Multiple dc outputs can be obtained in an inexpensive manner by adding multiple secondary windings and converter secondary-side circuits. The secondary turns ratios are chosen to obtain the desired output voltages.

**Equivalent circuit of a transformer**

- **Ideal transformer**

\[ \frac{v_1}{v_2} = \frac{n_1}{n_2} = \frac{i_2}{i_1} \]

However, in practice, the transformer is not ideal.

**Leakage inductance**

By ignoring \( R_1, R_2, L_1 \), \& \( L_2 \) we come up with:

\[ \frac{i_1}{i_2} = \frac{n_2}{n_1} = \frac{v_2}{v_1} \]

\[ + \frac{i_1}{i_2} = \frac{n_2}{n_1} = \frac{v_2}{v_1} \]
In a well-designed transformer, the impedance of the magnetizing inductance is large in magnitude over the intended range of frequency, such that the magnetizing current $i_m$ has much smaller magnitude than $i_{1t}$. Then $i_m(t) = i_{1t}(t)$, and the transformer behaves nearly as an ideal transformer.

\[ V_1 L_n \to i_1 \to V_2 \]

It should be noted that the magnetizing current $i_m$ and the primary winding current $i_1$ are independent quantities.

The magnetizing inductance must obey all of the usual rules for inductors including the inductor volt-sec equation.

\[ <V_{2n} > = 0 \]
Isolated DC-DC converters: Flyback Converter

The flyback converter is based on the back-bias converter. Its derivation is illustrated in Fig. 1. Fig. 1(a) shows the basic back-bias converter. In Fig. 1(b), the inductor winding is constructed using two wires, with a 1:1 turns ratio. The basic function of the inductor in this case and the parallel windings are equivalent to a single winding constructed of large wire. In Fig. 1(c), the connections between the two windings are broken. One winding is used while the MOSFET Q1 conducts while the other winding is used when diode D1 conducts. The total current in the two windings is unchanged from the circuit of Fig. 1(b), however, the current is now distributed between the winding differently. The magnetic fields inside the inductor in both cases are identical.

We come up with a transformer in the circuit. Fig. 1(d) illustrates the usual configuration of the flyback converter.