

Engine Test Stand – Titan T Technical Specification

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1 A Horiba Product with Definite Advantages

1.1 Areas of Application

The Titan T engine test stand provides a superior test system for the user. This test stand offers full functionality for carrying out transient tests such as:

- durability tests
- performance determination
- engine component testing
- catalyst ageing
- transient exhaust emission tests (e.g. HDTC)
- application tests of injection systems and engine control units

With the Titan T series test stands, semi- and fully automatic as well as manual tests can be carried out. The systems provide a self-contained overall solution for carrying out complete tests. The following major functions are available:

- test stand configuration
- test stand operation
- measured-data acquisition
- graphic display of process parameters and measured values
- load control of test specimen and dynamometer
- test preparation and evaluation
- monitoring of selected parameters
- safety functions

All system components are state-of-the-art and are optimally adjusted to one another.

Dynamometer and shaft connections are mechanically designed for testing internal combustion, in-line and V configuration engines with 4 or more cylinders.

The following table shows basic engine data for test stand sizing:

Parameter	Titan T 250	Titan T 460	Titan TH 460
Torque [Nm]	400	1000	2500
Power [kW]	220	400	350
Speed [rpm]	8000	6500	3000
Idle speed [rpm]	>700 ¹⁾	>700 ¹⁾	>700 ¹⁾
Moment of inertia [kgm ²]	>0.15	>0.3	>0.2

- 1) If test cycles with lower then the specified speed limits are required, the selected shaft connection possibly has to be changed by using the option "Design of alternative shaft connection".

1.2 Versatile and Flexible in Design

With the Titan series engine test systems, test stands for different applications can be supplied within a very short period of time. Therefore, this solution is a very attractive alternative for test stand owners needing short-term extensions to existing capabilities or modernisation projects.

Due to the very compact and well thought-out construction, only a few interfaces are required on the customer's side. Due to the high degree of standardisation and the use of high-quality components, these systems are very easy to maintain and can be commissioned on site within a short period of time.

Of course, each Titan test stand is made of components representing state-of-the-art of test stand technology.

1.3 Your Advantages

- Attractive price due to the high degree of standardisation
- Short delivery periods due to standardised handling processes
- Short assembly and commissioning periods due to pre-assembly, system test, and initial calibration by Horiba
- Low coordination efforts due to simple interfaces to the customer's infrastructure
- Complete system that can immediately start testing
- Easy maintenance due to use of high-quality components and standardised system construction
- Easy operation via the PC based STARS automation system
- High investment security because system extensions and upgrades within the entire Titan series can be achieved with minimum effort due to the compatibility of system components (e.g. upgrade of a stationary test stand to a dynamic test stand).

2 How it Works

This section provides an overview of the entire engine test stand system including essential options.

The Titan T engine test stand consists of the following system modules:

- test stand automation
- measured-data acquisition
- operator station
- dynamometer
- conditioning (Optional)

Additionally, all required services including commissioning and acceptance testing of the test stand are included in the scope of supply of the Titan engine test stands.

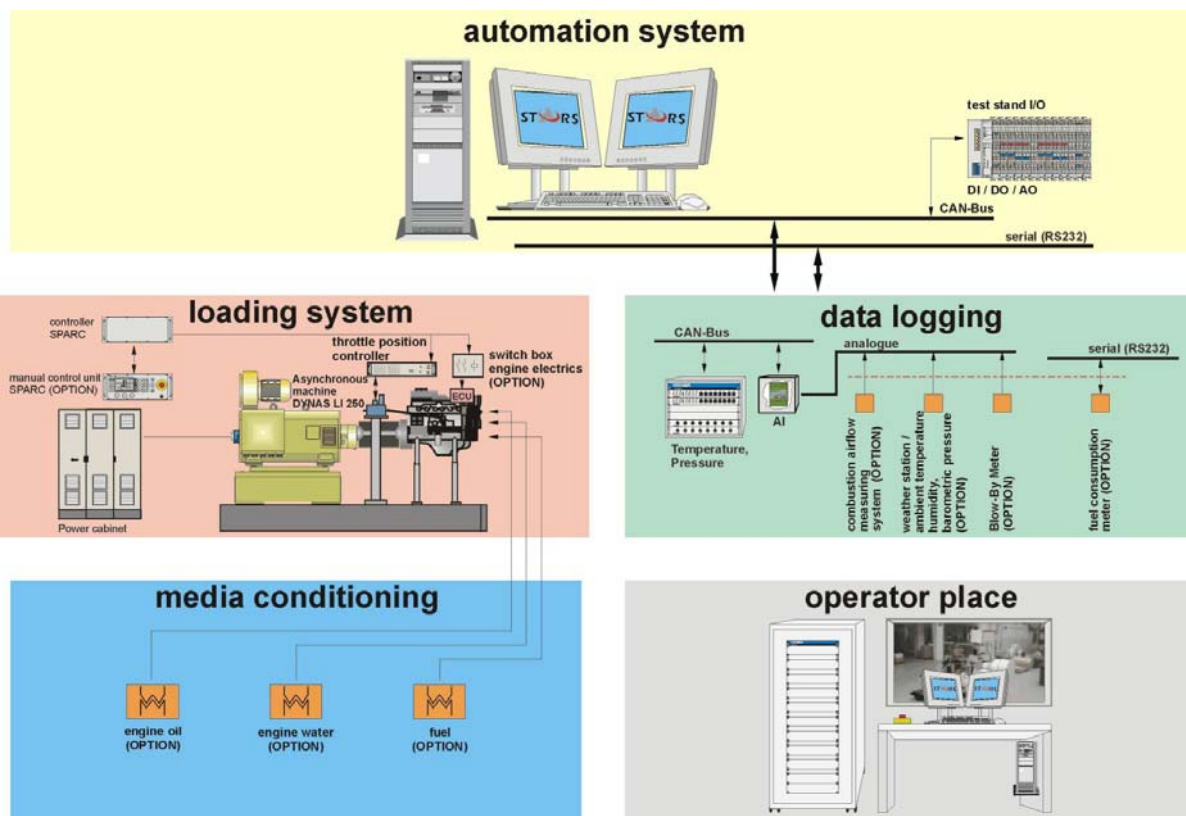


Figure 1: System overview – Titan T series engine test stand

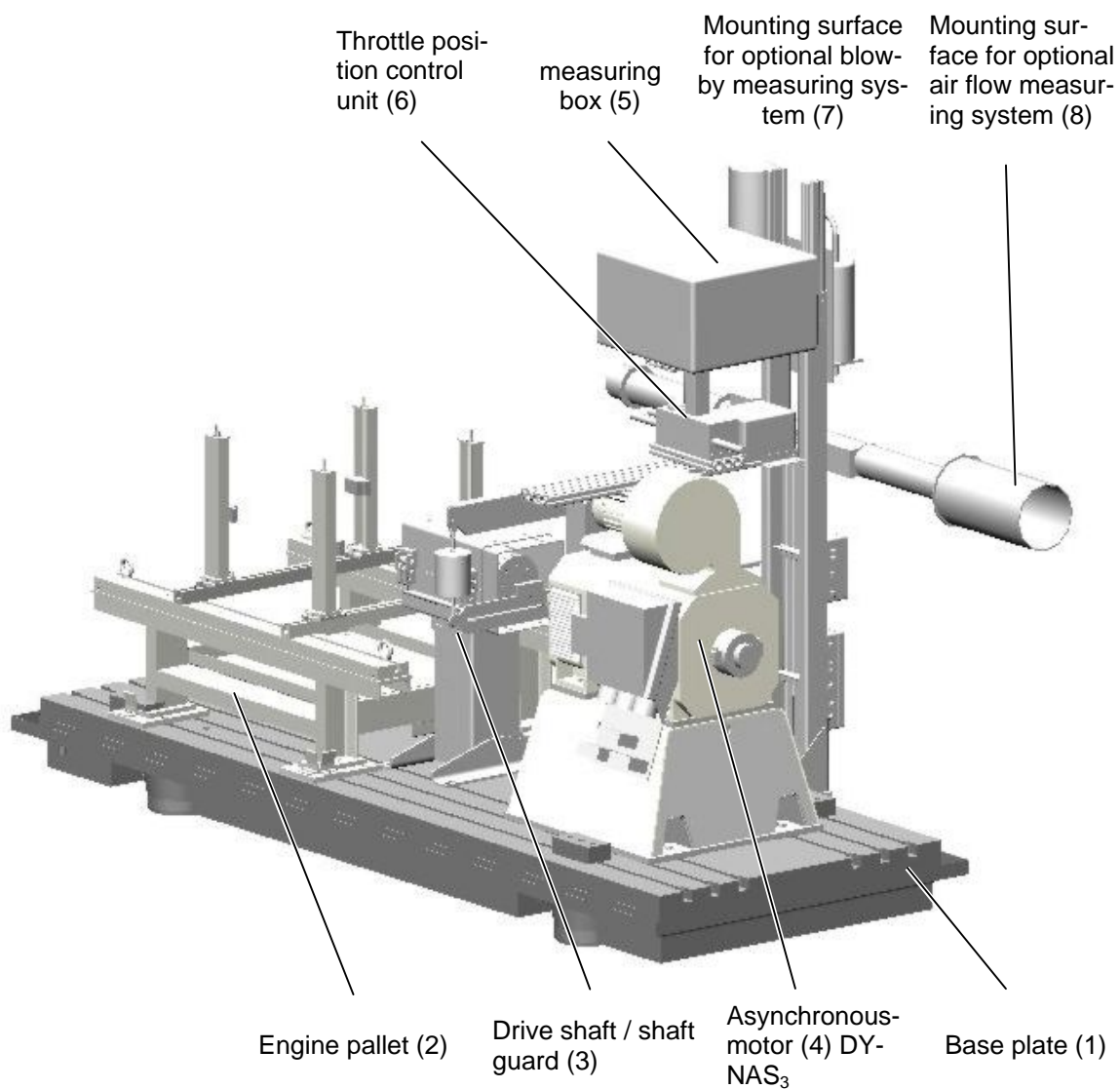


Figure 2: system illustration – mechanical test stand Module

The mechanical assembly is delivered completely installed on a base plate (1) with vibration insulation.

Because of this, the mechanical test stand assembly can be installed quickly and flexibly on common mounting surfaces provided by the customer. The following mounting methods, without modifications, are possible:

- installation on a level shop surface
- installation in a false floor / pit
- installation on a sub-construction provided by the customer (e.g. strip foundation) for height adjustment

The base plate is sized in a way that an additional vibration foundation is not required for the stated range of engines.

The engine to be tested is mounted on a test pallet (2). Mounting can be carried out outside the test cell and the test specimen can be taken to the test cell on the pallet.

The test specimen and dynamometer are connected using a special drive shaft. This drive shaft is designed for the specified engine range in a way that critical vibrations due to the excitation by the combustion engine are avoided throughout the entire speed range.

For safety reasons, the drive shaft is covered by a shaft guard (3). The shaft guard is interlocked with the emergency-stop circuit of the test stand by a limit switch.

Asynchronous motors with high torque (4) are used as dynamometers.

The SPARC test stand controller controls both combustion engines and dynamometers.

The sensors (installed on the engine by the customer) can be connected easily and quickly to the data acquisition modules (mounted in the connection box (5) near the test specimen) via quick connectors.

The SPARC test stand controller and data acquisition systems are connected to the STARS test stand automation system via CAN bus.

The STARS test stand automation system provides the following functions:

- test stand configuration
- test stand operation
- data acquisition
- visualisation
- test evaluation
- monitoring of specified parameters for limit violations

The STARS test stand automation system allows for the execution of semi- or fully automatic as well as manual tests.

Thus, complete operation of the test stand is possible via the STARS automation system.

3 What we Supply

3.1 Loading System

3.1.1 Mounting Plate

Common base plate for the dynamometer and test specimen with flexible steel springs.

