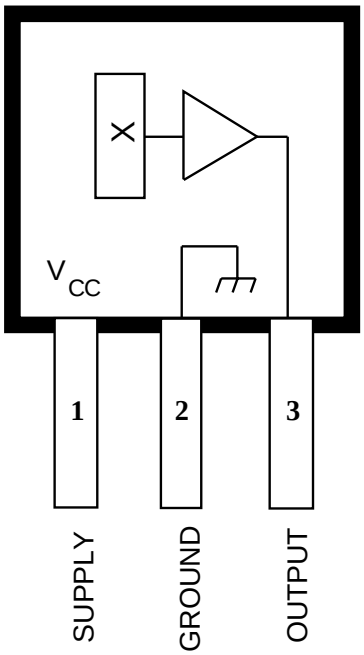
3503

Data Sheet
27501Bt

RATIOMETRIC, LINEAR HALL-EFFECT SENSORS



Dwg. PH-006

Pinning is shown viewed from branded side.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC} ..... **8 V**
Magnetic Flux Density, B ..... **Unlimited**
Operating Temperature Range,
T_A ..... **-20°C to +85°C**
Storage Temperature Range,
T_S ..... **-65°C to +150°C**

The UGN3503LT, UGN3503U, and UGN3503UA Hall-effect sensors accurately track extremely small changes in magnetic flux density—changes generally too small to operate Hall-effect switches.

As motion detectors, gear tooth sensors, and proximity detectors, they are magnetically driven mirrors of mechanical events. As sensitive monitors of electromagnets, they can effectively measure a system's performance with negligible system loading while providing isolation from contaminated and electrically noisy environments.

Each Hall-effect integrated circuit includes a Hall sensing element, linear amplifier, and emitter-follower output stage. Problems associated with handling tiny analog signals are minimized by having the Hall cell and amplifier on a single chip.

Three package styles provide a magnetically optimized package for most applications. Package suffix ‘LT’ is a miniature SOT-89/TO-243AA transistor package for surface-mount applications; suffix ‘U’ is a miniature three-lead plastic SIP, while ‘UA’ is a three-lead ultra-mini-SIP. All devices are rated for continuous operation over the temperature range of -20°C to +85°C.

FEATURES

- Extremely Sensitive
- Flat Response to 23 kHz
- Low-Noise Output
- 4.5 V to 6 V Operation
- Magnetically Optimized Package

Always order by complete part number, e.g., **UGN3503UA**.

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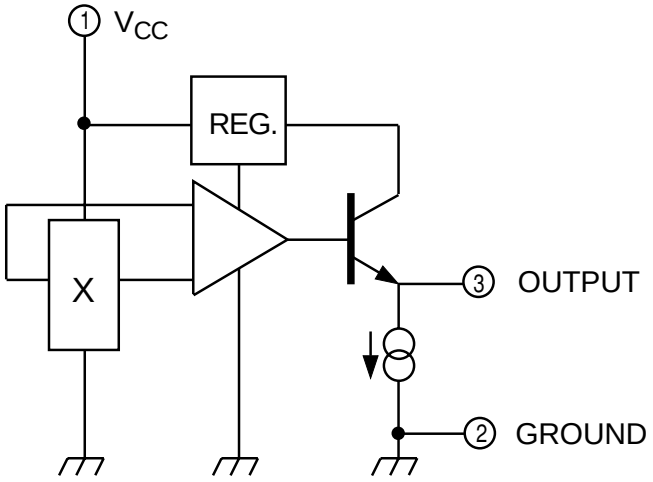
RATIOMETRIC, LINEAR HALL-EFFECT SENSORS

FUNCTIONAL BLOCK DIAGRAM



Dwg. FH-007

ELECTRICAL CHARACTERISTICS at T_A = +25°C, V_{CC} = 5 V

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
Operating Voltage	V_{CC}		4.5	—	6.0	V
Supply Current	I_{CC}		—	9.0	13	mA
Quiescent Output Voltage	V_{OUT}	B = 0 G	2.25	2.50	2.75	V
Sensitivity	ΔV_{OUT}	B = 0 G to ±900 G	0.75	1.30	1.75	mV/G
Bandwidth (-3 dB)	BW		—	23	—	kHz
Broadband Output Noise	V_{out}	BW = 10 Hz to 10 kHz	—	90	—	µV
Output Resistance	R_{OUT}		—	50	220	Ω

All output-voltage measurements are made with a voltmeter having an input impedance of at least 10 kΩ.

Magnetic flux density is measured at most sensitive area of device located 0.0165" (0.42 mm) below the branded face of the 'U' package; 0.0195" (0.50 mm) below the branded face of the 'UA' package; and 0.0305" (0.775 mm) below the branded face of the 'LT' package.

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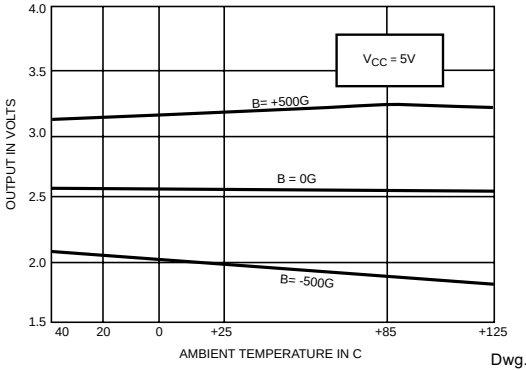
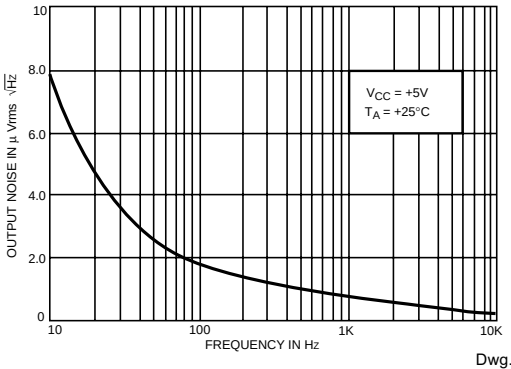
OUTPUT VOLTAGE AS A FUNCTION OF TEMPERATURE



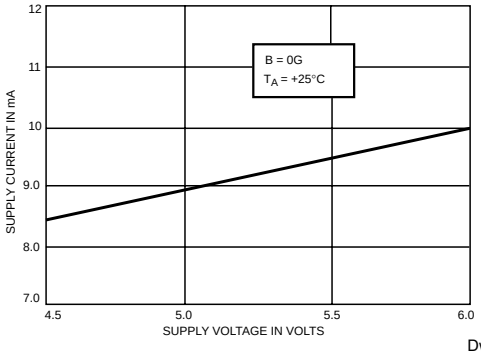
Dwg. A-12,573

OUTPUT NOISE AS A FUNCTION OF FREQUENCY



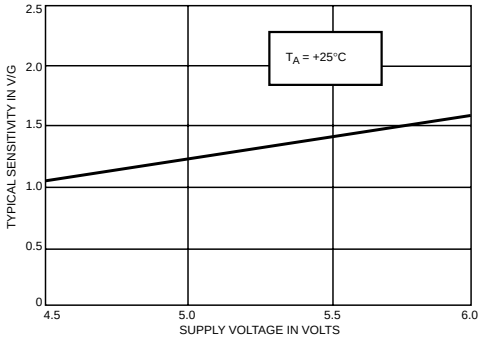
Dwg. A-12,505

SUPPLY CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



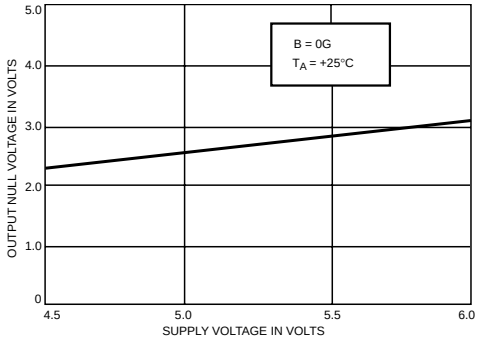
Dwg. A-12,506

DEVICE SENSITIVITY AS A FUNCTION OF SUPPLY VOLTAGE



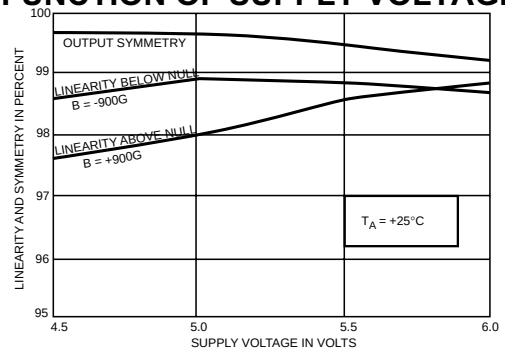
Dwg. A-12,507

OUTPUT NULL VOLTAGE AS A FUNCTION OF SUPPLY VOLTAGE



Dwg. A-12,508

LINEARITY AND SYMMETRY AS A FUNCTION OF SUPPLY VOLTAGE



Dwg.A-12,509

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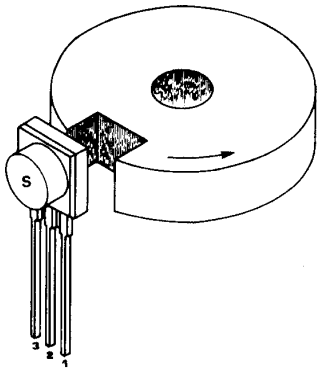
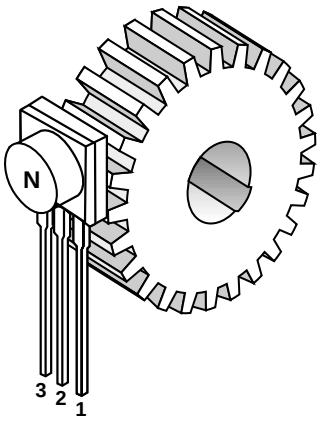
RATIOMETRIC, LINEAR HALL-EFFECT SENSORS

NOTCH SENSOR



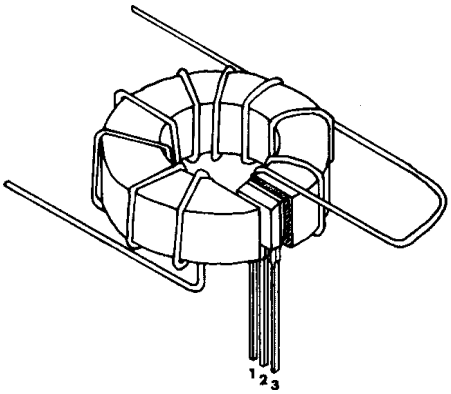
Dwg. A-12,574

GEAR TOOTH SENSOR



Dwg. A-12,512

CURRENT MONITOR



Dwg. A-12,513

OPERATION

The output null voltage (B = 0 G) is nominally one-half the supply voltage. A south magnetic pole, presented to the branded face of the Hall-effect sensor will drive the output higher than the null voltage level. A north magnetic pole will drive the output below the null level.

In operation, instantaneous and proportional output-voltage levels are dependent on magnetic flux density at the most sensitive area of the device. Greatest sensitivity is obtained with a supply voltage of 6 V, but at the cost of increased supply current and a slight loss of output symmetry. The sensor's output is usually capacitively coupled to an amplifier that boosts the output above the millivolt level.

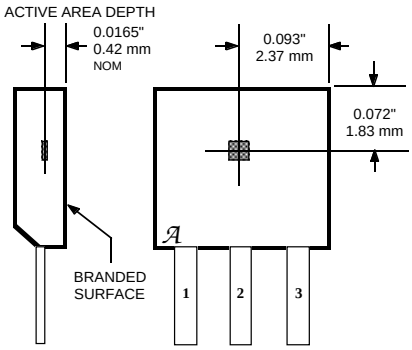
In two applications shown, a permanent bias magnet is attached with epoxy glue to the back of the epoxy package. The presence of ferrous material at the face of the package acts as a flux concentrator.

The south pole of a magnet is attached to the back of the package if the Hall-effect IC is to sense the presence of ferrous material. The north pole of a magnet is attached to the back surface if the integrated circuit is to sense the absence of ferrous matrial.

Calibrated linear Hall devices, which can be used to determine the actual flux density presented to the sensor in a particular application, are available.

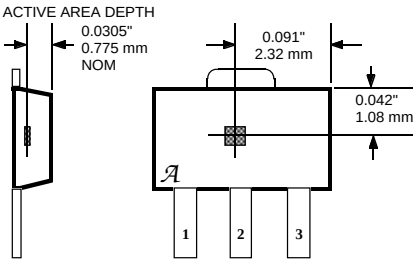
SENSOR LOCATIONS

SUFFIX “U”



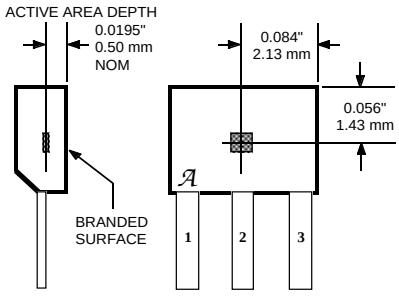
Dwg. MH-002-5D

SUFFIX “LT”



Dwg. MH-008-9A

SUFFIX “UA”



Dwg. MH-011-3D

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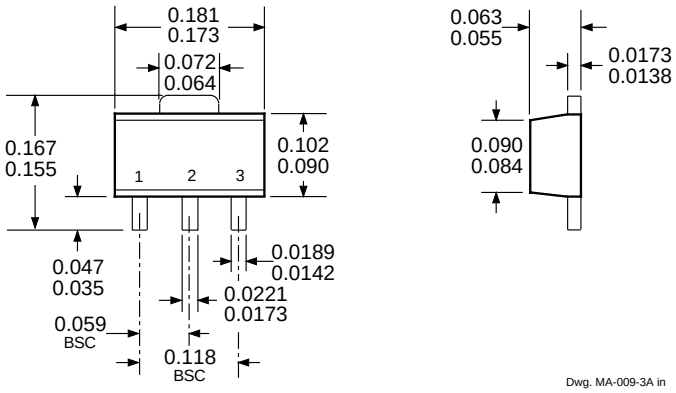
UGN3503LT

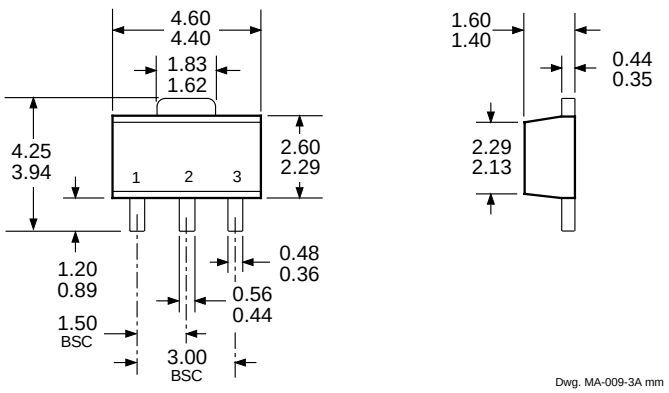
(SOT89/TO-243AA)

Dimensions in Inches
(for reference only)

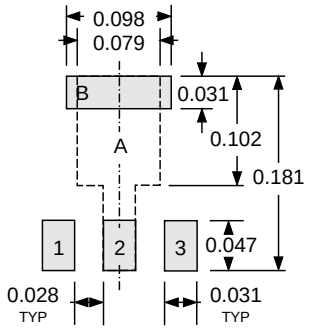


Dwg. MA-009-3A in

Dimensions in Millimeters
(controlling dimensions)

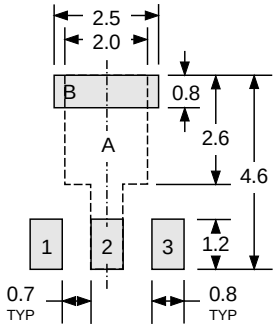


Dwg. MA-009-3A mm



Pads 1, 2, 3, and A — Standard SOT89 Layout
Pads 1, 2, 3, and B — Low-Stress Version
Pads 1, 2, and 3 only — Lowest Stress, But Not Self Aligning

Dwg. MA-012-3 in



Pads 1, 2, 3, and A — Standard SOT89 Layout
Pads 1, 2, 3, and B — Low-Stress Version
Pads 1, 2, and 3 only — Lowest Stress, But Not Self Aligning

Dwg. MA-012-3 mm

NOTES: 1. Exact body and lead configuration at vendor's option within limits shown.
2. Supplied in bulk pack (500 pieces per bag) or add "TR" to part number for tape and reel.
3. Only low-temperature (≤240°C) reflow-soldering techniques are recommended for SOT89 devices.

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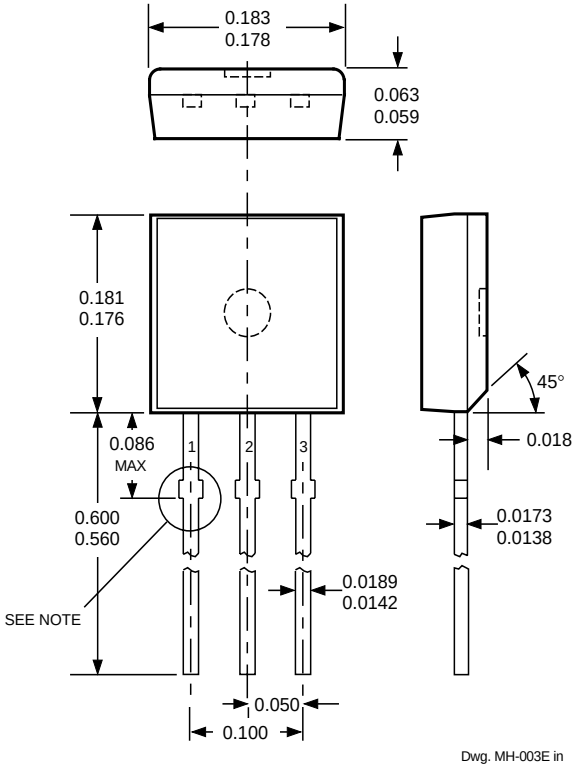
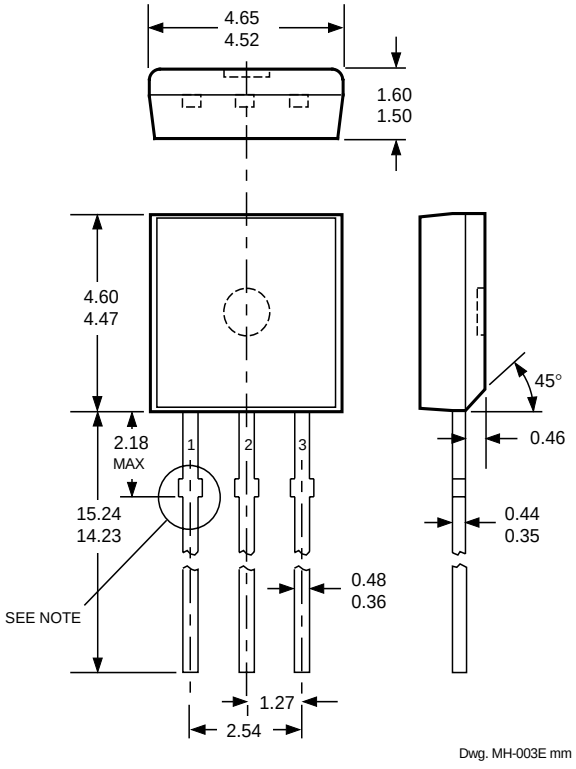
UGN3503U

Dimensions in Inches
(controlling dimensions)



Dwg. MH-003E in

Dimensions in Millimeters
(for reference only)



Dwg. MH-003E mm

Devices in the ‘U’ package are NOT RECOMMENDED FOR NEW DESIGN

NOTES:
1. Tolerances on package height and width represent allowable mold offsets. Dimensions given are measured at the widest point (parting line).
2. Exact body and lead configuration at vendor’s option within limits shown.
3. Height does not include mold gate flash.
4. Recommended minimum PWB hole diameter to clear transition area is 0.035" (0.89 mm).
5. Minimum lead length was 0.500" (12.70 mm). If existing product to the original specifications is not acceptable, contact sales office before ordering.

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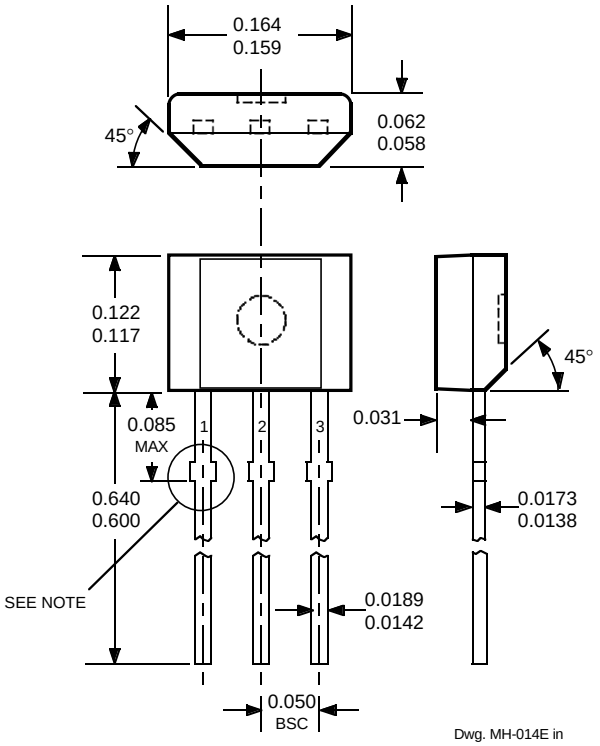
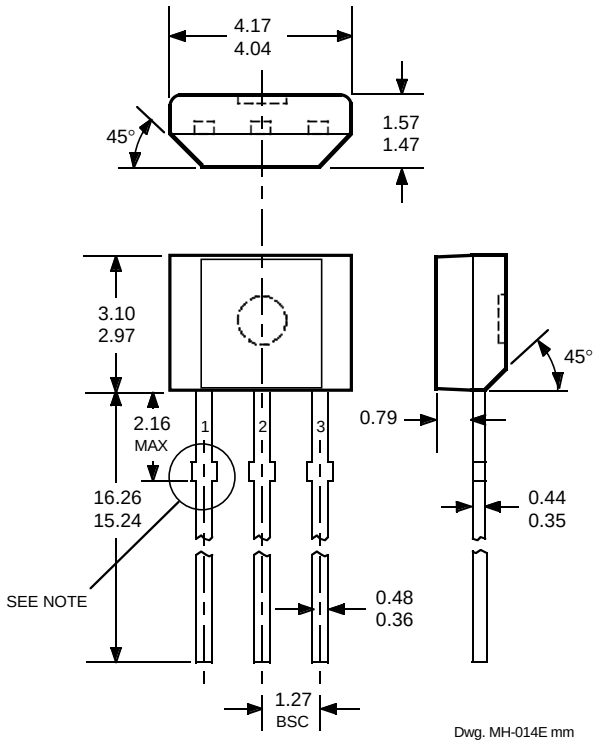
UGN3503UA

Dimensions in Inches
(controlling dimensions)

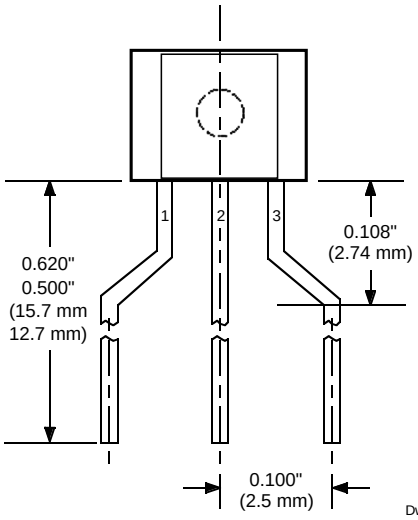


Dimensions in Millimeters
(for reference only)



NOTES:
1. Tolerances on package height and width represent allowable mold offsets. Dimensions given are measured at the widest point (parting line).
2. Exact body and lead configuration at vendor's option within limits shown.
3. Height does not include mold gate flash.
4. Recommended minimum PWB hole diameter to clear transition area is 0.035" (0.89 mm).
5. Where no tolerance is specified, dimension is nominal.
6. Supplied in bulk pack (500 pieces per bag).

