

Knock Sensor Controller (KSC3)

Engine Knock Detection
System

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Disclaimer

WARNING

MoviChip products should be used for motorsport and/or off-highway use **only**.

MoviChip products should **only** be used by persons who are experienced with automotive electrical and mechanical systems and the effects of altering such systems.

Misuse or improper tuning of MoviChip products can cause unexpected vehicle behaviour and/or failure (temporary or permanent) of existing vehicle systems e.g. limp mode, engine damage etc.

MoviChip products are **universal**. It is the responsibility of the end user to ensure MoviChip products are suitable for their specific application. MoviChip is not responsible for special, incidental or consequential damages or costs incurred due to the failure of this product.

MoviChip products are used entirely at the risk of the end user.



Introduction

The MoviChip KSC is a knock detection system designed for automotive use. The KSC is a tool to *help* the calibrator identify the optimum ignition timing. The KSC is not a device which is designed to compensate for a bad tune/calibration.

The KSC can integrate with 12 volt and 5 volt circuits. The 12 volt signal can be used with LED lights (5050 RGB LED) to alert the driver to knock in real time. The 5 volt signal can integrate with compensation tables in engine ECU so ignition timing can be retarded when engine knock is detected by the KSC3.

To get the KSC up and running there are five main steps.

1. Build the wiring loom and wire unit into car.
2. Pair KSC to Android device **first**. And then install KSC app onto Android device.
3. Check the wiring using the in-built test function in the app.
4. Identify the knock frequency window for the engine using the Knock ID tool in the KSC Android app.
5. Identify the engine's normal (no knock) knock signal level, in the knock frequency window, for the entire RPM range.
6. Set our knock signal threshold.

This manual will go through each of these five steps.

KSC is supplied with:

The **KSC unit**

Connector and crimps terminals. *User makes their own wiring loom.*

Build sheet detailing software and hardware versions and password for Bluetooth connection.

Instruction manual can be downloaded from the MoviChip website, it is **not** sent with the product.

The **Android app** can be downloaded from the MoviChip website.

Not Included

Wideband knock sensor

Wideband knock sensor pigtail connector

5050 LED strip (or other 12 volt LED)

Wiring (see photo of connector below)

KNOCK SENSOR CONTROLLER	8	7	6	5	4	3	2	1
A	LED Negative	LED Positive	MAP Signal In			RPM Input 0-5/15V		
B						Knock Signal from KSC to ECU		Power ACC 12V+ (1 AMP)
C					Knock Sensor Negative	Knock Sensor Positive		Battery Negative 12V

COLOUR KEY (NOTE: WIRE COLOURS IRRELEVANT)

A	INTERCEPT
B	TAP.
C	TAP TO SENSOR GROUND EVEN IF + SENSOR POWER SUPPLY NOT USED
D	ADD INLINE FUSE
E	OPTIONAL, USE IF REQUIRED. 0.5AMP CURRENT DRAW MAX
F	OPTIONAL

Figure 1 - Looking at connector from wiring/loom side



Figure 2 - Around the holes where we insert the wire into the connector, the columns and rows are marked/indented into the plastic. Characters are small.

Pin List

A3 - RPM Signal - Input, 0-15v

B1 - Power Positive 12v - Input (Powered when ignition on)

A6 - Load Signal - Input, 0-5v

B3 - Engine ECU - Output, up to 5 volts

A7 - LED Positive - 12 volt

A8 - LED Negative

C1 - Power Ground

C3 - Knock Sensor Positive

C4 - Knock Sensor Negative



Wiring Notes

The RPM signal should alternate between 0 volts and 5 to 15 volts

Power inputs should be fused as detailed above.

Knock sensor should preferably be connected **directly** to KSC and not spliced to other ECUs. If knock sensor signal is spliced to other ECUs it *may* cause interference and improper functioning and detection of knock.

We have tested the LED output with 5050 type LEDs in a short strip of around 10cm. Use a shorter strip if you wish.

