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Technical Note - TN26

Current probes droop compensation

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1. Scope

Passive current probes actually are current transformers and thus have a high pass behaviour. So they will not sustain the DC voltage but provide drooping effect that will loose signal with pulse time [1]. In order to have accurate pulse duration measurements, a method to compensate this error is provided according to the following development:

2. Analysis

The effect of the droop of the current transformer can be analysed with the following equation:

$$G(t) = F(t)\,H(t)$$

with

$$F(t) = I e^{-\frac{t}{RC}}$$

$$H(t) = e^{-tD}$$

D = droop factor in s^{-1}

G(t) = measured data with drooping probe

F(t) = real function to extract the pulse width

H(t) = drooping probe function

$$G(t) = I e^{-\frac{t}{RC}} e^{-tD} = I e^{-\frac{t}{\frac{1}{RC}+D}} = e^{-\frac{t}{\tau}} \quad \text{with} \quad \frac{1}{\tau} = \frac{1}{RC} + D$$

We measure the pulse width at half height: $T_m = \tau \ln(2)$

τ is the decay time constant which is the time where the value of the current is $\frac{\hat{I}}{e}$

$$\frac{1}{\ln(2)\tau} = \frac{1}{\ln(2)RC} + \frac{D}{\ln(2)}$$

$$\frac{1}{T_m} = \frac{1}{\ln(2)RC} + \frac{D}{\ln(2)}$$

$T_a = RC\ln(2)$ is the actual pulse length to be extracted with the next calculation:

$$T_a = \frac{T_m}{1 - T_m \frac{D}{\ln(2)}}$$

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3. Examples

The next example is done with real measured data from an intermediate pulse according to MIL-STD-188-125.

Pearson probe model 3025 has a droop of 0.004 %/us (4 %/ms or 4'000 %/s):

The droop in s^{-1} is:	$D = 40\ s^{-1}$	($\tau = 25$ ms)
Measured pulse length is:	$T_m = 3.05$ ms	
Calculated actual pulse length:	$T_a = 3.7$ ms	
Relative difference:	+ 21.3 %	

4. Lower cut-off frequency

The droop and the - 3 dB lower cut-off frequency are related by the following equation:

$$D = 2\pi F_{low}$$

[1]: CT tech note 03-07: droop rate ad lower cut-off frequency, Bergoz Instrumentation, Saint-Genis-Pouilly, France

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