ZERO VOLTAGE SWITCH

T·65·09

Temperature Control and or Safety Switch-off in Irons

Technology: Bipolar

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Features:

- Voltage monitoring
- Full wave logic/automatic pulse phase optimisation
- Temperature compensated reference voltage
- Digital ramp for proportional driver with 32 steps
- Internal comparator with special display outputs
- Motion detector
- Internal timer:
  - 123/31 s (50 Hz)
  - 8 min (50 Hz)
  - disabled
- Negative output pulse: min. 125 mA

Case: DIP 16, SO 16

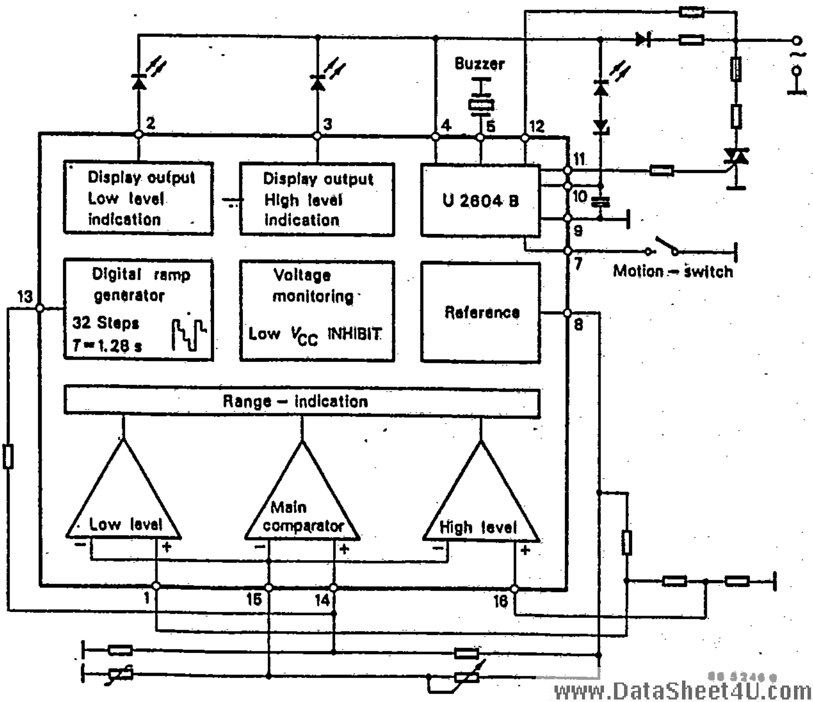

Fig. 1 Block diagram and application circuit

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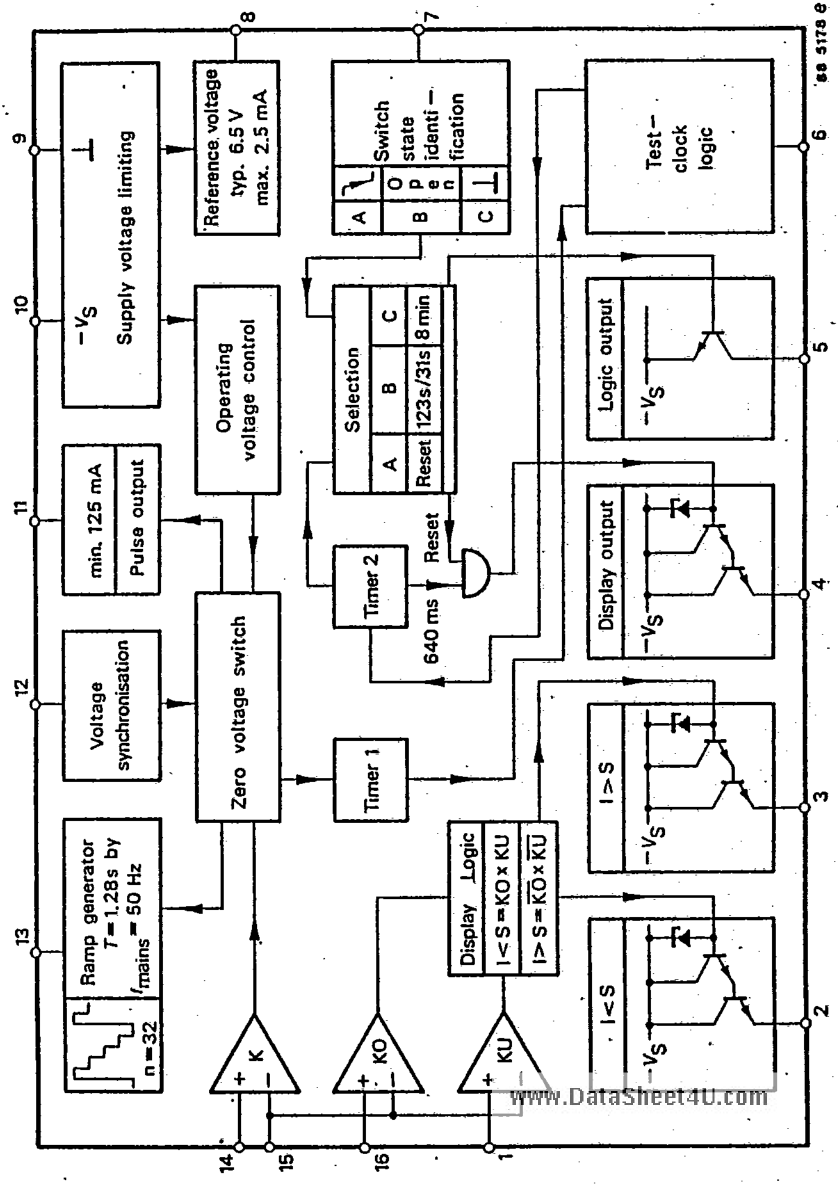


