Synapse as difference of 2 exponentials:

$$g_e(t) = \bar{g}_{AMPA}(e^{-\frac{t}{\tau_{e_d}}} - e^{-\frac{t}{\tau_{e_r}}}) \tag{1}$$

$$g_i(t) = \bar{g}_{GABA}(e^{-\frac{t-\delta}{\tau_{i_d}}} - e^{-\frac{t-\delta}{\tau_{i_r}}}) \tag{2}$$

Total conductance equation due to AMPA and GABA:

$$I_{syn}(t) = (E_{AMPA} - V_m)g_e(t) - (E_{GABA} - V_m)g_i(t) \tag{3}$$

Correspoding PSP equation:

$$\frac{dV_m}{dt} = \frac{1}{C_m}[(E_{leak} - V_m(t))g_{leak} + I_{syn}(t)] \tag{4}$$

At inflextion points, $\frac{dV_m}{dt} = 0$. Therefore,

$$(E_{leak} - V_m(t^*))g_{leak} + I_{syn}(t^*) = 0 \tag{5}$$

We know that there should be 2 inflexion points in the PSP from data (one higher and one lower than V_rest. Maybe I can use that information to constrain.

$$(E_{leak} - V_m(t^*))g_{leak} + (E_{AMPA} - V_m(t^*))g_e(t^*) - (E_{GABA} - V_m(t^*))g_i(t^*) = 0 \tag{6}$$

Using equations (1) and (2) in (6), and renaming $V_m(t^*)$ as V_m^* and E_{AMPA} and E_{AMPA} as E_e and E_i respectively and rearranging,

$$V_m^* = -\left[\frac{I_{leak} + \bar{I}_e(e^{-\frac{t^*}{\tau_{e_d}}} - e^{-\frac{t^*}{\tau_{e_r}}}) - \bar{I}_i(e^{-\frac{t^*-\delta}{\tau_{i_d}}} - e^{-\frac{t^*-\delta}{\tau_{i_r}}})}{g_{leak} + \bar{g}_e(e^{-\frac{t^*}{\tau_{e_d}}} - e^{-\frac{t^*}{\tau_{e_r}}}) - \bar{g}_i(e^{-\frac{t^*-\delta}{\tau_{i_d}}} - e^{-\frac{t^*-\delta}{\tau_{i_r}}})}\right] \tag{7}$$

When Gabazine is put in the bath, the inhibitory component of this equation is lost.

$$V_m^*(e) = -\left[\frac{I_{leak} + \bar{I}_e(e^{-\frac{t^*}{\tau_{e_d}}} - e^{-\frac{t^*}{\tau_{e_r}}})}{g_{leak} + \bar{g}_e(e^{-\frac{t^*}{\tau_{e_d}}} - e^{-\frac{t^*}{\tau_{e_r}}})}\right] \tag{8}$$

Now, for divisive normalization,

$$V_m^* = \frac{1}{f(e)}V_m^*(e) \tag{9}$$

where $f(E)$ is some linearly increasing function in E.

Or, $\frac{V_m^*(e)}{V_m^*} = f(e)$

From 7,8 and 9,

$$f(e) = \left[\frac{1 - \frac{\bar{g}_i(e^{-\frac{t^*-\delta}{\tau_{i_d}}} - e^{-\frac{t^*-\delta}{\tau_{i_r}}})}{g_{leak} + \bar{g}_e(e^{-\frac{t^*}{\tau_{e_d}}} - e^{-\frac{t^*}{\tau_{e_r}}})}}{1 - \frac{\bar{I}_i(e^{-\frac{t^*-\delta}{\tau_{i_d}}} - e^{-\frac{t^*-\delta}{\tau_{i_r}}})}{I_{leak} + \bar{I}_e(e^{-\frac{t^*}{\tau_{e_d}}} - e^{-\frac{t^*}{\tau_{e_r}}})}}\right] \tag{10}$$

The above equation is of the form $\frac{1-y}{1-x}$. For it to increase linearly in E,

1. $y \leq x$
2. It must be of the form $y = f(e)x - (f(e) - 1)$