PECU

PROGRAMMABLE ENGINE CONTROL UNIT

M54

Item no. 5818

Manual

Plug & play engine management for BMW M54 (Siemens MS43)

Date: November 2026

Applies to all board revisions up to R04 (differences in Appendix D.2), rusEFI firmware release_20260812 and CAN module firmware 1.3.1.

Contents

About this manual

1 Safety and legal notes
- 1.1 Intended use
- 1.2 Safety instructions
- 1.3 Liability
- 1.4 Open-source firmware

2 Product overview
- 2.1 Concept
- 2.2 PECU M54 variant
- 2.3 Scope of delivery
- 2.4 Housing and connectors
- 2.5 Technical data

3 Connections and functions
- 3.1 Power supply, ground and main relay
- 3.2 Crankshaft and camshaft sensors
- 3.3 Injection
- 3.4 Ignition
- 3.5 Temperature sensors
- 3.6 Electronic throttle, accelerator pedal and load
- 3.7 Wideband lambda control
- 3.8 Knock sensor and exhaust gas temperature
- 3.9 Inputs: vehicle speed, buttons and analogue inputs
- 3.10 Switched outputs
- 3.11 Idle
- 3.12 Additional connector X4 (24-pin)
- 3.13 Additional connector X7 (14-pin)
- 3.14 CAN bus
- 3.15 USB and microSD card
- 3.16 LEDs on the uaEFI module
- 3.17 Air conditioning
- 3.18 Tank venting
- 3.19 Unused pins and functions of the original DME

4 Installation
- 4.1 Preparation
- 4.2 Installing the control unit
- 4.3 Grounding and wiring for extensions

5 Software
- 5.1 Overview
- 5.2 Installing TunerStudio and creating a project
- 5.3 Basic operation of TunerStudio
- 5.4 Updating the firmware

6 TunerStudio menus
- 6.1 Menu “Setup”
- 6.2 Menu “Fuel”
- 6.3 Menu “Ignition”
- 6.4 Menu “Cranking”
- 6.5 Menu “Idle”
- 6.6 Menu “Advanced”

6.7 Menu “Sensors”
6.8 Menu “CAN-bus”
6.9 Menu “Controller”
6.10 Live data and gauges

7 Tuning basics
7.1 Order
7.2 Checking ignition timing with a timing light
7.3 Tuning the VE table
7.4 Data logging

8 CAN module with OLED display
8.1 Tasks
8.2 Firmware functions
8.3 Requirements in TunerStudio
8.4 OLED display
8.5 Status LED of the CAN module
8.6 Wi-Fi and dashboard
8.7 Settings page
8.8 CAN termination and error counters
8.9 Vehicle profile BMW E46/E39/E38/E53/Z3
8.10 Torque model, torque intervention and Lua script
8.11 Firmware update of the CAN module
8.12 A/C compressor

9 Diagnostics and troubleshooting
9.1 Procedure
9.2 Troubleshooting table
9.3 Back to the base calibration

10 Maintenance, warranty, support

Appendix A – Pinout of the uaEFI module

Appendix B – Vehicle connector X60001–X60005 (PECU M54)

Appendix C – Glossary

Appendix D – Changes to this manual
D.1 Editions of this manual
D.2 Board revisions
D.3 Firmware of the CAN module

About this manual

This manual describes all functions of the PECU M54, the plug & play engine control unit from k-data for the BMW M54. It is written for workshops, tuners and experienced private users.

If you are installing the PECU for the first time and only want to get the engine running, start with the separate document **“PECU Getting Started”**. It takes you to the first start in twelve steps and refers to the chapters of this manual for details.

Structure of this manual

Chapter	Content
1	Safety and legal notes
2	Product overview, variants, scope of delivery, technical data
3	Connections and functions: every function with its vehicle connector pin, signal and setting
4	Installation in the vehicle
5	Software: TunerStudio, rusEFI Console, firmware
6	TunerStudio menus item by item
7	Tuning basics
8	CAN module with OLED display: all firmware functions, Wi-Fi, vehicle profile, updates
9	Diagnostics and troubleshooting
10	Maintenance, warranty, support
Appendix	uaEFI pinout, vehicle connector pinout, glossary

Conventions

- TunerStudio menu paths are written as **Fuel › Injector Setup › Injection configuration**. This manual assumes TunerStudio in English.
- Settings in dialogs are written in *italics*, e.g. *Trigger Angle Advance*.
- uaEFI pins are given in square brackets, e.g. [D9] for the MAP input. Vehicle connector pins are written as **X60001–X60005 number**, e.g. **X60001–X60005-54**.

Structure of each section: A box first shows the essentials: what the function does and how it is set up at the factory. Connection and settings follow, technical details come last. If the box tells you that a function does not concern you, skip to the next section.

> **Note:** Menu names match the rusEFI firmware **release_20260812** that the PECU is delivered with. Other versions may name some items differently or show them elsewhere. The TunerStudio search function (magnifier at the top right, or Ctrl+F in the menu) finds every setting by its name.

1 Safety and legal notes

1.1 Intended use

The PECU is a freely programmable engine control unit for **motorsport and off-road use away from public roads**. It replaces the original control unit of the specified engine and plugs into the original wiring harness.

Use on public roads is only permitted if the vehicle with the PECU complies with the applicable regulations (emissions, noise, EMC, type approval). The operator is responsible for this.

1.2 Safety instructions

> **Warning:** Wrong settings can destroy the engine within a short time (knock, lean running, over-revving). Only change maps if you understand the effects, and check every change with a wideband lambda sensor and data logging.

- **Disconnect the battery** before any work on the wiring harness. Never plug or unplug the PECU with the ignition on.
- Petrol is highly flammable. Ensure ventilation when testing the fuel system, no open flames, keep a fire extinguisher ready.
- The ignition system produces life-threatening high voltage. Do not touch ignition leads or coils with the engine running or during the ignition test.
- Only work on a running engine outdoors or with exhaust extraction.
- Strap vehicles securely on test benches. Full-load tuning only on a chassis dynamometer or a closed track.
- The injectors are really actuated during the ignition and injection tests. For testing, disconnect the fuel pump or remove the injectors.

1.3 Liability

k-data supplies the PECU with a base calibration that starts and runs a standard engine in good condition. It is **not a finished tune** for a particular vehicle. k-data accepts no liability for damage caused by settings made by the customer or third parties.

1.4 Open-source firmware

The PECU runs the open-source firmware **rusEFI** (GPL-3). The firmware, its source code and documentation are freely available at rusefi.com. The firmware of the CAN module is made by k-data.

2 Product overview

2.1 Concept

The PECU consists of three assemblies in one housing:

1. **uaEFI module** – the actual engine control unit. An unmodified uaEFI board from the rusEFI project with processor, drivers for injection and ignition, wideband lambda controller, MAP sensor, SD card and USB. The module plugs onto the carrier board and can be replaced if necessary.
2. **PECU carrier board** – adapts the uaEFI to the specific vehicle. It carries the original vehicle connector, the ignition power stages (IGBT) for conventional ignition coils, the drivers for main relay and idle valve, protection circuits and the additional connectors.
3. **CAN module with OLED** – an OLED module with its own CAN interface. It shows engine data, generates the CAN messages the vehicle expects from the original DME (e.g. rev counter, temperature gauge, warning lights) and provides a Wi-Fi dashboard.

The assignment of inputs and outputs is fixed by the carrier board and already entered in the base calibration.

2.2 PECU M54 variant

Function: The PECU M54 replaces the Siemens MS43 of the BMW M54. It is plugged onto the five-part vehicle connector (X60001 to X60005) in place of the original DME; the engine wiring harness stays unchanged.

From the factory: base calibration “PECU M54 Alpha-N” for the rusEFI firmware release_20260812, load detection via the throttle (Alpha-N), electronic throttle and double Vanos controlled.

Feature	PECU M54
Engine	BMW M54B22, M54B25 and M54B30 (inline six, 24 valves, double Vanos, electronic throttle)
Original ECU	Siemens MS43
Vehicles	BMW E46, E39, E60/E61, Z3 and Z4 with M54
Vehicle connector	134-pin in five modules (X60001 to X60005), like the original DME
Load detection from the factory	Alpha-N (throttle angle); speed density possible with the MAP sensor of the uaEFI
CAN bus	on the vehicle connector (vehicle CAN) and on additional connector X4 (chapter 3.14)
Additional functions of the carrier board	double Vanos and intake manifold switch-over (chapter 3.10), A/C compressor via the CAN module (chapter 3.17), instrument cluster via CAN (chapter 8), switchable CAN termination

Distinction from other PECU variants

Engine	Original DME	Matching PECU
M52	Siemens MS41, 88-pin	PECU M52
M52TU	Siemens MS42	not suitable
M54	Siemens MS43	**PECU M54**
S54 (E46 M3)	own DME	not suitable

The MS42 of the M52TU has a similar five-part connector, but a different pin assignment. The PECU M54 only fits if the original DME is a Siemens MS43 (label on the type plate).

Pin designation in this manual: BMW calls the five connector modules X60001 to X60005. The tables give the module number first, then the pin: *3-08* is pin 8 in module X60003.

2.3 Scope of delivery

- PECU in a housing in RAL 4008 signal violet, with type plate (variant, item number, QR code)
- Mating connectors with crimp contacts for the additional connectors
- microSD card for data logging, already inserted in the slot of the uaEFI module
- Base calibration (stored on the unit and also supplied as an .msq file) for rusEFI firmware release_20260812

A Bosch LSU 4.9 wideband lambda sensor with weld-in boss, harnesses and further sensors are available as accessories.

2.4 Housing and connectors

Connector	Type	Function
Vehicle connector (X60001–X60005)	134-pin in five modules, like the original DME Siemens MS43	connection to the standard engine wiring harness
Additional connector X4	Molex Micro-Fit 3.0, 24-pin	free inputs/outputs, CAN, knock sensor, EGT, drive-by-wire (chap. 3.12)
Additional connector X7	Molex Micro-Fit 3.0, 14-pin	injection 1–6 and ignition signals for external power stages (chap. 3.13)
Lambda sensor (connector E)	Molex Micro-Fit 3.0, 6-pin (2 × 3)	Bosch LSU 4.9
USB	type B	TunerStudio, rusEFI Console, firmware update
microSD	slot on the uaEFI module	data logging

2.5 Technical data

Feature	Value
Operating voltage	9–16 V (12 V vehicle system)
Platform	uaEFI (rusEFI), 32-bit microcontroller
Injection	6 sequential outputs for high-impedance injectors, 2 further outputs usable as injector 7/8
Ignition	6 ignition power stages (IGBT ISL9V3040, each with a 2.5 A self-resetting fuse) for conventional coils, plus 6 logic signals for coils with integrated igniter
Crankshaft / camshaft	2 VR inputs (inductive sensors), 3 Hall inputs (12 V tolerant)
Analogue inputs	CLT, IAT, TPS 1/2, PPS 1/2, MAP, 3 AUX, battery/ignition
Wideband lambda	integrated controller for Bosch LSU 4.9
MAP sensor	KD6400AP on the uaEFI module, 20–400 kPa absolute (MPXH6400 curve), suitable for turbo up to approx. 3 bar boost
Knock sensor	1 input, software knock detection
Exhaust gas temperature	input for 1 type K thermocouple; components not fitted on the uaEFI module, retrofit required
Switched outputs	4 low-side outputs (3 of them with flyback diode), 2 low-side for relays, 2 H-bridges (drive-by-wire, stepper motor or 2 switched outputs)
Communication	USB, CAN 500 kbit/s
Data logging	microSD card (inserted on delivery)
CAN module	OLED module with CAN, Wi-Fi 2.4 GHz, switchable CAN termination, instrument cluster and vehicle CAN (BMW E46/E39), A/C compressor control
Software	TunerStudio MS (Lite free, Ultra recommended), rusEFI Console; PECU Konfigurator (Windows) for the CAN module via USB (chap. 8)

3 Connections and functions

This chapter describes each function of the PECU M54 with its connection to the engine wiring harness: pin on the vehicle connector (module-pin, e.g. 3-08 = X60003 pin 8), uaEFI pin, type of signal and setting in TunerStudio. The complete assignment of all 134 pins with signal direction and uaEFI pin is in Appendix B, the assignment of the uaEFI in Appendix A.

> **Important:** The assignment of inputs and outputs is defined by the carrier board and entered in the base calibration. Do not change settings marked **[fixed]** in this chapter. Otherwise sensors or outputs stop working.

3.1 Power supply, ground and main relay

Function: The PECU detects the switched-on ignition at 4-26 and switches the main relay (DME relay) via 2-23. Through the relay, the PECU, injectors, ignition coils and sensors receive their supply.

From the factory: set up. Nothing to adjust.

Pin	Signal	uaEFI	Properties
4-26	Ignition on (terminal 15)	[A7]	ignition detection, voltage measurement
1-1, 1-8, 1-9	+12 V from main relay	[A8]	supply of the uaEFI and the carrier board
2-23	Main relay control	[B9]	low-side output via the carrier board
1-4, 1-5, 1-6 and others (Appendix B)	Ground	GND	power, electronics and sensor ground
5-4, 5-5, 5-6	Ground of the ignition drivers	–	common emitter of the six ignition drivers (chapter 3.4)

Setting: TunerStudio **Setup › Outputs** › *Main relay output*: *Output* = B9 **[fixed]**. *Main Relay Disable Time* defines how long the relay stays on after the ignition is switched off.

