MOTOROLA

TDA1285A

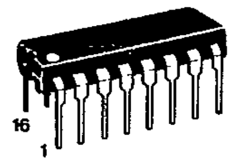
MOTOR SPEED CONTROLLER

The TDA1285A has all the necessary functions for the speed control of universal motors in a closed loop configuration. Directly driven from the ac line, the circuits generate a phase angle varied trigger pulse to the control triac. In addition it provides the following features:

- Full Wave Triac Drive
- Repeated Trigger Pulse if Triac Fails to Latch
- Over 65 mA Output Pulse Current
- Automatic Adaptation to Inductive or Hall Effect Sensors
- Sensor Circuit Continuity Detection
- Motor Current Limitation
- Controlled Motor Starting Acceleration
- Typical 1–2% Motor Speed Variation Within All Temperature and Load Ranges

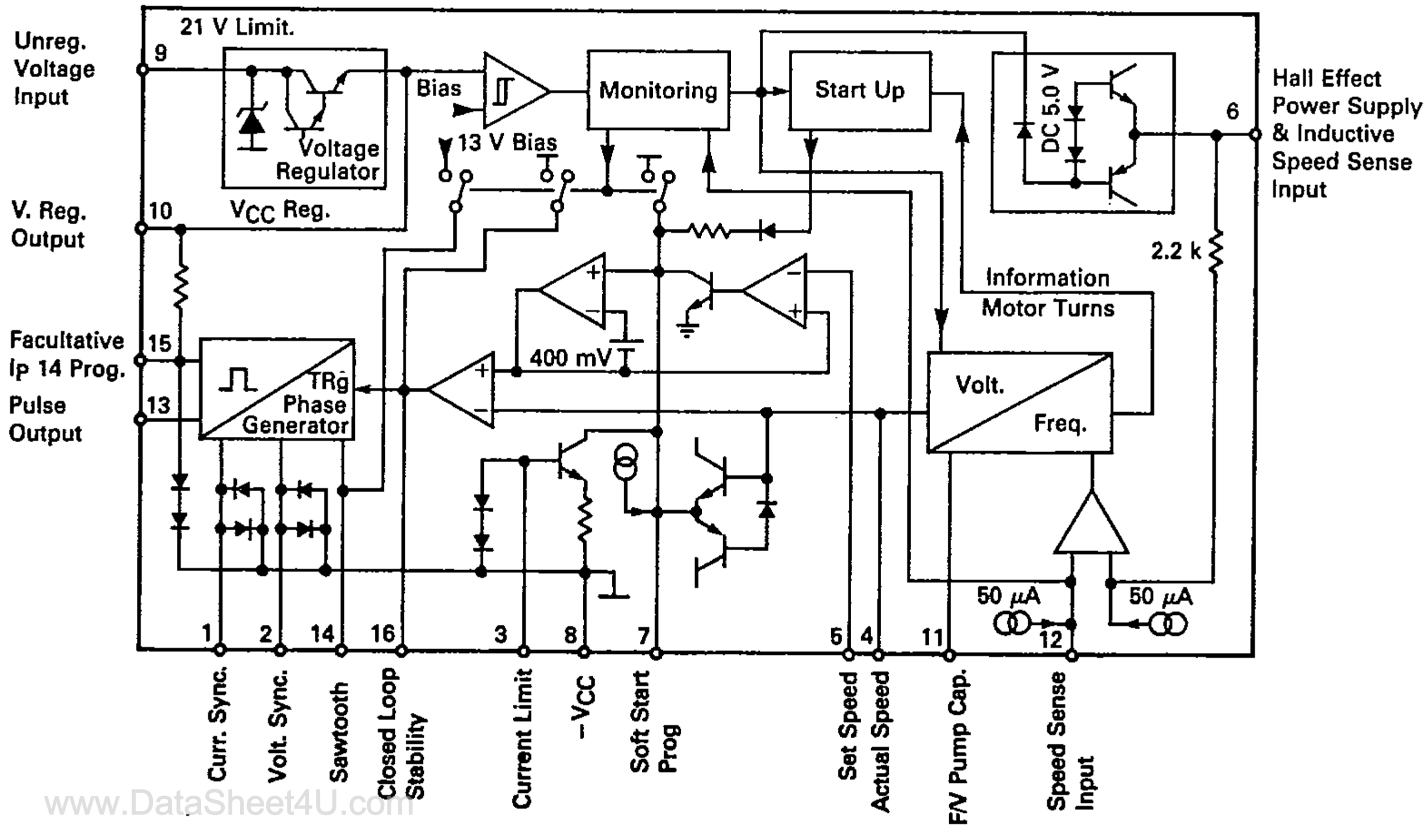
UNIVERSAL MOTOR SPEED CONTROLLER

SILICON MONOLITHIC INTEGRATED CIRCUIT



PLASTIC PACKAGE
CASE 648-06

FIGURE 1 — BLOCK DIAGRAM AND PIN ASSIGNMENT



MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Supply Current	$I_{Pin\ 9\ RMS}$	20	mA
Peak Supply Current, t < 250 μs	$I_{Pin\ 9\ PEAK}$	200	mA
Regulated Supply Current Drain	$I_{Pin\ 10}$	10	mA
Peak ac Synchronization Input Currents	$I_{Pin\ 1}$ $I_{Pin\ 2}$	±2.0 ±2.0	mA mA
Current Drain per Listed Pin	I_3	−1.0 +2.0	mA
	I_{12}	+500 −4.0	μA mA
	I_6	−7.0 +1.0	mA
	I_{15}	+1.0	mA
Pin 3 Reverse Voltage	$V_{Pin\ 3}$	−5.0	V
Power Dissipation (T_A = 25°C) Derate above 25°C	P_D $1/R_{\theta JA}$	625 6.8	mW mW/°C
Operating Temperature Range	T_A	0 to 70	°C
Storage Temperature Range	T_{stg}	−55 to +125	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Power Supply					
