USB FIFO - Fast Parallel Data Transfer IC

FEATURES

- **Single Chip Fast Data Transfer Solution**
- **Send / Receive Data over USB at up to 1 M Bytes / sec**
- **384 byte FIFO Transmit buffer / 128 byte FIFO receive buffer for high data throughput**
- **Simple interface to CPU or MCU bus**
- **No in-depth knowledge of USB required as all USB Protocol is handled automatically within the I.C.**
- **FTDI's Virtual COM port drivers eliminate the need for USB driver development in most cases.**
- **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
High Speed USB ⇔ PDA Communications
USB I/F for Digital Cameras
USB I/F for MP3 players
High Speed USB Instrumentation
USB ⇔ USB data transfer cables
USB ⇔ USB null-modem cables

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GENERAL DESCRIPTION

The FT8U245AM provides an easy cost-effective method of transferring data to / from a peripheral and a host P.C. at up to 8 Million bits (1 Megabyte) per second. It's simple FIFO-like design makes it easy to interface to any CPU (MCU) either by mapping the device into the Memory / IO map of the CPU, using DMA or controlling the device via IO ports.

To send data from the peripheral to the host P.C. simply write the byte wide data into the device when the transmitter empty status bit is not active. If the (384 byte) transmit buffer fills up, the device de-asserts transmit empty in order to stop further data being written to the device until some of the FIFO data has been transferred over USB.

When the host P.C. sends data to the peripheral over USB, the device will assert the receiver full status bit to let the peripheral know that data is available. The peripheral then reads the data until the receiver full status bit goes inactive, indicating no more data is available to read.

By using FTDI's virtual COM Port drivers, the peripheral looks like a standard COM Port to the application software. Commands to set the baud rate are ignored – the device always transfers data at it's fastest rate regardless of the application's baud rate setting.

Figure 1 – FT8U245AM Block Diagram (Simplified)

