



# STV9325

## Vertical deflection booster for 2.5 App TV/monitor applications with 70 V flyback generator

### Features

- Power amplifier
- Flyback generator
- Stand-by control
- Output current up to 2.5 App
- Thermal protection

### Description

The STV9325 is a vertical deflection booster designed for TV and monitor applications.

This device, supplied with up to 35 V, provides up to 2.5 App output current to drive the vertical deflection yoke.

The internal flyback generator delivers flyback voltages up to 75 V.

In double-supply applications, a standby state will be reached by stopping the (+) supply alone.

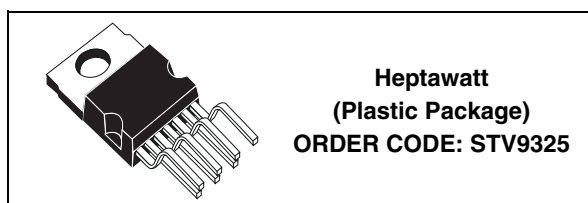


Figure 1. STV9325 pin detail

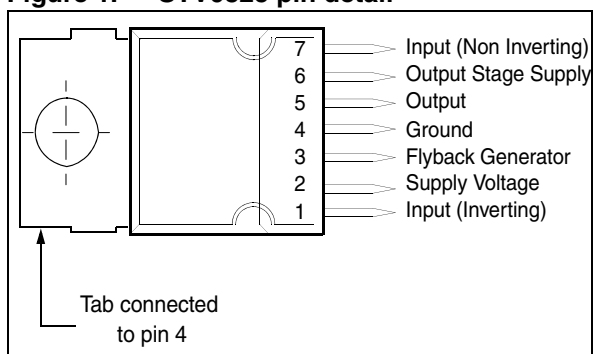
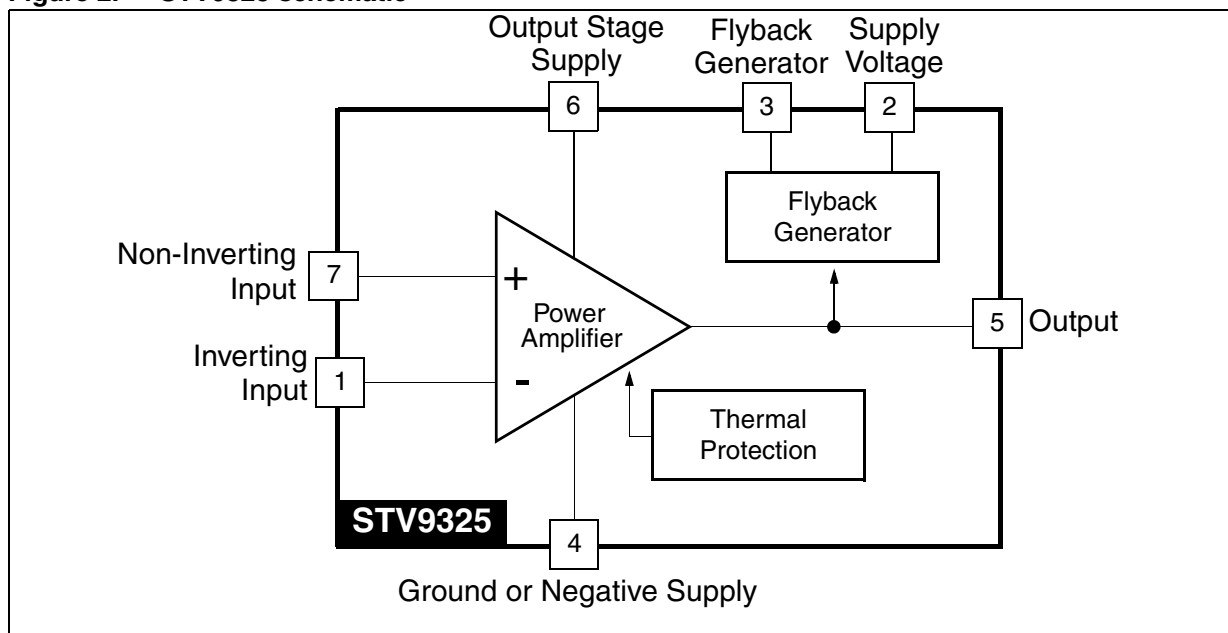


Figure 2. STV9325 schematic



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# 1 Absolute maximum ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
<b>Voltage</b>			
$V_S$	Supply voltage (pin 2) <sup>(1)</sup> and <sup>(2)</sup>	40	V
$V_5, V_6$	Flyback peak voltage <sup>(2)</sup>	70	V
$V_3$	Voltage at pin 3 <sup>(2), (3)</sup> and <sup>(4)</sup>	-0.4 to $(V_S + 3)$	V
$V_1, V_7$	Amplifier input voltage <sup>(2), (4)</sup> and <sup>(5)</sup>	- 0.4 to $(V_S + 2)$ or +40	V
<b>Current</b>			
$I_0$ (1)	Output peak current at $f = 50$ to $200$ Hz, $t \leq 10\mu s$ <sup>(6)</sup>	$\pm 5$	A
$I_0$ (2)	Output peak current non-repetitive <sup>(7)</sup>	$\pm 2$	A
$I_3$ Sink	Sink current, $t < 1ms$ <sup>(3)</sup>	2	A
$I_3$ Source	Source current, $t < 1ms$	2	A
$I_3$	Flyback pulse current at $f=50$ to $200$ Hz, $t \leq 10\mu s$ <sup>(6)</sup>	$\pm 5$	A
<b>ESD Susceptibility</b>			
ESD1	Human body model (100 pF discharged through 1.5 k $\Omega$ )	2	kV
ESD2	EIAJ standard (200 pF discharged through 0 $\Omega$ )	300	V
<b>Temperature</b>			
$T_s$	Storage temperature	-40 to 150	°C
$T_j$	Junction temperature	+150	°C

1. Usually the flyback voltage is slightly more than  $2 \times V_S$ . This must be taken into consideration when setting  $V_S$ .
2. Versus pin 4.
3.  $V_3$  is higher than  $V_S$  during the first half of the flyback pulse.
4. All pins have a reverse diode towards pin 4, these diodes should never be forward-biased.
5. Input voltages must not exceed the lower value of either  $V_S + 2$  or 40 volts.
6. Such repetitive output peak currents are usually observed just before and after the flyback pulse.
7. This non-repetitive output peak current can be observed, for example, during the Switch-On/Switch-Off phases. This peak current is acceptable providing the SOA is respected ([Figure 10](#) and [Figure 11](#)).

