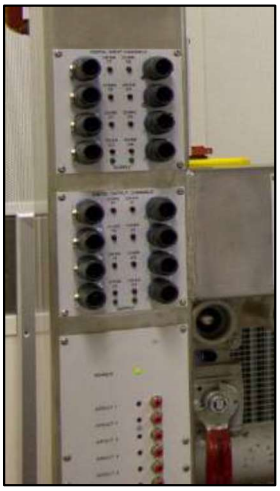
# CADET V14 Control, Automation and Data Logging System

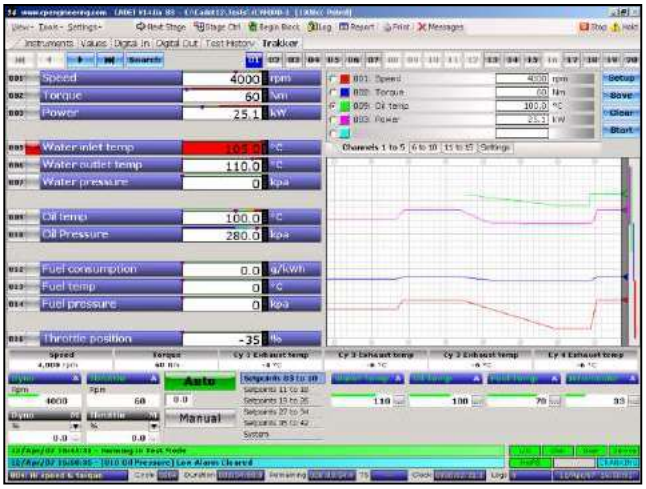
## CADET V14 Control, Automation and Datalogging System

Sierra-CPs first PC-based automation system was installed in mid 80s. Today the latest version of our powerful CADET Automation Technology is still at the heart of our system solutions. As an organization, our philosophy is to continually developing the CADET software and the CP128 control cabinet and data logging package means that we evolve the system architecture and implementation to meet the demands of an ever-changing marketplace. Covering a wide range of industrial applications, CADET serves engine, powertrain, transmission, emissions, analysis, vehicle and component testing.

CADET V14 is our most advanced system yet and includes innovations, many of which evolved directly from interacting with our customers specialized needs. Guided by our philosophy that we listen closely to our customers and do not try to force “one size fits all” solutions on them, we can rapidly adapt the CADET technology for our customers' unique applications. CADET is a truly open and intuitive software platform that provides a range of advanced features and benefits while assuring the flexibility to meet the demands of both current and future testing challenges.

CP offer a range of application specific additional software packages which complement CADET V14 such as our Test Laboratory System (TLS) which integrates seamlessly with the CADET V14 Test Automation software to provide a complete solution for configuring, and running tests, including auto compiling and generating test report data to assist the efficiency of the test and development process, on a bed by bed of facility basis.






# CADET V14 Software Overview

## Scope

This document provides an overview of the improvements made to the functionality of CADET V14.3 compared to the earlier CADET V12.5.

For a detailed explanation on individual aspects and capabilities the reader should contact CP Engineering Systems.

## Summary

| | |
|---|---|
| • Channel capacity | Increased |
| • User interface | Updated |
| • Input channel linearization | Added |
| • Transient logging feature | Added |
| • Test schedule sub-routines | Added |
| • Test schedule table loader | Added |
| • PID tuning | Now available during normal test running |
| • Channel calibration | Now available during normal test running<br>Added Calibration History viewer and printing |
| • Security levels | Now changeable during normal test running<br>Settable from menu option or USB key |
| • OBD II interface component | New |
| • Chassis Dynamometer component | Significant enhancements |
| • Vehicle Robot component | Significant enhancements |
| • CAN interface component | Significant enhancements |
| • TRACE | Added power curves and X-Y plot feature |
| Multi-threaded software design | Takes advantage of multi core processors and hyper threading technology |

