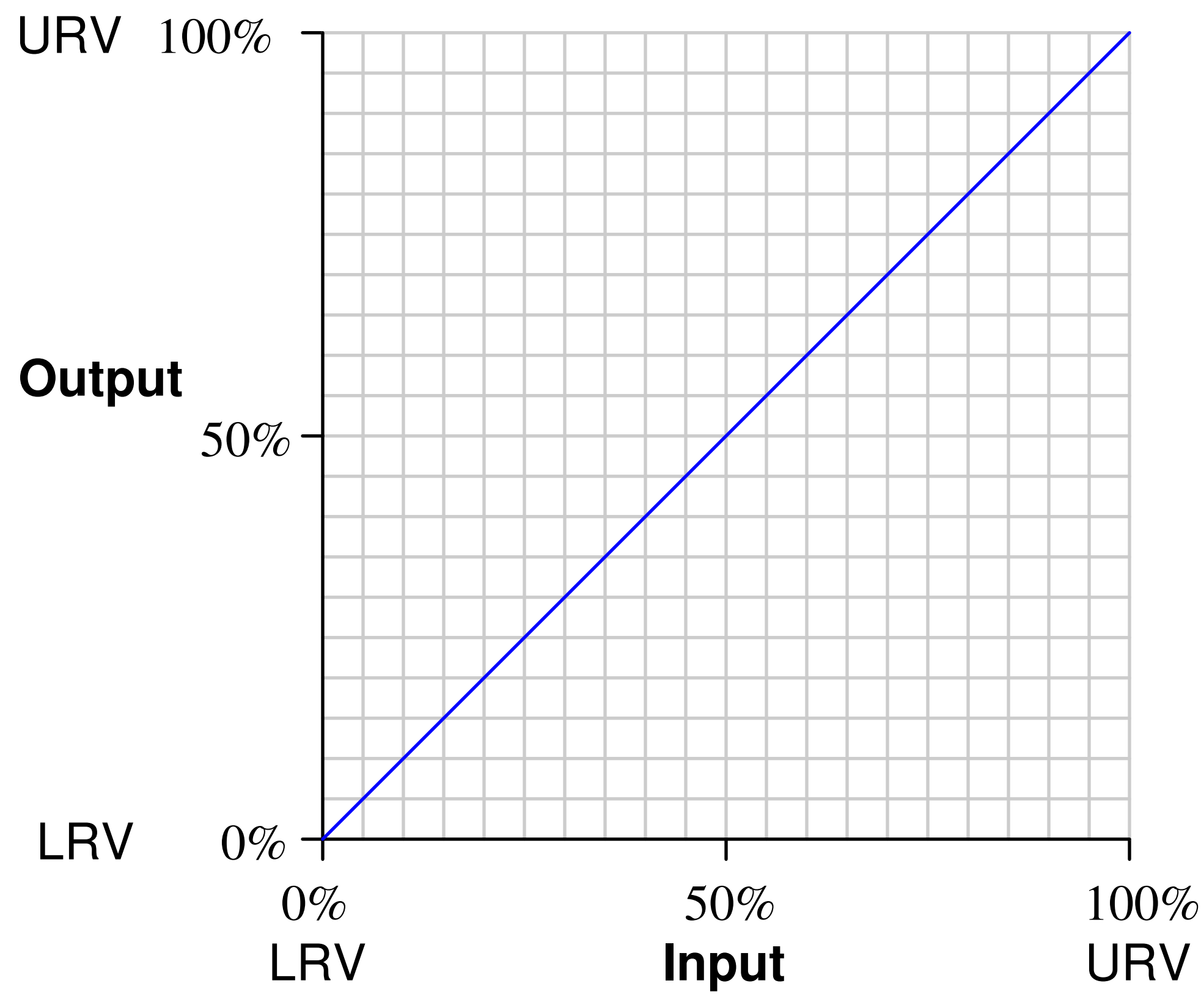
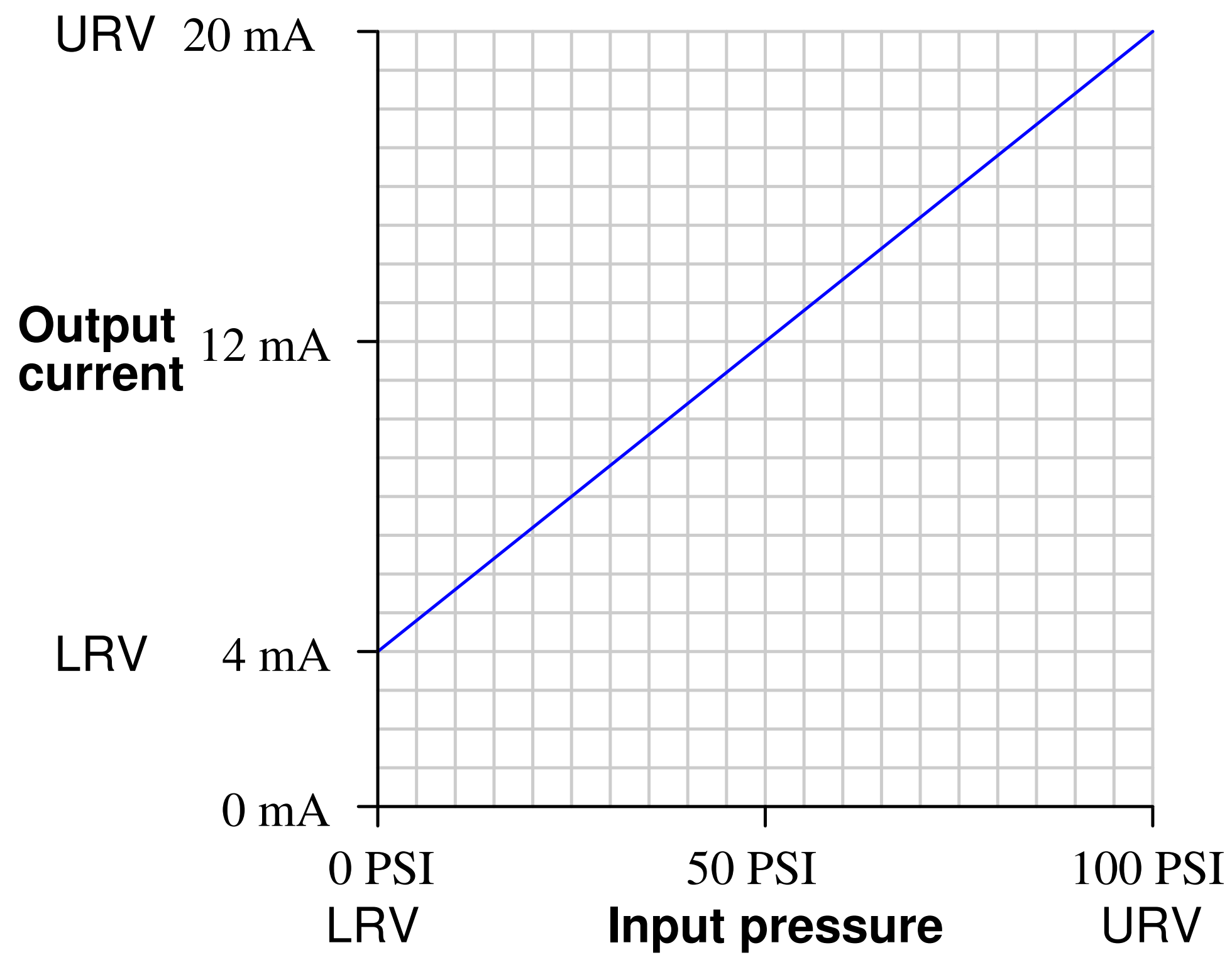

URV
100%
Output
50%
LRV
0%
0%
LRV
50%
100%
Input
URV


URV
20 mA
Output current
12 mA
LRV
4 mA
0 mA
0 PSI
LRV
50 PSI
Input pressure
100 PSI
URV

