

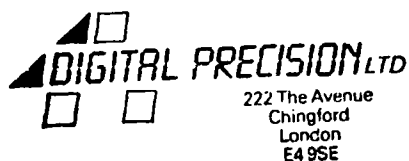
QMON II

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0 An Overview

QMON II is a low level monitor/debugger designed specifically for the QL and its operating system QDOS. It is ideally suited to the task of checking and debugging assembly language programs, and extensions to the SuperBASIC interpreter. Even if you already have a monitor/debugger for your QL, QMON II will provide extra assembly language programming power. QMON can also be used to monitor programs written in high level languages.

QMON is designed to integrate into the QDOS environment. This makes it possible to monitor just one job in the QL, or all the jobs that are executing. While tracing a job, QMON will normally skip the entries into QDOS, but it can trace right through QDOS. QMON does not interfere with QDOS so it is entirely feasible to examine one job in the QL, while other jobs continue unimpeded.

QMON has an extensive range of facilities including a window based memory editor, single- and multi- stepping, tracing and back-tracing with fixed and conditional breakpoints, as well as a macro command facility for tracing and patching, together with an unusually powerful set of commands for examining and altering machine code and data.

Despite its wide range of facilities QMON is very compact. The program includes a complete MC68008 single line assembler, editor and disassembler, occupies only 11k bytes, while a reduced version is included which takes 5k bytes.

1 About QMON

QMON is a tool to assist software developers. It is not intended as an aid to pirating other people's software or circumventing any of the mechanisms for protecting software. For this reason, there are some facilities, which could have been included, which have been omitted. This should not affect the use of QMON for legitimate purposes.

QMON is supplied on a Microdrive cartridge or floppy disk with a number of files:

BOOT	SuperBASIC program to load QMON_BIN
QMON	SuperBASIC program to load QMON_BIN
QMON_BIN	the QMON resident debugger
JOB	SuperBASIC program to load JOB_BIN
JOB_BIN	job control extensions to SuperBASIC
CLOCKS	configurable clock program
CLOCKS_LIST	assembly listing of clocks

The job control extensions and the configurable clock are supplied primarily as examples for learning to use QMON. But the job control extensions are also valuable for program development.

Before going any further please make a backup copy of the disk or cartridge, using WCOPY or similar (or our Transfer Utility!). Archive the original and use only the backup. This program is protected by international copyright law - do not break it.

If we have anything to add to the manual, we will put a Quill UPDATES_DOC on the medium.

2 QMON Commands

Commands may be in either upper or lower case. In general a command consists of a one or two letter abbreviation, followed by an optional channel number (which specifies where the output, if any, from the command will be sent) and some parameters separated by spaces:

D1 28000 10

Display on channel 1 from address 28000 10 (hex) bytes

In most cases, most or all of the parameters are optional. Thus, after the example above, new defaults for the display command are set so that:

D1 has the same effect as

D1 28010 10

Display on channel 1 from next address the same number

Note that, in QMON commands, a number is assumed to be hexadecimal to make the handling of data structures simpler, while the assembler assumes that a number is decimal. This is Motorola standard and it avoids confusion between, for example, register D2 and the address \$D2. Throughout, QMON will accept hexadecimal numbers starting with \$ (e.g. \$28000, the system variable base) and decimal numbers starting with & (e.g. &131072, the base address of the screen). The command handling of QMON will accept simple arithmetic expressions in both hexadecimal and decimal, and there is a command to calculate the value of an expression and print it in both (unsigned) decimal and (unsigned) hexadecimal.

In this document, the parts of commands which are printed in upper case are the actual characters typed, those parts in lower case are symbolic while square brackets ([...]) are used to denote optional parameters. A lower case 'c' is used to denote the optional channel number.

<ESC> denotes the key marked ESC, <ENTER> denotes the key marked ENTER and <CTRL> denotes the key marked CTRL.

<ENTER> will cause a line to be actioned, while <ESC> and the up and down arrows will abandon the current line.

When typing commands, errors may be corrected in the same way as for the standard line editing on the QL. The left and right arrows move the cursor, while in conjunction with <CTRL> they delete characters.

Execution (GO, TRACE and QUICK TRACE)

G	GO from current instruction
G address	GO from address
GB address	GO until breakpoint at address
GB address condition	GO until condition at breakpoint
GR	GO until return
Tc	TRACE one instruction
Tc number	TRACE number of instructions
TUc condition	TRACE until condition
TBc address	TRACE until breakpoint at address
TBc address condition	TRACE until condition at breakpoint
TRc	TRACE until return
Q number	QUICK number of instructions
QU condition	QUICK until condition
QB address	QUICK until breakpoint at address
QB address condition	QUICK until condition at breakpoint
QR	QUICK until return
<ENTER>	TRACE or QUICK trace

Trace Recall

RS number	creates buffer for number of steps
Rc	recall last step
<ENTER>	recall previous step

Trace Level

LU	traces user mode code only, GOes when trace enters a trap (default)
LS	traces supervisor mode code as well as user mode code

Breakpoint Control

B [addresses]	toggle breakpoint(s) and list them
BC	clear all breakpoints

Display Registers or Memory

Dc [address [number]]	display memory (in hex and ASCII)
Dic [address [number]]	display instructions in memory
DRC	display registers
<ENTER>	continue display

Set Registers or Memory

SB address byte	set byte in memory
SW address word	set word in memory
SL address long_word	set long word in memory
SDn value	set data register
SA n value	set address register
SSP value	set appropriate stack pointer
SUSP value	set USP (user stack pointer)
SSSP value	set SSP (supervisor stack pointer)
SSR value	set SR (status register)
SPC value	set PC (program counter)

Modify Memory

MBc [address]	modify memory in bytes
MWc [address]	modify memory in words
MLc [address]	modify memory in long words
Mic [address]	modify instructions in memory

Edit Memory

Ec [address]	edit memory
--------------	-------------

Find in Memory

F value [range]	find a matching string of bytes.
F 'string' [range]	find a matching string of characters
FI 'string' [range]	find string in an instruction
F or FI	continue search

Open Auxiliary Channels

Oc name	opens 'name' as channel 'c'
Oc	closes channel 'c'

Calculate Address

C address	calculates address and displays it
-----------	------------------------------------

Macro Command

CS	set macro command
CT	execute command every trace step
CB address	execute command at breakpoint
CC	clear CT or CB
CX	execute command

2.1 Addresses

Addresses (and most other values) may be given as a simple expression followed by an index. The expression must only include addition and subtraction, and the index may be one or more registers. All 32 bits of a register are used in calculating an address. There are some special addresses which may be used in the expression:

*	current PC (address of next instruction)
L	address used by the last display command
N	default next address
S	start address of job

The 'last address' is set by the display (D and DI) commands, modify (MB, MW, ML and MI) commands, and edit (E) command, the 'next address' is set by the find (F and FI) commands as well as by the display (D and DI) and modify (MB, MW, ML and MI) commands.

