



FALCON BMS

MICROCONTROLLER SIMULATOR

ENGLISH USER MANUAL



VIRTUAL HARDWARE / SAFE FIRST TEST

UNDERSTAND FIRST. WIRE IT LATER.

The simulator explained from the ground up
for complete beginners

CREATE / CONNECT / OBSERVE / UNDERSTAND

Inspect real packets before connecting real electronics.

TARGET SYSTEM

Windows x64

APPLICATION

BmsMicrocontrollerSimulator.exe

CONNECTIONS

Local USB simulation / LAN simulation

PROTOCOLS

LED 64 / NAME#WERT / GEMISCHT

Notes about this manual

SCOPE

This manual describes the standalone BMS Microcontroller Simulator 1.0.8 dated 2 September 2026 together with the MICROCONTROLLER tab in BMS Live Monitor.

It explains the simulator for someone who has never used a COM port, data packet or microcontroller. Every term is first described in everyday language and then placed in its technical context.

The most important boundary

The simulator replaces an endpoint on the PC. It shows what Live Monitor sends. It does not create Falcon flight data and it cannot prove real wiring, voltage or motor motion.

NO REAL HARDWARE REQUIRED

The first test needs no Arduino or ESP32, no virtual COM port and no LED board. Live Monitor and the simulator run side by side on the same PC.

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1. What is a simulator?

Imagine that you want to wire a lamp, but the lamp does not exist yet. The simulator draws the lamp on screen. When Live Monitor sends ON, the on-screen cell turns green. When it sends OFF, the cell becomes dark.

A child-simple picture

Live Monitor	The mail carrier. It brings messages from Falcon.
Simulator	The test receiver. It opens each letter and shows its contents.
Real microcontroller	The later receiver that controls real pins, LEDs or instruments.
Falcon BMS -> Live Monitor -> Simulator ~-> later: real hardware	

THE SIMULATOR DOES NOT FLY

It does not press switches in Falcon, change a mission or invent cockpit values. It only receives.

2. What can the simulator do?

- Represent several virtual WHOAMI controllers at the same time.
- Provide a local USB simulation path without a COM port or virtual COM driver.
- Reproduce a real local LAN path using UDP WHOAMI and TCP data packets.
- Answer WHOAMI requests and show every reply in the outgoing log.
- Decode LED# packets containing 16 hex characters into 64 LED cells.
- Show individual LED commands such as 271 and 272.
- List all name#value messages.
- Split DED and PFL into five visible lines each.
- Show packet counts and receive times down to milliseconds.

What can it not do?

- It cannot check voltage, current, pin assignment or driver circuitry.
- It cannot prove motor limits, servo direction or end switches.
- It cannot electrically protect a device after the PC connection is lost.

