D12 SMART

USER'S MANUAL

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D12 SMART KIT

1.1 Introduction

The Philips USB D12 Smart Kit is a comprehensive kit that offers you the full potential of Philips PDIUSBD12 (or D12), in addition to the know-how on how to convert your existing legacy into USB devices. This kit includes the D12 smart boards, test application program (or applet), USB driver, and some sample firmware source codes.

1.2 Description

D12 is a high performance USB interface device that offers DMA transfer capability as well as features for a cost-effective microcontroller-based system. This kit allows you to thoroughly evaluate the capabilities and features of the device, and provide quick grounding on how to convert your existing non-USB devices such as the digital still camera, mass storage device, and scanner into USB devices.

1.3 Features

The simple design of this kit aims to highlight the features of a USB device. It has the D12 and the 89C738/89C52 microcontroller interfaced to D12. Philips PDIUSBD12 implements all the functions of the USB device, and has an 8-bit parallel data bus for microcontroller interface. The MCU is a member of the 8051-family. The firmware implements all the USB enumeration, D12 Interrupt service, power down and resume signaling interfaces. Though the D12 has DMA capability, for simplicity, it is not incorporated in this board. A similar evaluation board, the USB-EPP, has all the DMA features built into it.

With the accompanying applet, you can operate the kit in three modes: Print, Scan, and Loop back modes. The purpose for having the print and scan modes is to allow the evaluation board to emulate either the printer or scanner environment. The Loop back mode is to indicate the integrity of the data when large data packet is sent and received from the host system.

1.4 Operating Environment

Running the kit only requires a new generation PC (motherboard with USB port) with Microsoft Windows 98 operating system. The firmware provided with the kit is written in C language (some Assembly codes for critical timing), and so allows you to port it to any other platforms for compiling. With this kit, you can develop your USB devices through the firmware and hardware schematics.

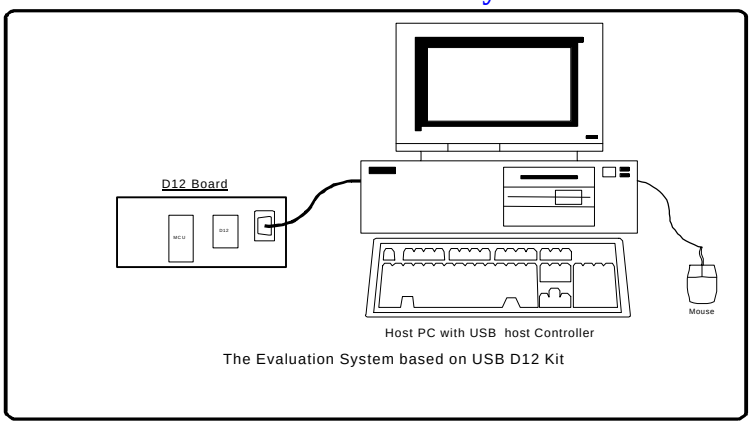
2. SETTING UP THE D12 SMART KIT

2.1 Connection and System Requirement

Connect the board to the host system via the USB upstream connector. Follow the instructions on the screen to install the device driver, and then install the software provided with the kit. Ensure that you have the following:

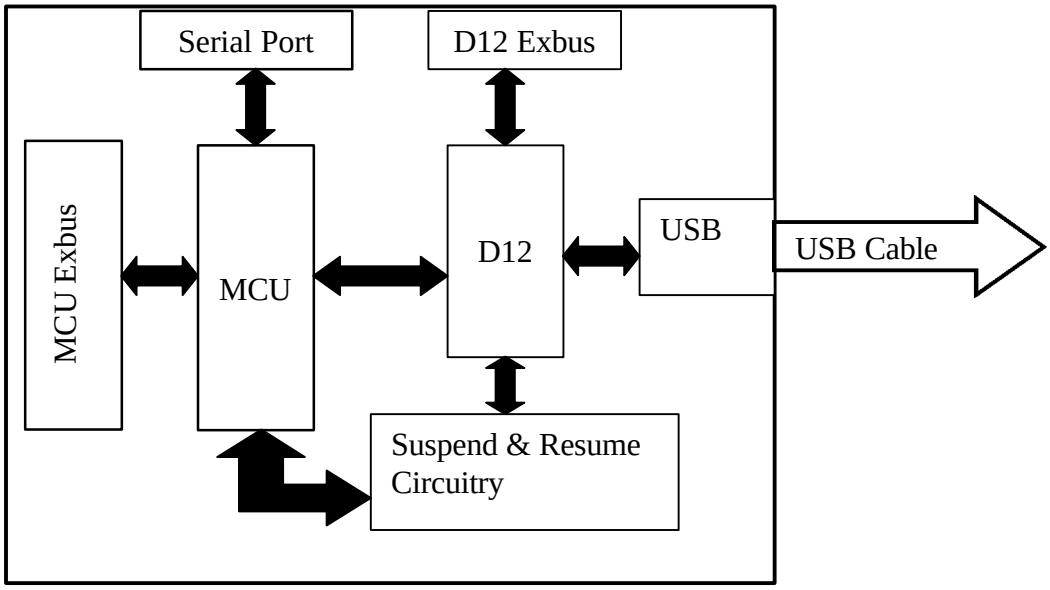
- **PC Host system with USB ports;**
- **Microsoft Windows 98 operating system; and**
- **D12 smart board, USB cable, and diskette provided with the kit**.

