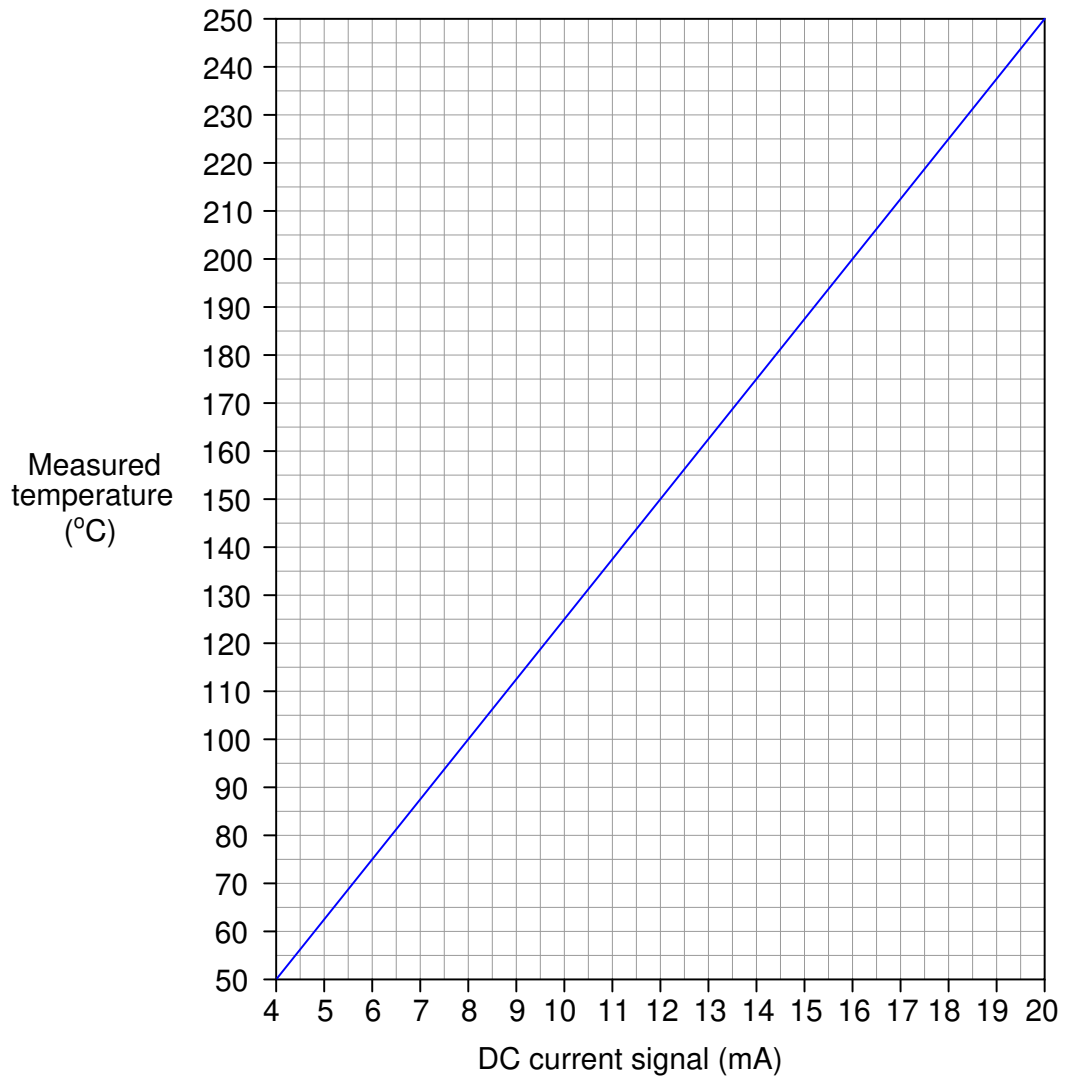
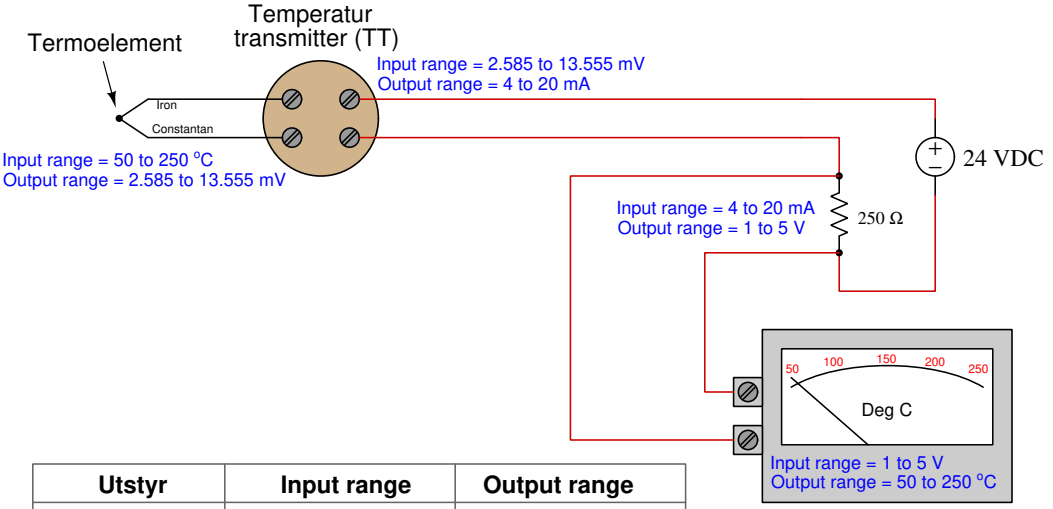
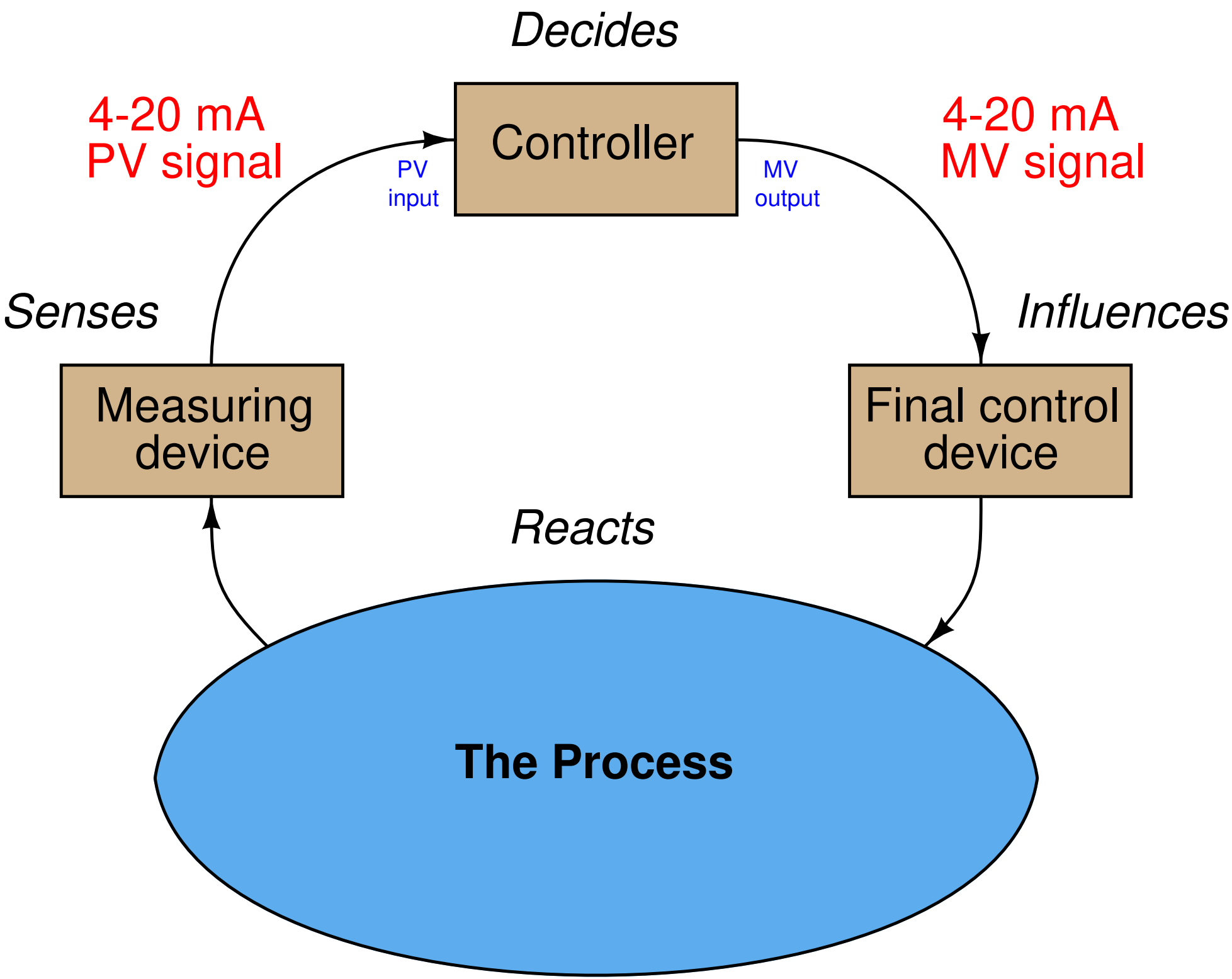
Current value	**% of scale**
4 mA	0%
8 mA	25%
12 mA	50%
16 mA	75%
20 mA	100%

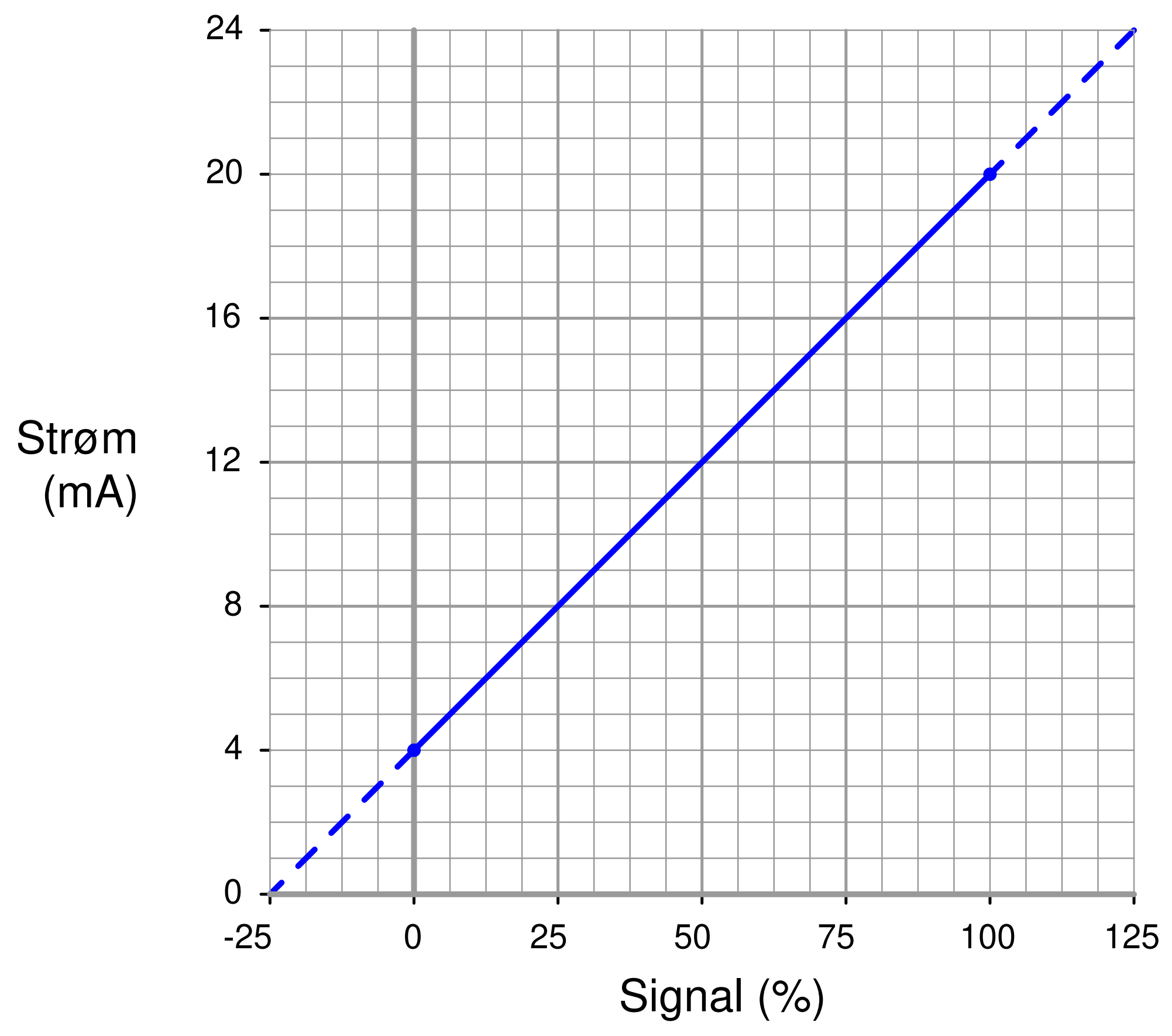

Measured temperature (°C)
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
DC current signal (mA)

-10



Utstyr	Input range	Output range
Termoelement	50 to 250 °C	2.585 to 13.555 mV
Transmitter	2.585 to 13.555 mV	4 to 20 mA
Resistor	4 to 20 mA	1 to 5 V
Display	1 to 5 V	50 to 250 °C


Decides
4-20 mA
PV signal
Controller
4-20 mA
MV signal
PV
input
MV
output
Senses
Influences
Measuring
device
Final control
device
Reacts
The Process