Load signal should be TPS or MAP

Use the Test function (click "Knock") in the app to confirm wiring is correct and to see minimum and max voltage signal being sent from KSC3 to engine ECU. And to also observe brightness range of LED. LED signal and ECU signal will pulse in Test mode. Click "No Knock" to turn off test mode.

The KSC Android App

The Android app is where we program the KSC unit.

Pairing KSC to Android device

First we need to pair the KSC to your Android device.

After wiring in the KSC3 unit to the car. With ignition on, open the settings menu of your Android device, go to Bluetooth settings, add new device, when KSC3 shows, pair your device with the KSC3 unit. Password for the KSC3 unit will be written on the build sheet included with the KSC3.

Now we can download the KSC app from the MoviChip website. Use the software version written on your build sheet.

Configuring KSC with Android App - Overview

Download the Android App from the MoviChip website.

To setup the KSC3 we use the KSC app to configure the settings. This is the process:

1. We calibrate/check the connections of the knock sensor input, MAP input and RPM signal
2. We setup the unit to use the Knock ID and Baseline tools
3. Identify the knock frequency. We use the Knock ID tool to identify/confirm the knock frequency, as read by the knock sensor, for the specific engine

4. Identify baseline volume. We use the Baseline Configuration tool to identify the normal knock sensor signal volume when engine is not knocking.

5. We confirm our settings are not outputting false positives and we confirm our settings are not missing knock events. If unit is not identifying knock to the accuracy required, we tune our settings (knock frequency window monitored and/or volume threshold) to achieve accuracy required.

The steps below are listed in order.

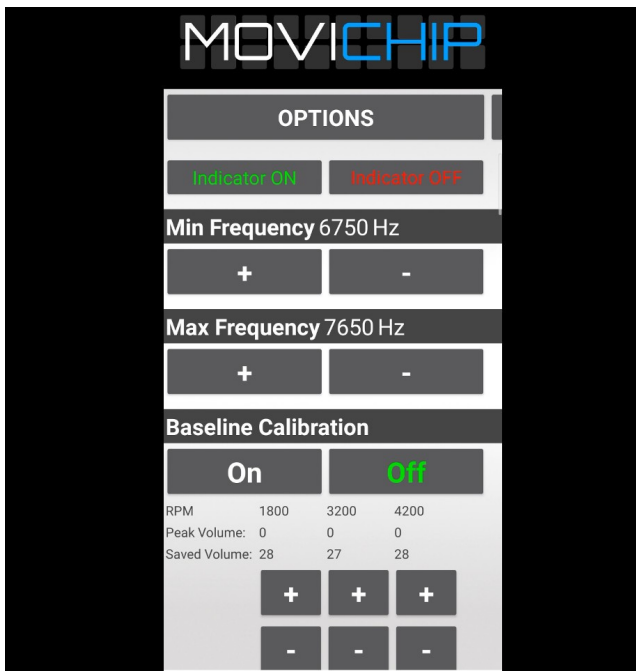


Figure 3 - A snap shot of the KSC Android app

Sensor Inputs

We need to calibrate/check the sensor inputs. We can see live sensor reading by clicking "Knock" in the "Test" section of the app.

If we simply want to populate the stored values already in the unit we press "Off" in the "Baseline Calibration" section.

NOTE: Pressing "On" will reset the RPM points. A new calibration run will need to be done. Setup procedure is detailed below.

Load Threshold

The KSC3 has a Load Threshold setting. This is used to ignore knock signals that occur below the set load threshold. The purpose of this feature is to stop the KSC3 from outputting a knock signal when the throttle is lifted. This setting is

optional. Use it if you think you need to. Start by setting the threshold to the minimum. Tune the setting when you are familiar with the KSC3.

Resolution

The KSC3 has two resolution settings for detecting knock. Normal and High. Choose the setting that works best for you.

RPM

Are we getting one signal per revolution on our RPM signal or 0.5 (1 signal every two revolutions of the engine). We enter the number.

