DATA HANDBOOK

Dry-reed switches

BOOK PC09 1990

Philips Components

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DRY-REED SWITCHES

DRY-REED SWITCHES

page

TYPE SELECTION

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description	unit	series									
		RI-23 general purpose micro-reed	RI-25 high power micro-reed			RI-27 general purpose pico-reed	RI-29 high power pico-reed		RI-45 switching mains voltage micro-reed	RI-46 high power micro-reed	
operate values	At	8 - 70	8 - 16	14 - 32	28 - 70	10 - 34	16 - 25	20 - 34	27 - 59	15 - 28	24 - 70
release values	At	4 - 32	4 - 14	7,5 - 22	12 - 32	4 - 19,5	5 - 18	7 - 19,5	8 - 21	5 - 16	8 - 22,5
contact resistance	mΩ	max. 100 typ. 70	max. 100 typ. 70	max. 100 typ. 70	max. 100 typ. 70	max. 115 typ. 90	max. 115 typ. 90	max. 115 typ. 90	max. 90 typ. 60	max. 90 typ. 60	max. 90 typ. 60
insulation resistance	Ω	min. 10^{12}	min. 10^{12}	min. 10^{12}	min. 10^{12}	min. 10^{12}	min. 10^{12}	min. 10^{12}	min. 10^{12}	min. 10^{12}	min. 10^{12}
switched power	W	max. 10	max. 10	max. 15	max. 25	max. 10	max. 15	max. 20	max. 40	max. 30	max. 40
switched voltage	V	max. 200 DC max. 140 AC	max. 200 DC max. 140 AC	max. 200 DC max. 140 AC	max. 200 DC max. 140 AC	max. 200 DC max. 140 AC	max. 200 DC max. 140 AC	max. 200 DC max. 140 AC	max. 250 AC	max. 200 DC max. 250 AC	max. 200 DC max. 250 AC
switched current	mA	max. 500	max. 750	max. 1000	max. 1000	max. 500	max. 1000	max. 1000	max. 1000	max. 1000	max. 1000
bounce time	µs	typ. 150 max. 300	typ. 50 max. 150	typ. 150 max. 300	typ. 150 max. 300	typ. 50 max. 150	typ. 50 max. 150	typ. 50 max. 150	typ. 150 max. 300	typ. 150 max. 300	typ. 150 max. 300
wire diameter	mm	max. 0,60	max. 0,60	max. 0,60	max. 0,60	max. 0,50	max. 0,50	max. 0,50	max. 0,65	max. 0,65	max. 0,65
glass diameter	mm	max. 2,54	max. 2,54	max. 2,54	max. 2,54	max. 1,8	max. 1,8	max. 1,8	max. 2,8	max. 2,8	max. 2,8
glass length	mm	max. 15,0	max. 15,0	max. 15,0	max. 15,0	max. 13,5	max. 13,5	max. 13,5	max. 21,5	max. 21,5	max. 21,5
total length	mm	46 ± 0,5	46 ± 0,5	46 ± 0,5	46 ± 0,5	46 ± 0,5	46 ± 0,5	46 ± 0,5	54,8 ± 0,5	54,8 ± 0,5	54,8 ± 0,5
	page	27	35			45	57		63	69	

GENERAL

INTRODUCTION

A dry-reed switch assembly contains ferromagnetic contact blades, hermetically sealed in a glass envelope, and filled with an inert gas. The switch is operated by an externally generated magnetic field, either from a coil or magnet.

Features

- long life
- contacts isolated from the environment
- excellent glass-to-metal seal
- ambient operating temperature −55 to + 150 °C
- low operating power
- plated or sputtered ruthenium on diffused gold for very low and stable contact resistance
- better than $10^{12}\ \Omega$ open resistance
- low cost compared with other magnetic devices

APPLICATION

Dry-reed switches may be used in a wide range of applications, including:

Reed relays, for use in	– audio/video equipment – automatic test equipment (ATE) – broadcast equipment – copy machines – motor transport – data processing equipment – domestic appliances – facsimile equipment – measuring and test equipment – military applications – modems – aircraft – security systems – smoke detectors – telephony
Keyboards, for use in	– computers – military equipment – terminals – telephones – vending machines
Key switches, for use in	– audio and video equipment – domestic appliances – pocket torches

APPLICATION (continued)

Automotive applications, for use with	– cruise control – level detectors – light control – safety belt sensors – tacho and speedometers
Proximity switches, for use in	– conveyors – elevators – escalators – pneumatic cylinders – robots
Security system applications, used in	– door sensors – window sensors – position sensors
Human implantation, for use in	– pace-makers
Games and toys, for use in	– chess boards – dolls
Miscellaneous applications, including	– automatic change machines – flow sensors – float sensors – power meters – thermostats

CUSTOMIZED DRY-REED SWITCHES

In addition to the standard products described in this publication, we can supply the following:

- At operate ranges to customer specification
- preformed leads
- leads tinned to the glass encapsulation

DEFINITIONS (based on IEC 255-9)

A *dry-reed switch* is an assembly containing ferromagnetic contact blades, hermetically sealed in a glass envelope and operated by an externally-generated magnetic fields, e.g. that from an actuating coil.

The *must-not-operate value* is the stated limit of the applied magnetic field at which the dry-reed switch shall not operate.

The *must-operate value* is the stated limit of the applied magnetic field at which the dry-reed switch shall operate (see Fig. 1).

The *operate time* is the time between the instant of application of a magnetic field to a dry-reed switch and the instant of the first physical closing of this switch. The operate time does not include bounce time.

The *must-not-release value* is the stated limit of the applied magnetic field at which the operated dry-reed switch shall remain physically closed (see Fig. 1).

The *must-release value* is the stated limit of the applied magnetic field at which the closed dry-reed switch shall physically release.

The *release time* is the time between the instant of removal of an applied magnetic field to a dry-reed switch and the instant of the first physical opening of this switch. The release time does not include bounce time.

Bounce is a momentary opening of a switch after initial closing, or a momentary closing after initial opening.

The *bounce time* is the interval of time between the instant of initial closing (or opening) and the instant of final closing (or opening) of the dry-reed switch.

The *dry reed switch contact resistance* is the resistance of the dry-reed switch under specified conditions of measurement.

The *saturate value* is the arbitrary defined value of the applied magnetic field at which the dry-reed switch is unaffected by further increase of the applied magnetic field (see Fig. 1).

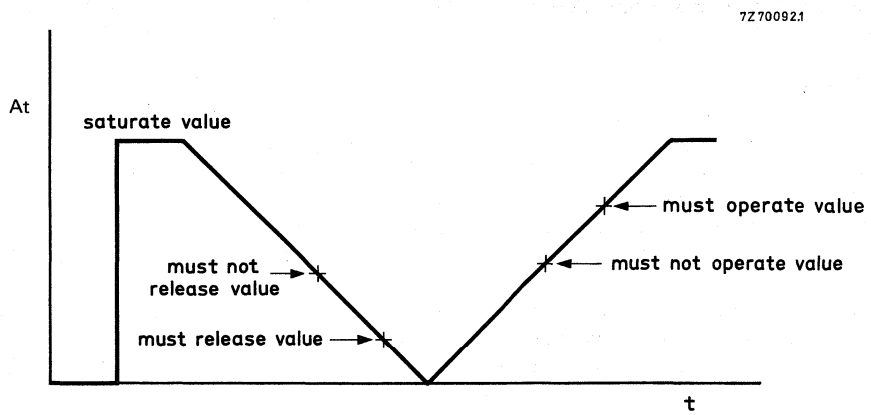


Fig. 1 Graphical representation of parameters.

CHARACTERISTICS

Operate and release values

Operate and release values are dependent on the measuring coil, the rate of energization (0,1 At/ms), the detection of the operate (closing) and the release (opening) moment, the position of the measuring coil relative to the earth's magnetic field and on the environmental conditions.

Operate and release times

The operate and release times are mostly dependent on the energization and de-energization rate. They are proportional to the R/L time of the coil. Operate time is inversely proportional to the ratio of energization to operate value. Release time is proportional to the ratio of energization to release value.

Bounce time

The bounce time is almost independent of the energization, however, a high energization gives a somewhat shorter bounce time. The bounce time is dependent on the current to be switched; above approximately 100 mA the bounce time is almost zero.

Contact resistance

The contact resistance is dependent on the wire diameter, energization and contact layer. The published contact resistance is measured with an open contact voltage of 20 mV and a current through the closed contacts of 10 mA, using the 4-point method (Kelvin method).

Breakdown voltage

The breakdown voltage depends on the gap between the contact blades, gas pressure, material of the contact layer and the availability of free electrons in the gas. The first three items are set by the design of a particular reed switch. The last item is very dependent on ambient conditions. Therefore minimum values are given in the published data.

Insulation resistance

The insulation resistance is dependent on the condition of the inside of the glass envelope and on the environment, e.g. relative humidity, conducting layers on the outside of the glass envelope.

Life expectancy

The life of a dry-reed switch is influenced by the contact layer, the wire diameter, the load, the load circuit parameters and the applied magnetic field. The contact layer and the wire diameter are determined by the manufacturer. Load, load circuit parameters and magnetic field are determined by the user. The load should be within the maximum published values. The load circuit parameters, e.g. wiring capacitance and inductance, should be kept as low as possible and the applied magnetic field must be stronger than necessary for obtaining the maximum must-operate value.

Note: Owing to the influence of the load circuit upon contact resistance and sticking, and also the influence of the applied magnetic field and used coil or magnet, life-test information can only be compared when they are the result of testing under exactly the same conditions (test equipment).

APPLICATION NOTES

Cutting and bending

Ensure that the glass-to-metal seals are not stressed while cutting and bending the leads. Shocks should be avoided. Cutting and bending the leads increases the must-operate value and the must-release value.

Coils

Most of the electrical characteristics are measured using a standard coil. Using another coil may change these characteristics. The measuring method e.g. speed, detection, and the position of the coil with respect to the earth's magnetic field may also affect the characteristics.

Calculating the magnetic field for a dry-reed switch in a coil

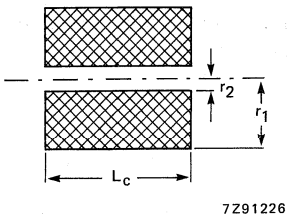


Fig. 2 Calculation of the magnetic field for a dry-reed switch in a coil.

The magnetic field an any point x on the central axis of a coil (see Fig. 2) can be calculated using the formulae:

$$H_x = \frac{NI_c}{2L_c(r_1 - r_2)} \left[(x + L_c) \ln \frac{\sqrt{r_1^2 + (x + L_c)^2} + r_1}{\sqrt{r_2^2 + (x + L_c)^2} + r_2} - x \ln \frac{\sqrt{r_1^2 + x^2} + r_1}{\sqrt{r_2^2 + x^2} + r_2} \right]$$

The number of windings in the coil is calculated using the formula:

$$N = \frac{4 f_{sp} L_c (r_1 - r_2)}{\pi d^2 Cu}$$

Coil resistance is calculated using the formula:

$$R_c = \frac{16 f_{sp} \rho L_c (r_1^2 - r_2^2)}{\pi d^4 Cu}$$

r_1	outer radius of a coil (mm)
r_2	inner radius of a coil (mm)
L_c	length of a coil (mm)
d_{Cu}	diameter of the copper wire used in a coil (μm)
f_{sp}	space factor of a coil
N	number of turns in a coil
R_c	coil resistance (Ω)
I_c	coil current (mA)
ρ	specific resistance of copper (Ωcm)
H_x	magnetic field ($At.m^{-1}$)

OPERATION

A dry-reed switch is operated by an externally generated magnetic field, either using a coil or a magnet.

The operate and release actions of a dry-reed switch are dependent upon:

- type of dry-reed switch
- dimensions of the dry-reed switch
- sensitivity (operate and release values) of the dry-reed switch
- position of the dry-reed switch with reference to the coil and/or magnet
- the dimensions of the coil
- the current through the coil
- the strength of the permanent magnet
- the influence of other magnetic materials and/or fields nearby.

Operation using a coil

There are several methods of operating the switch which may be employed using a coil. Figs 3 to 5 illustrate the different methods available.

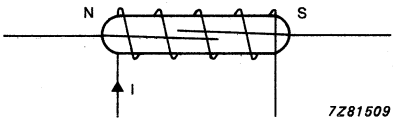


Fig. 3 A dry-reed switch mounted within a coil.

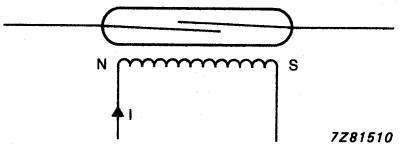
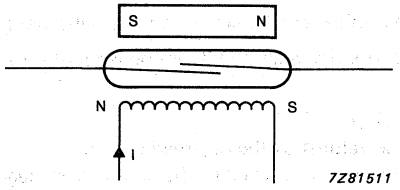


Fig. 4 A dry-reed switch mounted outside a coil.



Using this method the dry-reed switch and/or the magnet can be placed either within or outside the coil.

Fig. 5 A dry-reed switch biased by a permanent magnet and operated by a coil.

Operation using a magnet

Permanent magnets are also often used to operate dry-reed switches.
Figs 6 to 10 illustrate the various methods available.

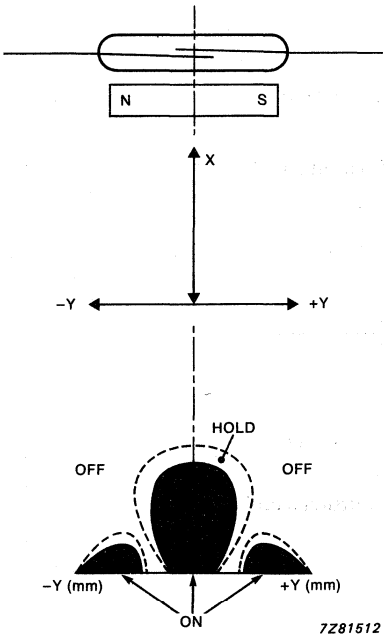


Fig. 6 Perpendicular movement, with the magnetic field parallel to the dry-reed switch.

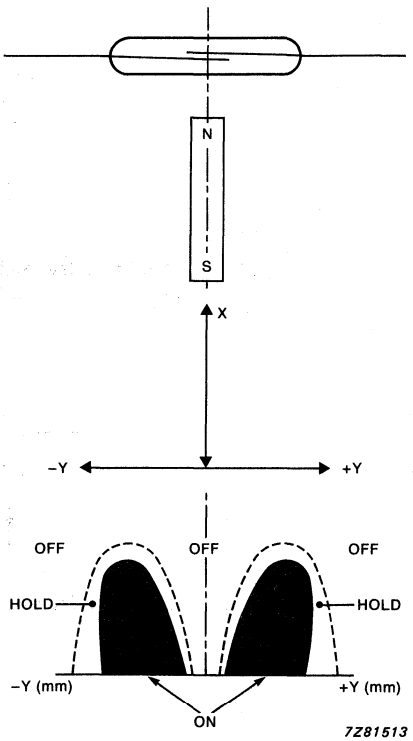


Fig. 7 Perpendicular movement, with the magnetic field perpendicular to the dry-reed switch.

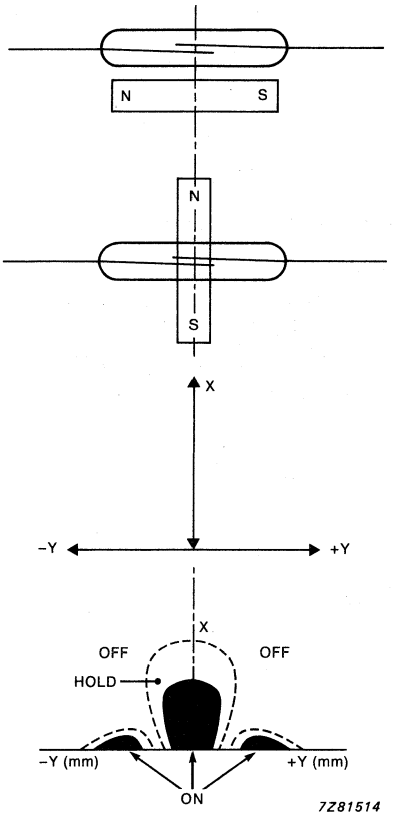


Fig. 8 Parallel movement.

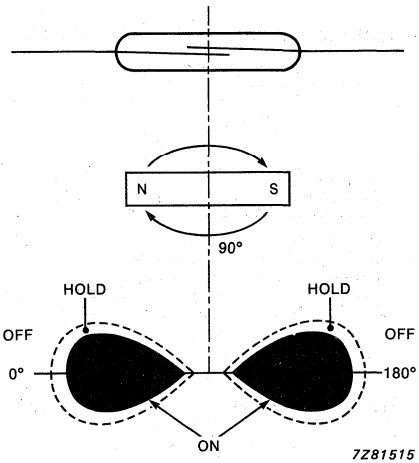


Fig. 9 Rotational movement with a bar shaped permanent magnet.

