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Basic knowledge

Internal combustion engines

Internal combustion engines are thermal fluid energy machines: they generate mechanical energy by burning a mixture of fuel and air. All work processes take place inside a working area: the cylinder. Since the force/energy within the cylinder is transferred by means of a variable volume, internal combustion engines are part of the group of positive displacement machines.

Motors or engines are often used to power motor vehicles, ships or locomotives. They are also used for drives that must be reliable and independent of the electrical power supply, such as emergency backup generators, construction machines or agricultural machinery.

Small single-cylinder engines are perfect for demonstrating the fundamentals of engine technology. GUNT offers various internal combustion engines with capacities of up to 75kW, including real car engines with a volumetric displacement of up to two litres. Among these engines are four-stroke diesel and petrol engines, petrol engines with variable compression and two-stroke petrol engines.

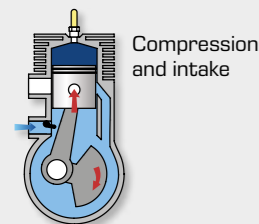
2-stroke engine: one work cycle = one crank revolution

1st stroke: compression/intake

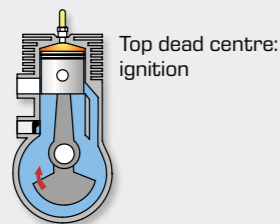
The piston moves upward: from bottom dead centre to top dead centre

Processes above the piston:

The precompressed mixture is further compressed above the piston. The compressed mixture is ignited shortly before the top dead centre is reached.



Compression and intake



Top dead centre: ignition

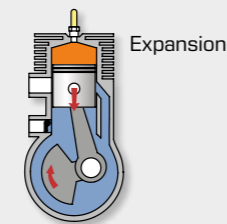
Processes below the piston:

The transfer port is closed as the piston travels upwards. Due to the resulting negative pressure the inlet valve opens: The fuel and air mixture is drawn in.

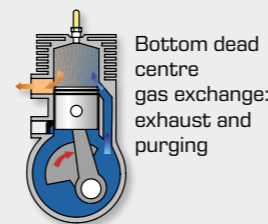
2nd stroke: power / precompression

Downward motion of the piston: from top dead centre to bottom dead centre

Processes above the piston: The resulting pressure forces the piston downward and opens first the outlet channel and then the transfer port. The precompressed mixture under the piston pushes the accumulated exhaust fumes out and fills the cylinder.



Expansion



Bottom dead centre gas exchange: exhaust and purging

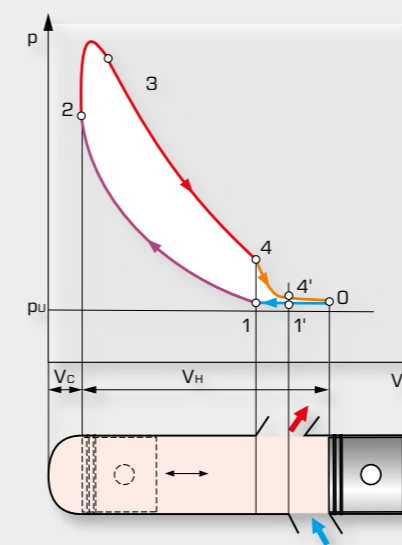
Processes below the piston:

The mixture that was sucked in is precompressed by the upward motion of the piston and pressed into the transfer port. The positive pressure closes the inlet valve.

Comparison of engines: 2-stroke petrol engine, 4-stroke petrol engine, 4-stroke diesel engine

	2-stroke petrol engine	4-stroke petrol engine	4-stroke diesel engine
Load	air/fuel mixture	air/fuel mixture	pure air
Fuel supply	carburettor	carburettor	injector nozzle
Ignition	ignition spark	ignition spark	compression
Compression ratio	5...8	5...12	14...21
Fuel-air ratio	0,8...1,2	0,8...1,2	1,5...10
Fuel	petrol	petrol	diesel

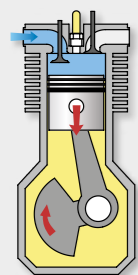
Indicator diagram of a 2-stroke engine



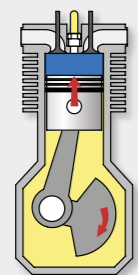
- 1st stroke (0 - 1):** the cylinder is charged with the fuel / air mixture,
(1 - 2): compression of the mixture,
(2 - 3): ignition and combustion of the mixture,
2nd stroke (3 - 4): expansion of the combustion gases,
4: exhaust opens, expansion is finished
4': transfer port opens, purging starts
1': purging is finished
1: exhaust closes and compression starts

intake, compression, power, exhaust;
 p_U ambient pressure, V volume,
 V_H displaced volume, V_C compression volume

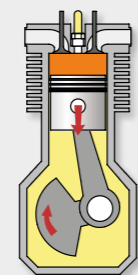
4-stroke engine: one work cycle = two crank revolutions

1st stroke: intake

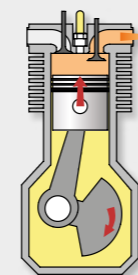
The piston moves from the top to the bottom dead centre. As it does, the fuel and air mixture is sucked in.

2nd stroke: compression

The piston moves from the bottom to the top dead centre. As it does, the fuel and air mixture is compressed.

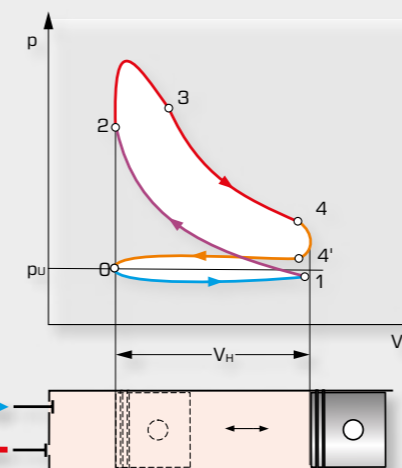
3rd stroke: power – ignition and expansion

The compressed fuel and air mixture is ignited shortly before the top dead centre is reached. The resulting pressure presses the piston downwards.

4th stroke: exhaust

The piston moves from the bottom to the top dead centre. As it does, the exhaust gases are discharged.

Indicator diagram of a 4-stroke engine



- 1st stroke (0 - 1):** intake
 ■ of the fuel and air mixture in a petrol engine,
 ■ of pure air in a diesel engine
2nd stroke (1 - 2): compression
 ■ of the fuel and air mixture in a petrol engine,
 ■ of air to a least 700°C in a diesel engine
3rd stroke (2 - 3): ignition and combustion
 ■ of the fuel and air mixture in a petrol engine (spark plugs),
 ■ injection of diesel oil, ignition caused by high air temperature
(3 - 4): expansion of the combustion gases
4th stroke (4 - 4'): exhaust of the combustion gases
(4' - 0): expulsion of the remaining combustion gases

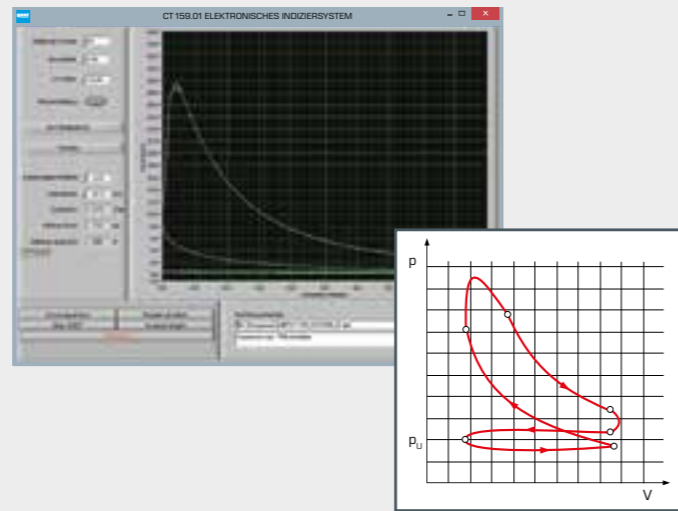
Test stands for internal combustion engines

GUNT offers four different test stands for internal combustion engines in the **2,2 kW to 75 kW** power range. The engines include four-stroke diesel and petrol engines, petrol engines with variable compression ratios and two-stroke petrol engines.

The engines are supplied with fuel and air via the test stands. The exhaust gases can be studied using an exhaust gas analyser.

The **electronic indicating system** is a good way to gain an in-depth understanding of how an engine works. Special pressure sensors record the pressure in the cylinder chamber. These data provide important information on the combustion process in the engine. In industrial applications, indicating systems are used to optimise the combustion process. The data are used to create the **indicator diagram**.

The indicating system helps identify the individual strokes of the engine. The process of **ignition** or an **ignition attempt**, and the **gas exchange** can be examined. Cranking without ignition can be simulated while examining the processes inside the cylinder chamber. The **idling behaviour** of diesel and petrol engines can be compared. The indicating system can be used to carry out a thermodynamic analysis of the engine.



