AN1781
APPLICATION NOTE

STR71x GPIO
DRIVING FOUR 7-SEGMENT DISPLAY

INTRODUCTION

Seven-segment devices are often preferred in display applications where high luminescence is required, both for indoor and outdoor applications. Segments are marked with letters: a, b, c, d, e, f, g and DP, where DP is the decimal point.

The technique described in this note is of a general nature and may be applied to a variety of applications.

Hardware considerations are reviewed and generation of control software using the STR71x is described.

Rev. 2

1 PRINCIPLE OF OPERATION

A 7-segment display consists of 7 LED's arranged in a figure-eight pattern, then by selectively powering-on various combinations of segments, alphanumeric characters may be displayed; a further LED is present which, when powered-on, causes a dot or decimal point to be displayed (Figure 1). The LED display can be driven by a common cathode or common anode. With a common cathode display, the common cathode must be connected to the 0V rail and the LEDs are turned on with a logic one.

Table 1 illustrates the required segment patterns for each numeric representation, including the optional decimal point.

Figure 1. Structure of a 7-segment display

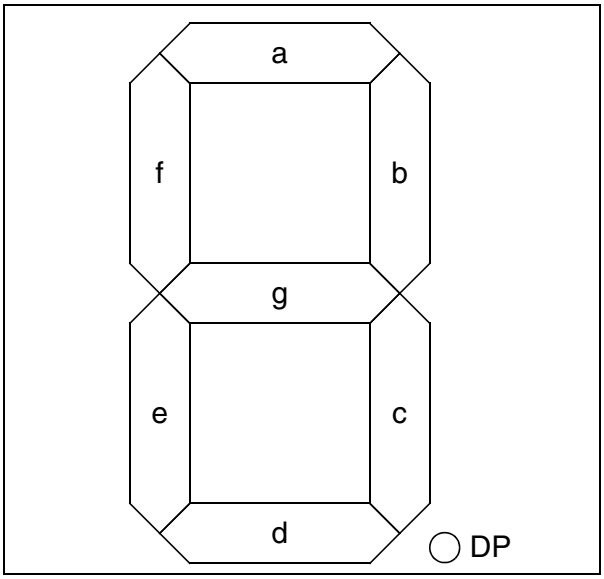


Table 1. LEDs turned on for a given digit

	a	b	c	d	e	f	g	DP	Hex
0	1	1	1	1	1	1	0	x	0x3F
1	0	1	1	0	0	0	0	x	0x06
2	1	1	0	1	1	0	1	x	0x5B
3	1	1	1	1	0	0	1	x	0x4F
4	0	1	1	0	0	1	1	x	0x66
5	1	0	1	1	0	1	1	x	0x6D
6	1	0	1	1	1	1	1	x	0x7D
7	1	1	1	0	0	0	0	x	0x07
8	1	1	1	1	1	1	1	x	0x7F
9	1	1	1	1	0	1	1	x	0x6F
A	1	1	1	1	0	1	1	x	0x77
B	0	1	1	1	1	0	1	x	0x7C
C	1	0	0	1	1	1	0	x	0x39
D	0	1	1	1	1	0	1	x	0x5E
E	1	0	0	1	1	1	1	x	0x79
F	1	0	0	0	1	1	1	x	0x71
DP	x	x	x	x	x	x	x	1	

