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F01 Head-up Display

Subject **Page**

Head-up Display (HUD)

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Describe the Head-up Display of the F01/F02
- Describe the functions of Head-up Display of the F01/F02
- Identify the components of the Head-up Display of the F01/F02

Introduction

The very name “Head-Up” describes the principle benefit of this system. The Head-up Display (HUD) projects a virtual image into the driver’s field of vision. Important information such as cruise control details or graphical directions from the navigation system are projected onto the windshield and are thus permanently visible within the driver’s field of view.

The driver of a BMW thus has the important data and graphics put up in his field of view, just like a pilot in his jet fighter.

The head-up display in the new BMW 7 Series incorporates various functions aimed at enhancing road safety and driver convenience.

That includes display of:

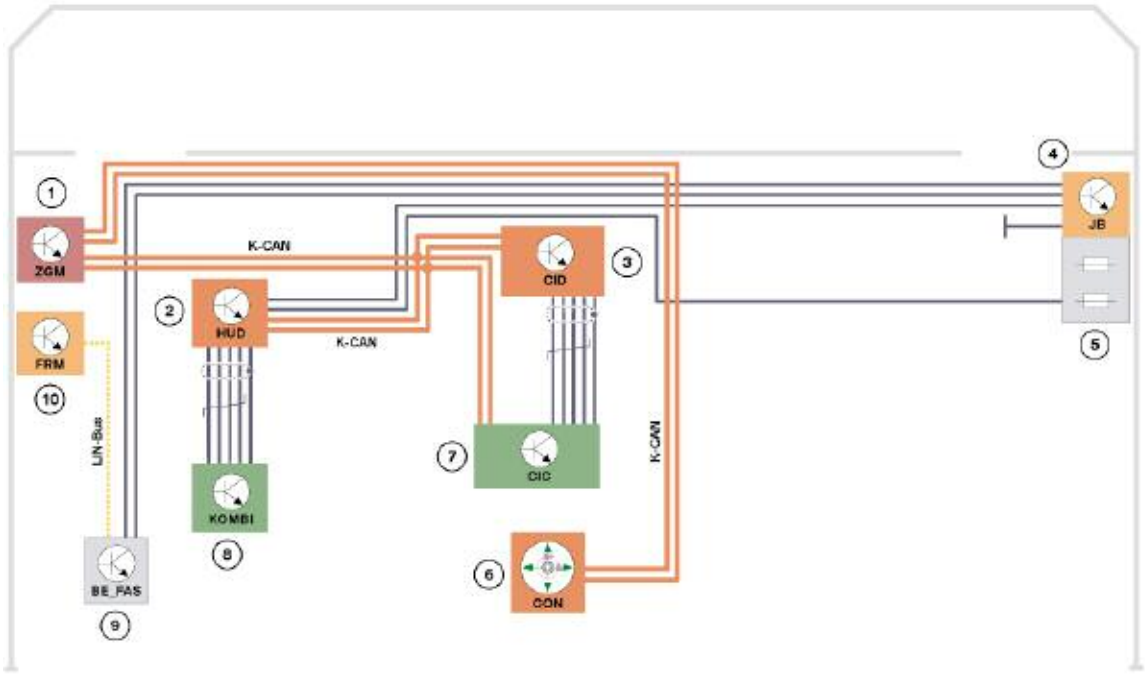
- Information from the DCC cruise control system
- Information from the navigation system
- Check Control messages
- Road speed

Having the displays in the driver’s direct field of view increases safety, as the eyes are always on the traffic.

Head-up Display (HUD) in F01/F02

System Overview

Head-up Display System Schematic Circuit Diagram



Index	Explanation	Index	Explanation
1	Central Gateway Module (ZGM)	7	Car Information Computer (CIC)
2	Head-up display (HUD)	8	Instrument cluster (KOMBI)
3	Central Information Display (CID)	9	Driver assistance system control panel (BAFAS)
4	Junction box (JB)	10	Footwell module (FRM)
5	Front power distribution box	K-CAN	Body controller area network
6	Controller	LIN-Bus	Local Interconnect Network bus

K-CAN signals to HUD control unit

In/out	Information	Source/sink	Function
In	Road speed	Instrument cluster	Display in the HUD
In	Check control message	Instrument cluster	Display in the HUD
In	Dimming/ brightness	Rain and driving light sensor (RLS) via roof function Center (FZD)	Brightness adjustment
In	Height adjustment	CIC	Height adjustment
In	Brightness offset	CIC	Brightness adjustment
In	DCC	EHB3 (Adaptive Brake Assistant Warning)	Display in the HUD
In	Function selection	CIC	What is displayed in the HUD
In	On/Off switch	BAFAS	Switching the HUD On/Off
In	Navigation	CIC	Display in the HUD