Details

- After the ignition is switched off, the uaEFI keeps the main relay on briefly to store settings safely.
- Permanent positive (terminal 30, 1-7) is not used.
- With USB alone the uaEFI can be reached by TunerStudio; sensor values, outputs and the CAN module only work with the ignition switched on.

3.2 Crankshaft and camshaft sensors

Function: The crankshaft sensor provides engine speed and crankshaft position (trigger wheel 60-2, Hall sensor). The two camshaft sensors measure the position of the intake and exhaust camshafts for phase detection and Vanos.

From the factory: all three sensors set up. If the camshaft signal is missing, the PECU automatically continues to fire in wasted-spark mode.

Pin	Signal	uaEFI	Properties
3-8	Crankshaft sensor	[C5]	Hall sensor, square wave
3-5	Camshaft sensor intake	[C6]	Hall sensor, square wave
3-2	Camshaft sensor exhaust	[C7]	Hall sensor, square wave
3-4, 3-7	+5 V sensor supply	+5 V	

Setting: Setup › Trigger

- *Trigger type* = 60-2, *Primary channel* = C5 **[fixed]**.
- **Cam Inputs:** *Cam sensor bank 1 intake* = C6, *Cam sensor bank 1 exhaust* = C7 **[fixed]**. The VVT offsets are entered in the base calibration **[fixed]**.
- **Setup › Advanced Trigger**: *Require cam/VVT sync for ignition* = no **[fixed]**.
- Check *Trigger Angle Advance* with the timing light (chapter 7.2), especially after a firmware update.

Details

- All sensors are Hall sensors. The VR LEDs 5 and 6 on the uaEFI module show nothing on the PECU M54. Whether a speed signal arrives is shown by TunerStudio while cranking (*RPM* and *Trigger errors*, chapter 9).
- In TunerStudio, *VVT: bank 1 intake* and *VVT: bank 1 exhaust* show the measured position of the camshafts.
- If the camshaft signal is missing, the PECU fires in wasted-spark mode, injects at a random position and the Vanos stays in its home position. If *Require cam/VVT sync for ignition* is yes, the engine does not start without the camshaft signal.

3.3 Injection

Function: Six outputs control the injectors individually (sequential injection).

From the factory: set up for the original injectors, constant fuel pressure.

Pin	Cylinder	uaEFI	Output of the uaEFI
3-33	1	[B6]	Injector 1
3-34	2	[B5]	Injector 2
3-35	3	[B4]	Injector 3
3-36	4	[B3]	Injector 4
3-37	5	[B2]	Injector 5
3-38	6	[B1]	Injector 6

The injectors receive +12 V via the main relay; the PECU switches them to ground. The outputs are designed for high-impedance injectors (approx. 12–16 Ω). The same signals are also available on additional connector X7 pins 1–6.

Setting: Fuel › Injector Setup (chapter 6.2.1). The assignment of the outputs is **[fixed]**. Enter other injectors via *Injector flow* and the dead time curve (*Injector lag*).

Details: On the PECU M54 the injection outputs are wired by cylinder (output 1 to cylinder 1 and so on), whereas the ignition outputs are wired in firing order (chapter 3.4). The base calibration takes this into account.

3.4 Ignition

Function: Six ignition drivers on the carrier board switch the individual ignition coils.

From the factory: individual ignition, dwell time for the original ignition coils.

Pin	Cylinder	uaEFI	Output in TunerStudio
5-3	1	[B15]	Coil 1
5-8	5	[B14]	Coil 2
5-1	3	[B12]	Coil 3
5-7	6	[B11]	Coil 4
5-2	2	[B13]	Coil 5
5-9	4	[B10]	Coil 6
5-4, 5-5, 5-6	Ground of the ignition drivers	–	–

The ignition coils receive +12 V via the main relay. Each driver (IGBT ISL9V3040) switches the primary side of its coil to ground (5-4 to 5-6) and is protected by a self-resetting fuse (2.5 A). The logic signals of the six ignition outputs are also available on X7 pins 8–13 for coils with integrated driver.

Setting: Ignition (chapter 6.3), dwell time under **Ignition › Dwell**.

Note on the firing order: On the PECU M54 this reads 1-2-3-4-5-6 because the carrier board already routes the ignition outputs to the cylinders in firing order (chapter 3.4). Do not change it to 1-5-3-6-2-4. The injection outputs are wired by cylinder; their assignment is entered accordingly in the base calibration (chapter 3.3).

Warning: The dwell time determines the coil current. Too long a dwell time overheats coils and drivers; the fuses then trip and reset themselves after cooling down. Only change values according to the coil data sheet.

3.5 Temperature sensors

Function: Coolant temperature and intake air temperature for warm-up, start and mixture correction.

From the factory: curves of the original BMW sensors (NTC) entered.

Pin	Signal	uaEFI	Properties
3-24	Coolant temperature (CLT)	[D16]	NTC to ground, pull-up on the uaEFI
3-22	Intake air temperature (IAT)	[D15]	NTC to ground

Setting: Sensors › CLT sensor, **Sensors › IAT sensor**. Only change if other sensors are fitted.

Details: On the M54 the temperature gauge in the instrument cluster receives its value via CAN from the CAN module (chapter 8). The oil temperature sensor (3-27) is not evaluated. A faulty coolant sensor shows in TunerStudio as an implausible value (e.g. −40 °C with a broken wire).

3.6 Electronic throttle, accelerator pedal and load

Function: The PECU controls the electronic throttle according to the position of the accelerator pedal. From the factory it calculates the engine load from the throttle angle (Alpha-N).

From the factory: throttle and accelerator pedal set up and calibrated to original parts; load detection Alpha-N; the air mass meter is not evaluated.

Pin	Signal	uaEFI	Properties
3-19	Throttle, potentiometer 1	[D13]	0–5 V
3-10	Throttle, potentiometer 2	[C14]	0–5 V, cross-check
3-44	Throttle motor +	[A5]	H-bridge 1
3-43	Throttle motor −	[A1]	H-bridge 1
4-8	Accelerator pedal, sensor 1	[D6]	0–5 V
4-13	Accelerator pedal, sensor 2	[C4]	0–5 V, cross-check
4-9, 4-14	+5 V supply accelerator pedal	+5 V	
4-7, 4-12	Ground accelerator pedal	GND	
–	Manifold pressure (MAP)	On-board MAP	sensor KD6400AP on the uaEFI module, 20–400 kPa absolute

Setting

- **Sensors › TPS** and **Sensors › Accelerator pedal**: learn the end values again after installation (buttons *Auto Calibrate*). This is necessary on every vehicle because throttle and pedal vary.
- **Electronic Throttle**: control parameters are entered in the base calibration **[fixed]**.
- **Setup › Vehicle Information** › *Fuel strategy*: Alpha-N (factory) or speed density.
- **Sensors › MAP sensor**: *MAP input* = On-board MAP, *MAP sensor type* = MPXH6400 **[fixed]**.

Warning: Before the first drive, check with the engine stopped and the ignition on that the throttle follows the pedal and closes when released. If one of the two cross-checks deviates, the PECU switches the throttle off; the engine then only runs at idle.

Details

- For speed density, run a hose from the intake manifold to the pressure port of the PECU (chapter 4.2).
- The air mass meter can stay installed; it remains part of the intake path, its signal is not used.

3.7 Wideband lambda control

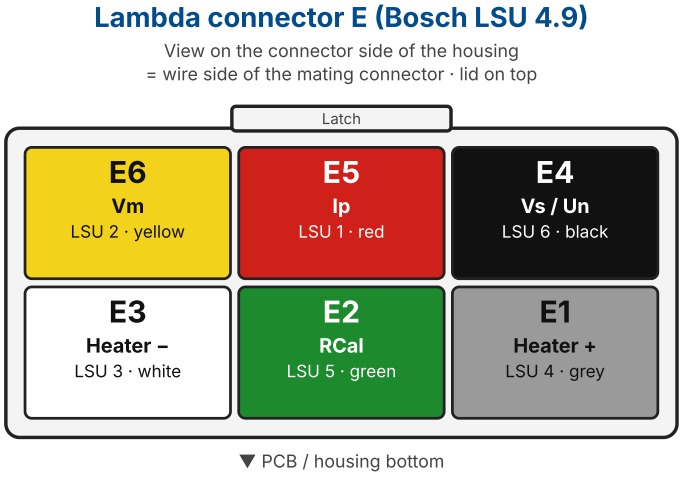
Function: The controller on the uaEFI module operates a Bosch LSU 4.9 wideband sensor and reports the lambda value to the engine control.

Factory setting: controller and gauge *Lambda 1* set up; the sensor plugs into the 6-pin connector E.

The uaEFI module has its own controller for a **Bosch LSU 4.9** (connector E, 6-pin). It heats the sensor, controls it and delivers the lambda value to the engine control via the internal CAN bus. No external lambda controller is needed.

- Weld in the sensor after the exhaust manifold pipes merge and at least 50 cm before the tailpipe, inclined at least 10° from horizontal, connector facing up.
- Only fit the sensor once the cable is connected. A cold, unheated sensor in the exhaust gas is damaged by condensation.
- The controller only starts heating once the engine is running.

Connecting the sensor to connector E



Lambda connector E, view onto the wire side of the mating connector, latch on top

Position (rear view of cable connector)	LSU 4.9 wire colour	Signal	LSU pin	uaEFI pin
top left	yellow	Vm / Vs/Ip	2	E6
top centre	red	Ip, pump current	1	E5
top right	black	Vs / Un	6	E4
bottom left	white	heater –	3	E3
bottom centre	green	RCal, trim resistor	5	E2
bottom right	grey	heater + 12 V	4	E1

The wire colours apply to the original Bosch LSU 4.9 with moulded cable. For extensions or third-party sensors, check the assignment by LSU pin.

The wideband controller shows its status on its own LEDs on the uaEFI module (chap. 3.16): the green LED 8 flashes quickly while the sensor heats up and slowly once control is active; the blue LED 9 flashes an error code.

TunerStudio: **Sensors › CAN O2 sensors**, **Sensors › rusEFI Wideband Tools** (firmware update of the controller), gauge *Lambda 1*.

3.8 Knock sensor and exhaust gas temperature

Function: Input for a knock sensor and for a thermocouple (exhaust gas temperature).

From the factory: knock sensor of the engine harness connected at 3-29; knock control is set during tuning. For exhaust gas temperature, components are missing on the uaEFI module (see note).

Input	Connection	uaEFI	Setting
Knock sensor	3-29, in parallel X4-2	[D14]	**Ignition › Knock Control**
Exhaust gas temperature (retrofit)	X4-12 (+), X4-24 (−)	[C10]/[C20]	**Sensors › Turbo sensors › EGT**

Note: The standard uaEFI module in the PECU does not have the components for the thermocouple input populated. Without retrofitting these components the EGT input shows no reading. Contact k-data if required.

The M54 has two knock sensors. The PECU evaluates one of them (3-29); the second sensor at 3-31 is not evaluated. rusEFI detects knock in software and retards the ignition timing. X4-2 is the same wire as 3-29 and therefore not free.

3.9 Inputs: vehicle speed, buttons and analogue inputs

3.9.1 Vehicle speed

Function: On the M54 the vehicle speed comes from the ABS/DSC via the CAN bus.

From the factory: set up via CAN; no input on the vehicle connector.

The PECU M54 has no input of its own for a speed signal. The uaEFI reads the speed via **CAN Vehicle speed sensor** from the wheel speeds on the vehicle CAN (chapter 6.8). Do not enter an input pin under **Sensors › Chassis sensors › Vehicle speed sensor**; on the PECU M54, C7 is the exhaust camshaft sensor.

3.9.2 Buttons and digital inputs

Function: Four free inputs for switches and sensors, e.g. clutch switch, launch control, map switching or ethanol sensor.

From the factory: free, only on additional connector X4.

Input	X4	uaEFI	Typical use
BUTTON1	3	[D2]	clutch switch, launch control
BUTTON2	14	[D10]	map switching, free
BUTTON3	15	[C9]	idle/neutral switch, free
FLEX	17	[D5]	ethanol sensor (flex fuel)

The inputs are 12 V tolerant and have a pull-down resistor. In TunerStudio the pin is selected in the respective function, e.g. **Advanced › Launch Control** *Launch Button*. The vehicle's clutch switch (4-23) is not connected; for launch control connect a switch to X4-3.

3.9.3 Analogue inputs AUX

Function: Three analogue inputs 0–5 V for additional sensors (fuel pressure, oil pressure, boost pressure).

From the factory: free, only on additional connector X4.

Input	Connection	uaEFI
AUX1	X4-4	[D1]
AUX2	X4-16	[C3]
AUX3 / fuel pressure	X4-5	[C15]

Connect sensors to +5 V (X4-1) and sensor ground (X4-13). Setting under **Sensors** in the respective function.

3.10 Switched outputs

Function: Fuel pump relay, double Vanos, intake manifold switch-over and map-controlled thermostat.

From the factory: all set up. The PECU M54 has no free outputs; rev counter and fan work via CAN or via the vehicle's own control units.