Radial Lead Form (order UGN3503UA-LC)



NOTE: Lead-form dimensions are the nominals produced on the forming equipment. No dimensional tolerance is implied or guaranteed for bulk packaging (500 pieces per bag).

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RATIOMETRIC, LINEAR HALL-EFFECT SENSORS

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Keypad 4x4™

Manual

All Mikroelektronika's development systems feature a large number of peripheral modules expanding microcontroller's range of application and making the process of program testing easier. In addition to these modules, it is also possible to use numerous additional modules linked to the development system through the I/O port connectors. Some of these additional modules can operate as stand-alone devices without being connected to the microcontroller.

Additional board

MikroElektronika
SOFTWARE AND HARDWARE SOLUTIONS FOR EMBEDDED WORLD ...making it simple

Keypad 4x4

Keypad 4x4 is used for loading numerics into the microcontroller. It consists of 16 buttons arranged in a form of an array containig four lines and four columns. It is connected to the development system by regular IDC 10 female connector plugged in some development system's port.

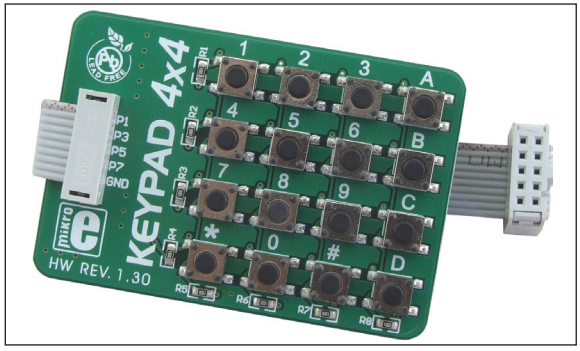

Figure 1: Keypad 4x4

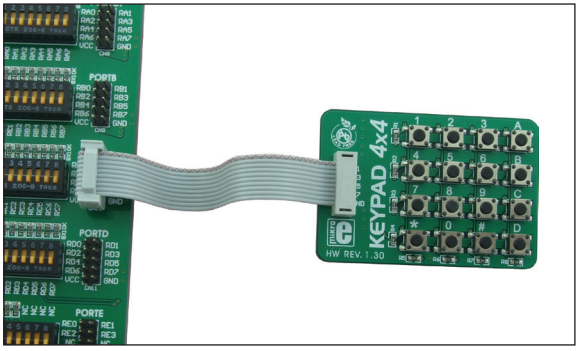

Figure 2: Keypad 4x4 connected to development system

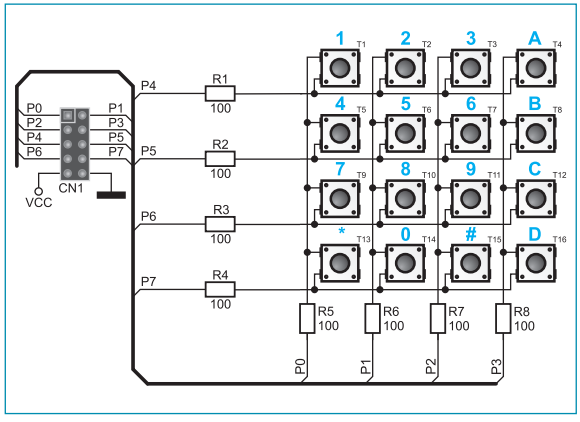

Figure 3: Keypad 4x4 connection schematic

The keyboard is usually used as follows:

1. Four microcontroller's pins should be defined as outputs, and other four pins should be defined as inputs. In order the keypad to work properly, pull-down resistors should be placed on the microcontroller's input pins, thus defining logic state when no button is pressed.
2. Then, the output pins are set to logic one (1) and input pins' logic state is read. By pressing any button, a logic one (1) will appear on some input pin.
3. By combining zeros and ones on the output pins, it is determined which button is pressed.

A far easier way to load data by using keypad 4x4 is by employing ready-to-use funtions provided in the *Keypad Library* of any Mikroelektronika's compiler. On the following pages there are three simple examples written for PIC16F887 microcontrolller in *mikroC*, *mikroBasic* and *mikroPascal* programming languages. In all cases, the number loaded via keypad is converted into the equivalent ASCII code (0...9, A...F) and then it is displayed in the second line of LCD display. In this case, pull-down resistors are placed on output pins RD0 - RD3 and are used to determine logic zero (0) in idle state.

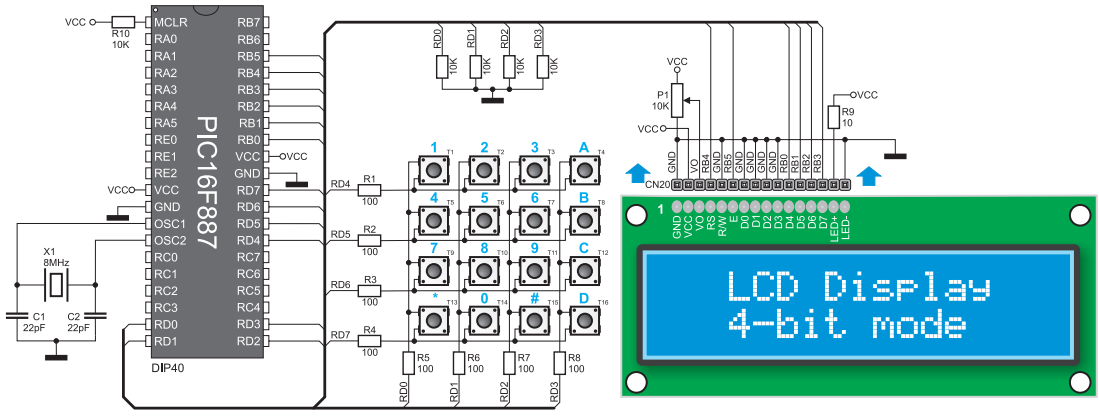

Figure 4: Keypad, LCD and microcontroller connection schematic

Example 1: Program written in mikroC PRO for PIC

```
unsigned short kp, cnt, oldstate = 0;
char txt[6];

                                        // Keypad module connections
char  keypadPort at PORTD;
                                        // End Keypad module connections

sbit LCD_RS at RB4_bit;                 // LCD module connections
sbit LCD_EN at RB5_bit;
sbit LCD_D4 at RB0_bit;
sbit LCD_D5 at RB1_bit;
sbit LCD_D6 at RB2_bit;
sbit LCD_D7 at RB3_bit;

sbit LCD_RS_Direction at TRISB4_bit;
sbit LCD_EN_Direction at TRISB5_bit;
sbit LCD_D4_Direction at TRISB0_bit;
sbit LCD_D5_Direction at TRISB1_bit;
sbit LCD_D6_Direction at TRISB2_bit;
sbit LCD_D7_Direction at TRISB3_bit;
                                        // End LCD module connections

void main() {
  cnt = 0;                              // Reset counter
  Keypad_Init();                        // Initialize Keypad
  ANSEL  = 0;                           // Configure AN pins as digital I/O
  ANSELH = 0;
  Lcd_Init();                           // Initialize LCD
  Lcd_Cmd(_LCD_CLEAR);                  // Clear display
  Lcd_Cmd(_LCD_CURSOR_OFF);             // Cursor off
  Lcd_Out(1, 1, "1");
  Lcd_Out(1, 1, "Key  :");              // Write message text on LCD
  Lcd_Out(2, 1, "Times:");

  do {
    kp = 0;                             // Reset key code variable

    // Wait for key to be pressed and released
    do
      kp = Keypad_Key_Click();          // Store key code in kp variable
    while (!kp);
                // Prepare value for output, transform key to it's ASCII value
    switch (kp) {
      //case 10: kp = 42; break;  // '*'      // Uncomment this block for keypad4x3
      //case 11: kp = 48; break;  // '0'
      //case 12: kp = 35; break;  // '#'
      //default: kp += 48;
      case  1: kp = 49; break; // 1           // Uncomment this block for keypad4x4
      case  2: kp = 50; break; // 2
      case  3: kp = 51; break; // 3
      case  4: kp = 65; break; // A
      case  5: kp = 52; break; // 4
      case  6: kp = 53; break; // 5
      case  7: kp = 54; break; // 6
      case  8: kp = 66; break; // B
      case  9: kp = 55; break; // 7
      case 10: kp = 56; break; // 8
      case 11: kp = 57; break; // 9
      case 12: kp = 67; break; // C
      case 13: kp = 42; break; // *
      case 14: kp = 48; break; // 0
      case 15: kp = 35; break; // #
      case 16: kp = 68; break; // D
    }

    if (kp != oldstate) {               // Pressed key differs from previous
      cnt = 1;
      oldstate = kp;
      }
    else {                              // Pressed key is same as previous
      cnt++;
      }

    Lcd_Chr(1, 10, kp);                 // Print key ASCII value on LCD

    if (cnt == 255) {                   // If counter varialble overflow
      cnt = 0;
      Lcd_Out(2, 10, "   ");
      }

    WordToStr(cnt, txt);                // Transform counter value to string
    Lcd_Out(2, 10, txt);                // Display counter value on LCD
  } while (1);
}
```

Example 2: Program written in mikroBasic PRO for PIC

```
program Keypad_Test
dim kp, cnt, oldstate as byte
    txt as char[7]

' Keypad module connections
dim keypadPort as byte at PORTD
' End Keypad module connections

' Lcd module connections
dim LCD_RS as sbit at RB4_bit
    LCD_EN as sbit at RB5_bit
    LCD_D4 as sbit at RB0_bit
    LCD_D5 as sbit at RB1_bit
    LCD_D6 as sbit at RB2_bit
    LCD_D7 as sbit at RB3_bit

    LCD_RS_Direction as sbit at TRISB4_bit
    LCD_EN_Direction as sbit at TRISB5_bit
    LCD_D4_Direction as sbit at TRISB0_bit
    LCD_D5_Direction as sbit at TRISB1_bit
    LCD_D6_Direction as sbit at TRISB2_bit
    LCD_D7_Direction as sbit at TRISB3_bit
' End Lcd module connections

main:
  oldstate = 0
  cnt = 0                               ' Reset counter
  Keypad_Init()                         ' Initialize Keypad
  ANSEL  = 0                            ' Configure AN pins as digital I/O
  ANSELH = 0
  Lcd_Init()                            ' Initialize LCD
  Lcd_Cmd(_LCD_CLEAR)                   ' Clear display
  Lcd_Cmd(_LCD_CURSOR_OFF)              ' Cursor off
  Lcd_Out(1, 1, "Key  :")               ' Write message text on LCD
  Lcd_Out(2, 1, "Times:")

  while TRUE

    kp = 0                              ' Reset key code variable

    ' Wait for key to be pressed and released
    while ( kp = 0 )
      kp = Keypad_Key_Click()           ' Store key code in kp variable
    wend
    ' Prepare value for output, transform key to it"s ASCII value
    select case kp
      'case 10: kp = 42   ' "*"         ' Uncomment this block for keypad4x3
      'case 11: kp = 48   ' "0"
      'case 12: kp = 35   ' "#"
      'default: kp += 48

    case 1
      kp = 49  ' 1                      ' Uncomment this block for keypad4x4
    case 2
      kp = 50  ' 2
    case 3
      kp = 51  ' 3
    case 4
      kp = 65  ' A
    case 5
      kp = 52  ' 4
    case 6
      kp = 53  ' 5
    case 7
      kp = 54  ' 6
    case 8
      kp = 66  ' B
    case 9
      kp = 55  ' 7
    case 10
      kp = 56  ' 8
    case 11
      kp = 57  ' 9
    case 12
      kp = 67  ' C
    case 13
      kp = 42  ' *
    case 14
      kp = 48  ' 0
    case 15
      kp = 35  ' #
    case 16
      kp = 68  ' D

    end select

    if (kp <> oldstate) then            ' Pressed key differs from previous
      cnt = 1
      oldstate = kp
    else                                ' Pressed key is same as previous
      Inc(cnt)
    end if
    Lcd_Chr(1, 10, kp)                  ' Print key ASCII value on LCD

    if (cnt = 255) then                 ' If counter varialble overflow
      cnt = 0
      Lcd_Out(2, 10, "    ")
    end if

    WordToStr(cnt, txt)                 ' Transform counter value to string
    Lcd_Out(2, 10, txt)                 ' Display counter value on LCD
  wend
end.
```

Example 3: Program written in mikroPascal PRO for PIC

```
program Keypad_Test;

var kp, cnt, oldstate : byte;
    txt : array[6] of byte;

// Keypad module connections
var keypadPort : byte at PORTD;
// End Keypad module connections

// Lcd module connections
var LCD_RS : sbit at RB4_bit;
    LCD_EN : sbit at RB5_bit;
    LCD_D4 : sbit at RB0_bit;
    LCD_D5 : sbit at RB1_bit;
    LCD_D6 : sbit at RB2_bit;
    LCD_D7 : sbit at RB3_bit;

var LCD_RS_Direction : sbit at TRISB4_bit;
    LCD_EN_Direction : sbit at TRISB5_bit;
    LCD_D4_Direction : sbit at TRISB0_bit;
    LCD_D5_Direction : sbit at TRISB1_bit;
    LCD_D6_Direction : sbit at TRISB2_bit;
    LCD_D7_Direction : sbit at TRISB3_bit;
// End Lcd module connections

  begin
    oldstate := 0;
    cnt := 0;                           // Reset counter
    Keypad_Init();                      // Initialize Keypad
    ANSEL  := 0;                        // Configure AN pins as digital I/O
    ANSELH := 0;
    Lcd_Init();                         // Initialize Lcd
    Lcd_Cmd(_LCD_CLEAR);                // Clear display
    Lcd_Cmd(_LCD_CURSOR_OFF);           // Cursor off
    Lcd_Out(1, 1, 'Key  :');            // Write message text on Lcd
    Lcd_Out(2, 1, 'Times:');

    while TRUE do
      begin
        kp := 0;                  // Reset key code variable

        // Wait for key to be pressed and released
        while ( kp = 0 ) do
          kp := Keypad_Key_Click();         // Store key code in kp variable
        // Prepare value for output, transform key to it's ASCII value
        case kp of
          //case 10: kp = 42;   // '*'       // Uncomment this block for keypad4x3
          //case 11: kp = 48;   // '0'
          //case 12: kp = 35;   // '#'
          //default: kp += 48;
          1: kp := 49;  // 1                 // Uncomment this block for keypad4x4
          2: kp := 50;  // 2
          3: kp := 51;  // 3
          4: kp := 65;  // A
          5: kp := 52;  // 4
          6: kp := 53;  // 5
          7: kp := 54;  // 6
          8: kp := 66;  // B
          9: kp := 55;  // 7
          10: kp := 56;  // 8
          11: kp := 57;  // 9
          12: kp := 67;  // C
          13: kp := 42;  // *
          14: kp := 48;  // 0
          15: kp := 35;  // #
          16: kp := 68;  // D

        end;

        if (kp <> oldstate) then            // Pressed key differs from previous
          begin
            cnt := 1;
            oldstate := kp;
          end
        else                                // Pressed key is same as previous
          Inc(cnt);

        Lcd_Chr(1, 10, kp);                 // Print key ASCII value on Lcd

        if (cnt = 255) then                 // If counter varialble overflow
          begin
            cnt := 0;
            Lcd_Out(2, 10, '    ');
          end;

        WordToStr(cnt, txt);                // Transform counter value to string


        Lcd_Out(2, 10, txt);                // Display counter value on Lcd
    end;
end.
```

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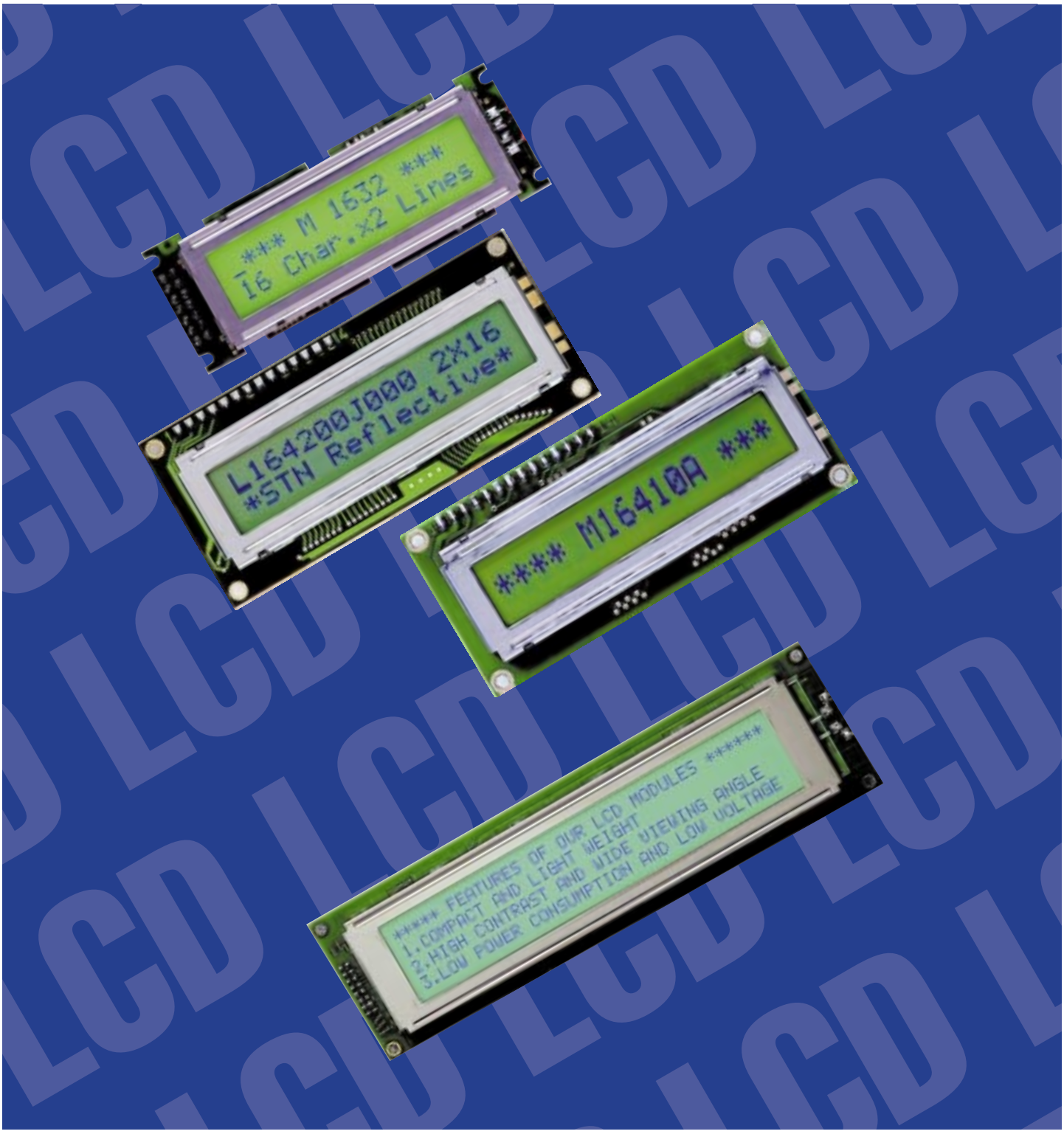
LCM

Liquid Crystal Display Modules

Seiko Instruments GmbH



Dot Matrix Liquid Crystal Display Modules

CHARACTER TYPE

- **FEATURES :**
  - Slim, light weight and low power consumption
  - High contrast and wide viewing angle
  - Built-in controller for easy interfacing
  - LCD modules with built-in EL or LED backlight

M1641

L1642

L1614

M1632

L1652

L2012

- **SPECIFICATIONS :**

: Standard products : Products of optional specification

Character Format (character x line)			16 x 1	16 x 2	16 x 2	16 x 2	16 x 4	20 x 2
Model			M1641	M1632	L1642	L1652	L1614	L2012
Reflective			M16410AS	M16320AS	L164200J000S	L165200J200S	L161400J000S	L201200J000S
EL backlight			M16419DWS	M16329DWS	L164221J000S	L165221J200S	L161421J000S	L201221J000S
LED backlight			M16417DYS	M16327DYS	L1642B1J000S	L1652B1J200S	L1614B1J000S	L2012B1J000S
Reflective (wide temp)			M16410CS	M16320CS	L164200L000S	L165200L200S	L161400L000S	L201200L000S
LED backlight (wide temp)			M16417JYS	M16327JYS	L1642B1L000S	L1652B1L200S	L1614B1L000S	L2012B1L000S
Character font			5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor
Module size (HxVxT) mm	Reflective		80,0 x 36,0 x 11,3	85,0 x 30,0 x 10,1	80,0 x 36,0 x 11,3	122,0 x 44,0 x 11,3	87,0 x 60,0 x 11,6	116,0 x 37,0 x 11,3
	EL backlight		80,0 x 36,0 x 11,3	85,0 x 30,0 x 10,1	80,0 x 36,0 x 11,3	122,0 x 44,0 x 11,3	87,0 x 60,0 x 11,6	116,0 x 37,0 x 11,3
	LED backlight		80,0 x 36,0 x 15,8	80,0 x 30,0 x 15,8	80,0 x 36,0 x 15,8	122,0 x 44,0 x 15,8	87,0 x 60,0 x 15,8	116,0 x 37,0 x 15,8
Viewing area (HxV) mm			64,5 x 13,8	62,0 x 16,0	64,5 x 13,8	99,0 x 24,0	61,8 x 25,2	83,0 x 18,6
Character size (HxV) mm *1			3,07 x 5,73	2,78 x 4,27	2,95 x 3,80	4,84 x 8,06	2,95 x 4,15	3,20 x 4,85
Dot size (HxV) mm			0,55 x 0,75	0,50 x 0,55	0,50 x 0,55	0,92 x 1,10	0,55 x 0,55	0,60 x 0,65
Power supply voltage (VDD-VSS) V			+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V
Current consumption (mA,typ)		IDD	1,5	2,0	1,6	2,0	2,7	2,0
		ILC *4	0,2	0,2	0,3	0,4	1,1	0,4
Driving method (duty)			1/16	1/16	1/16	1/16	1/16	1/16
Built-in LSI			KS0066 or equivalent	KS0066 MSM5839 or equivalent	KS0066 MSM5839 or equivalent	KS0066 MSM5839 or equivalent	KS0066 KS0063 or equivalent	KS0066 KS0063 or equivalent
Operating temperature (°C)		normal temp.	0 to + 50	0 to + 50	0 to + 50	0 to + 50	0 to + 50	0 to + 50
		wide temp. *2	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70
Storage temperature (°C)		normal temp.	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60
		wide temp.	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80
Weight (g, typ.)	Reflective		25	25	25	50	50	40
	EL backlight		30	30	30	55	55	45
	LED backlight		35	40	35	65	65	60
Inverters for EL	Model		5S	5S	5S	5C	5A	5A
	Power supply (V)		+ 5.0	+ 5,0	+ 5.0	+ 5.0	+ 5.0	+ 5.0
	current consumption (mA) *3		10	10	10	35	45	45
LED backlight	Forward current consumption (mA)		100	112	100	240	200	154
	Forward input voltage (V,typ.)		+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1

H : Horizontal V : Vertical T : Thickness (max)

*1 : Excluding cursor

*2 : With external temperature compensation

*3 : Including EL backlight

*4 : Based on normal temperature range

Since our policy is one of continues improvements we reserve the right to change the specifications for the products in the catalogue without notice.

