## U-UART - USB UltraBaud Data Transfer IC with RS232 / RS422 and CPU I/F Options

## FEATURES

- **Single Chip Multi-Function Data Transfer Solution**
- **RS232 link from 300 baud to 920K baud**
- **RS422/RS485 Link to 2000K baud**
- **384 byte receive buffer / 128 byte transmit buffer for high data throughput**
- **Full hardware assisted or X-On/X-Off handshaking**
- **Support for Event Characters and Line Break condition**
- **Auto Transmit Buffer control for RS485**
- **Compact 32 pin ( 7mm x 7mm ) MQFP package**
- **Integrated 6MHz - 48MHz Clock Multiplier aids FCC and CE compliance**
- **Integrated 3.3v Regulator – No External Regulator Required**
- **4.4v .. 5.25v Single Supply Operation**
- **UHCI / OHCI Compliant**
- **USB 1.1 Specification Compliant**
- **USB VID, PID, Serial Number and Product Description Strings in external E2PROM.**

**Virtual COM Port Drivers for –**

**Windows 98 and Windows 98 SE**

**Windows 2000**

**Windows Millennium ****

**Apple iMAC ****

**Linux ****

- **Application Areas**

**USB ISDN and ADSL Modems**

**USB 56k / V90 Modems**

**USB ⇔ PDA Interface Cables**

**USB ⇔ RS232 Converters / Cables**

**USB ⇔ RS422 / RS485 High Speed Industrial Links**

**USB Digital Cameras**

**USB I/F for MP3 players**

**Ultra-high performance Serial Port for legacy - free PC system boards / Easy PC's**

**USB Instrumentation**

**USB ⇔ USB data transfer cables**

**USB ⇔ USB null-modem cables**

**USB ⇔Serial Bar Code Readers**

**Note ** = Currently in development**

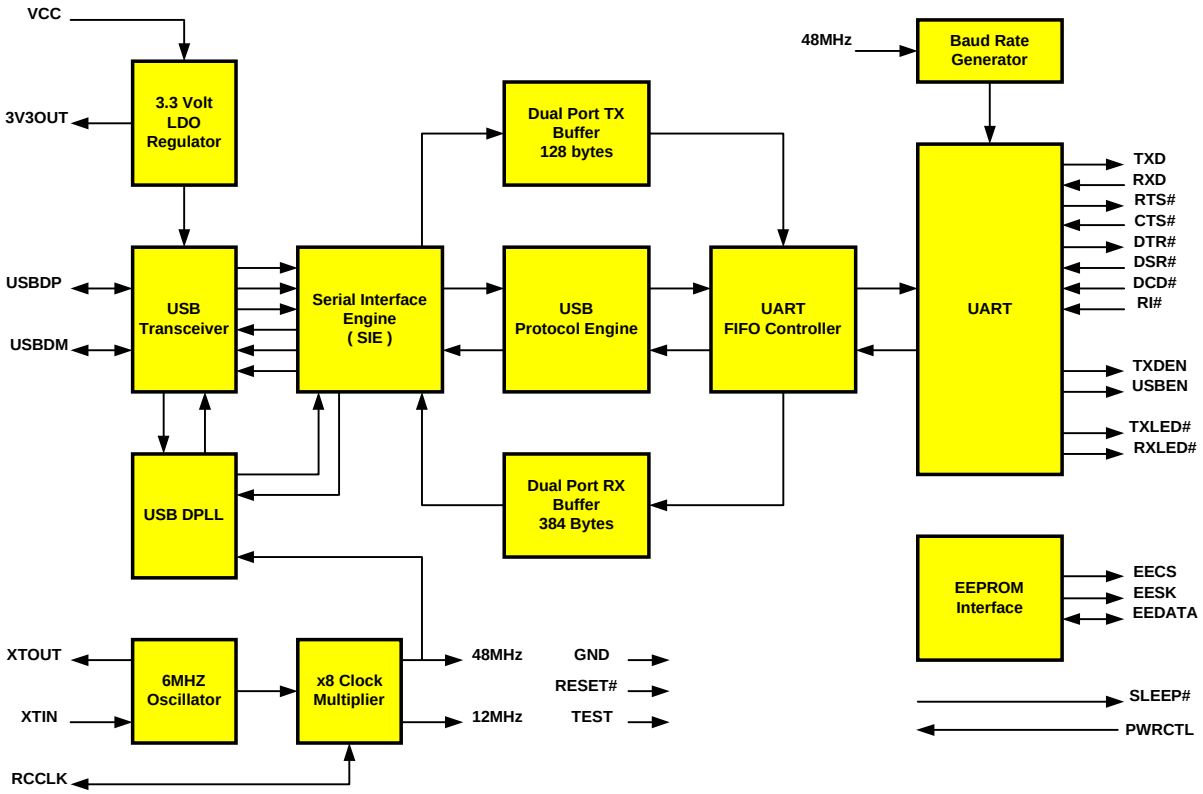
