12-BIT ARTICLES ....

Contributions and correspondence should be sent to:

    Robert Hassinger, 12 Bit Coordinator
    c/o DECUS MR2-3/E55   ..or.. Liberty Mutual Research Center
    One Iron Way   71 Frankland Road
    Marlboro, MA 01752   Hopkinton, MA 01748

DECUS/Europe contributions are solicited through:

    Lars Palmer
    DECUS/Europe 12 Bit News Liaison
    Hassle
    Fack
    S-431 20 MOLNDAL 1
    SWEDEN

(Please include reference to Newsletter number and page when inquiring about
material published.

NEWSLETTER SUBMISSIONS

     Submissions are accepted at all times and are normally used in the next
issue to go to press regardless of date of receipt.

     Material submitted in machine readable form is particularly desirable
because it can be edited and incorporated into the newsletter format more
easily. Higher quality reproduction is also possible this way. Contact Bob
Hassinger for further details on acceptable media and formats if you plan to
make a submission in machine readable form.

FUTURE DEADLINES

     I have been given the following deadlines for the next two issues:
February 1 and May 1. These are the dates my material must be in the hands of
the person I send it to. In order to make it into those issues, your material
must reach me ten days before these dates to cover mailing delays and to give me
time to edit and retype it. Machine readable input is greatly appreciated,
particularly near deadline time. In some cases it may actually be possible to
send your material electronically direct to my system. If you are interested,
give me a call.

12 BIT COMMITTEE

Robert Hassinger
- address above -
(617) 435-3452

COS/DIBOL and WPS liason
Lawrence H. Eisenberg
17141 Nance Street
Encino, California 91316
(213) 788-0354

Education, Multiuser systems, PASCAL
Father Geoffrey Chase O.S.B.
Portsmouth Abbey School
Portsmouth, RI 02871
(401) 683-2000

Representitive to DECUS Product Planning Committee
Jim van Zee
Lab Data Systems
10320 Ravenna Ave NE
Seattle, Washington 98125
(206) 522-6950

PASCAL-S IN DECUS LIBRARY

PASCAL-S for the OS/8 family is now available from the Decus Program Library. Here is an extract of the catalog listing:

Version: V2.0, March 1983

Author: Niklaus Wirth, E.T.H., Zurich, Switzerland

Submitted By: D. Geoffrey Chase, OSB, Portsmouth Abbey School, Portsmouth, RI

Operating System: OS/8 V3D. Tested under V3D, including ETOS and OMNI-8, would probably run under other OS/8 versions.

Source Language: PAL-8/PAL-III

Memory Required: 28K

PASCAL-S is a subset of the programming language PASCAL, defined by Niklaus Wirth in Report No. 12 of the Institute for Information Science at the E.T.H. in Zurich. This implementation of PASCAL was designed for a PDP-8 with 28K words of processor memory, running under the OS/8 operating system.

Source program text may be created or revised with any of the OS/8 File Editors, including EDIT, TECO and MUTOR.

Restrictions: (1) Uses BSW and MQL/MQA instructions. See file PASCAL.8E. (2) PASCAL-S is subset of PASCAL. It conforms to the definition of

PASCAL-S given by Niklaus Wirth, the original inventor of PASCAL.

Documentation is on the magnetic media.

Media (Service Charge Code): Write-Up (AA), DECtape (HA), Floppy
                              Diskette (KA)

Format: OS/8

CP/M OPTION ON THE DECMATE II - CAVEAT EMPTOR

Since OS/8 is not currently available for the DECmate II, a lab that I have
contact with with decided to buy a DECmate II with the CP/M option to solve a
problem they have. This has proven to be an unfortunate decision. They found
that contrary to their expectations based on the product descriptions, CP/M
could not do what they needed. We have tried all the usual ways of addressing
the problem, but in the case of the DECmate II CP/M and BASIC products, none of
them work. Potential purchasers should be cautious about decisions involving
these products.