L-10	\$10 bytes before the last display address
N	the next display address
*+2	2 bytes on from PC
4(A1)	contents of A1 plus 4
(A6,D2)	contents of A6 plus the contents of D2
100(A6,A1,D2)	\$100 more than A6 plus A1 plus d2

2.2 Conditions

A number of the execution control commands (GO, TRACE and QUICK) use a condition to determine whether to stop execution. The condition is of the form 'register=value' or 'address=value'. The value is assumed to be a word unless it is followed by '.B' for a byte, '.W' for a word or '.L' for a long word. The '=' may be replaced by a '<' for a less than condition, or '>' for a greater than condition. This condition is checked after every instruction during TRACE, or, if there is a temporary breakpoint, the condition is checked at the conditional breakpoint.

2.3 Escape

While tracing and while displaying memory, QMON checks the ESC key. If the key is found to be depressed, the command is terminated.

To ensure that the ESC key is detected, it should be held down until the trace or display stops.

ESC is also used to terminate MODIFY sequences, or to cancel command which has not yet been ENTERed.

3 Invoking QMON

QMON will be most effective if the QL is running in 4 colour mode as it will be possible to display more information than in the 8 colour mode.

QMON is a resident debugger and may be loaded into the QL without having any effect on the operation of the QL. QMON becomes active when invoked from SuperBASIC and remains active until the QL is reset or the job for which QMON was invoked is removed from the QL.

The QMON cartridge or diskette has a boot file and if this is in drive 1 when the QL is reset, QMON will be automatically loaded. Otherwise QMON may be loaded by putting the cartridge or diskette in drive 1 and typing:

```
LRUN "FLP1_QMON"    (or LRUN "MDV1_QMON") or LRESPR "QMON_BIN")
```

QMON may now be invoked for job 0 (the SuperBASIC interpreter) by typing:

```
QMON
```

This will produce the prompt 'Qmon>' in window zero. All the QMON commands may now be used. To allow the BASIC interpreter to continue the simple command 'g' (GO) should be used.

```
QMON                      (invoke QMON)
Qmon> D 28000              (display the first few system vars)
28000 D254 0000 0002 8E00 0000 00FC 0002 9800 .T.....
28010 0003 CA00 0003 DC00 0000 0000 0003 DC00 .....
28020 0004 0000 0000 0000 0000 0000 0000 212B .....
28030 0000 0000 00C0 0001 0000 0000 0000 2CF8 .....
Qmon> G                    (GO)
```

The input and output of QMON will usually share the screen channels of the SuperBASIC interpreter. Other screen channels may be used for both input and output, and other devices (such as a printer or a file on a microdrive or diskette) may be used for displaying memory, or trace output. As the channels are usually shared with SuperBASIC, there may be some conflict. This is reduced by suspending SuperBASIC. SuperBASIC may be released using the normal CTRL SPACE keystroke, and may be suspended with the QMON_W command. The QMON_W command has no other effect.

QMON recognises 4 channels. There is a primary channel which is used for all commands, and it is in this channel that QMON will produce the register display at a breakpoint or other exception. It is also the default channel used for memory displays, etc. Each job monitored by QMON has its own primary channel. The other three channels (1 to 3) are shared by all jobs being monitored and are used for displaying memory, or for listing the short trace.

QMON by default will trace job 0 (the BASIC interpreter) in channel #0 of the SuperBASIC interpreter. If another job is to be traced, then its default primary channel will be #1.

The primary channel for QMON may be either a normal CONsole window of it may be a special transient window. The transient window appears when QMON is entered to write something to the window, the area of the screen occupied by the window having been saved in the heap. When QMON is left by an execution command (GO or TRACE), then the original contents of the screen are restored. There are 5 five-line transient windows spaced down the screen: window 0 is at the top, while window 4 is at the bottom. In order to be able to get a reasonable amount of information displayed in the transient window, the display mode is set to 512 pixel mode while a transient window is visible.

QMON may be invoked for a job already executing in the QL, or it may load and start a job itself.

The command to invoke QMON has a number of forms:

```
QMON                      monitor job 0
QMON [channel] name      load program 'name' and monitor it
QMON [channel] number    invoke or re-enter QMON for job number
```

The channel may be omitted, in which case, if this is the first time QMON has been invoked for the job, the default primary channel will be used, otherwise the previously used primary channel will be used.

The channel or device must be a CON device. There are three ways in which the channel may be specified:

```
#number,      a SuperBASIC channel number
name,         the name of a console device
number\       a transient window number
```

The job number may be found using the JOBS command in the job control extensions provided with QMON. However a good guess would be that the job number will be 1 if it is the only job other than the SuperBASIC interpreter.

3.1 Examples of invoking QMON

```
QMON                      monitor job 0 in window #0
QMON #2,3                monitor job 3 in window #2
QMON CON_256x70a0x0,1    monitor job 1 in a small window
QMON FLPI_clocks         set up clocks program and monitor in window #1
QMON 0\FLPI_clocks       set up clocks program and monitor in the
                        transient window at the top of the screen
```

If QMON has already been invoked for a job and that job creates a daughter job, then the daughter job will share the QMON working area with the parent until QMON is invoked for the daughter.

4 Concepts

4.1 Trace

Instructions executed by the MC68008 microprocessor in the QL are traced by QMON using the built-in trace facility in the processor. If the trace flag is set, then every time the processor executes an instruction, QMON is called by QDOS. The trace flag is in the status register and is maintained by QDOS for each job. It is therefore possible to trace some jobs in the QL while others continue to run quite normally.

QMON has two trace modes: in the normal trace mode the next instruction to be executed is written to the trace window after every step while in the 'quick trace' mode there is no visible sign that an instruction has been executed. In both modes, however, the conditions that govern the termination of the trace are checked every step. These conditions are one or more of

- a count of instructions executed,
- a check on a register or memory value,
- one or more breakpoints.

4.2 Breakpoints

A breakpoint is an address which is stored in QMON. The job being monitored by QMON will be stopped when the address of the next instruction to be executed is the same as the address of one of the breakpoints.

QMON handles up to six normal breakpoints as well as one special command breakpoint and one temporary breakpoint.

Breakpoints are handled in two ways in QMON. The first way is used with the 'GO' commands. For each breakpoint the first (or only) two bytes of the instruction are saved in the QMON working area for the job, and the illegal instruction '\$4AFB' is substituted. To ensure that the first instruction after a 'GO' command is actually executed, even if it is a breakpoint, QMON does one invisible trace step before the breakpoints are actually set.

This mechanism will clearly not work if the code being executed is in read only memory and cannot be changed. The 'TRACE' commands use a different mechanism: the code is not modified to mark breakpoints, but the breakpoint list is checked after every step to see if the address of the next instruction is the same as one of the breakpoints. Whereas setting a breakpoint for a 'GO' command does not influence the speed of execution of a job (until it actually stops!), even 'quick trace' can slow down the execution of a job by a factor of 50.

4.3 Exceptions

The MC68008 processor has two modes of operation, user mode and supervisor mode. Applications programs execute their own instructions in user mode, while 'privileged' code (e.g. the operating system functions) execute in supervisor mode. Code executing in supervisor mode has its own stack (the supervisor stack) and so QDOS extends the concept of privilege to mean that a job executing in supervisor mode cannot be interrupted by the scheduler to allow another job to execute. This means that there need only be one supervisor stack for all jobs resulting in a considerable reduction in overheads per job by comparison with other multi-tasking operating systems for the MC68000 type of processor.