## GENERAL DESCRIPTION

**The FT8U232AM is a cost-effective single chip USB UART ( U-UART ) solution for transferring serial data over USB. With data transfer rates of up to 920k baud ( RS232 ) and 2,000 k baud ( RS422 / RS485 ) , the FT8U232AM significantly raises the performance level above that above that of traditional ISA and PCI based UART solutions whilst offering true plug and play and easy interfacing through it's USB interface.**

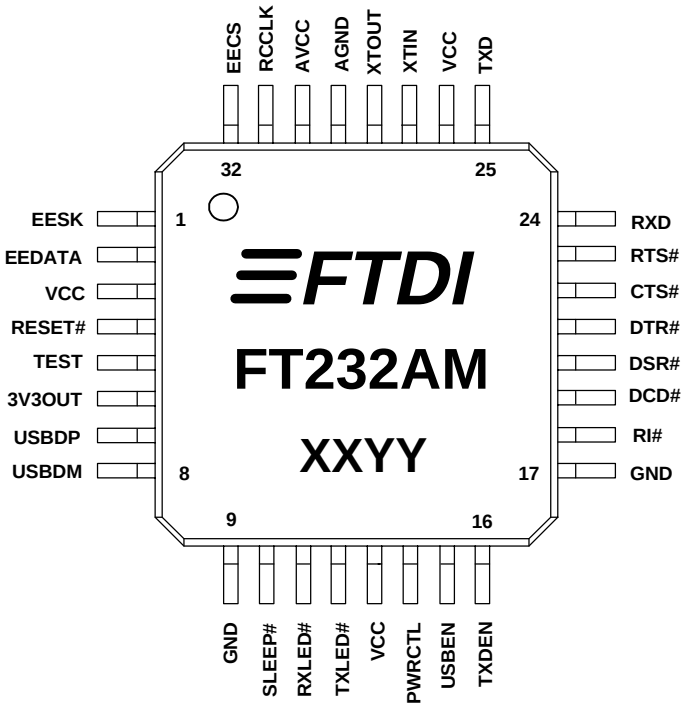
**Its flexible architecture allows this IC to be used in many different application areas - USB modems, Legacy RS232 ⇔ USB Converter cables, USB interface cables for PDA's , Bar Code Scanners , RS422 data links and instrumentation – in fact almost any equipment that previously used a slow RS232 link for communication.**

**Virtual COM port drivers are available for the FT8U232AM for Windows '98, Windows 98 SE and Windows 2000. Drivers for other operating systems are currently under development.**

## Figure 1 – FT8U232AM Block Diagram ( Simplified )




## Figure 2 – FT8U232AM I.C. Pinout



# FT8U232AM - FUNCTIONAL BLOCK DESCRIPTION

- **3.3V LDO Regulator**

  The 3.3V LDO Regulator generates the 3.3 volt reference voltage for driving the USB transceiver cell output buffers. It requires an external decoupling capacitor to be attached to the 3V3OUT regulator output pin.

- **USB Transceiver**

  The USB Transceiver Cell provides the USB 1.1 full-speed physical interface to the USB cable. The output drivers provide 3.3 volt level slew rate control signalling, whilst a differential receiver and two single ended receivers provide USB data in, SEO and USB Reset condition detection.

- **USB DPLL**

  The USB DPLL cell locks on to the incoming NRZI USB data and provides separate recovered clock and data signals to the SIE block.