Function	Connection	uaEFI	Properties
Fuel pump relay	4-10	[B16]	low-side with flyback diode, switches the relay coil to ground
Vanos intake	3-40, X4-8	[B7]	low-side with flyback diode, pulsed
Vanos exhaust	3-41, X4-20	[B18]	low-side with flyback diode, pulsed
Intake manifold switch-over (DISA)	3-49, X4-10	[B8]	weak low-side without diode
Map-controlled thermostat	3-45, 4-4, X4-22	[B17]	low-side, pull-up 1 kΩ to +12 V on the carrier board
H-bridge 1	3-43, 3-44, X4-9, X4-21	[A5]/[A1]	electronic throttle (chapter 3.6)

3.10.1 Fuel pump

When the ignition is switched on, the pump runs for a few seconds to build up pressure, and afterwards only while the engine is running. Setting: **Setup › Outputs** › *Fuel Pump*: *Output* = B16 **[fixed]**, *Prime duration* (factory 4 s).

3.10.2 Double Vanos

The two Vanos solenoid valves adjust the intake and exhaust camshafts continuously. The PECU pulses them via 3-40 and 3-41 and controls the position with the camshaft sensors (chapter 3.2) to the target values from the base calibration. Setting: **VVT** menu; outputs B7 and B18 are **[fixed]**. Only change the target tables if the engine has been modified.

3.10.3 Intake manifold switch-over and map-controlled thermostat

The intake manifold switch-over (DISA) changes the length of the intake runners depending on engine speed; the PECU switches it via 3-49. The map-controlled thermostat (3-45) is heated to lower the coolant temperature at full load. Both functions are entered in the base calibration.

Note: The outputs switch to ground. The X4 pins named in the table are the same wires as on the vehicle connector and can only be used if the related part in the engine harness is not connected.

3.11 Idle

Function: The electronic throttle holds the idle speed. The idle actuator of the M54 is connected to the second H-bridge of the uaEFI.

From the factory: idle control via the throttle.

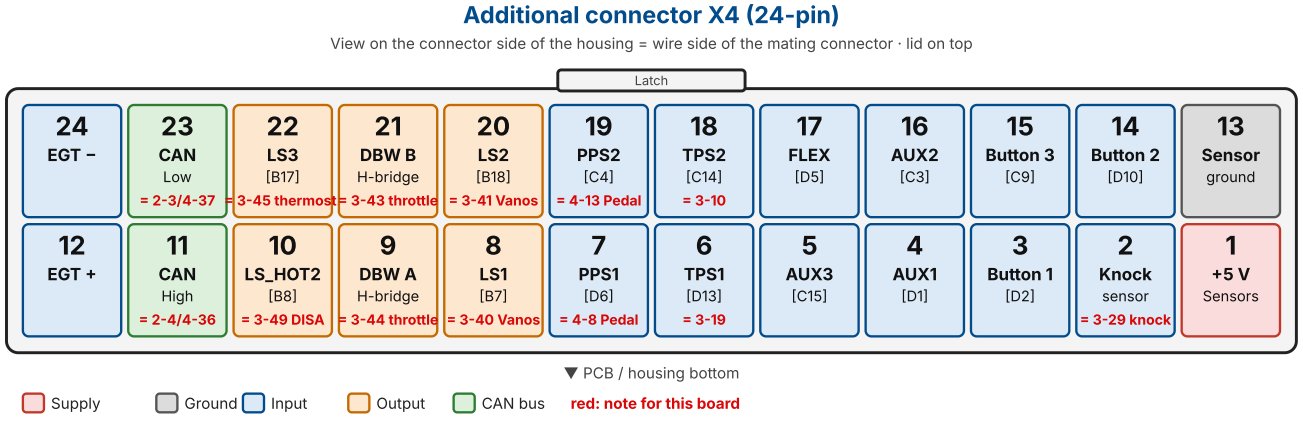
Pin	Signal	uaEFI	Drive
3-46	Idle actuator	[A2]	H-bridge 2
3-47	Idle actuator	[A6]	H-bridge 2

Setting: Idle › Idle settings and the tables in the **Idle** menu (chapter 6.5): target speed and base opening of the throttle.

3.12 Additional connector X4 (24-pin)

Function: Free inputs and outputs of the uaEFI, CAN bus, knock sensor, exhaust gas temperature and drive-by-wire.

Factory setting: not used; mating connector supplied.



Additional connector X4, view onto the wire side of the mating connector

The picture shows the connector as you see it when wiring, looking onto the wire side of the mating connector: lid on top, pin 1 at the bottom right. Pins marked in red already have a task on the PECU M54 or are in parallel with the vehicle connector (“= …”: the same line as the named pin of the vehicle connector).

Pin	Signal	Pin	Signal
1	+5 V sensor supply	13	sensor ground
2	knock sensor	14	BUTTON2 [D10]
3	BUTTON1 [D2]	15	BUTTON3 [C9]
4	AUX1 [D1]	16	AUX2 [C3]
5	AUX3 / fuel pressure [C15]	17	FLEX [D5]
6	TPS1 [D13]	18	TPS2 [C14]
7	PPS1 [D6]	19	PPS2 [C4]
8	VVT1 / LS1 [B7]	20	VVT2 / LS2 [B18]
9	DBW motor A (H-bridge 1)	21	DBW motor B (H-bridge 1)
10	LS_HOT2 [B8]	22	LS3 [B17]
11	CAN High	23	CAN Low
12	EGT +	24	EGT –

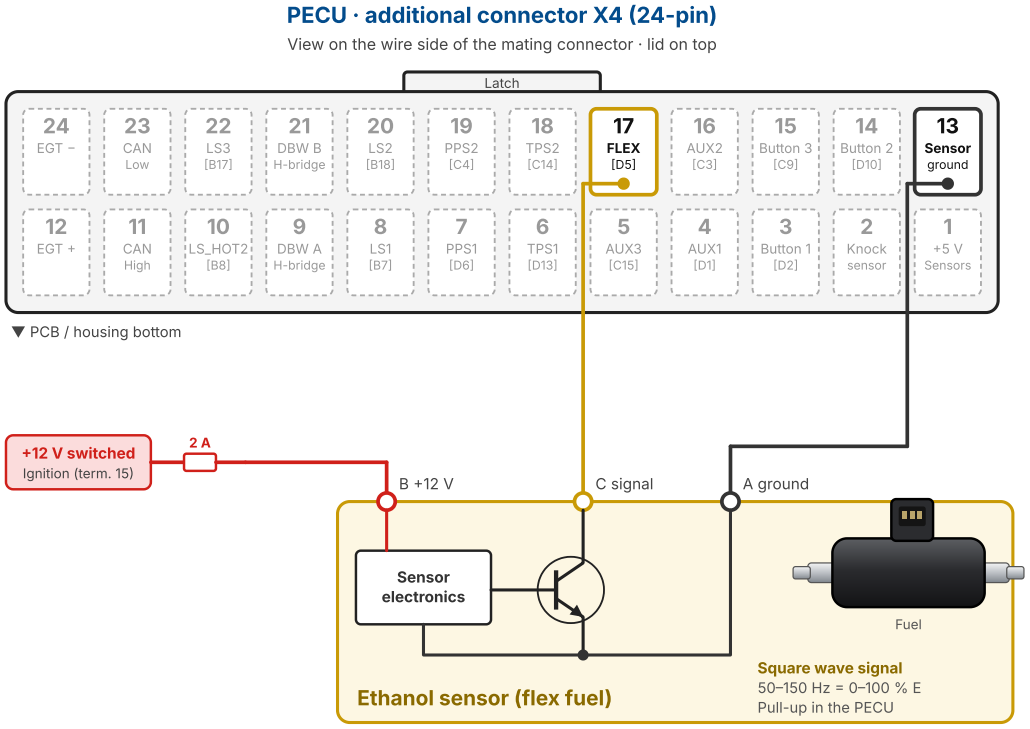
Pins brought out twice: Some pins of X4 and X7 are the same line as a pin of the vehicle connector (marked red in the picture). Such an output can only be used at the additional connector if the original component in the engine harness is no longer connected. Example: if the idle valve is removed or unplugged, its output at the additional connector is free for another function. The same applies to inputs: a sensor at the vehicle connector and a second one at the additional connector on the same line interfere with each other.

X4 lets you add functions the original harness does not have: electronic throttle, fuel pressure sensor, flex fuel, launch control button, exhaust gas temperature, external CAN devices (display, data logger).

3.12.1 Connection examples

The following pictures show typical additions at X4, each using pins that are free on the PECU M54. They are examples, not a complete overview; all pins are listed in the table above and in Appendix A. X4 has no +12 V pin: connect sensors, buttons and relays that need +12 V to switched +12 V (terminal 15) via their own fuse.

Flex fuel sensor: signal to X4-17 [D5], ground to X4-13 (sensor ground), supply +12 V via a fuse. The sensor delivers a square wave of 50 to 150 Hz for 0 to 100 % ethanol; the pull-up resistor is inside the PECU M54. The A/B/C assignment on the sensor differs between manufacturers, so check the data sheet.



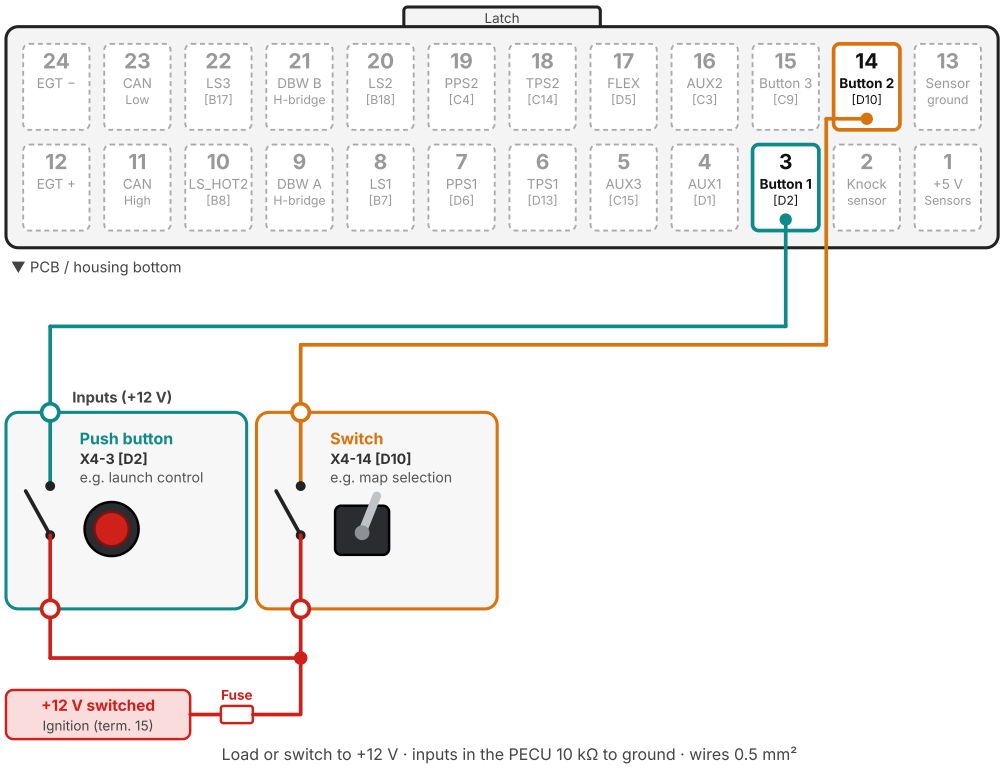
Connecting an ethanol sensor (flex fuel) to X4

Inputs and outputs: The button inputs have 10 kΩ to ground inside the PECU M54; buttons and switches therefore switch +12 V onto the input. The outputs switch to ground: the load (relay coil, valve) is connected with its other terminal to switched +12 V. For a relay (e.g. fan or additional pump) we recommend X4-10 [B8]: a weak output without flyback diode, intended for relay coils only. X4-8 [B7] has a flyback diode and suits pulsed valves such as a boost control valve.

On the PECU M54 all switched outputs of X4 are used by vehicle functions: X4-8 [B7] and X4-20 [B18] drive the Vanos (intake and exhaust), X4-10 [B8] the intake system (DISA) and X4-22 [B17] the map-controlled thermostat. The picture therefore shows inputs only. A relay or boost control valve can only be operated on an output that is used twice, for example on X4-8 or X4-20 if you do without the respective Vanos. Unplug the original component and assign the output to the new function in TunerStudio (see note “Pins brought out twice”).

