

Analog Input 3-wire 4-20mA Transmitters

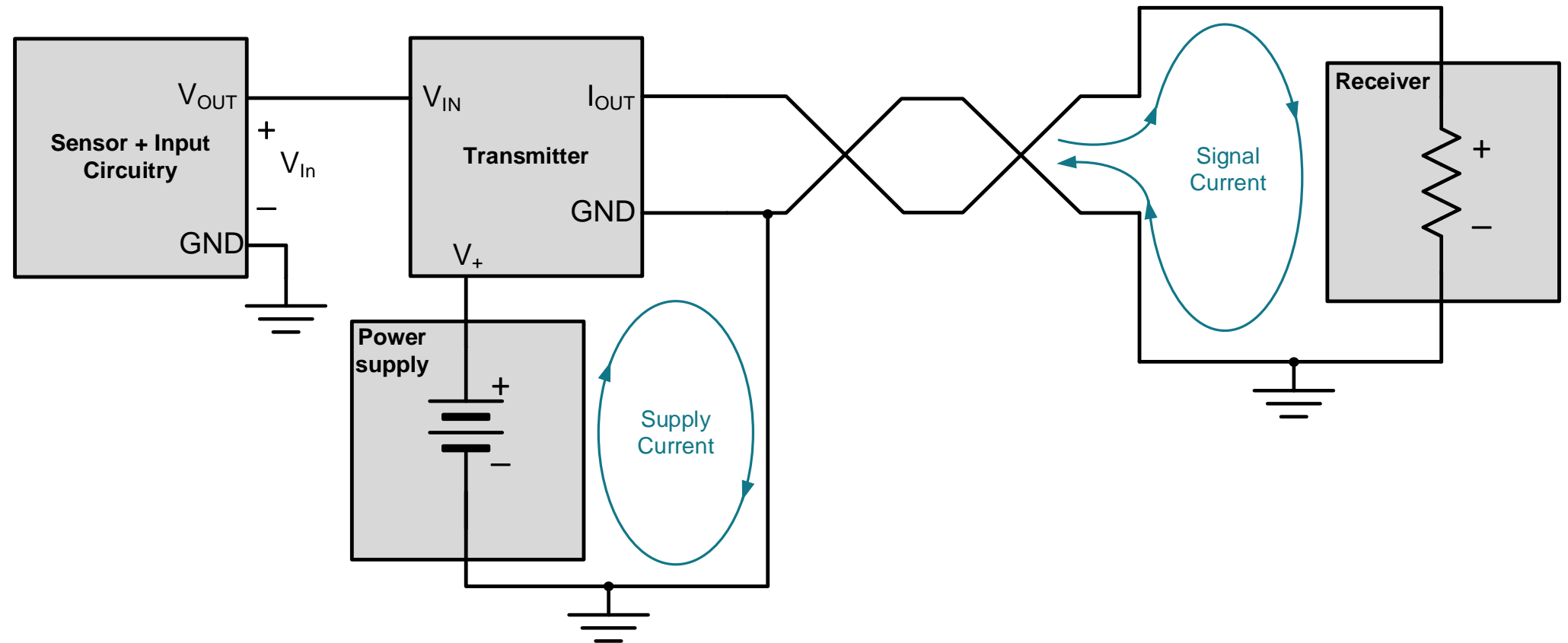
TI Precision Labs – Current Loop Transmitters

Presented by Katlynn Jones

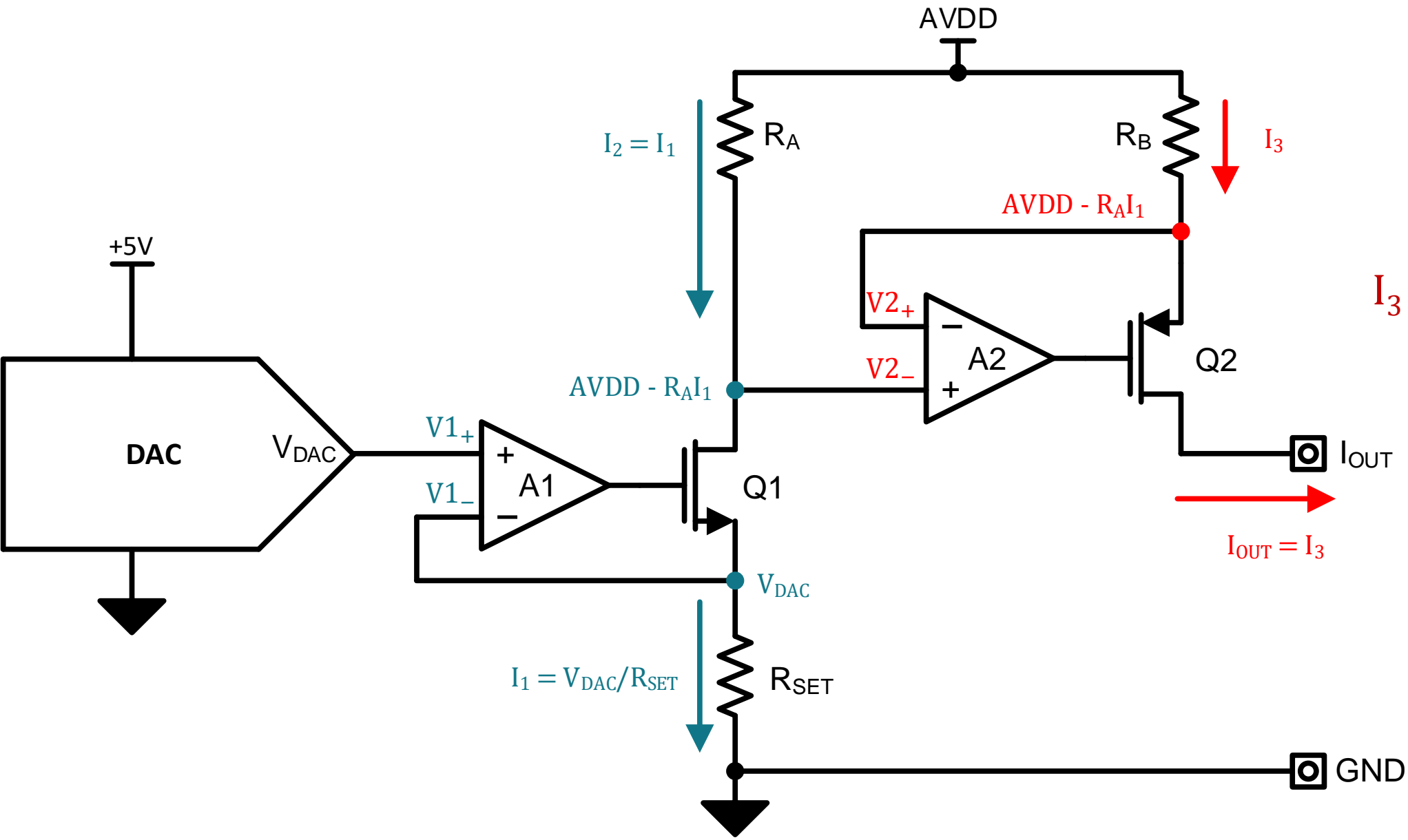
Prepared by Katlynn Jones

3-wire transmitter

- 3-wire transmitter block diagram
 - 3 wires create separate loops for the signal current and transmitter power
 - Transmitter ground is shared with the receiver
 - Can use 0-20mA, or 0-24mA ranges as well



