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Plastics pipes and fittings — Automatic recognition systems for electrofusion joints

Tubes et raccords en matières plastiques — Procédés de reconnaissance automatique d'un assemblage par électrosoudage

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13950 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This first edition of ISO 13950 cancels and replaces ISO/TR 13950:1997, of which it constitutes a technical revision.

Plastics pipes and fittings — Automatic recognition systems for electrofusion joints

1 Scope

This International Standard specifies the characteristics of automatic recognition systems (numerical recognition by means of bar codes or magnetic cards, electromechanical recognition using implanted-resistor connectors and self-regulation systems) that enable the energy supply to be delivered automatically to the thermoplastic electrofusion fittings used in pipe jointing.

It is applicable to electrofusion fittings intended to be used for plastics piping systems for the conveyance of gaseous fuels, water for human consumption (including raw water prior to treatment) and for general purposes, or of other fluids.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 7810:2003, *Identification cards — Physical characteristics*

ISO/IEC 7811-2:2001, *Identification cards — Recording technique — Part 2: Magnetic stripe — Low coercivity*

ISO/IEC 7811-6:2001, *Identification cards — Recording technique — Part 6: Magnetic stripe — High coercivity*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
fitting
accessory for the connection by fusion of thermoplastic pipes and/or other accessories

3.2
socket
female part of a fitting in which the fusion is performed

3.3
coupler
fitting constituted by two sockets

3.4
monofilar coupler
fitting constituted of two sockets for which fusion is performed in a single operation

3.5
bifilar coupler
fitting constituted of two sockets for which fusion is performed separately

3.6
saddle
electrofusion fitting for by-passing, branching, ballooning or other operations

3.7
reduction
electrofusion fitting for the assembly of two pipes and/or male terminating fittings of different dimensions

3.8
elbow
electrofusion fitting with two sockets with an angle

3.9
tee
electrofusion fitting with three electrofusion sockets or two sockets and one male end

3.10
plug
electrofusion fitting with one socket for plugging tubes and other accessories

3.11
connector
end of the cable connecting the electrofusion accessory to the fusion machine

3.12
terminal
fixed part of the heating element located on the outside of the fitting to enable electrical connection to be made with the fitting

3.13
terminal shroud
part of the fitting enabling the connector to be mounted externally

3.14
nominal fusion time
fusion time, in seconds, specified by the fitting manufacturer at the reference temperature and for the electrical parameters, such as nominal resistance, voltage and current, specified by the manufacturer

3.15
real fusion time
fusion time, in seconds, used in reality, taking account, if necessary, of the ambient temperature and/or the real electrical parameters

3.16
fusion voltage
voltage, in RMS AC volts, applied to the fitting during the fusion cycle

3.17
fusion current
current, in amperes, flowing in the fitting and its supply circuit during the fusion cycle

3.18
nominal fusion energy
energy, in kilojoules, specified by the fitting manufacturer at the reference temperature and for the electrical parameters whose values fall within the tolerance ranges specified by the manufacturer

3.19
real fusion energy
energy, in kilojoules, consumed by the fitting at a given ambient temperature and for electrical parameters whose values fall within the tolerance ranges specified by the manufacturer

3.20 Resistance of the heating element

3.20.1
nominal resistance
ohmic resistance of the heating element at 23 °C used in the basic design calculations for the electrofusion fitting, as specified by the manufacturer

3.20.2
identification resistance
ohmic resistance of the heating element at 20 °C measured on any electrofusion fitting

3.20.3
measured resistance
ohmic resistance at the ambient temperature measured on any electrofusion fitting

3.21
resistivity
reciprocal of the conductivity of the heating element, in ohm metres

3.22
temperature coefficient of the heating element
gradient of the change in resistance versus temperature, in reciprocal degrees kelvin

3.23
digit
whole number from zero to nine

3.24
character
whole number from zero to nine or a letter or a sign

4 Description of procedures

4.1 Numerical recognition

4.1.1 Principle

Methods for numerical recognition are based on systems such as bar codes and magnetic cards. Fusion parameters are recorded in code form on the data medium. At the manufacturer's initiative or in response to user request, other information for fitting identification, identification of test data, fusion cycle optimization, additional safety measures, etc. can also be encoded

For a heating cycle, the system reads, processes and memorizes the information recorded on the data medium.

Successive messages are displayed, or signal tones emitted, to request the operator to follow a procedure, defined by the fitting manufacturer, specific to the fitting in question and including its recognition.

4.1.2 Field of application and limits

Numerically controlled fusion machines capable of reading fusion parameters can be used for all electrofusion and electro-heating assembly techniques.

The limits of this type of fusion control unit shall be detailed by the manufacturer in terms of

— the maximum energy to be delivered,

— the fusion programmes incorporated,

— the fusion adaptations incorporated, and

— the limits of the programmable parameters.

4.1.3 Bar codes

4.1.3.1 General

The system for entering data using bar codes offers a number of different user possibilities, both for the fitting supplier and the manufacturer of the fusion machine:

— the fitting manufacturer records on the bar code the data he considers will be needed to ensure correct assembly, the amount of data depending on factors such as particular requirements or new technical developments;

— the control unit manufacturer is free to develop his own software and the technical design of the unit, and can choose which data to display, which commands will be available, the criteria for fusion cycle emergency stop, and the display and recording of the various faults, the memorization method for fusion data, etc.

4.1.3.2 Format of bar codes

The format of bar codes shall one or the other of the following.

a) The 24 digit “2-in-5” interleaved type. The ratio between the width of the thicker bar and the thinner bar shall be 2,5. The bar code content is summarized in Annex A.

b) The 32 digit “2-in-5” interleaved type, including traceability coding as summarized in Annex B. The ratio between the width of the thicker bar and the thinner bar shall be 2,5.

4.1.3.3 Bar code structure

The bar code structure shall have a predetermined overall length of either 24 digits or 32 digits. One of these digits is composed by a control character (checksum). A complementary character set can be added if further data is required. The content of each digit shall be in accordance with Annex A or Annex B, as applicable.

4.1.4 Magnetic cards

4.1.4.1 General

The system of data insertion by means of magnetic cards offers different possibilities for the fitting supplier, as well as for the user and control unit manufacturer.

— The fitting manufacturer records on the card the number of items of data necessary for the completion of an optimal fusion joint. In order to establish the fusion programme, he can choose between the functions described in Annex C, and adapt the data according to his wishes using nominal or real values. A fusion programme can contain up to 90 characters.

— The control unit manufacturer is completely free to develop his own software as well as the technological concept of the unit. He can choose, among others, the data appearing on the display, the different commands, the emergency stop of the fusion cycle, as well as the display and recording of the different faults, the fusion data storage mode, etc., unless these are already prescribed in other standards.

— With respect to the quality assurance of every fusion, a record containing all or part of the fusion process data can be stored either on the magnetic card or in the control box memory. When the fusion has been completed successfully and recorded on the magnetic card, the same magnetic card shall not be used again to carry out another fusion.

4.1.4.2 Description of technique

Use of a magnetic card for the transmission of data to a fusion control unit requires the following information:

- the card format;
- the magnetic tracks to be used;
- the recording technique;
- the data storage mode;
- the variables and the units in which they are expressed.

4.1.4.3 Physical characteristics of magnetic card

The magnetic card (ID-1) specified in this International Standard is in accordance with ISO/IEC 7810, ISO/IEC 7811-2 and ISO/IEC 7811-6. The magnetic card shall not contain embossed characters. The three tracks according to ISO/IEC 7811-2 and ISO/IEC 7811-6 may be used to store data (fusion programme: tracks 1 and 2 only, and a fusion record: tracks 1, 2 and 3) on the card.

4.1.4.4 Description of encoding

ISO/IEC 7811-2 specifies the characteristics of the magnetic stripe. The structure of the information on tracks 1, 2 and 3 is given in Annex C.

4.1.4.5 Data storage

For the data storage, the basic rules given in Annex C shall be followed.

4.2 Electromechanical recognition

4.2.1 Principle

The primary function of the electromechanical recognition method consists of converting the measured value of an identifying resistance into a fusion time.

Other functions may be carried out, such as fitting identification by the implanted resistance method.

4.2.2 Field of application and limits

Electromechanical recognition may be used when fittings are provided with the correct terminal housing and terminal pin configurations.

4.2.3 "Implanted resistor" connector

4.2.3.1 General

A resistor is implanted in one of the terminal pins of an electrofusion fitting. The value of this resistor is read by the control unit and the fusion time is determined automatically by the control box from stored data.

4.2.3.2 Description of system (see Annex D)

A resistor is placed in the fitting terminal as shown in Figure D.1. This terminal is moulded into the fitting together with a second plain terminal in the other fitting connector (see Figure D.2).

The preferred values of the dimensions versus the voltage of the system are given in Table D.1, by way of example.

The preferred values of the implanted resistor together with the equivalent fusion times are given in Table D.2, by way of example.

The connector (see Figure D.3) from the control box to the fitting is used to recognize the resistor value and to supply power to fittings. The fusion control unit determines the fusion time from the recognized resistance value using stored data.

4.3 Self-regulation

4.3.1 Principle

This fusion control process operates using the physico-chemical state of the material at the fitting/pipe interface. It automatically incorporates variations in fit, assembly temperature, supply voltages and the electrical resistance of the fitting.

During the fusion of a fitting to a pipe, the energy supplied causes an increase in temperature in the area around the heating element: the thermoplastic material therefore passes from the solid to the liquid state. This change in state is accompanied by a volume expansion which increases the pressure in the fusion zone. The quality of the fusion is essentially governed by the triple set (P = pressure, T = temperature, t^* = time during which the temperature of the material is less than the fusion temperature). The principle of self-regulation is to use the data terms P and T to govern the fusion time and thus to calculate the optimum t^*.

This requires no adjustment or fusion time correction. The pressure built up in the melted material interrupts the supply circuit.

4.3.2 Field of application and limits

The automatic regulation system enables fittings equipped with the appropriate terminal shroud to be processed.

The limits of this recognition system are either

— specific to the system (fixed value for the fusion parameter “fusion voltage”), or

— specific to the machine (maximum available energy).

4.3.3 System description (see Annex E)

Each fitting has two calibrated wells positioned above the fusion zone. When the voltage is applied, the heating wire melts the material in the well, firstly at the level of the wire itself, then over a greater area. Figure E.1 shows the melted zone at a given moment: this zone continues to spread in time (in Figure E.1, from zone limit a to zone limit b at the end of fusion). The wells are designed with the optimum dimensions and geometry for each fitting, ensuring that the melted material in the well bottom rises only when the correct physico-chemical state has been attained at the interface. A sensor located in the connector and an integral part of the supply cable is fitted over each well. It detects the rising level of molten material and transmits a signal to the fusion control unit which cuts the electricity supply. A diagrammatic representation of the whole detection process is given in Figure E.2 for a flat-bottomed well.

4.3.4 Dimensional characteristics

The terminal shroud shown in Figure E.3 is universal and can be used with all self-regulating fittings.

Annex A
(normative)

Structure of bar code

A.1 Digits 1 to 8 — Name/Trademark — Accessory type — Energy correction — Cycle type — Cooling time

A.1.1 Basic alphabetic codes

The coding of characters shall be in accordance with Table A.1

Table A.1 — Basic alphabetic code

Code					
A = 01	F = 06	K = 11	P = 16	U = 21	Z = 26
B = 02	G = 07	L = 12	Q = 17	V = 22	+ = 27
C = 03	H = 08	M = 13	R = 18	W = 23	“blank” = 28
D = 04	I = 09	N = 14	S = 19	X = 24	“black” = 29
E = 05	J = 10	O = 15	T = 20	Y = 25	
If the name/trademark of the accessory manufacturer has to be shortened, use code + (27), space (28) or black (29). 00 is an invalid code and may cause error messages for some decoding systems.					

A.1.2 Symbols/abbreviations for accessory types

The symbols, corresponding to the accessory types, used for fusion equipment are given in Table A.2.