The mode of operation of the MC68008 is changed to supervisor mode by an exception. Exceptions range from the unpredictable (one of the external interrupts) through the accidental (e.g. illegal instruction) to the controlled (e.g. the trap instructions). QDOS itself is entered by trap instructions and so executes in supervisor mode. QMON is also entered by exceptions and so it, too, executes in supervisor mode. It does not, therefore, use or modify any of the user stack of any job being monitored. However, to allow the QL to continue running other jobs while one is being monitored, QMON reverts to the job's own mode while it is idling waiting for input or output. If QMON is idling in supervisor mode the cursor will not be flashing.

It will not usually be necessary to trace the execution of QDOS traps, so provision is made in QMON to detect a change to supervisor mode during trace and 'GO' automatically. As the status register will now be saved with the trace flag set, when QDOS returns control to the application code, the trace will be restored. Unfortunately, the trace will not be activated until one instruction after the trap.

There should rarely be any need to trace supervisor mode code, but if this is to be done then the trace level may be set to supervisor. While QMON is monitoring supervisor mode code, no attempt should be made to display memory or to send trace output to one of the serial ports. The microdrives or floppy disks may, however, still be used.

If QMON is being used to trace a QDOS entry, then a GO instruction will GO until the status register is restored on exit from QDOS.

The exception vector used by QDOS during IO subsystem retries is not defined. If you wish to breakpoint or trace the operation of a device driver when handling IO with non-zero timeout, then you should ensure that all jobs executing have had QMON invoked, or, preferably, that the SuperBASIC interpreter is the only job executing.

When QMON is invoked, it creates an exception redirection vector so that QDOS will pass control to QMON when certain exceptions occur. If a job already has an exception vector set up (e.g. to action divide checks) then not all of the QMON exceptions will be redirected. In some cases, if the pointer in the vector does not point directly to an RTE (return from exception) instruction, then the original pointer will be copied into the new vector.

Exceptions not in the following list are irrelevant to the QL and are neither actioned by QDOS nor redirected.

Exception	Name	Action
Address Error	Add.er	always redirected to QMON
Illegal Instruction	Il.ins	always redirected to QMON
Zero Divide	Zero.d	pointer copied from old vector
CHK Instruction	Chk	pointer copied from old vector
TRAPV Instruction	Trapv	pointer copied from old vector
Privilege Violation	Priv.v	always redirected to QMON
Trace		always redirected to QMON
Level 2 Interrupt		handled by QDOS
Level 7 Interrupt	Int 7	always redirected to QMON
Trap #0 to Trap #4		handled by QDOS
Trap #5 to Trap #15	Trapn	pointer copied from old vector

When QMON is entered by one of these exceptions, the exception name is written to the primary channel, followed by a register display. If the entry was at a breakpoint, then 'At brp' is written instead of 'Il.ins'

4.4 Trap #4

Execution of a Trap #4 causes problems for a QDOS monitor. If the monitor uses any IO operation after a Trap #4 and before the following #2 or Trap #3, then the action of the Trap #4 will be transferred to the monitor with unpredictable results. For this reason an attempt to trace past a Trap #4 will cause the monitor to enter quick trace mode until the following Trap #2 or Trap #3 has been executed. Ideally the trace level should be set to user. There should be no breakpoints in between the Traps. When single stepping, if the next instruction is a Trap #4, then 'T' should be safe, but 'G' should only be used if it is essential to monitor the execution of the instructions between the Trap #4 and the following Trap #2 or Trap #3.

5 Assembler Format

The assembler and disassembler use Motorola format instructions. The assembler will accept the general form of those instructions which have more than one particular form (e.g. ADD may be used in place of ADDI and ADDA). One limitation is that it is necessary to specify the length of a direct address (e.g. TST.B \$280E0.L or MOVE.L \$110.W,A2). The disassembler produces instructions in the particular form (e.g. ADDA or ADDI rather than ADD).

The assembler does not accept expressions. Hexadecimal values or addresses should be preceded by \$.

6 Command Reference

6.1 GO

G	GO from next instruction
G address	GO from address
GB address	set temporary breakpoint and GO
GB address condition	GO until condition at breakpoint
GR	GO until return

The GO instructions trace one step invisibly then set \$4AFB (illegal instruction) at each breakpoint, clear the trace flag and continue execution of the job being monitored. In all cases execution will cease if QMON is entered by an exception (other than a breakpoint) or at a normal breakpoint. In the case of GB with a condition, if the condition is not met at the temporary breakpoint, then execution will continue.

G	GO from next instruction.
G 3FC50	set program counter to \$3FC50 and GO.
GB *+6	set the temporary breakpoint at 6 bytes on from the next instruction and GO from the next instruction.
GB 3FD46 D1=4	set the temporary breakpoint at \$3FD46 and GO from the next instruction. If the condition (D1.W=4) is not met when the instruction at the temporary breakpoint address is about to be executed, the temporary breakpoint remains set and execution continues. Execution will cease when either the condition is met at the temporary breakpoint address, or QMON is entered at one of the permanent breakpoints.
GR	trace one instruction then set the temporary breakpoint at the (return) address to be found on the stack and then continue. If the next instruction is at address \$3EFC0 and it is a BSR.L, after this is executed, the address \$3EFC4 will be on the stack. Thus the breakpoint is set on the first instruction to be executed after a normal return.

6.2 TRACE

Tc [number]	TRACE [number of instructions]
Q [number]	QUICK [number of instructions]
TUc condition	TRACE until condition
QU condition	QUICK until condition
TBc address	TRACE until breakpoint
QB address	QUICK until breakpoint
TBc address condition	TRACE until condition at breakpoint
QB address condition	QUICK until condition at breakpoint
TRc	TRACE until return
QR	QUICK until return

The TRACE instructions set the trace flag and execute the next instruction. If the command was TRACE rather than QUICK and there is more than one instruction to be traced, then the address of next instruction and the instruction itself are written to the channel 'c'. If 'c' is given, it should be in the range 1 to 3. TRACE and QUICK will continue until the trace count is exceeded, the next instruction is at a breakpoint, another exception occurs or the <ESC> is pressed.

T	trace one instruction.
T 20	trace \$20 instructions.
T2 10	trace \$10 instructions, writing the instructions executed to channel 2.
QU D0=0	trace invisibly until the condition (D0.W=0) is met.
TB 3FD46	set the temporary breakpoint at \$3FD46 and trace until next instruction is at a breakpoint.
TB3 3FD46 (a1)=20.b	set the temporary breakpoint at \$3FD46 and trace (to channel 3) until the the byte at the address currently in a1 is \$20 and the program counter is at the temporary breakpoint.
QR	trace one instruction then set the temporary breakpoint at the (return) address to be found on the stack and and quick trace until breakpoint. If the next instruction is at address \$3FF30 and it is a BSR.S, after this is executed, the address \$3FF32 will be on the stack. Thus the breakpoint is set on the first instruction to be executed after a normal return.

Default Command

If the previous command was a TRACE or GO command, then a blank line (just <ENTER>) is interpreted as trace one instruction.