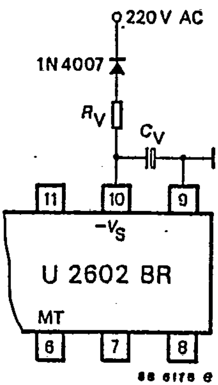
Pin configuration

1 Display comparator, low level
2 I<S (actual value < set point) output
3 I>S (actual value >set point) output
4 Display output
5 Logic output
6 Test clock logic
7 Switch state identification
8 Reference voltage
9 Ground
10 Supply voltage (negative)
11 Pulse output (min. 125 mA)
12 Voltage synchronisation
13 Ramp generator
14 Main comparator (+)
15 Main comparator (–)
16 Display comparator high level

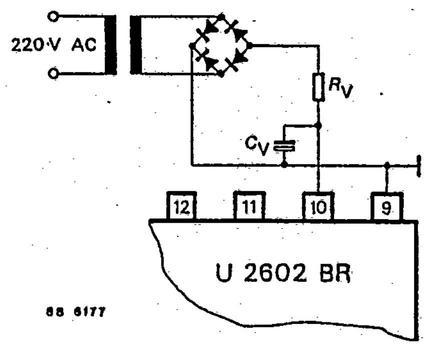
Description

Mains supply

Shunt regulator of an integrated circuit U 2602 BR, permits direct supply from the mains via dropper resistor, R_V and smoothing capacitor, C_V. Fig. 3 a and 3 b are circuit recommendations according to current requirements i.e. low or high.



a) Low current requirement



b) High current requirement

Fig. 3 Mains supply without LED indicator

If no LED indication is required, R_V can be connected directly to Pin 10. In case of LED indication, please refer to diagrams 9 through 12. For exact dimensioning of voltage limiter, please refer to "Design guide for mains supply" in the appendix.
Regulated reference voltage of 6.6 V is available at pin 8.

Zero voltage switch

The zero voltage switch is synchronized with the mains supply via R_{Sync} at Pin 12 (Fig. 4). The pulse width can be varied within wide limits by changing the value of resistor R_{Sync}. Higher the resistor value wider is the output pulse at Pin 11. Further informations regarding positioning of R_{sync}, please refer to $R_{sync} = f(t_p)$ in the appendix. Automatic pulse position optimization takes into account the triacs holding current and latching current (1/3). After switch on, the first third of the first pulse is suppressed. This avoids the phase cutting.