$$y = mx + b$$

y

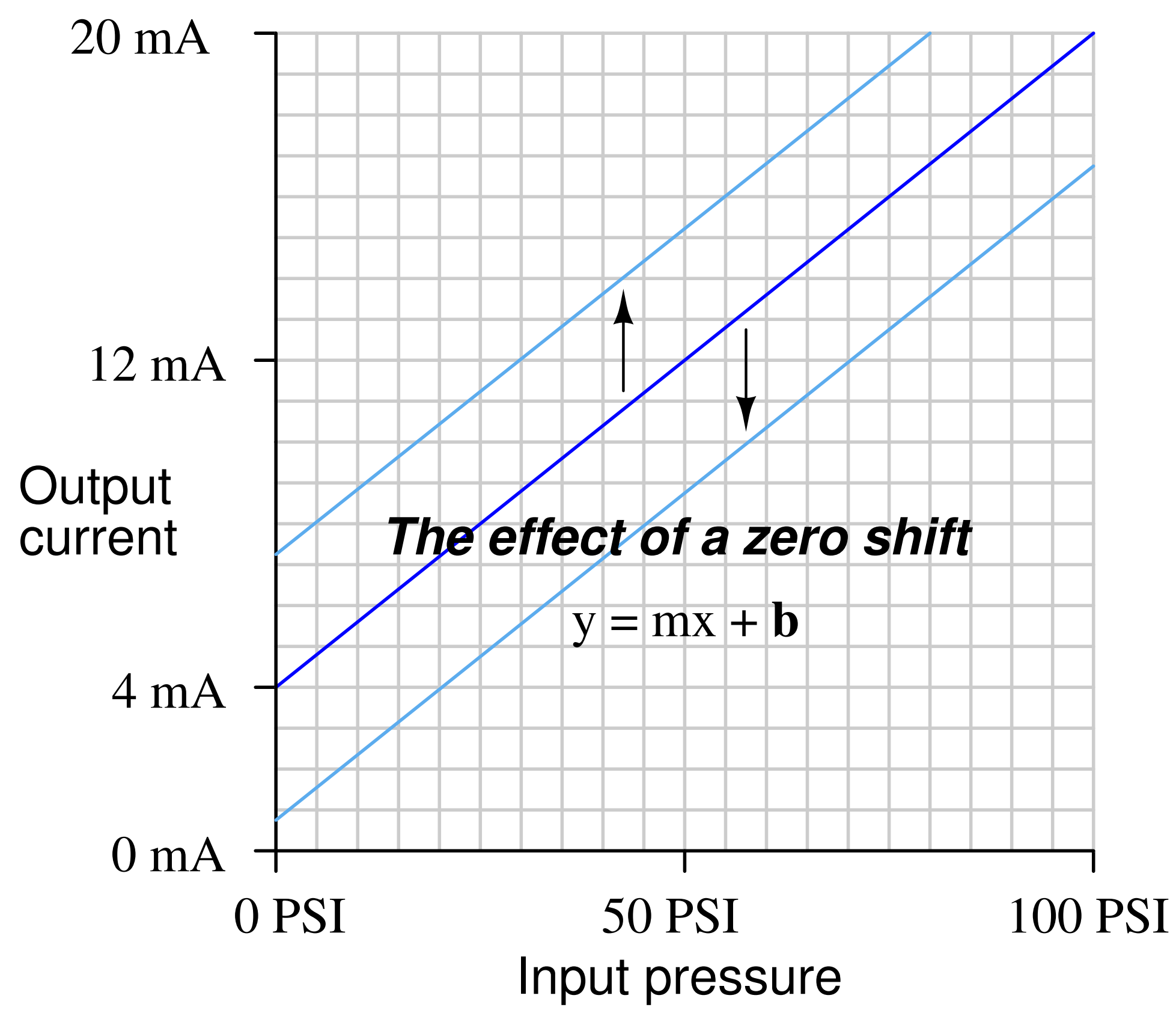
x

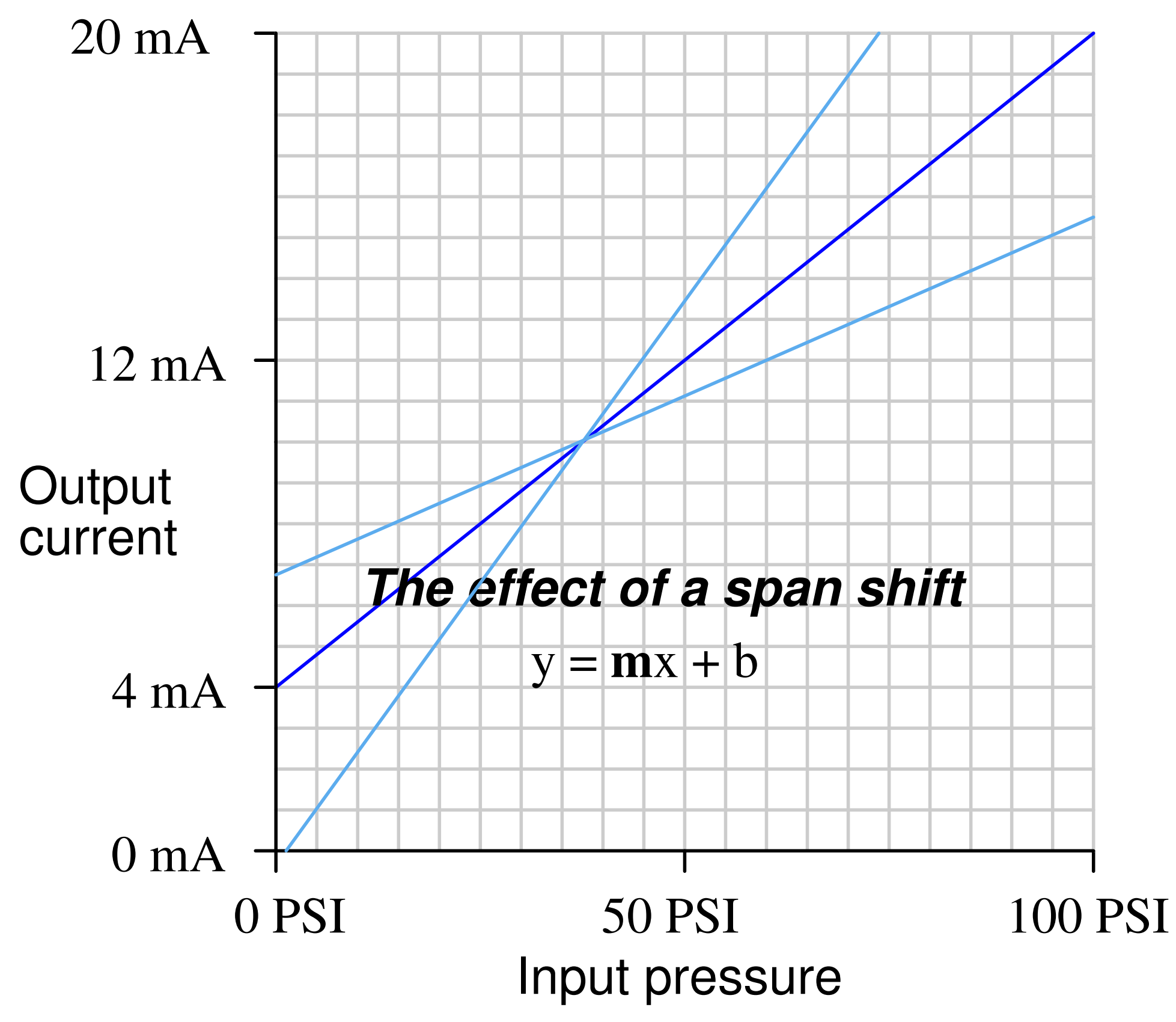
m

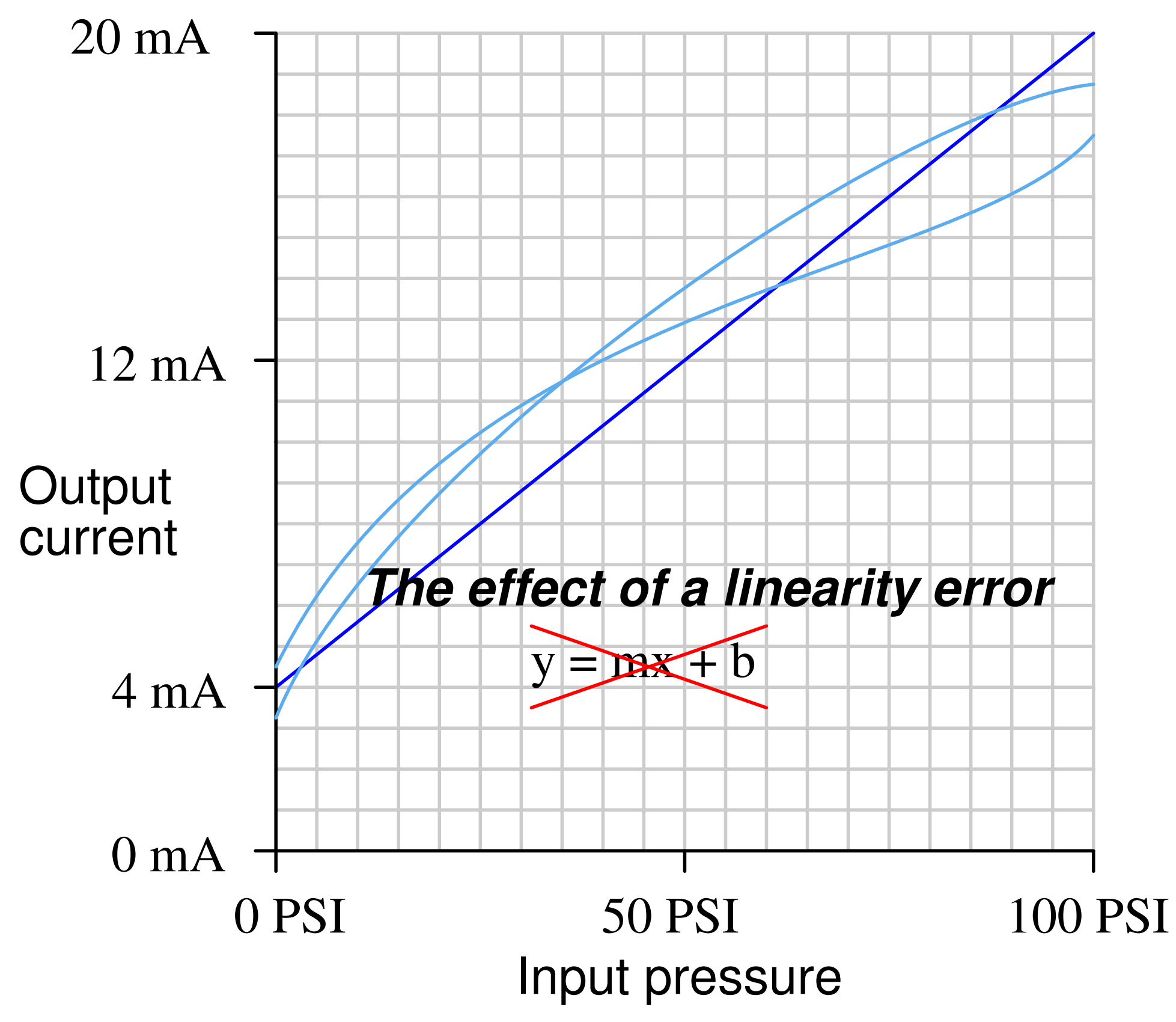
b

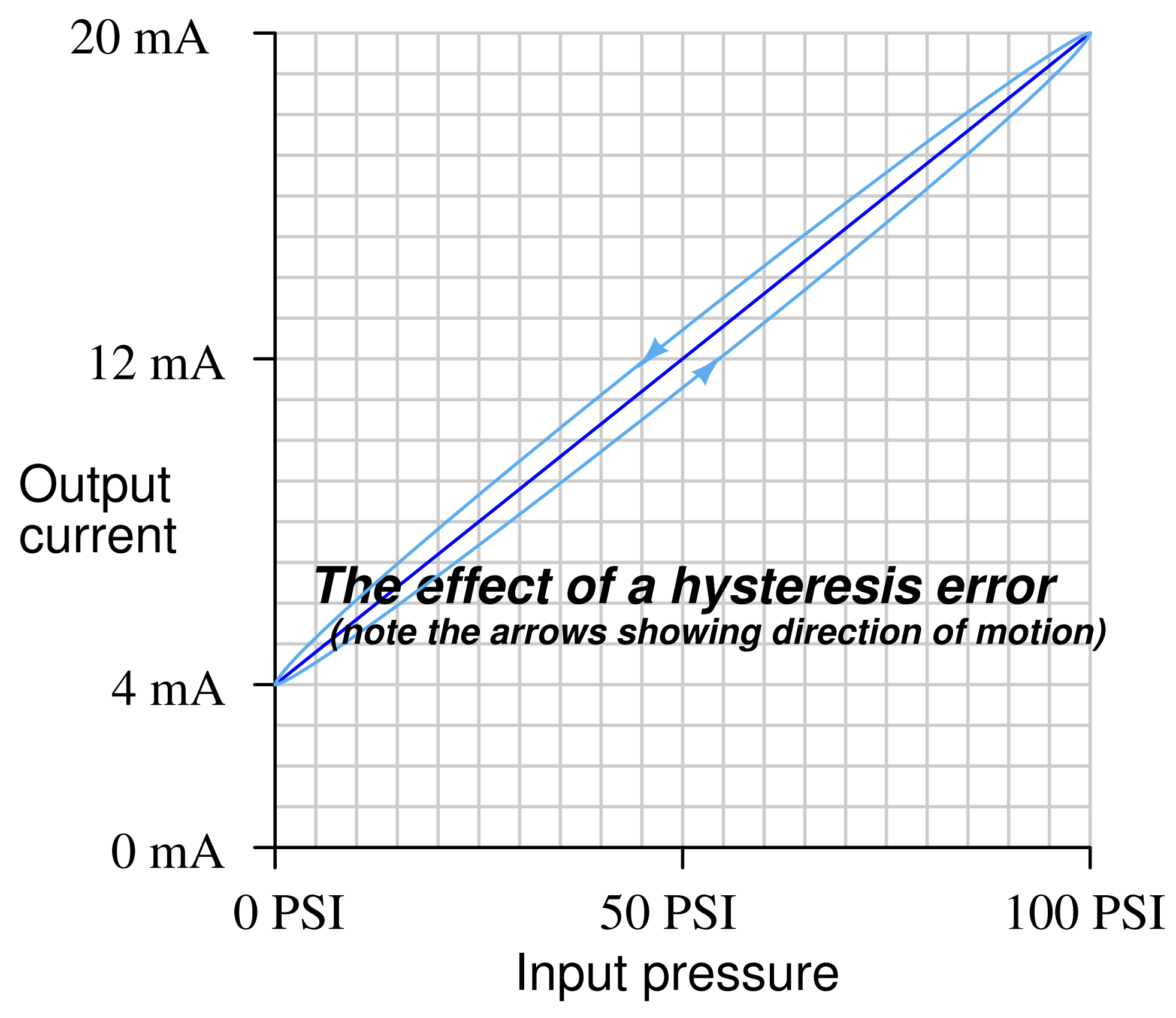
$$y = 0.16x + 4$$

mx

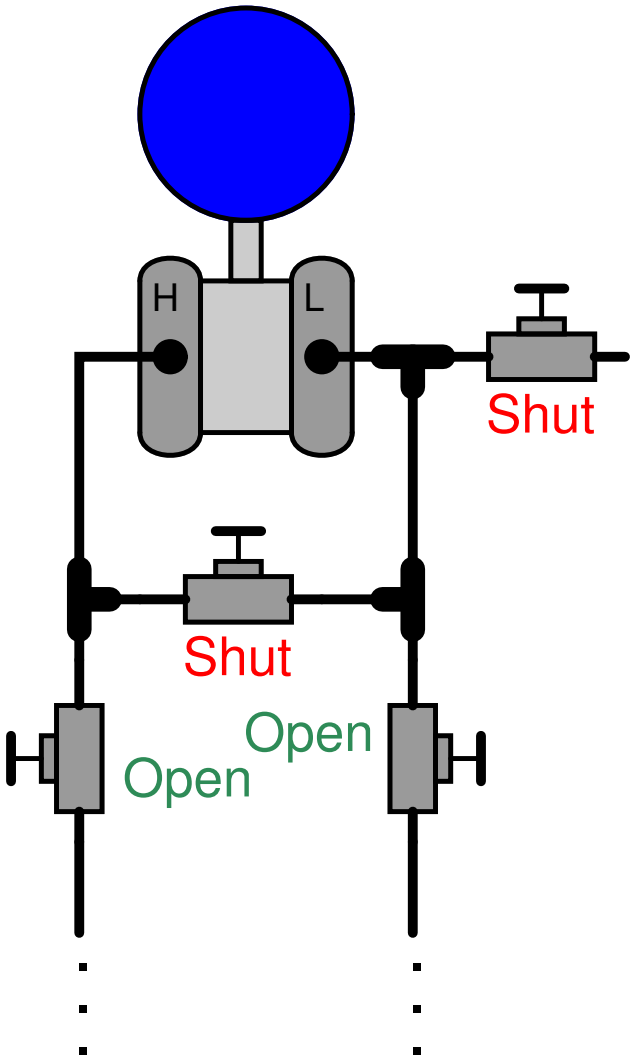

20 mA
12 mA
4 mA
0 mA
Output current
The effect of a zero shift
y = mx + b
0 PSI
50 PSI
100 PSI
Input pressure


20 mA
12 mA
4 mA
0 mA
Output current
The effect of a span shift
y = mx + b
0 PSI
50 PSI
100 PSI
Input pressure


20 mA
12 mA
4 mA
0 mA
Output current
The effect of a linearity error
y = mx + b
0 PSI
50 PSI
100 PSI
Input pressure

