Zwick / Roell

Intelligent testing

Pendulum Impact Instruments and Melt Flow Plastometers with new functions

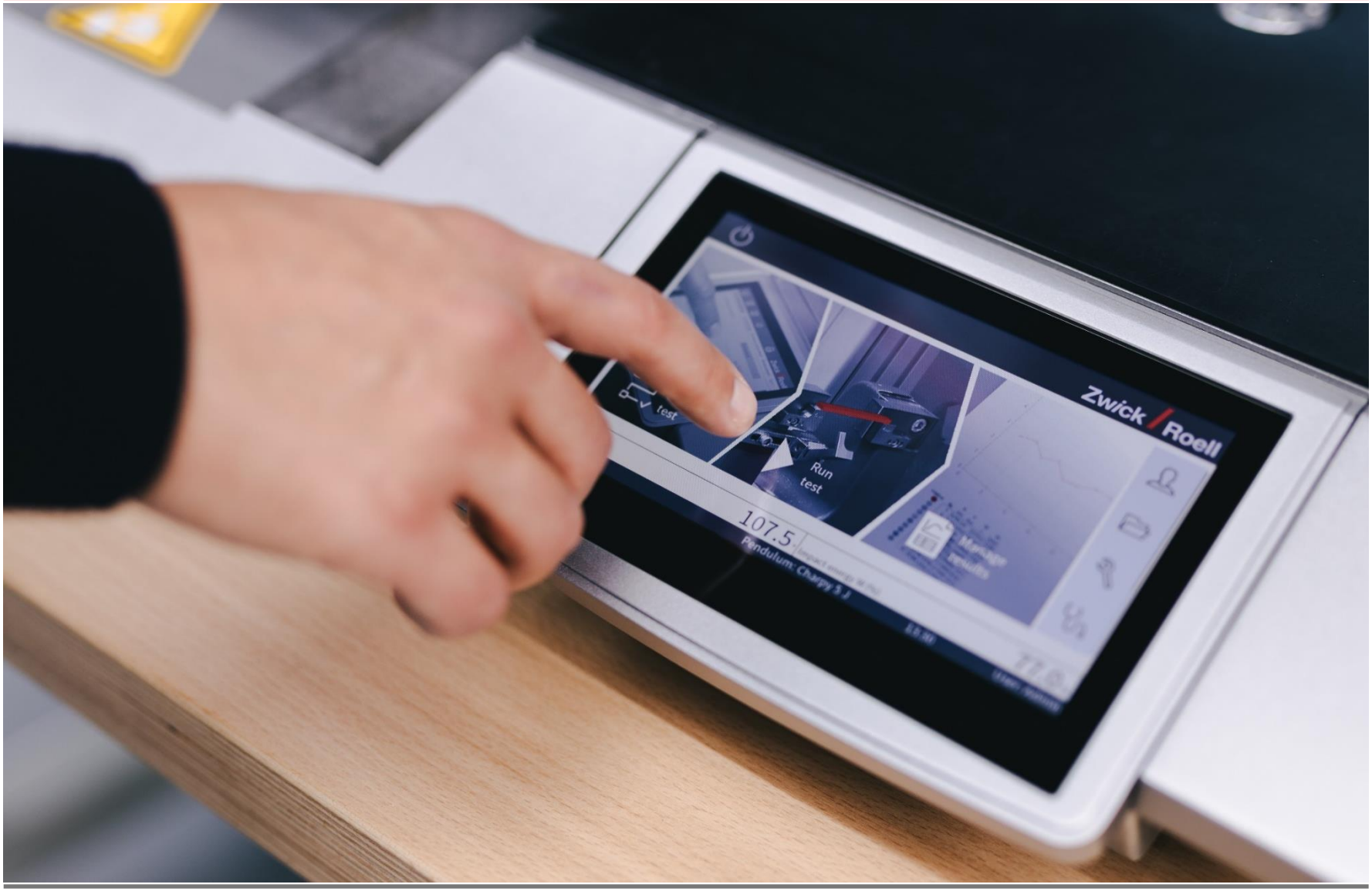
Helmut Fahrenholz

ZwickRoell, Ulm

Pendulum Impact for Plastics

Melt Flow Plastometers

The new controller



Agenda

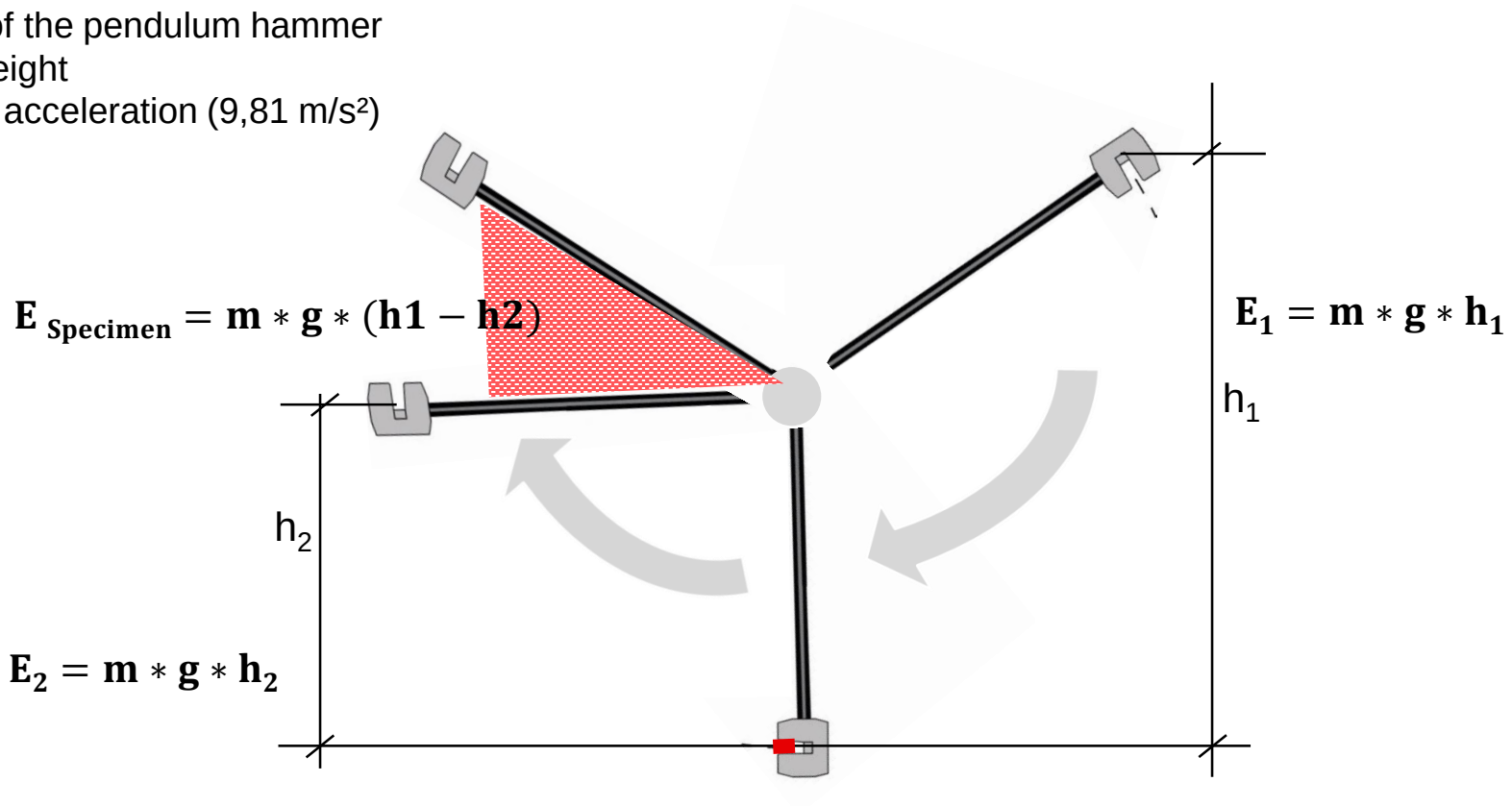
Pendulum Impact

Melt Flow Rates

Pendulum Impact – Working principle

In the conventional method, impact resilience is measured by height difference and the mass of the pendulum hammer.

E – energy
m – mass of the pendulum hammer
h – drop height
g – gravity acceleration (9,81 m/s²)



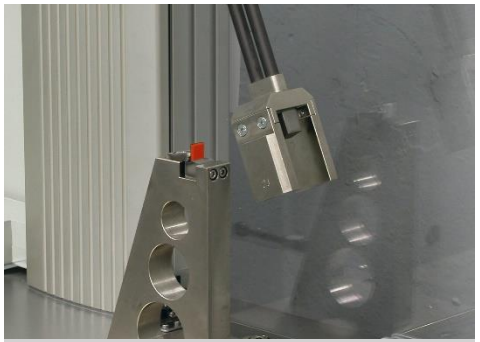
Pendulum Impact – Working principle

Four methods are currently applied: Charpy, Izod, tensile-impact and in the German automotive industry also Dynstat.

Charpy
ISO 179-1, -2, ASTM D 6110

IZOD
ISO 180, ASTM D 256

Tensile Impact
Here: ISO 8256 method A



Dynstat
DIN 53435

Pendulum Impact – Working principle

The type of break is an integral part of the result. Only same types of breaks supply comparable results.

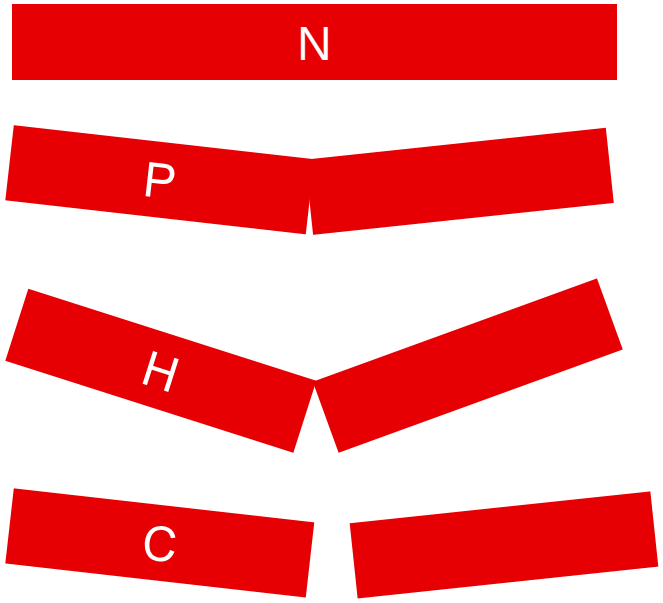
Standardized types of break:

N – non-break (no valid result)

P – partial break

(H – hinge break)

C – complete break



The most frequent type of break within a test series determines the results to be used in the statistics.

Pendulum Impact – Working principle

There is not result without specimen break !

