

## Engine Test Stand – Titan S Technical Specification

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# 1 A Horiba Product with Definite Advantages

## 1.1 Fields of Application

The Titan S engine test stand provides one complete test system for the user. This test stand offers full functionality for carrying out stationary tests such as:

- durability
- performance determination
- engine component testing
- catalyst ageing

With the Titan S 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
- visualization of process parameters and measured values
- load control of test specimen and loading unit
- 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 Gasoline, Diesel in-line and V configuration engines with 4 or more cylinders.

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

Parameter	TitanS 190	TitanS 470	TitanS 900
torque [Nm]	320	2800	3500
power [kW]	150	400	750
speed [rpm]	6800	4000	3000
idle/minimum speed [rpm]	>800 <sup>1)</sup>	>870 <sup>1)</sup>	>980 <sup>1)</sup>
Moment of inertia [kgm <sup>2</sup> ]	>0,15	>1,2	>3,5

1) If test cycles with lower than 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 standardization
- Short delivery periods due to standardized 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 S engine test stand consist 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.

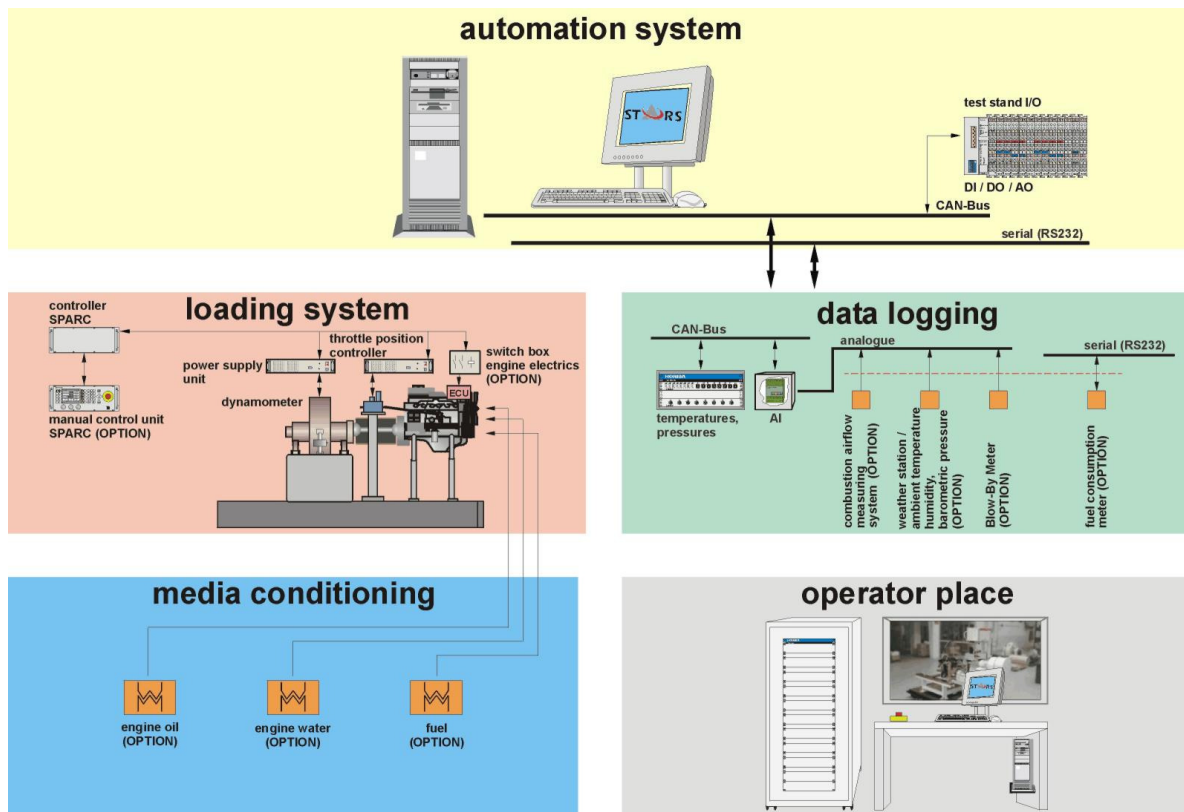


Figure 1: System Overview TitanS Series Engine Test Stand

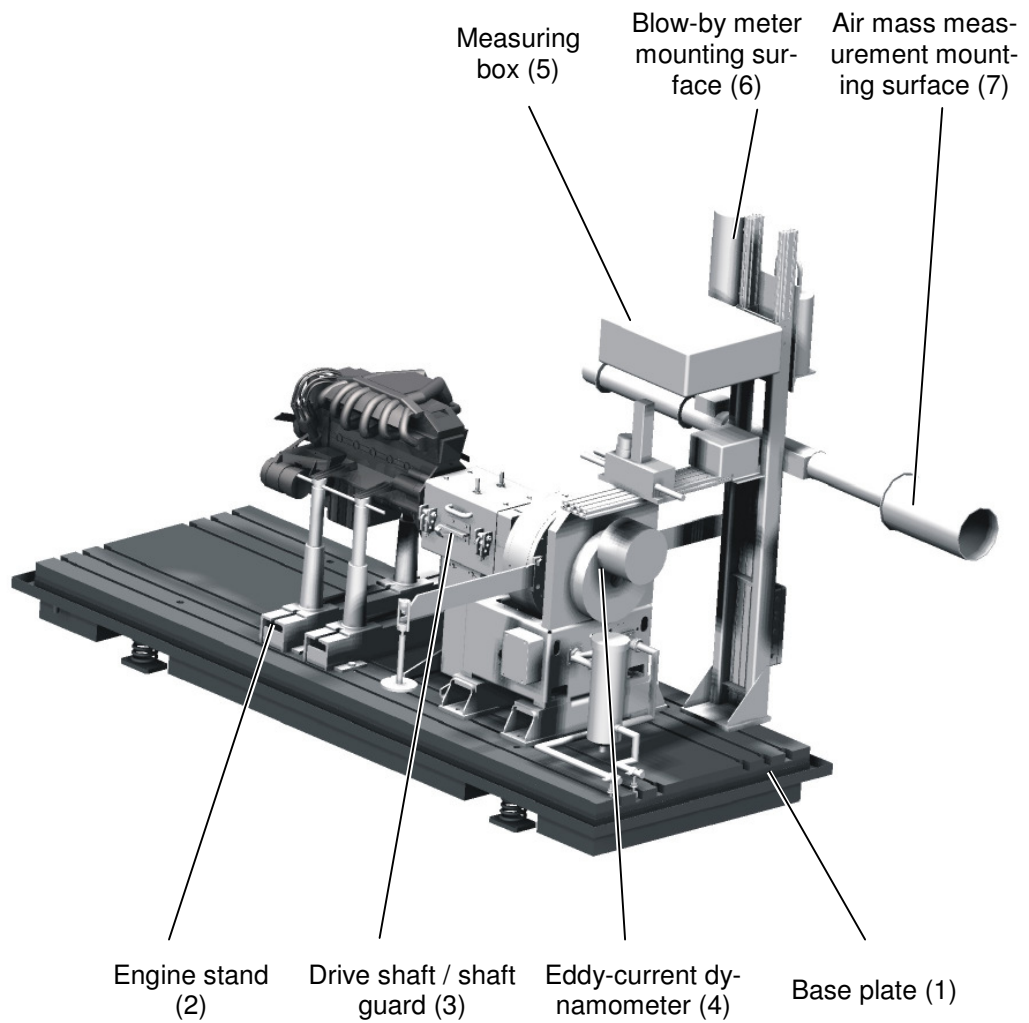


Figure 2: System Illustration Mechanical Test Stand Module

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 plain 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 such that an additional vibration foundation is not required for the stated range of engines.