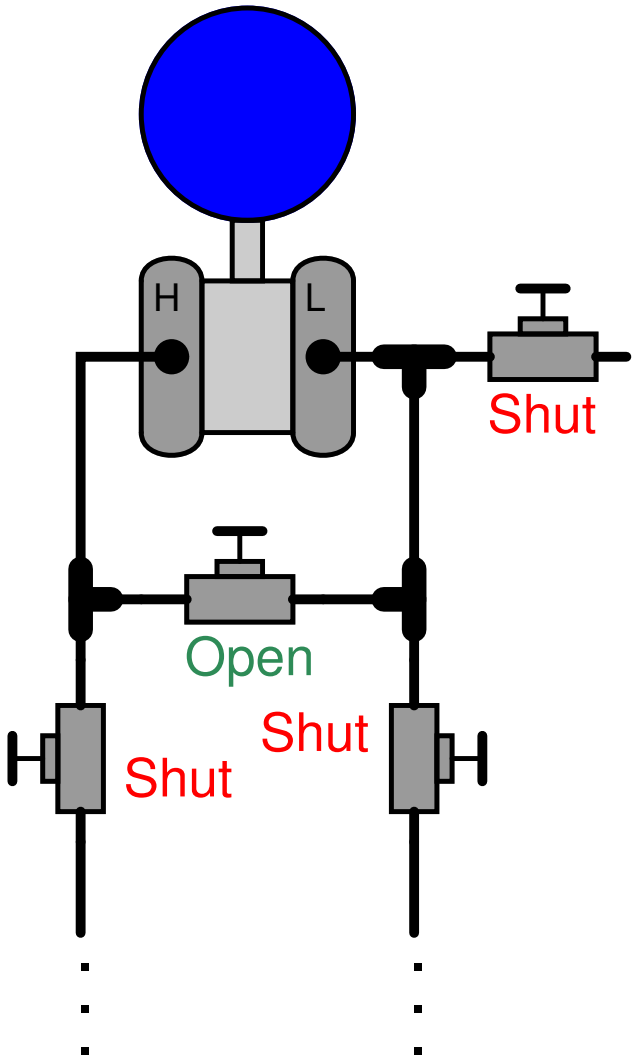

20 mA
12 mA
4 mA
0 mA
Output current
0 PSI
50 PSI
100 PSI
Input pressure
The effect of a hysteresis error
(note the arrows showing direction of motion)

Normal operation



Impulse lines to process

"Block and Equalize" tes



Impulse lines to process

Percent of range	**Input** pressure	**Output current** (ideal)	**Output current** (measured)	**Error** (percent of span)
0%	0 PSI	4.00 mA		
25%	50 PSI	8.00 mA		
50%	100 PSI	12.00 mA		
75%	150 PSI	16.00 mA		
100%	200 PSI	20.00 mA		

-78.112

-79

-0.888

Procedure: CA-012

Instrument Function: Maintain stable temp

Loop Components: N/A

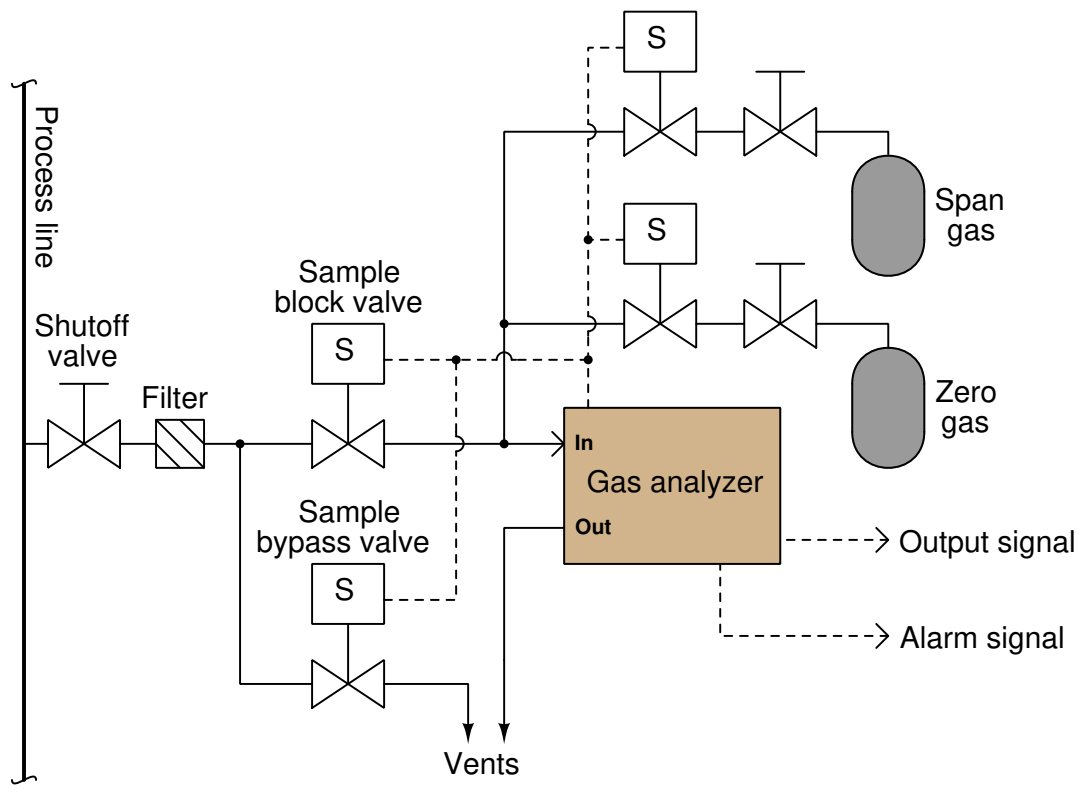
Process Units: °C

As found Readings CL: Local		
Standard	**IUT**	**Error**
°C	°C	°C
-78.112	-79.0	-0.988

$$\text{Error} = \frac{\text{IUT} - \text{Standard}}{\text{Span}} \times 100\%$$

Percent of range	**Input** pressure	**Output current** (ideal)	**Output current** (measured)	**Error** (percent of span)
0%	0 PSI	4.00 mA	3.99 mA	−0.0625 %
25% ↑	50 PSI	8.00 mA	**7.98 mA**	**−0.125 %**
50% ↑	100 PSI	12.00 mA	11.99 mA	−0.0625 %
75% ↑	150 PSI	16.00 mA	15.99 mA	−0.0625 %
100% ↑	200 PSI	20.00 mA	20.00 mA	0 %
75% ↓	150 PSI	16.00 mA	16.01 mA	+0.0625 %
50% ↓	100 PSI	12.00 mA	12.02 mA	+0.125 %
25% ↓	50 PSI	8.00 mA	**8.03 mA**	**+0.188 %**
0% ↓	0 PSI	4.00 mA	4.01 mA	+0.0625 %

$$\text{Error} = \left(\frac{I_{measured} - I_{ideal}}{16 \text{ mA}} \right) (100\%)$$


Process line
Shutoff valve
Filter
Sample block valve
S
Sample bypass valve
S
S
S
Span gas
Zero gas
In
Gas analyzer
Out
Output signal
Alarm signal
Vents


FLUKE
744
DOCUMENTING PROCESS CALIBRATOR
MEAS
SOURCE
mA
SETUP
V
V
Hz
Ω
TC
RTD
7
8
9
4
5
6
1
2
3
+/–
0
.
CLEAR
(ZERO)
HART
ENTER
V Ω
RTD
mA
mA
Ω
RTD
V
SOURCE
MEAS

