SIGMA Dynamometers

User Manual

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Sigma Dynamometer User Manual
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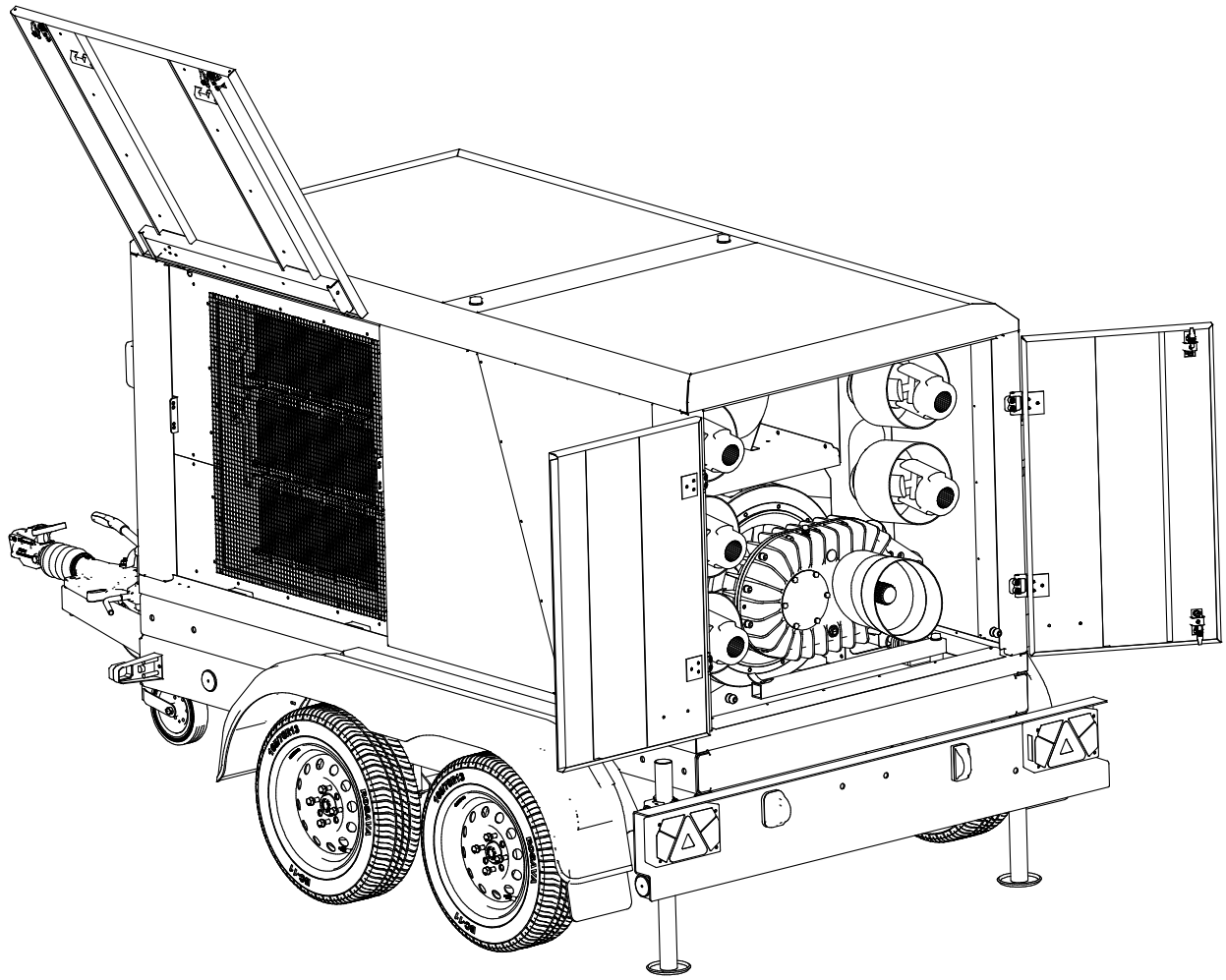

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Introduction

This manual should provide you with all the information that you need to safely install and operate Froment Sigma dynamometers. The manual is divided into five chapters:

Chapter One provides an introduction to the general principles of engine testing and explains how a Froment dynamometer makes the process easier, safer and more reliable. It then provides an introduction to the dynamometers, explains how they work, and then introduces their main features.

Chapter Two covers all of the procedures that need to be carried out before a dynamometer can be put into operation. It explains how to transport and install the unit, and describes how to choose a test area so it can be operated safely.

Chapter Three covers how to set up a dynamometer and tractor so that the engine can be tested effectively. It explains how to position the dynamometer in relation to the tractor and how to connect the PTO shaft. It then goes on to explain how to remove the input gearbox to allow the unit to be used for bare engine testing.

Chapter Four provides an introduction to the Dynamometer Hand-held Terminal (Hand-held) and explains how it is used to carry out engine tests.

Chapter Five covers the maintenance procedures you will need to follow to keep the dynamometer operating correctly. It also explains how to troubleshoot should a problem occur.

How to Use this Manual

This manual provides important instructions for the safe operation of the dynamometer. It is a reference book and should be kept in a safe place where all operators have access to it. If you pass the product on to a new user, then please ensure that this instruction manual is also handed over.

The manual is not intended to cover engine management or diagnostics. Please refer to the engine or tractor manufacturers' documentation and manuals for information on these subjects.

An Important Note on Safety

Froment dynamometers are designed with safety as a very high priority, but their operation does present some risks. Tractor PTO shafts can be particularly hazardous and you should not use this equipment unless you have read and understood this manual, the PTO shaft manufacturers manual and are familiar with the accepted practice for the industry.

The equipment should not be used by unskilled or unqualified personnel. Misuse could result in serious injury and damage to the equipment.

Be sure to follow all of the safety warnings in this manual. In particular, pay careful attention to the following points:

- Check that all guards, covers and protective screens are in place and secured before starting up.
- Ensure that the PTO shaft you are using is rated to suit the power you intend it to transmit. Please refer to PTO combination and life expectancy table on page 3-8.
- Do not mix series P600 and P700 half shafts as this may cause vibration under certain operating conditions.
- Never use PTO shaft spline converters in conjunction with the Dynamometer. They are not intended to transmit the high powers possible in a Dynamometer test. Their use could cause serious injury to people and damage to the equipment.
- Make sure the drive shaft is fitted correctly before operating the equipment.
- The Dynamometer and tractor must stand on firm ground; with the brakes of both units applied and the rear corner prop stands down and locked in position.
- Always use the safety chain provided to ensure the tractor and dynamometer cannot move apart during the test.
- Never handle any part of the drive shaft until the PTO is at rest and the engine stopped.

Before making any adjustments:

- Put the hand brake on.
- Make sure the controls are in neutral.
- Stop the engine.
- Remove the key.
- Wait for all movement to cease.

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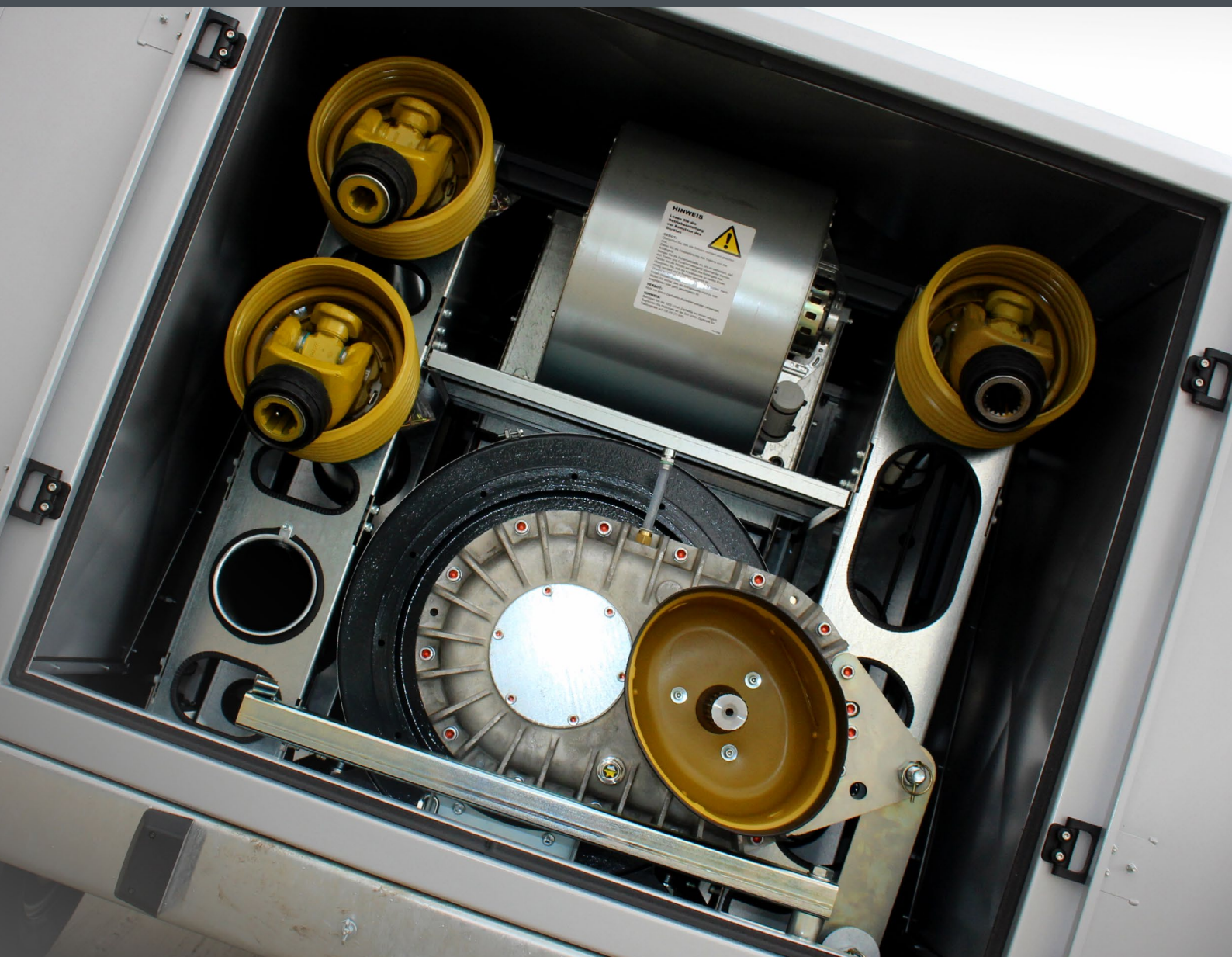
Chapter One

Introducing Froment Dynamometers

If you are not familiar with the use of Froment dynamometers you should start with this chapter. It provides an introduction to the general principles of agricultural engine testing and then explains how a Froment dynamometer makes the process easier, safer and more reliable.

If you are experienced at engine testing you may want to skip the earlier sections, but you should certainly read the specification which appears at the end of the chapter.



Why test tractor engines?

The diesel engines fitted to agricultural machines such as tractors are different from those fitted to ordinary vehicles in one very important respect. They often have to operate at full power output for long periods of time.

For some applications, such as ploughing, the ability to produce maximum power can be of critical importance. A performance decrease of only a few percent can make a significant difference to the time taken and costs of completing a job. This means that effective maintenance of an agricultural engine, particularly those aspects that influence its ability to produce maximum power, is essential.

This presents a problem if you are responsible for maintaining these vehicles because it can be difficult to detect a small reduction in performance using subjective methods. This is especially true when the reduction has occurred gradually over a period of time. It can be equally difficult to assess small improvements, or to demonstrate that the maintenance work or adjustments you have carried out have been effective.

The only way to be sure of this is to use a mechanical device to test the engine operating under full load and accurately measure its power output. This must be done with an instrument that is capable of providing reliable and repeatable measurement that can be compared against specifications or previous tests.

For vehicles fitted with Power Take Off (PTO) output shafts, the most effective way of doing this is to use a PTO driven dynamometer designed for the task.

Introducing Sigma Dynamometers

Froment's Sigma Dynamometers are purpose built for the testing of agricultural engines. They are designed to be connected to the vehicle's PTO output to allow the power output of engines to be measured quickly and accurately. They are mains powered, air cooled and are capable of handling the full power output of even the largest agricultural engines for extended periods.

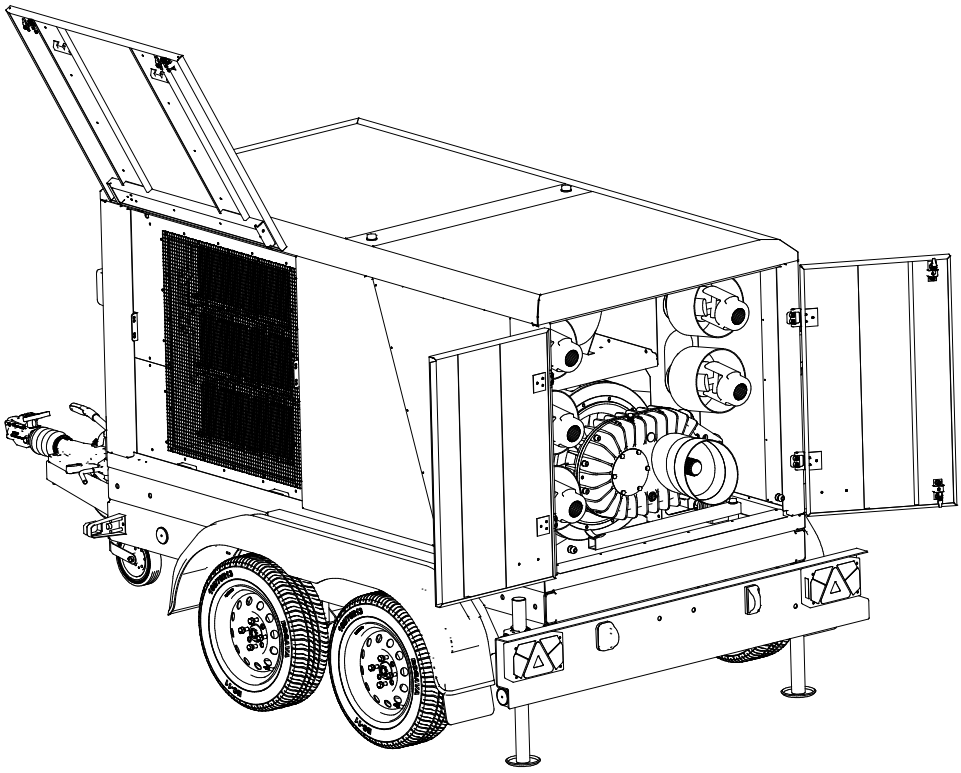


Figure 1-1 Sigma Dynamometers are purpose designed for testing agricultural engines.

Sigma Dynamometers are highly adaptable and have many features that ensure fast, safe and reliable testing.

- Automatic mode provides full and repeatable measurement of all essential engine parameters from a single key-press.
- Direct PTO drive allows tractor engines to be tested quickly and easily (bare diesel engines can be tested by direct coupling if required).
- Air Cooled - no cooling water is required.
- Trailer mounted to allow mobile operation (static mounted option for fixed installations).
- Remote control via a hand held controller or PC.

Model Range

Sigma Dynamometers are currently available in two capacities and two configurations. All units are similar in size and operation and are designed to vent hot air from a side panel.

Capacities

The Sigma 50 dynamometer has a maximum capacity of 380 kW (515 PS). It provides an economical option suitable for general use.

The Sigma 60 dynamometer has a maximum capacity of 500kW (680 PS). This additional capacity means that it can be used to test right through the power curve of the larger tractors on the market today.

Variants

Both dynamometers are available as trailer mounted for mobile operation, or on a frame intended for permanent mounting in a static installation.