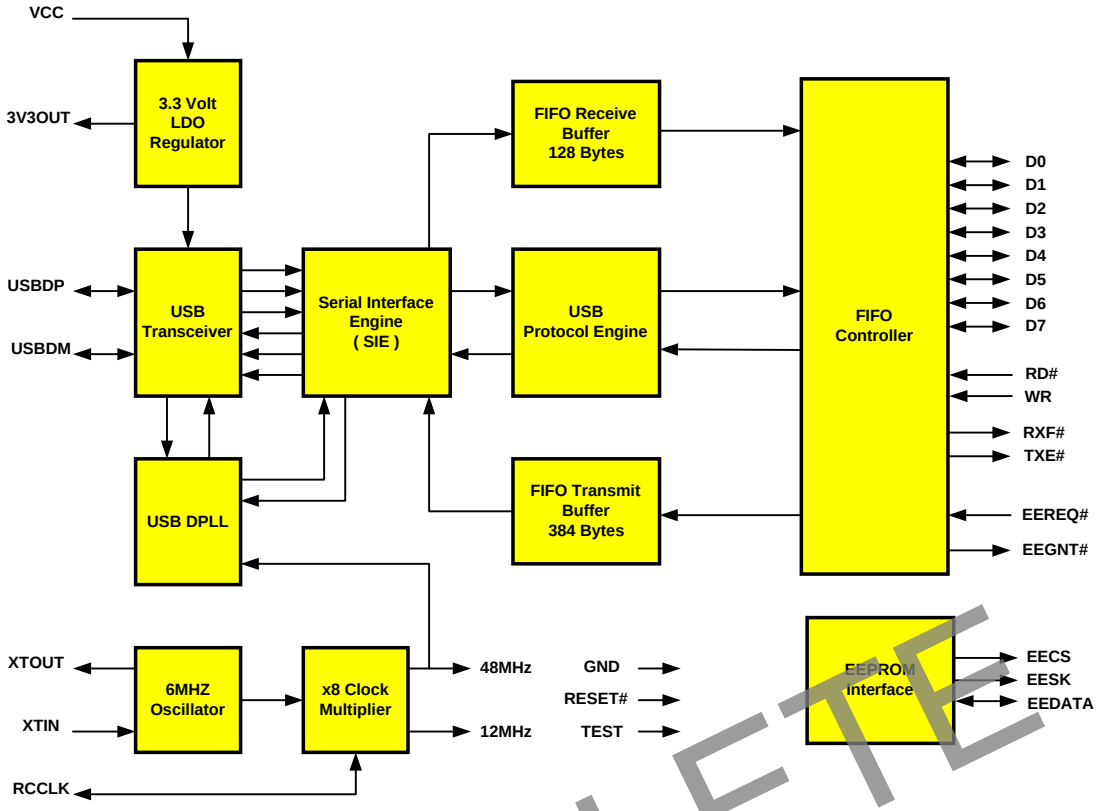

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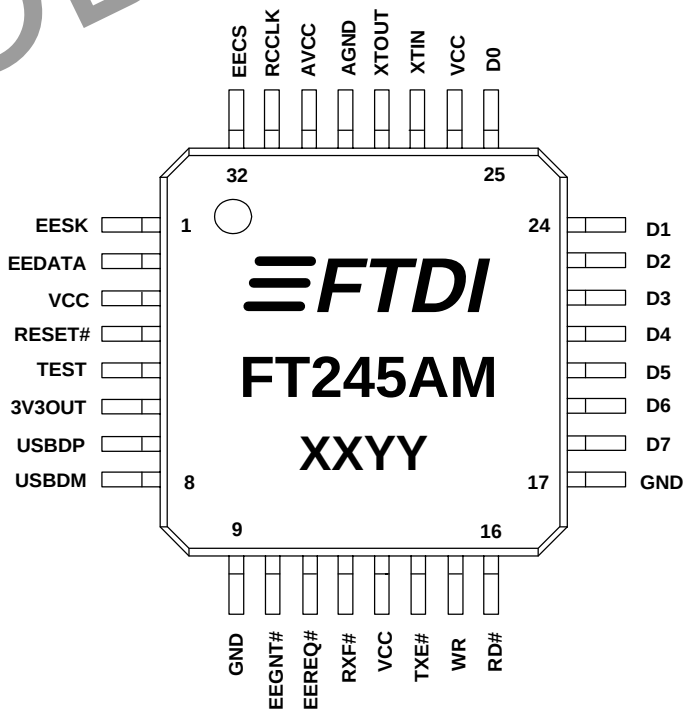
Figure 2 – FT8U245AM I.C. Pinout



FT8U245AM - 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.

- **Fifo Receive Buffer (128 bytes)**

  Data sent from the USB Host to the FIFO via the USB data out endpoint is stored in the FIFO Receive Buffer and is removed from the buffer by reading the FIFO contents using RD#.

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- **FIFO Transmit Buffer (384 bytes)**

  Data written into the FIFO using WR# is stored in the FIFO Transmit Buffer. The Host removes Data from the FIFO Transmit Data by sending a USB request for data from the device data in endpoint.

- **FIFO Controller**

  The FIFO Controller handles the transfer of data between the external FIFO interface pins and the FIFO Transmit and Receive buffers.

- **EEPROM Interface**

  The FT8U245AM uses an external 93C46 EEPROM to customise the USB VID, PID, Serial Number and Strings of the FT8U245AM for OEM applications. The FT8U245 Virtual Com Port Drivers rely on a unique device serial number for to bind a unique virtual COM port to each individual device.

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Table 1 - FT8U245AM - 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. Clamped low during reset or sleep condition.
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	D0	I/O	Bi-directional Data Bus Bit # 0
24	D1	I/O	Bi-directional Data Bus Bit # 1
23	D2	I/O	Bi-directional Data Bus Bit # 2
22	D3	I/O	Bi-directional Data Bus Bit # 3
21	D4	I/O	Bi-directional Data Bus Bit # 4
20	D5	I/O	Bi-directional Data Bus Bit # 5
19	D6	I/O	Bi-directional Data Bus Bit # 6
18	D7	I/O	Bi-directional Data Bus Bit # 7
16	RD#	IN	Enables Current FIFO Data Byte on D0..D7.when low. Fetches the next FIFO Data Byte (if available) from the Receive FIFO Buffer when RD# goes from low to high.
15	WR	IN	Writes the Data Byte on the D0..D7 into the Transmit FIFO Buffer when WR goes from high to low.
14	TXE#	OUT	When high, do not write data into the FIFO. When low, data can be written into the FIFO by strobing WR high then low.
12	RXF#	OUT	When high, do not read data from the FIFO. When low, there is data available in the FIFO which can be read by strobing RD# low then high again.
11	EEREQ#	IN	Requests the EEPROM contents to be accessed via the Data Bus.
10	EEGNT#	OUT	When low, allows the EEPROM contents to be accessed via the Data Bus.
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

