Divergent Box Integral 14: $I_4^{\{D=4-2\epsilon\}}(m_2^2, m_2^2, m_4^2, m_4^2; s_{12}, s_{23}; 0, m_2^2, 0, m_4^2)$

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We can calculate this doubly IR divergent box integral from Eq. (2.13) of ref.[**?**], using the simple replacement rule $\ln\lambda^2 \to \frac{r_\Gamma}{\epsilon} + \ln\mu^2$. We obtain

$$
\begin{aligned}
I_4^{\{D=4\}}(m_2^2, m_2^2, m_4^2, m_4^2; t, s; 0, m_2^2, 0, m_4^2) &= \frac{-2}{m_2 m_4 t} \frac{x_s \ln(x_s)}{1-x_s^2}\left[\frac{1}{\epsilon} + \ln\left(\frac{\mu^2}{-t}\right)\right], \quad s-(m_2-m_4)^2 \neq 0 \\
&= \frac{1}{m_2 m_4 t}\left[\frac{1}{\epsilon} + \ln\left(\frac{\mu^2}{-t}\right)\right], \quad s-(m_2-m_4)^2 = 0
\end{aligned}
$$

Note the reversal of the arguments s and t to conform with the notation of ref. [**?**]. The variable x_s is defined in terms of the function K, such that $x_s = -K(s+i\varepsilon, m_2, m_4)$ and K is given by

$$
\begin{aligned}
K(z,m,m') &= \frac{1-\sqrt{1-4mm'/[z-(m-m')^2]}}{1+\sqrt{1-4mm'/[z-(m-m')^2]}} \qquad z \neq (m-m')^2 \\
K(z,m,m') &= -1 \qquad z = (m-m')^2
\end{aligned}
$$

References

[1] W. Beenakker and A. Denner, Nucl. Phys. B **338**, 349 (1990). Inspire