BRITISH STANDARD

BS 7825 :
Part 2 : 1996

Calibration of rubber and plastics test equipment

Part 2. Calibration procedures

ICS 83.060; 83.080

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PRI/20, Accuracy of rubber and plastics test equipment, upon which the following bodies were represented:

British Rubber Manufacturers' Association
Department of Trade and Industry (National Physical Laboratory)
GAMBICA (Beama Ltd.)
Ministry of Defence
RAPRA Technology Ltd.

This British Standard, having been prepared under the direction of the Sector Board for Materials and Chemicals, was published under the authority of the Standards Board and comes into effect on
15 November 1996

Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
Committee reference PRI/20
Draft for comment 94/307320 DC

ISBN 0 580 25791 6

Contents

Foreword

This Part of BS 7825 has been prepared by Technical Committee PRI/20.

In commercial practice it is necessary for the parties concerned in the manufacture or supply of materials or products to operate or agree upon specified performance requirements. Those performance requirements are verified by standardized methods of test. Test result variability is influenced by both test variability and product variability. As it is product variability which needs to be identified, test variability has to be kept to a minimum. An important element in the achievement of this reduced variability is the calibration of test instrumentation, to traceable standards, at acceptable intervals.

The use of this Part of BS 7825 will encourage proper calibration and make it possible for all users and calibration laboratories to work to common procedures.

BS 7825 is published in three Parts:

Part 1 *Principles and general requirements*

Part 2 *Calibration procedures*

Part 3 *Calibration schedules*

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Section 1. General

1.1 Scope

This Part of BS 7825 describes methods of calibration for a range of parameters applicable to rubber and plastics test equipment.

1.2 References

1.2.1 Normative references

This Part of BS 7825 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 15. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Part of BS 7825 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This Part of BS 7825 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this Part of BS 7825, the definitions, where relevant, given in BS EN 30012-1, BS 5233, PD 6461 : Part 1, BS 4778 and ISO Guide 30 apply.

1.4 Procedures

A calibration is carried out following a defined procedure. Each parameter of an apparatus has its own procedure, but these procedures may be combined into a single procedure for the whole apparatus. This Part of BS 7825 gives procedures for individual parameters and these procedures are cited, where appropriate, in Part 3 of this British Standard. The procedures are arranged in sections according to the type of measurement involved (e.g. force, electrical).

Each procedure includes an outline of the methodology to be used, but is not sufficiently detailed to provide work instructions for a calibration technician. Individual laboratories will have to formulate specific working procedures for the particular calibration equipment and transfer standards to be used, the method to be followed and the records to be kept.

In addition to the references given in this Part of BS 7825 to standard procedures and guidance documents, there are also references to British Standards specifications for measuring equipment and to documents published by the National Measurement Accreditation Service (NAMAS) that list criteria for performing calibrations.

The number of replicate measurements made for each calibration will depend on the particular circumstances, and has to be specified in the detailed procedures. Typically, between one and five replicates will be required. An estimate of the component of uncertainty due to the measurement process will require at least three, and preferably five, repeats, but, where this uncertainty has been estimated from a separate trial, a single measurement may be considered adequate.

Attention is drawn to the difference between calibrating a measuring instrument and verifying a quantity (e.g. the difference between a dial gauge and the specified length of a component of the test equipment). In general, the procedures given apply to measuring instruments or devices which form part of the apparatus, e.g. a voltmeter or pressure gauge; however, where appropriate, the procedure may also discuss the measurement of a quantity. A quantity is normally verified using a measuring instrument.

1.5 Expression of results

If necessary, corrections shall be applied to the readings obtained.

Where two instruments are compared, differences between the two sets of readings shall be tabulated with respect to the reading of the reference source.

If required, the differences shall be plotted to produce a calibration curve.

Where a quantity has been measured, the readings shall be recorded.

The estimate of uncertainty shall be calculated.

1.6 Calibration records

The following information shall be recorded:

a) reference to this standard, i.e. BS 7825;

b) a description and unique identification of the equipment calibrated;

c) the parameters measured;

d) the measurement procedures used;

e) a unique identification of the calibration standards used;

f) the date on which each measurement was completed;

g) the calibration results obtained after and, where relevant, before any adjustment or repair;

h) the assigned calibration interval;

i) the designated limits of permissible error;

j) the relevant environmental conditions and a statement of any corrections necessary;

k) the estimated uncertainty of the measurement results;

l) details of any servicing, adjustment, repairs or modifications carried out;

m) identification of the person(s) performing the measurement;

n) identification of the person(s) responsible for ensuring the correctness of the recorded information.