L2022

L2432

L2014

L4042

M4024

• SPECIFICATIONS :

: Standard products : Products of optional specification

Character Format (character x line)			20 x 2	20 x 4	24 x 2	40 x 2	40 x 4
Model			L2022	L2014	L2432	L4042	M4024
Reflective			-	L201400J000S	L243200J000S	L404200J000S	M40240AS
EL backlight			-	L201421J000S	L243221J000S	L404221J000S	M40249DWS
LED backlight			-	L2014B1J000S	L2432B1J000S	L4042B1J000S	M40247DYS
Reflective (wide temp)			L202200P000S	L201400L000S	L243200L000S	L404200L000S	M40240CS
LED backlight (wide temp)			L2022B1P000S	L2014B1L000S	L2432B1L000S	L4042B1L000S	M40247JYS
Character font			5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor
Module size (HxVxT) mm	Reflective		180,0 x 40,0 x 10,5	98,0 x 60,0 x 11,6	118,0 x 36,0 x 11,3	182,0 x 33,5 x 11,3	190,0 x 54,0 x 10,1
	EL backlight		180,0 x 40,0 x 10,5	98,0 x 60,0 x 11,6	118,0 x 36,0 x 11,3	182,0 x 33,5 x 11,3	190,0 x 54,0 x 10,1
	LED backlight		180,0 x 40,0 x 14,8	98,0 x 60,0 x 15,8	118,0 x 36,0 x 15,8	182,0 x 33,5 x 16,3	190,0 x 54,0 x 16,3
Viewing area (HxV) mm			149,0 x 23,0	76,0 x 25,2	94,5 x 17,8	154,4 x 15,8	147,0 x 29,5
Character size (HxV) mm *1			6,00 x 9,66	2,95 x 4,15	3,20 x 4,85	3,20 x 4,85	2,78 x 4,27
Dot size (HxV) mm			1,12 x 1,12	0,55 x 0,55	0,60 x 0,65	0,60 x 0,65	0,50 x 0,55
Power supply voltage (VDD-VSS) V			+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V
Current consumption (mA,typ)		IDD	4,2	2,9	2,5	3,0	8,0
		ILC *4	2,6	1,2	0,5	1,0	3,0
Driving method (duty)			1/16	1/16	1/16	1/16	1/16
Built-in LSI			KS0066 KS0063 or equivalent	KS0066 MSM5839 or equivalent	KS0066 KS0063 or equivalent	KS0066 KS0063 or equivalent	KS0066 MSM5839 or equivalent
Operating temperature (°C)		normal temp.	-	0 to + 50	0 to + 50	0 to + 50	0 to + 50
		wide temp. *2	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70
Storage temperature (°C)		normal temp.	-	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60
		wide temp.	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80
Weight (g, typ.)	Reflective		80	55	40	70	90
	EL backlight		-	60	45	75	105
	LED backlight		110	70	60	95	140
Inverters for EL	Model		-	5A	5A	5C	5D
	Power supply (V)		+ 5.0	+ 5.0	+ 5.0	+ 5.0	+ 5.0
	current consumption (mA) *3		-	45	45	25	80
LED backlight	Forward current consumption (mA)		320	240	150	260	480
	Forward input voltage (V,typ.)		+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1

*1 : Excluding cursor H : Horizontal V : Vertical T : Thickness (max)

*2 : With external temperature compensation

*3 : Including EL backlight

*4 : Based on normal temperature range

Dot Matrix Liquid Crystal Display Modules

GRAPHIC TYPE

- **FEATURES :**

•Wide viewing angle and high contrast
•Full dot configuration fits any application
•Slim, light weight and low power consumption
•Available in STN and FSTN

- **SPECIFICATIONS :**

Dot format (HxV,dot)			97 x 32	128 x 32	128 x 64	128 x 64
Model			Y97031	G1213	G1216	G1226
STN type	Reflective	built-in RAM	-	-	-	-
(Gray mode)	Reflective wide temp.	built-in RAM	-	G121300N000S	G121600N000S	-
	LED backlight	built-in RAM	-	-	-	G1226B1J000S
	LED backlight wide temp	built-in RAM	-	G1213B1N000S	G1216B1N000S	-
FSTN type	Transmissive	-	-	-	-	-
(B&W mode)	with CFL backlight	built-in controller	-	-	-	-
	Transflective	built-in RAM	Y97031LF60W	-	-	-
Module size	Reflective (no backlight)		47,5 x 65,4 x 2,1	75,0 x 41,5 x 6,8	75,0 x 52,7 x 6,8	-
(H x V x T)	LED backlight		-	75,0 x 41,5 x 8,9	75,0 x 52,7 x 8,9	93,0 x 70,0 x 11,4
mm	CFL backlight		-	-	-	-
Viewing area (HxV) mm			43,5 x 23,9	60,0 x 21,3	60,0 x 32,5	70,7 x 38,8
Dot size (H x V) mm			0,35 x 0,48	0,40 x 0,48	0,40 x 0,40	0,44 x 0,44
Dot pitch (H x V) mm			0,39 x 0,52	0,43 x 0,51	0,43 x 0,43	0,48 x 0,48
Power supply voltage (V)		(VDD - VSS)	+ 5,0	+ 5,0	+ 5,0	+ 5,0
		(VLC - VSS)	-	- 8,0	- 8,1	-8,2
Current consumption		IDD	0,10	2,0	2,0	3,0
		IDD (built-in controller)	-	-	-	-
(mA, typ.)		ILC	-	1,8	1,8	2,0
Driving method (duty)			1/33	1/64	1/64	1/64
Built-in LSI		Driver	SED1530 or equivalent	HD61202 HD61203 or equivalent	HD61202 HD61203 or equivalent	KS0107 KS0108 or equivalent
		Controller	-	-	-	-
Operating temperature range (ºC)			- 20 to + 70	- 20 to + 70	- 20 to + 70	0 to + 50
Storage temperature range (ºC)			- 30 to + 80	- 30 to + 80	- 30 to + 80	- 20 to + 60
Weight	Reflective (Transflective no backlight)		10	23	35	-
(g, typ.)	LED backlight		-	35	45	72
	CFL backlight		-	-	-	-
LED backlight	Forward current consumption (mA)		-	40	90	125
	Forward input voltage (V, typ.)		-	3,8	4,1	4,1
Inverter for CFL	Mode		-	-	-	-
	Power supply voltage (V)		-	-	-	-
	Current consumption (mA, typ.)		-	-	-	-

*1 : built-in DC/DC converter (single power source)

*2 : Use with external temperature compensation circuit

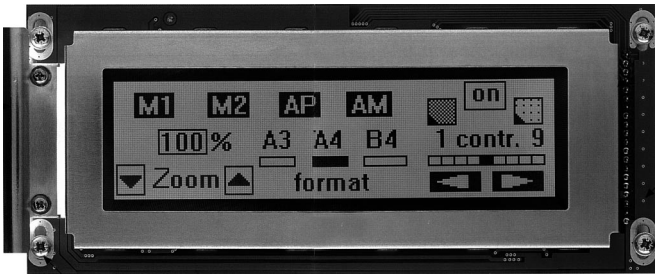
Since our policy is one of continues improvements we reserve the right to change the specifications of the products in the catalogue without notice.

Dot format (HxV,dot)			240 x 64	240 x 128	320 x 200	320 x 240	640 x 200
Model			G2446	G242C	G321D	G324E	G649D
STN type (Gray mode)	Reflective	built-in RAM	-	-	-	-	-
	Reflective wide temp.	built-in RAM	-	-	-	-	-
	LED backlight	built-in RAM	-	-	-	-	-
	LED backlight wide temp	built-in RAM	-	-	-	-	-
FSTN type (B&W mode)	Transmissive	-	G2446X5R1A0S	G242CX5R1ACS	G321DX5R1A0S	G324EX5R1A0S	G649DX5R010S
	with CFL backlight	built-in controller	G2446X5R1ACS	G242CX5R1A0S	G321DX5R1ACS	G324EX5R1ACS	-
	Transflective	built-in RAM	-	-	-	-	-
Module size (H x V x T) mm	Reflective (no backlight)			-	-	-	-
	LED backlight			-	-	-	-
	CFL backlight		191,0 x 79,0 x 15,1	180,0 x 110,0 x 15,1	166,0 x 134,0 x 15,1	166,0 x 134,0 x 15,1	260,0 x 122,0 x 15,7
Viewing area (HxV) mm			134,0 x 41,0	134,0 x 76,0	128,0 x 110,0	128,0 x 110,0	216,0 x 83,0
Dot size (H x V) mm			0,49 x 0,49	0,47 x 0,47	0,34 x 0,48	0,32 x 0,39	0,30 x 0,36
Dot pitch (H x V) mm			0,53 x 0,53	0,51 x 0,51	0,38 x 0,52	0,36 x 0,43	0,33 x 0,39
Power supply voltage (V)		(VDD - VSS)	+ 5,0	+ 5,0	+ 5,0	+ 5,0	+ 5,0
		(VLC - VSS)	*1	*1	-24,0	-24,0	-24,0
Current consumption (mA, typ.)		IDD	12	30	8	7,5	11
		IDD (built-in controller)	15	40	23	23	-
		ILC	-	-	6	6,5	9
Driving method (duty)			1/64	1/128	1/200	1/240	1/200
Built-in LSI		Driver	MSM5298 MSM5299 or equivalent	KS0103 KS0104 or equivalent	MSM5298 MSM5299 or equivalent	HD66204 HD66205 or equivalent	MSM5298 MSM5299 or equivalent
		Controller	SED1330FB	SED1330FB	SED1330FB	SED1330FB	-
Operating temperature range (ºC)			0 to + 50	0 to + 50	0 to + 50	0 to + 50	0 to + 50
Storage temperature range (ºC)			- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60
Weight (g, typ.)	Reflective (Transflective no backlight)		-	-	-	-	-
	LED backlight		-	-	-	-	-
	CFL backlight		200	280	350	350	420
LED backlight	Forward current consumption (mA)		-	-	-	-	-
	Forward input voltage (V, typ.)		-	-	-	-	-
Inverter for CFL	Mode		4800210	4800210	4800210	4800210	4800120
	Power supply voltage (V)		+ 5,0	+ 5,0	+ 5,0	+ 5,0	+ 12,0
	Current consumption (mA, typ.)		250	350	365	365	390

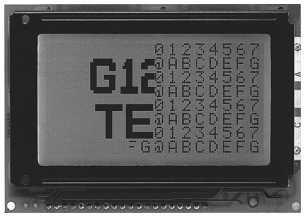
*1 : built-in DC/DC converter (single power source)

*2 : Use with external temperature compensation

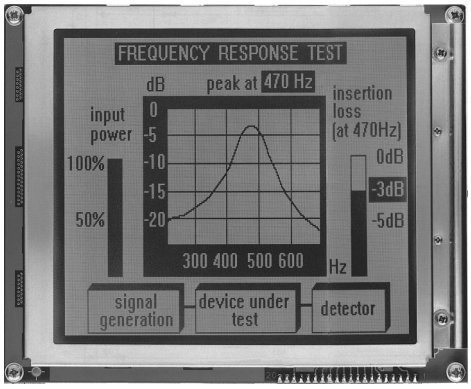
Since our policy is one of continous improvemets, we reserve the right to change the specifications of the products in the catalogue without notice.



G2446

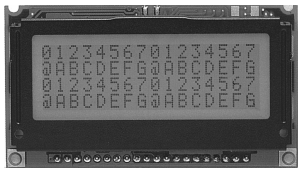


G1226

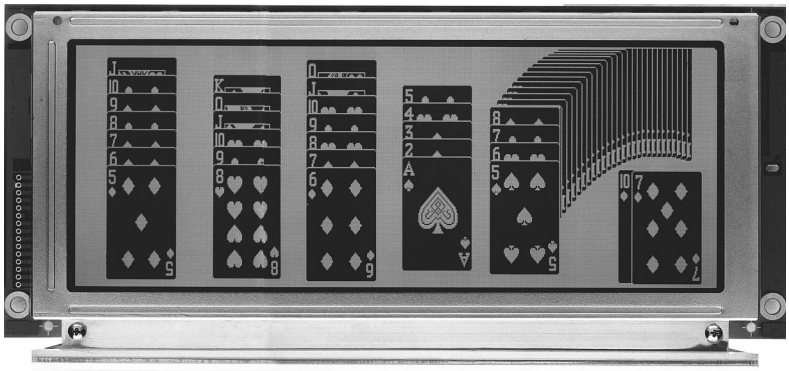


G321D

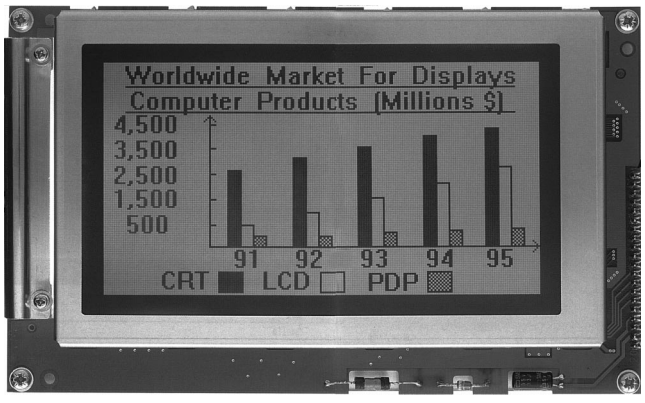
G1216



G1213



G649D



G242C

G324E

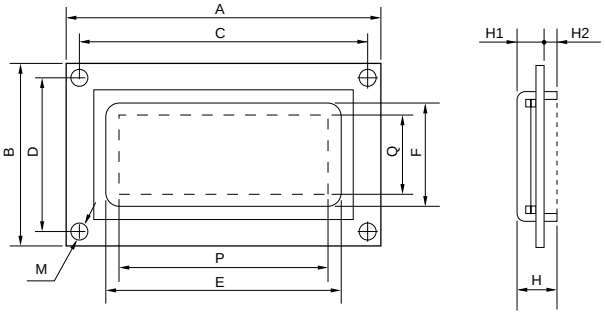
CHECK LIST FOR CUSTOM DESIGNED LCD MODULE

1. Company_____ **2. Application**_____ **3. Customer Specified Part No.**_____

4. Design

☐ New ☐ Modified : Manufacturer_____ , Part No._____ , Remarks _____
☐ Equivalent: Manufacturer_____ , Part No._____ , Remarks _____

5. LCM Dimensions



A x B : Module size _____ x _____ mm
E x F : Viewing area _____ x _____ mm
P x Q : Active display area _____ x _____ mm
C : Length between mounting holes _____ mm
D : Length between mounting holes _____ mm
M : Diameter of mounting hole _____ mm
H : Total thickness _____ mm
H1 : Upper thickness _____ mm
H2 : Lower thickness _____ mm

6. Display Contents

☐ Character type:_____characters_____lines
Character font_____x_____dots + cursor
Character pitch_____x_____mm
Dot pitch_____x_____mm
Dot size_____x_____mm
☐ Graphics (Full dot) type:_____x_____dots
Dot pitch_____x_____mm
Dot size_____x_____mm
☐ Segment type: _____digits_____lines
☐ Others _____

7. LCD Panel

Viewing angle: ☐6 o'clock ☐12 o'clock ☐____o'clock
Type: ☐ TN ☐ FSTN (Black and white)
☐ STN (☐ Yellow green ☐ Gray ☐ Blue)
Chromaticity coordinates
(_____ ≦ x ≦ _____ , _____ ≦ y ≦ _____)
☐ Positive type ☐ Negative type
☐ Reflective ☐ Transflective ☐ Transmissive
☐ Others _____
Gray scale: ☐ Yes_____ gray scale ☐ No
Preferential specifications:
☐ Response time t_{on} ____ ms (____°C) t_{off} ____ ms (____°C)
☐ Viewing angle____deg. (____°C) ☐ Contrast____(____°C)
☐ Others _____
LCD surface finishing:
☐ Normal ☐ Anti-glare ☐ _____
Polarizer color: ☐ Normal (neutral gray) ☐ Red
☐ Green ☐ Blue ☐ _____

8. Driving Method

Multiplexing:1/ _____ duty, 1/_____ bias
Frame frequency: _____ Hz

9. IC

LCD driver: ☐ Specified ☐ Unspecified
Segment driver _____ (Manufacturer _____)
Common driver _____ (Manufacturer _____)
Controller: ☐ Internal ☐ External
Type No._____ (Manufacturer _____)
MPU: ☐ Internal ☐ External
Type No._____ (Manufacturer _____)
RAM: ☐ Internal ☐ External
Type No. /Memory size_____(Kbit) (Manufacturer _____)

10. Power Supply

☐ Single power supply: ☐ 5V ☐ _____V
☐ 2 power supplies
For logic: (V_{DD}-V_{SS}) : ☐ 5V ☐ _____V
For LC drive: (V_{LC}-V_{SS}) : ☐ _____V

11. Temperature Compensation Circuit

☐ Internal ☐ External ☐ Unnecessary
Compensation range: ☐ 0°C to 50°C ☐ ___°C to ____°C

12. Current Consumption

For logic: typ._____mA, max._____mA
For LC drive: typ._____mA, max._____mA
Others ( ) : typ._____mA, max._____mA

13. Contrast Adjustment

☐ Internal ☐ External ☐ Unnecessary
Method: ☐ Temp. compensation circuit ☐ Volume ☐ ____

14. Temperature Range

Operating temperature range: ☐ 0°C to 50°C ☐ ____°C to____°C
Storage temperature range: ☐ - 20°C to 60°C ☐ ____°C to____°C

15. Input/Output Terminals

Specifying allocation: ☐ Yes ☐ No
Specifying position: ☐ Yes ☐ No

16. Weight

typ._____ g, max. _____ g

17. Connector

☐ Internal ☐ External ☐ Unnecessary
Type No._____ (Manufacturer _____)

18. Backlight

☐ Internal ☐ External ☐ Unnecessary
☐ EL: ☐ Green ☐ White ☐ _____
☐ LED: ☐ Yellow green ☐ Amber ☐ _____
☐ CFL: ☐ White ☐ _____
☐ Incandescent lamp ☐ Others _____
☐ Backlight type ☐ Edge backlight type
Brightness: _____ cd/m^2
Inverter: ☐ Internal ☐ External ☐ Unnecessary
Power supply voltage_____V
Current consumption (backlight included)_____ mA
Brightness control: ☐ Yes ☐ No

19. Others

_____
_____
_____

20. Schedule

Estimate: _____
Sample: Delivery_____, Quantity:_____pcs
Mass production: Target price: _____
Delivery _____ , Total quantity: _____pcs
Quantity per month_____pcs

CHECK LIST FOR CUSTOM DESIGNED LCD

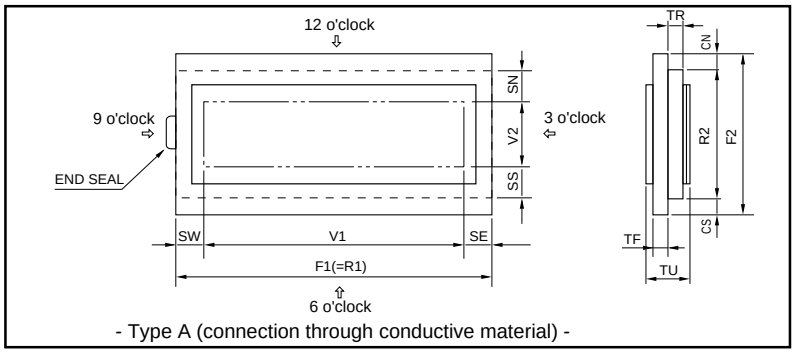
1. Company_____ **2. Application**_____**3. Customer Specified Part No.**_____

4. Design

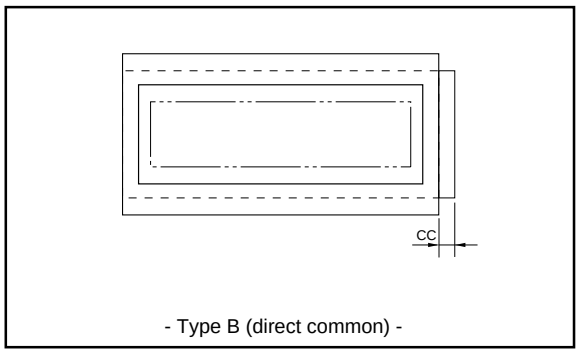
☐New ☐Modified: Manufacturer _____ , Part No. _____ , Remarks _____