Scope of Supply	Titan T 250	Titan T 460	Titan T H 460
T-slot plate with all-around oil drain channel	1 size 1	1 size 1	1 size 2
Air springs with level adjustment and pressure control unit	4	4	8
Set of compressed-air hoses between air springs and pressure control unit	1	1	1
Maintenance unit	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan T H 460
Weight [kg]	4200	4200	5600
Installation dimensions LxHxW [mm]	3640x1390x300	3640x1390x300	4640x1640x300
Spring adjustment[Hz]	3	3	3
Surface quality	DIN 876/III	DIN 876/III	DIN 876/III
Number of T-slots	6	6	6

3.1.2 Dynamometer

Scope of Supply	Titan T 250	Titan T 460	Titan T H 460
Loading device	AS machine	AS machine	AS machine
Type	Dynas 3 HT 250	Dynas 3 HT 460	Dynas 3 HD 460
Torque measuring unit	torque measuring flange	torque measuring flange	torque measuring flange
Speed measuring unit	with pulse generator 512 pulses/revolution	with pulse generator 512 pulses/revolution	with pulse generator 512 pulses/revolution
Power Supply	Frequency converter consisting of: - supply field - power filter - inverter - AS-maschine connction	Frequency converter consisting of: - supply field - power filter - inverter - AS-maschine connction	Frequency converter consisting of: - supply field - power filter - inverter - AS-maschine connction
Cable set	dyno-power supply unit power supply unit-controller dyno-controller	dyno-power supply unit power supply unit-controller dyno-controller	dyno-power supply unit power supply unit-controller dyno-controller
Frame for shaft height [mm]	700	700	800

Technical Data	Titan T 250	Titan T 460	Titan T H 460
Directions of rotation	2	2	2
Rated torque (generator/engine) [Nm]	718/685	1484/1439	2680/2600
Rated power (generator/engine) [kW]	250/235	460/440	462/445
Max. speed [rpm]	10000	8000	5010
Moment of inertia [kg/m ²]	0.84	1.76	6.1
Measuring range, torque [Nm]	1000	1900	4000
Max. deviation, torque [%]	<+/- 0,1 full scale	<+/- 0,1 full scale	<+/- 0,1 full scale
Temperature drift, torque measurement [%]	<+/-0,1 full scale/10K	<+/-0,1 full scale/10K	<+/-0,1 full scale/10K
Max. deviation, speed [1/min]	+/-1 for frequencies < 10 Hz	+/-1 for frequencies < 10 Hz	+/-1 for frequencies < 10 Hz

3.1.3 Drive Shaft

Extendable, flexible shaft connection for testing engines with non-uniform torque.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Design	drive shaft	drive shaft	drive shaft
Type	K015	K025	K060

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Rated torque [Nm]	700	1180	4400
Speed [rpm]	8100	8000	3000
Weight, engine side [kg]	15.5	16	105
Moment of inertia, engine side [kgm ²]	0.088	0.098	2.243
Outside centering	232g7	274g7	517.52g7
Bolt hole pattern	D217/6xd9	D256/8xd11	D488.9/8xd14

Note:

- The quoted shaft connection has been selected for specimens stated in 1.1. For other requirements, a shaft calculation is required (see options).
- Intermediate adapters for connecting the shaft to the specimen are not included in the scope of supply.

3.1.4 Shaft Guard

Extendable protection against contact with the shaft connection that can be mounted on the mounting plate.

Scope of Supply	Titan T 250	Titan T 460	Titan T H 460
Shaft protection	1	1	1
Safety limit contact	1	1	1
Set of fittings	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan T H 460
Shaft height [mm]	700	700	800
Inner diameter [mm]	285	285	300 shaft/ 600 coupling

3.1.5 Engine Pallet

For preparing the combustion engine outside the test stand and for mounting the specimen during the test.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Engine pallet	Pallet frame with : - 2 T-slot rails, longitudinal - 2 T-slot rails, transversal - 4 aggregate supports, height-adjustable - 1 leakage collection pan - pallet support for installation on the mounting plate	Pallet frame with : - 2 T-slot rails, longitudinal - 2 T-slot rails, transversal - 4 aggregate supports, height-adjustable - 1 leakage collection pan - pallet support for installation on the mounting plate	Pallet frame with: - 2 T-slot rails, longitudinal - 4 spindles, height-adjustable up to 50 mm - 1 leakage collection pan - pallet support for installation on the mounting plate

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Max. engine weight	500	500	2500

Note:

- Adaption between engine and engine support are not included.

3.1.6 Mounting Support

For mounting assemblies close to the test specimen. Column with mounting-plates for use in attaching equipment to the column, including fittings.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Mounting support	1	1	1
Set of fittings	1	1	1

3.1.7 SPARC Test Stand Controller

For controlling torque, speed, throttle position control unit, or a user defined parameter x with control operating modes idle, α/M , α/n , n/M , M/n , x/n , $x/M(n)$ ($M(n)$ = road-resistance curve)

For monitoring speed, torque, power, and an additional 3 limit value contacts (oil temperature, oil pressure, and cooling water temperature) with selectable responses.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Controller module	19" rack, 4 HU	19" rack, 4 HU	19" rack, 4 HU
CAN bus interface	1	1	1
Cable set	1	1	1

3.1.8 Throttle Position Control Unit

For controlling the throttle position of internal combustion engines.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Control and power component	19" rack, 4 HU	19"rack, 4 HU	19" rack, 4 HU
Actuator	1	1	1
Cable set	- control unit – test stand controller - connection RS232-PC	- control unit – test stand controller - connection RS232-PC	- control unit – test stand controller - connection RS232-PC
PC operating software	1	1	1
Bowden cable L= 1,5m	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Positioning range, linear [mm]	0...120	0...120	0...120
Positioning range, rotating [°]	270	270	270
Positioning force [N]	250	250	250
Positioning time for 100 mm or 180° [ms]	100	100	100
Positioning accuracy/ 100 mm [%]	0.3	0.3	0.3

Note:

- Adapters between actuator and throttle or injection-pump lever are not included in the scope of supply.
- The connection to the specimen is the responsibility of the customer.

3.2 Data Acquisition

3.2.1 Temperature Measurement

3.2.1.1 Resistance Thermometer

For measuring temperatures of up to 200°C.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
RTD Pt 100, type 1, with connecting cable, 3 m, and connector	16	16	16
Calibration certificate	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Accuracy class A according to DIN EN 60751	+/- (0.15K+0.005*/ T/) in the range -200...850°C	+/- (0.15K+0.005*/ T/) in the range -200...850°C	+/- (0.15K+0.005*/T/) in the range -200...850°C
Nominal length [mm]	100	100	100
Sheath diameter [mm]	3	3	3

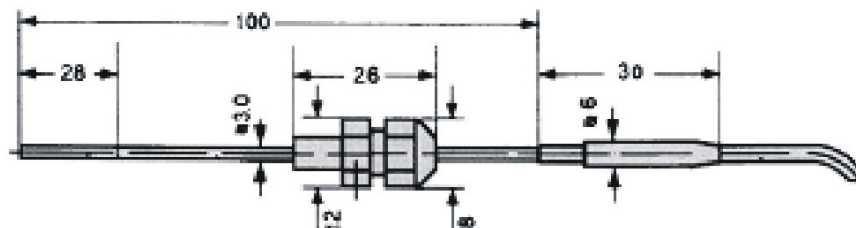


Figure 3: Type 1 Resistance Thermometer

3.2.1.2 Thermocouples

For measuring temperatures of up to 1200°C.

Scope of Supply	Titan T 250	Titan T 460	Titan T H 460
Type K Thermocouple with connecting cable, 3 m, and thermo connector	16	16	16
Calibration certificate	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Accuracy class 1 acc. to DIN EN 60684 / IEC 584-2	1.5°C or 0.004*/T/ in the range -40...1000°C	1.5°C or 0.004*/T/ in the range -40...1000°C	1.5°C or 0.004*/T/ in the range -40...1000°C
Nominal length [mm]	150	150	150
Sheath diameter [mm]	3	3	3

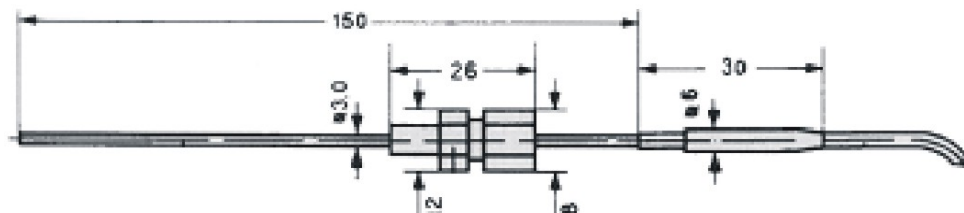


Figure 4: thermocouples Typ K

3.2.1.3 Temperature Measuring Rack

Plug-in module for measuring temperatures with 8 Pt100 RTDs and 8 type K thermocouples with CAN connection to the test stand computer.

Front side measuring module temperature (type SDT16)

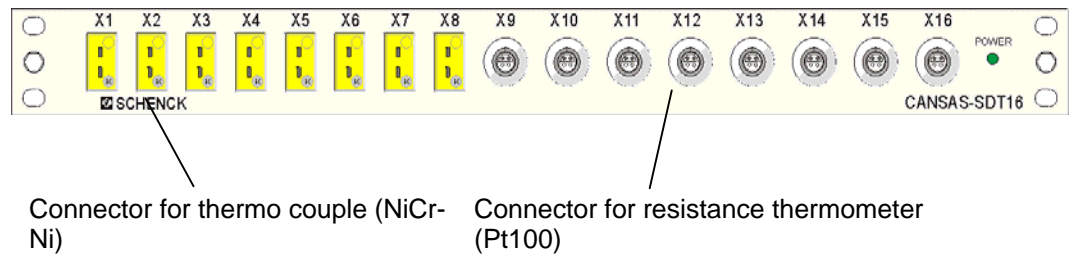


Figure 5: temperature measuring rack

Scope of Supply	Titan T 250	Titan T 460	Titan T H 460
Temperature plug-in module equipped with	2	2	2
- 8 female connectors 7p	19" rack, 1 HU	19" rack, 1 HU	19" rack, 1 HU
- 8 thermocouple female connectors 2p			
CAN connecting cable	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Measuring error, static, Pt100			
-200...+600°C	<1K	<1K	<1K
0...200°C	<0.5K	<0.5K	<0.5K
Measuring error, static, thermocouple			
-200...1200°C	<1K	<1K	<1K
Resolution	16 bit	16 bit	16 bit
Measuring rate, adjustable up to [Hz]	100	100	100
Operating temperature range [°C]	-40...65	-40...65	-40...65

Note:

- Measuring ranges set to -200 ... +1200°C for thermocouples and 0 ... 200°C for RTD (can be changed by the customer). The accuracy applies to the entire measuring and operating temperature range!
- Measuring rate < 10Hz recommended

3.2.2 Pressure Measurement

3.2.2.1 Pressure Transducer

For measuring the relative pressure of gaseous or fluid media.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Pressure transducer	8	8	8
Measuring range -100...150 kPa	2	2	2
Measuring range 0...250 kPa	3	3	3
Measuring range 0...1000 kPa	3	3	3
Connector	8	8	8
Connecting cable	8	8	8
Factory calibration certificate according to ISO/IEC 17025	8	8	8

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Error hysteresis, non-linearity, reproducibility	0.08% of the range	0.08% of the range	0.08% of the range
Temperature influence	0.08% of nominal range/10K	0.08% of nominal range/10K	0.08% of nominal range/10K
Compensated temperature range [°C]	20...80	20...80	20...80
Measuring signal [mA]	4...20	4...20	4...20
Pressure connection	¼" inside thread	¼" inside thread	¼" inside thread

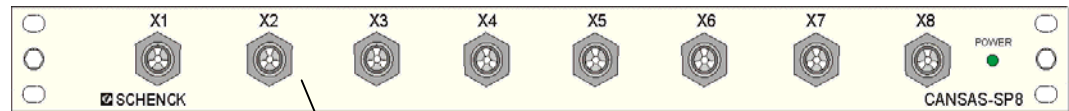
Note:

- The pressure transducers are installed in the SP8 pressure measuring rack in the measuring box.

3.2.2.2 Pressure Measuring Rack

Plug-in module for measuring pressures of gaseous and fluid media provided with CAN connection to the test stand computer.

