Universal Sheet Metal Testing Machines
for Research, Development and In-process Testing
Application
  - Example: Automotive Industry

Models
  - Technical Data
  - Additional Control Functions and Test Methods

Tests

References
Application

Example: Automotive Industry

The traditional tests e.g. the Cupping Test and the Deep-Drawing Cup Test, are now as before indispensable to the preparation of forming processes. However, they are increasingly supplemented by alternative methods. New materials and their combinations as used for the construction of vehicles, always require the choice of the most suitable test method. Today up-to-date test facilities very often work with optical image analysis and laser measuring technique.
A car body is a good example to show how many different materials are used for the various components.

Inspired by the endeavours of the automotive industry for weight reduction, new aluminium, magnesium and steel qualities have been developed which guarantee excellent strength properties and at the same time a good deformation behaviour even in the sheet thickness range of 1 to 2 mm.
DP: Dual Phases
CP: Complex Phases
TRIP: Transformation Induced Plasticity
DC: Cold Rolled Deep-Drawing Steel

1. Sillboard, Longitudinal Beam: DP Steel
2. Transversal Beam: CP Steel
3. B-Column: TRIP Steel
4. Outside Parts: Deep-Drawing Steel (e.g. DC04)

Erichsen
In the process of changing materials and increasingly complex production procedures the requirements concerning the test methods become more and more challenging.

The centre of interest remains, however, the fast, reproducible and reliable characterisation of the material. It is, in addition to the process and quality control, of decisive importance for the development of components and tools.
The determination of precise and practical material characteristics does not only depend on the selection of the suitable test method, but also on the right choice and configuration of the appropriate testing equipment.

In this respect it is particularly important to electronically control and regulate the forces generated by the hydraulic system corresponding to the required test parameters. Furthermore, a PC system especially designed for this purpose, is required for the capture, processing and evaluation of the measured data.
Universal Sheet Metal Testing Machines

Model 142

Model 145

Model 146
Universal Sheet Metal Testing Machine, Model 142
Universal Sheet Metal Testing Machine, Model 142

Product

Sheet Metal Testing Machine with electro-hydraulic drive, fully automatic test sequence and switch off at specimen failure, max. drawing forces 200 kN or 400 kN
Universal Sheet Metal Testing Machine, Model 142

**Application**

This Testing Machine can be used not only to perform effortlessly, quickly and accurately all important and known deep drawing tests for ferrous and non-ferrous metals, but it is also designed for a large number of additional technological investigations.
Universal Sheet Metal Testing Machine, Model 142

Application

The Sheet Metal Testing Machine, Model 142, was developed not only for testing as a means for continuous production control, using standardised and other established methods, but also for research into all aspects of testing of sheet metal for deep drawing by studying all that is relevant to sheet metal forming.
Universal Sheet Metal Testing Machine, Model 142

Application

The Testing Machine is driven electro-hydraulically.

The test sequence is controlled automatically or manually as appropriate.

A programme logic control is used to control the functions of the machine.

Drawing force and blankholder force as well as the drawing punch stroke are displayed digitally.
Universal Sheet Metal Testing Machine, Model 142

Application

The triple-acting hydraulic system in conjunction with the general design results in the following cost saving simplifications:

• Blanking press in the test head
• Hydraulic cup ejector
• Fully-automatic test sequence
Universal Sheet Metal Testing Machine, Model 142

Application

Further technical advantages:

Cylinder head with bayonet lock, permitting direct access to drawing dies, blanking rings, blank holders etc. and quick and convenient changing of the drawing and blanking tools.

Infinitely variable drawing speed, once set it remains constant throughout the drawing movement, independent of any change of load.
Universal Sheet Metal Testing Machine, Model 142

Application

Further technical advantages:

**Cardanic drawing die retention**, ensures the consistent, parallel clamping of the specimen, independent of variations in thickness
Universal Sheet Metal Testing Machine, Model 145

Application

Sheetholder Quick Release and Drawing Punch Stop (BSA-ZS)

During the drawing sequence the constant sheet holder force acts on a continuously reducing area of sheet metal under the sheet holder. The result is increasing specific pressure as the remaining flange reduces with the result that in the final phase of the drawing process and especially in cases with severe ear forming tendency, a squashing of the ear-ends will occur.
Universal Sheet Metal Testing Machine, Model 145

Application

For this reason, provision is made to release the sheet holder pressure completely at a preselected depth where there is no more tendency for folds to form.