Abbreviations according to Table A.2 may be chosen instead of the symbols. However, a software change should not be requested.

Table A.2 — Symbols for accessory types

Type	Symbol	Abbreviation
Tapping tee or saddle	.†.	SAD
Coupler	I	CPL
Single socket	[	SKT
Cycle with a flip-flop type dividing box	*	FFP
Electro-thermo-retractable sleeve	<	ERS
(TDW) tapping tee	J	TDW
Reduction	Y	RED
Tee	T	TEE
Elbow	C	BOW

A.1.3 Principle

Digits 1 to 8 are used to describe

- the name/trademark (logo) of the accessory manufacturer by contraction to two or four letters, as applicable,
- the type of the accessory,
- the energy correction applicable to the nominal fusion time,
- the type of the fusion cycle,
- the indication of the cooling time of the fusion cycle, and
- the cooling time, if applicable.

If the cooling time is not expressed (Case A), the name/trademark of the accessory manufacturer is expressed by four alphabetic characters, coded under digits 1 to 8 in accordance with Table A.1.

If the expression of the name/trademark requires fewer than four alphabetic characters, then the signs "+", blank or black should be used to complete it.

If the cooling time is expressed (Case B), the name/trademark of the accessory manufacturer is expressed by two alphabetic characters, coded under digits 3 to 6, in accordance with Table A.1.

Each odd digit, i.e. 1st, 3rd, 5th and 7th, controls additional information.

A.1.4 Digit 1

For Case A, accessory type information is added to digit 1. The offset value shall be in accordance with Table A.3.

Table A.3 — Offset for accessory type information

Accessory type	Offset
Tapping tee or saddle	+0
Monofilar coupler	+3
Single socket	+6

For Case B, the value of digit 1 is 9.

A.1.5 Digit 2

For Case B, accessory type information is given in digit 2, according to Table A.4.

Table A.4 — Codes for Case B accessory type

Accessory type	Code for digit 1	Code for digit 2
Cycle with a flip-flop type dividing box	9	0
Electro-thermo-retractable sleeve	9	1
(TDW) tapping tee	9	2
Reduction	9	3
Tapping tee	9	4
Coupler	9	5
Single socket	9	6
Tee	9	7
Elbow	9	8
Not to be used [a]	9	9

[a] Current display ERROR.

A.1.6 Digit 3

Digit 3 controls the energy correction.

The offset value for the energy correction shall be in accordance with Table A.5.

Table A.5 — Offset for energy correction

Control type	Offset
Mode U or mode I controlled with time or energy correction (depending on digit 7) related to the value given in digits 19 to 21.	+0
Mode U or mode I controlled with U or I power correction related to the value given in digits 13 and 14.	+3
Mode U or mode I controlled with time or energy correction (depending on digit 7) related to the value given in digits 19 to 21, with: — digit 18 controlling the independent expression of the temperature coefficient and of the manufacturing tolerance in per cent grouped in K or K′; — 10 available levels of manufacturing precision; — 10 available temperature coefficients.	+6
When non-active, display ERROR.	

A.1.7 Digit 5

The offset value for the fusion cycle (heating cycle) type shall be in accordance with Table A.6.

Table A.6 — Offset value for fusion cycle type

Fusion cycle	Offset
Uniform cycle	+0
Sequential cycle (available, waiting for a definition)	+3
Temperature cycle	+6
For +3 and +6, when non-active, display ERROR.	

A.1.8 Digit 7

Digit 7 controls either the heating time, when digits 19, 20 and 21 are expressing the time values, or the energy regulation, when digits 19, 20 and 21 are expressing the energetic values. Digit 7 shall be in accordance with Table A.7.

Table A.7 — Code for indication of cooling time

Case	Function	Code
A	Without cooling time indication	0, 1 or 2 [a]
B	With indication of cooling time)	3
	Regulation with energy where energy is expressed as (digit 19, digit 20) × $10^{\text{digit } 21}$ (joules) EXAMPLE 123 = 12 × 10^3 J or 12 000 J	4
	Case B (with indication of cooling time) or message referring to external table Energy control N · 10^x joules; Expression of the exponent in accordance with 10^x 5 = 10^1, 6 = 10^2, 7 = 10^3, 8 = 10^4, 9 = 10^5 (Digits 19, 20 and 21 are expressing the energy N value. Digit 8 refers to cooling time) Where non-active, display ERROR.	5, 6, 7, 8, 9

[a] According to the basic alphabetic code. See Table A.1.

A.1.9 Digit 8

For Case B, the code related to the cooling time shall be in accordance with Table A.8.

Table A.8 — Cooling time codes

Cooling time min	Code
5	0
10	1
15	2
20	3
30	4
45	5
60	6
75	7
90	8
	9 [a]

[a] Message with indication from the manufacturer.

A.2 Digits 9, 10, 11 — Accessory diameter(s)

A.2.1 Principle

Digits 9 to 11 express the diameter(s) of the accessory corresponding to the external diameter of the pipe on which it is fitted.

A.2.2 Electro-heating accessories

Code 000 is used for accessories not described by their diameter.

Codes 001 to 014 are reserved for fusion equipment manufacturers.

A.2.3 Accessories whose diameter is expressed in millimetres

Codes 015 to 799 are used to express the diameter as follows:

- digit 9 corresponds to the figure indicating the hundreds of millimetres;
- digit 10 corresponds to the figure indicating the tens of millimetres;
- digit 11 corresponds to the figure indicating the units of millimetres.

EXAMPLE 1 d_n = 20 mm, code: 020.

EXAMPLE 2 d_n = 63 mm, code: 063.

EXAMPLE 3 d_n = 110 mm, code: 110.

A.2.4 Accessories whose diameter is expressed in inches with IPS or CTS precision

Codes 800 to 999 are used to express the diameter as follows:

- digit 9 corresponds to the figure indicating the tens of inches;
- digit 10 corresponds to the figure indicating the inch units;
- digit 11 corresponds to the figure indicating the fraction of an inch according to Table A.9.

Table A.9 — Codes for inch fractions

System			
Iron pipe size (IPS)		Copper tube size (CTS)	
Fraction	Code	Fraction	Code
Whole inch	0	Whole inch	5
1/4 inch	1	1/4 inch	6
3/8 inch	2	3/8 inch	7
1/2 inch	3	1/2 inch	8
3/4 inch	4	3/4 inch	9

A.2.5 Reduction or monofilar tapping tee (two diameters)

In the case of a reduction or a monofilar tapping tee (corresponding to code 9 for digit 1 and code 3 or 4 for digit 2), the following coefficients are used for the calculation of the code value D:

- Coefficient C_1 for the first diameter, D_1;
- Coefficient C_2 for the second diameter, D_2;

where C_1 and C_2 are as given in Table A.10.

Select D_1 as being the greater diameter from the two diameters. Then, D is given by Equation (A.1):

$$D = (C_1 \times 31) + C_2 \quad \text{(A.1)}$$

EXAMPLE Reduction with D_1 = 110 mm and D_2 = 63 mm ; $D = (8 \times 31) + 5 = 253$.

Table A.10 — Coefficients used for diameter coding

Diameters					
Expressed in millimetres mm		**Expressed in inches** **CTS**		**Expressed in inches** **IPS**	
Coefficient C_1 or C_2	D_1 or D_2 mm	Coefficient C_1 or C_2	D_1 or D_2 in	Coefficient C_1 or C_2	D_1 or D_2 in
0	20	1/2 CTS	19	1/2 IPS	22
1	25	1 CTS	20	3/4 IPS	23
2	32	1 ¼ CTS	21	1 IPS	24
3	40			1 ¼ IPS	25
4	50			2 IPS	26
5	63			3 IPS	27
6	75			4 IPS	28
7	90			6 IPS	29
8	110			8 IPS	30
9	125				
10	140				
11	160				
12	180				
13	200				
14	225				
16	315				
17	—				
18	—				

A.3 Digit 12 — Position of comma for nominal resistance value and type of regulation

This controls, depending on the operating mode specified by the manufacturer, how the heating current is regulated:

— for Mode U, voltage control volt, if digit 3 has a value < 3.

— for Mode I, intensity control ampere, if digit 3 has a value < 3.

Digit 12 expresses the place of the comma in the value of the nominal resistance of the heating accessory (integer Ω, tenth of an Ω, hundredth of an Ω), coded in digits 15 to 17, depending on the correction mode of the variation of the nominal resistance (see A.6).

The codes shall be in accordance with Table A.11.

Table A.11 — Codes related to position of comma

Mode of correction (according to A.6)	**Mode U**		**Mode I**	
	Expression mode of nominal resistance	**Code**	**Expression mode of nominal resistance**	**Code**
Standard correction K	---	1	---	4
	--,-	2	--,-	5
	-,--	3	-,--	6
Advanced correction K′	--,-	7	--,-	9
	-,--	8	-,--	0

— For Mode P: power control, if digit 3 has a value $\geqslant 3$ and < 6.

The decimal place for the Ω value of the accessory is taken into account together with the choice of

— U for the calculation of power by U^2/R,

— I for the calculation of power by RI^2.

A.4 Digits 13 to 14 — Level of regulation (voltage or intensity)

A.4.1 Principle

Depending on the mode of regulation, U-mode or I-mode expressed in digit 12, and digits 13 and 14, define in volts or amperes the value of the regulation level selected.

A.4.2 Mode U

Codes 06 to 89 express directly the value in volts of the nominal fusion voltage selected and kept constant during the heating cycle at the heating element terminals.

EXAMPLE 35 V: digit 13 = 3, digit 14 = 5.

A.4.3 Mode I

Characters 13-14 = 02 to 99.

This gives a direct expression of the intensity selected and kept constant during the heating cycle.

EXAMPLE 1 4 A: digit 13 = 0, digit 14 = 4.

EXAMPLE 2 12 A: digit 13 = 1, digit 14 = 2.

A.4.4 Mode P

The selected level of U or I is used as a basis for the calculation of P, which is then kept constant at the terminals of the accessory resistance.

A.4.5 Codes 90 to 99

Codes 90 to 99 are available to express particular values in volts or amperes:

— Code 99 for a fusion voltage of 39,5 V;

— 90 to 98 waiting for definition, display ERROR.

A.5 Digits 15, 16 and 17 — Nominal resistance of heating element

The value of the nominal resistance shall be the most precise average value obtained at manufacture from the different batches of the same accessory.

Digits 15, 16 and 17 express either

— the value, in ohms, of the fusion voltage of the heating element of the accessory at 20 °C, measured in d.c., or

— the impedance measured at a low 50 Hz sinusoidal alternating voltage (e.g. less than 5 V), this method eliminating the influence of the self-induction effect in the accessories and consequently improving the selectivity of the CONTROL stage.

The place of the comma is determined using digit 12 (see A.3).

Code 000 indicates that the value of the resistance of the heating element is not determined (no CONTROL stage).

EXAMPLE 1 Code 002 corresponds to 2 Ω if code 1 is selected for digit 12.

EXAMPLE 2 Code 002 corresponds to 0,2 Ω if code 2, 5, 7 or 9 is selected for digit 12.

EXAMPLE 3 Code 002 corresponds to 0,02 Ω if code 3, 6, 8 or 0 is selected for digit 12.

A.6 Digit 18 — Variation of resistance of heating element

A.6.1 Principle

The resistance of the heating element of an accessory (coded in digits 15 to 17) at an ambient temperature other than 20 °C is dependant, on the one hand, on the manufactured tolerance of the accessory resistance element, and on the other hand, on the variation with temperature of the resistance value which is linked to the nature of the wire.

Taking this into consideration, digit 18 expresses the correction coefficient to apply according to two modes:

— a standard correction of the variation of the resistance, K, using a fixed tolerance range;

— an advanced correction of the variation of the resistance, K′, using temperature tolerance ranges taking into account the nature of the wire.

A.6.2 Standard correction K of resistance variation

For standard correction, levels are assigned according to the sum of the two elements given in A.6.1.

