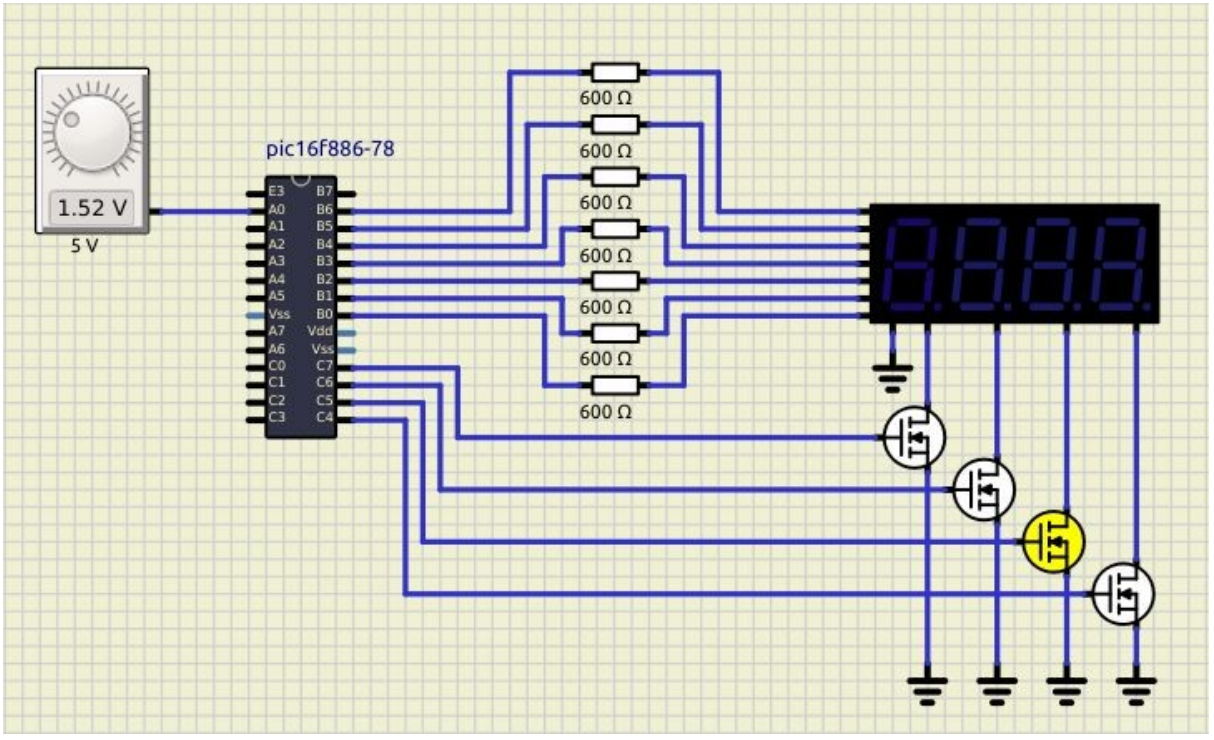
PMR3406 - Microprocessadores - Aula de 22/06/20
Gustavo Marangoni Rubo - 4584080

• Cálculo dos resistores:
Resistor vermelho: Vf = 2V (Typ)
If = 5mA
R = (Vss - Vf)/If = (5 - 2)/0,005 = 600Ω

• Cálculo da interrupção do timer 0 (cada 5ms):
Fosc = 20MHz, Tosc = 50ns, Tosc*4 = 0,2µs
Prescaler 1:128 ⇒ 0,2*128 = 25,6µs
5000/25,6 = 195,3125
195

• Circuito desligado:



• Código do MPLAB (arquivo main.c):

```
// PIC16F886 Configuration Bit Settings

// 'C' source line config statements

// CONFIG1
#pragma config FOSC = EC       // Oscillator Selection bits (EC: I/O function on RA6/OSC2/CLKOUT
pin, CLKIN on RA7/OSC1/CLKIN)
#pragma config WDTE = OFF      // Watchdog Timer Enable bit (WDT disabled and can be enabled by
SWDTEN bit of the WDTCON register)
#pragma config PWRTE = OFF     // Power-up Timer Enable bit (PWRT disabled)
```

```
#pragma config MCLRE = ON      // RE3/MCLR pin function select bit (RE3/MCLR pin function is MCLR)
#pragma config CP = OFF        // Code Protection bit (Program memory code protection is disabled)
#pragma config CPD = OFF       // Data Code Protection bit (Data memory code protection is
disabled)
#pragma config BOREN = ON      // Brown Out Reset Selection bits (BOR enabled)
#pragma config IESO = ON       // Internal External Switchover bit (Internal/External Switchover
mode is enabled)
#pragma config FCMEN = ON      // Fail-Safe Clock Monitor Enabled bit (Fail-Safe Clock Monitor is
enabled)
#pragma config LVP = OFF       // Low Voltage Programming Enable bit (RB3 pin has digital I/O, HV
on MCLR must be used for programming)

// CONFIG2
#pragma config BOR4V = BOR40V   // Brown-out Reset Selection bit (Brown-out Reset set to 4.0V)
#pragma config WRT = OFF       // Flash Program Memory Self Write Enable bits (Write protection
off)

// #pragma config statements should precede project file includes.
// Use project enums instead of #define for ON and OFF.

#include <xc.h>
#include <stdio.h>
#include "always.h"
#include "delay.h"
#include "io.h"
//#include "lcd.h"
//#include "adc.h"
//#include "debug.h"

// Variáveis globais
int valorPot;
char caracteres[10];

// função exponente
int pow (int num, int exp) {
        int res =1;
        for (int i = 0; i < exp; i ++) res *= num;
        return res;
}

// Função para tratamento de interrupções
void interrupt isr(void) {

  // Tratamento da interrupção do Timer 0
  if (T0IE && T0IF) {
        // Executar a cada 5ms
        delay_ms(2);
        GO_DONE =1;
        while(GO_DONE);
        valorPot = (ADRESH <<8) + ADRESL;

        delay_ms(2);

        TMR0 = 255 - 195; //interrupções a cada 5ms
        T0IF = 0;       //reseta a interrupt flag
  }
}

// Inicialização do Timer 0
void t0_init(void) {
        T0CS = 0;   //usar timer0
```

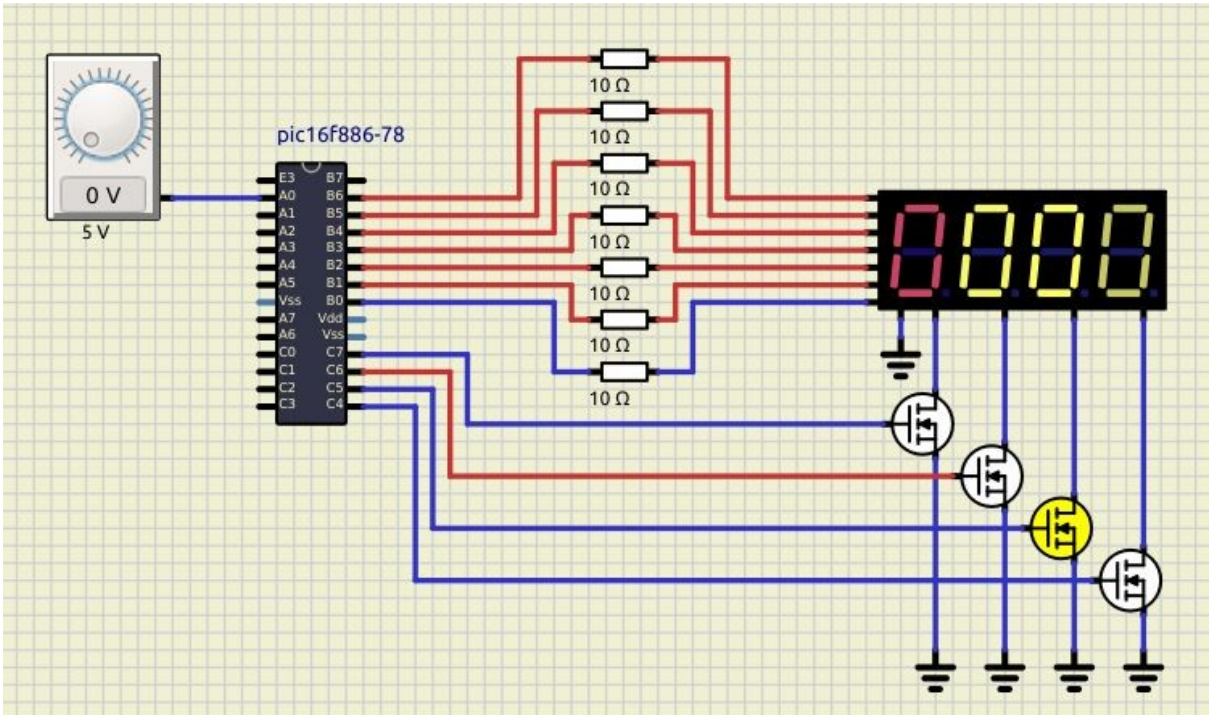
```
        PSA = 0;//prescaler usa timer0
        //define prescaler em 256:
        OPTION_REGbits.PS = 0b111;
        TMR0 = 255 - 195; //interrupções a 5ms
        T0IE = 1;   //habilita interrupções do timer0
}

// Inicialização do PortA aqui
void portA_init(void) {
        TRISA0 = 1; // configura como entrada
        ANS0 = 1;   // configura como analógica
        ADCON0bits.ADCS = 0b110;// divisor: Fosc/32
        ADCON0bits.CHS = 0b0000;// seleciona o canal a ser convertido
        VCFG0 = 0; // Vdd = 5V
        VCFG1 = 0; // Vss = 0V
        ADFM = 1; // justificar à direita
        ADON = 1; //ligar o modo conversor
}

// Inicialização do PortB aqui
void portB_init(void) {
        //configurar todas as portas B como saídas
        TRISB = 0b00000000;
}

// Inicialização do PortC aqui
void portC_init(void) {
        //configurar como saídas as portas 4 a 7
        TRISC &= 0b00001111;
}

void vetor_caracteres_init(void){
  for (int i = 0; i < 10; i++)
        caracteres[i] = EEPROM_READ(i);
  caracteres[0] = 0b01111110;
}

// Programa Principal
void main(void) {

  /* Escrevendo dados na EEPROM
   * (só é necessário rodar uma vez)
  EEPROM_WRITE(0, 0b01111110);
  EEPROM_WRITE(1, 0b00110000);
  EEPROM_WRITE(2, 0b01101101);
  EEPROM_WRITE(3, 0b01111001);
  EEPROM_WRITE(4, 0b00110011);
  EEPROM_WRITE(5, 0b01011011);
  EEPROM_WRITE(6, 0b01011111);
  EEPROM_WRITE(7, 0b01110000);
  EEPROM_WRITE(8, 0b01111111);
  EEPROM_WRITE(9, 0b01110011);*/

  // Inicializações
  t0_init();          // inicializa Timer 0
  portA_init();
  portB_init();       // inicializa portB
  portC_init();       // inicializa portB
  vetor_caracteres_init();
  ei();               // macro do XC8, equivale a GIE = 1, habilita interrupções
```