Zener Regulated Voltage, $I_{Pin\ 9}$ = 20 mA	$V_{Pin\ 9}$	19	20.5	23	V
Regulated Supply Voltage (Pin 10) $I_{Pin\ 10}$ = 0; $I_{Pin\ 13}$ = 0; $I_{Pin\ 15}$ = 0 $I_{Pin\ 7}$ = 0; $V_{Pin\ 9}$ = 18 V	V_{CC}	13.6	14.6	15.6	V
Current Consumption ($I_{Pin\ 9}$) $I_{Pin\ 6}$ = 0; $I_{Pin\ 13}$ = 0; $I_{Pin\ 10}$ = 0 $I_{Pin\ 15}$ = 0; $I_{Pin\ 7}$ = 0; $V_{Pin\ 9}$ = 18 V	I_{CC}	—	4.5	7.0	mA
Speed Reference					
Reference Input Voltage Range	$V_{Pin\ 5}$	0	—	12	V
Reference Input Bias Current ($V_{Pin\ 5}$: 0 to +12 V)	$I_{Pin\ 5}$	−2.0	—	0	μA
Frequency to Voltage Converter					
Inductive Sensor Application Range	$I_{Pin\ 6}$	−2.5	—	0	mA
Hall-Effect Sensor Application Range	$I_{Pin\ 6}$	−8.0	—	−3.5	mA
Maximum Input Signal Voltage	$V_{Pin\ 12} - V_{Pin\ 6}$	−5.0	—	+5.0	V
Common-Mode Reference Voltage	$V_{Pin\ 6}$	—	5.0	—	V
Polarization Current (−5.0 V < $V_{Pin\ 12} - V_{Pin\ 6}$ < +5.0 V)	$I_{Pin\ 12}$	—	−50	—	μA
Threshold Hysteresis Voltage (See Figure 4)	$(V_{Sensor} - V_{Pin\ 6})_{THRS}$	—	±60	—	mV
Floating Input Voltage ($I_{Pin\ 12}$ = 0)	$V_{Pin\ 12}$	12	—	—	V
Main Comparator					
Output Voltage Range ($I_{Pin\ 16}$ = 0)	$V_{Pin\ 16}$	—	0; +12	—	V
Output Current Swing	$I_{Pin\ 16}$	—	±100	—	μA
Transconductance ($I_{Pin\ 7}$ = 0; $I_{Pin\ 10}$ = 0; $V_{Pin\ 16}$ = 5.2 V)	$\frac{\Delta I_{Pin\ 16}}{\Delta V_{Pin\ 4}}$	140	205	265	μA/V
Output Resistance	$R_{out\ Pin\ 16}$	—	10^6	—	Ω
Offset Voltage ($I_{Pin\ 7}$ = 0; $I_{Pin\ 16}$ = 0; $V_{Pin\ 16}$ = 5.0 V)	$V_{Pin\ 5} - V_{Pin\ 4}$	−20	0	+20	mV

