Signetics

TDA1023
Time-Proportional Triac Trigger

Product Specification

Linear Products

DESCRIPTION

The TDA1023 is a bipolar integrated circuit for controlling triacs in the time-proportional or burst firing mode. It permits very precise temperature control of heating equipment and is especially suited to the control of panel heaters. The circuit generates positive-going trigger pulses and complies with the regulations on radio interference and mains distortion.

FEATURES

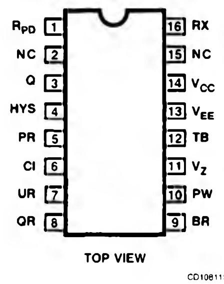
- **Adjustable proportional range width**
- **Adjustable hysteresis**
- **Adjustable trigger pulse width**
- **Adjustable firing burst repetition time**
- **Control range translation facility**
- **Failsafe operation**
- **Supplied from the mains**
- **Provides supply for external temperature bridge**

APPLICATIONS

- **Triac control**
- **Temperature control**
- **Panel heater control**

PIN CONFIGURATION

N Package

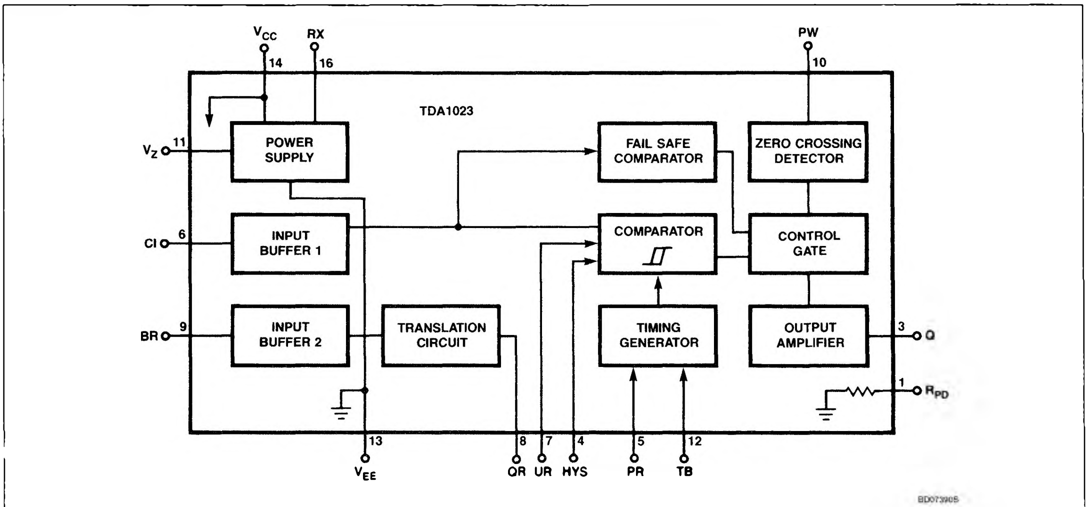


PIN NO.	SYMBOL	DESCRIPTION
1	R_{PD}	Internal pull-down resistor connection
2	NC	Not connected
3	O	Output
4	HYS	Hysteresis control input
5	PR	Proportional range control input
6	CI	Control input
7	UR	Unbuffered reference input
8	OR	Output of reference buffer
9	BR	Buffered reference input
10	PW	Pulse width control input
11	V_Z	Reference supply output
12	TB	Firing burst repetition time control input
13	V_{EE}	Ground connection
14	V_{CC}	Positive supply connection
15	NC	Not connected
16	RX	External resistor connection

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
16-Pin Plastic DIP (SOT-38)	−20°C to +75°C	TDA1023N

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage, DC	16	V
 $I_{16(AV)}$ $I_{16(RM)}$ $I_{16(SM)}$	Supply current average repetitive peak non-repetitive peak	 30 100 2	 mA mA A
V_I	Input voltage, all inputs	16	V
$I_{6;\,7;\,9;\,10}$	Input current, CI, UR, BR, PW input	10	mA
V	Voltage on R_{PD} connection (Pin 1)	16	V
$V_{3;\,8;\,11}$	Output voltage, Q, QR, V_Z output	16	V
 $-I_{OH(AV)}$ $-I_{OH(M)}$	Output current average peak, max. 300 μs	 30 700	 mA mA
P_{TOT}	Total power dissipation	500	mW
T_{STG}	Storage temperature range	-65 to +150	°C
T_A	Operating ambient temperature range	-20 to +75	°C

DC ELECTRICAL CHARACTERISTICS

V_{CC} = 11 to 16V; T_A = -20°C to +75°C, unless otherwise specified.

