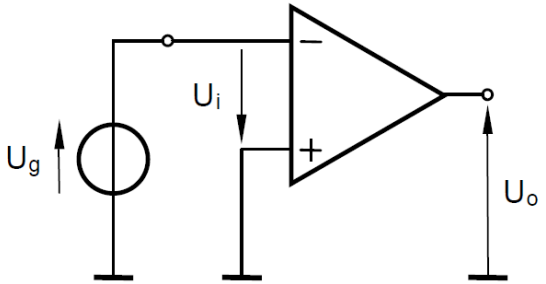
Elektronische signalen 2

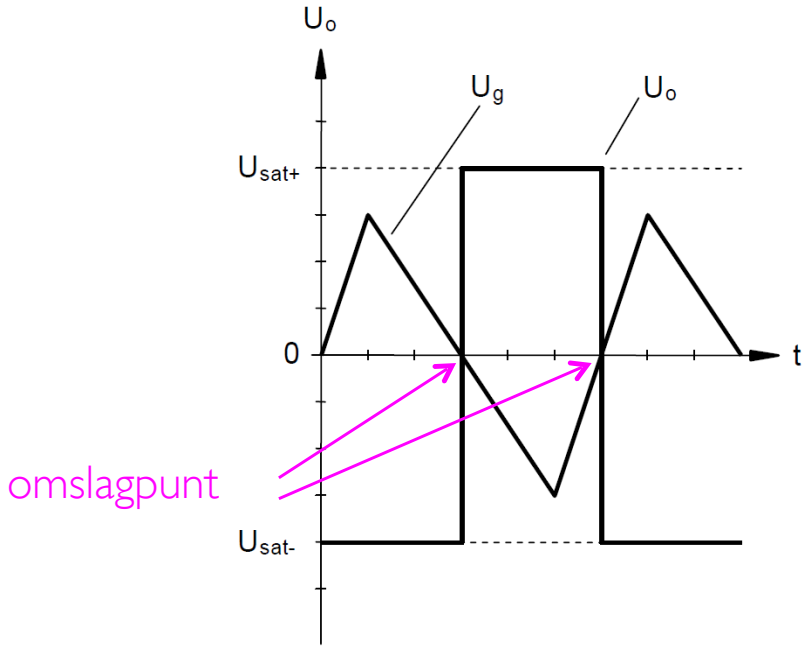
Spanningscomparatoren

P. Debbaut

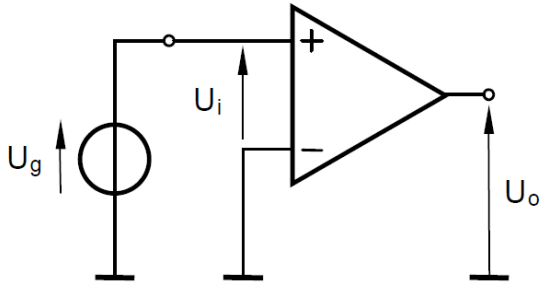
Nuldoorgangsdetector

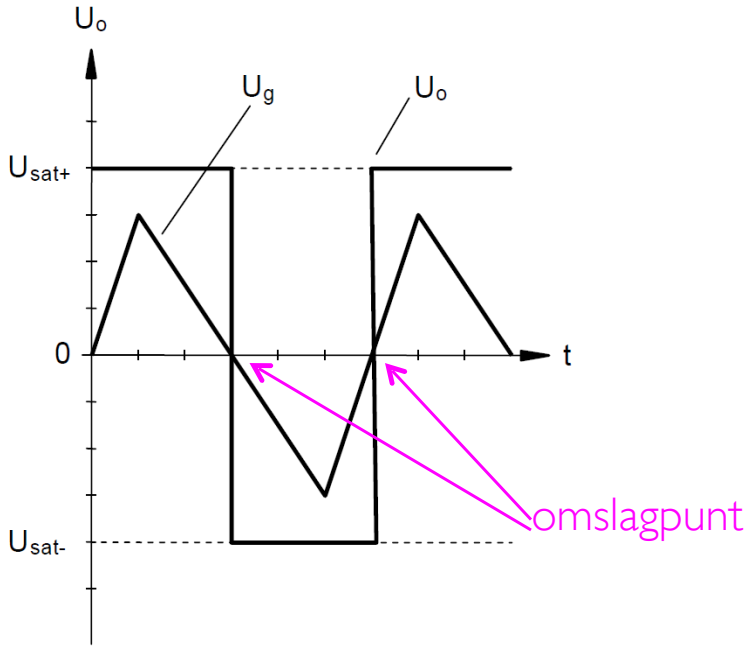
Inverterende-nuldoorgangsdetector





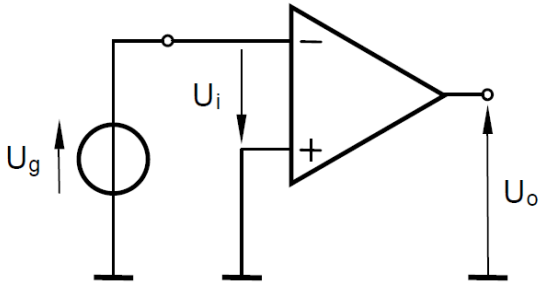
Niet-inverterende-nuldoorgangsdetector



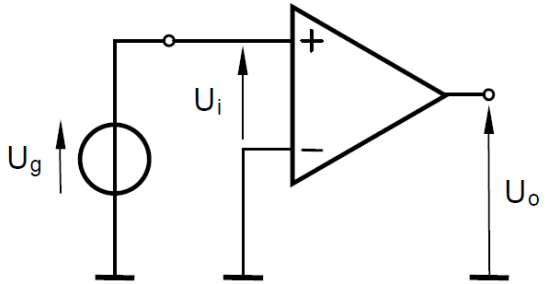


Nuldoorgangsdetector

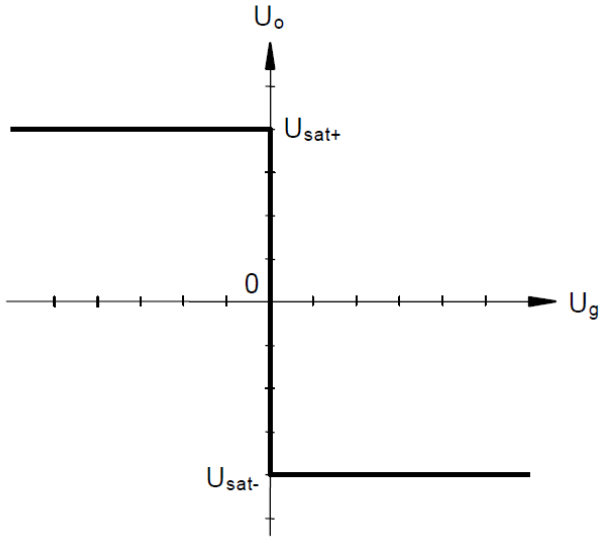
Inverterende-nuldoorgangsdetector

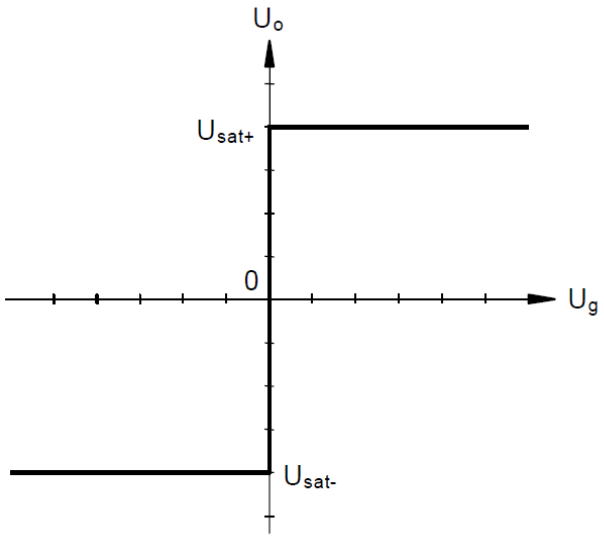


Niet-inverterende-nuldoorgangsdetector



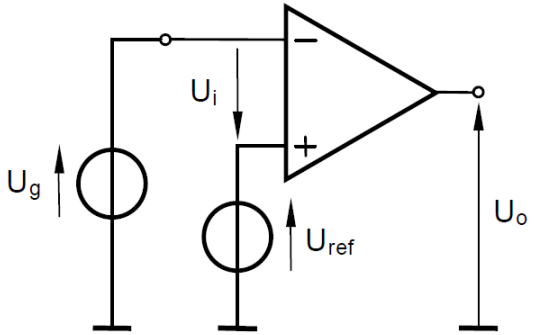
Transferkarakteristieken

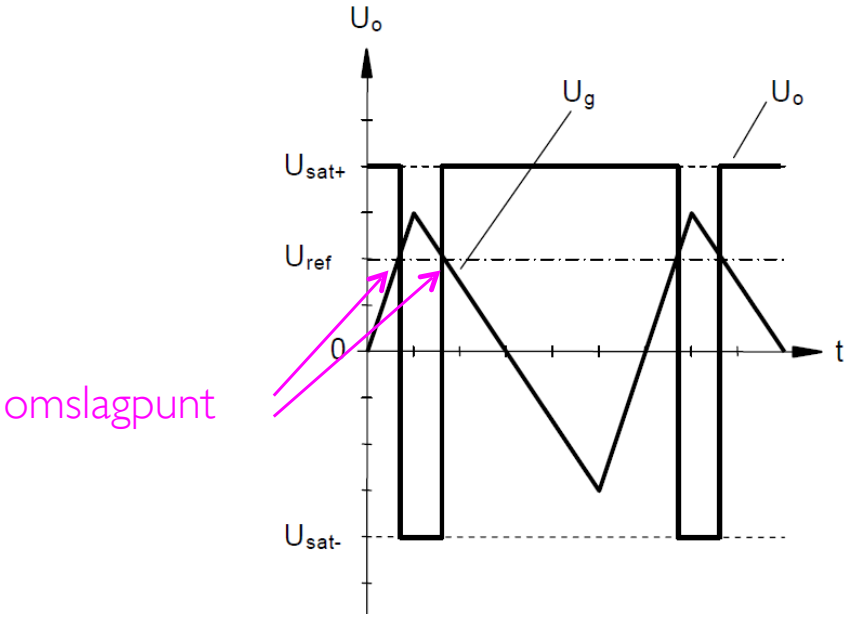




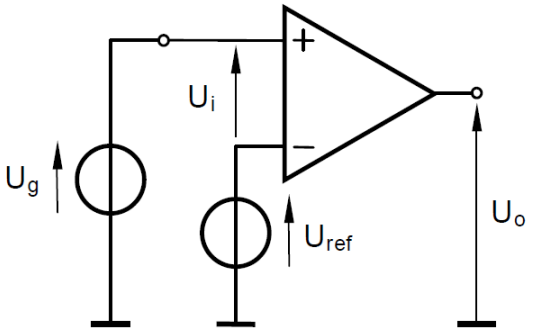
Niveaudetector

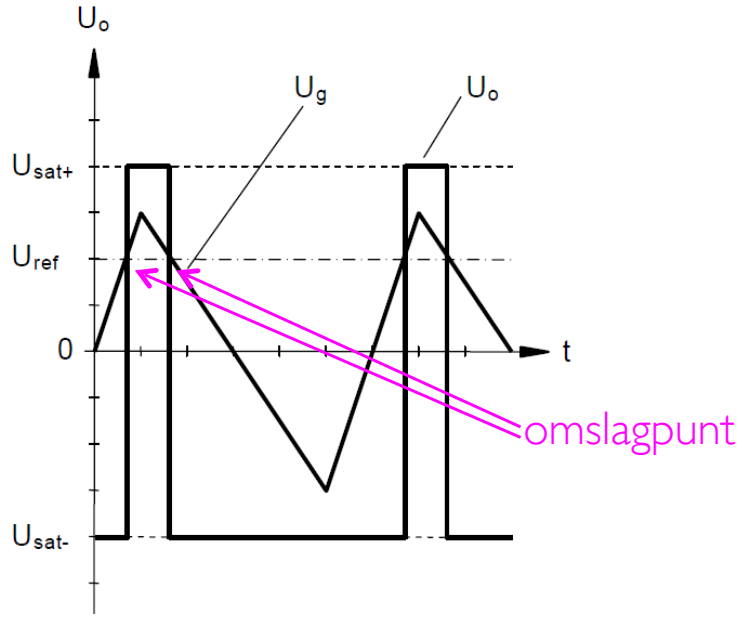
Inverterende-niveaudetector





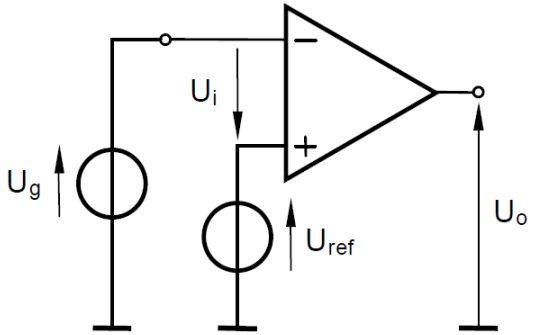
Niet-inverterende-niveadetector



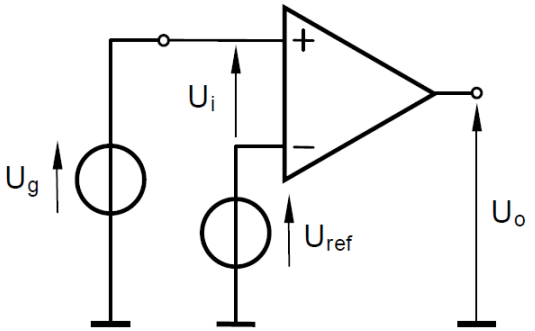


Niveaudetector

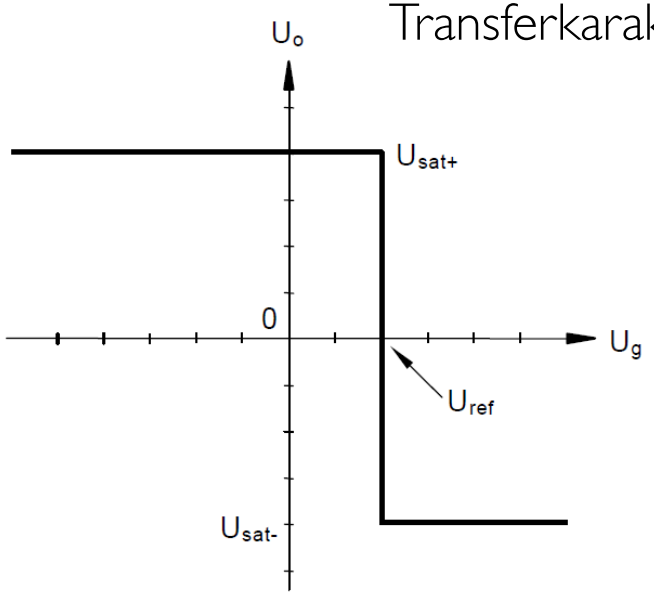
Inverterende-niveaudetector

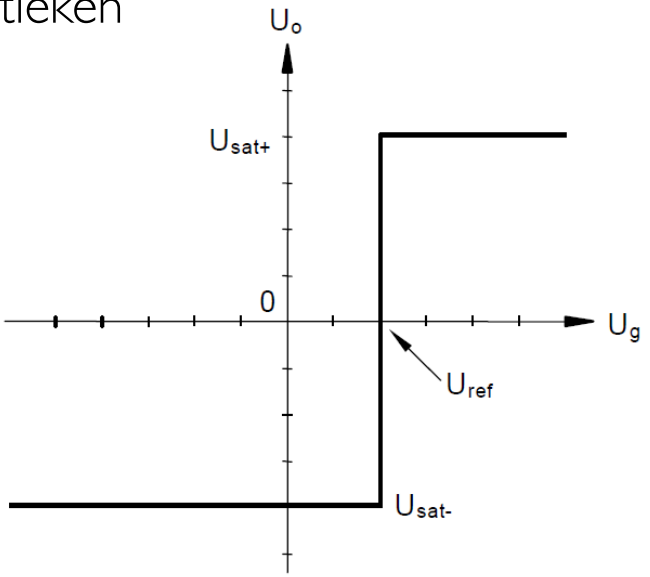


Niet-inverterende-niveadetector



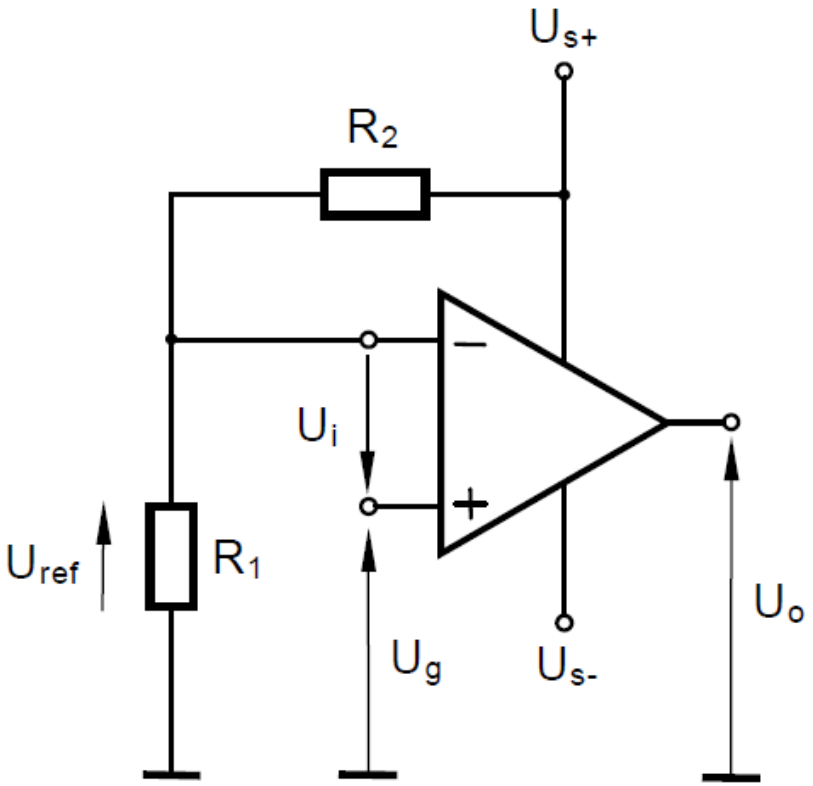
Transferkarakteristieken



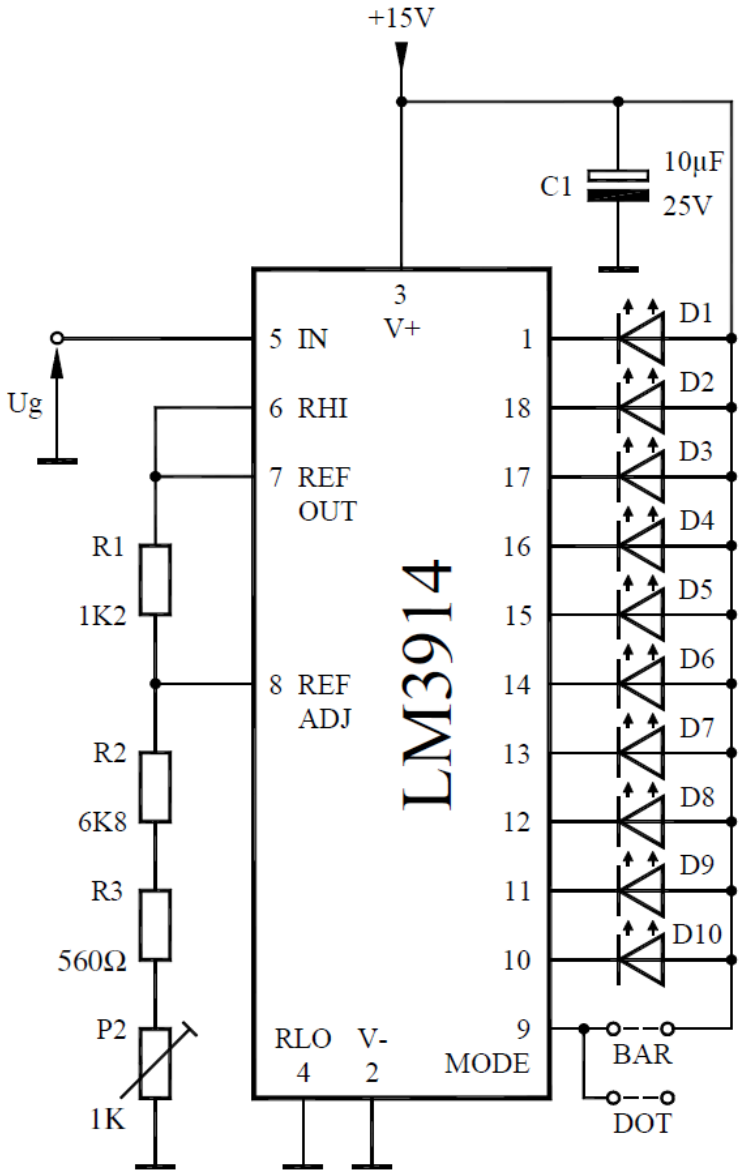


Niveaudetector

Voorbeeld: niet-inverterende niveaudetector met spanningsdeler als U_{ref}



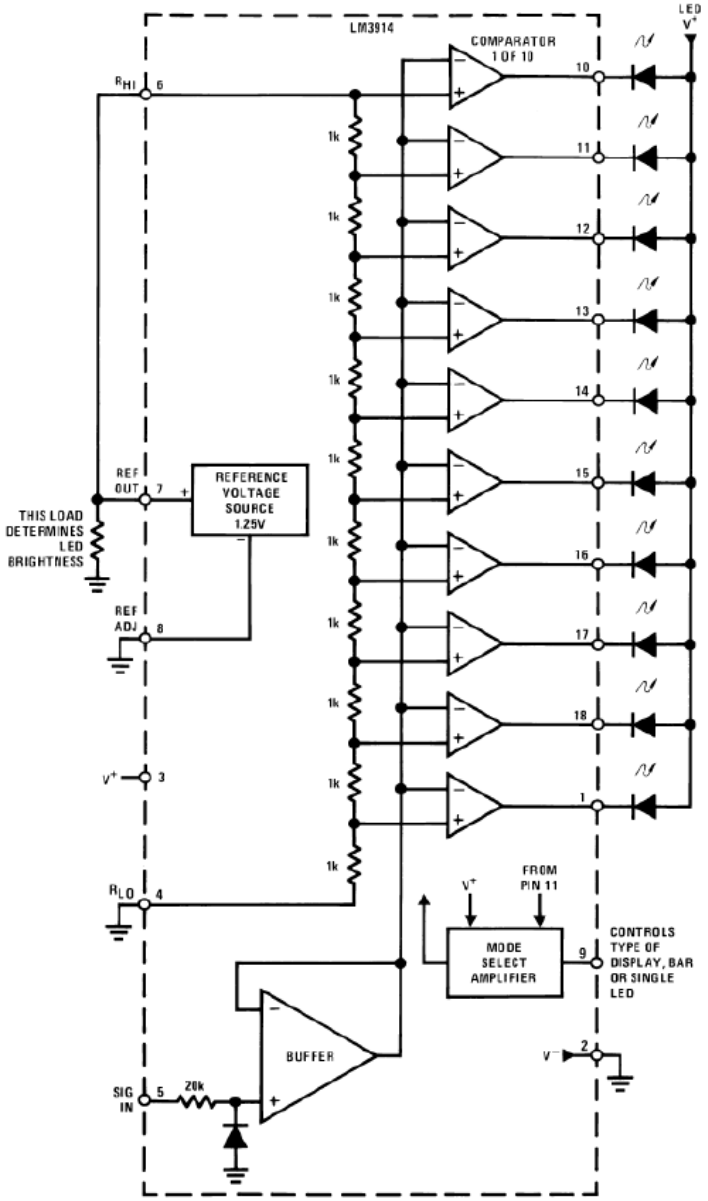
Dot/Bar Graph Display

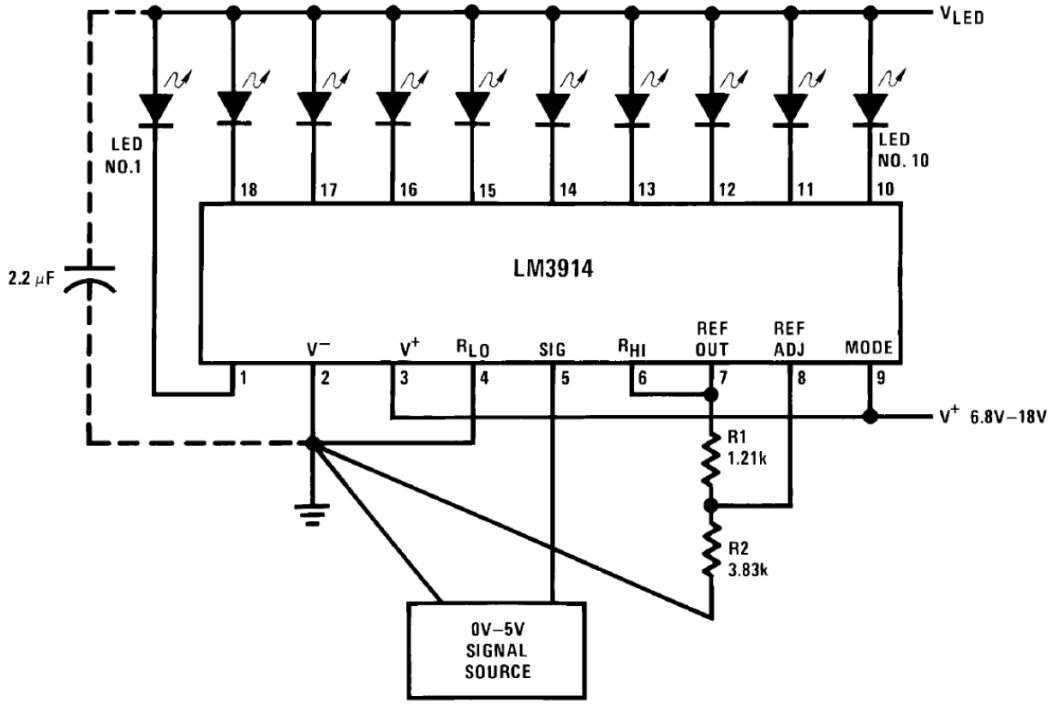


Toepassing:

ontwerpen van een lineaire voltmeter van 0V…10V met LM3914

Dot/Bar Graph Display





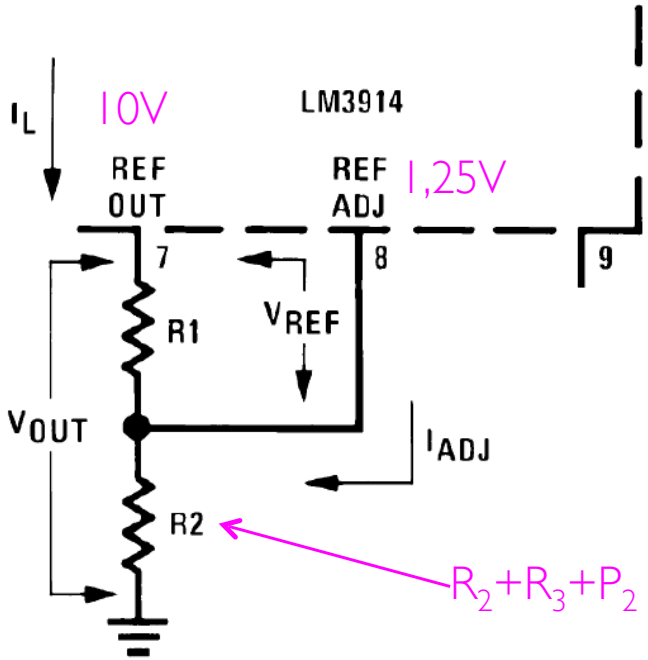
Stroom door de LED's

$$I_{LED} = \frac{12{,}5}{R_1}$$

Bij R_1 = 1,2kΩ → ≈10mA

Dot/Bar Graph Display

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}\,R_2$$



≈ middenstand potmeter 1K

Bepalen R_2

$$R_2 = \frac{V_{OUT} - V_{REF}}{\frac{V_{REF}}{R_1} + I_{ADJ}}$$

I_{ADJ} = 75µA en U_{REF} = 1,25V

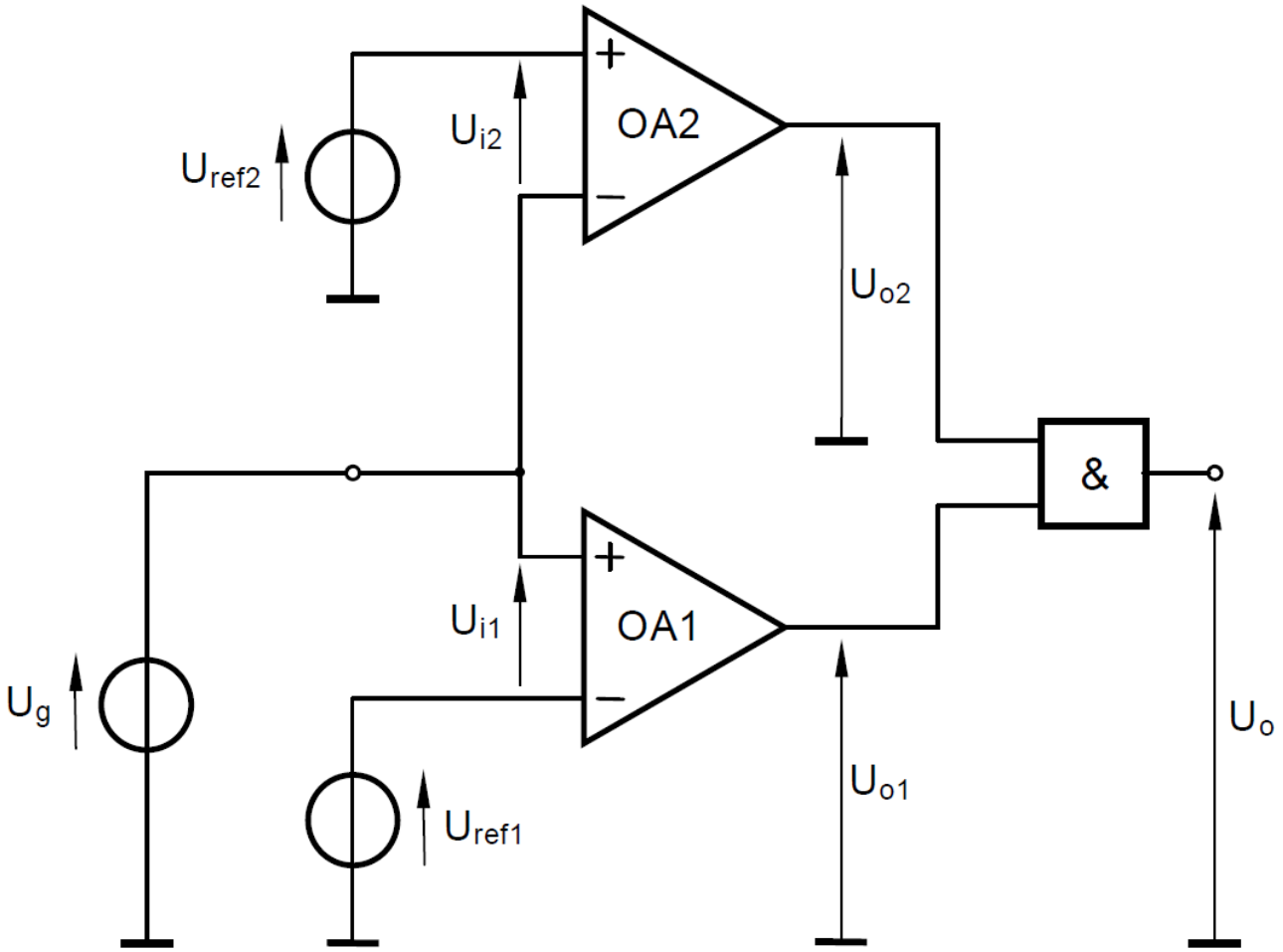
$$R_2 = \frac{10 - 1{,}25}{\frac{1{,}25}{1{,}2.10^3} + 75.10^{-6}} = 7836\Omega$$

$$P2 = R_2 - R2 - R3$$

$$= 7836\Omega - 6800\Omega - 560\Omega$$

$$= 475{,}82\Omega$$

Venstercomparator



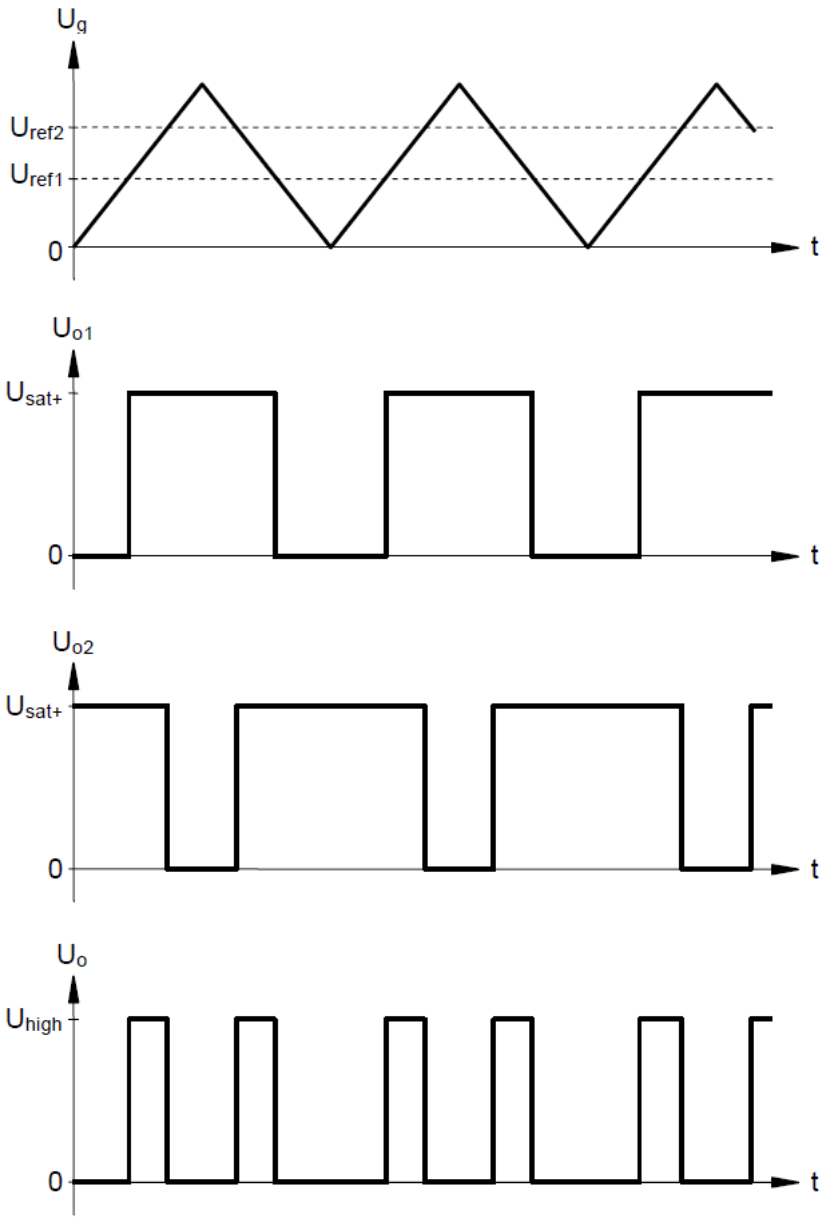
Voorwaarde:

$U_{ref2} > U_{ref1}$

Uitgang hoog:

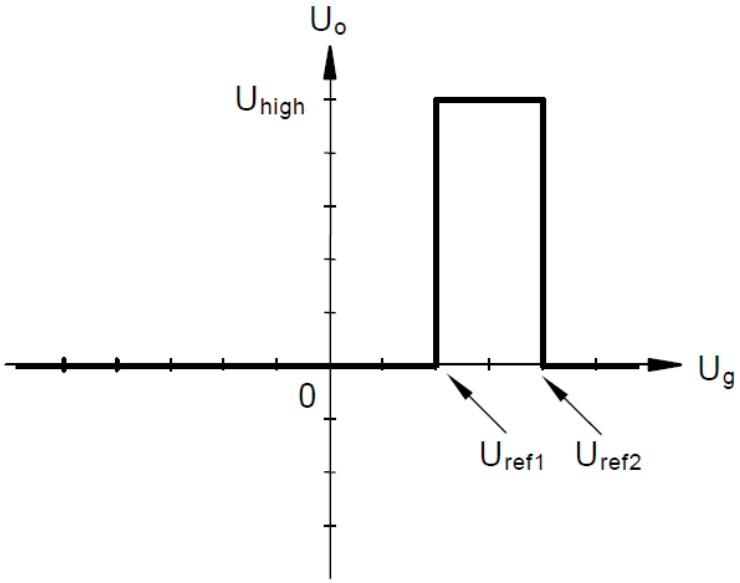
$U_g < U_{ref2}$ en
$U_g > U_{ref1}$

Venstercomparator-signalen

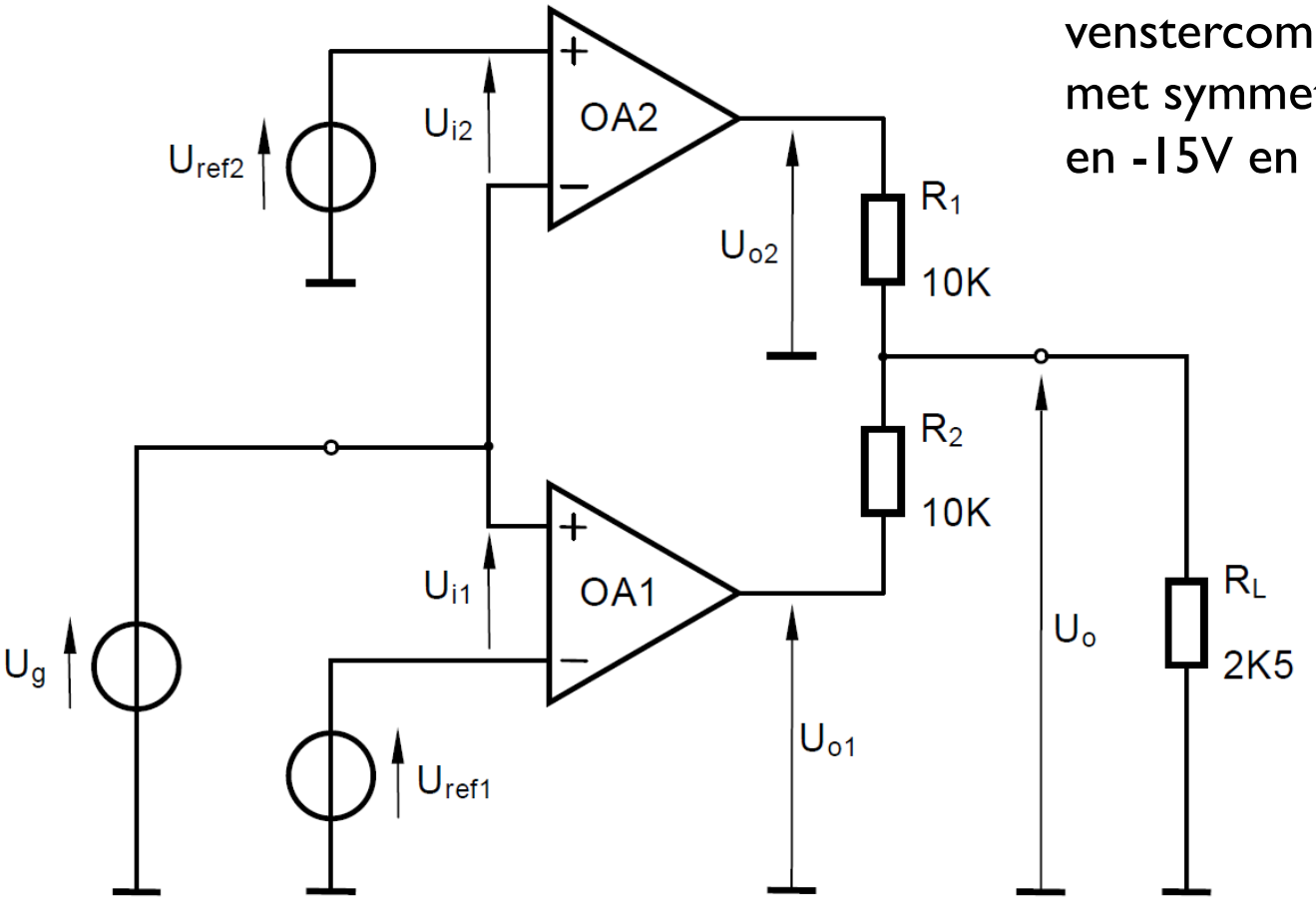


Opamps asymmetrisch gevoed (U_{s+} 15V en U_{s-} 0V)

Transferkarakteristiek



Venstercomparator



Voorbeeld:
venstercomparator zonder AND-poort
met symmetrische voeding van +15V
en -15V en ideale opamp

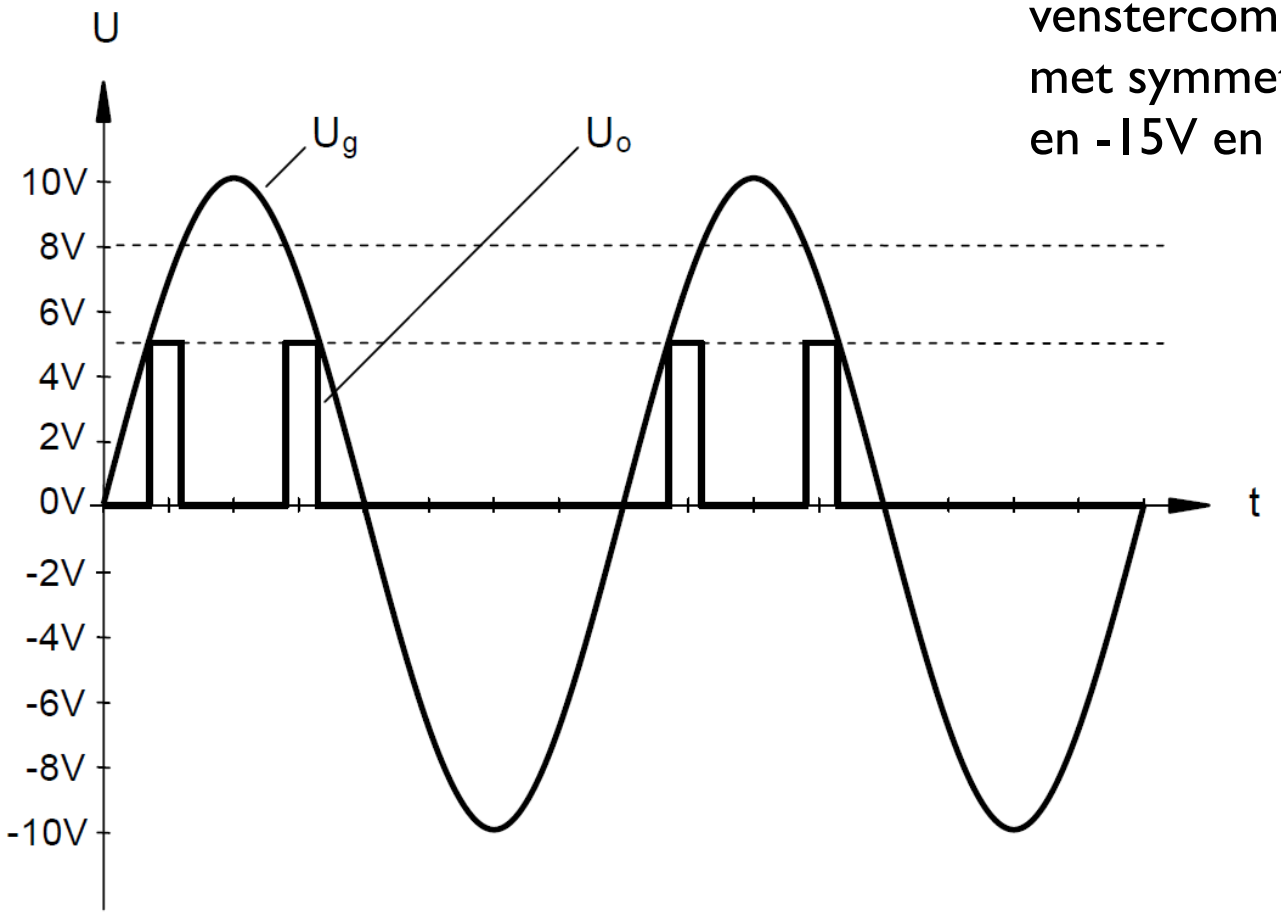
U_{ref1} = 5V

U_{ref2} = 8V

U_g: sinus van $20V_{tt}$

Venstercomparator

Voorbeeld:
venstercomparator zonder AND-poort
met symmetrische voeding van +15V
en -15V en ideale opamp

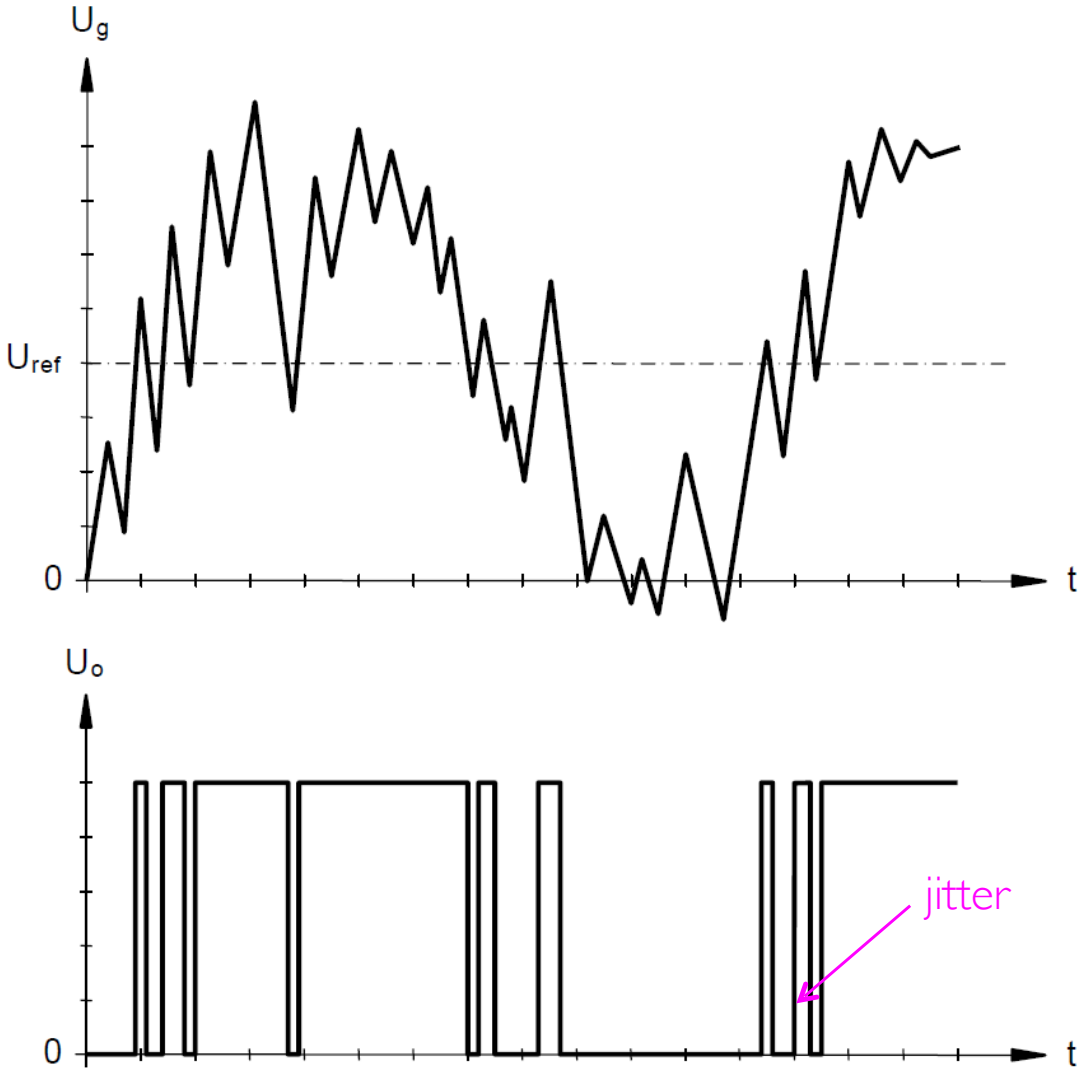


U_{ref1} = 5V

U_{ref2} = 8V

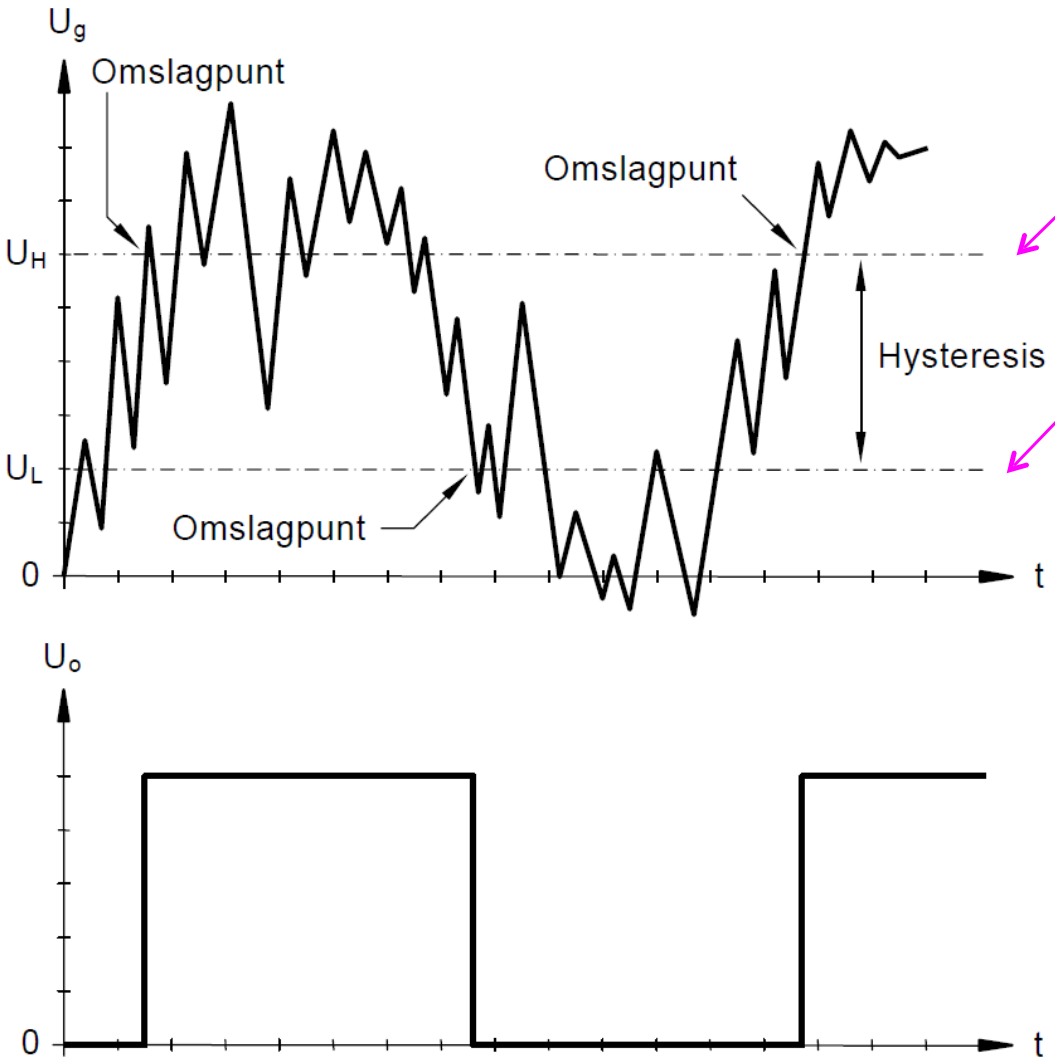
U_g: sinus van $20V_{tt}$

Schmitt-trigger



Foutieve pulsreconstructie bij gewone comparatoren met signaalstoringen

Comparator met hysteresis

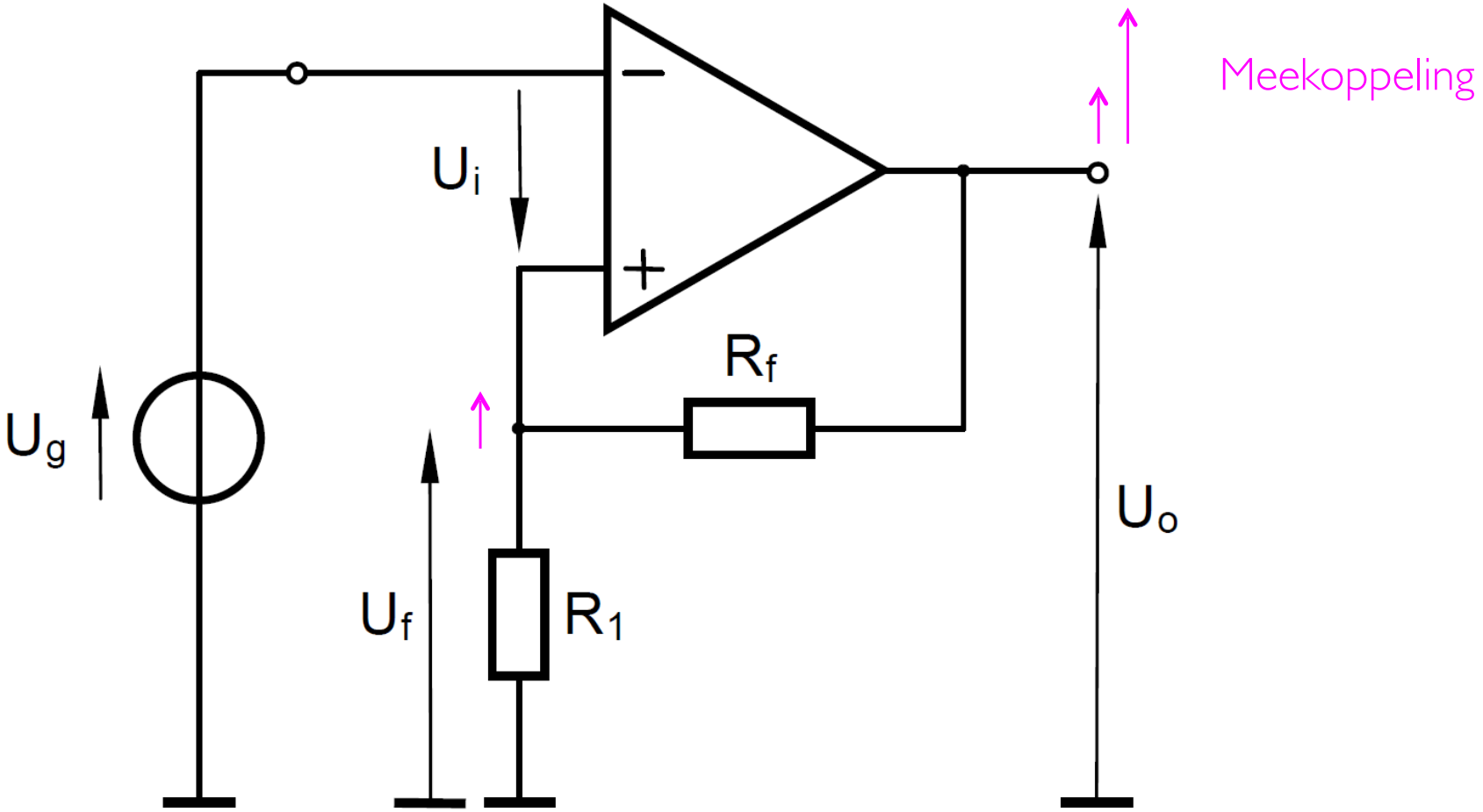


Hoog omklapniveau

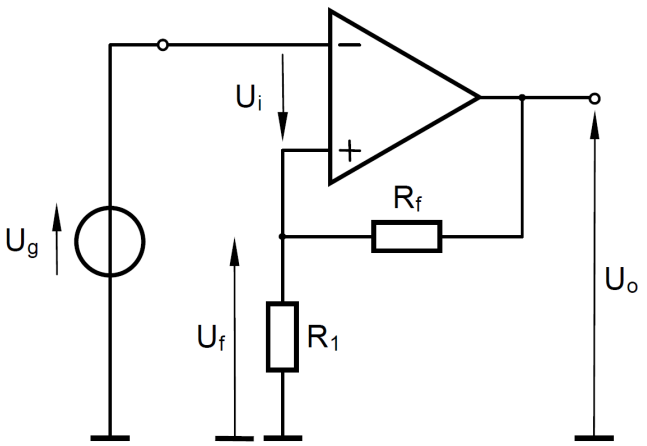
Laag omklapniveau

Correcte pulsreconstructie bij een comparator met hysteresis = Schmitt-trigger met signaalstoringen

Inverterende Schmitt-trigger



Inverterende Schmitt-trigger



Wanneer de uitgangsspanning U_o op U_{sat+} staat

$$U_{(+)} = U_{sat+}\frac{R_1}{R_1 + R_f}$$

$$\boxed{U_L = U_{sat+}\frac{R_1}{R_1 + R_f}}$$

Zolang $U_g < U_L$ blijft $U_o = U_{sat+}$

Wordt nu echter $U_g > U_L$ dan klapt de uitgang zeer snel om van U_{sat+} naar U_{sat-}.

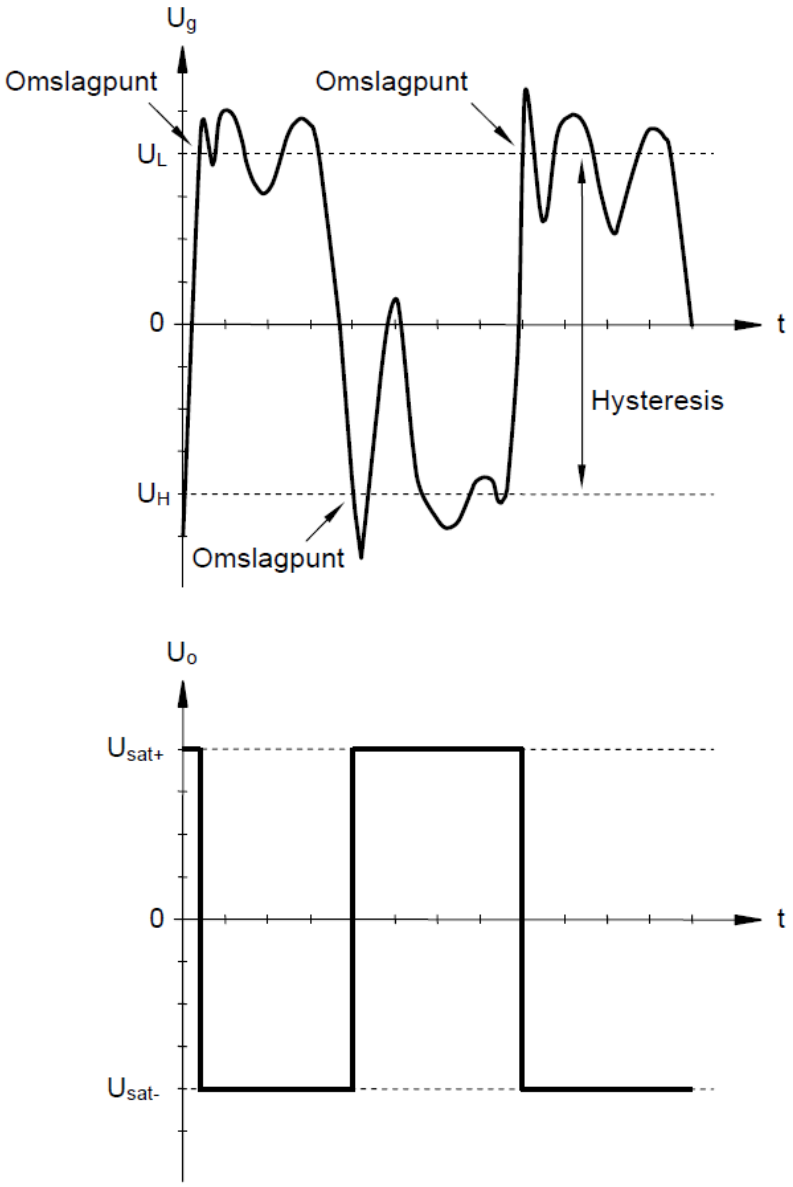
De nieuwe spanning (U_f) op de (+) klem wordt

$$U_{(+)} = U_{sat-}\frac{R_1}{R_1 + R_f}$$

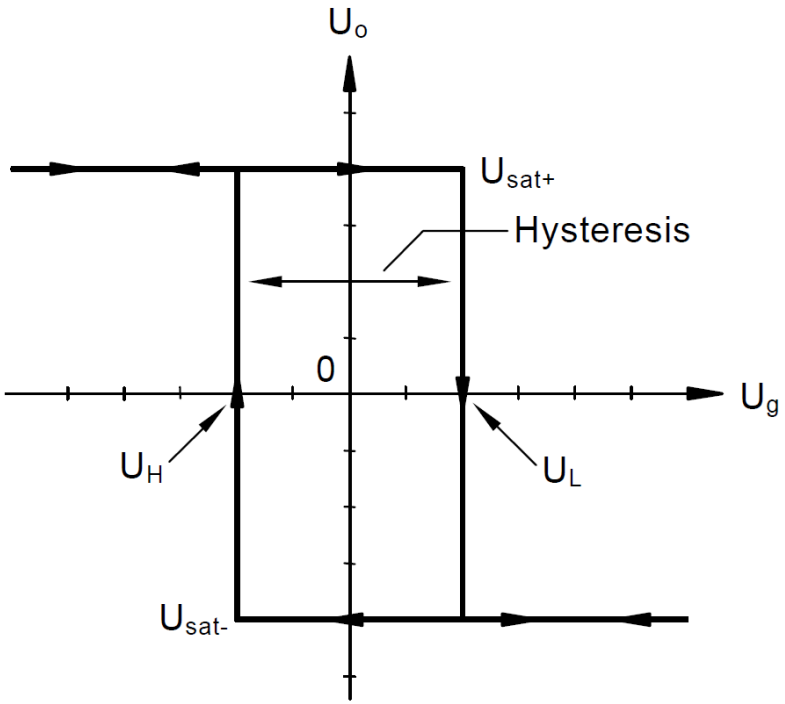
De ingangsspanning moet nu dalen tot onder dit niveau om de uitgang opnieuw te laten omschakelen van U_{sat-} naar U_{sat+}.

$$\boxed{U_H = U_{sat-}\frac{R_1}{R_1 + R_f}}$$

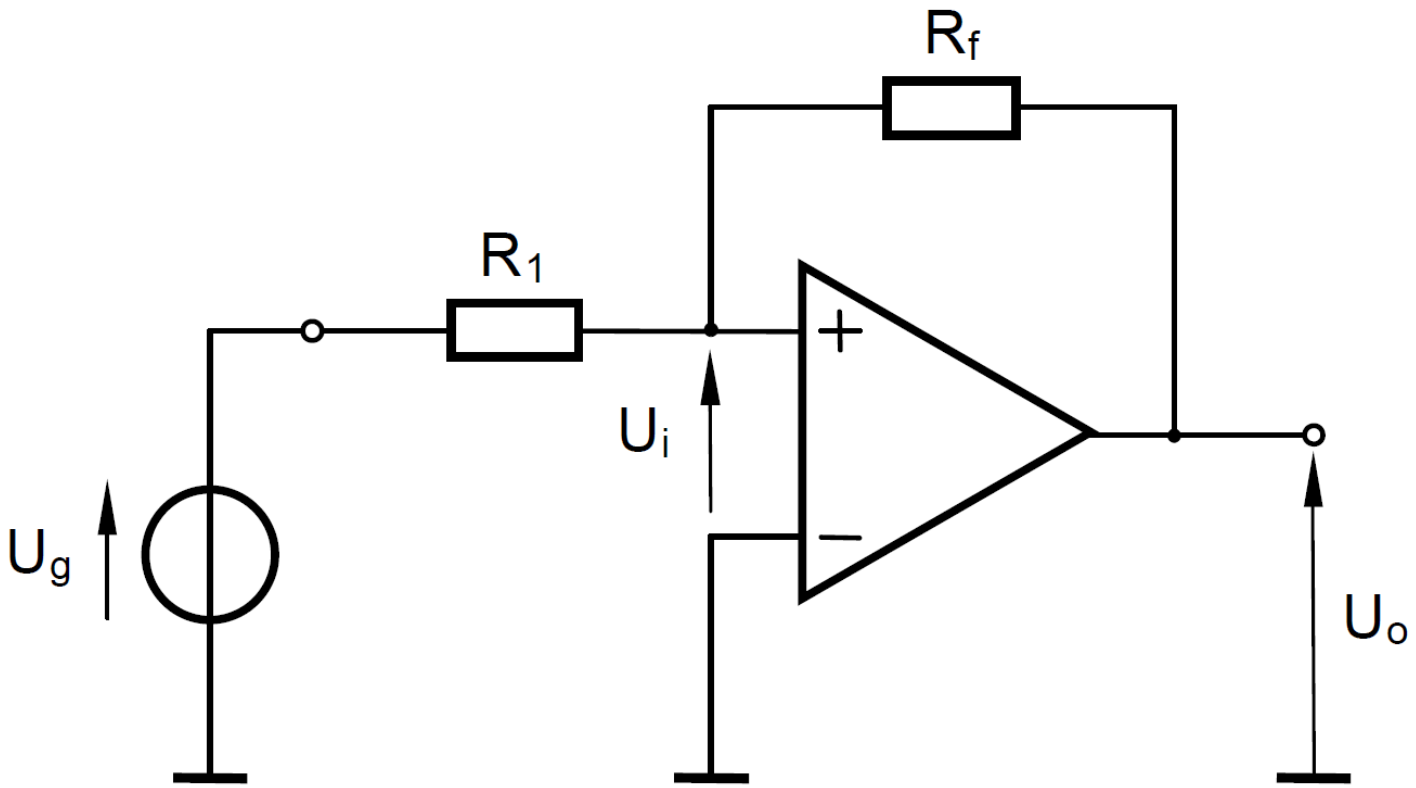
Inverterende Schmitt-trigger



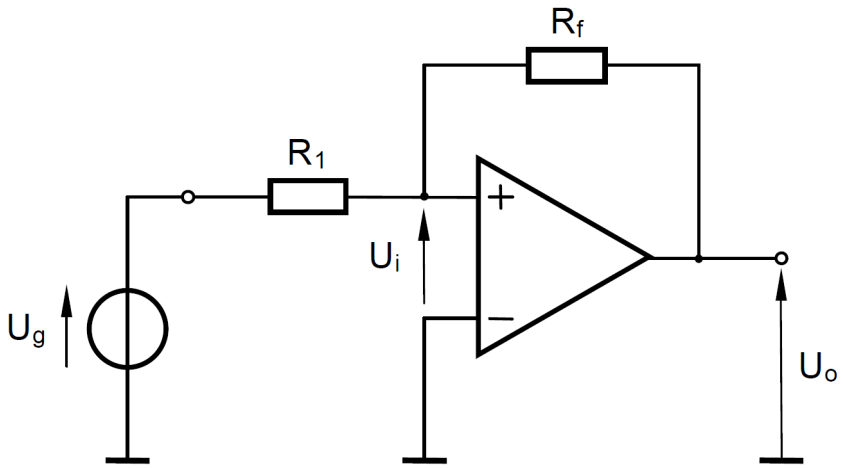
Transferkarakteristiek



Niet-inverterende Schmitt-trigger



Niet-inverterende Schmitt-trigger



Wanneer de uitgangsspanning U_o op U_{sat+} staat

Op het omschakelpunt ($U_{(+)}$=0V) staat U_{sat+} over R_f

$$I_{R_f} = \frac{U_{sat+}}{R_f}$$

$$U_L = -I_{R_f}.R_1$$

$$\boxed{U_L = -U_{sat+}\frac{R_1}{R_f}}$$

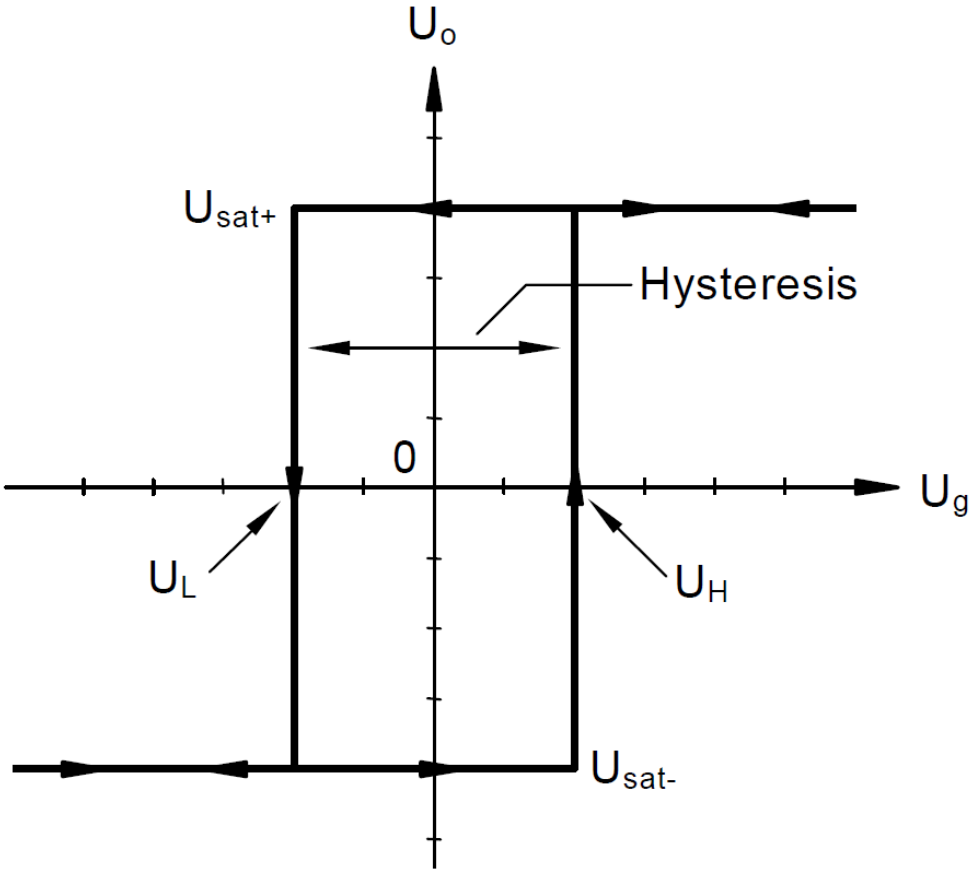
Wordt $U_g < U_L$ dan klapt de uitgang zeer snel om van U_{sat+} naar U_{sat-}

Op analoge wijze vinden we U_H

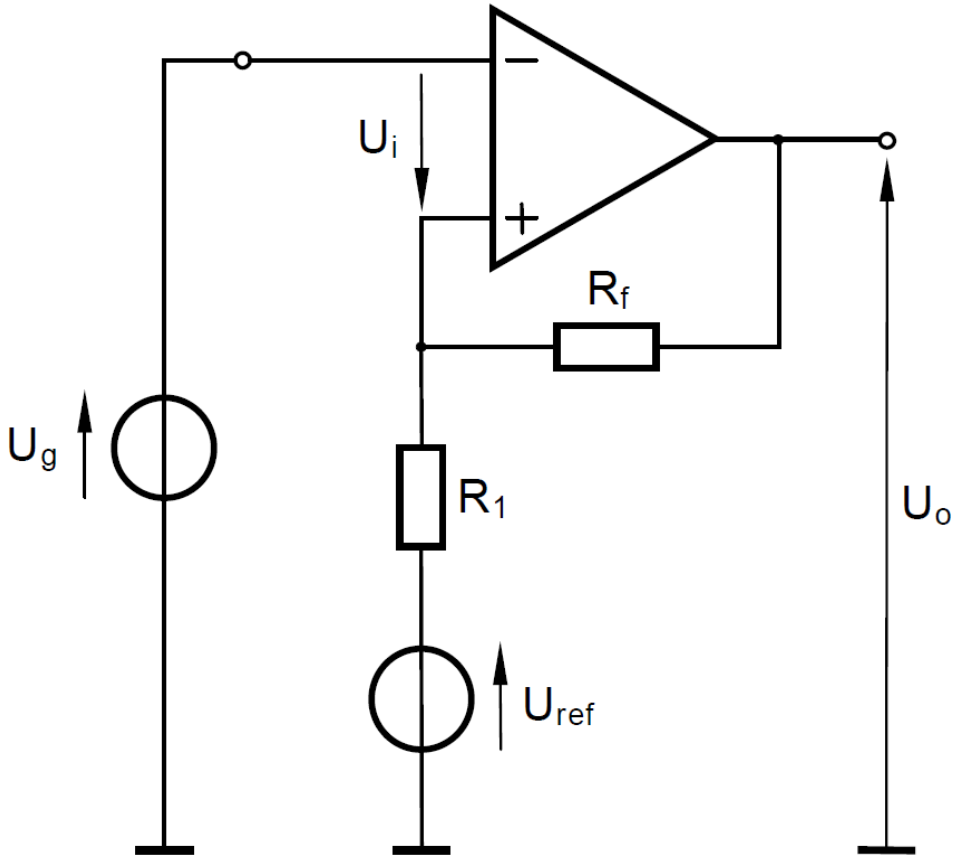
$$\boxed{U_H = -U_{sat-}\frac{R_1}{R_f}}$$

Niet-inverterende Schmitt-trigger

Transferkarakteristiek



Inverterende ST met referentiespanning

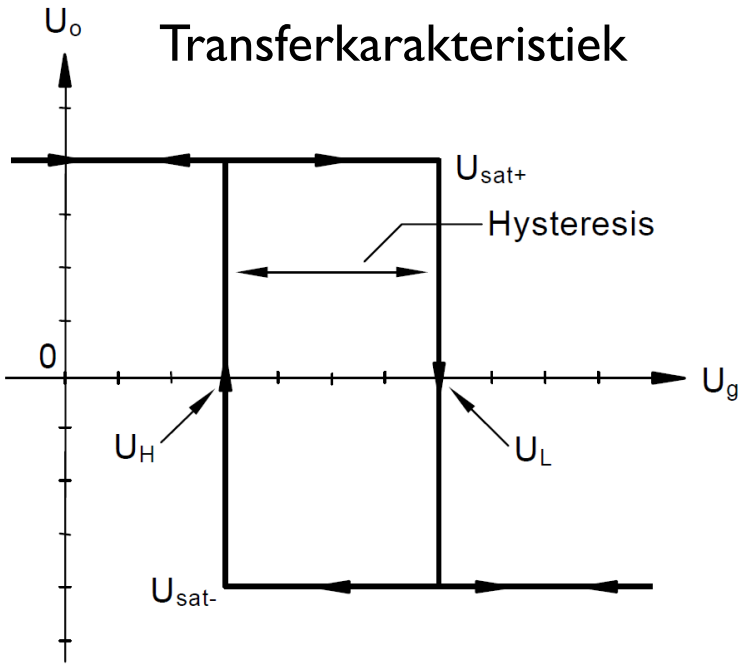


Schakelpunten

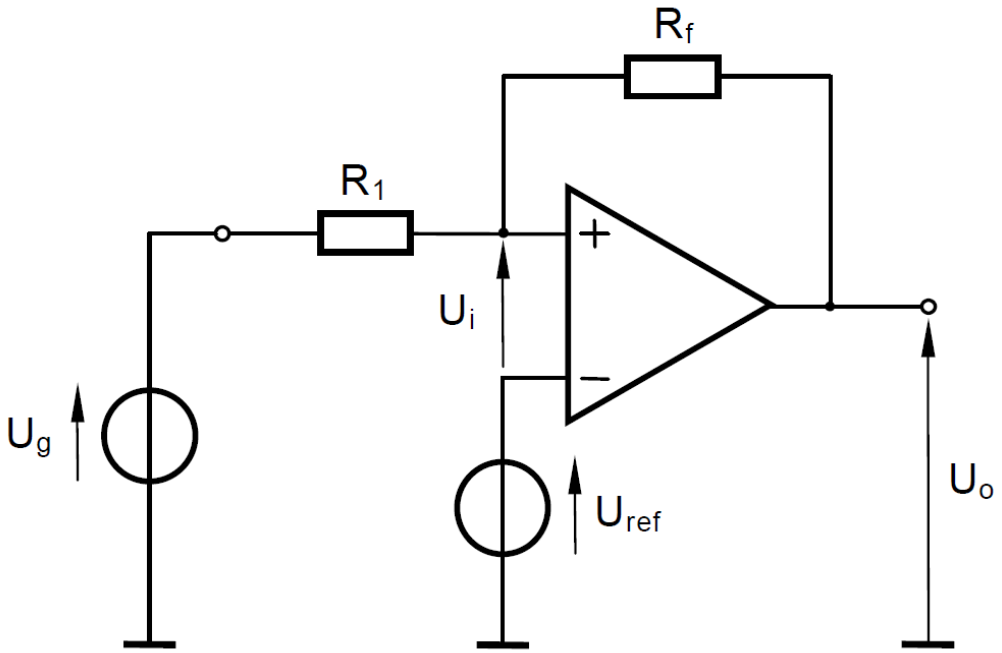
$$U_L = \frac{U_{ref}.R_f + U_{sat+}.R_2}{R_2 + R_f}$$

$$U_H = \frac{U_{ref}.R_f + U_{sat-}.R_2}{R_2 + R_f}$$

Transferkarakteristiek



Niet-inverterende ST met referentiespanning

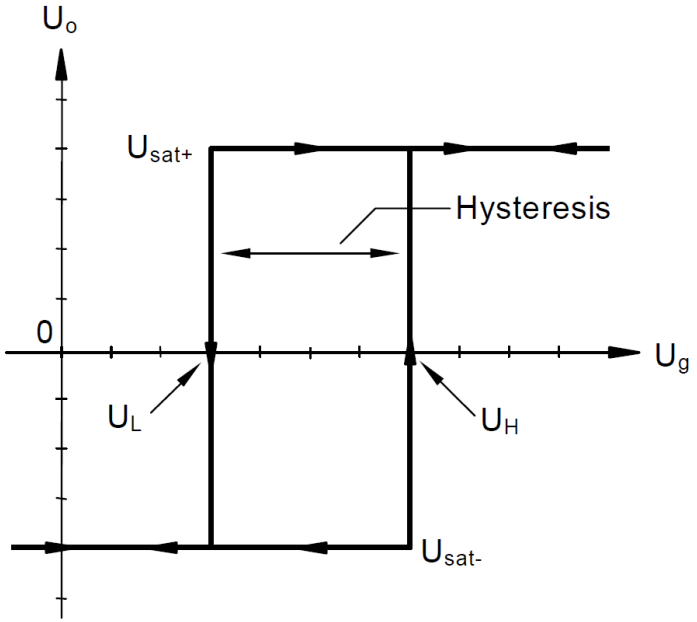


Schakelpunten

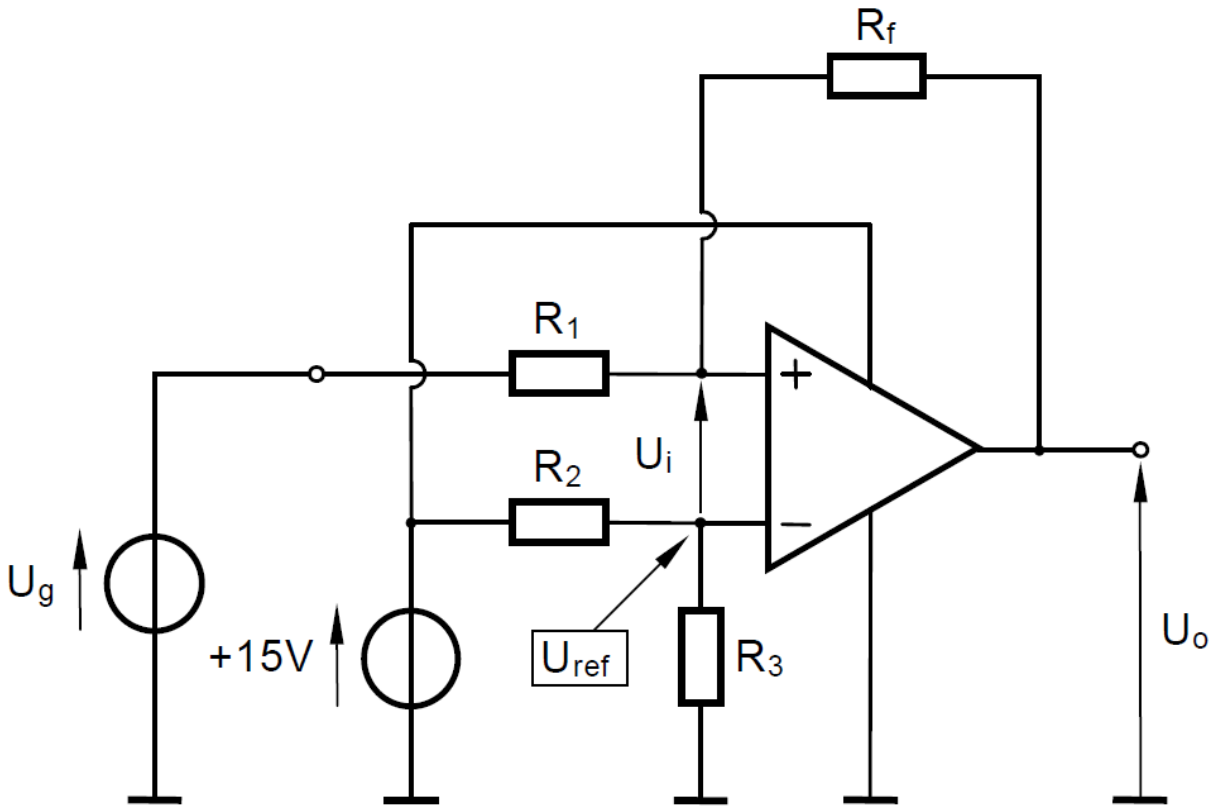
$$U_H = U_{ref} + \frac{R_1}{R_f}(U_{ref} - U_{sat-})$$

$$U_L = U_{ref} + \frac{R_1}{R_f}(U_{ref} - U_{sat+})$$

Transferkarakteristiek



Oefening



Componenten	
R_1:	20kΩ
R_2:	100kΩ
R_3:	200kΩ
R_f:	100kΩ

Niet-inverterende ST met referentiespanning

Oefening

Bepaling U_{ref}

$$U_{ref} = 15V \frac{R_3}{R_2 + R_f}$$

$$U_{ref} = 15V \frac{200k\Omega}{100k\Omega + 200k\Omega} = 10V$$

Oefening

Berekening van de schakelpunten

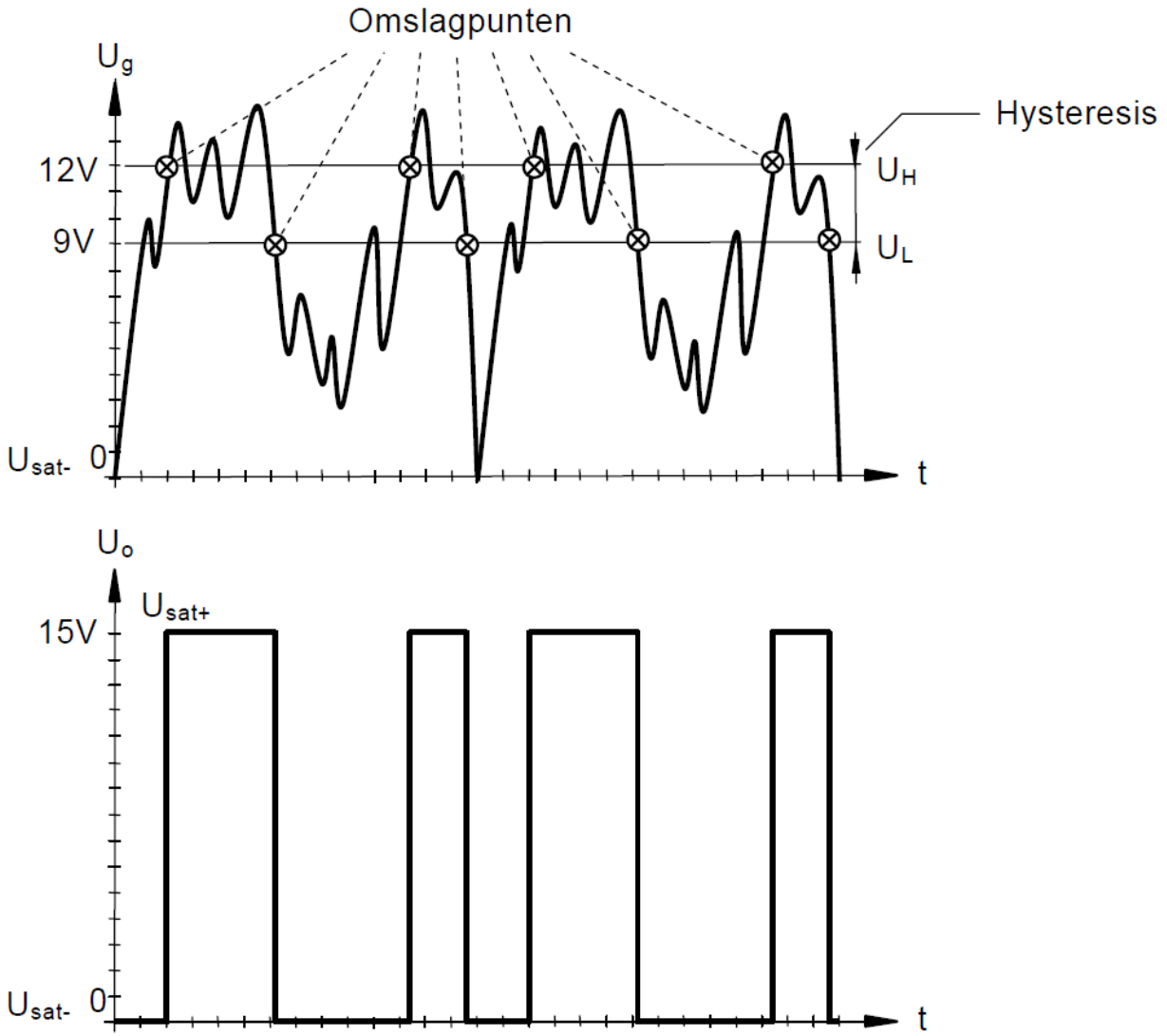
$$U_H = U_{ref} + \frac{R_1}{R_f}\left(U_{ref} - U_{sat-}\right)$$

$$U_H = 10V + \frac{20k\Omega}{100k\Omega}(10V - 0V) = 12V$$

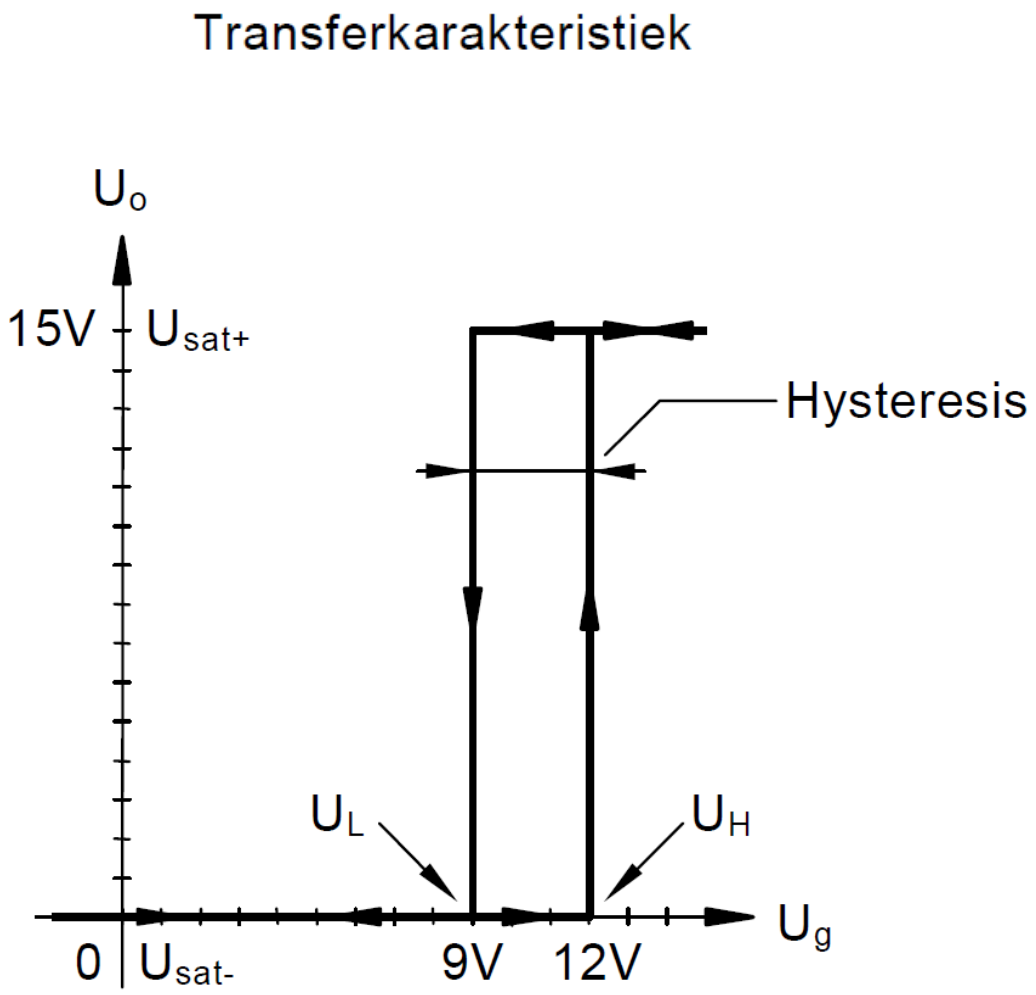
$$U_L = U_{ref} + \frac{R_1}{R_f}\left(U_{ref} - U_{sat+}\right)$$