6.3 RECALL

RS number	sets up a buffer for number steps
Rc	recalls last step to channel 'c'

RECALL is a backtrace facility which stores the registers for each trace step in a rolling buffer. The number of steps that can be stored depends on the memory available.

RS	set up a buffer for 8 steps
R1	recall last step to channel 1 ...
<ENTER>	... and previous step ...
<ENTER>	... and previous to that

6.4 TRACE LEVEL

LU	trace user mode code only, GOes when trace enters a trap (default)
LS	trace supervisor mode code as well as user mode code

These two commands are used to specify whether QMON will trace the internal operations of QDOS (QDOS code executes in supervisor mode). By default the level is set to user mode only. However, if an exception occurs which causes QMON to be entered in supervisor mode, then the level is automatically reset to supervisor mode.

Note that, if the level is set to user mode only, then when a trap instruction is traced, the instruction following the trap will not be traced unless it is at a breakpoint.

6.5 BREAKPOINTS

B [addresses]	toggle breakpoint(s)
BC	clear all breakpoints

QMON can handle up to 7 permanent and one temporary breakpoints. The temporary breakpoints are set by some of the GO and TRACE commands and are cleared on completion of the command. 6 of the permanent set of breakpoints are 'toggled' by the 'B' command, or all of these are cleared by the BC command. At completion of the B command, the current set of permanent breakpoints is listed. 'Toggling' a breakpoint means setting the breakpoint if it is not already set, otherwise clearing it. The seventh permanent breakpoint is set by the CB (macro command on breakpoint) command.

B	list the current set of breakpoints.
B 3ED80	if there is no breakpoint at \$3ED80 set one, otherwise clear it. Then list the current set of breakpoints.
B 3ED80 3EDF8	toggle the breakpoints at \$3ED80 and \$3EDF8.

6.6 DISPLAY

Dc [address [number]]	display memory (in hex and ASCII)
Dlc [address [number]]	display instructions in memory
DRC	display registers

The display commands can all send their output to the auxiliary channel 'c'. If given 'c' should be in the range 1 to 3.

The format of these displays are quite different from each other.

The display memory command displays on each line:

- the start address of the line,
- 8 or 16 bytes (depending on the window width) in HEX,
- the same bytes in ASCII if printable or else '.';

while the display instructions command displays on each line:

- the address of the instruction,
- the first 2 bytes of the instruction,
- the disassembled instruction.

The default number of lines for these is 16 or one less than the height of the display window, whichever is less. The default display address is updated to be the address after the end of the display.

The display registers command displays:

- the status register (in hex and the individual flags and the value of the interrupt mask) the alternative stack pointer,
- the values of the 8 data registers and the 8 address registers,
- the next instruction in display instruction format.

D 28000	display the start of the system vars.
D1	display from end of previous display to channel 1.
D L-10 10	display \$10 bytes previous to last display address
DI *	display instructions starting at the next instruction

Default Command

If the previous command was a 'D' or 'DI' command, then a blank line is taken to be another 'D' or 'DI' command to the same channel, and displaying the same number of bytes or instructions, starting from the new default address.

```
DI1 3FCE0 8          displays 8 instructions from address
                      $3FCE0 on channel 1 ....
<ENTER>             .... displays the next 8 instructions too.
```

6.7 SET

SB address byte	set byte in memory
SW address word	set word in memory
SL address long_word	set long word in memory
SDn value	set data register
SAn value	set address register
SSP value	set appropriate stack pointer
SUSP value	set USP (user stack pointer)
SSSP value	set SSP (supervisor stack pointer)
SSR value	set SR (status register)
SPC value	set PC (program counter - the address of the next instruction)

The SET commands set a single value.

```
SW 3E7C4 40          sets the word at $3E7C4 to $0040.
SD4 63              sets D4 to $00000063.
```

6.8 MODIFY

MBc [address]	modify memory in bytes
MWc [address]	modify memory in words
MLc [address]	modify memory in long words
MIc [address]	modify instructions in memory

The modify commands start a dialogue in either the primary channel window, or in the auxiliary channel 'c' (in the range 1 to 3) which must be a CONSOLE channel. QMON writes out the address and the value or instruction at that address, and the user can

```
press ENTER to leave the value or instruction unchanged,
press UP ARROW to go back a byte, word (MW or MI) or long word
press DOWN ARROW to go on a byte, word, long word or instruction
press ESC to stop the dialogue,
retype the value or instruction followed by enter
or edit the instruction using cursor keys in the normal way.
```

```
Qmon> MB 38798        start modifying bytes at $38798
38798 70              ENTER leaves byte unchanged
38799 1e              byte changed to $1E
3879A 72 <ESC>        ESC exits
Qmon> MW              modify words at default address
3879A 7204 <ESC>      ESC exits
Qmon> MI              modify instructions at default address
3879A MOVEQ #$4,D1    ENTER leaves instruction unchanged
3879C MOVEQ #$FF,D3   ... and so on.
```

Because the up arrow moves back by one word in the MI command, this will tend to create spurious disassemblies when there are instructions which are more than a word long. Equally, this facility may be used to get the disassembler back into alignment if the MI command does not start on the first word of an instruction.

6.9 EDIT

Ec [address] edit memory in specified channel

This is a hexadecimal and character window based editor. Memory contents may be changed simply by overtyping with the new values. The memory display is similar to that produced by the display command with memory addresses, hexadecimal values and characters. The up, down, left and right keys are used to move the cursor, and <TABULATE> is used to move between the hexadecimal area and the character area. <ESC> exits from the editor.

6.10 FIND

F value [range] find a string of bytes in memory
F 'string' [range] find a string of bytes in memory
FI 'string' [range] find a string within a disassembled
 instruction
F or FI continue last F or FI

These commands search for strings of bytes or instructions. The default range for the search is from the base of the system variables up to the top of RAM. If a lower limit is given for the search range, then that default is reset, if both a lower limit and an upper limit are given then both defaults are reset. If no parameters are given then the previously specified parameter will be used, and the search will start one byte or one instruction beyond the last match found.

The display address will be set to the even address which comes 8 bytes before the match. This means that a D or DI command will display the context of the match, while a modify command will start well before the match.

The value should be specified in hexadecimal and should have not more than 64 digits (up to 32 bytes). Find string should be specified with a string of not more than 32 characters. Find Instruction should also be specified with a string of not more than 32 characters. The FI command scans the memory disassembling every word, each disassembled instruction is then searched for a matching string. This enables references to particular addresses to be found as well as searching for particular instruction formats. (Note that the disassembler uses hexadecimal notation and the particular forms of commands: ADDA, ADDI, etc.) As Finding an Instruction is very slow, the Find can be interrupted by pressing <ESC>.

F 4AFB find two bytes \$4A and \$FB in default
 range.
F 704774 37000 reset range from \$37000 up to default
 top, and find 3 bytes \$70 \$47 \$74
F 'JOBS' find the string 'JOBS'
F find next occurrence of 'JOBS'
D and display the memory around it
FI 'addq.l #4,a7' find the instruction ADDQ.L #4,A7

6.11 OPEN

Oc name	opens 'name' as the debugger channel 'c'
Oc	closes or detaches debugger channel 'c'

The first action of the open command is to close or detach the channel open already as channel 'c'. If the channel is 'owned' by QMON, then the channel is closed, but if the channel is 'owned' by the SuperBASIC interpreter, it is merely forgotten.