2.1.1: The D12 Smart Evaluation System



The Evaluation System based on USB D12 Kit

2.1.2: Block Diagram of D12 Smart Board



3. INSTALLATION PROCEDURES

3.1 Installing the software

The software includes the firmware, the test application program (or the applet), and the device drivers. The firmware is programmed in the 89C738/89C52 microcontroller (Flash type). If you want to change the firmware or use your own firmware, you just need to reprogram the 89C738/89C52 microcontroller.

3.2 Installing the Applet

1. Insert the diskette into your disk drive.
2. Copy the file, D12TEST.EXE, contained in the diskette to a directory of your choice - C:\D12 Smart.
3. Create a shortcut by dragging the file D12TEST.EXE from the directory to the desktop. An icon similar to Figure 3.2.1 appears.

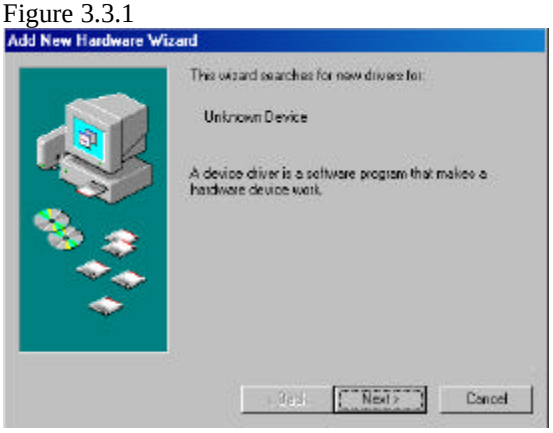
3.2.1: The icon on the desktop.

3.3 Installing the device drivers

When connecting the USB cable to your host system for the first time, a dialog box will appear and prompt you to install the device drivers. Navigate through it and load the device drivers provided in the floppy that comes along with the kit. To install the device drivers:

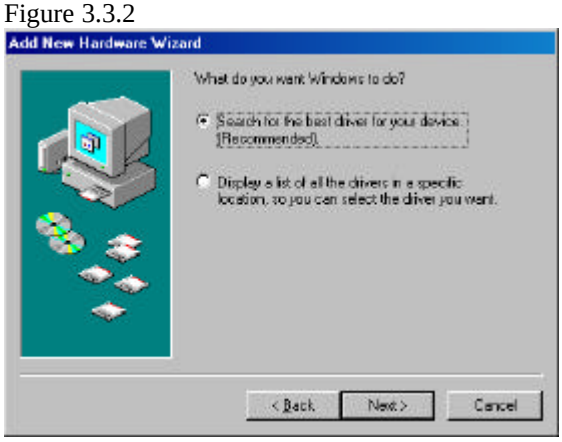
1. When you connect the USB cable to your host system for the first time, a dialog box similar to Figure 3.3.1 appears. Click the Next button.

Figure 3.3.1



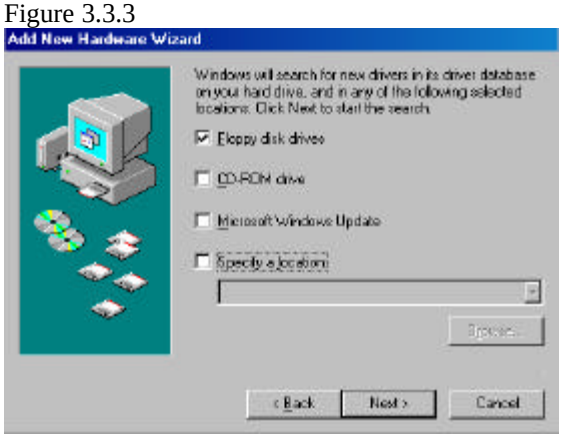
2. When a dialog box similar to Figure 3.3.2 appears, select the first item and click the Next button.

Figure 3.3.2



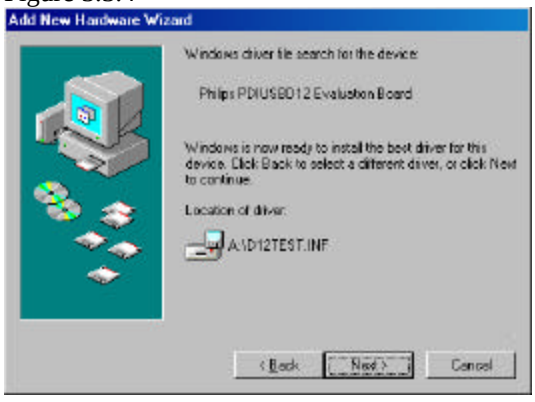
3. When a dialog box similar to Figure 3.3.3 appears, select Floppy disk drives and click the Next button.