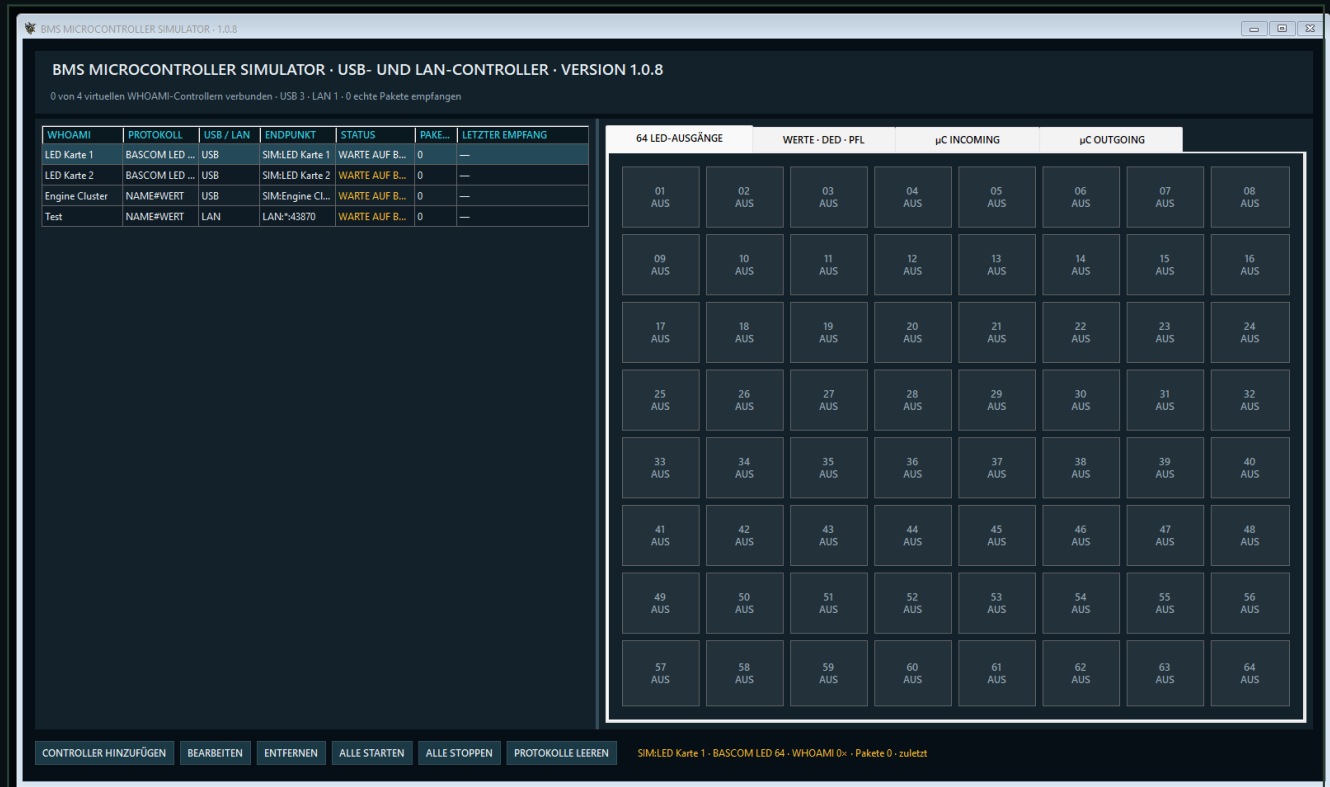
3. The data path in six small steps

- 1 Falcon BMS writes real cockpit data to shared memory.
- 2 BMS Live Monitor reads and processes it.
- 3 A microcontroller route selects a lamp, value or text packet.
- 4 Live Monitor opens the virtual USB or LAN path.
- 5 The simulator receives the exact wire command.
- 6 You compare indication, packet, channel and safe state with your plan.

Example	Falcon state	Visible in the simulator
MASTER CAUTION	Lamp active	LED channel ON or LED# bit set
RPM	75.3 percent	rpm#75.3
DED	Five cockpit lines	Five lines in the DED field
Leave pit	Output becomes safe	LEDs OFF, safe values, blank DED/PFL

4. Start it and look around

- 1 Download BmsMicrocontrollerSimulator.exe or use START SIMULATOR in Live Monitor.
- 2 Only one instance runs. A message appears if it is already open.
- 3 All saved virtual controllers start automatically when the window opens.
- 4 Select a controller on the left; inspect its received data on the right.
- 5 Buttons for creating, editing, starting and stopping are along the bottom.



Main window of BMS Microcontroller Simulator 1.0.8. The current application labels are German.

WAITING FOR BMS IS NORMAL

Immediately after startup, the simulator waits. Payload connects only after Live Monitor is configured and fresh Falcon data is available in the pit.

5. The summary at the top

The second header line is your quick health check.

```
0 of 4 virtual WHOAMI controllers connected
USB 3 / LAN 1 / 0 real packets received
```

Part	Meaning
0 of 4 connected	Four controllers exist; none has an active Live Monitor connection.
USB 3	Three controllers use the local USB simulation channel.
LAN 1	One controller is listening as a LAN endpoint.
0 real packets	No payload was processed yet. WHOAMI handshakes are counted separately.