If no name is given, no new channel is opened. Otherwise, a new channel is opened to the device or file specified. 'c' must be in the range 1 to 3 and the channel thus opened may be used by trace, display or (if a CONsole) modify commands.

These auxiliary channels are shared by all jobs being monitored by QMON.

When first loaded QMON has channel 1 opened to BASIC #1 and channel 2 opened to BASIC #2.

O3 MDV2_LOG	open file MDV2_LOG (a new file) as QMON auxiliary channel 3
O3	close or detach auxiliary channel 3

6.12 CALCULATE

Cc address	calculates the given address and writes it in hexadecimal and decimal to channel 'c'
------------	--

This command is used to calculate an address.

C 10(A6,A1)	if A6 is \$3b668 and A1 is \$448 then this will write out: 3BAC0 244416
-------------	--

6.13 MACRO COMMAND

CS	set macro command
CT	execute command every trace step
CB address	execute command at breakpoint
CC	clear CB and CT
CX	execute command

A macro command is a compound command which can be invoked directly, at a specified breakpoint or at every trace step. The command is set up by the CS command. It is a single line with one or more commands separated by the '\' symbol. The command may be used to expand the short trace produced by QMON, or to display memory contents or set memory locations or registers at a breakpoint. If a command is to be executed at a breakpoint, then, if execution of the job is required to continue, the last command on the line should be a GO or QUICK instruction as appropriate.

```
Qmon> CS
> D1 (A1) 8 \ SSP -4(SP) \ SL (SP) (D0) \ G
Qmon> CB 36786
Qmon> G
```

Just before the instruction at the breakpoint \$36786 is executed, 8 bytes pointed to by A1 will be written to channel 1, then the stack pointer will be decremented by 4 and the contents of D0 put on the stack.

MEDIA MANAGER SPECIAL EDITION MEDIA MANAGER

Media Manager Special Edition (MMSE) is a program to be used both when things have gone wrong as well as when things are perfectly OK. It allows for automatic, semi-automatic and manual correction of a huge variety of disk and tape problems. It allows you to explore disks and tapes to your heart's content, producing all sorts of different diagnostic reports. MMSE is very simple to operate, being menu-driven and assuming no degree of computer knowledge whatsoever.

MMSE also allows you to tidy, catalogue, sort and order your disks and cartridges.

The standard Media Manager is both less powerful and less user-friendly, but manages to work on an unexpanded QL.

Both programs allow for data transfer between PC and QL. With MMSE, this transfer is at file and directory level, is bi-directional and is completely automatic.

SPECIAL DESKTOP PUBLISHER DESKTOP PUBLISHER

These programs are quite primitive compared to Professional Publisher. However, if you have not experienced that program as yet, you will find both of these very competent. Both are capable of producing excellent results. The cheaper one has fewer features but is able to run on smaller systems.

EDITOR SPECIAL EDITION THE EDITOR

With the sole exception of Perfection, this is the best word handling system on the QL. Editor's features include an unrivalled degree of programmability and the ability to cope with the entire 256 character ASCII set. The Special Edition has enhanced document-type facilities, including column blocks and on-screen page break displays. Neither program is suitable for computing novices. Until Perfection, Editor Special Edition would have been our 'Desert Island Program'.

Editor SE can do a few things that Perfection can't, so the ideal combination is to have both (they are compatible at file level and can multitask). If you order Editor SE at the same time as Perfection, you can have Editor SE at half price.

PROFESSIONAL ASTROLOGER PROFESSIONAL ASTRONOMER

The Astrologer program teaches you Astrology from scratch and enables you to automatically produce text narrative on personality delineation, year-to-year and minute-to-minute life predictions, compatibility interpretations and so on. Whether or not you believe in astrology - indeed, especially if you do not - this program is one that you cannot afford to have. You can tailor the readouts (both in terms of quantity and what is said) to your own particular requirements. The amount of fun you can have with this program is endless. Do not blame us if you start believing in astrology, though!

Astronomer is an extremely fast and accurate solar system calculator, with planetarium views, planet faces, eclipses, cinerama display etc.

TURBO BASIC COMPILER

Turbo is the finest BASIC compiler for the QL and arguably the finest BASIC compiler for any computer!

Turbo automatically converts working BASIC programs into optimised machine code, usually with no need for human intervention. The benefits of this conversion are vastly enhanced running speed (as well as much faster loading, encryption and automatic bug fixing for a variety of QL interpreter oddities). Typical speed-up is 40x - 100x.

Turbo is provided with a 200 command toolkit, adding many useful commands to BASIC. Most of these commands will be of immediate use to the programmer, whether he is a novice or an expert. There are commands to load strings and floats into RAM, and to extract them automatically; to search memory and to move its contents; to control jobs and change their priorities, manage pipes, locate and deallocate memory, to control both rubber and virtual arrays, to present INPUT with an editable default, to have random access to files and much more.

TOOLKIT III

Toolkit III starts where Toolkit II stopped, adding about 60 new commands and enhancing many existing dual functions. Toolkit III is available either on disk or on ROM, and works whether or not you have Toolkit II.

Toolkit III commands can, with only a couple of exceptions, be compiled using Turbo.

QFLICK CARD INDEX

All QL owners have a copy of Archive, supplied free with the QL. While Archive is competent, it is very hard to get to grips with and is not particularly fast. QFlick presents a very convenient alternative - a snappy, simple-to-use, pointer-controlled card file database. You can move data between QFlick and Archive in either direction.

QFlick is not itself programmable but we document its data structure and give guidance on how to program it using Turbo.

ARCHDEV + RTM DATABASE ANALYSER ARCHIVE TUTORIAL NAMES + ADDRESSES MAILMERGE DAT-APPOINT SEdit SCREENPRINT RECOVER

This suite of utilities will greatly enhance your use of the Archive database system.

Archdev + RTM is a straight replacement for Archive: It gives enhanced speed, greater workspace and a much cleaner boot-up. All your existing applications will work.

Database Analyser provides very fast and comprehensive statistics about your Archive databases.

Archive Tutorial proceeds systematically through the whole philosophy and grammar of Archive, providing you with expert and patient guidance.

Names + addresses, Mailmerge and Dat-Appoint are ready-to-run, off-the-shelf Archive applications, providing an address database, mailmerging and appointment diary respectively. You now have no excuse not to use Archive.

SEdit allows you to create and edit screen format files in Archive. Screenprint allows you to print them out.

Recover allows you to get back lost Archive databases, created when you switched off the computer without properly exiting from Archive.

XREF SUPERBASIC MONITOR BETTERBASIC EXPERT SYSTEM

XRef analyses the structure of a BASIC program, providing detailed reports on things like variable usage, what calls what, dynamic call hierarchy of procedures and functions, and so on.

SuperBasic monitor actually monitors and reports on the performance of BASIC programs as they run under the interpreter.

BetterBasic analyses and automatically corrects structural flaws in your programs and allows you to customise things like indentation, number of statements per line, filtering out of noise words, etc.

The three programs together provide a matchless diagnostic and auto-correcting facility for BASIC programs.

