



HOW-TO

How-to Configure Trigger in EMU BLACK

Document version: 1.0

Software version: 2.169 or later

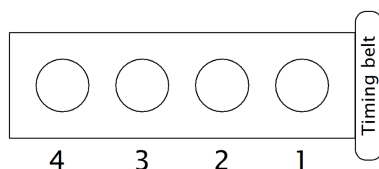
Published on: 05 November 2024



1. Ignition set up procedure

This guide covers the ignition setup procedure in EMU BLACK for both V2 and V3 software. Differences specific to V3 are marked with *In EMU Black V3*.

1. Set the engine to top dead center (TDC) on cylinder number 1. In most inline engines, cylinder number 1 is the cylinder closest to the timing belt/chain. In the case of V-engines, refer to the manufacturer's manual to accurately identify cylinder 1.



2. Make a mark on the timing belt/chain cover and the crankshaft pulley with the engine set at TDC. Use white paint or a corrector to create reflective marks for the timing light. If the engine is equipped with factory marks, ensure they match each other and use paint to make them more visible.
3. Connect the timing light to the high tension (HT) leads that connect the ignition coil to the spark plug in cylinder number one. If the engine is equipped with coil-on-plug ignition and there are no HT leads, remove the coil from cylinder number one and extend it with a spare HT lead to the spark plug. Secure the connection between the coil and HT lead with insulating tape.

**Attention:**

Do not connect the timing light inductive probe to the loop on the ignition signal wire to the coil. This mistake will lead to incorrect ignition timing settings.

4. Open the EMU Black software and, from the *Tree View*, choose *Ignition / Coils / Ignition Outputs*. Select spark distribution and the appropriate coil type. If the engine is equipped with passive coils, select *Coils without amplifier*. If the engine is equipped with active coils or an ignition module, select *Coils with built-in amplifier*.
5. Open the EMU Black software and navigate to *Tools / Output Test*.
Select: *Output / Ignition Out 1* and press the *Test* button.

If the coil type is selected correctly, the strobe lamp should flash when the trigger is pressed and a spark is generated. If the strobe lamp does not flash, remove the spark plug from the cylinder head, ground the spark plug electrode, and run the test again. Observe the spark

plug for a spark. If no spark appears after pressing the *Test* button, check the selected coil type in the options, as well as the power supply and grounding.

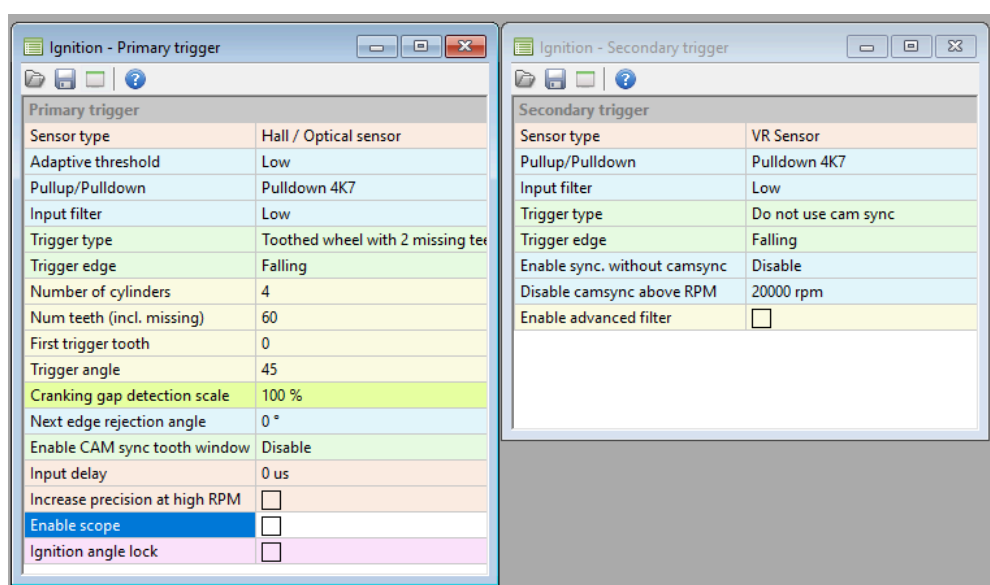
- With the timing light flashing when a spark is generated, open the *Ignition / Triggers / Primary* and **Secondary Trigger** configuration windows.