Guidance according ISO standards on how to obtain break

- **The preferred method is to use unnotched specimen**

if no valid break types can be achieved

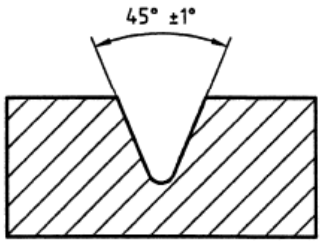
- Use specimen with type A notch (0.25 mm)

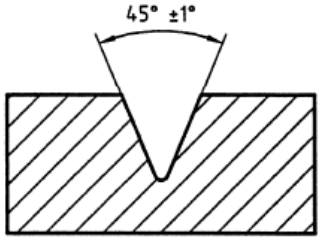
If still no valid break types can be achieved

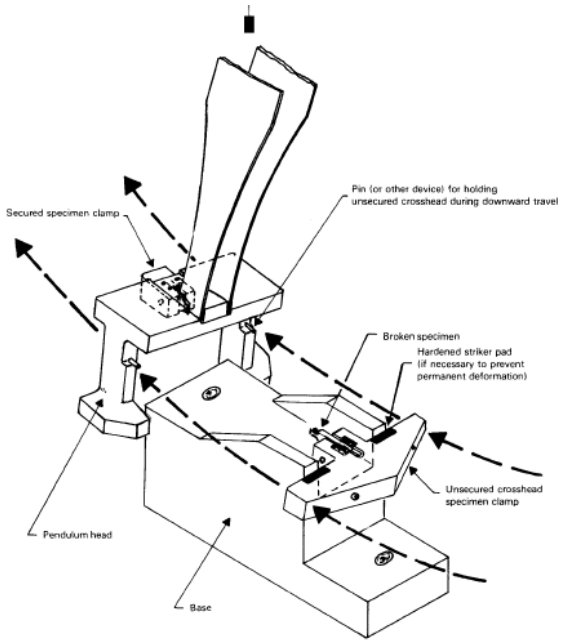
- Use specimen with type C notch (0.1 mm)

If still no valid break types can be achieved

- Use the tensile-impact method







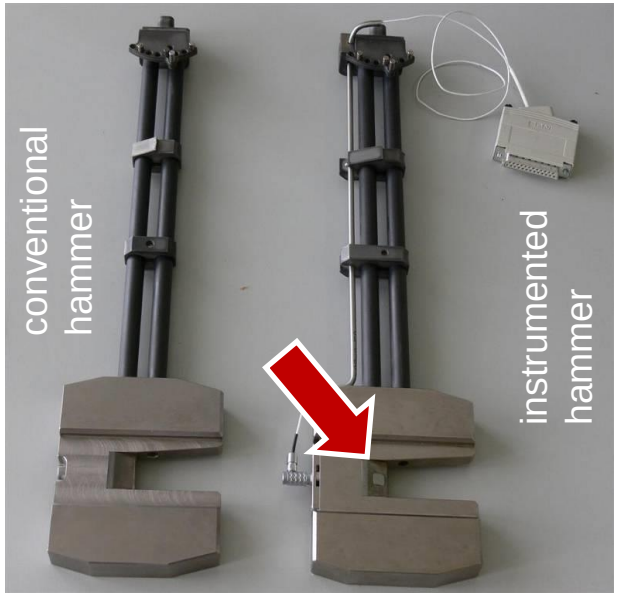
Instrumented Pendulum Impact Testing

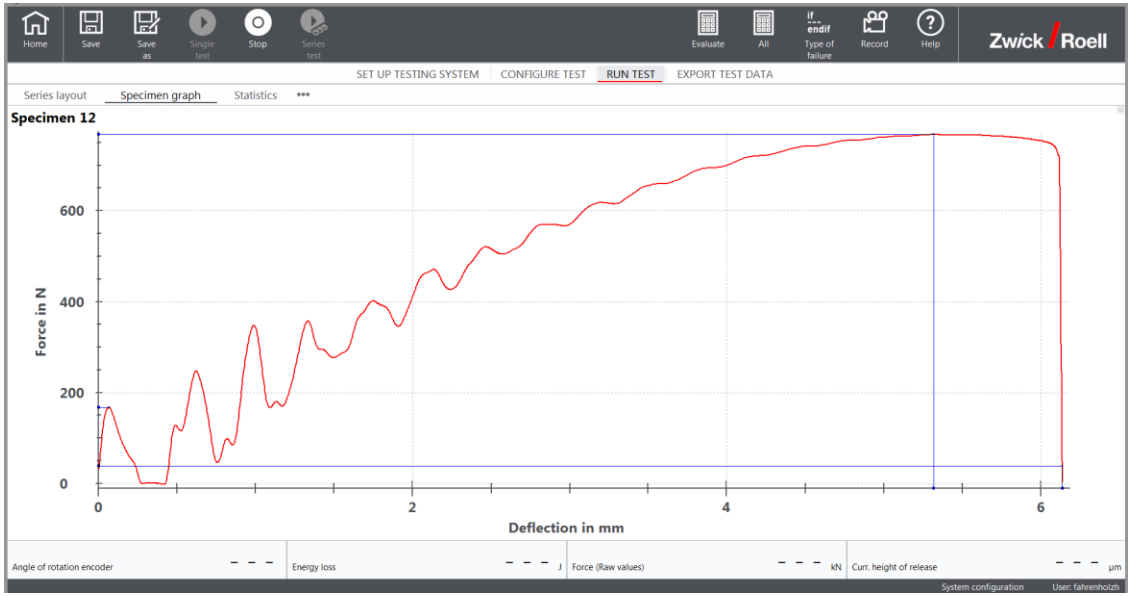
Instrumented pendulum impact means force measurement during impact. This offers supplementary result acquisition.

- used in R&D, TS and QA

- Charpy
- Izod

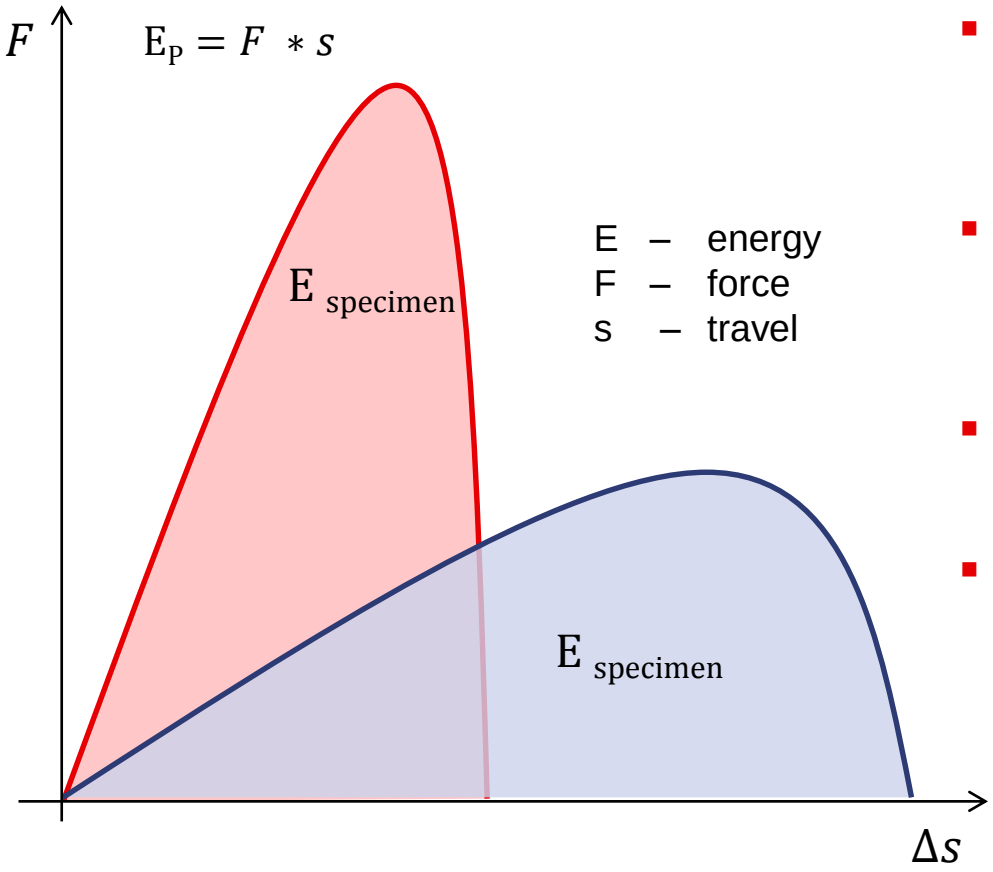
- tensile impact
- Fracture mechanics





Instrumented Impact Testing

The force-travel diagram provides supplementary materials data obtained under high deformation rates.



- The conventional method may show same results for completely different stress-strain behavior.
- Instrumented impact methods allow to distinguish such situations, while conventional impact can’t.
- Break types can automatically be detected
- Information about fracture mechanical characteristics can be obtained.

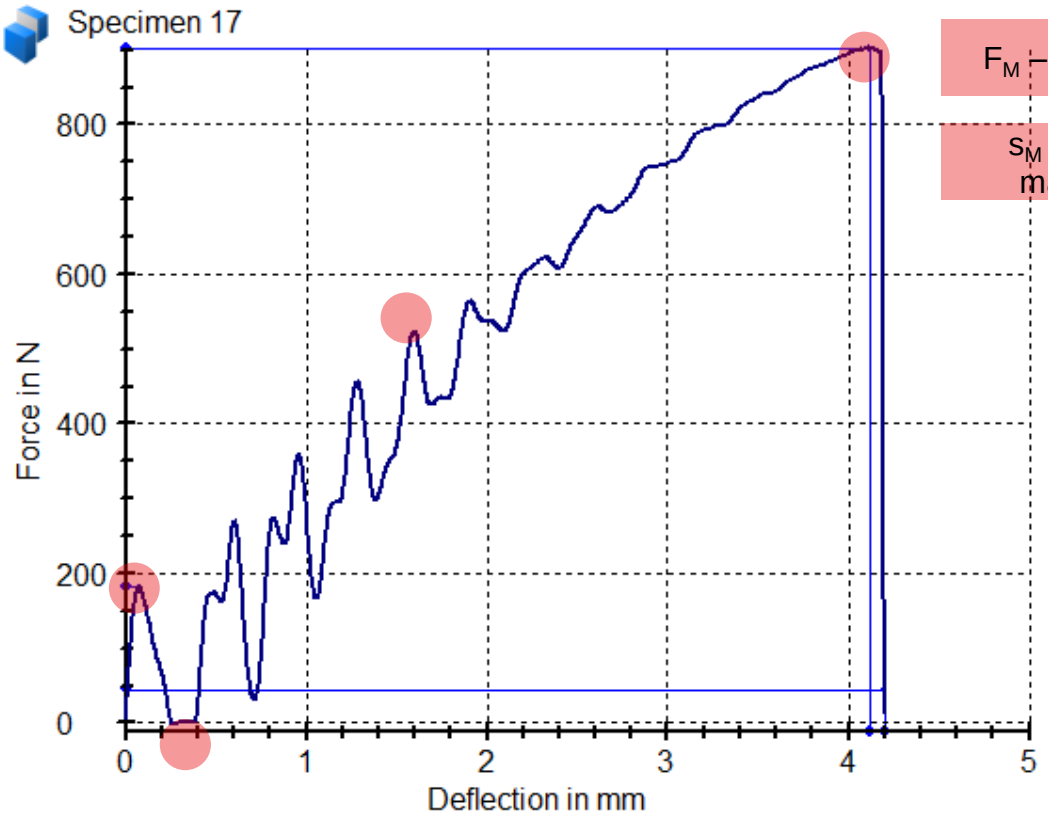
Pendulum Impact - Tests and Curves

Several points in a travel-deflection diagram are characteristic for instrumented Charpy tests