TRANSFER UTILITY

This program copies files at high speed between devices, performing translates as it goes along. Ideal for all sorts of applications, including transfers from microdrive to disk.

QMATHS SYSTEM

This is an incredible mathematical compendium for the QL. Pride of place goes to the symbolic problem solver: this can solve equations, simplify expressions, factorise, expand, etc. all symbolically. If you could sneak this one into a maths examination, you would have a formidable ally. QMaths knows about all the algebraic operators, powers, roots, brackets, trigonometry, matrices, determinants, vectors, factorials, permutations, combinations, binomials, exponentials, logarithms, hyperbolics, inverse functions, infinite series including Taylor & Maclaurin expansions, complex numbers, conversions, Fourier series, and lots of calculus: both differential and integral, including integration by parts and definite integrals. QMaths optionally displays its workings and comes with a superb interactive tutorial.

The package also contains an interpretive, fractal, image-generating language with loads of beautiful fractal programs supplied for you to use and edit - no programming skill is required.

There is also a multiple precision floating point maths package, giving calculations at precisions up to over 600 decimal digits of accuracy.

There is even more to this system, but we think we have told you enough.

QMON MACHINE CODE MONITOR

The latest version of Tony Tebby's superb monitor: an absolute must for those who really want to know what is going on in the QL. No other machine code monitor even comes close.

Do not confuse this program with SuperBasic monitor, which monitors SuperBasic, not machine code.

COMPARE

This program compares files - data or program - at colossal speed. Where a mismatch is detected, the relevant areas are highlighted and you can shuffle, displace and align very easily.

CASH TRADER WITH ANALYSER PAYROLL

Cash trader with Analyser is an accounts system designed by businessmen and not by wretched accountants! Consequently, it has excellent reporting and management facilities, and is very flexible. It is aimed primarily at the layman, probably a sole trader running a small or medium sized business. All the features you would expect - including audit trail - are present.

Payroll is a reasonably flexible system designed to automate the payroll function in small businesses.

Both programs are configurable, with editable defaults letting you adapt the programs from year to year.

HARDBACK WITH FINDER

This is the ultimate hard disk backup and management utility, with all the sophisticated features you could want. User dialogue is via overlapping pop-up windows - the whole program just feels right. It is possible to scan the disk at great speed, too.

DISKTOOL WITH QUICKDISK

This permits you to add password protection to disks, to optionally increase disk storage capacity on DSDD drives by 36K and to increase speed of access by as much as 30%. All this is done while maintaining full compatibility. Automatic file management is also provided.

DIGITAL C SPECIAL EDITION DIGITAL C

These are extremely fast and efficient C compilers, complying with and surpassing the Small C definition. The Special Edition goes much further, including support for structures, pointers, long pointers, >64K code size, direct access to QDOS traps, etc. The Special Edition C generates code that runs about twice as fast as the other.

```
Qmon> CS
> D3 (A1) 8 \ D3 38688 8
Qmon> CT
Qmon> TU D6>10
```

Until D6 is greater than 10, at every step there is a partial memory display to channel 3.

7 EXAMPLES OF USE

Note: press the ENTER key at the end of each command.

7.1 SuperBASIC Extensions I

To illustrate the use of QMON while developing extensions to the QL SuperBASIC, the JOBS procedure which is supplied with QMON will be examined.

This first example illustrates the use of QMON in 512 pixel (4 colour) mode. This is the preferred mode for QMON as colour is of little help while the advantage of 80 column output over 40 column is very great. The example SuperBASIC Extensions II illustrates the use of 256 pixel mode.

RESET the QL,
put QMON in drive 1 and press F1.

When the cursor appears QMON will be loaded but inactive. Before invoking QMON load the job control extensions and try out the JOBS command by typing

```
LRUN MDV1_JOB          (or LRUN FLP1_JOB)
JOBS
```

The list of jobs currently executing in the QL is written to window #1; there should only be one, the SuperBASIC interpreter, being job 0, tag 0, owner 0, priority 32 and no name. Now invoke QMON by typing

```
QMON
```

A prompt 'Qmon>' should appear in the command window. QMON is now linked into the SuperBASIC interpreter (and, by implication, linked into any jobs created by the SuperBASIC interpreter) and it is waiting for a command

If the JOBS procedure is to be examined in action, a breakpoint should be set to enter QMON when the procedure is called. The entry point of JOBS will not be at the start of the resident procedure area, but we can find it by examining the procedure definition table which will be near the start of the resident procedure area. Now type

```
Qmon> D 28000          (or d 28000)
```

The base of the system variables area is now displayed in the command window. The address of the base of the resident procedure area is at address 2801C, that is the last two groups of digits on the right hand end of the second line. This address should be 3CA00 on a QL with 128 kbytes of RAM. To display the start of the resident procedures in window #1, type

```
Qmon> D1 3CA00        (or d1 3ca00)
```

Those with expanded memory machines will need to work out their own addresses!

The right hand edge of the display in window #1 is mostly nonsense characters and dots. However, from the third line onwards the words 'AJOB', 'RJOB', 'SPJOB', 'JOBS' are visible. This is the procedure definition table.

To look at the start of the JOBS procedure, the start address of the procedure is found by adding the offset (00A0) which precedes the name 'JOBS' in the table to the address of this offset (3CA28).

```
Qmon> DI2 3CA28+A0
```

The code, now listed in window #2, starts with a branch to a routine to get the channel for the JOBS command, followed by a check on the error return from this subroutine. The register D7 is used as a count of the number of lines written to the output channel, and so has one added to it before the heading line is written out. To trace this code set a breakpoint at the start address 3CA28+A0:

```
Qmon> B L          (L is the last address used)
BRP 3CAC8          (confirms breakpoint set)
Qmon> G            (go on back to SuperBASIC)
JOBS               (do JOBS procedure)
```

The response to this should be the message 'At brp' (at breakpoint) followed by a display of the registers. The next instruction to be executed (a BSR.L) is displayed at the end. This call to a not very interesting routine is bypassed.

```
Qmon> GR           (go until return)
```

The Z flag in the condition code register should be set, so that the conditional branch (BNE) should not be taken. The condition code register is the less significant byte of the status register (SR) and is in the first line of the register display. The individual flags X, N, Z, V, and C are put in the line if they are set. The digit is the current interrupt mask value.

```
Qmon> T            (trace, just <ENTER> would do)
```

One instruction has been traced and the next is displayed. From now on just pressing ENTER will trace one instruction at a time. Note that when the next instruction to be traced is a TRAP then the trace is suspended until the instruction after the TRAP has been executed. As this is usually a TST.L D0, this is not a very serious problem.

Repeated operations in QMON are interruptable using the ESC key. Type:

```
Qmon> DI2 * FFFF   (display many instructions)
```

pressing ESC will stop the display, pressing ENTER will restart it.