Select the correct sensor type for the primary and secondary triggers.

For the trigger type, select:

- Primary: Multi-tooth
- Secondary: 1 tooth

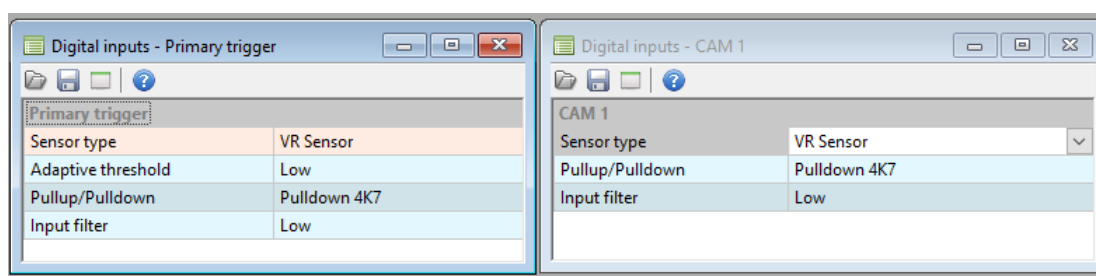
Finally, enable the *Scope* window.



In EMU Black V3

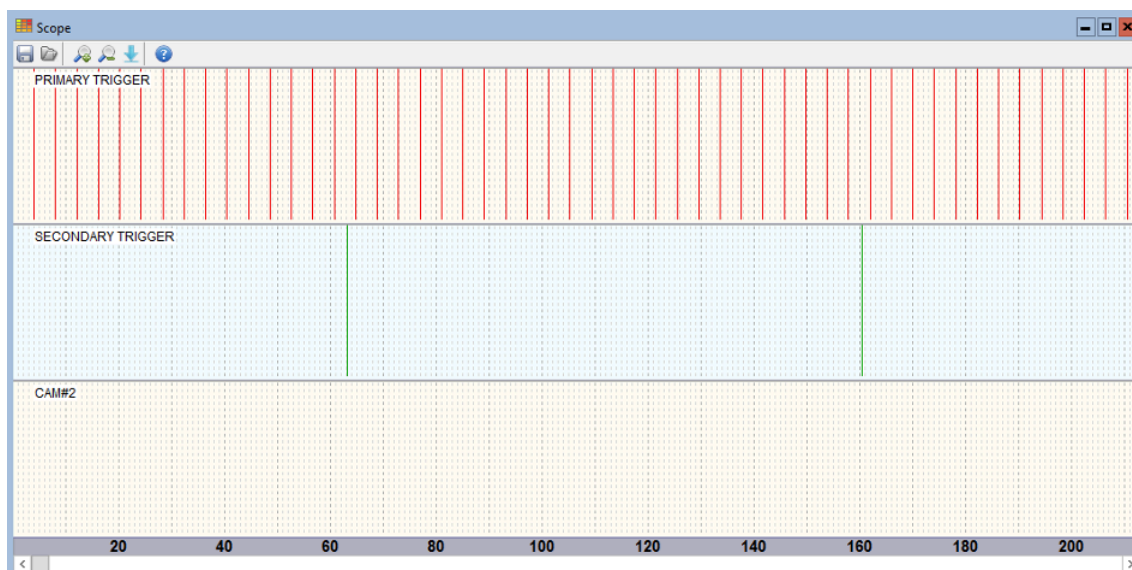
The sensors setup for secondary and primary triggers is defined in *Sensors and inputs / Digital inputs / Primary Trigger* and **CAM 1**

Other settings remain the same, except that the *Enable scope* parameter is no longer present, as the scope is always enabled.