## 2 Thermal data

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Junction-to-case thermal resistance	3	°C/W
$T_T$	Temperature for thermal shutdown	150	°C
$T_J$	Recommended max. junction temperature	120	°C

### 3 Electrical characteristics

$V_S = 34\text{ V}$ ,  $T_{AMB} = 25^\circ\text{C}$ , unless otherwise specified.

**Table 3. Electrical characteristics**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	Figure
<b>Supply</b>							
$V_S$	Operating supply voltage range ( $V_2$ - $V_4$ )	See note below <sup>(1)</sup>	10		35	V	<a href="#">Figure 6</a>
$I_2$	Pin 2 quiescent current	$I_3 = 0$ , $I_5 = 0$		5	20	mA	<a href="#">Figure 3</a>
$I_6$	Pin 6 quiescent current	$I_3 = 0$ , $I_5 = 0$ , $V_6 = 35\text{V}$	8	19	50	mA	<a href="#">Figure 3</a>
<b>Input</b>							
$I_1$	Input bias current	$V_1 = 1\text{ V}$ , $V_7 = 2.2\text{ V}$		- 0.6	-1.5	$\mu\text{A}$	<a href="#">Figure 3</a>
$I_7$	Input bias current	$V_1 = 2.2\text{ V}$ , $V_7 = 1\text{ V}$		- 0.6	-1.5	$\mu\text{A}$	
$V_{IR}$	Operating input voltage range		0		$V_S - 2$	V	
$V_{I0}$	Offset voltage			2		mV	
$\Delta V_{I0}/dt$	Offset drift versus temperature			10		$\mu\text{V}/^\circ\text{C}$	
<b>Output</b>							
$I_0$	Operating peak output current	$0^\circ < T_{case} < 125^\circ\text{C}$			$\pm 1.25$	A	
$V_{5L}$	Output saturation voltage to pin 4	$I_5 = 1.25\text{ A}$		0.9	1.6	V	<a href="#">Figure 5</a>
$V_{5H}$	Output saturation voltage to pin 6	$I_5 = -1.25\text{ A}$		1.5	2.2	V	<a href="#">Figure 4</a>
<b>Standby</b>							
$V_{5STBY}$	Output voltage in standby	$V_1 = V_7 = V_S = 0^{(2)}$					<a href="#">Figure 6</a>
<b>Miscellaneous</b>							
G	Voltage gain		80			dB	
$V_{D5-6}$	Diode forward voltage between pins 5-6	$I_5 = 1.25\text{ A}$		1.5	2.1	V	
$V_{D3-2}$	Diode forward voltage between pins 3-2	$I_3 = 1.25\text{ A}$		1.5	2.1	V	
$V_{3SL}$	Saturation voltage on pin 3	$I_3 = 20\text{ mA}$		0.4	1	V	<a href="#">Figure 5</a>
$V_{3SH}$	Saturation voltage to pin 2 (2nd part of flyback)	$I_3 = -1.25\text{ A}$		1.8	2.6	V	

1. In normal applications, the peak flyback voltage is slightly greater than  $2 \times (V_S - V_4)$ . Therefore,  $(V_S - V_4) = 35\text{ V}$  is not allowed without special circuitry.