7.2 SuperBASIC Extensions II

This a repeat of the SuperBASIC Extensions I, but for TV mode.

```
RESET the QL,
put QMON in drive 1 and press F2.
```

When the cursor appears, QMON will be loaded but inactive. Before invoking QMON load the job control extensions and try out the JOBS command by typing

```
LRUN MDV1_JOB          (or LRUN FLP1_JOB)
JOBS
```

The list of jobs currently executing in the QL is written to window #1; there should only be one, the SuperBASIC interpreter, being job 0, tag 0, owner 0, priority 32 and no name. Now invoke QMON window #1 by typing

```
QMON #1
```

A prompt 'Qmon>' should appear in the window #1. In this mode there is insufficient room for the register display in the command window, so it is necessary to use a larger window for QMON. QMON is now linked into the SuperBASIC interpreter (and, by implication, linked into any jobs created by the SuperBASIC interpreter) and it is waiting for a command.

If the JOBS procedure is to be examined in action, a breakpoint should be set to enter QMON when the procedure is called. The entry point of JOBS will not be at the start of the resident procedure area, but we can find it by examining the procedure definition table which will be near the start of the resident procedure area. Now type

```
Qmon> D 28000 20          (or d 28000 20)
```

The base of the system variables area is now displayed in window #1. The address of the base of the resident procedure area is at address 2801C, that is the last two groups of digits on the right hand end of the fourth line. This address should be 3CA00 on a QL with 128 kbytes of RAM. To display the start of the resident procedures, type

```
Qmon> D 3CA00             (or d 3ca00)
```

The right hand edge of the display in window #1 is mostly nonsense characters and dots. However, from the third line onwards the words 'AJOB', 'RJOB', 'SPJOB', 'JOBS' are visible. This is the procedure definition table.

To look at the start of the JOBS procedure, the start address of the procedure is found by adding the offset (00A0) which precedes the name 'JOBS' in the table to the address of this offset (3CA28).

```
Qmon> DI 3CA28+A0
```

The code, now listed in window #1, starts with a branch to a routine to get the channel for the JOBS command, followed by a check on the error return from this subroutine. The register D7 is used as a count of the number of lines written to the output channel, and so has one added to it before the heading line is written out. To trace this code set a breakpoint at the start address 3CA28+A0:

```
Qmon> B L                (L is the last address used)
BRP 3CAC8                (confirms breakpoint set)
Qmon> G                  (go on back to SuperBASIC)
JOBS                     (do JOBS procedure)
```

The response to this should be the message 'At brp' (at breakpoint) followed by a display of the registers. The next instruction to be executed (a BSR.L) is displayed at the end. This call to a not very interesting routine is bypassed

```
Qmon> GR                 (go until return)
```

The Z flag in the condition code register should be set, so that the conditional branch (BNE) should not be taken. The condition code register is the less significant byte of the status register (SR) and is in the first line of the register display. The individual flags X, N, Z, V, and C are put in the line if they are set. The digit is the current interrupt mask value.

Qmon> T (trace, just <ENTER> would do)

One instruction has been traced and the next is displayed. From now on just pressing ENTER will trace one instruction at a time. Note that when the next instruction to be traced is a TRAP then the trace is suspended until the instruction after the TRAP has been executed. As this is usually a TST.L D0, this is not a very serious problem.

Repeated operations in QMON are interruptable using the ESC key. Type

Qmon> DI * FFFF (display many instructions)

Pressing ESC will stop the display, pressing ENTER will restart it. The same principle holds for output to an external device. If a serial printer is available, plug it into SER1, type

Qmon> O3 SER1 (open SER1 as channel 3)
Qmon> DI3 * FFFF (display on printer)
<ESC> (stops the printer output)
Qmon> G (carry on)

7.3 SuperBASIC Extensions III

After trying the previous examples, it is a simple matter to use QMON to generate some trivial code. The first few bytes of the QMON and JOBS extensions are only used for initialisation. Once called they may be overwritten with complete safety. So, to illustrate the use of the QMON assembler type

QMON
Qmon> MI 3CA00 (modify instructions)
3CA00 LEA \$3CA0E(PC),A1 (first instruction)

Type

MOVEQ #\$F6,D0<ENTER>

This instruction is accepted, but is a different length from the previous instruction, and so the disassembler now makes a valiant, if incorrect, attempt at interpreting the next word as the start of a four byte instruction.

Type

RTS<ENTER>
<ESC>
Qmon> G

The escape returns to QMON command mode. 'G' returns to BASIC.

This code sets the error register to 'end of file' and returns. Try

CALL RESPR(0) (call base of resident procs)

The message 'end of file' should be written out.

7.4 Tips

If you are uncertain as to where to put a breakpoint, use the MI command and move through the code using the down arrow (or possibly up arrow) key, and, when you have found the instruction, press <ESC> and then type

B N (breakpoint at next address)

If you are uncertain as to what is about to happen, use Quick trace rather than Going. Then, if anything untoward happens, you can stop it with <ESC>.

It is a good idea, when you are starting to develop software, to scatter a number of TRAP #15 instructions through your code. These will not affect the normal operation of the code, but, if QMON has been invoked, then QMON will be entered at these instructions.

7.5 Executable Programs

A file 'clocks' is included with QMON as an example of an executable program.

Clocks is a digital clock which executes in a default window which is set up to be in the top right hand corner of window #0 for the default monitor mode windows. The clock displays the day of the week, as well as the day, month and time. Both the default window and the characters displayed may be patched.

The characters displayed in the window are selected using a list of bytes. The first byte is the number of bytes in the rest of the list and each of the following bytes selects a character to be written. If the byte is greater than hex 1F then the byte is the 'value' (or 'code') of a character to be written. If the byte is between 0 and \$17 (inclusive) then it is a pointer to a buffer containing the characters of the day and date:

00	08	10	18	
day#yyyy	mmm	dd hh:mm:ss		(the 4th byte is unset)

The list for the default display is:

14,0,1,2,C,D,E,F,9,A,B,C,10,11,12,13,14,15,16,17,20

The addresses which may be patched in the program CLOCKS are:

Address	Length	Value	Meaning
A8	byte	00	border width
A9	byte	00	border colour
AA	byte	10	strip colour
AB	byte	07	ink colour
AC	word	003C	window width
AE	word	0014	window height
B0	word	01C0	X origin
B2	word	00CE	Y origin
B4	bytes		character list

The assembler listing of this program is in the file `CLOCKS_LIST`, it will help to follow the execution of the program if you have a listing of this file handy. To experiment with this program:

```
RESET the QL,  
put QMON in drive 1 and press F1,  
type LRUN FLP1_JOB  
type QMON FLP1_CLOCKS
```

A register display should appear in window #1. The first instruction of `CLOCKS` has been executed and the next instruction will set `A6` to zero. Type

```
Qmon> D                                (display)
```

The start of the program should be displayed, and the name should be visible on the right hand side of the display. Type

```
Qmon> T 20                             (trace 20)
```

When 32 instructions have been traced another register display will be written. Type

```
Qmon> Q FFFF
```

A large number of instructions will now be traced in quick trace mode, pressing `<ESC>` will stop execution.