Section 2. Electrical measurements

2.1 Current

2.1.1 General

The measurement of current is largely confined to electrical and chemical tests. A variety of types of ammeter may be encountered and the range of current level and accuracy required is wide. In particular, some methods require the measurement of very small currents and specialist procedures and calibration standards are needed to achieve the necessary level of uncertainty.

2.1.2 Principle

The ammeter is compared to a standard instrument or to a standard current source.

2.1.3 Apparatus

2.1.3.1 *Standard ammeter or current source*, of appropriate range.

2.1.3.2 *Means of generating currents*, for comparison with the standard ammeter.

2.1.4 Procedure

Calibrate the ammeter in accordance with Parts 1, 2 and 9 of BS 89 or with BS 7194.

2.2 Voltage

2.2.1 General

The measurement of voltage is largely confined to electrical and chemical tests. A variety of types of voltmeter may be encountered and the range of voltage level and accuracy required is wide. In particular, some methods require the measurement of very small voltages and specialist procedures and calibration standards are needed to achieve the necessary level of uncertainty.

NOTE. Guidance on the calibration of digital voltmeters is given in NIS 4181.

2.2.2 Principle

The voltmeter is compared to a standard instrument or to a standard voltage source.

2.2.3 Apparatus

2.2.3.1 *Standard voltmeter source*, of appropriate range.

2.2.3.2 *Means of generating voltages*, for comparison with the standard voltmeter.

2.2.4 Procedure

Calibrate the voltmeter in accordance with Parts 1, 2 and 9 of BS 89 or with BS 7194.

2.3 Frequency and bandwidth

2.3.1 General

The usual situation involving frequency is where a frequency generator requires verification; however, it may also be necessary to calibrate a frequency meter. The principle is the same in both cases.

2.3.2 Principle

The frequency generator or meter is compared to a standard frequency meter.

2.3.3 Apparatus

2.3.3.1 *Standard frequency meter.*

2.3.3.2 *Frequency generator* (for meter calibration).

2.3.4 Procedure

Calibrate in accordance with Parts 1, 4 and 9 of BS 89 or BS 7194.

2.4 Resistance

2.4.1 General

The measurement of resistance is largely confined to electrical tests. The usual situation is that a resistor or resistor network requires verification, which is achieved using a calibrated resistance meter. As an alternative to using a resistance meter, the resistance may be measured by means of standard resistors in a bridge circuit.

2.4.2 Principle

The resistance meter is compared with standard resistors.

2.4.3 Apparatus

2.4.3.1 *Standard resistors.*

2.4.4 Procedure

Calibrate the instrument in accordance with Parts 1, 6 and 9 of BS 89.

2.5 Wattage

2.5.1 General

Power consumption is occasionally required in testing, but is more commonly used to monitor processing equipment. As an alternative to using a watt or watt hour meter the voltage and current may be measured.

2.5.2 Principle

The wattmeter is compared to a standard instrument.

2.5.3 Apparatus

2.5.3.1 *Standard wattmeter.*

2.5.3.2 *Means of generating voltages and currents*, for comparison with standard wattmeter.

2.5.4 Procedure

Calibrate the wattmeter in accordance with Parts 1, 3 and 9 of BS 89.

2.6 Chart recorders

2.6.1 General

Chart recorders are used in a variety of applications, and a number of different types and sensitivities may be encountered. In some cases the recorder scales will be calibrated integrally with, for example, a force transducer with which it is associated.

2.6.2 Principle

The recorder is compared to a standard signal or to a standard instrument.

2.6.3 Apparatus

2.6.3.1 *Standard instrument (e.g. voltmeter) or standard signal*, of appropriate range.

2.6.3.2 *Means of generating signals*, for comparison with standard instrument.

2.6.4 Procedure

Calibrate the chart recorder in accordance with BS EN 61143-1 and BS EN 61143-2 for $X-t$ recorders and with BS EN 61028 for $X-Y$ recorders.