24
20
16
12
8
4
0
Strøm
(mA)
-25
0
25
50
75
100
125
Signal (%)

$$y = mx + b$$

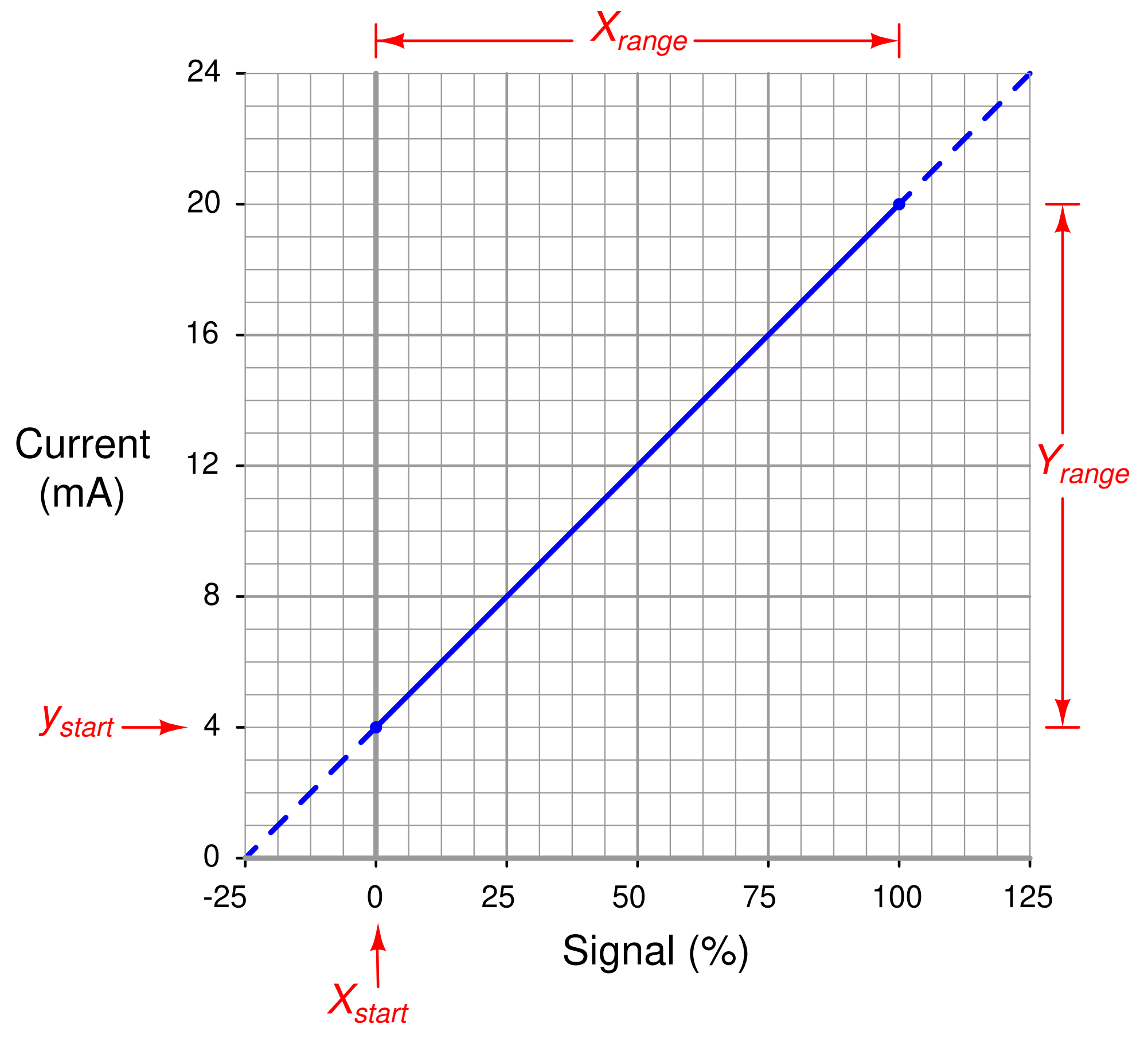
y

x

m

b


Yrange


X_{range}
24
20
16
12
8
4
0
Current
(mA)
y_{start}
Y_{range}
-25
0
25
50
75
100
125
Signal (%)
X_{start}

$$m = \frac{y_{range}}{x_{range}} = \frac{20 - 4}{100 - 0} = \frac{16}{100}$$

$$y = \left(\frac{16}{100} \right) x + y_{start}$$

(x, y)

$(x, y) = (0, 4)$

4

$$= \left(\frac{16}{100} \right) 0 + y_{start}$$

$= 0 + b$

b

$= 4$

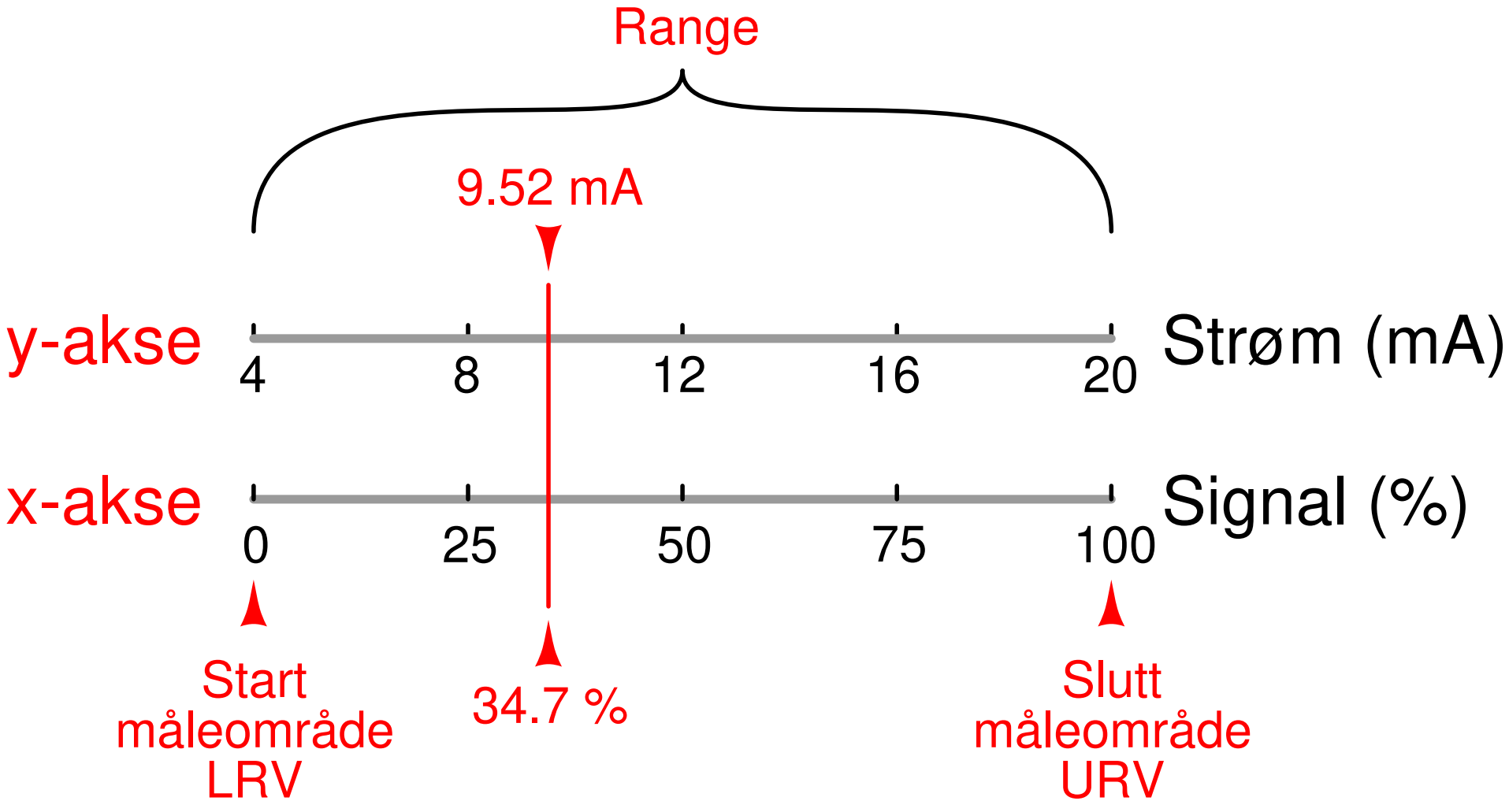
$$y = \left(\frac{16}{100} \right) x + 4$$

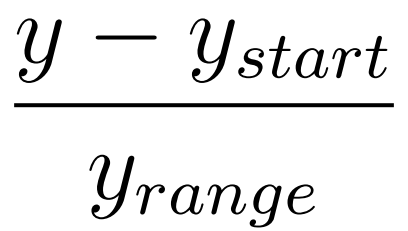
y

$$= \left(\frac{16}{100}\right) 34.7 + 4$$

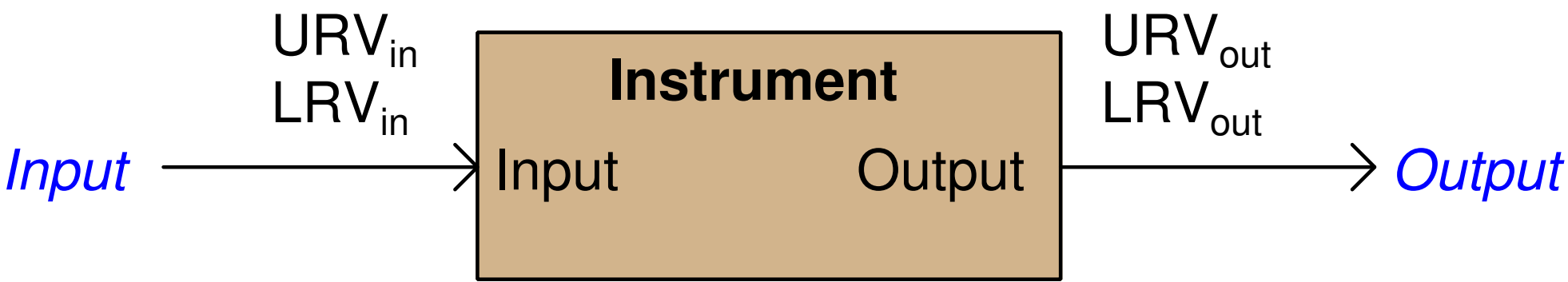
$= 5.552 + 4$

$= 9.552$

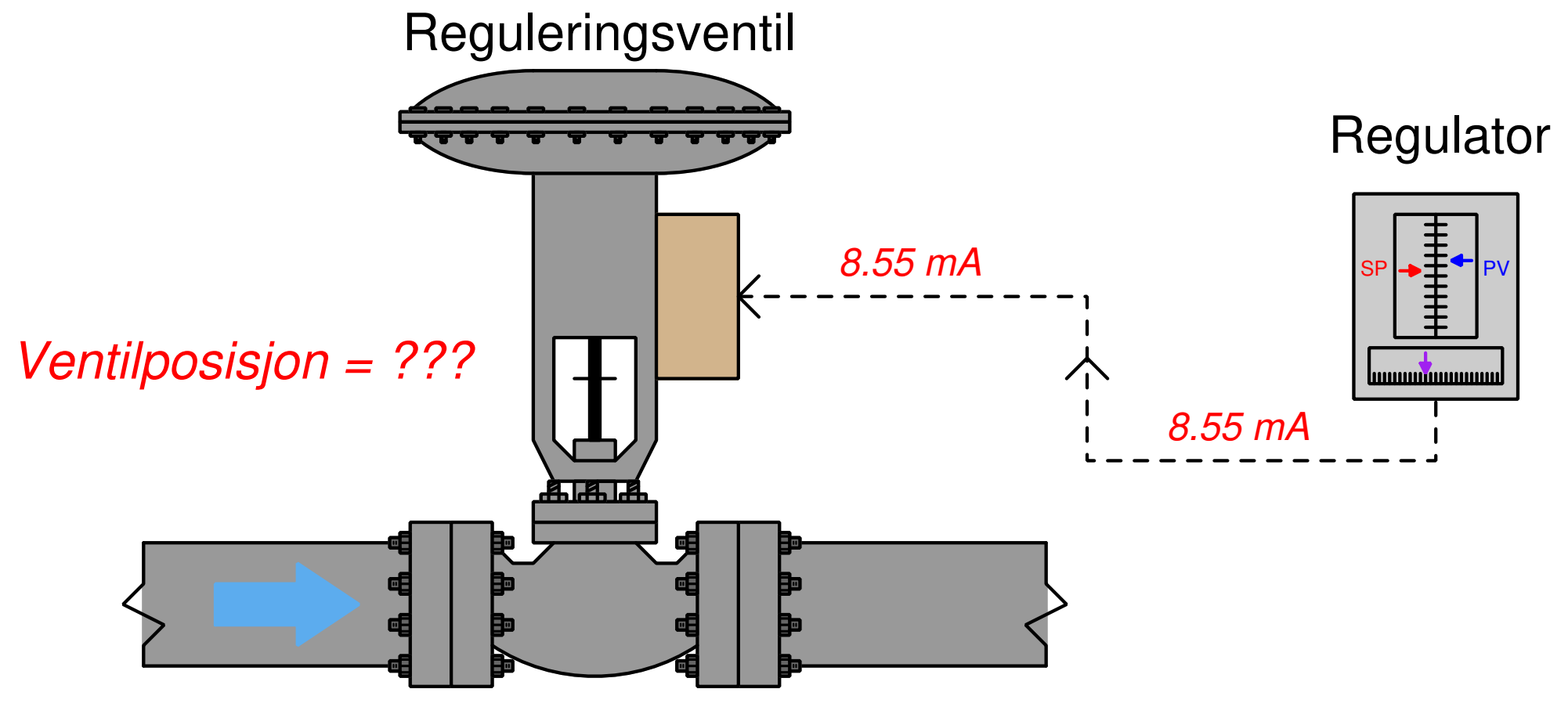

Range
9.52 mA
y-akse
4
8
12
16
20
Strøm (mA)
x-akse
0
25
50
75
100
Signal (%)
Start
måleområde
LRV
34.7 %
Slutt
måleområde
URV



$$= \frac{x - x_{start}}{x_{range}}$$



$$\frac{\textit{Input} - \text{LRV}_{in}}{\text{URV}_{in} - \text{LRV}_{in}} = \text{Per enhet av måle–område. fra 0 til og med 1} = \frac{\textit{Output} - \text{LRV}_{out}}{\text{URV}_{out} - \text{LRV}_{out}}$$


