

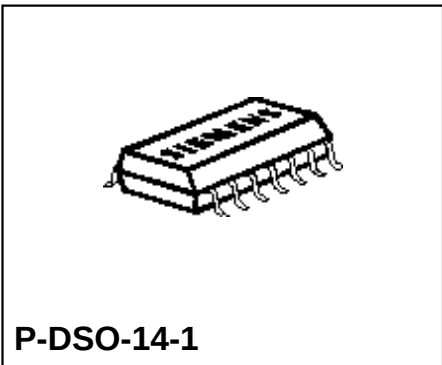
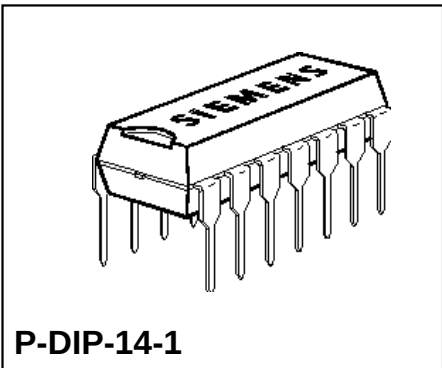
Window Discriminator

TCA 965 B

Preliminary Bipolar IC

Features

- Two window settings
 - direct setting of lower and upper edge voltage (window edges)
 - indirect setting by window center voltage and half window width
- Adjustable hysteresis
- Digital outputs with open collectors for currents up to 50 mA
- Adjustable reference voltage V_{Stab}



Type	Ordering Code	Package
■ TCA 965 B	Q67000-A8338	P-DIP-14-1
TCA 965 BG	Q67000-A8337	P-DSO-14-1 (SMD)

■ Not for new design

The window discriminator compares an input voltage to a defined voltage window. The digital outputs show whether the input voltage is below, within or above this window.

The TCA 965 B window discriminator is especially suitable as a tracking or compensating controller with a dead band in control engineering and for the selection of DC voltages within a certain tolerance of the required setpoint value in measurement engineering. When it is used as a Schmitt trigger, switching frequencies up to a typical value of 50 kHz are possible.

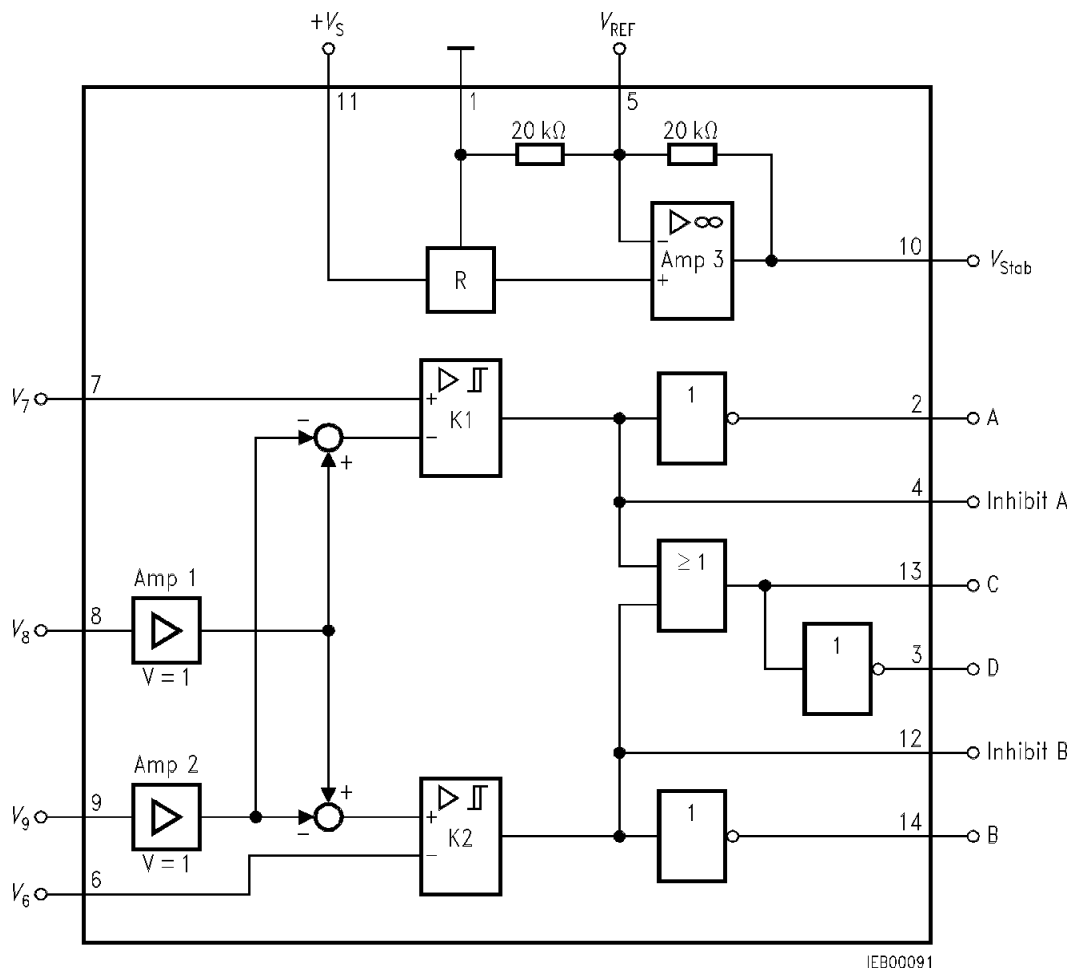
Functional Description

Amplifier Amp 3 increases the voltage of the reference source R to $V_{\text{Stab}} = 2 \times V_{\text{REF}}$. The amplification factor can be altered by external wiring. With direct setting of the window, the input voltage appears on amplifier Amp 1 (V_8), the upper edge voltage on comparator K2 (V_6) and the lower edge voltage on comparator K1 (V_7).

With indirect setting of the window, the input voltage appears on inputs V_6 and V_7 , while the center voltage is connected to amplifier A1 (V_8).

The voltage applied to the input (V_9) of amplifier Amp 2 is subtracted symmetrically from the output voltage of amplifier Amp 1 and added. The comparators switch with hysteresis. The logic gates have open-collector outputs.

