Importance of KI Readings between 20 and 80 KI

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It's pretty well known that any ANALOG style gauge will be most accurate around the center. So if the range is 0 to 100, it is likely that the gauge is most accurate @ 50 with a small band around it (say +/- 30 KI) to give you a credible measurement rom 20 to 80 KI.

This assumes the gauge is sized properly for the measurements and that the error band is highly linear and that the linearity is best at the mid-scale readings.

Resolution vs. Accuracy

Resolution: Is the smallest increment a gauge can show. For instance on a DVM (digital volt meter) with the following display formatting of XX.XX the smallest increment is 0.01

Resolution vs. Accuracy

Resolution: Is the smallest increment a gauge can show. On an analog meter such as this 15 PSI pressure gauge, the smallest increment is 0.25 or ¼ PSI.

Resolution vs. Accuracy

Resolution: Is the smallest increment a gauge can show. On our analog knock-meter this is?

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1 Knock Intensity Unit

(1 KI)

Resolution vs. Accuracy

Accuracy: All measurements contain some error. Usually this accuracy (or error) is defined as a percentage error, and typically can be found as % FS (or percent full scale).

So if that same DVM has a +/- 1% FS error/accuracy associated with it, and it read 12.65 and its full scale was 100.00 then the reading could be 12.65 +/- 1.00 volts or anywhere from 11.65 to 13.65

Just because it can read down to 0.01 resolution, does not mean that the accuracy is +/- 0.01

Resolution vs. Accuracy

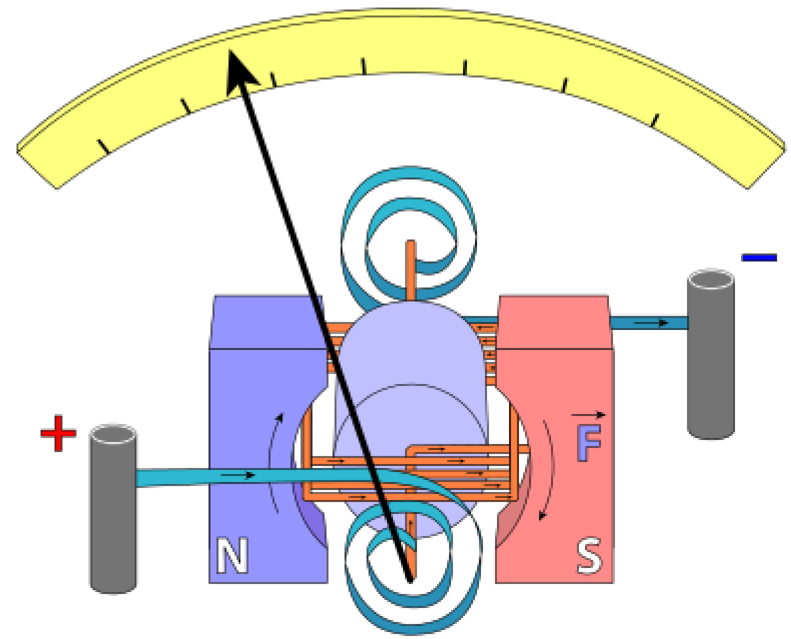
An analog gauge will also have the same accuracies or errors associated with them.

In the case of the knock-meter it is important to understand how the meter portion of the device works.

The knock meter is a type of Galvanometer. Although it is true that most Galvanometers measure amps or amperes or current flow. When the resistance of the coil is known to calculate the voltage required to reach full scale current- it can be used as a highly accurate volt-meter.

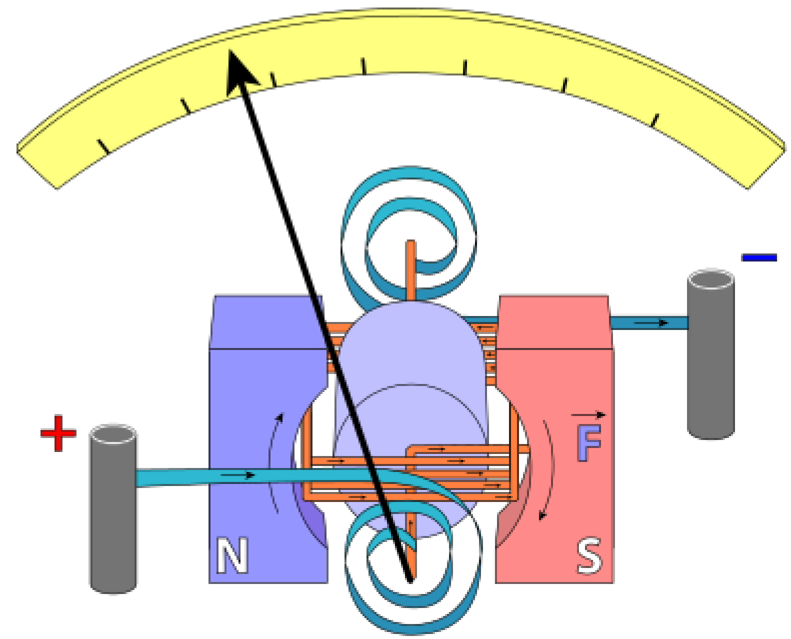
Galvanometer:

The D'Arsonval/Weston form used today (depicted on the right, with the moving coil shown in orange) is constructed with a small pivoting coil of wire in the field of a permanent magnet. The coil is attached to a thin pointer that traverses a calibrated scale. A tiny torsion spring pulls the coil and pointer to the zero position.



Galvanometer:

When a direct current (DC) flows through the coil, the coil generates a magnetic field. This field acts against the permanent magnet. The coil twists, pushing against the spring, and moves the pointer. The hand points at a scale indicating the electric current. Careful design of the pole pieces ensures that the magnetic field is uniform, so that the angular deflection of the pointer is proportional to the current. A useful meter generally contains provision for damping the mechanical resonance of the moving coil and pointer, so that the pointer settles quickly to its position without oscillation.



*** courtesy WIKIpedia

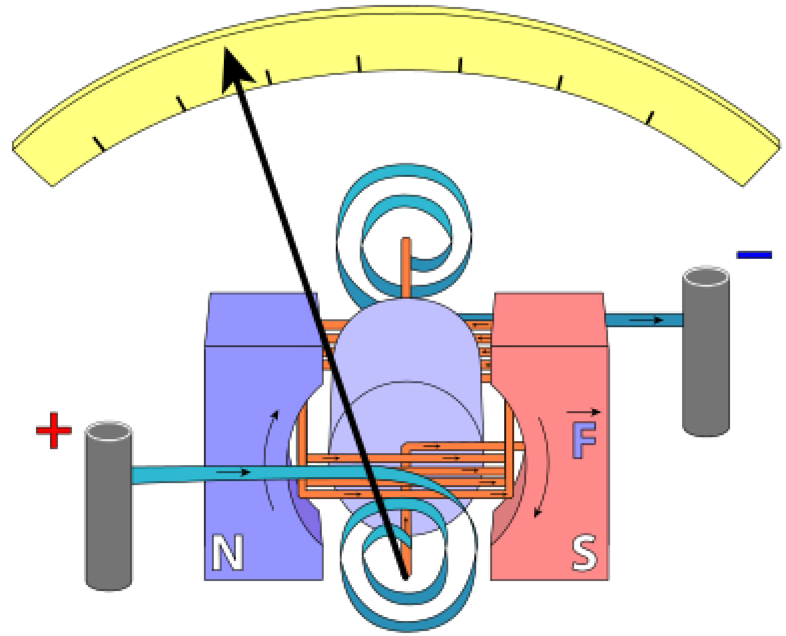
Galvanometer:

In the case of the knock-meter, the voltage required to generate full current is known, and calibrated. In this case it is set so that the full travel of the meter (full scale) is 15millivolts. Or 0.015 volts.

