Elektronica tutorial

NPN-transistor als schakelaar

W. Van Wichelen

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Wat gaan we in deze les leren?

- NPN-bipolaire junctietransistor als interface-component
- Interpreteren datasheet
- Dimensioneren basisweerstand
- Schakelen zuiver ohmse belasting

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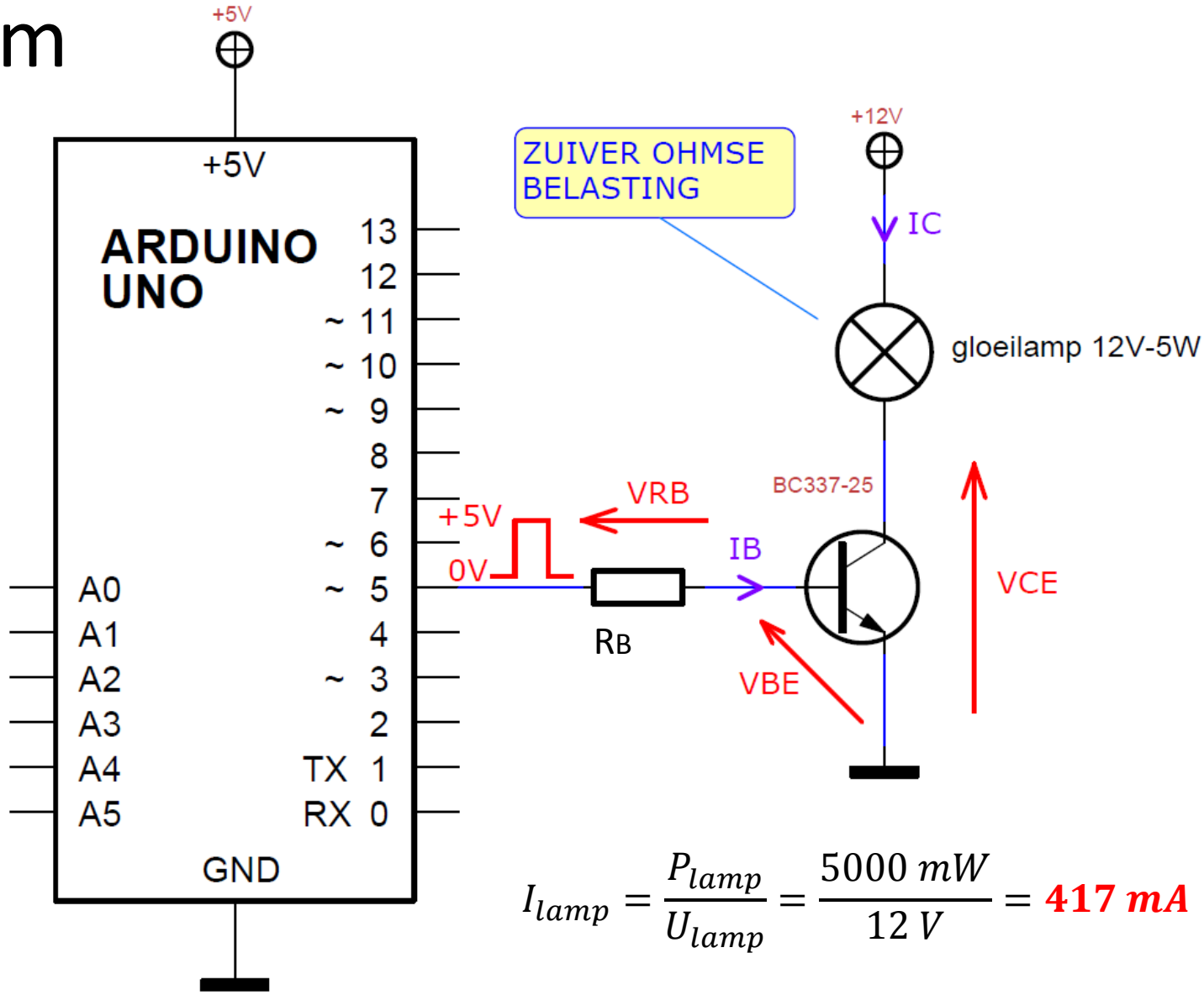
Probleem



$$I_{lamp} = \frac{P_{lamp}}{U_{lamp}} = \frac{5000\ mW}{12\ V} = \mathbf{417\ mA}$$

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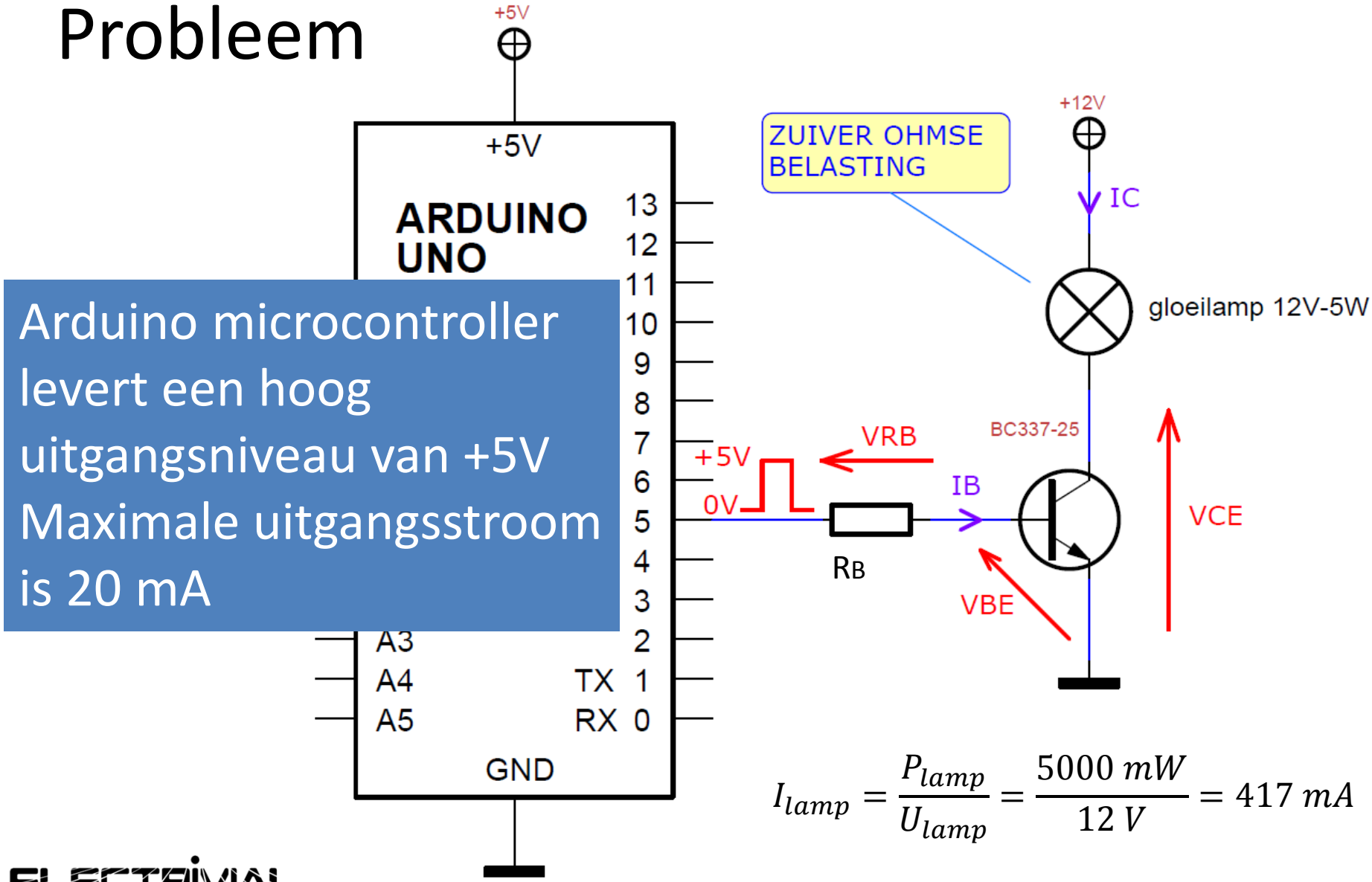
Probleem

Arduino microcontroller levert een hoog uitgangsniveau van +5V
Maximale uitgangsstroom is 20 mA