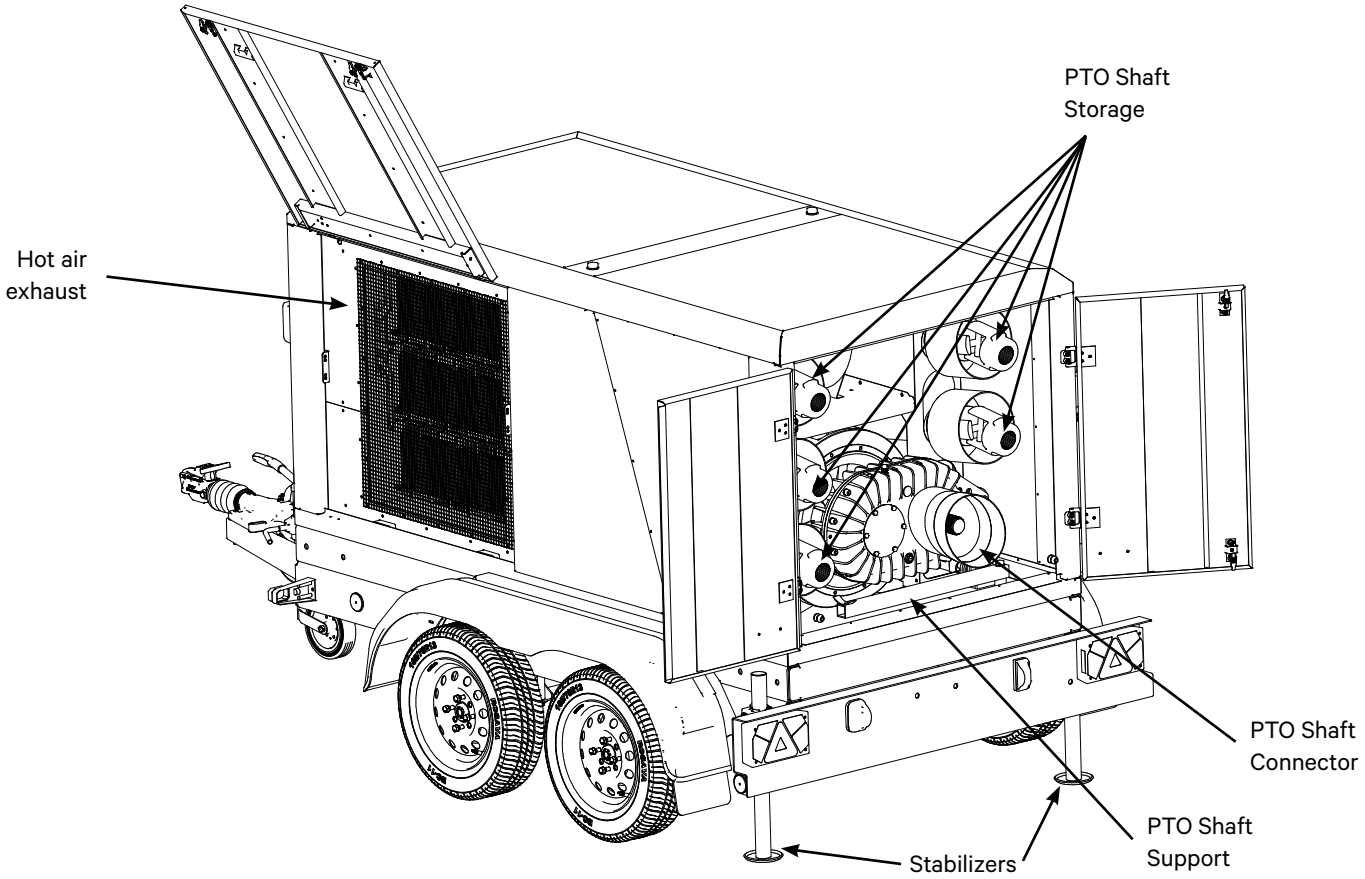


Figure 1-2 Trailer mounted mobile Sigma Dynamometer.

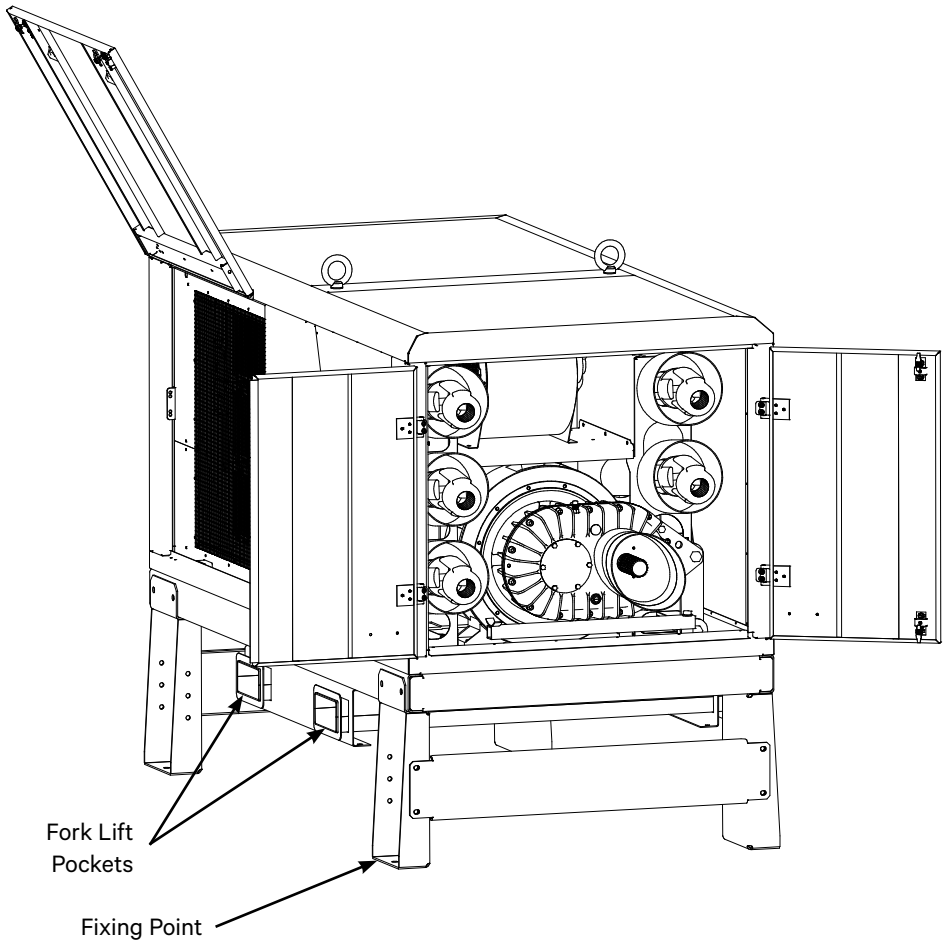


Figure 1-3 Static variant of the Sigma Dynamometer

Sigma Dynamometer Operation

Sigma Dynamometers are simple to use, with both fully automatic and manual test modes. During the test the dynamometer can be controlled either by a cable connected hand-held controller, or by using Froment's DynaTest software running on a PC.

To carry out an engine test the dynamometer is connected directly to the tractor's PTO. After safety checks are made, the tractor's engine is started and set to operate at full throttle. The dynamometer is switched on and can then be used to carry out tests by applying different loads and measuring how the engine responds.

Control Options

Froment dynamometers have two control methods that can be used, depending on the requirement.

The Sigma Dynamometer Hand-held. The hand-held has a outdoor rated enclosure with a custom-designed membrane keyboard and 4.3" colour TFT screen and is connected via a 10 metre cable to a control panel located in the front cabinet of the dynamometer.

Figure 1-4 The Dynamometer Hand-held.

The Hand-held has a simple to follow user interface that allows any of five test modes to be configured and selected. The clear back-lit display provides a live data readout of power, torque and speed measurements during the test.

We will describe the operation of the dynamometer using the Hand-held in more detail in Chapter Four.

Froment's DynaTest PC software. This runs on a Windows PC and provides a more advanced user interface than the Dynamometer Hand-held.

The software provides graphical visualisations of tests as they progress, and adds an engine warm up facility and a test database.

The test results (and customer details for a particular vehicle) can be stored to provide a comparison of how performance has varied over time. Test results can also be printed out to provide a permanent record that can be used as part of a service report.

The DynaTest PC software is provided with a comprehensive online help system and you should refer to this for further details of its operation.

How Sigma Dynamometers work

The dynamometer works by applying a calibrated and controlled braking force to the tractor engine, whilst measuring the speed of the engine's rotation. Measuring the speed and power under a specific load allows the amount of torque produced by the engine at different speeds to be calculated.

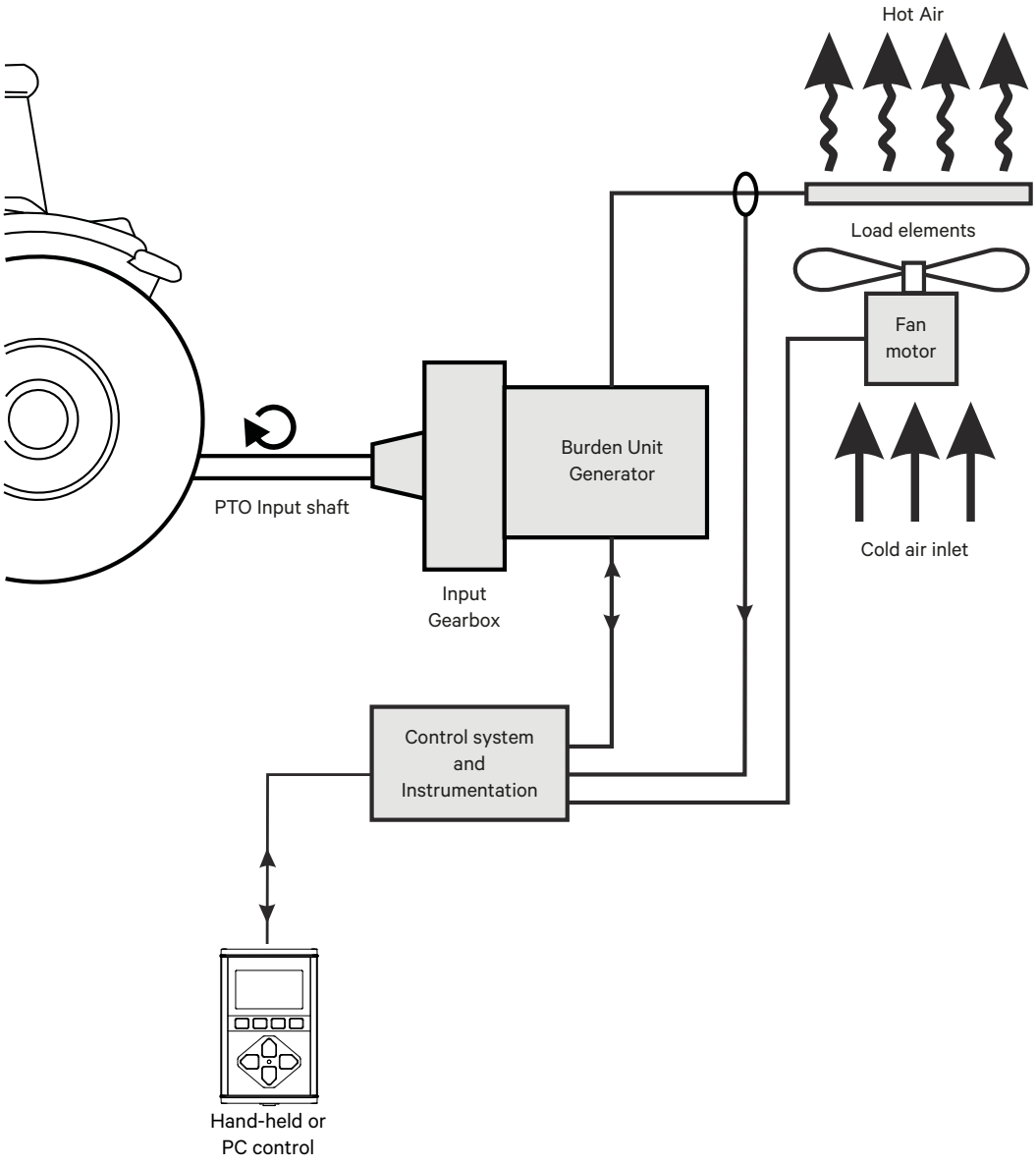


Figure 1-5 Simplified diagram showing the general principles of operation of a Sigma Dynamometer.

PTO Input

The dynamometer design exploits the fact that most tractors and many agricultural machines are fitted with a power take-off shaft. The PTO provides a quick method of connecting the dynamometer to the engine using a drive shaft without the need to remove the engine from the vehicle.

Burden Unit

To apply the braking force the dynamometer is fitted with what is known as a burden unit. This consists of an input gearbox connected to a modified AC electrical generator. The output of the generator is connected to an array of resistive load elements, which are arranged so that a cooling fan can be used to remove the heat generated during the test.

In operation, the tractor's PTO drive is engaged to turn the dynamometer's input shaft. The generator produces an electrical current, which is fed to the load element array and is converted to heat. An electronic control system varies the generator's output, and consequently varies the braking effect on the input shaft. Instrumentation measures the generator output current and the input shaft speed.

Specification and technical data

	Sigma 50	Sigma 60
Capacity (PTO Input)		
Maximum Power	380kW (515 PS) @1000 rpm	500kW (680 PS) @1000 rpm
Maximum Torque	3170Nm @800 rpm	4150 Nm @800 rpm
Capacity (Direct Input)		
Maximum Power	380kW (515 PS) @1800 rpm	500kW (680 PS) @1800 rpm
Maximum Torque	1790Nm @ 1400 rpm	2340 Nm @ 1400 rpm
Dimensions (trailer mounted)		
Kerb Mass	1780kg	1980kg
Height	1729 ± 25mm	1729 ± 25mm
Width	1850 ± 25mm	1850 ± 25mm
Length	3700 ± 50mm	3700 ± 50mm
Dimensions (static)		
Installation Mass	1460kg	1660kg
Height	1791 ± 5mm	1791 ± 5mm
Width	1350 ± 10mm	1350 ± 10mm
Length	2456 ± 10mm	2456 ± 10mm
Cooling System:	Side venting, mains powered forced air	Side venting, mains powered forced air
Maximum shaft rotation speed:	1250 rpm	1250 rpm

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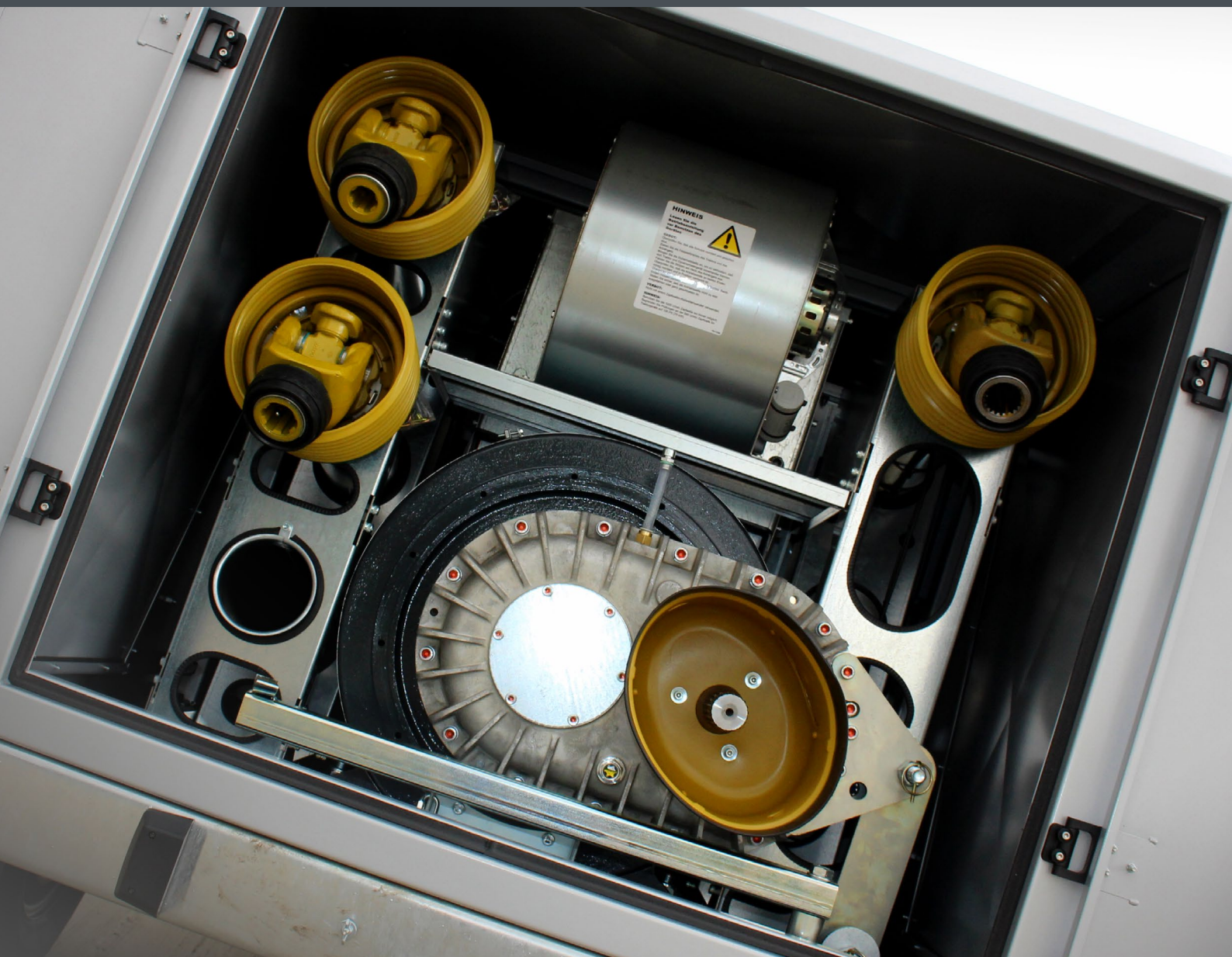
Chapter Two

Transportation, Installation, Location

Trailer mounted Froment Dynamometers are designed for mobile operation, and do not require a permanent installation as such. However the characteristics of the site where the unit is to be operated are important for both static and mobile variants, and are similar in many respects. This chapter explains the requirements for a successful, and safe, engine test.