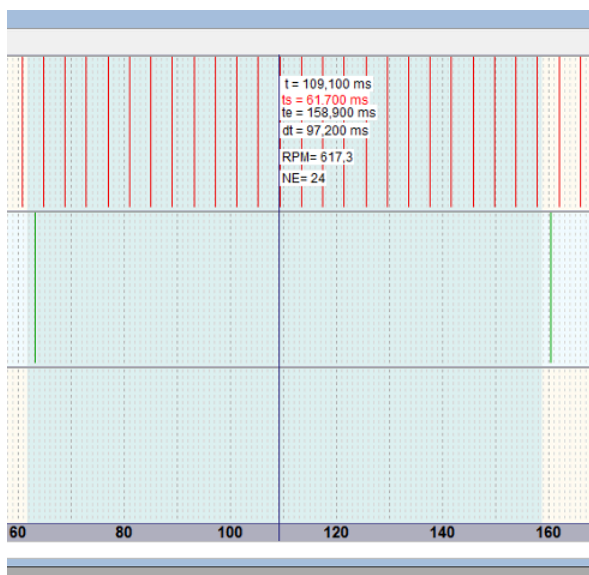


7. From the *Tree View*, open *Log / Scope* Window.

During engine cranking, press the blue arrow. If the triggers are set correctly, lines from the decoded wheels should appear.



8. Press the left mouse button and select the distance from the first edge of the secondary trigger signal to the last edge of the primary trigger signal, just before the next edge of the secondary trigger signal. The selected area will provide information about the trigger type used on the crankshaft (primary trigger). In the example screen, the primary trigger type is a 12-tooth wheel on the crankshaft. The crankshaft rotates twice during the entire engine cycle, so 12 times 2 equals 24.



9. The *First Trigger Tooth* setting determines which signal after the secondary trigger will start the new engine cycle. The *Trigger Angle* defines how much the crankshaft must rotate after the first trigger tooth appears to get the TDC of the cylinder. The maximum ignition advance cannot exceed the trigger angle.

The engine rotates 360 degrees every half cycle. In this example, the trigger wheel divides 360 degrees into 12 equal parts, so each tooth represents 30 degrees of rotation.

If the ignition table is set to 0 and *First Trigger Tooth* is set to 3 with a *Trigger Angle* of 0, the ignition event occurs at TDC (Top Dead Center) on cylinder 1. This configuration allows the ignition event to start at or after TDC, meaning only ignition retarding is possible.

If you set *First Trigger Tooth* to 2 and the *Trigger Angle* to 30, the spark will occur at TDC on cylinder 1. With 10 degrees of advance set in the ignition map, the ECU will trigger the ignition 20 degrees after the trigger tooth. The maximum possible advance in this setup is 30 degrees.

If *First Trigger Tooth* is set to 1 and *Trigger Angle* to 60, the spark will again occur at TDC on cylinder 1. For a 35-degree ignition advance, the ECU will calculate that the ignition event should occur 25 degrees after the first trigger tooth appears ($60 - 35 = 25$).

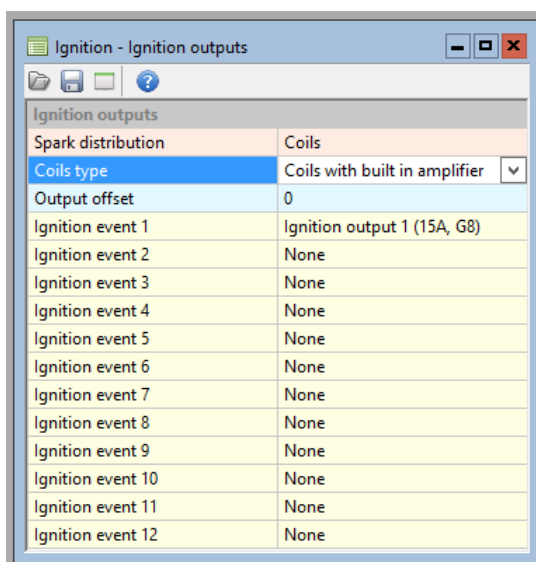
10. Open the graph log from the *Tree View* and select the following channels:

- RPM
- MAP
- Trigger Sync Status
- Trigger Error
- Cam Sync Trigger Tooth
- Executed Sparks Count

During cranking, the parameters on the graph will change. When the settings for the primary and secondary triggers are correct, the Trigger Sync Status will change from *No Sync* to *Synchronized*. Once the ECU is in a synchronized state, spark and injector pulses are generated.