Front side measuring module pressure (type SP8)



Clean brake coupling at the pipe (low leakage coupling)

Figure 6: Pressure Measuring Rack

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Pressure measuring rack equipped with - 8 installation places for quick couplings	1 19" rack, 1 HU	1 19" rack, 1 HU	1 19" rack, 1 HU
Quick connector coupling for hose connection	8	8	8
CAN connecting cable	1	1	1

Note:

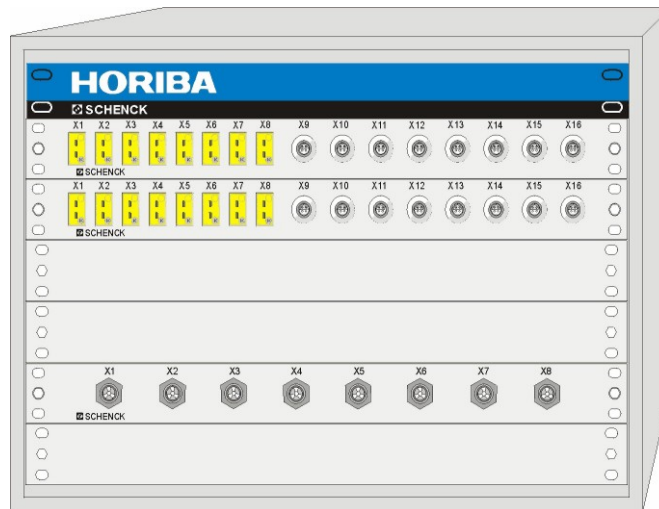
- Calibration of the measuring channels to the individual pressure transducers is carried out by Horiba prior to delivery.

3.2.3 Measuring Box

For installation of the ST / SP measuring racks, mounted on the mounting support.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Connection box incl. fittings	1	1	1

Front view



Back view

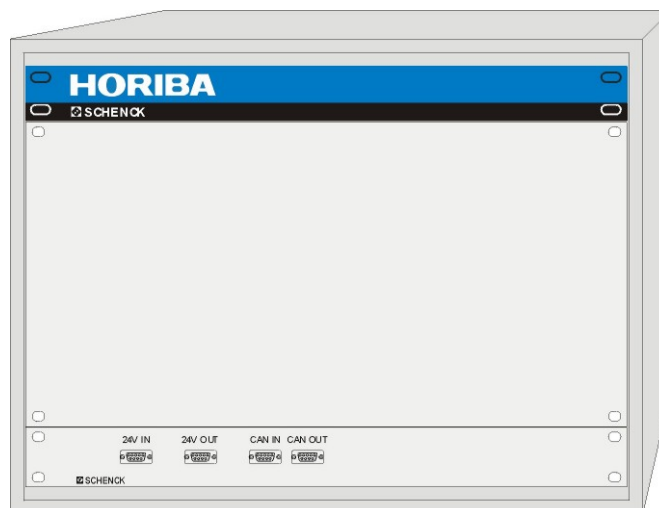


Figure 7: Measuring box 7 HU

3.2.4 Analogue Signal Acquisition

3.2.4.1 Signal Acquisition Module

For measuring, conditioning, converting analogue signals of PT100, NiCr-Ni thermocouples, voltages, currents.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
CAN module with:	1	1	1
- 8 universal AI			
- 8 sensor inputs for Pt100 and potentiometer			
- internal reference point			
- 8 linearised inputs			
- 8 antialiasing filters			
- 16 bit A/D converters			
- CAN controller			

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Measuring range type K thermocouple, set [°C]	-20...1000	-20...1000	-20...1000
Measuring range Pt 100, set [°C]	-20...200	-20...200	-20...200
Measuring range voltage [V]	0.1 / 0.2 / 0.5 / 1 / 2 / 5 / 10	0.1 / 0.2 / 0.5 / 1 / 2 / 5 / 10	0.1 / 0.2 / 0.5 / 1 / 2 / 5 / 10
Measuring range current [mA]	0 ... 20 / 4 ... 20	0 ... 20 / 4 ... 20	0 ... 20 / 4 ... 20
Measuring range potentiometer [%]	0 ... 100	0 ... 100	0 ... 100
Measuring rate, adjustable [Hz]	1 ... 100	1 ... 100	1 ... 100

Note:

- 6 channels pre-assigned for optionally available measuring devices ($T_{\text{environment}}$, $P_{\text{environment}}$, air humidity, blow-by, air flow, engine cooling water temperature)
- If thermocouples are connected, one measuring channel is used for the temperature reference point

3.2.4.2 Housing for Signal Acquisition Module

Installed at the mounting support to accommodate the signal acquisition module.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Housing	1	1	1
Set of mounting materials	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Protection class	IP65	IP65	IP65
Dimensions LxHxW [mm]	200x140x250	200x140x250	200x140x250

3.3 STARS Test Stand Automation System

STARS is a powerful automation system that combines

- test stand control
- monitoring
- measured-data acquisition
- graphical display
- test evaluation

functions into a corporate environment.

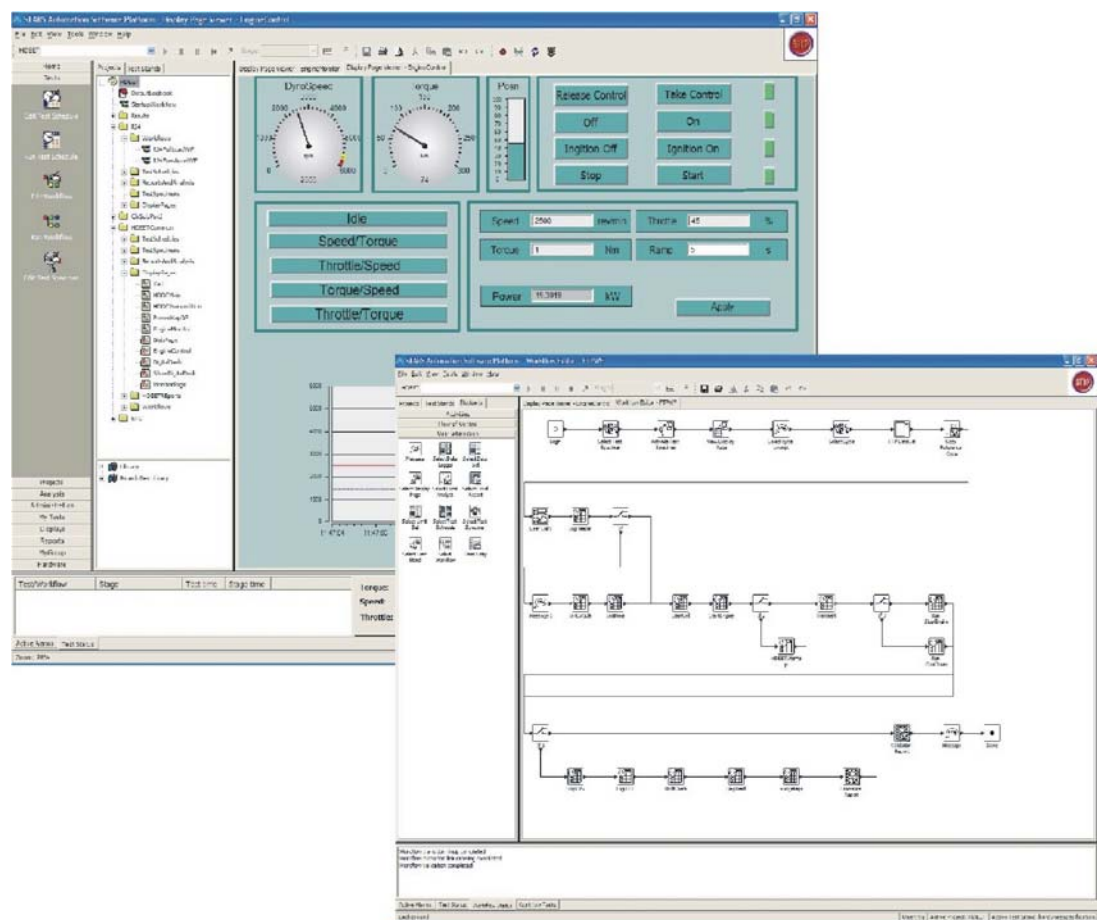


Figure 8: Visualisation and Test Run Definition via Workflow Editor

3.3.1 Software “STARS for Engine Testing”

STARS provides openness and flexibility to meet all requirements of different areas of engine testing. The powerful STARS Visual Workflow Editor allows the user to easily define new test procedures.

The software package is pre-installed on the hardware with all required components.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
STARS software	1	1	1
Driver for test stand controller SPARC	1	1	1
Driver for CAN I/O	1	1	1
Software license for real-time extension RTX (Venturecom)	1	1	1

STARS for engine testing provide the following functions:

Test stand configuration

- Easy test stand configuration based on a powerful library concept
- Integration and configuration of all measuring devices existing or being used at the test stand. Corresponding drivers are included
- Support of the plug and play configurations of a test stand

Test preparation

- Simple graphic creation of the test process using STARS workflow
- Simple creation of real-time test programs
- Powerful and flexible definition of measured-data acquisition
- Simple and powerful configuration of limit value monitoring
- Graphical configuration of display screens

Test execution

- Safe control and monitoring of the test stand under all operating conditions
- Execution of manual, semi- and fully automatic tests
- Process monitoring and intervention via display screens

Test evaluation and reporting

- Integration of automated evaluation and reporting into the STARS workflow
- Automated data export
- Automated start of external evaluation tools

Information and data management

- Powerful library concept for project and test stand
- Project and project library structure that can be defined by the user

3.3.2 Applications

To assist the customer in learning to use the test stand effectively within a short period of time, the system is delivered with three example tests.

The implementation of the tests consists of the following STARS components:

- a display screen for visualizing the test
- a workflow for defining the test process
- test programs for starting, warming up, executing the test, cooling down and stopping the engine
- monitoring the engine for limit values
- an excel report for displaying the measurement results
- if the optional UniPlot is ordered, selected measurement results are displayed in a UniPlot graph

All supplied components are installed in a library and integrated in an example project. This allows components to be easily re-used to facilitate the creation of new or modified test procedures..

3.3.2.1 Manual Measurement

In a manual test, operating points can be set via a display screen and measurements can be triggered manually. This allows all the usual manual tests to be executed in steady state operation. The test consists of the elements

- display screen
- workflow for defining the test process
- test programs for starting, warming up, setting operating points, taking measurements, cooling down and stopping the equipment
- monitoring of the engine for limit values
- measurement of the existing channels as mean value over a definable time

3.3.2.2 Automated Steady State Test

The automatic test consists of a workflow divided into five automatically running components:

- input of test parameters
- engine start and warm-up
- operating points in 2 different control modes
- engine cool-down and stop
- presentation of a report consisting of all measured parameters in an Excel table.

3.3.3 Hardware

3.3.3.1 STARS PC-Hardware

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Pentium P IV 3.2 GHz or comparable processor	1	1	1
17" TFT monitor (DVI)	2	2	2
1 GB RAM	1	1	1
IDE hard disk >= 80 GB	1	1	1
Dual-head graphic board (2 x DVI)	1	1	1
Keyboard, mouse via USB	1	1	1
Interfaces	1	1	1
- Computer network (Ethernet)			
- USB 2.0 printer (parallel)			
- 8 x serial RS232 interface			
- CAN bus interface for SPARC load controller			
- CAN bus interface for max. 4 segments for measuring equipment (1 segment assigned)			
Midi-tower housing	1	1	1
Operating system MS WINDOWS XP	1	1	1
EXCEL	1	1	1

Note:

- English or French versions for keyboard, operating system as an alternative option.
- Depending on the further development of the PC technology, the scope of supply may vary.
- A second monitor is available as an option

3.3.3.2 Test Stand I/O

for communication with test stand systems or infrastructure.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
CAN bus cable with bus termination	1	1	1
Available DI (pos. logic)	24	24	24
Available DO (pos. logic)	24	24	24
Available digital limit contact inputs	4	4	4
Available analogue outputs (+/-10V)	4	4	4
Digital inputs pre-assigned for the test stand	4	4	4
Digital outputs pre-assigned for the test stand	8	8	8

The test stand I/O is mounted on a mounting plate in the measuring and control cabinet.