Derivation of transfer function



$$V_{1+} = V_{1-} = V_{DAC}$$

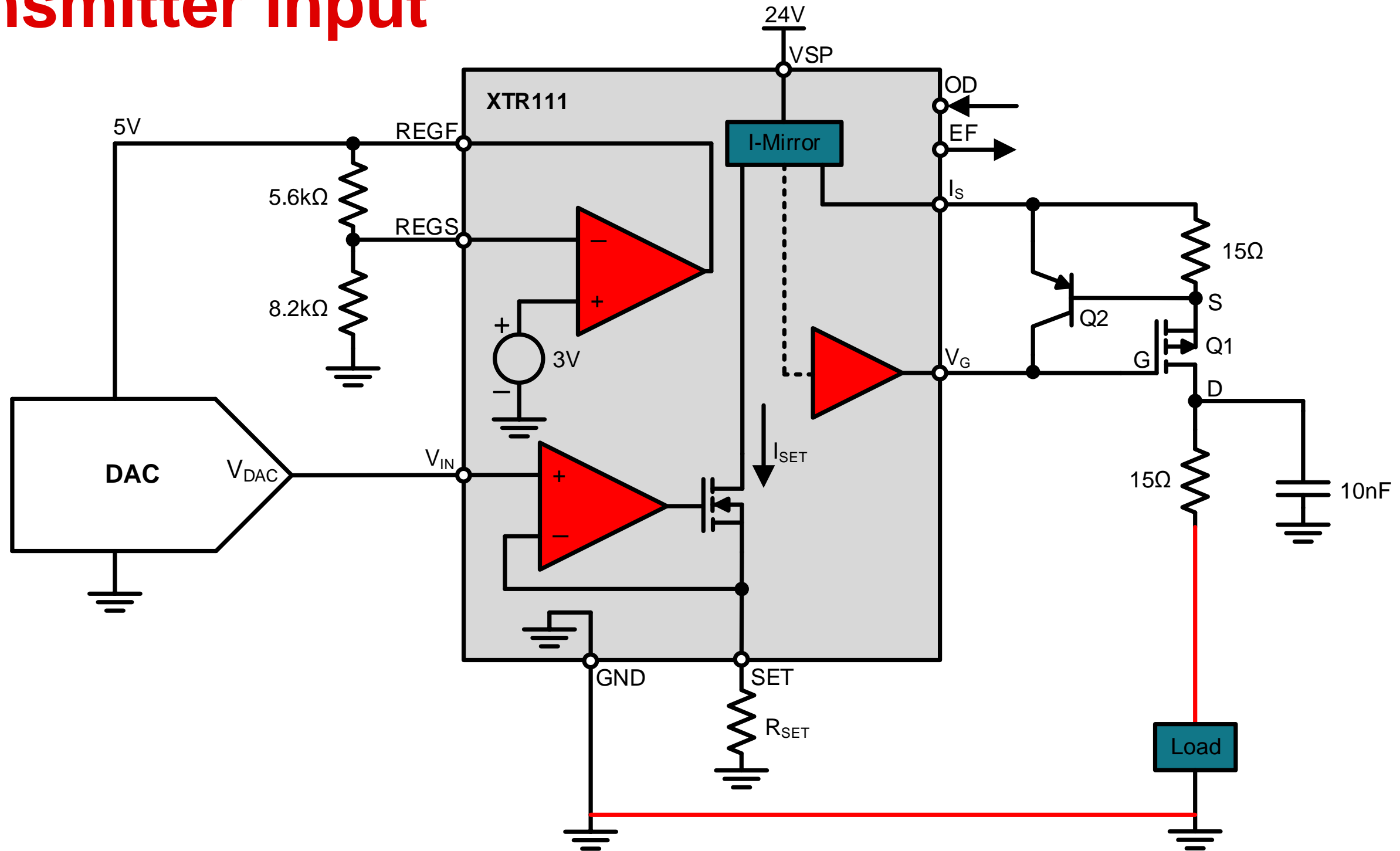
$$V_{2+} = V_{2-} = AVDD - R_A I_1$$

$$I_1 = I_2 = \frac{V_{DAC}}{R_{SET}}$$

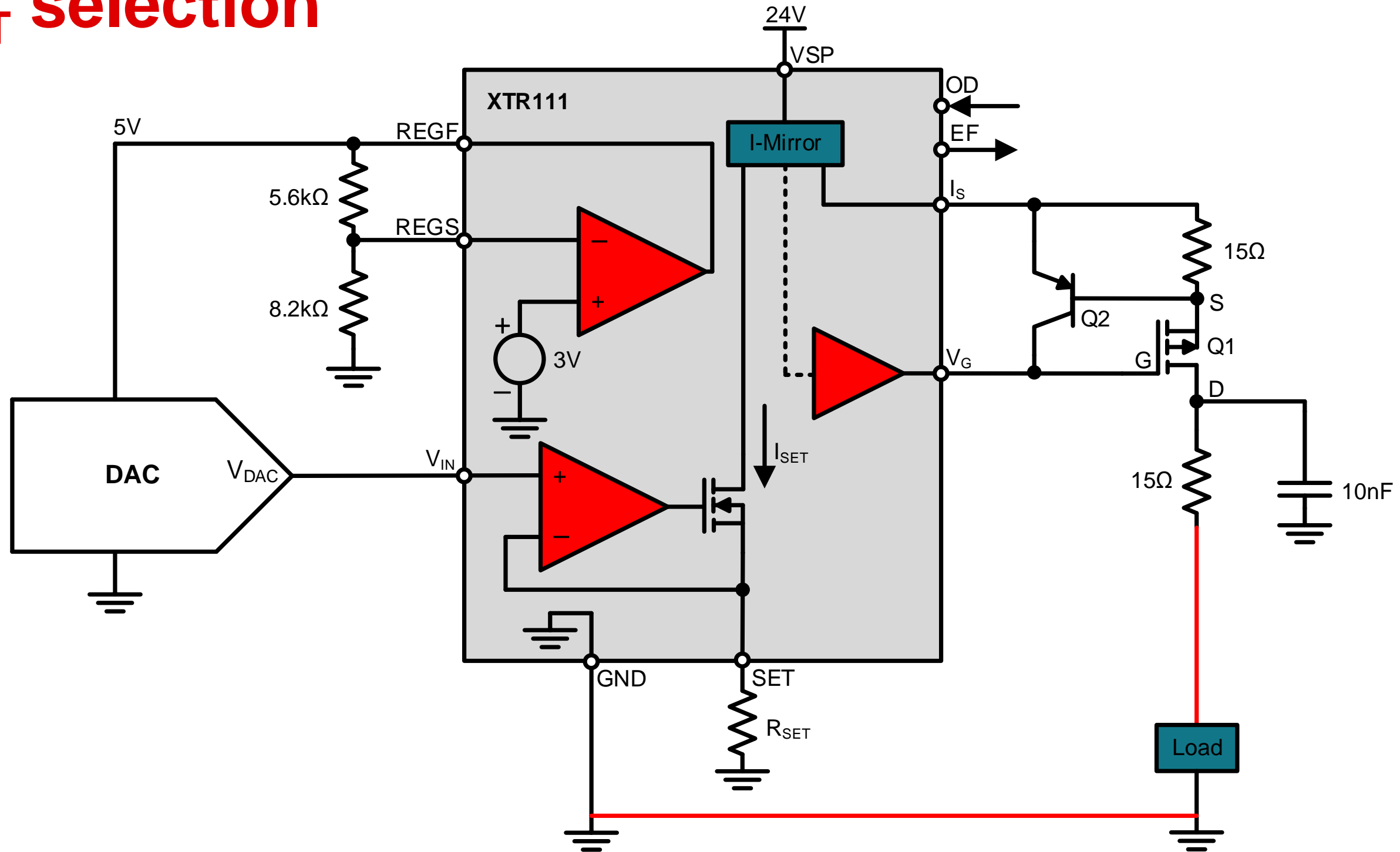
$$I_3 = \frac{AVDD - (AVDD - R_A I_1)}{R_B} = \frac{R_A}{R_B} I_1$$

$$I_{OUT} = I_3 = \frac{R_A}{R_B} I_1 = \frac{R_A}{R_B} \frac{V_{DAC}}{R_{SET}}$$