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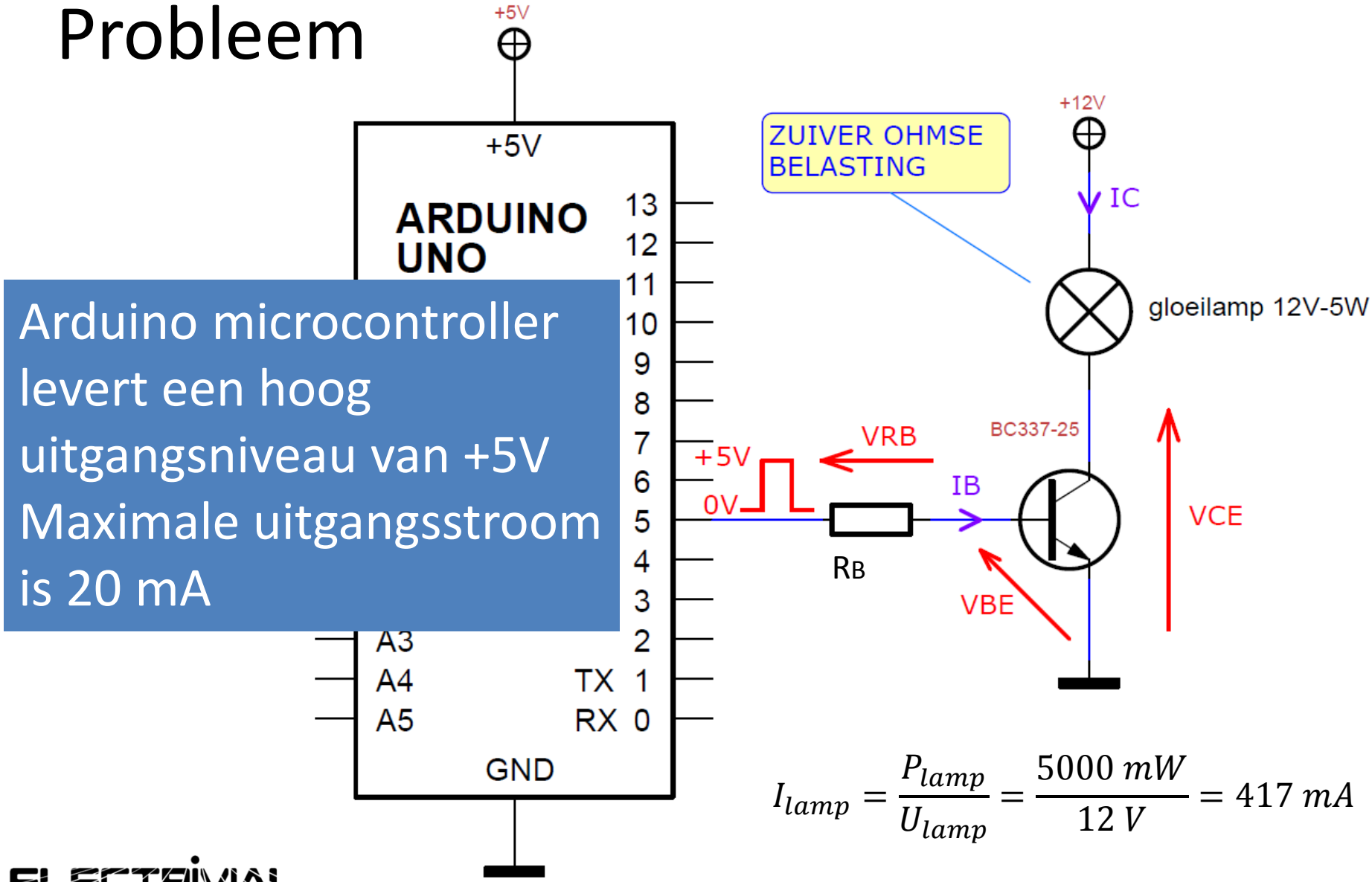

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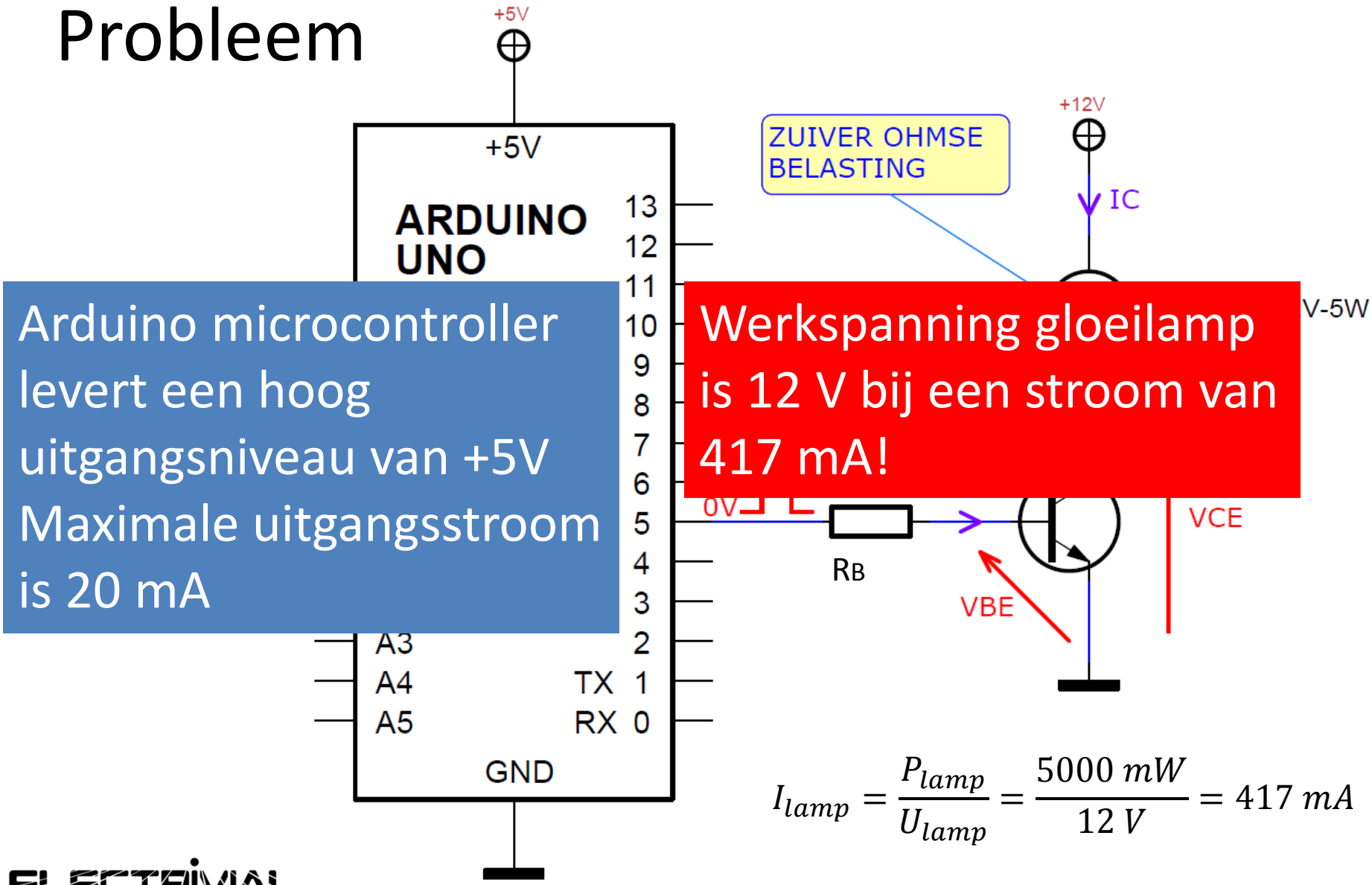
Probleem



Arduino microcontroller levert een hoog uitgangsniveau van +5V
Maximale uitgangsstroom is 20 mA

Werkspanning gloeilamp is 12 V bij een stroom van 417 mA!

$$I_{lamp} = \frac{P_{lamp}}{U_{lamp}} = \frac{5000\ mW}{12\ V} = 417\ mA$$

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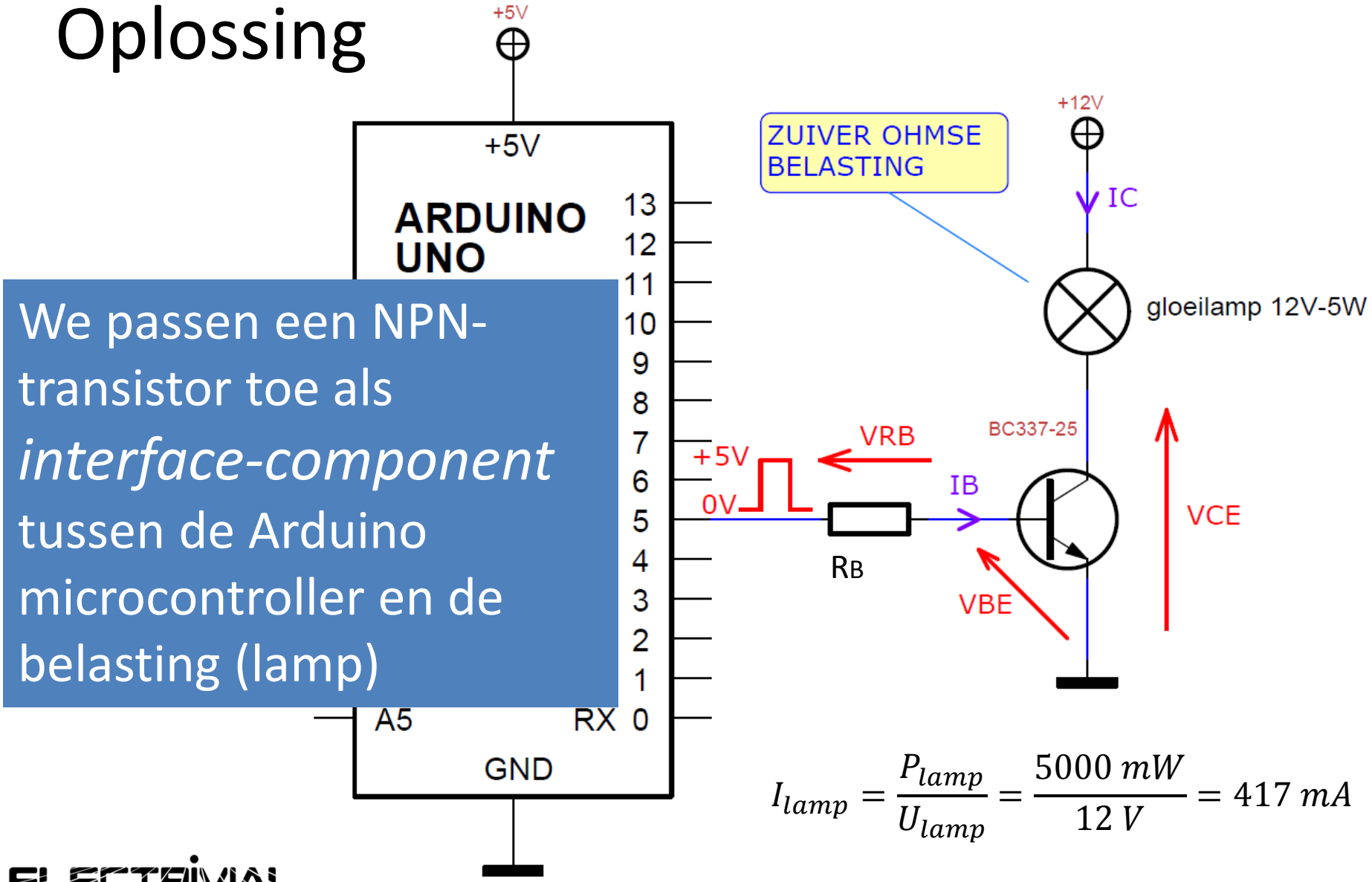
Oplossing