The engine to be tested is mounted on the engine mounting unit (2). The engine stand can be adjusted in height as well as in the longitudinal and transversal direction. Therefore it can be used for a wide variety of test specimens.

The test specimen and dynamometer are connected using a special drive shaft. This drive shaft is designed for the specified engine range so that critical vibrations due to 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.

Either an eddy-current dynamometer or hydraulic brake (4) is used as the loading unit. Optionally, these can be equipped with a starter unit for test specimens without one.

The SPARC test stand controller controls 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 alone.

### 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 S 190	Titan S 470	Titan S 900
T-slot plate with all-around oil drain channel	1 (size 1)	1 (size 2)	1 (size 2)
Steel spring damping elements	4	8	8

Technical Data	Titan S 190	Titan S 470	Titan S 900
Weight [kg]	4200	5600	5600
Installation dimensions LxHxW [mm]	3640x1390x300	4640x1640x300	4640x1640x300
Spring adjustment [Hz]	5	5	5
Surface quality	DIN 876/III	DIN 876/III	DIN 876/III
Number T-slots	6	6	6

**3.1.2 Loading Device**

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Loading device	Eddy-current dynamometer	Eddy-current dynamometer	Hydraulic dynamometer
Type	WT 190	WT 470	DT 900
Torque measuring unit	load cell	load cell	load cell
Speed measuring unit	with pulse generator and 60-teeth wheel	with pulse generator and 60-teeth wheel	with pulse generator and 60-teeth wheel
Power supply	19"- rack mount, 2 HE	19"- rack mount, 2 HE	19"- rack mount, 2 HE
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
Intermediate frame for shaft height [mm]	700	800	800

Technical Data	Titan S 190	Titan S 470	Titan S 900
Directions of rotation	2	2	1
Rated torque [Nm]	600	3000	4000
Rated power [kW]	190	470	900
Speed [rpm]	10000	4000	6500
Moment of inertia [kg/m <sup>2</sup> ]	0,17	1,96	0,6
Max. deviation, torque [%]	accuracy class 0,2 full scale	accuracy class 0,2 full scale	accuracy class 0,2 full scale
Max. deviation, speed [1/min]	+/-1 full scale	+/-1 full scale	+/-1 full scale

### 3.1.3 Drive Shaft

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

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Design	flexible drive shaft	drive shaft	drive shaft
Type	K010	K050	K065

Technical Data	TitanS 190	TitanS 470	TitanS 900
Rated torque [Nm]	520	4340	6300
Speed [1/min]	8700	4000	3000
Weight, engine side [kg]	11	112,5	137
Moment of inertia, engine side [kgm <sup>2</sup> ]	0,046	1,421	3,556
Outside centering	216 g7	466,725 g7	571,5 h6
Bolt hole pattern	D201/8xd9	D438,2/8x M12	D542,9/6xd18

Note:

- The quoted shaft connection has been selected for specimens stated in 1.1. For other requirements, a shaft calculation is required (see options).
- Possibly required 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 for the shaft connection that can be mounted on the mounting plate.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Shaft protection	1	1	1
Safety contact	1	1	1
Set of fittings	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Shaft height [mm]	700	800	800
Inner diameter [mm]	290	480	600

### 3.1.5 Engine Mounting Unit

Mechanism for mounting a combustion engine on the base plate.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Cross rails	2	2	2
Engine supports (adjustable in height)	4	4	4
Set of fittings	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Max. engine weight [kg]	750	1750	1750

Note:

- Adapters 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	TitanS 190	TitanS 470	TitanS 900
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 free parameter x with control operating modes idle,  $\alpha/M$ ,  $\alpha/n$ ,  $n/M$ ,  $M/n$ ,  $x/n$ ,  $x/M(n)$  (  $M(n)$  = road-resistance curve)

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

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
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 engines.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Control and power supply unit	19" plug-in module 4 HU	19" plug-in module 4 HU	19" plug-in module 4 HU
Actuator	1	1	1
Cable set	- control unit – test stand controller - RS232-PC connection	- control unit – test stand controller - RS232-PC connection	- control unit – test stand controller - RS232-PC connection
PC operating software	1	1	1
Bowden cable L=1,5m	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
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 100mm 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 carried out by the customer

### 3.2 Measured-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 S 190	Titan S 470	Titan S 900
Resistance thermometer Pt 100, type 1, with connecting cable, 3 m, and connector	8	8	8
Type certificate	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Accuracy class A according 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

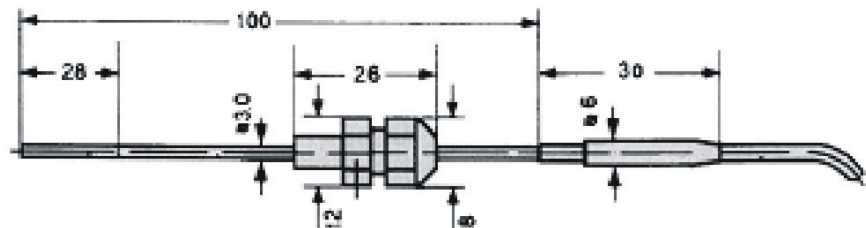


Figure 3: Type 1 Resistance Thermometer

**3.2.1.2 Thermocouples**

for measuring temperatures of up to 1200 °C.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Thermocouple type K with connecting cable, 3 m, and thermo connector	8	8	8
Type certificate	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
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

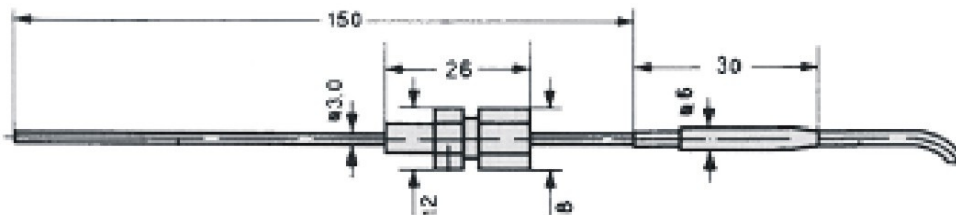


Figure 4: Type K Thermocouples

### 3.2.1.3 Temperature Module

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)

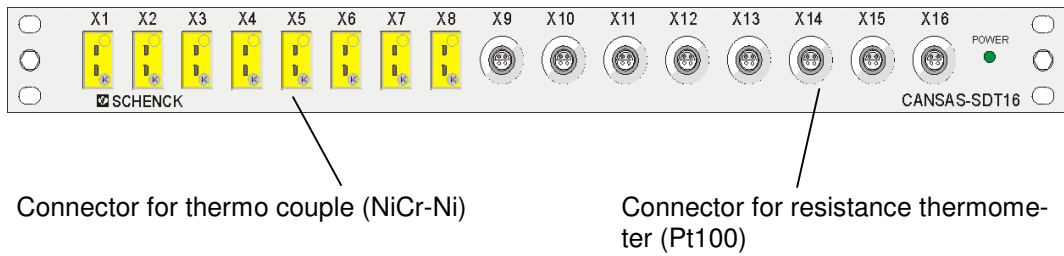


Figure 5: Temperature Plug-In Module

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Temperature plug-in module equipped with	19" rack, 1 HU	19" rack, 1 HU	19" rack, 1 HU
- 8 female connectors 7p			
- 8 thermo female connectors 2p			
CAN connecting cable	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
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 resistance thermometer (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 S 190	Titan S 470	Titan S 900
Pressure transducer	4	4	4
Measuring range -100...150 kPa	1	1	1
Measuring range 0...250 kPa	2	2	2
Measuring range 0...1000 kPa	1	1	1
Connector	4	4	4
Connecting cable	4	4	4
Factory calibration certificate according to ISO/IEC 17025	4	4	4

