Dynatest®

DYNATEST FWD/HWD

TEST SYSTEMS

OWNER'S MANUAL

Version 03a

ID Number 1110102

Dynatest®

!IMPORTANT SAFETY REMARKS!

Please Read this first:

For your own safety and the safety of others, please read this advice carefully.
An FWD/HWD is a powerful, hence dangerous piece of equipment that may injure persons in cases of malfunction or mistreatment.

Things that may happen:

The weight may drop unexpectedly.
Hydraulic oil may leak at high pressure.
Hydraulic leakage may 'DROP' the loading plate assembly onto the ground.

A few simple rules for the operator:

Stay clear of the moving parts of the FWD/HWD if at all possible.
Make sure nobody else gets close.
Never place objects like e.g. tools at or near the buffer hit plate.
Do not leave the weight raised to drop position.
Do not leave the subassembly raised and unlocked.
Support the weight or subassembly during maintenance.

During demonstrations, training etc.:

Announce what you are about to do before you press any buttons.

Overview

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1. Introduction

1.1 Intro

A major advantage of analytically based structural design methods over more empirical methods is that the former may be used with any type of material and structure and under all climatic conditions, whereas the latter only may be used under those conditions for which the empirical relationships were developed. Most pavement research effort has therefore concentrated on developing and perfecting analytically based methods (e.g., the first six Ann Arbor Conferences).

Analytically based methods can only be used if the moduli of the pavement layers can be determined. This may be done if the test method allows for:

1. A force amplitude and duration approximating the effect of a heavy moving wheel load in order to allow for non-linear and visco-elastic stress-strain response, and

2. Very accurate deflection measurements, especially at several large distances (i.e. larger than the thickness of the pavement) from the centre of the load. This is absolutely essential in order to get an accurate determination of the (non-linear!) Subgrade modulus, which generally contributes some 60-80% to the total centre deflection.

The Dynatest 8000 FWD (**F**alling **W**eight **D**eflectometer) Test System, 8000 VMD (**V**an **M**ounted **D**eflectometer) and 8081 HWD (**H**eavy **W**eight **D**eflectometer) Test System all satisfy these conditions, whereas most vibrating equipment has a light load capacity, and Benkelman or other beam type equipment is inaccurate at significant distances from the load because the deflection gauge must be supported within the deflection basin itself.

The FWD, VMD or HWD may therefore - contrary to most other equipment - be used with analytically based structural design methods.

1.2 History

Based on early work in France during the sixties, the Technical University of Denmark, the Danish Road Institute and the Dynatest Group have gradually developed and employed the Falling Weight Deflectometer (FWD) for use in Non-Destructive Testing of highway and airfield pavements. In 1977, the Dynatest 7800 Registration Equipment was introduced to obtain digital load and deflection value readouts, although it was still necessary to hand place the deflection sensors away from the load. Various research projects showed, however, that simultaneous measurements of at least six deflections (plus the load) were necessary for quick and precise deflection basin determinations, from which it became possible to evaluate the In Situ E-moduli or stiffnesses of all structural layers in an existing pavement system through the use of the Dynatest “ISSEM4” main frame Fortran computer program, and in the recent years through the ELMOD PC computer program.

In 1979, Dynatest introduced the Model 8001 FWD featuring compact mechanical design with integrated raise/lower sensor bar and remote control of all operations, including load level. Finally, the 7800 Registration Equipment was precluded in 1981 by a more compact micro-processing system called the Dynatest 8600 System Processor. In conjunction with a newer model FWD, the Dynatest 8002 FWD featuring a loading range of 7 kN (1,500 lbf) to 120 kN (27,000 lbf), and a matching Hewlett Packard HP-85 Computer, this system was able to handle seven simultaneous deflections, one load and numerous site and configuration identifiers, in very short order, by a single operator doing inventory work.

In 1986, the computer program for the FWD Test System, called the Field Program, was made DOS compatible and extended with a lot of features. The DOS compatibility made it possible to use almost any IBM compatible PC as the Computer. The latest version of this Field Program is Edition 20 (which may be replaced by the latest FwdWin program, see below).

In 1987, Dynatest introduced a “big brother” to the FWD, the Dynatest 8081 HWD Test System, which with a dynamic peak load capacity of up to 240 kN was developed to simulate heavy aircraft loads. The HWD can, however, also be used for road evaluation at load levels down to 30 kN. The Model 8081 HWD uses almost exactly the same electronics and software as the Model 8000 FWD (apart from adjustments for the higher load capacity), so that the HWD is producing data at the same high accuracy as the FWD.

In early 1989, a second-generation microprocessor control and data acquisition unit was introduced, called the Dynatest 9000 System Processor, featuring two (and prepared for eight) additional deflection channels, so that a total of 10 channels (1 load + 9 deflections) was available (required Edition 25 or FwdWin Field Program - please see below). The 9000 had several new features, e.g. a 40 character LCD display for system status monitoring (even without a PC connected).

In 1992, Dynatest introduced the Edition 25 Field Program, based on Object Oriented Programming, featuring window pull-down menus and a series of features over the Edition 20 FP, mainly providing for 9 (10) (and prepared for 15) deflection channels, 0.1 micron deflection resolution, load sensing/targeting, on-line Help System, fast sampling/storage of signal time histories, user modifiable data file format, etc.

In 2001, Dynatest introduced a Microsoft Windows® version of the Field Program called FwdWin. FwdWin now runs under Windows 2000, XP and Vista. It offers all the advantages of a graphical user interface (GUI), plus real time display of many data elements. It also utilizes Microsoft Access® database format for data storage in addition to the traditional ASCII data formats.

In 2003, a third-generation control and data acquisition unit was introduced, called the Dynatest Compact15, featuring fifteen deflection channels, so that a total of 16 channels (1 load + 15 deflections) is available (FwdWin Field Program required - please see above). Compact15 is an embedded computer unit mounted on the loading subunit and communicating with the host computer through an Ethernet connection.

The FWD/HWD, including a Compact15 System Controller and a standard PC with the FwdWin Field Program constitutes the newest, most sophisticated Dynatest FWD/HWD Test System, which fulfil or exceed all requirements to meet e.g., ASTM D-4694 and D-4695 standards.

1.3 General Specifications

A Dynatest FWD/HWD Test System consists of five main components:

- A Dynatest 8002 FWD Trailer, a van mounted FWD Subunit or an 8082 HWD Trailer.
- A Dynatest Compact15 System Controller.
- A Remote Control Box
- An IBM compatible computer like e.g., a Notebook or Laptop type PC with Windows®.
- The FwdWin field data collection program.

1.3.1 The FWD/HWD Mechanics

By means of a falling weight striking a specially designed rubber spring system, a Dynatest FWD/HWD produces an essentially half-sine shaped, single “impact” load of 25-30 msec in duration, closely approximating the effect of a moving wheel load of up to 120 kN (27,000 lbf) (optionally 150 kN (33,000 lbf)) for the FWD/VMD or 240 kN (59,000 lbf) (optionally 300 kN (66,000 lbf)) for the HWD.

- Peak load range 7 to 120 (opt. 150) kN (1,500 to 27,000 (opt. 33,000) lbf) for the 8000 FWD or the VMD
- Peak load range 30 to 240 (opt. 300) kN (6,500 to 54,000 (opt. 66,000) lbf) for the 8081 HWD
- Light weight, trailer or van mounted. Trailer versions may be towed by an ordinary passenger automobile or van.
- Height of trailers less than 1.5 m (58”) in transport as well as measuring mode, low centre of gravity, stable at normal highway speeds.
- Centre mounted load cell, integrated with the loading plate and swivel suspended.
- 7 (optionally up to 15) seismic deflection transducers, in movable holders along a 2.45 m (8 ft) raise/lower bar, for precise deflection basin measurements.
- Automatic, remote controlled operation (including falling height selection) by one person (the driver).
- A typical testing sequence in one measuring point is performed in less than 40 seconds (HWD: 50 secs.)
- Weather resistant (–20C to +50C (–5F to +122F)) for all components located outside the towing vehicle.
- 12V DC power requirement only, heavy duty buffer battery supply provided.
-

1.3.2 The Compact15 System Controller

The Dynatest Compact15 System Controller is a PC based control and signal processing unit, which is networked with the host computer (Ethernet).

- A temperature-controlled case, compact and light.
- Controls FWD/HWD operation.
- Performs scanning, conditioning and further processing of the transducer signals (1 load + up to 15 deflections).
- Monitors status of the FWD/HWD unit to ensure correct measurements.
- 12VDC powered.

1.3.3 The Remote Control Box

The Remote Control Box (placed in the towing vehicle) interfaces the Park Alarm signal and switches on and off the System electronics and (optional) warning lights.

1.3.4 The Computer

The computer is used for input of control and site/test identification data as well as for displaying, storing (on disc), editing, sorting and further processing of FWD/HWD test data.

- Ethernet RJ45 connector (10/100 Mbit)

1.3.5 FwdWin, a Windows based FWD/HWD Field Program

Features

User Interface

- Flexible layout through floating, resizable windows
- Voice feedback (error- and warning-messages)
- Support for multiple languages

Data Files

- Test data is stored in databases for ease of processing.
- Earlier Dynatest ASCII file formats are still supported.
- Pavement Deflection Data eXchange (PDDX by AASHTO)

Section Database

- The operator can retrieve Roadway network information in the field:
  Facility Names and Codes
  Sectioning

Quality Assessment

- Changes to primary program- and equipment-parameters are logged.

1.4 Performance Specifications

1.4.1 Accuracy

The deflections are measured with an absolute accuracy of better than 2% ± 2 microns, and with a typical, relative accuracy of 1% ± 1 micron. The resolution of the equipment (in terms of deflection) is 0.1 micron (1 micron = 0.04 mil).

The load is measured with an accuracy of better than 2% ± 0.3 kN. The resolution of the equipment (in terms of load) is 0.03 to 0.2 kN (7 to 45 lbf), magnitude dependent.

1.4.2 Reproducibility

The reproducibility of successive FWD/HWD tests run on the same elastic materials is typically 1% in terms of the load/deflection ratio, for a given falling height and mass configuration.

2. Tow Vehicle Installation

2.1 Short form Vehicle Installation Guide

2.1.1 General Remarks

Normally, the delivery of a Dynatest FWD/HWD Test System does not include a towing vehicle.

In this section, therefore, are given all Installation Instructions (and hints) necessary to prepare a towing vehicle for a proper FWD/HWD System Setup.

In this section are NOT described all the “non-permanent” connections (regarding transducers, computer power and interface cable) which are performed using quick-connect plugs - refer to subsequent sections 7, “Connecting the Electronics” and 12, “Transducers/Cables” for descriptions and cable diagrams.

The Hardware Installation Instructions are given below in a rather short form, backed up by supplementary Notes where necessary (to be found in subsection 2.2).

Items followed by “(provided)” will be included in the system delivery or be shipped in advance of delivery if so agreed.

2.1.2 Vehicle Type

The towing vehicle should be of adequate size and engine power to tow the FWD/HWD trailer with max. permissible weight. The engine compartment should preferably allow for space for an additional alternator (see below).

2.1.3 Trailer Hitch

The vehicle should be fitted with a trailer hitch with a 50 mm (or 2”) diameter hitch ball, the centre of which should be located 480-500 mm (18-20”) above ground level when LOADED with some 100kg (see also Note 2.2.1). The hitch must be rated for towing of the FWD/HWD trailer max. permissible weight.

2.1.4 Trailer Lights Socket (provided)

A trailer tail lights connection socket should be mounted on the rear of the towing vehicle close to the towing hitch ball (preferably in front of and some 200 mm to any side of the ball) (see also Note 2.2.2).

2.1.5 Additional 12V Alternator

For optimum powering of the FWD/HWD Test System, an <u>additional</u> 12V alternator of at least 60 Amp. output capacity, preferably 90 Amp. or more (HWD: at least 90 Amp., preferably 110 Amp. or more) should be mounted onto (and belt driven by) the vehicle engine (see Note 2.2.3). ALTERNATIVELY, IF this solution is not possible/desirable, the vehicle’s own (existing) alternator MAY be used under certain conditions. A third solution is using an optional trailer mounted Power Unit, see notes in the following.

2.1.6 Using/ (Replacing) the Existing Vehicle Alternator

If it is NOT possible or desirable to mount an ADDITIONAL alternator in the towing vehicle, then the vehicle’s EXISTING alternator MAY alternatively be used, IF it has an adequate current output rating (FWD: at least 90 Amp. output capacity, preferably 110 Amp. HWD: at least 120 Amp. output capacity, preferably 150 Amp.). IF NOT, it could be REPLACED by a heavier alternator, if available/possible.

A battery separating RELAY should be used (see below).

2.1.7 Battery Separation Relay (provided if needed)

IF (and ONLY if) the FWD/HWD System is powered from the EXISTING vehicle alternator (or its replacement), a special, heavy duty battery separation RELAY should be installed (see Note 2.2.3).

2.1.8 Electronics Buffer Battery (provided if required)

For buffering of the alternator generated 12VDC power supply to a 12VDC-to-110/220VAC Power Inverter (see 2.1.11), an additional battery should be mounted in the vehicle cabin. Preferably use a maintenance-free (“add-no-water”) 12V battery of 40-60 Ah capacity (standard size in most small passenger vehicles) (see Note 2.2.3).

2.1.9 Heavy Fuse Box (provided)

A heavy fuse box should be installed for protection of the 12V power circuits (see Note 2.2.3).

2.1.10 12V Power Socket for Trailer (provided)

A heavy, 2-pin (female) power output socket for powering/charging of the trailer 12V electrohydraulic system and buffer battery should be mounted close to the towing hitch ball (like the lights output socket, but preferably to the opposite side of the ball (see Note 2.2.3).

2.1.11 Power Inverter (provided if needed)

If the Computer requires 110/220VAC powering, a 12VDC-to-110/220VAC Power Inverter should be installed (see Note 2.2.3).

2.1.12 Throttle Regulator

If the Vehicle alternator capacity is in the low end, the vehicle engine should preferably be fitted with a manual or automated throttle regulator, so that the engine <u>idling</u> RPM can be raised to 1000-1500, to ensure adequate 12VDC power supply from the alternator during testing. On most new vehicles, this is difficult or not possible, in which case it is important to use an alternator with an output capacity in the high end.

2.1.13 Alarm Connection Plug (provided)

A 3-pin DIN plug should be used for connection of the vehicle’s PARK indicator OR hand brake (emergency brake) indicator to the ALARM socket on the Remote Control Box. This enables the system to give a warning ALARM signal AND to automatically raise the loading plate, if the vehicle is set into DRIVE (or the emergency hand brake is released) during testing (see Note 2.2.4).

2.1.14 Emergency Switch

An emergency switch (with a momentary <u>break</u> contact) may be connected in series with the above-mentioned ALARM connection for immediate raising of the loading plate in an emergency situation. This switch could e.g. be dash mounted and have a large, visible push knob (see Note 2.2.4).

2.1.15 Cable Access Opening

The towing vehicle should be fitted with some kind of an opening in the rear, so that the network cable can be easily passed from the Computer to the Trailer (see Note 2.2.5).

2.1.16 Placing the Computer

The towing vehicle should be fitted with some kind of a small table or the like for the computer (see Note 2.2.6).

2.1.17 Air Conditioning

If necessary, the vehicle should be equipped with an air conditioner to keep the interior of the vehicle below 40°C (105°F) (and to keep out dust from open windows). A white roof, tinted glass and/or curtains can perhaps also be used to reduce sun heating.

2.1.18 Warning Signs / Flasher Lights

To warn the traffic during testing, warning flasher lights should be mounted on top of the towing vehicle.

Warning signs may also be mounted on the rear of the vehicle and/or the Trailer (see also Note 2.2.7).

2.2 Notes for the Vehicle Installation

2.2.1 Trailer Hitch Requirements

The Trailer Hitch should be approved for the FWD/HWD trailer max. permissible weight (see “Trailer Specifications”).

The Dynatest FWD/HWD Trailer can be delivered with a coupler intended for a trailer hitch ball diameter of either 50 mm (1-31/32”) OR (optionally) 2” (50.8mm).

WARNING!

Make sure that the trailer hitch ball matches the coupler!

The trailer frame will be parallel to the ground surface (so that the guide shaft for the drop weight will be perpendicular to the ground), if the **centre** of the trailer hitch ball is kept in a height of 480-500 mm (18-20”) from the road surface when loaded with some 100kg, see figure on a following page.

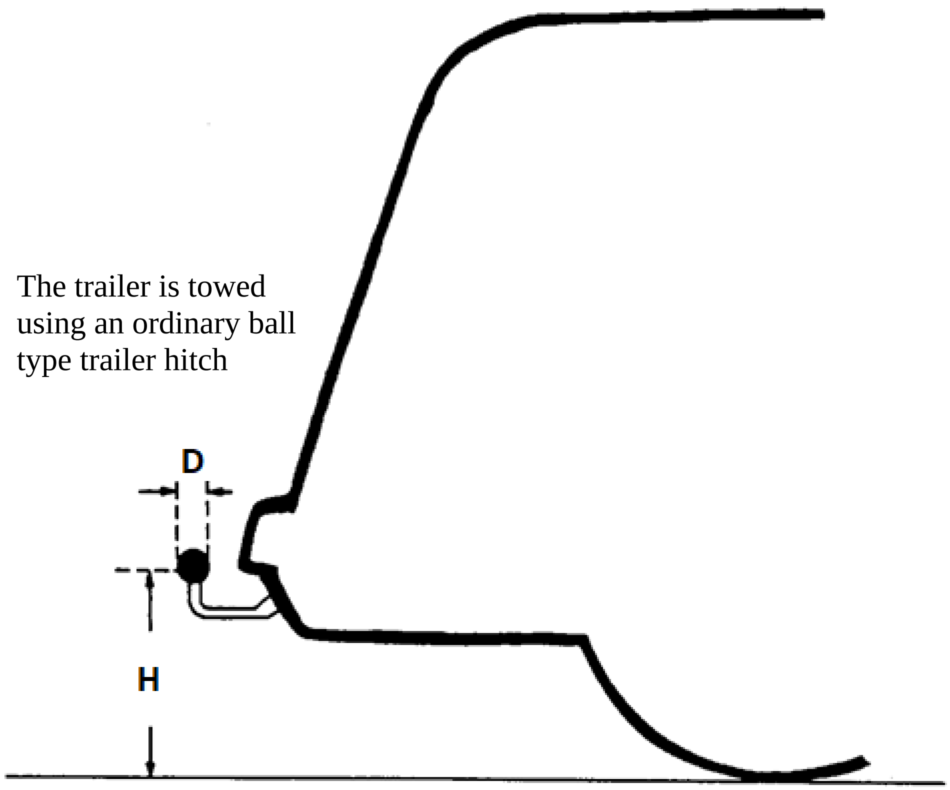
WARNING!

Be careful when loading the towing vehicle.

Do NOT put too much cargo in the rear of the car, which will not only affect the tilt of the trailer frame but also driving stability of the vehicle

If the **vehicle** is heavy loaded with cargo and/or personnel when testing, then make sure that the hitch ball is still in the correct height (480-500 mm) from the road surface with the FWD/HWD trailer attached.

For further guidelines please consult the Owner’s Manual from the vehicle manufacturer.



Ball diameter "**D**": 50 mm **or** 2 inches (optional)

Ball height "**H**": 480 to 500 mm (19 to 20 inches) **with 100 kg load**

(typically 530 to 550 mm (21 to 22 inches) unloaded)

2.2.2 Trailer Tail Lights Wiring

The FWD/HWD trailer is equipped with two tail light assemblies. They provide:

- two bright, amber indicator lights (12V, 21W bulb)
- two combined, red running/stop light (running: dim, stop: bright) (dual filament bulb 12V 5+20W)
- one bright, red fog light
- one backup light

The trailer lights are connected to the car by means of a cable typically equipped with a 13-pin plug (European Standard, other plugs/connections are optional).

The towing vehicle should be equipped with a corresponding SOCKET (provided).

The trailer lights wiring diagram for a specific trailer can be obtained from Dynatest on request.

2.2.3 System Powering

General remarks

The entire FWD/HWD Test System, i.e. the Loading Unit Hydraulics as well as the Electronics, is powered exclusively by 12VDC, normally supplied from an alternator in the towing vehicle.

Optionally, a "stand-alone", trailer mounted, gasoline engine driven Power Generator Unit is available for vehicle independent powering, see 17.1.9, "Power Unit".

The FWD/HWD trailer electrical system is connected to the 12V system in the towing vehicle (or to the optional, trailer mounted Power Unit) by a "Trailer Power Cable".

The entire Test System (FWD/HWD hydraulics and Electronics) typically requires a total supply of up to 40 Amps (HWD: 60Amps) ***average*** during extensive use, like e.g., three full-height drops plus one lowering/raising of the drop weight subassembly every two minutes.

ADDITIONAL Alternator (RECOMMENDED Solution)

As mentioned above, the FWD/HWD towing vehicle should preferably be equipped with an ADDITIONAL alternator of 12V, 60 Amp. (HWD: 90 Amp.) minimum output rating. Please take this into account when selecting the towing vehicle and make sure that the engine compartment has sufficient space for this. Perhaps ask your vehicle supplier to deliver the vehicle fitted with such an extra alternator.

IF you use this recommended, additional alternator solution, then you can skip the following paragraph and continue from "Electronics Buffer Battery" below.

Using/Replacing the EXISTING Vehicle Alternator (ALTERNATIVE solution)

If for some reason the only possible solution is to use the existing alternator, then this should have an output current rating of at least 90 Amps (HWD: 120 Amps) and if a Diode Unit is used for battery separation, it should preferably be ADJUSTABLE (to 15.0 Volts output instead of the standard 14.3 Volts - see below).

Many vehicles are factory fitted with a 65 Amp. alternator which MAY be sufficient (FWD only, *not* for the HWD), if it can be adjusted and if the FWD is not used very extensively and the need for 12V supply for other devices (like warning flasher lights, etc.) is rather limited, but we strongly recommend to get the existing vehicle alternator upgraded/replaced to achieve the recommended 90 Amp. (HWD: 120 Amp.) min. current output rating.

Note on alternator rating

Please note that the buffer batteries i.e., the 12V 40-60 Ah Electronics Buffer Battery in the towing vehicle and the Loading Unit Buffer Battery(-ies), are NOT intended for providing CONTINUOUS supply, but ONLY for peak current BUFFER supply OR to provide a couple of hours of back-up supply in case of alternator failure or disconnection, e.g., due to blown fuse(s), so THEREFORE the alternator MUST be able to supply AT LEAST the AVERAGE current consumption of up to some 40 A (HWD: 60 A), otherwise the batteries will be discharged after some time.

A larger buffer battery capacity will ONLY be useful, if OVERNIGHT charging is applied, using a HEAVY, mains operated battery charger with at least a 40 Amp charging current output rating. In that case the buffer batteries MAY be able to supply what the alternator "misses" during a day's work.

All in all, the EXISTING alternator MUST be POWERFUL (and be adjusted as explained below) to be able to provide an adequate and stable power supply for the FWD/HWD Test System.

Diode Unit and Alternator Voltage Adjustment

A so-called DIODE UNIT or Battery Separation Relay (provided if needed) should be installed for battery separation if the existing alternator is used - see diagrams on a following page. This Diode Unit or Battery Separation Relay serves two purposes:

First it is prevented that the electronics buffer battery voltage can drop at vehicle engine starting and secondly the vehicle battery cannot be drained by the Test System.

If using the Diode Unit solution, the alternator output voltage should be adjusted (raised) to approx. 15.0 Volts (instead of the normal 14.3 Volts) to compensate for the voltage drop of the diodes in the Diode Unit. This alternator output voltage adjustment is often a problem as most alternator regulators are NOT adjustable, but if the regulator is separated from the alternator, it is possible to insert a diode in one of the three wires connecting the regulator to the alternator, see diagrams on following pages. The diode should be inserted in the wire denoted “D”, (or “+” or “IGN”), which is the most positive of the three wires (with the alternator running).

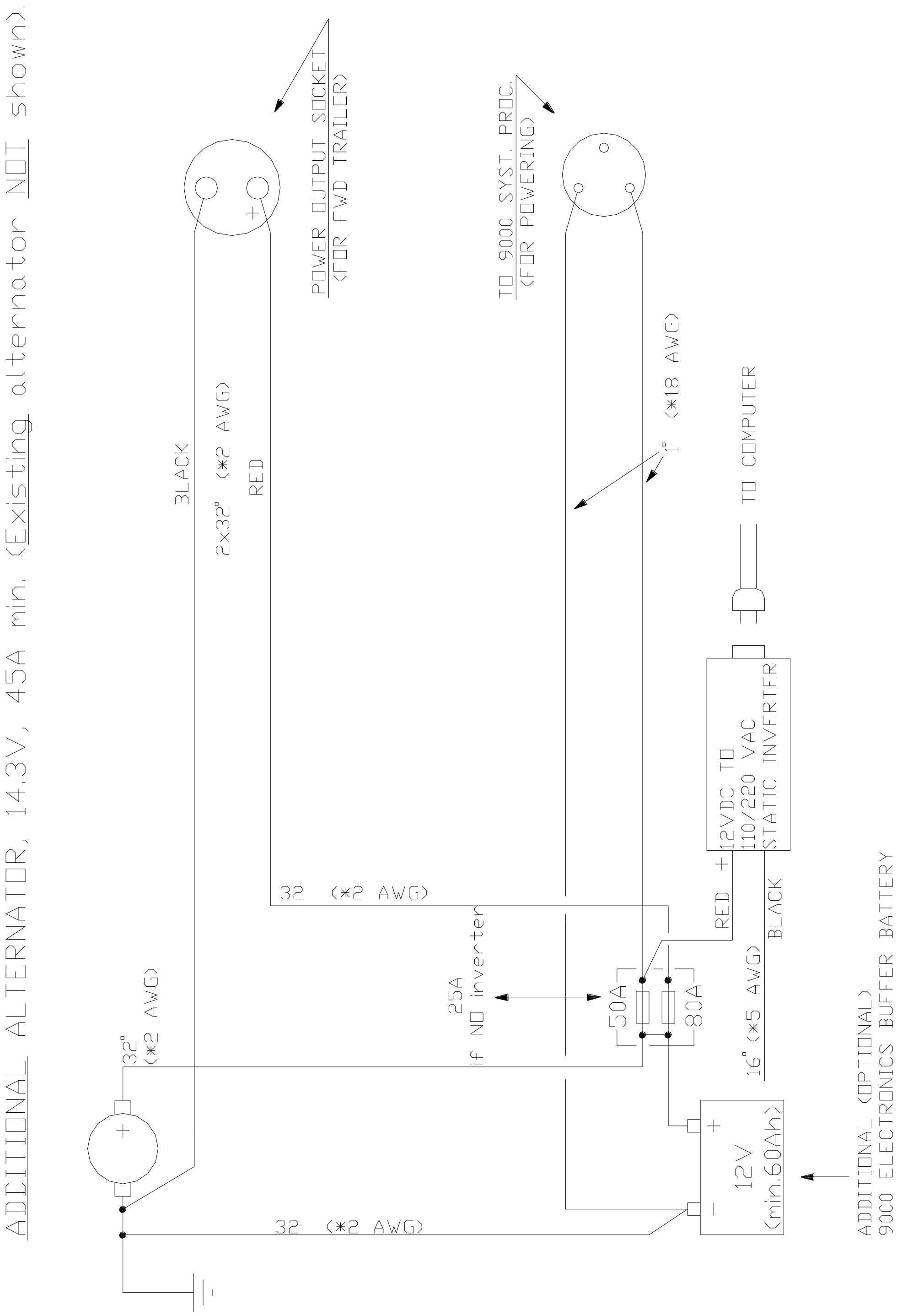
NOTE that the magnetic field excitation current (a few Amps.) will flow through this diode, so the diode used should have a current rating of at least 10A and if necessary be mounted with a small heat sink to be able to withstand a continuous DC current of at least 5 Amps. The diode should be a standard silicon diode, e.g. an “International Rectifier 21PT10” or similar, which may be used without heat sink and be insulated with heat shrink tube.

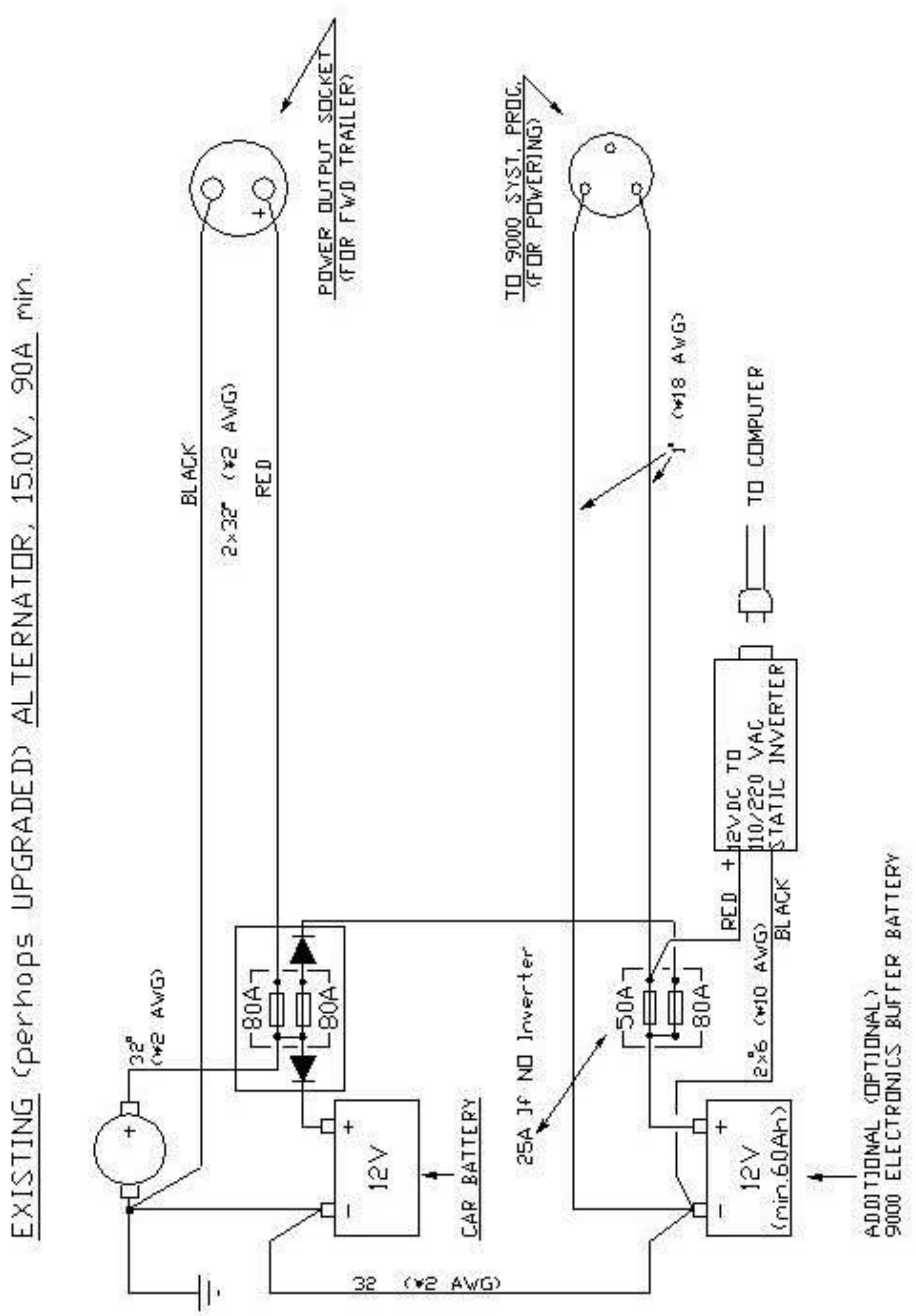
Many modern alternators have the regulator mounted directly on the alternator housing with no accessible connections, but in these cases it is normally possible to exchange such a regulator with a field brushes holder, which can then be connected to a separate adjustable regulator.

Heavy Fuse Box

A heavy fuse box (provided) with a 100A and a 25 (or 50)A fuse should be placed somewhere between the Electronics Buffer Battery and the alternator, preferably closest to the battery.

The wiring to this fuse box depends on the alternator solution, so please refer to relevant diagram(s).


ADDITIONAL ALTERNATOR, 14.3V, 45A min. (Existing alternator NOT shown).
POWER OUTPUT SOCKET
(FOR FWD TRAILER)
TO 9000 SYST. PROC.
(FOR POWERING)
BLACK
2x32° (*2 AWG)
RED
1°
(*18 AWG)
TO COMPUTER
12VDC TO
110/220 VAC
STATIC INVERTER
32 (*2 AWG)
RED +
BLACK
25A
if NO inverter
50A
80A
16° (*5 AWG)
32°
(*2 AWG)
+
12V
(min.60Ah)
−
32 (*2 AWG)
ADDITIONAL (OPTIONAL)
9000 ELECTRONICS BUFFER BATTERY


EXISTING (perhops UPGRADED) ALTERNATOR, 15.0V, 90A min.
POWER OUTPUT SOCKET
(FOR FWD TRAILER)
TO 9000 SYST. PROC.
(FOR POWERING)
BLACK
2x32² (#2 AWG)
RED
1² (#18 AWG)
TO COMPUTER
12VDC TO
110/220 VAC
STATIC INVERTER
RED +
BLACK
2x6² (#10 AWG)
25A if NO Inverter
80A
80A
50A
80A
32² (#2 AWG)
12V
CAR BATTERY
12V
(min.60Ah)
ADDITIONAL (OPTIONAL)
9000 ELECTRONICS BUFFER BATTERY
32 (#2 AWG)

12V Power Socket for Trailer

The heavy, (provided) circular 12V Power Output Socket for connection of the Trailer Power Cable should be mounted on the rear of the vehicle, close to the trailer hitch ball, but so much above or to one side of this, that it will allow for sharp turning of the vehicle/trailer.

The socket should be connected to the alternator by two heavy wires (provided, 35 sq. mm / No 2 AWG or heavier) as follows:

- The POSITIVE terminal should be wired to the 100A fuse in the heavy fuse box (OR in the diode unit, if applied).
- The NEGATIVE terminal should be wired directly to the alternator GND connection (normally the alternator housing). ALTERNATIVELY, the negative socket terminal AS WELL as the alternator GDN could BOTH be connected to a GOOD, SOLID CHASSIS BEAM GROUND point or the like. Connection points should then be cleaned to BARE METAL before connection. This alternative GDN wiring will only work if performed carefully and will easily fail after some time if not properly corrosion protected.

Power Inverter

If a 12VDC-to-110/220VAC Power Inverter is needed for Computer supply, then it will be provided. This Inverter will produce heat and should therefore be placed so that natural air flow can cool the unit. Alternatively (or in addition), a fan could be used for forced cooling of the inverter, if high ambient temperatures are expected.

The 12V input terminals of the Inverter should be connected to the Heavy Fuse Box as follows, using heavy wires (provided, 16 sq. mm (No 6 AWG) or heavier):

Terminal	**Connect to:**
Positive (red)	50A fuse
Negative (black)	Battery GND terminal

This connection should be performed very carefully, using as short wires as possible to reduce voltage drop. TOO LOW VOLTAGE input to the Inverter MAY CAUSE OVERHEATING/BREAKDOWN of this unit.

2.2.4 Plate-Low Alarm Connection

If the ALARM socket of the Remote Control Box is connected to the electrical system of the towing vehicle as described below, then the system will produce a warning if it is attempted to drive before the FWD/HWD plate has been raised from the ground during the measurements, or if the plate lowers while driving between test points. In both cases the plate will be raised automatically.

When the towing vehicle is in PARK mode (alternatively when handbrake is pulled), then the external connection to this socket should either provide 12VDC across pins 1 (positive) and 3 (ground) or provide a current flow (of 0.1 to 0.5 Amp.) into pin 2 (positive) and out of pin 3. When the vehicle is NOT in PARK mode (handbrake NOT pulled), the voltage/current must disappear. The Park LED on the Compact15 front panel should reflect the state of the signal (LED ON=PARK).

Emergency Switch

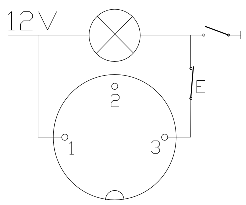
In the following examples, an emergency switch (indicated by an “E” in the example figures) may be included for instantaneous raising of the loading plate in an emergency situation. Such a switch should preferably have a large, red push knob and be mounted on the vehicle’s dash board in a place where it is visible and easy to get to. It should have a BREAK contact connected in series with the Alarm connection as indicated in the examples. The switch needs only be activated momentarily to instantaneously initiate a complete Raise Plate cycle.

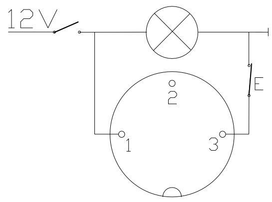
Connection Examples:

<u>Example No 1</u>**:**

Parallel connection in a vehicle with a PARK indicator switched to GND or 12V:

If the vehicle is equipped with a PARK indicating lamp, which is switched on when the vehicle is in PARK mode (or when handbrake is pulled), then use the provided plug and connect pin 1 to the positive side of the lamp and pin 3 to the lamp GND terminal.

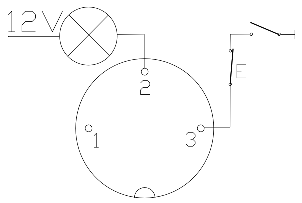


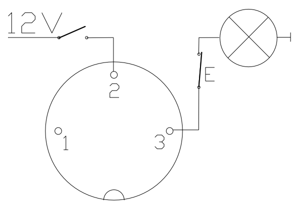


<u>Example No 2</u>**:**

Series connection in a vehicle with a PARK indicator switched to GND or 12V:

Inserting the Alarm circuit in series with the lamp is often easier but reduces the lamp voltage by approximately 2V. The lamp circuit can be broken anywhere in the chain from 12V to GND. Connect pin 2 to the most positive side and pin 3 to the negative side of the break.





<u>Example No 3</u>**:**

In a vehicle WITHOUT a park indicator:

If the towing vehicle is NOT equipped with a PARK switch/indicator, so that a separate switch (e.g. a small “Micro-Switch”) has to be applied, then this switch should be applied as shown in Example No. 1 above

<u>Example No 4</u>**:**

Using a proximity switch in a vehicle WITHOUT a park indicator:

The mechanical switch in example No 3 may be replaced by a proximity switch (optional). A suitable proximity switch may be ordered from Dynatest. A proximity switch of the same type as used for the System status sensors (described in a later section) may be used (NPN output type, active low output).

PARK/ALARM Override Plug

Use this Plug to check out the PARK/ALARM functioning in servicing situations. Connecting this plug to the ALARM socket asserts the "Vehicle in PARK" signal (causing the PRK LED on the Compact15 front panel to be lit).

WARNING!

NOTE that this PARK/ALARM Plug should NOT be used in the field, but ONLY for servicing purposes (in the workshop or laboratory).

2.2.5 Cable Access Opening

Some kind of a gate should be provided somewhere in the back of the tow vehicle, through which the Ethernet cable can be passed out of the vehicle and further be passed on to the Compact15 front panel. For this purpose, e.g. a "trap door" or some kind of plastic tubing bending from the vehicle floor down under the rear bumper may be used, ending not too far from the trailer hitch captive ball. The gate/trap door opening should be 25 by 25 mm (1" by 1") (or 25 mm (1") in diameter) minimum, and if tubing is used, the tube diameter should be 25 mm (1") minimum, and sharp bends of the tubing should be avoided to ease passing of the plug. The gate should be kept closed at all times (maybe simply plugged with e.g. a cloth) to prevent engine exhaust from entering the vehicle cabin.

It is a BAD idea to pass the cable through a back door, in which it too easily may be damaged by squeezing/clipping.

2.2.6 Placing the Computer and the Remote Control Box

The Remote Control Box and the Computer may be placed anywhere inside the tow vehicle, observing a few precautions:

The Computer should be placed conveniently for the operator, and the Remote Control Box should be placed so that the front panel LED indicators are visible from the operator's position. All units should be appropriately prevented from bumping and/or tilting during driving, e.g. using rubber straps and perhaps foam rubber underlays.

MAKE SURE that the Computer is mounted in the vehicle in such a manner that NO ventilation grids in the Computer enclosure are covered!

The maximum ambient temperature limit for the Computer is typically 40°C (105°F), if placed IN SHADE, so if the temperature in the vehicle approaches this limit, then direct sunlight should be avoided! Note also that the Computer should not be OPERATING below 5°C (40°F). Storage temperature range is -40 to +65°C (-40 to 150°F).

Electronic equipment does not like condensing moisture, as this may introduce creep currents on circuit boards etc. Therefore, it is recommended that the Computer (in cases of high air humidity and large temperature shifts from day to night) is removed from the vehicle after use in the evening and stored in room temperature overnight.

2.2.7 Warning Signs / Flasher Lights

The FWD/HWD System usually does not include any warning signs and/or flasher lights.

Due to the limited height of the FWD/HWD Trailer, warning lights should be mounted on top of the towing vehicle for maximum visibility.

If so required by local regulations, warning signs could/should be mounted on the rear of the FWD/HWD Trailer. We recommend you consult the local authorities concerning guidelines for signs selection and positioning.

Dynatest can deliver an optional, tailored rear sign assembly with two beacon (or flashing) lights. Please consult Dynatest for details.

3. Computer Configuration

The computer must be considered an integral part of the data collection equipment. It should not be used for any other purposes. Therefore, we recommend that Dynatest supply and configure the computer for the equipment. If the customer supplies the computer, then it must be open for modifications to Computer Name, Workgroup/Domain membership, Security Setup, User accounts, Network Setup, Power Options and Virus Protection.

Configuring the computer consists of

Verifying that the requirements are fulfilled
Installing the program packages
Establishing a network connection between the PC and the Compact 15
Running the program to setup initial parameters

Dynatest personnel normally handle this task. However, this information is supplied in the event that the end-user may need to reconfigure or replace the PC.

3.1 Requirements

Core i5, 2 GHz
8 GB RAM
500 Gigabyte Hard Drive
1920 by 1080 Monitor
1 GB LAN connection
Windows 10 Professional, 64-bit
Support of DirectX 9 or newer (for camera support)

3.2 Installing Programs

The programs are available from ftp://ftp.dynatest.com/downloads/DDC2 as two packages named DDC Prerequisites 2.n.n.n.exe and DDC 2.n.n.n.exe, where 2.n.n.n is the version number.

If you are upgrading, please **Backup existing files and folders, then uninstall the previous DDC** (Dynatest Data Collection)**.** Your equipment information and setups are preserved.

Prior to installation, please close any running programs.

Failure to close all programs may result in failure of the installation process. This is not a serious problem, but the user will be inconvenienced by having to restart the installation process.

If this installation requests that a Dynatest program be uninstalled, then please do so (equipment information and setups are preserved) and then re-run the installation.
Locate the installation packages and then launch DDC Prerequisites 2.n.n.n.exe first. This package contains general system modules. Launch DDC 2.n.n.n.exe next. Just use common sense and click [Next] [OK] [Allow] etc to accept the defaults where appropriate.

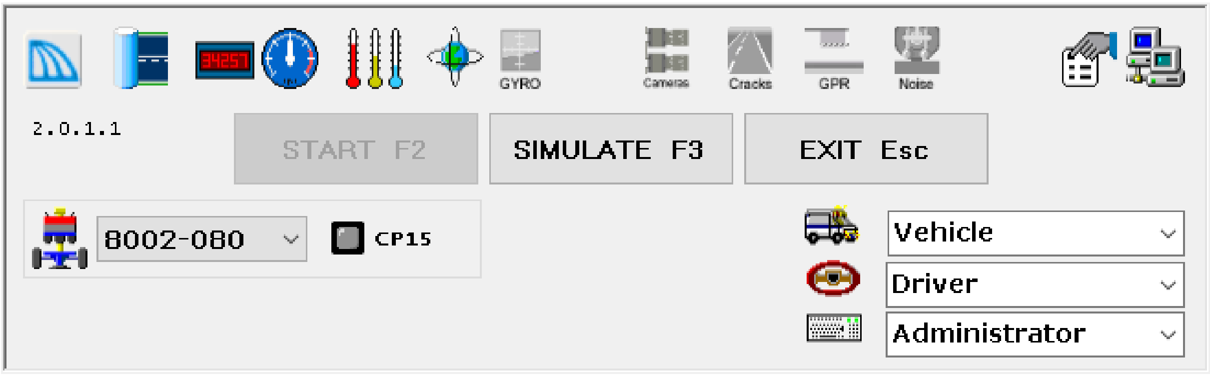
The installation will result in the following folder structure:

C:\Program Files (x86)\Dynatest\Elements	Control Center and various applets
C:\Program Files (x86)\Dynatest\FwdWin	Falling Weights (FWD/HWD)
C:\Program Files (x86)\Dynatest\RspWin	Road Surface Profilers
C:\Program Files (x86)\Dynatest\Survey	Manual Survey

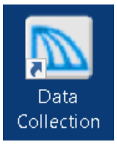
Additional working folders are created under C:\Dynatest.

In addition to the program installation package you may have received a file specifically for your equipment. The filename is composed of the equipment serial number and the extension MDB (e.g. 8002-080.MDB). Copy this file to C:\Dynatest\FwdWin\MDB

Initial execution of DDC showing that FWD 8002-080 is available:

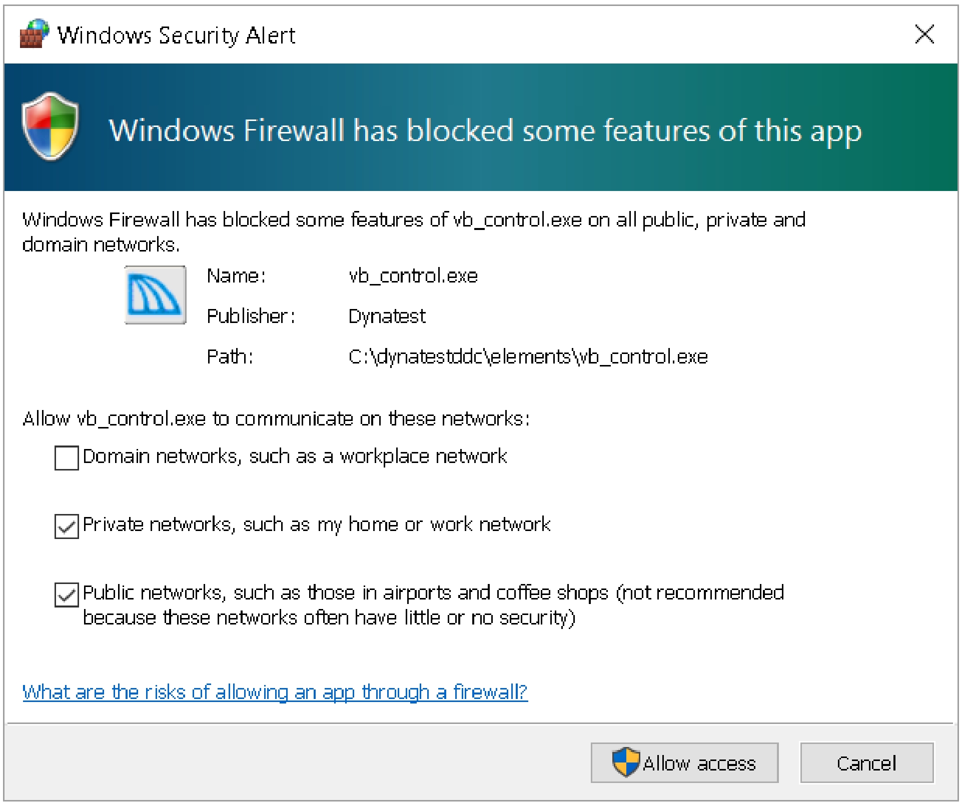


Your desktop should now have an icon for the Dynatest Data Collection (DDC):



Windows Firewall may show a message saying it is blocking certain functionality of the DDC. You will have the option to remove the blocking. Please do so (see below).

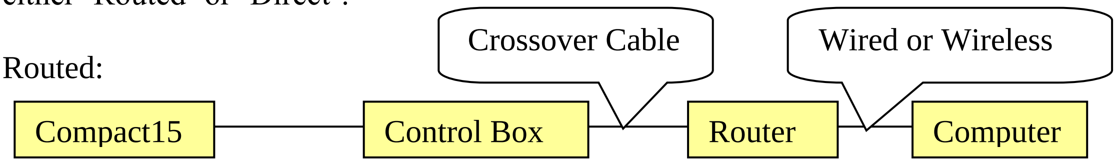
Make sure both **Private** and **Public** are checked, then click **Allow Access**:



3.3 *Network Settings*

The PC communicates with the Compact15 in peer-to-peer mode utilizing the TCP/IP protocol. System setup depends on the way Compact15 is connected to the computer, which is either ‘Routed’ or ‘Direct’:

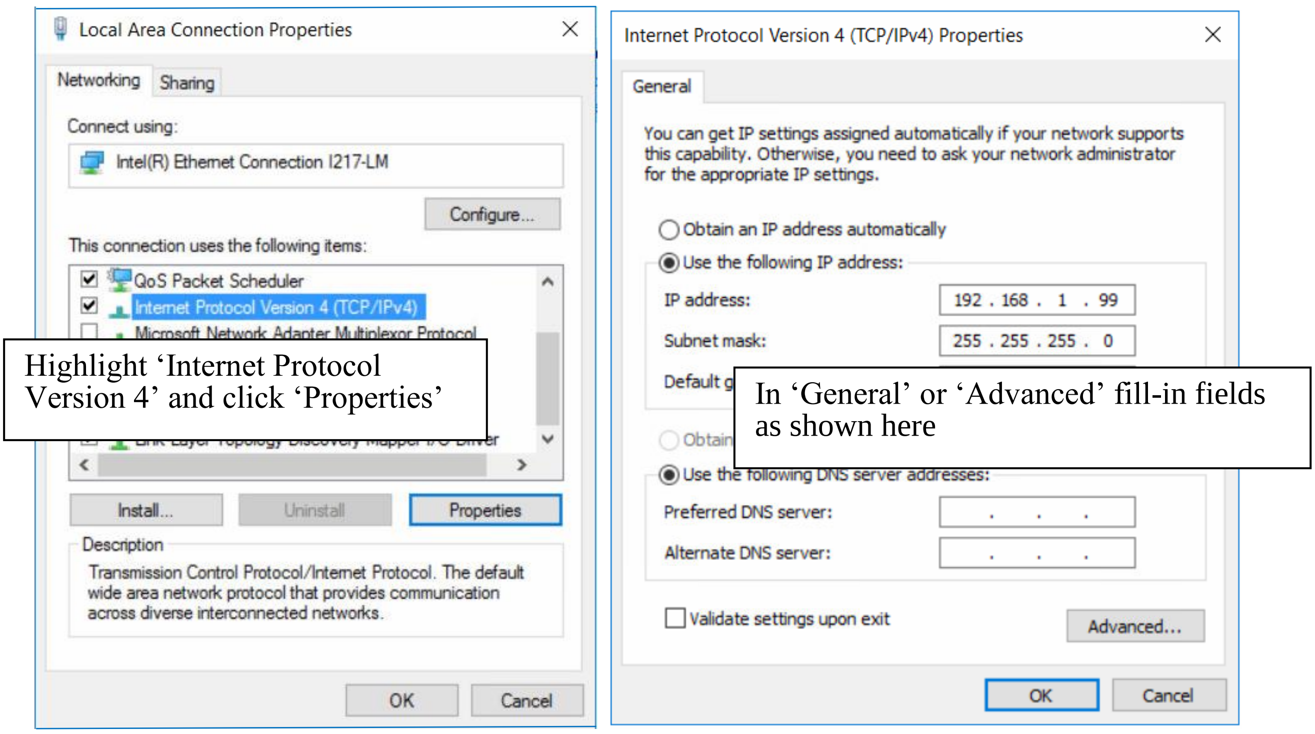
Routed:



Direct:

If a standard router with base address 192.168.1.1 is used, then there is nothing to configure. The Router will provide the IP address. For a direct connection setting up the network depends on the computer Operating System, but the Windows 10 procedure below gives the general picture.

Right click the Windows icon (bottom left) and choose ‘**Network Connections**’, then right-click the ‘**Local Area Connection’**, then choose **Properties**:



3.4 *Virus Protection*

AntiVirus software can significantly degrade the performance because it intercepts all file transfers between Compact15 and the computer. This can in some cases “Stall” the computer. To avoid this you should:

EXCLUDE the C:\Dynatest folder and all sub-folders from automatic protection.
EXCLUDE the following image/picture file types from automatic protection.
Extensions: *.JPG, *.BMP

3.5 Backup

In order to preserve your work in case the computer is damaged, you should regularly backup a number of files. Assuming that the default location was used during installation then backup all MS Access database files found in the following two folders:

C:\Dynatest\FwdWin\MDB)

C:\Dynatest\Elements\MDB)

In particular:

TestSetup.MDB	Test Setups
8082-075.MDB	Equipment calibrations (sample file name shown here)
Sections.MDB	Roadway Sections

3.6 Software Updates

Updates to the Dynatest DDC program suite are periodically posted to, and may be downloaded from, the following location (simply type the address in your internet browser or click the hyperlink): ftp://ftp.dynatest.com/downloads/DDC2

Always un-install any previous version before updating!
The equipment file 8082-123.mdb (example) and all other working MDB databases are preserved.

If DDC finds information for multiple FWDs/HWDs, it will import information for all of them. The user can then select the appropriate unit by clicking on the serial number box.

To the extent possible when upgrading database files the program attempts to keep the users previous settings (window positions, language support, hardware settings, test setups etc.).

3.7 Cameras

The software package includes two applets for camera support:
Camera General support for Windows compatible DirectX cameras
HCamera Halcon (MvTec) based camera support (hardware triggered)

3.7.1 Camera Applet

Go to the manufacturer's software support site and look for "DirectX Drivers" or a proprietary "Capture" program. Follow installation instructions and check that the capture program can connect to the camera and show images. Shut down the capture program and check that the camera appears in the Camera Applet's "Pick Camera" list.

3.7.2 HCamera Applet

This applet is used with the Dynatest MFV (Multi Function Vehicle) and all preparations are performed by Dynatest prior to delivery.

4. *Program Configuration*

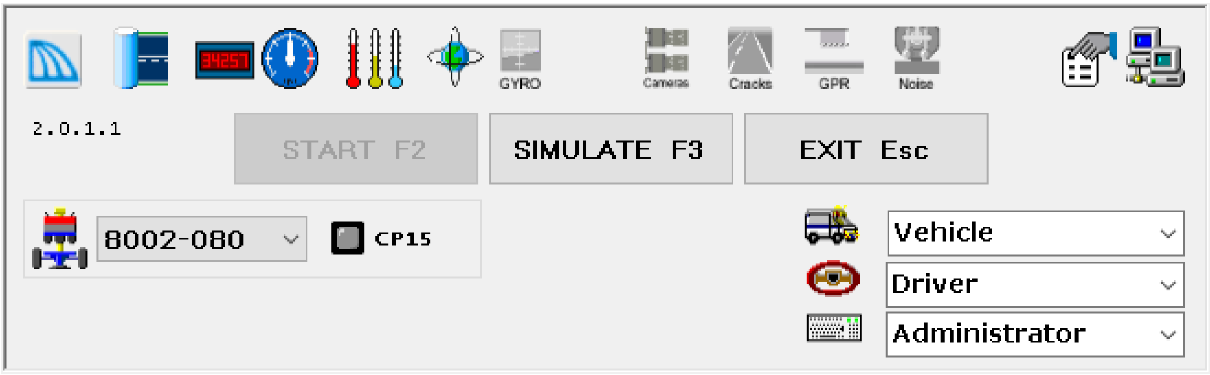
This section provides the necessary information for configuring the field program for first time use. Information regarding program operation is presented in Section 9 of this manual.

If the software is already configured upon delivery, this configuration information will prove useful in the event that the present configuration is somehow lost.

This process should preferably take place with the electronics and any additional hardware connected, powered up, and ready.

4.1 Dynatest Data Collection (DDC)

When the “Dynatest Data Collection” is first started, this screen appears:



This sample shows that you will run tests with FWD S/N 8002-080 and activate the following Applets:

Network (roadway section database), DMI, Speedometer, Thermometer and GPS.

There are various controls on this screen that affect program functionality. These controls and their functions will be discussed in the next few sections.

The first step in setting up the program is to enter vehicle identification (e.g. license plate number), the driver name and operator name or initials. This enables the field program to identify the vehicle and operators in the data files. It also enables the program to place the operator’s name in any log files. These log files are written to disk whenever changes are made to test setups, equipment calibration factors, or component operating parameters.

4.1.1 Vehicle ID

Use this field to enter a “Vehicle Identification” (license plate number or other identification). The program maintains a list of several Vehicle IDs if required.

4.1.2 Driver

Use this field to enter a Driver name. The program maintains a list of several Drivers if required.

4.1.3 User

Initially there are three users each having different levels of access.

Administrator allows changes to layout and calibrations
Dynatest is for Dynatest personnel, only
Operator is for general data collection

To create another Operator or Administrator entry, first choose the appropriate level from the list and then type the desired name (replacing the level). Then use e.g. TAB to leave the control.

4.1.4 Administrator

Administrative access is required for changes to calibration and operating parameters of critical components. It is important to note that this feature has nothing to do with the Windows “Administrator”. Its purpose is merely to avoid accidental deletions or changes to important operating parameters. It is recommended to choose Administrator for at least the first few runs.

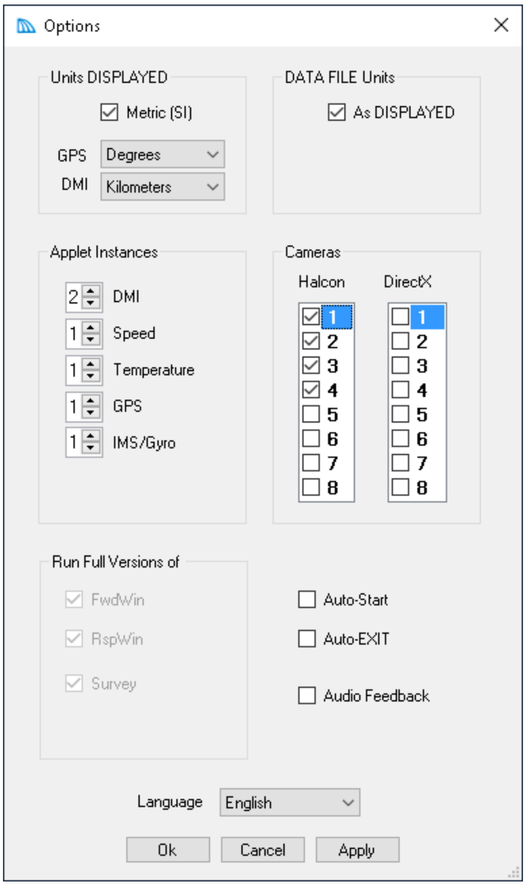
The Administrator can make changes to the following components:

- Load cell serial number and calibration data.
- Deflector serial numbers and calibration data.
- Air Temperature sensor serial number(s) and calibration data.
- Surface Temperature sensor serial numbers and calibration factors.

If the operator *needs* to make changes to any of the above components, he needs only pick the “Administrator” entry.

4.1.5 Settings

 Click the Settings icon to show the DDC Options window.



Units DISPLAYED
Set the default units for your displays here.

DATA FILE Units
Usually, the units used for data files are the same as what you see on the display. Un-check the “As DISPLAYED” if you want specific units in the data files.

Applet Instances
Allows you to run several instances of the Applets.

Cameras
Up to eight cameras can be run simultaneously. You can freely mix Halcon and DirectX cameras.

