Appendix

Calculation of model parameters based on a linear regression

The steady-state equations (equations 10 and 11) can be rewritten as

$$\lim_{t\to\infty}\omega_m(t) = C_1 * A - C_2 \qquad [A1]$$

$$\lim_{t\to\infty}\tau_m(t) = C_3 * A - C_4 \qquad [A2]$$

where A is the magnitude of the step in put in volts and the equations describing the coefficients, C_1 through C_4, are as follows

$$C_1 = \frac{\kappa}{B_m + K_b * \kappa} \qquad [A3]$$

$$C_2 = \frac{T_m}{B_m + K_b * \kappa} \qquad [A4]$$

$$C_3 = \frac{B_m * \kappa}{B_m + K_b * \kappa} \qquad [A5]$$

$$C_4 = \frac{B_m * T_m}{B_m + K_b * \kappa} \qquad [A6]$$

thus providing four equations for the five unknown parameters. Therefore, at least one more independent coefficient (i.e. equation) is required to solve for the five unknown parameters. Using the results from the linear regression analysis of the steady-state response and performing a logarithmic transformation on the transient equations, equations 6 and 7 can be rewritten as

$$\omega_m(t) = (C_1 * A - C_2) * [1 - \exp(-C_5 * t)] \qquad [A7]$$

$$\tau_m(t) = C_6 * \exp(-C_5 * t) + C_3 * A - C_4 \qquad [A8]$$

where the equations describing the coefficients, C_5 and C_6, are as follows

$$C_5 = \frac{B_m + K_b * \kappa}{J_m} \qquad [A9]$$

$$C_6 = \left(A * \kappa - T_m\right) * \left(1 - \frac{B_m}{B_m + K_b * \kappa}\right) \qquad [A10]$$

Upon initial inspection, it may appear that any five of the six equations describing the coefficients may be selected in order to calculate the five parameters. However, upon further analysis it can be seen that only two sets of equations give explicit solutions. The two sets are (A3), (A5), (A6), (A9), (A10) and (A3), (A4), (A5), (A9), (A10). Note that this method assumes that the transient and steady-state responses are obtained from two independent processes, however, they are obtained from the same process. This is a weakness of the linear regression analysis.