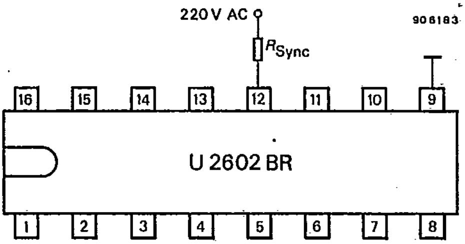


Fig. 4 Synchronisation

Pulse output, Fig. 5

A pulse amplifier which follows the full wave logic is fully protected against the effect of a short circuit and provides a negative output pulse with a minimal current of 125 mA at Pin 11. Fig. 6 shows the function, $I_G = f(R_G)$, for positioning of low ignition current

$$R_G \sim \frac{6.3\ V}{I_G} - 42\ \Omega \text{ (typ. value)}$$

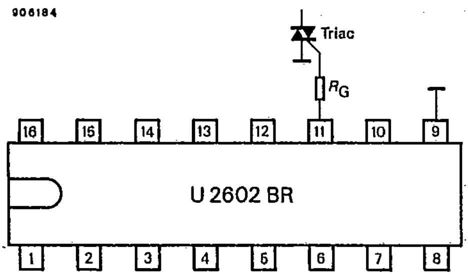
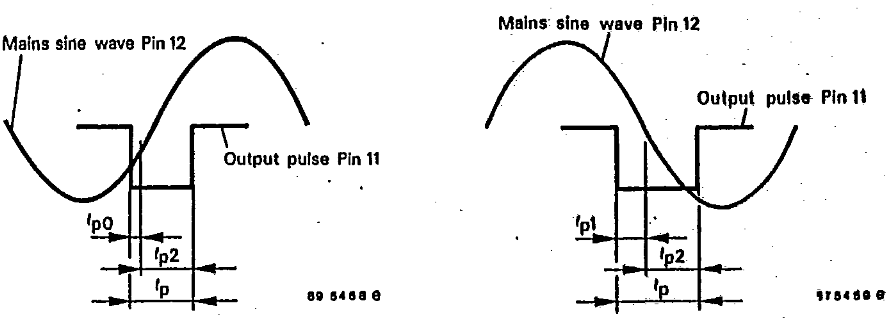


Fig. 5 Pulse output, Pin 11



a) First pulse of sequence

b) Sequence after first pulse ($t_{p2}/t_{p1} \sim 2$)

Fig. 6 Pulse output – Pulse shape

Ramp generator

A ramp generator whose frequency is derived from the mains supply permits implementation of proportional controls. The fixed ramps has a cycle length of 1.28 s when operated from a 50 Hz mains supply and is thus matched to the flicker standard (VDE 0838/10.76) for loads up to 1.3 kW. The ramp amplitude is typically 4.4 V, and consists of 32 steps.

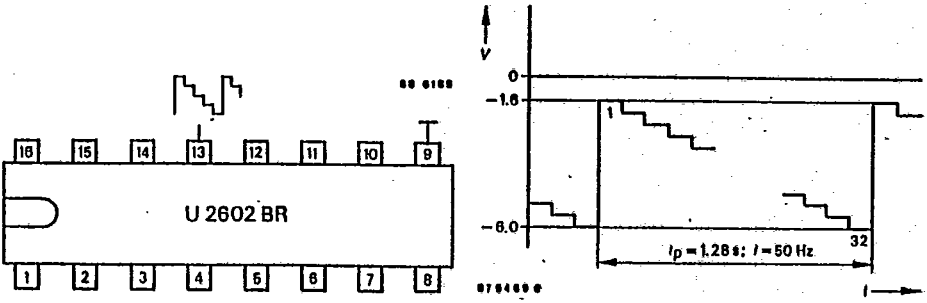


Fig. 7 Ramp generator

Function of time

A programmable counter clocked by the input frequency at the synchronization input (Pin 12) switches after the specified time programmed at input Pin 7 has elapsed. Depending on the comparator circuit, for example, a temperature regulator can be switched off or switched to another temperature.
This switching state is indicated by LED (at Pin 4) which blinks at 1.6 Hz (50 Hz mains).

The following time functions can be programmed at input Pin 7

Pin 7	Function
⊥	8 min
open	123 s/31 s
‾_	Reset

123 s: Preselected set point does not exceed at comparators limit

31 s: Preselected set point does exceed at comparators limit

If Pin 6 is connected to V_S (Pin 10), time function is void, ramp function still valid.

