```mathematica
Z_d_[K_] := Module[{Cs, φ, n, A, s, i, j, k, Δ, G, d1, Z1, Z2, Z3},
    {Cs, φ} = Rot[K]; n = Length[Cs]; A = IdentityMatrix[2 n + 1];
    Cases[Cs, {s_, i_, j_} :> (A[[{i, j}, {i + 1, j + 1}]] += ( -T^s  T^s - 1 ) )];
                                                              (  0     -1    )
    {Δ, G} = Factor@{T^(-Total[φ]-Total[Cs[[All,1]]])/2 Det@A, Inverse@A};
    Z1 =
     Exp[Total[Cases[Cs, {s_, i_, j_} :> Sum[ε^d1 r_{d1,s}[i, j], {d1, d}]]] +
         Sum[ε^d1 γ_{d1,φ[[k]]}[k], {k, 2 n}, {d1, d}] /. γ_{_,0}[_] -> 0];
    Z2 = Expand[F[{}, {}] × Normal@Series[Z1, {ε, 0, d}]] //.
      F[fs_, {es___}] × (f : (r | γ)_ps__[is__])^p_. :>
        F[Join[fs, Table[f, p]], DeleteDuplicates@{es, is}];
    Z3 = Expand[Z2 /. F[fs_, es_] :> Expand[gPair[
            Replace[fs, Thread[es -> Range@Length@es], {2}], Length@es
          ] /. g_{α_,β_} :> G[[es[[α]], es[[β]]]] ] ];
    Collect[{Δ, Z3 /. ε^p_. -> p ! Δ^2 p ε^p}, ε, T2z] ];
```