Half-Duplex UART

CE52024

Project Name: Code_Example_Half_Duplex_UART
Programming Language: C
Associated Part Families: CY8C24x23, CY8C27x43, CY8C29x66
CY8C24x94, CY8C21x34
Software Version: PSoC® Designer™ 5.1
Author: Maansy Wahegaonkar

Code Example Objective

This code example implements an 8-bit half-duplex UART in PSoC® 1 by using dynamic reconfiguration and a single digital communication block.

Overview

This code example demonstrates a serial port interface between PSoC 1 and the PC with a baud rate of 19.2 Kbps. The PC uses HyperTerminal as a user interface to view the characters transmitted and received over the serial port. Half-duplex UART is implemented using dynamic reconfiguration where the same digital block is shared by the transmitter (TX8) and the receiver (RX8). To learn more about dynamic reconfiguration, see the Video training module.

User Module List and Placement

The following table lists the user modules in this project and the hardware resources occupied by each user module.

User Module	Placement
Counter8_1	DBB01 (Base Configuration)
RX8_1	DCB02 (Receiver Configuration)
TX8_1	DCB02 (Transmitter Configuration)

User Module Parameter Settings

The following tables show the user module parameter settings for each user module in the project.

Counter8_1		
Parameter	**Value**	**Comments**
Clock	VC1	This parameter is left at its default setting. The clock setting overrides the ClockSync parameter.
ClockSync	Use SysClock Direct	This selects SysClk as the clock source. This setting also overrides the Clock parameter.
Enable	High	This enables the counter.
CompareOut	None	The CompareOut output is not used in this application.
TerminalCountOut	None	The TerminalCountOut is not used in this application.
Period	155	The divider of the counter is set to 156 (Period + 1). This generates a 153.846 kHz at the counter output. This in turn sets the baud rate of the UART to 19230 bps.
CompareValue	78	This parameter sets the duty cycle of the Counter Output. Duty cycle is set to 50%.
CompareType	Less Than or Equal To	This value sets the divider of the counter as Period+1.
InterruptType	Terminal Count	This parameter is not used in this application.
InvertEnable	Normal	This sets the Enable of Counter to Active High.

Notes

- The Counter8_1 UM is included in this project as a baud rate generator for the RX8_1 and TX8_1 UMs. It provides more flexibility because various baud rates may be obtained by changing the period value of the counter on the fly. Alternatively, VC1, VC2, and VC3 can also be used as the clock source to the RX8 and TX8 modules thus saving a digital block.

- The Counter8_1 UM is placed in the base configuration and is never unloaded. This ensures that the module runs throughout the application, regardless of any other configuration being loaded or unloaded. Therefore, the clock supply to the transmitter and receiver UMs is continuous.

RX8_1		
Parameter	**Value**	**Comments**
Clock	DBB01	The clock to the RX8 is derived from the counter.
Input	Row_0_Input_2	Port pin P1.6 is assigned as the input for the half-duplex UART. The input from this pin to the RX8_1 block is routed via the Row_0_Input_1 net.
ClockSync	Sync To SysClock	Because the clock to the RX8 is derived from SysClk, the clock sync must be set to 'SyncToSysClk'.
RxCmdBuffer	Disable	Buffer for command processing is disabled.
RxBufferSize	16 Bytes	Not applicable.
RX Output	None	RX output is not used.
Data Clock Out	None	Data clock is not used.
InvertInput	Normal	The input signal is not inverted.

Note The clock to the RX8 user module must be eight times the desired baud rate.

TX8_1		
Parameter	**Value**	**Comments**
Clock	DBB01	The clock to the transmitter module must be eight times the output baud rate. DBB01 output clock is 153.846 kHz, which is eight times 19.230 kbps.
Output	Row_0_Output_3	Port pin P2.7 is assigned as the output for the half-duplex UART. The output from the TX8_1 block is routed to this pin via the Row_0_Output_3 net and Global_Out_Even7.
TX Interrupt Mode	TxRegEmpty	This parameter is not used and retains the default value.
ClockSynch	Sync to SysClock	Clock is synchronized with the SysClock.
Data Clock Out	None	

Note The clock to the TX8 user module must be eight times the desired baud rate.