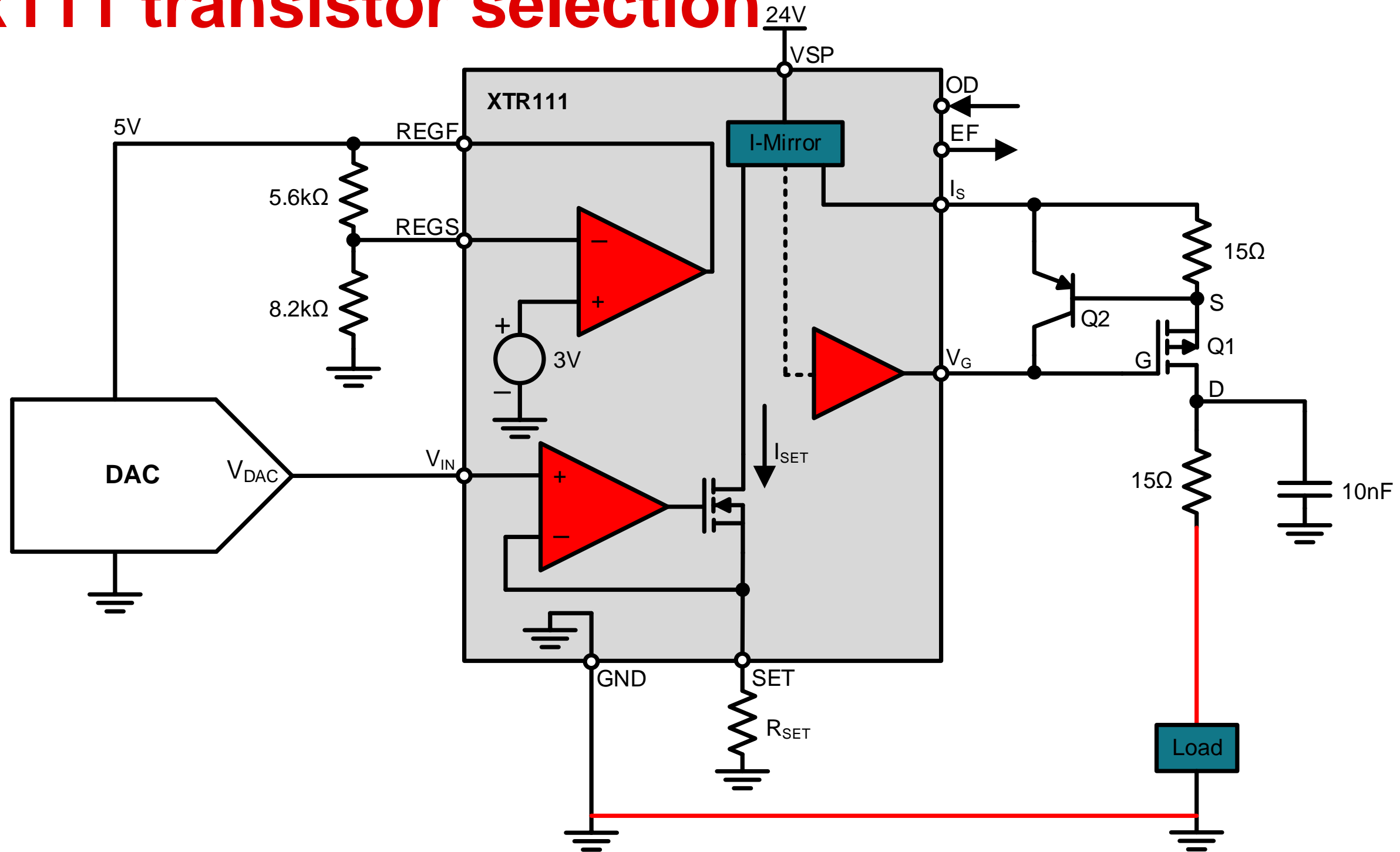
Transmitter input



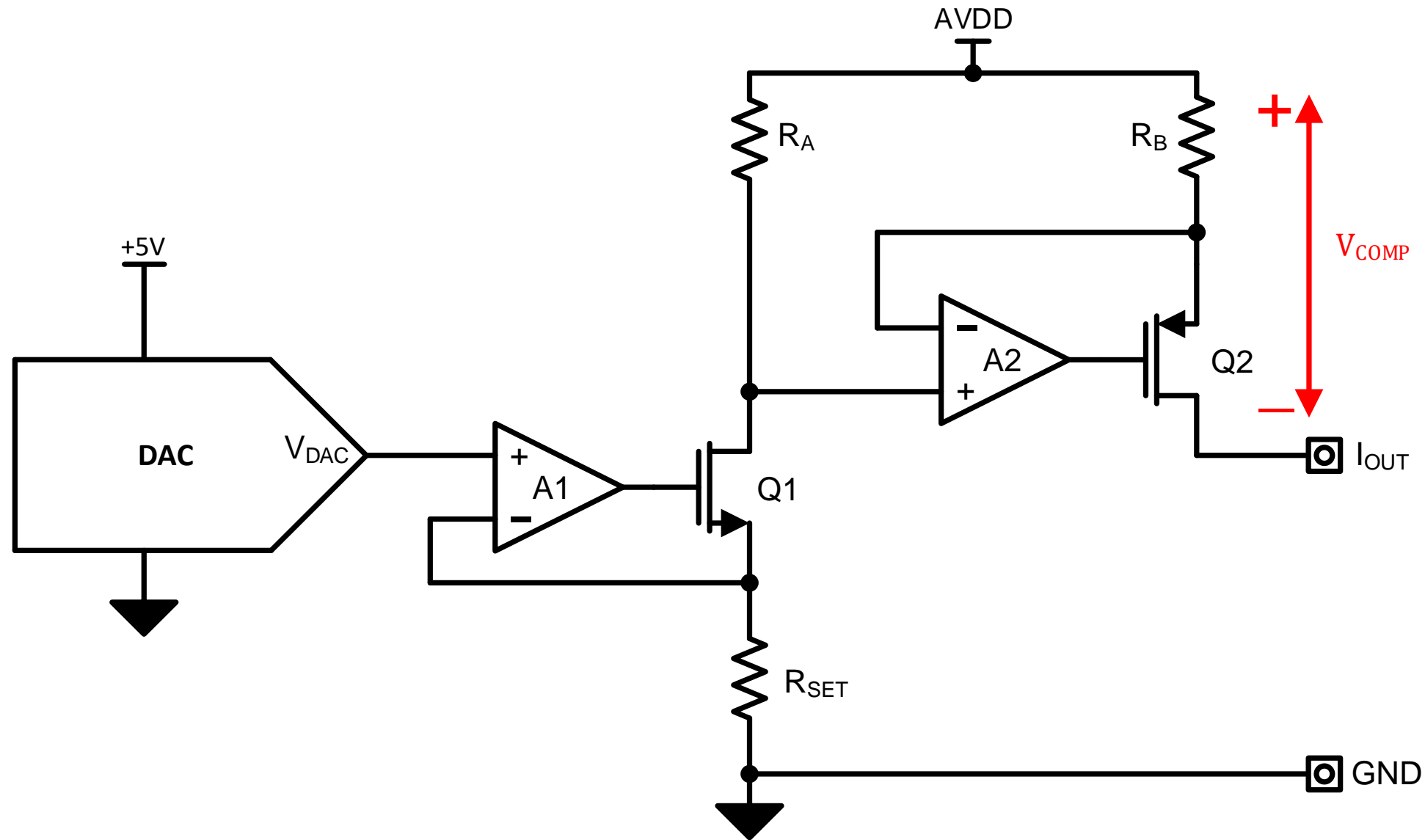
R_{SET} selection



XTR111 transistor selection



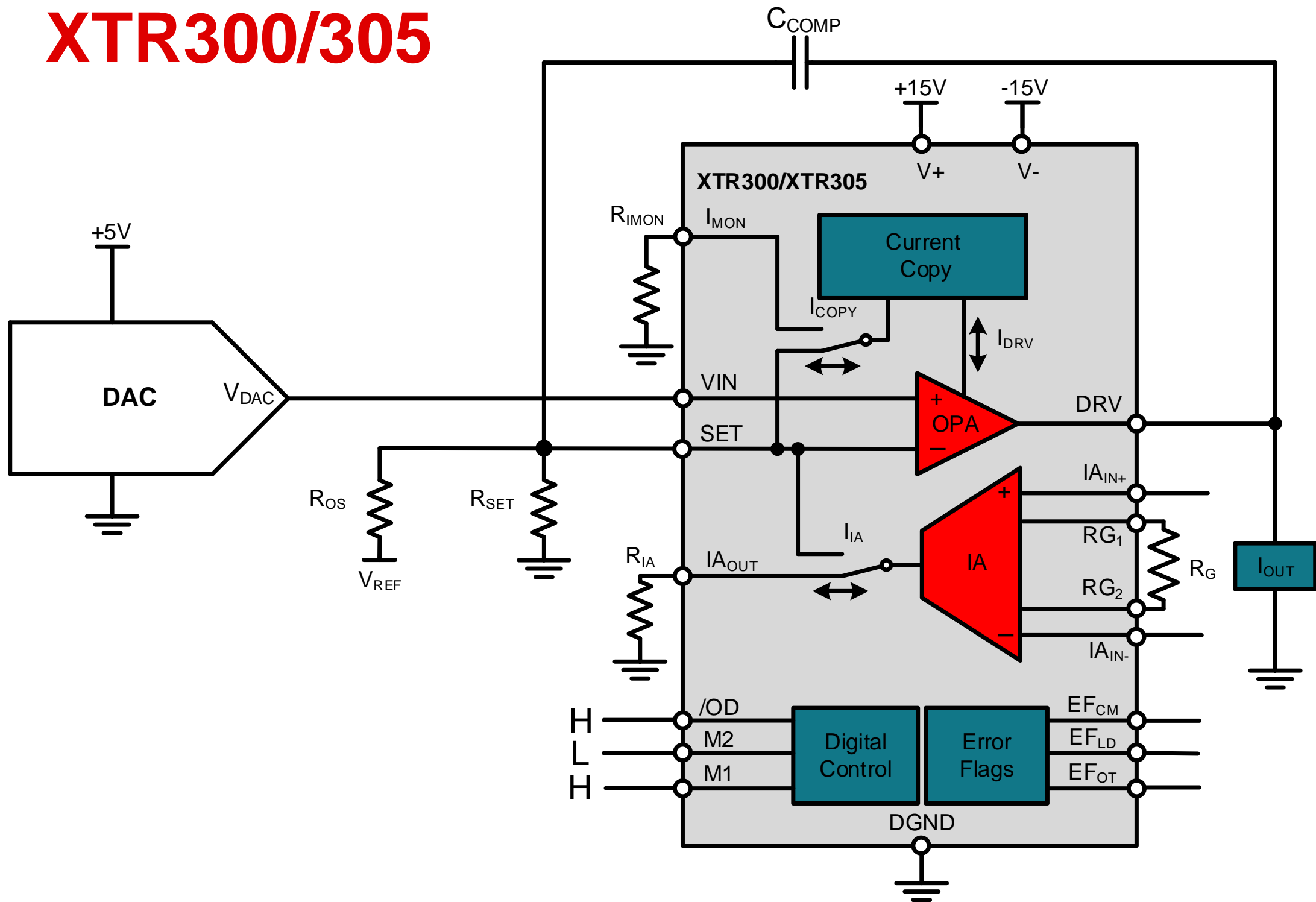
Compliance voltage



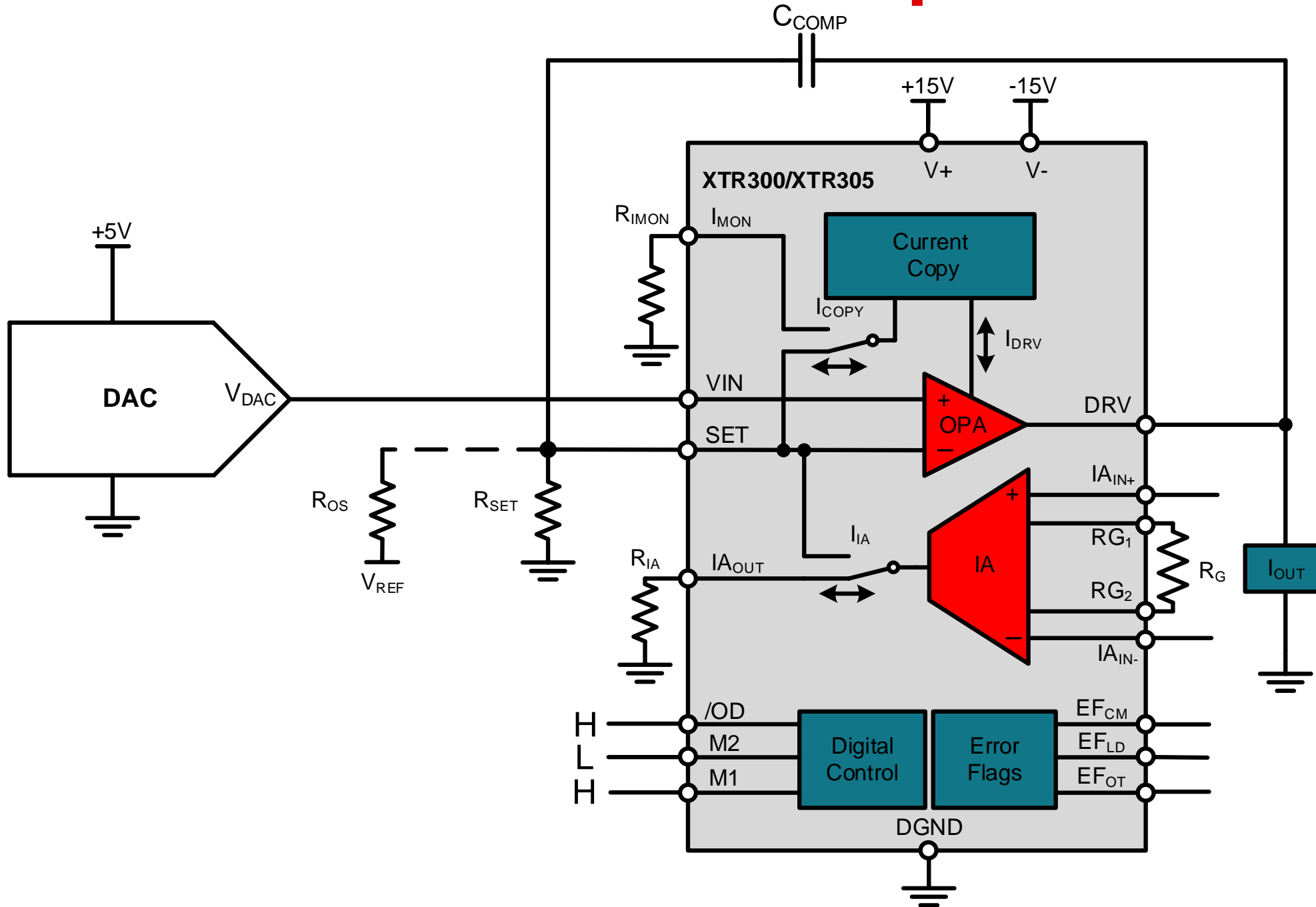
When this voltage drops below V_{COMP} , Q2 is no longer in saturation

