

# LH1605/LH1605C

## 5 Amp, High Efficiency Switching Regulator

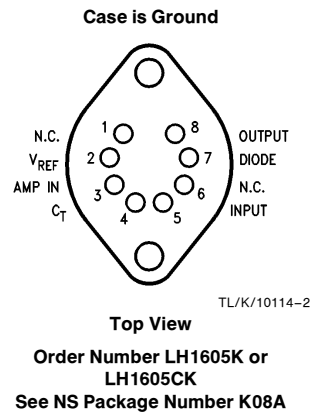
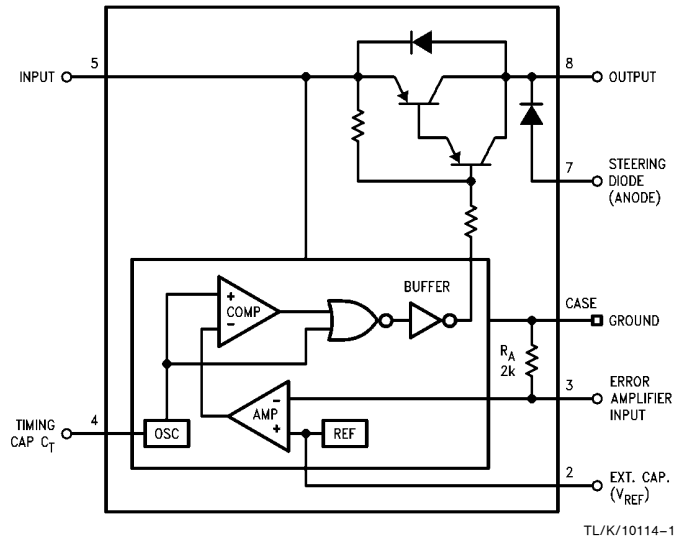
### General Description

The LH1605 is a hybrid switching regulator with high output current capabilities. It incorporates a temperature-compensated voltage reference, a duty cycle modulator with the oscillator frequency programmable, error amplifier, high current-high voltage output switch, and a power diode. The LH1605 can supply up to 5A of output current over a wide range of regulated output voltage.

### Features

- Step down switching regulator
- Output adjustable from 3.0V to 30V
- 5A output current
- High efficiency
- Frequency adjustable to 100 kHz
- Standard 8-pin TO-3 package

### Block and Connection Diagrams



LH1605/LH1605C 5 Amp, High Efficiency Switching Regulator

## Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Input Voltage ( $V_{IN}$ )	35V max
Output Current ( $I_O$ )	6A
Operating Temperature ( $T_J$ )	150°C
Internal Power Dissipation ( $P_D$ ) (Note 1)	20W
Operating Temperature ( $T_A$ )	
LH1605C	-25°C to +85°C
LH1605	-55°C to +125°C

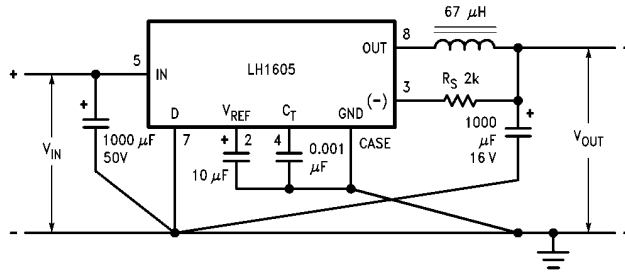
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C
Duty Cycle (D.C.)	20% to 80%
Steering Diode Reverse Voltage ( $V_R$ ) ( $V_{8-7}$ )	60V
Steering Diode Forward Current ( $I_D$ ) ( $I_{7-8}$ )	6A

## Electrical Characteristics $T_C = 25^\circ\text{C}$ , $V_{IN} = 15\text{V}$ , $V_{OUT} = 10\text{V}$ unless otherwise specified

Symbol	Characteristics	Conditions	LH1605			LH1605C			Units
			Min	Typ	Max	Min	Typ	Max	
$V_{OUT}$	Output Voltage Range	$V_{IN} \geq V_O + 5\text{V}$ $I_O = 2\text{A}$ (Note 2)	3.0		30	3.0		30	
$V_S$	Switch Saturation Voltage	$I_C = 5.0\text{A}$ $I_C = 2.0\text{A}$		1.6 1.0	2.0 1.2		1.6 1.0	2.0 1.2	V
$V_F$	Steering Diode On Voltage	$I_D = 5.0\text{A}$ $I_D = 2.0\text{A}$		1.2 1.0	2.8 2.0		1.2 1.0	2.8 2.0	
$V_{IN}$	Supply Voltage Range		10		35	10		35	
$I_R$	Steering Diode Reverse Current	$V_R = 25\text{V}$		0.1	5.0		0.1	5.0	$\mu\text{A}$
$I_Q$	Quiescent Current	$I_{OUT} = 0.2\text{A}$		20			20		mA
$V_2$	Voltage on Pin 2			2.5			2.5		V
$\Delta V_2/\Delta T$	$V_2$ Temperature Coeff.			100			100		ppm/°C
$V_4$	Voltage Swing—Pin 4			3.0			3.0		V
$I_4$	Charging Current—Pin 4			70			70		$\mu\text{A}$
$R_A$	Resistance Pin 3 to GND			2.0			2.0		k $\Omega$
$\Delta R_A/\Delta T$	Resistance Temp. Coeff.			75			75		ppm/°C
$t_r$	Voltage Rise Time	$I_{OUT} = 2.0\text{A}$ $I_{OUT} = 5.0\text{A}$		350 500			350 500		ns
$t_f$	Voltage Fall Time	$I_{OUT} = 2.0\text{A}$ $I_{OUT} = 5.0\text{A}$		300 400			300 400		
$t_s$	Storage Time	$I_{OUT} = 5.0\text{A}$		1.5			1.5		$\mu\text{s}$
$t_d$	Delay Time			100			100		ns
$P_D$	Power Dissipation	$V_{OUT} = 10\text{V}$ $I_{OUT} = 5.0\text{A}$		16			16		W
$\eta$	Efficiency			75			75		%
$\theta_{JC}$	Thermal Resistance (Note 1)			5.0			5.0		°C/W

Note 1:  $\theta_{JA}$  is typically 30°C/W for natural convection cooling.