ELECTRICAL CHARACTERISTICS (continued)

Characteristic	Symbol	Min	Typ	Max	Unit
Current Limitation					
Detection Level	$V_{Pin\ 3\ Min.}$	—	0.65	—	V
Clamping Voltage Level	$V_{Pin\ 3\ CLAMP}$	—	1.3	—	V
Output Discharge Current	I_{DL7}	—	0.5	—	mA
Saturation Resistance	$R_{sat\ Pin\ 7}$	—	1.6	—	kΩ
Start-up					
Maximum Start-up Voltage ($I_{Pin\ 7}$ = 0)	$V_{Pin\ 7}$	—	4.5	—	V
Start-up Current (until motor turns) ($_{Pin\ 7}$ = 0)	$I_{Pin\ 7}$	—	−1.0	—	mA
Soft-Start					
Acceleration Charging Current	$I_{Pin\ 7}$	—	−8.0	—	μA
Trigger Pulse Generator					
Trigger Pulse Width*	tp	—	100	—	μs
Trigger Pulse Repetition Period*	t	—	600	—	μs
Output Pulse Current ($V_{Pin\ 13}$ = 1.0 V)	$I_{Pin\ 13}$	−70	—	−65	mA
Output Leakage Current ($V_{Pin\ 13}$ = −2.0 V)	$I_{o\ Pin\ 13}$	—	—	10	μA
Current Synchronization Threshold Levels (Pin 1 and Pin 2)	I_{Thrs}	—	±80	—	μA
Sawtooth Current Generator	$I_{Pin\ 14}$	—	−65	—	μA
Pin 15 Voltage ($I_{Pin\ 15}$ = 0)	$V_{Pin\ 15}$	—	1.3	—	Volt

* These figures apply for the application shown in this data sheet.

CIRCUIT DESCRIPTION

The TDA1285A generates trigger pulses for a triac controlling the power into an ac motor connected to a line voltage. The firing angle of the triac is determined by comparison between a sawtooth signal (line voltage synchronized) and the main internal comparator signal. The latter is the difference between a set voltage (externally adjustable) representing the reference speed and the actual motor speed issued from an external sensor and converted by an internal frequency to voltage converter. This sensor may be inductive (tachometer) or Hall-effect. Other functions are also provided by the TDA1285A.

DC POWER SUPPLY

DC Power is directly derived from the ac line by a low cost resistor-rectifier-capacitor circuit. The voltage on Pin 9 is Zener protected. The voltage on Pin 10 is fully regulated by a series ballast regulator, but is not self-limiting. Special provisions for Hall-effect sensor power are included.

TACHOMETER INPUT (Pins 6 and 12)

The maximum allowable voltage swing is -5.0 to $+5.0$ V. Circuit continuity is permanently checked by the monitor.

HALL-EFFECT INPUT (Pins 6 and 12)

When $I_{Pin\ 6}$ exceeds 3.0 mA, the circuit detects the use of a Hall-effect sensor and thus sensor circuit continuity is not checked (an open circuit would provide full triac conduction angle).

FREQUENCY TO VOLTAGE CONVERTER

This circuit converts the tachometer input frequency into a proportional voltage on Pin 4 (eventually usable for any feedback). Particular care must be devoted to the conversion ratio of the F/V converter which is under the user control. In effect, it depends on the values of the C_{11} capacitor and on tachometer frequency f(Hz).

$$V_{Pin\ 4} = 1.410 \times 10^{-10} \times C_{11}\,(pF) \times R_4 \times F(Hz) \times (1 \pm 0.15)$$

$V_{Pin\ 4}$ corresponding to maximum allowed motor speed must be chosen as close as possible to 12 V in order to minimize noise disturbance down to a negligible level.