- **6MHz Oscillator**

  The 6MHz Oscillator cell generates a 6MHz reference clock input to the X8 Clock multiplier from an external 6MHz crystal or ceramic resonator.

- **X8 Clock Multiplier**

  The X8 Clock Multiplier takes the 6MHz input from the Oscillator cell and generates a 12MHz reference clock for the SIE, USB Protocol Engine and UART FIFO controller blocks. It also generates a 48MHz reference clock for the USB DPPL and the Baud Rate Generator blocks.

- **Serial Interface Engine ( SIE )**

  The Serial Interface Engine ( SIE ) block performs the Parallel to Serial and Serial to Parallel conversion of the USB data. In accordance to the USB 1.1 specification, it performs bit stuffing / un-stuffing and CRC5 / CRC16 generation / checking on the USB data stream.

- **USB Protocol Engine**

  The USB Protocol Engine manages the data stream from the device USB control endpoint. It handles the low level USB protocol ( Chapter 9 ) requests generated by the USB host controller and the commands for controlling the functional parameters of the UART.

- **Dual Port TX Buffer ( 128 bytes )**

  Data from the USB data out endpoint is stored in the Dual Port TX buffer and removed from the buffer to the UART transmit register under control of the UART FIFO controller.

- **Dual Port RX Buffer ( 384 bytes )**

  Data from the UART receive register is stored in the Dual Port RX buffer prior to being removed by the SIE on a USB request for data from the device data in endpoint.

- **UART FIFO Controller**

  The UART FIFO controller handles the transfer of data between the Dual Port RX and TX buffers and the UART transmit and receive registers.

- **UART**

  The UART performs asynchronous 7 / 8 bit Parallel to Serial and Serial to Parallel conversion of the data on the RS232 ( RS422 and RS485 ) interface. Control signals supported by the UART include RTS, CTS, DSR , DTR, DCD and RI. The UART provides a transmitter enable control signal ( TXDEN ) to assist with interfacing to RS485 transceivers.

- **Baud Rate Generator**

  The Baud Rate Generator provides a x16 clock input to the UART from the 48MHz reference clock and consists of a 14 bit prescaler and 2 register bits which provide fine tuning of the baud rate ( e.g. to divide by 2.5 ). This determines the Baud Rate of the UART which is programmable from 300 baud to 2 million baud. For more details please contact FTDI.

