Appendix A

The code :-

Project : control and mitigation of Drinking water losses in distribution system
Version : 2.5.3
Date : 20/09/2013
Author : Adam Mohamed Ibrahim
Company : Sudan University of science and technology
Chip type : ATmega32
Program type : Application
AVR Core Clock frequency: 4.000000 MHz
Memory model : Small
External RAM size : 0
Data Stack size : 512

/*************************************************************/

#include <mega32.h>
#include <delay.h>

// Alphanumeric LCD functions
#include <alcd.h>

// Standard Input/Output functions
#include <stdio.h>

// Timer 0 overflow interrupt service routine
interrupt [TIM0_OVF] void timer0_ovf_isr(void)
{
    // Place your code here
}

#define ADC_VREF_TYPE 0x00

// Read the AD conversion result
unsigned int read_adc(unsigned char adc_input)
{
    ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);
// Delay needed for the stabilization of the ADC input voltage
delay_us(10);
// Start the AD conversion
ADCSRA|=0x40;
// Wait for the AD conversion to complete
while ((ADCSRA & 0x10)==0);
ADCSRA|=0x10;
return ADCW;
}

unsigned adc_value;
// Declare your global variables here

void main(void)
{

// Declare your local variables here

// Input/Output Ports initialization
// Port A initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTA=0x00;
DDRA=0x00;

// Port B initialization
// Func7=In Func6=Out Func5=Out Func4=Out Func3=Out Func2=Out Func1=Out Func0=Out
// State7=T State6=0 State5=0 State4=0 State3=0 State2=0 State1=0 State0=0
PORTB=0x00;
DDRB=0x7F;
// Port C initialization
// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In
// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T
PORTC=0x00;
DDRC=0x00;
// Port D initialization
// Func7=Out Func6=Out Func5=Out Func4=Out Func3=Out Func2=Out
// Func1=Out Func0=Out
// State7=0 State6=0 State5=0 State4=0 State3=0 State2=0 State1=0
// State0=0
PORTD=0x00;
DDRD=0xFF;

// USART initialization
// Communication Parameters: 8 Data, 1 Stop, No Parity
// USART Receiver: On
// USART Transmitter: On
// USART Mode: Asynchronous
// USART Baud Rate: 9600
UCSRA=0x00;
UCSRB=0x18;
UCSRC=0x86;
UBRRH=0x00;
UBRRL=0x19;

// ADC initialization
// ADC Clock frequency: 1000.000 kHz
// ADC Voltage Reference: AREF pin
ADMUX=ADC_VREF_TYPE & 0xff;
ADCSRA=0x82;