Figure 3.3.3



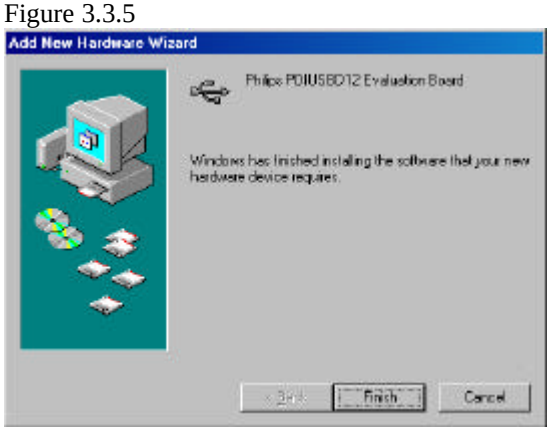
4. When a dialog box similar to Figure 3.3.4 appears, click the Next button.

Figure 3.3.4



5. When a dialog box similar to Figure 3.3.5 appears, click the Finish button to end the installation.

Figure 3.3.5

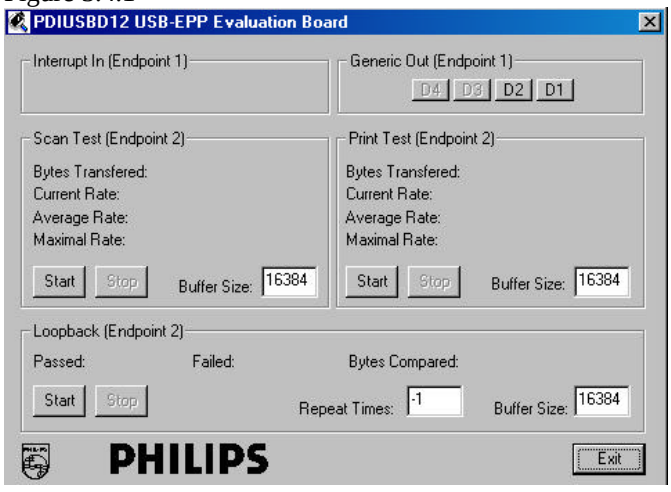


3.4 Running the applet

The applet supports three test modes: Print, Scan, and Loop back modes. The print and scan modes allow the evaluation board to emulate either the printer or scanner environment. The Loop back mode shows the integrity of the data when a large data packet is sent and received by the host system.

To run the applet, click the D12Test.exe icon on your desktop and an interface similar to Figure 3.4.1 appears.

Figure 3.4.1



4. DESCRIPTION OF D12 ENDPOINTS

4.1 D12 Endpoints Configuration

Table 4.1.1 describes the PDIUSBD12 Endpoints configuration Mode 0, i.e., it is Non-Iso mode. The reset 3 mode (Isochronous mode) can be found on the D12 specification.

4.1.1 Configuration of D12 Endpoints Table

Endpoint Number	Endpoint Index	Transfer Type	Endpoint Type	Direction	Max Packet Size(Bytes)
0	0 1	Control Out Control In	Default	Out In	16 16
1	2 3	Generic Out Generic In	Generic Generic	Out In	16 16
2	4 5	Generic(Main) Out Generic(Main) In	Generic Generic	Out In	64(another 64 for double buffer) 64(another 64 for double buffer)

4.2 Operations of D12 Endpoints

The table below describes in detail the operations of the endpoints.

4.2.1 Operations of D12 Endpoints Table

Endpoint Number	Endpoint Type	Operations
1	Generic In	This pipe is defined as Interrupt pipe. The D12-Smart evaluation board sends specific data packet to the host system when the test key is pressed or released.
1	Generic Out	This pipe is defined as Bulk Out pipe. Data packet received from the host system is interpreted as LED control, and the firmware will light up the corresponding LED.
2	Main In Main Out	These pipes are defined as Bulk In/Out endpoints. The Applet and the evaluation board support 3 test modes: loop back, print, and scan modes.

The Generic In and Generic Out endpoints have a maximal packet size of 16 bytes. This capacity makes them suitable for devices that require small size data transfer such as the keyboard, mouse and logic controls. The main endpoints have a maximal packet size of 64 bytes for Bulk/Isochronous mode or 128 bytes for Isochronous mode with double buffering capacity. Hence, they are suitable for high data rate and large size data transfer.

Three test modes are supported at the main endpoints. They are:

- Scan mode: The evaluation board emulates the scanner environment. This mode is used to evaluate the maximal Bulk In transfer rate.
- Print mode: The evaluation board emulates the printer environment. This mode is used to evaluate the maximal Bulk Out transfer rate.
- Loop back mode: The evaluation board receives data packets from the Main Out endpoint (Endpoint Index 4) and sends them back to the host system from the Main In endpoint (Endpoint Index 5). This mode helps test the firmware's ability to control the

data flow and the integrity of data transfers.

Since the firmware is protocol-based, the host system can inform the firmware to set any possible modes. There is, therefore, no longer any need to manually set the scan test mode before running the scan test on the firmware.

The "buffer size" of the applet is the size of the data buffer, which the applet transmits to the USB system drivers for receiving or transmitting. Hence, it is the responsibility of the USB system drivers to divide them into smaller data packets, e.g., 64 bytes for bulk transfer. The maximal buffer size is limited by the USB system drivers. The best transfer rate over the USB can be achieved by optimizing the buffer size.