They are used, as a ± % range, in the calculation that compares the theoretical value of the resistance measured at 20 °C with the measurement of the resistance at the CONTROL stage before the heating cycle.

The codes corresponding to the variation of the resistance of the heating element versus ± % range shall be in accordance with Table A.12.

When non-active, display ERROR.

Table A.12 — Codes related to variation of resistance

Variation of resistance %	Code
± 6	1
± 8	2
± 10	3
± 12	4
± 15	5
± 19	6
± 24	7
± 30	8
—	9 [a]
—	0 [b]

[a] Code 9 is reserved for requesting the calculation of the accessory's real temperature, compared with the theoretical bar code value at 20 °C, and the value measured in testing. This formula only applies to accessories for which the resistance wire is made of pure copper (99,9 % electrolytic) with a resistivity of $4,1 \times 10^{-3}$ per degree Celsius used in the calculation.

[b] Code 0 is used when the value of resistance is not determined, corresponding to code 000 for digits 15 to 17.

EXAMPLE 1

— Possible working temperature conditions: (−10 °C to +40 °C) with ± 5 °C measurement error; therefore 35 °C maximum *vis-à-vis* 20 °C.

— Manufacturing tolerance: ± 5 %.

— Wire resistivity variation coefficient per degree Celsius: between $+3 \times 10^{-3}$ and $+4 \times 10^{-3}$.

Sum variation: ± 19 %, corresponding to code 6.

EXAMPLE 2

— Possible working temperature conditions: (−10 °C to +40 °C) with ± 5 °C measurement error; therefore 35 °C maximum *vis-à-vis* 20 °C.

— Manufacturing tolerance: ± 5 %.

— Wire resistivity variation coefficient per degree Celsius: between $-0,5 \times 10^{-3}$ and $+0,5 \times 10^{-3}$.

Sum variation: ± 8 %, corresponding to code 2.

A.6.3 Advanced correction K′ of resistance variation

For the advanced correction K′:

- three classes of manufacturing precision are pre-defined: ± 7 %, ± 12 %, ± 20 %;
- four classes of variation of the resistivity of the heating element, versus the temperature are pre-defined and represented by gradients: per variation of temperature expressed in °C, 0,0 $\leqslant 10^{-3}$, $10^{-3} \leqslant 4 \times 10^{-3}$ and $4 \times 10^{-3} \leqslant 6 \times 10^{-3}$.

The codes corresponding to the variation of the resistance of the heating element versus classes of manufacturing precision and variation of the resistivity shall be in accordance with Table A.13.

Table A.13 — Codes related to variation of resistance

Class of manufacturing precision %	**Class of resistivity variation** 10^{-3}	**Code**
± 7	0	0
± 7	0 ⩽ 1	1
± 7	1 ⩽ 4	2
± 7	4 ⩽ 6	3
± 12	0 ⩽ 1	4
± 12	1 ⩽ 4	5
± 12	4 ⩽ 6	6
± 20	0 ⩽ 1	7
± 20	1 ⩽ 4	8
± 20	4 ⩽ 6	9

The use of advanced correction K′ includes the obligatory “temperature measurement” stage for the pipe, except where the class of resistivity variation is 0 (Code 0, see Table A.13).

A.7 Digits 19, 20 and 21 — Heating time — Energy — Stop temperature

A.7.1 Heating time

The heating time is expressed from 003 to 999.

a) Case A: time expressed in seconds

Usable codes, 003 to 899:

- digit 19 expresses hundreds of seconds;
- digit 20 expresses tens of seconds;
- digit 21 expresses second units.

b) Case B: time expressed in minutes

Usable codes, 900 to 999:

— digit 19 is always set to 9;

— digit 20 expressed tens of minutes;

— digit 21 expressed minute units.

Code 000 expressed an infinite heating time indicated by the display “t = infinity” during the heating cycle. This implies that digits 22 and 23 are 1.

A.7.2 Energy

Where digit 7 is 5, 6, 7, 8 or 9 (see Table A.7), energy is expressed according to $N \times 10^{x}$ joules.

Digit 7 is used to define the exponent: 10^{x}.

Digits 19-20-21 express the energy N value.

EXAMPLE Where digit 7 is 4, then 10^{2}; digits 19-20-21 = 234. The cycle will be performed with a total value of 23 400 joules.

Where digit 7 is 4, energy is expressed as (digit 19, digit 20) $\times 10^{\text{digit 21}}$ joules.

When non-active, display ERROR.

A.7.3 Temperature

Use digit 5 to select this mode. See Table A.6.

a) Case A: expression of temperature without progressive regulated voltage start

Digit 19-20-21 expressed the temperature in degrees Celsius at which the heating cycle shall stop, with a maximum of 299 °C.

EXAMPLE 1 165 = 165 °C; 200 = 200 °C.

b) Case B: expression of temperature with progressive regulated voltage start

Digit 19, always greater than 2, expresses the time in seconds for the progressive regulated voltage start.

The codes for digit 19 shall be in accordance with Table A.14; digits 20 and 21 express the temperature in hundreds and tens of degrees Celsius.

EXAMPLE 2 Digit 19-20-21: 3-1-5 = a progressive rise of 3 s at 150 °C.

Digits 22 and 23 should be used for a heating cycle at a pre-selected temperature.

When non-active, display ERROR.

Table A.14 — Codes for time for progressive rise

Time s	Code
3	3
6	4
10	5
15	6
20	7
25	8
30	9

A.8 Digits 22 to 23 — Energy correction — Regulation to pre-defined temperature

A.8.1 Energy correction

A.8.1.1 Principle

The energy is corrected according to the temperature of the elements to be assembled, taking into account the different climatic conditions of the worksite, according the following:

— at the reference temperature of 20 °C, no energy correction is made;

— below 20 °C, a *positive* energy correction — per degree Celsius of difference from 20 °C and as a percentage of the initial value — is made, expressed by digit 22.

— above 20 °C, a *negative* energy correction — per degree Celsius of difference from 20 °C and as a percentage of the initial value — is made, expressed by digit 23.

A.8.1.2 Codification of energy correction

Codes corresponding to the energy correction shall be in accordance with Table A.15.

Table A.15 — Codes for energy correction

Code		Uses
Digit 22	Digit 23	
2 to 9	2 to 9	Digit 22 corresponds to the figure which indicates the tenth of the energy correction percentage, below 20 °C, per degree Celsius of difference. Digit 23 corresponds to the figure which indicates the tenth of the energy correction percentage, above 20 °C, per degree Celsius of difference. If digit 22 and digit 23 are equal, the energy correction is a “straight line” that passes by 0 % at 20 °C. If digit 22 and digit 23 are not equal, the energy correction is a “broken line” around 0 % at 20 °C.
0	0	Waiting for definition, display ERROR.
0	1 to 9	Available for safety thresholds on “flags” for accessories with automatic cycle cut-out. Waiting for definition, display ERROR.
1	1	These values express that there is no need for difference of temperature Δt or for ΔP, no accounting for θ °C, stage jumped. These values are used for accessories with uncompensated energy or for manual accessories “t = infinite”.
1	2 to 9	Waiting for definition, display ERROR.
1 to 9	0	Waiting for definition, display ERROR.
2 to 9	1	Waiting for definition, display ERROR.

A.8.2 Heating cycle regulated at a pre-set temperature

The heating cycle holding time regulated by the pre-set temperature is given in Table A.16.

When non-active, display ERROR.

Table A.16 — Heating time

Digits 22-23	Corresponding time s **or** min									
00 to 09	0 s	1 s	2 s	3 s	4 s	5 s	6 s	7 s	8 s	9 s
10 to 19	10 s	11 s	12 s	13 s	14 s	15 s	16 s	17 s	18 s	19 s
20 to 29	20 s	22 s	24 s	26 s	28 s	30 s	32 s	34 s	36 s	38 s
30 to 39	40 s	44 s	48 s	52 s	56 s	60 s	64 s	68 s	72 s	76 s
40 to 49	80 s	90 s	100 s	110 s	120 s	130 s	140 s	150 s	160 s	170 s
50 to 59	190 s	210 s	230 s	250 s	270 s	290 s	310 s	330 s	350 s	370 s
60 to 69	400 s	440 s	480 s	520 s	560 s	600 s	640 s	680 s	720 s	760 s
70 to 79	13 min	14 min	15 min	16 min	18 min	19 min	20 min	21 min	22 min	23 min
80 to 89	24 min	26 min	28 min	30 min	32 min	34 min	36 min	38 min	40 min	42 min
90 to 99	46 min	50 min	54 min	58 min	62 min	66 min	70 min	74 min	78 min	82 min

A.9 Digit 24 — Control character (checksum)

Digit 24 states that the message is read in its entirety and recognized as being significant.

The value of digit 24, calculated from the values of all digits 1 to 23, is determined as follows:

— addition of the numerical values of the odd positions in the message read from left to right, followed by multiplication of this total by a factor of 3;

— addition of the numerical values of the even positions in the message read from left to right;

— addition of the odd and even totals of stages 1 and 2;

— determination of the checksum — smallest figure that when added to the sum of stage 3 produces a multiple of 10.

Digit 24 expresses this figure, placed in the 24th position of the message read from left to right.

A.10 Structure of bar code and examples

The bar code structure is summarized in Tables A.17 and A.18 for Cases A and B, respectively (see A.1.3). Tables A.17 and A.18 also give examples of codes.

Table A.17 — Structure of bar code — Case A

Digit	Information	Offset	Example	
1	Name trademark of manufacturer [d]	+0, +3, +6 [a]	3	Monofilar coupler
2		—	1	A
3		+0 [b]	0	
4		—	2	B
5		+0 [c]	0	
6		—	3	C
7		—	0	
8		—	4	D
9	Accessory diameter	—	1	110 mm
10		—	1	
11		—	0	
12	Expression of resistance	—	3	-,-- K
13	Nominal fusion voltage U	—	4	40 V
14		—	0	
15	Resistance of heating element	—	1	1,20 Ω
16		—	2	
17		—	0	
18	Variation of resistance	—	5	± 15 %
19	Nominal heating time	—	2	200 s
20		—	0	
21		—	0	
22	Energy correction	—	3	0,3 %
23		—	3	0,3 %
24	Checksum	—	4	

EXAMPLE Code 310203041103401205200334 is given for a coupler, trademark ABCD, diameter 110 mm, resistance 1,2 Ω, with a possible variation of 15 % (standard correction), fusion voltage 40 V during a fusion time 200 s and energy correction coefficients above and below 20 °C of 0,3 % per degree Celsius of difference.

[a] Type of accessory.

[b] Time correction.

[c] Fusion (heating) cycle.

[d] Without cooling time indication.

Table A.18 — Structure of bar code — Case B

Digit	Information	Offset	Example	
1	[a]	—	9	
2	Accessory type	—	3	Reduction
3	Name trademark of manufacturer	+0 [b]	0	A
4		—	1	
5		+0 [c]	0	B
6		—	2	
7	Indication of cooling time	—	3	Indication of cooling time
8	Cooling time	—	4	30 min
9	Accessory diameter	—	2	2 diameters
10		—	5	110 mm and 63 mm
11		—	3	
12	Expression of resistance	—	3	-,-- K
13	Nominal fusion voltage U	—	4	40 V
14		—	0	
15	Resistance of heating element	—	0	0,85 Ω
16		—	8	
17		—	5	
18	Variation of resistance	—	8	± 30 %
19	Heating time	—	1	120 s
20		—	2	
21		—	0	
22	Energy correction	—	5	+0,5 % by °C < 20 °C
23		—	4	–0,4 % by °C > 20 °C
24	Checksum	—	6	

EXAMPLE Code 930102342533400858120546 is given for a reduction, trademark AB, with a cooling time 30 min, diameters 110 mm et 63 mm, resistance 0,85 Ω, with a possible variation of 30 % (standard correction), fusion voltage 40 V during a heating time of 120 s, and energy correction coefficients of 0,5 % per degree Celsius of difference below 20 °C and 0,4 % per degree Celsius of difference above 20 °C.