Indicator diagram of a 4-stroke engine



Modern GUNT software for Windows with comprehensive visualisation functions:

- process schematic for all engines with real-time display of all measured and calculated variables
- display of up to four characteristics at the same time
- representation of characteristics: select any assignment for the axes of the diagram
- storage of measuring data
- selection between four preset languages
- easy connection to a PC via USB
- calculated variables
 - ▶ specific fuel consumption
 - ▶ intake air volumetric flow rate
 - ▶ mechanical power
 - ▶ efficiency
 - ▶ volumetric efficiency
 - ▶ fuel-air ratio λ

CT 159
Modular test stand for single-cylinder engines, 2,2kW



2,2 kW

CT 110
Test stand for single-cylinder engines, 7,5kW



7,5 kW

CT 300
Engine test stand, 11kW



11 kW

CT 400
Load unit, 75kW, for four-cylinder engines



75 kW

CT 159 Modular test stand for single-cylinder engines, 2,2 kW

The series CT 159 offers four different internal combustion engines in the power range up to 2,2 kW: A four-stroke diesel and petrol engine, a petrol engine with adjustable compression ratio and a two-stroke petrol engine. The engines are supplied with fuel and air via a modular test stand, CT 159. The exhaust fumes are discharged to the outside via hoses.

The engines are connected to the HM 365 Universal drive and brake unit by a V-belt. HM 365 is first used to start the engines.

While the engines are running, HM 365 is operated in generator mode, thus braking the engines. The engines can be examined under full load or under partial load conditions. The characteristic diagram is determined with variable load and speed. The interaction of the brake and engine can also be examined in this context.



HM 365 Universal drive and brake unit

CT 159 Modular test stand for single-cylinder engines, 2,2 kW

HM 365 + CT 159 + test engine (CT 150 – CT 153) incl. software for data acquisition

- characteristics for full and partial load
- determination of friction loss in the engine
- comparison of diesel and petrol engines
- comparison of 2-stroke and 4-stroke engines
- 4-stroke petrol engine with variable compression

Extended range of experiments

with electronic indication including software for data acquisition with CT 159.01 + engine-specific pressure transducer with TDC sensor (CT 159.03 – CT 159.05)

and/or exhaust gas analysis with CT 159.02

CT 150 Four-stroke petrol engine

Air-cooled, single-cylinder, 4-stroke petrol engine with external carburation



CT 151 Four-stroke diesel engine

Air-cooled, single-cylinder, 4-stroke diesel engine with direct injection



CT 152 Four-stroke petrol engine with variable compression

Air-cooled, single-cylinder, 4-stroke petrol engine:

- variable compression ratios that can be set by changing the combustion chamber geometry
- adjustable ignition point and variable carburettor jet



CT 153 Two-stroke petrol engine

Air-cooled, single-cylinder, 2-stroke petrol engine with diaphragm carburettor

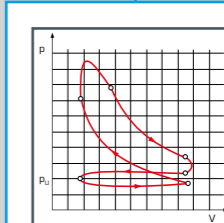


CT 159.03 Pressure transducer and TDC sensor

CT 159.04 Pressure transducer and TDC sensor

CT 159.03 Pressure transducer and TDC sensor

CT 159.05 Pressure transducer and TDC sensor



CT 159.01 Electronic engine indicating system for CT 159

Pressure measurement in the cylinder chamber of an internal combustion engine

- p-V diagram
- p-t diagram
- pressure curve during gas exchange
- determination of the indicated performance
- determination of mechanical efficiency



CT 159.02 Exhaust gas analysing unit

Measurement of the composition of exhaust gases (CO, CO₂, HC, O₂), the fuel/air ratio λ and the oil temperature of the engine.

CT 150

Four-stroke petrol engine for CT 159



Learning objectives/experiments

- in conjunction with CT 159 test stand + HM 365 load unit
 - ▶ familiarisation with a four-stroke petrol engine
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of the frictional power of the engine

Specification

- [1] air-cooled single-cylinder four-stroke petrol engine for installation in the CT 159 test stand
- [2] engine mounted on vibration-insulated base plate
- [3] force transmission to brake via pulley
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling

Technical data

Air-cooled single-cylinder petrol engine

- power output: 2,2kW at 3200min⁻¹
- bore: 62mm
- stroke: 42mm

Belt pulley: Ø 125mm

LxWxH: 450x360x380mm
Weight: approx. 22kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

Description

- engine for installation in the CT 159 test stand
- part of the GUNT-FEMLine

In conjunction with the CT 159 test stand and the HM 365 load unit, the simple four-stroke petrol engine is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is an air-cooled single-cylinder four-stroke petrol engine with external carburation. The engine is started by an electric motor mounted in the HM 365 unit. The air cooling is effected by a flywheel fan. The HM 365 load unit is coupled by way of a pulley on the drive shaft.

The engine includes a sensor to measure the exhaust gas temperature. The sensor, ignition cut-off as well as air and fuel supply are connected to the CT 159 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

CT 151

Four-stroke diesel engine for CT 159



Learning objectives/experiments

- in conjunction with CT 159 test stand and HM 365 load unit
 - ▶ familiarisation with a four-stroke diesel engine
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of the frictional power of the engine

Specification

- [1] air-cooled single-cylinder four-stroke diesel engine for installation in the CT 159 test stand
- [2] engine mounted on vibration-insulated base plate
- [3] force transmission to brake via pulley
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling

Technical data

Air-cooled single-cylinder diesel engine

- power output: 1.5kW at 3000min⁻¹
- bore: 69mm
- stroke: 62mm

V-belt: Ø 125mm

LxWxH: 430x350x350mm
Weight: approx. 38kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

Description

- engine for installation in the CT 159 test stand
- part of the GUNT-FEMLine

In conjunction with the CT 159 test stand and the HM 365 load unit, the air-cooled four-stroke diesel engine is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is an air-cooled single-cylinder four-stroke diesel engine with direct injection. The engine is started by an electric motor mounted in the HM 365 unit. The air cooling is effected by a flywheel fan. The HM 365 load unit is coupled by way of a pulley on the drive shaft. The engine includes a sensor to measure the exhaust gas temperature. The sensor, ignition cut-off as well as air and fuel supply are connected to the CT 159 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

CT 152**Four-stroke petrol engine with variable compression for CT 159****Description**

- engine for installation in the CT 159 test stand
- part of the GUNT-FEMLine

In conjunction with the CT 159 test stand and the HM 365 load unit, the engine is highly suitable for investigation of different compression ratios, ignition timing adjustment and an adjustable jet nozzle.

The engine used here is an air-cooled single-cylinder four-stroke petrol engine with external carburation. A modified cylinder head permits experiments with various combustion chamber inserts and compression ratios. To adjust the mixture composition, the carburettor was modified. CT 152 is fitted with a manual adjustment to adjust the ignition timing – from advanced to retarded.

The engine includes a sensor to measure the exhaust gas temperature. The sensor, ignition cut-off as well as air and fuel supply are connected to the CT 159 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

Learning objectives/experiments

- in conjunction with CT 159 test stand + HM 365 load unit, in addition to the standard basic experiments
 - ▶ influence of compression ratio, mixture composition, ignition timing on engine characteristics and exhaust gas temperature

Specification

- [1] air-cooled single-cylinder four-stroke petrol engine for installation in the CT 159 test stand
- [2] 5 variable compression ratios, adjustable by varying the combustion chamber geometry
- [3] adjustable ignition point
- [4] mixture composition adjustable
- [5] engine mounted on vibration-insulated base plate
- [6] force transmission to brake via pulley
- [7] engine complete with fuel hose and exhaust gas temperature sensor
- [8] fuel hose with self-sealing quick-release coupling

Technical data

- Air-cooled single-cylinder petrol engine
- power output: 1,2kW at 2500min⁻¹
 - bore: 65,1mm
 - stroke: 44,4mm
 - compression ratios: 1:10; 1:8,5; 1:7 (original compression ratio), 1:5,5; 1:4
 - ignition timing adjustable in 11 stages: 10° after TDC to 40° before TDC

Belt pulley: Ø 125mm

LxWxH: 350x420x500mm
Weight: approx. 21kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 5 combustion chamber inserts
- 1 pin type face wrench
- 1 manual

CT 153**Two-stroke petrol engine for CT 159****Description**

- engine for installation in the CT 159 test stand
- part of the GUNT-FEMLine

In conjunction with the CT 159 test stand and the HM 365 load unit, the two-stroke petrol engine is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is an air-cooled single-cylinder two-stroke petrol engine with a membrane carburettor. The engine is started by an electric motor mounted in the HM 365 unit. The air cooling is effected by a flywheel fan. The engine output is dissipated via a centrifugal clutch. The HM 365 load unit is coupled by way of a covered V-belt drive. Because of the high speed this engine is provided with a smaller pulley than other engines in the series.

The engine includes a sensor to measure the exhaust gas temperature. The sensor, ignition cut-off as well as air and fuel supply are connected to the CT 159 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

Learning objectives/experiments

- in conjunction with CT 159 test stand and HM 365 load unit
 - ▶ familiarisation with a four-stroke petrol engine
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)

Specification

- [1] air-cooled single-cylinder two-stroke petrol engine for installation in CT 159 test stand
- [2] engine mounted on a base plate with vibration dampers
- [3] force transmission to brake via pulley, gear transmission 2:1
- [4] engine completely equipped with fuel line, throttle cable and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling

Technical data

- Air-cooled single-cylinder petrol engine
- power output: 1,32kW at 6500min⁻¹
 - displacement: 45cm³
 - bore: 42,5mm
 - stroke: 32mm

V-belt: diameter=63mm

LxWxH: 430x355x310mm
Weight: approx. 8kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

CT 159

Modular test stand for single-cylinder engines, 2,2kW



Learning objectives/experiments

- in conjunction with the HM 365 load unit and one of the engines (CT 150 – CT 153)
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of the frictional power of the engine (in passive mode)

Description

- **setup of a complete test stand in conjunction with the universal drive and brake unit HM 365 and an engine**
- **test stand for single-cylinder internal combustion engines up to 2,2kW**
- **HM 365 drive and brake unit used as belt-driven starter-generator**
- **part of the GUNT-FEMLine**

This test stand measures the power output of internal combustion engines delivering up to 2,2kW. The complete test stand consists of three main elements: The CT 159 for mounting of the engine and as a control unit, the universal drive and brake unit HM 365 as a load unit and a choice of engine: four-stroke diesel engine (CT 151), two-stroke petrol engine (CT 153) and two four-stroke petrol engines (CT 150 or CT 152 with variable compression).