The machine is provided with an digital display of the drawing punch stroke and a selector switch for either "BSA" or "ZS". When the depth of draw selected on the digital display unit is reached the drawing punch stops completely - in case of the "ZS" mode, or the sheet holder force is released - in the case of the "BSA" mode.
# Universal Sheet Metal Testing Machine, Model 142

## Data Sheet

<table>
<thead>
<tr>
<th>Feature</th>
<th>Model 142-20</th>
<th>Model 142-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing force:</td>
<td>200 kN</td>
<td>400 kN</td>
</tr>
<tr>
<td>Blanking force:</td>
<td>260 kN</td>
<td>600 kN</td>
</tr>
<tr>
<td>Blankholder force:</td>
<td>up to 100 kN</td>
<td>up to 220 kN</td>
</tr>
</tbody>
</table>
## Universal Sheet Metal Testing Machine, Model 142

### Data Sheet

<table>
<thead>
<tr>
<th></th>
<th>142-20</th>
<th>approx.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing punch stroke:</td>
<td></td>
<td>80 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120 mm</td>
</tr>
<tr>
<td>Blankholder stroke:</td>
<td></td>
<td>38 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>38 mm</td>
</tr>
<tr>
<td>Drawing punch dia.:</td>
<td></td>
<td>50 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 mm</td>
</tr>
</tbody>
</table>
# Universal Sheet Metal Testing Machine, Model 142

## Data Sheet

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Description</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLC Test</td>
<td>Drawing punch dia.</td>
<td>up to 100 mm</td>
</tr>
<tr>
<td>Bulge Test</td>
<td>Bulge dia.</td>
<td>up to 100 mm</td>
</tr>
<tr>
<td>Blank diameter</td>
<td>142-20</td>
<td>up to 120 mm</td>
</tr>
<tr>
<td></td>
<td>142-40</td>
<td>up to 170 mm</td>
</tr>
<tr>
<td>Drawing speed</td>
<td>142-20</td>
<td>approx. 800 mm/min</td>
</tr>
<tr>
<td></td>
<td>142-40</td>
<td>approx. 900 mm/min</td>
</tr>
</tbody>
</table>
Universal Sheet Metal Testing Machine, Model 145
Universal Sheet Metal Testing Machine, Model 145

Product

Sheet Metal Testing Machine with electro-hydraulic drive, fully automatic test sequence and switch off at specimen failure, max. drawing forces 600 kN or 1000 kN, incl. an increased blanking force and blank holder holder force for blank diameters up to 220 mm
Universal Sheet Metal Testing Machine, Model 145

Application

This Testing Machine can be used not only to perform effortlessly, quickly and accurately all important and known deep drawing tests for ferrous and non-ferrous metals, but it is also designed for a large number of additional technological investigations.
Universal Sheet Metal Testing Machine, Model 145

Application

The Sheet Metal Testing Machine, Model 145, was developed not only for testing as a means for continuous production control, using standardised and other established methods, but also for research into all aspects of testing of sheet metal for deep drawing by studying all that is relevant to sheet metal forming.
Universal Sheet Metal Testing Machine, Model 145

Application

The Testing Machine is driven electro-hydraulically.

The test sequence is controlled automatically or manually as appropriate.

A programme logic controller is used for the functions of the machine (optional computer controls).

The drawing force and blankholder force as well as the drawing punch stroke are digitally displayed.
Universal Sheet Metal Testing Machine, Model 145

Application

The triple-acting hydraulic system in conjunction with the general design results in the following cost saving simplifications:

• Blanking press in the test head
• Hydraulic cup ejector
• Fully-automatic test sequence
Universal Sheet Metal Testing Machine, Model 145

Application

Further technical advantages:

Cylinder head with bayonet lock, permitting direct access to drawing dies, blanking rings, blank holders etc. and quick and convenient changing of the drawing and blanking tools

