exact location of the vehicle. It can plot out the best way of getting to a destination and can also tell the driver how many miles have been traveled and how many remain before reaching a destination. It can also display traffic information regarding traffic backups due to congestion, roadwork, and/or accidents, then display alternative routes so travel is not delayed.



2. Instrument cluster system displays

Read your vehicle's owner's manual. Before you touch so much as a screw around the vehicle's instrument cluster, thoroughly read the owner's manual. You will find helpful information in the manual concerning the wiring around the dash cluster, as well as a schematic for the instrument panel that will help locating the correct hardware, wiring, components, etc.

- ✓ Many cars, especially those purchased used from private owners may no longer have the owner's manual. You might be able to find a downloadable version of the manual online from the manufacturer's website, but if not, you should be able to order one directly from the manufacturer via a certified dealership.

Find an appropriate speedometer. The dimensions of a speedometer vary from vehicle to vehicle and after-market products are most certainly not universal. You can consult the parts department at a certified dealer to ensure that you order a speedometer that will fit properly into your instrument panel.

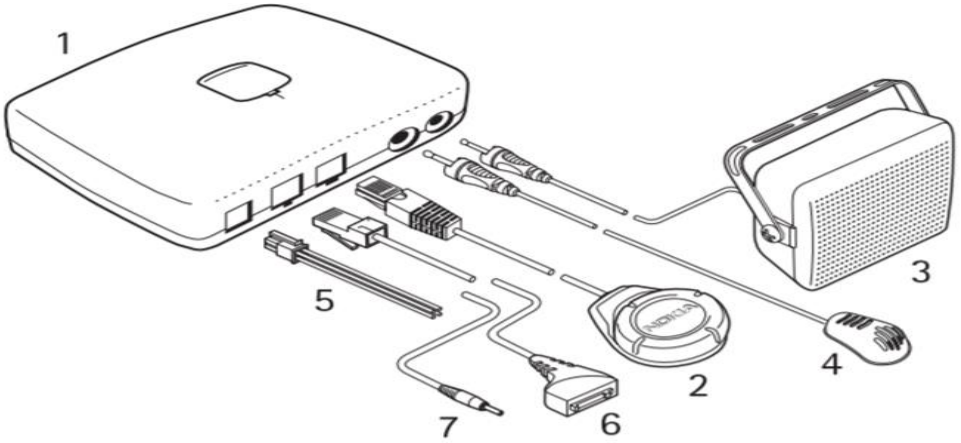
- ✓ The gauge won't just need to meet dimension specifications, but you also have to consider what all connects to your specific vehicle's speedometer. Some have one wire for a dash light while some have two. Vehicles with an automatic transmission may also have a gear selection wire connected to the speedometer. Ordering a component with everything you need is essential.
- ✓ If you would rather not go through a dealership but you have a trusted mechanic, he or she will likely have access to the same parts information and can also ensure that you order an appropriate speedometer.

Gather the necessary tools. While removing and installing a speedometer doesn't require any specialized equipment, you do need to make sure that you have both phillips and flathead screwdrivers on hand, as well as a pair of pliers, a good wrench set, and possibly a good socket wrench set.

Loosen the screws around your vehicle's instrument cluster. One of the schematic pages in your owner's manual should point out the location of each screw you will need to remove. Pay close attention to which screws instead of removing every screw around the cluster since some of them may not need to be removed.

Set the new speedometer in place on the instrument panel. Reattach it by screwing it to the mounting points that held the old speedometer in position.

3. **Mobile phones component**



The advanced Car Kit includes the components shown above

- ✓ 1 Handsfree unit HF-5 with mounting plate MK-2
- ✓ 2 Remote control button CU-7
- ✓ 3 loudspeeker HFS-12
- ✓ 4 Microphone MH-2
- ✓ 5Cable set PCU-4

- ✓ 6 Data cable CA-27
- ✓ 7 Charger cable CA-116

4. Audio/TV

Installation

Each car model has a slightly different installation process. However, these general guidelines apply to any car capable of supporting this device.