YES- 0.015 volts!

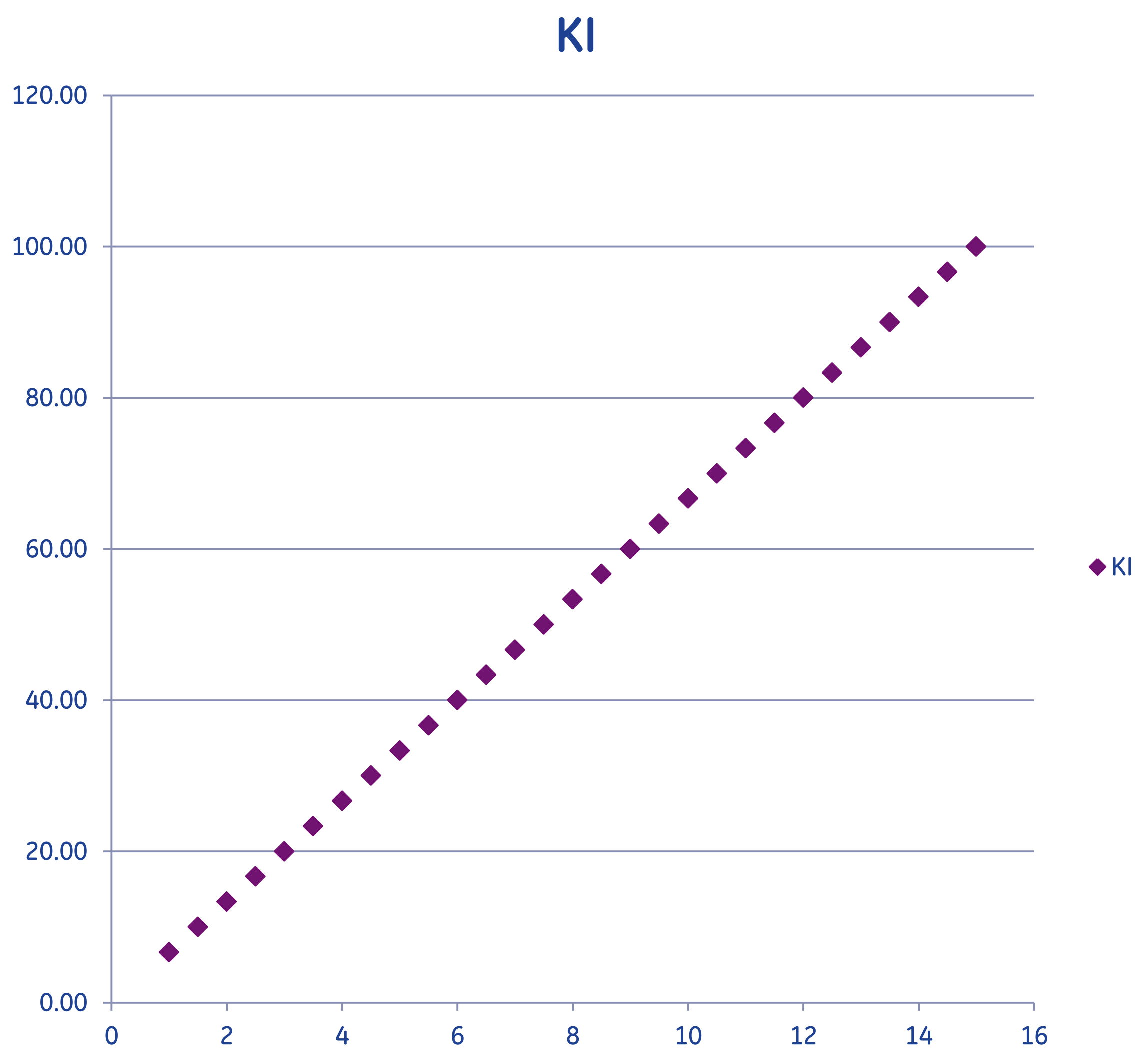
This means @ 100 KI we have 15 mV
@ 50 KI we have 7.5 mV
And at 25 KI we have 3.75 mV

I've charted this on the next slide for a closer view.



Knock Meter V, mV vs. KI:

voltage	millivolt	KI
0.001	1	6.67
0.0015	1.5	10.00
0.002	2	13.33
0.0025	2.5	16.67
0.003	3	20.00
0.0035	3.5	23.33
0.004	4	26.67
0.0045	4.5	30.00
0.005	5	33.33
0.0055	5.5	36.67
0.006	6	40.00
0.0065	6.5	43.33
0.007	7	46.67
0.0075	7.5	50.00
0.008	8	53.33
0.0085	8.5	56.67
0.009	9	60.00
0.0095	9.5	63.33
0.01	10	66.67
0.0105	10.5	70.00
0.011	11	73.33
0.0115	11.5	76.67
0.012	12	80.00
0.0125	12.5	83.33
0.013	13	86.67
0.0135	13.5	90.00
0.014	14	93.33
0.0145	14.5	96.67
0.015	15	100.00



Note: 20 KI = 3mV and 80 KI = 12 mV

Knock Meter V, mV vs. KI:

At a measurement of 1 KI the input to the meter is 0.15 mV or 0.00015 volts!

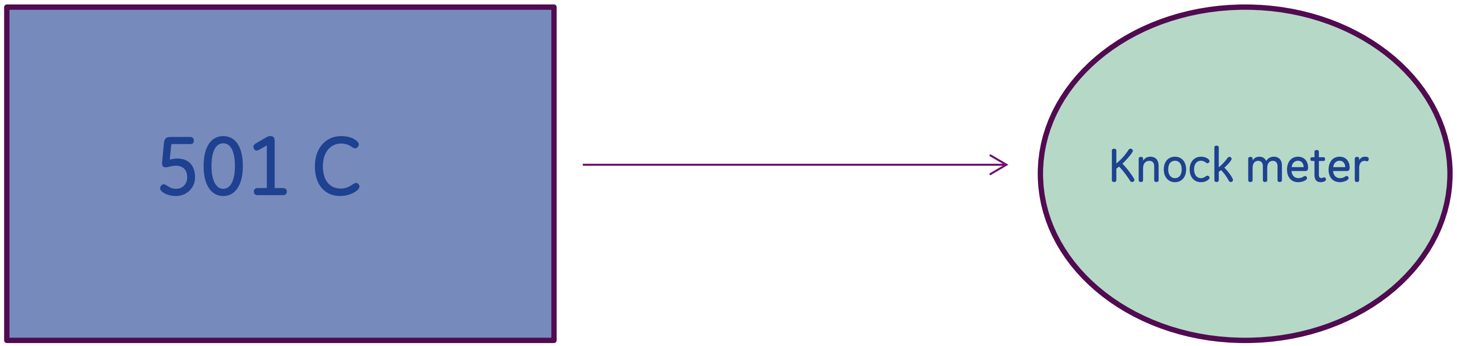
So a resolution of 1 KI is a resolution of
0.15 mV
Or
0.00015 volts !

