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CIRRUS LOGIC

APPLICATION NOTE
AN–CD1

CL-CD180 Flow Control

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Scope and Applicability

This applications note explains the data flow control features of the CL-CD180. It will be useful to designers who need a more detailed description of those features and their interaction than is given in the CL-CD180 Data Sheet.

Related Documents

Reference to the CL-CD180 Preliminary Data Sheet, June, 1988, as well as the application note AN-CD2, CL-CD180 Interrupt Schemes.

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Note:
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The architecture and interrupt schemes of the CL-CD180 are patent pending.

1. INTRODUCTION

Variations in response times and real data transfer rates between systems communicating across asynchronous interfaces give rise to a need to control the flow of data between them. Systems typically work with a receive buffer, which, when nearly full prompts flow controlling of the remote transmitter. When more buffer space is available for the receive process, data flow is once more enabled. Flow control is achieved in one of two ways either through out of band or in band signaling. Out of band signaling is performed via the modem leads such as the RTS/CTS pair and has the advantage of complete independence from the data stream. However due to the many variations in the physical interface leads that are supported by different systems, and the inability to pass this information over modems, in band flow control is more popular. In band flow control has the advantage that the data circuit is always provided, except in some unidirectional equipment such as printers. The main disadvantage is that the side receiving flow control must process the data and respond in a timely manner to avoid overrun at the remote receiver. The CD180 provides significant performance advantages over conventional solutions during both the receive processing of and the transmission of flow control characters.

2. TRANSMIT FLOW CONTROL

Because the CD180 performs flow control functions before the data is passed to the Host, the Host's response time requirements in processing receive data, along with the possibility of data overrun are greatly reduced. Additionally the flow control characters themselves can be stripped from the data stream, relieving the Host from any processing of them. The status of the transmitter is maintained in the Channel Control Status Register (CCSR), and is thereby always available to the Host.

The interpretation of flow control characters is performed in the CD180 as a subset of special character processing. The Special Character Detection (SCDE) must be enabled via bit 4 of Channel Option Register 3 (COR3). This causes all error free received data to be compared for a match with the Special Character Registers (SCHR1-4). When flow control is enabled via Transmit In Band Enable (TxIBE, bit 6) of COR2, the special characters are interpreted as flow control characters. For single character flow control sequences SCHR1 is used as Xon, SCHR2 as Xoff, and SCHR3-4 as normal special detect characters. If two character sequences are enabled via XoffCH and XonCH (bits 6 and 7) of COR3, SCHR1 and SCHR3 form the Xon sequence, and SCHR2 and SCHR4 form the Xoff sequence. Having the flow control characters programmable on a per channel basis is important to support operating systems which allow users to configure their own terminal settings independently.

When flow control characters are passed to the Host they are marked as special characters 1 or 2 in the Receive Channel Status Register (RCSR). If a two character sequence is detected it is compressed to the second character and a status indicating a match of the first character is set. A valid two character sequence requires that both characters be received without error, if an error occurs on the second character the first character is treated as a normal character. If flow control character stripping is required the Flow Control Transparency bit (bit 5) in COR3 must be set, this does not affect non-flow control special character detection.

2.1 Transmit Flow Control Status

The flow control status of a channel is always available to the Host via the Channel Control Status Register (CCSR). When an Xoff character is received the Transmit Flow Off bit (TxFloff, bit 2) is set and no more data is transmitted from the fifo. When an Xon character is received TxFloff is cleared, Transmit Flow On (TxFlon, bit 1) is set, and data transmission is resumed. Whenever a character from the fifo is transmitted the TxFlon bit is cleared, this means TxFlon may only be set for a very short while. The Transmit Enabled bit (Txen, bit 3) is unaffected by flow control it is only affected by the channel control commands via the Channel Command Register (CCR).

2.2 Implied Xon Mode

When the Implied Xon Mode (IXM, bit 7) is enabled in COR2 flow control operations are performed as normal, but in addition any other receive character is treated as an implied Xon. In this mode it is assumed that if the remote is capable of transmitting data it is in a fit state to receive as well. If a character is treated as an implied Xon no special status is recorded in the RCSR, and the TxFlon bit is not set in the CCSR. An implied Xon character will not be stripped if flow control transparency is enabled.