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
Supply: V_{CC} and RX (Pins 14 and 16)					
 V_{CC} $\Delta V_{CC}/\Delta I_{16}$	Internally stabilized supply voltage at I_{16} = 10mA Variation with I_{16}	 12	 13.7 30	 15	 V mV/mA
  I_{16} I_{16}	Supply current at V_{16-13} = 11 to 16V; I_{10} = 1mA; f = 50Hz; Pin 11 open; $V_{6-13} > V_{7-13}$; Pins 4 and 5 open Pins 4 and 5 grounded			 6 7.1	 mA mA
Reference supply output V_Z for external temperature bridge 0(Pin 11)					
V_{11-13}	Output voltage		8		V
$-I_{11}$	Output current			1	mA
Control and reference inputs CI, BR, and UR (Pins 6, 9, and 7)					
V_{6-13}	Input voltage to inhibit the output		7.6		V
$I_{6;\,7;\,9}$	Input current at V_I = 4V			2	μA
Hysteresis control input HYS (Pin 4)					
ΔV_6 ΔV_6	Hysteresis, Pin 4 open Pin 4 grounded	9	20 320	40	mV mV
Proportional range control input PR (Pin 5)					
ΔV_6 ΔV_6	Proportional range, Pin 5 open Pin 5 grounded	50	80 400	130	mV mV
Pulse width control input PW (Pin 10)					
t_W	Pulse width at $I_{10(RMS)}$ = 1mA; f = 50Hz	100	200	300	μs
Firing burst repetition time control input t_B (Pin 12)					
t_B/C_T	Firing burst repetition time, ratio to capacitor C_T	320	600	960	ms/μF

DC ELECTRICAL CHARACTERISTICS V_{CC} = 11 to 16V; T_A = −20°C to +75°C, unless otherwise specified.

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
Output of reference buffer QR (Pin 8)					
	Output voltage				
V_{8-13}	at input voltage V_{9-13} = 1.6V		3.2		V
V_{8-13}	V_{9-13} = 4.8V		4.8		V
V_{8-13}	V_{9-13} = 8V		6.4		V
Output Q (Pin 3)					
V_{OH}	Output voltage HIGH at $-I_{OH}$ = 150mA	10			V
$-I_{OH}$	Output current HIGH			150	mA
Internal pull-down resistor R_{PD} (Pin 1)					
R_{PD}	Resistance to V_{EE}	1	1.5	3	kΩ

FUNCTIONAL DESCRIPTION

The TDA1023 generates pulses to trigger a triac. These trigger pulses coincide with the zero crossings of the mains voltage. This minimizes RF interference and transients on the mains supply. The trigger pulses come in bursts, with the net effect that the load is periodically switched on and off. This further minimizes mains pollution. The average power in the load is varied by varying the duration of the trigger pulse burst in accordance with the voltage difference between the control input CI and the reference input, either UR or BR.

Power Supply: V_{CC}, RX and V_Z (Pins 14, 16, and 11)

The TDA1023 is supplied from the AC mains via resistor R_D to the RX connection (Pin 16), while the V_{EE} connection (Pin 13) is connected to the neutral line (see Figure 5). A smoothing capacitor C_S has to be connected between the V_{CC} and V_{EE} connections.

The circuit contains a string of stabilizer diodes between the RX and V_{EE} connections that limit the DC supply voltage and a rectifier diode between the RX and V_{CC} connections (see Figure 1).

At Pin 11 the device provides a stabilized reference voltage V_Z for an external temperature sensing bridge.

The operation of the supply arrangement is as follows. During the positive half of the mains cycles the current through external voltage dropping resistor R_D charges the external smoothing capacitor C_S until RX reaches the stabilizing voltage of the internal stabilizer diodes. R_D should be chosen such that it can supply the current I_{CC} for the TDA1023 itself plus the average output current $I_{3(AV)}$ plus the current required from the V_Z connection for an external temperature bridge, and recharge the smoothing capacitor C_S (see Figures 7 to 10). Any excess current is bypassed by the internal stabilizer diodes. Note that the maximum rated supply current must not be exceeded.

During the negative half of the mains cycles, external smoothing capacitor C_S has to supply the sum of the currents mentioned above. Its capacitance must be high enough to maintain the supply voltage above the minimum specified limit.

Dissipation in resistor R_D is halved by connecting a diode in series (see Figures 2 and 7 to 10).

