D3000

Digital Dynamometer Controller

Installation, commissioning and user manual.

Introduction

The D3000 Digital Dynamometer Controller is a new design based on many years experience working in all kinds of control applications. It encompasses all the ‘legacy’ features that end users really appreciate with modern supportable hardware for the future.The system was designed to easily handle AC, DC, EC & hydraulic dynamometers and be a straightforward replacement for the popular TA S3000 controller.

- Ergonomic control encoders.
- Positive tactile push buttons.
- Bright clear visual displays.
- Powered by 2 industrial grade micro-controllers, all solid state design.

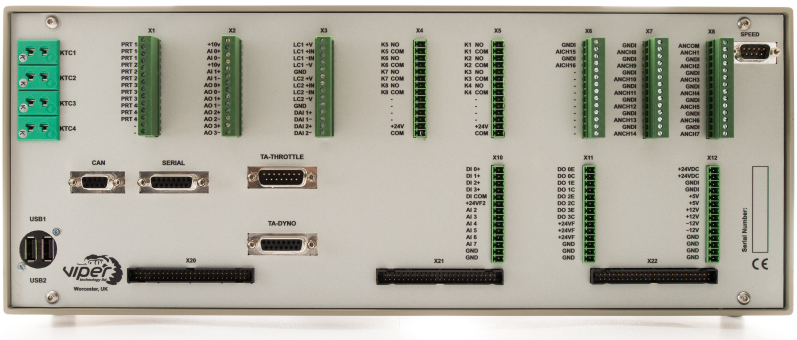
The controller is able to support both traditional and modern installations with a number of key features:

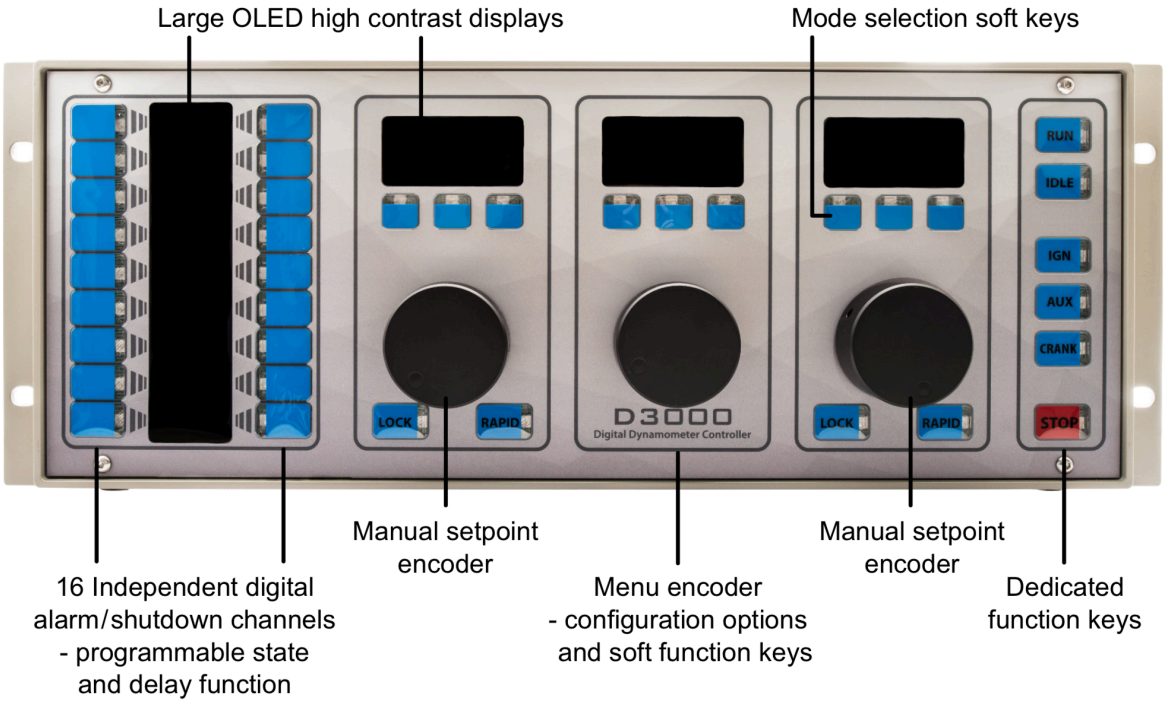
- Pin compatible with S3000 controller. 50 pin IDC headers connect directly to S3000 terminals.
- Direct speed feedback using optical, TTL, active and passive encoders
- Traditional load cell and / or shaft mounted torque transducers
- Drive interfaces via analogue or CAN bus
- Drive cycles can be loaded via SD card, CAN or serial
- Spare additional CAN capability
- Multiple PID ‘Set’ storage and remote selection
- Realtime road load modelling / prop-law modelling
- No user licence or anti-virus software required
- Desktop or rack mountable
- Built in ‘Servo valve’ hardware system - for hydraulic servo valve control and position feedback.

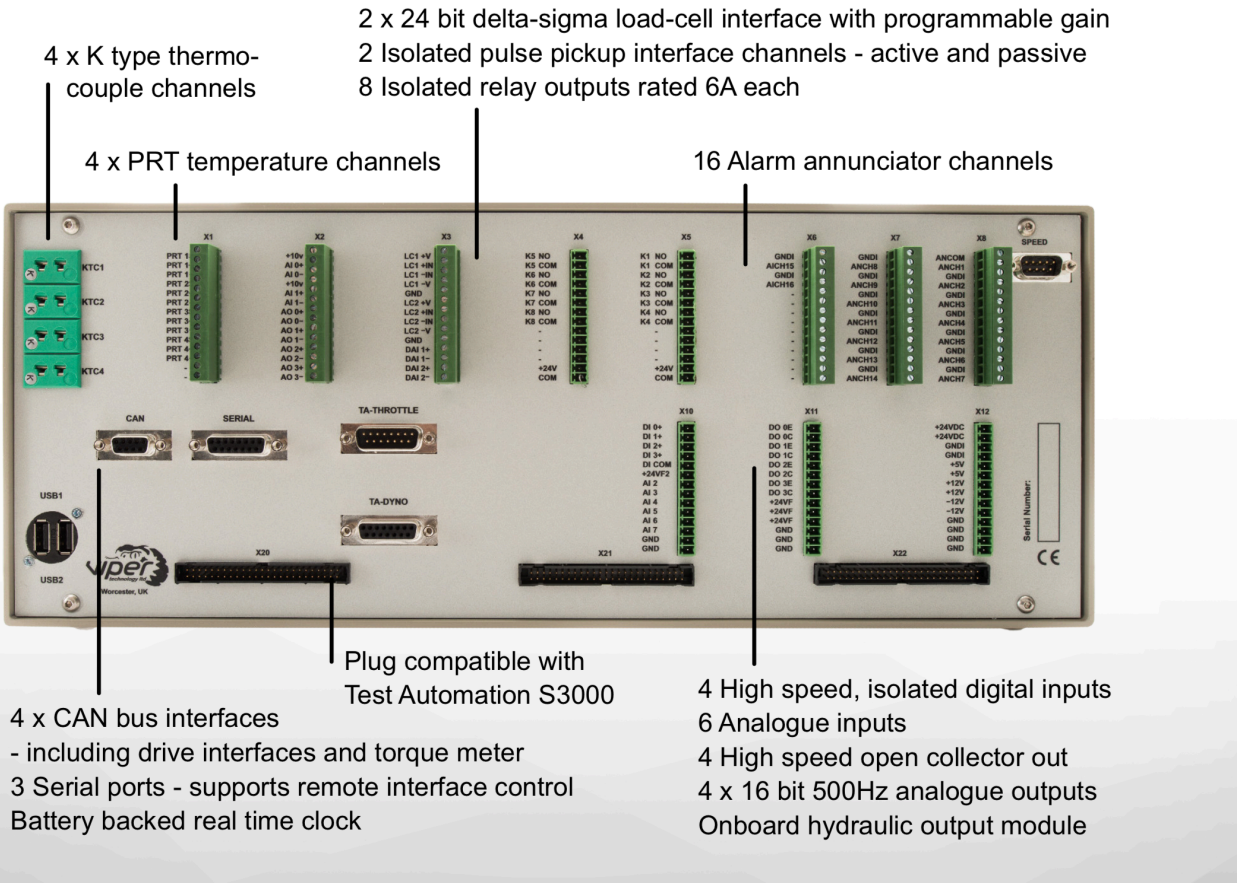
This feature set makes the D3000 much more that a dynamometer controller, it can control pretty much any high speed system and provide multi mode control of multiple machines over analogue, serial or CAN bus interfaces. It provides a hardware based I/O sub-system with realtime high speed configurable software control.

A typical system would have a single dynamometer and throttle system. This would have channels for speed, torque and throttle position. Output for control would be via an analogue interface to a power module as a voltage signal. A load cell on the dynamometer would be conditioned by the controller, calibration applied so that torque in real units of Nm / Lbft is displayed. Speed would be a frequency input from a pulse pickup.

All of this is possible with the D3000. But torque could also come from a shaft mounted torque meter with a frequency, voltage or CAN output. Speed could be measured using a shaft mounted quadrature encoder. The dynamometer may be an AC machine with CAN interface. The whole interface could be controlled over CAN and multiple drive systems could be synchronised from a single controller.







Hardware

The controller hardware has been carefully selected to provide high performance and flexibility. Particular focus was placed on providing an isolated and noise immune design which is robust enough to withstand industrial environments.

The front panel if made of a durable polycarbonate membrane and a single PCB supports all the the control push buttons and display components.Speed

The system has multiple methods of measuring speed information.

- Variable reluctance pickup - Magnetic type - 60 tooth wheel to 20kHz
- Active pickup - 5v TTL or 12v - as above
- Encoder - single or quadrature output 5v TTL - 100MHz maximum frequency

These type are selectable with internal control board jumpers and software configuration.

Torque
The system also has multiple methods of measuring torque information.

- 2 x Analogue Input +- 10v @ 16bit resolution
- 2 x Bridge amplifier +-30mV @ 24bit resolution
- 2 x Frequency Input 5v TTL 10kHz with +- 5kHz

Analogue Inputs
The system has multiple analogue input types for general purpose sensors, remote set points (pressure, torque, speed etc)

- 2 x +-10vdc @ 16bit resolution
- 5 x 0-10vdc @ 12bit resolution

Analogue Outputs
The system has multiple analogue outputs for high speed control. Dynamometer demand signals, throttle demand, water / oil temperature control valves etc.

- 4 x +-10 vdc @ 16bit resolution

CAN Channels
The system can read / write any of the control / feedback channels over CAN bus. This include CAN based throttles for direct pedal simulation. A full remote host system interface can be implemented over CAN.

- 2 x CAN 2.0b fully isolated transceivers @ up to 1mbps rate.
- 1 x CAN 2.0b fully isolated transceivers @ up to 1mbps for drive control / torque meter.

Frequency Outputs
The system can also output PWM frequency outputs for pedal position etc

4 x PWM outputs 5v TTL.

Temperature Sensor Inputs
The system has general purpose temperature inputs designed to be used for information, control and alarm level indication.

- 4 x Type K Thermocouple inputs @ 1Hz. 0-1370˚C
- 4 x PRT PT-100 Resistance thermometer inputs @ 1Hz. 0-200˚C

Alarm Channels
Alarm input channels require a ‘volt free’ contact in a normally closed condition. Alarm channels can be configured to provide ‘warning’ or ‘shutdown’. Alarms can also be ‘zero speed overridden’ to prevent false triggering (eg no oil pressure at zero speed). Alarms can also be disabled in temporary fashion if required.

16 x ‘Volt Free’ digital input alarm channels
18 x Alarm front panel indicators
18 x Configurable alarm text legends

Refer to Alarms section for more information.

Digital Inputs
Digital inputs are split in two specific types. High and normal speed. These can be used for external interfacing.

Relay Outputs
The system has onboard relay outputs with screw terminal connectors on the rear panel. Some of these outputs have pre-determined functions (Ignition, Crank, Aux etc) but other can be configured to control other output functions.

- 8 x 6A NO contact relay outputs

Serial Communications
Serial ports can be used for remote interfaces via an AK type protocol or to connect additional remote I/O systems. Additional instruments can also be connected with the serial interface (eg AVL 733s, 415)

3 x High speed serial interfaces - upto 2MBit data rate

S3000 Capability
The system has interface connectors that allow direct connection of a S3000 rear terminal panel. This allows a D3000 to be quickly connected to an existing S3000 cabinet using the original wiring. All S3000 functionality can be replicated by the D3000 system.

Installation

This manual attempt to provide a comprehensive guide to allow correct installation of the D3000 Digital Dynamometer System. In order for this to happen it is highly recommended that installation should be carried out by trained personnel as certain aspects of this system involves high voltage electronics that can be very hazardous if treated incorrectly.

To ensure correct performance of this system selection of cable types is very important and grounding / screening must be observed at all times.

The system is designed to be installed into an external cabinet or enclosure even when being used in a desktop application. This will ensure that external noise / radio frequency interference (RFI) does not adversely affect the performance of the system. The enclosure of the D3000 is connected to earth potential (including its covers) but the rear terminal area needs to be within an additional screened enclosure to achieve ideal RFI performance.

The D3000 is housed in a 4u 19” rack mount metal enclosure. It should be installed in a suitable desktop or free standing 19” rack mount cabinet. Access is required to the front control panel area during normal use, unless a remote host interface is being used to control the system.

The unit front panel is splash proof only and should not be subjected to direct or high pressure water jets. Rating is IP54 for the front panel only.

Vibration must be kept to a minimum. The unit is designed for static installations only.

Operating temperature 0-40˚C. Humidity 0-90% non-condensing.

Terminal connections

All terminations are located on the rear panel. The following cable types should be used.

- All frequency / encoder cables (Speed, Torque etc) - Twisted pair with overall screen min 7/0.2mm CSA conductor size.

- All analogue input / output cables and load cell bridge cables - Overall screen cable with min 7/0.2mm CSA conductor size. Separate cables should be used for each signal.

- All power module cables should be min 1.5mm CSA twisted with overall screen CY / SY cable type with earth conductor.

- CAN bus cables - Twisted pair 7/0.2mm CSA with overall foil screen and drain wire eg Belden 6520. Screen must be used.

- Power supply input cables for D3000 (24vdc @ 6A). Single 16/0.2mm - Blue / White

Specifications

Dynamometer Control	Control accuracy	Better than 0.1% of full scale			
	Temperature Coefficient	± 0.01% per ˚C			
Engine Control	Control accuracy	Better than 0.1% of full scale			
	Temperature Coefficient	± 0.01% per ˚C			
Display	Digital speed indication	Range	0 to 20000rpm		
		Accuracy	±1rpm		
	Digital torque indication	Range	0-20000		
		Accuracy	±0.05 FSD		
	Temperature Coeficient	±0.01% per ˚C			
	Speed Input	Type	Inductive	Active	Encoder
		Range	0 to 20kHz	0 to 20kHz	100MHz
		Amplitude	0.5v RMS Min	0.5v RMS Min	5v TTL
	Torque Input	Type	Bridge 200-350R	Frequency 0-20kHz	
		Range	5mV to 10V FS	0-20kHz	
		Excitation	5V ±0.1%	na	
		Resolution	24bit Delta Sigma	1Hz	

Dimensions	D3000 Control Unit	Width	483mm (19”)
		Height	180mm (4U Panel units)
		Depth	400mm (inc. connectors)
		Weight	3kg
	Power Modules	Width	483mm (19in)
		Height	120mm (2U Panel units)
		Depth	500mm (inc. connectors)
		Weight	6kg
Operating Conditions	Temperature	10 to 40 ˚C	
	Humidity	0-90% Non condensing	
	Vibration	Static installation only.	
Warm-up	Allow at least 10 minutes from power on for analogue system to stabilise.		
Dynamometer Power Module (Eddy current)	Power Supply	230vac ±15%, 50/60Hz, 16A	
	Outputs	200vdc @ 16A for eddy current coil	
Dynamometer Power Built into D3000 (Hydraulic)	Output	10vdc @ ±100mA for servo valve	
Actuator Power Module (Talon, HS70 or CP)	Power Supply	230vac ±15% @ 3.5A continuous for Talon. Others may vary.	

Interfaces

DC Supplies	Power to the D3000 via an external 24vdc @ 6A PSU. Unless being used with the S3000 connectors and rear termination panel, then power is derived from the Power Modules ±22vdc. **Do not** connect both power supplies at the same time!		
	X12	24vdc	24vdc power supply
		24vdc	as above
		GNDI	3kg
		GNDI	
		+5v	Internal 5vdc power supply @ 500mA
		+5v	as above
		+12v	Internal +12vdc power supply @ 50mA
		+12v	as above
		-12v	Internal -12vdc power supply @ 50mA
		-12v	as above
		GND	Internal ground
		GND	Internal ground
		GND	Internal ground
		GND	Internal ground
System Common (GND)	All sensor commons should be terminated to the above GND terminals. GNDI and GND and isolated from each other and depending on the ground arrangement of the test cell can be connected or removed.		
Digital Common (DICOM)	Digital common is used for all digital I/O to the D3000. These are fully optically isolated from the internal GND and GNDI. They should be powered externally to maintain this isolation. Using D3000 internal power supplies for this purpose will negate the system isolation.		
Digital Inputs - Type 1	Opto-coupled interface to host system signals. Used for interfacing with external systems		
Digital Inputs - Type 2	Inputs that require a ‘volt-free’ contacts from an external source. These are typically alarm / warnings from external systems. They are fully optically isolated from the internal system and should use an external 24vdc power supply. The internal power supply can also be used and is provided at X6, X7 & X8 terminals.		
	Inputs are normally closed. See I/O schematic 10-13 for input details.		

Digital Outputs - Type 1	Optically isolated darlington pair 100mA @ 24vdc. Collector and emitter available at terminals. See I/O schematic 3-13 for more information.		
Digital Outputs - Type 2	Optically isolated darlington pair 100mA @ 5v TTL. For digital speed signal output only.		
Relay Outputs	8 x 250VAC @ 6A rated normally open (NO) contacts.		
	K1	Ignition	Ignition status - controlled by front panel
	K2	Crank	Crank status - controlled by front panel
	K3	Aux	Auxiliary status - controlled by front panel
Analogue Inputs	Functions as follows:		
	Normally 0 to 10v but can be bipolar -10v to +10v. With respect to GND. All 16bit resolution.		
	DAI 1+	Torque Input as analogue	
	DAI 1-	GND	
	DAI 2+	Spare analogue input	
	DAI 2-	GND	
	Normally 0 to 10v but can be bipolar -10v to +10v. With respect to GND. All 16bit resolution.		
	AI 0+	Dynamometer Valve Position	
	AI 0-	GND	
	AI 1+	Throttle Valve Position	
	AI 1-	GND	
	0-10V input @ 12 bit resolution. With respect to GND.		
	AI2	Spare analogue input	
	AI3	Spare analogue input	
	AI4	Spare analogue input	
	AI5	Spare analogue input	
	AI6	Spare analogue input	
	AI7	Spare analogue input	
	GND		

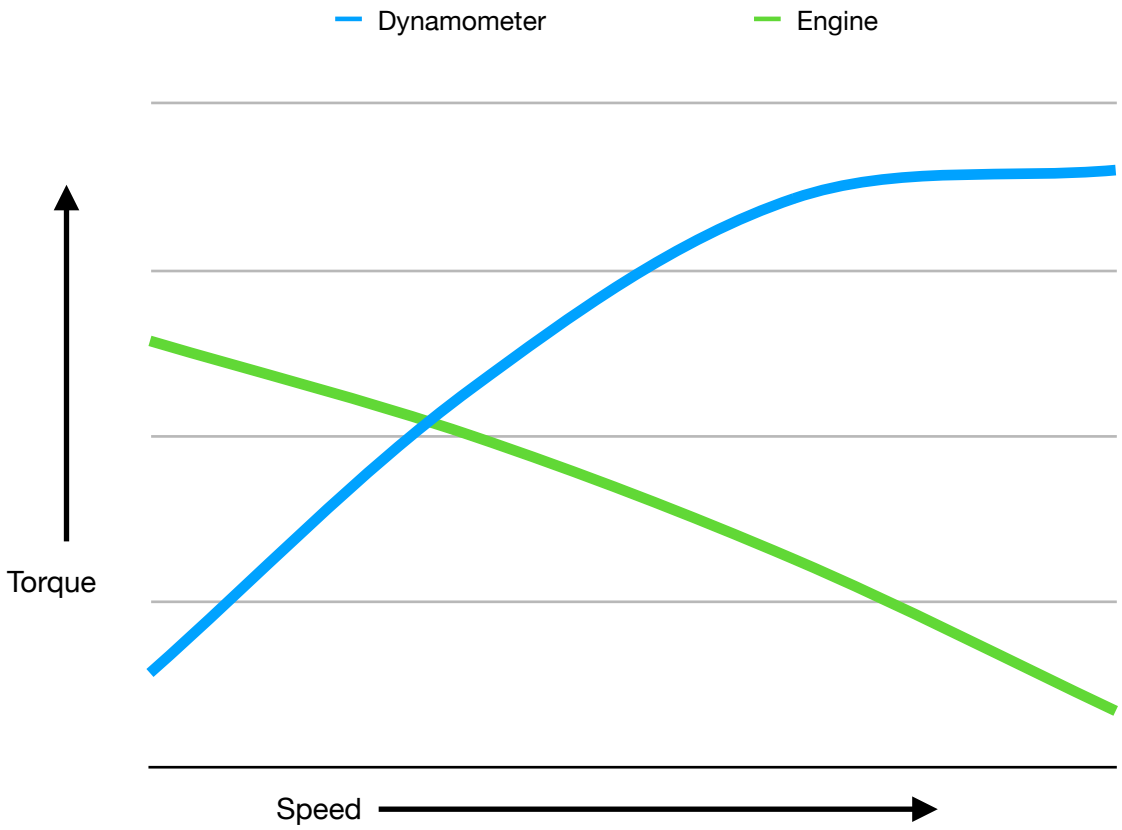
Analogue Outputs	Voltage Outputs for power module demands		
	Dynamometer	AO 0+	±10vdc
	Dynamometer	AO 0-	GND
	Throttle	AO 1+	±10vdc
	Throttle	AO 1-	GND
	Speed	AO 2+	±10vdc
	Speed	AO 2-	GND
	Torque	AO 3+	±10vdc
	Torque AO 3+	AO 3-	GND
Temperature - Thermocouple	K-Type thermocouples 0-1370˚C. Compensated connector must be used. Internal cold junction compensation.		
		KTC1	Channel 1
		KTC2	Channel 2
		KTC3	Channel 3
		KTC4	Channel 4
Temperature - PT100	PT-100 type sensors with 0-200˚C input range. 3 wire.		
		PRT1S	Sense return - for compensation
		PRT1+	Sensor +
		PRT1-	Sensor -
		PRT2S	Sense return - for compensation
		PRT2+	Sensor +
		PRT2-	Sensor -
		PRT3S	Sense return - for compensation
		PRT3+	Sensor +
		PRT3-	Sensor -
		PRT4S	Sense return - for compensation
		PRT4+	Sensor +
		PRT4-	Sensor -

CAN Bus	Isolated bus driver with 3 separate channels. Requires a bus breakout lead to convert rear panel 9-way d-type into 3 x 9 way d-type standard pinout CAN bus channels. All channels 1mbit capable.		
	CAN0 H	pin 7	Internal bus
	CAN0 L	pin 2	Internal bus
	CAN0 GND	pin 3	
	CAN1 H	pin 8	Drive System / CAN pedal
	CAN1 L	pin 4	Drive System / CAN pedal
	CAN1 GND	pin 3	
	CAN2 H	pin 9	Remote CAN interface
	CAN2 L	pin 5	Remote CAN interface
	CAN2 GND	pin 3	
Serial ports	RS232 serial ports with bus driver. 3 channels.		
	Serial 1 TX	pin 9	S3000 RX
	Serial 1 RX	pin 10	S3000 TX
	Serial GND	pin 11	GND
	Serial 2 TX	pin 5	spare serial
	Serial 2 RX	pin 6	spare serial
	Serial GND	pin 4	
	Serial 3 TX	pin 12	spare serial
	Serial 3 RX	pin 13	spare serial
Hydraulic Servo Valve	Connector for direct connection of hydraulic servo valve. Internal D3000 hydraulic power module. Closed loop control in hardware analogue.		
	Valve Pos Out	pin 1	0-10v = 0-100% valve position output
		pin 3	GND for above sensors
	Valve Pos FB	pin 4	Valve position feedback
		pin 5	Hydraulic Servo Valve - (GND)
		pin 6	Hydraulic Servo Valve +

Operation

A brief examination of the principles used in the control system will best illustrate the capabilities of the D3000 and effective uses to which it can be applied.

The operating conditions of an engine and dynamometer are characterised by torque and speed. For any selected speed at which the engine is run, a stable condition will exist provided that the dynamometer is more powerful than the engine at and above that selected speed.



Therefore for every setting of the engine control (throttle) and dynamometer control there is a clearly defined torque/speed characteristic curve with a defined point of intersection.

The D3000 dynamometer control electronics and software drive a Dynamometer Power Module which is a power amplifier that controls the coil current of an eddy current dynamometer or the servo valve of a hydraulic dynamometer or current demand to an AC drive system in order to change the load.

The load applied by the dynamometer is set by the D3000 pushbutton selectable modes and is generated in one of the engine/dynamometer modes. The mode is selected in accordance with the requirements of the engine under test and results in the characteristics shown on the following pages.

Dynamometer Control	**Speed Mode**	
	The required speed is set by means of the dynamometer Setpoint Control and the load applied is such that speed remains almost constant, irrespective of the power produced by the engine under test.	
	Torque Mode	
	The required torque is set by means of the dynamometer Setpoint Control and the load applied is such that torque remains almost constant irrespective of dynamometer speed. This mode gives stable operation for speed governed piston engines and all types of electric motors.	
	Direct Mode	
	The dynamometer load is controlled directly as a percentage 0-100%. Care must be taken when using this mode especially with AC drive systems. Direct mode may be disabled to prevent operation	
	Slope Mode	
	This mode combines the features of the two previous modes to give a torque which increases linearly with speed.	
	The 'slope' (or gradient) of the speed / torque relationship is set by a D3000 Configuration Parameter and the working position can be 'offset' by the dynamometer Setpoint Control.	
	The defining equation is:	% full scale torque = m × % full scale speed + % Offset
	m is the slope as set by Parameter 43	
	% Offset is offset as set by dynamometer Setpoint	
	Control in the range -100% to +100%	
Engine Control	The D3000 engine control electronics drive an Actuator Power Module which is a power amplifier that controls the throttle actuator to move the engine throttle. The engine control facility of the D3000 provides Speed and Torque modes for the *Engine* as previously described for the *Dynamometer*. Position mode is also provided, in which the actual position of the throttle actuator is set by means of the Engine Setpoint Control.	

Front Panel Controls and Functions

The D3000 control panel is split into 5 distinct groups.

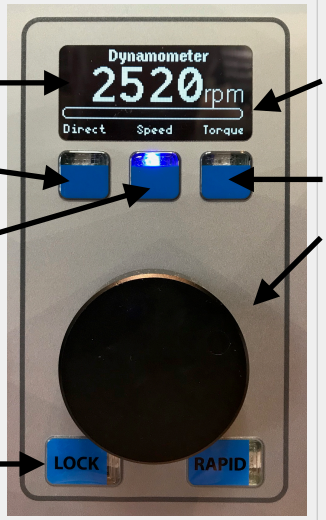
Alarms | Engine | Status / Info | Dynamometer | Controls

Some of the controls in these groups are fixed function and others have ‘soft’ functionality that can change if required. These adds to the flexibility of the D3000 controller and allows screens to change along with labels for functions.

As a standard product the displays will be configured as above.

Front Panel Controls and Functions - continued

Dynamometer Controls



Actual Speed

Direct Mode

Speed Mode

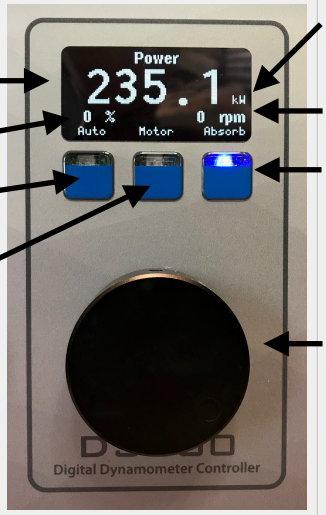
Encoder Lock

Output level to power module.

Torque Mode

Setpoint Encoder

Information Display Controls



Power Display

Throttle setpoint

Auto Mode

Dynamometer Motor Mode - Used with AC / DC drive systems

Power Units

Dynamometer setpoint

Dynamometer Absorb Mode - Normal mode for EC or Hydraulic dynos.

Screen display mode select encoder

BHP / KW / CAN Remote set points display.

Front Panel Controls and Functions - continued

Engine Controls

Actual Torque

Output level to power module.

Direct Mode

Torque Mode

Speed Mode

Setpoint Encoder

Encoder Lock prevents setpoint changing

Controls Section

Run Mode - Enables engine controls and drive system (if fitted)

Idle Mode - returns engine throttle to idle position

Ignition - operates ignition relay to power ECM etc

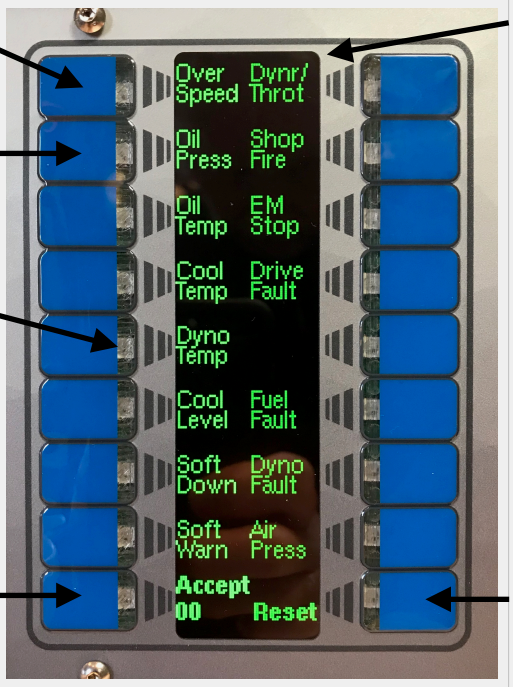
Auxiliary - operates aux relay to power permanent ECM supply

Crank - operates engine starter relay or motoring drive to start.

Stop - moves from run to idle mode and switches off ignition

Front Panel Controls and Functions - continued

Alarm Panel	



Alarms

Introduction	
	The D3000 include a 16 channels alarm panel. Each channel can be configured to be with ‘Off’ , ‘Warning’ or ‘Shutdown mode.
	Two channels are reserved for ‘Over Speed’ and ‘Dynr/Throt’ services. The remaining 14 channels can be used for user preferred safety functions. The text descriptions if software configurable. Connection to the alarm channels is via the rear panel on connectors X6, X7 and X8. If using S3000 interface refer to S3000 Manual. **Do not connect** alarm channels to the D3000 if using the S3000 interface, connect directly to the S3000 terminal panel.
	All 16 channels have a separate indicator that will show ‘yellow’ for a warning status, ‘red’ for a shutdown status and flashing ‘red’ for the first alarm that triggered and caused all subsequent alarms or warnings.
Overspeed	This channel operates from the D3000 speed measurement system and if held down allows the overspeed trip level to be adjusted using the right hand dynamometer encoder.
Dynr / Throt Services	This channel operates if the following faults occur: • Eddy current power module failure • Dynamometer power module failure • AC / DC drive system fault
Shutdown Channels	These are configure with the ‘red flashing’ status and cause the following actions. • STOP condition (ignition off / throttle to idle) • Alarm status digital output ON. • Change from Auto status to Manual • Apply shutdown load to dynamometer is configure.
Warning Channels	These are configure with the ‘yellow’ status and cause a warning buzzer if configured. No other action is taken.
Zero Speed Override	Setting parameter 18 to ‘red’ will cause these alarms to be disabled at zero speed. A delay of 5 seconds after the engine has crossed minimum run speed (~500rpm) enables engine oil pressure to build, or the alarm will trip.

Calibration and Configuration Parameters

Parameter Setting	Parameters are divided into 2 groups: 1) Calibration (Parameters 1 to 15) 2) Configuration (Parameters 16 onwards)
	To access parameter configuration menus press the right hand ‘Rapid’ push button in the ‘Dynamometer’ section.
	Turn the centre encoder the select the parameter to change. Changes cannot be made until the ‘Lock’ button in the ‘Dynamometer’ section is released (red light goes out). A description of the parameters function will appear ini the right hand display and other helpful / parameters settings will appear in the left hand display. Dynamometer / Engine functions are locked when using the parameter menus. Setpoints will not change.
	Changes to parameters are temporary unless the ‘Accept’ button is pressed. This will save the changes to non-volatile memory in the controller.
	Press the ‘Rapid’ push button in the ‘Dynamometer’ control section to exit the parameter menu.

Calibration Parameters

Parameter	Function	Action
1	Speed Full Scale	Use the Engine Setpoint Control to set the Speed Indicator to the required full scale engineering units for speed (typically rpm).
2	Torque Full Scale	Use the Engine Setpoint Control to set the Torque Indicator to the required full scale engineering units for torque (typically Nm).
3	Engine Position Full Scale	Use the Engine Setpoint Control to set the Engine Setpoint Indicator to the required full scale engineering units for position (typically 100%).
4	Dynr Excitation Position Full Scale	Use the Engine Setpoint Control to set the Engine Setpoint Indicator to the required full scale engineering units for position (typically 100%).
5	Speed Zero	Connect a signal generator to Speed Transducer 1 terminals, and set to zero frequency. Ensuring that LOCK is off, momentarily press ACCEPT which flashes for up to a minute until a 'beep' signifies that the D3000 is set up and the data has been saved.
6	Speed Span	Set a signal generator (with accurate digital readout) to a frequency near to that required for full scale speed (range 2kHz to 20kHz), and adjust Engine Setpoint Control until the Engine Setpoint Indicator shows the equivalent speed. For example, with a desired full scale 8000 rpm from a 60 tooth wheel, the signal generator may give 7956 Hz and the Engine Setpoint Indicator must also be set to 7956. Ensuring that LOCK is off, momentarily press ACCEPT which flashes for up to a minute until a 'beep' signifies the D3000 is set up and data has been saved. Note that using less than 60 pulses per revolution will degrade control performance.
7	Torque Zero	Attach the dynamometer calibration weight hangers/pans but no weights. Ensuring that LOCK is off, momentarily press ACCEPT which flashes for up to a minute until a 'beep' signifies the D3000 is set up and data has been saved.

8	Torque Span	Add weights to approximate with the required full scale. Adjust the Engine Setpoint Control until the Engine Setpoint Indicator shows the equivalent torque in engineering units corresponding to the applied weights. When the reading has stabilised, ensure that LOCK is off and momentarily press ACCEPT which flashes for up to a minute until a 'beep' signifies that the D3000 is set up and data has been saved.
9	Auto Speed Zero	Not implemented at this time. Internal values set for 0 = 0 rpm and 10v = SpeedFS
10	Auto Speed Span	as above
11	Auto Torque Zero	Not implemented at this time. Internal values set for 0 = 0Nm and 10v = TorqueFS
12	Auto Torque Span	as above
13	Reserved	
14	Reserved	
15	Reserved	

Configuration Parameters

Parameter	Function	Action
16	Alarm Setup	Alarm pushbuttons allow setting of each alarm state cycling through ‘off’, ‘yellow’ Warning or ‘flashing red’ Shutdown. Changes are temporary unless ‘Accept’ is pressed to save the alarm, power off will revert to previous setting.
17	Manual Override	Toggle individual alarms either ‘off’ or ‘red’. If red the alarms are disabled. Changes are temporary unless ‘Accept’ is pressed to save the alarm, power off will revert to previous setting.
18	Zero Speed Override	Individual alarm buttons select either ‘off’, or ‘red’ overridden state. Changes are temporary unless ‘Accept’ is pressed to save the alarm, power off will revert to previous setting.
19	Zero Speed Timer	Not implemented - Hard coded to 5 seconds
20	Alarm Idle	Not implemented
21	Alarm Idle Timer	Not implemented
22	Running Speed Trip	Hard coded to 500rpm
23	Zero Speed Trip	Hard coded to 300rpm
24	Crank Speed	Hard coded to 250rpm
25	Power Up Mode	Hard coded to Absorb only
26	Local Remote	Not implemented at this time.
28	Shutdown Load	Hard coded and controlled by parameter 57 ramp rate.

29	Engine Speed Ramp	Hard coded
30	Engine Torque Ramp	Hard coded
31	Engine Position Ramp	Hard coded
32	Dynr Speed Ramp	Hard coded
33	Dynr Torque Ramp	Hard coded
34	Dynr Position Ramp	Hard coded
35	Self Reset	Currently set to auto reset in code.
36	Road Load Coefficient A	
37	Road Load Coefficient B	
38	Road Load Coefficient C	
39	Road Load Coefficient D	
40	Auto without Auto Accept	Disabled
41	Auto on Auto Accept	Disabled
42	Special Mode	Disabled
43	Slope M	Disabled
44	Torque Unit & Resolution	Different Implementation for D3000

45	Run In Auto / Ignition	Not implemented
46	Ignition in Auto	Not implemented
47	Digital Output 1	Hard coded
48	Digital Output 2	Hard coded
49	Digital Output 3	Hard coded
50	Digital Output 4	Hard coded
51	Speed transducer 2	Not implemented
52	Underspeed trip	Hard coded to 300rpm
54	Dyno Powermodule	Select '1' if an engine (throttle actuator) power module is present. Enables the internal and external alarms associated with the power module to be detected.
55	Reserved	
56	Dyno Type	Select '0' for a conventional absorbing dynamometer, '1' for a full motoring/absorbing DC/AC drive, and '2' for a 'piggy back' motoring facility with a conventional absorbing dynamometer. ‘3’ for DC setpoint drive.
96	Fireware Version	Shows current version of firmware installed in D3000.
99	Config Reset	Not implemented yet

CAN Bus Drive Interface

The D3000 can interface directly with a CAN bus based digital drive system. Support is currently based upon ABB drives but can be adapted to work with just about any drive system.

CAN Bus Remote Host Interface

The following CAN bus messages are required to implement remote host control over CAN bus

Alarm Status 0x153

	Address: 0x153								Ext 29 bit
	Byte	7	6	5	4	3	2	1	0	
Alarm 0	0									
Alarm 1	1									
Alarm 2	2									
Alarm 0L	3									
Alarm 1L	4									
Alarm 2L	5									
First Out	6									
	7									

Feedback C 0x154

Address: 0x152									Ext 29 bit
Byte	7	6	5	4	3	2	1	0	
0	Engine FB								0-100%
1	Dyno FB								0-100%
2	Engine OP Low Byte								Offset = 0
3	Engine OP High Byte								Gain = 10
4	Dyno OP Low Byte								Offset = 0
5	Dyno OP High Byte								Gain = 10
6	Loop Time uS								
7	Active Motor Absorb							AUTO	Auto mode confirmation

CAN Bus Remote Host Interface - continued

Control 0x150

Address: 0x150									Ext 29 bit
Byte	7	6	5	4	3	2	1	0	
0	Dyno SP Low Byte								Setpoint scaled units based on mode eg
1	Dyno SP High Byte								100% = 100, 2000 rpm = 2000, 3000Nm = 3000
2	Eng SP Low Byte								Setpoint scaled units based on mode eg
3	Eng SP High Byte								100% = 100, 2000 rpm = 2000, 3000Nm = 3000
4	DynoMode								0 = Direct, 1 = Speed, 2 = Torque
5	EngMode								0 = Direct, 1 = Speed, 2 = Torque
6	Motor / Absorb								0 = Neither, 1 = Motor, 2 = Absorb, 3 = Both
7	BEEP	AUTO	STOP	CRK	Aux	IGN	RUN	IDLE	

Feedback A 0x151

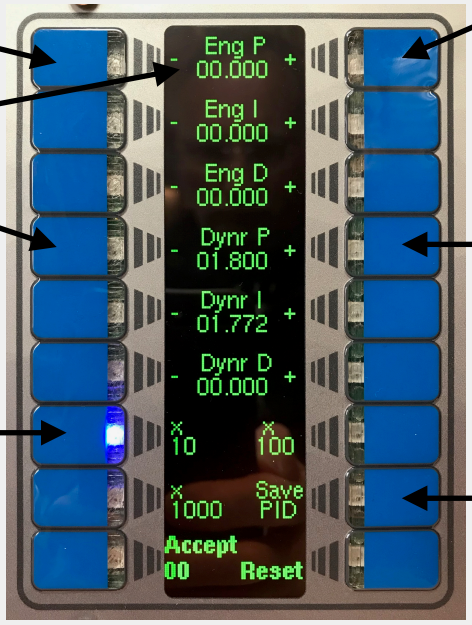
Address: 0x151									Ext 29 bit
Byte	7	6	5	4	3	2	1	0	
0	Dyno Speed Low Byte								Offset = 0
1	Dyno Speed High Byte								Gain = 1
2	Torque Low Byte								Offset = 0
3	Torque High Byte								Gain = 10
4	Power kW Low Byte								Offset = 0
5	Power kW High Byte								Gain = 10
6	ActiveEngineMode								
7	ActiveDynoMode								

Feedback B 0x152

Address: 0x152									Ext 29 bit
Byte	7	6	5	4	3	2	1	0	
0	Engine FB								0-100%
1	Dyno FB								0-100%
2	Engine OP Low Byte								Offset = 0
3	Engine OP High Byte								Gain = 10
4	Dyno OP Low Byte								Offset = 0
5	Dyno OP High Byte								Gain = 10
6	Loop Time uS								
7	Active Motor Absorb							AUTO	Auto mode confirmation

PID Tuning

PID tuning must be carried out to get the best possible response from the system. The D3000 uses fully digital PID that can be adjusted on a ‘live’ testbed.

PID Tuning Menu			
	To access the PID tuning menu by pressing the left hand ‘Rapid’ button.		
	Each PID term can be adjusted using the ‘+’ and ‘-‘ buttons. The terms displayed changed based on which ‘Engine’ or ‘Dynamometer’ mode is selected. All modes should be tuned during commissioning to ensure stable operation. Combinations of all modes must also be tested to ensure stability.		
	Engine P term ‘-‘ Current P term setting. Dynamometer P term ‘-‘ Term adjustment multipliers. Currently set to x10  Engine P term ‘+’ Dynamometer P term ‘+’ Save PID Terms		
	Adjustment multipliers can be selected to allow fast adjustment of control terms. All changes are temporary until ‘Save PID’ is pressed. Exit the PID tuning menu by pressing the left hand ‘Rapid’ button.		

Schematics