System Functions

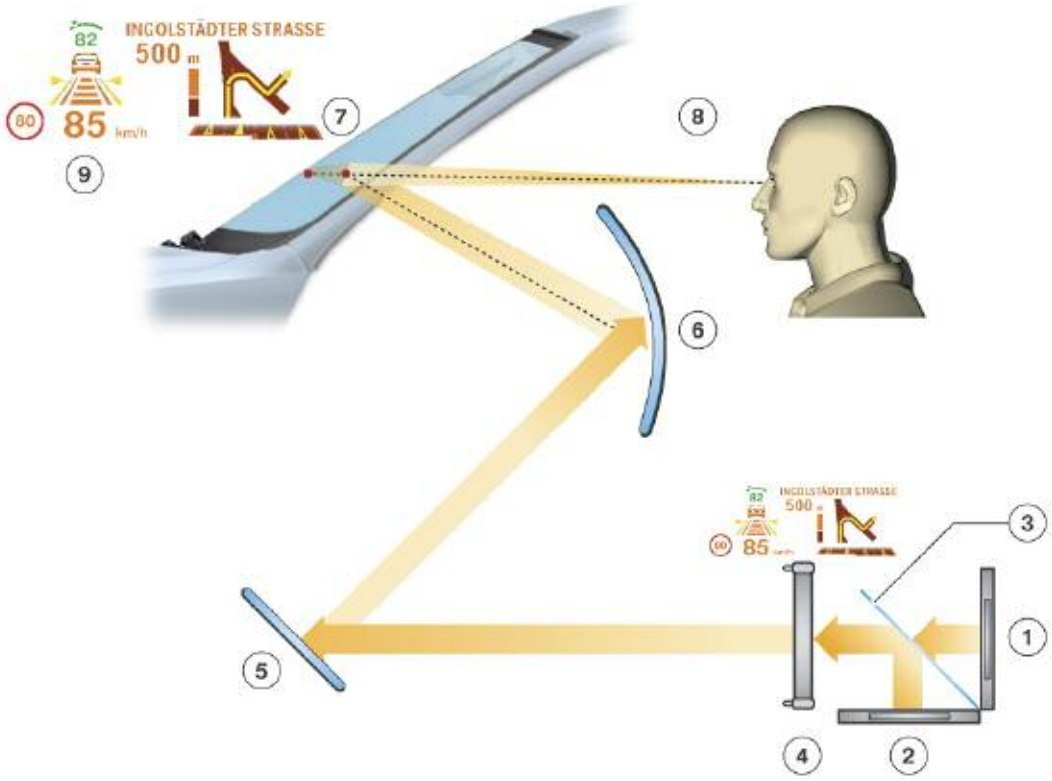
The Principle

The HUD can be compared to a projection device. A light source is required to project the HUD information. The two LED arrays (red and green) serve as the light source. The image content is created by the TFT projection display. The TFT projection display can be compared to a filter which admits or blocks light.

An optical imaging element determines the shape, distance and size of the HUD images.

The image appears to float freely over the road, the windshield acts as a deflecting mirror.