Transporting and storing Froment Dynamometers

Note: Ensure that you dispose of any packaging materials correctly, recycling where possible.

Trailer mounted Sigma Dynamometer units can be moved from site to site using a standard vehicle mounted towing hitch.

The Static variants of the Sigma dynamometers are intended for permanent installation on-site, and are fitted with a base frame which contains fork lift pockets to allow the unit to be lifted and manoeuvred using a suitable fork lift truck.

Lifting by fork lift truck

Note: Fork pockets are intended for manoeuvring and transport only. They should not be used for support during testing.

Check the specifications to ensure that the forklift truck has sufficient capacity to safely lift the weight. Add 5% to the specified weight for minimum packing, and 15% for a unit in an export wooden case.

Lifting by crane or hoist

The crane and any lifting chains or straps used must have sufficient capacity to safely lift the weight of the dynamometer. A suitable spreader should be used to ensure that the straps or chains used do not crush or otherwise damage the unit.

Protection and securing transport

If a dynamometer is carried on an open goods vehicle, it should be covered with a tarpaulin, or a similar to protect it from the elements. As far as is possible tie the unit down using the fork lift pockets and lifting eyes. For trailer mounted units ensure that the hand brake is applied and the corner props are down and locked in position.

Trailer Operation

There are a number of factors that need to be taken into account to ensure that a trailer mounted Sigma Dynamometer can be used safely, effectively and within the regulations that apply locally. You must check whether you have an appropriate driving licence, and be sure to observe any speed limits that are in force for towing vehicles.

Towing vehicle. One of the most important things to consider is whether the towing vehicle that you use is a good match for the trailer mounted unit. The vehicle must be fitted with the correct type of towing coupling (Froment trailers may be fitted with a standard 50mm ball or a ring type coupling) and must be capable of towing the trailer's weight.

Note: The permissable maximum laden mass (fully laden) of the trailer is shown on the rating plate (figure 2-2). The kerb mass is shown in the table on page 1-10.

Figure 2-2 Trailer rating plate

Load distribution. Froment equipment mounted trailers are supplied correctly load balanced so that an appropriate amount of nose weight is applied. This is important to maintain stability when towing. Due to weight limitations no additional equipment should be transported in the trailer. The nose weight should be between 50-100 kg.

Brakes. All Froment trailers are fitted with a hydraulically damped overrun braking system and auto reverse brakes. An emergency breakaway cable is provided. The end of this should be clipped or fixed round some fixture on the towing vehicle (not the towing ball). The other end is attached to the trailer braking system so that the cable will apply the parking brake automatically if the trailer becomes separated from the towing vehicle.

Before towing:

1. Ensure that all opening panels are securely closed and the rear corner props are fully up and locked in place.
2. Check the ball head cup is well greased.
3. Inspect the break-away cable. If it is kinked, frayed or damaged replace it immediately.
4. Inspect the lighting cable and plug. If it is damaged replace it immediately.
5. Check that the trailer lights are undamaged and working correctly.
6. The trailer is in a roadworthy condition
7. Check that the tyres are fully inflated, have adequate tread and are free from cuts, bulges or other damage.
8. Ensure that a number plate showing the registration number of the towing vehicle is attached to the trailer.
9. When hitched to the towing vehicle, release the hand brake and check that the jockey wheel is retracted and locked in place.

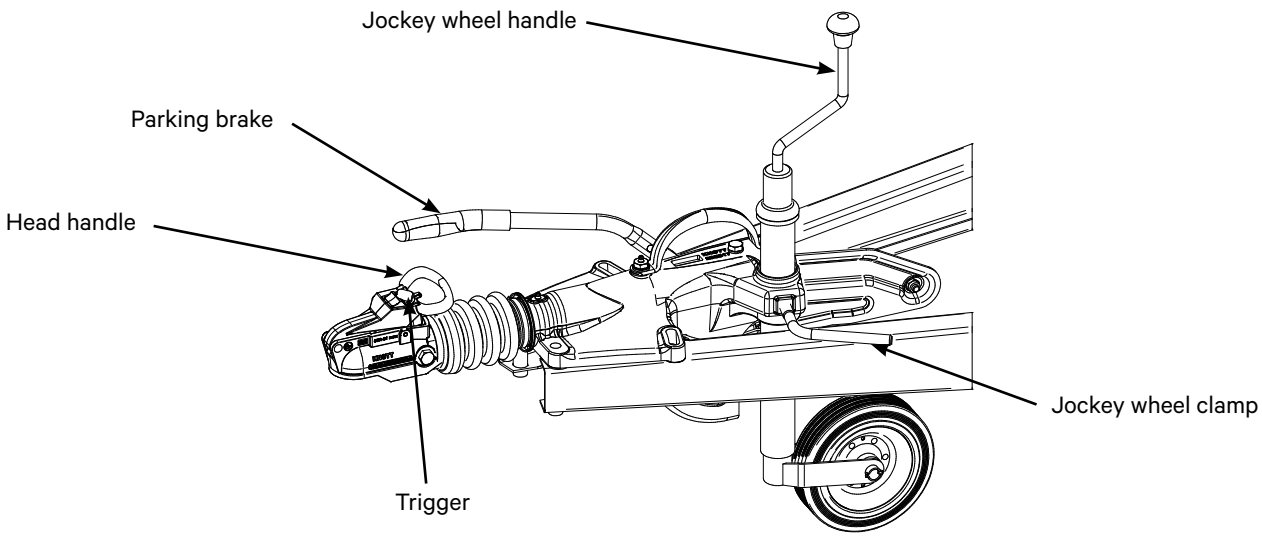


Figure 2-3 General arrangement of the trailer towing hitch (showing a ball type coupling)

Dynamometer Installation

The trailer mounted versions of the Sigma Dynamometer are intended for use as mobile units at temporary locations. As such, no permanent installation is required. However, the environmental and site location requirements, particularly regarding the need to ensure an adequate airflow, are similar for all units.

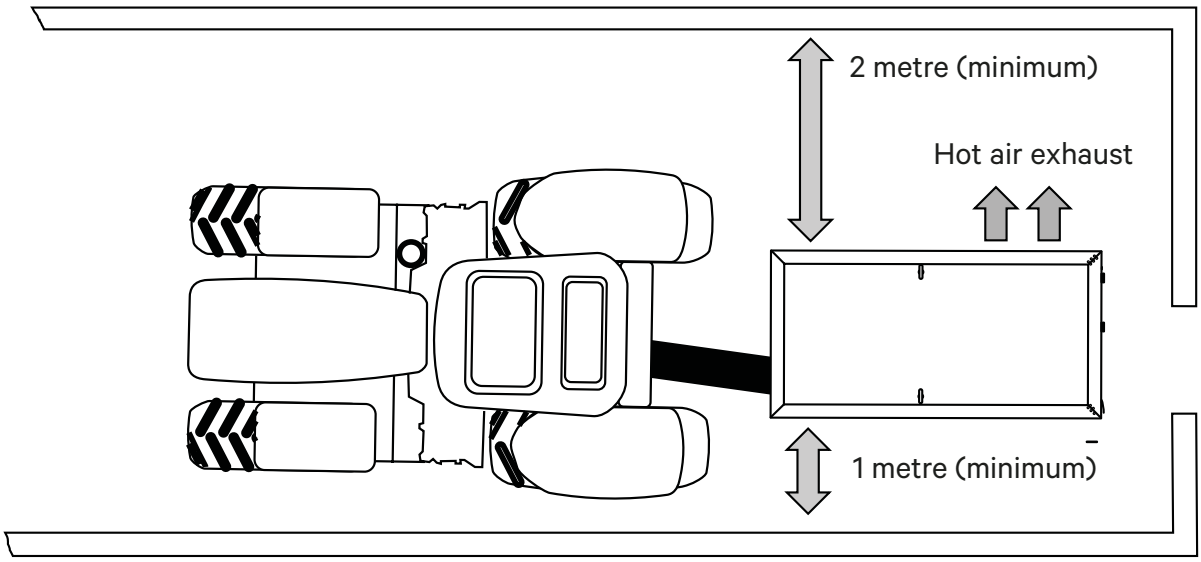


Figure 2-4 The Sigma 60 dynamometer minimum space and airflow requirements.

To choose a suitable location you must consider the requirements for the operation of both the dynamometer and the tractor under test.

Choose a clean, dry, well ventilated location, which gives easy access to the control panel and a single phase 230V AC power supply.

Airflow requirements

During a test, all the energy produced at the tractor PTO is discharged from the dynamometer in the form of hot air. Ensure that there is nothing in the region of the hot air exhaust that is inflammable, or could be damaged by the heat. Take particular care to avoid directing the hot air discharge near electrical equipment or wiring.

Pay attention to the following points:

- There must be a minimum of one metre of clear airspace around the dynamometer and two metres for the exhaust side (for Sigma 4/5 units, with their vertical exhaust, two clear metres above).
- There must be sufficient ventilation to ensure that the surrounding air temperature does not rise by more than 10°C above ambient during full load operation.

- The dynamometer should be mounted in free air with equal pressure at the air inlet and outlet screens when the fan is at rest.
- Do not fit air deflectors, louvres, control flaps or trunking to the dynamometer. Open the doors or use ventilators to discharge excess heat within the building.

Tractor Standing

For a fixed installation, or if regular testing with a trailer mounted unit is to be carried out, we recommend a concrete slab be laid to provide the tractor standing. Hard-core or compacted soil will quickly deteriorate with constant use.

Warning! If an enclosed area in the workshop is used as a test bay it is essential to use extraction equipment to safely remove engine exhaust fumes.

To avoid excessive vibration the tractor standing must be level and large enough so that the tractor can stand parallel with the base of the dynamometer.

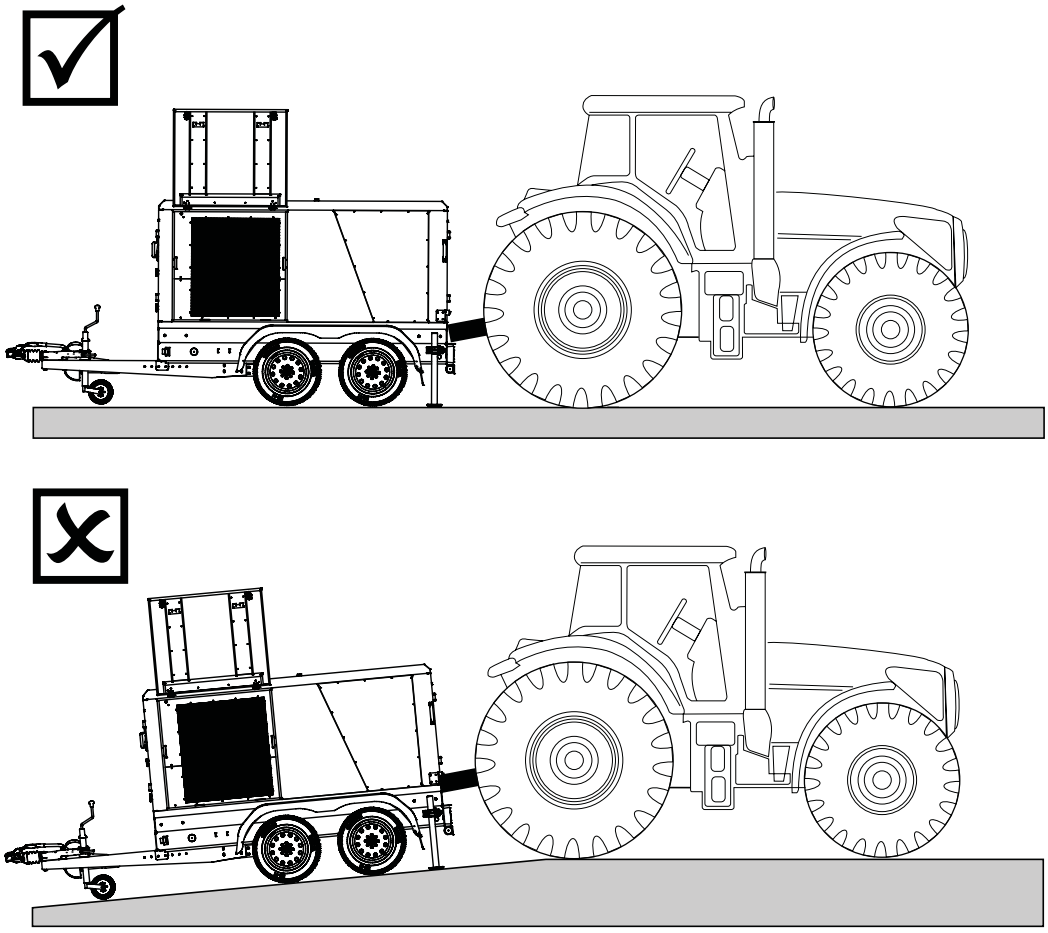


Figure 2-5 The test area must be level and large enough for both tractor and dynamometer.

Static Dynamometer Permanent Installation

The dynamometer must be securely bolted to the floor. Four 12mm high tensile rag bolts, grouted into the concrete, or expanding wedge type bolts such as 'Rawlbolts' should be used.

A minimum floor area of 2600 mm x 1500 mm is required. The concrete floor should be free of cracks, in sound condition and at least 150mm (6") thick.

