## catoolRT

## **CANbus Start of Combustion (SOC)**

**NOTE**: Measuring the start of combustion using the ECM requested spark angle has two obvious drawbacks. Firstly, this is the angle that the ECM would like to initiate spark, not that actual angle that the coil fires. Secondly, delays between the ECM transmitting the spark angle and catooIRT receiving it can lead to cyclic delays. It is therefore recommended that a current clamp is used to measure spark angle if possible, especially if the engine is measured in transient operation or for the purposed of knock control development.

**NOTE**: catoolRT uses an angular convention in degrees <u>after</u> compression top dead centre. Most ECM software indicates spark timing in degrees <u>before</u> compression top dead centre. Start of combustion will therefore need to be inverted between the value transmitted by ECM and value used by catoolRT. This will be handled in the channel configuration.

#### 1. Configure CANbus Input Signal

This document describes adding an SOC channel acquired from CANbus. Much the same process also applies if using the ATI VISION interface.

**NOTE:** The following will describe adding a single CANbus channel for all cylinders. If possible use a CANbus channel for each individual cylinder spark timing. This is particularly critical when the ECM adjusts individual cylinder spark timing for either idle balance or knock control.

Configure DAQ				
Channel	Device IFile IFile IFile IFile IFile	Channel Name /Simulated/CYLPR1 /Simulated/CYLPR2 /Simulated/CYLPR3 /Simulated/CYLPR4 ExtClock ExtTrigger	Type Cylinder Pressure Cylinder Pressure Cylinder Pressure External Clock: 1800 pulses/r Trigger: 90.0 deg BTDC	Add Edit Delete Abscissa Engine Import Export

Select "Acquisition" -> "Configure DAQ". Click on "Add"

New Channel	×
Select the type of channel to add	
DAQ Channel	^
A II VISION Channel	
Low Speed DAQ Channel	
CAN Channel	
CAN Channel: Bosch Motorsport LT2/LT4	×
	OK Cancel

Give the channel a name and click "OK":

New Channel		×
Channel Name		
SPARK		
	ОК	Cancel

The easiest way to use CANbus channels is with a CANdb (DBC) database file. Browse for a file by clicking on the "..." icon.

Add Channel: "SPARK"			
CANdb Filenam	ne		<b></b>
Message		Signal	
	~		~
Message ID	Type	Uni	ts
Chart Dit Law	-bit · Onsigne		
Start bit Ler	ngth iviuitipiex		pe
7 8	Normal	✓ … 1	/bit
Format	Segment	Off	set
Motorola	✓ 0 (0 deg)	) ~ 0	
Description			
Min: 0 Max: 255	5 Res: 1		
Rename	Properties	ОК	Cancel

Once the database file is loaded you can select the "Message" and then "Signal" for the start of combustion indication:

Add Channel: "SPARK"				
CANdb Filename SCS_Delta.dbc				
Message		Signal		
44sq300 [0x300]	~	MainA		$\sim$
Message ID 300 11-bit	Type t ∨ Unsigne	u d Word 🗸	Jnits deg	
Start Bit Lengtl	h Multiplex	Mode S	ilope 0.25	deg/bit
Format Motorola	Segment	) ~ (	Offset -10.0	deg
Description				
Main Fuel Injection Timing				
Min: -10 Max: 16373.8 Res: 0.25				
Rename	Properties	ОК	Ca	ncel

You can generate a DBC using the free Kvaser Database Editor 3 which you can download from <a href="https://www.kvaser.com/download/">https://www.kvaser.com/download/</a>. The editor helps to visualise CAN bit positioning.

**NOTE**: the start bit numbering used by catoolRT is the same as the raw CANdb DBC file format. This differs from both the Vector and Kvaser bit numbering conventions depending on the endian format. If generating your own DBC file or entering CAN format direct to catoolRT, be sure to understand how these formats differ.

Once the CANbus signal is adequately described click "OK".

# 2. Configure Start of Combustion

Select each cylinder pressure channel in turn to configure the SOC by clicking "Edit":

Configure DAQ				
Channel	Device	Channel Name	Туре	Add
Tri CYLPR1 Tri CYLPR2 Tri CYLPR3 Tri CYLPR4 Tri Clock Trigger At SPARK	IFile IFile IFile IFile IFile IFile Msg300	/Simulated/CYLPR1 /Simulated/CYLPR2 /Simulated/CYLPR3 /Simulated/CYLPR4 ExtClock ExtTrigger MainA	Cylinder Pressure Cylinder Pressure Cylinder Pressure Cylinder Pressure External Clock: 1800 pulses/r Trigger: 90.0 deg BTDC CAN Signal	Edit Delete Abscissa Engine
				Export OK

### Click "Properties":

Edit Channel: "CYLPR1"	
Device	Units
IFile: "Simulated"	∽ bar ∽
Channel	Slope
Simulated/CYLPR1	√ 1 bar/V
Input Configuration Range	Offset
Differential $\checkmark$ ±10V	√ 0 bar
Description	
Cylinder Pressure for Cylinder 1	
Channel Type	
Cylinder Pressure - Other	~
TDC Offset 0.0 degrees	Cylinder
Rename Properties 0	K Cancel

In the "Start of Combustion" section change "Type" to "Channel Value", "Channel" to the CANbus channel you have configured and "Invert Value" to "True". This will convert the signal value from ECM to catoolRT angle reference.

CYLPR1 Properties			
-	Offset Correction		
	Туре	Polytropic 🗸	
	Window Start	-100	deg
	Window Finish	-65	deg
	Polytropic Index	1.32	
	Interval	11	samples
	Truncate	False	
	Start of Combustion		
	Туре	Channel Value	
	Channel	SPARK	
	Invert Value	True	
	Filtering		
	Туре	FIR Low Pass	
	Lower Frequency	25000	Hz
	Digital Conversion		
	Туре	None	
		ОК	Cancel

Repeat this process for the remaining cylinder pressure channels.

### 3. Configure CANbus Hardware

"Acquisition" -> "Configure CANbus". Click on the "Configuration" tab.

Conf	igure CANbus			
CA	Nbus Output Configuration			
	CAN Input			
	CAN Channel	PEAK PCAN-USB		
	Bus Speed	500 kbit/s		
	Remote Control (CAN AK)			
	CAN ID	0x7F0		
	Enabled	False		
=	CAN Output			
	CAN Channel	PEAK PCAN-USB		
	Bus Speed	500 kbit/s		
=	ХСР			
	CAN Channel	PEAK PCAN-USB		
	Bus Speed	1 Mbit/s		
	Broadcast ID	0x100		
	Master ID	0x200		
	Slave ID	0x300		
	Enabled	False		
		<b>OK</b> Cancel		

In the "CAN Input" section change the "CAN Channel" and "Bus Speed" to match your setup. Then click "OK".

### 4. Validation

You should now be ready to test the configuration.

Go online and add a plot of the CAN channel and cylinder pressure start of combustion to ensure that the signal value matches the ECM output.



Note that the CAN channel value is not inverted. Only the cylinder pressure SOC value will reflect this inversion.



If possible, fix the spark value with the ECM software and check that the CAN and SOC channel values match.

**NOTE**: Fix spark with the engine in a safe speed-load condition, i.e. idle, where engine damage is unlikely. Do not allow the exhaust temperature to damage the catalyst.