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TECHNICAL INFORMATION

Asynchronous HDLC
MC68360 ASYNC HDLC Protocol Microcode
User's Manual
Rev 1.1

January 24, 1996

Freescale Semiconductor, Inc.



MOTOROLA

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Asynchronous HDLC

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1 ASYNC HDLC Controller Overview

Asynchronous HDLC is a frame-based protocol which uses HDLC framing techniques in conjunction with UART-type characters. This protocol is typically used as the physical layer for the Point-to-Point (PPP) protocol. While this protocol can be implemented by the UART controller on the QUICC in conjunction with the CPU32+, it is more efficient and less compute-intensive for the CPU to allow the Communications Processor Module (CPM) of the QUICC to perform the framing and transparency functions of the protocol.

2 ASYNC HDLC Controller Key Features

- Flexible data buffer structure which allows an entire frame or a section of a frame to be transmitted and received.
- Separate interrupts for received frames and transmitted buffers
- Automatic CRC generation and checking (CRC-CCITT)
- Support for NMSI control signals (Carrier Detect, Clear to Send, Ready to Send)
- Automatic generation of opening and closing flags
- Reception of frames with only one “shared” flag
- Automatic generation and stripping of transparency characters according to RFC 1549 utilizing transmit and receive control character maps.
- Automatic transmission of the ABORT sequence (0x7D,0x7E) after the STOP TRANSMIT command is issued.
- Automatic transmission of IDLE characters between frames and characters.
- “Small” RAM Microcode (consumes 768 bytes of Dual-Port RAM)

2.1 ASYNC HDLC Channel Frame Transmission Processing

The ASYNC HDLC Controller is designed to work with a minimum amount of intervention from the CPU32+ core. It operates in a similar fashion to the HDLC controller on the QUICC.

When the core enables one of the transmitters and sets the ready (R) bit in the first Buffer Descriptor, the ASYNC HDLC Controller fetches the data from memory and start transmitting the frame (after transmitting the opening flag). When the controller reaches the end of the current BD, the CRC and the closing flag are appended if the last (L) bit in the Tx BD is set. If the continuous mode (CM) bit is clear, the ASYNC HDLC transmitter writes the frame status bits into the BD and clears the ready bit. If the interrupt (I) bit is set, the controller sets the TXB event bit in the event register. Thus, the I bit may be used to generate an interrupt after each buffer, after a group of buffers, or after each complete frame has been transmitted.

If the CM bit in the Tx BD is set, the ASYNC HDLC controller will write the signal unit status bits into the BD after transmission but it will not clear the ready bit.

The ASYNC HDLC controller will then proceed to the next Tx BD in the table. If it is not ready, the ASYNC HDLC controller will wait until the Tx BD is ready.

While the ASYNC HDLC controller is transmitting data from the buffers, it automatically performs the transparency encoding specified by the protocol. This encoding is described in detail in section 2.3 on page 5.

If the user wishes to re-arrange the transmit queue before the Communications Processor (CP) has completed transmission of all buffers, the user should issue the STOP TRANSMIT command. This can be useful for transmitting expedited data prior to previously linked buffers or for error situations. The ASYNC HDLC controller, when receiving the STOP TRANSMIT command, will stop transmitting and will send the ASYNC HDLC ABORT sequence (0x7d, 0x7e). It will then transmit IDLE characters until the RESTART TRANSMIT command is given, at which point it will resume transmission with the next Tx BD.

2.2 ASYNC HDLC Channel Frame Reception Processing

The ASYNC HDLC receiver is also designed to work with a minimum amount of intervention from the CPU32+ core. The ASYNC HDLC receiver can perform the decoding of the transparency characters, check the CRC of the frame, and detect errors on the line and in the controller.

When the core enables one of the receivers, the receiver waits for data to be present on the line. When the receiver detects a data byte of the incoming frame, the ASYNC HDLC controller fetches the next buffer descriptor (BD) and, if the empty (E) bit is set, starts transferring the incoming frame into the BD's associated data buffer. When the data buffer is full, the ASYNC HDLC controller clears the empty bit in the BD. If the incoming frame exceeds the length of the data buffer (as defined in the MRBLR parameter), the ASYNC HDLC controller fetches the next BD in the table and, if empty, continues to transfer the rest of the frame into this BD's associated data buffer.

During this process, the receiver will automatically perform the transparency character decoding required of the ASYNC HDLC protocol. This procedure is described in detail in section section 2.4 on page 6.

When the frame ends, the controller checks the incoming CRC field and writes it to the data buffer. It then writes the length of the entire frame to the data length field of the last BD. The ASYNC HDLC controller sets the last (L) bit, writes the frame status bits into the BD, and clears the empty bit if the continuous mode (CM) bit is clear. It then sets the RXF bit in the event register indicating that a frame has been received and is in memory. The ASYNC HDLC controller then waits for the start of the next frame which may, or may not, have an opening FLAG.