The main function of CT 159 is to mount the engine, supply it with fuel and air and record and display relevant measurement data. The engine is mounted on a vibration-insulated base plate and connected by way of a belt drive to HM 365.

HM 365 is initially used to start the engine. As soon as the engine is running, HM 365 acts as a brake for applying a load to the engine.

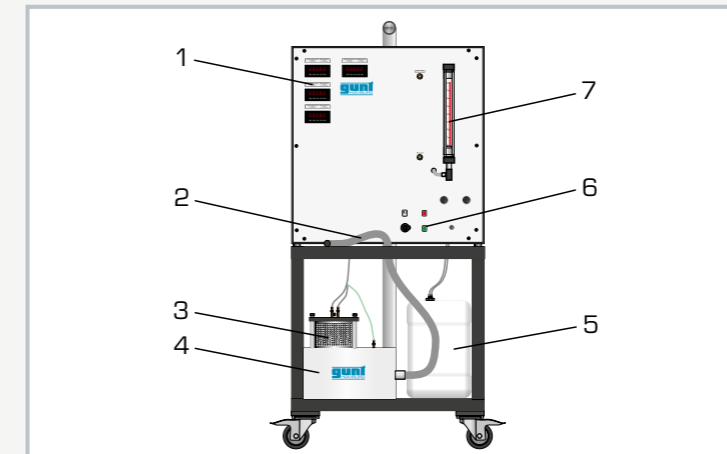
The lower section of the mobile frame contains fuel tanks and a stabilisation tank for the intake air.

The vibration-dampened switch cabinet contains digital displays for temperatures (one display each for exhaust gas, fuel and intake air) and air consumption. The speed and torque are adjusted and displayed on the HM 365.

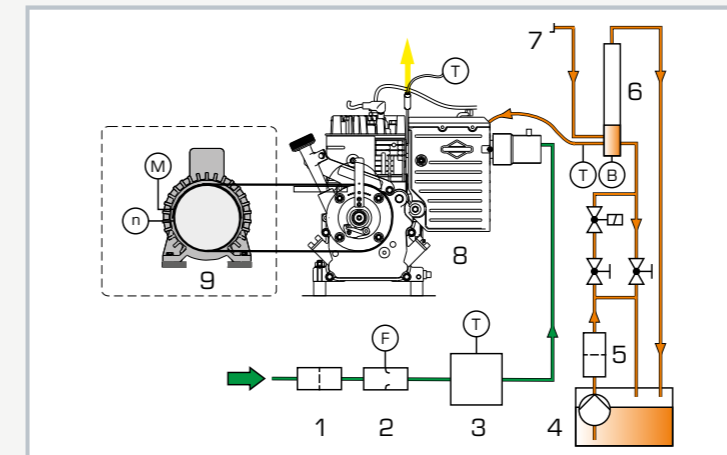
The measured values are transmitted directly to a PC via USB. The data acquisition software is included.

CT 159

Modular test stand for single-cylinder engines, 2,2kW



1 displays, 2 air hose, 3 air filter, 4 stabilisation tank, 5 fuel tank with pump, 6 connections and controls, 7 measuring tube for fuel consumption



1 air filter, 2 orifice plate, 3 stabilisation tank, 4 fuel tank with pump, 5 fuel filter, 6 measuring tube for fuel consumption, 7 diesel return, 8 motor (CT 150-CT 153), 9 HM 365; B fuel consumption, T temperature, F volumetric flow rate, n speed, M torque, orange: fuel, green: intake air, yellow: exhaust gas



Complete experimental setup with HM 365, CT 159 and CT 151

Specification

- [1] test stand for mounting of prepared single-cylinder engines (two-stroke and four-stroke) with a maximum power output of 2,2kW
- [2] engine started by HM 365
- [3] HM 365 acting as a brake generates the engine load
- [4] force transmission from engine to load unit via V-belt drive
- [5] continuous adjustment of speed and torque using HM 365
- [6] vibration-dampened switch cabinet for display and control
- [7] measuring tube with scale and pressure sensor for manual and electronic fuel consumption measurement
- [8] measurement and display of air consumption, ambient temperature and fuel temperature
- [9] measured value displays for engine exhaust gas temperature
- [10] stabilisation tank for intake air
- [11] 3 supply tanks for different fuels
- [12] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

3 fuel tanks: 5L each

Measuring ranges

- temperature:
 - ▶ 0...100°C (ambient)
 - ▶ 0...100°C (fuel)
 - ▶ 0...1000°C (exhaust gas)
- air consumption: 30...333L/min
- fuel consumption: 0...50cm³/min

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase; 120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 900x900x1900mm
Weight: approx. 135kg

Required for operation

exhaust gas routing, ventilation
PC with Windows recommended

Scope of delivery

- 1 test stand (devoid of engine and load unit)
- 1 set of tools
- 1 set of accessories
- 1 GUNT software CD + USB cable
- 1 set of instructional material

CT 110 Test stand for single-cylinder engines, 7,5kW

The CT 110 test stand can be used for a wide range of experiments on small internal combustion engines with a power output of up to 7.5kW. There is a choice of 4 different engines, which can be mounted on the base plate in the test stand as required. An engine can be installed in just a few minutes.

A load is applied to the engines by an air-cooled asynchronous motor, which is actuated by a frequency converter.

The engines can be investigated under full and partial load. A variable load and speed is used to determine the characteristic diagram for the engine. The interaction of the brake and the engine can also be investigated.

The test stand is ideal for both demonstrations and for independent experiments by students. The powerful software provides excellent support for the learning process. The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

The test stand can be operated in normal laboratory facilities. The engine and asynchronous motor are mounted on a single vibration-insulated frame. Intake sound absorption reduces noise. The exhaust gases are vented externally via a hose.



CT 110 Test stand for single-cylinder engines, 7,5kW

CT 110 + test engine (CT 100.20 – CT 100.23) incl. software for data acquisition

- characteristic curves at full and partial load
- determination of engine friction loss
- comparison of diesel and petrol engines
- comparison of two-stroke and four-stroke engines

Extended range of experiments

with
electronic indication with PC-based data acquisition
with CT 100.13 + engine-specific pressure transducer
(CT 100.14 – CT 100.17)

and/or
exhaust gas analysis
with CT 159.02

and/or
exhaust gas calorimeter
with CT 100.11

CT 100.20 Four-stroke petrol engine

Air-cooled four-stroke
petrol engine with
carburettor



CT 100.21 Two-stroke petrol engine

Air-cooled
two-stroke
petrol engine
with reverse
scavenging



CT 100.22 Four-stroke diesel engine

Air-cooled
four-stroke
diesel engine
with direct
injection



CT 100.23 Water-cooled four-stroke diesel engine

Water-cooled
four-stroke diesel
engine using the
swirl chamber
principle

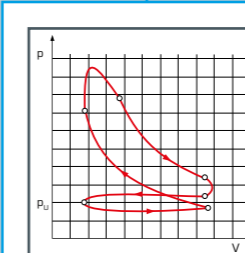


CT 100.14 Pressure transducer

CT 100.17 Pressure transducer

CT 100.16 Pressure transducer

CT 100.15 Pressure transducer



CT 100.13 Electronic engine indicating system

Pressure measurement
in the cylinder chamber
of an internal combustion
engine

- p-V diagram
- p-t diagram
- pressure curve during
gas exchange
- determination of the
indicated performance
- determination of
mechanical efficiency

TDC sensors for all
models are included in
the scope of delivery

CT 159.02 Exhaust gas analysing unit

Measurement of
the composition of
exhaust gases
(CO, CO₂, HC, O₂),
the fuel/air ratio λ and
the oil temperature of
the engine.



CT 100.11 Exhaust gas calorimeter

Counterflow heat
exchanger for calorimet-
ric analysis of exhaust
gases from internal
combustion engines



CT 100.20

Four-stroke petrol engine for CT 110



Learning objectives/experiments

- in conjunction with CT 110 test stand
 - ▶ familiarisation with a four-stroke petrol engine
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of the frictional power of the engine

Specification

- [1] air-cooled single-cylinder four-stroke petrol engine for installation in the CT 110 test stand
- [2] engine mounted on base plate
- [3] force transmission to brake via elastic claw coupling
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling

Technical data

- Air-cooled single-cylinder petrol engine
- power output: 7,5kW at 3000min⁻¹
 - bore: 87,3mm
 - stroke: 66,7mm

LxWxH: 600x480x630mm
Weight: approx. 36kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

Description

■ engine for use in CT 110 test stand

In conjunction with the CT 110 test stand, which includes a drive and brake unit, the four-stroke petrol engine is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is an air-cooled single-cylinder four-stroke petrol engine with external carburation. The engine is started and slowed down by an electric motor mounted in the CT 110 unit. The air cooling is effected by a flywheel fan. The brake unit is connected by way of an elastic claw coupling.

