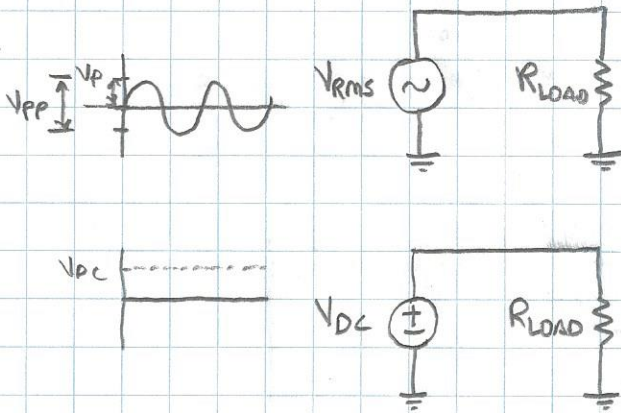


W2AEW

RMS VOLTAGE

- THE MEASURE OF THE MAGNITUDE OF AN AC VOLTAGE THAT WILL DELIVER THE SAME POWER TO A LOAD AS AN EQUIVALENT DC VOLTAGE.



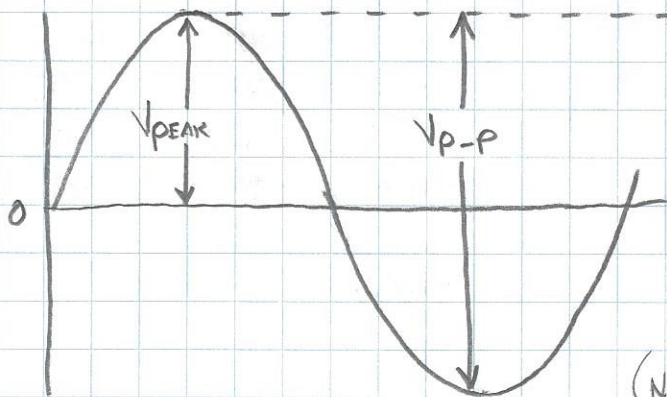
- FOR DC, POWER CALCULATION IS EASY...

$$P_{LOAD} = V_{DC}^2 / R_{LOAD}$$

FOR $V_{DC} = 5V$ & $R_{LOAD} = 1K\Omega$

$$P_{LOAD} = 5^2 / 1000 = 25mW$$

- FOR AC SIGNALS, IT ISN'T SO EASY...



FOR SINE WAVES

$$V_{RMS} = V_{PEAK} / \sqrt{2}$$

$$= V_{PEAK} * 0.7071$$

(NOT THE AVERAGE)

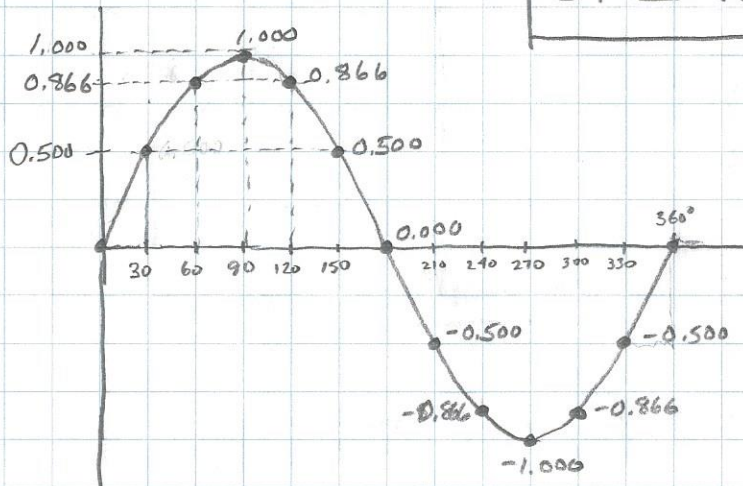
ALL DMMs SHOULD
MEASURE THIS FINE
(WITH FREQ. LIMITS)

RMS A PRACTICAL LOOK ...