2. Refer to [Figure 6](#), standby condition.

Figure 3. Measurement of  $I_1$ ,  $I_2$  and  $I_6$

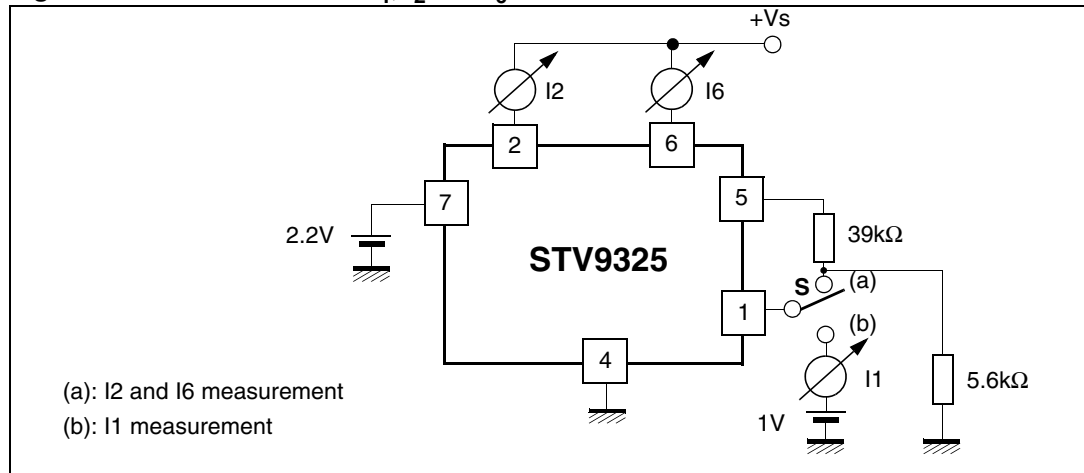


Figure 4. Measurement of  $V_{5H}$

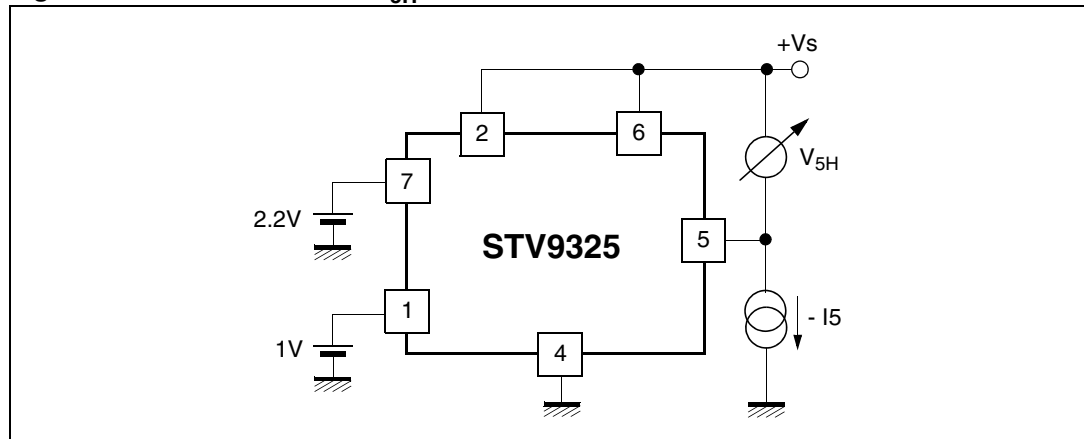
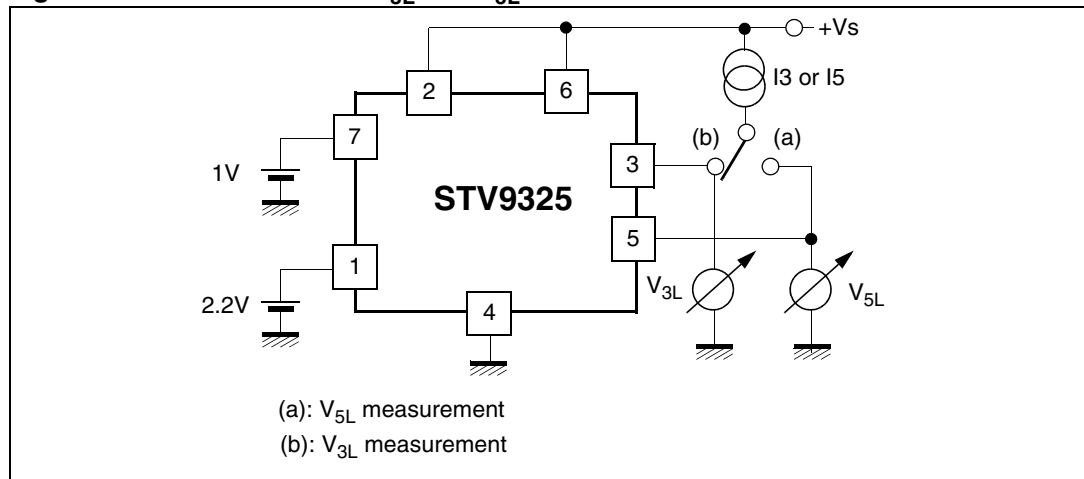


Figure 5. Measurement of  $V_{3L}$  and  $V_{5L}$



## 4 Application hints

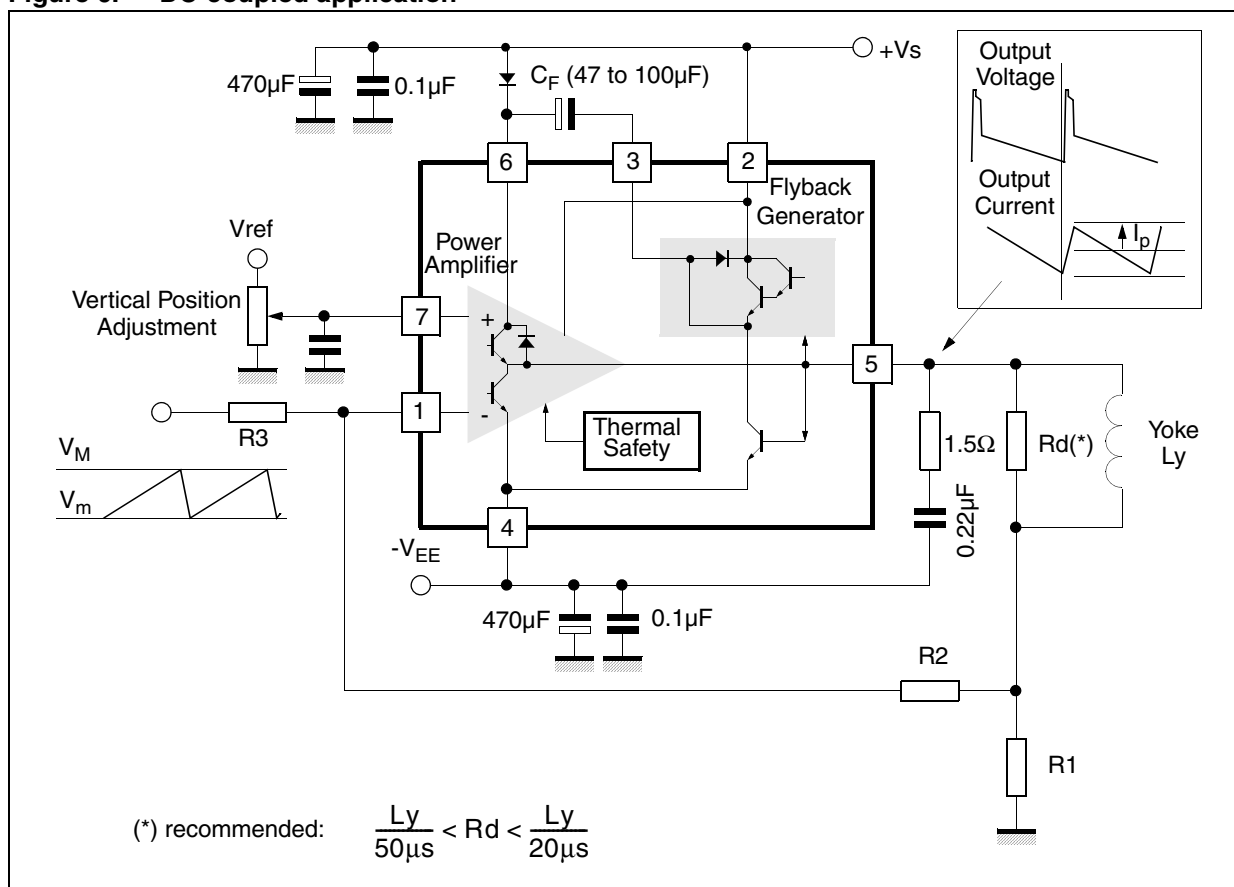
The yoke can be coupled either in AC or DC.

### 4.1 DC-coupled application

When DC coupled (see [Figure 6](#)), the display vertical position can be adjusted with input bias. On the other hand, 2 supply sources ( $V_S$  and  $-V_{EE}$ ) are required.

A standby state will be reached by switching OFF the positive supply alone. In this state, where both inputs are the same voltage as pin 2 or higher, the output will sink negligible current from the deviation coil.

**Figure 6. DC-coupled application**



### 4.1.1 Application hints

For calculations, treat the IC as an op-amp, where the feedback loop maintains  $V_1 = V_7$ .