CONNECTED IS NOT THE SAME AS DISCOVERED

WHOAMI can discover a controller before a persistent payload connection exists. In normal use that connection opens only in the pit.

6. The controller list on the left

WHOAMI	PROTOKOLL	USB / LAN	ENDPUNKT	STATUS	PAKE...	LETZTER EMPFANG
LED Karte 1	BASCOM LED ...	USB	SIM:LED Karte 1	WARTE AUF B...	0	—
LED Karte 2	BASCOM LED ...	USB	SIM:LED Karte 2	WARTE AUF B...	0	—
Engine Cluster	NAME#WERT	USB	SIM:Engine Cl...	WARTE AUF B...	0	—
Test	NAME#WERT	LAN	LAN:*:43870	WARTE AUF B...	0	—

List of all virtual controllers

Column	Simple explanation
WHOAMI	The unique name of the virtual device.
PROTOKOLL	Planned language: BASCOM LED 64, NAME#WERT or GEMISCHT.
USB / LAN	The simulated transport.
ENDPUNKT	SIM:NAME for USB or LAN:*:PORT for LAN.
STATUS	GESTOPPT, WARTE AUF BMS or BMS VERBUNDEN.
PAKETE	Payload count; WHOAMI is separate.
LETZTER EMPFANG	Last received command, including visible \r.

The application currently uses German interface labels. This manual repeats them exactly so you can find each field.

7. Create a virtual controller

- 1 Select CONTROLLER HINZUFÜGEN.
- 2 Enter a unique WHOAMI name, for example LED-TEST-01.
- 3 Choose the protocol that the later real controller will use.
- 4 Choose USB or LAN under VERBINDUNG.
- 5 For LAN, choose a free data port; the first suggestion is 43870.
- 6 Select ÜBERNEHMEN. The controller starts and its definition is saved immediately.

Field	Rule	Example
WHOAMI-NAME	Not empty; no , #, CR or LF; unique in this list	LED-TEST-01
PROTOKOLL	Must match the planned Live Monitor setup	BASCOM LED 64
VERBINDUNG	USB for local simulation; LAN for network testing	USB
LAN-DATENPORT	1024 to 65535; unique for every LAN controller	43870

THE NAME MATTERS MORE THAN THE ROW ORDER

Live Monitor finds the virtual controller through WHOAMI. The spelling must be identical on both sides.

8. USB simulation without a COM port

USB does not simulate a physical cable. Live Monitor uses a safe local PC channel representing the same logical controller. Technically this is a Windows named pipe.

Endpoint	SIM: followed by WHOAMI, for example SIM:LED-TEST-01.
COM port	Not required. No virtual COM driver is installed.
WHOAMI	The local discovery list returns running USB simulators only.
Payload	Live Monitor connects to the unique local channel for that identity.

When USB simulation is ideal

- For the very first risk-free test.
- When everything runs on one PC.
- When COM-port issues should be excluded.
- When you want to check packet formats and routes before firmware exists.

9. LAN simulation in plain language

In LAN mode, the PC behaves like a network microcontroller. This lets you test a later ESP32 or Ethernet route with real UDP and TCP connections.

```
Live Monitor -> WHOAMI\r on UDP 43862
Simulator    -> NAME|PROTOCOL|DATAPORT\r
Live Monitor -> payload over TCP to DATAPORT
```

Part	Job
UDP 43862	One-time discovery of running LAN simulators.
TCP data port	Persistent payload path, for example 43870.
LAN:*.43870	Simulator listens on all local network interfaces on this port.
Unique port	Two LAN controllers may not use the same TCP port.

NEVER EXPOSE IT TO THE INTERNET

The simulator LAN path has no TLS and no sign-in. Do not add router port forwarding or an exposed host. Use a trusted local network only.