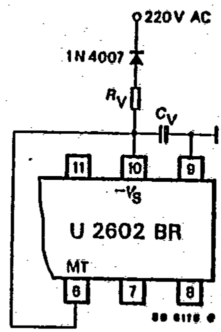


Fig. 8 Time function switched off

Display

An actual value display with 3 LEDs is possible:

Actual value < set point (I < S)
Actual value = set point (I = S)
Actual value > set point (I > S)

In order to keep the power dissipation as low as possible for direct supply from the main via a resistor, the indicator LEDs are connected in series. The following states can be indicated:

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Actual value < set point (Pin 2)
Actual value = set point
Actual value > set point (Pin3)

Elapsed time function (Pin 4: switched with a frequency of ca. 1.6 Hz).

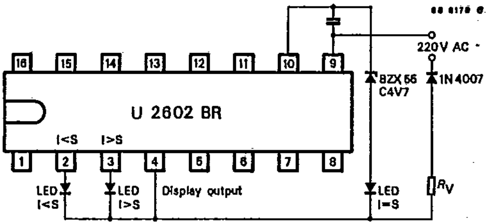


Fig. 9 Three LED set point indicator

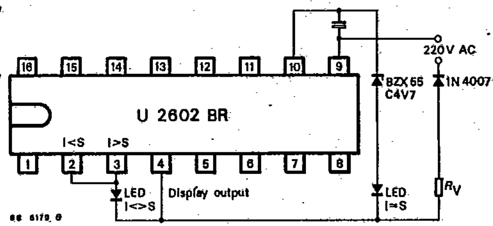


Fig. 10 Two LED indicator

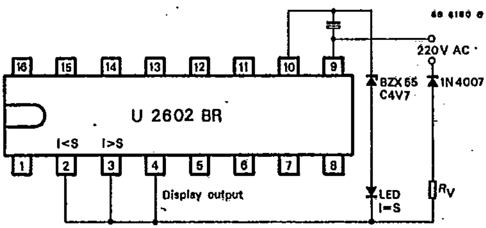


Fig. 11 One LED indicator
$I = S$

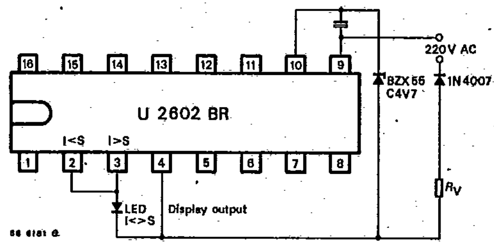
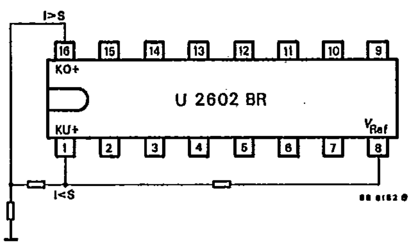


Fig. 12 One LED indicator
$I \neq S$

The display range can be set independently of the regulation range at the inputs (Pins 16, 1). If the display range (set point, s = actual value, I) is made greater than the regulation range, then switching due to ripple voltage of the display can be avoided. The range I > S is set at Pin 16 and the range I < S is set at Pin 1.



KO = Comparator high level
KU = Comparator low level

Fig. 13 Indicator range

Comparator

Comparison of the set point and actual value is carried out via the main comparator inputs (see Fig. 1,2: Pin 14, 15).

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Absolute maximum ratings

Reference point Pin 9, unless otherwise specified

Input current	Pin 2,3,4,10	$-I_I$	30	mA
$t \leq 10\ \mu s$		$-i_i$	100	mA
Synchronisation input current	Pin 12	$\pm I_{sync}$	5	mA
$t \leq 10\ \mu s$		$\pm i_{sync}$	35	mA
Output current	Pin 8	$-I_O$	2.5	mA
Input voltage	Pin 11	V_I	V_S...2.5	V
Input voltage	Pin 1,5,6,7,13,14,15,16	V_I	0... V_S	V
Junction temperature		T_j	125	°C
Ambient temperature range		T_{amb}	−10...+100	°C
Storage temperature range		T_{stg}	−40....+125	°C

