APPENDIX A

DERIVATION OF MINIMUM INTERFACING INDUCTOR

In practice, a controllable voltage source \( v_t \) is applied to the interfacing inductor \( L_f \) to establish the compensation current \( i_f \) as illustrated by Figure A.1.

\[
v_t = v_s + R_f i_f + L_f \frac{di_f}{dt}
\]  

(A.1)

The terminal voltage and the compensation current can be expressed in terms of their DC and the switching ripple components as

\[
v_t(t) = V_t + v_{sw}(t), \quad i_f(t) = I_f + i_{sw}(t)
\]  

(A.2)

where \( v_{sw}(t) \) and \( i_{sw}(t) \) are the ripple components in \( v_t \) and \( i_f \), respectively. From Eqns.(A.1) and
We know that the ripple current is high frequency component and primarily determined by the interfacing inductor($L_s$). Therefore, $v_s$ and $R_f$ are assumed to have negligible effects. From Eqn.(A.5),

$$v_{sw}(t) \approx L_f \frac{di_{sw}(t)}{dt}$$  \hspace{1cm} (A.6)$$

Figure A.2 shows the voltage ripple $v_{sw}(t)$ and the resulting ripple current $i_{sw}(t)$ using Eqn.(A.6). Assumed that the voltage ripple $v_{sw}(t)$ is represented by the bipolar DC-bus voltage($V_{dc}$ or $-V_{dc}$).

From these waveforms, the peak-to-peak switching ripple can be calculated as
\[
\frac{di_{sw}(t)}{dt} = \frac{v_{sw}(t)}{L_f}
\]

\[
\Delta I_{sw,p-p} = \frac{1}{L_f} \int_0^{T_{sw}/2} v_{sw}(t) \, dt
\]

\[
\Delta I_{sw,p-p} = \frac{V_{dc} T_{sw}}{2L_f}
\]

\[
\Delta I_{sw,p-p} = \frac{V_{dc}}{2L_f f_{sw}}
\]  \quad (A.7)

From (A.7), the minimum interfacing inductor \((L_{f,min})\) can be derived as

\[
L_{f,min} = \frac{V_{dc}}{2(\Delta I_{sw,p-p}) f_{sw,\text{max}}}
\]  \quad (A.8)

where \(f_{sw,\text{max}}\) is maximum frequency of switching ripple and \(\Delta I_{sw,p-p}\) is the peak-to-peak switching ripple of compensation current.