5. MISCELLANEOUS

- Press-Button S1—Reset or Resume the system
- Press-Button S2—PIPE testing
- Press-Button S3—PIPE testing
- LED D1—USB interface GoodLink indicator. When it is on, it means that the link between the USB host and the USB device has been set up and the enumeration done. If it is blinking, it means that data is being transmitted or received
- LED D2—PIPE testing
- LED D3—PIPE testing
- Header pin J5 —Connected to Ground leads
- HCT123 with D12 and MCU firmware support the Power down and RESUME operations, i.e., when D12 comes out from suspend state, the suspend pin state changes from high to low. When this happens, the HCT123 monostate generates a positive pulse to reset/wakeup 89C52/89C738.

6. DESCRIPTION OF HEADERS

6.1 Header J1

The J1 test header is for D12's signals as illustrated in the following table:

Pin No.	Signal Name	Signal Type	Description
1	D∅	I/O	D12 Data ∅
2	D12A∅	I	D12 Address A∅
3	D1	I/O	D12 Data 1
4	/D12RST	I	D12 Reset
5	D2	I/O	D12 Data 2
6	/D12 EOT	I	D12 End of Transfer
7	D3	I/O	D12 Data 3
8	/D12DACK	I	D12 DMA ACK
9	D4	I/O	D12 Data 4
10	D12REQ	O	D12 DMA Request
11	D5	I/O	D12 Data 5
12	/D12WR	I	D12 Write
13	D6	I/O	D12 Data 6
14	/D12RD	I	D12 Read
15	D7	I/O	D12 Data 7
16	/D12CS	I	D12 Chip Select
17	5V	Power	5 Volts Power
18	D12ALE	I	D12 Address Catch
19	5V	Power	5 volts Power
20	D12SUSPD	I/O	D12 Suspend
21			Not Connected
22	/D12INT	O	D12 Interrupt
23	GND	Power	Ground
24			Not Connected
25	GND	Power	Ground
26	CLK12M	O	D12 Clock Out

6.2 Header J2

The expansion connector J2 is connected from Pin1 to Pin 40 of the MCU. These connectors allow the use of MCUs from other makes through a pin converter. It will also allow you to debug signal lines of MPU.

Header J2

Pin No.	Signal Name	Signal Type	Description
1	GND	Power	Ground
2	SWM0	I	Press Button ∅
3	GND	Power	Ground
4	SWM1	I	Press Button 1
5	GND	Power	Ground
6	RLED0	O	Red LED ∅
7	GND	Power	Ground
8	RLED1	O	Red LED 1
9	GND	Power	Ground
10	P1x4	I/O	MCU Port 1 bit 4 (Not in use)
11	GND	Power	Ground
12	P1x5	I/O	MCU Port 1 bit 5 (Not in use)
13	GND	Power	Ground
14	/D12CS	I	D12 Chip Select
15	GND	Power	Ground
16	/D12RST	O	D12 Reset
17	GND	Power	Ground
18	MCURST	I	MCU Reset
19	GND	Power	Ground
20	S232RXD	I	Receive Data Line
21	GND	Power	Ground
22	S232TXD	O	Transmit Data Line
23	GND	Power	Ground
24	/D12INT	I	D12 Interrupt
25	GND	Power	Ground
26	D12 SUSPD	I/O	D12 Suspend
27	GND	Power	Ground
28	P3x4	I/O	MCU Port 3 bit 4 (Not in use)
29	GND	Power	Ground
30	P3x5	I/O	MCU Port 3 bit 5 (Not in use)
31	GND	Power	Ground
32	/D12WR	O	D12 Write
33	GND	Power	Ground
34	/D12RD	O	D12 Read
35	GND	Power	Ground
36	MCUXTAL2	O	Crystal Output
37	GND	Power	Ground
38	MCUXTAL1	I	Crystal Input
39	GND	Power	Ground
40	VCC	Power	+5V