Maximum thermal resistance

Junction ambient			
DIP 16	R_{thJA}	120	K/W
SO 16 soldered on pc-board	R_{thJA}	180	K/W
on ceramic substrate without silicone grease	R_{thJA}	100	K/W
on ceramic substrate with silicone grease	R_{thJA}	80.	K/W

Electrical characteristics

$-V_S = 8.5$ V, $T_{amb} = 25$ °C, reference point Pin 9, unless otherwise specified

			Min.	Typ.	Max.	
Supply voltage limitation						
$-I_S =$ 4 mA	Pin 10	$-V_S$	8.6	9.3	9.7	V
$-I_S =$ 30 mA	Pin 10	$-V_S$	8.6		10.2	V
Temperature coefficient	Pin 10	$-TC$		8		mV/K
DC supply current						
$-V_S = 8.5$ V	Pin 10	$-I_S$	1.0	2.2	3.6	mA
Reference voltage source						
$-I_L = 10\ \mu A$	Pin 8	$-V_{Ref}$	6.1	6.6	7.0	V
$-I_L = 2.5$ mA	Pin 8	$-V_{Ref}$	5.9	6.5	6.9	V
Temperature coefficient	Pin 8	$-TC_{Ref}$		0.3		mV/K
Voltage monitoring						
Turn-on threshold	Pin 10	$-V_{SON}$	8.8		9.7	V
Turn-off threshold	Pin 10	$-V_{SOFF}$	3.4	4.6	6.5	V
Synchronisation						
Current synchronisation	Pin 12	$-I_{syncVeff}$	0.1		2.5	mA
Voltage limitation						
$I_L = 5$ mA	Pin 12	$-V_I$	1.5	1.65	1.8	V

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			Min.	Typ.	Max.	
Pulse output						
Output pulse current $V_G = 0$ V	Pin 11	$-I_o$	125	170		mA
Reverse current	Pin 11	$-I_{or}$		0.01	10	µA
Pulse width	Pin 11	t_{po}	8	15	30	µs
$V_{sync} = 220$ V ~; $R_{sync} = 220$ kΩ		t_{p1}	38	52	80	µs
		t_{p2}	70	112	190	µs
Ramp generator						
Period (50 Hz)	Pin 13	T		1.28		s
Steps number	Pin 13	n		32		
Ramp amplitude (without additional current)	Pin 13	V_R	3.5	4.5	5.6	mV
Step tolerance	Pin 13			10%		
Initial voltage	Pin 13	$-V_o$	1.4	1.6	1.8	V
Final voltage	Pin 13	$-V_o$	4.9	6.1	7.4	V
Internal resistance	Pin 13	$-R_i$		25		kΩ
Comparator						
Input zero voltage	Pin 14, 15	V_{IO}		2.5	10	mV
Input current $V_{14} = -5$ V; $V_{15} = -4$ V	Pin 14	$-I_i$		0.05	1	µA
Input current $V_{14} = -4$ V, $V_{15} = -5$ V, $V_{16} = -6$ V, $V_1 = -6$ V	Pin 15	$-I_i$		0.05	1	µA
Common mode input range	Pin 14, 15	$-V_{IC}$	1.8		V_S	V
Display comparators						
Input zero voltages:	Pin 15-16	V_{IO}		2.5	10	mV
	Pin 15-1	V_{IO}		2.5	10	mV
Input currents: $V_{15} = -4$ V, $V_{16} = -5$ V	Pin 16	$-I_i$		0.05	1	µA
$V_{14} = -6$ V, $V_{15} = -5$ V, $V_{16} = -4$ V, $V_1 = -6$ V	Pin 14	$-I_i$		0.05	1	µA
$V_{15} = -4$ V, $V_{16} = -5$ V	Pin 1	$-I_i$		0.05	1	µA
$V_{14} = -6$ V, $V_{15} = -5$ V, $V_{16} = -6$ V, $V_1 = -4$ V	Pin 15	$-I_i$		0.05	1	µA
Common mode input range	Pin 1,15,16	$-V_{IC}$		1.8	V_S	V
Display selection:						
Input voltage limitation switched-on, $I_2 = -4$ mA	Pin 2,3,4	$-V_i$	$V_S+0.6$		$V_S+1.6$	V
$I_2 = -30$ mA	Pin 2,3,4	$-V_i$	$V_S+0.78$		$V_S+1.7$	V
switched-off, $I_2 = -4$ mA	Pin 2,3,4	$-V_i$	$V_S+6.8$		$V_S+7.8$	V
$I_2 = -30$ mA	Pin 2,3,4	$-V_i$	$V_S+7.1$		$V_S+7.9$	V