#### Centering

Display will be centered (null mean current in yoke) when voltage on pin 7 is ( $R_1$  is negligible):

$$V_7 = \frac{V_M + V_m}{2} \times \left( \frac{R_2}{R_2 + R_3} \right)$$

#### Peak current

$$I_P = \frac{(V_M - V_m)}{2} \times \frac{R_2}{R_1 \times R_3}$$

Example: for  $V_m = 2$  V,  $V_M = 5$  V and  $I_P = 1$  A

Choose  $R_1$  in the 1  $\Omega$  range, for instance  $R_1 = 1$   $\Omega$

From equation of peak current:

$$\frac{R_2}{R_3} = \frac{2 \times I_P \times R_1}{V_M - V_m} = \frac{2}{3}$$

Then choose  $R_2$  or  $R_3$ . For instance, if  $R_2 = 10$  k $\Omega$  then  $R_3 = 15$  k $\Omega$

Finally, the bias voltage on pin 7 should be:

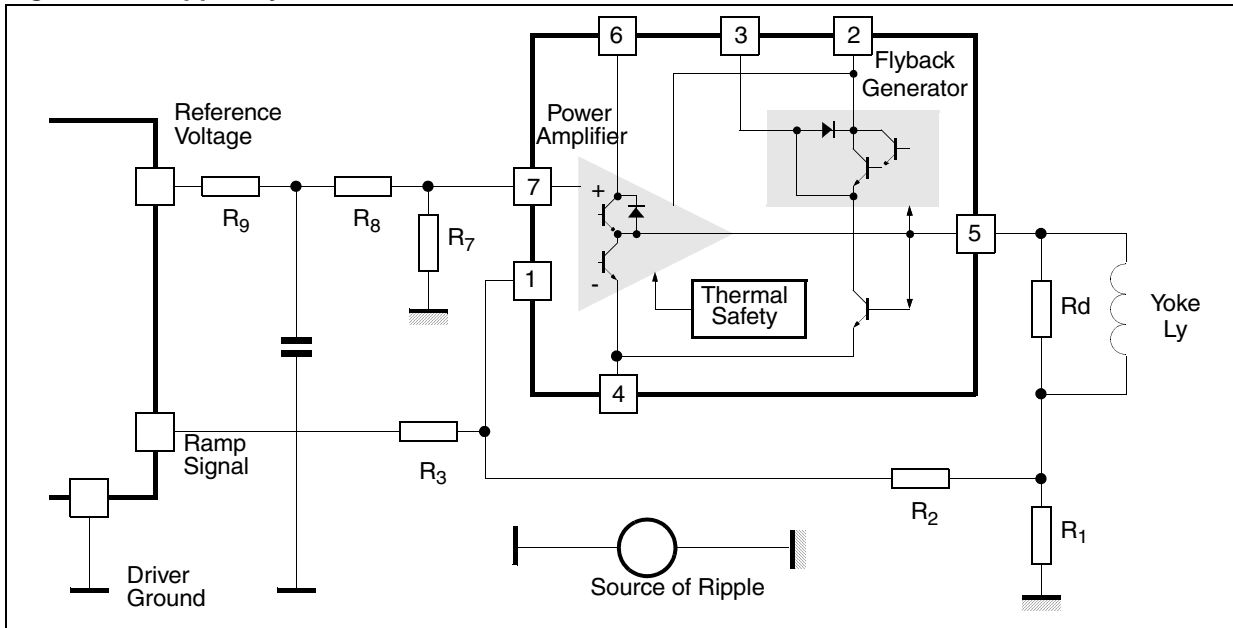
$$V_7 = \frac{V_M + V_m}{2} \times \frac{1}{1 + \frac{R_3}{R_2}} = \frac{7}{2} \times \frac{1}{2.5} = 1.4 \text{ V}$$



### 4.1.2 Ripple rejection

When both ramp signal and bias are provided by the same driver IC, you can gain natural rejection of any ripple caused by a voltage drop in the ground (see [Figure 7](#)), if you manage to apply the same fraction of ripple voltage to both booster inputs. For that purpose, arrange an intermediate point in the bias resistor bridge, such that  $(R_8 / R_7) = (R_3 / R_2)$ , and connect the bias filtering capacitor between the intermediate point and the local driver ground. Of course,  $R_7$  should be connected to the booster reference point, which is the ground side of  $R_1$ .