It's obvious to see why a small electrical interference of EMI (Electro-magnetic Interference can cause a large disruption on the meter)

Note: 20 KI = 3mV and 80 KI = 12 mV

Input to the knock meter:

Before understanding the full impacts of accuracy and the importance of operating in the range of 20 to 80 KI, we should further understand the inputs to the knock meter, which is the outputs of the 501C Detonation Meter.



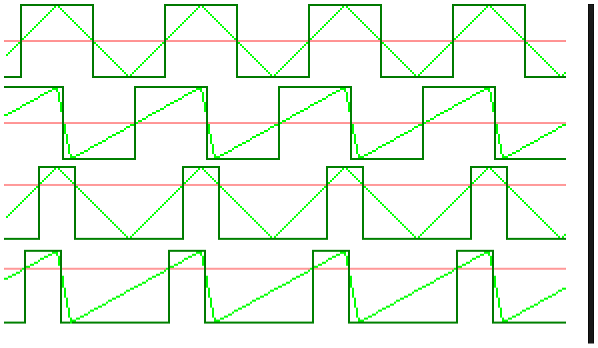
Output of the detonation meter:

Many understand how to set the Meter Reading and Spread on the Input side of the 501C Detonation meter, but very few people understand what the output of the 501C is.

Output of the detonation meter:

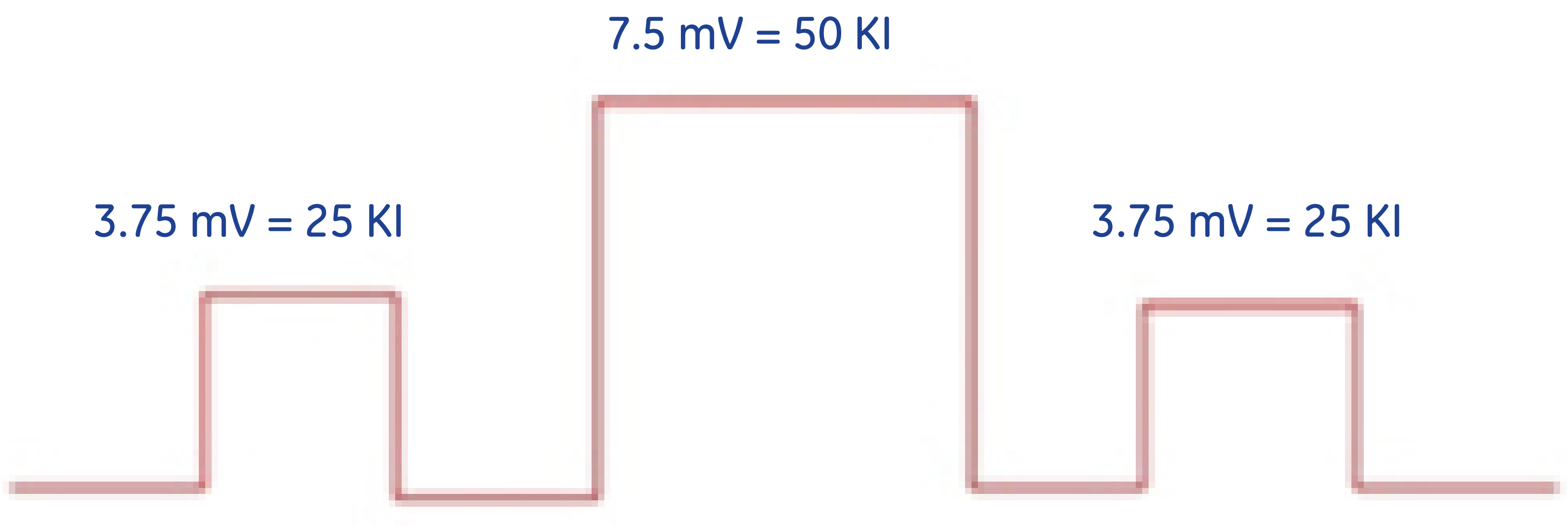
The Detonation Meter outputs a DC pulse every combustion cycle. This pulse is proportional to the Knock Intensity based on the input from the Detonation Pickup and the settings being used on the 501C.

The frequency of these pulses on RON are ~ 5 Hz and on MON ~ 7.5 Hz



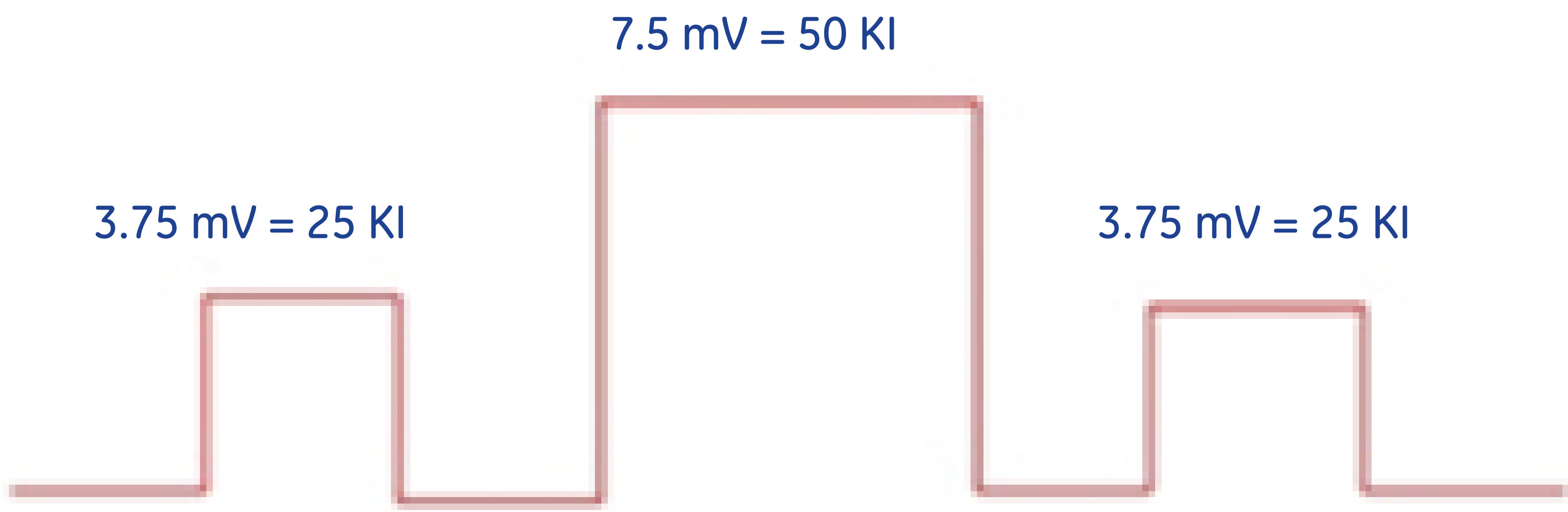
Output of the detonation meter:

The height or max voltage of these pulses are the individual KI readings for each combustion event. (Remember 1 KI = 0.15 mV)



Voltage Perspective:

To put these small voltages into perspective. For a Type K Thermocouple (Remember 1 KI = 0.15 mV)



Voltage Perspective:

To put these small voltages into perspective. For a Type K Thermocouple (Remember 1 KI = 0.15 mV)

100 deg C = 212 Deg F = 4.096 mV
101 deg C = 213.8 Deg F = 4.138 mV

= 0.042 mV difference

100 deg C = 212 Deg F = 4.096 mV + 0.15 mV = 4.246mV

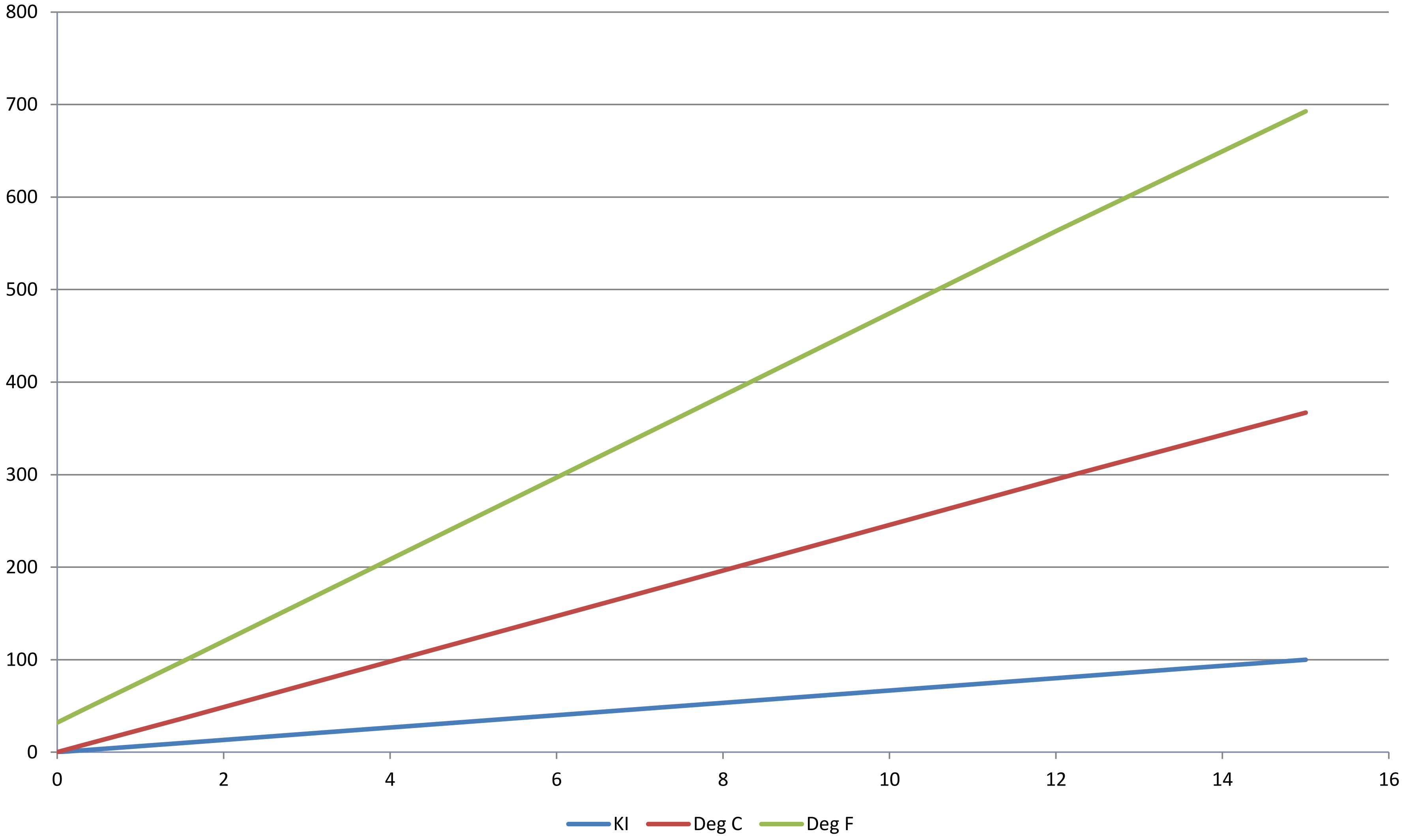
4.246 mV = 103.5 deg C = 218.3 deg F

Or a change in 3.5 deg C (6.3 deg F)

Voltage Perspective K type thermocouple analogy:

KI	mV	Deg C	Deg F
0	0	0	32
2	0.3	7.5	45.5
10	1.5	36.5	97.7
20	3	73.5	164.3
50	7.5	184	363.2
80	12	295	563
90	13.5	331	627.8
100	15	367	692.6

Voltage Perspective K type thermocouple analogy:



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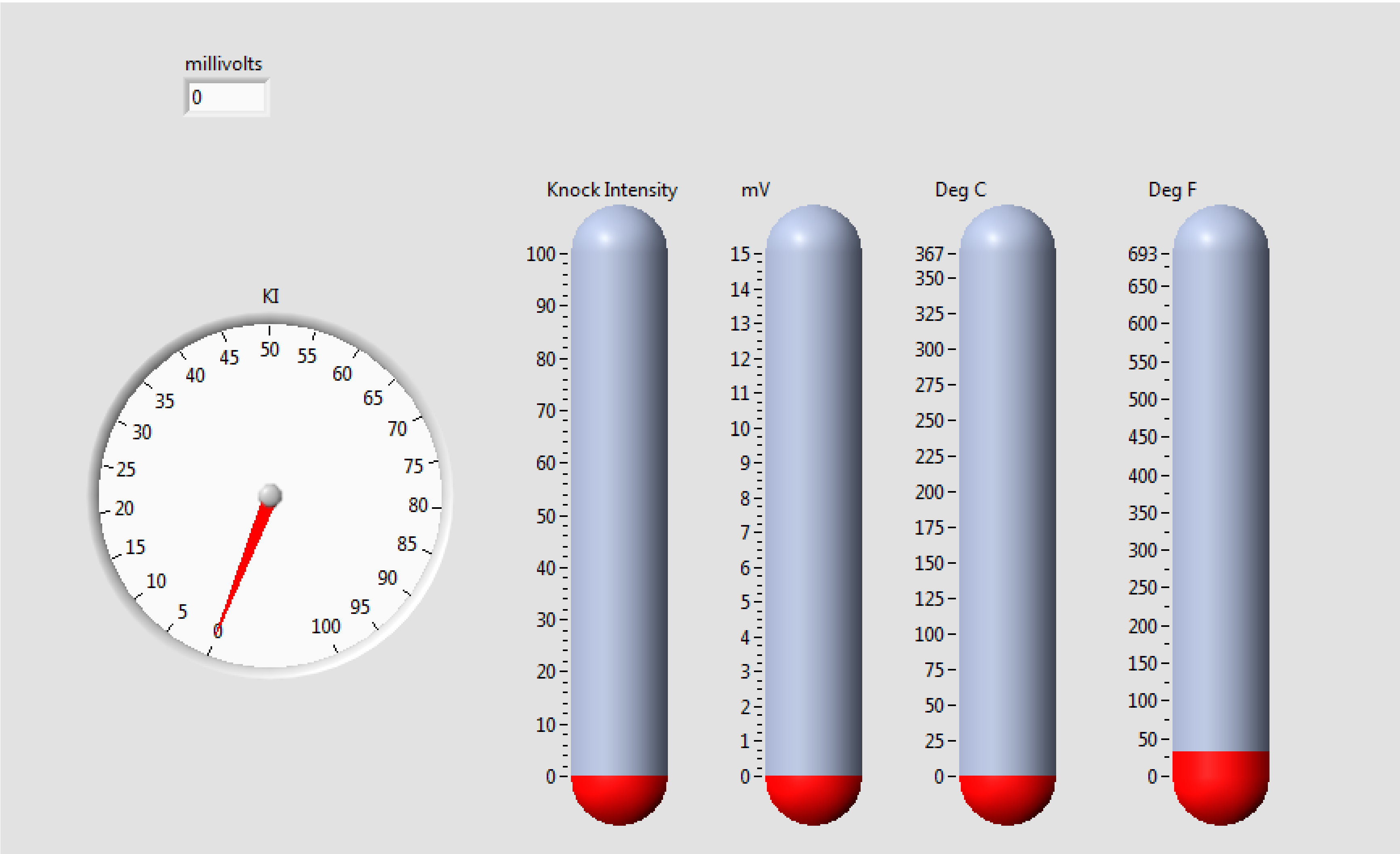