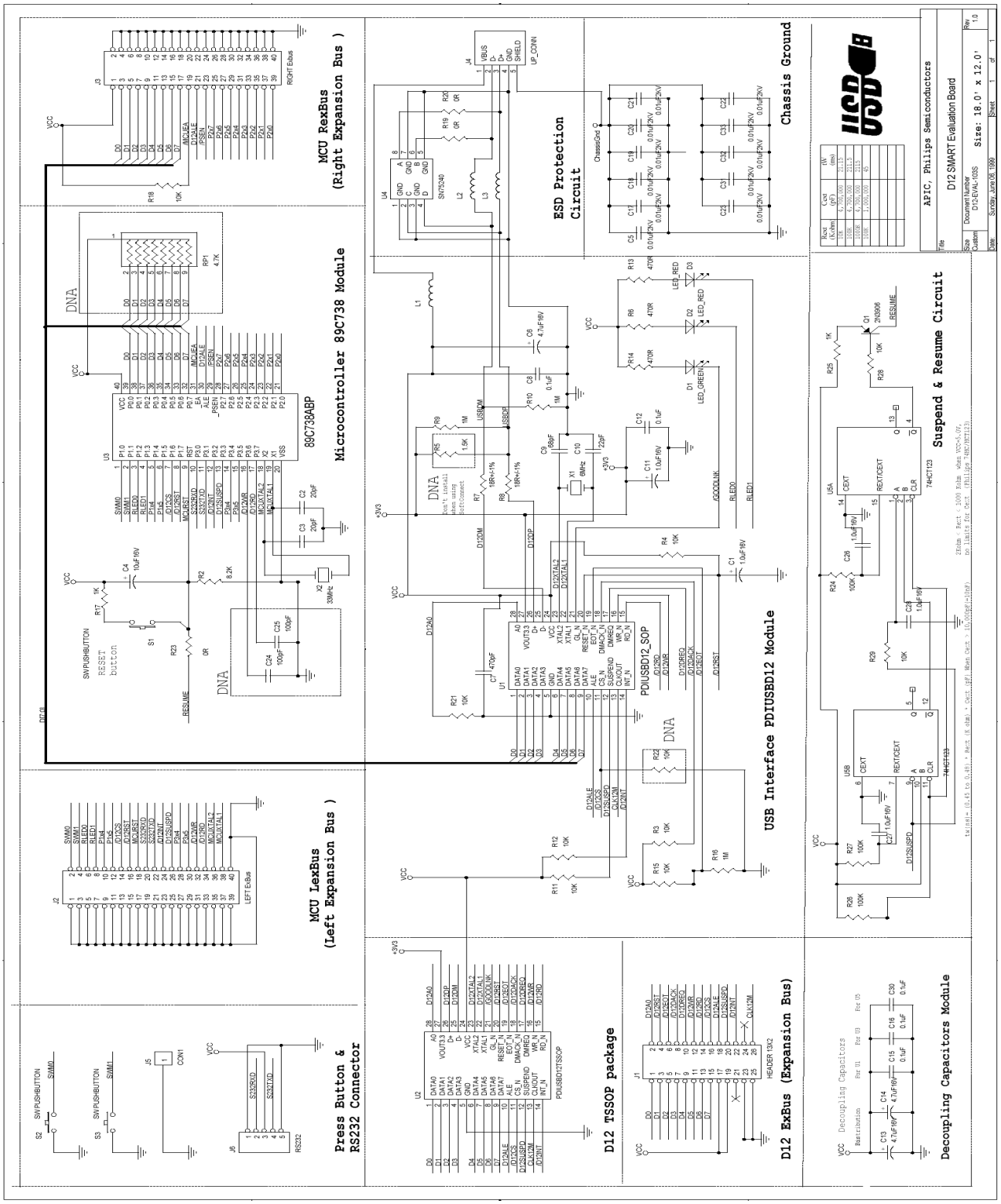
6.3 Header J3

Pin No.	Signal Name	Signal Type	Description
1.	VCC	Power	+5V
2.	GND	Power	Ground
3.	D0	I/O	Data ∅
4.	GND	Power	Ground
5.	D1	I/O	Data 1
6.	GND	Power	Ground
7.	D2	I/O	Data 2
8.	GND	Power	Ground
9.	D3	I/O	Data 3
10.	GND	Power	Ground
11.	D4	I/O	Data 4
12.	GND	Power	Ground
13.	D5	I/O	Data 5
14.	GND	Power	Ground
15.	D6	I/O	Data 6
16.	GND	Power	Ground
17.	D7	I/O	Data 7
18.	GND	Power	Ground
19.	/MCUEA	O	MCU External Excess
20.	GND	Power	Ground
21.	D12ALE	O	D12 Address Catch Enable
22.	GND	Power	Ground
23.	/PSEN	O	Program Strobe Enable
24.	GND	Power	Ground
25.	P2x7	I/O	MCU Port 2 bit 7 (Not in use)
26.	GND	Power	Ground
27.	P2x6	I/O	MCU Port 2 bit 6 (Not in use)
28.	GND	Power	Ground
29.	P2x5	I/O	MCU Port 2 bit 5 (Not in use)
30.	GND	Power	Ground
31.	P2x4	I/O	MCU Port 2 bit 4 (Not in use)
32.	GND	Power	Ground
33.	P2x3	I/O	MCU Port 2 bit 3 (Not in use)
34.	GND	Power	Ground
35.	P2x2	I/O	MCU Port 2 bit 2 (Not in use)
36.	GND	Power	Ground
37.	P2x1	I/O	MCU Port 2 bit 1 (Not in use)
38.	GND	Power	Ground
39.	P2x0	I/O	MCU Port 2 bit 0 (Not in use)
40.	GND	Power	Ground