We passen een NPN-transistor toe als *interface-component* tussen de Arduino microcontroller en de belasting (lamp)



$$I_{lamp} = \frac{P_{lamp}}{U_{lamp}} = \frac{5000\ mW}{12\ V} = 417\ mA$$

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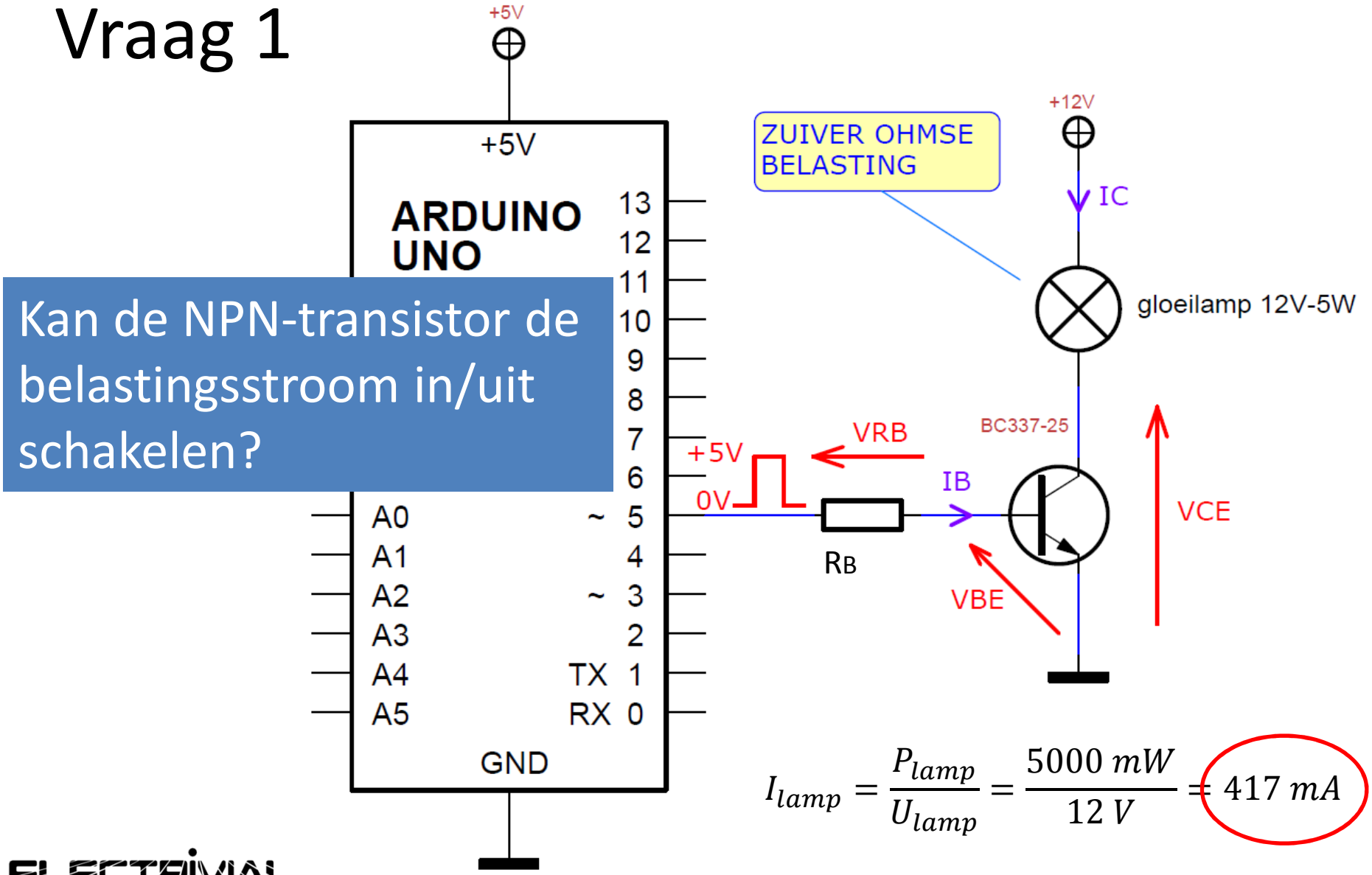
Vraag 1

Kan de NPN-transistor de belastingsstroom in/uit schakelen?



$$I_{lamp} = \frac{P_{lamp}}{U_{lamp}} = \frac{5000\ mW}{12\ V} = 417\ mA$$

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Antwoord vraag 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector – Emitter Voltage	V_{CEO}	45	Vdc
	V_{CBO}	50	Vdc
	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	800	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5	W
Operating and Storage Junction Temperature Range	T_J, T_{stg}		

Detail uit datasheet BC337-25

800 mA >> 417 mA : ok!

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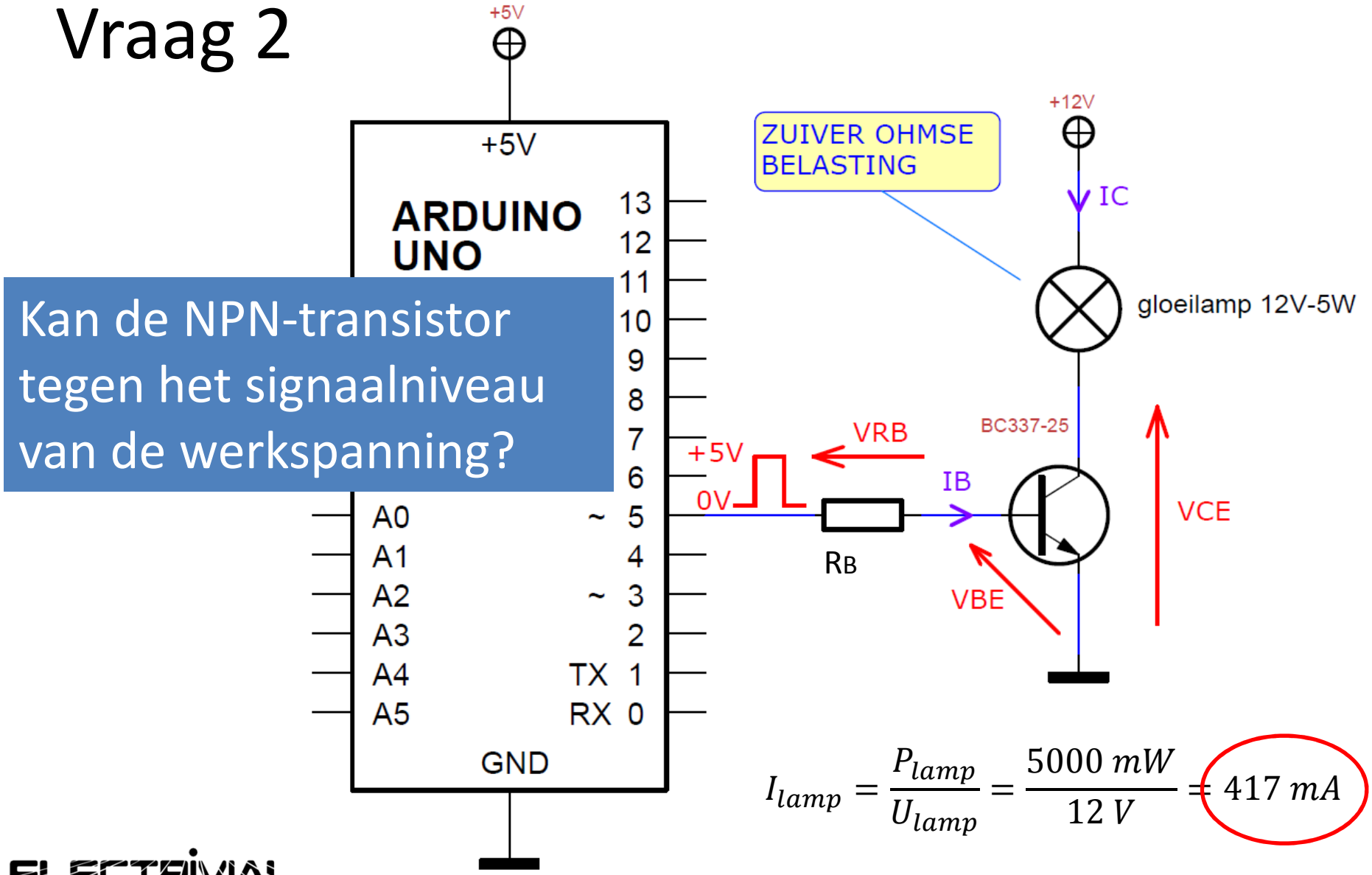
Vraag 2