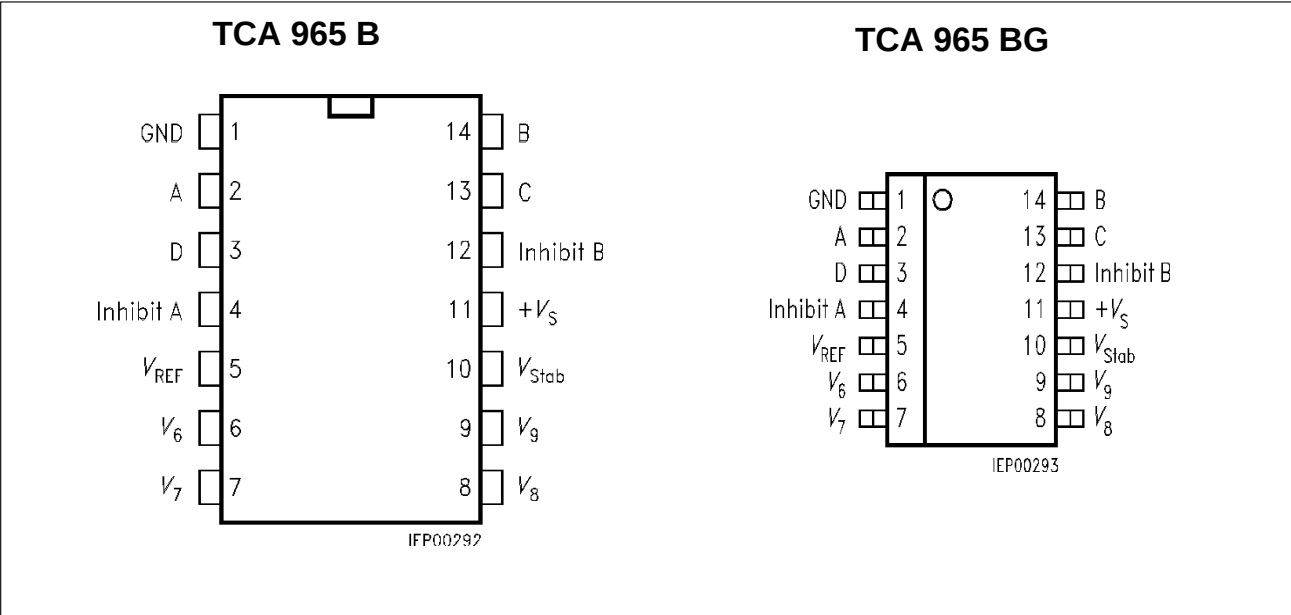
If the inhibit input A or B is connected to ground, output A or B will always be high.



Outputs A, B, C, D are open-collector

Block Diagram

Pin Configurations
(top view)



Pin Definitions and Functions

Pin	Symbol	Pin Function in	
		Direct Setting	Indirect Setting
		of Window	
1	GND	GND	
2	A	Logic output A	
3	D	Logic output D = A @ B (AND)	
4	Inhibit A	Connected to GND: logic output A = HIGH	
5	V _{REF}	Internal V _{REF} = 3 V	
6	V ₆	Upper edge voltage	Input voltage V _{6/7}
7	V ₇	Lower edge voltage	Input voltage V _{6/7}
8	V ₈	Input voltage	Center voltage
9	V ₉	GND	Half window width
10	V _{Stab}	Internal V _{Stab} = 6 V	
11	+ V _S	Supply voltage	
12	Inhibit B	Connected to GND: logic output B = HIGH	
13	C	Logic output C = A @ B (NAND)	
14	B	Logic output B	

Absolute Maximum Ratings

Maximum ratings for ambient temperature $T_A = -25$ to 85 °C

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Supply voltage (pin 11)	V_S		30	V
Difference in input voltage between pins 6, 7, 8	V_I		15	V
Input voltage (pins 6, 7, 8, 9)	V_I		30	V
Output current (pins 2, 3, 13, 14)	I_Q		50	mA
Output voltage (pins 2, 3, 13, 14) independent of V_S	V_Q		30	V
Voltage on V_{REF} (pin 5)	V_R		8	V
Output current of stabilized voltage (pin 10)	I_{10}		10	mA
Inhibit input voltage (pins 4, 12)	V_{IH}		7	V
Junction temperature	T_j		150	°C
Storage temperature	T_{stg}	- 55	125	°C
Thermal resistance system - air	P-DIP-14-1 $R_{th\ SA}$		80	K/W
	P-DSO-14-1 $R_{th\ SA}$		125	K/W

