

# DATA SHEET

**TDA3601Q**

**TDA3601AQ**

**Multiple output voltage regulators**

Product specification  
Supersedes data of September 1994  
File under Integrated Circuits, IC01

1995 Dec 13

## Multiple output voltage regulators

**TDA3601Q**  
**TDA3601AQ**

### FEATURES

- Six fixed voltage regulators
- Three microprocessor-controlled regulators
- Two  $V_P$ -state controlled regulators
- One fixed voltage regulator (can operate during load dump or thermal shutdown)
- $V_{P1}$  supply pin (low current pin)
- $V_{P2}$  supply pin (high current pin)
- RESET output (TDA3601Q) or  $\overline{\text{RESET}}$  output (TDA3601AQ)
- Internally fixed timer of 100  $\mu\text{s}$
- Externally fixed delay timer
- High ripple rejection
- Flexible leads.

### PROTECTION

- Current limit protection for regulator 1
- Foldback current limit protection (regulators 2 to 6)
- Load dump protection
- Thermal protection
- Regulator outputs DC short-circuit-safe to ground,  $V_P$  and other regulator outputs
- Capable of handling high energy on any of the output pins
- Reverse polarity safe.

### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Entire device</b>						
$V_{P1}$	supply voltage range	operating	11	13.2	18	V
		load dump; notes 1 and 2	–	–	50	V
$V_{P2}$	supply voltage range	operating	11	13.2	18	V
		non-operating	–	–	30	V
		load dump; note 1	–	–	50	V
$I_{\text{tot}}$	total quiescent current, $V_{P1}$	$V_{P2} = 0$ ; note 3	–	1	1.4	mA
$T_c$	crystal temperature		–	–	150	$^{\circ}\text{C}$
<b>Voltage regulators</b>						
$V_{R1}$	output voltage regulator 1	$0.5 \text{ mA} \leq I_{R1} \leq 20 \text{ mA}$	4.75	5	5.25	V
$V_{R2}$	output voltage regulator 2	$5 \text{ mA} \leq I_{R2} \leq 200 \text{ mA}$	1.9	2.1	2.3	V
$V_{R3}$	output voltage regulator 3	$5 \text{ mA} \leq I_{R3} \leq 150 \text{ mA}$	4.75	5	5.25	V
$V_{R4}$	output voltage regulator 4	$5 \text{ mA} \leq I_{R4} \leq 150 \text{ mA}$	9	9.5	10	V
$V_{R5}$	output voltage regulator 5	$5 \text{ mA} \leq I_{R5} \leq 200 \text{ mA}$	9	9.5	10	V
$V_{R6}$	output voltage regulator 6	$5 \text{ mA} \leq I_{R6} \leq 200 \text{ mA}$	9.3	9.75	10.2	V

### Notes

1. Load dump, during 50 ms,  $t_r > 2.5 \text{ ms}$ .
2. Regulator 1 operating,  $0.5 \text{ mA} \leq I_{R1} \leq 20 \text{ mA}$ .
3.  $V_{P1} = 13.2 \text{ V}$ ;  $V_{P2} = R4\text{-sel} = R5\text{-sel} = 0$ ;  $I_{R1} = 0$ .

