



Application Note 17

Title: **ADC application with EM6X20, ex.: temp measure**
Product Family: **4 bits Microcontroller**

Part Number: EM6620, EM6520
Keywords: 4 bits micro-controller, rom, ram, data table
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This application note can be use on an another micro-controllers 4 bit with the same configuration.

The target is to measure the temperature dependent resister together with a capacitor with the dual slope method.

It is done by switching high the resistor at port PB0, at the same time, the counter is started. As soon as the voltage at the capacitor reaches the switching input level of the input PA0, the counter is stopped. The result is shown in the display. PB0 is switched to 0 and the capacitor is discharged. During this time the measured value is shown in the display.

With the following schematic diagram (figure 1) 12, 13 and 14 bit resolution can be tested. The resolution is selected with the jumper at pos. 1 or 2 or no jumper.

The display shows "0" up to "4095" afterwards the counter overflow "EEEE".

In addition a two wire interface is created to send the data to a PC or other components if required. This serial PC interface uses PB1 for the clock and PB2 for the data. The interface functions as follows:

- start sequence, data is changing from high to low during clock is high.
- stop sequence, data is changing from low to high during clock is high.

Transmission of 4 bits data, data is changing while clock is low. The LSB of the 4 bits is the first bit in the transmission. 6 bits will be transferred between the start and the stop sequence (transmission: zero nibble, measuring result nibbles (4 bits), zero nibble). The measuring result nibbles correspond to the display which can take the values "0" to "9" in case of counter overflow the transmission is "0EH".

The display shows "6620" after the start-up, followed by the measuring result. The program works in an endless loop. The waiting loop for the discharge of the capacitor is not necessary if the μC has other tasks in the meantime.

Measuring result show that with the selected components, time constant is $0.64RC$. The time for one step is $61\mu\text{s}$ (1 instruction) with a resistor $R=1\text{M}\Omega$ the following results are summarised in the table below.

Capacitors have big tolerances because of manufacturing reasons therefore it can happen that the counter gets an overflow. It is wise to use a smaller capacitor and higher resolution

(longer measuring time) to avoid overflow.

Table 1:

Resolution	Max steps	Max measuring time	C_{exact} at $R=1\text{M}\Omega$	$C_{\text{available}}$	R_{max} resulting	Resolution	Resolution 12 bit
14 Bit	16384	1,0 sec	1,56 μF	1,5 μF	1,05M Ω	63,6 Ω	254 Ω
13 Bit	8192	0,5 sec	781nF	680nF	2,3M Ω	140 Ω	280 Ω
13 Bit	8192	0,5 sec		680nF + 100nF	2,0M Ω	122 Ω	245 Ω
12 Bit	4096	0,25 sec	390nF	330nF	4,7M Ω	288 Ω	288 Ω
12 Bit	4096	0,25 sec		330nF + 47nF	4,1M Ω	252 Ω	252 Ω

Schematic:

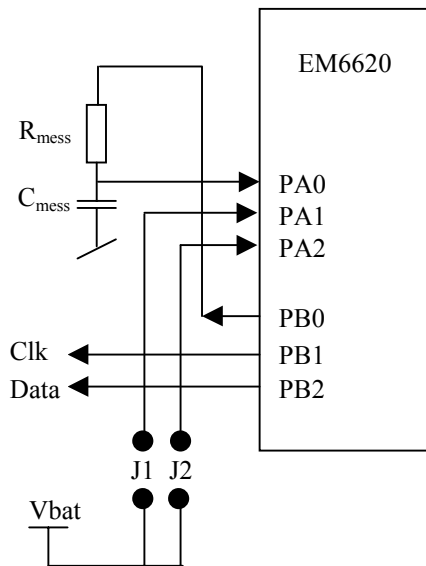


Figure 1.