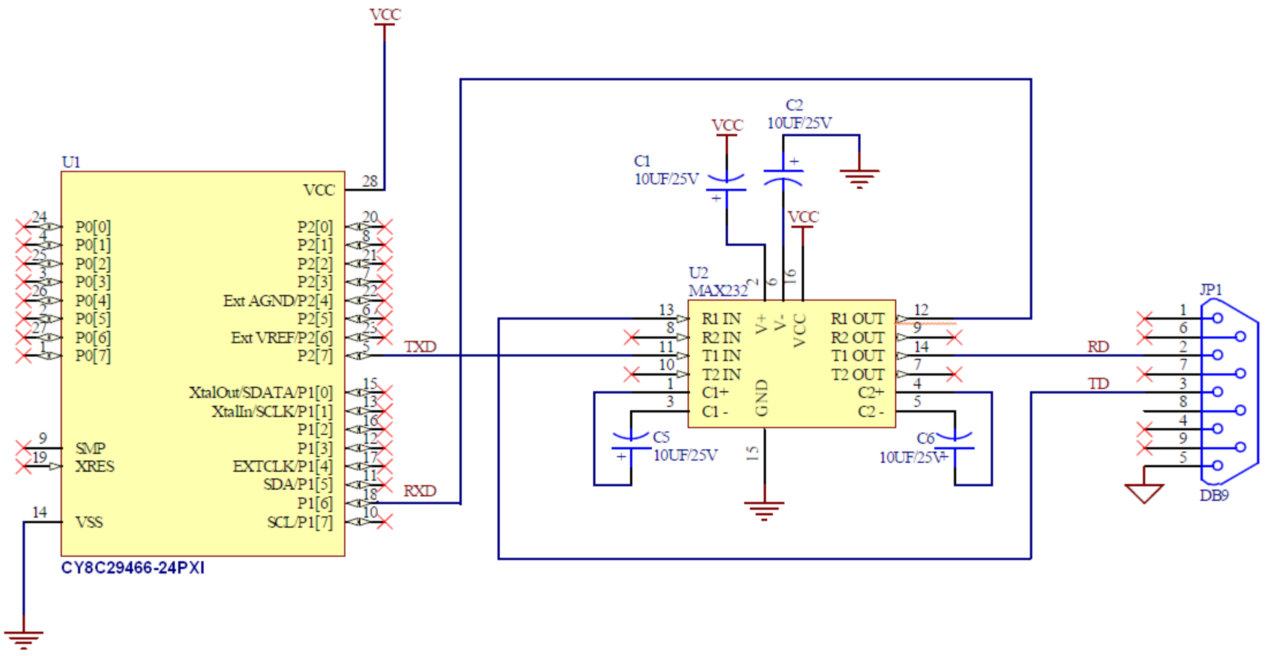
Global Resources

Important Global Resources		
Parameter	**Value**	**Comments**
CPU Clock	SysClk/2	Sets the CPU frequency to 12 MHz.

All other global resources retain the default values because they are not specific to this project.

Hardware Connections

Figure 1. Project Schematic Diagram



MAX232, an RS-232 transceiver, is used to translate the ±10 V RS-232 signals to TTL level signals of the PSoC.

JP1 is a 9-pin female serial port connector, which is used to connect the project with a PC.

The project can be tested using the CY3210 – PSoC Eval1 board. This board has an RS-232 transceiver and a serial port connector. To test the project using the CY3210 board, the following connections must be made:

- Connect P16 of J8 to RX of J13
- Connect P27 of J7 to TX of J13

Operation

On reset, all hardware settings from the device configuration are loaded into the device and *main.c* is executed. Before the program enters *main.c*, the base configuration with the Counter8_1 is loaded. The following operations are performed in *main.c:*

1. Counter8_1 is started in the beginning of *main.c*. After it is started, the Counter8_1 is never stopped, nor the base configuration unloaded in the project. This ensures that the Counter8_1 is always running, which generates the baud clock. Because the ClockSyc parameter of the counter is set to “Use Sysclk Direct”, the clock input to the counter is 24 MHz. The counter divides the 24 MHz clock by 156, which generates a 153.846 kHz clock. This is eight times the final baud rate of 19.2 Kbps that the UART communicates. Alternatively, the baud rate can also be generated using different combinations of VC1, VC2, and VC3.
   - VC1 = 12; VC2 = 13; Clock input to Counter = VC2
   - VC1 = NA; VC2 = NA; VC3 Source = SysClk; VC3 Divider = 156; Clock input to Counter = VC3

     The advantage of using VC1, VC2, and VC3 is that the digital block used for the Counter8_1 is saved.
2. A ‘1’ is written to Bit-7 of PRT2DR register. This is a workaround for the following condition: When the transmitter configuration is unloaded, P2[7] is still connected to the global bus and Row_0_Output3 net. When the TX8 block is unloaded from DCB02, the output P2[7] goes low. This is treated as a start bit by the PC and results in a framing error condition. To avoid this condition, before unloading the Transmitter configuration, P2[7] is disconnected from the global bus by clearing Bit-7 of PRT2GS register. The ‘1’ written to Bit-7 of PRT2DR register maintains a HIGH state on the TX pin, thus preventing the false start bit. Whenever the Transmitter configuration is loaded, P2[7] is connected to the global bus.
3. The Receiver configuration is loaded and RX8_1 is enabled with no parity.