PECU · additional connector X4 (24-pin)

View on the wire side of the mating connector · lid on top

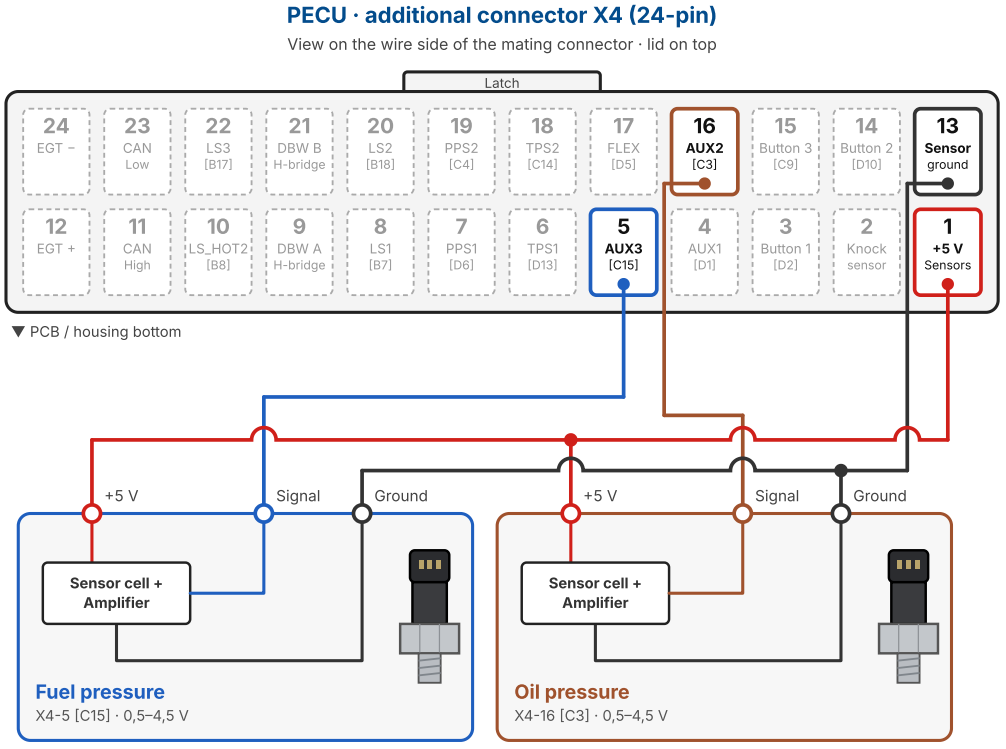


Load or switch to +12 V · inputs in the PECU 10 kΩ to ground · wires 0.5 mm²

Example – not a complete overview of the connection options (all pins: chapter 3.12 and Appendix A)

Connecting buttons, switches and switched outputs to X4

Pressure sensors: Sensors with three terminals and 0.5 to 4.5 V output (e.g. fuel or oil pressure) are supplied from X4-1 (+5 V) and X4-13 (sensor ground). The signal goes to a free analogue input. Enter the characteristic (voltage to pressure) from the data sheet in TunerStudio.



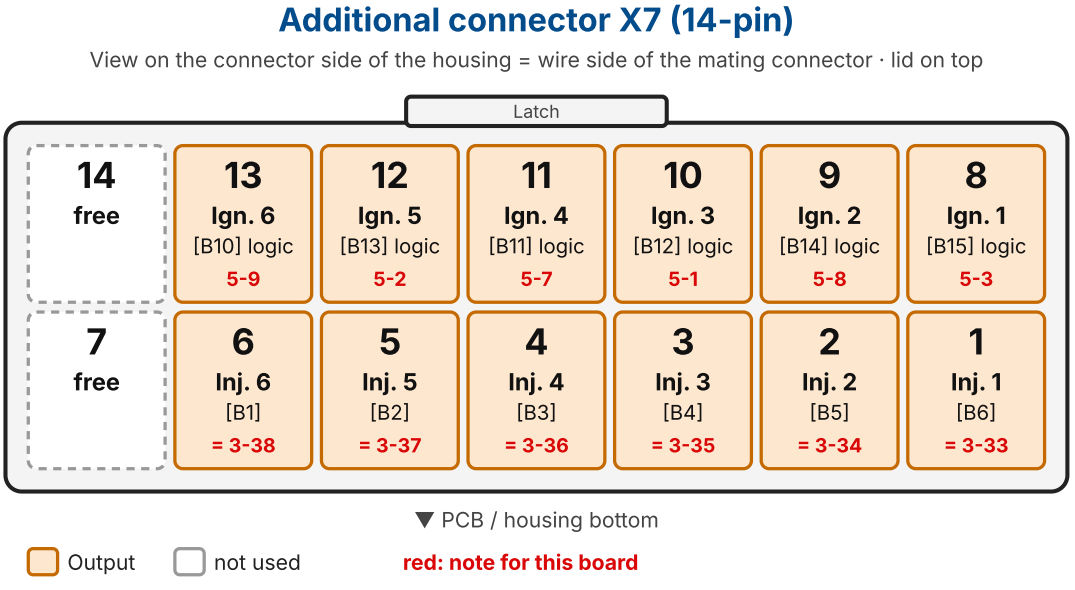
Pressure sensors with 3 terminals (0.5–4.5 V) · curve in TunerStudio as per data sheet · wires 0.5 mm²
Example – not a complete overview of the connection options (all pins: chapter 3.12 and Appendix A)

Connecting pressure sensors to X4

3.13 Additional connector X7 (14-pin)

Function: Injection signals 1–6 and ignition signals 1–6 (logic level) for a separate harness.

Factory setting: not used.



Additional connector X7, view onto the wire side of the mating connector

The injection signals at X7 are the same lines as at the vehicle connector (red: "= ...") and can only be used if the corresponding injectors are not connected to the engine harness. The ignition signals at pins 8–13 are the logic signals before the ignition power stages; in red is the vehicle connector pin at which the corresponding power stage switches the ignition coil. If coils with integrated igniter are driven via X7, no ignition coils may remain connected to these pins of the vehicle connector.

Pin	Signal	Pin	Signal
1–6	injection 1–6 (in parallel with the vehicle connector)	8–13	ignition signal 1–6, logic level, for coils with igniter
7	not used	14	not used

X7 is used to connect a separate injection or ignition harness, e.g. when converting an engine to individual coils with igniters.

3.14 CAN bus

Function: Shared data bus of uaEFI, CAN module and connected devices.

Factory setting: the uaEFI sends its readings as rusEFI broadcast; termination resistor on.

The PECU has one CAN bus (500 kbit/s) that the uaEFI [D7]/[D8], the CAN module and connected devices **share**. On the PECU M54 the CAN bus is connected to the vehicle CAN (X60002-3/-4 and X60004-36/-37) and also brought out on additional connector X4. On the M54, rev counter, temperature gauge and A/C request run via CAN. The uaEFI sends its readings as "rusEFI CAN broadcast"; the CAN module translates them into the vehicle's messages (chap. 8).

A CAN bus needs a 120 Ω termination resistor at each end. The PECU has its own switchable termination, which the CAN module switches on (chap. 8.8). It is on at the factory.

TunerStudio: **CAN-bus › CAN Bus Settings** (chap. 6.8).

3.15 USB and microSD card

Function: Connection to the laptop and data logging inside the control unit.

Factory setting: microSD card inserted.

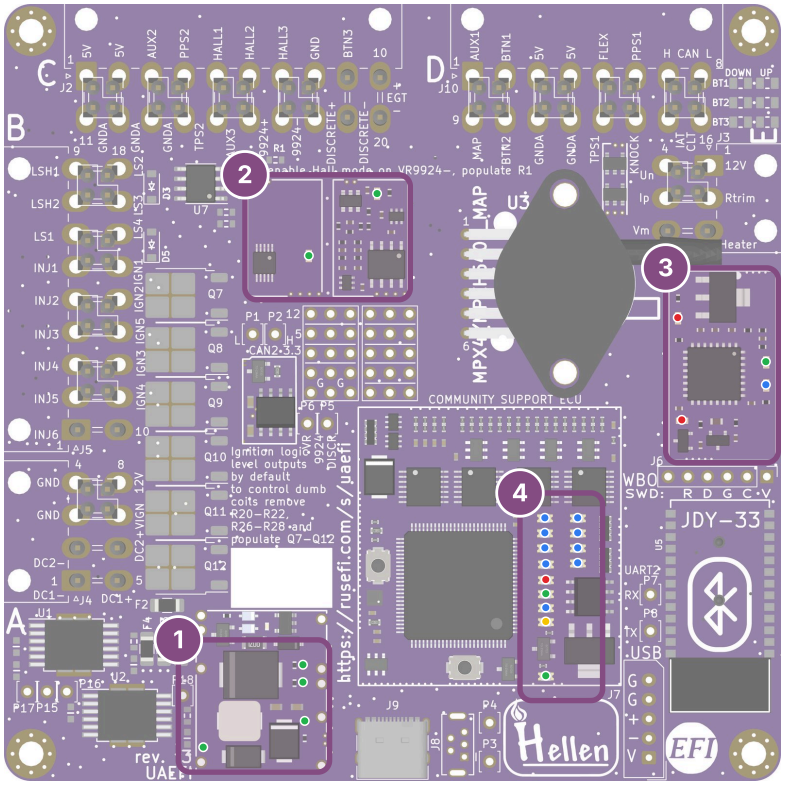
- **USB:** connection to TunerStudio and rusEFI Console. The PC detects the PECU as a serial port and additionally as a drive containing the matching TunerStudio definition file.
- **microSD:** data logging inside the control unit, independent of the laptop. The card is already in the slot of the uaEFI module on delivery. Only remove or insert the card with the ignition off. TunerStudio: **Controller › SD Card Logger** (chap. 6.9).

3.16 LEDs on the uaEFI module

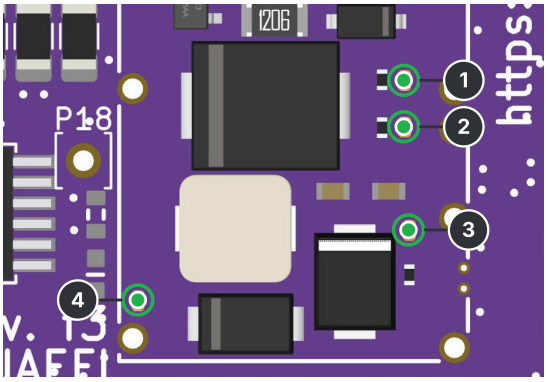
Function: 23 LEDs show supply, speed signals, wideband lambda controller, processor and outputs.

Factory setting: always active.

The LEDs are visible once the lid is removed. They help with troubleshooting. The numbers in the pictures belong to the tables next to them. When switching on, LEDs 11 to 14 light up briefly together (self-test).

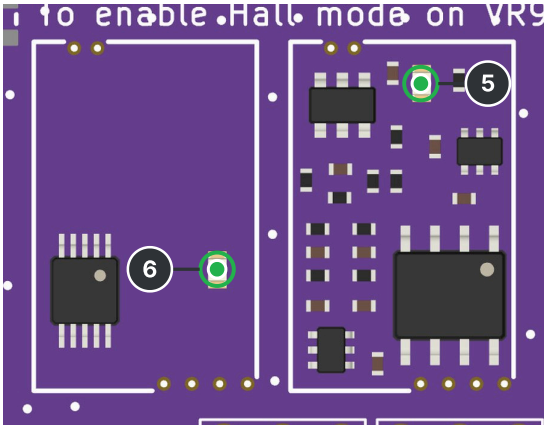


Position of the LED groups on the uaEFI module (top view)



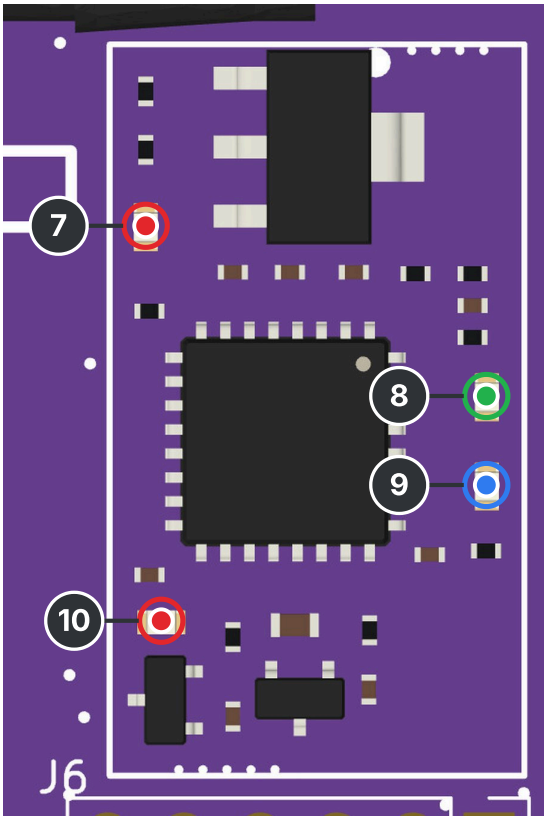
1 Supply

No.	Colour	Meaning
1		on: 12 V supply present
2		on: ignition on
3		on: 5 V supply OK
4		on: 5 V sensor supply OK



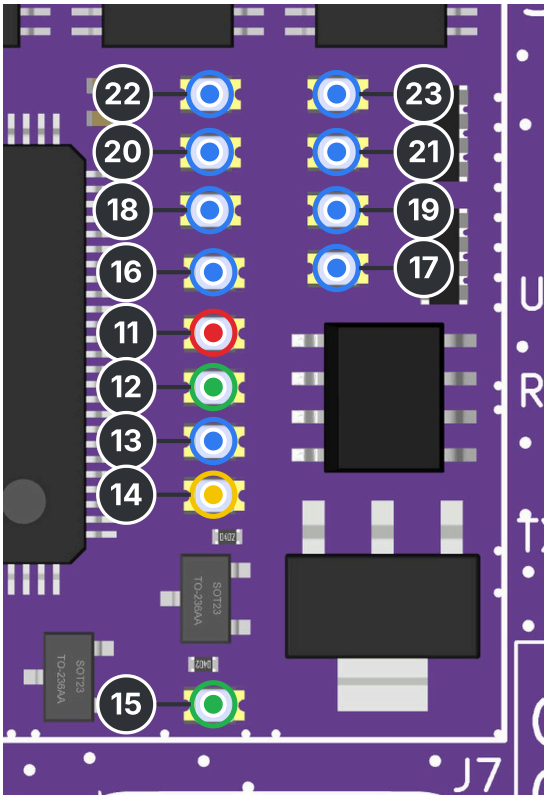
2 Speed signals

No.	Colour	Meaning
5		input VR1 (C18/C19). Not used on the PECU M54; crankshaft and camshaft sensors are Hall sensors.
6		input VR2 (C17). Not used on the PECU M54; crankshaft and camshaft sensors are Hall sensors.