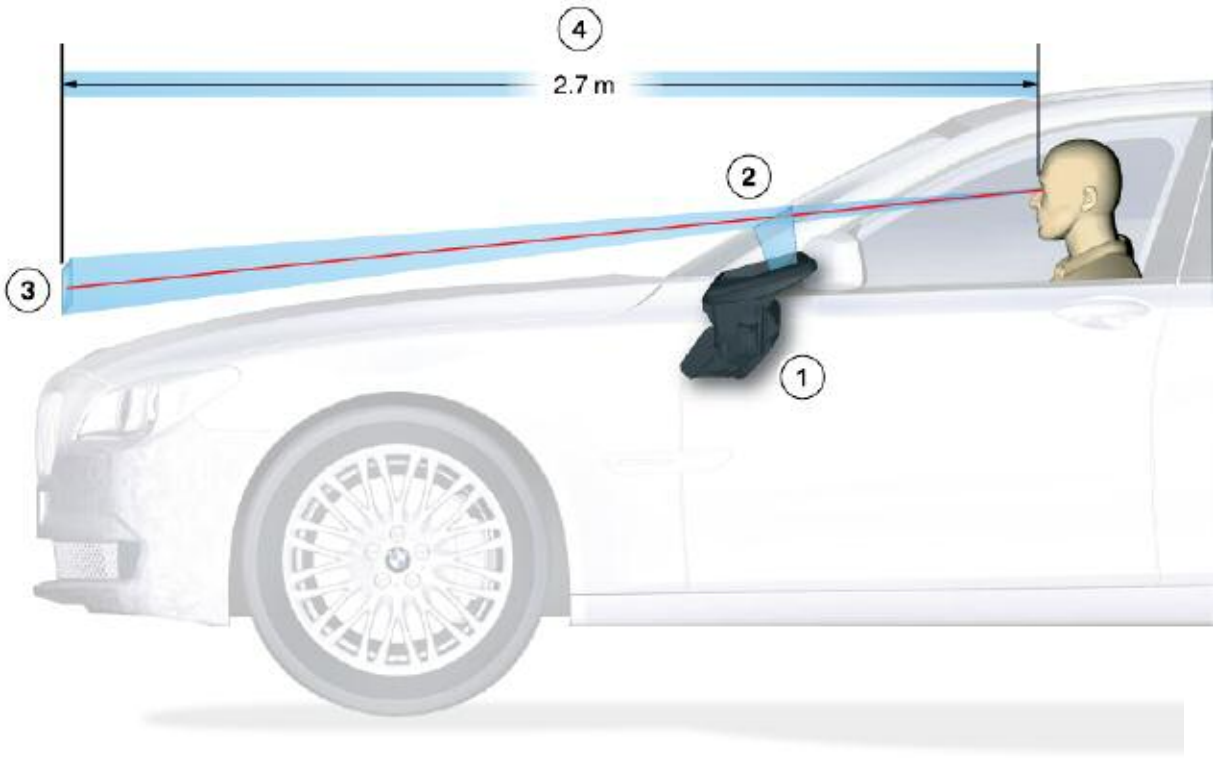
Principle of the head-up display



Index	Explanation	Index	Explanation
1	LED array, green	6	Curved mirror
2	LED array, red	7	Windshield
3	Transparent mirror	8	Observer's point of vision
4	TFT projection display	9	Projected image
5	Plane mirror		

Projection Distance

The projected HUD image content appears at a distance of approximately 2.7 m from the observer's eye.



Projection distance

Index	Explanation	Index	Explanation
1	Head-up display	3	Projected Image
2	Windshield	4	Projected distance

Switch-on Conditions

The following conditions are required to release the light:

- Terminal 15 ON
- Button (HUD) pressed on the driver assistance system control panel, BEFAS.

Switch-on Performance

The HUD receives the terminal 30 ON status via the K-CAN. The HUD is partially ready for operation from terminal R ON. That means that:

- The HUD can communicate with the other electrical-system devices via the K-CAN
- The TFT projection display is initialized and blanked
- The LEDs are off.

The HUD receives the terminal 15 ON status via the K-CAN. The HUD is ready for operation from terminal 15 ON. This permits the following actions:

- Switching on of the backlighting by the button on the BAFAS
- HUD height adjustment
- Adjustment of HUD brightness
- Display of information via the HUD.

When the vehicle is started, the vehicle is set to terminal 50 status. In terminal 50, i.e. Lights Off, the HUD goes into a hold status. This hold status is maintained until shortly after the end of the terminal 50 status.

ON/OFF button on the BAFAS

Switch-off Conditions

The HUD is switched off under the following conditions:

- Button on the BAFAS pressed
- Terminal R OFF

Brightness Offset

Brightness offset is a PIA Personal Profile function. Brightness offset allows the customer to set and save his/her own individual HUD default brightness setting. Each time the HUD is switched on, this setting is used as the brightness offset for the HUD.

The brightness setting is adjusted with the controller via the CID. Any value between -10 and +10 can be set. The mid-position value is 0.

The value is transferred via the K-CAN to the HUD.

Brightness setting

The brightness setting is automatically corrected in order to compensate for different light conditions. Compensation is based on signals from the rain and light sensor.

The automatic brightness setting is configured in such a way that no HUD brightness jumps occur.

The differing light conditions depend, for instance, on:

- Environmental conditions, such as day, night, sunshine, clouds, rain, fog, snow, etc.
- Surrounding structural features, such as tunnels, underground car parks, etc.
- The driver can adjust the brightness of the instrument lighting with the knurled wheel.
- From terminal 58g lights on, the HUD brightness is determined by the brightness setting of the instrument lighting.

The brightness is dependent on the following conditions:

- Dimmer-wheel setting
- Brightness offset
- Rain/light sensor, RLS

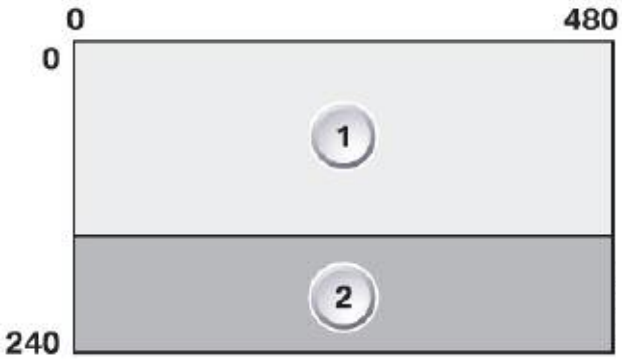
Operating-hours Counter

The HUD incorporates individual service-time counters for the HUD and the LED arrays.