This signal should alternate between 0 volts and 5 to 15 volts.



Figure 4 - Number of signals we get per RPM

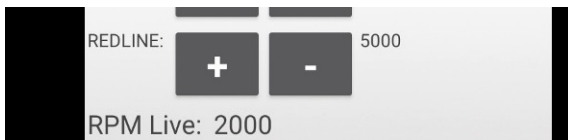


Figure 5 - We can verify RPM is correct by pressing the "Knock" button in the "Test" section of the app.

Knock Sensor Signal Gain

We want to process the highest possible number. If we see the Knock Sensor Live number is less than 200, we can increase the Signal Gain to "2".

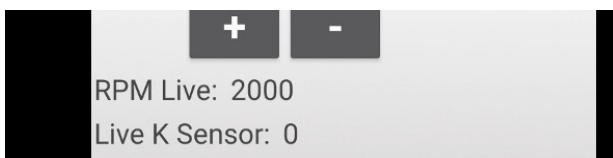


Figure 6 - If the "Live K Sensor" number peaks at less than 200 in normal driving we can increase Gain to "2"



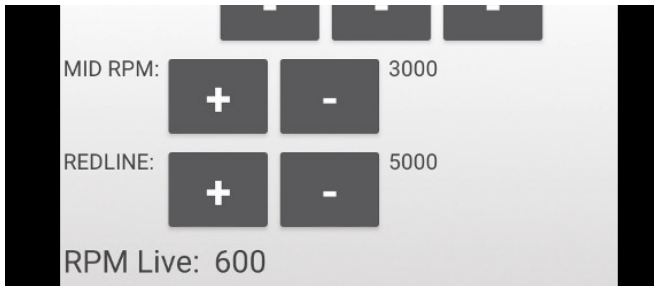
Figure 7 - Increase signal gain if possible

Setting Up The Unit

Before we can use the inbuilt apps to identify the knock frequency and volume we need to choose some settings.

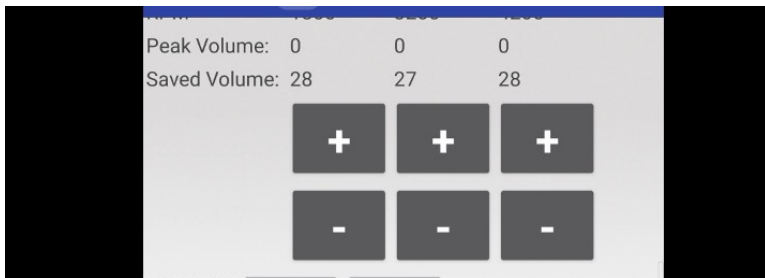
RPM

We need to choose a **mid** RPM and the **redline** RPM. Redline RPM is self explanatory. It is recommended to choose an RPM slightly lower than redline eg if redline is 7000rpm, redline could be set as 6500rpm. Mid RPM point will be somewhere around 50% of the rev range. If the engine has an 8000 rpm redline, we set this value to around 4000 rpm. You can adjust these RPM numbers to suit your preferences.



Save Volume

This is the knock volume threshold. During the set up process we want to be able to hear (light, non-damaging) engine knock without the KSC interfering with the engine ECU. We can either disconnect the KSC from the ECU and/or we set the Saved Volumes to very high numbers.



Find Knock Frequency - Knock ID Tool

To identify knock we first must know the knock frequency. There are **two** methods to find the knock frequency. The **first** is to use a Knock Frequency Calculator **and then verify** that frequency using an audio knock frequency detector.

The **second** method is to use the Knock ID tool inside the KSC Android app.

How to use the Knock ID tool.

1. In the engine ECU, **set a conservative/retarded ignition timing** over an RPM band. We suggest 2000-3000rpm. We want the ignition timing at this RPM band to be conservative so we can guarantee that the engine will **not** be knocking at high/full load.