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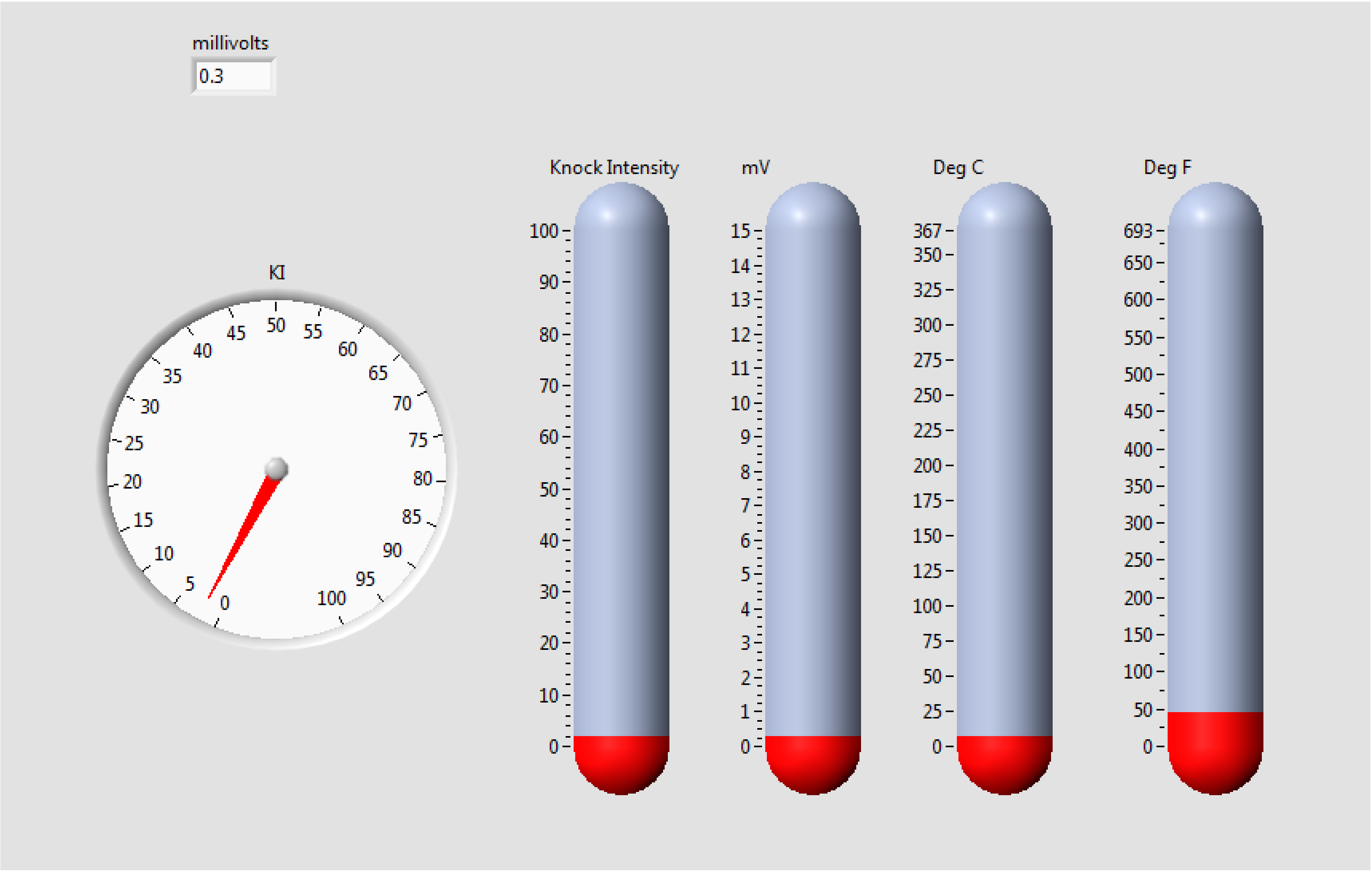