## Channel & variable capacity

| Description | V12.3 | V12.4 | V12.5 | V12.6 | V14.1 | V14.2 | V14.3 |
|---|---|---|---|---|---|---|---|
| | 2003 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| Logical channels | 512 | | | | | 1024 | |
| Physical input channels | 256 | | 512 | | | | |
| Physical output channels | 64 | | 128 | | | | |
| Digital input channels | 64 | | 256 | | | | |
| Digital output channels | 64 | | 256 | | | | |
| Primary set points | 2 | | | | | | |
| Secondary set-points | 18 | | 60 | | | | |
| PIDs | 16 | | 64 | | | | |
| User variables | 200 | 500 | | | | 1000 | |
| User text | 25 | 200 | | | | | |
| Control functions | 32 | | | | | | |
| EPP channels | 16 | | | | 24 | | |
| ASAP-3 monitored channels | 25 | | | | 100 | | |
| ASAP-3 set points | 12 | | | 14 | 50 | | |
| CAN interface ports | 2 | | 8 | | | | |
| CAN variables | 64 | | | | | | 100 |
| CP128 device channels | 1 | | 5 | | | | |
| CP128 device channel data rate | 115200bps | | 921600bps | | | | |
| Internal channel resolution | 16-bit | | 32-bit | | | | |
| Digital control resolution | 16/32-bit | | 32/64-bit | | | | |