RMS = ROOT - MEAN - SQUARE

"THE SQUARE ROOT OF THE AVERAGE OF THE SQUARES"

SINE WAVES



PHASE	V	V ²
0	0.000	0.000
30	0.500	0.250
60	0.866	0.750
90	1.000	1.000
120	0.866	0.750
150	0.500	0.500
180	0.000	0.000
210	-0.500	0.250
240	-0.866	0.750
270	-1.000	1.000
300	-0.866	0.750
330	-0.500	0.250
360	0.000	0.000

(FIRST POINT OF NEXT CYCLE)

CALCULATE R-M-S

- ① COMPUTE THE SQUARES
- ② COMPUTE THE MEAN (AVERAGE) OF THE SQUARES

$$\text{MEAN} = \frac{\text{SUM}}{N}$$

$$\text{MEAN} = \frac{6.000}{12} = 0.5$$

- ③ COMPUTE SQUARE ROOT OF THE MEAN

$$V_{\text{RMS}} = \sqrt{\text{MEAN OF SQUARES}}$$

$$= \sqrt{0.5}$$

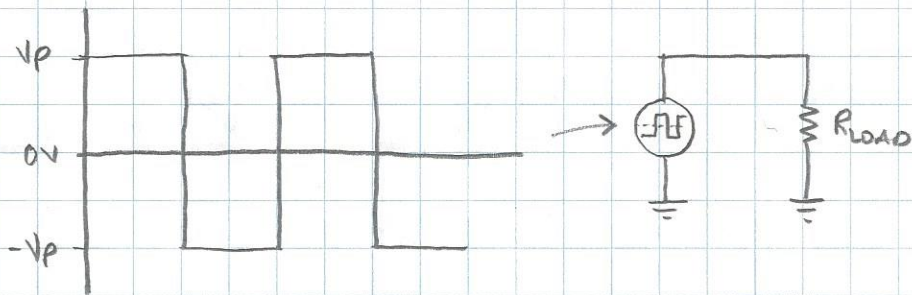
$$V_{\text{RMS}} = 0.7071$$

WZAEW

RMS FOR SQUARE WAVES...

FOR TRUE AC SQUARE WAVES (BALANCED AROUND ZERO)

THE RMS IS TRIVIAL...



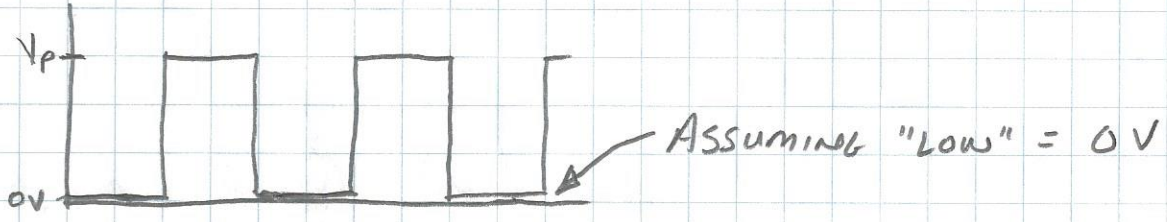
$$\underline{V_{RMS} = V_p} \quad \text{FOR ANY DUTY CYCLE}$$

- BUT WATCH OUT FOR DMM READINGS!

- TRUE RMS METERS OK
(WITHIN THEIR FREQUENCY RANGE)

- NOT TRUE-RMS METERS WILL BE WRONG
(THEY ASSUME 0.7071 FACTOR)

RMS FOR "DIGITAL" WAVEFORMS (LIKE PWM, ETC.)



COMPUTE R-M-S FOR A COMPLETE CYCLE

FOR 50% DUTY CYCLE ...

	V	V ²
OFF	0.000	0.000
ON	V _p	V _p ²

① COMPUTE SQUARES

② COMPUTE MEAN OF

$$\frac{V_p^2 + 0.000}{2} = \frac{V_p^2}{2}$$

OR

$$V_p^2 \cdot \text{DUTY CYCLE}$$

③ COMPUTE SQUARE ROOT OF

$$V_{RMS} = \sqrt{V_p^2 \cdot \text{DUTY CYCLE}}$$

$$V_{RMS} = V_p \cdot \sqrt{\text{DUTY CYCLE}}$$

FOR 50% DUTY CYCLE

$$V_{AVG} = V_p \cdot 0.500$$

$$V_{RMS} = V_p \cdot 0.7071$$

BUT WATCH OUT FOR DMM READINGS

- MOST DMMs WILL AC-COUPLE THE SIGNAL WHEN SET TO AC AND WILL NOT PROPERLY MEASURE THE ACTUAL RMS VALUE!

- EVEN MOST TRUE-RMS DMMs!

- UNLESS IT MEASURES TRUE RMS AC+DC