The engine is prepared for measurement of the cylinder pressure for indication. It includes a sensor to measure the exhaust gas temperature and a connection to measure the intake pressure. Both sensors, ignition cut-off and fuel supply are connected to the CT 110 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

CT 100.21

Two-stroke petrol engine for CT 110



Learning objectives/experiments

- in conjunction with CT 110 test stand
 - ▶ familiarisation with a two-stroke petrol engine
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)

Specification

- [1] air-cooled single-cylinder two-stroke petrol engine for installation in the CT 110 test stand
- [2] engine mounted on base plate
- [3] force transmission to brake via elastic claw coupling
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling

Technical data

- Air-cooled single-cylinder petrol engine with reverse scavenging
- power output: 4.9kW at 4500min⁻¹
 - compression ratio: 7.1:1
 - bore: 61mm
 - stroke: 54mm

LxWxH: 570x350x470mm
Weight: approx. 20kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

Description

■ test engine for use in CT 110 test stand

In conjunction with the CT 110 test stand, which includes a drive and brake unit, the two-stroke petrol engine is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is an air-cooled single-cylinder two-stroke petrol engine with reverse scavenging. The engine is started and slowed down by an electric motor mounted in the CT 110 unit. The air cooling is effected by a flywheel fan. The brake unit is connected by way of an elastic claw coupling.

The engine is prepared for measurement of the cylinder pressure for indication. It includes a sensor to measure the exhaust gas temperature and a connection to measure the intake pressure. Both sensors, ignition cut-off and fuel supply are connected to the CT 110 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

CT 100.22

Four-stroke diesel engine for CT 110



Description

■ test engine for use in CT 110 test stand

In conjunction with the CT 110 test stand, which includes a drive and brake unit, the four-stroke diesel engine is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is an air-cooled single-cylinder four-stroke diesel engine with direct injection. The diesel engine is started and slowed down by an electric motor mounted in the CT 110 unit. The air cooling is effected by a flywheel fan. The brake unit is connected by way of an elastic claw coupling.

The engine is prepared for measurement of the cylinder pressure for indication. It includes a sensor to measure the exhaust gas temperature and a connection to measure the intake pressure. Both sensors, ignition cut-off and fuel supply are connected to the CT 110 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

Learning objectives/experiments

- in conjunction with CT 110 test stand
 - ▶ familiarisation with a four-stroke diesel engine
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of engine friction loss

Specification

- [1] air-cooled single-cylinder four-stroke diesel engine for installation in the CT 110 test stand
- [2] engine mounted on base plate
- [3] force transmission to brake via elastic claw coupling
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling
- [6] engine also available as biodiesel engine CT 100.24

Technical data

Air-cooled single-cylinder diesel engine with direct injection

- power output: 4,5kW at 2700min⁻¹
- compression ratio 22:1
- bore: 80mm
- stroke: 69mm

LxWxH: 470x400x480mm
Weight: approx. 43kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

CT 100.23

Water-cooled four-stroke diesel engine for CT 110



Description

■ test engine for use in CT 110 test stand

In conjunction with the CT 110 test stand, which includes a drive and brake unit, the four-stroke diesel engine is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is a water-cooled single-cylinder four-stroke diesel engine with indirect injection. The engine is started and slowed down by an electric motor mounted in the CT 110 unit. The cooling water circulation contains a circulating pump, flow meter and temperature sensors. The brake unit is connected by way of an elastic claw coupling.

The engine is prepared for measurement of the cylinder pressure for indication. It includes a sensor to measure the exhaust gas temperature and a connection to measure the intake pressure. Both sensors, ignition cut-off and fuel supply are connected to the CT 110 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

Learning objectives/experiments

- in conjunction with CT 110 test stand
 - ▶ familiarisation with a water-cooled four-stroke diesel engine
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of engine friction loss
 - ▶ determination of amount of heat emitted by the engine

Specification

- [1] water-cooled single-cylinder four-stroke diesel engine with swirl chamber for installation in the CT 110 test stand
- [2] engine mounted on base plate
- [3] force transmission to brake via elastic claw coupling
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] cooling water circuit with circulating pump, flow meter and temperature sensors
- [6] fuel hose with self-sealing quick-release coupling

Technical data

Single-cylinder diesel engine with indirect injection

- bore: 75mm, stroke: 70mm
- power output: 5,1kW at 3000min⁻¹

Cooling water circuit
 ■ capacity: 2,5L
 ■ pump: max. 640L/h

Measuring ranges
 ■ temperature: 2x 0...100°C
 ■ flow rate: 30...300L/h

LxWxH: 600x420x600mm
Weight: approx. 50kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

CT 110

Test stand for single-cylinder engines, 7,5kW



The illustration shows the CT 110 with the CT 100.20 engine and the CT 100.13 electronic indication system (on the shelf).

Learning objectives/experiments

- in conjunction with an engine (CT 100.20 – CT 100.23)
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of the frictional power of the engine (in passive mode)

Description

- control and load unit for single-cylinder internal combustion engines up to 7,5kW
- asynchronous motor used as load unit, also as starter motor
- vibration-insulated base plate for engine mounting

This test stand measures the power output of internal combustion engines delivering up to 7,5kW. The complete test stand consists of two main elements: The CT 110 as the control and load unit and a choice of engine: four-stroke petrol engine (CT 100.20), two-stroke petrol engine (CT 100.21) and two four-stroke diesel engines (CT 100.22, air-cooled with direct injection; CT 100.23, water-cooled with indirect injection).

The main function of the CT 110 is to provide the required braking power.

The brake unit is an air-cooled asynchronous motor with an energy recovery unit. The torque and speed are generated by way of a frequency converter. The energy recovery of the braking energy into the system provides for highly energy-efficient operation of the test stand. The torque is measured by means of a suspended brake unit and force sensor.

The engine is mounted on a vibration-insulated base plate and connected to the asynchronous motor. The mass of the base plate in conjunction with the soft bearing support ensures that the test stand runs very smoothly.

The asynchronous motor is initially used to start the engine. As soon as the engine is running, the asynchronous motor and energy recovery unit act as a brake unit for applying a load to the engine.

The braking power is fed back into the electrical system. In passive mode of the engine the asynchronous motor is also used to determine the frictional power of the engine.

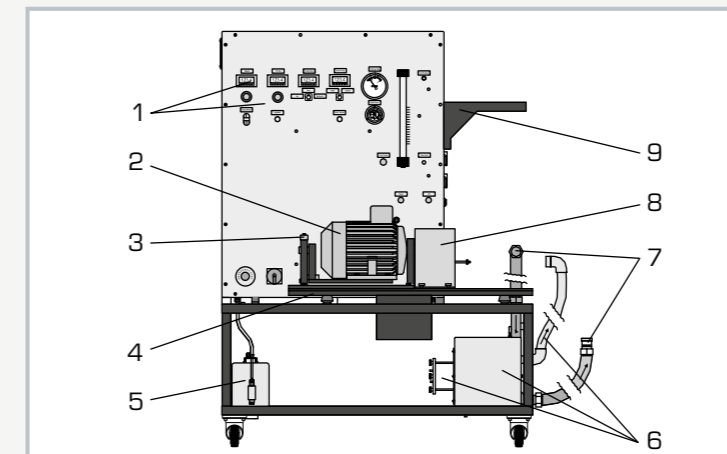
The lower section of the mobile frame contains fuel tanks and a stabilisation tank for the intake air.

The air consumption is measured by way of a measuring nozzle. The fuel consumption is measured by way of the level in a vertical pipe.

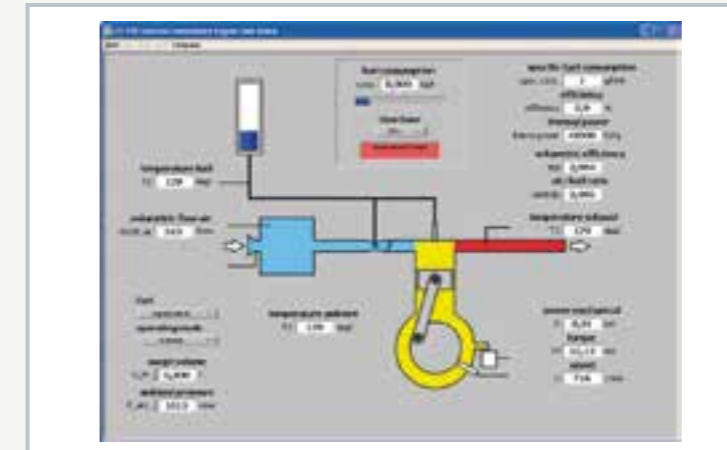
The switch cabinet contains digital displays for the speed, torque and temperatures. Pressure gauges indicate negative intake pressure and air consumption. The measured values are transmitted directly to a PC via USB. The data acquisition software is included.