Run Full Version of
Presently not an option

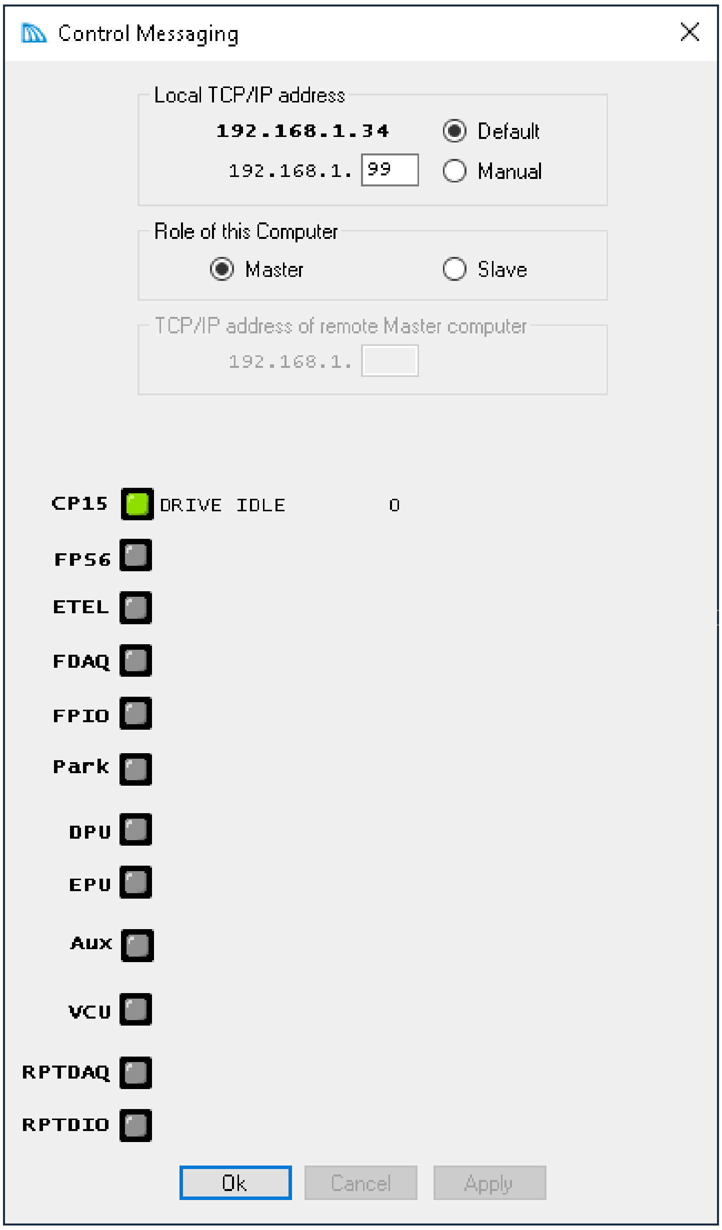
Auto-Start
Check Auto-Start to make DDC start as soon as it detects that the electronics are ready.

Auto-EXIT
Check Auto-EXIT to close the opening DDC window when the main program is terminated.

Language
All programs support English. If the chosen language is not available in a program’s database, then the user interface will be English.

4.1.6 *Network Connections*

 Click the Network icon to show the DDC Network Connections window.



Local TCP/IP address
The local subnet for Dynatest electronics must be 192.168.1.XXX

Default: Suggested (detected) address
Manual: For a specific NIC

Role of this Computer
Master: The main computer
Slave: Secondary computer

TCP/IP of remote Master computer
A slave computer must know the TCP/IP of the Master

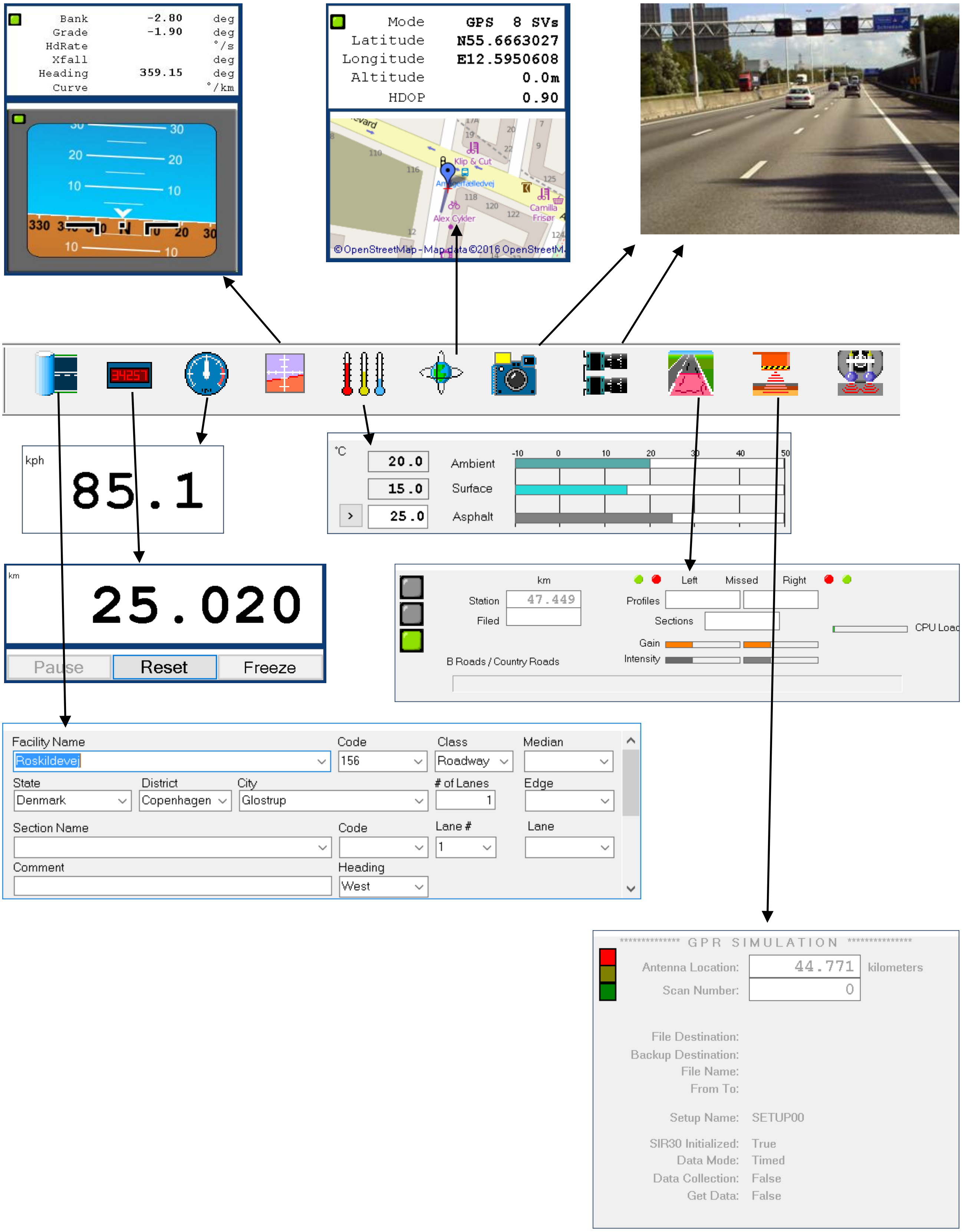
Dynatest Electronics
The remaining icons show the status of Dynatest electronics.

4.1.7 *Entering the Main Program*

Once everything in the introductory screen is configured, you may click the “Start” button (make sure “Administrator” is selected). The data collection screen should now appear. The Administrator can now complete the setup process.

4.2 *Applet Overview*

Applets are programs providing specific functionality to the main applications. Most applets appear in resizable floating windows. The Administrator can arrange the windows, but the resulting layout is locked for the Operator. This page shows the typical appearance of each.



4.3 Completing the Setup

This section shall address setup of the FWD/HWD hardware components. These components include the following (note that some of the components are optional and may not be present on your FWD/HWD):

- Loading Unit
- System Controller
- Load cell
- Deflectors
- Air Temperature Sensor
- Surface Temperature Sensor
- Distance Measurement (DMI)
- Global Positioning System (GPS)

In order to complete the setup, the user must be "Administrator" (see Section 4.1.4).

IMPORTANT!

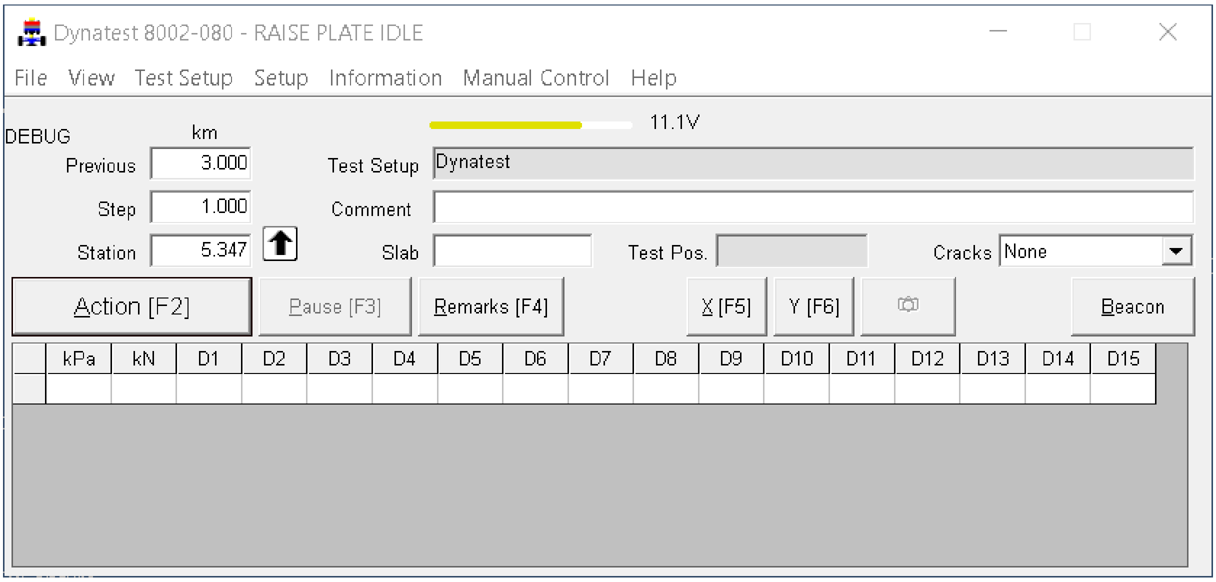
Hardware parameters (like all other parameters) are stored in a database file in order to better manage multiple RSP setups.

Before making changes to Hardware parameters make sure that you have activated the correct equipment S/N in the introductory screen (8002-XXX).

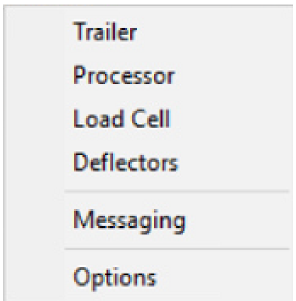
Any changes you make to the hardware setup – be it calibration or otherwise - will be stored in the equipment information file you selected in the introductory screen.

4.3.1 Entering the Data Collection Screen

Configuration of the hardware is accomplished from a menu item at the top of the data collection screen or through the dedicated applets DMI, GPS etc. The data collection screen opens automatically when the user clicks the **Start** button on the introductory screen. This screen is the primary user interface for operating the FWD/HWD. The data collection screen interface, in its simplest form, is shown below.



To make changes to the hardware setup, the user should click the **Setup** menu item along the top of the data collection screen. A drop-down list of configurable items will appear as shown next.



Each item opens a dedicated window with options and variables and the three common function buttons:

The **OK** button saves the changes and closes the window.

The **APPLY** button saves the changes but leaves the window open.

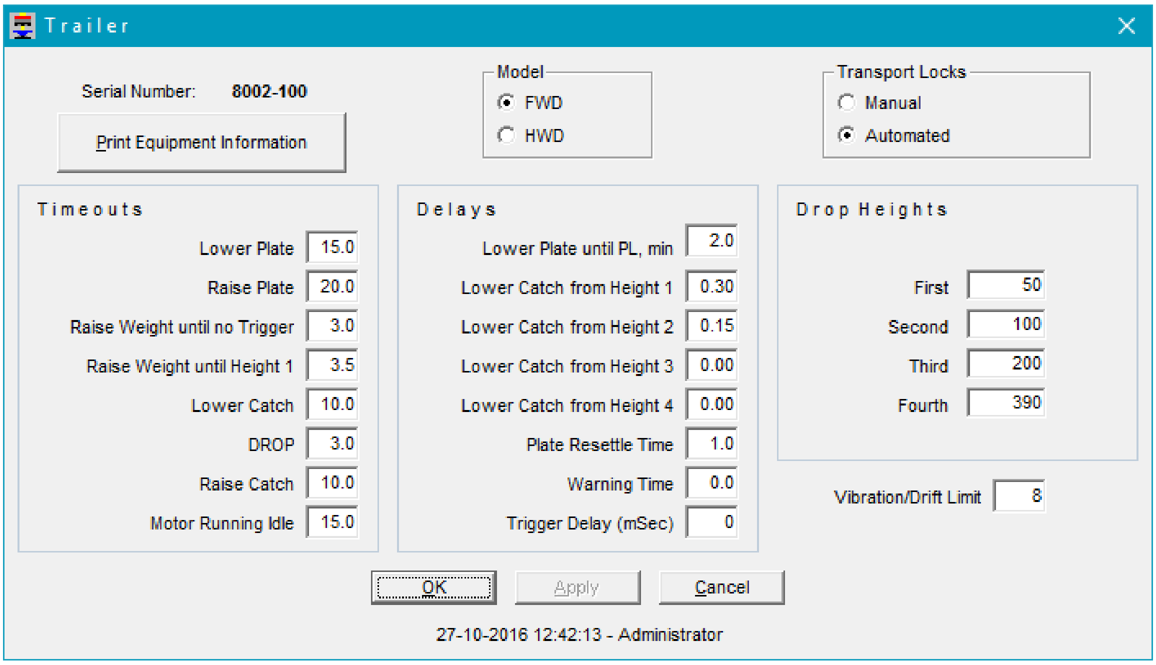
The **CANCEL** button discards changes and closes the window.

The **Apply** button is disabled (greyed out) until the user makes a change to one of the fields.

4.3.2 Loading Unit

The loading unit parameters (like all other parameters) are stored in a database in order to better manage multiple FWD/HWD setups. For example, let's suppose you have two vehicles each equipped with a computer for FWD/HWD data collection. Switching trailers between the two vehicles is then only a matter of activating the right trailer in the introductory screen.

To configure the loading unit, select **Setup**, then **Trailer** from the data collection screen. This will open the trailer setup window.



The first item to verify is the **Serial Number**. The serial number can be found on the nameplate installed on every FWD/HWD unit. If the serial number does not match your FWD/HWD, then you must exit FwdWin. At the introductory screen, click on the correct serial number, and then return to the above window. The serial number should now be correct.

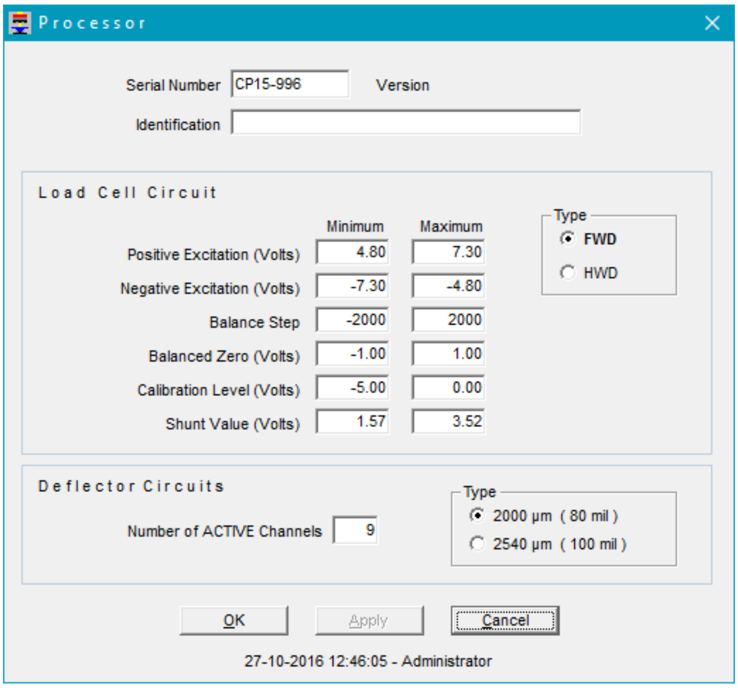
The next item to verify or enter is the type of **Transport Locks**. Transport locks prevent the FWD/HWD load plate from settling and contacting the road surface during transport. The automated transport locks are optional, and your unit may not be so equipped. The presence of automated transport locks is easy to determine by visually inspecting the FWD/HWD subassembly.

Timeouts are displayed in units of seconds. These timeout values are used by the computer to monitor the status of and to control the hardware. For example, if for some reason the FWD/HWD requires more than 15 seconds to lower the plate to the pavement surface (lower plate = 15.0), an error message is generated by the program, indicating that some malfunction has occurred. To assist the operator, Tooltips are provided to show the upper and lower limits for these fields. The values shown are defaults and should not be changed unless the user has a specific reason to do so.

Delays are also displayed in units of seconds. Default values are shown. Tooltips are provided for each field to assist the user in entering proper values. Delay values cause the field program to pause for the specified number of seconds prior to performing the indicated function. For example, "Lower Catch from Height 1" is set to 0.3 seconds. This prevents the catch from lowering to soon after weight release. If the catch is lowered too soon, it may collide with the catch ring as the weight rebounds off the rubber buffers.

Finally, the **Drop Heights** must be entered or verified. The drop height unit is either mm or inches as specified under "Options". The values shown represent the distance from the WH sensor to each of the four drop height stops on the subassembly. Check to make sure that the values are correct for your System. Each time any one of the stops is adjusted, these fields must be updated. For information on drop height adjustment, see Section 4.2 of this manual.

4.3.3 *Compact15 System Controller*



To configure the Compact15 System Controller, select **Setup** then **Processor** from the data collection screen.

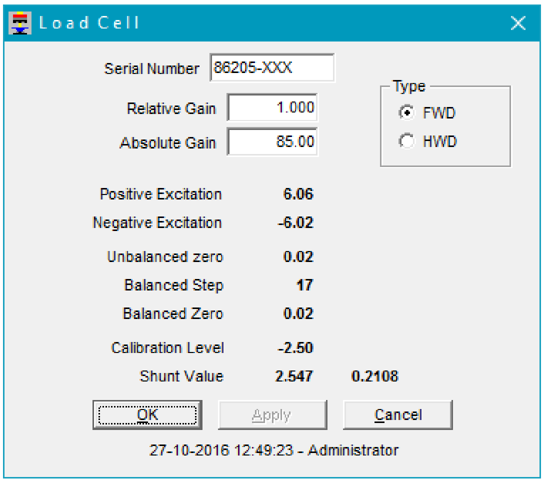
The **Version** is retrieved from the Compact15 System Controller and refers to the firmware version.

The **Identification** field allows the user to enter any useful information of his choice that may be related to the System Controller setup.

The area of the screen labelled **Load Cell Circuit** contains operating voltage limits for a typical load cell. These values do not affect load cell operation. Their purpose is to establish limits beyond which the field program will issue an error message. To the right of these numbers, the user can indicate whether the load cell is an FWD or HWD type.

In the **Deflector Circuits** area, the user can indicate the **Number of ACTIVE Channels**. Note that to the right the user can also specify the maximum range of the deflectors. Dynatest produce two types, 2000 and 2450 microns (80 or 100 mils). You should consult your delivery documents and specifications to verify the type of deflectors provided.

4.3.4 *Load Cell*



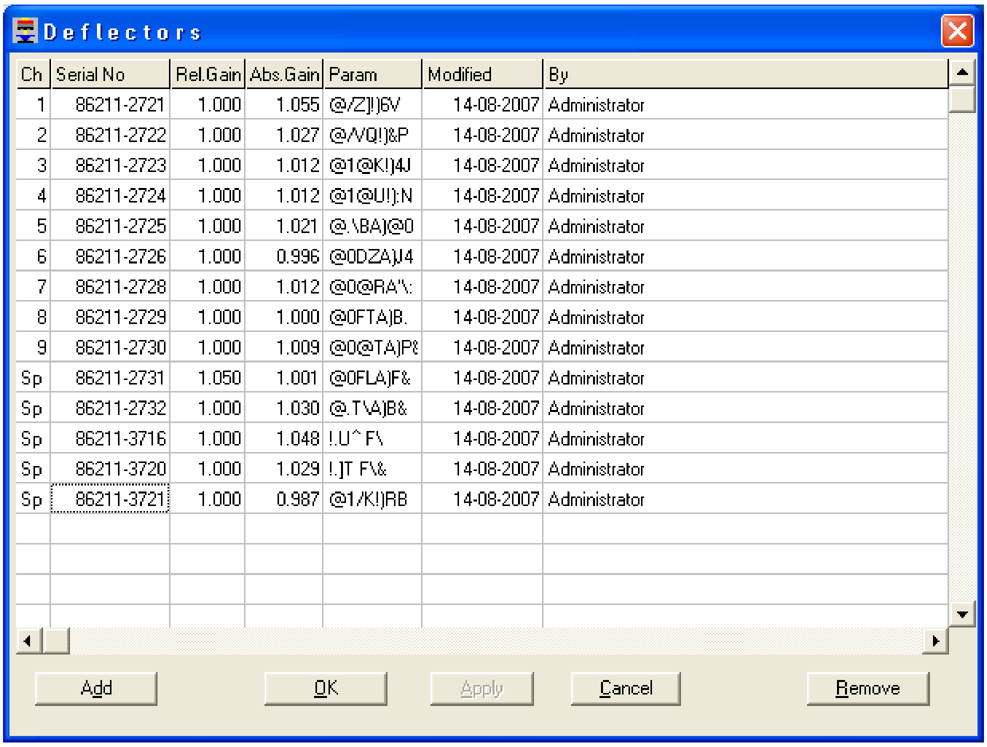
To configure the **Load Cell** parameters, select **Setup** then **Load Cell** from the data collection screen. The operator should first verify or enter the **Serial Number**. The user should also verify or specify whether the load cell is mounted on an FWD or HWD by checking the appropriate button in the **Type** box.

The **Relative Gain** and **Absolute gain** (calibration factors) are provided by Dynatest upon delivery of the equipment or delivery of a replacement load cell. The absolute gain can only be changed by the user after consulting Dynatest. The relative gain is provided to accommodate modest changes that are required as a result of a calibration of the load cell.

The remaining fields (Unbalanced Zero … Shunt Value) provide a real time display of load cell voltages and other parameters. These fields are not accessible by the user.

4.3.5 Deflectors

To configure the deflectors, select **Setup** then **Deflectors** from the data collection screen.



Ch	Serial No	Rel.Gain	Abs.Gain	Param	Modified	By
1	86211-2721	1.000	1.055	@/Z]!)6V	14-08-2007	Administrator
2	86211-2722	1.000	1.027	@/VQ!)&P	14-08-2007	Administrator
3	86211-2723	1.000	1.012	@1@K!)4J	14-08-2007	Administrator
4	86211-2724	1.000	1.012	@1@U!):N	14-08-2007	Administrator
5	86211-2725	1.000	1.021	@.\BA)@0	14-08-2007	Administrator
6	86211-2726	1.000	0.996	@0DZA)J4	14-08-2007	Administrator
7	86211-2728	1.000	1.012	@0@RA'\:	14-08-2007	Administrator
8	86211-2729	1.000	1.000	@0FTA)B.	14-08-2007	Administrator
9	86211-2730	1.000	1.009	@0@TA)P8	14-08-2007	Administrator
Sp	86211-2731	1.050	1.001	@0FLA)F&	14-08-2007	Administrator
Sp	86211-2732	1.000	1.030	@.T\A)B&	14-08-2007	Administrator
Sp	86211-3716	1.000	1.048	!.U^ F\	14-08-2007	Administrator
Sp	86211-3720	1.000	1.029	!.]T F\&	14-08-2007	Administrator
Sp	86211-3721	1.000	0.987	@1/K!)RB	14-08-2007	Administrator

The **Deflectors** window shown above displays information regarding the deflectors. There should be one row for each of the deflectors connected to the system as well as additional rows for any spare deflectors. This information is supplied by Dynatest for new FWD/HWD units. Changes to the values in this screen should only be performed by knowledgeable personnel.

The first column indicates the **Channel** to which each deflector is connected. The deflector situated at the centre of the load plate occupies channel 1. Deflectors situated at increasing distances from the load plate occupy sequentially increasing channels, however this varies in practice, especially if one or more deflectors are located behind or beside the load plate.

The **Serial Number** of each deflector is shown in column two. Dynatest physically label each deflector with a serial number for easy identification. It is important that the operator visually inspects the deflector serial numbers and channel positions on the FWD/HWD itself to ensure that the information in the table is correct, especially after maintenance or calibration activities. Channel numbers are labelled on the CP15 front panel next to the deflector connection sockets.

The **Relative Gain** is typically updated after performing a relative or reference calibration or installing a new deflector.

The **Absolute Gain** is provided by Dynatest and should not be changed without consulting a Dynatest technician.

The **Param** column information is provided by Dynatest and should definitely not be changed without consulting a Dynatest technician.

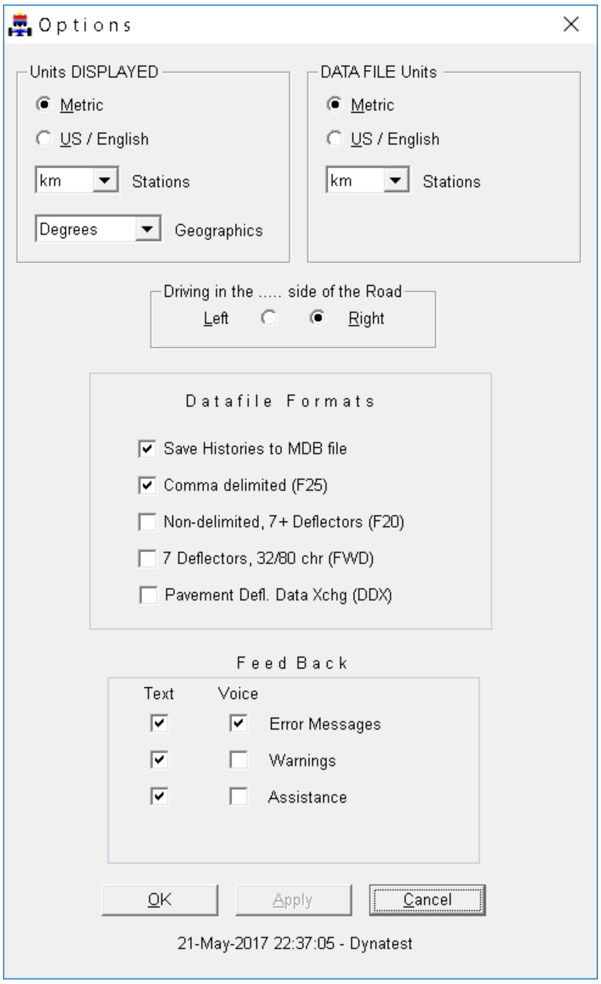
The **Modified** and **By** columns are not editable by the user. The field program updates them automatically whenever a user makes changes in any of the other columns.

Each of the user-accessible fields can be edited by clicking in the box, then typing changes.

4.3.6 *Program Options*

This section provides guidance for setting up miscellaneous options including measurement units, driving conventions, file formats, messaging behaviour, and screen appearance. The operator can access these options by clicking **Setup**, then **Options** from the main data collection screen.

Specifying Display and Storage Units



The operator can specify the display (screen) units in the upper left corner of the window and the data file units in the upper right. **This means that the computer can be configured to display test results on the screen in the metric system while storing data in English Standard units (and vice-versa).** Furthermore, as shown in the figure at left, it is possible to e.g. configure the DMI display to show distances in meters while storing these distances to data file in units of kilometres.

Specifying Driving Conventions

The user can also indicate which side of the road he is driving on – left or right. This affects lane designations as shown in the section **Lane Designations**. This is done by checking the **Left** or **Right** button in the **Driving in the…. side of the Road** box.

Specifying File Formats

FwdWin always stores data in Microsoft Access (MDB) format. You can choose to save load and deflection histories (recommended). The remaining formats are all text based. The first three (F25, F20, FWD) are earlier Dynatest ASCII formats. 'Pavement Deflection Data Exchange' (DDX) was developed by AASHTO in 1998.

Microsoft Access (MDB)

The Access file format is the 'working' format, meaning that during testing all results are stored in this format, only. When all test points are done and you close the file, then the optional ASCII files are generated based on the contents of the Access file (see also section *10.8 Opening a Data File)*

Comma delimited (.F25)

This format is the last ASCII file formats developed by Dynatest. Those familiar with the Dynatest Edition 25 FWD/HWD Field Program may have experience with this file format. It is designed to accommodate up to 15 deflectors, is easy to import into spreadsheets and databases, can handle GPS data, among other things.

Nondelimited, 7+ (.F20)

Persons involved in the SHRP LTPP data collection program use the .F20 file format. It can accommodate up to 9 deflectors, but resembles the older .FWD file format.

7 Defl., 32/80 chr. (.FWD)

This file format is one of the oldest developed by Dynatest for PC driven FWD/HWD equipment. It is the least versatile format and will only accommodate seven deflectors. A number of back calculation programs (Modulus, Evercalc, Modcomp) were designed for this file format, only. If you intend to use one of these programs, be sure to also select this file format.

Pavement Deflection Data Exchange (DDX)

This format is similar to the 'System.INI' in Windows. The file is divided into sections each having a bracketed header line, like: [Operations Information]. The data is composed of a descriptive name, an equal sign followed by the value(s), like: Operator = John Johnson. For details see www.normas.com/AASHTO/pages/PDDX.html.

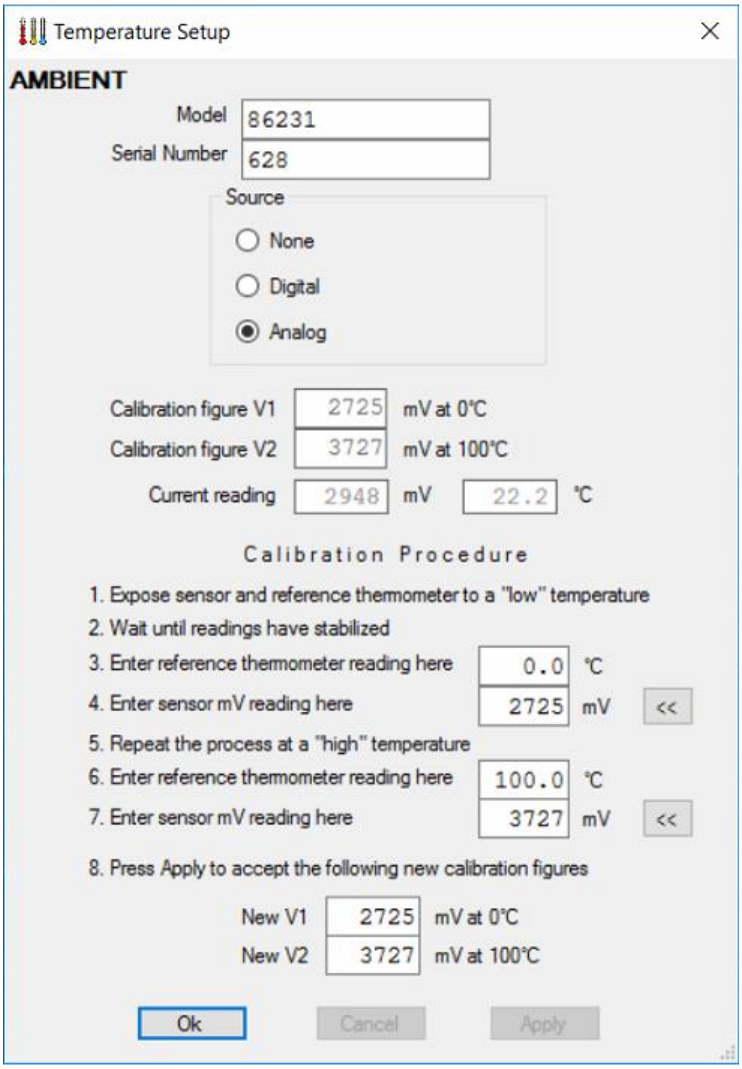
Specifying Feedback Type

The **Feedback** box allows the operator to control the way messages are issued by FwdWin. The computer (if suitably equipped) can issue audible warnings, error messages, and assistance if desired. Each type of message can be set to either **Text** (messages displayed on the computer screen) or **Voice** (audible messages played on the computer sound system).

4.3.7 *Air Temperature Sensor*

Dynatest provides an optional ambient temperature sensor for the FWD/HWD. If your unit is so equipped, FwdWin will monitor the output of this sensor and automatically record the information in the data file for each test point.

Right click the Temperature applet and chose "Ambient Temperature".



Verify that Model and Serial Number are correct.

If your unit is not equipped with an air temperature sensor, then you should select "None" here. Analog is for probes connected to the CP15.

The two fields, V1 and V2, are the calibration figures for the temperature sensor. Note that these values represent the predicted voltages across the sensor terminals (wires) under two temperature conditions: 0 degrees C and 100 degrees C (Note: Centigrade units are used and displayed here regardless of the units specified (Metric vs. US/English) elsewhere in the setup facility).

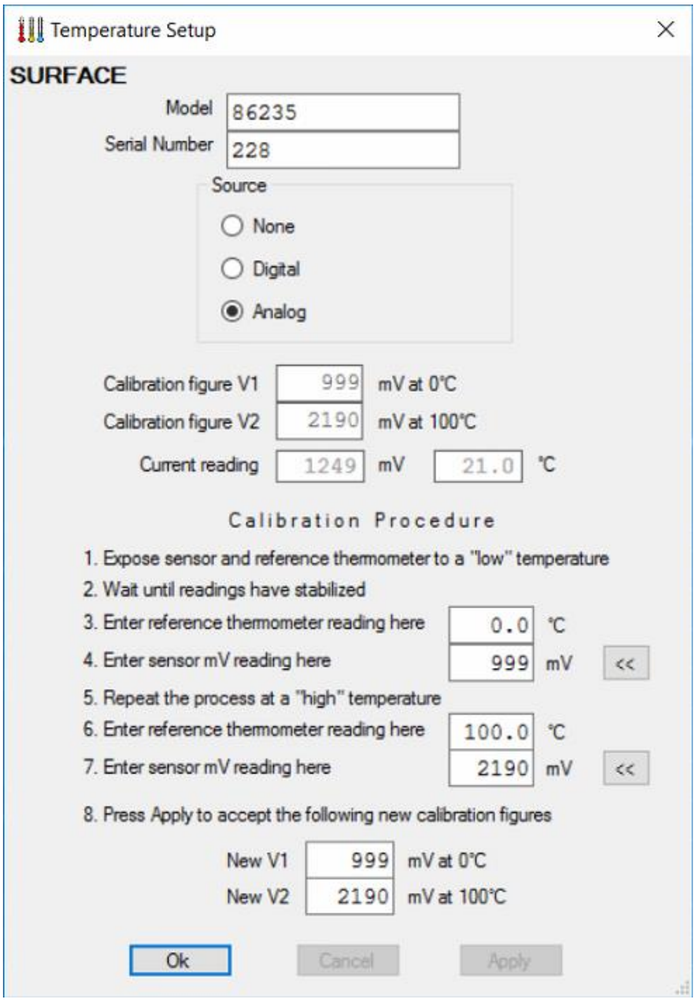
If a temperature sensor is connected and working properly, the current voltage and measured temperature is displayed in the **Current Reading** fields. This allows the operator to quickly assess the accuracy of the sensor and determine if a calibration is necessary.

All fields below "Current Reading" are of interest only when a calibration is performed (see *13.2 Air Temperature Sensor Calibration*).

4.3.8 *Surface Temperature Sensor*

Dynatest provides an optional pavement surface temperature sensor for the FWD/HWD. If your unit is so equipped, FwdWin will monitor the output of this sensor and automatically record the pavement surface temperature in the data file for each test point.

Right click the Temperature applet and chose "Surface Temperature".



Verify that Model and Serial Number are correct.

If your unit is not equipped with such sensor, then you should select "None" here. Analog is for probes connected to the CP15.

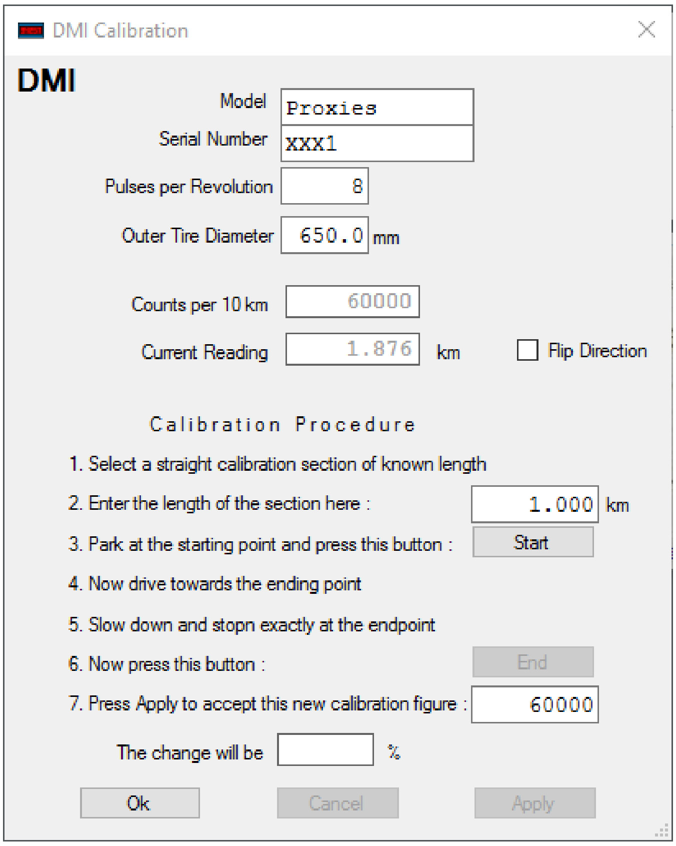
The two fields, V1 and V2, are the calibration figures for the temperature sensor. Note that these values represent the predicted voltages across the sensor terminals (wires) under two temperature conditions: 0 degrees C and 100 degrees C (Note: Centigrade units are used and displayed here regardless of the units specified (Metric vs. US/English) elsewhere in the setup facility).

If a temperature sensor is connected and working properly, the current voltage and measured temperature is displayed in the **Current Reading** fields. This allows the operator to quickly assess the accuracy of the sensor and determine if a calibration is necessary. The voltage reading is also used during the calibration process.

All fields below "Current Reading" are of interest only when a calibration is performed (see *13.3 Surface Temperature Sensor Calibration*).

4.3.9 *Distance Measuring Instrument*

Right click the DMI applet and choose **Calibration.** This window shows the Model, Serial Number, Pulses per Revolution (Advertised PPR), measured tire diameter, Calibration figure and a Calibration Procedure.



The calibration figure for the DMI is shown in the box labelled **Counts per 10 km**. This represents the expected total number of counts that would be accumulated over a distance of 10 km. The calibration figure is always displayed in units of **Counts per 10 km** regardless of the distance unit selected by the operator.

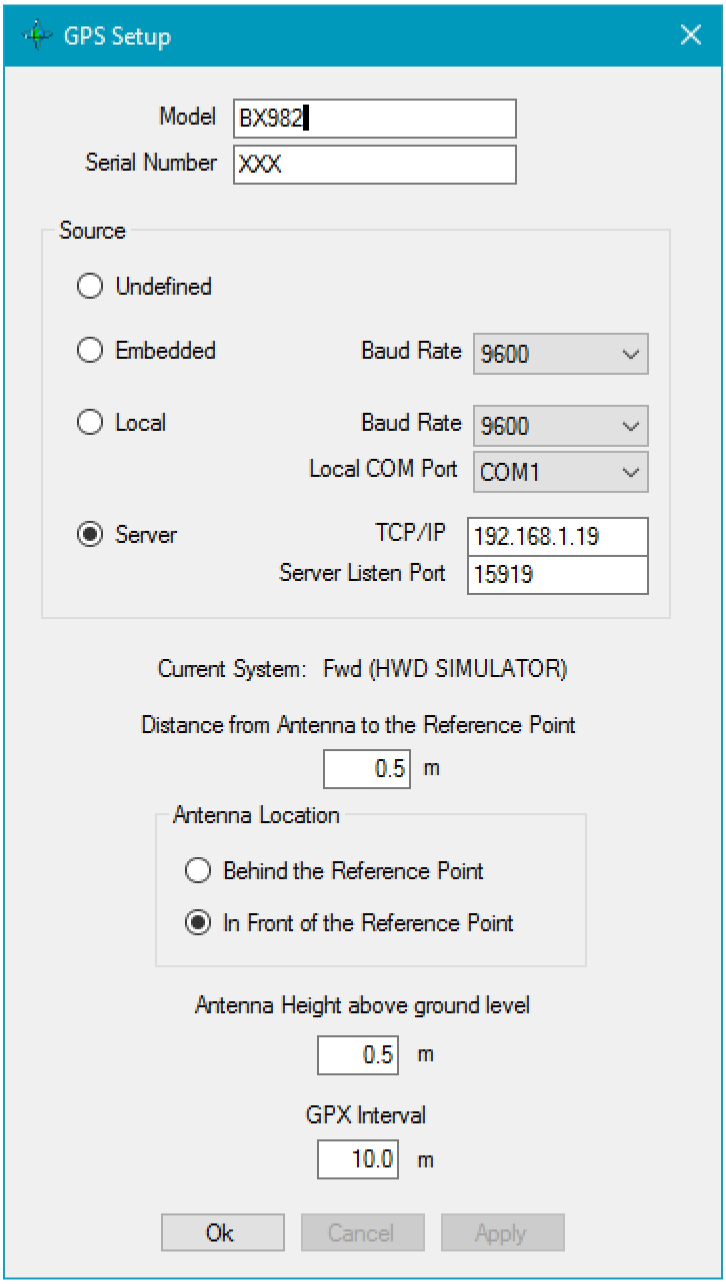
The current value of the measured distance is shown in the **Current reading** box. The value displayed here depends on the distance unit selected by the operator.

The **Flip Direction** should be toggled if the reading decreases while driving forward.

The Calibration Procedure is described in section *13.4 DMI Calibration*

4.3.10 *Global Positioning System (Optional)*

Right click the GPS applet and choose **Setup.** This window shows the Model, Serial Number, Source options, geometric parameters and GPX option:



Embedded means that the GPS device is connected to CP15 electronics.
Local is for a GPS connected directly to the computer.
Server is for Ethernet-enabled GPS servers (e.g. Trimble BX982 or an iPhone).

The **Reference Point** is typically the center of the Load Cell.

For preparation of maps see 14.1.1 Prefetch Maps.

5. Preparing for Measurements

5.1 Checking the FWD/HWD Hardware

Four pushbuttons and several LEDs (Light Emitting Diodes) at the Compact15 front panel may be used for manual control and check of the FWD/HWD operation. The pushbuttons are enabled by turning and holding the MAN.KEY switch in the clockwise position (which in turn will disable remote control from the computer in the towing vehicle).

If the FWD/HWD hydraulics at any time does not operate as expected when the manual control pushbuttons are used, then refer to Section 17, "**Trouble Shooting**".

SAFETY NOTE!

Whenever somebody is close to the moving parts of the FWD/HWD, MAKE SURE that all POWER has been switched OFF!

(ON.KEY switch OFF and, if the Remote Control Box in the vehicle is connected, the SYSTEM ON switch should be toggled OFF (out) as well). All LEDs (except 12V Bat) at the Compact15 front panel should be off!

Prepare/check the FWD/HWD Hardware as follows, noting that the MAN.KEY must be turned for the manual buttons to function:

1) While the drop weight subassembly is still in its top (transport) position, check that the rod of the centre deflection device (deflector holder) sticks out through the bottom of the loading plate at least a distance of some 10-20 mm.

2) Check the springs, foam rubber guides and set up of all deflector holders to ensure they are functioning properly. Make sure that the spring tensions are properly adjusted such that a force on the end of a feeler can move the holder and feeler upwards until the feeler is at least some 5 mm inside the bottom of the holder body (resp. the loading plate), and that it returns easily when released again (otherwise apply a few drops of silicone oil to the top guide rod).

3) Check that the cable for the raise/lower bar is properly positioned on both guide pulleys.

4) Turn the MAN.KEY switch while you shortly press the RP (Raise Plate) button, so that the drop weight subassy. is raised to its topmost position, releasing the transport locks.

5) Unlock the transport locks. (In case of automated locks, this is done by pressing the LC button).

6) Remove the locking pin securing the guide mechanism of the far (front) end of the raise/lower bar.

7) Lower the plate (subassy.) to the ground by pressing the LP/RW (Lower Plate/Raise Weight) button. Keep the LP/RW button pressed until the PL LED has turned off (see 5.3 "Lock error" and "Plate not low error" below).

8) Check that the front end of the raise/lower bar is now resting properly on the ground.

9) Raise again the plate (subassy.) by pressing the RP button. Check that the raise/lower bar is raised concurrently with the plate. Keep the RP button pressed until the plate subassy. has reached its top position.

10) If the FWD is not at the measuring location, then lock and settle the plate subassy.: Make sure the transport locks are engaged in BOTH sides, and then press LP/RW until motor stops.

11) Lock the front end of the raise/lower bar.

12) Adjust the drop heights (if desired - see "Drop Heights Adjustment" below).

5.2 Drop Heights Adjustment

4 movable drop height stops (activators) are placed in a detachable, vertical rail on the drop weight. A proximity switch is placed opposite to the stops, so that this switch (denoted "WH" = Weight High) will be activated when any stop passes the switch.

> ***SAFETY NOTE!***
>
> The plate subassy. must be in its top position and settled onto the transport locks before (and during) any drop heights adjustment.

The topmost stop is denoted stop No. 1 (corresponding to h1 (drop height No. 1), as this will be the first stop that passes the WH proximity switch when the weight is raised. The actual drop height h1 can be monitored (with e.g. a steel measure) as the (Vertical) distance from the TOP of stop No. 1 to the TOP of the WH proximity switch, WHEN THE WEIGHT is in its LOW, RESTING POSITION.

Drop heights h2, h3 and h4 are monitored in the same manner as h1, as the distance from the top of the stop in question to the top of the WH proximity switch, when the weight is in its low position.

Within the field program, a "load targeting" feature can be selected, in which case it will normally not be necessary to adjust the height stops at all, if they are positioned reasonably, such as (approx.):

h1 = 50mm (2"), h2 = 100mm (4"), h3 = 200mm (8"), and h4 = 390mm (15-1/4").

Obviously, h1 < h2 < h3 < h4. There are the following restrictions to the placing of the stops:

1) Although the stops are removable, ALL FOUR STOPS MUST BE PRESENT, as the CP15 System Controller has been programmed to detect up to four WH pulses.

2) h1 should NOT be LESS THAN 50mm (1-1/2") (to ensure proper triggering) and NOT GREATER THAN 100mm (4") (to prevent "raise weight time-out").

3) The distance between two adjacent stops (centre to centre) should NOT be LESS THAN 50mm (2") (to ensure that the WH proximity switch will always be able to separate adjacent stops).

4) h4 should NOT EXCEED 390 mm (15-1/4”) (to ensure that the weight can be stopped at height No. 4 BEFORE it reaches its mechanical top position, which would otherwise result in a “premature” dropping of the weight.

NOTE that the lower a stop is placed, the greater a drop height it corresponds to.

Use a 4 mm (5/32”) Allen key wrench for the adjustment. It may be necessary to detach the stops rail to get access to especially stop No. 3 and No. 4. Loosen a stop only so much that it can be moved, and when tightening again, you must be careful not to damage the rail by over-tightening.

If you want to adjust for a specific peak load level Pmax, then the following, THEORETICAL equation may be used to ESTIMATE the corresponding drop height h in mm:

$h(mm) = (Pmax/k)^2$

$h(ins) = (Pmax/k)^2/25.4 = h(mm)/25.4$

k will depend on the weight setup, on the unit chosen for Pmax, and, if the metric pressure (stress) unit kPa is chosen, k will also depend on the loading plate diameter. (In the tables below, kPa/300 means stress in kPa using 300 mm dia. plate. For 450 mm dia. plate, the kPa values should be divided by 2.25).

Tables 1 and 2 below apply for the FWD only.

Tables 3 and 4 below apply for the HWD only.

Table 1 (FWD ONLY!)

MASS of WEIGHT		k (approx.)		
kg	(lbs)	kPa/300	kN	lbf
350	(770)	85	6	1,350
250	(550)	60	4.2	935
150	(330)	35	2.5	550
50	(110)	14	1	220

Before the drop height is calculated, it is necessary to select a weight setup (50, 150, 250 or 350 kg). To do this, use the following Table 2 showing the usable load ranges for each weight setup:

Table 2 (FWD ONLY!)

MASS of WEIGHT		Load Range (approx.)		
kg	(lbs)	kPa/300	kN	lbf
350	(770)	565-1700	40-120	9,000 -27,000
250	(550)	380-1200	27-85	6,000 -18,500
150	(330)	225-700	16-50	3,500 -11,000
50	(110)	100-270	7-20	1,500 -4,400

Table 3 (HWD ONLY!)

MASS of WEIGHT		k (approx.)		
kg	(lbs)	kPa/300	kN	lbf
740	(1650)	225	16	3500
540	(1200)	165	12	2700
340	(755)	105	7.5	1700
240	(535)	72	5.2	1150

Before the drop height is calculated, it is necessary to select a weight setup (240, 340, 540 or 740 kg). To do this, use the following Table 4 showing the usable load ranges for each weight setup:

Table 4 (HWD ONLY!)

MASS of WEIGHT		Load Range (approx.)		
kg	(lbs)	kPa/300	kN	lbf
740	1650	1600-4500	115-320	26,000-70,000
540	1200	1200-3300	85-240	19,000-54,000
340	755	770-2100	55-150	12,300-34,000
240	535	530-1450	38-105	8,600-23,000

Example 1 **(FWD ONLY!)**:

If you want an approx. peak load of e.g. 11,000 lbf. (50 kN), then it can be seen from Table 2 that

the 250 kg (550 lb.) weight setup

OR the 350 kg (770 lb.) setup

can be used, and then Table 1 gives:

250 kg (550 lb.): k = 935 lbf

OR 350 kg (770 lb.): k = 1,350 lbf

which results in a drop height ESTIMATE of

250 kg: h = $(Pmax/k)^2 = (11{,}000/\ 935)^2$ = 138 mm (/25.4 = 5-1/2")

350 kg: h = $(Pmax/k)^2 = (11{,}000/1{,}350)^2$ = 66 mm (/25.4 = 2-5/8")

At system delivery, the drop heights will normally have been factory pre-adjusted to:

h1 = 50 mm, h2 = 100 mm, h3 = 200 mm and h4 = 390 mm

(h1 = 2", h2 = 4", h3 = 8" and h4 = 15-1/4")

SO, IF you choose the 250 kg (550 lb.) weight, you can move stop no. 2 downwards from it's initial h2 = 100 mm (4") to the desired 138 mm (5-1/2").

OR, IF you choose the 350 kg (770 kg) weight, you can move stop no.1 downwards from it's initial h1 = 50 mm to the desired 66 mm (2-5/8"), BUT PLEASE NOTE that you then in addition will have to move stop no. 2 downwards so much that the minimum distance of 50 mm (2") between adjacent stops is achieved.

NOTE that all the above, calculated figures are theoretical and therefore only APPROXIMATE, as the load is rather dependent on the stiffness of the pavement.

Example 2 **(<u>HWD</u> ONLY!):**

If you want an approx. peak load of e.g. 18,000 lbf., then it can be seen from Table 4 that

the 340 kg (755 lb.) weight setup

can be used, and then Table 3 gives:

k = 1,700 lbf

which results in a drop height ESTIMATE of

h = $(Pmax/k)^2 = (18{,}000/\ 1700)^2$ = 112 mm (/25.4 =4.4 ")

At system delivery, the drop heights will normally have been factory pre-adjusted to:

h1 = 50 mm, h2 = 100 mm, h3 = 200 mm and h4 = 390 mm

(h1 = 2", h2 = 4", h3 = 8" and h4 = 15-1/4")

SO, in the above example it would be convenient to readjust h2 to 112 mm (4.4"). (This gives a distance to h3 of 88 mm (3.5"), which is greater than 50 mm (2") as prescribed).

NOTE that all the above, calculated figures are theoretical and therefore only APPROXIMATE, as the load is rather dependent on the stiffness of the pavement.

5.3 *"Lock error" and "Plate not low error"*

If you forget to release one of the plate subassembly transport locks and you press the LP/RW button to lower the plate, then the lowering will stop, when the PL LED turns off (while PH LED is still on), i.e. the LP/RW button will become inactive. RP button will still be active, so that the plate can be re-raised to enable releasing of lock(s).

Also, for smaller drop weight setups, the weight MAY start raising (slowly) during lowering of the plate using the LP/RW button. If this causes the TG LED to turn off before the PL LED, then it will not be possible to lower the plate further. In that case, use the LC button to return the weight and try again (perhaps use DROP (LP/RW + red button) to lower the plate, until the PL LED turns off).

So, if the LP/RW button will not work, then always check that the PH, PL and TG LEDs do NOT fulfil any of the following, erroneous combinations (x means don't care):

	PH	PL	TG
"Lock Error":	on	off	x
"Plate Not Low Error":	x	on	off

6. *Weight Setup*

6.1 Changing the FWD Weight Setup

(IF you have an HWD, please proceed to Paragraph 6.2)

By changing size (mass) of the FWD drop weight, any of 4 loading ranges can be selected (refer also to 5.2, "**Drop Heights Adjustment**").

The FWD drop weight consists of a basic 50 kg (110 lbs) weight, to which may be added four, eight or twelve detachable 25 kg (55 lbs) weights and two, four or six detachable rubber buffers with shafts and fixing bolts to constitute a 50, 150, 250 or 350 kg (110, 330, 550 or 770 lbs) weight assembly.

In this way it is possible to maintain the duration of some 25-30 msec. of the load impulse for any drop height with any of the weight setups.

Refer to 5.2, "**Drop Heights Adjustment**" for advice on selection of the drop weight mass (size), once you know which load (range) you wish to use.

To change the weight size, use the following procedure:

1) Switch ON the Compact15 power.

2) Release the transport locks by turning MAN.KEY and pressing shortly the RP button.

3) Unlock the transport locks. (In case of automated locks, this is done by turning MAN.KEY and pressing the LC button).

4) Turn MAN.KEY and press the LP/RW until the plate has been lowered completely and the weight has subsequently been raised so much (**and ONLY so much**) that the two weight security supports can be turned clockwise to lean against the side of the weight package.

> ***SAFETY NOTE!***
>
> **(Note that IF the weight is RAISED TO ITS TOP POSITION, then IT WILL DROP!!!).**
>
> **NEVER PUT HANDS *UNDER* DROP WEIGHT when this is not supported!**

5) Turn MAN.KEY and press again the LP/RW button until (**and ONLY until**) the security supports flip into their locking position.

6) Perhaps settle the weight onto the security supports by activating manually the "A" valve (the one closest to the hyd. oil filter) using e.g. a small screwdriver. **DO NOT** use the LC button for this settling!!

7) SWITCH OFF all power (green LED labelled "12V Bat" ON, all others OFF).

8) Remove the rubber buffers sideways by unscrewing the appropriate spanner bolts (with tightening handles).

9) Remove or attach detachable 25 kg (55 lbs) weights (on both sides), until the desired weight mass is obtained (none, two, four or six detachable weights on EACH side for 50, 150, 250 or 350 kg weight setup). The cut-outs in the weights should face outwards.

10) Attach rubber buffers corresponding to the weight setup:

50kg (110 lbs) setup (NO 25 kg (55 lbs) weights applied):

Attach TWO small-size (70 mm (2-3/4") dia.) buffers (w. very short shafts, approx. 3 cm (1") long), ONE to the centre slot of EACH side of the (basic) weight.

150kg (330 lbs) setup (FOUR (25kg (55 lbs) weights applied, TWO in each side):

Attach TWO long-stem buffers, ONE to the CENTER slot of EACH side of the weight. Apply the 2 long PVC spacers over the top of the stems.

250kg (550 lbs) setup (EIGHT 25kg (55 lbs) weights applied, FOUR in each side):

Attach FOUR long-stem buffers, TWO to the OUTER slots of EACH side of the weight. Apply the 4 short PVC spacers over the top of the stems.

350kg (770 lbs) setup (TWELVE 25kg (55 lbs) weights applied, SIX in each side):

Attach all SIX long-stem buffers, THREE to EACH side of the weight.

NOTE that when a buffer is attached, it is VERY IMPORTANT that the circular flange in the centre of the buffer fits the corresponding cut-out in the underside of the weight, so that the buffer is prevented from moving sideways.

11) Switch ON again the Compact15 power.

12) RAISE the weight some 5 cm (2") (LP/RW button) and <u>MAKE SURE</u> that BOTH security supports swing downwards to their "OFF" position.

13) Lower the weight completely by pressing the LC (Lower Catch) button.

14) Raise the weight some 5-10 cm (2-4") (LP/RW button).

15) Drop the weight: Press LP/RW <u>plus</u> red button (red button first in, last out).

16) Lower the catch completely (LC button).

17) Re-tighten the rubber buffer securing spanners.

18) Repeat steps 14) to 17) with maximum drop height (or, in case of a weak pavement or floor, with maximum allowable load level).

19) If the FWD should be moved before measuring, then press the RP button until the subassembly reaches its top position and lock all transport locks.

20) Turn OFF the Compact15 power.

NOTE! From time to time, especially in the first period of time after changing a weight setup, it should be checked that none of the buffer spanners are loose!

6.2 *Changing the HWD Weight Setup*

By changing size (mass) of the HWD drop weight, any of 4 loading ranges can be selected (refer also to 5.2, "**Drop Heights Adjustment**").

The HWD drop weight consists of a basic 240 kg (535 lbs) weight, to which may be added two, six or ten detachable 50 kg (110 lbs) weights.

Each detachable 50 kg (110 lbs) weight is subdivided into two 25 kg (55 lbs) sub weights for easier handling.

Each 50 kg weight can be mounted EITHER on one of the 10 studs on the basic 240 kg (535 lbs) drop weight OR on one of the 10 "stand-by" studs on the subunit frame.

In this manner it is possible to constitute four different sizes of active drop weight as shown in the figures on the following page. The 25-30 msec. duration of the load impulse will be maintained for any drop height with any of the weight setups.

Refer to 5.2, "**Drop Heights Adjustment**" for advice on selection of the drop weight mass (size), once you know which load (range) you wish to use.

Each 50 kg weight is fastened to its stud by a tubular nut with a 36 mm hex head (for which a matching wrench is provided). A split pin at the end of the stud prevents the tubular nut from unscrewing in case it should loosen by itself.

To move a 50 kg weight from a stand-by stud to a basic weight stud (or vice versa), use the step-by-step procedure below.

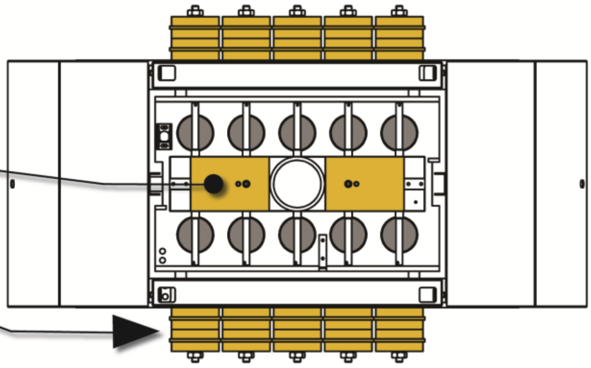
> ***SAFETY NOTE!***
>
> **Before changing weights around, you must make sure that the HWD trailer and/or the tow vehicle has been securely braked**

1) Make sure that the HWD is in its transport position, i.e., that the subassy. has been raised to its topmost position and that the transport locks are in their locked position.
2) Remove the split pin from the weight stud in question.
3) Unscrew and remove the tubular weight holding nut while supporting (i.e., keeping vertical) the weight by holding the top handle of the outer sub weight.

240 KG WEIGHT SETUP

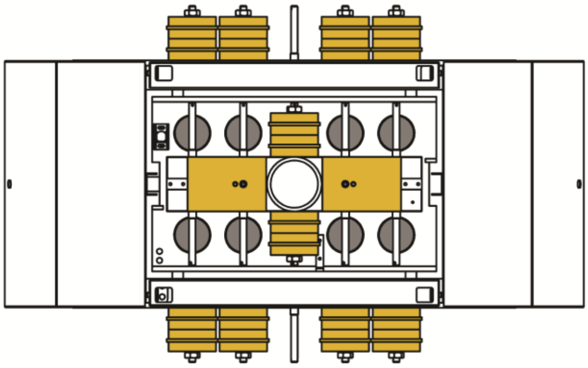
Drop weight is basic weight only

All detachable weights moved to their standby rods.