3.4 Operator Station

The operator station consists of

- a measuring and control cabinet in which the control racks and power components of the test stand equipment as well as the voltage supply are integrated
- an operator desk for test stand operation via the STARS automation system



Figure 9: operator station

3.4.1 19" Measuring and Control Cabinet

For the installation of 19" plug-in modules and test stand electrics, completely assembled.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Cabinet	1	1	1
Power component with main switch integrated in the front panel	1	1	1
Set of cabinet rollers	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Dimensions WxDxH [mm]	600x800x1700	600x800x1700	600x800x1700

Note:

- The plug-in modules are mounted from the cabinet front
- The mounting plate is accessible through the rear door
- Cable outlet under the back door with integrated cable clamp (sponge rubber)

3.4.2 Operator Desk

for PC, monitor, keyboard, mouse, etc.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Desk	1	1	1
PC support	1	1	1
Cabling	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Dimensions WxDxH [mm]	1800x800x720	1800x800x720	1800x800x720

3.5 Central Safety Module

Central safety module (19") ready for connection to the emergency-stop circuit, safety circuit, and display functions, installed in the measuring and control cabinet.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Central safety module - display screen with LED - Diagnostics interface	19" rack, 2 HU	19" rack, 2 HU	19" rack, 2 HU
Emergency-stop button for installation in the test stand with connecting cable, 20 m, connected to the central safety module	2	2	2
Emergency-stop button for operating desk connected to the central safety module	1	1	1
Cable set	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Number of inputs for emergency-stop (DIN VDE 113/part 1) with positively driven contacts	5	5	5
Number of outputs for emergency stop for the integration of safety-relevant switch-offs (e.g. test stand controller)	6	6	6
Number of inputs for safety circuit	3	3	3
Number of outputs for safety circuit	3	3	3

Note:

- The emergency-stop circuit usually includes the emergency-stop buttons. If the circuit is operated, the rotating machines (dynamometer and specimen) are brought to a stand-still as fast as possible and switched off (quick stop).
- The safety circuit usually includes fault detection of devices. In case of a detected device break down the rotating machines (dynamometer and specimen) are switched off. Rotation stops by internal friction of the machines.

In both cases, the supply voltage to the test stand computer and the test stand controller remains switched on so that error messages are retained.

3.6 Services

3.6.1 System Test

The system test includes tests, system configuration, and calibration by Horiba.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Functional and system tests at Horiba's plant	1	1	1
Setup of measuring and control channels with standard default names, units, and measuring ranges	1	1	1
Initial calibration according to DIN EN ISO/IEC 17025 for torque / speed, pressure, temperature, and analogue channels	1	1	1
Calibration certificates according to DIN EN ISO / IEC 17025 issued by the manufacturers of special measuring devices	1	1	1

3.6.2 Documentation

In compliance with the currently applicable standards and EU machine guidelines, the technical documentation is divided into:

- System description (block diagram etc.)
- Safety instructions
- Technical data
- Commissioning
- Operation
- Maintenance instructions and advice
- Electrical drawings, printout DIN A4
- Mechanical drawings (survey / total construction) printout DIN A4 / A3

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Set of paper documentation	1	1	1
Set of documentation on CD	1	1	1

3.6.3 Assembly, Commissioning, Instruction, and Acceptance

3.6.3.1 Assembly

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Unpacking of parts and check for completeness	1	1	1
Mechanical setup, alignment, and checkout	1	1	1
Electrical setup and check	1	1	1
Installation of power and signal lines in ducts or racks provided by the customer	1	1	1

Services provided by the customer:

- Transportation of the test stand to the installation location as well as setting up and alignment of the basic test stand including antivibration dampers (Corresponding transport fixtures are included in the scope of supply)
- Cable ducts, cable lines, apertures (including closing/sealing them after assembly, etc).
- Connection of the fluid piping the test stand
- Your fitters and electrical shop shall be available to our personnel
- Suitable lifting devices and means of transportation

3.6.3.2 Commissioning

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Commissioning of mechanical parts, electrics, and software	1	1	1

Note:

- Measuring units are calibrated at the manufacturer's plant and supplied with a test certificate.

3.6.3.3 Informal Training

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Informal Training on test stand operation and individual assemblies	1	1	1

Note:

- Informal Training for the delivered systems by a commissioning engineer for 3 workdays on site directly following commissioning
- The Informal Training do not replace formal training. Formal training can be provided at Horiba's or the customer's facility and may be purchased as an option.

3.6.3.4 Acceptance at the Customer's Plant

The acceptance of the delivered system includes the following:

- Visual inspection of protection systems, tubes, hoses, cables, markings
- Check of completeness of the documentation
- Functional check of safety and emergency-stop circuit
- Manual control to the operating points of the power diagram of the loading device as far as permitted by specimen, shaft connection, and environment of the test stand.
- Perform a HORIBA ATS standard acceptance procedure (max. 2 hrs.) for one specimen with different functions of the test stand computer.
- The acceptance program includes:
 - Warm-up phase for the combustion engine (approx. 15 min), until stable operating conditions e.g. for engine cooling water and oil have been reached
 - Running a test sequence
 - Demonstration of the function of interfaces for included measuring devices by transmission of a typical series of commands for a measuring process
 - Standard Acceptance report will be prepared

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Acceptance	1	1	1

Note:

- The acceptance procedure is performed by a commissioning engineer limited to ½ day directly following the informal training.

Notes for Assembly, Commissioning, and Acceptance:

Services provided by the customer:

- All preparatory work normally completed by the customer, especially construction work (such as sealing of anchor screws, cable ducts, openings) must be finished so that our personnel can start working without delay.
- Our personnel can use the customer's fitters and electrical shop as well as lifting and transportation devices free of charge. For temporary storage, dry, frost-proof and lockable rooms are to be made available free of charge by customer.
- For the installation of big or heavy parts the customer provides assistance at request of Horiba installation staff free of charge
- During commissioning, customer's maintenance and operating personnel are to be present on the site.
- For commissioning, an engine ready for testing is available.
- The mechanical setup and the positioning of the sensors and measuring systems, as well as putting the engine into operation, will be done by the customer.
- Acceptance directly follows commissioning to avoid additional travelling expenses.

4 Figures, Data, Facts

4.1 System Interfaces

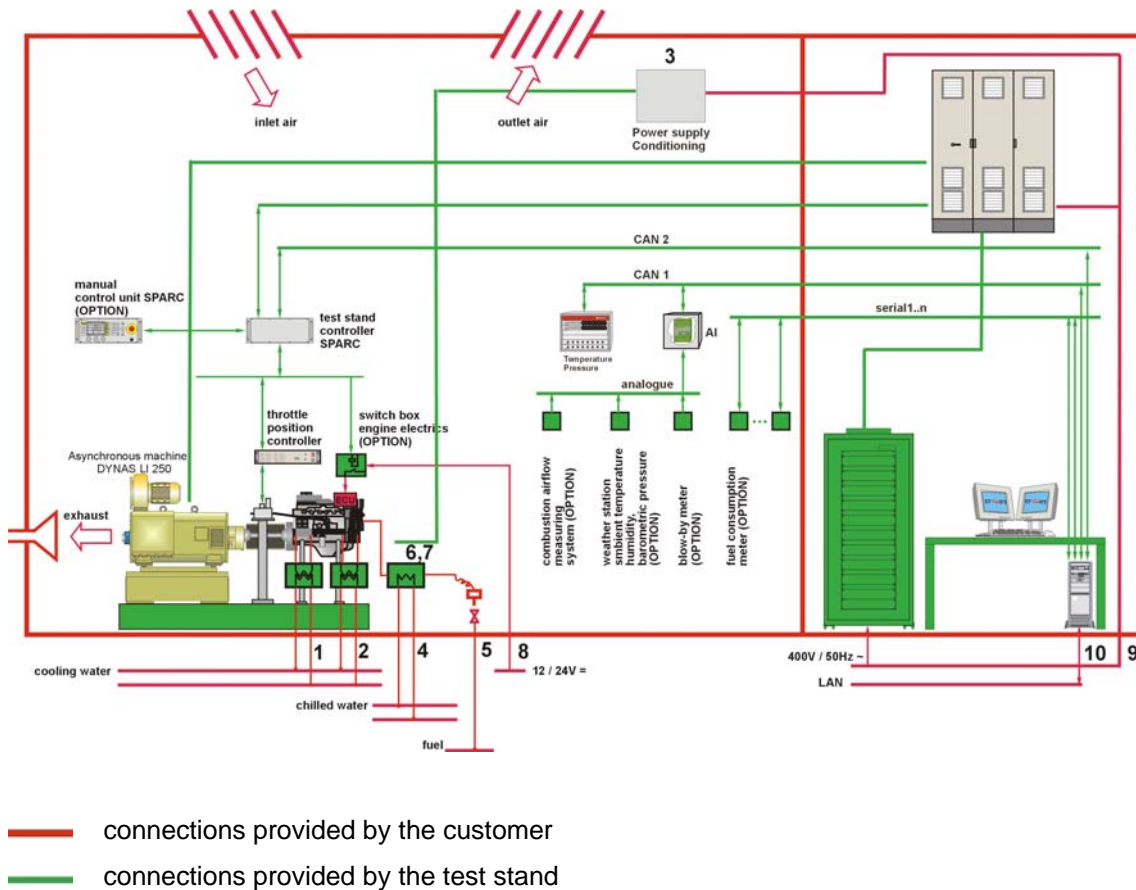


Figure 10: system over view

Connection	No.	Titan T 250	Titan T 460	Titan TH 460
Cooling water, engine cooling water conditioning	1	Facility side: - G1½" inside thread - motor side: - G2" inside thread	Facility side: - G2" inside thread - motor side: - G2½" inside thread	Facility side: - G1½" inside thread - motor side: - G2" inside thread
Cooling water, engine oil conditioning	2	Facility side: - G1" inside thread motor side: - G3/4" inside thread	Facility side: - G1½" inside thread motor side: - G1" inside thread	Facility side: - G1" inside thread motor side: - G3/4" inside thread
Electrics connection, fluids conditioning without heating	3	4 kW	8 kW	4 kW
Electrics connection, fluids conditioning with heating	3	34 kW	40 kW	34 kW
Chilled water, fuel cooling	4	½"	½"	½"
Fuel, fuel consumption measuring system	5	10 mm, outside thread	10 mm, outside thread	10 mm, outside thread
Fuel, engine inlet	6	10 mm, outside thread	10 mm, outside thread	10 mm, outside thread
Fuel, engine outlet	7	12 mm, outside thread	12 mm, outside thread	12 mm, outside thread
Direct-current supply, engine electrics	8	12/24V DC, 4...10mm, screwed connection	12/24V DC, 4...10mm, screwed connection	12/24V DC, 4...10mm, screwed connection
Power feeding frequency converter AS machine	9	3PEN/400V/AC/ 50 Hz +/- 10% / 275 KVA 500 A side fuses	3PEN/400V/AC/ 50 Hz +/- 10% / 550 KVA 800 A side fuses	3PEN/400V/AC/ 50 Hz +/- 10% / 554 KVA 800 A side fuses
Network, test stand computer	10	Ethernet 10/100 Mbit CRS 45	Ethernet 10/100 Mbit CRS 45	Ethernet 10/100 Mbit CRS 45