DPCTrack2

File Tools Records Reports Lists Help

Fluke Customer

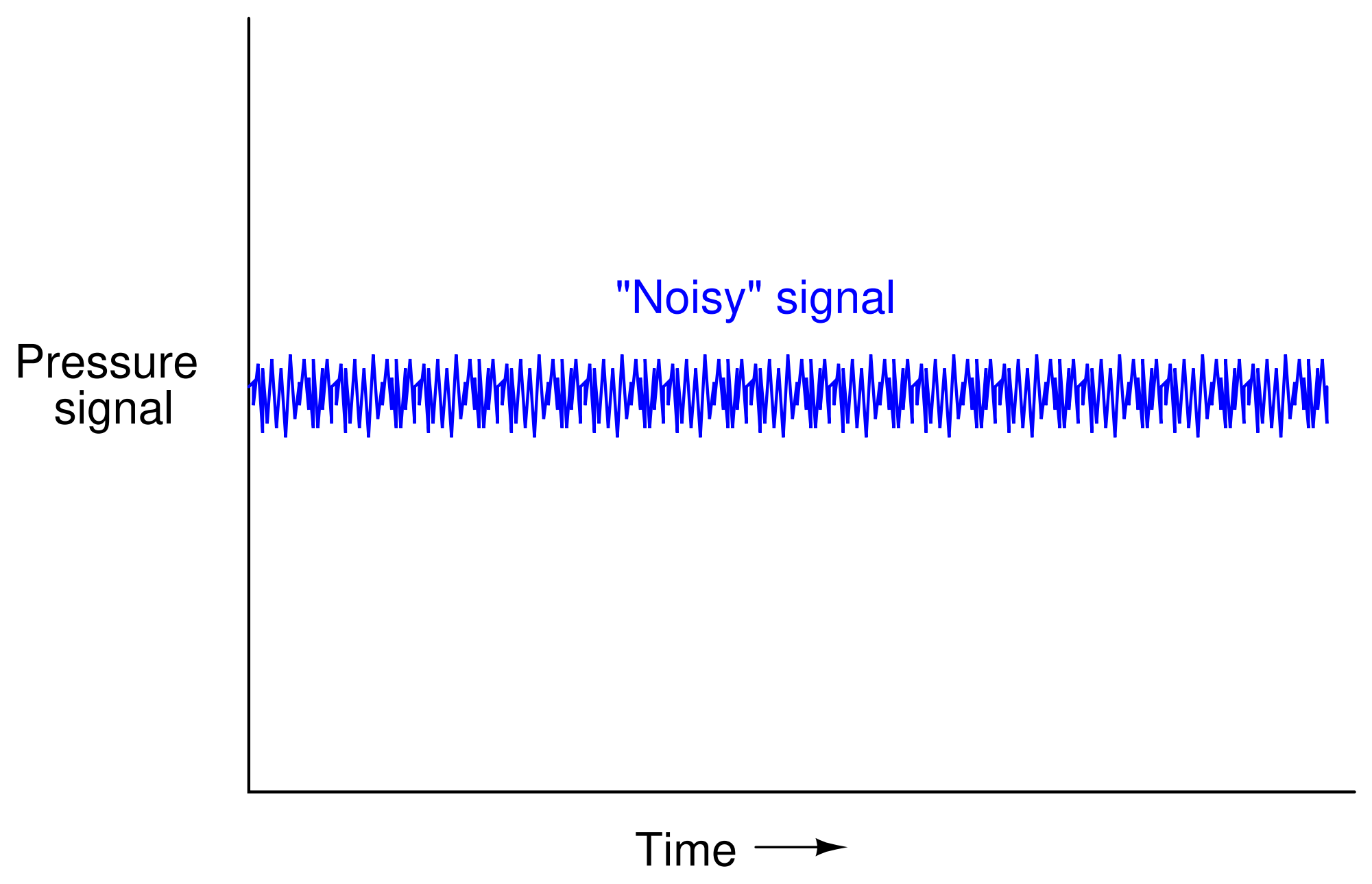
View Reminders | DPCTrack Explorer

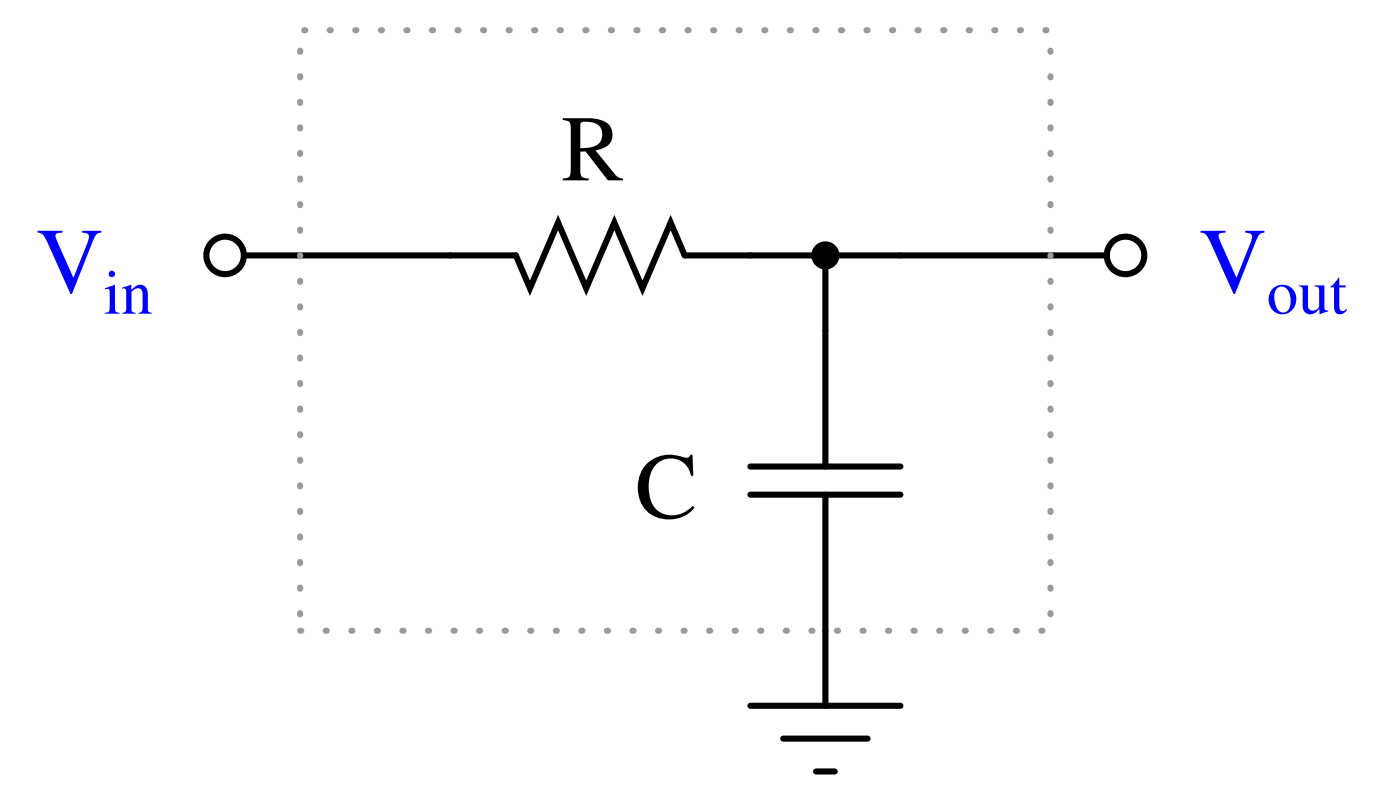
- Company
- Instruments
- Loops
- Equipment
- Test Instruments
- Calibrations
- Documents
- Upload/Download
- Logged Data

Right-Click for Tool Bar Options

Current User : ADMIN (Administrator)

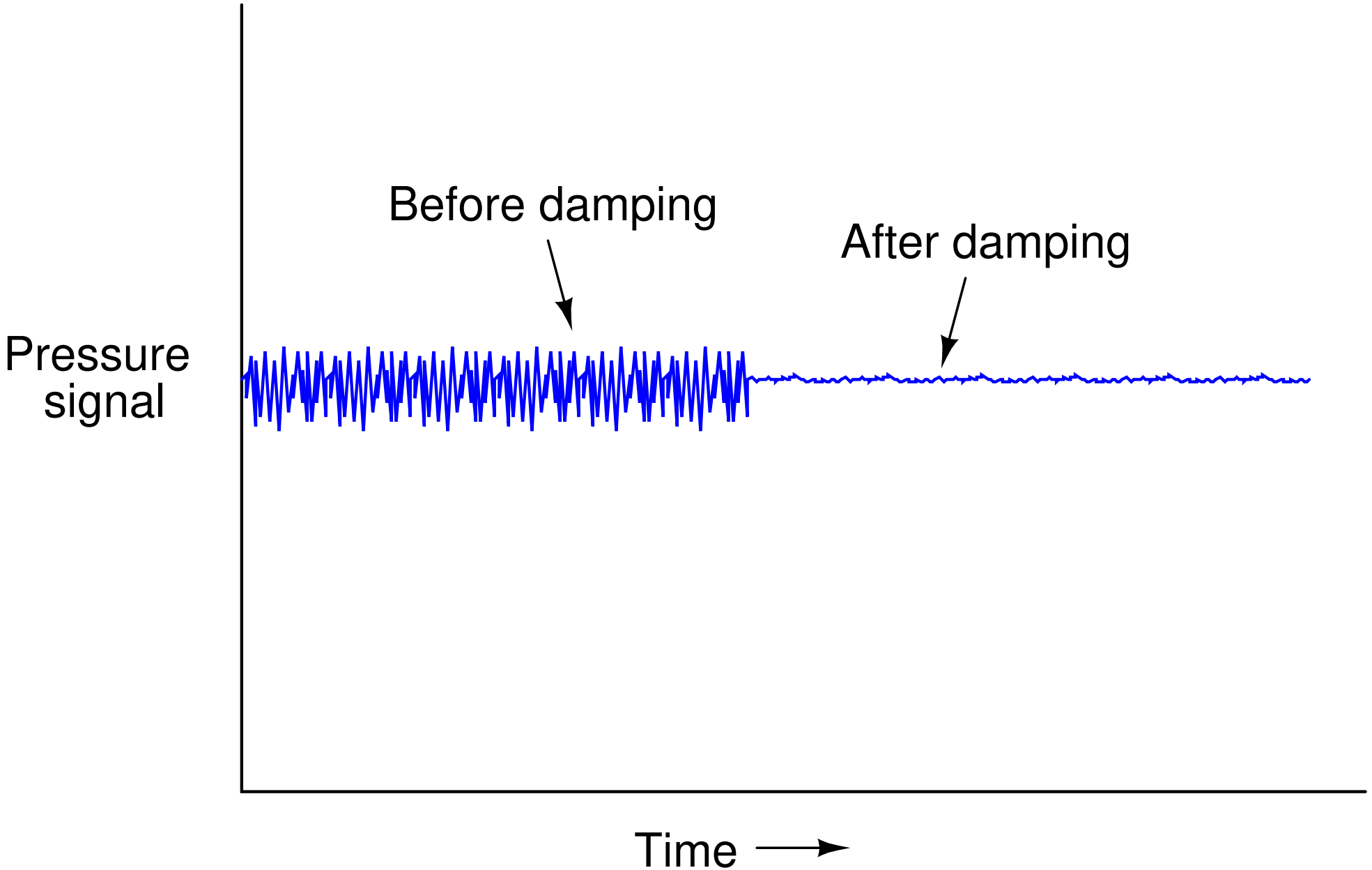
Start | Removable Disk (E:) | DPCTrack2 | 2:34 PM