MAIN COMPARATOR

Its role is to amplify the signal error. Negative feedback from the output (Pin 16) to the input may be used to reduce the closed loop gain of the system and increase stability.

SOFT START (Pin 7)

Set speed input (Pin 5) is overruled by similar data from Pin 7 as long as $V_{Pin\ 7}$ is smaller than $V_{Pin\ 5}$ + 400 mV (Typ). An internal 8.0 μA current source allows an external capacitor, C_7 to be charged slowly and thus lets the ac motor soft start (Figure 2). Pin 4 offset may be set appropriately by an external resistor (R_1 = 1 MΩ). Notice that R_1 may affect F/V conversion ratio. An external 10 nF capacitor on Pin 5 reduces noise sensitivity.

START-UP CIRCUIT

From the moment power is applied to the circuit (or the circuit is enabled by Monitoring) to the moment a speed input signal is detected, C_7 is charged at a high current level (typically 1.0 mA). Detection of the first tachometer input resets the Pin 7 current to its nominal value (8.0 μA). The result of such a circuit is to start the acceleration ramp at the moment the motor starts to turn, avoiding any dead time (see Figure 2). When the motor is cycled on and off in close succession, the acceleration ramp is started immediately without waiting for the motor to stop.

MOTOR CURRENT LIMITATION (Pin 3)

The motor current is sensed as a voltage developed across a resistor (R_3) in series with the triac. The limiter acts on positive peak values of $R_3 \times I$ filtered by a 22 k and 0.1 μF, RC network (Figure 7). The motor current is reduced, decreasing its speed reference by discharging C_7 until current limit equilibrium is reached (see Figure 3).

TRIGGER PULSE GENERATOR

It delivers a 65 mA min. current pulse to the triac gate and repeats it if the triac fails to latch or if brush bounce has switched it off (Figure 6). Current and voltage detection through the triac are performed by Pins 1 and 2, delaying the trigger pulse until the triac current collapses. The pulse time is determined by the comparison of a sawtooth signal (available at Pin 14 and synchronous with line voltage) and the error signal directly supplied by the comparator.

Sawtooth slope is determined by the external capacitor C_{14}. Under these conditions pulse width is typically 100 μs (Figure 5).

MONITORING

This is an internal function, disabling the circuit when
- V_{CC} is insufficient
- Tachometer circuit is open and $I_{Pin\ 6} < |-3.0\ mA|$