☐Equivalent: Manufacturer_____ , Part No. _____ , Remarks_____

5. Panel Dimensions



- Type A (connection through conductive material) -



- Type B (direct common) -

F1: Horizontal length of upper glass _____mm
F2: Vertical length of upper glass_____mm
R1: Horizontal length of lower glass_____the same as F1
R2*: Vertical length of lower glass_____mm
*R2 is generally longer than F2 when terminals are with pin.
TF, TR***: Thickness of glass _____mm
***Standard type: 1.1 mm or 0.7 mm
TU: Thickness of LCD_____mm
End seal: ☐Right ☐Left ☐Right or Left

V1 :Horizontal length of viewing area _____mm
V2 :Vertical length of viewing area _____mm
CN**: Terminal length_____mm
CS**:Terminal length_____mm
**CN or CS=0 in case of one side terminal type.
CC: Terminal length_____mm
SE,SW,SN,SS : Seal width
(According to design or manufacturing condition:
about 2.0 mm to 4.0 mm)

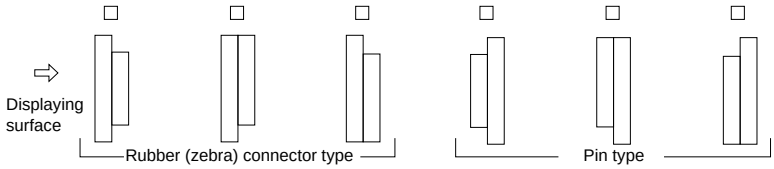
6. Panel Form

• Terminal ☐

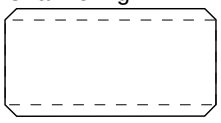
- Type A -

☐

- Type B -

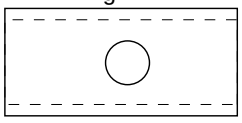


• Chamfering



☐ Yes
☐ No

• Drilling



☐ Yes
☐ No

7. Display Mode

Viewing angle : ☐6 o'clock ☐12 o'clock ☐_____o'clock
Type: ☐TN ☐FSTN (Black and white)
☐STN: (☐ Yellow green ☐ Gray ☐ Blue)
Chromaticity coordinates (____≦ x ≦ ____, _____≦ y ≦ ____)
☐Positive type ☐Negative type
☐Reflective ☐Transflective ☐Transmissive
Preferential specifications:
☐Response time t_{on} ____ ms (____ °C) t_{off} ____ ms (____ °C)
☐Viewing angle ____deg. (____ °C) ☐Contrast____ (____ °C)
☐Others _____

8. Polarizer

Surface finishing: ☐Normal ☐Anti-glare ☐_____
Color: ☐Normal (neutral gray) ☐Red ☐Green
☐Blue ☐_____
Front polarizer : ☐ Attached type ☐ Separate type
Rear polarizer : ☐ Attached type ☐ Separate type

9. Driving Method

☐ Static ☐ Multiplexing: (1/_____duty, 1/_____bias)
Operating voltage (V_{opr}) :_____ V
Frame frequency:_____ Hz
Driving IC:_____(Manufacturer _____)
Current consumption: _____ μA

10. Temperature Range

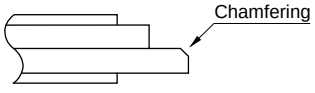
Operating temperature range
☐With temperature compensation circuit (or volume)
(☐ 0°C to 50°C ☐_____°C to_____°C)
☐Without temperature compensation circuit
(☐ 0°C to 50°C ☐_____°C to_____°C)
Storage temperature range
(☐ - 20°C to 60°C ☐_____°C to_____°C)

11. Terminal Connecting Method

☐Rubber connector (Zebra rubber)
☐Pin: ☐DIL ☐SIL ☐_____
Pitch (☐2.54 ☐_____mm) Length (_____mm)
☐Heat seal: ☐Equipped ☐Unnecessary

12. Others

Print (Characters, lines, masks etc.) : ☐Yes ☐ No
Protective film:
☐Yes (Color: ☐ Red ☐Translucent ☐Transparent) ☐No
Chamfering (for heat-seal connector) :
☐Yes (Position:_____)
(Quantity:_____)
☐No



13. Schedule

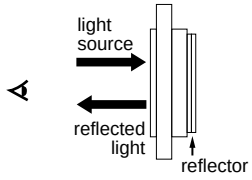
Estimate :_____
Sample : Delivery_____ , Quantity :_____ pcs
Mass production : Target price : _____
Delivery _____ , Total quantity:_____ pcs
Quantity per month:_____pcs

Liquid Crystal Display Modules

■ REFLECTIVE/TRANSFLECTIVE/TRANSMISSIVE LCD

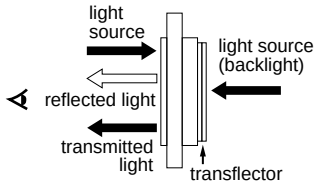
❶ Reflective LCD

Reflector bonded to the rear polarizer reflects the incoming ambient light. Low power consumption because no backlight is required.



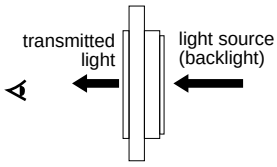
❷ Transflective LCD

Transflector bonded to the rear polarizer reflects light from the front as well as enabling lights to pass through the back. Used with backlight off in bright light and with it on in low light to reduce power consumption.

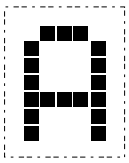


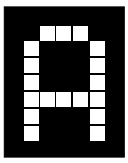
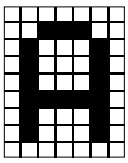
❸ Transmissive LCD

Without reflector or transflector bonded to the rear polarizer. Backlight required. Most common is transmissive negative image.



■ POSITIVE/NEGATIVE MODE

Positive type	

Negative type		Negative type (inverse image) (when data is inverted)	

■ TN TYPE/STN TYPE/FSTN TYPE

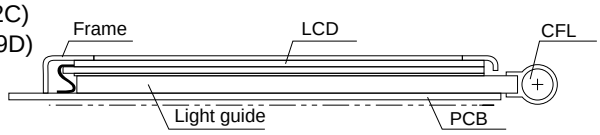
TN	(Background/dot color) Gray/Black	TN(Twisted Nematic) type is most conventional and economical. It is used for static drive LCD and low-duty drive LCD (watch,calculator, etc.)
STN	Yellowgreen/Dark blue Gray/Dark blue White/Blue	STN (Super Twisted Nematic) type has a higher twist angle, and thus provides clear visibility and wider viewing angle. This is suitable especially for high-duty drive LCD.
FSTN	White/Black	FSTN (Film Super Twisted Nematic) type utilizes RCF (Retardation Control Film) to remove the coloring of STN LCD. Thus FSTN type provides easy-to-read black-and-white display.

■ STRUCTURE AND FEATURE OF LCD MODULE WITH BACKLIGHT

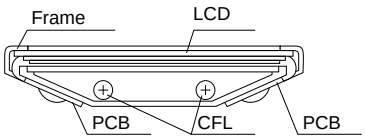
CFL (Cold Cathode Fluorescent Lamp) backlight

Features: high brightness, long service life, inverter required

- Edge backlight type
  (G2446,G242C)
  (G321D,G649D)

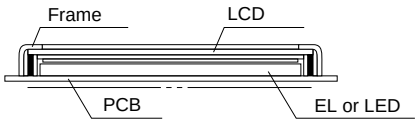


- Backlight type



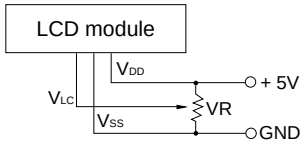
EL (Electroluminescent Lamp) backlight
LED (Light Emitting Diode) backlight

Features: EL: thin, inverter required
LED: long service life, low voltage driving, no inverter required

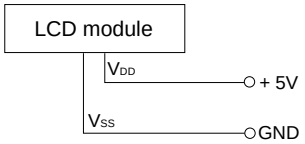


■ POWER SUPPLY

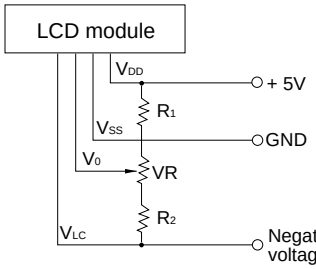
- Character modules (single power supply)



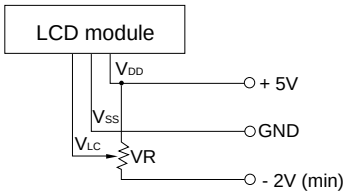
- G2446,G242C (Built-in DC-DC conv.)



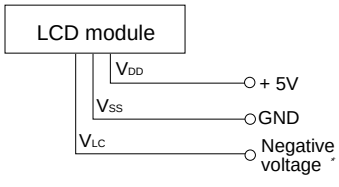
- G321D, G324E and G649D



- Character Modules(Dual power supply)



- Y1206 and G1226



・Negative voltage should be variable for contrast adjustment.

Note 1:Contrast can be adjusted by VR.
Note 2:For module with backlight, power supply for backlight is necessary.

Precautions

Safety Instructions

- If the LCD panel is damaged, be careful not to get the liquid crystal in your mouth and not to be injured by crushed glasses.
- If you should swallow the liquid crystal, first, wash your mouth thoroughly with water, then, drink a lot of water and induce vomiting, and then, consult a physician.
- If the liquid crystal should get in your eye, flush your eye with running water for at least fifteen minutes.
- If the liquid crystal touches your skin or clothes, remove it and wash the affected part of your skin or clothes with soap and running water.
- EL or CFL backlight is driven by a high voltage with an inverter. Do not touch the connection part or the wiring pattern of the inverter.
- Do not use inverters without a load or in the short-circuit mode.
- Use the LCD module within the rated voltage to prevent overheating and/or damage. Also, take steps to ensure that the connector does not come off.

Handling Precautions

- Since the LCD panel has glass substrate, avoid applying mechanical shock or pressure on the module. Do not drop, bend, twist or press the module.
- Do not soil or damage LCD panel terminals.
- Since the polarizer is made of easily-scratched material, be careful not to touch or place objects on the display surface.
- Keep the display surface clean. Do not touch it with your skin.
- CMOS LSI is used in the LCD module. Be careful of static electricity.
- Do not disassemble the module or remove the liquid crystal panel or the panel frame.
- Do not damage the film surface of the EL lamp; otherwise the lamp will be damaged by humidity.
- To set an EL lamp in an LCD module, push the EL lamp with its emitting side up, without pushing the rubber connectors too hard. If you damage them, the LCD module may not work properly.

Mounting and Designing

- To protect the polarizer and the LCD panel, cover the display surface with a transparent plate (e.g., acrylic or glass) with a small gap between the transparent plate and the display surface.
- Keep the module dry. Avoid condensation to prevent the transparent electrodes from being damaged.
- Drive LCD panel with AC waveform in which DC element is not included to prevent deterioration in the LCD panel.
- Contrast of LCD varies depending on the ambient temperature. To offer the optimum contrast, LC drive voltage should be adjusted. LCD driven in a high duty ratio must be provided with drive voltage adjustment method.
- Mount a LCD module with the specified mounting part/ holes.
- Design the equipment so that input signal is not applied to the LCD module while power supply voltage is not applied to it.
- Do not locate the CFL tube and the lamp lead wire close to a metal plate or a plated part inside the equipment. Otherwise stray capacity causes a drop in voltage, decreasing the brightness and the ability to start-up.

Cleaning

- Do not wipe the polarizer with a dry cloth, as it may scratch the surface.
- Wipe the LCD panel gently with a soft cloth soaked with a petroleum benzine.
- Do not use ketonic solvents (ketone and acetone)or aromatic solvents (toluene and xylene), as they may damage the polarizer.

Storing

- Store the LCD panel in a dark place, where the temperature is 25°C±10°C and the relative humidity below 65%. If possible, store the LCD panel in the packaging situation when it was delivered.
- Do not store the module near organic solvents or corrosive gases.
- Keep the module (including accessories) safe from vibration, shock and pressure.
- Use an LCD module with built-in EL backlight within six months of delivery.
- EL backlight is easily affected by environmental conditions such as temperature and humidity; the quality may deteriorate if stored for an extended period of time. Contact Seiko Instruments GmbH for details.
- Some parts of the backlight and the inverter generate heat. Take care so that the heat does not affect the liquid crystal or any other parts.
- Dust particles attached to the surface of the LCD or the surface of the backlight degrade the display quality. Be careful to keep dust out in designing the structure as well as in handling the module.
- Black or white air-bubbles may be produced if the LCD panel is stored for long time in the lower temperature or mechanical shocks are applied onto the LCD panel.

On This Brochure

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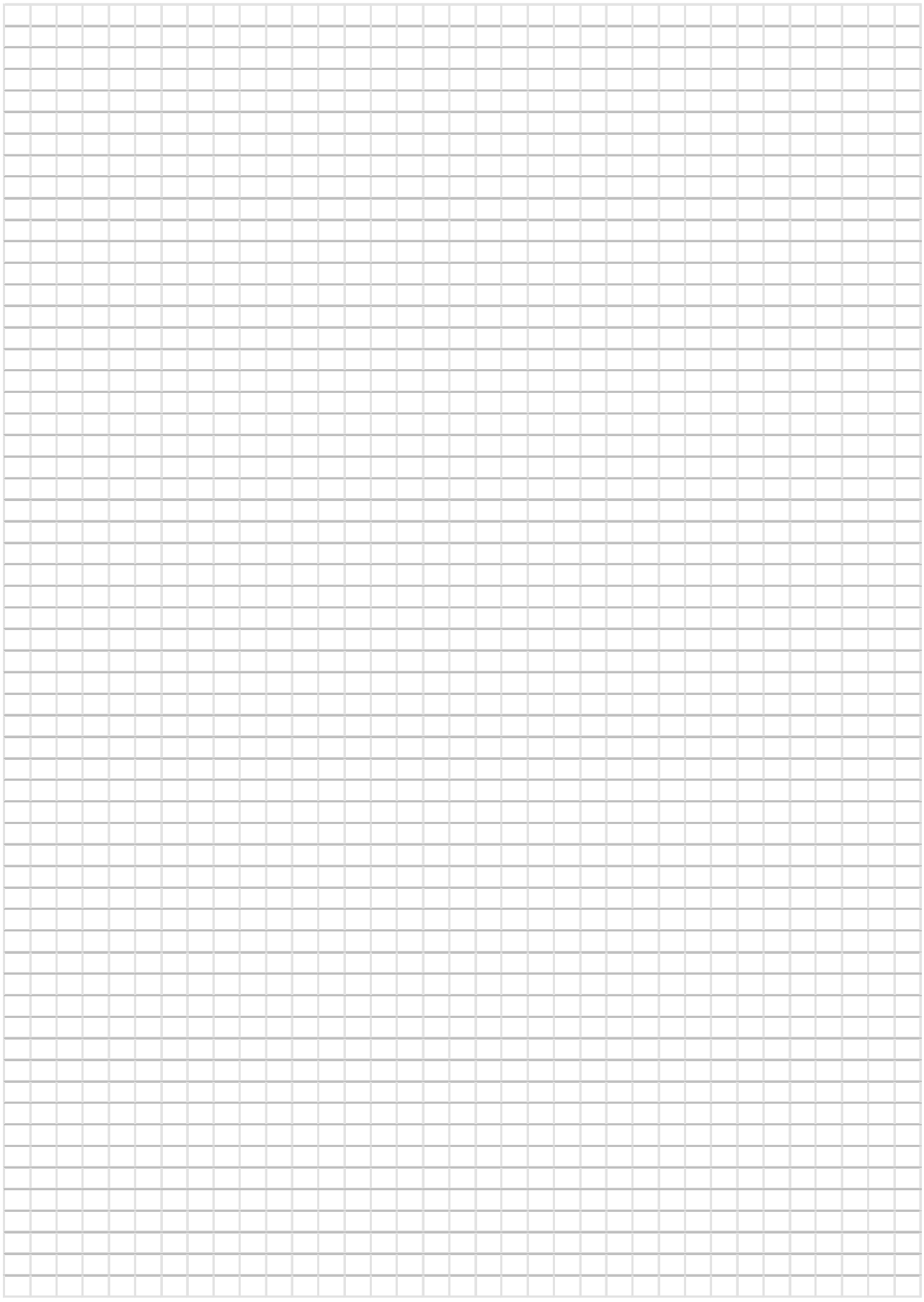
Notes :



Features

- High-performance, Low-power AVR® 8-bit Microcontroller
- Advanced RISC Architecture
  - 130 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 16 MIPS Throughput at 16 MHz
  - On-chip 2-cycle Multiplier
- Nonvolatile Program and Data Memories
  - 8K Bytes of In-System Self-Programmable Flash
    Endurance: 10,000 Write/Erase Cycles
  - Optional Boot Code Section with Independent Lock Bits
    In-System Programming by On-chip Boot Program
    True Read-While-Write Operation
  - 512 Bytes EEPROM
    Endurance: 100,000 Write/Erase Cycles
  - 512 Bytes Internal SRAM
  - Programming Lock for Software Security
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Four PWM Channels
  - 8-channel, 10-bit ADC
    8 Single-ended Channels
    7 Differential Channels for TQFP Package Only
    2 Differential Channels with Programmable Gain at 1x, 10x, or 200x for TQFP Package Only
  - Byte-oriented Two-wire Serial Interface
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated RC Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby
- I/O and Packages
  - 32 Programmable I/O Lines
  - 40-pin PDIP, 44-lead TQFP, 44-lead PLCC, and 44-pad QFN/MLF
- Operating Voltages
  - 2.7 - 5.5V for ATmega8535L
  - 4.5 - 5.5V for ATmega8535
- Speed Grades
  - 0 - 8 MHz for ATmega8535L
  - 0 - 16 MHz for ATmega8535

8-bit AVR® Microcontroller with 8K Bytes In-System Programmable Flash

ATmega8535
ATmega8535L

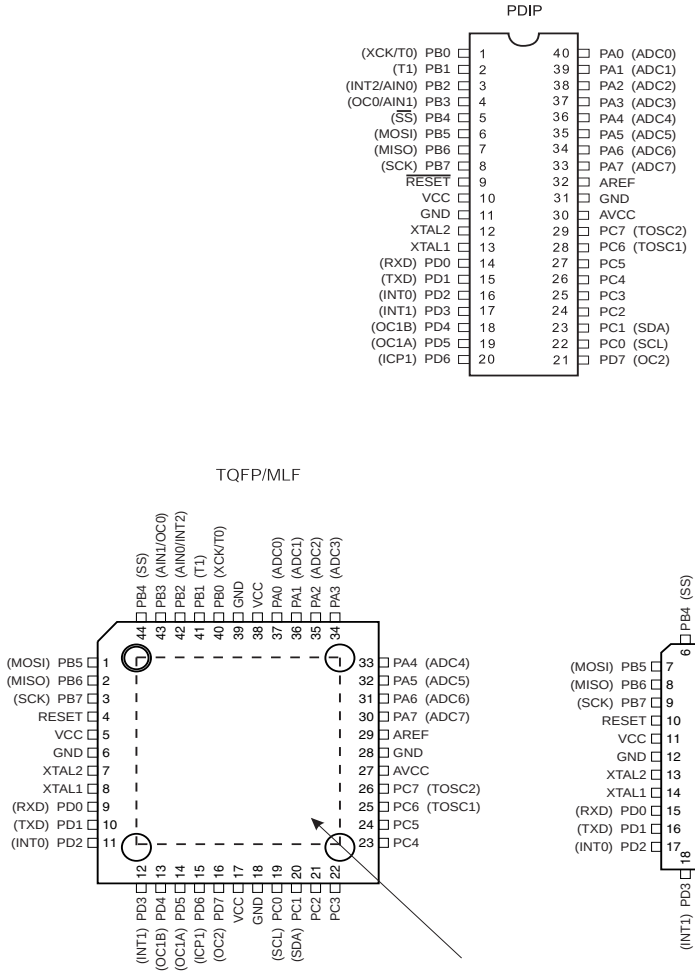
Summary

2502KS–AVR–10/06

Note: This is a summary document. A complete document is available on our Web site at www.atmel.com.

Pin Configurations

Figure 1. Pinout ATmega8535



NOTE: MLF Bottom pad should be soldered to ground.

Disclaimer

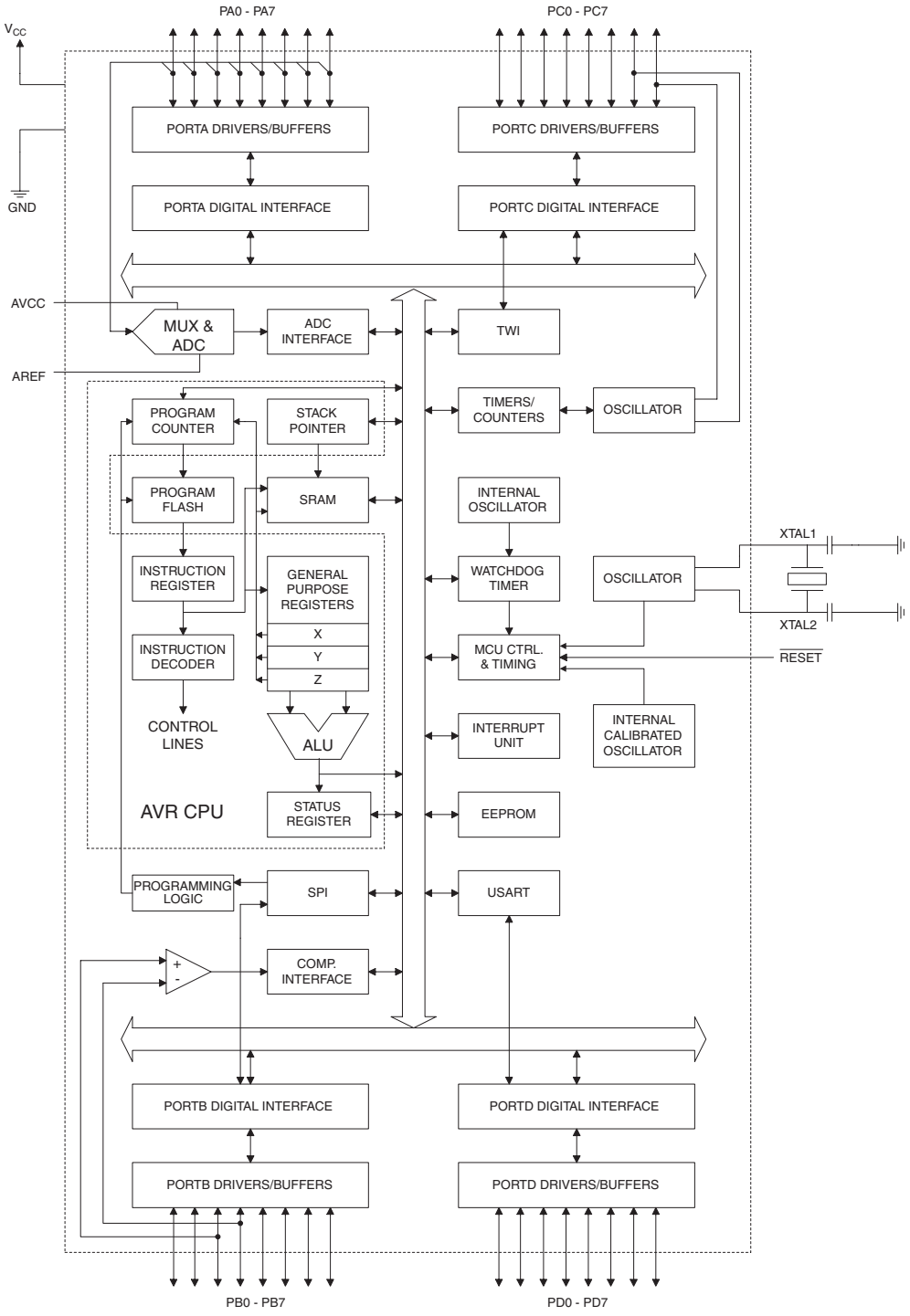
Typical values contained in this data sheet are based on simulations and characterization of other AVR microcontrollers manufactured on the same process technology. Min and Max values will be available after the device is characterized.