Reguleringsventil
Regulator
8.55 mA
8.55 mA
Ventilposisjon = ???
SP
PV

$$\frac{8.55 - 4}{16}$$

$$= \frac{x - 0}{100}$$

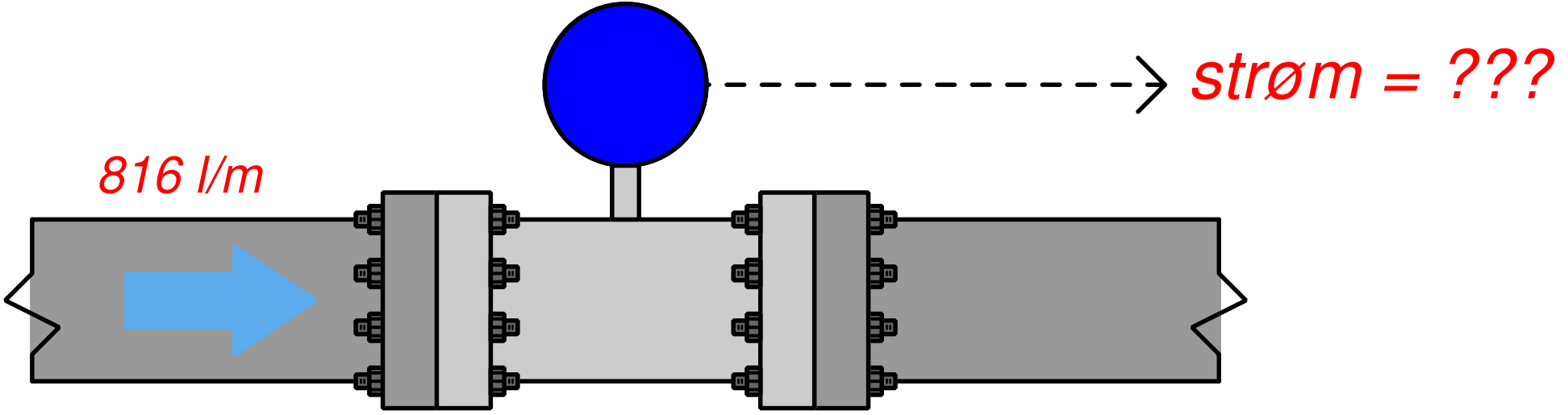
$$\frac{100 \cdot 4.55}{16}$$

$= x$

x

$= 28.4$

Strømningsmåler
(0 to 1400 l/m range)

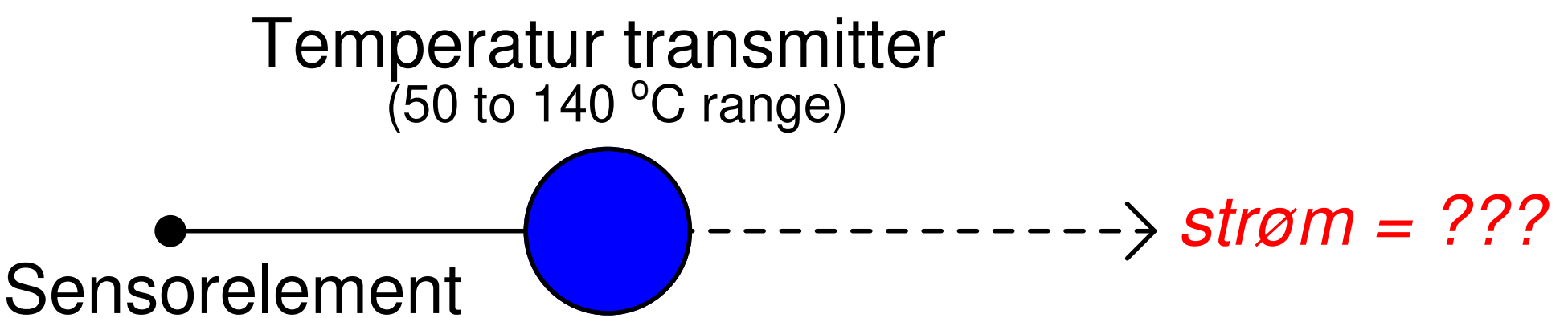


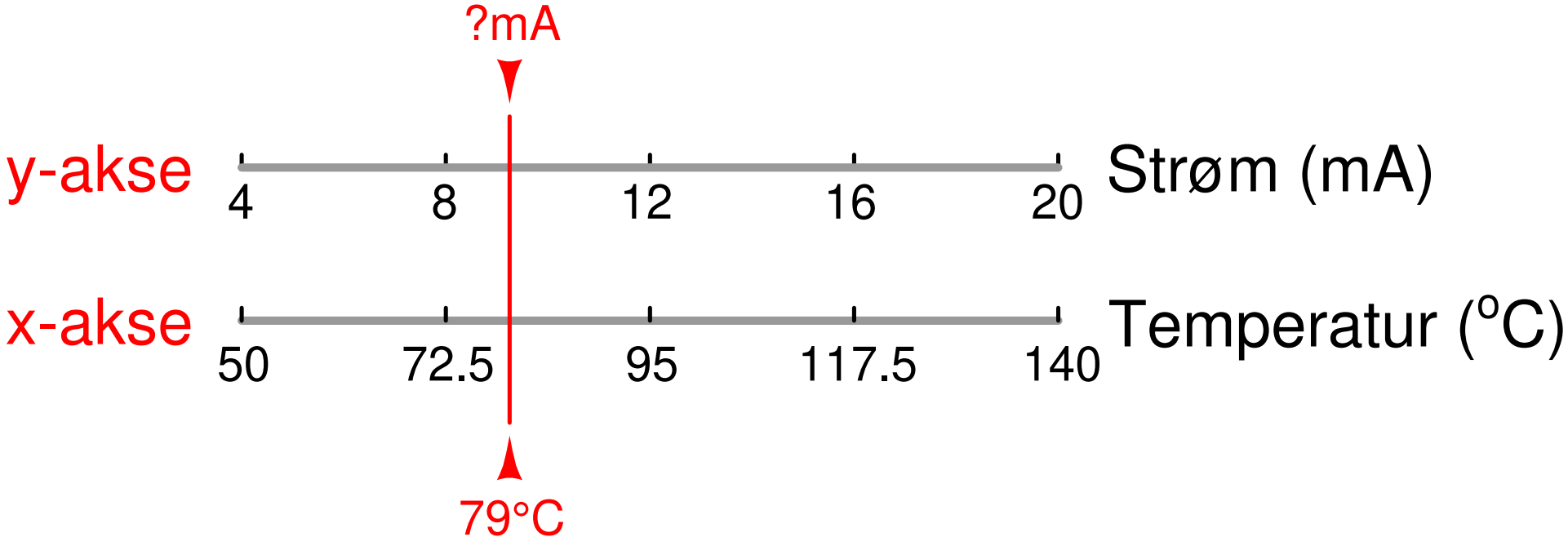
$$\frac{y-4}{16}$$

$$= \frac{816 - 0}{1400}$$

$$= \frac{816 \cdot 16}{1400} + 4$$

$= 13.3mA$

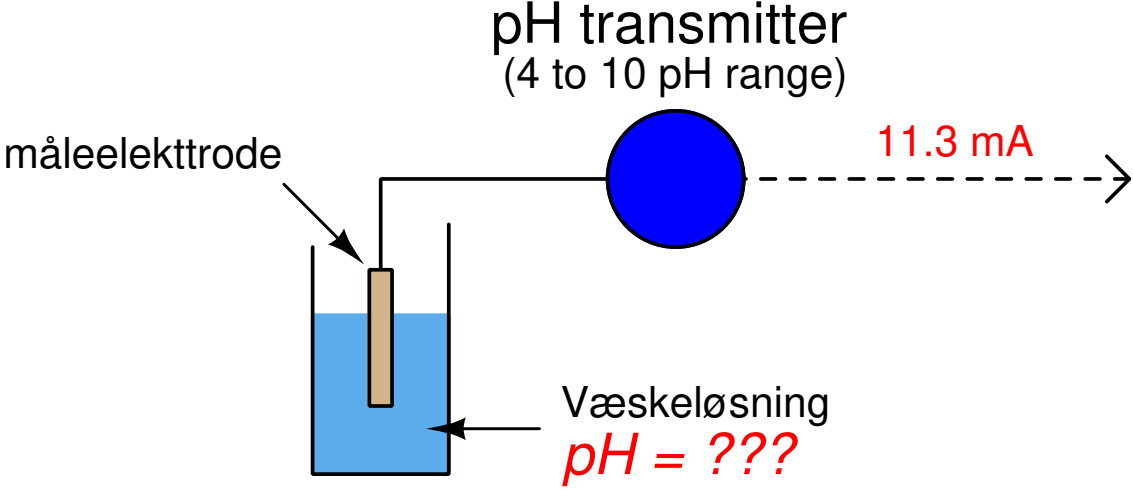

Temperatur transmitter
(50 to 140 °C range)
Sensorelement
strøm = ???

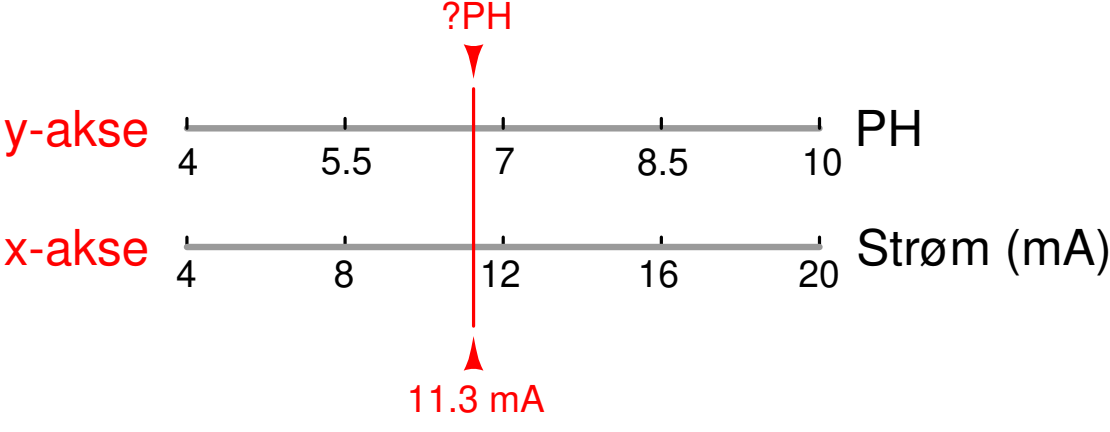

?mA
y-akse
4
8
12
16
20
Strøm (mA)
x-akse
50
72.5
95
117.5
140
Temperatur (°C)
79°C

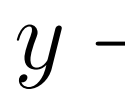
$$= \frac{79 - 50}{90}$$

$$= \frac{29 \cdot 16}{90} + 4$$

$= 9.2mA$


pH transmitter
(4 to 10 pH range)
måleelekttrode
11.3 mA
Væskeløsning
pH = ???


?PH
y-akse
4
5.5
7
8.5
10
PH
x-akse
4
8
12
16
20
Strøm (mA)
11.3 mA

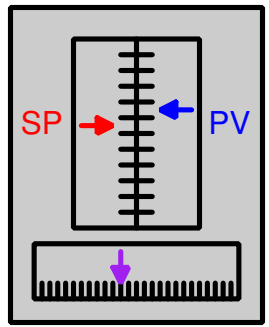


$$= \frac{11.3 - 4}{16}$$

$$= \frac{7.3 \cdot 6}{16} + 4$$

$= 6.74mA$

Regulator



I/P Omformer

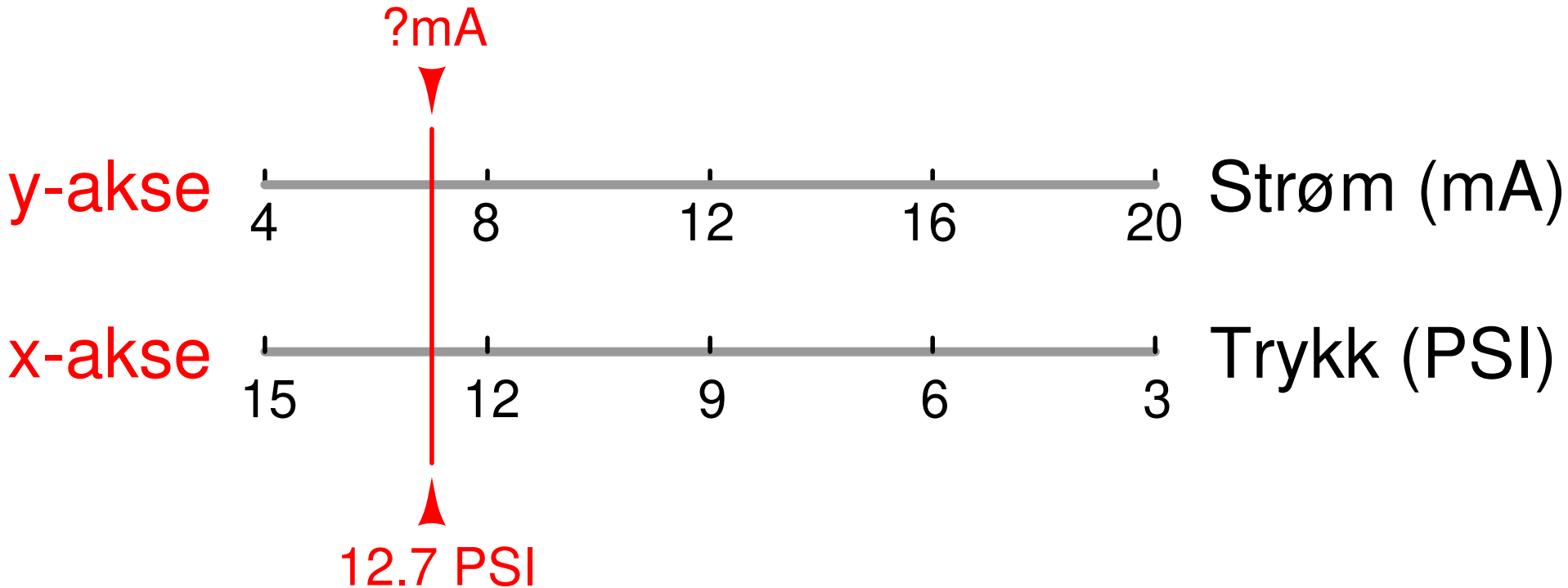
(15 to 3 PSI reverse action)

Strøm = ???