3 Wideband lambda controller

No.	Colour	Meaning
7		on: sensor heater is driven, brightness depends on heater power
8		flashing fast: sensor heating up · flashing slowly: control active · off: error, see 9
9		flashes in groups: error code of the lambda controller, count the flashes
10		on: supply of the lambda controller OK



4 Processor and outputs

No.	Colour	Meaning
11		on or long flashes: serious firmware error, read out with TunerStudio
12		on while cranking, flashes with the engine running
13		always flashes (heartbeat) · faster when connected to TunerStudio
14		flashing: error in the speed signal · steady: after an unexpected restart, error report on the microSD card
15		on: 3.3 V processor supply OK
16		ignition output 1 (B15) driven
17		ignition output 2 (B14) driven
18		ignition output 3 (B12) driven
19		ignition output 4 (B11) driven
20		ignition output 5 (B13) driven
21		ignition output 6 (B10) driven
22		output B9 driven (main relay at the factory)
23		output B8 driven (fan at the factory)

> **Note:** The output LEDs only show that the processor drives the output, not that current actually flows. An LED that lights while the function is missing points to the wiring, a fuse or the load.

Quick check with the LEDs

Observation	Meaning
1 or 2 off with ignition on	no supply or no ignition signal: check fuses, main relay, connector
11 on	firmware reports a serious error: read the error message with TunerStudio
14 flashing	speed signal disturbed: check sensor, gap, wiring and shielding
8 still flashing fast after minutes	sensor does not get warm: check heater, sensor, connector E
9 flashing	lambda controller reports an error: check sensor and wiring

3.17 Air conditioning

Function: The CAN module switches the A/C compressor relay when the air conditioning requests the compressor via CAN and the engine is running.

From the factory: off. The compressor only runs once the function is switched on in the settings page of the CAN module (chapter 8.12).

Pin	Signal	Evaluation	Properties
4-29	A/C compressor relay	CAN module → low-side semiconductor output	switches the relay coil to ground
2-3/2-4, 4-36/4-37	A/C request	CAN module via CAN (BMW E46: message 0x615)	–

How the control works: On the M54 the air conditioning reports via the vehicle CAN that it needs the compressor; it monitors the refrigerant pressure itself. The CAN module reads the request and switches the compressor relay at 4-29 as long as the request is present and the engine is running.

Setting: settings page of the CAN module › *Klimakompressor* (A/C compressor, chapter 8.12): *Anforderung* (request) = CAN 0x615 (BMW E46), *Druckschalter* (pressure switch) = nicht vorhanden (not present). Then check that the "Klima-Anforderung" (A/C request) indicator in the dashboard follows the A/C switch.

Details

- The A/C function is in the CAN module, not in the uaEFI. The uaEFI settings under **Setup › Air Conditioning** (*A/C Relay*, *A/C Switch*) stay empty.
- In vehicles whose air conditioning does not send the request as message 0x615, the compressor control does not work. For vehicles other than the E46, ask k-data before installation.
- If the CAN module fails or the uaEFI sends no data, the compressor stays off.

3.18 Tank venting

Function: The tank venting valve at 3-42 is not pulsed by the PECU.

From the factory: 3-42 is permanently connected to ground on the carrier board via a 0 Ω bridge (R343).

The original DME pulses the tank venting valve to purge the activated carbon canister. On the PECU M54 the pin is permanently connected to ground. The uaEFI function “Canister purge” is not used.

3.19 Unused pins and functions of the original DME

All pins marked as *not used* in Appendix B are not connected on the carrier board. Some pins are, as in the original DME, only connected to each other (*bridge*). This removes the following functions of the Siemens MS43:

Function of the original DME	On the PECU M54
Lambda sensors (narrowband)	replaced by the wideband sensor on connector E (chapter 3.7); the original sensors can be removed
Air mass meter	not evaluated, load detection via the throttle (chapter 3.6)
Oil temperature (3-27), second knock sensor (3-31)	not evaluated
Exhaust flap (4-18)	not connected
Clutch switch (4-23)	not connected; replacement via BUTTON1 on X4 (chapter 3.9.2)
Engine speed signal for other control units, diagnostic line	not connected; engine speed via CAN, diagnostics via USB with TunerStudio (chapter 9)
Tank venting (3-42)	permanently on ground (chapter 3.18)

4 Installation

4.1 Preparation

1. Check that the PECU matches the engine (type plate, chap. 2.2).
2. Check the condition of the engine: spark plugs, ignition leads, fuel pressure, vacuum hoses, sensors. The PECU cannot compensate for a faulty sensor.
3. Back up the original DME data if you plan to convert back.
4. Have a laptop with Windows 10/11, macOS or Linux and TunerStudio installed, plus a USB-A to USB-B cable ready (chap. 5). The cable is not included in the scope of delivery.
5. Have the wideband lambda sensor welded in (chap. 3.7).

4.2 Installing the control unit

1. Ignition off, remove the key, **disconnect the battery negative terminal**.
2. Release the original control unit in the ECU box and unplug the vehicle connector.
3. Check the connector contacts for corrosion and bent pins.
4. Fit the PECU in place of the original DME and secure it.
5. Plug in the vehicle connector and close the lock completely.
6. Connect the lambda sensor to the 6-pin connector and route the cable away from the manifold, ignition leads and moving parts.
7. If manifold pressure (MAP) is used: run a hose from the intake manifold (after the throttle) to the pressure port of the PECU. A tee in the vacuum line of the fuel pressure regulator is quick and effective. Keep the hose free of kinks, as short as possible, without a fuel trap.
8. Only connect additional connectors X4/X7 if they are used.
9. Reconnect the battery.

4.3 Grounding and wiring for extensions

- Always connect sensors to **sensor ground** (GNDA), never to chassis ground. Otherwise ground offsets distort the readings.
- Use shielded wiring for crankshaft and knock sensors; connect the shield to ground at the control unit end only.
- Supply load outputs (solenoid valves, relays) with +12 V from the switched main relay and switch them to ground via the PECU.
- All additional connectors (X4, X7 and lambda connector E) are Molex Micro-Fit 3.0. Use the matching crimp tool and contacts suitable for the wire cross-section; 0.35–0.5 mm^2 is usual.

5 Software

5.1 Overview

Program	Purpose	Source
TunerStudio MS	configuration, tuning, gauges, data logging	tunerstudio.com; Lite free, **Ultra** (paid) recommended for VE analysis, autotune and map tools
rusEFI Console	firmware update, diagnostics, Lua console	in the rusEFI bundle for the uaEFI (rusefi.com)
MegaLogViewer	analysis of data logs	tunerstudio.com (HD version recommended)
Web browser	Wi-Fi dashboard and settings of the CAN module	any smartphone/laptop

5.2 Installing TunerStudio and creating a project

1. Download TunerStudio MS from tunerstudio.com and install it.
2. Connect the PECU via USB. No driver is needed on Windows 10/11.
3. In TunerStudio, **File › New Project**.
4. Enter a project name, e.g. “PECU M54 customer Smith”.
5. Under *Firmware*, click **Detect**. TunerStudio reads the firmware signature and loads the matching definition file (.ini). Without internet: **Other / Browse** and select the .ini file from the drive that the PECU presents to the PC.
6. Connection: select the port (COM port or /dev/tty…) or use **Detect**. The baud rate does not matter with USB.
7. Create the project. TunerStudio connects and reads the settings from the PECU.
8. Make a backup straight away: **File › Save Tune As…** (file extension .msq).

> **Tip:** Create a separate project for each vehicle and save a new .msq with the date in its name before every larger change.

5.3 Basic operation of TunerStudio

Function	Operation
Change values	Click the field, enter the value, Enter. Changes take effect immediately in the working memory of the PECU.
Save permanently (“Burn”)	**Burn** button in the dialog or **Ctrl+B**. Without Burn, changes are lost when switching off.
Edit tables	Select an area, then **+** / **–** (step), **Shift+/–** (large step), **=** (set value), ***** (percent), **H**/**V** (interpolate), **S** (smooth).
Current operating point	The crosshair cursor in tables shows where the engine is currently running.
Gauges	Main screen with round gauges; right-click a gauge to choose another reading.
Data logging	**Data Logging › Start Logging** (F2), stop with F3.
Compare tunes	**File › Compare Tune** (TunerStudio Ultra: differences between two .msq files).
Work offline	Open the project without the PECU, save changes, transfer them later.

5.4 Updating the firmware

The uaEFI firmware is updated with the **rusEFI Console**.

1. Close TunerStudio (the USB port may only be used by one program).
2. Save the current calibration as .msq.
3. Use the rusEFI bundle for **uaEFI** released by k-data (currently **release_20260812**). Only install other versions, especially nightly builds, when instructed by k-data: the base calibration and this manual apply to the released version.
4. Unpack the bundle, start `rusefi_console`, connect the PECU via USB.
5. Select **Update Firmware** and follow the instructions. The PECU restarts afterwards.
6. Open TunerStudio. If TunerStudio reports a new firmware signature, accept the new .ini and load the saved .msq with **File › Open Tune**, then **Burn**.

> **Warning:** Do not disconnect USB or interrupt the power supply during the update.

The firmware of the CAN module is updated separately via Wi-Fi (chap. 8.11).

6 TunerStudio menus

This chapter describes the menus that matter for a plug & play PECU. Items fixed by the carrier board are marked **[fixed]**: they are entered correctly in the base calibration and must not be changed, otherwise outputs or sensors stop working.

6.1 Menu “Setup”

6.1.1 Vehicle Information

Setting	Meaning
Number of cylinders	number of cylinders
Displacement	displacement in litres; used for the fuel calculation
Firing order	firing order **[fixed]**. On the PECU M54 this reads 1-2-3-4-5-6 because the carrier board already routes the ignition outputs to the cylinders in firing order (chapter 3.4). Do not change it to 1-5-3-6-2-4. The injection outputs are wired by cylinder; their assignment is entered accordingly in the base calibration (chapter 3.3).
Fuel strategy	load detection: Speed Density, Alpha-N or MAF
Tuning View	shows or hides expert menus
Lambda display	display in lambda or AFR
Engine Make / Engine Code / VIN	documentation, stored in logs

6.1.2 Limits and protection

- **Limits and fallbacks:** rev limiter. Choose *Cut fuel on RPM limit* / *Cut spark on RPM limit*, set *RPM hard limit, RPM limit hysteresis* (re-enable). Optionally *Use Engine Temperature RPM limit curve* for a lower limit with a cold engine. *Boost cut pressure* is also set here.
- **Low/High oil pressure protection:** shutdown on missing oil pressure (requires an oil pressure sensor).
- **Lambda protection:** power limitation with a lean mixture under load.
- **Misfire Detection:** misfire detection.

6.1.3 Trigger

Setting	Meaning
Trigger type	type of trigger wheel, e.g. 60-2 **[fixed]**
Trigger Angle Advance	offset between trigger wheel and TDC of cylinder 1. Checked with the timing light (chap. 7.2).
Crank Sensor / Cam Sensor (Primary channel)	input of the crankshaft sensor **[fixed]**
Primary Edge	evaluated edge; only change in case of sync problems
Cam Inputs: *Cam mode, Cam sensor bank 1 intake, VVT offset*	camshaft sensor for sequential injection and Vanos **[fixed, except VVT offset]**

6.1.4 Check Engine Settings

Output and conditions of the check engine light. On vehicles with a CAN instrument cluster the CAN module drives the light (chap. 8.9).

6.1.5 Battery and alternator, Ignition key input Settings

Voltage measurement and ignition detection **[fixed]**.

6.1.6 Outputs, Cooling Fans, Air Conditioning

Dialog	Important settings
Outputs	main relay, fuel pump, rev counter output **[fixed]**; *Fuel pump prime duration* = pump run time after ignition on (default 3–4 s)
Cooling Fans	*On temperature* / *Off temperature* of the electric fan, *Disable when engine stopped*, *Idle adder* (idle increase with fan on)
Air Conditioning	A/C compressor enable, cut-off at full load and high rpm

6.2 Menu “Fuel”

6.2.1 Injector Setup

Injection configuration

Setting	Meaning
Injection	injection on/off (switch off for ignition tests)
Mode	Sequential (with camshaft signal), Batch, Simultaneous
Injection timing control mode	end of injection relative to TDC
Injector flow	injector flow in cc/min at reference pressure. **Must match the fitted injector.**
Fuel rail pressure sensor / *Injector flow compensation mode*	fuel pressure compensation. On standard BMWs with the regulator referenced to the manifold: “Fixed rail pressure” or referenced to the manifold, depending on the fuel system. Requires a restart.
Injector reference pressure	pressure at which *Injector flow* applies (usually 3 bar)
Stoichiometric ratio	14.7 for petrol, 9.0 for E85 (automatic with flex fuel)

Injector deadtime (BatV vs fuel pressure): opening delay of the injector over battery voltage. Important for idle and part load; take the values from the injector data sheet.