Overview

The ATmega8535 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing instructions in a single clock cycle, the ATmega8535 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

Block Diagram

Figure 2. Block Diagram



The AVR core combines a rich instruction set with 32 general purpose working registers. All 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega8535 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes EEPROM, 512 bytes SRAM, 32 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain in TQFP package, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or Hardware Reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the asynchronous timer continue to run.

The device is manufactured using Atmel's high density nonvolatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega8535 is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega8535 AVR is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, In-Circuit Emulators, and evaluation kits.

AT90S8535 Compatibility

The ATmega8535 provides all the features of the AT90S8535. In addition, several new features are added. The ATmega8535 is backward compatible with AT90S8535 in most cases. However, some incompatibilities between the two microcontrollers exist. To solve this problem, an AT90S8535 compatibility mode can be selected by programming the S8535C fuse. ATmega8535 is pin compatible with AT90S8535, and can replace the AT90S8535 on current Printed Circuit Boards. However, the location of fuse bits and the electrical characteristics differs between the two devices.

AT90S8535 Compatibility Mode

Programming the S8535C fuse will change the following functionality:

- The timed sequence for changing the Watchdog Time-out period is disabled. See "Timed Sequences for Changing the Configuration of the Watchdog Timer" on page 45 for details.
- The double buffering of the USART Receive Register is disabled. See "AVR USART vs. AVR UART – Compatibility" on page 146 for details.

Pin Descriptions

V_{CC} — Digital supply voltage.

GND — Ground.

Port A (PA7..PA0) — Port A serves as the analog inputs to the A/D Converter.

Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7..PB0) — Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B also serves the functions of various special features of the ATmega8535 as listed on page 60.

Port C (PC7..PC0) — Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port D (PD7..PD0) — Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port D also serves the functions of various special features of the ATmega8535 as listed on page 64.

$\overline{\text{RESET}}$ — Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is given in Table 15 on page 37. Shorter pulses are not guaranteed to generate a reset.

XTAL1 — Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2 — Output from the inverting Oscillator amplifier.

AVCC — AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to V_{CC}, even if the ADC is not used. If the ADC is used, it should be connected to V_{CC} through a low-pass filter.

AREF — AREF is the analog reference pin for the A/D Converter.

Resources

A comprehensive set of development tools, application notes and datasheets are available for download on http://www.atmel.com/avr.

About Code Examples

This documentation contains simple code examples that briefly show how to use various parts of the device. These code examples assume that the part specific header file is included before compilation. Be aware that not all C compiler vendors include bit definitions in the header files and interrupt handling in C is compiler dependent. Please confirm with the C Compiler documentation for more details.

Register Summary

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x3F (0x5F)	SREG	I	T	H	S	V	N	Z	C	10
0x3E (0x5E)	SPH	–	–	–	–	–	–	SP9	SP8	12
0x3D (0x5D)	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	12
0x3C (0x5C)	OCR0	Timer/Counter0 Output Compare Register								85
0x3B (0x5B)	GICR	INT1	INT0	INT2	–	–	–	IVSEL	IVCE	49, 69
0x3A (0x5A)	GIFR	INTF1	INTF0	INTF2	–	–	–	–	–	70
0x39 (0x59)	TIMSK	OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0	85, 115, 133
0x38 (0x58)	TIFR	OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0	86, 116, 134
0x37 (0x57)	SPMCR	SPMIE	RWWSB	–	RWWSRE	BLBSET	PGWRT	PGERS	SPMEN	228
0x36 (0x56)	TWCR	TWINT	TWEA	TWSTA	TWSTO	TWWC	TWEN	–	TWIE	181
0x35 (0x55)	MCUCR	SM2	SE	SM1	SM0	ISC11	ISC10	ISC01	ISC00	32, 68
0x34 (0x54)	MCUCSR	–	ISC2	–	–	WDRF	BORF	EXTRF	PORF	40, 69
0x33 (0x53)	TCCR0	FOC0	WGM00	COM01	COM00	WGM01	CS02	CS01	CS00	83
0x32 (0x52)	TCNT0	Timer/Counter0 (8 Bits)								85
0x31 (0x51)	OSCCAL	Oscillator Calibration Register								30
0x30 (0x50)	SFIOR	ADTS2	ADTS1	ADTS0	–	ACME	PUD	PSR2	PSR10	59,88,135,203,223
0x2F (0x4F)	TCCR1A	COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10	110
0x2E (0x4E)	TCCR1B	ICNC1	ICES1	–	WGM13	WGM12	CS12	CS11	CS10	113
0x2D (0x4D)	TCNT1H	Timer/Counter1 – Counter Register High Byte								114
0x2C (0x4C)	TCNT1L	Timer/Counter1 – Counter Register Low Byte								114
0x2B (0x4B)	OCR1AH	Timer/Counter1 – Output Compare Register A High Byte								114
0x2A (0x4A)	OCR1AL	Timer/Counter1 – Output Compare Register A Low Byte								114
0x29 (0x49)	OCR1BH	Timer/Counter1 – Output Compare Register B High Byte								114
0x28 (0x48)	OCR1BL	Timer/Counter1 – Output Compare Register B Low Byte								114
0x27 (0x47)	ICR1H	Timer/Counter1 – Input Capture Register High Byte								114
0x26 (0x46)	ICR1L	Timer/Counter1 – Input Capture Register Low Byte								114
0x25 (0x45)	TCCR2	FOC2	WGM20	COM21	COM20	WGM21	CS22	CS21	CS20	128
0x24 (0x44)	TCNT2	Timer/Counter2 (8 Bits)								130
0x23 (0x43)	OCR2	Timer/Counter2 Output Compare Register								131
0x22 (0x42)	ASSR	–	–	–	–	AS2	TCN2UB	OCR2UB	TCR2UB	131
0x21 (0x41)	WDTCR	–	–	–	WDCE	WDE	WDP2	WDP1	WDP0	42
0x20[1] (0x40)[1]	UBRRH	URSEL	–	–	–	UBRR[11:8]				169
	UCSRC	URSEL	UMSEL	UPM1	UPM0	USBS	UCSZ1	UCSZ0	UCPOL	167
0x1F (0x3F)	EEARH	–	–	–	–	–	–	–	EEAR8	19
0x1E (0x3E)	EEARL	EEPROM Address Register Low Byte								19
0x1D (0x3D)	EEDR	EEPROM Data Register								19
0x1C (0x3C)	EECR	–	–	–	–	EERIE	EEMWE	EEWE	EERE	19
0x1B (0x3B)	PORTA	PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0	66
0x1A (0x3A)	DDRA	DDA7	DDA6	DDA5	DDA4	DDA3	DDA2	DDA1	DDA0	66
0x19 (0x39)	PINA	PINA7	PINA6	PINA5	PINA4	PINA3	PINA2	PINA1	PINA0	66
0x18 (0x38)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	66
0x17 (0x37)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	66
0x16 (0x36)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	67
0x15 (0x35)	PORTC	PORTC7	PORTC6	PORTC5	PORTC4	PORTC3	PORTC2	PORTC1	PORTC0	67
0x14 (0x34)	DDRC	DDC7	DDC6	DDC5	DDC4	DDC3	DDC2	DDC1	DDC0	67
0x13 (0x33)	PINC	PINC7	PINC6	PINC5	PINC4	PINC3	PINC2	PINC1	PINC0	67
0x12 (0x32)	PORTD	PORTD7	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	67
0x11 (0x31)	DDRD	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	67
0x10 (0x30)	PIND	PIND7	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	67
0x0F (0x2F)	SPDR	SPI Data Register								143
0x0E (0x2E)	SPSR	SPIF	WCOL	–	–	–	–	–	SPI2X	143
0x0D (0x2D)	SPCR	SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0	141
0x0C (0x2C)	UDR	USART I/O Data Register								164
0x0B (0x2B)	UCSRA	RXC	TXC	UDRE	FE	DOR	PE	U2X	MPCM	165
0x0A (0x2A)	UCSRB	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8	166
0x09 (0x29)	UBRRL	USART Baud Rate Register Low Byte								169
0x08 (0x28)	ACSR	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	203
0x07 (0x27)	ADMUX	REFS1	REFS0	ADLAR	MUX4	MUX3	MUX2	MUX1	MUX0	219
0x06 (0x26)	ADCSRA	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0	221
0x05 (0x25)	ADCH	ADC Data Register High Byte								222
0x04 (0x24)	ADCL	ADC Data Register Low Byte								222
0x03 (0x23)	TWDR	Two-wire Serial Interface Data Register								183
0x02 (0x22)	TWAR	TWA6	TWA5	TWA4	TWA3	TWA2	TWA1	TWA0	TWGCE	183
0x01 (0x21)	TWSR	TWS7	TWS6	TWS5	TWS4	TWS3	–	TWPS1	TWPS0	183

Register Summary (Continued)

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x00 (0x20)	TWBR	Two-wire Serial Interface Bit Rate Register								181

Notes:
1. Refer to the USART description for details on how to access UBRRH and UCSRC.
2. For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.
3. Some of the status flags are cleared by writing a logical one to them. Note that the CBI and SBI instructions will operate on all bits in the I/O Register, writing a one back into any flag read as set, thus clearing the flag. The CBI and SBI instructions work with registers 0x00 to 0x1F only.

Instruction Set Summary

Mnemonics	Operands	Description	Operation	Flags	#Clocks
ARITHMETIC AND LOGIC INSTRUCTIONS					
ADD	Rd, Rr	Add two Registers	Rd ← Rd + Rr	Z,C,N,V,H	1
ADC	Rd, Rr	Add with Carry two Registers	Rd ← Rd + Rr + C	Z,C,N,V,H	1
ADIW	Rdl,K	Add Immediate to Word	Rdh:Rdl ← Rdh:Rdl + K	Z,C,N,V,S	2
SUB	Rd, Rr	Subtract two Registers	Rd ← Rd - Rr	Z,C,N,V,H	1
SUBI	Rd, K	Subtract Constant from Register	Rd ← Rd - K	Z,C,N,V,H	1
SBC	Rd, Rr	Subtract with Carry two Registers	Rd ← Rd - Rr - C	Z,C,N,V,H	1
SBCI	Rd, K	Subtract with Carry Constant from Reg.	Rd ← Rd - K - C	Z,C,N,V,H	1
SBIW	Rdl,K	Subtract Immediate from Word	Rdh:Rdl ← Rdh:Rdl - K	Z,C,N,V,S	2
AND	Rd, Rr	Logical AND Registers	Rd ← Rd • Rr	Z,N,V	1
ANDI	Rd, K	Logical AND Register and Constant	Rd ← Rd • K	Z,N,V	1
OR	Rd, Rr	Logical OR Registers	Rd ← Rd v Rr	Z,N,V	1
ORI	Rd, K	Logical OR Register and Constant	Rd ← Rd v K	Z,N,V	1
EOR	Rd, Rr	Exclusive OR Registers	Rd ← Rd ⊕ Rr	Z,N,V	1
COM	Rd	One's Complement	Rd ← 0xFF − Rd	Z,C,N,V	1
NEG	Rd	Two's Complement	Rd ← 0x00 − Rd	Z,C,N,V,H	1
SBR	Rd,K	Set Bit(s) in Register	Rd ← Rd v K	Z,N,V	1
CBR	Rd,K	Clear Bit(s) in Register	Rd ← Rd • (0xFF - K)	Z,N,V	1
INC	Rd	Increment	Rd ← Rd + 1	Z,N,V	1
DEC	Rd	Decrement	Rd ← Rd − 1	Z,N,V	1
TST	Rd	Test for Zero or Minus	Rd ← Rd • Rd	Z,N,V	1
CLR	Rd	Clear Register	Rd ← Rd ⊕ Rd	Z,N,V	1
SER	Rd	Set Register	Rd ← 0xFF	None	1
MUL	Rd, Rr	Multiply Unsigned	R1:R0 ← Rd x Rr	Z,C	2
MULS	Rd, Rr	Multiply Signed	R1:R0 ← Rd x Rr	Z,C	2
MULSU	Rd, Rr	Multiply Signed with Unsigned	R1:R0 ← Rd x Rr	Z,C	2
FMUL	Rd, Rr	Fractional Multiply Unsigned	R1:R0 ← (Rd x Rr) << 1	Z,C	2
FMULS	Rd, Rr	Fractional Multiply Signed	R1:R0 ← (Rd x Rr) << 1	Z,C	2
FMULSU	Rd, Rr	Fractional Multiply Signed with Unsigned	R1:R0 ← (Rd x Rr) << 1	Z,C	2
BRANCH INSTRUCTIONS					
RJMP	k	Relative Jump	PC ← PC + k + 1	None	2
IJMP		Indirect Jump to (Z)	PC ← Z	None	2
RCALL	k	Relative Subroutine Call	PC ← PC + k + 1	None	3
ICALL		Indirect Call to (Z)	PC ← Z	None	3
RET		Subroutine Return	PC ← STACK	None	4
RETI		Interrupt Return	PC ← STACK	I	4
CPSE	Rd,Rr	Compare, Skip if Equal	if (Rd = Rr) PC ← PC + 2 or 3	None	1 / 2 / 3
CP	Rd,Rr	Compare	Rd − Rr	Z, N,V,C,H	1
CPC	Rd,Rr	Compare with Carry	Rd − Rr − C	Z, N,V,C,H	1
CPI	Rd,K	Compare Register with Immediate	Rd − K	Z, N,V,C,H	1
SBRC	Rr, b	Skip if Bit in Register Cleared	if (Rr(b)=0) PC ← PC + 2 or 3	None	1 / 2 / 3
SBRS	Rr, b	Skip if Bit in Register is Set	if (Rr(b)=1) PC ← PC + 2 or 3	None	1 / 2 / 3
SBIC	P, b	Skip if Bit in I/O Register Cleared	if (P(b)=0) PC ← PC + 2 or 3	None	1 / 2 / 3
SBIS	P, b	Skip if Bit in I/O Register is Set	if (P(b)=1) PC ← PC + 2 or 3	None	1 / 2 / 3
BRBS	s, k	Branch if Status Flag Set	if (SREG(s) = 1) then PC←PC+k + 1	None	1 / 2
BRBC	s, k	Branch if Status Flag Cleared	if (SREG(s) = 0) then PC←PC+k + 1	None	1 / 2
BREQ	k	Branch if Equal	if (Z = 1) then PC ← PC + k + 1	None	1 / 2
BRNE	k	Branch if Not Equal	if (Z = 0) then PC ← PC + k + 1	None	1 / 2
BRCS	k	Branch if Carry Set	if (C = 1) then PC ← PC + k + 1	None	1 / 2
BRCC	k	Branch if Carry Cleared	if (C = 0) then PC ← PC + k + 1	None	1 / 2
BRSH	k	Branch if Same or Higher	if (C = 0) then PC ← PC + k + 1	None	1 / 2
BRLO	k	Branch if Lower	if (C = 1) then PC ← PC + k + 1	None	1 / 2
BRMI	k	Branch if Minus	if (N = 1) then PC ← PC + k + 1	None	1 / 2
BRPL	k	Branch if Plus	if (N = 0) then PC ← PC + k + 1	None	1 / 2
BRGE	k	Branch if Greater or Equal, Signed	if (N ⊕ V= 0) then PC ← PC + k + 1	None	1 / 2
BRLT	k	Branch if Less Than Zero, Signed	if (N ⊕ V= 1) then PC ← PC + k + 1	None	1 / 2
BRHS	k	Branch if Half Carry Flag Set	if (H = 1) then PC ← PC + k + 1	None	1 / 2
BRHC	k	Branch if Half Carry Flag Cleared	if (H = 0) then PC ← PC + k + 1	None	1 / 2
BRTS	k	Branch if T Flag Set	if (T = 1) then PC ← PC + k + 1	None	1 / 2
BRTC	k	Branch if T Flag Cleared	if (T = 0) then PC ← PC + k + 1	None	1 / 2
BRVS	k	Branch if Overflow Flag is Set	if (V = 1) then PC ← PC + k + 1	None	1 / 2
BRVC	k	Branch if Overflow Flag is Cleared	if (V = 0) then PC ← PC + k + 1	None	1 / 2
BRIE	k	Branch if Interrupt Enabled	if (I = 1) then PC ← PC + k + 1	None	1 / 2
BRID	k	Branch if Interrupt Disabled	if (I = 0) then PC ← PC + k + 1	None	1 / 2
DATA TRANSFER INSTRUCTIONS					

Mnemonics	Operands	Description	Operation	Flags	#Clocks
MOV	Rd, Rr	Move Between Registers	Rd ← Rr	None	1
MOVW	Rd, Rr	Copy Register Word	Rd+1:Rd ← Rr+1:Rr	None	1
LDI	Rd, K	Load Immediate	Rd ← K	None	1
LD	Rd, X	Load Indirect	Rd ← (X)	None	2
LD	Rd, X+	Load Indirect and Post-Inc.	Rd ← (X), X ← X + 1	None	2
LD	Rd, - X	Load Indirect and Pre-Dec.	X ← X - 1, Rd ← (X)	None	2
LD	Rd, Y	Load Indirect	Rd ← (Y)	None	2
LD	Rd, Y+	Load Indirect and Post-Inc.	Rd ← (Y), Y ← Y + 1	None	2
LD	Rd, - Y	Load Indirect and Pre-Dec.	Y ← Y - 1, Rd ← (Y)	None	2
LDD	Rd,Y+q	Load Indirect with Displacement	Rd ← (Y + q)	None	2
LD	Rd, Z	Load Indirect	Rd ← (Z)	None	2
LD	Rd, Z+	Load Indirect and Post-Inc.	Rd ← (Z), Z ← Z+1	None	2
LD	Rd, -Z	Load Indirect and Pre-Dec.	Z ← Z - 1, Rd ← (Z)	None	2
LDD	Rd, Z+q	Load Indirect with Displacement	Rd ← (Z + q)	None	2
LDS	Rd, k	Load Direct from SRAM	Rd ← (k)	None	2
ST	X, Rr	Store Indirect	(X) ← Rr	None	2
ST	X+, Rr	Store Indirect and Post-Inc.	(X) ← Rr, X ← X + 1	None	2
ST	- X, Rr	Store Indirect and Pre-Dec.	X ← X - 1, (X) ← Rr	None	2
ST	Y, Rr	Store Indirect	(Y) ← Rr	None	2
ST	Y+, Rr	Store Indirect and Post-Inc.	(Y) ← Rr, Y ← Y + 1	None	2
ST	- Y, Rr	Store Indirect and Pre-Dec.	Y ← Y - 1, (Y) ← Rr	None	2
STD	Y+q,Rr	Store Indirect with Displacement	(Y + q) ← Rr	None	2
ST	Z, Rr	Store Indirect	(Z) ← Rr	None	2
ST	Z+, Rr	Store Indirect and Post-Inc.	(Z) ← Rr, Z ← Z + 1	None	2
ST	-Z, Rr	Store Indirect and Pre-Dec.	Z ← Z - 1, (Z) ← Rr	None	2
STD	Z+q,Rr	Store Indirect with Displacement	(Z + q) ← Rr	None	2
STS	k, Rr	Store Direct to SRAM	(k) ← Rr	None	2
LPM		Load Program Memory	R0 ← (Z)	None	3
LPM	Rd, Z	Load Program Memory	Rd ← (Z)	None	3
LPM	Rd, Z+	Load Program Memory and Post-Inc	Rd ← (Z), Z ← Z+1	None	3
SPM		Store Program Memory	(Z) ← R1:R0	None	-
IN	Rd, P	In Port	Rd ← P	None	1
OUT	P, Rr	Out Port	P ← Rr	None	1
PUSH	Rr	Push Register on Stack	STACK ← Rr	None	2
POP	Rd	Pop Register from Stack	Rd ← STACK	None	2
BIT AND BIT-TEST INSTRUCTIONS					
SBI	P,b	Set Bit in I/O Register	I/O(P,b) ← 1	None	2
CBI	P,b	Clear Bit in I/O Register	I/O(P,b) ← 0	None	2
LSL	Rd	Logical Shift Left	Rd(n+1) ← Rd(n), Rd(0) ← 0	Z,C,N,V	1
LSR	Rd	Logical Shift Right	Rd(n) ← Rd(n+1), Rd(7) ← 0	Z,C,N,V	1
ROL	Rd	Rotate Left Through Carry	Rd(0)←C,Rd(n+1)← Rd(n),C←Rd(7)	Z,C,N,V	1
ROR	Rd	Rotate Right Through Carry	Rd(7)←C,Rd(n)← Rd(n+1),C←Rd(0)	Z,C,N,V	1
ASR	Rd	Arithmetic Shift Right	Rd(n) ← Rd(n+1), n=0..6	Z,C,N,V	1
SWAP	Rd	Swap Nibbles	Rd(3..0)←Rd(7..4),Rd(7..4)←Rd(3..0)	None	1
BSET	s	Flag Set	SREG(s) ← 1	SREG(s)	1
BCLR	s	Flag Clear	SREG(s) ← 0	SREG(s)	1
BST	Rr, b	Bit Store from Register to T	T ← Rr(b)	T	1
BLD	Rd, b	Bit load from T to Register	Rd(b) ← T	None	1
SEC		Set Carry	C ← 1	C	1
CLC		Clear Carry	C ← 0	C	1
SEN		Set Negative Flag	N ← 1	N	1
CLN		Clear Negative Flag	N ← 0	N	1
SEZ		Set Zero Flag	Z ← 1	Z	1
CLZ		Clear Zero Flag	Z ← 0	Z	1
SEI		Global Interrupt Enable	I ← 1	I	1
CLI		Global Interrupt Disable	I ← 0	I	1
SES		Set Signed Test Flag	S ← 1	S	1
CLS		Clear Signed Test Flag	S ← 0	S	1
SEV		Set Twos Complement Overflow.	V ← 1	V	1
CLV		Clear Twos Complement Overflow	V ← 0	V	1
SET		Set T in SREG	T ← 1	T	1
CLT		Clear T in SREG	T ← 0	T	1
SEH		Set Half Carry Flag in SREG	H ← 1	H	1
CLH		Clear Half Carry Flag in SREG	H ← 0	H	1
MCU CONTROL INSTRUCTIONS					
NOP		No Operation		None	1