1. First, open the hood.
2. Locate the car battery. Car batteries all have two metal clamps connected to them.
3. Use a wrench to loosen and disconnect the negative battery cable clamp. It's the one with the negative symbol that looks like this
4. Next, you need to remove the old or original factory car stereo unit.
    - First locate the vehicle service/repair manual or consult with a local professional for proper instructions. Note that removing the original stereo system might require special tools and could be difficult for beginners because it's necessary to disassemble some parts of the dash panel. Pull out the unit and disconnect the cables.
5. Some vehicles require a dash adapter faceplate, in order to fit the unit perfectly, seamlessly. If necessary install it now. Pull out the car stereo wire harness.
6. Connect an ISO wire harness connector and additional cables. If necessary install a car specific wire harness adapter. Refer to wiring diagram.
7. Slide the new car DVD player into the slot. Fix it into the bracket. Reinstall the dash panels.
8. Reconnect the battery cable.

When installing the hands free unit, ensure that the cables for the microphone and loudspeaker will reach the places you intend to mount these components. Take care not to mount the handsfree unit inside a closed metal housing or in a place in the car where it would be shielded from radio waves as this may impair the use of the Bluetooth feature. To mount the unit, first attach the mounting plate supplied with the Advanced Car Kit and then secure the handsfree unit using the screw that goes through the unit. Finally, insert the cover imprinted with the Nokia logo into the recess and press it into place.

- **Content/Topic 4.Installation of electrical and electronic infotainment systems**

1. Instrument cluster

Electronic systems are finding a place in every aspect of an automobile. This trend shows in such recent advances in automotive electronics as electronic stability control, traction control, airbag safety, power steering, satellite radio, emissions controls, active suspension, anti-lock brakes, noise cancellation, powertrains (hybrid/all-electric), and the list goes on and on. Automotive infotainment is growing in popularity and taking root to become another major driver of competition shortly. As it's such a new field, infotainment has yet to take on an exact definition, which is part of the reason it's so exciting. We have yet to witness the latest technologies and applications that will evolve as automobiles become more connected and highly integrated smart devices in and of themselves. Truly, the only limit to the development of infotainment is our imagination. (www.popularmechanics.com/technology/how-to/3380301)

2. Navigation system

Take the device out of the original box and locate the instruction booklet. It is always important to follow any specific guidelines that are given in the manufacturer's instructions.

There should be three main pieces. The GPS device is a small box with a screen on the front. A power cord should also be included with an adapter that plugs in to your vehicle's cigarette lighter. Also included should be some type of holder with an affixed suction cup for mounting the device to your windshield or dash board.

First, place the GPS device into the holder.

Next, mount the device inside your vehicle. It is highly ill-advised to mount the device on a portion of your windshield where it will distract or block your view of the road. The safest place to mount your GPS device is on your dashboard, either in the center or to the far left of the driver's seat. You may have to moisten the suction cup to successfully affix it to either surface.

3. Mobile phones

All equipment must be mounted so that it does not interfere with the operation of the vehicle.

- ✓ Your service technician may be able to provide you with information on alternatives for mounting the equipment suitably in your vehicle without requiring boreholes.
- ✓ The mount for the phone holder is to be fixed to the dashboard or to any other location in the cockpit area where the display is clearly visible for the user but does not impair control or operation of the vehicle. The keypad should be within easy reach of the driver.
- ✓ Make sure not to impact the steering or braking systems or other key systems essential for proper operation of the car when installing Advanced Car Kit equipment. Check to make sure that deployment of the airbag is not blocked or impaired in any way.
- ✓ Do not smoke when working on the car. Make sure that there is no source of fire or flame nearby.

- ✓ Take care not to cause damage to electrical cables, fuel or brake lines or safety equipment during installation work. Connecting a mobile phone using the data cable and a phone holder
- ✓ When connected via the data cable, the compatible mobile phone is ready for operation with the Advanced Car Kit when placed into the phone holder.

Depending on your mobile phone and your vehicle equipment, enhancements such as a phone holder, antenna coupler or external antenna may be required.

4. Audio/TV

STEP 1: Connect the negative (+) terminal of the capacitor to a good chassis ground.
STEP 2:: Insert an automotive 12 V light bulb, such as a headlight or parking light, between the positive terminal of the capacitor and the positive terminal of the battery. The light will light as the capacitor is being charged and then go out when the capacitor is fully charged.
STEP 3 Disconnect the light from the capacitor, then connect the power lead to the capacitor. The capacitor is now fully charged and ready to provide the extra power necessary to supplement battery power to the amplifier.
Check whether the fuse is blown using a multimeter. First make sure that the system's power is off, then having set your multimeter to ohms, touch the metal caps of the fuse with the multimeter's testing leads and see whether or not a reading is recorded. If the multimeter shows a reading, the fuse is not blown; otherwise, no reading indicates that fuse is blown.