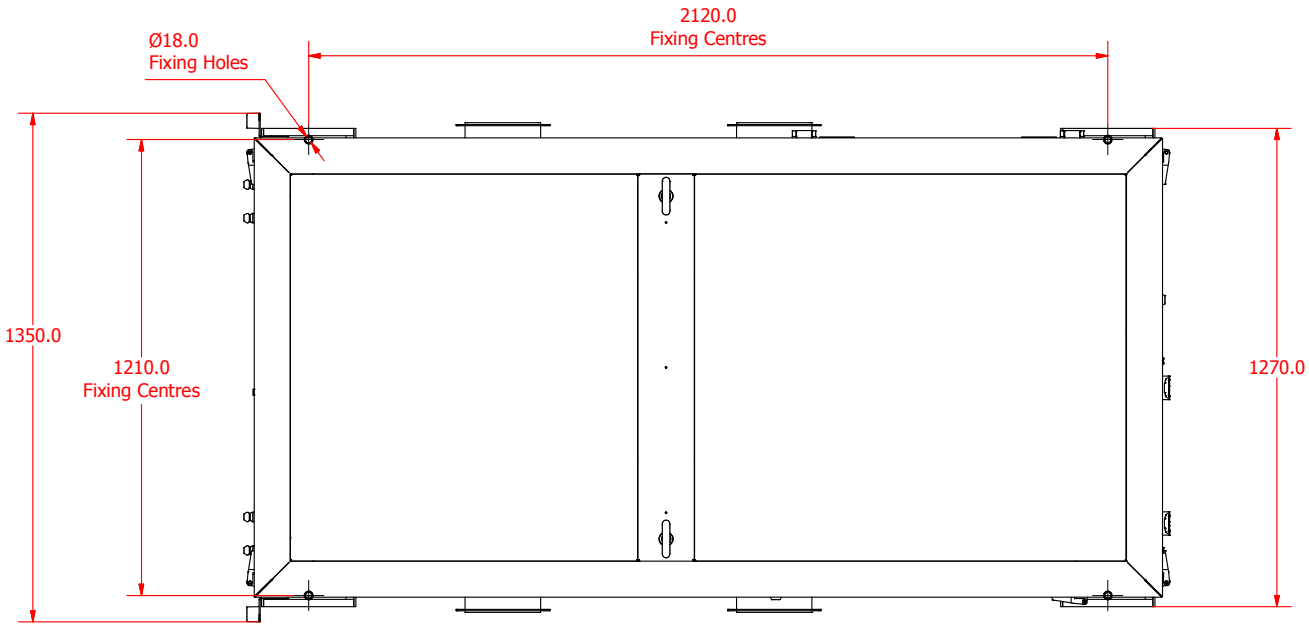


Figure 2-6 Sigma 50 & 60 static installation fixing points

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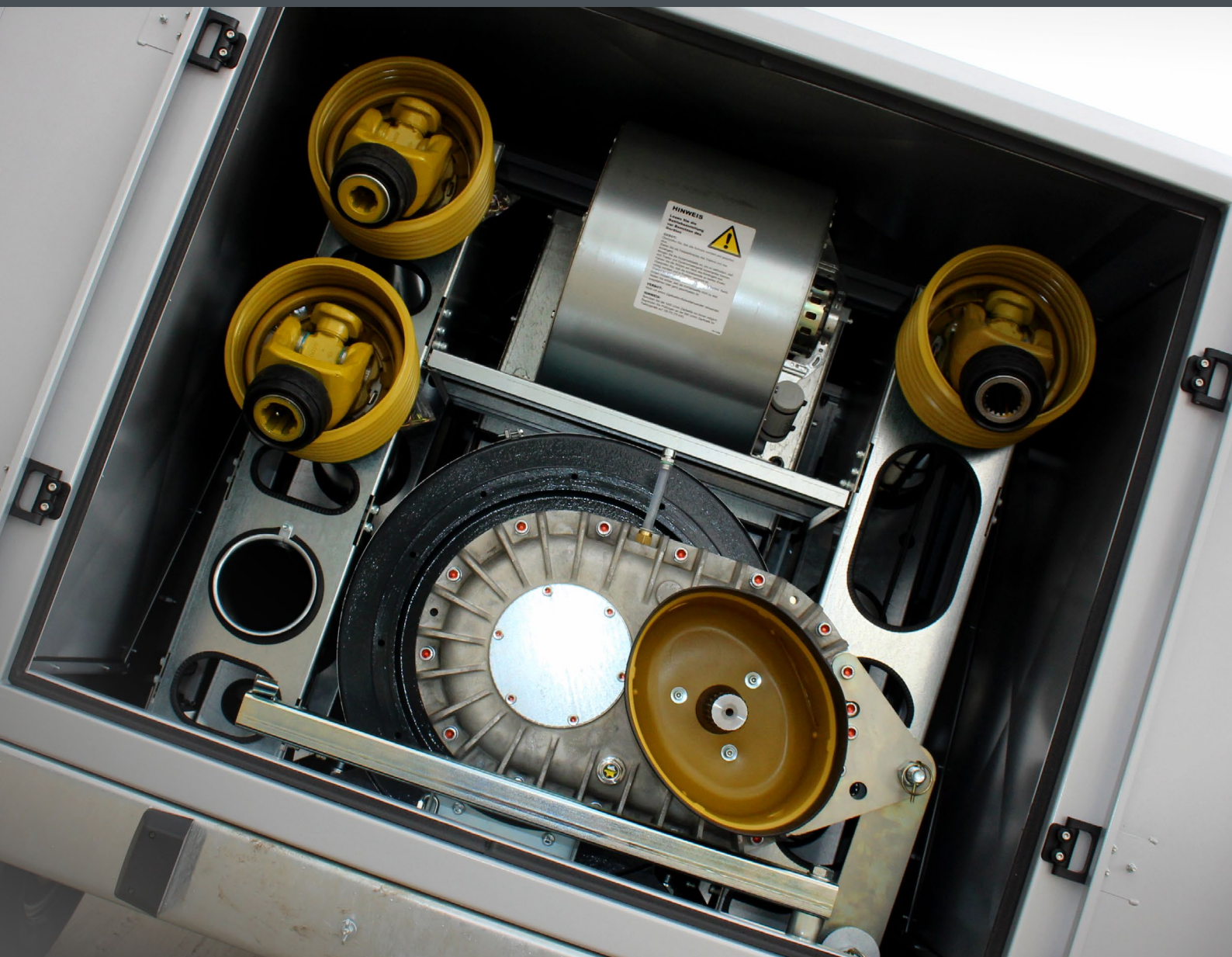
Chapter Three

Setting up a Tractor Test

This chapter explains how to set up the dynamometer with a tractor in preparation for a test. Please pay particular attention to the safety information that appears at the beginning.



About Safety

Tractor PTO shafts can be extremely dangerous and dynamometer testing exposes them to very high levels of stress - much higher than they are normally exposed to in day-to-day operation. This means that you should only make use of drive shafts that are in good condition. Any mechanical weakness will quickly be revealed and that could create a very dangerous situation.

This equipment should only be used by qualified persons with the appropriate levels of experience and training to ensure that they can operate it safely.

It is very important that you read, understand and follow all safety warnings:

- Do not attempt to operate your Sigma Dynamometer until you have read this instruction manual and the PTO shaft manufacturers manual.
- Ensure that the PTO shaft you are using is rated to suit the power you intend it to transmit. Please refer to PTO combination and life expectancy table on page 3-8.
- Check that all guards are in place and secured before starting up.
- Do not mix series P600 and P700 half shafts as this may cause vibration under certain operating conditions.
- Never use PTO shaft spline converters in conjunction with the Dynamometer. They are not intended to transmit the high powers possible in a Dynamometer test. Their use could cause serious injury to people and damage to the equipment.
- Make sure the drive shaft is fitted correctly before operating the equipment.
- Keep the equipment dry at all times. Protect your dynamometer from driving rain or snow and do not use it where water or snow could be drawn in by the cooling fan.
- Always use the safety chain provided to ensure the tractor and dynamometer cannot move apart during the test.
- Never handle any part of the drive shaft until the PTO is at rest and the engine stopped.
- Never operate the dynamometer with any of the covers or protective screens removed. Serious injury could result from contact with high voltage and extensive equipment damage due to short-circuiting of the cooling air.

Safe Stop

It is extremely dangerous to carry out any work on a machine while it is under power. Follow the Health and Safety Executive's Safe Stop procedure before carrying out any maintenance or adjustments:

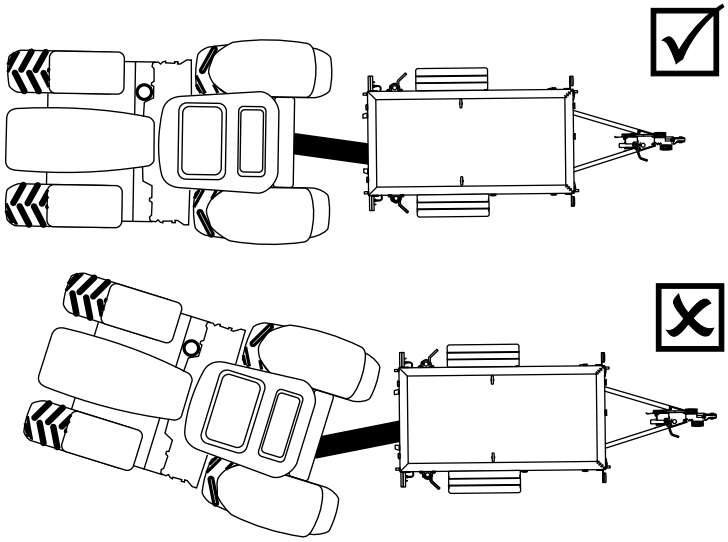
1. Put the hand brake on.
2. Make sure the controls are in neutral.
3. Stop the engine.
4. Remove the key.
5. Wait for all movement to cease.

Tractor Position

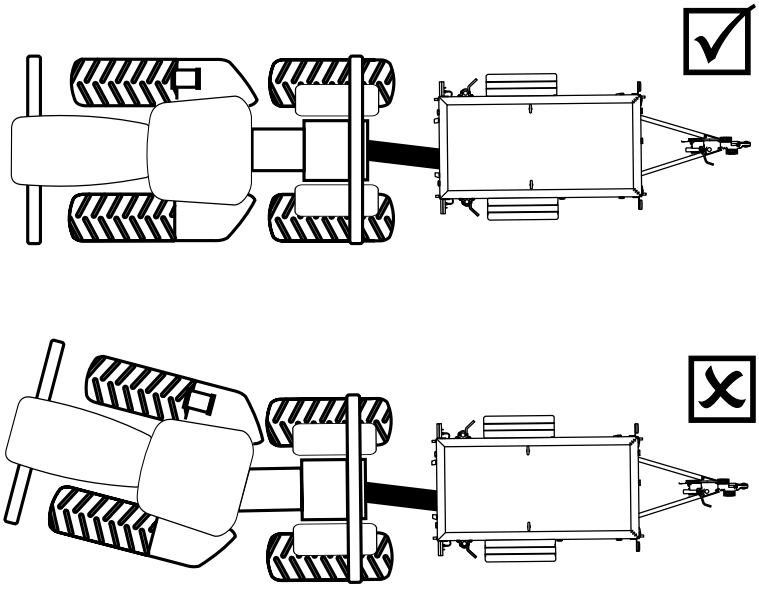
The position of the tractor in respect of the dynamometer is extremely important.

Note: Poor positioning of the tractor will cause excessive vibration and could prove damaging to the equipment.

1. Ensure that the tractor PTO output and the input shaft are in line and parallel.



2. Articulated tractors must stand with both axles parallel to each other so that the drive shafts are in line.



3. Adjust the gap with the dynamometer to ensure that the drive shaft is not over extended or fully closed and that the retaining pins can engage properly.
4. Apply the tractor's parking brake

Positioning a Trailer Mounted Dynamometer

Before testing can begin you must ensure that the tractor standing and test area are suitable for the purpose. The dynamometer and tractor must stand on a level, firm surface with no possibility that the prop stands or jockey wheel will sink into the ground (refer to Chapter Two for details).

1. Position the dynamometer and firmly apply the parking brake.
2. Adjust the jockey wheel to cause the trailer chassis to tilt down at the coupling end by 30-50 mm (1-2”). Lower the two rear corner prop stands and firmly lock them in position.
3. Turn the jockey wheel level adjuster until the trailer chassis is again parallel with the ground. This adds greater stability to the dynamometer during test by transferring the dead weight rearwards and outwards.
4. Fully open the dynamometers (PTO) end and air outlet doors.

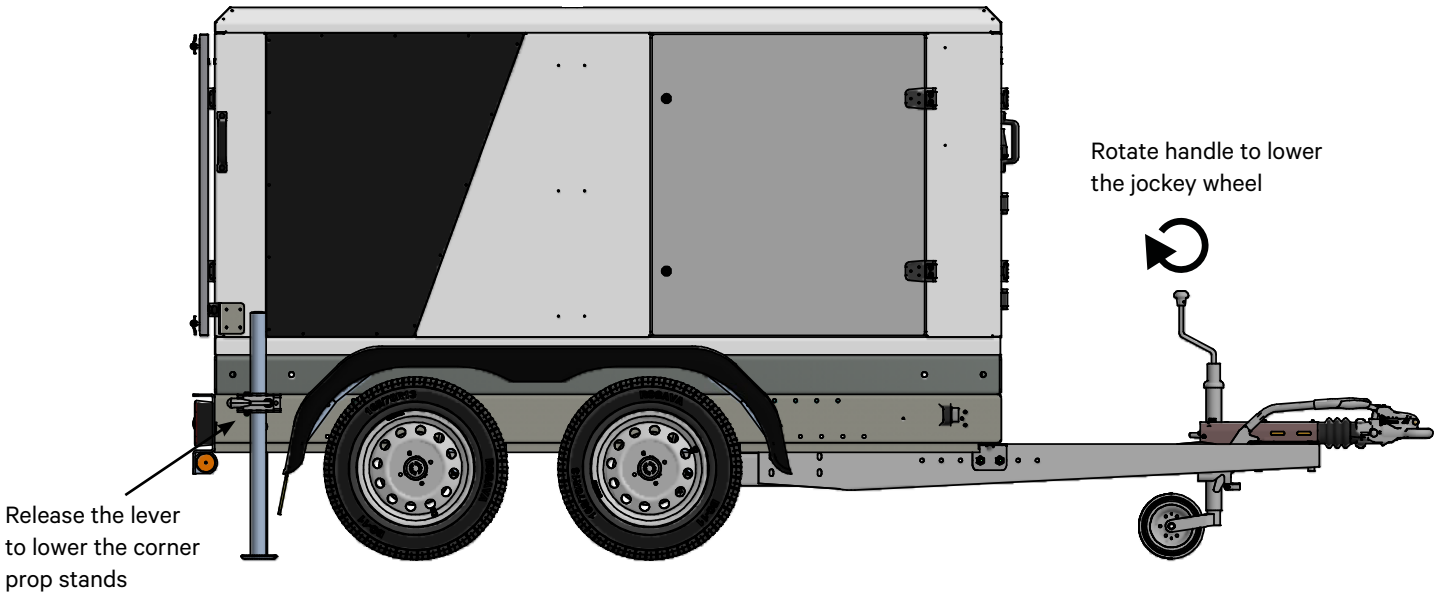


Figure 3-1 Use the corner props and jockey wheel to stabilise the dynamometer.

Dynamometer Setup

Open the control panel door at the end of the dynamometer:

1. Connect the 230V AC supply to the mains input connector.
2. Connect the Hand-held controller (or PC) cable to the Hand Held Controller input.

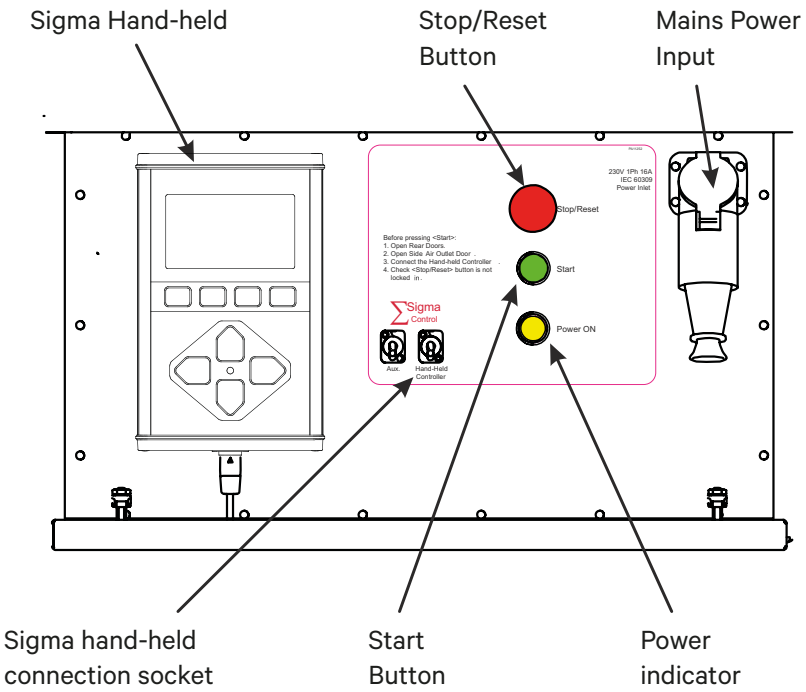


Figure 3-2 Sigma 50 & 60 Control panel Layout

At the PTO input end of the dynamometer:

1. Check the oil level in the gearbox. A sight glass located immediately under the input shaft indicates the oil level.
2. Make sure the input shafts are clean, undamaged and lightly oiled.
3. Closely inspect the gearbox. Check the retaining clip(s) are in position on the torque pins.
4. Ensure the airflow path to the dynamometer is unobstructed and clear of debris that might have been picked up by the cooling fan.