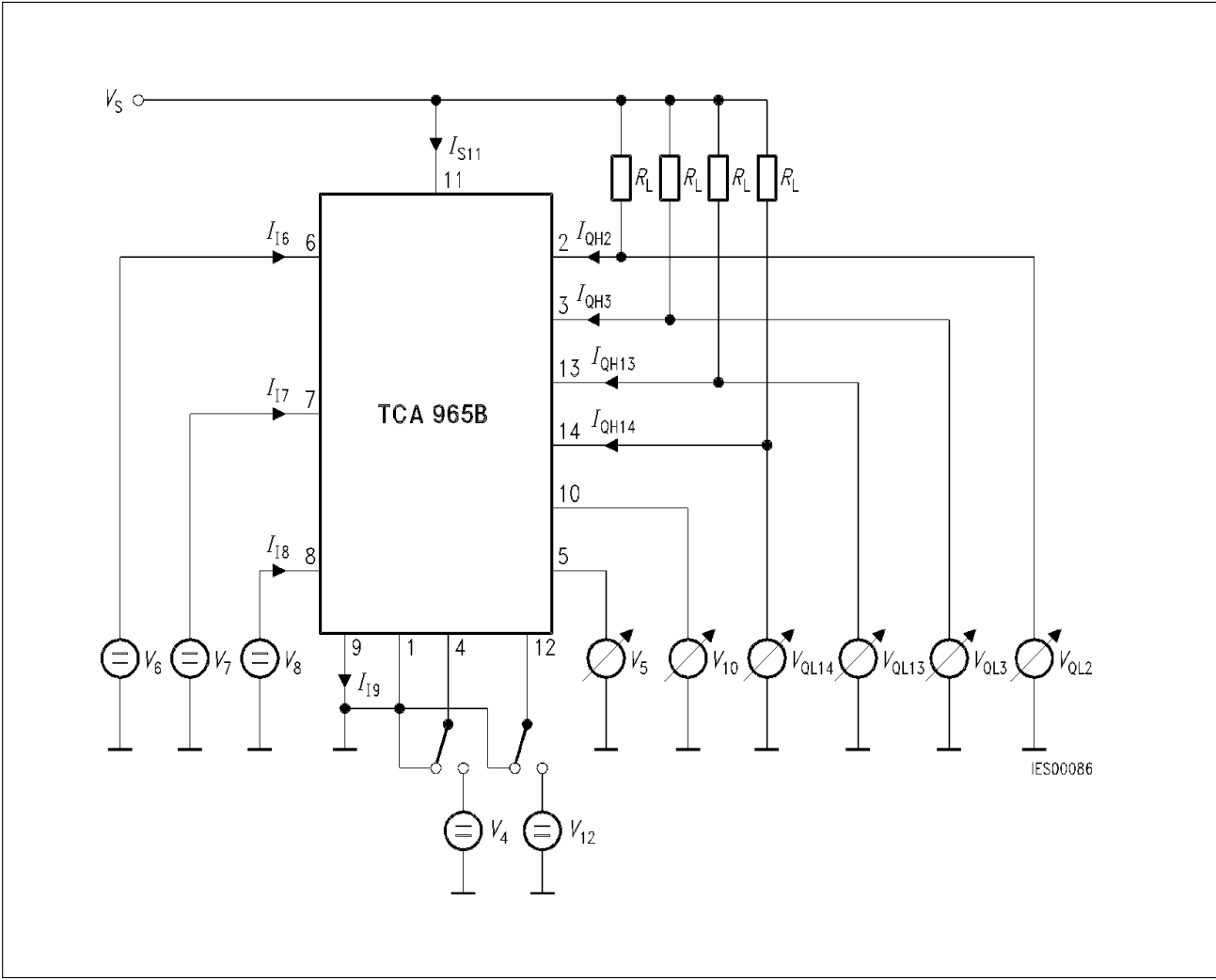
Operating Range

Supply voltage	V_S	4.5	30	V
Ambient temperature	T_A	- 25	85	°C

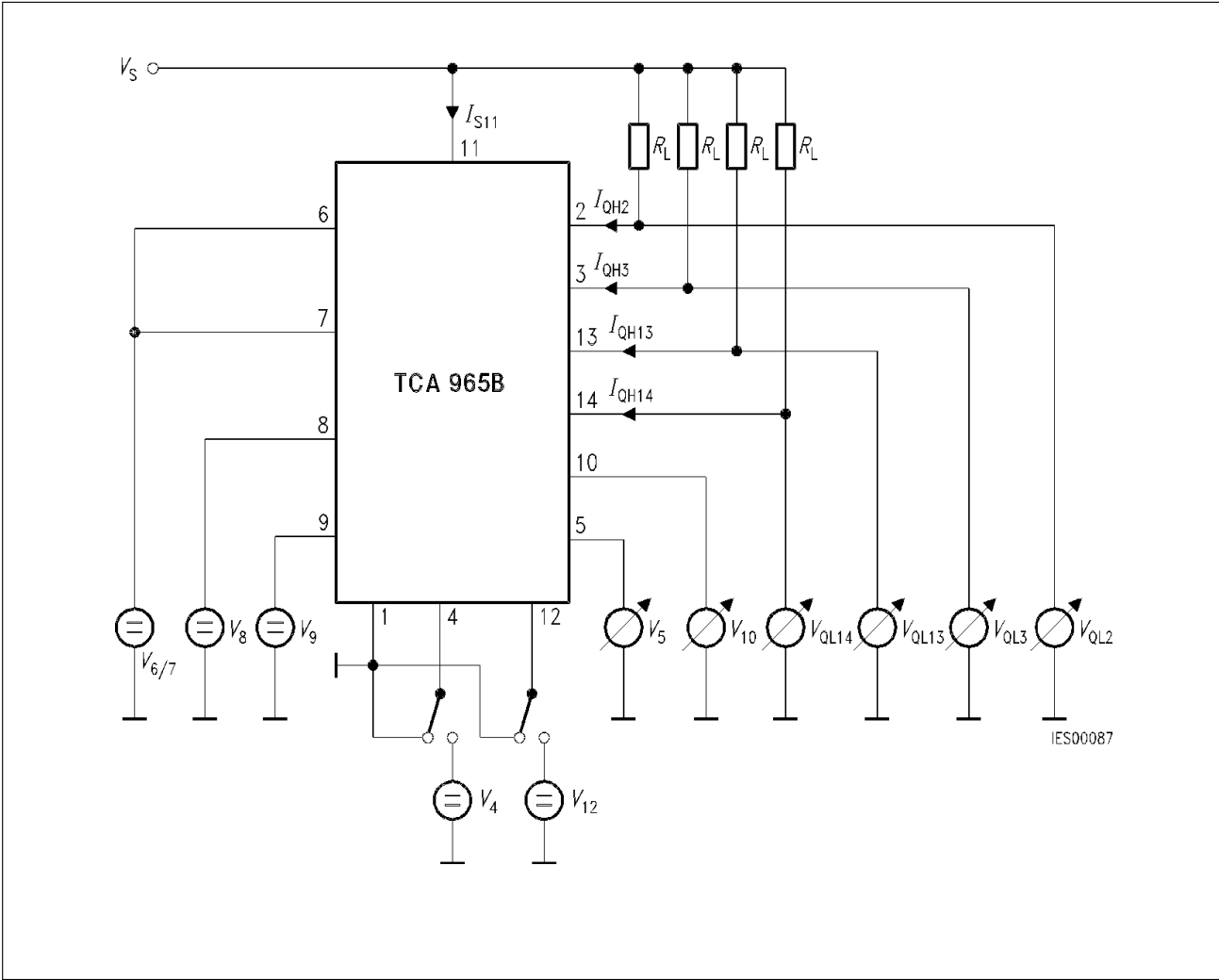
Characteristics

$V_S = 10\text{ V}$; $T_A = 25\text{ °C}$

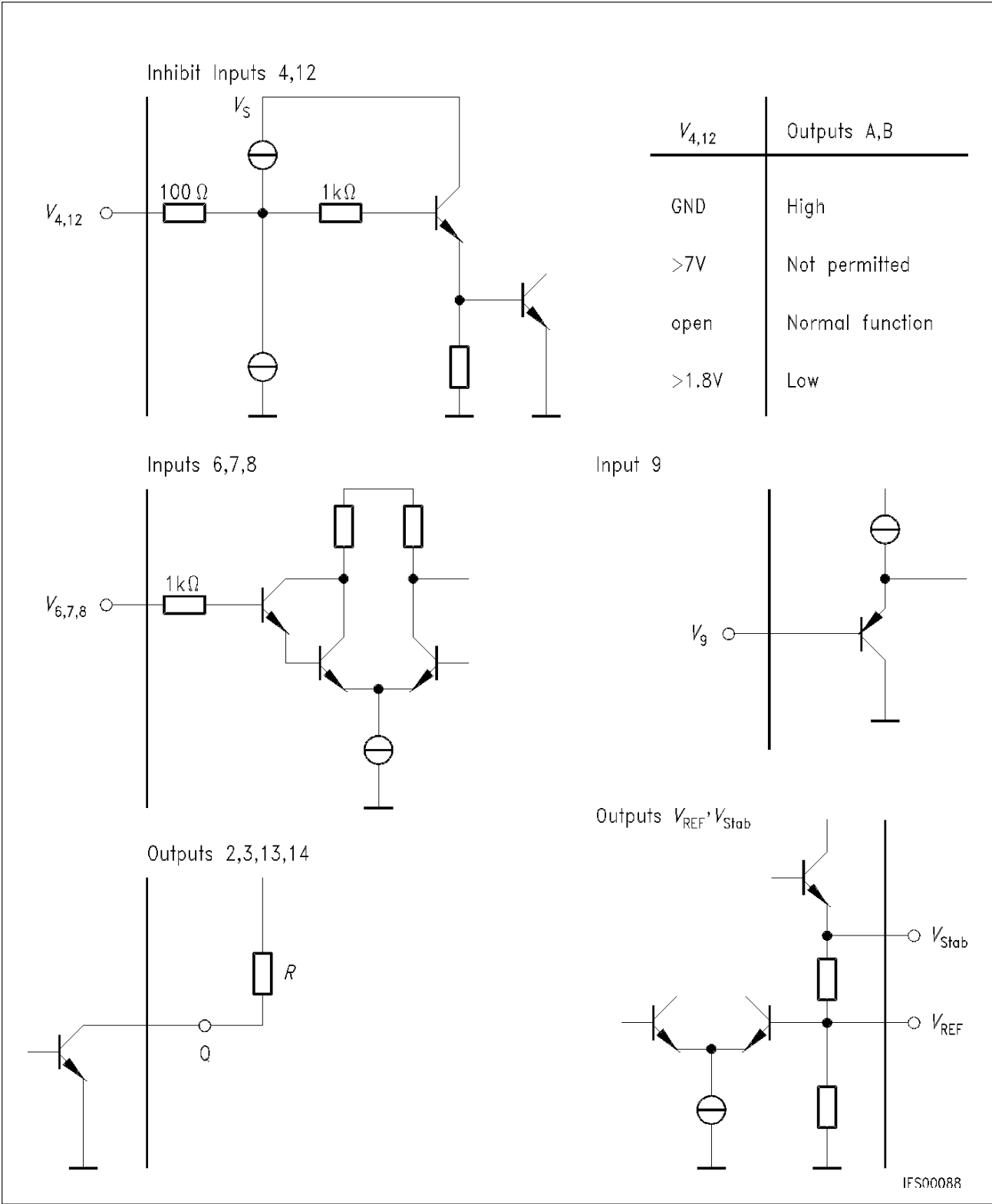
Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Current consumption	I_S		5	7	mA	$V_2, V_{13} = V_{QH}$	1
Input current (pins 6, 7, 8)	I_I		20	50	nA		1
Input current, pin 9	$-I_I$		400	3000	nA		1
Input offset voltage in direct setting of window	V_{IO}	- 20		20	mV		1
Input offset voltage in indirect setting of window	V_{IO}	- 50		50	mV		2
Input-voltage range on pins 6, 7, 8	V_I	1.5		$V_S - 1$	V	$\Delta V_I < 13\text{ V}$	1
Input-voltage range on pin 9	V_I	50		$V_S/2$	mV		2
Differential input voltage	$V_6 - (V_8 - V_9)$ $(V_8 + V_9) - V_7$			13 13	V V		
Reference voltage	V_5	2.8	3	3.2	V	$I_{REF} = 0$	
Stabilized voltage on pin 10	V_{10}	5.5	6	6.5	V	$V_S > 7.9\text{ V}$	
TC of reference voltage	αV_5		0.4		mV/K		
Sensitivity of reference voltage to supply-voltage variation	$\Delta V_5/\Delta V_S$		2		mV/V		
Output reverse current	I_{QH}			10	μA		
Output saturation voltage	V_{QL}		100 500	200 800	mV mV	$I_Q = 10\text{ mA}$ $I_Q = 50\text{ mA}$	1
Hysteresis of window edges	$V_U - V_L$	18	22	35	mV		
Inhibit threshold	$V_{4, 12}$	1		1.8	V		
Inhibit current	$I_{4, 12}$		- 100		μA		
Switching frequency	f_{dir} f_{ind}		20 50		kHz kHz		1 2