12.7 PSI

Luft tilførsel

$3 - 15 = -12$

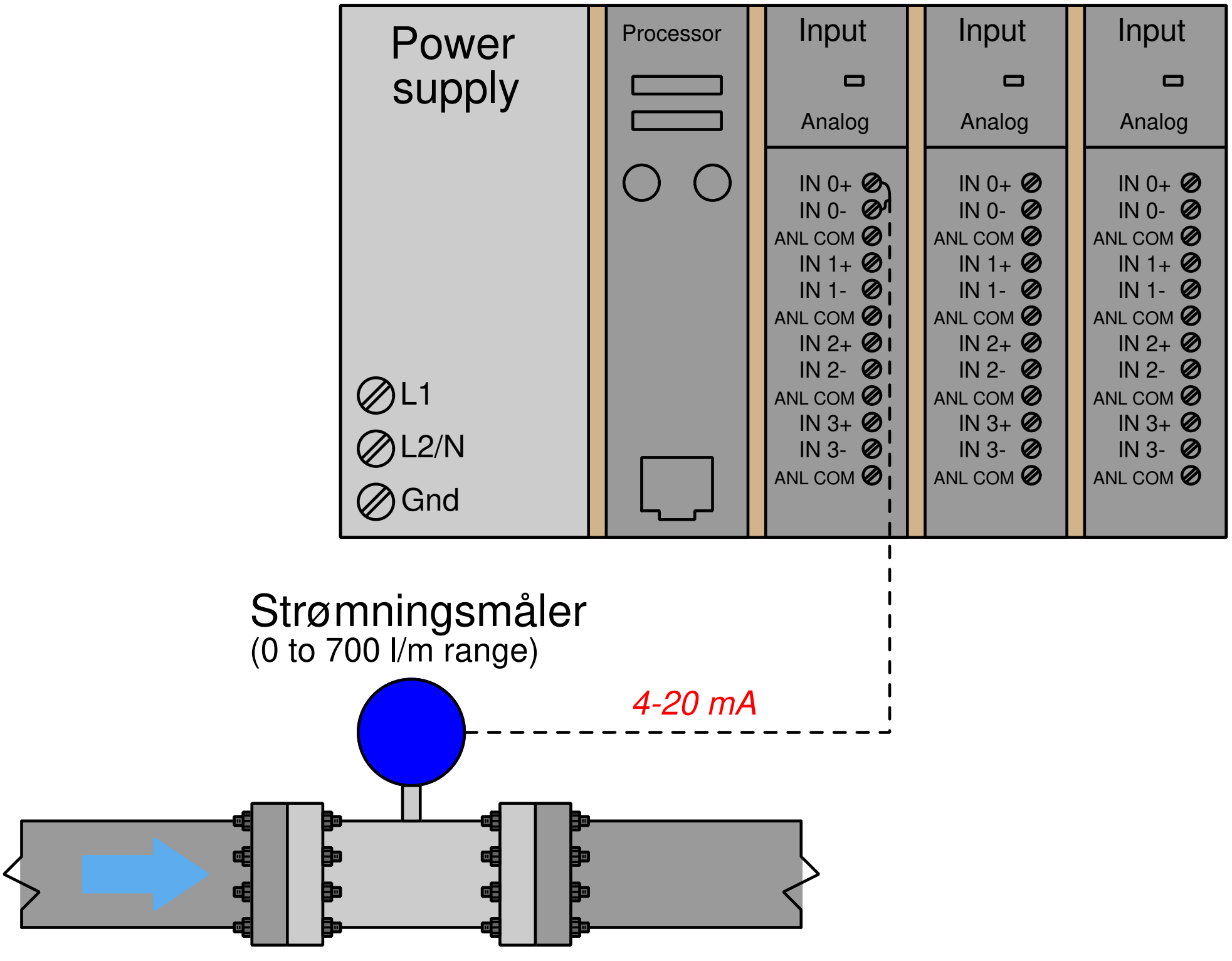

?mA
y-akse
4
8
12
16
20
Strøm (mA)
x-akse
15
12
9
6
3
Trykk (PSI)
12.7 PSI

$$= \frac{12.7 - 15}{-12}$$

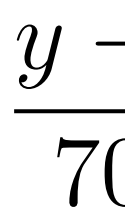
$$= \frac{-2.3 \cdot 16}{-12} + 4$$

$= 7.1mA$

Allen-Bradley SLC 500 PLS



y-akse
0
175
350
525
700
Strømning (l/m)
x-akse
3277
6554
9931
13107
16384
PLS inngang (INT)

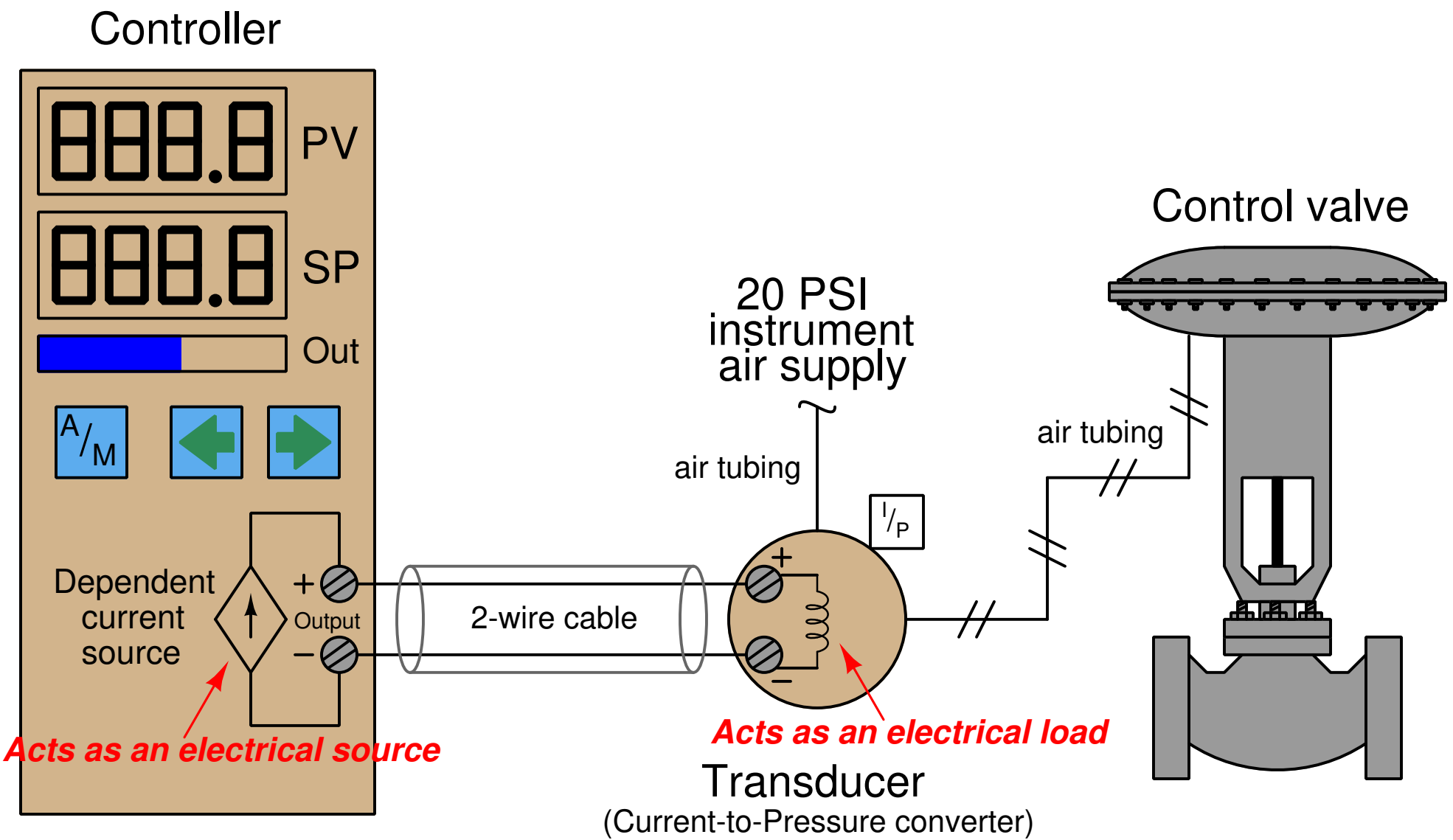


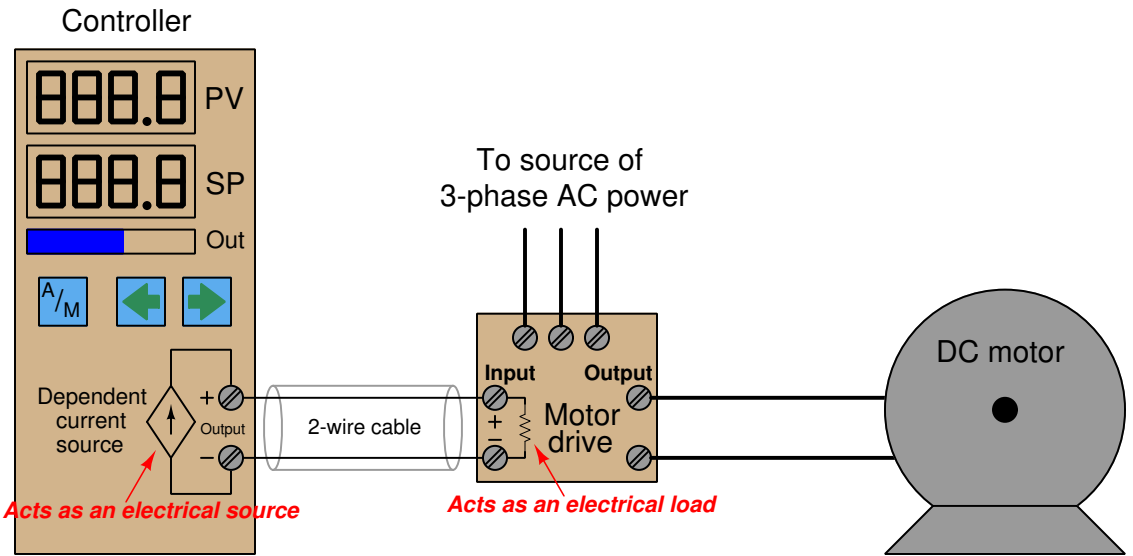
$$= \frac{x - 3277}{16384 - 3277}$$

$$f(x) = y$$

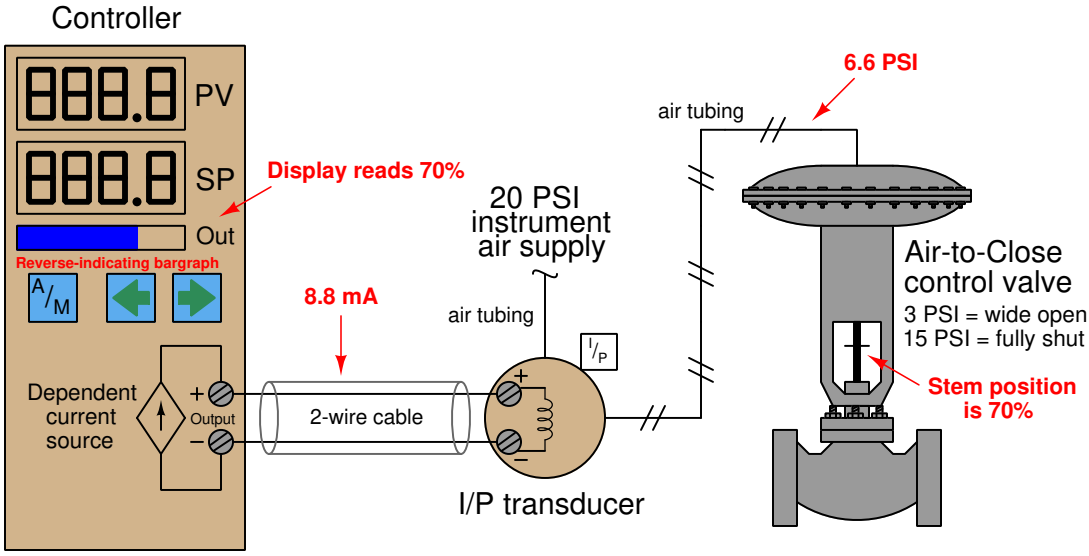
$$= \frac{(x - 3277) \cdot 700}{13107}$$