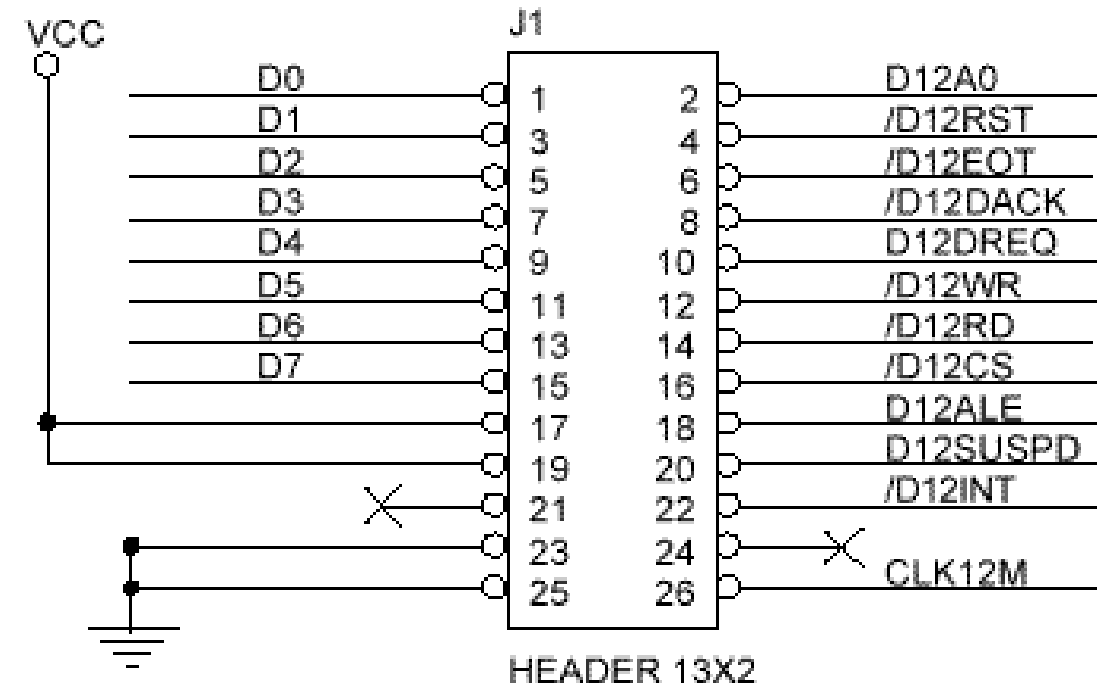
6.4 Header J4 (USB Upstream)

Pin No.	Signal Name	Signal Type	Description
1	V_BUS	Power	+5V
2	D-	I/O	Data Minus Line,
3	D+	I/O	Data plus Line
4	GND	Power	Ground