Display Area of Head-up Display

The HUD size is approximately 200 mm x 100 mm with a display resolution of 480 x 240 pixels. The HUD is separated into 2 display areas. The individual fields are “optically” separated in the image so that they can be identified more easily.

Display area in the head-up display



Index	Explanation
1	Navigation/CC display area
2	Road speed/Cruise control display area

The upper area shows navigation information and CC messages in the form of symbol, bar display and text.

The lower area shows speed-related displays in the form of unit, current speed and cruise control.

Color Selection
Symbols (such as e.g. warning symbols) are specified by the individual control units. The color specifications are adopted by the instrument cluster for display and representation on the HUD.

“Flat” 2D symbols are used for optimum visibility and readability.

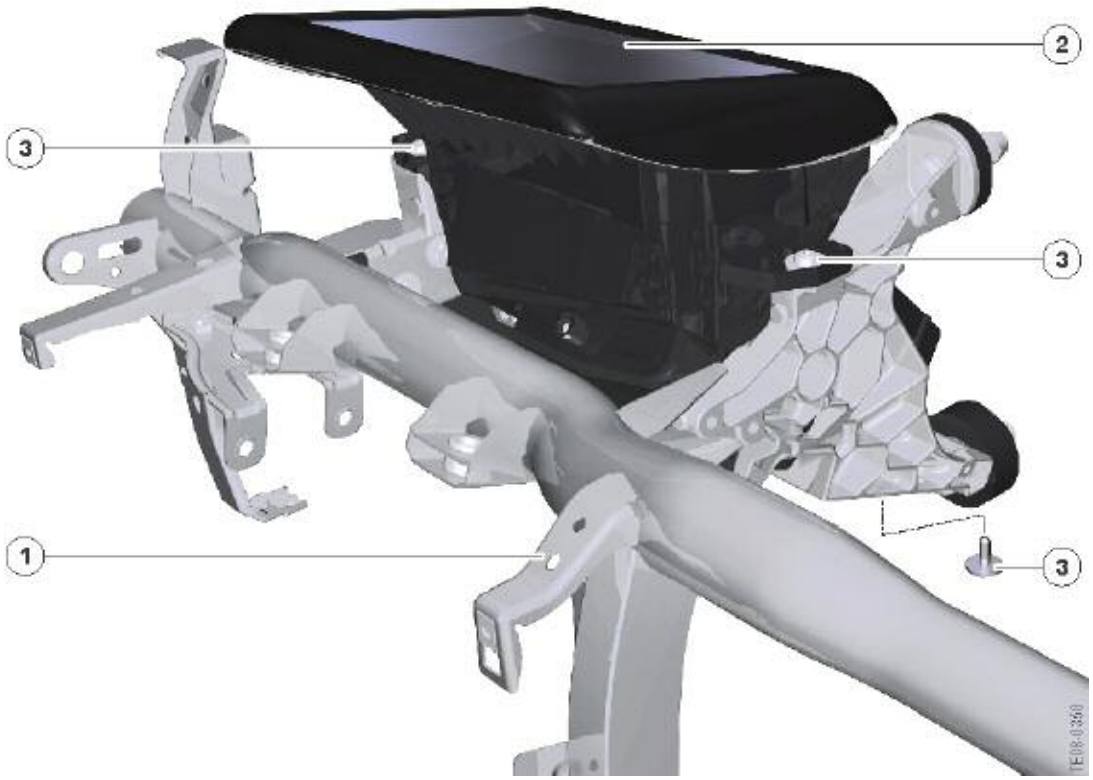
The colors are:

- Orange as the standard color
- Red or yellow for warning messages
- Green for the set speed
- The HUD background is transparent

System Components

The head-up display is fitted above the steering column, immediately behind the instrument cluster. It is fastened to the bulkhead supporting structure by three hexagon-head bolts.

Location of head-up display (HUD) in F01/F02



Index	Explanation	Index	Explanation
1	Carrier bracket	3	Hexagon bolt
2	Head-up display HUD		

The head-up display comprises the following components:

- Cover glass
- Mirrors
- 2 LED arrays
- TFT projection display
- PCB
- Housing

The following components are required in addition to the components listed above:

- Windshield
- Light module and BEFAS
- Rain/light sensor
- Roof function Center and junction box
- HUD trim

The following controls are required to operate the HUD:

- On/Off button on the BEFAS
- Light switch in the light switch cluster
- Instrument-lighting dimmer
- Controller

Cover Glass

The cover glass is made from scratch-resistant, coated polycarbonate (PC) and forms the top cover of the HUD. The cover glass protects the interior of the HUD against dust and objects accidentally placed on it.