The problem to be solved is this. The lab does word processing for their
correspondence and technical papers on a very unfriendly Perkin-Elmer system,
using a program somewhat like RUNOFF and a primitive line editor. This has to
be done over slow, noisy dial-up phone lines. The lab also has a digitizing
tablet they use in their research. They measure the area and circumference of
irregular nerve cell outlines. This tablet must also be used over the same
phone lines to the P-E system. The combination of the uncooperative computer
and the poor connections make the tablet almost impossible to use.

A few months ago this situation got to the point where it was intolerable.
The DECmate II looked ideal for the job. It would give much improved word
processing under WPS and it could also solve the tablet problem. This would be
done by connecting the tablet through the DECmate's communication port and
writing a program in CP/M BASIC program to collect and process the data from it.
On this basis a DECmate II was purchased from DEC with an LQP02 printer, the WPS
software, and the CP/M option including the "Soft-card", CP/M and BASIC.

As expected, WPS has been a great success. So much so that the lab's
principle investigators have been purchasing their own DECmates for use at home.

A couple of weeks ago we decided to get CP/M going and set up the tablet
application. Much to my dismay, I discovered that the version of BASIC DEC
supplies for the CP/M option can not do I/O to the communications port! You can
not OPEN the port for I/O! In CP/M there is provision for the COM port but
BASIC can not access it at all. I asked my CP/M expert about this and he says
this is most unexpected. Just as with OS/8, in CP/M systems you expect software
like BASIC to do I/O to any of the supported devices and you expect CP/M to
properly support the hardware supplied in the basic machine.

It also turned out that the CP/M system does not even have a way to set the
speed and so on for the COM port. I understand that good CP/M systems are not
this crude and incomplete. I have heard rumors of a new, extra cost, option
that will offer some help for "communications" from CP/M but I could not get
technical details before the Newsletter deadline. In any case, you should not
have to pay extra for something so basic as the ability to set up the COM port

and do I/O through it from BASIC!

Before I gave up on CP/M, I noticed another little quirk. BASIC was very willing to create files that the rest of the CP/M system would not recognize. It looks like BASIC will create file name entries in the directory with illegal characters in them. Apparently BASIC just goes ahead and writes what ever you you give it for a name without bothering to do any checking! That would not be too bad if the "manual"s DEC gives you warned you about it but they do not.

Speaking of the "manual"s you get with CP/M and BASIC, they look like something DEC did in 1968 or so. There is a whole set of CP/M commands that are mentioned but not documented. If you look real close you can find a line in the manual that tells you to buy another option to get documentation on those commands. You can not write assembly language programs because of this and the lack of documentation on the machine and the CP/M BIOS (BIOS is sort of like OS/8 device drivers, you always need documentation on it in any CP/M system so you have a chance to deal with problems like this).

The BASIC manual is a classic. You have a generic language section that applies to a great many different versions, then you have a section on extensions for the disk version and disk files, then you go on to another section that discussess differences for the CP/M version then you go back and notice in the generic section that some of the commands have footnotes saying that the command is not in "some" versions and then you notice some more commands that say they are not in the DECmate version.

OK, you say, all new products have problems, we know what to do about that. You check the SPD (Software Product Description - DEC's formal product description for software) to be sure the product is supposed to do what you want then you send in an SPR (Software Performance Report) to get a fix. If that does not work you do a little programming to get around the problem. Maybe write a device driver for example. If this still does not solve the problem you go to your DECUS Special Interest Group. They are supposed to have contacts at DEC for resolving problems.

In this case none of the above works! Take a look at the SPD that comes with CP/M and BASIC. It says there is no support offered with the product and that you buy it "AS IS"! You do not get any SPR forms to send in a complaint. After noting this I reviewed the SPD to see if any limitations were documented. The SPDs turn out to be very non-committal. They don't say you can and they don't say you can't. Based on past experience, any limitation as serious as these would be explicitly mentioned. Since there are no limitations given and since it is the norm for CP/M systems to do these things, it seems reasonable to expect this product would do them.

The only thing left to do was call the WPS hotline. They are really supporting WPS but it was worth a chance since there was no where else to turn. Eventually, after a round of telephone tag, I talked to someone who does try to deal with CP/M questions. She had to go off and check with other people since she really had no background on this level. The answer was yes, BASIC can't do I/O to the COM port - there is no fix available - submit an SPR. Only you do not get SPR service with this product - Catch-22! Also, the telephone support people had no information to offer on the rumored "communication option" either.