Kan de NPN-transistor tegen het signaalniveau van de werkspanning?



$$I_{lamp} = \frac{P_{lamp}}{U_{lamp}} = \frac{5000\ mW}{12\ V} = 417\ mA$$

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Antwoord vraag 2

MAXIMUM RATINGS

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Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5	W
Operating and Storage Junction Temperature Range	T_J, T_{stg}		

Detail uit datasheet BC337-25

45 V >> 12 V : ok!

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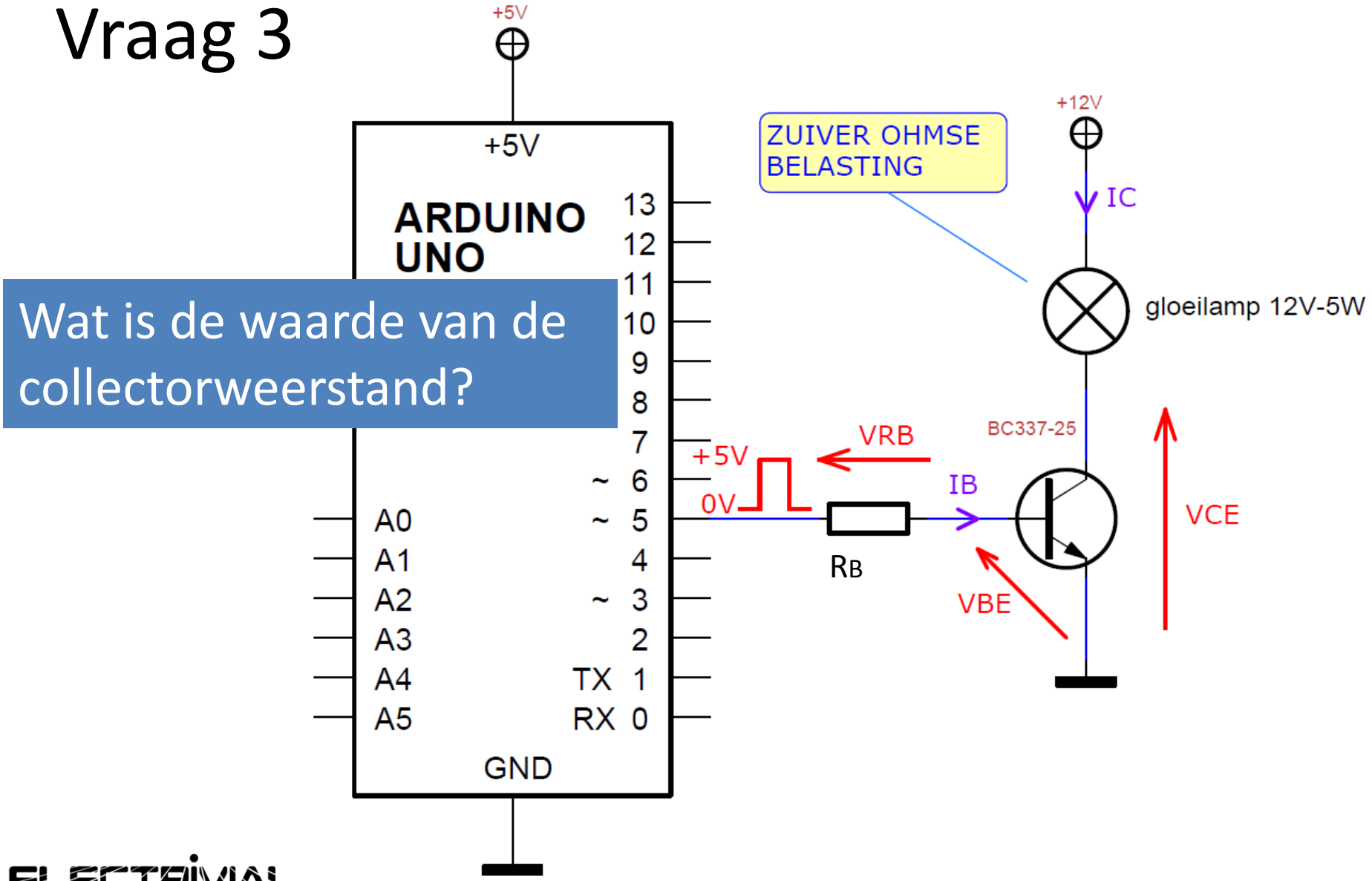
Vraag 3

Wat is de waarde van de collectorweerstand?



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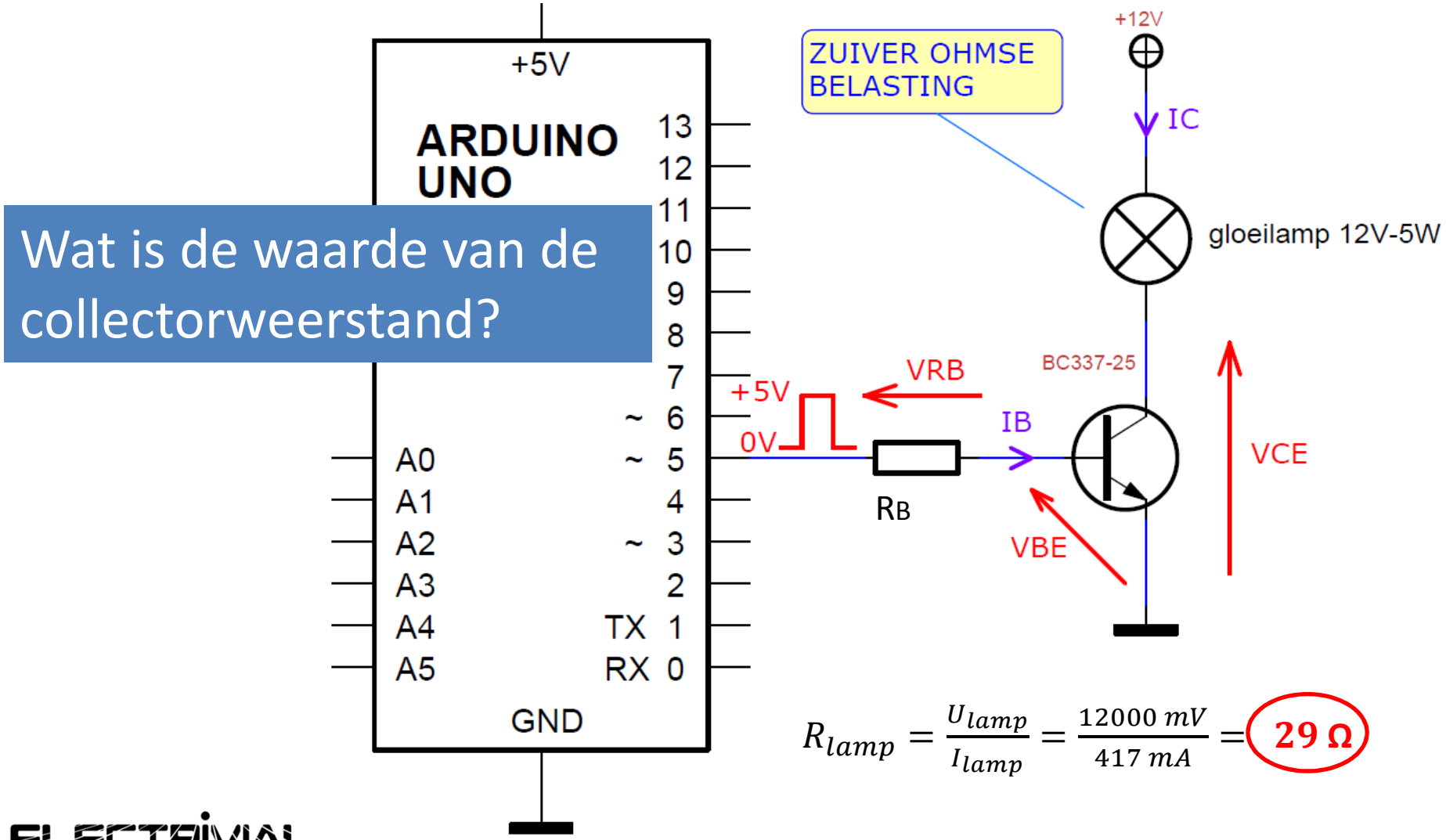
Antwoord vraag 3

Wat is de waarde van de collectorweerstand?



$$R_{lamp} = \frac{U_{lamp}}{I_{lamp}} = \frac{12000\ mV}{417\ mA} = \mathbf{29\ \Omega}$$

