GAS FILLED INDICATOR DIODE

Shock and vibration resistant cold-cathode gas-filled subminiature diode with visible glow-discharge for read-out purposes.
The tube contains two electrodes, a rod shaped molybdenum cathode and a concentric gauze anode.

APPLICATION

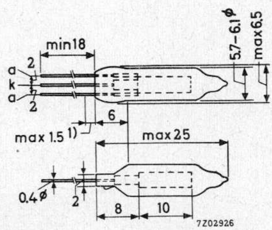
Indicator in low voltage transistor circuits. The diode can be used in combination with CdS photoconductive cells and it can be controlled by voltage signals down to 3 V.

QUICK REFERENCE DATA				
Ignition voltage	V_{ign}	=	90	V
Extinction voltage	V_{ext}	>	83.5	V
Cathode current	I_k	=	1	mA
Light intensity at I_k = 1 mA	E	=	60	lux

MECHANICAL DATA

Dimensions in mm

Type indication on pinch: yellow dot.



MOUNTING

The tube may be soldered directly into the circuit, but heat conducted to the glass-to-metall seals should be kept to a minimum by the use of a thermal shunt. The leads may be dip-soldered to a minimum of 5 mm from the glass-to-metal seals at a solder temperature of 240 °C during max. 10 seconds.
If the tube is held in its position by the leads only, the connection of both anode leads is recommended.
Care should be taken not to bend the leads nearer than 1.5 mm from the seals.

1) Not tinned

SHOCK AND VIBRATION RESISTANCE

These conditions are solely used to assess the mechanical quality of the tube. The tube must not be continuously operated under these conditions.

Shock resistance 500 g

Forces as applied by the NRL impact machine for electronic devices caused by 5 blows of the hammer lifted over an angle of 30^{o} in each of 4 positions of the tube.

Vibration resistance 2.5 g (peak)

Vibrational forces for a period of 32 hours at a frequency of 50 Hz in each of 3 directions.

CHARACTERISTICS

Valid over 15000 operating hours within the preferred current range and at room temperature unless otherwise stated.
The electrical characteristics are independent of ambient illumination.

Non conduction

Anode voltage below which ignition will not occur in any tube	$V_{ign\,min.}$	=	88	V	
Insulation resistance	r_{isol}	>	300	MΩ	

Ignition

Ignition voltage,					
upper limit	$V_{ign\,max.}$	=	93	V	[1]
individual variation during life	ΔV_{ign}	<	2.5	V	
Ignition delay at V_{ba} = 93 V	T_{delay}	≙	0.05	s	[2]
Temperature coefficient of ignition voltage	$\frac{\Delta V_{ign}}{\Delta t_{bulb}}$	<	-15	mV/°C	[3]
Reignition voltage in case of full wave rectified a.c. supply	V_{reign}	<	101	V	[4]
		>	96.5	V	[4]

[1]) The ignition and extinction voltage depression (hysteresis) is max. 0.75 V per mA prior current measured 50 ms after cessation of conduction.

[2]) Due to the statistical nature of ignition delay values of delay time > 1 s may occasionally occur.

[3]) Characteristic range value for equipment design.

[4]) These values apply to 220 V (+10 %, −15 %), 50 Hz to 60 Hz full-wave rectified unsmoothed supply and assume conduction in the course of the preceeding half cycle, so that residual ionization eliminates delay of the following ignition.

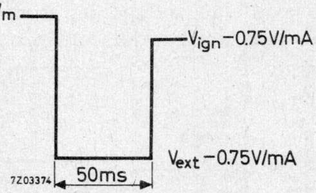
CHARACTERISTICS (continued)

Conduction

Cathode current,					
preferred range	I_k	=	0.4 to 2	mA	5)
peak	I_{kp}	=	3	mA	
Maintaining voltage	V_m	<	86 V + 4.25	V/mA	6)
		>	83 V + 2.5	V/mA	7)
Individual variation during life	ΔV_m	<	1.5	V	
Temperature coefficient of maintaining voltage	$\frac{\Delta V_m}{\Delta t_{bulb}}$	<	-15	mV/°C	3)
Rise in bulb temperature	$\frac{\Delta t_{bulb}}{\Delta I_k}$	=	10	°C/mA	
Light intensity,	E	>	30	lux/mA	8) 9)
individual minimum, measured over an angle of 70° averaged over the full circumference of the tube	E_{av}	>	60	lux/mA	8) 9)

Extinction

Extinction voltage	V_{ext}	>	83.5	V	1)



5) Current excursions during ignition and extinction are not taken into account.