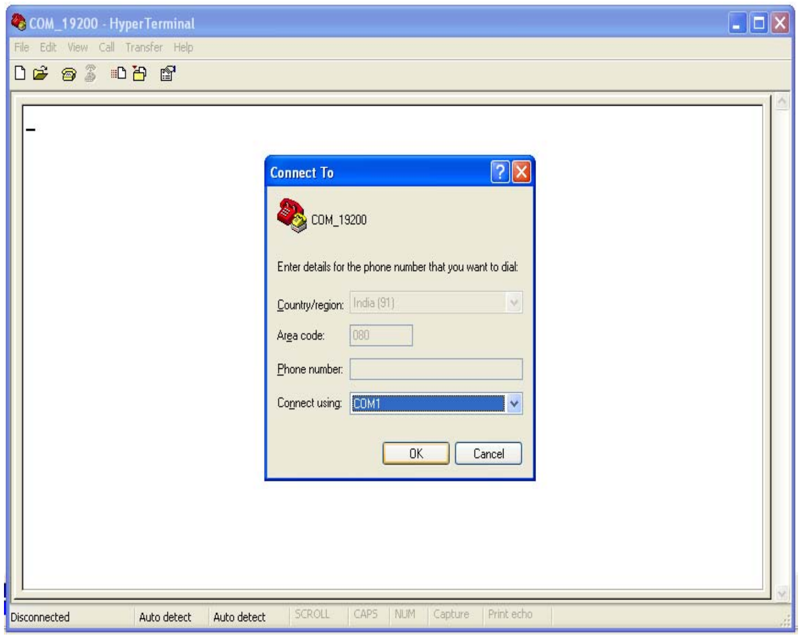
4. The RX8_1 is polled for an input character, by using the RX8_1_cGetChar function.
5. On receiving a character, the Receiver configuration is unloaded.
6. The Transmitter configuration is loaded.
7. The TX pin is connected to the global bus.
8. The received character is transmitted on the serial bus.
9. The TX pin is disconnected from the global bus.
10. The Transmitter configuration is unloaded.
11. Steps 3 to 10 are repeated in an infinite loop.

Testing the Project

HyperTerminal or any other terminal program may be used to test the project. HyperTerminal can be configured in Windows:

1. Connect the CY3210 board to the PC serial port using a serial port cable.
2. Start HyperTerminal:
   Start > Program Files > Accessories > Communication > HyperTerminal
3. Enter a name for the connection, for example “COM1_19200”, and select **OK**.
4. In the “ConnectTo” option, select a serial port (for example, COM1) from the **Connect using** drop-down list. Click **OK**.

Figure 2. Connect to COM Port



COM_19200 - HyperTerminal

Connect To

COM_19200

Enter details for the phone number that you want to dial:

Country/region: India (91)

Area code: 080

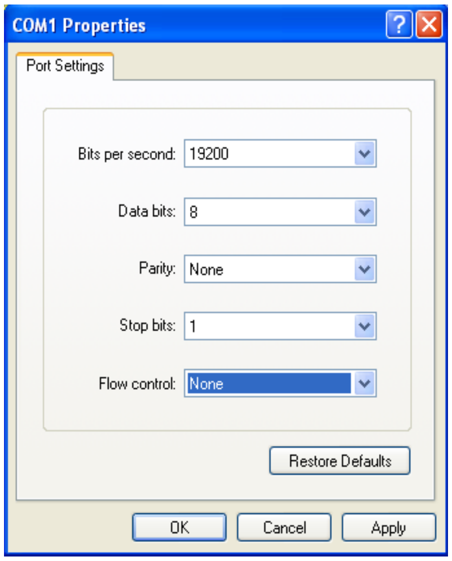
Phone number:

Connect using: COM1

5. For the COM1 properties, set the following parameters:
   - Bits per second = 19200
   - Data bits = 8
   - Parity = None
   - Stop Bits = 1
   - Flow Control = None

   Click **OK**.