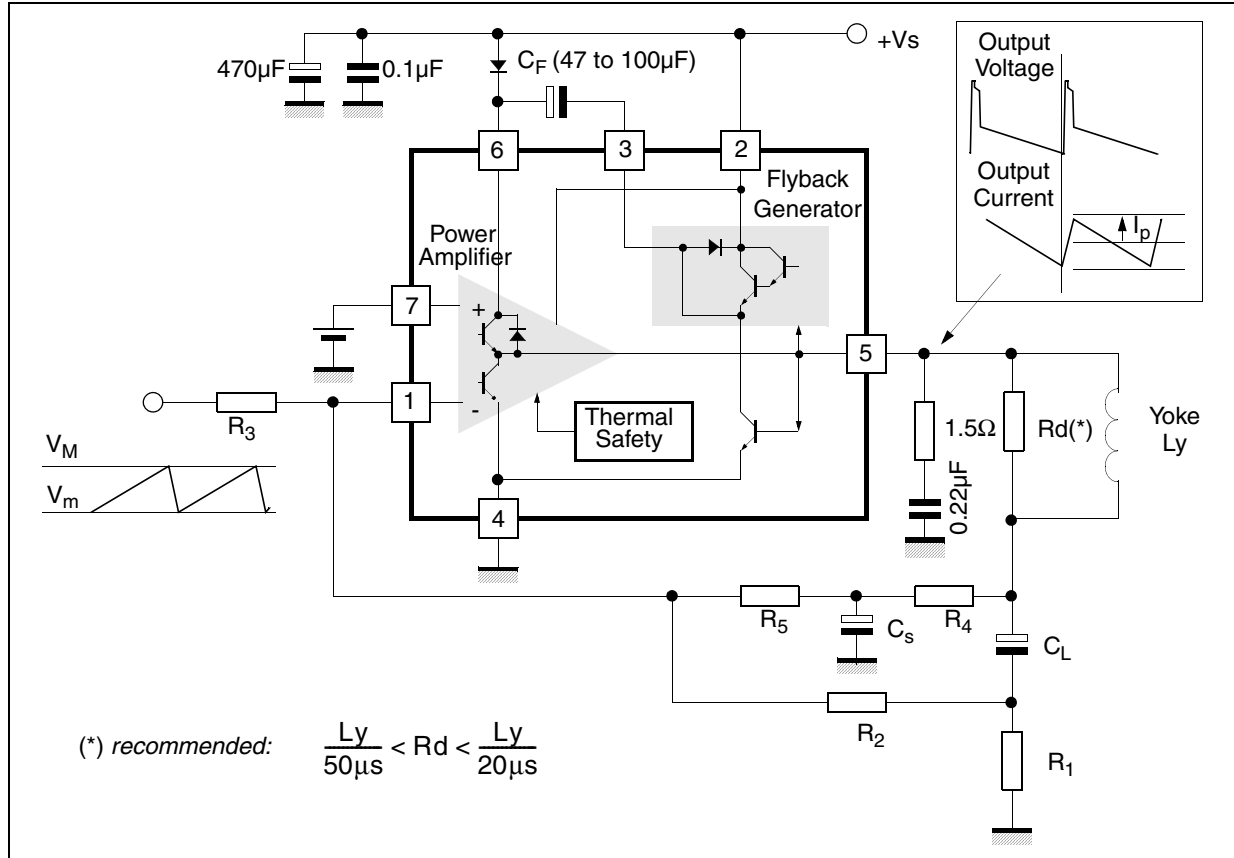
Figure 7. Ripple rejection



## 4.2 AC-coupled applications

In AC-coupled applications (See [Figure 8](#)), only one supply ( $V_S$ ) is needed. The vertical position of the scanning cannot be adjusted with input bias (for that purpose, usually some current is injected or sunk with a resistor in the low side of the yoke).

**Figure 8. AC-coupled application**



### 4.2.1 Application hints

Gain is defined as in the previous case:

$$I_p = \frac{V_M - V_m}{2} \times \frac{R_2}{R_1 \times R_3}$$

Choose  $R_1$  then either  $R_2$  or  $R_3$ . For good output centering,  $V_7$  must fulfill the following equation:

$$\frac{\frac{V_S}{2} - V_7}{R_4 + R_5} = \frac{V_7 - \frac{V_M + V_m}{2}}{R_3} + \frac{V_7}{R_2}$$

or

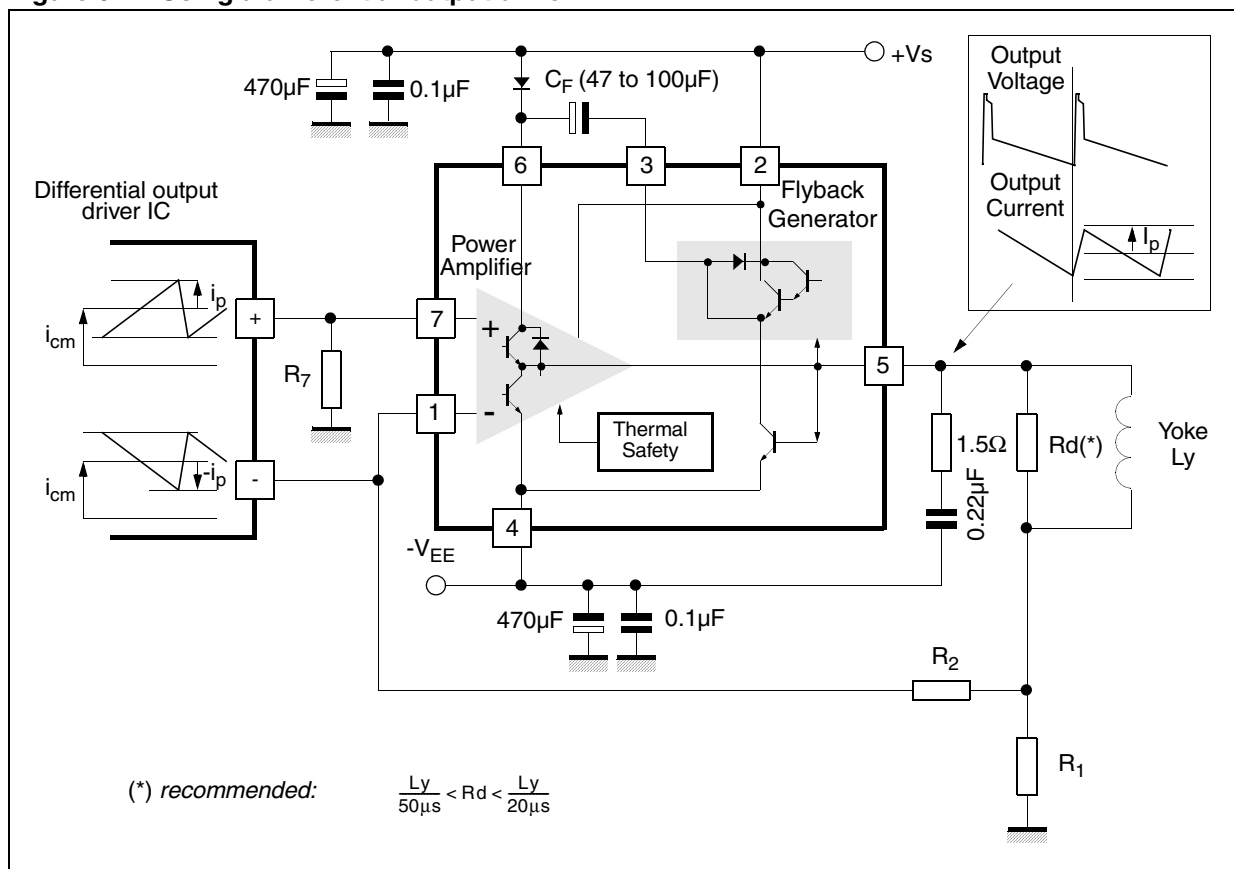
$$V_7 \times \left( \frac{1}{R_3} + \frac{1}{R_2} + \frac{1}{R_4 + R_5} \right) = \left( \frac{V_S}{2(R_4 + R_5)} + \frac{V_M + V_m}{2 \times R_3} \right)$$

C<sub>S</sub> performs an integration of the parabolic signal on C<sub>L</sub>, therefore the amount of S correction is set by the combination of C<sub>L</sub> and C<sub>S</sub>.