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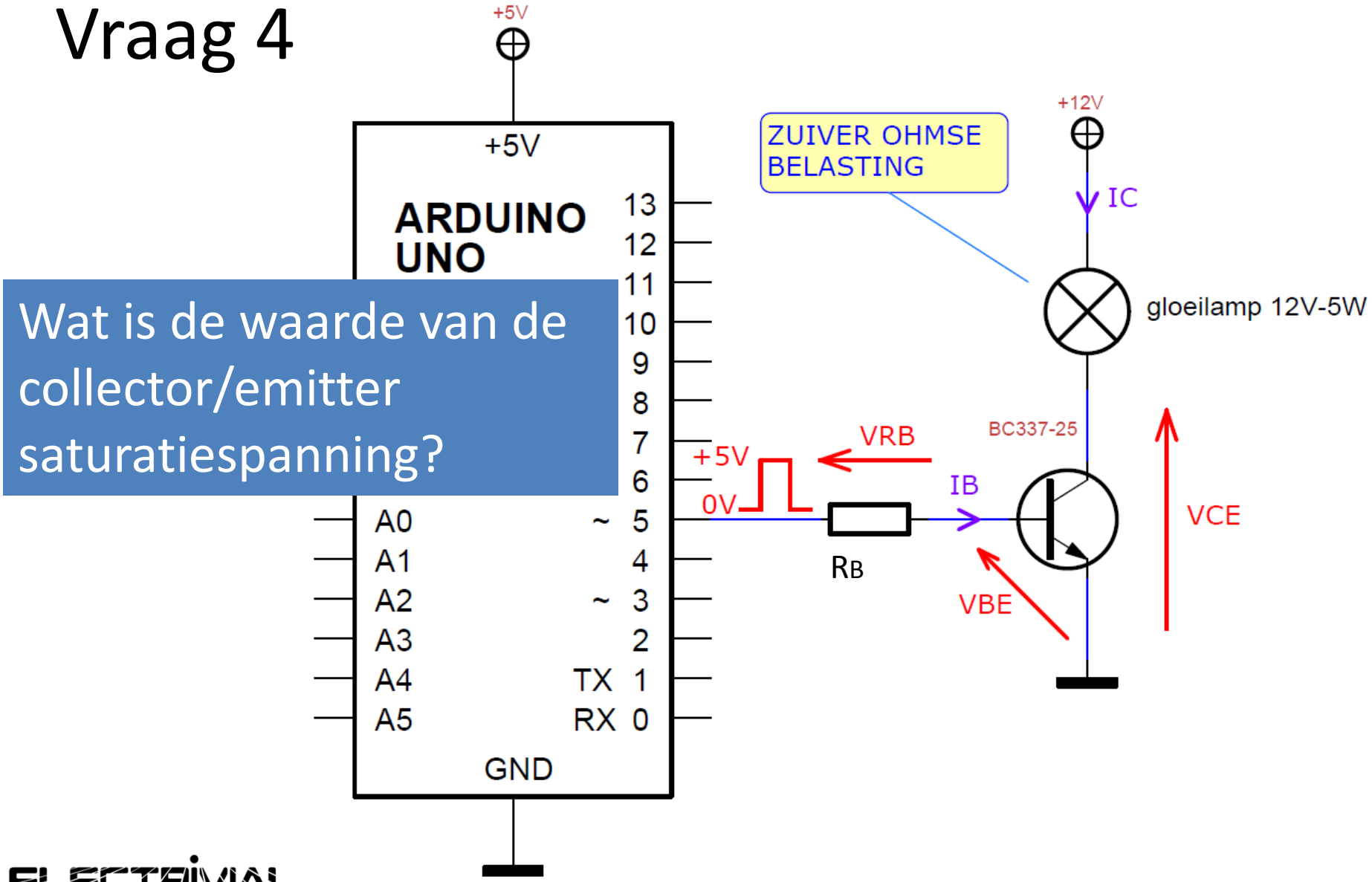
Vraag 4

Wat is de waarde van de collector/emitter saturatiespanning?



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Antwoord vraag 4

ON CHARACTERISTICS			min		max	
DC Current Gain (I_C = 100 mA, V_{CE} = 1.0 V) (I_C = 300 mA, V_{CE} = 1.0 V)	BC337 BC337–25 BC337–40	h_{FE}	100 160 250 60	– – – –	630 400 630 –	–
Base–Emitter On Voltage (I_C = 300 mA, V_{CE} = 1.0 V)		$V_{BE(on)}$	–	–	1.2	Vdc
Collector–Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	–	–	0.7	Vdc

Detail datasheet: ‘Collector-emitter saturation voltage’

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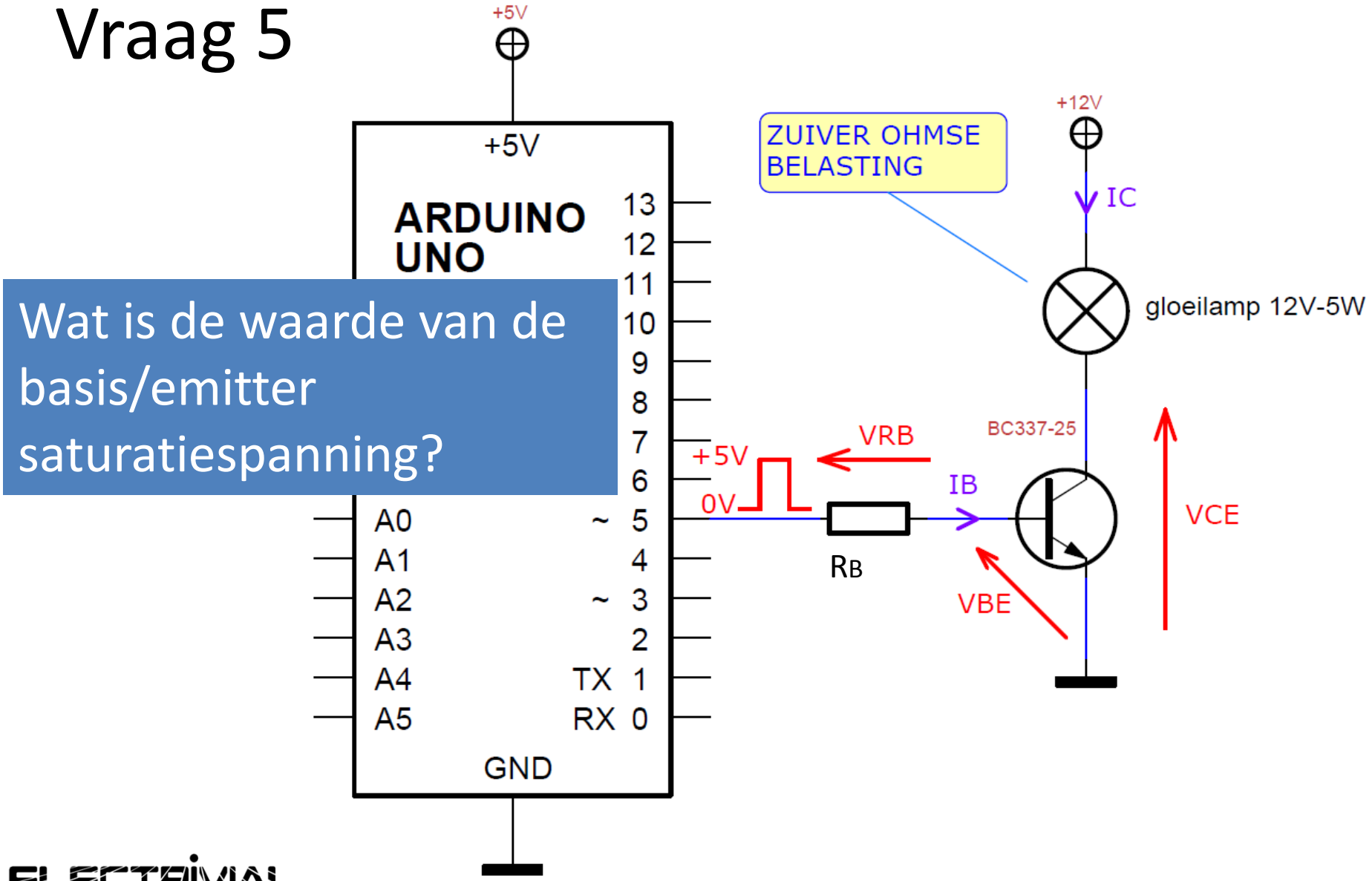
Vraag 5

Wat is de waarde van de basis/emitter saturatiespanning?