Injection hardware: assignment of the injector outputs **[fixed]**. **Injector Test** lets you drive individual injectors.

Injector small-pulse correction: correction for very short injection times.

6.2.2 VE (volumetric efficiency)

The **VE table** is the central fuel map: volumetric efficiency in % over rpm and load (MAP or TPS). From it, the displacement, the air density and the lambda target, rusEFI calculates the injection time. Because injector size, dead time and lambda target are handled separately, the VE table remains valid when injectors are changed.

6.2.3 Target lambda / Target AFR

Lambda target over rpm and load. Typical values:

Operating range	Lambda
Idle, part load	1.00
Medium load	0.95–0.98
Full load, naturally aspirated	0.86–0.90
Full load, boosted	0.78–0.82

6.2.4 Corrections

Dialog	Function
Warmup enrichment	additional fuel in % over coolant temperature
IAT multiplier	correction over intake air temperature
Deceleration fuel cutoff (DFCO)	overrun fuel cut-off: *Enable Fuel Cutoff*, rpm limits, *Cut fuel below MAP*, *No cut below CLT*
Short term fuel trim/Closed loop	lambda control: continuously corrects the fuel quantity towards the lambda target. Limits and enable conditions (temperature, rpm, load)
Long term fuel trims	learning correction
Cylinder fuel trims	fuel trim of individual cylinders
TPS Acceleration Enrichment / Wall Wetting AE	acceleration enrichment from throttle and MAP changes
Wall wetting AE	physical wall film model, alternative to classic acceleration enrichment
Barometric pressure correction	altitude compensation

6.3 Menu “Ignition”

Dialog	Function
Ignition advance	ignition advance in degrees before TDC over rpm and load
CLT / IAT timing correction	timing correction for a cold engine or hot intake air
Dwell	coil dwell over rpm and battery voltage
Ignition hardware	*Spark* on/off, *Mode* (Individual Coils, Wasted Spark), *Timing Mode* (Dynamic or **Fixed** for checking), *Fixed Timing*, outputs **[fixed]**
Cylinder ign trims	timing correction per cylinder
Knock Control, **Max knock retard**	knock control and maximum retard
Multispark	multiple sparks at low rpm

> **Warning:** Too much ignition advance causes knock and destroys pistons. Only increase advance in small steps (1–2°) and only with knock monitoring or on a dyno.

6.4 Menu “Cranking”

Dialog	Function
Cranking settings	*Cranking RPM limit* (cranking mode applies up to this rpm, typ. 400–550 rpm), *Injection mode* while cranking, *Fixed cranking advance* (ignition advance while cranking, typ. 8–10°), *Flood clear* (no injection at full throttle while cranking, to clear a flooded engine)
Cranking Fuel multiplier	cranking fuel over coolant temperature
After-start enrichment	after-start enrichment, decays within a few seconds
Priming pulse	injection pulse at ignition on, wets the intake manifold
Cranking ignition advance	cranking advance over rpm
Cranking Air Amount vs CLT	idle valve opening while cranking

6.5 Menu “Idle”

Dialog	Function
Idle settings	*Idle control mode*: Open Loop (fixed valve position) or Closed Loop (PID control to target rpm); detection thresholds (*TPS threshold, RPM upper limit*); adders for A/C and fan; PID parameters
Idle hardware	type of idle valve, outputs and frequency **[fixed]**
Idle Target RPM from CLT	target idle speed over temperature (e.g. 1200 rpm cold, 750 rpm warm)
Idle Position from CLT vs Idle Target RPM	base opening of the valve; the most important table for a stable idle
Idle After Start Taper	transition from cranking opening to idle opening
Closed-loop Ignition idle timing	idle stabilisation via ignition advance (fast)
Idle VE, **Idle Ignition advance**	separate maps for idle (enable in *Idle settings › Extra Idle Features*)
Coasting Idle position	valve position during overrun (prevents stalling when declutching)

6.6 Menu “Advanced”

Dialog	Function
Launch Control, **Rolling Launch Control**	launch rev limiter for standing starts
Torque Control (Shift Torque Reduction, Flat Shift)	ignition cut when upshifting without lifting
Boost Control	boost control via a pulsed valve
Generic PWM	freely configurable PWM outputs (e.g. water pump, intake manifold switch-over)
VVT outputs and PID, **VVT intake target**	Vanos: output **[fixed]**, control parameters, target angle over rpm and load
Electronic Throttle Body actuator, **ETB pedal target**	electronic throttle (only with retrofit via X4)
Lua	Lua script in the control unit. For the CAN module, `pecu_io.lua` is inserted here (chap. 8.10).
Nitrous Control, **Anti-Lag ALS**	motorsport functions

6.7 Menu “Sensors”

Dialog	Function
CLT sensor, **IAT sensor**	NTC characteristic (three points temperature/resistance) **[fixed for standard sensors]**
TPS	throttle calibration: ignition on, engine off. Throttle closed → *Grab closed throttle position*; full throttle → *Grab wide open throttle position*; Burn. TPS must then show 0 % and 100 %.
Accelerator pedal	pedal calibration, same procedure
MAP sensor, **MAP sampling**	sensor type and characteristic; averaging over the intake stroke
Baro sensor	ambient pressure
MAF sensor, **MAF transfer function**	air mass meter (variant with MAF)
CAN O2 sensors	internal wideband controller: must be enabled for lambda to be shown
rusEFI Wideband Tools	firmware update and status of the wideband controller
Vehicle speed sensor	vehicle speed (alternatively via CAN)
Oil / Fuel / Turbo / Aux sensors	additional sensors on AUX inputs

6.8 Menu “CAN-bus”

CAN Bus Settings – mandatory settings for operation with the CAN module:

Setting	PECU value
Bitrate (Primary CAN)	500 kbit/s
CAN read enabled / CAN write enabled	on
Enable rusEFI CAN broadcast	**on**
rusEFI CAN data base address	**512** (= 0x200)
rusEFI CAN data address type	11 bit
rusEFI CAN data period	**20 ms**
CAN dash type	**None**

> **Important:** *CAN dash type* must be set to **None**. The messages for the instrument cluster are generated by the CAN module. If the uaEFI additionally sends e.g. “BMW E46”, duplicate messages result; the CAN module then reports “ID!” (chap. 8.4).

CAN Vehicle speed sensor: vehicle speed from the vehicle CAN (e.g. BMW E46 wheel speeds).

6.9 Menu “Controller”

Dialog	Function
Bench test	individual test of injectors, ignition coils, fuel pump, fan, idle valve, main relay. Essential for the first commissioning.
Injector test	flow check of injectors
SD Card Logger	*SD Card Logging* on, *Always start in Logging mode*, *SD logger mode*, logging rate; conditional logging from rpm/load
Base Tunes	factory settings for known engines. **Do not use**: overwrites the PECU pin assignment.
Tune Lock	protect the tune with a password
Traction Control	traction control (requires wheel speeds)
Full pinout	overview of the pins and their current function

6.10 Live data and gauges

Readings, status displays and diagnostic pages are available via **View** (or the main screen). The most important channels:

Channel	Meaning
RPM, Sync	engine speed, trigger synchronisation (must be stable without error count)
MAP, TPS, CLT, IAT, VBatt	basic sensors
Lambda 1, Target lambda	actual and target mixture
Fuel: VE, Injector pulse width, Duty cycle	injection; keep injector duty below 85 %
Ignition advance, Dwell	ignition
Idle position, Idle target RPM	idle
Warning / Error codes	error messages

7 Tuning basics

This chapter summarises the procedure. It does not replace training; the rusEFI wiki (wiki.rusefi.com) and specialist literature go into more depth.

7.1 Order

1. Check and calibrate sensors (TPS, CLT, IAT, MAP, lambda).
2. Check trigger and ignition timing (7.2).
3. Starting (cranking) and warm-up.
4. Idle.
5. VE table at part load, then full load.
6. Optimise ignition advance (dyno).
7. Transitions: acceleration enrichment, overrun fuel cut-off.
8. Comfort functions: fan, A/C, lambda control.

7.2 Checking ignition timing with a timing light

This check is mandatory after every installation.

1. Start the engine and let it warm up.
2. **Ignition › Ignition hardware**: *Timing Mode* = **Fixed**, *Fixed Timing* = **10°**.
3. Connect the timing light to cylinder 1 and watch the TDC mark.
4. If the light does not show 10°, adjust **Setup › Trigger** *Trigger Angle Advance* in small steps until the mark shows 10°.
5. Set *Timing Mode* back to **Dynamic**, Burn.

7.3 Tuning the VE table

- Engine at operating temperature, lambda control off (otherwise it hides the error).
- At steady operating points compare actual lambda with target lambda. New VE value = old VE value × actual lambda / target lambda.
- With TunerStudio Ultra, **VE Analyze Live** does this calculation automatically from the readings.
- Smooth neighbouring cells; the table should have no steps.

7.4 Data logging

- Logging via laptop (F2) or to microSD.
- Analysis in MegaLogViewer: lambda vs. target lambda, knock count, injector duty, voltage.
- Always include the **.msq and log** with support requests.

8 CAN module with OLED display

This chapter describes the firmware of the CAN module, version 1.3.1 (November 2026). The version running on your module is shown on the start screen of the OLED display and on the update page in the Wi-Fi.

8.1 Tasks

The CAN module (OLED module with its own CAN interface) works independently of the engine control:

- **Display:** engine data on the OLED display and in the Wi-Fi dashboard.
- **Vehicle CAN:** generates the messages of the original DME so that rev counter, temperature gauge, warning lights, consumption display and ASC/DSC work.
- **A/C compressor:** switches the compressor on request from the air conditioning, evaluating the pressure switch.
- **Torque intervention:** evaluates torque requests from ASC/DSC and passes them on to the engine control.
- **CAN diagnostics:** switchable termination resistor and error counters.
- **Configuration and update** via Wi-Fi, without programming skills and without cables.

The module reads **only the rusEFI broadcast** of the uaEFI. If the CAN module fails, the engine keeps running; only displays and vehicle functions via CAN are missing.

On the PECU M54 the CAN bus is connected to the vehicle CAN (X60002-3/-4 and X60004-36/-37) and also brought out on additional connector X4. On the M54, rev counter, temperature gauge and A/C request run via CAN.

The CAN module is powered from the sensor supply of the uaEFI. It therefore only works with the **ignition on**, not with USB power alone.

8.2 Firmware functions

Function	Description	Setting
OLED display	7 pages with engine, vehicle and CAN data, start screen, OK screen, error pop-ups	BOOT button (8.4)
Status LED	flash code for operating state and faults	– (8.5)
Wi-Fi hotspot	name PECU-xxxx, password changeable, can be hidden	settings page › Wi-Fi (8.6)
Dashboard	engine values, torque, vehicle CAN, status, memory	192.168.4.1
Settings page	all parameters, effective immediately, kept during updates	192.168.4.1/settings (8.7)
CAN page	termination resistor, measuring guide, error counters	192.168.4.1/can (8.8)
Vehicle profile BMW E46/E39/E38/E53/Z3	messages 0x316, 0x329, 0x545, substitute 0x153; reads 0x153 (ASC/DSC)	settings page › General (8.9)
A/C compressor	switches the compressor via its own output at the vehicle connector	settings page › A/C compressor (8.12)
Torque model	estimate of the engine torque from the cylinder air mass	settings page › torque model (8.10)
Torque intervention	ignition retard and soft spark cut via `pecu_io.lua`	Lua in TunerStudio (8.10)
Warning lights	MIL, cruise control, EML, fuel cap, overheating, charge warning, oil pressure	settings page › lamps
Multilingual	German, English, French, Spanish for web interface and OLED	settings page › General
Firmware update	via Wi-Fi with encrypted and signed .pecu files, locked while the engine is running	192.168.4.1/update (8.11)
Monitoring	watchdog restarts the module if the firmware hangs; detection of duplicate CAN IDs	–

8.3 Requirements in TunerStudio

The settings from chap. 6.8 must be set: broadcast on, base address 512, period 20 ms, *CAN dash type* = None. Torque intervention and lamps additionally need the Lua script `pecu_io.lua` (chap. 8.10).