6) Valid within the range 0.1 mA to 3 mA.

7) Valid within the range 0.2 mA to 3 mA. Between 0.05 mA and 0.2 mA $V_{m\,min.} = V_{ext} = 83.5$ V.

8) Light intensity at a distance of 3.6 mm from the tube axis opposite the anode cylinder, measured with a standard Weston cell adopted to eye sensitivity. Because the emission of the neon discharge is mainly contained in the red region the illumination resistance of a CdS cell will be 1.5 to 2 times lower than in case of irradiation by a 2700 °K incandescent light source. The exact conversion factor depends on the type of CdS cell used.

9) At least 90% of the tubes will meet the figure stated.

RELIABILITY AND LIFE EXPECTANCY

The electrical characteristics have been assessed in a life test programme, totalling 3.0×10^6 tube hours with no failures, denoting a failure rate of better than 0.1 % per 1000 hours. The maximum test period was 19000 hours on 22 tubes. This failure rate is not expected to increase over the first 25000 hours of continuous operation within the preferred current range.

LIMITING VALUES (Absolute maximum rating system)

Cathode current, averaging time = 5 s	I_k	= max.	2.5	mA
Cathode current during conduction	I_k	= min.	0.1	mA [1]
Cathode current, peak	I_{kp}	= max.	3	mA
Anode voltage, negative peak	$-V_{ap}$	= max.	70	V
Bulb temperature	t_{bulb}	= min.	-55	°C
		= max.	70 °C + 10	°C/mA
Altitude	h	= max.	24	km

READ-OUT CIRCUIT BISTABLE MULTIVIBRATORS

Principle of operation

The figures 1 and 2 show equivalent circuits for bistable multivibrators, equipped with p-n-p- and n-p-n transistors respectively, to which a read-out circuit has been added. The transistors are replaced by ideal switches, the voltage source V_T represents the available voltage that controls the diodes 2) and R_T is the output resistance as measured at the collector of the cut-off transistor.

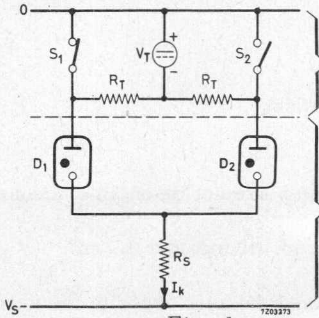


Fig. 1

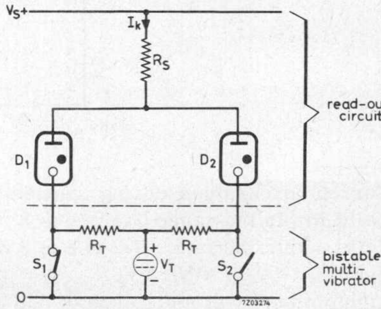


Fig. 2

1) Current excursions down to 50 μA with a duration < 1 s are permitted.

2) $V_T = V_{c.o.} - V_{sat}$ (V) in which

$V_{c.o.}$ = voltage between collector of the cut-off transistor and the common terminal (absolute value).

V_{sat} = voltage across the bottomed transistor (absolute value).

READ-OUT CIRCUIT BISTABLE MULTIVIBRATORS (continued)

Correct read-out is obtained when only the diode corresponding to the bottomed transistor conducts. For this the following conditions must be met: [1])

(I) Ignition of the correct diode, corresponding to the bottomed transistor, when the other diode is conducting.

Thus: $V_{m\,min.} + I_k R_T + V_T > V_{ign\,max}$,

resulting in $I_k > \dfrac{10 - V_T}{R_T + 2.5} \quad \dfrac{(V)}{(k\Omega)}$ for $I_k > 0.2$ mA

(II) Extinction of the diode corresponding to the cut-off transistor, when the correct diode is conducting.

Thus: $V_{m\,max.} - V_T < V_{ext\,min}$,

resulting in $I_k < \dfrac{V_T - 2.5}{5} \quad \dfrac{(V)}{(k\Omega)}$ for $I_k > 0.1$ mA

(III) Non-ignition of the diode corresponding to the cut-off transistor when the correct diode is conducting.