// Alphanumeric LCD initialization
// Connections are specified in the
// Project|Configure|C Compiler|Libraries|Alphanumeric LCD menu:
// RS - PORTC Bit 0
// RD - PORTC Bit 1
// EN - PORTC Bit 2
// D4 - PORTC Bit 4
// D5 - PORTC Bit 5
// D6 - PORTC Bit 6
// D7 - PORTC Bit 7
// Characters/line: 16
lcd_init(16);
// Global enable interrupts
asm("sei")
while (1)
{
  adc_value=read_adc(0);
  if(adc_value>200&&adc_value<300)
  {PORTB.0=1;
   delay_us(1500);
   PORTB.0=0;
   lcd_putsf("pressure is medium in sensor one");
   delay_ms(1000);
   lcd_clear();
   lcd_putsf("open the valve one");
   delay_ms(1000);
   lcd_clear();
  }
  if(adc_value>=300)
  {
   PORTB.0=1;
   delay_us(2000);
   PORTB.0=0;
   lcd_putsf("pressure high in sensor one");
   delay_ms(1000);
   lcd_clear();
   lcd_putsf("turn off valve one");
   delay_ms(1000);
   lcd_clear();
  }
  if(adc_value<=200)
  {
   PORTB.0=1;
   delay_us(1000);
   PORTB.0=0;
   lcd_putsf("pressure is low in sensor one");
   delay_ms(1000);
   lcd_clear();
   lcd_putsf("turn on the valve one");
   delay_ms(1000);
   lcd_clear();
  }
}
/********************************************The operation of the sensor two and valve two********************************************
adc_value=read_adc(1);
if(adc_value>200&&adc_value<300)
{
  PORTB.1=1;
delay_us(1500);
  PORTB.1=0;
lcd_puts("pressure is medium in sensor two");
delay_ms(1000);
lcd_clear();
lcd_puts("open the valve two or check");
delay_ms(1000);
lcd_clear();
}
if(adc_value>=300)
{
  PORTB.1=1;
delay_us(2000);
  PORTB.1=0;
lcd_puts("pressure is high in sensor two");
delay_ms(1000);
lcd_clear();
lcd_puts("turn off valve two");
delay_ms(1000);
lcd_clear();
}
if(adc_value<=200)
{
  PORTB.1=1;
delay_us(1000);
  PORTB.1=0;
lcd_clear();
lcd_puts("pressure is low in sensor two");
delay_ms(2000);
lcd_clear();
lcd_puts("check the valve two for leak");
delay_ms(1000);
lcd_clear();
}
The operation of sensor and valve three

```c
adc_value=read_adc(2);
if(adc_value>200&&adc_value<300)
{
  PORTB.2=1;
delay_us(1500);
  PORTB.2=0;
lcd_putsf("pressure is medium in sensor three");
delay_ms(1000);
lcd_clear();
lcd_putsf("Open the valve three or check for leak");
delay_ms(1000);
lcd_clear();
}
if(adc_value>=300)
{
  PORTB.2=1;
delay_us(2000);
  PORTB.2=0;
lcd_putsf("pressure is high in sensor three");
delay_ms(1000);
lcd_clear();
lcd_putsf("please turn off the valve three");
delay_ms(1000);
lcd_clear();
}
if(adc_value<=200)
{
  PORTB.2=1;
delay_us(1000);
  PORTB.2=0;
lcd_putsf("pressure low in sensor three");
delay_ms(1000);
lcd_clear();
lcd_putsf("check the valve three for leak");
delay_ms(1000);
lcd_clear();
}
```

Appendix B

Liquid pressure sensor modeling circuit:

![Diagram of liquid pressure sensor circuit](image)

**Figure 7. Liquid Monitoring System**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>LM741A</th>
<th>LM741</th>
<th>LM741C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Offset Voltage</td>
<td>$T_A = 25^\circ C$</td>
<td>0.8</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>$R_S \leq 10 , \Omega$</td>
<td>3.0</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>$R_S \leq 5 , \Omega$</td>
<td>4.0</td>
<td>6.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Average Input Offset Voltage</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Units: mV, μV/°C
### Electrical Characteristics (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>LM741A</th>
<th>LM741</th>
<th>LM741C</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Offset Voltage Adjustment Range</strong></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td><strong>Input Offset Current</strong></td>
<td></td>
<td>±0.3</td>
<td>0.2</td>
<td>0.3</td>
<td>±0.3</td>
</tr>
<tr>
<td><strong>Large Signal Voltage Gain</strong></td>
<td></td>
<td>±1.5</td>
<td>±1.5</td>
<td>±1.5</td>
<td>±1.5</td>
</tr>
<tr>
<td><strong>Output Voltage Swing</strong></td>
<td></td>
<td>±0.15</td>
<td>±0.15</td>
<td></td>
<td>±0.15</td>
</tr>
<tr>
<td><strong>Common-Mode Rejection Ratio</strong></td>
<td></td>
<td>±1.5</td>
<td>±1.5</td>
<td>±1.5</td>
<td>±1.5</td>
</tr>
<tr>
<td><strong>Supply Voltage Rejection Ratio</strong></td>
<td></td>
<td>±1.5</td>
<td>±1.5</td>
<td>±1.5</td>
<td>±1.5</td>
</tr>
<tr>
<td><strong>Transient Response Time Overhead</strong></td>
<td></td>
<td>±0.05</td>
<td>±0.05</td>
<td>±0.05</td>
<td>±0.05</td>
</tr>
<tr>
<td><strong>Bandwidth (2)</strong></td>
<td></td>
<td>0.43</td>
<td>1.5</td>
<td></td>
<td>0.43</td>
</tr>
<tr>
<td><strong>Slew Rate</strong></td>
<td></td>
<td>0.3</td>
<td>0.7</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td></td>
<td>±1.7</td>
<td>±2.8</td>
<td>±1.7</td>
<td>±2.8</td>
</tr>
</tbody>
</table>