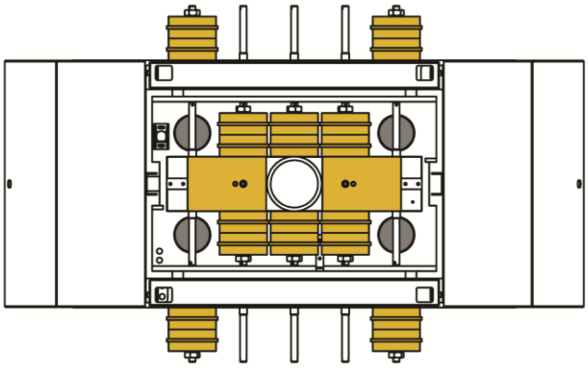
340 KG WEIGHT SETUP

Two 50 kg weights (2 x 25 kg each) added to the basic weight.



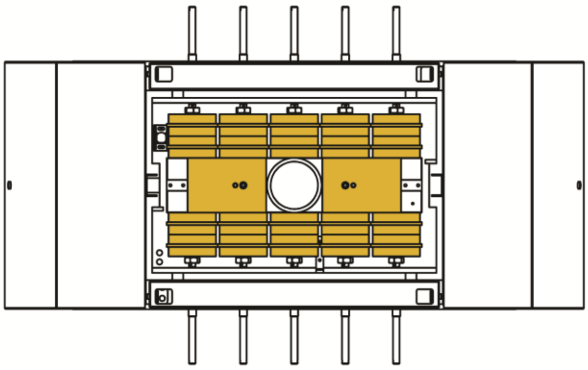
540 KG WEIGHT SETUP

Six 50 kg weights added to the basic weight.



740 KG WEIGHT SETUP

All 50 kg weights added to the basic weight.



4) Remove the outer 25 kg sub weight and place it on the ground (i.e., NOT on a stud!).
5) Move the inner 25 kg sub weight from its standby stud to the corresponding basic weight stud (or vice versa).
6) Add again the outer 25 kg sub weight.
7) Apply the tubular nut and tighten it firmly.
8) Secure the nut by applying the split pin.

WARNING!

NEVER USE ANY OTHER WEIGHT SETUP(S) than one of the (SYMMETRICAL) setups shown in the figures!!

7. Connecting the Electronics

7.1 Connecting Transducers/Cables

When the FWD/HWD equipment has been installed as described in section 2, "**Tow Vehicle Installation**", then connection of the Electronics (the Compact15 System Controller and the Computer) should be performed as outlined in the step-by-step procedure below.

Perhaps also refer to Section 14, "The Compact15 System Controller".

The cables from the transducers (i.e. from the Load Cell and from the Deflectors) should be connected to sockets of the Compact15 Front Panel. The 12V power supply for the Comapct15 should be connected to the power socket at the bottom panel. Refer to the step-by-step procedure in the following.

If necessary, use an anti-oxidizing, silicone-based spray (like that used for moisture protection of vehicle ignition systems, such as e.g. "WD40") to clean plugs and sockets and to protect them from condensing moisture and corrosion.

1. MAKE SURE that the Compact15 has been switched off, when any cable is connected or disconnected.
2. Connect the (black, plastic) female plug of the Compact15 Power Cable to the mating socket on the System Controller bottom panel. Make sure that the plug is inserted STRAIGHT, and that the lock ring to its end stop.
3. Connect the 5-pin male, bayonet-lock-type DIN plug of the load cell cable (labelled FWDL) to the LC socket of the Compact15 Front Panel.
4. Place the Deflector with the S/N assigned to Deflection Channel No.1 in the centre deflection holder in the hollow above the load cell, making sure that the magnet clamps well to the bottom plate of the holder (the magnet as well as the plate should be clean before the placing).
5. Connect the bayonet-lock-type DIN plug of the Channel 1 Deflector to the D1 socket of the Compact15 Front Panel.
6. Place the remaining Deflectors assigned to Deflection Channels No. 2, 3, 4, etc. in the (movable) holders on the raise/lower bar (see 7.1.2, "Note on Placing the Deflectors" below). Standard Test Setups imply that the Deflectors are placed in order of increasing distance from the loading plate with increasing Channel No.
7. Connect the plugs of the Channel 2, 3, 4, etc. deflectors to the appropriate sockets of the Compact15 Front Panel. See 7.1.3, "Important Notice!!!" below!**)**.
8. Connect the bayonet-lock-type DIN plug of the cable connected to the hand/emergency brake indicator circuit (or to the PARK indicator circuit) to the PARK socket on the Remote Control Box. (Refer also to 2.2.4, "Plate-Low Alarm Connection").
9. Connect the Computer interfacing and power cables as explained below in 7.2, "Connecting the Computer"
10. If an (optional) Air Temperature Probe has been supplied, connect the bayonet-lock-type DIN plug of this to the AIR socket of the Compact15 Front Panel
11. If an (optional) Infrared, non-contact Temperature Sensor has been supplied, connect the bayonet-lock-type DIN plug of this to the IR socket of the Compact15 Front Panel.

7.1.1 Note on Load Cell Cable connection:

Step 3 is usually factory performed and the cable for the Load Cell should be left connected, also when the equipment is not in use, and should only be disconnected in case of servicing or the like.

7.1.2 Note on Placing the Deflectors

Before placing the Deflectors, the holders should be at (or at least close to) the desired positions (i.e. distances from the loading centre), and the loading plate and the raise/lower bar should be lowered close to, but not touching the ground. Pass a deflector to a holder from above, so that the cable passes up between the two rails of the raise/lower bar. Tie the cable along one of the bar beams using the provided cable ties. The clamping magnet of a deflector and the matching bottom plate of the holder should be clean before attaching the deflector. After attachment, hold the holder with one hand while pushing down AND from side to side the deflector to remove residual dirt and to feel if the clamping is good.

Please note that a deflector MAY jump off a holder, if a bump in the road is passed at high speed. Therefore, tie the deflector cable(s) to the bar in such a way that IF a deflector should jump off, it will not be able to reach the road surface! (Tie while the bar is clear of the ground, so that the deflectors are in their lowest position in respect to the bar, but make sure that no cable will be strained when the bar is lowered again).

MAKE SURE that no cable(s) is/are strained at ANY level of the bar!

7.1.3 Important Notice!!!

- It is **VERY important** that the Deflectors are properly connected, as the individual calibration data of each deflector have been programmed into the Compact15 System Controller so that a specific deflector S/N is allocated to a specific channel No., and therefore the connections **MUST** be performed in accordance herewith.
- If you have changed round and/or exchanged any of the deflectors, then **MAKE SURE** that the listing in the “Deflectors” window in the Field Program is in exact accordance with the order of the actual deflector connections! See also 4.2.5, “Deflectors”.
- **In ANY case** of doubt, perform a **RELATIVE DEFLECTOR CALIBRATION** procedure as outlined in the supplied FwdCal30 package.

7.2 Connecting the Computer

7.2.1 Interface connections

To interface the Compact15 System Controller to the Computer, connect the Ethernet RJ45 socket on the Compact15 System Controller to the “CP15” RJ45 socket on the Remote Control Box using a standard CAT5 patch cable.

If you use a Router (or ‘Switch’):

Connect a Cross-Over Ethernet cable from the “PC” RJ45 socket on the Remote Control Box to one of the Network sockets on the Router.

Connect a standard Ethernet cable from the computer to another socket on the Router (the Router / Computer connection could also be established wirelessly).

If you use Direct connection (no Router):

Connect a standard CAT5 patch cable from the “PC” RJ45 socket on the Remote Control Box to the Network socket on the Computer.

7.2.2 Power Connections

Normally, the computer will be powered by connecting the line voltage power cord of the Computer power adapter to a provided static inverter (which inverts 12VDC from the Electronics Buffer Battery to AC line voltage).

Alternatively, a 12VDC powered computer power adapter may be used, connected to e.g. a cigarette lighter adapter.

8. Leaving Base

To ensure that your entire FWD/HWD Test System is properly prepared and set up to perform field testing, always as a minimum perform the following procedure before leaving your base:

8.1 Maintenance Checks

See also Section 15, "**Maintenance**" for more details.

8.1.1 Tire Pressure

Check tire pressure of both/all wheels and adjust if necessary (to 2.8 bar / 40 psi cold).

8.1.2 Hydraulic Oil Level

Refill only when the plate (i.e. the subunit) has been raised completely!

8.1.3 Battery Acid Level

Refill with distilled water only.

8.2 Connect Trailer to Tow Vehicle

8.2.1 Hook to Hitch

Hook up the FWD/HWD Trailer to the tow vehicle's trailer hitch ball. MAKE SURE THAT the trailer tongue hitch is properly locked to the ball. Attach the inertial brake breakaway security wire to the vehicle's towing hitch assembly. ALTERNATIVELY, (OR in addition), attach heavy safety chains from the trailer to the vehicle, if provided / required.

8.2.2 Rear Lights Connection

Connect the plug of the FWD/HWD rear lights cable to the appropriate socket on the rear of the towing vehicle and check the function of all lights.

8.2.3 Front Support Wheel

Raise and secure the FWD/HWD front supporting wheel, using the heavy split-pin. (Tighten the clamp VERY well).

8.2.4 Power Cable

Connect the heavy, 2-pin male plug of the trailer power cable to the matching, female power output socket on the rear of the towing vehicle (or to an optional gasoline power generator if applied). (Be CAREFUL NOT to SHORT the pins in the plug, as these are directly connected to the trailer buffer battery supply!).

8.2.5 Network Cable

Connect the Network Cable as explained in Section 7.2.1 "Interface connections".
Be careful NOT to get ANY DIRT into the connectors!

8.3 Functional Check

At this point in the FWD/HWD preparation it might be a good idea to perform a functional check of the complete Test System BEFORE driving to the test site, to make sure that everything is operational when you arrive to the test site. If you are in a hurry, you may continue below at step 8.4 "Just Before Leaving...".

To perform a functional check, you need to be familiar with Section 9, "Running the Program". We recommend performing at least one full testing sequence with the setup that is going to be used in the field.

8.4 Just Before Leaving...

8.4.1 Transport Locks (Automated or Manual)

Please NOTE that this step MUST ALWAYS be performed, no matter whether the transport locks are automated or manually operated!

Make sure that the plate subassembly is in its topmost position and that ALL of its transport locks have been brought properly into their locking position in BOTH SIDES!

After having done this, **the subassembly MUST *MANUALLY* be *SETTLED* onto the locks by turning MAN.KEY and pressing the LP/RW button** (of the Compact15 Front Panel) and **keeping it pressed until the motor stops automatically**. The subassembly should settle firmly on the locks after having lowered ONLY a couple cm (some 1") MAX. IF NOT, then corrective action MUST be taken before driving!

8.4.2 Raise/Lower Bar Locking Pin

Make sure that the rod of the raise/lower bar front end guide mechanism has been locked in its top position by a locking pin.

8.4.3 Trailer Handbrake

IMPORTANT! Make sure that the Trailer handbrake is fully released!

8.5 During Driving

WARNING!

NEVER switch ON or OFF or perform Computer HARD-RESET WHILE DRIVING!! This MAY initiate uncontrolled hydraulics activity!

9. Running the Program

9.1 Switch ON

IMPORTANT: DO NOT DRIVE while you or your co-pilot switches on the system!

You must switch on the computer and Compact 15 as follows:

1. Make sure everything is switched off (Check Power key at Compact15 front panel).
2. Switch ON the computer and wait until it is ready (harddisk idle).
3. Make sure that the PARK/ALARM signal is active.
4. Switch ON Compact 15 by pressing ON at the Remote Control Box (after approx 30 seconds Compact15 sounds a beep).
5. Wait at least one minute (watch LEDs for network activity at the RJ45 socket).
6. Start “Dynatest Data Collection” (Shortly after the Welcome screen is shown the Compact 15 sounds another beep).

Windows Firewall

The first time you run “Dynatest Data Collection” the Windows Firewall may show a message saying it is blocking certain functionality of the DDC. You will have the option to remove the blocking. Please do so.

Network Timeout

If you get a “Network Timeout” error, then check the 12V power on the Trailer, Network cables, Router/Switch and Park/Alarm circuit and then re-sequence power.

9.2 Warnings

9.2.1 Emergencies

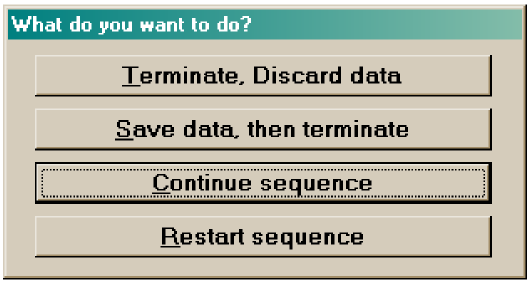
If you have to move away from the test site swiftly:

1) Go OUT OF PARK or RELEASE the HAND BRAKE. This will instantaneously initiate a Raise Plate operation.
2) WAIT until the Plate AND the deflectors are OFF GROUND.
3) Drive away.

The automated Raise Plate action in step 1 is on condition that Alarm circuits have been installed properly! See 2.2.4, “Plate-Low Alarm Connection”.

9.2.2 Stopping a Sequence

If e.g. someone approaches the equipment it may be necessary to Stop or Pause an ongoing test sequence. Pressing ESCape or any of function keys F1, F2 or F3 will pause the test and bring up a screen with the following options:



In any case, be very careful what you do next!

If you stopped because you suspect some malfunction, do NOT continue the sequence. Instead, lower the weight manually and do trouble shooting.

9.2.3 *Driving*

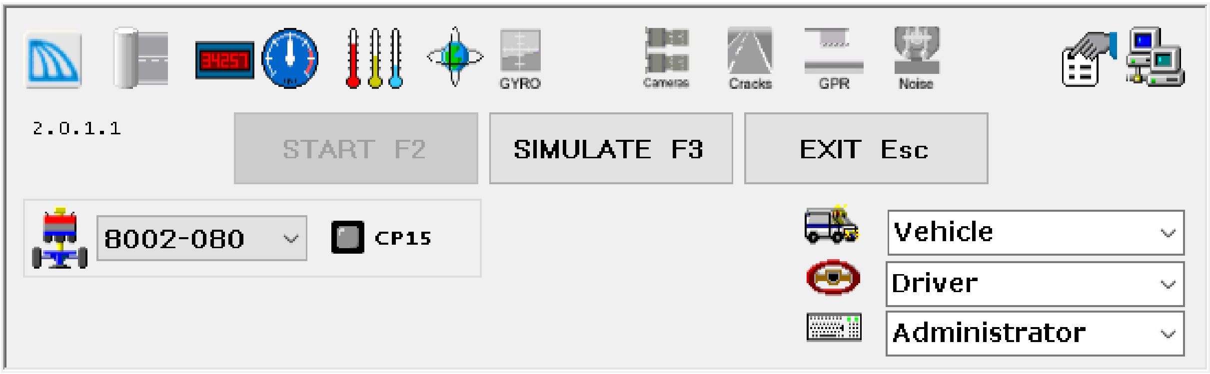
Things you should NOT do while driving:

NEVER switch the Computer OFF or ON

NEVER perform Computer HARD-RESET as this may cause UNCONTROLLED HYDRAULICS ACTIVITY

9.3 *Dynatest Data Collection (DDC)*

When the “Dynatest Data Collection” is first started, this screen appears:



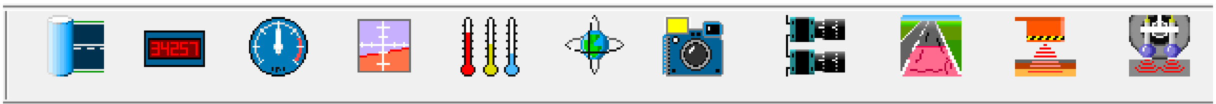
This sample shows that you will run tests with FWD S/N 8002-080 and run the DMI, Speed, Thermometers and GPS “Applets”.

Check Vehicle ID, Driver Name and User Name

If the CP15 “LED” stays pale, then check the 12V power on the Trailer, Network cables, Router/Switch and Park/Alarm circuit and then re-sequence power.

9.3.1 *Applets*

Applets are programs providing specific functionality to the main applications. Most applets appear in resizable floating windows. The Administrator can arrange the windows but the resulting layout is locked for the Operator.



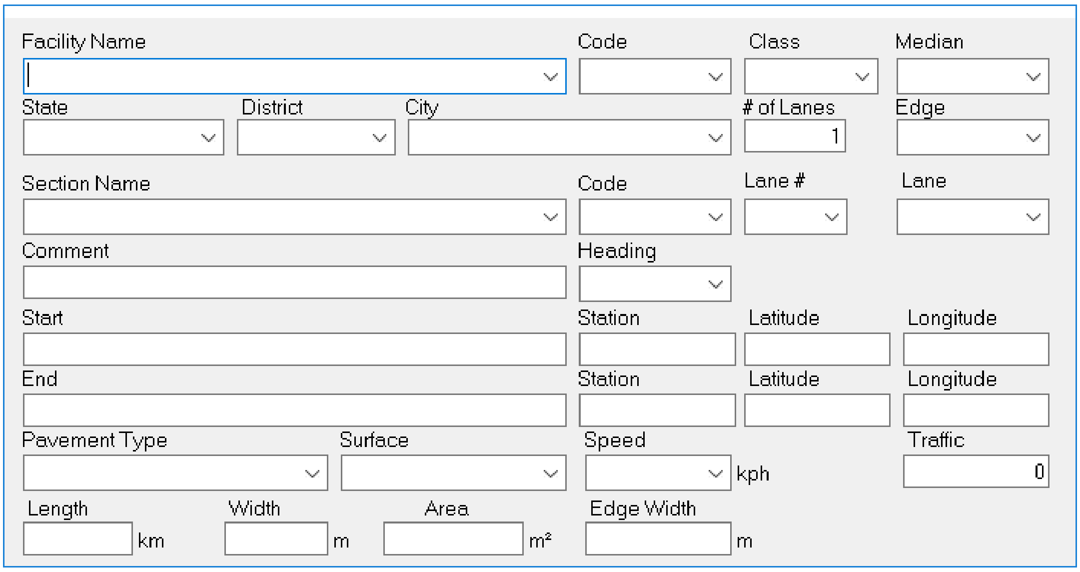
Click an icon to toggle between colored and gray icons. When you press [Start] then all colored applets are launched together with the main program, FwdWin. After this the opening window “Dynatest Data Collection” minimizes, but must be left running during the mission.

The next chapters cover the FWD relevant applets, only.

The menus shown in the following appear when you right click the applet.

9.3.1.1 *Network*

The Network applet manages Section information. The entered information is saved in a SectionLog database for each test run. Some of the fields are also saved in the data files.

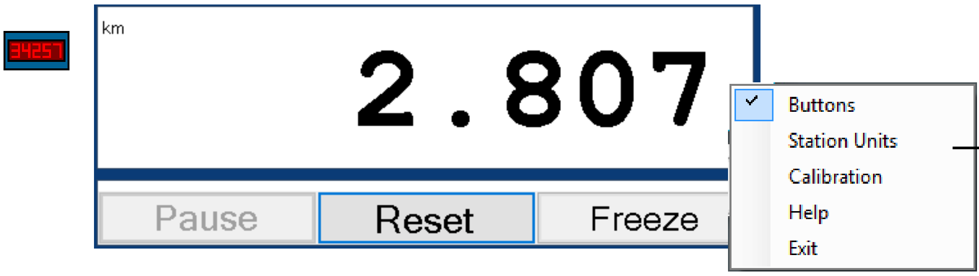


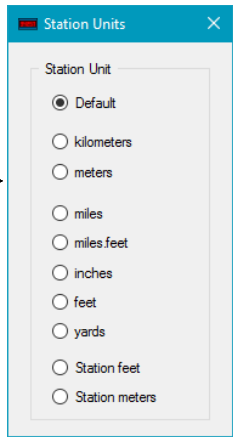
A “Facility” can be anything from roadways, runways and streets to parking lots or even railways. Often a facility is identified by both its common name and a code which links into a pavement management system.

A single facility is often composed of sections of varying construction. This “Sectioning” can be both longitudinal and transverse. The latter is appropriate for multilane roadways where traffic load varies across the construction.

9.3.1.2 DMI

The DMI applet displays the current DMI reading.

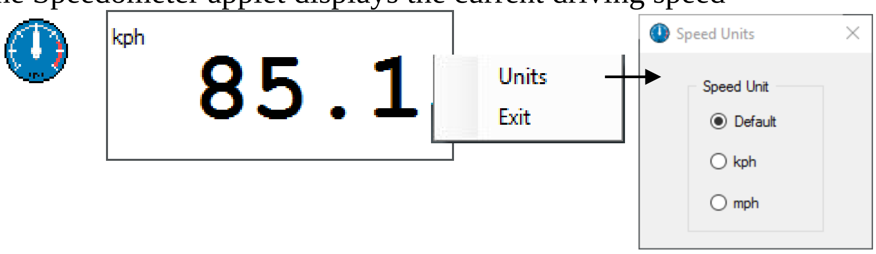




Uncheck “Buttons” to hide the Pause, Reset and Freeze buttons.
The unit can either track the unit used in FwdWin (Default) or be set to any other desired format.

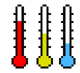
9.3.1.3 Speedometer

The Speedometer applet displays the current driving speed

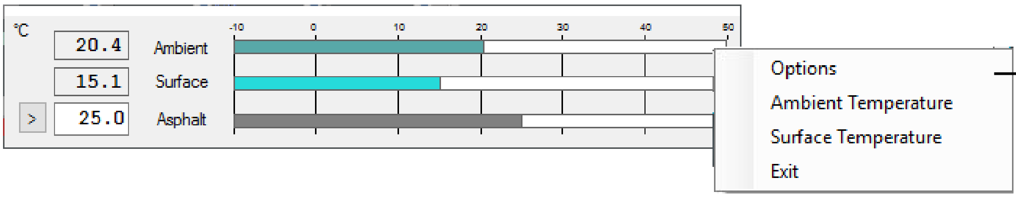


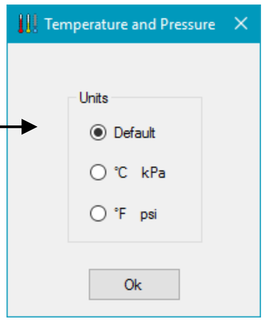
The unit can either track the unit used in FwdWin (Default) or be set to kph or mph.

9.3.1.4 *Thermometers*



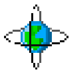
The Thermometer applet displays three temperatures and colorizes Air and Surface temperature relative to the Asphalt temperature.



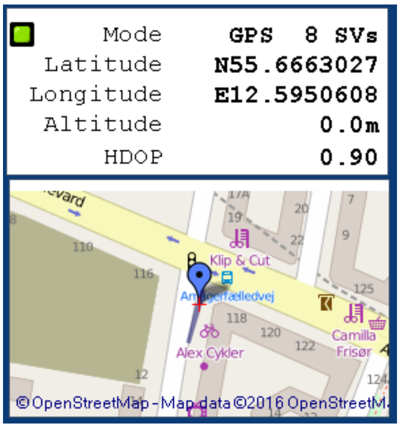


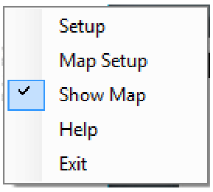
The unit can either track the unit used in FwdWin or be set to C or F.

9.3.1.5 *GPS*

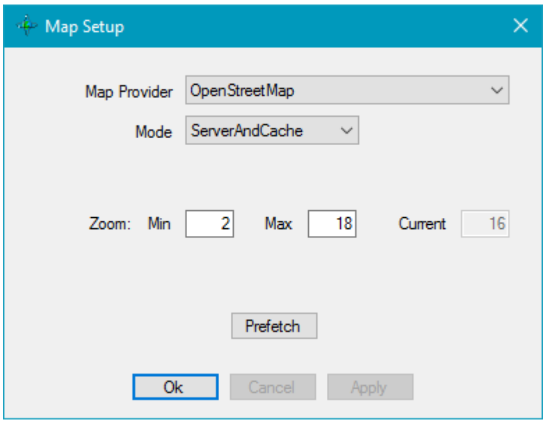


The GPS applet displays the current geographical coordinates and a map.



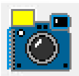


Uncheck "Show Map" to hide the map window

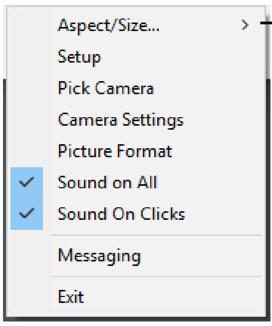


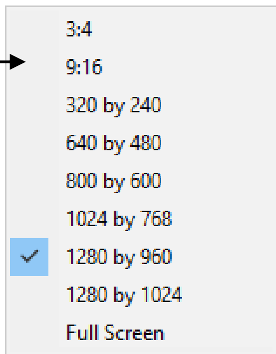
Chose the desired map provider and the maximum zoom level.

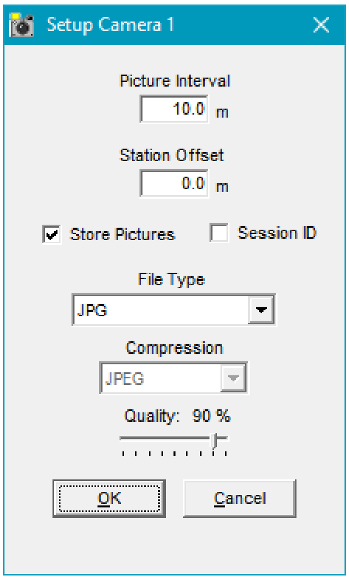
9.3.1.6 *Camera*



The Camera applet displays and saves images from DirectX cameras.







Setup:

Picture Interval:
This example shows 1 image stored every 10 meters.
Station Offset:
Adjustment of your distance reading. (Part of the image file name).
Session ID:
Ad Session ID No to image file name. (For FWD and Survey testing only).
File Type:
BMP, JPG, TIFF or PNG.
Quality:
100% is least compressed ~bigger files.

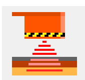
Pick Camera
Lists available DirectShow devices
Camera Settings and **Picture Format**
These windows are supplied by the camera manufacturer
Sound
Uncheck to shut off the shutter sound

For detailed setup of specific camera models see chapter 14.2 Camera.

Unibrain
The following items must be performed for each camera after camera power-off!

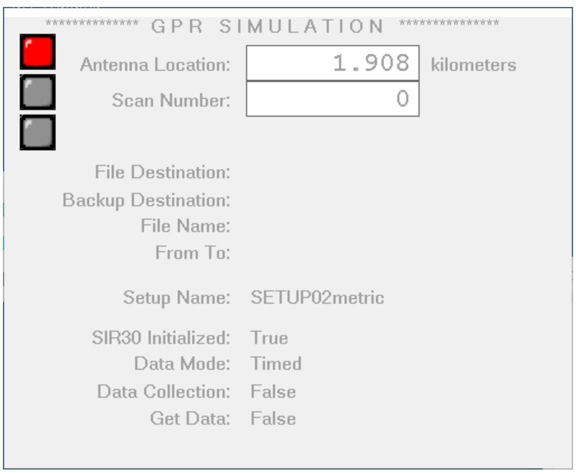
1. Right-click on the ROW picture and select “Camera Settings” and then “Exposure”
2. For “Shutter” as well as for “Gain”, check the “at” box
3. Click the “Basic” tab.
4. In the “Basic” window, adjust “Gamma” to 1 or 2 and “Sharpness” to 16 _

9.3.1.7 Ground Penetrating Radar

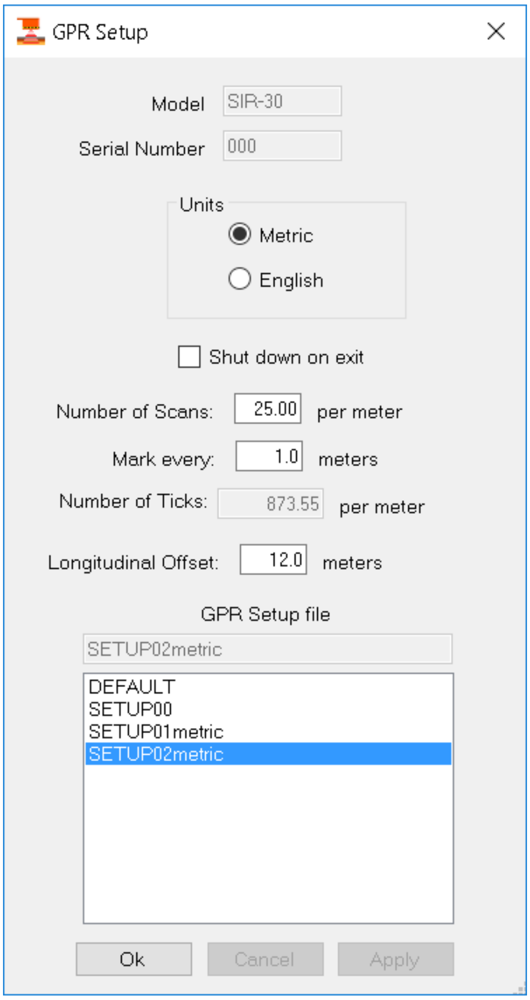


The GPR option enables simultaneous and automated collection of layer properties. GSSI’s model SIR-30 is presently supported.

Red: Idle state
Yellow: Prepared to start
Green: Started



Setup:



Shut down the GPR system when DDC is closed

Encoder pulses per meter

Offset from FWD loading plate to GPR antenna (negative if the antenna is behind the FWD)

9.3.2 Simulation Mode

If the opening window cannot detect the presence of FWD hardware, you can still run the system in Simulation Mode.

Simulation mode allows the user to run FwdWin even when the equipment is not connected. In this mode artificial data is fed into the program at the appropriate times to create the appearance that an FWD/HWD is actually connected.

Simulation mode is useful for training purposes. Using simulation mode, an instructor can conduct classroom training with one or more computers and operators (no hardware is needed). The operator can also "practice" running the equipment in the office.

In simulation mode you can use **Ctrl** + **P** to toggle the PARK state.

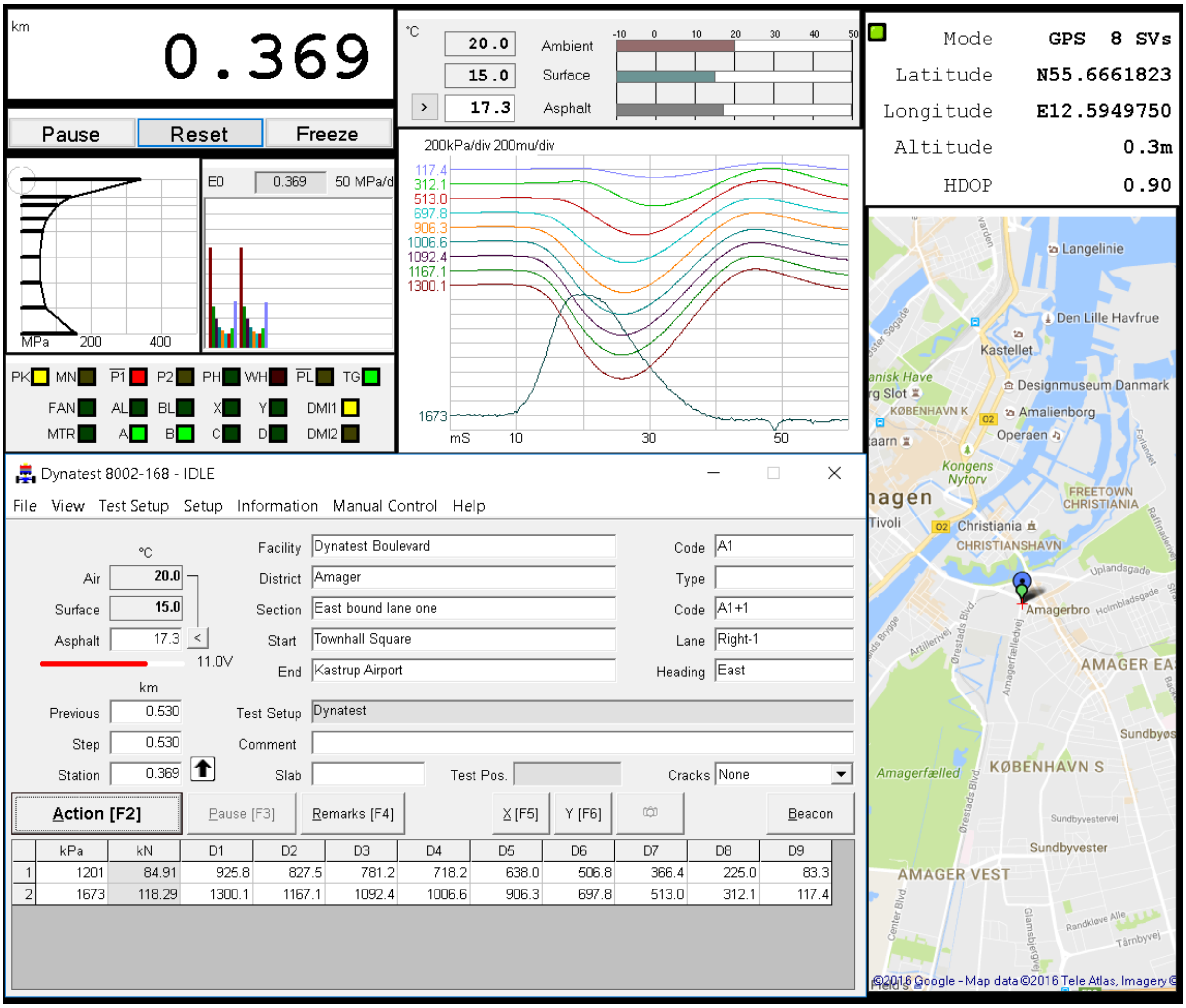
9.3.3 Entering the Main Program

Once everything in the "Dynatest Data Collection" screen is configured, the user may click the "Start" button (choose "Administrator" first). The data collection screen should now appear. The user can now complete the setup process.

NOTE: Some of the features shown in the following may not apply to your system.

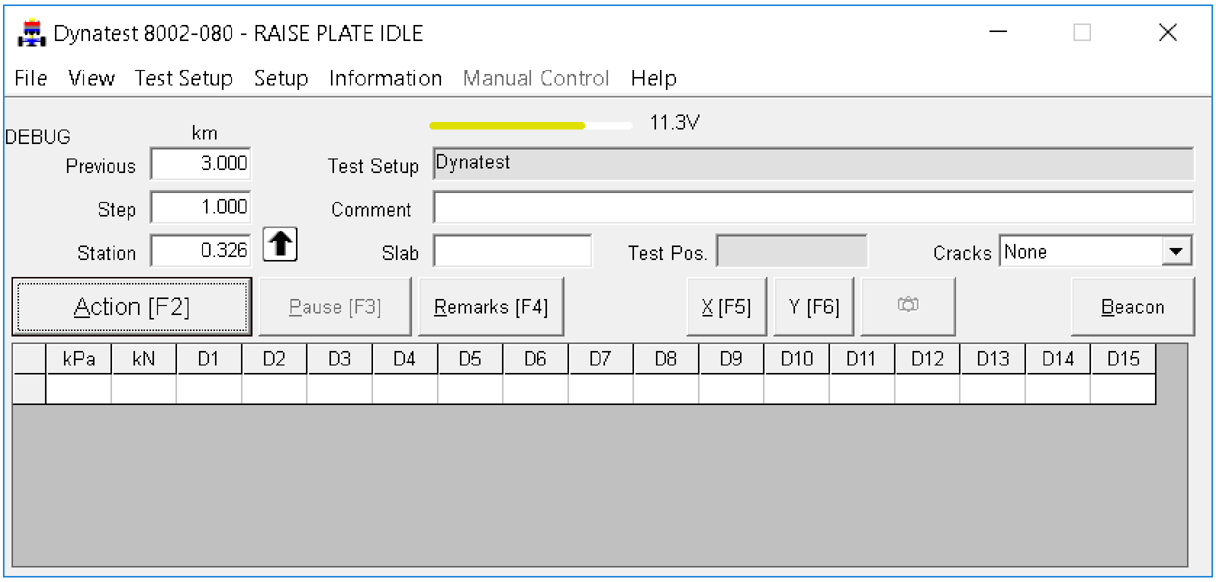
9.4 The Data Collection Screen

The data collection screen opens when the user clicks the "Start" button in "Dynatest Data Collection".



The screen consists of a Main window, sub-windows and applets. The large Main window is the primary interface or "mission control" for operating the program, i.e. all things is controlled from here. Each of the sub-windows and applets tend to mimic a real-life instrument like, for instance, a GPS navigator, Distance Measuring Instrument etc. Sub-windows and applets may be resized and moved around independently by simple drag operations using the mouse pointer. They may even be moved to a secondary monitor.

9.5 Main Window



As mentioned earlier the Main window is the "mission control" for operation of the program. From this window the additional sub-windows can be toggled on and off by clicking the **View** menu item on the menu bar. Applets can be turned off from their individual menus.

Greyed text boxes cannot be edited directly. Some are filled automatically (temperatures) others may open sub-windows for data entry.

At this point, if any setup changes are required to the loading unit, the System Controller, the deflectors, etc. they should be made now through Main Menu item **Setup**. Details regarding setup changes are documented in Chapter 4.

9.5.1 Navigating with the Keyboard

Often, when using the program within a confined space (like in a testing vehicle), it is impossible or – at its best – inconvenient to use a mouse to operate the program. Therefore, it may be a good idea for the user to brush-up the basics of navigating with the keyboard.

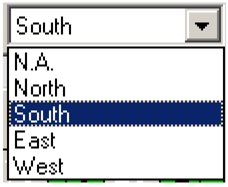
Actually, most of the operations you can do using a mouse (except drag-and-drop operations) can be done using the keyboard instead. The key to navigating with the keyboard is using the **TAB** (↔) key to put the focus on a *control* in the active window (controls are all the items that a window contains, like command buttons, textboxes, drop-down lists etc.).

When a control has the focus it has a *focus rectangle* around it as shown below (the **Apply** command button has the focus):

Each control in a window has been assigned a tab order, so that when the user presses the **TAB** key the focus rectangle is moved to the next control in the tab order, and when **TAB** is pressed while simultaneously holding down the Shift key the focus rectangle is moved to the previous control in the TAB order.

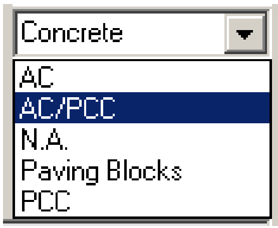
When a control has focus the user can manipulate it using the keyboard. Here is a quick overview of how to manipulate the most common of windows controls using the keyboard:

- Command Buttons:
  To activate a command button simply press the Enter key on the keyboard.
- Drop-down lists:



To make a drop-down list drop down or retract simply press the up- or down arrow while at the same time holding down the **Alt** key. To navigate in the drop-down list simply use the up- and down-arrows WITHOUT pressing the **Alt** key. When an item in the drop-down list is highlighted, the user can select it by pressing the **Enter** key on the keyboard.

- Combo Boxes:



A combo box is a combination of a textbox and a drop-down list. The text portion of a drop-down list can only display items from the list, whereas a combo box allows the user to directly enter an input into the text portion as if it was a plain textbox as well.

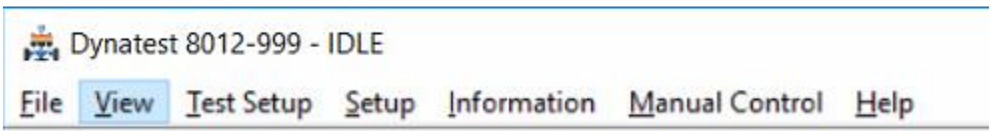
In the combo box shown above the user has been allowed to enter the word “Concrete” into the text portion of the combo box although “Concrete” doesn’t appear in the list of pavement types to choose from.

- Check Boxes:

The checkmark in a checkbox can be toggled ON and OFF by pressing the **Enter** key.

The menu bar (along the top of the main window) is accessed in a rather special way. Actually, there is two ways a user can access the menu bar using the keyboard:

- The user can shift the focus between the menu bar and the rest of the window by pressing the **Alt** key. When the menu bar has the focus one of the headline items is “depressed” as shown below (the **View** headline item is highlighted):



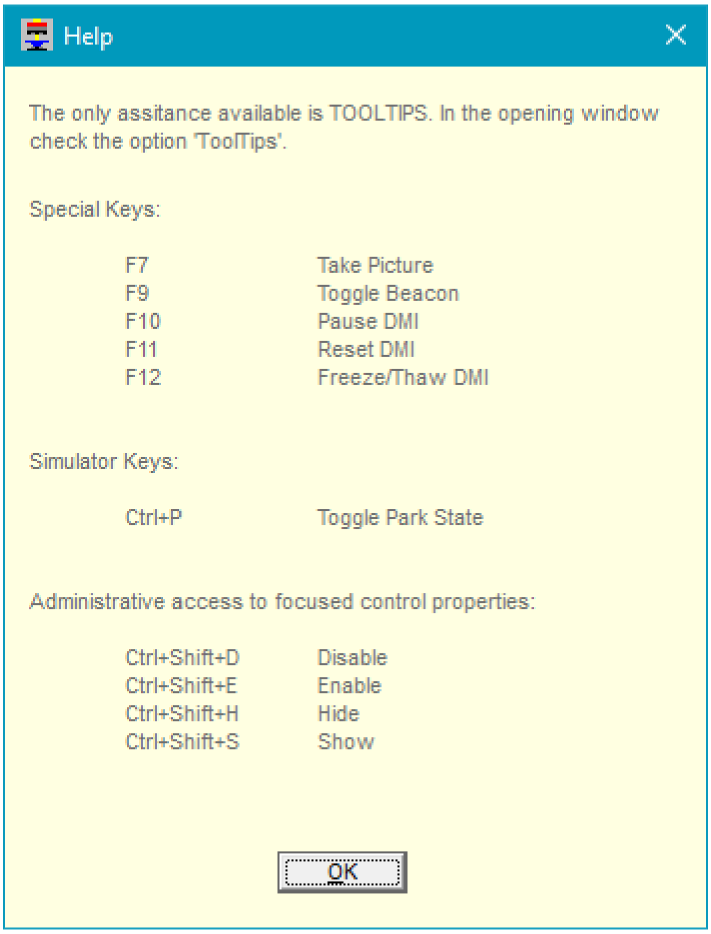
  Use the left- and right arrows to highlight the desired headline item. Each headline item conceals a list that the user can drop-down by pressing the **down-arrow**. To navigate in the drop-down list simply use the up- and down-arrows. When an item in the drop-down list is highlighted, the user can select it by pressing the **Enter** key.

- The user can navigate the menu bar using *short-cuts*. Each of the items in the menu bar has an underscored letter in their name. A menu item can be selected by pressing the underscored letter in combination with the **Alt** key. For instance, pressing **Alt + V** would be a direct way to select the **View** menu and make it drop-down at the same time:

Note: Short-cuts not only apply to menu bars, but can be used for ordinary control items as well. For instance an **OK** button like the one shown elsewhere in this chapter can be focused and activated (pressed) in a single keyboard operation by pressing **Alt + O**.

9.5.2 *Special Keys*

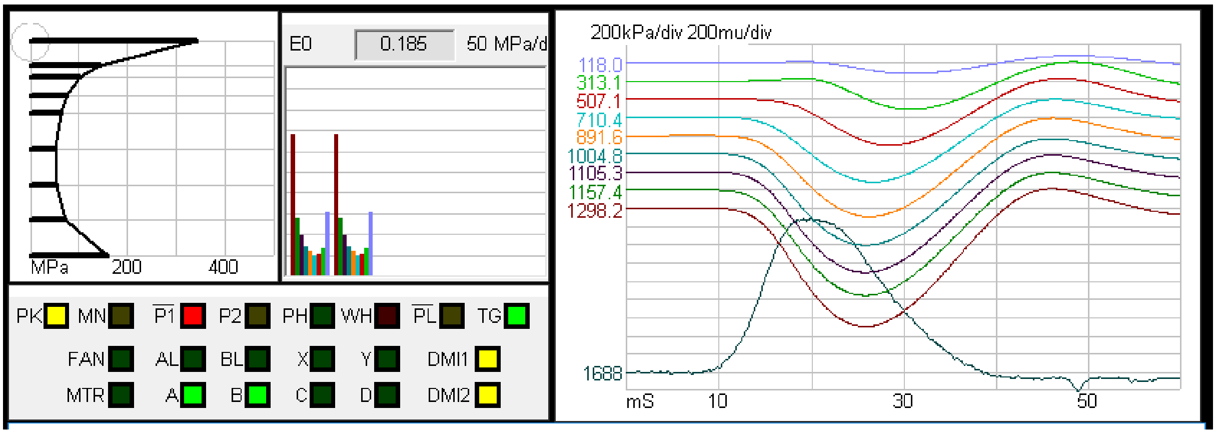
Some Function Keys and key combinations are allocated for various special purposes. Some of the functions are available for the Administrator, only.
The Help entry in the menu item Help displays the full list of special keys.



9.6 Sub-Windows

The sub-windows listed here are FWD/HWD dedicated windows. General functions are handled by the previously described applets.

- LED Panel
- Time Histories Plot
- Surface Modulus Plot
- Surface Moduli Chart



The additional display components can be toggled on and off by clicking the **View** menu item at the upper left corner of the data collection screen.

9.6.1 LED Panel

This window gives feedback for proximity and pressure sensors and also the state of the MOS output drivers

9.6.2 Time Histories

This window shows the time histories of the last drop. The peak stress and peak center deflection rules the auto scaling.

9.6.3 Surface Moduli

This window shows the Surface Moduli. Center modulus at the top and farthest measurement at the bottom.

9.6.4 Surface Moduli Chart

This window shows the development of surface moduli as you go.

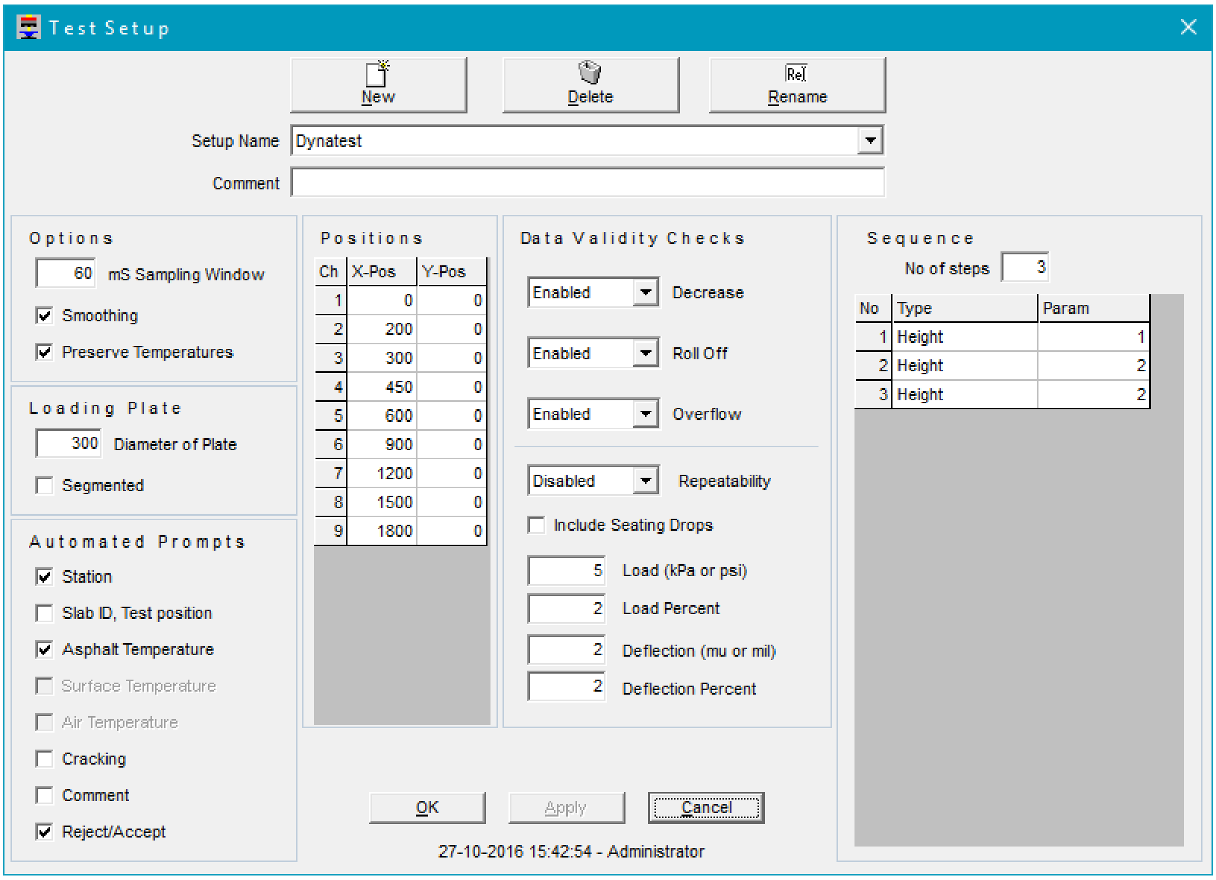
10. *Performing the Measurements*

10.1 *Test Setups*

The next step in the process is to establish a test setup that meets the procedures required by the particular project. Accessing the test setup screen can be done in several ways:

1. Click the **Test Setup** menu item at the top of the data collection screen.
2. Hold down the Alt key and then press the T key (Alt-T shortcut).
3. Click on the **Test Setup** label in the middle of the data collection screen.
4. Click in the greyed text box to the right of the Test Setup label.

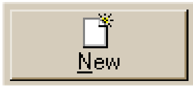
Once the Test Setup window is opened the user will be presented with the following screen.



It may be useful to the operator at this point to define what a "Test Setup" is. It is a collection of software settings that tell FwdWin the type of loading plate, the positions of all deflectors and what actions to take during each test cycle. For example, you might want FwdWin to collect four drops at each test point, all from different heights. A Test Setup can be created to do this. Moreover, you might have several different deflector spacings commonly used on different types of jobs. You can create a Test Setup for each job type and store them for easy retrieval next time a similar job comes up.

Note that the Test Setup screen is divided into different areas that control specific operational aspects of the FWD/HWD. These will be discussed in detail below.

New



Creates a new test setup based on the present test setup, so, BEFORE you press this button you should select the Test Setup that best matches your needs from the drop-down list to the right of the **Setup Name** label. The operator must specify a new name in the **Setup Name** field then click the **Apply** button. The operator can then make changes to the test setup. Once changes are complete, the operator should then click the **OK** button to save the changes.

Delete

This deletes the present Test Setup. The operator will be prompted to confirm that he/she wishes to delete the setup.

Rename

This allows the operator to rename the present Test Setup. The operator must enter a new name in the **Setup Name** field, then click **OK**.

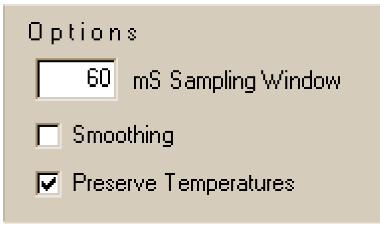
Setup Name

This is a drop-down list that contains all of the test setups that have been created by the operator. If you click on this box, a list of all setups stored in the program will appear. Clicking on one of the setups loads it into the FwdWin program. It is useful to include descriptive information in the setup name for easy identification (when you operate an FWD/HWD for a while, you'll create MANY setups).

Comment

The operator can use this line to include additional descriptive information regarding the present test setup.

Options



The options box contains three program controls:

Sampling Window

For each drop the system samples the load and deflection signals for a period of typically 60 milliseconds. This parameter also controls the range of the time axis on the time-history plot (see "Time History Plots" later in this chapter).

Smoothing

The Smoothing (or Smoothed Peaks Option) is a special feature, which ensures that the influence on the load and deflection peak values from possible undesired, high frequency components in the load cycle will be reduced to a minimum. Correlation trials have proved the value of this option, and it is recommended to always use it during testing.

Nevertheless, use of this feature is left to the discretion of the operator or responsible engineer. For further information, please refer to section 10.12.

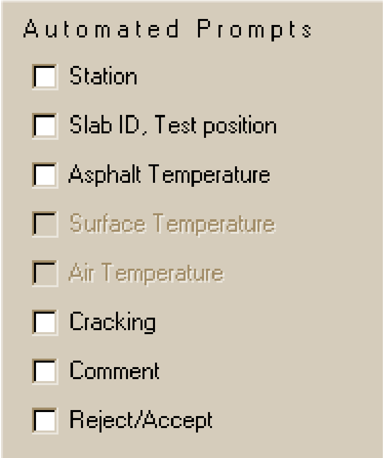
Preserve Temperatures

Some agencies manually measure asphalt temperatures at time of test in addition to or in-lieu of the surface temperature measurements. These measurements are labour intensive, so they cannot be done at each test point. If this box is checked, FwdWin will record the last entered asphalt temperature at each successive test point until a new temperature measurement is recorded and entered into FwdWin.

Loading Plate

The FWD/HWD is provided with two sizes of load plates – a 300 mm (5.9 in.) and a 450 mm (11.8 in.) diameter plate. You must indicate which plate is presently installed on the FWD/HWD. If the plate is segmented (split) the **Segmented** box should be checked as well. A quick visual inspection of the load plate will reveal its size and whether it is segmented. A segmented plate consists of two semicircular pieces.

Automated Prompts



Automated prompts provide an interactive way for the operator to enter or verify certain information at each test point prior to storage in the data file. Automated prompts should be used sparingly as they contribute heavily to operator fatigue and slow production.

Station

This item is mostly used when the FWD/HWD is equipped with a third-party odometer that is not physically connected to the system. The operator would then read the distance from the dash and enter it into the dialog box that appears at each test point.

Slab ID, Test Position

This prompt is only used on jointed Portland Cement Concrete pavements. It is common practice to assign numbers to slabs so that they can be positively identified during the data analysis phase of the project, which almost always occurs in the office away from the test site. If this option is checked, FwdWin will prompt the operator to enter the slab number and position (corner, joint, midslab, etc.) of the load plate.

Asphalt Temperature

This option is activated on projects where the operator or technician is manually measuring (average) asphalt temperatures (e.g. at mid-depth of layer). This provides a way to record these manually measured temperatures in the data file.

Surface Temperature

Same as “Asphalt Temperature” except that the temperatures are measured at the surface as opposed to mid- or third- depths. This item is greyed (irrelevant) in the Test Setup screen when an automated surface temperature measurement system is installed.

Air Temperature

Same as “Asphalt Temperature”, except that the technician or operator is measuring and recording the air temperature. This item is greyed (irrelevant) in the Test Setup screen when an automated air temperature measurement system is installed.

Cracking

Pavement surface cracking can influence the measured deflections making it difficult to analyze the deflection data. If cracking is turned on, the operator can record the severity of cracks in the vicinity of the test point. This will aid the analyst in properly processing the deflection data.

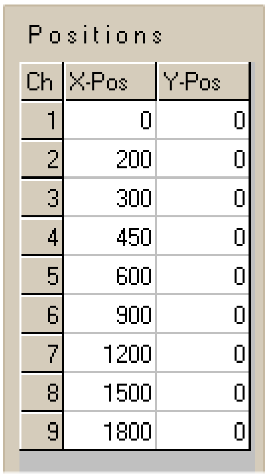
Comment

If this option is activated, the operator can enter a comment at each test point.

Reject/Accept

This option allows the operator to review, then reject or accept the measured deflections at each test point. This option is most commonly used on structures where irregular deflection basins are prevalent. This includes severely distressed pavements or structures with extensive underground utilities, pipes or culverts.

Positions


Positions

Ch	X-Pos	Y-Pos
1	0	0
2	200	0
3	300	0
4	450	0
5	600	0
6	900	0
7	1200	0
8	1500	0
9	1800	0

This area is used to record the positions of the deflectors. The number of deflectors shown is determined by the number of active sensors as indicated in **Setup - Processor - Deflector Circuits**.

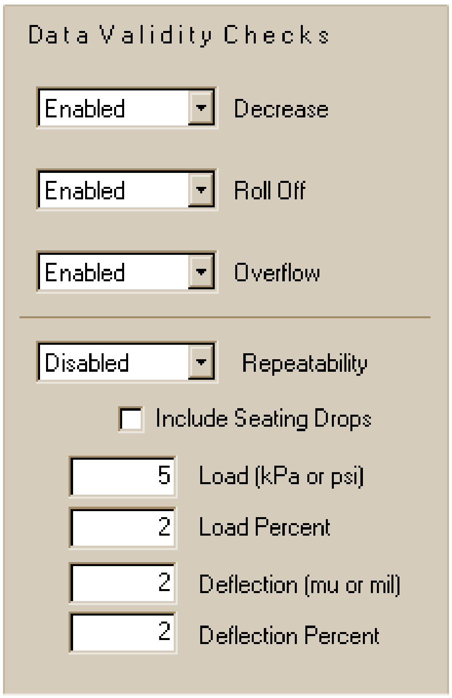
Note that the deflectors are referenced by channel number. To view a list of deflectors and assigned channels, select **Setup** then **Deflectors** from the main menu.

Each channel is assigned an X position and a Y position. The values displayed are a function of the display units selected, in this case millimetres. Both the X and Y positions represent the distance from the deflector to the centre of the load plate.

A positive X value indicates that the deflector is “in front” of the load plate. The X axis is assumed to be parallel with the travelled lane.

The Y axis is assumed to be oriented perpendicular to the travelled lane. The meaning of a positive Y value may differ depending on location. The local agency should establish the convention. (If no convention, we suggest positive towards the roadway centreline).

Data Validity Checks



Data validity checks is a quality assurance feature which alerts the operator to irregularities in the deflection data immediately during the testing cycle. There are three simple types of validity checks, Decrease, Roll off, and Overflow and the more complex Repeatability.

Each type of test can be:

Disabled: The test is not performed

Enabled: If the test fails, then the test cycle will stop and prompt the operator to decide whether to keep the data or throw it away and repeat the test.

Relaxed: If the test fails, then the results in the data grid will be flagged somehow but the test cycle continues.

Smart: If the test fails, then the program will automatically repeat the last drop to obtain data that pass the test.

Decrease

It is commonly accepted in pavement engineering that the measured pavement deflections should decrease as the distance from the centre of the load and point of measurement increases. In other words, the farther a deflector is positioned from the centre of a load, the smaller deflection it should measure. This is true in theory, but sometimes not in practice.

Pavement cracks, joints, and other irregularities (such as defective deflectors) result in "non-decreasing deflections" whereby some outermost sensor records a higher deflection than its neighbour who might be closer to the load impact point. This results in data that is extremely difficult or impossible to analyse.

Roll Off

At the end of the sampling interval (60 msec), the program expects the deflection time history to return to less than 90% of the peak value. Roll-off errors may occur when a deflector is lowered onto a piece of gravel or some other unstable surface, then falls off when the weights drop. A roll-off error can also occur if the pavement is experiencing excessive vibrations due to heavy traffic in an adjoining lane. Finally, a roll-off error may be caused by a defective deflector.

Overflow

Most deflectors delivered with Dynatest FWD/HWDs are capable of measuring deflections of up to 2000 microns (80 mils). Deflectors delivered with some systems are rated at 2450 microns (100 mils). If the range is exceeded, the deflectors may exceed their stated accuracy and the quality of the data may be in question. Overflows can occur on soft pavements, near joints and corners on Portland Cement Concrete, or may be caused by defective deflectors.

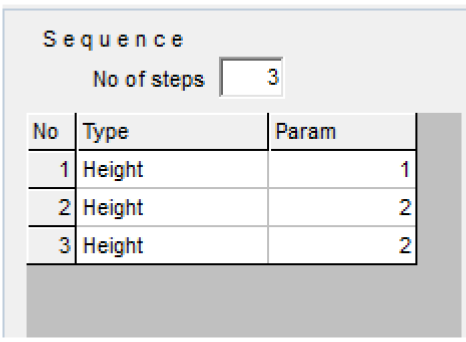
Repeatability

Some agencies (most notably the FHWA LTPP group in the USA) utilize a repeatability check as an additional quality assurance measure. Repeatability specifications require that a series of consecutive similar drops give similar results. These specifications are intended to alert the operator in the event that the testing is in some way affecting the physical properties of the pavement structure, or that the surface of the pavement is unstable. They also alert the operator to variations in loads or deflections caused by defective equipment.

The program allows the operator to specify the allowable variation in load and/or deflection, both in terms of the actual measurement units as well as in percent. Seating drops can also be included in the repeatability check. Note that the test only applies to a series of drops that are conducted from the same drop height (or the same target value).

Sequence

Prior to testing, the operator must define the sequence. A sequence is a series of programmed tasks to be performed by the FWD/HWD at each test point. The sequence box allows the operator to specify the number of steps, step types, and step parameters utilized at each test point. It also allows the operator to enable on-screen plotting (D) and storage of time history data (F) for each applicable step.