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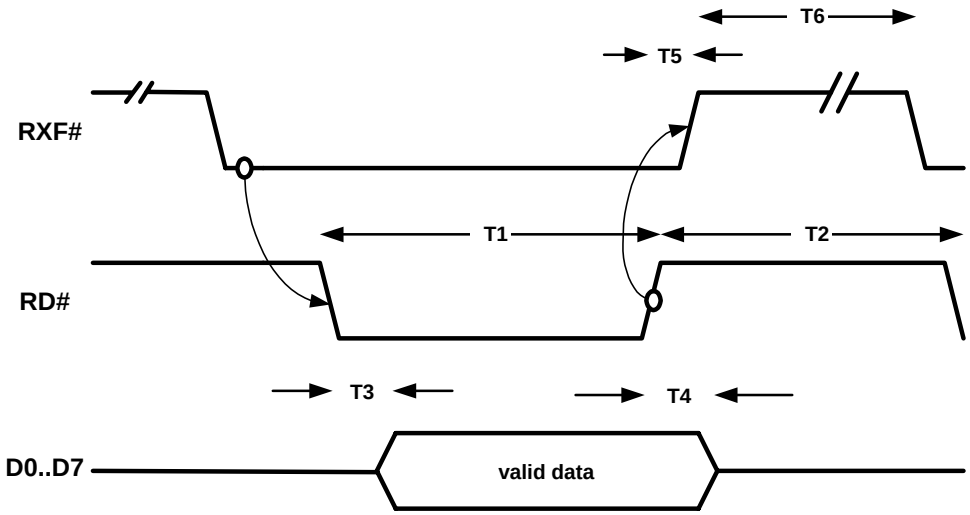
FT8U245AM TIMING DIAGRAM – FIFO READ CYCLE



Time	Description	Min	Max	Unit
T1	RD Active Pulse Width	50		ns
T2	RD to RD Pre-Charge Time	50		ns
T3	RD Active to Valid Data		30	ns
T4	Valid Data Hold Time from RD inactive	10		ns
T5	RD Inactive to RXF#	5	25	ns
T6	RXF inactive after RD cycle	80		ns

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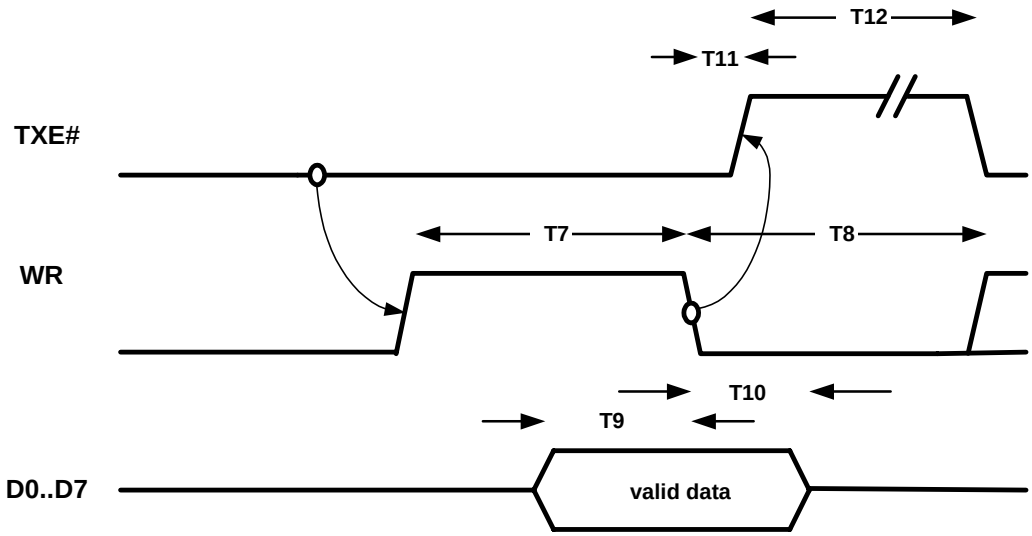
FT8U245AM TIMING DIAGRAM – FIFO WRITE CYCLE



Time	Description	Min	Max	Unit
T7	WR Active Pulse Width	50		ns
T8	WR to WR Pre-Charge Time	50		ns
T9	Data Setup Time before WR inactive		20	ns
T10	Data Hold Time from WR inactive	10		ns
T11	WR Inactive to TXE#	5	25	ns
T12	TXE inactive after RD cycle	80		ns