# Components & tools

| Description | V12.3 | V12.4 | V12.5 | V12.6 | V14.1 | V14.2 | V14.3 | |
|---|---|---|---|---|---|---|---|---|
| | 2003 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | |
| **User interfaces** | | | | | | | | |
| Value display tabs | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Instruments display tab | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Digital Input display tab | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Digital Output display tab | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Trakker display tab | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| User Displays | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Calibration functionality | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| PID tuning functionality | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Test History/Datalog manager | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Test Manager (TLS interface) | | □ | □ | □ | □ | □ | □ | |
| **Tools** | | | | | | | | |
| Calibration history | | | | ■ | ■ | ■ | ■ | |
| Test Schedule editor | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Transient Schedule Editor | | ■ | ■ | ■ | ■ | ■ | ■ | |
| VSIM | □ | □ | □ | □ | □ | □ | □ | |
| Test Schedule upgrader | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| TSENC | ■ | ■ | ■ | ■ | | | | |
| **Communications interfaces** | | | | | | | | |
| CP-128 protocol | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| ASAP-3 | □ | □ | □ | □ | □ | □ | □ | |
| CAN | □ | □ | □ | □ | □ | □ | □ | |
| OBD II | | | | | □ | □ | □ | |
| MATLAB | □ | □ | □ | □ | □ | □ | □ | |
| AK protocols | □ | □ | □ | □ | □ | □ | □ | |
| Ethernet TCP/IP & UDP | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Serial (RS232/RS485/RS422) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| GPIB | □ | □ | □ | □ | □ | □ | □ | |
| Modbus | □ | □ | □ | □ | □ | □ | □ | |
| **Chassis Dynamometer**<br>**AVL, Brush, Burke Porter, CP Engineering, Froude, Labeco, Maha, MRW Merilab, Schenck, Superflow, Zoellner** | | | | | | | | |
| CP CDS | □ | □ | □ | □ | □ | □ | □ | |
| Burke Porter CDS using AK | | | | □ | □ | □ | □ | |
| Maha CDS using AK | | | | | □ | □ | □ | |
| CDS Power checker | | □ | □ | □ | □ | □ | □ | |
| Drivers Aid | □ | □ | □ | □ | □ | □ | □ | |
| NVH | | | | | □ | □ | □ | |
| **Emissions bench interfaces** | | | | | | | | |
| Horiba MEXA 9000 series | □ | □ | □ | □ | □ | □ | □ | |
| Horiba MEXA 7000 series | □ | □ | □ | □ | □ | □ | □ | |
| Horiba EXSA 1500 | | □ | □ | □ | □ | □ | □ | |
| AVL i60 series | | | | | | □ | □ | |
| Fischer Rosemount NGA2000 | | □ | □ | □ | □ | □ | □ | |
| Signal Instruments series 3 | □ | □ | □ | □ | □ | □ | □ | |
| Signal Instruments series 4 | | | □ | □ | □ | □ | □ | |
| **CVS interfaces** | | | | | | | | |
| Horiba 9000 series | □ | □ | □ | □ | □ | □ | □ | |
| Horiba 7000 series | □ | □ | □ | □ | □ | □ | □ | |
| Signal Instruments | □ | □ | □ | □ | □ | □ | □ | |
| Fischer Rosemount | | □ | □ | □ | □ | □ | □ | |
| **Miscellaneous instrumentation interfaces** | | | | | | | | |
| LA3 Lambda Meter | □ | □ | □ | □ | □ | □ | □ | |
| AVL 442 Blow-by meter | □ | □ | □ | □ | □ | □ | □ | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Horiba MEXA 1170 HFID | | □ | □ | □ | □ | □ | □ | |
| Horiba MEXA J series portable | | □ | □ | □ | □ | □ | □ | |
| **Combustion analysis and ignition timing** | | | | | | | | |
| AVL 620 Indiset | □ | □ | □ | □ | □ | □ | □ | |
| AVL 647 Indiskop | □ | □ | □ | □ | □ | □ | □ | |
| CP iCAS | □ | □ | □ | □ | □ | □ | □ | |
| IC 5460 ignition controller | □ | □ | □ | □ | □ | □ | □ | |
| **Fuel measurement interfaces** | | | | | | | | |
| CP FMS series | □ | □ | □ | □ | □ | □ | □ | |
| CP TFMS series | | □ | □ | □ | □ | □ | □ | |
| AVL 730 Fuel meter | □ | □ | □ | □ | □ | □ | □ | |
| AVL 733 Fuel meter | □ | □ | □ | □ | □ | □ | □ | |
| Pierburg KMA 4000 Fuel Meter | | □ | □ | □ | □ | □ | □ | |
| **Particulate measurement interfaces** | | | | | | | | |
| Sierra BG-2 and BG-3 particulates | | | | □ | □ | □ | □ | |
| AVL-415/415S Smoke meter | □ | □ | □ | □ | □ | □ | □ | |
| AVL 439 Opacity meter | □ | □ | □ | □ | □ | □ | □ | |
| AVL 472 particulates | □ | □ | □ | □ | □ | □ | □ | |
| NOVA microtrol 4 particulates | | □ | □ | □ | □ | □ | □ | |
| **Equipment interfaces** | | | | | | | | |
| CP Vehicle Robot | □ | □ | □ | □ | □ | □ | □ | |
| CP Transmission Robot | | □ | □ | □ | □ | □ | □ | |
| CP EMaCs ignition controller | □ | □ | □ | □ | □ | □ | □ | |
| **Instrumentation and rig systems** | | | | | | | | |
| CP Combustion Air Handling Unit | | □ | □ | □ | □ | □ | □ | |
| Sierra BG-2 & BG-3 particulates | □ | □ | □ | □ | | | | |
| CP Brake test rig | | □ | □ | □ | □ | □ | □ | |
| Horiba synthetic catalyst rig | □ | □ | □ | □ | □ | □ | □ | |
| Horiba SIGU synthetic catalyst rig | | | | | | □ | □ | |
| Oribital synthetic catalyst rig | | □ | □ | □ | □ | □ | □ | |
| **Special functions** | | | | | | | | |
| Data archiver | □ | □ | □ | □ | ■ | ■ | ■ | |
| Transient Scheduler | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Emissions bench & CVS controller | □ | □ | □ | □ | □ | □ | □ | |
| TVS mapper | | □ | □ | □ | □ | □ | □ | |
| iCAM | □ | □ | □ | □ | □ | □ | □ | |
| Engine test automation (TLS) | | □ | □ | □ | □ | □ | □ | |
| Vehicle test automation (TLS) | | □ | □ | □ | □ | □ | □ | |
| **Test sequencing** | | | | | | | | |
| Test stage control | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Test schedule sequencing | ■ | ■ | ■ | ■ | | ■ | ■ | |
| Test Laboratory System (TLS) | | □ | □ | □ | □ | □ | □ | |
| Production test system (PTS) | | | | | | □ | □ | |
| **Data Analysis and Exporting** | | | | | | | | |
| Datalog exporter | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| TRACE | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| TTAS (Transmission Shift test) | □ | □ | □ | □ | □ | □ | □ | |
| ALR (Regulatory calcs) | □ | □ | □ | □ | □ | □ | □ | |
| EmanRep (Regulatory calcs) | □ | □ | □ | □ | | | | |
| TLS (Regulatory calcs) | □ | □ | □ | □ | □ | □ | □ | |
| Trace To CSV exporter | | ■ | ■ | ■ | ■ | ■ | ■ | |

