

## 7-seg-LEDs - an Keil $\mu$ Vision extension DLL for simulating 7-segment LED displays

Enables simulation of multiple 7-segment LED display connected to any port (SFR) on 8051 uC

:: Last update date: 30.07.2009 -- AGSI 7segLEDs.DLL v0.9-beta ::



Picture shows peripheral dialog of *7-seg-LEDs* in action.

One or more 7-seg LED displays constitute one or more led-groups. Here, two groups are configured: "Temperature:" and "Pressure:".

Inside each led-group, we can put variable number of separately configurable 7-seg LED displays.

*7-seg-LEDs* supports time-multiplexing. In this example, it drives five 7-seg LED displays with 13 uC port-pins (8 for segments + 5 for common terminals).

Time-multiplexing support came from way that *7-seg-LEDs* samples port-pins  $Pi.j$  on which 7-seg LED display pins are connected.

On each write to port-pin  $Pi.j$ , a new pair values of (pin-states, time) is pushed to cyclic buffer dedicated to hold last  $N$  pair values (pin-states, time). From that cyclic buffer, on each dialog update called from  $\mu$ Vision simulator, the *mean-ON-time* for each segment is calculated. (dialog update is called from  $\mu$ Vision simulator on each write to port-pins used by any segment-pin or commonTerminal-pin)

From that *mean-ON-time*, intensity of onColor for all affected segments are calculated and segments are repainted in real-time.

[Link to sample screen-shoot picture.](#)

### List of features

- configurable via `SevenSegConf.xml` configuration file (located in  $\mu$ Vision project folder)
- all colors for each 7-seg LED display is configurable
- all segment-pins and commonTerminal-pin of 7-seg LED display can be connected to any port (in fact to any SFR)
- multiple segment-pins or commonTerminal-pins can be connected to same port-pin
- support for time-multiplexing
- true mean-ON-time for each segment is calculated in real-time (on each write to any port-pin used by any segment-pin or commonTerminal-pin)
- multiple 7-seg LED displays are grouped into led-group - better visual organisation

### Usage

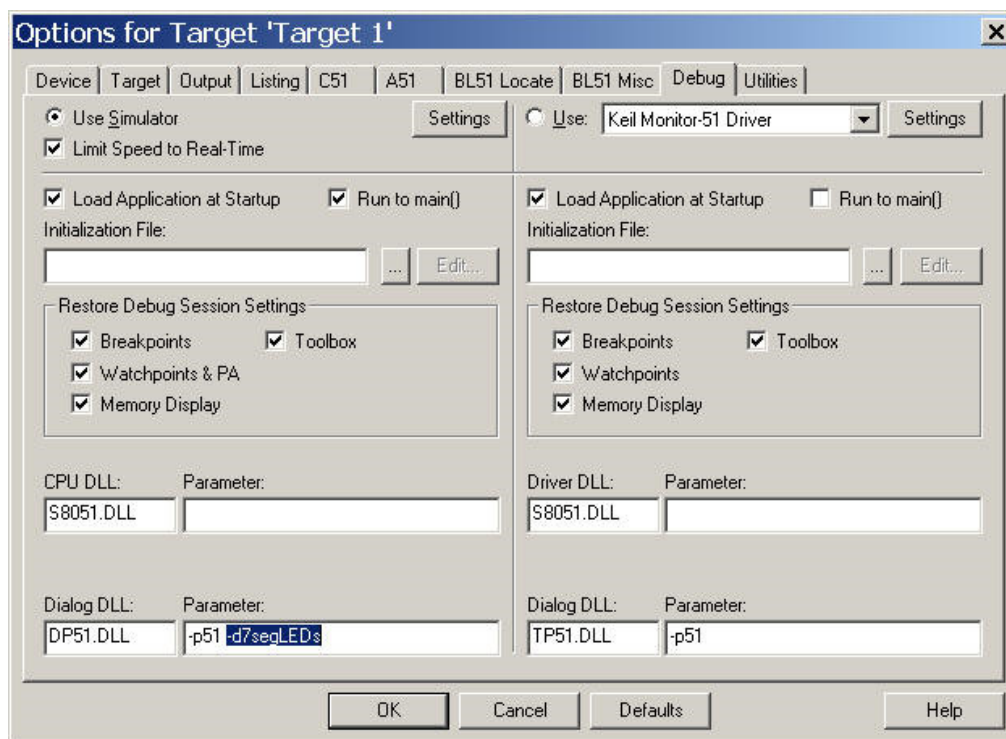
To use 7-seg-LEDs, you should have `7segLEDs.dll` in Keil's BIN folder and configuration file `SevenSegConf.xml` in project folder. So, different projects have their own configuration file. This and all other  $\mu$ Vision AGSI extension DLL's can be used only when debugging target project from  $\mu$ Vision