$$AVDD > I_{MAX} * LOAD_{MAX} + V_{COMP}$$

XTR300/305



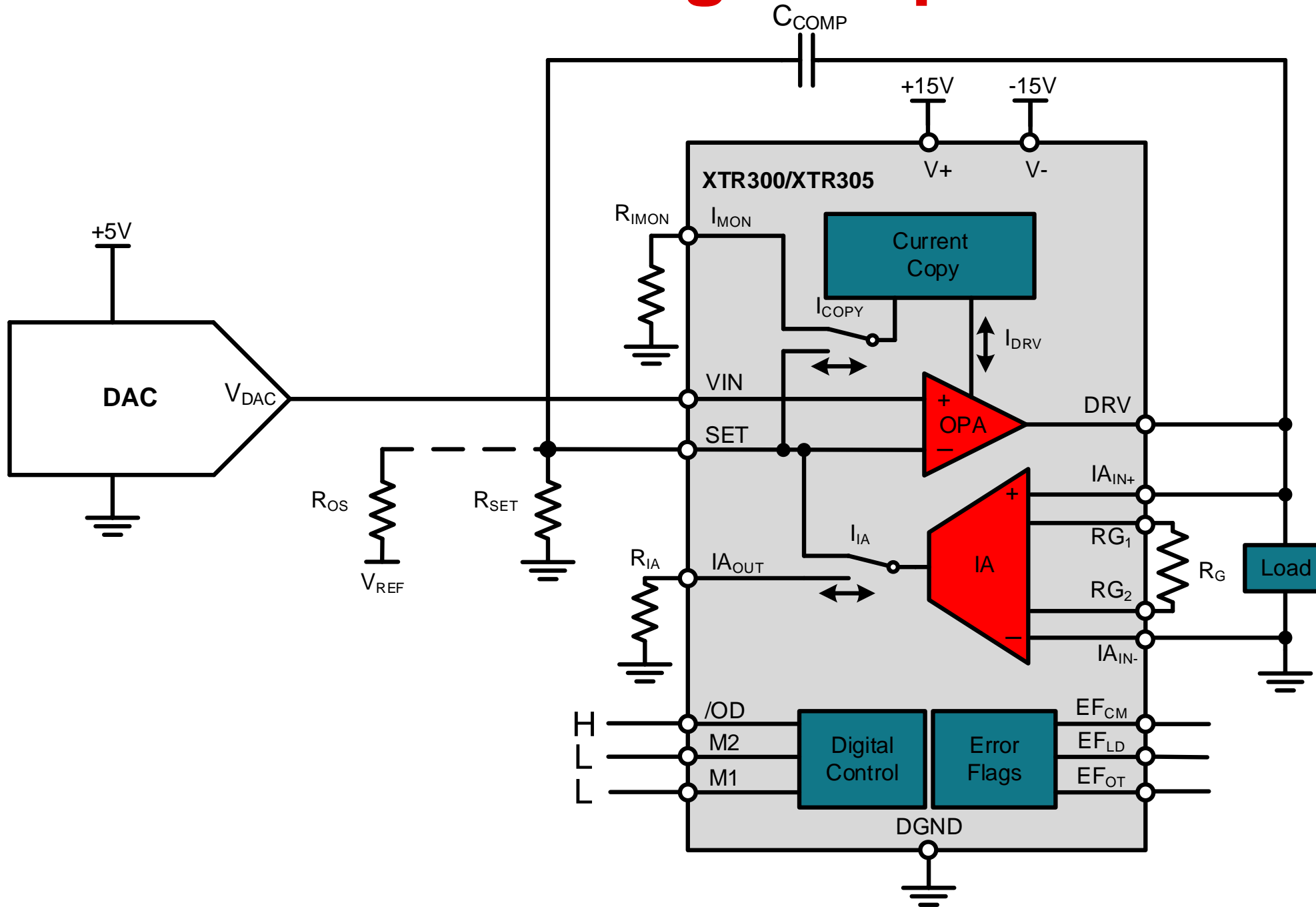
XTR300/305 current output mode



$$I_{OUT} = 10 \left(\frac{V_{IN}}{R_{SET}} \right)$$

$$I_{OUT} = 10 \left(\frac{V_{IN}}{R_{SET}} + \frac{V_{IN} - V_{REF}}{R_{OS}} \right)$$