The glass combined with the HUD trim are curved so that any incident light is not reflected back to the driver.

It also guarantees unobstructed projection of the display information onto the windshield without interference from stray light effects, for instance.

Plane mirror

Mirrors

Two mirrors are fitted in the head-up display. They reflect the information in the display onto the windshield.

The concave mirror (1) is responsible for compensating for the curvature of the windshield and for the size and distance of the image.

The flat mirror (2) is a deflecting mirror to keep the beam in the space provided.

The convex mirror is made of plastic while the flat mirror is made of glass.

Index	Explanation
1	Curved mirror
2	Plane mirror

Mirrors in the HUD

LED Array

There are two LED arrays. The LED array is an arrangement of LEDs in one plane and acts as the back lighting for the TFT projection display. The LED array generates the light required for the HUD brightness. The LED arrays consist of red and green LEDs. The LEDs generate the brightness of the HUD content as controlled by the master PCB.

PCB

The following components among others are incorporated on the PCB:

- K-CAN interface
- Processor (CPU)
- LVDS controller
- EEPROM memory
- Power supply

The video signals are passed on to the display by the instrument cluster via an LVDS lead.

Housing

The casing is made of aluminum and consists of a bottom section and the plastic cover. The (aluminum) cooling fins and the electrical power supply are attached to the bottom section. The cover glass is integrated into the cover.

Windshield

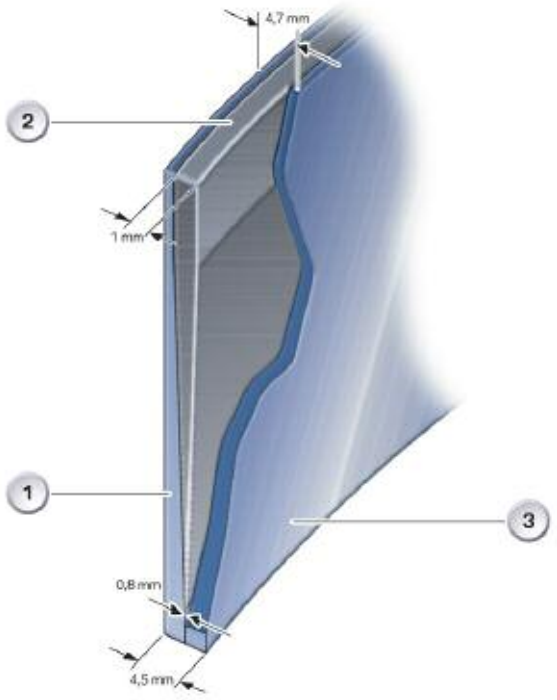
The windshield is a “special design” that is essential for projection of the displays. The outer and inner glass panes are bonded to a plastic film, just like in the standard windshield. Unlike in the standard windshield, this plastic film is not parallel but is tapered over the entire area of the windshield.

The taper prevents the HUD from displaying images twice. The taper tip points downwards and starts at a distance of approximately 10 cm to the bottom edge of the windshield.

The end of the taper is located at approximately 2/3 windshield height. In the top third of the windshield, the plastic film runs parallel to the outer and inner glass panes. The thickness of the taper tip is 0.8 mm. The thickness of the end of the taper is 1 mm.

The total thickness of the bottom edge of the windshield is 4.5 mm. The total thickness of the top edge of the windshield is 4.7 mm.