Mnemonics	Operands	Description	Operation	Flags	#Clocks
SLEEP		Sleep	(see specific descr. for Sleep function)	None	1
WDR		Watchdog Reset	(see specific descr. for WDR/Timer)	None	1
BREAK		Break	For On-chip Debug Only	None	N/A

Ordering Information

Speed (MHz)	Power Supply	Ordering Code	Package[1]	Operation Range
8	2.7 - 5.5V	ATmega8535L-8AC	44A	Commercial (0°C to 70°C)
		ATmega8535L-8PC	40P6	
		ATmega8535L-8JC	44J	
		ATmega8535L-8MC	44M1	
		ATmega8535L-8AI	44A	Industrial (-40°C to 85°C)
		ATmega8535L-8PI	40P6	
		ATmega8535L-8JI	44J	
		ATmega8535L-8MI	44M1	
		ATmega8535L-8AU[2]	44A	
		ATmega8535L-8PU[2]	40P6	
		ATmega8535L-8JU[2]	44J	
		ATmega8535L-8MU[2]	44M1	
16	4.5 - 5.5V	ATmega8535-16AC	44A	Commercial (0°C to 70°C)
		ATmega8535-16PC	40P6	
		ATmega8535-16JC	44J	
		ATmega8535-16MC	44M1	
		ATmega8535-16AI	44A	Industrial (-40°C to 85°C)
		ATmega8535-16PI	40P6	
		ATmega8535-16JI	44J	
		ATmega8535-16MI	44M1	
		ATmega8535-16AU[2]	44A	
		ATmega8535-16PU[2]	40P6	
		ATmega8535-16JU[2]	44J	
		ATmega8535-16MU[2]	44M1	

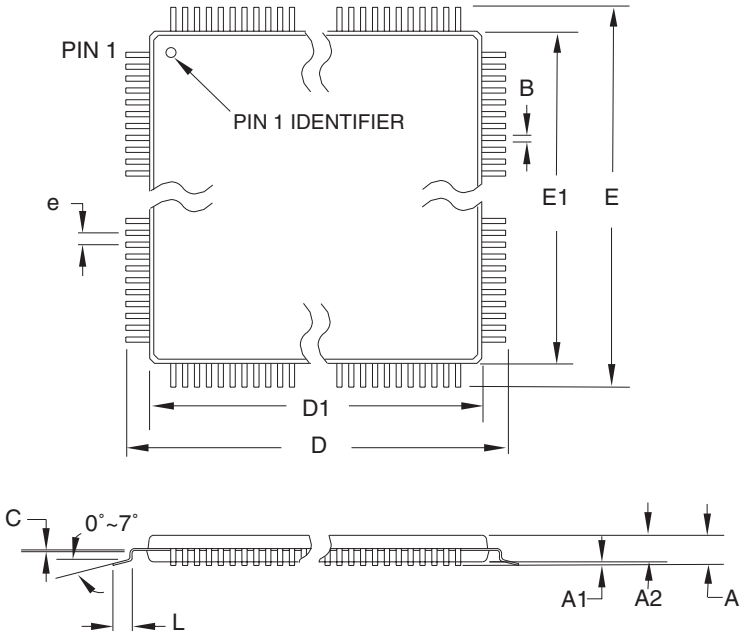
Note: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities..

2. Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive).Also Halide free and fully Green.

Package Type	
44A	44-lead, Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (TQFP)
40P6	40-pin, 0.600” Wide, Plastic Dual Inline Package (PDIP)
44J	44-lead, Plastic J-leaded Chip Carrier (PLCC)
44M1-A	44-pad, 7 x 7 x 1.0 mm body, lead pitch 0.50 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

Packaging Information

44A



COMMON DIMENSIONS
(Unit of Measure = mm)

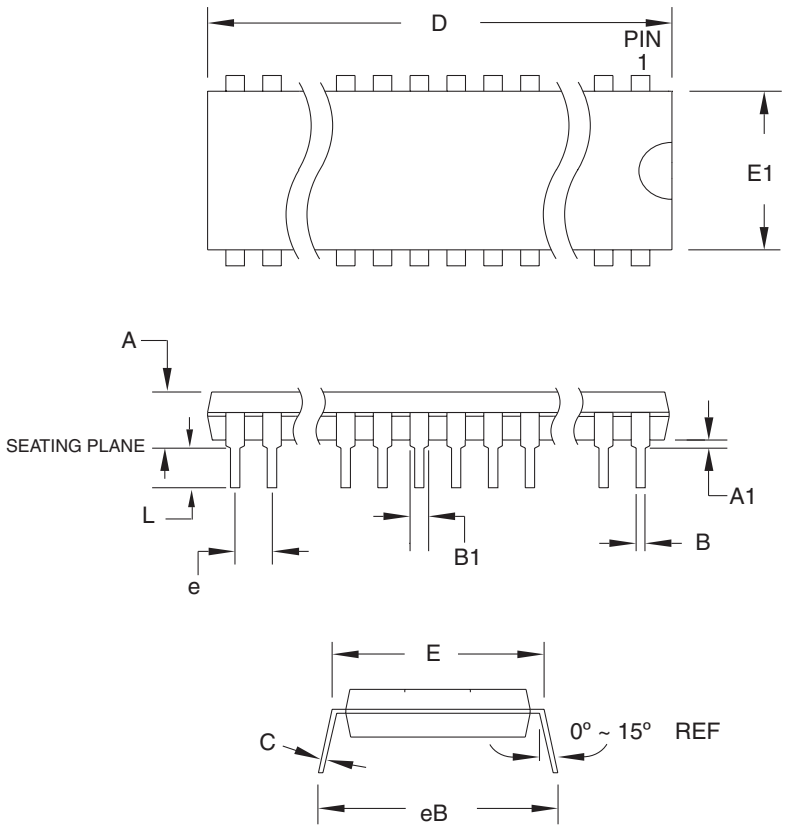
SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	1.20	
A1	0.05	–	0.15	
A2	0.95	1.00	1.05	
D	11.75	12.00	12.25	
D1	9.90	10.00	10.10	Note 2
E	11.75	12.00	12.25	
E1	9.90	10.00	10.10	Note 2
B	0.30	–	0.45	
C	0.09	–	0.20	
L	0.45	–	0.75	
e	0.80 TYP			

Notes:
1. This package conforms to JEDEC reference MS-026, Variation ACB.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25 mm per side. Dimensions D1 and E1 are maximum plastic body size dimensions including mold mismatch.
3. Lead coplanarity is 0.10 mm maximum.

10/5/2001

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**44A,** 44-lead, 10 x 10 mm Body Size, 1.0 mm Body Thickness, 0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)	44A	B

40P6



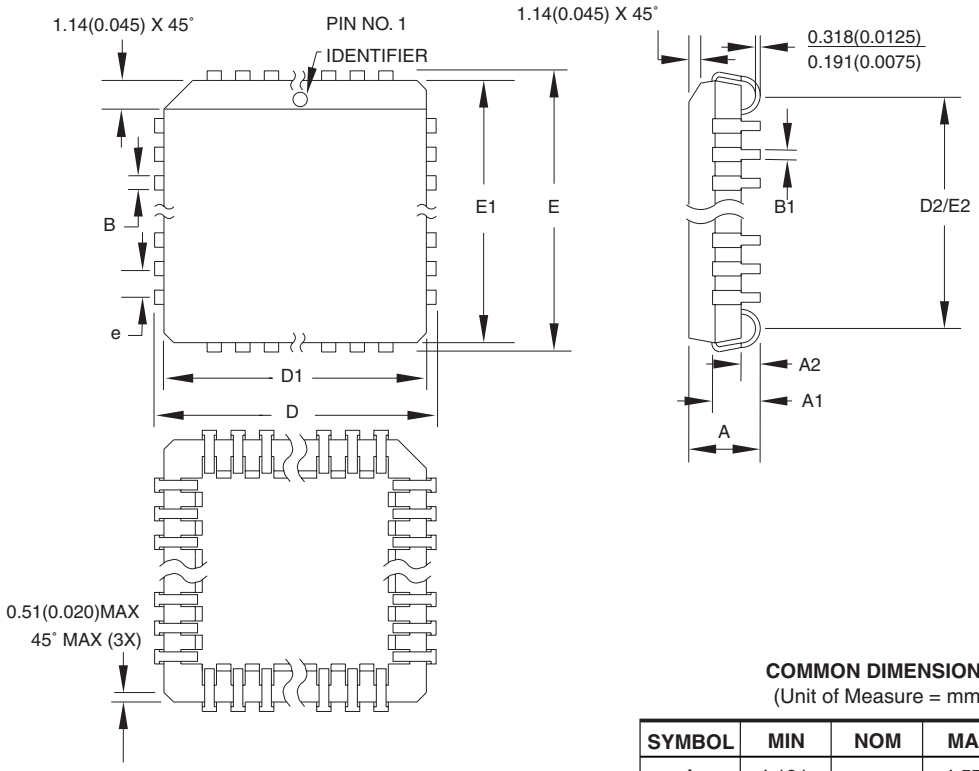
COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	4.826	
A1	0.381	–	–	
D	52.070	–	52.578	Note 2
E	15.240	–	15.875	
E1	13.462	–	13.970	Note 2
B	0.356	–	0.559	
B1	1.041	–	1.651	
L	3.048	–	3.556	
C	0.203	–	0.381	
eB	15.494	–	17.526	
e	2.540 TYP			

Notes:
1. This package conforms to JEDEC reference MS-011, Variation AC.
2. Dimensions D and E1 do not include mold Flash or Protrusion. Mold Flash or Protrusion shall not exceed 0.25 mm (0.010").

09/28/01

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**40P6**, 40-lead (0.600"/15.24 mm Wide) Plastic Dual Inline Package (PDIP)	40P6	B



COMMON DIMENSIONS
(Unit of Measure = mm)

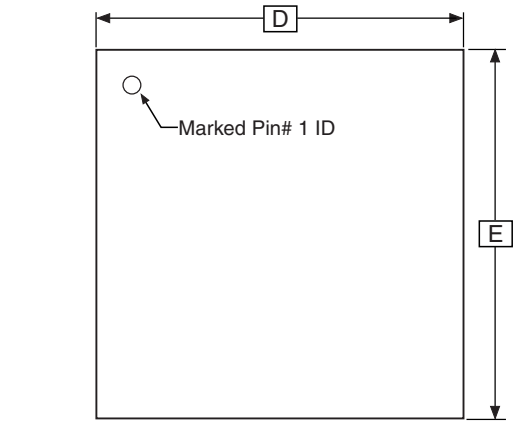
SYMBOL	MIN	NOM	MAX	NOTE
A	4.191	–	4.572	
A1	2.286	–	3.048	
A2	0.508	–	–	
D	17.399	–	17.653	
D1	16.510	–	16.662	Note 2
E	17.399	–	17.653	
E1	16.510	–	16.662	Note 2
D2/E2	14.986	–	16.002	
B	0.660	–	0.813	
B1	0.330	–	0.533	
e	1.270 TYP			

Notes:
1. This package conforms to JEDEC reference MS-018, Variation AC.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is .010"(0.254 mm) per side. Dimension D1 and E1 include mold mismatch and are measured at the extreme material condition at the upper or lower parting line.
3. Lead coplanarity is 0.004" (0.102 mm) maximum.

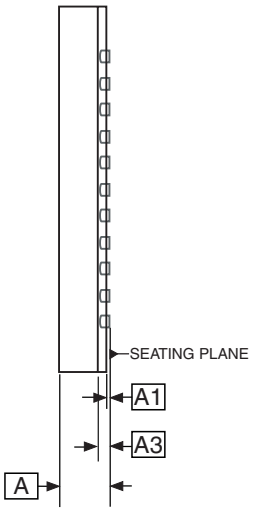
10/04/01

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**44J**, 44-lead, Plastic J-leaded Chip Carrier (PLCC)	44J	B

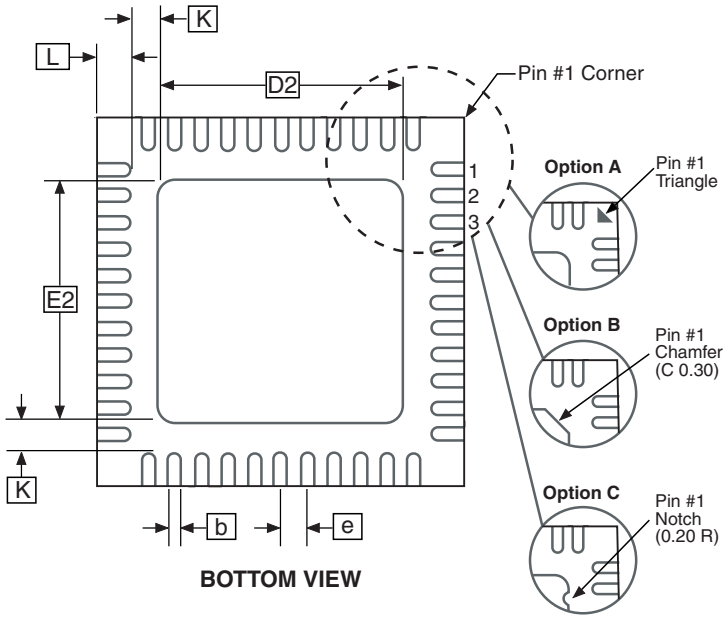
44M1-A



TOP VIEW



SIDE VIEW



BOTTOM VIEW

Note: JEDEC Standard MO-220, Fig. 1 (SAW Singulation) VKKD-3.

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	0.80	0.90	1.00	
A1	–	0.02	0.05	
A3		0.25 REF		
b	0.18	0.23	0.30	
D	6.90	7.00	7.10	
D2	5.00	5.20	5.40	
E	6.90	7.00	7.10	
E2	5.00	5.20	5.40	
e		0.50 BSC		
L	0.59	0.64	0.69	
K	0.20	0.26	0.41	

5/27/06

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**44M1**, 44-pad, 7 x 7 x 1.0 mm Body, Lead Pitch 0.50 mm, 5.20 mm Exposed Pad, Micro Lead Frame Package (MLF)	44M1	G

Errata

The revision letter refer to the device revision.

ATmega8535 Rev. A and B

- **First Analog Comparator conversion may be delayed**
- **Asynchronous Oscillator does not stop in Power-down**

1. First Analog Comparator conversion may be delayed

If the device is powered by a slow rising V_{CC}, the first Analog Comparator conversion will take longer than expected on some devices.

Problem Fix/Workaround

When the device has been powered or reset, disable then enable the Analog Comparator before the first conversion.

2. Asynchronous Oscillator does not stop in Power-down

The asynchronous oscillator does not stop when entering Power-down mode. This leads to higher power consumption than expected.

Problem Fix/Workaround

Manually disable the asynchronous timer before entering Power-down.

Datasheet Revision History

Please note that the referring page numbers in this section are referring to this document. The referring revision in this section are referring to the document revision.

Changes from Rev. 2502J- 08/06 to Rev. 2502K- 10/06

1. **Updated TOP/BOTTOM description for all Timer/Counters Fast PWM mode.**
2. **Updated "Errata" on page 18.**

Changes from Rev. 2502I- 06/06 to Rev. 2502J- 08/06

1. **Updated "Ordering Information" on page 13.**

Changes from Rev. 2502H- 04/06 to Rev. 2502I- 06/06

1. **Updated code example "USART Initialization" on page 150.**

Changes from Rev. 2502G- 04/05 to Rev. 2502H- 04/06

1. **Added "Resources" on page 6.**
2. **Updated Table 7 on page 29, Table 17 on page 42 and Table 111 on page 258.**
3. **Updated "Serial Peripheral Interface – SPI" on page 136.**
4. **Updated note in "Bit Rate Generator Unit" on page 180.**

Changes from Rev. 2502F- 06/04 to Rev. 2502G- 04/05

1. **Removed "Preliminary" and TBD's.**
2. **Updated Table 37 on page 69 and Table 113 on page 261.**
3. **Updated "Electrical Characteristics" on page 255.**
4. **Updated "Ordering Information" on page 13.**

Changes from Rev. 2502E-12/03 to Rev. 2502G-06/04

1. **MLF-package alternative changed to "Quad Flat No-Lead/Micro Lead Frame Package QFN/MLF".**

Changes from Rev. 2502E-12/03 to Rev. 2502F-06/04

1. **Updated "Reset Characteristics" on page 37.**
2. **Updated SPH in "Stack Pointer" on page 12.**
3. **Updated C code in "USART Initialization" on page 150.**
4. **Updated "Errata" on page 18.**

Changes from Rev. 2502D-09/03 to Rev. 2502E-12/03

1. **Updated "Calibrated Internal RC Oscillator" on page 29.**
2. **Added section "Errata" on page 18.**

Changes from Rev. 2502C-04/03 to Rev. 2502D-09/03

1. Removed “Advance Information” and some TBD’s from the datasheet.
2. Added note to “Pinout ATmega8535” on page 2.
3. Updated “Reset Characteristics” on page 37.
4. Updated “Absolute Maximum Ratings” and “DC Characteristics” in “Electrical Characteristics” on page 255.
5. Updated Table 111 on page 258.
6. Updated “ADC Characteristics” on page 263.
7. Updated “ATmega8535 Typical Characteristics” on page 266.
8. Removed CALL and JMP instructions from code examples and “Instruction Set Summary” on page 10.

Changes from Rev. 2502B-09/02 to Rev. 2502C-04/03

1. Updated “Packaging Information” on page 14.
2. Updated Figure 1 on page 2, Figure 84 on page 179, Figure 85 on page 185, Figure 87 on page 191, Figure 98 on page 207.
3. Added the section “EEPROM Write During Power-down Sleep Mode” on page 22.
4. Removed the references to the application notes “Multi-purpose Oscillator” and “32 kHz Crystal Oscillator”, which do not exist.
5. Updated code examples on page 44.
6. Removed ADHSM bit.
7. Renamed Port D pin ICP to ICP1. See “Alternate Functions of Port D” on page 64.
8. Added information about PWM symmetry for Timer 0 on page 79 and Timer 2 on page 126.
9. Updated Table 68 on page 169, Table 75 on page 190, Table 76 on page 193, Table 77 on page 196, Table 108 on page 253, Table 113 on page 261.
10. Updated description on “Bit 5 – TWSTA: TWI START Condition Bit” on page 182.
11. Updated the description in “Filling the Temporary Buffer (Page Loading)” and “Performing a Page Write” on page 231.
12. Removed the section description in “SPI Serial Programming Characteristics” on page 254.
13. Updated “Electrical Characteristics” on page 255.

14. Updated “ADC Characteristics” on page 263.

14. Updated “Register Summary” on page 8.

15. Various Timer 1 corrections.

16. Added WD_FUSE period in Table 108 on page 253.

Changes from Rev. 2502A-06/02 to Rev. 2502B-09/02

1. Canged the Endurance on the Flash to 10,000 Write/Erase Cycles.

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RF/Automotive
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Biometrics/Imaging/Hi-Rel MPU/
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38521 Saint-Egreve Cedex, France
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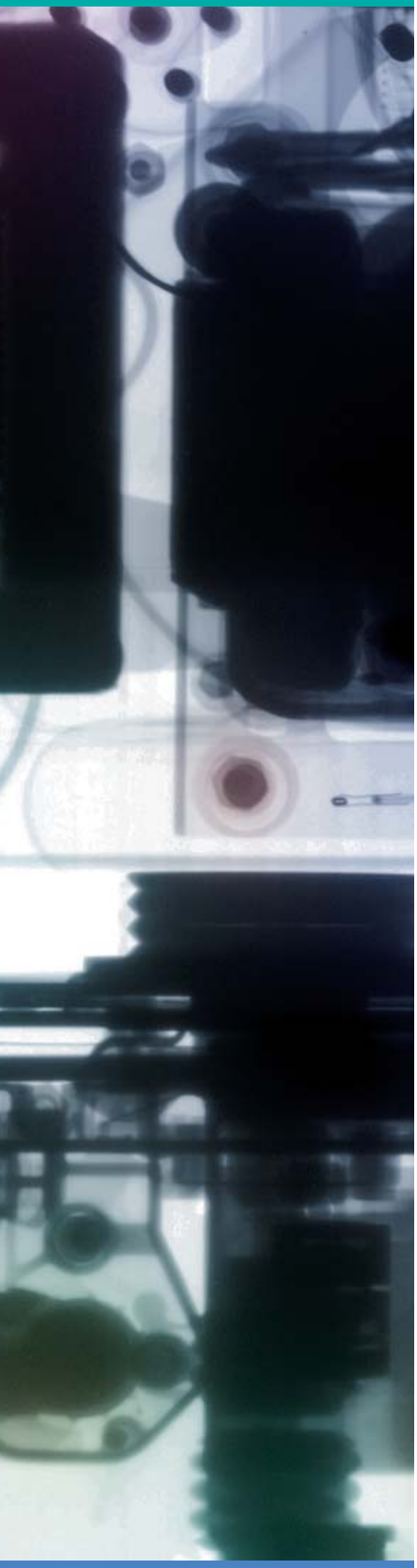
Fax: (33) 4-76-58-34-80

Literature Requests
www.atmel.com/literature

2502KS–AVR–10/06



M2M modem

FASTRACK GSM/GPRS MODEM M1306B

DEPEND ON A WIRELESS WORKHORSE

Wavecom's rugged, discrete Fastrack GSM/GPRS modem has proven itself for stable, reliable performance on wireless networks worldwide for more than five years. Updated with new features, the now legendary Fastrack continues to deliver rapid time to market and painless integration for machine-to-machine applications.