CT 110

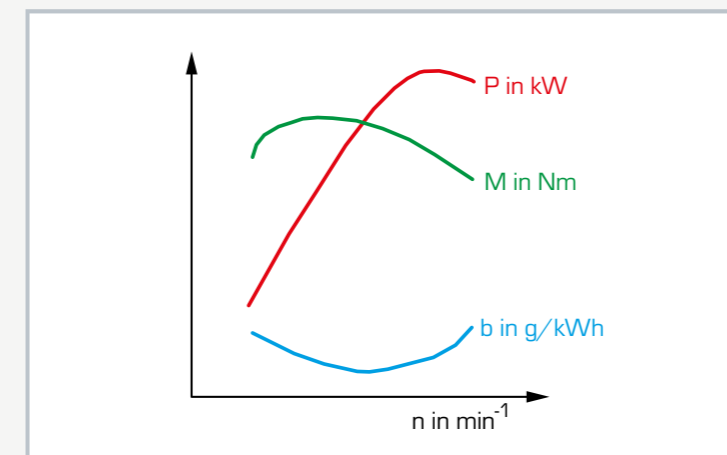
Test stand for single-cylinder engines, 7,5kW



1 display and control panel, 2 asynchronous motor, 3 force sensor (torque), 4 base plate, 5 fuel tank with pump, 6 stabilisation tank with air filter and air hose, 7 exhaust gas connection, 8 coupling cover, 9 shelf, e.g. for CT 100.13



Software screenshot: process schematic



Characteristics of a four-stroke petrol engine:
 n speed, M torque, P power, b specific fuel consumption

Specification

- [1] control and load unit for prepared single-cylinder engines (two-stroke and four-stroke) with a maximum power output of 7,5kW
- [2] asynchronous motor with energy recovery unit as brake generates engine load
- [3] engine started and experiments in passive mode by asynchronous motor
- [4] force transmission from engine to brake via elastic claw coupling
- [5] vibration-insulated base plate for engine mounting
- [6] stabilisation tank for intake air
- [7] potentiometer for continuous adjustment of braking torque
- [8] potentiometer for continuous adjustment of braking speed
- [9] measurement and display of torque, air temperature, air intake quantity, negative intake pressure, speed, fuel consumption, fuel temperature
- [10] measured value displays for engine: exhaust gas temperature and cooling water temperatures
- [11] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

Asynchronous motor as brake
 ■ power output: approx. 7,5kW at 2900min^{-1}

Measuring ranges

- torque: -50...50Nm
- temperature: 0...900°C
- speed: 0...5000 min^{-1}
- fuel consumption: 50 cm^3/min
- engine intake pressure: -400...0mbar
- air consumption: 0...690L/h

400V, 50Hz, 3 phases
 400V, 60Hz, 3 phases, 230V, 60Hz, 3 phases
 UL/CSA optional
 LxWxH: 1450x850x1880mm
 Weight: approx. 245kg

Required for operation

ventilation, exhaust gas routing
 PC with Windows recommended

Scope of delivery

- 1 test stand (without engine)
- 1 set of tools
- 1 set of accessories
- 1 GUNT software CD + USB cable
- 1 set of instructional material

CT 300 Test stand for two-cylinder engines, 11 kW

The CT 300 test stand enables a wide range of experiments on 4-stroke internal combustion engines in the power range up to 11 kW.

Two different engines are available, each of which is mounted on a base: an air-cooled 2-cylinder petrol engine and a water-cooled 2-cylinder diesel engine.

The test stand and the engine being studied can be operated separately from each other. The engine runs in a separate area and is operated and adjusted remotely by the test stand. This means experiments on the test stand can be carried out and demonstrated in the laboratory or in the lecture hall without disturbing noise from the engine. The test stand and engine are connected to each other via appropriate cables.

Due to the engine's own weight, a hoist is required to install the engine. Load is applied to the engines via an air-cooled asynchronous motor controlled by a frequency converter.

The engines can be examined under full load or under partial load conditions. The characteristic diagram is determined with variable load and speed. The interaction of the brake and engine can also be examined in this context.



CT 300 Engine test stand, 11kW



The engine is installed on the stable base with the brake unit of the test stand. The test stand and engine can be set up at different locations, even in completely separate rooms, and connected to each other via appropriate cables. The engine is operated from the test stand via remote control.

CT 300 + test engine (CT 300.04 – CT 300.05) incl. software for data acquisition

- characteristic curves at full and partial load
- determination of engine friction loss
- comparison of diesel and petrol engines

Extended range of experiments

with

electronic indication including software for data acquisition with CT 300.09 + engine-specific pressure transducer with TDC sensor (CT 300.17 – CT 300.18)

and/or

exhaust gas analysis with CT 159.02

and/or

exhaust gas calorimeter (amount of heat in exhaust gas) with CT 300.01

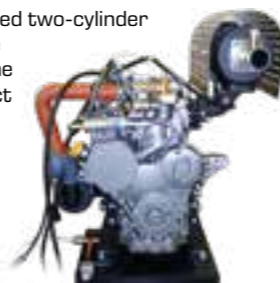
CT 300.04 Two-cylinder petrol engine for CT 300

Air-cooled two-cylinder four-stroke petrol engine with external carburation

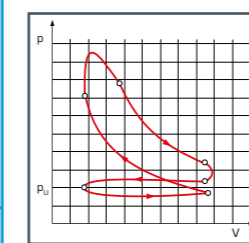


CT 300.05 Two-cylinder diesel engine for CT 300

Water-cooled two-cylinder four-stroke diesel engine with indirect injection



CT 300.17 Pressure transducer and TDC sensor



CT 300.09 Electronic engine indicating system

Pressure measurement in the cylinder chamber of an internal combustion engine

- p-V diagram
- p-t diagram
- pressure curve during gas exchange
- determination of the indicated performance
- determination of mechanical efficiency

CT 300.18 Pressure transducer and TDC sensor

CT 159.02 Exhaust gas analysing unit

Measurement of the composition of exhaust gases (CO, CO₂, HC, O₂), the fuel/air ratio λ and the oil temperature of the engine.



CT 300.01 Exhaust gas calorimeter

Counterflow heat exchanger for calorimetric analysis of exhaust gases from internal combustion engines



CT 300.04

Two-cylinder petrol engine for CT 300



Learning objectives/experiments

- plotting of torque and power curves
- determination of specific fuel consumption
- determination of volumetric efficiency and lambda (fuel-air ratio)
- energy balance
- determination of the frictional power of the engine (in passive mode)

Specification

- [1] air-cooled two-cylinder four-stroke petrol engine for installation in the CT 300 test stand
- [2] engine mounted on base plate
- [3] force transmission to brake via elastic claw coupling
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling

Technical data

- Air-cooled two-cylinder petrol engine
- displacement: 480cm³
 - bore: 68mm
 - stroke: 66mm
 - power output: approx. 11,9kW at 3600min⁻¹

LxWxH: 500x440x550mm
Weight: approx. 60kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

Description

■ engine for use in CT 300 test stand

In conjunction with the CT 300 test stand, which includes a drive and brake unit, the four-stroke petrol engine CT 300.04 is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

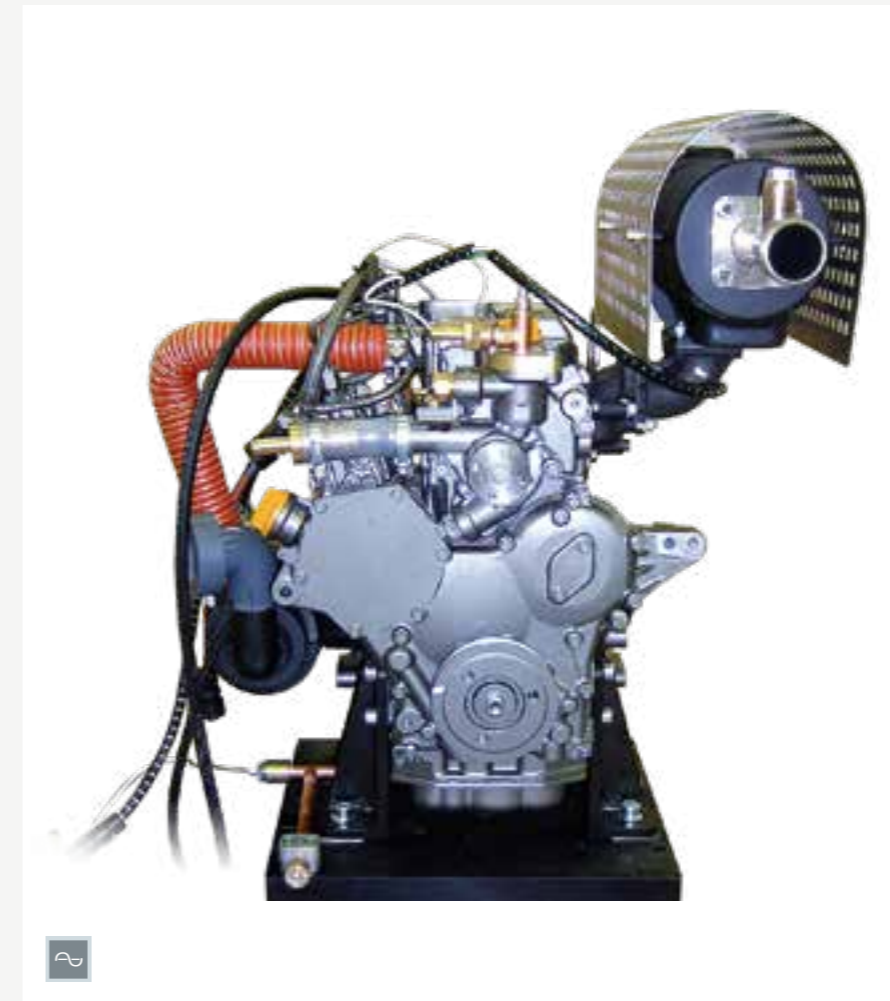
The engine used here is an air-cooled two-cylinder four-stroke petrol engine with external carburation. The engine is started, run in passive mode and slowed down by an electric motor mounted in the CT 300 unit. The brake unit is connected by way of a elastic claw coupling.