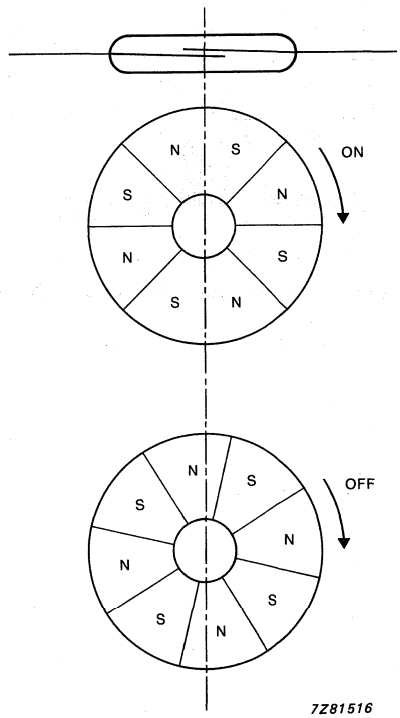


Fig. 10 Rotational movement with two or more pole ring magnets.

Shielding

Ferromagnetic materials which shunt the magnetic fields may be used to shield a dry-reed switch (see Figs 11 and 12).

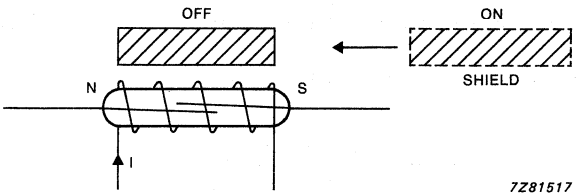


Fig. 11 Shielding a coil operated switch.

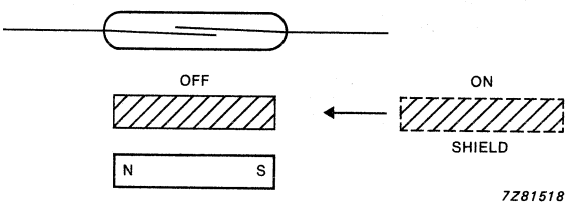


Fig. 12 Shielding a magnetically operated switch.

General

Please contact the manufacturer should your application require further information.

Contact protection

The published life-expectancy data are based on resistive loads unless stated otherwise. For inductive, capacitive or lamp loads, inrush current or reverse voltage can affect the life of a reed switch. For a maximum life-time, contact protection is advised.

Inductive loads

To reduce the high reverse voltage produced when a reed switch opens, the following contact protection can be applied.
a) DC voltage: a diode parallel to the load or the reed switch, see Fig. 13.

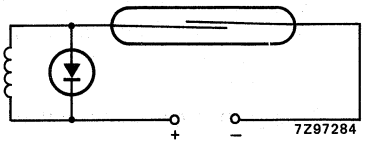


Fig. 13 DC voltage contact protection.

b) AC voltage: an RC-network parallel to the load or the reed switch, see Fig. 14.

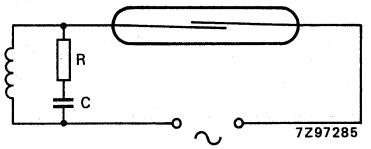


Fig. 14 AC voltage contact protection.

$$C = \frac{I^2}{10} \qquad R = \frac{V}{10(1 + 50/V)}$$

C in μF and I in A
R in Ω and V in V

Capacitive loads

To reduce the high inrush current when a reed switch closes, a resistor must be connected in series with the capacitance or the reed switch.

Lamp loads

To reduce the high inrush current when a cold incandescent lamp has to be switched by a reed switch (closing only), a resistor must be connected in series with the lamp or a resistor parallel to the reed switch.

QUALITY

Dry-reed switches are designed for, and used in, the most demanding applications; these include computer keyboards, telephone equipment, automatic test equipment and automobiles. Thus, their quality must be exceptionally high from conformity and reliability aspects. This quality is built into our dry reed switches during every stage of their design and manufacture.

Quality methods are generally in accordance with IEC Publication 68, with procedures corresponding to CECC 19 000 (although CECC release is not available).

Organized for Quality

The exceptional quality of our dry-reed switches is founded at every step their design, development, manufacture and application. Responsibilities and communication paths are well defined. Quality control is independent, but integrated with production and development. The importance of continual education and training is fully recognized and implemented. The quality achieved is evident from:

- uniform product characteristics from batch to batch
- rugged construction
- long life
- low early-failure rate
- low AQLs (from 0.065%) ensuring that only reliable products are supplied
- process-average reject level better than AQLs.

The high quality of our dry-reed switches is constantly being improved. Our comprehensive quality improvement programme features:

- close collaboration with customers to satisfy specific application requirements
- production-processing spread reduction
- stabilization of process conditions with rigorous significant change procedures
- involvement of everyone in improvement activities
- statistical process control
- well understood quality indicators

Our working environment is designed to encourage quality awareness with:

- close collaboration between individuals and departments
- close co-operation between Marketing, Quality, Development and Production
- clearly defined responsibilities
- ISO 9000 procedures guiding all activities
- in-depth training
- high-grade support from service departments
- effective dissemination of information at all levels

QUALITY PROCEDURES

Properly documented procedures are essential to the achievement, maintenance and improvement of high product quality. They help to ensure that all aspects of our dry-reed switch activity, from development to customer service, are carried out thoroughly, and that maximum information is available to refine designs and processes, and also to generate new designs.

Release procedure

Before new dry-reed switches can be delivered, even as samples, to customers, they must be granted an approval for delivery (AFD), in accordance with our release procedure. This is obtained at a meeting including representatives from the Development, Marketing, Production and especially, Quality departments, at which data obtained from samples is reviewed.

Once AFD is granted, small scale production is sanctioned. Quality evaluation during this stage provides data for a release report. This report is examined at a release meeting, before release for (full scale) production (RFP) is granted. Release for production is also required for new cut and/or bent-lead versions of existing dry reed switches.

Manufacturing instructions

The routing of dry-reed switches through the production process is fully documented in the manufacturing instructions for each type. These instructions also describe incoming and on-line inspection, and quality control methods and requirements.

Calibration procedures

Accurate test and measuring equipment is an essential pre-requisite for the maintenance and improvement of product quality. Calibration procedures are laid down in the quality manual. Basic requirements include regular calibration of all equipment, with clear reporting of accuracy.

Deviations from the required accuracy of any equipment must be clearly reported and acknowledged. Nature of the deviation must be specified and responsibility for the equipment defined, so that its rectification can be verified.

Quality reporting

Quality reporting requirements are laid down for:

- incoming material and component inspection
- production yield
- sampling inspection (quality control) results
- customer returns
- quality improvement planning
- process and performance changes

QUALITY IN DRY-REED SWITCH PRODUCTION

Inspection and quality control are integrated into our dry-reed switch production. Quality control inspections are carried out both by the operators and line inspectors. The quality department monitors quality control, inspection, and process conditions, and carries out final acceptance and qualification testing. Test equipment is checked by line inspectors and calibrated by the quality service department (see Fig. 15).

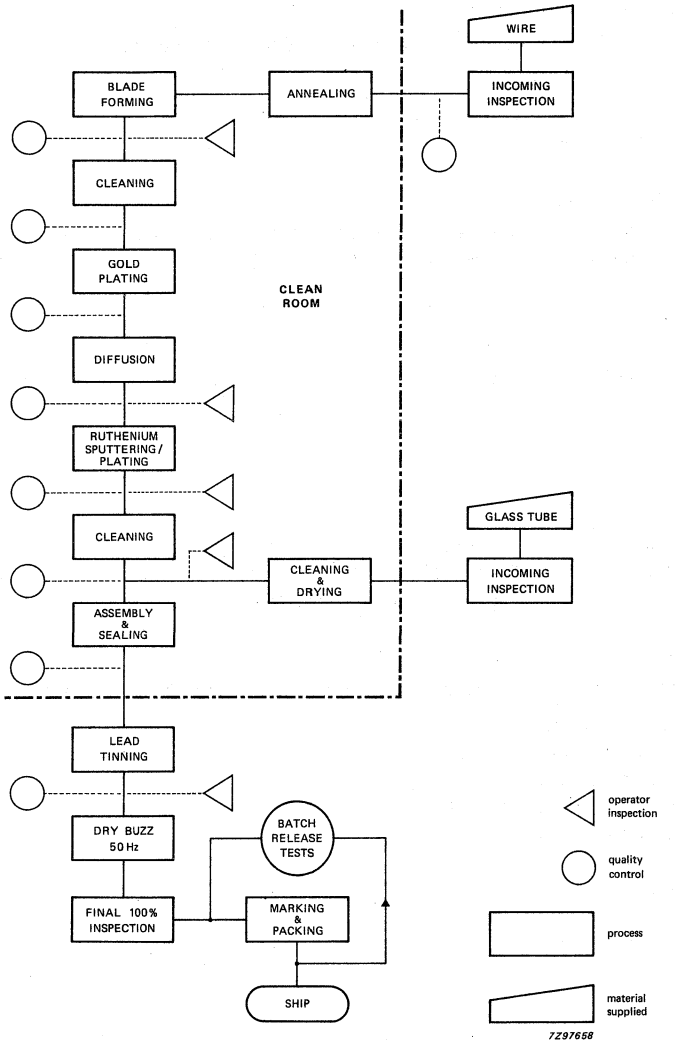


Fig. 15 Quality control and inspection flow chart for the production cycle.

Incoming inspection

Wire used in the manufacture of dry-reed switches is checked for:

- appearance
- diameter
- circularity
- chemical composition
- magnetic characteristics
- scoring and cracking

After the annealing process is complete, the expansion coefficient of the wire is checked, and the magnetic characteristics measured again.

Glass tubing used in the manufacture of dry-reed switches is checked for:

- appearance
- dimensions

before being ultrasonically cleaned and dried.

Quality control inspection

As shown in Fig. 15, inspection or quality control is performed after each mechanical or chemical process stage. In addition, to ensure product uniformity, the quality department constantly monitors the critical process conditions of:

- gold plating
- gold diffusion
- ruthenium plating or sputtering
- sealing
- appearance
- dust levels in the dust free room

Acceptance testing

After final inspection, samples of dry reed switches are taken from each batch in accordance with the requirements of MIL-STD 105D (ISO 2859). These samples are subjected to in-depth evaluation to ensure that all requirements are fully met before despatch.

Acceptance tests

Using a standard test coil, samples of dry-reed switches from each batch are tested for:

- dynamic contact resistance
- 'must not release' ampere-turns value
- 'must release' ampere-turns value
- 'must not operate' ampere-turns value
- 'must operate' ampere-turns value
- static contact resistance
- visual inspection
- solderability
- gauge check (dimensions)
- hermeticity

Life tests

Samples of dry-reed switches are subjected to the life tests and all failures are analysed to provide additional corrective action data.

Note: Due to wiring inductance and capacitance, switching waveforms in the loaded life tests include an initial, very short, high current pulse component. It is necessary to specify and control the amplitude of this pulse, since it can have a marked effect on the results of the life-test.

Laboratory tests

Samples are tested for conformance to the published data at four monthly intervals, and the results recorded.

The samples are tested for:

- operate and release ampere-turns
- ratio operate: release ampere-turns
- dynamic and static contact resistance
- static contact resistance change
- insulation resistance
- capacitance
- operate, bounce and release times
- break-down voltage with and without pre-ionization
- remanence
- bend, tensile and torsional strain
- dimensions

Packing and labelling

After a batch is accepted according to the specification, the dry-reed switches are packed and labelled with the production week number for traceability.

CUSTOMER RETURNS

The efficient processing of returned dry-reed switches is regarded as vitally important, both to our customers and to ourselves. Our in-depth examination of rejected switches provides valuable additional data for our own quality improvement activities, helps guide the development of new or improved switches, and extends our knowledge of their behaviour in real applications.

DRY-REED SWITCHES

Micro dry-reed switch hermetically sealed in a glass-filled glass capsule. Single-pole, single-throw type, having normally open contacts, and containing two magnetically actuated reeds. The switch is of the double-ended type and may be actuated by means of either an electromagnet or a permanent magnet or combinations of both. The device is intended for use in push buttons, relays or in similar devices, in conjunction with semiconductor devices.

QUICK REFERENCE DATA

Contact		SPST normally open
Switched power	max.	10 W
Switched voltage		
DC	max.	200 V
AC (r.m.s.)	max.	140 V
Switched current, DC or AC (r.m.s.)	max.	500 mA
Contact resistance (initial)	typ.	70 mΩ

The RI-23 series comprises the types RI-23AAA, RI-23AA, RI-23A, RI-23B and RI-23C with the following basic magnetic characteristics, measured with the standard coil.

	RI-23AAA	RI-23AA	RI-23A	RI-23B	RI-23C
Operate range (At)	8 to 16	14 to 23	18 to 32	28 to 52	46 to 70
Release range (At)	4 to 14	7,5 to 17,5	8 to 22	12 to 29	16 to 32

MECHANICAL DATA

Contact arrangement	normally open
Lead finish	tinned
Resonant frequency of single reed	approx. 5500 Hz
Net mass	approx. 0,19 grams
Mounting position	any

Dimensions in mm

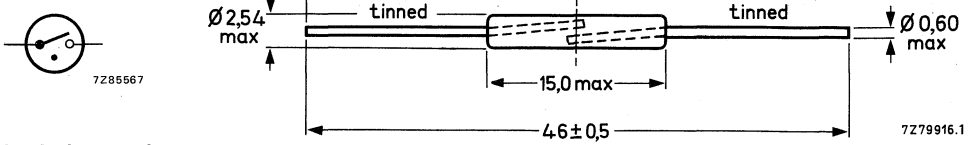


Fig. 1 Physical dimensions.

Mechanical strength

The robustness of terminations is tested according to IEC Publication 68-2-21, test Ua (load 40N).

Mounting

The leads should not be bent nearer than 1 mm to the glass-to-metal seals. Stress on the seals should be avoided. Care must be taken to prevent stray magnetic fields from influencing the operating and measuring conditions. The switches can also be supplied with cut and bent leads to customer specification.

Resistance to soldering heat

The switch can withstand IEC 68-2-20 test Tb, method 1B: solder bath at 350 ± 10 °C during 3,5 ± 0,5 s.

Solderability

Solderability is tested according to IEC 68-2-20 test Ta, method 3: solder globule 235 °C, ageing 1b: 4 hours steam.

Weldability

The leads are weldable.

The RI-23 series comprises four types: RI-23AAA; RI-23AA; RI-23A; RI-23B and RI-23C.

CHARACTERISTICS RI-23AAA

Not operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,30		pF	
		coil I	coil II		
Must-not-operate value	max.	8	9	At	
Operate					
Must-operate value	max.	16	15	At	
Operate time, including bounce	typ.	0,10		ms	2
	max.	0,25		ms	2
Bounce time	typ.	0,05		ms	2
	max.	0,15		ms	2
→ Contact resistance, initial	typ.	70		mΩ	6
	max.	100		mΩ	6
Not-release					
Must-not-release value	min.	14	12	At	
Release					
Must-release value	max.	4	4	At	
Release time	max.	70		μs	2

Notes

1. Measured at a relative humidity of max. 45%.
2. Measured with 100 At.
3. Measured with 25 At, distance between measuring points: 41 mm. Wire resistance typ. 1,2 mΩ/mm.
4. Measured with 30 At, distance between measuring points: 41 mm. Wire resistance typ. 1,2 mΩ/mm.
5. Measured with 40 At, distance between measuring points: 41 mm. Wire resistance typ. 1,2 mΩ/mm.
6. → Measured with 20 At, distance between measuring points: 41 mm. Wire resistance typ. 1.2 mΩ/mm.