simulator.

- download file [7segLEDs.zip](#) that contains **7segLEDs.dll**.  
Copy DLL into \$Keil-uVision-Install-Folder\$\C51\BIN
- download example µVision project [LEDs](#) that demonstrate usage. Inside this Project, you can see how configuration file `SevenSegConf.xml` looks like. Details on configuration file can be found in `main.c` file inside project, or in [Configuration file `SevenSegConf.xml`](#)

## Attaching 7segLEDs.dll to µVision

- to use this DLL in others or newly created projects, you need to attach **7segLEDs.dll** to µVision. Choose one from two listed ways:
  - for permanent attaching it to all projects ( close µVision IDE before doing this ):
    - edit file \$Keil-uVision-Install-Folder\$\tools.ini and in the section **[C51]** include following line :  
AGS11=7segLEDs.DLL ("7-seg LEDs")
  - for attaching it to currently opened project,
    - from menu "**Project**" select "**Options for Target 'yourProjectName'**" and make shure that dialog contains **-d7segLEDs** in marked place :



## Configuration file `SevenSegConf.xml`

### 1. Segment naming/ordering is always like this:

```

***A***
*      *
F      B
*      *

```

```

***G***
*       *
E       C
*       *
***D*** DP
        COMMA

```

- common terminal does not have significance for this picture.

## 2. XML global configuration parameters

### 2A. `sizeofBufferForMeanValue`

Found as attribute in `/LEDS/COMMON` XML element.

Determines size of buffer used for calculation of mean-ON-time value for each 7-seg pin. Basically, buffer is a cyclic buffer that holds variable pairs: (7-seg-pin-state, time).

From values in this buffer, each 7-segment pin mean value is calculated. Based on calculated mean value, intensity of light is calculated.

Choose array size XXX so that buffer can hold all writes to port pins on which LED's pins (segment and common) are connected indise full multiplex cycle:

- preferred size : 15x number of multiplexed LED's for this example.
- absolute minimum : number of multiplexed LED's
- if during simulation, segments intensity is periodicaly fading/rising -> increase buffer size
- NOTE: increasing buffer size until some limit will actualy speed-up simulation, but above it, will slightly slow-down simulation speed.

## 3. XML parameters for led-groups

Only one parameter exist, is it `groupName` which is name of led-group that will be displayed in dialog as group-box caption.

## 4. XML parameters for 7-segment LED display's

All parameters are found as elements in `/LEDS/LED_GROUP/LED` XML elements.

### 4A. `segXXX` and `commonTerminal( XXX` is segment name: [A-F], DP or COMMA )

Each entry represents connection of segment-pin to port-bit of uC.

Set `SFRPortAddress` to SFR address of some port, and `bitPosition` to port-bit to which this segment is connected.

Set `activeOn` to logical value of port-pin that will drive segment-pin or common terminal. With values of this attribute, we can definine type of 7-seg LED display (common-anode or common-cathode), driving mechanism (direct drive or thru NPN or PNP transistor)

NOTE: `SFRPortAddress` must be entered in HEX number base. `bitPosition` must be from range 0-7 as DEC number. `activeOn` must be 1 or 0.