Housed in a rugged metallic casing, 25 mm shorter than the previous version, the Fastrack M1306B now offers two general purpose input/output access points, which can be multiplexed with an I2C bus to connect peripherals. In addition, the new serial auto shut down feature enables a programmable energy conservation mode especially valuable for battery-powered applications.

Fully certified, the dual-band 900/1800 MHz Fastrack M1306B offers GPRS Class 10 capability, supports Open AT and IT protocols such as IP connectivity.

RUGGED MACHINE-TO-MACHINE RELIABILITY

Add wireless to existing applications

Such as remote control and monitoring, vending, fleet management and others.

Reduce extra components

By embedding your application right on the Wavecom platform with Open AT.

Save time

Thanks to a fully integrated, fully certified wireless solution.

Get connected

And benefit from wireless services: GSM/GPRS data, SMS and voice via a simple serial connection.

wavecom

M2M modem SPECIFICATIONS

PRODUCT FEATURES

Dual Band GSM modem (EGSM900/1800 MHz) designed for data, fax, SMS and voice applications
Fully Type Approved
Fully compliant with ETSI GSM Phase 2 + Small MS

Output power:
Class 4 (2W @ 900 MHz)
Class 1 (1W @ 1800 MHz)
Power supply:

Input voltage: 5V-32V
- 5mA in idle mode, 140mA in communication GSM 900 @ 12V
- 5mA in idle mode, 100mA in communication GSM 1800 @ 12V
- Peak 1,7A @ 5.5V

Overall dimensions: 73 x 54 x 25mm
Weight: 82g

VOICE, DATA/FAX, SHORT MESSAGE SERVICES

Voice features:
- Telephony
- Emergency calls
- Full Rate, Enhanced Full Rate and Half Rate (FR/EFR/HR)
- Dual Tone Multi Frequency Function (DTMF)

GSM Data/Fax features:
- Data circuit asynchronous, transparent and non transparent up to 14,400 bits/s
- Automatic fax group 3 (Class 1 and Class 2)
- MNP2, V.42bis

GPRS packet Data features:
- GPRS Class 10, PBCCH support

Coding schemes: CS1 to CS4
Compliant with SMG31bis
- Embedded TCP/IP stack

Short Messages Services features:
- Text and PDU
- Point to point (MT/MO)
- Cell Broadcast

GSM SUPPLEMENTARY SERVICES

- Call Forwarding
- Call Barring
- Multiparty
- Call Waiting and Call Hold
- Calling Line Identity
- Advice of Charge
- USSD
- Closed User Group
- Explicit Call Transfer

OTHER FEATURES

- Advanced Open Software Platform: MUSE Platform Open AT
- Fixed Dialling Number
- SIM Toolkit Class 2
- SIM, network and service provider locks
- Real Time Clock
- Alarm management
- Software upgrade through Xmodem protocol
- UCS2 character set management

INTERFACES

- RS-232 and audio through mini sub-D 15-pin connector supporting:
  - Serial link autoshutdown controlled by software (AT)
  - Baud rate
  - Autobauding

AT commands interface:
- GSM 07.05 and 07.07 AT commands
- comprehensive set of enhanced AT commands

Open AT APIs:
- numerous interfaces for embedded applications
- 2x GPIOs/I2C (multiplexed) + power supply through micro-FIT 4-pin connector
- SMA antenna connector
- Sliding SIM holder (3V SIM interface)

APPROVALS

The M1306B is approved worldwide under test standards including;
Radio and Telecommunication Terminal Equipment (R&TTE), Global Certification Forum – Certification Criteria (GCF-CC), EMC, Safety and Chinese approvals

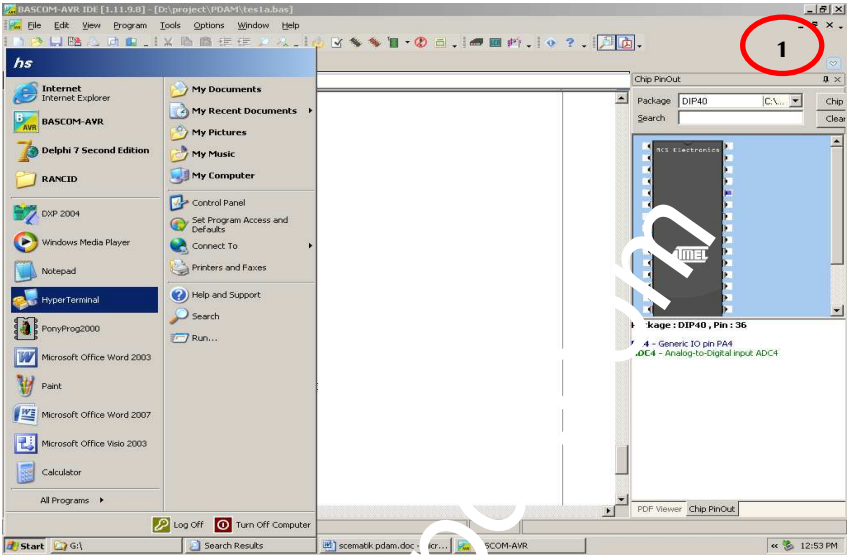
DELIVERABLES

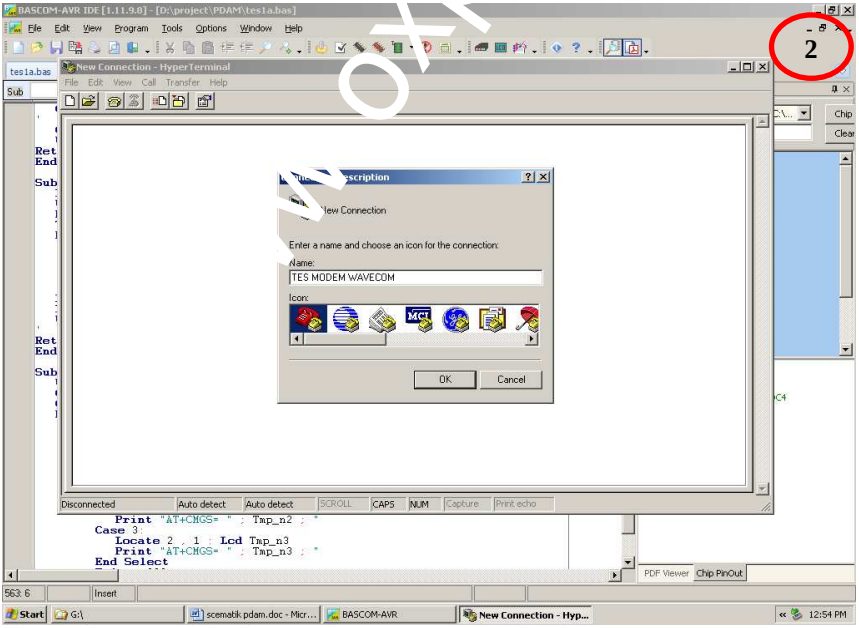
- User guide
- Power supply cable
- Y-cable for data and audio connection (optional)
- By DDS www.D-D-S.nl

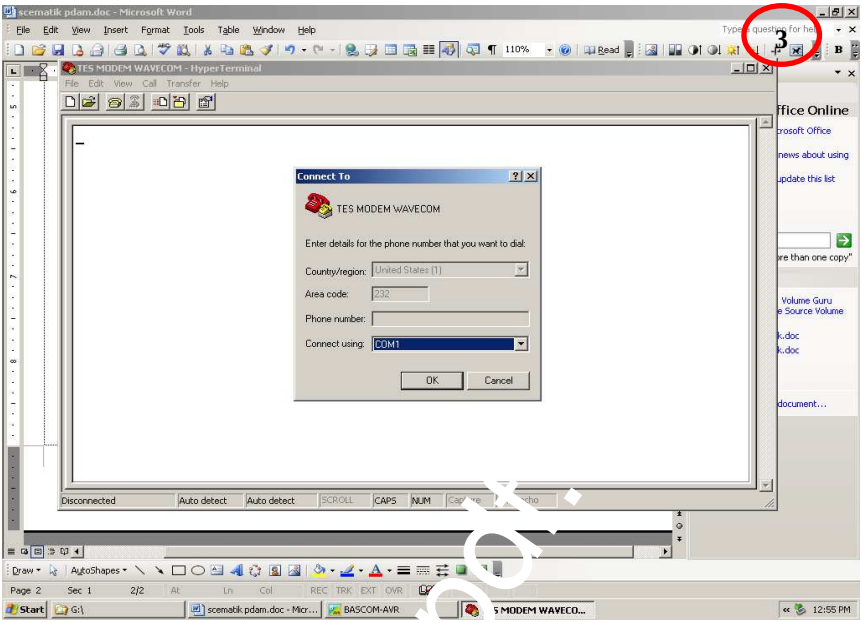
early bird

wavecom

Pengetesan Koneksi Modem Wavecom



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Connect To
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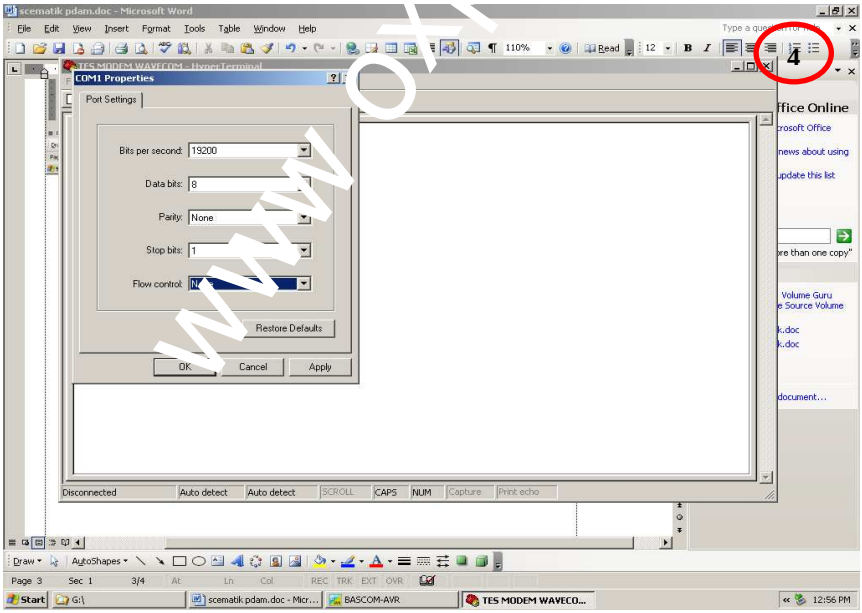
Enter details for the phone number that you want to dial:
Country/region:
Area code:
Phone number:
Connect using:
COM1
OK
Cancel
Disconnected
Auto detect
Auto detect
3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Port Settings
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Parity: None
Stop bits: 1
Flow control:
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OK
Cancel
Apply
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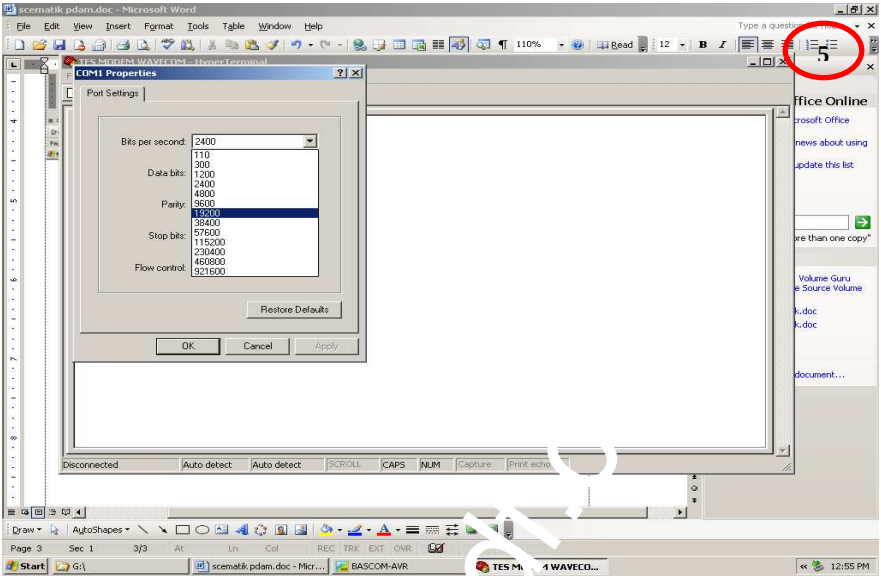
Auto detect
Auto detect
4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Parity:
Stop bits:
Flow control:
110
300
1200
2400
4800
9600
19200
38400
57600
115200
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921600
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Cancel
Apply
Disconnected
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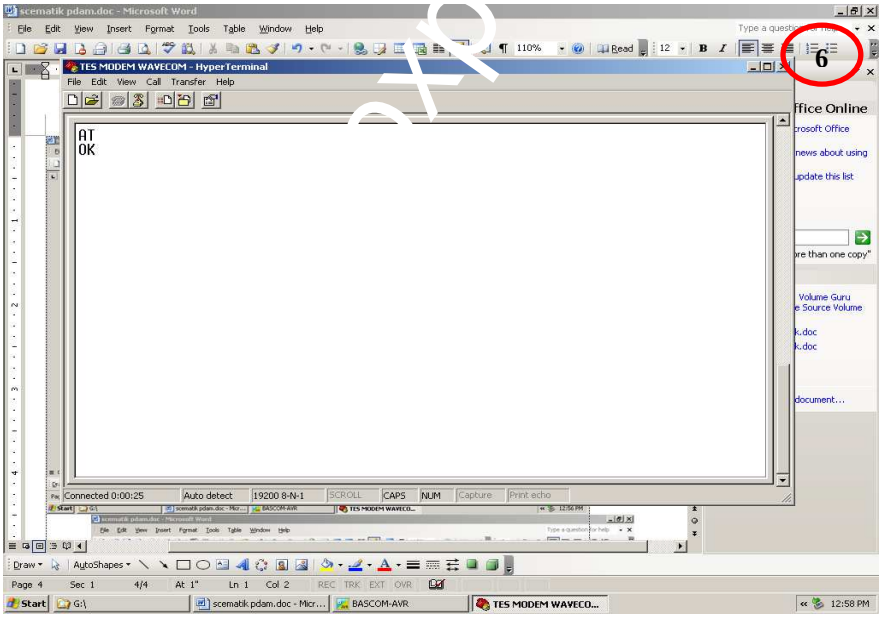
Auto detect
SCROLL
CAPS
NUM
Capture
Print echo
5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OK
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Auto detect
19200 8-N-1
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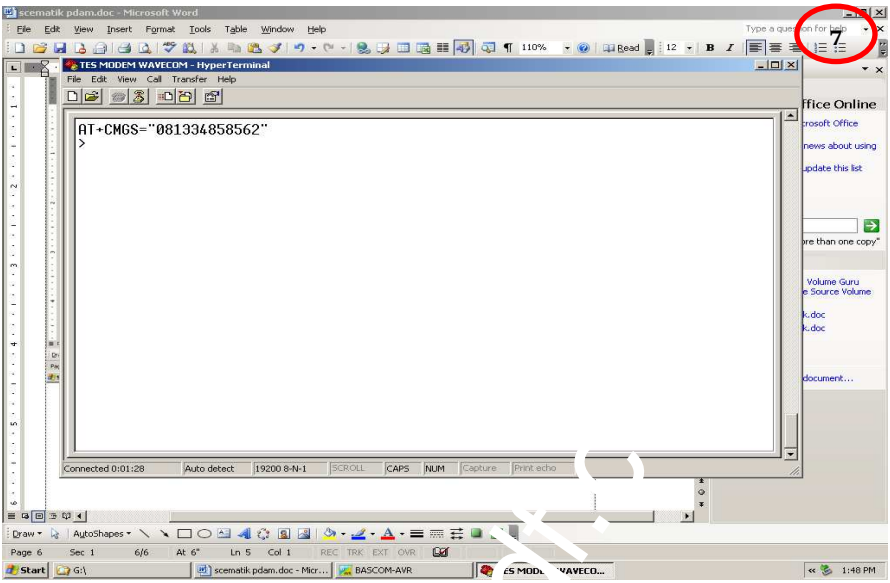
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Auto detect
19200 8-N-1
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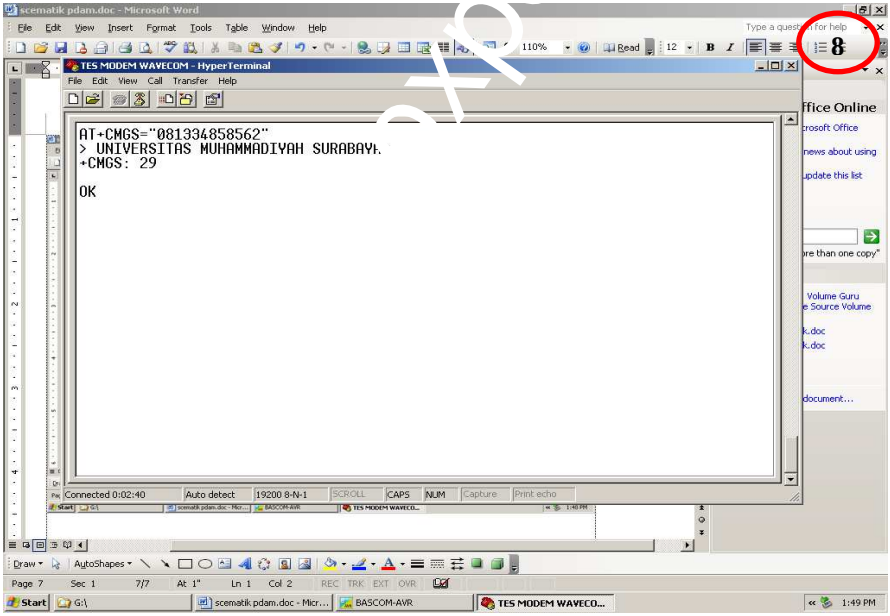
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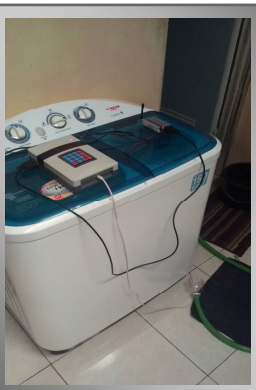
TES MODEM WAVECOM - HyperTerminal
AT+CMGS="081334858562"
> UNIVERSITAS MUHAMMADIYAH SURABAYA.
+CMGS: 29
OK
Connected 0:02:40
Auto detect
19200 8-N-1
8



PERCOBAAN PENGAMBILAN DATA

NO	GAMBAR	KETERANGAN
1		Air akan melewati Water Flow Meter yang didalamnya terdapat baling – baling
2		Output dari water flow meter yang berupa sinyal pulsa akan menggerakkan program counter di Microcontroller
3		Display debit (L) dan Harga pemakaian (Rp) diperoleh dari counter pada Microcontroller
4		Setiap per tanggal 1 alat akan mengirimkan perintah pada Modem untuk mengirimkan SMS pada konsumen
5		SMS diterima oleh konsumen

ALUR PERCOBAAN ALAT FLOWMETER DIGITAL

PERNYATAAN BEBAS PLAGIAT

Saya yang bertanda tangan dibawah ini :

Nama : Risky Rahadian Pratama

NIM : 20131330033

Menyatakan bahwa Tugas Akhir ini telah ditulis sendiri dengan sungguh-sungguh dan tidak ada bagian yang merupakan penjiplakan karya orang lain.

Apabila di kemudian hari terbukti bahwa pernyataan ini tidak benar, maka saya akan sanggup menerima sanksi berupa pembatalan dan segala konsekuensinya.

