

AVR041: EMC Performances Improvement for ATmega32M1

1. Introduction

Thanks to a new Atmel IC design methodology, the EMC constraints are taken into account earlier in the IC design phase. This allows a better assessment of the EMC performances such as the self-compatibility of the IC, the level of the radiated and conducted emissions as well as the internal and external immunity. The EMC performances of the Mega32M1 product are improved thanks to some design improvements detailed in this document.



8-bit **AVR**[®]
Microcontrollers

Application Note

8118A-AVR-02/08



2. Theory of Operation

Figure 2-1 compares the radiated emissions of a not optimized product to the EMC optimized Mega32M1. The radiated emissions measurement has been performed using the IEC61967-2 standard and some details about it are given in Section 3. on page 3. A full measurement report is also available (Mega32M1 IEC61967-2 measurement report).

Figure 2-1. The radiated emissions of the Mega32M1 are reduced down to 15dB in FM band (IEC61967-2 Measurement standard).

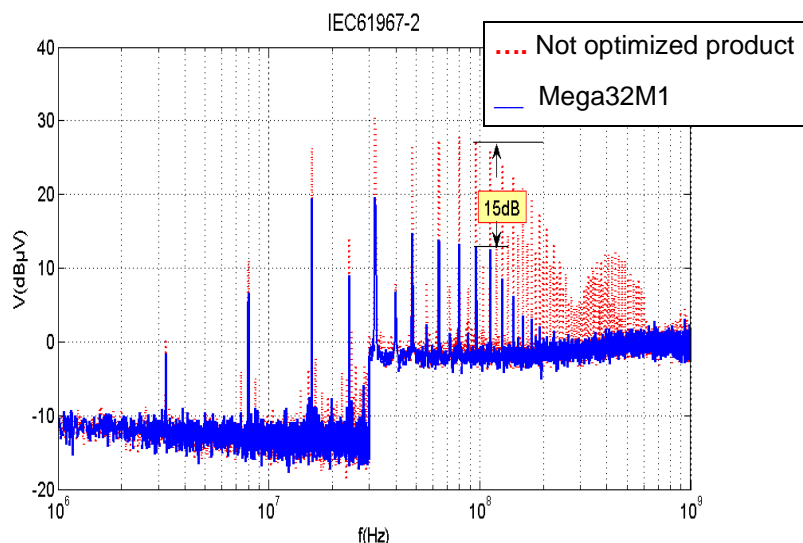


Figure 2-1 clearly shows the emissions are significantly reduced (15dB in the FM band and 12dB in the 433MHz remote control band). The frequency bandwidth is also limited to 200MHz instead of 700MHz for the not optimized one.

The first design improvement concerns the internal power-supply networks (PDN) structure. The electrical insulations (low-pass filtering) between the different blocks such as the Flash and RAM memories, the digital core, the IO lines and analog blocks are now more efficient and it leads to reduce the conducted emissions. The better the insulation, the lower the radiated and conducted emissions.

The second improvement concerns the instantaneous peak current due to the internal digital activities involved during the program execution. They are now spread through time allowing to smooth the slopes and the peak currents. The smoother the peak current, the lower the emissions.

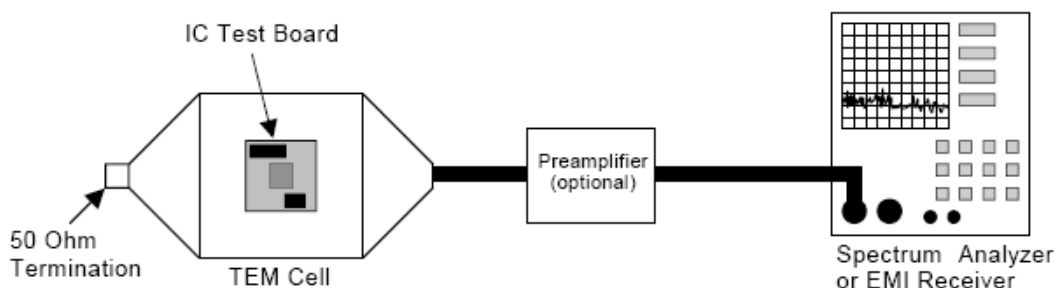
All these improvements lead to limit the high frequency components to flow through the package and therefore limits the amount of the radiated energy. The package acts as an antenna and is the major contributor to the emissions. The external and internal immunity is improved in the same way due to the better insulation (low-pass filtering) of the PDNs. The external disturbances are drastically attenuated before reaching all the internal parts of the IC. Immunity tests are planned before end of 2008 in order to check the robustness of some features such as the oscillator, the reset input, the power-supply, etc. The results will be published in a forth-coming application note.