### Electrical Characteristics (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>LM741A</th>
<th>LM741</th>
<th>LM741C</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LM741A</strong></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td><strong>LM741</strong></td>
<td></td>
<td>165</td>
<td>135</td>
<td></td>
<td>165</td>
</tr>
</tbody>
</table>

### Thermal Resistances

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_J$ (Junction to Ambient)</td>
<td>100°CW</td>
</tr>
<tr>
<td>$\theta_C$ (Junction to Case)</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### OPERATING CHARACTERISTICS

(Vg = 5.1 Vdc, Ta = 25°C unless otherwise noted, P1 > P2. Decoupling circuit shown in Figure 3 required to meet Electrical Specifications.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Range</td>
<td>Pₚₑₑ</td>
<td>15</td>
<td>—</td>
<td>115</td>
<td>kPa</td>
</tr>
<tr>
<td>Supply Voltage(1)</td>
<td>Vₚₑₑ</td>
<td>4.65</td>
<td>5.1</td>
<td>5.35</td>
<td>Vdc</td>
</tr>
<tr>
<td>Supply Current</td>
<td>Is</td>
<td>—</td>
<td>7.0</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>Minimum Pressure Offset(2)</td>
<td></td>
<td></td>
<td>Vₚₑₑ</td>
<td></td>
<td>Vdc</td>
</tr>
<tr>
<td>@ Vg = 5.1 Volts, (0 to 85°C)</td>
<td></td>
<td></td>
<td>0.135</td>
<td>0.204</td>
<td>0.273</td>
</tr>
<tr>
<td>Full Scale Output(3)</td>
<td></td>
<td></td>
<td>Vₚₑₑ</td>
<td></td>
<td>Vdc</td>
</tr>
<tr>
<td>@ Vg = 5.1 Volts, (0 to 85°C)</td>
<td></td>
<td></td>
<td>4.725</td>
<td>4.794</td>
<td>4.833</td>
</tr>
<tr>
<td>Full Scale Span(4)</td>
<td></td>
<td></td>
<td>Vₚₑₑ</td>
<td></td>
<td>Vdc</td>
</tr>
<tr>
<td>@ Vg = 5.1 Volts, (0 to 85°C)</td>
<td></td>
<td></td>
<td>4.521</td>
<td>4.590</td>
<td>4.659</td>
</tr>
<tr>
<td>Accuracy(5)</td>
<td></td>
<td></td>
<td>—</td>
<td>—</td>
<td>±1.5% Vₚₑₑ</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>V/P</td>
<td>—</td>
<td>45.9</td>
<td>—</td>
<td>mV/NPa</td>
</tr>
<tr>
<td>Response Time(6)</td>
<td>tₑₑ</td>
<td>—</td>
<td>1.0</td>
<td>—</td>
<td>ms</td>
</tr>
<tr>
<td>Output Source Current at Full Scale Output</td>
<td>Iₑₑ</td>
<td>—</td>
<td>0.1</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>Warm-Up Time(7)</td>
<td></td>
<td></td>
<td>20</td>
<td>—</td>
<td>ms</td>
</tr>
<tr>
<td>Offset Stability(8)</td>
<td></td>
<td></td>
<td>±0.5</td>
<td>—</td>
<td>% Vₚₑₑ</td>
</tr>
</tbody>
</table>
Appendix  D

Datasheet ASK transmitter & Receiver

Features
- Operating voltage
  - 2.4V–5V for the HT12A
  - 2.4V–12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low standby current: 0.1μA (typ.) at VDD=5V
- HT12A with a 38kHz carrier for infrared transmission medium
- Minimum transmission word
  - One word for the HT12E
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity
- Minimal external components
- HT12A/E: 18-pin DIP/20-pin SOP package

Applications
- Burglar alarm system
- Smoke and fire alarm system
- Garage door controllers
- Car door controllers
- Car alarm system
- Security system
- Cordless telephones
- Other remote control systems

General Description
The 2^{12} encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12–N data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E or a DATA trigger on the HT12A further enhances the application flexibility of the 2^{12} series of encoders. The HT12A additionally provides a 38kHz carrier for infrared systems.