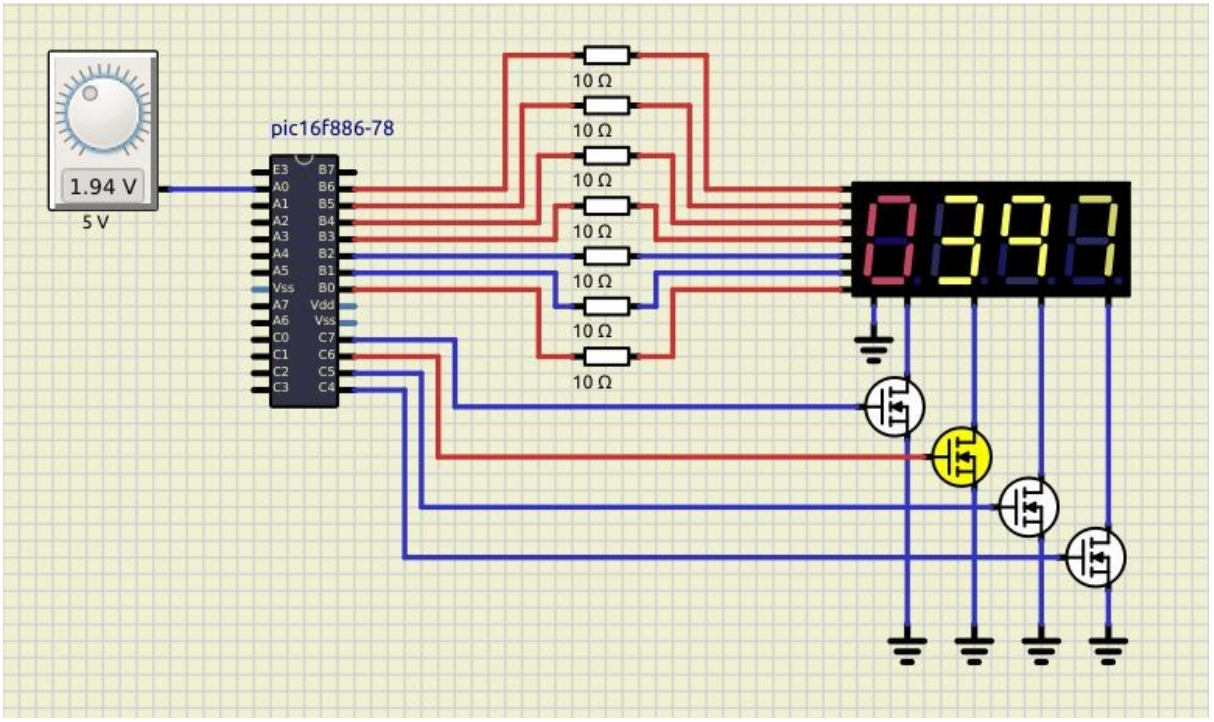
```
  // Loop principal (infinito))
  while(1) {
        //escrever os quatro números, da casa menos significantes para mais
        for (int i = 0; i < 4; i++) {
        int num = (int)((valorPot % pow(10, i+1)) / pow(10, i));
        PORTB = caracteres[num];
        PORTC = (1 << (i + 4)) |0b00000000;
        delay_ms(10); // espera de 10 ms -> refresh de 25Hz pro display inteiro
        }
  }
}
```