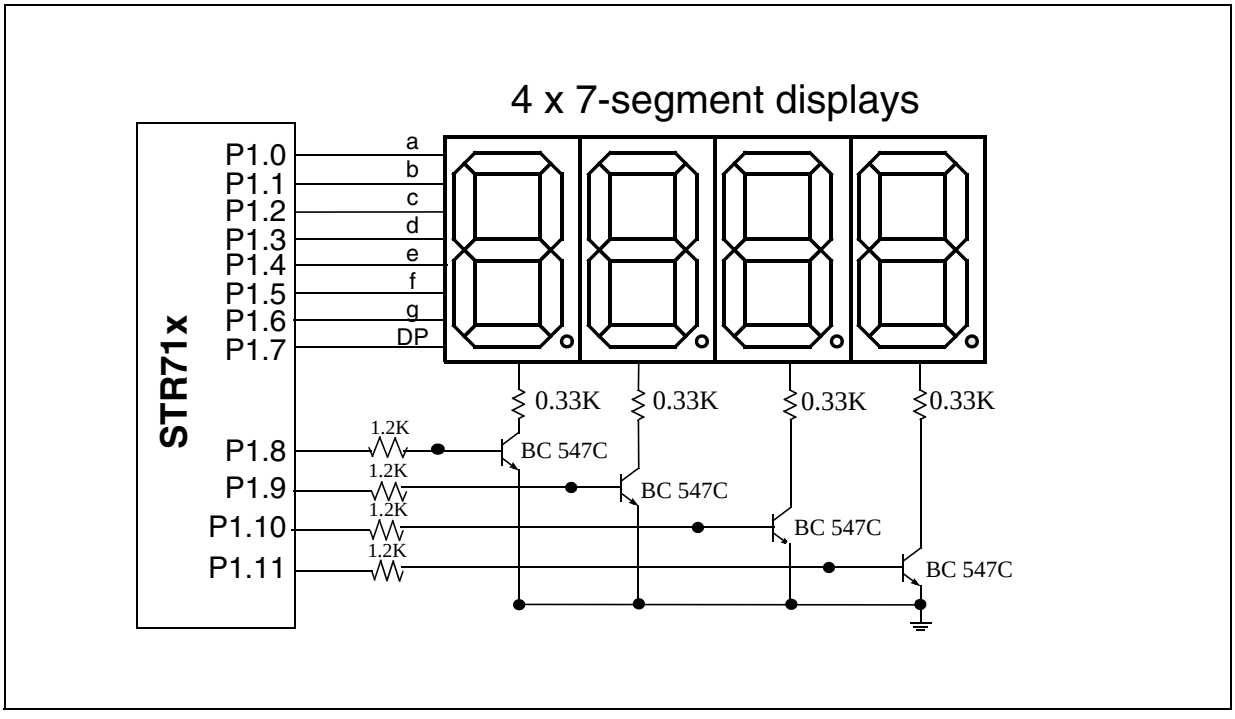
x = Don’t care

2 MULTIPLEXING FOUR 7-SEGMENT LED DISPLAYS

2.1 HARDWARE LAYOUT

Biasing is achieved using the STR71x I/O lines. Eight lines (P1.0 - 7) are assigned to LED segments a - g and the DP. Four lines (P1.8 - 11) are used to drive and select the 7-segment displays through sink transistors (Figure 2).

Figure 2. Multiplexing four 7-segments displays



2.2 SOFTWARE IMPLEMENTATION

Biasing can be either continuous or multiplexed as long as the refresh frequency is high enough to ensure image persistence for the human eye (at least 25 cycles per second to avoid flicker) and it will appear that all the displays are turned on at the same time. As each display is turned on, the appropriate information must be delivered to it so that it will give the correct reading.

The multiplexing is achieved by turning on each display for 5 ms duration every 20 ms. This gives an update rate of 50 Hz. The 5 ms time-base can be generated using a timer overflow interrupt.

The main program uses a global pointer which refers to the variable to display. The lower 4 bits correspond to the least significant digit, the next 4 bits correspond to the second digit and so on.

Depending on which display is selected, and using a Hexadecimal to 7-segment display correspondence table, the corresponding 4 bits are extracted, then decoded to a 7-segment display and finally sent to the 7-segment LED display.