### 4.3 Application with differential-output drivers

Certain driver ICs provide the ramp signal in differential form, as two current sources *i*<sub>+</sub> and *i*<sub>-</sub> with opposite variations.

Figure 9. Using a differential-output driver



Some definitions:

- *i*<sub>cm</sub> is the common-mode current:  $i_{cm} = \frac{1}{2}(i_+ + i_-)$

- at peak of signal, *i*<sub>+</sub> = *i*<sub>cm</sub> + *i*<sub>p</sub> and *i*<sub>-</sub> = *i*<sub>cm</sub> - *i*<sub>p</sub>, therefore the peak differential signal is *i*<sub>p</sub> - (-*i*<sub>p</sub>) = 2 *i*<sub>p</sub>, and the peak-peak differential signal, 4*i*<sub>p</sub>.

The application is described in Figure 9 with DC yoke coupling. The calculations still rely on the fact that V<sub>1</sub> remains equal to V<sub>7</sub>.

### 4.3.1 Centering

When idle, both driver outputs provide  $i_{cm}$  and the yoke current should be null ( $R_1$  is negligible), hence:

$$i_{cm} \cdot R_7 = i_{cm} \cdot R_2 \quad \text{therefore} \quad R_7 = R_2$$

### 4.3.2 Peak current

Scanning current should be  $I_p$  when positive and negative driver outputs provide respectively  $i_{cm} - i$  and  $i_{cm} + i$ , therefore

$$(i_{cm} - i) \cdot R_7 = I_p \cdot R_1 + (i_{cm} + i) \cdot R_2$$

and since  $R_7 = R_2$

$$\frac{I_p}{i} = -\frac{2R_7}{R_1}$$

Choose  $R_1$  in the  $1\Omega$  range, the value of  $R_2 = R_7$  follows. Remember that  $i$  is one-quarter of driver peak-peak differential signal! Also check that the voltages on the driver outputs remain inside allowed range.

**Example:**

for  $i_{cm} = 0.4\text{mA}$ ,  $i = 0.2\text{mA}$  (corresponding to  $0.8\text{mA}$  of peak-peak differential current),  
 $I_p = 1\text{A}$

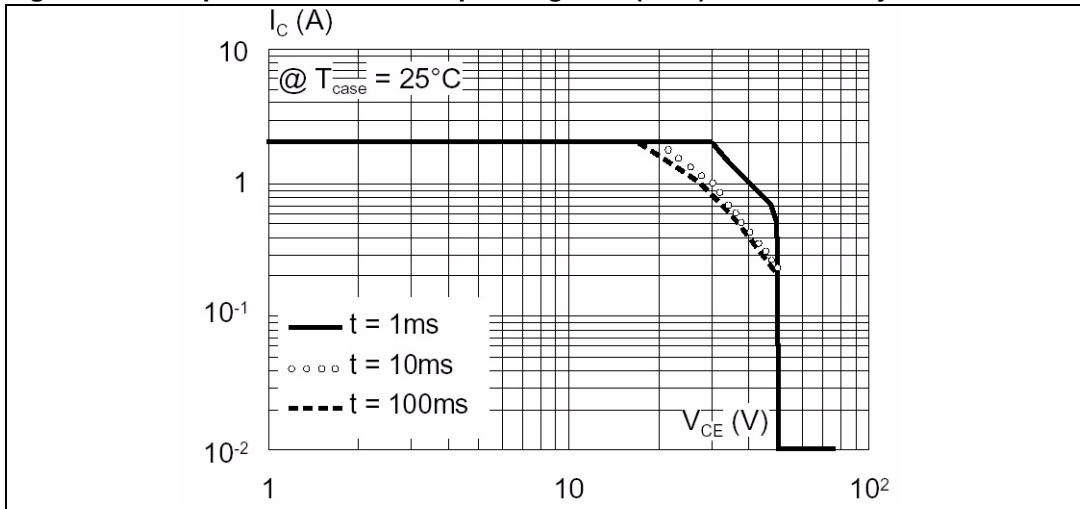
Choose  $R_1 = 0.75\Omega$  it follows  $R_2 = R_7 = 1.875\text{k}\Omega$

### 4.3.3 Ripple rejection

Make sure to connect  $R_7$  directly to the ground side of  $R_1$ .

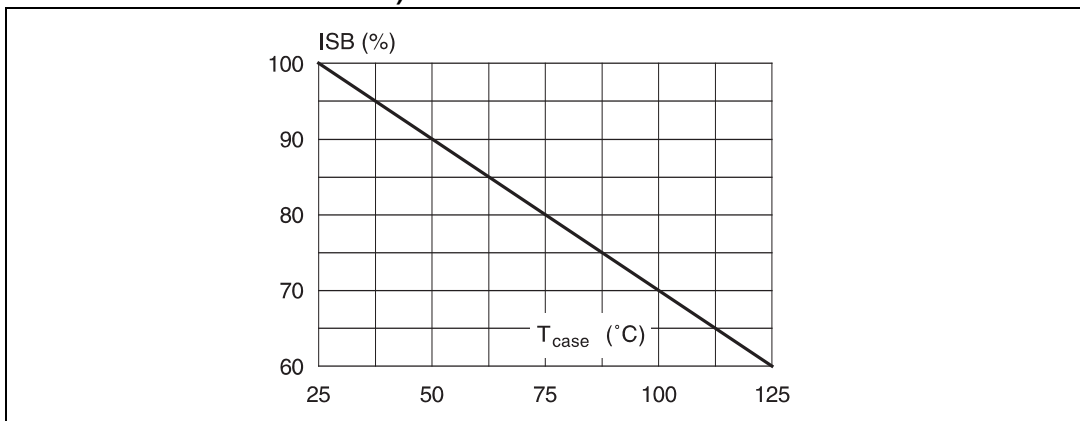
4.3.4 Secondary breakdown diagrams

Figure 10. Output transistor safe operating area (SOA) for secondary breakdown



The diagram has been arbitrarily limited to max I0 (2A).