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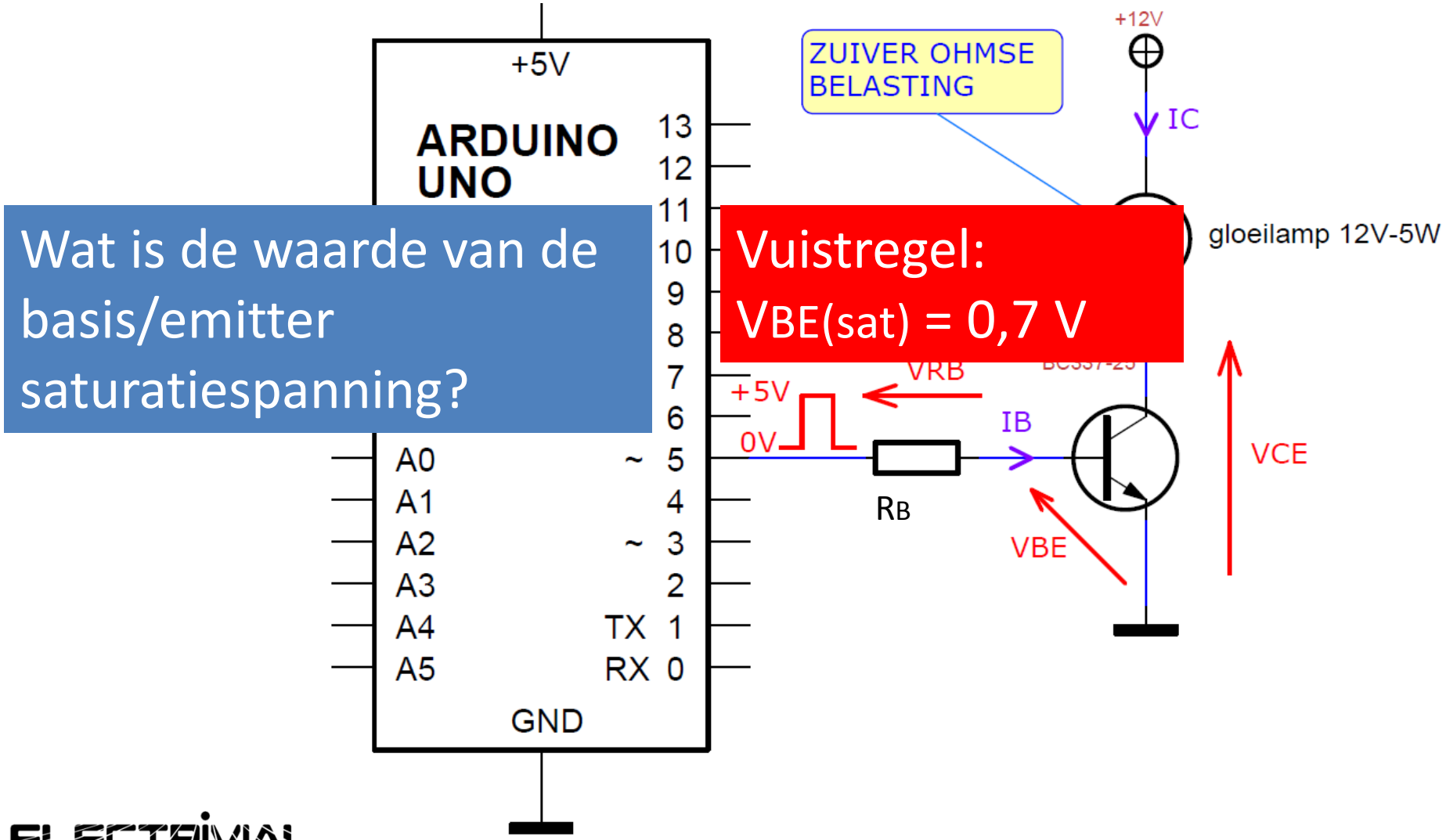
Antwoord vraag 5

Wat is de waarde van de basis/emitter saturatiespanning?

Vuistregel:
$V_{BE(sat)} = 0{,}7\ V$



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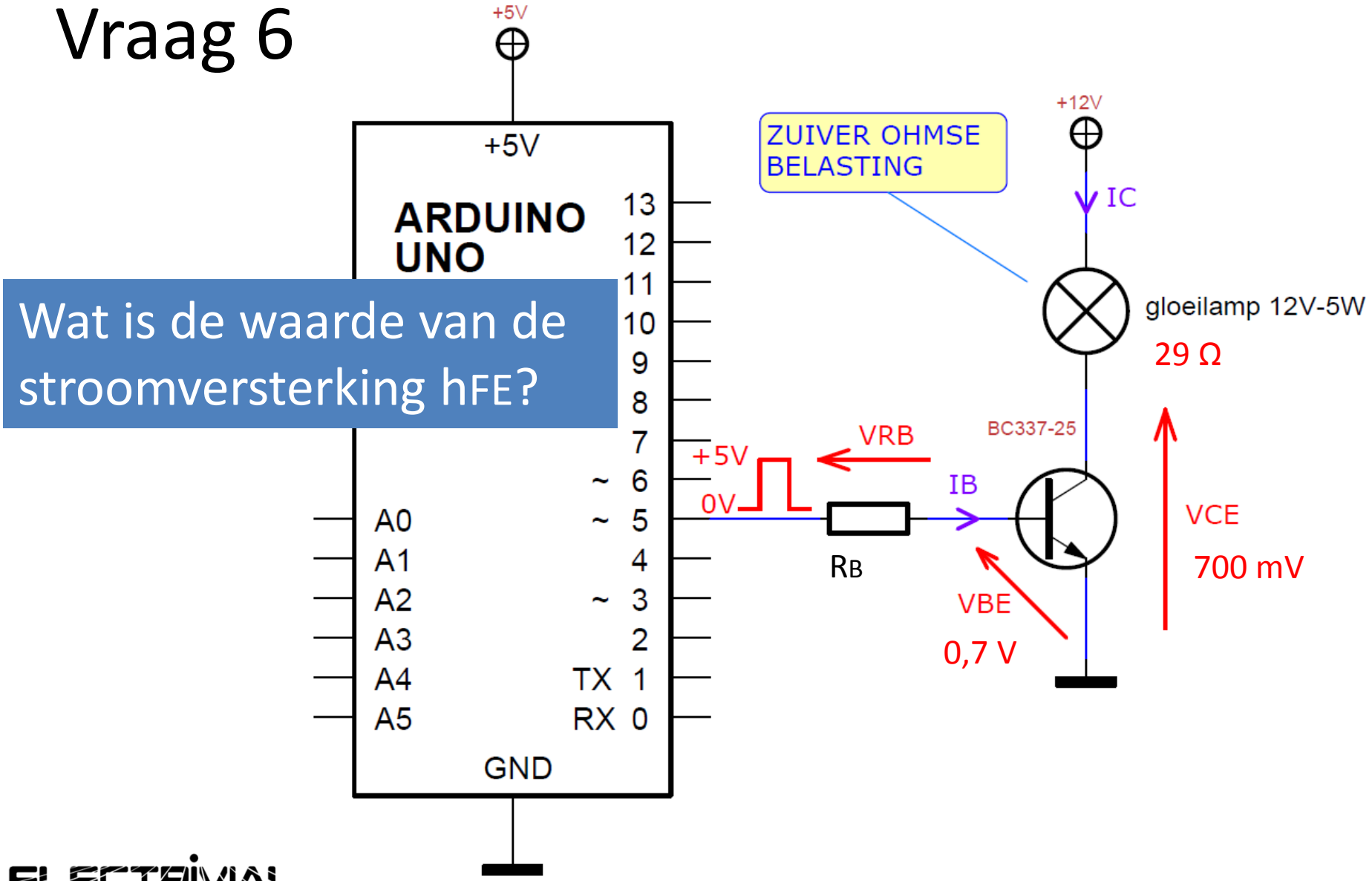
Vraag 6

Wat is de waarde van de stroomversterking h_{FE}?



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Antwoord vraag 6

ON CHARACTERISTICS			min		max	
DC Current Gain (I_C = 100 mA, V_{CE} = 1.0 V) (I_C = 300 mA, V_{CE} = 1.0 V)	BC337 BC337–25 BC337–40	h_{FE}	 100 160 250 60	 – – – –	 630 400 630 –	–
Base–Emitter On Voltage (I_C = 300 mA, V_{CE} = 1.0 V)		$V_{BE(on)}$	–	–	1.2	Vdc
Collector–Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	–	–	0.7	Vdc

Detail datasheet ‘ON-characteristics’:

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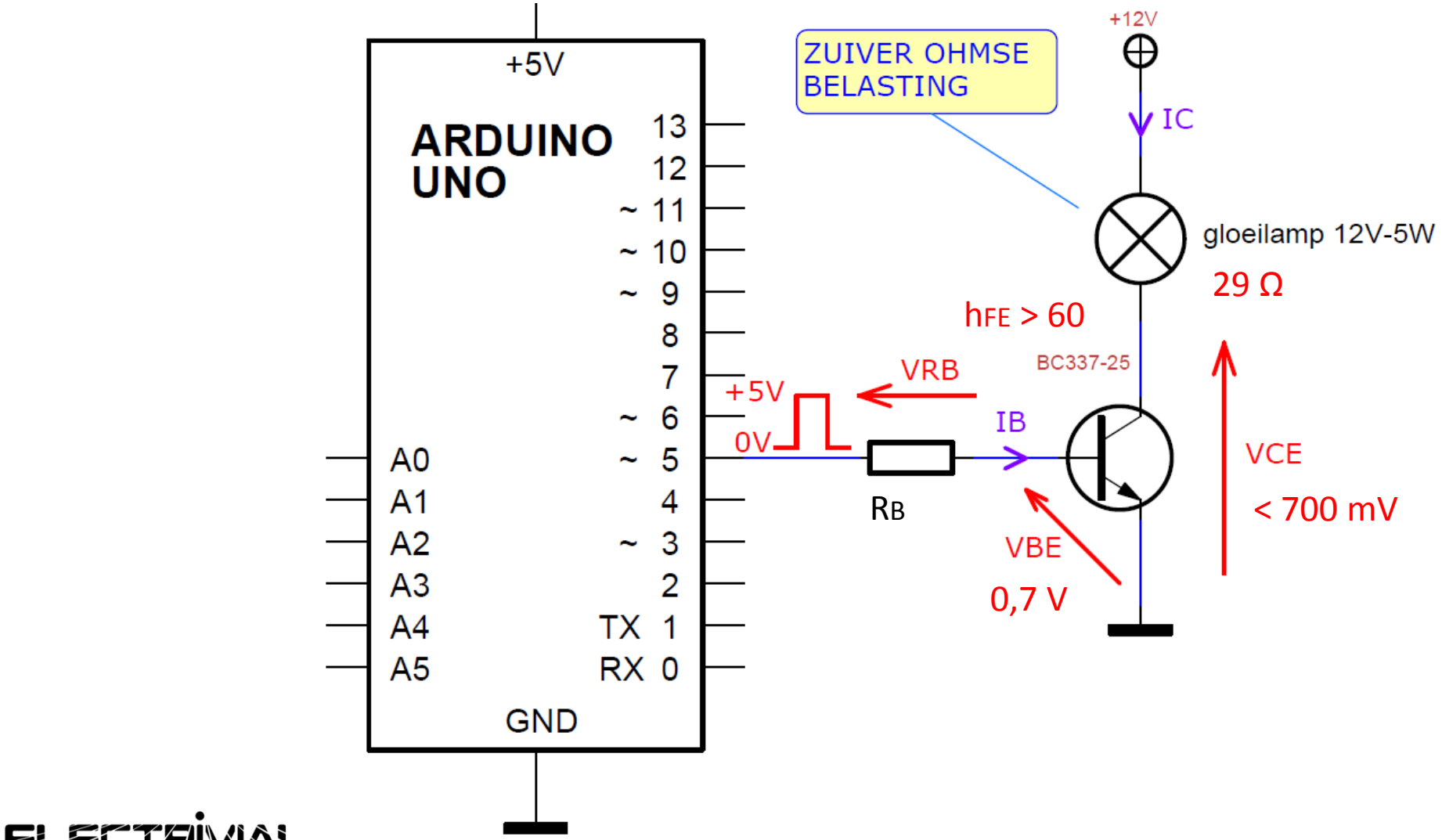
Samenvatting