Table 2:

Jumpers	Resolution
Jumper 1	12 bit
Jumper 2	13 bit
No jumper	14 bit

Appendix A: Flowchart of the program

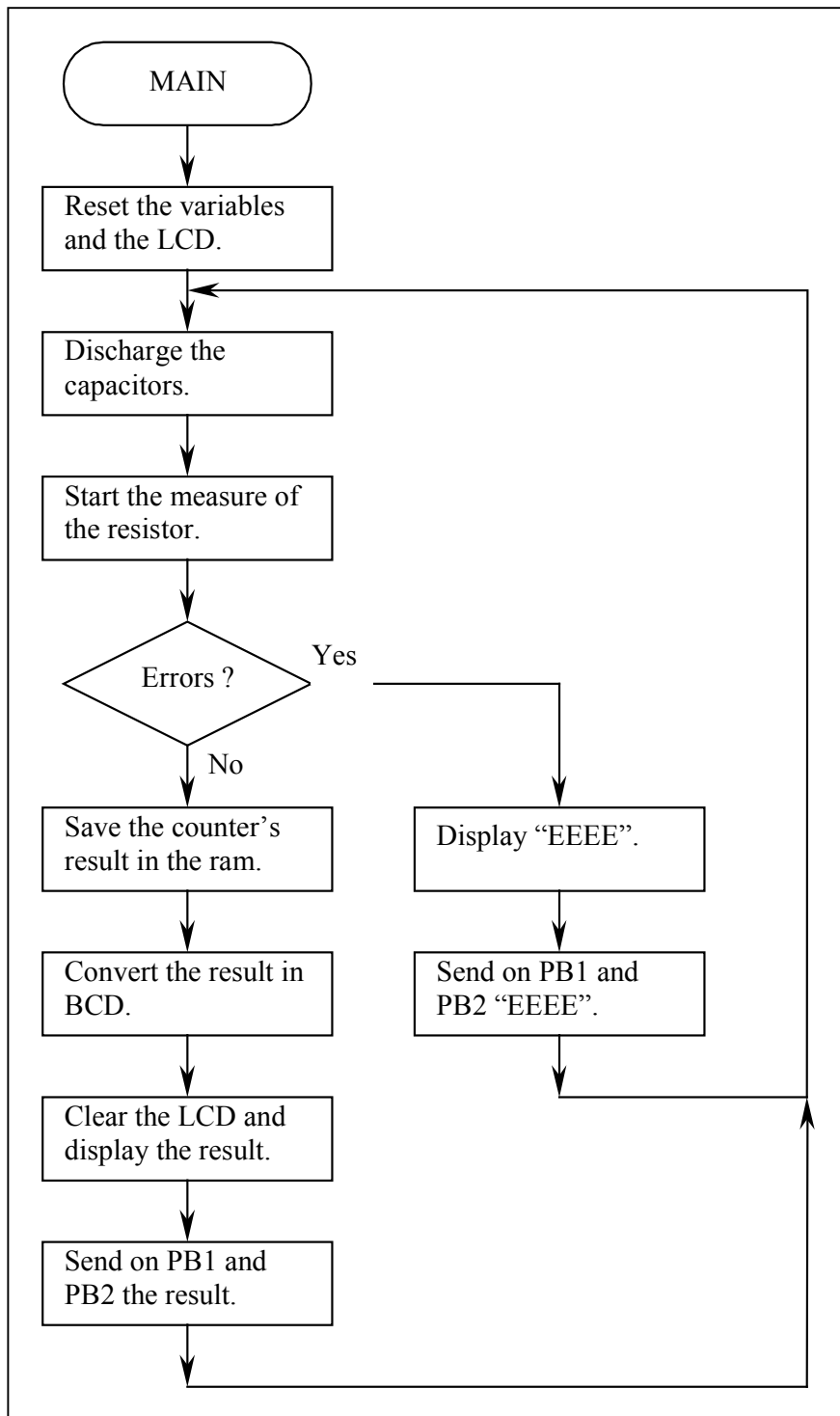


Figure 2.