$$U_L = 10V + \frac{20k\Omega}{100k\Omega}(10V - 15V) = 9V$$

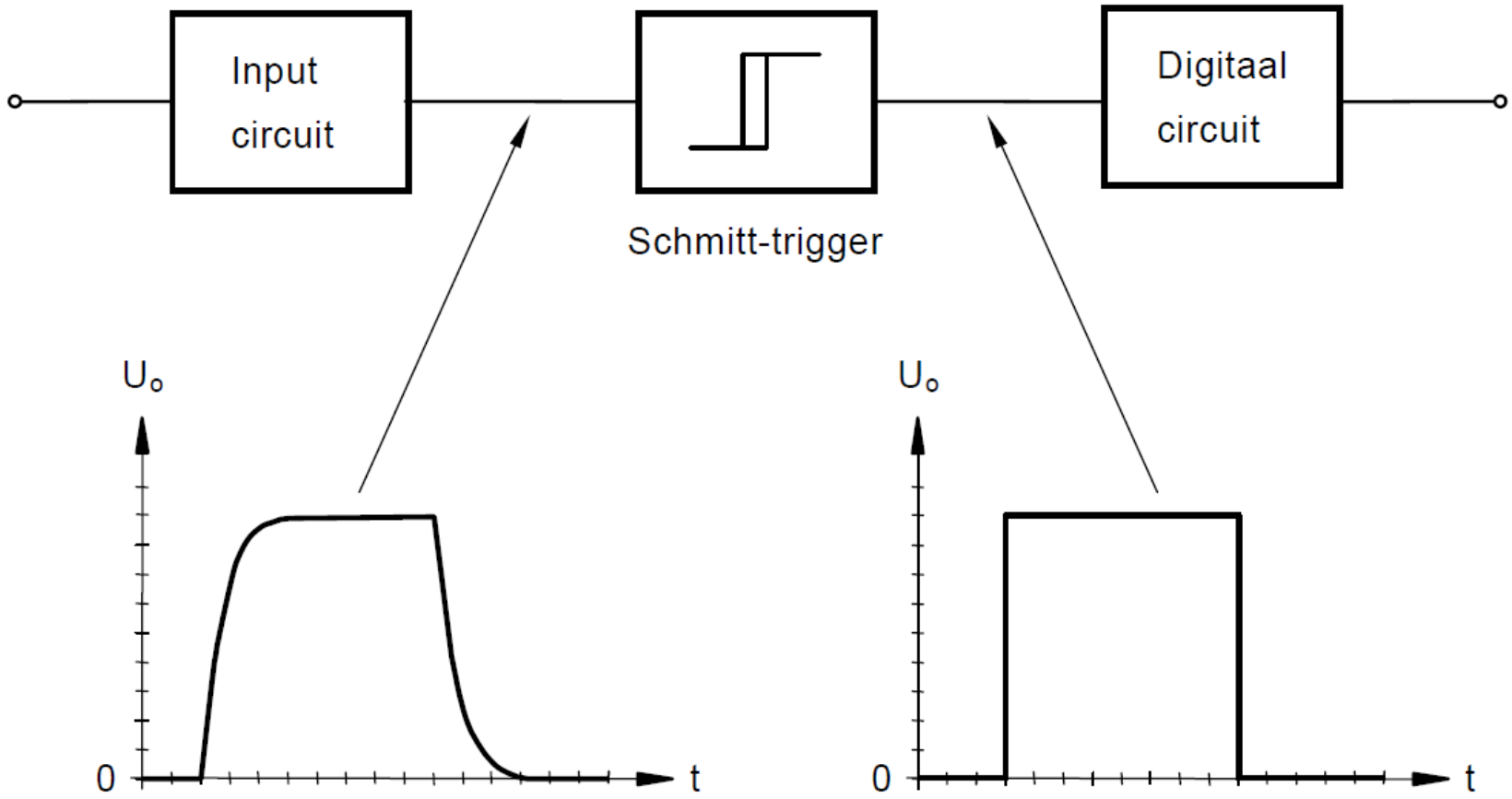
Oefening


Omslagpunten
U_g
12V
9V
U_{sat-}
0
t
Hysteresis
U_H
U_L
U_o
U_{sat+}
15V
U_{sat-}
0
t

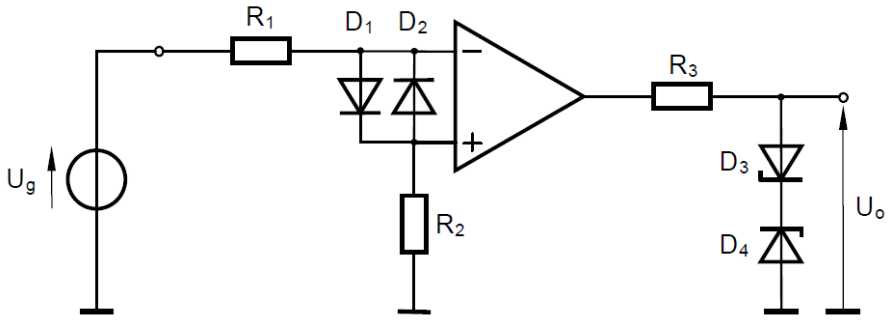
Oefening

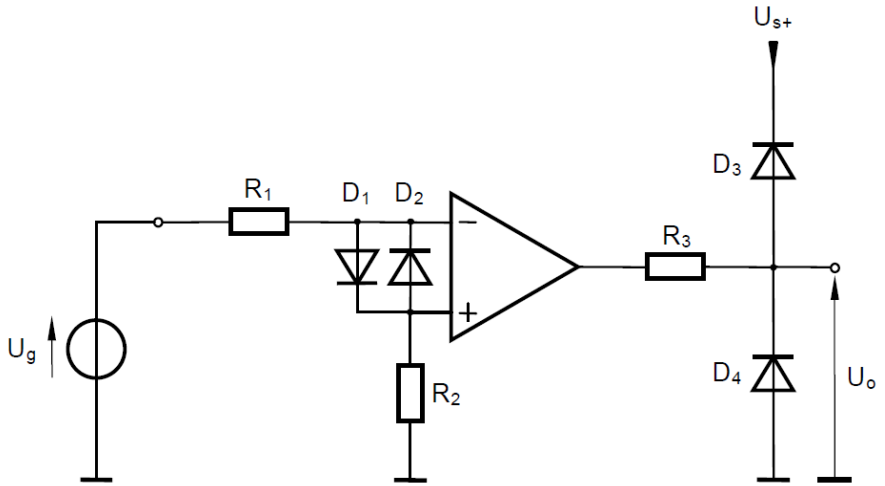

Transferkarakteristiek
U_o
15V
U_{sat+}
Hysteresis
U_L
U_H
U_g
0
U_{sat-}
9V
12V

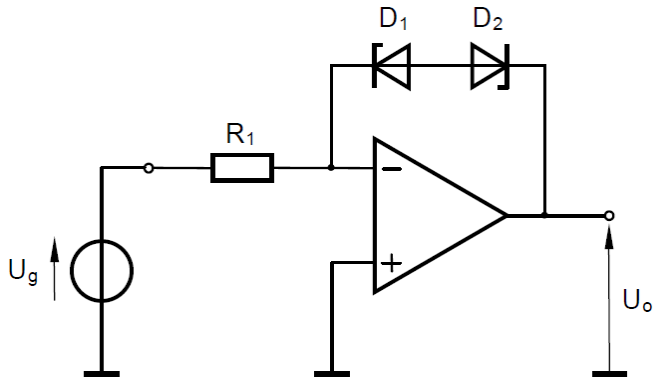
Schmitt-trigger als pulsvormer

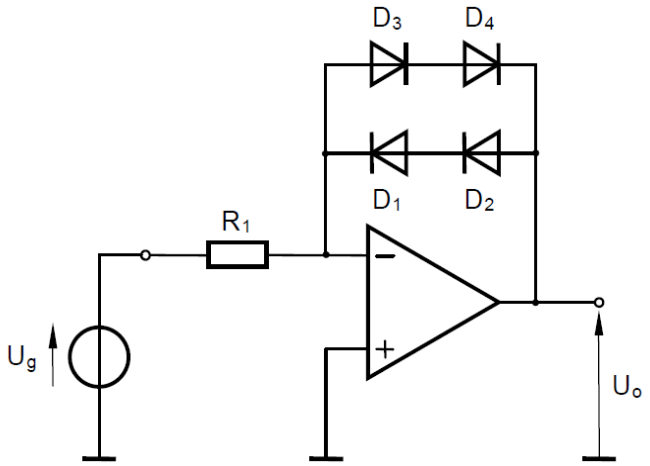


Beveiliging en begrenzing





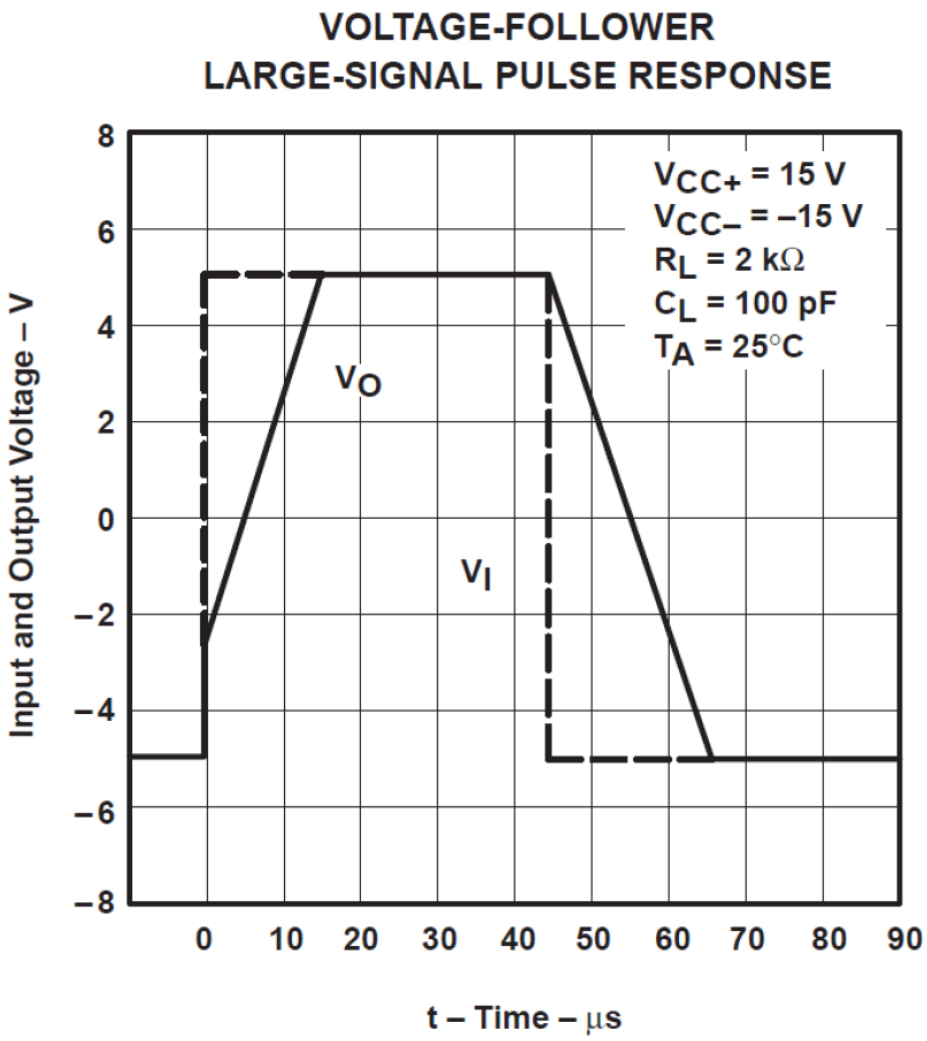




Eigenschappen comparatoren

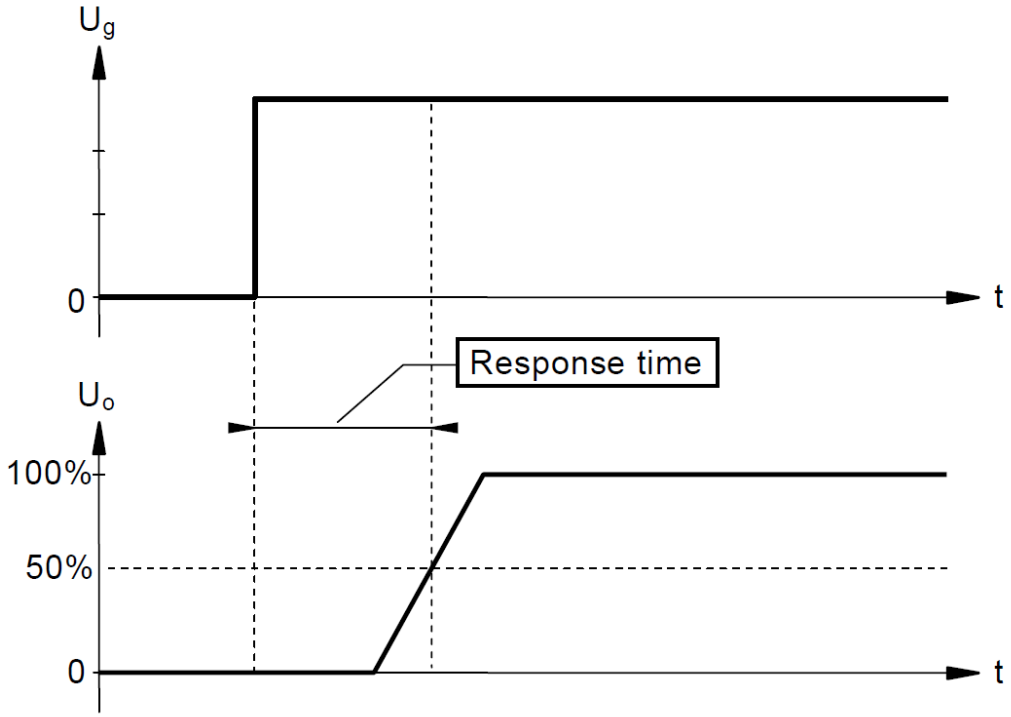
Slew rate

$$SR = \left(\frac{\Delta U_o}{\Delta t}\right)_{max}$$



Eigenschappen comparatoren

Response time



Ingangs offset-spanning

Input Bias Current