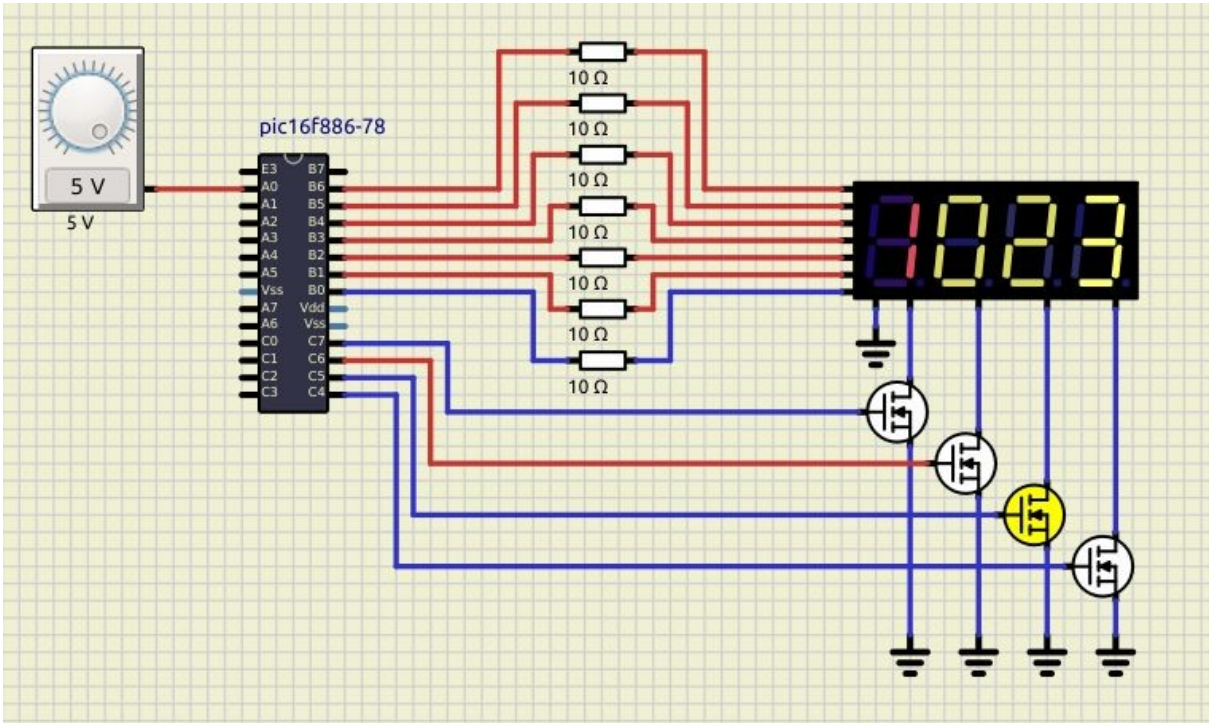
• Circuito em funcionamento:

Obs1: o valor dos resistores foi calculado em 600Ω, mas o com esses valores, os LEDs ficam pouco visíveis no simulIDE. Por isso os valores foram mudados para 10, o que está errado e possivelmente danificaria os LEDs na realidade.