The engine is prepared for measurement of the cylinder pressure for indication, and additionally includes a sensor to measure the exhaust gas temperature. The sensor, ignition cut-off and fuel supply are connected to the CT 300 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

CT 300.05

Two-cylinder diesel engine for CT 300



Learning objectives/experiments

- plotting of torque and power curves
- determination of specific fuel consumption
- determination of volumetric efficiency and lambda (fuel-air ratio)
- energy balance
- determination of the frictional power of the engine (in passive mode)

Specification

- [1] water-cooled two-cylinder four-stroke diesel engine for installation in the CT 300 test stand
- [2] engine mounted on base plate
- [3] force transmission to brake via elastic claw coupling
- [4] engine complete with fuel hose and exhaust gas temperature sensor
- [5] fuel hose with self-sealing quick-release coupling

Technical data

- Water-cooled two-cylinder diesel engine
- displacement: 570cm³
 - bore: 70mm
 - stroke: 74mm
 - power output: approx. 10,2kW at 3600min⁻¹

LxWxH: 650x610x710mm
Weight: approx. 110kg

Scope of delivery

- 1 engine, complete with all connections and supply lines
- 1 manual

Description

■ engine for use in CT 300 test stand

In conjunction with the CT 300 test stand, which includes a drive and brake unit, the four-stroke diesel engine CT 300.05 is highly suitable for use in teaching the fundamentals of engine functioning and measurement.

The engine used here is a water-cooled two-cylinder four-stroke diesel engine with indirect injection. The engine is started, run in passive mode and slowed down by an electric motor mounted in the CT 300 unit. The brake unit is connected by way of a elastic claw coupling.

The engine is prepared for measurement of the cylinder pressure for indication, and additionally includes a sensor to measure the exhaust gas temperature. The sensor, ignition cut-off and fuel supply are connected to the CT 300 test stand.

The full load and partial load characteristic curves of the engine are plotted in experiments.

CT 300

Engine test stand, 11kW



Description

- test stand for industrial two-cylinder engines up to 11kW
- asynchronous motor used as load unit, also as starter motor

This test stand measures the power output of internal combustion engines delivering up to 11kW. The complete test stand consists of two main elements: The CT 300 as the control and load unit and a choice of engine: two-cylinder petrol engine (CT 300.04, air-cooled) and two-cylinder diesel engine (CT 300.05, water-cooled).

The main function of the CT 300 is to provide the required braking power. The brake unit is an air-cooled asynchronous motor with an energy recovery unit. The braking speed and torque can be precisely adjusted using a frequency converter. The recovery of the braking energy into the system provides for highly energy-efficient operation of the test stand. The torque is measured by means of a suspended brake unit and force sensor.

The engine is mounted on a base plate and connected to the asynchronous motor. The base plate is vibration-insulated, so no vibrations are transmitted

to the surrounding environment. The asynchronous motor is initially used to start the engine. As soon as the engine is running, the asynchronous motor and energy recovery unit act as a brake for applying a load to the engine. The braking power is fed back into the electrical system.

The lower section of the mobile frame contains fuel supply tanks and a stabilisation tank for the intake air. Two separate fuel gauge systems allow the quick change between diesel and petrol operation.

The switch cabinet contains digital displays for the speed, torque, air consumption and temperatures (engine cooling water inlet and outlet, exhaust gas, fuel and intake air). The fuel consumption and cooling water flow rate in the engine and the CT 300.01 calorimeter available as an option are displayed in analogue form. The measured values are transmitted directly to a PC via USB. The data acquisition software is included.

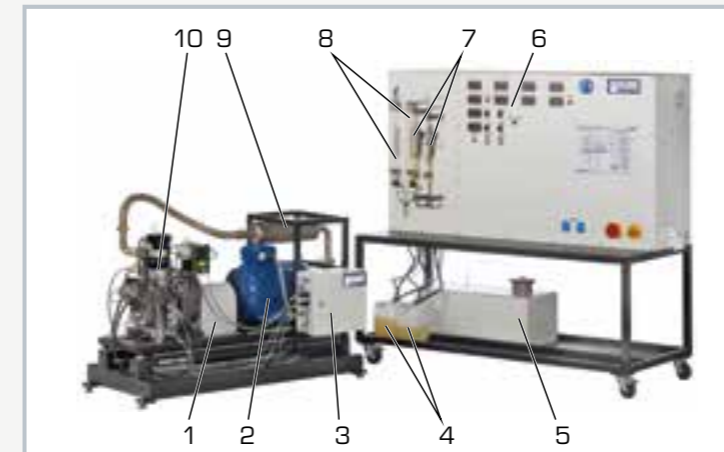
Lifting gear is required to exchange the engines.

Learning objectives/experiments

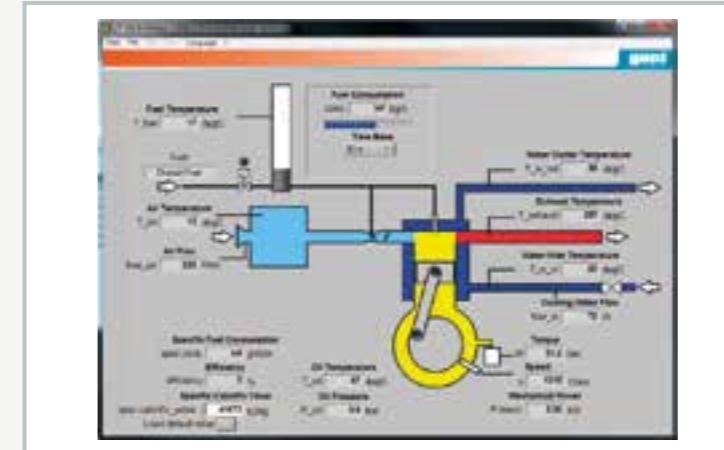
- in conjunction with an engine (CT 300.04 – CT 300.05)
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ determination of the frictional power (in passive mode)
 - ▶ energy balances (for water-cooled engines)

CT 300

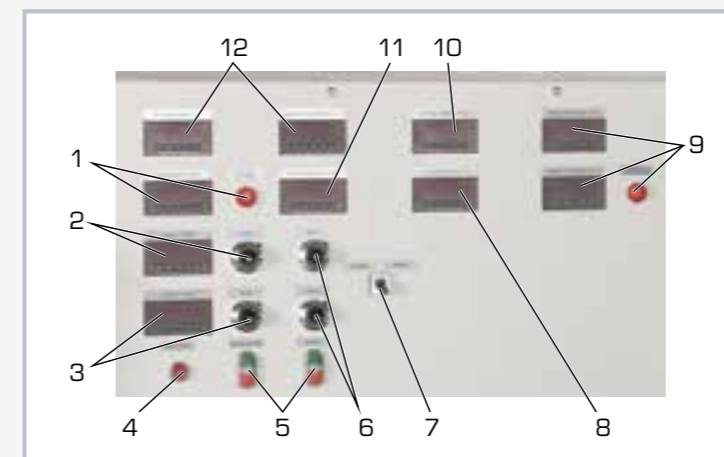
Engine test stand, 11kW



1 elastic coupling, 2 asynchronous motor, 3 switch cabinet, 4 fuel tank, 5 stabilisation tank, 6 display and control panel, 7 fuel consumption, 8 cooling water flow measurement (engine and CT 300.01 calorimeter), 9 exhaust, 10 experimental engine



Software screenshot: process schematic



Instrumentation: 1 oil pressure with warning lamp, 2 torque with adjustment, 3 speed with adjustment, 4 reset frequency converter, 5 switch for motor and brake, 6 engine accelerator, 7 switch petrol/engine operation, 8 air temperature, 9 cooling water temperatures with alarm lamp, 10 intake air consumption, 11 fuel temperature, 12 exhaust gas and oil temperatures

Specification

- [1] control and load unit for prepared four-stroke engines with a maximum power output of 11kW
- [2] vibration-insulated base plate for mounting of the engine and the asynchronous motor
- [3] asynchronous motor with energy recovery unit as brake generates engine load
- [4] engine and passive mode started by asynchronous motor
- [5] force transmission from engine to brake via elastic claw coupling
- [6] 2 separate fuel gauge systems
- [7] stabilisation tank for intake air 75L
- [8] potentiometer for continuous adjustment of braking speed and torque
- [9] measurement and display of temperatures (oil, fuel, air), engine load, engine speed, fuel consumption, air intake quantity, oil pressure
- [10] measured value displays for engine: exhaust gas temperature and cooling water temperatures
- [11] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

Asynchronous motor as brake
 ■ nominal power output: 11kW at 3000min⁻¹

Measuring ranges

- torque: -200...200Nm
- speed: 0...5000min⁻¹
- volumetric flow rate: 0...938L/min (intake air)
- flow rate: 0...250L/h (cooling water)
- temperature:
 - ▶ 4x 0...120°C
 - ▶ 1x 0...150°C (oil)
 - ▶ 1x 0...900°C (exhaust gas)
- pressure: 0...6bar (oil)

400V, 50Hz, 3 phases
 400V, 60Hz, 3 phases
 230V, 60Hz, 3 phases
 UL/CSA optional
 LxWxH: 2100x790x1800mm (switch cabinet)
 LxWxH: 1550x800x910mm (base plate)
 Weight: approx. 350kg

Required for operation

water connection: 500L/h
 ventilation, exhaust gas routing
 PC with Windows recommended

Scope of delivery

- 1 test stand (without engine)
- 1 set of tools
- 1 set of accessories
- 1 GUNT software CD + USB cable
- 1 set of instructional material

CT 400

Test stand for four-cylinder engines, 75 kW

The series CT 400 equipment offers a wide range of experiments on industrial engines with a power output of up to 75 kW.