2.3 Flow Control Toggle Mode

Toggle mode is implied in the CD180 if the Xon and Xoff characters or character sequences are equal. In this mode whenever the special character is received the current state of flow control is toggled. If not in flow control transparency mode the character is passed to the Host with special character 1 status in single character mode. In two character sequence mode the second character along with special character 1 status is passed to the Host.

3. RECEIVE FLOW CONTROL

Transmitting flow control characters is an additional complication and source of delay when using conventional devices. As the Host's receive buffer becomes full the transmit process must be flagged to insert a flow control character (or sequence) in the transmit data stream. Any data already in the transmit fifo will be transmitted ahead of the flow control increasing the response time at the remote end. The situation becomes even more difficult if some form of DMA is used for the transmit driver, where the DMA process must be interrupted and then restarted. The CD180 transmits special characters via a command in the CCR bypassing any data already in the transmit fifo, thereby providing the minimum transmit delay. Special characters are sent no matter what the current state of the channel enable or transmit flow control. This feature means that transmitting flow control characters can be handled independent of the current state of the transmit channel.

Flow control characters are transmitted via the send special character command in the Channel Control Register (CCR). The lower three bits in the command determine which of the four special characters are to be sent, if the two character sequences are enabled requesting either SCHR1 or SCHR2 causes the appropriate two character sequence to be transmitted. Special characters are transmitted regardless of the state of transmit enable or transmit flow control, if however a break is currently being transmitted the break will have to be terminated before the special character is transmitted.

3.1 Receive Flow Control Status

The CD180 keeps a copy of the current state of the receive flow in the CCSR. Whenever an Xoff is transmitted the Receive Flow off (RxFloff, bit 6) is set, when a subsequent Xon is transmitted RxFloff is cleared and RxFlon is set. When data is received from the remote RxFlon is cleared, if RxFlon remains set during normal operation it could indicate that the remote did not correctly receive the last Xon. If flow control characters are transmitted through the transmit fifo the CCSR is not affected.

4.0 EMBEDDED TRANSMIT COMMANDS

An alternative mode of flow control is sometimes performed on usually older mechanical equipment. Here a delay is inserted after certain characters such as carriage return to compensate for the mechanical recovery time. This would conventionally be accomplished by outgoing pattern recognition and the insertion of a software delay loop in which the transmitter is kept disabled. In the CD180 delays can be generated simply by inserting a command string in the data path, and enabling the Embedded Transmit Command (ETC) mode via bit 5 of COR2. A command string must start with an ascii NULL and then one of three codes. Sending 81H will cause a line break condition, 83H will terminate a line break, and

82H followed by XXH will cause a delay of XX timer periods. The timer period is set via two other registers the Prescaler Period Registers high and low (PPRh and PPRl), these two registers contain the number of CLK cycles that comprise one timer period. For accurate timer periods the value in the prescaler registers should not be set too low, (ie > 12,000).
If the ETC mode is enabled a NULL character can be transmitted by inserting an extra NULL in the data stream. Any character other than 81H, 82H or 83H following a NULL will be transmitted normally and the NULL will be ignored.

5. OUT OF BAND FLOW CONTROL

Transmit flow control out of band is performed automatically by the CD180 via the CTS pin if the CTS auto enable (CtsAE) mode is enabled in bit 1 of COR2. In this mode before a character from the fifo is transmitted the CTS pin will be tested and if inactive transmission will be delayed. Special character transmission will not be affected by this mode. In order to handshake with the remote device an RTS automatic output (RtsAO, bit 2) mode is also provided this causes the RTS pin to be activated throughout any data transmission - normal characters, break characters and special characters. The RTS pin is activated before the start bit and held active until after the last stop bit is transmitted, it will only be inactivated when the channel has been disabled via CCR or when the fifo is empty.

Receive data can be qualified with the DSR pin by enabling the DSR Automatic Enable mode (DsrAE, bit 0) in COR2. DsrAE mode causes receive data to be discarded if the DSR pin is inactive, data is discarded without performing any special character checking.

Independently to any of the above out of band features the CD180 performs a modem lead scanning function which detects either or both positive and negative going changes on any of the modem leads. Change detection is enabled via the Modem Change Option Registers (MCOR1, MCOR2), while the pins changed are recorded in the Modem Change Register (MCR) and the current pin values can be read via the Modem Signal Value Register (MSVR). Once changes are detected an interrupt will be generated by the CD180 if enabled via the corresponding bit in the Interrupt Enable Register (IER). After a modem change interrupt has been generated by the CD180 no further modem change information will be recorded until the interrupt has been processed.