Tractor Setup

The Sigma Dynamometer allows you, within the capacity of the dynamometer in use, to apply the full load capability of the tractor on test by pressing a small control key. In many cases the tractors you will test will not have been subjected to such demands of power since manufacture or pre-delivery inspection, when all systems were new.

- It is important to ensure that the tractor is in good mechanical condition with all fluids (oil, etc.) at optimum levels.
- All dynamometer tests must be carefully monitored, both visually and audibly, if there are any sudden changes then the test should be aborted while the cause is investigated.
- Consider erecting barriers to keep personnel away from the test area and ensure that nobody is allowed in the vicinity of the PTO shaft while the tractor is running.

Parasitic Loads

In order to measure the full output power of the tractor's engine it is important to minimise the extent of any parasitic load. Parasitic loads are additional loads that have a negative effect on the power available at the PTO shaft.

To minimise parasitic loads:

- Deactivate the hydraulic system.
- Switch off the air condition system.
- Ensure that the tractor's battery is fully charged (the alternator can put a significant load on the engine).
- Ensure that no auxiliary items of equipment are engaged (directly, electrically or hydraulically).

Note: A sticking hydraulic system spool valve can cause losses of up to 15 horsepower. With experience, you can sometimes hear if this problem exists

Choosing and Checking the PTO shaft

A variety of half drive shafts are stored at the rear of the trailer in storage tubes.

The drive shaft consists of a male and female telescopic section fitted with internally splined end yokes supported by needle roller bearings. A two section, telescopic, non-rotating, plastic guard should cover the entire shaft. A chain is fitted to each half of the guard to prevent rotation when the shaft is in use.

Warning! Never use PTO shaft spline converters in conjunction with the Dynamometer. They are not intended to transmit the high powers possible in a dynamometer test. Their use could cause serious injury to people and damage to the equipment.

Determine the PTO speed, power and spline configuration of the tractor to be tested. Select the appropriate sections and inspect them, checking the following points:

- The cross joint bearings coupling the end yokes to the drive shaft must not show any signs of play or stiffness. With the drive shaft held horizontally the end yoke should fall freely at its four quadrants.
- The cross joint bearings must have been lubricated according to the manufacturer's instructions.
- The end yoke spline must be clean and slightly oiled.
- The end yoke retaining pins or collar must be free to be pushed in and, when released, return with a click.
- The telescopic sections of the drive shaft must be lightly greased and free to move in and out.
- The rotating guard must be free to move. Its bearings must be lightly oiled.
- The plastic guard and securing chain must be undamaged.

If the shaft fails on any of these points it should not be used until the fault has been rectified.

Fitting the PTO Shaft

The PTO shaft that connects onto the Sigma 60 Gearbox is fitted with a taper pin clamp yoke. This requires that a taper pin bolt be fitted to ensure that it is locked in place on the shaft. The Sigma 50 dynamometer PTO drive shafts are fitted with a quick release collar.

1. Clean and grease the tractor and dynamometer PTO shaft splines
2. Fit the drive shaft at the dynamometer end, pushing the end yokes in fully. Use the drive shaft rest to support the PTO shaft.
3. Fit the taper pin bolt or quick release coupling according to the drive shaft manufacturers instructions.
4. Fit the tractor end of the shaft pushing the end yokes in fully. Pushing the end yokes in until the locking pin returns to the fully out position with a click.
5. Fit the safety chain to ensure the tractor and dynamometer cannot move apart during the test.
6. Ensure the drive shaft safety chains are fitted correctly.

Warning! Switch off the tractor and power take-off drive before fitting the PTO shaft.

Note: During testing do not exceed the test power limits for the tractor PTO shaft.

PTO Shaft Combinations and Life Expectancy

Type	PTO Series	Dynamometer PTO Connection	Tractor PTO connection	Test limits for tractor PTO			Life expectancy temporary load <15mins
				Speed	Torque	HP	
Sigma 60	P700	Half shaft 2.1/4" - 22 Spline	Half shaft 1.3/4" - 20 Spline	1000rpm	4770Nm	670hp	200 hrs
				1000rpm	2905Nm	408hp	1040 hrs
	P600	Half shaft 2.1/4" - 22 Spline	Half shaft 1.3/4" - 20 Spline	1000rpm	2492Nm	350hp	760 hrs
			Half shaft 1.3/8" - 21 Spline	1000rpm	1100Nm	154hp	6200 hrs
			Half shaft 1.3/8" - 6 Spline	540rpm	1060Nm	80hp	11600 hrs
Sigma 50	P600	Half shaft 1.3/4" - 20 Spline	Half shaft 1.3/4" - 20 Spline	1000rpm	2492Nm	350hp	760 hrs
			Half shaft 1.3/8" - 21 Spline	1000rpm	1100Nm	154hp	6200 hrs
			Half shaft 1.3/8" - 6 Spline	540rpm	1060Nm	80hp	11600 hrs

Setup for Bare Engine Testing

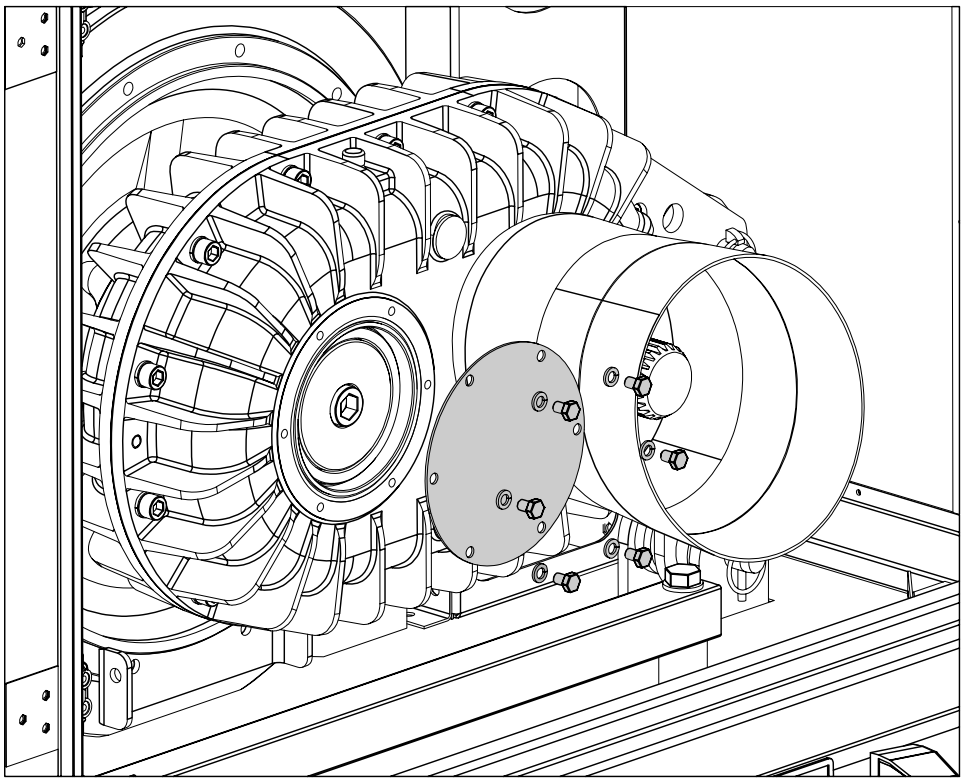
Sigma dynamometers can be used for bare engine testing if the appropriate drive shafts and adaptors are available. Depending on engine speed the engine can be connected via the burden unit gearbox or the gearbox can be removed to provide direct drive.

Removing the Sigma 50 & 60 Gearbox

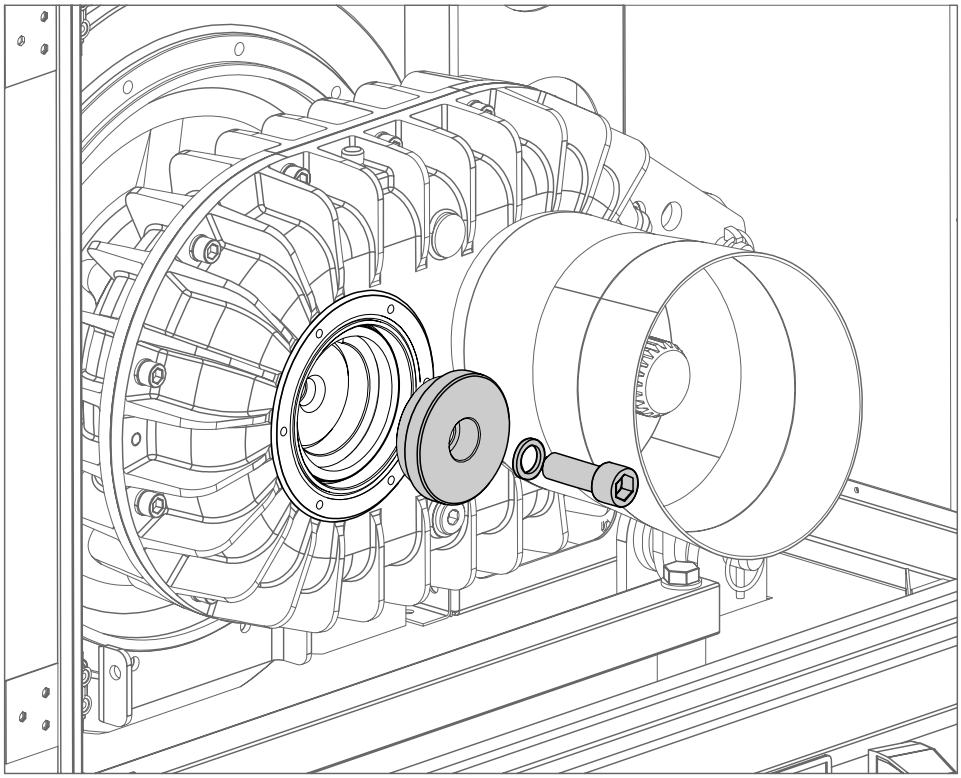
When driven via the gearbox the Sigma 50 & 60 dynamometers can be used to test engines in the speed range between 270 to 1250 RPM. Removing the gear box and connecting directly to the burden unit input shaft will increase the speed range to between 480 to 2200 RPM.

For bare engine testing at these higher speeds you will need Froment's optional direct drive kit. This contains a gearbox removal tool and a drive shaft adaptor for the burden unit shaft.

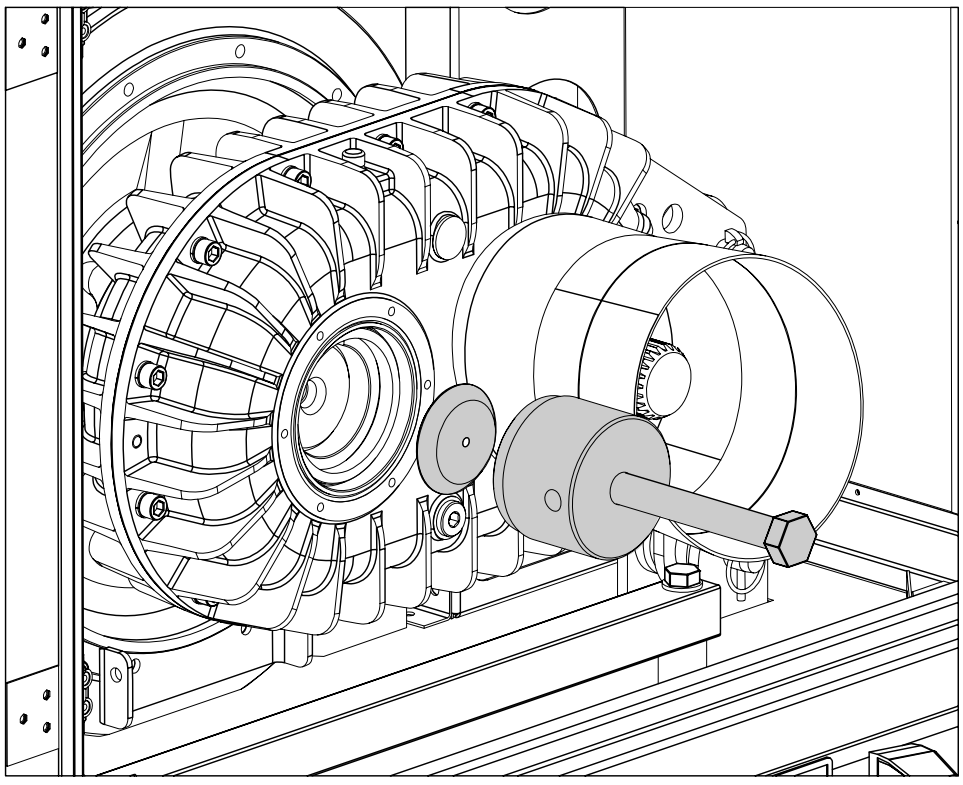
To remove the gearbox:



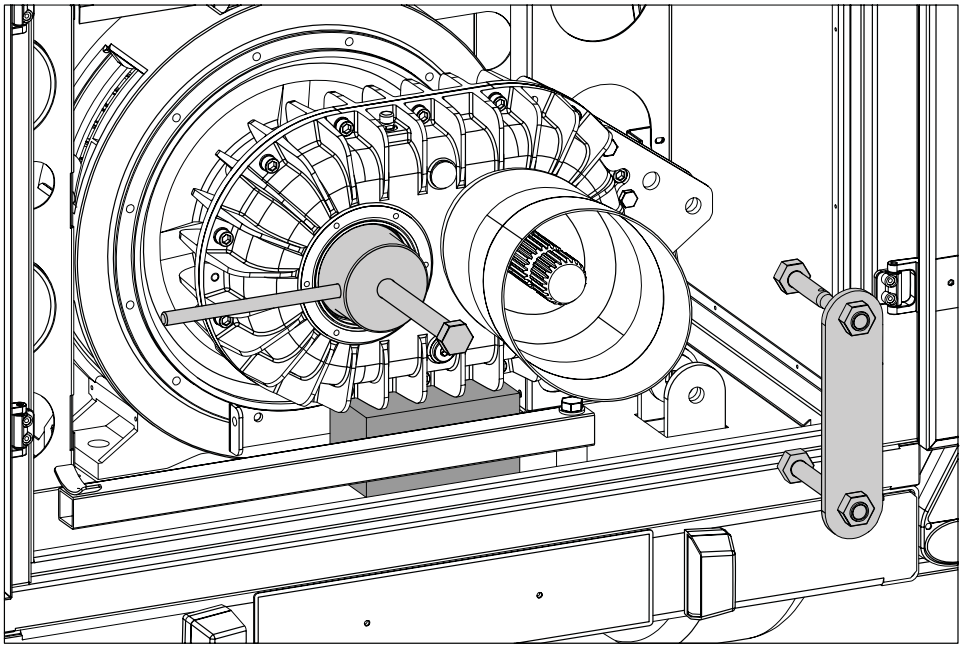
1. Remove the six bolts retaining the gearbox cover plate and remove the plate.