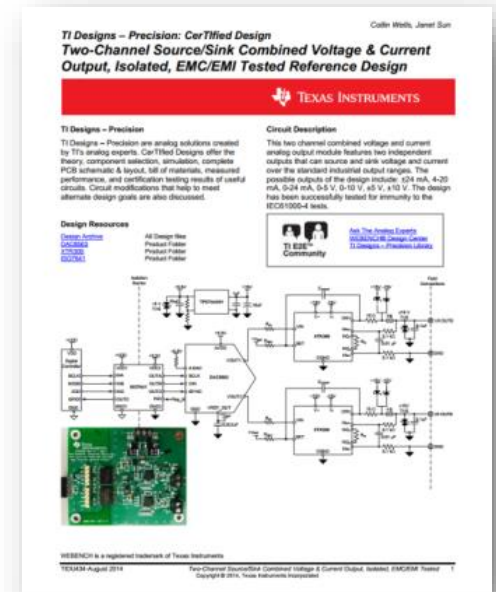
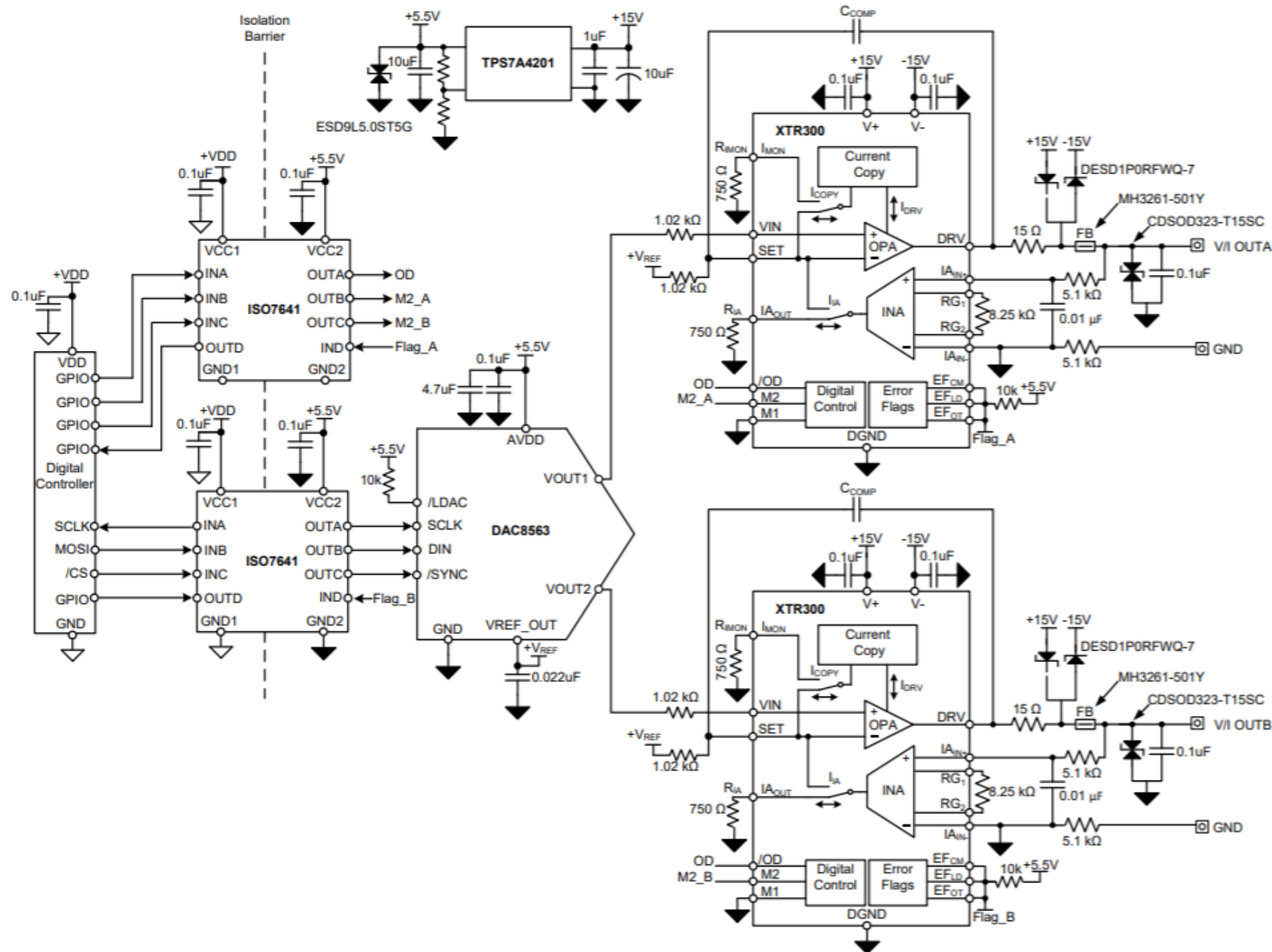
XTR300/305 voltage output mode



$$V_{OUT} = \frac{R_{GAIN}}{2} \left(\frac{V_{IN}}{R_{SET}} \right)$$

$$V_{OUT} = \frac{R_{GAIN}}{2} \left(\frac{V_{IN}}{R_{SET}} + \frac{V_{IN} - V_{REF}}{R_{OS}} \right)$$

Transmitting more than one sensor signal



TIPD155

XTR parts

Part	Description	Supply Voltage (V)	Input Range (V)	Output Range	Features
XTR110	Precision Voltage-to-Current Transmitter with Selectable Input/Output Ranges	13.5-40	0-5, 0-10	0-20mA, 4-20mA, 5-25mA	10V reference
XTR111	Precision Voltage to Current Transmitter	8-40	0-12	0-25mA	Adjustable 3V-15V regulator
XTR300/ XTR305	Industrial Analog Current/Voltage Output Driver	10-40, bipolar	(V-)+3- (V+)-3	±10V or ±20mA	Short/open circuit fault, over temperature, and exceeding IA CM input range error flags. Digital select pins for voltage or current output modes.

Thanks for your time!
Please try the quiz.