Section 3. Dimensional measurements

3.1 Length measuring instruments

3.1.1 General

The type of instrument used in rubber or plastics testing ranges from microscopes to tape measures and, consequently, the range of magnitudes and accuracies to be covered is large. The standard used to transfer traceable calibration is chosen accordingly.

3.1.2 Principle

The measuring instrument is compared to a standard instrument, standard gauge blocks or equivalent.

3.1.3 Apparatus

3.1.3.1 *Standard length measuring device or length standards.*

3.1.4 Procedure

Calibrate the measuring instrument in accordance with the relevant British standard:

- coordinate measuring machines: BS 6808 : Part 2;
- comparators: BS 1054;
- depth gauges: BS 6365;
- dial gauges: BS 907;
- height gauges: BS 1643;
- measuring rules: BS 4372;
- micrometers (depth): BS 6468;
- micrometers (external): BS 870;
- micrometers (internal): BS 959;
- roundness (stylus instruments): BS 3730 : Part 2;
- vernier gauges: BS 887.

For other instruments for which there is no British Standard covering calibration, compare the instrument to an appropriate standard instrument at a series of points over its range.

3.2 Linear dimensions

Depending on the circumstances and the magnitude and accuracy needed, callipers, a coordinate measuring machine, height gauge, travelling microscope, dial gauge and rig, ruler, etc. are used to verify a dimension. Although in most cases this will be straightforward in practical terms, in some instances it may be difficult to obtain access to the dimension with an instrument of adequate accuracy.

3.3 Profiles

A variety of profiles will require verification and a suitable instrument and technique has to be selected for each case. In many instances, a projection system with a standard template is convenient.

3.4 Extensometry and extensions

3.4.1 General

Several types of extensometer covering a considerable strain range are in common use. Additionally, dial gauges or other transducers or crosshead movement of the testing machine may be used to monitor extension, compression or deflection.

3.4.2 Principle

The extension or deflection device is compared to a standard instrument or length standard.

3.4.3 Apparatus

3.4.3.1 *Appropriate length standard.*

3.4.4 Procedure

Calibrate extensometers in accordance with BS 5214 and apply the same principles to the calibration of crosshead movement. Calibrate other transducers in accordance with **3.1**.

3.5 Finish, roughness and flatness

Where a surface finish is specified, it shall be verified with a surface roughness meter, but, for measures of flatness on a larger scale, a coordinate measuring machine, a straightedge and gauge blocks or feeler gauges or a dial gauge may be used to map the surface profile.

NOTE 1. Surface roughness meters are normally calibrated and adjusted in use by means of standard reference blocks.

NOTE 2. Requirements for surface plates are given in BS 817, requirements for straightedges in BS 5204 : Part 2 and BS 852, and requirements for surface texture in BS 1134.

3.6 Sieves, mesh and pore size

3.6.1 General

A considerable range of mesh and pore size (from relatively coarse sieves to very fine pores) may be encountered. This may necessitate more than one approach to calibration.

3.6.2 Principle

The relevant dimensions are measured using an appropriate, calibrated instrument.

3.6.3 Apparatus

3.6.3.1 *Calibrated length measuring instrument*, of appropriate range.

3.6.4 Procedure

Calibrate sieves in accordance with BS 410.

Graticules shall conform to BS 7012 : Part 8.

3.7 Area

Areas are usually verified by calculation from measurements of the relevant dimensions; however, in some cases, comparison with a template, as for profiles, is convenient.

3.8 Volume (see also glassware)

Volumes other than glassware and similar containers are normally verified by calculation from measurements of the relevant dimensions or by weighing the amount of a liquid of known density, e.g. water, that they hold.

3.9 Angle

3.9.1 General

Many angles encountered in test equipment are fixed and form part of a profile or may be verified by calculation from measurements of relevant dimensions. Where variable angles are involved, a scale will probably require calibration.

3.9.2 Principle

The indicated angles are measured using a calibrated protractor or equivalent.

3.9.3 Apparatus

3.9.3.1 *Calibrated protractor or equivalent instrument.* Bevel protractors and engineer's squares shall conform to BS 1685 or BS 939, respectively.