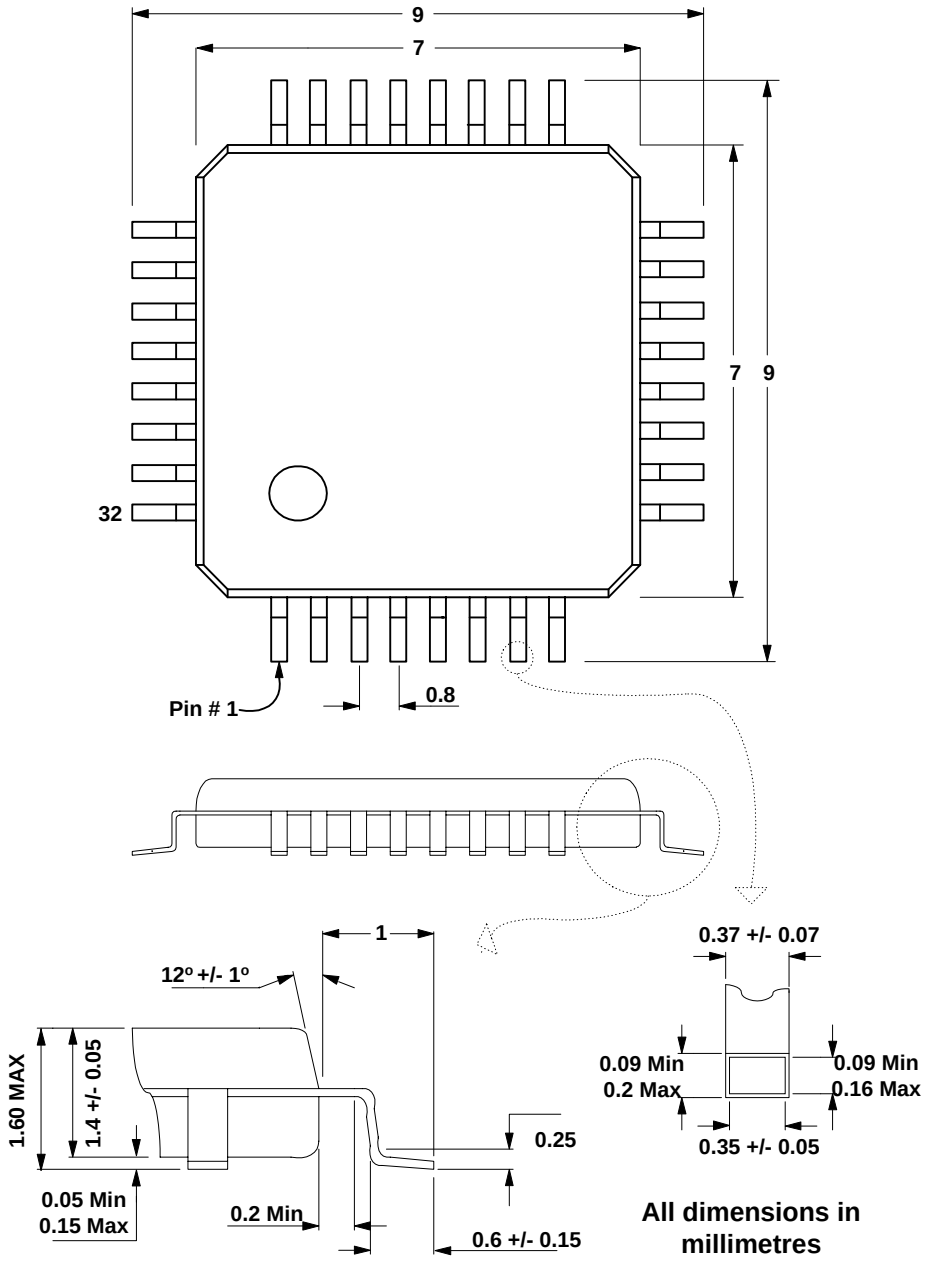
- **EEPROM Interface**

  Though the FT8U232AM will work without the optional EEPROM, an external 93C46 EEPROM can be used to customise the USB VID, PID, Serial Number and Strings of the FT8U232AM for OEM applications. The EEPROM is also required for applications where multiple FT8U232AM's are connected to a single PC as the drivers rely on a unique serial number for each device to bind a unique virtual COM port to each individual device.

## Table 1 - FT8U232AM - PINOUT DESCRIPTION

| Pin # | Signal | Type | Description |
|---|---|---|---|
| ***7*** | USBDP | I/O | USB Data Signal Plus – Requires 1.5k pull-up to 3V3OUT |
| ***8*** | USBDM | I/O | USB Data Signal Minus |
| ***6*** | 3V3OUT | OUT | 3.3 volt Output from integrated regulator |
| ***27*** | XTIN | IN | Input to 6MHz Crystal Oscillator Cell |
| ***28*** | XTOUT | OUT | Output from 6MHz Crystal Oscillator Cell |
| ***31*** | RCCLK | I/O | RC timer – used to guarantee clock stability on exiting sleep mode |
| ***4*** | RESET# | IN | Resets entire device using external RC network |
| ***32*** | EECS | I/O | Optional EEPROM – Chip Select |
| ***1*** | EESK | I/O | Optional EEPROM – Clock |
| ***2*** | EEDATA | I/O | Optional EEPROM – Data I/O |
| ***5*** | TEST | IN | Puts device in i.c. test mode – must be tied to GND |
| ***25*** | TXD | OUT | UART – Transmit Data Output |
| ***24*** | RXD | IN | UART – Receive Data Input |
| ***23*** | RTS# | OUT | UART – Request To Send Control Output |
| ***22*** | CTS# | IN | UART – Clear To Send Control Input |
| ***21*** | DTR# | OUT | UART – Data Terminal Ready Control Output |
| ***20*** | DSR# | IN | UART – Data Set Ready Control Input |
| ***19*** | DCD# | IN | UART – Data Carrier Detect Control Input |
| ***18*** | RI# | IN | UART – Ring Indicator Control Input |
| ***16*** | TXDEN | OUT | UART – Enable Transmit Data for RS485 |
| ***15*** | USBEN | OUT | USB Enabled – High after device is configured via USB |
| ***14*** | PWRCTL | IN | Bus Powered – Tie Low / Self Powered – Tie High |
| ***12*** | TXLED# | O.C. | LED Drive - Pulses Low when Transmitting Data via USB |
| ***11*** | RXLED# | O.C. | LED Drive - Pulses Low when Receiving Data via USB |
| ***10*** | SLEEP# | OUT | Goes Low during USB Suspend Mode |
| ***3,13,26*** | VCC | PWR | Device - +4.4 volt to +5.25 volt Power Supply Pins |
| ***9.17*** | GND | PWR | Device – Ground Supply Pins |
| ***30*** | AVCC | PWR | Device - Analog Power Supply for the internal x8 clock multiplier |
| ***29*** | AGND | PWR | Device - Analog Ground Supply for the internal x8 clock multiplier |

