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ABSTRACT and CONTENTS

This is a specification of all of the calls that can be made on the CHIO by the CPU. It also specifies under what conditions a CPU program will be awakened by the CHIO. Required initialization procedure is also covered.

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General Information about CPU calls

Calls from the CPU to the CHIO may only occur if the request waiting flag (RWCH) is off. This flag must be turned on as part of the request (the CHIO will turn it off on completion). Since the CHIO may reference the CPU interface table (CPUIT) at any time while it is processing a request, the CPU should not start to set up the next request in CPUIT until RWCH is off.

LNO must contain a legal line number for the request (even if it is not used). A request may be made to either an input or an output line. Unless otherwise specified, NSR is always equal to \emptyset on return. If NSR is equal to a 1 it indicates some sort of failure and is equivalent to a no skip return from a function that normally skips. Similarly, NSR may be set to 2 for some requests.

If the value of a CHIO request is a string, then the string, which may be no longer than 21 characters (7 words), is placed in the buffer beginning at RWSB. The number of characters is placed in VALU.

The completion of the request is indicated by RWCH being turned off.

NFB always contains the number of free buffers.

Memory pointers are of the form:

bit 4, 1, if CHIO's private memory;

∅, if main memory

bits 5,23: address in selected memory.

It is assumed that all references to fields are done by field instructions, as the definition of fields will change for each new version of the CHIO;

The first (even) line of a line pair is an input line and the second (odd) line of a line pair is the output line.

WST (Write String)

Arguments:

- 1) number of characters (\emptyset to 21);
- 2) 4B7 if it is legal to send all possible control characters to the CHIO in this request. If \emptyset , any illegal control character that a user sends to the CHIO will be deleted.

Value: none

Side effects: If the last buffer for the line is used, then NOQ (no output requests desired) (or NIQ if input line), WOC (wakeup on output condition, output line only), and NSR are all set to 1. Otherwise, these three quantities are left as they were (normally zero).

NSR will be set to 2 if there has been an attempt to send an illegal character to a line. This will take precedence over the setting of NSR to 1 but WOC and NOQ will be set as before.

A WST to an input line will cause the process to be awakened if WIC is set.

There are two philosophies for the use of WST. The first and simplest would be used with teletypes.

First the program would check to ensure that NFB is more than a preset minimum; and block if it isn't. Second the program would execute the WST and wait for the return; it would then block if NSR was equal to 1, or continue writing if NSR was equal to \emptyset . It would indicate an error if NSR was equal to 2, and write the null string to see whether it should block.

The second philosophy would be used by the printer driver and any other interfaces to high speed devices. The program would first check NFB, then write a string. The program would then check the NOQ bit and if it was off it would write the next string as soon as RWCH was turned off. This program would ignore the value of the call with two side effects.

- 1) It might use one extra buffer before it blocks.
- 2) It would give no error indication of extraneous control characters in the output.

Either of these side effects is quite acceptable for high speed devices such as a printer.

RSND (Read String non-destructively);

N characters starting with the one pointed to ($N \leq 2\emptyset$)
are read by the CHIO but the pointer is not advanced;

Arguments:

1) N, number of characters to be read.

Value: returned string, NSR = 1 if the specified number
of characters was not read.

RSTB (Read String to Break Character);

This call causes the CHIO to read characters up to and including:

- 1) A character that caused echoing to stop (Break Character); (NSR = 2)
- 2) The Nth character where N is the number of characters specified by the first argument, and N is not a shift1. (NSR = \emptyset)
- 3) The N + 1st character when the Nth character is a shift1 (NSR = \emptyset)
- 4) The last character in the line (NSR = 1)

If more than one of the above conditions is met the first one determines the value of NSR.

Arguments

- 1) N, the maximum number of characters ($N \leq 2\emptyset$)

Value: string read, NSR is set as specified above.

If NSR is set to 2 then WIC (or WOC) is set to 1.

When a string is read from an input line the appropriate echoing will occur if the line is in deferred echo mode. All of the characters typed into the system

appear in correct synchronization with those that are typed out by the computer (except for non-echoable control characters which are not echoed at all.)

MMB (Move Memory Block);

This causes the CHIO to do a block move of ARG3 words from the location specified by ARG1 to the location specified by ARG2.

Arguments:

- 1) memory pointer;
- 2) memory printer;
- 3) number of words.

This command may be used to load or store into the CHIO's private memory. It could also be used to do a block move within either memory.

Because this command requires the full attention of the CHIO, it should be used to move large blocks (larger than 256 words) only under special circumstances. A series of several of these commands is legitimate. If large block transfers are attempted input lines might generate errors.

Value: none

IG (Ignore non-CPU Requests);

Arguments: none

Value: none

This command puts the CHIO in a mode such that CPU requests only will be considered. Other requests (2400 Baud line, and Teletype bit-scanning) will be turned off, and characters may be lost if the CHIO is in this mode for an extended period of time.