Key symbol ■ Standard feature □ Optional feature Blank: not available

Key colour BLACK: No change GREEN: Bug fix or minor change RED: New or significant change

## Updated user interface

The V14 user interface has been updated to include the following new features over V12:-

- Dual screen operation
- New layouts for Values, Instruments, Digital i/o, Trakker, Calibration, PID tuning & Test History displays
- Configurable User Display layout pages
- Primary set-points and up to 8 Secondary set-points displayed at the same time
- Mode of both primary set-points can be changed at same time using pop-up dialog box
- Manual entry of primary set point values using pop-up dialog box
- System status mini-tab showing log file paths and calibration time remaining
- Menu and button control bar added at top of window
- Test status indicators moved to bottom of window
- Flashing indicator indicates out of calibration
- Four configurable function buttons to call event, stage jump, e.g. for idle no load
- Averaged manual log (in addition to original snap shot), editable drop list for average time
- Fixed value, Dial and Trakker displays use standard logical channel names
- Drag any logical channel to a fixed channel, trakker or dial display position

## Dual screen support

- Choose between dual or single screen operation
- Minimise/Maximise individual screens
- Easily move ‘tabs’ between the screens using button click
- Hide/show tabs from menu option
- Save tab selection and position using layout configurations

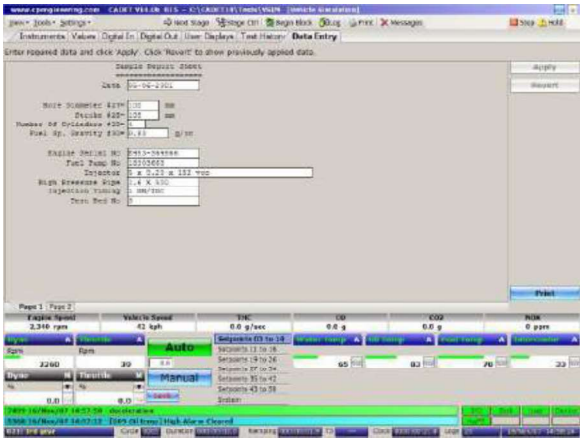
## User displays

V14 user displays allow customised screen layouts to be created and have been significantly enhanced over previous versions of CADET:-

- 8 configurable pages
- Change the layout during normal test running
- Use drag & drop and pop-up menu features to move controls and assign channels
- Use dials, bars, digital input & output, fixed value GUI controls
- Layout grid shown when in design mode
- Save tab selections using screen layout configurations
- No Visual Basic programming required

## Data entry tab

The new V14 data entry tab replaces the report sheet in previous versions of CADET:-




## PID tuning tab

The V14 PID tuning function has been enhanced to include the following additional features

- PID tuning tab can be shown or hidden at any time from a menu option, previous V12 versions restricted this feature to a special mode of operation.

## Security access feature

The V14 security access feature has been enhanced over previous V12 versions with the following additional features:-

- Use menu option to change the current security levels whilst the system is running a test
- Inserting a previously registered USB drive allows automatic login at a configured level

## Channel calibration

The V14 Calibration function has been significantly enhanced over previous versions of V12 to include the following additional features:-