### 4B. `backgroundColor`, `onColor` and `offColor`

They defines colors of 7-seg LED display.

NOTE: values must entered as 3-byte HEX number where each byte represent RGB components of color like this:

0xBBGGRR

#### 4C. saturationCoefficient

Found as element in /LEDS/LED\_GROUP/LED XML elements.

As mentioned in [2A.](#), mean-ON-time value is base on which segment light intensity is calculated. If this parameter is 0, function of segment-light-intensity v.s. mean-ON-time is pure linear function. Increasing this parameter to 1 and more will introduce saturation in function segment-light-intensity v.s. mean-ON-time.

There exist several reasons to introduce this parameter. One obvious is nonlinear light emitted from LED for a linear change on mean-ON-time. Second is human eye interpretation of pulsed light source. Both of them make me to introduce this parameter, so simulation of 7-seg LED will show more real light intensity than using simple linear function.

Choose this parameter should be based on number of LED's in multiplex chain:

- for one LED -> use 0
- for two LED -> use 1
- for four LED -> use 2
- for five LED -> use 3

## XML configuration file content from example project

```
<?xml version="1.0" ?>
<LEDS>
  <COMMON sizeOfBufferForMeanValue="75" />
  <LED_GROUP groupName="Temperature:">
    <LED>
      <segA SFRPortAddress="0x80" bitPosition="0" activeOn="0" />
      <segB SFRPortAddress="0x80" bitPosition="1" activeOn="0" />
      <segC SFRPortAddress="0x80" bitPosition="2" activeOn="0" />
      <segD SFRPortAddress="0x80" bitPosition="3" activeOn="0" />
      <segE SFRPortAddress="0x80" bitPosition="4" activeOn="0" />
      <segF SFRPortAddress="0x80" bitPosition="5" activeOn="0" />
      <segG SFRPortAddress="0x80" bitPosition="6" activeOn="0" />
      <segDP SFRPortAddress="0x80" bitPosition="7" activeOn="0" />
      <segCOMMA SFRPortAddress="0x80" bitPosition="7" activeOn="0" />
      <commonTerminal SFRPortAddress="0x90" bitPosition="0" activeOn="1" />

      <backgroundColor>0x484848</backgroundColor>
      <onColor>0x0000FF</onColor>
      <offColor>0x585858</offColor>
      <saturationCoefficient>4</saturationCoefficient>
    </LED>
    <LED>
      <segA SFRPortAddress="0x80" bitPosition="0" activeOn="0" />
      <segB SFRPortAddress="0x80" bitPosition="1" activeOn="0" />
      <segC SFRPortAddress="0x80" bitPosition="2" activeOn="0" />
      <segD SFRPortAddress="0x80" bitPosition="3" activeOn="0" />
      <segE SFRPortAddress="0x80" bitPosition="4" activeOn="0" />
      <segF SFRPortAddress="0x80" bitPosition="5" activeOn="0" />
      <segG SFRPortAddress="0x80" bitPosition="6" activeOn="0" />
      <segDP SFRPortAddress="0x80" bitPosition="7" activeOn="0" />
      <segCOMMA SFRPortAddress="0x80" bitPosition="7" activeOn="0" />
      <commonTerminal SFRPortAddress="0x90" bitPosition="1" activeOn="1" />