Thus: $V_{m\,max.} - V_T < V_{ign\,min}$,

resulting in $I_k < \dfrac{V_T + 2}{5} \quad \dfrac{(V)}{(k\Omega)}$ for $I_k > 0.1$ mA

These conditions are shown graphically on page A below.

Condensed instructions for designing the read-out circuit. [2])

The following directives are based on the requirement that correct read-out shall be ensured under worst case conditions, after the instant that the bistable circuit has reached its final stationary state. It is irrelevant whether the read-out diodes follow the changes of state of the multivibrator during its dynamic operation or not.

A choice can be made between the following modes of operating the diodes, namely by means of:

(A) a constant direct current

(B) a constant direct current on which a pulse is superimposed prior to reading-out. Three kinds of pulses are possible:
 a) a positive going pulse;
 b) a negative going pulse;
 c) a positive going pulse followed by a negative going one

(C) an unsmoothed current supplied by a full wave rectifier.

---

[1]) It is assumed that the supply voltage V_S exceeds the ignition voltage of the gas diodes, so that ignition of at least one diode is ensured; the most adverse situation being that only the wrong diode conducts.

[2]) For a detailed analysis of the design procedure please apply to the manufacturer.

READ-OUT CIRCUIT BISTABLE MULTIVIBRATORS (continued)

In fig. 3, schematically representing these waveforms, the required minimum duration of the superimposed pulses is indicated;
t_S denotes the instant at which the bistable circuit reaches its final state.

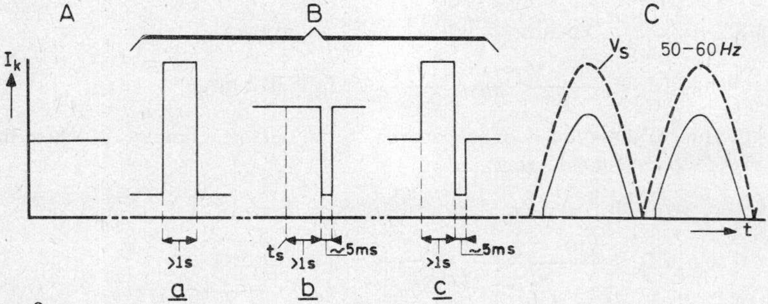


Fig. 3

The conditions to be obeyed by the current I_k are specified in the table below:

Mode of operation		Values of I_k lower limit	Values of I_k upper limit	V_T
(A) constant direct current		(I)	(II)	> 5 V
(B) direct current with superimposed:				
(a) positive going pulses	steady state current	-	(II)	> 4.5 V
	pulse current	(I)	-	
(b) negative going pulses	steady state current	(I)	(III)	> 3 V
	pulse current	-	(II)	
(c) positive and negative going pulses	steady state current	-	(III)	> 3 V
	positive going pulse	(I)	-	
	negative going pulse	-	(II)	
(C) rectified alternating current, peak value of I_k		(I)	(III)	> 4.5 V [1]
This table should be read in conjunction with the specified recommended operating conditions and limiting values.				

[1] Since both diodes are extinguished at the end of each half cycle of the supply voltage, condition (II) is not required, and is replaced by the condition that only the correct diode will reignite. The lower limit is thus given by the spread of the reignition voltage (e.i. 4.5 V).

READ-OUT CIRCUIT BISTABLE MULTIVIBRATORS (continued)

The minimum available value of V_T being known, the points of intersection with the curves I, II and III on page 8, and hence the limits of I_k (I_{kI}, I_{kII} and I_{kIII}) can be determined. This having been done, the required values of $V_{S\,min}$ and R_S can be evaluated from the following expressions: [1]