[a] Type of accessory.

[b] Time correction.

[c] Fusion (heating) cycle.

Annex B
(normative)

Structure of 32-digit bar code

B.1 Structure of bar code

The 32-digit bar code is divided into two parts:

a) a common part (digits 1 to 19) that describes all data related to the characteristics of the element to be fused;

b) a specific part (digits 20 to 32) that describes all data related to the technique used to fuse the element.

B.2 Common part

B.2.1 Digits 1 to 4 — Manufacturer's name/trademark

B.2.1.1 Basic alphabetic codes

The coding of characters shall be in accordance with Table B.1.

Table B.1 — Basic alphabetic code

Basic alphabetic code					
A = 01 B = 02 C = 03 D = 04 E = 05	F = 06 G = 07 H = 08 I = 09 J = 10	K = 11 L = 12 M = 13 N = 14 O = 15	P = 16 Q = 17 R = 18 S = 19 T = 20	U = 21 V = 22 W = 23 X = 24 Y = 25	Z = 26 + = 27 “blank” = 28 “black” = 29

B.2.1.2 Principle

The manufacturer shall be identified by a unique codification composed of two alphabetic characters (character A for digits 1 and 2, character B for digits 3 and 4) and based on geographical tables. The manufacturer's tables are managed by recognized organizations such as GERG for Europe or GRI for the USA.

As the representation of characters A and B cannot be higher than 29, offset values for the fusion process and the type of regulation are added to digits 1 and 3 according to the Table B.2.

Table B.2 — Offset for fusion process and type of regulation

Process	Offset for digit 1	Type of regulation	Offset for digit 3
Electrofusion process	+0	Mode U or mode I	+0
		Energy regulation	+3
		Power regulation	+6
Heated tool process	+3	Butt fusion	+0
		Socket fusion	+3
		Saddle fusion	+6
Process not specified	+6	Mechanical fitting	+0
		Induction	+3
		Others	+6

B.2.2 Digits 5 and 6 — Accessory type

Digits 5 and 6 express the accessory type.

The symbols, corresponding to the accessory types, used for fusion equipment and accessory type information are given in Table B.3.

Table B.3 — Symbols and codes for accessory type

Accessory type	Symbol	Code
Pipe, straight		01
Pipe, coiled		02
Socket	I	03
Tapping saddle	.†.	04
Branching saddle	.†.	05
Elbow, 90°	C	06
Elbow, 45°	C	07
Elbow, undefined	C	08
Tee	T	09
End cap	[	10
Reducer	Y	11
Swept bend		12
Flange adaptor		13
Mechanical fitting		14
PE body valve, quarter turn	V	15
PE body valve, multi-turn	V	16
Not PE body valve, quarter turn		17
Not PE body valve, multi-turn		18
Repair fitting		19

B.2.3 Digits 7 to 9 — Accessory diameter(s)

Digits 7 to 9 are used to describe the diameter(s) of the accessory corresponding to the external diameter of the pipe on which it is fitted. They express the value of D, calculated from the values of the two different diameters or the diameter (coupler), as applicable, of the accessory, as follows:

— Digit 7 corresponds to the figure indicating the hundreds of the calculated value D;

— Digit 8 corresponds to the figure indicating the tens of the calculated value D;

— Digit 9 corresponds to the figure indicating the units of the calculated value D.

In the case of an accessory with two different diameters, D_1 and D_2, select D_1 as being the greater diameter from the two diameters. In the case of an accessory (coupler), the two diameters are identical, $D_1 = D_2$.

For accessories whose diameter(s) is (are) expressed in millimetres, the value of D shall be calculated using Equation (B.1):

$$D = (C_1 \times 31) + C_2 \tag{B.1}$$

where

C_1 is the coefficient for the first diameter D_1;

C_2 is the coefficient for the second diameter D_2.

For accessories whose diameter or diameter are expressed in inches, the value of D shall be calculated using Equation (B.2):

$$D = (C_2 \times 31) + C_1 + 1 \tag{B.2}$$

where

C_1 is the coefficient for the first diameter D_1;

C_2 is the coefficient for the second diameter D_2.

The values of coefficients C_1 and C_2 are given in Table B.4.

For a coupler whose diameter is expressed in inches, the value of D may taken directly as the inch value if less than 31 in.

Table B.4 — Coefficients used for diameter coding

Coefficient C_1 or C_2	Diameter D_1 or D_2 mm		
	Expressed in millimetres	Expressed in inches CTS	Expressed in inches IPS
1	16	1/2	
2	20	1	
3	25	1 1/4	
4	32		
5	40		
6	50		
7	63		
8	75		
9	90		
10	110		
11	125		1/2
12	140		3/4
13	160		1
14	180		1 1/2
15	200		1 1/4
16	225		2
17	250		3
18	280		4
19	315		6
20	355		8
21	400		10
22	450		11
23	500		12
24	560		13
25	630		14
26	710		
27	800		
28	900		
29	1 000		
30	1 200		
31	$>$ 1 400		

EXAMPLE 1 Coupler with $D_1 = D_2$ = 1/2 in CTS; $D = (1 \times 31) + 1 + 1 = 33$.

EXAMPLE 2 Coupler with $D_1 = D_2$ = 200 mm; $D = (15 \times 31) + 15 = 480$.

EXAMPLE 3 Reduction with D_1 = 2 in and D_2 = 1/2 inch IPS; $D = (11 \times 31) + 16 + 1 = 358$.

EXAMPLE 4 Reduction with D_1 = 90 mm and D_2 = 63 mm; $D = (9 \times 31) + 7 = 286$.

EXAMPLE 5 Coupler with $D_1 = D_2$ = 21 in IPS; D = 021.

B.2.4 Digits 10 to 15 — Product batch number

Digits 10 to 15 express the production batch number; the codes shall be defined by the manufacturer.

B.2.5 Digit 16 — SDR

Digit 16 expresses the standard dimension ratio (SDR); the code shall be in accordance with Table B.5.

Table B.5 — SDR codes

SDR	Code
> 33	0
33	1
26	2
21	3
17,6	4
17	5
13,6	6
11	7
9	8
< 9	9

B.2.6 Digits 17 to 19 — Material

The material shall be identified by a unique codification composed by one alphabetic character and one numerical character, and based on geographical tables. The material tables are managed by recognized organisations such as GERG for Europe or GRI for the USA.

For coding the alphabetic character, see B.2.1.1.

B.3 Specific part

B.3.1 Electrofusion process with Mode U or Mode I regulation

B.3.1.1 Digits 20 and 21 — U or I level

Depending on the mode of regulation, U-mode or I-mode, expressed in digit 3, digits 20 and 21 define in volts or amperes the value of the regulation level selected. The codes corresponding to U or I level shall be in accordance with Table B.6.

Table B.6 — Codes for U or I level

U or I level	Code
39,5 V	00
79 V	01
Not used	02
03 A	03
04 A	04
Not used	05
Not used	06
Not used	07
Voltage level	08 to 49
Not used	50 to 99

B.3.1.2 Digits 22 to 24 — Value of nominal resistance

Digits 22 to 24 express the value of the nominal resistance of the heating element, coded as follows:

— for code (RRR) $<$ 333, nominal resistance = RRR $\times$ 0,01 (0,01 Ω to 3,32 Ω);

— for code (RRR) $<$ 666 but $\geqslant$ 333, nominal resistance = (RRR $-$ 333) $\times$ 0,05 (0,05 Ω to 16,60 Ω);

— for code (RRR) $\geqslant$ 666, nominal resistance = (RRR $-$ 666) $\times$ 0,30 (0,30 Ω to 99,90 Ω).

Code 000 indicates that the value of the resistance of the heating element is not determined.

B.3.1.3 Digit 25 — Tolerance on value of nominal resistance

Digit 25 expresses the tolerance on the value of the nominal resistance; the code shall be in accordance with Table B.7.

Table B.7 — Codes for tolerance on value of nominal resistance

Tolerance %	Code
2,5	0
5	1
7,5	2
10	3
15	4
Not used	5 to 9

B.3.1.4 Digit 26 — Variation of nominal resistance

Digit 26 expresses the variation of the nominal resistance of the heating element as a function of φ, in 10^{-3} Ω by °C of difference with 20 °C, and the code shall be in accordance with Table B.8.

Table B.8 — Codes for the variation of the nominal resistance

φ	**Code**
= 0	0
$0 < \varphi \leqslant 0{,}5$	1
$0{,}5 < \varphi \leqslant 1$	2
$1 < \varphi \leqslant 1{,}4$	3
$1{,}4 < \varphi \leqslant 1{,}8$	4
$1{,}8 < \varphi \leqslant 2{,}4$	5
$2{,}4 < \varphi \leqslant 3{,}2$	6
$3{,}2 < \varphi \leqslant 4$	7
$4 < \varphi \leqslant 5$	8
$5 < \varphi \leqslant 6$	9

After correction of the value of the nominal resistance as given by digits 22 to 24 according to digit 26, the corrected value is checked at ± tolerance as given by digit 25.

B.3.1.5 Digits 27 to 29 — Heating time

Digits 27 to 29 express the heating time.

When the heating time is expressed in seconds, codes 001 to 899 are used as follows:

— digit 27 expresses hundred of seconds;

— digit 28 expresses tens of seconds;

— digit 29 expresses second units.

When the heating time is expressed in minutes, codes 900 to 999 are used as follows:

— digit 27 is always set to 9;

— digit 28 expresses tens of minutes;

— digit 29 expresses minute units.

This value is corrected according to the ambient temperature and is indicated by the digits 30 and 31.

B.3.1.6 Digits 30 and 31 — Heating time correction

Digits 30 and 31 are used to correct the heating time with regard to the ambient temperature as follows:

— at the reference temperature of 20 °C, no heating time correction is made;

— below 20 °C, a *positive* heating time correction — per degree Celsius of difference from 20 °C and as 0,x % of the initial value of the heating time — is made, expressed by digit 30;

— above 20 °C, a *negative* heating time correction — per degree Celsius of difference from 20 °C and as 0,x % of the initial value of the heating time — is made, expressed by digit 31.

B.3.1.7 Digit 32 — Control character (checksum)

Digit 32 states that the message is read in its entirety and recognized as being significant.

The value of digit 32, calculated from the values of all digits 1 to 31, is determined as follows:

a) addition of the numerical values of the odd positions in the message read from left to right, followed by multiplication of this total by a factor of 3;

b) addition of the numerical values of the even positions in the message, read from left to right;

c) addition of the odd and even totals of stages 1 and 2;

d) determination of the checksum — smallest figure that when added to the sum of stage 3 produces a multiple of 10.

B.3.2 Electrofusion process with energy regulation

B.3.2.1 Digits 20 and 21 — U or I level and level of energy index (x)

Depending on the mode of regulation, energy regulation expressed in digit 3, digits 20 and 21, define in volts or amperes the value of the regulation level selected and the level of energy index (x). The codes shall be in accordance with Table B.9.

Table B.9 — Codes for U or I level and level of energy index

U or I level	Code	U or I level	Code
x = 0		x = 2	
39,5 V	00	39,5 V	50
79 V	01	79 V	51
Not used	02	Not used	52
03 A	03	03 A	53
04 A	04	04 A	54
Not used	05	Not used	55
Not used	06	Not used	56
Not used	07	Not used	57
Voltage level	08 to 49	Voltage level — 50	58 to 99

B.3.2.2 Digits 22 to 24 — Value of nominal resistance

Digits 22 to 24 express the value of the nominal resistance of the heating element, coded as follows:

— for code (RRR) $<$ 333, nominal resistance = RRR $\times$ 0,01 (0,01 Ω to 3,32 Ω);

— for code (RRR) $<$ 666 but $\geqslant$ 333, nominal resistance = (RRR $-$ 333) $\times$ 0,05 (0,05 Ω to 16,60 Ω);

— for code (RRR) $\geqslant$ 666, nominal resistance = (RRR $-$ 666) $\times$ 0,30 (0,30 Ω to 99,90 Ω).