4.2 Systemabmessungen

4.2.1 Titan T 250

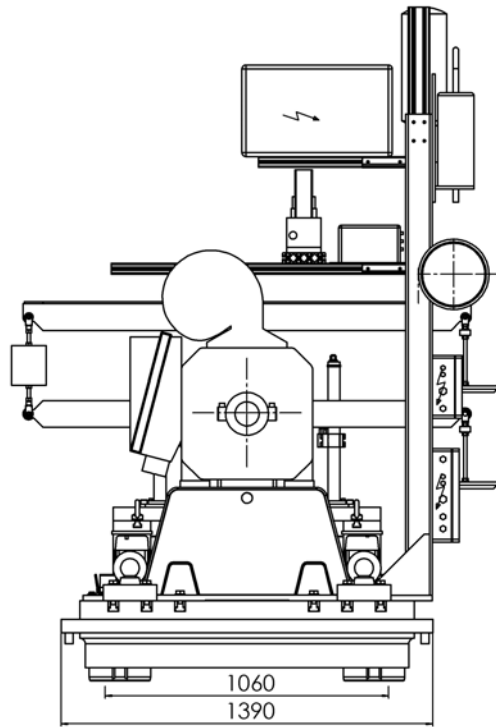


Figure 11: Titan T 250 front view

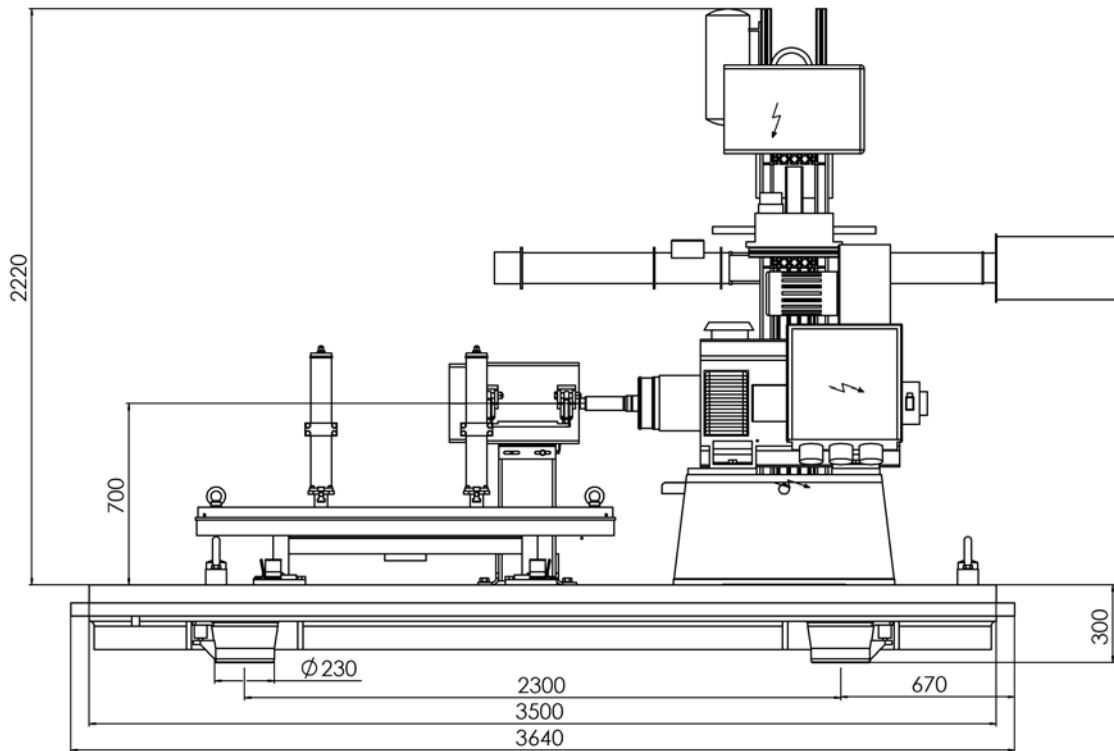


figure 12: Titan T 250 side view

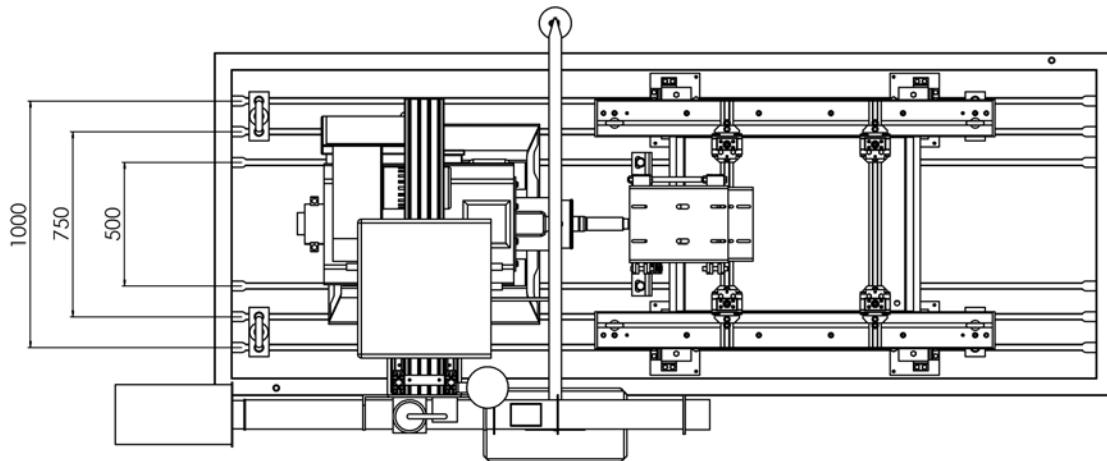


figure 13: Titan T 250 top view

4.2.2 Titan T 460

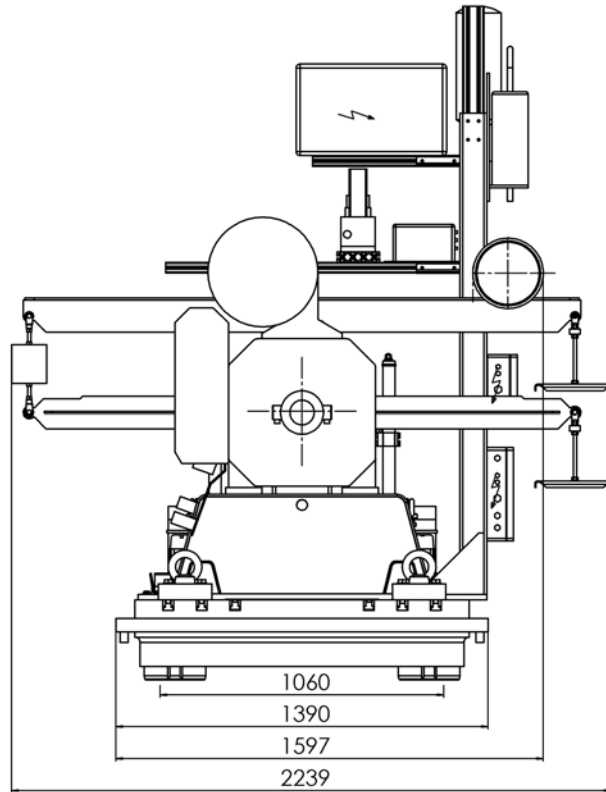


Figure 14: Titan T 460 front view

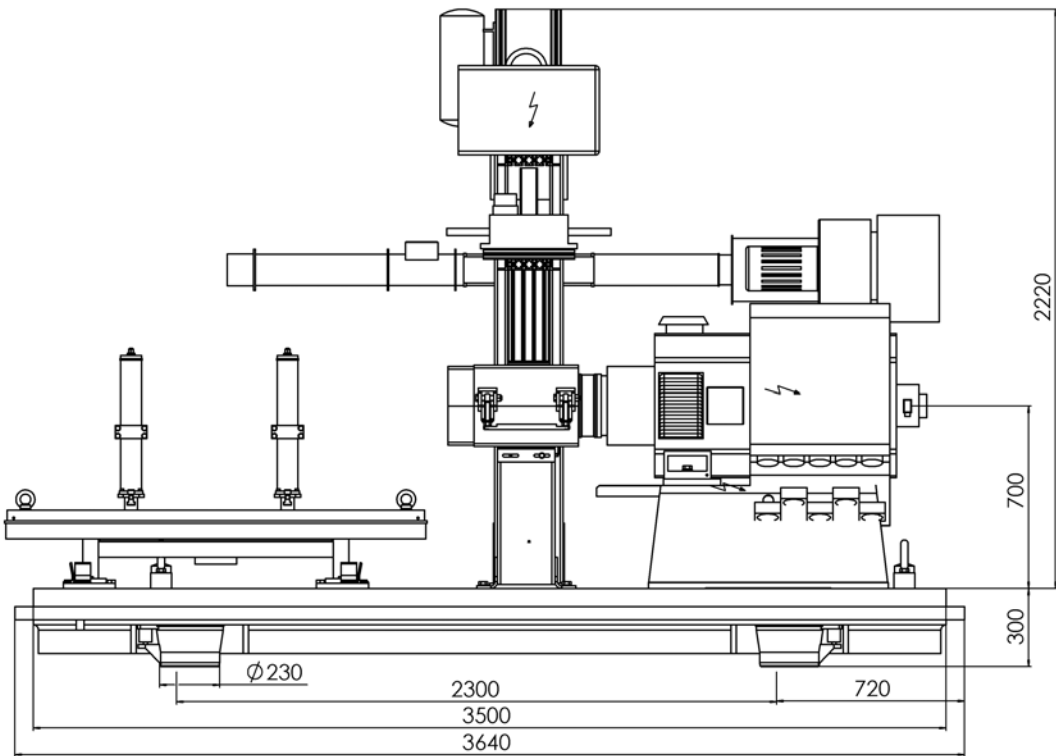


figure 15: Titan T 460 side view

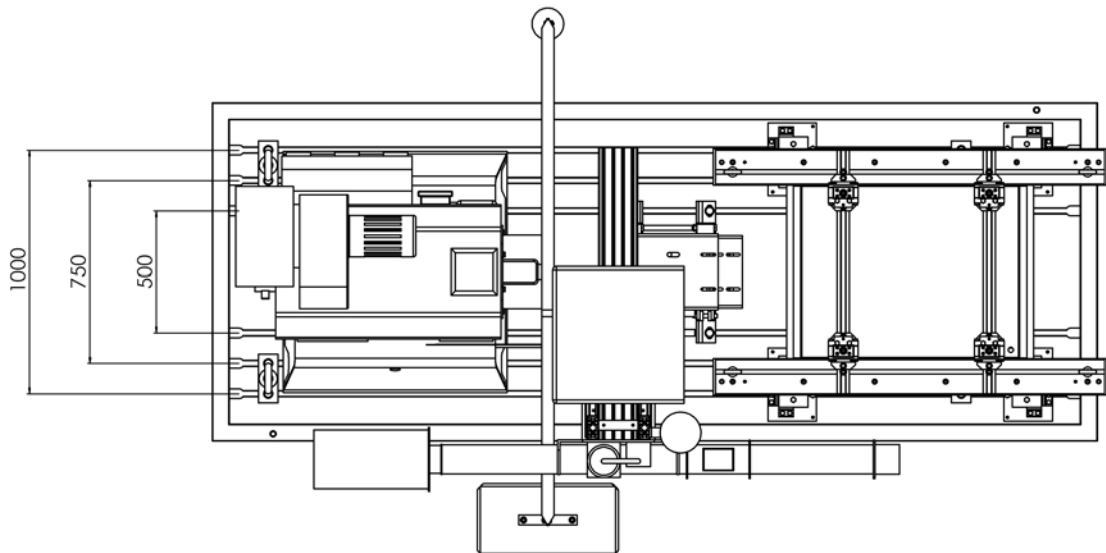


figure 16: Titan T 460 top view

4.2.3 Titan TH 460

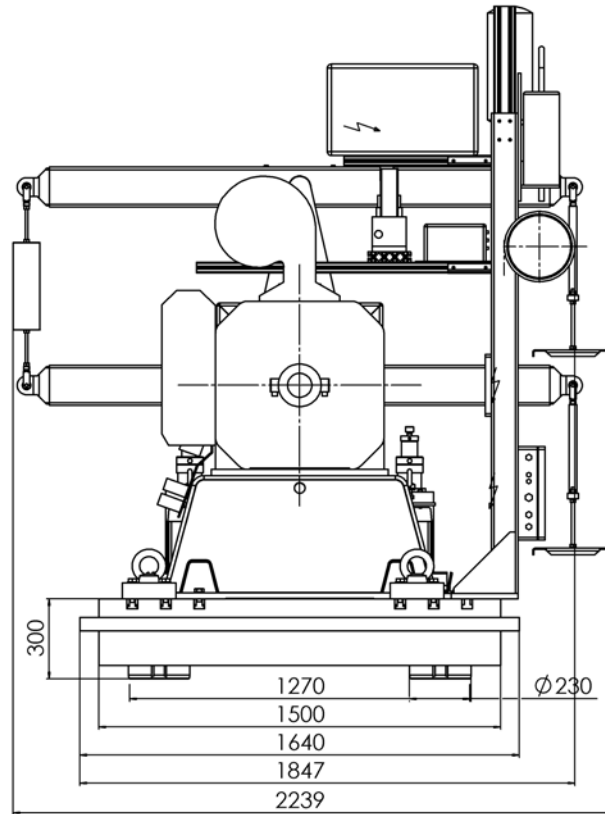


figure 17: Titan TH 460 front view

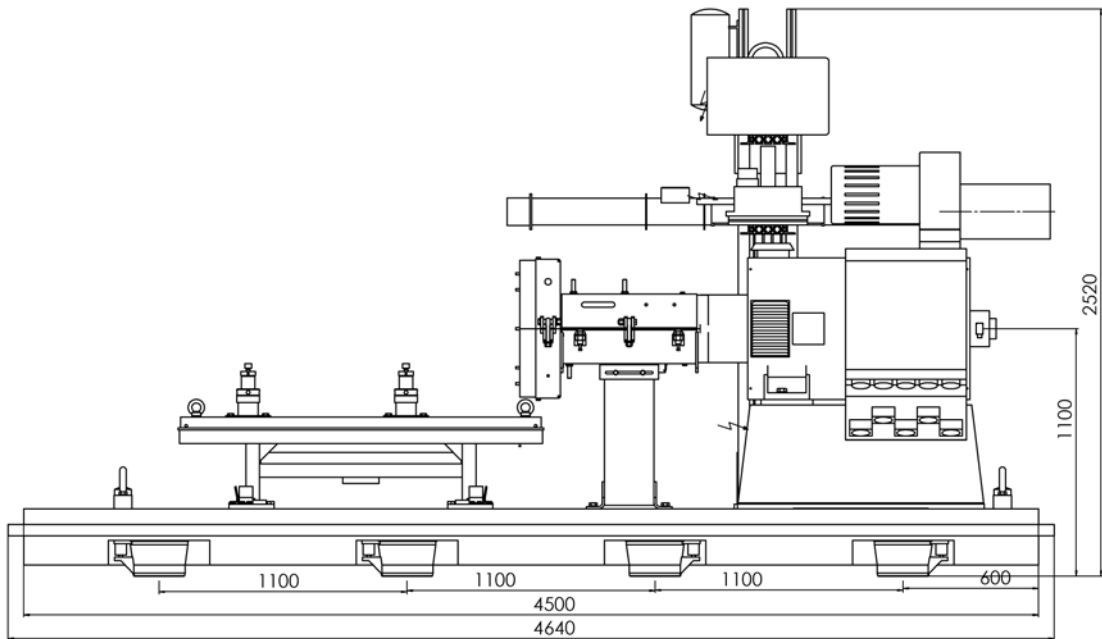


figure 18: Titan TH 460 side view

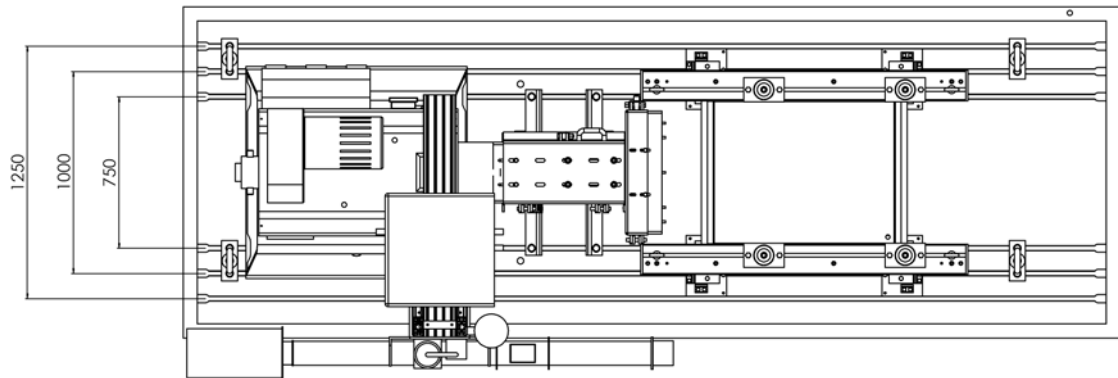


figure 19: Titan TH 460 top view

4.3 Production Guidelines

- Line protection as per DIN EN 60204-1 (VDE 0113 Vol. 1)
- Conductor cross sections as per DIN EN 60204-01
- Wire colours as per DIN EN 60204-1 (VDE0113 Vol. 1))
- Identification of electric equipment with system, location and identification as per IEC 61346-1 (1996) / DIN EN 6779-1 (1992-09,t), DIN EN 61346-2 (2000-12), DIN 61346-1 (1997-01)

4.4 Colours

- Painted assemblies in RAL 7035 (light grey)
- Optional calibration unit, lever in RAL 2002 (blood orange)

5 Important Notes

	Dimensioning
Ambient conditions, operating station	Humidity 95%, non-condensing. Temperature +5 .. +40 °C According to EN60204-1 (VDE 0113 Vol. 1)
Ambient conditions, test cell	Humidity 95%, non-condensing. Temperature +5 .. +40 °C
Delivery / transport	Transport in 3 transport units (test stand, cabinet, desk/accessories) Weight of test stand: approx. 6 tons Lifting devices for unloading and installation to be provided by the customer. Delivery is made ex works Darmstadt if not agreed otherwise

- A manufacturer's certificate covering the delivered equipment will be supplied. Integration of additional test equipment into the test stand safety concept is the responsibility of the customer.
- The integration of the test stand into the customer's safety systems is the responsibility of the customer.
- After order placement, a complete specification of interfaces will be sent and should be checked and confirmed by the customer within 4 weeks. This confirmation is considered as a prerequisite for delivery and start-up.
- " Engine OFF / ignition OFF" Safety functions for the combustion engine are connected as follows:
 - a) Basic test stand: on safety rack
 - b) With optional engine electrics: on the "Ignition" relay
- Power supply and measuring lines must be run separately in the test stand to prevent electrical interference on the measuring equipment.
- Exhaust gas removal for the test specimen (provided by customer) must be run such that the measuring cabinet should not be exposed to excessive heat radiation (minimum distance > 40cm, a heat shield must be installed if necessary)
- To begin installation / start-up, the test cell and operating room must be clean, floor and walls painted or covered by the customer. A functional combustion engine and operating personnel must be available.
- The customer is responsible to fulfil the regional technical standards and legislations concerning the technical installations and safe test stand operation

6 Product Options

The described services for system test, installation, commissioning, training and final acceptance are only valid if the options are ordered and delivered together with the basis test stand.

6.1 Dynamometer

6.1.1 Calibration Unit for dynamometer

For checking the measuring accuracy of the torque measuring chain (measuring unit Nm) of the dynamometer with lateral force-free torque application.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Testing lever	2	2	2
Weight trays	2	2	2

Note:

- without calibration weights
- the AS machines are equipped with a blocking system

6.1.2 Design of a Special Shaft Connection

If the standard shaft connection of the test stand is not sufficient for a special specimen, a special shaft connection can be designed. The following services are provided:

- Design of a shaft connection with torsion vibration analysis and selection of a suitable shaft connection for the same dynamometer.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Shaft design	1	1	1

Note:

- For the design, we need a completed questionnaire Z 250 for each engine.

6.1.3 Additional Engine Pallet

To prepare additional engines for test outside the room to increase test capacity.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Engine pallet	Pallet frame with : <ul style="list-style-type: none"> - 2 T-slot rails, longitudinal - 2 T-slot rails, transversal - 4 aggregate supports, height-adjustable - 1 leakage collection pan - pallet support for installation on the mounting plate 	Pallet frame with : <ul style="list-style-type: none"> - 2 T-slot rails, longitudinal - 2 T-slot rails, transversal - 4 aggregate supports, height-adjustable - 1 leakage collection pan - pallet support for installation on the mounting plate 	Pallet frame with: <ul style="list-style-type: none"> - 2 T-slot rails, longitudinal - 4 spindles, height-adjustable up to 50 mm - 1 leakage collection pan - pallet support for installation on the mounting plate

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Max. engine weight [kg]	500	500	2500

6.1.3.1 Mounting Gauge for Engine Pallet

For aligning the specimen on the pallet in the rigging area.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Mounting gauge	1	1	1

6.1.4 Fluid Interface

Docking point on the test stand side mounted on mounting plate for manual connection of specimen adapter hoses for engine powers up to 250 kW. The fluid interface permits quick coupling of engine fluids when engine changing paletts are used. The following fluids can be connected via the fluid interface using quick-connect couplings:

- engine coolant
- engine oil
- fuel

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Fluid interface with:	1	-	-
- Quick-connect couplings and nipples, low leakage for coolant, inlet and outlet			
- Quick-connect couplings and nipples, low leakage for engine oil, inlet and outlet			
- Quick-connect couplings and nipples, low leakage for fuel, inlet and outlet			
- Drop pan mounted in suspension			

Note:

- The hoses between the fluid interface in the test cell and the engine are to be installed by the customer.

6.1.5 Additional Fluid Connections

For equipping additional pallets with corresponding nipples for quick docking at the fluid interface on the test stand side.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Quick-connect nipples for coolant, inlet and outlet	2	-	-
Quick-connect nipples for fuel, inlet and outlet	2		
Quick-connect nipples for engine oil, inlet and outlet	2		

6.1.6 Manual Control Panel for the SPARC Digital Test Stand Controller

Control panel for SPARC test stand controller for manual operation via potentiometer and buttons,. Measurement display with status bar on LCD monitor.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Control panel	19" panel, 4 HU	19" panel, 4 HU	19" panel, 4 HU
Cable set	1	1	1



figure 20: manual control SPARC

6.1.7 SPARC E-Gas-Potentiometer-Simulation

For electronic reproduction of the pedal sensor potentiometer of the combustion engine by the SPARC digital test stand controller. The analogue interface module is integrated in a housing, installed at the mounting support close to the specimen.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
AI for pre-setting the throttle position parameters	2	2	2
AO for connecting the reference voltage of the ECU	2	2	2
Isolated AO for displaying idle and full speed position	2	2	2
Default setup data record	1	1	1
Cable set, 20m, to the control cabinet	1	1	1

6.1.8 Engine Electronics Switchbox

For controlling the power switches of the customer for :

- ignition
- preheating
- starting

The corresponding control buttons are included in the SPARC digital test stand controller.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Switchbox with built-in relays for:	1	1	1
- ignition			
- preheating			
- starting			
Cable set, 20 m, to measuring cabinet	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Ignition [A/V]	20/12	20/12	20/12
Preheating [A/V]	80/12	80/12	80/12
Starting [A/V]	80/12	80/12	80/12
Protection class	IP 54	IP 54	IP 54

Note:

- The power supply (12 / 24 V) for the specimen and the cabling to the engine are provided by the customer.
- The ignition relay connector must always be connected to the combustion engine in order to safely switch off the engine in case of an emergency stop.

6.1.9 Portable Operating Hand-Set for Throttle Position Control Unit

For adjusting the throttle position directly at the engine in the test cell .

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Portable operating hand-set for throttle position control unit	1	1	1
Cable set 15m	1	1	1
Connection box with cable, 15 m, as an extension	1	1	1

6.1.10 Intermediate Gearbox for Connecting a Pedal Sensor

This is used for adjusting the rotary motion of the actuator to an angle range suitable for the pedal sensor (270° to 90°).

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Intermediate gearbox	1	1	1

6.2 Media Conditioning

6.2.1 Conditioning Module for Engine Coolant and Engine Oil

For controlling the engine coolant temperature of a combustion engine. This unit consists of the following components:

Mechanical unit: engine coolant with basic cooling function

- Engine coolant temperature measurement
- System pump
- Control valve
- Pressure switch for safety monitoring
- Heat exchanger coolant-glycol / water
- All fittings assembled and mounted on a rack
- All functional elements cabled to an interface box at the rack
- Expansion tank for attaching to the mounting support

Mechanical module: engine oil with basic cooling function

- Oil temperature measurement
- System pump oil circuit
- System pump water circuit
- Control valve
- Pressure switch for safety monitoring
- Heat exchanger coolant-glycol / oil
- All fittings assembled and mounted on a rack
- All functional elements cabled on interface box at the rack

Digital controller for engine oil and engine coolant temperature

- System control with safety functions
- Installed in wall-mounted cabinet
- Cabled ready for operation in cable ducts provided by the customer
- CAN I/O interface module as interface to the STARS automation system

Scope of Supply	Titan T 250	Titan T 460	Titan T H 460
Type	CM 15/200	CM 30/400	CM 15/200
Mechanical module	1	1	1
Expansion tank with fittings	1	1	1
Electric module	1	1	1
Cable set	- mechanics- E-module - E-module- STARS	- mechanics- E-module - E-module- STARS	- mechanics- E-module - E-module- STARS

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Inlet pressure difference coolant/oil [kPa]	350 / 350	350 / 350	350 / 350
Required cooling water flow coolant/oil [m ³ /h]	18 / 1.3	35 / 2.6	18 / 1.3
Permissible cooling water temperature supply/return coolant/oil[°C]	35/45 / 25/35	35/45 / 25/35	35/45 / 25/35
Cooling performance coolant/oil [kW]	200 / 15	400 / 30	200 / 15
Stationary control accuracy coolant/oil [K]	+/-1	+/-1	+/-1
El. connection power without heating [kW]	4	8	4
El. connection power with heating [kW]	34	40	34

Note:

- Connection of piping / hoses to the combustion engine and on-site cooling water supply system is the responsibility of the customer.