Technical Data	Titan S 190	Titan S 470	Titan S 900
Error hysteresis, non-linearity, reproducibility	0.15% of the range	0.15% of the range	0.15% of the range
Temperature influence	0,1% of nominal range / 10K	0,1% of nominal range / 10K	0,1% 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

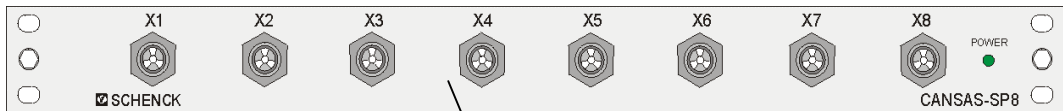
Note:

- 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 S 190	Titan S 470	Titan S 900
Pressure measuring rack equipped with: - 8 installation places for quick couplings	19" rack, 1 HU	19" rack, 1 HU	19" rack, 1 HU
Quick connector coupling for hose connection	4	4	4
CAN connecting cable	1	1	1

Note:

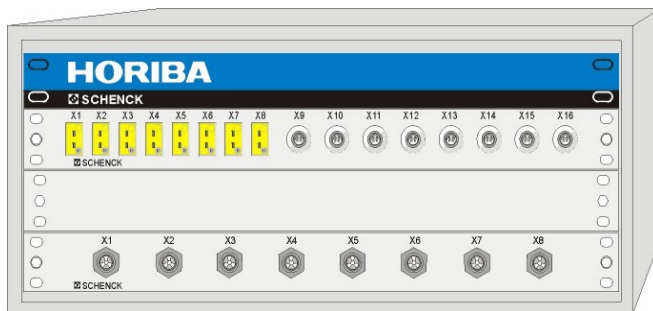
- Calibration of the measuring channels to the individual pressure transducers is carried out by Horiba prior to delivery.

**3.2.3 Measuring Box**

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

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Measuring box including fittings	1	1	1

Front view



Back view



Figure 7: Measuring Box 4 HU

### 3.2.4 Analog Signal Acquisition

#### 3.2.4.1 Signal Acquisition Module

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

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
CAN module with:	1	1	1
- 8 universal AI			
- 8 sensor inputs for Pt100 and potentiometer			
- internal reference point			
- 8 linearized inputs			
- 8 antialiasing filters			
- 16 bit A/D converters			
- CAN controller			

Technical Data	Titan S 190	Titan S 470	Titan S 900
Measuring range type K thermocouple, set [°C]	-20...1000	-20...1000	-20...1000
Measuring range Pt 100, set [°C]	-200...200	-200...200	-200...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)
- In case 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 for accommodating the signal acquisition module.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Housing including fittings	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
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 the functions

- test stand control
- monitoring
- measured-data acquisition
- visualization
- test evaluation

function into a corporate environment.

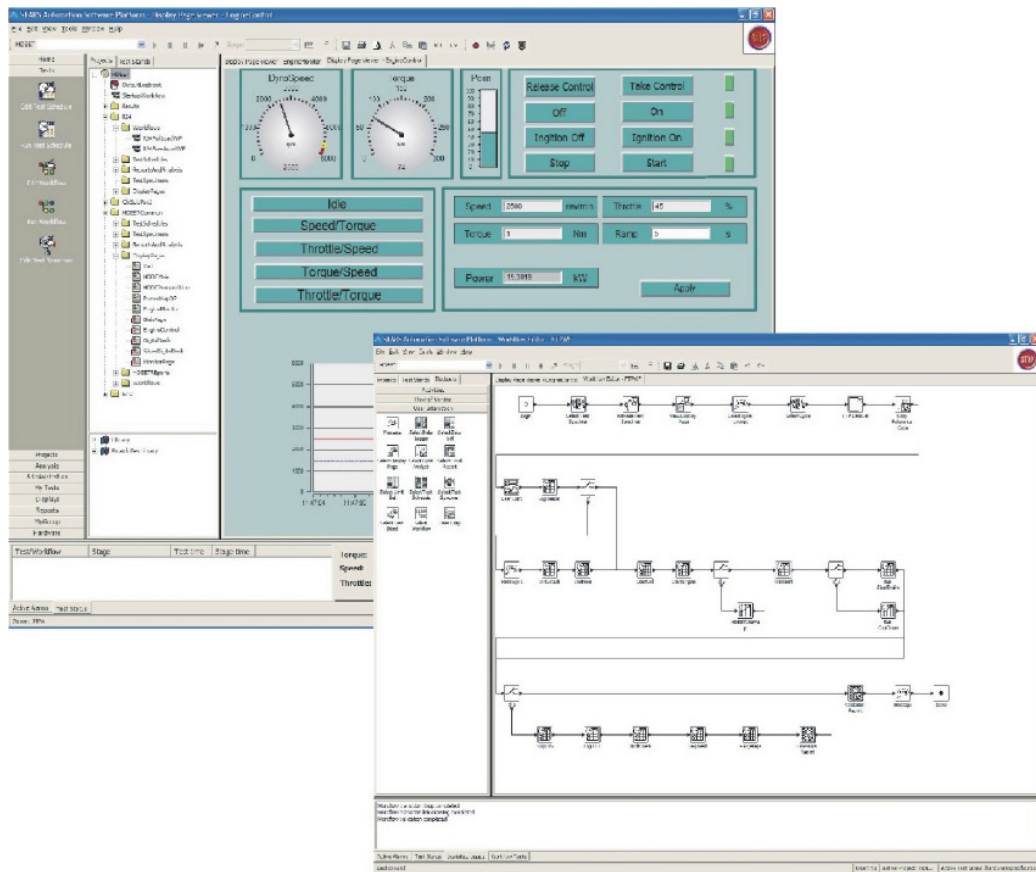


Figure 8: Visualization and definition of test procedure by using the Workflow Editor

### 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 S 190	Titan S 470	Titan S 900
Stars software	1	1	1
Device driver for test stand controller SPARC	1	1	1
Device 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 two example tests.

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

- a display screen for visualising 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 S 190	Titan S 470	Titan S 900
Pentium P IV 3.2 GHz or comparable processor	1	1	1
1 x 17" TFT monitor (DVI)	1	1	1
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 - 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)	1	1	1
Midi-tower housing	1	1	1
Operating system MS WINDOWS XP	1	1	1
EXCEL	1	1	1

Note:

- English 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 S 190	Titan S 470	Titan S 900
CAN bus cable with bus termination	1	1	1
Free DI (pos. logic)	8	8	8
Free DO (pos. logic)	8	8	8
Free digital limit contact inputs	4	4	4
Free analog outputs (+/-10V)	2	2	2
Digital inputs per-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 supply units 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 S 190	Titan S 470	Titan S 900
Cabinet	1	1	1
Power supply unit with main switch integrated in the front panel	1	1	1
Set of cabinet rollers	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
Desk	1	1	1
PC support	1	1	1
Cabling	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Dimensions WxDxH [mm]	1800x800x720	1800x800x720	1800x800x720



### 3.5 Central Safety Module

Central safety module, ready for connection to the emergency-stop circuit, safety circuit, and display function, installed in the measuring and control cabinet.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
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 opened, the rotating machines (loading unit and specimen) are braked down as fast as possible, put to rest, and switched off (quick stop).
- The safety circuit usually includes fault detection of devices. In case of a fault the rotating machines (loading unit and specimen) are switched off and run down (breaking of rotating parts by internal friction of the system).