# Multiple output voltage regulators

**TDA3601Q**  
**TDA3601AQ**

## BLOCK DIAGRAM

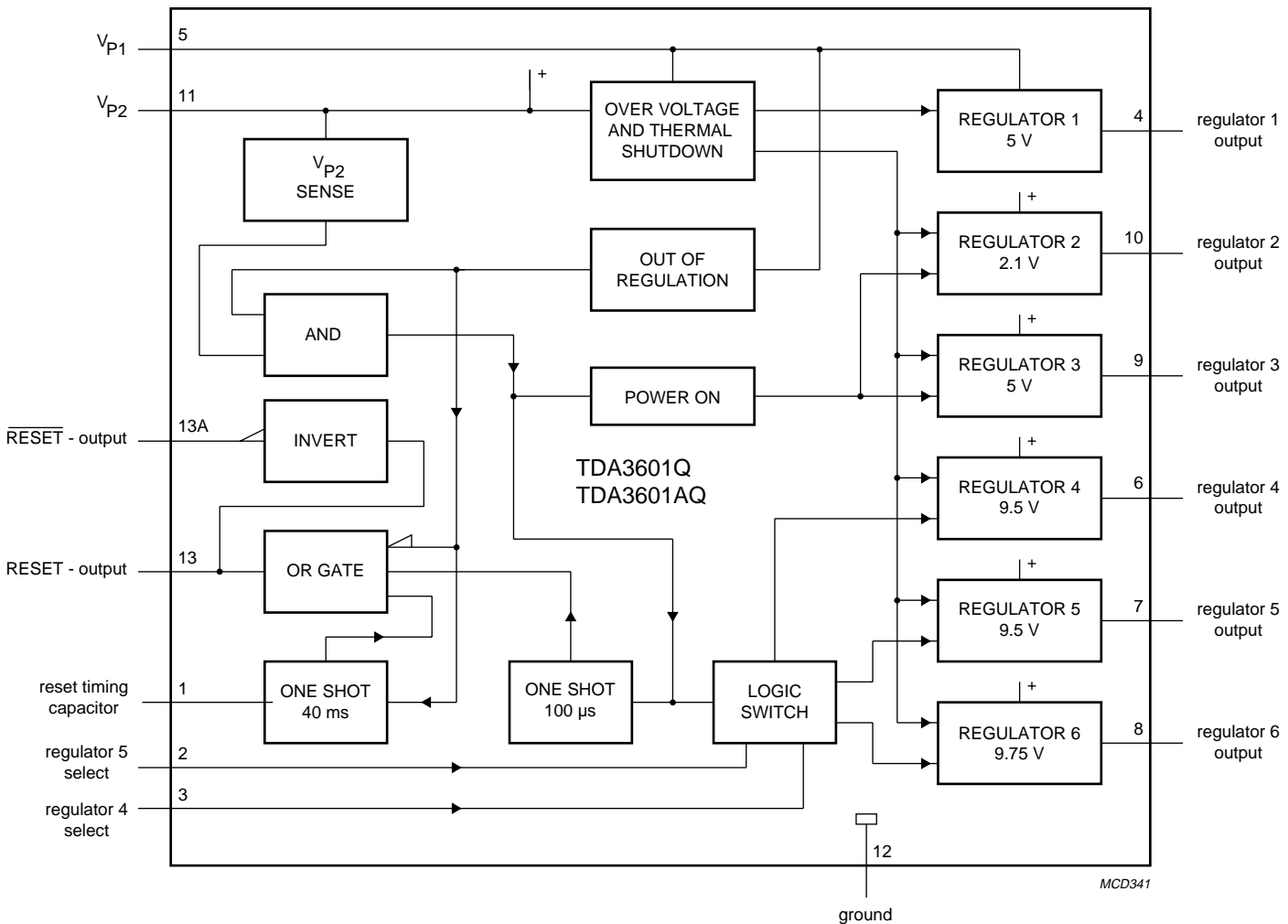


Fig.1 Block diagram.

# Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

## ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA3601Q	DBS13P	plastic DIL-bent-SIL power package; 13 leads (lead length 12 mm)	SOT141-6
TDA3601AQ			

## GENERAL DESCRIPTION

The circuit contains five fixed voltage regulators with foldback current protection and one fixed voltage regulator (REGULATOR 1) that also operates during a load dump. In addition, a RESET function (TDA3601Q) or  $\overline{\text{RESET}}$  function (TDA3601AQ), timer functions and a logic multiplexer are implemented.

## PINNING

SYMBOL	PIN	DESCRIPTION
$C_{\text{RESET}}$	1	reset timing capacitor
R5-sel	2	regulator 5 select
R4-sel	3	regulator 4 select
REG1	4	regulator 1 output (5 V)
$V_{P1}$	5	supply voltage
REG4	6	regulator 4 output (9.5 V)
REG5	7	regulator 5 output (9.5 V)
REG6	8	regulator 6 output (9.75 V)
REG3	9	regulator 3 output (5 V)
REG2	10	regulator 2 output (2.4 V)
$V_{P2}$	11	supply voltage
GND	12	ground
RES	13	RESET output (TDA3601Q)
$\overline{\text{RES}}$	13A	$\overline{\text{RESET}}$ output (TDA3601AQ)

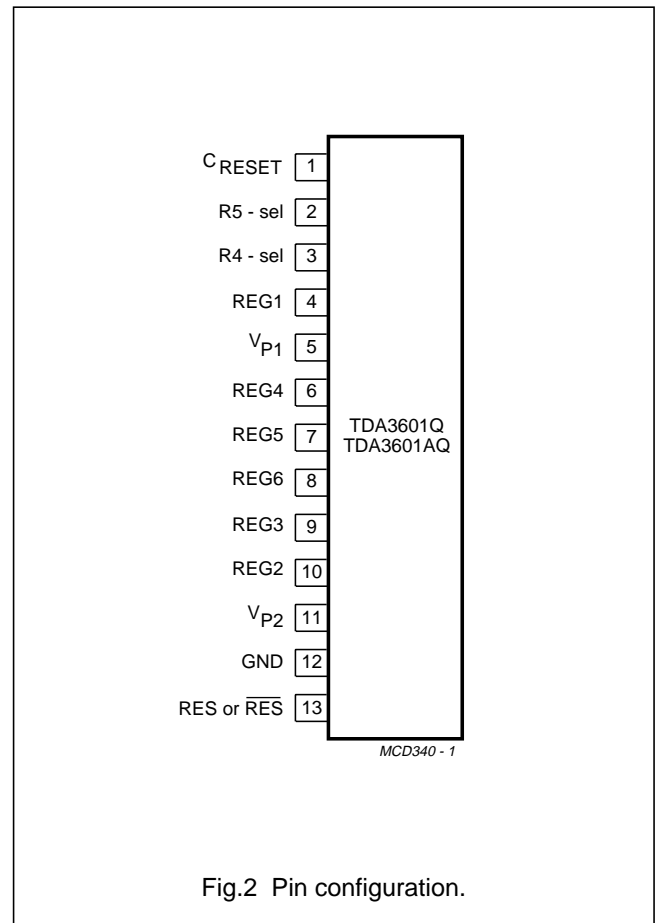


Fig.2 Pin configuration.

## Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

### FUNCTIONAL DESCRIPTION

The TDA3601Q is a multiple output voltage regulator with six fixed voltage regulators. Three, logical switch controlled, voltage regulators (numbers 4 to 6) are available, and one non-switchable voltage regulator (number 1). In addition, there are two further regulators (numbers 2 and 3), which are controlled by supply voltages  $V_{P1}$  and  $V_{P2}$  (Schmitt trigger).

Regulator 1 is not affected by load dump or thermal shutdown. Regulators 2 to 6 are supplied by  $V_{P2}$ ; they can therefore be switched off by an ignition switch, for example. An internal bandgap voltage reference, which provides a reference voltage for each independent regulator, is supplied by  $V_{P1}$ . This supply voltage  $V_{P1}$  also supplies regulator 1.

A  $V_{P2}$  sense circuit outputs a logical high when the  $V_{P2}$  voltage rises through  $V_{thr}$ , which remains high until the  $V_{P2}$  voltage falls through  $V_{thf}$ .

The supply voltage  $V_{P1}$  is sensed by an out-of-regulation Schmitt trigger.

When this voltage drops below 5.95 V typical, the reset output is disabled, to prevent a microprocessor being disturbed by a too-low supply voltage. An out-of-regulation condition is indicated by a logical low and an in-regulation condition indicated by a logical high.

The 'Power On' switch low will disable regulator 2 and 3 outputs. In addition, the logic switch will be disabled, so that regulators 4 to 6 are switched off. When both  $V_{P2}$ -sense and out-of-regulation are high, the 'Power On' will be high, so that the logic multiplexer and regulators 2 and 3 are enabled. Regulators 4 to 6 can now be selected by the multiplexer.

Re-triggerable one-shot circuits produce a RESET (open collector output) when  $V_{P1}$  is available (40 ms delay signal), or when both  $V_{P1}$  and  $V_{P2}$  are available (100  $\mu$ s pulse). RESET will be held in a constant high state when the supply voltage  $V_{P1}$  is less than 5.5 V (5.95 V typical).

The TDA3601 has a RESET output, but the TDA3601A has an inverted RESET output (RESET).

### LIMITING VALUES

In accordance with the Absolute maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{P1}, V_{P2}$	supply voltage	operating	–	18	V
		non-operating	–	30	V
		load dump protected; during 50 ms; $t_r > 2.5$ ms; note 1	–	50	V
$P_{tot}$	total power dissipation	$T_{case} < 30$ °C	–	15	W
$T_{stg}$	storage temperature range	non-operating	–55	150	°C
$T_{vj}$	virtual junction temperature	operating	–40	150	°C
$V_{pr}$	reverse polarity	non-operating	–	6	V

#### Note

- Regulator 1 operating,  $0.5 \text{ mA} \leq I_{R1} \leq 20 \text{ mA}$ .

### THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th j-c}$	thermal resistance from junction to case	8	K/W
$R_{th j-amb}$	thermal resistance from junction to ambient in free air	40	K/W

### QUALITY SPECIFICATION

Quality according to UZW-BO/FQ-0601.

## Multiple output voltage regulators

TDA3601Q  
TDA3601AQ**CHARACTERISTICS** $V_{P1} = V_{P2} = 13.2\text{ V}$ ,  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$ ,  $C_{\text{out}} = 10\text{ }\mu\text{F}$ ; unless otherwise specified (see Fig.5).

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>						
$V_{P1}$	supply voltage range	operating	11	13.2	18	V
$V_{P1}$	supply voltage range	load dump; notes 1 and 2	–	–	50	V
$V_{P2}$	supply voltage range	operating	11	13.2	18	V
$V_{P2}$	supply voltage range	load dump; note 1	–	–	50	V
$I_{P1}$	quiescent current	$V_{P2} = 0$ ; note 3	–	1.1	1.4	mA
<b>Schmitt triggers</b>						
V <sub>P2</sub> -SENSE THRESHOLD						
$V_{\text{thr}}$	rising threshold voltage		7.6	8	8.4	V
$V_{\text{thf}}$	falling threshold voltage		6.2	6.5	6.8	V
$V_{\text{hy}}$	hysteresis		1.35	1.5	1.65	V
OUT-OF-REGULATION THRESHOLD						
$V_{\text{thr}}$	rising threshold voltage		6.8	7.35	7.9	V
$V_{\text{thf}}$	falling threshold voltage		5.5	5.95	6.4	V
$V_{\text{hy}}$	hysteresis		1.2	1.4	1.6	V
<b>Reset circuits</b> (for timing, see Fig.3)						
$t_{\text{rst1}}$	reset delay time	$C_{\text{rst}} = 100\text{ nF}$	20	40	100	ms
$t_{\text{rst}}$	reset hold time		50	100	150	$\mu\text{s}$
$V_{\text{rl}}$	reset low	$I_{\text{sync}} = 1\text{ mA}$	–	0.15	0.8	V
$I_{\text{cr}}$	delay current (pin 1 to $C_{\text{rst}}$ )		–	–5	–	$\mu\text{A}$
$t_{\text{r}}$	reset rise time	note 4	–	–	1	$\mu\text{s}$
$t_{\text{f}}$	reset fall time	note 4	–	–	1	$\mu\text{s}$
$V_{\text{CAP}}$	voltage pin 1	$C_{\text{rst}} = 0$	5.5	6.0	–	V
$R_{\text{sp}}$	spike-on reset	on-state; note 5	–	0	100	mV
<b>Regulators</b>						
SELECTOR CONTROL INPUTS R4-SEL AND R5-SEL						
$V_{\text{sl}}$	input low voltage		–0.5	–	0.8	V
$V_{\text{sh}}$	input high voltage		2	–	–	V
$I_{\text{hs}}$	input high current	$V_{\text{RXsel}} > 2\text{ V}$	–	–	1	$\mu\text{A}$
$I_{\text{ls}}$	input low current	$V_{\text{RXsel}} < 0.8\text{ V}$	–1	–	–	$\mu\text{A}$

## Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
REGULATOR 1 ( $I_{R1} = 1 \text{ mA}$ UNLESS OTHERWISE SPECIFIED)						
$V_{R1}$	output voltage	$0.5 \text{ mA} \leq I_{R1} \leq 20 \text{ mA}$	4.75	5	5.25	V
		$6.25 \text{ V} \leq V_{P1} \leq 18 \text{ V}$	4.75	5	5.25	V
$V_{R1L}$	output voltage	$18 \text{ V} \leq V_P \leq 50 \text{ V}$	4.75	5	5.25	V
$\Delta V_{R1}$	line regulation	$6.25 \text{ V} \leq V_P \leq 18 \text{ V}$	–	–	50	mV
$\Delta V_{RL1}$	load regulation	$0.5 \text{ mA} \leq I_{R1} \leq 20 \text{ mA}$	–	–	60	mV
RR1	ripple rejection	$f_o = 120 \text{ Hz}$ ; $V_{P1} = V_{P2}$ ; note 6	60	–	–	dB
$V_{Rd1}$	drop-out voltage	$I_{R1} = 20 \text{ mA}$	–	–	1	V
$I_{Rm1}$	current limit		30	–	–	mA
$\Delta V/\Delta T$	thermal drift	$-40 \leq T \leq 80 \text{ }^\circ\text{C}$	–	tbn	–	mV/ $^\circ\text{C}$
REGULATOR 2 ( $I_{R2} = 5 \text{ mA}$ UNLESS OTHERWISE SPECIFIED)						
$V_{R2}$	output voltage	$5 \text{ mA} \leq I_{R2} \leq 200 \text{ mA}$	1.9	2.1	2.3	V
		$7 \text{ V} \leq V_P \leq 18 \text{ V}$	1.9	2.1	2.3	V
$\Delta V_{R2}$	line regulation	$7 \text{ V} \leq V_P \leq 18 \text{ V}$	–	–	50	mV
$\Delta V_{RL2}$	load regulation	$5 \text{ mA} \leq I_{R2} \leq 200 \text{ mA}$	–	–	70	mV
RR2	ripple rejection	$f_o = 120 \text{ Hz}$ ; $V_{P1} = V_{P2}$ ; note 6	60	–	–	dB
$I_{Rm2}$	current limit	$V_{R2} > 1.75 \text{ V}$ ; note 7	250	–	–	mA
$I_{Rsc2}$	short-circuit current	$R_L \leq 0.5 \text{ } \Omega$ ; note 7	–	tbn	–	mA
$\Delta V/\Delta T$	thermal drift	$-40 \leq T \leq 80 \text{ }^\circ\text{C}$	–	tbn	–	mV/ $^\circ\text{C}$
REGULATOR 3 ( $I_{R3} = 5 \text{ mA}$ UNLESS OTHERWISE SPECIFIED)						
$V_{R3}$	output voltage	$5 \text{ mA} \leq I_{R3} \leq 150 \text{ mA}$	4.75	5	5.25	V
		$7 \text{ V} \leq V_P \leq 18 \text{ V}$	4.75	5	5.25	V
$\Delta V_{R3}$	line regulation	$7 \text{ V} \leq V_P \leq 18 \text{ V}$	–	–	50	mV
$\Delta V_{RL3}$	load regulation	$5 \text{ mA} \leq I_{R3} \leq 150 \text{ mA}$	–	–	70	mV
RR3	ripple rejection	$f_o = 120 \text{ Hz}$ ; $V_{P1} = V_{P2}$ ; note 6	60	–	–	dB
$I_{Rm3}$	current limit	$V_{R3} > 4.5 \text{ V}$ ; note 7	200	–	–	mA
$I_{Rsc3}$	short-circuit current	$R_L \leq 0.5 \text{ } \Omega$ ; note 7	–	tbn	–	mA
$\Delta V/\Delta T$	thermal drift	$-40 \leq T \leq 80 \text{ }^\circ\text{C}$	–	tbn	–	mV/ $^\circ\text{C}$
REGULATOR 4 ( $I_{R4} = 5 \text{ mA}$ UNLESS OTHERWISE SPECIFIED)						
$V_{R4}$	output voltage	$5 \text{ mA} \leq I_{R4} \leq 150 \text{ mA}$	9	9.5	10	V
		$11 \text{ V} \leq V_P \leq 18 \text{ V}$	9	9.5	10	V
$\Delta V_{R4}$	line regulation	$11 \text{ V} \leq V_P \leq 18 \text{ V}$	–	–	50	mV
$\Delta V_{RL4}$	load regulation	$5 \text{ mA} \leq I_{R4} \leq 150 \text{ mA}$	–	–	70	mV
RR4	ripple rejection	$f_o = 120 \text{ Hz}$ ; $V_{P1} = V_{P2}$ ; note 6	60	–	–	dB
$V_{Rd4}$	drop-out voltage	$I_{R4} = 150 \text{ mA}$	–	–	1	V
$I_{Rm4}$	current limit	$V_{R4} > 8.5 \text{ V}$ ; note 7	200	–	–	mA
$I_{Rsc4}$	short-circuit current	$R_L \leq 0.5 \text{ } \Omega$ ; note 7	–	tbn	–	mA
$\Delta V/\Delta T$	thermal drift	$-40 \leq T \leq 80 \text{ }^\circ\text{C}$	–	tbn	–	mV/ $^\circ\text{C}$

## Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
REGULATOR 5 ( $I_{R5} = 5 \text{ mA}$ UNLESS OTHERWISE SPECIFIED)						
$V_{R5}$	output voltage	$5 \text{ mA} \leq I_{R5} \leq 200 \text{ mA}$	9	9.5	10	V
		$11 \text{ V} \leq V_P \leq 18 \text{ V}$	9	9.5	10	V
$\Delta V_{R5}$	line regulation	$11 \text{ V} \leq V_P \leq 18 \text{ V}$	–	–	50	mV
$\Delta V_{RL5}$	load regulation	$5 \text{ mA} \leq I_{R5} \leq 200 \text{ mA}$	–	–	70	mV
RR5	ripple rejection	$f_o = 120 \text{ Hz}$ ; $V_{P1} = V_{P2}$ ; note 6	60	–	–	dB
$V_{Rd5}$	dropout voltage	$I_{R5} = 200 \text{ mA}$	–	–	1	V
$I_{Rm5}$	current limit	$V_{R5} > 8.5 \text{ V}$ ; note 7	250	–	–	mA
$I_{Rsc5}$	short-circuit current	$R_L \leq 0.5 \Omega$ ; note 7	–	tbn	–	mA
$\Delta V/\Delta T$	thermal drift	$-40 \leq T \leq 80 \text{ }^\circ\text{C}$	–	tbn	–	mV/ $^\circ\text{C}$
REGULATOR 6 ( $I_{R6} = 5 \text{ mA}$ UNLESS OTHERWISE SPECIFIED)						
$V_{R6}$	output voltage	$5 \text{ mA} \leq I_{R6} \leq 200 \text{ mA}$	9.3	9.75	10.25	V
		$11 \text{ V} \leq V_P \leq 18 \text{ V}$	9.3	9.75	10.25	V
$\Delta V_{R6}$	line regulation	$11 \text{ V} \leq V_P \leq 18 \text{ V}$	–	–	50	mV
$\Delta V_{RL6}$	load regulation	$5 \text{ mA} \leq I_{R6} \leq 200 \text{ mA}$	–	–	70	mV
RR6	ripple rejection	$f_o = 120 \text{ Hz}$ ; $V_{P1} = V_{P2}$ ; note 6	60	–	–	dB
$V_{Rd6}$	dropout voltage	$I_{R6} = 200 \text{ mA}$	–	–	0.5	V
$I_{Rm6}$	current limit	$V_{R6} > 8.5 \text{ V}$ ; note 7	300	–	–	mA
$I_{Rsc6}$	short-circuit current	$R_{bel} \leq 0.5 \Omega$ ; note 7	–	tbn	–	mA
$\Delta V/\Delta T$	thermal drift	$-40 \leq T \leq 80 \text{ }^\circ\text{C}$	–	tbn	–	mV/ $^\circ\text{C}$

**Notes**

1. During 50 ms,  $t_r > 2.5 \text{ ms}$ .
2. Regulator 1 operating,  $0.5 \text{ mA} \leq I_{R1} \leq 20 \text{ mA}$ .
3.  $V_{P1} = 13.2 \text{ V}$ ,  $V_{P2} = R4\text{-sel} = R5\text{-sel} = 0$ ,  $I_{R1} = 0$ .
4. External pull-up resistor of  $10 \text{ k}\Omega$  to 5 V required, and  $C_{load} \leq 10 \text{ pF}$ .
5. Spike-on reset measured within a time frame of 75 msec.
6.  $V_{P1} = V_{P2} = 13.2 \text{ V}$ , ripple on  $V_{P1} = V_{P2}$  of:  $1 \text{ V}_{(p-p)}$ ,  $f_o = 120 \text{ Hz}$ .
7. Foldback current protection behaviour: see Fig.4.



Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

Reset circuits

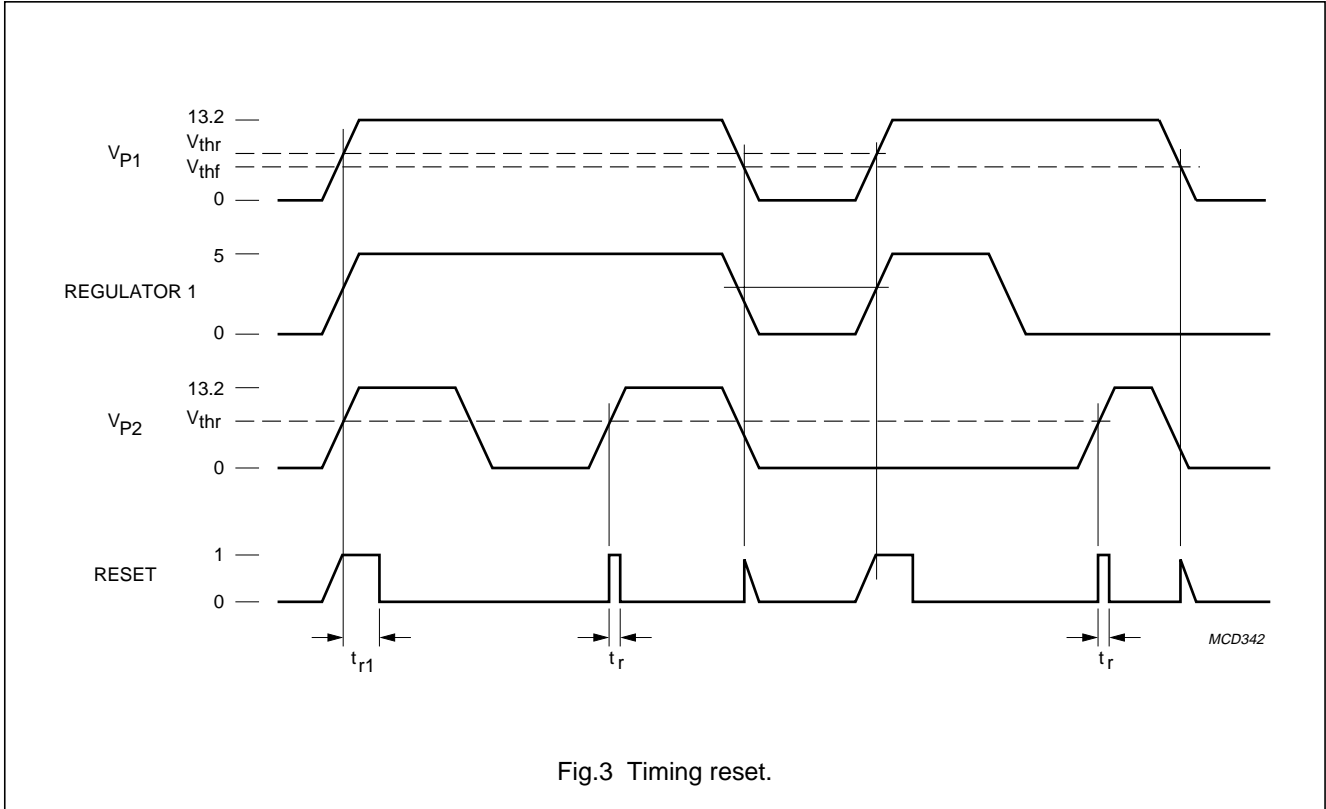


Fig.3 Timing reset.

Regulators truth table (see note 1)

INPUTS				OUTPUTS				
V <sub>P1</sub>	V <sub>P2</sub>	R4-SEL	R5-SEL	REG.1	REGS 2 & 3	REG.4	REG.5	REG.6
0	X	X	X	0	0	0	0	0
1	0	X	X	1	0	0	0	0
1	1	0	0	1	1	0	0	0
1	1	1	0	1	1	1	0	1
1	1	0	1	1	1	0	1	1
1	1	1	1	1	1	0	0	1

Note

- 1. 0 = LOW/OFF;
- 1 = HIGH/ON;
- X = don't care.

Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

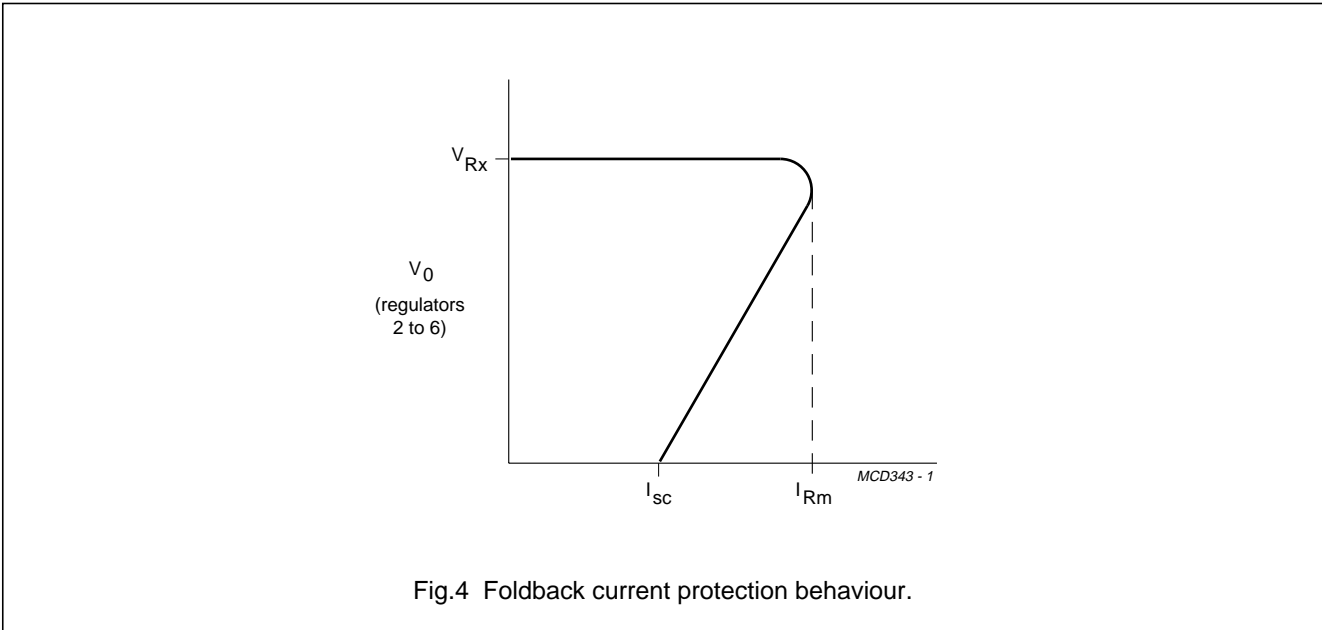
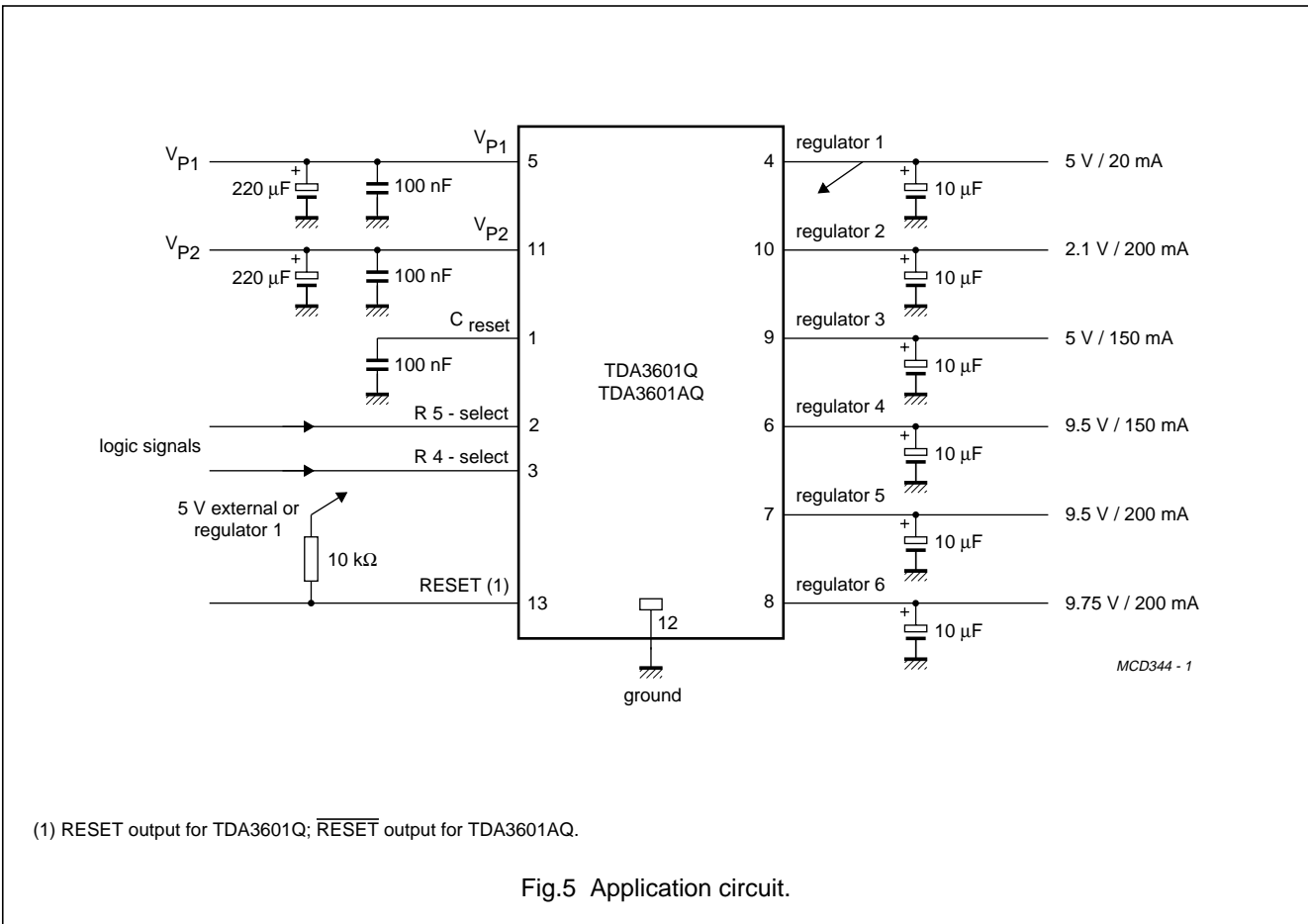


Fig.4 Foldback current protection behaviour.

