FREQUENCY MODULATION ON L4981B

Devices Description

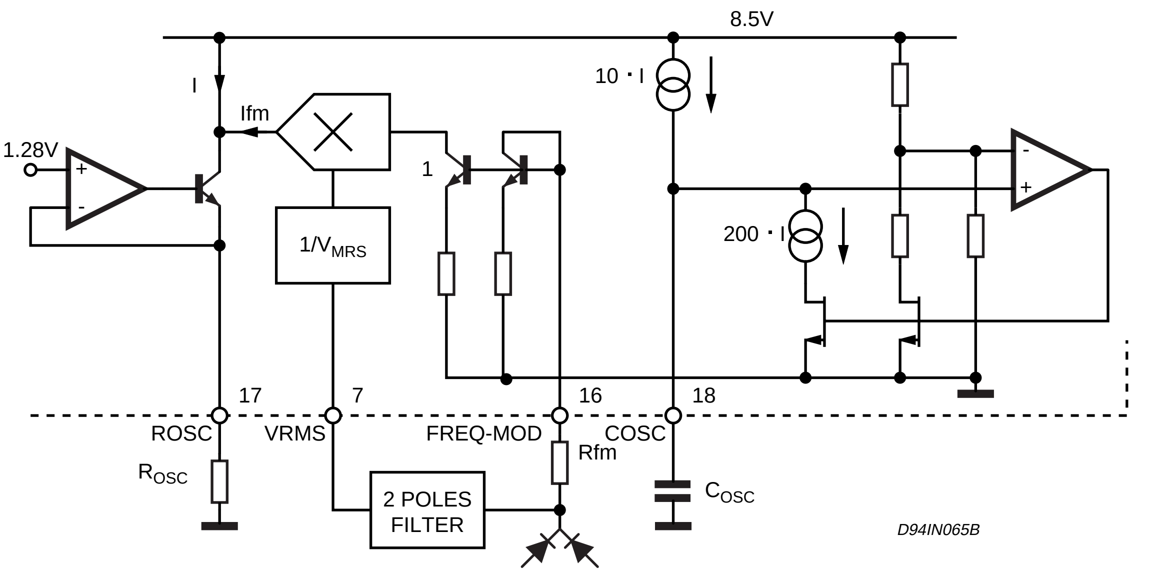
Designing PFC, an important parameter to consider and control is the high frequency noise. This noise is produced by the switching itself and its level depends on several parameters such as high frequency current ripple, PCB layout, active switch performance and also some particular circuital solutions.

The parameter to keep under control is the electromagnetic interference (EMI) content, versus the RFI norms and design requirements (EN60555 and VDE0871B). To get more information about this, please refer also to the CIRCUIT FOR POWER FACTOR CORRECTION WITH REGARDS TO MAINS FILTERING (AN510). The PFC controller L4981B version can be useful to solve the EMI problems using the frequency modulation technique that allows to spread the noise spectrum over a wider range, reducing in this way the peak of the associated energy. This section deals with the way to use this device feature getting the best results. The L4981B performs the frequency modulation function by using Pin16, that in this version is named FREQ-MOD.

This pin (see fig. 1) is internally connected (with a current mirror) to an input of the multiplier.

The output of the multiplier is used to dynamically change the current forced into the external oscillator capacitance changing in this way the switching frequency. The second terms (input) of the multiplier is connected to the divider (1/Vrms) that, through the VRMS (Pin7), senses the input mains making the frequency modulation not affected by the line variations (see also Pin 16 description in AN628).

Figure 1. Frequency Modulation with L4981B.



Connecting pin16 at the rectified mains through a resistor, it is possible to define the modulation depth using the formula:

$$\frac{\Delta f_{SW}}{f_{SW}} = K \frac{V_{IPK} \cdot R_{OSC}}{V_{RMS} \cdot R_{fm}} \Rightarrow R_{fm} = K \cdot \frac{V_{IPK(mains)} \cdot R_{OSc} \cdot f_{Sw}}{V_{RMS(pin7)} \cdot \Delta f_{sw}}$$

where:

R_{fm} is the programming current resistor.

K is a constant value = 0.1157

V_{IPK} is the $V_{RMSmAINS} \cdot \sqrt{2}$

V_{RMS} is the voltage at pin 7

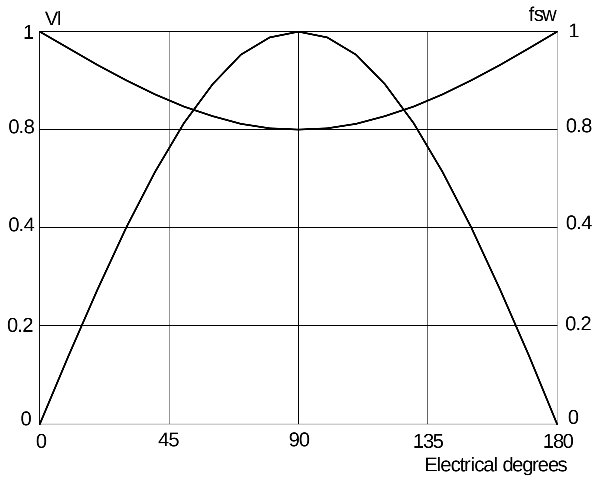
Typically a good compromise can be 10% to 20% of the starting frequency. Designing the frequency modulation it is useful to remind few points :

a) The switching frequency (fsw) is modulated by the mains instantaneous value and decreases as the rectified voltage increases, so the minimum fsw occurs at the input peak voltage and current (see fig. 2).

b) The switching losses increase with the frequency (and obviously with the current).

c) The current ripple increases (for the same boost inductor value) as the switching frequency decreases, the higher current ripple produces an higher EMI.

Figure 2. Modulation Frequency Normalized in a Half Cycle of the Mains Voltage. (eg. RFM = 1100kΩ, Rosc = 24kΩ, Cosc = 820pF).



Considering the above mentioned points, to make a reasonable comparison with an equivalent fixed frequency PFC application in terms of EMI, it is recommended to modify the starting frequency (oscillator).

The suggested criterion for designing a L4981B application is to follow the same procedure used for the fixed frequency version (L4981A) except for the oscillator that must be designed for the desired frequency (fmin) that occurs at the peak of the current, plus the modulation contribution, that is:

$$f_{SW} = \Delta f_{sw} + f_{min} = \frac{2.44}{R_{OSC} \cdot C_{OSC}}$$

eg. designing a 100kHz minimum fsw with a modulation depth » 20%:

$$f_{SW} = 124KHz = \frac{2.44}{24 \cdot 10^{-3} \cdot 0.82 \cdot 10^{-9}}$$

fIn this way the advantage, in terms of reduction of the peak of energy in the noise spectrum, is remarkable. On the other hand the increase of switching losses can be neglected because the maximum frequency occurs at the minimum line current.