2.3 Transmitter Transparency Encoding

The ASYNC-HDLC Controller maps characters according to RFC 1549. It will examine the outgoing data bytes and perform the transparency algorithm on a given byte if it matches one of the following criteria:

- The byte is a FLAG (0x7E)
- The byte is a Control-Escape Character (0x7D)

- The byte has a value between 0x00 and 0x1F and the corresponding bit in the TX Control Character Table is set.

If the outgoing byte matches one of these three criteria, a two-byte sequence is transmitted in place of the byte. This sequence consists of the Control-Escape Character (0x7D) followed by the original byte exclusive-or'ed with 0x20.

For more information on the transparency algorithm, please see the references in Appendix C - References.

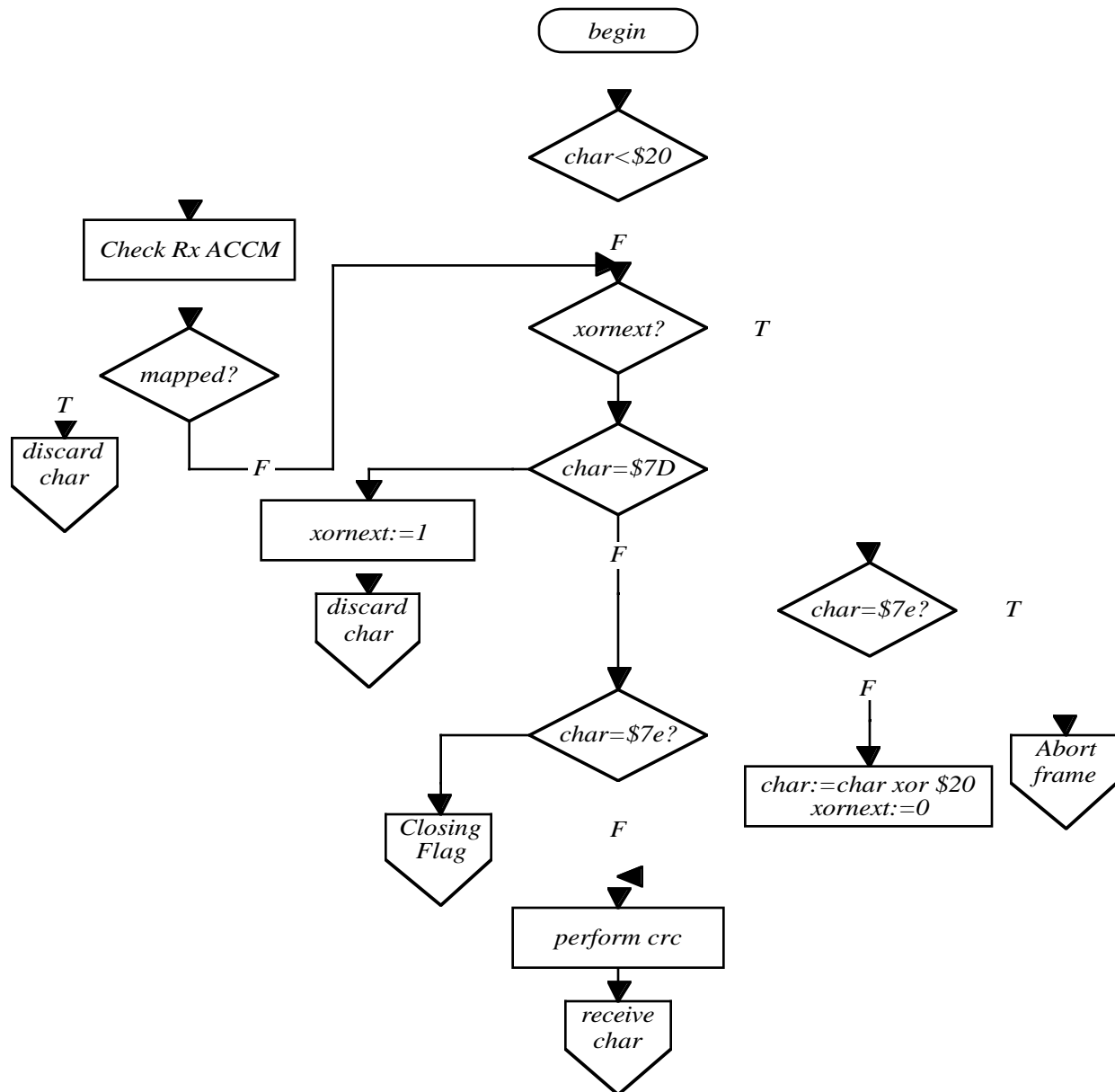
2.4 Receiver Transparency Decoding

The ASYNC-HDLC Controller maps characters according to RFC 1549. It will examine the incoming data bytes and perform the transparency algorithm to recover the original data. The algorithm does the following:

- Discards any character that has its corresponding bit set in the RX Control Character Map. This character is assumed to have been inserted in the character stream by an intermediate device and thus not be part of the originally transmitted frame.
- Reverses the transmission transparency sequence by discarding a received Control-Escape Character (0x7D) and exclusive-or'ing the following byte with 0x20 before performing the CRC calculation and writing the byte into memory.

For more information on the transparency algorithm, please see the references in Appendix C - References.