Selection Table

<table>
<thead>
<tr>
<th>Function</th>
<th>Address No.</th>
<th>Address/ Data No.</th>
<th>Data No.</th>
<th>Oscillator</th>
<th>Trigger</th>
<th>Package</th>
<th>Carrier Output</th>
<th>Negative Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>HT12A</td>
<td>8</td>
<td>8</td>
<td>4</td>
<td>455kHz resonator</td>
<td>D8–D11</td>
<td>18 DIP</td>
<td>38kHz</td>
<td>No</td>
</tr>
<tr>
<td>HT12E</td>
<td>8</td>
<td>4</td>
<td>0</td>
<td>RC oscillator</td>
<td>TE</td>
<td>18 DIP</td>
<td>38kHz</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: Address/Data represents pins that can be address or data according to the decoder requirement.
Block Diagram

**TE trigger**

HT12E

![Block Diagram TE trigger](image)

**DATA trigger**

HT12A

![Block Diagram DATA trigger](image)

Note: The address data pins are available in various combinations (refer to the address/data table).
## Pin Assignment

<table>
<thead>
<tr>
<th>8-Address 4-Data</th>
<th>8-Address 4-Data</th>
<th>8-Address 4-Data</th>
<th>8-Address 4-Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0 □ 1</td>
<td>18□ VDD</td>
<td>A0 □ 1</td>
<td>18□ VDD</td>
</tr>
<tr>
<td>A1 □ 2</td>
<td>17□ DOUT</td>
<td>A1 □ 2</td>
<td>17□ DOUT</td>
</tr>
<tr>
<td>A2 □ 3</td>
<td>18□ X1</td>
<td>A2 □ 3</td>
<td>18□ X1</td>
</tr>
<tr>
<td>A3 □ 4</td>
<td>19□ X2</td>
<td>A3 □ 4</td>
<td>19□ X2</td>
</tr>
<tr>
<td>A4 □ 5</td>
<td>14□ L/M8</td>
<td>A4 □ 5</td>
<td>14□ L/M8</td>
</tr>
<tr>
<td>A5 □ 6</td>
<td>15□ D11</td>
<td>A5 □ 6</td>
<td>15□ D11</td>
</tr>
<tr>
<td>A6 □ 7</td>
<td>16□ D10</td>
<td>A6 □ 7</td>
<td>16□ D10</td>
</tr>
<tr>
<td>A7 □ 8</td>
<td>17□ D9</td>
<td>A7 □ 8</td>
<td>17□ D9</td>
</tr>
<tr>
<td>VSS □ 9</td>
<td>18□ D8</td>
<td>VSS □ 9</td>
<td>18□ D8</td>
</tr>
<tr>
<td>H12A □ 18 DIP</td>
<td>H12A □ 20 SOP</td>
<td>H12E □ 18 DIP</td>
<td>H12E □ 20 SOP</td>
</tr>
</tbody>
</table>

## Pin Description

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>I/O</th>
<th>Internal Connection</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0–A7</td>
<td>I</td>
<td>CMOS IN Pull-high (HT12A)</td>
<td>Input pins for address A0–A7 setting. These pins can be externally set to VSS or left open.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)</td>
<td></td>
</tr>
<tr>
<td>AD8–AD11</td>
<td>I</td>
<td>CMOS IN Pull-high</td>
<td>Input pins for address/data AD8–AD11 setting. These pins can be externally set to VSS or left open.</td>
</tr>
<tr>
<td>D8–D11</td>
<td>I</td>
<td>CMOS OUT</td>
<td>Encoder data serial transmission output.</td>
</tr>
<tr>
<td>DOUT</td>
<td>O</td>
<td>CMOS OUT</td>
<td>Encoder data serial transmission output.</td>
</tr>
<tr>
<td>L/M8</td>
<td>I</td>
<td>CMOS IN Pull-high</td>
<td>Latch/ Momentary transmission format selection pin: Latch: Floating or VDD Momentary: VSS.</td>
</tr>
</tbody>
</table>