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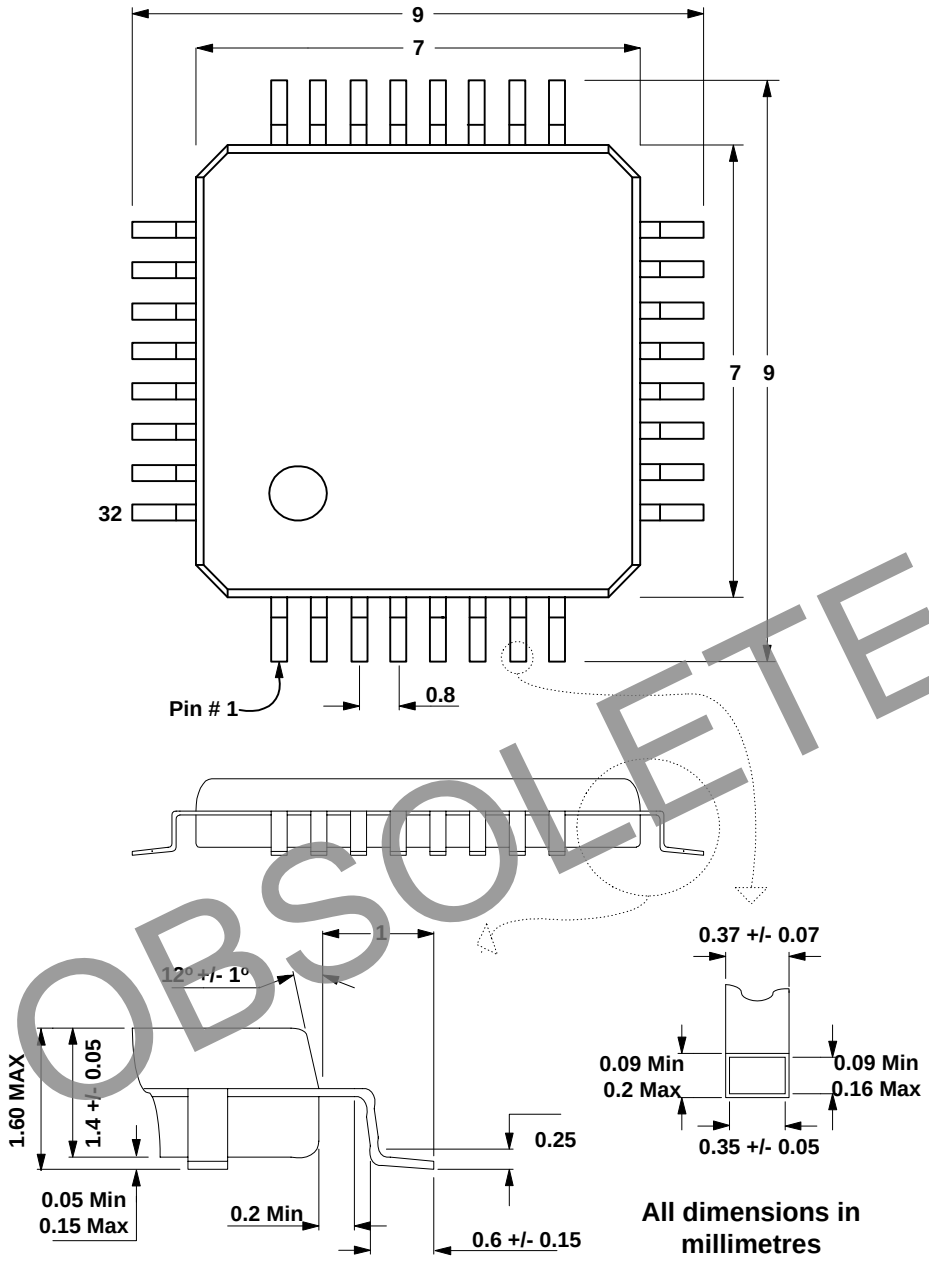
Figure 3. FT8U245AM - PACKAGE DESCRIPTION – QFP 7mm x 7mm



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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	4		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

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Contact Information

Future Technology Devices Intl. Limited
St. George's Studios
93/97 St. George's Road
Glasgow G3 6JA, UK

Telephone : +44 (0) 141 353 2565
Fax : +44 (0) 141 353 2656
Email : support@ftdi.co.uk
Internet : http://www.ftdi.co.uk

Agents and Sales Representatives

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Appendix A

USB Device Descriptors

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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}
```

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```
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;
```

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Appendix B

EEPROM Data Structure

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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}
```

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