A step can be any one of the following types:

1. No Op — No Operation (fill)
2. Pause — Waits for user action
3. Seating — A drop from a specified height, data will not be stored to disk
4. Height — A drop from a specified height
5. Loading — The drop height is adjusted to achieve a specified target load
6. Deflection — The drop height is adjusted to achieve a specified centre deflection
7. Resettle — The plate is lifted of the ground and then lowered again
8. Weight Up — The weight is raised to a specified height (but not dropped)
9. Catch Dn — The catch is lowered (returning the weight to the hit plate)
10. Terminate — Leaves the plate on the ground

3, 4, 5, 6 and 8 require a “Step Parameter”. A step parameter is a ‘modifier’ associated with the step type. For example, “Seating” and “Height” requires that the desired height (1,2,3 or 4) is chosen (see Section 5.2-"Drop Heights Adjustment”).

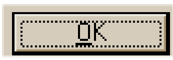
To define a sequence, the operator first enters the number of desired steps in the **No of steps** box. The number of rows in the table expands or shrinks to accommodate the specified number of steps. The leftmost column shows the step numbers.

Next, for each step, the operator must select the action to be performed. In the example above, the operator has specified that three drops from a specified height will be performed at each test point.

The operator then assigns a step parameter for each step type. In the example above, the parameters are 1, 2 and 2. This will perform one drop at drop height 1 and two at drop height 2 at each test point.

The fourth and fifth columns act as toggle (on/off) switches. If a round symbol appears in the **D** column for a given step, the time history data (O-Scope) will be plotted to the screen during the test cycle. Similarly, if a round symbol appears in the **F** column the load/deflection time history for that step will be written to the data base file.

OK



Once all of the items in the “Test Setup” screen have been modified as needed, the operator can then click the OK button to save the data and return to the data collection screen.

Apply

The Apply button serves the same function as the OK button except that the “Test Setup” window remains open. Note that the button shown here is “greyed out” indicating that the button is disabled. This button is disabled by default and is only enabled when a change is made anywhere in the “Test Setup” screen.

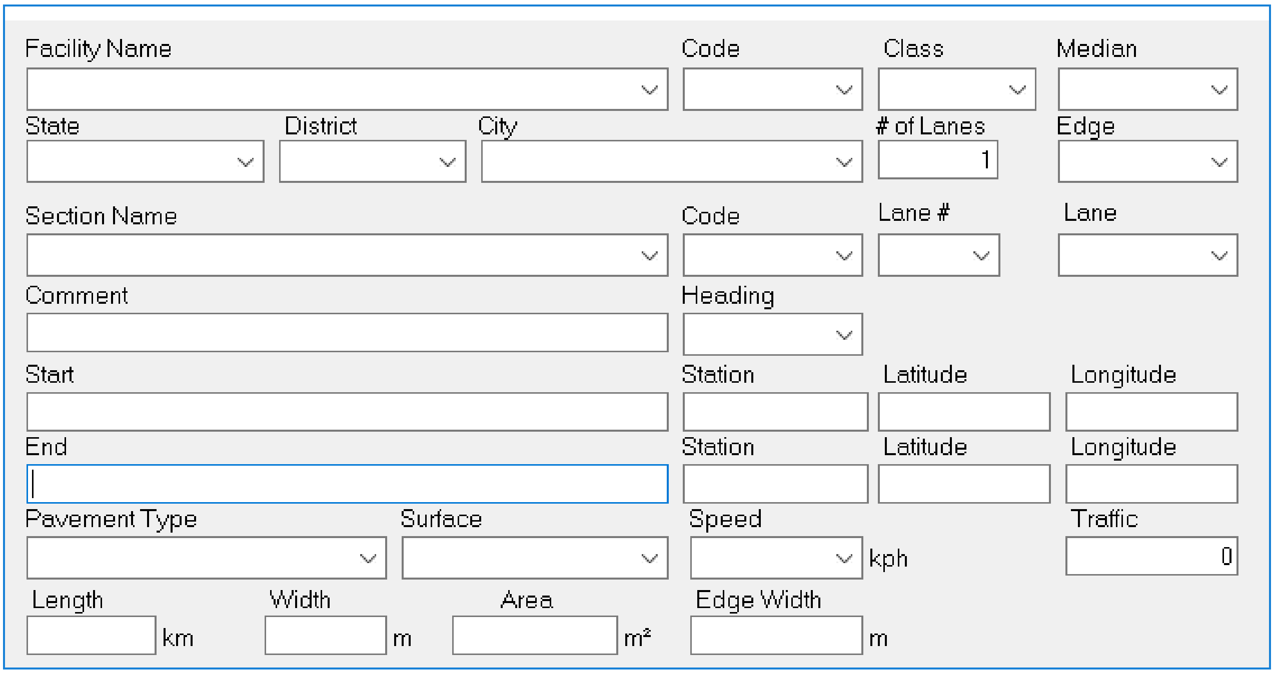
Cancel

The “Cancel” button discards any changes made in the “Test Setup” and returns the user to the data collection screen.

10.2 Test Section

Before initiating a data collection, you also need to specify the test Section information.

The Network applet provides a wealth of opportunities to incorporate section information in your data files. In addition, many attributes, such as your start location, end location, pavement type, lane, and other useful bits of information can be included as seen below:



All fields default to plain text entry mode, however there are a few features that make it easier for the operator to incorporate location and other information in the datafile.

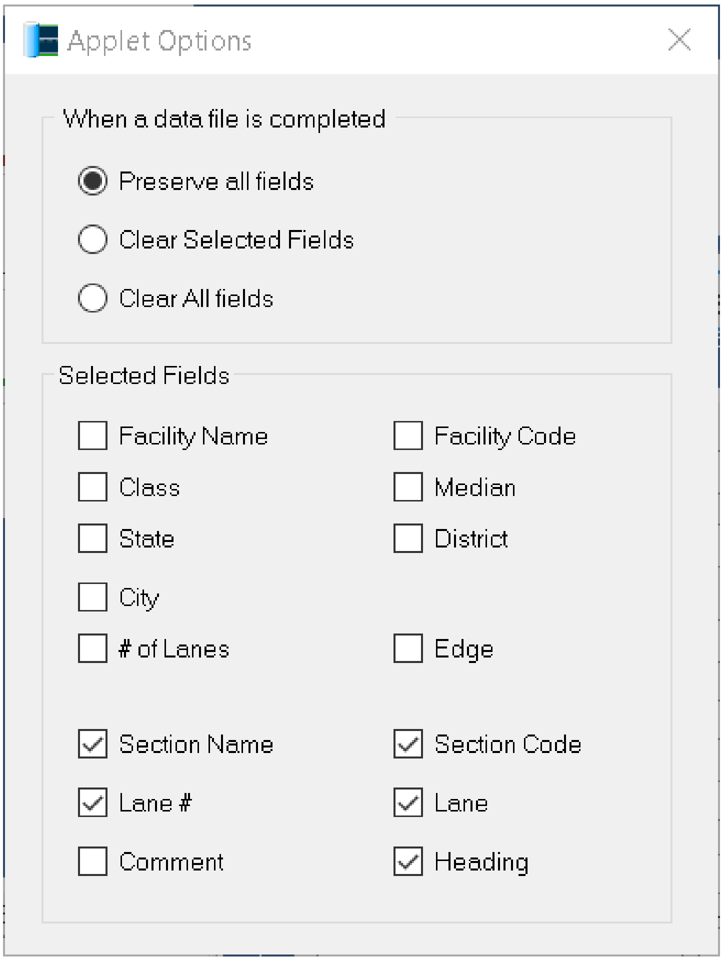
All fields with a drop-down arrow provide access to previously used information.

Districts
Most highway agencies subdivide their networks into Districts for more efficient management.

Facilities
Various attributes of the facility under test can be entered by the operator. A “Facility” can be anything from roadways, runways, streets to parking lots or even railways. Often a facility is identified by both its common name and a roadway code.

Section
A single facility is often composed of sections of varying construction. This “Sectioning” can be both longitudinal and transverse. The latter is appropriate for multilane roadways where traffic load varies across the construction.

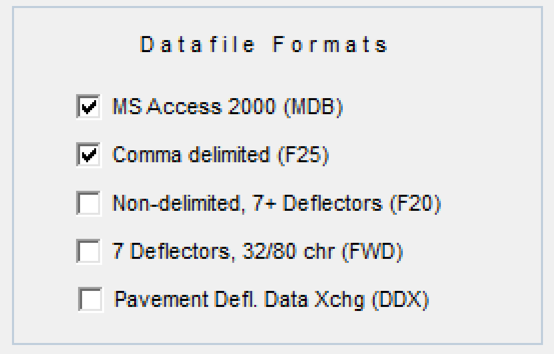
When a data file is closed you have the following options to act upon the fields in the Network window:


Applet Options
When a data file is completed
Preserve all fields
Clear Selected Fields
Clear All fields
Selected Fields
Facility Name
Facility Code
Class
Median
State
District
City
# of Lanes
Edge
Section Name
Section Code
Lane #
Lane
Comment
Heading

10.3 Data Files

Once the operator has configured the test setup and made the necessary changes or additions to the network information, it is time to test. It will now be necessary to create a file for storage of the deflection data. Prior to opening a file, a few words about file formats are necessary.

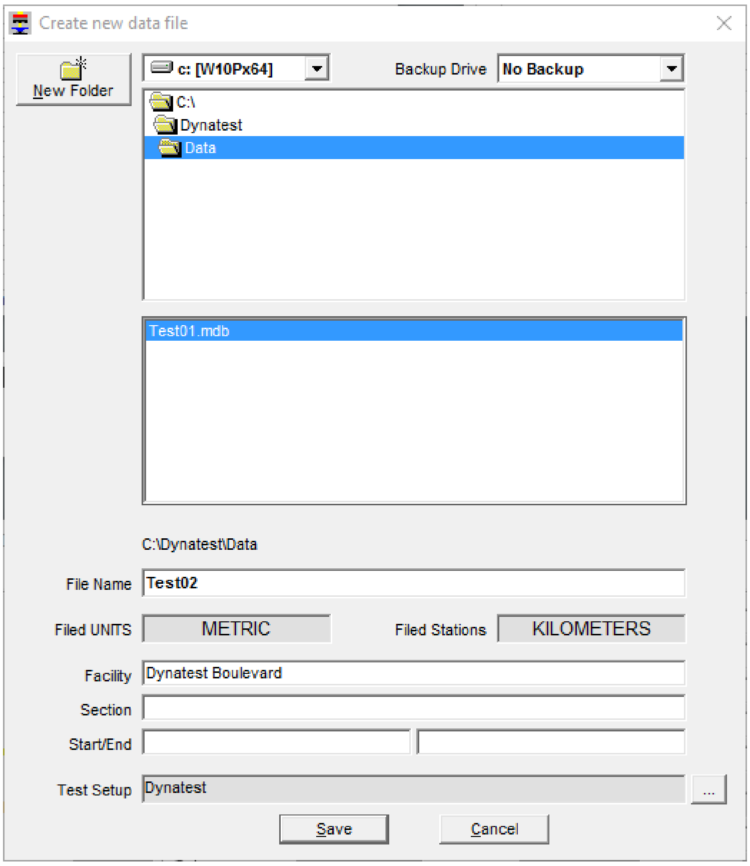
Specifying File Formats



From the main menu, select **Setup** then **Options**, which reveals that FwdWin can store data in several formats. The native format is Microsoft Access 2000®, which is the most versatile and HIGHLY recommended. The remaining formats are all text based. The first three (F25, F20, FWD) are earlier Dynatest ASCII formats. 'Pavement Deflection Data Exchange' (DDX) was developed by AASHTO in 1998.

For further information see *4.3*.

Creating a Data File



A data file is created by clicking the **File** menu item from the data collection screen, then choosing **New**. The resulting dialog box allows the operator to navigate to an existing subdirectory for file storage. It also allows the operator to create a **New Folder**. To create a new file, the operator merely needs to type the data file name in the **File Name** field, or click an existing file to serialize filenames pertaining to the same facility.

This window also informs the user which system of units will be employed for storage of data. The user is also given a last chance to sort out the facility information and choose a suitable test setup. A button is provided for convenient navigation to the Test Setup window.

Once the information on the screen has been entered, the operator should click the **Save** button. The program will now prepare the disk file and then return to the data collection screen.

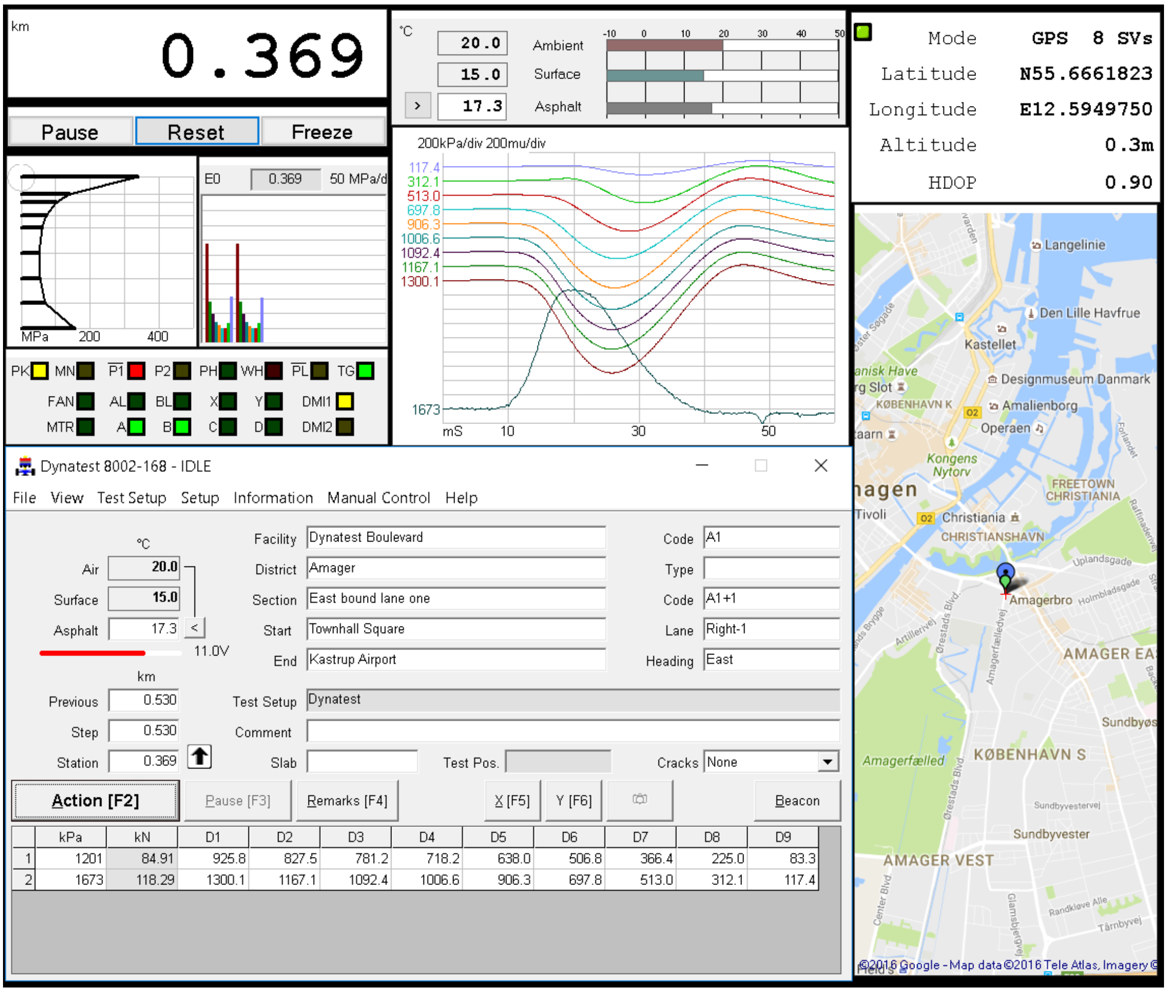
We are now ready to test!

10.4 Running a Test

Prior to running a test, it is assumed that the following functions have been performed (in addition to driving to the site and positioning on the first test point):

- The program has been configured for the appropriate FWD/HWD unit
- A proper test setup has been created (or loaded).
- The location information has been entered.
- A file has been created.

The data collection screen serves as the primary control interface.



The testing process is fairly simple. When the vehicle is located in the appropriate test position, the operator merely clicks the **Action** button to start the test sequence. When the sequence completes, the computer will issue one of a variety of sounds indicating that the plate has been raised to the transport position and it is OK to move to the next test point.

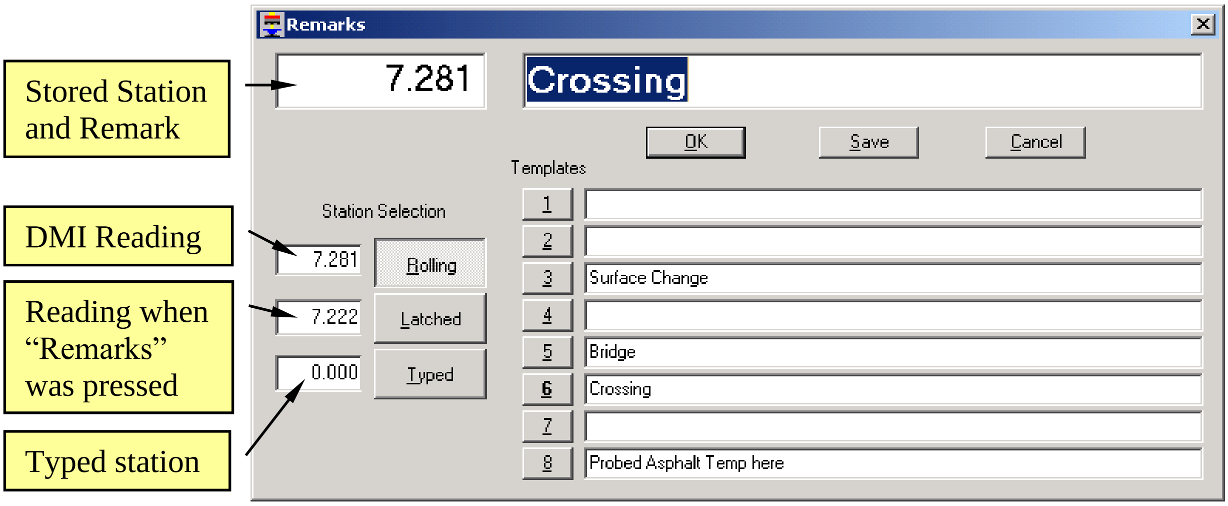
If an error or other problem occurs during the test sequence, a pop-up window will appear indicating the nature of the problem or error. If so equipped, the computer may also issue an audible version of the error message.

During the test sequence, there is generally nothing for the operator to do until it is complete. This is a good time to scan the surroundings to make sure persons stay clear of the equipment and that traffic is not posing a hazard.

After each drop, the load and deflection data are written to the data collection window. This provides a convenient method for monitoring the progress of each test sequence.

10.5 Remarks

It is sometimes desirable to enter additional Remarks after testing or while moving on to the next test station. Pressing the “Remarks” button (or F4 or Alt+R) opens the following window:



Rolling Use this mode if you want the rolling DMI reading to be stored with your remarks. In this example the **Remarks** button was pressed at 7.222 (ahead of the Crossing), then **6** and then **OK** (or **Save**) was pressed at 7.281 while passing the Crossing.

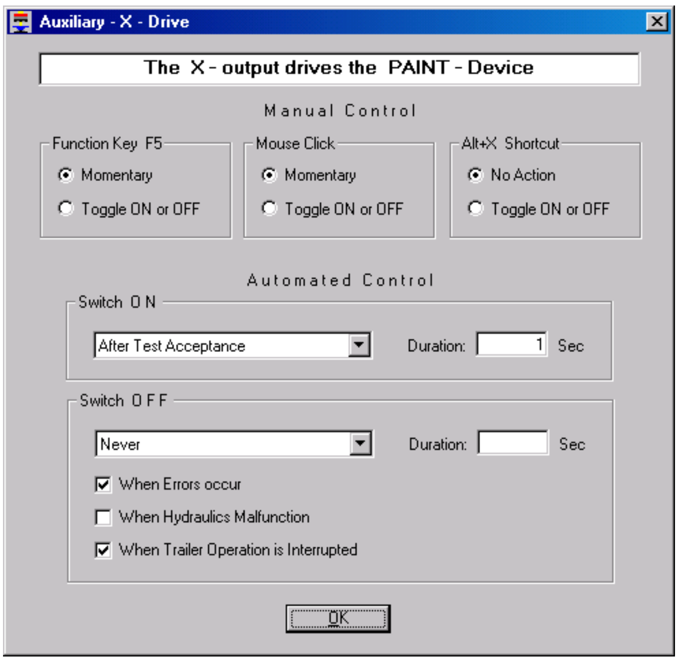
Latched Use this mode if you prefer to use the DMI reading at the moment you press the **Remarks** button (while passing the spot of interest).

Typed Use this mode if you want to enter the station manually.

The eight templates can be used to prepare often used remarks.

10.6 Auxiliary Outputs X and Y

Function Keys F5 and F6 are dedicated to control two auxiliary outputs (MOS Switches) at the Compact 15 front panel. Right click either button to access the options:

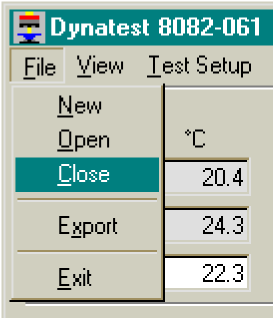


In this case output X controls a paint spray device. F5 (or the mouse) will switch ON the output momentarily, only.

In addition to manual control, the output is activated for one second “After Test Acceptance”.

Further, the output is switched OFF if errors occur or if the user interrupts the System operation.

10.7 *Closing the Data File*



The operator can close the data file by selecting **Close** from the **File** menu item. The Microsoft Access (MDB) file closes and optional ASCII files as selected in **Setup** – **Options** are subsequently written (se also *10.9 Exporting Data*).

Closing the program (**Exit**) will automatically close the data file properly before shutting down.

10.8 *Opening a Data File*

You can use **File** – **Open** to re-open an MDB file in order to store another data collection session. Note that you cannot re-open an ASCII file, i.e. the program cannot append data to such files. Instead, additional sessions generate additional ASCII files with sequenced file names (se also *10.9 Exporting Data*).

10.9 *Exporting Data*

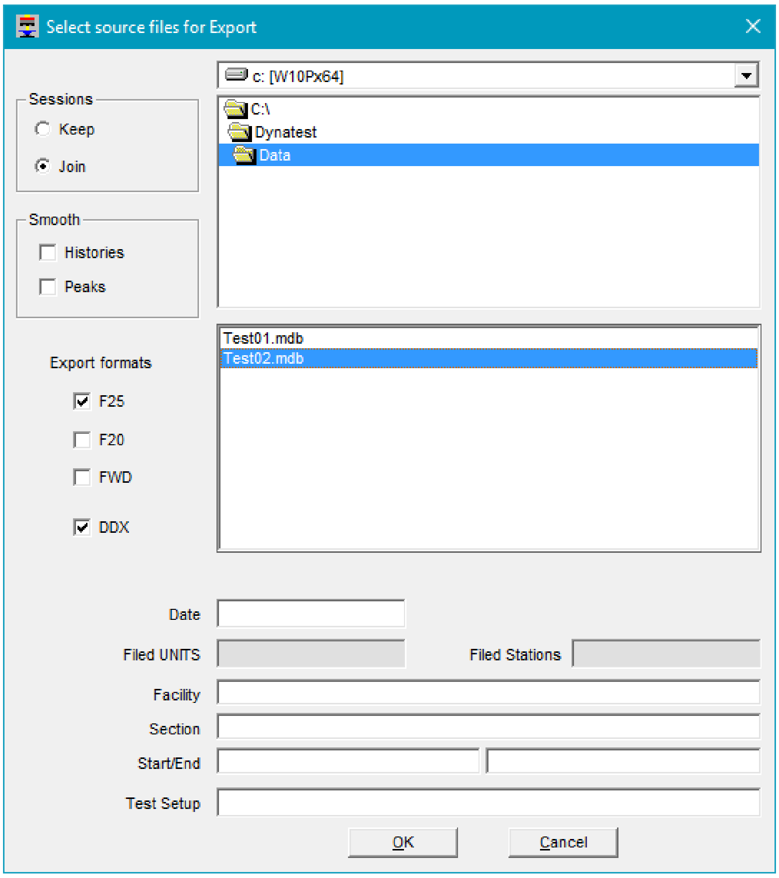
Use the **File** - **Export** facility to generate ASCII files based on MDB files at a later time (in the office). This option means that you can safely un-check all ASCII options in **Setup** – **Options**.

Sessions – Keep generates multiple files from multiple sessions.
Sessions – Join merges multiple sessions (from re-opened files)

Smooth - This option enables post-smoothing of stored histories. The resulting files contain smoothed peak results. Check “Histories” to generate CSV files with smoothed histories.

The selection of formats here is independent of the chosen “real-time” **Setup** - **Options**.

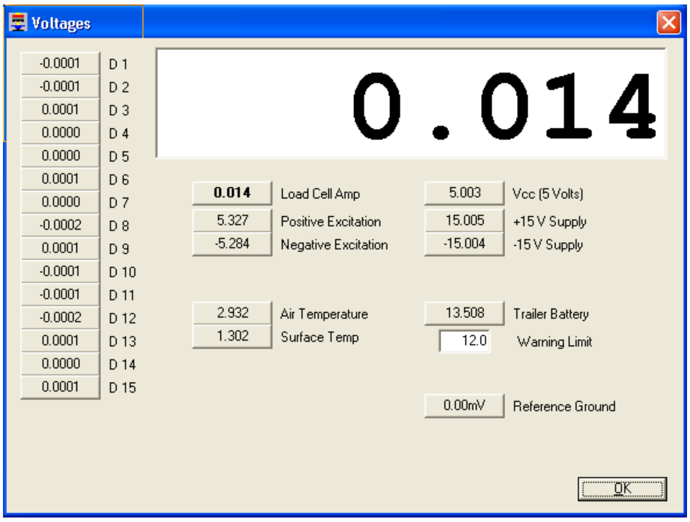
Note that you may select multiple source files from the same folder.



10.10 *Monitoring the System's Status*

The program provides an interface that can be used to monitor the status of the FWD/HWD systems including voltages, deflector drifts, and statistics regarding the number of tests performed. These screens are accessed from the **Information** menu item in the data collection screen. Three menu items are available in the list box: **Voltages**, **Drift/Vibration**, and **Statistics**.

Voltages



The voltage screen is shown at right. The list of voltages appearing along the left side of this window corresponds to the various deflectors. If a deflector is stationary, the voltage should be very close to zero. If the voltage is varying with time, it either means the deflector is experiencing vibration from some source or is defective.

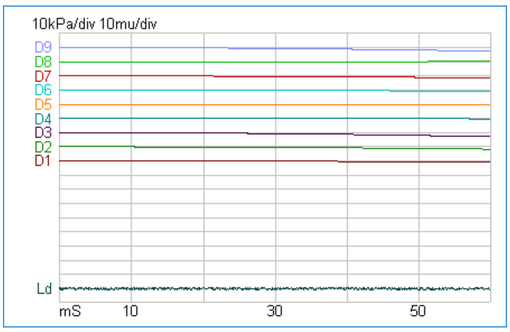
Clicking on a button on this screen causes the reading to be displayed on the large readout at the top of the screen as well as on the face of the button. This aids in troubleshooting as the reading can be seen from some distance.

Where applicable the tool tip shows the typical voltage range for the component.

The "Warning Limit" sets the Trailer Battery threshold for warning the operator of low voltage condition.

Pressing the **OK** button closes this screen and returns to the data collection window.

Drift/Vibration



Selecting this menu item will bring up a continuously updating time-history plot of the load cell and deflector outputs. This screen is used mainly for troubleshooting suspected problems. Time in milliseconds is plotted along the X-axis while load and deflections are plotted for each device on the Y-axis. Load reading is plotted with positive in the "up" direction, while deflections are plotted as positive downward.

Prior to activating the drift screen, the operator should lower the plate and deflectors to the pavement surface. The pavement should be free of vibrations (due to traffic or other sources).

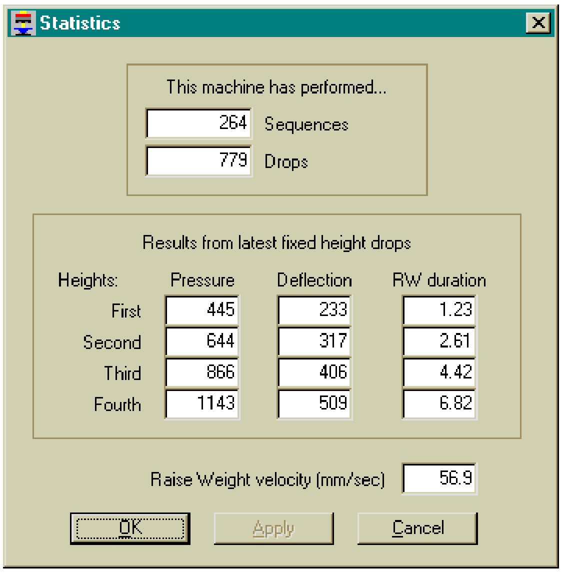
The base line for each transducer is adjacent to the respective label Ld, D1 … D9.

The Y axis scale for load and deflection is shown at the top of the plot. In this case, each horizontal line represents and increases of 10 kPa of pressure for the load cell. Each horizontal line represents 10 microns of deflection for the deflectors.

If the FWD/HWD is working properly, the lines should be fairly flat and coincident with the each components base line. If one or more lines are tracking away from their origins, this is indicative of a problem with the system.

Statistics

FwdWin can track certain statistics such as the number of test sequences and drops completed by a given machine. These statistics are stored in a database and are serial-number specific. In other words, if you use the same computer to run two or more FWD/HWDs, the program will keep separate statistics for each. Note that the operator can overwrite the numbers shown in the **Sequences** and **Drops** fields. Pressing **OK** saves the changes and closes the window. Pressing **Apply** saves the changes but leaves the window open. The Apply button is "greyed-out" (disabled) until some change is made in one of the fields. The **Cancel** button discards any changes and closes the window.



The program also monitors and records the plate pressure, pavement centre deflection, and length of time required to raise the weights to a specific height. This information pertains only to the last drop completed at each fixed drop height. The program also calculates the velocity with which the weight is raised. Velocity information is required since the height stops may be occasionally moved thus changing the time required to lift the weights to a certain height.

This information is useful for troubleshooting such problems as e.g.:

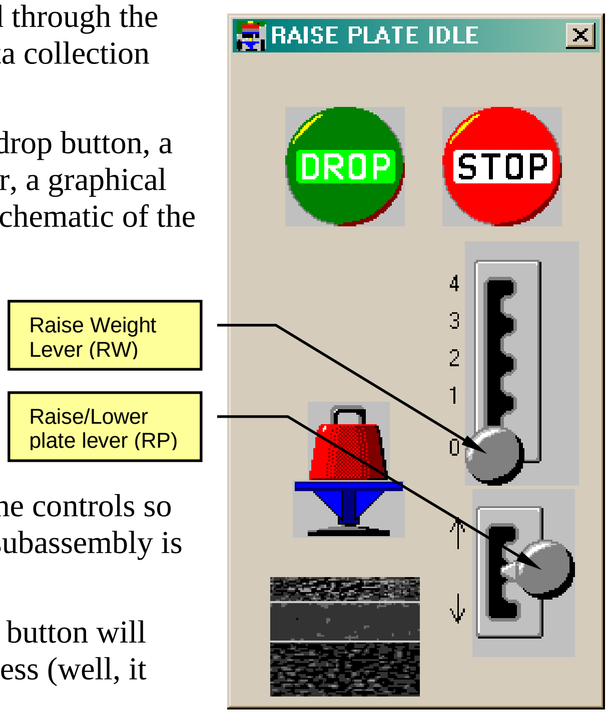
- Inadequate charging systems - as loading unit batteries discharge, weights are lifted progressively slower.
- Effects of cold weather on loading unit hydraulics – thickening of the fluid due to cold temperatures will slow the system down.
- Air accumulation in loading unit hydraulics – air in the hydraulic fluid will slow the system down.

It is a good idea for the operator to record typical values for "RW Duration" and "Raise Weight Velocity" when the system is new or known to be in good operating condition. This will provide a baseline for later comparisons.

10.11 Manual Control

Occasions will arise when it will be convenient or necessary for the operator to take manual control of the loading unit systems. For example, if a testing sequence terminates abnormally and it is necessary for the operator to raise the plate prior to vehicle movement, he/she can do so from within the program. This eliminates the need to exit the vehicle to operate the manual buttons at the Compact15 front panel.

Manual control of the FWD/HWD is accomplished through the **Manual Control** menu item near the top of the data collection screen.



The manual control screen consists of 6 objects: a drop button, a stop button, a raise weight lever, a lower plate lever, a graphical schematic of the FWD/HWD subassembly, and a schematic of the pavement structure.

The RP lever lifts the plate when it is moved upwards and lowers the plate when moved to the downward position. The RW lever is indexed so that the operator can lift the weight to a specific height.

The subassembly diagram will respond visibly to the controls so that the operator knows what position the loading subassembly is in.

The drop button causes the weight to fall. The stop button will cause an immediate abort to any operation in progress (well, it won't stop the weight from falling).

Errors are issued if conflicting commands are given, for example, if the operator tries to lift the weights while the plate is lifted off the pavement surface.

10.12 Exit

The operator can close the program by selecting **Exit** from the **File** menu item. Windows can now be shut down in the usual way.

IMPORTANT!!

Before driving away from the test site, the operator should:

1. Secure the loading unit. Transport locks and locking pins must be in position (see section 8.4, "**Just Before Leaving...**")
2. Switch OFF the Compact15 System Controller.

Switch off the computer.

10.13 Smoothing Option

The “Smoothed Peaks Option” (usually just called “Smoothing”) is a special feature in the Dynatest FWD/HWD Field Programs, which has been introduced mainly for the following reasons:

* To obtain load and deflection signal (peak) readings that will represent their respective signal time histories more accurately than the peak readings of the direct (un-smoothed) time histories
* To obtain more precise load/deflection reading ratios for all load levels and all types of pavements
* To improve HWD-to-FWD correlation, in particular at HWD low end load levels

Smoothing is basically a digital signal processing, more specifically a frequency domain low-pass filtering, that in the time domain will “even out” any “high frequency distortion” of the “direct” load and deflection signal time histories, restoring the essentially half-sine shaped basic signal histories from which more relevant “Smoothed Peak” readings are derived. Below is described in more detail why and how this is done, so it is strongly recommended to read all of this (including supplementary Notes, placed at the end of the main text and referred to in parenthesis where relevant) before it is decided whether to use this option (Note 1).

The FWD/HWD drop weights and rubber buffers have been designed to produce essentially half-sine shaped load pulses of approx. 25 msec. duration, for all drop weight masses and drop heights, for the FWD as well as for the HWD. This is achieved by making sure that whenever the drop weight (mass) is adjusted, the number of rubber buffers (i.e. the spring constant) is adjusted accordingly, so that the natural frequency of the harmonic oscillator (drop weight + rubber buffers) will remain almost constant at all times.

However, several factors will create some distortion of the shape and duration of the theoretical half-sine load pulse, such as non-linearity, damping and temperature dependency of the rubber buffers, mass of load transfer bracket plus elastic properties of load distribution pad and pavement, etc. This makes the load pulse shape slightly dependent on drop height, drop weight mass, type of equipment (FWD or HWD), type of pavement, etc.

If a pavement could be modeled by a system of “ideal springs”, i.e., linear springs with no mass or damping, then the above-mentioned irregularities in the load pulse shape would **not** matter **at all** as the corresponding pavement **deflection** pulse would then have **exactly** the same shape as the applied **load** pulse. In such case it would not matter whether the direct or the Smoothed Peak readings were used since the (peak) load / (peak) deflection **ratio** (which is directly related to E-modulus and therefore the important parameter) would be the **same** in both cases (see Figure 1).

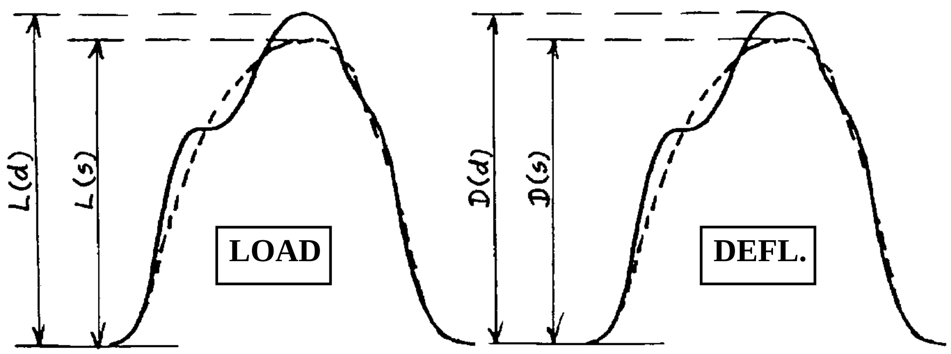


Figure 1 **Response of “ideal” pavement** (acting as a spring w/o mass & damping)
L(s)/D(s) = L(d)/D(d)

However, any pavement will obviously have **some** mass and damping, which may vary significantly (in particular the damping) from pavement to pavement. This means that **any** pavement will act like a (mechanical) "filter" that will have a reduced deflection response to "high frequency" components of the load pulse, for frequencies above some "cut-off" frequency which will vary from pavement to pavement, and which may also depend on type and/or moisture content of the unbound layers and on temperature.

The **problem** is therefore that **if** the FWD/HWD load pulse contains frequency components **above** this "cut-off frequency" of the pavement, then the **peak** readings of the **direct** load and deflection signals will usually give slightly wrong load/deflection **ratios,** as the pavement will "attenuate" the high frequency components of the load pulse, so that the **deflection** signals will include only **partial** responses to these high frequency components (see Figure 2).

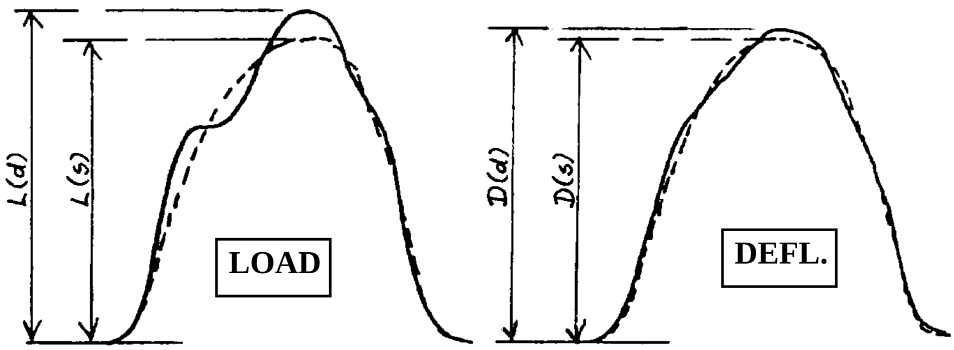


Figure 2 **Response of "typical" pavement** (with **some** "high frequency" damping)
Example: L(d)/L(s) = 1.05, D(d)/D(s) = 1.02, or
L(d)/D(d) = 1.03 (L(s)/D(s))
(i.e., the direct peak values render a 3% too high L/D ratio)

A "clean" (i.e., un-distorted) half-sine pulse of 25msec. duration contains frequency components mainly below 60Hz, but has some small contents of higher frequencies (Note 2). A distorted pulse may have a significant amount of components above 60Hz, and many pavements may very well have a cut-off frequency as **low** as 60Hz. Therefore, this frequency has been selected as the cut-off frequency for the Smoothing filter, as this frequency is the lowest that can be used without affecting the **basic** half-sine component of the load and deflection signals significantly (For a **true** half-sine pulse, the Smoothed Peak is less that 1% smaller than the direct peak).

So, by introducing Smoothing to the direct load signal **as well as** to the direct deflection signals, the thereby obtained Smoothed Peak readings will result in more precise load/deflection **ratios,** and each individual, smoothed peak reading will also be a better "representative" of the direct signal history from which it was derived (Note 3).

In general, the effect of Smoothing is **least** significant (in the order of a couple percent on the load/defl. ratios) for the **maximum** (FWD or HWD) drop weight mass, and **most** significant for the **minimum** weight mass. This means that as long as an FWD or HWD is used in the upper end of its load range, the importance of using the Smoothed Peaks option will be minor, but when e.g., the HWD (which has mainly been designed for heavy (airport) pavement evaluation) is used for evaluation of roads at a load level of e.g., "only" 50 kN (11 kips - which is only approx. 20% of the HWD load capacity) then the Smoothing will render a more significant improvement which is also confirmed by a closer correlation between HWD and FWD results (at same load level), when the Smoothed Peaks Option is used throughout.

In by far the most cases, the corrected E-moduli derived from Smoothed Peaks will be a few percent **smaller** than moduli from direct peak values, resulting in a slightly more conservative overlay design (i.e., a slight increase in overlay thickness).

Let it be repeated and emphasized that the “problem” is **not** that some pavements perhaps **may** respond to (load) frequencies above 60Hz (in which case the load/deflection ratios would **also** be correct when using the Smoothed Peaks - please refer to the “ideal spring” analogy discussed earlier. **On the contrary,** the problem is that any pavement will give a **very limited** (deflection) response to (load) components with frequencies above some limit (which can very well be as **low** as 60Hz), in which case distorting oscillations in this “high” frequency range influences the **direct** load and deflection peaks **differently,** causing an error in the (direct) load/deflection **ratios** - an error that can be virtually eliminated by using the Smoothed Peaks Option.

Please observe that the Smoothed Peaks Option must be turned **off** when performing dynamic **reference** calibration (please refer to Note 4).

Dynatest believes that this option is beneficial to FWD/HWD users, but it is also our policy to make our customers able to make their own choices whenever desirable and possible (Note 5), and this paragraph is meant for giving the reader sufficient understanding of the mode of operation of the Smoothed Peaks Option to decide whether to use it.

Smoothing - NOTE 1

A general problem with FWD/HWD data interpretation is that each load and/or deflection measurement actually provides hundreds of discrete samples over time, of which only **one** (normally the maximum (peak) reading sample) is picked as **the** load or **the** deflection **reading.** This of course means that it is **very** important that this **one** reading is a good representative for the **entire** set of samples.

This is exactly the main purpose of Smoothing - to provide a method that ensures that the **one** reading we use to “represent” each signal history in further calculations (of E-moduli, etc.), is as “relevant” as possible.

This does not mean, of course, that it should not be possible to develop other and perhaps better means of utilizing the many available samples of each signal history, but until this may be done, the Smoothed Peaks should be considered a better choice than the direct peaks.

It should be noted that particularly in case of long term, research-oriented projects it is recommended to always store at least one “Whole History” (of direct samples) for each test point (along with the direct **or** Smoothed Peak readings), as this will render a possibility of applying any improved processing procedures that might be developed at a later time. After-the-fact derivation of Smoothed Peaks (and/or histories) from stored, direct histories is also possible (in the FwdWin Main window, select **File**, then **Export**).

Smoothing - NOTE 2

In the frequency domain, a true 25 msec. half-sine pulse will be described by a frequency spectrum (Fourier Spectrum) as shown in Figure 3.

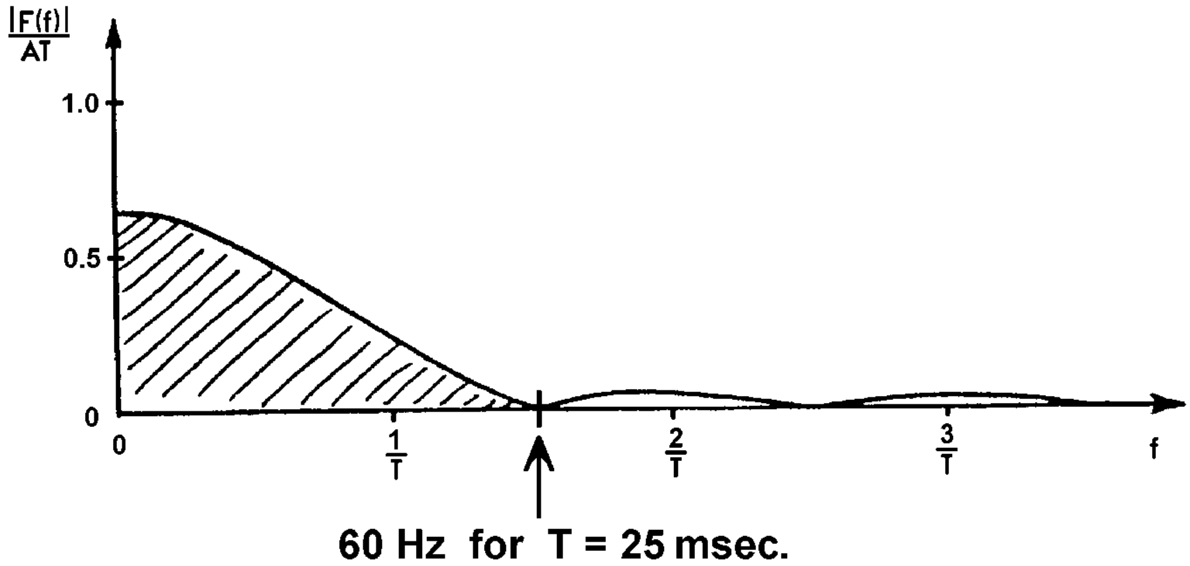


Figure 3 - Frequency spectrum of 25msec. half-sine pulse.

Please NOTE that even though such a half-sine pulse (in the time domain) forms part of a 20 Hz sinusoidal wave (starting at time “zero”) and therefore could make one believe that 20Hz would be the dominant frequency component of this pulse, Figure 3 clearly shows that this is definitely **not** the case. No **single** frequency is dominant, and 0 (zero) Hz is the component with the greatest amplitude!

Figure 3 also shows that a 25 msec half-sine pulse has its main frequency components between 0 and 60Hz, with some additional, minor components above 60Hz.

Smoothing - NOTE 3

The name “Smoothing” was chosen on purpose, because it refers directly to the time domain (i.e., to the signal **time** histories). “Filtering” refers to the frequency domain and **might** be perceived as something that will remove maybe valuable information from the signals. It is correct that high frequency components will be removed from the **frequency spectrum** by the smoothing filter, but in the **time domain** this has exactly the effect that is desired:

The smoothing filtering will actually smooth out (“even out”) distorting oscillations in such a manner that the **area** of the smoothed signal (pulse) is very closely the same as the area of the original, direct signal, meaning that the “energy” of the signal is virtually not affected by the smoothing. The **peak** reading of a **smoothed** pulse will of course normally be different (from the **peak** reading of the **direct** (unsmoothed) pulse) **and** will be a much better representative for the “energy” of the **direct** pulse, as the Smoothed Peak reading will virtually not be affected by the actual shape or frequency of the distorting oscillations, as long as the “energy” (i.e., the area) of the direct signal (pulse) is the same, whereas the direct peak will be significantly dependent on the nature of these oscillations. Please see example in Figure 4.

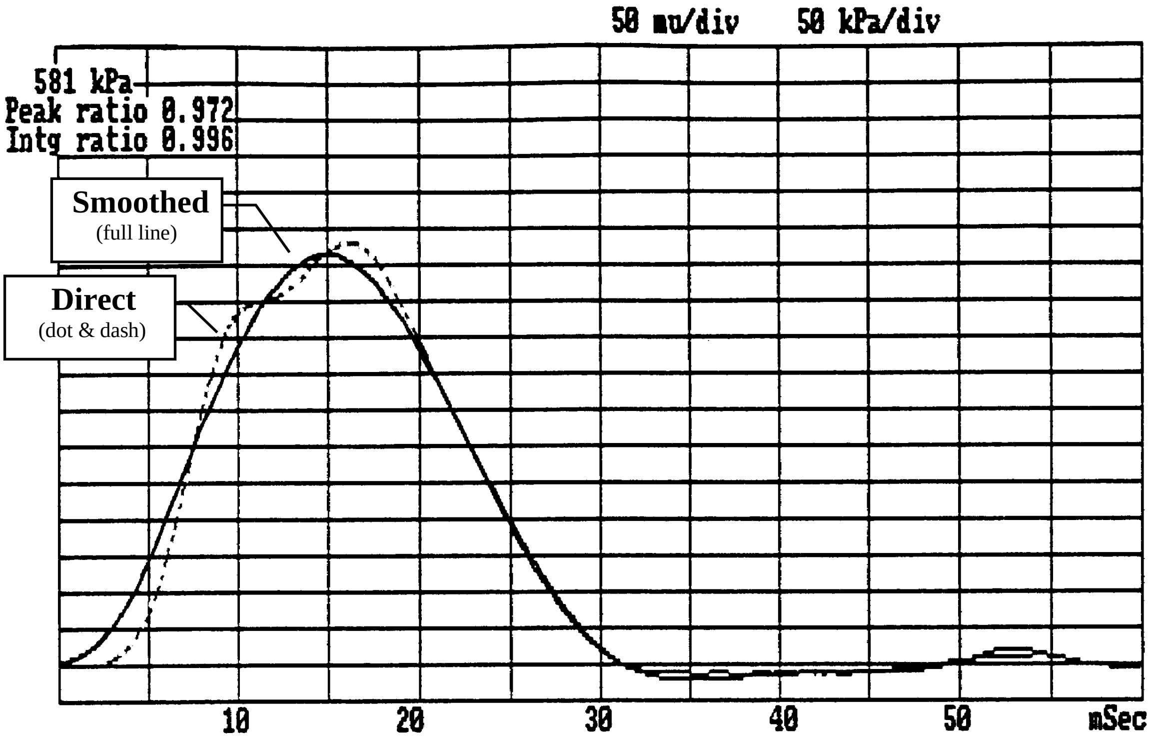


Figure 4 **Real load signal, direct and smoothed**
(time shifted to approx. same "phase").

Even though the smoothing has reduced the **peak value** with 2.8%, the **area** of the pulse is almost not affected (only **0.4%** reduction).

Thus, a Smoothed Peak reading of an FWD/HWD signal will obviously, in most cases, be slightly smaller than the direct peak reading. But in some cases, the Smoothed Peak will actually exceed the direct peak. This may be the case if distorting oscillation happens to have a minimum (i.e. a negative) value at the time of the "smoothed peak", so that the "distorted peak" will obviously be too small, and the smoothing will "restore" the greater Smoothed Peak reading.

The Smoothed Peak of a true 25 msec. half-sine pulse is almost 1% smaller than the direct peak. This is difficult to explain in the time domain, but in the frequency domain, Figure 3 shows that some components (above 60 Hz) will be removed. Firstly, this is done on purpose because some pavements have cut-off frequencies as low as 60 Hz. Secondly, it will have **no** effect on the load/deflection **ratios,** when Smoothed Peak readings are used for the **load signal as well as for the deflection signals.**

It should be mentioned that the smoothing causes a time delay from a direct signal history to the corresponding smoothed one. This has no influence on the parameters discussed in this Tech. Note and has therefore been disregarded throughout (including Figure 4 which has been corrected for time shift to improve signal shape comparison). Even if load-to-deflection time delays should be of interest, these (relative) times should be valid **also if** derived from the smoothed signal histories, since **all** signals will be delayed by the smoothing, and the delay is not amplitude dependent).

Smoothing - NOTE 4

It should be **noted** that the peak reading corrections obtained by the smoothing has **nothing** to do with possible **calibration** errors of load cell(s) and/or deflectors. It is assumed throughout this Tech. Note that **any** mentioned load and/or deflection signal is in perfect calibration, i.e., that any (direct) signal, distorted or not, is reproducing the load or deflection in question correctly.

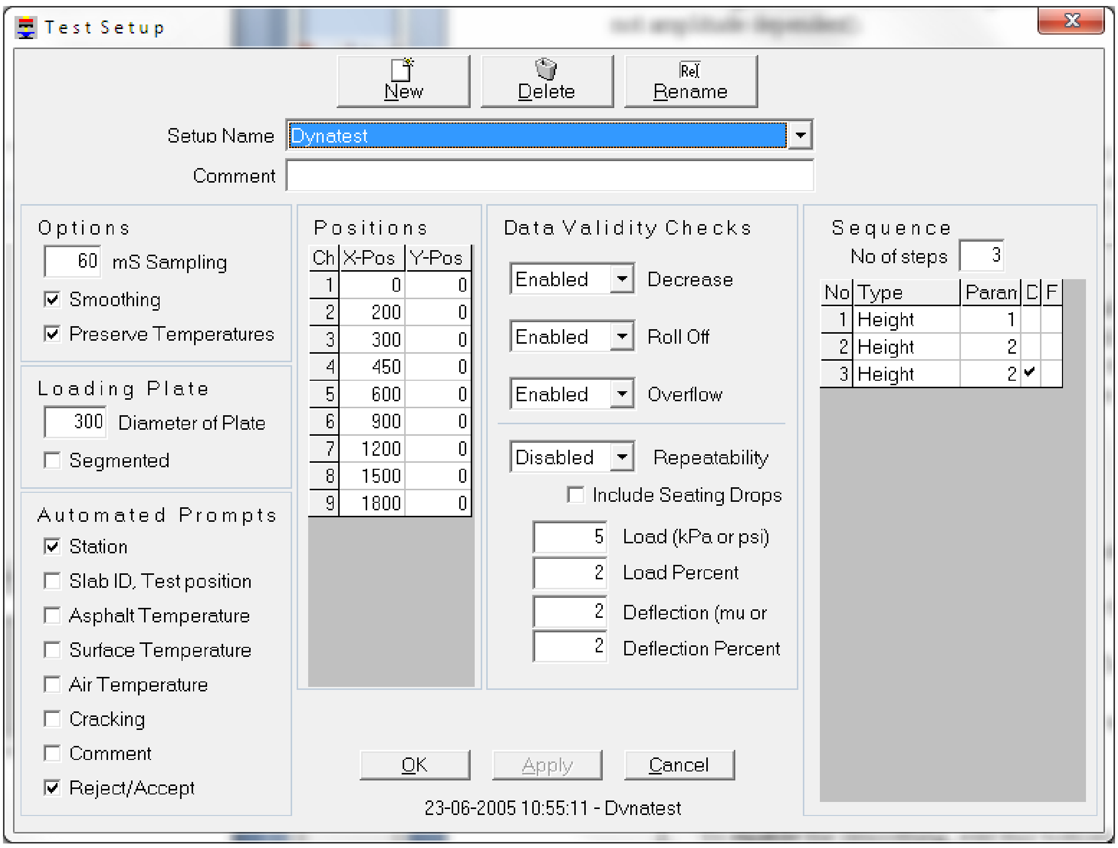
Obviously, if an FWD or HWD is going to be calibrated (dynamically) against a reference system, the Smoothed Peaks option should be **dis**abled during this process since the reference system will not apply a smoothing filtering. (It might actually be preferable to leave the smoothing on if the reference system could feature an **identical** Smoothed Peaks filtering).

Smoothing - NOTE 5

Selecting the Smoothed Peaks Option in the Dynatest FwdWin Field Program

In any **Test Setup**, where the Smoothing feature is desired, please tick the **Smoothing** box (located in the upper left part of the Test Setup window, please see the figure below).

The Smoothed Peaks option will then be in effect, so that all displayed, printed and stored **peak readings** will be derived from smoothed signal histories.
It is recommended to use the smoothing feature for all testing in the field, as this will give more accurate, back-calculated E-moduli data for a pavement!



Please **note** that if display of time history **plots** has been enabled, these will reproduce the **direct** signal histories. The same applies for stored time history data, if enabled (to make it possible to apply alternative post-processing to this data if so wished).
Please observe that if your FWD or HWD is going to be calibration verified (dynamically) against a reference system, then the Smoothing option should be **disabled** during this process, see also the previous Note 4.

11. The Dynatest FWD/HWD Hardware

11.1 General Description

The Dynatest 8002 FWD and 8082 HWD are trailer mounted Falling Weight Deflectometers of balanced and durable construction, having a low tongue load and a front supporting wheel. A low centre of gravity ensures stable towing at highway speeds.

The drop weight guide shaft will be perpendicular to the road surface, if the tongue (i.e. centre of towing ball) is kept in a height of 480-500 mm (19-20") from the ground surface. The loading plate is able to tilt up to 6 degrees (in any direction from a position perpendicular to the guide shaft), as it is ball joint swivel suspended.

The impact of the drop weight is capable of producing impact loads essentially half-sine waved in form, and having duration of between 25 and 30 msec. In addition, the drop weight / buffer subassembly is furnished such that four different configurations of drop weight mass can be used, all capable of producing the same 25 to 30 msec time of loading. Furthermore, the weight can be released from a variable height, such that the peak load ranges for the four specified masses are producible as follows:

Mass of Drop Weight		**8002 FWD Trailer** (Peak) Load Range (approx.)		
kg	(lbs)	kPa/300	kN	lbf
350	770	635 - 1700	45 - 120	10,000 - 27,000
250	550	425 - 1200	30 - 85	6,600 - 18,500
150	330	250 - 700	18 - 50	4,000 - 11,000
50	110	100 - 280	7 - 20	1,500 - 4,400

Mass of Drop Weight		**8082 HWD Trailer** (Peak) Load Range (approx.)		
Kg	(lbs)	kPa/300	kN	lbf
740	1650	1630 - 4530	115 - 320	26,000 - 72,000
540	1200	1200 - 3110	85 - 220	19,000 - 50,000
340	775	780 - 1980	55 – 140	12,300 - 31,000
240	535	425 - 1270	30 - 90	6,700 - 20,000

Two loading plate sizes may be used, either the basic, 300 mm (11.8") dia. plate or a 450 mm (17.7") dia. plate added below the basic plate. A rubber sheet is used to improve uniformity of loading stress distribution over the whole loading plate area.

The unit is operated by means of a 12VDC electro-hydraulic system, powered from the towing vehicle's 12V electrical system (or from an optional, trailer mounted gasoline engine driven Power Unit) via a heavy buffer battery setup (on the trailer).

Should the electro-hydraulic system fail to operate during a test, a mechanical jacking device is furnished so the subassembly can be raised for removal of the equipment from the roadway.

A load cell with a central bore is placed immediately above the loading plate for direct measurement of the loading force (stress).

A raise/lower bar is furnished which automatically raises or lowers the row of deflectors present concurrently with the raising or lowering of the drop weight subassembly.

A suitable hole is provided in the centre of the loading plate such that the centre deflection may also be measured. A transducer holder is provided for each of the seven (optionally nine) deflectors, i.e. one above the hole at the centre of the load cell (with a measuring rod passing through the cell and the loading plate centre hole), and six (optionally up to fourteen) additional holders which can be positioned anywhere along the raise/lower bar. All deflector holders are spring loaded ensuring good contact between the deflector (via a free rod beneath their centre) and the surface being tested. The raise/lower bar stretches from the edge of the loading plate to a distance of at least 2.45m (8 ft.) from the loading centre.

All transducers (i.e. the load cell and the deflectors) are connected to sockets at the Compact15 Front Panel on the trailer. The panel also carries four pushbuttons and six LEDs for manual control/check of the FWD trailer operation (only intended for use in case of servicing or emergency).

Only two cables connect the FWD trailer to the electronics in the car:

- One Ethernet cable connects the Compact15 System Controller to the Remote Control Box.
- One “Trailer Power Cable” connects the 12V system of the FWD trailer to the alternator in the towing vehicle (or to an optional, trailer mounted Power Unit).

All exposed items are weather-proof, so the FWD trailer may be operated in all kinds of weather within the temperature ranges specified in the following table. For operation below 0°C (32°F), lower viscosity hyd. oil may be necessary. Please consult Dynatest.