Infinitely variable drawing speed, once set it remains constant throughout the drawing movement, independent of any change of load
Universal Sheet Metal Testing Machine, Model 145

Application

Further technical advantages:

Cardanic drawing die retention, ensures the consistent, parallel clamping of the specimen, independent of variations in thickness.
Universal Sheet Metal Testing Machine, Model 145

Application

Sheetholder Quick Release and Drawing Punch Stop (BSA-ZS)

During the drawing sequence the constant sheet holder force acts on a continuously reducing area of sheet metal under the sheet holder. The result is increasing specific pressure as the remaining flange reduces with the result that in the final phase of the drawing process and especially in cases with severe ear forming tendency, a squashing of the ear-ends will occur.
Universal Sheet Metal Testing Machine, Model 145

Application

For this reason, provision is made to release the sheet holder pressure completely at a preselected depth where there is no more tendency for folds to form.

The machine is provided with an digital display of the drawing punch stroke and a selector switch for either "BSA" or "ZS". When the depth of draw selected on the digital display unit is reached the drawing punch stops completely - in case of the "ZS" mode, or the sheet holder force is released - in the case of the "BSA" mode.
Universal Sheet Metal Testing Machine, Model 145

### Data Sheet

<table>
<thead>
<tr>
<th>Feature</th>
<th>145-60</th>
<th>145-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing force:</td>
<td>600 kN</td>
<td>1000 kN</td>
</tr>
<tr>
<td>Blanking force:</td>
<td>700 kN</td>
<td>1000 kN</td>
</tr>
<tr>
<td>Blankholder force:</td>
<td>600 kN</td>
<td>1000 kN</td>
</tr>
</tbody>
</table>
**Universal Sheet Metal Testing Machine, Model 145**

**Data Sheet**

- **Drawing punch stroke:** 145-60/100  approx. 150 mm  
  (Option: upon request approx. 250 mm – only used for sheet holder force up to 400 kN)

- **Blankholder stroke:** 145-60/100  approx. 38 mm

- **Ejector stroke:** 145-60/100  approx. 150 mm  
  (Option: upon request approx. 250 mm – only used for sheet holder force up to 400 kN)
### Universal Sheet Metal Testing Machine, Model 145

**Data Sheet**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing punch dia.:</td>
<td>up to 100 mm</td>
</tr>
<tr>
<td>FLC Test (drawing punch dia.):</td>
<td>up to 100 mm</td>
</tr>
<tr>
<td>Bulge-Test (bulge dia.):</td>
<td>up to 100 mm</td>
</tr>
<tr>
<td>Blank diameter:</td>
<td>up to 220 mm</td>
</tr>
<tr>
<td>Drawing speed:</td>
<td>approx. 0 - 750 mm/min</td>
</tr>
</tbody>
</table>
Universal Sheet Metal Testing Machine, Model 146
Universal Sheet Metal Testing Machine, Model 146

Product

Special feature is the increased drawing speed of the drawing punch which can be adjusted, in an infinitely variable manner and independent of load, up to 3000 mm/min. A constant drawing speed behaviour is guaranteed over the total displacement of 150 mm. Technically equivalent to Models 145.
Universal Sheet Metal Testing Machine, Model 146

Application

This Testing Machine can be used not only to perform effortlessly, quickly and accurately all important and known deep drawing tests for ferrous and non-ferrous metals, but it is also designed for a large number of additional technological investigations.
Universal Sheet Metal Testing Machine, Model 146

Application

The Sheet Metal Testing Machine, Model 146, was developed not only for testing as a means for continuous production control, using standardised and other established methods, but also for research into all aspects of testing of sheet metal for deep drawing by studying all that is relevant to sheet metal forming.
Universal Sheet Metal Testing Machine, Model 146

Application

The Testing Machine is driven electro-hydraulically.

The test sequence is controlled automatically or manually as appropriate.

A programme logic controller is used for the functions of the machine (optional computer controls).