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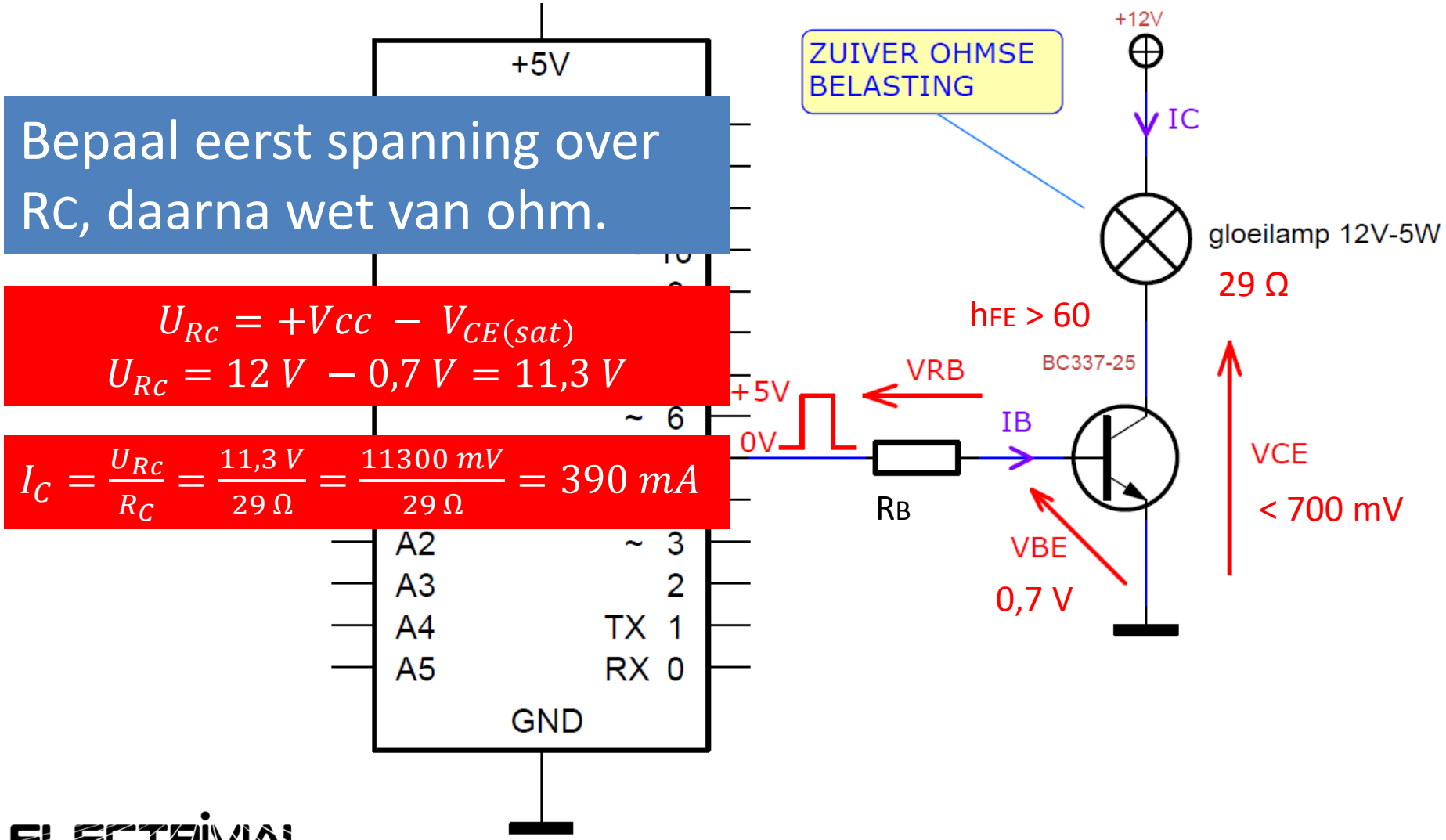
Bepalen collectorstroom

Bepaal eerst spanning over Rc, daarna wet van ohm.

$$U_{Rc} = +Vcc - V_{CE(sat)}$$
$$U_{Rc} = 12\,V - 0{,}7\,V = 11{,}3\,V$$

$$I_C = \frac{U_{Rc}}{R_C} = \frac{11{,}3\,V}{29\,\Omega} = \frac{11300\,mV}{29\,\Omega} = 390\,mA$$



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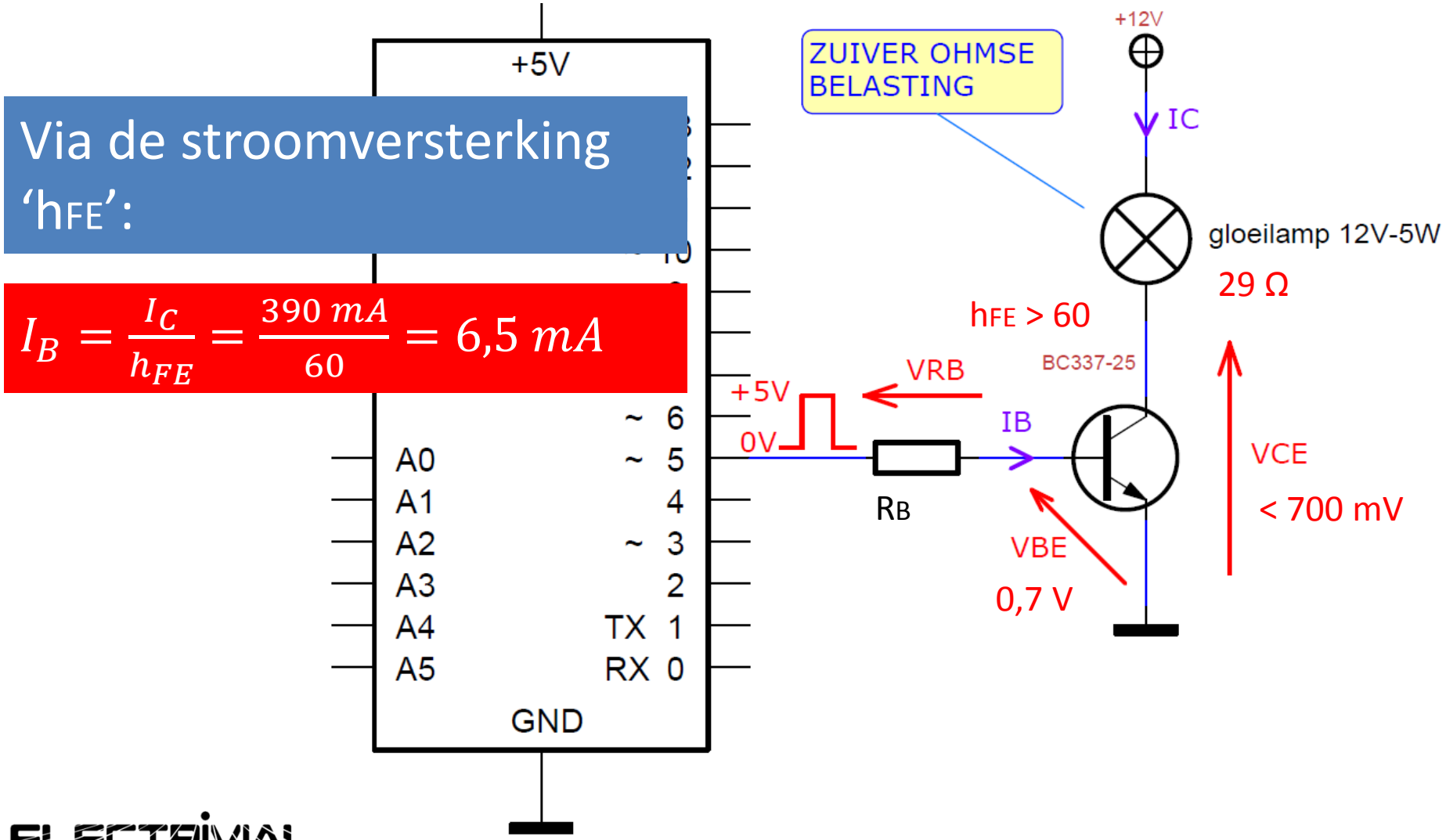
Bepalen basisstroom