CHARACTERISTICS RI-23AA

Not-operate

Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,30		pF	
		coil I	coil II		
Must-not-operate value	max.	14	13,5	At	
Operate					
Must-operate value	max.	23	20	At	
Operate time, including bounce	typ.	0,25		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	70		mΩ	3
	max.	100		mΩ	3
Not-release					
Must-not-release value	min.	17,5	15	At	
Release					
Must-release value	max.	7,5	7	At	
Release time	max.	30		μs	2

CHARACTERISTICS RI-23A

Not-operate

Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not-operate value	max.	18	16	At	
Operate					
Must-operate value	max.	32	27	At	
Operate time, including bounce	typ.	0,25		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	70		mΩ	4
	max.	100		mΩ	4
Not-release					
Must-not-release value	min.	22	19	At	
Release					
Must-release value	max.	8	7	At	
Release time	max.	30		μs	2

CHARACTERISTICS RI-23B

Not-operate

Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not-operate value	max.	28	23	At	
Operate					
Must-operate value	max.	52	42	At	
Operate time, including bounce	typ.	0,25		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	70		mΩ	5
	max.	100		mΩ	5
Not-release					
Must-not-release value	min.	29	24	At	
Release					
Must-release value	max.	12	10	At	
Release time	max.	30		μs	2

CHARACTERISTICS RI-23C

Not-operate

Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not-operate value	max.	46	37	At	
Operate					
Must-operate value	max.	70	55	At	
Operate time, including bounce	typ.	0,25		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	70		mΩ	5
	max.	100		mΩ	5
Not-release					
Must-not-release value	min.	32	27	At	
Release					
Must-release value	max.	16	13	At	
Release time	max.	30		μs	2

LIMITING VALUES

Absolute maximum rating system

Switched power	max.	10	W
Switched voltage			
DC	max.	200	V
AC (r.m.s.)	max.	140	V
Switched current, DC or AC (r.m.s.)	max.	500	mA
Current through closed contacts, DC or AC (r.m.s.)	max.	2	A
Temperature, storage and operating	max.	125	°C*
	min.	−55	°C

LIFE EXPECTANCY AND RELIABILITY

For life expectancy data end of life is defined as being reached when either:

(a) the contact resistance exceeds either 1 Ω for no-load conditions or 2 Ω for loaded conditions, measured 2,5 ms after energizing coil; or

(b) the release time exceeds 2,5 ms after de-energizing the coil (latching or contact sticking).

No-load conditions (operating frequency 100 Hz)

Life expectancy at 10^8 operations is a failure rate of less than 10^{-9} with a confidence level of 90%. After each operation (a) and (b) are tested.

Loaded conditions resistive load: 12 V, 4 mA; (15 mA peak); operating frequency 100 Hz. ←

Life expectancy min. 10^7 operations with a failure rate of less than 10^{-8} with a confidence level of 90%. After each operation points (a) and (b) are tested.

Note

Switching other loads involves different life expectancy and reliability. Consult us beforehand.

SHOCK AND VIBRATION

Shock

The switches are tested according to IEC Publication 68-2-27, test Ea (peak acceleration 150g, half sine-wave). Such a shock will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

Vibration

The switches are tested according to IEC Publication 68-2-6, test Fc (acceleration 10g, below cross-over frequency 57 to 62 Hz, amplitude 0,75 mm, frequency range 10 to 2000 Hz, duration 90 min.). Such a vibration will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

COILS

Coil I: Standard coil

5000 turns of 42 SWG single enamelled copper wire on a coil former of 25,4 mm winding length and a core diameter of 8,75 mm.

Coil II: Miniature coil A according to MIL-S-55433B (3/4 inch coil) ←

10 000 turns of 48 SWG single enamelled copper wire on a coil former of 19,05 mm winding length and a core diameter of 4,32 mm.

* Excursions up to 150 °C may be permissible. Consult us.

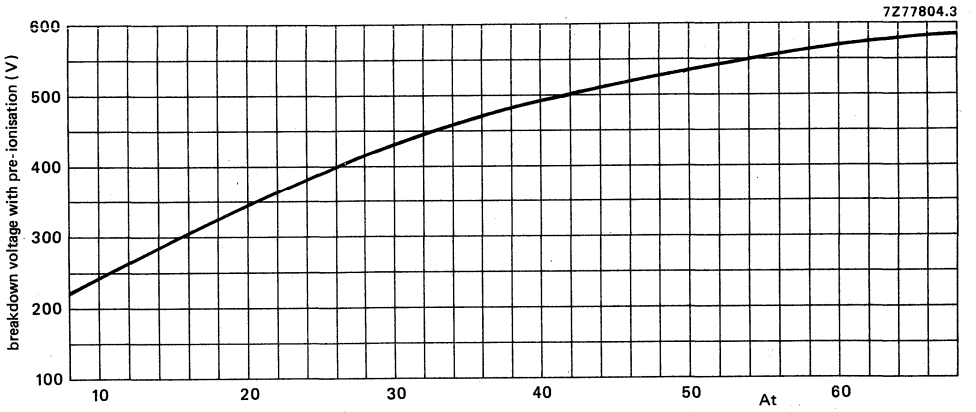


Fig. 2 Breakdown voltage as a function of operate ampere-turns (standard coil).

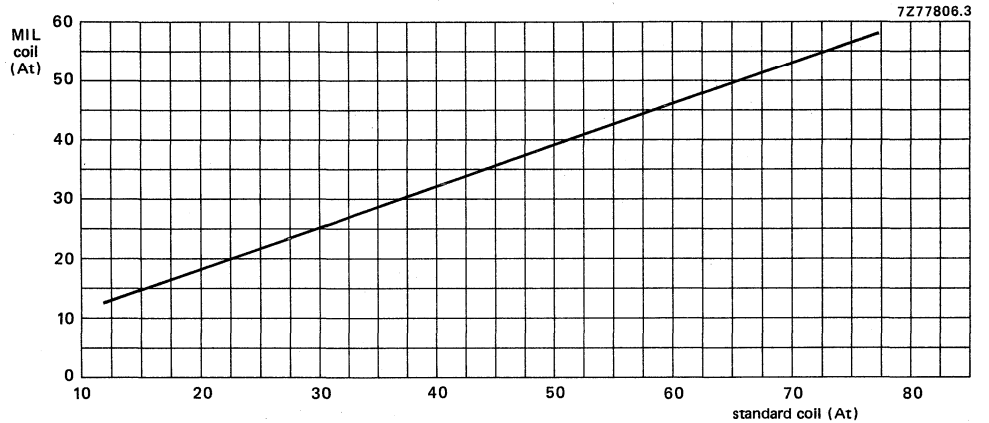


Fig. 3 Correlation of At operate in standard coil and MIL coil.

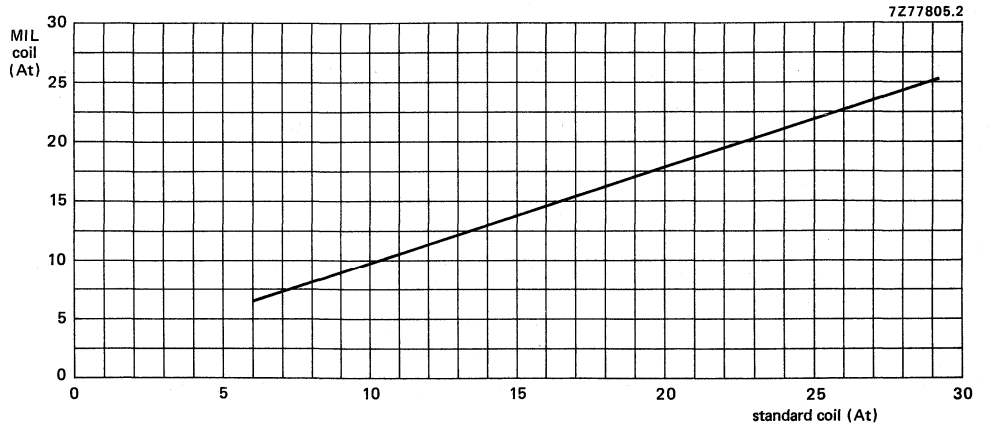


Fig. 4 Correlation of At release in standard coil and MIL coil.

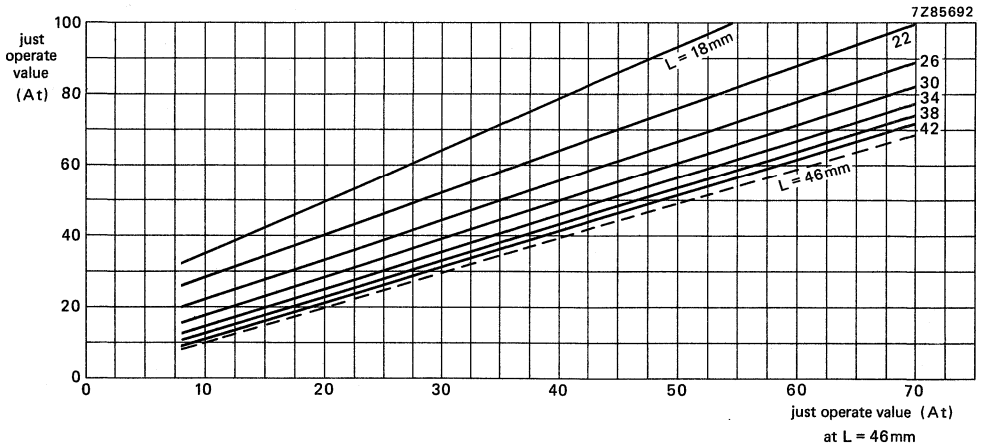


Fig. 5 Just operate values at various overall lengths, compared with standard length of 46 mm (standard coil).

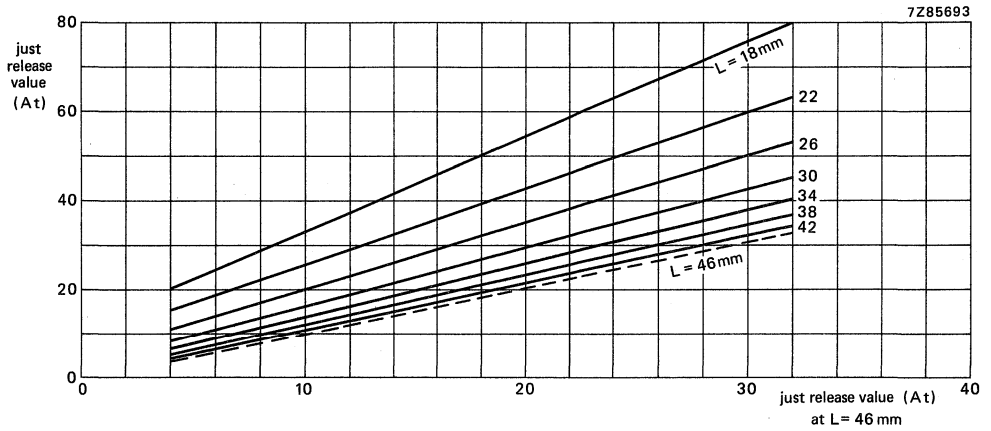


Fig. 6 Just release values at various overall lengths, compared with standard length of 46 mm (standard coil).

DRY-REED SWITCHES

Micro dry reed switch hermetically sealed in a gas-filled glass capsule. Single-pole, single-throw type, having normally open contacts, and containing two magnetically actuated reeds. The switch is of the double-ended type and may be actuated by means of either an electromagnet, a permanent magnet, or combinations of both. The device is intended for use in high load applications in relays or switching devices.

QUICK REFERENCE DATA

Contact	SPST normally open	
Switch power		
Type RI-25AAA	max.	10 W
Type RI-25AA and RI-25A	max.	15 W
Type RI-25B and RI-25C	max.	25 W
Switched voltage		
DC	max.	200 V
AC (r.m.s.)	max.	140 V
Switched current, DC or AC (r.m.s.)	max.	1000 mA
Contact resistance (initial)	typ.	70 mΩ

The RI-25 series comprises the types RI-25AAA, RI-25AA, RI-25A, RI-25B and RI-25C with the following basic magnetic characteristics, measured with the standard coil.

	RI-25AAA	RI-25AA	RI-25A	RI-25B	RI-25C
Operate range (At)	8 – 16	14 – 23	18 – 32	28 – 52	46 – 70
Release range (At)	4 – 14	7,5 – 17,5	8 – 22	12 – 29	16 – 32

MECHANICAL DATA

Contact arrangement	normally open
Lead finish	tinned
Resonant frequency of single reed	approx. 5100 Hz
Net mass	approx. 0,19 grams
Mounting position	any

Dimensions in mm

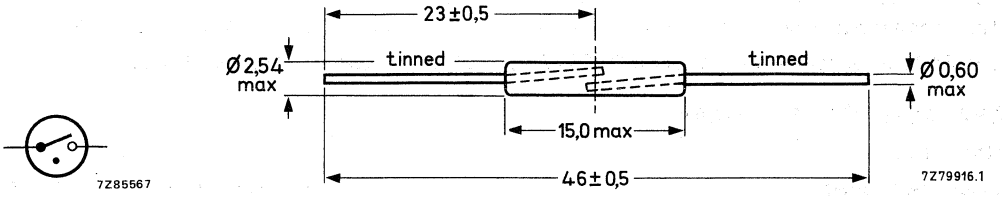


Fig. 1 Physical dimensions.

Mechanical strength

The robustness of terminations is tested in accordance with IEC Publication 68-2-21, test Ua_1 (load 40 N).

Mounting

The leads should not be bent nearer than 1 mm to the glass-to-metal seals. Stress on the seals should be avoided. Care must be taken to prevent stray magnetic fields from influencing the operating and measuring conditions. The switches can also be supplied with cut and bent leads, to customer specification.

Resistance to soldering heat

The switch can withstand IEC 68-2-20 test Tb, method 1B: solder bath at 350 ± 10 °C during 3,5 ± 0,5 s.

Solderability

Solderability is tested according to IEC 68-2-20 test Ta, method 3: solder globule 235 °C, ageing 1b: 4 hours steam.

Weldability

The leads are weldable.

The RI-25 series comprises five types: RI-25AAA, RI-25AA, RI-25A, RI-25B and RI-25C.

CHARACTERISTICS RI-25AAA

Not operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,30		pF	
		coil I	coil II		
Must-not-operate value	max.	8	9	At	
Operate					
Must-operate value	max.	16	15	At	
Operate time, including bounce	typ.	0,25		ms	2
	max.	0,50		ms	2
Bounce time	typ.	0,05		ms	2
	max.	0,15		ms	2
Contact resistance, initial	typ.	70		mΩ	10 ←
	max.	100		mΩ	10 ←
Not-release					
Must-not-release value	min.	14	12,5	At	
Release					
Must-release value	max.	4	4,5	At	
Release time	max.	70		μs	2

Notes:

1. Measured at a relative humidity of max. 45%.
2. Measured with 20 At.
3. Measured with 25 At, distance between measuring points: 41 mm. Wire resistance typ. 1,2 mΩ/mm.
4. Measured with 30 At, distance between measuring points: 41 mm. Wire resistance typ. 1,2 mΩ/mm.
5. Measured with 29 At.
6. Measured with 40 At.
7. Measured with 65 At.
8. Measured with 40 At, distance between measuring points: 41 mm. Wire resistance typ. 1,2 mΩ/mm.
9. Measured with 88 At.
10. Measured with 20 At, distance between measuring points: 41 mm. Wire resistance typ. 1.2 mΩ/mm. ←

CHARACTERISTICS RI-25AA

					notes
Not-operate					
Breakdown voltage		see relevant graph			
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,30		pF	
		coil I	coil II		
Must-not operate value	max.	14	13	At	
Operate					
Must-operate value	max.	23	20	At	
Operate time, including bounce	typ.	0,25		ms	5
	max.	0,5		ms	5
Bounce time	typ.	0,15		ms	5
	max.	0,3		ms	5
Contact resistance, initial	typ.	70		mΩ	3
	max.	100		mΩ	3
Not-release					
Must-not-release value	min.	17,5	15,5	At	
Release					
Must-release value	max.	7,5	7,5	At	
Release time	max.	30		μs	5

CHARACTERISTICS RI-25A

					notes
Not-operate					
Breakdown voltage		see relevant graph			
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not operate value	max.	18	16	At	
Operate					
Must-operate value	max.	32	26,5	At	
Operate time, including bounce	typ.	0,25		ms	6
	max.	0,5		ms	6
Bounce time	typ.	0,15		ms	6
	max.	0,3		ms	6
Contact resistance, initial	typ.	70		mΩ	4
	max.	100		mΩ	4
Not-release					
Must-not-release value	min.	22	19	At	
Release					
Must-release value	max.	8	8	At	
Release time	max.	30		μs	6

CHARACTERISTICS RI-25B

Not-operate

					notes
Breakdown voltage		see relevant graph			
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not-operate value	max.	28	23,5	At	
Operate					
Must-operate value	max.	52	41	At	
Operate time, including bounce	typ.	0,25		ms	7
	max.	0,5		ms	7
Bounce time	typ.	0,15		ms	7
	max.	0,3		ms	7
Contact resistance, initial	typ.	70		mΩ	8
	max.	100		mΩ	8
Not-release					
Must-not-release value	min.	29	24,5	At	
Release					
Must-release value	max.	12	11	At	
Release time	max.	30		μs	7

CHARACTERISTICS RI-25C

Not-operate

Breakdown voltage		see relevant graph			
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not-operate value	max.	46	37	At	
Operate					
Must-operate value	max.	70	54	At	
Operate time, including bounce	typ.	0,25		ms	9
	max.	0,5		ms	9
Bounce time	typ.	0,15		ms	9
	max.	0,3		ms	9
Contact resistance, initial	typ.	70		mΩ	8
	max.	100		mΩ	8
Not-release					
Must-not-release value	min.	32	27	At	
Release					
Must-release value	max.	16	14	At	
Release time	max.	30		μs	9

LIMITING VALUES

Absolute maximum rating system

Switched power		
→ Type RI-25AAA	max.	10 W
Type RI-25AA and RI-25A	max.	15 W
Type RI-25B and RI-25C	max.	25 W
Switched voltage		
DC	max.	200 V
AC (r.m.s.)	max.	140 V
Switched current, DC or AC (r.m.s.)		
Type RI-25AAA	max.	700 mA
Type RI-25AA, RI-25A, RI-25B and RI-25C	max.	1000 mA
Current through closed contacts, DC or AC (r.m.s.)		
Type RI-25AAA	max.	1,5 A
Type RI-25AA and RI-25A	max.	2,0 A
Type RI-25B and RI-25C	max.	2,5 A
Temperature, storage and operating	max.	125 °C*
	min.	−55 °C

LIFE EXPECTANCY AND RELIABILITY

The life expectancy data mentioned below are given at a coil energization value of 1,25 x the published must-operate value for each group. Coil energization above this value will result in better life performance.