3
April 11, 2000
Appendix C

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>I/O</th>
<th>Connection</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE</td>
<td>1</td>
<td>CMOS IN</td>
<td>Transmission enable, active low (see Note)</td>
</tr>
<tr>
<td>OSC1</td>
<td>1</td>
<td>OSCILLATOR 1</td>
<td>Oscillator input pin</td>
</tr>
<tr>
<td>OSC2</td>
<td>0</td>
<td>OSCILLATOR 1</td>
<td>Oscillator output pin</td>
</tr>
<tr>
<td>X1</td>
<td>1</td>
<td>OSCILLATOR 2</td>
<td>455kHz resonator oscillator input</td>
</tr>
<tr>
<td>X2</td>
<td>0</td>
<td>OSCILLATOR 2</td>
<td>455kHz resonator oscillator output</td>
</tr>
<tr>
<td>VSS</td>
<td>1</td>
<td>—</td>
<td>Negative power supply, grounds</td>
</tr>
<tr>
<td>VDD</td>
<td>1</td>
<td>—</td>
<td>Positive power supply</td>
</tr>
</tbody>
</table>

Note: D8–D11 are all data input and transmission enable pins of the HT12A. TE is a transmission enable pin of the HT12E.

Approximate internal connections

![Diagram of internal connections]

Absolute Maximum Ratings

Supply Voltage (HT12A) ...............-0.3V to 5.5V
Input Voltage .....................VSS to VDD+0.3V
Operating Temperature ............-20°C to 75°C

Note: These are stress ratings only. Stresses exceeding the range specified under “Absolute Maximum Ratings” may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.
## Electrical Characteristics

### HT12A

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(_{DD})</td>
<td>Operating Voltage</td>
<td>—</td>
<td>2.4</td>
<td>3</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>I(_{STB})</td>
<td>Standby Current</td>
<td>—</td>
<td>—</td>
<td>0.1</td>
<td>1</td>
<td>(\mu)A</td>
</tr>
<tr>
<td>I(_{DD})</td>
<td>Operating Current</td>
<td>3V Oscillator stops</td>
<td>—</td>
<td>0.1</td>
<td>1</td>
<td>(\mu)A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5V</td>
<td>—</td>
<td>0.1</td>
<td>1</td>
<td>(\mu)A</td>
</tr>
<tr>
<td>I(_{DOUT})</td>
<td>Output Drive Current</td>
<td>3V No load (f_{OSC}=455kHz)</td>
<td>—</td>
<td>200</td>
<td>400</td>
<td>(\mu)A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5V</td>
<td>—</td>
<td>400</td>
<td>800</td>
<td>(\mu)A</td>
</tr>
<tr>
<td>V(_{IH})</td>
<td>“H” Input Voltage</td>
<td>—</td>
<td>—</td>
<td>0.8(V_{DD})</td>
<td>—</td>
<td>(V_{DD})</td>
</tr>
<tr>
<td>V(_{IL})</td>
<td>“L” Input Voltage</td>
<td>—</td>
<td>—</td>
<td>0</td>
<td>0.2(V_{DD})</td>
<td>—</td>
</tr>
<tr>
<td>R(_{DATA})</td>
<td>D8–D11 Pull-high Resistance</td>
<td>5V (V_{DATA}=0V)</td>
<td>—</td>
<td>150</td>
<td>300</td>
<td>k(\Omega)</td>
</tr>
</tbody>
</table>