3.9.4 Procedure

Measure the indicated angle using a calibrated device at a series of points over the range required.

3.10 Level

3.10.1 General

The usual situation is that an apparatus has to be levelled.

3.10.2 Principle

The level and or level indication is verified by means of a standard level.

3.10.3 Apparatus

3.10.3.1 *Standard level or electronic precision level.* Spirit levels shall conform to BS 958.

3.10.4 Procedure

Adjust the apparatus until any indicator shows level, and verify using the standard level.

3.11 Centre of percussion

Specification of centre of percussion is virtually restricted to impact testers and is calculated from the appropriate parameters of the pendulum using standard formulae. Guidance is given in some test method standards, e.g. BS 903 : Part A8.

Section 4. Fluids: flow, pressure, viscosity and density measurements

4.1 Flow meters

4.1.1 General

Flow meters may be for air, other gases or liquids. The calibration has to be valid for the fluid to be measured.

4.1.2 Principle

The flow meter is compared to a standard instrument.

4.1.3 Apparatus

4.1.3.1 *Standard flow meter.*

4.1.3.2 *Means of generating gas or liquid flow,* for comparison with standard flow meter.

4.1.4 Procedure

Calibrate the flow meter in accordance with BS 7118.

4.2 Devices producing a specified flow rate

The device shall be verified using a calibrated flow meter or, if appropriate, by measurement of the quantity of gas or liquid flowing in a given time.

4.3 Exchange rate

For environmental chambers such as ageing ovens, the air exchange rate is a specified parameter. The preferred method of verification is by measurement of flow rate into the oven using a flow meter. However, for some designs this is not possible because there are multiple or inaccessible inlet points. Alternative procedures that may give estimates of adequate accuracy are measurement of the power consumption of the oven with normal air flow and with the air inlets blocked off or measurement of the time to fill a flexible sack attached to the air outlet.

4.4 Pressure transducers

4.4.1 General

Pressure gauges are much more commonly found in processing equipment than in test apparatus; however, when required, pressure gauges may be used for gases or liquids over a wide range of capacities.

4.4.2 Principle

The transducer is compared to a standard instrument.

4.4.3 Apparatus

4.4.3.1 *Standard pressure gauge.*

4.4.3.2 *Means of generating pressures.*

4.4.4 Procedure

Calibrate the transducer in accordance with BS 1780.

4.5 Manometers

Where manometers rather than a pressure transducer are used, they are usually calibrated by measurement of the relevant dimensions; however, they may also be compared to a standard pressure gauge.

4.6 Devices producing a specified pressure

Some test methods specify a pressure that is produced by a device, for example, by using gravity. Verification of such devices usually involves direct measurement of the pressure produced using a jig and calibrated pressure transducer appropriate to the particular apparatus and may require frequent reverification because of, for example, friction effects. In some cases, it may be acceptable to calculate the pressure by measurement of relevant parameters of the device.

4.7 Density

Density measurement usually involves the use of a form of balance. In some cases, the measurement also involves the measurement of dimensions or the use of a container of standard volume. The instruments calibrated are therefore the balance, dimension gauges and container. Specially designed balances are commonly found which also require calculations to be performed to verify the readings or a procedure involving comparison of weights of known relative mass.

Density columns are calibrated in use using standard reference floats.

Section 5. Optical measurements

5.1 Irradiance

Irradiance measurement is required for weathering test methods, which should specify the wavelength range to be included. A calibrated radiometer is used to measure the irradiance at a specified position relative to the light source.

Spectrally non-selective radiometers shall be calibrated and traceable to the World Radiation Reference and filter radiometers by one of the methods given in CIE publication No. 64

5.2 Refractometers

The Abbe refractometer and an immersion method using a microscope are most frequently employed, although other designs of refractometer are available. The refractometer scale is calibrated using standard reference liquids of known refractive index, and in the microscope method standard liquids are used during the determination in accordance with the test method standard.

5.3 Colour measuring instruments

Calibration is achieved by checking against diffuse reflectance transfer standard plaques traceable to the reference spectrophotometer held at the UK National Physical Laboratory and by checking the linearity of the spectral response of the instrument. Procedures are normally given by the instrument manufacture.

