

REO-dEC R2

REO-dEC R2 is the second generation Engine and Dynamometer Controller designed and built by 6dm Ltd. Based on the original Reo systems designed by Klas Real time systems, 6dm have continued to develop and add features to the originally successful product.



REO-dEC R2 offers outstanding features while maintaining the ruggedness that is required in the engine testing environment.

Based on Intel i7 technologies with Microsoft Embedded OS, REO-dEC R2 is designed from the base up to be as reliable a platform as is possible. The End-User sees no evidence that there is a Windows OS in the background – in fact the End-User is not able to access the Windows environment. Using the Lockdown features provided as standard in the

Microsoft Embedded OS the keyboard and mouse can only be plugged into the rear two USB ports on the REO-dEC R2, all Windows key functions of the keyboard are disabled, blocking access to unwanted areas of the system. The front USB port of the REO-dEC R2 will only accept Flash Drives, and certainly will not allow the user to boot up the system other than from the internal SSD unit. The front USB Port allows a Flash Drive to be inserted for datalog storage and for transfer of System Files to and from the Controller. All system files transferred to and from the controller are encrypted so cannot be tampered with. Datalog files are saved as non-encrypted Comma Separated Variable files (CSV).

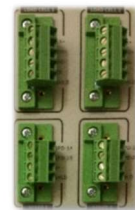
The Windows Embedded OS provides a File Based Write Protect Filter. Using the filter, the SSD Drive is protected from power failures and always boots back to its original state.

There are two built-in Ethernet Ports. One of these is dedicated to remote control from a testbed control and data acquisition system, the other for file transfer to/from the controller using a remote PC or for Remote Ethernet support. It is not possible for other access to the system through the Ethernet Ports.

When the system is powered on, the User is presented with a Logo that can be either a static bitmap or an animated GIF – No Windows Logo is presented. The Logo Screen (either a fixed bitmap or an animated GIF, both of which can be provided by the OEM) is presented for 10 seconds during which time the user is able to press the “Utilities” button to access the Controller Utilities Menu Screen.

Tandem Dynamometer Control is offered as an option. For Water Brake (Hydraulic Dynamometers), REO-dEC R2 offers individual control of each inlet and outlet valve for up to two dynamometers.

Each of the two Dynamometers can be fitted with a load cell (torque transducer) and speed input to the system.



Dynamometer Controller - Utilities

| | |
|-----------------------------------|--|
| KEYPAD | Access the Keypad |
| USB FILE-SET TRANSFER | Transfer File-Sets to/from USB Flash Drive |
| USB DATALOG TRANSFER | Transfer Datalog Files to a USB Flash Drive |
| ETHERNET FILE-SET TRANSFER | Transfer File-Sets across an Ethernet Connection |
| ETHERNET DATALOG TRANSFER | Transfer Datalog Files across an Ethernet Connection |
| EXIT | Exit The Utilities Menu |

| | | | | | |
|---------------|------|-------|-----|------|-----|
| Date and Time | Year | Month | Day | Hour | Min |
| | 2016 | 2 | 25 | 12 | 25 |

The Utilities Menu

From the Utilities Menu the User can select:

- KEYPAD
- USB FILE-SET TRANSFER
- USB DATALOG TRANSFER
- ETHERNET FILE-SET TRANSFER
- ETHERNET DATALOG TRANSFER
- EXIT
- Adjust System Clock Time

USB FILE-SET TRANSFER



Dynamometer Controller : USB File-Set Transfer

CONTROLLER FILES | **USB FILES**

File-Sets on Controller

222
333
444

↑

COPY TO USB

↓

Instructions

1. Select a File-Set located on the Controller
2. Click COPY TO USB to copy the File-Set to a USB Flash Drive located in the Front Panel USB Port

Note that any File-Set on the USB Flash Drive with the same name will be over-written

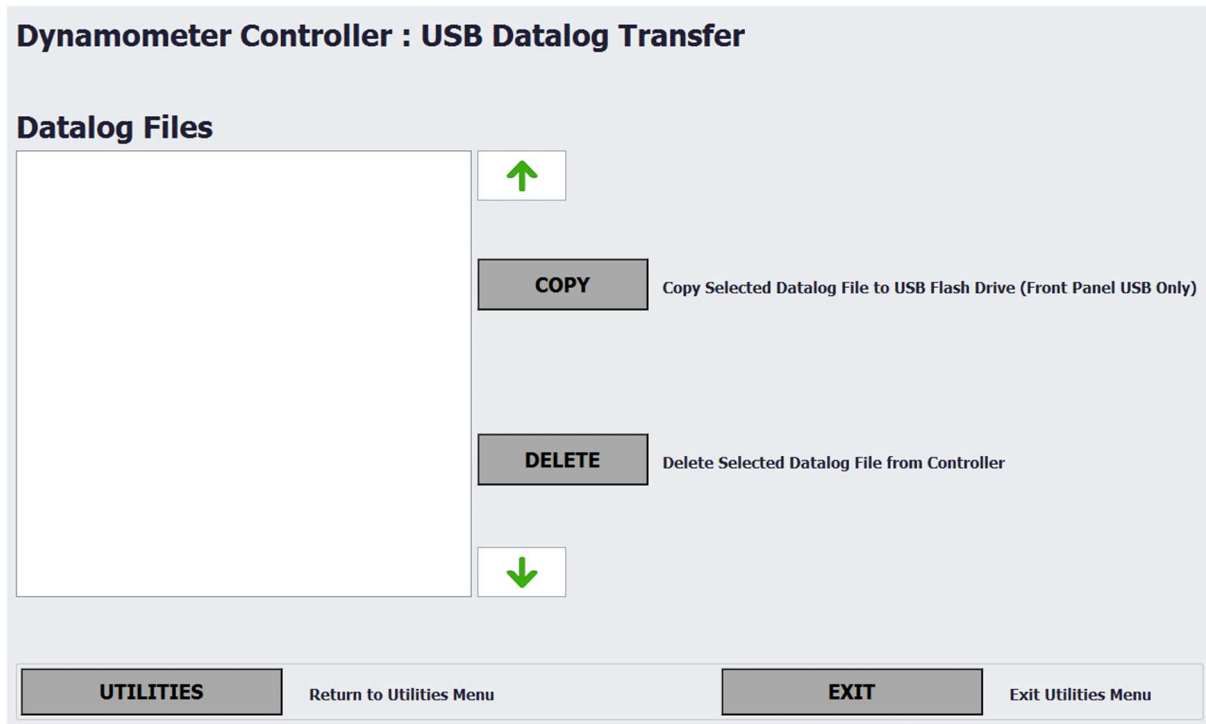
UTILITIES Return to Utilities Menu | **EXIT** Exit Utilities Menu

A File-Set defines a complete system configuration. Different Engine configurations may need a completely different configuration of the controller. These controller File-Sets are defined and stored on the controller. It is possible to transfer the File-Set to a USB Flash Drive for archiving and backup purposes. The File-Set can

be transferred back to the controller at any time. Alternatively, it is also possible to move a configuration from one controller to another. The File-Set is an encrypted file and is always tested for integrity before being used.

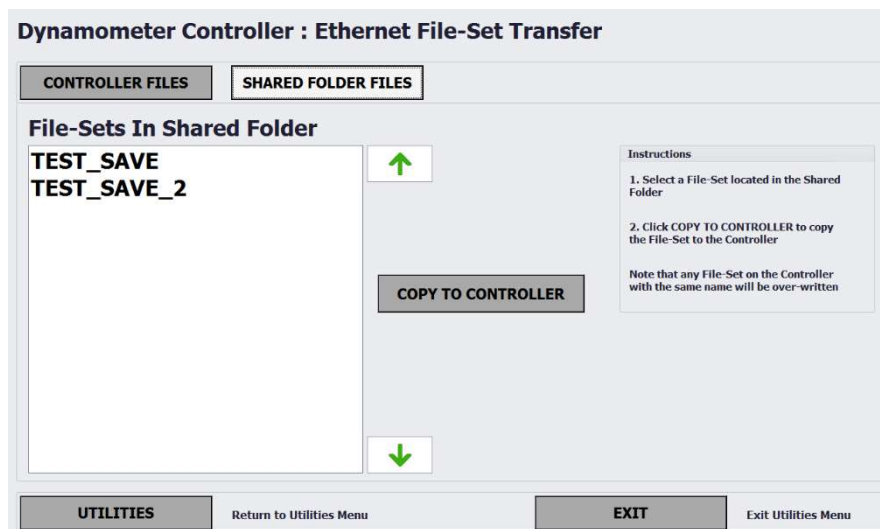
USB DATALOG TRANSFER

REO-dEC R2 allows datalogging to either the local SSD or to a Flash Drive. If datalog files have been stored on the local SSD then these can be transferred to a Flash Drive using the Utilities Menu.



ETHERNET FILE-SET TRANSFER

On some sites, the use of USB Flash Drives is not permitted. REO-dEC R2 provides the ability to transfer File-Sets to a remote PC over one of its Ethernet Ports.




The method employed to allow connection protects both the REO-dEC R2 Controller and the remote PC from unwanted actions. File-Sets can be transferred to and from the remote PC. As with USB Flash Drive transfer, all File-Sets are encrypted to ensure integrity.

ETHERNET DATALOG TRANSFER

Using the connection , it is possible for the user to transfer Datlog files that are stored on the local SDD to a computer connected via the Ethernet Port.