No-load conditions (operating frequency 100 Hz)

Life expectancy at 3×10^8 operations is a failure rate of less than $0{,}9 \times 10^{-9}$ and with a confidence level of 90%.
End of life criteria: contact resistance $> 1\ \Omega$ after 2 ms
release time > 2 ms

Loaded conditions

- Resistive load: 20 V, 500 mA; operating frequency 125 Hz

for types RI-25AA, RI-25A, RI-25B and RI-25C
Life expectancy: min. 2×10^7 operations with a failure rate of less than 10^{-8} and with a confidence level of 90%.
End of life criteria: contact resistance $> 1\ \Omega$ after 2,5 ms, release time > 2,5 ms

- Resistive load: 50 V, 100 mA; operating frequency 50 Hz

Life expectancy: min. 10^6 operations with a failure rate of less than 2×10^{-7} and with a confidence level of 90%.
End of life criteria: contact resistance $> 1\ \Omega$ after 5 ms, release time > 2 ms

Note:

Switching different loads will provide different life expectancy and reliability data. Further information is available upon request.

* Variations of up to 150 °C may be permissible.

SHOCK AND VIBRATION

Shock

The switches are tested in accordance with IEC Publication 68-2-27, test Ea (peak acceleration 150 g, half sine-wave). Such a shock will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

Vibration

The switches are tested in accordance with IEC Publication 68-2-6, test Fc (acceleration 10 g, below cross-over frequency 57 to 62 Hz, amplitude 0,75 mm, frequency range 10 to 2000 Hz, duration 90 minutes). Such a vibration will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

COILS

Coil I: Standard coil

5000 turns of 42 SWG single enamelled copper wire on a coil former of 25,4 mm winding length and a core diameter of 8,75 mm.

Coil II: Miniature coil A in accordance with MIL-S-55433B (3/4 inch coil) ←

10 000 turns of 48 SWG single enamelled copper wire on a coil former of 19,05 mm winding length and a core diameter of 4,32 mm.

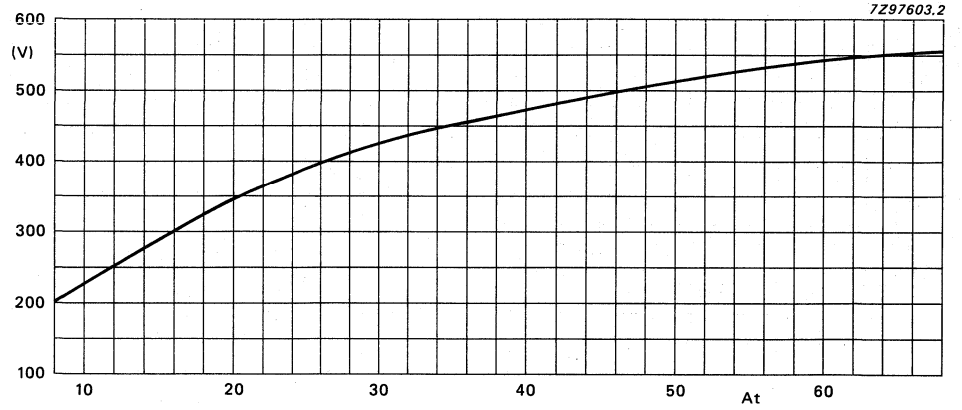


Fig. 2 Minimum breakdown voltage with pre-ionisation (V) as a function of operate-At (standard coil).

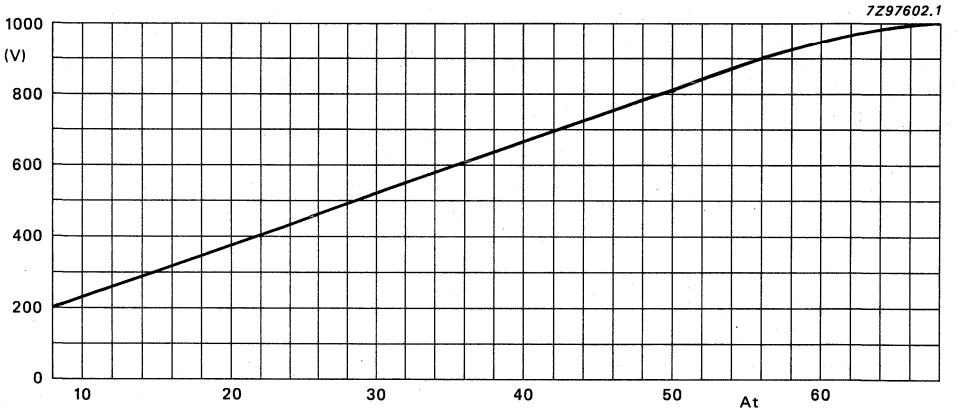


Fig. 3 Minimum breakdown voltage without pre-ionisation (V) as a function of operate-At (standard coil).

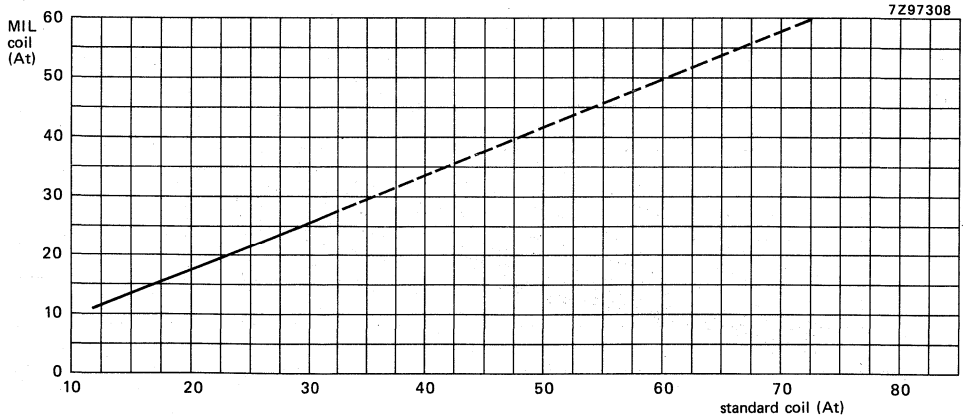


Fig. 4 Correlation of At operate in standard coil and MIL coil.

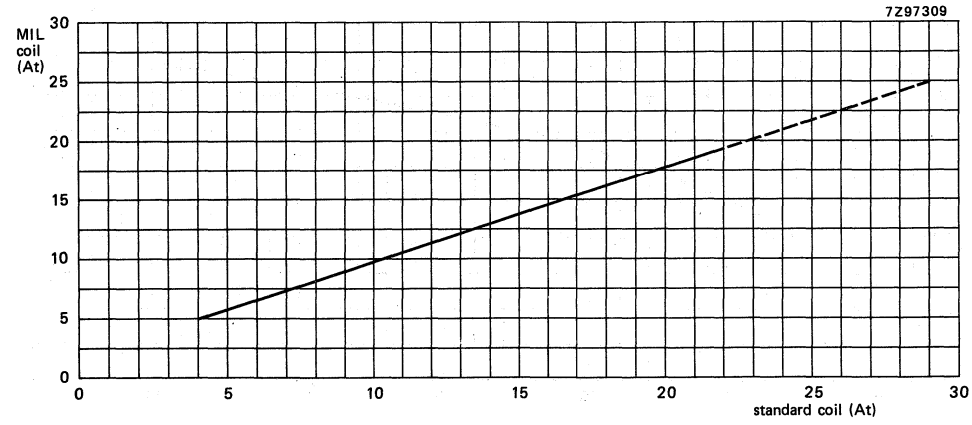


Fig. 5 Correlation of At release in standard coil and MIL coil.

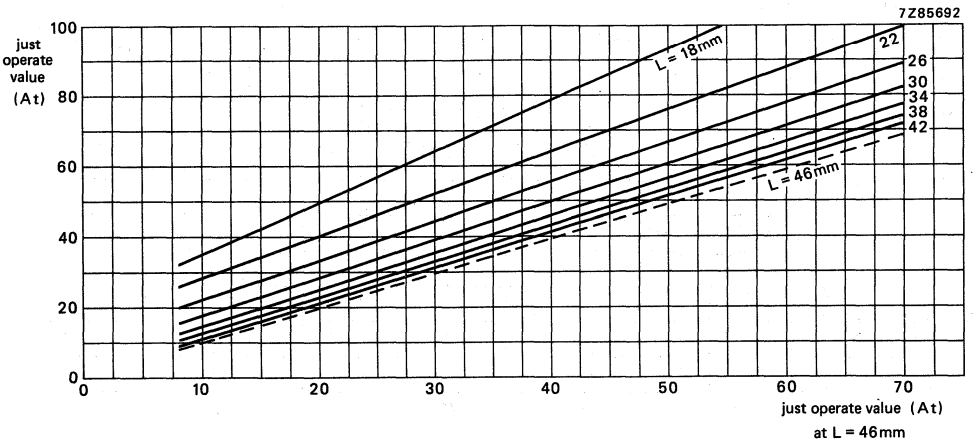


Fig. 6 Just operate values at various overall lengths, compared with standard length of 46 mm (standard coil).

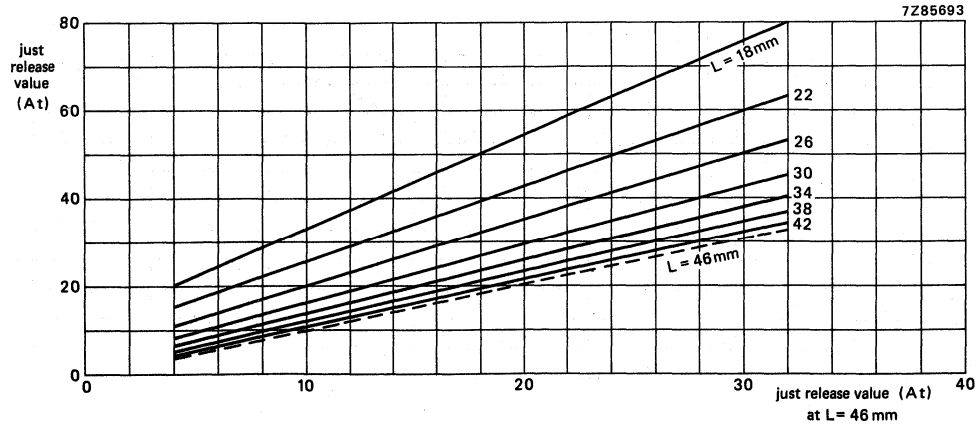


Fig. 7 Just release values at various overall lengths, compared with standard length of 46 mm (standard coil).

DRY-REED SWITCHES

Pico dry-reed contact unit hermetically sealed in a gas-filled glass capsule. Single-pole, single-throw type, having normally open contacts, and containing two magnetically actuated reeds. The contact unit is of the double-ended type and may be actuated by means of either an electromagnet or a permanent magnet or combinations of both. The device is intended for use in relays or in similar devices.

QUICK REFERENCE DATA

Contact		SPST normally open	
Switched power	max.	10	W
Switched voltage			
DC	max.	200	V
AC (r.m.s.)	max.	140	V
Switched current, DC or AC (r.m.s.)	max.	500	mA
Contact resistance (initial)	typ.	90	mΩ

The RI-27 series comprises the types RI-27AA and RI-27A with the following basic magnetic characteristics, measured with the standard coil.

		RI-27AA	RI-27A
Operate range	(At)	16 to 25	20 to 34
Release range	(At)	5 to 18	7 to 19,5

MECHANICAL DATA

Contact arrangement	normally open
Lead finish	tinned
Resonant frequency of single reed	approx. 6700 Hz
Net mass	approx. 0,1 grams
Mounting position	any

Dimensions in mm

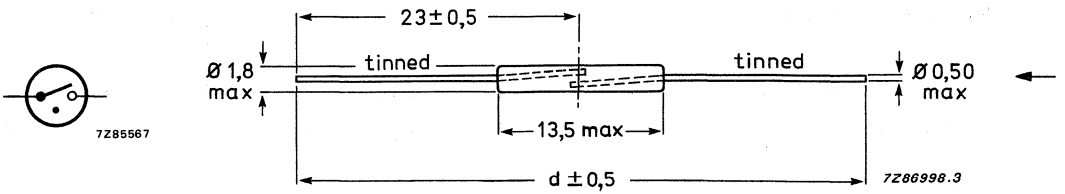


Fig. 1 Physical dimensions.

Mechanical strength

The robustness of terminations is tested according to IEC Publication 68-2-21, test Ua (load 10 N).

Mounting

The leads should not be bent nearer than 1 mm to the glass-to-metal seals. Stress on the seals should be avoided. Care must be taken to prevent stray magnetic fields from influencing the operating and measuring conditions. The switches can also be supplied with leads cut and bent to customer specification.

Resistance to soldering heat

The switch can withstand IEC 68-2-20 test Tb, method 1B: solder bath at 350 ± 10 °C during 3,5 ± 0,5 s.

Solderability

Solderability is tested according to IEC 68-2-20 test Ta, method 3: solder globule 235 °C, ageing 1b: 4 hours steam.

Weldability

The leads are weldable.

CHARACTERISTICS RI-27AA

Not operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,30		pF	
		coil I	coil II		
Must-not-operate value	max.	16	13,5	At	
Operate					
Must-operate value	max.	25	21	At	
Operate time, including bounce	typ.	0,25		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,05		ms	2
	max.	0,15		ms	2
Contact resistance, initial	typ.	90		mΩ	3
	max.	115		mΩ	3
Not-release					
Must-not-release value	min.	18	15	At	
Release					
Must-release value	max.	5	4	At	
Release time	max.	30		μs	2

Notes

1. Measured at a relative humidity of max. 45%.
2. Measured with 29 At.
3. Measured with 25 At, distance between measuring points: 41 mm. Wire resistance typ. 1,8 mΩ/mm.
4. Measured with 40 At.

CHARACTERISTICS RI-27A

Not-operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not operate value	max.	20	16	At	
Operate					
Must-operate value	max.	34	27	At	
Operate time, including bounce	typ.	0,25		ms	4
	max.	0,5		ms	4
Bounce time	typ.	0,05		ms	4
	max.	0,15		ms	4
Contact resistance, initial	typ.	90		mΩ	3
	max.	115		mΩ	3
Not release					
Must-not-release value	min.	19,5	16	At	
Release					
Must-release value	max.	7	6	At	
Release time	max.	30		μs	2

LIMITING VALUES

Absolute maximum rating system				
Switched power	max.	10	W	
Switched voltage				
DC	max.	200	V	
AC (r.m.s.)	max.	140	V	
Switched current, DC or AC (r.m.s.)	max.	500	mA	
Current through closed contacts, DC or AC (r.m.s.)	max.	1,5	A	
Temperature, storage and operating	max.	125	°C*	
	min.	−55	°C	

* Excursions up to 150 °C may be permissible. Consult us.

Notes: see previous page.

LIFE EXPECTANCY AND RELIABILITY

The life expectancy data mentioned below are given at a coil energization of 1,25 x the published must-operate value for each group. Coil energizations above 1,25 x will result in better life performance.

No-load conditions (operating frequency 100 Hz)

Life expectancy at 2.10^8 operations is a failure rate of less than 10^{-9} with a confidence level of 90%.
End of life criteria: contact resistance $> 1\ \Omega$ after 2 ms
release time > 2 ms

Loaded conditions

- resistive load: 5 V, 100 mA; operating frequency 125 Hz.

Life expectancy 5.10^7 operations a failure rate of less than $0{,}5.10^{-8}$ with a confidence level of 90%.
End of life criteria: contact resistance $> 1\ \Omega$ after 2,5 ms
release time > 1 ms

- resistive load: 12 V, 4 mA (15 mAp); operating frequency 170 Hz.

