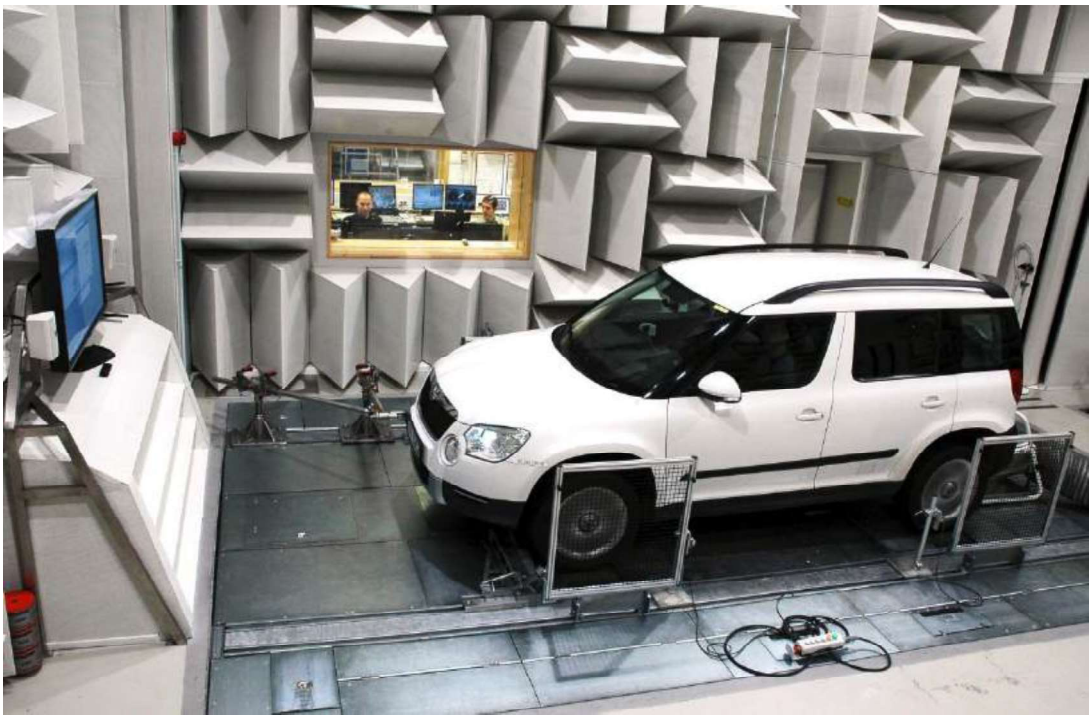


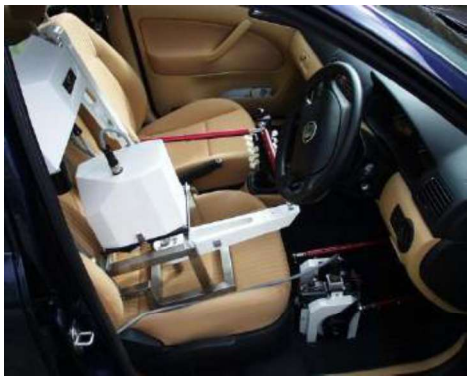
Chassis Dynamometer Systems

Chassis Dynamometers

Since the mid-1990's, Sierra-CP have been a global supplier of chassis dynamometer solutions for a wide variety of Vehicle Test applications. We can provide chassis dynamometers to suit most customer test cell specifications. Sierra-CP are able to offer custom designed dynamometers to suit vehicles from motorbikes to trucks and tracked vehicles including combination test sets that accommodate a wide range of vehicle types in a single installation.

Sierra-CP provides solutions for a variety of test cell conditions ranging from climatic test cells with temperatures down to -40 degrees C to specialty NVH evaluation test cells with specific chassis dynamometer noise constraints.

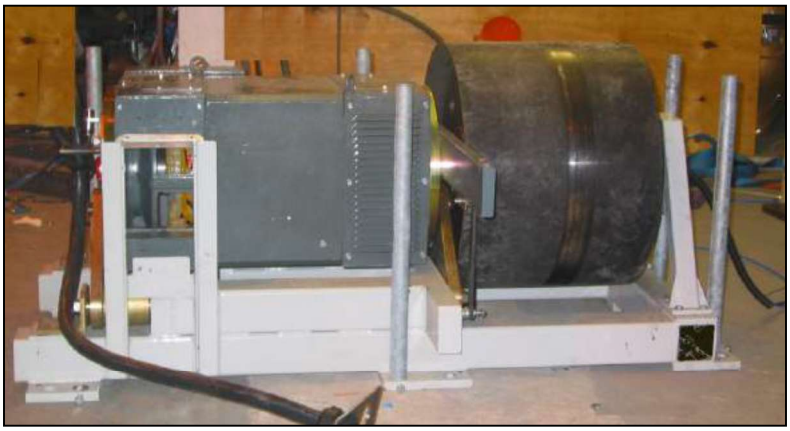
We also offer a variety of drive options to suit customer testing specifications and budget requirements. These are supported by a range of standard products such as Robot Drivers and vehicle restraints. Our chassis dynamometer solutions are precision controlled by our advanced CADET V14 CDS control system which enables the total integration of the chassis dynamometer system with third party instruments such as Emissions Measurement & Analysis Systems.



Motor Cycle & Three Wheeler Chassis Dynamometer Type MC-CD 600/60

Introduction

This range of Modular Chassis Dynamometers has been designed and developed to provide a cost effective solutions for the testing of motorcycles & scooters on the single roll set and three-wheeler, Quad bike and sub compact city type vehicles on the twin roller version.



For Specific High performance motorcycles alternative dyno options are available on request for performance envelopes outside the standard versions described in this document.

Benefits & Features

- Automatic compensation of bearing losses
- Low Maintenance Design
- Reduced Installation and Commissioning Program
- Compact design of the Centre Machine reduces the Pit / foundation requirements
- AC Drive & Motor technology –providing fast response and extended inertia Simulation
- Above floor Calibration
- Cost effective System solution
- Future Proof Dynamometer and Control System

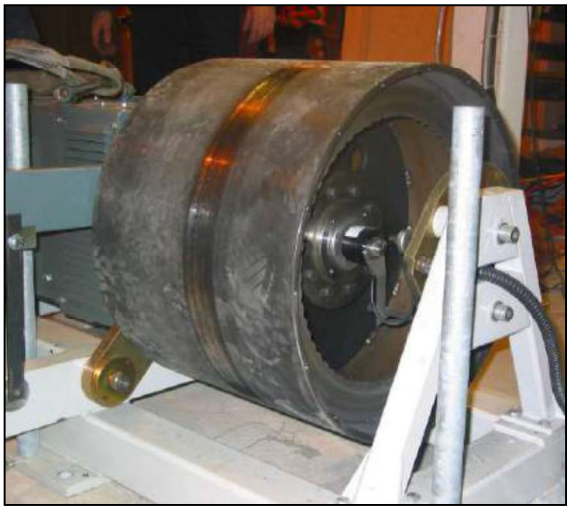
Applications

This Range of Chassis Dynamometers is suitable for the types of testing indicated below:

- Emissions
- Durability
- Performance Testing
- Quality audit

System Description

Roller Features



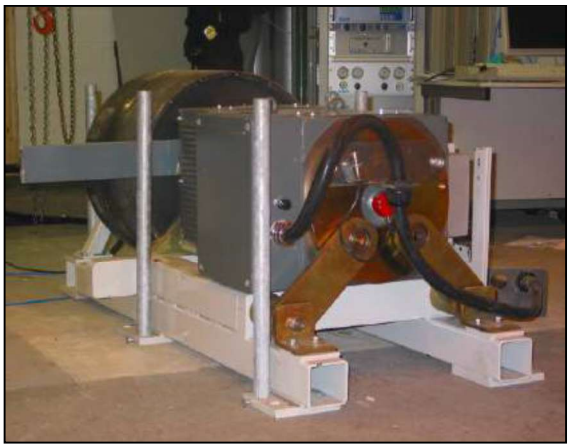
The roller is manufactured as a steel fabrication and is capable of supporting the axle loads indicated within this document. The roller mass is designed to provide the base inertia of the dynamometer, after stress relieving it is machined and balanced.

A pneumatically actuated brake is incorporated into the system and acts upon the stiffening webbing of the roller. This is designed for use as a parking brake only. A pressure switch and control valve are included; both mounted on the machine base frame.

Speed is measured using a precision incremental encoder, directly connected to the AC motor/roller shaft end and provides an accurate output of roller speed.

Reacted torque is measured with a load cell, connected between the dynamometer base frame and the AC motor carcass. As forces are applied to the roller surface the reaction through the motor carcass is measured by the load cell.

AC Motor Features



The chassis dynamometer utilises an AC motor as the motor/absorber unit capable to work in both directions and simulating test vehicle inertias electrically. The motor is air-cooled using a fan mounted off the base frame.
The AC motor is supported on torque reaction arms to allow free rotation of the motor carcass. The torque reaction arms are directly supported from the base frame.

All base frames are of a welded construction using hollow steel sections with machined pads to accept the motor/roller sub assembly. Features are included to mount the brake and roller encoder.

The base frame incorporates suitable lifting eyes and pads/feet to allow it to be bolted to concrete plinths.

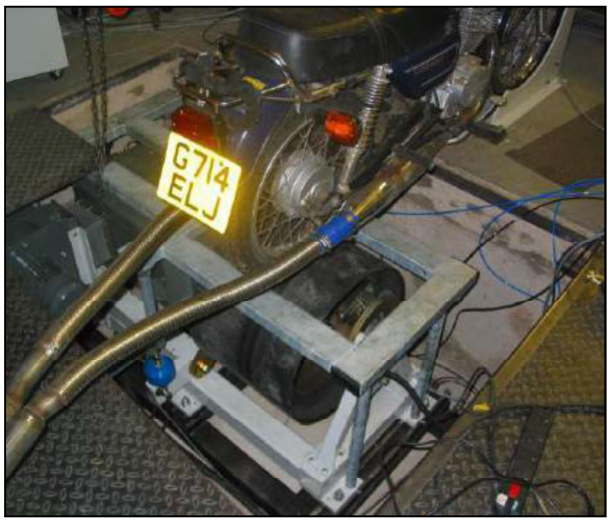
The base frame should include machine pads and fixing points to attach another motor/roller assembly for the expansion of the dynamometer enabling 3 wheel drive vehicles to be tested.

Calibration

Mechanical calibration equipment is in the form of a load arm of known lengths with mechanical calibration weights. Multi point calibration in both directions is therefore available.
One set of calibration weights is included.

Floor Plates

Steel floor plates and supporting beams will be provided to maintain a level floor around the roller surface and are to be supported from the pit edge trimming. CP will provide drawing details of required Pit Edge Trim.



Chassis Dynamometer Control System

CADET V14 CDS consists of the following major assemblies:

- **Control Cabinet** housing the system hardware
- **Software** installed onto the system computer
- **Operator Interface**. Providing a display of all data and manual control
- **In-Cell Equipment** providing the system interfaces with the Vehicle

Control Cabinet

The control cabinet is based on a standard 19” rack format. Into this are fitted the relevant components such as power supplies, terminal rails etc. The cabinet for such projects is generally a 19" x 38U cabinet 1,798mm high and having a 600mm x 600mm base.

The heart of the control cabinet are CP128 control and data logging racks, the number of these is determined by the extent of control and monitoring required by the system. Specific features of the hardware are discussed in the associated documentation.

All control channels operate at 80 Hz standard with fast and standard speed channels operating at between 10 Hz and 1 Hz. Data-logging channels offer 16-bit resolution, over a user-selected range.

A specification of each I/O card from the CP128 Control and Monitoring System can be found in the relevant Data Sheet.

CP128 and CADET V14 have been designed to allow increases in the capability of the system, by the simple addition of extra cards as required.

Vehicle Protection Panel

This eight-channel computer independent shutdown system will be configured to critical channels. These usually include over speed, low engine oil pressure and high engine water temperature being driven from the CP128 Control and Monitoring System cards. Other channels usually include software failure, fire and cell services failure. The remaining channels are spare to be specified by the customer.

Chassis Dynamometer Interlocks

The panel will operate independently of the PC, but with annunciation on the monitor. In addition every channel within the system has a software selectable high and low level warning and shutdown capability. Chassis Dynamometer Interlock.
The control system will include a chassis dynamometer interlock card (M-CDI-01) to protect the test bed from operation of lift out platform, E-stop / reset and other relevant actions while the rolls are turning.

System Controller

The System Controller is a PC based unit driven by Intel Core 2 technology; drivers and additional hardware have been researched and proven to run with the specific demands of CADET V14. The System Controller is located on a shelf in the control cabinet. The access to the controller is via a single drop down door. This will provide a tidy solution and keeps the desk area clear.
A three-meter loom is supplied for connecting the System Controller to the Operator Interface (i.e. system monitor, winged keyboard, and mouse).

CP have found by experience that to supply our own designed System Controllers is the most reliable method to ensure good operation of the test bed. The system controllers although PC based are not intended for use as general office PC's, they are specifically for use with the control system.

Software

The following software is generally supplied and configured to the system controller.

- Microsoft Windows XP operating system software
- Microsoft VB.NET
- CP CADET V14 CDS Vehicle Test System software with:
  - Programming capability
  - Programmable bed protection
  - Automatic and Manual Control modes
  - Data logging
  - CP Trace V14, multiple y-axis, real-time display and analysis software
  - Bumpless transfer between Auto and Manual control
  - Form based Calibration Mode
  - Low and High Alarm and Shutdown levels

Operator Interface

CADET V14 is designed for both unattended and manual operation. The following equipment is the only interface required between the test system and the operator.

- CP ‘winged keyboard’ Features;
  - 102-Key standard English (UK) keyboard
  - Encoders for dynamometer and throttle (rack) manual control set-points
  - Vehicle/test bed emergency-stop ‘mushroom’ type push-button
  - Bed ‘Alarm Accept’, and ‘Reset’ push-buttons
- 19” flat screen colour system monitor

Chassis Dynamometer – Additional Options

Motorcycle Wheel Clamp

The Motorcycle wheel clamp enables an efficient positive location of the front motorcycle wheel and also acts as a fast method of referencing the rear wheel on to the apex of the Chassis Dynamometer roll set for repeat tests

- The wheel clamp device is suitable for most scooter /Motor cycle wheel profiles [refer to chart below]
- In the event of power loss the wheel clamp will remain locked.

	Min.	Max.	Adjustment
*Wheel base adjustment	-- -- --	600	Manual
*Wheel Width	63mm	140mm	Pneumatic
*Wheel Diameter	350mm	700mm	-- -- -- --

*Wheel clamping devices to suit specific ranges of motorcycles can be offered on request.

Head Wind Fan

Depending on the application we offer the choice of either Axial or Centrifugal Variable speed head wind fans. Typically the centrifugal fan is quieter at max speed, but has a cost premium of typically 30% higher than the Axial\ Version.
The fan speed will automatically track the speed of the chassis dynamometer up to the fan maximum speed. Manual control of the fan will also be available via the incremental encoder on the 'winged' keyboard.
Alarm conditions with both low and high alarm and low and high shutdown parameters can be set for each channel. Post mortem logging for all channels is automatically available with the user defining pre and post logging time.

- The fan assembly is mounted on castors to allow the correct positioning between 0.3 and 0.45 m from the motorcycle front wheel before being fixed in position on jacks.
- Adjustment of the duct between 50mm and 200mm above floor level, all as required by ECE R 040 and the draft WMTC
- This speed range is sized (+/-10%) to meet the requirement of the draft WMTC

Type	Axial	Centrifugal
Variable speed	Y	Y
Air Speed range*	0-125 Kph	0-125 Kph
Noise/full speed@ 1m	105 dB (A)	95dB(A)
Outlet cross section area	> 0.4m2	> 0.4m2

*Based on ambient conditions 1013mbar @20 deg C

Roll Set Surface Coatings

As an option we can offer the Chassis Dynamometer with alternative roll surface coatings upon request.

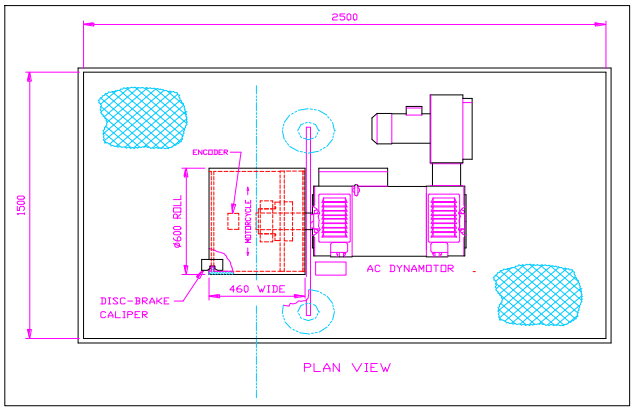
System Extensions - Option

CP Engineering offers a range of integrated System components and products to support the complete operation of a Chassis dynamometer Facility.

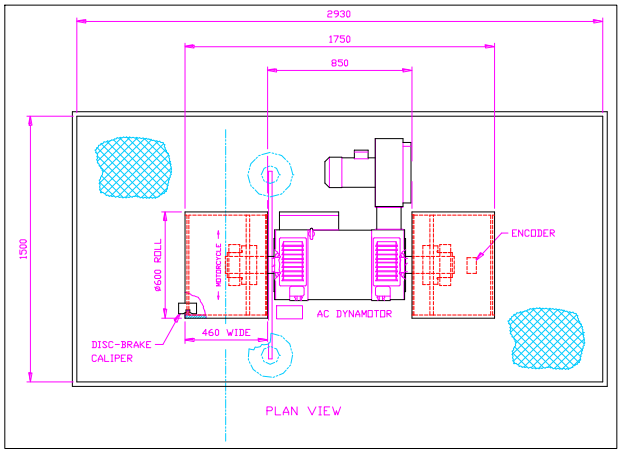
Further Details can be obtained upon request

- TLS – facility management & reporting Software
- Drivers Aid
- Robot Driver
- Hand Grip Throttle Actuator
- Auto Fuelling / Measurement

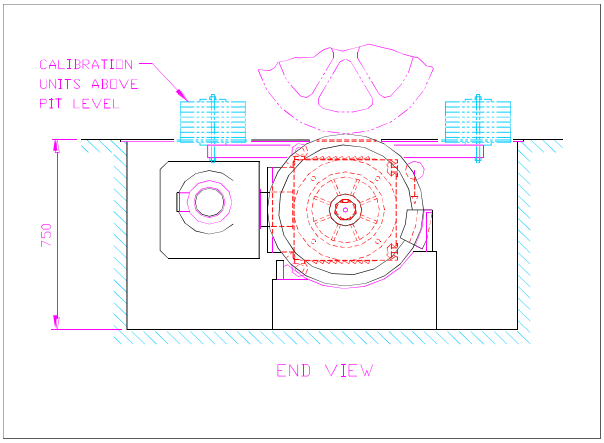
Schematic diagrams



Single Roll Version



Twin Roll Version



Single / Twin version

Specification & Performance Data

Max. test speed	200 km/h
Max. tractive /braking force 0 – 84 km/h	2,100 N
Max. power 84 – 200 km/h	60 kW

Simulation of vehicle mass range

The basic mechanical inertia of the machine includes all the rotating test rig compone
The dynamometer will have the following specification:

Base inertia 1 Single Roller – approximate	140 kg
Base inertia 2 Twin Roller – approximate	240 kg
Mass simulation, achieved electrically-Single Roll	100 kg – 450 kg
Mass simulation, achieved electrically-Twin Roll	100Kg – 850 kg

Roller

Roller diameter	600 mm
Tolerance on diameter	±0,1 mm
Roller – Width	450mm
Roller – Min inside Track width – Twin Roller	850 mm
Roller – Max outside Track width-Twin Roller	1750mm
Balance grade	ISO 1940 Q 2.5
Maximum axle load	800 kg [Twin Roll]
Roller surface	Machined Finish [plain]

Motor

Motor/generator:	3-phase AC motor
Operating modes:	Motor/generator
Direction of rotation:	Both directions
Position - Single	Side mounted
Position - Twin	Centre Mounted
Mounting	Swing frame
Nominal power (motor/generator):	60 kW
Protection class:	IP 23
Insulation class:	F
Thermal motor protection	PTC thermistor
AC Motor cooling	Fan
Cooling air temperature	Max. 40°C
Cooling air humidity	Max. 95% non condensing
Operating temperature range	+10 to +40°C
Max. height above sea level	1000 m

Customer Responsibilities

Generally the customer should make available or prepare the following services:

- Electrical Power Supply
- Fuel supply
- Compressed Air
- Pit Drainage
- Ductwork
- Foundations / Pit works [drawing supplied by CP]
- Pit Edge Trimmings [drawing supplied by CP]
- Fire suppression systems
- Fire/ vapour detection

These will be confirmed and discussed during the project phase.

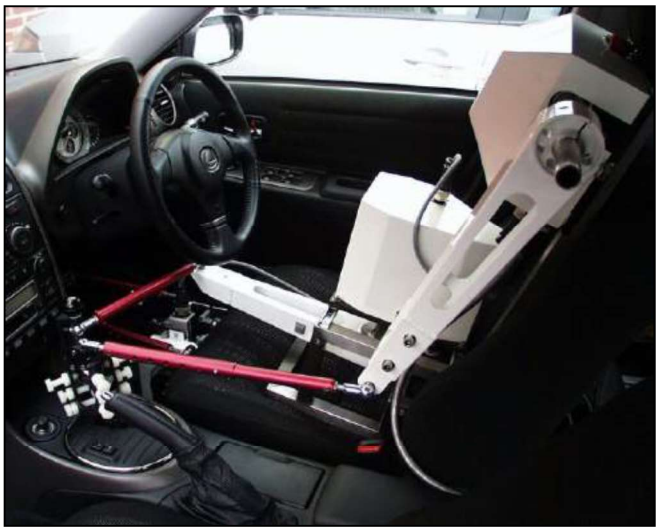
Vehicle Robot

Emissions and Endurance

Introduction

The CP Engineering Systems Ltd., Vehicle Robot consists of a number of sub-assemblies that are light enough to be assembled by one person into a vehicle, connected together, *taught* and transferred to the chassis dynamometer in minimal time.

The Vehicle Robot can be supplied as a stand-alone system or integrated into the CP Vehicle Test system.



Benefits and Features

- Flexible channel assignment to different controls, as project requires
- Modular construction allows easy installation
- Up to six different actuation channels
- Non-intrusive design
- Cost effective solution

Applications

- Emissions Work
- Endurance Testing
- Mileage Accumulation
- Research and Development

System Description

The Vehicle Robot sub-assemblies include:

- Torso shift module. X-axis gear shift position
- Torso select module. Y-axis gear select position
- Pedal Box
  - Throttle
  - Clutch
  - Brake - optional
- Electronic Control Unit. Power supply for the Torso and Pedal Box
- CP128 Control and Monitoring System (I/O)
- Standard Pentium computer

DC actuators and mechanical linkages are part of the Torso and Pedal Box and powered by the stand alone 110 Volts AC Electronic Control Unit. A standard PC controls the power circuitry through the CP128 Control and Monitoring rack. The CP128 rack and computer may be a stand-alone Robot Control, or part of an integral CADET chassis dynamometer system.

To minimise gearbox wear and to assist in gear training, magnetic clutches are used to de-couple the gearshift arms from the drive actuators. By employing this method, minimum wear on the selector forks and hubs within the gearbox is achieved. The overall design is suitable for the inclusion of force sensing at the gear lever by the inclusion of in-line load cells in the actuator struts.

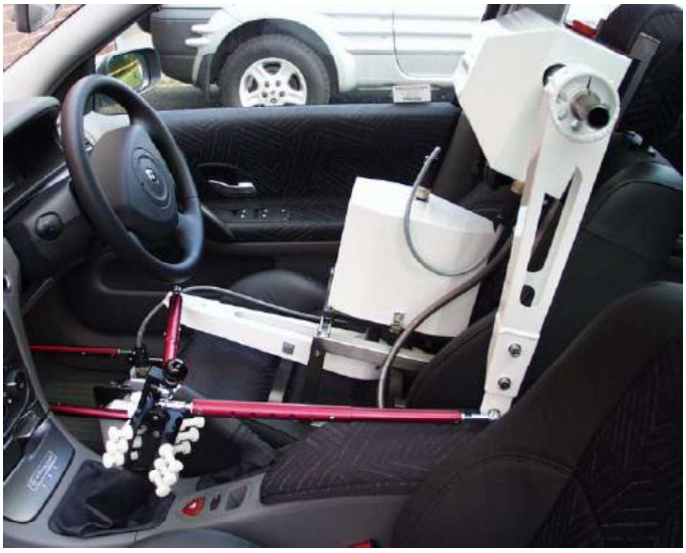
The software only engages the magnetic clutches when a gearshift is taking place to ensure that the forces acting on the gearshift during normal operation may be ignored. A further benefit of the clutches is their guaranteed maximum force transfer that protects the transmission in fault conditions.

Description of Torso Module

The Torso module is split into two sections that are locked together in use. These contain the Shift (left-right X-axis) and the Select (front-back Y-axis) modules. One person may split the torso to enable installation of the robot.

The Torso gear selector module has been designed around the general envelope of a human driver to allow it to be used in the majority of vehicles.

The performance of the system is commensurate with typical driver operation with a total gear-gear time of less than one second supported by the standard actuators. As an option special high performance actuators are available.



Adjustment of the X-axis shift actuator mechanism relative to the seat is provided to allow the maximum length of strut to be used in vehicles of both right hand and left hand drive. Overall positioning may use the seat while actuation struts, with low friction ball joints, are expandable in steps of 25 mm using press release keys.

The Y-axis shift module gear change arm may be mounted on either end of the actuator shaft that allows rapid set-up for either right-hand or left-hand drive vehicles. It is possible to convert from left-hand drive to right-hand drive configuration in less than two minutes.

Description of the Pedal Box

The pedal box module provides three actuation struts for clutch, throttle and optional brake. The struts are expandable in steps of 25 mm using press release keys and are fitted with ball joints at each end. A clamp bracket with integral ball end is fixed to the pedal to allow the strut to be clicked into place. The pedal box module is fixed to the vehicle by brackets clamped to the seat sub-frame. Alternatively, fixtures are provided in the pedal box module to accept the torso module fixings when they are both installed in the driving seat.

The electronic control unit contains all the necessary power electronics to drive the Vehicle Robot. Line supply is via an IEC connector and three multi-pole connectors allow interfacing to:

The Select/Shift Torso
The Pedal Box
The CP128 Control and Monitoring System

A number of LED displays on the unit indicate the state of the drive and clutch control signals, and a precision 5 Volts position potentiometer excitation supply is included.

The Torso shift and select drivers are controlled by open loop driver circuits with H bridge drive capable of accepting an external 'drive demand' set point. Current limit protection is included with a pre-set characteristic to protect the actuators.
The Pedal Box throttle, clutch and optional brake drivers are controlled by closed loop driver circuits with H bridge drive capable of accepting an external position set point and input position data from a precision position potentiometer or a direct input voltage. Feedback of position to the external controller is available.
Current limit protection is included with a pre-set characteristic to protect the actuators.

The computer control software and CP128 Control and Monitoring System are capable of controlling the Vehicle Robot as a stand-alone system. The software includes a programmable auto-shift facility, safety limits and the ability to follow a pre-programmed test schedule from an internally stored data file. Miss-shift recovery routines and manual and automatic training routines ensure reliable operation.

When used in conjunction with the standard CP Engineering Chassis Dynamometer Test System, that includes inertia simulation to meet the EPA requirements, road load and coast down features, the Vehicle Robot software would be integrated onto the dynamometer test system control computer.

Configuring the Vehicle Robot

The strategy used by the Vehicle Robot during gearshifts is set within the program but it is fully configurable. This allows the optimum settings of change times and forces to be determined and stored along with calibration data for the rolls speed and engine speed. A full safety and automatic gear map may also be stored. Gear ratios are stored to assist in detecting a miss-shift. These ratios may be determined from a technical manual or by operating the vehicle manually on the rolls.

Once these settings have been stored they may be re-called and the system is ready for use once training has been carried out.

Training the Vehicle Robot

The Vehicle Robot is trained in a number of steps to perform gearshifts. This is achieved by the use of a keyboard and monitor positioned locally to, or within, the vehicle. It is generally necessary to carry out this training on each occasion that the Vehicle Robot is installed in a vehicle.

The X-Y positions of the centre point of each gear position are taught to the system. This process is very fast making it possible to quickly re-train the system if the position of the Vehicle Robot is changed.

The throttle is automatically mapped to determine the required throttle positions during the gear changes. This is achieved under the control of the software with the engine running. A signal is required which represents the engine RPM.

Both the clutch, and when applicable the brake, bite-points are taught to the system by the press of a single key as it is determined manually.

Customer Responsibilities

Generally the customer should make available or prepare the following services:

- o Electrical Power Supply, Single Phase
- o Test Vehicle
- o Rolling Road, or Rig

Specification

Torso Both Shift and Select modules use the same actuator systems.

Torque (In-shift)	**10 Nm**
Reduction Gear ratio	**4.167:1**
Material	**Delrin**
Arm Length	**350 mm. Shorter arms, for more force, are available**
Clutch Limit	**6 Nm**
Lever Force (at max speed)	**60 N (Clutch protected at max speed)**
Movement	**250 mm**
Traverse Time	**220 ms - Off-load**
Materials Unit	**Stainless Steel and Aluminium (Hard Anodised)**
Cover	**Aluminium Powder finish**
Weight Torso shift module	**10 kg**
Torso select module	**9 kg**

Pedal Box The pedal box contains throttle and clutch (brake as an option) actuators mounted on a single 30mm diameter stainless steel shaft. The shaft may be mounted to the torso or the vehicle seat in a number of configurations.

Width (throttle and clutch)	**250 mm**
Height	**190 mm**
Depth	**190 mm**
Weight **(throttle and clutch)**	**6 kg**
Electrical Connections	**1 off 19 pin connector**
Materials	**Stainless Steel and Aluminium (Hard Anodised)**
Torque (In shift)	**10 Nm**
Reduction Gear ratio	**3:1**
Material	**Delrin**
Lever radius positions	**90 mm, 115 mm and 140 mm**
Max Force	**250 N**
Movement	**250 mm max**
Shift Time - Clutch	**350 ms Typical**
Shift Time - Throttle	**250 ms Typical**

The keyswitch actuator module is supplied with supporting and adjustable brackets. It is suitable for most keys and keyswitch mounting positions. Additional heating to the standard version allows for low temperature use. The keyswitch actuator is also provided with an adaptor for use with push button stop/start systems.

Keyswitch	**1.5 Nm 180° movement**
push button stop/start	**Adaptor included**

Electronic Control Unit

Width	**520 mm**
Height	**160 mm**
Depth	**400 mm**
Weight	**17 kg**
Line Power Supply	**110 Volts AC 50 – 60 Hz**
Power supply Voltage	**60 Volts DC Nominal**
Power	**1 kW Type in-shift capacity**
Output Circuits	**H Bridge - Switched Mode 20 Amps Capacity**
Input Circuits	**±5 Volts or 0 - 5 Volts**
Hardwired Shutdown Circuits	**Clutch Down/Throttle Closed/Gear Unloaded**

Additional Options

- Alternative Mounting Systems
- Spare Clamps and Grips
- Key Switch Actuator
- Shift Force Measurement

Customer	Axis #	Type	Robot Actuation Modules	No
Cosworth Technology	2	D	Throttle – Clutch	2
Associated Octel	5	V	Throttle – Gear change – Clutch – Ignition key	6
Shell Research	4	V	Throttle – Gear change – Clutch	4
Ford Motor Co.	1	V	Throttle [Auto Transmissions]	3
AVL – Zöllner	5	M	Throttle - Gear shift –-Clutch – Brake	1
Hyundai	2	V	Gear shift	1
Winsmex	5	M	Throttle - Gear shift –-Clutch – Brake	2
Castrol	5	D	Throttle – Gear change – Clutch – Ignition key	1
Castrol	3	V	Gear shift – Clutch	1
Sanden	4	D	Throttle – Gear change – Clutch	1
Land Rover	5	V	Throttle - Gear shift –-Clutch – Brake	1
Land Rover	2	V	Gear shift	2
Cranfield	4	V	Throttle – Gear change – Clutch	1
Huddersfield University	4	D	Throttle – Gear change – Clutch	1
Bath University	5	D	Throttle – Gear change – Clutch – Ignition key	1
Ricardo	2	V	Gear shift	1
Proton	5	V	Throttle – Gear change – Clutch – Ignition key	1
Prodrive	4	D	Throttle – Gear change – Clutch	1
SAAB	1	V	Throttle	1
ARAI, India	5	D	Throttle – Gear change – Clutch – Key Ignition	2
AAA Denso	1	V	Climatic Throttle	1
Ford Australia	5	V	Throttle – Gear change – Clutch – Ignition key	1
Uzel	5	V	Throttle - Gear shift –-Clutch – Brake	1
Land Rover	1	V	Climatic Throttle	1
Ford Australia	5	V	Throttle – Gear change – Clutch – Ignition key	1
Lubrizol	2	V	Gear shift	1
Skoda	5	V	Throttle – Gear change – Clutch – Ignition key	1
Shell	5	V	Throttle – Gear change – Clutch – Ignition key	1
Shell	5	V	Throttle – Gear change – Clutch – Ignition key	1
			Total	**43**

TYPE KEY: V = Vehicle, M = Motor Cycle, D = Dual Purpose (car and Motor cycle)

Motorcycle and 2-3 Wheeler Robot Actuator