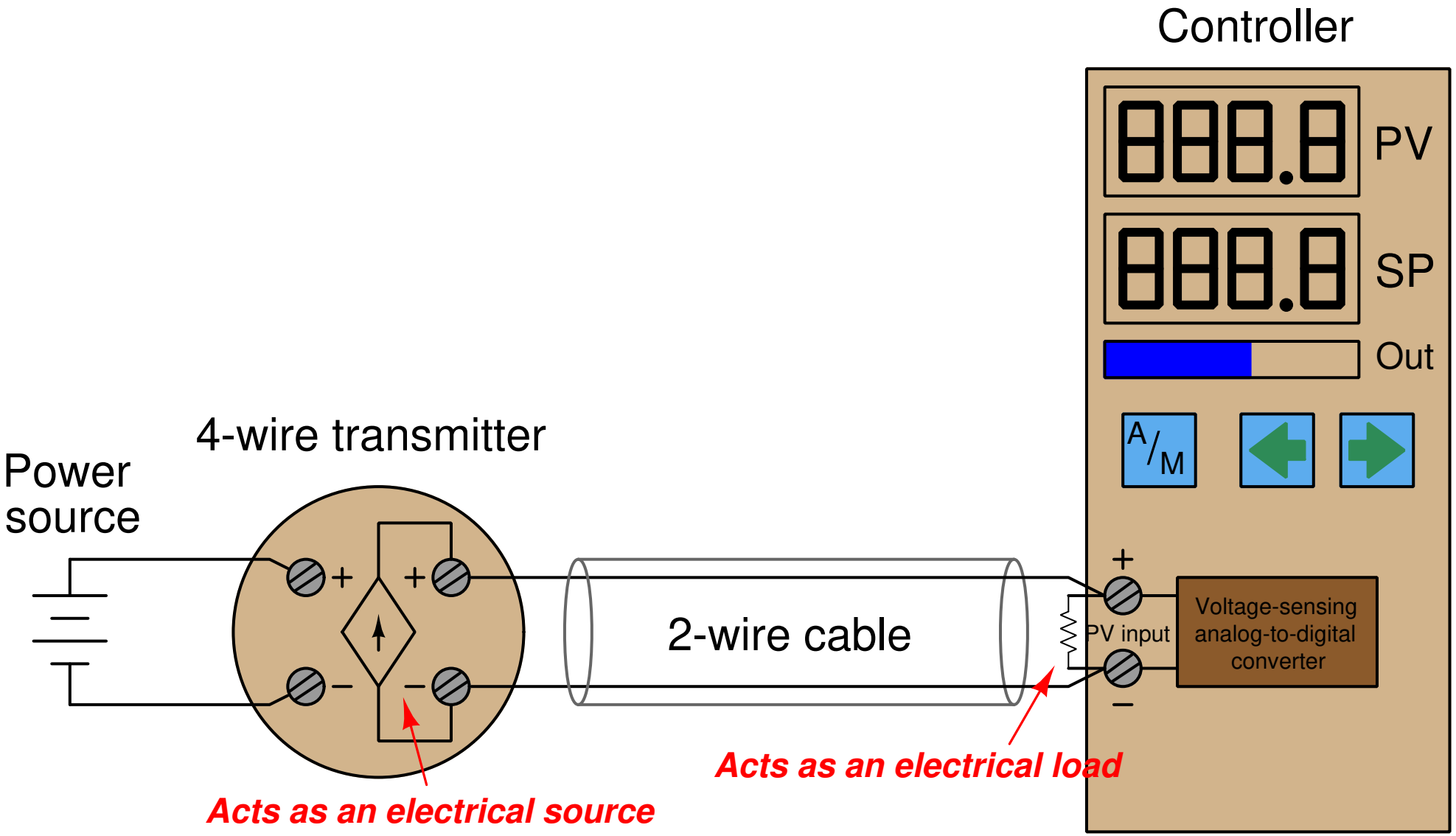
$x - 3277$

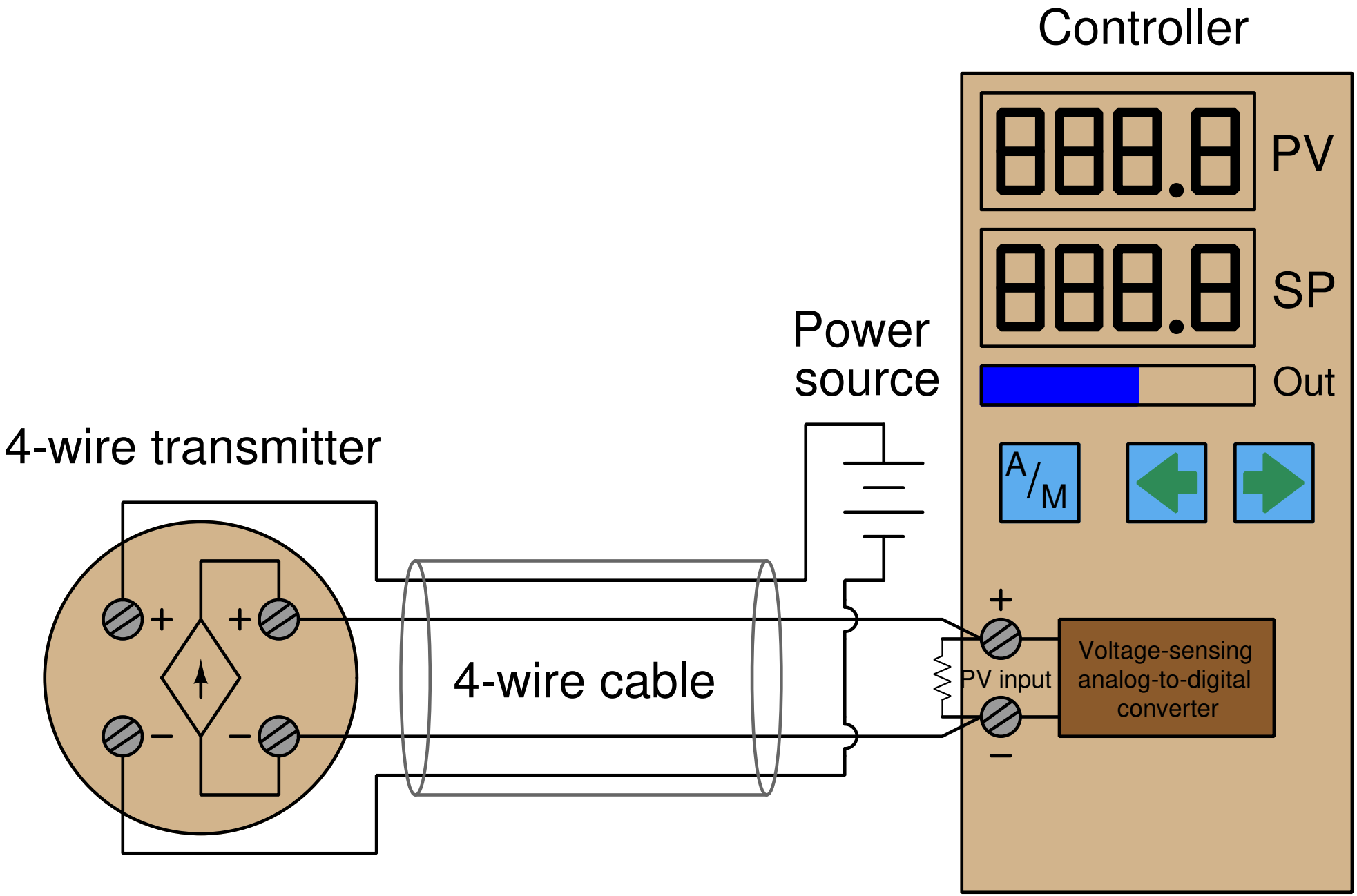

Controller
888.8
PV
888.8
SP
Out
A/M
Dependent current source
+
Output
−
Acts as an electrical source
2-wire cable
20 PSI instrument air supply
air tubing
I/P
+
−
Acts as an electrical load
Transducer
(Current-to-Pressure converter)
air tubing
Control valve

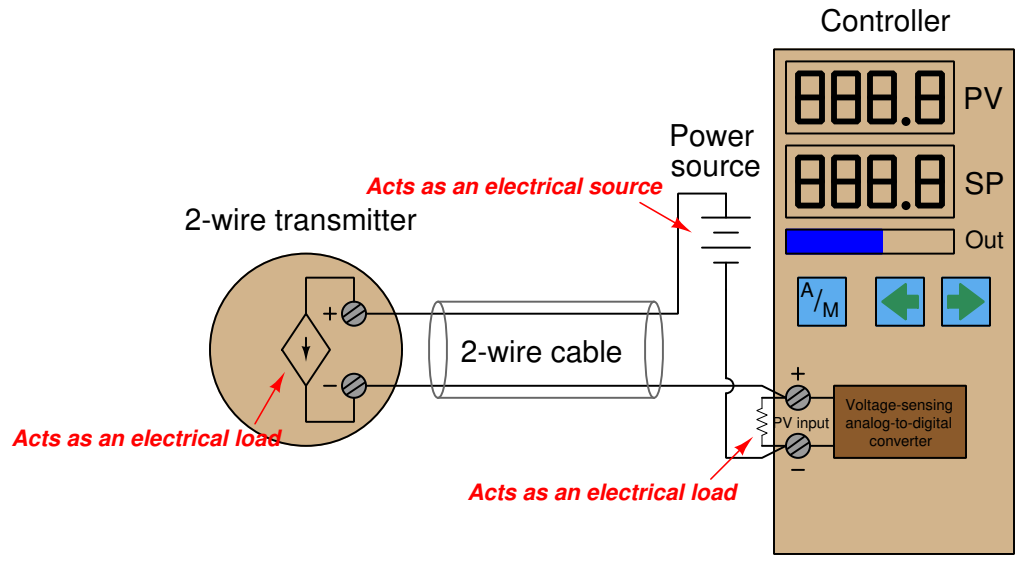

Controller
888.8
PV
888.8
SP
Out
A/M
Dependent current source
+
Output
−
2-wire cable
To source of 3-phase AC power
Input
Output
+
−
Motor drive
DC motor
Acts as an electrical source
Acts as an electrical load

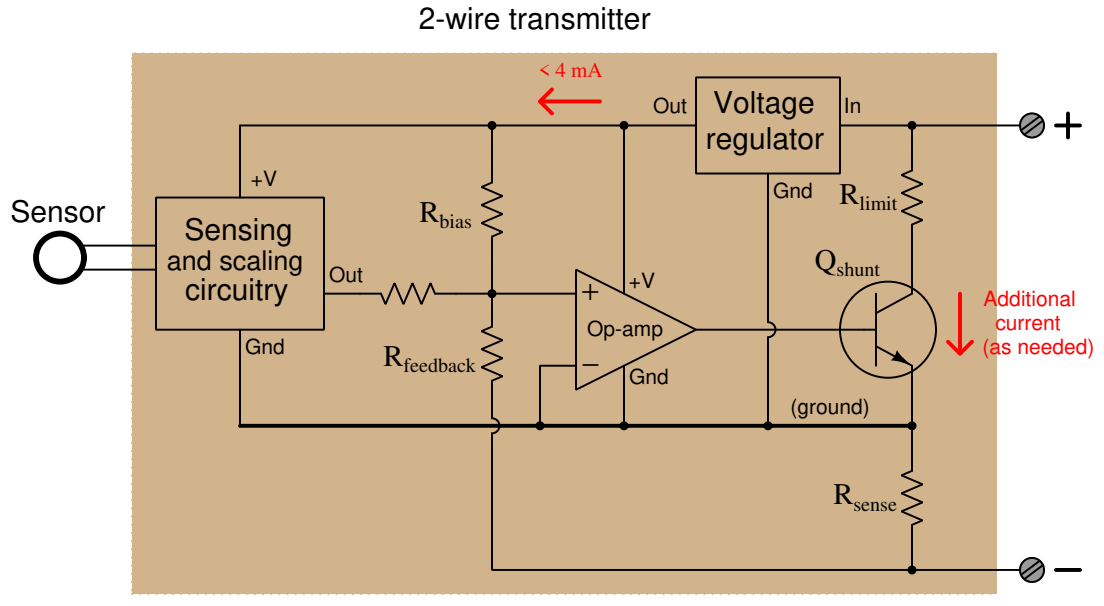
Air-to-Close valve with controller configured for "reverse indication" on its output display

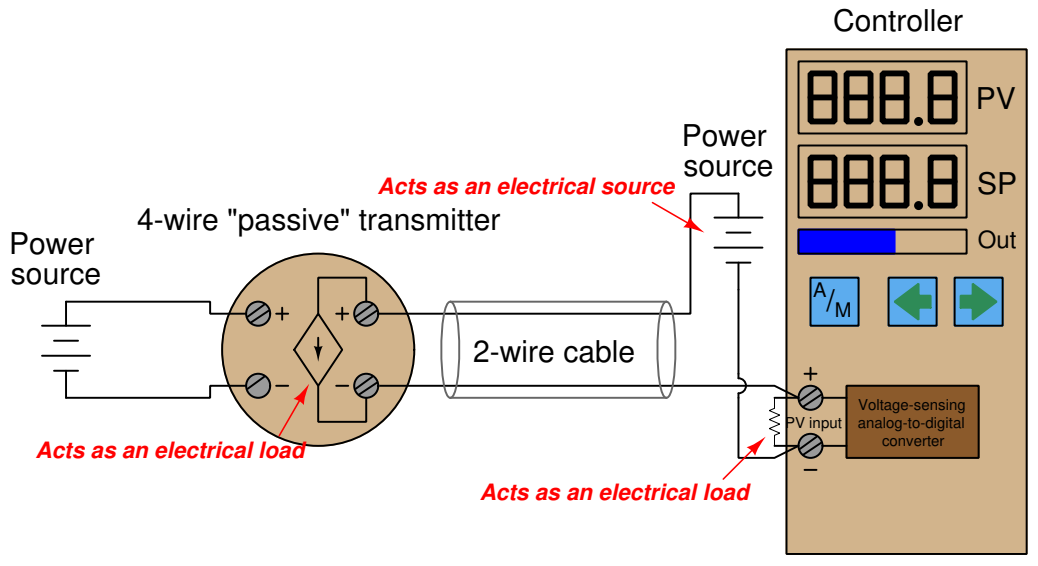



Controller
PV
SP
Out
A/M
Power source
4-wire transmitter
2-wire cable
PV input
Voltage-sensing analog-to-digital converter
Acts as an electrical source
Acts as an electrical load