3. Annex

The measurement test setup used the IEC61967-2 radiated emission standard using a TEM-cell and is depicted in [Figure 3-1](#). The device to test is mounted on the bottom side of the test board and all the electronic features needed to operate the device are on the top side.

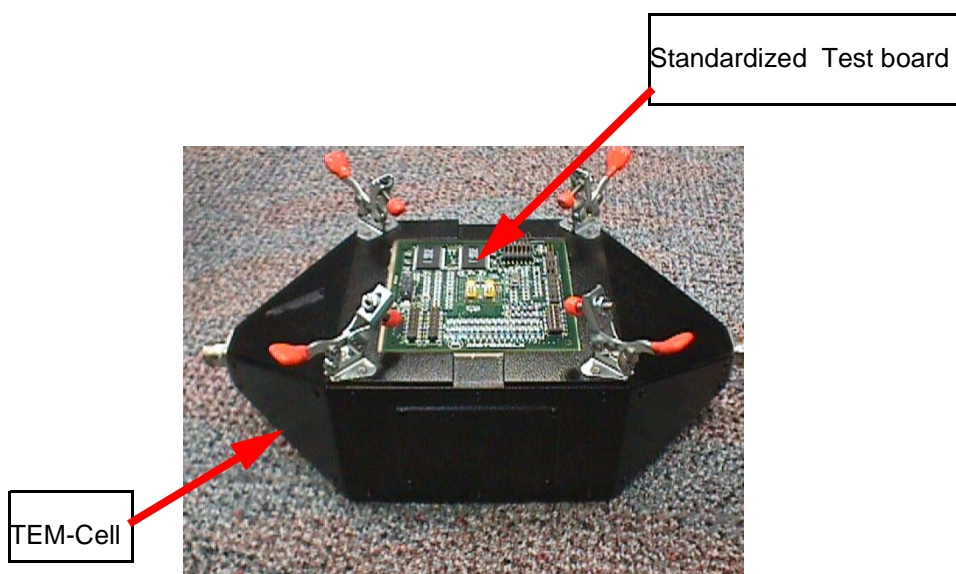
The TEM-cell is connected to a spectrum analyzer or a receiver and it measures the radiated emissions propagated by the device.

Figure 3-1. Measurement test set-up (IEC61967-2).



[Figure 3-2](#) is a zoom on the TEM-Cell and the test board.

Figure 3-2. Test board and TEM-Cell board.



[Figure 3-3](#) shows the electrical schematic of the test board and the decoupling capacitors scheme. This board is used also to measure the IEC61967-4 standard (conducted emissions).