The drawing force and blankholder force as well as the drawing punch stroke are digitally displayed.
Universal Sheet Metal Testing Machine, Model 146

Application

The triple-acting hydraulic system in conjunction with the general design results in the following cost saving simplifications:

- Blanking press in the test head
- Hydraulic cup ejector
- Fully-automatic test sequence
Universal Sheet Metal Testing Machine, Model 146

Application

Further technical advantages:

**Cylinder head with bayonet lock,** permitting direct access to drawing dies, blanking rings, blank holders etc. and quick and convenient changing of the drawing and blanking tools

**Infinitely variable drawing speed,** once set it remains constant throughout the drawing movement, independent of any change of load
Universal Sheet Metal Testing Machine, Model 146

Application

Further technical advantages:

**Cardanic drawing die retention**, ensures the consistent, parallel clamping of the specimen, independent of variations in thickness.
Universal Sheet Metal Testing Machine, Model 146

Application

Sheetholder Quick Release and Drawing Punch Stop (BSA-ZS)

During the drawing sequence the constant sheet holder force acts on a continuously reducing area of sheet metal under the sheet holder. The result is increasing specific pressure as the remaining flange reduces with the result that in the final phase of the drawing process and especially in cases with severe ear forming tendency, a squashing of the ear-ends will occur.
Universal Sheet Metal Testing Machine, Model 146

Application

For this reason, provision is made to release the sheet holder pressure completely at a preselected depth where there is no more tendency for folds to form.

The machine is provided with an digital display of the drawing punch stroke and a selector switch for either "BSA" or "ZS". When the depth of draw selected on the digital display unit is reached the drawing punch stops completely - in case of the "ZS" mode, or the sheet holder force is released - in the case of the "BSA" mode.
# Universal Sheet Metal Testing Machine, Model 146

## Data Sheet

<table>
<thead>
<tr>
<th>Force Type</th>
<th>Model 146-60</th>
<th>Model 146-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing force:</td>
<td>600 kN</td>
<td>1000 kN</td>
</tr>
<tr>
<td>Blanking force:</td>
<td>700 kN</td>
<td>1000 kN</td>
</tr>
<tr>
<td>Blankholder force:</td>
<td>600 kN</td>
<td>1000 kN</td>
</tr>
</tbody>
</table>
Universal Sheet Metal Testing Machine, Model 146

<table>
<thead>
<tr>
<th></th>
<th>Drawing punch stroke:</th>
<th>Blankholder stroke:</th>
<th>Ejector stroke:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>145-60</td>
<td>145-60</td>
<td>145-60</td>
</tr>
<tr>
<td></td>
<td>approx. 150 mm</td>
<td>approx. 38 mm</td>
<td>approx. 150 mm</td>
</tr>
<tr>
<td></td>
<td>145-100</td>
<td>145-100</td>
<td>145-100</td>
</tr>
<tr>
<td></td>
<td>approx. 150 mm</td>
<td>approx. 38 mm</td>
<td>approx. 150 mm</td>
</tr>
</tbody>
</table>
Universal Sheet Metal Testing Machine, Model 146

**Data Sheet**

- Drawing punch dia.: up to 100 mm
- FLC Test (drawing punch dia.): up to 100 mm
- Bulge-Test (bulge dia.): up to 100 mm
- Blank diameter: up to 220 mm
- Drawing speed: approx. 0 - 3000 mm/min
Additional Control Functions and Test Methods

Data Evalution System

Universal User Software

Hot Drawing Equipment up to 550 °C

High Temperature Facility up to 900 °C

Equipment for High Speed Tests

3D-Analysing System
Data Evaluation System

The software enables the continuous acquisition of measured values with simultaneous display of the force/displacement diagram throughout the forming process. Once the maximum force has been reached, the movement of the drawing punch is stopped automatically and the diagram is evaluated by the PC.
Universal User Software

The software enables the control, adjustment, documentation and filing of measuring data of the sheet metal testing machine. Software for recording of force-displacement diagrams such as drawing force and blank holder force, stroke. Creation of scripts (test sequences); pre-setting of freely selectable parameters such as drawing and blank holder force as well as drawing speed.
Hot Drawing Equipment up to 550 °C

An electronic temperature measuring device is incorporated, and on this the preset intended temperature and the current measure temperature are displayed. The preset temperature can be set up to 550 °C, and in the test, the temperature remains constant within ± 10 °C.
High Temperature Facility up to 900 °C

A high temperature facility enables to characterize the forming behaviour of metal sheets at up 900 °C.