"Noisy" signal
Pressure signal
Time

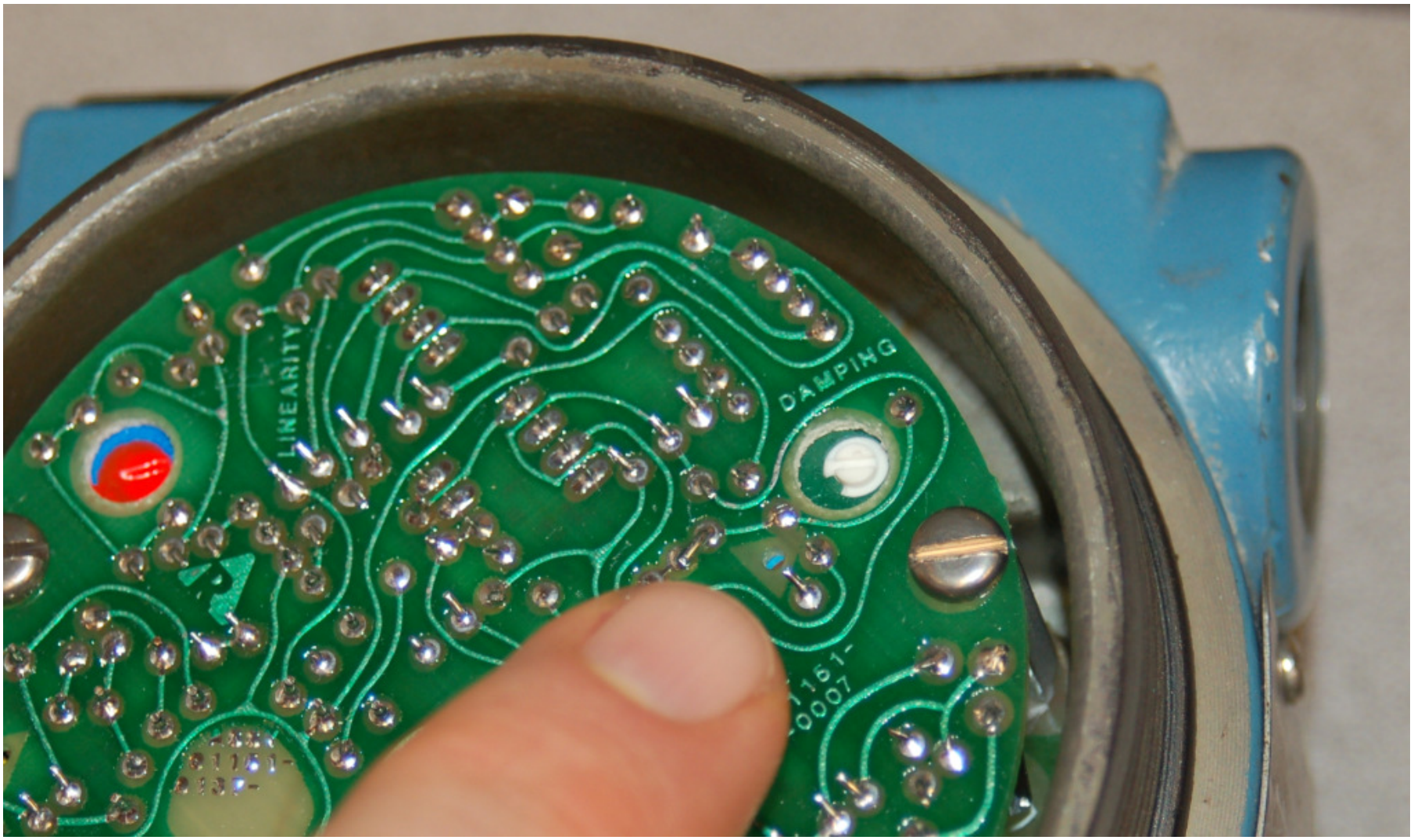

R
V_{in}
V_{out}
C

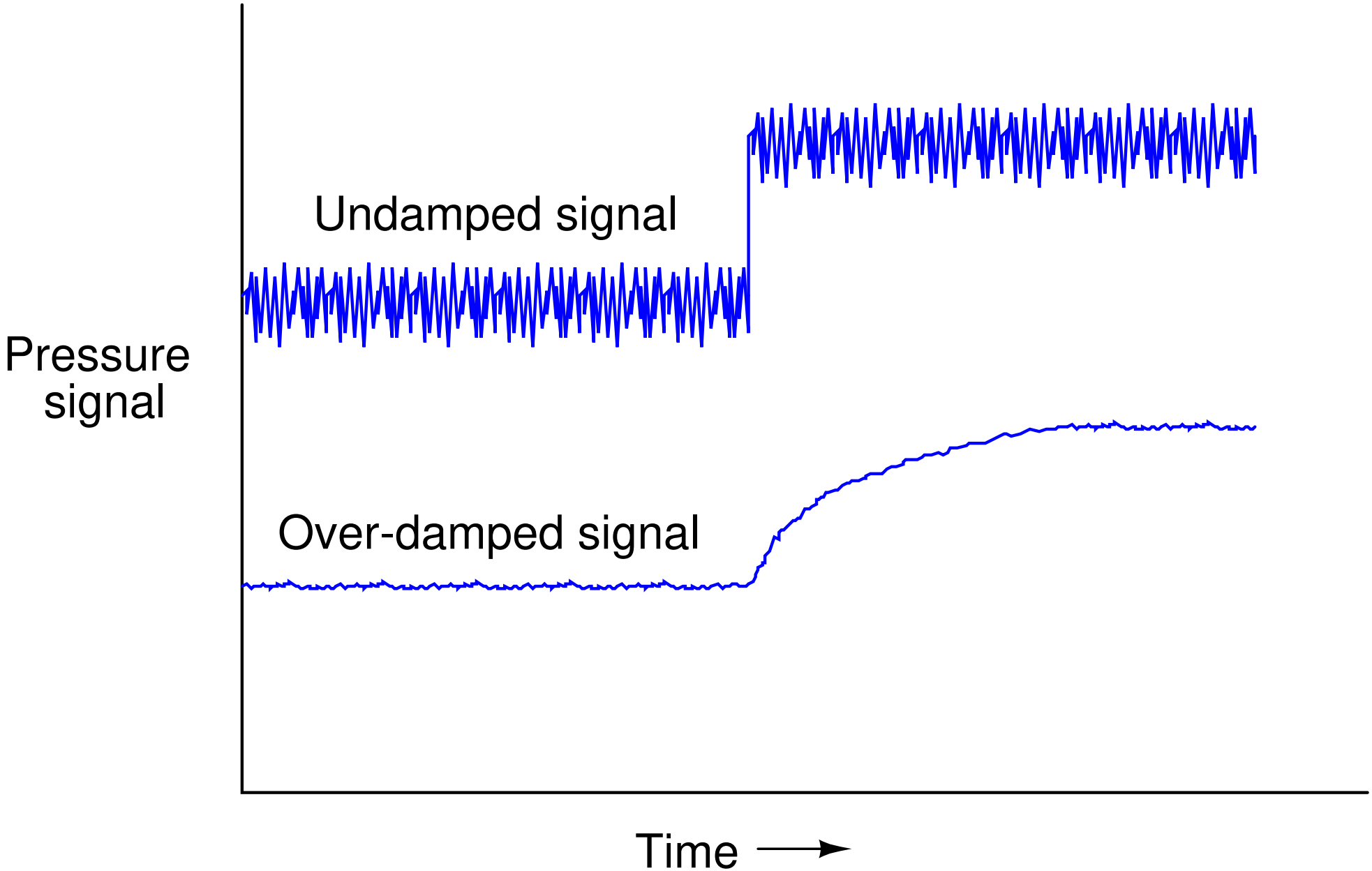
$$f = \frac{1}{2\pi RC}$$

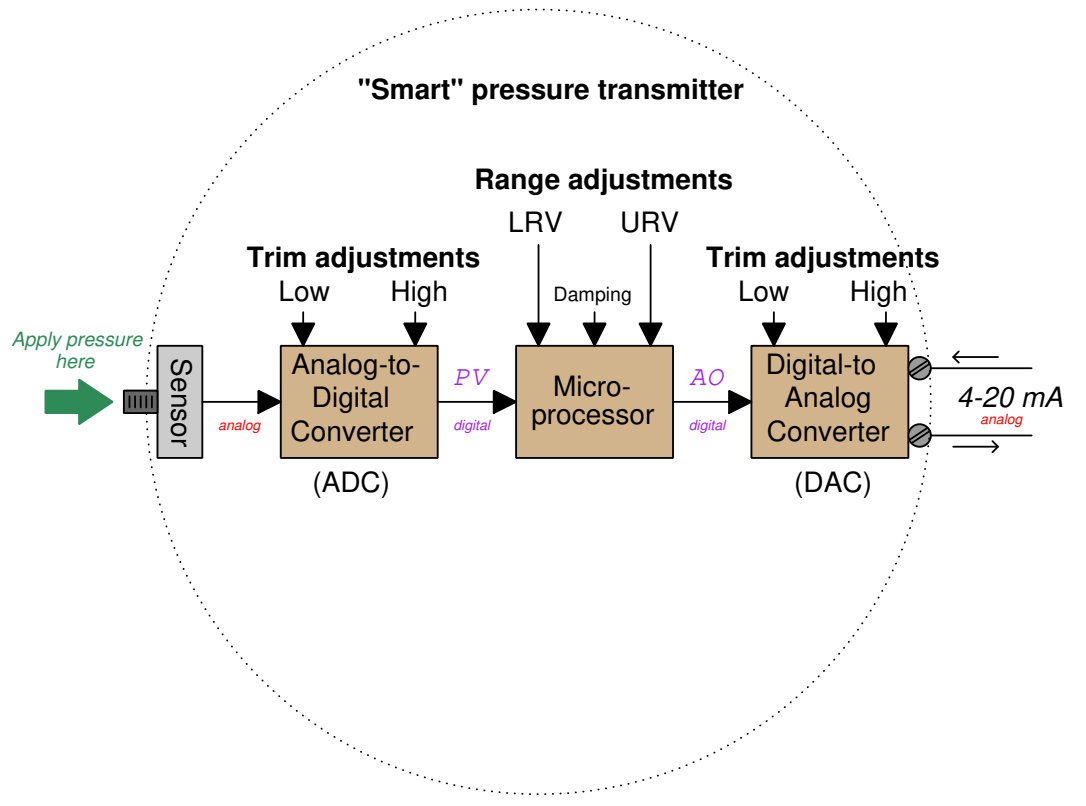
-3

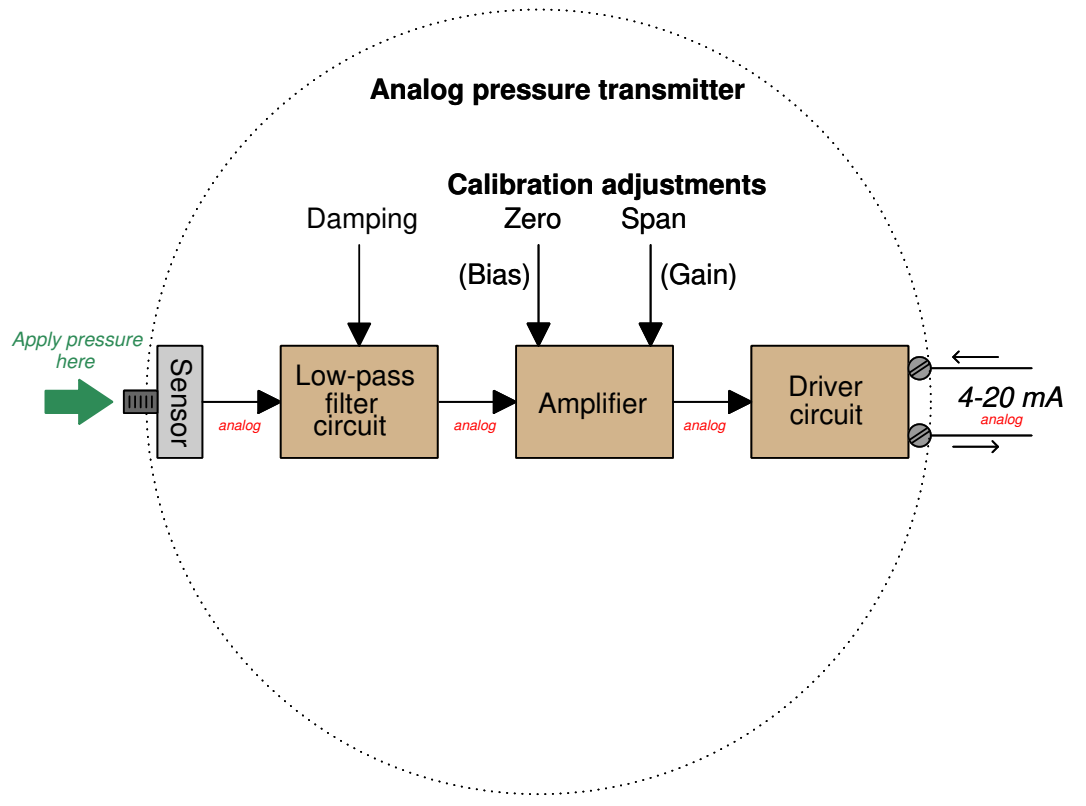

Before damping
After damping
Pressure signal
Time

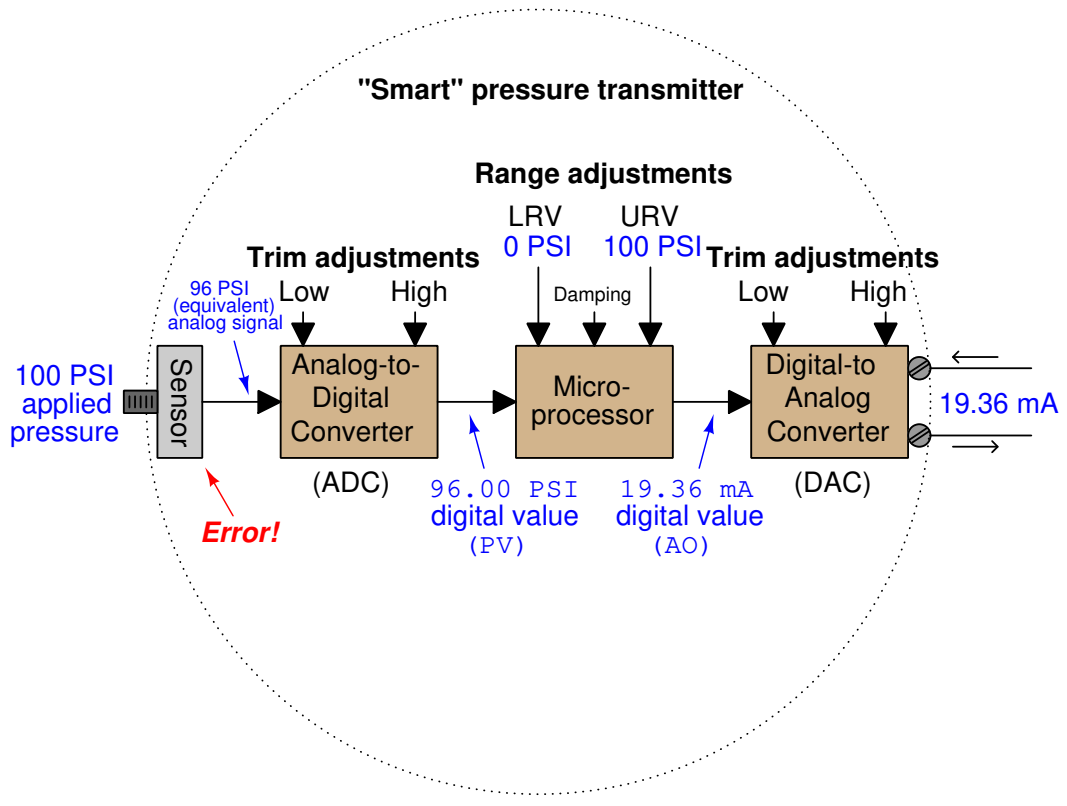
R

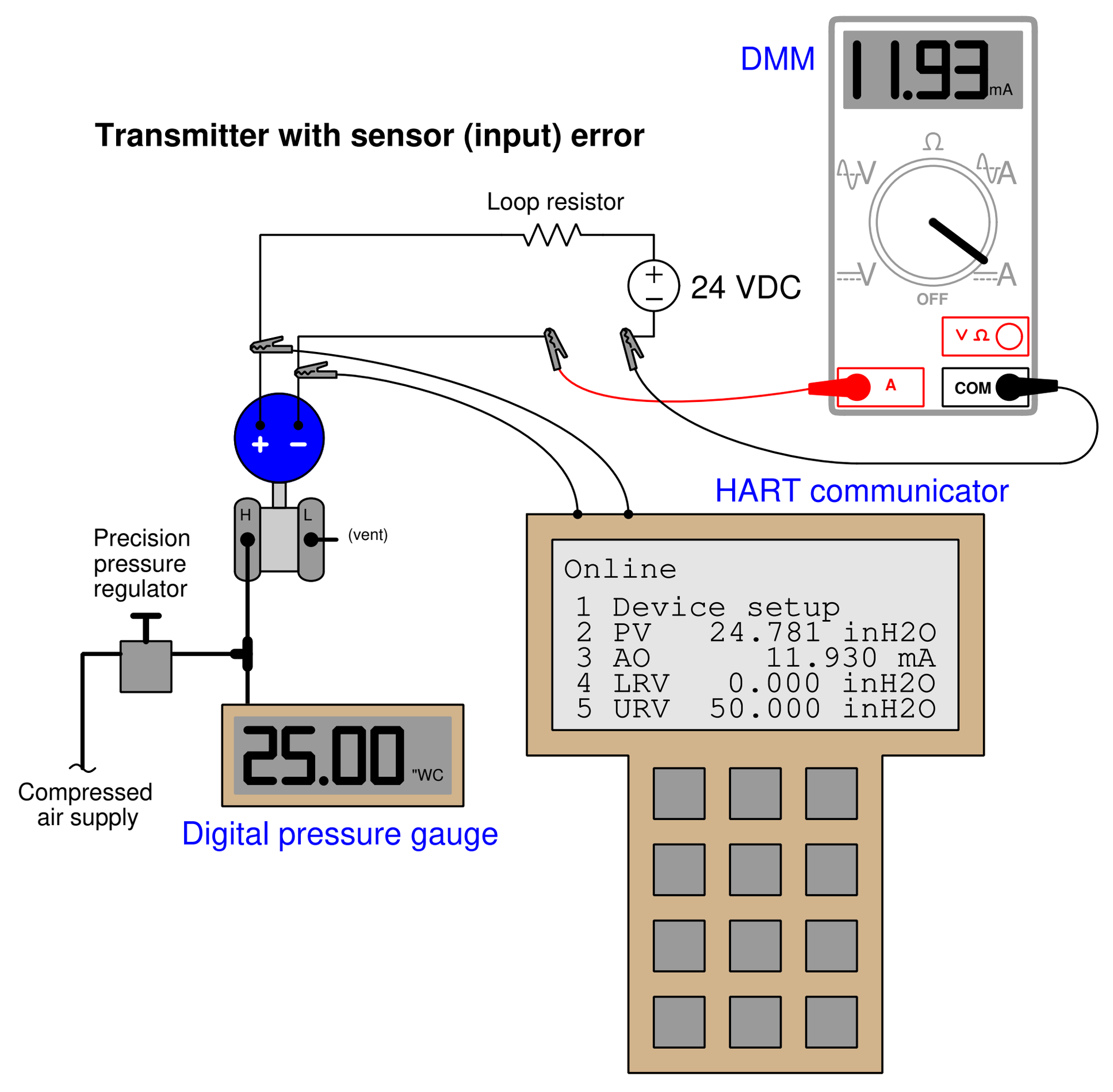

LINEARITY
DAMPING

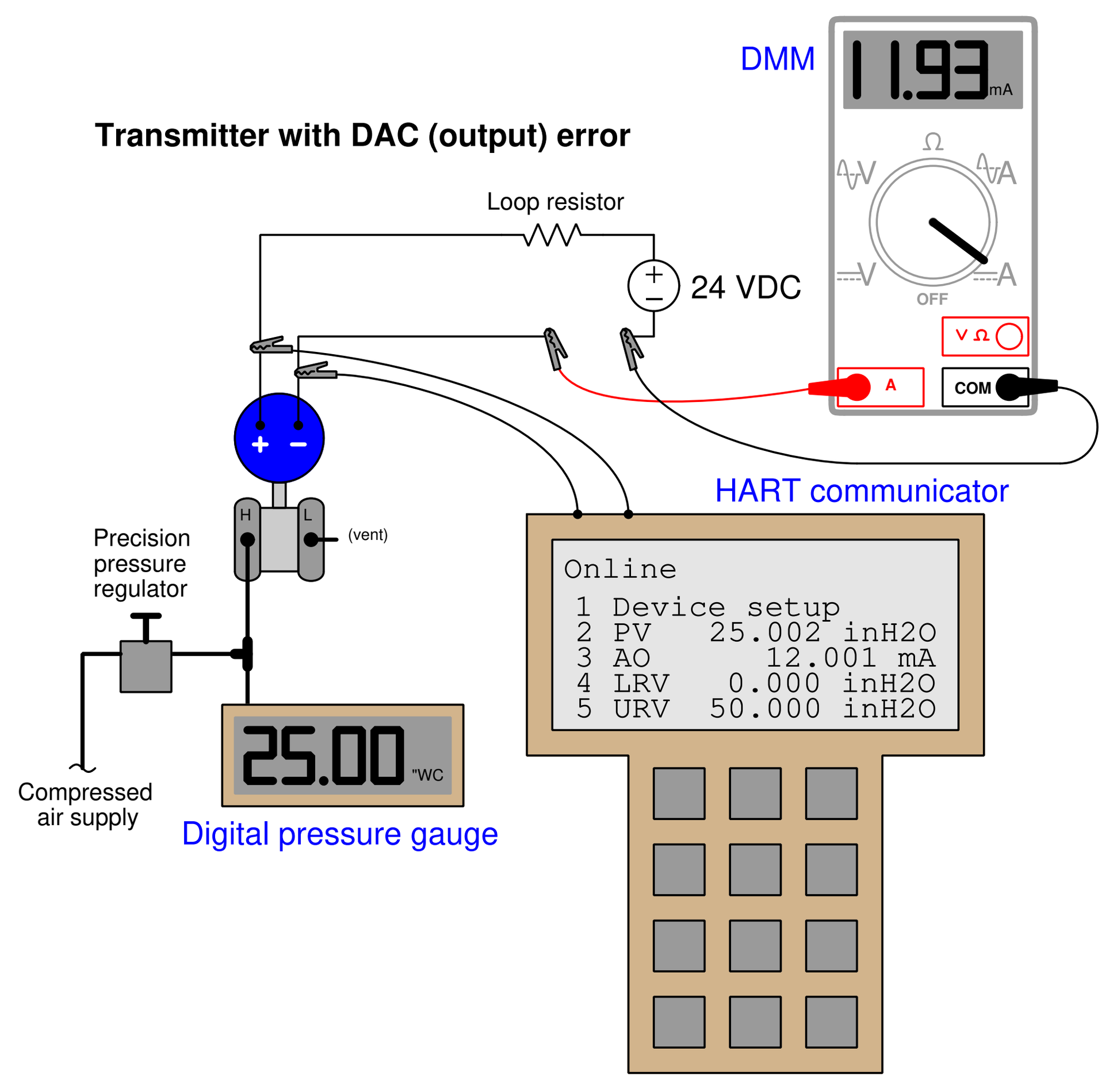

Undamped signal
Pressure signal
Over-damped signal
Time


"Smart" pressure transmitter
Range adjustments
LRV
URV
Trim adjustments
Low
High
Damping
Trim adjustments
Low
High
Apply pressure here
Sensor
analog
Analog-to-Digital Converter
(ADC)
PV
digital
Micro-processor
AO
digital
Digital-to Analog Converter
(DAC)
4-20 mA
analog

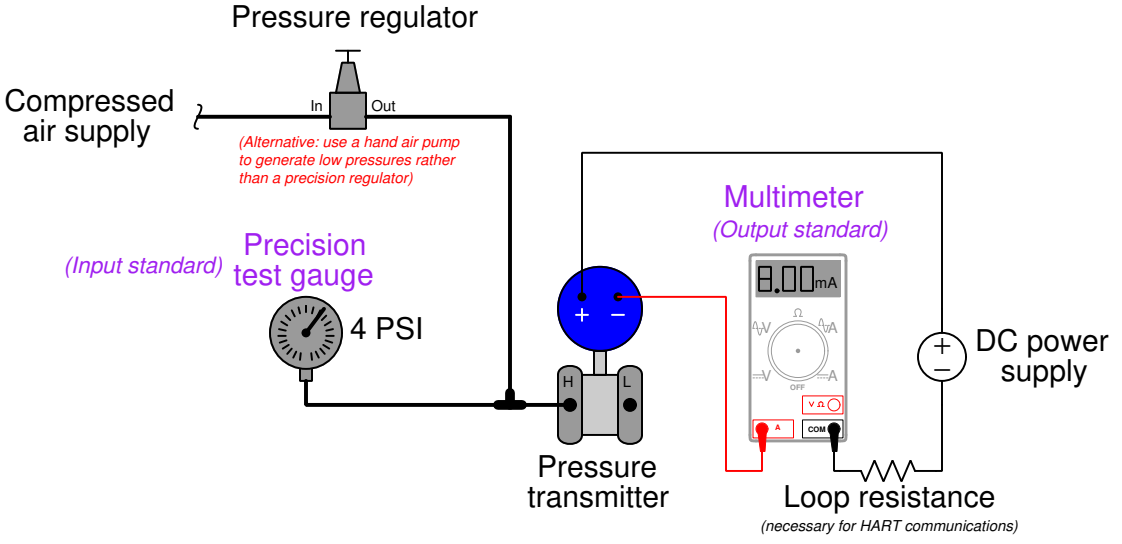

Analog pressure transmitter
Calibration adjustments
Damping
Zero
Span
(Bias)
(Gain)
Apply pressure here
Sensor
analog
Low-pass filter circuit
analog
Amplifier
analog
Driver circuit
4-20 mA
analog


"Smart" pressure transmitter
Range adjustments
LRV
0 PSI
URV