			Min.	Typ.	Max.	
Logic output						
Output residual voltage						
$I_6 = -3$ mA	Pin 5	$-V_o$	$V_S-1.7$		$V_S-0.9$	V
$I_6 = -1$ mA	Pin 5	$-V_o$	$V_S-1.6$		$V_S-0.6$	V
Output current limitation	Pin 5	$-I_o$	3	15	30	mA
Reverse current	Pin 5	$-I_{or}$			10	µA
Switching state recognition:						
Input voltage						
Switching range C	Pin 7	$-V_i$			0.5	V
Switching range B	Pin 7	$-V_i$	1.6		V_S	V
Input current						
$V_7 = 0$ V	Pin 7	$\pm I_i$	20		115	µA
$V_7 = V_S$	Pin 7	I_i		1.6	7.3	mA

Design guide for mains supply

The value of resistance R_V depends on the total current (I_{tot}) consumption, which is as follows:

$I_{tot} = I_{Smax} + I_x + I_p$ whereas,

I_{Smax} = Current consumption of the integrated circuit = 3.3 mA.

I_x = Current consumption of the external components

I_P = Current component of the pulse output on Pin 11 which depends on I_G, t_p,

$$I_P = I_G \cdot 2 \cdot \frac{t_p}{T}$$

Curves shown in Figs. 14 through 19 are calculated for mains supply of 220 V (50 Hz). Precautions should be taken, if the dimensioning is for other than mentioned operating voltages.

a. Select the triacs according to the load, with the smallest possible gate- and dynamic holding current.

b. Evaluate the pulse width t_p from Fig. 14, $t_p = f(I_L, P)$

c. Determine the synchronisation resistance R_{sync} from Fig. 15 $R_{sync} = f(t_p)$.

d. If a gate-series resistor R_G is necessary to reduce the gate current I_G see Fig. 16, $R_G = f(I_G)$.

e. Determination of max. D.C. component of the triac control pulse $I_p = f(R_{sync}, R_G)$, Fig. 17.

f. Evaluate max. allowable series resistance $R_V = f(I_{tot})$ with the help of Fig. 18.

g. Fig. 19 determine the power dissipation of R_V.

I_L = Latching current (triac)

V_{Smin} = 8.8 V; $V_{Smax} = 9.7$ V

$V_{Nmin} = V_{RMS}$ -15%; $V_{Nmax} = V_{RMS} + 10\%$

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Equations

Fig. 3 $t_p = f(I_L, P)$

$$t_p = \frac{1.4}{\omega} \cdot \arcsin\left(\frac{I_L \cdot V_{RMS}}{P \cdot \sqrt{2}}\right)$$

Fig. 4 $R_{sync} = f(t_p)$

$$R_{sync} = \frac{V_{RMS} \cdot \sqrt{2} \cdot \sin(0.714 \cdot t_p \cdot \omega) - 0.67\ V}{29\ \mu A} - 1.4\ k\Omega$$

Fig. 5 $R_G = f(I_G)$

$$R_G = \frac{V_{Smin} - V_G - 1.5\ V}{I_G} - 42\ \Omega \approx \frac{6.3\ V}{I_G} - 42\ \Omega$$

Fig. 6 $I_P = f(R_{sync}, R_G)$

$$I_{Pmax} = \frac{1100}{(R_G + 29\ \Omega) \cdot \omega \cdot \arcsin\left(\frac{80\ \mu A \cdot (R_{sync} + 1.4\ k\Omega) + 0.69\ V}{V_{RMS} \cdot \sqrt{2}}\right)}$$