FIGURE 2 — START-UP AND SOFT-START CIRCUIT ACTIONS

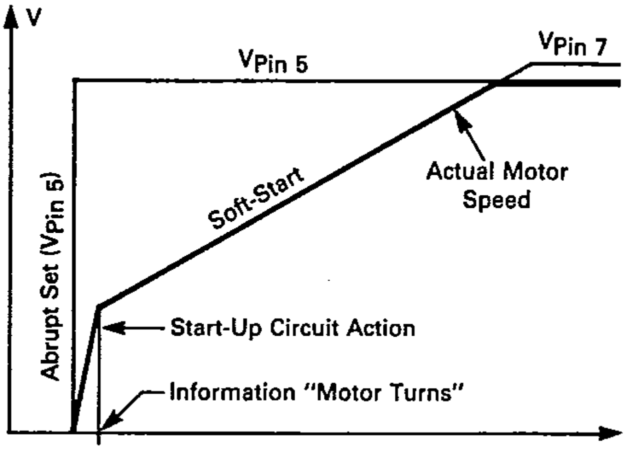


FIGURE 3 — CURRENT LIMITATION

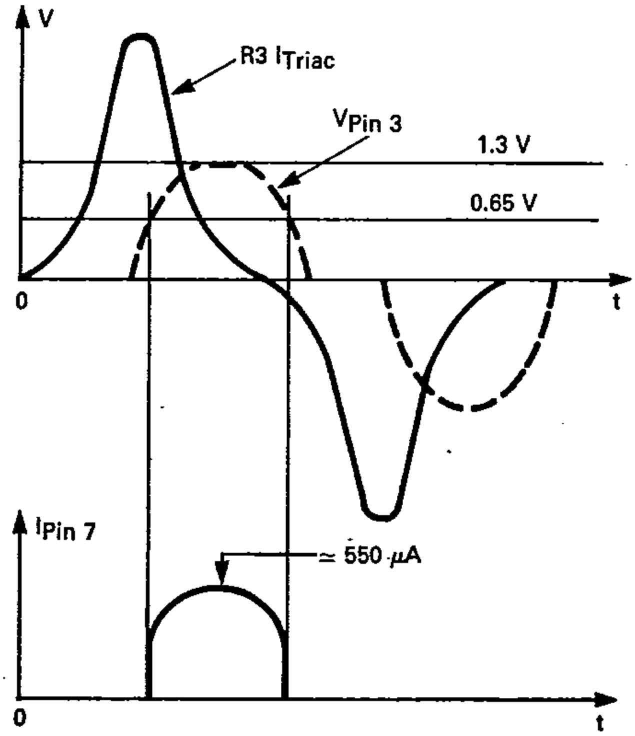
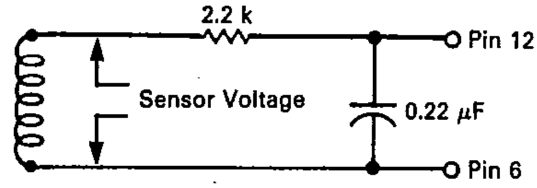


FIGURE 4 — SENSOR VOLTAGE DEFINITION



2.2 k is a recommended value to balance the voltage offset caused by sensor continuity detection circuit.