100 PSI
Trim adjustments
Low
High
Damping
Trim adjustments
Low
High
96 PSI
(equivalent)
analog signal
100 PSI
applied
pressure
Sensor
Analog-to-
Digital
Converter
(ADC)
Micro-
processor
Digital-to
Analog
Converter
(DAC)
19.36 mA
Error!
96.00 PSI
digital value
(PV)
19.36 mA
digital value
(AO)

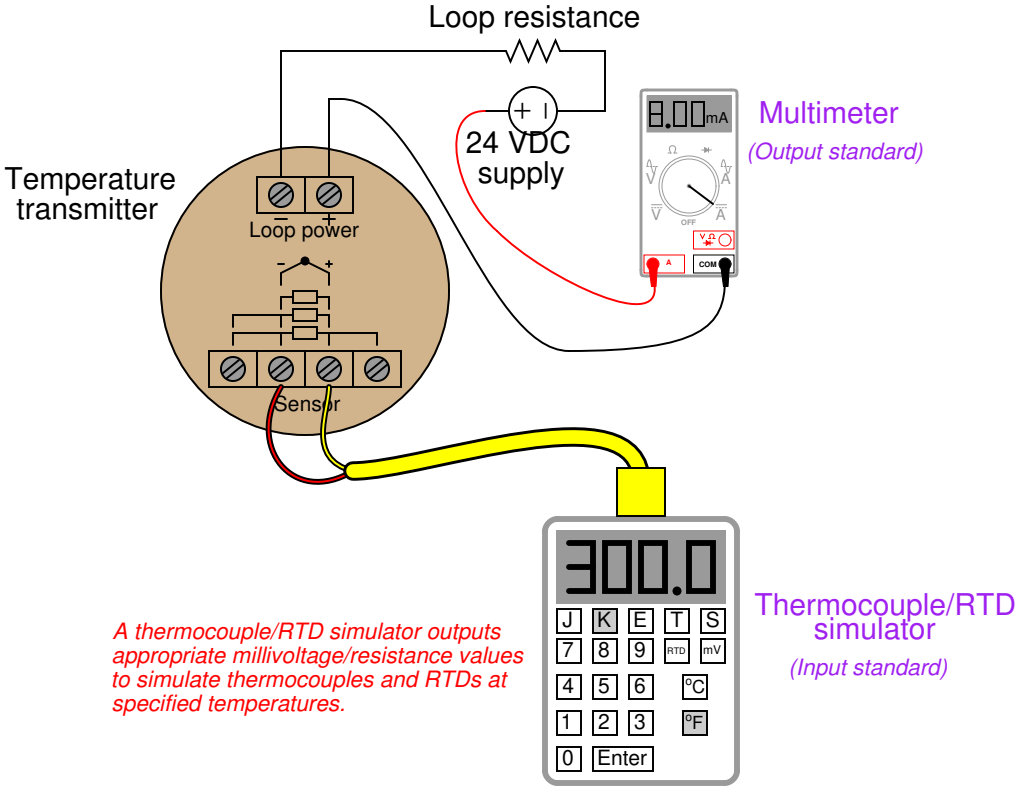

Transmitter with sensor (input) error
DMM
11.93 mA
Loop resistor
24 VDC
HART communicator
Online
1 Device setup
2 PV 24.781 inH2O
3 AO 11.930 mA
4 LRV 0.000 inH2O
5 URV 50.000 inH2O
Precision pressure regulator
H
L
(vent)
Compressed air supply
25.00 "WC
Digital pressure gauge


Transmitter with DAC (output) error
DMM
11.93 mA
Loop resistor
24 VDC
OFF
A
COM
HART communicator
Online
1 Device setup
2 PV 25.002 inH2O
3 AO 12.001 mA
4 LRV 0.000 inH2O
5 URV 50.000 inH2O
H
L
(vent)
Precision pressure regulator
25.00 "WC
Digital pressure gauge
Compressed air supply

Typical calibration setup for an electronic pressure transmitter



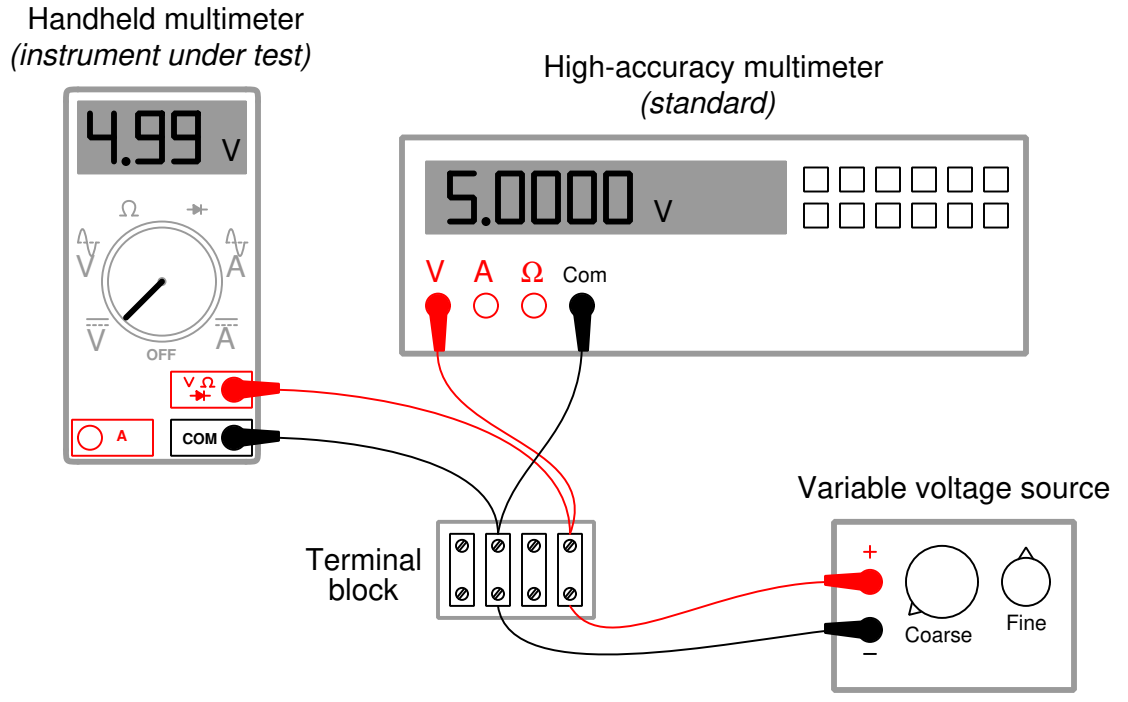
Typical calibration setup for an electronic temperature transmitter