Via de stroomversterking ‘h_{FE}’:

$$I_B = \frac{I_C}{h_{FE}} = \frac{390\ mA}{60} = 6{,}5\ mA$$



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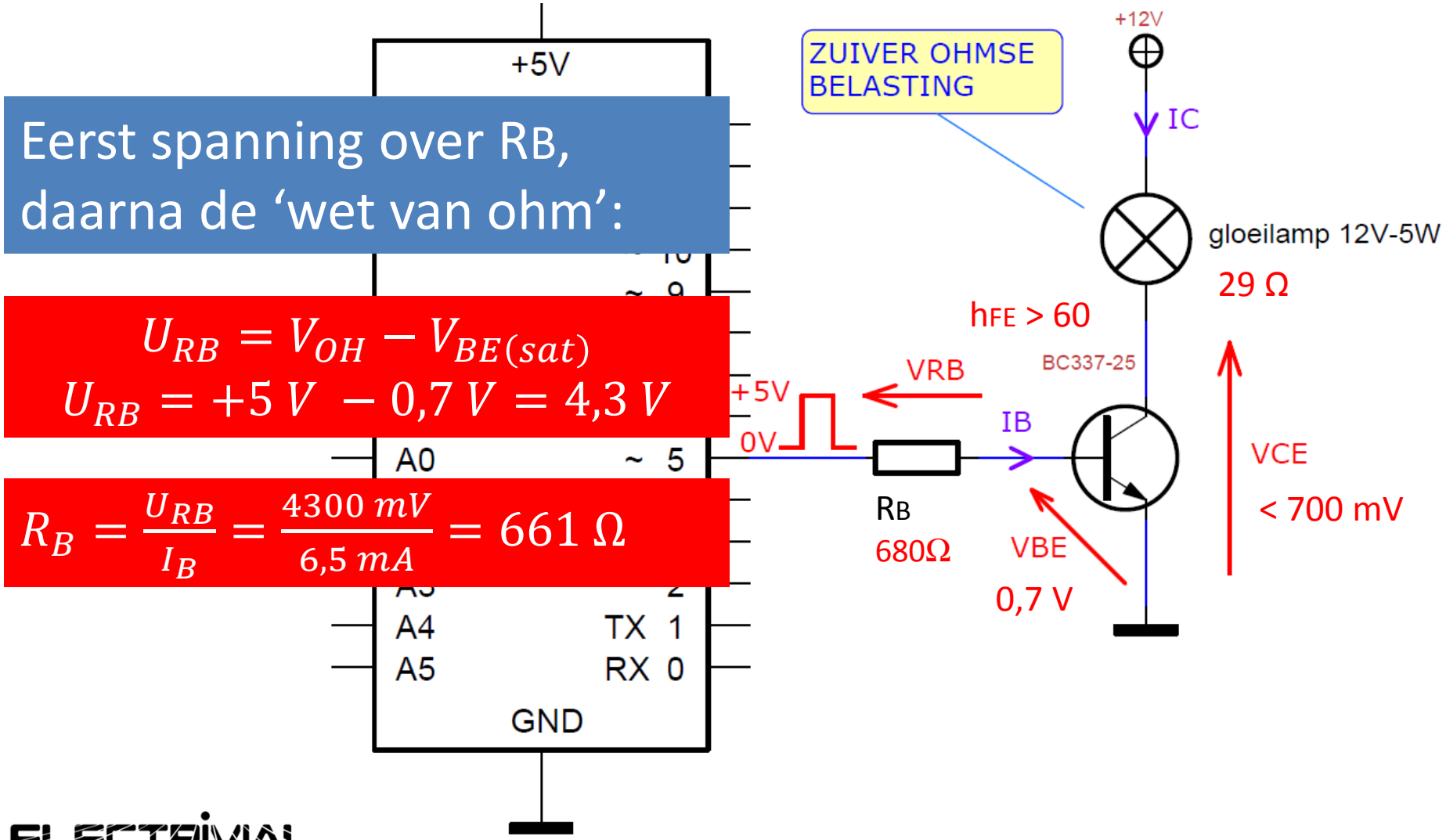
Bepalen basisweerstand

Eerst spanning over RB,
daarna de 'wet van ohm':

$$U_{RB} = V_{OH} - V_{BE(sat)}$$
$$U_{RB} = +5\,V - 0{,}7\,V = 4{,}3\,V$$

$$R_B = \frac{U_{RB}}{I_B} = \frac{4300\,mV}{6{,}5\,mA} = 661\,\Omega$$



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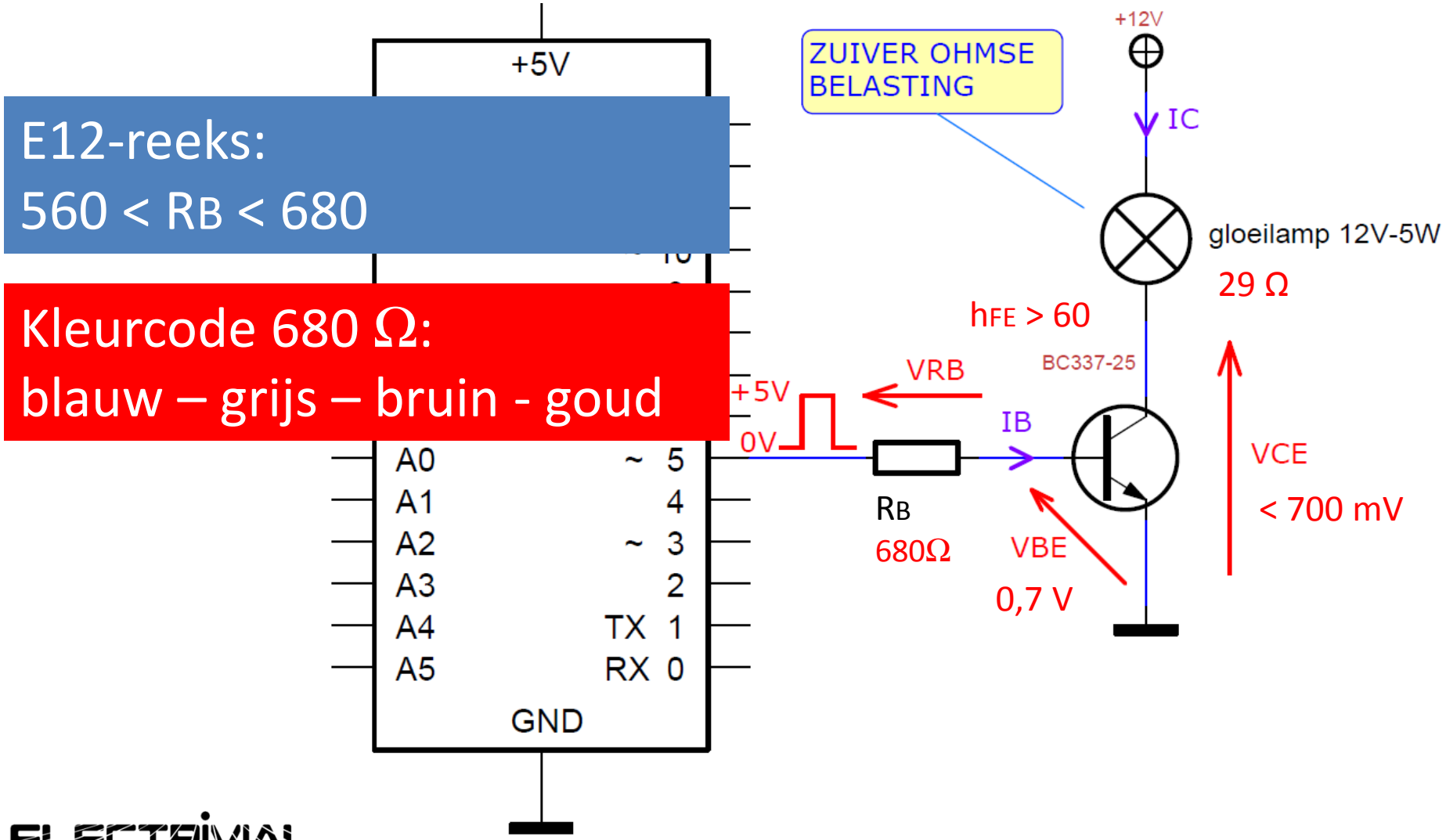
Keuze uit E12-reeks

E12-reeks:
560 < R_B < 680

Kleurcode 680 Ω:
blauw – grijs – bruin - goud



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EINDE

CREATIE & VOICE-OVER

W. Van Wichelen

DATUM SCREENCAST

2021.02.08

DOELPUBLIEK

Industriële ICT

Elektromechanica

GEBRUIKTE SOFTWARE

iSpring Free Cam

DATUM PUBLICATIE

2021.02.26

LEERPLANDOELEN

OO-2017-005/41/42/46

2016-024/110/111/112

178/181

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