Surabaya, September 2014

Risky Rahadian Pratama

LAMPIRAN

```
'########################Inisialisasi
MCU#######################################

$regfile = "m8535.dat"

'$regfile = "m16def.dat"

$crystal = 11059200

'$baud = 115200

 $baud = 19200

'########################Inisialisasi
LCD#######################################

Config Lcdpin = Pin , Db4 = Pinc.4 , Db5 = Pinc.5 , Db6 = Pinc.6
, Db7 = Pinc.7 , E = Pinc.3 , Rs = Pinc.2

Config Lcdbus = 4

Config Lcd = 16 * 2

Cursor Off

Cls

'###########################Inisialisasi
KBD#######################################

Config Kbd = Porta

'Config Rc5 = Pind.2

'########################Inisialisasi
RTC#######################################

Config Sda = Portc.1
```

```
Config Scl = Portc.0

Const Addressw = 208

Const Addressr = 209


'Config Timer1 = Timer , Prescale = 1024

'On Timer1 Tim1_isr Nosave

'Timer1 = &HF0BD


'#########################Inisiasi
INT#########################

Config Int1 = Falling

On Int1 Encoder1                              'Nosave

Enable Int1

Enable Interrupts


'###########################Inisialisasi
Variable#############################


Dim Adres As Byte

Dim B As Long

Dim B1 As Long , B2 As Long , Kalib As Long

Dim C As Long
```

```
Dim Tanggal As Byte , Bulan As Byte , Tahun As Byte , Jam As
Byte , Detik As Byte

Dim Menit As Byte

Dim Value As Byte

Dim I As Byte , J As Byte                    ', D As Long

Dim Keyp As Byte                             ', Keyset As Byte

Dim Tempb(16) As Byte

Dim Menu(4) As String * 16

Dim Tempw(3) As Word

Dim Dwn As Byte

Dim Tg As Byte , Tmp_no(16) As Byte , Tmp_no1 As String *
16 , Serx1 As Byte

Dim Temps As String * 6 , Serx As String * 1 , Ckbln As Byte , Cks
As Byte

Dim Tmp_n2 As String * 16 , Tmp_n3 As String * 16


'Locate 1 , 1 : Lcd "Water Debit DGTL" : Locate 2 , 3 : Lcd "H-
Technology"

'Wait 5

Cls

'########################Declaration
Sub#######################################

Declare Sub Inf(byval Typ As Byte)
```

Declare Sub Rtc

Declare Sub Tampilan

'Declare Sub Getkeyp(byval Keystt As Byte)

Declare Sub Getkeyp

Declare Sub Write_rtc(byval Adres As Byte , Byval Value As Byte)

Declare Sub Read_rtc(byval Adres As Byte , Value As Byte)

'Declare Sub Timset(byval Timstt As Byte)

Declare Sub Clrlcd(byval Row As Byte)

'Declare Sub Calculate

Declare Sub Settingtime

Declare Sub Settingdate

Declare Sub Settingcalc

Declare Sub Baca_nc

Declare Sub Baca_nc1(byval Typ As Byte)

Declare Sub Tulis_no

Declare Sub Kirim_no

Declare Sub Cekhp

Declare Sub Kirim_pesan

Declare Sub Hitung

'#####################################rumus perhitugan air#################################

'conter*1000/harga air per m3

'harga=literXharga air/m3/(1000)

'#####################################rumus perhitugan air#################################

'Wait 5

'----------

'Program set Time and Date

'----------

'NOTE:

'UNTUK MENSETTING WAKTU DAN TANGGAL PROGRAM DIUBAH HARUS DIAKTIFKAN

'DAN UNTUK PENGISIAN SELANJUTNYA DIMATIKAN/DINONAKTIFKAN

'Call Write_rtc(0 , &H30) 'detik

'Call Write_rtc(1 , &H37) 'menit

'Call Write_rtc(2 , &H17) 'jam

```
'Call Write_rtc(4 , &H22)                    'tgl
'Call Write_rtc(5 , &H01)                    'bulan
'Call Write_rtc(6 , &H11)                    'tahun
'Call Write_rtc(7 , &B00010000)                  'control
interupt
'Call Rtc
'Wait 5
Menu(1) = "1.Setting Time "
Menu(2) = "2.Setting Date "
Menu(3) = "3.Setting Calc "
Menu(4) = "4.Setting Nomor"
Tg = 0

Readeeprom Ckbln , 32
Cks = 0
Call Write_rtc( , B00010000)
Wait 1
'Call Cekhp
Kalib = 500                                  'nilai kalibrasi
Menu1:
Cls
Do
```

```
Waitms 250
Call Getkeyp
Call Rtc
 If Cks <> Detik Then
   Cks = Detik
   B2 = B1 / Kalib
   B = B2 * Tempw(3)
   C = B / 1000
   Call Tampilan
   If Ckbln <> Bulan And Tanggal = 1 Then
     Cls
     Ckbln = Bulan
     Call Kirim_pesan
     B1 = 0
     Cls
   End If
 End If
If Keyp = 13 Then : Goto Menu : End If
If Keyp = 14 Then
   Waitms 500
   Call Clrlcd(2)
```

```
    'Locate 2 , 1 : Lcd "                "
    If Tg = 0 Then : Tg = 1 : Else : Tg = 0 : End If :
  End If

Loop

Menu:
Cls
Dwn = 1
Do
  Waitms 500
  Locate 1 , 1 : Lcd "Pilih 1/2/3/4"
  Locate 2 , 1 : Lcd Men(dwn)
  Call Getkeyp
  If Keyp = 15 Then
    Incr Dwn : If Dwn = 5 Then : Dwn = 4 : End If
  Elseif Keyp = 10 Then
    Decr Dwn : If Dwn = 0 Then : Dwn = 1 : End If
  End If
  If Keyp = 1 Then : Call Settingtime
  Elseif Keyp = 2 Then : Call Settingdate
```

```
  Elseif Keyp = 3 Then : Call Settingcalc
  Elseif Keyp = 4 Then : Call Isi_no
  Elseif Keyp = 5 Then : Call Kirim_pesan
  Elseif Keyp = 11 Then : Goto Menu1
  End If
Loop
Sub Settingtime
Cls
  For I = 1 To 16 : Tempb(i) = 0 : Next : J = 1
  Locate 1 , 1 : Lcd "Setting Time'
  Locate 2 , 5 : Lcd "00:00:00" : I = 5 : Locate 2 , I : Cursor Blink
  Do
    Call Getkeyp
    Select Case Keyp
    Case 0 To 9:
      Lcd Keyp : Tempb(j) = Keyp
      Incr J : Incr I : If J = 7 Then J = 6
      If I = 7 Then I = 8 : If I = 10 Then I = 11
      If I = 13 Then I = 12
    End Select
    If Keyp = 10 Then
```

```
        Decr I : Decr J : If J = 0 Then J = 1

        If I = 4 Then I = 5 : If I = 7 Then I = 6 : If I = 10 Then I = 9

      End If

      Locate 2 , I

      If Keyp = 11 Then Goto Menu1

   Loop Until Keyp = 12

   Cursor Noblink

   Call Inf(0)

   Tempb(1) = Tempb(1) * 10 : Tempb(1) = Tempb(1) +
Tempb(2)

   Tempb(3) = Tempb(3) * 10 : Tempb(3) = Tempb(3) +
Tempb(4)

   Tempb(5) = Tempb(5) * 10 : Tempb(5) = Tempb(5) +
Tempb(6)

   Tempb(1) = Makebcd(tempb(1)) : Tempb(3) =
Makebcd(tempb(3))

   Tempb(5) = Makebcd(tempb(5)) : Call Write_rtc(0 , Tempb(5))

   Call Write_rtc(2 , Tempb(3)) : Call Write_rtc(2 , Tempb(1))

   Call Write_rtc(7 , &B00010000)

   Call Inf(1)

   Goto Menu1

Return

End Sub
```

```
Sub Hitung

  Tempb(1) = Tempb(1) * 10 : Tempb(1) = Tempb(1) +
Tempb(2)

  Tempb(3) = Tempb(3) * 10 : Tempb(3) = Tempb(3) +
Tempb(4)

  Tempb(5) = Tempb(5) * 10 : Tempb(5) = Tempb(5) +
Tempb(6)

Return

End Sub

Sub Settingdate

Cls

  For I = 1 To 16 : Tempb(i) = 0 : Next : J = 1

  Locate 1 , 1 : Lcd "Setting Date"

  Locate 2 , 5 : Lcd "00:00:00" : I = 5 : Locate 2 , I : Cursor
Blink

  Do

    Call Getkeyp

    Select Case Keyp

    Case 0 To 9:

      Lcd Keyp : Tempb(j) = Keyp

      Incr J : Incr I : If J = 9 Then J = 8

      If I = 7 Then I = 8 : If I = 10 Then I = 11

      If I = 15 Then I = 14
```

```
    End Select

    If Keyp = 10 Then

    Decr I : Decr J : If J = 0 Then J = 1

    If I = 4 Then I = 5 : If I = 7 Then I = 6 : If I = 10 Then I = 9

    End If

    Locate 2 , I

    If Keyp = 11 Then Goto Menu1

  Loop Until Keyp = 12

  Cursor Noblink

  Tempb(1) = Tempb(1) * 10 : Tempb(1) = Tempb(1) + Tempb(2)

  Tempb(3) = Tempb(3) * 10 : Tempb(3) = Tempb(3) + Tempb(4)

  Tempb(7) = Tempb(7) * 10 : Tempb(7) = Tempb(7) + Tempb(8)

  Tempb(1) = Makebcd(tempb(1)) : Tempb(3) = Makebcd(tempb(3))

  Tempb(7) = Makebcd(tempb(7)) : Call Write_rtc(4 , Tempb(1))

  Call Write_rtc(5 , Tempb(3)) : Call Write_rtc(6 , Tempb(7))

  Call Inf(1)

  Goto Menu1

Return

End Sub
```

```
Sub Settingcalc

Cls

  For I = 1 To 16 : Tempb(i) = 0 : Next : J = 1

  Locate 1 , 1 : Lcd "Rp/Debit"

  Locate 2 , 1 : Lcd "Rp= 0000      " : I = 5 : Locate 2 , 1 : Cursor
Blink

  Do

    Call Getkeyp

    Select Case Keyp

    Case 0 To 9:

      Lcd Keyp : Tempb(j) = Keyp

      Incr J : Incr I : If J = 5 Then J = 4

      If I = 9 Then I = 8

      'If I = 15 Then I = 14

    End Select

    If Keyp = 10 Then

    Decr I : Decr J : If J = 0 Then J = 1

    If I = 4 Then I = 5                          ': If I = 10 Then I = 9

    End If

    Locate 2 , I

    If Keyp = 11 Then Goto Menu1
```

```
   Loop Until Keyp = 12

   Cursor Noblink

   Tempw(1) = 0 : Tempw(1) = Tempb(1) * 1000

   Tempw(2) = 0 : Tempw(2) = Tempb(2) * 100

   Tempw(3) = 0 : Tempw(3) = Tempb(3) * 10

   Tempw(3) = Tempw(3) + Tempw(2) : Tempw(3) = Tempw(3)
+ Tempw(1)

   Tempw(3) = Tempw(3) + Tempb(4)

'   D = Tempw(3)

'   Call Calculate

   Call Inf(1)

   Goto Menu1

Return

End Sub

'-------------------------------------------------------------------

'Subroutine tampilan akses tulis ke LCD

'-------------------------------------------------------------------

Sub Tampilan

   Locate 1 , 1 : Lcd "" ; Hex(tanggal) ; "/" ; Hex(bulan) ; "/" ;
Hex(tahun) ; Hex(jam) ; ":" ; Hex(menit) ; ":" ; Hex(detik)

   If Tg = 0 Then

      Locate 2 , 1 : Lcd "Rp= " ; C                    ', Locate 2 , 1 :
Lcd ",-"
```

```
  Else
    Locate 2 , 1 : Lcd "Debit= " ; B2                    'C , Locate 2 , 1
: Lcd ",-"
  End If
  Waitms 250
Return
End Sub
'-------------------------------------------------- ---- ------------------
'Subroutine KBD akses tulis ke LCD
'-------------------------------------------------- ---- ------------------
Sub Getkeyp(byval Keystt As B
  'If Keystt = 1 Then
  '  Do
  '    Keyp = Getkbd()
  '    Keyp = Lookup(Keyp , Keypad)
  '    Waitms 200
  '  Loop Until Keyp <> 16
  '  Set Portd.5
  '  Waitms 100
  '  Reset Portd.5
  'Else
  '  Keyp = Getkbd()
```

```
   '   Keyp = Lookup(keyp , Keypad)
   '   Waitms 100
   'End If
   Keyp = Getkbd()
   Do : Loop Until Getkbd() = 16
   Keyp = Lookup(keyp , Keypad)
Return
End Sub
'-------------------------------------------- ------ ----------------------------
'Subroutine I2C akses tulis ke RTC
'-------------------------------------- ----- ---------------------------------
Sub Write_rtc(byval Adres As Byte , Byval Value As Byte)
   I2cstart                              'start condition
   I2cwbyte Addressw                        'slave address
   I2cwbyte Adres                        'asdress of RTC
   I2cwbyte Value                        'value to write
   I2cstop                              'stop condition
   Waitms 10                             'wait for 10
milliseconds
Return
End Sub
'-------------------------------------------------------------------------------
```

```
'Subroutine I2C akses baca RTC
'-------------------------------------------------------------------------------
Sub Read_rtc(byval Adres As Byte , Value As Byte)
  I2cstart                              'generate start
  I2cwbyte Addressw                         'slave adsress
  I2cwbyte Adres                        'address of RTC
  I2cstart                              'repeated start
  I2cwbyte Addressr                         'slave address (read)
  I2crbyte Value , Nack
  I2cstop
Return                                  'generate stop
End Sub
'-------------------------------------------------------------------------------
'Subroutine SAVE SETTING DISPLAY
'-------------------------------------------------------------------------------
Sub Inf(byval Typ As Byte)
  If Typ = 0 Then
    Cursor Noblink : Cls : Locate 1 , 1 : Lcd "Sedang
Menyimpan" : Wait 1
  Else
    Locate 2 , 4 : Lcd "Selesai..." : Wait 1
  End If
```

```
Return
End Sub
'-------------------------------------------------------------------------------
'Subroutine RTC
'-------------------------------------------------------------------------------
Sub Rtc
  Call Read_rtc(0 , Value)
  Detik = Value
  Call Read_rtc(1 , Value)
  Menit = Value
  Call Read_rtc(2 , Value)
  Jam = Value
  Call Read_rtc(4 , Value)
  Tanggal = Value
  Call Read_rtc(5 , Value)
  Bulan = Value
  Call Read_rtc(6 , Value)
  Tahun = Value
Return
End Sub
'-------------------------------------------------------------------------------
```

```
'Subroutine timset
'--------------------------------------------------------------------------------
'Sub Timset(byval Timstt As Byte)
'   If Timstt = 1 Then
'      Cursor Noblink : Enable Interrupts : Timout = 0 : Enable Int0 : Cls       ': Timer1 = &HD239 : Enable Timer1
'   Else
'      Disable Interrupts : Disable Int0 : Set Portd.7 : Cls ': Disable Timer1
'   End If
'Return
'End Sub
'--------------------------------------------------------------------------------
'Subroutine CLR LCD
'--------------------------------------------------------------------------------
Sub Clrlcd(byval Row As Byte)
   Locate Row , 1 : Lcd "                "
Return
End Sub
'--------------------------------------------------------------------------------
'Subroutine calculate debite
'--------------------------------------------------------------------------------
```

```
'Sub Calculate
'   Goto Encoder1
'   D = Tempb(3) * 1
'Return
'End Sub


Sub Baca_no
  Tmp_no1 = ""
  For I = 1 To 14
    J = I + 15
    Readeeprom Tmp_no(1) , J

    If Tmp_no(1) < 10 Then
      Tmp_no1 = Tmp_no1 + Str(tmp_no(1))
    End If
  Next
  Tmp_no2 = ""
  For I = 1 To 14
    J = I + 31
    Readeeprom Tmp_no(1) , J
```

```
    If Tmp_no(1) < 10 Then
      Tmp_n2 = Tmp_n2 + Str(tmp_no(1))
    End If
  Next
  Tmp_n3 = ""
  For I = 1 To 14
    J = I + 47
    Readeeprom Tmp_no(1) , J

    If Tmp_no(1) < 10 Then
      Tmp_n3 = Tmp_n3 + Str(tmp_no(1))
    End If
  Next
Return
End Sub
Sub Baca_no(byval Typ As Byte)
  Locate 2 , 1                              'Tmp_no1
  For I = 1 To 14
'   J = I + 15
    J = I + Typ
    Readeeprom Tmp_no(i) , J
```

```
    If Tmp_no(i) < 10 Then : Lcd Tmp_no(i) : Else : Lcd "-" :
End If
  Next
Return
End Sub

Sub Tulis_no
  For I = 1 To 14
    J = I + 15
      Writeeeprom Tmp_no(i) , J
  Next
Return
End Sub

Sub Isi_no
  Locate 1 , 1 : Lcd "SET NOMER HP #1 "
'  Locate 2 , 1 : Lcd "----------------"
  Call Clrlcd(2)
  Wait 2
  Call Baca_no1(15)
  I = 1 : Locate 2 , I : Cursor Blink : Cursor On
  Do
```

```
Call Getkeyp
Select Case Keyp
Case 0 To 9:
  Lcd Keyp : Tmp_no(i) = Keyp
  Incr I : If I = 15 Then I = 1
Case 12:                          'tmbl #-geser kanan
  Incr I
  If I = 15 Then I = 1
Case 11:                          'tmbl *-geser kiri
  Decr I
  If I = 0 Then I = 14
Case 13:                          'tmbl B-hapus
  Lcd "-" : Tmp_no(i) = 10
  Incr I : If I = 15 Then I = 1
Case 15:                          'tmbl D-simpan
  Locate 2 , 1 : Lcd "----SAVING-------"
  Call Simp_no
  Wait 1
  'Locate 2 , 1 : Lcd "----------------"
  Call Clrlcd(2)
  Call Baca_no1(15)
```

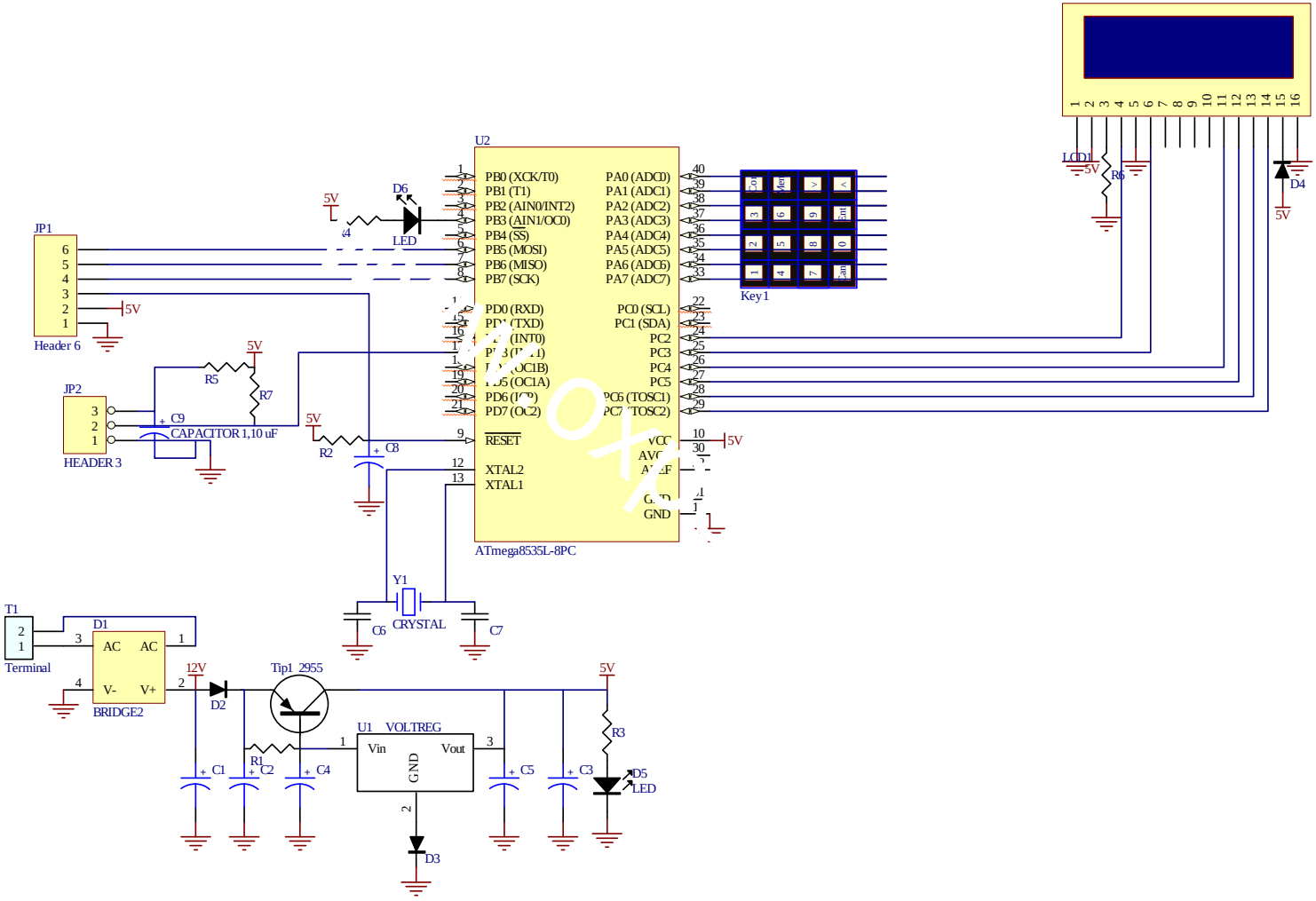
```
        'Locate 2 , 1 : Lcd Tmp_no1
        I = 1
      Case 10:                              'tmbl C-cancel
      End Select
      Locate 2 , I
   Loop Until Keyp = 15 Or Keyp = 10
   Call Baca_no
   'Locate 2 , 1 : Lcd "----------------"
   Call Clrlcd(2)
   Locate 2 , 1 : Lcd Tmp_no1
   Cursor Noblink : Cursor Off
   Wait 1
Return
End Sub

Sub Cekhp
   Locate 1 , 1 . Lcd " MENGECEK MODEM "
   Waitms 900
   Print "ATE0"
   Tmp_no1 = ""
   Do
```

```
      Serx1 = Waitkey()
      If Serx1 <> 13 And Serx1 <> 10 Then
        'Lcd Chr(serx1)
        Tmp_no1 = Tmp_no1 + Chr(serx1)
      End If
    Loop Until Tmp_no1 = "OK"
    Locate 2 , 1 : Lcd "  TERHUBUNG  "
    Wait 1
'   Call Isi_no
Return
End Sub

Sub Kirim_pesan
    Writeeeprom Bulan , 32
    Call Baca_no
    Call Rtc
    Locate 1 , 1 . Lcd Tmp_no1
    Print "AT+CMGS= " ; Tmp_no1 ; "
    Waitms 300
    Print "Pelanggan yth meter air bulan ini:"
    Print Hex(tanggal) ; "/" ; Hex(bulan) ; "/" ; Hex(tahun);
```

```
   Print " " ; Hex(jam) ; ":" ; Hex(menit) ; ":" ; Hex(detik)
   Print "Debit:" ; B
   Print "Rp:" ; C
   Waitms 100
   Print "{026}";
   Wait 2
   Locate 2 , 1 : Lcd "TERKIRIM"
Return
End Sub
'Tim1_isr:
'   Timer1 = &HF0BD
'   Print Hex(jam) ; ":" ; Hex(menit) ; ":" ; Hex(detik)
'Return
Encoder1:
   Incr B1
'   B = B1                                    '* 1000
'   C = B / 1
Return
Keypad:
Data 15 , 12 , 0 , 11 , 10 , 9 , 8 , 7 , 13 , 6 , 5 , 4 , 14 , 3 , 2 , 1 , 16
```


U2
ATmega8535L-8PC
PB0 (XCK/T0)
PB1 (T1)
PB2 (AIN0/INT2)
PB3 (AIN1/OC0)
PB4 (SS)
PB5 (MOSI)
PB6 (MISO)
PB7 (SCK)
PA0 (ADC0)
PA1 (ADC1)
PA2 (ADC2)
PA3 (ADC3)
PA4 (ADC4)
PA5 (ADC5)
PA6 (ADC6)
PA7 (ADC7)
PD0 (RXD)
PD1 (TXD)
PD2 (INT0)
PD3 (INT1)
PD4 (OC1B)
PD5 (OC1A)
PD6 (ICP)
PD7 (OC2)
PC0 (SCL)
PC1 (SDA)
PC2
PC3
PC4
PC5
PC6 (TOSC1)
PC7 (TOSC2)
RESET
XTAL2
XTAL1
VCC
GND
JP1
Header 6
JP2
HEADER 3
LED
D6
D4
D5
D3
D2
D1
BRIDGE2
T1
Terminal
Y1
CRYSTAL
C6
C7
C8
C9
CAPACITOR 1,10 uF
C1
C2
C3
C4
C5
R1
R2
R3
R5
R6
R7
5V
12V
Tip1 2955
U1 VOLTREG
Vin
Vout
GND
LCD1
Key 1