Obs2: por algum bug do simulIDE, o display tem três números amarelos. Porém, nas propriedades dele, a cor é vermelha.







• Escolha de MOSFET:

Escolhemos um display de catodo comum, portanto devemos usar MOSFETs tipo N.

Requisitos:

Id > 45mA

Vgs > 5V

Vds > 5V

Vgs(th) < 2,4V

MOSFET escolhido: **DMN601VK**

DUAL N-CHANNEL ENHANCEMENT MODE FIELD EFFECT TRANSISTOR

Features

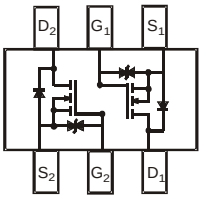
- Dual N-Channel MOSFET
- Low On-Resistance
- Low Gate Threshold Voltage
- Low Input Capacitance
- Fast Switching Speed
- Low Input/Output Leakage
- Ultra-Small Surface Mount Package
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **An Automotive-Compliant Part is Available Under Separate Datasheet (DMN601VKQ)**

Mechanical Data

- Case: SOT563
- Case Material: Molded Plastic, "Green" Molding Compound; UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminal Connections: See Diagram
- Terminals: Finish - Matte Tin Annealed over Copper Leadframe. Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.006 grams (Approximate)

SOT563

TOP VIEW



TOP VIEW
Internal Schematic

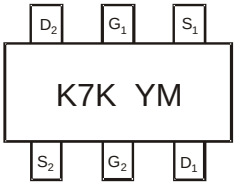
Ordering Information (Note 4)

Part Number	Case	Packaging
DMN601VK-7	SOT563	3,000/Tape & Reel

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. For packaging details, go to our website at http://www.diodes.com/products/packages.html.

Marking Information

SOT563



K7K = Marking Code
YM = Date Code Marking
Y = Year (ex: D = 2016)
M = Month (ex: 9 = September)

Date Code Key

Month	2005	…	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Code	S	…	C	D	E	F	G	H	I	J	K	L

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Code	1	2	3	4	5	6	7	8	9	O	N	D

Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

Characteristic		Symbol	Value	Unit
Drain-Source Voltage		V_{DSS}	60	V
Gate-Source Voltage		V_{GSS}	±20	V
Drain Current (Note 5)	Continuous Pulsed (Note 6)	I_D	305 800	mA

Thermal Characteristics (@T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Value	Unit
Total Power Dissipation (Note 5)	P_D	250	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	°C/W
Operating and Storage Temperature Range	T_J, T_{STG}	-65 to +150	°C

Electrical Characteristics (@T_A = +25°C unless otherwise specified.)

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
OFF CHARACTERISTICS (Note 7)						
Drain-Source Breakdown Voltage	BV_{DSS}	60	–	–	V	V_{GS} = 0V, I_D = 10μA
Zero Gate Voltage Drain Current	I_{DSS}	–	–	250	nA	V_{DS} = 50V, V_{GS} = 0V
Gate-Source Leakage	I_{GSS}	–	–	±500	nA	V_{GS} = ±10V, V_{DS} = 0V
		–	–	±100		V_{GS} = ±5V, V_{DS} = 0V
ON CHARACTERISTICS (Note 7)						
Gate Threshold Voltage	$V_{GS(th)}$	1.0	1.6	2.5	V	V_{DS} = V_{GS}, I_D = 250μA
Static Drain-Source On-Resistance	$R_{DS(ON)}$	– –	– –	2.0 3.0	Ω	V_{GS} = 10V, I_D = 0.5A V_{GS} = 4.5V, I_D = 200mA
Forward Transfer Admittance	$\|Y_{fs}\|$	–	284	–	ms	V_{DS} =10V, I_D = 0.2A
Diode Forward Voltage (Note 7)	V_{SD}	0.5	–	1.4	V	V_{GS} = 0V, I_S = 115mA
DYNAMIC CHARACTERISTICS						
Input Capacitance	C_{iss}	–	–	50	pF	V_{DS} = 25V, V_{GS} = 0V f = 1.0MHz
Output Capacitance	C_{oss}	–	–	25	pF	
Reverse Transfer Capacitance	C_{rss}	–	–	5.0	pF	

Notes: 5. Device mounted on FR-4 PCB.
6. Pulse width ≤10μs, Duty Cycle ≤1%.
7. Short duration pulse test used to minimize self-heating effect.