The complete test stand is made up of the CT 400 load unit and an engine. A choice of two water-cooled engines is available:

- 4 cylinder in-line engine, petrol
- 4 cylinder in-line engine, diesel

The engine can be connected to the load unit quickly and easily. The CT 400 load mechanism essentially consists of an adjustable air-cooled eddy current brake. The engines can be investigated in two modes:

- **torque control:** Manual adjustment of braking torque. The characteristic curve for the brake is changed, different full load points are approached and measurements are carried out depending on the speed.
- **speed control:** A controller keeps the speed constant, while the engine torque is increased. This allows different load points to be approached and measurements are carried out depending on the load.

An indicating system with software for data acquisition for the pressure curves in the engines and an exhaust gas analysis unit are available as accessories.



CT 400 Load unit, 75 kW, for four-cylinder engines

CT 400

+ test engine (CT 400.01 or CT 400.02) incl. software for data acquisition

- characteristic curves depending on speed and power output
- creation of heat balances at full and partial load
 - ▶ determination of imparted energy, effective usable power, amount of heat in cooler, amount of heat in exhaust gas losses, heat losses due to radiation and convection
 - ▶ representation in Sankey diagram
- comparison of diesel and petrol engines

Extended range of experiments

with

electronic indication including software for data acquisition with CT 400.09 + engine-specific pressure transducer with TDC sensor (CT 400.16 or CT 400.17)

and/or

exhaust gas analysis with CT 159.02

CT 400.01

Four-cylinder petrol engine for CT 400

Water-cooled petrol engine with intake-manifold fuel injection, max. 55 kW



CT 400.02

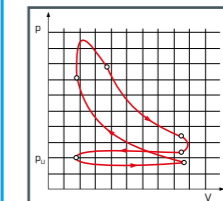
Four-cylinder diesel engine for CT 400

Water-cooled naturally aspirated diesel engine with direct injection, max. 41 kW



CT 400.16

Pressure transducer and TDC sensor



CT 400.09

Electronic engine indicating system for CT 400

Pressure measurement in the cylinder chamber of an internal combustion engine

- p-V diagram
- p-t diagram
- pressure curve during gas exchange
- determination of the indicated performance
- determination of mechanical efficiency

CT 400.17

Pressure transducer and TDC sensor



CT 159.02

Exhaust gas analysing unit

Measurement of the composition of exhaust gases (CO, CO₂, HC, O₂), the fuel/air ratio λ and the oil temperature of the engine.

CT 400.01

Four-cylinder petrol engine for CT 400



Learning objectives/experiments

- in conjunction with CT 400 load unit
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ energy balances
 - ▶ overall engine efficiency

Description

- engine for setup of a test stand in conjunction with the CT 400 load unit
- closed cooling water circuit
- easy connection to the CT 400 load unit

In conjunction with the CT 400 load unit, the CT 400.01 engine is a complete engine test stand. The engine used here is a four-cylinder petrol engine with a controlled catalytic converter. It has its own closed cooling water circuit.

A solid welded frame on rollers carries the entire setup. Hazardous areas such as hot surfaces and rotating parts are covered with perforated plates. The connection to the brake is made via a rotationally elastic coupling with a jointed shaft. The engine is attached to the load unit by fasteners.

The engine is fitted with sensors that measure the temperatures and the cooling water flow rate. The switch cabinet contains all of the electronic equipment for managing the engine (factory set). On the switch cabinet are an ignition key, an operating time counter and warning lamps. Data is transferred between the CT 400 load unit and the engine via a data cable connecting the switch cabinets for the two units. A starter battery is also housed in the frame.

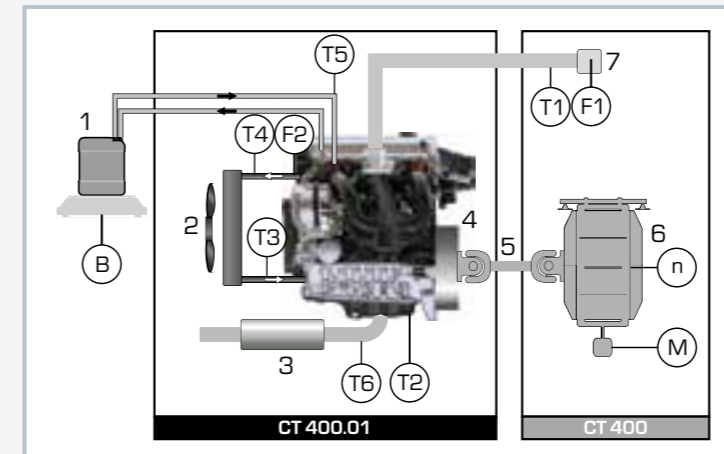
For safety reasons, the engine has been modified in a way that it only starts when it is connected to the load unit both mechanically and electrically.

CT 400.01

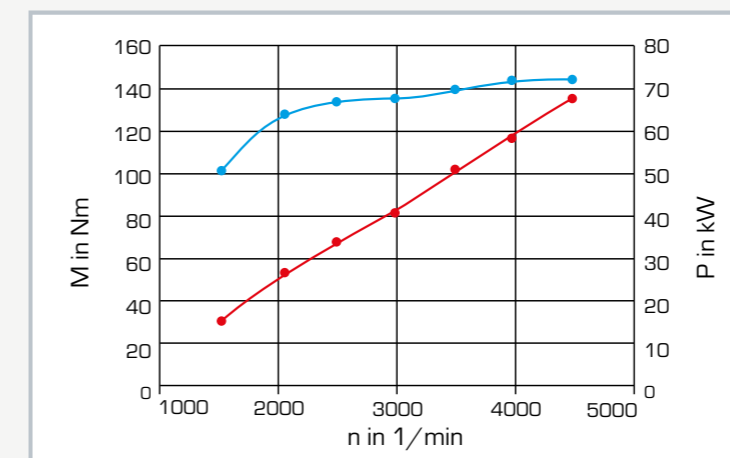
Four-cylinder petrol engine for CT 400



1 cooling water tank, 2 radiator with protective screen, 3 exhaust gas connection, 4 fuel tank, 5 battery with main switch, 6 operating time counter, 7 warning lamps, 8 key switch for ignition, 9 connection for engine feed air



1 fuel tank, 2 radiator, 3 exhaust, 4 engine, 5 cardan shaft, 6 eddy current brake, 7 air inlet; n speed, M torque, B fuel consumption, volumetric flow rate: F1 air, F2 cooling water, temperatures: T1 intake air, T2 oil, T3 cooling water inlet, T4 cooling water outlet, T5 fuel, T6 exhaust gas



Power and torque characteristics of the engine
n speed, M torque, P power

Specification

- [1] water-cooled four-cylinder petrol engine for setup of a test stand in conjunction with the CT 400 load unit
- [2] engine flexibly mounted on mobile frame
- [3] force transmission to brake via rotationally elastic coupling and jointed shaft
- [4] engine complete with fuel supply (tank, pump, hose) and cooling water circuit
- [5] sensors for cooling water flow rate and temperatures (exhaust gas, cooling water, fuel, oil)
- [6] transfer of measured data via data cable from switch cabinet to CT 400 switch cabinet
- [7] switch cabinet with warning lamps (oil pressure, alternator failure), operating time counter and ignition key

Technical data

- Water-cooled four-cylinder petrol engine
- displacement: 1596cm³
 - bore: 79mm
 - stroke: 81,4mm
 - power output: max. 75kW at 4800min⁻¹
 - torque: max. 155Nm at 4150min⁻¹
 - compression ratio: 11:1
 - ignition sequence: 1-3-4-2

Starter battery: 12V
Fuel tank capacity: 5L
Fuel: petrol 95 Octane
Engine oil: SAE 5W-30

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
230V, 60Hz, 3 phases
LxWxH: 1200x1120x1340mm
Weight: approx. 400kg

Scope of delivery

- 1 engine, built into frame
- 1 manual

CT 400.02

Four-cylinder diesel engine for CT 400



Learning objectives/experiments

- in conjunction with CT 400 load unit
- plotting of torque and power curves
- determination of specific fuel consumption
- determination of volumetric efficiency and lambda (fuel-air ratio)
- energy balances
 - ▶ overall engine efficiency



Description

- engine for setup of a test stand in conjunction with the CT 400 load unit
- closed cooling water circuit
- easy connection with CT 400 load unit

In conjunction with the CT 400 load unit, the CT 400.02 test engine is a complete engine test stand. The engine used here is a four-cylinder diesel engine. It has its own closed cooling water circuit.

A solid welded frame on rollers carries the entire setup. Hazardous areas such as hot surfaces and rotating parts are covered with perforated plates. The connection to the brake is made via a rotationally elastic coupling with a jointed shaft. The engine is attached to the load unit by fasteners.

The engine is fitted with sensors that measure the temperatures and the cooling water flow rate. The switch cabinet contains all of the electronic equipment for managing the engine (factory set). On the switch cabinet are an ignition key, an operating time counter and warning lamps. Data is transferred between the CT 400 load unit and the engine via a data cable connecting the switch cabinets for the two units. A starter battery is also housed in the frame.