**Figure 3. FT8U232AM - PACKAGE DESCRIPTION – QFP 7mm x 7mm**



## Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature …… | -65°C to + 150°C |
| Ambient Temperature ( Power Applied )…….. | 0°C to + 70°C |
| VCC Supply Voltage …….. | -0.5v to +6.00v |
| DC Input Voltage - Inputs …….. | -0.5v to VCC + 0.5v |
| DC Input Voltage - High Impedance Bidirectionals …… | -0.5v to VCC + 0.5v |
| DC Output Current – Outputs …… | 24mA |
| DC Output Current – Low Impedance Bidirectionals …… | 24mA |
| Power Dissipation …… | 500mW |

**DC Characteristics ( Ambient Temperature = 0 .. 70 Degrees C )**

| | Description | Min | Max | Units | Conditions |
|---|---|---|---|---|---|
| ***VCC*** | Operating Supply Voltage | 4.4 | 5.25 | v | |
| ***Icc1*** | Operating Supply Current | | 50 | mA | Normal Operation |
| ***Icc2*** | Operating Supply Current | | 250 | uA | USB Suspend |
| ***Ioh1*** | Digital IO Pins Source Current | 4 | | mA | Voh = VCC – 0.5v |
| ***Iol1*** | Digital IO Pins Sink Current | 8 | | mA | Vol = + 0.5v |
| ***Voh1*** | Input Voltage Threshold ( Low ) | | 0.6 | v | |
| ***Vol1*** | Input Voltage Threshold ( High ) | 2.7 | | v | |
| ***VDif*** | USB Differential Input Sensitivity | 0.2 | | v | |
| ***VCom*** | USB Differential Common Mode | 0.8 | 2.5 | v | |
| ***URxt*** | USB Single Ended Rx Threshold | 0.8 | 2.0 | v | |
| ***UVh*** | USB IO Pins Static Output ( Low ) | | 0.3v | | Rl = 1.5k to 3.6v |
| ***UVl*** | USB IO Pins Static Output ( High ) | 2.8 | | | Rl = 15k to GND |

## *Disclaimer*



## *Contact Information*

| | | |
|---|---|---|
| Future Technology Devices Intl. Limited | Telephone : | +44 ( 0 ) 141 353 2565 |
| St. George's Studios | Fax : | +44 ( 0 ) 141 353 2656 |
| 93/97 St. George's Road | Email : | support@ftdi.co.uk |
| Glasgow G3 6JA, UK | Internet : | http://www.ftdi.co.uk |

## *Agents and Sales Representatives*

Please visit our internet site for the latest contact details of our Agents and Sales Representatives world-wide.

