

I-CAM

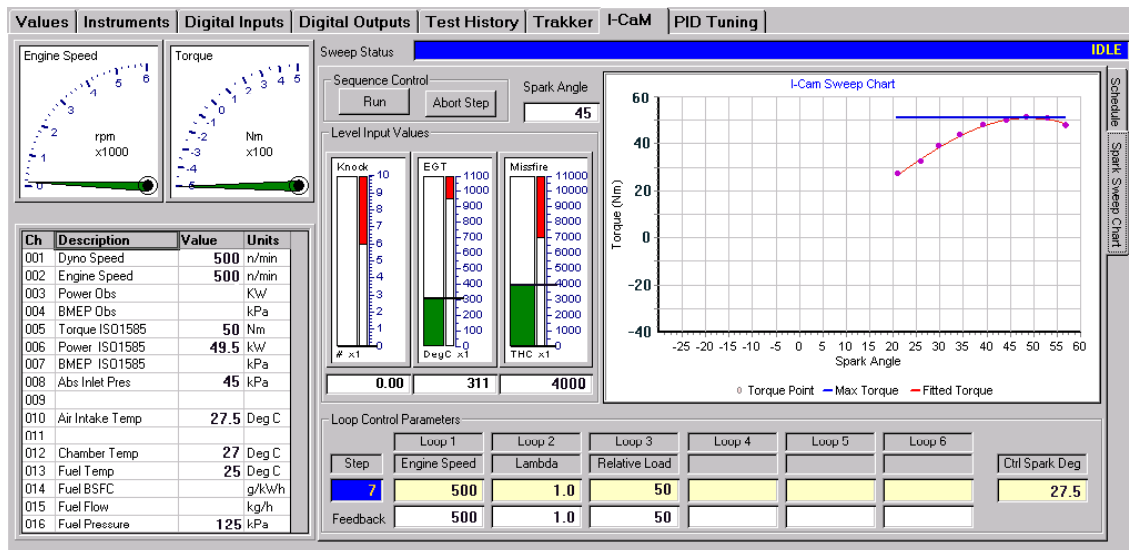
Introduction: I-CAM, Integrated Calibration And Automated Mapping as a component add-on to the advanced CADET V12 Engine and Vehicle Test System, provides a state-of-the-art, automatic engine spark calibration facility.

I-CAM fully automates a highly sophisticated task, which up until now has generally had to be carried out by a highly skilled test bed operator proficient in using up to three computers at a time. The test bed operator has had to have a lot of knowledge about the procedure being carried out – and has had to monitor the state of many parameters whilst adjusting others.

The skilled operator has had to make the decision as to where the MBT (Mean Best Torque) point is and also decide where and when the system has entered BLD (Borderline Detonation), also known as knock. When moving from one set-point condition to another set-point condition the operator must ensure that the system gets there successfully without going into exhaust temperature, misfire or knock conditions.

If any of these conditions are found then the operator must adjust the system accordingly to overcome these situations, by for instance increasing fuelling. When set-points are arrived at the operator must re-adjust the spark and fuelling to the desired levels then carry out the sweep procedure by manually adjusting the spark set-point and ensuring that none of the control parameters drift outside set tolerances.

The entire sweep test is a very time-consuming procedure that can lead to errors. By fully automating the entire procedure, I-CAM ensures the calibration engineer of reliable and repeatable data. Tests can be run unattended if required, with CADET V12 and systems built into I-CAM fully protecting the engine.



I-CAM fully automates the entire calibration procedure, from adjusting set-points to monitoring all engine conditions and producing a complete data-log file set. By being fully integrated into the CADET V12 System, I-CAM is able to provide a robust and safe automatic sweep system.

CP Data Sheet

Features: Easy to configure control loops. Up to 6 control loops can be externally specified, e.g. Speed, AFR, Relative Load, EGR.

Fully Automatic Calibration procedure: Define the loop set-points and I-CAM will do the rest.

Forward Spark Sweep determines Max Torque Point, or Knock Limit Point.

Reverse Spark Sweep determines Exhaust Temperature Limit, or Misfire Limit.

Provides option to carry out a friction loss test at end of each loop.

Produces a data-log file that contains all monitored points.

Control of Fuelling and Spark position.

Full engine protection during entire test sequence.

System Requirements: I-CAM essentially sends set-points to CADET V12 and monitors parameters. The following MUST be provided within the CADET V12 System as a minimum requirement for I-CAM:

Input Channels

Engine Torque.

Engine Knock Level Indication.

Actual Spark Angle.

At least one Exhaust Gas Temperature Indication.

Misfire Level Indication.

AFR Level Indication.

Set-Points

Spark Angle (not a Loop set-point).

Fuel Trim (not a Loop set-point).

AFR.

Digital Output Channels

AFR Control On/Off.

I-CAM in itself does not interface directly to the ECU to control Spark or Fuel Trim, typically this will be through an additional V12 component that provides sending and reading of data to/from the ECU via the ASAP3 interface protocol over a 115200baud Serial Interface.

Sophisticated control of set-points, such as Relative Load where a combination of Throttle Position and Boost are used to control to the set-point, is provided by add-on modules within the User Function and Control Function areas of CADET V12.

I-CAM Tab

This is an overview of the workings of I-CAM. For more detailed information please refer to CP's Software Department.

CP Data Sheet

Sweep Scheduler

Ch	Description	Value	Units
001	Dyno Speed	500	n/min
002	Engine Speed	500	n/min
003	Power Obs		kW
004	BMEP Obs		kPa
005	Torque ISO1585	50	Nm
006	Power ISO1585	49.5	kW
007	BMEP ISO1585		kPa
008	Abs Inlet Pres	45	kPa
009			
010	Air Intake Temp	27.5	Deg C
011			
012	Chamber Temp	27	Deg C
013	Fuel Temp	25	Deg C
014	Fuel BSFC		g/kWh
015	Fuel Flow		kg/h
016	Fuel Pressure	125	kPa

Run Step	LOOP 1	LOOP 2	LOOP 3	LOOP 4	LOOP 5	LOOP 6	Status	Run Fric
1	500	1	20					<input checked="" type="checkbox"/>
2	500	1	30					<input type="checkbox"/>
3	500	1	40					<input type="checkbox"/>
4	500	1	50					<input type="checkbox"/>
5	500	1	60					<input type="checkbox"/>
6	500	1	15					<input type="checkbox"/>
7	500	1	25					<input type="checkbox"/>
8	500	1	35					<input type="checkbox"/>
9	1000	1	10					<input checked="" type="checkbox"/>
10	1000	1	20					<input checked="" type="checkbox"/>
11	1000	1	30					<input checked="" type="checkbox"/>
12	1000	1.05	30					<input checked="" type="checkbox"/>
13	1000	0.9	30					<input checked="" type="checkbox"/>
14	1000	0.8	30					<input checked="" type="checkbox"/>
15	1000	1	40					<input checked="" type="checkbox"/>
16	1000	1.05	40					<input checked="" type="checkbox"/>
17	1000	0.9	40					<input checked="" type="checkbox"/>
18	1000	0.8	40					<input checked="" type="checkbox"/>
19	1000	1	50					<input checked="" type="checkbox"/>
20	1000	1.05	50					<input checked="" type="checkbox"/>
21	1000	0.9	50					<input checked="" type="checkbox"/>

The I-CAM tab is sub-divided into two tabs, the **Schedule** tab and the **Spark Sweep Chart**. The Schedule tab shows the loaded Sweep Schedule together with a status indication when active.