2. **Record the volumes** of the knock frequency bands by driving with a high/full load between 2000 and 3000 rpm. We record the runs by pressing "On" on the app before starting the run and pressing "Off" before finishing.

Press "Off" on the app to stop recording.

Ideally, we want to stop recording **before** the throttle is lifted.

3. Repeat this process 3-5 times. At the end of each run, when pressing "Off", the tool will output the frequency segments and the maximum volume recorded.

NOTE: There will be a delay of around 3 seconds between pressing "Off" and the list being populated. If the list does not populate, press Off again and wait 3 seconds. Repeat this until the line is populated, *if necessary*.

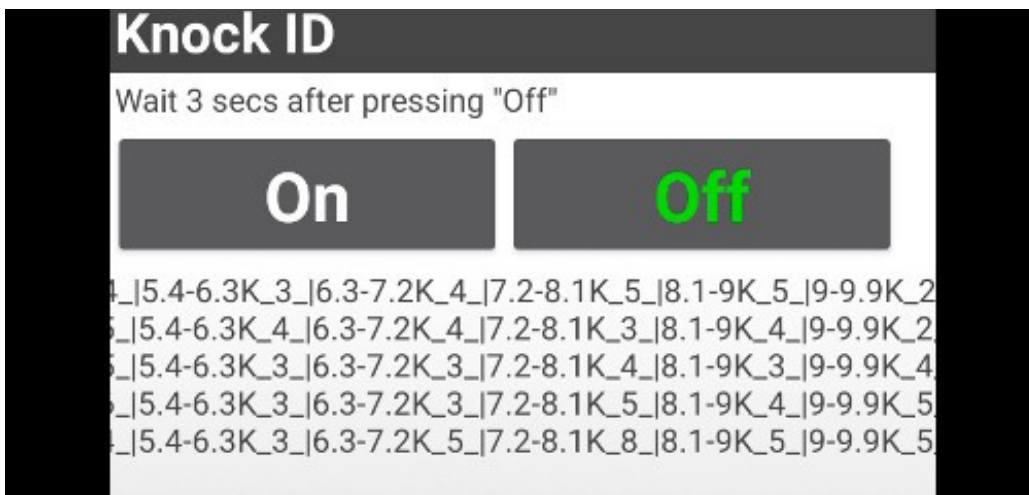


Figure 8 - Knock ID output. Each line represents one run.

4. Repeat the process, without switching the engine off, but this time with the ignition timing advanced to cause **slight**, non-damaging knock between 2000 and 3000 rpm, at light throttle.

5. **Look through** the runs (compare the lines to those where ignition was retarded) and identify the frequency segments whose volume has **changed** between the runs with retarded ignition and advanced ignition timing. This will indicate the knock frequency of the engine. **This will normally be close** to the theoretical knock frequency of the engine.

