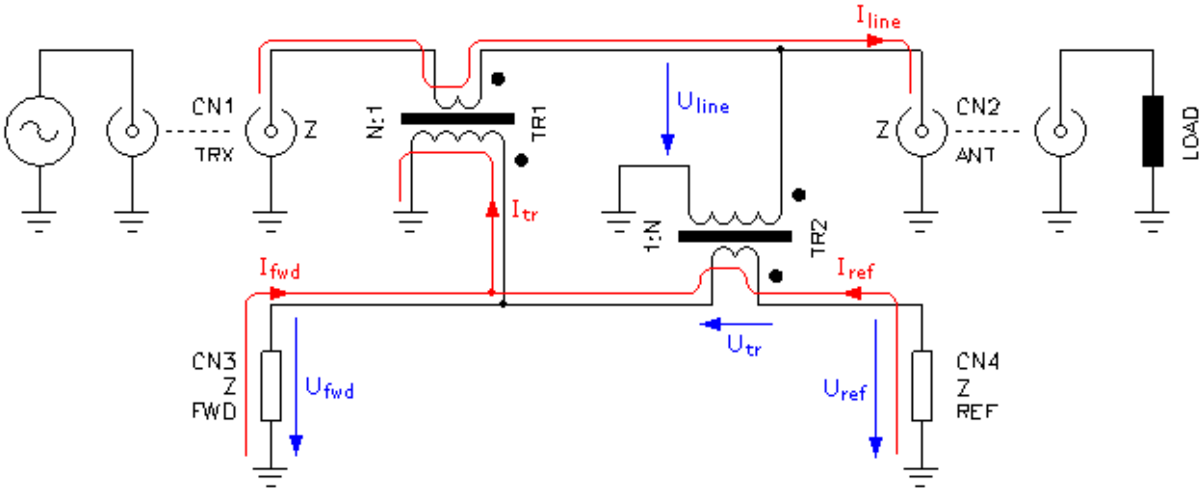
The SWR Bridge

The voltage U_{line} is positive and a current I_{line} is flowing from TRX to ANT.

Two impedances Z are connected to FWD and REF and have the same value of the line impedance Z.



VOLTAGE: TR2 works as a voltage transformer, on its secondary

$$U_{tr} = \frac{U_{line}}{N}$$

The two loads on FWD and REF are connected in series, each one gets half of this induced voltage but with opposite polarity:

$$U_{fwd,U} = -\frac{U_{line}}{2N} \qquad U_{ref,U} = \frac{U_{line}}{2N}$$

These voltages represent the contribution of the voltage transformer to the voltage on FWD and REF.

CURRENT: TR1 works as a current transformer inducing on its secondary a current N times smaller than the main line current

$$I_{tr} = \frac{I_{line}}{N}$$

The wave voltage and wave current are in phase, and their relation is controlled by the line impedance Z. So,

$$I_{line} = \frac{U_{line}}{Z}$$

Or

$$I_{tr} = \frac{I_{line}}{N} = \frac{U_{line}}{NZ}$$

The current that will flow in the ports FWD and REF due to the current transformer is,

$$I_{fwd} = -\frac{I_{line}}{2N} = -\frac{U_{line}}{2NZ} \qquad I_{ref} = -\frac{I_{line}}{2N} = -\frac{U_{line}}{2NZ}$$

Or, in terms of voltages,

$$U_{fwd,I} = -\frac{U_{line}}{2N} \qquad U_{ref,I} = -\frac{U_{line}}{2N}$$

The current and voltage contribution at FWD is,

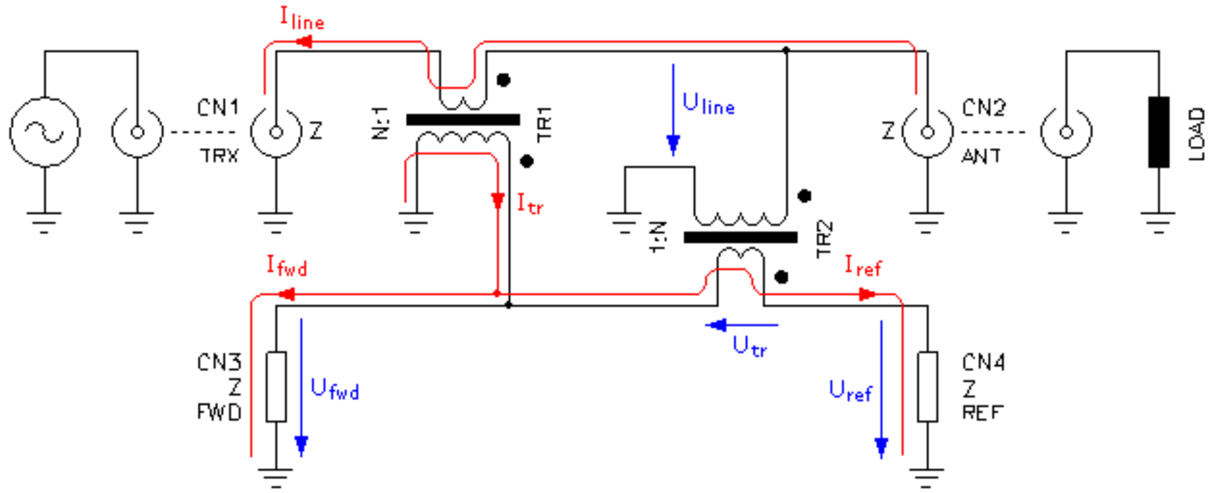
$$U_{fwd} = U_{fwd,U} + U_{fwd,I} = -\frac{U_{line}}{2N} - \frac{U_{line}}{2N} = -\frac{U_{line}}{N}$$

And at REF,

$$U_{ref} = U_{ref,U} + U_{ref,I} = \frac{U_{line}}{2N} - \frac{U_{line}}{2N} = 0$$

So, when a wave travels from TRX to ANT, no voltage appears on REF and a voltage stepped down N times appears on FWD. The minus sign tells us that the voltage on FWD is 180° out of phase from the line voltage.

If we look now at the reflected wave, the voltage has still the same sign, but the current flows in the opposite direction,



This time we have at FWD:

$$U_{fwd} = U_{fwd,U} + U_{fwd,I} = \frac{U_{line}}{2N} - \frac{U_{line}}{2N} = 0$$

And at REF:

$$U_{ref} = U_{ref,U} + U_{ref,I} = -\frac{U_{line}}{2N} - \frac{U_{line}}{2N} = -\frac{U_{line}}{N}$$

In other words, when a wave travels from ANT to TRX, no voltage appears on FWD and a voltage stepped down N times appears on REF. Again, the minus sign tells us that this signal is 180° out of phase.

If we have a standing wave, on FWD we have a voltage which is an N fraction of the forward wave voltage and on REF we have the same for the reflected wave.

The voltages FWD & REF are loaded with Z = 50R and two AD8307s and used to measure the FWD & REF voltages in dBm.

This is converted to power in mW pFwd and pRef and the SWR calculated from

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p = sqrt( pRef / pFwd)

VSWR = (1 + p) / (1 - p)
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