Figure 3. COM1 Properties



Bits per second: 19200

Data bits: 8

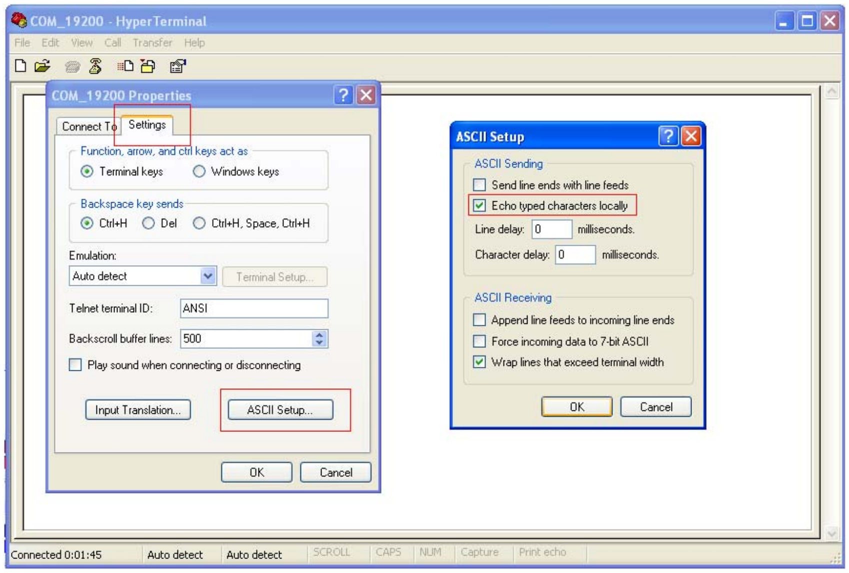
Parity: None

Stop bits: 1

Flow control: None

6. At this point, HyperTerminal connects to COM1. Set the following configurations before testing the project.
7. Click the “Disconnect” icon.
8. Select **File > Properties > Settings > ASCII Setup**.
9. Select the **Echo typed characters locally** check box.
10. Click **OK**.

Figure 4. Setting HyperTerminal for Echo Typed Characters Locally



Function, arrow, and ctrl keys act as: [✓ Terminal keys] Windows keys

Backspace key sends: [✓ Ctrl+H] Del Ctrl+H, Space, Ctrl+H

Emulation: Auto detect

Telnet terminal ID: ANSI

Backscroll buffer lines: 500

☐ Play sound when connecting or disconnecting

ASCII Sending

☐ Send line ends with line feeds

☑ Echo typed characters locally

Line delay: 0 milliseconds.

Character delay: 0 milliseconds.

ASCII Receiving

☐ Append line feeds to incoming line ends

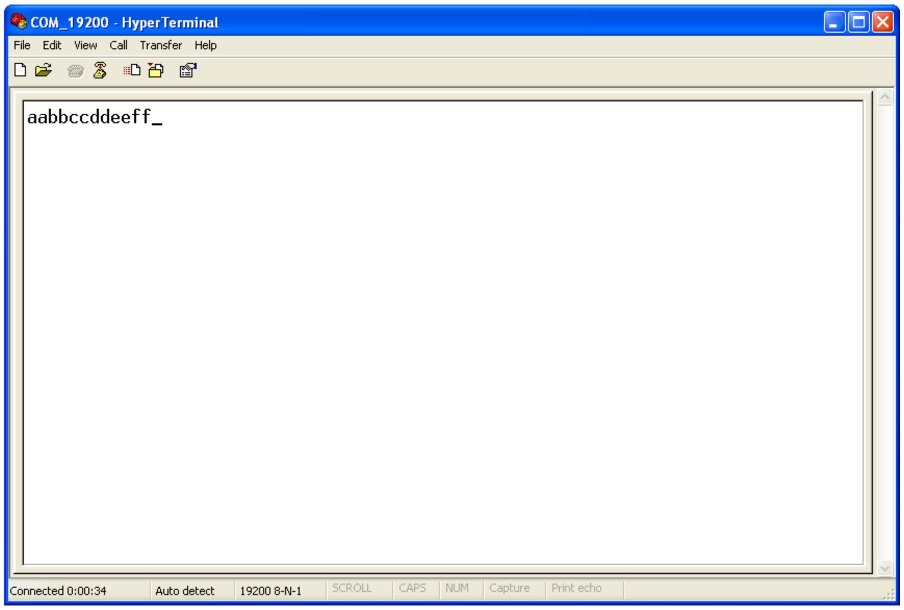
☐ Force incoming data to 7-bit ASCII

☑ Wrap lines that exceed terminal width

11. Click the “Connect” icon. HyperTerminal is now ready to be used with the UART example project.
12. Power up the CY3210 board.

Type characters and see them echoed on the HyperTerminal window. Each character is displayed twice on the HyperTerminal window. The first is the local echo and the second is the character echoed by the PSoC.

Figure 5. Echoed Characters on the HyperTerminal Window



```
aabbccddeeff_
```

Connected 0:00:34

19200 8-N-1

Document History

Document Title: Half-Duplex UART – CE52024

Document Number: 001-52024

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	2667904	GRAA	03/02/2009	New example project.
*A	3203147	PRKR	03/15/2011	Project name changed to Code Example Half_Duplex_UART. Video Training link added. Added screenshots of HyperTerminal configuration.

Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709
Phone: 408-943-2600
Fax: 408-943-4730
http://www.cypress.com/