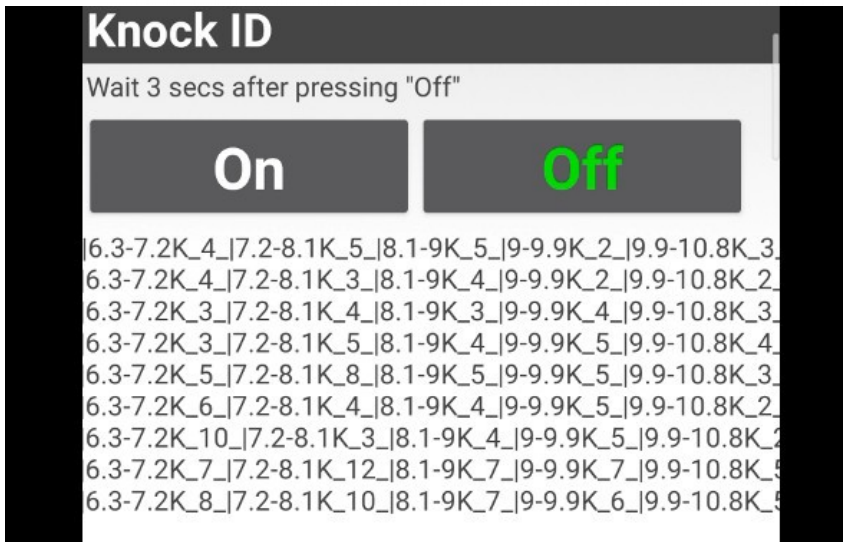


Figure 9 - Comparing runs with ignition timing retarded vs advanced. 6.3-7.2K & 7.2-8.3K have jumps in volume. Theoretical knock frequency is 7.2k. We will set frequency window at 6.7k minimum and 7.6k maximum.

Setting the Knock Frequency

When we have identified the knock frequency we need to enter the values into the app.

Minimum and maximum frequency should match the frequency segment found using the Knock ID tool. It is recommended to give a broad frequency range until you are familiar with the product.



Figure 10 - Setting the knock frequency window to be monitored

Setting the Knock Volume Threshold

To set the threshold we need to know what is a **normal** volume for the engine in the frequency window set in the previous step. We measure this using the "Baseline" tool inside the app.

1. Set a **conservative** ignition timing map for high/full load for the **entire** rev range of the engine

2. Press "On" in "Baseline Calibration". Do a run from around 1000 rpm at high/full load to redline rpm. Record the run by pressing "On" and finish recording (**before lifting the accelerator**) by pressing Off. This will output the peak volume at three RPM points through the rev range. The RPM points are drawn from the mid-point and redline RPM numbers we entered earlier.

Baseline Calibration			
	On	Off	
RPM	1800	2600	4200
Peak Volume:	3	3	7
Saved Volume:	4	4	8

Figure 11 - Baseline output shows max volume @ 1800 RPM as 3, 2600 RPM as 3 and 4200 RPM as 7. We set our thresholds ("Saved Volume") just above these values.

3. We set the Saved Volume to numbers slightly higher than the peak numbers we have just recorded.
4. We should verify the thresholds we have just entered by repeating the run (with the same ignition timing). We should not receive any warning signals coming from the KSC. If we do we should either tune the knock frequency and/or the volume thresholds we have entered.
5. When we are happy we are not getting false positives, we return the engine ignition timing map back to normal.

Confirm volume threshold. We increase the ignition timing at a set RPM to induce slight knock. We then check that the KSC is detecting the knock (it sends a signal to the LED and/or ECU). If it does not, tune the threshold volume and or the frequency window we are monitoring.

The KSC is now ready to detect knock.

We can now close the app by pressing the red bar at the bottom.

We **only** need to use the app again if we want to adjust the settings entered above.

Variable Knock Indication Output

The KSC3 will output a variable signal to the LEDs (PWM) and to the engine ECU. The lowest signal will be sent when the knock volume threshold is exceeded by one point. The maximum signal will be sent when the volume threshold is exceeded by 20 points *or more*.

You can check the range of the outputs by clicking the "Knock" button in the "Test" section of the app.

Lower LED brightness indicates lower breach of volume threshold



Lower voltage signal to engine ECU indicates lower breach of volume threshold.

The variable signal going to engine ECU can be used in a compensation table to reduce ignition advance, reduce throttle opening, increase fuel etc. It's recommended to set the correction table to maximum safety at the lowest signal from the KSC3 and increase as you get a feel for how the KSC3 is performing.

IMPORTANT: The knock indication outputs are activated for **two seconds** when the KSC detects knock. *If the knock intensity increases during this two second period, the level of the knock indication output will **not** increase, it will stay the **same**, even if knock stops during that two second period **or** if it increases.*

Why two seconds?

It is easier to see the LEDs illuminated for two seconds than a fraction of a second.

It is easier to see knock events detected by the KSC on datalogs if the signal last for two seconds vs a fraction of a second.

More Information

Check the product page on the MoviChip website for more information including videos on the KSC