Contrary to the already existing hot drawing equipment (550 °C), here the test panel is inserted directly into the sheet metal testing machine. By means of a temperature measurement temperature profiles can be established.
Equipment for High Speed Tests

This optional equipment enables deep drawing tests to be conducted at elevated speeds that arise in practise.

The speed of the drawing punch is preselected from 3 m/min to 25 m/min and is digitally displayed.
3D-Analysing System

This Sheet Metal Testing Machines can be customized and extended to accommodate special requirements, e.g. determination of forming limit curves (FLC) using a 3D.

Generally the sheet metal testing machine will be equipped with proportional technology and difference pressure measuring. As option it is possible to select a PC controls/regulation with software.
Tests

• **ERICHSEN Cupping Test** in accordance with
  - ISO 8490
  - EN 14-58
  - EN 14-67
  - EN ISO 20482
  - BS 38 55
  - NF A 03-602
  - NF A 03-652
  - ASTM 643-84
  - GB 4156-84
  - JIS Z-2247
  - JIS Z-7729
  - UNI 3037
  - UNE 7080
  - GOST 10 510
  - ICONTEC 21
  - SIS 11 26 35
  - SABS 0132-197

on sheet and strip metal 0.1 to 6.0 mm thick
• **ERICHSEN Deep Drawing Cup Test** in accordance with
  ISO 11 531  
  DIN 50 155  
  EN 16-69  
  GB/T 15825  
  MSZ 5731-68  
  UNI 6124-67  
  JIS Z 2249

• **Square Cup Test** (40 x 40 mm or 70 x 70 mm)
• **Hole Expansion Test (KWI Test)**
• **Olsen Cupping Test**
• **Persoz Cupping Test**
• **Deep Drawing Cup Test acc. to Swift I** (32 mm dia.)
• **Deep Drawing Cup Test acc. to Swift II** (50 mm dia.)
• Fukui Test
• Engelhardt Test
• Determination of the Forming Limit Curves (FLC)
• LDH Test
• High Speed Deep Drawing Cup Test
• Deep Drawing Tests with Blankholder Quick Release (for Earing Test)
• Deep Drawing Tests with Preselected Punch Stroke
• Deep Drawing Test at High Temperatures up to 550 °C/High Temperature Facility up to 900 °C
• Deep Drawing Test with PC (incl. software) for data evaluation
- **Bulge Test** (50 mm dia. or 100 mm dia.)
- **Counter Draw**
- **Fine Blanking Test**
- **Tensile Test**
- **Brinell Hardness Test**
- **Lubricant Test**
- **Tube Expanding Test** according to DIN EN 10234
- **Ring Expanding Test** according to DIN EN 10236
- **ERICHSEN Cupping Test** for Lacquer and Paint in accordance with DIN ISO 1520
- **Stamping Lacquer Test** and **Deep Drawing Cup Test on Coil Coatings**
Bulge Test

The test panel is fixed between the drawing die and the blank holder. Underneath the test panel a chamber filled with oil is located. The test panel is clamped and then frictionless deformed by means of the drawing piston which moves upwards and presses against the oil.
Nakazima Test

Based on the principle of deforming sheet metal blanks of different geometries using a hemispherical punch until fracture occurs. By varying the specimen width strongly different deep draw and stretch forming conditions – from a regular biaxial deformation to a simple tensile load - occur on the sheet metal surface.
Marciniak Test

The Marciniak Test differs from the Nakazima Test only in using a cylindrical drawing punch instead of a semi-spherical and in working with another tool geometry. In addition, a pierced liner is used instead of a plastic sliding foil (made of PE or PTFE) to reduce the friction.
Evaluation with the Laser Light Section Procedure and Dot Tracking

1. Triangulation Camera Modul 2
2. Ringlight
3. Camera Lens
4. Camera Modul 3
5. Dichroich Mirror
6. Diod-Laser Modul 1
7. Polarising Beam Splitter
8. Diod-Laser Modul 2
9. Protection-Glass
10. Sheet Metal
11. Testing Machine
Specimen

• Marciniak
• Nakazima (wide)
• Nakazima (small)
• Nakazima (wide)
• Drawing cup