To the left of the screen there are two dials showing Engine Speed and Torque. Below these two dials is a small channel display area. This shows the channel list as defined in the main V12 test editor. To navigate around the channels, click with the left mouse button on any of the channels, then use the cursor keys and Page-Up/Page-Down keys to scroll through the channels. If a low or high alarm occurs on any of the channels whilst the system is running, then the display will change to show the block of 16 channels that contains the alarm channel. The alarm channel will be highlighted in RED for a high alarm and in BLUE for a low alarm.

The engineer defines in the schedule file the Loop set-points and whether a step is to be run together with the option to carry out a friction test at the end of a step.

The set-points for each step are displayed in the spreadsheet, together with tick boxes to indicate whether the step is to be run and whether a friction test is to be carried out at the end of the step. The operator is able to change the state of a tick box by clicking on the box. The button can have two states:

In this state the feature will not be run

In this state the feature will be run

There are twenty one numbered steps displayed at any one time. To scroll through the steps click with the left mouse button on a cell within the spreadsheet, then use the cursor keys and the Page-Up and Page-Down keys to navigate around the spreadsheet.

Starting and Stopping a Schedule

Before starting the sweep it is important that the operator ensures that the CADET V12 Test System is ready to carry out the test and that all relevant systems have been started.

CP Data Sheet



To start the sweep sequence the operator should click on the “Run” button.

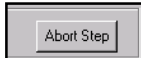
Once a test is running it can be stopped and reset by clicking the “Stop and Reset” button. Clicking this button will halt the system at its current point in the test and set a UserVariable flag to indicate that the system has been stopped. I-CAM is reset as if the steps schedule had not been run.



If a schedule has been stopped then the Status Column can be cleared by clicking the “Clear Status” Button.

The Status Column indicates the condition of each step. If it is blank, then that step has not been run. Whilst running a step the Status Column will change to read “Logging”, indicating that the step is active.

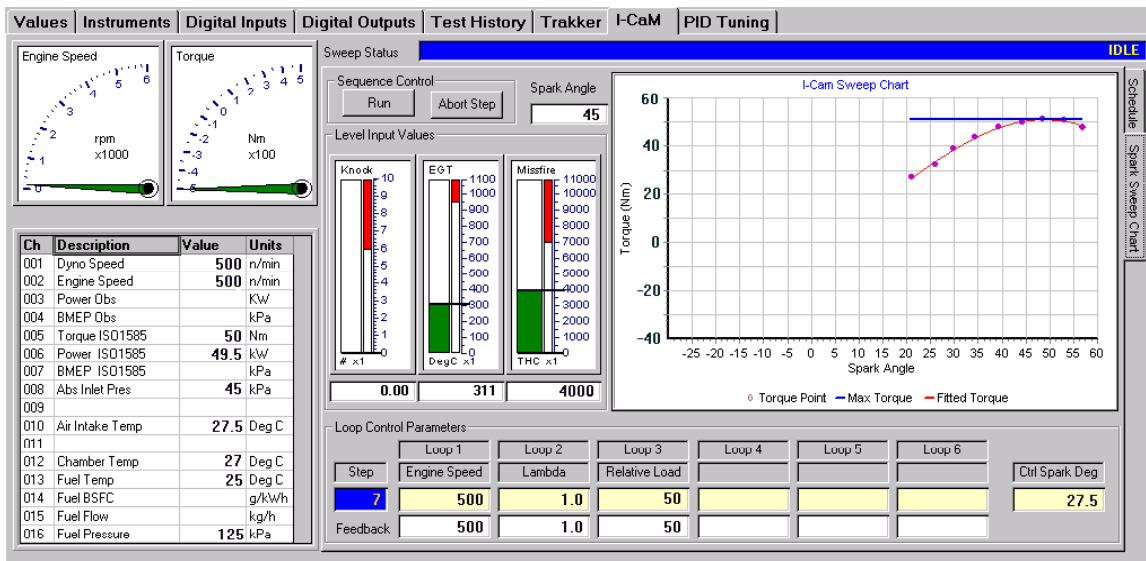
Manually Aborting a Step



Once a step is active the operator can abort the step by clicking the “Abort Step” button.