The receive Flow-chart is shown below to detail the algorithm because there are some cases which are not addressed in the RFC.

2.4.1 Receive Flowchart

2.4.2 Cases not covered by RFC 1549

The following cases are not covered by RFC 1549.

- If an 0x7D is followed by a control character, and the control character is NOT mapped, the control character itself will be “modified” by the xor process. It is assumed that this will be caught by the CRC check.
- In addition to the Abort sequence, frames will be terminated by following errors:
 - Noisy Character received

- Carrier Detect Lost
- Receiver Overrun
- If the invalid sequence (0x7D, 0x7D) is received, the first control escape character will be discarded and the second will be unconditionally exclusive-or'ed with 0x20. This sequence will thus be stored in the buffer descriptor as (0x5D).

2.5 Implementation Specifics related to Asynchronous HDLC

2.5.1 FLAG sequence

When transmitting, the controller automatically generates the opening and closing flag for the frame.

When receiving, the controller strips off the opening and closing FLAG before writing the frame to memory. It will receive frames with only one “shared” flag between them. It will also ignore multiple flags between frames.

2.5.2 Address Field

The address field is neither generated nor examined by the microcode while transmitting or receiving. The address field of the frame must be included in the data buffer pointed to by the transmit buffer descriptor. Any address field compression, expansion, or checking must be performed by the core.

2.5.3 Control Field

The control field is neither generated nor examined by the microcode while transmitting or receiving. The control field of the frame must be included in the data buffer pointed to by the transmit buffer descriptor. Any control field compression, expansion, or checking must be performed by the core.

2.5.4 Frame Check Sequence

When transmitting, the frame check sequence (CRC) is automatically appended to the end of the frame prior to transmission of closing flag. The frame check sequence is generated on the original frame before addition of transparency characters, start/stop bits, or flags. The controller will only use a 16-bit CRC-CCITT polynomial.

When receiving, the frame check sequence is automatically checked. The frame check sequence is calculated after removal of any transparency characters, start/stop bits, and flags. The controller will only use a 16-bit CRC-CCITT polynomial.

2.5.5 Encoding

The Asynchronous-HDLC controller only supports 8 data bits, one start bit, one stop bit, and no parity.

2.5.6 Time-Fill

When transmitting, the Asynchronous HDLC controller will transmit IDLE characters (characters consisting of only “1”s) when no data is available for transmission.

When receiving, the Asynchronous HDLC controller will ignore any IDLE characters.

3 Microcode Use

The Asynchronous HDLC microcode must be loaded into QUICC DPRAM at initialization time. It is a 'small' (512 byte) microcode and thus will consume the memory area from DPR-BASE + \$000 to DPRBASE + \$1FF. In addition, the "Microcode Scratch" area of the memory map from DPRBASE + \$600 to DPRBASE + \$6FF will be inaccessible to the user. (See Section 3.1 of the MC68360 User's Manual for more information.)

The memory areas listed above are physically locked once the ERAM bit is set in the RCCR register. Thus, any reads or writes to that area by the CPU32+ will have no effect on memory or the microcode.

3.1 Initialization Procedure

See Appendix A - Microcode Initialization Procedure, for instructions on how to load and initialize the microcode.

3.2 Performance

At 25Mhz, an aggregate Asynchronous HDLC data rate of 3 Mbps divided among the 4 SCCs consumes 100% of the processing power of the RISC communications engine. If only a percentage of the total available Asynchronous HDLC data rate is used, the remaining RISC processing power can be used to run other protocols on other channels. The following table illustrates some example configurations of the QUICC using the ASYNC-HDLC microcode. This table can be used in conjunction with the table in Appendix A of the MC68360 User's Manual to determine if your desired configuration can be handled by the QUICC.

AHDLC Channels	Risc Bandwidth Consumed (est)	Possible Configuration of Other Channels
1 x 115 Kbit/s	4%	1 x 10Mbit Ethernet, 2 x 1.5 Mbit HDLC, 9.6 Kbit SMC UART
2 x 230 Kbit/s	15%	1 x 10Mbit Ethernet, 1 x 1.5 Mbit HDLC, 9.6 Kbit SMC UART
3 x 230 Kbit/s	24%	1 x 5Mbit HDLC, 2 x 9.6 Kbit SMC UART

The "Risc Bandwidth Consumed" column indicates the amount of RISC bandwidth being consumed by the ASYNC HDLC controller only.

4 ASYNC HDLC Memory Map

4.1 ASYNC HDLC-Specific Parameters

When configured to operate in ASYNC HDLC mode, the QUICC overlays the structure illustrated listed in Table 7-5 with the ASYNC HDLC-specific parameters described in Table 1.

Table 1. ASYNC HDLC-Specific Parameters

Address	Name	Width	Description
SCC Base+34	C_MASK	Long	CRC Constant
SCC Base+38	C_PRES	Long	CRC Preset
SCC Base+3C		Word	
SCC Base+3E		Word	
SCC Base+40		Word	
SCC Base+42	Reserved	Word	
SCC Base+44	Reserved	Word	

Table 1. ASYNC HDLC-Specific Parameters

Address	Name	Width	Description
SCC Base+46	Zero	Word	Must be initialized to zero by user
SCC Base+48	Reserved	Word	
SCC Base+4A	RFTHR	Word	Received Frames Threshold
SCC Base+4C	Reserved	Word	
SCC Base+4E	Reserved	Word	
SCC Base+50	TXCTL_TBL	Long	TX Control Character Mapping Table
SCC Base+54	RXCTL_TBL	Long	RX Control Character Mapping Table
SCC Base+58		Word	
SCC Base+5A		Word	

Note: Entries in boldface must be initialized by the user.

Reserved

These areas are temporary storage locations for the microcode. They need not be initialized and should never be modified.

C_MASK

This value should be initialized with \$0000F0B8.

C_PRES

This value should be initialized with \$0000FFFF.

Zero

This field must be set to zero by the user.

RFTHR

Received Frames Threshold. This indicates how many frames will be received before the RXF bit is set in the event register.

TXCTL_TBL

Transmit Control Character Table. This stores the bit array used for the TX Control Character Table. Each bit corresponds to a character that should be mapped according to RFC 1549. If the bit is set, the character corresponding to that bit will be mapped. If the bit is not set, the character corresponding to that bit will not be mapped.



RXCTL_TBL

Receive Control Character Table. This stores the bit array used for the RX Control Character Table. Each bit corresponds to a character that should be mapped according to RFC 1549. If the bit is set, the character corresponding to that bit will be discarded if received. If the bit is not set, the character corresponding to that bit will be received normally.



4.2 Configuring the General SCC Parameters

The general SCC parameters can be configured as described on pages 7-112 through 7-131 of the QUICC User's Manual except for the following changes:

4.2.1 GSMR Register

The General SCC Mode Register bits are the same except for:

RFW—Rx FIFO Width

- 0— Should not be used
- 1— Low-latency operation. The Rx FIFO is 8-bits wide, and the receive FIFO is one fourth its normal size (8 bytes for SCC1 and 4 bytes for the other SCCs). This allows data to be written to the data buffer each time a character is received, without waiting for 32 bits to be received. This configuration must be chosen for character-oriented protocols such as UART, BISYNC, and ASYNC-HDLC.

TDCR—Transmit Divide Clock Rate

The TDCR bits determine the divider rate of the transmitter. If the DPLL is not used, the 1x value should be chosen, except in asynchronous UART mode or Asynchronous-HDLC mode where 8x, 16x, or 32x must be chosen. The user should program TDCR to equal RDCR in most applications.

- 00— do not use
- 01— 8x clock mode
- 10— 16x clock mode
- 11— 32x clock mode

RDCR—Receive DPLL Clock Rate

The RDCR bits determine the divider rate of the receive DPLL. If the DPLL is not used, the 1x value should be chosen, except in asynchronous UART mode or Asynchronous-HDLC mode where 8x, 16x, or 32x must be chosen. The user should program RDCR to equal TDCR in most applications.

- 00— do not use
- 01— 8x clock mode
- 10— 16x clock mode
- 11— 32x clock mode

4.2.2 DSR Register

The SCC Data Synchronization Register is reserved in Asynchronous-HDLC mode. It should be set to zero.

5 ASYNC HDLC Programming Model

The core configures each SCC to operate in one of the protocols by setting the MODE bits in the GSMR. The ASYNC HDLC controller uses the same data structure as in the other protocols. This data structure supports multi-buffer operation.

The receive errors are reported through the Rx BD. The transmit errors are reported through the Tx BD. An indication about the status lines (\overline{CD} and \overline{CTS}) is reported through the port C

pins. A maskable interrupt may be generated upon a status change in either one of those lines.

5.1 ASYNC HDLC Command Set

The following commands are issued to the Command Register (CR) documented in Section 7.1 of the MC68360 User's Manual.

5.1.1 Transmit Commands

After a hardware or software reset and the enabling of the channel in the SCC mode register, the channel is in the transmit enable mode and starts polling the first BD in the table every 8 transmit bit-times, or immediately if the TOD bit in the TODR is set.

***STOP TRANSMIT* Command**

The *STOP TRANSMIT* command transmits the Asynchronous HDLC ABORT sequence (\$7d, \$7e) and then disables the transmission of data. If this command is received by the ASYNC HDLC controller during frame transmission, the ABORT sequence will be placed into the FIFO and the transmitter will not attempt to send any more data from the current Tx BD. The controller does not advance to the next Tx BD. You can determine which BD was terminated by examining the TBPTR entry in the SCC parameter RAM table. No new BD will be accessed for this channel.

Note

Unlike the other QUICC protocols, the Asynchronous HDLC controller does not flush the FIFO due to the *STOP TRANSMIT* command. Thus, up to 16 characters (32 on SCC1) may be transmitted before the ABORT sequence is transmitted. This can be avoided by programming TFL to 1 in the GSMR register.

***GRACEFUL STOP TRANSMIT* Command**

This command is not supported by the Asynchronous HDLC controller.

***RESTART TRANSMIT* Command**

The *RESTART TRANSMIT* command re-enables the transmission of characters on the transmit channel. This command is expected by the ASYNC HDLC controller after a *STOP TRANSMIT* command or after a transmitter error. The ASYNC HDLC controller will resume transmission from the first character in the current transmitter BD (TBPTR) in the channel's transmit BD table.

***INIT TX PARAMETERS* Command**

Initializes all the transmit parameters in this serial channel's parameter RAM to their reset state. This command must be issued before the transmitter is enabled for the first time. This command should only be issued when the transmitter is disabled. Note that the *INIT TX AND RX PARAMETERS* command may also be used to reset both transmit and receive parameters.

5.1.2 Receive Commands

After a hardware or software reset and the enabling of the channel by its SCC mode register, the channel is in the receive enable mode and will use the first BD in the table.

***ENTER HUNT MODE* Command**

This command is not supported by the ASYNC HDLC controller.

***CLOSE RX BD* Command**

This command is not supported by the ASYNC HDLC controller.

***INIT RX PARAMETERS* Command**

This command initializes all the receive parameters in this serial channel's parameter RAM to their reset state. This command should only be issued when the receiver is disabled. Note that the *INIT TX AND RX PARAMETERS* command may also be used to reset both receive and transmit parameters.

5.2 ASYNC HDLC Error Handling Procedure

The ASYNC HDLC controller reports frame reception and transmission error conditions using the channel BDs and the ASYNC HDLC event register.

5.2.1 Transmission Errors

CTS Lost During Frame Transmission

When this error occurs, the channel terminates buffer transmission, closes the buffer, sets the Clear to Send lost (CT) bit in the Tx BD, and sets the TXE bit in the SCC Event Register. The channel will resume transmission from the next Tx BD after the RESTART TRANSMIT command is given.

5.2.2 Reception Errors

Overrun Error

The ASYNC HDLC controller maintains an internal 32 byte FIFO in SCC1 and 16 byte FIFO in the other SCCs for receiving data. A receive overrun occurs when the Communications Processor (CP) was unable to keep up with the data rate or the SDMA channel was unable to write the received data to memory. The previous data byte and the frame status are lost. The controller closes the buffer with the overrun (OV) bit in the BD set and sets the RXF bit in the SCC Event Register. The receiver then searches for the next frame.

Note

Unlike the HDLC Controller, the ASYNC HDLC controller will not search for an opening flag after this error occurs. It will start receiving again as soon as possible. Thus, the next frame received will probably not be a complete frame.

CD Lost During Frame Reception

When this error occurs, the channel terminates frame reception, closes the buffer, sets the Carrier Detect lost (CD) bit in the BD, and sets the RXF bit in the event register. This error

has the highest priority. The rest of the frame is lost and other errors are not checked in that frame. The receiver then searches for the next frame once CD is reasserted.

Abort Sequence

An abort sequence is detected by the ASYNC HDLC controller when the ABORT sequence is received (0x7d followed by 0x7e). When this error occurs, the channel closes the buffer (if it was already open) by setting the Rx Abort Sequence (AB) bit in the BD and sets the RXF bit in the SCC Event Register. The CRC error status condition is not checked on aborted frames. If the ABORT sequence was received and no frame was currently being received, the next BD will be opened and then closed with the AB bit set.

CRC Error

When this error occurs, the channel writes the received CRC (Cyclic Redundancy Check) to the data buffer, closes the buffer, sets the CR bit in the BD, and sets the RXF bit in the SCC Event Register. After receiving a signal unit with a CRC error, the receiver prepares to receive the next frame.

Break Sequence Received

This occurs when the UART receiver detects the first character of a break sequence (one or more all-zero characters). When this error occurs, the channel closes the buffer (if it was already open) by setting the Rx Break Sequence (BRK) bit in the BD, and sets the RXF bit in the SCC Event Register. The CRC error status condition is not checked. If the Break sequence was received and no frame was currently being received, the next BD will be opened and then closed with the BRK bit set.

6 Registers

6.1 ASYNC HDLC Event Register

The SCCE register for an SCC is called the ASYNC HDLC Event Register when the SCC is operating in Asynchronous HDLC mode. The ASYNC HDLC Event Register is a 16-bit register which is used to report events recognized by the ASYNC HDLC channel and generate interrupts. Upon recognition of an event, the ASYNC HDLC controller will set the corresponding bit in the ASYNC HDLC event register. Interrupts generated by this register may be masked by the ASYNC HDLC mask register.

The ASYNC HDLC event register is a memory-mapped register that may be read at any time. A bit is cleared by writing a one (writing a zero does not affect a bit's value). More than one bit may be cleared at a time. All unmasked bits must be cleared before the CP will clear the internal interrupt request. This register is cleared at reset.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-		GLr	GLt		-	IDL		-		TXE	RXF	BSY	TXB	RXB

bits 15-13, 10-9, 7-5—Reserved, should be written with zeros.

GLr—Glitch on Rx

A clock glitch was detected by this SCC on the receive clock

GLt—Glitch on Tx

A clock glitch was detected by this SCC on the transmit clock

IDL—Idle Sequence Status Changed

A change in the status of the serial line was detected. The real-time status of the line may be read in SCCS.

TXE—Tx Error

An error (CTS lost) occurred on the transmitter channel.

RXF—Rx Frame

A complete frame has been received on the ASYNC HDLC channel. This bit is set no sooner than two bit times after the receipt of the last bit of the closing flag.

BSY—Busy Condition

A frame was received and discarded due to lack of buffers.

TXB—Transmit Buffer

A buffer that had its I bit set has been transmitted on the ASYNC-HDLC channel. This bit is set no sooner than when the last bit of the closing flag begins its transmission if the buffer is the last one in the frame. Otherwise, this bit is set after that last byte of the buffer has been written to the transmit FIFO.

RXB—Rx Buffer

A Buffer has been received over the ASYNC-HDLC channel that had its I bit set but not the L bit.

6.2 ASYNC HDLC Mode Register (PSMR)

Each ASYNC HDLC mode register is a 16-bit, memory-mapped, read-write register that controls SCC operation. The term ASYNC HDLC mode register refers to the PSMR of the SCC when that SCC is configured in ASYNC HDLC mode.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FLC	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Bits 14,11-0—Reserved, must be set to zero.

Bits 13,12—Reserved, must be set to one.

FLC—Flow Control

0— Normal Operation.

1— Asynchronous flow control. When the $\overline{\text{CTS}}$ pin is negated, the transmitter will stop transmitting at the end of the current character. (If $\overline{\text{CTS}}$ is negated past the middle

of the current character, the next full character may be sent, and then transmission will be stopped.) When \overline{CTS} is asserted once more, transmission will continue where it left off. No \overline{CTS} lost error will be reported. No characters except idles will be transmitted while \overline{CTS} is negated.

7 ASYNC-HDLC Rx Buffer Descriptor

The ASYNC-HDLC controller uses the Rx BD to report information about the received data for each buffer. An example of the Rx BD process is shown in Figure 7-52 of the User's Manual.

The first word of the Rx BD contains control and status bits. Bits 12 to 15 and bit 9 are written by the user; bits 0-7 and 10-11 are set by the CP following frame reception. Bit 15 is set by the core when the buffer is available to the ASYNC HDLC controller, and it is cleared by the ASYNC HDLC controller when the buffer is full. The format of the control and status word is detailed below.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OFFSET + 0	E	-	W	I	L	F	CM	-	BRK	-	-	I	AB	CR	OV	CD
OFFSET + 2	DATALENGTH															
OFFSET + 4	RX DATA BUFFER POINTER															
OFFSET + 6																

Note: Entries in boldface must be initialized by the user.

E—Empty

- 0— The data buffer associated with this BD has been filled with received data, or data reception has been aborted due to an error condition. The CPU32+ core is free to examine or write to any fields of this Rx BD. The CP will not use this BD again while the E-bit remains zero.
- 1— The data buffer associated with this BD is empty, or reception is currently in progress. This Rx BD and its associated receive buffer are owned by the CP. Once the E-bit is set, the CPU32+ core should not write any fields of this Rx BD.

Bits 14, 8, 6-4—Reserved, should be set to zero

W—Wrap (Final BD in Table)

- 0— This is not the last buffer descriptor in the Rx BD table.
- 1— This is the last buffer descriptor in the Rx BD table. After this buffer has been used, the CP will receive incoming data into the first BD in the table (the BD pointed to by RBASE). The number of Rx BDs in this table is programmable, and is determined only by the W-bit and the overall space constraints of the dual-port RAM.

I—Interrupt

- 0— The RXB bit in the ASYNC HDLC Event Register will not be set after this buffer has been used, but RXF operation remains unaffected.
- 1— The RXB or RXF bit in the ASYNC HDLC Event Register will be set when this buffer has been used by the ASYNC HDLC controller.

L—Last in frame

This bit is set by the ASYNC HDLC controller when this buffer is the last in a frame. This implies the reception of a closing flag or reception of an error, in which case one or more of the BRK, CD, OV, and AB bits are set. The ASYNC HDLC controller will write the number of frame octets to the data length field.

- 0— This buffer is not the last in a frame.
- 1— This buffer is the last in a frame.

F—First in frame

This bit is set by the ASYNC-HDLC controller when this buffer is the first in a frame.

- 0— The buffer is not the first in a frame.
- 1— The buffer is the first in a frame.

CM—Continuous Mode

- 0— Normal operation.
- 1— The E-bit is not cleared by the CP after this BD is closed, allowing the associated data buffer to be overwritten automatically when the CP next accesses this BD. However, the E-bit will be cleared if an error (other than CRC error) occurs during reception, regardless of the CM bit.

BRK—Break Character Received

The current frame was closed because a Break Character was received.

AB—Rx Abort Sequence

The ASYNC HDLC Abort Sequence or a framing error was received to terminate this frame.

CR—Rx CRC Error

This frame contains a CRC error. The received CRC bytes are always written to the receive buffer.

OV—Overrun

A receiver overrun occurred during frame reception.

CD—Carrier Detect Lost

The carrier detect signal was negated during frame reception.

Data Length

Data length is the number of octets written by the CP into this BD's data buffer. It is written by the CP once as the BD is closed.

When this BD is the last BD in a frame (L=1), the data length contains the total number of frame octets (including the 2 bytes for CRC).

Note

If the received frame has a length (plus CRC) which is an exact multiple of MRBLR, the BD with the "L" bit set will not actually

have any characters in it and the “Data Length” field will contain a value equal to the sum of the “Data Length” fields of the other buffer descriptors in the frame.

The actual amount of memory allocated for this buffer should be greater than or equal to the contents of the MRBLR.

Rx Data Buffer Pointer

The receive buffer pointer, which always points to the first location of the associated data buffer, may reside in either internal or external memory.

8 ASYNC-HDLC Tx Buffer Descriptor

Data is presented to the ASYNC-HDLC controller for transmission on an SCC channel by arranging it in buffers referenced by the channel’s TX BD table. The HDLC controller confirms transmission (or indicates error conditions) using the BDs to inform the CPU32+ core that the buffers have been serviced.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OFFSET + 0	R	-	W	I	L	-	CM	-	-	-	-	-	-	-	-	CT
OFFSET + 2	DATALENGTH															
OFFSET + 4	TX DATA BUFFER POINTER															
OFFSET + 6																

Note: Entries in boldface must be initialized by the user

R—Ready

- 0— The data buffer associated with this BD is not ready for transmission. The user is free to manipulate this BD or its associated data buffer. The CP clears this bit after the buffer has been transmitted or after an error condition is encountered.
- 1— The data buffer, which has been prepared for transmission by the user, has not been transmitted or is currently being transmitted. No fields of this BD may be written once this bit is set.

Bits 14, 10, 8-1—Reserved, should be set to zero

W—Wrap (Final BD in Table)

- 0— This is not the last buffer descriptor in the Tx BD table.
- 1— This is the last buffer descriptor in the Tx BD table. After this buffer has been used, the CP will transmit from the first BD in the table (the BD pointed to by TBASE). The number of Tx BDs in this table is programmable, and is determined only by the W-bit and the overall space constraints of the dual-port RAM.

I—Interrupt

- 0— The TXB bit in the ASYNC HDLC Event Register will not be set after this buffer has been used.
- 1— The TXB bit in the ASYNC HDLC Event Register will be set when this buffer has been transmitted by the ASYNC HDLC controller.

L—Last

- 0— This is not the last buffer in the current frame.
- 1— This is the last buffer in the current frame. The proper CRC and closing FLAG will be transmitted following the transmission of the last data byte.

CM—Continuous Mode

- 0— Normal operation.
- 1— The R-bit is not cleared by the CP after this BD is closed, allowing the associated data buffer to be retransmitted automatically when the CP next accesses this BD. However, the R-bit will be cleared if an error occurs during transmission, regardless of the CM bit.

The following status bits are written by the ASYNC HDLC controller after it has finished transmitting the associated data buffer.

CTS— $\overline{\text{CTS}}$ Lost

$\overline{\text{CTS}}$ in NMSI mode was lost during frame transmission. If data from more than one buffer is currently in the FIFO when this error occurs, this bit will be set in the TX BD that is currently open.

Data Length

Data length is the number of bytes the ASYNC-HDLC controller should transmit from this BD's data buffer. It is never modified by the CP. The value of this field must be greater than zero.

Tx Data Buffer Pointer

The transmit buffer pointer, which contains the address of the associated data buffer, may be even or odd. The buffer may reside in either internal or external memory. This value is never modified by the CP.

9 Differences Between HDLC and ASYNC-HDLC

In order to fit this controller into the “small” microcode area, various compromises had to be made. Thus, the ASYNC HDLC controller does not work exactly like the standard HDLC controller. This section details some of the differences.

9.1 Max Received Frame Length Counter

There is no maximum received frame length counter in the ASYNC-HDLC controller. Therefore, the controller will receive ALL characters between opening and closing flags. There is no way to have the controller stop writing to memory. This in no way affects the number of bytes received into a specific buffer descriptor. This just means that a frame that is over the maximum length will be received into memory in its entirety.

9.2 Frame termination due to error

If frame reception terminates due to an error condition (CD lost, Overrun, break character received), the character being received at the time that the error occurred will not be written into memory. For example, if a CD lost error occurred, the frame will be closed and the par-

tial character will NOT be written to memory, (and thus the octet count will only reflect the number of bytes written to memory).

9.3 Commands

The following commands are not supported:

- GRACEFUL STOP TRANSMIT
- ENTER HUNT MODE

9.4 Automatic Error Counters

The Automatic Error Counters in HDLC mode (CRCEC, ABTEC, etc..) have not been implemented in ASYNC-HDLC.

9.5 Noisy Characters

Noisy characters (those whose three samples are not the same) are not accounted for in this controller. It is assumed that the CRC will catch any data integrity problems.

Appendix A - Microcode Initialization Procedure

The initialization procedure and S-Record will vary depending upon the QUICC ROM revision that the microcode was written for. Be sure to check the Rev_Num register in the Misc_Base area to determine which S-Record to load.

A.1 Initialization Procedure for QUICC Version \$0001

Revision \$0001 silicon can be identified by a value of \$0001 in the Rev_Num register.

1. Download the supplied S-Record for version \$001 onto the QUICC that is going to be running the ASYNC-HDLC microcode package. The S-Record was created assuming that the base of Dual-Port RAM on the selected QUICC starts at \$20000. If this is not the case, you will have to either modify the S-Record or extract the data from the S-Record and load it using some other method.
2. Write \$806C to REGB + \$5CC (CPCR1)
3. Write \$804C to REGB + \$5CE (CPCR2)
4. Write \$0000 to REGB + \$5D0 (CPCR3)
5. Write \$0000 to REGB + \$5D2 (CPCR4)
6. Write \$0001 to the RCCR register
7. Write \$8000 to the CR register

Note

If the QUICC is ever reset (by RESETS or RESETH), the microcode must be reloaded and reinitialized.

A.2 Initialization Procedure for QUICC Revision \$0002

Revision \$0002 silicon can be identified by a value of \$0002 in the Rev_Num register.

1. Download the supplied S-Record for version \$0002 onto the QUICC that is going to be running the ASYNC-HDLC microcode package. The S-Record was created assuming that the base of Dual-Port RAM on the selected QUICC starts at \$20000. If this is not the case, you will have to either modify the S-Record or extract the data from the S-Record and load it using some other method.
2. Write \$806C to REGB + \$5CC (CPCR1)
3. Write \$804C to REGB + \$5CE (CPCR2)
4. Write \$0000 to REGB + \$5D0 (CPCR3)
5. Write \$0000 to REGB + \$5D2 (CPCR4)
6. Write \$0001 to the RCCR register
7. Write \$8000 to the CR register

Note

If the QUICC is ever reset (by RESETS or RESETH), the microcode must be reloaded and reinitialized.

A.3 Initialization Procedure for QUICC Version \$0003

Revision \$0003 silicon can be identified by a value of \$0003 in the Rev_Num register.

1. Download the supplied S-Record for Rev \$0003 onto the QUICC that is going to be running the ASYNC-HDLC microcode package. The S-Record was created assuming that the base of Dual-Port RAM on the selected QUICC starts at \$20000. If this is not the case, you will have to either modify the S-Record or extract the data from the S-Record and load it using some other method.
2. Write \$806C to REGB + \$5CC (CPCR1)
3. Write \$804C to REGB + \$5CE (CPCR2)
4. Write \$0000 to REGB + \$5D0 (CPCR3)
5. Write \$0000 to REGB + \$5D2 (CPCR4)
6. Write \$0001 to the RCCR register
7. Write \$8000 to the CR register

Note

If the QUICC is ever reset (by RESETS or RESETH), the microcode must be reloaded and reinitialized.

Appendix B - Programming Example

The following list is a suggested initialization sequence when using ASYNC-HDLC. This assumes that you have already followed the initialization procedure in Section 3.1.

1. Initialize the SDCR register.
2. Configure Port A and Port C pins to enable RXD, TXD, $\overline{\text{CTS}}$, $\overline{\text{CD}}$, and $\overline{\text{CTS}}$. (This assumes you are using NMSI mode. If not, appropriately configure the time slot assigner and TSA pins)
3. Configure a BRG to generate appropriate channel clocking frequency.
4. Program the SICR to route the BRG clocking to the SCC running ASYNC-HDLC.
5. Select whether the channel is using the Time Slot Assigner or the NMSI pins in the SICR.
6. Write RBASE and TBASE in the SCC's parameter RAM to point to the first RxBd and the first TxBD. (note that they cannot reside in the locked areas described in Section 3)
7. Issue the INIT RX & TX PARAMETERS command for that SCC.
8. Program RFCR and TFCR.
9. Write MRBLR with the maximum receive buffer size.
10. Write C_MASK and C_PRES with the standard values.
11. Write the "zero" register to 0x0000.
12. Program the RFTHR register to the number of frames that should be received before an interrupt is generated.
13. Program the TX and RX Control Character Tables.
14. Initialize all RxBd's.
15. Initialize all TxBD's.
16. Clear the SCCE register by writing \$FFFF to it.
17. Program the SCCM register with the proper mask to allow all desired interrupts.
18. Program the GSMR_H. (see Section 4.2.1)
19. Program the GSMR_L register to ASYNC HDLC mode, but do not turn on the transmitter or receiver.
20. Set the PSMR register appropriately. (see Section 6.2)
21. Turn on the transmitter and receiver in the GSMR_L register.

Appendix C - References

- [1] "RFC 1549 - PPP in HDLC Framing", W. Simpson, December 1993.
- [2] "RFC 1548 - The Point-to-Point Protocol (PPP)", W. Simpson, December 1993.

These two documents can be obtained via anonymous FTP from *nic.ddn.mil* in the */rfc* directory.