Fig. 7 $R_v = f(I_{tot})$

$$R_v \approx 0.85 \cdot \frac{V_{Nmin} - V_{Smax}}{2 \cdot I_{tot}}$$

$$I_{tot} = I_{Smax} + I_p + I_x$$

Fig. 8 $$P_{Rv} \approx \frac{(V_{Nmax} - V_{Smin})^2}{2 \cdot R_v}$$

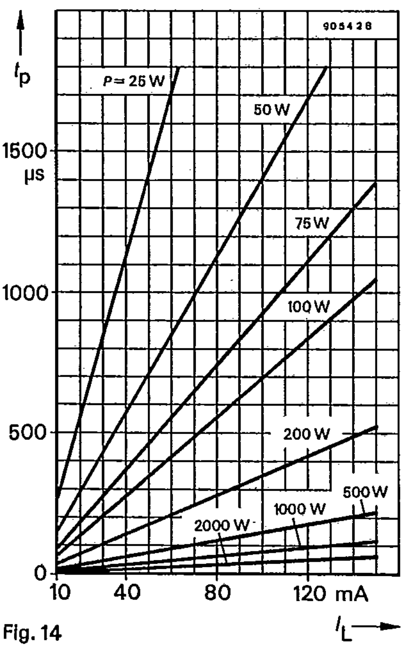

Fig. 14

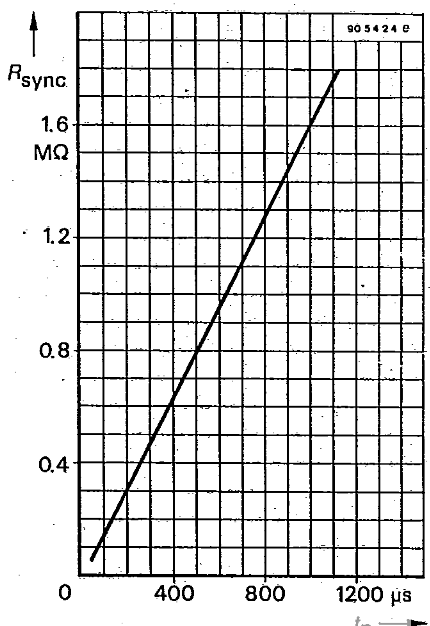

Fig. 15

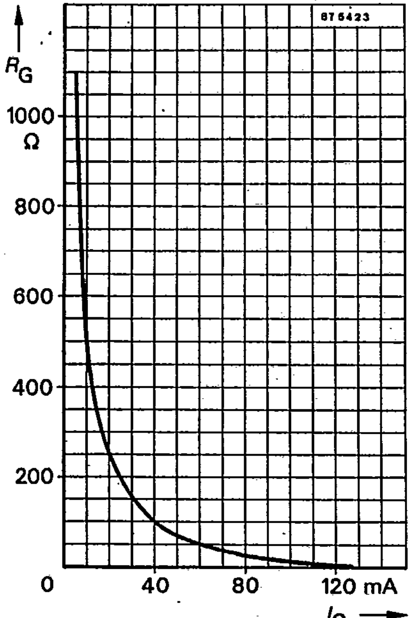

