

1. Unloaded system with sinusoid

Multimeter

DCV	ACV	Frequency	Period
-00.0017 V	2.848 V	10.000 kHz	99.999 us

Oscilloscope

Average	Peak to Peak	AC RMS	DC RMS	Frequency	Period
-55.1 mV	8.4 V	2.885 V	2.89 V	10.001 kHz	100 us

P-P calculation:

8 cubes by 1.00 V: $8 * 1 = 8V$

Period calculation:

5 blocks for 20 us for one period: $5 * 20 = 100 \text{ us}$

Closeness of $DCV^2 + ACV^2$ to $(DC \text{ RMS})^2$:

$$2.89^2 - (0.0017^2 + 2.848^2) = 0.24$$

Sources of error:

1. Internal resistance of the probes
2. Incomplete contact with the probes
3. Systematic errors in the machines

2. Loaded system with sinusoid

Multimeter

DCV	ACV	Frequency	Period
-00.001 V	1.406 V	10.001 kHz	99.999 us

Oscilloscope

Average	Peak to Peak	AC RMS	DC RMS	Frequency	Period
-43.3 mV	4.10 V	1.429 V	1.43 V	10.001 kHz	100.43 us

P-P calculation:

$$500 \text{ mV} * 8 \text{ cubes} = 4 \text{ V}$$

Period calculation:

$$20 \text{ us} * 5 \text{ blocs} = 100 \text{ us}$$

Closeness:

$$1.43^2 - (0.001^2 + 1.406^2) = 0.068$$

Sources of error:

1. Internal resistance of the wires/resistors/breadboard
2. Incomplete contact with the probes
3. Systematic errors in the machines

3. 0V offset, 50% duty cycle

Multimeter

DCV	ACV	Frequency	Period
-00.0005 V	1.976 V	10.0001 kHz	99.999 us

Oscilloscope

Average	Peak to Peak	AC RMS	DC RMS	Frequency	Period
-43.5 mV	4.32 V	2.02 V	2.02 V	10.000 kHz	99.999 us

P-P calculation:

$$4 \text{ blocks} * 1.0 \text{ V} = 4 \text{ V}$$

Period calculation:

$$5 \text{ blocks} * 20 \text{ us} = 100 \text{ us}$$

Closeness of $\text{DCV}^2 + \text{ACV}^2$ to $(\text{DC RMS})^2$:

$$2.02^2 - (0.0005^2 + 1.976^2) = 0.175$$

Sources of error:

1. Internal resistance of the wires/resistors/breadboard
2. Incomplete contact with the probes
3. Systematic errors in the machines

4. 2V offset, 50% duty cycle

Multimeter

DCV	ACV	Frequency	Period
1.990 V	1.974 V	10.001 kHz	99.999 us

Oscilloscope

Average	Peak to Peak	AC RMS	DC RMS	Frequency	Period
1.95 V	4.32 V	2.017 V	2.80 V	10.000 kHz	99.998 us

P-P calculation:

$$4 \text{ blocks} * 1.0 \text{ V} = 4 \text{ V}$$

Period calculation:

$$5 \text{ blocks} * 20 \text{ us} = 100 \text{ us}$$

Closeness of $\text{DCV}^2 + \text{ACV}^2$ to $(\text{DC RMS})^2$:

$$2.80^2 - (1.99^2 + 1.974^2) = -0.01$$

Sources of error:

1. Internal resistance of the wires/resistors/breadboard
2. Incomplete contact with the probes
3. Systematic errors in the machines

5. 2V offset, 10% duty cycle

Multimeter

DCV	ACV	Frequency	Period
0.4 V	1.174 V	10.001 kHz	99.999 us

Oscilloscope

Average	Peak to Peak	AC RMS	DC RMS	Frequency	Period
356.2 mV	4.30 V	1.211 V	1.263 V	10.000 kHz	99.998 us

P-P calculation:

$$4 \text{ blocks} * 1.0 \text{ V} = 4 \text{ V}$$

Period calculation:

$$5 \text{ blocks} * 20 \text{ us} = 100 \text{ us}$$

Closeness of $\text{DCV}^2 + \text{ACV}^2$ to $(\text{DC RMS})^2$:

$$1.263^2 - (0.4^2 + 1.174^2) = 0.056$$

Sources of error:

1. Internal resistance of the wires/resistors/breadboard
2. Incomplete contact with the probes
3. Systematic errors in the machines