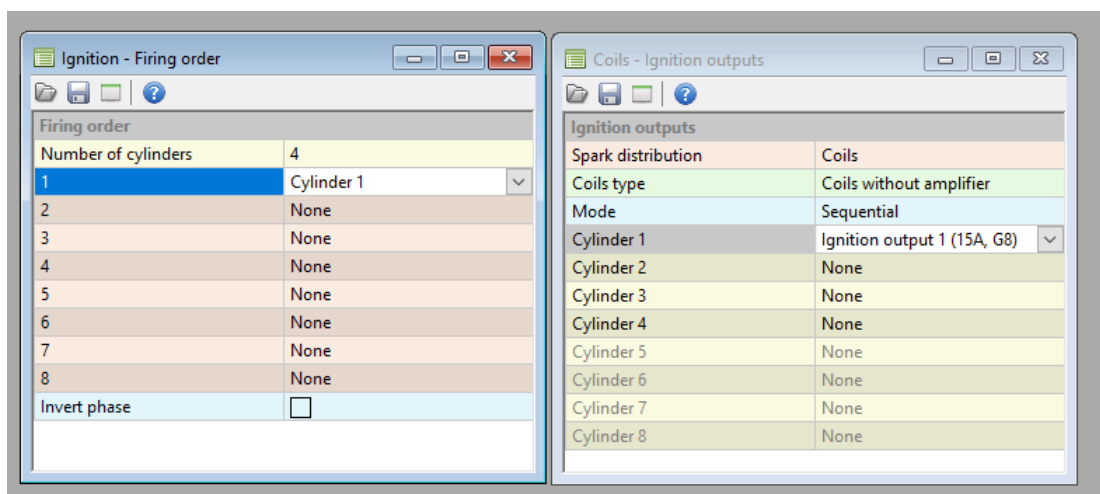


11. Open the *Ignition / Coils / Ignition Outputs* window from the *Tree View*. Assign Ignition Output #1 to *Ignition Event 1* (the coil for cylinder number one is connected to Output #1).

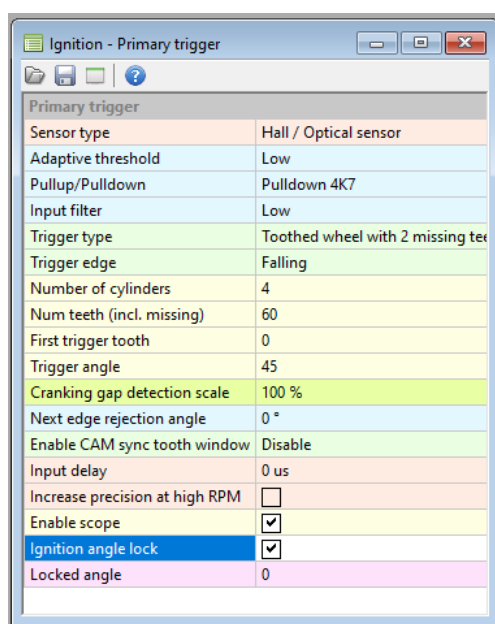


In EMU Black V3

Configuring ignition outputs is split in V3. First, open *Ignition / Firing order* and assign 1 - *Cylinder 1*. Then, in *Ignition / Coils / Ignition Outputs*, assign the correct output for *Cylinder 1*.



Open the *Ignition / Triggers / Primary Trigger* window and select the *Ignition Angle Lock* option. Set the Locked Angle to 0 degrees. Configure the proper number of cylinders and the number of teeth on the primary trigger. Set the *First Trigger Tooth* to 2 and the *Trigger Angle* to 60 degrees. These settings are theoretical and will be adjusted during testing with a timing light.



12. Aim the timing light at the TDC mark you created on the timing belt/chain cover. Crank the engine and observe if the crankshaft pulley mark aligns closely with the mark on the timing

cover. If the mark on the pulley is not present and the timing light is flashing, change the *First Trigger Tooth* to a value of 3 and repeat the test with the timing light.

Continue adjusting the *First Trigger Tooth* until the crankshaft pulley mark is as close as possible to the mark on the timing cover. Each trigger tooth adjustment changes the ignition angle by 30 degrees. Increasing the trigger tooth value will retard the ignition, while decreasing it will advance the ignition.