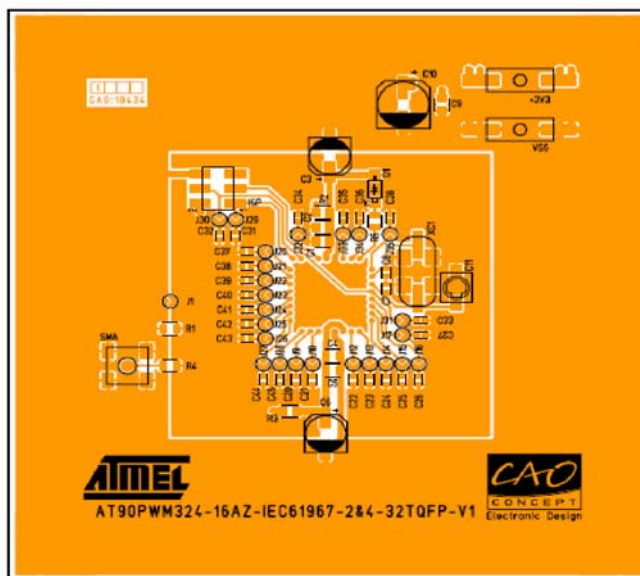
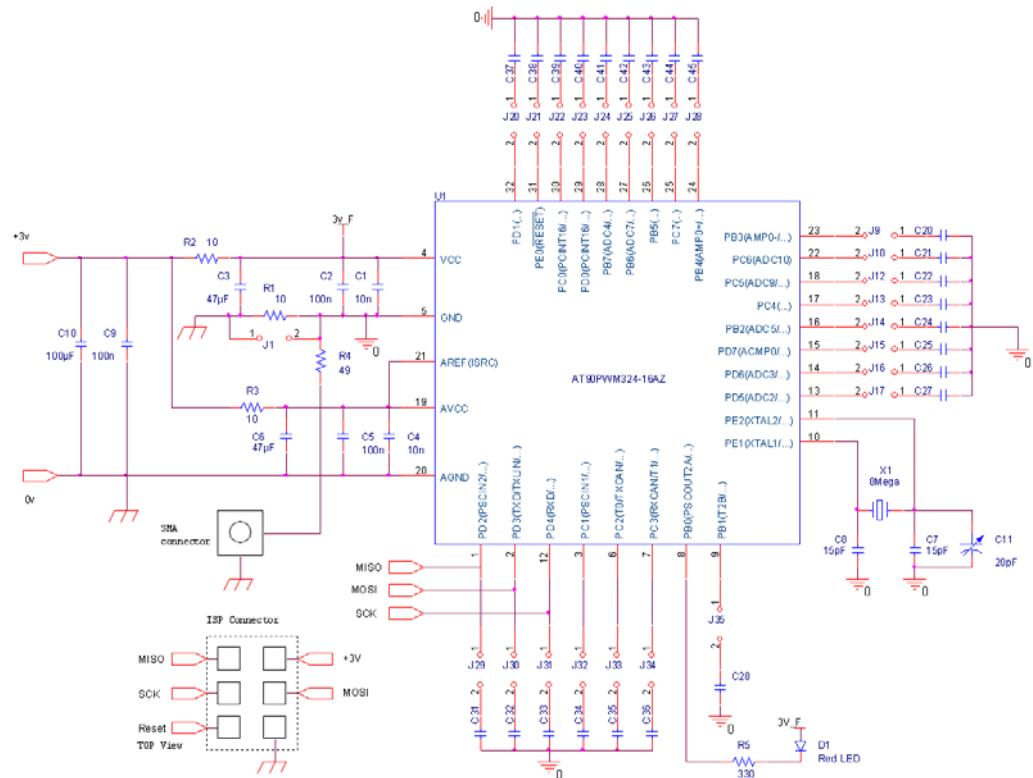
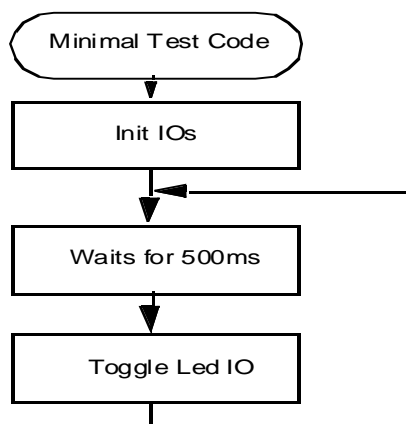


Figure 3-5 shows the flow diagram used to measure the radiated emissions. It is the default test program and it toggles a LED every 2 seconds.

Figure 3-5. Test program flow diagram.



IEC Standard References

- IEC 61967 consists of the following parts, under the general title: *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz*:
- IEC61967 - 1: *General and definitions*
- IEC61967 - 2: *Measurement of radiated emissions – TEM-cell method*
- IEC61967 - 4: *Measurement of conducted emissions – 1 Ω /150 Ω direct coupling method*



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