Note 2:  $V_{OUT}$  refers to the output voltage range of switching supply after the output LC filter as shown in the Typical Application circuit.



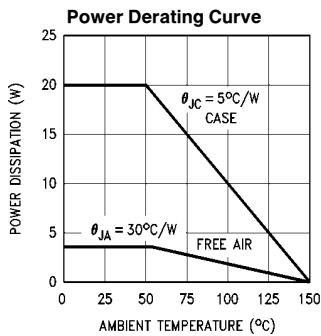
TL/K/10114-3

Minimum  $V_{IN} - V_{OUT} = 5V$  for Proper Operation

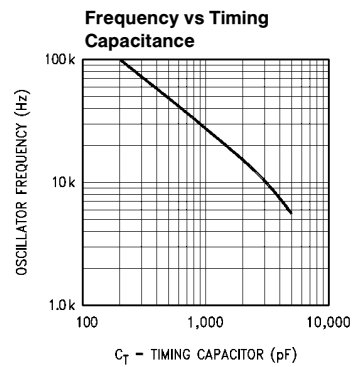
$$R_S = \frac{2 \times 10^3 (V_{OUT} - 2.5)}{2.5}$$

$V_{IN} = 10 - 18V$   
 $V_{OUT} = 5V$   
 $I_{OUT} = 3A$  (Max)  
 $I_{OUT} = 1A$  (Min)  
 $\eta \approx 70\%$

Load Reg. = 50 mV  
 Line Reg. = 10 mV  
 Ripple = 20 mV



TL/K/10114-4



TL/K/10114-5

#### Design Equations

$$\text{Efficiency } (\eta) = \frac{P_{OUT} \times 100}{P_{IN}}$$

$$\text{Transistor DC Losses } (P_T) = I_{OUT} \times V_S \left( \frac{t_{ON}}{t_{ON} + t_{OFF}} \right)$$

$$\text{Diode DC Losses } (P_D) = I_{OUT} \times V_F \left( \frac{t_{OFF}}{t_{ON} + t_{OFF}} \right)$$

$$\text{Drive Circuit Losses } (D_L) = \frac{V_{IN}^2}{300} \times \frac{t_{ON}}{t_{ON} + t_{OFF}}$$

$$\text{Switching Losses Transistor } (P_S) = V_{IN} \times I_{OUT} \times \frac{t_r + t_f}{2(t_{ON} + t_{OFF})}$$

$$\text{Transistor Duty Cycle} = \frac{t_{ON}}{t_{ON} + t_{OFF}} = \frac{V_{OUT}}{V_{IN}}$$

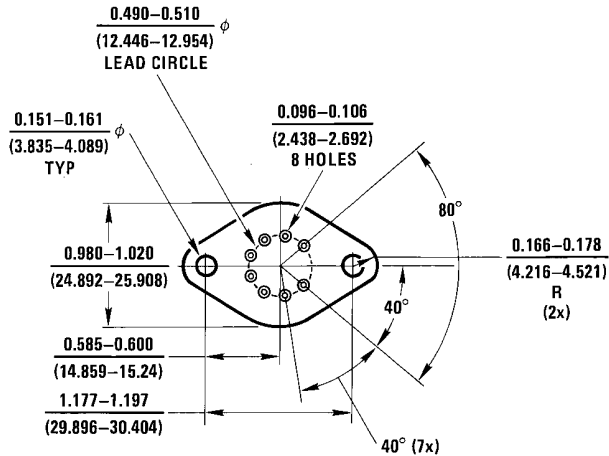
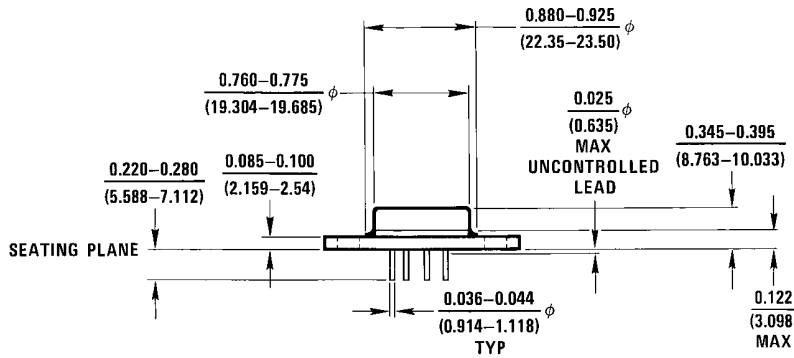
$$\text{Diode Duty Cycle} = \frac{t_{OFF}}{t_{ON} + t_{OFF}} = 1 - \frac{V_{OUT}}{V_{IN}}$$

$$\text{Power Inductor } (P_L) = I_{OUT}^2 \times R_L \text{ (Winding Resistance)}$$

$$\text{Efficiency } (\eta) = \frac{V_{OUT} I_{OUT}}{V_{OUT} I_{OUT} + P_T + P_D + D_L + P_S + P_L} \times 100\%$$

**Physical Dimensions** inches (millimeters)

Lit. # 106377



**8-Lead TO-3 Metal Can Package (K)**  
NS Package Number K08A

K08A (REV C)

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