As it so happens I <u>AM</u> the DECUS SIG person you would get in touch with to try to get help with a problem like this. Unfortunately, I have been working through DECUS since the DECmate II announcement a year ago last Spring, trying to get DEC to establish a line of communication with us for this sort of thing without success. I spent the last week trying again to make contact with someone in DEC who could address these issues. At deadline time I still have gotten no response.

All the customary means of resolving a product problem have failed. At this point I think potential purchasers of the CP/M option should look very carefully at what is offered and be careful to make no assumptions about it. It looks like DEC has given this CP/M product "a lick and a promise". I can't find anyone inside DEC who knows anything about this CP/M product. It looks like they contracted outside for the product and they have no idea what it is about, what is good or bad about it, and they don't seem to have any way to address problems. The implementation seems to me to be sloppy and poorly engineered - about on a par with the first release of the 4K Disc Monitor for the PDP-8 back in 1968.

These particular limitations may not bother you at all. You may be lucky enough to use an application that runs fine under this system but what I have found makes me very cautious about this product. I think there are likely to be more than the usual number of problems with it and, worst of all, there seems to be no recourse at all for the unlucky purchaser who runs up against one.

If your decision to go with the DECmate II is predicated on the availability of a general programming capability for implementing your own application, as was the case for this lab, you might want to reconsider your decision.

This demonstrates one of the main reasons I advocate making the OS/8 family available on the DECmate II. Unlike the CP/M option, it is an open, modifiable system. If all else fails you can write your own device driver or program that does I/O directly. Even the WPS training disks use OS/8 because of these advantages. Direct screen I/O is particularly good from the OS/8 side. Due to the architecture of the CP/M system on the DECmate II and the undocumented (secret?) nature of the I/O system, you do not have this option with CP/M.

NOTE FROM RUDI STANGE

"Ref.: OA SIG Newsletter Volume 1, No. 2 *** May 1983

"I like to say that I am glad the 12-Bit SIG has the OA Newsletter as a carrier for their concerns. What I appreciate much less is the fact, that they start it with crying and complaining about DEC not producing the old PDP8 anymore. I wonder if anyone of those people still drives the old model T from Henry Ford??? (For him I would make some concessions)!

"When you, Bob, did run the 12-Bit SIG it was flourishing and sprouting like crocusses in April, and as soon as the experts took over, they managed to almost erase the group completely. Well, may be I should not brag, for I belong to the German 12-Bit SIG which seems to be the only one alive and active despite the fact that we could not buy a DECMATE-I because it was not sold in Germany, and the DECMATE-II will only appear early next year on the German market, that is the German Version of it (US versions could be obtained right now).

"DECMATE-II really is much better than any previous PDP8, it runs C/PM programs, Word Processing with Sort, Math, List Processing and real good communications, also it allows access to RX01/RX02's, and it has DIBOL8/11. We will soon have OS/8 on it and a C Compiler, and we can make use of 48 Kilo-Words of memory. It has 2x32 KW, one of it is the usual bank while the second bank functions as control memory, but only half of it is used for such purposes. It also offers some new instructions with the 6120 processor e.g. push and pop. I am really enthusiastic about it.

"Now getting to some requests from the a.m newsletter:

"Mr. Orlowski asks for some means to correspond between the PDP8 and the VAX. We have some WPS8's connected to a VAX via a PAX (Permanent Address Extension) which allows to transfer ASCII code between both machines. Data files could be written in FILEX (available on COS-310) FILEX writes IBM format and accepts OS/8 or COS files which can be read on any machine able to read IBM compatible format.

"Mr. Lee Roberts seems to be dissatisfied with WPS, I can only answer him to try to use something else in order to appreciate WPS8.

"PASCAL-S, Ronald Larkin's remarks on it are (in general) right. I have some instructions on it in German language. Anyone having a DECMATE-II should use PASCAL MT PLUS running under C/PM, (same with BASIC.)