A further reduction of dissipation is possible by using a high-quality voltage dropping capacitor C_D in series with a resistor R_{SD} (see Figures 2 and 12). A suitable VDR connected across the mains provides protection of the TDA1023 and of the triac against mains-borne transients.

Control and Reference Inputs CI, BR and UR (Pins 6, 9, and 7)

For room temperature control (5°C to 30°C) the best performance is obtained by using the translation circuit. The buffered reference input BR (Pin 9) is used as a reference input, and the output of the reference buffer QR (Pin 8) is connected to the unbuffered reference input UR (Pin 7). In this arrangement, the translation circuit ensures that most of the potentiometer rotation can be used to cover the room temperature range. This provides an accurate temperature setting and a linear temperature scale.

If the translation circuit is not required, the unbuffered reference input UR (Pin 7) is used as a reference input. The buffered reference input BR (Pin 9) must be connected to the reference supply output V_Z (Pin 11).

For proportional power control the unbuffered reference input UR (Pin 7) must be connected to the firing burst repetition time control input TB (Pin 12), and the buffered reference input BR (Pin 9), which is inactive now, must be connected to the reference supply output V_Z (Pin 11).

In all arrangements, the train of output pulses becomes longer when the voltage at the control input CI (Pin 6) becomes lower.

Proportional Range Control Input PR (Pin 5)

With the proportional range control input PR open, the output duty factor changes from 0% to 100% by a variation of 80mV at the control input CI (Pin 6). For temperature control, this corresponds with a temperature difference of only 1k.

This range may be increased to 400mV, i.e., 5k, by connecting the proportional range control input PR (Pin 5) to ground. Intermediate values are obtained by connecting the PR input to ground via a resistor R5 (see Table 1).

Hysteresis Control Input HYS (Pin 4)

With the hysteresis control input HYS (Pin 4) open, the device has a built-in hysteresis of 20mV. For temperature control this corresponds with 0.25k.

Hysteresis is increased to 320mV, corresponding with 4k, by grounding HYS (Pin 4). Intermediate values are obtained by connecting Pin 4 to ground via a resistor R4. See Table 1 for a set of values for R4 and R5 giving a fixed ratio between hysteresis and proportional range.

Trigger Pulse Width Control Input PW (Pin 10)

The trigger pulse width may be adjusted to the value required for the triac by choosing the value of the external synchronization resistor R_S between the trigger pulse width control input PW (Pin 10) and the AC mains.

The pulse width is inversely proportional to the input current (see Figure 11).

Output Q (Pin 3)

Since the circuit has an open-emitter output, it is capable of sourcing current; i.e., supplying a current out of the output. Therefore, it is especially suited for generating positive-going trigger pulses. The output is current-limited and protected against short-circuits. The maximum output current is 150mA and the output pulses are stabilized at 10V for output currents up to that value.

A gate resistor R_G must be connected between the output Q and the triac gate to limit the output current to the minimum required by the triac (see Figures 3 to 6). This minimizes the total supply current and the power dissipation.

Pull-Down Resistor R_{PD} (Pin 1)

The TDA1023 includes a 1.5kΩ pull-down resistor R_{PD} between Pins 1 and 13 (V_{EE}, ground connection), intended for use with sensitive triacs.

Table 1. Adjustment of Proportional Range and Hysteresis. Combinations of Resistor Values Giving Hysteresis > ¼ Proportional Range

PROPORTIONAL RANGE (mV)	PROPORTIONAL RANGE RESISTOR R5 (kΩ)	MINIMUM HYSTERESIS (mV)	MAXIMUM HYSTERESIS RESISTOR R4 (kΩ)
80	Open	20	Open
160	3.3	40	9.1
240	1.1	60	4.3
320	0.43	80	2.7
400	0	100	1.8

Table 2. Timing Capacitor C_T Values (Electrolytic Capacitors)