7. SCHEMATIC OF D12 SMART EVALUATION BOARD

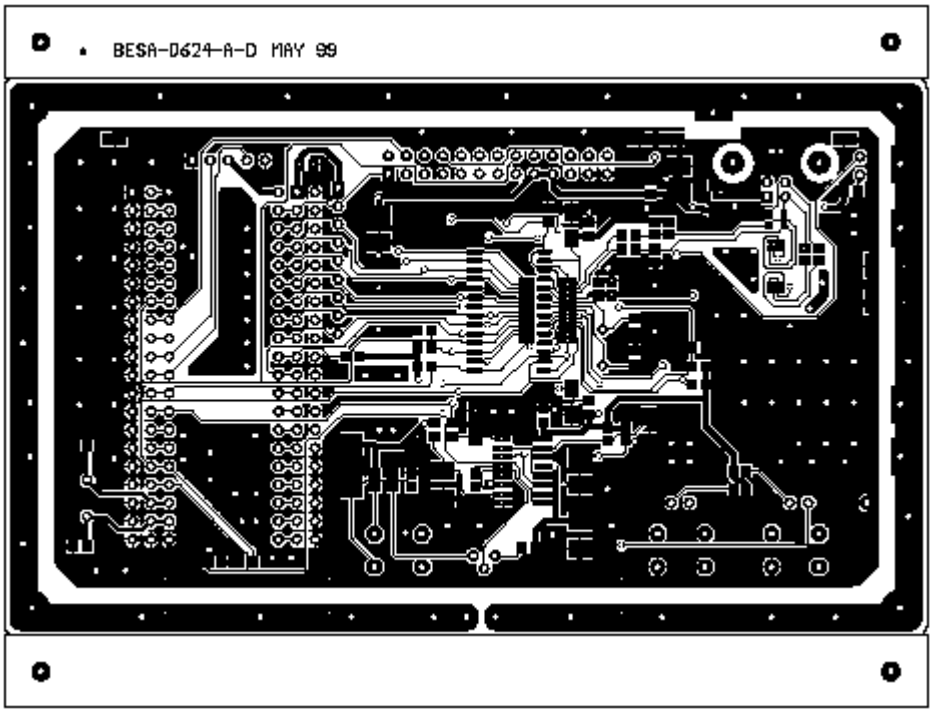


8. ENLARGED SCHEMATIC OF D12 EXPANSION BUS

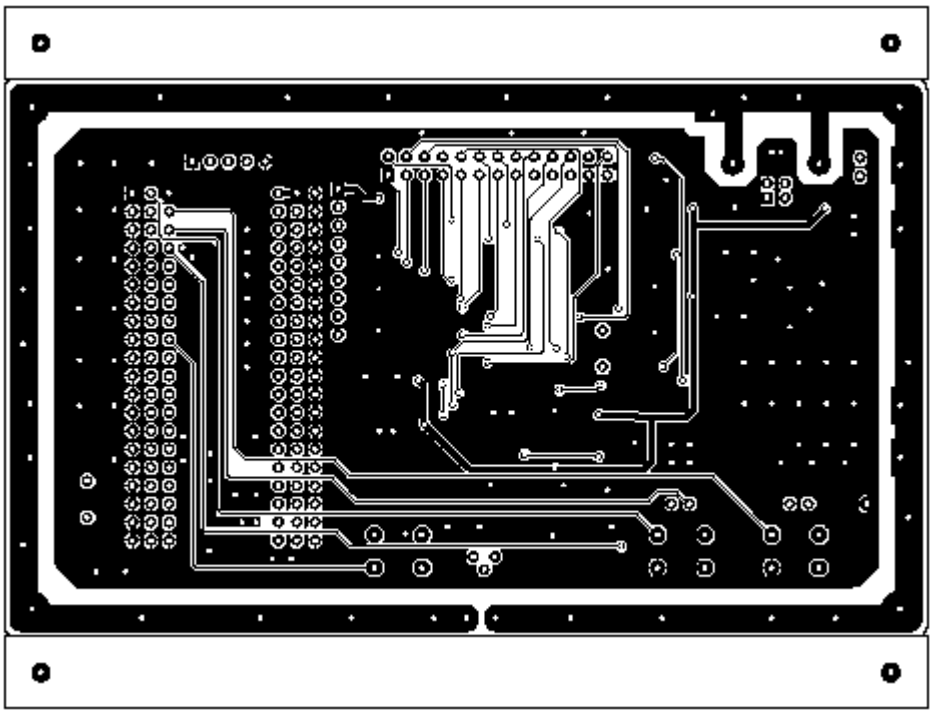


D12 ExBus (Expansion Bus)

9. PCB PLOTS OF D12 SMART EVALUATION BOARD



Top Layer



Bottom Layer

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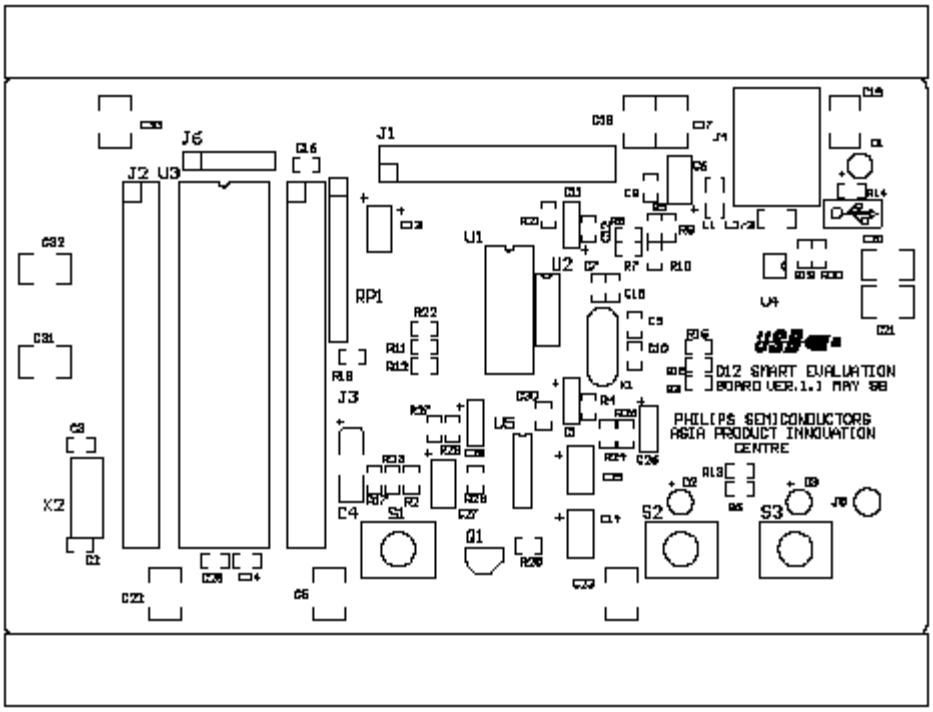
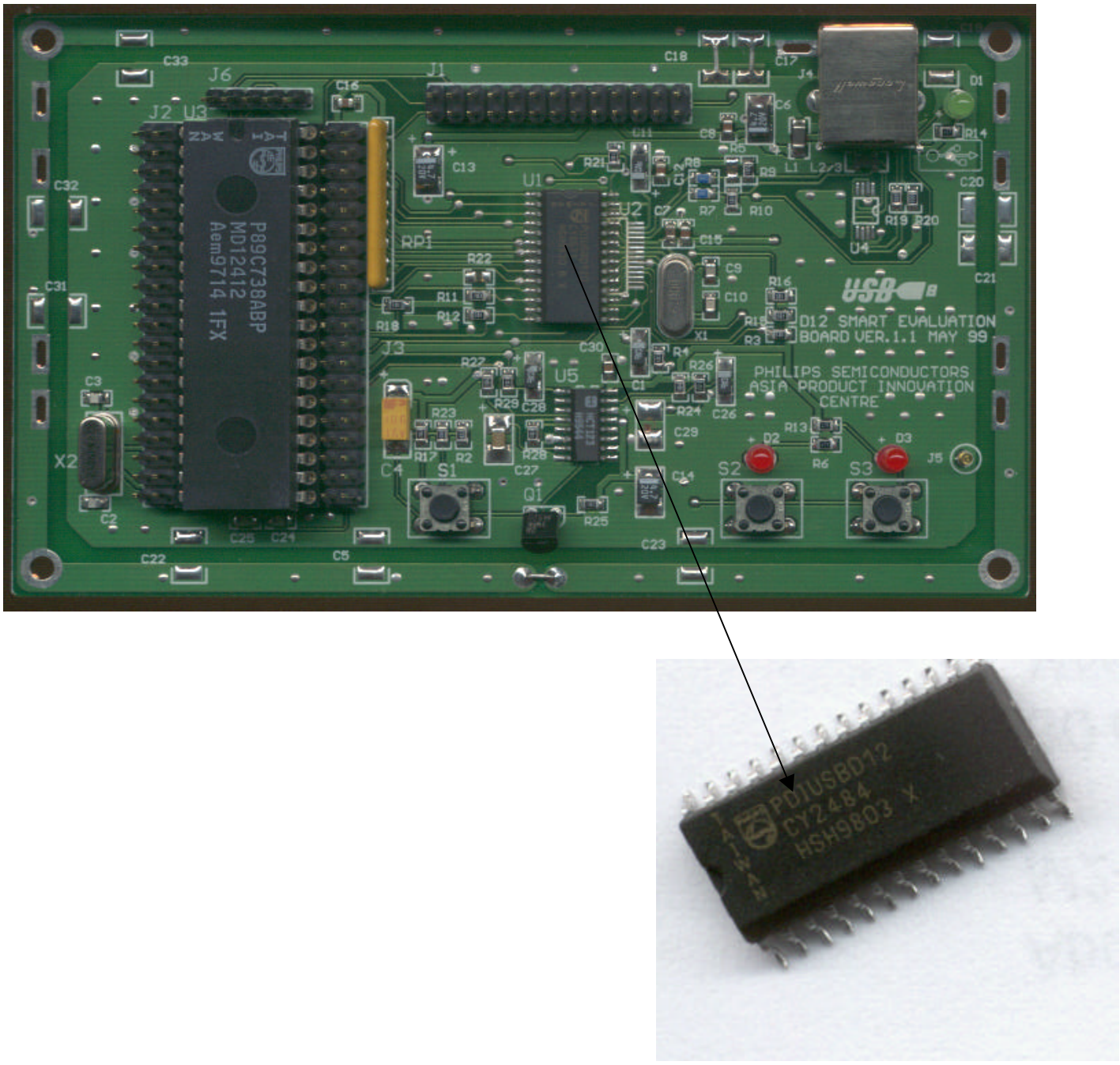