"Dr. John A Hawkinson and Nancy Holley want to do more than just WPS, i.e. patients/customer files, billings, inventory etc. I urgently advise not to use OS/8 for this, the expenses in time and effort would be too much, use DIBOL, it is similar to COBOL but much easier to handle, also faster and elegant. It is runs on all DEC computers and will soon appear for C/PM as I understand. It offers a good Data Base System with easy screen handling. Just try to program the screen in OS/8 and compare it to DIBOL: the statements are e.g.:

```
DISPLAY(R,C,0)        Position cursor at row R character position C
DISPLAY(R,C,1)        Erase screen starting at row R character C
DISPLAY(R,C,2)        Erase row R starting from character C
DISPLAY(R,C,'ANY TEXT')    Display text in single quotes starting in
                             row R at character position C
DISPLAY(R,C,LOC)       Display contents of LOC starting in row R
                             character position C.
```

"DIBOL statements are in plain English (like BASIC). DIBOL runs under COS-310. DIBOL is fast and efficient. I have submitted a DIBOL Floppy to DECUS library, containing some subroutines for screen and file handling as well as an example customer file system along with comments for beginners and experts. In case more readers are interested, I am willing to conduct an introductory course to DIBOL via this news letter.

"Bob, I am delighted to see you back aboard, let's start to get the 12 Bit SIG to new horizons."

Rudi's address is c/o Digital Equipment GmbH, Freischütz-Strasse 91, D8000 München 81.

HELP - DIGITAL SOFTWARE NEWS

Dr. F. E. James sent the following note asking for help:

"In your Fall 1982 12 Bit SIG Newsletter, you made reference to a publication called "Digital Software News". You mentioned that a DEC order number QQF097-2Z would get us twelve months' worth of this service.

"I'd like to tell you that we have attempted to contact DECUS several times in order to get this, and have been in touch with DEC, but we can't find anyone there who knows anything about it. Can you help?"

I told Dr. James that of course he had to go to DEC rather than DECUS but other than that I did not know what the current situation was because we do not have a subscription due to budget problems. Note: the order number was actually QJ097-2Z but that should not have been a problem. Can anyone help? Let me know for the next Newsletter.

Dr. James is at James Investment Research, Inc., PO Box 8, Alpha, Ohio 45301 (513) 426-7640.

PROBLEMS WITH CROSS ASSEMBLY ON RT-11

Ronald P. Larkin sent the following note:

"Cross-assembly of PDP-8 assembly language programs on an RT-11 system seemed to be an attractive possibility for us. We tried a DECUS program (11-405) but found that this program was not usable for any but the most rudimentary PDP-8 programs. For instance: XLIST is not properly handled, the listing file contains no error messages, literals are not recognized, and the double quote is not recognized. We discovered these problems with a working PAL8 program of 15 lines."

With my DECUS Library Committee hat on, I looked up the program in question to see if I could understand the reason for Ron's problems. I noticed that the abstract states the program is compatible with PAL III (the old paper tape version of PAL) rather than PAL8. I think PAL8 is very close to being a proper superset of PAL III or, in other words, PAL III and DECUS 11-405 handle subsets of PAL8 syntax. I think that at least some of Ron's problems come from using features that were introduced in PAL8 that were not in PAL III. I have not looked at PAL III since the late sixties so I can not say for sure. Can any of you old timers out there help out? Send me a note for the next Newsletter.

Ron is Assistant Wildlife Ecologist, Illinois Department of Energy and Natural Resources, 607 East Peabody Drive, Champaign, IL 61820 (217) 333-6880.

WINCHESTER DISK CONTROLLER

DEC is not developing any new hardware for the Omnibus machines (8/E, 8/m, etc.) so owners of those machines do not get much chance to take advantage of new peripheral devices like Winchester disks. As a result it was encouraging to see information on a new product that I recently received from CESI.

The CESI MDC8 is a single, hex-wide circuit board that performs data and control functions to a family of SASI disk controllers. The MDC8 and a SASI disk controller allow the addition of families of 5 1/4 and 8 inch Winchester disk drives to Omnibus based systems. Each unit will support two Winchester drives plus two floppy drives. Further information is available from Computer Extensions Systems, Inc., 17511 El Camino Real, #131, Houston, Texas 77058 (713) 488-8830.

