

1 Protocol

1.1 Setup(l) \rightarrow (mpk , msk)

$p \leftarrow \|\mathbb{G}\|$
 generate $g \in \mathbb{G}_1$ randomly
 $H_1 : \{0, 1\}^* \rightarrow \mathbb{G}_1$
 $H_2 : \{0, 1\}^* \rightarrow \mathbb{G}_2$
 $\hat{H} : \{0, 1\}^* \rightarrow \{0, 1\}^\lambda$
 generate $g_0, g_1 \in \mathbb{G}_1$ randomly
 generate $w, \alpha, t_1, t_2 \in \mathbb{Z}_p^*$
 $\Omega \leftarrow e(g, g)^w$
 $v \leftarrow g^{t_1}$
 $v \leftarrow g^{t_2}$
 $mpk \leftarrow (p, g, g_0, g_1, v_1, v_2, \Omega, H_1, H_2, \hat{H})$
 $msk \leftarrow (w, \alpha, t_1, t_2)$
return (mpk , msk)

1.2 EGen(id_S) $\rightarrow ek_{id_S}$

$ek_{id_S} \leftarrow H_1(id_S)$
return ek_{id_S}

1.3 DGen(id_R) $\rightarrow dk_{id_R}$

generate $r \in \mathbb{Z}_p^*$ randomly
 $dk_0 \leftarrow H_2(id_R)^\alpha$
 $dk_1 \leftarrow g^r$
 $dk_2 \leftarrow g^{-\frac{w}{t_1}} (g_0 g_1^{id_R})^{-\frac{r}{t_1}}$
 $dk_3 \leftarrow g^{-\frac{w}{t_2}} (g_0 g_1^{id_R})^{-\frac{r}{t_2}}$
 $dk_{ID_R} \leftarrow (dk_0, dk_1, dk_2, dk_3)$
return dk_{id_R}

1.4 TGen(id_R) $\rightarrow tk_{id_R}$

generate $k \in \mathbb{Z}_p^*$ randomly
 $tk_1 \leftarrow g^k$
 $tk_2 \leftarrow g^{\frac{1}{t_1}} (g_0 g_1^{id_R})^{-\frac{k}{t_1}}$
 $tk_3 \leftarrow g^{\frac{1}{t_2}} (g_0 g_1^{id_R})^{-\frac{k}{t_2}}$
 $tk_{ID_R} \leftarrow (tk_1, tk_2, tk_3)$
return tk_{id_R}

1.5 Enc(ek_{id_S}, id_{Rev}, m) $\rightarrow ct$

generate $s_1, s_2, \beta \in \mathbb{Z}_p^*$ randomly
 $s = s_1 + s_2$
 $R = \Omega^s$
 $T \leftarrow g^\beta$
 $K \leftarrow e(H_2(id_{Rev}), ek_{id_S} \cdot T)$
 $ct_0 \leftarrow \hat{H}(R) \oplus \hat{H}(K) \oplus m$

$ct_1 \leftarrow (g_0 g_1^{id_{Rev}})^s$
 $ct_2 \leftarrow v_1^{s_1}$
 $ct_3 \leftarrow v_2^{s_2}$
 $e(g, g)^s$
 $ct \leftarrow (ct_0, ct_1, ct_2, ct_3, T, V)$
return ct

1.6 $\text{Dec}(dk_{id_R}, id_{Rev}, id_{Snd}, ct) \rightarrow m$

$R' \leftarrow e(dk_1, ct_1) \cdot e(dk_2, ct_2) \cdot e(dk_3, ct_3)$
 $K' \leftarrow e(dk_0, H_1(id_{Snd})) \cdot e(H_2(id_R), T)$
 $m \leftarrow ct_0 \oplus \hat{H}(R') \oplus \hat{H}(K')$
return m

1.7 $\text{TVerify}(tk_{id_R}, ct) \rightarrow y, y \in \{0, 1\}$

return $V = e(tk_1, ct_1) \cdot e(tk_2, ct_2) \cdot e(tk_3, ct_3)$