6.2.1.1 Heating Module for Conditioning Module Engine Coolant

For heating the engine coolant

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Heating element with fittings	1	1	1
Expansion of the electric component of the conditioning module	1	1	1
Cable set 15 m	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Heating power [kW]	15	15	15

6.2.1.2 Heating Module for Conditioning Module Engine Oil

For heating the engine oil.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Heating element with fittings	1	1	1
Expansion of the electric component of the conditioning module	1	1	1
Cable set 15 m	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Heating power [kW]	15	15	15

6.2.1.3 Facility Filter Set

Removes solids from the customer's cooling water supply system.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Facility filter coolant module	1	1	1
Facility filter oil module	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Mesh width facility filter coolant module [mm]	0.5	0.5	0.5
Mesh width facility filter oil module [mm]	0.5	0.5	0.5

6.2.1.4 Engine Filter Set

Removes solids from the engine cooling water circuit.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Engine Coolant filter	1	1	1
Engine Oil filter	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Mesh width coolant water filter of the engine [mm]	0.5	0.5	0.5
Mesh width oil filter of the engine [mm]	30 ym	30 ym	30 ym

6.3 Measuring Equipment

6.3.1 Weather Station

For measuring the environmental conditions (absolute pressure, relative humidity, and ambient temperature).

Absolute barometric pressure measuring unit

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Pressure transducer	1	1	1
Connector	1	1	1
Wall-mounted support	1	1	1
Calibration certificate for pressure transducer	1	1	1
Connecting cable, 15m, to the signal acquisition module	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Measuring range [kPa]	85...120	85...120	85...120
Error hysteresis, non-linearity, reproducibility	0.05% of the range	0.05% of the range	0.05% of the range
Temperature influence	0.02% of nominal range/10K	0.02% of nominal range/10K	0.02% of nominal range/10K
Compensated temperature range [°C]	-40...80	-40...80	-40...80
Measuring signal [mA]	4...20	4...20	4...20

Humidity / temperature measuring unit

For measuring the relative humidity and the ambient temperature, Device includes a dual-sensor head.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Electronic module with selectable outputs	1	1	1
Combined sensor for relative humidity and air temperature in plastics housing	1	1	1
Mounting set	1	1	1
Connecting cable, 15m, to the signal acquisition module	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Humidity measuring range [%rH]	0...100	0...100	0...100
Measuring accuracy humidity measuring 0...90%rH [%rH]	1	1	1
Measuring accuracy humidity measuring 90...100%rH [%rH]	1.7	1.7	1.7
Temperature measuring range [°C]	-20...+60	-20...+60	-20...+60
Measuring accuracy temperature measurement [°C]	0.2	0.2	0.2
Measuring signal [mA]	4...20	4...20	4...20

6.3.2 Fuel Consumption Measuring System KMA

For measuring the continuous volumetric and gravimetric fuel consumption and the fuel temperature as well as controlled cooling of the fuel.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Measuring and conditioning unit KMA 4000	1	1	1
Calibration record	1	1	1
Set of mounting equipment	1	1	1
4 plastic hoses 500 mm with nipples for system connection	1	1	1
outlet pump	1	1	1
Inlet pressure reducer with manometer	1	1	1
Cable set, 15m, to test stand automation	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Measuring range [l/h / kg/h]	0.35...150 / 0.26...110	0.35...150 / 0.26...110	0.35...150 / 0.26...110
Measuring accuracy, volumetric [% of measured value]	0.1	0.1	0.1
Measuring accuracy, gravimetric [%of measured value]	0.1	0.1	0.1
Measuring accuracy, density measurement [%of measured value]	0.03	0.03	0.03
Inlet pressure range [kPa]	0...50	0...50	0...50
Outlet pressure range [kPa]	10...800	10...800	10...800
Max. fuel inlet temperature [°C]	60	60	60
Fuel outlet temperature with cooling, adjustable [°C]	10...60	10...60	10...60
Fuel resistance	DIN 51600 and DIN 5160	DIN 51600 and DIN 5160	DIN 51600 and DIN 5160
Alcohol resistance	M 100, E100 (on request)	M 100, E100 (on request)	M 100, E100 (on request)

Note:

- Connection and pipes of the measuring system to the central fuel supply or the combustion engine will be supplied by the customer.
- A fuel filter at the inlet of the fuel consumption measuring system is to be provided by the customer.
- Requires water approx. 6°K colder than the desired fuel outlet temperature.

6.3.2.1 External Vacuum Controller

for creating reduced pressure at the motor inlet

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Vacuum controller	1	1	1

Note:

- Installation of the vacuum controller into the system will be carried out by the customer

6.3.2.2 Total Consumption Counter

For determining the total fuel consumption of the test stand in liters

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Total consumption counter	1	1	1

6.3.2.3 Overflow Collector Tank

For detecting leaking fuel or condensate into the ventilation line. The overflow collector tank is installed between the ventilation connection of the system and the customer's ventilation line.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Overflow connector tank	1	1	1

6.3.3 Air Flow Measuring Unit Sensyflow

For measuring the continuous gravimetric air consumption of combustion engines using the hot-film anemometer principle.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Measuring tube	DN 100	DN 150	DN 150
Damper with air filter, inlet tube 10 x DN, outlet tube 5 x DN	1	1	1
Evaluation unit	19" rack, 3 HU	19" rack, 3 HU	19" rack, 3 HU
Cable set, 20m, to control cabinet	1	1	1
Connection plate for installation at the mounting support	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Measuring range [kg/h]	40...1200	80...2400	80...2400
Hysteresis and non-linearity [% of measured value]	1	1	1
Reproducibility [% of measured value]	0.25	0.25	0.25
Temperature influence [% of measured value]	0.03	0.03	0.03
Pressure influence [% of measured value]	0.2	0.2	0.2

Note:

- Connection to the specimen and the combustion air supply of the facility will be provided by the customer.

6.3.4 Blow-By Measuring Unit

For measuring the blow-by gas of combustion engines. The measuring principle is based on a special ultrasonic scanning method .

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Sensor	1	1	1
Control and evaluation unit	19" rack, 2 HU	19" rack, 2 HU	19" rack, 2 HU
Silencer for silencing pulsations	1	1	1
Cable set, 20m, to control cabinet	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Measuring range [l/min]	6...280	10...450	10...450
Measuring error [% of measured value]	<1	<1	<1

Note:

- The positioning of the blow-by measuring unit in the engine will be made by the customer.

6.3.5 Additional Pressure Measuring Equipment

6.3.5.1 Pressure Transducers

For measuring the relative pressure of gaseous or fluid media.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Pressure transducer	8	8	8
Measuring range -100...150 kPa	2	2	2
Measuring range 0...250 kPa	3	3	3
Measuring range 0...1000 kPa	3	3	3
Connector	8	8	8
Connecting cable	8	8	8
Factory calibration certificate according to ISO/IEC 17025	8	8	8

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Error hysteresis, non-linearity, reproducibility	0.08% of the range	0.08% of the range	0.08% of the range
Temperature influence	0.08% of MBE/10K	0.08% of MBE/10K	0.08% of MBE/10K
Compensated temperature range [°C]	20...80	20...80	20...80
Measuring signal [mA]	4...20	4...20	4...20
Pressure connection	¼" inside thread	¼" inside thread	¼" inside thread

Note:

- The pressure transducers are installed in the SP8 pressure measuring rack in the connection box.

6.3.5.2 Pressure Measuring Rack

Plug-in module for measuring pressures of gaseous and fluid media provided for CAN connection to the test stand computer.

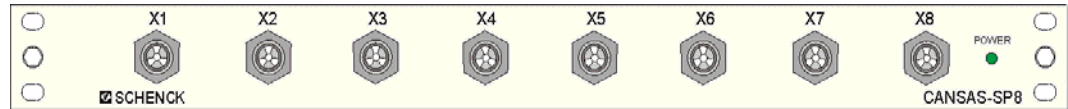


figure 21: pressure measuring rack

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Pressure measuring rack equipped with - 8 installation places for quick coupling	1 19" rack, 1 HU	1 19" rack, 1 HU	1 19" rack, 1 HU
Quick connector couplings for hose connection	8	8	8
CAN connecting cable	1	1	1

Note:

- Calibration of the measuring channels to the individual pressure transducers is carried out by Horiba prior to delivery.

6.3.6 Additional Temperature Measuring Equipment

6.3.6.1 Resistance Thermometer Pt100

For measuring temperatures of up to 200° C.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
RTD Pt 100, type 1, with connecting cable, 3 m, and connector	8	8	8
Calibration certificate	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Accuracy class A according to DIN EN 60751	+/- (0.15K+0.005*/T/) in the range -200...850°C	+/- (0.15K+0.005*/T/) in the range -200...850°C	+/- (0.15K+0.005*/T/) in the range -200...850°C
Nominal length [mm]	100	100	100
Sheath diameter [mm]	3	3	3

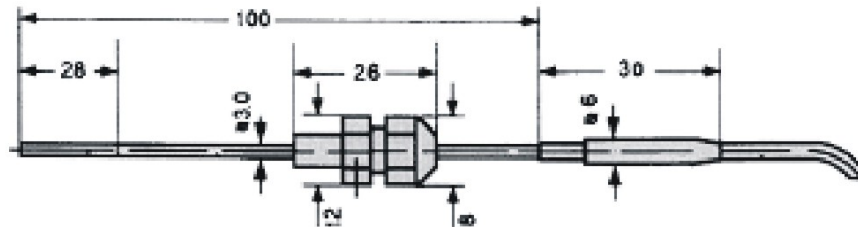


figure 22: Type 1 Resistance Thermometer

6.3.6.2 Thermocouples

For measuring temperatures of up to 1200° C.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Thermocouple type K with connecting cable, 3 m, and thermo connector	8	8	8
Calibration certificate	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Accuracy class 1 acc. to DIN IEC 584	1.5°C or 0.004*/T/ in the range -40...1000°C	1.5°C or 0.004*/T/ in the range -40...1000°C	1.5°C or 0.004*/T/ in the range -40...1000°C
Nominal length [mm]	150	150	150
Sheath diameter [mm]	3	3	3

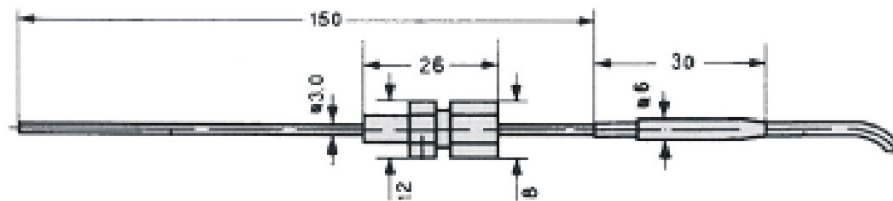


figure 23: Thermocouples Typ K

6.3.6.3 Temperature Measuring Rack

Plug-in module for measuring temperatures with 8 Pt100 RTDs and 8 type K thermocouples with CAN connection to the test stand controller..

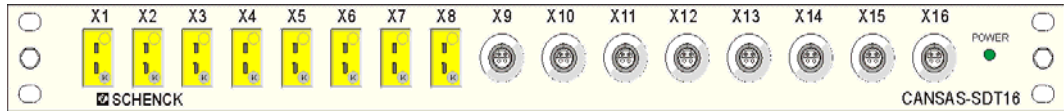


figure 24: temperature measuring rack

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Temperature plug-in module equipped with	19" rack, 1 HU	19" rack, 1 HU	19" rack, 1 HU
- 8 female connectors 7-pin			
- 8 thermo female connectors 2-pin			
CAN connecting cable	1	1	1

Technical Data	Titan T 250	Titan T 460	Titan TH 460
Measuring error, static, Pt100			
-200...+600°C	<1K	<1K	<1K
0...200°C	<0.5K	<0.5K	<0.5K
Measuring error, static, thermocouple			
-200...1200°C	<1K	<1K	<1K
Resolution	16 bit	16 bit	16 bit
Measuring rate, adjustable up to [Hz]	100	100	100
Operating temperature range [°C]	-40...65	-40...65	-40...65

Note:

- Measuring ranges set to -200 ... +1200°C for thermocouples and 0...200°C for RTDs (can be changed by customer). The accuracy is valid over the entire measuring and operating temperature range!