Section 6. Temperature measurements

6.1 Temperature

6.1.1 General

Virtually all test methods specify the temperature of the atmosphere in which the test is conducted and the temperature for conditioning of samples. A variety of instruments are used to measure the temperature and may be portable or built into the apparatus. The term thermometer is taken here to cover all types of instrument. There are two separate situations:

a) where a measuring instrument is calibrated; and

b) where the atmosphere is verified.

Guidance on traceability of temperature measurement is given in NIS 7.

6.1.2 Principle

6.1.2.1 *Procedure A*

The temperature measuring instrument is compared to a standard instrument in a carefully controlled enclosure.

6.1.2.2 *Procedure B*

A temperature measuring instrument is used to verify the atmosphere of a room or enclosure.

6.1.3 Apparatus

6.1.3.1 *Standard temperature measuring instrument*, usually of the platinum resistance thermometer type.

6.1.3.2 *Bath or other enclosure*, in which the temperature can be controlled.

6.1.4 Procedure

6.1.4.1 *Procedure A*

Compare the instrument at selected temperatures ensuring that equilibrium conditions have been reached.

6.1.4.2 *Procedure B*

Position the standard instrument as required and, after equilibrium conditions are reached, measure the temperature.

Repeat the procedure at other points within the room or enclosure to cover the volume of interest.

Section 7. Chemical analysis and reference materials

7.1 Glassware

Many specifications only require glassware to be of recognized standard grade, and no further calibration is necessary. If calibration is required, it shall be in accordance with BS 6696.

NOTE. Guidance on traceability of volumetric glassware is given in NIS 5 and tables for correction of volume for temperature are given in BS 1797.

7.2 pH meters

7.2.1 General

A variety of pH meters and indicators are in common use, and these have differing levels of accuracy. For most purposes, calibration is adequately achieved by the use of buffer solutions; however, for higher accuracy applications, calibration involves the input of known millivolt signals.

7.2.2 Principle

The meter is compared with standard buffer solutions or with a calibrated millivolt source.

7.2.3 Apparatus

7.2.3.1 *Buffer solution or a calibrated millivolt source.*

7.2.4 Procedure

7.2.4.1 ***Using buffer solutions***

Measure the pH of a series of buffer solutions covering the range of interest.

7.2.4.2 ***Using a millivolt source***

Calibrate the meter in accordance with BS 3145.

7.3 Reference materials

A great many chemical analysis methods rely on standard reagents and reference materials, the use of which effectively calibrates the measurement. However, the certification of reference materials is outside the scope of this standard.

Section 8. Hardness measurements

8.1 Hardness meters

Hardness meters are calibrated by verification of the essential parameters, generally force and dimensions, in some cases in combination with the use of standard reference blocks. Procedures for Rockwell hardness are given in BS 891, for superficial Rockwell in BS 4175, for Vickers hardness in BS 427 and for Brinell hardness in BS EN 10003-1, BS EN 10003-2 and BS EN 10003-3.

The parameters to be calibrated for rubber hardness meters, both dead load and durometer types are given in Part 3 of this British Standard. The alternative use of rubber hardness blocks is described in **8.2**.

NOTE. Guidance on the traceability of hardness measurements is given in NIS 13.

8.2 Rubber hardness blocks

Certified standard hardness blocks are recommended for use as regular checks between calibrations with all rubber hardness tests. However, they shall only be used as the sole calibration procedure on hand-held instruments for which relatively low accuracy is acceptable and are not used for specification purposes.

Section 9. Humidity measurements

9.1 Relative humidity

9.1.1 General

Relative humidity is specified in many test methods for the atmosphere in which the test is carried out and for conditioning samples. The instruments used to measure humidity may be portable or built into the room or cabinet and there are two separate situations:

a) where a measuring instrument is calibrated; and

b) where the atmosphere is verified.

NOTE 1. Guidance on traceability and measurement of humidity is given in NIS 19 and its supplement.

NOTE 2. Although some test methods specify ±2 %, this is not generally achievable with the instruments and calibration standards available.

9.1.2 Principle

9.1.2.1 *Procedure A*

The relative humidity instrument is compared to a standard instrument or a standard atmosphere in a carefully controlled enclosure.

9.1.2.2 *Procedure B*

A relative humidity instrument is used to verify the atmosphere of a room or cabinet.