Also check for wiring problems and issues with ground connections. If the ground connection is loose or rusted, it has to be fixed for the radio to work properly.

LEARNING UNITY 3- TEST INFOTAINMENT SYSTEM

LO 3.1: Test infotainment system Operation

- **Content/Topic 1Perform drive testing to check on infotainment**

1. **Instrument cluster**

Step 1 Save the headlights from excessive use
Step 2 Starting the self test inputs
Step 3 Turn the light on
Step 4 Turn the ignition switch to ON (position II).
Step 5 Within five seconds, and still holding in the **Sel/Reset** button, turn the headlights OFF, then ON, then OFF again.
Step 6 Final inputs, and here comes the show
Within 5 seconds, release the Sel/reset button.
Push and release the Sel/reset button button 3 times repeatedly.
The instrument cluster begins its self-test.
Each successive press of the Sel/reset button initiates a new cycling of all the gauges.
To end, turn the ignition switch to OFF, or vehicle speed exceeds 1.5 mph.

2. **Navigation system**

There are many different systems that provide cell phone hookup and other entertainment features, including rear-seat DVD players. But the latest trend is to join all of these into a single system. These systems may also have voice control. The communication and entertainment systems are connected by Bluetooth technology or a standard USB port.

3. **Mobile phones**

The testing will be conducted on both hardware and software. And from the view of different procedures, the testing comprises R&D testing, factory testing and certificate testing.

Mobile-device testing involves a set of activities from monitoring and troubleshooting mobile application, content and services on real handsets. Testing includes verification and validation of hardware devices and software applications.

4. **Audio/TV**

Poor speaker or sound quality is usually caused by one of the following:
- Damaged speaker cones, internal mountings, or wiring.
- Interference from the ignition system, neon signs,or electrical power lines.

- **Content/Topic 2. Re-scanning each infotainment system components operation**

Automotive equipment manufacturers continue to face the challenge of providing in-vehicle infotainment (IVI) systems that delight their customers. Automobile occupants expect to interact with new infotainment systems that are intuitive, powerful and exhibit high quality. For a new IVI system to be viable in the marketplace, it must easily integrate with mobile device features and provide seamless connectivity.

Newer technologies continually increase the expectations of vehicle owners, so IVI manufacturers are under constant pressure to add more features and content. Many vehicle owners also have direct experience with the innovation in computing devices and smartphones, so naturally, they expect the same evolution in newer automobiles.

This additional complexity increases the probability that product defects will occur. Compounding this is the steady pressure to reduce the new product development cycle down from the conventional 4-5 years to aggressive consumer expectation of about 1 year for new product features. Add it all up and it's clear that testing the newer IVI systems can be an extremely challenging effort.

The challenges of testing complex infotainment systems

Owing to its extensive and elaborate functionality, a new infotainment system is now the most complex system in the vehicle. It has a broad-distribution architecture with a wide range of I/O types, a modern infotainment system must support multiple buses, RFs, and wireless connectivity. The IVI must also process huge data volumes and expose several MMI interfaces such as touch screen, multiple user displays, audio I/O, and various switch interfaces.

Taking all this complexity—together with the incessant product innovation and risk of product defects—automotive manufacturers and equipment suppliers have come to these two urgent realizations:

- ✓ Conventional automotive system and software testing tools are quickly becoming inadequate for evaluating and verify newer IVI systems.
- ✓ Because of the diversity and extent of asynchronous I/O, it has become virtually impossible to maintain a manual testing program to test even a subset of all use cases for a new infotainment system.

Autonomous testing platforms are emerging to accommodate highly complex systems

The Functionize testing platform can readily accommodate extensively complex systems such as IVI. Functionize has many capabilities that make it highly suitable for IVI testing, such as accommodating a wide variety of new interfaces, pattern generation from test primitives, support for concurrent testing, image capture, and environment simulation. With Functionize, users can develop function-level or feature-level test cases and automate test execution—much more rapidly than was possible before. Extensive stress, stability, and endurance tests can be built from primitives that will expose any remaining defects or inefficiencies—earlier in the development cycle and well prior to in-vehicle testing.