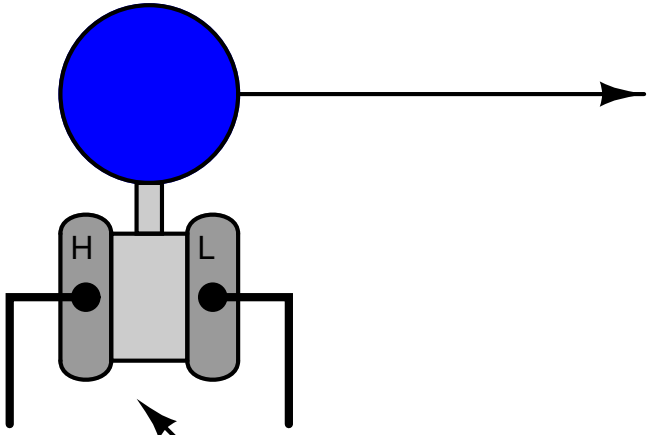

Controller
888.8
PV
888.8
SP
Out
A/M
Power source
4-wire transmitter
+
+
−
−
4-wire cable
+
PV input
−
Voltage-sensing analog-to-digital converter


Controller
PV
SP
Out
A/M
Power source
Acts as an electrical source
2-wire transmitter
+
−
2-wire cable
Acts as an electrical load
+
PV input
−
Voltage-sensing analog-to-digital converter
Acts as an electrical load


2-wire transmitter
< 4 mA
Out
Voltage regulator
In
+
Sensor
+V
Sensing and scaling circuitry
Out
Gnd
R bias
R feedback
+V
Op-amp
Gnd
Gnd
R limit
Q shunt
Additional current (as needed)
(ground)
R sense
−


Controller
PV
SP
Out
A/M
Power source
4-wire "passive" transmitter
Power source
Acts as an electrical source
2-wire cable
PV input
Voltage-sensing analog-to-digital converter
Acts as an electrical load
Acts as an electrical load

Differential pressure transmitter

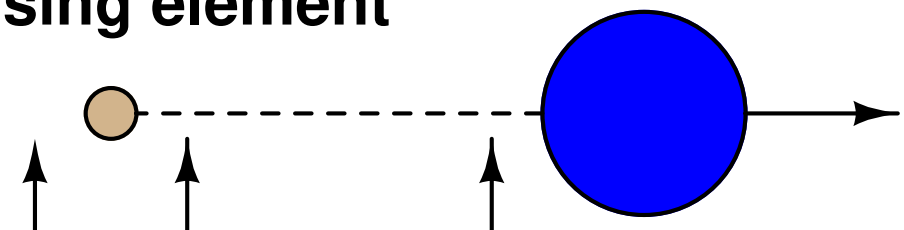


Output = 3 to 15 PSI (pneumatic signal)
Output = 4 to 20 mA (analog electronic signal)
Output = digital data (Fieldbus signal)

Inputs = "high" and "low" side pressures

Temperature sensing element

Temperature transmitter

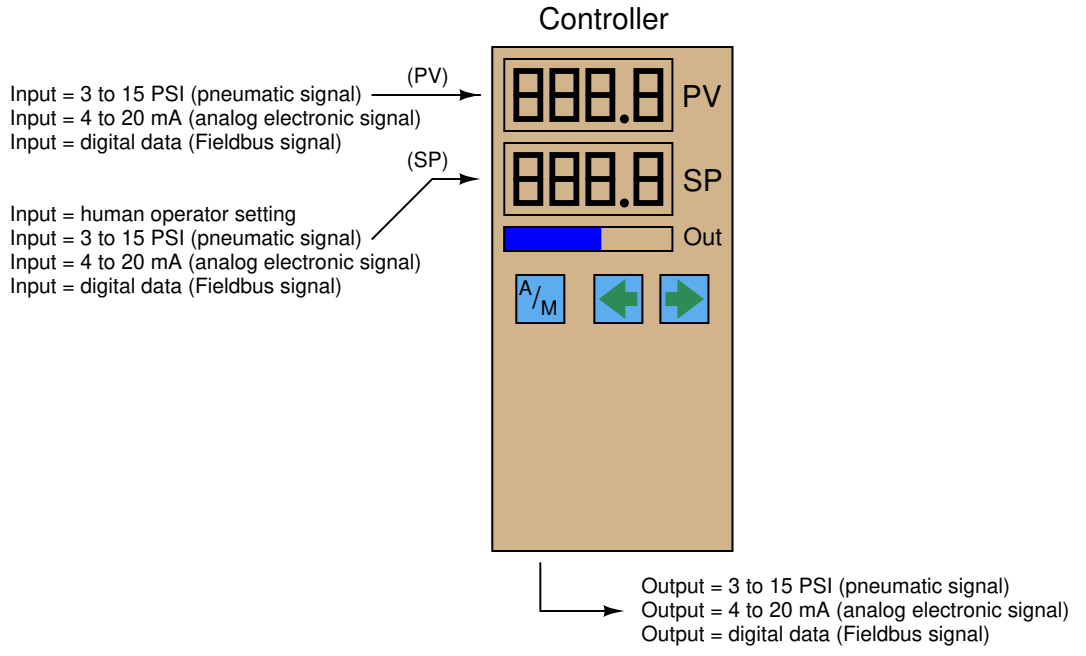


Output = 3 to 15 PSI (pneumatic signal)
Output = 4 to 20 mA (analog electronic signal)
Output = digital data (Fieldbus signal)

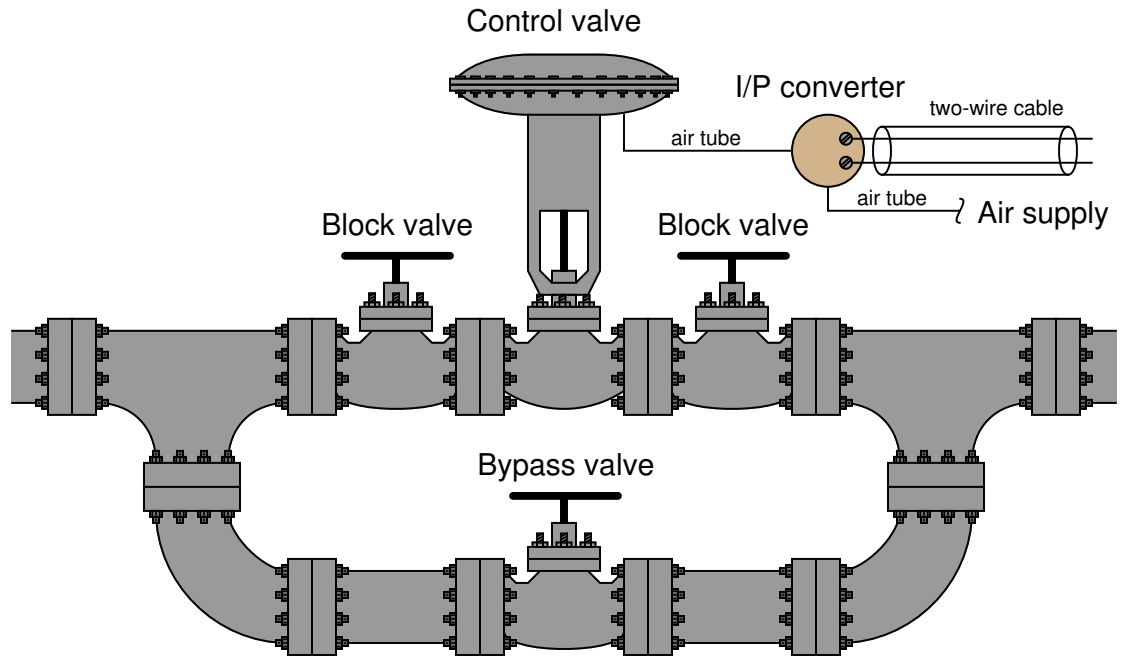
Input = variable resistance (RTD)
Input = millivoltage (thermocouple)

Output = variable resistance (RTD)
Output = millivoltage (thermocouple)

Input = process temperature

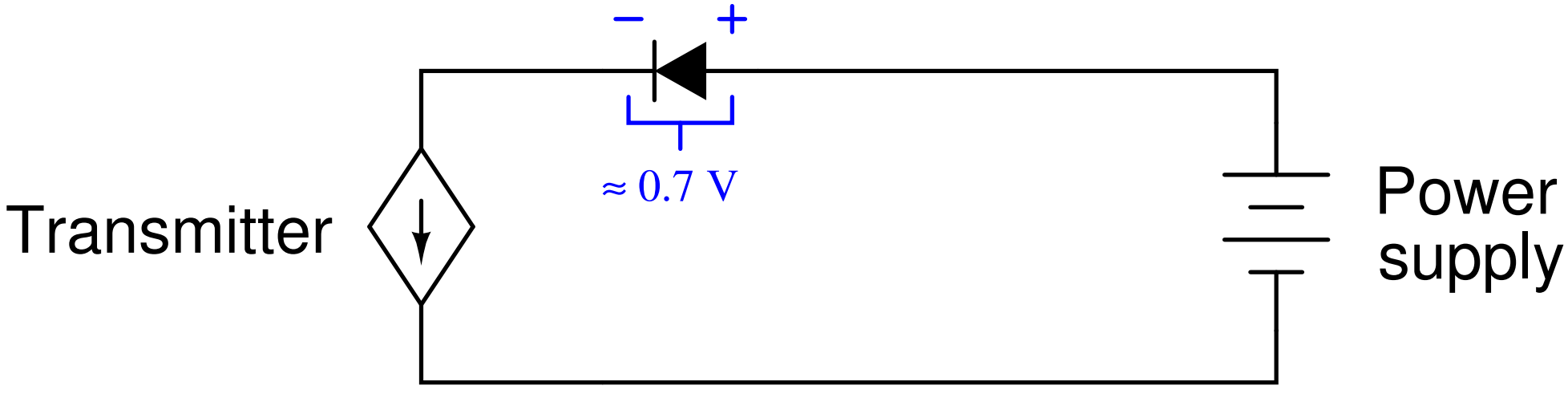

Controller
(PV)
Input = 3 to 15 PSI (pneumatic signal)
Input = 4 to 20 mA (analog electronic signal)
Input = digital data (Fieldbus signal)
(SP)
Input = human operator setting
Input = 3 to 15 PSI (pneumatic signal)
Input = 4 to 20 mA (analog electronic signal)
Input = digital data (Fieldbus signal)
888.8
PV
888.8
SP
Out
A/M
Output = 3 to 15 PSI (pneumatic signal)
Output = 4 to 20 mA (analog electronic signal)
Output = digital data (Fieldbus signal)

-25

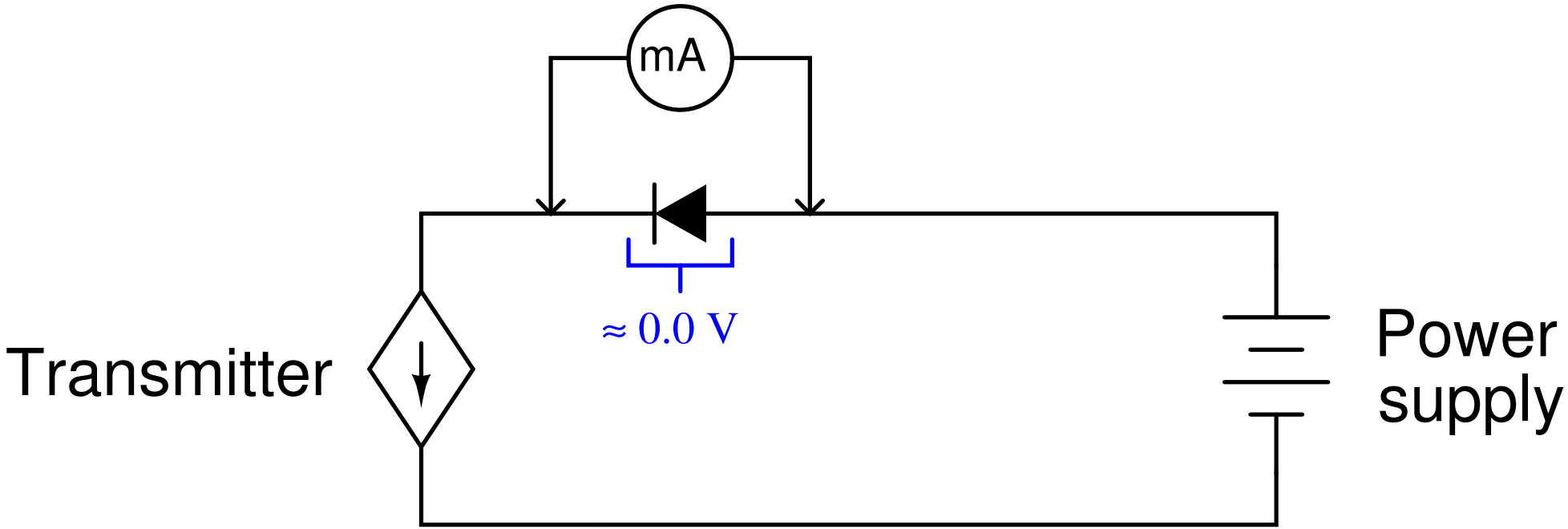

Control valve
I/P converter
two-wire cable
air tube
air tube
Air supply
Block valve
Block valve
Bypass valve