Life expectancy average 45.10^6 operations (tested up to 50.10^6 operations).
End of life criteria: contact resistance $> 2\ \Omega$ after 4 ms
release time > 0,7 ms

Note
Switching other loads involves different life expectancy and reliability. Consult us beforehand.

SHOCK AND VIBRATION

Shock

The switches are tested according to IEC Publication 68-2-27, test Ea (peak acceleration 150g, half sine-wave). Such a shock will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

Vibration

The switches are tested according to IEC Publication 68-2-6, test Fc (acceleration 10g, below cross-over frequency 57 to 62 Hz, amplitude 0,75 mm, frequency range 10 to 2000 Hz, duration 90 minutes). Such a vibration will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

COILS

Coil I: Standard coil

5000 turns of 42 SWG single enamelled copper wire on a coil former of 25,4 mm winding length and a core diameter of 8,75 mm.

→ **Coil II: Miniature coil A according to MIL-S-55433B** (¾ inch coil)

10 000 turns of 48 SWG single enamelled copper wire on a coil former of 19,05 mm winding length and a core diameter of 4,32 mm.

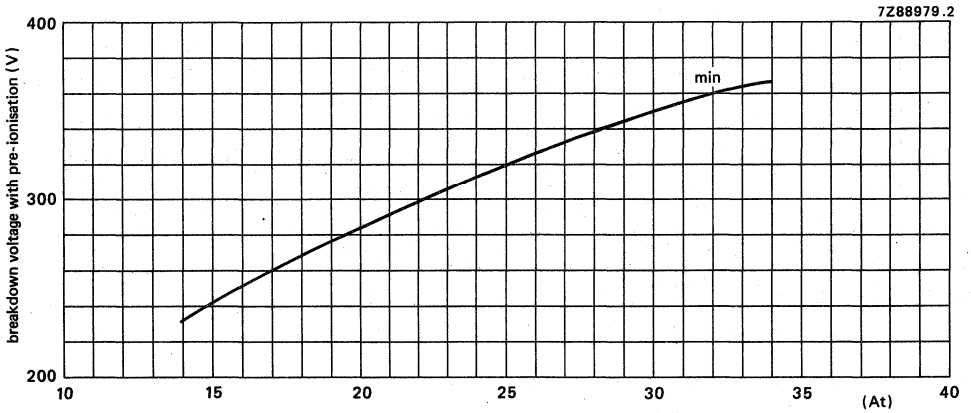


Fig. 2 Breakdown voltage as a function of operate ampere-turns (standard coil).

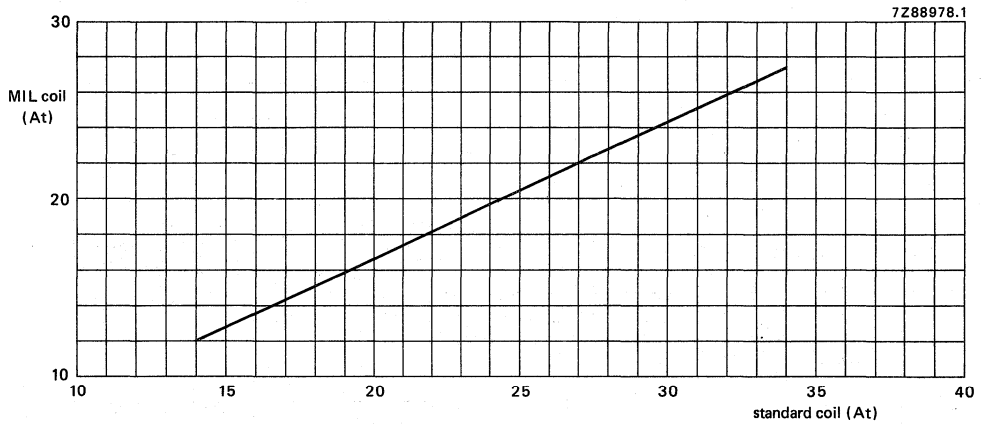


Fig. 3 Correlation of At operate in standard coil and MIL coil.

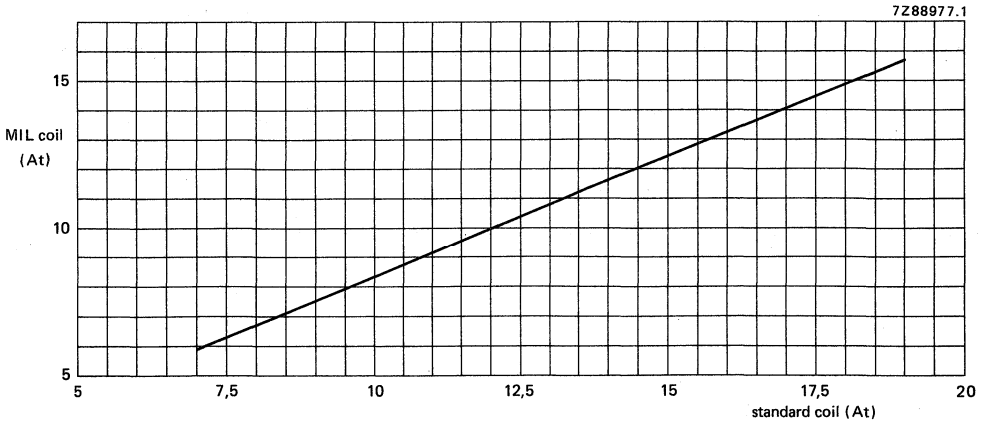
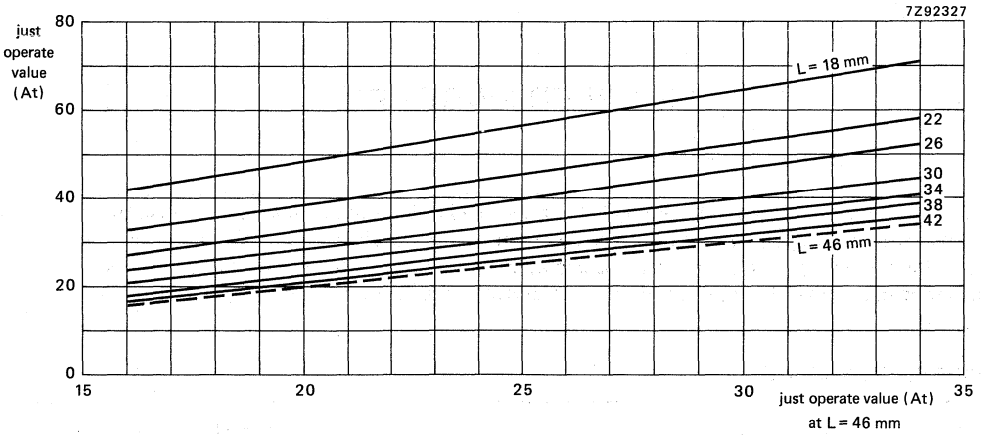
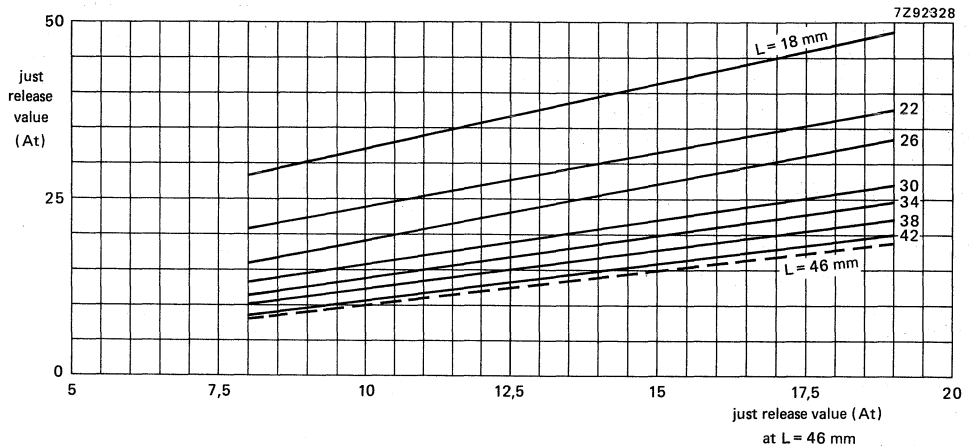


Fig. 4 Correlation of At release in standard coil and MIL coil.



→ Fig. 5 Just operate values at various lengths, compared with standard length of 46 mm. (standard coil).



→ Fig. 6 Just release values at various lengths, compared with standard length of 46 mm. (standard coil).

DRY-REED SWITCHES

Pico dry-reed contact unit hermetically sealed in a gas-filled glass capsule. Single-pole, single-throw type, having normally open contacts, and containing two magnetically actuated reeds. The contact unit is of the double-ended type and may be actuated by means of either an electromagnet or a permanent magnet or combinations of both. The device is intended for use in relays or in similar devices.

QUICK REFERENCE DATA

Contact		SPST normally open
Switched power	max.	10 W
Switched voltage		
DC	max.	180 V
AC (r.m.s.)	max.	130 V
Switched current, DC or AC (r.m.s.)	max.	500 mA
Contact resistance (initial)	typ.	90 mΩ

Operate range	(At)	10 to 19
Release range	(At)	4 to 16

MECHANICAL DATA

Contact arrangement	normally open
Lead finish	tinned
Resonant frequency of single reed	approx. 6700 Hz
Net mass	approx. 0,1 grams
Mounting position	any

Dimensions in mm

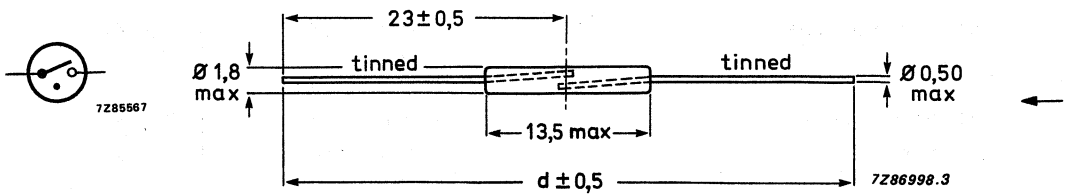


Fig. 1 Physical dimensions.

Mechanical strength

The robustness of terminations is tested according to IEC publication 68-2-21, test Ua (load 10 N).

Mounting

The leads should not be bent nearer than 1 mm to the glass-to-metal seals. Stress on the seals should be avoided. Care must be taken to prevent stray magnetic fields from influencing the operating and measuring conditions. The switches can also be supplied with leads cut and bent to customer specification.

Resistance to soldering heat

The switch can withstand IEC 68-2-20 test Tb, method 1 B: solder bath at 350 ± 10 °C during 3,5 ± 0,5 s.

Solderability

Solderability is tested according to IEC 68-2-20 test Ta, method 3: solder globule 235 °C, ageing 1b: 4 hours steam.

Weldability

The leads are weldable.

CHARACTERISTICS RI-27AAA

Not operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,30			
		coil I	coil II		
Must-not-operate value	max.	10	8,5	At	
Operate					
Must-operate value	max.	19	16	At	
Operating time, including bounce	typ.	0,25		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,05		ms	2
	max.	0,15		ms	2
Contact resistance, initial	typ.	90		mΩ	3
	max.	115		mΩ	3
Not-release					
Must-not-release value	min.	16	13,5	At	
Release					
Must-release value	max.	4	3	At	
Release time	max.	30		μs	2

Notes
1. Measured at a relative humidity of max. 45%.
2. Measured with 29 At.
3. Measured with 20 At, distance between measuring points: 41 mm. Wire resistance typ. 1,8 mΩ/mm.

LIMITING VALUES

Absolute maximum rating system

Switched power	max.	10 W
Switched voltage		
DC	max.	180 V
AC (r.m.s.)	max.	130 V
Switched current, DC or AC (r.m.s.)	max.	500 mA
Current through closed contacts, DC or AC (r.m.s.)	max.	1,5 A
Temperature, storage and operating	max.	125 °C*
	min.	−55 °C

LIFE EXPECTANCY AND RELIABILITY

The life expectancy data mentioned below are given at a coil energization of 1,25 x the published must-operate value for each group. Coil energizations above 1,25 x will result in better life performance.

No-load conditions (operating frequency 100 Hz)

Life expectancy at 2.10^8 operations is a failure rate of less than 10^{-9} with a confidence level of 90%.
End of life criteria: contact resistance $>$ 1 Ω after 2 ms
release time $>$ 2 ms

Loaded conditions

- resistive load: 5 V, 100 mA; operating frequency 125 Hz.

Life expectancy at 2.10^7 operations is a failure rate of less than 10^{-8} with a confidence level of 90%.
End of life criteria: contact resistance $>$ 1 Ω after 2,5 ms
release time $>$ 1 ms

Note
Switching other loads involves different life expectancy and reliability. Consult us beforehand.

SHOCK AND VIBRATION

Not yet fixed.

COILS

Coil I: Standard coil

5000 turns of 42 SWG single enamelled copper wire on a coil former of 25,4 mm winding length and a core diameter of 8,75 mm.

Coil II: Miniature coil A according to MIL-S-55433B

10 000 turns of 48 SWG single enamelled copper wire on a coil former of 19,05 mm winding length and a core diameter of 4,32 mm.

* Excursions up to 150 °C may be permissible. Consult us.

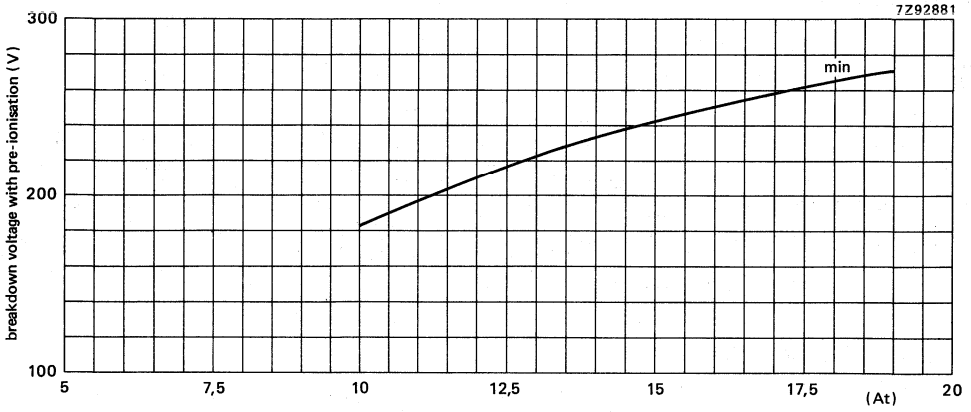


Fig. 2 Breakdown voltage as a function of operate ampere-turns (standard coil).

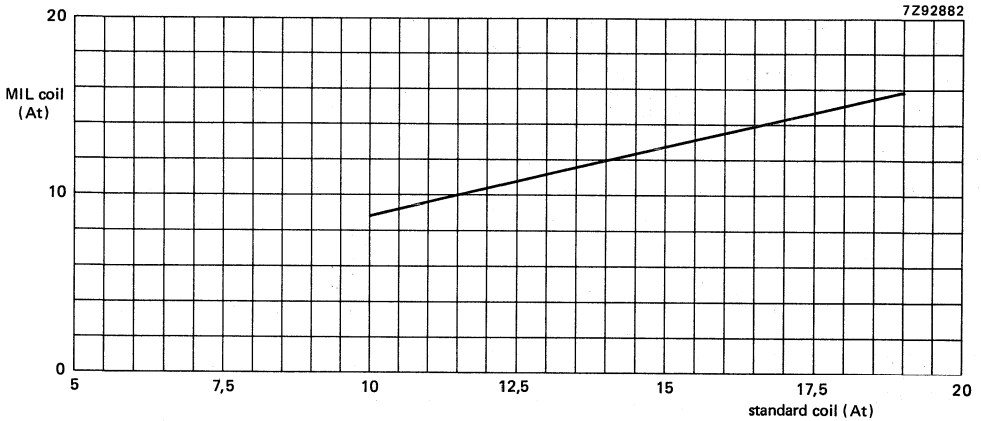


Fig. 3 Correlation of At operate in standard coil and MIL coil.