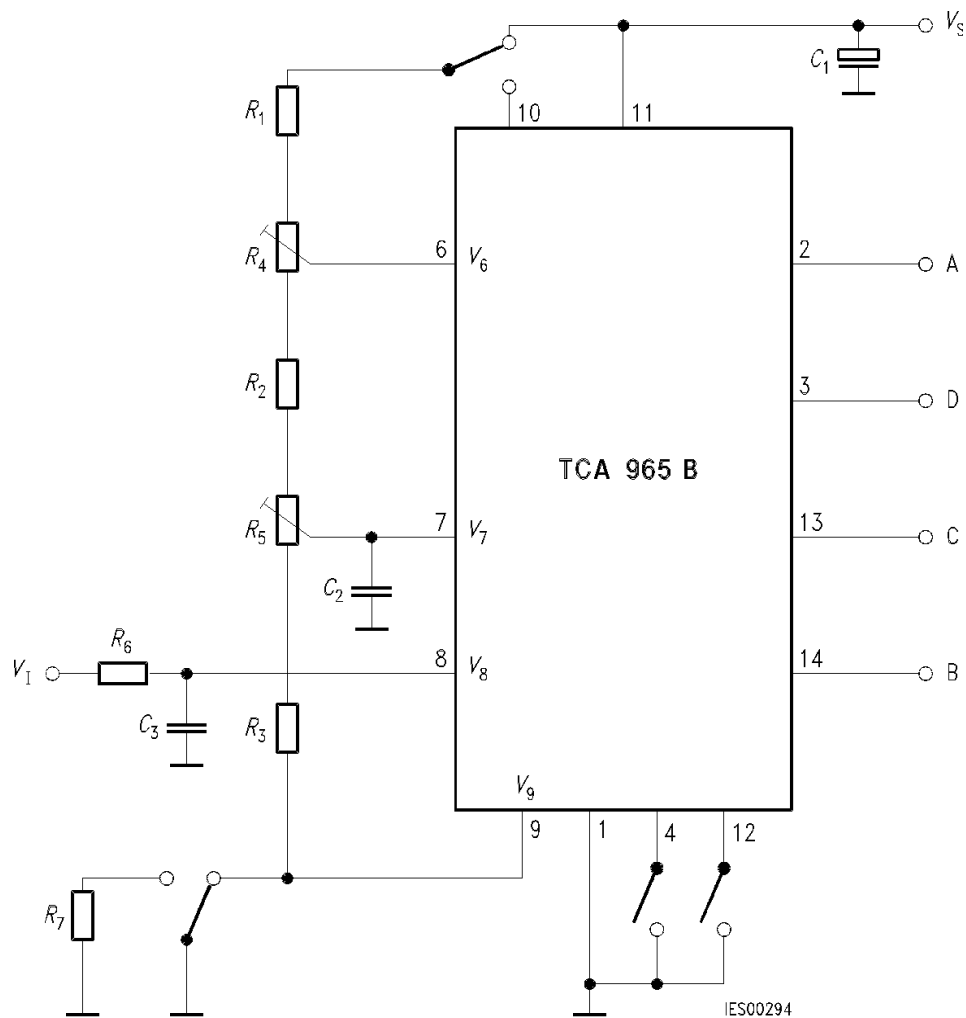
Test Circuit 1
Direct Setting of Window



Test Circuit 2
Indirect Setting of Window by Center Voltage and Half Window Width



Schematic Circuit Diagrams



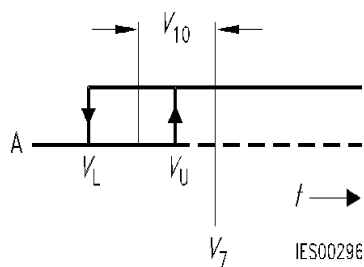
To increase the switching frequency, pin 9 may be grounded via R_7 (V_9 approx. 30...40mV).

