```c
/*
 * interrupt_echo_line.c
 *
 * Created: 3/18/2021 7:33:19 PM
 * Author : Judah Ben-Eliezer
 */

#define BAUD_RATE 4800UL                                                    //  ↵
  baud rate.
#define F_CPU 4000000UL                                                     //  ↵
  clock at 4 MHz.

#include <avr/io.h>
#include <util/delay.h>
#include <avr/interrupt.h>

uint8_t USART_sw_read();                                                    //  ↵
  read function declaration.
void USART_sw_write(char);                                                  //  ↵
  write function declaration.

char c[80];                                                                 //  ↵
  buffer.
uint8_t i = 0;

int main(void)
{
    PORTB.DIRCLR = PIN1_bm;                                                 //  ↵
      set PB1 as input.
    PORTB.PIN1CTRL |= PORT_ISC_FALLING_gc;                                  //  ↵
      enable interrupt on falling edge of PB1.
    sei();                                                                  //  ↵
      enable global interrupts.

    while (1)
    {
        asm volatile ("nop");                                               //  ↵
          nop to avoid optimization deletion of while loop.
    }
}

ISR (PORTB_PORT_vect) {
    c[i++] = USART_sw_read();                                               //  ↵
      call USART_sw_read.
    if (c[i] == 0x0D) {                                                     //  ↵
      check for CR.
        uint8_t j;
        for (j = 0; j <= i; ++j) {
            USART_sw_write(c[j]);                                           //  ↵
```

```
                write line.
39          }
40          i = 0;                                                  //  ↵
              clear buffer
41      }
42      PORTB.INTFLAGS |= PIN1_bm;                                  //  ↵
          clear interrupt.
43  }
44
45  uint8_t USART_sw_read() {
46
47      uint8_t d;                                                  //  ↵
          bit time.
48      if (BAUD_RATE == 4800UL) {
49          d = 48;
50      } else if (BAUD_RATE == 9600UL) {
51          d = 99;
52      } else if (BAUD_RATE == 19200UL) {
53          d = 201;
54      } else return 0x00;
55
56      uint8_t data = 0;
57
58      _delay_us(d/2);
59      if ((PORTB_IN & PIN1_bm) != 0) return 0x00;                 //  ↵
          check for false start.
60      _delay_us(d);                                               //  ↵
          delay for bit time.
61
62      uint8_t i;
63      for (i = 0; i < 8; ++i) {
64          data >>= data | ((PORTB_IN | PIN1_bm) << 6);            //  ↵
              read little endian input into data.
65          _delay_us(d);                                           //  ↵
              delay for bit time.
66      }
67
68      return data;
69  }
70
71  void USART_sw_write(char c) {
72      PORTB.DIRSET = PIN0_bm;                                     //  ↵
          set PB0 as output.
73      uint8_t d;                                                  //  ↵
          bit time.
74      if (BAUD_RATE == 4800L) {
75          d = 48;
76      } else if (BAUD_RATE == 9600L) {
77          d = 99;
```

```
78      } else if (BAUD_RATE == 19200L) {
79          d = 201;
80      } else return;
81
82      uint8_t data = (uint8_t) c;
83
84      PORTB_OUT = 0x00 | PIN0_bm;                                    //
          send start bit.
85      _delay_us(d);                                                  //
          delay for bit time.
86
87      uint8_t i;
88      for (i = 0; i < 8; ++i) {
89          PORTB_OUT = data | PIN0_bm;                                //
              send lsb of data.
90          data >>= data;                                             //
              shift data right.
91          _delay_us(d);                                              //
              delay for bit time.
92      }
93
94      PORTB_OUT = PIN0_bm;                                           //
          send end bit.
95      _delay_us(d);                                                  //
          delay for bit time.
96  }
97
98
```