11.2 Trailer Specifications

	8002 FWD Trailer	8082 HWD Trailer
Max. permissible weight	1200 kg (2,600 lbm) (single axle) 1300 kg (2,800 lbm) (tandem axle)	2,000 kg (4,400 lbm) (tandem axle (standard))
Tire size	165-13”	185 R14 C
Tire pressure	2.8 bar (40 psi) cold	2.8 bar (40 psi) cold
Max. recommended driving speed	70 km/h (45 mph)	70 km/h (45 mph)
Total length (max.)	4.35 m (171”)	4.45 m (175”)
Total width (max.)	1.65 m (65”) (single axle) 1.68 m (66”) (tandem axle)	1.78 m (70”)
Total height (max. during driving)	1.40 m (55”)	1.45 m (57”)
Towing ball diameter (of towing vehicle hitch)	50 mm OR 50.8 mm (1-31/32” OR 2”)	50 mm OR 50.8 mm (1-31/32” OR 2”)
Optimum height of tow ball (ground to ball centre), loaded with 100 kg (220 lb)	480 mm - 500 mm (19 - 20”)	480 mm - 500 mm (19 - 20”)
Hyd. oil quality	“Shell” Tellus Oil T37 or “Exxon” Univis N46	“Shell” Tellus Oil T37 or “Exxon” Univis N46
Hyd. system capacity	approx. 10 litres (approx. 2.5 gal.)	approx. 13 litres (approx. 3.5 gal.)
Approx. falling height range of the drop weight	50-390 mm (2-15.3”)	50-390 mm (2-15.3”)
Loading plate diameter(s)	300 & 450 mm (11.8 & 17.7”)	300 & 450 mm (11.8 & 17.7”)
Range of distances of movable raise/lower bar deflector holders (from loading centre)	185-2450 mm	185-2450 mm
Max. tilt of loading plate	6 degrees	6 degrees
Storage temperature range	-30 to 70°C (-20 to 160°F)	-30 to 70°C (-20 to 160°F)
Operating temperature range	-10 to 50°C (14 to 122°F)	-10 to 50°C (14 to 122°F)

11.3 FWD/HWD Hydraulics

11.3.1 General Description

The hydraulic system incorporates the following main items (refer to drawings on the following pages):

- A hydraulic cylinder ("Main Cylinder") for raising/lowering of the weight catch.
- Two (parallel connected) cylinders ("Side Cylinders") for raising/lowering of the falling weight subassembly.
- A hydraulic pump including an adjustable excess pressure valve, and operated by:
- A 12V DC motor
- A "DC" (Directional Control) valve with two 12V DC coils (denoted "A" and "B"). This valve is also called the A/B valve.
- A normally open solenoid valve (w. a 12V DC coil, denoted "C").
- A normally closed solenoid valve (w. a 12V DC coil, denoted "D")
- A hyd. oil reservoir (tank) which is an integral part of the falling weight subassembly frame.
- Two pressure sensitive switches (one normally closed contact and one normally open contact) used in the electronic control circuits (please refer to descriptions in subsequent sub-sections).
- An optional DC valve (with AL and BL coils), also called the "locks A/B" valve. (This valve is only present in case the optional automated transport locks feature has been acquired).

The modes of operation are best explained by a "truth table":

Mode	**A**	**B**	**C**	**D**	**M**		**AL**	**BL**
Raise Weight (Lower Plate)	OFF	**ON**	OFF	OFF	**ON**	(Notes 1, 2, 3)	OFF	**ON**
Drop (Lower Plate)	OFF	**ON**	**ON**	OFF	**ON**	(Notes 1, 3)	OFF	**ON**
Lower Catch	**ON**	OFF	**ON**	OFF	**ON**	Note 5)	OFF	**ON**
Raise Plate	**ON**	OFF	**ON**	**ON**	**ON**		**ON**	OFF

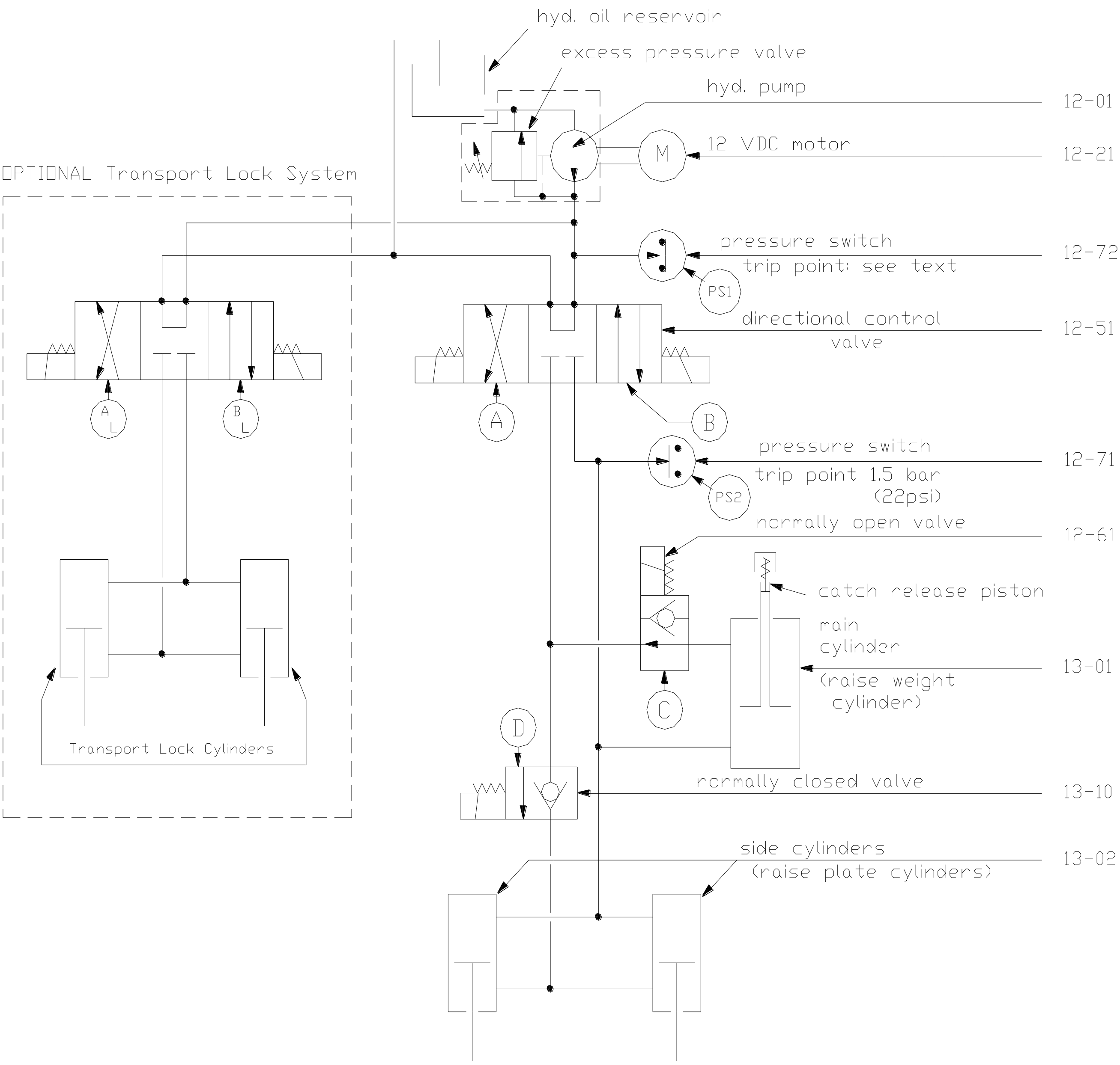
M is the coil of the motor starting relay.

Note 1: "Plate" means falling weight subassembly.

Note 2: If the weight has dropped, then this will be a "Raise Catch"-mode.

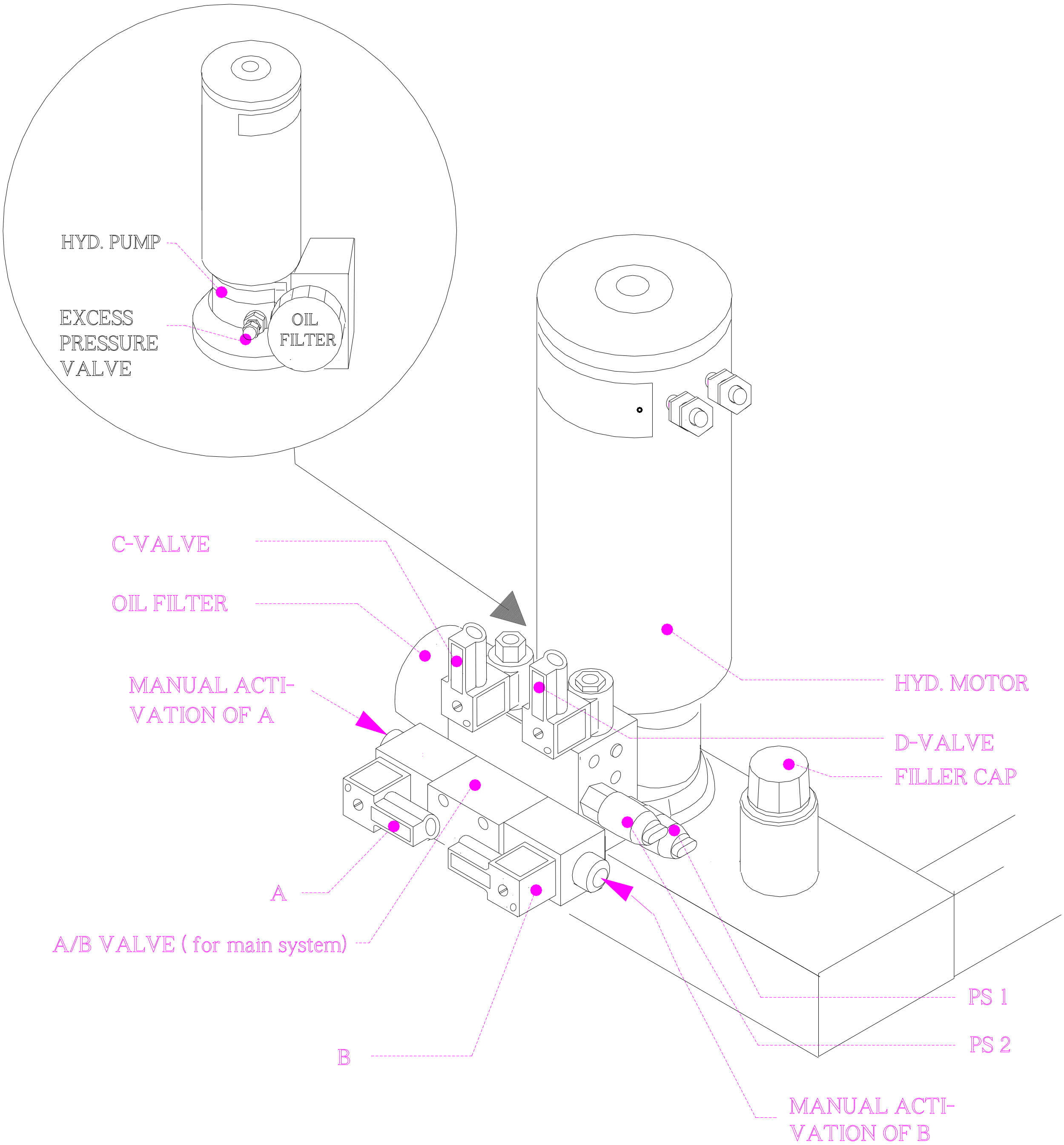
Note 3: This mode will also cause lowering of the plate and will not be fully active, until both shafts of the two "raise plate" cylinders (side cylinders) have been pressed out completely (to their bottom position).

Note 5: This mode also lowers the catch.

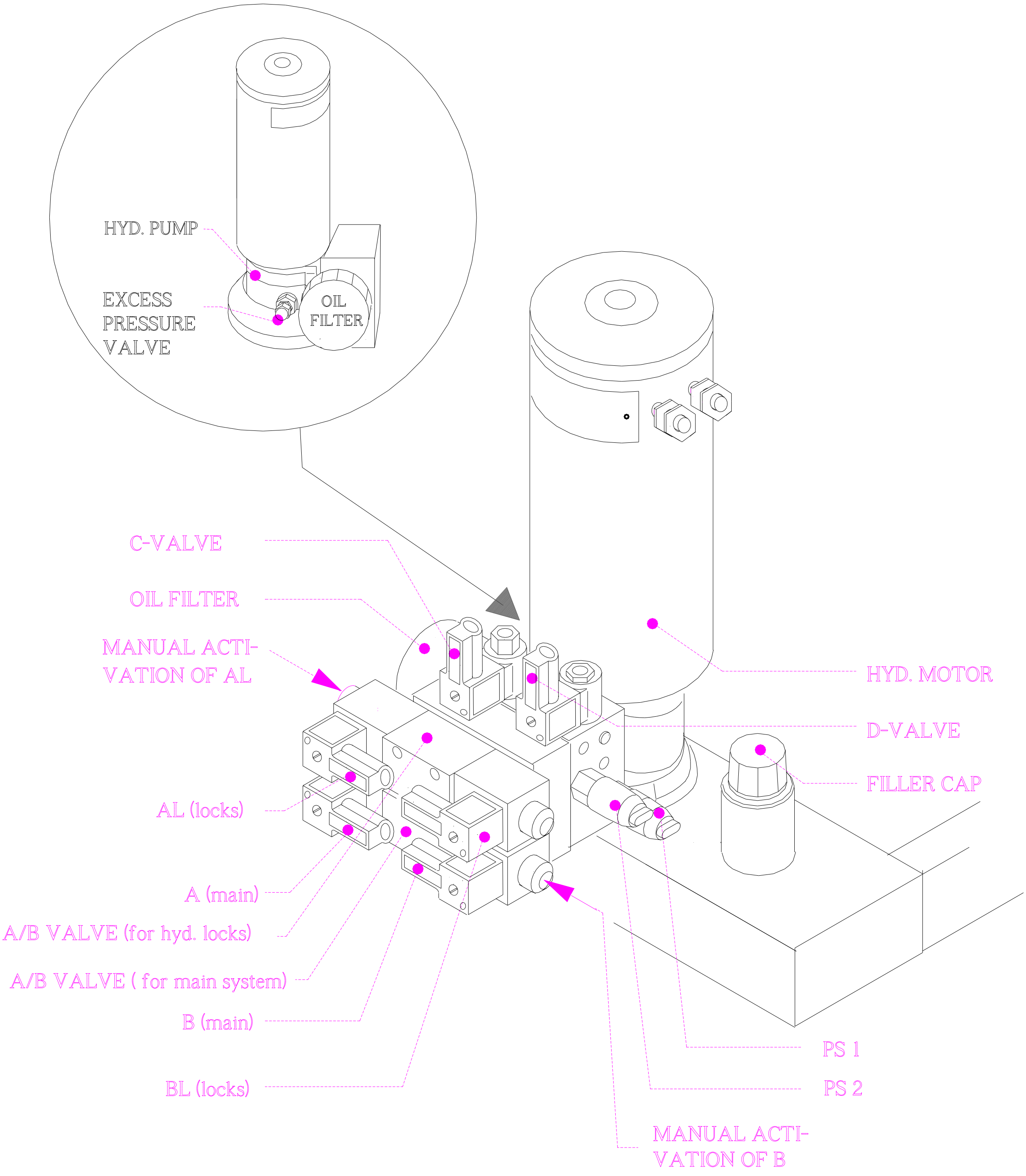


HYDRAULICS DIAGRAM

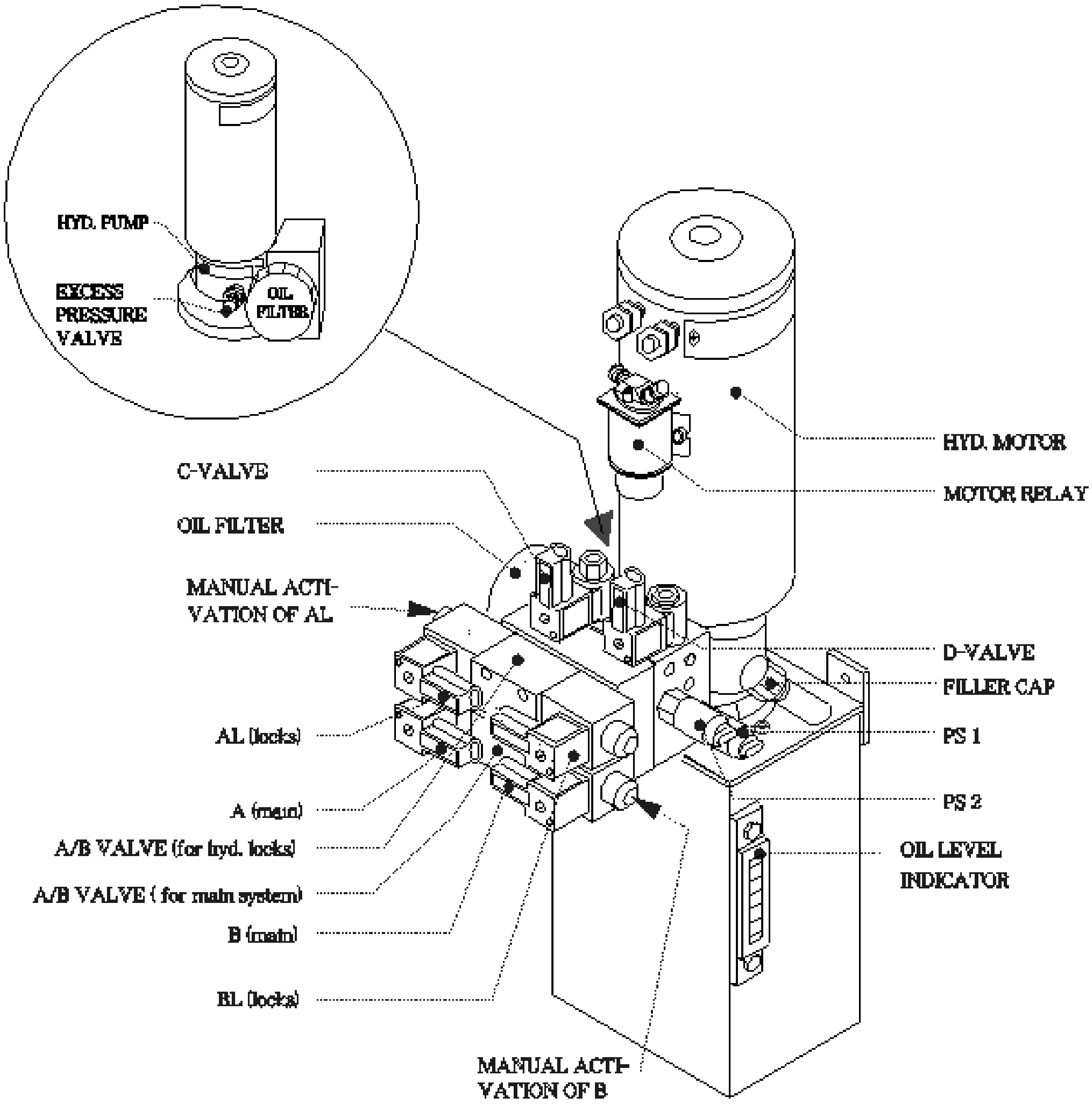
Dynatest®



FWD Hydraulics (without Automated Transport Locks)



FWD Hydraulics (with Automated Transport Locks)



HWD Hydraulics (with Automated Transport Locks)

Bleeding the Hydraulics

Bleeding may be necessary from time to time, and especially after exchange of a hydraulic component or in case of a too low hyd. oil level in the reservoir. The need for bleeding will often result in a “Drop time-out” error.

Use the procedure in the following for the bleeding (turn ON the MAN.KEY switch of the Compact15 Front Panel while using the manual pushbuttons for operation of the FWD):

1) Refill the hyd. Reservoir with hyd. oil if necessary (See 17.1, “Checking the Hydraulic Oil Level”).

First bleed the two “raise plate” cylinders by moving their shafts full-stroke a few times in the following manner:

2) Unlock the transport locks (first release by pressing shortly the RP button).

3) Lower the plate by pressing the LP/RW button and KEEP this button pressed only until the weight starts raising (the TG LED turns off).

4) Raise again the plate completely by pressing the RP button, until the P1 LED turns off (PH LED should then be ON).

5) Repeat steps 3) and 4) at least twice.

Then the main cylinder (raise weight cylinder) should be bled - two Allen screws for this purpose are placed as indicated on the figure in the following:

6) Repeat step 3).

7) Drop the weight from a small height (press and keep pressed the red DROP button, then also press the LP/RW button, until the weight has dropped, then release both buttons).

8) Raise the catch to its top position (LP/RW button).

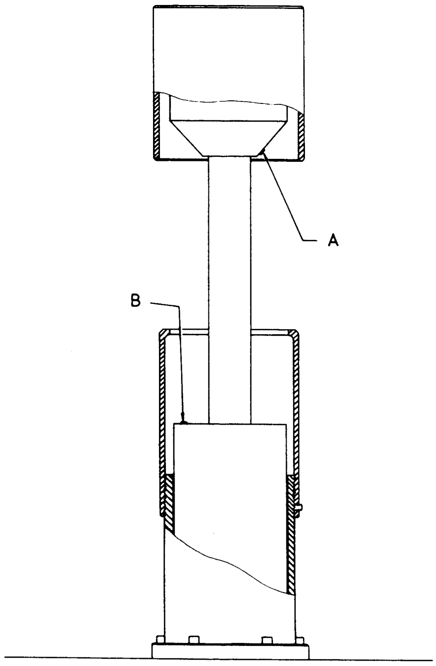
9) Lower the catch completely (LC button).

10) Repeat steps 7) to 9) at least twice, the last time only lowering the catch some 10 cm.

SAFETY NOTE!

At all times, MAKE SURE that all power is OFF and KEPT OFF while anybody is close to the trailer mechanics/hydraulics!

12) **FWD ONLY**: Now it should be possible to press up the ring “C” (see figure) by hand. The ring should stay in the upper position.



HWD Bleeding Screws Positions

13) LOOSEN (ONLY one revolution or so) the Allen set screw “A”, using the provided, special 3 mm metric Allen wrench. DO NOT REMOVE the screw!

14) Remove the Allen wrench.

15) LOOSEN (DO NOT REMOVE!) the “B” screw and REMOVE the Allen wrench!

16) Make sure that nobody is close to the catch/weight/plate! Switch on again the MAN.KEY switch.

17) Lower the catch to approx. mid-stroke, i.e. some 200 mm (8”) below top position.

18) Activate the DROP mode (red DROP button first in - last out) until only oil (i.e. no air) gets out by both bleeding screws. If the catch moves to its top position during this, then lower again the catch some 20 cm (8”) and repeat.

20) **FWD ONLY**: Repeat step 12).

21) Tighten the A and B screws and remove the Allen wrench.

22) Turn the MAN.KEY, lower the catch completely and raise the plate.

It may be necessary to repeat the entire bleeding procedure after e.g. one day of FWD testing.

11.3.2 Adjusting the Hyd. Pump Excess Pressure

The hyd. pump excess pressure should normally not need re-adjustment, but under very hot conditions (OR after change to a thinner oil under cold conditions), the excess pressure may decrease so much that pressure switch P1 will not be activated. This will normally first result in a “Raise Plate Time-out” error, but other errors like “Lower Plate Time-out”, “Drop Time-out” or “Lower Catch Time-out” may also occur. Any of these error situations may be removed simply by increasing the excess pressure as explained below, BUT this will ONLY work, IF pressure switch P1 is not defective!

The hyd. pump excess pressure has been **factory adjusted to:**

FWD: 60-70 bar (800-1000 psi)

HWD: 75-85 bar (1050-1200 psi).

This setting must at all times exceed the P1 setting, which is:

FWD: approx. 40 bar (560 psi)

HWD: approx. 60 bar (850 psi)

which in turn must be higher than the pressure needed to raise the drop weight subassembly with maximum weight set-up, even under cold conditions (this pressure is normally at least 10 bar (150 psi) lower than the P1 settings listed above). NOTE, though, that a too high excess pressure may cause excessive wear on especially the catch mechanism.

The adjustable excess pressure valve is located on the hyd. pump housing (see previous hydraulics figures). To adjust, use the following procedure:

SAFETY NOTE!

At all times, MAKE SURE that all power is OFF and KEPT OFF while anybody is close to the trailer mechanics/hydraulics!

1) Lower the plate to the ground (OR settle it on the transport locks).
2) Release all hyd. pressure by manually activating the A and B valves (at least twice).
3) Remove the dome nut of the excess pressure valve.
4) Remove the washer and “O”-ring (which were behind the dome nut).
5) Loosen the nut locking the adjustment screw.

If a pressure gauge is available, then you may proceed from step 12 below, otherwise continue here:

6) Turn the adjustment screw CLOCKWISE HALF a revolution (and NOT MORE than half a revolution!!).
7) Check that the P1 LED of the Compact15 Front Panel now turns OFF, when the LC button is pressed (MAN.KEY ON). Make sure that the catch is LOW and that the trailer buffer battery is in a well charged condition when performing this check.

If step 7) was fulfilled, then further adjustment should not be necessary, and you may re-mount washer, O-ring and dome nut as explained below (steps 14 and 15). As soon as possible after this, though, the pressure should be checked using a pressure gauge (as outlined below in steps 12 through 16).

If step 7) failed (P1 LED will NOT turn OFF), then this MAY be due to a defective P1. If a pressure gauge is still not available, then replace P1 with the spare one provided with the standard Spare Parts Kit and then repeat step 7). If this STILL fails, then a pressure gauge must be acquired and used as explained below (from step 12). If step 7) checks out OK with the new P1, then re-adjust the excess pressure as follows:

8) Turn the adjustment screw counter clockwise HALF a revolution.

9) Repeat step 7).

IF step 7) was still fulfilled,

THEN return to step 8),

ELSE continue below.

10) Turn the adjustment screw CLOCKWISE ONE QUARTER of a revolution.

11) Repeat step 7).

IF step 7) is now fulfilled again,

THEN turn the adjustment screw counter clockwise 1/8 of a revolution,

ELSE turn CLOCKWISE 1/8 revolution.

Now the excess pressure should be equal to or very close to the P1 trip point pressure:

FWD: approx. 40 bar (560 psi)

HWD: approx. 60 bar (850 psi)

best indicated by a flickering P1 LED (while the LC button is pressed).

Once the P1 trip point pressure has been established, then the excess pressure should finally be increased by turning the adjustment screw CLOCKWISE ¾ (three quarters) of a revolution. This is the FINAL setting. Refer to steps 14) and 15) below for re-application of washer, O-ring and dome nut.

If a pressure gauge is available, then adjust the excess pressure as follows (make sure that steps 1) and 2) have been performed):

12) Apply a (optional) pressure gauge (range 100 bar or 1000 psi) to the “quick-connect” stud on top of the hydraulic block.

13) Adjust the excess pressure adjustment screw in 1/8-revolution increments (CLOCKWISE for higher pressure, COUNTER clockwise for lower pressure) until performance of step 7) gives a pressure reading of

FWD: 60-70 bar (800-1000 psi)
HWD: 75-85 bar (1050-1200 psi).

14) Tighten the adjustment screw lock nut WHILE retaining the adjustment screw, so that this does not change setting.

15) Re-apply the O-ring, washer and dome nut: MAKE SURE that the O-ring is positioned “inside” the washer, so that it will not be sheared when the dome nut is tightened.

16) Make sure that step 7) checks out OK, otherwise P1 is defective and must be exchanged.

11.4 *Electrical System*

11.4.1 Transducers

The transducers, i.e. the Load Cell and the Deflectors, are connected to sockets at the Compact15 front panel. Refer to descriptions in the following.

Refer to Section 12, "**Transducers/Cables**" for descriptions of the transducers and for cable wiring diagrams.

11.4.2 FWD/HWD Control Circuits

The remaining electrical circuits of the FWD/HWD unit are exclusively used for operational control, powered via the 12V trailer buffer battery.

The Compact15 front panel incorporates 4 pushbuttons for manual operation of the FWD/HWD unit, and 6 LEDs for monitoring of the trailer proximity- and pressure switches.

11.4.3 Trailer Status Switches

Two pressure sensitive switches, placed as indicated in the previous descriptions of the hydraulics, and four proximity switches, placed as indicated in figures in the following, are used for detection of the trailer "status" and are monitored by 6 LED indicators of the Compact15 Front Panel, close by their respective connection sockets.

P1: A pressure sensitive switch with a normally closed contact that opens when the pump outlet pressure exceeds its setting of approx.

FWD: 40 bar (560 psi)
HWD: 60 bar (850 psi)

P1 is used for excess pressure detection. Thus, **the (red) P1 LED must turn OFF at excess pressure**.

P2: A pressure sensitive switch with a normally open contact that will close by the pressure in the RETURN oil during catch lowering (setting approx. 2 bar (25-30 psi). **P2 MUST stay ON WHILE the catch is MOVING DOWNwards, and it MUST come OFF when the catch stops at its bottom position.**

PH: "Plate High" proximity switch sensor, only activated when the plate (i.e. the falling weight subassembly) is close to its highest position. Thus, **the PH LED must be ON when the plate is high. It must also be ON when the subassy is resting on the transport locks in EITHER or BOTH side(s).**

WH: "Weight High" proximity switch sensor, activated by close presence of any of the falling height stops (located in a rail on the drop weight). Thus, **the WH LED must turn ON at each passing of a falling height stop.**

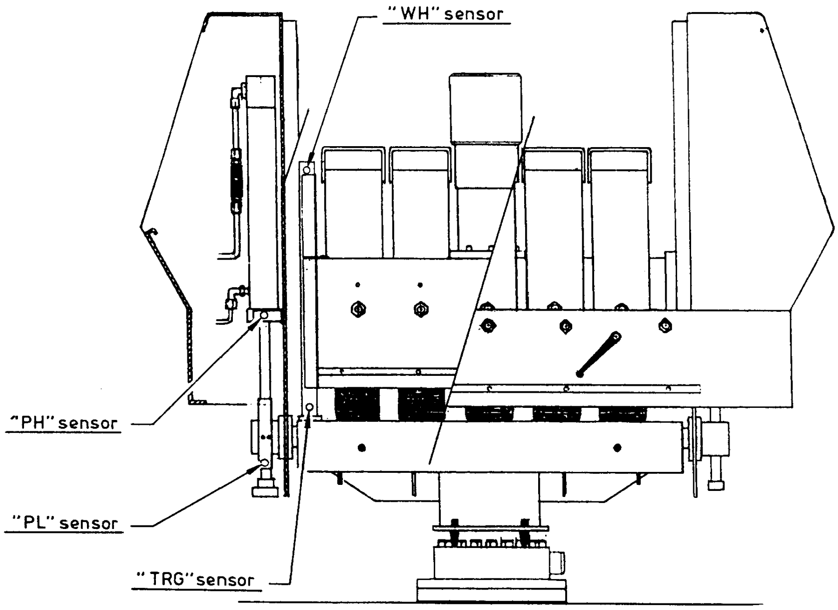
PL: "Plate Low" proximity switch sensor, which is DEactivated, when the falling weight subassembly is no longer suspended from the two shafts of the side cylinders. This is normally only the case, when the plate has come to rest on the ground, but may occur, if the subassembly should for some reason be prevented from being lowered (e.g. if the transport locks have not been unlocked). Thus, **the PL LED must turn OFF when the plate is low.**

TG: "Trigger" proximity switch sensor, activated when the drop weight is less than 6 to 12 mm (1/4" to ½") from its lower, resting position. Thus, **the TG LED must be ON when the weight is low AND it must turn OFF when the weight has been raised more than 6 to 12 mm (1/4" to ½").**

The four proximity switch sensors and the pressure switches are connected to individual sockets of the Compact15 Front Panel.

On activation, the output of a proximity sensor is pulled low (by an internal, current limited NPN-transistor) to max. some 1V from the PWR GND, which must cause the corresponding LED indicator to turn ON.

Test procedures for these status sensors are given in 17.10, “Checking the four Proximity Switch Sensors” and 17.11, “Checking the Pressure Switches”.



HWD Proximity Swithes (Sensors) Positions

11.4.4 Hyd. Unit Connections

The A, B, C and D (plus perhaps optional AL and BL) solenoids of the hyd. valves, the M coil of the motor starting relay are all connected to the Compact15 Front Panel. Each of the 5 solenoids is shunted by a diode for transient suppression on switch-off.

11.4.5 Trailer Powering

The positive terminal of the 12V trailer buffer battery is connected to the motor starting relay via a 150A fuse and to the TRAILER POWER CABLE via an 80A fuse, both placed in a heavy fuse box. The negative terminal of the battery supply is connected to a common GND point on the FWD/HWD frame.

For powering of all other circuits than the motor, separate wires are connected directly from the battery supply to the bottom of the Compact 15 System Controller.

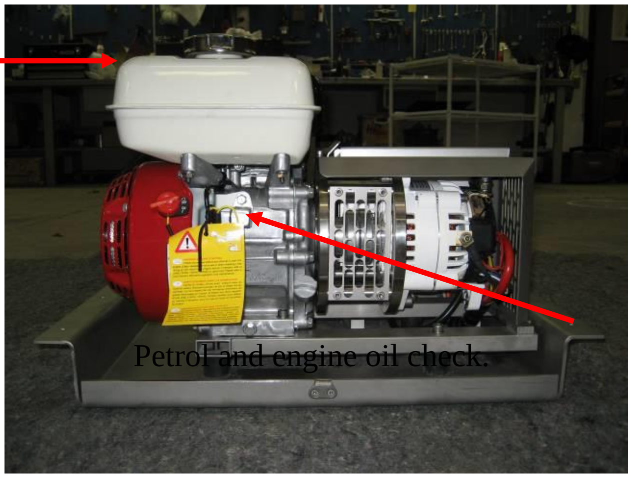
11.5 FWD/HWD Trailer Mounted Power Unit (Generator - Optional)

The **Dynatest 7071 Rapid Charge Generator** has the following specifications:

- Custom built 12VDC, with 120 Amps output, rapid charge generator driven directly (no belt) by a 4-stroke, 5.5HP Honda combustion engine
- Microprocessor regulator with excess temperature shutdown, LCD Voltmeter, Ammeter and Hour Counter
- Stainless Mounting Tray for Dynatest FWD or HWD
- Stainless Protection Cover
- Weight incl. tray & cover: Approx. 55 kgs.
- Dimensions incl. tray & cover: L: 610mm, W: 440mm, H: 460mm

Fuel Type: Unleaded Petrol.
Check List prior to use:

Check the fuel level in tank.



Petrol and engine oil check.

Check oil level (Type SAE 10W-30)

11.5.1 *Generator Operating Instructions*

Turn "ON" choke
(Lever pushed to the
far left).

Turn "ON" fuel
(Lever pushed to
far right).

Choke and Fuel

Plug the charging connector

Note: You can leave the plug connected even when the generator is not operating.

IMPORTANT:
NEVER DISconnect the plug while the motor is spinning!!!

NB. Please pull the green, protective cover upwards before inserting the charging plug (as shown in the picture).

Turn engine switch to "ON"
(on the side of the Honda engine).

Engine ON/OFF switch

Pull rope to start.
Adjust choke during running as necessary.

Press the START switch for a few seconds to initiate the charging.

Generator electronics panel.

Charging
Note that the alternator will adjust electronically for about one minute to the present condition of the battery/batteries before charging starts.

Control Lamps
The GREEN light must light up when the charging cable has been connected and the START switch is pressed. It should stay on while the engine is running. If it the light does turn off, re-activate the START switch and keep it pressed for a few seconds.

The YELLOW light will be on if the alternator is not capable of supplying sufficient current and keeping charging output voltage level of approx. 14.1 volts. Momentary lighting can be expected during normal operation of the FWD or HWD. This does not indicate any problem with the generator.

If the lamp stays lighted for extended periods and the output voltage drops below 12.8 Volts, please increase the engine RPM (see picture below), which will normally solve this problem.

The RED light would turn on if:
1. The alternator body temperature exceeds some 100 deg.C.
2. The output voltage drops below 12.8 volts or exceeds 15.2 volts.

In case of 1., the output current will automatically be reduced to 50% of the normal charging level, thus reducing the alternator temperature to a safe level after some time, causing the lamp to turn off again and the output current to return to normal level.
In case of 2., please increase or decrease engine RPM. See picture below:

Throttle Adjusting Lever

Choke and Fuel

To STOP
Turn “OFF” all switches in the following order: Engine switch and fuel lever. You can leave the power plug connected even when the generator is not operating.

Important notes and warnings
- Generator will run for approx. 4 hours on a full tank of petrol.
- Do NOT refill generator fuel tank whilst the generator is running or hot.
  Spillage of fuel on any part of the hot generator, including the exhaust, could result in fire and injury.
- Please consult your company’s Safety Representative for your company’s safety procedures.

In doubt on any of these procedures or if difficulties are encountered whilst operating the generator, please contact Dynatest.

12. Transducers/Cables

NOTE: 12.1 covers the FWD Load Cell and 12.2 covers the HWD Load Cell.

12.1 FWD Load Cell 86207

12.1.1 Key Features

- Compact Size
- Centre Bore for Centre Deflector rod
- Resistance to Extraneous Forces
- Long Term Stability and Fatigue Life
- True Linearity
- High Output

12.1.2 Description

The DYNATEST FWD LOAD CELL 86207 is a low-profile shear web design strain gauge type load cell. Despite its range of 250 kN (55 kips), it features a height of only 45 mm (1.75”). Due to the shear web design, the cell will deflect less than 30 microns (1.2 mil) at max. FWD peak load.

The load cell is mounted directly on top of the loading plate to minimize errors due to inertial forces from masses below the cell. This placing requires, however, that the load cell has a centre-bore for the centre deflector holder stem.

Despite the low profile, the high range and the low cell deflection, the FWD load cell features a high electrical output of approx. 36 mV at max. FWD peak load and 15V excitation.

12.1.3 Specifications

Range:	250 kN (55 kips)
Nom. sensitivity:	Approx. 16 µV/V/kN (73 µV/V/kip)
Excitation:	20V (DC or ACrms) max.
Sensitivity shift with temp.:	0.002%/deg. C (0.001%/deg. F) max.
Output resistance:	350 ohms (± 0.5%)
Temperature range:	-30 to +80°C (-20 to 175°F)

12.1.4 Calibration

The DYNATEST FWD LOAD CELL 86207 has a nominal sensitivity of approx. 16 microvolts per volt excitation per kilo Newton of applied load (73 µV/V/kip).

The exact sensitivity has been achieved by a multi-point calibration against a special high-precision reference load cell.

As the load cell is used in connection with the Compact 15 System controller, which has an automatic shunt calibration facility, the cell sensitivity achieved by the above-mentioned calibration is specified as a shunt calibration value.

Shunt calibration means that a very precise resistor (0.1% tolerance) is connected in parallel with one of the four “legs” of the strain gage bridge of the load cell, thus equivalating a specific physical load applied to the cell. This specific, equivalent load is the shunt calibration value.

The advantage of using shunt calibration is that the final, registered load reading caused by the shunt calibration at any time will be equivalent to a physical load on the cell equal to the shunt calibration value, independent of the excitation voltage, input impedance, amplification etc. used in the registration equipment.

12.2 HWD Load Cell 86205

12.2.1 Key Features

- Compact Size
- Centre Bore for Centre Deflector rod
- Resistance to Extraneous Forces
- Long Term Stability and Fatigue Life
- True Linearity
- High Output

12.2.2 Description

The DYNATEST HWD LOAD CELL 86205 is a low-profile shear web design strain gauge type load cell. Despite its range of 400 kN (88 kips), it features a height of only 63 mm (2.50”). Due to the shear web design, the cell will deflect less than 50 microns (2 mil) at max. HWD peak load.

The load cell is mounted directly on top of the loading plate to minimize errors due to inertial forces from masses below the cell. This placing requires, however, that the load cell has a centre-bore for the centre deflector holder stem.

Despite the low profile, the high range and the low cell deflection, the HWD load cell features a high electrical output of approx. 40 mV at max. HWD peak load and 15V excitation.

12.2.3 Specifications

Range:	450 kN (100 kips)
Nom. sensitivity:	Approx. 9 µV/V/kN (40 µV/V/kip)
Excitation:	20V (DC or ACrms) max.
Sensitivity shift with temp.:	0.002%/deg. C (0.001%/deg. F) max.
Output resistance:	350 ohms (± 0.5%)
Temperature range:	-30 to +80°C (-20 to 175°F)

12.2.4 Calibration

The DYNATEST HWD LOAD CELL 86205 has a nominal sensitivity of approx. 9 microvolts per volt excitation per kilo Newton of applied load (40 µV/V/kip).

The exact sensitivity has been achieved by a multi-point calibration against a special high-precision reference load cell.

As the load cell is used in connection with the Compact 15 System controller, which has an automatic shunt calibration facility, the cell sensitivity achieved by the above-mentioned calibration is specified as a shunt calibration value.

Shunt calibration means that a very precise resistor (0.1% tolerance) is connected in parallel with one of the four “legs” of the strain gage bridge of the load cell, thus equivalating a specific physical load applied to the cell. This specific, equivalent load is the shunt calibration value.

The advantage of using shunt calibration is that the final, registered load reading caused by the shunt calibration at any time will be equivalent to a physical load on the cell equal to the shunt calibration value, independent of the excitation voltage, input impedance, amplification etc. used in the registration equipment.

12.3 Seismic Detector 86211

12.3.1 Key Features

- High precision
- Long term calibration stability
- Very robust
- Light weight
- Weatherproof construction
- Clamping magnet for easy mounting
- Low impedance
- Requires no power

12.3.2 Description

The DYNATEST SEISMIC DETECTOR 86211 (SD, also sometimes named “deflector”, “deflection sensor” or “geophone”) is a very robust, high precision, light weight, seismic velocity transducer in a sealed aluminium housing with an internal electrical shield. It has a natural frequency of approx. 5Hz and ± 2mm available movement of the seismic mass.

The SD is delivered with a cable length of 5 m. A clamping magnet at the bottom of the Deflector makes fixture to and removal from a deflector holder quick and easy.

The SD can only be used for the measurement of vertical movements with the clamping magnet downwards and the mounting surface horizontal. If the Deflector is tilted, the measuring *range* will be decreased, but the *sensitivity* will remain virtually unaffected.

12.3.3 Specifications

(SD vertical within 10 degrees, clamping magnet downwards, values typical at 25°C unless otherwise specified):

Natural frequency:	approx. 4.7 Hz
Output resistance:	375 ohms
Damping coefficient:	approx. 0.7 (when connected to the Compact 15)
Available movement of seismic mass:	4 mm (total, i.e., +/- 2 mm from equilibrium position)
Weight:	250 g (excl. cable)

13. Calibration

13.1 Relative Deflector Calibration

Relative Deflector Calibration Procedure assures the highest possible degree of deflection basin accuracy and consistency (without performing a *reference* calibration). This calibration can be performed by the user. The Relative Deflector Calibration Procedure verifies the similarity of the response from each of the deflection sensors. A series of multiple drops are recorded when all the deflection sensors are mounted in a stand and exposed to the same deflection.

Reference Deflector Calibration Verification requires specialized equipment (can be performed by Dynatest) and will not be detailed here. The *Relative* Calibration Procedure, however, also reveals if the gain of a deflector is out of range. Hence this Relative Calibration Procedure is so very important. The procedure is the same for FWD, HWD and Fast FWD.

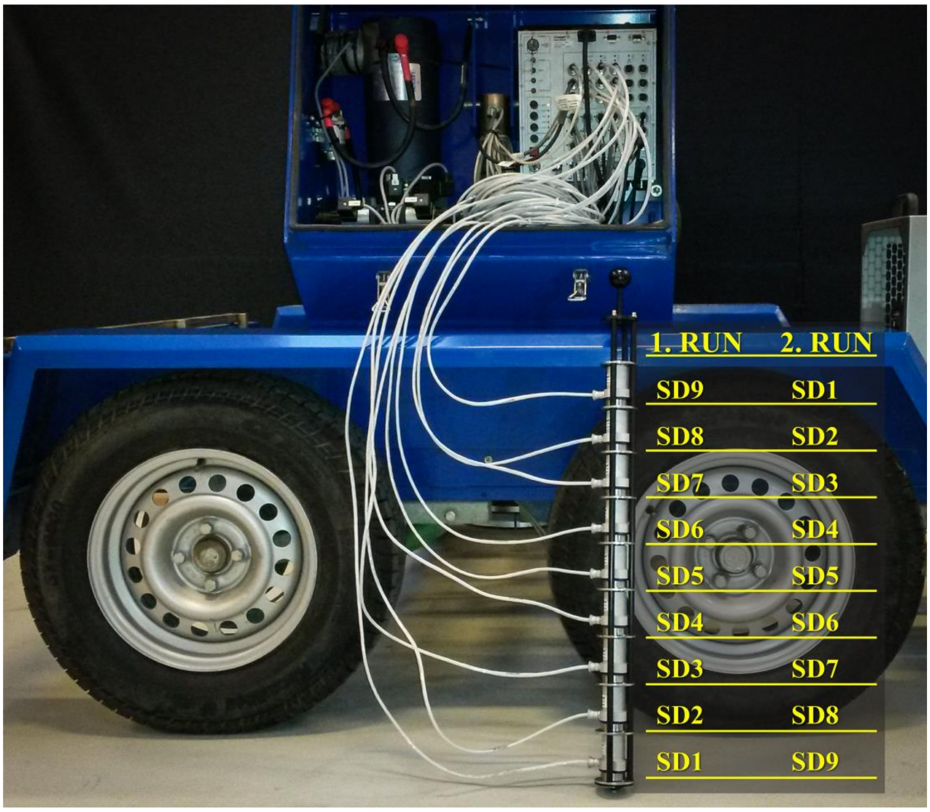
The system should be charged during testing.

The Relative Deflector Calibration consists of three steps.

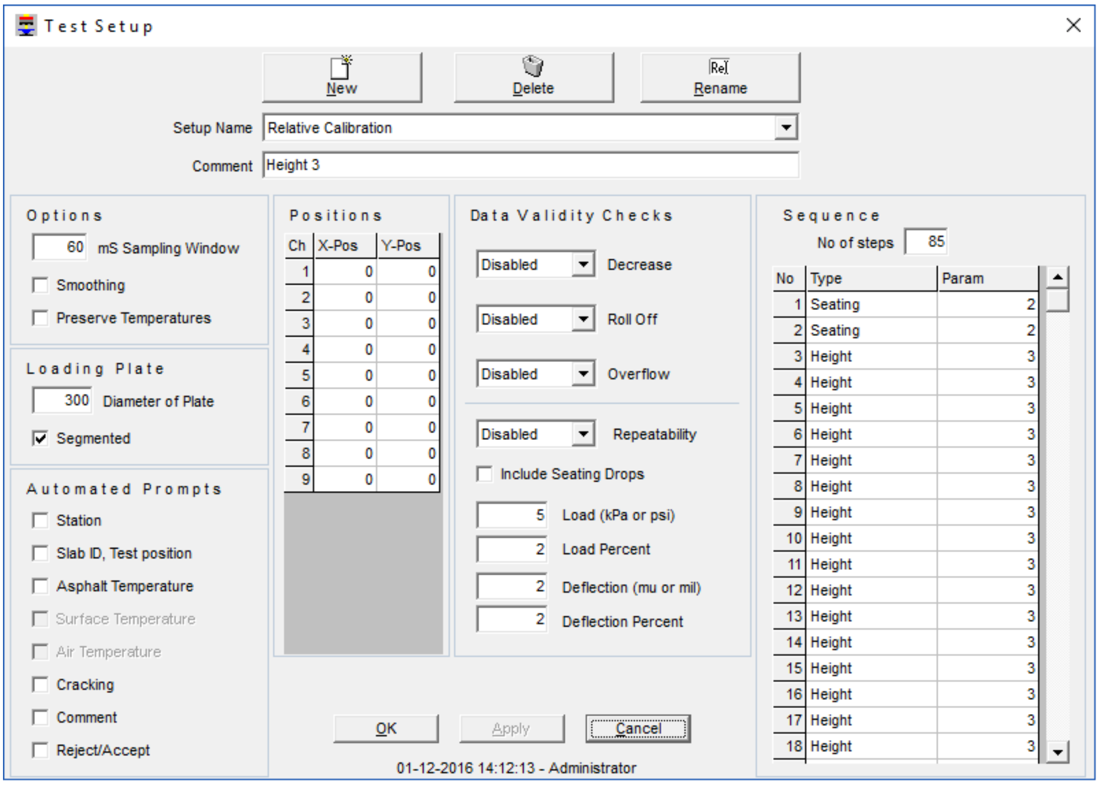
Data collection	A test is performed to obtain data from the deflection sensors
Analysis	”PrEN-5 RelCal.xlsx” is used to calculate the data
Gain adjustment:	If required the relative gains are adjusted in DDC

13.1.1 Data Collection

Remove the deflection sensors from the raise/lower bar and place them in the calibration column starting with deflector number one in the bottom as shown under “1. RUN” in below picture.



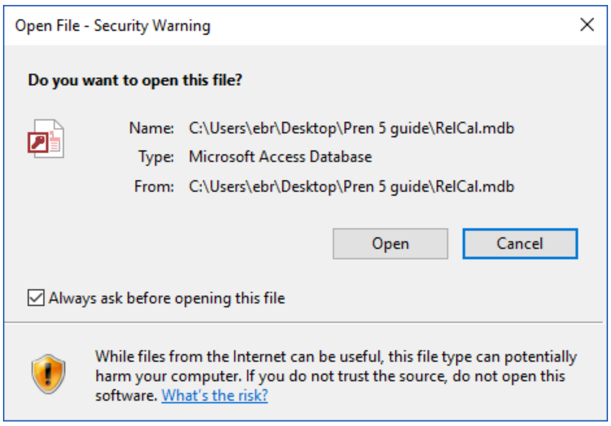
The Test-Setup for the Relative Deflector Calibration consists of 2 sets of 42 drops (2 seating and 40 recorded) separated by a pause. Thus, a total of 85 steps.
The recorded deflection must be 350µm ± 100µm. Place the Calibration Column with the deflectors in a vertical position close to the load cell and press it firmly to the ground. Use the manual function in DDC to determine which drop height would be suitable to generate the requested deflection and use this Height Parameter in the Test Setup.



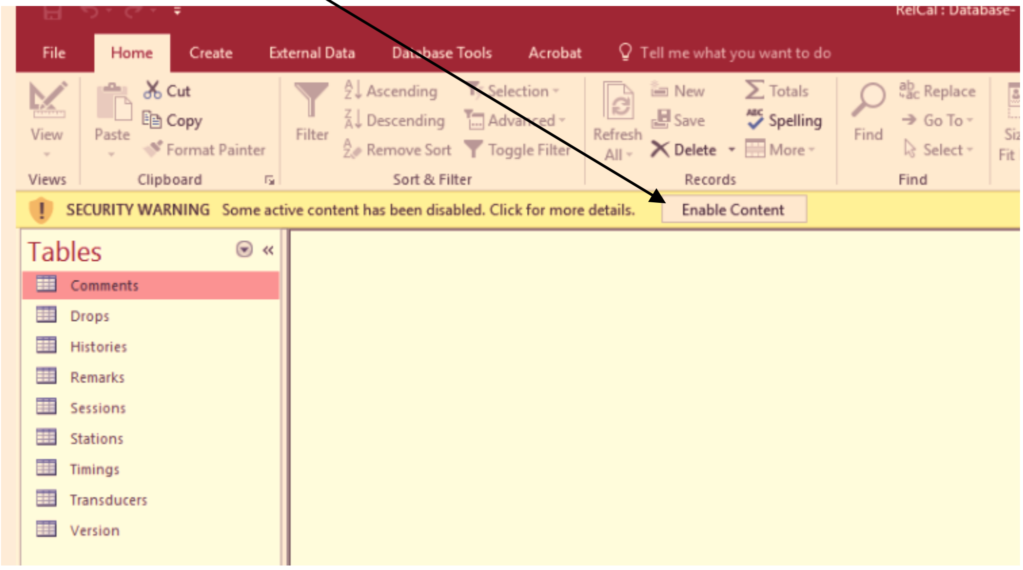
After preparation of Test Setup, open a new file and start the test with the calibration column placed in the same position as when drop height was selected. Again, it's vital that the column is held vertical and with a firm pressure to the surface.
After 2 seating drops and 40 recorded drops the pause will appear. The pause is used to mirror the deflectors in the calibration column. The deflectors should now be placed as described in "2. RUN" in previous page illustration. Now run the last 42 drops and close the file.

13.1.2 Analysis

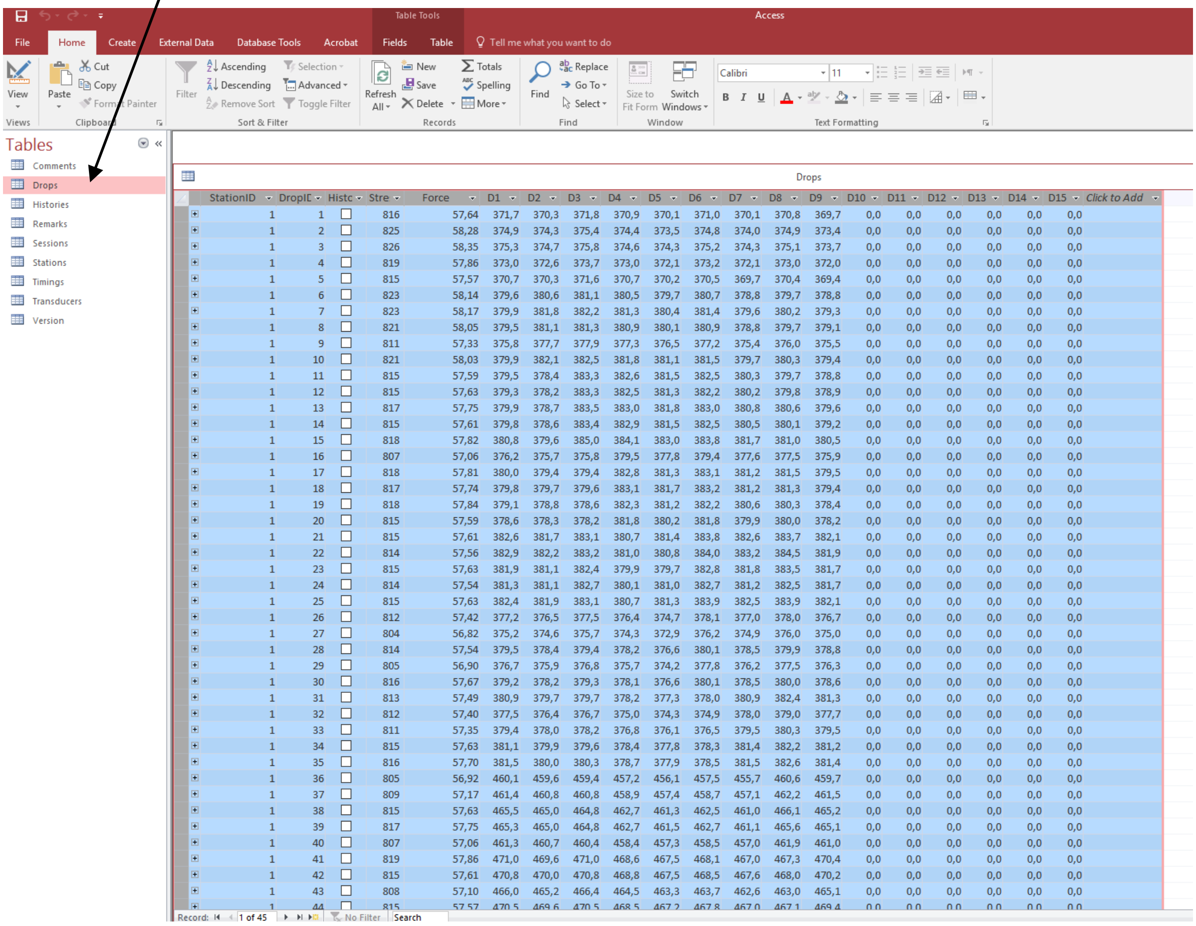
Open the .mdb test file that was generated. If a security warning pops up, click "Open".



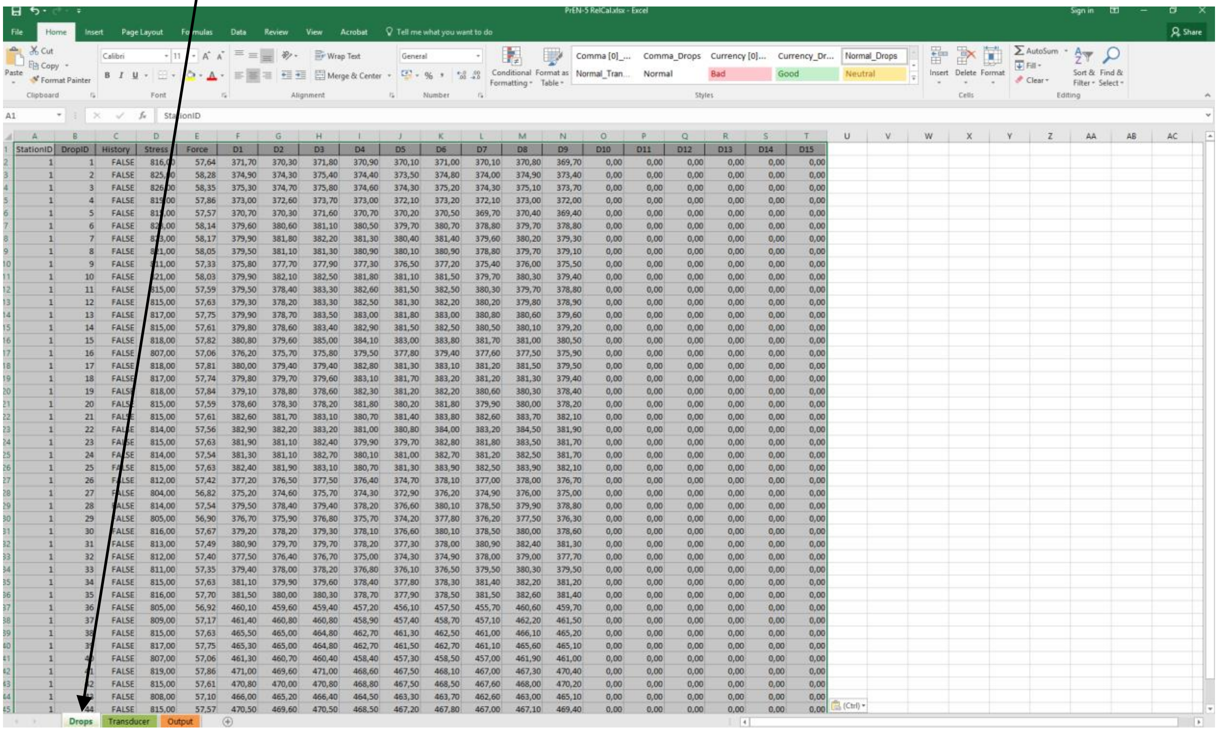
Choose ”Enable content”.



Open the “Drops” tab and copy all content.



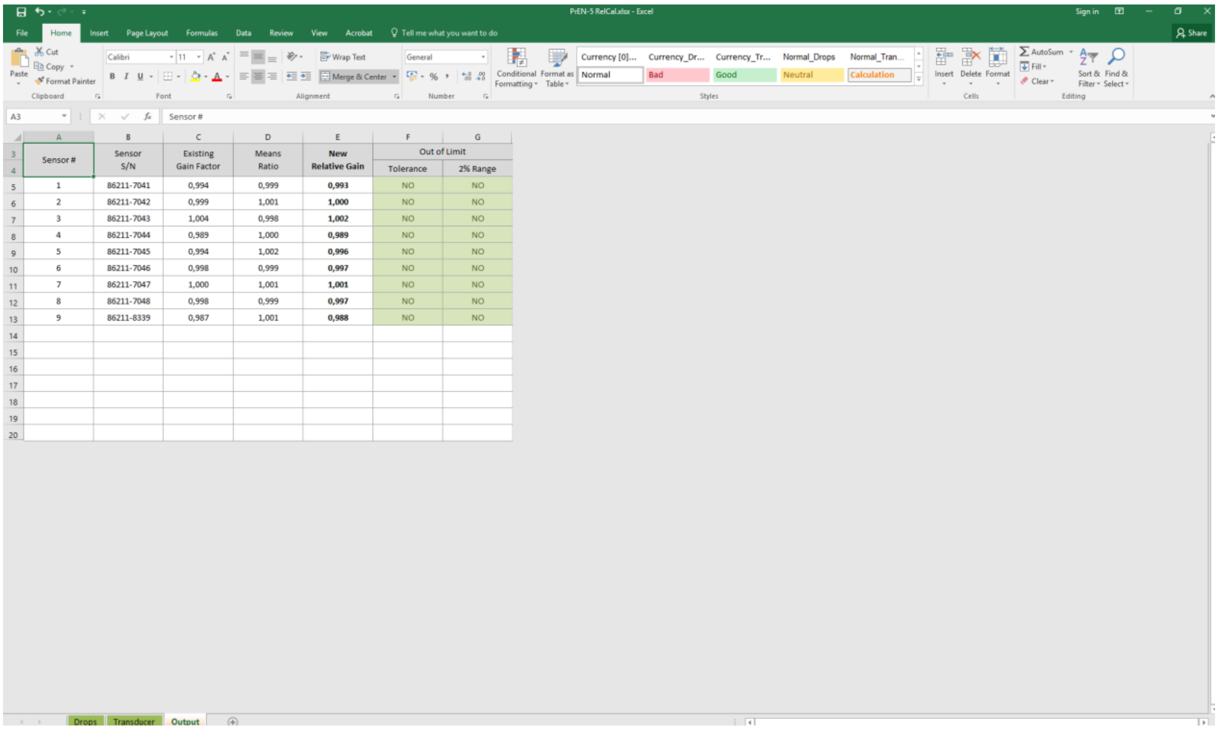
Go to [C:\Dynatest\Data] and open “PrEN-5 RelCal.xlsx”.
Choose the “Drops” tab and paste the copied data from the .mdb test file.