NIG (No longer Ignore non-CPU Requests);

Value: none

This command puts the CHIO back in the normal mode so that Non-CPU requests will also be serviced.

PCF (Put into CHIO Field) [Linetable . ARG1 ← ARG2];

Arguments:

- 1) SPL field descriptor: If the displacement is < 16 the descriptor is taken relative to the main table, if ≥ 16 the descriptor is taken relative to the character pointer table, with a new displacement 16 less than the specified displacement.

The Sign extension bit is ignored.

- 2) Value for field.

Value: none

GCF (Get from CHIO Field) [VALU ← linetable . ARG1];

Arguments:

1) SPL field descriptor (same as for PCF)

Value: field specified.

PSR (Put Scratch Pad Register);

This command is used to load a CHIO scratch pad register.

This command when used in conjunction with IG and MMB will allow the location of the CHIO's tables to be changed on the fly. It is also used for initialization.

Arguments:

- 1) Scratch Pad Register to load (0 - 63);
- 2) Value for Register

Value: none

GSR (Get Scratch Pad Register);

This command will cause the CPU to get a scratch pad register value.

Arguments:

- 1) Scratch Pad Register number (0 - 63)

Value: Contents of selected Scratch Pad Register

DOAPOT

This command allows the CPU to execute a POT. This command and a few others are used for system debugging. If the monitor ever uses them it will be to cover a deficiency in the design of the CHIO.

Arguments:

- 1) Z register value for Alert
- 2) Z register value for POT

Value: none

DOAPIN (see DOAPOT)

Arguments

- 1) Z register value for Alert

Value: E2 when PIN is done;

DOA24D: Output request for all 2400 Baud devices.

This will do an output request to each 2400 Baud devices.

Arguments:

- 1) Z register value for POT

Value: none

Responsibilities of the Device Interface Module

The Device Interface Module will know that all characters that it has read have been echoed.

Deferred echo mode will be left if:

- 1) WIC is one and
- 2) output is empty

The Device Interface Module also must insert the appropriate number of SNULLs after each carriage return to insure the carriage's returning before typing continues.

Wakeups

WIC (Wakeup if Input Condition) is used to indicate the process should wakeup for input. WOC (Wakeup if Output Condition) is used to indicate that the process should wakeup for an output condition.

In the following discussion, the phrase "attempt to wakeup for input," (output) means the process is awakened if WIC (WOC) is set. When this happens WIC (WOC) is turned off. If WIC (WOC) is not on, no wakeup is generated.

WIC for an input line is set by:

- 1) Any RSTB to the line that has NSR =1 (see RSTB).
- 2) Any CPU program that wants to set WIC (abnormal case)

WOC is set for an output line by:

- 1) Any WST to the line that uses the last buffer;
- 2) Any CPU program (abnormal case)

An attempt to wakeup a program for input will occur if:

- 1) A wakeup character is received;
- 2) $WCNT \leq CCNT$ for the input line;
- 3) Any WST is made to the input line.

The NIQ (NOQ) bit is set if an input (output) line is too full ($ABCNT > MP * XBCNT/64$).

The NIQ (NOQ) bit is reset if an input (output) line is too empty. ($CCNT \leq WCNT$.) These bits may be tested by CPU

programs to determine whether or not to output more characters to the lines. They have no other use.

An attempt to wakeup a program for output will occur if:

- 1) $WCNT \geq CCNT$ for the output line and the line is in normal or CCP mode.
- 2) The $WCNT$ th character is output, the line is in link or advise mode and the line linked to has fewer than $WCNT$ (for its line) characters left in the output buffer, in this case an attempt to wakeup the processes associated with both lines is made.

If B is advising A then A will be in advise mode. If A does a RSTB that fails the other process associated with line B is awakened.

Links

The link flag (LF) may take on the values:

- 0) Normal mode;
- 1) Link;
- 2) CCP mode;
- 3) Advise mode;

Assume in the following discussion that line A has the specified link type and is linked to B.

In normal mode nothing unusual happens.

In link mode any characters written by the CPU in the output line for A (WST) are automatically placed in the output line for B. Also whenever a character is read (RSTB) from A's input line it is placed on B's output line (if A's echo strategy is echo). When two teletypes are linked each must be in link mode.

In CCP mode the only difference from normal mode is that when a RSTB fails the process in LINK is awakened. In this mode LINK is a process, in all other modes LINK is a line number.

Advise mode is identical to link mode except that when a RSTB fails the process associated with B is awakened. In this case B is advising A. B must be in link mode. One way links (LF = 1 or 3) are not allowed because the correct wakeups might not occur.