13. For fine-tuning the primary trigger settings, use the *Trigger Angle* option. Crank the engine and adjust the *Trigger Angle* value to align the marks on the pulley and the timing cover. Increasing the angle will retard the ignition, while decreasing the angle will advance the ignition.
14. When the *First Trigger Tooth* and *Trigger Angle* are set correctly, select a different value for the *Ignition Lock Angle*, such as 10 degrees, to perform an additional check. During cranking, the ignition angle will be advanced by 10 degrees.



Warning:

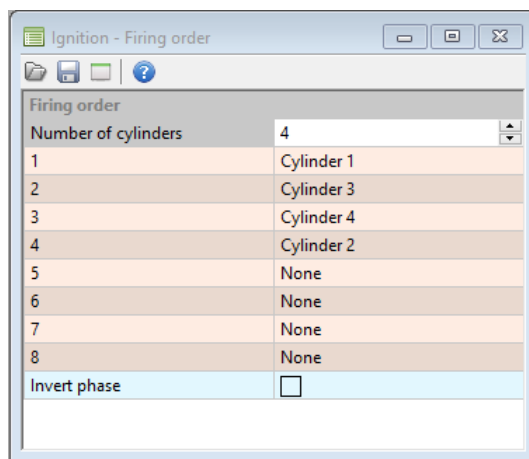
Remember to uncheck the *Ignition Lock* option after adjustments are finished to prevent a permanent ignition lock during engine mapping.

15. After the trigger settings are finished, assign the remaining ignition outputs. A typical 4-cylinder inline engine has a firing order of 1–3–4–2. When the ignition output number matches the cylinder number, the ignition outputs will be assigned to the ignition events as follows:

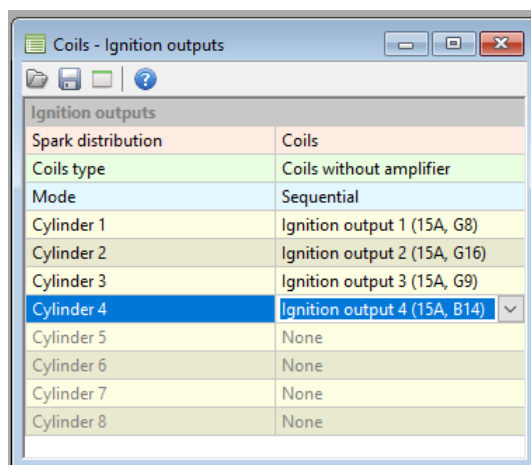
Ignition outputs	
Spark distribution	Coils
Coils type	Coils without amplifier
Output offset	2
Ignition event 1	Ignition output 1 (15A, G8)
Ignition event 2	Ignition output 3 (15A, G9)
Ignition event 3	Ignition output 4 (15A, B14)
Ignition event 4	Ignition output 2 (15A, G16)
Ignition event 5	None
Ignition event 6	None
Ignition event 7	None
Ignition event 8	None
Ignition event 9	None
Ignition event 10	None
Ignition event 11	None
Ignition event 12	None

In EMU Black V3

The firing order in V3 software is set up in *Ignition / **Firing order*** for a 1-3-4-2 sequence:



The next step is assigning the cylinders to the ignition outputs of the ECU. Unlike in EMU Black V2, the wiring does not need to match the firing order. For example, you can wire Cylinder 1 to Ignition output 1, and so on.



The crankshaft in a 4-stroke engine completes two rotations for the entire engine cycle. This means that the piston reaches the top dead center (TDC) twice per cycle. It's possible for the spark to be triggered when the cylinder is in the intake stroke, in which case the engine won't start. Common symptoms of this issue include backfires in the exhaust or intake system, or the engine stalling during cranking.

In such cases, you need to reverse the engine phase. For a 4-cylinder engine with a firing order of 1-3-4-2, the easiest way to do this is by changing the ignition event offset from 0 to 2.

In EMU Black V3

To reverse the engine phase, enable the *Invert phase* setting in *Ignition* / **Firing order**.

2. Document history

Revision	Date	Changes
1.0	2024.11.05	Initial release