Windshield

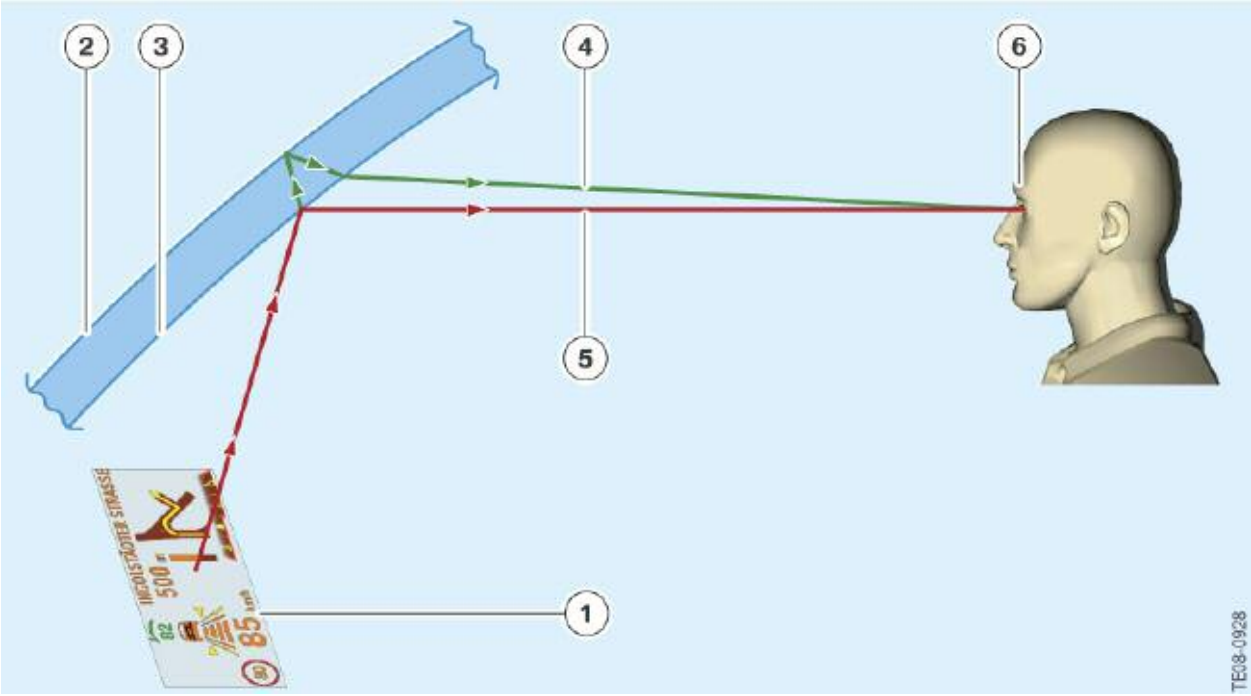


Index	Explanation	Index	Explanation
1	Outer glass pane	3	Inner glass pane
2	Plastic film	mm	Unit of measurement in mm

Incorrect Windshield Fitted

The HUD image is always reflected on the These two images are overlaid by the angle of inner surface and outer surface of the taper in the HUD screen, so that the driver windshield only sees “one” image.

Double reflection



Index	Explanation	Index	Explanation
1	Display	4	Reflection on the outer surface of the windshield
2	Outer surface of the windshield	5	Reflection on the inner surface of the windshield
3	Inner surface of the windshield	6	

Because of the angle of tilt of the glass in a standard windshield, the two reflected images are offset against one another.

The illustration below shows the result when a Rain/light sensor standard windshield is fitted.

Double display by HUD

The rain and light sensor provides the brightness signal over the LIN bus to the roof function Center FZD and then to the K-CAN.

Eyebox

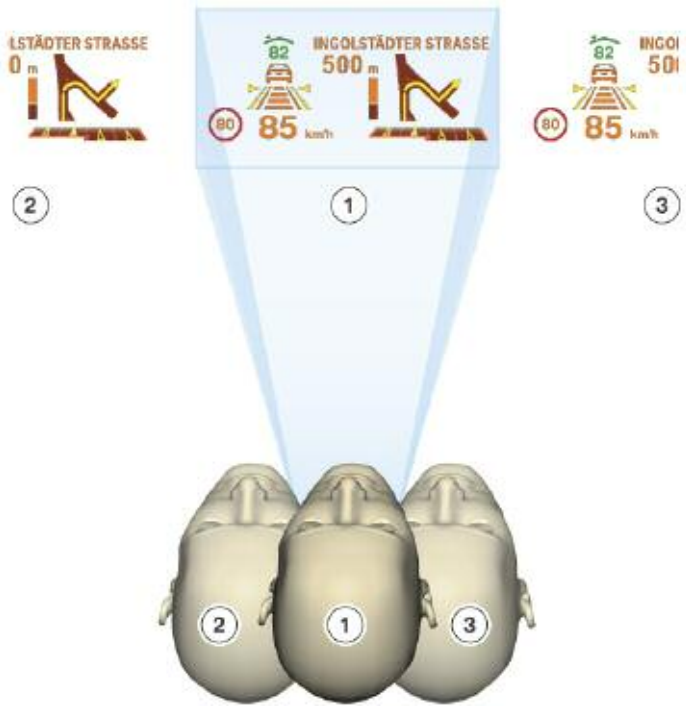
The eyebox is the movement space in which the driver can move without his view of the image in the HUD being impaired.

The freedom of movement within the eyebox is roughly:

- 70 mm vertically plus ± 30 mm range of adjustment
- 130 mm horizontally.