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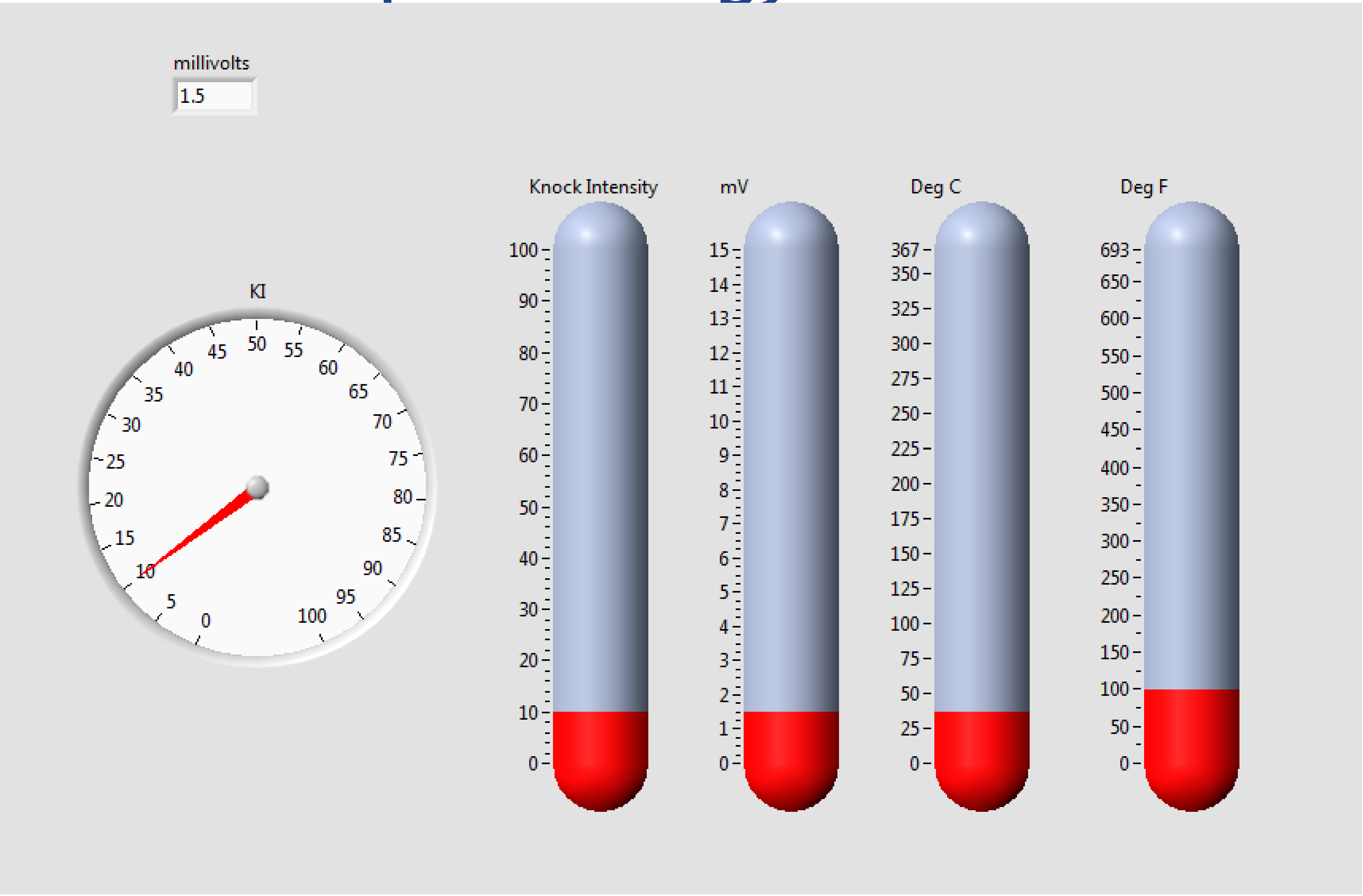

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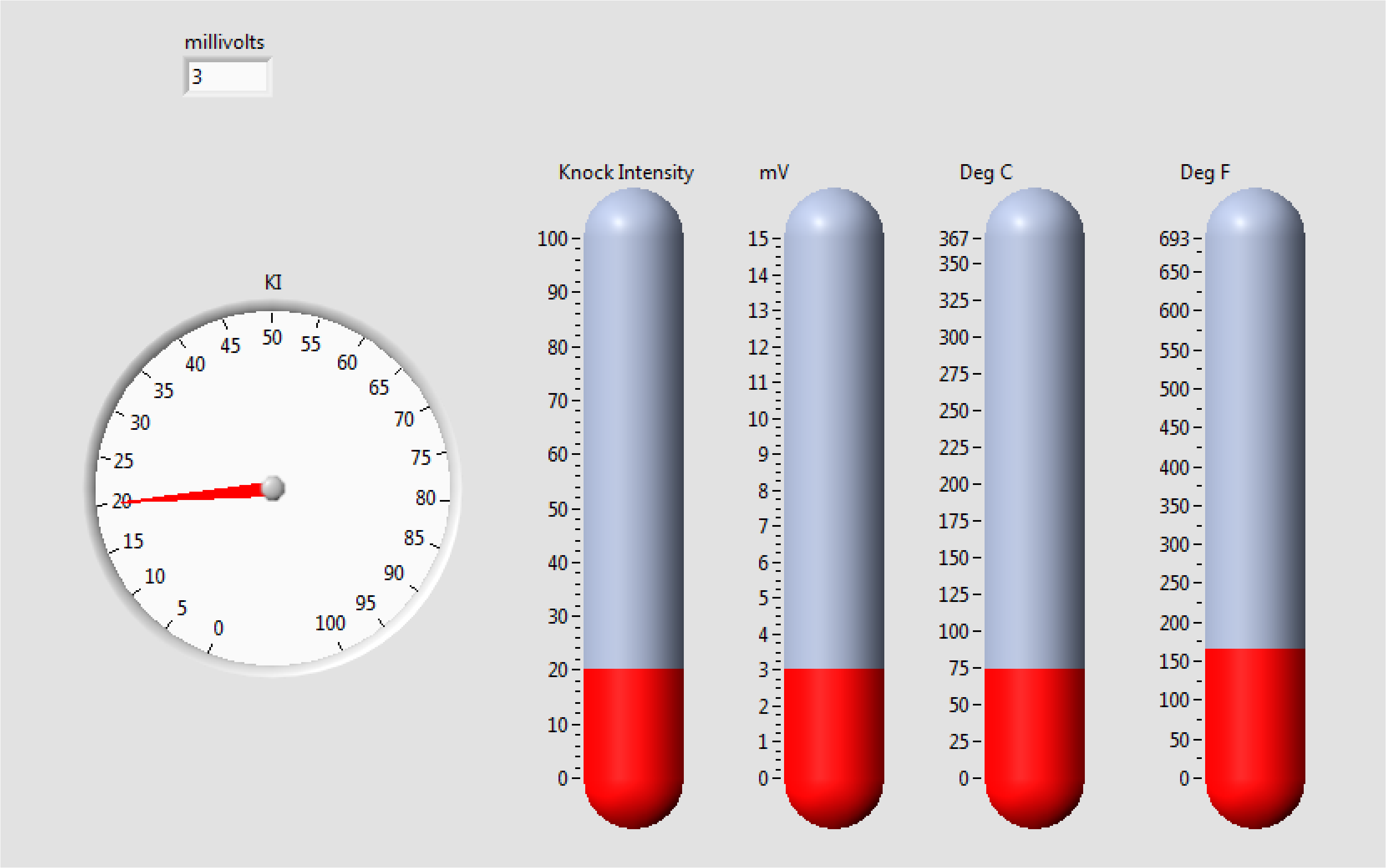