EFFECTIVE DC VALUE (μF)	MARKED AC SPECIFICATION	
	μF	V
68	47	25
47	33	40
33	22	25
22	15	40
15	10	25
10	6.8	40

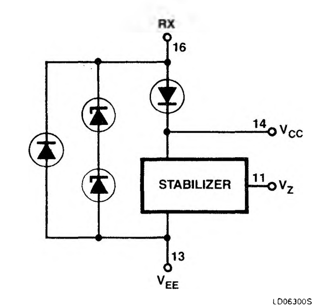


Figure 1. Internal Supply Connections

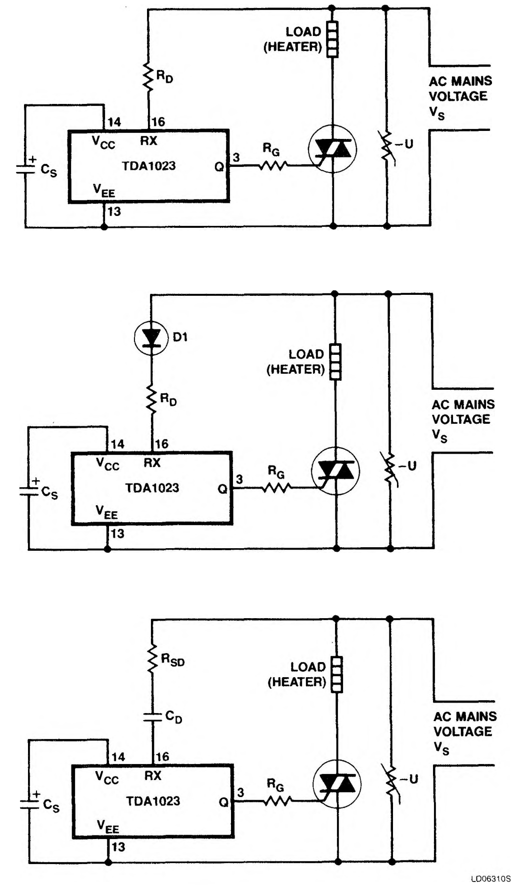


Figure 2. Alternative Supply Arrangements

Time-Proportional Triac Trigger TDA1023

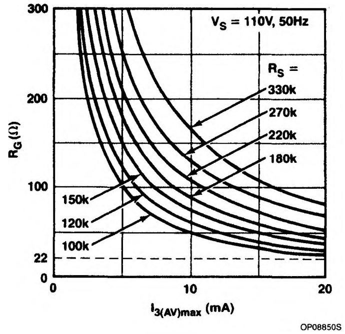


Figure 3

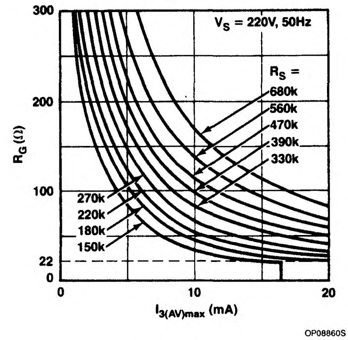


Figure 4

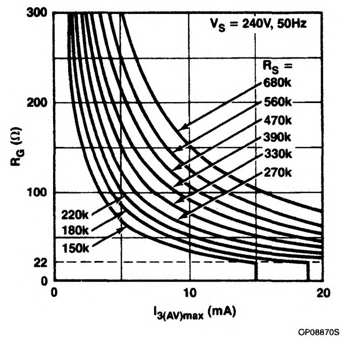


Figure 5

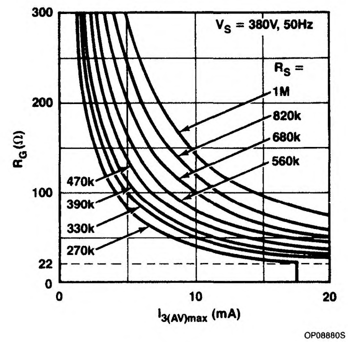


Figure 6

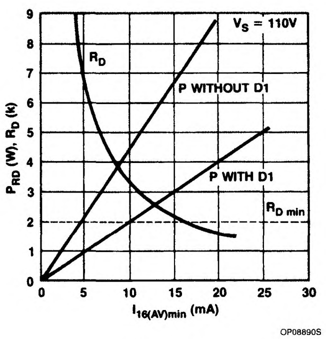


Figure 7

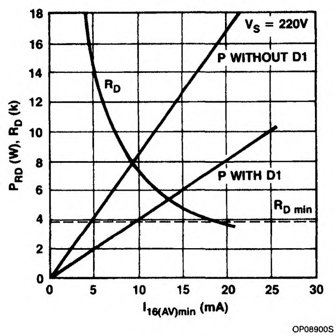


Figure 8

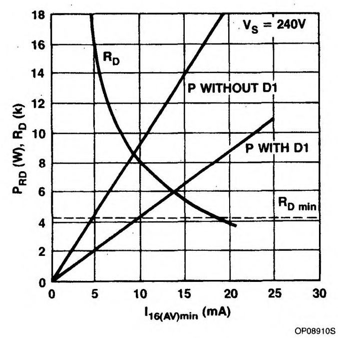


Figure 9

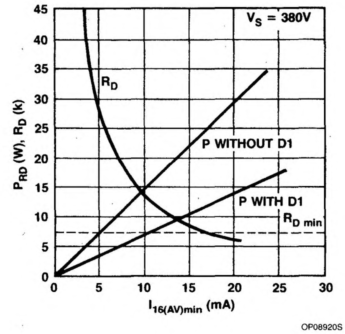


Figure 10

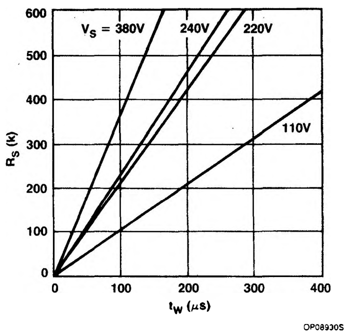


Figure 11

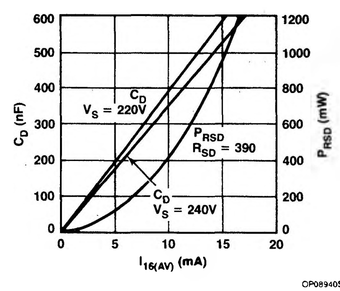


Figure 12. Nominal Value of Voltage Dropping Capacitor C_D and Power P_{RSD} Dissipated in Voltage Dropping Resistor R_{SD} as a Function of the Average Supply Current $I_{16(AV)}$ with the Mains Supply Voltage V_S as a Parameter

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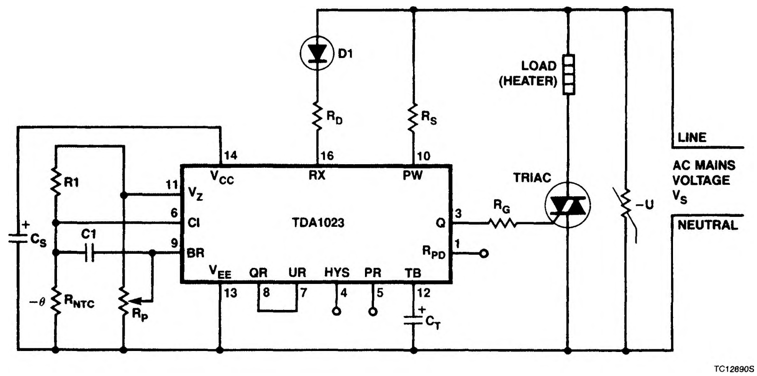

NOTE:
Mains supply: V_S = 220V
Temperature range = 5 to 30°C