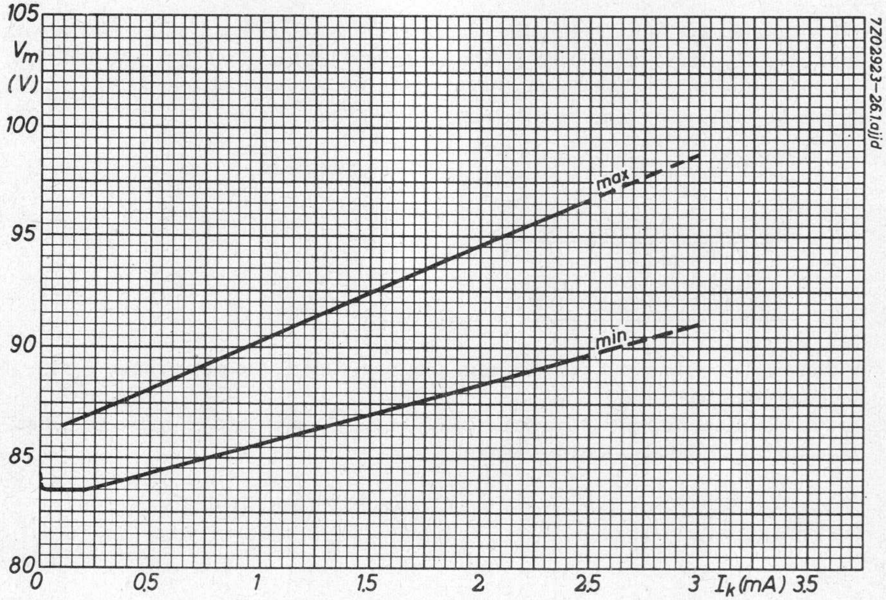
$$\frac{V_{S\,min} - V_{ign\,max}}{R_{S\,max}} = I_{kI} \qquad (1)$$

$$\frac{V_{S\,max} - V_{ext\,min} - V_T}{R_{S\,min}} = I_{kII} \qquad (2)$$

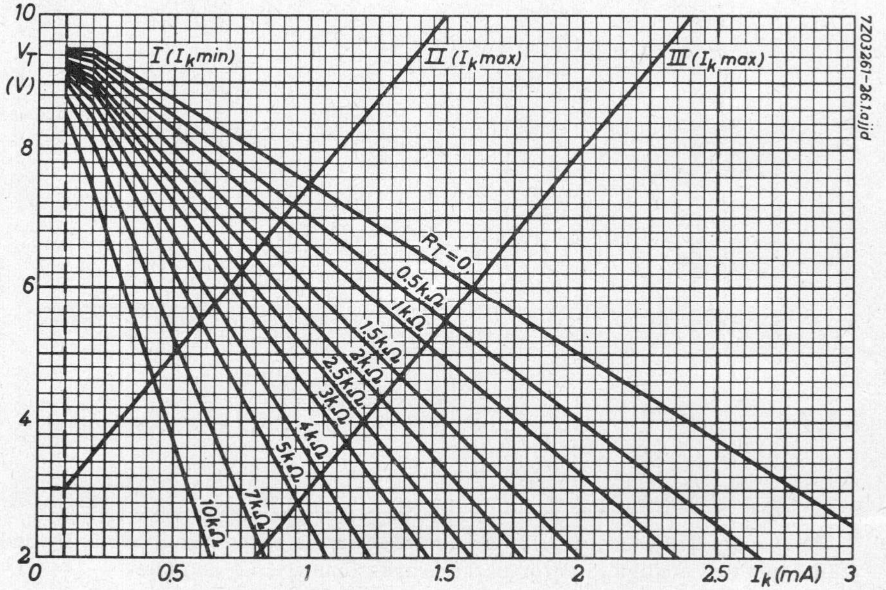
$$\frac{V_{S\,max} - V_{ign\,min} - V_T}{R_{S\,min}} = I_{kIII} \qquad (3)$$

In these expressions the suffices min and max denote the worst case limits of the quantities concerned.
For mode of operation (C) the peak value of the supply voltage must be substituted for V_S in the above expressions.

[1]) The use of equivalent circuits for establishing the exact conditions I, II, and III leads to a negligible error in the expressions (1), (2) and (3).



105
V_m
(V)
100
95
90
85
80
0
0.5
1
1.5
2
2.5
3
I_k(mA)
3.5
max
min
7Z02923-26.1ajd



10
V_T
(V)
8
6
4
2
0
0.5
1
1.5
2
2.5
I_k(mA)
3
I ($I_k$min)
II ($I_k$max)
III ($I_k$max)
R_T=0
0.5kΩ
1kΩ
1.5kΩ
2kΩ
2.5kΩ
3kΩ
4kΩ
5kΩ
7kΩ
10kΩ
7Z03261-26.1ajd