The specimens natural frequency has a square-root function with the materials tensile modulus

F_I – First impact maximum

No contact between pendulum hammer and specimen



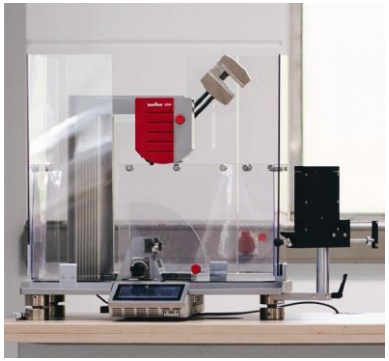
F_M – maximum force

s_M – deflection at maximum force

Pendulum Impact - Products

A complete product range for pendulum impact testing

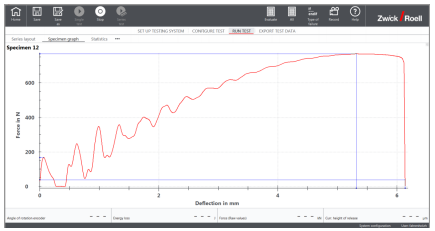
5.5 / 25 / 50 Joule universal, digital



5 Joule ISO

Notch cutting machine

Manual notch cutter



Instrumentation

Charpy

Izod

tensile impact

Dynstat

Automation

The HIT5P is a compact pendulum impact instrument only for ISO tests

- Compact dimensions
- Maximum energy of 5 joules
- Covers Charpy tests to ISO standard (2.9 m/s)
- Covers tensile-impact up to 5 J to method A of the ISO standard (2.9 m/s)

HIT 5P

HIT 5.5P

HIT5.5P pendulum impact tester for up to 5.5 joules

- universal impact instrument
- covers ISO and ASTM
- Charpy, Izod, Tensile-impact, Dynstat
- 3 impact speeds up to 3.5 m/s
- potential energy up to 5.5 J

Key advantages:

- automatic pendulum identification
- low-vibration carbon twin-rods
- easy vice and pendulum change
- Option for instrumented testing

HIT25P and HIT50P pendulum impact tester

The HIT 25P and HIT 50 P cover all current standards

- Universal impact instrument
- covers ISO and ASTM
- Charpy, Izod, Tensile-impact, Dynstat
- 4 impact speeds up to 3.8 m/s
- potential energy up to 25 / 50 J

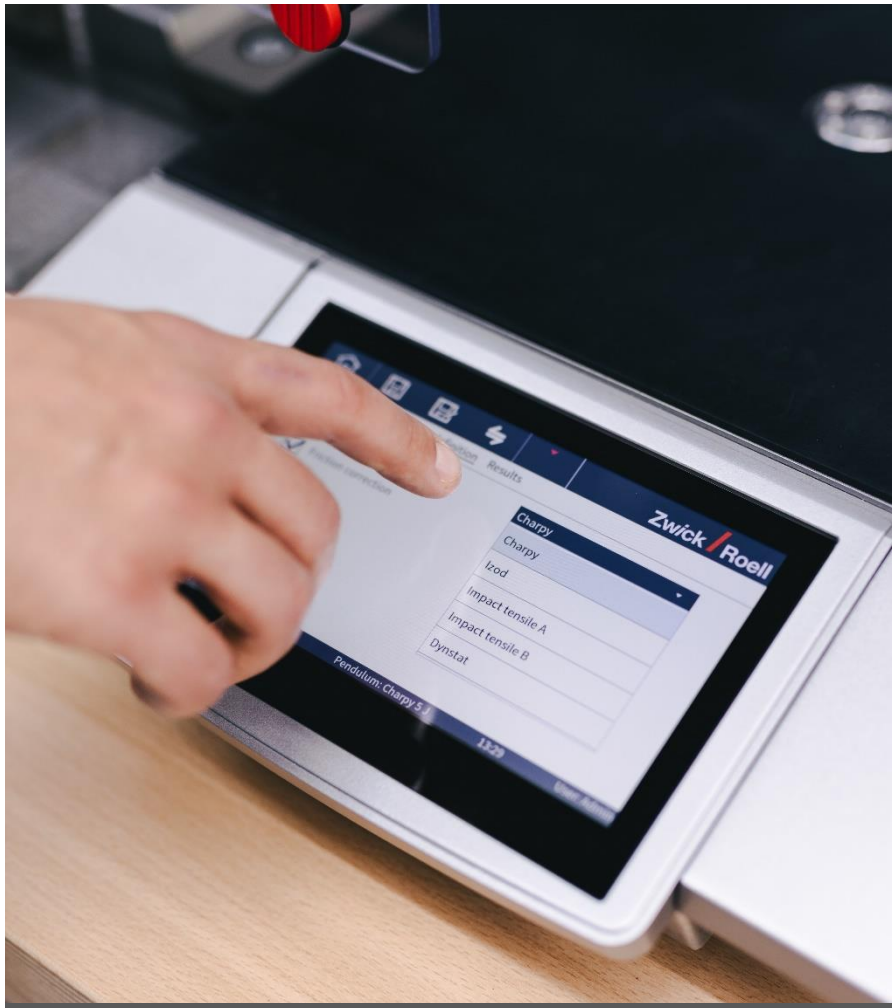
Advantages:

- pendulum identification
- low-vibration carbon twin-rods
- easy fixture and pendulum change
- Option for instrumented testing

HIT 25P

Pendulum Impact - Controller

The new controller uses the same user interface as testXpert III



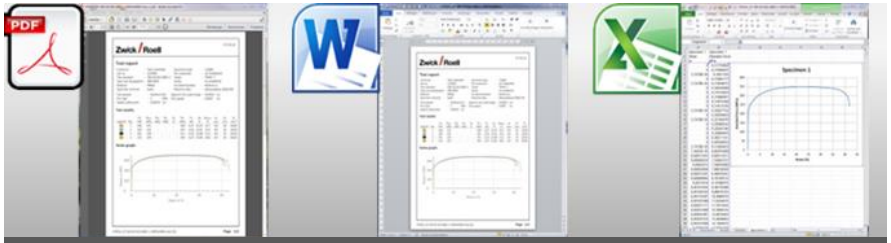
The new controller is operated by a touchscreen

- Stand alone function without PC
- Automatic recognition of the hammer and the attributed calibration
- Input of specimen dimensions and remaining width for notched specimen
- Input of the type of failure
- Visualisation of calculated results and statistics
- Visualisation of the test curve for instrumented tests
- Printing of test protocols
- Ethernet network connection
- Export of results to USB memory sticks
- User administration, access limitation
- Full integration with testXpert III software

testXpert III

Databases and transmission formats

testXpert Analytics



Adobe Reader and Microsoft Office packages

Agenda

Zwick / Roell

Pendulum Impact

Melt Flow Rates

Standards

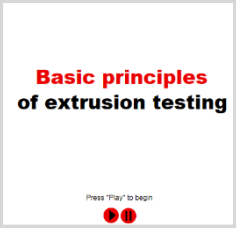
ZwickRoell extrusion plastometers fulfill all commonly used global testing standards

- ISO 1133 (part 1 and part 2)
- ASTM D 1238
- JIS K 7210
  (Version 10/1999, identic to ISO 1133)
- ASTM D 3364 (specific for PVC)

Operating principle

Melt flow rates represent the speed of extrusion of a polymer under defined temperature, through a defined die and under a defined constant pressure.

www.zwickroell.com



Method A

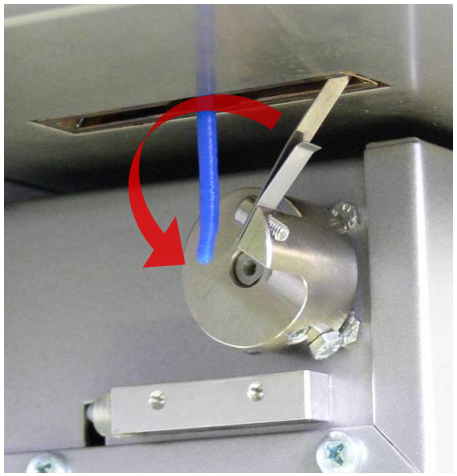
The melt-mass flow-rate is determined by weighting extrudates cut-off in known intervals.

Method A – MFR (Melt Mass Flow Rate)

The extrudates are cut off at constant time intervals.

- cut-off lengths between 10 and 20mm
- the time interval must not exceed 240s
- maximum test time 25 min.

The cut-offs are weighed on analytical scales and the result is stated in **g/10min.**



+

Range of application

- simple manual testing (low specimen volumes)
- filled plastics

Method B

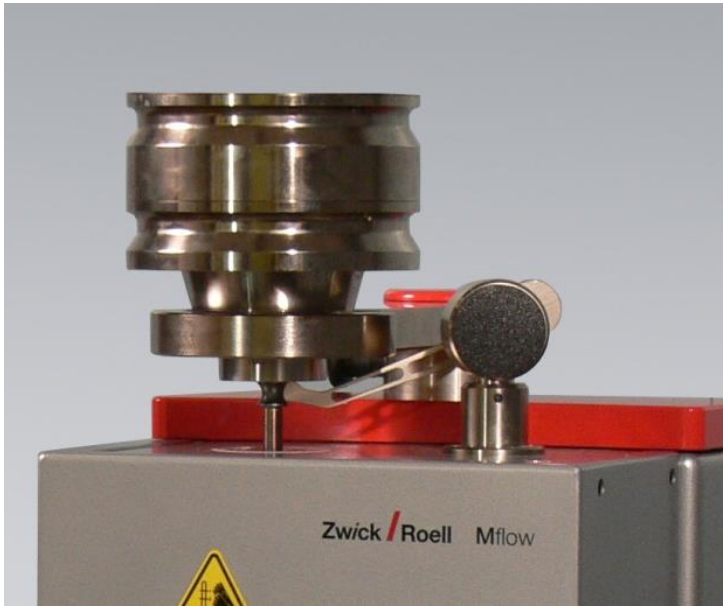
The melt volume rate is determined from piston travel measurement.

Method B – MVR (Melt Volume Rate)

Measurement of piston travel per time and conversion to extruded volume per time

- measurement interval can be travel or time-controlled
- time interval shall not exceed 240s
- maximum test time 25 min.

The result is stated in **cm³/10min.**



Range of application

- medium to high specimen volumes
- more automatic test sequences

ISO versus ASTM

ISO and ASTM procedures are different in several conditions, but the same equipment can be used for both standards.

