MEASURING REGULATOR EFFICIENCY OF DC-DC CONVERTERS

In determining converter efficiency, the first thing that must be measured is the total consumed power (PTOTAL). Assuming a DC input voltage, PTOTAL is defined as the total power drawn from the source, which is equal to:

$$PTOTAL = VIN \times IIN\ (AVE)$$

It must be noted that the input current value used in the calculation must be the average value of the waveform (the input current will not be DC or sinusoidal). Because the total power dissipated must be constant from input to output, PTOTAL is also equal to the load power plus the internal regulator power losses:

$$PTOTAL = PLOAD + PLOSSES$$

Measuring (or calculating) the power to the load is very simple, since the output voltage and current are both DC. The load power is found by:

$$PLOAD = VOUT \times ILOAD$$

Measuring the input power drawn from the source is not simple. Although the input voltage to the regulator is DC, the current drawn at the input of a switching regulator is not. If a typical "clip-on" current meter is used to measure the input current, the taken data will be essentially meaningless. The average input current to the regulator can be measured with reasonable accuracy by using a wide-bandwidth current probe connected to an oscilloscope.

The average value of input current can be closely estimated by drawing a horizontal line that divides the waveform in such a way that the area of the figure above the line will equal the "missing" area below the line. In this way, the "average" current shown is equivalent to the value of DC current that would produce the same input power.
If more exact measurements are needed, it is possible to force the current in the line

going to the input of the DC-DC converter to be DC by using an L-C filter between the power source and the input of the converter If the L-C filter components are adequate, the current coming from the output of the DC power supply will be DC current (with no high-frequency switching component) which means it can be accurately measured with a cheap clip-on ammeter and digital volt meter.

It is essential that a large, low-ESR capacitor be placed at CIN to support the input of the switching converter. The L-C filter that the converter sees looking back into the source presents a high impedance for switching current, which means CIN is necessary to provide the switching current required at the input of the converter.

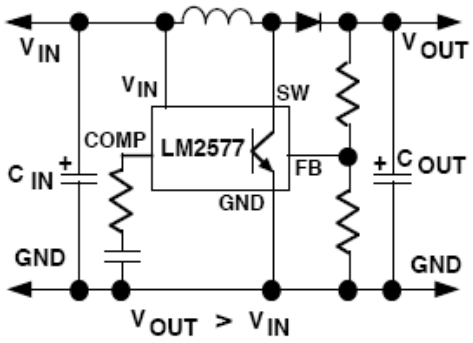
Measuring Regulator Efficiency of Off-Line Converters:

Off-Line converters are powered directly from the AC line, by using a bridge rectifier and capacitive filter to generate an unregulated DC voltage for conversion.
Measuring the total power drawn from the AC source is fairly difficult because of the power factor. If both the voltage and current are sinusoidal, power factor is defined as the cosine of the phase angle between the voltage and current waveforms.

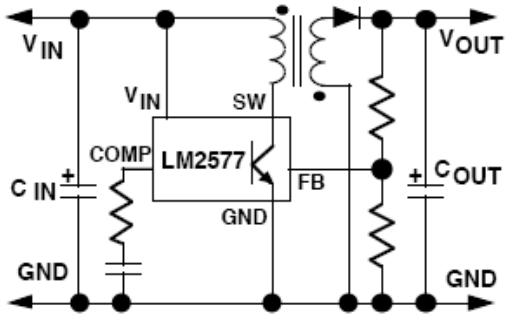
The capacitive-input filter in an off-line converter causes the input current to be very non-sinusoidal. The current flows in narrow, high-amplitude pulses (called Haversine pulses) which requires that the power factor be re-defined in such cases.
For capacitive-input filter converters, power factor is defined as:

P.F. = PREAL / PAPPARENT

LM 2577: An Example of a Complete FlyBack/ Boost Regulator IC



BOOST REGULATOR



FLYBACK REGULATOR

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