Figure 11. Secondary breakdown temperature derating curve (ISB = secondary breakdown current)

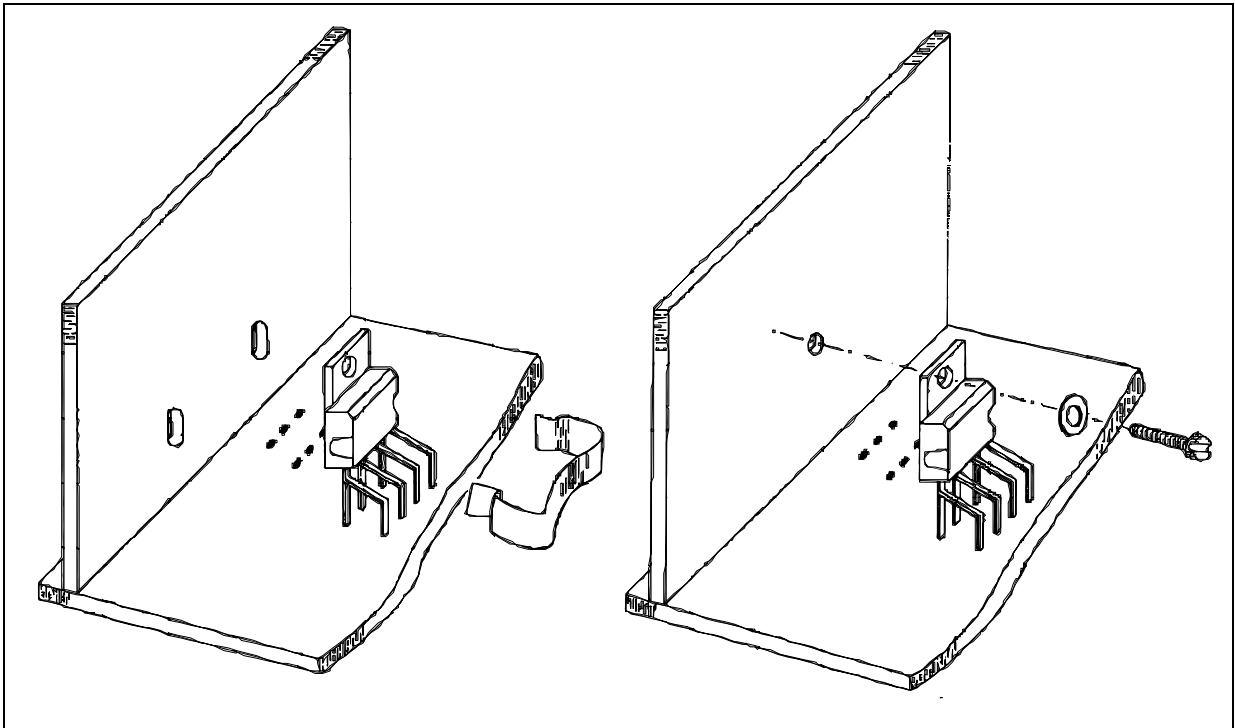


## 5 Mounting instructions

The power dissipated in the circuit is removed by adding an external heatsink. With the Heptawatt package, the heatsink is simply attached with a screw or a compression spring (clip).

A layer of silicon grease inserted between heatsink and package optimizes thermal contact. In DC-coupled applications we recommend to use a silicone tape between the device tab and the heatsink to electrically isolate the tab.

**Figure 12. Mounting examples**



## 6 Pin configuration

Figure 13. Pins 1 and 7

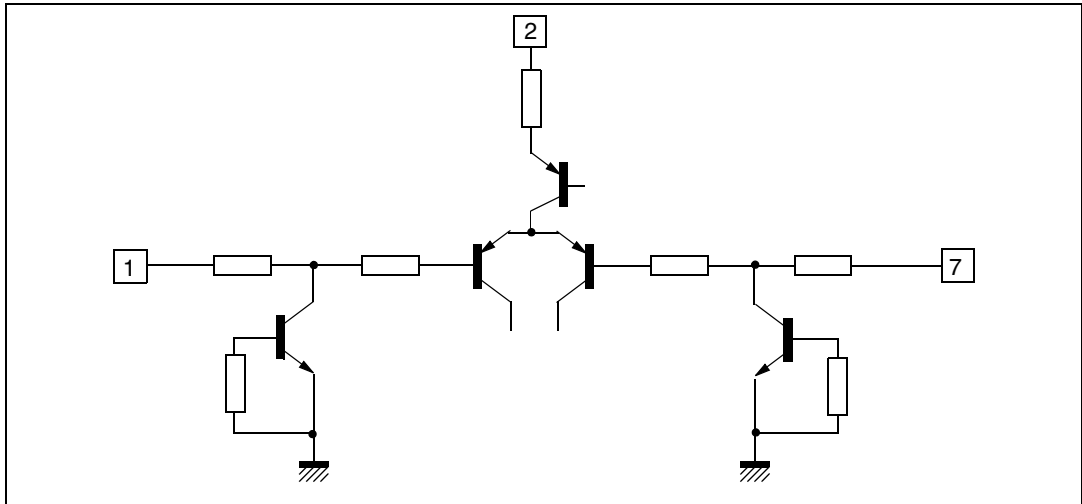
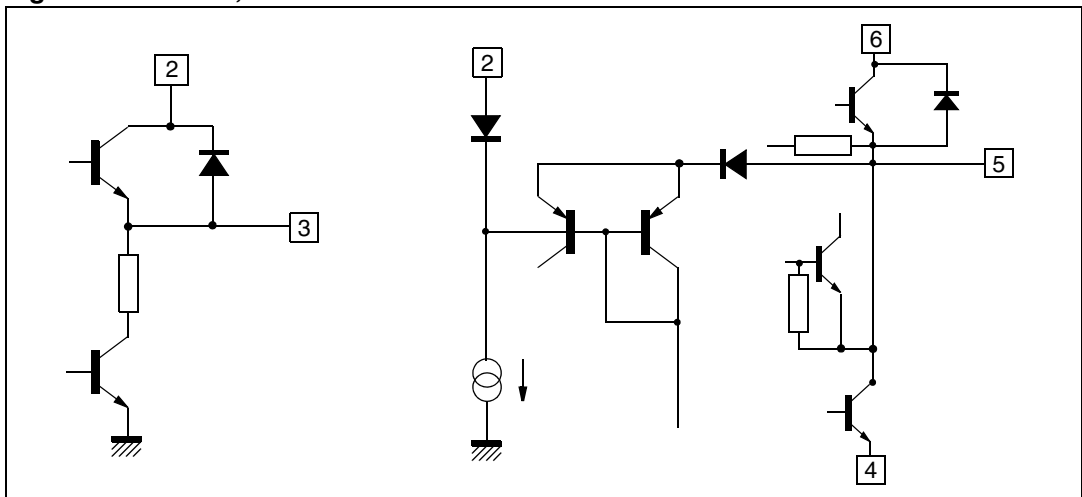