The C code given below is for guidance only. The file cannot be used alone, the complete software can be found at http://www.st.com/mcu

```
#include "71x_lib.h"

const u8 b7SegmentTable[16] = {0x3F,   /* 0 */
                0x06,   /* 1 */
                0x5B,   /* 2 */
                0x4F,   /* 3 */
                0x66,   /* 4 */
                0x6D,   /* 5 */
                0x7D,   /* 6 */
                0x07,   /* 7 */
                0x7F,   /* 8 */
                0x6F,   /* 9 */
                0x77,   /* A */
                0x7C,   /* B */
                0x39,   /* C */
                0x5E,   /* D */
                0x79,   /* E */
                0x71   /* F */
               };

 /* Pointer to the variable to display */
 u16 *pCharToDisplay;
 /* DP to display */
 u8 bDP;

int main(void)
{
 #ifdef DEBUG
 debug();
 #endif

/* Set system clock to 32 MHz----------------------------------------------------------*/

 /* Configure the PLL with a multiplication factor = 16 and division factor = 4 */
 RCCU_PLL1Config(RCCU_Mul_16, RCCU_Div_4);

 /* Set the APB2 clock to default */
 RCCU_PCLKConfig(RCCU_DEFAULT);

 /* Set the RCLK to the PLL output */
 RCCU_RCLKSourceConfig(RCCU_PLL1_Output);

/* EIC configuration ------------------------------------------------------------- */

 /* Set the Timer 0 IRQ channel priority to 1 */
```

```
 EIC_IRQChannelPriorityConfig(T0TIMI_IRQChannel, 1);

 /* Enable the Timer 0 IRQ channel interrupts */
 EIC_IRQChannelConfig(T0TIMI_IRQChannel, ENABLE);

 /* Enable IRQ interrupts */
 EIC_IRQConfig(ENABLE);

/* GPIO 1 configuration ------------------------------------------------------ */

 /* Configure the GPIO 1 port to output Puch-Pull */
 GPIO_Config(GPIO1, 0xFFFF, GPIO_OUT_PP);

 /* Disable all 7-segment displays */
 GPIO_WordWrite(GPIO1, 0);

/* TIM0 configuration -------------------------------------------------------- */
 /* Configure the Prescaler to 0x02 to get an Overflow interrupt every 5.120 ms
   This will gives an update rate of 48.8 Hz*/

 /* Inisialize the Timer 0 */
 TIM_Init(TIM0);

 /* Configure the Timer 0 prescaler */
 TIM_PrescalerConfig(TIM0, 0x02);

 /* Enable the Overflow Interrupt */
 TIM_ITConfig(TIM0, TIM_TO_IT, ENABLE);

 /* Start the TIM0 Counter */
 TIM_CounterConfig(TIM0, TIM_START);

 /* Configure the real time clock */
 RTC_PrescalerConfig(0x8000);

 /* Get the RTC->CNTL register address */
 pCharToDisplay = (u16 *)RTC->CNTL;

 /* Enable the third DP */
 bDP = 0x04;
 /* infinite loop */
 while(1);
}
/*******************************************************************************
* Function Name  : T0TIMI_IRQHandler
* Description    : This function handles the Timer0 global interrupt.
* Input          : None
* Output         : None
* Return         : None
*******************************************************************************/
void T0TIMI_IRQHandler(void)
{
 /* Holds the number of the selected 7 -segment display.*/
 static u8 Displayer = 0x00;
```

```
 /* Clear Timer 0 Overflow flag */
 TIM_FlagClear ( TIM0 , TIM_TOF );

 /* Turn Off all 7-segment LED displays */
 GPIO1->PD = 0x0000;

 /* Send the next digit */
 GPIO_ByteWrite(GPIO1, GPIO_LSB, b7SegmentTable[(*pCharToDisplay>>(Display-
er*4))&0x000F]);

 /* Drive the DP of the selected display */
 GPIO_BitWrite(GPIO1, 7, bDP>>Displayer);

 /* Turn on the selected 7-segment display */
 GPIO_BitWrite(GPIO1, 8+Displayer, 1);

 /* Adjust the number of the next 7-segment display */
 Displayer++;
 if (Displayer==4) Displayer=0;
}
```

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