### HT12E

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(_{DD})</td>
<td>Operating Voltage</td>
<td>—</td>
<td>2.4</td>
<td>5</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>I(_{STB})</td>
<td>Standby Current</td>
<td>—</td>
<td>—</td>
<td>0.1</td>
<td>1</td>
<td>(\mu)A</td>
</tr>
<tr>
<td>I(_{DD})</td>
<td>Operating Current</td>
<td>3V Oscillator stops</td>
<td>—</td>
<td>2</td>
<td>4</td>
<td>(\mu)A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12V</td>
<td>—</td>
<td>2</td>
<td>4</td>
<td>(\mu)A</td>
</tr>
<tr>
<td>I(_{DOUT})</td>
<td>Output Drive Current</td>
<td>3V No load (f_{OSC}=3kHz)</td>
<td>—</td>
<td>40</td>
<td>80</td>
<td>(\mu)A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12V</td>
<td>—</td>
<td>150</td>
<td>300</td>
<td>(\mu)A</td>
</tr>
<tr>
<td>V(_{IH})</td>
<td>“H” Input Voltage</td>
<td>—</td>
<td>—</td>
<td>0.8(V_{DD})</td>
<td>—</td>
<td>(V_{DD})</td>
</tr>
<tr>
<td>V(_{IL})</td>
<td>“L” Input Voltage</td>
<td>—</td>
<td>—</td>
<td>0</td>
<td>0.2(V_{DD})</td>
<td>—</td>
</tr>
<tr>
<td>f(_{OSC})</td>
<td>Oscillator Frequency</td>
<td>5V (R_{OSC}=1.1M\Omega)</td>
<td>—</td>
<td>3</td>
<td>—</td>
<td>kHz</td>
</tr>
<tr>
<td>R(_{TE})</td>
<td>TE Pull-high Resistance</td>
<td>5V (V_{TE}=0V)</td>
<td>—</td>
<td>1.5</td>
<td>3</td>
<td>M(\Omega)</td>
</tr>
</tbody>
</table>
**Functional Description**

**Operation**
The 2ⁱ² series of encoders begin a 4-word transmission cycle upon receipt of a transmission enable (TE for the HT12E or D8-D11 for the HT12A, active low). This cycle will repeat itself as long as the transmission enable (TE or D8-D11) is held low. Once the transmission enable returns high, the encoder output completes its final cycle and then stops as shown below.

![Transmission timing for the HT12E](image1.png)

Transmission timing for the HT12E

![Transmission timing for the HT12A (L/MB=Floating or VDD)](image2.png)

Transmission timing for the HT12A (L/MB=VSS)
Information word

If L/MB=1 the device is in the latch mode (for use with the latch type of data decoders). When the transmission enable is removed during a transmission, the DOUT pin outputs a complete word and then stops. On the other hand, if L/MB=0 the device is in the momentary mode (for use with the momentary type of data decoders). When the transmission enable is removed during a transmission, the DOUT outputs a complete word and then adds 7 words all with the “1” data code.

An information word consists of 4 periods as illustrated below.

Composition of information

Address/data waveform

Each programmable address/data pin can be externally set to one of the following two logic states as shown below.

Address/Data bit waveform for the HT12E

Address/Data bit waveform for the HT12A
The address/data bits of the HT12A are transmitted with a 38kHz carrier for infrared remote controller flexibility.

**Address/data programming (preset)**

The status of each address/data pin can be individually pre-set to logic "high" or "low". If a transmission-enable signal is applied, the encoder scans and transmits the status of the 12 bits of address/data serially in the order A0 to AD11 for the HT12E encoder and A0 to D11 for the HT12A encoder.

During information transmission these bits are transmitted with a preceding synchronization bit. If the trigger signal is not applied, the chip enters the standby mode and consumes a reduced current of less than 1μA for a supply voltage of 5V.

Usual applications preset the address pins with individual security codes using DIP switches or PCB wiring, while the data is selected by push buttons or electronic switches.