10. The three protocols

Protocol	Purpose	Typical view
BASCOM LED 64	One board with 64 lamp bits in a full packet	64 LED-AUSGÄNGE tab
NAME#WERT	Numbers and text displays	WERTE / DED / PFL tab
GEMISCHT	Individual lamps plus numbers/text in one stream	Both tabs

The selected protocol is reported during WHOAMI and helps the UI choose a useful detail tab. The simulator still displays known packet formats it receives. A visible packet alone therefore does not prove that later firmware is configured correctly.

USE THE REAL TARGET CONFIGURATION

Select exactly the protocol intended for the future microcontroller. That keeps the test meaningful.

11. The 64 LED-AUSGÄNGE tab

64 LED-AUSGÄNGE								WERTE · DED · PFL								µC INCOMING								µC OUTGOING							
01 AUS				02 AUS				03 AUS				04 AUS				05 AUS				06 AUS				07 AUS				08 AUS			
09 AUS				10 AUS				11 AUS				12 AUS				13 AUS				14 AUS				15 AUS				16 AUS			
17 AUS				18 AUS				19 AUS				20 AUS				21 AUS				22 AUS				23 AUS				24 AUS			
25 AUS				26 AUS				27 AUS				28 AUS				29 AUS				30 AUS				31 AUS				32 AUS			
33 AUS				34 AUS				35 AUS				36 AUS				37 AUS				38 AUS				39 AUS				40 AUS			
41 AUS				42 AUS				43 AUS				44 AUS				45 AUS				46 AUS				47 AUS				48 AUS			
49 AUS				50 AUS				51 AUS				52 AUS				53 AUS				54 AUS				55 AUS				56 AUS			
57 AUS				58 AUS				59 AUS				60 AUS				61 AUS				62 AUS				63 AUS				64 AUS			

Detail area containing the 64 LED cells and protocol tabs

The 64 cells represent channels 1 through 64. A dark cell is OFF. A green cell is ON.

```
LED#8000000000000000\r -> channel 1 ON
LED#0000002000000000\r -> channel 27 ON
LED#0000000000000001\r -> channel 64 ON
LED#0000000000000000\r -> all OFF
```

EXACTLY 16 HEX CHARACTERS

After LED#, the simulator expects exactly 16 valid hexadecimal characters. Wrong length or invalid characters create an error in the incoming log.

12. Individual LED commands

NAME#WERT and GEMISCHT can carry individual lamp commands. The default convention is the channel number followed by one final digit.

Command	Meaning	Result
51 + CR	Channel 5, final digit 1	LED 5 ON
52 + CR	Channel 5, final digit 2	LED 5 OFF
271 + CR	Channel 27, final digit 1	LED 27 ON
272 + CR	Channel 27, final digit 2	LED 27 OFF

Another single command remains visible in the raw log and is marked as unknown, so it never disappears silently.

THE SIMULATOR DOES NOT CONTROL A PIN

The green screen cell is only a representation. Firmware later decides which physical pin or shift-register output belongs to channel 27.

13. The WERTE / DED / PFL tab

Every message containing # is split into a name on the left and a value on the right.

```
rpm#75.4\r  
fuel-total#6120\r  
trim-pitch#-0.12\r
```

Column	Meaning
NAME	Wire name to the left of #, for example rpm.
EMPFANGENER WERT	Text to the right of #, displayed unchanged.
PROTOKOLL	The complete visible name#value form.

When the same name arrives again, the new value replaces the previous table row. Rows are sorted alphabetically by name.

THE SIMULATOR DOES NOT CONVERT THE VALUE

75.4 remains 75.4. Whether it means percent, knots, psi or a position comes from the selected data route in Live Monitor.

14. Read DED and PFL

The names ded and pfl receive special treatment. Text to the right of # is split at vertical bars and written into five on-screen lines.

```
ded#ONE|TWO|THREE|FOUR|FIVE\r
pfl1#A|B|C|D|E\r
```

Five parts	The first five separated parts become lines 1 through 5.
Missing parts	Missing lines remain blank.
Extra parts	More than five parts are not shown in the DED/PFL boxes.
Safe packet	A safe state must arrive as five complete blank lines.