If a step is manually aborted then a message in the Status Column will indicate such. I-CAM will automatically move on to the next step in the schedule.

Spark Sweep Chart



Once the test has started the operator can switch to the “Spark Sweep Chart” to get a real-time display of the sweep process. From the Spark Sweep Chart the operator is able to monitor the primary Step set-points and feedback parameters.

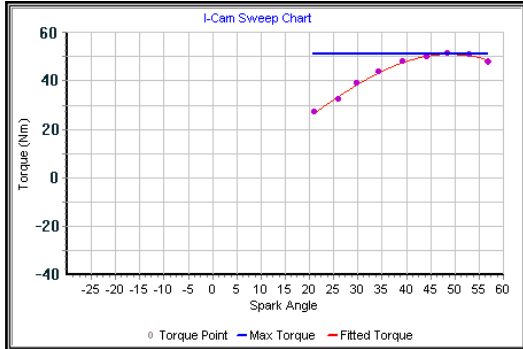
Loop Control Parameters							
	Loop 1	Loop 2	Loop 3	Loop 4	Loop 5	Loop 6	
Step	Engine Speed	Lambda	Relative Load				Ctrl Spark Deg
7	500	1.0	50				27.5
Feedback	500	1.0	50				

CP Data Sheet

The current Step number being run is indicated together with the Loop set-points and the current required spark angle. It is to be noted that the "Ctrl Spark Angle" is the spark angle adjustment made away from base-map and as such will not necessarily be the same value as the Actual Measured Spark. When a set-point has been successfully achieved, the background colour of the Loop set-point will change to GREEN.

For each of the Loop set-points, the input channel feedback associated with the Loop set-point number is also displayed.

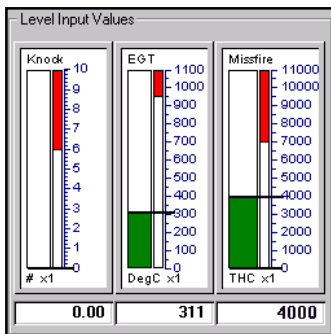
The I-CAM Spark Sweep Chart Display



The I-CAM Sweep chart displays each data log point as the system is progressing through the spark sweep.

The user can zoom into an area of the chart by holding down the left mouse button and dragging down and to the right, releasing the mouse button when the required area has been marked out. To zoom out, hold down the left button and drag up and the left, then release the mouse button. To pan around the chart after zooming in, hold down the right mouse button and move the mouse, releasing the mouse button when finished.

Initially the forward spark sweep is carried out to determine whether, at the Loop set-points, the engine is MBT (Mean Best Torque), or BLD (Borderline Detonation) limited. A second order curve fit is used to fit the data to determine MBT. When the system completes the forward sweep, it will begin a reverse sweep to find the EGT, or Misfire limit point. If during the reverse sweep the system finds that the Max Spark Angle has been reached then it will finish the reverse sweep logging the fact that this was the reason.



Level indicators inform the operator of the state of the primary I-CAM input channels.

During the reverse sweep the forward sweep data line is dimmed in colour whilst the reverse sweep line is drawn brighter.

At the completion of the sweep I-CAM will carry out a friction test if required. Once the entire step has been completed the "Status Column" for the Step will show either the MBT or BLD point. If the system was unable to arrive at the Loop set-points then the cause of the problem will be shown in the "Status Column".

The following are examples of results displayed in the "Status Column":

- MBT = 16.5 : MBT point found at 16.5 degrees Actual Spark Angle.
- BLD = 25.5 : BLD point found at 25.5 degrees Actual Spark Angle.
- Lost Loop3 : During the spark sweep, Loop set-point 3 could not be maintained.
- ? Loop3 : Loop set-point 3 could not be achieved.

At the completion of the schedule I-CAM sets a UserVar Flag to indicate that the schedule has completed.
06/2000