Application Circuit 1 Direct Setting of Lower and Upper Edge Voltages

$V_6 - V_9$ = Upper edge voltage

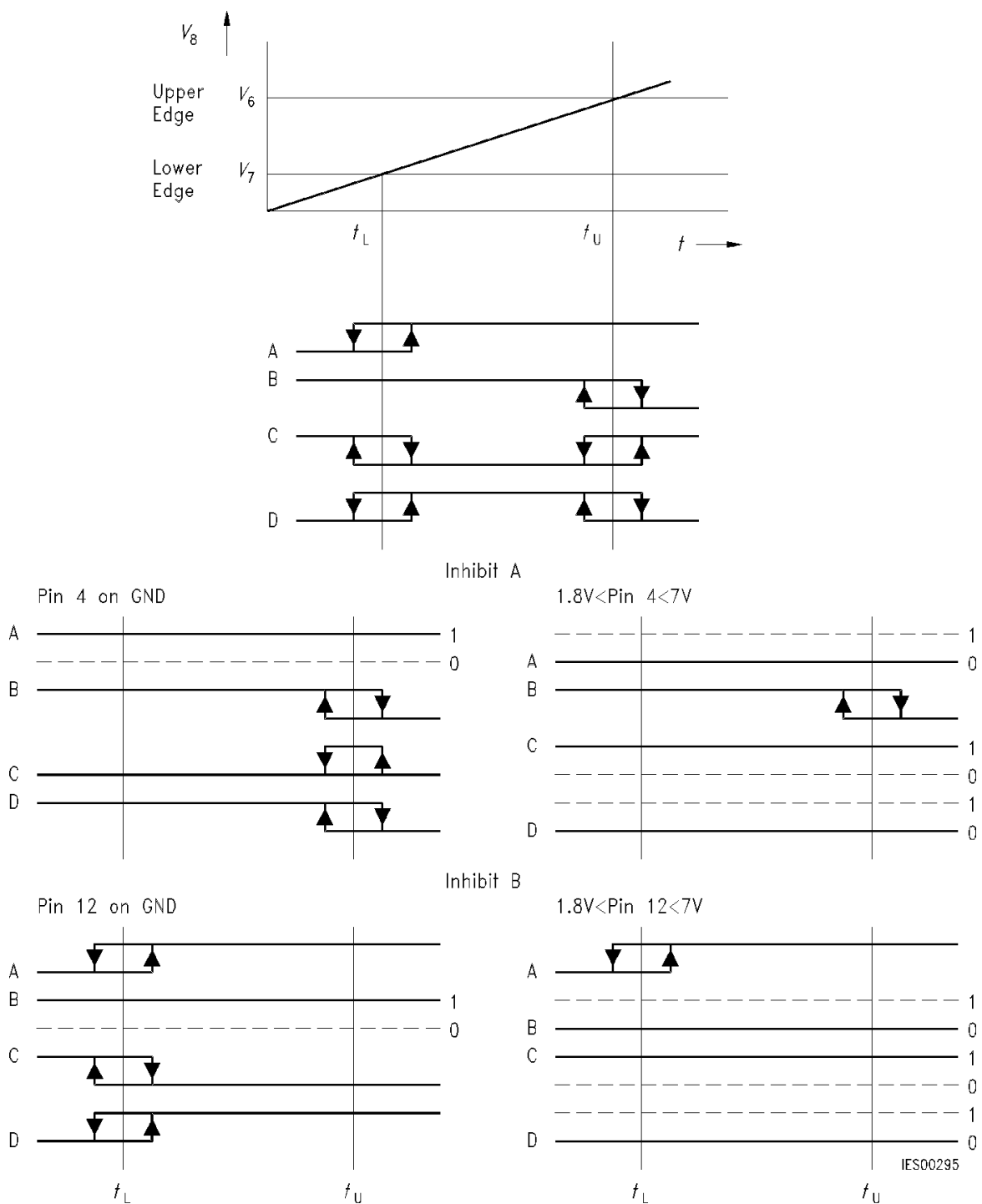
$V_7 + V_9$ = Lower edge voltage

V_8 = Input voltage

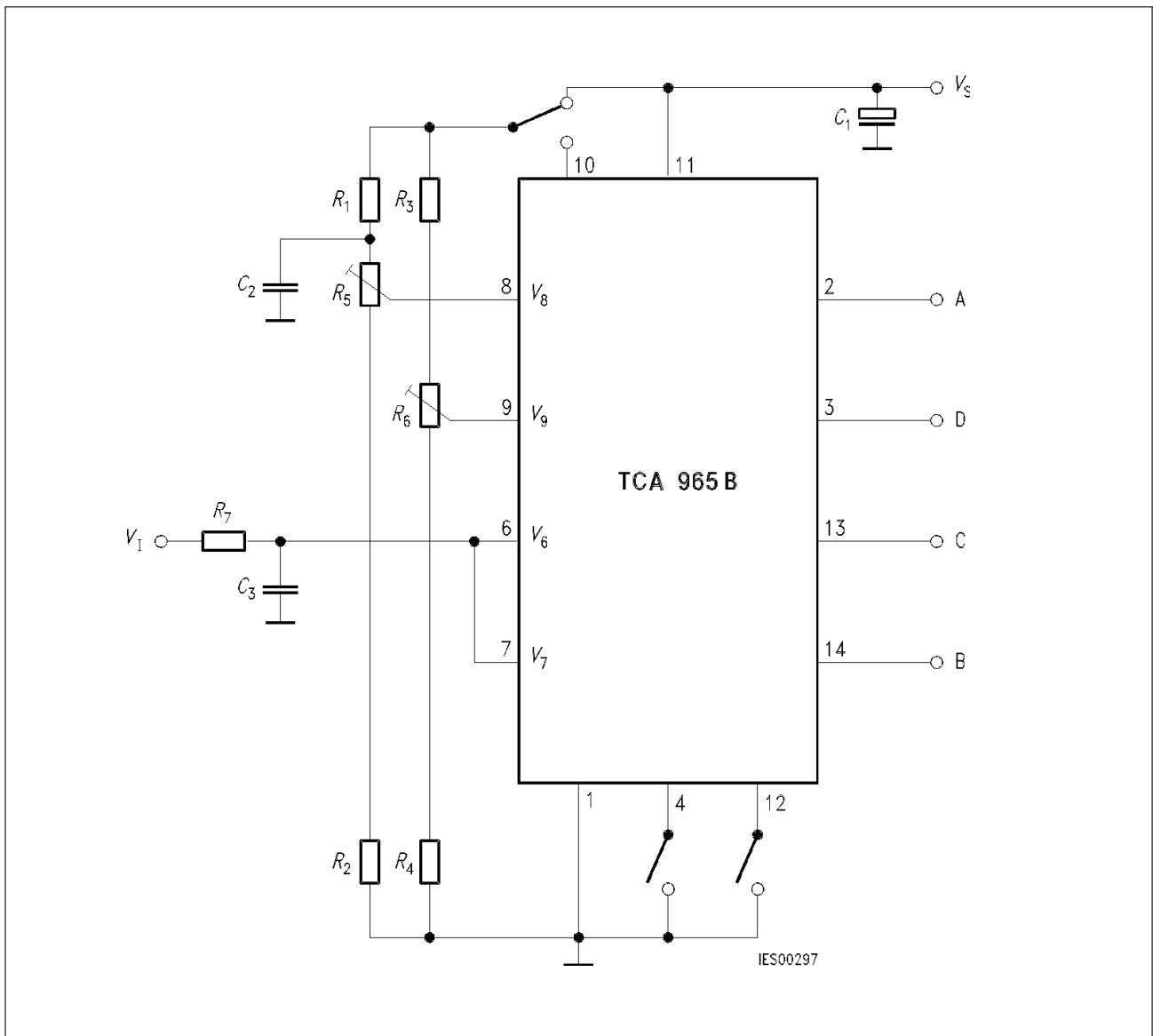


Definition of the Offset Voltage V_{10}