      <backgroundColor>0x484848</backgroundColor>
      <onColor>0x0000FF</onColor>
      <offColor>0x585858</offColor>
      <saturationCoefficient>4</saturationCoefficient>
    </LED>
  </LED_GROUP>
</LEDS>
```

```

</LED>
<LED>
  <segA SFRPortAddress="0x80" bitPosition="0" activeOn="0" />
  <segB SFRPortAddress="0x80" bitPosition="1" activeOn="0" />
  <segC SFRPortAddress="0x80" bitPosition="2" activeOn="0" />
  <segD SFRPortAddress="0x80" bitPosition="3" activeOn="0" />
  <segE SFRPortAddress="0x80" bitPosition="4" activeOn="0" />
  <segF SFRPortAddress="0x80" bitPosition="5" activeOn="0" />
  <segG SFRPortAddress="0x80" bitPosition="6" activeOn="0" />
  <segDP SFRPortAddress="0x80" bitPosition="7" activeOn="0" />
  <segCOMMA SFRPortAddress="0x80" bitPosition="7" activeOn="0" />
  <commonTerminal SFRPortAddress="0x90" bitPosition="2" activeOn="1" />

  <backgroundColor>0x484848</backgroundColor>
  <onColor>0x0000FF</onColor>
  <offColor>0x585858</offColor>
  <saturationCoefficient>4</saturationCoefficient>
</LED>
</LED_GROUP>
<LED_GROUP groupName="Pressure: ">
  <LED>
    <segA SFRPortAddress="0x80" bitPosition="0" activeOn="1" />
    <segB SFRPortAddress="0x80" bitPosition="1" activeOn="1" />
    <segC SFRPortAddress="0x80" bitPosition="2" activeOn="1" />
    <segD SFRPortAddress="0x80" bitPosition="3" activeOn="1" />
    <segE SFRPortAddress="0x80" bitPosition="4" activeOn="1" />
    <segF SFRPortAddress="0x80" bitPosition="5" activeOn="1" />
    <segG SFRPortAddress="0x80" bitPosition="6" activeOn="1" />
    <segDP SFRPortAddress="0x80" bitPosition="7" activeOn="1" />
    <segCOMMA SFRPortAddress="0x80" bitPosition="7" activeOn="1" />
    <commonTerminal SFRPortAddress="0x90" bitPosition="3" activeOn="1" />

    <backgroundColor>0x484848</backgroundColor>
    <onColor>0x00FF00</onColor>
    <offColor>0x585858</offColor>
    <saturationCoefficient>4</saturationCoefficient>
  </LED>
  <LED>
    <segA SFRPortAddress="0x80" bitPosition="0" activeOn="1" />
    <segB SFRPortAddress="0x80" bitPosition="1" activeOn="1" />
    <segC SFRPortAddress="0x80" bitPosition="2" activeOn="1" />
    <segD SFRPortAddress="0x80" bitPosition="3" activeOn="1" />
    <segE SFRPortAddress="0x80" bitPosition="4" activeOn="1" />
    <segF SFRPortAddress="0x80" bitPosition="5" activeOn="1" />
    <segG SFRPortAddress="0x80" bitPosition="6" activeOn="1" />
    <segDP SFRPortAddress="0x80" bitPosition="7" activeOn="1" />
    <segCOMMA SFRPortAddress="0x80" bitPosition="7" activeOn="1" />
    <commonTerminal SFRPortAddress="0x90" bitPosition="4" activeOn="1" />

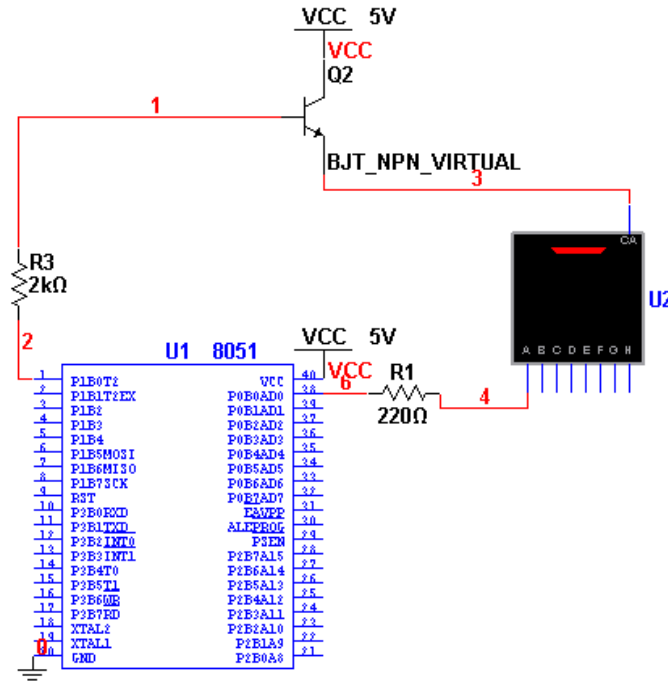
    <backgroundColor>0x484848</backgroundColor>
    <onColor>0x00FF00</onColor>
    <offColor>0x585858</offColor>
    <saturationCoefficient>4</saturationCoefficient>
  </LED>
</LED_GROUP>
</LEDS>