Code 000 indicates that the value of the resistance of the heating element is not determined.

B.3.2.3 Digit 25 — Tolerance on value of nominal resistance and level of energy index (x)

Digit 25 expresses the tolerance on the value of the nominal resistance and the level of energy index; the code shall be in accordance with Table B.10

Table B.10 — Codes for tolerance on value of nominal resistance and level of energy index

Tolerance %	Code	Tolerance %	Code
x = x + 1		x = x + 2	
2,5	0	2,5	5
5	1	5	6
7,5	2	7,5	7
10	3	10	8
15	4	15	9

B.3.2.4 Digit 26 — Variation of nominal resistance

Digit 26 expresses the variation of the nominal resistance of the heating element as a function of φ, in 10^{-3} Ω by degree Celsius of difference with 20 °C; the code shall be in accordance with Table B.11.

Table B.11 — Codes for variation of nominal resistance

φ	Code
= 0	0
$0 < \varphi \leqslant 0,5$	1
$0,5 < \varphi \leqslant 1$	2
$1 < \varphi \leqslant 1,4$	3
$1,4 < \varphi \leqslant 1,8$	4
$1,8 < \varphi \leqslant 2,4$	5
$2,4 < \varphi \leqslant 3,2$	6
$3,2 < \varphi \leqslant 4$	7
$4 < \varphi \leqslant 5$	8
$5 < \varphi \leqslant 6$	9

After correction of the value of the nominal resistance as given by digits 22 to 24 and according to digit 26, the corrected value is checked at ± tolerance as given by digit 25.

B.3.2.5 Digits 27 to 29 — Energy level

Digits 27 to 29 express the energy level.

Energy is expressed, in joules, according to

$$xyz\ 10^{\mathrm{x}}$$

where

x is digit 27;

y is digit 28;

z is digit 29.

This value is corrected according to the ambient temperature and is indicated by the digits 30 and 31.

B.3.2.6 Digits 30 and 31 — Energy correction

Digits 30 and 31 are used to correct the energy with regard to the ambient temperature according the following:

— at the reference temperature of 20 °C, no heating time correction is made;

— below 20 °C, a *positive* energy correction — per degree Celsius of difference from 20 °C as a percentage of the initial value of the energy — is made, expressed by digit 30;

— above 20 °C a *negative* energy correction — per degree Celsius of difference from 20 °C as a percentage of the initial value of the energy — is made, expressed by digit 31.

B.3.2.7 Digit 32 — Control character (checksum)

Digit 32 states that the message is read in its entirety and recognized as being significant.

The value of digit 32, calculated from the values of all digits 1 to 31, is determined as follows:

a) addition of the numerical values of the odd positions in the message, read from left to right, followed by multiplication of this total by a factor of 3;

b) addition of the numerical values of the even positions in the message, read from left to right;

c) addition of the odd and even totals of stages 1 and 2;

d) determination of the checksum — smallest figure that when added to the sum of stage 3 produces a multiple of 10.

B.3.3 Electrofusion process with power regulation

B.3.3.1 Digits 20 and 21 — U or I Level and level of energy index (x)

Depending on the mode of regulation, power regulation expressed in digit 3, digits 20 and 21 define in volts or amperes the value of the regulation level selected and the level of energy index (x). The codes shall be in accordance with Table B.12.

Table B.12 — Codes for U or I level and level of energy index

U or I level	Code	U or I level	Code
x = 0		x = 2	
39,5 V	00	39,5 V	50
79 V	01	79 V	51
Not used	02	Not used	52
03 A	03	03 A	53
04 A	04	04 A	54
Not used	05	Not used	55
Not used	06	Not used	56
Not used	07	Not used	57
Voltage level	08 to 49	Voltage level − 50	58 to 99

B.3.3.2 Digits 22 to 24 — Value of nominal power

Digits 22 to 24 express the value of the nominal power, coded as follows:

— for code (WWW) < 500, nominal power = RRR (000 W to 500 W);

— for code (WWW) ⩾ 500, nominal power = [(RRR − 500) × 100] + 500 (500 W to 5490 W).

B.3.3.3 Digit 25 — Tolerance on the value of the nominal resistance and level of energy index (x)

Digit 25 expresses the tolerance on the value of the nominal resistance and the level of energy index; the code shall be in accordance with Table B.13.

Table B.13 — Codes for tolerance on value of nominal resistance and level of energy index

Tolerance %	Code	Tolerance %	Code
x = x + 1		x = x + 2	
2,5	0	2,5	5
5	1	5	6
7,5	2	7,5	7
10	3	10	8
15	4	15	9

B.3.3.4 Digit 26 — Variation of the nominal resistance

Digit 26 expresses the variation of the nominal resistance of the heating element as a function of φ, in 10^{-3} Ω by degrees Celsius of difference with 20 °C; the code shall be in accordance with Table B.14.

Table B.14 — Codes for the variation of nominal resistance

φ	Code
= 0	0
$0 < \varphi \leqslant 0,5$	1
$0,5 < \varphi \leqslant 1$	2
$1 < \varphi \leqslant 1,4$	3
$1,4 < \varphi \leqslant 1,8$	4
$1,8 < \varphi \leqslant 2,4$	5
$2,4 < \varphi \leqslant 3,2$	6
$3,2 < \varphi \leqslant 4$	7
$4 < \varphi \leqslant 5$	8
$5 < \varphi \leqslant 6$	9

The value of the resistance is calculated with regard to the number of watts and the voltage/current level.

B.3.3.5 Digits 27 to 29 — Energy level

Digits 27 to 29 express the energy level.

Energy is expressed, in joules, according to

$xyz\ 10^{x}$

where

x is digit 27;

y is digit 28;

z is digit 29.

This value is corrected according to the ambient temperature and is indicated by the digits 30 and 31 (see B.3.3.6).

B.3.3.6 Digits 30 and 31 — Energy correction

Digits 30 and 31 are used to correct the energy with regard to the ambient temperature according the following:

- at the reference temperature of 20 °C, no heating time correction is made;
- below 20 °C, a *positive* energy correction — per degree Celsius of difference from 20 °C as a percentage of the initial value of the energy — is made, expressed by digit 30.
- above 20 °C a *negative* energy correction — per degree Celsius of difference from 20 °C as a percentage of the initial value of the energy — is made, expressed by digit 31.

B.3.3.7 Digit 32 — Control character (checksum)

Digit 32 states that the message is read in its entirety and recognized as being significant.

The value of digit 32, calculated from the values of all digits 1 to 31, is determined as follows:

a) addition of the numerical values of the odd positions in the message, read from left to right, followed by multiplication of this total by a factor of 3;

b) addition of the numerical values of the even positions in the message, read from left to right;

c) addition of the odd and even totals of stages 1 and 2;

d) determination of the checksum — smallest figure that when added to the sum of stage 3 produces a multiple of 10.

B.4 Structure of bar code

See Table B.15.

Table B.15 — Bar code structure

Digit No.	Mode U or Mode I regulation		Energy regulation		Power regulation	
	Information	**Offset**	**Information**	**Offset**	**Information**	**Offset**
1	Name / trademark of manufacturer	0	Name / trademark of manufacturer	0	Name / trademark of manufacturer	0
2				—		—
3		0		+3		+6
4		—		—		—
5	Accessory type	—	Accessory type	—	Accessory type	—
6		—		—		—
7	Accessory diameter	—	Accessory diameter	—	Accessory diameter	—
8		—		—		—
9		—		—		—
10	Product batch number	—	Product batch number	—	Product batch number	—
11		—		—		—
12		—		—		—
13		—		—		—
14		—		—		—
15		—		—		—
16	SDR	—	SDR	—	SDR	—
17	Material	—	Material	—	Material	—
18		—		—		—
19		—		—		—
20	U or I level	—	U or I level and level of energy index	—	U or I level and level of energy index	—
21		—		—		—
22	Nominal resistance	—	Nominal resistance	—	Nominal power	—
23		—		—		—
24		—		—		—
25	Tolerance on nominal resistance	—	Tolerance on nominal resistance and level of energy index	—	Tolerance on nominal resistance and level of energy index	—
26	Variation of nominal resistance	—	Variation of nominal resistance	—	Variation of nominal resistance	—
27	Heating time	—	Energy level	—	Energy level	—
28		—		—		—
29		—		—		—
30	Heating time correction	—	Energy correction	—	Energy correction	—
31		—		—		—
32	Checksum	—	Checksum	—	Checksum	—

Annex C
(normative)

Magnetic cards

C.1 Data structure

C.1.1 Principle

The magnetic card system enables 226 characters in all to be stored on the three tracks. Table C.1 gives the number of characters stored per track.

Table C.1 — Number of characters stored per track

Track	Density bit per inch	Max. number of characters [a]
1	210	79
2	75	40
3	210	107

[a] Includes the start and end sentinels and the LRC character.

C.1.2 Track 1

Specific characters shall be used for this application. In order to store data on track 1, ISO/IEC 7811-2:2001, Table 4 (coded character set for track 1) is extended in accordance with B.2.

The structure of track 1 is according to Table C.2.

EXAMPLE Fusion programme M1 with a constant voltage of 40 V and a fusion time of 180 s.

Table C.2 — Structure of track 1

Character	Binary code		Signification
1	%	1000101	Start sentinel
2	M	1101101	Identification code
3	1	1010001	Index number
4	,	1001100	Comma symbol (,)
5	4	1010100	) 1st parameter
6	0	1010000	(
7	,	1001100	Comma symbol (,)
8	1	1010001	)
9	8	1011000	(2nd parameter
10	0	1010000	)
.	.		
.	.		
77			Sentinel of the last data
78	?		End sentinel
79		0011111	LRC (low resistance coercivity)

C.1.3 Tracks 2 and 3

If track 2 or 3 is not used to store data (fusion programme or record), the start and end sentinels and the LRC shall be programmed on the respective track.

In order to store data on track 2 or 3, ISO/IEC 7811-2:2001, Table 7 (coded character set for track 2 and 3) is extended in accordance with C.3.

This extended set of coded characters only enables numerical characters and the symbol for the comma (,), the full stop (.) and the minus sign (–) to be stored.

As a result, the extended character set given in C.2 is used to transform an alphanumerical code into a numerical character coded at 2-bit.

This transformation procedure is according to Tables C.3 and C.4.

The first character of a data series is always a separation sentinel (HEX D), while the second and third characters are the identification code composed, at first, by the 3-bits of the inferior level (b1-b3), then by the superior level (b4-b6) of the respective data.

EXAMPLE 1 Identification code X.

Table C.3 — Transformation procedure

Bit number				
4	**3**	**2**	**1**	**0**
Parity bit	0	b3	b2	b1
Parity bit	0	b6	b5	b4

Table C.4 — Transformation procedure

Bit number				
4	**3**	**2**	**1**	**0**
1	0	0	0	0
0	0	1	1	1

The structure of tracks 2 and 3 is according to Table C.5.

EXAMPLE 2 Fusion programme M1 with constant voltage of 40 V and a fusion time of 180 s.

Table C.5 — Structure of tracks 2 and 3

Character		Binary code		Signification
Track 2	Track 3			
1	1	HEX B	01011	Start sentinel
2	2	HEX D	01101	Separation sentinel
3	3	5	10101	) Identification code (M)
4	4	5	10101	(
5	5	1	00001	Index number
6	6	HEX E	01110	Comma symbol (,)
7	7	4	00100	) 1^{st} parameter
8	8	0	10000	(
9	9	HEX E	01110	Comma symbol (,)
10	10	1	00001	)
11	11	8	01000	(2^{nd} parameter
12	12	0	10000	)
13	13	HEX D	01101	Separation sentinel
14	14			Following identification code
15	15			
.	.			
.	.			
38	105			Last data sentinel
39	106	HEX F	11111	End sentinel
40	107			LRC

C.2 Extended set of coded characters for track 1

See Table C.6.