9.1.3 Apparatus

9.1.3.1 *Standard relative humidity instrument or suitable standard salt solution.*

9.1.3.2 *Enclosure*, in which temperature and relative humidity can be controlled, the latter either by water injection or by using a salt solution.

9.1.4 Procedure

9.1.4.1 *Procedure A*

Compare the instruments at selected conditions of temperature and humidity ensuring that equilibrium conditions have been reached.

9.1.4.2 *Procedure B*

Position the standard instrument as required and, after equilibrium conditions are reached, measure the relative humidity.

Repeat the procedure at other specified points within the room or cabinet to cover the volume of interest.

Section 10. Force measurements

10.1 Tensile, flexural or compression machines

Machines used to measure tensile, compression and flexural properties are calibrated by verification of the essential parameters. Calibration shall be in accordance with BS 5214.

Criteria for the verification of testing machines employing a measuring ring to indicate force are given in NIS 0415.

10.2 Force transducers

10.2.1 General

Force transducers are usually incorporated into 'tensile' machines, but are also found in other apparatus. They may have a number of ranges and some function in both tension and compression.

10.2.2 Principle

The transducer is compared to a standard proving device.

10.2.3 Apparatus

10.2.3.1 *Standard proving device*, of appropriate capacity.

10.2.4 Procedure

Calibrate the transducer in accordance with BS 1610 : Part 1 and BS EN 10002-2.

10.3 Devices producing a specified force

Some test methods require that a force is produced by a device, for example by using gravity. Such devices require verification by direct measurement of the force produced using a jig and calibrated force transducer appropriate to the particular apparatus and may require frequent reverification because of, for example, friction effects. In some cases, it may be acceptable to calculate the force by measurement of relevant parameters of the device.

10.4 Torque

10.4.1 General

Torque measurement is not commonly required, but is used in certain low temperature and adhesion methods and some test rigs incorporate torque wrenches. Where the torque is produced by a weight and pulley system, calibration is usually achieved by calculation from the mass and dimensions. A procedure for torque wires in the Gehman test is given in ISO 1432.

10.4.2 Principle

The torque transducer is compared to a standard instrument.

10.4.3 Apparatus

10.4.3.1 *Standard torque transducer.*

10.4.3.2 *Means of generating torque.*

10.4.4 Procedure

Compare the transducer with the standard instrument at a series of points over its range.

Calibrate torque wrenches in accordance with BS EN 26789.

10.5 Energy

Energy is specified in tests involving impact. The energy of the impact device is verified by calculation from measurements of the relevant parameters of the apparatus. In some cases, it may be necessary to make corrections for friction.

10.6 Inertia

If the inertia of a component of an apparatus is required it is verified by calculation from measurements of the relevant parameters of the apparatus.

Section 11. Mass measurements

11.1 Balances

11.1.1 General

The measurement of mass is involved in a large number of test methods with a wide range of specified accuracy. However, the majority of measurements are made using a general purpose laboratory balance reading to 1 mg.

Guidance on the calibration of weighing machines and weights is given in NIS 6.

11.1.2 Principle

The balance is used to measure standard weights.

11.1.3 Apparatus

11.1.3.1 *Standard weights*, of appropriate value and uncertainty.

11.1.4 Procedure

Calibrate the balance in accordance with BS 6199 : Section 1.2.

11.2 Weights

Weights in various forms are utilized in many test methods. In many cases the mass to be verified includes a support and/or is made up of more than one weight. Weights can be calibrated by comparison with standard weights, but for testing purposes the normal procedure is weighing using a calibrated balance.

Section 12. Miscellaneous measurements

12.1 Timers, clocks, etc.

12.1.1 General

Timers, clocks, etc. are required in a great many test methods and cover a very wide range of accuracies and time intervals. The principle of calibration is the same in all cases, but several levels of calibration standard may be required. However, for the majority of purposes comparison with the telephone 'speaking clock' is satisfactory.

12.1.2 Principle

The timer is compared to a standard time signal.

12.1.3 Apparatus

12.1.3.1 *Source of standard time signal*, usually the telephone 'speaking clock'.

12.1.4 Procedure

Compare the timer with the standard time signal over time periods appropriate to the intended use of the timer.