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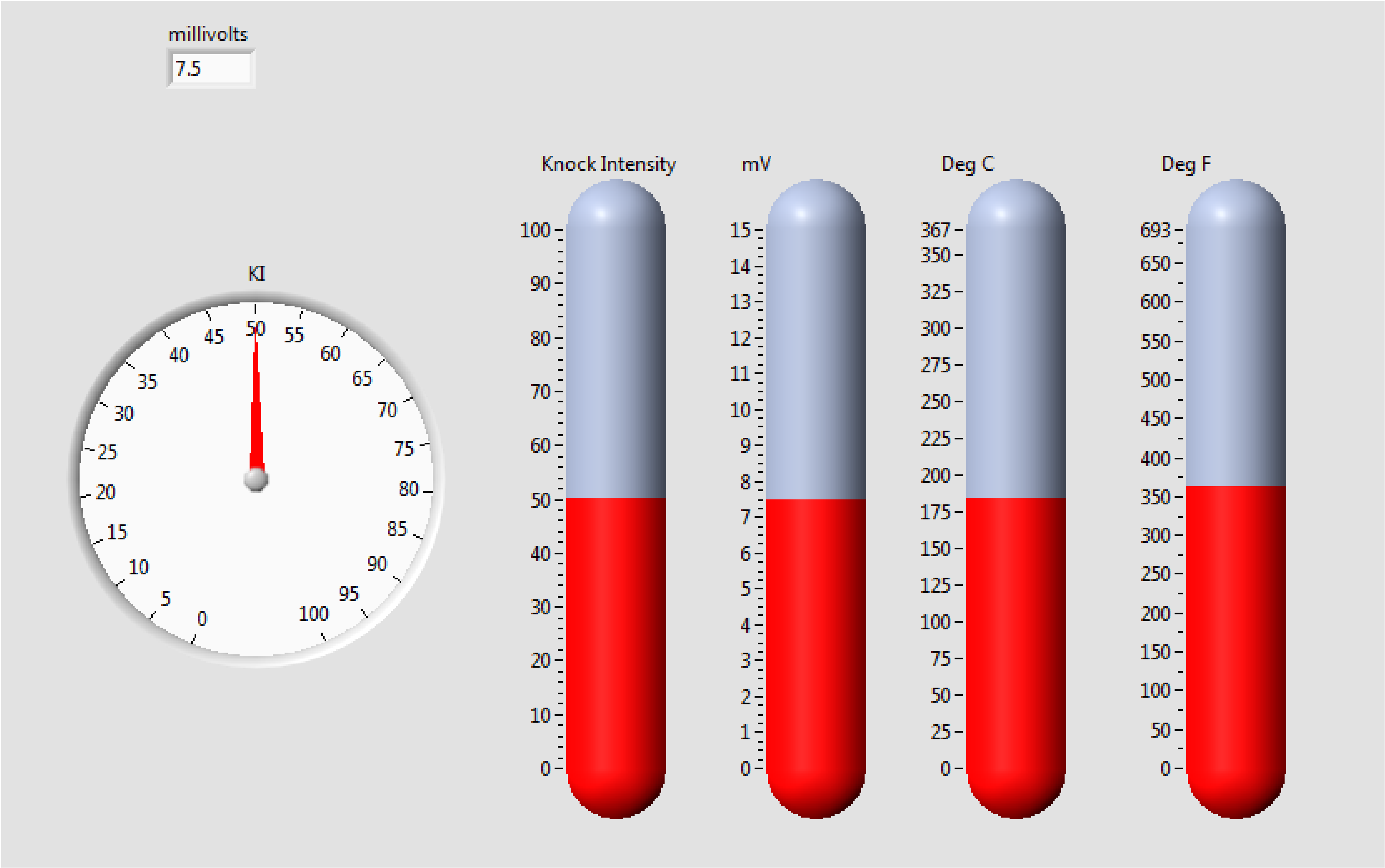

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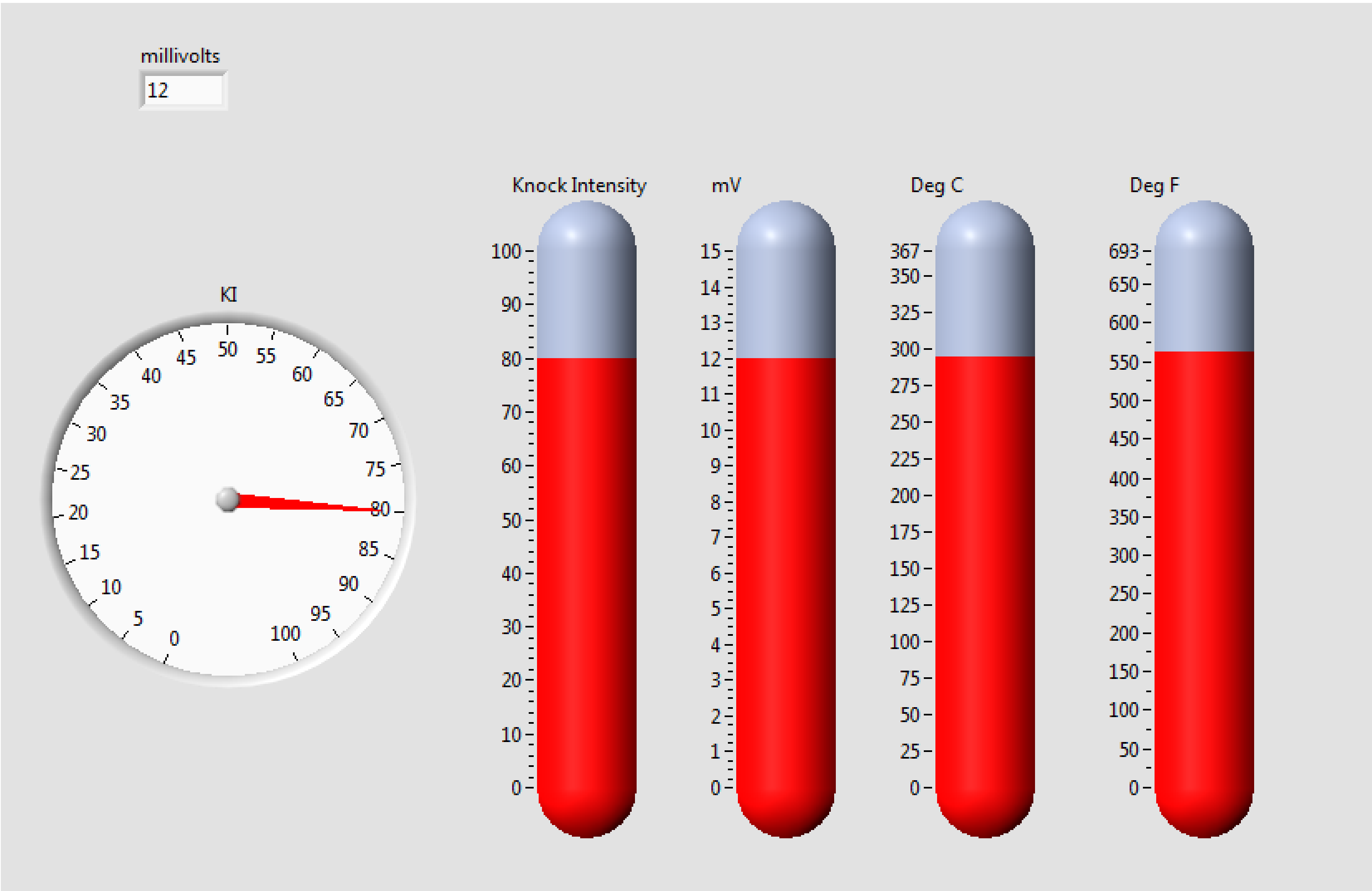