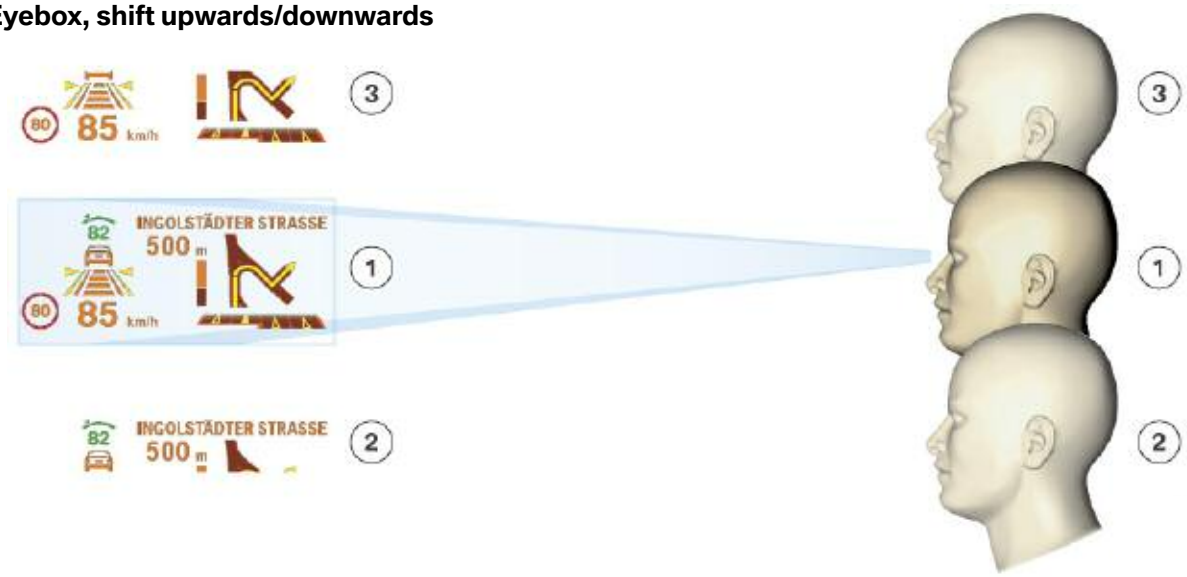
The HUD image is not clearly visible outside the eyebox limits.

Eyebox, shift to the left/to the right



Index	Point of vision	HUD image
1	Within the eyebox	Optimum illumination of the image
2	Offset to the left	Image cut off on the left
3	Offset to the right	Image cut off on the right

Eyebox, shift upwards/downwards



Index	Point of vision	HUD image
1	Within the eyebox	Optimum illumination of the image
2	Offset downwards	Image cut off at the bottom
3	Offset upwards	Image cut off at the top

Instrument Cluster

For the purposes of filtering the speed reading, a distinction is made between acceleration, braking and coasting phases.

When the car is in the coasting phase, 3 successive values are averaged and then the speed is updated.

Check Control Messages

All CC messages are also displayed on the HUD. The instrument cluster has the master function for the messages. The symbol together with the associated text is transmitted by the instrument cluster. CC messages are given precedence over the display of other information such as navigation-system directions, for instance.

Note: A Check Control message is displayed for 8 seconds. If several CC messages occur simultaneously, each one is displayed for 3 seconds.

Controls

The following controls are used in the operation of the HUD:

- ON/OFF button on the BEFAS
- Dimmer wheel in the light switch cluster
- Controller.

Driver Assistance System Control Panel
The HUD On/Off button is located on the BEFAS. The button is resistance-coded and routed directly to the HUD. The HUD can identify the button signals or a button fault using the resistance coding.

ON/OFF button on the BEFAS

Instrument-lighting Dimming
The dimmer setting is also used for the HUD with active headlights. The dimmer signal is emitted by the light module.

Instrument-lighting dimming

Controller
The HUD brightness and height settings are adjusted with the Controller via the CID. Brightness setting is also termed brightness offset.

Functions such as e.g. navigation can also be set with the Controller in the Function selection menu. Therefore these settings have an indirect effect on the HUD display.

Service Information

The following information for the technician is described in this section:

- Adjusting the brightness
- Adjusting the height of the horizon on the HUD
- Vertical rotation of the image
- Test functions
- Replacing the HUD
- HUD
- Diagnostics

Adjusting the Brightness

The brightness of the HUD can be individually adjusted. The CID is the display instrument and the controller the control element for brightness adjustment.

The brightness is set as follows:

- Call up the main menu by pressing the menu button.
- Press the Controller and select the menu option “Settings”.
- Turn the Controller until “Head-up display” is selected on the menu bar and then press the Controller to confirm selection.
- Turn the Controller until “Brightness” is selected and then confirm.
- Set the desired brightness by turning the Controller and confirm by pressing.

Adjusting the brightness

Adjusting the Height of the Horizon on the HUD

On the BMW 7 Series F01/F02, the driver can adjust the location of the image and the eyebox to suit his/her particular requirements using the iDrive controller.

The eyebox can be shifted up to a maximum of ± 30 mm upwards or downwards.