NOTE FROM WALLY KALINOWSKI

As I sit here finishing up the last article for the Newsletter, Wally has transmitted a short rundown on what is going on in his area directly into my system. Here is a summary of it. Hopefully we will have details for the next time.

"A new version of TKPLOT was submitted by E. Lynch to DECUS about one month ago. E. Lynch is making great progress on a Symbiont for OS/8. The printer and the plotter now run in the background with no noticeable slowing of the computer running OS/8. There are a few things left to be done though before we will be sending it out to DECUS. When FRTS comes up it occasionally halts. We expect to clear this up tonight. Also, wild cards need to be added to the queue program and also an un-queue."

"Jonathan Easton said that he will definitely have U of M Pascal in DECUS. He expects to have it submitted by Christmas. I will soon get MULTOS/8 (thanks to Bill Haygood) in to DECUS. It is presently configured to run only with RK05 disc as the system. I guess we could maybe find someone out there with time to implement it on a floppy. Speaking of "anyone out there", has anyone modified LOAD (FORTRAN IV) so that more than one library can be used?. Has anyone been able to get it to load more than one module (subroutine) from a single file?

"By the way, I talked to Ian Templeton the other day. He has a circuit drawing for an IEEE488 interface (GPIB) for the PDP/8 along with software which he is willing to share with whoever wants it.

"Well BOB that is more or less it on Louis's and my outline of what we were going to write plus a thing on how the symbiont works but we didn't get to it in time."

Bill Haygood at D-R Monterey
408 646-6271 or 375-5364   Wally Kalinowski   *phoned   10-Feb-84*
213 648-5604   *to send   MULTOS/8 & modem 2 PAGES*

RE: WALLY KALINOWSKI'S "CALL TO ARMS"

In the last Newsletter there was a note from Wally Kalinowski and Louis Tribble. They are interested in finding ways for the 12 Bit user community to acquire rights to as much of the existing software for our systems as possible and place it were it will be accessible. A lot of important software is being lost because the people who control it have lost interest or gone on to other things.

Wally and Louis were particularly interested in finding other users who are interested and willing to help. Part of their input for the last Newsletter was a questionaire you could use to indicate your interest. Unfortunately, Murphy's law is very active in DECUS. The page with the form got swallowed along the way

from East coast to West coast and back to Decus on the East coast. So, I am going to print it here again but I am not going to try to make it a separate, pull out page. That should cut down on the chances of getting lost. Don't worry too much about the money questions at this point. We can do a lot even without any money. (For example a few years back I shelled out one whole dollar and got OS/8 RUNOFF and some other things for the Library.) What we are looking for is an indication of interest and support at this point.

---

12 BIT SOFTWARE PROJECT QUESTIONAIRE

Name   _____

and   _____

Address _____

          _____

Phone   _____

1) Can you contribute ten dollars?   _____

2) If you can contribute more, how much? $_____

3) What mass storage devices do you have?   _____

4) Can you help distribute, if necessary?   _____

Comments, suggestions, (offers of help!):

Mail to:

        Bob Hassinger
        Liberty Mutual Research Center
        71 Frankland Road
        Hopkinton, MA 01748 USA

Approved 12 bit CMOS-processor with new design

Wolfgang Leber
Max-Planck-Institut für Hirnforschung
D 6000 Frankfurt 71
W-Germany

For a long time only a few CMOS-technology microprocessors have been avail-
able. Right from the start, the PDP-8 compatible 12 bit processor of the
6100 family belonged to that group. Now a newly designed and improved
version is available. Its development was initiated by a big manufacturer -
hence the delay of two or three years for the 6120 being for sale. The fact
that a lot of effort was invested in software worldwide seems to be the
reason for that development.
To use the 6120 on an established 6100 bus structure it takes a few modifi-
cations of control signals because this chip set is not pin-compatible to
the 6100 family.