CHECK THE COMPLETE PACKET

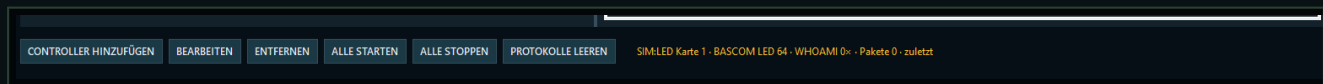
A short |||| has four separators, but it is not automatically equal to five Falcon lines padded to 25 characters. Inspect the complete packet in the incoming log.

15. μ C INCOMING and μ C OUTGOING

Tab	Direction	Contents
μ C INCOMING	Live Monitor -> simulator	Payload, millisecond timestamp and the simulator's interpretation.
μ C OUTGOING	Simulator -> Live Monitor	WHOAMI replies from discovery and the selected controller.
<pre>19:12:04.125 RX rpm#75.4\r -> value rpm = 75.4 19:12:03.900 TX DISCOVERY {...}\r\n 19:12:03.905 TX SIM:LED001 LED001\r</pre>		

- Newest lines appear at the top.
- The UI shows at most the newest 300 lines.
- Each internal log keeps up to 1000 lines.
- PROTOKOLLE LEEREN clears log history, not controllers or current LED/value states.

16. Buttons along the bottom



Simulator action bar

Button	Effect
CONTROLLER HINZUFÜGEN	Opens the dialog and starts the new controller after acceptance.
BEARBEITEN	Edits the selected controller; a running endpoint restarts briefly.
ENTFERNEN	Stops and removes the selected controller immediately.
ALLE STARTEN	Starts all endpoints and includes them in WHOAMI discovery.
ALLE STOPPEN	Closes all endpoints but keeps their saved definitions.
PROTOKOLLE LEEREN	Clears incoming and outgoing logs.

REMOVE HAS NO UNDO BUTTON

Write down WHOAMI, protocol, connection and LAN port before removing a controller you may need again.

17. Understand status messages

Status	Meaning	What to do
GESTOPPT	The virtual controller is not listening.	Use ALLE STARTEN or create it again.
WARTE AUF BMS	Endpoint is running; Live Monitor is not connected.	Check setup, WHOAMI and pit state.
BMS VERBUNDEN	An active payload connection exists.	Watch packets and detail tabs.
LAN-FEHLER	The TCP port could not open.	Check duplicate/busy port and local software.
FEHLER LED64	LED# did not contain exactly 16 valid hex characters.	Check protocol and complete packet.
Unbekannter Einzelbefehl	Text matched no LED#, name#value or channel1/channel2 form.	Compare incoming text with firmware plan.

18. Complete first LED test

- 1 Start the simulator and create USB controller LED-TEST-01 using BASCOM LED 64.
- 2 In Live Monitor, create an active SIMULATOR controller with the same WHOAMI name.
- 3 Run FIND WHOAMI NOW and adopt the SIM endpoint.
- 4 Create and activate one LED route, for example MASTER CAUTION on channel 27.
- 5 Load a Falcon mission and enter the pit.
- 6 Verify BMS VERBUNDEN and an LED# packet.
- 7 Trigger the Falcon lamp and confirm cell 27 turns green.
- 8 Leave the pit and confirm LED#0000000000000000 arrives and all cells are OFF.

ONE ROUTE FOR THE FIRST TEST

With one lamp, every failure can be traced directly to WHOAMI, route, channel or packet.

19. Complete first value test

- 1 Create USB controller GAUGE-TEST-01 with NAME#WERT.
- 2 Find and adopt the same SIMULATOR controller in Live Monitor.
- 3 Create an active RPM route with wire name rpm, one decimal, delta 0.5 and safe value 0.
- 4 Enter the pit and check rpm#... in the value tab.
- 5 Change RPM; only sufficiently large raw changes are resent.
- 6 Leave the pit; rpm#0 must appear as the safe value in the incoming log.