8.4 OLED display

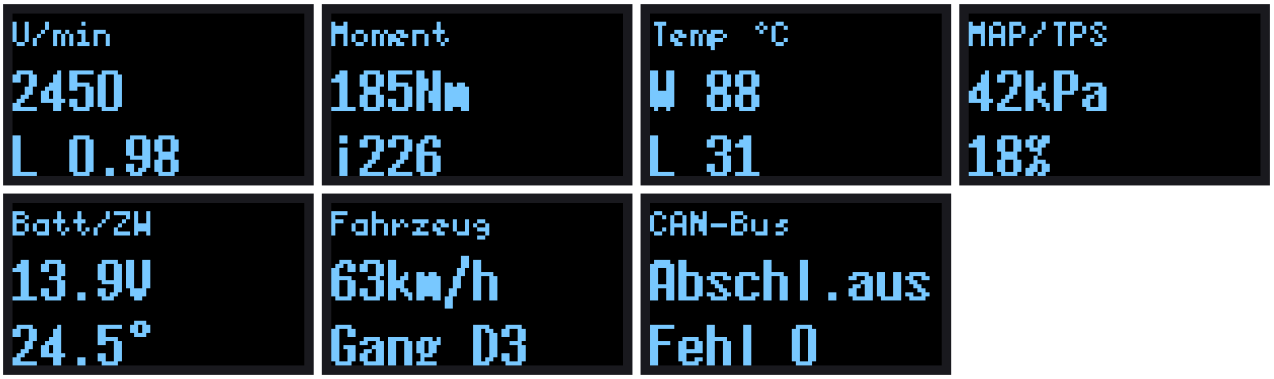
After switching on, the display shows the k-data logo for 2 s, “PECU CAN” with the firmware version for 1.5 s and the Wi-Fi name, password and IP address for 4 s. Then a large **“OK”** appears as long as everything is fine. Pressing the **BOOT** button skips the start screen; the first press after the OK screen switches to the rpm page. The CAN bus is already working normally during this time.

The display shows German texts at the factory. Select English on the settings page (chap. 8.7); the pictures in this chapter show the German texts.



Start screen: logo, version, Wi-Fi data, OK screen

The **BOOT** button on the module pages through seven pages:



OLED pages (example values)

Page	Title (German)	Line 1	Line 2
1	U/min	engine speed	lambda (L)
2	Moment	estimated crankshaft torque in Nm	indicated torque (i)
3	Temp °C	coolant (W)	intake air (L)
4	MAP/TPS	manifold pressure in kPa	throttle in %
5	Batt/ZW	system voltage	ignition advance
6	Fahrzeug	speed from ASC/DSC	gear, if the vehicle reports it via CAN
7	CAN-Bus	termination on/off	CAN errors since start

Symbols in the title line

Symbol	Meaning
MIL	check engine light active (fault in the uaEFI)
!	a fault is present; the error text is shown for 1.2 s every 5 s
ID!	ID conflict: *CAN dash type* in TunerStudio is not set to None

Pop-ups

Display	Meaning	Remedy
“Fehler / MCP2515 / SPI?”	CAN controller does not respond	send the unit for service (hardware fault)
“CAN / warte auf / rusEFI”	no data from the uaEFI	switch on broadcast in TunerStudio, check base address 512
“Fehler / CAN / Bus-Off”	CAN bus disturbed	check wiring, termination (8.8), bit rate; the controller restarts by itself
“WLAN unsichtb. / PECU-xxxx / Passwort”	reminder when the Wi-Fi is hidden (8.6), for 1.2 s every 5 s	–



Symbols in the title line and pop-ups

A button press hides an error text immediately and shows the next page.

8.5 Status LED of the CAN module

LED	Meaning
steady on	everything OK
2 × flash, pause	no rusEFI data
3 × flash	CAN controller does not respond
4 × flash	CAN bus-off
5 × flash	ID conflict (*CAN dash type* ≠ None)

8.6 Wi-Fi and dashboard

1. Switch on the ignition.
2. Look for the Wi-Fi **PECU-xxxx** with a smartphone or laptop (xxxx = last four digits of the device ID). Factory password: **kdatapecu**.
3. Open **http://192.168.4.1** in the browser.

The dashboard shows engine values, the estimated torque, data from the vehicle CAN (speed, brake, gear, interventions), the status of the module, the CAN errors, the termination and the free memory. All values are available in machine-readable form at **http://192.168.4.1/data.json**.

> **Important:** Change the Wi-Fi password during commissioning (settings page, group Wi-Fi, at least 8 characters). With the default password anyone within range can change the settings of the module.

Wi-Fi hidden: If this setting is on, the hotspot stays active but no longer appears in the Wi-Fi list. Connect via “Add hidden network” with name **PECU-xxxx** and password. So that name and password are not lost, the OLED display briefly shows both every 5 s.

Password forgotten (recovery via USB): If the Wi-Fi password is lost and cannot be read on the small OLED display, the module can also be configured without Wi-Fi. Switch the ignition off, remove the housing lid, connect the PC with a USB cable to the USB socket of the CAN module and start the program **PECU Konfigurator** (Windows, on the k-data download page). It finds the module by itself and shows dashboard, settings page and update page as in the Wi-Fi. Set a new Wi-Fi password there, switch off *Wi-Fi hidden* or reset everything with **factory settings** (password afterwards `kdatapecu` again). Then unplug the USB cable and refit the lid.

8.7 Settings page

http://192.168.4.1/settings. Changes take effect immediately and are kept during firmware updates. **Factory settings** resets everything (including the Wi-Fi password to `kdatapecu`).

Group	Setting	Factory setting	Explanation
General	Language	German	Deutsch, English, Français, Español for web interface and OLED
	Vehicle profile	BMW E46/E39/E38/E53/Z3	protocol of the original DME; “none” for VAG
	rusEFI base ID	200 (hex)	must match TunerStudio (512 decimal)
Messages	0x316 / 0x329 / 0x545	on	can be switched off individually, e.g. on vehicles without cluster CAN
	DSC lamp off (substitute 0x153)	off	switch on **only** if no ASC/DSC unit is fitted
Engine	MD_NORM	D9 (400 Nm)	reference torque in the torque messages (S54: DF)
	OBD_STEUER engine stopped / running	80 / 86	status values in 0x329
	engine running from / idle below	500 / 1000 rpm	status bits for the instrument cluster
	report ASC intervention	on	requires `pecu_io.lua`
Torque model	source, air mass for 400 Nm, offset, friction	cylinder air mass, 700 mg, −24 Nm, 20 Nm + 5 Nm/1000 rpm	estimate of the engine torque (8.10)
Pedal	send pedal, source, kickdown	on, TPS, 98 %	pedal value for ASC/DSC; PPS with drive-by-wire
	air pressure	1013 hPa	
Lamps	overheating / charge warning / oil pressure	115 °C / 12.2 V / off	thresholds for the warning lights
	oil temperature = coolant	off	for vehicles without oil temperature sensor
	consumption factor	25 steps/ml	**calibrate against the on-board computer**
A/C compressor	switch A/C compressor via the module	off	compressor runs on request, pressure OK and engine running (8.12)
	request	CAN 0x615 (BMW E46)	On the PECU M54 in the BMW E46 select **CAN 0x615** (factory). The PECU M54 has no input for the request.
	request active at	12 V	only for request via the input
	pressure switch	not present	not present / pressure OK at 12 V / pressure OK at 0 V
	minimum rpm	500 rpm	compressor only with the engine running
CAN bus	CAN termination 120 Ω	on	measure in case of faults (8.8)
Wi-Fi	password	kdatapecu	at least 8 characters

Group	Setting	Factory setting	Explanation
	Wi-Fi hidden	off	name is not broadcast, hotspot stays active

The names on the settings page depend on the selected language and may differ slightly from this table.

8.8 CAN termination and error counters

A CAN bus needs a 120 Ω termination resistor at each end, together 60 Ω between CAN High and CAN Low. If the original DME is removed, one termination may be missing; if only one device is connected to X4, usually both are missing. Every PECU board has its own 120 Ω termination, which the CAN module switches by a setting. It is on at the factory, because the PECU usually replaces a control unit at the end of the bus.

Setting (dashboard › CAN bus or http://192.168.4.1/can):

1. Switch the termination **off**, ignition off, wait a few minutes until all control units are asleep.
2. Measure the resistance between CAN High and CAN Low at the PECU connector with a multimeter.

Reading	Meaning	Setting
≈ 60 Ω	correctly terminated	off
≈ 120 Ω	one termination missing	**on**
≤ 40 Ω	too many terminations	off, remove another one
very high / open	line interrupted or no other termination	check the wiring

Error counters: The CAN page, the OLED page “CAN-Bus” and the dashboard show the CAN errors since start (transmission errors, buffer overflows, send errors, bus-off, warning and passive level, error counters REC/TEC). With the engine running, all values should stay at 0 or rise only very rarely. If they keep rising, the bus is incorrectly terminated or disturbed.

8.9 Vehicle profile BMW E46/E39/E38/E53/Z3

The module sends the messages of the Siemens MS42/MS43 every 10 ms:

Message	Content
0x316 DME1	engine speed, engine torques, status bits (terminal 15, ASC, gear change possible)
0x329 DME2	coolant temperature, air pressure, pedal, idle, brake, kickdown, further status values multiplexed
0x545 DME4	warning lights (MIL, cruise control, EML, fuel cap, overheating, charge warning, oil pressure), consumption, oil temperature
0x153 (substitute)	only on request, if no ASC/DSC is fitted: suppresses the DSC warning light

It reads 0x153 (ASC/DSC: speed, brake, torque intervention).

8.10 Torque model, torque intervention and Lua script

ASC/DSC expects the current engine torque from the engine control and requests a torque reduction in case of wheel slip.

- **Torque estimate:** The module calculates the torque from the cylinder air mass of the uaEFI (indicated torque minus friction). Plausibility check: A stock M54B30 should show about 300 Nm at the crankshaft at full load, an M54B25 about 245 Nm, an M54B22 about 210 Nm.
- **Intervention:** If ASC/DSC requests less torque, the module calculates the reduction share and sends it to the uaEFI. There, `pecu_io.lua` first retards the ignition by up to 30° and beyond that softly cuts individual sparks (never two in a row). An intervention ends after 1.25 s at the latest.

Including the Lua script

1. Obtain `pecu_io.lua` from k-data and copy its content.
2. TunerStudio: **Advanced › Lua › Lua Script Settings** (or the Lua script editor), paste the content.
3. Burn and switch the ignition off/on.

The script also transfers warning lights (MIL, cruise control, EML, fuel cap) from the uaEFI to the instrument cluster.

8.11 Firmware update of the CAN module

k-data provides updates as a file **`pecu-can-<version>-update.pecu`**. These files are encrypted and signed; the module only accepts files with a valid k-data signature. With a faulty file the previous firmware remains active.

1. **Engine off**, ignition on. (The update is locked while the engine is running.)
2. Connect to the Wi-Fi PECU-xxxx, open **http://192.168.4.1/update**.
3. Select the .pecu file, start **Update** and wait until the module restarts (approx. 30 s). Do not switch off the ignition during the update.
4. Check the new version number on the OLED start screen or in the dashboard.

The settings are kept. The changes in each version are listed in the change log that k-data publishes with every version.

8.12 A/C compressor

Function: The CAN module switches the A/C compressor when the air conditioning requests it, the pressure switch enables it and the engine is running.

Factory setting: off. The compressor stays off until the function is switched on.

Setting (settings page › A/C compressor):

1. Switch on *switch A/C compressor via the module*.
2. Choose *request*: On the PECU M54 in the BMW E46 select **CAN 0x615** (factory). The PECU M54 has no input for the request.
3. For a request via the input: *request active at* 12 V or 0 V. Watch the indicator “A/C request” in the dashboard and press the A/C button; the indicator must follow.
4. *Pressure switch*: On the PECU M54 *Druckschalter* (pressure switch) = nicht vorhanden (not present); the pressure is monitored by the air conditioning itself.
5. Only change *minimum rpm* (factory 500 rpm) if the compressor should not run during cranking.

The dashboard shows “A/C request”, “A/C pressure OK” and “A/C compressor”. The compressor only runs when all conditions are met and the uaEFI sends data. If the CAN module fails, the compressor stays off.

Technology: request and pressure switch act via transistor stages on two inputs of the CAN controller; the output is a low-side semiconductor output, switches to ground and is designed for a relay coil. Vehicle connector pins: chap. 3.17.

> **Note:** The idle increase with the A/C on is set in the uaEFI (**Setup › Air Conditioning**, *A/C Idle RPM*). For this the uaEFI needs the information that the compressor is running; this is not set up in the base calibration.

9 Diagnostics and troubleshooting

9.1 Procedure

1. Look at the error messages in TunerStudio (warning indicators, error codes).
2. Check sensor readings with the ignition on for plausibility (CLT ≈ ambient temperature with a cold engine, MAP ≈ 95–102 kPa, TPS 0 %, VBatt > 12 V).
3. Check actuators individually with **Controller › Bench test**.
4. Record and analyse a log.