Top Overlay

10. D12 SMART EVALUATION BOARD



10.1: Enlarged Picture of PDIUSBD12

11. BILL OF MATERIALS FOR D12 EVALUATION BOARD

Item	Description	Reference	Value	Quantity
1.	Capacitor	C1, C11, C26, C27, C28	1.0uF16V	5
2.	Capacitor	C3, C2	20pF	2
3.	Capacitor	C4	10uF16V	1
4.	Capacitor	C5, C17, C18, C19, C20, C21, C22, C23, C31, C32, C33	0.01uF2KV	11
5.	Capacitor	C6, C13, C14	4.7uF16V	3
6.	Capacitor	C7	470pF	1
7.	Capacitor	C8, C12, C15, C16, C30	0.1uF	5
8.	Capacitor	C9	68pF	1
9.	Capacitor	C10	22pF	1
10.	Capacitor	C24, C25	100pF	2
11.	Light Emitting Diode	D1	LED_GREEN	1
12.	Light Emitting Diode	D3, D2	LED_RED	2
13.	Jumper	J1	HEADER 13×2	1
14.	Jumper	J2	LEFT Exbus	1
15.	Jumper	J3	RIGHT Exbus	1
16.	Jumper	J4	UP_CONN	1
17.	Jumper	J5	CON1	1
18.	Jumper	J6	RS232	1
19.	Ferrite Bead	L1, L2, L3	FERRITE BEAD	3
20.	Transistor	Q1	2N3906	1
21.	Resistor Array	RP1	4.7K	1
22.	Resistor	R2	8.2K	1
23.	Resistor	R3, R4, R11, R12, R15, R18, R21, R22, R28, R29	10K	10
24.	Resistor	R5	1.5K	1
25.	Resistor	R6, R13, R14	470R	3
26.	Resistor	R8, R7	18R±1%	2
27.	Resistor	R9, R10, R16	1M	3
28.	Resistor	R17, R25	1K	2
29.	Resistor	R19, R20, R23	0R	3
30.	Resistor	R24, R26, R27	100K	3
31.	Switches	S1, S2, S3	PUSHBUTTON	3
32.	Integrated Circuit	U1	PDIUSBD12_SOP	1
33.	Integrated Circuit	U2	PDIUSBD12TSSOP	1
34.	Integrated Circuit	U3	89C738ABP	1
35.	Integrated Circuit	U4	SN75240	1
36.	Integrated Circuit	U5	74HCT123	1
37.	Crystal	X1	6MHz	1
38.	Crystal	X2	33MHz	1