BT139 data: V_{GT} < 1.5V; I_{GT} > 70mA; I_L < 60mA } at T_J = 25°C

Figure 13. The TDA1023 Used in a 1200 to 2000W Heater With Triac BT139. For Component Values see Table 3

Table 3. Temperature Controller Component Values (see Figure 13)

SYMBOL	PARAMETER	VALUE	REMARKS
t_W	Trigger pulse width	75μs	See BT139 data sheet
R_S	Synchronization resistor	180kΩ	See Figure 11
R_G	Gate resistor	110Ω	See Figure 4
$I_{3(AV)}$	Maximum average gate current	4.1mA	See Figure 6
R4	Hysteresis resistor	NC	See Table 1
R5	Proportional band resistor	NC	See Table 1
$I_{16(AV)}$	Minimum required supply current	11.1mA	
R_D	Mains dropping resistor	6.2kΩ	See Figure 8
P_{RD}	Power dissipated in R_D	4.6W	See Figure 8
C_T	Timing capacitor (eff. value)	68μF	See Table 2
VDR	Voltage-dependent resistor	$250V_{AC}$	Cat. no. 2322 593 62512
D1	Rectifier diode	BYW56	
R1	Resistor to Pin 11	18.7kΩ	1% tolerance
R_{NTC}	NTC thermistor (at 25°C)	22kΩ	B = 4200k Cat. no. 2322 642 12223
R_P	Potentiometer	22kΩ	
C1	Capacitor between Pins 6 and 9	47nF	
C_S	Smoothing capacitor	220μF; 16V	
If R_D and D1 are replaced by C_D and R_{SD}			
C_D	Mains dropping capacitor	470nF	}
R_{SD}	Series dropping resistor	390Ω	}
P_{RSD}	Power dissipated in R_{SD}	0.6W	}
VDR	Voltage-dependent resistor	$250V_{AC}$	Cat. no. 2322 594 62512