Topic	ISO 1133-1	ISO 1133-2 (moisture sensitive & time dependend materials)	ASTM
Filling Quantity	3 to 5 g for flowrates 0.1 to 0.5 g/10min	not standardized	2.5 to 3 g for flowrates 0.15 to 1 g/10min
	4 to 6 g for flowrates > 0.5 g/10min	not standardized	3 to 5g for flowrates > 1 g/10min
	4 to 8 g for flowrates > 3.5 g/10min	4 - 5 g for flowrates 10 to 20 g/10min	4 to 8 g for flowrates > 3.5 g/10 min
		5 - 6 g for flowrates > 20 g/10min	
		6 - 7 g for flowrates > 30 g/10min	
		> 7 g for flowrates > 40 g/10min	
Preheat	loading of the material charge within 1 min	loading of the material charge within 1 min	loading of the material charge within 1 min
	5 min of preheat time, followed by the time needed to reach the start position 50 mm (no exact tolerance for the maximum preheat time)	5 min of preheat time, start position 50 mm must be reached at 5.75 ± 0.25 min after charging was completed	7 ± 0.5 min until start of measurements at a position of 46 ± 2 mm (double condition!)
Pre-compaction	Piston may be loaded, unloaded of partly loaded durin pre-heat. Purging must be completed latest 2 min before measurements begin and shall not take longer 1 min.	No specific limitations. Piston may be loaded, unloaded of partly loaded during pre-heat.	Purging must be completed latest 2 min before measurements begin.
Method A	Maximum time per measurement = 240 s	Maximum time per measurement = 240 s	Measurement at fixed time intervals:
	Maximum time im the barrel = 25 min	Maximum time im the barrel = 25 min	6 min for MFR 0,15 to 1 g/10min
	Any cutting time allowed, preferred filament length is 10 to 20 mm	Any cutting time allowed, provided that the filament length is > 10 mm. Use all cut filaments within the avail. 30 mm of piston travel for the result calculation.	3 min for MFR 1 to 3.5 g/10min 1 min for MFR 3.5 to 10 g/10min 0.5 min for MFR 10 to 25 g/10 min 0.25 min for MFR > 25 g/10 min
Method B	Maximum time per measurement = 240 s	Maximum time per measurement = 240 s	MVR up to 10 --> 6.35 ± 0.25 mm
	Maximum time im the barrel = 25 min	Maximum time im the barrel = 25 min	MVR > 10 --> 25.4 ± 0.25 mm
	Every possible measurement travel and times are allowed. Standard indicates preferred values.	Fixed measurement travel between 20 and 30 mm	

Extrusion plastometers

The Xflow series – the ideal extrusion plastometer for every testing situation.

Cflow
Compact

- manual instrument for goods inwards checks
- fast, reliable testing to Method A

Mflow
Modular

- modular instrument for higher testing volumes
- low-cost entry, capable of successive expansion
- method A and method B

Aflow
All-round

- handy all-rounder for 24-hour operation
- optimum test sequence - efficient and reliable
- Method A, B, C and D

Higher testing volume, higher level of automation, greater convenience

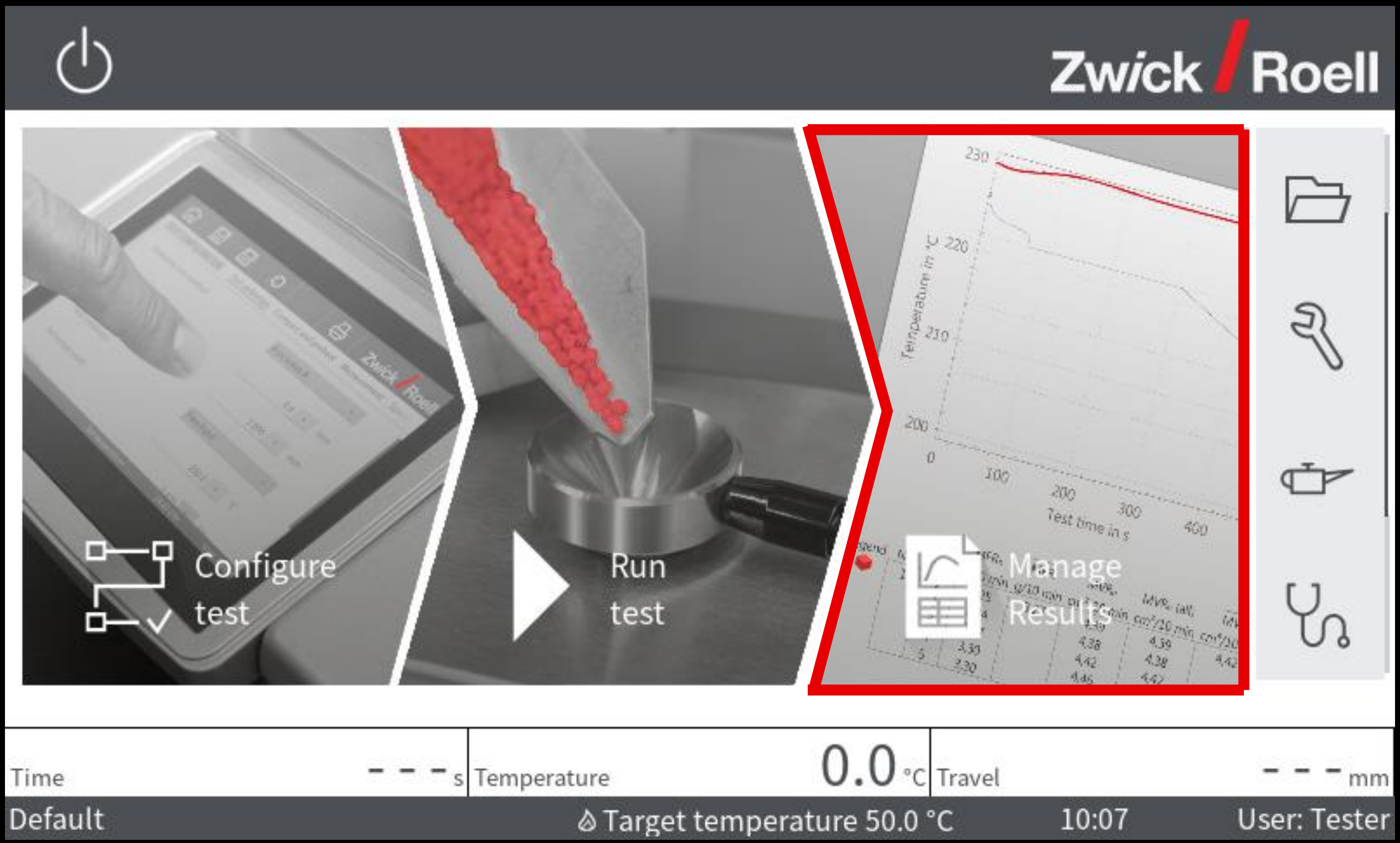
Next generation Xflows – modern and designed for tomorrow's technology.

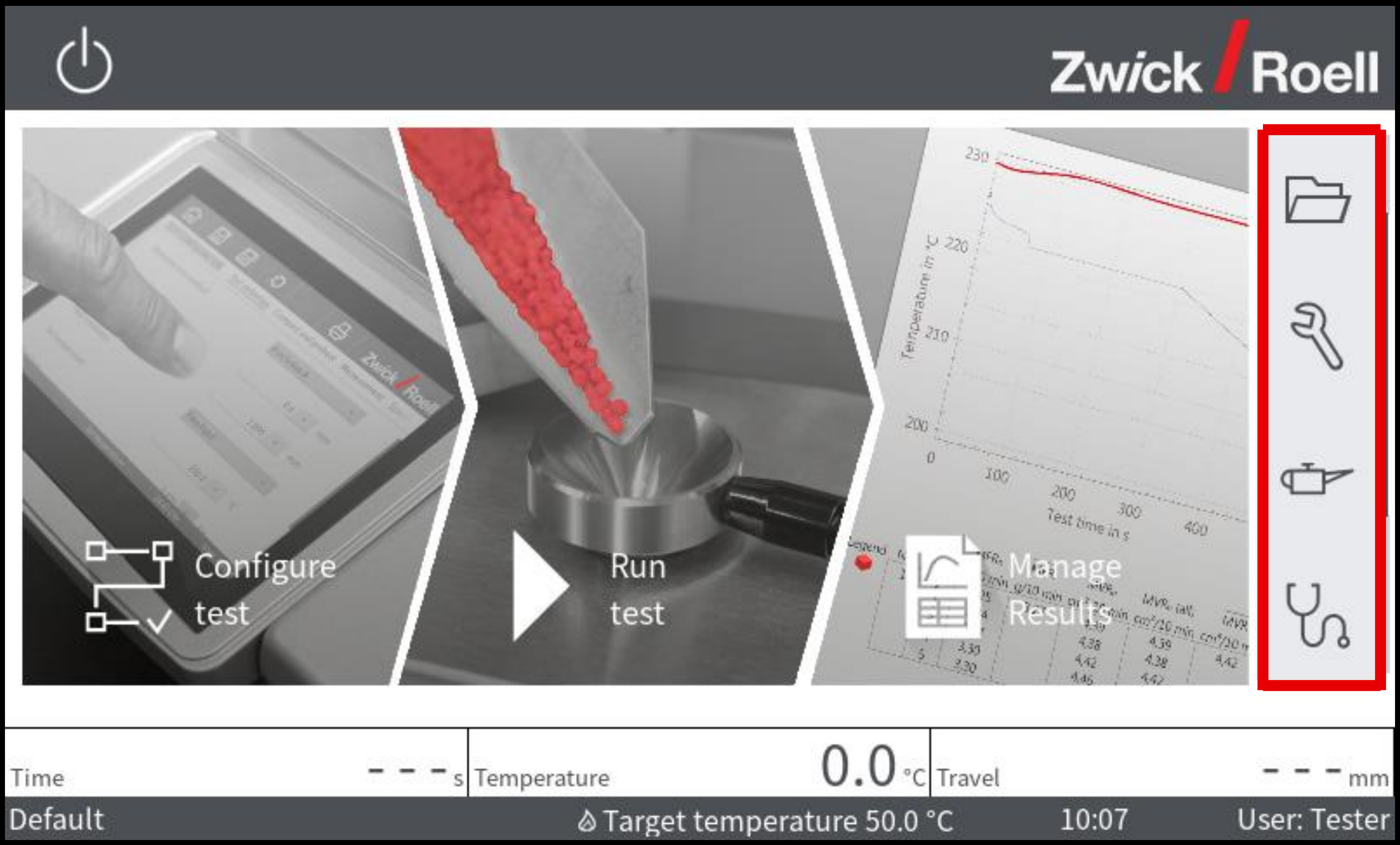
- Flexible use with or without a PC
- Intuitive and workflow-based right from the start!
- Quick familiarization with user management