StationID	DropID	History	Stress	Force	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
1	1	FALSE	816,00	57,64	371,70	370,30	371,80	370,90	370,10	371,00	370,10	370,80	369,70	0,00	0,00	0,00	0,00	0,00	0,00
1	2	FALSE	825,00	58,28	374,90	374,30	375,40	374,40	373,50	374,80	374,00	374,90	373,40	0,00	0,00	0,00	0,00	0,00	0,00
1	3	FALSE	826,00	58,35	375,30	374,70	375,80	374,60	374,30	375,20	374,30	375,10	373,70	0,00	0,00	0,00	0,00	0,00	0,00
1	4	FALSE	819,00	57,86	373,00	372,60	373,70	373,00	372,10	373,20	372,10	373,00	372,00	0,00	0,00	0,00	0,00	0,00	0,00
1	5	FALSE	[illegible]	57,57	370,70	370,30	371,60	370,70	370,20	370,50	369,70	370,40	369,40	0,00	0,00	0,00	0,00	0,00	0,00
1	6	FALSE	[illegible]	58,14	379,60	380,60	381,10	380,50	379,70	380,70	378,80	379,70	378,80	0,00	0,00	0,00	0,00	0,00	0,00
1	7	FALSE	[illegible]	58,17	379,90	381,80	382,20	381,30	380,40	381,40	379,60	380,20	379,30	0,00	0,00	0,00	0,00	0,00	0,00
1	8	FALSE	[illegible]	58,05	379,50	381,10	381,30	380,90	380,10	380,90	378,80	379,70	379,10	0,00	0,00	0,00	0,00	0,00	0,00
1	9	FALSE	811,00	57,33	375,80	377,70	377,90	377,30	376,50	377,20	375,40	376,00	375,50	0,00	0,00	0,00	0,00	0,00	0,00
1	10	FALSE	821,00	58,03	379,90	382,10	382,50	381,80	381,10	381,50	379,70	380,30	379,40	0,00	0,00	0,00	0,00	0,00	0,00
1	11	FALSE	815,00	57,59	379,50	378,40	383,30	382,60	381,50	382,50	380,30	379,70	378,80	0,00	0,00	0,00	0,00	0,00	0,00
1	12	FALSE	815,00	57,63	379,30	378,20	383,30	382,50	381,30	382,20	380,20	379,80	378,90	0,00	0,00	0,00	0,00	0,00	0,00
1	13	FALSE	817,00	57,75	379,90	378,70	383,50	383,00	381,80	383,00	380,80	380,60	379,60	0,00	0,00	0,00	0,00	0,00	0,00
1	14	FALSE	815,00	57,61	379,80	378,60	383,40	382,90	381,50	382,50	380,50	380,10	379,20	0,00	0,00	0,00	0,00	0,00	0,00
1	15	FALSE	818,00	57,82	380,80	379,60	385,00	384,10	383,00	383,80	381,70	381,00	380,50	0,00	0,00	0,00	0,00	0,00	0,00
1	16	FALSE	807,00	57,06	376,20	375,70	375,80	379,50	377,80	379,40	377,60	377,50	375,90	0,00	0,00	0,00	0,00	0,00	0,00
1	17	FALSE	818,00	57,81	380,00	379,40	379,40	382,80	381,30	383,10	381,20	381,50	379,50	0,00	0,00	0,00	0,00	0,00	0,00
1	18	FALSE	817,00	57,74	379,80	379,70	379,60	383,10	381,70	383,20	381,20	381,30	379,40	0,00	0,00	0,00	0,00	0,00	0,00
1	19	FALSE	818,00	57,84	379,10	378,80	378,60	382,30	381,20	382,20	380,60	380,30	378,40	0,00	0,00	0,00	0,00	0,00	0,00
1	20	FALSE	815,00	57,59	378,60	378,30	378,20	381,80	380,20	381,80	379,90	380,00	378,20	0,00	0,00	0,00	0,00	0,00	0,00
1	21	FALSE	815,00	57,61	382,60	381,70	383,10	380,70	381,40	383,80	382,60	383,70	382,10	0,00	0,00	0,00	0,00	0,00	0,00
1	22	FALSE	814,00	57,56	382,90	382,20	383,20	381,00	380,80	384,00	383,20	384,50	381,90	0,00	0,00	0,00	0,00	0,00	0,00
1	23	FALSE	815,00	57,63	381,90	381,10	382,40	379,90	379,70	382,80	381,80	383,50	381,70	0,00	0,00	0,00	0,00	0,00	0,00
1	24	FALSE	814,00	57,54	381,30	381,10	382,70	380,10	381,00	382,70	381,20	382,50	381,70	0,00	0,00	0,00	0,00	0,00	0,00
1	25	FALSE	815,00	57,63	382,40	381,90	383,10	380,70	381,30	383,90	382,50	383,90	382,10	0,00	0,00	0,00	0,00	0,00	0,00
1	26	FALSE	812,00	57,42	377,20	376,50	377,50	376,40	374,70	378,10	377,00	378,00	376,70	0,00	0,00	0,00	0,00	0,00	0,00
1	27	FALSE	804,00	56,82	375,20	374,60	375,70	374,30	372,90	376,20	374,90	376,00	375,00	0,00	0,00	0,00	0,00	0,00	0,00
1	28	FALSE	814,00	57,54	379,50	378,40	379,40	378,20	376,60	380,10	378,50	379,90	378,80	0,00	0,00	0,00	0,00	0,00	0,00
1	29	FALSE	805,00	56,90	376,70	375,90	376,80	375,70	374,20	377,80	376,20	377,50	376,30	0,00	0,00	0,00	0,00	0,00	0,00
1	30	FALSE	816,00	57,67	379,20	378,20	379,30	378,10	376,60	380,10	378,50	380,00	378,60	0,00	0,00	0,00	0,00	0,00	0,00
1	31	FALSE	813,00	57,49	380,90	379,70	379,70	378,20	377,30	378,00	380,90	382,40	381,30	0,00	0,00	0,00	0,00	0,00	0,00
1	32	FALSE	812,00	57,40	377,50	376,40	376,70	375,00	374,30	374,90	378,00	379,00	377,70	0,00	0,00	0,00	0,00	0,00	0,00
1	33	FALSE	811,00	57,35	379,40	378,00	378,20	376,80	376,10	376,50	379,50	380,30	379,50	0,00	0,00	0,00	0,00	0,00	0,00
1	34	FALSE	815,00	57,63	381,10	379,90	379,60	378,40	377,80	378,30	381,40	382,20	381,20	0,00	0,00	0,00	0,00	0,00	0,00
1	35	FALSE	816,00	57,70	381,50	380,00	380,30	378,70	377,90	378,50	381,50	382,60	381,40	0,00	0,00	0,00	0,00	0,00	0,00
1	36	FALSE	805,00	56,92	460,10	459,60	459,40	457,20	456,10	457,50	455,70	460,60	459,70	0,00	0,00	0,00	0,00	0,00	0,00
1	37	FALSE	809,00	57,17	461,40	460,80	460,80	458,90	457,40	458,70	457,10	462,20	461,50	0,00	0,00	0,00	0,00	0,00	0,00
1	38	FALSE	815,00	57,63	465,50	465,00	464,80	462,70	461,30	462,50	461,00	466,10	465,20	0,00	0,00	0,00	0,00	0,00	0,00
1	39	FALSE	817,00	57,75	465,30	465,00	464,80	462,70	461,50	462,70	461,10	465,60	465,10	0,00	0,00	0,00	0,00	0,00	0,00
1	40	FALSE	807,00	57,06	461,30	460,70	460,40	458,40	457,30	458,50	457,00	461,90	461,00	0,00	0,00	0,00	0,00	0,00	0,00
1	41	FALSE	819,00	57,86	471,00	469,60	471,00	468,60	467,50	468,10	467,00	467,30	470,40	0,00	0,00	0,00	0,00	0,00	0,00
1	42	FALSE	815,00	57,61	470,80	470,00	470,80	468,80	467,50	468,50	467,60	468,00	470,20	0,00	0,00	0,00	0,00	0,00	0,00
1	43	FALSE	808,00	57,10	466,00	465,20	466,40	464,50	463,30	463,70	462,60	463,00	465,10	0,00	0,00	0,00	0,00	0,00	0,00
1	44	FALSE	815,00	57,57	470,50	469,60	470,50	468,50	467,20	467,80	467,00	467,10	469,40	0,00	0,00	0,00	0,00	0,00	0,00

Now copy the content from the “Transducer” tab in the .mdb test file to the “Transducer” tab in the .xlsx file, in the same manner as the drops content.

Choose the “Output” tab in the .xlsx file to view the result of the relative calibration.



Sensor #	Sensor S/N	Existing Gain Factor	Means Ratio	New Relative Gain	Out of Limit: Tolerance	Out of Limit: 2% Range
1	86211-7041	0,994	0,999	0,993	NO	NO
2	86211-7042	0,999	1,001	1,000	NO	NO
3	86211-7043	1,004	0,998	1,002	NO	NO
4	86211-7044	0,989	1,000	0,989	NO	NO
5	86211-7045	0,994	1,002	0,996	NO	NO
6	86211-7046	0,998	0,999	0,997	NO	NO
7	86211-7047	1,000	1,001	1,001	NO	NO
8	86211-7048	0,998	0,999	0,997	NO	NO
9	86211-8339	0,987	1,001	0,988	NO	NO

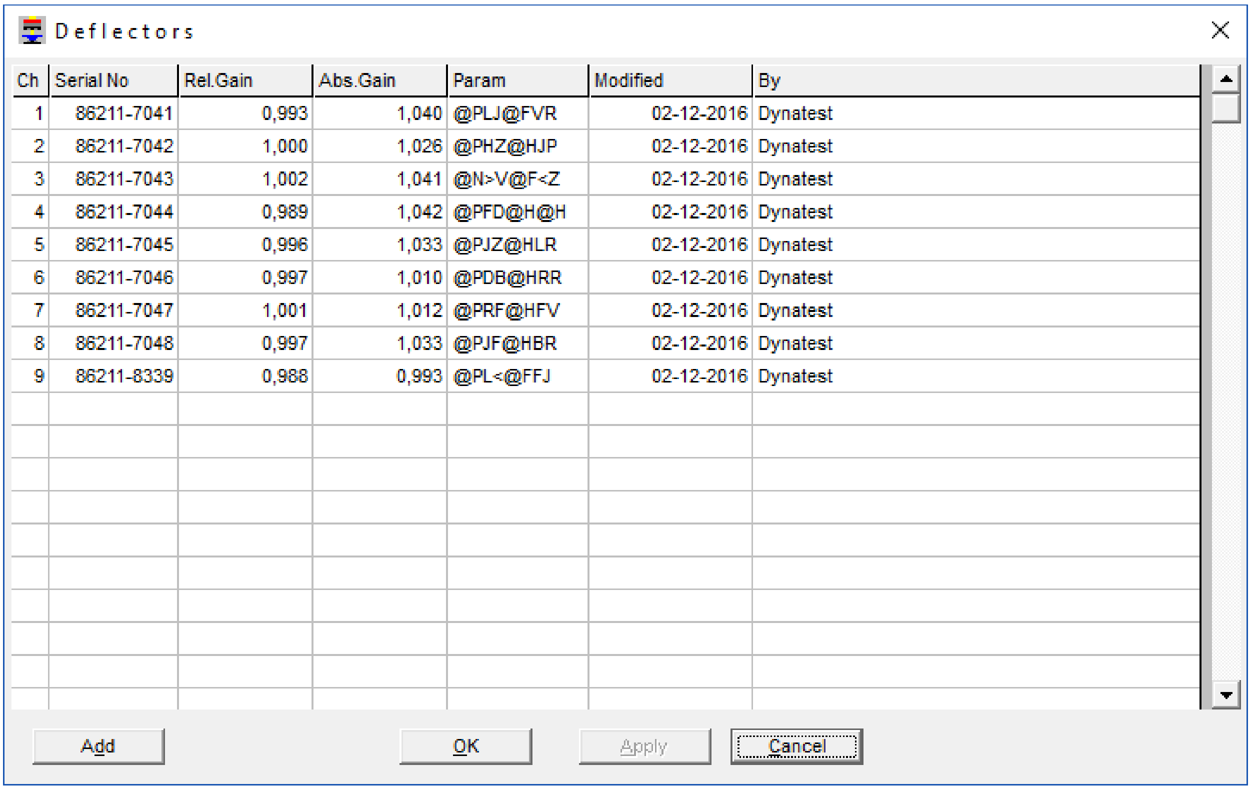
In the Output table, the calibration results for each individual deflection sensor is represented.

Tolerance:
A means ratio between 0.995 and 1.005 inclusive is considered equal to a ratio of 1.000, and no adjustments to the Relative gain is necessary. In this case the “Tolerance” field will be green and state “No”.
If the means ratio is greater than ±0.005 the “Tolerance” field will be red and state “YES”. The Relative Gain will then have to be updated in DDC (see next section “Deflector gain adjustment”) and the Relative calibration should be performed again.

2% Range:
The means ratio must be within the range of 0.980 and 1.020. Contact Dynatest for evaluation of the deflection sensor if it is out of the 2% range.

13.1.3 Gain Adjustment

As described in previous section a means ratio greater than ±0.005 requires an update of the relative gain for the deflection sensor.
In DDC go to [Setup] [deflectors].



Ch	Serial No	Rel.Gain	Abs.Gain	Param	Modified	By
1	86211-7041	0,993	1,040	@PLJ@FVR	02-12-2016	Dynatest
2	86211-7042	1,000	1,026	@PHZ@HJP	02-12-2016	Dynatest
3	86211-7043	1,002	1,041	@N>V@F<Z	02-12-2016	Dynatest
4	86211-7044	0,989	1,042	@PFD@H@H	02-12-2016	Dynatest
5	86211-7045	0,996	1,033	@PJZ@HLR	02-12-2016	Dynatest
6	86211-7046	0,997	1,010	@PDB@HRR	02-12-2016	Dynatest
7	86211-7047	1,001	1,012	@PRF@HFV	02-12-2016	Dynatest
8	86211-7048	0,997	1,033	@PJF@HBR	02-12-2016	Dynatest
9	86211-8339	0,988	0,993	@PL<@FFJ	02-12-2016	Dynatest

Update the values in “Rel. Gain” column to reflect the ones in the “New Relative Gain” column in the “PrEN-5 RelCal.xlsx”. The Relative calibration should now be performed again, to ensure that the new relative gain is correct, and means ratio are within tolerance.

The relative calibration is now completed.
If you want to save the result in “PrEN-5 RelCal.xlsx” remember to choose the “Save as” option and leave the original worksheet for the next relative calibration.

13.2 Air Temperature Sensor Calibration

Before delivery of a Dynatest Air Temperature Sensor, the best-fit calibration line for this sensor has been established from linear regression on a set of 9 values obtained from a reference calibration procedure performed by means of a high-accuracy, certified, dry-block calibrator traceable to international standards. The 9 reference temperatures are 5 to 45 °C in steps of 5 °C. A sensor is only approved if it performs to linearity specifications.

The Temperature Applet needs two calibration "numbers" (V1 and V2, i.e. sensor output values (in mV)) to calculate and display the air temperature. These values are the sensor outputs at 0 °C and 100 °C *calculated* from the above-mentioned, linear regression line (and therefore not necessarily the values which the sensor would *actually* output at these temperatures). This procedure ensures maximum possible accuracy in the most important range of 0 °C to 50 °C.

The Temperature Applet provides an automated procedure for periodic verification of the calibration numbers of the Air Temperature Sensor in TWO points, which is in most cases adequate, as the *linearity* of a sensor has been checked at the initial calibration and normally does not change significantly with time, and two points therefore will suffice to determine the (linear) calibration line.

For maximum accuracy, Dynatest render a 9-point re-calibration service.

For a user to perform the two-point calibration verification procedure, one or two stirred liquid bath(s) will be required. To monitor the (reference) temperature of the liquid, we recommend a digital reference thermometer with a traceable accuracy of ±0.4 °C or better (in the 0 °C to 50 °C range) and a resolution of 0.1 °C or less.

The temperature of the stirred liquid bath(s) must be adjustable to "low" and "high", stable reference temperatures. The low temperature should be in the range of 0 °C to 10 °C, and the high temperature should be in the range of 40 °C to 50 °C. The measuring tips of the Air Temperature Sensor and the reference temperature sensor should be in as close contact as possible at all times during the calibration.

Calibration instructions are provided on the screen. The operator need only follow these instructions to successfully perform a calibration. When each of the temperature readings stabilizes, the buttons near the right edge of the screen can be used to enter the voltage values. This reduces the possibility of typed input errors.

When the calibration is complete, the Temperature Applet calculates new calibration voltages and display them in the fields labelled **New V1** and **New V2**. The operator may then click the **Apply** button to store and use the new calibration figures. Alternatively, if the operator is not satisfied with the calibration results, he may click **Cancel** to discard the new figures and keep the old ones.

If the operator wishes to enter calibration values without performing the calibration, he may do so by clicking on the **Calibration figure V1** and **Calibration figure V2** fields and manually overtyping the existing values. In this case, the operator would then click the **OK** button to store the new values.

13.3 Surface Temperature Sensor Calibration

Before delivery of a non-contact Dynatest IR (Infra-Red) Surface Temperature Sensor, the best-fit calibration line for this sensor has been established from linear regression on a set of 9 values obtained from a reference calibration procedure performed by means of a high-accuracy, certified, dry-block calibrator (with a special adapter giving the desired emissivity of 0.95) traceable to international standards. The 9 reference temperatures are 5 to 45 °C in steps of 5 °C. A sensor is only approved if it performs to linearity specifications.

The Temperature Applet needs two calibration “numbers” (V1 and V2, i.e. sensor output values (in mV)) to calculate and display the air temperature. These values are the sensor outputs at 0 °C and 100 °C *calculated* from the above-mentioned, linear regression line (and therefore not necessarily the values which the sensor would *actually* output at these temperatures). This procedure ensures maximum possible accuracy in the most important range of 0 °C to 50 °C.

The Temperature Applet provides an automated procedure for periodic verification, establishing the calibration numbers of the Surface Temperature Sensor in TWO points, which is in most cases adequate, as the *linearity* of a sensor has been checked at the initial calibration and normally does not change significantly with time, and two points therefore will suffice to determine the (linear) calibration line.

Calibration of an IR sensor is NOT a simple task, so we recommend users NOT to perform this procedure themselves unless absolutely necessary. For maximum accuracy, Dynatest render a 9-point re-calibration service.

If a user decides to perform the two-point calibration verification procedure anyway, one or two stirred water bath(s) can be used. To monitor the (reference) temperature of the water, we recommend a digital reference thermometer with a traceable accuracy of ±0.4 °C or better (in the 0 °C to 50 °C range) and a resolution of 0.1 °C or less.

The temperature of the stirred water bath(s) must be adjustable to “low” and “high”, stable reference temperatures. The low temperature should be in the range of 0 °C to 10 °C, and the high temperature should be in the range of 40 °C to 50 °C. The Surface Temperature Sensor and the liquid bath with the reference temperature sensor should be enclosed, so evaporation from the water will not decrease its surface temperature, and also to prevent condensing moisture on the lens of the Surface Temperature Sensor, which should be placed vertically, preferably with a distance of some 300 mm between the lens of the sensor and the surface of the water, with no objects between the lens and the water surface.

Calibration instructions are provided on the screen. The operator need only follow these instructions to successfully perform a calibration. “Low” and “high” temperature measurements are obtained as explained above. When each of the temperature readings has stabilized, the buttons near the right edge of the screen can be used to enter the voltage values. This reduces the possibility of typed input errors.

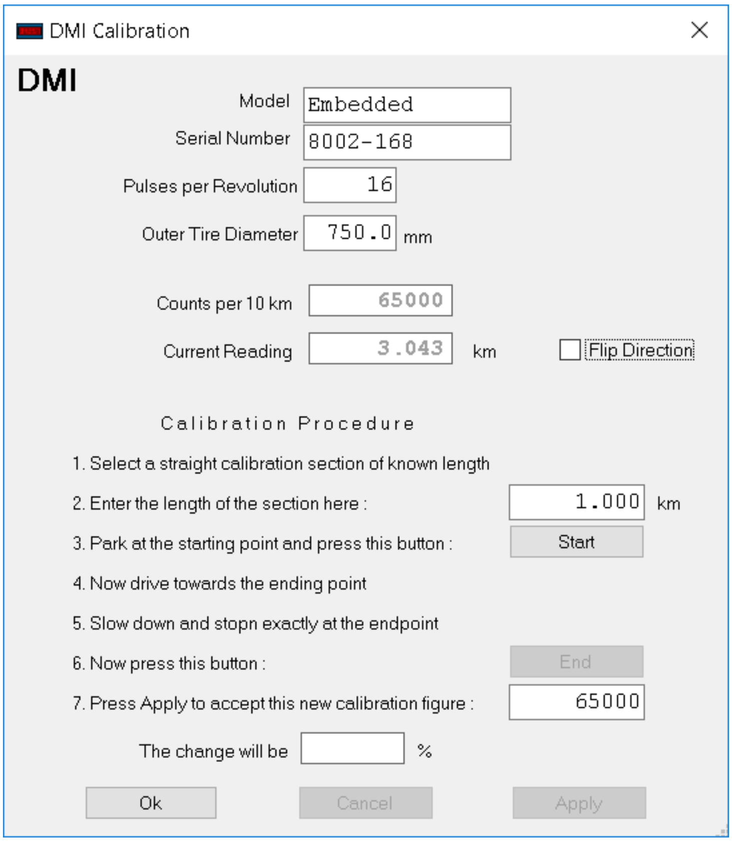
When the calibration is complete, the Temperature Applet will automatically calculate new calibration voltages and display them in the fields labelled **New V1** and **New V2**. The operator may then click the **Apply** button to store and use the new calibration figures. Alternatively, if the operator is not satisfied with the calibration results, he may click **Cancel** to discard the new figures and keep the old ones.

If the operator wishes to enter calibration values without performing the calibration, he may do so by clicking on the **Calibration figure V1** and **Calibration figure V2** fields and manually overtyping the existing values. In this case, the operator would then click the **OK** button to store the new values.

13.4 *DMI Calibration*

Dynatest provides a simple user-friendly method for calibrating the DMI. It does require however, that the user has access to a smooth straight pavement section (of say 1 km or 1 mile of length) which has been accurately measured and whose endpoints have been marked.

To initiate the DMI calibration, right click the DMI applet and select **Calibration**.



The first fields in the screen holds the encoder Model, Serial Number and Pulses per Revolution.

Enter the approximate tire diameter.

"Counts per 10 km" is the calibration value currently in effect. This is the total number of counts received from the wheel encoder over 10 kilometres.

The field labelled "Current reading" is the distance travelled since the DMI was last reset.

The "Flip Direction" (phase reversal) should be toggled if the reading decreases when driving forward.

The Calibration Procedure consists of the following steps:

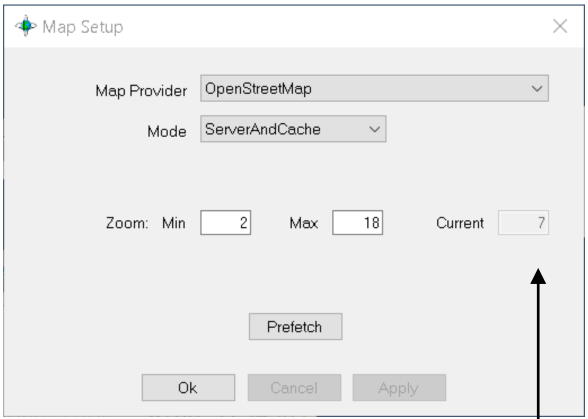
1. Locate a straight, smooth, accurately measured pavement section with no distresses.
2. Enter the measured length of the section.
3. Locate the starting point and stop the vehicle as close as possible, then press **Start**.
4. Accelerate gently to a constant speed, maintaining a straight trajectory over the length of the calibration section.
5. Slow down in a smooth manner and stop the vehicle as close to the end of the section as possible.
6. Click the **End** button. The program will calculate a new calibration figure and display it in the window under the **End** button.
7. If the calibration figure is within a few percent of the old figure, click the **Apply** button to accept it. Note that the box at the bottom of the window shows the percent change from last calibration.
8. Click the **Ok** button to return to close the window.
9. If the calibration figure is more than 1% different from the old figure, subsequent runs should be performed. If the calibration figure is erratic, check the system for possible problems with the tires, encoder mounting, encoder wiring, etc.
10. The calibration process can be abandoned at any time provided the **Cancel** button is pressed before the **Apply** button.

14. Setup Details

14.1 GPS

14.1.1 Prefetch Maps

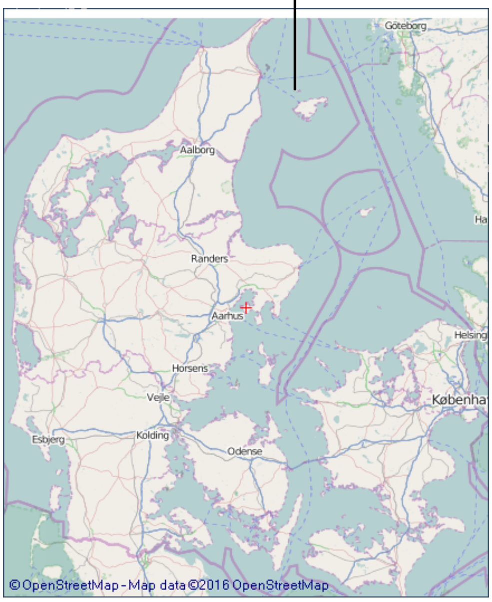
If you do not have Internet connection during data collection, then you may prefetch map imagery when the Internet is available. This can be done by connecting your laptop to an office network and run DDC in simulation mode.
Right click the GPS applet and chose “Map Setup”



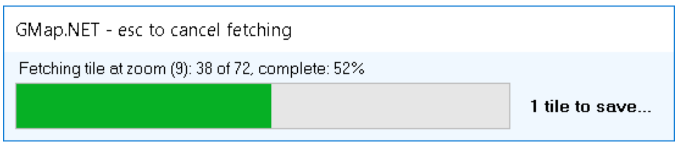
Select the desired Map Provider. ServerAndCache means that if a tile is not found in the cache, then it is fetched from the Internet.

Embrace your area of interest (Denmark) and get familiar with the detail of zoom levels. This is zoom level 15 with a fair amount of detail:

Zoom out again to level 7 to embrace all of Denmark and then set Zoom Max to 15.



Press “Prefetch” to start the process. This may take several hours!

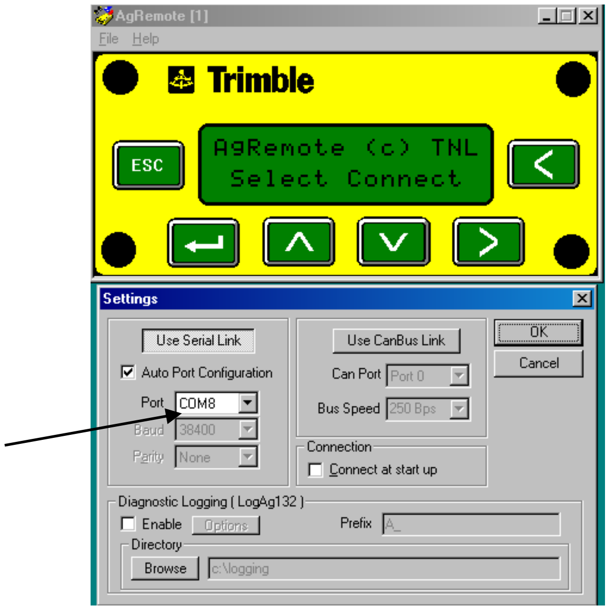


14.1.2 Trimble Ag262 Setup

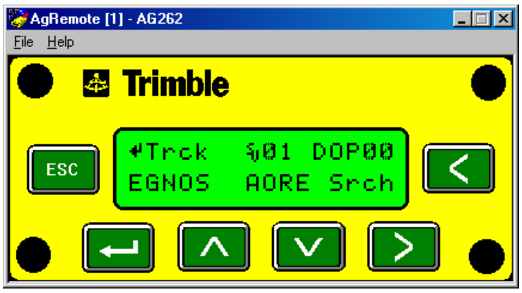
We will setup the Ag262 through port B and later use the device through port A

Install Trimble's AgRemote software
Connect signal cable to port B
Connect RS232 plug to computer
Apply power

Start AgRemote and choose File – Connect, then select the right COM Port:

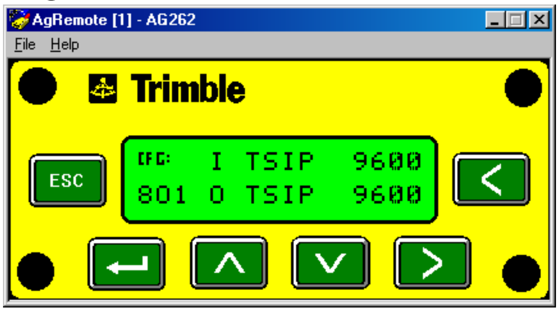


Connection is established if this comes up:

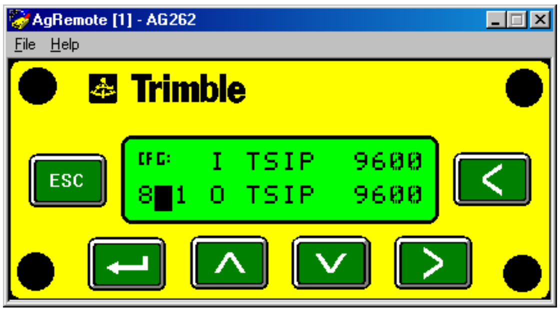


Click **>** until **Configuration** then **V** once, then **>** until **Port A Config**:

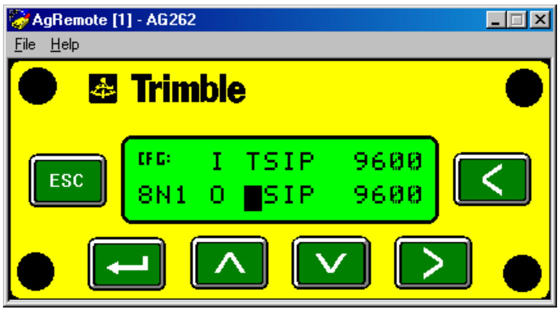
Click **V** to enter Port A configuration:



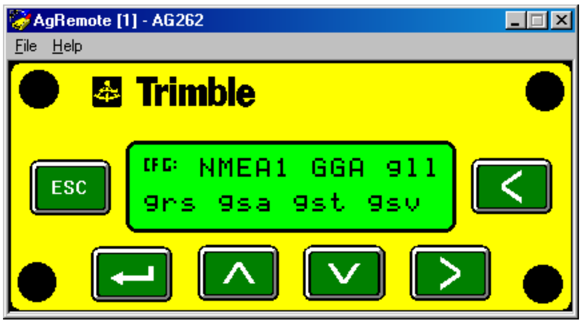
Click **>** until cursor reaches **O** in **8O1**, then click **V** once to make it **N** (no parity)

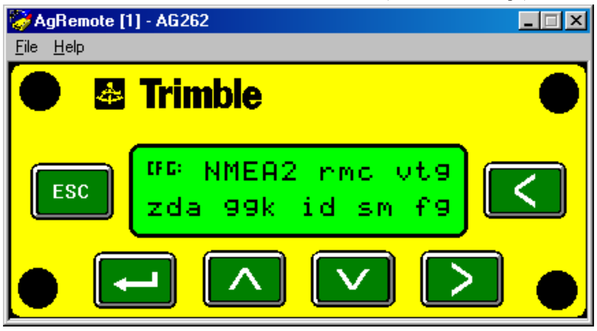


Click **>** until cursor reaches **TSIP**, then click **V** until you get **NMEA**



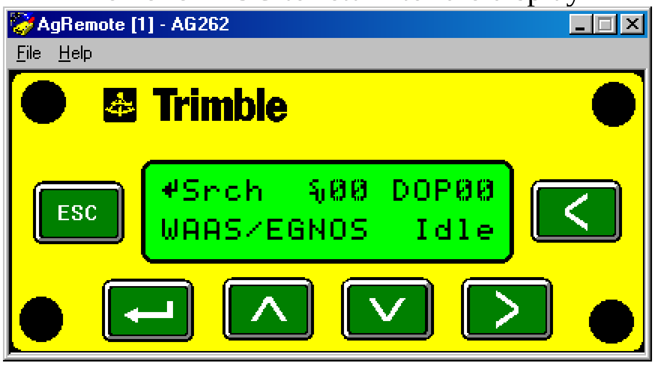
If the baud rate is not 9600, then change it
Press ← (Enter) to terminate edit mode
Click **V** to check the NMEA message settings, which should be as follows (GGA only):





Click **V** to get to:

Then click **ESC** to return to idle display



Then Choose [File] – [Disconnect] and exit the AgRemote program.

Switch off the GPS
Connect signal cable to port A
Check the GPS with DDC

14.1.3 Trimble BX982, Ver. 85992-01 (Basic Version) Setup

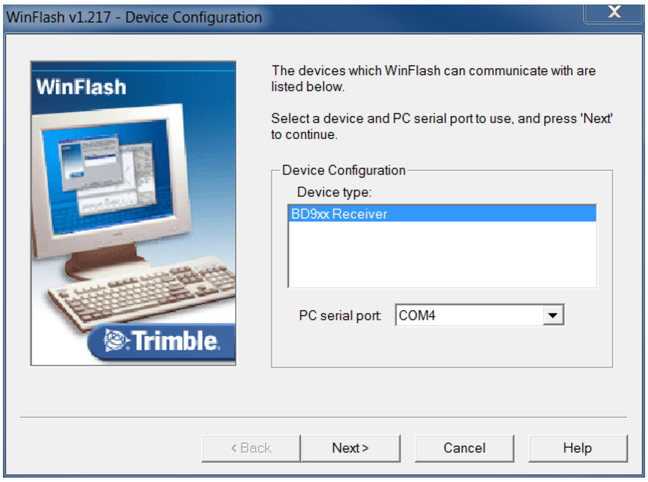
Download WFC-BD9xx-V494.exe from this web site:
http://intech.trimble.com/support/oem_gnss/trimble_bd982

Install on a computer on the usual 192.168.1.xxx network.

Connect a Serial cross over cable to PORT4 at the BX 982

Connect an Ethernet cable to the BX 982 "Dongle"

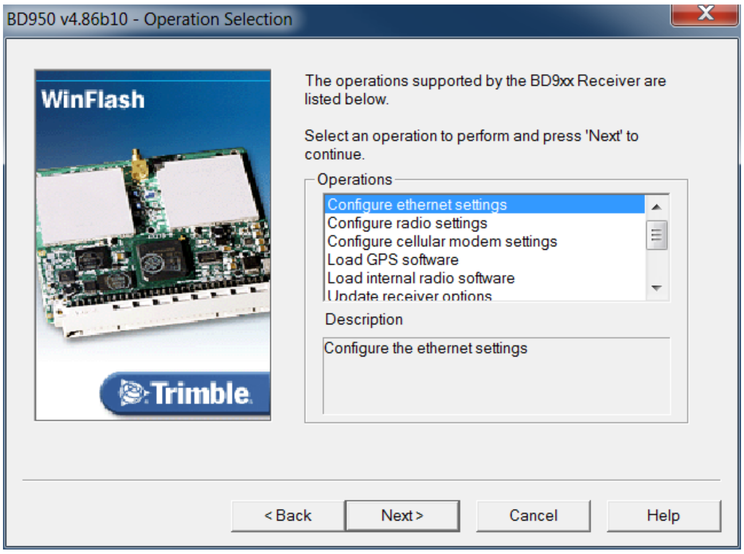
Start WinFlash and set the COM port for your computer:



Chose "Configure Ethernet settings"

Click "Next" then "Finish"

The program now tries to communicate via COM



The default setting is DHCP

Change that to “Static IP address”

and enter IP Address: 192.168.1.19

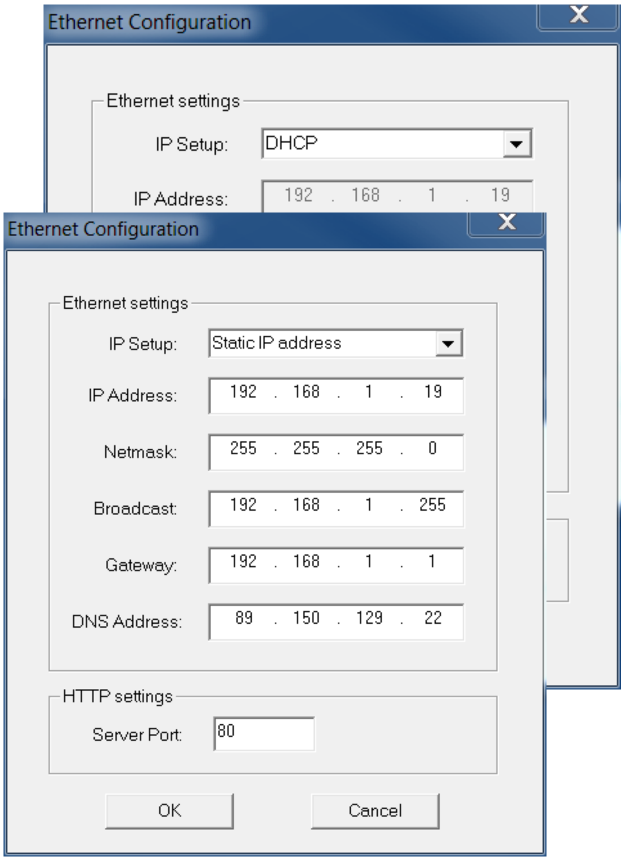
Press OK and the BX 982 will reboot

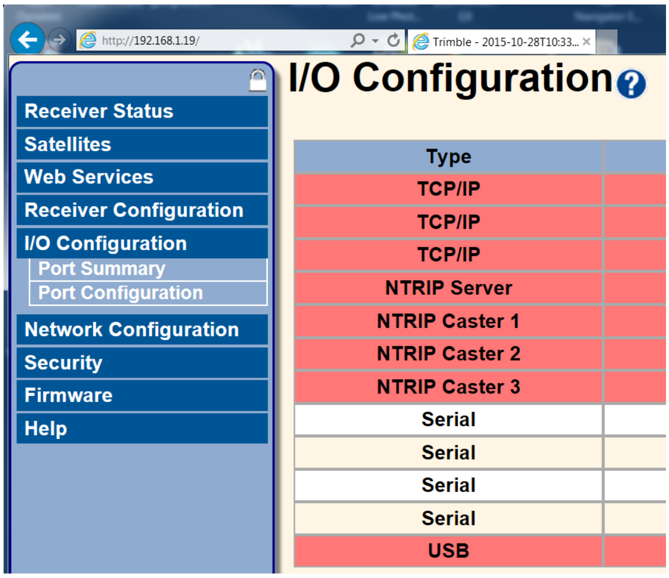
Exit WinFlash

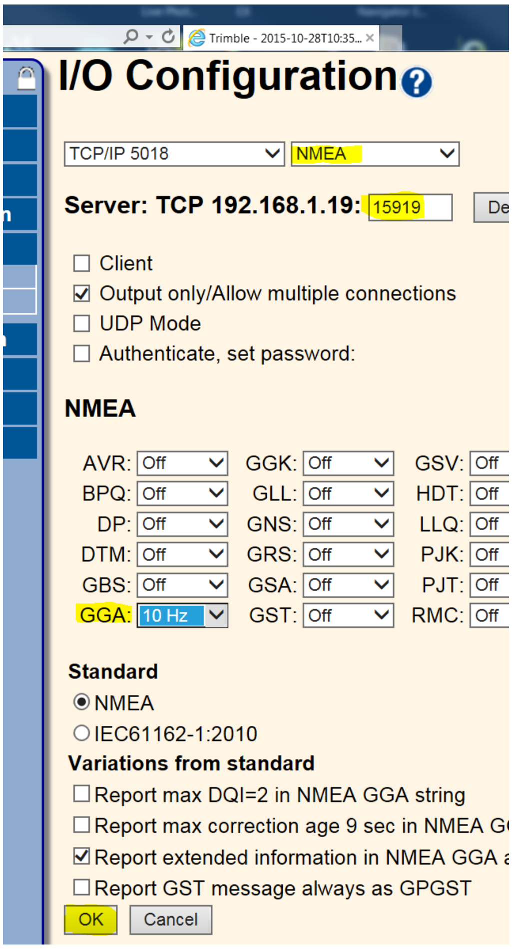
Open an Internet browser and enter 192.168.1.19 in the address line

User name: admin

Password: password



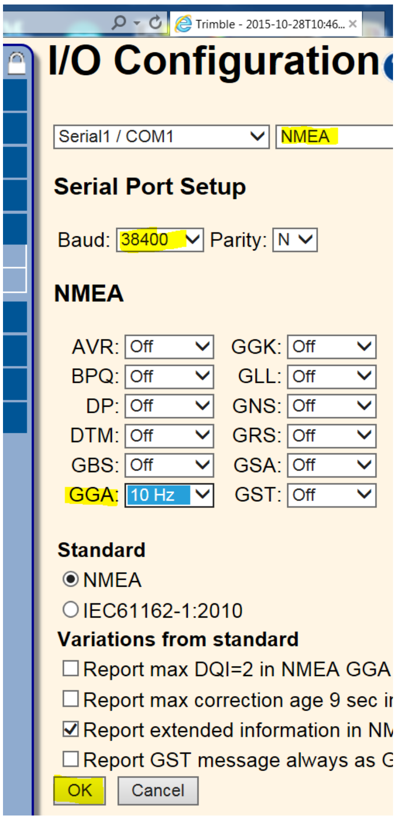




In I/O Configuration click one of the TCP/IPs

Chose: **NMEA,** Listen port: **15919, GGA** at **10 Hz**

Press OK



Chose Serial COM1 and setup for

NMEA, 38400 Baud, GGA at 10Hz

And Press OK

Start DDC with GPS applet colored

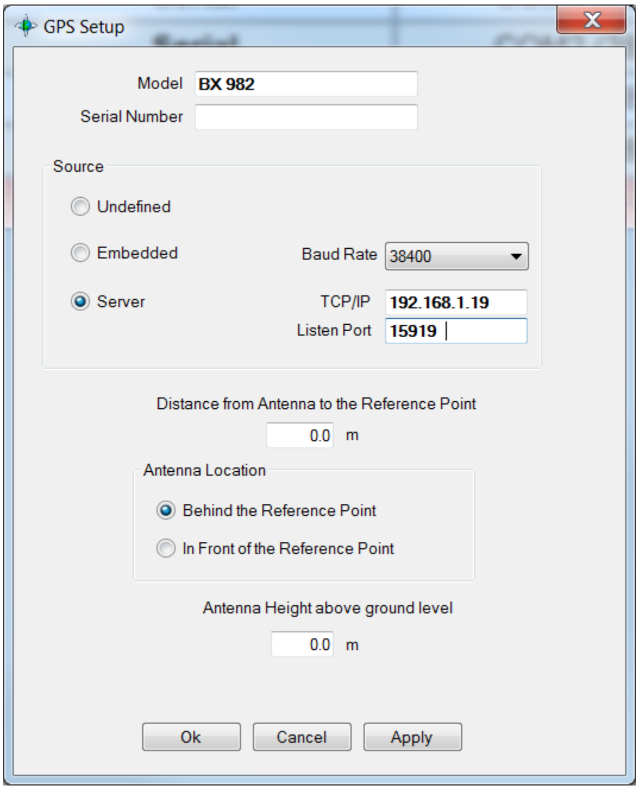
Right click the GPS window and chose [Setup]

Set Server to 192.168.1.19 and Listen port 15919

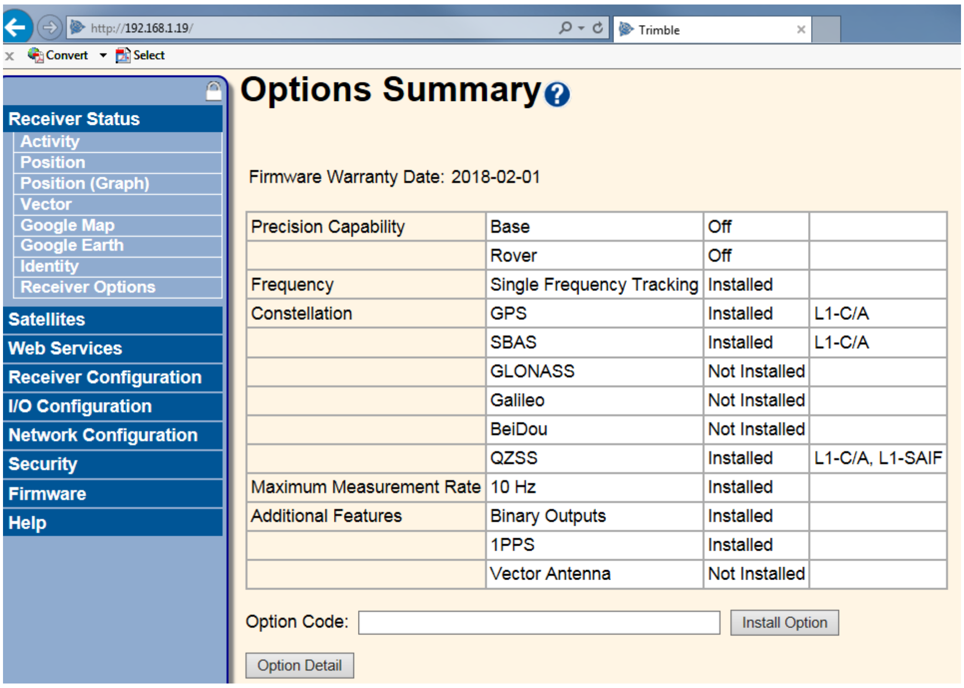
Enter figures for antenna position

(There will be two Distance from Antenna fields, one for FWDs and one for RSPs)

For standard GPSs the “Reference Point” is the location of the Antenna. For Applanix the Reference Point can be chosen freely. For an RSP this will typically be the Laser spot produced by the Center Line laser or the center of the IMU unit.



When the setup (of a standard, basic version BX982, Version 85992-01) has been completed, the Options Summary should look like this:

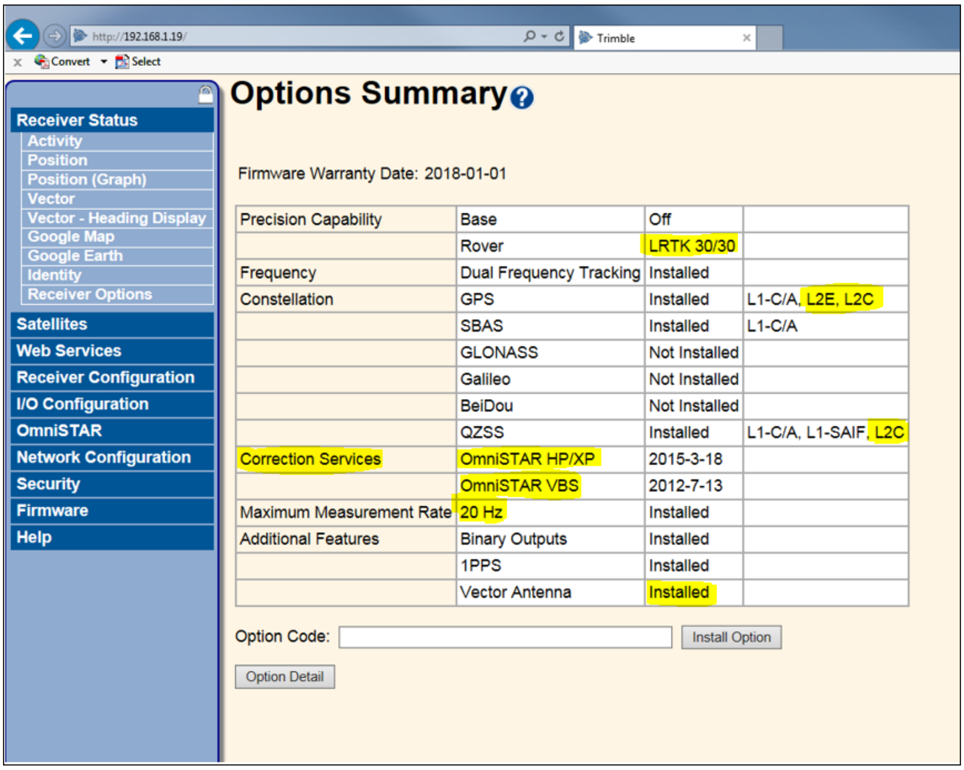


Precision Capability	Base	Off	
	Rover	Off	
Frequency	Single Frequency Tracking	Installed	
Constellation	GPS	Installed	L1-C/A
	SBAS	Installed	L1-C/A
	GLONASS	Not Installed	
	Galileo	Not Installed	
	BeiDou	Not Installed	
	QZSS	Installed	L1-C/A, L1-SAIF
Maximum Measurement Rate	10 Hz	Installed	
Additional Features	Binary Outputs	Installed	
	1PPS	Installed	
	Vector Antenna	Not Installed	

14.1.4 *Upgrading a BX982 to Ver. 85992-02*

To upgrade a ver. 85992-01 (which has been set up as described above) to a ver. 85992-02, do the following:

1. Use the equipment laptop PC (or a computer with the usual 192.168.1.xxx network)
2. Connect an Ethernet cable to the BX 982 “Dongle”
3. Open a web-browser and type 192.168.1.19 in the address field
4. Press “Enter”
5. Click “Receiver Status”
6. Click “Receiver Options”
7. Enter the supplied Password / Code in the “Option Code” field
8. Press the “Install Option” button, which should result in an updated “Options Summary” window as shown below
9. Check additions marked with yellow highlighting



14.2 Cameras

14.2.1 Mounting

Camera Suction Disc Mount

Clean the suction disk

Clean the window

Pull back the plastic housing to protrude the rubber suction disk

Press the rubber suction disk firmly against the window.

Apply suction with the lever and lock in position.

Adjust focus and aperture.

14.2.2 *Exposure*

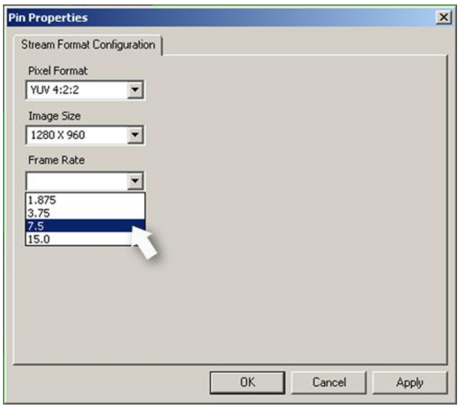
Aperture Adjustment
Shutter Speed and Field of Depth depends on the F-stop setting, the size of the aperture opening. The lens aperture ranges from F 1.4 to F 22 typically
Smaller F-stops numbers = larger opening.
Larger openings = more light.
Larger openings = faster shutter speed.
Larger openings = narrows the Field of Depth. Background and foreground becomes blurred, out of focus.

Balancing Shutter and Aperture
F stop 4 is a good all-round setting. On bright sunny days this gives fast shutter speed, to avoid motion blur, together with “full” Field of Depth.
On dark overcast days and when approaching sunset you can continue to drive as fast as the trucks do and produce good sharp images.
Shutter is defined as the integration time of the incoming light where both the Manual and Auto Shutter are supported.
The shutter range varies from 1us ~ 3600sec.

Camera Auto Exposure Control
The automatic shutter/gain mode is based on a feedback loop which calculates the average pixel luminance. Then the average is compared with the exposure reference value, adjusting shutter and gain accordingly.

14.2.3 *Unibrain Camera*

Unibrain Fire-i™ 780c 1394b SXGA, 2/3" CCD camera with a 12.5mm Fujinon C-mount "Megapixel lens".

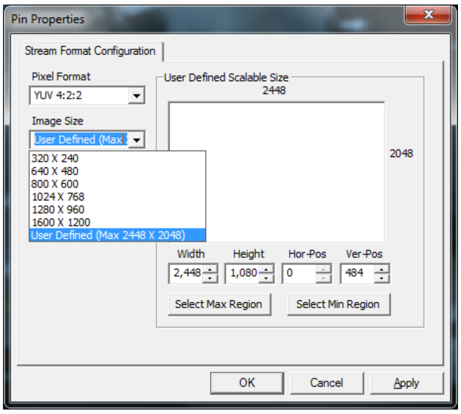


Right click the Camera applet and chose "Picture Format"

Values shall be:

Pixel Format: YUV 4:2:2

Image Size: 1280 x 960.
Fire-i 780c Frame Rate 7.5 (Frames/Sec).

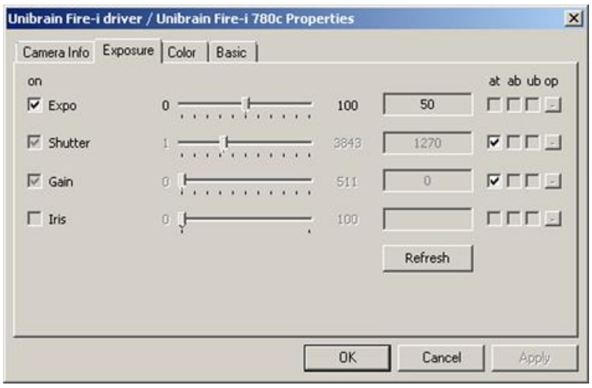


Unibrain Fire-i 980c

Max resolution 2448 x 2048 pixels.

The following items are normally "one-time adjustments" only, or should be done if any unusual problems with picture focusing or brightness occur.

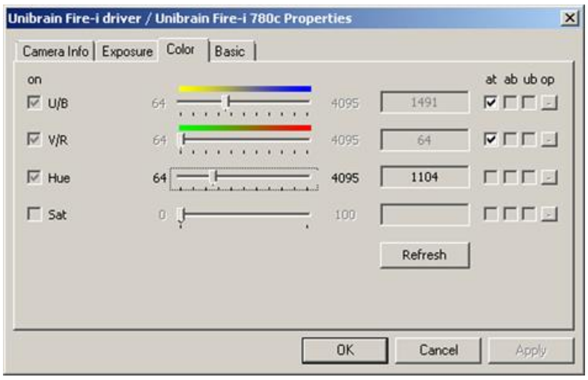
Park the vehicle and make sure to have an object (preferably vertical) with some text on it (a road sign, a paint bottle or the like) some 10-15m from the camera.
Boot the system, so that ROW pictures are shown on the monitor.
Right-click on the ROW picture and select "Aspect/Size", then select "Full Screen".
Right-click on the ROW picture and select "Camera Settings" and then "Exposure"



For “Shutter” as well as for “Gain”, check the “at” box.

Expo: Regulates the total amount of light.
Can be used to regulate the overall “lightness / darkness” of the pictures.
Shutter: and Gain: With check marks in Shutter and Gain “at” the camera automatically adjusts the optimum exposure value.

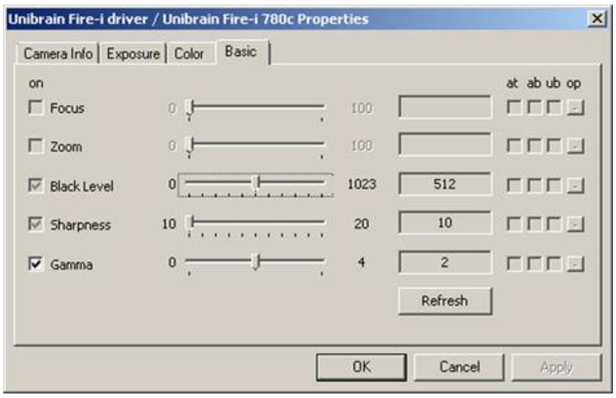
Right-click on the ROW picture and select “Camera Settings” and then “Color”.



For “U/B” as well as for “V/R”, check the “at” box

Color (White Balance):
With check marks in U/B and V/R the camera automatically adjusts correct color balance.
U/B Ultraviolet-Blue.
V/R Visible-Red.
Hue: Can be used to adjust overall color cast of the pictures.

Right-click on the ROW picture and select “Camera Settings” and then “Basic”.



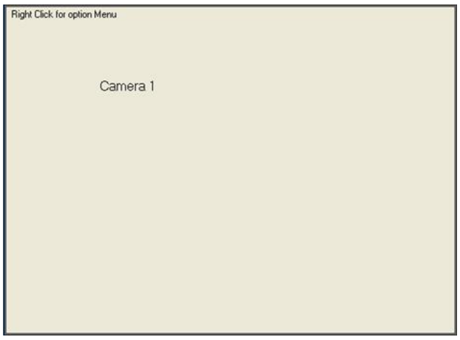
Black Level: Adjust brightness and tonal range by specifying the location of complete black.
Sharpness: Sharpening enhances the definition of edges in an image. Too high setting will create “noise” in the picture.
Gamma ~ “Brightness”.
Corrects the ratio between maximum light (white areas) and minimum light (black areas) in the picture.
If too high “contrast” in your picture adjust gamma down.

If necessary (normally a one-time adjustment), adjust the focus manually as follows:

a) Loosen the f-stop ring locking screw and set the f-stop to the minimum No. (1.4), i.e. maximum aperture opening (maximum light)
b) Then loosen the focusing ring locking screw and adjust the focusing till you get max. sharpness of the object 10-15m away
c) Lock the focusing ring lock screw
d) Set the f-stop No. to 4
e) Lock the f-stop ring locking screw

It is recommended that the Focus Adjustment is done with camera image displayed on the monitor in the camera chip’s native size.
Unibrain Fire-i 780c: 1280x960 pixels.
Unibrain Fire-i 980c: “Panoramic View”, typ. 2448x1080 pixels.

14.2.4 Unibrain Troubleshooting



Empty Image Holder

Camera has not been recognized by Windows.

Is the LED on the camera on?

Check all cable connections.

Power and connection ok and still empty Image Holder?

Drivers for laptops build-in web-camera may also be listed

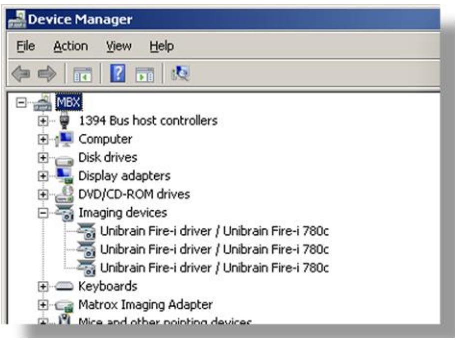
Right Click Image Holder.

In the pop-up Menu Click “Pick Camera”.

Choose “Unibrain Fire-I driver / Unibrain Fire-i 780c”.

Click OK.

Still no image?

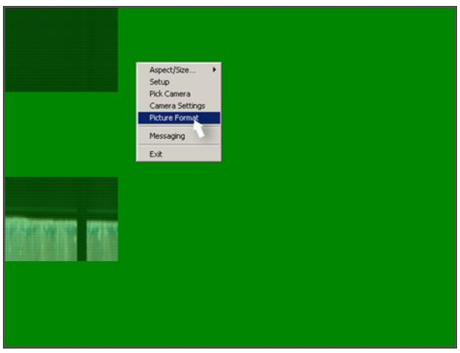


Check Windows’ Device Manager -> Imaging devices.

Under “Imaging devices” the “Unibrain Fire-i driver…” must be listed.

If no “Imaging devices” listed, or only the laptop’s build-in web-camera?

Check that the PC-card is in place.
Check cables for loose connections.
Reinstall drivers.

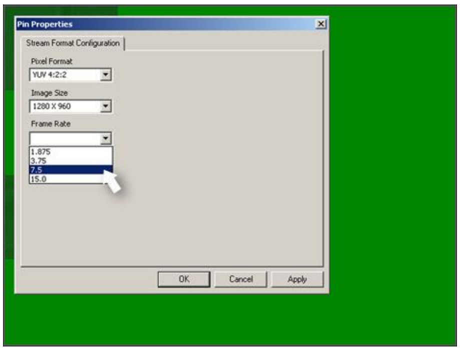


Scrambled / Distorted Image

Camera(s) working, signals received by DDC, but image are scrambled.

Right-Click image holder to bring up the menu.

Click “Picture Format”.