Block valve
Bypass valve
Control valve
Block valve

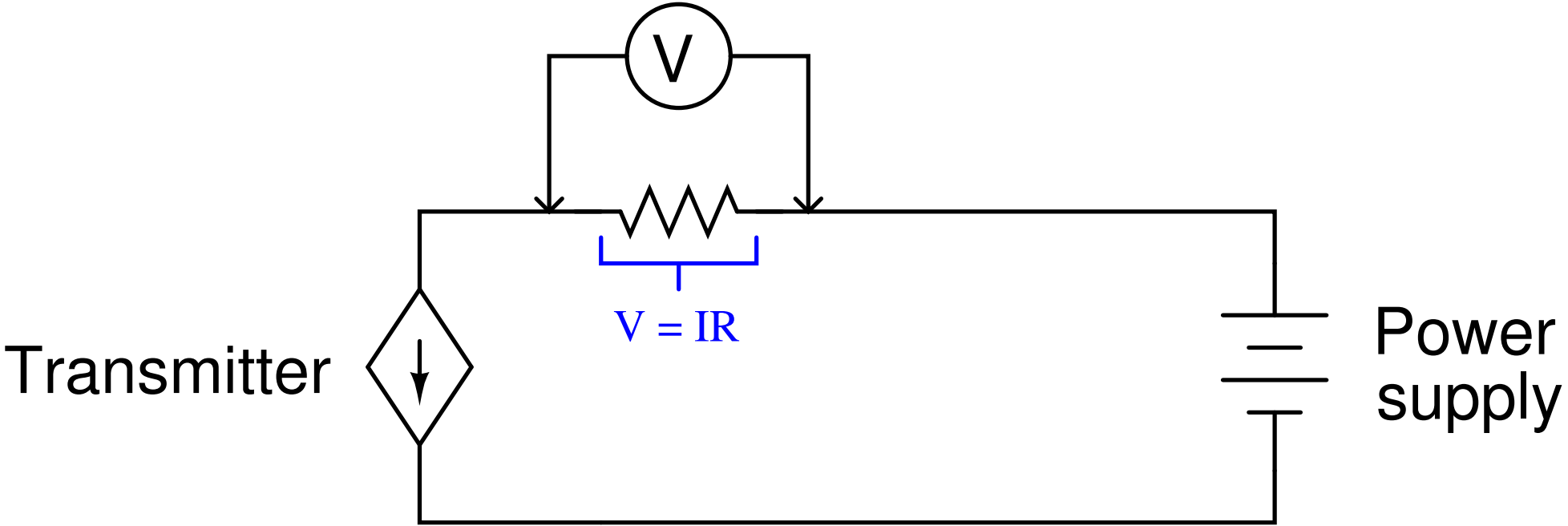

ZERO
HOLD
WAKE UP
- 0.1%
mA
3.98
FLUKE 771
MILLIAMP PROCESS CLAMP METER

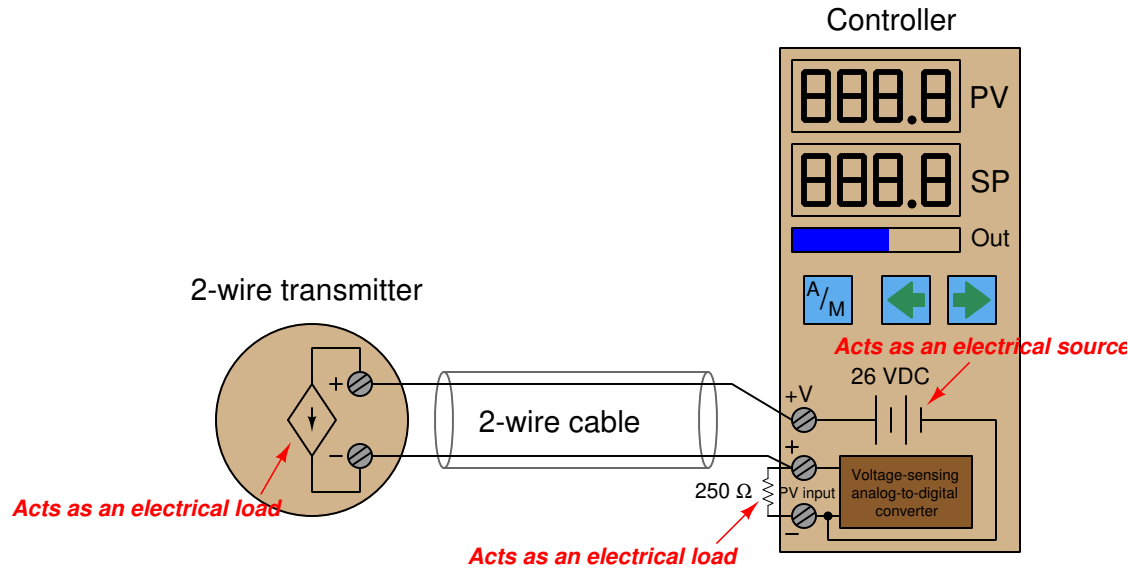

−
+
≈ 0.7 V
Transmitter
Power
supply

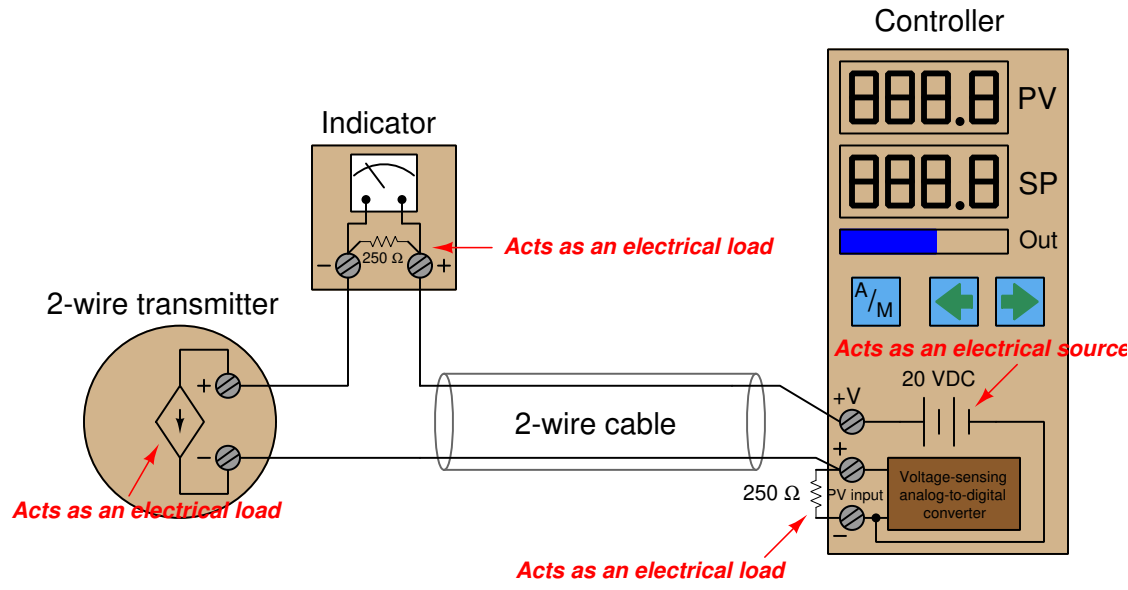
All current goes through the milliammeter!