The new controller

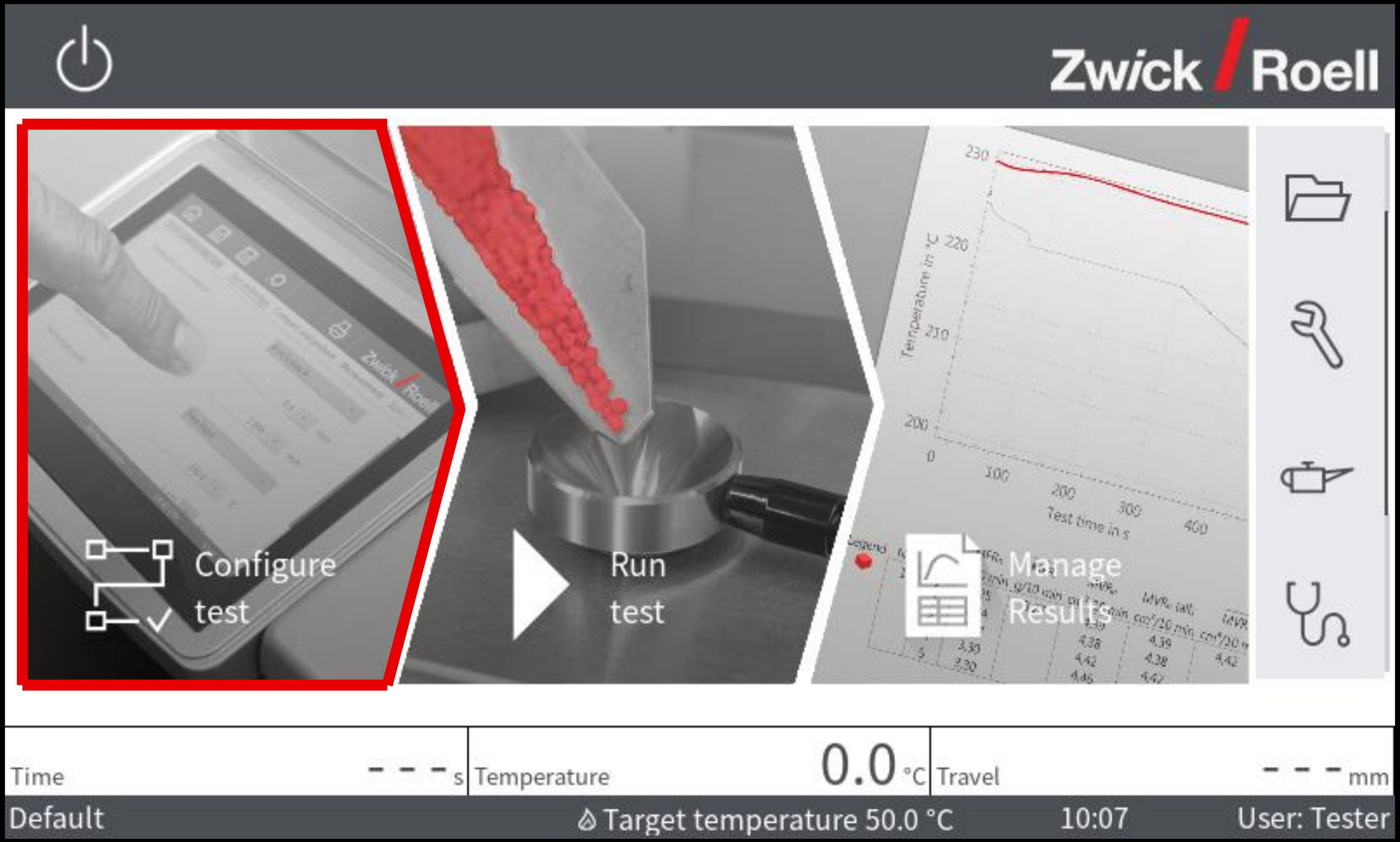

ZwickRoell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester


Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester

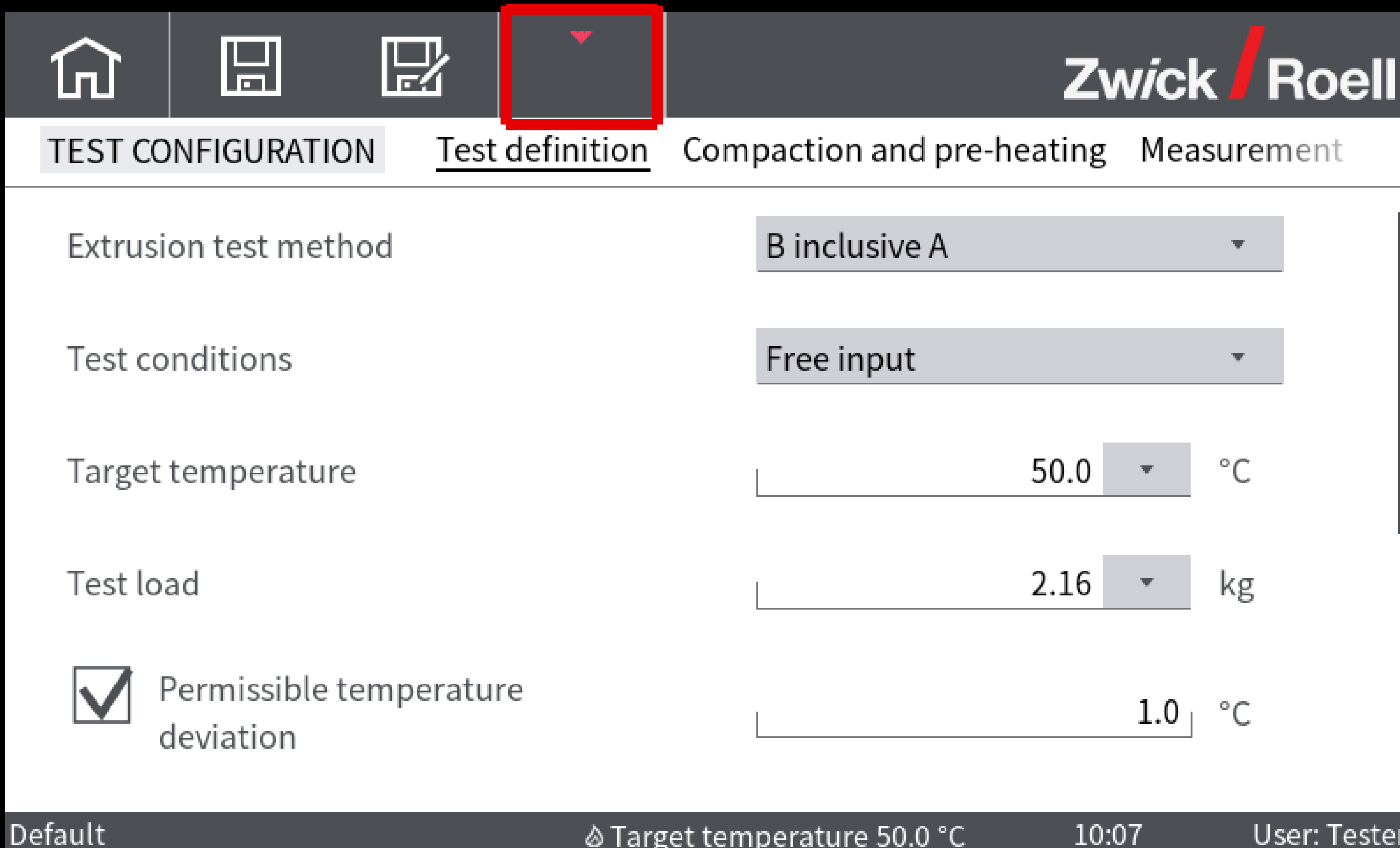

Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester

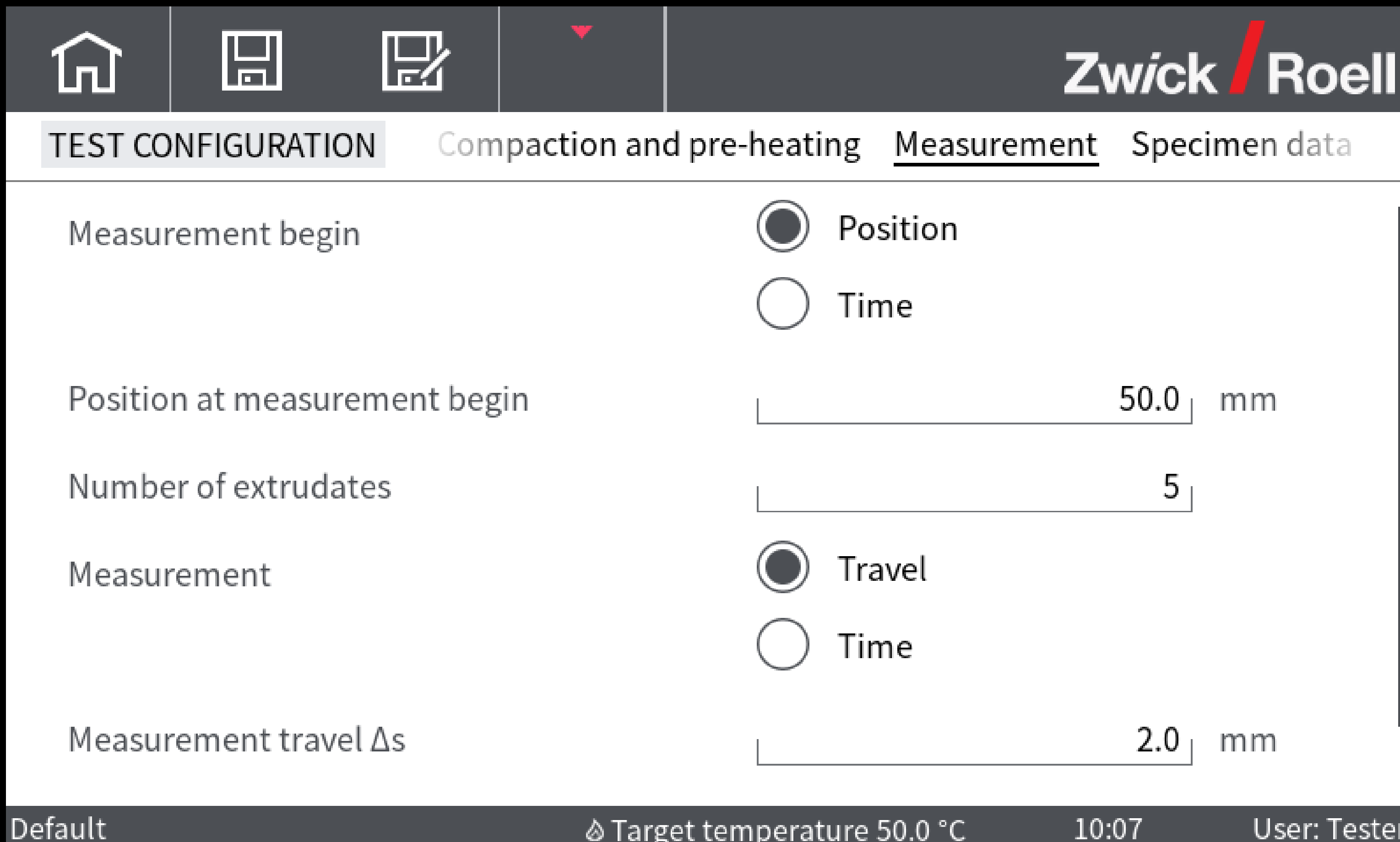

Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester

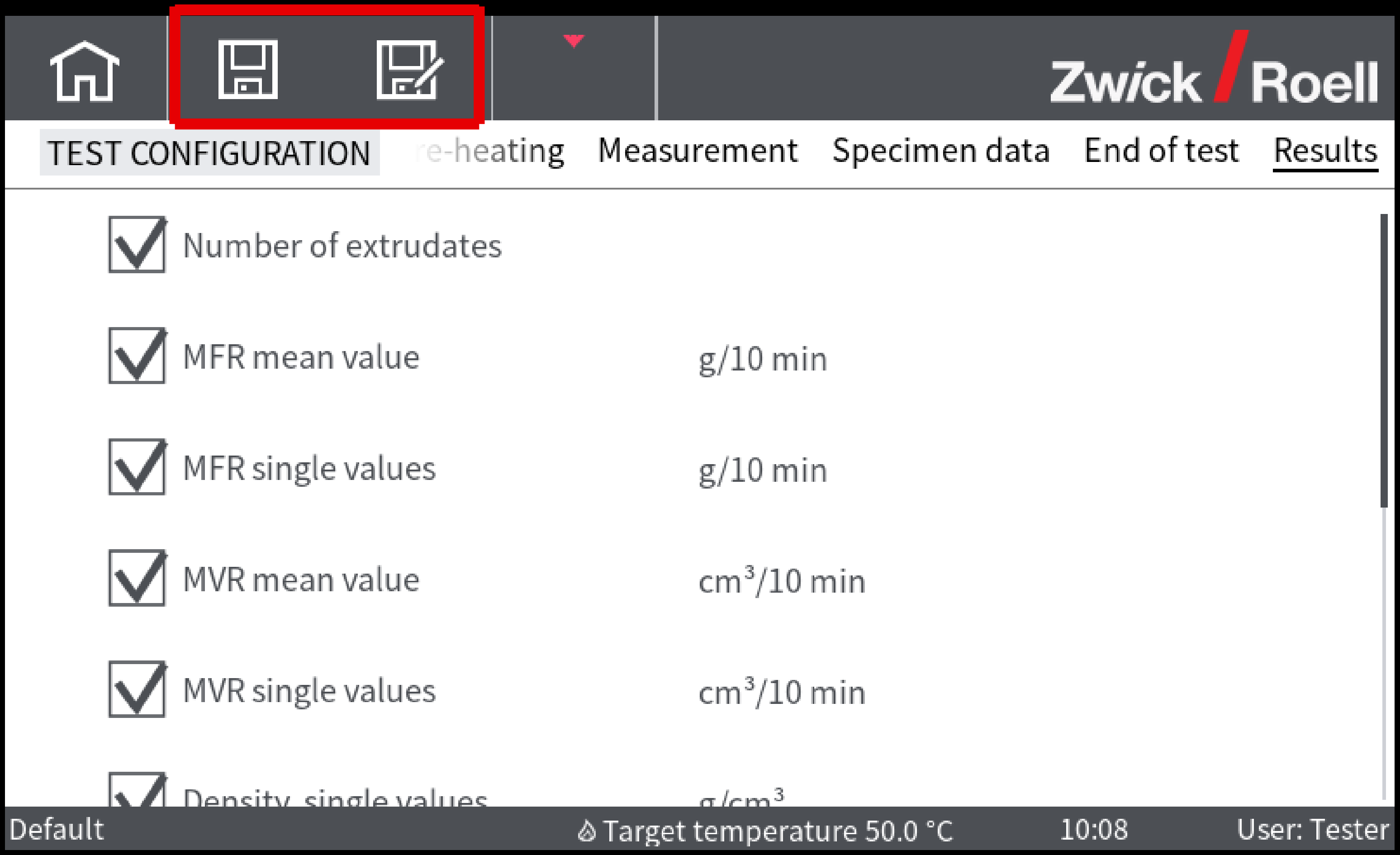
Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester

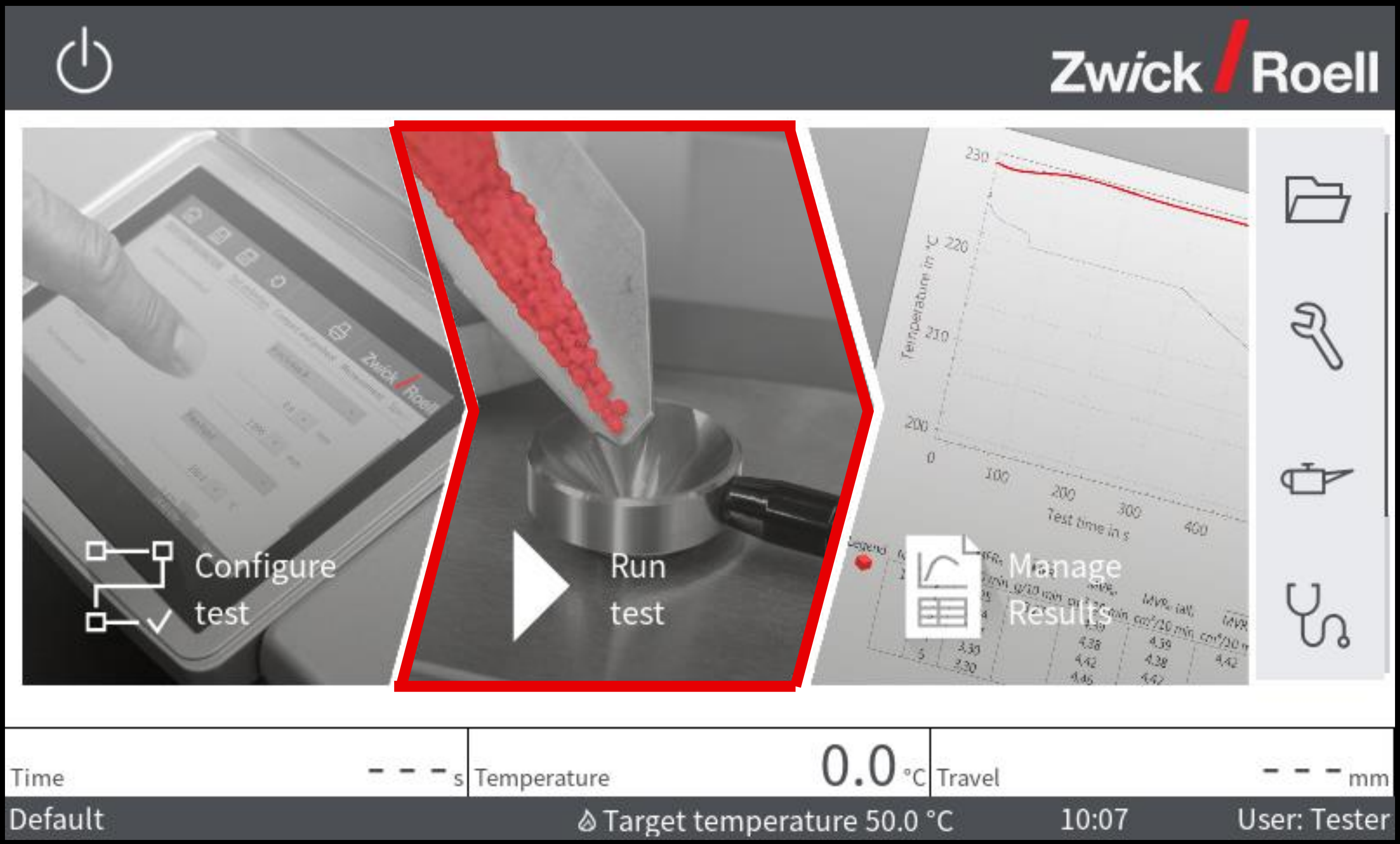


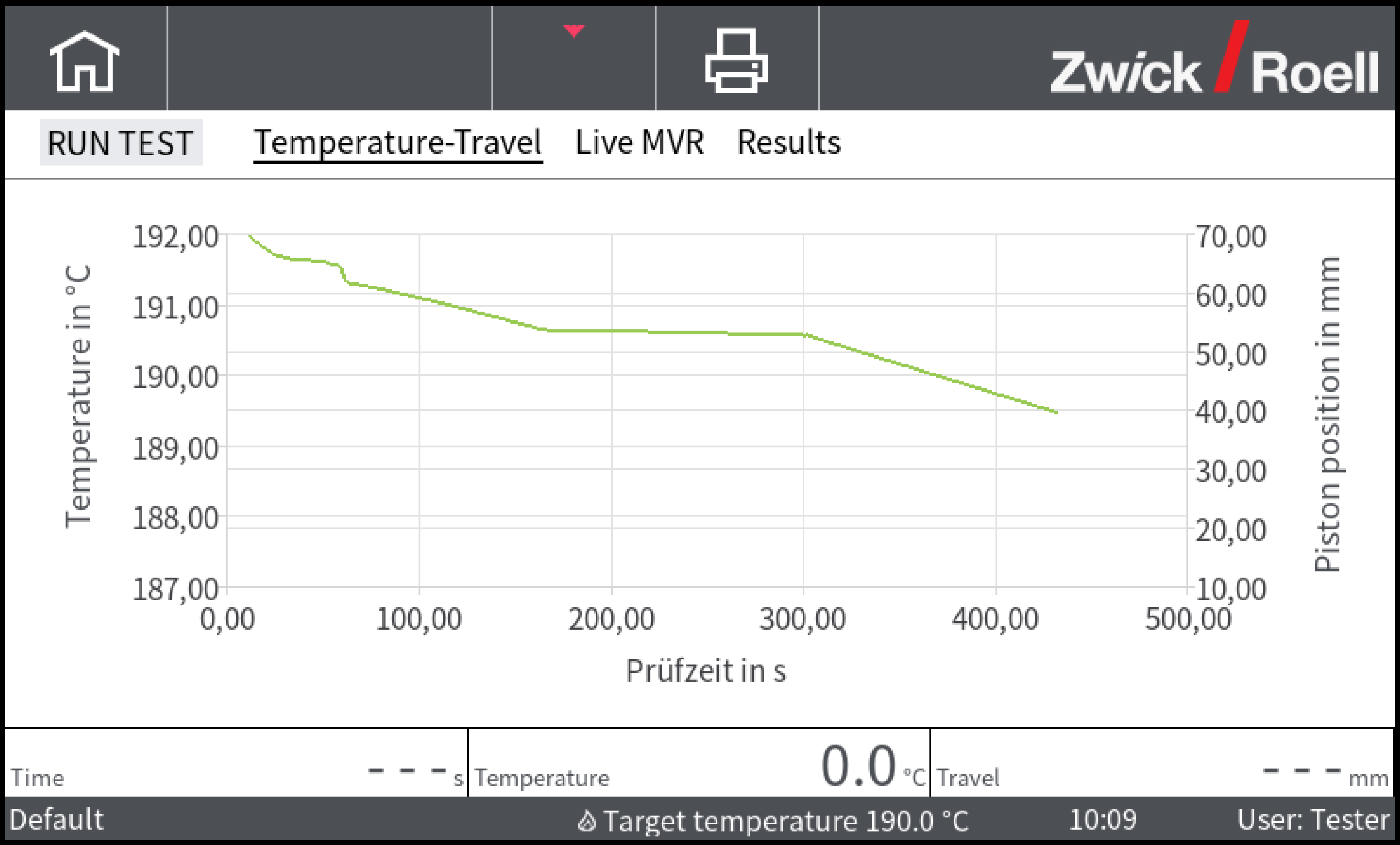
Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester

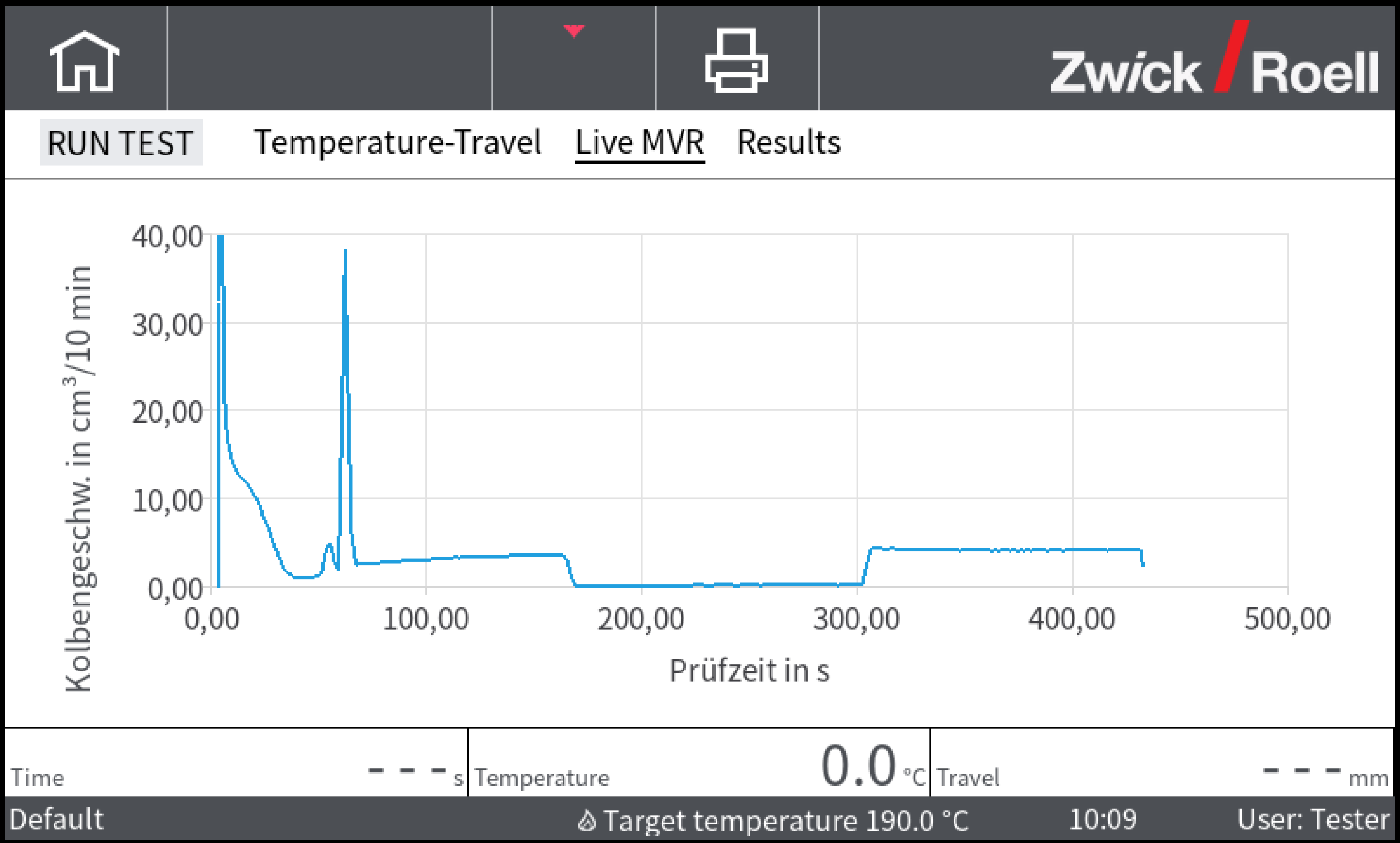

Zwick Roell
TEST CONFIGURATION
Test definition
Compaction and pre-heating
Measurement
Extrusion test method
B inclusive A
Test conditions
Free input
Target temperature
50.0
°C
Test load
2.16
kg
Permissible temperature deviation
1.0
°C
Default
Target temperature 50.0 °C
10:07
User: Tester


ZwickRoell
TEST CONFIGURATION
Compaction and pre-heating
Measurement
Specimen data
Measurement begin
Position
Time
Position at measurement begin
50.0
mm
Number of extrudates
5
Measurement
Travel
Time
Measurement travel Δs
2.0
mm
Default
Target temperature 50.0 °C
10:07
User: Tester


Zwick Roell
TEST CONFIGURATION
re-heating
Measurement
Specimen data
End of test
Results
Number of extrudates
MFR mean value g/10 min
MFR single values g/10 min
MVR mean value cm³/10 min
MVR single values cm³/10 min
Default
Target temperature 50.0 °C
10:08
User: Tester


Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester


Zwick Roell
RUN TEST
Temperature-Travel
Live MVR
Results
Temperature in °C
192,00
191,00
190,00
189,00
188,00
187,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
Piston position in mm
0,00
100,00
200,00
300,00
400,00
500,00
Prüfzeit in s
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 190.0 °C
10:09
User: Tester


Zwick Roell
RUN TEST
Temperature-Travel
Live MVR
Results
40,00
30,00
20,00
10,00
0,00
Kolbengeschw. in cm³/10 min
0,00
100,00
200,00
300,00
400,00
500,00
Prüfzeit in s
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 190.0 °C
10:09
User: Tester

RUN TEST Temperature-Travel Live MVR Results

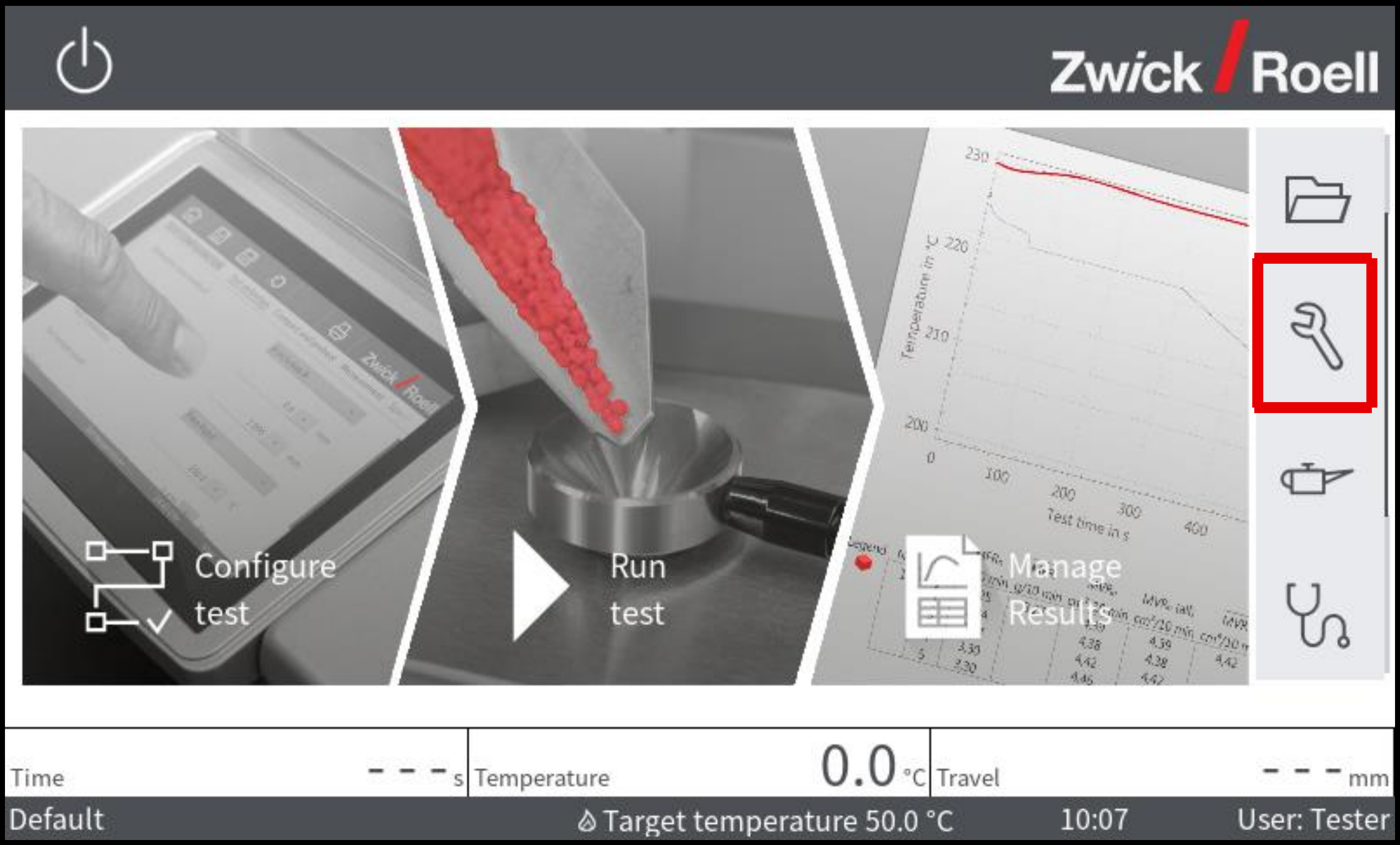
Index	MFR g/10 min	Mean MFR g/10 min	MVR cm^3/10 min	Mean MVR cm^3/10 min	Density g/cm^3	Mean density g/cm^3	Weight g	Total we g
☑ 1	31.339	30.772	21.916	21.519	1.430	1.430	???	- - -
☐ 2	24.157		16.893		1.430		???	
☑ 3	30.205		21.123		1.430		???	
(!) 4	22.767		15.921		1.430		???	