$$V_{10} = \frac{V_L + V_U}{2} - V_7$$

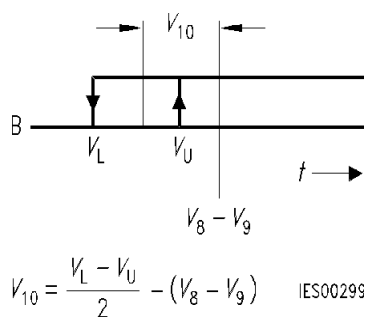


Application Circuit 1
Direct Setting of Lower and Upper Edge Voltages



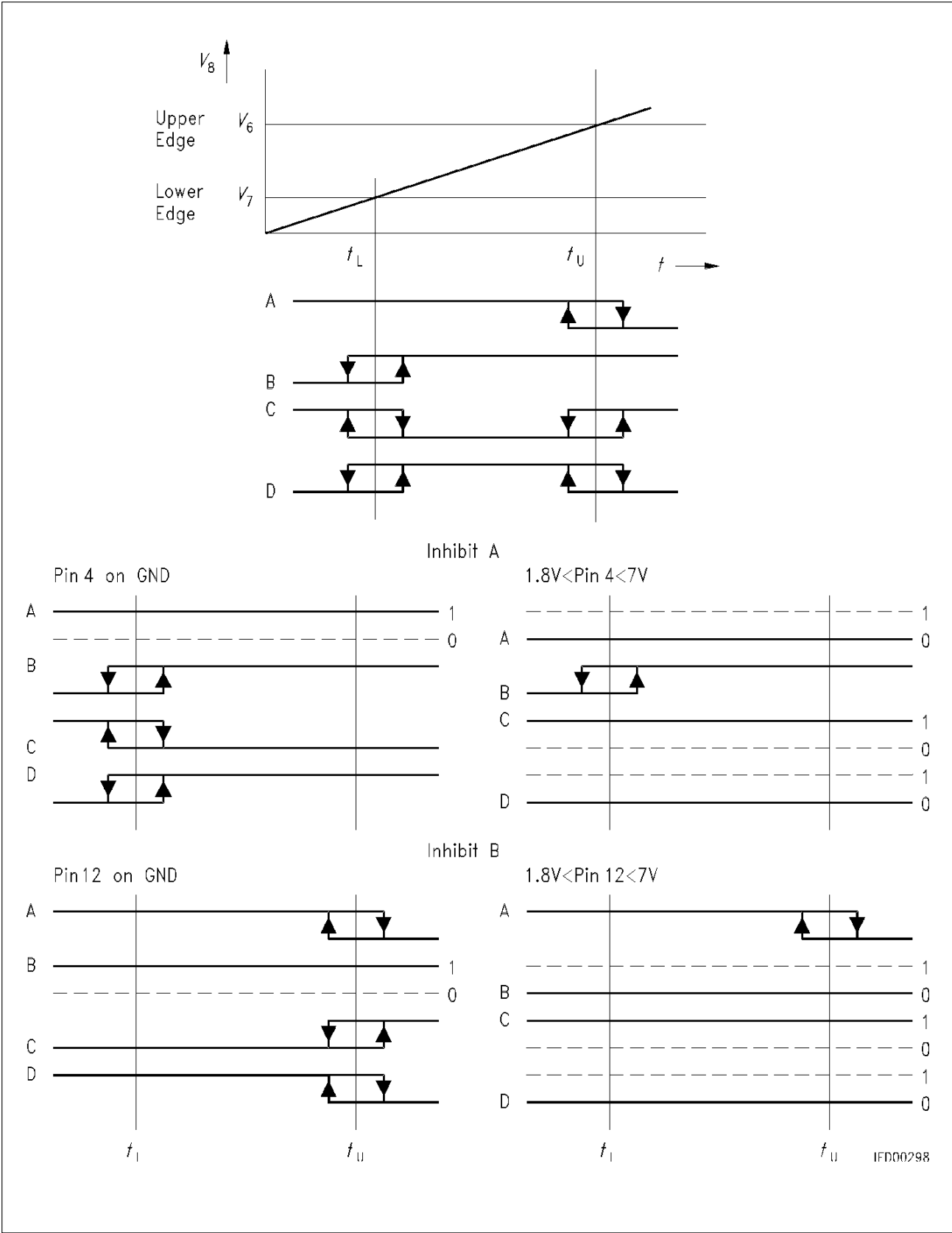
Application Circuit 2
Indirect Setting of Window by Center Voltage and Half-Window Width V