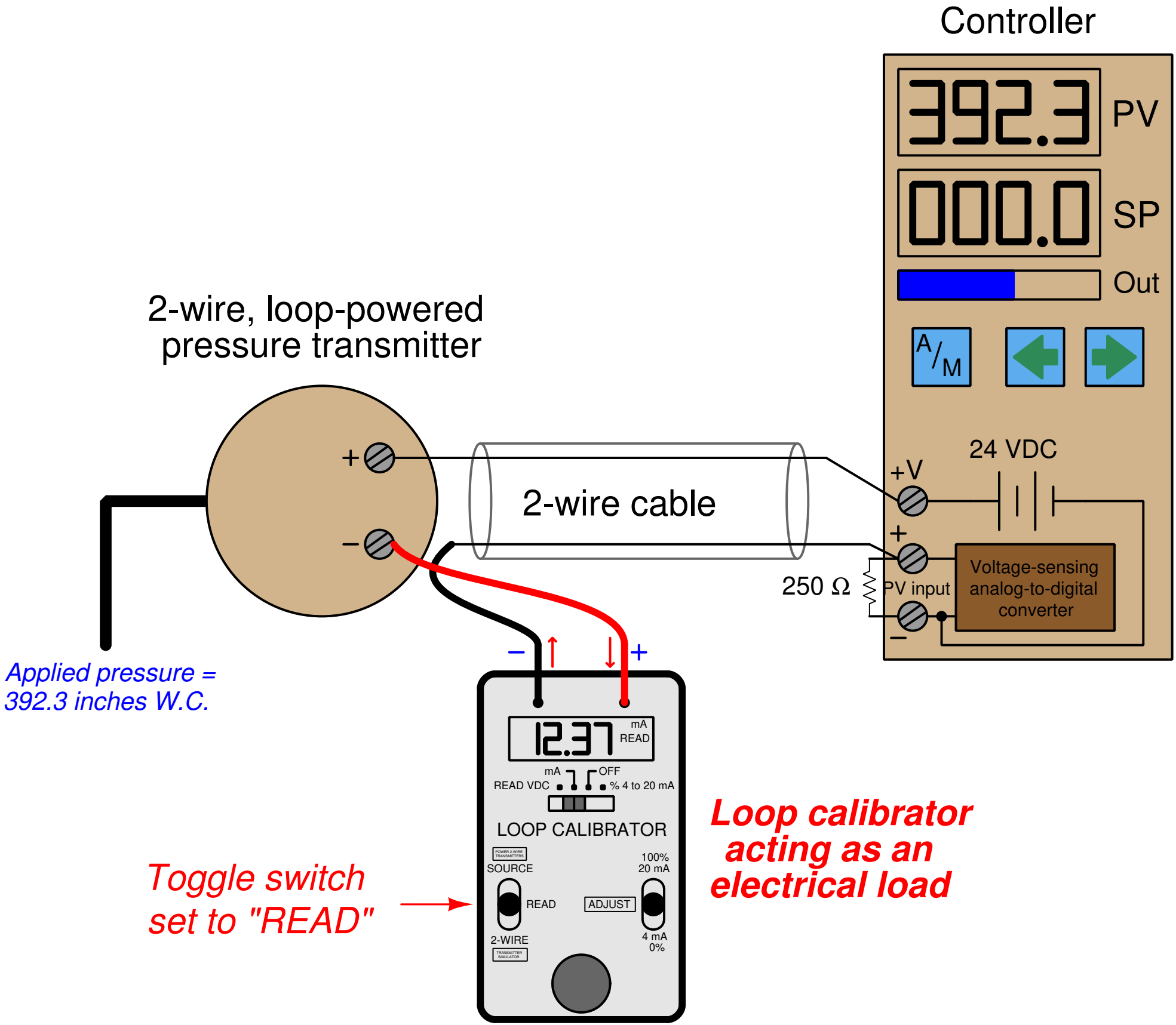


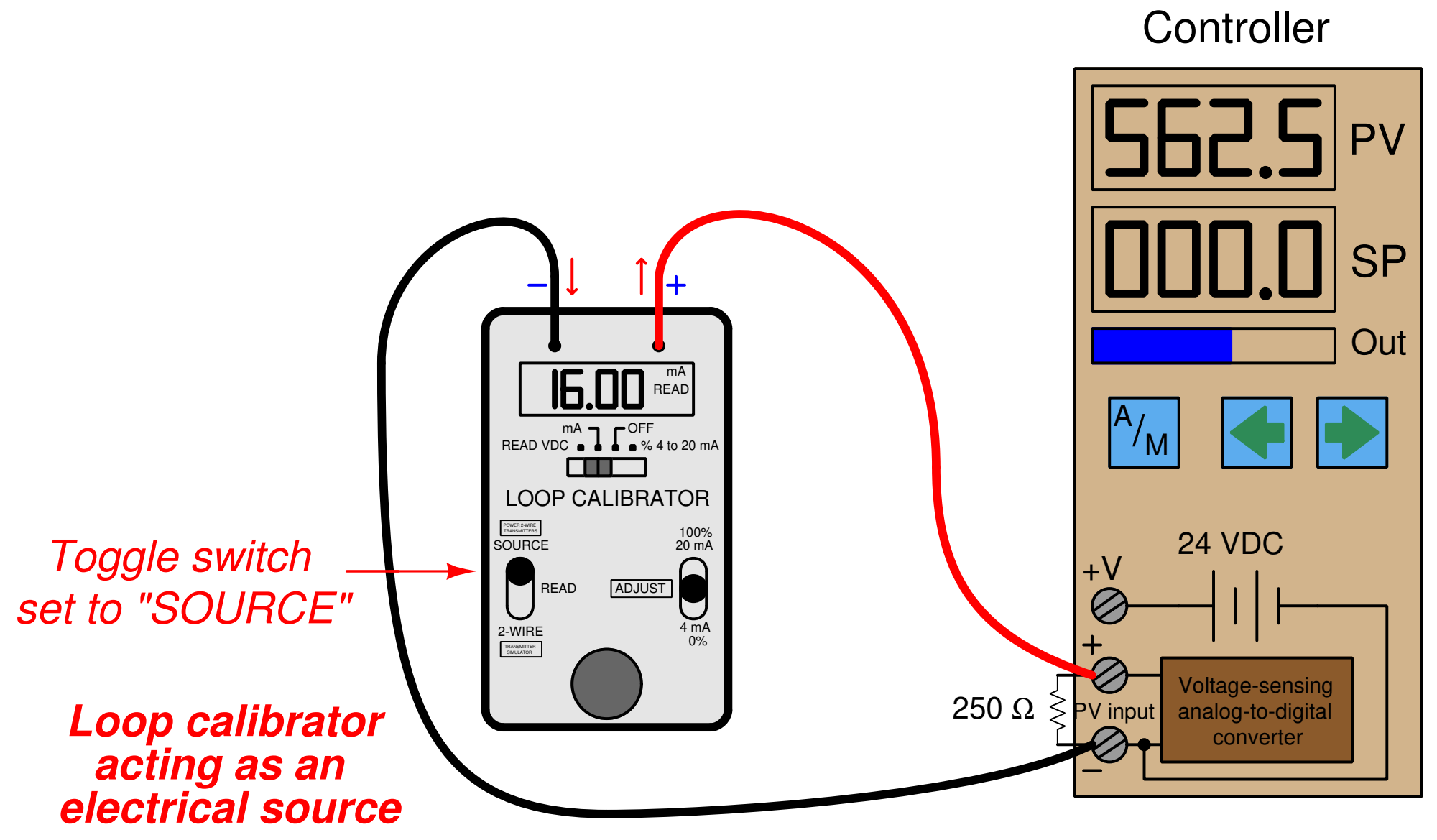

+
−
COMM
TEST
FIELD

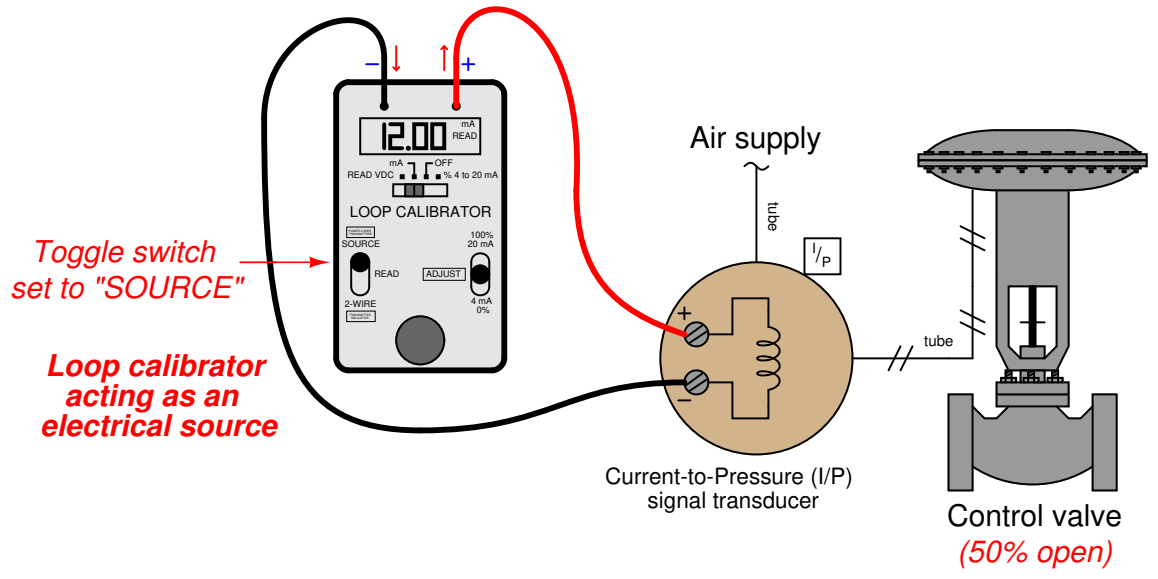

V
V = IR
Transmitter
Power
supply

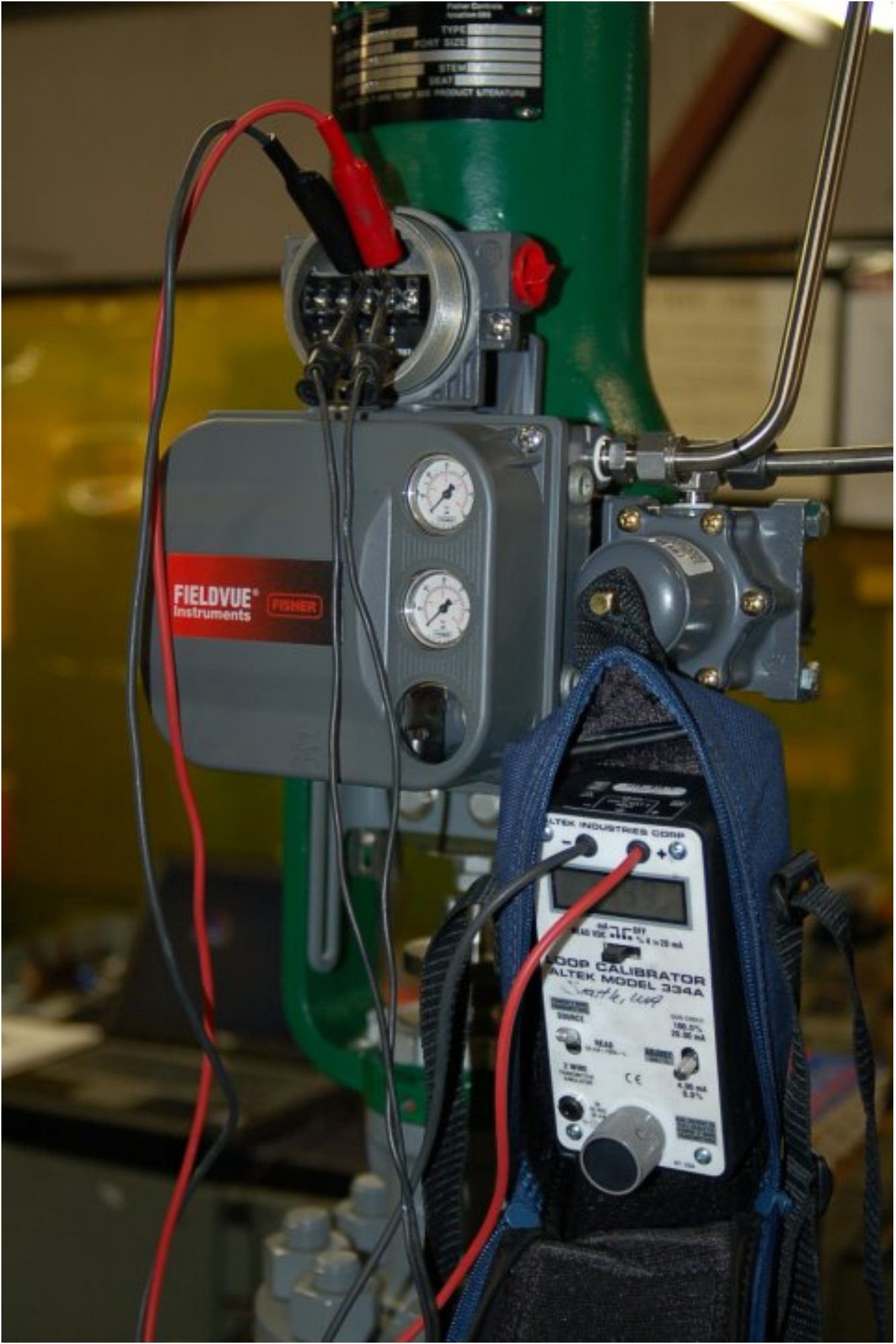

Controller
888.8
PV
888.8
SP
Out
A/M
2-wire transmitter
+
−
2-wire cable
Acts as an electrical source
26 VDC
+V
+
250 Ω
PV input
Voltage-sensing analog-to-digital converter
−
Acts as an electrical load
Acts as an electrical load

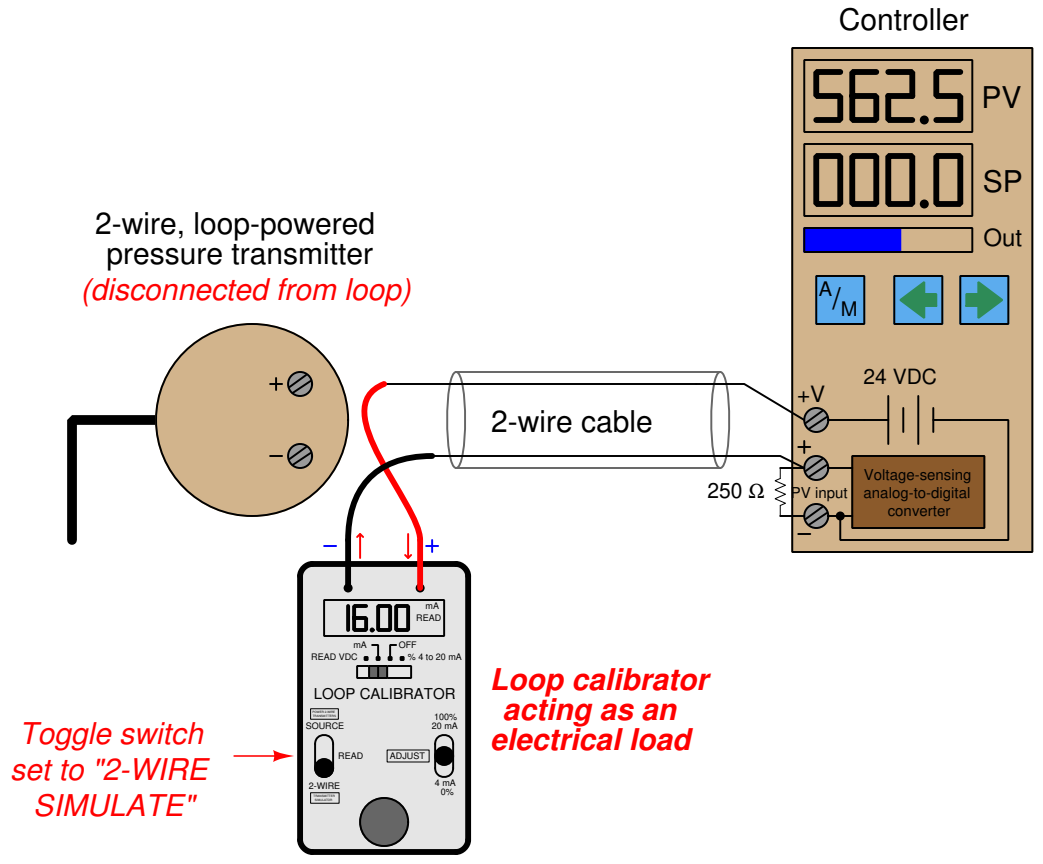

Controller
888.8
PV
888.8
SP
Out
A/M
Indicator
250 Ω
Acts as an electrical load
2-wire transmitter
Acts as an electrical source
20 VDC
+V
2-wire cable
+
250 Ω
PV input
Voltage-sensing analog-to-digital converter
−
Acts as an electrical load
Acts as an electrical load


Controller
392.3
PV
000.0
SP
Out
A/M
2-wire, loop-powered
pressure transmitter
+
−
2-wire cable
24 VDC
+V
+
250 Ω
PV input
Voltage-sensing
analog-to-digital
converter
−
Applied pressure =
392.3 inches W.C.
12.37
mA
READ
mA
READ VDC
OFF
% 4 to 20 mA
LOOP CALIBRATOR
SOURCE
READ
2-WIRE
ADJUST
100%
20 mA
4 mA
0%
Toggle switch
set to "READ"
Loop calibrator
acting as an
electrical load


Controller
562.5
PV
000.0
SP
Out
A/M
24 VDC
+V
+
PV input
−
250 Ω
Voltage-sensing analog-to-digital converter
16.00
mA READ
mA
OFF
READ VDC
% 4 to 20 mA
LOOP CALIBRATOR
SOURCE
READ
2-WIRE
100% 20 mA
ADJUST
4 mA 0%
Toggle switch set to "SOURCE"
Loop calibrator acting as an electrical source


12.00
mA
READ
mA
OFF
READ VDC
% 4 to 20 mA
LOOP CALIBRATOR
SOURCE
READ
2-WIRE
100%
20 mA
ADJUST
4 mA
0%
Toggle switch
set to "SOURCE"
Loop calibrator
acting as an
electrical source
Air supply
tube
I/P
tube
Current-to-Pressure (I/P)
signal transducer
Control valve
(50% open)


FIELDVUE
Instruments
FISHER
LOOP CALIBRATOR
MODEL 334A

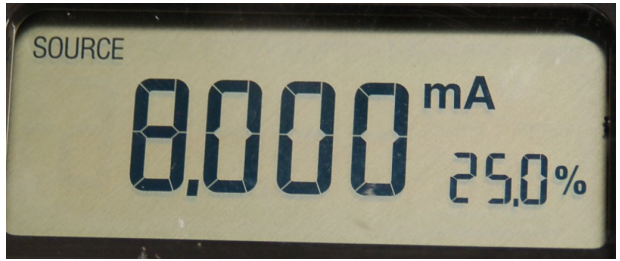

Controller
562.5
PV
000.0
SP
Out
A/M
24 VDC
+V
+
250 Ω
PV input
−
Voltage-sensing analog-to-digital converter
2-wire, loop-powered pressure transmitter
(disconnected from loop)
+
−
2-wire cable
− ↑ ↓ +
16.00
mA READ
mA READ VDC
OFF
% 4 to 20 mA
LOOP CALIBRATOR
SOURCE
READ
2-WIRE
ADJUST
100% 20 mA
4 mA 0%
Loop calibrator acting as an electrical load
Toggle switch set to "2-WIRE SIMULATE"


0 - 11V OUT
mA IN
0 - 110mV OUT
0 - 110mV IN
mA OUT
0 - 11V IN
XMTR SIM
FUNCTION SWITCH
V.IN/OUT
COARSE
40
50
60
30
70
20
80
10
90
0
100
mA IN
BAT. CHK
4.7V MIN.
FINE
LIFT
OFF
mA OUT
ON
XMTR SIM
PPS DIGITAL CALIBRATOR
MODEL 1040 SER. 1040 2190
TRANSMATION inc.
ROCHESTER, N.Y. U.S.A.
U.S. PATENT NO. 3817105


AUTO mA CALIBRATOR
MODEL 8060
BELOW 10V OUTPUT BATTERIES LOW
METER
OUT
BAT CK
24V
INPUT
20mA
50mA
OUTPUT
5mA
55 MA 2 WIRE XMTR
RAMP
PERCENT OUT
50
25
0
2P
5P
NASSAU INSTRUMENT CO.
24V IN
24V
INPUT
OUTPUT


VERSA-CAL
CALIBRATOR
DISPLAY
RANGE
CHANNEL
TC/MV TYPE
LAMP
CHECK
VOLUME
MEASURE A
MEASURE B
% RANGE
COARSE
FINE
ADJUST
LO
MAGNITUDE
OUTPUT


FLUKE
705 LOOP CALIBRATOR
8.000 mA
25.0%
0-100%
SOURCE
SIM
MEAS
25%
OFF
mA
SOURCE
SIMULATE
MEASURE
V
MEASURE
Span Check
30V
COM
+


MEASURE
0.000
mA
- 25.0%

SOURCE
8.000
mA
25.0%

SIMULATE
8.000
mA
25.0%

Signal level	Fault condition
Output $\leq$ 3.6 mA	Sensing transducer failed low
3.6 mA $<$ Output $<$ 3.8 mA	Sensing transducer failed (detected) low
3.8 mA $\leq$ Output $<$ 4.0 mA	Measurement under-range
21.0 $>$ Output $\geq$ 20.5 mA	Measurement over-range
Output $\geq$ 21.0 mA	Sensing transducer failed high

$$y = mx + b$$