Dynamometer Controller : Ethernet Datalog Transfer

Datalog Files



COPY

DELETE



Copy Selected Datalog File to the Shared Folder

Delete Selected Datalog File from Controller

UTILITIES

Return to Utilities Menu

EXIT

Exit Utilities Menu

KEYPAD

The Keypad is used to allow the Engineer to access protected functions of the Utilities Menu:

Dynamometer Controller - Utilities

KEYPAD

USB FILE-SET TRANSFER

USB DATALOG TRANSFER

ETHERNET FILE-SET TRANSFER

ETHERNET DATALOG TRANSFER

EXIT

Access the Keypad

Transfe

Transfe

Transfe

Transfe

Please Enter Required Value

CLEAR

| | | |
|---|---|---|
| 7 | 8 | 9 |
| 4 | 5 | 6 |
| 1 | 2 | 3 |
| 0 | | |

CANCEL

OK

Exit The Utilities menu

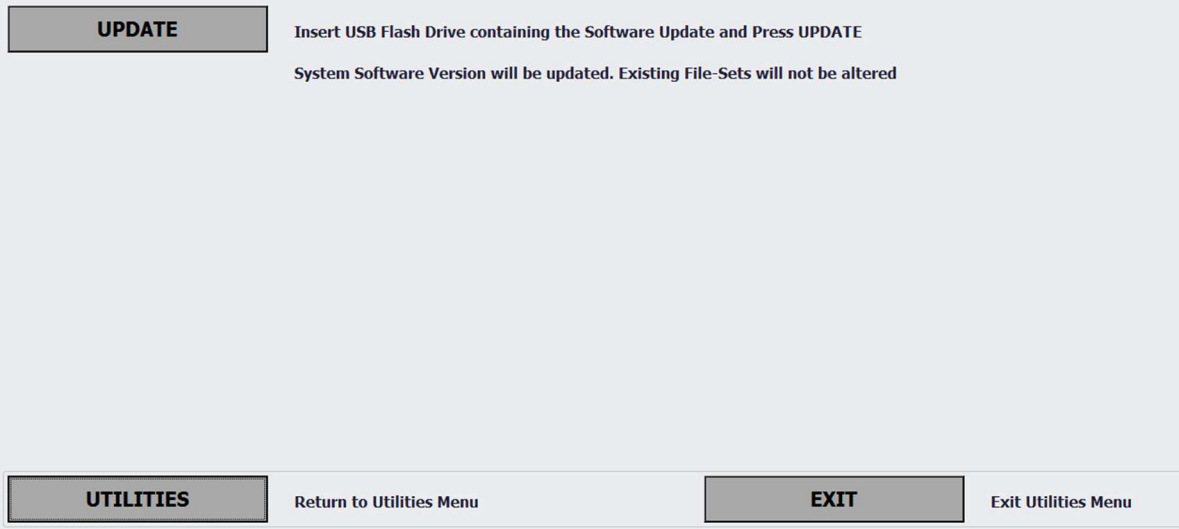
Date and Time Year: **2016** Month: **05** Day: **10** Hour: **21** Min: **32**

4 | Page

UPGRADE SYSTEM SOFTWARE

From time to time, the REO-dEC R2 software system has upgrades to its features included in new releases. Also, new releases may contain bug fixes to any issues found in the main software. Software Upgrades are provided to the User as an Encrypted file on a USB Flash Drive. By entering the required Password at the Keypad, the Engineer is able to access the Upgrade Feature.

Dynamometer Controller : System Software Update



UPDATE Insert USB Flash Drive containing the Software Update and Press UPDATE
System Software Version will be updated. Existing File-Sets will not be altered



UTILITIES Return to Utilities Menu **EXIT** Exit Utilities Menu

A Software upgrade does not affect the System Configuration. As part of the Upgrade Process, the existing system software is automatically backed up if the user wishes to return to using it.

RESTORE SOFTWARE

Dynamometer Controller : System Software Restore / Reset

Available Versions


RESTORE
FACTORY RESET


Instructions

Previous Versions of the system software are available for use if required.

1. Select the required version in the AVAILABLE VERSIONS list.
2. Click the RESTORE button to return to the selected software version.

The existing File-Set is not changed - only the software version.

FACTORY RESET restores the entire system back to the initial Factory Condition.

UTILITIES Return to Utilities Menu **EXIT** Exit Utilities Menu

On entering the correct Password at the keypad, the Engineer gains access to the **System Software Restore / Reset** feature. This allows previous versions of the software to be selected for use. Also, the User is able to completely reset the system back to the Factory Default condition and the version of the software that was installed when the system was delivered.

The User/Engineer can exit the Utilities Menu at any time and return to the controller where it will continue to start up.

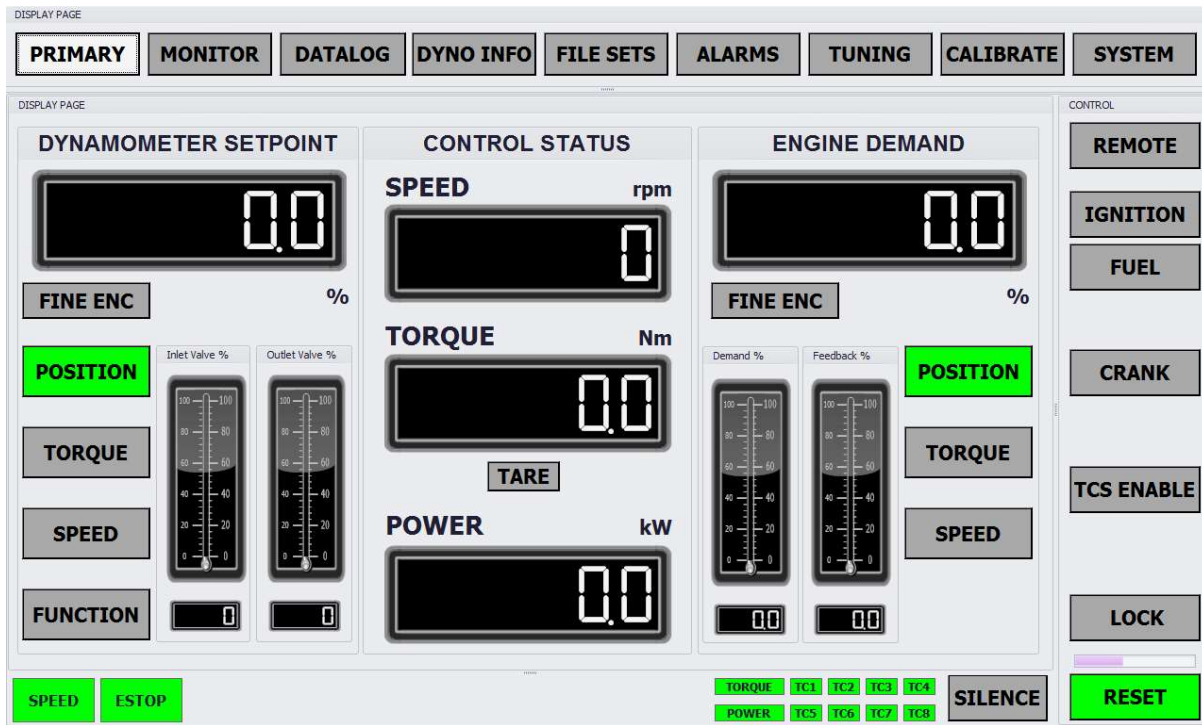
REO-dEC R2 : Controller

The 12" high resolution Touch Screen is used to interface between the User and the Controller. Once the Start-Up cycle has completed the User is presented with the REO-dEC R2 screen display:

The Dynamometer and Engine demands are manually controllable using hi-precision optical encoders mounted on the front of the REO-dEC R2 controller.

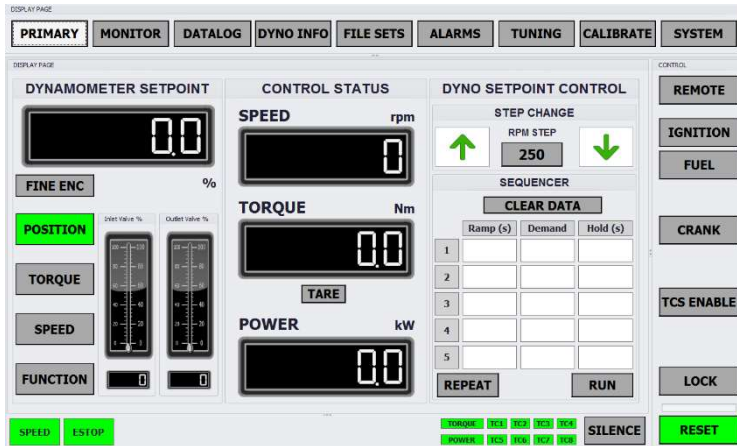
Various Controller pages are selectable by pressing the buttons at the top of the controller screen.

PRIMARY



The Primary Display Page allows the user to select the control modes for the dynamometer and the engine. The user is also able to monitor the demands and to access various user defined push buttons on the right of the screen.

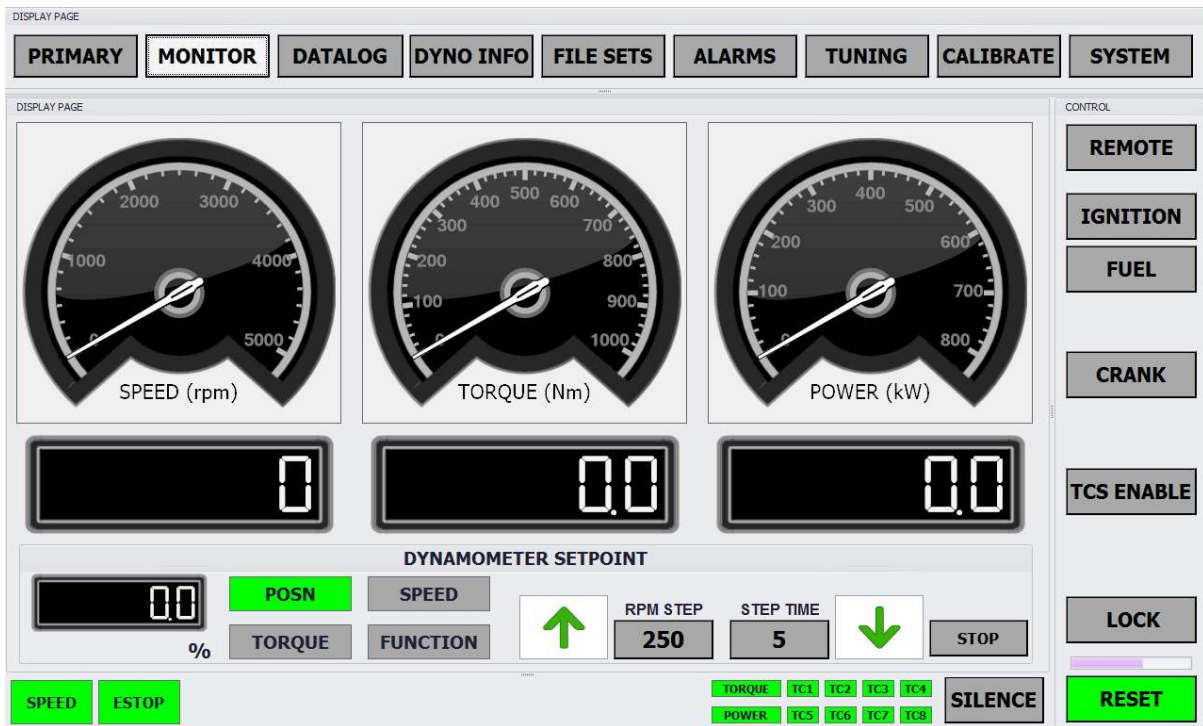
This display page varies depending on the system configuration:



If no Engine Control is required, then the right hand side of the page introduces a simple Test Step Controller for the Dynamometer.

There are other configurations that support Tandem Dynamometers.

MONITOR



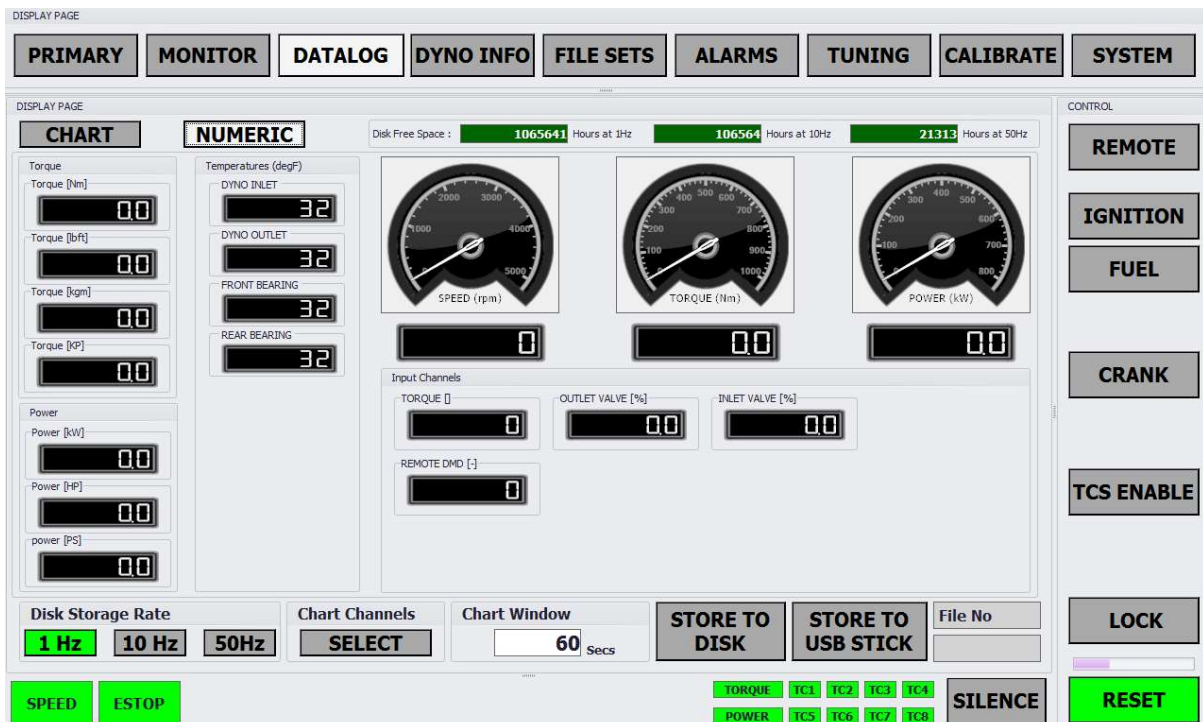
The Monitor Display Page allows the user to view the primary controller channels, Speed, Torque and Power on three user configurable dials. A simple Manual Dyno Demand facility is also provided.

DATALOG



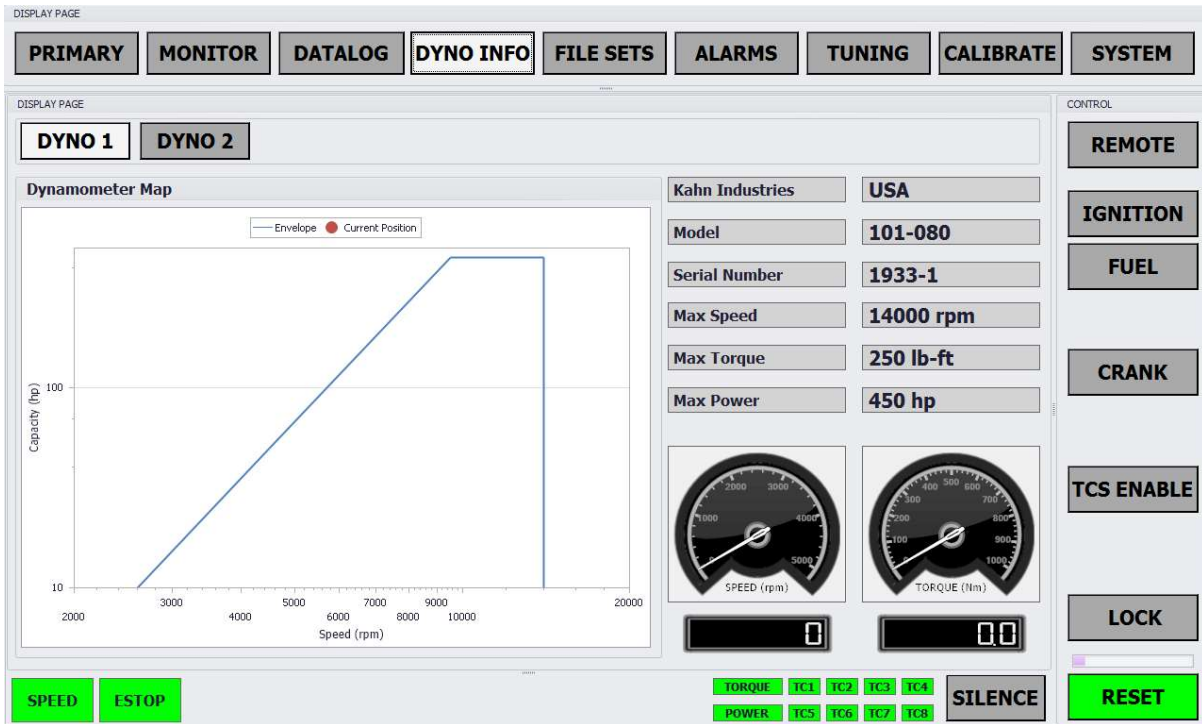
The Datalog Display Page provides continuous data logging to the local SSD or to a Flash Drive. The user is able to select 1Hz, 10Hz and 50Hz logging. Data is stored as standard CSV file format.

A graphical display also allows the user to select up to 6 channels that are plotted on the display in real-time.



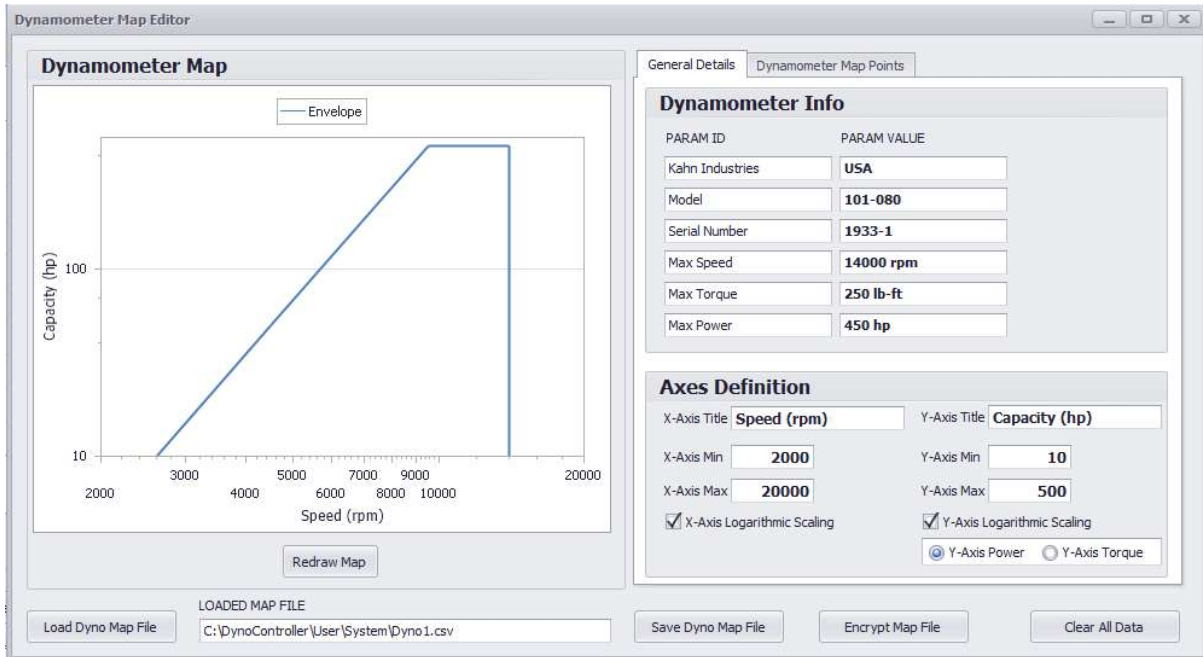
The user can select to display the data that is being stored to disk on a Numeric Display Page as shown above.

DYNO INFO



The Dyno Info Display Page presents the Dynamometer Curve for the Dynamometer. The REO-dEC R2 system monitors the current Speed and Torque (or Power) and plots this in real-time on the chart allowing the user to see that the operating point is within the operational range of the dynamometer.

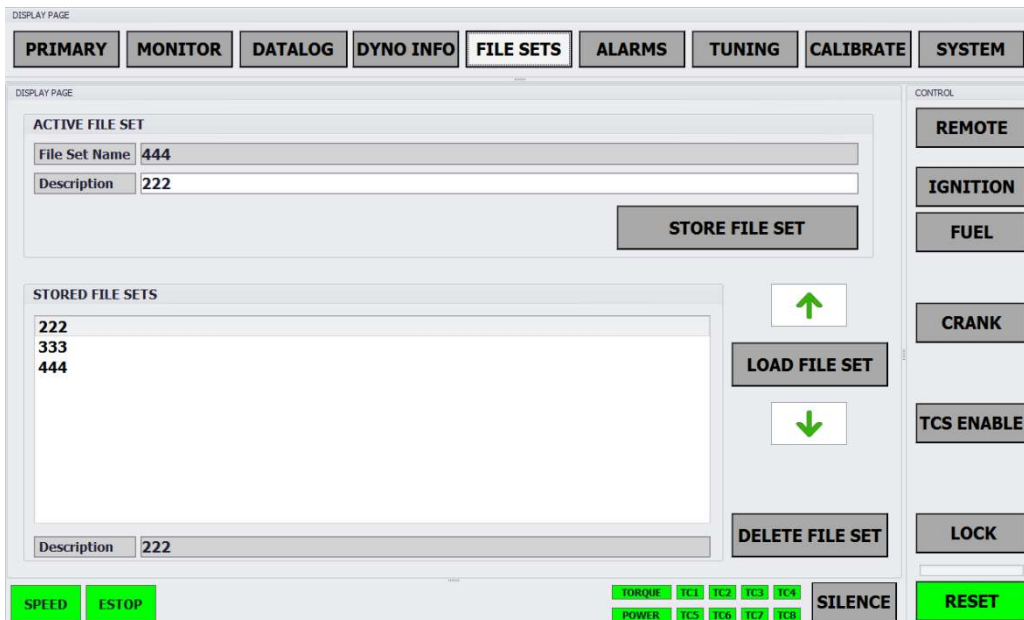
A utility is provided for the Engineer to produce the information on this Display Page.



This utility, shown above, is provided for running on a separate PC. The Map is encrypted and transferred to the Controller using on the the options available on the REO-dEC R2 Utilities Menu.

FILE SETS

REO-dEC R2 allows the suer to save and load complete File-Sets. A File-Set describes the entire controller configuration. Any number of File-Sets can be saved and reloaded for different engine and dynamometer configurations.



ALARMS

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS **ALARMS** TUNING CALIBRATE SYSTEM

DISPLAY PAGE

ALARM PANEL CONFIGURATION

| Ch No | Description | IP Ch | Lo SD | Lo Alarm | Hi Alarm | Hi SD | Alarm Type | Disable | DBS | Arming Delay (s) | Debounce (s) |
|-------|-------------|-------|-------|----------|----------|-------|------------|---------|-----|------------------|--------------|
| 1 | SPEED | Hz 1 | Blue | Cyan | 5000 | 6000 | 1 | N | N | 1 | |
| 2 | ESTOP | DI 1 | Blue | Cyan | 1 | 1 | 2 | N | Y | | 1 |
| 3 | | | Blue | Cyan | | | 1 | Y | N | | |
| 4 | | | Blue | Cyan | | | 1 | N | N | | |
| 5 | | | Blue | Cyan | | | 1 | N | N | | |
| 6 | | | Blue | Cyan | | | 1 | N | N | | |
| 7 | | | Blue | Cyan | | | 1 | N | N | | |
| 8 | | | Blue | Cyan | | | 1 | N | N | | |

TEMPERATURE ALARMS (degF)

| Ch No | Hi Alarm | Hi SD | Type | Ch No | Hi Alarm | Hi SD | Type |
|-------|----------|-------|------|-------|----------|-------|------|
| TC 1 | Orange | Red | - | TC 5 | Orange | Red | - |
| TC 2 | Orange | Red | - | TC 6 | Orange | Red | - |
| TC 3 | Orange | Red | - | TC 7 | Orange | Red | - |
| TC 4 | Orange | Red | - | TC 8 | Orange | Red | - |

GENERAL

Disable Below Speed: RPM

Note: Arming Delay(s) defined above is only active once the engine speed is above the defined DBS. Below DBS then if Arming Delay(s) is defined the channel will not alarm.

| | Hi Alarm | Hi SD | Type |
|-----------------|----------|-------|------|
| Max Torque (Nm) | Orange | Red | 1 |
| Max Power (kW) | Orange | Red | 1 |

CONTROL

REMOTE

IGNITION

FUEL

CRANK

TCS ENABLE

LOCK

SPEED ESTOP

TORQUE TC1 TC2 TC3 TC4

POWER TCS TC6 TC7 TC8

SILENCE

RESET

An extensive Alarm and Shutdown Monitoring System is provided. The Alarm configuration is stored as part of the File-Set described previously

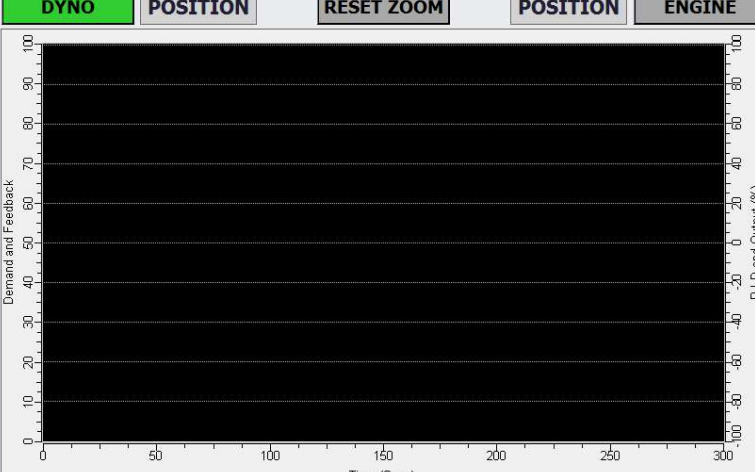
PID TUNING

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS **TUNING** CALIBRATE SYSTEM

DISPLAY PAGE

DYNO POSITION RESET ZOOM POSITION ENGINE



PID Adjustment

RAPID FINE

P Term I Term D Term

0.000 0.000 0.000

↑ ↓ ↑ ↓ ↑ ↓

Step Sequencer

| Ramp (s) | Demand | Hold (s) |
|----------------------|----------------------|----------------------|
| <input type="text"/> | <input type="text"/> | <input type="text"/> |
| <input type="text"/> | <input type="text"/> | <input type="text"/> |
| <input type="text"/> | <input type="text"/> | <input type="text"/> |

REPEAT RUN

Speed Torque Nm

DMD FB P I D OP

SPEED ESTOP

TORQUE TC1 TC2 TC3 TC4

POWER TCS TC6 TC7 TC8

SILENCE

RESET

CONTROL

REMOTE

IGNITION

FUEL

CRANK

TCS ENABLE

LOCK

The advanced PID Tuning Display Page allows the user to program a simple test step sequence to test the performance of the PID system. The graphical display shows:

- P contribution to the output
- I contribution to the output
- D contribution to the output
- The Output
- The Demand
- The Feedback

All these parameters are shown on the graph in realtime as the test sequence is followed.

The P, I and D terms can all be adjusted using the arrows under each active parameter. The PID values are stored as part of the File-Set described previously.

Input Channel Calibration

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING **CALIBRATE** SYSTEM

DISPLAY PAGE

Analog Inputs Output Channels Repeat Outputs **Torque CAL Check**

IP 1 IP 2 IP 3 IP 4 IP 5 IP 6 IP 7 IP 8 IP 9 IP 10 IP 11 IP 12

HZ 1 HZ 2 TC 1 TC 2 TC 3 TC 4 TC 5 TC 6 TC 7 TC 8

General Details

Channel Description Units Smoothing Eng Min Eng Max

TORQUE Units Smoothing .1 Eng Min 0 Eng Max 1000

TORQUE Calibration Units **N.m** lb.ft

Calibration Table

| Applied Eng | DAQ Value | ENG Value |
|--------------|-----------|-----------|
| Cal Min 0 | -0.005 | 0 |
| Cal Max 1000 | 9.724 | 1000 |

Calibration Check

| Applied Eng | CLEAR | Read Value | %FS Error |
|-------------|-------|------------|-----------|
| | → | | |
| | → | | |
| | → | | |
| | → | | |
| | → | | |
| | → | | |
| | → | | |
| | → | | |
| | → | | |
| | → | | |

Calibrate **Stored**

SPEED ESTOP TORQUE TC1 TC2 TC3 TC4 POWER TC5 TC6 TC7 TC8 **SILENCE** **RESET**

CONTROL

REMOTE IGNITION FUEL CRANK TCS ENABLE LOCK

REO-deC R2 provides a comprehensive calibration facility for all input and output channels.

Torque CAL Check

To ensure validity of Torque values, a multipoint loading and unloading dynamometer Calibration Check is provided.

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING **CALIBRATE** SYSTEM

DISPLAY PAGE

Analog Inputs Output Channels Repeat Outputs **Torque CAL Check**

Calibration Check - Loading Dynamometer

| Applied Eng | Read Value | %FS Error |
|-------------|------------|-----------|
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |

Calibration Check - Unloading Dynamometer

| Applied Eng | Read Value | %FS Error |
|-------------|------------|-----------|
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |
| | → | |

DYNO 1 DYNO 2

Torque **0**

Cal Check **Stored**

SPEED ESTOP TORQUE TC1 TC2 TC3 TC4 POWER TC5 TC6 TC7 TC8 **SILENCE** **RESET**

CONTROL

REMOTE IGNITION FUEL CRANK TCS ENABLE LOCK

Output Channel Calibration

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING **CALIBRATE** SYSTEM

DISPLAY PAGE

Analog Inputs **Output Channels** Repeat Outputs Torque CAL Check

OP 1 OP 2 **OP 3** OP 4 Use Dynamometer Demand Encoder to adjust demand voltage levels when calibrating

General Details

Output Channel Description (OP) **INLET VALVE** Feedback Channel (FB) **IP3: INLET VALVE**

Calibration Signals (Volts)

Output Demand (OP) Feedback Value (FB)

Demand Feedback

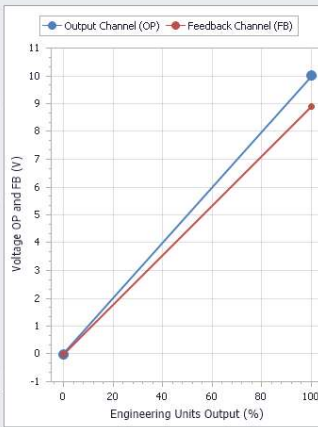
| Position | Feedback (V) | Position | Feedback (V) |
|----------|--------------|----------|--------------|
| MIN | 0.000 | MIN | -0.009 |
| MAX | 10.000 | MAX | 8.893 |

Calibrate Stored

SPEED ESTOP

TORQUE TC1 TC2 TC3 TC4
POWER TC5 TC6 TC7 TC8 SILENCE

RESET



| Engineering Units Output (%) | Output Channel (OP) Voltage (V) | Feedback Channel (FB) Voltage (V) |
|------------------------------|---------------------------------|-----------------------------------|
| 0 | 0 | 0 |
| 100 | 10 | 8.893 |

CONTROL

REMOTE

IGNITION

FUEL

CRANK

TCS ENABLE

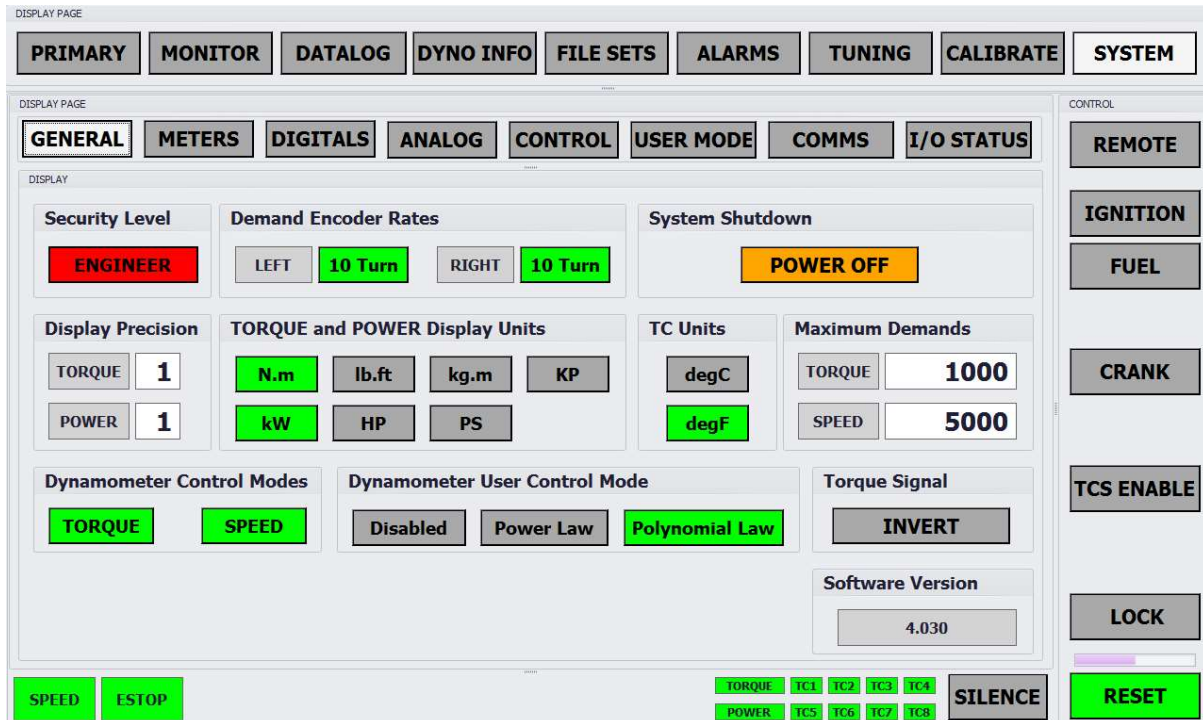
LOCK

Comprehensive Output Channel Calibration provides plots of the demand and the feedback ranging.

SYSTEM

The System Display Page allows the ENGINEER to configure the system. It should be noted that various areas of the system and the controller as a whole are protected by various levels of user definable passwords.

The first Tab on the System Page is the *General* tab.



This Display Tab allows the User to change some display parameters. Other areas are protected by password level. REO-dEC R2 Controller has three levels of operation:

- User
- Calibration
- Engineer

The User level allows use of the system with very little ability to reconfigure the system

The Calibration level allows for the system to be calibrated

The Engineer Level allows full control and adjustment of all aspects of the controller configuration.

METERS

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING CALIBRATE SYSTEM

DISPLAY PAGE

GENERAL METERS DIGITALS ANALOG CONTROL USER MODE COMMS I/O STATUS

CONTROL

REMOTE

IGNITION

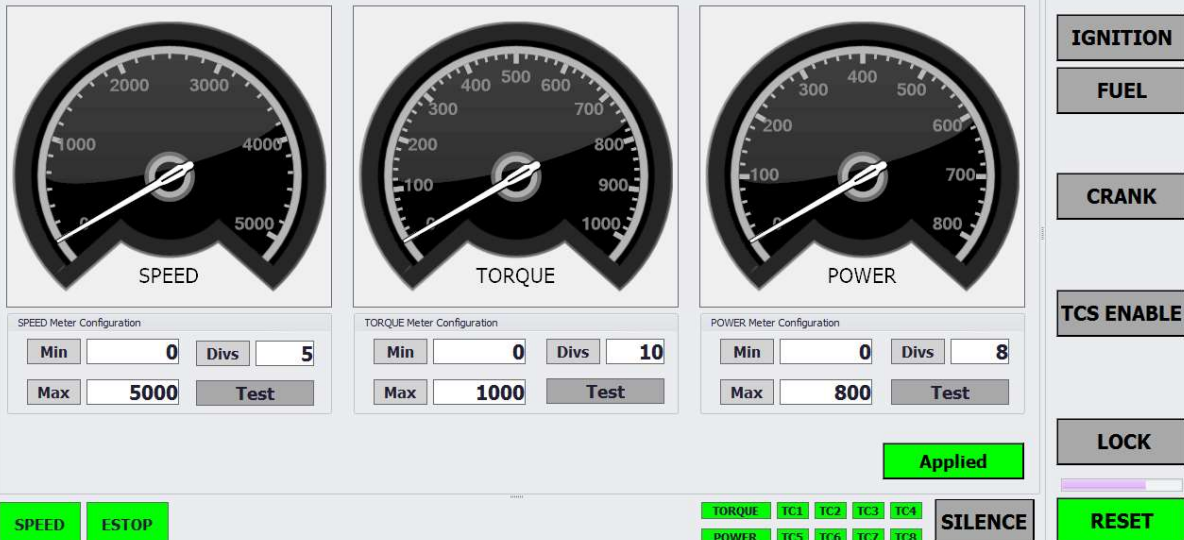
FUEL

CRANK

TCS ENABLE

LOCK

RESET



SPEED Meter Configuration

Min Divs

Max Test

TORQUE Meter Configuration

Min Divs

Max Test

POWER Meter Configuration

Min Divs

Max Test

Applied

SPEED ESTOP

TORQUE TC1 TC2 TC3 TC4

POWER TC5 TC6 TC7 TC8

SILENCE

This Display Tab is used by the Engineer to configure the Meters shown on the *Monitor* Display Page as previously described.

DIGITALS

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING CALIBRATE SYSTEM

DISPLAY PAGE

GENERAL METERS DIGITALS ANALOG CONTROL USER MODE COMMS I/O STATUS

CONTROL

REMOTE

IGNITION

FUEL

CRANK

TCS ENABLE

LOCK

RESET

DIGITALS

Channel Names

| Ch No | Description | Type | Ch No | Description | Type | Invert |
|-------|-------------|------|-------|-------------|------|--------|
| 1 | IGNITION | OUT | 1 | ESTOP | IN | N |
| 2 | FUEL | OUT | 2 | DYNO | IN | N |
| 3 | CRANK | OUT | 3 | | IN | N |
| 4 | ALARM 1 | OUT | 4 | | IN | N |
| 5 | HEALTHY | OUT | 5 | | IN | N |
| 6 | RUNNING | OUT | 6 | | IN | N |
| 7 | | OUT | | | | |
| 8 | | OUT | | | | |

System Digital Output Channels

| Digi Ch Desc | Dig No | Digi Ch Desc | Dig No |
|--------------|--------|---------------|--------|
| HEALTHY | 5 | IGNITION | 1 |
| ALARM 1 | 4 | FUEL | 2 |
| ALARM 2 | | | |
| CRANK | 3 | Max Crank rpm | 600 |
| RUNNING | 6 | Run Speed rpm | 800 |

User Buttons

| Posn | Dig No | Digi Ch Desc |
|------|--------|--------------|
| 1 | 1 | IGNITION |
| 2 | 2 | FUEL |
| 3 | | |
| 4 | 3 | CRANK |
| 5 | | |

Applied

SPEED ESTOP

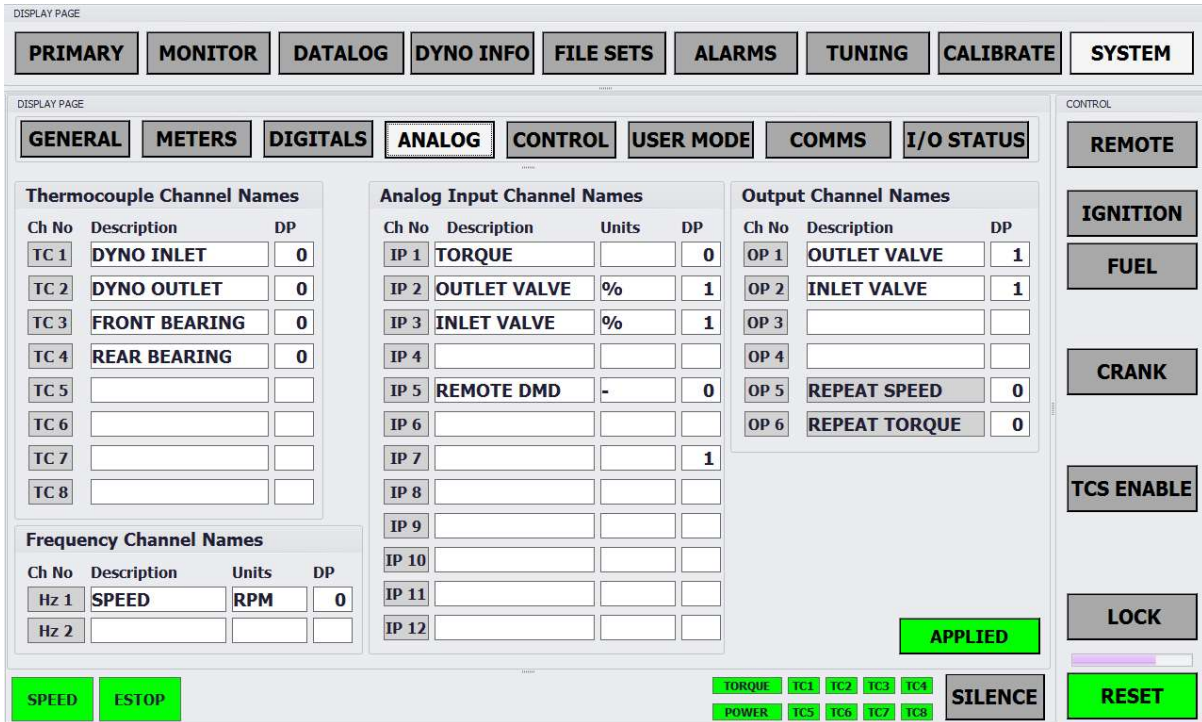
TORQUE TC1 TC2 TC3 TC4

POWER TC5 TC6 TC7 TC8

SILENCE

This Display Tab is used by the Engineer to configure the System Digital Input and Output Channels.

ANALOG



The Analog Inputs and Output Channels are configured using this Display Tab.

REO-dEC R2 supports the following I/O:

- 2 off Frequency Inputs (100kHz Max per channel)
- 8 off k-type Thermocouple Inputs
- 12 off Voltage Inputs (+/- 10V)
- 6 off Voltage Outputs(+/- 10V)
- 8 off Digital Output
- 6 off Digital Inputs

Signal Condition for up to two Load Cells is included using an advanced conditioning module with a built-in 3rd order butterworth filter to improve noise immunity.

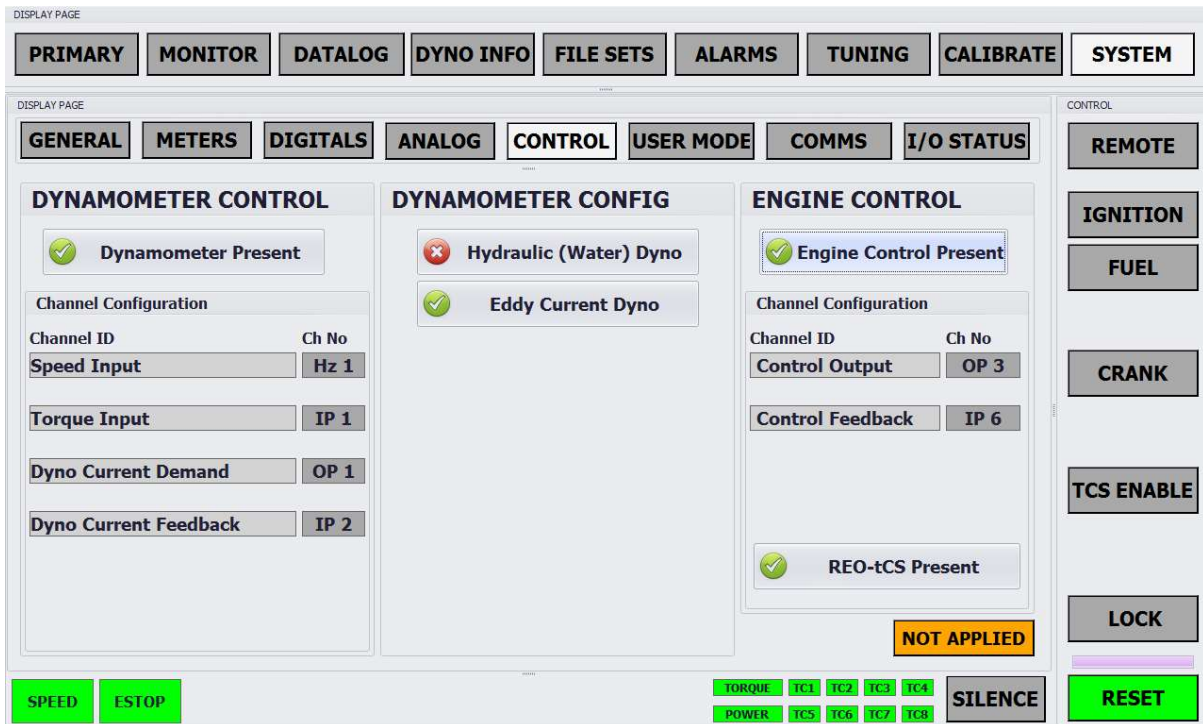
CONTROL

REO-dEC R2 offers control of:

- 1 or 2 dynamometers in Tandem configuration
- Hydraulic (Water) Dynamometers
 - Outlet Valve Control
 - Static Inlet Valve Control
 - Dynamic Inlet Valve Control
- Eddy Current Dynamometers
- Engine Control (Throttle or Pedal)

Different Configurations will be displayed depending on the dynamometer/engine configuration:

Configuration 1. Eddy Current Dynamometer with Engine Control (Throttle/Pedal)



This would be a standard configuration for a typical Eddy Current Engine Testbed. The Engine Control also provides the option for the REO-tCS – This is the Throttle/Pedal Controller offered by KLaS.

Configuration 2. Eddy Current Dynamometer with no Engine Control

DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING CALIBRATE SYSTEM

DISPLAY PAGE CONTROL

GENERAL METERS DIGITALS ANALOG CONTROL USER MODE COMMS I/O STATUS

DYNAMOMETER CONTROL

Dynamometer Present

Channel Configuration

| Channel ID | Ch No |
|-----------------------|-------|
| Speed Input | Hz 1 |
| Torque Input | IP 1 |
| Dyno Current Demand | OP 1 |
| Dyno Current Feedback | IP 2 |

DYNAMOMETER CONFIG

Hydraulic (Water) Dyno

Eddy Current Dyno

ENGINE CONTROL

Engine Control Present

Channel Configuration

| Channel ID | Ch No |
|------------------|-------|
| Control Output | OP 3 |
| Control Feedback | IP 6 |

REO-tCS Present

NOT APPLIED

SPEED
ESTOP

TORQUE
TCL
TC2
TC3
TC4

POWER
TCS
TC6
TC7
TC8

SILENCE

RESET

REMOTE

IGNITION

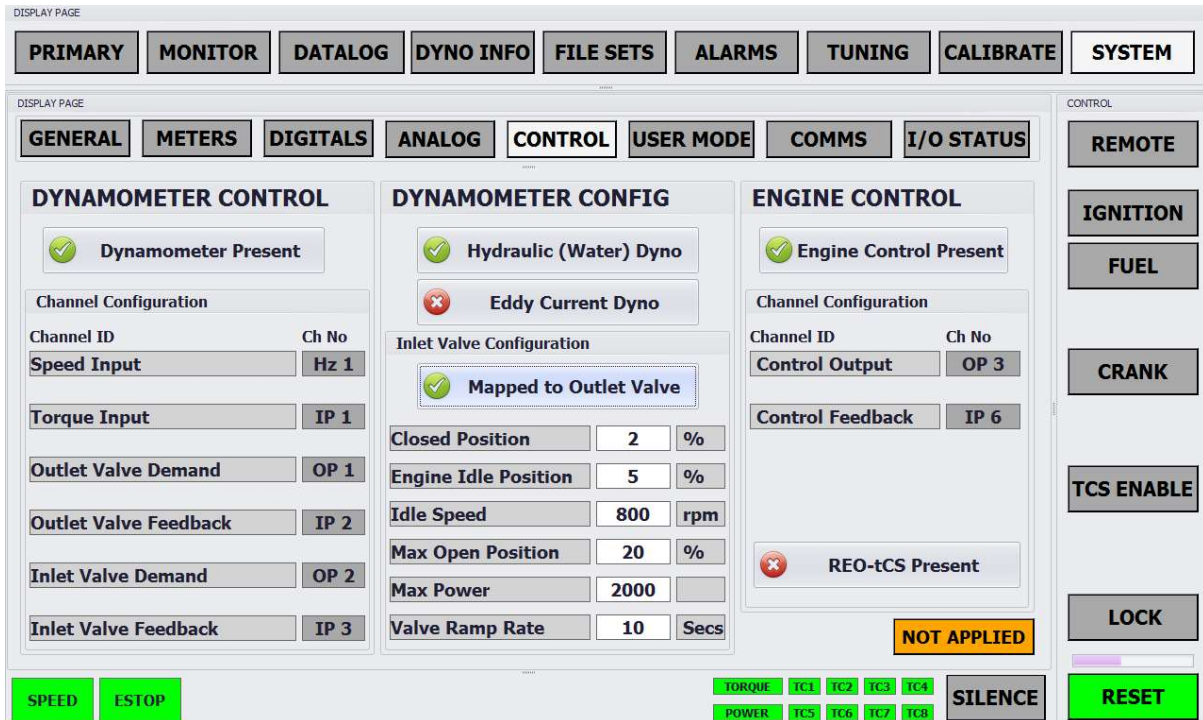
FUEL

CRANK

TCS ENABLE

LOCK

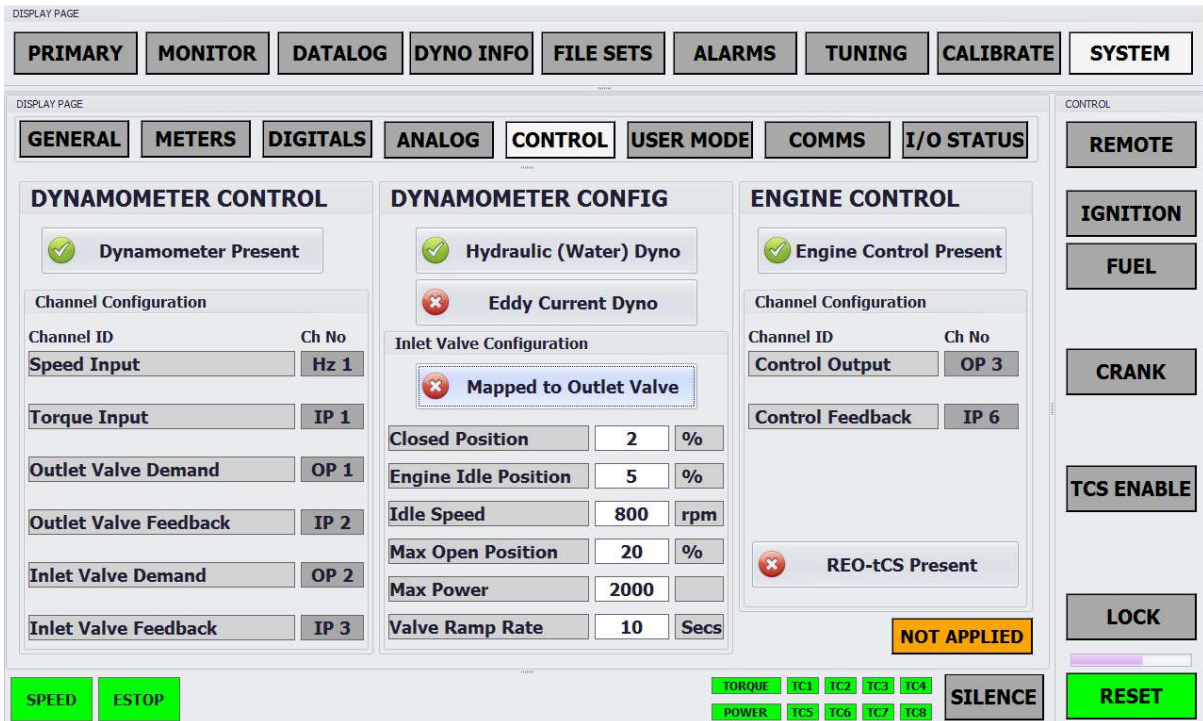
Configuration 3. Hydraulic Dynamometer with Engine Control. Mapped Inlet Valve



In this configuration, the Inlet Valve is matched to the Outlet Valve, For this mode of control to work it is important that the Inlet Valve has the same response time as the Output Valve. The system operates the valves in anti-phase to give a greatly improved control of high-speed engines. This configuration would be typically used on aero engine test beds.

As the Outlet valve closes to increase the load on the engine, the inlet valve is opened at the same rate to allow more water into the dyno. The operational range of the two valves will typically not be the same, however the speed of response must be similar.

Configuration 4. Hydraulic Dynamometer with Engine Control. Static Inlet Valve



The screenshot displays the 6dm control interface for Configuration 4. The interface is organized into several functional areas:

- Navigation:** A top menu bar includes PRIMARY, MONITOR, DATALOG, DYNO INFO, FILE SETS, ALARMS, TUNING, CALIBRATE, and SYSTEM. A secondary menu bar includes GENERAL, METERS, DIGITALS, ANALOG, CONTROL (selected), USER MODE, COMMS, and I/O STATUS.
- DYNAMOMETER CONTROL:**
 - Status: Dynamometer Present
 - Channel Configuration:
 - Speed Input: Ch No Hz 1
 - Torque Input: IP 1
 - Outlet Valve Demand: OP 1
 - Outlet Valve Feedback: IP 2
 - Inlet Valve Demand: OP 2
 - Inlet Valve Feedback: IP 3
- DYNAMOMETER CONFIG:**
 - Type: Hydraulic (Water) Dyno; Eddy Current Dyno
 - Inlet Valve Configuration: Mapped to Outlet Valve
 - Parameters:
 - Closed Position: 2 %
 - Engine Idle Position: 5 %
 - Idle Speed: 800 rpm
 - Max Open Position: 20 %
 - Max Power: 2000
 - Valve Ramp Rate: 10 Secs
- ENGINE CONTROL:**
 - Status: Engine Control Present
 - Channel Configuration:
 - Control Output: Ch No OP 3
 - Control Feedback: IP 6
 - REO-tCS Present: (with NOT APPLIED label)
- CONTROL Column (Right):** REMOTE, IGNITION, FUEL, CRANK, TCS ENABLE, LOCK, RESET
- Bottom Bar:** SPEED, ESTOP, TORQUE, POWER, TCS, TCS1-TCS8, SILENCE

In this configuration the Inlet Valve is considered Static, even though it will take up different positions depending upon the engine condition. The valve does not require to be fast acting for this type of control. However, it does need to be motorised.

USER MODE

Typically the dynamometer is run in one of three two control modes:

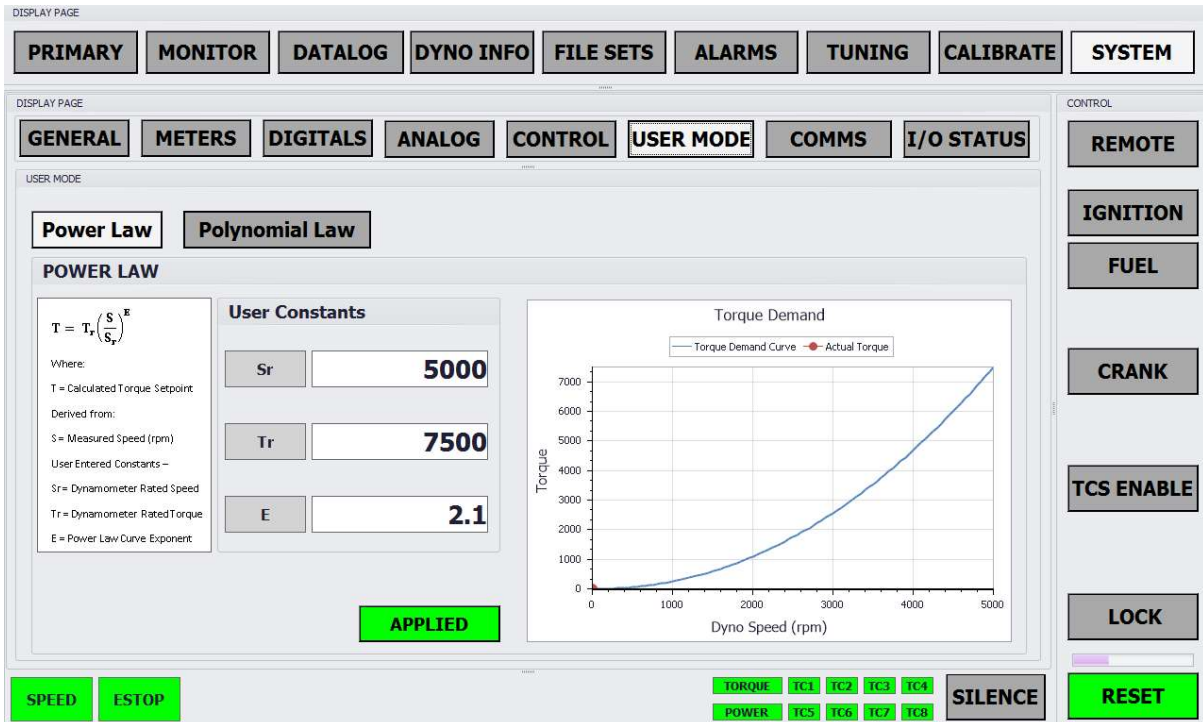
- Speed Control
- Torque Control

Additionally, REO-dEC R2 supports two different Function Control Modes:

- Power Law
- Polynomial Law

Power Law

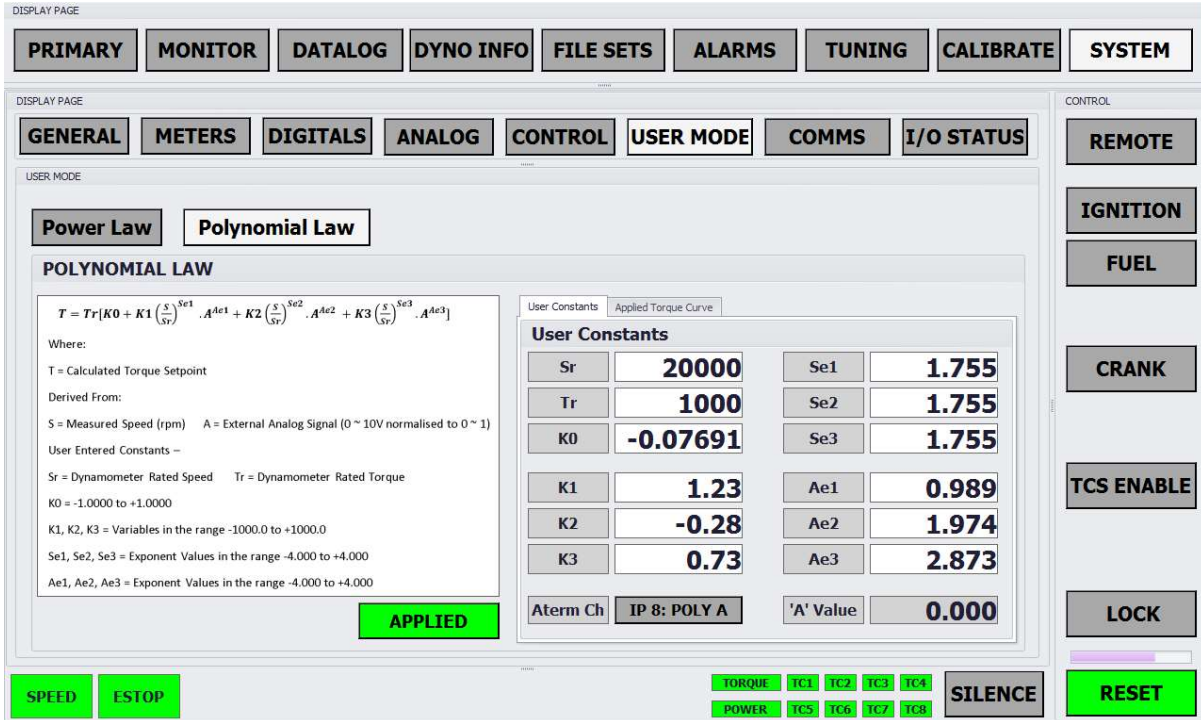
In Power Law the Engineer defines the slope of the curve the Torque Curve that the Engine will follow depending upon the speed of the engine.



When the Engine is running, the current condition point is displayed in real-time on the chart. This Chart has a static curve dependent upon the values entered by the engineer.

Polynomial Law

This is a much more complex control mode and allows for variability of the slope of the curve based on an additional analog input, for example pedal/throttle position.



DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING CALIBRATE SYSTEM

DISPLAY PAGE

GENERAL METERS DIGITALS ANALOG CONTROL USER MODE COMMS I/O STATUS

USER MODE

Power Law Polynomial Law

POLYNOMIAL LAW

$$T = Tr[K0 + K1 \left(\frac{S}{Sr}\right)^{Se1} \cdot A^{Ae1} + K2 \left(\frac{S}{Sr}\right)^{Se2} \cdot A^{Ae2} + K3 \left(\frac{S}{Sr}\right)^{Se3} \cdot A^{Ae3}]$$

Where:
 T = Calculated Torque Setpoint
 Derived From:
 S = Measured Speed (rpm) A = External Analog Signal (0 ~ 10V normalised to 0 ~ 1)
 User Entered Constants –
 Sr = Dynamometer Rated Speed Tr = Dynamometer Rated Torque
 K0 = -1.0000 to +1.0000
 K1, K2, K3 = Variables in the range -1000.0 to +1000.0
 Se1, Se2, Se3 = Exponent Values in the range -4.000 to +4.000
 Ae1, Ae2, Ae3 = Exponent Values in the range -4.000 to +4.000

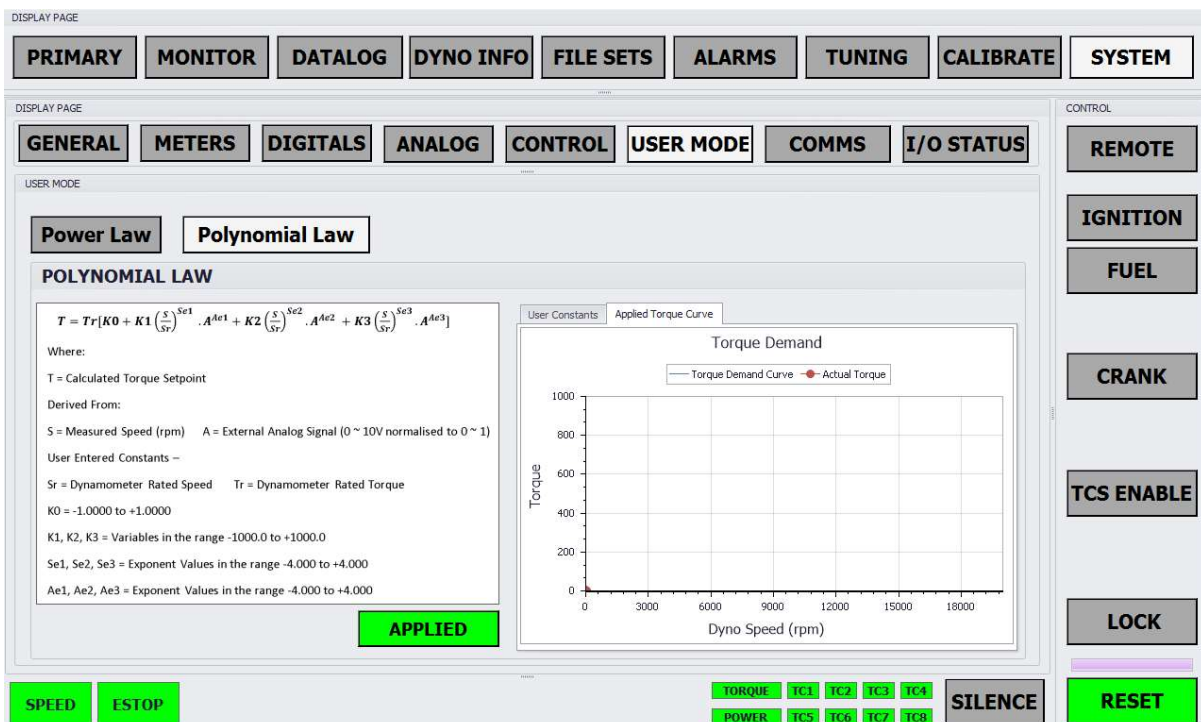
User Constants

| | | | |
|----------|--------------|-----------|-------|
| Sr | 20000 | Se1 | 1.755 |
| Tr | 1000 | Se2 | 1.755 |
| K0 | -0.07691 | Se3 | 1.755 |
| K1 | 1.23 | Ae1 | 0.989 |
| K2 | -0.28 | Ae2 | 1.974 |
| K3 | 0.73 | Ae3 | 2.873 |
| Aterm Ch | IP 8: POLY A | 'A' Value | 0.000 |

APPLIED

SPEED ESTOP TORQUE TC1 TC2 TC3 TC4 POWER TCS TC6 TC7 TC8 SILENCE RESET

As with the Power Law Curve, the Polynomial Law Curve is plotted in real-time with the currently active point shown on the chart.



DISPLAY PAGE

PRIMARY MONITOR DATALOG DYNO INFO FILE SETS ALARMS TUNING CALIBRATE SYSTEM

DISPLAY PAGE

GENERAL METERS DIGITALS ANALOG CONTROL USER MODE COMMS I/O STATUS

USER MODE

Power Law Polynomial Law

POLYNOMIAL LAW

$$T = Tr[K0 + K1 \left(\frac{S}{Sr}\right)^{Se1} \cdot A^{Ae1} + K2 \left(\frac{S}{Sr}\right)^{Se2} \cdot A^{Ae2} + K3 \left(\frac{S}{Sr}\right)^{Se3} \cdot A^{Ae3}]$$

Where:
 T = Calculated Torque Setpoint
 Derived From:
 S = Measured Speed (rpm) A = External Analog Signal (0 ~ 10V normalised to 0 ~ 1)
 User Entered Constants –
 Sr = Dynamometer Rated Speed Tr = Dynamometer Rated Torque
 K0 = -1.0000 to +1.0000
 K1, K2, K3 = Variables in the range -1000.0 to +1000.0
 Se1, Se2, Se3 = Exponent Values in the range -4.000 to +4.000
 Ae1, Ae2, Ae3 = Exponent Values in the range -4.000 to +4.000

User Constants

| | | | |
|----------|--------------|-----------|-------|
| Sr | 20000 | Se1 | 1.755 |
| Tr | 1000 | Se2 | 1.755 |
| K0 | -0.07691 | Se3 | 1.755 |
| K1 | 1.23 | Ae1 | 0.989 |
| K2 | -0.28 | Ae2 | 1.974 |
| K3 | 0.73 | Ae3 | 2.873 |
| Aterm Ch | IP 8: POLY A | 'A' Value | 0.000 |

APPLIED

Torque Demand

— Torque Demand Curve ● Actual Torque

Torque

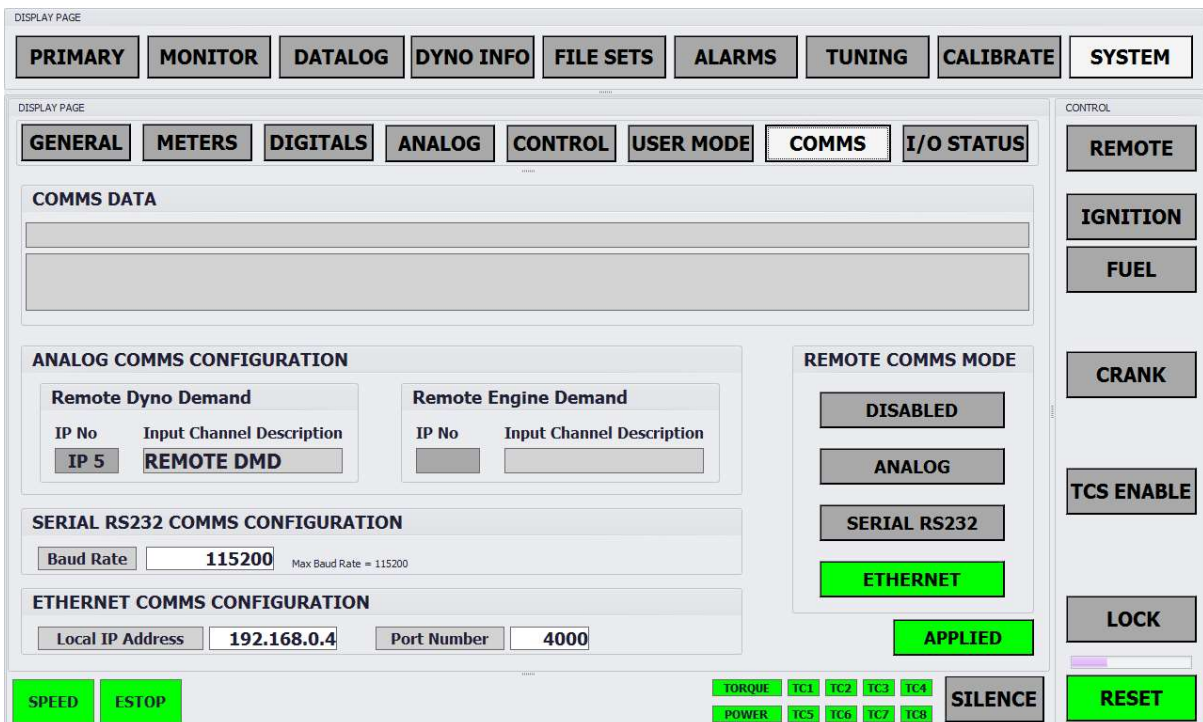
Dyno Speed (rpm)

SPEED ESTOP TORQUE TC1 TC2 TC3 TC4 POWER TCS TC6 TC7 TC8 SILENCE RESET

COMMS

To allow remote control of the controller from a testbed PC. REO-dEC R2 offers three methods of external interface

- Analog
- Serial (RS232)
- Ethernet (TCP-IP)

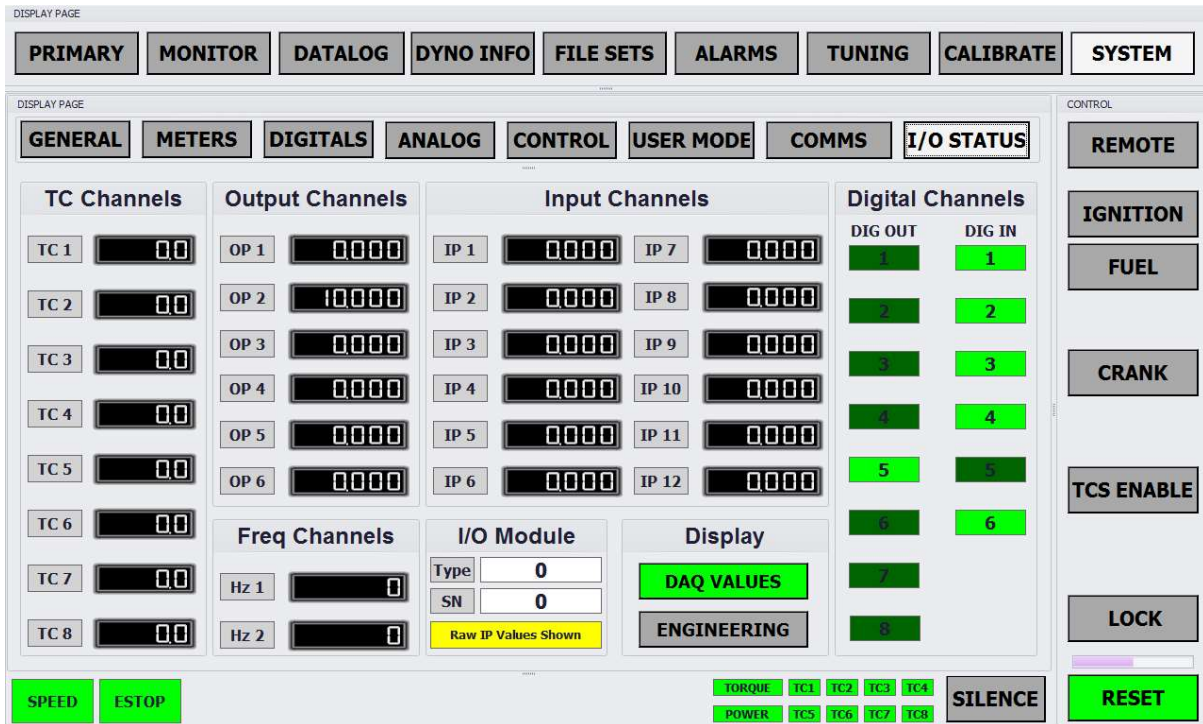


The screenshot displays the REO-dEC R2 control interface, specifically the COMMS configuration page. The interface is divided into several sections:

- Navigation Menu:** Includes buttons for PRIMARY, MONITOR, DATALOG, DYNO INFO, FILE SETS, ALARMS, TUNING, CALIBRATE, and SYSTEM.
- Display Page:** Includes buttons for GENERAL, METERS, DIGITALS, ANALOG, CONTROL, USER MODE, COMMS (selected), and I/O STATUS.
- Control Panel:** Includes buttons for REMOTE, IGNITION, FUEL, CRANK, TCS ENABLE, LOCK, and RESET.
- COMMS DATA:** A section for displaying communication data.
- ANALOG COMMS CONFIGURATION:**
 - Remote Dyno Demand:** IP No: IP 5, Input Channel Description: REMOTE DMD.
 - Remote Engine Demand:** IP No: [blank], Input Channel Description: [blank].
- SERIAL RS232 COMMS CONFIGURATION:** Baud Rate: 115200 (Max Baud Rate = 115200).
- ETHERNET COMMS CONFIGURATION:** Local IP Address: 192.168.0.4, Port Number: 4000.
- REMOTE COMMS MODE:** Includes buttons for DISABLED, ANALOG, SERIAL RS232, and ETHERNET (highlighted in green).
- APPLIED:** A green button to apply the configuration.
- Bottom Panel:** Includes buttons for SPEED, ESTOP, TORQUE, TCS, POWER, and SILENCE, along with torque control buttons (TC1-TC8).

A sample program is provided with full source code to demonstrate the use of the Serial and Ethernet Interfaces.

IO Status



The screenshot shows the 'IO STATUS' tab within a larger 'DISPLAY PAGE'. The interface is organized into several sections:

- Navigation:** A top row of tabs includes PRIMARY, MONITOR, DATALOG, DYNO INFO, FILE SETS, ALARMS, TUNING, CALIBRATE, and SYSTEM. A second row includes GENERAL, METERS, DIGITALS, ANALOG, CONTROL, USER MODE, COMMS, and I/O STATUS (which is currently selected).
- TC Channels:** Eight digital readouts labeled TC 1 through TC 8, each showing a value of 00.
- Output Channels:** Six digital readouts labeled OP 1 through OP 6. OP 2 shows a value of 10000, while others show 0000.
- Input Channels:** Twelve digital readouts labeled IP 1 through IP 12, all showing 0000.
- Digital Channels:** Two columns of digital readouts. 'DIG OUT' shows values 1 through 8. 'DIG IN' shows values 1 through 6.
- Freq Channels:** Two digital readouts labeled Hz 1 and Hz 2, both showing 0.
- I/O Module:** Fields for 'Type' (0) and 'SN' (0), with a yellow 'Raw IP Values Shown' indicator.
- Display:** Two buttons: 'DAQ VALUES' (highlighted in green) and 'ENGINEERING'.
- Control Panel:** A vertical column of buttons on the right side: REMOTE, IGNITION, FUEL, CRANK, TCS ENABLE, LOCK, and RESET (highlighted in green).
- Bottom Bar:** Includes 'SPEED' and 'ESTOP' buttons on the left, and 'TORQUE' (TC1-TC4), 'POWER' (TC5-TC8), and 'SILENCE' buttons on the right.

This Display Tab allows the user to view all the system channels in one location. Display can be as either DAQ values or as Engineering Calibrated values.