# Appendix A

# USB Device Descriptors

## USB Device Descriptors

Note: **E** - replaced by E2Rom Value, **C** - modified by configuration option

```
                                {* device descriptor *}
LABEL : Device_Des;

   0010 12      Val : Device_Len;{length of this descriptor in bytes}
   0011 01      Val : $01;{Device descriptor type}
   0012 10 01   Val : $10,$01;{USB Spec rev 1.10}
   0014 00      Val : $00;{Device class ?}
   0015 00      Val : $00;{Device subclass ?}
   0016 00      Val : $00;{Device protocol ?}
   0017 08      Val : Max_Length;{maximum packet size}

LABEL : Device_Des_Vendor;

E  0018 03 04   Val : $03,$04;{Vendor ID FTDI}
E  001A 01 60   Val : $01,$60;{product number 6001}

LABEL : Device_Des_Vendor_End;

E  001C 00 02   Val : $00,$02;{device release number 02.00}
   001E 01      Val : $01;{index of string descriptor describing manufacturer}
   001F 02      Val : $02;{index of string descriptor describing product}
   0020 03      Val : $03;{index of string descriptor describing serial number}
   0021 01      Val : $01;{number of possible configurations}

{* end of device descriptor *}
LABEL : Device_Des_End;

LABEL : Config_Des;
{* configuration descriptor *}

   0022 09      Val : $09;{length of this descriptor in bytes}
   0023 02      Val : $02;{Configuration descriptor}
   0024 20 00   Val : Config_Len,$00;{length of data returned for all things}
   0026 01      Val : $01;{number of interfaces supported by this configuration}
   0027 01      Val : $01;{configuration value}
   0028 00      Val : $00;{index of string descriptor describing this configuration}
EC 0029 80      Val : 10000000b;{configured as bus powered and not remote wakeup}
E  002A 2D      Val : 45;{maximum power in 2 mA ie 90mA for now}

{* end of configuration descriptor *}

LABEL : Interface_Des;
{* interface descriptor *}

   002B 09      Val : $09;{length of this descriptor in bytes}
   002C 04      Val : $04;{Interface descriptor}
   002D 00      Val : $00;{interface number}
   002E 00      Val : $00;{alternate setting}
   002F 02      Val : $02;{number of endpoints excluding 0 = 1}
   0030 FF      Val : $ff;{class code}
   0031 FF      Val : $ff;{subclass}
   0032 FF      Val : $ff;{protocol code}
   0033 02      Val : $02;{index of string descriptor describing this interface}

{* end of interface descriptor *}

LABEL : Interface_Des_End;

LABEL : Endpoint_Des;

LABEL : Endpoint3_Des_End;

   0034 07      Val : $07;{length of this descriptor in bytes}
   0035 05      Val : $05;{End point descriptor}
   0036 81      Val : 10000001b;{in endpoint at address 1}
   0037 02      Val : 00000010b;{attribute as bulk}
   0038 40 00   Val : 64,$00;{maximum packet size}
   003A 00      Val : $00;{interval for polling endpoint for data transfers}
```

```
LABEL : Endpoint3_Des; {* end point descriptor *}

   003B 07      Val : $07;{length of this descriptor in bytes}
   003C 05      Val : $05;{End point descriptor}
   003D 02      Val : 00000010b;{out endpoint at address 2}
   003E 02      Val : 00000010b;{attribute as bulk}
   003F 40 00   Val : 64,$00;{maximum packet size}
   0041 00      Val : $00;{interval for polling endpoint for data transfers}

LABEL : Endpoint_Des_End;
LABEL : Config_Des_End;


LABEL : Str0_Des;

   0042 04      Val : Str0_Len;      {length of string descriptor}
   0043 03      Val : $03;    {type string}
   0044 09 04   Val : $09,$04;       {language ID 0009 English}
LABEL : Str0_Des_End;

LABEL : Str1_Des;

E  0046 0A      Val : Str1_Len;      {length of string descriptor}
E  0047 03      Val : $03;    {type string}
E  0048 46 00   Val : 'F',$00;
E  004A 54 00   Val : 'T',$00;
E  004C 44 00   Val : 'D',$00;
E  004E 49 00   Val : 'I',$00;
LABEL : Str1_Des_End;

LABEL : Str2_Des;

E  0050 1E      Val : Str2_Len;      {length of string descriptor}
E  0051 03      Val : $03;    {type string}
E  0052 55 00   Val : 'U',$00;
E  0054 53 00   Val : 'S',$00;
E  0056 42 00   Val : 'B',$00;
E  0058 20 00   Val : ' ',$00;
E  005A 3C 00   Val : '<',$00;
E  005C 2D 00   Val : '-',$00;
E  005E 3E 00   Val : '>',$00;
E  0060 20 00   Val : ' ',$00;
E  0062 53 00   Val : 'S',$00;
E  0064 65 00   Val : 'e',$00;
E  0066 72 00   Val : 'r',$00;
E  0068 69 00   Val : 'i',$00;
E  006A 61 00   Val : 'a',$00;
E  006C 6C 00   Val : 'l',$00;
LABEL : Str2_Des_End;

LABEL : Str3_Des;

E  006E 12      Val : Str3_Len;      {serial number string}
E  006F 03      Val : $03;          {type string}
E  0070 31 00   Val : '1',00;
E  0072 32 00   Val : '2',00;
E  0074 33 00   Val : '3',00;
E  0076 34 00   Val : '4',00;
E  0078 35 00   Val : '5',00;
E  007A 36 00   Val : '6',00;
E  007C 37 00   Val : '7',00;
E  007E 38 00   Val : '8',00;
LABEL : Str3_Des_End;
```