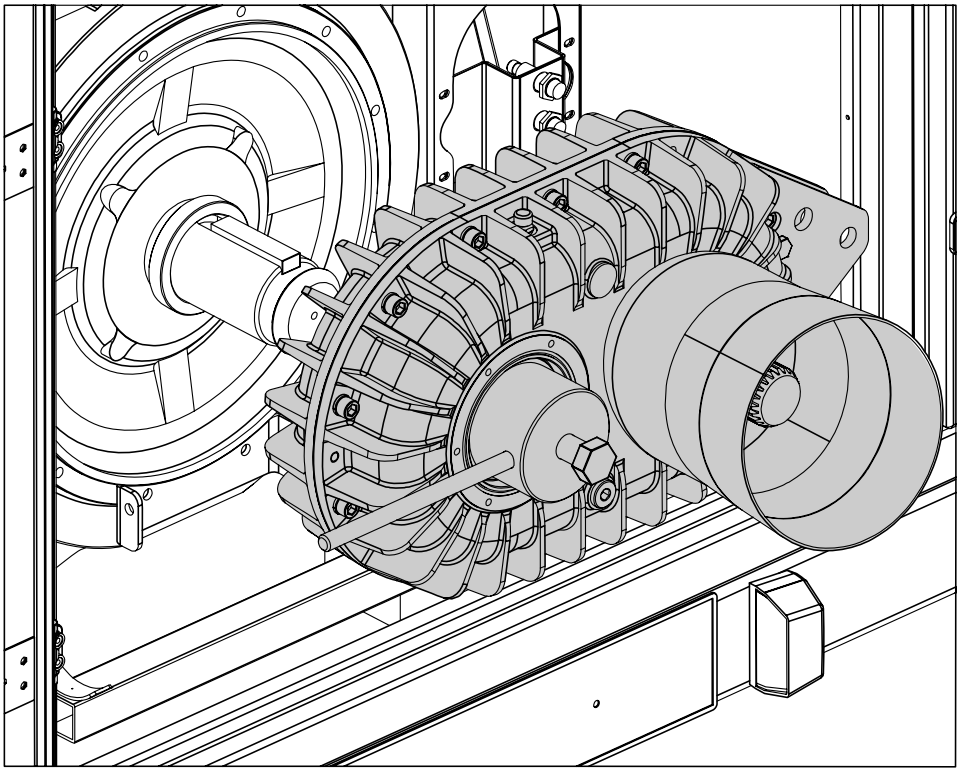
2. Remove the gearbox drive bolt and retainer.



3. Fit the Froment gearbox removal tool and its pressure plate.

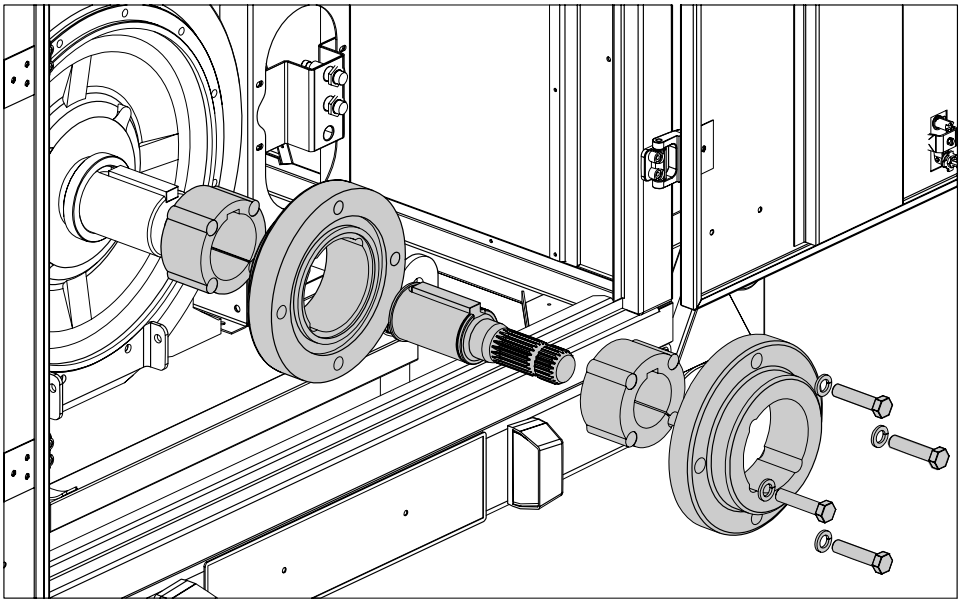


4. Place a suitably sized wooden block under the gearbox to support it during removal. Fit the removal tool tommy bar, remove the lock pins from the torque arm, and the remove the gearbox torque arm.

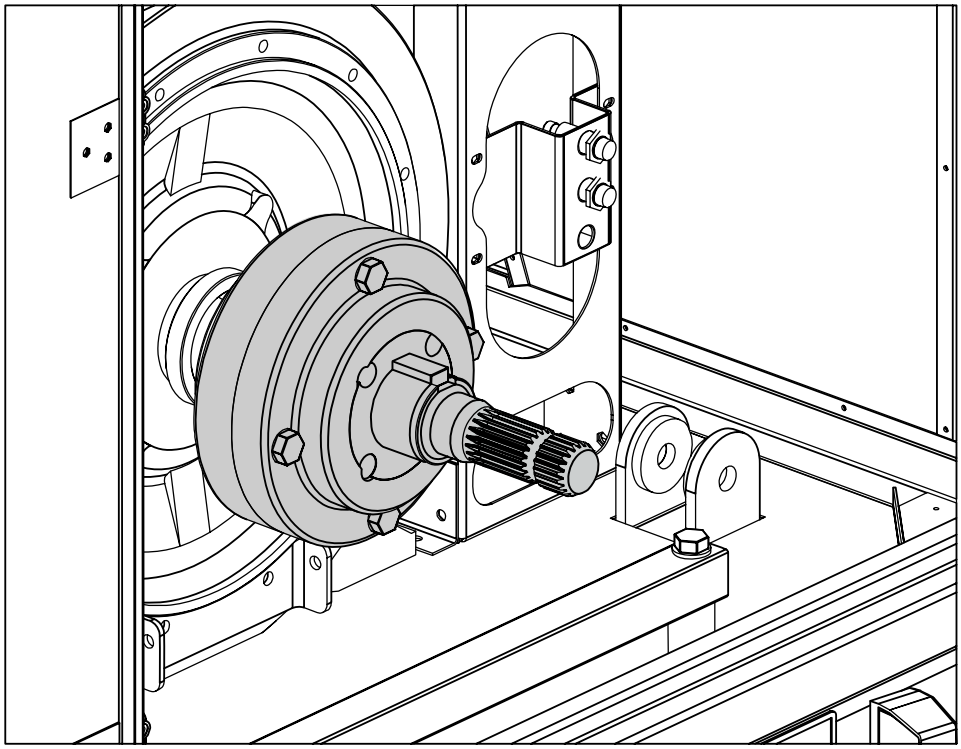


Warning! Take care whilst handling the gearbox. The gearbox weighs 58kg and lifting equipment may be required.

5. Tighten the gearbox removal tool's centre bolt and pull the gearbox off of the burden unit shaft. Be careful to support the weight of the gearbox whilst removing it.



6. Fit the direct drive shaft to the burden unit's input shaft.



7. Tighten the four retaining bolts (refer to the manufacturer's instructions for the correct torque).

Re-fitting the gearbox is a reversal of the removal sequence:

1. Remove the four direct drive shaft retaining bolts and remove the direct drive shaft.
2. Apply copper anti seize grease to the burden unit shaft.
3. Using the support block, position the gearbox on to the burden unit output shaft (ensure that the keyways are aligned and the key is inserted).
4. Slide the gearbox onto the burden unit output shaft.
5. Put the retainer in position and use the extended M20 screws and nuts provided in the direct drive kit to pull the gearbox in to position on the output shaft.
6. Secure the gearbox to the burden unit using the M20 x 55mm screw with the M20 Nordlock washer and the retainer. Tighten the bolt to a torque of 260Nm.
7. Re-fit the torque arm, ensuring that the bolts are tight.
8. Re-fit the gearbox cover plate.

Starting the Dynamometer

Start the dynamometer with the following procedure:

1. Switch on the mains electrical power to the dynamometer.

2. POWER ON and START indicators on the control panel will light. After a brief self-test the START Indicator will extinguish.

3. Press the START button to enable the dynamometer. The cooling fans will start running and the following screen will display:

Warning! Ensure that the Hand-held cable is kept well away from the drive shaft.

4. Take the Hand-held and climb into the tractor cab.

5. You are now ready to test the tractor's engine.

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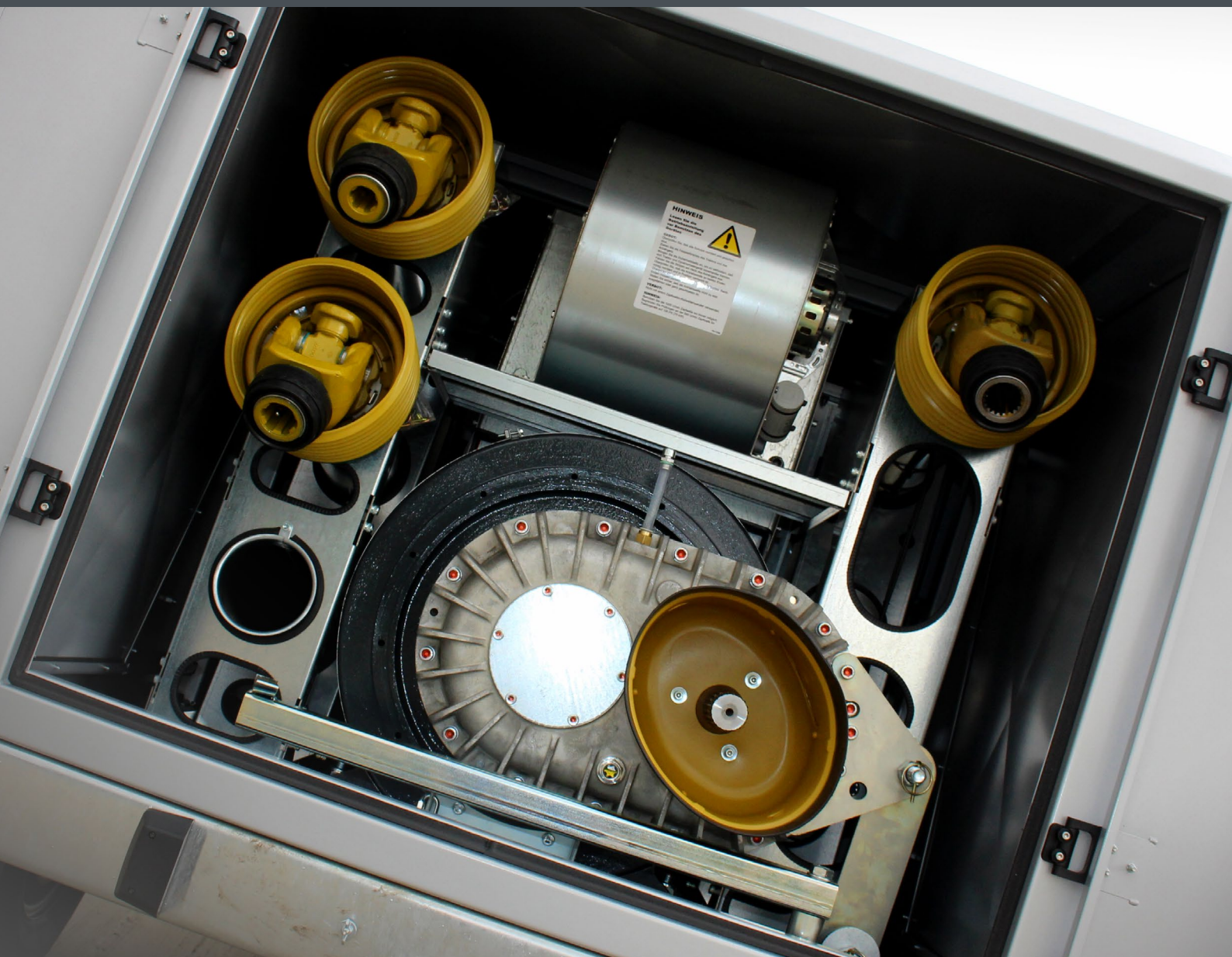
Chapter Four

Hand-held Engine Testing

This chapter explains how to operate the dynamometer using the Dynamometer Hand-held. If you intend to make use of Froment's Dynatest PC software instead, please refer to the online help system provided with the software.



The Sigma Hand-held

The Sigma Dynamometer Hand-held is a rugged controller that provides a simple method of both controlling the dynamometer during testing and of displaying the test results during and after a test.

The hand-held has an outdoor rated enclosure with a custom-designed membrane keyboard and 4.3" colour TFT screen. The keyboard is used to provide control inputs and the display provides visual feedback in the form of the dynamometer's test instrumentation.

The Hand-held is connected to the dynamometer's control panel via a 10 metre long cable. This length is provided to allow you to carry out testing whilst sitting in the tractor cab. This is our recommended safe location during testing that will provide you with simultaneous control over the tractor's engine and PTO, and the dynamometer.

This manual describes Version 1.00 of the Hand-held software.

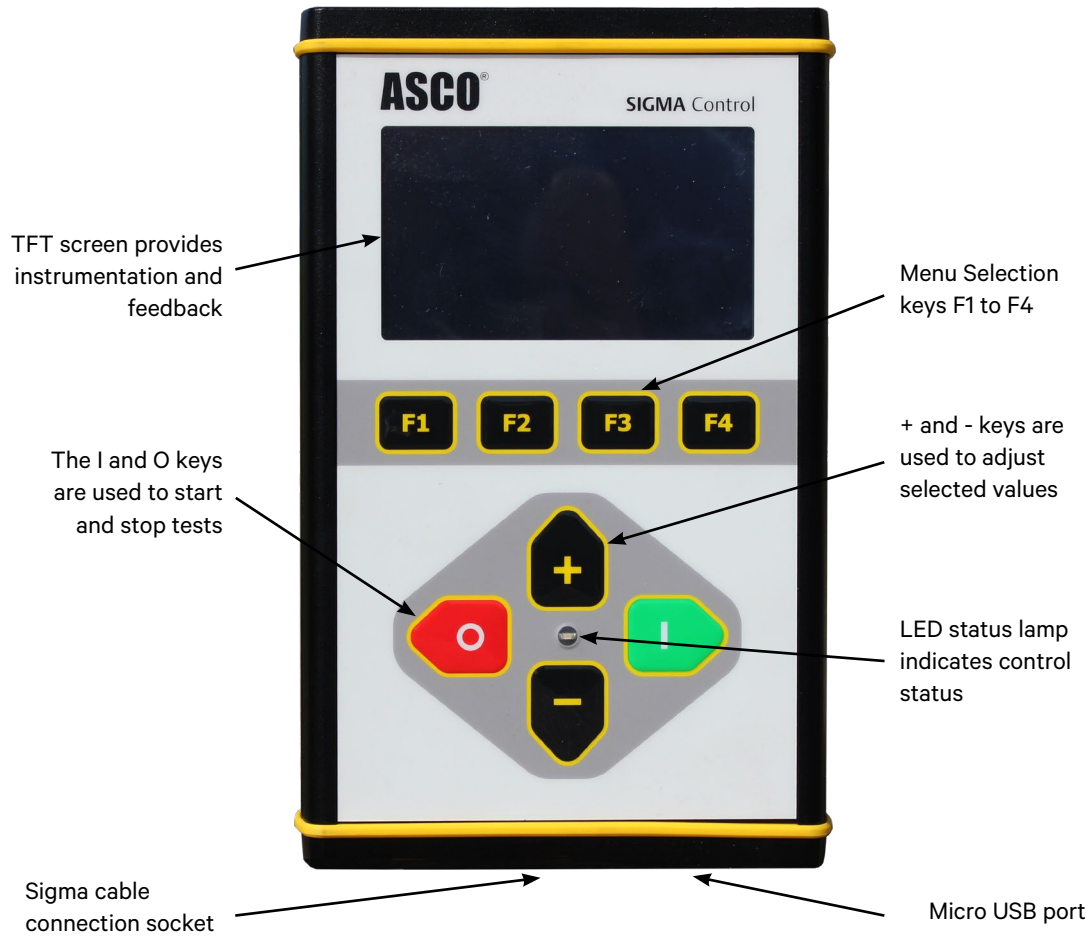


Figure 4-1 The Sigma Dynamometer Hand-held

Updating Hand-held Firmware

Making sure the firmware is up to date on the Sigma Hand-held is important to maximise testing capabilities and ensure correct operation. The Sigma Hand-held has a micro USB port to enable firmware to be updated from a USB flashdrive. The current version of the firmware is displayed on start up in the bottom right corner of the screen.

To update firmware ensure you have the latest firmware .sig file on a USB flash drive. This can be downloaded from: www.fromentdynamometers.com/firmware

1. Connect Sigma Hand-held to power supply or use supply from dynamometer (Hand-held power supply can be ordered directly from sales@froment.co.uk).
2. Connect USB drive to micro USB connector using USB-OTG Adapter (order from RS Part: 790-3647) - see below.