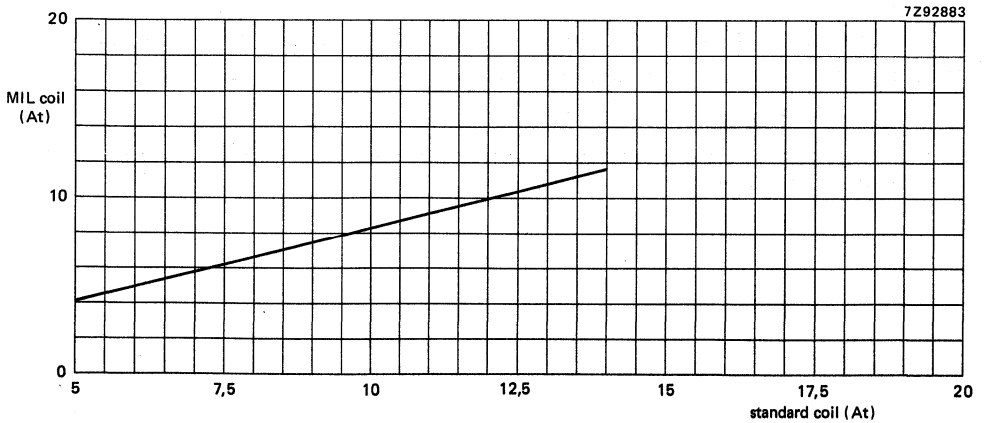


Fig. 4 Correlation of At release in standard coil and MIL coil.

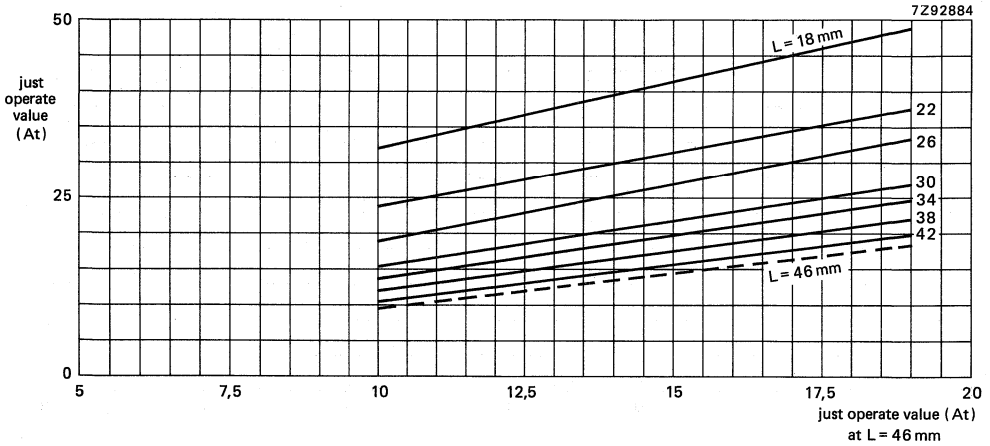


Fig. 5 Just operate values at various lengths, compared with standard length of 46 mm (standard coil). ←

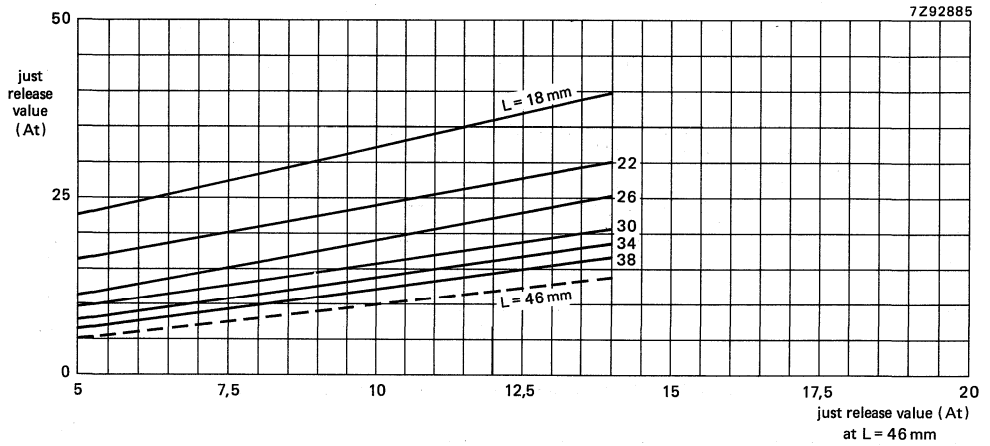


Fig. 6 Just release values at various lengths, compared with standard length of 46 mm (standard coil). ←

DRY-REED SWITCHES

Pico dry-reed contact switch hermetically sealed in a gas-filled glass capsule. Single-pole, single-throw type, having normally open contacts, and containing two magnetically actuated reeds. The contact unit is of the double-ended type and may be actuated by means of either an electromagnet or a permanent magnet or combinations of both. The device is intended for use in high inrush current applications in relays or switching devices.

QUICK REFERENCE DATA

Contact		SPST normally open
Switched power		
Type RI-29AA	max.	15 W
Type RI-29A	max.	20 W
Switched voltage		
DC	max.	200 V
AC (r.m.s.)	max.	140 V
Switched current, DC or AC (r.m.s.)	max.	1000 mA
Contact resistance (initial)	typ.	90 mΩ

The RI-29 series comprises the types RI-29AA and RI-29A with the following basic magnetic characteristics, measured with the standard coil.

		RI-29AA	RI-29A
Operate range	(At)	16 to 25	20 to 34
Release range	(At)	5 to 18	7 to 19,5

MECHANICAL DATA

Contact arrangement	normally open
Lead finish	tinned
Resonant frequency of single reed	approx. 6500 Hz
Net mass	approx. 0,1 grams
Mounting position	any

Dimensions in mm

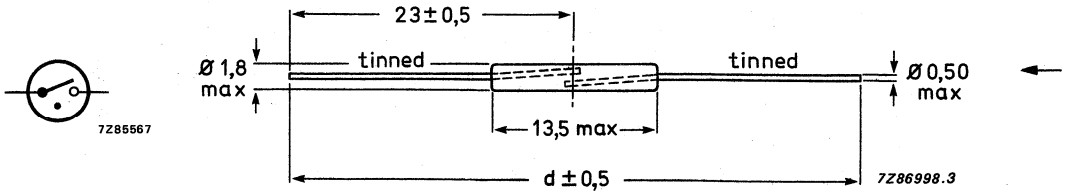


Fig. 1. Physical dimensions.

Mechanical strength

The robustness of terminations is tested according to IEC Publication 68-2-21, test Ua (load 10 N).

Mounting

The leads should not be bent nearer than 1 mm to the glass-to-metal seals. Stress on the seals should be avoided. Care must be taken to prevent stray magnetic fields from influencing the operating and measuring conditions. The switches can also be supplied with leads cut and bent to customer specification.

Resistance to soldering heat

The switch can withstand IEC 68-2-20 test Tb, method 1B: solder bath at 350 ± 10 °C during 3,5 ± 0,5 s.

Solderability

Solderability is tested according to IEC 68-2-20 test Ta, method 3: solder globule 235 °C, ageing 1b: 4 hours steam.

Weldability

The leads are weldable.

CHARACTERISTICS RI-29AA

Not operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,30		pF	
		coil I	coil II		
Must-not-operate value	max.	16	13,5	At	
Operate					
Must-operate value	max.	25	21	At	
Operate time, including bounce	typ.	0,25		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,05		ms	2
	max.	0,15		ms	2
Contact resistance, initial	typ.	90		mΩ	3
	max.	115		mΩ	3
Not-release					
Must-not-release value	min.	18	15	At	
Release					
Must-release value	max.	5	4	At	
Release time	max.	30		μs	2

Notes
1. Measured at a relative humidity of max. 45%.
2. Measured with 31 At.
3. Measured with 25 At, distance between measuring points: 41 mm. Wire resistance typ. 1,8 mΩ/mm.
4. Measured with 42,5 At.

CHARACTERISTICS RI-29A

Not-operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,25		pF	
		coil I	coil II		
Must-not operate value	max.	20	16	At	
Operate					
Must-operate value	max.	34	27	At	
Operate time, including bounce	typ.	0,25		ms	4
	max.	0,5		ms	4
Bounce time	typ.	0,05		ms	4
	max.	0,15		ms	4
Contact resistance, initial	typ.	90		mΩ	3
	max.	115		mΩ	3
Not release					
Must-not-release value	min.	19,5	16	At	
Release					
Must-release value	max.	7	6	At	
Release time	max.	30		μs	4

LIMITING VALUES

Absolute maximum rating system

Switched power				
Type RI-29AA	max.	15	W	
Type RI-29A	max.	20	W	
Switched voltage				
DC	max.	200	V	
AC (r.m.s.)	max.	140	V	
Switched current, DC or AC (r.m.s.)	max.	1000	mA	
Current through closed contacts, DC or AC (r.m.s.)	max.	1,25	A	
Temperature				
Operating	max.	75	°C	
Storage	max.	125	°C	
Operating and storage	min.	−55	°C	

Notes: see previous page.

LIFE EXPECTANCY AND RELIABILITY

The life expectancy data mentioned below are given at a coil energization of 1,25 x the published must-operate value for each group. Coil energization above 1,25 x will result in better life performance.

No-load conditions (operating frequency 100 Hz)

Life expectancy at 2×10^8 operations is a failure rate of less than 10^{-9} with a confidence level of 90%.
End of life criteria: contact resistance $> 1\ \Omega$ after 2 ms
release time > 2 ms.

Loaded conditions (capacitive load: 80 V, 0,7 A_p; 0,1 mA; operating frequency 100 Hz)

Life expectancy: RI-29AA min. 10^7 operations with a failure rate of less than 2×10^{-8} with a confidence level of 90%.
RI-29A min. 2×10^7 operations with a failure rate of less than 10^{-8} with a confidence level of 90%.

Note
Switching other loads involves different life expectancy and reliability. Consult us beforehand.

SHOCK AND VIBRATION

Shock

The switches are tested according to IEC Publication 68-2-27, test Ea (peak acceleration 150g, half sine-wave). Such a shock will not cause an open switch (no magnetic field present) to close nor a switch kept closed by an 80 At coil to open.

Vibration

The switches are tested according to IEC Publication 68-2-6, test Fc (acceleration 10g, below cross-over frequency 57 to 62 Hz, amplitude 0,75 mm, frequency range 10 to 2000 Hz, duration 90 minutes). Such a vibration will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

COILS

Coil I: Standard coil

5000 turns of 42 SWG single enamelled copper wire on a coil former of 25,4 mm winding length and a core diameter of 8,75 mm.

→ **Coil II: Miniature coil according to MIL-S-55433B** (¾ inch coil)

10 000 turns of 48 SWG single enamelled copper wire on a coil former of 19,05 mm winding length and a core diameter of 4,32 mm.

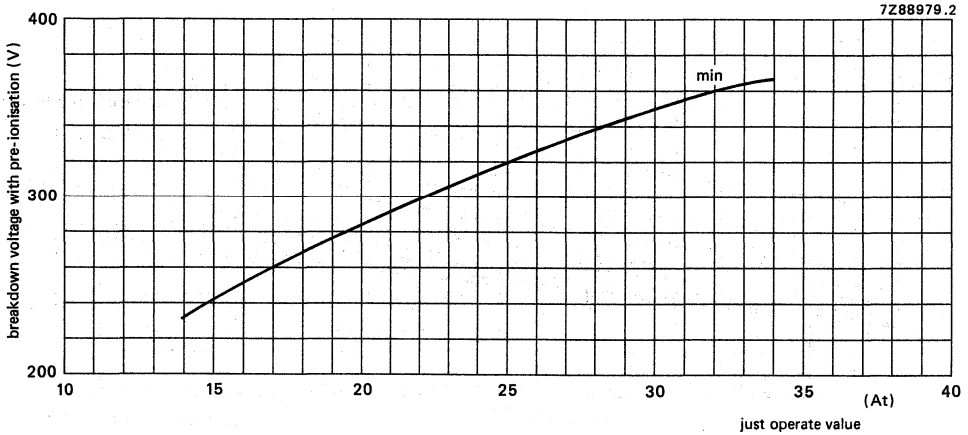


Fig. 2 Breakdown voltage as a function of just operate values (standard coil).

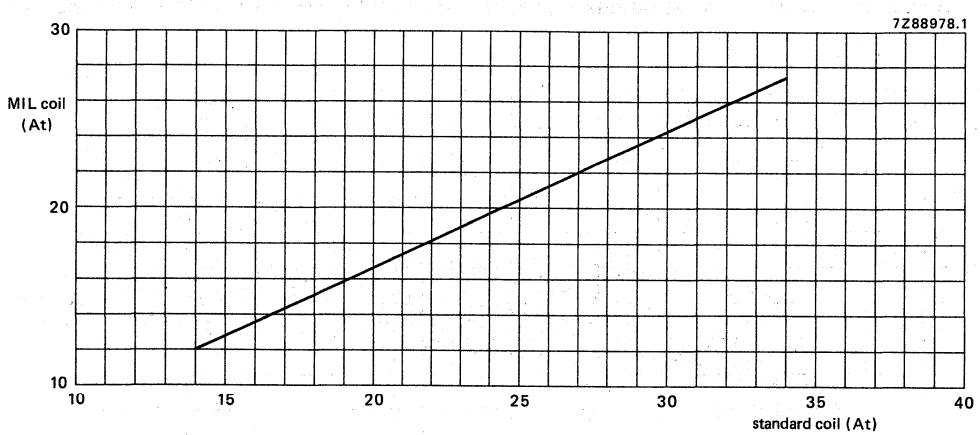


Fig. 3 Correlation of At operate in standard coil and MIL coil.

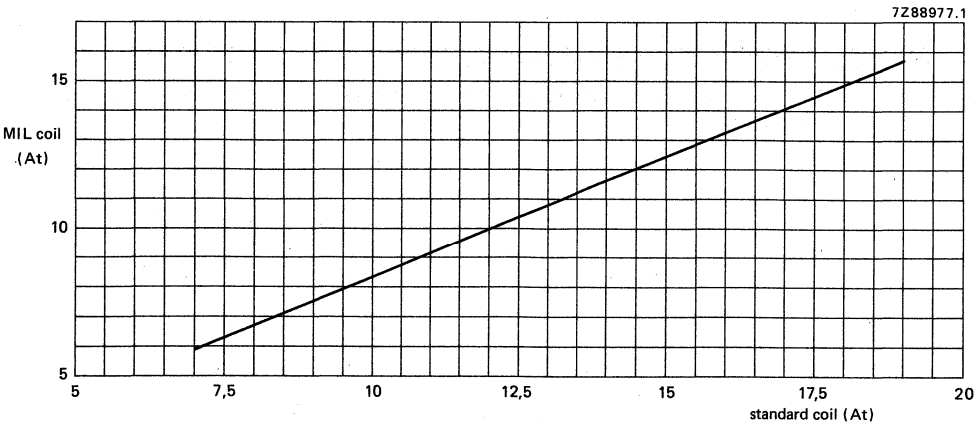


Fig. 4 Correlation of At release in standard coil and MIL coil.

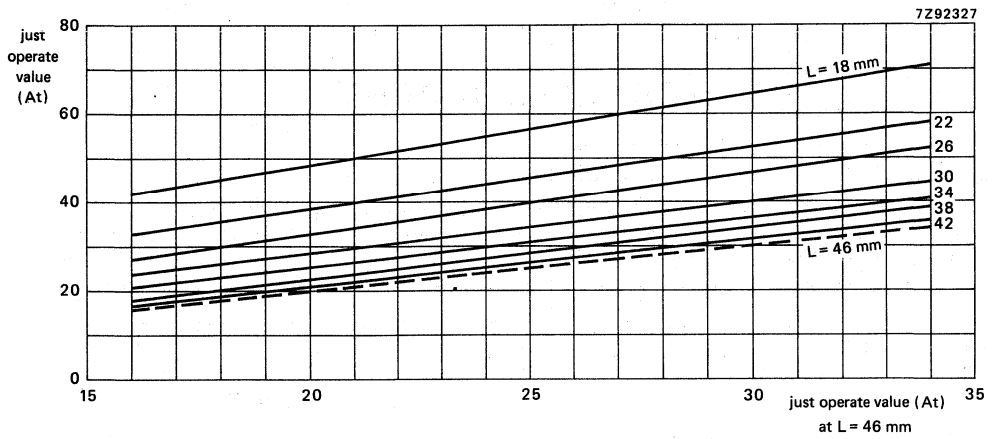


Fig. 5 Just operate values at various lengths, compared with standard length of 46 mm (standard coil).