The following figure shows an application using the HT12E:

![Diagram](attachment:image.png)

The transmitted information is as shown:

<table>
<thead>
<tr>
<th>Pilot &amp; Sync.</th>
<th>A0</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>A7</th>
<th>AD8</th>
<th>AD9</th>
<th>AD10</th>
<th>AD11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Address/Data sequence

The following provides the address/data sequence table for various models of the $2^{12}$ series of encoders. The correct device should be selected according to the individual address and data requirements.

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Address/Data Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>HT12A</td>
<td>A0</td>
</tr>
<tr>
<td>HT12E</td>
<td>A0</td>
</tr>
</tbody>
</table>

Transmission enable

For the HT12E encoders, transmission is enabled by applying a low signal to the $\overline{TE}$ pin. For the HT12A encoders, transmission is enabled by applying a low signal to one of the data pins D8–D11.

Two erroneous HT12E application circuits

The HT12E must follow closely the application circuits provided by Holtek (see the "Application circuits").

* Error: AD8–AD11 pins input voltage > $V_{DD} + 0.3V$
Error: The IC’s power source is activated by pins AD8–AD11

Flowchart

- **HT12A**
  
  - Power on
  
  - Standby mode

  - Data enable?
    
    - Yes
      
      - Data with carrier serial output
        
        - Data still enabled?
          
          - Yes
            
            - L/MB=GND?
              
              - Yes
                
                - Send the last code
              
              - No
                
                - Send "1" 7 times for all of the data codes
          
          - No
        
    - No

- **HT12E**
  
  - Power on
  
  - Standby mode

  - Transmission enabled?
    
    - Yes
      
      - 4 data words transmitted
        
        - Transmission still enabled?
          
          - Yes
            
            - 4 data words transmitted continuously
          
          - No
            
            - Transmission enabled?
              
              - Yes
                
                - 4 data words transmitted
              
              - No

Note: D8–D11 are transmission enables of the HT12A. TE is the transmission enable of the HT12E.
Oscillator frequency vs supply voltage

The recommended oscillator frequency is $f_{\text{OSCD (decoder)}} \leq 50 f_{\text{OSCE (HT12E encoder)}}$

$\leq \frac{1}{3} f_{\text{OSCE (HT12A encoder)}}$

Application Circuits

Note: Typical infrared diode: EL-1L2 (KODENSHI CORP.)
Typical RF transmitter: JR-220 (JUWA CORP.)
*Frequency Range: 433.92 MHz
*Modulate Mode: ASK
*Circuit Shape: SAW
*Date Rate: 8kbps
*Supply Voltage: 3~12 V
*Power Supply and All Input / Output Pins: -0.3 to +12.0 V
*Non-Operating Case Temperature: -20 to +85 °C
*Soldering Temperature (10 Seconds ): 230 °C (10 Seconds )

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Rating</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply and All Input/Output Pins</td>
<td>-0.3 to +12.0</td>
<td>V</td>
</tr>
<tr>
<td>Non-Operating Case Temperature</td>
<td>-20 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Soldering Temperature(10 seconds)</td>
<td>230</td>
<td>°C</td>
</tr>
</tbody>
</table>

Electrical Characteristics, $T=25^\circ C$, $V_{cc}=3.6v$, $Freq=433.92MHz$

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sym</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Frequency (200KHz)</td>
<td>Vcc</td>
<td>433.92</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Rate</td>
<td>ASK</td>
<td>8K</td>
<td>Kbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmitter Performance(<a href="mailto:OOK@2.4kbps">OOK@2.4kbps</a>)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Input Current,12 Vdc Supply</td>
<td>ITP</td>
<td>45</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Output Power</td>
<td>PO</td>
<td>10</td>
<td>mW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn On/ Turn Off Time</td>
<td>T ON/T OFF</td>
<td>1</td>
<td>US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply Voltage Range</td>
<td>Vcc</td>
<td>3</td>
<td>VDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Ambient Temperature</td>
<td>TA</td>
<td>-20</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tx Antenna Out (3V) +2.4dB</td>
<td>Vcc</td>
<td></td>
<td>mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Application Note:

pin 1: GND
pin 2: Data in
pin 3: VCC
pin 4: ANT
Application Note: