Thermal Transient Computational Information

Software Version 3.2

1. Acquired Data

Symbol	Description
V_n	acquired voltage samples, sampled and quantized V(t)
I_n	acquired current samples, sampled and quantized I(t)
t_n	acquired sample times

2. Thermal Transient Computation

Symbol/Equation	Description
$R_n = V_n/I_n$	sampled bridgewire resistance
$Vcorr_n = R_n * I_{test}$	corrected voltage, I_{test} = requested test current
$P_{VA}(\,), P_{IA}(\,), P_{RA}(\,)$	regression predictors for V(t), I(t) and R(t) computed over $R_A = [t_A, t_A + \Delta t_A]$
$P_{VB}(\,), P_{IB}(\,), P_{RB}(\,)$	regression predictors for V(t), I(t) and R(t) computed over $R_B = [t_{pulse} - t_B - \Delta t_B, t_{pulse} - t_B]$
$V_{TR} = P_{VB}(t_{pulse}) - P_{VA}(t_{TR})$	Thermal Response voltage
$R_0 = P_{RA}(t_{start})$	initial (cold) resistance
$\Delta R = P_{RB}(t_{pulse}) - P_{RA}(t_{start})$	total change resistance. Note that the ΔR change in resistance does not correspond to the V_{TR} change in voltage.
$P_{RA}^{-1}(\,)$	inverse function of P_{RA} predictor
$\tau = P_{RA}^{-1}(P_{RB}(t_{pulse}))$	thermal response time constant

Note: t_A, Δt_A, t_B, Δt_B, t_{TR} are programmable values. Please refer to Figure A.

Default settings:

$t_A = 72.5uS$	$\Delta t_A = 145uS$	$t_{TR} = 100uS$
$t_B = 0uS$	$\Delta t_B = 362.5uS$	

3. Heat Model Analysis

Symbol/Equation	Description
α_{BW}	bridgewire temperature resistance coefficient
$\Theta = \frac{1}{\alpha_{BW}} \cdot \frac{\Delta R}{R_0}$	final bridgewire temperature offset from ambient
$\overline{PA} = [P_{IA}(t_{AMID})]^2 \cdot P_{RA}(t_{AMID})$	average dissipated power over range R_A
Slope(P_{RA}), Slope(P_{RB})	P_{RA} and P_{RB} predictor slopes

(continued on next page)

$$C_P = \frac{E_A}{\Delta T_A} = \frac{\overline{P_A} \cdot \Delta t_A}{\frac{\Delta R_A}{R_0} \cdot \frac{1}{\alpha_{BW}}} = \overline{P_A} \cdot R_0 \cdot \alpha_{BW} \cdot \frac{\Delta t_A}{\Delta R_A} = \alpha_{BW} \frac{\overline{P_A} \cdot R_0}{Slope(P_{RA})}$$

C_P of the bridgewire

$$\overline{P_B} = \frac{E_B}{\Delta t_B} = \frac{C_P \Delta T_B}{\Delta t_B} = CP \frac{\frac{1}{\alpha_{BW}} \cdot \frac{\Delta R_B}{R_0}}{\Delta t_B} = \frac{C_P}{\alpha_{BW} \cdot R_0} Slope(P_{RB})$$

average dissipated power over range R_A

$$\gamma = \frac{\overline{P_A} - \overline{P_B}}{\Theta}$$

thermal conductance in $\left[\frac{Watts}{\deg C}\right]$

$IF_{n,}$ $\left(\frac{dIF}{dt}\right)_n$ filtered I_n and $\left(\frac{dI_n}{dt}\right)_n$, respectively

RF_n, $\left(\frac{dRF}{dt}\right)_n$ filtered R_n and $\left(\frac{dR_n}{dt}\right)_n$, respectively

$$Tn = \left(\frac{RF_n}{R_0} - 1\right) \cdot \frac{1}{\alpha_{BW}} \qquad \left(\frac{dT}{dt}\right)_n = \frac{\left(\frac{dRF_n}{dt}\right)_n}{R_0} \cdot \frac{1}{\alpha_{BW}}$$

bridgewire temperature

$$P_n = IF_n^2 \cdot RF_n$$

total dissipated power

$$Cp_n = \frac{E_n}{\Delta T_n} = \frac{Pn}{\frac{\Delta T_n}{\Delta t_n}} = \left(\frac{dT}{d_t}\right)_n$$

instant C_P of the bridgewire

$$P_{BW_n} = \frac{E_{BWn}}{\Delta T_n} = \frac{CPn \cdot \Delta T_n}{\Delta T_n} = CP_n \cdot \left(\frac{dT}{dt_n}\right)_n$$

power consumed on heating the bridgewire proper

$$P_{PH_n} = P_n - P_{BWn}$$

power dissipated into the rest of the structures

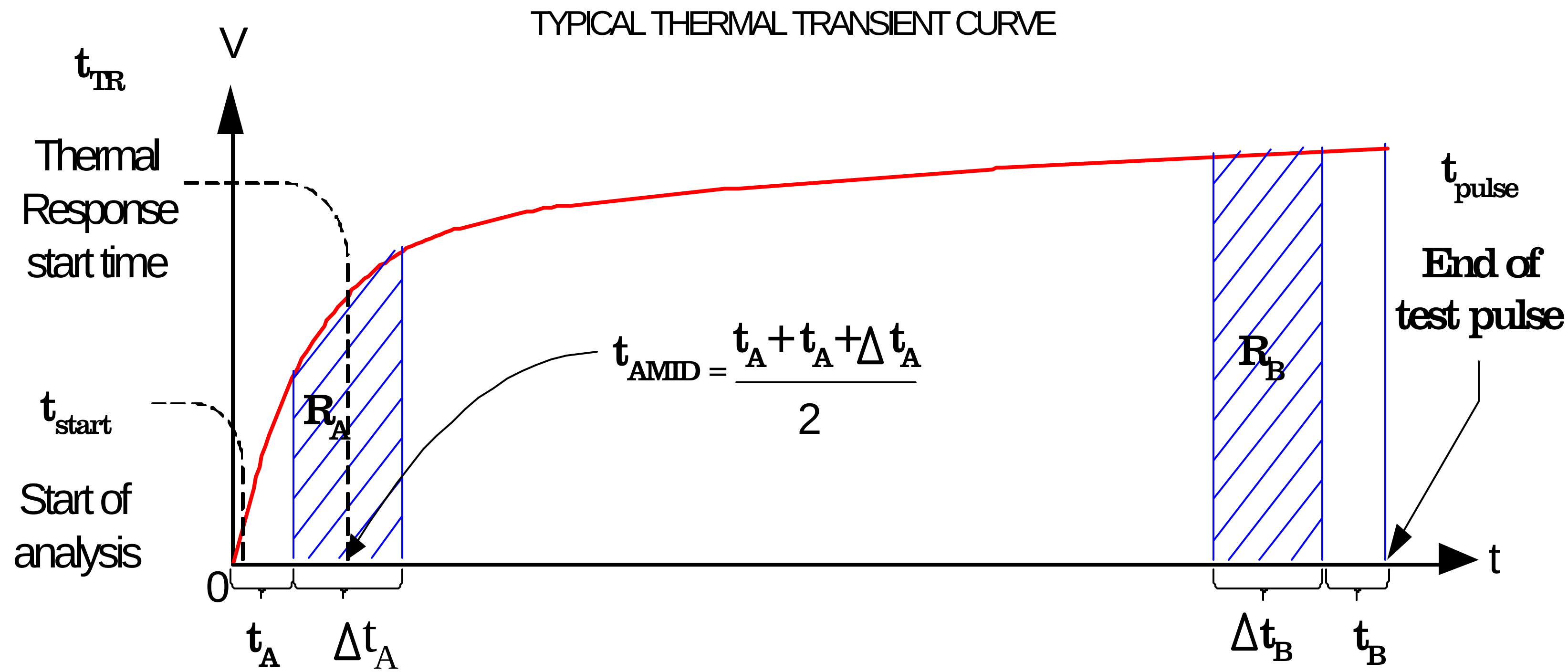

Figure A. Thermal Response Curve Timing