Observation	Meaning
No rpm row	Route inactive, wrong controller, not in pit or no fresh data.
Value changes rarely	Delta is large or the Falcon value barely changes.
Very many rows	Delta is small; every relevant raw change is visible.

20. Test the safe state correctly

The most important test is not only LIVE, but SAFE. A cockpit indication must not silently hold an old value when data disappears.

- 1 Create a clear live state in the pit.
- 2 Note the final live command in the incoming log.
- 3 Leave the pit or end Falcon normally.
- 4 Verify: LED64 gets an all-zero packet; individual LEDs get OFF; numbers get configured safe values; DED/PFL become completely blank.
- 5 Verify: Live Monitor disconnects and the simulator returns to WARTE AUF BMS.
- 6 Re-enter the pit and check the new full synchronization.

A SIMULATED SAFE STATE DOES NOT REPLACE A FIRMWARE WATCHDOG

If a cable is removed or a controller blocks, the PC cannot guarantee a final command. Real firmware must set safe outputs by itself after a timeout.

21. Several controllers and saving

The simulator list is saved automatically in %LOCALAPPDATA%\BmsLiveMonitor\MicrocontrollerSimulator.json. Definitions are loaded and started automatically next time.

Example	Connection	Protocol	Purpose
LED-LEFT	USB	BASCOM LED 64	Left warning lamps
GAUGE-PC	USB	NAME#WERT	Local instrument values
ESP32-TEST	LAN / 43870	GEMISCHT	Test network path before real firmware

- WHOAMI names must be unique.
- LAN data ports must be unique.
- Stopping keeps a definition; removing deletes it from the list.
- Packet, LED and value states are runtime observations, not a replacement for your documented target configuration.

22. Troubleshoot without guessing

Problem	Likely cause	Focused check
Simulator not found	Controller stopped or WHOAMI was not run	ALLE STARTEN, then search again
Name does not match	Different WHOAMI spelling	Compare both names character by character
Found but not connected	Not in pit or controller/route inactive	Check Live Monitor header and ACTIVE
Wrong detail tab	Selected controller does not match tab	Click controller row; check protocol
LAN port busy	Other software/controller uses it	Choose a free port beginning at 43870
Wrong LED channel	Bit order or route misunderstood	Test only channel 1, 27 or 64
DED/PFL incomplete	Packet or power/pit state	Inspect incoming log and five displayed lines
No safe output	Connection was not live or safe value is blank	Connect LIVE first, then close the gate

DO NOT DISABLE THE GRAPHICS CARD

Simulator, WHOAMI, COM and LAN problems are diagnosed through identity, status, protocol, port and one test route. The graphics card and Windows drivers remain untouched.

23. What a passed test really proves

Passed test	Proven	Not yet proven
WHOAMI	Live Monitor finds the correct virtual identity	Real USB firmware and cable
LED#	Route, channel and 64-bit packet agree	Electrical LED driver circuit
NAME#WERT	Wire name, text format, delta and safe value agree	Motor/servo scaling
DED/PFL	Five lines reach the endpoint	Physical display and character set
LAN	UDP discovery and TCP payload work locally	Future Wi-Fi/Ethernet board stability

The correct next stage

- 1 Save the simulator summary and expected packets.
- 2 Build firmware with a boot safe state and receive timeout.
- 3 Connect one harmless real output.
- 4 Only then add more channels, displays or actuators.

BMS MICROCONTROLLER SIMULATOR

See it first. Understand it. Then build safely.

THE SAFE DRESS REHEARSAL

The simulator reveals Live Monitor's real data path without involving a miswired LED, motor or unknown driver stage. Move to physical hardware only after both live and safe-state tests pass.

Private cockpit project / English simulator documentation / 2 September 2026