$V_6 = V_7$ = Input voltage
 V_8 = Center voltage
 V_9 = Half window width

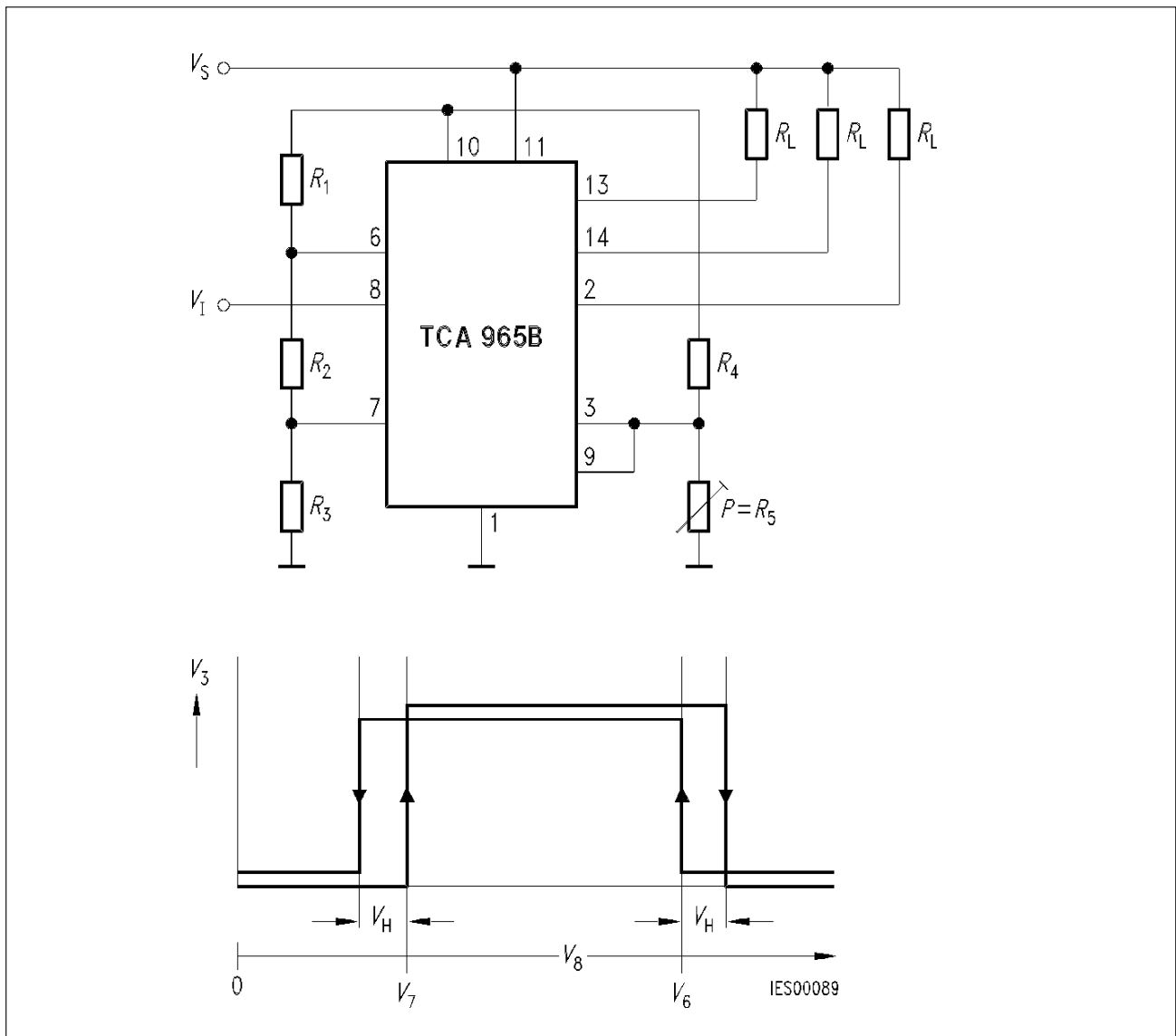


Definition of the Offset Voltage V_{10}

$$V_{10} = \frac{V_L + V_U}{2} - (V_8 - V_9)$$



Application Circuit 2
Indirect Setting of Window by Center Voltage and Half-Window Width V

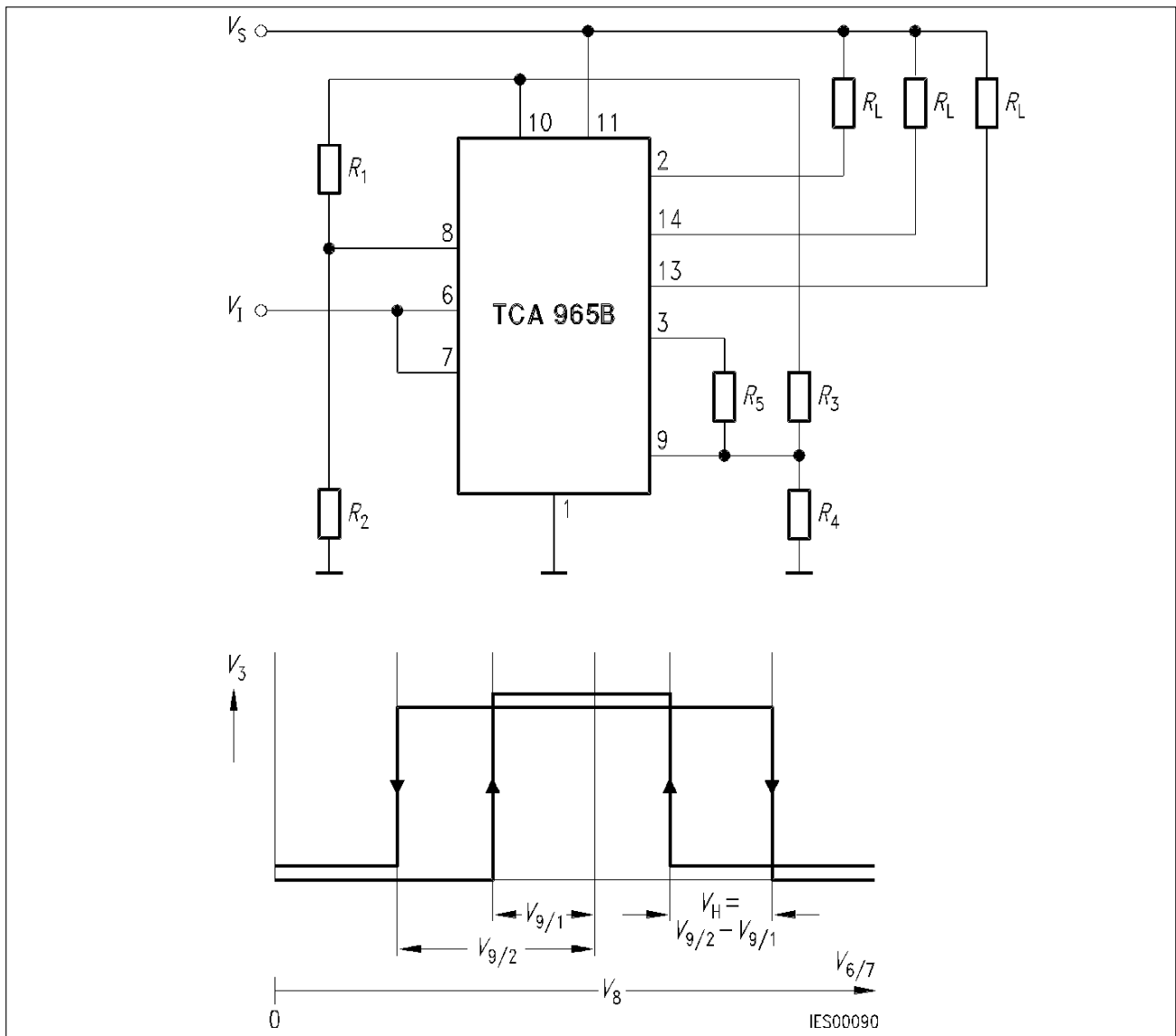


Application Circuit 3
Symmetrically Enlarged Edge Hysteresis in Direct Setting of Window

Calculation of Hysteresis V_H

$$V_H = V_{10} \frac{R_5}{R_4 + R_5}$$

$$\frac{V_{10}}{R_4 + R_5} + \frac{V_{10}}{R_1 + R_2 + R_3} \leq 10 \text{ mA}$$



Application Circuit 4 Symmetrically Enlarged Edge Hysteresis in Indirect Setting of Window

Calculation of Hysteresis V_H

$$V_H = V_{9/2} - V_{9/1}$$

$$V_{9/1} = V_{10} \frac{R_4 \parallel R_5}{R_3 + R_4 \parallel R_5}$$

$$V_{9/2} = V_{10} \frac{R_4}{R_3 + R_4}$$