Three enhanced capabilities make the 6120 is different from its predeces-
sors:

1. On chip memory extension control for an address space of 2x 32K words.

2. Something long known to the 8 and 16 bit world: Increase of the in-
   struction set to control two stackpointers.

3. Although the clock frequency is the same, speed is twice as high, which
   was achieved by an optimized microcode.

While the 6100 line consisted of the following members

a) 6100 12 bit CPU
b) 6101 PIE peripheral interface element
c) 6102 memory extension, DMA, refresh and clock controller
d) 6103 20 bit input/output,

only two chips have been developped for the 6120 family so far:

a) 6120 12 bit CPU with memory extension controller
b) 6121 input/output controller with PDP-8 compatible I/O structure.

An adaption onto the EURO-12 bus used in "12-bit domain" in Europe seemed
reasonable because a lot of interfaces have been developped for that bus.
The increased functionality of the 6120 promised a denser packaging, too.
While three EURO-12 cards were needed before to establish the functions
CPU, extended memory control, memory management for 1 MW of memory and
control panel monitor, this is now possible on one board.

Some functions used could be implemented by the 6102 which has been de-
velopped as a 'super chip' (memory extension, DMA, memory refresh, clock
controller). A few instruction incompatibilities and the fact that there
was no other manufacturer for this chip put up a lot of problems for some
designers.

In addition a long-existing requirement for higher working speed could only be met with special design techniques (10V operating using level converters). The 6120 is now twice as fast as its predecessor at the same clock frequency. The multiplexed bus structure has not been changed basically, it has been increased by two signals though.

Most signals did not change, so that in the following only the differences and increased functions are described in detail. These refer to new or deleted signals or signals whose functions have changed.

1. STARTUP   This input enables to differentiate between starting the program in the control panel memory (as it is done by the 6100) or in the main memory. The start address in both cases is 07777.

2. IOCLR   This output gets active if
                     a) a RESET-signal is applied or
                     b) the instruction CAF (clear all flags) is given.
                     This signal corresponds to the EURO-12 signal INIT.

3. EMA2   is the lowest order bit of the extended memory address. The two higher-order bits are multiplexed with the C-lines.

4. LXDAR   While with the 6100 each address (main memory, panel
   LXPAR   memory and device addresses) had to be latched with
   LXMAR   LXMAR there are now separate signals available.

                     a) LXMAR - main memory addresses
                     b) LXPAR - panel memory addresses
                     c) LXDAR - device addresses.

                     Timing was slightly changed, too, but does not influence compatibility (see description of schematics).

5. READ   This signal is active when the CPU wants to read data from the bus and is similar to XTA, but with reversed polarity.

6. WRITE   This signal is active when the CPU wants to put out data onto the bus and corresponds to XTC for writing operations.

7. OUT   This new signal simplifies controlling the bus transceiver. It can be used like XTB.

The signals
                     LINK, C2, SWSEL and DEVSEL
are not available anymore.

DEVSEL, which used to be necessary for all device operations, can easily be generated by a few gates. With most applications the LINK-bit was not used externally, so there is no real loss. The other signals can be created by control panel firmware.

This part of the schematics shows how bus compatibility with the 6100 can be realized.

The IX-signals are present during the whole cycle. Therefore they are not
only used for latching the addresses but also for generating the select
signals. Consequently it is very simple to make the same signals on the bus
available which exist with the 6100. As there was no difference between
main memory-, panel memory- and device addresses before, all three signals
can be put together into one signal for the bus. It should be noted that a
few signals' polarity has been changed. More difficult is the control of
the busreceiver for C-lines and the SKIP-line. Here you find a general
difference between both processors. With the 6100 each WRITE is preceded by
a READ, which means that so-called dummy READs are added. At this time the
control lines are sampled and corresponding functions are executed. The
6120 works differently in that respect. Here a possible READ- follows a
WRITE-phase. The control lines are always sampled during the WRITE-phase.
Basically the time of sampling does not matter, but incompatibilities can
occur when an interface decodes the control signals using the READ/WRITE
conditions for the decoding of control signals. In our application all
interfaces could be used without modifications. A foreign development made
alterations in this part necessary. For the sake of compatibility of both
processors it is advisable not to gate the control lines with READ or
WRITE.
On the CPU-side you must take care that the bus driver for these signals
multiplexed with the extended address line will be controlled with the
correct timing. The delay circuit to control the bus receiver is necessary
to transmit the C-lines slightly longer than the WRITE-phase. The timing
diagram for the a input/output phase illustrates this.

