where

$$
\begin{aligned}
I_1 &= -4s\operatorname{Re}\int_\Omega i\partial_t z\left(\nabla_y\varphi\cdot\nabla_y\overline{z}-\nabla_x\varphi\cdot\nabla_x\overline{z}\right)dxdydt,\\
I_2 &= -2s\operatorname{Re}\int_\Omega i\partial_t z\left(\Delta_y\varphi-\Delta_x\varphi\right)\overline{z}dxdydt,\\
I_3 &= -4s\operatorname{Re}\int_\Omega \Delta_y z\left(\nabla_y\varphi\cdot\nabla_y\overline{z}-\nabla_x\varphi\cdot\nabla_x\overline{z}\right)dxdydt,\\
I_4 &= -2s\operatorname{Re}\int_\Omega \Delta_y z\left(\Delta_y\varphi-\Delta_x\varphi\right)\overline{z}dxdydt,\\
I_5 &= 4s\operatorname{Re}\int_\Omega \Delta_x z\left(\nabla_y\varphi\cdot\nabla_y\overline{z}-\nabla_x\varphi\cdot\nabla_x\overline{z}\right)dxdydt,\\
I_6 &= 2s\operatorname{Re}\int_\Omega \Delta_x z\left(\Delta_y\varphi-\Delta_x\varphi\right)\overline{z}dxdydt,\\
I_7 &= -4s^3\operatorname{Re}\int_\Omega \left(\left|\nabla_y\varphi\right|^2-\left|\nabla_x\varphi\right|^2\right)z\left(\nabla_y\varphi\cdot\nabla_y\overline{z}-\nabla_x\varphi\cdot\nabla_x\overline{z}\right)dxdydt,\\
I_8 &= -2s^3\operatorname{Re}\int_\Omega \left(\left|\nabla_y\varphi\right|^2-\left|\nabla_x\varphi\right|^2\right)z\left(\Delta_y\varphi-\Delta_x\varphi\right)\overline{z}dxdydt,
\end{aligned}
$$

and $\overline{z}$ is the conjugate of z.

Now, we shall estimate the terms I_k, $1\leq k\leq 8$, using the integration by parts and the condition $z\left(x,y,\pm T\right)=0$. Then we have

$$
\begin{aligned}
I_1 &= -4s\operatorname{Re}\int_\Omega i\partial_t z\nabla_y\varphi\cdot\nabla_y\overline{z}dxdydt+4s\operatorname{Re}\int_\Omega i\partial_t z\nabla_x\varphi\cdot\nabla_x\overline{z}dxdydt\\
&= -2s\operatorname{Im}\int_\Omega z\partial_t(\nabla_y\varphi)\cdot\nabla_y\overline{z}dxdydt-2s\operatorname{Im}\int_{\Gamma_y} z\partial_t\overline{z}\left(\nabla_y\varphi\cdot\nu\right)dS_ydxdt\\
&\quad +2s\operatorname{Im}\int_\Omega z\Delta_y\varphi\partial_t\overline{z}dxdydt+2s\operatorname{Im}\int_\Omega z\partial_t(\nabla_x\varphi)\cdot\nabla_x\overline{z}dxdydt\\
&\quad +2s\operatorname{Im}\int_{\Gamma_x} z\partial_t\overline{z}\left(\nabla_x\varphi\cdot\nu\right)dS_xdydt-2s\operatorname{Im}\int_\Omega z\Delta_x\varphi\partial_t\overline{z}dxdydt. \qquad (3.14)
\end{aligned}
$$

In (3.14), we used the equality $\operatorname{Re}(iz)=-\operatorname{Im}(z)$ and $\operatorname{Im}(z)-\operatorname{Im}(\bar{z})=2\operatorname{Im}(z)$, where $\operatorname{Im}(z)$ denotes the imaginary part of $z\in\mathbb{C}$.

$$
\begin{aligned}
I_2 &= -2s\operatorname{Re}\int_\Omega i\partial_t z\overline{z}\left(\Delta_y\varphi-\Delta_x\varphi\right)dxdydt\\
&= -2s\operatorname{Im}\int_\Omega \partial_t\overline{z}z\left(\Delta_y\varphi-\Delta_x\varphi\right)dxdydt. \qquad (3.15)
\end{aligned}
$$