9.2 Troubleshooting table

Symptom	Possible cause	Remedy
No connection to TunerStudio	wrong COM port, another program uses the port, USB cable	select the port again, close rusEFI Console, try another cable
TunerStudio reports a wrong firmware signature	.ini does not match the firmware	project properties: let TunerStudio detect the .ini again (chap. 5.2)
Engine turns, no rpm in TunerStudio	crankshaft sensor, trigger setting changed	check sensor/connector, restore the trigger settings of the base calibration
Rpm present, no spark	spark off, ignition coil supply, main relay	switch *Spark* on, bench test coil, check main relay and fuses
Spark present, does not start	fuel pump, injectors, cranking fuel, ignition timing	bench test pump/injectors, measure fuel pressure, cranking fuel, timing light (7.2)
Starts and stalls	idle valve, after-start enrichment, air leak	increase idle position, after-start enrichment, look for air leaks
Lambda shows nothing / a fixed value	sensor not connected, CAN O2 not enabled, engine not running	chap. 3.7 and 6.7
Idle hunts	control parameters too aggressive, VE wrong at idle	first tune open loop to be stable, then PID; use closed-loop ignition idle timing
Instrument cluster: rev counter/temperature dead	CAN module receives no data	check OLED/LED (8.4/8.5), broadcast settings (6.8)
CAN error counters rise, cluster flickers	termination resistor missing or doubled	measure the resistance, set the CAN termination (8.8)
Wi-Fi PECU-xxxx not visible	ignition off, or “Wi-Fi hidden” on	ignition on; read name and password from the OLED display and connect as a hidden network (8.6)
Wi-Fi password forgotten	–	change the setting from a connected device, otherwise have k-data reset the module
Update is rejected	no .pecu file, wrong signature or engine running	use the current file from k-data, engine off
uaEFI LED D103 lights red	serious firmware error	read the error message in TunerStudio (3.16)
OLED “ID!”	*CAN dash type* ≠ None	set to None, Burn
DSC light on without a DSC unit	substitute 0x153 off	settings page: switch on “DSC lamp off”

9.3 Back to the base calibration

If things are unclear: **File › Open Tune**, load the supplied base calibration (.msq), Burn, ignition off/on. Save your own changes first.

10 Maintenance, warranty, support

- The PECU is maintenance-free. Keep the connectors dry.
- The wideband sensor is a wear part. Leaded fuel, oil in the exhaust and short trips shorten its life.
- Warranty according to the terms and conditions of k-data. Damage caused by reverse polarity, overvoltage, water and improper intervention is excluded.
- **Support:** k-data.org. Please include the serial number or type plate, firmware version, .msq file and a log.
- **Disposal:** electronic waste, not household waste (WEEE).

Appendix A – Pinout of the uaEFI module

Source: rusEFI project, uaEFI connector description. The PECU carrier board makes the connection to the vehicle; this table is for troubleshooting and extensions.

Connector A (supply, H-bridges)

Pin	Function
A1 / A5	H-bridge 1 (DC1− / DC1+)
A2 / A6	H-bridge 2 (DC2− / DC2+)
A3, A4	power ground
A7	ignition / battery voltage
A8	+12 V from the main relay

Connector B (outputs)

Pin	Function	Pin	Function
B1–B6	injection 6 … 1	B10	ignition 6
B7	LS1 / VVT1 (diode)	B11	ignition 4
B8	LS_HOT2 fan relay	B12	ignition 3
B9	LS_HOT1 main relay	B13	ignition 5
B16	LS4 / fuel pump (diode)	B14	ignition 2
B17	LS3 / injector 7 (diode)	B15	ignition 1
B18	LS2 / VVT2 / idle / injector 8 (diode)		

Connector C (sensors, trigger)

Pin	Function	Pin	Function
C1, C2	+5 V sensor supply	C11–C13	sensor ground
C3	AUX2	C14	TPS2
C4	PPS2	C15	AUX3 / fuel pressure
C5	HALL1 / camshaft 1	C16 / C17	VR2+ / VR2−
C6	HALL2 / camshaft 2	C18 / C19	VR1+ / VR1−
C7	HALL3 / VSS	C10 / C20	EGT+ / EGT−
C8	power ground / VR shield	C9	BUTTON3

Connector D (sensors, CAN)

Pin	Function	Pin	Function
D1	AUX1	D9	external MAP
D2	BUTTON1	D10	BUTTON2 / A/C request
D3, D4	+5 V sensor supply	D11, D12	sensor ground
D5	FLEX / digital input	D13	TPS1
D6	PPS1	D14	knock sensor
D7 / D8	CAN High / CAN Low	D15 / D16	IAT / CLT

Connector E (Bosch LSU 4.9)

Pin	Function	LSU pin	Wire colour
E1	heater + 12 V	4	grey
E2	trim resistor (RCal)	5	green
E3	heater –	3	white
E4	Vs (Un)	6	black
E5	Ip, pump current	1	red
E6	Vs/Ip (Vm)	2	yellow

Position in the connector: see chap. 3.7.

Appendix B – Vehicle connector X60001–X60005 (PECU M54)

Five-part connector like the original DME Siemens MS43. Pin *3-8* means module X60003, pin 8. Pins not connected on the carrier board are marked as *not used* (removed functions of the original DME: chapter 3.19). *Bridge* means: as in the original DME, the pin is only connected to the pin named. Details of each signal are in the chapter given. The table is read directly from the board layout when the manual is generated.

Pin	Signal	Type	uaEFI	Ch.	Pin	Signal	Type	uaEFI	Ch.
1-1	+12 V from main relay	V	[A8]	3.1	**3-2**	Camshaft sensor exhaust	E	[C7]	3.2
1-2	*not used*				**3-3**	*not used*			
1-3	*not used*				**3-4**	+5 V sensor supply	V	+5 V	3.6
1-4	Ground	M	GND	3.1	**3-5**	Camshaft sensor intake	E	[C6]	3.2
1-5	Ground	M	GND	3.1	**3-6**	*not used*			
1-6	Ground	M	GND	3.1	**3-7**	+5 V sensor supply	V	+5 V	3.6
1-7	*not used*				**3-8**	Crankshaft sensor (Hall)	E	[C5]	3.2
1-8	+12 V from main relay	V	[A8]	3.1	**3-9**	*not used*			
1-9	+12 V from main relay	V	[A8]	3.1	**3-10**	Throttle position sensor 2	E	[C14]	3.6
2-1	*not used*				**3-11**	*not used*			
2-2	*not used*				**3-12**	Bridge to 4-2		–	
2-3	CAN Low	B	[D8]	3.14	**3-13**	Bridge to 4-1		–	
2-4	CAN High	B	[D7]	3.14	**3-14**	Ground	M	GND	3.1
2-5	*not used*				**3-15**	Ground	M	GND	3.1
2-6	*not used*				**3-16**	*not used*			
2-7	*not used*				**3-17**	Ground	M	GND	3.1
2-8	*not used*				**3-18**	Ground	M	GND	3.1
2-9	*not used*				**3-19**	Throttle position sensor	E	[D13]	3.6
2-10	*not used*				**3-20**	Ground	M	GND	3.1
2-11	*not used*				**3-21**	Ground	M	GND	3.1
2-12	*not used*				**3-22**	Intake air temperature	E	[D15]	3.5
2-13	*not used*				**3-23**	Ground	M	GND	3.1
2-14	*not used*				**3-24**	Coolant temperature	E	[D16]	3.5
2-15	*not used*				**3-25**	Ground	M	GND	3.1
2-16	*not used*				**3-26**	Bridge to 4-11		–	
2-17	*not used*				**3-27**	*not used*			3.19
2-18	*not used*				**3-28**	Ground	M	GND	3.1
2-19	*not used*				**3-29**	Knock sensor	E	[D14]	3.8
2-20	Ground	M	GND	3.1	**3-30**	Ground	M	GND	3.1
2-21	Ground	M	GND	3.1	**3-31**	*not used*			3.8
2-22	Ground	M	GND	3.1	**3-32**	Ground	M	GND	3.1
2-23	Main relay	A	[B9]	3.1	**3-33**	Injector cyl. 1	A	[B6]	3.3
2-24	Ground	M	GND	3.1	**3-34**	Injector cyl. 2	A	[B5]	3.3
3-1	*not used*			3.19					

Pin	Signal	Type	uaEFI	Ch.	Pin	Signal	Type	uaEFI	Ch.
3-35	Injector cyl. 3	A	[B4]	3.3	**4-17**	*not used*			3.19
3-36	Injector cyl. 4	A	[B3]	3.3	**4-18**	*not used*			3.19
3-37	Injector cyl. 5	A	[B2]	3.3	**4-19**	*not used*			
3-38	Injector cyl. 6	A	[B1]	3.3	**4-20**	*not used*			
3-39	Bridge to 4-21		–		**4-21**	Bridge to 3-39		–	
3-40	Vanos intake	A	[B7]	3.10	**4-22**	*not used*			
3-41	Vanos exhaust	A	[B18]	3.10	**4-23**	*not used*			3.19
3-42	Tank venting (EVAP)	M	R343	3.18	**4-24**	*not used*			
3-43	Throttle motor –	A	[A1]	3.6	**4-25**	*not used*			
3-44	Throttle motor +	A	[A5]	3.6	**4-26**	Ignition on (terminal 15)	E	[A7]	3.1
3-45	Map-controlled thermostat	A	[B17]	3.10	**4-27**	*not used*			
3-46	Idle actuator	A	[A2]	3.11	**4-28**	*not used*			
3-47	Idle actuator	A	[A6]	3.11	**4-29**	A/C compressor relay	A	CAN module	3.17
3-48	Ground	M	GND	3.1	**4-30**	*not used*			
3-49	Intake manifold switch-over (DISA)	A	[B8]	3.10	**4-31**	*not used*			
3-50	*not used*				**4-32**	*not used*			
3-51	*not used*				**4-33**	*not used*			
3-52	*not used*				**4-34**	*not used*			
4-1	Bridge to 3-13		–		**4-35**	*not used*			
4-2	Bridge to 3-12		–		**4-36**	CAN High	B	[D7]	3.14
4-3	*not used*				**4-37**	CAN Low	B	[D8]	3.14
4-4	Switched output B17 (= 3-45)	A	[B17]	3.10	**4-38**	Ground	M	GND	3.1
4-5	*not used*				**4-39**	*not used*			
4-6	*not used*				**4-40**	*not used*			
4-7	Ground	M	GND	3.1	**5-1**	Ignition coil cyl. 3	Z	[B12]	3.4
4-8	Accelerator pedal 1	E	[D6]	3.6	**5-2**	Ignition coil cyl. 2	Z	[B13]	3.4
4-9	+5 V sensor supply	V	+5 V	3.6	**5-3**	Ignition coil cyl. 1	Z	[B15]	3.4
4-10	Fuel pump relay	A	[B16]	3.10	**5-4**	Ground ignition drivers	M	Q3–Q8	3.4
4-11	Bridge to 3-26		–		**5-5**	Ground ignition drivers	M	Q3–Q8	3.4
4-12	Ground	M	GND	3.1	**5-6**	Ground ignition drivers	M	Q3–Q8	3.4
4-13	Accelerator pedal 2	E	[C4]	3.6	**5-7**	Ignition coil cyl. 6	Z	[B11]	3.4
4-14	+5 V sensor supply	V	+5 V	3.6	**5-8**	Ignition coil cyl. 5	Z	[B14]	3.4
4-15	*not used*				**5-9**	Ignition coil cyl. 4	Z	[B10]	3.4
4-16	*not used*								

Type: E = Input · A = Output, switches to ground · Z = Ignition output (ignition driver) · B = CAN bus · V = Supply · M = Ground

R343 = fixed bridge to ground (chapter 3.18). The cylinder numbers follow BMW numbering (cylinder 1 at the front).

Appendix C – Glossary

Term	Explanation
Alpha-N	load detection via throttle angle and engine speed
Burn	permanently saving the settings in the control unit
CLT / IAT	coolant / intake air temperature
DME	Digital Motor Electronics, BMW's name for the engine control unit
Dwell	charging time of the ignition coil
IGBT	power transistor for the ignition coil
Lambda	air-fuel ratio; 1.0 = stoichiometric, < 1 rich, > 1 lean
MAP	manifold absolute pressure
.msq	TunerStudio calibration file
TDC	top dead centre
PPS / TPS	pedal / throttle position sensor
Speed Density	load detection via manifold pressure, temperature and engine speed
Trigger	signal from crankshaft and camshaft used to determine the engine position
VE	volumetric efficiency
VR sensor	inductive (variable reluctance) speed sensor
VVT / Vanos	variable camshaft timing

Appendix D – Changes to this manual

This appendix lists what has changed for you: in this manual, between the board revisions and in the firmware of the CAN module. The latest edition and firmware are available on the k-data download page.

D.1 Editions of this manual

Edition	Date	Changes
2.0	November 2026	First edition for the PECU M54. Applies to board revision R04, rusEFI firmware release_20260812 and CAN module firmware 1.3.1.

D.2 Board revisions

This manual applies to all revisions of the PECU M54. The revision is printed on the board after the product name (for example “PECU M54 R04”). The chapters describe the latest revision; where older revisions differ, this is stated in the table and at the relevant place in the text (“from …” or “up to …”).

Revision	Delivered from	Differences from the previous revision
R04	November 2026	First series revision.

D.3 Firmware of the CAN module

Your version is shown on the start screen of the display and on the update page in the Wi-Fi. All settings are kept during an update. Detailed notes on each version are in the release notes supplied with the firmware on the k-data download page.

Version	Date	Main changes
1.3.0–1.3.1	07.11.2026	no change for this board
1.2.3	03.11.2026	A/C compressor control with pressure switch
1.2.1	03.11.2026	OK screen, Wi-Fi data in the start screen, PECU Konfigurator (Windows), switchable CAN termination, hidden Wi-Fi, only signed updates, factory Wi-Fi password **kdatapecu**
1.2.0	02.11.2026	languages German, English, French, Spanish
1.1.3	02.11.2026	start screen with version, faults no longer block the display
1.1.0–1.1.2	02.11.2026	settings page in the Wi-Fi, update via Wi-Fi, engine torque, ASC/DSC intervention, warning lights
1.0.0	02.11.2026	first version: OLED, Wi-Fi dashboard, E46 messages