86


JJ SYSTEM
NON-MAGNETIC

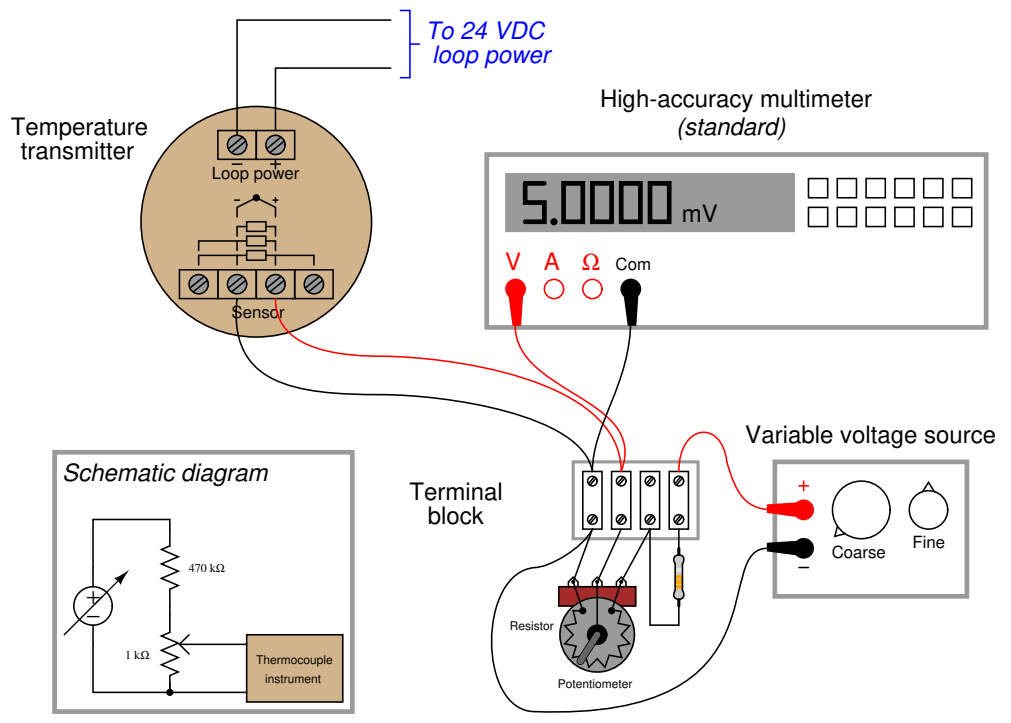

FLUKE 5500A CALIBRATOR
NORMAL
AUX
SCOPE
TRIG OUT
TC
STBY
EARTH
SCOPE
BOOST
PREV MENU
SETUP
RESET
EDIT FIELD
ENTER
SHIFT
FLUKE 5700A CALIBRATOR
OUTPUT
SENSE
ENTER
FLUKE 87


Handheld multimeter
(instrument under test)
4.99 V
Ω
V
A
V
A
OFF
A
COM
High-accuracy multimeter
(standard)
5.0000 V
V
A
Ω
Com
Terminal
block
Variable voltage source
+
−
Coarse
Fine


GALV.
EMF
EMF
SC


+ STD. CELL −
+ EMF −
2000
200
LOW
MED
HIGH
LEEDS & NORTHRUP CO.
PHILADELPHIA
MADE IN U.S.A.
DEC. RES.
DEC. RES.


FLUKE 525A TEMPERATURE / PRESSURE CALIBRATOR
AUTO: 0.1 VDC
Stby 0.000000 V
VOLTS
mA
100mA MAX
RTD Ω
HI
HI
OUTPUT
100V MAX
LO
LO
20V P
MAX
TC
INPUT/OUTPUT
4W RTD Ω
LO
STBY OPR
VOLTS mA
TC RTD
Ω
TYPE UNITS
OUTPUT
INPUT
ZERO
7
8
9
SHIFT
SETUP
CJC
C / F
4
5
6
SET
RECALL
AUTOSET
1
2
3
RNG LOCK
LOCAL
EXP
+/-
0
.
CE


To 24 VDC
loop power
Temperature
transmitter
Loop power
Sensor
High-accuracy multimeter
(standard)
5.0000 mV
V
A
Ω
Com
Variable voltage source
+
−
Coarse
Fine
Terminal
block
Resistor
Potentiometer
Schematic diagram
470 kΩ
1 kΩ
Thermocouple
instrument

Triple Point of Water Temperature Standard

Fluke acquired Hart Scientific and added temperature calibration to its metrology product portfolio. Contains only pure water and pure water vapor. (There is almost no residual air left in them.) A portion of the water is frozen and water coexists within the cell in its three phases – liquid, vapor and solid, providing a critical calibration point with unequaled uncertainties.