Addressing the challenges of infotainment system testing

IVI system software presents significant challenges. Electronic control unit (ECU) suppliers specify choose one or several operating systems and software frameworks. Many cars built today contain more than 100 Electronic Control Units (ECUs) and a total of over 10 million lines of software code. While the number and complexity of ECUs in vehicles continue to increase, pressure continues to intensify on manufacturers to ensure the safety and reliability of ECU software.

A particular IVI or ECU software feature can function independently—or it may cooperate with other components to provide more complex functionality. As a software team develops a multitude of features, late arrival of some features will often negate or neutralize some of the original assumptions about expected performance. Moreover, the integration with the IVI system can reveal issues that apparent upstream in the product pipeline. (www.ehow.com/how_7312008_install-double-din-stereo.html)

Achieving thorough and proper testing of the IVI system requires that the team mitigate the most difficult challenges first. Considering the technical complexities of an IVI system, it's unsurprising that these are the top concerns of OEMs and systems suppliers:

- ✓ Huge number of features
- ✓ Numerous interfaces
- ✓ Complex user interfaces
- ✓ Mobile device support—different hardware and software
- ✓ Interactions among many ECUs
- ✓ Adding unplanned features into the current product development lifecycle

An IVI testing solution must take these and other considerations into account. The Functioned testing platform is designed with these and many other platform challenges in mind.

Computer vision can significantly improve testing automation

An area of particular concern to human testers is the visual inspection and verification of display screen feedback. For example, when a driver or passenger selects a different language that is verbose and requires additional space for legible display, most automation platforms fail to handle this correctly. The additional text may overlap another control or button and make it difficult to read properly.

Using enhanced computer vision algorithms, Functioned captures screenshots at every test case step for analysis by machine learning algorithms. Managed by a highly autonomous apparatus, many test cases will repeat and permutated hundreds of times. Even after any display elements have been relocated or altered. This is made possible through a proprietary AI subsystem known as *Adaptive Event Analysis*—a breakthrough technology that clearly distinguishes pages and page-elements that are new or have been relocated during the most recent development cycle.

The challenge of multiple interfaces

A vehicle may have multiple user interfaces, such as the human-machine interface (HMI) device for input and display located on the center console. Another common HMI is the instrument cluster display that is controllable by steering wheel switches. Commonly, there is also an HMI

to control features in the rear of the vehicle. System control design must implement the command hierarchy throughout the vehicle and at each HMI. It should also easily resolve any contradictory instructions or inputs.

To test such a system, the test designs must cover all combinations of each normal use case. Test architecture must also cover undefined or inconsistent inputs. Permutations must be done with respect to timing, order, and cadence to ensure system resilience. The testing systems must also track and I/O and handle pass/fail resolution. Each exception and failure must capture all possible details so that the tester can readily determine the state of each participating device.

Testing automation can be so much better

Here's something to think about: How does your testing automation solution handle all of this? Does it have any capability to test IVI, or systems of such high complexity? Functionize has been built from the ground up to accommodate all of this complexity, and so much more. (https://www.einfochips.com/blog/everything-you-need-to-know-about-in-vehicle-infotainment-system/)

As we wrap up this article, we leave you to consider these Functionize benefits:

- ✓ Automatic test setup—no need for additional investment on test tools or hardware
- ✓ Easily reproduce test case failures
- ✓ Large-scale, highly automatable overnight test capability.
- ✓ Short learning curve for installation and use.
- ✓ Reduces multi-interface/device interoperability cycle time
- ✓ Find many issues that would not be found with manual or conventional automated tests
- ✓ Measure and report on the performance of each test case

LO3.2: Report achieved work.

- **Content/Topic 1.Record and Report preparation on performed work**

Although every shop may enter different information onto the original RO, most ROs contain the following information:

- ✓ Complete customer information
- ✓ Complete vehicle identification
- ✓ The service history of the vehicle
- ✓ The customer's complaint
- ✓ The preliminary diagnosis of the problem
- ✓ An estimate of the amount of time required for the service
- ✓ An estimate of the costs of the parts involved in the service
- ✓ The time the services should be completed
- ✓ The name or other identification of the technician assigned to perform the services
- ✓ The actual services performed with their cost
- ✓ The parts replaced during the services

- ✓ Recommendations for future services
- ✓ The total cost of the services

- **Content/Topic 2. Repair validation Guarantee provision**

Guarantees are usually free and offered by the manufacturer. They are an assurance regarding quality / lifespan with a promise to repair or replace if the product doesn't live up to billing. Often, companies require you to fill out a registration card to validate the guarantee.