Time - - - s | Temperature 0.0 °C | Travel - - - mm

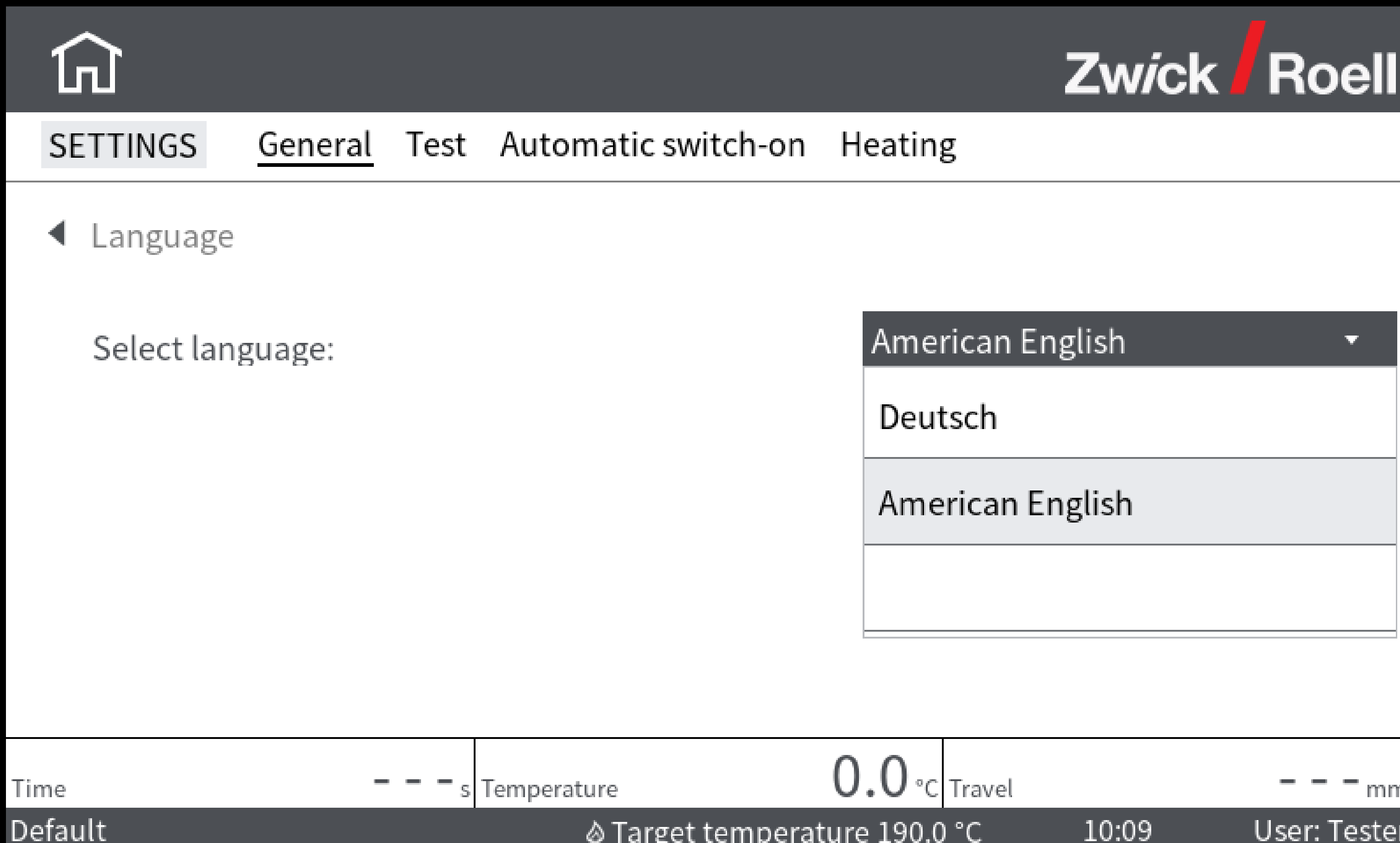
Default | Target temperature 190.0 °C | 10:09 | User: Tester

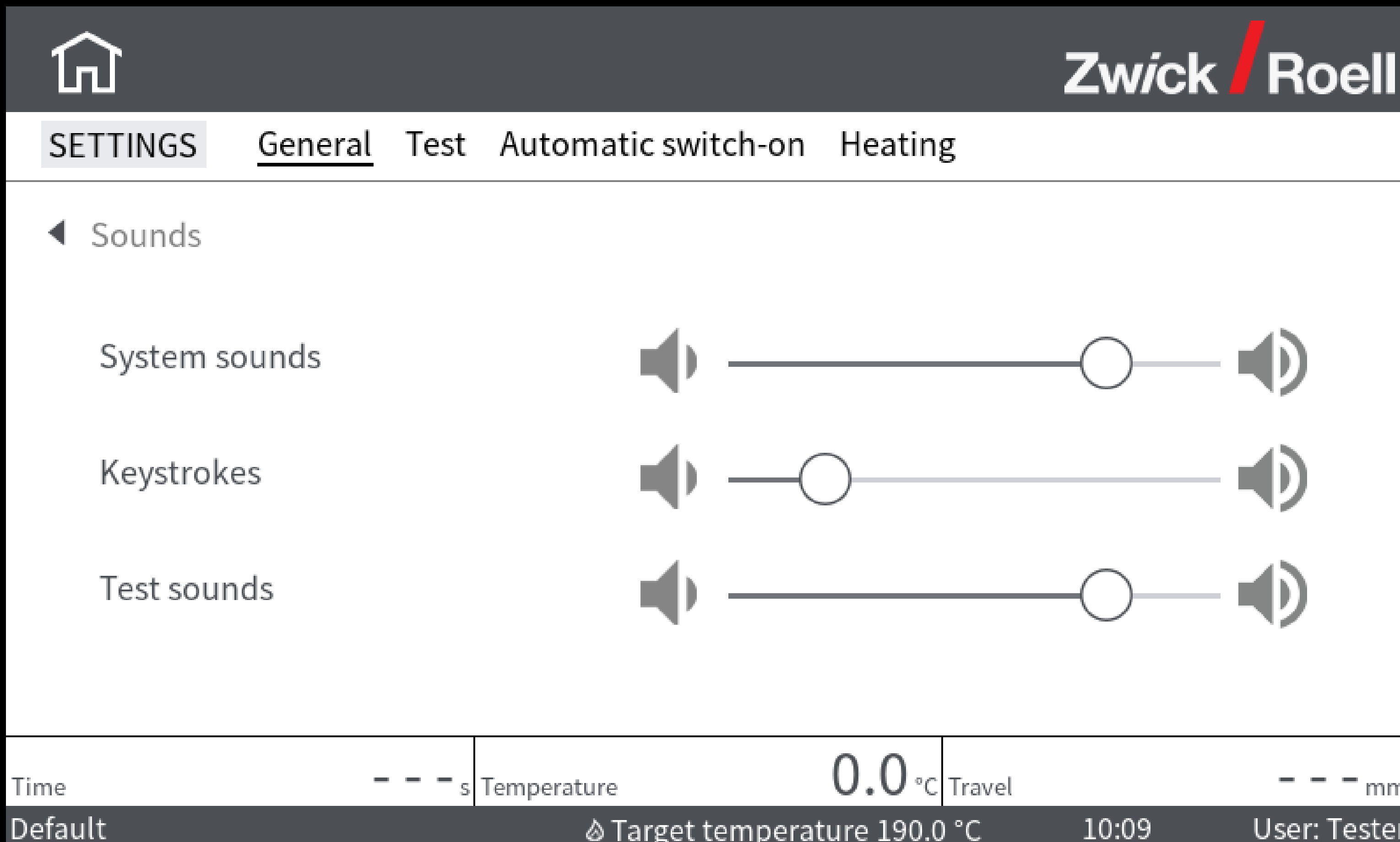
- **Einfaches Schwenken vom Vorkompaktieren in die Prüfposition**

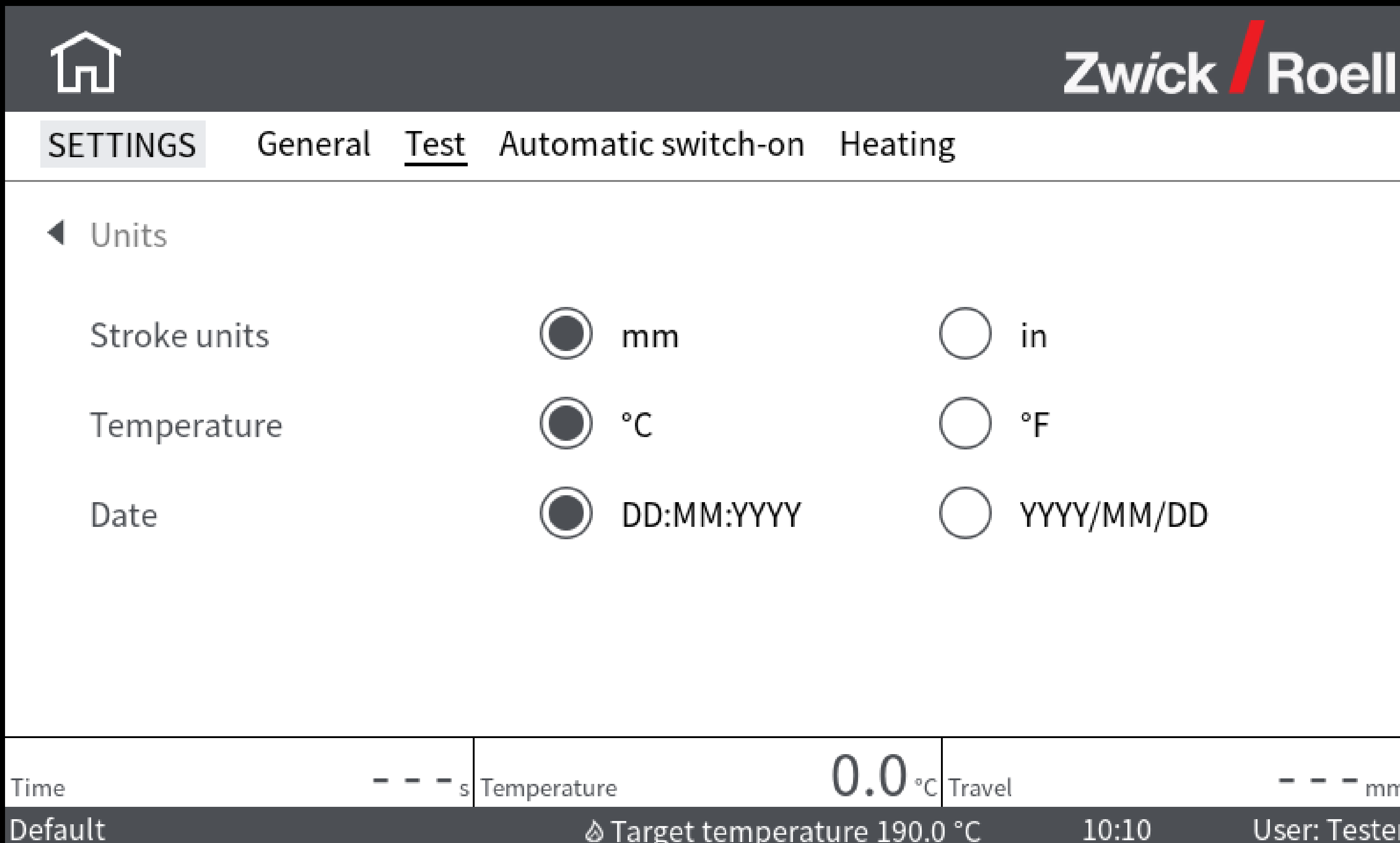

Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester



Zwick Roell
Configure test
Run test
Manage Results
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 50.0 °C
10:07
User: Tester


Zwick Roell
SETTINGS
General
Test
Automatic switch-on
Heating
Language
Select language:
American English
Deutsch
American English
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 190.0 °C
10:09
User: Tester


Zwick Roell
SETTINGS
General
Test
Automatic switch-on
Heating
Sounds
System sounds
Keystrokes
Test sounds
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 190.0 °C
10:09
User: Tester


Zwick Roell
SETTINGS
General
Test
Automatic switch-on
Heating
Units
Stroke units
mm
in
Temperature
°C
°F
Date
DD:MM:YYYY
YYYY/MM/DD
Time
- - - s
Temperature
0.0 °C
Travel
- - - mm
Default
Target temperature 190.0 °C
10:10
User: Tester

Plastometer product range