O

-248.6

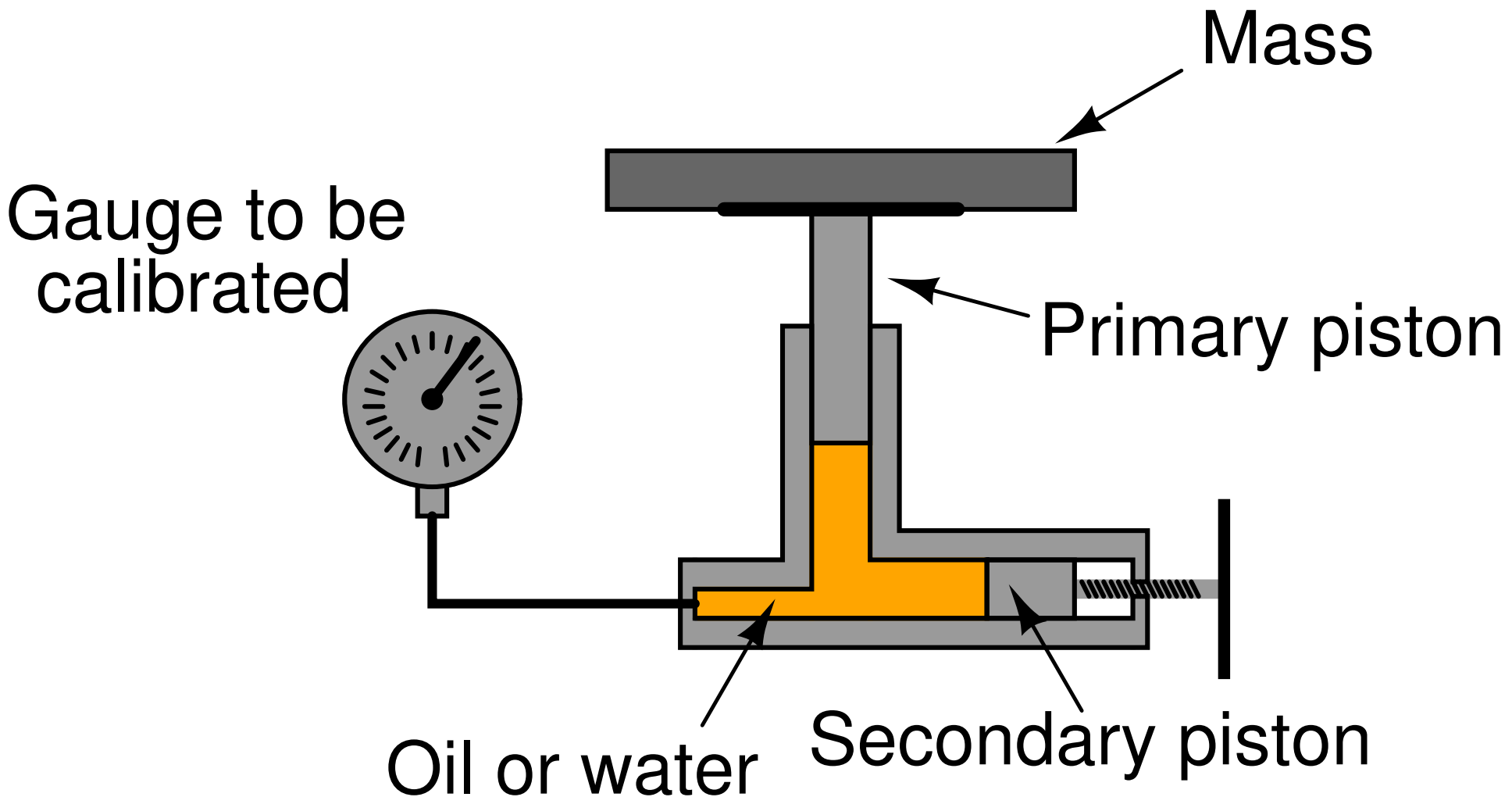
-218.8

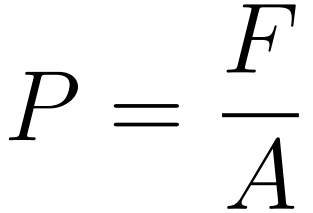

-38.83


GUARD HEATER
MAIN HEATER
TEMPERATURE CONTROL
HTR/150
RISE
KAYE


OMEGA
CL-351A

Deadweight tester

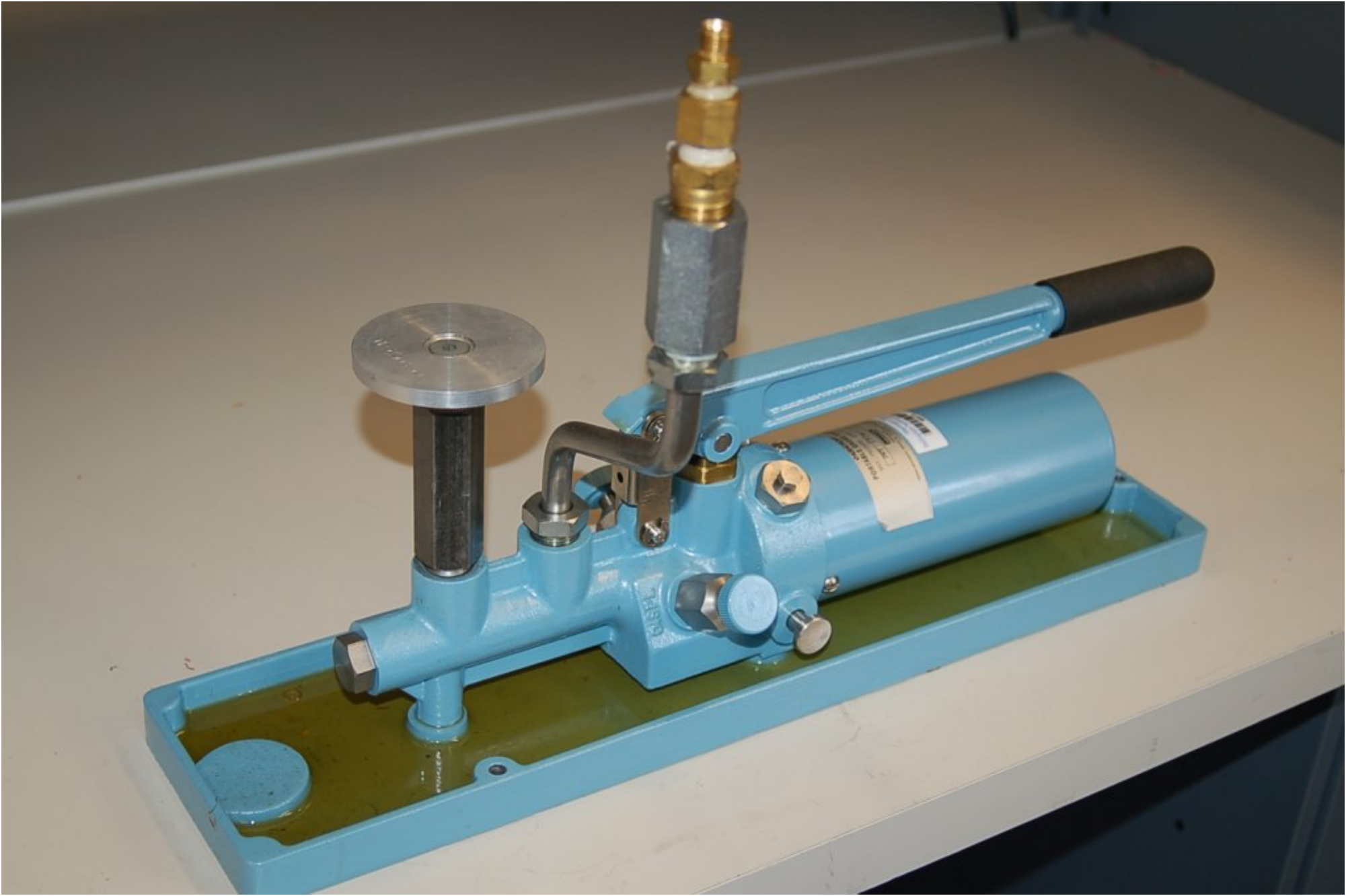



$$P = \frac{F}{A}$$

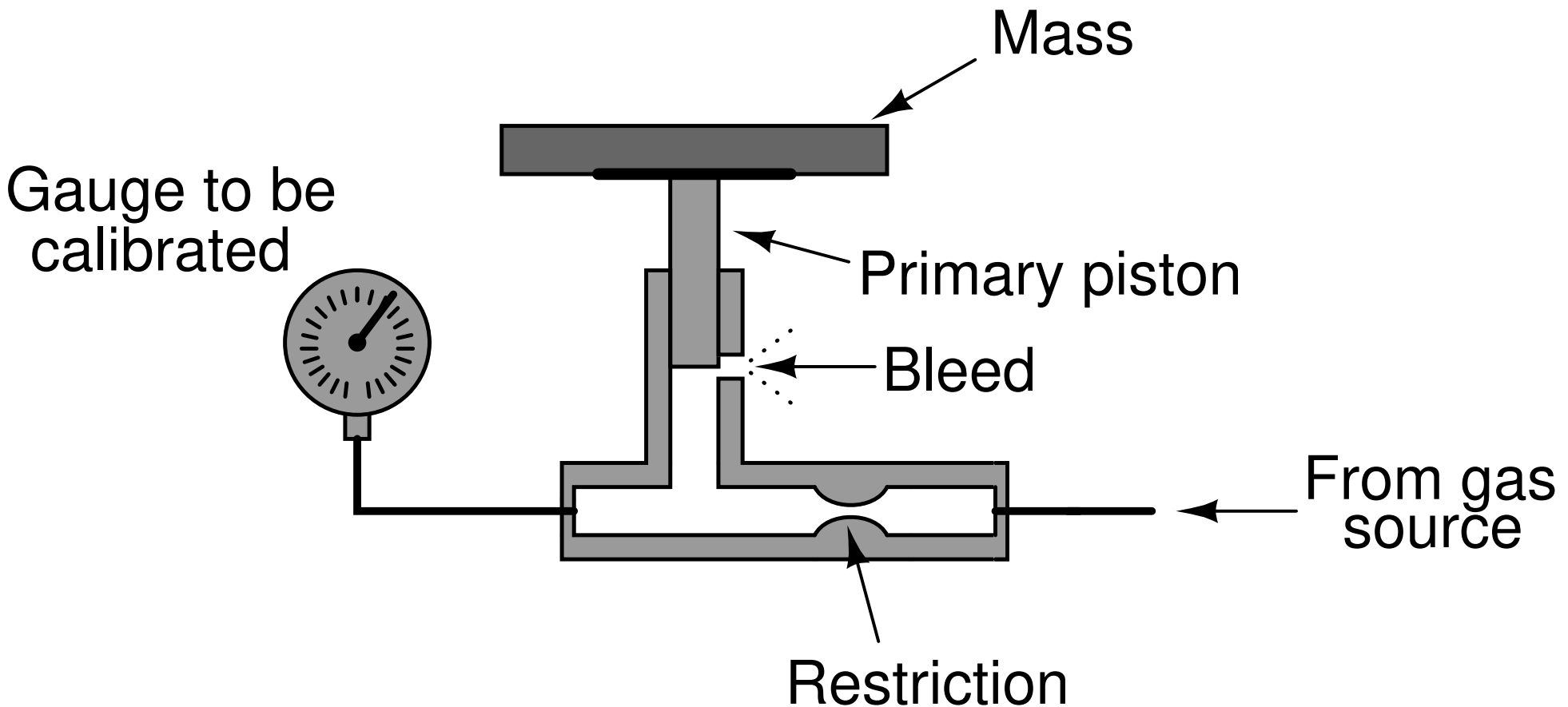
P

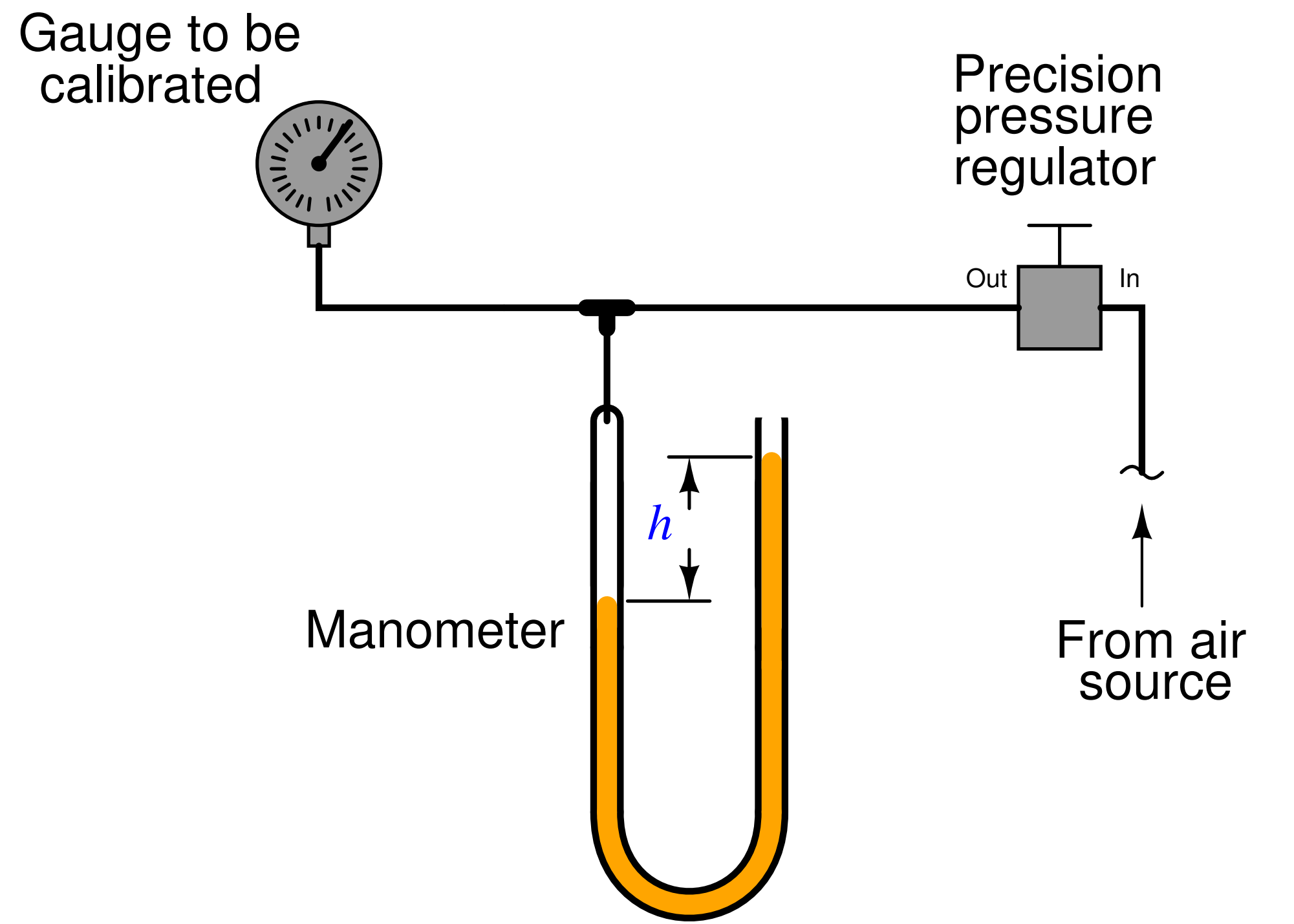
$$F_{weight} = mg$$


ASHCROFT
GAUGE TESTER
ASHCROFT GAUGE DIVISION



Pneumatic deadweight tester



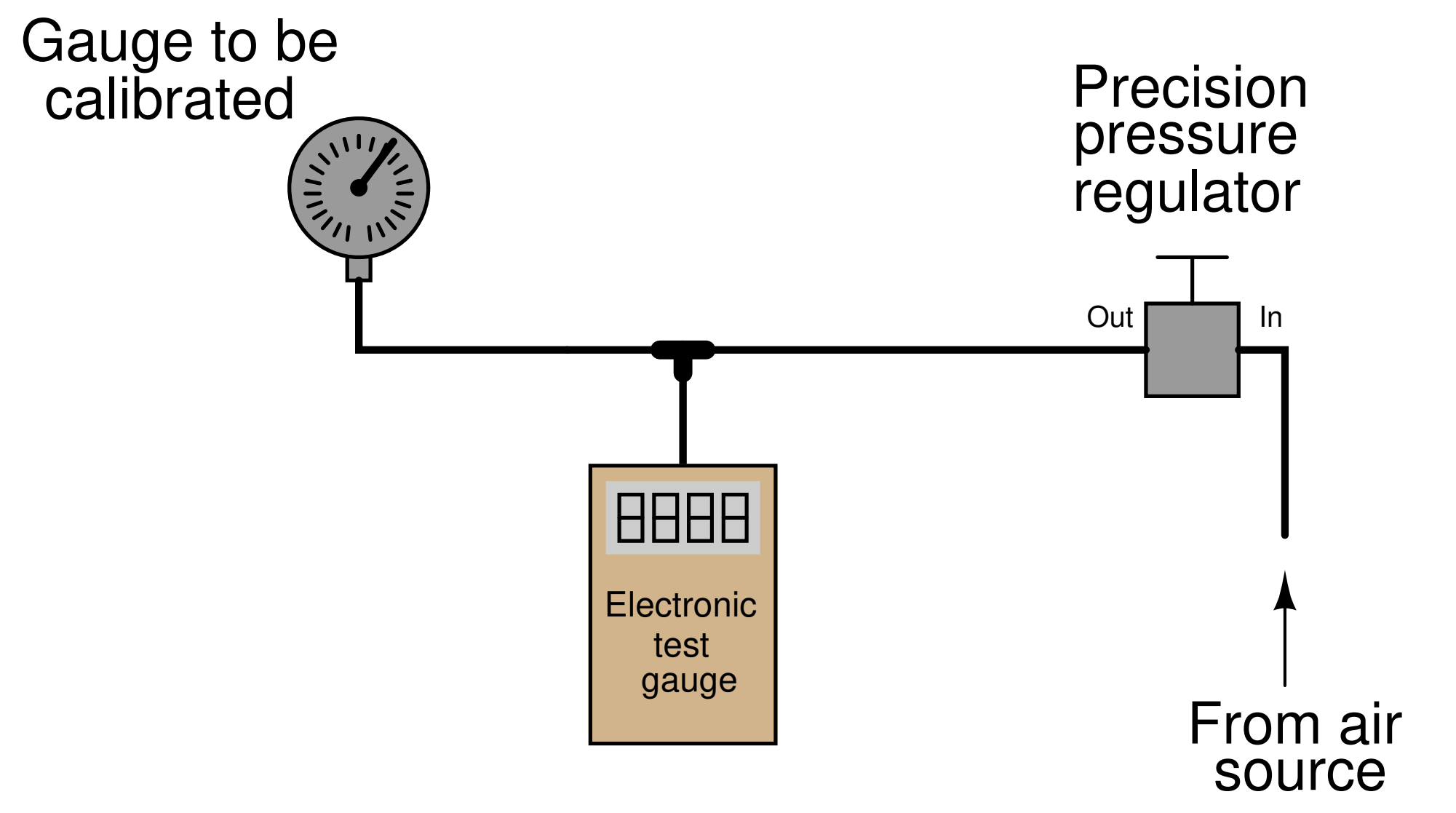

Gauge to be calibrated
Precision pressure regulator
Out
In
h
Manometer
From air source

h

$$P = \rho g h \qquad (\text{or}) \qquad P = \gamma h$$

ρ

g


Gauge to be calibrated
Precision pressure regulator
Out
In
Electronic test gauge
From air source

$$\frac{\Delta V}{\Delta t} = \text{ Average flow}$$

$$\frac{\Delta V}{\Delta t} \approx \frac{dV}{dt} = \text{ Instantaneous flow}$$

$10^{-4.7}$


pHydrion
COLOR SA
pH BUFFE
CAPSULE
CERTIFIED AT
7.00 ± 0.02 @ 2
Dissolve powder in 100
of distilled water.
Solution will be color
and protected against
MICRO ESSENTIAL LABO
BROOKLYN, N. Y. 1

2

$$y = mx + b$$