Warranties are akin to an insurance policy and are often not free. Standard and extended warranties may last longer than guarantees and may offer wider protection in cases of accidental damage.

You also have statutory rights that apply to everything you buy. These rights set a legal minimum and run in parallel to a warranty or guarantee. A warranty or guarantee does not replace your statutory rights.

If you have or are thinking of getting a manufacturer guarantee or extended warranty from the retailer, always be clear on what it covers – especially if you are paying money for it, as it may only cover part of the item.

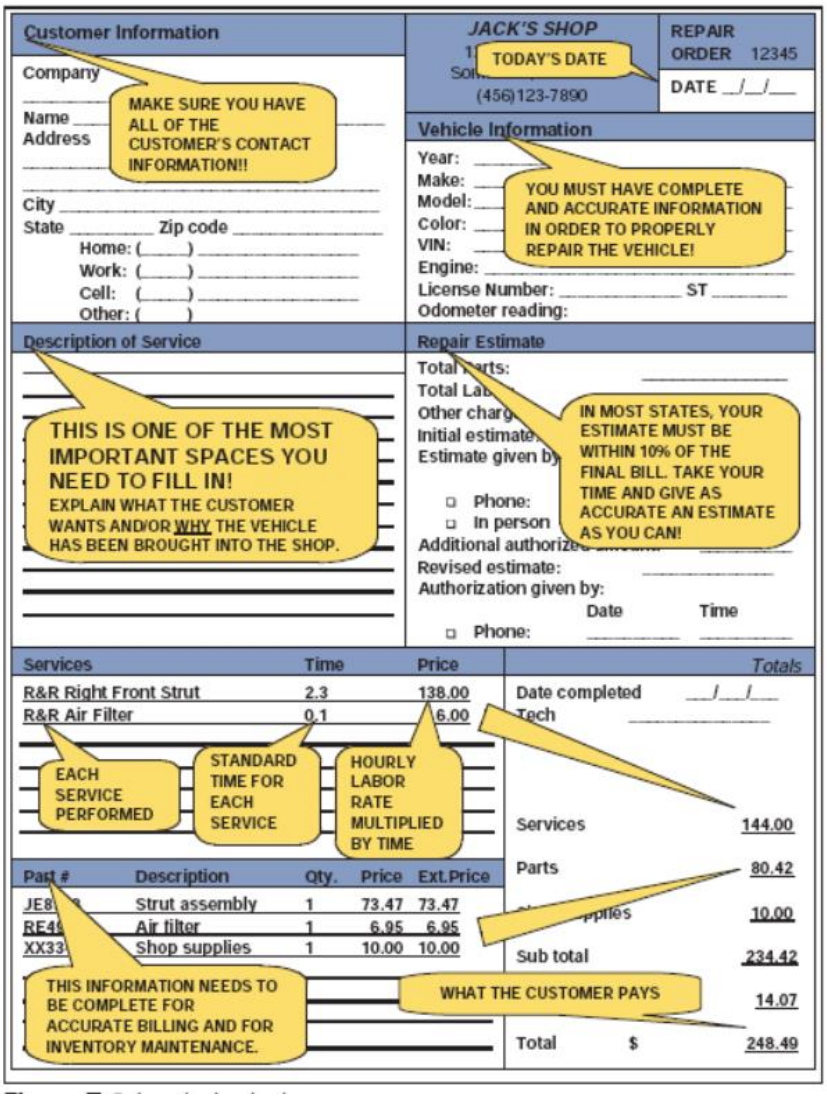
Because a manufacturer warranty or guarantee claim will be a contractual claim, you need to be clear about what it will and won't cover.

- **Content/Topic 3.Repair records(file appropriate documentation for each repair)**

REPAIR ORDERS

A **repair order (RO)** is written for every vehicle brought into the shop for service. ROs may also be called service or work orders. ROs contain information about the customer, the vehicle, the customer's concern or request, an estimate of the cost for the services, and the time the services should be completed. ROs are legal documents that are used for many other purposes, such as payroll and general record keeping . Legally, an RO protects the shop and the customer.

EXAMPLE OF A COMPLETE REPAIR FORM



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