Battery Charger_UCC25600 Calculations

$Vin := 800\ V$
$Vin\_max := 850\ V$
$Vin\_min := 750\ V$
$Vo := 30\ V$
$Vo\_max := 30\ V$
$Vo\_min := 30\ V$
$Io := 20\ A$
$Mg := 1$
$fo := 100\ kHz$
$Vloss := 1.05\ V$
$Vf := 0.7\ V$
$Qe := 0.5$
$Ln := 3.5$

Transformer Turns Ratio

$$n := \frac{\frac{Vin}{2}}{\frac{Vo}{Mg}}$$

$n = 13.333$

Mg Minimum & Maximum

$$Mg\_minimum := n \cdot \frac{(Vo\_min + Vf)}{\frac{Vin\_max}{2}}$$

$Mg\_minimum = 0.963$

$$Mg\_maximum := n \cdot \frac{(Vo\_max + Vf + Vloss)}{\frac{Vin\_min}{2}}$$

$Mg\_maximum = 1.129$

Equivalent Load Resistance

$$Re\_fl := \left(8 \cdot \frac{n^2}{\pi^2}\right) \cdot \left(\frac{Vo}{Io}\right)$$

$$Re\_fl = 216.152\ \Omega$$

$$Re\_ol := \left(8 \cdot \frac{n^2}{\pi^2}\right) \cdot \left(\frac{Vo}{Io \cdot 110\%}\right)$$

$$Re\_ol = 196.502\ \Omega$$

Resonant Circuit Design

$$Cr := \frac{1}{2\ \pi \cdot Qe \cdot fo \cdot Re\_fl}$$

$$Cr = 14.726\ nF$$

Selected Part: B32672L8153J

$$Lr := \frac{1}{(2\ \pi \cdot fo)^2 \cdot Cr}$$

$$Lr = 172.008\ \mu H$$

$$Lr\_actual := 172\ \mu H$$

Selected Part: 732-2284-ND
(Less in stock)

$$Lm := Ln \cdot Lr\_actual$$

$$Lm = 602\ \mu H$$

Verify Resonant Circuit

$$fo\_actual := \frac{1}{2\ \pi \cdot \sqrt{Lr\_actual \cdot Cr}}$$

$$fo\_actual = 100.002\ kHz$$

Inductance ratio

$$Ln\_actual := \frac{Lm}{Lr\_actual}$$

$$Ln\_actual = 3.5$$

Quality factor at full load

$$Qe\_fl := \frac{\sqrt{\frac{Lr\_actual}{Cr}}}{Re\_fl}$$

$$Qe\_fl = 0.5$$

Quality factor at 110% Over load

$$Qe\_ol := \frac{\sqrt{\frac{Lr\_actual}{Cr}}}{Re\_ol}$$

$$Qe\_ol = 0.55$$

It is necessary to understand how Mg behaves as a function of the three factors fn, Ln, and Qe. In the gain function, frequency fn is the control variable. Ln and Qe are dummy variables, since they are fixed after their physical parameters are determined. Mg is adjusted by fn after a design is complete. As such, a good way to explain how the gain function behaves is to plot Mg with respect to fn at given conditions from a family of values for Ln and Qe.

Plot the gain curves corresponding to the design parameters (Fig. 16). The plot shows that the initial design meets the requirements of both
Equation (26) and the following frequency specifications:

- The frequency at series resonance is f0 = 98.364 kHz.
- The frequency at (Mg_min, fsw_max) is fn_max × f0
- The frequency at (Mg_max, fsw_min) with an overload (Qe = 0.52) is fn_min × f0

$fn\_max := 1.2$

$fn\_min := 0.85$

$fr\_Mg\_min\_fsw\_max := fn\_max \cdot fo$

$fr\_Mg\_min\_fsw\_max = 120\ kHz$

$fr\_Mg\_max\_fsw\_min := fn\_min \cdot fo$

$fr\_Mg\_max\_fsw\_min = 85\ kHz$