**To find more Current Transmitter
technical resources and search
products, visit:**

**[ti.com/amplifier-circuit/special-
function/4-20ma-signal-conditioners.html](https://www.ti.com/amplifier-circuit/special-function/4-20ma-signal-conditioners.html)**

Quiz: 3-wire 4-20mA Transmitters

TI Precision Labs – Current Loop Transmitters

Presented by Katlynn Jones

Prepared by Katlynn Jones

Quiz: 3-wire 4-20mA Transmitters || Question

1. Which statement about a 3-wire transmitter is true?
 - a) The transmitter always uses an independent supply from the receiver.
 - b) The transmitter and receiver share a ground.
 - c) The signal current and supply current are shared in one loop.
 - d) None of the above

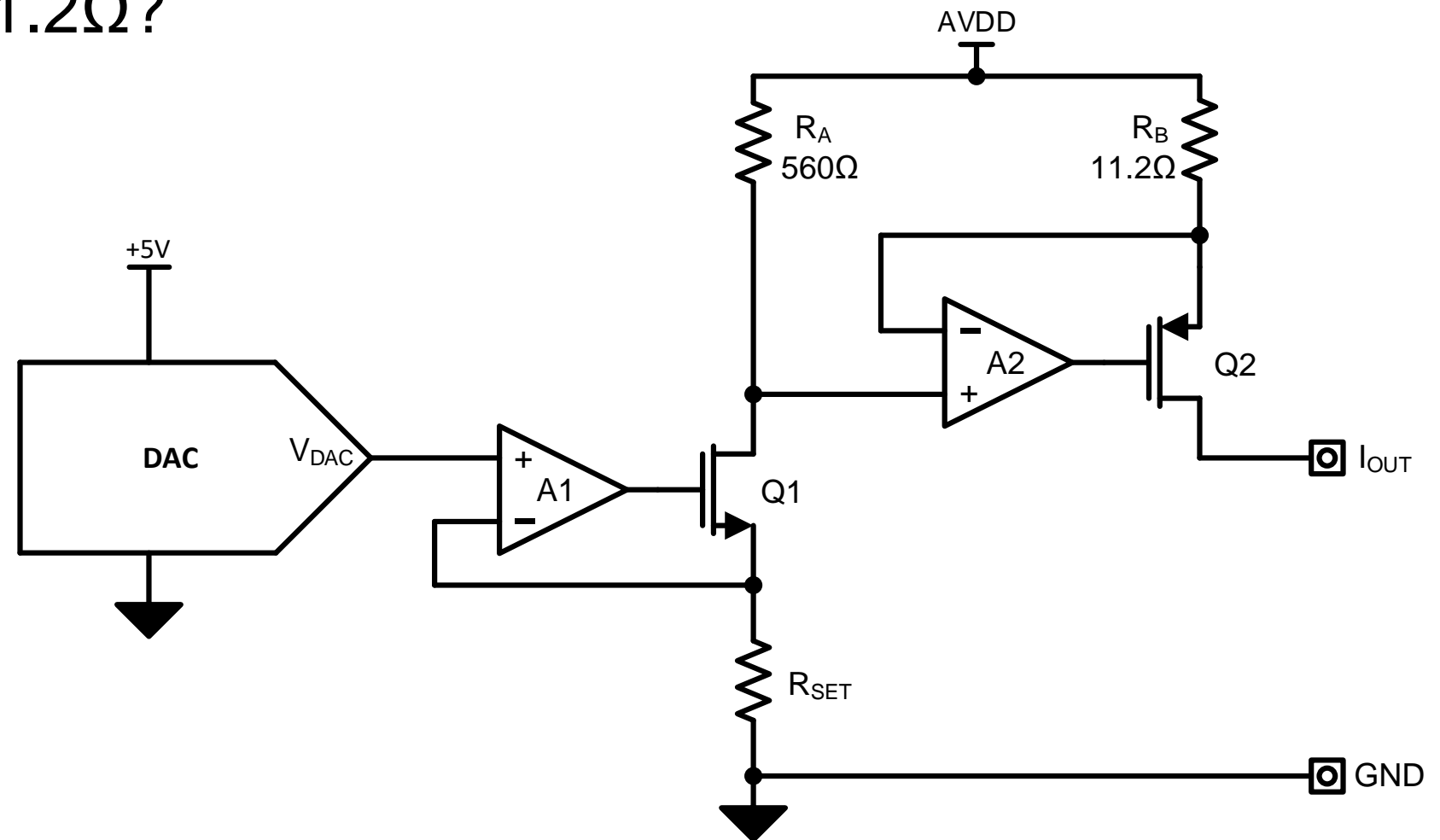
Quiz: 3-wire 4-20mA Transmitters || Answer

1. Which statement about a 3-wire transmitter is true?
 - a) The transmitter always uses an independent supply from the receiver.
 - b) The transmitter and receiver share a ground.**
 - c) The signal current and supply current are shared in one loop.
 - d) None of the above