FIGURE 5 — FIRING PULSE GENERATION

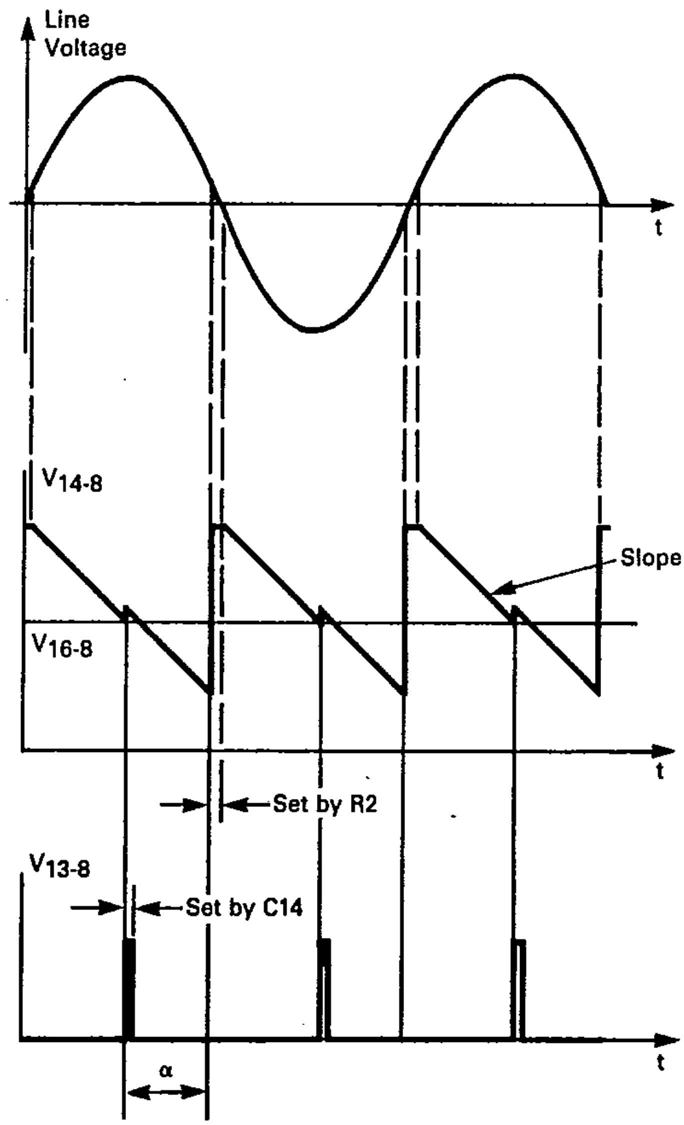
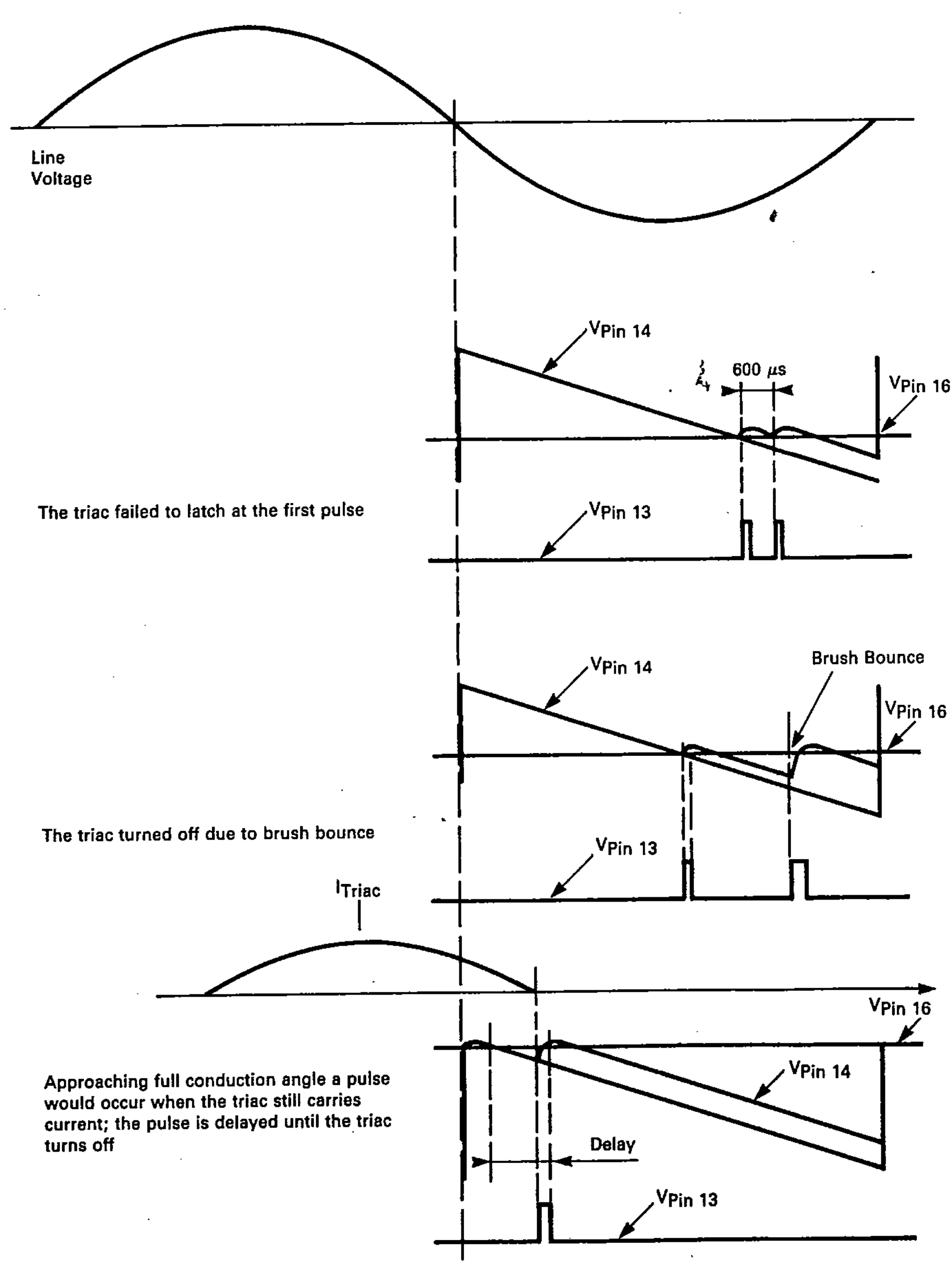