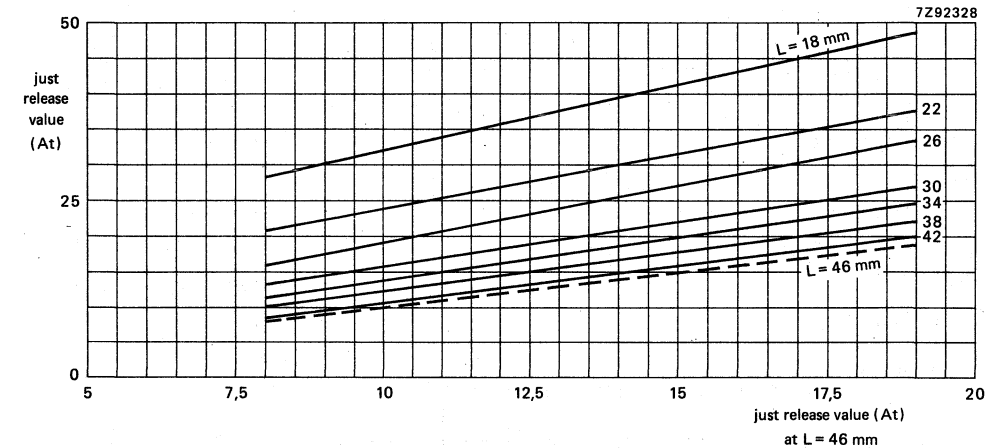


Fig. 6 Just release values at various lengths, compared with standard length of 46 mm (standard coil).

DRY-REED SWITCH

Micro dry-reed switch hermetically sealed in a gas-filled glass capsule. Single-pole, single-throw type, having normally open contacts, and containing two magnetically actuated reeds. The contact switch is of the double-ended type and may be actuated by means of either an electromagnet or a permanent magnet or combinations of both. The device is intended for use in relays for switching main loads.

QUICK REFERENCE DATA

Contact	SPST normally open	
Switched power	max.	40 W
Switched voltage, AC (r.m.s.)	max.	250 V
Switched current, resistive AC (r.m.s.)	max.	1 A
Contact resistance (initial)	max.	90 mΩ
Basic magnetic characteristics, measured with the standard coil		
Operate range		27 to 59 At
Release range		8 to 21 At

MECHANICAL DATA

Contact arrangement	normally open
Lead finish	tinned
Resonant frequency of single reed	approx. 3200 Hz
Net mass	approx. 0,28 grams
Mounting position	any

Dimensions in mm

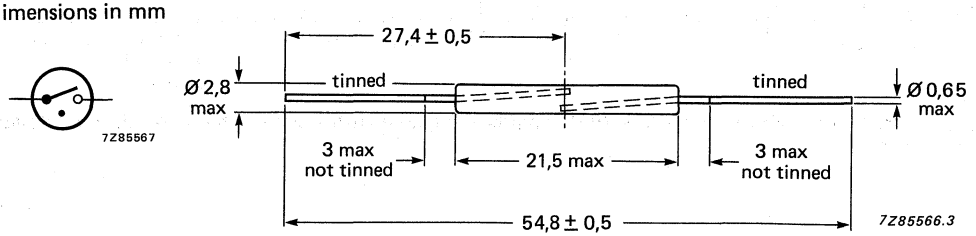


Fig. 1 Physical dimensions.

Mechanical strength

The robustness of terminations is tested according to IEC Publication 68-2-21, test Ua (load 40N).

Mounting

The leads should not be bent nearer than 1 mm to the glass-to-metal seals. Stress on the seals should be avoided. Care must be taken to prevent stray magnetic fields from influencing the operating and measuring conditions. The switches can also be supplied with cut and bent leads to customer specification.

Resistance to soldering heat

The switch can withstand IEC 68-2-20 test Tb, method 1B: solder bath at 350 ± 10 °C during 3,5 ± 0,5 s.

Solderability

Solderability is tested according to IEC 68-2-20 test Ta, method 3: solder globule 235 °C, ageing 1b: 4 hours steam.

Weldability

The leads are weldable.

CHARACTERISTICS

					notes
Not-operate					
Breakdown voltage	min.		750	V	
Insulation resistance, initial	min.		10^6	MΩ	1
Capacitance, without test coil	max.		0,20	pF	
		coil I	coil II		
Must-not-operate value	max.	27	23,5	At	
Operate					
Must-operate value	max.	59	49	At	
Operate time, including bounce	typ.	0,35		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	60		mΩ	3
	max.	90		mΩ	3
Not-release					
Must-not-release value	min.	21	18,5	At	
Release					
Must-release value	max.	8	8	At	
Release time	max.	30		μs	2

Notes

1. Measured at a relative humidity of max. 45%.
2. Measured with 75 At.
3. Measured with 35 At, distance between measuring points: 41 mm, wire resistance: typ. 1 mΩ/mm.
4. Switching higher currents is possible depending on the signature of the load.

LIMITING VALUES

Absolute maximum rating systems

Switched power	max.	40	W
Switched voltage, AC (r.m.s.)	max.	250	V
Switched current, resistive AC (r.m.s.)	max.	1	A (note 4)
Current through closed contacts	max.	3,0	A
Temperature, storage and operating	max.	125	°C
	min.	−55	°C

LIFE EXPECTANCY AND RELIABILITY

Inductive loads

A. 220 V AC (r.m.s.); L = 3,95 H; R = 662 Ω; operating freq. 2 Hz; minimum 10^4 operations. (No sticking allowed). With a failure rate of max. 2.10^{-5} at 90% confidence level.
B. 220 V AC (r.m.s.); L = 5,5 H; R = 2230 Ω; operating freq. 2 Hz; minimum 10^5 operations. (No sticking allowed). With a failure rate of max. 2.10^{-6} at 90% confidence level.
C. 220 V AC (r.m.s.); L = 0,28 H; R = 106 Ω; switching on only; operating freq. 0,6 Hz minimum 2.10^4 operations. (No sticking allowed). With a failure rate of max. 2.10^{-5} at 90% confidence level.

Resistive load

A. 250 V AC (r.m.s.); R = 1 MΩ; operating freq. 20 Hz; minimum 2.10^6 operations. Contact resistance max. 100 Ω and no sticking allowed. With a failure rate of 10^{-7} at 90% confidence level.

Note
Switching other loads involves different life expectancy and reliability. Consult us beforehand.

SHOCK AND VIBRATION

Shock

The switches are tested according to IEC Publication 68-2-27, test Ea (peak acceleration 500g, half sine-wave). Such a shock will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 75 At coil to open.

Vibration

The switches are tested according to IEC Publication 68-2-6, test Fc (acceleration 10g, below cross-over frequency 57 to 62 Hz, amplitude 0,75 mm, frequency range 10 to 2000 Hz, duration 90 minutes). Such a vibration will not cause an open switch (no magnetic field present) to close, nor a switch kept closed. by an 75 At coil to open.

COILS

Coil I: Standard coil

5000 turns of 42 SWG single enamelled copper wire on a coil former of 25,4 mm winding length and a core diameter of 8,75 mm.

Coil II: Miniature coil A according to MIL-S-55433B (3/4 inch coil)

10 000 turns of 48 SWG single enamelled copper wire on a coil former of 19,05 mm winding length and a core diameter of 4,32 mm.

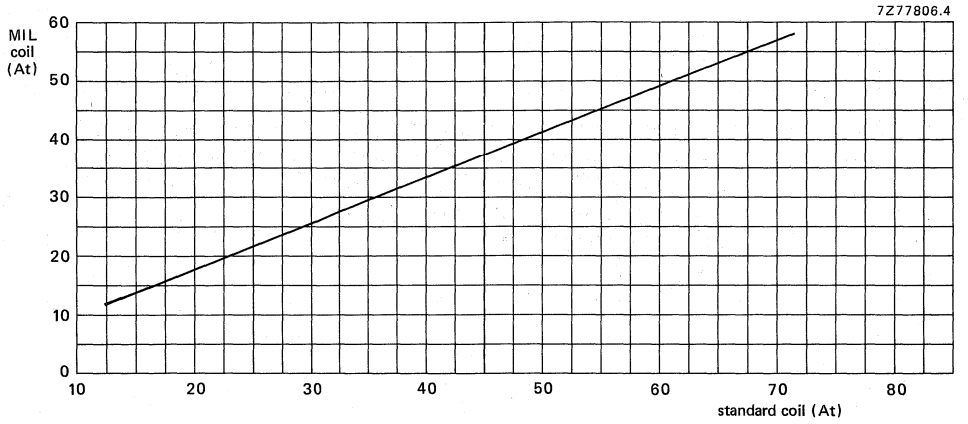


Fig. 2 Correlation at At operate in standard coil and MIL coil.

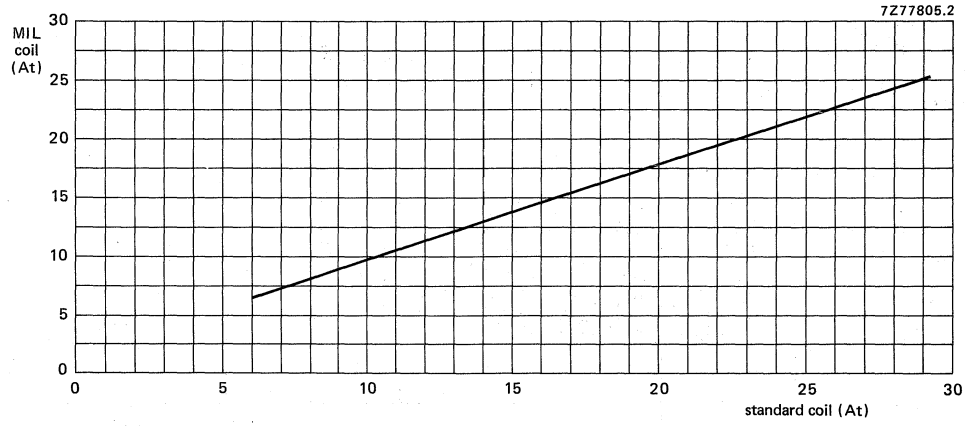


Fig. 3 Correlation of At release in standard coil and MIL coil.

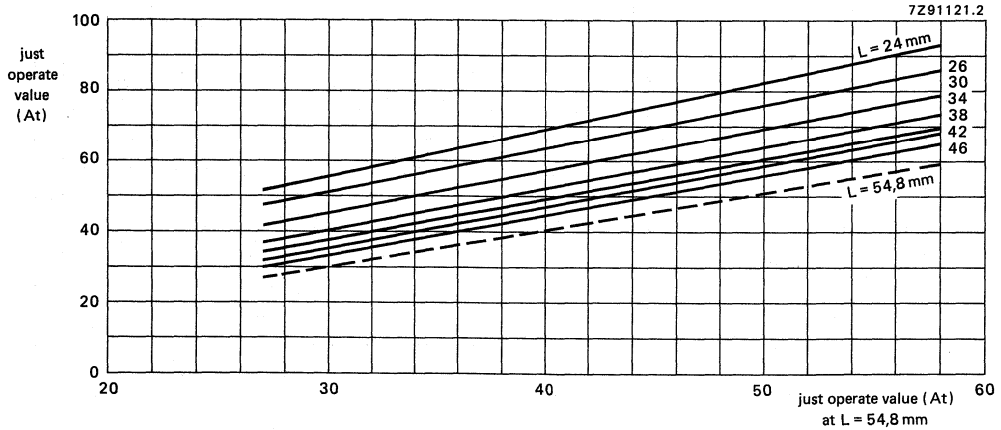


Fig. 4 Just operate values at various lengths compared with standard length of 54,8 mm (standard coil)

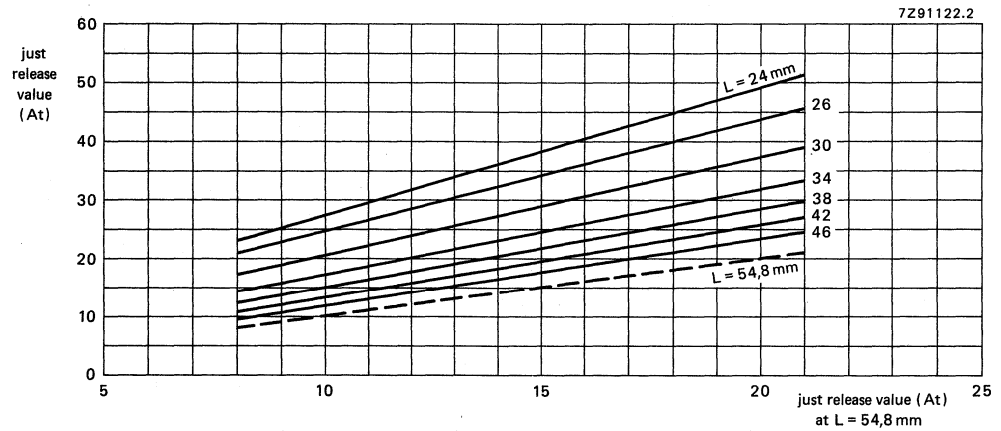


Fig. 5 Just release values at various overall lengths compared with standard length of 54,8 mm (standard coil)

DRY-REED SWITCHES

Micro dry-reed switch hermetically sealed in a gas-filled glass capsule. Single-pole, single-throw type, having normally open contacts, and containing two magnetically actuated reeds. The switch is of the double-ended type and may be actuated by means of either an electromagnet or a permanent magnet or combinations of both. The device is intended for use in relays for switching power loads and high stand-off voltage applications.

QUICK REFERENCE DATA

Contact		SPST normally open	
Switched power			
type RI-46A	max.	30	W
types RI-46B and RI-46C	max.	40	W
Switched voltage			
DC	max.	200	V
AC (r.m.s.)	max.	250	V
Switched current, resistive DC or AC (r.m.s.)	max.	1	A
Contact resistance (initial)	typ.	60	mΩ

The RI-46 series comprises the types RI-46A, RI-46B and RI-46C with the following basic magnetic characteristics, measured with the standard coil.

		RI-46A	RI-46B	RI-46C
Operate range	(At)	15 to 28	24 to 51	46 to 70
Release range	(At)	5 to 16	8 to 20,5	12 to 22,5

MECHANICAL DATA

Contact arrangement	normally open
Lead finish	tinned
Resonant frequency of single reed	approx. 3200 Hz
Net mass	approx. 0,28 grams
Mounting position	any

Dimensions in mm

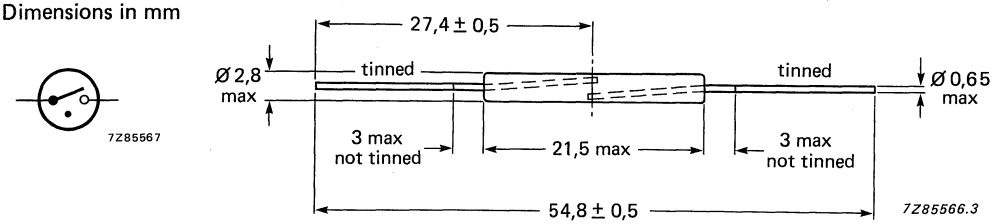


Fig. 1 Physical dimensions.

Mechanical strength

The robustness of terminations is tested according to IEC Publication 68-2-21, test Ua (load 40N).

Mounting

The leads should not be bent nearer than 1 mm to the glass-to-metal seals. Stress on the seals should be avoided. Care must be taken to prevent stray magnetic fields from influencing the operating and measuring conditions. The switches can also be supplied with cut and bent leads to customer specification.

Resistance to soldering heat

The switch can withstand IEC 68-2-20 test Tb, method 1B: solder bath at 350 ± 10 °C during 3,5 ± 0,5 s.

Solderability

Solderability is tested according to IEC 68-2-20 test Ta, method 3: solder globule 235 °C, ageing 1b: 4 hours steam.

Weldability

The leads are weldable.

CHARACTERISTICS RI-46A

Not-operate

Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	2
Capacitance, without test coil	max.	0,20		pF	
		coil I	coil II		
Must-not-operate value	max.	15	14	At	
Operate					
Must-operate value	max.	28	24,5	At	
Operate time, including bounce	typ.	0,35		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	60		mΩ	3
	max.	90		mΩ	3
Not-release					
Must-not-release value	min.	16	14,5	At	
Release					
Must-release value	max.	5	5,5	At	
Release time	max.	30		μs	2

CHARACTERISTICS RI-46B

Not-operate

Breakdown voltage		see relevant graph			
Insulation resistance	min.	10^6		MΩ	2
Capacitance, without test coil	max.	0,20		pF	
		coil I	coil II		
Must-not-operate value	max.	24	21	At	
Operate					
Must-operate value	max.	51	42,5	At	
Operate time, including bounce	typ.	0,35		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	60		mΩ	4
	max.	90		mΩ	4
Not-release					
Must-not-release value	min.	20,5	18,5	At	
Release					
Must-release value	max.	8	8	At	
Release time	max.	30		μs	2

CHARACTERISTICS RI-46C

Not-operate					
Breakdown voltage		see relevant graph			notes
Insulation resistance, initial	min.	10^6		MΩ	1
Capacitance, without test coil	max.	0,20		pF	
		coil I	coil II		
Must-not-operate value	max.	46	38,5	At	
Operate					
Must-operate value	max.	70	57,5	At	
Operate time, including bounce	typ.	0,35		ms	2
	max.	0,5		ms	2
Bounce time	typ.	0,15		ms	2
	max.	0,3		ms	2
Contact resistance, initial	typ.	60		mΩ	4
	max.	90		mΩ	4
Not-release					
Must-not-release value	min.	22,5	20	At	
Release					
Must-release value	max.	12	11,3	At	
Release time	max.	30		μs	2

LIMITING VALUES

Absolute maximum rating system				
Switched power				
type RI-46A	max.	30	W	
types RI-46B and RI-46C	max.	40	W	
Switched voltage				
DC	max.	200	V	
AC (r.m.s.)	max.	250	V	
Switched current, resistive DC or AC (r.m.s.)	max.	1	A	5
Current through closed contacts				
type RI-46A	max.	2,5	A	
type RI-46B	max.	3,0	A	
type RI-46C	max.	3,0	A	
Temperature, storage and operating	max.	125	°C	
	min.	−55	°C	

Excursions up to 150 °C may be permissible. Consult us.