The allowable link modes are:

mode	ttyA.LF	ttyA.LQNK	ttyB.LF	ttyB.LQNK
A linked to B	1	B	1	A
B advises A	3	B	1	A
B treats A as a CCP process	2	process #	∅	∅
no linking	∅	∅	∅	∅

Links are only legal between devices that have identical character sets. The timing may be different however. Thus a Model 37 may be linked to a Model 35, but not an IBM 2741.

INITIALIZATION REQUIRED BY CPU PROGRAMS

The following scratch pad registers must be setup by the CPU:

BUFØ: Origin of free list. First 8 words following
BUFØ should be Ø.

MTAA: Origin of Main line table.

MTCA: Origin of character pointer line table.

LDVTA: Local device table address (for bit scanned
teletypes)

LB24T: Base of 2400 Baud line table (for local
2400 Baud lines.)

LBTBA: Local Bit table base address.

FREEL: Pointer to first location in free list
(taken relative to BUFØ).

MP: Multiplier for buffer counts. (Ø - 64); maximum
buffer count of a line is taken the specified
count * MP/64. MP's normal value is 64.

MAXFB and MINFB: If the free buffer count is less than
MINFB or greater than MAXFB a special process
(BRECHT) is awakened.

UPAM: Every UPAM * 10 microseconds the real time
clock is updated. UPAM should be set to 100.

XLINE: Largest legal line number. If the line number in a CPU request is greater than the value of XLINE the CHIO aborts.

ICC, OUTCC Input (Output) character counts which the CHIO increments for each RSTB (WST) done by the CPU.

PLINE: should be set to zero

AVB, PRB: should both be set to -1

BFLAG: should be set to 4B7 after AVB, FREEL, and PRB are setup but set to zero before AVB and PRB and FREEL are setup.

CPUFLAG: setting CPUFLAG to -1 is equivalent to doing an IG (Ignore non-CPU requests). Setting it to \emptyset is equivalent to 'NIG'.

OBITS: should be set to -1.

NCI to LCI: should contain 00B6 to 06B6

The following In-core tables must be set up as Main Line tables. For each line all of the fields should be set to appropriate values (see appendix).

Character Pointer Line Table: XBCNT and WKCNT should be initialized. Other quantities should be zero.

Character Buffers: should be linked (relative to BUF \emptyset) through the field NEXT. The last buffer should contain a zero in NEXT. (NFB should be initialized to the number of free buffers.)

The CPU Interface Table: NFB should be initialized and RWCH should be set to zero.

Device Table: for each device ESCCH, (escape character) and C \emptyset to C255 should be set up.

Low Speed Device Table: This table (which comes in two sections, part pointed to by LB24T, part by LDVTA) should have the CPU line number in CLINE, and zero in COP.

Local Bit Table: everything in this table should be zero except NCIP. NCIP in the table entry for device type T should have the Nth bit set ($\emptyset \leq N \leq 15$) if the Nth device is of type T.

The following Public Memory core locations should be initialized for the CHIO to function

WPL: Wakeup pointer
SRMEM: Restart switches
RTLBASE, RTHBASE: adjustment for real time clock
(see also CPU interface table)

The following public memory locations may be modified by the CHIO: WPL, RTLOW, RTHIGH and the CPU interface table.

The following locations must be initialized by the CPU.

(Taken relative to BUFØ) Locations Ø-7 should be set to Ø.

XIB(6ØB), XOB(61B): Number of extra input (output) buffers used (should be zero).

BERTHOLD(62B): Should be zero.

BRECHT(63B): Number of process to awaken if buffer count goes out of range. (NFB > MAXFB or NFB < MINFB)

The following locations should be initialized to zero.

They are incremented whenever something goes wrong.

RECC(64B): Input rate error count

TREREC(65B): Output rate error count

IDLCNT(66B): CHIO has nothing to do

F24C(67B): A null request from the 2400 baud line scanner was received

PROB(70B): CHIO was saturated with work for at least a half second.

BADWK(71B): An attempt to awaken a process found the wakeup buffer full.

ILC24(72B): Illegal character sent to 2400 Baud line count

NULCPU(73B): Null CPU request count

Control Characters Used by the CHIO

- NULL (\emptyset): This character is legal for WST. It will be deleted from the output string.
- SNULL (35B): This character will cause a 1 character time output delay at the device it is being sent to. It is usually used to allow the carriage to return.
- SHIFT1 (37B): Shift1 is used to transmit a character between \emptyset and 37B. The character following shift1 is taken mod 40B. This character may be either sent by the CPU to the CHIO or sent by the CHIO to the CPU.
- CBREAK (32B): Received by CPU if a line becomes disconnected (Break key on teletype depressed).
- SUBI (31B): Indefinite number of characters lost in input.
- SUB (30B): One character lost in input.
- FLDCHAR (33B): A status change in the 2400 Baud line has occurred. The low order 7 bits of the next character give the status of line, bits 9-15, of the word obtained by PIN.

Important Note: None of the characters' values should be assumed. They all should be referenced symbolically!