Quiz: 3-wire 4-20mA Transmitters || Question

2. Given the discrete 3-wire transmitter below, what is the gain of the transmitter if R_A is 560Ω and R_B is 11.2Ω ?

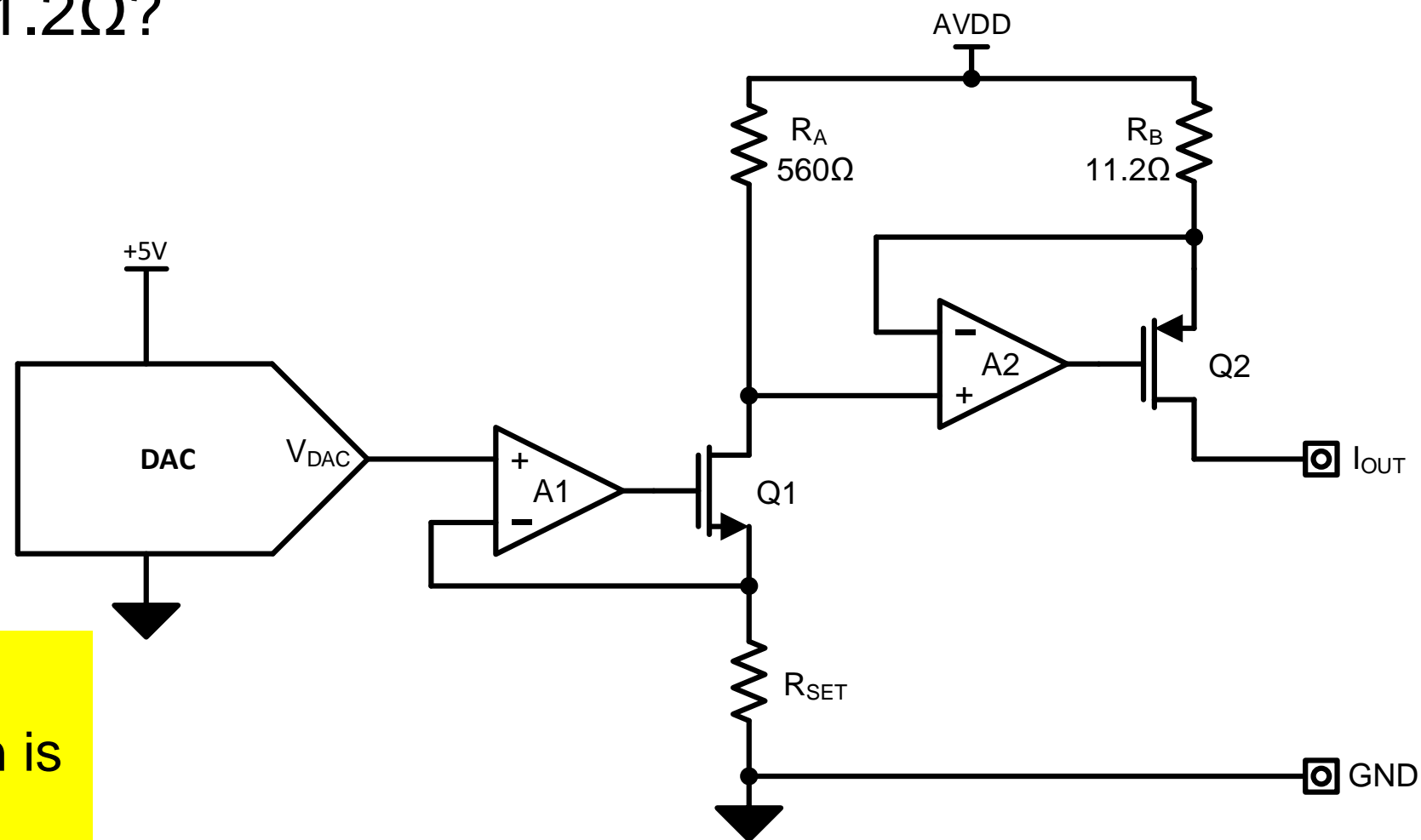
- a) 50
- b) 51
- c) 99
- d) 100



Quiz: 3-wire 4-20mA Transmitters || Answer

2. Given the discrete 3-wire transmitter below, what is the gain of the transmitter if R_A is 560Ω and R_B is 11.2Ω ?

- a) 50
- b) 51
- c) 99
- d) 100

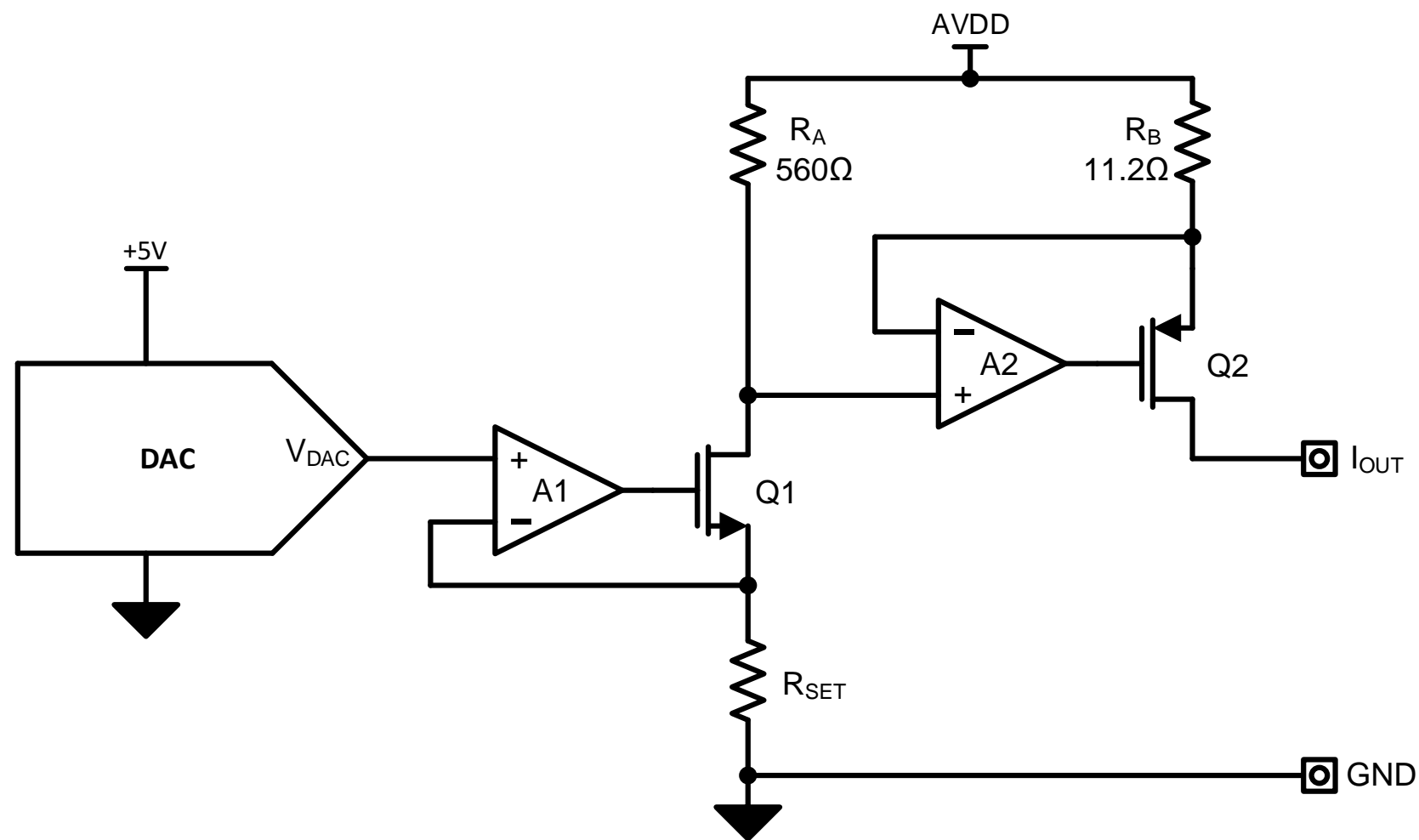


The transfer function of this 3-wire transmitter is $I_{OUT} = \frac{R_A}{R_B} \frac{V_{DAC}}{R_{SET}}$. The gain is defined by $\left(\frac{R_A}{R_B}\right)$.

Quiz: 3-wire 4-20mA Transmitters || Question

3. Given the 3-wire transmitter below, what value for R_{SET} should be chosen to get an output of 0-25mA with V_{DAC} voltage of 0-4V?

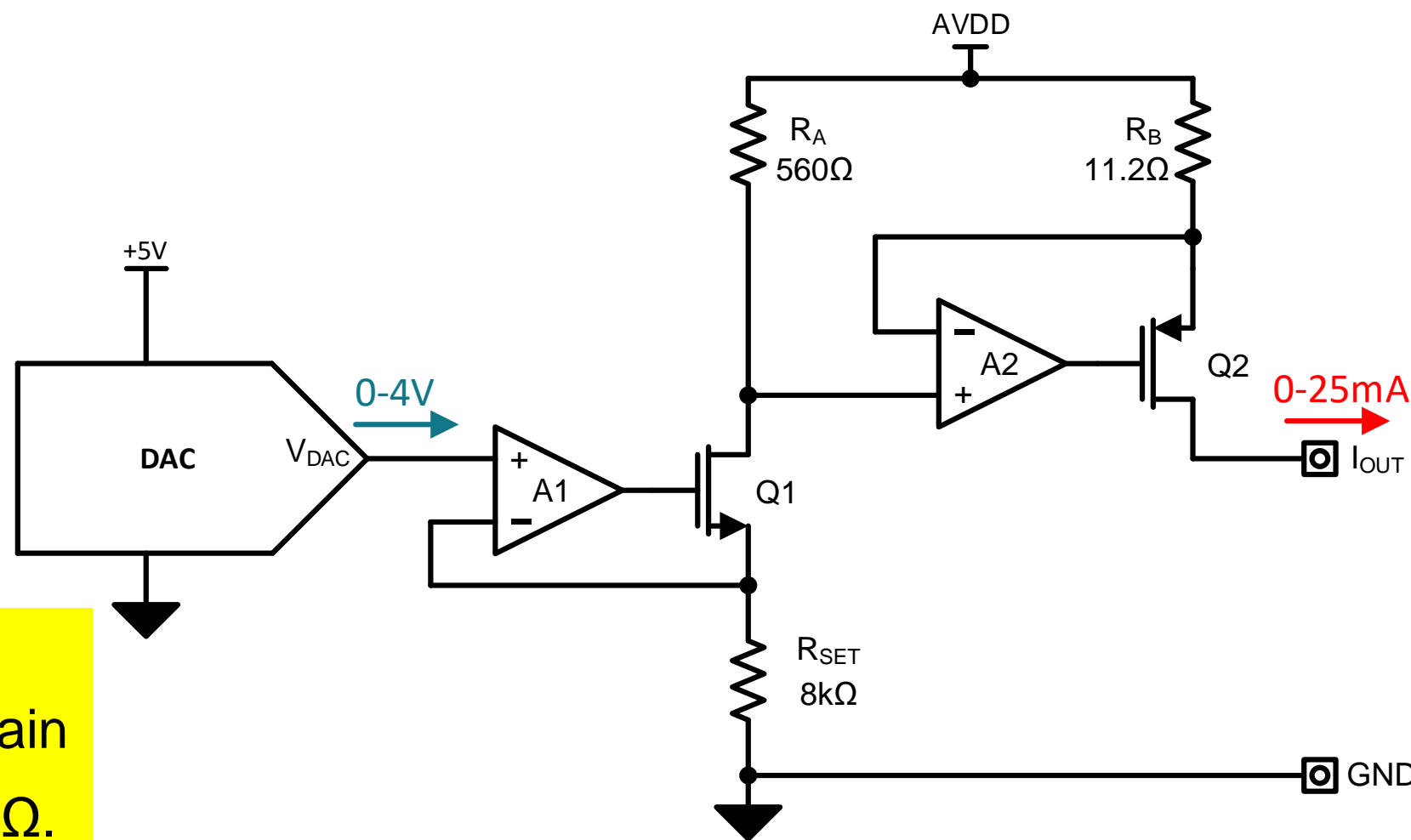
- a) $5k\Omega$
- b) $8k\Omega$
- c) $10k\Omega$
- d) $12k\Omega$



Quiz: 3-wire 4-20mA Transmitters || Answer

3. Given the 3-wire transmitter below, what value for R_{SET} should be chosen to get an output of 0-25mA with V_{DAC} voltage of 0-4V?

- a) 5k Ω
- b) 8k Ω**
- c) 10k Ω
- d) 12k Ω



The transfer function of this 3-wire transmitter is $I_{OUT} = \frac{R_A V_{DAC}}{R_B R_{SET}}$. With a gain of 50, the correct value for R_{SET} is 8k Ω .