6.4 STARS Test Stand Automation

6.4.1 "UniPlot" Software Module

Powerful graphic evaluation tool at the operating system Windows NT/2000/XP for displaying 2D / 3D graphics with the following basic functions:

- Function for transmitting the selected test results to the evaluation tool
- 2D / 3D graphics
- Several axes on one sheet
- Free axis calculation of the graphics with comments etc.
- Use of samples
- Programmable via script
- Exportation of the graphics into other tools possible, e.g. MS-WORD

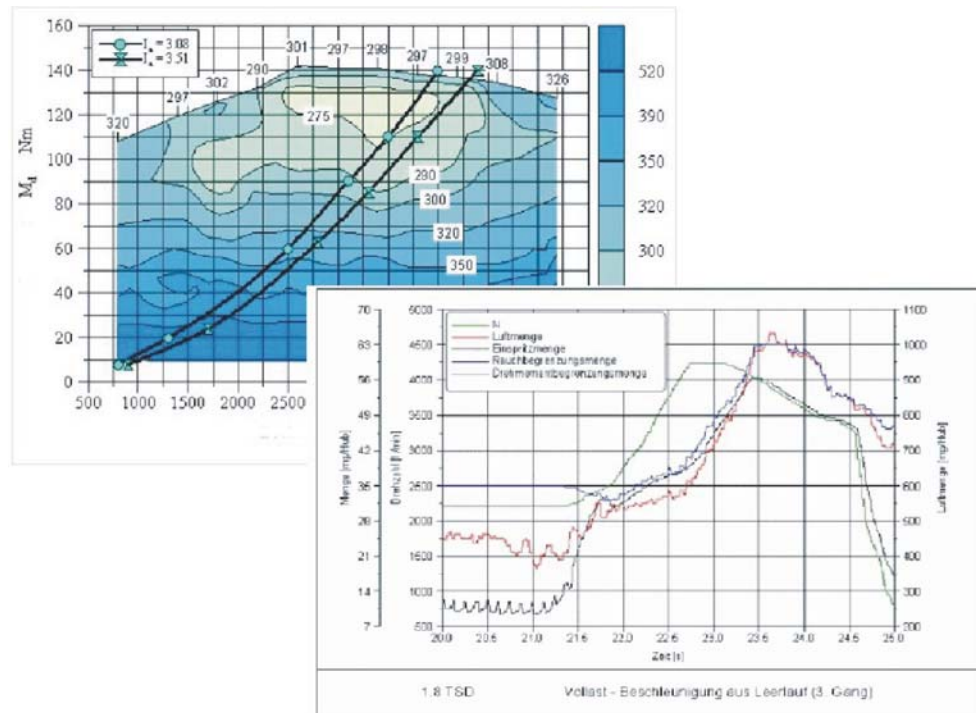


figure 25 Uniplot example

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Software package UniPlot	1	1	1

Note:

- Customisations / pre-settings according to customer's specifications are not included, however these can be offered after clarification.

6.4.2 Software License - Exhaust Emission Measuring System

For controlling the measuring system and transmitting the measured values to the test stand automation system via serial cable (RS 232).

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Driver and parameterisation for Mexa 7000 systems	1	1	1
Integration into the test stand automation system	1	1	1
Setup of the system channels	1	1	1
Standard visualisation screen for displaying the measured values	1	1	1

6.4.3 Software License - Particle Measurement

For controlling a partial-flow particle sampler via an AK interface.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Driver and parameterisation for a partial-flow particle sampler by MBB-Nova	1	1	1
Integration into the test stand automation system	1	1	1
Setup of the system channels	1	1	1

Note:

- Input of the measured values into the STARS automation system is done manually

6.4.4 Heavy Duty Engine Emissions Test Suite

The Heavy Duty Engine Emissions Testing (HDEET) application suite is a comprehensive suite of turn key test procedures for performing a range of legislative emissions test procedures on heavy duty engines.

HDEET provides a turn key solution to carry out the following legislative test procedures:

European Regulation 1999/96/EC Euro 3

- Power map
- European steady state cycle (ESC)
- European transient cycle (ETC)
- European load response test (ELR)

European regulation 88/77/EEC Euro1/2

- ECE R49 13 Mode

European regulation 72/306/EEC

- ECE R24 Smoke Test

US Code of Federal Regulations 2004, 2007

- Part 86, Subpart N; Transient Cycle
- Part 86, Subpart I ; Smoke Test

US Code of Federal Regulations 2004, 2007

- Part 86, Subpart N; Transient Cycle
- Part 86, Subpart I ; Smoke Test

ISO 1878

- Part 1 ; Test bed measurement of gaseous and particulate exhaust emissions
- Part 4 ; Test cycles for different engine applications; Cycles B (universal); C (off highway); D (constant speed)
- Part 11; Test bed measurement of gaseous and particulate exhaust emissions under transient test conditions

Japanese Trias regulations

- 13 Mode test
- JE05/ED12 (Transient cycle)

The HDEET-Software offers the necessary functionality for the listed test procedures like :

- Automated Tests
- Engine Data Entry
- Transient Cycle Generation Tool
- Data Analysis and interaction
- Automated Emission System Control
- Instrument Drivers

6.4.5 Software License - Opacimeter

For controlling an opacimeter and transmitting the measured values to the test stand automation system via serial cable (RS 232).

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Driver and parameterisation for AVL 439	1	1	1
Integration into the test stand automation system	1	1	1
Setup of the system channels	1	1	1
Standard visualisation screen for displaying the measured values	1	1	1

6.4.6 Software License - Application System/ASAP 3

For connecting application systems such as Bosch VS 100 / Inca-PC, Kleinknecht GREDI, Siemens SAM2000 via serial cable (RS 232) and ASAP 3 protocol

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Driver	1	1	1
Integration into the test stand automation system	1	1	1
Setup of the system channels	1	1	1
Standard visualisation screen for displaying the measured values	1	1	1

Note:

- Application systems and engine control unit will be connected by the customer
- The functioning of the interface will be verified using a GREDI simulation
- The parameterisation of the channels in the engine control unit will be carried out by the customer

6.4.7 Software License - ASAM-ACI/LAN

For remote control of the test stand automation system via an external optimisation system (e.g. VEGA, Cameo). The test stand automation system makes measured data and test stand functions available to the optimisation system.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Software license for ASAM ACI driver	1	1	1
Setup of interface and function evidence	1	1	1

Note:

- For operation, a local (peer-to-peer) Ethernet LAN (TCP/IP) connection between the test stand automation and the optimisation system is required, e.g. via hub or switch. These hardware and cable connections are not included in the scope of supply.

6.4.8 VEGA Automatic Engine Map Optimisation System

VEGA is a stand-alone system for automatic calibration and optimisation of electronic management systems for combustion engines and powertrain. The system can either be connected with an intelligent test stand controller (online) or work independent of the test stand with data measured before (offline, office).

The VEGA software is PC-based, runs with Windows NT/2000/XP operating system and consists of:

- integrated database for the management of optimisation definitions and results with
- graphical user interface with display and edit functions for all functions relevant for the optimisation
- export functions for optimisation results in EXCEL, LOTUS, and ASCII compatible formats
- report functions for printing parameters and results
- formula editor for creating formulas by which parameters derived from measurement parameters can be calculated
- test cycle analysis for generating operating point lists from test cycles

Optimisation software with

- a graphical user interface for controlling and monitoring the optimisation process.
- an optimisation module for achieving the optimisation target. The optimisation module carries out all steps required for finding the optimisation target. The module determines the measured data required for evaluation for different parameter combinations thus determining the best parameter combination in the sense of the optimisation target.

In the online version, the optimisation module is equipped with the VEGA high-level interface specified by Horiba ATS by which it can access the test stand automation directly and the functions of which it can use to determine the measured values for the parameters required by the optimisation algorithm. As hardware interface, VEGA supports a RS232 as well as a TCP/IP connection to the test stand automation.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Software module "VEGA-Online"	1	1	1
Integration into the test stand automation system	1	1	1
Setup of the system channels	1	1	1

6.4.9 Software Maintenance

A software maintenance contract for the STARS Automation system can be made for the purchased software.

Extent of services:

- (1) Software maintenance by provision of existing updates adjusting the STARS software to the current state of the STARS development.
- (2) Access right to the STARS Helpdesk (on workdays, Monday to Friday during the normal working hours of your local Horiba office) rendering the following service by telephone, e-mail or online through remote access via WebEx:
- Assistance in interpretation of fault and error messages from the STARS automation system
- Diagnosis of faults and errors indicated by the software
- Elimination of software errors through provision of patches or workarounds.

The Helpdesk is able to investigate the test stand status and transmit data via remote access. The customer is responsible for establishing remote access. Preference is given to communication via WebEx which only requires an Internet connection at the test stand PC. WebEx is a safe connection for remote service (more information about WebEx can be obtained under <http://www.webex.com>)

The type of access must be defined in cooperation with the customer's IT department. Access via WebEx will not cause additional costs except those for establishing an Internet connection on the test stand PC.

Delivered updates are installed by the customer. On-site installation by us will be offered on request.

Further details of software maintenance are given in the STARS software maintenance contract.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Software maintenance contract	1	1	1

6.4.10 Language Versions for STARS Automation

In addition to English, the following languages are available as an alternative for STARS operation and documentation.

- German
- Japanese

Scope of Supply	Titan T 250	Titan T 460	Titan T H 460
Language package German/Japanese	1	1	1
Keyboard German/Japanese	1	1	1
Windows, Excel German/Japanese	1	1	1
Documentation, online help German/Japanese	1	1	1

6.5 Alternative Cable Sets

The following alternative cable sets are available as an alternative to the standard cable set (length = 20m) at extra charge.

Scope of Supply	Titan T 250	Titan T 460	Titan TH 460
Cable set test stand-meas.- and control cabinet [m]	25 / 30 / 35 / 40	25 / 30 / 35 / 40	25 / 30 / 35 / 40
Cable set control cable VFD cabinet / test stand [m]	25 / 30 / 35 / 40	25 / 30 / 35 / 40	25 / 30 / 35 / 40
Power cable VFD cabinet / test stand [m]	25 / 30 / 35 / 40	25 / 30 / 35 / 40	25 / 30 / 35 / 40
Cable set VDF cabinet/ meas.- and control cabinet [m]	25 / 30 / 35 / 40	25 / 30 / 35 / 40	25 / 30 / 35 / 40
Cable set engine electrics switchbox [m]	25 / 30 / 35 / 40	25 / 30 / 35 / 40	25 / 30 / 35 / 40
Cable emergency-stop button test cell / control cabinet [m]	25 / 30 / 35 / 40	25 / 30 / 35 / 40	25 / 30 / 35 / 40
Cable operating unit for throttle position control unit [m]	25 / 30 / 35	25 / 30 / 35	25 / 30 / 35
Cable weather station [m]	20 / 25 / 30 / 35 / 40	20 / 25 / 30 / 35 / 40	20 / 25 / 30 / 35 / 40
Cable set to conditioning system cooling water [m]	20 / 25 / 30 / 35 / 40	20 / 25 / 30 / 35 / 40	20 / 25 / 30 / 35 / 40
Cable set to fuel consumption measuring system [m]	20 / 25 / 30 / 35 / 40	20 / 25 / 30 / 35 / 40	20 / 25 / 30 / 35 / 40
Cable set to Blow By measuring unit [m]	25 / 25 / 30 / 35 / 40	25 / 25 / 30 / 35 / 40	25 / 25 / 30 / 35 / 40
Cable set to air flow measuring unit Sensy-flow [m]	25 / 25 / 30 / 35 / 40	25 / 25 / 30 / 35 / 40	25 / 25 / 30 / 35 / 40
Cable set to E-Gas-potentiometer simulation [m]	25 / 25 / 30 / 35 / 40	25 / 25 / 30 / 35 / 40	25 / 25 / 30 / 35 / 40

Note:

- Other cable lengths possible on request.

6.6 Special Colours

On request.

6.7 Extended Scope of Supply for USA/Canada

For an application in the USA or Canada, an adjusted scope of supply is provided to cover the local technical standards and requirements.

HORIBA

Automotive Test Systems

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