TEST AND APPLICATION INFORMATION



(1) RESET output for TDA3601Q;  $\overline{\text{RESET}}$  output for TDA3601AQ.

Fig.5 Application circuit.

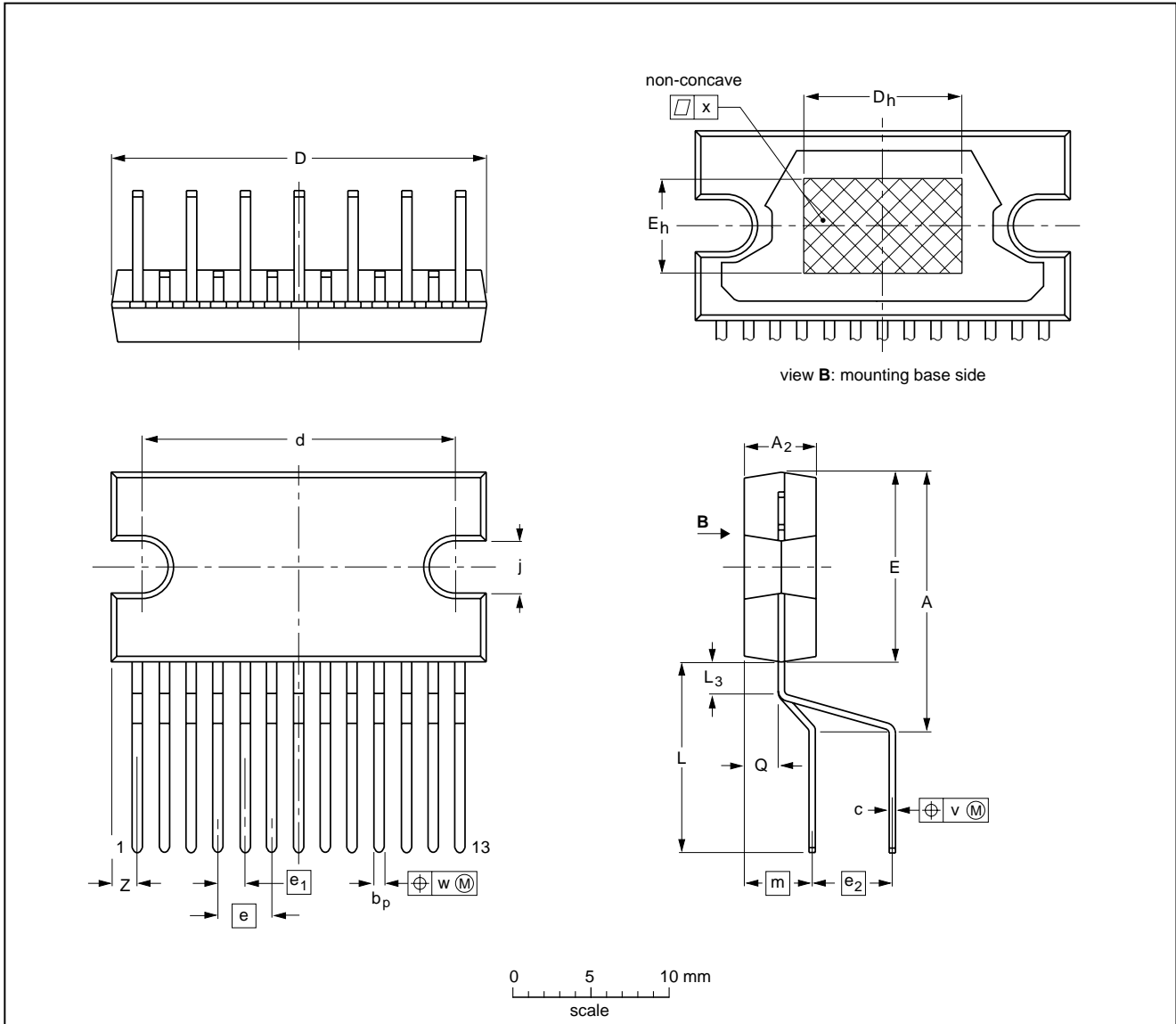
Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

PACKAGE OUTLINE

DBS13P: plastic DIL-bent-SIL power package; 13 leads (lead length 12 mm)

SOT141-6



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>2</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	d	D <sub>h</sub>	E <sup>(1)</sup>	e	e <sub>1</sub>	e <sub>2</sub>	E <sub>h</sub>	j	L	L <sub>3</sub>	m	Q	v	w	x	Z <sup>(1)</sup>
mm	17.0 15.5	4.6 4.2	0.75 0.60	0.48 0.38	24.0 23.6	20.0 19.6	10	12.2 11.8	3.4	1.7	5.08	6	3.4 3.1	12.4 11.0	2.4 1.6	4.3	2.1 1.8	0.8	0.25	0.03	2.00 1.45

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT141-6						95-03-11 97-12-16

## Multiple output voltage regulators

TDA3601Q  
TDA3601AQ

### SOLDERING

#### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "IC Package Databook" (order code 9398 652 90011).

#### Soldering by dipping or by wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ( $T_{stg\ max}$ ). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

#### Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

### DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

### LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.