3. Power on hand-held and check bootloader has been entered - see below.

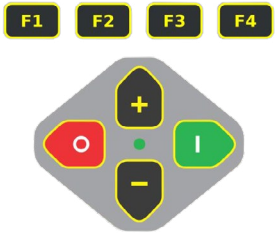
4. F1 (update) will start the main application programming.
5. The current firmware version will be updated once programming is complete.
6. Remove USB adapter and press F4 (Exit) to finish the update.

Using the Hand-held keypad

The keypad contains eight membrane switch keys and a single LED indicator. The switches provide four function keys (marked F1 to F4) arranged below the screen and a quadrant of four control keys (labelled **O**, **I**, **+**, and **-**) arranged around the LED.

The function keys

The operation of the function keys is context dependant. A menu bar, containing labels for each of the keys, appears at the bottom of the screen. The labels for each function key change to indicate the function available (SETUP, MODE, etc.) in the particular context.



The quadrant keys

The four quadrant keys are used to make adjustments to values, to apply or remove load, or to start an automatic test sequence is one is configured.

The **+** and **–** keys are used to increase or reduce values that are highlighted or displayed on the screen.

Pressing **I** applies load or starts an automatic test (depending on the operating mode selected - see “Selecting the Load Control Mode” on page 4-7).

Pressing **O** at any time will remove the load or abort any automatic test that is running.

The LED status lamp

The LED indicator provides feedback of the current load status:

Continuously Lit. Manual control enabled (use the **+** and **–** keys to adjust the load).

Half Second Blink. Automatic test in progress.

Rapid Blink. Tractor RPM changing quickly (will return to previous state when the engine speed stabilises).

Using the Hand-held

Immediately after the START button on the control panel is pressed the search screen will appear on the Hand-held. After the search is complete the current screen will be displayed.

Note: The software version number is displayed on the search screen.

The Menu Display System

The Hand-held uses a menu display system for initial settings and also during the testing process. The screen provides real-time instrumentation readings, status information, and labels for the four function keys (F1 to F4).

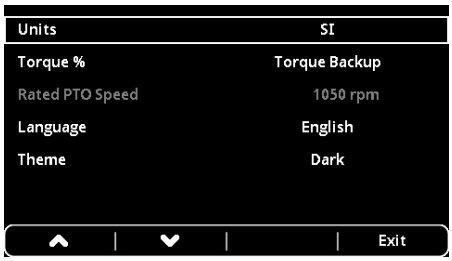
Using the Setup Menus

Note: There are six configurable options when using a legacy dynamometer fitted with inbuilt printer.

Pressing F4 (SETUP) from the Current screen will reveal the Setup Menu. There are four configurable options, you can switch between them by using the F1 or F2 keys.

Press F4 (EXIT) to return to the Current screen at any time.

Adjust various features of the Hand-held's operation as follows:



Units. Use this tab to set the default display units. The unit sets are IMPERIAL (hp and lb-ft), SI (kW and Nm) and METRIC (PS and Nm). Use the **+** and **-** keys to select the required unit settings.

Torque %. The percentage torque rise since the start of the test is displayed on the summary page and on printed reports. Percent Torque rise can be calculated as Torque Reserve or Torque Backup.

Torque Reserve is calculated from the torque at the Rated PTO Speed to maximum torque. The PTO Rated Speed must be set using the setup parameter. Use this when testing a 'Constant Power' type engine.

Torque Backup is the torque rise calculated from the torque at maximum power to maximum torque.

Use the **+** and **-** keys to select the Torque %.

Rated PTO. This is used to modify the PTO rpm at the engine rated PTO speed using the + and - keys. The Rated PTO is used in the calculation of Torque Reserve if the Torque % is calculated from Torque Reserve.

Language. Use to select the display language used. Languages implemented in the first release of Version 1.0 are: English, French, German, Italian, Spanish and Danish. Additional languages may be incorporated if required.

Use the **+** and **-** keys to select the language interface.

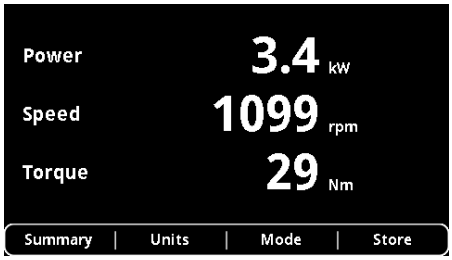
Report Type. This option will only be displayed on legacy dynamometer products that have the inbuilt printer option. Choose how a report is printed between full, summary only, graph & summary and table & summary options.

Themes. Select the screen colour type best suited to you. Choose between dark, light, green or blue.

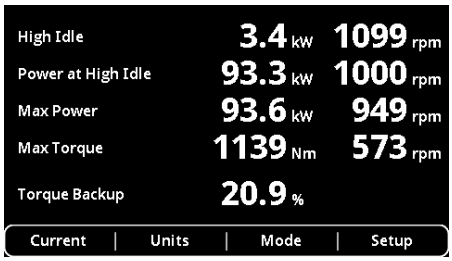
Using the Instrumentation Screens

After the dynamometer has been found the Current instrumentation screen will display.

There are two instrumentation screens, Current and Summary, are available and you can toggle between them by pressing F1 (SUMMARY/CURRENT).



The Current screen provides a real time display of the power output, RPM and Torque that the dynamometer is measuring.



The Summary screen shows data that has been calculated since the I key was last pressed to initiate a test:

- Maximum speed (High Idle rpm) with the power at that speed.
- Peak Power (or Power at Rated PTO if Torque Reserve has been selected during setup) and the rpm.
- Power at Nominal rpm.
- Peak Torque at rpm
- Torque Backup (or Torque Reserve), depending on the selection in the SETUP

The test summary data can be cleared on the next press of the I key, to start the next test.

Selecting the Load Control Mode

Pressing F3 (MODE) from either instrumentation screen will allow you to select the dynamometer's load control mode (Constant Speed, Constant Power, Direct or Auto). Press F3 (MODE) to step through until the correct mode is displayed in the pop-up window.

Note: Each time the START key is pressed the load control mode is reset to its default (Constant Speed).

The load control mode determines how the dynamometer operates during a test. The Constant Speed, Constant Power and Direct provide different control methods to use during manual testing, whilst Automatic Test, as the name implies, provides a fully automatic test sequence (see "The Automatic Test" on page 4-9 for details).

Constant Speed control (the default) allows you to set the tractor PTO speed directly using the keypad. The load is adjusted automatically until the RPM matches the value that you choose.

Constant Power control allows you to set the engine power level directly from the keypad. The dynamometer will continuously adjust the braking force to maintain the selected power.

Direct control provides control over the braking force applied by the dynamometer.

Memory allows different load step values to be set and recalled during a manual test.

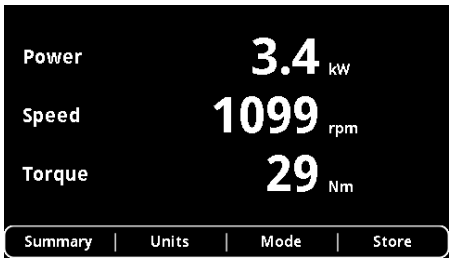
Pre-Test Setup

Before running a full engine test we recommend running a brief test to ensure that everything has been set up correctly and that the engine is capable of achieving the quoted high idle speed.

The following assumes that you have followed the instructions in Chapters Two and Three up to and including “Starting the Dynamometer” on page 3-14.

Note: It is recommended that the test is performed from the tractors cab.

1. Press the start button on the dynamometer. The hand-held will initialise. Once the dynamometer has been found the current instrumentation screen will be displayed.



Note: If you are testing a “Constant Power” type engine you will need to select the Torque % setting as “Reserve” and enter the Rated PTO speed in the setup menus before you start testing (see ‘Using the Setup Menus’ on page 4-5)

2. Make sure the PTO control lever on the tractor is in the OFF position and start the engine and set it at Low Idle.

3. Engage the PTO clutch. Slowly and steadily increase the engine throttle to High Idle (Full Throttle) while monitoring the speed display on the hand-held controller. The speed should not exceed 1250 rpm.

4. Inspect the tractor and dynamometer for any obvious faults. Look for excess vibration due to misalignment of the drive shaft and check that the anchor chains are in position and the guard remains stationary.

5. Correct any problems that you find before continuing.

Note: The gearbox torque arm may cause an audible noise when the tractor PTO shaft is rotating on idle revs and no load is applied to the dynamometer.
This is normal and will disappear when load is applied to the dynamometer during testing.

The tractor and dynamometer are now ready for running tests.

The Automatic Test

For the majority of general engine tests we recommend that you make use the of the Sigma Dynamometer's Automatic Test mode.

This automatic test sequence takes control of the dynamometer and runs tests to measure the engine's maximum power, peak torque and power at nominal speed. During the engine test sequence the dynamometer will automatically vary the load on the PTO shaft, depending on the rate of change of speed and power of the engine.

From the tractor's cab:

1. With the tractor's PTO engaged, open the throttle until it is either fully open (high idle) or a maximum PTO speed of 1250 rpm (as shown on the Hand-held) has been reached.
2. Press F3 (MODE) and select Auto. Test from the pop-up menu.
3. Press the **I** key to start the automatic test sequence.
4. The LED will flash slowly throughout the test, which may take up to ten minutes to complete, depending on the engine size.
5. After the initial pre-test, load is gradually applied until the speed has been reduced to 40% of nominal or the maximum torque has been reached and then dropped by 20%. The load is then removed in a controlled manner.
6. When test is completed the LED will switch off.
7. Close the tractor's throttle and disengage the PTO drive. Allow the dynamometer and engine to run with no load for a few minutes to cool down.

Note: The Auto Test control mode is only available in the Mode Menu when all load is removed, and the **O** key has been pressed.

Manual Testing

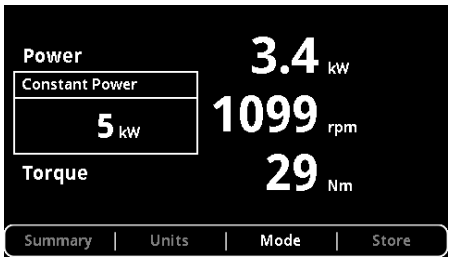
Manual testing using the manual control modes provides direct control over the braking force that the dynamometer applies to the engine. It can be useful if you want to see how an engine performs at a specific load or range of loads, or when you want to measure the engine's performance at a particular RPM.

From the tractor's cab:

1. With the tractor's PTO engaged, open the throttle until it is either fully open (high idle) or a maximum PTO speed of 1250 rpm (as shown on the Hand-held) has been reached.

2. Press F3 (MODE) and select either Constant Speed, Constant Power or Direct mode from the pop-up menu.

3. Press the **I** key to start the test.



4. Press F3 (MODE) to scroll through options to select set point. Press the **–** or **+** keys to adjust the set point value. The current value (depending on the mode you have selected) is shown on a pop-up display.

Note: If the set point is above the high idle speed of the engine no load will be applied.

5. The LED on the keypad will flash until the load is stable. When the load is stable, the LED will remain on and a data point is collected for the results.

6. Press F3 (MODE) at any point during the test to change the control mode.

7. Use the **–** or **+** keys to set a new set point or press **O** to remove the load and end the test.

8. When the test is completed the LED will switch off.

9. Close the tractor's throttle and disengage the PTO drive. Allow the dynamometer and engine to run with no load for a few minutes to cool down.

Memory Mode

The current load value can be stored in a memory at any time during a Constant Speed, Constant Power or Direct mode test. The stored value can then be recalled as load step changes from Memory mode. This can be useful if you need to check the engine's governor response or check for clutch slippage.

There are four memory set points that can be stored: M1, M2, M3 and M4. They can all be recalled from within Memory mode.

Before the test begins, load values must be saved in one or more of these memory areas. To do this:

1. Start a test in Direct, Constant Speed or Constant Power mode
2. Change the set point to what is needed, and wait until the engine has stabilised (the Hand-held's LED indicator will stop flashing).
3. Press the STORE key and Pick a MEMORY from the list.

Do this for each load you wish to save. To use the memory:

1. Select MEMORY mode
2. Use the + or - key to select a memory.
3. Press the l key to change to the stored set point.
4. Repeat step 2 and 3 to change and apply the different memories.

Note: If the **O** key is pressed all the memories will be cleared.

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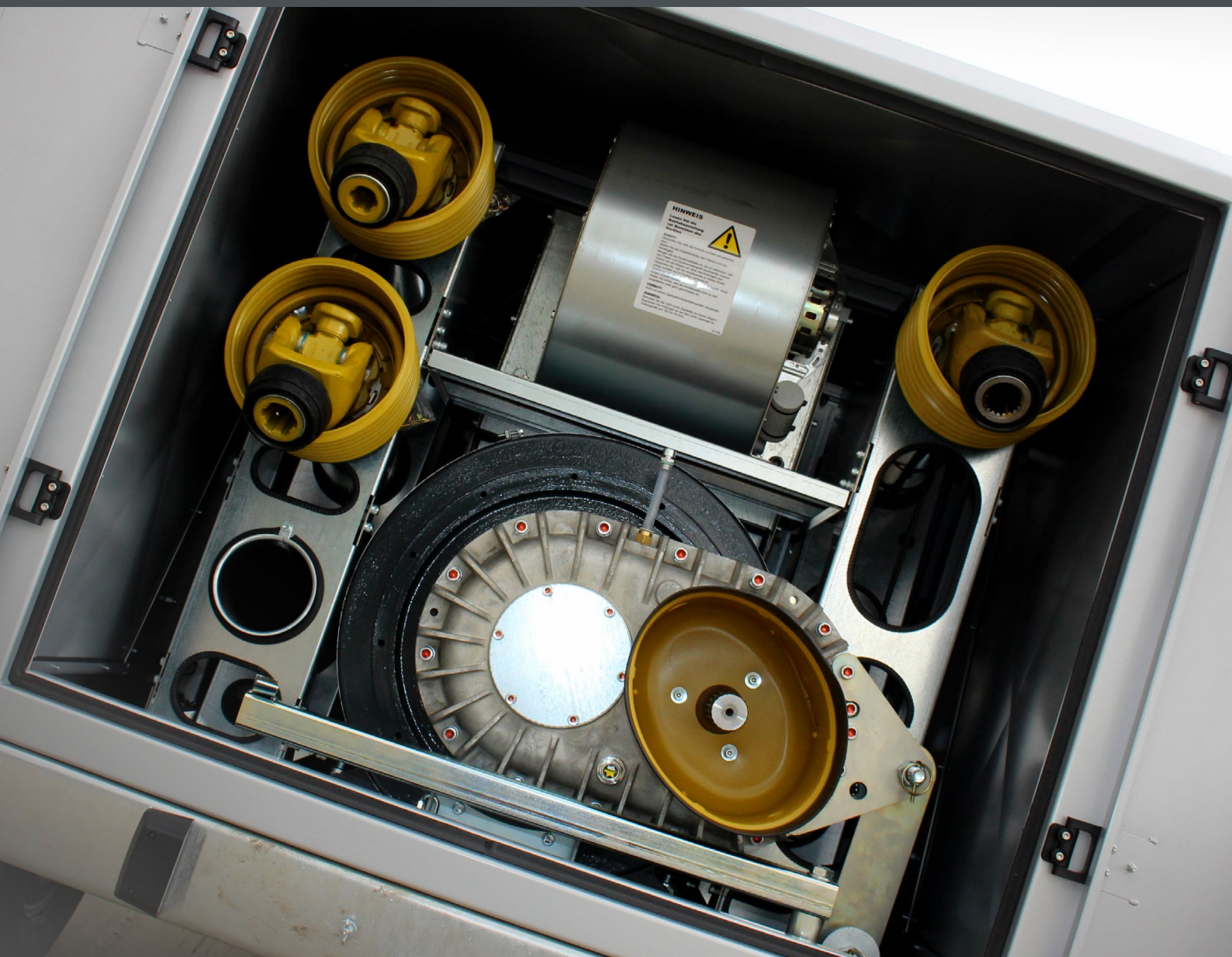
Chapter Five

Maintenance & Troubleshooting

This chapter provides information about the routine maintenance of the dynamometer. It also contains diagnostic information that may be useful if you have problems operating the dynamometer.



