1 SchemeIBMETR

This scheme is only applicable to symmetric groups of prime orders.

1.1 Setup() $\rightarrow (\boldsymbol{mpk}, \boldsymbol{msk})$

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

1.2 EKGen($\boldsymbol{id}_S$) $\rightarrow \boldsymbol{ek}_{\boldsymbol{id}_S}$

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

1.3 DKGen($\boldsymbol{id}_R$) $\rightarrow \boldsymbol{dk}_{\boldsymbol{id}_R}$

```
generate $r \in \mathbb{Z}_r$ 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 TKGen($\boldsymbol{id}_R$) $\rightarrow \boldsymbol{tk}_{\boldsymbol{id}_R}$

```
generate $k \in \mathbb{Z}_r$ 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($\boldsymbol{ek}_{\boldsymbol{id}_S}, \boldsymbol{id}_{\boldsymbol{Rev}}, m$) $\rightarrow \boldsymbol{ct}$

```
generate $s_1, s_2, beta \in \mathbb{Z}_r$ 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 Dec($\boldsymbol{dk_{id_R}}, \boldsymbol{id_{Rev}}, \boldsymbol{id_{Snd}}, \boldsymbol{ct}$) $\rightarrow m$

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

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

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