Figure 14. Pins 3, 5 and 6



## 7 Package mechanical data

Figure 15. 7-pin Heptawatt package

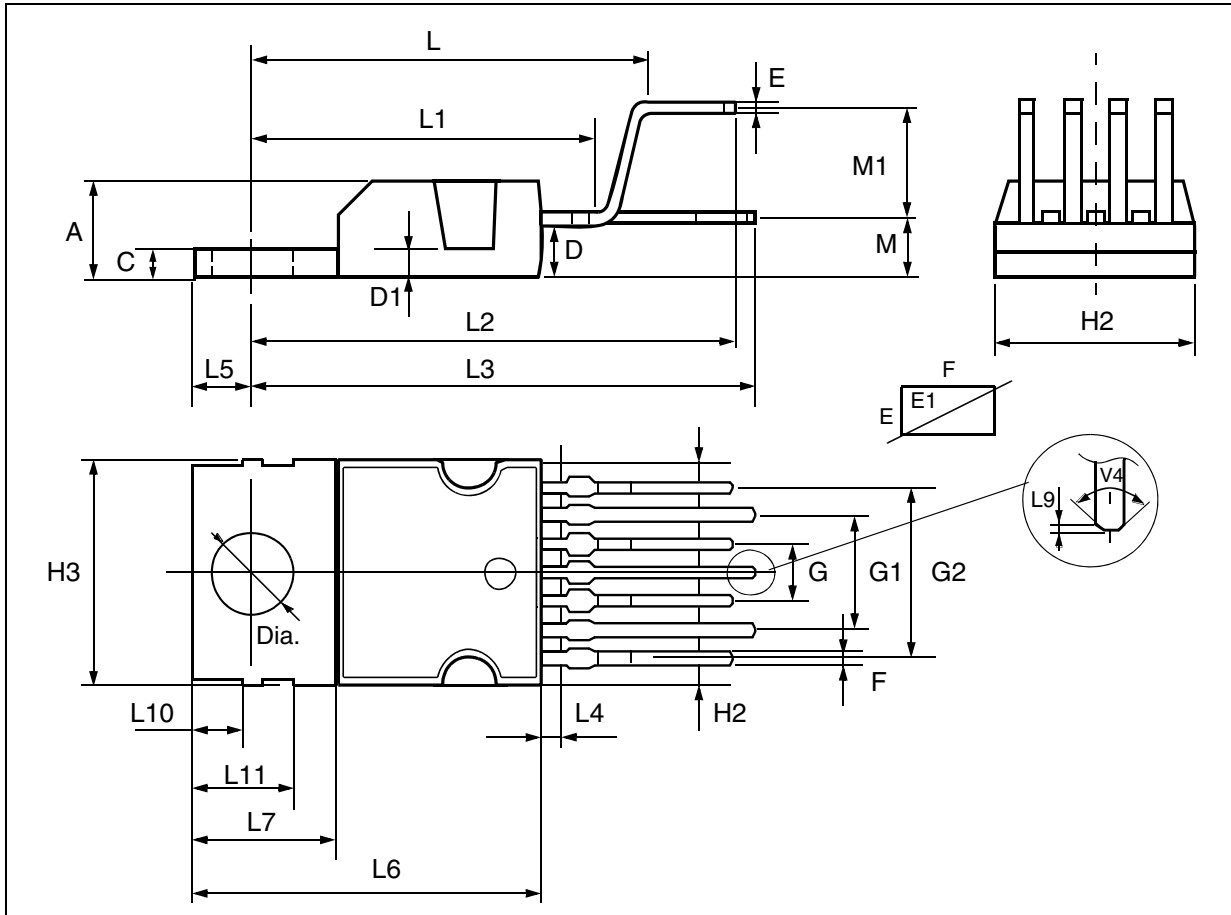


Table 4. Heptawatt package

Dim.	mm			inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			4.8			0.189
C			1.37			0.054
D	2.40		2.80	0.094		0.110
D1	1.20		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
E1	0.70		0.97	0.028		0.038
F	0.60		0.80	0.024		0.031



Table 4. Heptawatt package (continued)

Dim.	mm			inches		
<b>G</b>	2.34	2.54	2.74	0.095	0.100	0.105
<b>G1</b>	4.88	5.08	5.28	0.193	0.200	0.205
<b>G2</b>	7.42	7.62	7.82	0.295	0.300	0.307
<b>H2</b>			10.40			0.409
<b>H3</b>	10.05		10.40	0.396		0.409
<b>L</b>	16.70	16.90	17.10	0.657	0.668	0.673
<b>L1</b>		14.92			0.587	
<b>L2</b>	21.24	21.54	21.84	0.386	0.848	0.860
<b>L3</b>	22.27	22.52	22.77	0.877	0.891	0.896
<b>L4</b>			1.29			0.051
<b>L5</b>	2.60	2.80	3.00	0.102	0.110	0.118
<b>L6</b>	15.10	15.50	15.80	0.594	0.610	0.622
<b>L7</b>	6.00	6.35	6.60	0.0236	0.250	0.260
<b>L9</b>		0.20			0.008	
<b>L10</b>	2.10		2.70	0.082		0.106
<b>L11</b>	4.30		4.80	0.169		0.190
<b>M</b>	2.55	2.80	3.05	0.100	0.110	0.120
<b>M1</b>	4.83	5.08	5.33	0.190	0.200	0.210
<b>V4</b>	40 (Typ.)					
<b>Dia.</b>	3.65		3.85	0.144		0.152

## 7.1 Environmentally-friendly packages

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance.

ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

## 8 Revision history

**Table 5. Document revision history**

Date	Revision	Changes
April 2003	1	First issue.
April 2003	1.1	Correction to <i>Peak current</i> . Creation of new title <i>Section 4.3.4</i> .
November 2003	1.2	Datasheet status changed to preliminary data.
December 2003	1.3	Modification to <i>Figure 13</i> .
April 2004	1.4	Flyback voltage value changed on page 1.
June 2004	1.5	Datasheet status changed to datasheet.
February 2005	2	Updated <i>Figure 9</i> .
17-Jan-2007	3	Modified.
11-Dec-2008	4	<i>Section 7.1</i> added, new template applied.

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