Frame Rate

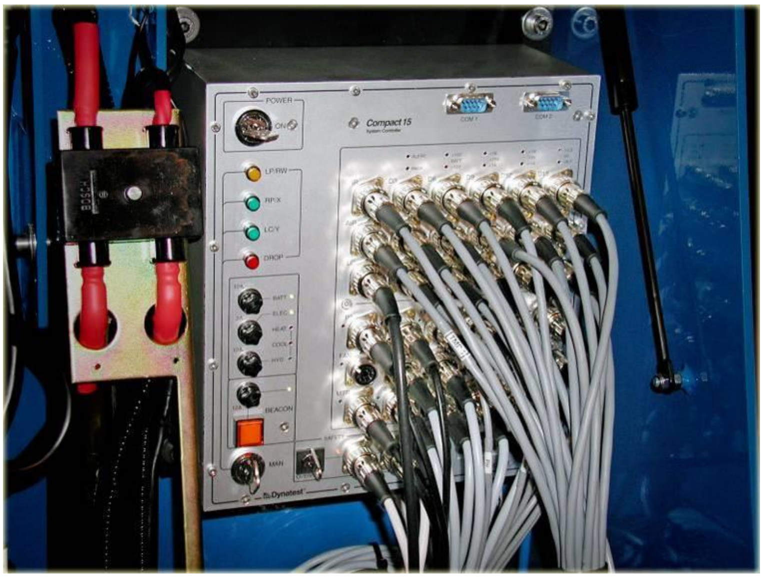
Fire-I 780: Values should be:

Pixel Format: YUV 4:2:2

Image Size: 1280 x 960.

Frame Rate 7.5 (Frames/Sec).

15. The Compact15 System Controller



The Compact15 (CP15) System Controller.

15.1 Key Features

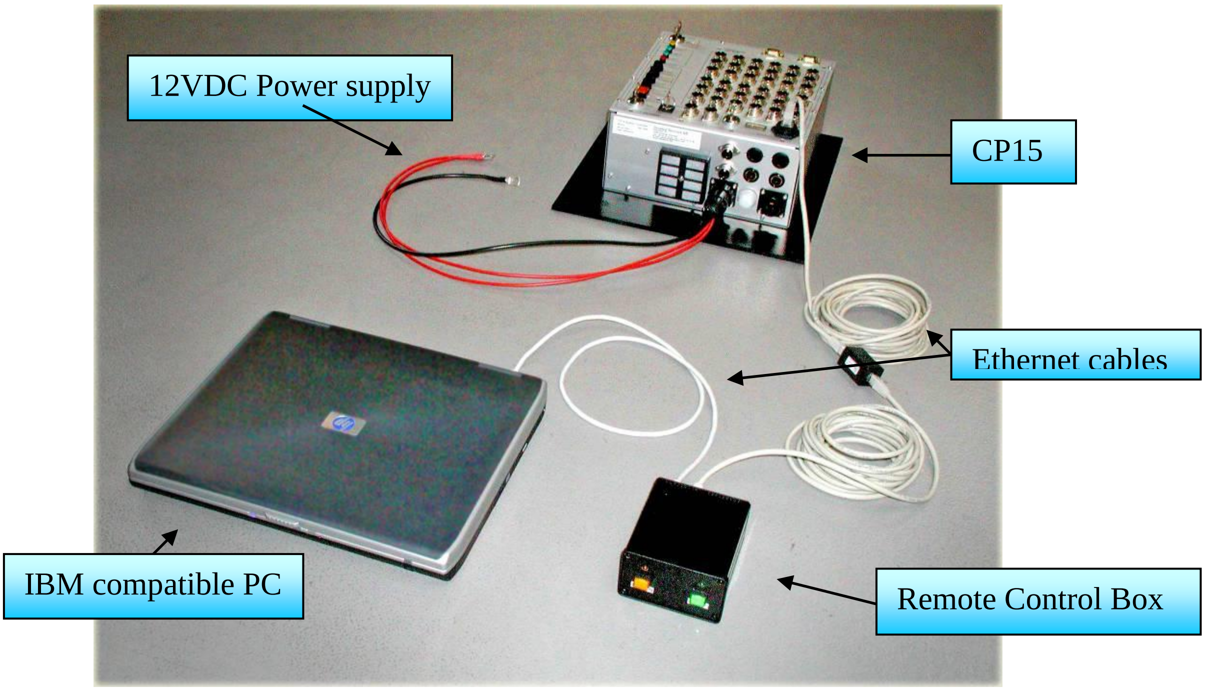
- Light and compact design
- Based on Embedded PC technology
- Performs control of the FWD/HWD system operation
- Performs scanning and conditioning of up to sixteen transducer signals (from one load cell + fifteen deflection transducers max).
- Scans and stores the time history of the transducer signals and calculates peak values.
- Self-test.
- Ethernet interface for connection to host computer
- COM1 port for diagnostics and GPS.
- COM2 port not assigned.
- 12VDC powered, current drain approx. 4 Amps.

15.2 General Description

The Dynatest Compact15 System Controller is a compact, PC based electronic unit, interfaced with the electrical components of the FWD/HWD unit as well as with the computer.

The main functions of the System Controller are:

- controls the FWD/HWD system hydraulics.
- conditioning, scanning, digitizing and transmission to the computer of the signals from up to sixteen transducers, i.e. one load cell and fifteen deflection transducers (Deflectors).
- a continuous testing of system performance to reveal functional or operational errors.



A standard CAT5 Ethernet patch cable connects the Comapct15 System Controller to a Remote Control Box (inside the vehicle) which in turn connects with another patch cable to an IBM compatible PC. These connections are used for normal data collection with the FwdWin field program.
The Remote Control Box enables the operator to remotely switch on power to the Compact15, to optional trailer mounted safety Beacons, and it allows for connections of a Park signal.

For diagnostics and setup purposes the COM1 port may be connected through a “NULL-Modem” cable to a PC running a simple terminal program like Windows Hyperterminal.

Hourmeter and Ethernet interface.

COM1 (Diagnostics and GPS) and COM2.

The only power source needed to power the Compact15 System Controller is 12VDC (10 to 15VDC).

Key Specifications

Power Requirements:

Voltage:	12VDC nominal, range 10 to 15VDC
Current drain:	Approx. 2 Amps. (Not including output power for extern solenoids etc.)

Ambient Temperature Ranges:

Operating:	-20 to 50°C (0 to 120°F)
Storage:	-40 to 85°C (-40 to 185°F)

15.3 Notes on Specifications

Note that the temperature range of the connected Computer may be narrower than that of the Compact15. Note also that the upper limit of 50°C (120°F) will be exceeded at a lower ambient temperature when the unit is exposed to direct sunlight.

With respect to moisture, condensing should be avoided. Normally, this is not a problem with the electronics operating, as the built-in temperature control dries out the unit. But if the unit is colder than the ambient (e.g. after a cold night in a towing vehicle), condensing can occur, and if problems are observed, the electronics has to be kept switched on for a while to dry out the box. Condensing moisture may result in a wrong load cell shunt calibration value and/or amplifier offset(s), which will be detected as "excess vibration or drift".

15.4 Switch ON

The Compact15 contains an Embedded PC. The sequence of events when the system is powered is as follows:

1. BIOS initializes the standard PC components.
2. DOS boots up and initializes the network drivers.
3. A "Stand-Alone" program named CP15BOOT starts (sounds a short beep).
4. When CP15BOOT detects the Host computer, then it requests a connection.
5. When DDC has established the connection, then Compact15 starts the main embedded program named CP15MAIN (sounds another short beep).

Step one and two above lasts approximately 30 seconds.
CP15BOOT starts by sounding a short beep. After that, the manual buttons are operable.
The whole boot process and the output of both CP15BOOT and CP15MAIN can be observed by running a terminal program with a Null-Modem cable from Compact15 COM1 to the Host PC (or any other PC running a terminal program).

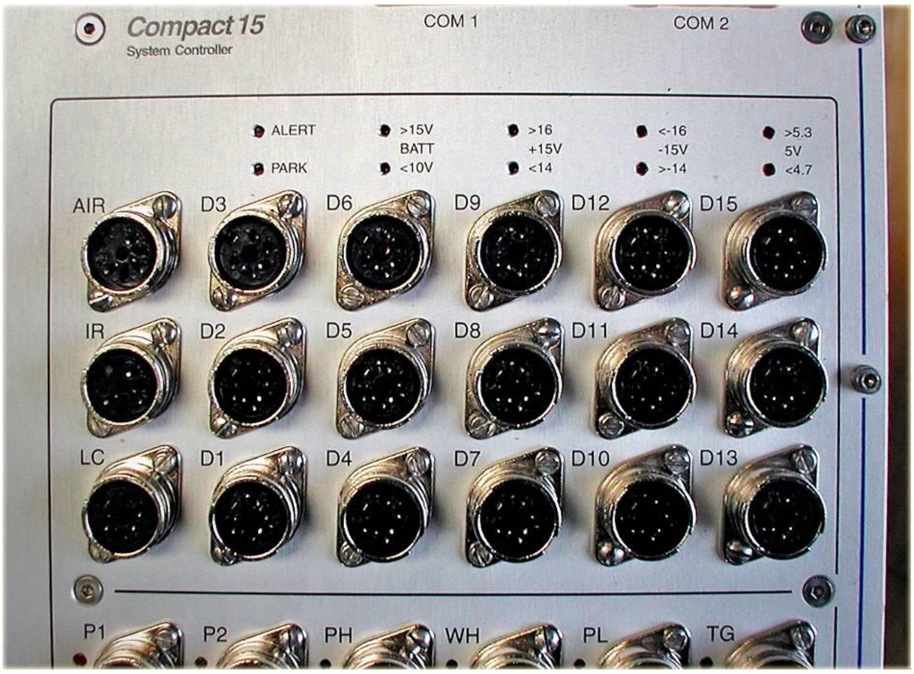
15.5 Setup and Diagnostics

Compact15 is usually delivered set up and ready for use with the appropriate field computer. In the event that you need to run the system with another computer, then the Compact15 must retrieve the new "Computer Name" in order to establish network communication. This may prolong the first start-up.

15.6 Description

LED indicator lights

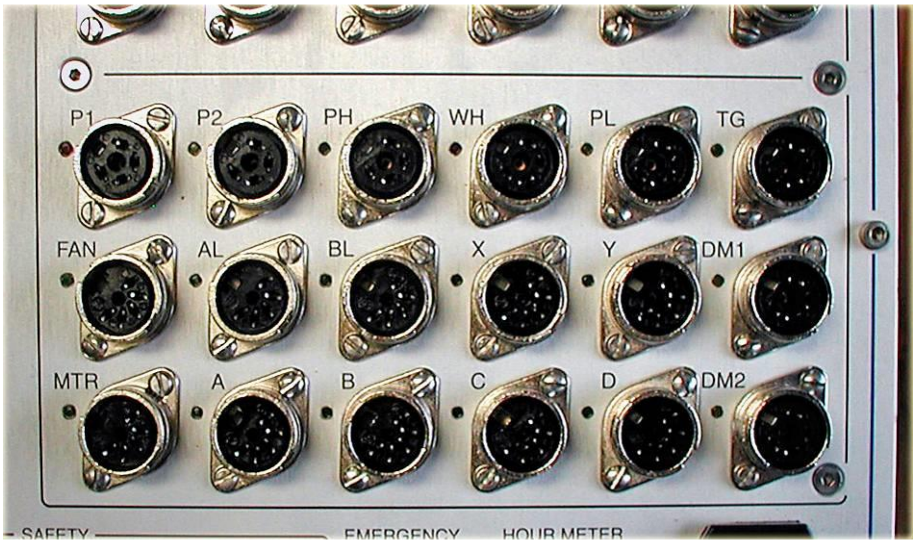
ALERT	Indicates any “forbidden” Status Sensor Signal combination.
PARK	Towing vehicle Park indicator
BATT	Trailer battery voltage indicators.
+15V	Internal, stabilized +15V supply.
-15	Internal, stabilized -15V supply.
5V	Internal, stabilized +5V supply.



CP15 Front Panel

Transducer Connections Sockets:

AIR	Socket for air-temperature probe.
IR	Socket for Infra-Red temperature sensor.
LC	Socket for Load Cell cable.
D1-D15	Sockets “D1” through “D15” for Seismic Detectors.



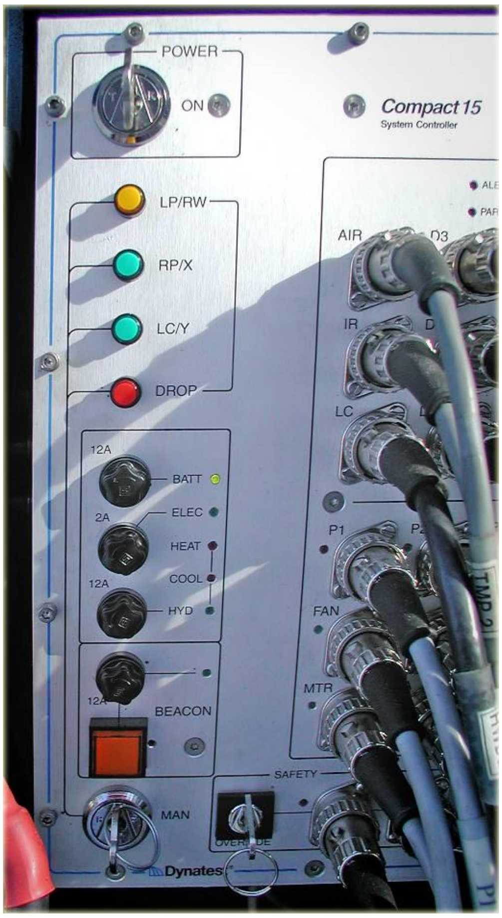
CP15 Front Panel

P1	Pressure Switch 1 (Hydraulics)
P2	Pressure Switch 2 (Hydraulics)
PH	Plate High Proximity Sensor.
WH	Weight High Proximity Sensor
PL	Plate Low Proximity Sensor
TG	Trigger Proximity Sensor
FAN	Power for fan in Air Temperature device.
AL	Solenoid AL (Automatic locks).
BL	Solenoid BL (Automated locks)
X	12V power outlet (Activated by pressing the RP/X button (See below)
Y	12V power outlet (Activated by pressing the LC/Y button (See below)
DMI1	Distance Measurement Instrument Sensor 1.
MTR	Motor Relay.
A	Solenoid A (Hydraulics)
B	Solenoid B (Hydraulics)
C	Solenoid C (Hydraulics)
D	Solenoid D (Hydraulics)
DMI2	Distance Measurement Instrument Sensor 2.

15.7 Manual Operation

- Turn the POWER key "ON"
  If the embedded computer has not been booted through the laptop, wait approximately 30 seconds for the booting sequence to finish. (CP15 sounds a short beep).
- For safety reasons the spring disengaged "MAN" key must be kept activated for the manual buttons to work!
- Press the RP/X (Raise Plate) button to lift the hit bracket off the transport locks.
- Press the LC/Y (Lower Catch) button shortly to disengage the transport locks.
  On deflectometers with manual locks, manually disengage the transport locks.
- Press the LP/RW (Lower Plate/Raise Weight) button to lower the loading plate to the road surface.
- Press (or keep pressing) the LP/RW button to raise the weights.
- Simultaneously press the LP/RW and DROP buttons to release the weights from the Catch.
- Press the LC/Y to lower the catch to lock on to the lifting collar of the weight package.
- Press the RP/X button to raise the hit bracket back to transport position.

CP15 Push Button Panel:



The embedded computer must boot and the "MAN" key must be kept activated for the buttons to work!

Pressing the "RP/X" button without engaging the "MAN" key, activates the 12V "X" outlet.

Pressing the "LC/Y" button without engaging the "MAN" key, activates the 12V "Y" outlet.

CP15 Systems fuses.

Four green diodes indicate "Fuses OK".

12A "Batt" fuse.

2A "Elec" fuse.

12A "Hyd" fuse.

12A "Beacon" fuse.

CP15 Front Panel lower part.

The “BEACON” button (and the yellow button on the Remote Control Box): Turns power on/off to the two coaxial 12V sockets and the three pin socket positioned on the bottom panel of the CP15. (See image “*CP15 Bottom Panel*” below.)

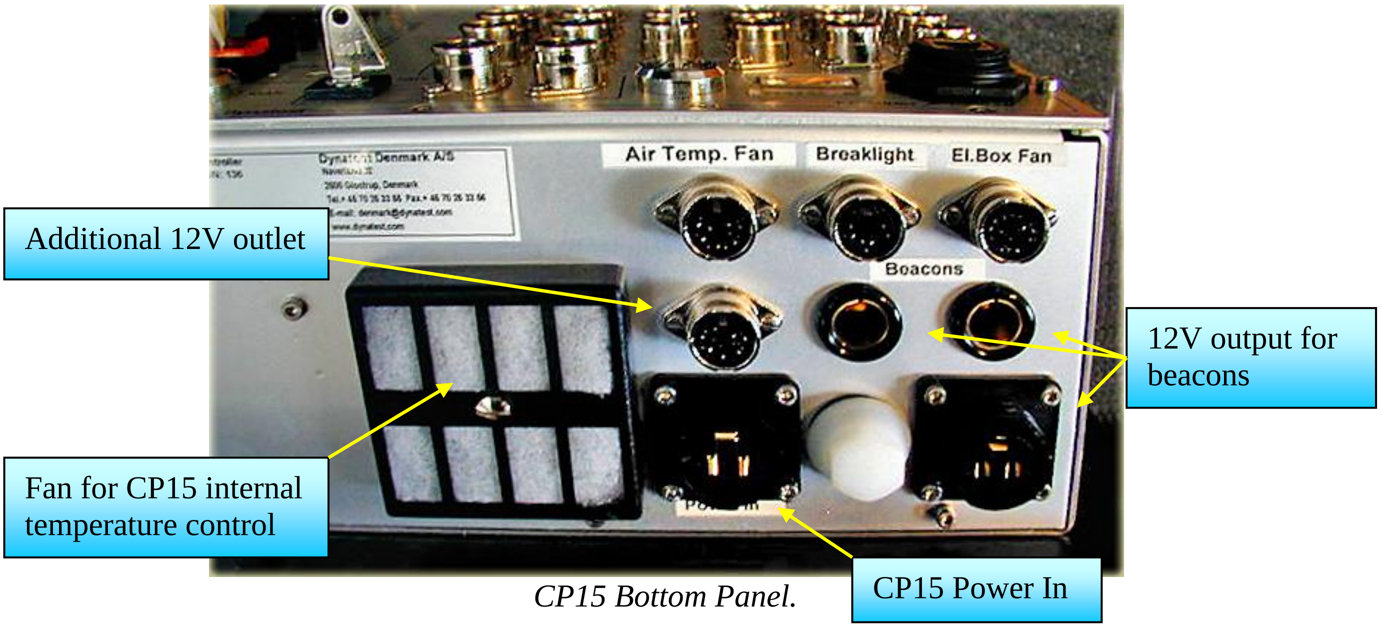
“MAN” switch: For manual operation (See above description).

“SAFETY / OVERRIDE” switch: Overrides the two safety panel switches connected to the two DIN sockets to enable operation of the hydraulics with the safety screens removed, for e.g. servicing purposes. – ONLY to be used by trained personnel.

“**EMERGENCY**” Raise Plate switch: Raises the loading plate to transport position. **Careful:** Overrides the FwdWin programme and the embedded CP15 computer.

“HOURMETER”: Counts the time the hydraulics engine is powered.

“ETHERNET”: A standard CAT5 Ethernet patch cable connects the Comapct15 System Controller to the Remote Control Box (inside the vehicle) which in turn connects with another patch cable to an IBM compatible PC.



CP15 Bottom Panel.

“Air Temp. Fan” 12V power outlet for fan in Air Temperature device.
“Brakelight” Alternative Park Alarm input from brake light.
“El. Box Fan” 12V power outlet for (optional) fan in FWD Electronics Box.
“Beacons” Two coaxial 12V outlet plus one additional 12V outlet for beacons.

16. Maintenance

FWD/HWD System Maintenance

SAFETY NOTE!

Whenever somebody is close to the moving parts of the FWD/HWD System, MAKE SURE that all POWER has been switched OFF!

NEVER PUT HANDS *UNDER* DROP WEIGHT when this is not supported!

16.1 Wheels/Brake System

1) Tire pressure should be set at 2.8 bar (ato) (40 psi) cold.
2) Check that all wheel lug nuts are tight. (Torque: 10 kgm / 100 Nm / 75 lb.ft.)
3) Ensure that all nuts, bolts and pins are secured on all exposed parts of the brake system (i.e. all parts that move when the handbrake is pulled).
4) Check brake adjustment to ensure that trailer will stop its own weight and not push the tow vehicle: First check brake shoes adjustment:
   - release hand brake completely
   - jack up one side of the trailer, so that the wheel(s) can be rotated by hand
   - tighten (clockwise) the 8 mm adjustment nut (on the rear (i.e., the inner side) of the wheel hub), until the wheel gets very hard to turn
   - turn wheel in direction of travel to centre brake shoes
   - loosen again the adjustment nut only so much that the wheel turns freely
   - repeat above procedure for the other wheel(s)
   - check for uniform brake response in both sides of the trailer.

   If trailer now pushes tow vehicle, then adjust (shorten) pull rod behind hand brake, so that hand brake travel decreases. Hand brake should become active when pulled a few “clicks”.
5) Grease inertial brake system every 5.000 km (3,000 miles). Two grease fittings are located by the hand brake. Use high quality grease.

16.2 Drop Weight Subassembly

1) Check that the rubber stabilizers for the load plate are not broken or otherwise damaged, or loose. In case of an (optional) 4-segment loading plate, apply silicone oil or grease into the 4 segment swivel bearings periodically.
2) All exposed nuts and bolts should be periodically checked and retightened if necessary.
3) Inner parts of catch surfaces may be lubricated using a DRY spray lubricate such as Teflon of silicon.
4) **FWD ONLY:** The two external weight guide rollers may be lubricated using a dry spray lubricate such as Teflon or silicon.

5) No lubricant should be used on the weight guide shaft.

6) Check that raise/lower bar cable has no bends or broken strands and check that it is in place on both guide pulleys. Check that the length of cable is properly adjusted and that cable holding clamps are tight. Check that the two cable tightening springs are not broken.

7) Check that all parts of the movable deflector holders are tight, especially the bottom measuring tips.

16.3 Electrical/Electronic Parts:

1) Battery terminal clamps must be kept clean and coated to prevent corrosion.
If relevant, check acid level of the trailer buffer battery(-ies) and refill with distilled water.

2) Check motor brushes for excessive wear at least once a year. Exchange of brushes should only be performed by qualified personnel (e.g. by Dynatest).

3) Check all four proximity sensors to ensure that they are securely fastened.

4) Check (and exchange if necessary) the two protective rubber boots (caps) of the two pressure switches P1 and P2. Make sure that the parts of the switches inside the boots are coated to prevent moisture from penetrating into the switch contact elements. Preferably fill the boot completely with silicone grease like e.g. Dow Corning DC-4 grease.

5) The heavy trailer fuse box should be periodically checked for possible corrosion. All metal parts inside the fuse box should be sprayed regularly with e.g. WD40 to prevent corrosion.

16.4 Hydraulic System

1) Check hydraulic oil level: When the FWD/HWD loading unit is in its transport position (i.e. when the plate (subunit) has been raised completely) and when parked on a level surface, then the hyd. oil level should be within the upper half of the level indicator on the hyd. oil reservoir. The level indicator should NOT be filled completely!

   Refill with hydraulic oil (Exxon (Esso) Univis N46 or Shell Tellus T37) if necessary. If hyd. oil level has been very low, then bleeding may be necessary, refer to Chapter 11.3 FWD/HWD Hydraulics, and the paragraph “Bleeding the Hydraulics”.

2) The hydraulic oil should be exchanged every year (at least). If the equipment is not used for a longer period (e.g. several months during the wintertime), then preferably perform the oil exchange at the beginning of this period. After hyd. oil exchange, the hyd. system should be operated so much that remaining old oil in all cylinders, pipes, etc., will be exchanged with the new oil, and then the system should be bled, refer to Chapter 11.3 FWD/HWD Hydraulics, and the paragraph, “Bleeding the Hydraulics”

3) Oil filter should be changed every year.

17. *Trouble Shooting*

If a functional error occurs during operation of the Dynatest FWD/HWD Test System, this will normally result in an error message on the computer screen.

In cases where it is hard to find the cause for the error message, or in cases where something strange happens (without creating a computer error message), then the following Trouble Shooting Procedure should be used, which should reveal most of the possible errors, especially errors related to the FWD/HWD hardware.

This section mainly consists of Notes which are referred to in the check list below.

Always first check all fuses and battery conditions. Check also that the computer power is OK.

SAFETY NOTE!

Whenever somebody is close to the moving parts of the FWD/HWD System, MAKE SURE that all POWER has been switched OFF!

NEVER PUT HANDS *UNDER* DROP WEIGHT when this is not supported!

1. Check hyd. oil level. (See 17.1, “Checking the Hydraulic Oil Level”).
2. Switch off all power (See 17.2, “Switching off all Power”).
3. Disconnect the Ethernet Cable from the Compact15 Front Panel.
4. Turn ON the Compact15 and check that at least one of the LEDs turn(s) on (See 17.3, “Checking Trailer Electronics Power”).
5. Check trailer buffer battery condition, hyd. motor and motor relay (See 17.4, “Checking Trailer Battery Condition”).
6. Check RAISE PLATE mode (See 17.5, “Revealing hyd. leakage error”, 17.6, “General Functional Checking of the Hydraulics”).
7. Check LOWER PLATE/RAISE WEIGHT mode (See 17.6, “General Functional Checking of the Hydraulics”, 17.7, “Checking the Lower Plate/Raise Weight mode”).
8. Check DROP mode (See 17.6, ”General Functional Checking of the Hydraulics”, 17.8, “Checking the DROP mode”).
9. Check LOWER CATCH mode (See 17.6, “General Functional Checking of the Hydraulics”, 17.9, “Checking the LOWER CATCH mode”).
10. Check all proximity switch sensors (See 17.10, “Checking the four Proximity Switch Sensors”).
11. Check the two pressure switches (See 17.11, “Checking the Pressure Switches”).

17.1 Checking the Hydraulic Oil Level

When the FWD/HWD loading unit is in its transport position (i.e. when the plate (subunit) has been raised completely) and when parked on a level surface, then the hyd. oil level should be within the upper half of the level indicator on the hyd. oil reservoir. The level indicator should NOT be filled completely!

Refill with hydraulic oil (Exxon (Esso) Univis N46 or Shell Tellus T37) if necessary. If hyd. oil level has been very low, then bleeding may be necessary, refer to Chapter 11.3 FWD/HWD Hydraulics, and the paragraph “Bleeding the Hydraulics”.

17.2 Switching off all Power

The trailer power is switched on either by the Power Switch of the Compact15 Front Panel or remotely (if the Network Cable is connected) by the SYSTEM ON push-button on the Remote Control Box.

So, to switch off ALL power, disconnect the network cable and switch OFF the Compact15.

17.3 Checking Trailer Electronics Power

On switching on the Compact15, at least the P1 LED must turn on. If not, check the 2A and the 16A fuses (of the Compact15 Front Panel) and exchange if necessary (slow blow type). If P1 LED did not turn on, but one or more of the others did, then power is OK, but the P1 circuit may be defective (will be checked in a later step).

17.4 Checking Trailer Battery Condition

The battery voltage, monitored directly on the battery terminals, should be at least 12.0 Volts unloaded (i.e., hyd. motor not running).

Turn MAN.KEY and press LC button for 3 to 5 seconds and check that the hyd. motor runs properly, and that the battery voltage does not decrease below 10.5 Volts.

If the voltage decreased too much, or if the motor relay and motor toggles on and off, then the trailer battery needs recharging. Check that the trailer battery voltage increases when the Trailer Power Cable is connected, and the vehicle engine is speeded up. If not, check that the Trailer Power Cable is properly connected. Check also the two heavy, flat kind fuses in the charging line (80-100A): One in the heavy fuse box on the trailer and another in the heavy fuse box in the vehicle engine compartment (this fuse box is integral with the diode unit, if such is used). If still not, then check all screwed connections to the vehicle alternator and in the two above mentioned heavy fuse boxes for corrosion. If any corrosion, remove screws and fuses, clean all joints to bare metal and re-assemble. Spray with a corrosion preventer (e.g. silicone).

If motor did not start at all, then check the motor fuse in the heavy trailer fuse box and exchange, if necessary, then press again LC button and check motor.

If motor fuse is OK and motor will still not start, then press e.g., a small screwdriver into the hole in the end cap of the motor relay (end opposite to the terminals) to activate the relay mechanically. This must cause the motor to run.

If the motor did not run, then check if the other heavy terminal of the relay (connected to the motor) carries voltage when relay pulls. If so, check motor brushes. If not, then the relay contact must be defective, and the relay should be exchanged.

Note that brush exchange should only be performed by qualified personnel (e.g. by Dynatest).

17.5 *Revealing hyd. leakage error*

A hydraulic leakage can cause one or more of the following errors:

E1) The weight drops prematurely.

E2) The weight slides down (without dropping).

E3) The plate slides down.

E2) and/or E3) can be caused by an external leakage which will cause oil spilling, usually making it rather easy to locate.

One or more of the above errors can also be caused by internal leakages, such as:

L1) A leaking or loose centre cylinder piston.

L2) A leaking or loose piston in any of the side cylinders.

L3) A leak in the (one of the) A/B valve(s), e.g. due to a stuck plunger.

Re. E1: E1 can be caused by L1 and/or L2.

Re. E2: E2 can be caused by L3.

Re. E3: E3 can be caused by any of the three errors L1, L2 and L3.

Revealing/correcting L1, L2, L3:

L3 can in some cases be cured by alternately activating manually the A and B solenoids, as this may remove particles that caused the plunger to stick. The same applies for optional AL and BL solenoids.

L1 and/or L2 can be revealed by cutting off the cylinders one by one until the error(s) disappear(s), as follows:

- Lower plate to the ground and DO NOT raise the weight.
- Release all hyd. pressure by pressing a rod alternately into the A and B solenoids a couple times.
- Disconnect centre cylinder flexible hoses from the hyd. block and plug the hoses as well as the block connections using the hyd. plugs from the Std. Spare Parts/Tools Kit, to prevent oil spilling.
- Raise the plate off ground. If the plate can stay raised without sliding down more than max. 2 mm (1/10”) per minute or so, then the side cylinders and/or the A/B valve(s) are OK, and the centre cylinder must be leaky and should be repaired/replaced.

If centre cylinder cut-off did not help, then the A/B valve MAY be leaking OR, more likely, at least one of the two side cylinder pistons must be leaking.

17.6 General Functional Checking of the Hydraulics

17.6.1 Brief Functional Description of the Hydraulics

The different operational modes of the Trailer Hydraulics are activated by powering of one or more of the four hydraulic solenoids (coils), denoted A, B, C and D, plus the motor starting relay solenoid denoted M, refer also to 11.3, “FWD/HWD Hydraulics”, from which the truth table is repeated here for convenience:

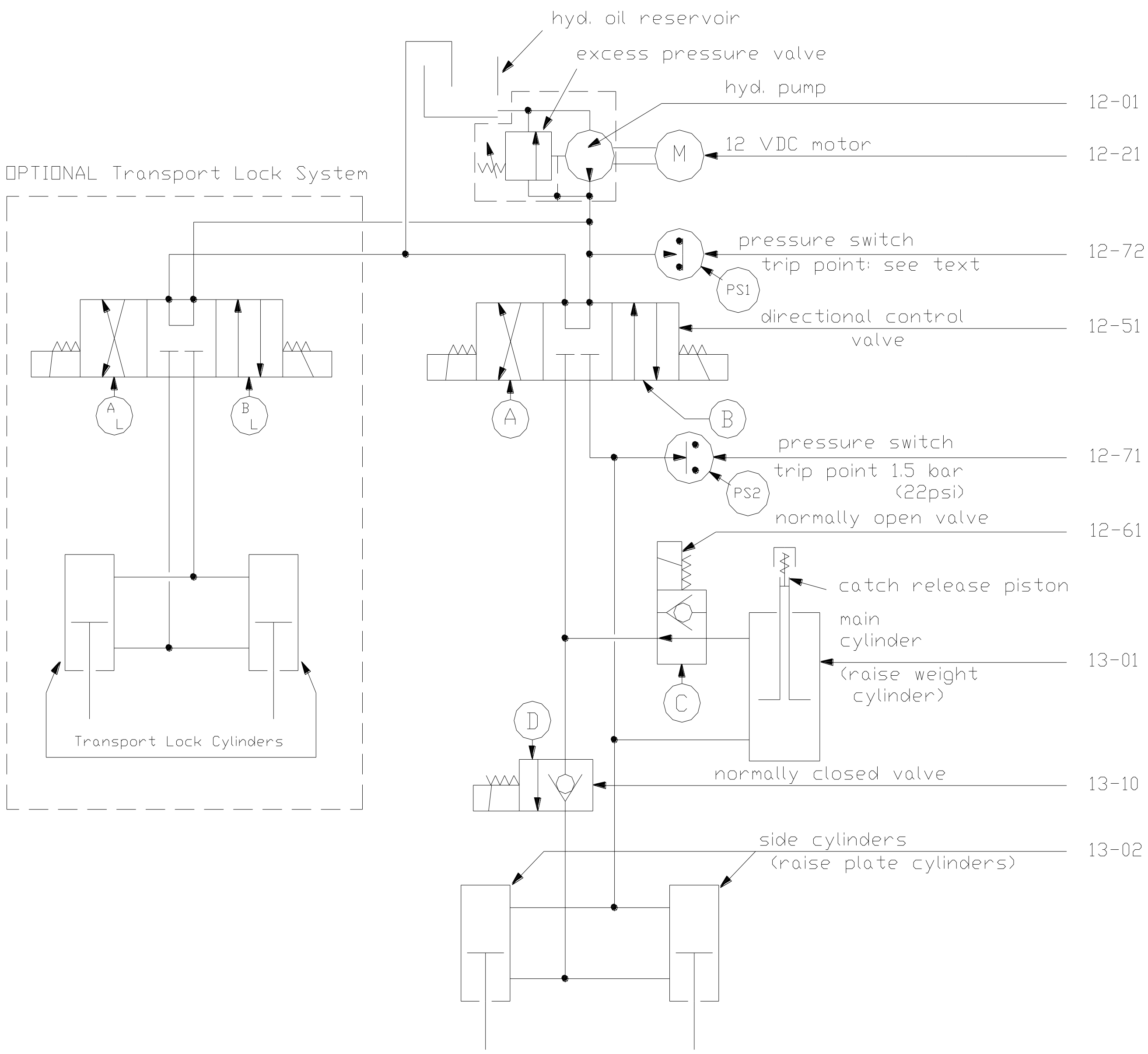
Mode	**A**	**B**	**C**	**D**	**M**	**AL**	**BL**
Raise Weight (Lower Plate)	OFF	**ON**	OFF	OFF	**ON**	OFF	**ON**
Drop (Lower Plate)	OFF	**ON**	**ON**	OFF	**ON**	OFF	**ON**
Lower Catch	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**
Raise Plate	**ON**	OFF	**ON**	**ON**	**ON**	**ON**	OFF

From the hydraulics diagram it can be seen that A/B valve(s) is physically one unit with three possible positions, also called a directional control valve or a 4-way valve. Therefore, A and B solenoids should never be on at the same time, and when both are off, the in- and outlets of all cylinders are cut off from the pump supply, which in turn is shunted directly back to the reservoir.

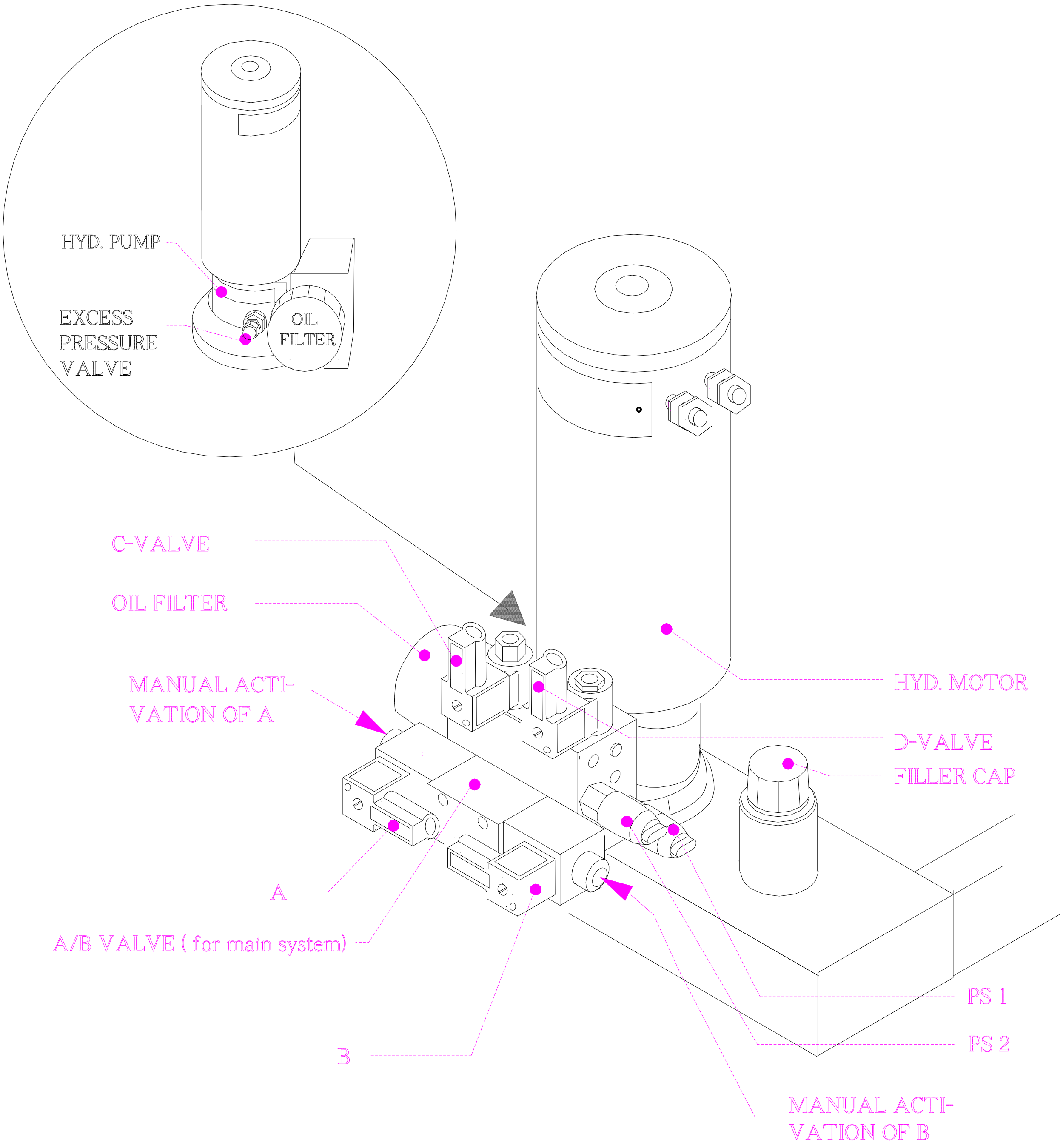
The only difference between RAISE WEIGHT and DROP modes is additional powering of the C valve in DROP mode, which will cut off the return oil from the raise weight cylinder, creating an excess pressure below the piston of this cylinder, a pressure that will propagate through a centre bore in the shaft to a small release piston in the catch, which will then release and drop the weight.

SAFETY NOTE!

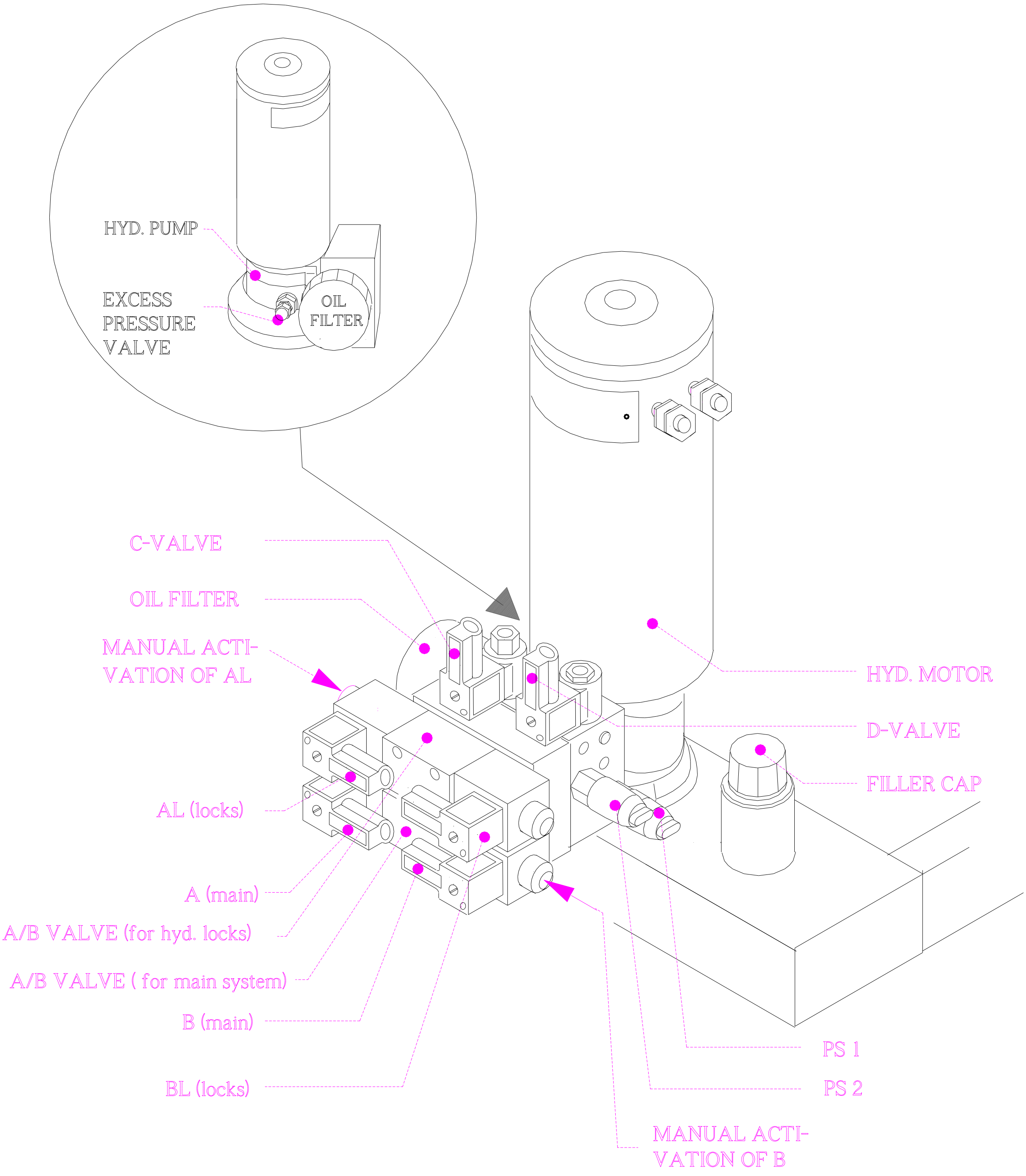
Note that IF the weight is RAISED TO ITS TOP POSITION, then IT WILL DROP!!!



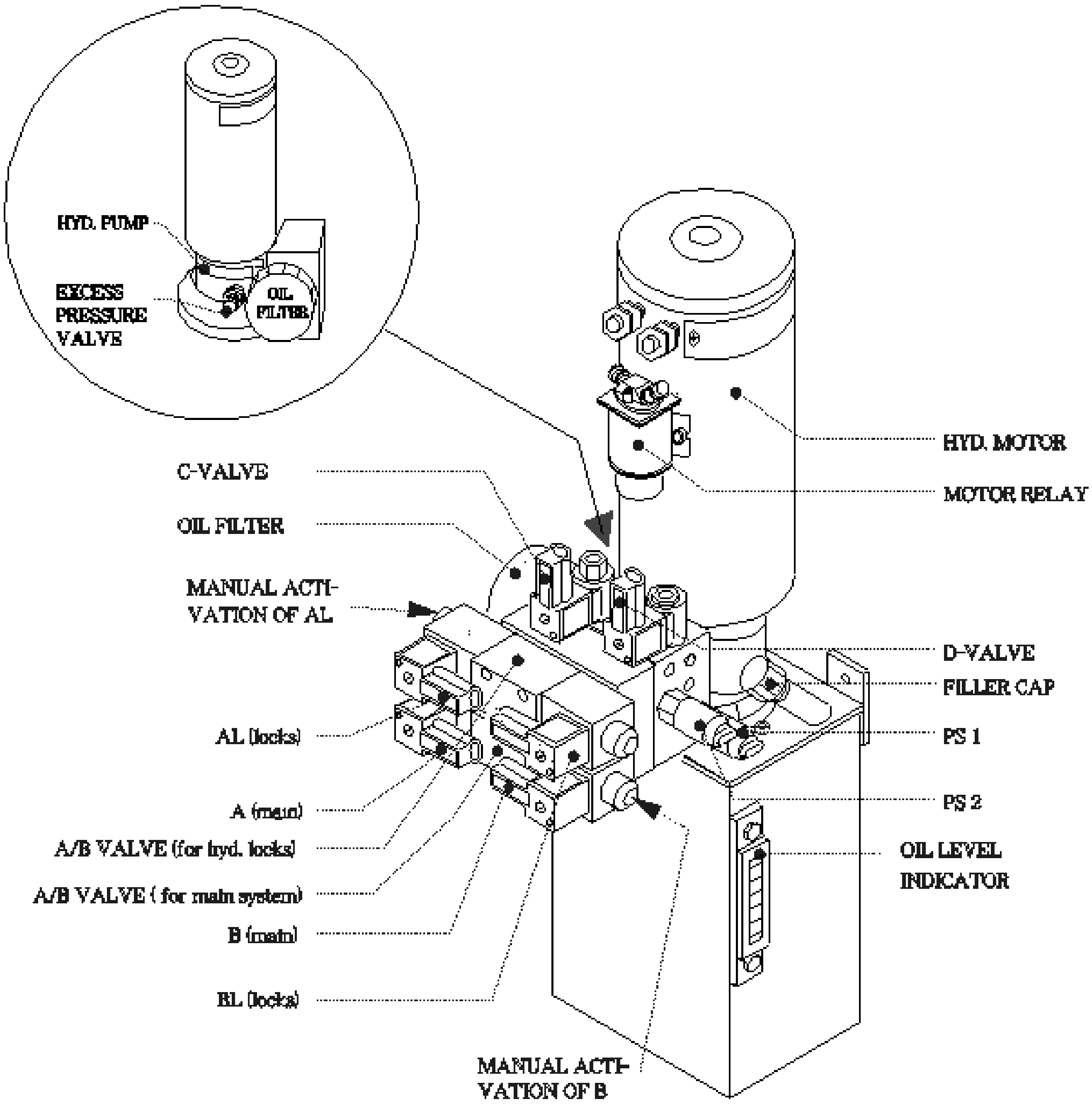
HYDRAULICS DIAGRAM



FWD Hydraulics (without Automated Transport Locks)



FWD Hydraulics (with Automated Transport Locks)



HWD Hydraulics (with Automated Transport Locks)

The D valve is only used to “convert” LOWER CATCH mode to RAISE PLATE mode (which will also lower the catch).

Note that if plate is not low, then RAISE WEIGHT as well as DROP mode will cause the plate to be lowered and the two side cylinder shafts to be fully extended, before the relevant mode becomes active.

17.6.2 Checking the Hydraulic Modes

If any mode fails when operated from the pushbuttons of the Compact15, and this is not due to a blown fuse, a defective proximity sensor, etc. (see 17.3, 17.5, 17.7 and 17.8), then check that the indicator lamps of the plugs of the relevant solenoids for the mode in question are lit while the mode is activated. If not, then likewise check that the relevant LED(s) next to the relevant connection socket(s) on the Compact15 front panel are turning on, when the mode is activated.

17.6.3 Checking the Hydraulic Solenoids/Valves

If (for any mode) the solenoids DO receive correct POWER, but the mode fails, then the error may be located in a valve solenoid or valve element.

First connect a jumper (preferably protected with a 16A fuse) from battery positive terminal to the hot terminal of each solenoid in succession (except for the M solenoid which has been checked in step 5) and check that each valve pulls (can be heard as a weak “click” sound). If no reaction, then use an ammeter (range 3ADC min.) as “jumper” and monitor the current in each of the solenoids. A and B current should be at least 2 amps, C and D at least 1 amp. If current is too low, then the solenoid may be defective and should be exchanged (do not over tighten the lock nut!).

If a solenoid current is OK, but the valve does not “click”, then the valve element may be defective, or maybe the valve plunger is stuck due to dirt in the hyd oil.

The A/B valve may be checked further by pressing a rod into the end of one of the solenoids, which must equivalate powering of the respective solenoid. So, NO change should be observed when pressing B valve WHILE the LP/RW button is pressed (or A valve WHILE the LC or RP button is pressed) but before trying this, make sure that the opposite solenoid is not powered due to an electrical error. If A and B solenoids are both powered at the same time, then the valve will either stay in the neutral position, OR ANY of the two solenoids may “win” and pull.

17.6.4 Hydraulic Solenoids Driver Circuits

If a mode fails, and this is due to a missing voltage to a solenoid, then first check that the mode WILL work if a jumper (16A fused) or an ammeter (range 3ADC min.) is connected from battery positive terminal (OR from wire No. 6) to the hot terminal of the solenoid in question, WHILE the mode that failed is activated.

If so, then driver circuit(s) (solid state switch(es)) of the Compact15 may be defective.

17.7 Checking the Lower Plate/Raise Weight mode

a) If the plate lowers when and as it should, but the weight cannot be raised or slides down again after raising, then the most likely reason is a leak in (one of) the A/B valve(s) due to a stuck plunger. If so, it may help to press a rod into the A solenoid(s) to return the plunger.
b) If the PL LED turns off BEFORE the PH LED turns off, then the LP/RW button must become inactive. This will normally ONLY happen, if it is attempted to lower the plate with the transport locks in the locked position. ("lock error"). So, if for some reason the PH LED should turn on (e.g. due to a defective PH sensor or wiring) after the plate has been lowered (PL LED off), then LP/RW button will be disabled.
c) Furthermore, if the TG LED turns off BEFORE the PL LED turns off, then the LP/RW button will also be disabled. This is to ensure that the weight cannot be raised if the plate is not low, i.e. not resting on the ground surface ("plate not low error"). So, if for some reason TG should turn off before the plate has reached the ground (e.g. due to a defective TG sensor or wiring), then the LP/RW button will be disabled. NOTE that for smaller weight set-ups, the weight MAY start raising (slowly) during lowering of the plate using the LP/RW button. If this causes TG LED to turn off before the PL LED, then it will not be possible to raise the weight. In that case, press the LC button to lower the weight (so that trigger is activated) and try again.

So, if the LP/RW button will not work, then always check that PH, PL and TG LEDs do NOT fulfil any of the following combinations ("x" means do not care):

	PH	PL	TG
"Lock Error":	on	off	x
"Plate Not Low Error":	x	on	off

17.8 Checking the DROP mode

To check the DROP mode, raise the weight to any height well below maximum and check that the PH, PL and TG LEDs are ALL off.

If TG LED is not off, raise weight a few cm. If still not off, check trigger sensor (see 17.10). If PH and/or PL LED(s) is/are not off, check these sensors too (see 17.10).

Now press the LP/RW AND the red button until the weight drops (red button first in, last out). If it took more than 2 seconds to get the weight to drop, then the raise weight cylinder may need bleeding. (Refer to bleeding instructions in Chapter 11.3 FWD/HWD Hydraulics, the paragraph "Bleeding the Hydraulics").

If the DROP activation caused the catch to raise without releasing the weight (unless full height was reached), then check the hyd. valves etc. as explained in Note 7 (especially the C valve).

If the catch raised less than 1 cm (1/2") or so but still did not release, then it may need cleaning. Spray all inner catch parts with a not too aggressive degreaser, like e.g. "Heavy Duty Engine Degreaser" from "STP" or "Engine Clean" from "Holts". Press in (upwards) the release ring in the catch (like for bleeding - refer to bleeding instructions in section 3) and spray again. Rinse with pressurized (preferably hot) water while rotating the catch and then dry with compressed air (preferably hot). After drying, spray all inner catch surfaces with a penetrating dry spray lubricant, preferably a "Teflon" type.

If the cleaning/lubricating did not result in proper catch operation, then check and adjust, if necessary, the hyd. excess pressure (refer to instructions in a previous section).

If the catch will still not work, then it may be defective and should be repaired or replaced. In that case, contact Dynatest for further advice and instructions.

17.9 Checking the LOWER CATCH mode

Lower the plate, raise and drop the weight. Now press the LC button and check that the catch lowers as it should. If it did, BUT in addition the plate was raised too, then this could be due to a leaking or falsely powered D valve. Therefore, check that the D solenoid is NOT powered when pressing LC button, otherwise check the wiring.

IF LC caused (false) plate raising AND the D solenoid WAS NOT powered, then clean or exchange D valve.

If the catch does not catch the weight when lowered, then raise the catch (LP/RW button) a few cm (1” or so), press DROP (LP/RW and red button) to “open” the catch, and then again lower the catch. If the catch will still not catch, then check (and adjust, if necessary) the excess pressure (refer to separate instructions in section 3).

If catch will not catch, even if the excess pressure is OK, then the catch may need cleaning and/or lubrication, OR it may be defective and should be replaced or repaired (see also 17.8 above).

17.10 Checking the four Proximity Switch Sensors

Four proximity switch sensors are placed as indicated in a figure on the following page. Please also refer to their descriptions in 11.4.3, “Trailer Status Switches“.

To test that all of the proximity switch sensors are operational, lower the plate and raise the weight to a height around mid-stroke, so that the WH proximity switch is NOT activated. DO NOT DROP the weight!

Now all 4 sensors are accessible. Activate them one by one using a magnetic material (iron or steel), e.g. a file or a long steel ruler.

SAFETY NOTE!

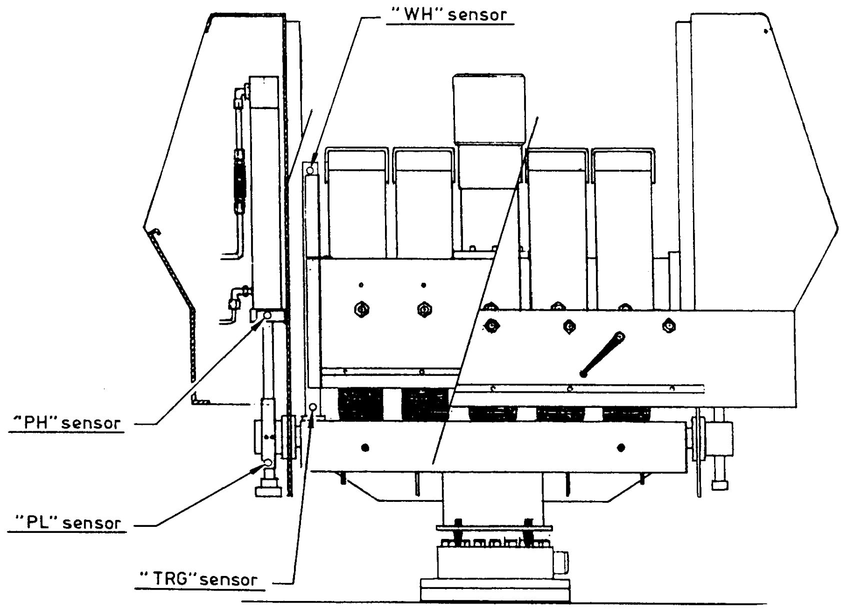
When activating the sensors, AVOID to put hands below the weight (e.g. when activating the TG sensor)!

Place the activator in direct contact with and covering the target area.

Check that the corresponding LED on the Compact 15 front panel (next to the connection socket of the proximity switch in question) turns ON.

Check that any proximity switch remains activated (LED on), until the activator is removed more than approx. 5 mm (3/16”) from the sensitive surface. If not, the sensor should be exchanged.

If a switch will not turn on at all (and fuses are OK) then perhaps disconnect a WORKING switch (they are all identical) from its DIN socket on the CP15 front panel and connect the suspicious switch instead and check again. IF the switch now works, then the CP15 internal circuitry for the original switch socket may be defective, otherwise the switch itself is defective.



HWD Proximity Swithes (Sensors) Positions

17.11 Checking the Pressure Switches

The hydraulics incorporates two pressure sensitive switches, P1 and P2, placed as indicated on the previous hydraulics figure. They are monitored by LEDs next to the P1 and P2 sockets on the Compact 15 front panel.

P1 is the main switch, connected to the hyd. pump output pressure. The P1 switch contact is normally closed and must OPEN at EXCESS pressure, turning OFF the P1 LED. This is used to detect that LOWER PLATE, DROP, LOWER CATCH or RAISE PLATE mode has been completed. But, as the hyd. pressure during catch lowering MAY raise to a level close to and sometimes exceeding the excess pressure (especially under cold conditions), an additional switch P2 (with a normally open contact) has been applied for sensing of the (rather low) pressure of the RETURN oil from the raise weight cylinder DURING catch lowering, a pressure that disappears (P2 LED turns OFF), when the catch has reached its bottom position.

To check P1/P2 functioning, use the following procedures:

17.11.1 P1 check

1) First check that the P1 LED is ON (motor not running). If so, go to step 2. If not, first check fuses (see 16.3). If still not, then short-circuit the two P1 terminals, which must cause P1 to turn on. If still not, then check the P1 cable to the P1 socket on the Compact 15 front panel.
2) Press LC button for 2 seconds or so (the catch should be low, the plate may be in any height) and check that the P1 LED turns off all the time WHILE pressing, and that it turns on again within 1 second after LC button release. Repeat several times to make sure.

3) If step 2) was fulfilled, then P1 is probably OK. Perhaps also check that P1 LED remains ON during raising of the plate even with maximum weight set-up. If this is OK too, then you may proceed with P2 check below.

If step 2 failed, this may be due to any of three causes:

4) Defective Wiring: Disconnect one of the two P1 wires directly on the switch. This must cause P1 LED to turn OFF. If so, go to step 5). If not, check cable to the Compact 15. Connect again P1.

5) Too low Excess Pressure: If the hyd. pump excess pressure has not recently been checked/adjusted, then perform this (refer to 11.3.2, “Adjusting the Hyd. Pump Excess Pressure”).

6) P1 is defective and should be replaced.

17.11.2 P2 check

9) First check P2 wiring and the P2 LED: if P2 LED is ON, then press LC button for some 2 seconds (catch should be low), which must cause P2 LED to turn OFF (if P2 LED WAS OFF, then go to step 10).If P2 LED will NOT turn OFF, then disconnect one of the P2 wires directly on the P2 switch, which must cause P2 LED to turn off, otherwise check P2 cable to Compact 15. Connect again P2.

10) If the P2 LED is OFF, then raise the weight (to any height), which MUST turn ON the P2 LED.

    If the P2 LED will NOT turn ON, then short-circuit the P2 terminals, which must cause P2 LED to turn on, otherwise check P2 cable to Compact 15.

    WHEN the above steps 9 and 10 check out OK, perhaps after exchange of P2, then make a final check as follows:

11) Drop the weight and raise the catch completely.

12) WHILE WATCHING the P2 LED, press the LC button and check that the LED is ON AND REMAINS ON AS LONG AS THE CATCH IS MOVING DOWNWARDS, AND that it turns OFF very shortly (max. 0.5 sec.) after the catch has reached its bottom position (the LC button should be kept pressed until P2 turn-off, unless this is delayed too much). Perhaps repeat once or twice. If this check fails, replace P2.

13) Raise the weight (to any height) and check that P2 LED is ON. This must also apply for minimum weight package. If NOT, replace P2.

18. Optional Accessories

18.1 Optional Hardware

A variety of optional accessories are available for the Dynatest FWD and HWD Test Systems. Unless otherwise stated these will apply for the FWD as well as for the HWD.

18.1.1 Distance Measuring Instrument

Distance information may be generated by the CP15 or by devices connected directly to the PC. A DMI provides automatic display and recording of distance information (in English or Metric units).

Trailer Mounted

Distance Measuring is accomplished by a Trailer mounted two phase encoder system connected to the Compact 15. Approximate resolution 0.15 m or 0.5 ft. Accuracy 0.4% when calibrated using the procedure in the DMI applet.

Vehicle Mounted

Distance Measuring is accomplished by a vehicle mounted encoder or by tapping into the vehicle's speedometer/odometer circuit. Distance pulses are processed by an adapter (EncIf/EnCam), which connects to the PC using a USB port. The DMI Applet carries out calibration and control.