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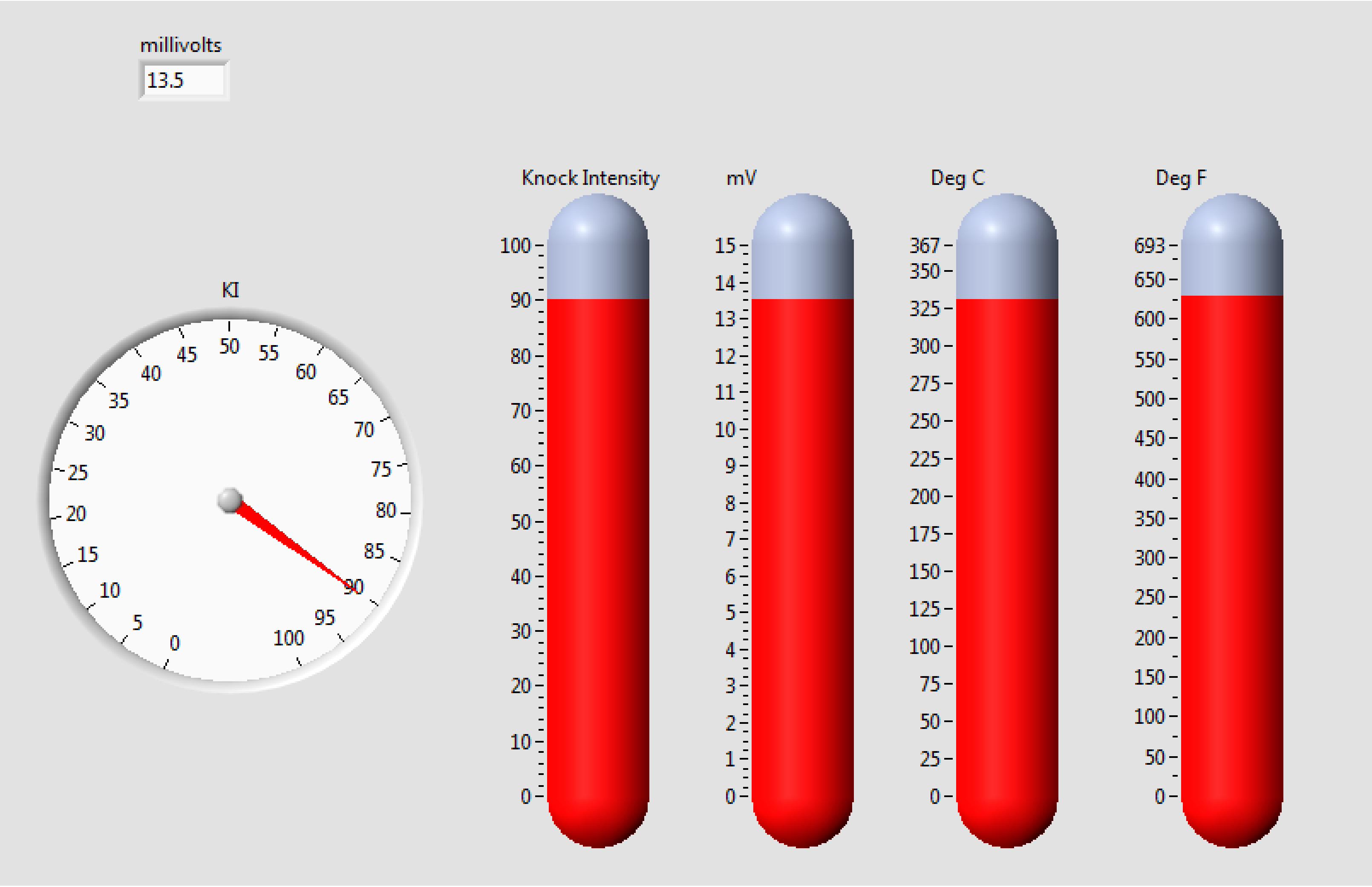

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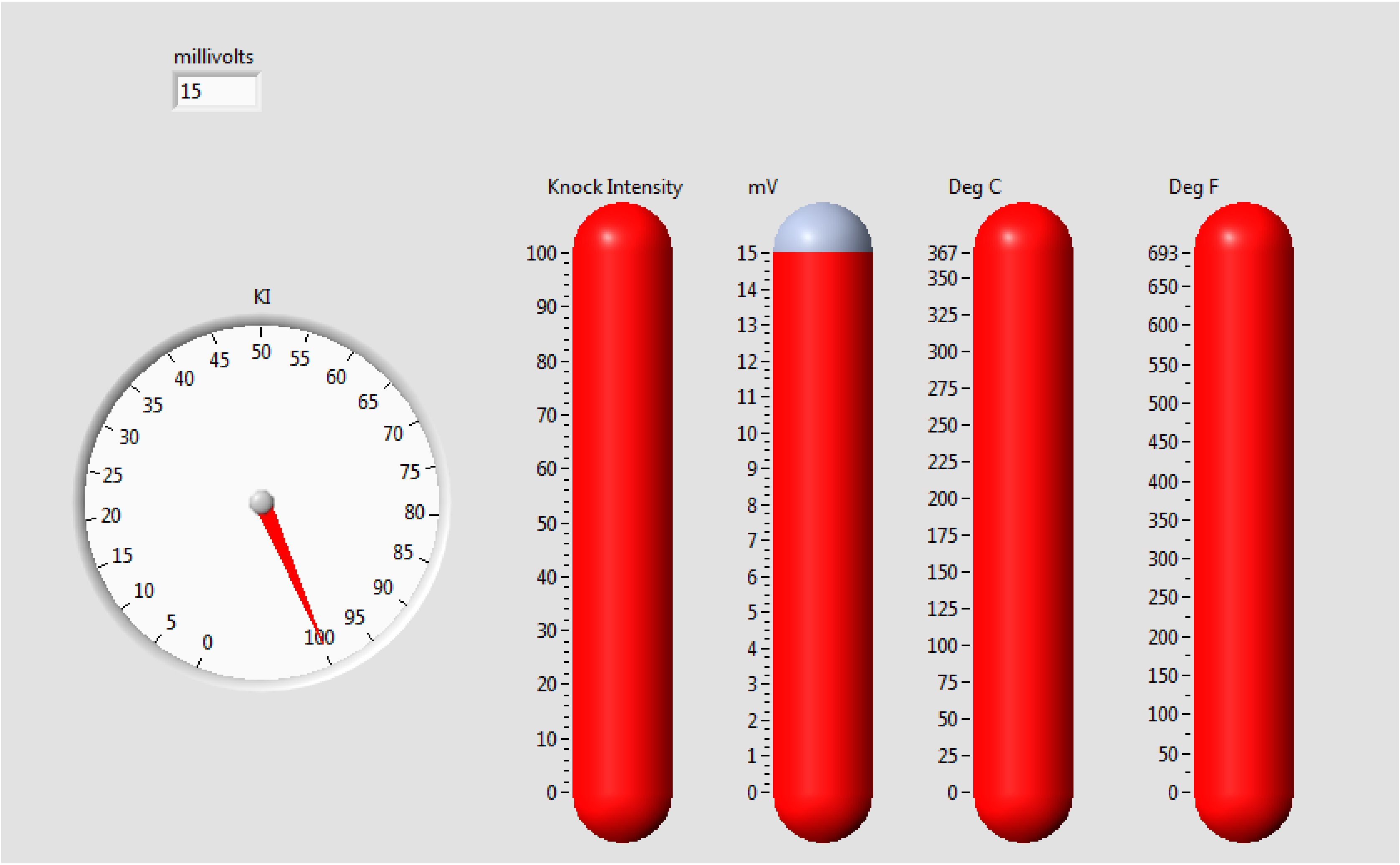

Voltage, Temperature, and KI Perspective:

Would you bet your Octane Rating on a +/- 3.5 deg C reading?

+/- 1 KI = +/- 3.5 deg C

Would you use a 367 deg C thermometer to measure 0 deg C? 36.5 deg C? 73.5 deg C?