Table C.6 — Extended set of coded characters for track 1

				b6	0	0	1	1
				b5	0	1	0	1
b4	b3	b2	b1	Row	Column			
					0	1	2	3
0	0	0	0	**0**	sp	0	@	p
0	0	0	1	**1**	!	1	a	q
0	0	1	0	**2**	"	2	b	r
0	0	1	1	**3**	#	3	c	s
0	1	0	0	**4**	$	4	d	t
0	1	0	1	**5**	%	5	e	u
0	1	1	0	**6**	&	6	f	v
0	1	1	1	**7**	'	7	g	w
1	0	0	0	**8**	(	8	h	x
1	0	0	1	**9**	)	9	i	y
1	0	1	0	**10**	*	:	j	z
1	0	1	1	**11**	+	;	k	[
1	1	0	0	**12**	,	<	l	\
1	1	0	1	**13**	–	=	m	]
1	1	1	0	**14**	.	>	n	^
1	1	1	1	**15**	/	?	o	–

Position 0/5 “%” represents the “start sentinel”.

Position 1/15 “?” represents the “end sentinel”.

C.3 Extended set of coded characters for tracks 2 and 3

See Table C.7.

Table C.7 — Extended set of coded characters for tracks 2 and 3

Bit					Row	Character
p	b4	b3	b2	b1		
1	0	0	0	0	0	0
0	0	0	0	1	1	1
0	0	0	1	0	2	2
1	0	0	1	1	3	3
0	0	1	0	0	4	4
1	0	1	0	1	5	5
1	0	1	1	0	6	6
0	0	1	1	1	7	7
0	1	0	0	0	8	8
1	1	0	0	1	9	9
1	1	0	1	0	10	.
0	1	0	1	1	11	HEX B
1	1	1	0	0	12	–
0	1	1	0	1	13	HEX D
0	1	1	1	0	14	,
1	1	1	1	1	15	HEX F

Position 11 (HEX B) represents the “start sentinel”.

Position 13 (HEX D) represents the “separation sentinel”.

Position 15 (HEX F) represents the “end sentinel”.

C.4 Data storage

C.4.1 Basic rules

The following are the basic rules for storing data.

- The fusion programme may be stored on track 1 or on tracks 1 and 2.
- Every data series shall be preceded by an identification code.
- The identification code shall be composed of a letter followed, as necessary, by an index number.
- The comma symbol (,) shall be used to separate the different data, as well as the coded initial, if followed by an index number.
- For certain data series, numbers, letters and other characters are allowed. The semicolon (;) shall be used to indicate the end of a data series. These data series shall be stored on track 1.

- Every identification code of a data series on tracks 2 and 3 shall be preceded by a separation sentinel.
- The dot symbol (.) shall precede a decimal. The leading zero may be omitted.
- A parameter block belonging to the identification code shall not be separated at the end of the track.

C.4.2 Variables and units

The units for the different variables to be used for the establishment of a fusion programme are given in Table C.8.

Table C.8 — Parameters and corresponding units

Parameter	Unit
Time	Second (s)
Voltage	Volt (V)
Current	Ampere (A)
Power	Watt (W)
Energy	Kilojoule (kJ)
Temperature	Degree Celsius (°C)
Ohmic resistance	Ohm (Ω)
Temperature coefficient of heating wire	10^{-5}/Kelvin (K)
Cooling time	Minute (min)

C.4.3 Identification data

C.4.3.1 General

All or some of these data may appear on the control unit display.

The fusion control unit software shall contain all the identification data described below.

C.4.3.2 Physical identification

C.4.3.2.1 Name of manufacturer or product

The description of data related to the manufacturer and product is given in Table C.9. The variable that follows the identification code indicates the name of the manufacturer and/or his logo or the name of the product.

Table C.9 — Data for manufacturer and product

Data	Description
Data structure	Fi;
Identification code	F
Variable format	Alphanumeric
Parameter “i”	Name/logo of manufacturer or product
— Variable length	2
Character restrictions	[,] [;] [?] [%] not allowed in data series
Symbol at the end of data	;
Storage on track	1
EXAMPLE F12;	

C.4.3.2.2 Product type and dimension(s)

The description of data related to the product type and dimension(s) is given in Table C.10. The variable following the identification code indicates the fitting dimension(s).

Table C.10 — Data for type and dimension(s)

Data	Description
Data structure	Pi,j;
Identification code, (i) index number	Pi
Variable format	Alphanumeric
Parameter “j”	Fitting dimension(s)
— Variable length	10 (variable)
Character restrictions	[,] [;] [?] [%] not allowed in data series
Symbol at the end of data	;
Storage on track	1
EXAMPLE P1,1234567890;	

The symbols for the indication of the product type on the control unit display are given in C.5.

C.4.3.2.3 Product series identification

The description of data related to the product series is given in Table C.11. The variable or variables following the identification code indicate in some way the product series identification.

Table C.11 — Data for product series

Data	Description
Data structure	Si,j,k,l;
Identification code	S
Variable format	Alphanumeric
1st parameter “i”	Production lot identification
— Variable length	Max. 16 (variable)
2nd parameter “j”	Product type [a]
— Variable length	2
3rd parameter “k”	SDR series [a]
— Variable length	1
4th parameter “l”	Raw material type [a]
— Variable length	2
Character restrictions	[,] [;] [?] [%] not allowed in data series
Symbol at the end of data	;
Storage on track	1
Where the traceability coding is used, all parameters shall be coded.	
EXAMPLE 1 S123456;	
EXAMPLE 2 S123456,12,1,12;	
[a] To provide traceability.	

C.4.3.3 Electrical identification

C.4.3.3.1 Ohmic resistance

The description of data related to ohmic resistance is given in Table C.12. The variables following the identification code indicate the identification resistance at 20 °C and the tolerance allowed on the fitting resistance value, measured by the control unit at ambient temperature, up to which the fusion process can be carried out.

Table C.12 — Data for ohmic resistance

Data	Description
Data structure	R1,i,j
Identification code	R1
Variable format	Numerical
1st parameter “i”	Identification resistance at 20 °C
— Variable length	5 (variable)
— Number of decimals	Max. 3
2nd parameter “j”	Admitted tolerance in percent
— Variable length	2 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE R1,12.12,12	

C.4.3.3.2 Temperature coefficient of the heating wire

The description of data related to the temperature coefficient of the heating wire is given in Table C.13. The numbers following the identification code indicate the temperature coefficient value of the heating wire.

Table C.13 — Data for temperature coefficient for the heating wire

Data	Description
Data structure	Ai
Identification code	A
Variable format	Numerical
Parameter “i”	Real temperature coefficient
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE 1 A123	
EXAMPLE 2 A390 corresponds to 390×10^{-5}/K (0,003 9/K)	

C.4.4 Fusion data

C.4.4.1 Fusion programme

Standardized fusion programmes are given in Table C.14. A fusion control unit shall include in its software at least fusion programmes M1 and M3.

Table C.14 — Standardized programmes

Code	Variable				
	1	2	3	4	5
M1	Voltage	Time			
M2	Current	Time			
M3	Voltage	Energy			
M4	Current	Energy			
M5	Power (U^2/R)	Time			
M6	Power (U^2/R)	Energy			
M7	Voltage	Time	Time 1	Time 2	Time 3
M8	Current	Time	Time 1	Time 2	Time 3
M9	Power (U^2/R)	Time	Time 1	Time 2	Time 3
M10	Voltage	Energy	Time 1	Time 2	Time 3
M11	Current	Energy	Time 1	Time 2	Time 3
M12	Power (U^2/R)	Energy	Time 1	Time 2	Time 3
M13					

The description of data related to the fusion programme is given in Table C.15. The numbers following the identification code indicate the variable parameters of a fusion programme in the order given in Table C.15.

Table C.15 — Data for fusion programme

Data	Description
Data structure	Mi,j,k,l,m,n
Identification code, (i) index number	M(i)
Variable format	Numerical
1st parameter "j"	Fusion voltage, current or power
— Variable length	
Voltage	4 (variable)
Number of decimals	Max. 1
Current	4 (variable)
Number of decimals	Max. 1
Power	4 (variable)
Number of decimals	0
2nd parameter "k"	Total energy or nominal time of fusion cycle, including stop time of sequential cycle
— Variable length	
Time	4 (variable)
Number of decimals	0
Energy	6 (variable)
Number of decimals	
$E \leqslant 650$ kJ	Max. 2
650 kJ $< E \leqslant$ 6 500 kJ	Max. 1
$E >$ 6 500 kJ	0
3rd parameter "l"	First load time in a sequential fusion cycle
— Variable length	3 (variable)
— Number of decimals	0
4th parameter "m"	Stop time in a sequential fusion cycle
— Variable length	3 (variable)
— Number of decimals	0
5th parameter "n"	Repeating load time in a sequential fusion cycle
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE 1 M1,12.1,1234	
EXAMPLE 2 M3,12.1,123.12	
EXAMPLE 3 M6,1234,123.12	
EXAMPLE 4 M12,1234,123.12,123,123,123	

C.4.4.2 Starting phase of fusion cycle

In order to vary the power at the beginning of the fusion cycle, the control unit shall offer the attenuation or load increase functions in accordance with Table C.16, which gives standardized blocks. The function influences the variable 1 according to Table C.14 of a fusion programme in fixed blocks of 10 % during a defined variable period. The use of two load level functions shall be possible. In such cases, the function with the higher index number starts after the function with the lower index number.

Table C.16 — Standardized blocks

Code	Nominal load value %
B5	50
B6	60
B7	70
B8	80
B9	90
B11	110
B12	120
B13	130
B14	140
B15	150

The description of data related to the starting phase is given in Table C.17. The numbers following the identification code indicate the period during which the function is active.

Table C.17 — Data for starting phase

Data	Description
Data structure	Bi,j
Identification code, (i) index number	B(i)
Variable format	Numerical
Parameter “j”	Variable time of the function
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE B8,20 Superposition: B8,20B12,10	

C.4.4.3 Safety against overheating

The heating of the wire induces an increase of the resistance which creates a decrease of the current. To prevent overheating by short-circuiting of the wire, this function allows the energy input to be limited.

The fusion control unit shall offer the function of limiting energy input in fixed blocks of 10 % in accordance with Table C.18.

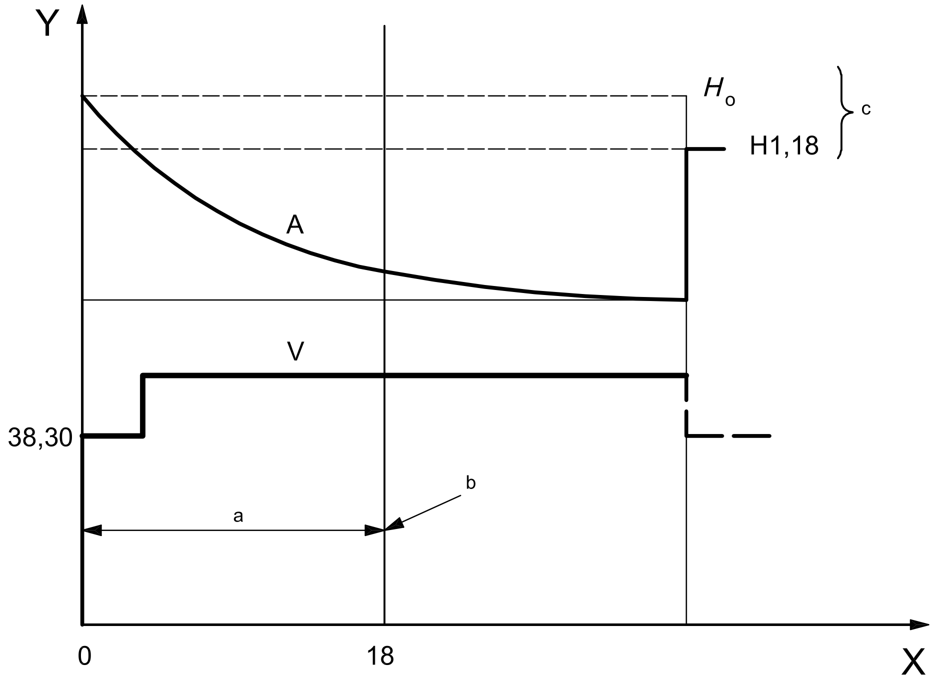
Table C.18 — Current reduction codes

Code	Current reduction %
H0	0
H1	10
H2	20
H3	30
H4	40
H5	50

The description of the data related to safety against overheating is given in Table C.19. The values following the identification code indicate the time period, in seconds, after the fusion cycle is launched, from which the function is activated.