Routine Maintenance

About Safety

Never operate the Dynamometer with any of the covers or protective screens removed. Serious injury could result from contact with high voltage and extensive equipment damage due to short-circuiting of the cooling air.

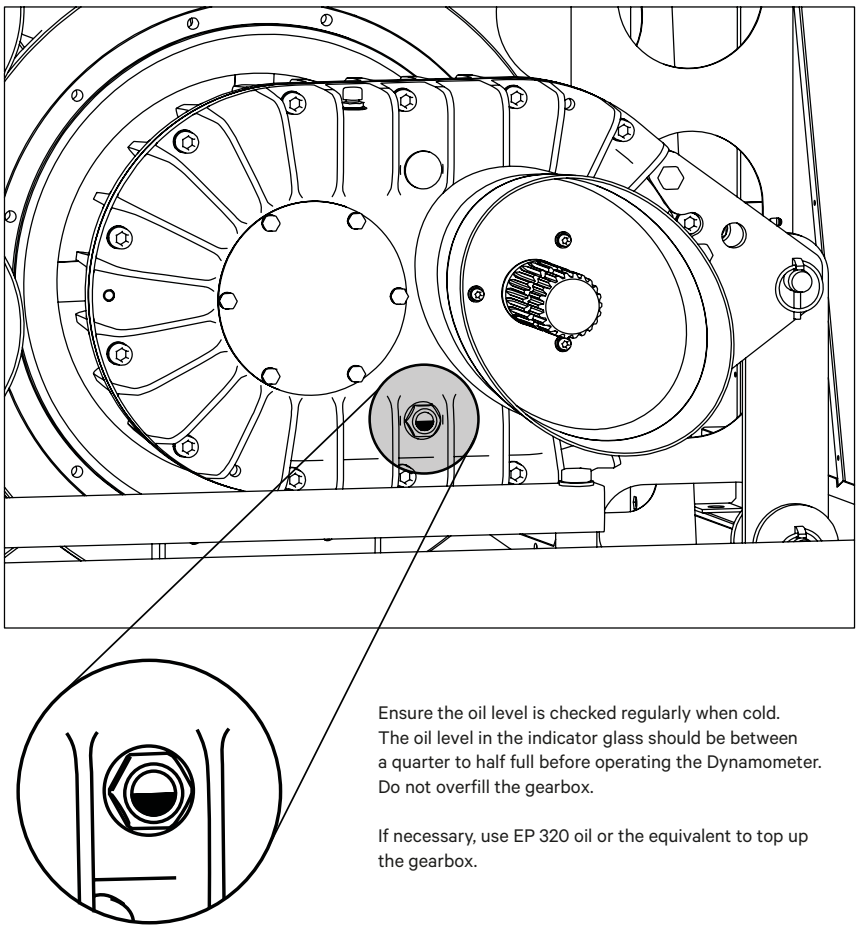
Dynamometer maintenance

Weekly (or before each use)

Note: Change the gearbox oil with EP320 or equivalent after the first 30hrs of operation.

1. Inspect the dynamometer looking for signs of damage and any obstructions to the airflow around the fan.
2. Check the gearbox oil level and top up if necessary.

Note: Extended operation of the dynamometer could cause oil to weep out of the breather. This does not affect the operation of the gearbox. However, it is advisable to check the oil level after the extended operation when the oil has cooled.



Ensure the oil level is checked regularly when cold. The oil level in the indicator glass should be between a quarter to half full before operating the Dynamometer. Do not overfill the gearbox.

If necessary, use EP 320 oil or the equivalent to top up the gearbox.

Yearly

1. Ensure torque arm bolts are tight.
2. Contact Froment technical support and arrange to have the dynamometer serviced and calibrated.

Trailer Maintenance

For the full list of trailer maintenance procedures please refer to the Knott trailer manual.

Daily checks prior to use

Trailer component	Procedure
Coupling head	Ensure positive locking onto ball and wear indicator acceptable.
Lighting	Secure plug and check lights are operational.
Tyres/Wheels	Check correctly inflated, sidewalls for damage, tread for wear, wheel nuts secure.
Noseweight	Ensure positive noseweight not exceeding maximum recommendations.
Towing Height	Ensure trailer is 'towing' horizontal to ground.
Load	Ensure load is safe and secure and does not exceed maximum weight capacity.
Tow Vehicle	Ensure that trailer is within tow vehicle manufacturers weight range.
Legal Obligations	Ensure driver has license category for the trailer. Tachograph regulations and duty hours to be observed if applicable.

General checks

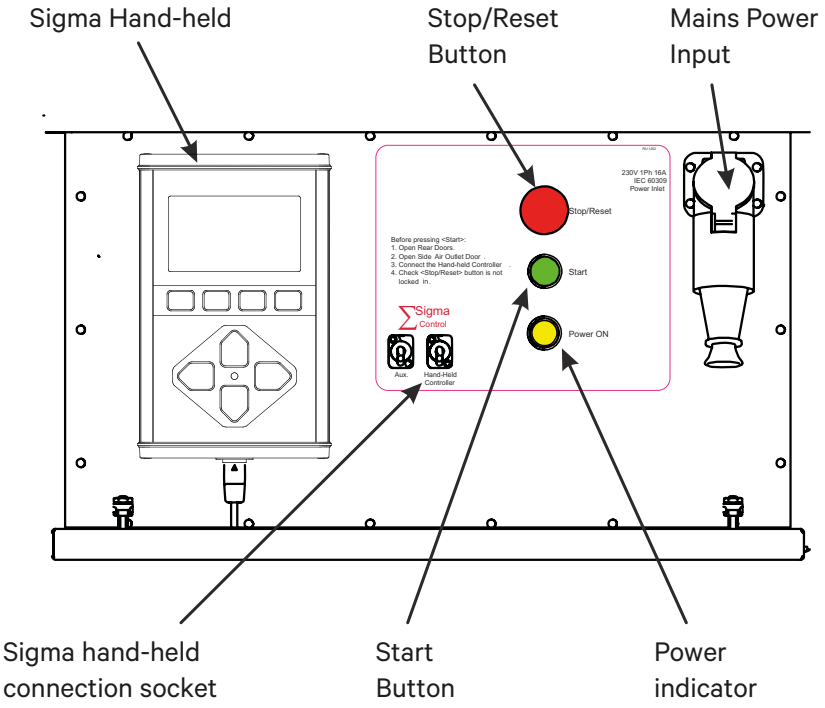
Trailer component	Procedure
Coupling head	• Oil moving parts and pivots • Clean and lubricate coupling head • Check coupling head for positive locking onto tow ball
Coupling Assembly	• Check bellows for damage and apply grease to the two grease nipples on the coupling body and check drawtube for play. • Carry out a damper reaction test. Pull the handbrake lever as far as possible. Push the ball coupling as far back into the overrunning hitch. This requires force to compress and should extend smoothly when released. • Check the handbrake lever including auto reverse. • Braked: check break-away cable for damage, fraying and security of the fittings. • The use of a break-away cable or secondary coupling is a legal requirement. Always use a compatible cable from the original manufacturer.
Wheelbrake / brake rod mechanism	• After 500 miles and then every 3000 miles (or annually) adjust the wheel brakes at the backplate and re-check the mechanism. Note it is important that the brake wear is taken up by adjusting the brake hubs and not by adjusting the linkage to compensate for mis-adjusted hubs. Ensure that cables/rods are not pre-tensioned prior to adjusting the wheel brake.
Rubber torsion axle	• Check ride height • Check wheel bearings
Jockey wheel	• Dismantle and lubricate.

MOT Style Annual Checks

Test	Method	Go/no-go
Check drawtube for play	Grasp and feel play vertically and horizontally	Max 1-2mm play at the head
Check damper operation	Force inwards and allow to extend	Requires force to compress and extend smoothly
Check coupling head “fit onto” tow ball	Trial fit tow ball	Head indicators should show acceptable
Check coupling head and coupling assembly for loose, worn or broken parts. Particularly the bellows for damage	Inspection and check moving parts	All parts move freely, no damage or wear
Check rubber suspension for soundness	Visual inspection and measurement	Ride height at the same height on both sides
Check coupling assembly and suspension mounting points (axle pads) for security	Use spanner to check critical fasteners (coupling or delta plate plus axle pad bolts)	All secure
Look at the tyre treads for any clues to misalignment or possible suspension failure	Inspection	Tyres must be legal, have the correct load rating and any unusual treadwear investigated further
Check wheel bearing	Raise trailer, rock wheel	No/minimal play
Check the handbrake lever including brakes in auto reverse	Apply handbrake, push rearwards and observe lever	Brakes should re-lock as handbrake lever travels further overcentre
With trailer handbrake on check adjustment	Apply handbrake	Check that compensator remains parallel
With trailer handbrake on check function of compensator	Raise trailer, turn each wheel backwards until it locks	Wheels should lock one at a time, compensator must articulate and return to a parallel position when all wheels are locked
Check that the trailer holds securely on the handbrake	Apply handbrake and attempt to tow forwards with vehicle	Braking effect should be felt plus likelihood of skidding wheels on poor terrain
Inspect linkage, cables and compensator for security and corrosion	Inspection	All secure and minimal corrosion

Dynamometer Status Indicators

The POWER and START Indicators are a standard fitment on all dynamometer control panels. The operation of these indicators, along with the display on the Dynamometer Hand-held Terminal (hand-hedl), provides important diagnostic information if a fault should occur.



The following table provides further information on the dynamometer indicators.

Indicator Status	Reason	Possible Causes
POWER ON and START not illuminate	Dynamometer power supply off.	• Dynamometer not connected • Confirm supply fuses not blown • Faulty indicators
START flashes after self-test	Dynamometer system fault	• Self test failure
START not illuminated	Dynamometer in stopped state	• Press the start button • Press the stop/reset button and check it is released, then press start • Ensure Hand-held is connected • Check message on Hand-held
Start illuminated	Dynamometer running	

Warning and Error Messages

The Sigma Dynamometer has two indicator lamps as standard to indicate POWER ON and Running. The operation of these indicators, along with the display on the Dynamometer Hand-held Terminal (Hand-held), provides important diagnostic information if a fault should occur.

Further error indicators are located on the I/O PCB, located behind the control panel.

Hand-held Messages

The following table details the information and error messages that can be displayed on the Hand-held along with an explanation and possible causes.

No	Message	Reason	Possible Causes
1	Not receiving messages from the dynamometer	The Hand-held is not receiving messages from the dynamometer.	• Faulty transmit cable between I/O PCB and Hand-held. • Faulty ribbon cable between I/O and CPU PCBs. Monitor communications statistics on diagnostics terminal.
2	Dynamometer not receiving messages	The dynamometer is not receiving messages from the Hand-held.	• Hand-held has been unplugged, and plugged back in again, press OK. • Faulty receive cable between I/O PCB and Hand-held. • Faulty ribbon cable between I/O and CPU PCBs. Monitor communications statistics on diagnostics terminal.
3	Open the door on the dynamometer	The exhaust door is closed.	• The exhaust door is closed. • Faulty proximity detector. Replace faulty component.
4	Instrumentation fault on the dynamometer	Fault on dynamometer CPU PCB.	• Replace faulty dynamometer CPU board.
5	Overspeed on the dynamometer	Input speed too high.	• Input speed exceeds limits. Reduce input speed.
6	Fan overload tripped on the dynamometer	Fan overload signal not present.	• Fan faulty or obstructed. Check the cooling fan located under the element pack. • Supply voltage and frequency incorrect • Overload faulty or set incorrectly. Monitor input LED on I/O PCB. Check and replace faulty component.
7	Blower overload tripped on the dynamometer	Blower overload signal not present.	• Blower faulty or obstructed. Check the centrifugal blower located under the control compartment. • Supply voltage and frequency incorrect. • Overload faulty or set incorrectly. Monitor input LED on I/O PCB. Check and replace faulty component.

No	Message	Reason	Possible Causes
8	Gearbox switches faulty on the dynamometer	Both proximity detector signals are present.	• Faulty proximity detector or wiring. Check the proximity detectors located on the gearbox.
9	Phase load fault on the dynamometer	Load not balanced between phases.	• Faulty load element or connection. • Faulty VT or CT.
10	Voltage too Low on the Dynamometer	An instrumentation or excitation failure.	
11	Elements too Hot on the Dynamometer	Over Temperature signal is present.	• Load elements are too hot. Ambient temperature too high or airflow obstructed. Wait for 5 minutes for the dynamometer to cool and check the elements and fan for obstructions. • Faulty thermal trip.
12	Windings too Hot on the Dynamometer	Alternator winding thermistors indicate over temperature.	• Alternator too hot. Ambient temperature too high. Wait for 5 minutes for the dynamometer to cool. • Faulty thermistors. Monitor input LED on I/O PCB. Replace faulty component • Blower failure or obstructed. Check the centrifugal blower located under the control compartment.
13	Voltage too High on the Dynamometer	Over voltage signal present from OV Module.	• Load element or power connection fault. • OV Module faulty. Check operation of LED. • OV to I/O PCB Ribbon cable fault.
14	OVM Module Fault on the Dynamometer	Over voltage module present signal missing.	• OV Module faulty. Check operation of LED. • OV to I/O PCB Ribbon cable fault.
15	Field Control too Hot on the Dynamometer	Over temperature device on Field MOSFET tripped.	• Field MOSFET too hot. Ambient temperature too high. Wait for 5 minutes for the dynamometer to cool. • Over temperature trip faulty. Device should trip at 90C. • Blower failure or obstructed. Check blower.
16	Field Current too High on the Dynamometer	Field current control fault.	• Faulty MOSFET. Check and replace. • Faulty I/O PCB.
17	Press STOP/RESET on the Control Panel	Protection circuit is tripped.	• An error occurred which tripped the protection circuit. Pressing the stop button resets the protection circuit.

No	Message	Reason	Possible Causes
18	Close the Guard on the Control Panel Press START on the Control Panel	The guard is open The dynamometer is not running.	• Guard is open if fitted • Start button has not been pressed or was pressed before the dynamometer had performed its POWER ON self-test (start illuminated at Power On). Wait until the start lamp is extinguished before pressing start the button. • Dynamometer ESR not energising or faulty auxiliary contact. Monitor input LED on I/O PCB.
	Unexpected Exception	Hand-held hardware fault	• Replace faulty Hand-held board.
	System Error ROM Sum: 012345	Hand-held Self Test failed	• If EEPROM error, may be new or faulty EEPROM. Start up in diagnostic mode and save set up. • Replace faulty Hand-held board.

Declaration of conformity

Name of Manufacturer	**N J Froment & Company Limited,** Easton-on-the-Hill, STAMFORD, PE9 3NP, United Kingdom
Telephone e-mail Website	+44 (0)1780 480033 support@froment.co.uk www.fromentdynamometers.com
Country of Origin	United Kingdom
Description of Product	**Sigma Dynamometer**
Mass	Sigma 50 (Trailer Mounted) 1780kg (Kerb Mass) Sigma 60 (Trailer Mounted) 1980kg (Kerb Mass) Sigma 50 (Static) 1460kg (Installation Mass) Sigma 60 (Static) 1660kg (Installation Mass)
Standards Used	**EN 60204-1:2006+A1:2009** - Safety of Machinery. Electrical Equipment of Machines. **EN 61000-6-3:2001** - Electromagnetic Compatibility. Generic Emission Standard. **EN 61000-6-2:2001** - Electromagnetic Compatibility. Generic Immunity Standard.
Relevant EC Council Directives:	**Machinery Directive** (2006/42/EC) **Type A** **Electromagnetic Compatibility Directive** (2004/108/EC)
Basis of self attestation:	**Quality Assurance to BS EN ISO 9001:2008** Registered Firm Certification No: FM 38927
Declaration	I, as the authorised representative, declare that the above information in relation to the manufacture of this product is in conformity with the stated standards and other related documents.
Authorised Representative	J. W. Barratt
Position	Managing Director
Place of Issue	Easton-on-the-Hill, STAMFORD, UK
Date of Issue	16th July 2018

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One copy of this declaration accompanies each dynamometer, for customer retention

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