In both cases, the supply voltage to test stand computer and test stand controller remains switched on so that error messages do not get lost.

### 3.6 Services

#### 3.6.1 System Test

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

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
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 analog 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 S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
Unpacking of parts and check for completeness	1	1	1
Mechanical setup, alignment, and check	1	1	1
Electrical setup and checkout	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 set up and alignment of the basic test stand including vibration springs. Corresponding transport fixtures are included in the scope of supply
- Cable ducts, cable lines, apertures (including closing/sealing them after assembly, etc).
- Connection of media to the test stand interfaces
- 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 S 190	Titan S 470	Titan S 900
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 Instruction

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Instructions 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
- 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 the safety and emergency 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 S 190	Titan S 470	Titan S 900
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 preparation work, 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

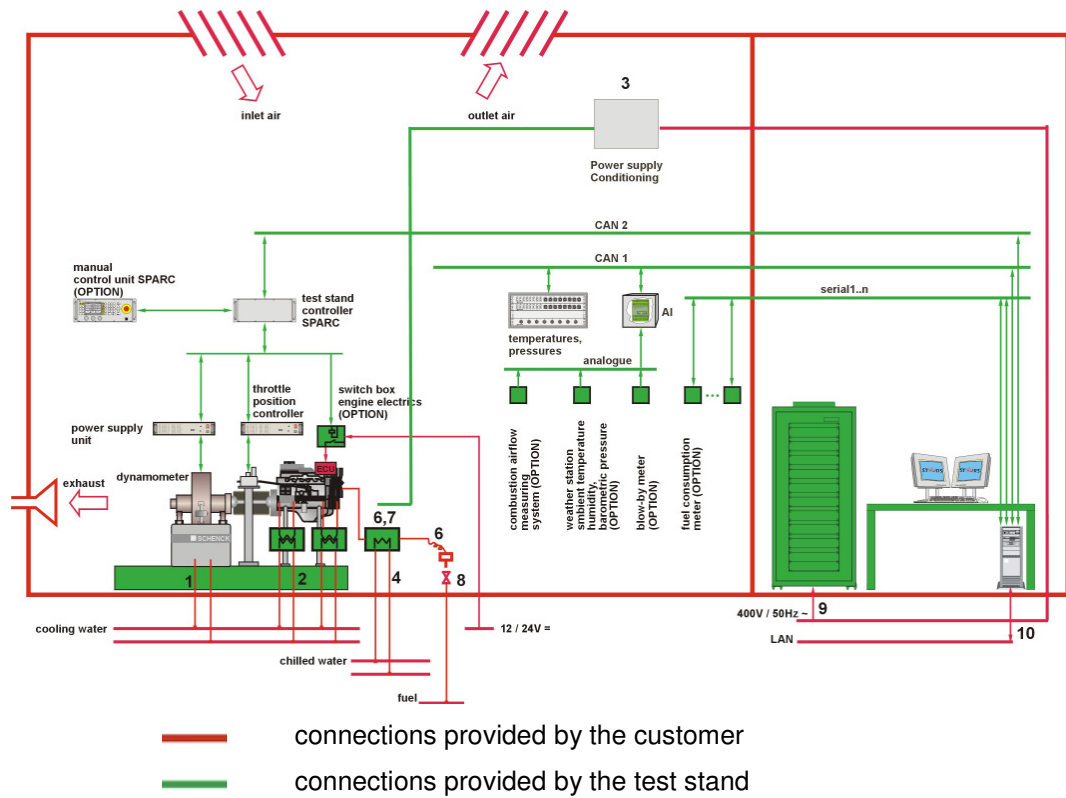


Figure 10: System interface

# TITAN S

## Technical Specification

Connection	Nr.	Titan S 190	Titan S 470	Titan S 900
Cooling water, dynamometer	1	G1/4"- inside thread (0,6...4bar)	G2"- inside thread (0,6...4bar)	Flange joint according to the specification of Dynamometer D 900 (0,4 bar) <sup>1)</sup>
Cooling water, engine cooling water conditioning	2	Plant side: G1 1/2"- inside thread Motor side: G2"- inside thread	Plant side: G1 1/2"- inside thread Motor side: G2"- inside thread	Plant side: G2"- inside thread Motor side: G21/2"-inside thread
Electrical power supply, conditioning system, without heating	3	2 kW	2 kW	2 kW
Electrical power supply, conditioning system, with heating	3	17 kW	17 kW	23 kW
Chilled water, fuel cooling	4	1/2"- inside thread	1/2"- inside thread	1/2"- inside thread
Fuel, fuel inlet	5	1/2" (the site incoming pipes have to be designed to cover the pressure losses at maximal volume flow)	1/2" (the site incoming pipes have to be designed to cover the pressure losses at maximal volume flow)	1/2" (the site incoming pipes have to be designed to cover the pressure losses at maximal volume flow)
Fuel, engine inlet	6	Pipe connection, 10 mm outside diameter	Pipe connection, 10 mm outside diameter	Pipe connection, 10 mm outside diameter
Fuel, engine outlet	7	Pipe connection, 10 mm outside diameter	Pipe connection, 10 mm outside diameter	Pipe connection, 10 mm outside diameter
Direct-current supply, engine electrics	8	12/24V DC, 4...10mm, screw connection	12/24V DC, 4...10mm, screw connection	12/24V DC, 4...10mm, screw connection
Power feeding, measuring and control cabinet	9	3/N/PE, 400VAC, 50...60Hz, 10kVA; 20A site fuses	3/N/PE, 400VAC, 50...60Hz, 10kVA; 20A site fuses	3/N/PE, 400VAC, 50...60Hz, 10kVA; 20A site fuses
Network, test stand computer	10	Ethernet 10/100 Mbit CRS 45	Ethernet 10/100 Mbit CRS 45	Ethernet 10/100 Mbit CRS 45

<sup>1)</sup> In case of a higher pre pressure then 0,4 bar in the site cooling water circuit, the customer has to install a pressure control valve in the connection pipe of the brake, which controls the pressure independent from the actual flow rate of the water.

## 4.2 System Dimensions

### 4.2.1 TITAN S 190

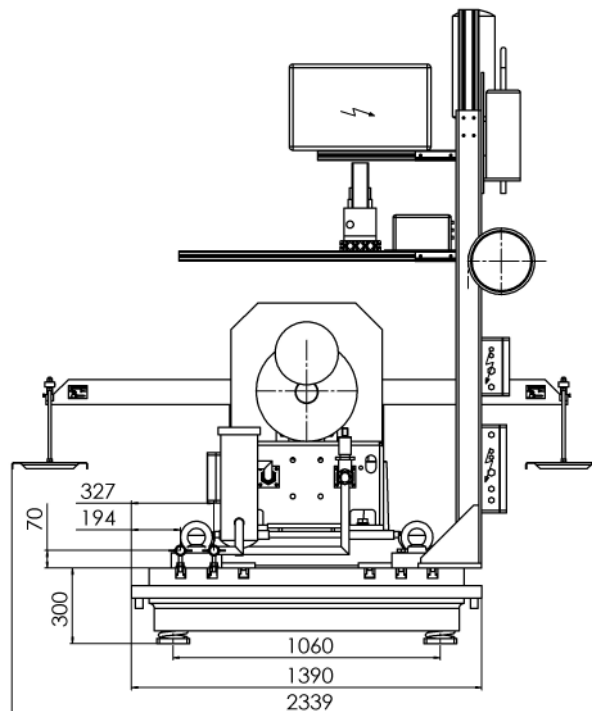


figure 11: front view



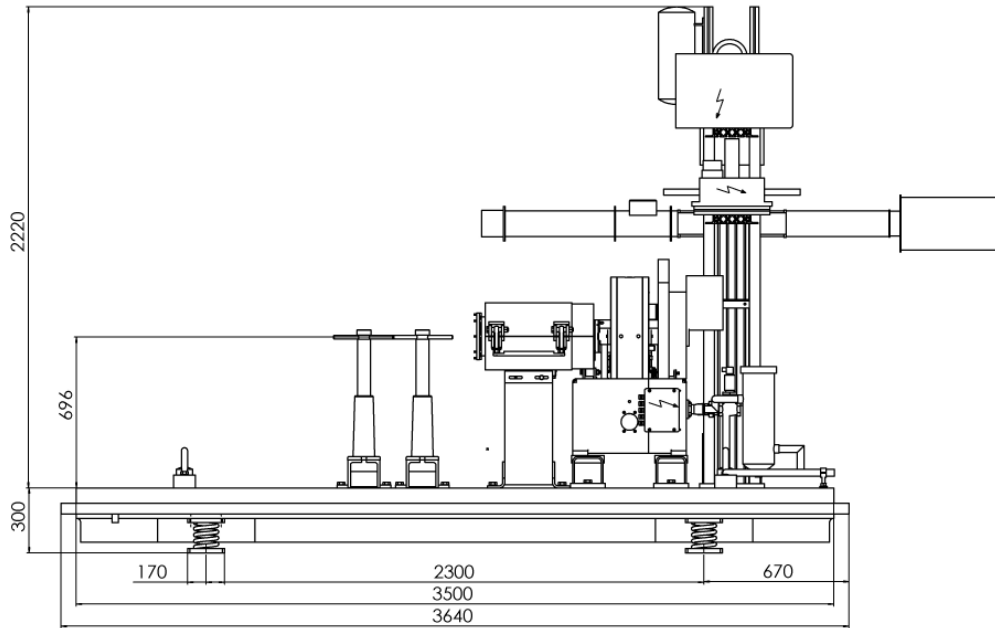


figure 12: side view

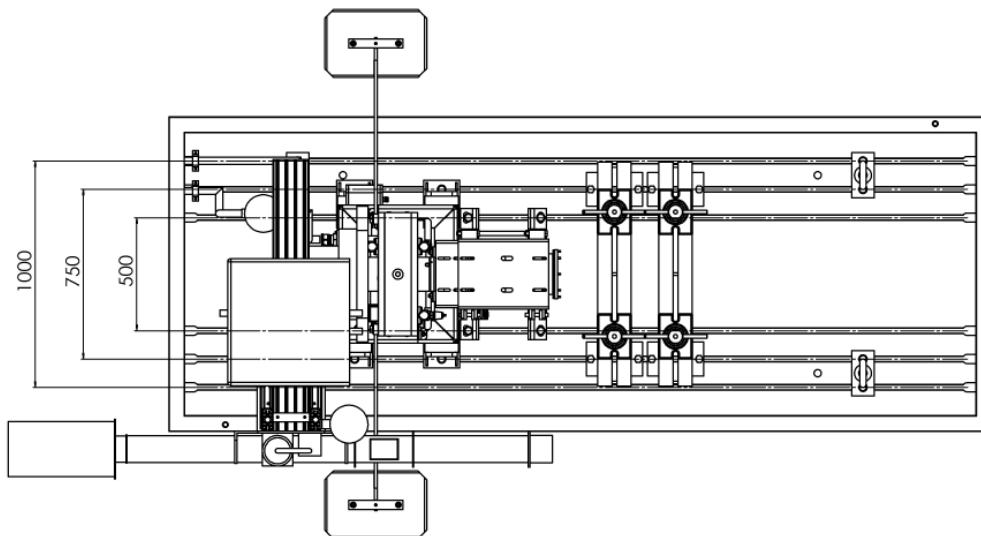


figure 13: top view

**4.2.2 TITAN S 470**

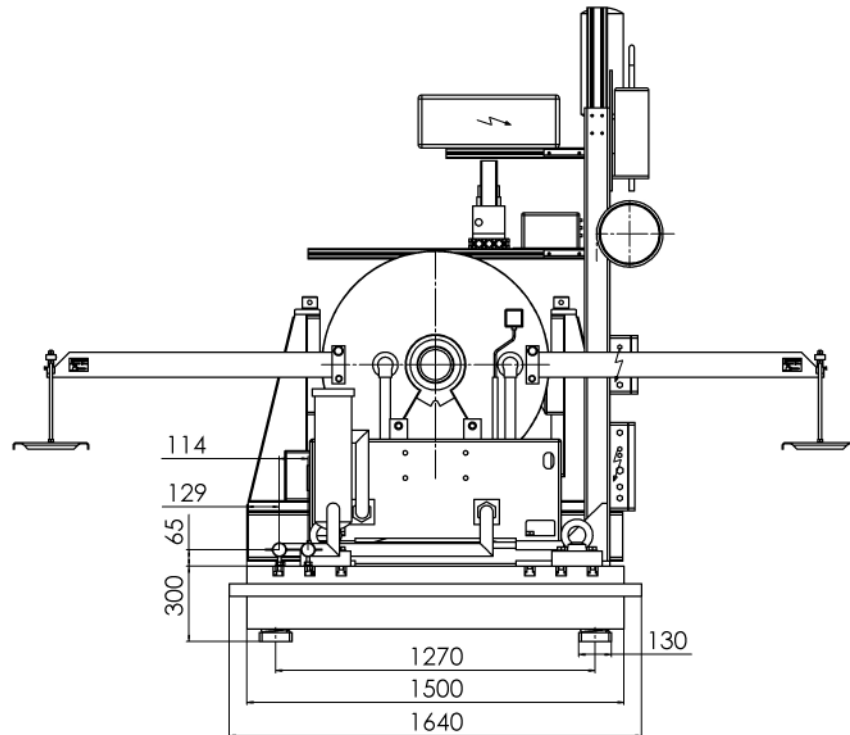


figure 14: front view

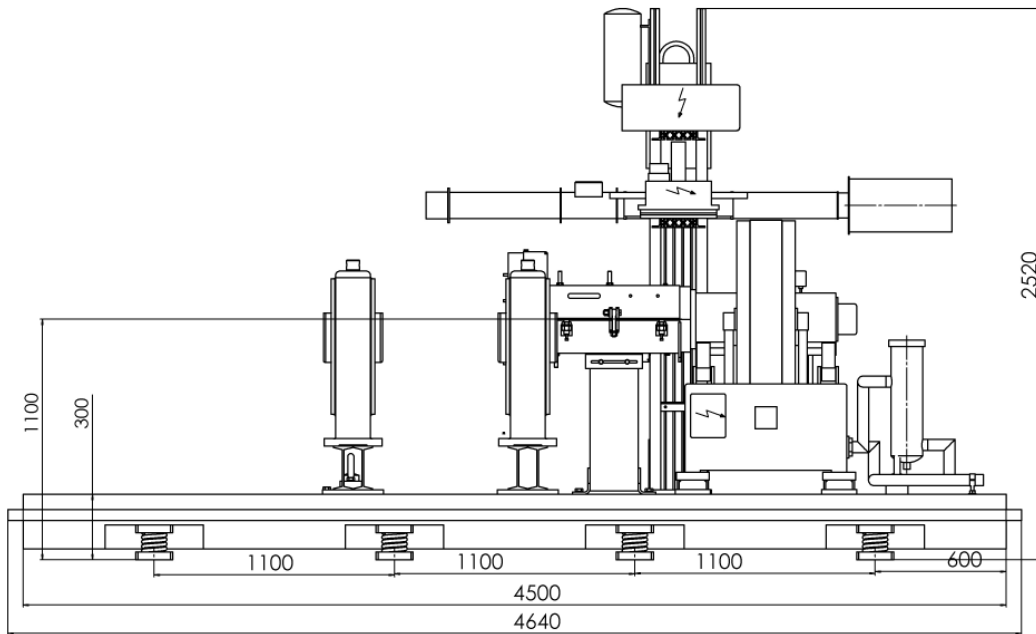


figure 15: side view

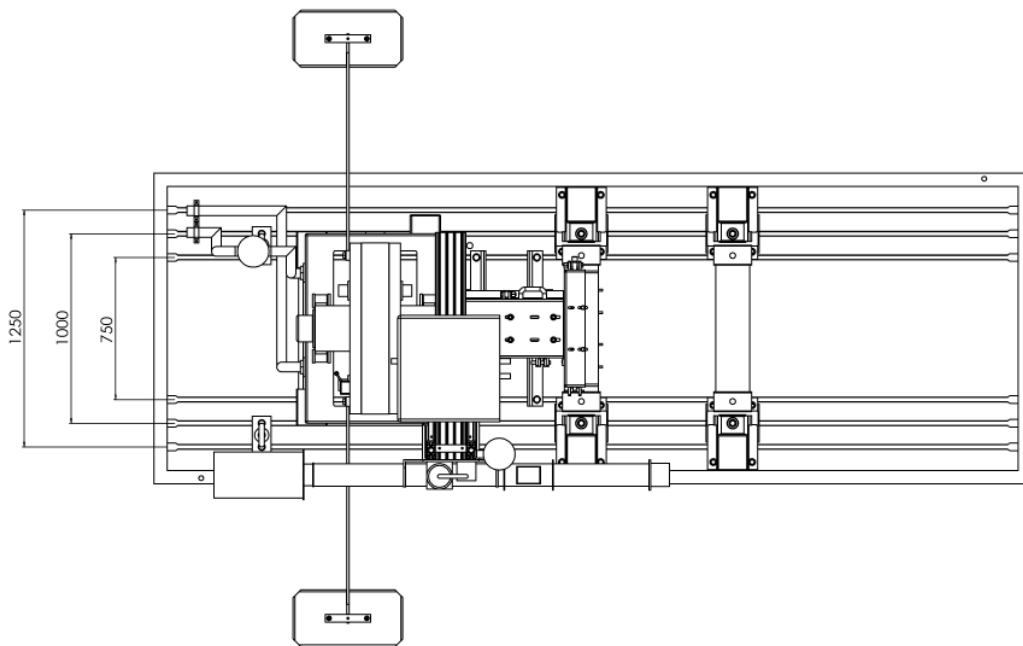


figure 16: top view

**4.2.3 TITAN S 900**

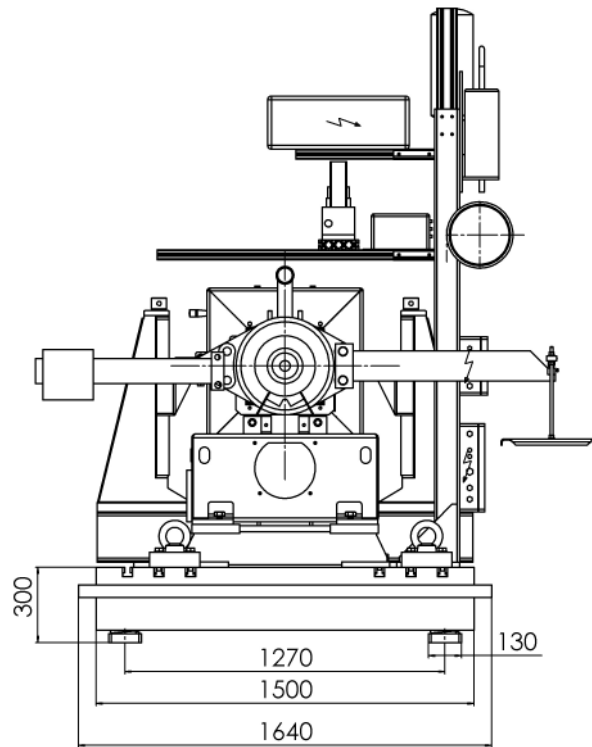


figure 17: front view

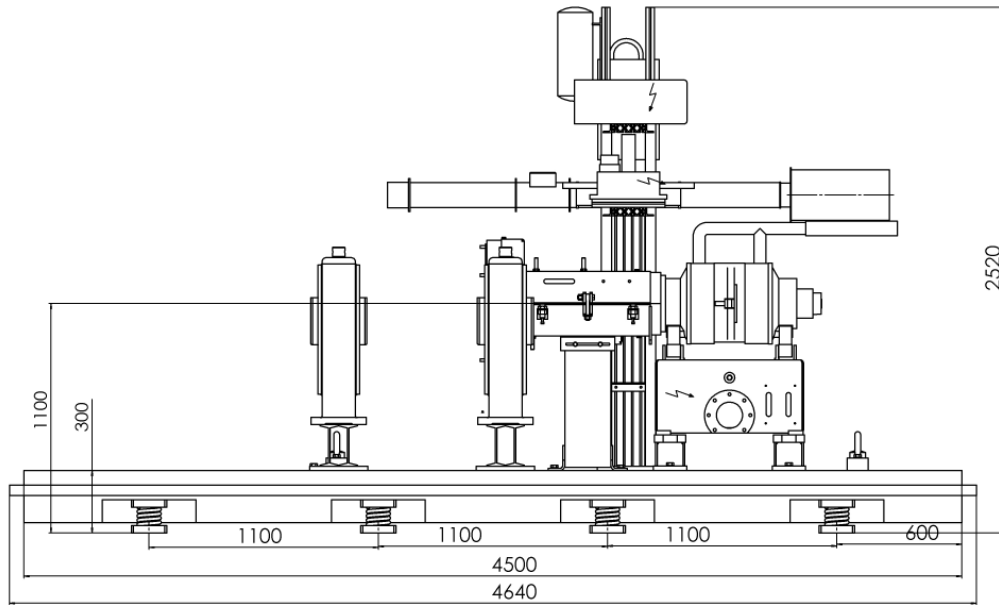


figure 18: side view

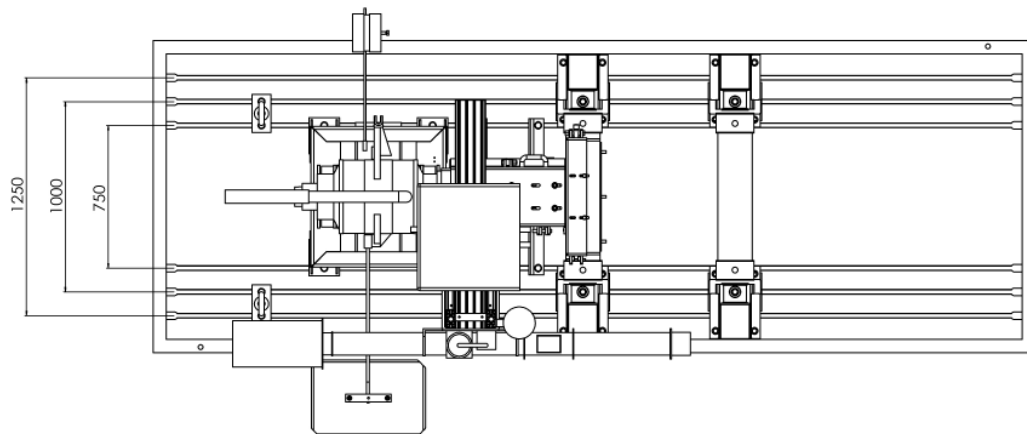


figure 19: top view

### **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 colors 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 Colors**

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

## 5 Please Note

	Dimension
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 ON" 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 Loading Unit

#### 6.1.1 Calibration Unit for dynamometer

For checking the measuring accuracy of the dynamometer torque measuring chain (measuring unit Nm)

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Testing lever	1	1	1
Weight trays	2	2	2

Note:

- without weight stones

#### 6.1.2 Magnetic Filter

For separating magnetisable particles and non-magnetisable solid ingredients.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Magnetic filter	MFGH 150	MFGH 400	-



### 6.1.3 Starter System

The starter system is used for starting Gasoline and Diesel engines at engine test stands with dynamometers if they do not have a starter system of their own. The starter system is mounted on the free end of the dynamometer shaft.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Starter system	size 1	size 2	size 2
Starter motor			
Starter mounting support with sheet-metal cover			
Starter toothed wheel on 2nd coupling flange			
Cable set			

Technical Data	Titan S 190	Titan S 470	Titan S 900
Rated power [kW]	2,4	5,4	5,4
Starter voltage [V]	12	24	24

Note:

Not included in the scope of supply are:

- battery
- power supply

### 6.1.4 Design of a Special Shaft Connection

For an engine deviating from the base specification, a special shaft connection can be designed. The following services are provided for that:

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

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Shaft design	1	1	1

Note:

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

**6.1.5 Manual Operating Unit 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 S 190	Titan S 470	Titan S 900
Operating panel	19" panel, 4 HU	19" panel, 4 HU	19" panel, 4 HU
Cable set	1	1	1



Figure 20: SPARC Operating Unit

**6.1.6 Engine Electrics 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 S 190	Titan S 470	Titan S 900
Switchbox with built-in relay for:	1	1	1
- ignition			
- preheating			
- starting			
Cable set, 20 m, to the control cabinet	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
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 V) for the specimen and the cabling to the engine are provided by the customer.
- The ignition relay connector must always be connected with the combustion engine in order to safely switch off the specimen in case of an emergency stop.

### 6.1.7 SPARC E-Gas-Potentiometer-Simulation

Required to simulate the pedal sensor signal of the combustion engine by the SPARC controller. Therefore an analogue interface module, integrated in a housing, is installed at the mounting support close to the specimen.

Scope of supply	Titan S 190	Titan S 470	Titan S 900
AI for demand value of throttle position signal	2	2	2
AO for connecting the reference signal of the ECU	2	2	2
potential Available AO to display idle- and full load throttle position	2	2	2
Default Setup data set	1	1	1
Cable set, 20m, to the control cabinet	1	1	1

### 6.1.8 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	TitanS 190	TitanS 470	TitanS 900
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

**6.1.9 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	TitanS 190	TitanS 470	TitanS 900
Intermediate gearbox	1	1	1

**6.2 Media Conditioning**

**6.2.1 Conditioning Module for Engine Coolant**

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

Mechanic module with basic cooling function

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

Electric module digital controller engine coolant temperature

- System control with safety functions
- Installation 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 system

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Type	WM 200	WM200	WM 400
Mechanics module	1	1	1
Expansion tank with fittings	1	1	1
Electric modules	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 S 190	Titan S 470	Titan S 900
Inlet pressure difference [kPa]	350	350	350
Required cooling water flow [m <sup>3</sup> /h]	18	18	35
Permissible cooling water temperature supply/return [°C]	35/45	35/45	35/45
Cooling performance [kW]	200	200	400
Stationary control accuracy [K]	+/-1	+/-1	+/-1
El. connection power without heating option [kW]	2	2	4
El. connection power with heating option [kW]	17	17	23

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 15 kW for Conditioning Module Engine Coolant

for heating the engine coolant.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
Heating power [kW]	15	15	15

**6.2.1.2 Facility Cooling Water Filter**

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

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Filter	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Mesh width [mm]	0.5	0.5	0.5

**6.2.1.3 Cooling Water Filter of the Engine**

Removes solids from the engine cooling water circuit.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Filter	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Mesh width [mm]	0.5	0.5	0.5

## 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 S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
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	0.2% of nominal range	0.2% of nominal range	0.2% of nominal range
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 S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
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 measuring [°C]	0.2	0.2	0.2
Measuring signal [mA]	4...20	4...20	4...20



### 6.3.2 Fuel Consumption Measuring System PLU-KV2

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 S 190	Titan S 470	Titan S 900
Measuring and cooling unit KV2	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
Cable set, 15m, to test stand automation	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Measuring range [l/h / kg/h]	1...120 / 0.8...90	1.5...160 / 1.2...130	1.5...160 / 1.2...130
Measuring accuracy, volumetric [% of MV]	0.5	0.5	0.5
Measuring accuracy, gravimetric [%of MV]	0.52	0.52	0.52
Measuring accuracy, density measurement [%of MV]	0.13	0.13	0.13
Inlet pressure range [kPa]	0...30	0...30	0...30
Outlet pressure range [kPa]	10...80	10...80	10...80
Max. fuel inlet temperature [°C]	40	40	40
Fuel outlet temperature with cooling, adjustable [°C]	10...30	10...30	10...30
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 carried out by the customer.
- A fuel filter at the inlet of the fuel consumption measuring system is to be provided by the customer.
- Requires cold water approx. 6°K colder than the desired fuel outlet temperature.

### 6.3.2.1 Input Pressure Reducing Valve

for adjusting the input pressure of the fuel to the system pressure of the measuring unit.

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Input pressure reducing valve with manometer	1	1	1

### 6.3.2.2 Density Measuring Unit

Density sensor for online measurement of the fuel density. For installation into the PLU-KV2.

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Density measuring unit, installed in PLU-KV2	1	1	1
Electronic module, installed in PLU-KV2	1	1	1

### 6.3.2.3 Outlet Pump with Bypass Valve

For increasing the fuel output pressure to approx. 6 bar.

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Fuel pump and bypass valve, mounted on mounting panel for measuring range [l/h / kg/h]	1...120 / 0.8...90	1...120 / 0.8...90	1.5...160 / 1.2...130
Fittings	1	1	1
Connecting cable	1	1	1

### 6.3.2.4 Overflow Collector Tank

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

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Overflow connector tank	1	1	1

### 6.3.3 Air Flow Measuring Unit

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

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Measuring tube	DN 80	DN 150	DN 200
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 S 190	Titan S 470	Titan S 900
Measuring range [kg/h]	20...720	80...2400	200...4000
Hysteresis and non-linearity [% of Measured Value]	1	1	1
Reproducibility [% of Measured Value]	0.25	0.25	0.25
Temperature influence [%/K of Measured Value]	0.03	0.03	0.03
Pressure influence [%/bar of Measured Value ]	0.2	0.2	0.2

Note:

- Hose connection to the engine 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 gases of combustion engines. The measuring principle is based on a special ultrasonic scanning method

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
Measuring range [l/min]	6...280	10...450	25...2260
Measuring error [% of Measured Value]	<1	<1	<1

Note:

- The adaptation of the blow-by measuring unit to the test specimen 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 S 190	Titan S 470	Titan S 900
Pressure transducer	4	4	4
Measuring range -100...150 kPa	1	1	1
Measuring range 0...250 kPa	2	2	2
Measuring range 0...1000 kPa	1	1	1
Connector	4	4	4
Connecting cable	4	4	4
Factory calibration certificate according to ISO/IEC 17025	4	4	4

Technical Data	Titan S 190	Titan S 470	Titan S 900
Error hysteresis, non-linearity, reproducibility	0.15% of the range	0.15% of the range	0.15% of the range
Temperature influence	0,1% of nominal range / 10K	0,1% of nominal range / 10K	0,1% 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	1/4" inside thread	1/4" inside thread	1/4" inside thread

Note:

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

### 6.3.6 Extension Temperature Measuring Equipment

#### 6.3.6.1 Resistance Thermometer Pt100

For measuring temperatures of up to 200° C.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
RTD Pt 100, type 1, with connecting cable, 3 m, and connector	8	8	8
Calibration certificate	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Accuracy class A 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

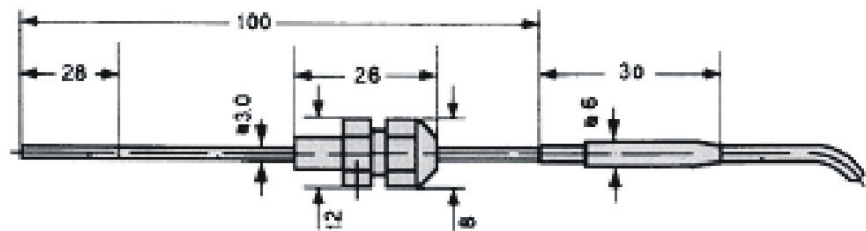


Figure 21: Type 1 Resistance Thermometer

**6.3.6.2 Thermocouples**

For measuring temperatures of up to 1200° C.

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Thermocouple type K with connecting cable, 3 m, and thermo connector	8	8	8
Calibration certificate	1	1	1

Technical Data	Titan S 190	Titan S 470	Titan S 900
Accuracy class 1 according 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

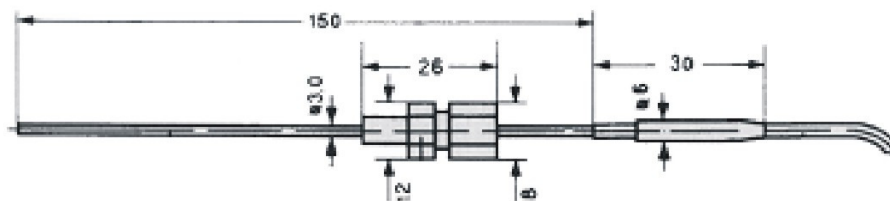


Figure 22: Type K Thermocouple

### 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.

Front side measuring module temperature (type SDT16)

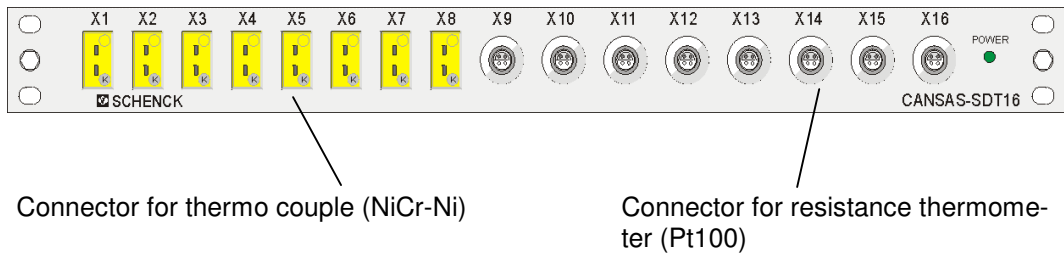


Figure 23: Temperature Measuring Rack

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
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 S 190	Titan S 470	Titan S 900
Measuring error, static, Pt100			
- -200...+600 °C	<1K	<1K	<1K
- 0...200 °C	<0.5K	<0.5K	<0.5K
Measuring error, static, thermo-couple			
- -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 resistance thermometers (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

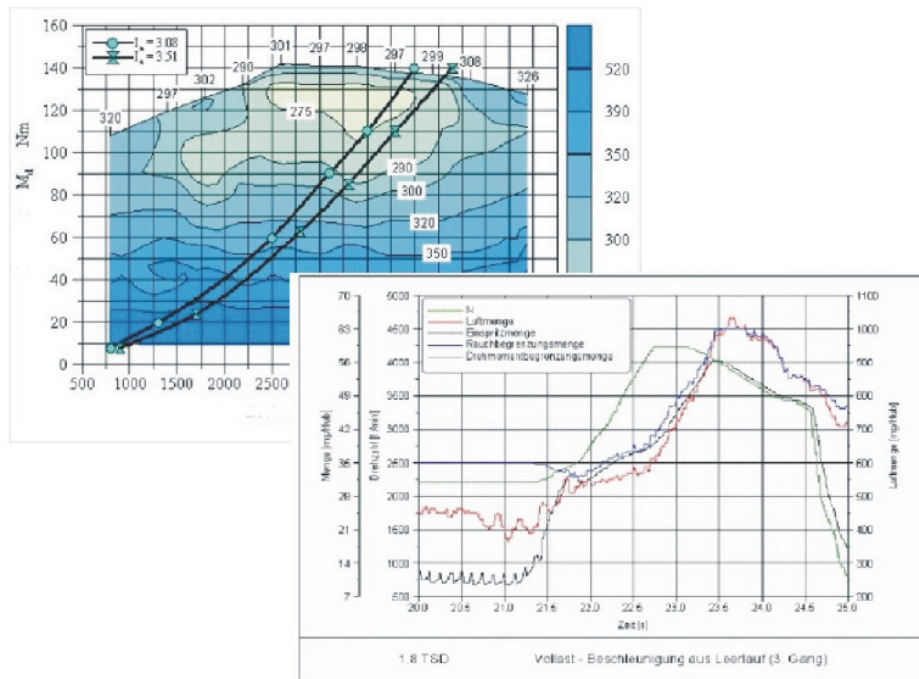


Figure 24: Uniplot Examples

Scope of Supply	Titan S 190	Titan S 470	Titan S 900
Software package UniPlot	1	1	1

Note:

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

### 6.4.2 Software Maintenance

A software maintenance contract for the STARS Automation 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 the responsible Horiba office) rendering the following service by telephone, e-mail or on-line through remote access via WebEx:
  - Assistance in interpretation of fault and error message 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 can be offered on request.

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

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Software maintenance contract	1	1	1

### 6.4.3 Language Versions for STARS Automation

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

- English
- Japanese

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
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

### 6.4.4 Additional TFT Monitor

for STARS automation.

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
17" TFT Monitor (DVI)	1	1	1
3m power and video cable	1	1	1

## 6.5 Alternative Cable Sets

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

Scope of Supply	TitanS 190	TitanS 470	TitanS 900
Cable set test stand-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 Sensyflow [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 Colors**

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 regulations.

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