Table C.19 — Data for safety against overheating

Data	Description
Data structure	Hi,j
Identification code, (i) index number	H(i)
Variable format	Numerical
Parameter "j"	Time period, in seconds, during which the function is activated
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE H1,18 See Figure C.1.	



Key

X fusion time, s

Y voltage, V

[a] No check.

[b] Start of checking.

[c] Control level.

Figure C.1 — Fusion time versus voltage

C.4.4.4 Temperature compensation

In order that the energy may be varied according to the ambient temperature, the fusion control unit shall offer the compensation functions in accordance with Table C.20. The use of compensation shall be possible for one or two variables of a fusion programme. The use of two compensation functions shall be possible. In such cases, one function shall have an even index number and the other an odd index number.

Standardized compensation programmes are given in Table C.20.

Table C.20 — Compensation programme

Code	Ambient temperature			Variable to be compensated in fusion programmes in Table B.14
	⩽ 0 °C	⩽ 20 °C	> 20 °C	
K1		x		1
K2		x		2
K3		x	x	1
K4		x	x	2
K5	x	x	x	1
K6	x	x	x	2
K7	x			1
K8	x			2

The description of data related to the temperature compensation is given in Table C.21. The numbers following the identification code indicate the values for the correction coefficients in 0/00 per degree Celsius of the unit concerned.

Table C.21 — Data for temperature compensation

Data	Description
Data structure	Ki,j,k,l
Identification code, (i) index number	K(i)
Variable format	numerical
1st parameter “j”	Correction coefficient for lowest temperature range in compensation programme
— Variable length	2 (variable)
— Number of decimals	0
2nd parameter “k”	Correction coefficient for temperature range next to first programme parameter, if existing
— Variable length	2 (variable)
— Number of decimals	0
3rd parameter “l”	Correction coefficient for temperature range next to second programme parameter, if existing
— Variable length	2 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE K2,12 Superposition: K4,12,12K7,12	

C.4.4.5 Fusibility limits of the fitting

The fusion control unit shall offer standardized fusibility limitation programmes in accordance with Table C.22.

Table C.22 — Fusibility limitation programmes

Code	Ambient temperature		Notes
	Min.	Max.	
V1	⩽ 0 °C	> 0 °C	Temperature limits to be specified
V2	⩾ 0 °C	> 0 °C	Temperature limits to be specified
V3	−10 °C	+45 °C	Fixed temperature limits

The description of data related to the fusibility limits is given in Table C.23. The numbers following the identification code indicate the values for the limit temperature of the fusibility range.

Table C.23 — Data for fusibility limits

Data	Description
Data structure	Vi,j,k
Identification code, (i) index number	V(i)
Variable format	Numerical
1st parameter “j”	Minimum temperature of the fusibility limitation range
— Variable length	2 (variable)
— Number of decimals	0
2nd parameter “k”	Maximum temperature of the fusibility limitation range
— Variable length	2 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE V1,12,12 Fixed temperature limits: V3	

The limits of use of the control unit may not be extended.

C.4.5 Cooling time

The fusion control unit shall offer the possibility of indicating the minimal cooling time on the display.

The description of data related to cooling time is given in Table C.24.

Table C.24 — Data for cooling time

Data	Description
Data structure	Xi
Identification code	X
Variable format	Numerical
Parameter "i"	Cooling time of the respective fitting
— Variable length	3 (variable)
— Number of decimals	0
Storage on track	1 or 2
EXAMPLE X123	

C.4.6 Fusion record

For efficient fusion joint control and follow-up of control unit performance, a fusion record may be established.

Standardized codes for the fusion record are given in Table C.25. The record may contain any of the data given in Table C.25.

Table C.25 — Fusion records

Code	Description
F	Name of manufacturer or product
P	Product type and dimensions
S	Production series
R1	Identification resistance
R2	Resistance measured by the control unit at ambient temperature
G	Control unit number and date of latest revision
D	Minimum and maximum primary voltage measured during fusion cycle
U	Date and time of fusion
N	Consecutive fusion number
T	Ambient temperature measured by fusion unit before starting cycle
C	Total duration of the fusion
W	Energy supplied to the fitting
E	Indication of any error which appeared during the fusion cycle
Z	Particular functions offered by the control unit manufacturer

C.4.7 Particular functions

The description of data related to particular functions is given in Table C.26.

The letter "Z" is at the disposal of the control unit manufacturer for free use regarding particular functions.

Table C.26 — Particular functions

Data	Description
Identification code	Z
Variable format	Alphanumerical or numerical
Storage on track	1
EXAMPLE Z2,MSA, Any Co	

C.4.8 Available letters

The letters I, J, L, O, Q and Y remain available for codification within the same standardization.

C.5 Standardized product types

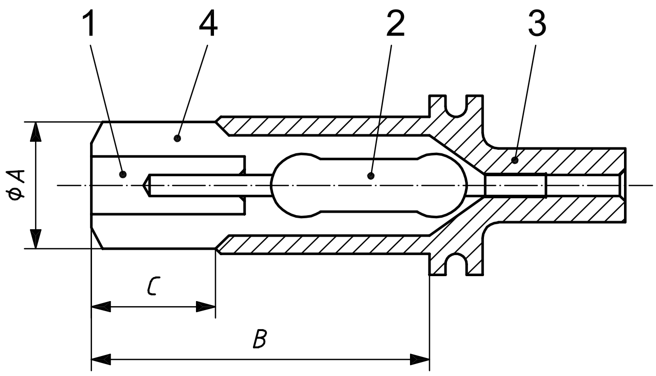
Codes and symbols on the fusion control unit display for product types are given in Table C.27.

Table C.27 — Symbols for product types

Code	Product type	Symbol on fusion control unit display
P0	Others	*
P1	Monofilar socket	I
P2	Bifilar socket	]
P3	Saddle	.†.
P4	Monofilar reduction	Y
P5	Monofilar elbow	L
P6	Monofilar tee	T

Annex D
(informative)

Implanted-resistor connector



Key

1 end contact

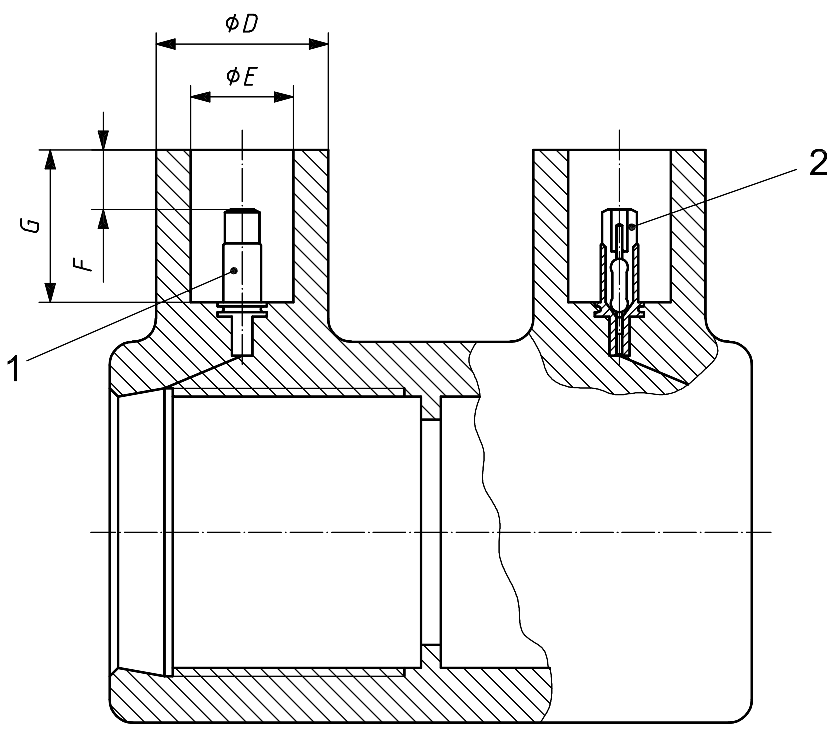
2 resistor

3 terminal-pin body

4 insulation

NOTE For the dimensions, see Table D.1.

Figure D.1 — Implanted-resistor terminal



Key

1 plain terminal

2 implanted-resistor terminal

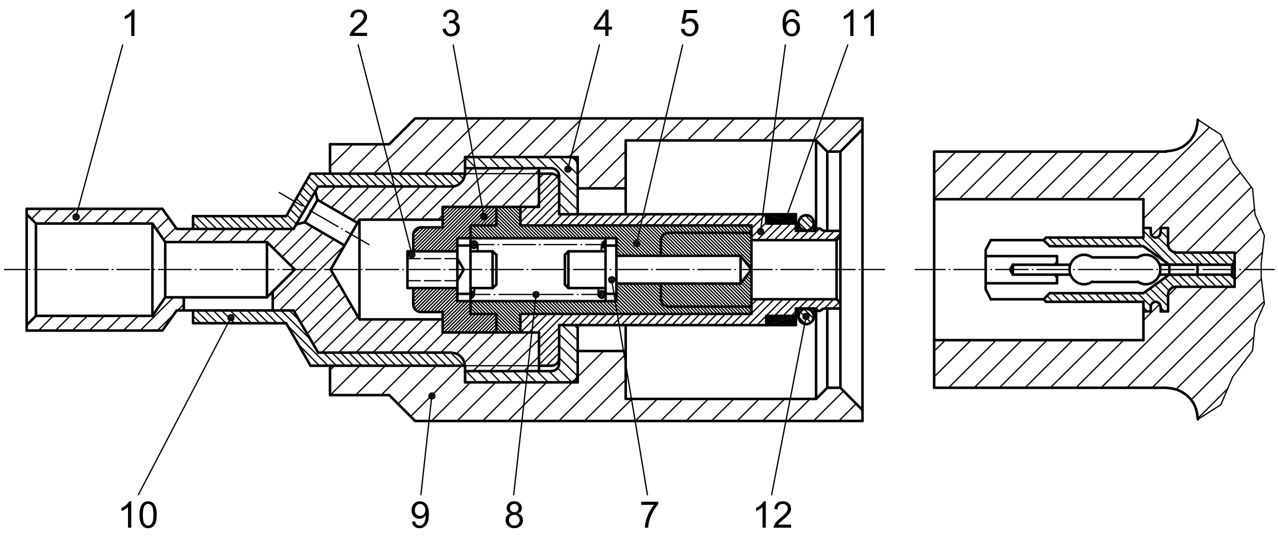
NOTE For the dimensions, see Table D.1.