Fig. 16

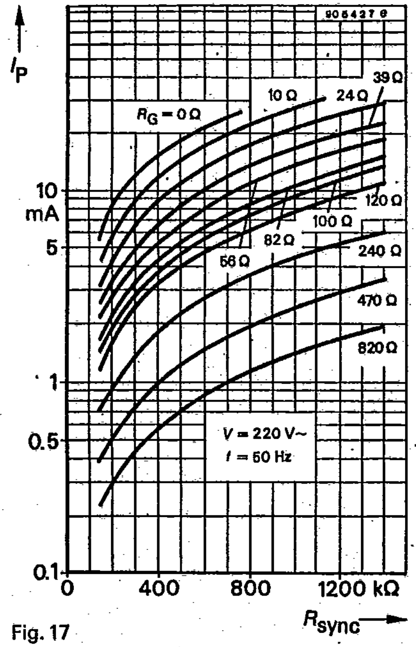

Fig. 17

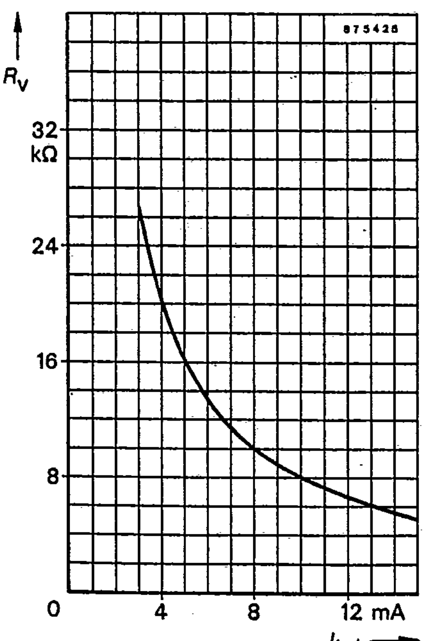

Fig. 18

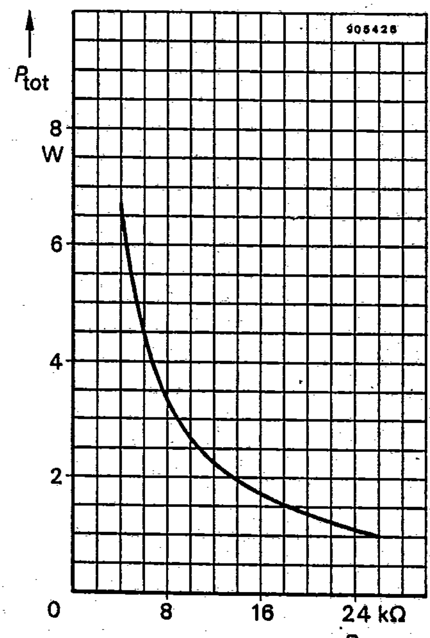

Fig. 19

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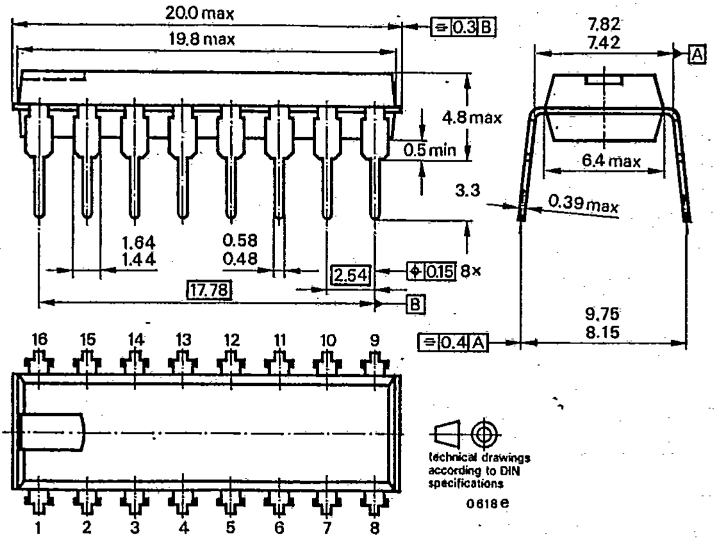
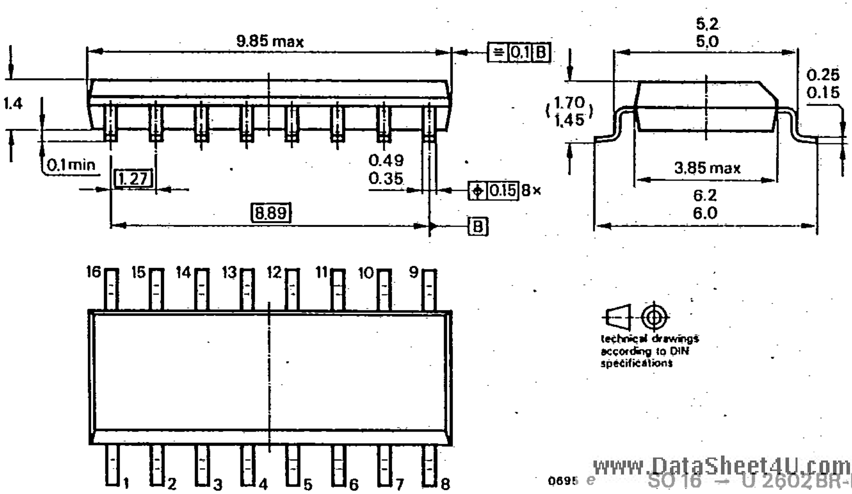
Dimensions



Case: DIP 16 — U 2602 BR



SO 16 — U 2602 BR-FP