FIGURE 6 — MULTIPLE FIRING PULSE AND FIRING PULSE DELAY



TYPICAL APPLICATION CIRCUITS

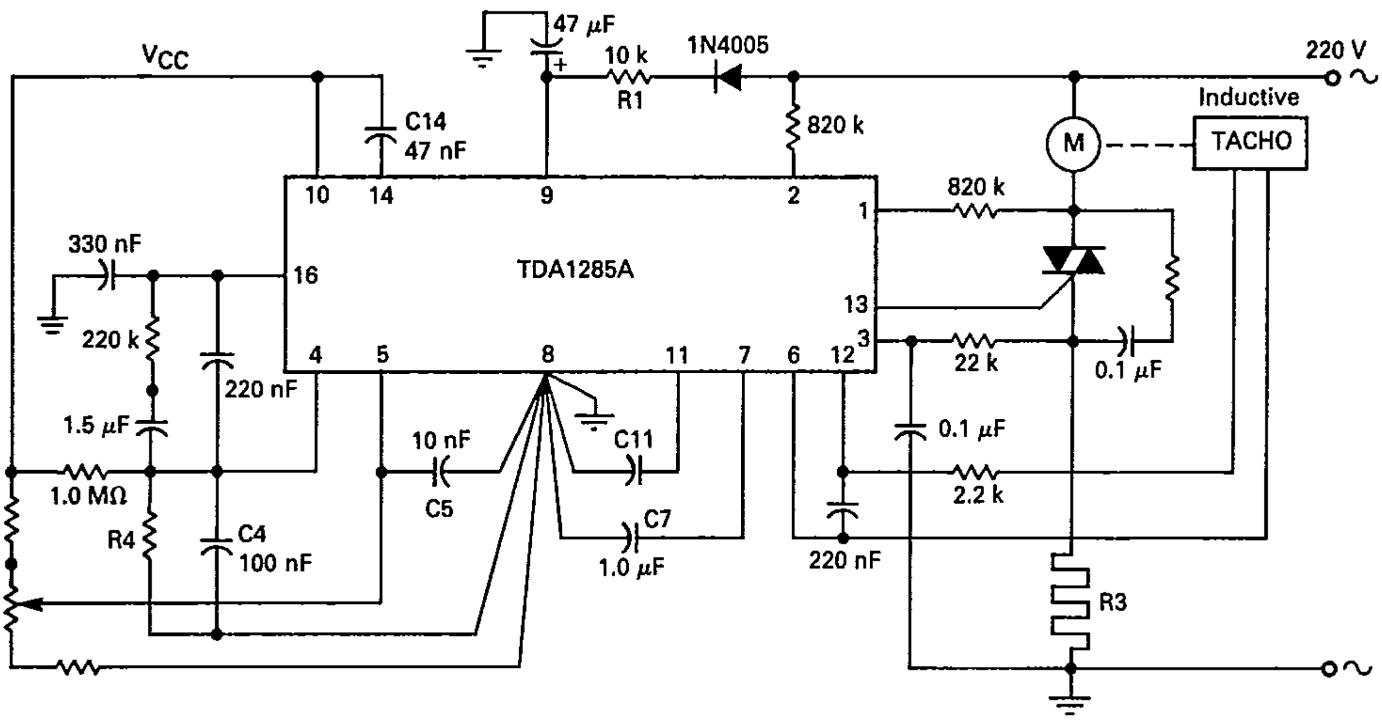
A motor control circuit using tachometer as speed sensor. It provides speed regulation as follows:

- ±1.0% from 20 to 70°C
- 1.0% in full load range.

It is strictly recommended to design the PC board in order to plug every connection to ground (Pin 8) directly and individually; otherwise, violent erratic currents may induce high level noise in the circuitry.

Motor will run full speed in case of tacho open circuit if a 47 k resistor is connncted permanently between Pins 6 and 12.

FIGURE 7 — MOTOR CONTROL CIRCUIT



NOTES:

Frequency to Voltage converter

— Max. motor speed 30,000 rpm

— Tachogenerator 4 pairs of poles: max. frequency $= \frac{30,000}{60} \times 4 = 2$ kHz

— C11 = 680 pF. R4 adjusted to obtain $V_{Pin\ 4} = 12$ V at max. speed: 68 kΩ

— Power Supply
with $V_{mains} = 120$ Vac, $R_1 = 4.7$ kΩ. Perfect operation will occur down to 80 Vac.

FIGURE 8 — CIRCUIT MODIFICATIONS TO CONNECT A HALL-EFFECT SENSOR