# Appendix B

# EEPROM Data Structure

## E2Rom Data example

```
0000 00 00  Val : $00,$00;{Configuration value}
0002 03 04  Val : $03,$04;{Vendor ID FTDI}
0004 01 60  Val : $01,$60;{product number 6001}
0006 00 02  Val : $00,$02;{device release number}
0008 A0     Val : 10100000b;   {config descriptor value bus powered and remote wakeup}
0009 2D     Val : 45;    {max power =  value * 2 mA}
000A 00 00  Val : $00,$00;{reserved}
000C 00 00  Val : $00,$00;{reserved}

000E 94     VAL : PTR_ManStringDes;
000F 0C     Val : ManStringDes_Len;  {length of string descriptor}
0010 A0     VAL : PTR_ProdStringDes;
0011 34     Val : ProdStringDes_Len; {length of string descriptor}
0012 D4     VAL : PTR_SerStringDes;
0013 12     Val : SerStringDes_Len;

LABEL : ManStringDes;

0014 0C     Val : ManStringDes_Len;  {length of string descriptor}
0015 03     Val : $03; {type string}
0016 41 00  Val : 'A',$00;
0018 6E 00  Val : 'n',$00;
001A 64 00  Val : 'd',$00;
001C 79 00  Val : 'y',$00;
001E 73 00  Val : 's',$00;
LABEL : ManStringDes_End;

LABEL : ProdStringDes;

0020 34     Val : ProdStringDes_Len; {length of string descriptor}
0021 03     Val : $03; {type string}
0022 57 00  Val : 'W',$00;
0024 6F 00  Val : 'o',$00;
0026 6E 00  Val : 'n',$00;
0028 64 00  Val : 'd',$00;
002A 65 00  Val : 'e',$00;
002C 72 00  Val : 'r',$00;
002E 66 00  Val : 'f',$00;
0030 75 00  Val : 'u',$00;
0032 6C 00  Val : 'l',$00;
0034 6C 00  Val : 'l',$00;
0036 20 00  Val : ' ',$00;
0038 55 00  Val : 'U',$00;
003A 53 00  Val : 'S',$00;
003C 42 00  Val : 'B',$00;
003E 20 00  Val : ' ',$00;
0040 3C 00  Val : '<',$00;
0042 2D 00  Val : '-',$00;
0044 3E 00  Val : '>',$00;
0046 20 00  Val : ' ',$00;
0048 53 00  Val : 'S',$00;
004A 65 00  Val : 'e',$00;
004C 72 00  Val : 'r',$00;
004E 69 00  Val : 'i',$00;
0050 61 00  Val : 'a',$00;
0052 6C 00  Val : 'l',$00;
LABEL : ProdStringDes_End;

LABEL : SerStringDes;

0054 12     Val : SerStringDes_Len;
0055 03     Val : $03; {type string}
0056 32 00  Val : '2',00;
0058 32 00  Val : '2',00;
005A 33 00  Val : '3',00;
005C 34 00  Val : '4',00;
005E 35 00  Val : '5',00;
0060 36 00  Val : '6',00;
0062 37 00  Val : '7',00;
0064 38 00  Val : '8',00;
LABEL : SerStringDes_End;


0066 00 00  Val : $00,$00;   {reserved for Checksum}
```