666001 Gearbox Controller Manual

Scania SBAT TGB 30 / TGB 40

Operator • Setup • Diagnostics

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Introduction

This manual describes the upgraded gearbox controller developed for Scania SBAT TGB 30 / TGB 40 equipped with the original GA763 gearbox and transferase. The purpose of the controller is to replace the original electric control unit while retaining the functional operating principle of the transmission system as well as additional functionality. The gearbox is a fully automatic hydraulic main gearbox with four forward gears and one reverse, integrated with a compressed-air controlled transferase.

The upgraded controller is designed to preserve the original control philosophy and signal structure of the drivetrain. This includes the original selector positions R, N, D, S and TS, the normal shift sequence H1-H2-H3-M3, the engine-brake sequence M3-H3-H2-H1, the transfer gearbox selections ROAD, TERRAIN and DD, automatic front wheel drive engagement in TERRAIN, and the original requirement that winch power take-off is only enabled in TERRAIN.

Compared with the original automatic gear selector, the updated controller adds extended operating and service functions, including selectable control programs, CAN-based user interface support, live telemetry, calibration routines, configurable shift parameters, emergency operation, diagnostic output testing, and expanded supervision of selector plausibility, confirmation signals, transfer-case feedback, and output-to-feedback consistency.

This manual covers system description, installation, input and output assignment, operating modes, calibration, diagnostics, fault handling and commissioning of the upgraded controller. It is intended for to operators and service personnel familiar with the original transmission system, vehicle wiring, pneumatic interfaces and gearbox operating logic. Before the controller is put into service, all gearbox, transfer gearbox.

This manual is intended primarily as an operator manual for the upgraded gearbox controller, part number 666001. It also serves as a practical reference for installation, commissioning, diagnostics and maintenance. Compared with the original controller, routine checks and system verification are significantly easier to carry out, because the upgraded controller provides direct access to operating states, fault information, confirmation signals and diagnostic test functions. For that reason, this manual covers both daily vehicle operation and the technical procedures required to verify gearbox, transfer gearbox, winch and safety functions during commissioning and service.

Gearbox controller

The upgraded gearbox controller is the central logic unit of the transmission control system. It reads the vehicle input signals and speed signal, processes the selected operating logic, and drives the gearbox and transfer-case control outputs accordingly. In the original GA763 system, the gearbox and transfer box are controlled via an electric control system, and the original automatic gearbox controller is the computerized logic unit that converts selector and switch inputs plus the speed-sensor signal into output signals for the solenoid valves.

The upgraded controller is designed so that, in Original mode, it behaves like the original gearbox controller. At the same time, it adds user-unit support, diagnostics, monitoring, telemetry, emergency functions and additional safety logic.

Hardware concept

The controller is built around a **microcontroller-based main control board**. The microcontroller reads the vehicle inputs, evaluates the speed signal, runs the gearbox logic, and drives the output stages. The output stages actuate the gearbox and transfer-case control functions through **relays**, and these relays are in turn controlled by the microcontroller.

The controller consists of **two PCBs**:

- a **main PCB**, carrying the microcontroller and all active control electronics
- a **secondary PCB**, used mainly to bring the second connector into the main PCB system

The controller is supplied in a **3D-printed housing**, but it can also be installed in the **original housing**. When the original housing is used, direct rear integration of the **emergency-shifting connection** and the **RJ45 connection** is no longer possible in the same way as with the 3D-printed version. In that case, an adapter must be used to route these connections to the vehicle-mounted connector and the RJ45 socket must be removed, from where they can still be connected.

The controller includes electrical protection features such as:

- **reverse-polarity protection**
- **overvoltage protection**

These protection functions are part of the controller hardware and do not change the operating logic.

Basic control principle

Like the original controller, the upgraded controller reads the vehicle-side control inputs, interprets them according to the active operating mode, and commands the gearbox and transfer-case outputs.

The gearbox controller is driven by the speed sensor and the gear selector / switch inputs, and the speed-sensor frequency controls the automatic upshift and downshift logic.

The upgraded controller follows the same basic principle, but expands it with additional programmable and diagnostic functions.

Input signals

The controller reads the same practical vehicle-side control information as the original gearbox controller.

Main selector and operating inputs

- **R** — Reverse selector
- **N** — Neutral selector
- **D** — Drive selector
- **S** — S / Gear 2 selector
- **TS** — Tow Start selector

Transfer / auxiliary inputs

- **DD** — Drive disengagement / DD input
- **TER** — Terrain transfer input
- **PW** — Winch
- **TB** — Engine brake / terrain brake input

Driver / engine-related inputs

- **AC** — Accelerator pedal switch input
- **BR** — Brake switch input

Additional emergency and mode-related inputs

- **MAN** — small analog user-unit mode selection
- **UP** — SUU upshift button input
- **DOWN** — SUU downshift button input
- **POT** — SUU potentiometer input
- **EMG** — external emergency-shifting input
- **Display button** — local OLED

Speed signal

- the controller reads the gearbox speed sensor signal in **Hz**

In the original system, the speed sensor is a frequency-based signal source used by the automatic gear selector for shift logic.
The upgraded controller uses the same principle and extends it with additional frequency supervision and safety logic.

Output functions and confirmation monitoring

The upgraded controller drives the same functional gearbox and transfer-case outputs as the original controller concept. These functions include the gearbox outputs for G1, G2, G3, GM and GR, as well as the transfer and auxiliary outputs for TC, R, T and TB. Functionally, this corresponds to the original electric control system.

These include:

- **G1** — Gear 1 output
- **G2** — Gear 2 output
- **G3** — Gear 3 output
- **GM** — Mechanical gear output
- **GR** — Reverse output
- **TC** — Torque converter / torque converter reduction control
- **R** — Road output
- **T** — Terrain output
- **TB** — Terrain brake output

The difference is that the upgraded controller does not only command these functions. It also reads the corresponding gearbox and transfer-case confirmation signals for all of them and continuously checks whether the commanded state was actually reached. In other words, all relevant output functions are verified by feedback.

This gives the controller the ability to:

- verify actual gearbox and transfer-case signal state
- detect command/feedback mismatches
- report diagnostic faults
- improve troubleshooting and serviceability compared with the original controller

Original compatibility

A central design goal of the upgraded controller is compatibility with the original vehicle system.

This means:

- it uses the original-style input logic
- it drives the original-style gearbox and transfer-case functions
- it supports the original selector logic
- it supports the original transfer-case logic
- it supports the original winch-related interlocks
- in **Original mode**, it behaves like the original gearbox controller
- it uses the same electrical connections
- it uses the same housing mounts and place

So if the system is operated in **Original mode**, the controller reproduces the original control behavior rather than forcing the user into the extended program modes.

Additional functions beyond the original controller

I
n addition to original-mode behavior, the upgraded controller provides a large number of extra functions.

These include:

- support for the **BUU** and **SUU**
- selectable alternative shift programs
- programmable **FS** and **FO** modes
- diagnostic output testing
- visual fault and state indication
- telemetry and communication functions
- input/output monitoring
- mismatch detection between output command and feedback
- local OLED service display
- potentiometer shift variation and user setup functions

So the upgraded controller keeps original compatibility, but adds a much higher level of configurability and transparency for the driver and for maintenance.

Driver-side user-unit support

The controller can be used with:

- the **SUU** — small analog user unit
- the **BUU** — big user unit with display and CAN communication

This gives the driver the ability to operate the transmission either in a simple analog style or with the expanded display, setup and diagnostic functions of the BUU.

The BUU and SUU therefore extend the controller beyond the fixed original behavior and allow the transmission to be configured and operated in a way that better matches the operator’s needs.

Monitoring and diagnostics

All important output functions are monitored by feedback / confirmation signals.

This means the controller can check whether:

- an output was commanded
- the expected gearbox or transfer-case confirmation followed
- the requested state and the real state match

As a result, the upgraded controller can detect problems such as:

- output/feedback mismatch
- selector ambiguity
- invalid confirmation combinations
- transfer-case confirmation faults
- speed-signal failures

This greatly improves troubleshooting compared with the original controller, because the driver or technician receives direct visual fault information instead of having to infer faults indirectly.

Emergency capability

The controller system provides **two different emergency-shifting paths**.

One is the **EMG mode** inside the controller logic.
The other is the **external emergency-shifting path**, which bypasses the controller logic and shifts the gearbox through a separate fixed relay circuit using the same output lines.

This means the system is not dependent on only one control path.

In practical terms, this gives the vehicle a very high degree of redundancy. As long as the gearbox itself and the vehicle wiring to the gearbox remain functional, failure of the normal control path does not necessarily mean loss of mobility.

- the system is designed so that, if the gearbox hardware and gearbox wiring remain intact, there are two independent emergency-shifting possibilities available

That is a strong practical reliability advantage of the upgraded system.

Additional safety functions

The upgraded controller also adds safety functions that the original controller did not provide in this form, and these safety functions also work in Original mode.

Examples include:

- blocking **Tow Start** at excessive speed
- blocking winch engagement at excessive or invalid operating speed
- blocking other selector requests that are not safe at the current speed
- output/feedback mismatch supervision
- speed-signal loss protection
- selector ambiguity blocking
- impossible confirmation-state blocking

These functions are intended to prevent damage and unsafe engagement conditions.

So even when the controller is being used in a way that feels original to the operator, the protective logic in the background is more advanced than in the original system.

Transfer-case shifting conditions and behavior

Transfer states and request latching

The upgraded controller manages three transfer states: DD, T and R. DD is the drive-disconnect state. T and R are the two stored transfer states that are reached by pulsing the Terrain or Road outputs and then checking the related signal confirmations. When the selector request and the stored transfer state no longer match while DD is not active, the controller latches a pending transfer request. A latched request does not mean that the pulse is executed immediately. It means the request is stored and will be executed later as soon as the switching conditions are fulfilled.

When a transfer change is permitted to execute

A latched T/R change is executed only when the transfer manager allows it. For Road or Terrain switching, DD must be inactive, Tow Start must not be active, and the gearbox output-speed value must be below about 100 Hz. Outside EMG, the controller only executes the transfer pulse when the torque-converter confirmation is released or when the gearbox is in Neutral. In EMG, the controller allows transfer switching only in N, H1 or R, again below the same speed limit.

Execution behavior and confirmation check

When the conditions are met, the controller drives a Road or Terrain pulse for about 2.5 seconds. While pulse it checks the corresponding Road and Terrain signal confirmations. If the expected confirmation is reached, the new transfer state is stored. If the confirmation does not match, the controller can latch an F3 indication such as RO or TER. If the selector request changes while a transfer pulse is already running, the controller first completes the active pulse and can then chase immediately with the opposite pulse so that the final stored state matches the selector request.

DD and DIAG behavior

If DD becomes active, any pending Road/Terrain request is cancelled and the stored transfer state is set to DD. While DIAG output mode is active, the transfer manager is frozen completely. No transfer scheduling or pulsing is executed. When DIAG is left, the controller forces one fresh transfer pulse from the current selector state so that the stored transfer state is synchronized again.

Safety warning for EMG

In EMG, a transfer request can be latched even though it is not yet permitted to execute. Because EMG allows transfer switching only in N, H1 or R, a request made while driving in H2 or H3 can remain pending. If the driver later downshifts from H2 / H3 to H1, the previously latched transfer change can then be executed at that moment. For that reason, changing transfer state in EMG while the vehicle is still moving is not recommended. The safer procedure is to stop, or reduce to a very low safe speed, before requesting the transfer change. This is especially important because EMG does not use the normal protected drive-program behavior.

Mechanical and installation concept

The controller is delivered in a new housing and can also be adapted to the **original housing**.

This gives two installation directions:

New housing

- easier integration of the additional connections
- easier access to extra functions such as emergency shifting and RJ45 connection
- rubber mounts for vibration damping

Original housing

- retains the original installation concept and appearance more closely
- requires an adapter arrangement for the additional external connections

So the controller can be installed either with emphasis on original appearance or with emphasis on simpler access to the extended functions.

Short description

The upgraded gearbox controller is a microcontroller-based, relay-driven control unit for the Scania TGB gearbox and transfer-case system. It reads the original-style vehicle inputs, the speed signal and the confirmation signals, and drives the same functional gearbox and transfer-case outputs as the original controller. In Original mode it behaves like the original controller, but it adds BUU/SUU support, diagnostics, monitoring, programmable modes, advanced safety functions and two independent emergency-shifting paths. Its hardware consists of a main PCB and a secondary connector PCB, protected against reverse polarity and overvoltage, and it can be installed either in its 3D-printed housing or in the original housing with the appropriate adapter solution.

Installation

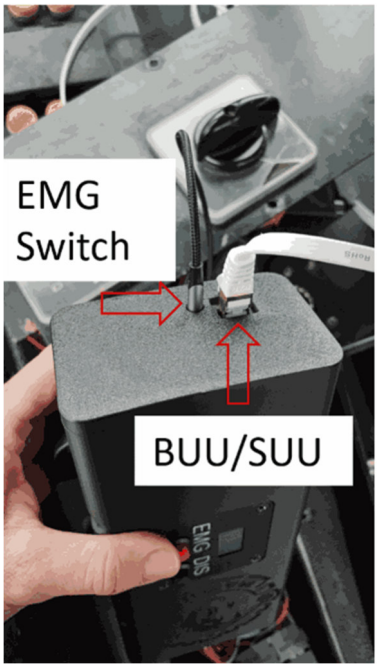
Mount the controller like the original control unit. The controller can be mounted on the original plate; see the picture below.

When mounting the controller on the original plate it is recommended to:

Tighten the mounting screws until the rubber boots are compressed

Ensure that the screw engages past the locking ring of the nut

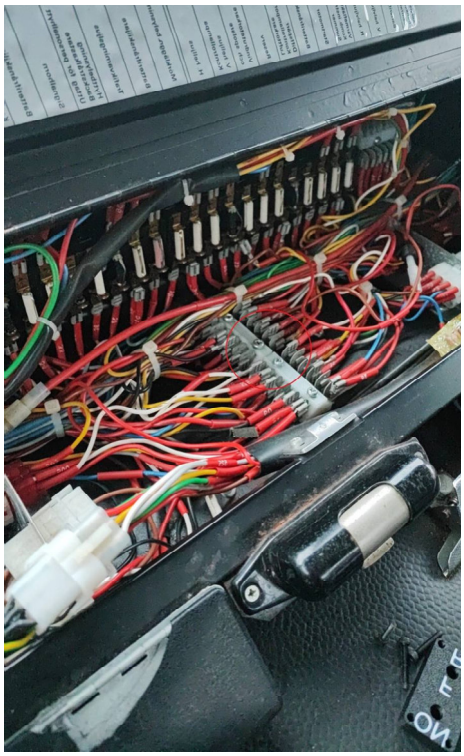
Connect the EMG and UU cables, as well as the main cables.



Connect the SUU or BUU

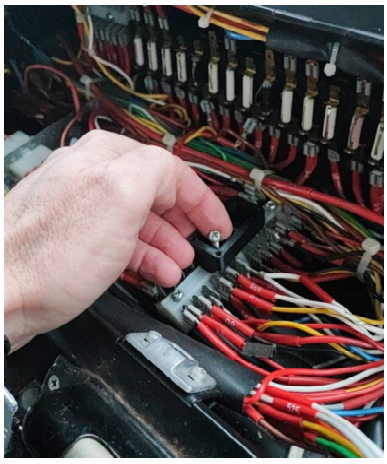
Mount and connect the emergency unit

Remove the screws in the fuse compartment.

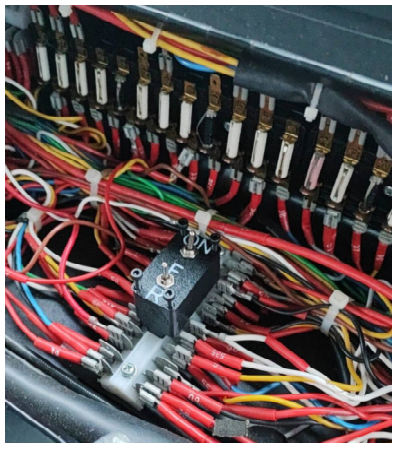


Remove the screws from the emergency unit, as shown below, and separate the lower part of the emergency unit.

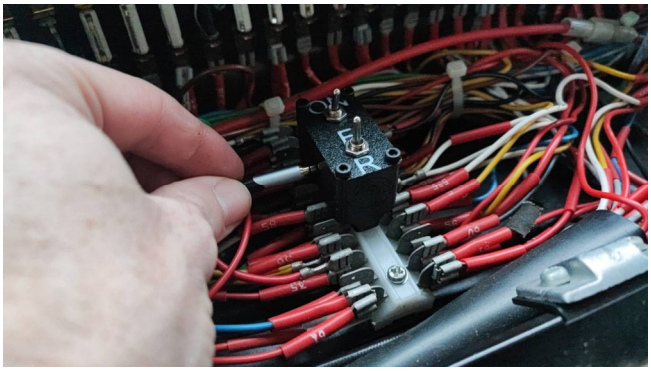
Mount the lower part of the emergency unit using the screws removed in step 3.1.



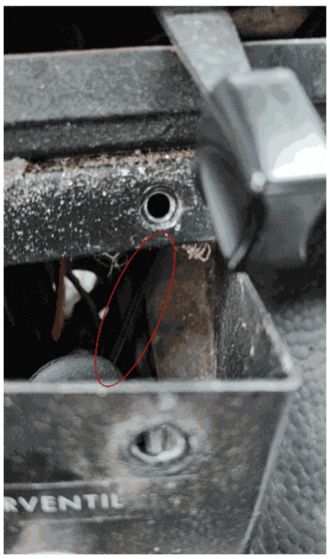
Refit the screws removed in step 3.2.



Connect the emergency switch.



Remove the panels, route the cable from the emergency unit to the controller underneath the panels, and connect it to the controller.



Refit the panels removed erlier

Installation is now complete. Turn on the ignition.

Gearbox programs

The upgraded controller supports several different operating programs. These programs use the same basic gearbox hardware, but they differ in:

- shift pattern
- amount of automatic shifting
- use of the potentiometer
- amount of driver control
- intended use

The programs can be grouped into four families:

- **manual-first programs**: **UD**, **SS**
- **automatic programs with potentiometer**: **UDP**, **SSP**
- **fully automatic programs without user interference**: **OR**, **SSX**
- **Freestyle Programs: FS, FO**
- **emergency programs**: **EMG**

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1. Two basic shift patterns

All normal drive programs are built around one of two basic shift patterns.

UD family shift pattern

The **UD family** uses:

H1 → H2 → H3 → M3

This is the same general pattern used by the original automatic logic.

Programs in this family are:

- **UD**
- **UDP**
- **OR**
- **FO**

SS family shift pattern

The **SS family** uses:

H1 → H2 → M2 → M3

This is the special shift pattern.

Programs in this family are:

- **SS**
- **SSP**
- **SSX**
- **FS**

In this family, the transition from **M2 to M3** is handled through the controller's soft intermediate sequence via **H2**.

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2. UD — Up / Down

UD is the manual-first program of the **UD family**.

Shift pattern

H1 → H2 → H3 → M3

Character

UD does **not** use potentiometer scaling.

It is intended mainly as a **manual driving mode**. The operator is expected to shift with **UP** and **DOWN**.

At the same time, the controller still protects the gearbox. If the operator does not shift and the current gear leaves its safe operating window, the controller will still shift automatically.

Practical meaning

So UD should not be understood as a completely free manual mode.
It is better understood as:

- a **manual mode with gearbox protection**
- with **late automatic backup shifts** at the window limits

Because the allowed gear windows are relatively wide, the automatic upshift and downshift points are reached quite late. That is why UD is mainly intended for the driver to shift manually, while the controller only steps in if necessary.

Intended use

UD is useful when the operator wants:

- clear manual control
- the original H1-H2-H3-M3 path
- no potentiometer influence
- gearbox protection in the background

3. SS — Special Shift

SS is the manual-first program of the **SS family**.

Shift pattern

H1 → H2 → M2 → M3

Character

Like UD, SS does **not** use potentiometer scaling.

It is also intended mainly as a **manual driving mode** with gearbox protection in the background.

The operator shifts with **UP** and **DOWN**, and the controller only performs automatic correction when the gear leaves its safe window.

Practical meaning

So SS is technically the same concept as UD, but with the **special shift pattern** instead of the original one.

Like UD, SS should be seen as:

- a **manual mode**
- with **late protective automatic shifting**
- and no potentiometer influence

Intended use

SS is useful when the operator wants:

- manual control
- the special **H1-H2-M2-M3** pattern
- no potentiometer influence
- protective automatic correction only when needed

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4. UDP — Up / Down Poti

UDP is the potentiometer-based automatic program of the **UD family**.

Shift pattern

H1 → H2 → H3 → M3

Character

UDP uses the same basic shift pattern as UD, but adds **potentiometer scaling**.

Unlike UD, UDP is intended as a **proper automatic driving program**.

The controller performs the shifts automatically, and the operator uses the potentiometer to move the shift behavior depending on:

- road conditions
- terrain
- weather
- load
- personal preference

Manual up/down intervention is still possible, but the program is fundamentally intended to work as an automatic program.

Practical meaning

UDP is the correct choice when the driver wants:

- the original-style shift pattern
- automatic shifting
- live adjustment of the shift points with the potentiometer

---

5. SSP — Special Shift Poti

SSP is the potentiometer-based automatic program of the **SS family**.

Shift pattern

H1 → H2 → M2 → M3

Character

SSP is the SS-family equivalent of UDP.

Like UDP, it is intended as a **proper automatic driving program**. The driver can adjust the shift behavior with the potentiometer depending on conditions and preference.

Manual intervention is still possible, but the program is mainly intended to be used as an automatic mode.

Practical meaning

SSP is the correct choice when the driver wants:

- the special **H1-H2-M2-M3** pattern
- automatic shifting
- live adjustment of shift behavior through the potentiometer

---

6. OR — Original Auto

OR is the original automatic program.

Shift pattern

Functionally, it follows the original controller logic and the original gearbox behavior.

Character

OR is the program reproduces the original automatic controller behavior.

It is the program to use when the system is intended to behave like the original gearbox controller, but within the upgraded controller system.

Important distinction

There are two different things that can both appear as “original”:

OR program

This is the selectable **drive program** inside the controller.

Original no-user-unit mode

This is the controller system mode when no user unit is active and the controller runs as the original controller by default.

So **OR** can exist both as a selected drive program and as the fallback behavior when no user unit is active.

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7. SSX — Special Shift Ex

SSX is the fully automatic program of the **SS family**.

Shift pattern

H1 → H2 → M2 → M3

Character

SSX is a pure automatic program:

- no potentiometer scaling
- no manual UP/DOWN shift logic
- automatic shifting only

So SSX is the fully automatic special-shift program.

Practical meaning

It behaves like the fully automatic idea of the original controller, but with the **SS-family** shift pattern instead of the original one.

Availability

SSX is a BUU only program.

It is not directly selectable from the small analog SUU.

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8. EMG — Emergency

EMG is the controller's software emergency-driving program.

Shift pattern

H1 → H2 → H3 → M3

Character

EMG is a **pure manual up/down mode** intended for reduced-function recovery driving.

In this program:

- shifting is manual with **UP / DOWN**
- the normal manual speed-window protection is removed
- several normal protection or convenience functions are intentionally bypassed

So EMG can still be used even when faults are present that would disturb normal operation.

Selector behavior

In EMG, **D** and **S / GS** are treated equally as forward-program selector inputs.

This improves redundancy because the alternative selector path can still be used for forward emergency driving.

Note

The full EMG behavior and the separate hard-wired emergency shifting circuit are explained in the dedicated **emergency shifting** section.

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9. FS — Free Special

FS is the freely adjustable version of the **SSP / SS family**.

Shift pattern

H1 → H2 → M2 → M3

Character

FS is technically an **SS-family automatic program** like SSP, but with user-adjustable shift points.

In FS, the user can set up the shift thresholds himself through the BUU.

The user can also decide whether the program uses:

- the **physical potentiometer**
- or a **fixed reference value**

Practical meaning

FS is a **freely programmable special-shift automatic mode**.
It is intended for users who want to define their own SS-family shift behavior instead of using the fixed SSP setup.

Availability

FS is configured and practically used through the **BUU** because it depends on:

- the **user preset selection page**
- the **shift setup page**

---

10. FO — Free Original

FO is the freely adjustable version of the **UDP / original family**.

Shift pattern

H1 → H2 → H3 → M3

Character

FO is technically a **UD / original-family automatic program** like UDP, but with user-adjustable shift points.

In FO, the user can set up the shift thresholds himself through the BUU.

The user can also choose whether the program uses:

- the **physical potentiometer**
- or a **fixed reference value**

Practical meaning

FO is a **freely programmable original-pattern automatic mode**.
It is intended for users who want to define their own UD-family shift behavior instead of using the fixed UDP setup.

Availability

Like FS, FO is configured and practically used through the **BUU** because it depends on:

- the **user preset selection page**
- the **shift setup page**

---

11. Which programs are manual-first and which are automatic?

Manual-first programs

These are mainly intended for the driver to shift manually, while the controller only intervenes late for protection:

- **UD**
- **SS**

Proper automatic programs with potentiometer scaling

These are intended to be used as real automatic programs, with the potentiometer adjusting shift behavior:

- **UDP**
- **SSP**
- **FS / FO**

Fully automatic programs without potentiometer

These are automatic-only programs without normal manual shift operation:

- **OR**
- **SSX**

Special programs

- **EMG** = reduced-function manual recovery mode

12. How the programs are selected

BUU selection

With the **BUU**, the drive programs are selected through the **PROG page**.

From the BUU PROG page, the driver can select:

- **OR**
- **UD**
- **UDP**
- **SS**
- **SSP**
- **EMG**
- **FS**
- **FO**

SUU selection

With the small analog SUU, the controller selects the program when the **MAN** switch is moved from OR to SP.

The button state at that moment determines the result:

- **UP only** = **SS**
- **DOWN only** = **UD**
- **UP + DOWN together** = **EMG**
- **no button** = restore the **last stored drive program**
- **MAN** switch in **OR** = **OR**

UDP and SSP are not entered by their own direct button combination. To get UDP or SSP from the SUU, the driver must first enter UD or SS and then perform the potentiometer calibration. After a successful calibration, the controller automatically changes UD to UDP or SS to SSP.

So if the driver wants SSP, he must first choose SS, then complete the potentiometer calibration, after which the controller changes the active program to SSP. The same applies to UDP, starting from UD.

Important detail

If the restored stored program is not valid for analog entry, the controller falls back to **OR**.

So with the SUU, the no-button entry restores the last stored drive program, but if that stored program is not valid for analog entry, the controller uses OR instead.

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13. What is stored

The controller stores the active **drive program** in EEPROM.

Stored programs

The stored drive programs are:

- **UD**
- **SS**
- **UDP**
- **SSP**
- **SSX**
- **OR**
- **EMG**
- **FS**
- **FO**

14. What happens if the BUU is disconnected?

Loss of BUU / CAN traffic does not automatically force an immediate fallback to Original mode during the same power cycle as long as the MAN switch remains in the BUU / CAN path.

During the same power cycle:

- the active program remains logically active
- the controller keeps that program
- no automatic change to original occurs simply because BUU traffic disappears

If the MAN switch is to SP during the same power cycle, the controller immediately drops logical BUU mode and hands control over to the analog user-unit path. In that case the BUU is no longer the active control path, even if a BUU-controlled program had been latched previously.

So in practical terms:

- if the BUU is unplugged or communication is lost while driving
- the controller keeps the current active program
- this remains so until restart, unless the controller configuration is intentionally changed

After restart without BUU

After a restart without BUU present:

- if the MAN switch is in OR and there is no CAN user unit, the controller starts in original mode
- if the MAN switch is in SP, the analog SUU entry logic applies

So after reboot, behavior depends on whether the analog user-unit path is requested or not.

15. Practical summary

UD and SS
Manual-first modes with wide safe gear windows and only late automatic protective shifts.

UDP and SSP
True automatic modes with potentiometer influence for adapting the shift behavior to load, terrain, weather and driver preference.

OR
Original automatic behavior.

SSX
Fully automatic SS-family mode without potentiometer scaling and without manual shift operation. BUU only like OR with the SS Pattern.

EMG
Reduced-function manual recovery mode.

FS and FO
Freely programmable automatic modes based on SSP and UDP, configured through the BUU.

Short description

The upgraded controller offers manual-first, automatic, emergency and freely programmable shift programs. UD and SS are primarily manual modes with late automatic protective shifts. UDP and SSP are proper automatic modes with potentiometer-adjustable shift behavior. OR reproduces the original automatic behavior, while SSX is the fully automatic SS-family variant. EMG is the controller's software emergency mode and FS / FO are the freely programmable versions of the SS and original-pattern automatic families. The controller stores the active drive program in EEPROM, restores it as required, and keeps the active program even if BUU communication is lost during the same power cycle.

Engine Brake (EB), HOLD and Anti-Slip (AS)

In addition to the selectable driving programs, the gearbox controller also includes three important operating functions that influence vehicle behavior during deceleration and in low-traction situations: Engine Brake (EB), HOLD and Anti-Slip (AS). These are not separate main drive programs. They are additional controller functions that become active under defined operating conditions.

Engine Brake (EB)

Purpose

The Engine Brake function is intended to use as much braking effect of the engine as possible during deceleration. In general terms, engine braking means that the engine is used as a retarding force instead of relying only on the service brakes. This is strongest when the transmission is in a lower gear and the engine speed is higher. For that reason, the controller uses a dedicated EB shift pattern and dedicated EB thresholds to keep the engine in a speed range where the braking effect is high.

EB shift pattern and thresholds

When EB is active, the controller uses the dedicated EB gear ladder:

H1 ↔ M1 ↔ M2 ↔ M3

This is different from the normal drive shift patterns. If the current forward-drive gear is not already one of these EB gears, the controller selects the appropriate EB gear according to the current speed signal. The controller uses dedicated EB thresholds so that the engine remains in a useful braking range. In practical terms, EB is therefore not just a normal downshift sequence. It is a dedicated braking strategy.

Activation

EB can activate only when the physical gear selector is in D, the Terrain Brake input is pressed, and the other normal EB conditions are satisfied, including released accelerator, no winch operation and an EB-capable program.

Deactivation

Moving the physical selector from D to R, N, Gear S or TS cancels EB. EB is also cancelled by accelerator pressing the accelerator pedal or a higher-priority function or a program that does not allow EB.

Terrain Brake remains independent

TB means Terrain Brake. In D, operating TB can also activate EB when all EB conditions are satisfied. Leaving D prevents or cancels EB, but it does not remove the normal Terrain Brake function.

Priority

EB has priority over AS. If AS is active and EB is requested, the controller clears AS and activates EB.

Availability

EB is available in the normal driving programs, including UD, SS, UDP, SSP, SSX, OR, FS and FO. It is not active in EMG or DIAG.

Safety warning

The engine brake function should not be used on icy, slippery or very low-traction roads unless the operator is certain that the available grip is sufficient. Because EB intentionally uses lower gears and higher engine braking torque, it can increase retarding torque at the driven wheels and contribute to wheel slip, wheel blocking, loss of traction or engine stalling. For this reason, EB should be used with caution and should not be treated as a substitute for proper low-traction driving technique.

HOLD

Purpose

HOLD is the engine-brake hold function. It is intended for situations such as curving downhill roads, technical descents, or any situation where the driver wants to use engine braking but does not want the controller to downshift automatically at the wrong moment.

Practical meaning

With HOLD active, the controller does not run the normal fully automatic EB step logic. Instead, the driver can use the engine brake and shift manually with UP and DOWN. This is useful in a curve, because the vehicle can remain stable and keep full traction through the curve before the driver requests the next downshift. After the critical part of the maneuver is over, the driver can downshift manually and use the full braking effect again. HOLD is therefore best understood as engine brake with manual downshift control.

Activation

In the controller logic, HOLD is only active when the BUU is present and active in CAN mode, a supported program is active, EB is active, and the operator requests HOLD by holding FORW + BACK for about 1.5 seconds. HOLD is therefore not a standalone drive program. It is an additional EB-related function.

Availability

HOLD is available in UD, UDP, SS, SSP, FS and FO. It is not available in OR, SSX, EMG or DIAG.

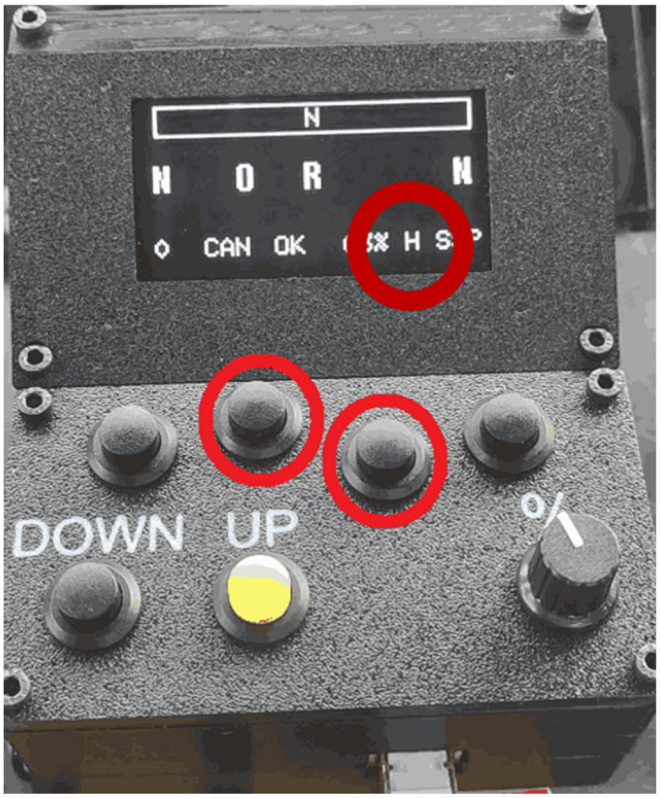
Deactivation

HOLD is deactivated when the operator toggles the HOLD request again with FORW + BACK held for about 1.5 seconds, when the controller leaves BUU / CAN operation, when the active program does not support HOLD, or when EB is no longer active.

Engine break switch behavior while H is selected

With H selected and engine break switch released, the gearbox holds the braking gear longer. Holding the engine break switch pressed requests the earlier normal Engine Brake downshift. The engine break switch can request downshifts only; it cannot request an upshift. Pressing TB too early does not store or arm a later downshift, but if the engine break switch remains held the downshift can occur when the correct operating point is reached.

Releasing the engine break switch does not command an immediate upshift. A later upshift occurs only when the normal Engine Brake upshift condition is reached or the driver makes an allowed manual upshift. If a a downshift caused by the engine break switch while H is selected, the gearbox therefore remains in the braking gear after TB is released until one of those conditions occurs.



Anti-Slip (AS)

Purpose

AS is the anti-slip function. It is intended for icy roads, slippery roads and low-traction normal driving situations. The function tries to prevent engine stalling, wheel blocking, sudden excessive braking torque at the wheels and unnecessary loss of traction.

Controller behavior

The controller does this by automatically shifting down to H3 and keeping the transmission away from M3 so that the torque converter benefits remain available. This is important because the torque converter gives a more forgiving driveline response than a direct mechanical top gear in low-traction situations.

Activation

AS is activated when the vehicle is in D, the brake switch becomes active, the accelerator is not active, the active program supports AS, and EB is not already taking priority. In practical terms: brake input activates AS.

Deactivation

AS is deactivated when the accelerator switch becomes active or when another function with higher priority takes over. In normal use, pressing the accelerator cancels AS.

Priority

The controller priority is: EB overrides AS. That means if AS is active and EB is requested, EB takes over, AS is cleared, and the controller enters EB behavior. In practical terms: brake switch can activate AS, accelerator switch deactivates AS, and engine-brake / terrain-brake switch overrules AS and activates EB.

Availability

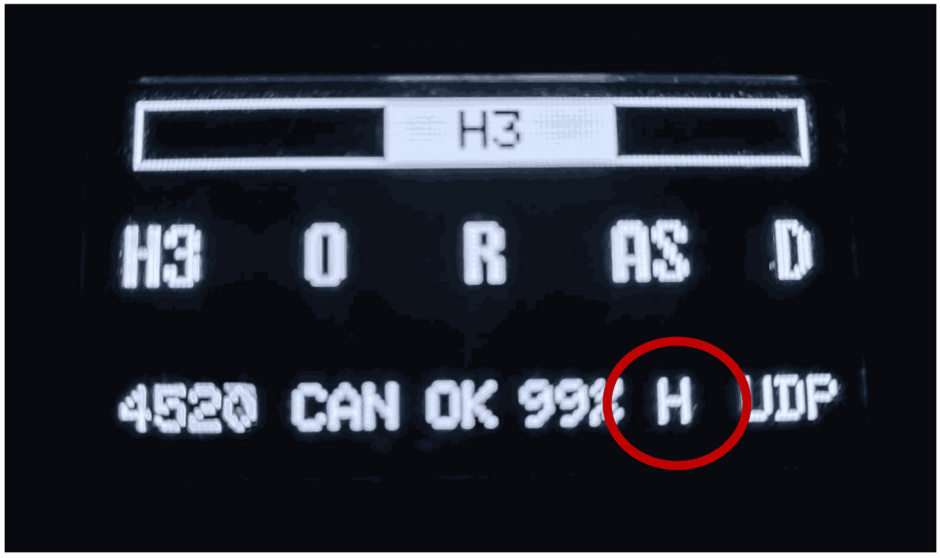
AS is only available in the programs that use the OR / UD-family H3-M3 structure, because the function depends on the H3 fallback behavior. This means AS is available in OR, UD, UDP and FO. AS is not available in SS, SSP, SSX, FS, EMG or DIAG.

Recommendation for slippery conditions

Because AS is specifically designed to preserve traction by using H3 and the torque converter, programs without AS support are not recommended for icy or slippery road conditions. For low-traction road use, the preferred programs are the OR-pattern programs that support AS: OR, UD, UDP and FO.

Practical summary

EB uses a dedicated braking gear ladder and thresholds to maximize engine braking effect. HOLD is the manual-control version of EB and is intended for situations where the driver wants to decide himself when the next downshift should happen, for example in downhill curves, and it is requested or cancelled from the BUU with a FORW + BACK hold of about 1.5 seconds and can be overwritten while engine break switch is pressed. AS is the anti-slip function for icy or slippery roads; it automatically keeps the transmission in H3 and prevents the shift into M3 so that the torque converter remains effective and traction is preserved. In the controller logic, EB has priority over AS, and programs without AS support are not recommended for low-traction conditions



Emergency shifting

The system provides two independent emergency-shifting paths:

a hard-wired emergency shifting circuit with separate relays

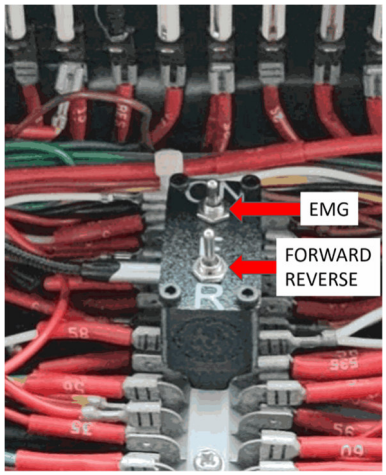
the EMG mode inside the gearbox controller software

These two paths are different and should not be confused with each other.

The hard-wired emergency shifting circuit is intended to keep the vehicle movable even if the normal controller-controlled shifting path is no longer available. The EMG mode is the controller's own reduced-function emergency driving mode.

The following section describes the hard-wired emergency-shifting arrangement together with the related controller behavior.

1. 1. Hard-wired emergency shifting circuit



Basic principle

The hard-wired emergency shifting circuit works **electrically beside the gearbox controller**. It uses its **own separate relays**, but switches the **same output lines** as the normal gearbox controller.

To prevent the emergency path from interfering with normal relay operation, the emergency shifting connection is implemented through a **diode-isolated path**. This ensures that the emergency circuit does not feed back into the normal controller-driven relay path during normal use.

So in practical terms:

- during normal operation, the gearbox controller controls the outputs
- during emergency shifting, the separate relay circuit can take over those same outputs
- the two paths are isolated so that the emergency path does not disturb normal operation

Physical access

The gearbox controller comes with an internal and additional **emergency switch unit** that is installed in the **fuse box** for easy access.

This emergency switch unit is connected to the gearbox controller through a **4-pin click cable**.

Its purpose is to provide emergency access **without opening the gear selector panel**.

Two emergency-shifting activation points

Emergency shifting can be activated in two ways:

- by the emergency switch directly on the controller
- by the easy-access emergency switch in the fuse box

So the operator does not need to remove the gear selector panel in order to activate emergency shifting.

Additional selector redundancy

The easy-access emergency switch unit also provides a **second gear-selector switch**.

This creates an additional redundant selector path for emergency use.

In this arrangement:

- in **F**, this second selector switch behaves like **GS**
- in **R**, it behaves like **R**

This gives an additional selector path if the normal selector path is not available.

2. Hard-wired emergency shifting states

Once the emergency shifting circuit is activated, the relay circuit commands fixed output combinations depending on the selected position.

Neutral

When emergency shifting is activated in **Neutral**, it activates:

- **Torque converter**
- **Road**

This prepares the driveline in a safe ready-to-drive state.

Reverse

When the selector is switched to **Reverse**, the emergency circuit activates:

- **Torque converter**
- **Reverse**
- **Road**

So reverse remains available through the emergency path.

Drive

When the selector is switched to **D**, the emergency circuit activates:

- **Torque converter**
- **H3**

This gives a usable forward gear for getting the vehicle moving and returning to base.

S / F

When the selector is switched to **S** — or when the additional emergency selector switch is put into **F**, which behaves like GS — the emergency circuit activates:

- **Torque converter**
- **H2**

This gives a stronger and slower forward gear, which is useful for:

- loaded operation
- moving off
- low-speed recovery driving

Why Road is forced in emergency mode

In the emergency circuit, **Road** is activated deliberately, even if **DD** had previously been selected.

This ensures that the transfer case is in a drivable state for emergency movement. In other words, the emergency system prepares the transfer case for actual road movement instead of leaving the vehicle in a disconnected state.

3. Additional reverse redundancy

The emergency-shifting **reverse output** can also be wired so that the original **Scania reverse relay** is bridged.

With this arrangement, reverse can still be obtained even if the original reverse relay has failed.

For this, only **one additional wire** is needed between:

- the **controller plug**
- and the **reverse relay output**

This provides the highest possible redundancy for reverse operation.

In practical terms, this means that even if the original reverse relay is broken, the emergency-shifting path can still keep the truck operational in reverse, provided the gearbox and the remaining wiring are still intact.

4. What the gearbox controller does during hard-wired emergency shifting

The controller monitors a dedicated external emergency-shifting input.

When this input is active:

- the local gearbox-controller OLED shows **EMERGENCY SHIFTING**
- the controller gives this page the highest display priority
- the controller changes its monitoring logic to a selector-based emergency supervision

Important point

In this state, the controller is **not the active shifter**.
It is being **overwritten by the separate emergency relay circuit**.

The hard-wired emergency circuit operates beside the controller and uses the same outputs independently of the normal controller logic.

So while this state is active:

- the normal controller-controlled shift path is overridden
- the fixed relay emergency circuit is the active authority for shifting
- the controller mainly monitors the resulting confirmation signals and reports the state

Confirmation supervision during hard-wired emergency shifting

When the external emergency-shifting input is active, the controller expects these confirmation states:

- **N**: torque converter + road
- **R**: torque converter + reverse + road
- **D**: torque converter + H3
- **S / GS**: torque converter + H2

This matches the intended emergency relay behavior.

So the controller does not simply ignore emergency shifting. It actively checks whether the emergency relay circuit is producing the expected gearbox confirmations.

5. EMG mode inside the controller software

Separate from the hard-wired emergency circuit, the gearbox controller also contains the **EMG mode**.

This is a **software emergency mode** inside the normal controller logic.

It is not the same as the external emergency relay path.

Purpose

The EMG mode is intended to keep the vehicle movable when the controller is still functioning, but normal automatic or protected logic is no longer desirable or possible.

It is a simplified manual mode with reduced dependencies on the normal signal logic.

6. How EMG is selected from the SUU

The **small analog user unit (SUU)** can select the **EMG** mode as follows:

- the system must be in the analog user-unit path, not in CAN-BUU control
- **MAN** is switched from **HIGH** to **LOW**
- while doing this, **UP and DOWN are pressed together**

In that case, the controller selects:

- **EMG**

So with the SUU, EMG is entered by switching into user-unit mode while holding both shift buttons.

Operator note

The Forward, Reverse, Neutral and NG procedures described below work the same way with BUU and SUU. Both use the same 2-second hold requirement for virtual Forward and Reverse.

7. EMG mode behavior

Software EMG is the gearbox controller's reduced-function manual recovery program. It is intended to keep the vehicle movable when the controller and gearbox actuation system still work, but normal operation is unavailable because of failed input signals.

EMG may be used for recovery with:

- accelerator-pedal switch/input failure;
- brake-switch input failure;
- physical gear-selector or selector-wiring failure, including conflicting selector inputs;
- gearbox speed-sensor or speed-signal failure.

EMG is not a repair and is not a normal driving program. Use it only to move the vehicle to a safe location or return it for repair. Vehicle electrical power, the gearbox controller, UP/DOWN controls, output stages and relays, wiring, solenoids, and the mechanical and pneumatic/hydraulic gearbox functions must remain operational.

Operation in EMG

- Manual gear path: **H1 → H2 → H3 → M3.**
- Shifting is manual with UP and DOWN. Normal automatic shifting, manual speed windows and protective automatic shifts are not used.
- POTI has no influence. EB, HOLD and AS are not available.

The driver is responsible for selecting a suitable gear and preventing engine overspeed, engine lugging, unsafe downshifts and loss of traction. Stop the vehicle before changing direction. Make transfer-case changes only while stopped whenever possible.

Safety behavior in EMG

- F1 protection against simultaneous Forward and Reverse confirmation remains a hard safety block. F3 command/confirmation mismatch monitoring remains active.
- Normal F2, F4, F5 and F6 blocking is suppressed. An F2 selector conflict is handled by automatic NG and virtual Neutral as described in Section 8.

Critical winch warning in EMG

When the winch input is active, W reports the electrical input only. In EMG, the controller does not apply normal F4 winch protection, automatically select H1, force Neutral, or enforce normal winch speed, transfer-case or selector restrictions.

The physical winch switch can energize the winch circuit without gearbox-controller control. The operator must verify the complete winch setup and safe operating condition. Normal winch protection remains unchanged outside EMG.

Software EMG is separate from the hard-wired emergency shifting system. Both require vehicle electrical power. The hard-wired system bypasses the software and microcontroller; software EMG requires both.

8. Selector information and automatic F2-to-NG in EMG

While NG is not active, the physical selector is displayed as follows:

Physical Reverse displays R.

- Physical Neutral displays N.
- Physical Drive or Gear S displays F.

Physical Tow Start displays TS.

If conflicting selector signals create F2 while EMG is active, or while EMG is being activated, the controller automatically ignores the physical selector and selects virtual Gear selector in Neutral.

The display then shows NG and N. The driver does not need to press UP and DOWN together first. This automatic F2-to-NG behavior applies only in EMG.

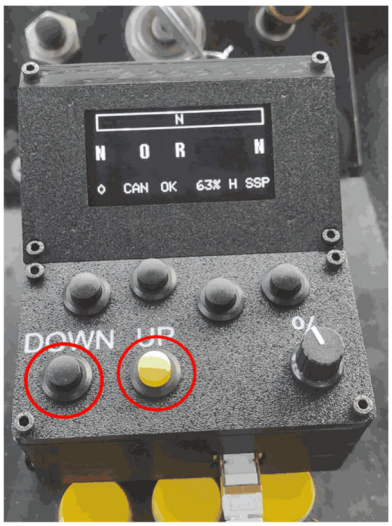
Practical meaning

NG means the UP/DOWN virtual selector is active. N means Neutral is requested.

NG remains active after virtual F, R or N is selected. Selecting F or R does not return control to the physical selector.

Forward or Reverse can then be selected with the 2-second EMG button procedures.

9. Manual shifting and virtual selector control in EMG



Manual gear shifting uses UP for upshift and DOWN for downshift.

- **Manual gear path: H1 → H2 → H3 → M3.**
- **The following button procedures control the selector request; they do not by themselves confirm actual gear engagement.**

Select virtual Neutral

- **Press UP and DOWN together.**
- **NG becomes active and the selector information shows N.**
- **Select virtual Forward**
- **Precondition: the gearbox output must be Neutral.**

Hold DOWN for at least 2 seconds, then press UP while DOWN remains held. The selector request changes to F.

If UP is pressed before 2 seconds, no later request is queued. Keep DOWN held and press UP again after the hold time.

Select virtual Reverse

Precondition: gearbox output Neutral. Hold UP for at least 2 seconds, then press DOWN while UP remains held. The selector request changes to R.

If DOWN is pressed before 2 seconds, no later request is queued. Keep UP held and press DOWN again after the hold time. BUU and SUU use the same procedure.

---

10. NG and virtual selector operating examples

Automatic F2-to-NG: conflicting selector signals in EMG produce NG and N without a first button command.

- Manual virtual Neutral: UP + DOWN produces NG and N.
- Virtual Forward: from gearbox output Neutral, hold DOWN for 2 seconds and press UP while DOWN remains held.
- **Virtual Reverse: from gearbox output Neutral, hold UP for 2 seconds and press DOWN while UP remains held.**

Important

NG remains active after virtual F, R or N. NG and N must not be confused.

W and NG can be displayed together as W NG when the winch input is active during virtual-selector operation.

W is information only and does not confirm a safe winch condition or mechanical engagement.

Temporary gearbox Neutral during transfer switching does not erase an active F or R selector request.

---

11. Practical summary

Hard-wired emergency shifting circuit

- separate relay path
- diode isolated from the normal relay path
- overrides the normal controller-controlled shifting path
- accessible both on the controller and by the fuse-box emergency switch
- includes an additional redundant selector switch
- can force:
  - **N = TC + Road**
  - **R = TC + Reverse + Road**
  - **D = TC + H3**
  - **S / F = TC + H2**
- can bridge the original reverse relay with one extra wire for maximum redundancy
- works even if the microcontroller would be completely dead

EMG software program

- selected from the SUU by switching MAN to LOW while pressing UP + DOWN
- selected from the BUU by choosing EMG
- uses manual UP / DOWN gear shifting
- gear path: H1 → H2 → H3 → M3
- physical D or Gear S displays F; physical R, N and TS display R, N and TS
- automatically changes F2 selector conflict to NG and virtual N
- manual UP + DOWN selects NG and virtual N

- USED TO RECOVER THE VEHICLE
- VERY LIMITED SAFTEY
- NO SPEEDSENSOR READING

virtual F: hold DOWN at least 2 seconds and press UP from gearbox output Neutral

virtual R: hold UP at least 2 seconds and press DOWN from gearbox output Neutral

Short description

The system has two separate emergency concepts: the independent hard-wired emergency shifting system and software EMG. Software EMG is a simplified manual recovery mode. In EMG, conflicting selector signals automatically select NG and virtual N; the same virtual selector can be operated with BUU or SUU. W remains an information-only winch-input indication, and F/R/N/TS remain selector requests even if the gearbox output is temporarily Neutral during a transfer-case change.

Gearbox controller OLED display

The local OLED on the gearbox controller is mounted on the top of the controller housing. To view it, the gear selector panel must be removed. Because of this installation position, the OLED is intended primarily as a service and diagnostic display for operating parameters, active input states, warnings and failure pages.

Display enable / disable

The local OLED is controlled by the **display button** input:

- **display button pressed** = display requested **ON**
- **display button depressed** = display requested **OFF**

If the display is off, no local information or warning page is visible.

Power-cycle screen protection

The gearbox-controller also contains a display protection function.

If the **display is requested ON for 10 consecutive power cycles**, the controller locks the OLED **OFF** until the display button is switched **OFF** and then **ON** again.

This should be understood as a **screen saver / display protection function**. Because the OLED is mounted under the gear selector panel and is normally not visible during driving without removing that panel, the same picture could otherwise remain burned into the oled. The lockout helps avoid leaving the OLED showing the same symbols and text through many hours of vehicle use.

This function only affects the OLED display. It does **not** change gearbox operation.

Practical purpose of the local OLED

Because the OLED is mounted on the controller and is normally only visible after removing the gear selector panel, it should be treated as a **service and diagnostic display**.

In practical use, it is mainly there to provide quick local information about:

- active warnings and failure states
- current gear, selector and transfer status
- active input badges
- current operating values such as **Hz** and active program

So the local OLED is primarily a **controller-side diagnostic display**, not a normal driving display.

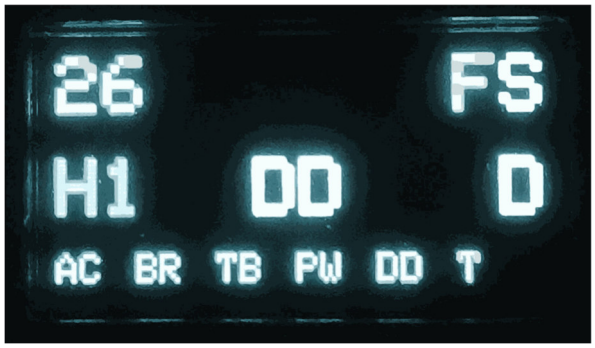
Display priority

The OLED page priority is:

1. **EMERGENCY SHIFTING**
2. **F5**
3. **F1**
4. **F2**
5. **F3**
6. **F4**
7. **F6**
8. **CAL**
9. normal information page

So if several conditions exist at the same time, only the **highest-priority page** is shown.

Normal information page



When no higher-priority warning or calibration page is active, the OLED shows the normal information page.

Top row

Left side: Hz value

The top-left value is the current gearbox output speed value in **Hz**.

Right side: program / mode

The top-right field shows the active program.

Possible values are:

- UD
- SS
- UDP
- SSP
- SSX
- OR
- EMG
- DIAG
- FS
- FO
- If the controller is operating in original no-user-unit mode, the display shows OR.

Middle row

Left side: actual gear

The left side of the middle row shows the current actual gear.

Possible values are:

- **N = Neutral**
- **R = Reverse**
- **H1 = Gear 1**
- **H2 = Gear 2**
- **H3 = Gear 3**
- **M1 = Mechanical Gear 1**
- **M2 = Mechanical Gear 2**
- **M3 = Mechanical Gear 3**
- **GS = Off-road Gear H2**
- **TS = Tow Start Gear M1**

Center: transfer state

The center of the middle row shows the transfer state.

Possible values are:

- **DD = Drive Drain Disconnect**
- **T = Terrain**
- **R = Road**

Display rule:

- if **DD** is active, the display shows **DD**
- otherwise it shows the stored transfer state as **T** or **R**

Display behavior

• If a transfer request is latched but cannot yet be executed, the transfer field is shown inverted continuously.
• If the transfer pulse is currently being executed, the transfer field blinks inverted.
• After successful completion, the highlighting disappears and the displayed state changes to the new stored state.

Right side: selector request

The right side of the middle row shows the effective driver selector request.

Possible values are:

- D = Drive
- S = Offroadgear
- **F = Forward request**
- **R = Reverse request**
- **N = Neutral request**
- **TS = Tow Start request**
- **NG = physical selector ignored; the UP/DOWN virtual selector is active**

F, R, N and TS are selector requests, not actual gear confirmations. During a transfer-case change, output Neutral can be temporary while F or R remains displayed.

Bottom row

The bottom row shows active input-status badges.

Only active inputs are shown.

Possible badges are:

- **AC = Gas Pedal Switch**
- **BR = Brake Switch**
- **TB = Terrain Brake input**
- **W = Winch input active**
- **DD = Drive disconnect switch**
- **T = Terrain on selector active**

So the bottom row is a live quick view of important active controller inputs.

EMERGENCY SHIFTING page

Display condition

This page is shown when the **external emergency-shifting input** is active.

This is the dedicated emergency switch input. It is **not simply the same thing as selecting the EMG driving program**. It is a separate emergency-switch condition with highest display priority.

What the OLED shows

The local OLED shows:

EMERGENCY
SHIFTING

Meaning

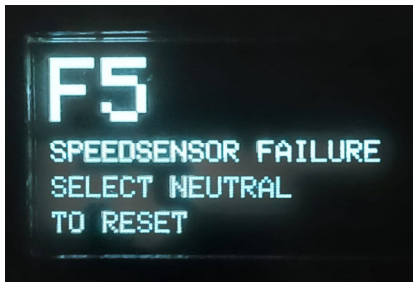
When this page is shown, all normal information and all failure pages are hidden behind it.

Practical meaning

The vehicle is in an **emergency-shifting state**. In this condition, the normal gearbox-controller shifting path is **overridden by a fixed relay circuit with separate relays**. The emergency circuit operates **electrically beside the controller**, not through the normal controller logic, and it switches the **same output lines** independently of the controller.

So while this state is active, the gearbox controller is **no longer the active authority for shifting**. The shifting is being carried out by the separate emergency relay circuit, which only shares the same outputs with the controller.

F5 page



Display condition

This page is shown when **F5** is active or latched.

What the OLED shows

The local OLED shows:

F5
SPEEDSENSOR FAILURE
SELECT NEUTRAL
TO RESET

Meaning

This is the speed-sensor / raw-frequency failure page.

Gearbox behavior

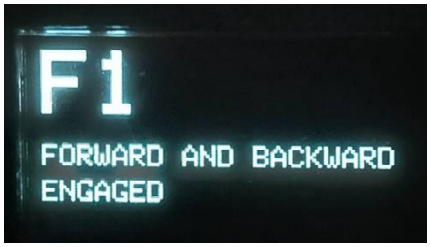
When **F5** is latched:

- the controller freezes normal shifting logic
- the gearbox is forced toward **H3**
- the **torque converter is opened**
- the purpose is to prevent excessive engine speed and to avoid wheel blocking

Clear condition

The controller clears **F5** when the required reset condition is reached, especially by selecting **Neutral**.

F1 page



Display condition

This page is shown when **F1** is active.

What the OLED shows
The local OLED shows:

F1
FORWARD AND BACKWARD
ENGAGED

Meaning
The controller sees **forward** and **reverse** output signal at the same time.

Gearbox behavior
This is a **hard blocking safety condition**.
When **F1** is detected, the controller:

- forces a safe output state
- turns the gear outputs off
- stops normal gearbox logic
- waits in a blocking loop until the confirmation state becomes valid again

So in practice, with **F1** active, the gearbox controller refuses to continue normal operation until the fault clears.

Clear condition
F1 clears only when the relevant confirmation signals return to a valid state and remain stable.

F2 page

Display condition
This page is shown when **F2** is active.

What the OLED shows
The local OLED shows:

F2
and underneath it the detected selector conflict, for example:

- **R+N**
- **N+D**
- **D+S**
- **TS+S**

or a two-input combination with **(+X)** if more than two inputs are active.

Meaning
The selector inputs are ambiguous. More than one selector input is active at the same time.

Gearbox behavior from the controller
Outside EMG, F2 is a hard blocking safety condition.

Outside EMG, when F2 is detected, the controller:

- forces its defined safe output state
- stops normal selector and shifting operation
- waits until the selector inputs become unambiguous again

EMG exception: if F2 occurs while EMG is active or being selected, the controller automatically ignores the physical selector and selects virtual Neutral. The display shows NG and N; no first UP + DOWN command is required.

Clear condition
Outside EMG, normal operation resumes only after selector inputs are valid and stable. In EMG, the driver can continue with the NG virtual-selector procedures.

F3 page

Display condition
This page is shown when **F3** is active.

What the OLED shows
The local OLED shows:

F3
and below it the current stored mismatch text.

Possible examples are:

- **GR HIGH**
- **TC LOW**
- **G1 LOW**
- **G2 HIGH**
- **G3 LOW**
- **GM HIGH**
- **RO**
- **TER**
- **TB LOW**

The exact text depends on the channel and the type of mismatch detected by the controller.

Meaning

F3 means that the commanded output state and the returned confirmation / readback state do not match.

In practical terms, the controller is commanding a function and the expected feedback does not match that command, or it is seeing a feedback state that should not be present.

Gearbox behavior

Unlike **F1** and **F2**, **F3** is **not** a hard blocking safety stop.

The controller:

- detects the mismatch
- waits until it persists long enough
- reports **F3**
- continues running the rest of the gearbox logic

So in practice, **F3** is a **diagnostic mismatch page**, not an automatic stop page.

Practical meaning

An **F3** indication means that the affected function needs to be checked. This is normally a **maintenance / diagnostic issue**, not just an operator message.

It indicates that the controller command and the real electrical or mechanical result do not agree.

Typical causes

Typical causes include:

- broken relay
- failed output stage
- broken wiring
- missing supply voltage at the output
- defective confirmation switch
- defective actuator or solenoid
- transfer feedback not matching the commanded transfer output
- mechanical function not reaching the expected position

Important interpretation

A message such as **LOW** usually means that the controller has switched the output **on**, but the expected readback or confirmation did **not** appear. One possible cause is a **broken relay**, but the fault can also be anywhere else in the output path.

A message such as **HIGH** means that the controller sees a confirmation signal active when that output should not currently be active.

Required action

When **F3** is shown, the affected channel should be checked by maintenance.

Typical checks are:

- check whether the output is actually being driven
- check whether voltage is present at the relevant output through the vehicle wiring
- check the associated relay
- check the return / confirmation signal
- check the actuator or solenoid
- check for broken or shorted wiring
- check whether the commanded mechanical movement is actually being completed

So **F3** should be treated as a **maintenance fault indication** that requires electrical or mechanical checking of the affected function.

F4 page

Display condition
This page is shown when **F4** is active.

What the OLED shows
The local OLED shows:

F4
WINCH SPEED TOO HIGH

Meaning
F4 is the winch-entry failure / winch-condition warning.

Gearbox behavior
When winch is requested but the required entry conditions are not valid, the controller:

- sets **F4**
- forces **Neutral**
- refuses winch mode entry

So in practice, **F4** means the controller has prevented an invalid winch engagement request.

Important interpretation
On the local OLED, **F4** is better understood as a warning of an active safety function than as a technical defect message.

It usually means the operating condition is wrong, not that hardware has failed.

F6 page

Display condition
This page is shown when **F6** is active.

What the OLED shows
The local OLED shows:

F6
SPEED TOO HIGH
FOR "R"
or
FOR "TS"
or
FOR "S"
depending on which selector request is currently blocked.

Meaning
The requested selector function is not allowed at the current speed.

Gearbox behavior
When **F6** is active, the controller:

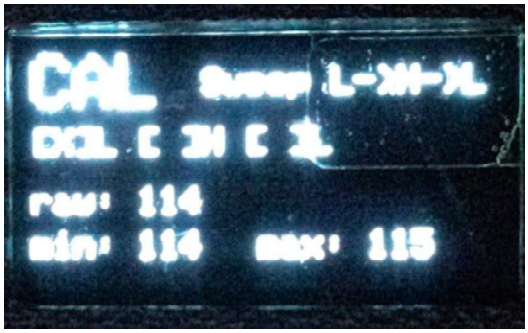
- refuses the requested selector engagement
- keeps the gearbox in the last safe state
- waits until speed is low enough for the request to become valid

So in practice, **F6** means the controller has actively prevented a potentially damaging selector engagement.

Important interpretation
Like **F4**, **F6** is better understood as a warning of an active safety function than as a technical failure page.

It usually means the operator request is not currently allowed.

Calibration page



Purpose
The **Calibration page** is used to calibrate the **SUU potentiometer range** in the gearbox controller as well as entry condition for UDP and SSP.

This calibration is needed so the controller learns the real **minimum** and **maximum** potentiometer values of the connected **small analog user unit (SUU)**. That allows the controller to use the full potentiometer travel correctly for the potentiometer-based programs.

In practical terms, the calibration is required so that:

- the SUU potentiometer uses its full working range
- the shift-point scaling in **UDP** and **SSP** works correctly
- the controller does not work with an incorrect or reduced potentiometer range

So this page is not only an information page. It is part of the actual **SUU potentiometer calibration procedure**.

How calibration is started from the SUU
Calibration is started from the **SUU** as follows:

- press and hold **UP + DOWN** together
- hold both buttons for about **2.5 seconds**
- the controller must see a low speed condition, **below 50 Hz**

If these conditions are met, the controller enters the calibration mode and the local OLED shows the **Calibration page**.

What the OLED shows

The local OLED shows:

- **CAL**
- Sweep L->H->L
- three progress indicators for the required movement sequence
- current **raw**
- current **min**
- current **max**

Required movement

After entering calibration, the SUU potentiometer must be moved through the full sequence:

LOW → HIGH → LOW

Only when this full sequence has been completed does the controller accept the calibration as valid.

Result

If calibration is completed successfully:

- the controller stores the new potentiometer **minimum** and **maximum** values
- the full potentiometer travel is then used correctly in the potentiometer-based programs

A successful calibration does also automatically upgrade:

- **UD → UDP**
- **SS → SSP**

if one of those base programs was active when calibration was performed.

Behavior

While this page is active, the normal information page is hidden and the OLED is dedicated to the calibration process until calibration is either completed or aborted.

.

Calibration abort page

If calibration is not completed correctly, the local OLED can briefly show an abort page.

What the OLED shows

The abort page shows:

- **CAL X**
- a message that the required **LOW → HIGH → LOW** sequence was not completed

Meaning

Calibration was entered, but not finished successfully.

The previous stored calibration remains active.

Can warnings be acknowledged on the local gearbox-controller OLED?

The local OLED has **no user acknowledgment or dismiss function** like the BUU overlay handling.

That means:

- the displayed page changes automatically with the controller state
- warnings are **not manually quitted** on the local OLED
- the shown warning page disappears only when:
  - the underlying condition clears, or
  - the display is switched off

So for the local gearbox-controller OLED, the warning pages are **state-driven only**.

Practical interpretation summary

Normal page
Shows current **Hz**, **program**, **gear**, **transfer state**, **selector state**, and active bottom-row input badges.

EMERGENCY SHIFTING
Highest-priority emergency page.

F5
Speed-sensor failure page with protective gearbox reaction.

F1
Forward and reverse confirmation conflict. Hard blocking safety stop.

F2
Multiple selector inputs active. Hard blocking safety stop.

F3
Output / feedback mismatch. Diagnostic page, not a full stop.

F4
Winch entry refused. Safety warning, usually not a technical defect.

F6
Requested selector state blocked by speed. Safety warning, usually not a technical defect.

CAL
Active local potentiometer calibration page.

CAL OK
Calibration completed successfully.

CAL X
Calibration was not completed successfully.

SUU

General description

The SUU is the simple hard-wired analog user unit of the gearbox controller.

It has no microcontroller, no software of its own, no display, and no internal logic.

It is only an extension of the gearbox controller through switches and a potentiometer. All logic is done inside the gearbox controller itself. The controller directly reads the SUU signals and performs program selection, manual shifting, potentiometer evaluation, calibration, and all safety and protection functions.

So the SUU is not a separate controller. It is only a simple operator interface for the gearbox controller.

Controls

The SUU consists of four operating elements: MAN switch, UP, DOWN, and POTI.

MAN switch

The MAN switch is the main program operating selector of the SUU.

MAN switch OR = original controller behavior

MAN switch SP = shift-program behavior

With MAN switch OR, the gearbox controller behaves like the original controller. With MAN switch SP, the gearbox controller uses the selected shift program.

Moving the MAN switch into SP also activates the analog SUU path immediately and releases BUU / CAN control. In practical terms, the BUU and SUU are alternative active user-unit paths, not two simultaneously active control paths.

UP button

The UP button is the manual upshift button. During shift-program behavior, UP requests the next higher gear. The actual result depends on the active program and the controller logic.

DOWN button

The DOWN button is the manual downshift button. During shift-program behavior, DOWN requests the next lower gear. The actual result depends on the active program and the controller logic.

POTI

The POTI is the analog potentiometer of the SUU. It is read directly by the gearbox controller and is used to move the automatic shift points forward or backward in the potentiometer-based programs.

It is relevant for UDP and SSP. The potentiometer itself contains no logic. It is only an analog input device.

Shift-program entry and selection

Programs are selected when the MAN switch is moved from OR to SP. At that moment, the controller checks which buttons are pressed.

UP pressed = SS

DOWN pressed = UD

UP + DOWN pressed together = EMG

no button pressed = restore the last stored drive program

UDP and SSP are not entered directly by a separate button combination. To get these programs from the SUU, the driver must first enter UD or SS and then perform the potentiometer calibration. After a successful potentiometer calibration, the controller automatically changes UD to UDP or SS to SSP.

So if the operator wants SSP, he must first select SS, then perform the potentiometer calibration, after which the controller changes SS into SSP. The same applies to UDP, starting from UD.

If UDP or SSP was already stored previously, it can also be restored by just switching from OR to SP with no button pressed, because in that case the controller restores the last stored drive program.

OR → original mode

UD mode

Hold DOWN while the switch is moved to SP.

UDP mode

UD must be selected.

Speed below 50 Hz (vehicle should be stationary).

Hold UP + DOWN for 2.5 s.

Then turn the POTI FULL LEFT, FULL RIGHT and FULL LEFT. UP + DOWN may be held during calibration.

CALIBRATION MUST BE COMPLETED WITHIN 6 SECONDS; OTHERWISE IT IS ABORTED.

SS Mode

Hold UP while the switch is moved to SP.

SSP mode

SP must be selected.

Speed below 50 Hz (vehicle should be stationary).

Hold UP + DOWN for 2.5 s.

Then turn the POTI FULL LEFT, FULL RIGHT and FULL LEFT. UP + DOWN may be held during calibration.

CALIBRATION MUST BE COMPLETED WITHIN 6 SECONDS; OTHERWISE IT IS ABORTED.

Emergency mode (Software)

Hold UP and DOWN while the switch is moved to SP.

Forward / Reverse in EMG (Normal operation)

In EMG mode, forward and reverse are primarily selected using the gear selector:

D or S = forward / R = reverse

Shifting is done manually using UP / DOWN

GEAR SELECTOR OVERRIDE IN EMG (in case of a malfunctioning gear selector)

Press UP and DOWN simultaneously

D/R or forward/reverse must now be selected with the UP and DOWN buttons, as explained below. This remains active until restart.

Potentiometer calibration

Because the SUU potentiometer is only a direct analog input, the gearbox controller must know its real minimum and maximum values. That is why the SUU potentiometer can be calibrated through the gearbox controller.

Calibration is started from the SUU by pressing UP + DOWN together, holding them for about 2.5 seconds, while the controller speed is below about 50 Hz.

After entry, the potentiometer must be moved through LOW → HIGH → LOW. The gearbox controller then stores the new potentiometer minimum and maximum values.

A successful potentiometer calibration will also change the active program automatically: UD → UDP and SS → SSP.

SUU connection

The SUU uses the same cable and the same connector as the BUU. This means the two user units are electrically interchangeable at the gearbox controller connection.

As with the BUU connection, a non-twisted cable must be used.

Practical note

The SUU has no own display and no direct feedback from the controller. Because of this, during installation and first familiarization it is useful to check the selected mode and the calibration status on the local gearbox-controller OLED before the gear selector panel is closed.

This helps the operator get used to the system and verify that the intended mode or calibration procedure has actually been accepted by the controller.

BUU

The BUU is the big user unit of the MAMUT gearbox controller and provides the driver with a display-based CAN interface for operating and monitoring the transmission.

It shows the current gear, transfer-case state, selector request, active shift program, gearbox speed signal, communication status and active warnings.

The UP and DOWN buttons are used for manual shift requests, the POTI adjusts the automatic shift points in supported programs, and FORW and BACK move through the available display pages.

ENTER and ESC are used to open, confirm, cancel or leave menu and setup functions.

Through the PROG page, the driver can view and select the available gearbox programs.

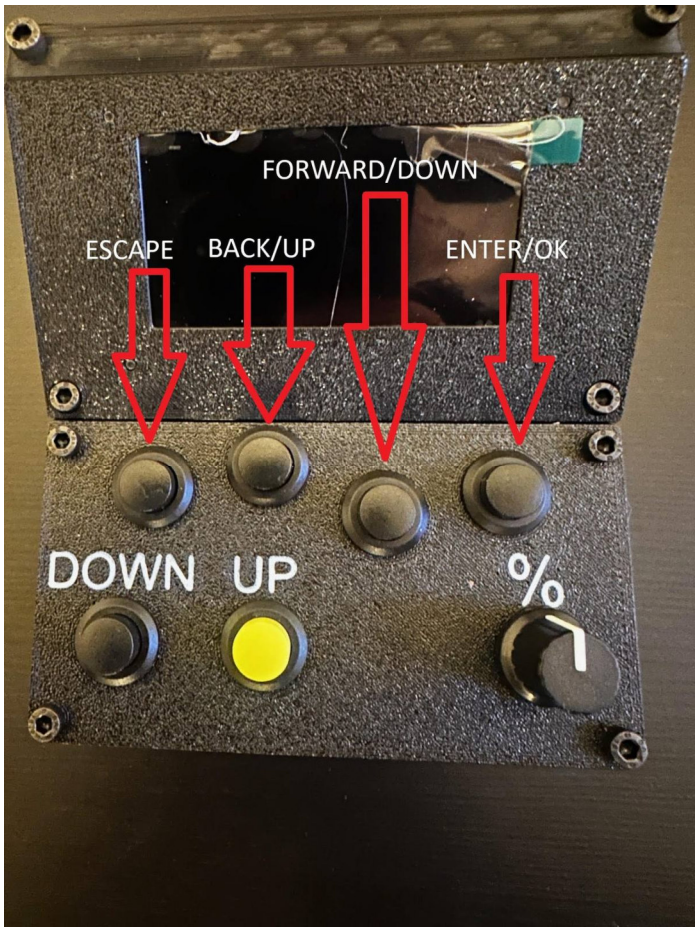
The INPUT and DIAG pages support troubleshooting by showing vehicle input signals, output confirmations and command-to-feedback mismatches.

In FS and FO, the BUU also provides user-preset selection and adjustment of the stored shift thresholds.

Depending on the installed configuration, the GPS pages can show speed, heading, distance, waypoints, altitude and satellite information.

Warning and failure overlays inform the operator about communication loss, emergency shifting and faults F1 to F6, but acknowledging a message does not cancel the underlying condition.

The BUU therefore combines the driver display, gearbox controls, adjustable shift behavior, setup functions and diagnostic information in one operator interface.



Screens

FULL BUU NAVIGATION MAP

(full configuration shown: GPS available + FS/FO active)

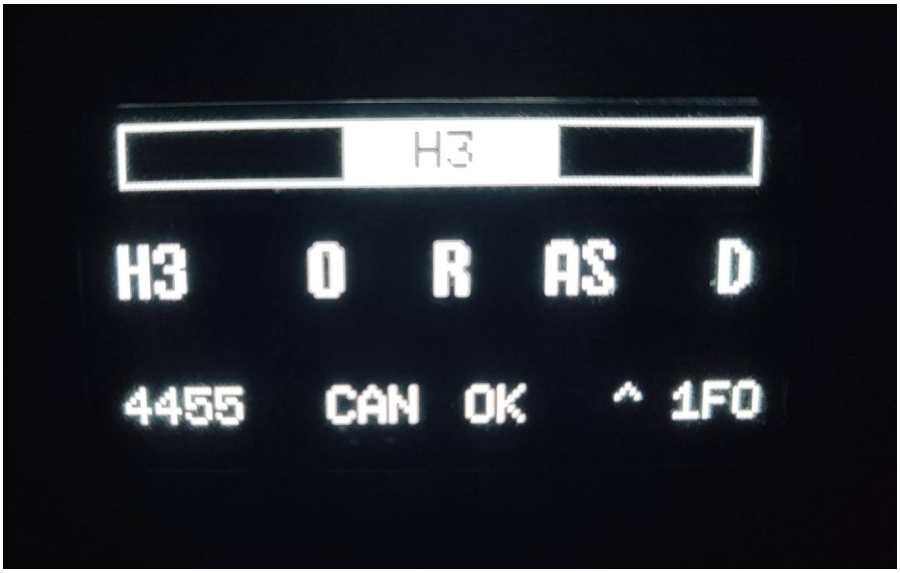
```
GPS TARGET
├─ BACK  → SHIFT SETUP
├─ FORW  → GPS MAIN
├─ ENTER short        = select next target / waypoint
├─ ENTER hold 1.5 s   = save current position to current waypoint
├─ ESC short          → MAIN
├─ ESC hold 2.5 s     = delete current waypoint
└─ FORW + BACK hold 2 s
   └─ GPS INFO
      └─ any button = exit → GPS TARGET
GPS MAIN
├─ BACK  → GPS TARGET
├─ FORW  → OFF
└─ FORW + BACK hold 2 s
   └─ GPS INFO
      └─ any button = exit → GPS MAIN
OFF
├─ BACK  → GPS MAIN
└─ FORW  → BAR
BAR
├─ BACK  → OFF
└─ FORW  → MAIN
MAIN
├─ BACK  → BAR
└─ FORW  → PROG
PROG
├─ BACK  → MAIN
├─ FORW  → DIAG
├─ ESC   → MAIN
└─ ENTER
   └─ PROG CHOOSE
      ├─ BACK / FORW = move cursor
      ├─ ENTER       = confirm program → PROG
      └─ ESC         = cancel → PROG
DIAG
├─ BACK  → PROG
├─ FORW  → INPUT
├─ ESC   → MAIN
└─ ENTER hold 3 s
   └─ DIAG CONFIRM
      ├─ ESC   = NO  → DIAG
      └─ ENTER = YES
         └─ DIAG WAIT FOR ECU
            ├─ ESC = cancel → DIAG
            └─ ECU confirms DIAG
               └─ OPERATE OUTPUTS
                  ├─ BACK / FORW = select output
                  ├─ ENTER       = toggle selected output
                  └─ ESC hold 2 s
                     └─ all outputs OFF
                        previous drive program restored
                        return → DIAG
INPUT
├─ BACK  → DIAG
└─ FORW  → USER PRESET SELECTION PAGE
```

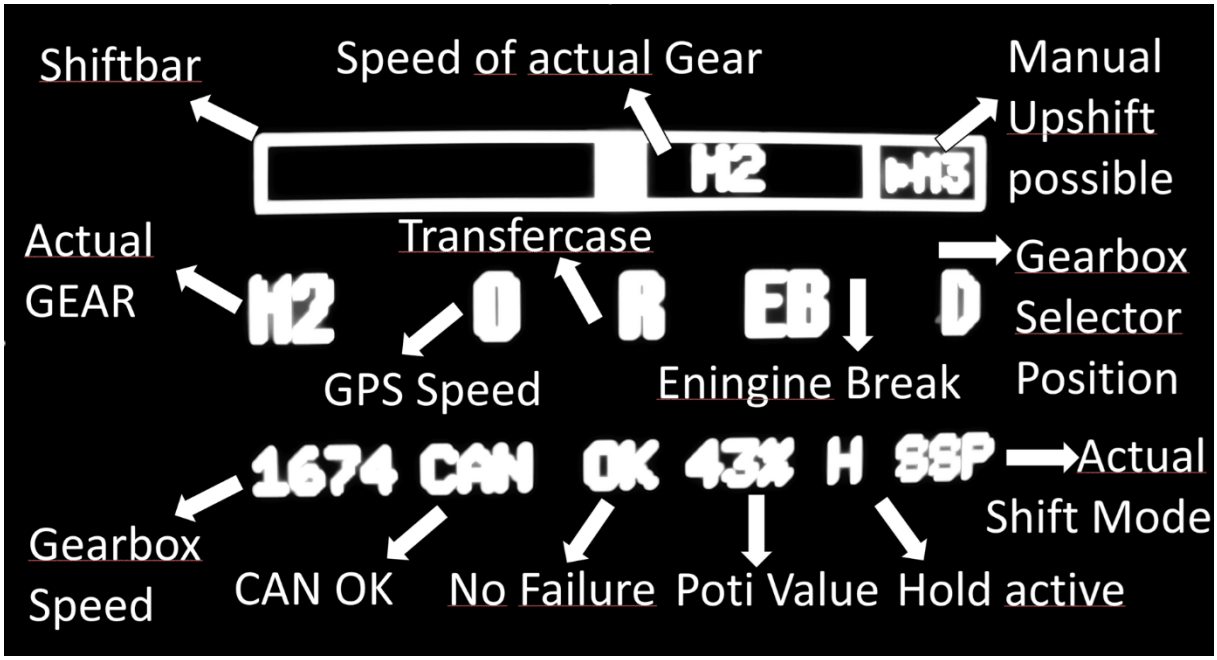
```
USER PRESET SELECTION PAGE
├─ BACK  → INPUT
├─ FORW  → SHIFT SETUP
├─ ESC   → MAIN
└─ ENTER
   └─ PRESET CHOOSE
      ├─ BACK / FORW = select preset
      ├─ ENTER       = confirm preset → USER PRESET SELECTION PAGE
      └─ ESC         = cancel → USER PRESET SELECTION PAGE
SHIFT SETUP
├─ BACK  → USER PRESET SELECTION PAGE
├─ FORW  → GPS TARGET
├─ ENTER hold 5 s
│  └─ SETUP CONFIRM EDIT
│     ├─ ESC   = NO  → SHIFT SETUP VIEW
│     └─ ENTER = YES
│        └─ SETUP EDIT SELECT
│           ├─ BACK / FORW = select field
│           ├─ ENTER        = edit selected field
│           │  ├─ H1 left field = POTI ON / OFF toggle
│           │  └─ threshold field
│           │     └─ SETUP EDIT ADJUST
│           │        ├─ BACK / FORW   = fine adjust
│           │        ├─ UP hold + pot = coarse adjust
│           │        ├─ ENTER         = accept → SETUP EDIT SELECT
│           │        └─ ESC           = cancel → SETUP EDIT SELECT
│           └─ ESC hold 2 s
│              ├─ no changes
│              │  └─ leave → stored display page
│              └─ changes present
│                 └─ SETUP CONFIRM SAVE
│                    ├─ ESC   = discard changes → SHIFT SETUP VIEW
│                    └─ ENTER = save changes
│                       └─ SENDING
│                          └─ SAVED
│                             └─ SHIFT SETUP VIEW
└─ normal BACK / FORW page navigation only while not inside edit / confirm mode
```

Notes

- **FORW** and **BACK** are used to move through the normal page loop.
- **GPS INFO** is not a normal page. It is an overlay opened from **GPS TARGET** or **GPS MAIN**.
- In **GPS INFO**, **any button = exit** and return to the previous GPS page.
- **OPERATE OUTPUTS** is not a normal page either. It is only accessible through **DIAG**.
- If GPS Module is not available, **GPS TARGET** and **GPS MAIN** are not shown.
- If the active mode is not **FS** or **FO**, **USER PRESET SELECTION PAGE** and **SHIFT SETUP** are not shown.

Main Screen





Shift bar

The shift bar is shown on the BAR and MAIN pages. Its arrows and highlighted range show the currently applicable shift information for the active program and gear.

- the **left threshold marker** shows the active downshift point
- the **right threshold marker** shows the active upshift point
- the **filled part of the bar** begins at the active downshift point and extends to the current Hz value
- if the current Hz value is **below** the active downshift point, no filled bar is shown
- if the current Hz value is **above** the active upshift point, the filled bar ends at the upshift marker
- in operating states where only one shift limit exists, the BUU uses the corresponding bar edge as the open end of the display range

The displayed shift information can change after a gear change, program change, POTI adjustment, EB/H change or AS change.

A very short visual stabilization after a gear change is normal display behavior and does not delay gearbox control.

Manual shift arrows

The **manual shift arrows** are only shown when a manual shift is currently permitted by the gearbox controller. Whether an arrow is displayed depends on the active program, the current speed, the current gear, the operating mode, and the applicable controller release and protection conditions.

If a manual upshift or downshift is not permitted in the current situation, the corresponding arrow is not shown.

In EMG, the normal EMG shiftbar remains in use when W is visible. The manual arrows continue to follow the EMG H1-H2-H3-M3 path.

Actual gear

The field at the left side of the middle row shows the current actual gearbox gear.

Possible values are:

N, R, H1, H2, H3, M1, M2, M3, GS, TS

This is the direct gear status from the gearbox controller.

Technical note: **H1 to H3** and **M1 to M3** use the same basic **G1 / G2 / G3** output combinations in pairs. The difference between **H** and **M** is created by the additional **GM** state. **TS** uses the same basic gear-output combination as **M1**, but with the tow-start / converter state added.

GPS speed

If GPS is active, the second field in the middle row shows the current **GPS speed**.

- with valid live GPS data, the BUU shows the current GPS speed
- if GPS is active but no valid live value is available, the displayed value falls back to **0**
- if GPS is not available in that BUU configuration, this field is **not shown**

Transfercase

The middle field shows the current **transfer case state**.

Possible values are:

DD = drive disconnect
T = terrain
R = road

This field shows the transfer state reported by the gearbox controller. The displayed DD / T / R is not replaced by the separate transfer-event target. Instead, the BUU uses the transfer-event stream only to style the field: a latched but not yet executable change is shown inverted, an actually executing change is shown blinking inverted, and the highlighting disappears again after completion.

If no fresh transfer-event update arrives, the BUU clears stale transfer highlighting automatically and returns to the normal DD / T / R display.

Special status and selector-source field

The field between transfer case and selector request shows the active special status and, where applicable, the virtual-selector source.

Possible values are:

AS = Anti-Slip active
EB = Engine Brake active
W = winch input active
NG = No Gearselector / virtual selector active
blank = normal operation

W is information only and does not confirm mechanical winch engagement or a safe winch condition. W and NG can be visible together.

Gearbox selector request

The field at the right side of the middle row shows the effective driver selector request, not the actual gearbox gear.

Possible values are:

D, S, F, R, N, TS
NG is shown in the adjacent status/source field when the physical selector is ignored and the UP/DOWN virtual selector is active.

During a transfer-case change, gearbox output can temporarily be Neutral while an active F or R request correctly remains displayed.

Hz value

The number at the bottom left shows the current gearbox output speed signal in **Hz**.

This is the **gearbox output speed before the transfer case**. It is the speed value used by the gearbox controller for the shift logic and for the bar display.

This value can also help identify a **speed sensor failure**, especially if the displayed Hz value drops unexpectedly or if a speed-related fault such as **F5** is present.

CAN status

The text **CAN** in the bottom row confirms that CAN communication with the gearbox controller is active.

Failure status

The field next to **CAN** shows the compact system failure status.

Possible values are:

OK = no active failure currently shown
F1, F2, F3, F4, F5, F6 = active failure code

This is the compact summary field. If a full failure overlay is active, the BUU replaces the normal page with the corresponding failure screen.

Poti value

In the normal automatic programs, the bottom-right status group begins with the current potentiometer setting in percent. The BUU does not show EMG is a a potentiometer value in any mode without potentiometer scaling.

Example:

43%

The potentiometer value is used to move the automatic shift points **forward or backward** in the programs that use potentiometer scaling.

This mainly applies to:

- **UDP**
- **SSP**
- **FS**
- **FO**

In **FS** and **FO** presets with fixed potentiometer mode, the BUU uses a fixed internal value instead of the live physical potentiometer. This ensures that the selected shift points remain fixed.

Additional BUU behavior:

- in certain programs, when the potentiometer is exactly at the defined reference setting, the BUU can show **^** instead of **86%**

H selected

If Engine Brake Hold has been selected, the BUU shows the letter:

H

H appears in the bottom-right status group before the active shift mode and may remain displayed even when EB is not currently engaged.

Actual Hold shifting operates only while EB is active, and therefore only with the physical selector in D. H is never shown or active in OR, SSX, EMG or DIAG.

The BUU displays the H selection reported by the gearbox controller. The SUU does not provide the Hold function

Hold selected Hold not selected

Actual shift mode

The last element on the bottom right shows the currently active **shift mode / program**.

Possible values are:

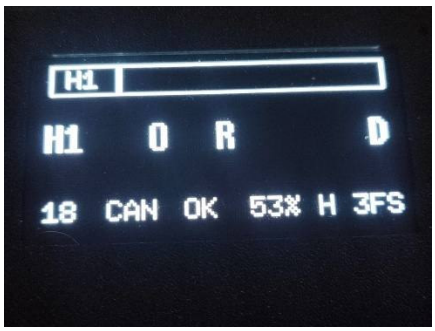
UD
SS
UDP
SSP
SSX
OR
EMG

For the free preset modes, the BUU shows the selected preset number together with the program:

1FS to 6FS
1FO to 6FO

In the potentiometer-based programs, the BUU uses 86% as the reference setting. When this reference point is reached, the display can show an up arrow (^) instead of 86%. In FS and FO presets with deactivated potentiometer, will not show a poti value.

The up-arrow marker is therefore a quick visual indication that the potentiometer is at the defined reference position for the stored shift setup.



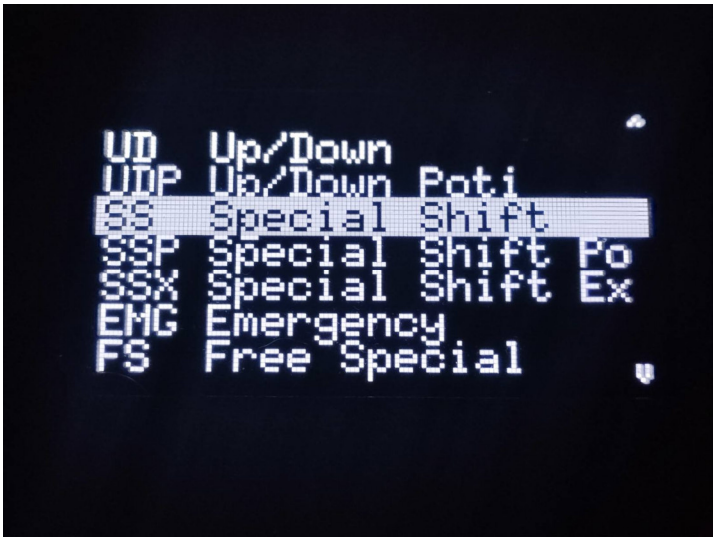
Example of a complete display reading

A display like this:

H2 0 R EB D
1674 CAN OK 43% H SSP
means:

- actual gear = **H2**
- GPS speed = **0**
- transfer case = **R**
- engine brake active = **EB**
- Gearselector = D
- current gearbox speed signal = **1674 Hz**
- CAN communication is active
- no active failure
- potentiometer setting = **43%**
- H is active
- active shift mode = **SSP**

PROG



Program page operation

The **PROG** page is used to view and select the active driving program.

Display logic

- The **highlighted line** shows the currently active program.
- In selection mode, the BUU uses a **cursor frame** to show the program that is currently selected for change.
- The small symbols at the right edge indicate that more entries are available above or below the visible list.

Operation

- **FORW / BACK** move to the PROG page from the normal page loop.
- On the PROG page, **ENTER** opens the program selection mode.
- In program selection mode:
  - **BACK / FORW** move the cursor through the program list
  - **ENTER** confirms the selected program
  - **ESC** cancels the selection and returns to the normal PROG page
- **ESC** from the normal PROG page returns to **MAIN**

Important notes:

- **UP / DOWN** still remain the global manual shift buttons
- **DIAG** is **not** selected from the PROG page; it is entered from the **DIAG** page

---

Programs shown on the PROG page

OR — Original Auto

Original automatic gearbox behavior.
This is the original shift logic and used as the standard fallback mode.

UD — Up/Down

Manual shift program with gearbox protection.
Shift path: **H1** → **H2** → **H3** → **M3**

UDP — Up/Down Poti

UD-based program with potentiometer influence.
Automatic and manual operation are combined, and the potentiometer shifts the change points forward or backward.

SS — Special Shift

Manual shift program with the special shift sequence.
Shift path: **H1** → **H2** → **M2** → **M3**

SSP — Special Shift Poti

SS-based program with potentiometer influence.
Automatic and manual operation are combined, using the special shift sequence.

SSX — Special Shift Ex

Pure automatic special-shift program.
Like SSP without potentiometer scaling. Its behaves like the original mode with the special shift pattern.

EMG — Emergency

Emergency driving program.
Used for reduced-function manual operation under abnormal conditions.

FS — Free Special

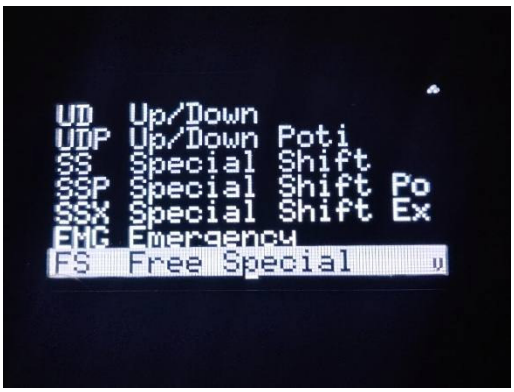
User-configurable special-shift program.
This is the adjustable version of the **SS-family** and works with the stored user preset and shift setup values.

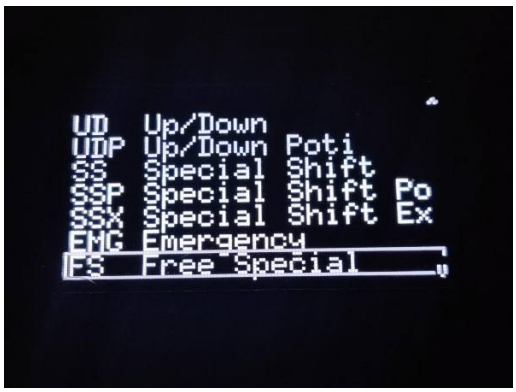
FO — Free Original

User-configurable original-pattern program.
This is the adjustable version of the **UD / original family** and works with the stored user preset and shift setup values.

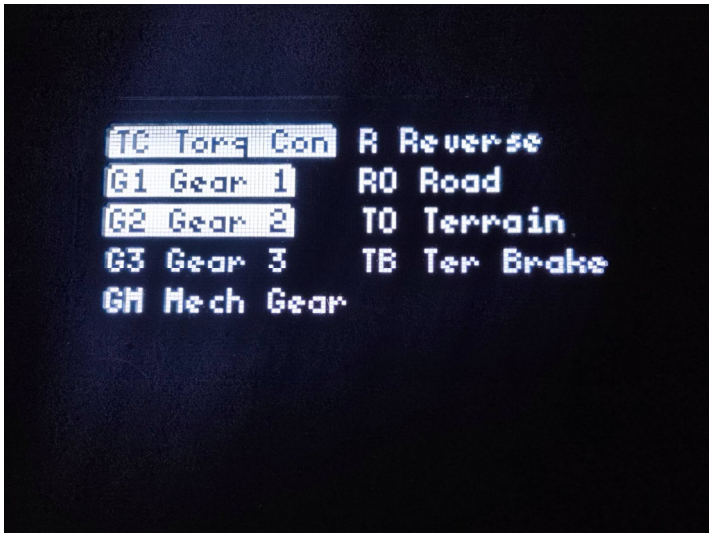
Practical reading of the page

If a line is highlighted, that is the **active current program**.
If you press **ENTER**, the page changes into selection mode. Then you move with **BACK / FORW** to the desired program and confirm it with **ENTER**.





Output page



The output page is the **DIAG page** of the BUU. It is used to display the status of the gearbox and transfer-case output functions and, after entering DIAG mode, to operate these outputs individually.

In normal page navigation, this page appears as **DIAG**.
The actual output control state is the **OPERATE OUTPUTS** subpage inside DIAG.

Purpose

The output page has two functions:

- to show the status of the main gearbox and transfer-case output functions
- to allow individual output testing after DIAG mode has been entered and confirmed

This page is mainly intended for diagnostic and service use.

Display layout

The page shows the output channels in two columns.

Left column:

- **TC** — Torq Converter
- **G1** — Gear 1
- **G2** — Gear 2
- **G3** — Gear 3
- **GM** — Mechanical Gear

Right column:

- **R** — Reverse
- **RO** — Road
- **TO** — Terrain
- **TB** — Terrain Brake

Signal principle

The output page does not only show what the BUU or gearbox controller commands.
Each output function is also read back through its corresponding **input feedback / confirmation signal**.

The display therefore shows the **input confirmation signals** assigned to the output functions, and these signals are checked against the **output command set by the controller**.

In practical terms:

- the controller sets an output command
- the related feedback input reports whether that function is actually active
- the BUU displays this input feedback state
- the BUU checks whether the feedback state matches the commanded output state

This makes the page useful both for function display and for mismatch diagnosis.

Meaning of the display

A highlighted line means that the corresponding **input confirmation signal** is active.

So the display is not only showing what has been commanded. It mainly shows what the controller receives back as the confirmed state of that output function.

This makes the page useful for checking whether the commanded output and the actual confirmation agree.

Mismatch indication

In the normal DIAG view, the BUU can show a blinking frame around an entry.

A blinking frame means that there is a **mismatch between the controller output command and the corresponding input confirmation signal** for that channel.

This helps identify outputs that are being commanded but not confirmed correctly, or confirmation signals that are active when the output should not be active.

Conditions required to enter output operation

The output page is not immediately in control mode when the DIAG page is opened.

To enter **OPERATE OUTPUTS**, the following conditions must be met:

- the **DIAG** page must be opened
- **ENTER** must be held for **3 seconds**
- the DIAG request must be confirmed with **ENTER**
- the gearbox selector must be in **Neutral**
- the speed value used for the DIAG check must be below **150 Hz**
- the gearbox controller must accept the request and confirm **DIAG mode**

The BUU itself shows these entry conditions on the confirmation page. If they are not met, the BUU can show messages such as:

- **SPEED TOO HIGH**
- **SELECT N**
- **HZ < 150**

Only after the gearbox controller confirms DIAG mode does the BUU enter **OPERATE OUTPUTS**.

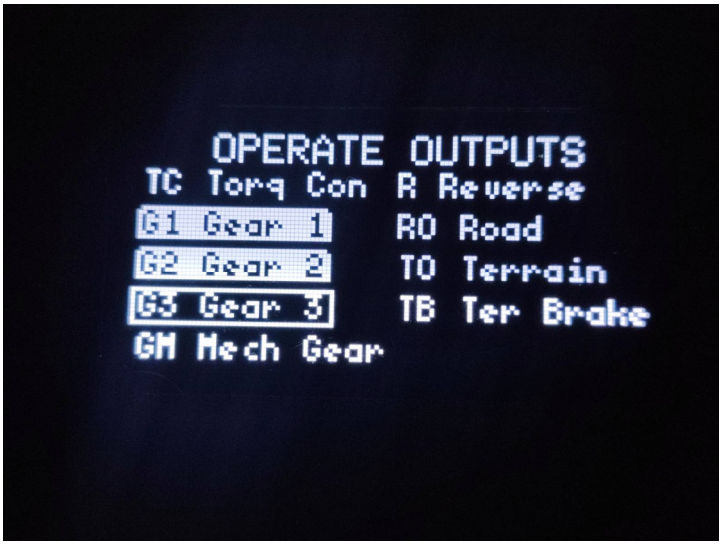
Entering output operation

The operating sequence is:

- open the **DIAG** page
- hold **ENTER** for **3 seconds**
- confirm the DIAG request
- wait for the gearbox controller to confirm DIAG mode
- after confirmation, the BUU enters **OPERATE OUTPUTS**

Only after this confirmation process can the outputs be switched individually.

Output operation



In **OPERATE OUTPUTS**:

- **BACK / FORW** select the output channel
- **ENTER** toggles the selected output
- **ESC hold 2 seconds** switches all outputs off, restores the previous drive program, and returns to the DIAG page

In OPERATE OUTPUTS, the currently selected channel is shown with a frame.

Warning

The DIAG output page switches **real vehicle output functions**.
These are not simulated display functions.

That means the gearbox, transfer-case, reverse, terrain, torque-converter and brake-related control outputs can be electrically actuated during testing. With the engine running, the vehicle can react.

For this reason, the intended use of the output page is:

- **engine off**
- **vehicle stationary**
- vehicle secured against movement
- use for testing, checking and measuring through the original truck wiring

Typical intended use is checking whether voltage or switching state is present at a gearbox-related signal in the vehicle wiring while the vehicle is standing and the engine is off.

The output page is therefore a **diagnostic test function**, not a driving function.

Important safety behavior

DIAG output operation is only accessible through the **DIAG** page and its confirmation sequence.

When leaving OPERATE OUTPUTS, the BUU commands:

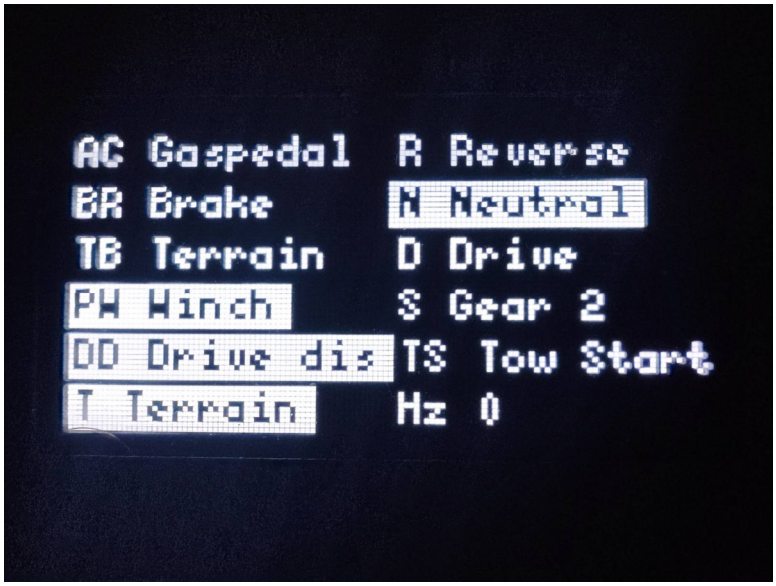
- all DIAG outputs **OFF**
- return to the **previous drive program**

This is an important safety function.

Practical interpretation

- If a line is highlighted, the corresponding **input confirmation signal** is active.
- If a line is framed and blinking in the normal DIAG view, the **commanded output state** and the **returned input confirmation state** do not match.
- If the page shows the **OPERATE OUTPUTS** heading, the BUU is in active output-test mode and the selected channel can be switched with **ENTER**.

Input page



The **INPUT** page shows the current status of the main input signals used by the gearbox controller.

This page is a **status and diagnostic page only**.
It does not switch or command any functions. It is used to check which input signals are currently active and to verify whether switches, selector positions and vehicle-side control signals are reaching the controller correctly.

Purpose

The input page has two main functions:

- to show the current state of the relevant gearbox-controller input signals
- to help diagnose wiring, switch and selector problems by showing which inputs are active at that moment

This page is mainly intended for checking the vehicle-side control signals while operating, commissioning or troubleshooting the system.

Display layout

The page shows the input channels in two columns.

Left column

- **AC** — Gaspedal
- **BR** — Brake
- **TB — Terrain brake**
- **PW** — Winch
- **DD — Drive disconect**
- **T** — Terrain

Right column

- **R** — Reverse
- **N** — Neutral
- **D** — Drive
- S — Gear S
- **TS** — Tow Start

At the lower right, the BUU shows Hz, the current speed-sensor frequency.

Signal principle

The input page shows the **actual input states received by the gearbox controller**.
This makes the page useful for checking whether:

- the selector position is reaching the controller correctly
- pedal or brake-related signals are present
- terrain, winch, drive-disconnect or tow-start related inputs are present
- the vehicle wiring and switch contacts are behaving as expected

Meaning of the display

A highlighted line means that the corresponding **input signal is active**.

If a line is not highlighted, that input is currently inactive.

Unlike the output page, the input page does **not** compare command and confirmation. It is a direct input-state display.

Hz display

At the bottom of the INPUT page, the BUU shows the current Hz value used for input-signal diagnosis.

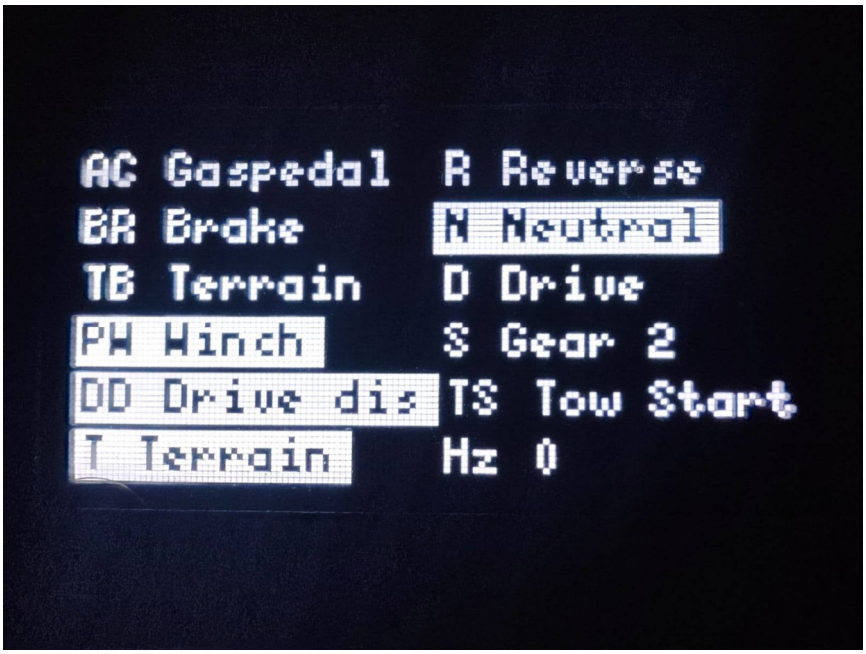
The BUU shows the averaged raw speed-frequency signal as raw data is available. If no fresh raw data in Hz. The page is therefore intended mainly for signal checking and diagnosis, for example when checking the speed signal itself or tracing a speed-sensor or wiring fault.

Typical use

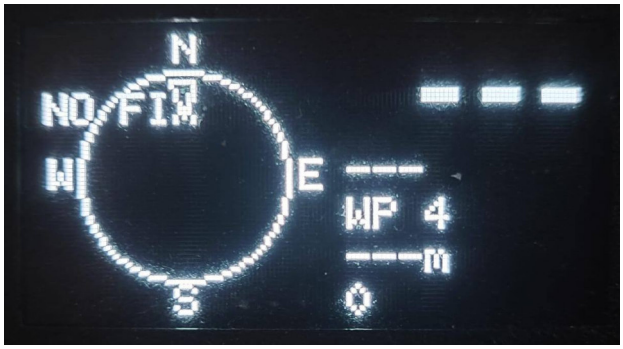
Typical uses of the INPUT page include:

- checking selector inputs with ignition on and vehicle stationary
- verifying whether a pedal, brake or terrain-related signal reaches the controller
- checking truck wiring during troubleshooting
- confirming signal presence before deeper electrical diagnosis
- checking whether the raw speed signal is present for speed-sensor diagnosis

The INPUT page is therefore a **diagnostic signal-display page**, not an operating page.



Target page



The **TARGET** page is the GPS target and waypoint page of the BUU. It is used to show the direction and distance to the currently selected waypoint and to manage the stored waypoint positions.

If the GPS Pages are not shown the GPS Module is defective or not mounted.

The presence of GPS pages does not prove that current GPS speed data is valid. If speed remains 0, check reception, antenna, module power and whether valid speed data is currently being transmitted. Very low movement may intentionally be shown as 0.

Purpose

The target page has four main functions:

- to show the direction to the currently selected waypoint
- to show the distance to the currently selected waypoint
- to select the active waypoint
- to save or delete waypoint positions

This page is intended as a simple navigation aid and waypoint management page.

Display layout

The TARGET page is divided into a left navigation area and a right information area.

Left side

The left side shows a circular direction display.

It contains:

- a compass circle
- rotating **N / E / S / W** references
- a direction arrow pointing toward the selected waypoint

The arrow shows the **relative direction to the selected waypoint** based on the current vehicle heading.

If a valid position fix and a valid waypoint are available, the arrow points toward the target.

If no waypoint is stored in the selected waypoint slot, the page shows:

NO WP

If there is no valid current GPS fix, the page shows:

NO FIX

Right side

The right side shows the target-related data.

From top to bottom it shows:

- current **GPS speed**
- current **distance to the selected waypoint**
- current **waypoint number**
- current **altitude**
- current **satellite count**

Speed

The large number at the top right shows the current GPS speed.

If no valid live speed is available, the BUU shows:

Distance

The distance to the selected waypoint is shown below the speed.

Display behavior:

- if the distance is **1.0 km or more**, it is shown in **km**
- if the distance is **below 1.0 km**, it is shown in **m**
- if no valid waypoint or no valid position is available, the distance is shown as unavailable

Waypoint number

The page shows the currently selected waypoint slot as:

WP 1 to **WP 9**

Altitude

The altitude is shown in **m** when valid GPS altitude data is available.

If altitude data is not valid, the BUU shows:

---m

Satellite count

The number of received satellites is shown when valid satellite data is available.

If that information is not valid, the BUU shows:

--

Signal principle

The target page uses GPS data directly from the BUU GPS receiver.

The page uses:

- current GPS position
- current GPS speed
- current GPS heading
- stored waypoint coordinates from EEPROM

The direction arrow is calculated from the current GPS position to the selected waypoint.

The displayed target direction is therefore a real calculated navigation direction and not a fixed symbol.

Heading behavior

The target page uses the current GPS course as heading reference when valid movement data is available.

If no fresh moving-course data is available, the BUU keeps the **last valid heading**. This keeps the target arrow stable when the vehicle is stationary or moving too slowly for a reliable new heading.

Waypoint handling

The BUU supports **9 waypoint slots**.

Each slot can either contain a stored target position or be empty.

The currently selected waypoint is stored in EEPROM, so it remains selected after restart.

Operation

Select next waypoint

- **ENTER short** selects the next waypoint / target slot

The selection steps through the available waypoint numbers in sequence.

Save current position to waypoint

- **ENTER hold 1.5 seconds** saves the current GPS position into the currently selected waypoint slot

This overwrites the previous position stored in that slot.

After saving, the page shows a short confirmation message:

SAVED

Delete current waypoint

- **ESC hold 2.5 seconds** deletes the currently selected waypoint slot

After deletion, the page shows a short confirmation message:

DELETED

If a waypoint does not have stored data its shows in the top left NO WP.

Leave the page

- **ESC short** returns to **MAIN**

GPS info overlay

- **FORW + BACK hold 2 seconds** opens the **GPS INFO** overlay

While GPS INFO is open:

- any button closes the overlay
- after exit, the display returns to the TARGET page

GPS offline behavior

If GPS was available at boot but there is currently no live NMEA data, the TARGET page is still accessible, but the normal target display is replaced by the offline page.

In this case the OLED shows:

- **GPS OFFLINE**
- **NO NMEA DATA**

This means the GPS page exists, but there is currently no active live GPS data stream.

Practical interpretation

The TARGET page is useful for quickly checking:

- which waypoint is currently selected
- how far away the target is
- in which direction the target lies
- whether the waypoint has been saved correctly
- whether valid GPS, altitude and satellite data are available

Typical use

Typical uses of the TARGET page include:

- saving a new field waypoint
- checking straight target distance and direction

The TARGET page is therefore a **GPS navigation and waypoint management page**.

Compass page

The **Compass page** is the **GPS MAIN** page of the BUU. It shows the current travel direction together with general GPS travel information.

Purpose

The Compass page has four main functions:

- to show the current vehicle heading
- to show the current GPS speed
- to show the travelled distance since BUU start
- to show additional GPS status values such as altitude and satellite count

Display layout

The Compass page is divided into a left compass area and a right information area.

Left side

The left side shows a circular compass display.

It contains:

- a compass circle
- fixed **N / E / S / W** markings
- a direction arrow showing the current heading

The arrow shows the **current direction of travel**, not the direction to a waypoint.
Waypoint direction is shown on the **TARGET** page.

Right side

The right side shows the GPS information values.

From top to bottom it shows:

- current **GPS speed**
- **travelled distance** since BUU start
- **average speed** since BUU start
- current **altitude**
- current **satellite count**

Speed

The large number at the top right shows the current GPS speed.

If no valid live speed is available, the BUU shows:

Travelled distance

Below the speed, the page shows the accumulated travelled distance since the BUU was started.

The value is shown in **km**.

This distance is built from the live GPS position changes and is intended as a simple trip value for the current BUU runtime.

Average speed

Below the travelled distance, the page shows the average speed value for the current BUU runtime.

This is calculated from the travelled distance and the elapsed runtime since BUU start.

Altitude

The altitude is shown in **m** when valid GPS altitude data is available.

If altitude data is not valid, the BUU shows:

---m

Satellite count

The number of received satellites is shown when valid satellite data is available.

If that information is not valid, the BUU shows:

--

Signal principle

The Compass page uses GPS data directly from the BUU GPS receiver.

The page uses:

- **GPS speed**
- GPS course
- GPS altitude
- satellite count

The travelled distance and average speed are generated inside the BUU from the GPS data.

Heading behavior

The compass arrow uses the current GPS course as heading reference when valid movement data is available.

If no fresh moving-course data is available, the BUU keeps the **last valid heading**. This keeps the compass stable when the vehicle is stationary or moving too slowly for a reliable new heading update.

So the Compass page does not continuously spin randomly at standstill. It holds the last valid travel direction until a new valid heading is available.

Offline behavior

If GPS was available at boot but there is currently no live NMEA data, the Compass page is still accessible, but the normal compass display is replaced by the offline page.

In this case the OLED shows:

- **GPS OFFLINE**
- **NO NMEA DATA**

This means the GPS page exists, but there is currently no active live GPS data stream.

Operation

The Compass page has no waypoint save or delete function.

Page movement

- **BACK** moves to **GPS TARGET**
- **FORW** moves to **OFF**

GPS info overlay

- **FORW + BACK hold 2 seconds** opens the **GPS INFO** overlay

While GPS INFO is open:

- any button closes the overlay
- after exit, the display returns to the Compass page

Other buttons

- **ENTER** has no page-specific function on this page
- **ESC** has no page-specific function on this page
- **UP / DOWN** remain the global manual shift buttons

Practical interpretation

The Compass page is useful for quickly checking:

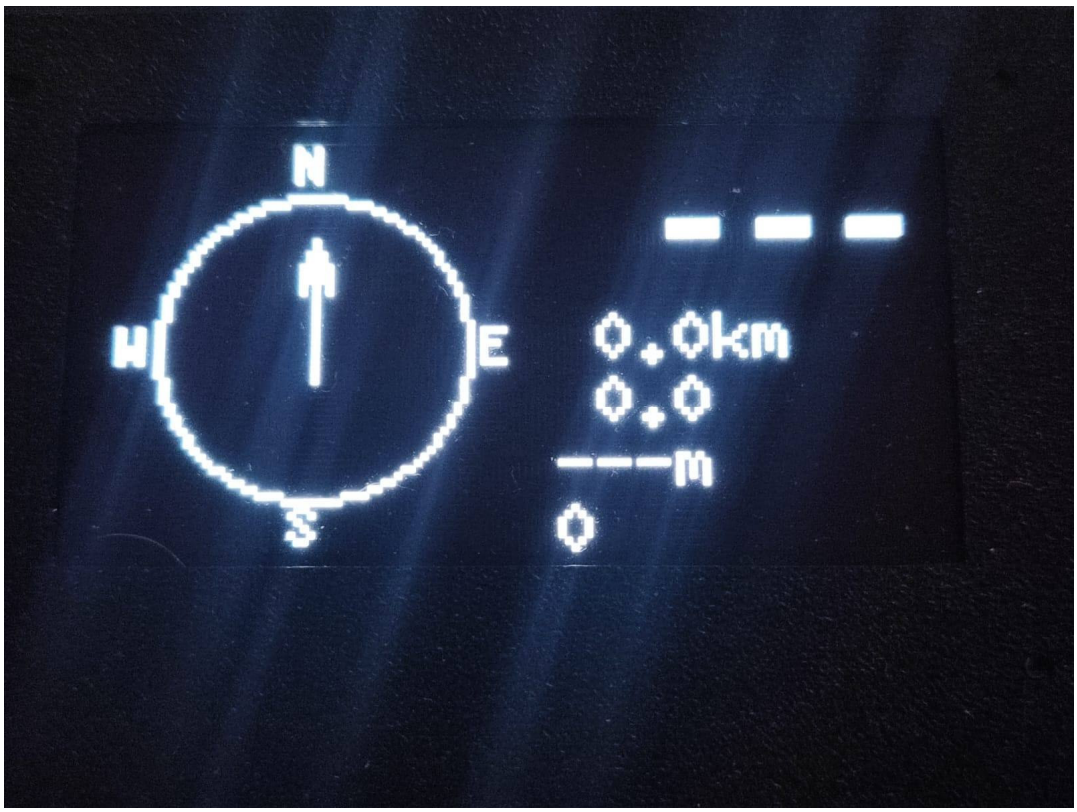
- current travel direction
- current GPS speed
- whether the GPS receiver is alive
- travelled distance since startup
- average travel speed since startup
- altitude and satellite status

Typical use

Typical uses of the Compass page include:

- checking current heading while driving
- checking GPS speed independently of drivetrain data
- monitoring trip distance during vehicle use
- verifying that GPS altitude and satellite data are available
- confirming that the GPS receiver is currently active

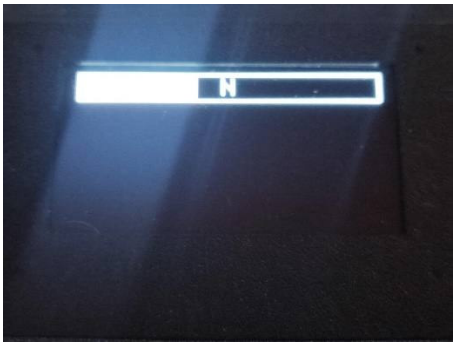
The Compass page is therefore a **GPS overview and heading page**.



Bar page

The **BAR** page is the simplified driving-information page. It only shows the **shift bar**, the **current gear**, and the **possible manual shift indications**. It is intended to give quick shift and operating feedback in the clearest possible form without the additional information shown on the MAIN page.

For all detailed information about the shift bar, gear display, and possible manual shift arrows, refer to the **MAIN page** description.



Off page

The **OFF** page switches the display dark. It is used when no display light is wanted, for example during **BLACKOUT** operation and other special night operations. It does not change gearbox operation. It only suppresses the BUU light output.

Important exception: OFF page

When the BUU is on the **OFF** page, the display stays dark and no overlay, warning, information page, or failure message is shown. In this state, no message or warning is passed through to the display.

User preset selection page

The **User preset selection page** is used to select which stored user preset is active for the adjustable shift modes.

This page is only available when the active program is:

- **FS**
- **FO**

It does not change shift values directly. It only selects which stored user preset is used.

Purpose

The page has two functions:

- to show which user preset is currently active
- to allow the operator or technician to select another stored user preset

Each mode has **six user preset positions**.

So the selectable presets are:

- **1FS to 6FS** for **FS**
- **1FO to 6FO** for **FO**

Display logic

The page shows a vertical list of the available preset numbers.

Examples:

- **1 FS**
- **2 FS**
- **3 FS**
- **4 FS**
- **5 FS**
- **6 FS**

or, in FO mode:

- **1 FO**
- **2 FO**
- **3 FO**
- **4 FO**
- **5 FO**
- **6 FO**

Highlighted line

The **highlighted line** shows the **currently active preset**.

Cursor frame

When selection mode is entered, the BUU shows a **cursor frame** around the preset currently selected for change.

Asterisk

If a preset contains stored data, the BUU shows an **asterisk** after the preset name.

Examples:

- **2 FS***
- **5 FO***

The asterisk means that a stored preset exists in that memory position.

If no asterisk is shown, that preset position is currently empty.

Operation

Normal page state

On the normal user preset selection page:

- **BACK / FORW** move to the previous or next page in the normal page loop
- **ENTER** opens preset selection mode
- **ESC** returns to **MAIN**

Preset selection mode

After pressing **ENTER**, the page enters selection mode.

In selection mode:

- **BACK / FORW** move the cursor through the preset list
- **ENTER** confirms the selected preset
- **ESC** cancels the selection and returns to the normal user preset selection page

Effect of a selection

When a preset is confirmed:

- the selected preset number is stored in EEPROM
- that preset becomes the active preset for the current mode
- the BUU requests synchronization of the selected preset with the gearbox controller

This means the page itself does not edit thresholds. It only chooses which stored user preset is active and sends it to the gearboxcontroller.

The actual adjustment of threshold values is done on the **SHIFT SETUP** page.

Practical meaning

The user preset selection page is used when several stored shift setups are needed for different drivers or different scenarios.

For example, different preset slots can be used for:

- different vehicles
- different load conditions
- different driver preferences
- different test or tuning setups

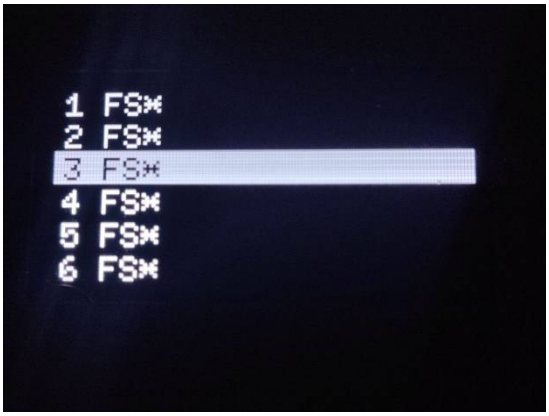
The page therefore acts as a **preset selector**, while the detailed threshold editing is done separately on the **SHIFT SETUP** page.

Practical interpretation

- a **highlighted line** = currently active preset
- a **framed line** = preset currently selected for change
- an **asterisk** = preset data is stored in that slot
- **no asterisk** = that slot is empty

Short description

The **User preset selection page** selects which of the six stored user presets is active in **FS** or **FO**. It does not edit shift values itself. It only chooses the stored preset that will be used by the controller.



Shift setup page

The **Shift Setup** page is the adjustment page for the active **FS** or **FO** user preset.

It is used to view and change the stored shift thresholds of the currently selected preset.
This page is only available when the active program is:

- **FS**
- **FO**

The **User preset selection page** chooses **which** preset is active.
The **Shift Setup** page changes the **values inside that preset**.

Purpose

The Shift Setup page has three main functions:

- to show the currently stored shift thresholds of the active FS or FO preset
- to allow these thresholds to be adjusted per gear
- to define whether the preset uses the **physical potentiometer** or a **fixed reference value**

The page is intended for setup, tuning and diagnostic work, not for normal driving use.

Which rows are shown

The page shows one row per relevant gear step of the active adjustable program.

In FS mode

The rows are:

- **H1**
- **H2**
- **M2**
- **M3**

In FO mode

The rows are:

- **H1**
- **H2**
- **H3**
- **M3**

This matches the shift path of the active program family.

Display layout

Each row contains:

- the **gear name** in the center
- a **bar** showing the valid range and the current set shift window
- a **down shift value**
- a **up shift value**

Meaning of the values

- the **left value** is the **downshift threshold**
- the **right value** is the **upshift threshold**

Exceptions:

- on **H1**, there is no downshift threshold
- on **M3**, there is no upshift threshold

Because of that:

- on **H1**, the left field is used for **PON / POFF**
- on **M3**, only the left threshold value is used

Meaning of the bar

The row bar shows three different things:

1. Fixed gear safety window

The full bar width represents the fixed allowed range of that gear.

This is the basic safety range for that gear and does not move during setup.

2. Fixed reference markers

Thin markers inside the bar show the fixed reference thresholds of the standard base program.

These markers are for orientation only. They are not the editable values.

3. Editable set values

The editable preset thresholds are shown as the active set window inside the bar.

- the filled range runs from the set downshift value to the set upshift value

So the page lets the operator compare:

- the fixed gear window
- the standard reference thresholds
- the currently stored preset thresholds

PON / POFF

On the **H1** row, the left field does not represent a threshold.
It is used to select the preset potentiometer behavior.

PON

PON means the preset uses the **physical potentiometer**.

In this case, the shift points are moved forward or backward by the live potentiometer value.

POFF

POFF means the preset does **not** use the physical potentiometer.

In this case, the BUU uses its fixed internal reference value instead.

Opening the page

The Shift Setup page is reached through the normal page loop when **FS** or **FO** is active.

In normal view state:

- **BACK / FORW** move to the previous or next page
- **ENTER hold 5 seconds** starts edit entry
- **UP / DOWN** still remain the global manual shift buttons

Entering edit mode

To start editing:

- open the **Shift Setup** page
- hold **ENTER** for **5 seconds**
- confirm the edit request

The page then changes from view mode into edit mode.

Edit sequence

The edit process has several steps.

1. Confirm edit

After the ENTER hold, the BUU asks whether editing should begin.

- **ENTER** = yes
- **ESC** = no

If confirmed, the page enters field selection mode.

---

2. Select field

In selection mode:

- **BACK / FORW** move between editable fields
- **ENTER** opens the selected field for editing

Special case:

- on the **H1 left field**, **ENTER** toggles **PON / POFF**

---

3. Adjust value

When a threshold field is opened:

- **BACK / FORW** change the selected threshold in fine steps
- **UP hold + potentiometer** changes the selected threshold in coarse adjustment mode
- **ENTER** accepts the value
- **ESC** cancels the change and restores the original value

During this adjustment state, the global shift-button function is not used for normal shifting.

Automatic threshold protection during setup

While values are adjusted, the BUU automatically keeps the threshold structure valid.

This includes:

- minimum spacing between the thresholds of the same gear
- minimum spacing between the neighboring gears
- clamping inside the fixed gear safety window

This means the page does not allow invalid or overlapping threshold relationships to remain active.

Leaving edit mode

From field selection mode:

- **ESC hold 2 seconds** ends the edit session

Then two cases are possible:

No changes

If no values were changed, the BUU leaves the page and returns to the stored display page.

Changes present

If values were changed, the BUU opens the save confirmation.

Save confirmation

If changed values are present, the BUU asks whether the changes should be saved.

- **ENTER** = save
- **ESC** = discard changes

If saved:

- the BUU sends the new values to the gearbox controller
- the BUU stores the values in EEPROM in the active user preset
- the BUU briefly shows **SENDING**
- then briefly shows **SAVED**
- then returns to the Shift Setup view page

If discarded:

- the page returns to the Shift Setup view without applying the edited changes

What is stored

The Shift Setup page stores the values inside the **currently selected FS or FO preset**.

That means the saved data belongs to:

- the active mode family (**FS** or **FO**)
- the currently selected preset number (**1 to 6**)

So changing values here does not change all presets.
It only changes the active preset.

Practical meaning

The Shift Setup page is used to define how the selected FS or FO preset shifts.

Typical uses are:

- adapting one preset for a specific vehicle
- adapting one preset for a specific load condition
- creating different presets for different driving styles
- keeping one preset with live potentiometer influence and another with fixed values

Practical interpretation

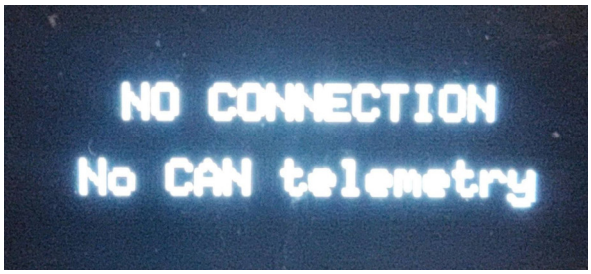
- the **gear name** identifies the current row
- the **left value** is the downshift threshold
- the **right value** is the upshift threshold
- the **filled bar** shows the currently stored active shift window
- the **thin markers** show the fixed reference thresholds
- **PON** means live potentiometer influence is active
- **POFF** means fixed set values are used without live potentiometer influence

Short description

The **Shift Setup** page is the adjustment page for the active **FS** or **FO** user preset. It allows the shift thresholds of that preset to be viewed and changed per gear, and it also allows selection between **physical potentiometer scaling** and **fixed set values**.

Failure and warning indications

NO CONNECTION



Meaning

NO CONNECTION means no CAN communication is active between the BUU and the gearbox controller.

Display condition

The BUU shows **NO CONNECTION** when no relevant controller telemetry has been received for the defined timeout period.

What the operator sees

The OLED shows:

NO CONNECTION
No CAN telemetry

For the picture text or screen explanation, use:

NO CONNECTION means no CAN communication is active.

What it means in practice

Typical causes are:

- gearbox controller not powered
- BUU not powered correctly
- CAN wiring fault
- CAN communication failure
- controller not transmitting

Behavior

- normal page display is replaced by the **NO CONNECTION** overlay
- if the BUU is on the **OFF** page, this warning is not shown
- when the display is off, no message, warning or information page is passed through to the display

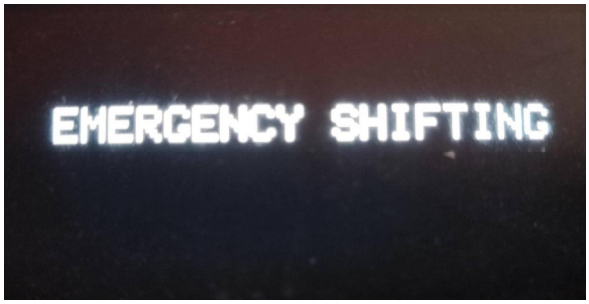
Acknowledging the display message

The **NO CONNECTION** overlay can be acknowledged by holding **ESC for 5 seconds**.

The BUU then returns to the previously selected page and normal display operation resumes.

This only acknowledges the displayed message. It does **not** restore CAN communication. The underlying condition remains until communication with the gearbox controller is active again.

EMERGENCY SHIFTING



Meaning

EMERGENCY SHIFTING is an emergency-state overlay, not an F-code.

It is shown when the operator has activated the external emergency-shifting input. In this state, the emergency shifting function bypasses the normal gearbox-controller output path and shifts the gearbox through separate relay logic.

What it means in practice

This is not just a warning text. It indicates that the normal gearbox-controller control path is being **overwritten** by the emergency shifting circuit.

In this condition:

- the operator has activated the emergency-shifting input
- the normal MCU-controlled shifting path is bypassed
- the gearbox is shifted through separate relays
- the gearbox controller is therefore no longer the active authority for normal shifting in that state

The vehicle is in an emergency-related shifting condition and should be treated as being outside normal operation.

Behavior

- normal page display is replaced by the **EMERGENCY SHIFTING** overlay
- while this condition is active, the BUU also suppresses normal **F3** display behavior
- if the BUU is on the **OFF** page, this warning is not shown
- when the display is off, no message, warning or information page is passed through to the display

Acknowledging the display message

The **EMERGENCY SHIFTING** overlay can be acknowledged by holding **ESC for 5 seconds**.

The BUU then returns to the previously selected page and normal display operation resumes.

This only acknowledges the displayed message. It does **not** cancel the emergency-shifting state. The underlying emergency input remains active until the operator switches that emergency-shifting off.

F1 — impossible confirmation state

Meaning

F1 means that the controller sees **Gear 1 confirmation** and **Reverse confirmation** active at the same time.

This is treated as an impossible and unsafe gearbox state.

BUU display

The BUU shows:

F1
FORWARD AND BACKWARD
ENGAGED

What the gearbox controller actually does

In the gearbox controller, **F1 is a hard safety stop**.

When F1 is detected, the controller immediately forces a safe output state:

- **Reverse OFF**
- **Gear 1 OFF**
- **Gear 2 OFF**
- **Gear 3 OFF**
- **Mechanical Gear OFF**
- **Torqueconverter OFF**

So effectively, the controller releases the gearbox outputs and stops normal actuation.

After that, the controller enters a **blocking safety loop**. While in that loop:

- no normal shifting logic continues
- no program logic continues
- no normal selector processing continues
- the controller waits only for the confirmation signals to become sane again

So for practical purposes:
with F1 active, the gearbox controller refuses to do anything except hold the safety state and wait for the fault to disappear.

Clear condition

F1 only clears when the readback of the Reverse and Forward Gears make sense again.

Only then does the controller leave the blocking loop and return to normal operation.

What it means in practice

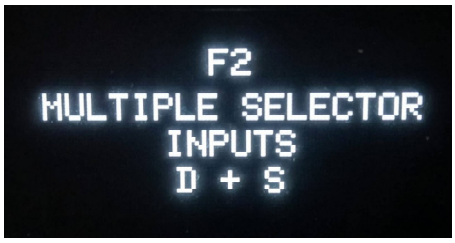
This is not just a warning. It is a real hard safety reaction.

The controller has detected a contradiction in the gearbox confirmation signals and has stopped normal gearbox control until the contradiction is gone.

Typical causes

- wiring fault
- defective confirmation switch
- short circuit or wrong feedback state
- actuator or relay feedback problem

F2 — multiple selector inputs



Meaning

F2 means that more than one selector input is active at the same time.

The gearbox controller expects only one valid selector state. If two or more selector lines are active together, it treats this as an invalid selector condition.

BUU display

The BUU shows:

F2
MULTIPLE SELECTOR
INPUTS

The BUU can also show the first detected active selector combination, for example:

- **R + N**
- **N + D**
- **D + S**
- **R +TS**

What the gearbox controller actually does

Outside EMG, F2 is a hard blocking safety state.

Outside EMG, selector ambiguity forces the controller into its defined safe state and stops normal shifting.

- **In EMG, or while EMG is being activated, F2 automatically selects NG virtual Gears elector and Neutral.**
- **The display shows NG and N.**
- **The driver does not need to press UP and DOWN together first.**
- **Forward or Reverse can then be selected with the 2-second EMG button procedure.**
- **This automatic F2-to-NG behavior applies only in EMG.**
- **Outside EMG, F2 remains a blocking safety condition.**

Outside EMG, normal operation resumes only after the selector inputs are unambiguous and stable.

- EMG example: conflicting selector signals → NG and N.
- NG active with virtual Forward selected → NG and F.
- NG identifies the virtual selector source; N identifies a Neutral request.

Temporary gearbox Neutral during a transfer-case change does not erase an active F or R request.

Clear condition

Outside EMG, F2 clears when the selector inputs are valid and stable.

In EMG, the physical selector remains ignored while NG is active, and the driver uses the virtual-selector procedures.

What it means in practice

Outside EMG, F2 is a real safety block caused by an invalid selector-input combination.

In EMG, the same conflict is handled by automatic NG and virtual Neutral so recovery operation can continue with the defined EMG procedures.

Typical causes

- selector switch fault
- short between selector signal lines
- miss wiring
- broken gear selector

F3 — output mismatch

Meaning

F3 means that the commanded output state and the returned confirmation / readback state do not match.

This is the main output-diagnosis fault.

What is monitored

The mismatch can affect these output functions:

- **TC = Torqueconverter**
- **G1 = Gear 1**
- **G2 = Gear 2**
- **G3 = Gear 3**
- **GM = Mechanical Gear**
- **R = Reverse Gear**
- **RO = Road**
- **T = Terrain**
- **TB = Terrain Brake**

The controller also checks transfer-related feedback after **RO** and **TO** pulses.