Quiz: 3-wire 4-20mA Transmitters || Question

4. The _____ uses digital control inputs to select between a current and voltage output mode.
- a) XTR110
 - b) XTR111
 - c) XTR115
 - d) XTR300/305

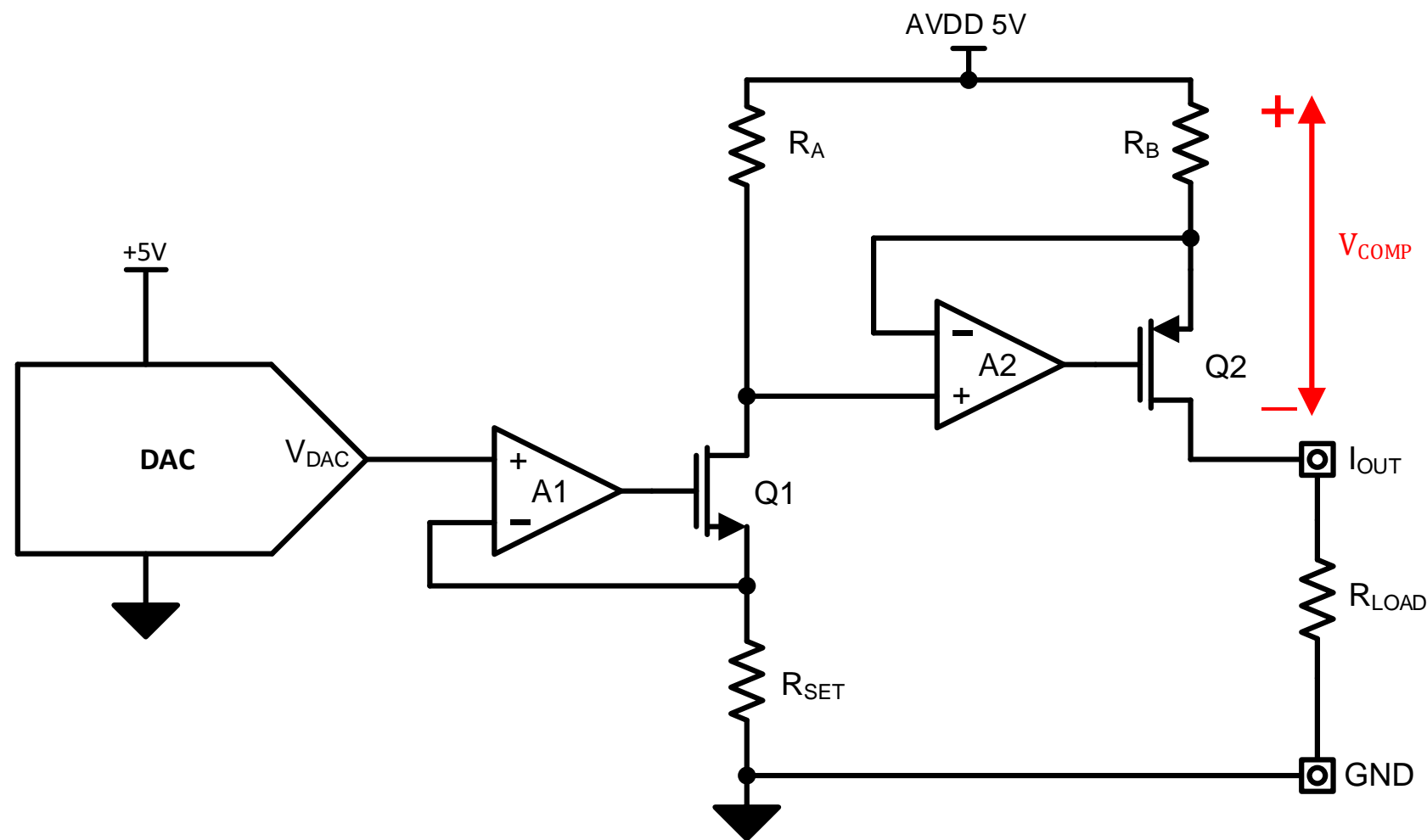
Quiz: 3-wire 4-20mA Transmitters || Answer

4. The _____ uses digital control inputs to select between a current and voltage output mode.
- a) XTR110
 - b) XTR111
 - c) XTR115
 - d) XTR300/305**

Quiz: 3-wire 4-20mA Transmitters || Question

5. If the below 3-wire transmitter has a compliance voltage of 1V and a full scale current output of 20mA, what is the max allowed R_{LOAD} that can be used to ensure operation.

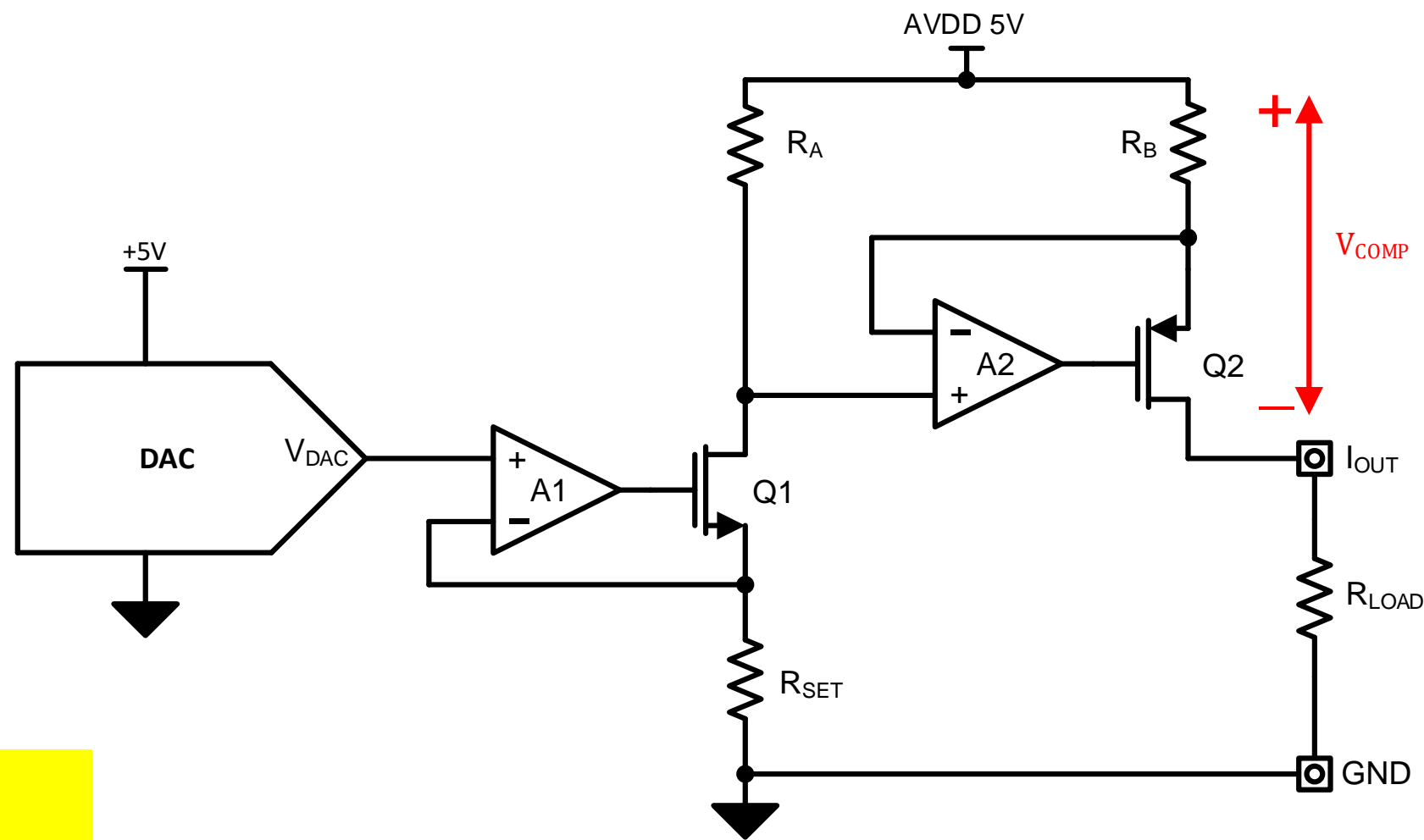
- a) 100Ω
- b) 150Ω
- c) 200Ω
- d) 250Ω



Quiz: 3-wire 4-20mA Transmitters || Answer

5. If the below 3-wire transmitter has a compliance voltage of 1V and a full scale current output of 20mA, what is the max allowed R_{LOAD} that can be used to ensure operation.

- a) 100 Ω
- b) 150 Ω
- c) 200 Ω**
- d) 250 Ω



$$\frac{AVDD - V_{COMP}}{I_{MAX}} > R_{LOAD_MAX}$$

Thanks for your time!

To find more Current Transmitter technical resources and search products, visit:

<https://www.ti.com/amplifier-circuit/special-function/4-20ma-signal-conditioners.html>