```

### Short analysis of 7-seg LED's in LED\_GROUP "Temperature:"

- segments are active on logical 0, common terminal is active on 1. Thus configuration of this 7-seg LED says that it is common-anode with anode driven with NPN transistor, and segments are driven with low-level state of port Px pins. (port P0 pins are sinking current)
- NOTE: this is configuration when port P0 pins (or any other) are sinking current - consult your uC datasheet if they can handle that amount of current.

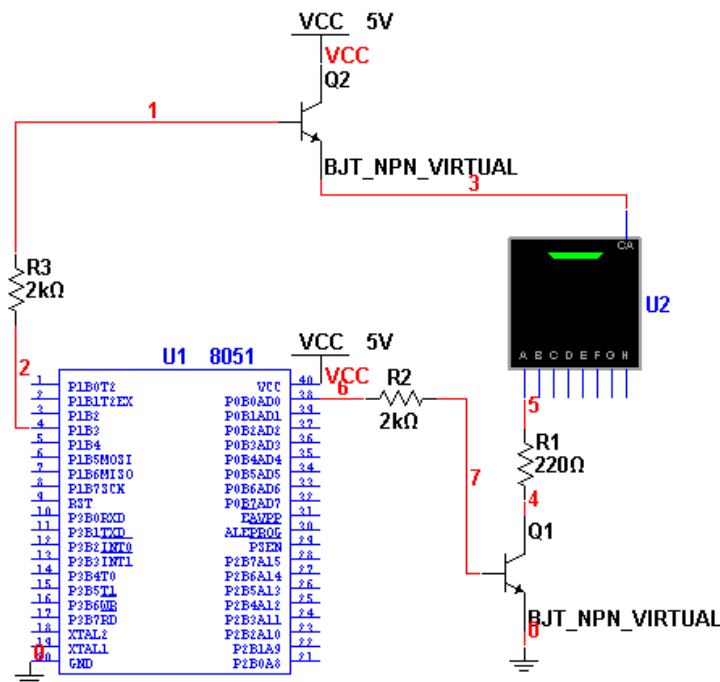
- circuit diagram that represent connection of first 7-seg LED *segA* pin in this LEG\_GROUP would be like this:



Picture 2.

#### Short analysis of 7-seg LED's in LED\_GROUP "Pressure:"

- segments are active on logical 1, common terminal is active on 1. Thus configuration of this 7-seg LED says that it is common-anode with anode driven with NPN transistor, and segments are driven with NPN transistors connected to port Px pins. (IMHO, this is better way, because in this way we are avoiding sinking large current into port pins)
- circuit diagram that represent connection of first 7-seg LED *segA* in this LEG\_GROUP would be like this:



Picture 3.

## At the end

If you have any questions, improvements suggestions, bugs to report ( :- ( ), or only to say thanks do not hesitate to contact me via e-mail.

bboris<insert-at>etfos<insert-dot>hr

History notes for web-page or AGSI 7segLEDs.DLL:

::29.07.2009.:: Added pictures 2 and 3 plus some minor changes in text.

::29.07.2009.:: Web-page created. First public release of 7segLEDs.dll (v0.9-beta).