What the gearbox controller actually does

In the gearbox controller, **F3 does not enter a blocking safety loop**.

That is the important difference from F1 and F2.

Instead, the controller:

- monitors output/feedback mismatches
- waits until the mismatch persists for the configured time
- then sets the F3 indication text
- keeps running the rest of the gearbox logic

So in practice:

F3 is a diagnostic fault indication, not an automatic hard stop.

The controller can continue operating while reporting F3, unless the underlying hardware problem itself prevents the gearbox from working correctly.

Variants

F3 can appear as **HIGH** or **LOW**.

HIGH variant

HIGH means the confirmation is active even though the corresponding output is not commanded active.

In practical terms: the controller sees the feedback as active although it is not requesting that state.

LOW variant

LOW means the controller has commanded the output **ON**, but the returned readback / confirmation remains **LOW** or inactive.

In practical terms: the controller is driving the output, but the expected feedback does not appear.

A possible cause could be a **broken relay**, but the reason can also be elsewhere in the output path.

BUU overlay behavior

The BUU groups F3 by **HIGH** and **LOW**.

Examples:

- **TC HIGH**
- **G1 LOW**
- **RO + TO HIGH**
- **G2 + GM LOW**

If more affected channels exist than can be shown, the BUU uses **X** to indicate additional channels not listed on the screen.

Example:

RO + X HIGH

This means **RO** is one of the affected channels and there are further HIGH mismatches not fully listed.

DIAG page behavior

On the **DIAG / output** page, a mismatching channel is shown with a **blinking frame**.

So even without the full-screen F3 page, the operator can see which channel has a command / readback mismatch.

Typical causes

- broken actuator wiring
- defective relay or output stage
- missing supply voltage at the output
- defective confirmation switch

Clear condition

F3 clears when the mismatch disappears.

On the BUU side it is displayed with a longer delay and hold behavior than the other failures, which is why it appears a little slower and can remain visible briefly even after a short change.

F4 — winch condition not met

Meaning

F4 means that a winch-related request was refused because the required entry conditions were not met.

The BUU shows:

F4
WINCH
SPEED TOO HIGH

What the gearbox controller actually does

If winch operation is requested but the entry conditions are not valid, the controller does this:

- sets **F4**
- commands **N**
- refuses winch entry by not excepting a gear

So in practice:
the controller prevents winch engagement and forces the gearbox into Neutral.

This is not a general gearbox fault reaction. It is a protective response to an invalid winch request.

There is also recovery logic of the gearbox controller. When the winch request is removed and normal conditions resume:

- the controller can leave the winch-failure condition
- return from **N** into a suitable drive gear again
- clear **F4**

There is also an automatic clear path that just allows a safe winch entry when:

- **Neutral** is active
- or speed is low enough

Important interpretation

F4 is better understood as a warning of an active safety function than as a technical failure.

It means the controller has prevented an operator-requested action in order to avoid damage or unsafe operation. It does **not** by itself mean that a component has failed.

Typical causes

- vehicle speed too high
- required transfer state not present
- winch request made in an invalid operating condition

Clear condition

F4 clears when the operating conditions become valid again, for example after the winch request is removed or the vehicle is brought back into the correct condition that mostly refers to the Gearbox output speed.

So **F4 is operator-controlled** in the sense that the operator can usually clear it by correcting the operating situation.

F5 — speed sensor failure

Meaning

F5 is the speed-sensor / raw-frequency failure latch.

It is triggered when the controller sees the raw speed signal drop to zero in the monitored driving condition.

From the gearbox controller , the monitored condition is:

- selector in **GD**
- actual gear **M2** or **M3**
- raw frequency changes from a real value to **0**
- zero condition remains long enough for the arming timer to expire

BUU display

The BUU shows:

F5
SPEEDSENSOR FAILURE
SELECT NEUTRAL
TO RESET

What the gearbox controller actually does

F5 is a latched protective reaction.
Once F5 latches:

- further normal shifting logic is effectively frozen
- the controller forces the gearbox toward **H3** while still in **D**
- the **torque converter is opened**
- the OLED on the gearbox controller shows only the F5 page

So in practice:
with F5 active, the controller actively changes gearbox behavior into a protective state.

The reason for forcing **H3** with open torque converter is to reduce the risk of excessive engine speed and to avoid wheel blocking if the speed signal has been lost.

Operator action

The reset instruction shown to the operator:

- select **Neutral**
- then investigate the speed signal, sensor and wiring
- If necessary chose Emergency Program and drive manually with care

Typical causes

- failed speed sensor
- broken speed-signal wiring
- loose or miss set speed sensor

Clear condition

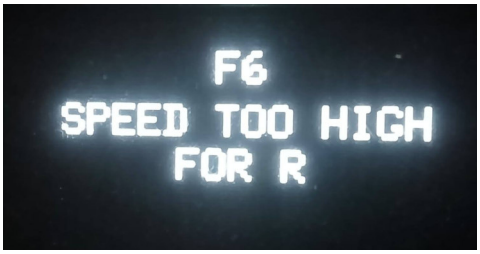
F5 clears when:

- the selector set to **N**, or
- **Neutral** becomes active

So the practical reset path is:

- select **Neutral**
- F5 clears
- then investigate the cause before returning to normal operation
- use the Emergency Mode to return to Base

F6 — speed too high



Meaning

F6 means that the requested selector function is not permitted at the current speed.

It is the speed-inhibit warning.

Variants

The BUU can show **F6** for these requested states:

- **R**
- **S**
- **TS**

BUU display

The BUU shows:

F6
SPEED TOO HIGH
FOR R
or
FOR S
or
FOR TS
depending on which selector request is currently being blocked.

What the gearbox controller actually does

In the gearbox controller, F6 is used when the operator requests a selector state that is above its allowed speed threshold.

The controller then **refuses the requested selector engagement**.
The exact behavior depends on which request is being made:

Reverse requested too fast

If **R** is requested above the allowed speed:

- the controller does **not** engage reverse
- **F6** is set
- the request remains blocked until speed is low enough

TS requested too fast

If **TS** is requested above the allowed speed:

- the controller does **not** engage TS
- **F6** is set
- the request remains blocked until speed is low enough

S / GS requested too fast

If **S / GS** is requested above the allowed speed:

- the controller does **not** engage GS
- **F6** is set

Then the controller behavior depends on the previous selector state:

- if the previous state was **N**, or the gearbox is currently in **N**, the controller holds or returns to **N**
- if the previous state was **D**, the controller continues the normal **D** behavior
- otherwise, it simply refuses the request

So, in practice:
F6 does not stop the gearbox. It blocks the requested selector engagement and keeps the gearbox in the last safe state.

Important interpretation

F6 is better understood as a warning of an active safety function than as a technical failure.

It means the controller is preventing an operator-requested action in order to avoid damage or unsafe engagement. It does **not** by itself indicate a technical defect.

Typical causes

- reverse requested above the allowed speed
- gear-2 / S requested above the allowed speed
- tow-start requested above the allowed speed

Clear condition

F6 clears when the requested function becomes valid again, usually because speed has been reduced enough.

So **F6 is also operator-controlled** in the sense that the operator can normally clear it by returning to a safe operating condition.

Compact status line

In the lower status line of the **MAIN** page, the BUU shows a short status:

- **OK** = no active failure currently shown
- **F1**
- **F2**
- **F3**
- **F4**
- **F5**
- **F6**

This is the compact status only.
If a full overlay is active, the full warning or failure page replaces the normal page.

If the BUU is on the **OFF** page, this compact status is also not shown, because the display remains dark.

Acknowledging F1 to F6 on the display

The active **F1 to F6** display overlay can be acknowledged by holding **ESC for 5 seconds**.

Result

After acknowledgment:

- the currently shown overlay is dismissed
- the BUU returns to the **previously selected page**
- normal **display operation** resumes on that page

What does acknowledgment mean?

Acknowledgment only affects the **display**.

It means:

- the current overlay is hidden from the screen
- the underlying condition is **not** cancelled
- the actual warning, failure or safety function remains active until the real cause disappears

So the message can be **acknowledged on the display**, but it is **not overruled** by doing so.

Important note

The acknowledgment is only temporary.

It resets automatically when the condition clears and appears again if the condition returns.

If the BUU is on the **OFF** page, no overlay is shown anyway, because the display remains dark and all displayed messages are blocked while the display is off.

Practical interpretation summary

F1

Forward and reverse confirmation conflict. The controller enters a hard safety block, releases the gearbox outputs, and waits until the confirmation state becomes sane again.

F2

More than one selector input active. Outside EMG this is a hard safety block. In EMG, or while EMG is being activated, F2 automatically selects NG and virtual Neutral and the display shows NG and N.

F3

Output command and feedback confirmation do not match.
In the **LOW** case, the controller has commanded the output on, but the readback remains low or inactive.

F4

Winch request refused because required conditions were not met. The controller forces **Neutral** and prevents winch engagement. This is mainly a safety warning, not a technical failure.

F5

Speed sensor / raw frequency failure latched. The controller selects **H3** with open torque converter to protect the engine, drivetrain and safety of the vehicle.

F6

Requested selector function not allowed at current speed. The controller blocks the requested selector engagement and keeps the gearbox in a safe state. This is mainly a safety warning, not a technical failure.

BUU potentiometer calibration

The **BUU potentiometer calibration** teaches the BUU the real electrical **minimum** and **maximum** positions of its physical potentiometer. This ensures that the displayed percentage and the potentiometer value sent to the gearbox controller use the full available knob travel correctly.

This calibration affects the BUU potentiometer input only. It does **not** directly change the stored shift thresholds.

Use

BUU potentiometer calibration is available only when one of these eligible configurations is active:

- **UDP**
- **SSP**
- **FS/FREES with physical POTI enabled for the active preset**
- **FO/FREEO with physical POTI enabled for the active preset**
- Do not perform calibration while driving.

Start conditions
Before calibration:

- bring gearbox frequency below 150 Hz
- use a normal BUU page; calibration cannot start from OFF or a GPS page

Start
To start calibration:

- hold UP + DOWN together continuously
- keep both buttons held for approximately 2.5 seconds until CAL starts

then follow the full potentiometer movement shown below

Calibration procedure
Move the potentiometer:

fully HIGH → fully LOW → fully HIGH

The calibration screen shows:

- the current raw potentiometer value
- the detected minimum value
- the detected maximum value
- a three-step direction indicator for the required movement sequence

Successful completion
When the BUU detects the full HIGH → LOW → HIGH sequence, it stores the new minimum and maximum values and completes calibration.

Abort
Calibration can be aborted at any time with:

- **ESC**

If aborted, the previous stored calibration values remain active.

Behavior during calibration
While calibration is active:

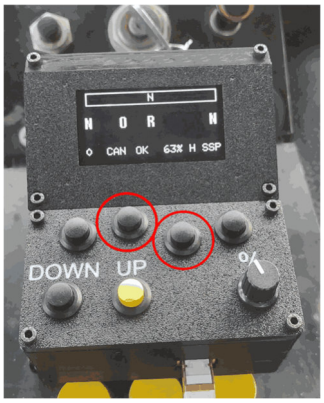
- the normal page display is replaced by the calibration screen
- normal page navigation is interrupted
- **UP / DOWN** are not used as normal shift commands

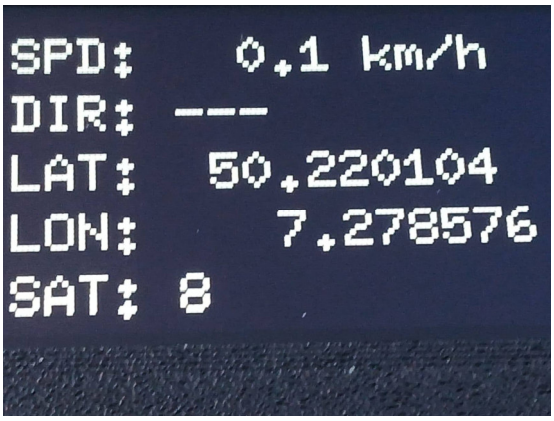
Result
After calibration:

- the BUU uses the full potentiometer travel correctly
- the displayed potentiometer percentage is more accurate
- the transmitted potentiometer value is scaled correctly
- potentiometer-based shift-point adjustment behaves more predictably

Short description
Secure the vehicle, select an eligible POTI-based program or preset, bring gearbox frequency below 150 Hz and use a normal non-OFF, non-GPS page. Hold UP + DOWN for approximately 2.5 seconds until CAL starts, move the potentiometer fully HIGH → LOW → HIGH, and wait for successful completion.

GPS info overlay page





The **GPS INFO** page is a temporary GPS information overlay that can be opened from the two normal GPS pages:

- **GPS MAIN**
- **GPS TARGET**

It is not part of the normal page loop.
It is an overlay page opened by a button combination.

Purpose

The GPS INFO overlay is used to show detailed GPS information in text form.

It gives the operator a direct readout of the main live GPS values without the compass or target graphics.

How to open it

From either:

- **GPS MAIN**
- **GPS TARGET**

hold:

- **FORWARD + BACKWARD**
- for about **2 seconds**

This opens the GPS INFO overlay.

How to leave it

While GPS INFO is active:

- **any button** closes it

After exit, the BUU returns to the GPS page from which the overlay was opened.

So:

- GPS INFO opened from **GPS MAIN** returns to **GPS MAIN**
- GPS INFO opened from **GPS TARGET** returns to **GPS TARGET**

What the overlay shows

The GPS INFO overlay shows five text lines:

- **SPD**
- **DIR**
- **LAT**
- **LON**
- **SAT**

SPD — speed

The first line shows:

- current **GPS speed** in **km/h**

If a valid recent speed value is available, the overlay shows it as a numeric value.

If not, it shows:

- **SPD: ---.- km/h**

So SPD is the direct GPS speed readout.

DIR — direction

The second line shows:

- the current travel direction as a compass direction
- and the corresponding heading angle

Example format:

- **DIR: NE (045)**

The BUU uses a 16-point compass naming scheme, such as:

- N
- NNE
- NE
- ENE
- E
- ESE
- SE
- SSE
- S
- SSW
- SW
- WSW
- W
- WNW
- NW
- NNW

Important condition

The direction line is only shown as a valid direction when:

- course data is valid
- and the vehicle is moving fast enough for the BUU to trust the direction

If direction cannot be determined reliably, the overlay shows:

- **DIR: ---**

So this is a movement-based heading display, not a fixed magnetic compass.

LAT — latitude

The third line shows:

- the current GPS latitude

If valid GPS position data is available, the latitude is shown numerically.

If not, the overlay shows:

- **LAT: ---**

LON — longitude

The fourth line shows:

- the current GPS longitude

If valid GPS position data is available, the longitude is shown numerically.

If not, the overlay shows:

- **LON: ---**

SAT — satellites

The fifth line shows:

- the current number of received satellites

If valid satellite information is available, the numeric satellite count is shown.

If not, the overlay shows:

- **SAT: --**

Signal principle

The GPS INFO overlay uses live GPS data from the BUU GPS receiver.

It is a text-based status view of the same GPS information used elsewhere in the GPS pages.

It does not calculate new navigation logic of its own.
It simply presents the GPS status values in compact text form.

Availability

The GPS INFO overlay can only be opened if GPS pages exist.

That means GPS must have been successfully detected during startup.

If GPS was not detected at boot:

- **GPS MAIN** and **GPS TARGET** are not part of the page loop
- therefore **GPS INFO** cannot be opened either

Practical use

The GPS INFO overlay is useful when the operator wants a quick direct check of:

- current GPS speed
- current course / travel direction
- current latitude
- current longitude
- current satellite count

This is especially helpful for:

- checking whether valid GPS data is present
- checking the exact live coordinates
- checking direction quality
- verifying satellite reception

Short description

The **GPS INFO** page is a temporary text overlay opened from **GPS MAIN** or **GPS TARGET** by holding **FORW + BACK for 2 seconds**. It shows direct GPS information for **speed, direction, latitude, longitude, and satellite count**. It is closed by pressing any button and then returns to the previously active GPS page.

Practical guide to normal BUU use

Normal driving use

In normal driving, the buttons are usually used like this:

- **UP / DOWN** = manual gear change requests
- **FORW / BACK** = browse pages
- **ENTER / ESC** = usually not needed unless you want to change something

The most common driving pages are:

- **MAIN**
- **BAR**
- **OFF**

Changing the driving program

To change the program:

1. go to **PROG**
2. press **ENTER**
3. use **BACK / FORW** to choose the desired program
4. press **ENTER** to confirm

If you do not want to change it:

- press **ESC**

Acknowledging a displayed warning or failure

If a warning or failure page is shown and you only want to remove it from the display:

- hold **ESC for 5 seconds**

The BUU returns to the previously selected page.
This does not cancel the real condition. It only acknowledges the display.

Using the DIAG output page

To enter output testing:

1. go to **DIAG**
2. hold **ENTER for 3 seconds**
3. confirm with **ENTER**
4. wait until the controller confirms DIAG
5. in **OPERATE OUTPUTS**, use:
    - **BACK / FORW** to select the channel
    - **ENTER** to switch the selected channel

To leave safely:

- hold **ESC for 2 seconds**

This switches all outputs off and restores the previous drive program.

Using the GPS target page

On the **GPS TARGET** page:

- **ENTER short** = select next target / waypoint
- **ENTER hold 1.5 seconds** = save current position to the selected waypoint
- **ESC hold 2.5 seconds** = delete the selected waypoint
- **ESC short** = return to **MAIN**

Using the GPS info page

On **GPS MAIN** or **GPS TARGET**:

- hold **FORW + BACK for 2 seconds**

This opens **GPS INFO**.

While GPS INFO is open:

- **any button** closes it

Using HOLD

On the BUU in UD, UDP, SS, SSP, FS/FREES or FO/FREEO:

- hold FORW + BACK for about 1.5 seconds to select or cancel H

H may remain displayed without current EB; actual Hold shifting requires active EB and physical selector D
SUU does not provide H. H is not available in OR, SSX, EMG or DIAG.

Using potentiometer calibration

To calibrate the BUU potentiometer:

1. select UDP, SSP, or FS/FO with physical POTI enabled; use a normal page, not OFF or GPS
2. bring gearbox frequency below 150 Hz and hold UP + DOWN continuously for approximately 2.5 seconds until CAL starts
3. move the potentiometer fully HIGH, then fully LOW, then fully HIGH
4. wait for successful completion

To abort:

- press ESC; the previous stored calibration remains active

Using the SHIFT SETUP page

On **SHIFT SETUP**:

- **ENTER hold 5 seconds** = enter setup editing
- **BACK / FORW** = select fields
- **ENTER** = edit a selected value
- in adjustment mode:
  - **BACK / FORW** = fine adjustment
  - **UP hold + potentiometer** = coarse adjustment
- **ESC** = cancel current edit
- **ESC hold 2 seconds** = finish setup editing

Short practical button summary

Usually used while driving

- **UP / DOWN** = shift requests
- **FORW / BACK** = page browsing

Usually used for setup / menu work

- **ENTER** = open / confirm
- **ESC** = cancel / leave / acknowledge display message

Usually used for special functions

- **FORW + BACK** = HOLD or GPS INFO, depending on page
- **UP + DOWN** = potentiometer calibration
- **UP hold + potentiometer** = fine adjustment in SHIFT SETUP

BUU connection

The **BUU** is connected to the gearbox controller through an **RJ45 connector**.
For this system, a **non-twisted cable must be used** between the BUU and the gearbox controller.