Figure D.2 — Typical assembly of fitting

Table D.1 — Dimensions (see Figures D.1 and D.2)

Dimensions in millimetres

Dimension	**39/40 V system**	**78/80 V system**	**39/40 V system** (4 mm terminal pin)
A	4,68/4,73	5,74/5,69	4,00
B	11,25/11,00	14,25/14,00	11,25/11,00
C	4,25/4,15	4,1/4,0	NA
D	20,5	20,0	13
E	12,2	13,5	8,9
F	8,5	6,5	3,2
G	18,5	20,5	14,3



Key

1 connector, fixed end
2 sensor
3 bush
4 retaining collar
5 bush
6 connector, contact front
7 probe
8 compression spring
9 shroud
10 heat shrink
11 collar
12 retaining spring

Figure D.3 — Connector

Table D.2 — Implanted-resistance values and equivalent fusion times

39/40 V Resistance value nominal kΩ	**Fusion time** s	**78/80 V Resistance value nominal** kΩ
73,2	20	
43	25	
30	30	
22,6	35	
18,2	40	
15	45	
12,7	50	
9,76	60	
7,68	70	
6,19	80	
5,1	90	
4,22	100	
3,9	110	
3,57	120	
3,01	140	
2,61	160	
2,21	180	
1,91	200	1,91
1,74	220	1,74
1,62	240	1,62
	260	73,2
1,37	280	1,37
1,24	300	1,24
1,15	320	1,15
	340	43
0,976	360	0,976
	380	30
0,806	400	0,806
	420	22,6
0,649	440	0,649
	460	18,2
	480	15
0,453	500	0,453
	520	12,7
	540	9,76
	560	7,68
	580	6,19
0,300	600	0,300
	650	5,1
	700	4,22
	740	3,9
0,150	750	0,150
	800	3,57
	840	3,01
	850	2,61
0,100	900	0,100
	950	2,21

Annex E
(normative)

Self-regulation

E.1 Start of fusion

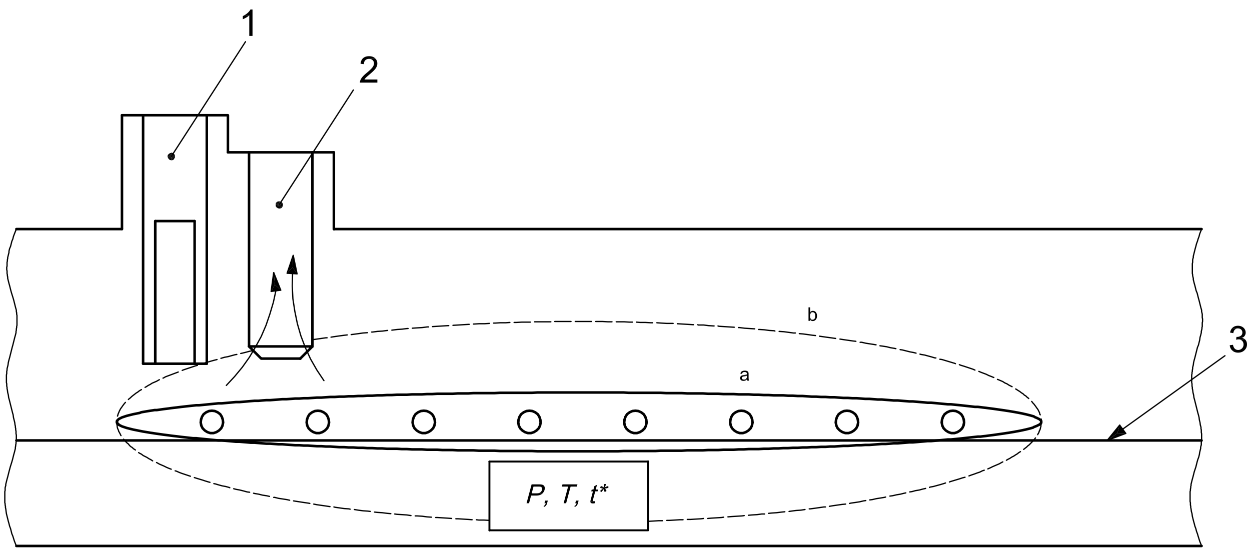
The sensor is in place in the well, the material in the base of the well is still in the solid state and the piston is still at its lowest position. At the interface, the pressure is P_0 and the temperature T_0.

E.2 Middle of fusion

The material begins to rise in the well and pushes the piston up. This will eventually trigger the sensor, but contact has not yet been made between the piston and the sensor. At the interface, the temperature is T_1 and the pressure P_1.

E.3 End of fusion

The expanding material has pushed the piston all the way up, and this has triggered the sensor. At the interface, the conditions made possible by the values for pressure P_2 and for temperature T_2 have produced sufficient molecular diffusion to ensure a good-quality join.



Key

1 fitting terminal

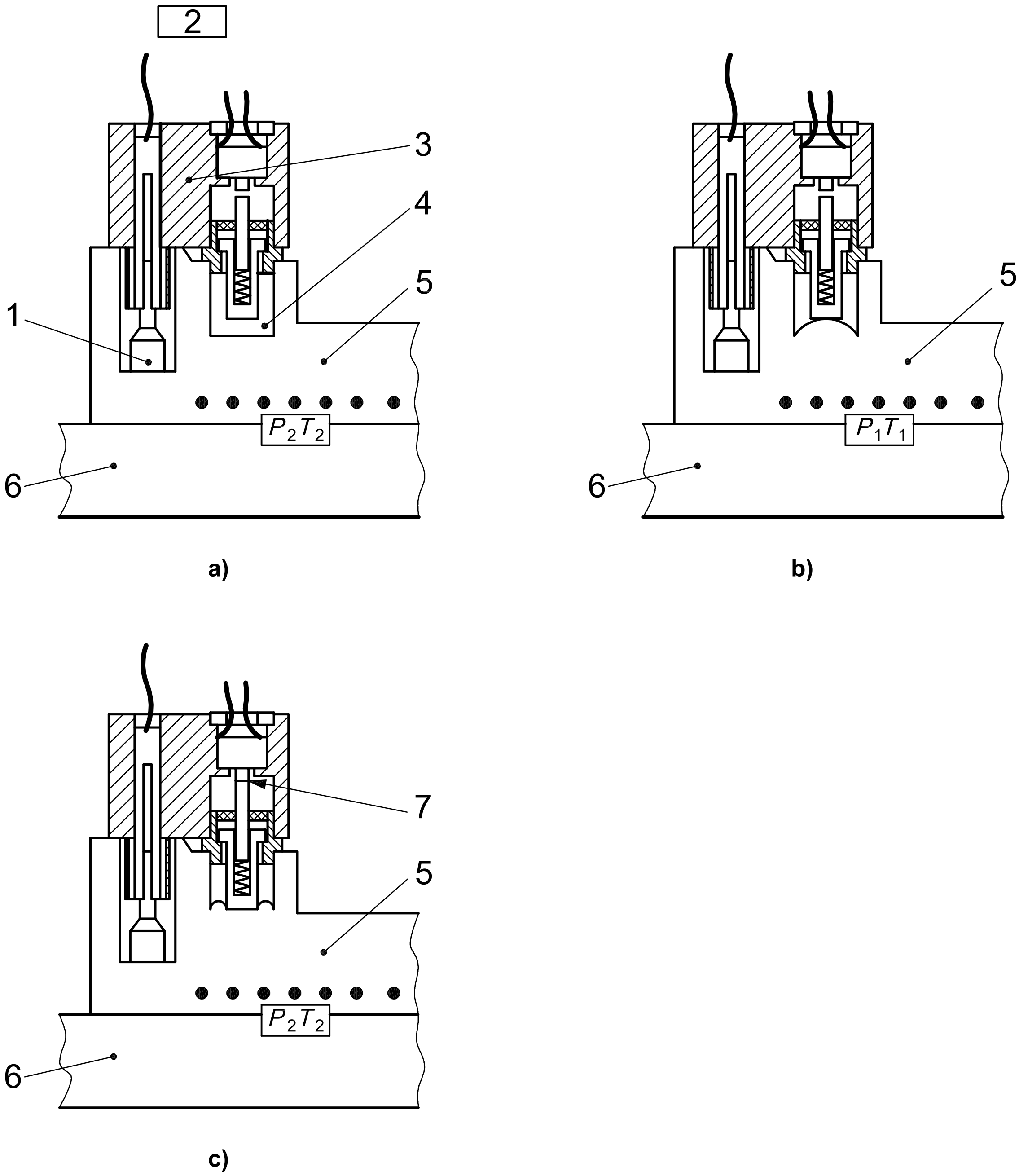
2 well

3 interface

[a] Zone limit a. See 4.3.3.

[b] Zone limit b. See 4.3.3.

Figure E.1 — Melted zone

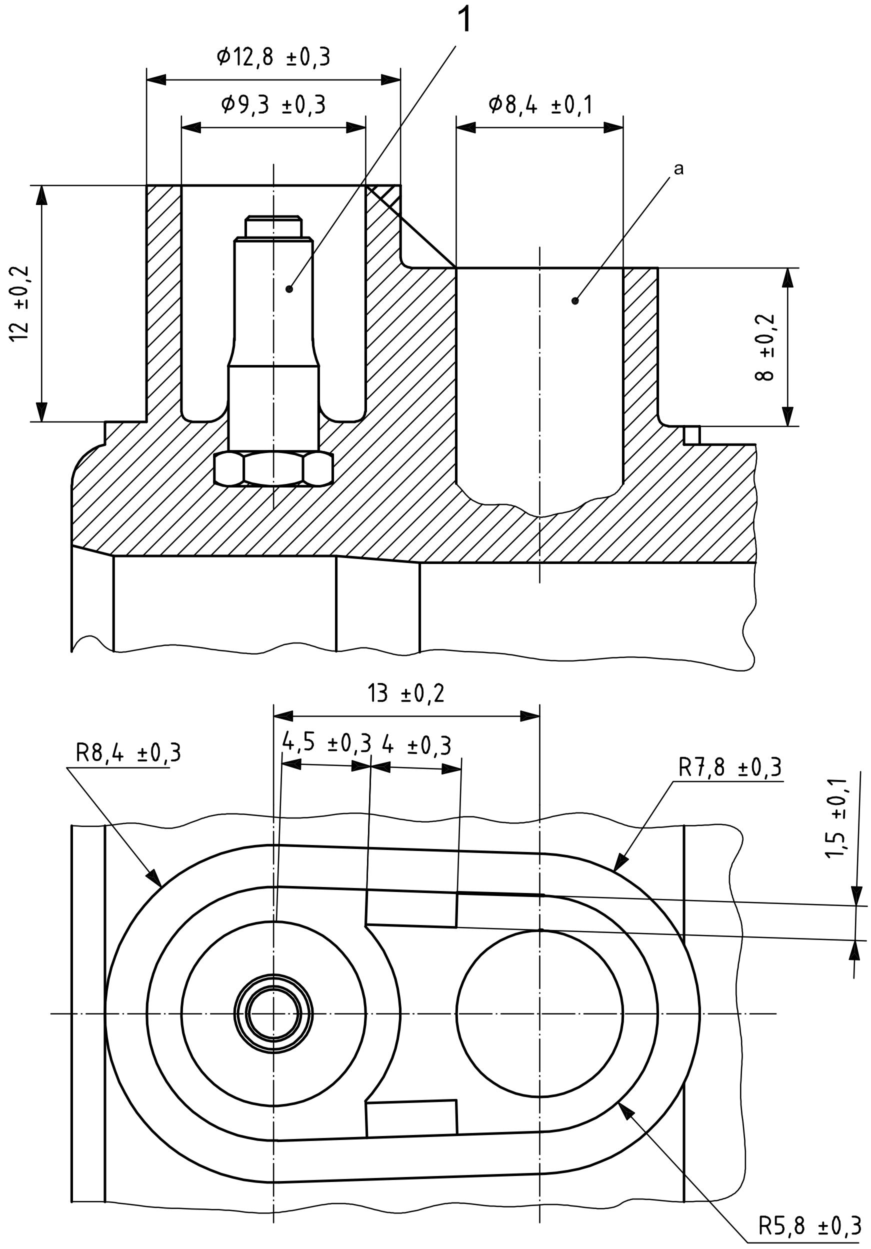


Key

1 terminal pin
2 control unit
3 connector (schematic representation)
4 well (exact geometry depends on fitting)
5 fitting
6 pipe
7 contact

Figure E.2 — Detection process for flat-bottomed well

Dimensions in millimetres



Key

1 terminal pin (diameter 4 mm or 4,7 mm)

a Geometry of well depends on type of fitting.

Figure E.3 — Dimensions of a terminal shroud

ICS 23.040.20; 23.040.45

Price based on 57 pages