To summarize you can say that the adaption is no basic problem. Tests have
shown that - adequate clock frequency provided (10 MHz) - a system is
available which allows a higher processing speed than all other versions of
the PDP-8 product line ever produced.
In spite of the rather "aged" instruction set (created in 1964) one can see
that because of the 6120 the PDP-8 sees its renaissance in the DECmate II
personal computer. This is a good example of hardware being built for
excellent software and operating system already existing, like WPS-8 and
COS-310 and OS/78.

Legends:

Table 1: Suggestion for a circuit to exchange 6100/6102 for a 6120, keeping
         the original signals and their significations.
Table 2: Signal diagramm of the 6120 during an input/output instruction.
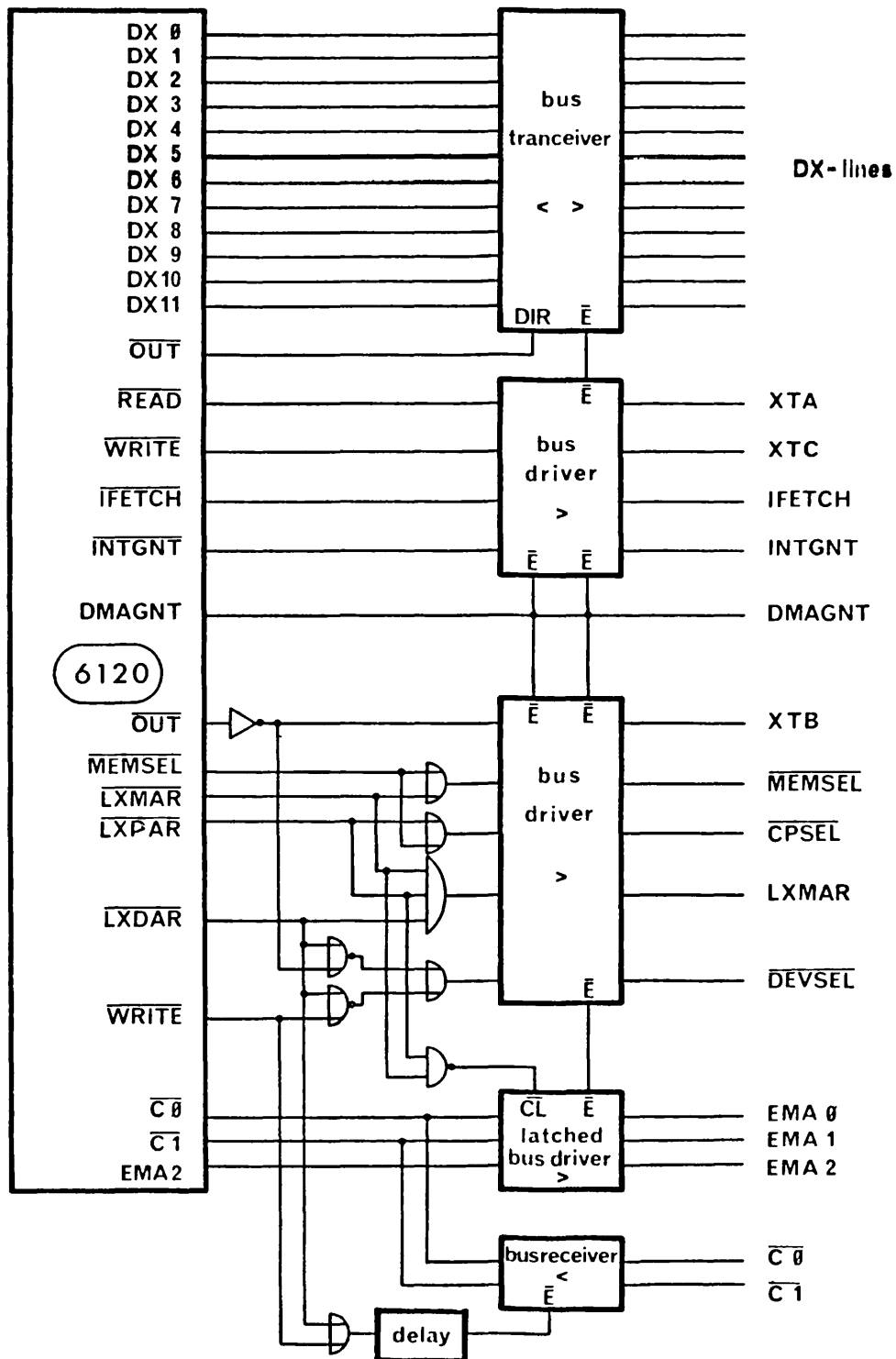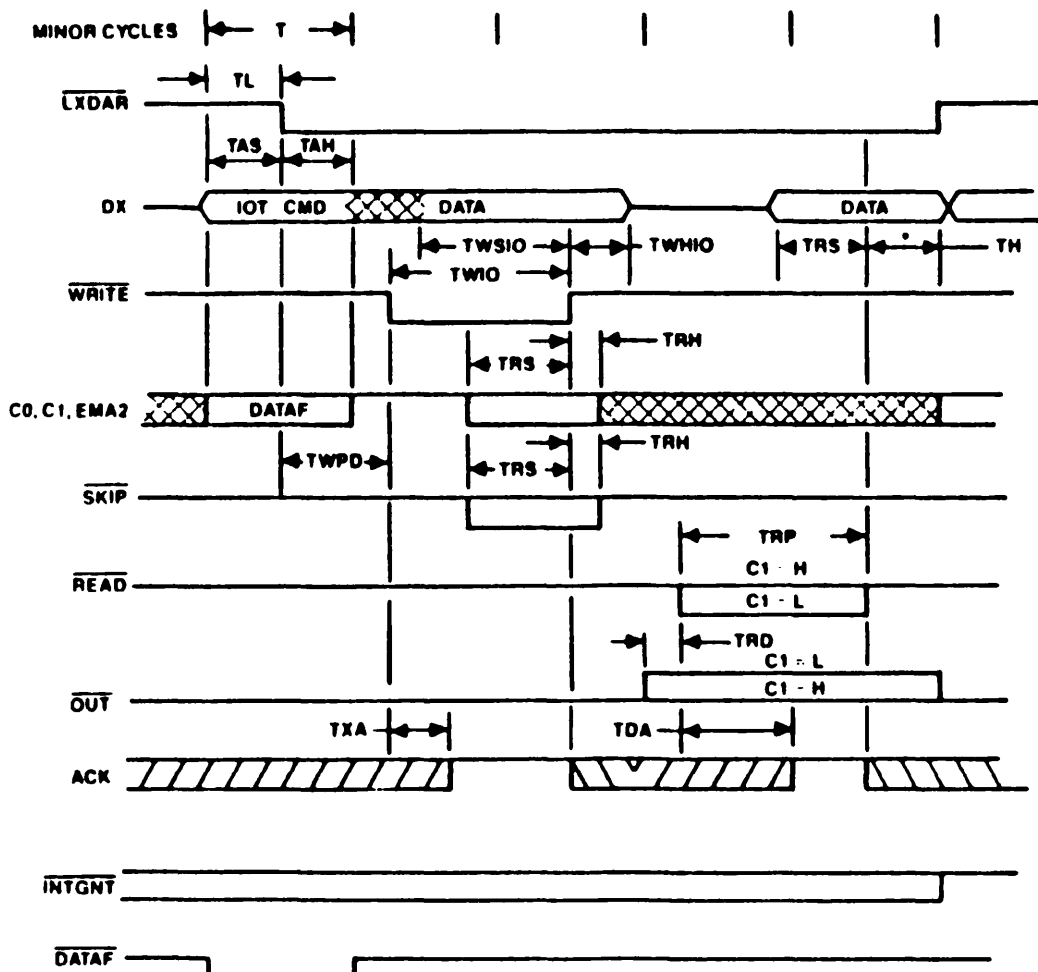
NOTES: Operation is shortened one Minor Cycle if READ is not executed.
* Read Data must be held until the rising edge of LXDAR for Read IOTs

EXTERNAL IOT OPERATION