Notes
1. Measured at a relative humidity of max. 45%.
2. Measured with 1,25 times the max. must-operate value per group.
3. Measured with 27 At, distance between measuring points: 41 mm. Wire resistance typ. 1,0 mΩ/mm.
4. Measured with 36 At, distance between measuring points: 41 mm. Wire resistance typ. 1,0 mΩ/mm.
5. Switching higher currents is possible depending on the signature of the load.

LIFE EXPECTANCY AND RELIABILITY

The life expectancy data mentioned below are given at a coil energization of 1,5 x the published must-operate value for each group. Coil energizations above 1,5 x will result in better life performance.

No-load conditions (operating frequency 100 Hz)

Life expectancy at 10^8 operations is, a failure rate of less than 10^{-9} with a confidence level of 90%.
End of life criteria: contact resistance $> 1\ \Omega$ after 2 ms
release time > 2 ms

Loaded conditions

Resistive load: 20 V, 500 mA; operating frequency 125 Hz.
Life expectancy min. $2{,}5 \cdot 10^7$ operations with a failure rate of less than 10^{-8} with a confidence level of 90%.
End of life criteria: contact resistance $> 2\ \Omega$ after 2,5 ms
release time $> 2{,}5$ ms

Note
Switching other loads involves different life expectancy and reliability. Consult us beforehand. Currents between 50 and 200 mA may result in a reduced life expectancy.

SHOCK AND VIBRATION

Shock

The switches are tested according to IEC Publication 68-2-27, test Ea (peak acceleration 500g, half sine-wave). Such a shock will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

Vibration

The switches are tested according to IEC Publication 68-2-6, test Fc (acceleration 10g, below cross-over frequency 57 to 62 Hz, amplitude 0,75 mm, frequency range 10 to 2000 Hz, duration 90 min.). Such a vibration will not cause an open switch (no magnetic field present) to close, nor a switch kept closed by an 80 At coil to open.

COILS

Coil I: Standard coil

5000 turns of 42 SWG single enamelled copper wire on a coil former of 25,4 mm winding length and a core diameter of 8,75 mm.

Coil II: Miniature coil A according to MIL-S-55433B (3/4 inch coil)

10 000 turns of 48 SWG single enamelled copper wire on a coil former of 19,05 mm winding length and a core diameter of 4,32 mm.

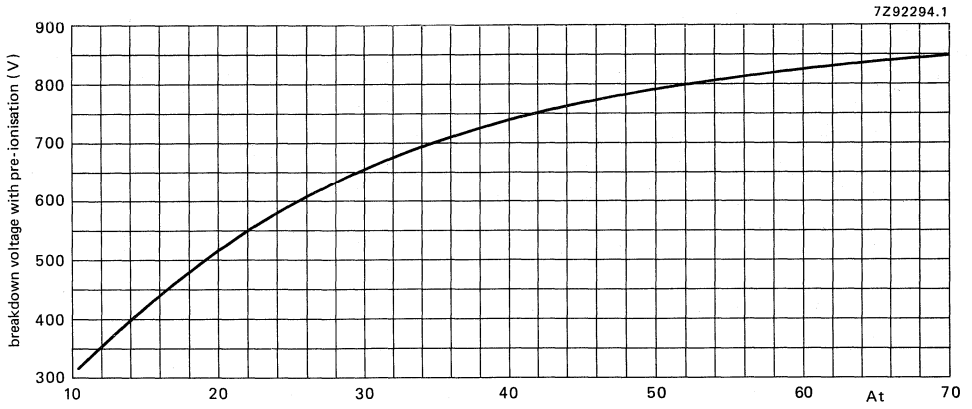


Fig. 2 Minimum breakdown voltage with pre-ionisation as a function of operate ampere-turns (standard coil).

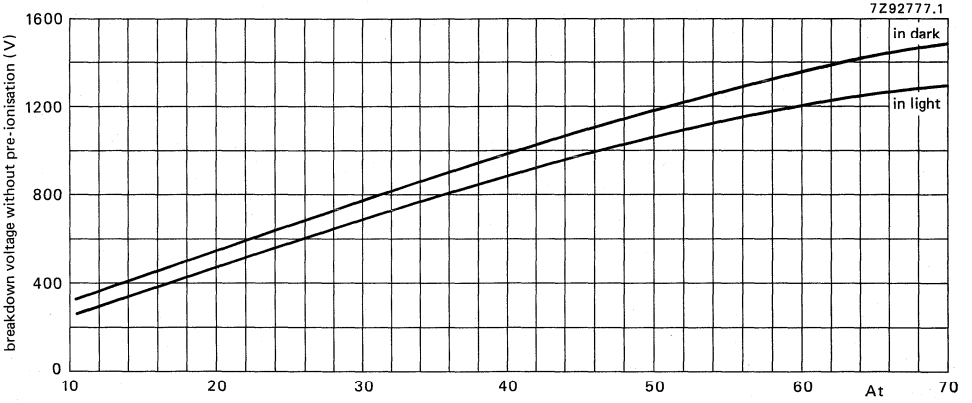


Fig. 3 Minimum breakdown voltage without pre-ionisation as a function of operate ampere-turns (standard coil).

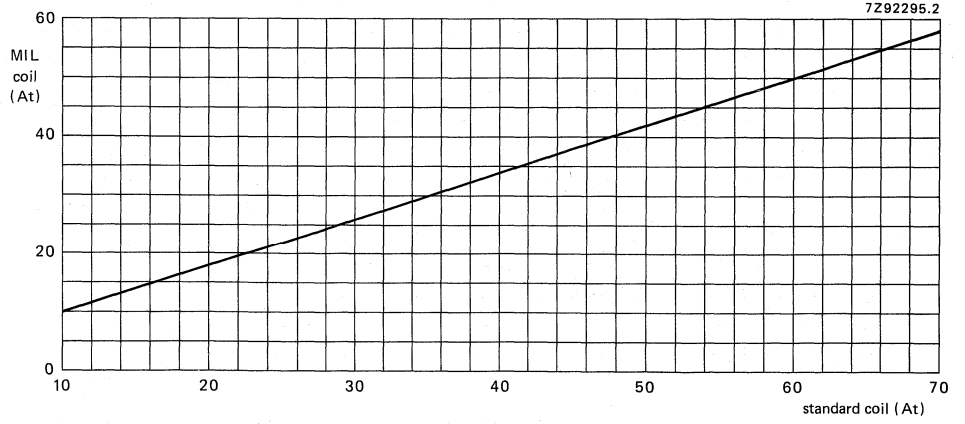


Fig. 4 Correlation of At operate in standard coil and MIL coil.

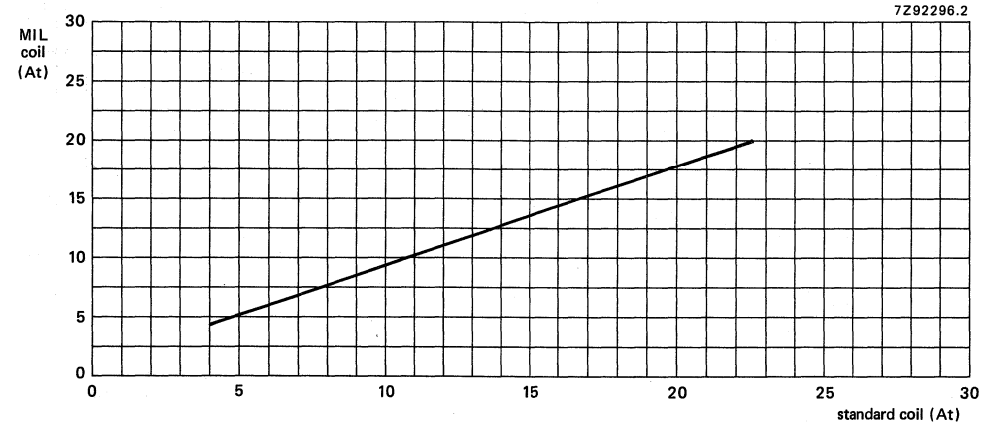


Fig. 5 Correlation of At release in standard coil and MIL coil.

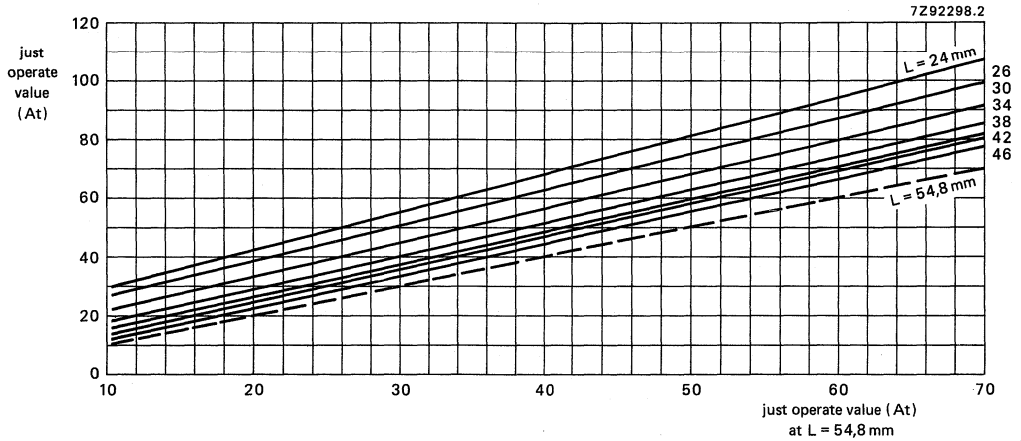


Fig. 6 Just operate values at various overall lengths compared with standard length of 54,8 mm (standard coil).

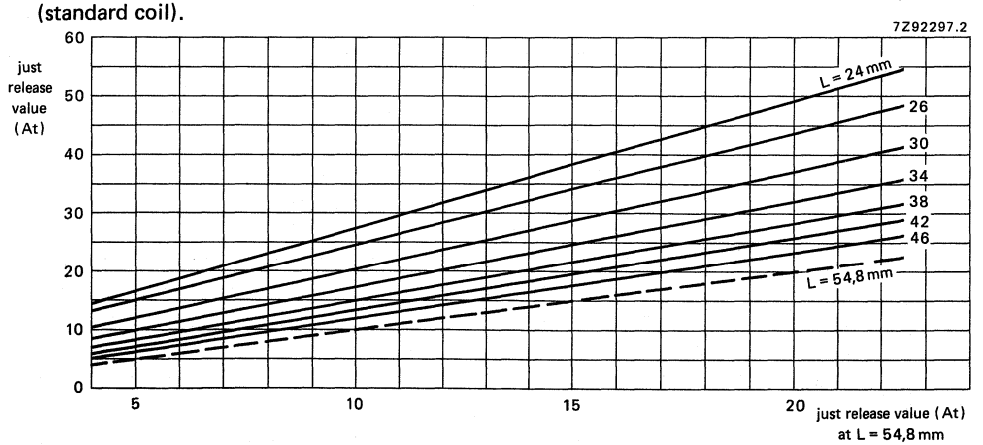


Fig. 7 Just release values at various overall lengths compared with standard length of 54,8 mm (standard coil).

NOTES

DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of six series of handbooks:

INTEGRATED CIRCUITS

DISCRETE SEMICONDUCTORS

DISPLAY COMPONENTS

PASSIVE COMPONENTS*

PROFESSIONAL COMPONENTS**

MATERIALS*

The contents of each series are listed on pages iii to viii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Components is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

* Will replace the Components and materials (green) series of handbooks.
** Will replace the Electron tubes (blue) series of handbooks.

INTEGRATED CIRCUITS

This series of handbooks comprises:

code	handbook title
IC01	**Radio, audio and associated systems** Bipolar, MOS
IC02a/b	**Video and associated systems** Bipolar, MOS
IC03	**ICs for Telecom** Bipolar, MOS Subscriber sets, Cordless Telephones
IC04	**HE4000B logic family** CMOS
IC05	**Advanced Low-power Schottky (ALS) Logic Series**
IC06	**High-speed CMOS; PC74HC/HCT/HCU** Logic family
IC07	**Advanced CMOS logic (ACL)**
IC08	**ECL 10K and 100K logic families**
IC09N	**TTL logic series**
IC10	**Memories** MOS, TTL, ECL
IC11	**Linear Products**
IC12	**I^2C-bus compatible ICs**
IC13	**Semi-custom** Programmable Logic Devices (PLD)
IC14	**Microcontrollers** NMOS, CMOS
IC15	**FAST TTL logic series**
IC16	**CMOS integrated circuits for clocks and watches**
IC17	**ICs for Telecom** Bipolar, MOS Radio pagers Mobile telephones ISDN
IC18	**Microprocessors and peripherals**
IC19	**Data communication products**

DISCRETE SEMICONDUCTORS

This series of data handbooks comprises:

current code	new code	handbook title
S1	**SC01**	**Diodes** High-voltage tripler units
S2a	**SC02**	**Power diodes**
S2b	**SC03***	**Thyristors and triacs**
S3	**SC04**	**Small-signal transistors**
S4a	**SC05**	**Low-frequency power transistors and hybrid IC power modules**
S4b	**SC06**	**High-voltage and switching power transistors**
S5	**SC07**	**Small-signal field-effect transistors**
S6	**SC08**	**RF power transistors**
	SC09	**RF power modules**
S7	**SC10**	**Surface mounted semiconductors**
S8a	**SC11***	**Light emitting diodes**
S8b	**SC12**	**Optocouplers**
S9	**SC13***	**PowerMOS transistors**
S10	**SC14**	**Wideband transistors and wideband hybrid IC modules**
S11	**SC15**	**Microwave transistors**
S15**	**SC16**	**Laser diodes**
S13	**SC17**	**Semiconductor sensors**
S14	**SC18***	**Liquid crystal displays and driver ICs for LCDs**

* Not yet issued with the new code in this series of handbooks.
** New handbook in this series; will be issued shortly.

DISPLAY COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T8	**DC01**	**Colour display components**
T16	**DC02**	**Monochrome monitor tubes and deflection units**
C2	**DC03**	**Television tuners, coaxial aerial input assemblies**
C3	**DC04***	**Loudspeakers**
C20	**DC05**	**Flyback transformers, mains transformers and general-purpose FXC assemblies**

* These handbooks are currently issued in another series; they are not yet issued in the Display Components series of handbooks.

PASSIVE COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
C14	**PA01**	**Electrolytic capacitors; solid and non-solid**
C11	**PA02**	**Varistors, thermistors and sensors**
C12	**PA03**	**Potentiometers and switches**
C7	**PA04**	**Variable capacitors**
C22	**PA05***	**Film capacitors**
C15	**PA06***	**Ceramic capacitors**
C9	**PA07***	**Piezoelectric quartz devices**
C13	**PA08**	**Fixed resistors**

* Not yet issued with the new code in this series of handbooks.

PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T1	*	Power tubes for RF heating and communications
T2a	*	Transmitting tubes for communications, glass types
T2b	*	Transmitting tubes for communications, ceramic types
T3	PC01	High-power klystrons and accessories
T4	*	Magnetrons for microwave heating
T5	PC02**	Cathode-ray tubes
T6	PC03**	Geiger-Müller tubes
T9	PC04**	Photo and electron multipliers
T10	PC05	Plumbicon camera tubes and accessories
T11	PC06	Circulators and Isolators
T12	PC07	Vidicon and Newvicon camera tubes and deflection units
T13	PC08	Image intensifiers
T15	PC09	Dry-reed switches
C8	PC10	Variable mains transformers; annular fixed transformers
	PC11	Solid state image sensors and peripheral integrated circuits

* These handbooks will not be reissued.

** Not yet issued with the new code in this series of handbooks.

MATERIALS

This series of data handbooks comprises:

current code	new code	handbook title
C4 C5	MA01*	**Soft Ferrites**
C16	MA02**	**Permanent magnet materials**
C19	MA03**	**Piezoelectric ceramics**

* Handbooks C4 and C5 will be reissued as one handbook having the new code MA01.

** Not yet issued with the new code in this series of handbooks.

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