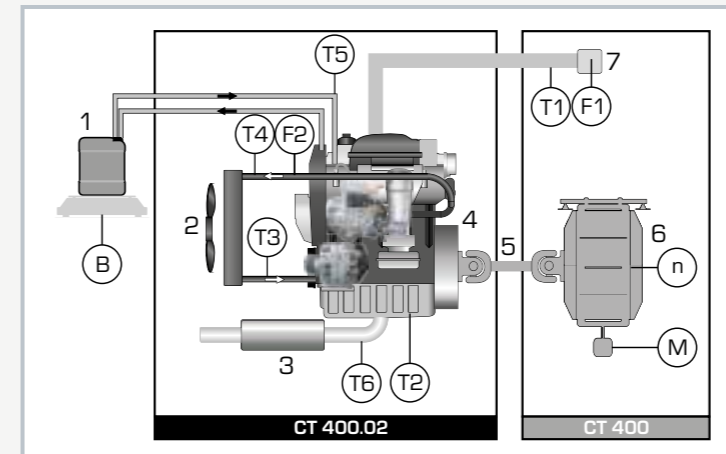
For safety reasons, the engine has been modified in a way that it only starts when it is connected to the load unit both mechanically and electrically.

CT 400.02

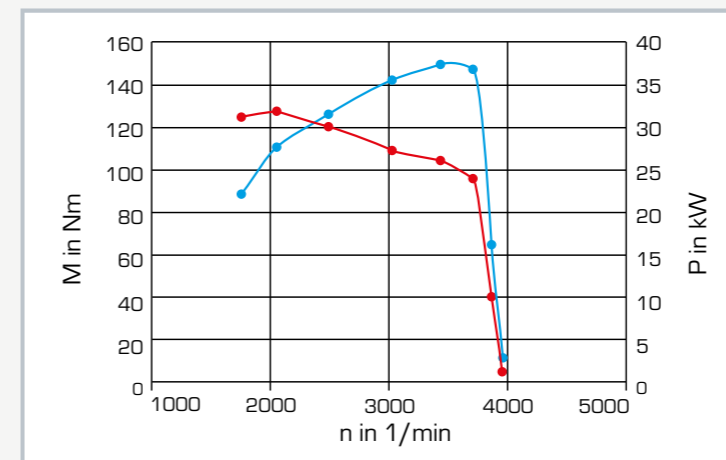
Four-cylinder diesel engine for CT 400



1 cooling water tank, 2 cooler with protective screen, 3 exhaust gas connection, 4 fuel tank, 5 battery with main switch, 6 operating time counter, 7 warning lamps, 8 key switch for ignition, 9 connection for engine feed air



1 fuel tank, 2 radiator, 3 exhaust, 4 engine, 5 cardan shaft, 6 eddy current brake, 7 air inlet; n speed, M torque, B fuel consumption, volumetric flow rate: F1 air, F2 cooling water, temperatures: T1 intake air, T2 oil, T3 cooling water inlet, T4 cooling water outlet, T5 fuel, T6 exhaust gas



Power and torque characteristics of the engine
n speed, M torque, P power

Specification

- [1] water-cooled four-cylinder diesel engine for setup an engine test stand in conjunction with CT 400 load unit
- [2] engine flexibly mounted on mobile frame
- [3] power transmission to brake unit via elastic coupling and a jointed shaft
- [4] engine complete with fuel supply (tank, pump, line) and cooling water circuit
- [5] sensors for cooling water flow rate and temperatures (exhaust gas, cooling water, fuel, oil)
- [6] transfer of measured data via data cable from switch cabinet to CT 400 control cabinet
- [7] switch cabinet with warning lamps (oil pressure, alternator failure, preheat), operating time counter and ignition key

Technical data

- Water-cooled four-cylinder diesel engine
- displacement: 1968cm³
 - bore: 81 mm
 - stroke: 95,5mm
 - power output: max. 41kW at 3000min⁻¹
 - torque: max. 130Nm at 1750min⁻¹

Starter battery: 12V

Fuel tank capacity: 5L
Engine oil: SAE 5W-30

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
230V, 60Hz, 3 phases
LxWxH: 1200x1150x1430mm
Weight: approx. 440kg

Scope of delivery

- 1 engine, built into frame
- 1 set of instructional material

CT 400

Load unit, 75kW, for four-cylinder engines



Learning objectives/experiments

- in conjunction with an engine (CT 400.01 / CT 400.02)
 - ▶ plotting of torque and power curves
 - ▶ determination of specific fuel consumption
 - ▶ determination of volumetric efficiency and lambda (fuel-air ratio)
 - ▶ energy balances
 - ▶ overall engine efficiency

Description

- control and load unit for four-cylinder diesel and petrol engines up to 75kW
- air-cooled eddy current brake with precise torque adjustment for use as load unit for engine
- easy connection of engine
- complete test stand setup in conjunction with an engine

This test stand measures the power output of internal combustion engines delivering up to 75kW. The complete test stand consists of two main elements: The CT 400 as the control and load unit and a choice of engine: CT 400.01 petrol engine or CT 400.02 diesel engine. The engine to be investigated is connected to the CT 400 using a coupling with jointed shaft.

The main function of the CT 400 is to provide the required braking power. The brake unit is an air-cooled eddy current brake. The braking torque can be precisely adjusted using the exciting current. The braking torque is measured by means of a suspended brake unit and force sensor. Due to the air cooling of the brake, the engine test stand does not require cooling water inlet or outlet. A stabilisation tank with an intake air duct for the combustion air is mounted on the frame. The quantity of air taken in is measured in the duct.

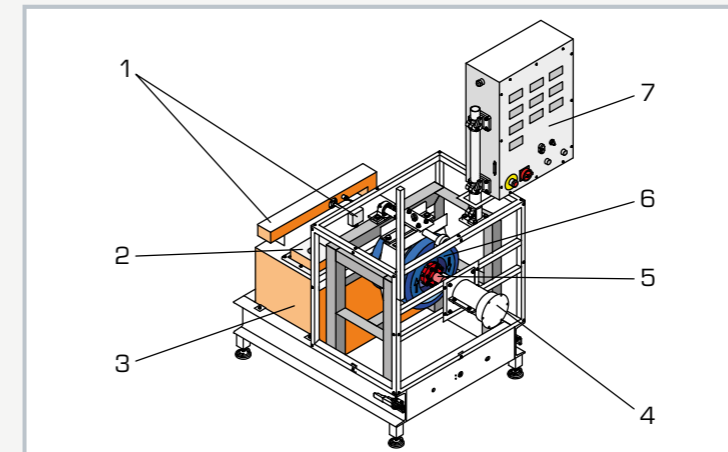
The switch cabinet contains digital displays for the speed, torque, volumetric intake air flow rate and temperatures (exhaust gas, engine oil, engine cooling water (inlet and outlet), fuel and intake air). The switch cabinet pivots, enabling the operator to adjust it to the optimum viewing angle.

Data is transferred between the CT 400 load unit and the engine via a data cable connecting the switch cabinets of the two units. The measured values can be read on digital displays. At the same time, the measured values can also be transmitted directly to a PC via USB. The data acquisition software is included.

In addition to the standard safety features (e.g. oil pressure, temperature limiter), the load unit contains a limit switch to monitor whether the brake and the engine are correctly connected.

CT 400

Load unit, 75kW, for four-cylinder engines



1 air intake duct with anemometer, 2 air filter, 3 intake air stabilisation tank, 4 jointed shaft cover, 5 jointed shaft with coupling, 6 eddy current brake, 7 switch cabinet with displays and controls



The illustration shows the CT 400 in conjunction with the CT 400.02 diesel engine.



The eddy current brake is mounted in a suspended frame (1 bearing, 2 frame). The supporting force generated by the torque is recorded by a force gauge (3). 4 jointed shaft with spline

Specification

- [1] load unit for prepared four-stroke diesel or petrol engines (CT 400.01 and CT 400.02) with a maximum power output of 75kW
- [2] air-cooled eddy current brake
- [3] force transmission from engine to brake via rotationally elastic coupling and jointed shaft
- [4] stabilisation tank for intake air approx. 220L
- [5] 2 modes of operation: 1. torque directly adjustable (full load characteristic), 2. torque is adjustable by speed, speed remains constant (partial load characteristic)
- [6] potentiometer for continuous adjustment of brake
- [7] potentiometer to "accelerate" engine
- [8] recording of braking power via speed and braking torque
- [9] measurement and display of engine load, air temperature, intake air consumption, speed
- [10] measured value displays for engine: temperatures (oil, exhaust gas, cooling water, fuel), oil pressure, fuel consumption (using precision scale)
- [11] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

- Eddy current brake
- max. braking torque: 200Nm
 - max. speed: 5000min⁻¹
- Measuring ranges
- speed: 0...6000min⁻¹
 - torque: 0...240Nm
 - volumetric flow rate:
 - ▶ 0...6m³/min (intake air)
 - ▶ 0...50L/min (cooling water)
 - temperature:
 - ▶ -50...200°C
 - ▶ 0...1200°C (exhaust gas)

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 1380x950x1920mm
Weight: approx. 446kg

Required for operation

PC with Windows recommended, ventilation

Scope of delivery

- 1 load unit
- 1 set of tools
- 1 set of accessories
- 1 GUNT software CD + USB cable
- 1 set of instructional material