12.2 Time intervals

Time intervals are commonly specified and are normally measured with a timer, clock, etc. Where intervals are set automatically, they are verified by means of a calibrated timing device. In certain cases, the timing device may conveniently be a frequency counter.

12.3 Frequency and counters

A number of test methods involve the frequency of events (including revolutions) or counting of the number of events. The general approach taken to calibration is to count events over a set time period. For lower frequencies, this can be done manually, but, commonly, the apparatus will incorporate a mechanical or electrical counter. These can be verified by input of a known frequency from a mechanical or electrical source, as appropriate, although it may be sufficient for mechanical devices to simply check for correct operation.

12.4 Velocity

Velocity (speed) is specified in a variety of tests and the magnitude and accuracy required varies considerably. Verification is usually achieved by calculation from measurements of time and distance using instruments appropriate to those requirements.

Air velocity, in, for example, ovens, is normally verified by calculation from the volume flow and the oven dimensions.

12.5 Tachometers

12.5.1 General

Commonly, a fixed angular velocity is specified, which requires verification with a calibrated tachometer. Where variable speeds are involved, a tachometer will probably be incorporated in the apparatus and hence will require calibration.

12.5.2 Principle

The tachometer is compared to a standard instrument.

12.5.3 Apparatus

12.5.3.1 *Standard tachometer.*

12.5.3.2 *Revolving member with adjustable velocity.*

12.5.4 Procedure

Compare the tachometer with the standard instrument with reference to the revolving member at a series of points over its range.

12.6 Rate of heating or cooling

Heating and cooling rates are verified by measurement of temperature as a function of time. In many cases, the measurements are conveniently displayed graphically to demonstrate variations of the rate over the interval of interest.

List of references (see 1.2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 89 :	*Direct acting indicating analogue electrical measuring instruments and their accessories*
BS 89 : Part 1 : 1990	*Specification for definitions and general requirements common to all Parts*
BS 89 : Part 2 : 1990	*Specification for special requirements for ammeters and voltmeters*
BS 89 : Part 3 : 1990	*Specification for special requirements for wattmeters and varmeters*
BS 89 : Part 4 : 1990	*Specification for special requirements for frequency meters*
BS 89 : Part 6 : 1990	*Specification for special requirements for ohmmeters (impedence meters) and conductance meters*
BS 89 : Part 9 : 1990	*Recommended test methods*
BS 410 : 1986	*Specification for test sieves*
BS 870 : 1950	*Specification for external micrometers*
BS 887 : 1982	*Specification for precision vernier callipers*
BS 907 : 1965	*Specification for dial gauges for linear measurement*
BS 939 : 1977	*Specification for engineer's squares (including cylindrical and block squares)*
BS 958 : 1968	*Specification for spirit levels for use in precision engineering*
BS 959 : 1950	*Specification for internal micrometers (including stick micrometers)*
BS 1054 : 1975	*Specification for engineer's comparators for external measurement*
BS 1610 :	*Materials testing machines and force verification equipment*
BS 1610 : Part 1 : 1992	*Specification for the grading of the forces applied by materials testing machines when used in the compression mode*
BS 1610 : Part 3 : 1990	*Specification for the grading of the forces applied by the deadweight and lever creep testing machines*
BS 1643 : 1983	*Specification for precision vernier height gauges*
BS 1685 : 1951	*Specification for bevel protractors (mechanical and optical)*
BS 1780 : 1985	*Specification for bourdon tube pressure and vacuum gauges*
BS 3145 : 1978	*Specification for laboratory pH meters*
BS 3730 :	*Assessment of departures from roundness*
BS 3730 : Part 1 : 1987	*Glossary of roundness measurement terms*
BS 3730 : Part 2 : 1982	*Specification for characteristics of stylus instruments for measuring variations in radius (including guidance on use and calibration)*
BS 3730 : Part 3 : 1982	*Methods for determining departures from roundness using two- and three-point measurement*
BS 4372 : 1968	*Specification for engineer's steel measuring rules*
BS 4778 :	*Quality vocabulary*
BS 5214 :	*Specification for testing machines for rubbers and plastics*
BS 5214 : Part 1 : 1995	*Tensile, flexural and compression types (constant rate of traverse)*
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ISBN 0 580 25791 6