The height setting is adjusted as follows:

- Call up the main menu by pressing the menu button.
- Press the Controller and select the menu option “Settings”.
- Turn the Controller until “Head-up display” is selected and then press the Controller to confirm selection.
- Turn the Controller until “Height setting” is selected and then press to confirm.
- Set the desired height by turning the Controller and confirm by pressing.

Note: The height can only be adjusted when the HUD is active.

The height adjustment is in the scope of the PIA. The setting is stored in the EEPROM for each key. If the signal “Radio remote key status” is received when Terminal 30 is on, the mirror moves to the position set for the current key.

The mirror remains in that position as long as the HUD is switched on.

Vertical Rotation of the HUD

The HUD is supplied as standard with a defined basic setting. The HUD image can be rotated in the horizontal by a service technician using vertical rotation, after a change of windshield, for instance.

The display is adjustable within a range of -3° to +3° by means of a motor.

Detailed information may be found in the BMW diagnostic system.

Test Functions

Calling/quitting Test Functions

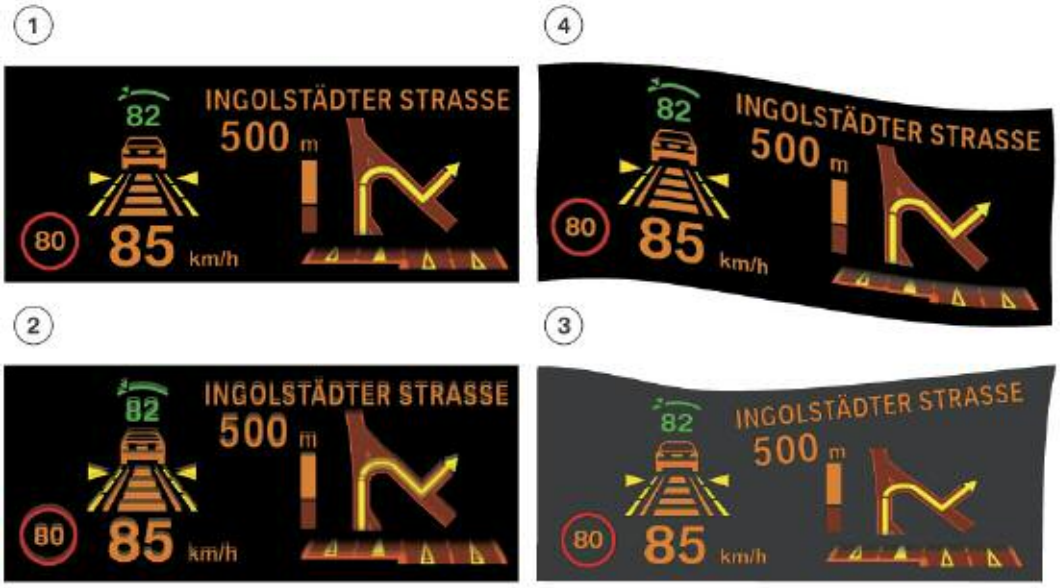
Certain test functions may be also invoked directly on the HUD without using a BMW diagnostic system, as follows:

- Press and hold the button on the BEFAS for approximately 20 seconds and then release.
- Call up further test functions by pressing the button again.
- To exit this function, press and hold the button on the BEFAS for more than 20 seconds.

Replacing the HUD

Image Defects

Incorrect installation of the HUD or of the windshield may result in faulty HUD projections.



HUD image defects

HUD Image defects are explained as follows:

- Image 1 is compressed, (windshield installed incorrectly)
- Image 2 is duplicated, (wrong windshield installed)
- Images 3 and 4 are distorted, the HUD has been fitted incorrectly

The image is blanked out by light striking the windshield or the HUD in unfavorable light conditions. Excessive heat in the HUD will also cause the image to fade.

Image defect caused by incident light or overheating in the HUD

Correcting Distortion (Warping)
Should the image be distorted after a change of windshield, the image display can be improved using the Warping function. Warping is the technical term for the improvement of the image display.

Detailed information on the subject of warping can be found in the BMW diagnostic system.

Diagnosis

The most important functions for service can be called up in diagnosis.
These functions are:

- Initiate self-test
- Read out fault memory
- Delete fault memory
- Read out status
- Specify status

The following errors/faults are stored in the HUD and can be read out with the aid of the diagnosis program:

- Communication faults with the connected bus systems
- Internal HUD faults

Sleep Mode

The following functions are possible in sleep mode:

- Terminal 30b OFF,
  - HUD is switched off completely
- Terminal 30b ON,
  - Monitor K-CAN
- Terminal R soft,
  - Display and LED array off
  - Switch query
  - Diagnostics
  - System test (no display of test cards)
  - Flash program
  - Output data to the display
- Terminal 15 soft,
  - LED array on