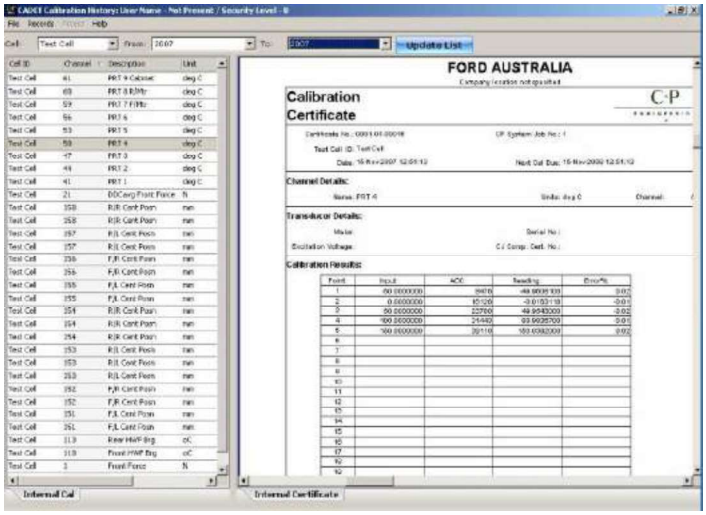
## Calibration function

- Calibration tab can be shown or hidden at any time from a menu option, previous V12 versions restricted this feature to a special mode of operation
- Up to 100 calibration points (V12 supported 5 points)
- Linearization
  - Polynomial (up to 5$^{th}$ order), optionally specify zero error point
  - Look-up table (up to 100 points)
  - Linear fit (least squares), optionally specify zero error point
- Definition of sensor characteristic by online calibration or from external calibration data
- Import & export of sensor characteristic & info to CSV format text file
- Standard sensor characteristics for K, J, T, N, B, E, R & S type thermocouples (V12 required user code)
- Selection of optional compensation channel if applicable (e.g. cold junction channel for thermocouples)
- Load cell calibration, calibrator definition stores individual weight information
- Calculation of hysteresis at each calibration point, and maximum, when calibrating load cells
- Calculation of non-linearity (end-point method) at each calibration point, and maximum
- Named calibrator definitions
- Channel reading offset (tare) adjustment option
- Configurable value of acceleration due to gravity optionally specified in [System] section of CADET.INI file for calibration of load cell using weights
- Calibration record written to history file each time a calibration is performed
- Online printing of calibration record certificate through the existing CADET print manager
- Spreadsheet style display of calibration data
- Select channel from a logical or physical channel list

## Calibration manager tool

V14 provides a new tool for offline viewing of CADET calibration records and certificate printing:-

- Installed on the local CADET system controller or office PC to allow remote viewing of calibration history from multiple CADET installations
- View entire calibration history for each channel
- Filter calibration records by test cell and year
- Print certificates for any calibration record
- Export certificate data to EXCEL & HTML format files




## Calibration certificates

V14 channel calibration certificates have been redesigned to provide all available calibration data:-

- Revised layout, may span multiple pages
- Sensor characteristic data if defined
- Sensor compensation channel details if applicable (e.g. cold junction channel for thermocouples)
- Extended calibrator data (e.g. weights information when calibrating load cells)

## Calibration status check

- Current overall input channel calibration status indicated on running screen
- Optionally enable calibration status checking on individual channels

## Input channel linearization and compensation

- Performed at system control rate
- Single input channel requirement for thermocouples (V12 required two per thermocouple)

# Test Schedules

## Sub-routines

- Test flow stage call and return allows groups of stages to be treated as a sub-routine
- Event based stage call and return, similar to above but returning to the time-into-stage calling point
- Sub-routine stack stored at shutdown allowing test continue from this point
- Stage table loading using Test Manager allows manual loading of stage definitions and events etc. into currently running test.

## Test sequences

- Create sequences of multiple CADET test schedules with loops and variable initialisation

## Configuration

- Test schedule editor stage import allows stage data to be imported from CSV format file
- Edit test stages from a running test

## User code

- Write user code in VB6 or VB.Net syntax

## Chassis Dynamometer and Road load simulation

The Chassis Dynamometer component has been extended:-

- Support for up to 10 independently driven dynamometers
- Support for bidirectional operation, forward and reverse
- Support for installed direction (allows vehicle to be mounted on rolls facing ether way)
- Increased speed measurement resolution
- Simplified configuration settings

## Vehicle Robot

The Vehicle Robot component has been extended:-

- Improvements to manual pull-away, clutch wear detection
- Support for motor cycles and 3-wheeler vehicles with various actuation methods
- Support for automatics has been enhanced for modern tip-tronic style
- Optional drive violation detection

## CAN interface

The CAN component has been redesigned to enhance functionality and simplify use:-

- Uses standard CAN DB files for message definition
- Map up to 100 CAN variables directly to physical channels, user variables, set-points and digital I/O using configuration file
- Variables can be updated at control rate, with faster repeat using interface card
- Supports single/dual port National Instrument interface cards
- Supports multiple interface cards with up to 8 ports in total
- No Visual Basic programming required

## OBD interface

New interface to OBD II port.

## ASAP-3

- TCP/IP or serial communications interface options
- 50 set-points
- 100 monitored channels

## TRACE analysis package

- New tabbed interface
- X-Y plot feature for power curves

# CADET Compact – Control and Data Logging System

## Introduction

CADET-Compact offers an easily expandable solution to meet the needs of educational establishments, smaller companies or those who require accurate dyno and engine control but with limited monitoring channels. CADET-Compact uses the same control and data logging system and base structure as the Full CADET V14 systems but with a reduced channel count and associated cost.

CADET-Compact Modular components are:

- 12U Cabinet including
  - 3U Control rack
  - 3U Datalogging rack
  - System Controller PC
- CADET-Compact Software
- Winged Keyboard Operator Interface
- Dyno Control and Engine Electrics Box
- AT12 Throttle Actuator
- In-Cell Transducer Box with Starter Module

## Benefits and Features

- Cut-Down version of our latest software, not ‘previous version’ software
- Integrate into existing test cell hardware, dynamometers etc.
- Compact Design
- Plug Socket Installation
- Easily Expandable

## Applications

- Basic Control with Protection and Data logging
- Durability Work
- Additional Beds to Compliment Other Research Beds

Initial purchase that can be upgraded to a full CADET system

## System Description

### Cabinet

The CADET-Compact cabinet houses the two CP i/o racks and also the rack mounted system controller PC.
The cabinet includes all the termination for the control, safety and data-logging sub-systems such as the Engine Protection Panel.
Any wiring associated with in-cell equipment is terminated into modules within the cabinet that provide a multi-way connection for onward connection using the supplied looms. The looms are soldered to multi-way connectors at each end, these are then connected to the corresponding connector in the cabinet and also the connector in the in-cell enclosures.

### Operator Interface

The winged keyboard, display, mouse and system control PC are all connected to the CADET-Cabinet by 3m flying leads.

The winged keyboard enables the operator to enter test information with the QWERTY keyboard, abort tests using the E-stop mushroom, enter a RESET condition after a shutdown and silence the Alarm.

The incremental Optical Encoders allow the operator to take manual control of the throttle and dyno.

Note: A monitor is not supplied as part of this system.

## Software

At the heart of the CADET-Compact system is the control software, this enables full control of the Dyno and Throttle Actuator, as well as monitoring the selected datalogging channels.

CADET-Compact also provides calculated channels to be created using information from the monitored channels. For test writing CADET-Compact allows up to 10 stages to be written. These can be looped to provide additional test stages or Transient Schedules can be called from within a test. A Transient Schedule is a schedule of pre-written setpoints in a prescribed format within an Excel spreadsheet.

CADET-Compact uses a cut down version of the full control CADET V14 software. All controls and displays are of the same format so all the design benefits of the fully developed version are available.

Features of CADET V14 available at the Operator Level allow tests to be defined, run and data results processed. Test strategies can be defined easily at the computer screen by entering information into simple to understand forms.

Tests may use control processes previously defined at the Engineering Level and simply define the required set points and, if required, any additional control constants. The test editor allows the creation of Event Based Test Flow (EBTF) that will allow test strategies to be developed with little, or no computer programming knowledge.

## AT12 Throttle Actuator

The AT12 is an enclosed DC motor driven Throttle Actuator that forms part of the CADET-Compact Dynamometer and Throttle control system. The actuator provides performance suitable for applications ranging from small two stroke engines up to heavy diesels and Racing Engines.

## Dyno Control and Engine Electrics Box

This in-cell box contains the power modules for the Throttle Actuator and EC dyno's.
There are four relay switched low voltage terminals, that switch from a common power source connection such as an in-cell power supply or Battery. These can be switched on or off with the associated Digital Output during tests. They are typically linked to ECU, Fuel, Glowplugs and Ignition. There are connections to the PRT sensors on a cooling post.
The Transducer Panel below is mounted on the front of the door this allows a single box solution. The panel has a plug socket connector and can be removed and installed into a transducer box later if the system is expanded.
The Oil Switch is fitted to the bottom of the box with a threaded connection.

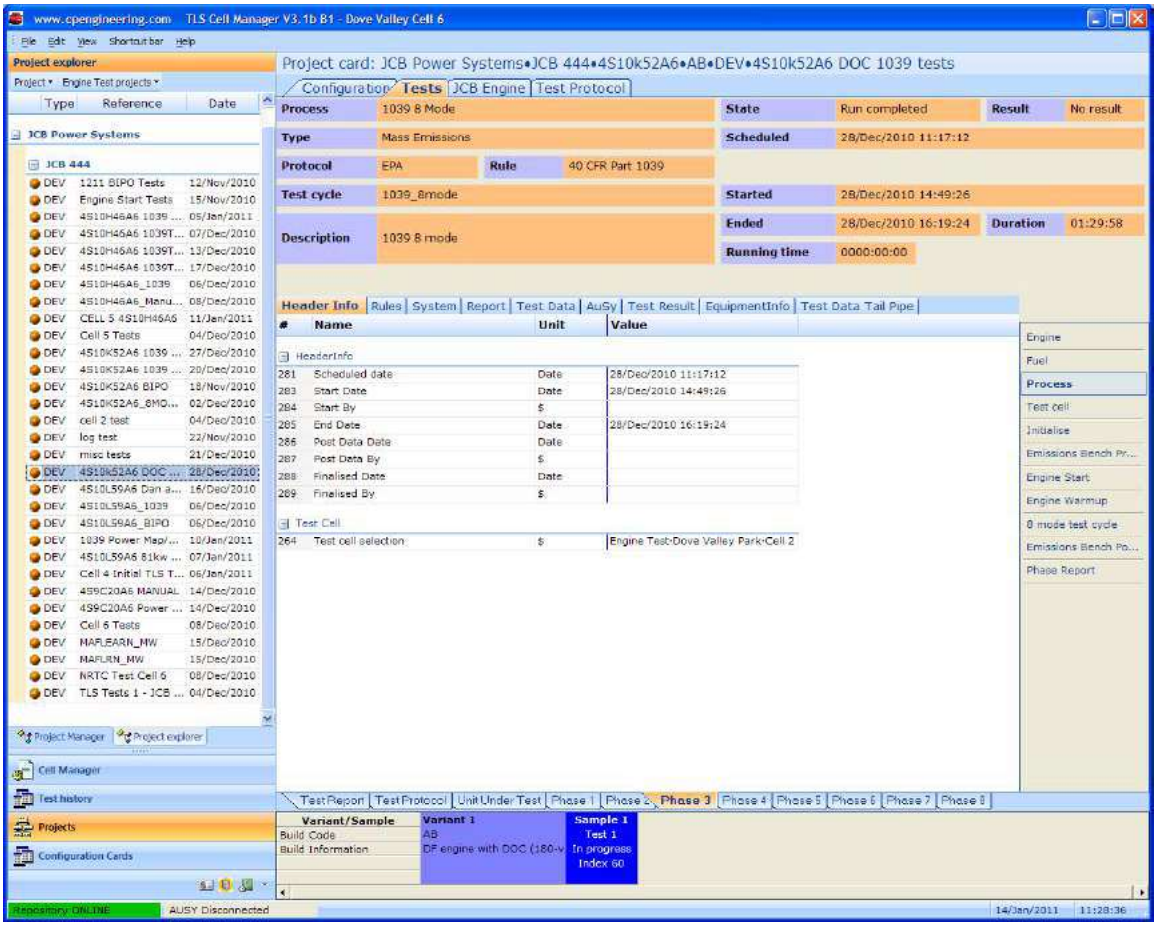
## In-Cell Transducer Panel

The new CP Transducer Panels are a modular system with a variety of configurations. They have a 37 way D type connector on the back which connects to a matching daughterboard PCB in the control cabinet with a standard looms. Different modules can be purchased initially or later to provide different configurations of channels within the system.

The modules have been designed to offer a flexible solution to most testing needs. A loom is connected to 3 or 4 of the CP128 datalogging cards to offer 16 channels.

The system is supplied as standard with the Starter Module, this has the following datalogging channels:

- 7 off K-type Thermocouples
- 2 off PRT's
- 2 off Auxiliary Voltage Channels
- 1 off Cold Junction Compensation




# Test Laboratory System TLS