18.1.2 Global Positioning System

A GPS unit may be connected directly to the CP15 or to the PC using a COM (serial RS232) port. Most laptops require a "Serial to USB" converter due to lack of built in COM ports. The GPS unit must be set to 2400, 4800, 9600, 19200 or 38400 baud. Alternatively, an Ethernet enabled GPS receiver may connect directly to a Network switch inside the vehicle.
The GPS unit must be set to send the NMEA standard message "GGA". The maximum reporting rate is 10 Hz. At this rate you must assure that no other messages are sent from the GPS unit.

18.1.3 Air/Pavement Temperature Probe

A Temperature Monitoring Probe, for automatic recording of Air Temperature and/or Pavement Temperature (in a drilled hole in the pavement, to get pavement MEAN temperature). Electronic (integrated circuit) sensing element in a stainless steel probe. Mounts on the FWD/HWD Unit in a special holder with air circulation and connects to the Compact15. Resolution 0.5 deg. C, accuracy within +/- 1 deg.C (in the -18 to +70 deg.C range) when properly calibrated using provided procedure in the Temperature Applet.

18.1.4 IR Surface Temperature Transmitter

A non-contact, Infra-Red Temperature Transmitter, for automatic recording of pavement SURFACE temperature ONLY. Features an integrated IR-detector and digital electronics in a weather-proof enclosure. Mounts on the FWD/HWD Unit and connects to the Compact15. Resolution 0.5 deg.C, accuracy within +/- 1 deg.C (in the -18 to +70 deg.C range) when properly calibrated using provided procedure in the Temperature Applet.

18.1.5 Rear Extension Bar

The “Rear Extension Bar” extends the Raise/Lower Bar rearwards, so that two deflections can be monitored BEHIND the loading plate, for PCC slabs joint transfer measurement. Stainless steel design, mounts on the existing Raise/Lower Bar. Includes two deflector holders with a (rearward) positioning range of 200 to 300 (optionally up to 610) mm from the loading centre. For the HWD, a 610 mm (2 ft) REB is included as a standard accessory.

18.1.6 Rear/Side Extension Bar

Same as the above mentioned Rear Extension Bar, but with two additional “wings” with two deflector holders each, to enable additional deflection measurements to either side of the load centre in a 200 to 300 (optionally 450) mm distance range. For the HWD, only the side “wings” are optional, as the REB is included as a standard accessory.

18.1.7 Segmented Loading Plate

For improved uniformity of load distribution, especially in case of rutting, a four-segment 300 mm diameter loading plate is available, which will replace the standard solid 300 mm dia. loading plate and be integral with the load cell.

18.1.8 Video Camera/Monitor Setup

A 12 Volt operated independent Video Camera/Monitor system for easy positioning of the deflectors (normally only used with the above mentioned Rear (or Rear/Side) Extension Bar). Includes camera mounting hardware and all necessary cables.

18.1.9 Power Unit

A gasoline driven power generator unit, custom built for vehicle independent FWD/HWD powering (e.g., in cases where it will be necessary to operate an FWD or HWD with another vehicle than the one set up for this purpose). Provides 12V DC, 100 A. Includes a stainless steel bracket and protective cover for mounting on the FWD or HWD Trailer.

18.1.10 Automated Transport Locks

This option consists of additional hydraulic and electronic components, controlled by the Field Program and the Compact15, to provide for automatic engagement of the transport locks after each raising of the loading plate.

18.1.11 Tandem Axle Trailer

The FWD trailer can optionally be delivered with a tandem axle system (two axles, four wheels) instead of the standard one-axle, two-wheel setup. This option will give smoother riding on rough roads, but will decrease the manoeuvrability of the trailer when unhooked from the towing vehicle. The HWD trailer has tandem axles as standard.

18.1.12 Special Trailer Colour

The standard colour of a Dynatest FWD or HWD trailer is bright blue (colour code: RAL 5017). At the time of ordering an FWD or HWD, any other colour with a RAL code can be specified at no or little extra cost (depending on actual colour). Colour matching to e.g., a towing vehicle colour may also be possible.

18.2 Data Processing Software

18.2.1 ELMOD

For routine purposes, Dynatest can provide the ELMOD program (acronym for: **E**valuation of **L**ayer **M**oduli and **O**verlay **D**esign).

ELMOD is used to calculate the layer moduli and the remaining service life of an existing flexible pavement, and to carry out the structural overlay design.

For evaluation of rigid structures, ELMOD is used to calculate layer moduli, modulus of subgrade reaction and load transfer conditions at joints, to calculate the remaining service life and to carry out the structural overlay design or rehabilitation measure.

19. Data Formats

Data file extensions are shown in parentheses.

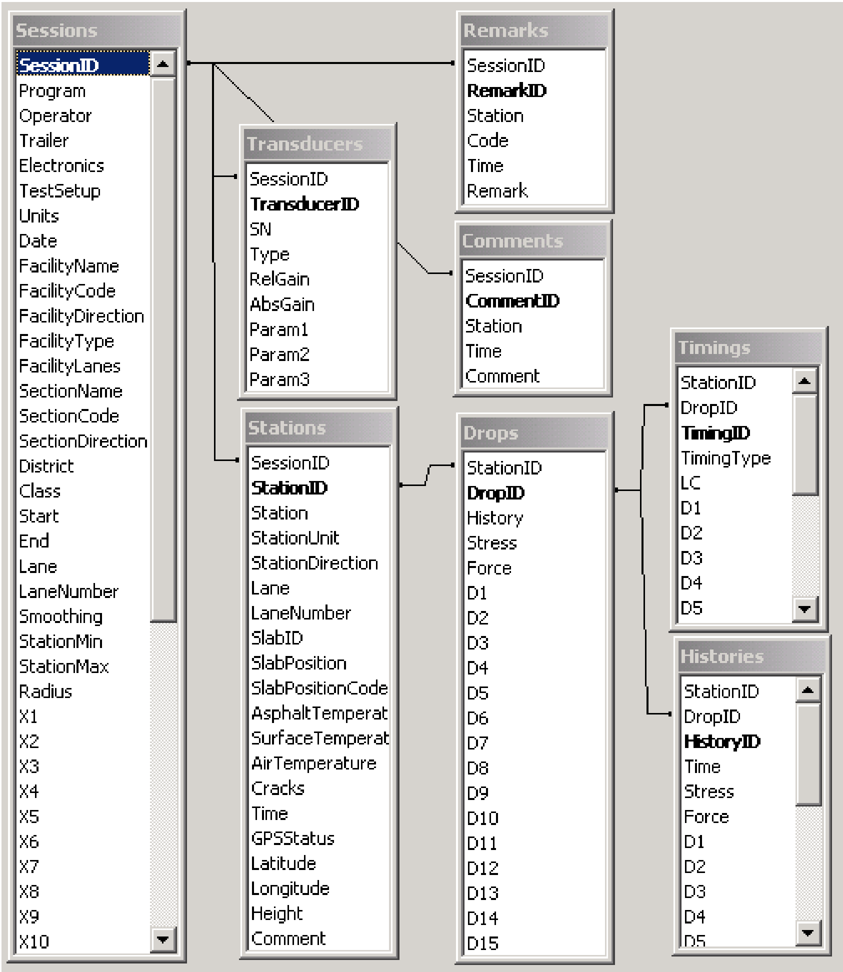
19.1 MS Access 2000 (MDB)

This is the native format for FwdWin data files. Field data is stored in a number of tables as shown in the following relational diagram:

The **Sessions** and **Transducers** tables record 'Header' information when an MDB file is created and every time it eventually is re-opened (actually this information is updated when you CLOSE the file).

The **Stations** table records information about each particular testing location.

The **Drops** table records all drops and lastly, the **Histories** table records the time history if so programmed in the Test Setup.



19.2 Comma Delimited (F25)

This file format produces files that are directly 'Importable' to most spread sheet software and easily readable by dedicated software. This is accomplished thru the following main features:

Items are separated by a comma character.
Each line is prefixed (the very first item on the line) by a 'Line-ID-Number' which is the 'key' to the contents of the line.

File Type: SEQUENTIAL UASCII Text File (Line length varies).

A file consists of 40 lines of "Header" information followed by TEST DATA, Comments etc. Optional Global Positioning data are stored BEFORE the related FWD/HWD test sequence data.

Text items
The width of a text field may vary
Most text items are “Quoted“
Numbers
May be preceded and/or padded with spaces
The special Nil value ('No use' number) is written as "N0".
The number of decimals shown are just examples
Units
Temperatures, Pressure, Deflections etc. are stored in EITHER Metric OR English systems.
Stations
meters,km,miles,feet etc.
Geographic
Decimal degrees. Latitude is positive North. Longitude is positive east. Both are floating point degrees.
Altitude is meters, always.

Common to ALL lines is the leading Line ID number.

..1. Program Version

```
5001,25.80,1,40, 3, 1,"FwdWin",5.05,"92D7690D-1F87-4407-802DBD5460A18919"
     25.08            Program Edition
           1          No of Headers (ONE always)
             40       No of Lines in Header
                 3             Lines per Station Id
                    1          Lines per Drop
                       Fwd...                   Program Comment
                               5.05             Firmware version
                                     92D7690D-  GUID
```

2. Primary “Files”

```
5002,"25SI    ","8002-080","CP15-123"
      25SI       SI for metric, US for English units
                 8002-080               Trailer SN
                            CP15-123    Processor SN
```

3. Secondary "Files"

```
5003,"JOHN    ","STANDARD","TEST1","F25"
      JOHN                            Operator name
                 STANDARD             Test Setup name
                            TEST1     The File name
                                  F25 File extension
```

4. Units & Stationing options

```
5010,0,0,0,0,0,0,0,3,1,0,0,0,0,0,1,0,0,0,0,0,1,"MDB" ,"SI","kilometers"
     -----------------Legacy options--------------
                                                        SI   (US)
                                                             Kilometers
```

5. Date and Time

```
5011,0,1,2016,12,24,14,07,0,"Non",000
     0 1         Legacy
       2016      Year
           12    Month
              24 Day
                 14      Hour
                   07    Minute
                     0   Non  000   Legacy
```

6. Load Cell

```
5200,"XX1     ",2,1.000,89.00,  0.02,  7.129
      XX1         Serial Number
              2   Type 2:FWD  3:HWD
               1.000       Relative Gain
                    89.00  Absolute Gain
                            0.02       Unbalanced Zero
                                  7.130  Shunt Value
```

7. Centre SD

```
5201,"0231    ",4,1.000,1.000
      0231        Serail Number
              4   Type 4:2mm  5:100mil
               1.000       Relative Gain
                    1.000  Absolute Gain
```

Lines 8..24 hold SD 2 to 18 similar to Line 7.

25. Plate Radius and X-Positions

```
5020,   150,    0,   200,   300,   ......
        150   Radius of Plate
                0           D1, Center deflector
                     200   D2
```

26. Diameter of Plate and Y-Positions

```
5021,   300,    0,     0,     0,   ......
        300   Diameter of Plate
               0          D1, Center deflector
                      0  D2
```

27. "Other" Physicals

```
5022,0,   0,   0,  45,  97,  195,  386,
     0        Plate Type: 0=Standard  1=Split Plate
          0         NA
               0    NA
                  45                 Height ONE
                      97             Height TWO
                           195       Height THREE
                                386  Height FOUR
```

28. Station and Lane Information

```
5023,1,3,0,  23.800,  31.200,  31.200,   0.200,   0.000,1,1
     1 3 0  Legacy
          23.800            Min Station
                   31.200   Max Station
                            31.200           Previous Station
                                     0.200   Station Step
                                               0.000,1,1 Legacy
```

29. Test Setup Options

```
5024,0,1,1,1,1,1,     0, 0.0,     0, 0.0,0,0,0,  60
     0           Station Prompt
       1         Temperature Prompt(s)
         1       Condition Prompt
           1     Reject Prompt
             1   Decrease Check
               1 Roll Off Check
                      0      Pressure Variation
                         0.0 Pressure Variation %
                                  0       Deflection Variation
                                     0.0   Deflection Variation %
                                         0       Temperatures "Keep"
                                           0     Smoothing
                                              0   60   Leagacy
```

30. No of Sequences, Drops total

```
5029,       4,      12,     120,     683
            4 Sequences stored
                   12 Drops stored
                           120 Sequences total
                                   683 Drops total
```

31. Operator Name

```
5030,”Operator Name‟
```

32. Facility Information

```
5031,"Facility Name","Code","Type","Class"
```

33. Subsection Information

```
5032,”Section Name”,”Code”,”Start”,”End”
```

Lines 34-35-36 presents the layout of “Station Information”.

34. Station Id

```
5301,0,1,3,3,  31.500,1,1,       3,1991,06,05,20,07
     0 1 3  Legacy
           3           Location unit
               31.500  Station
                      1 1 Legacy
                                 3   Lane
                                   2016             Year
                                       12           Month
                                          05        Day
                                             20     Hour
                                                06 Minute
```

35. Comments

```
5302,0,1,8,0,0,0,0,0,"Comment"
     0 1 8   Legacy
           0 Level of Cracking
             0 0 0 0 Legacy
                      Comment
```

36. Temperatures

```
5303,0, 24.0, 27.0, 25.0
     0        0=Centigrade  1=Fahrenheit
        24.0              Asphalt
              27.0        Surface
                    25.0  Air/Ambient
```

Lines 37..40 are not used.

------------ END of HEADER ----------

TEST data are stored chronologically from line 41 and up in groups of:
"Station Information" as lines 34,35,36 above and
one or more lines of Load and Deflection PEAK READINGS.
Remarks and optional GPS information.

Load and Deflection PEAK READINGS:

```
      1,   574,   434,   396,   375,   337,  .....
      2,  1194,   907,   828,   776,   712,  .....
      3,  1677,  1283,  1155,  1095,  1001,  .....
      1  Sequence Step No is "Line ID Number"
           574                    Peak Load (kPa)
                  434             Centre Deflection
                         396      SD2 Deflection
                                375  SD3     -
    .
```

Remarks:

```
7651,  23.846,"Railroad crossing"
7651 to 7658 for Remarks 1 to 8
       23.800  Station
               Remark text
```

GPS Navigation Results:

```
5280,0,235959.9,+90.0000000,+180.0000000,999.9, 0, 7, 0, 0
     0  Legacy
       235959.9  UTC Hours Minutes Seconds
                +90.0000000              Latitude (degrees, real)
                            +180.0000000  Longitude (degrees, real)
                                         999.9 Altitude (m)
                                                0  Status
                                                   7     No of Sats
                                                      0
                                                         0
```

19.3 *Nondelimited, 7+ Deflectors (F20)*

File Type: SEQUENTIAL UASCII Text File with varying line lengths.

A file consists of 36 lines of "Header" information followed by TEST DATA.
Optional Global Positioning data are stored BEFORE the related FWD/HWD test sequence data.

Items are located within fixed fields indicated by [X,Y], which defines the first and last character positions.

Text data
    is stored exactly as entered by the operator, i.e. leading and trailing spaces may appear.
Numbers
    are right justified except for the special Nil value ("No use" number) which is stored as "N0" followed by spaces.
Units
    Temperatures, Pressure, Deflections etc. are stored to EITHER Metric (SI) OR Non-Metric (US) systems. To accommodate both, most fields are six characters wide.
Stations
    meters, km, miles, feet etc.
Geographic
Latitude is positive North. Longitude is positive east. Both are floating point degrees, elevation is in meters, always.

```
1.  "S 120SI    19910212FILENAME36F25.00"
    [1]     S        Sequential type file.
    [2,3]    1       No of Headers (ONE always)
    [4,11]  20SI     NA
    [12,19] 19900212 Date: YearMtDy
    [20,27] FILENAME Name of this file.
    [28,29] 36       Number of lines in HEADER.
    [30]    F        FWD DATA File Identifier.
    [31,35] 25.99    Field Program Edition.
    [36,36] 0        NA
    [37,39] XXX      NA
    [40,42] 000      NA

2.  "90      08002-XXX   8000000 120 ."
    [1]     9        No of Deflectors.
    [2]     0        Range 0=2000 mu  1=100 mil.
    [3,7]            NA
    [8]     0        Temperatures: 0=Keep  1=Blank
    [9,16]  8002-XXX FWD/HWD Serial Number.
    [17,24]    80000 DMI Calibration figure.
    [25]    0        Smoothing: 0=OFF <>0:ON
    [26]    0        History:   0=Preserved (always)
    [27,30]   60     Smoothing Filter cut off (Hz)
    [31,32]          Reserved.
```

```
3.  "   150     0   200  -200   450   600   900  1200  1500  1800
    These numbers are either "mm" or "in.
    Negative values means "Behind" the loading plate.
    [1,6]      150   RADIUS of PLATE
    [7,12]       0   Centre dummy, probably ZERO
    [13,18]    200   Distance from center Chnl.2
    [19,24]   -200      -      -      -     -   3
    etc. in fields: [25,30] [31,36] [37,42] [43,48] ...

4.  "C:\DYNATEST\DATA\           .F200H20"
    [1,2]   C:       Working Disc Drive
    [3,28]  \DYNA... Working Directory (26 characters max).
    [29,32] .F20     FWD Data file Extension.
    [33,33] 1        History Mode (NA)
    [34,36] MDB      History stored in database

5.  "Generatorvej 21 ...
    [1,60]  Roadway Identification.

6.  NA

7.  NA

8.  "SUR-035 AIR-123   0.000   5.150   5.050   0.100   0.000"
    [1,8]   SUR-035  Surface temperature sensor SN
    [9,16]  AIR-123  Air temperature sensor SN
    [17,24]     1000 Lowest "Station"
    [25,32]     1150 Highest "Station"
    [33,40]     1150 Previous Station
    [41,48]      100 Station Step
    [49,56]    0.000 NA

9.  "  2015.0 3.5 5.0 2.015.0 2.0 5.0"
    Limits, four characters each.
    [1,4]     20 Vibr/Drift Limit (mu or mil)
    [5,8]   15.0 Lower Plate Time Limit
    [9,12]   3.5 Raise.Weight    -      (1.Stop)
    [13,16]  5.0 Lower Catch     -      (NO Pres2)
    [17,20]  2.0 Drop            -      (till TG)
    [21,24] 15.0 Raise Plate     -
    [25,28]  2.0 Raise Weight    -      (til NO TG)
    [29,32]  5.0 Raise Catch     -

10. "Ld XXX      1.000 89.00        ."
    [1,3]   Ld       Load Cell Id.
    [4,11]  XXX      Serial No
    [12]             Space
    [13,17] 1.000    Relative Gain
    [18]             Space
    [19,23] 89.00    Absolute Gain
    [24,32]          Reserved.

11. to 20. Deflector Serial Numbers and Gains similar to line 10.
    A vacant Deflector channel looks like:
    "D9 NA       0.000 0.000        ."

21. "Operator Name ....
    [1,32]      Operator Name.
```

```
22. Test Units and Options.
    "00   20100002 1 1               ."
    [1]  0 Deflections     0=mu  1=mil
    [2]  0 Temperatures    0=“C  1=“F
    [3]    NA
    [4]    NA
    [5]    NA
    [6]  2 Location        2=Meters
                           3=km
                           5=feet
                           6=yards
                           7=Miles
    [7]    NA
    [8]    NA
    [9]    NA
    [10] 0 Pressure unit   0=kPa 1=psi
    [11] 0 Weight (mass)   0=kg  1=lb
    [12] 0 Distances       0=mm  1=in
    [13] 0 NA
    [14,15]  1 Lines per Station ID (ONE)
    [16,17]  1 Lines per Drop (ONE)
    [18,32]   NA

23. "     0 0.0     0 0.0            ."
    Accepted Variations.
    [1,6]        0 Load (kPa or psi)               @) [1,4]
    [7,10]     0.0  -   (percent)                  @) [5,8]
    [11,16]      0 Deflection (mu or mil)          @) [9,12]
    [17,20]    0.0     -      (percent)            @) [13,16]
    [21,32]        Reserved

24. "*Subsection ...
    SUBSECTION ID
    [1]     *    Subsection Prefix character
    [2,61]       User specified (see line 27)

25. NA

26. NA

27. NA

28. "   300     0   200  -200     0     0     0     0     0     0
    Diameter of Plate and
    Y-Positions: Off center-line complement to line 3 (mm or in).
    Positive to the “Left”.
    [1,6]             Diameter of Plate (mm or in).
    [7,12]       0    Centre dummy, probably ZERO
    [13,18]    200    Distance from centerline Chnl.2
    [19,24]   -200       -      -     -         -   3
    etc. in fields: [25,30] [31,36] [37,42] [43,48] ....

29. "      10      54     112     556"
    Approximate Sequence and Drop totals.
    [ 1, 8]       10 No of Sequences stored in this file
    [ 9,16]       54 -  -   Drops      -    -   -    -
    [17,24]      112 Total No of Sequences
    [25,32]      556   -   -  -    Drops

30. " A1aaB2bbC3ccD4dd..........
   copy of line 31 below
```

```
31. "A111B222C333D444...........
    [1,89]  Sequence step types (most recently used).
            A..D:   Seating drops (never stored)
            1..4:   Drops at heights 1 to 4 (stored).
            e..n:   "Load Sensing" drops (stored).
            P:      Pause.
            R:      Resettle loading plate.
            S:      Stop (leave plate on the ground).

32. NA

33. ".***.***.***.***
    Steps stored

34. NA

35. NA

36. "SETUP   Standard Setup          "
    [1,8]   SETUP    First eight characters of setup name.
    [9,32]           Setup Comment.
```

------------ END of HEADER ----------

```
37. "*subsection ...
    [1]     *    Subsection Prefix character
    [2,61]       User specified
```

TEST data are stored chronologically from line 38 and up in groups of:

Optional GPS data.
One STATION IDENTIFIER and
one or more lines of Load and Deflection PEAK READINGS.

Comments may precede or follow any group of TEST data.

GPS Navigation Results:

```
    "G0000000+90.0000000+180.0000000999.9"
    [1]     G            GPS prefix character
    [2]     0            Failure Cause
                         1: Too few satellites
                         2: DOPs too large
                         3: Position STD too large
                         4: Velocity STD too large
                         5: Too many iterations for velocity
                         6: Too many iterations for position
                         7: 3 sat startup failed
                         8: Initial Acq.
                         9: Timeout
    [3,8]   000000       (UTC time, seconds into the week)
    [9,19]  +90.0000000 Latitude (degrees, real)
    [20,31]+180.0000000 Longitude (degrees, real)
    [32,36] 999.9        Height (meters, always)
```

STATION IDENTIFIER (the first one):

```
"S    11506hvv 20.000 20 200209300110010112"
  Station_LaneAsphtCdSurAirLSHrMnWSPCEFGHsn
[1]      S         Station prefix
[2,9]        1150 Station (see [28])
[10,13] 6hvv      Lane (text)
[14,18]  20.0     Asphalt Temperature
[19,20]  00       "Condition" field (text)
[21,23]   20      Surface Temp (Optional)
[24,26]   20      AIR Temperature (Optional)
[27]    0         NA
[28]    2         "Location" unit
                  (as line 22.[6])
[29,32] 0930      Time of Day (HrMn)
[33,40] 00010101 General purpose "Conditions"
[33,35] 000       NA
[36]    Cracks    0=None 1=Moderate 2=Severe
[37,42] 000012    NA
```

DATA SET: (the first one)

```
"   751  2540  2000  1900  1800  1700  1600  1500 ....
All fields are six characters wide.
[1,6]       751 Peak Load (kPa/psi)
[7,12]     2540 Peak D1 deflection (mu/mil)
[13,18]    2000  -   D2      -
etc in fields
[19,24] [25,30] [31,36] [37,42] [43,48]
[49,54] [55,60] [61,66] ...
Notes: The lengths of these lines depend on the last USED
       deflector, which may vary within a DATA SET.
```

COMMENTS:

```
""Comment 4:This is a Comment
[1]      "           Comment prefix character
[2,:]    Comment 4   The "Name" (Identifier) of the "Object".
         :           Separator.
[:...]   This is...  The Comment text.
The User may store ANY Text or Numeric "object" this way.
(The "Name" + colon part may be omitted)
```

19.4 Nondelimited, 7 Deflectors (FWD/HWD)

FWD/HWD Data File Type: RANDOM UASCII Text File (Fixed Line length).

A file consists of 36 lines of "Header" information immediately followed by TEST DATA and Comments. Optional Global Positioning data are stored BEFORE the related FWD/HWD test sequence data.

Items are located within fixed fields indicated by [X,Y], which defines the first and last character positions.

Text data

is stored exactly as entered by the operator, i.e. leading and trailing spaces may appear.

Numbers

are right justified except for the special Nil value ("No use" number) which is stored as "N0" followed by spaces.

Units

Temperatures, Pressure, Deflections etc. are stored Metrically in positions 1 to 32. The wide "R80" format ADDS English unit test results in the extra positions (33 to 80).

Stations

meters,km,miles,feet etc.

Geographic

Latitude is positive North. Longitude is positive east. Both are floating point degrees. GPS height is meters, always.

```
1.   "R32        19920121FILENAME36F25"
     [1]     R        Random type file.
     [2,3]   32       Line length 32/80
     [4,11]           Reserved
     [12,19] 19900212 Date: YearMtDy
     [20,27] FILENAME Name of this file.
     [28,29] 36       Number of lines in HEADER.
     [30]    F        FWD DATA File Identifier.
     [31,32] 25       Field Program Edition.         @) 10/20

2.   "70     08002-XXX   8000000 120 ."
     [1]     7        No of Deflectors.
     [2]     0        Range 0=2000 mu  1=100 mil.
     [3,7]            Reserved.
     [8]     0        Temperatures: 0=Keep  1=Blank
     [9,16]  8002-XXX FWD/HWD Serial Number.
     [17,24]    80000 DMI Calibration figure.
     [25]    0        Smoothing: 0=OFF <>0:ON
     [26]    0        History:   0=Preserved  <>0:Smoothed too
     [27,30]  120     Smoothing Filter cut off (Hz)
     [31,32]          Reserved.

3.   "150 0   200 300 450 650 900 1200   5.9     0   7.9  etc....

     [1,4]    RADIUS of PLATE (mm)
     [5,8]    always ZERO
     [9,12]   Distance from center Chnl.2 (mm)
     [13,16]     -      -     -     -   3  -
     [17,20]     -      -     -     -   4  -
     [21,24]     -      -     -     -   5  -
     [25,28]     -      -     -     -   6  -
     [29,32]     -      -     -     -   7  -
```

```
    [33,38]  Radius of plate (inches)
    [39,44]  Zero
    [45,50]  Distance from center Chnl.2 (inches)
    [51,56]     -      -     -     -   3    -
    [57,62]     -      -     -     -   4    -
    [63,68]     -      -     -     -   5    -
    [69,74]     -      -     -     -   6    -
    [75,80]     -      -     -     -   7    -

4.  "C:\DYNATEST\DATA\           .FWD"
    [1,2]   C:       Working Disc Drive
    [3,28]  \DYNA... Working Directory (26 characters max).
    [29,32] .FWD     FWD/HWD Data file Extension.

5.  "Generatorvej 21 ...
    [1,32] or [1,60]  Roadway Identification.

6.  "S    11506hvv 20.000 20 20020930"
    Copy of last STATION ID stored in file (see line 38).

7.  "S    12006hvv 20.000 20 20020930"
    Next Expected STATION ID.

8.  "SUR-MAN AIR-MAN     1000    1150"
    [1,8]   SUR-MAN  Surface "Xducer"
    [9,16]  AIR-MAN  Air "Xducer"
    [17,24]     1000 Lowest "Station"
    [25,32]     1150 Highest "Station"

9.  "  2015.0 3.5 5.0 2.015.0 2.0 5.0"
    Limits, four characters each.
    [1,4]     20 Vibr/Drift Limit (mu or mil)
    [5,8]   15.0 Lower Plate Time Limit
    [9,12]   3.5 Raise.Weight    -      (1.Stop)
    [13,16]  5.0 Lower Catch     -      (NO Pres2)
    [17,20]  2.0 Drop            -      (till TG)
    [21,24] 15.0 Raise Plate     -
    [25,28]  2.0 Raise Weight    -      (til NO TG)
    [29,32]  5.0 Raise Catch     -

10. "LdXXX     1.000   89.00        ."
    [1,2]   Ld       Load Cell Id.
    [3,10]  XXX      Serial No (File Name)
    [11,15] 1.000    Relative Gain
    [16,18]          Reserved
    [19,23] 89.00    Absolute Gain
    [24,32]          Reserved.

11. to 20. Deflector Serial Numbers and Gains similar to line 10.
    A vacant Deflector channel looks like:
    "D0NA      0.0000.000           ."

21. "Operator Name ....
    [1,32]       Operator Name.

22. "0000120100002 1 1              ."
    Test Units and Options.
    [1]   0 Deflections     0=mu  1=mil
    [2]   0 Temperatures    0="C  1="F
    [3]   0 Stn. Prompt     0=OFF 1=ON
    [4]   0 Decrease Check  0=OFF 1=ON
    [5]   1 Rejection       0=OFF 1=ON
    [6]   2 Location        2=Meters
                            3=km
```

```
                          4=km extended
                          5=feet
                          6=yards
                          7=Miles
                          8=Miles ext. ext.
                          9=Miles.feet
    [7]  0 Tmp. Prompt(s)  0=OFF 1=ON
    [8]  1 Cnd. Prompt     0=OFF 1=ON
    [9]  0 Roll off check  0=OFF 1=ON
    [10] 0 Pressure unit   0=kPa 1=psi
    [11] 0 Weight (mass)   0=kg  1=lb
    [12] 0 Distances       0=mm  1=in

    [13] 2 Station Step Mode, 0=No  1=Fixed  2=Logical

    [14,15]  1 Lines per Station ID (ONE)
    [16,17]  1 Lines per Drop (ONE)

    [18,32]    Reserved

23. "5   2   5   2                  "
    [1,4]      5 Allowed LOAD Variation (kPa)
    [5,8]      2    -     -       -     (percent)
    [9,12]     5    -  Deflection  -    (mu)
    [13,16]    2    -      -       -    (percent)
    [17,32]      Reserved

24. Last stored SUBSECTION ID (see line 37).

25. "DtCty PxNnnnS 000+0.0 000+0.0 St ....
    [1,32] or [1,60] Roadway ID TEMPLATE

26. "  Cty P Nnnn
    [1,32] or [1,60] File name generation mask

27. "000+0.0 000+0.0 St ...
    [1,32] or [1,60] Roadway Subsection ID TEMPLATE

28. " 300   0 200-200   0   0   0   0"
    Diameter of Plate and
    Y-Positions: Off center-line complement to line 3.
    Positive to the “Left”.
    [1,4]      300   Diameter of Plate (mm).
    [5,8]        0   Centre dummy, probably ZERO
    [9,12]   Distance from center-line Chnl.2 (mm)
    [13,16]     -      -     -     -    -   3  -
    [17,20]     -      -     -     -    -   4  -
    [21,24]     -      -     -     -    -   5  -
    [25,28]     -      -     -     -    -   6  -
    [29,32]     -      -     -     -    -   7  -
    [33,38]  Diameter of plate (inches)
    [39,44]  Zero
    [45,50]  Distance from center-line Chnl.2 (inches)
    [51,56]     -      -     -     -    -   3    -
    [57,62]     -      -     -     -    -   4    -
    [63,68]     -      -     -     -    -   5    -
    [69,74]     -      -     -     -    -   6    -
    [75,80]     -      -     -     -    -   7    -

29. "      10      54      112      556"
    APPROXIMATE Sequence and Drop totals.
    [ 1, 8]       10 No of Sequences stored in this file
    [ 9,16]       54 -  -    Drops      -    -   -    -
    [17,24]      112 Total No of Sequences
```

```
    [25,32]      556    -   -  -    Drops

30. Not used

31. "A1aaB2bbC3ccD4dd...........
    [1,89]  Sequence step types (most recently used).
            A..D:   Seating drops (never stored)
            1..4:   Drops at heights 1 to 4 (stored).
            e..n:   "Target Sensing" drops (stored).
            P:      Pause.
            R:      Resettle loading plate.
            S:      Stop (leave plate on the ground).
    [65,80]         Reserved

32. Not used

33. ".***.***.***.***..........
    Indication of which sequence peaks are stored.

34. Not used

35. "...*...*...*...*..........
    Indication of which sequence "Whole Histories" are stored.

36. "SETUP   Standard Setup          "
    [1,8]   SETUP    Name of "Test Setup" File.
    [9,32]           Setup Comment.
```

------------ END of HEADER ----------

```
37. "*First subsection ...
    Initial SUBSECTION ID (the first one)
    [1]     *     Subsection Prefix character
    [2,61]        User specified (see line 27)
```

TEST data are stored chronologically from line 38 and up in groups of:
Optional GPS data.
One STATION IDENTIFIER and
one or more lines of Load and Deflection PEAK READINGS.

Comments may precede or follow any group of TEST data.

GPS Navigation Results:

```
    "G0400743+90.0000000+180.0000000999.9"
    [1]     G           GPS prefix character
    [2]     0           Failure Cause
                        1: Too few satellites
                        2: DOPs too large
                        3: Position STD too large
                        4: Velocity STD too large
                        5: Too many iterations for velocity
                        6: Too many iterations for position
                        7: 3 sat startup failed
                        8: Initial Acq.
                        9: Timeout
    [3,8]   400743      UTC time, seconds into the week
    [9,19]  +90.0000000 Latitude (degrees, real)
    [20,31]+180.0000000 Longitude (degrees, real)
    [32,36] 999.9       Height (meters)
```

STATION IDENTIFIER:

```
"S    11506hvv 20.000 20 20I20930  68  68  68"
  Station_LaneAsphtCdSurAirLSHrMnWSPCEFGHsn
[1]     S        Station prefix, No specific "direction"
[2,9]       1150 Station (see [28])
[10,13] 6hvv     Lane
[14,18]  20.0    Asphalt Temperature
[19,20] 00       "Condition" field (text)
[21,23]  20      Surface Temp (Optional)
[24,26]  20      AIR Temperature (Optional)
[27]    I        Station "Direction"
                 I:Increasing or D:Decreasing
[28]    2        "Location" unit (as line 22.[6])
[29,32] 0930     Time of Day (HrMn)
[33,36]   68     Asphalt Temperature ("F)
[37,40]   68     PAVEMENT Surface Temp ("F)
[41,44]   68     AIR Temperature ("F)
[45,80]          Reserved
```

DATA SET: (the first one)

```
"754 1280905 837 688 431 234 122  10730 50.39 35.63 32.95…
[1,4]    LOAD (kPa)
[5,8]    CENTER Defl  (mu)
[9,12]   DEFLECTION 2
[13,16]      -      3
[17,20]      -      4
[21,24]      -      5
[25,28]      -      6
[29,32]      -      7
[33,38]  Force (lbf)
[39,44]  CENTER Defl  (mil)
[45,50]  DEFLECTION 2
[51,56]      -      3
[57,62]      -      4
[63,68]      -      5
[69,74]      -      6
[75,80]      -      7
```

COMMENTS:

```
""This is a Comment......
[1]     "           Comment prefix character
[2.80]  This is...  The Comment text.
```

19.5 Pavement Deflection Data Exchange (DDX)

This format is similar to the "System.INI" in Windows. The file is divided into sections each having a bracketed header line. The data is composed of a descriptive name, an equal sign followed by the value(s), like: Operator = John Johnson. For details see:

www.normas.com/AASHTO/pages/PDDX.html.

The following shows the beginning of a DDX data file.

```
[Pavement Deflection Data Exchange File]
PDDXVersionNumber = 1.0
DelimiterSymbol = ,
DecimalSymbol = .

[Operations Information]
FileLocation = C:\FwdWin\Data\DBV.DDX
EndTime = 20:07:20
EndDate = 11-Dec-2001
OperatorName = ks

[Units]
LoadPlateRadiusUnits = millimetre
LoadUnits = kilo-Pascal
DeflectionUnits = micron
TemperatureUnits = Celsius
SensorsLocationUnits = millimetre
TestLocationUnits = kilometre, millimetre, millimetre
GPSUnits = degree, degree, meter
DropHistoryDataFrequencyUnits = Hertz

[Device Information]
DeviceDesignationName = Dynatest FWD
DeviceModelNumber = 8082
DeviceSerialNumber = 8082-061
LoadCellSerialNumber = 86205-0071
SensorSerialNumbers = 86211-3701,86211-3702,86211-3703,86211-3704,86211-
3705,86211-3706,86211-3707,86211-3708,86211-3709
DeviceLoadType = impulse

[Device Configuration]
LoadCellRadius =    150
NumberOfDeflectionSensors = 9
DeflectionSensorXAxisDistances =      0,   200,   300,   450,   600,   900,
1200,  1500,  1800
DeflectionSensorYAxisDistances =      0,     0,     0,     0,     0,     0,
0,     0,     0
NumberOfTemperatureSensors = 3
TemperatureSensorUse = air, surface, mid-depth

[Device Calibration]
LoadCellCalibrationFactor =  147.8
SensorDynamicCalibrationFactor = 0.977, 0.966, 0.994, 0.998, 1.022, 0.970,
0.970, 0.974, 0.983
SensorReferenceCalibrationFactor = 1.000, 1.000, 1.000, 1.000, 1.000,
1.000, 1.000, 1.000, 1.000
DMIDeviceCalibrationFactor = 60000

[Location Identification]
SiteName = Copenhagen, DK
FacilityName = Dynatest Boulevard
SectionName = East bound lane one
PavementType = ACC
```

```
[Data Configuration]
NumberOfTestLocations =  0
NumberOfDropHistoryDataSamples = 600
DropHistoryDataFrequency = 10000

[Test Location 1]
TestLocation =    8.000, 0, 0
GPSLocation =  30.0000000, -82.0000000,   5.0
TestLane = Right-1
TestTemperatures =  20.4, 24.1, 22.3
TestTime = 19:48:19
TestComment =
DropData_1 =   596, 459.8, 414.6, 392.8, 355.6, 324.3, 254.1, 182.2, 111.8,
41.6
DropData_2 =   845, 649.2, 589.3, 559.9, 503.2, 453.2, 359.2, 255.6, 158.7,
59.5
DropData_3 =  1203, 927.9, 836.8, 778.0, 712.7, 648.4, 501.8, 365.4, 223.6,
84.6

[Test Location 2]
TestLocation =    9.000, 0, 0
GPSLocation =  30.0000000, -82.0000000,   5.0
TestLane = Right-1
TestTemperatures =  20.3, 24.2, 22.3
TestTime = 19:50:04
TestComment =
DropData_1 =   606, 461.2, 417.9, 394.5, 357.9, 321.2, 252.5, 182.6, 112.2,
41.6
DropData_2 =   855, 647.8, 583.5, 552.5, 504.4, 454.8, 359.0, 255.2, 159.7,
59.1
DropData_3 =  1190, 929.5, 823.3, 778.6, 716.7, 641.2, 507.6, 362.0, 222.9,
84.0
```

20. Error Messages

The following is a list of equipment error messages.

Error 536: Deflection OFF RANGE
One or more deflections exceed the specified range ! (2000/2540 mu).
Plot the test to check the shape of the **Time History**.

Error 537: Repeatability check failed
Pressure and/or Normalized Deflections of latest "Comparable" tests failed
the repeatability check.

Error 538: Roll-Off
The POST-IMPACT shape of one or more Deflection signals failed.
If peak instants of the outermost deflectors fall close to the
end of the sampling window you may cancel Roll Off check or
increase the Sampling Window Size to avoid error.
Perhaps plot the test to check the **Time History** shape.

Error 539: Deflections are not Decreasing
Peak deflections do not agree with the entered Transducer positions.
Perhaps check ACTUAL physical positions against entered positions.
Disable **Decrease** check if this test is not relevant.

Error 540: Excess Vibration/Drift
One or more channels did not settle within 1.5 seconds.
Check that all sensors make good contact to the Pavement.
Perhaps inspect a **Drift/Vibration** plot.

WARNING: THE WEIGHT IS PROBABLY IN A RATHER
DANGEROUS POSITION.

Error 581: Load Amplifier Mismatch
The Load Cell Amplifier is not the right type.

Error 582: Deflector Amplifier Mismatch
The Deflector Amplifiers are not the right type.

Error 584: Duplicate Deflector
At least one Deflector is assigned to more than one channel!
Check the setup and make sure the right UNIQUE serial numbers
match the deflectors actually plugged.

Error 603: Network time-out
The communication between the Computer and the Trailer fails.
Possible causes:
Trailer boot process not completed.
Network Cables (Ethernet) not connected.
Power supply failure in the Trailer, maybe only momentarily!
Computer Network Adapter defective.

- You must allow the Trailer sufficient time to boot before the computer initiates communication.
- Check Interface setting (Setup - Processor - Embedded)
- Check all connections.
- Check Trailer power Leds, recharge battery and/or exchange fuse(s).
- If all connections and supplies are OK, then shut down Windows, switch OFF Trailer
  and computer power, wait 10 sec, then switch ON again to re-start.
- If re-starting the program results in another time-out failure, then exchange the Network cables.
- To determine if the computer is malfunctioning, exchange the computer or have

  the computer Network port verified by a technician.

After this message you will have the opportunity to exit the program.

Error 604: +/-15V supply OFF RANGE

The system has measured a too high or too low +15V or -15V supply.
Possible causes:
 Battery voltage off range.
 Power Supply defective.
- Recharge battery if low. Check car alternator regulator if voltage is too high.
- Monitor the +/-15V in the Information - Voltages window.

Error 605: Offset beyond +/-2mV

The system has measured a too high or too low amplifier reference offset. This MAY produce unacceptable Deflector Drift rates. If "Drift" plots turn out acceptable, reliable measurements may still be carried out, however it is recommended that the system be serviced.

Error 606: Battery voltage OFF RANGE

The system has measured a too high or too low battery voltage.
If too low voltage: Check alternator, charging circuits,
                    charging cable connections and fuses.
If too high voltage: Check alternator regulator. NOTE that a too high voltage on the battery may damage system circuits.

Error 608: Load cell

A Load Cell Calibration found one or more of the following Voltages in error:
 Positive Excitation, Negative Excitation,
 Balanced Zero, Calibration Level, Shuntvalue
Posible reasons:
 +/-15V supply off range.
 Load Cell cable not connected or defective.
 Load Cell has been overloaded e.g. due to lack of grease in the loading plate swivel or due to dropping of weight without buffers (affects Bal.Zero and perhaps Shuntvalue, but rarely Excitation).
- Check +/-15V supplies (Information - Voltages).
- Check Cell resistances thru Load Cell Cable first:

Ohms approx	DIN plug	Load Cell Socket
240 - 243	2 - 4	2 - 4
240 - 243	1 - 5	1 - 5
180 - 183	2 - 1	2 - 1
180 - 183	4 - 5	4 - 5
180 - 183	2 - 5	2 - 5
180 - 183	1 - 4	1 - 4

 The middle one of the 3 male pins in the cell socket is no.5 (CW decrease).

Error 609: 5V supply OFF RANGE

```
The system has measured a too high or too low 5V supply.
Possible causes:
 Battery voltage Off Range.
 5V power supply defective or overloaded/short circuited.
- Recharge battery if low.
  Check alternator regulator if voltage is too high,
  which may have damaged the 5V power supply.
- Monitor the 5V in the Information - Voltages window.
```

Error 614: Trailer has executed Hardreset

```
The RESET circuit in the Trailer has been triggered.
Possible causes:
 A momentary break in the electronics battery supply.
 An abrupt fall (noise) in the battery supply voltage.
 A break in the internal 5V supply, maybe only of very short duration!
- Make sure that the power connections to the battery is good and
  stable (clips should NOT be used for this connection!).
- Monitor the trailer battery voltage with a scope WHILE testing.
  This might reveal "spikes" not captured by the Over/Under voltage detectors.
- Monitor the 5V supply in the Information - Voltages window.
- Check trailer fuses.
```

Error 620: Command echo

```
The system did not recognize the last command.
```

Error 621: Command fault

```
The system did not accept the last command.
```

Error 622: System Response

```
The system response to the last command is not accepted.
- Bad Numeric format.
```

Error 623: Battery needs charging

```
Voltage detectors found a too low battery voltage.
- Check alternator and charging circuits.
- Check charging cable connections and fuses.
- Check Over/Under voltage detectors by supplying "battery" power from a
  variable (9 to 15V) supply.
  NOTE: do not exceed 14.5V for a longer period of time.
```

Error 624: Battery over-charged

```
Voltage detectors found a too high battery voltage.
NOTE that battery overvoltage may damage the System.
- Check alternator.
- Check alternator regulator.
- Check Over/Under voltage detectors by supplying "battery" power from a
  variable (9 to 15V) supply.
NOTE: do not exceed 14.5V for a longer period of time.
```

Error 625: 30V OFF RANGE

```
Voltage detectors found a too low or too high 30V (+/-15V) supply voltage
(less than approx. 28V or greater than approx. 32V).
 Possible causes:
 Battery voltage off range.
 +/-15V power supply defective/short circuited.
- Recharge battery if low. Check alternator regulator if voltage is too high,
  which may damage the power supply.
- Monitor the +/-15V in the Information - Voltages window.
```

Error 626: 5V TOO LOW

```
Voltage detectors have caught a too low 5V supply voltage
(less than approx. 4.7V).
Possible causes:
 Battery voltage Off Range.
```

5V power supply defective or overloaded/short circuited.
- Recharge battery if low. Check alternator regulator if voltage is too high, which may have damaged the 5V power supply.
- Monitor the 5V in the Infomation - Voltages window.

Error 627: 5V TOO HIGH

Voltage detectors have caught a too high 5V supply voltage (greater than approx. 5.3V).
NOTE that the digital circuits are specified to operate properly at a max. supply voltage of 5.3V, and if the supply voltage exceeds 7V, then the digital circuits may be damaged!
Possible causes:
5V supply defective.
- Monitor the 5V in the Information - Voltages window.

Error 630: Transport lock

1. When Lower Plate is initiated from "Transport Position" (PH activated), then the PL switch must remain ACTIVATED for at least 2 seconds (typ.).
2. Deactivation of the PH switch must occur prior to PL Deactivation.

If 1 or 2 fails, then the plate will be raised automatically to release the locks.
Possible causes:
The Transport locks have not been unlocked.
Defective PH and/or PL proximity switches.
- Check ALL transport locks and optional unlocking hardware.
- Check switch to LED correspondence in the Trailer. NOTE that a Deactivated PL switch (PL LED in Trailer OFF) means that the Plate IS Low.
- Check that PH and PL switches appear correctly on the Computer.

Error 632: Trigger Timeout

When Raise Weight is initiated, it is tested that the trigger (TG) proximity switch is Deactivated within a pre-determined time limit (1.5 sec. typ.), to make sure that the catch do not elevate without the weight.
Possible causes:
The catch was not locked to the weight.
Trigger switch defective.
Hydraulics needs bleeding.
- Release and lower the catch
  by use of **Manual Control** window (from the Computer) or
  by turning the MAN.KEY while pressing Drop and LP/RW buttons, and then LC button.
- Check Trigger (TG) switch (LED in Trailer and "TG" on Computer).
- Bleed the raise weight cylinder as explained in the Manual.
- Increase the Raise Weight (until TG off) time limit to 3 seconds max.

Error 633: PS1 activated/disconnected

Pressure switch P1 was activated or disconnected during Raise Weight.
- Check P1 wiring.
- Check that "P1" on Computer corresponds to P1 LED OFF in the Trailer.

Error 641: Lower Plate Timeout

Lower Plate has not completed within a predetermined time limit (15 sec. typ).
Possible causes:
The catch was not locked to the weight.
Pressure switch No. 1 (P1) defective or improperly adjusted.
Trigger (TG) proximity switch trouble.
Hydraulics failure.
- Release and lower the catch
  by use of **Manual Control** at Computer screen or
  by turning ON MAN.KEY while pressing Drop (LP/RW and RED button), then LC button.
- Check that "P1" on Computer corresponds to P1 LED OFF in Trailer and "TG" to TG Led ON.
- Refer to the Manual for adjustment instructions.
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).
- Increase the Lower Plate (until P1 on) time limit to 20 seconds max.

Error 642: Raise Weight Timeout

After initiation of Raise Weight the system must see the first WH (Weight High) signal within a predetermined time limit (3.5 sec. typ.) and the time between any two WH signals must not exceed twice this limit.
This prevents the weight from being raised to its top position (which would cause the weight to drop!) if the WH switch fails or if no falling height stops are applied.
Possible causes:
 WH proximity switch defective.
 The uppermost falling height stop (No. 1) is placed too low
 (too great falling height No. 1).
 Hydraulics failure.
- Check that "WH" on Computer corresponds to WH LED ON in the Trailer.
- Reduce falling height No. 1 to less than approx. 100 mm (4").
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).
- Increase the Raise Weight (until Stop 1) time limit to 4 seconds max.

Error 643: Drop Timeout

The time from initiation of the Drop mode until activation of the trigger (TG) proximity switch has exceeded a predetermined time limit (2 sec. typ.).
Possible causes:
 TG proximity switch defective.
 Hydraulics need bleeding.
 Hydraulics failure.
- If the weight actually dropped, then the TG switch MAY be defective.
- Check that "TG" on Computer corresponds to TG LED ON in the Trailer.
- If Drop causes the weight to raise more than approx. 20 mm (1"), before it is dropped, then the raise weight cylinder needs bleeding (or C valve is bad).
  Refer to the Manual for bleeding instructions.
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).
- Increase the Drop (until TG on) time limit to 5 seconds max.

Error 644: Lower catch Timeout

The time from initiation of the Lower Catch mode until pressure switch No. 2 (P2) is Deactivated AND P1 is activated, has exceeded a predetermined time limit (5 sec. typ.).
Possible causes:
 Pressure switch P2 and/or P1 defective or improperly adjusted.
 Hyd. pump excess pressure is too low.
 Hydraulics failure.
- Check that "P2" on Computer corresponds to P2 LED ON in the Trailer (and "P1" to P1 LED OFF!).
- Refer to the Manual for adjustment instructions.
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).
- Increase the Lower Catch (until P2 off) time limit to 6 seconds max.

Error 645: Raise Plate Timeout

The time from initiation of the Raise Plate mode until activation of the PH proximity switch(es) AND the P1 pressure switch has exceeded a predetermined time limit (15 sec. typ.).
Possible causes:
 Pressure switch P1 defective or improperly adjusted.
 Hyd. pump excess pressure is too low.
 PH proximity switch(es) defective or not activated when plate is high.
 Hydraulics failure.
- Check that "P1" on Computer corresponds to P1 LED OFF in the Trailer (and "PH" to PH LED ON).
- Refer to the Manual for adjustment instructions.
- Check that PH activator gap(s) is less than 4 mm (5/32") when the plate is in it"s locked position.
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).
- Increase the Raise Plate (until PH on) time limit to 20 seconds max.

Error 646: Release Catch Timeout

The time from initiation of the Release Catch mode until activation of the P1 pressure switch has exceeded a predetermined time limit (2 sec. typ.).
Possible causes:
Pressure switch P1 defective or improperly adjusted.
Hyd. pump excess pressure is too low.
Hydraulics failure.

- Check that "P1" on Computer corresponds to P1 LED OFF in the Trailer
- Refer to the Manual for adjustment instructions.
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).
- Increase the time limit to a maximum of 5 seconds.

Error 647: Raise catch Timeout

The time from initiation of the Raise Catch mode until activation of the P1 pressure switch has exceeded a predetermined time limit (5 sec. typ.).
Possible causes:
Pressure switch P1 defective or improperly adjusted.
Hyd. pump excess pressure is too low.
Hydraulics failure.

- Check that "P1" on Computer corresponds to P1 LED OFF in the Trailer
- Refer to the Manual for adjustment instructions.
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).
- Increase the time limit to a maximum of 10 seconds.

Error 648: Auto Raise Plate Timeout

The hyd.motor has been running continuously for more than 20 seconds in the (auto-) RAISE PLATE state, to keep the loading plate high.
Possible causes:
Pressure switch P1 defective or improperly adjusted.
Hyd. pump excess pressure is too low.
PH proximity switch defective or not activated when the plate is high.
Hydraulics failure.

- Check that "P1" on Computer corresponds to P1 LED OFF in the Trailer (and "PH" to PH LED ON).
- Refer to the Manual for adjustment instructions.
- Check that PH activator gap(s) is less than 4 mm (5/32") when the plate is in it″s locked position.
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).

Error 650: PS2 was ACTIVATED

The P2 pressure switch was activated on completion of the Raise Plate mode.
Possible causes:
Pressure switch P2 defective.
P2 wires short-circuited.
P2 setting too low.
-Check that "P2" on Computer corresponds to P2 LED ON in the Trailer.
-Refer to the Manual for adjustment instructions.

Error 651: PS2 was NOT activated

The P2 pressure switch was not activated on completion of Raise Weight mode.
Possible causes:
Pressure switch P2 defective.
P2 wires disconnected.
P2 setting too high.

- Check that "P2" on Computer corresponds to P2 LED ON in the Trailer.
- Refer to the Manual for adjustment instructions.

Error 652: PH was ACTIVATED

The Plate High Proximity Switch Signal was ACTIVE.
Possible causes:
 The plate IS high (of course).
 PH proximity switch defective.
 P1 pressure switch defective or too sensitive.
- Check that "PH" on Computer corresponds to PH LED ON in the Trailer.
- Check P1 adjustment.

Error 653: PH was NOT activated

The Plate High Proximity Switch was not activated on completion of the Raise Plate mode.
Possible causes:
 PH Proximity Switch defective.
 PH signal is not active when plate is high.
- Check that "PH" on Computer corresponds to PH LED ON in the Trailer
- Check that activator gap(s) is less than 4 mm (5/32") when the plate is in it"s locked position.

Error 654: PL was ACTIVATED

The PL (Plate Low) proximity switch was activated (i.e. Plate is NOT low!):
Possible causes:
 The plate is NOT low (of course).
 PL proximity switch defective.
 P1 pressure switch defective or too sensitive.
- The length of raise plate cylinder shafts limits the depth of "below ground" tests.
- Check that "PL" on Computer corresponds to PL LED in the Trailer.
- Check P1 adjustment.

Error 655: PL was NOT activated

The PL (Plate Low) proximity switch was not activated (which means that the Plate WAS low!) on completion of the Raise Plate mode.
Possible causes:
 PL proximity switch defective.
 PL activator trouble.
- Check that "PL" on Computer corresponds to PL LED in the Trailer
- Check that the PL proximity switch is activated when the plate is raised.

Error 656: WH was ACTIVATED

The WH (Weight High) proximity switch was activated.
Possible causes:
 WH switch defective.
 Falling height stop No. 1 is misplaced.
 Hydraulics malfunction.
- Check that "WH" on Computer corresponds to WH LED ON in the Trailer
- Lower falling height stop No. 1 (the uppermost hexagonal stop in the rail on the falling weight).
- Check the Hydraulics, in particular the C Valve (refer to the Manual).

Error 657: WH was NOT activated

The WH (Weight High) proximity switch was NOT activated on completion of the Raise Weight mode.
Possible causes:
 WH switch defective.
 Too great distance (clearance) between hexagonal stop and WH switch.
 Hydraulics failure.
- Check that "WH" on Computer corresponds to WH LED ON in the Trailer.
- Check that clearance is less than 6 mm (1/4").
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).

Error 658: TG was ACTIVATED

The TG (Trigger) proximity switch was activated (which means that the weight was low) Prior to DROP.

Possible causes:

TG switch defective.

Falling height stop No. 1 is misplaced.

Hydraulics failure.

- Check that "TG" on Computer corresponds to TG LED ON in the Trailer
- Increase falling height No. 1 to at least 40 mm (1.5"), but no more than 100 mm (4").
- Check that the hydraulic valves, the motor and the motor relay are powered and functioning properly (refer to the Manual).

Error 659: TG was NOT activated

The TG (Trigger) proximity switch was NOT activated (which means that the weight was not low) Prior to Raise Weight.

Possible causes:

The weight WAS not low (of course).

TG activator trouble.

TG switch defective.

- Check the TG activator (located at bottom of the falling height stops rail). NOTE that the Trigger MUST be activated as long as the weight is raised less than 6 to 12 mm (1/4" to 1/2") !
- Check that "TG" on Computer corresponds to TG LED ON in the Trailer.

Error 660: Vehicle was NOT PARKed

The PARK (ALARM) signal obstructed the initiation of Lower Plate.

Possible causes:

You DID not Park (of course).

PARK circuit troubles.

- Check the connection to the ALARM socket at the control box (refer to the Installation Section in the Manual).
- Check that the PRK LED at the control box light up when you park.
- Check that the PRK LED in the Trailer reflects the actual status.

Error 661: MAN.KEY was ON

The MAN.KEY in the Trailer was switched ON, which Disables control of the hydraulics from the Computer.

Possible causes:

The MAN.KEY WAS on (of course).

MAN.KEY switch element troubles.

- Check that hydraulics cannot be operated from the trailer buttons unless the MAN.KEY is turned ON.
- Check that "MN" on the Computer reflects the actual status

Error 662: PS1 was ACTIVATED

Pressure switch P1 was activated or disconnected continuously for a period of more than 4 seconds, while the hyd. motor was NOT running.

- Check P1 and wiring (Trouble Shooting Procedure in the Manual).
- Check that "P1" LED on Trailer and Computer is lit when pressure is low.

Error 671: Trailer Battery Drained

WARNING !!

At completion of Raise Plate, the Trailer Battery Voltage was TOO LOW !!

Error 672: CP15 Battery Drained

WARNING!!

To avoid uncontrolled operation,
please charge the battery immediately!
The CP15 power supply is CRITICALLY LOW!

Error 675: Load Cell Excitation

```
A Load Cell Calibration found one or both of the following Voltages in
error:
 Positive Excitation, typ +5.3V for FWD, +6.65V for HWD
 Negative Excitation, typ -5.3V for FWD, -6.65V for HWD
Posible reasons:
 Load Cell cable not connected or defective.
 Connections exposed to moisture.
 +/-15V supply off range.
 Compact15 circuits defective or exposed to condensing moisture.
- Check cables and connections.
- Check +/-15V supplies (Information - Voltages).
- Check Cell resistances thru Load Cell Cable DIN plug first:
  Ohms approx     DIN plug       Load Cell Socket
   240 - 243       2 - 4              2 - 4
   240 - 243       1 - 5              1 - 5
   180 - 183       2 - 1              2 - 1
   180 - 183       4 - 5              4 - 5
   180 - 183       2 - 5              2 - 5
   180 - 183       1 - 4              1 - 4
 The middle one of the 3 male pins in the cell socket is no.5 (CW
decrease).
```

Error 676: Load Cell Balance

```
A Load Cell Calibration found one or both of the following in error:
 Balance Step (typ zero)
 Balanced Zero (typ zero)
Posible reasons:
 Load Cell cable not connected or defective.
 Connections exposed to moisture.
 +/-15V supply off range.
 Load Cell has been overloaded e.g. due to lack of grease in the loading
plate
 swivel or due to dropping of weight without buffers.
 Compact15 circuits defective or exposed to condensing moisture.
- Check cables and connections.
- Check +/-15V supplies (Information - Voltages).
- Check Cell resistances thru Load Cell Cable DIN plug first:
  Ohms approx     DIN plug       Load Cell Socket
   240 - 243       2 - 4              2 - 4
   240 - 243       1 - 5              1 - 5
   180 - 183       2 - 1              2 - 1
   180 - 183       4 - 5              4 - 5
   180 - 183       2 - 5              2 - 5
   180 - 183       1 - 4              1 - 4
 The middle one of the 3 male pins in the cell socket is no.5 (CW
decrease).
```

Error 677: Load Cell Calibration

A Load Cell Calibration found one or both of the following Voltages in error:

Calibration Level

Shuntvalue type 3.5V for FWD, 3.25V for HWD

Posible reasons:

Load Cell cable not connected or defective.

Connections exposed to moisture.

+/-15V supply off range.

Load Cell has been overloaded e.g. due to lack of grease in the loading plate

swivel or due to dropping of weight without buffers.

Compact15 circuits defective or exposed to condensing moisture.

- Check cables and connections.
- Check +/-15V supplies (Information - Voltages).
- Check Cell resistances thru Load Cell Cable DIN plug first:

Ohms approx	DIN plug	Load Cell Socket
240 - 243	2 - 4	2 - 4
240 - 243	1 - 5	1 - 5
180 - 183	2 - 1	2 - 1
180 - 183	4 - 5	4 - 5
180 - 183	2 - 5	2 - 5
180 - 183	1 - 4	1 - 4

The middle one of the 3 male pins in the cell socket is no.5 (CW decrease).

Error 682: Deflector Amplifier Mismatch

The Deflector Amplifiers are not the right type.