To trace the execution from the point where the clock is read, type

```
Qmon> FI 'Q #$13,D0' S    (find MOVEQ #$13,D0 after the start)  
3D116  
Qmon> MI                  (confirm it)  
3D10E MOVEQ #$FF,D1  
3D110 MOVEQ #$A,D3  
3D112 SUBA.L A1,A1  
3D114 TRAP #1  
3D116 MOVEQ #$13,D0  
3D118 TRAP #1 <ESC>      (escape)  
Qmon> B N                (set breakpoint at next address)  
Qmon> G
```

The program should now stop at the breakpoint. Type

```
Qmon> T                    (or just <ENTER>)
```

The time has been fetched in `D1`, and the next instructions enter the ROM to convert the time to characters.

```
Qmon> T                    (next is JSR (A2))  
Qmon> GR                   (go until return)  
Qmon> T                    (next is JSR (A2))  
Qmon> GR                   (go until return)  
Qmon> D (a1) 20            (print 20 bytes from (a1))
```

As the next few instructions are traced, it should become apparent that a loop is being executed, writing out individual characters. `D6` is being decremented. To speed up the trace, type

```
Qmon> QU D6=1              (quick trace until D6=1)
```

The trace should stop when `D6` has been decremented and there is a conditional branch `BGT.S` as the next instruction. The final iteration round the loop may now be traced one step at a time.

Typing the command 'G' will cause the program to execute until it comes to the breakpoint again, so type

```
Qmon> BC                (clear breakpoints)
Qmon> G                  (carry on)
```

Use CTRL SPACE to release SuperBASIC, (this, and CTRL C, could have been done at any stage to list directories etc.) and type

JOBS

There should now be two jobs running. The clock is job 1, tag 0 owner 0, priority 1 and name 'Clocks'. To start tracing it again, type

```
QMON 1                  (monitor job 1)
or QMON 0\1             (monitor job 1 in transient window 0)
```

8 Quick Reference Guide

GO and TRACE

G		GO from current instruction
G	address	GO from address
GB	address	GO until breakpoint at address
GB	address condition	GO until condition at breakpoint
GR		GO until return
T	c	TRACE one instruction
T	c number	TRACE number of instructions
TU	c condition	TRACE until condition
TB	c address	TRACE until breakpoint at address
TB	c address condition	TRACE until condition at breakpoint
TR	c	TRACE until return
Q	number	QUICK number of instructions
QU	condition	QUICK until condition
QB	address	QUICK until breakpoint at address
QB	address condition	QUICK until condition at breakpoint
QR		QUICK until return

RECALL

RS	number	creates buffer for number of steps
R	c	recall last step

TRACE level

LU		traces user mode code only, GOes when trace enters a trap (default)
LS		traces supervisor mode code as well as user mode code

BREAKPOINTS

B	addresses	toggle breakpoint(s) and list them
BC		clear all breakpoints

DISPLAY memory

D	c address number	display memory (in hex and ASCII)
DI	c address number	display instructions in memory
DR	c	display registers

SET memory and registers

SB	address byte	set byte in memory
SW	address word	set word in memory
SL	address long word	set long word in memory
SD	n value	set data register
SA	n value	set address register
SSP	value	set appropriate stack pointer
SUSP	value	set USP (user stack pointer)
SSSP	value	set SSP (supervisor stack pointer)
SSR	value	set SR (status register)
SPC	value	set PC (program counter)

MODIFY memory and registers

MB	c address	modify memory in bytes
MW	c address	modify memory in words
ML	c address	modify memory in long words
MI	c address	modify instructions in memory
E	c address	edit memory

FIND in memory

F	value range	find a matching string of bytes.
F	'string' range	find a matching string of characters
FI	'string' range	find string in an instruction
F or FI		continue search

OPEN and Close

O	c name	opens 'name' as channel 'c'
O	c	closes channel 'c'

CALCULATE address

C	address	calculates address and displays it
---	---------	------------------------------------

Macro COMMANDS

CS		set macro command
CT		execute command every trace step
CB	address	execute command at breakpoint
CC		clear CT or CB
CX		execute command

9 Job Control Extensions

There are four job control extensions in the file JOBS_BIN. These are identical in form to the commands in the Sinclair QL Toolkit.

JOBS		list all jobs
JOBS #channel		list all jobs to channel
RJOB	job number, job tag, error code	remove job
AJOB	job number, job tag, priority	activate job
SPJOB	job number, job tag, priority	set job priority

The job number and tag are listed with the job name by the JOBS command. A job may only be activated if it has a priority of zero. On activation, a job will start execution at the start address.

10 QMON Version Updates

This version of QMON is the first revision to QMON in more than 5 years. In this time there had been a number of changes the QL world which have left QMON behind. This version is slightly larger, and copes with many of these changes.

10.1 Minerva

The QMON exception handling allows for the Minerva second screen. The QMON SuperBASIC command copes with integer constants.

10.2 Pointer Environment

SuperBASIC is automatically suspended by the QMON command if

- a) QMON is invoked for another Job and
- b) QMON is invoked in channel owned by SuperBASIC.

The new command QMON_W suspends SuperBASIC - you can still break in with CTRL SPACE.

The QMON output window is automatically picked before it is used.

The Job being monitored is picked when you GO.

Within QMON, the Job being monitored can be picked momentarily:

F1	0.5 seconds
F2	1.0 seconds
F3	2.0 seconds
F4	4.0 seconds
F5	8.0 Seconds

10.3 GOLD card / Atari ST

The keyboard auto-repeat is independent of processor speed.

10.4 General

The Find buffer has been enlarged to 32 bytes

11 General Structure of QMON

QMON divides into four distinct sections plus utilities.

Setup	called from SuperBASIC in QL QMON
Exception handling	vectored entries
Commands	display M/C status, modify M/C status or set QMON parameters
(Dis)assembler	single line assembler/disassembler
QMON utilities	I/O, numeric conversions, etc
SuperBASIC utilities	procedure parameter handling

There are some general rules which apply to the code of QMON. These rules do not limit the generality of QMON, but make it possible for QMON (which is entered on exception and thus uses the supervisor mode stack) to trace jobs in the multitasking environment of QDOS which has a single shared supervisor stack and where supervisor mode code is treated as atomic.

While waiting for I/O, QMON idles in the mode of the job (or task) which caused the entry into QMON.

QMON does not use any user mode stack.

Any path of subroutine calls that leads to an I/O call, is required to maintain the supervisor stack in a clean state.

QMON does not modify the base register A6.

11.1 Setup

The setup code is environment specific. In the case of the QL, the setup code is called from SuperBASIC and allocates the QDOS exception vector together with a QMON working area. QMON uses four I/O channels, these are identified by a long word. In the case of QL QMON, this long word is a channel ID.

11.2 Exception processing

The exception processing starts with a vectored jump to a set of branches to subroutines, followed by an exception name. The effect of this is to put a pointer to the exception name on the stack. Illegal instruction is used as a breakpoint, so this is flagged in the MSB of address. TRACE exception is indicated with a zero address.

The first action of the exception processing code is to set the pointer to the QMON working area. In the QL QMON, this is the same as the exception vector address. Next, the registers are saved. (Note that in the QL, a program's data area is potentially moveable; A6 (base register) and USP are liable to be changed whenever I/O is performed.)

If the primary channel save area pointer is set, then the command window is swapped into the screen. This is QL specific.

11.3 Commands

When the exception processing is complete, QMON will either return to the job or task, or call the command routine to accept commands to display or modify memory or registers, or to set the QMON parameters for breakpoints or tracing.

The command routine is also entered directly from SuperBASIC.

The command table is in the main program and may be extended or altered without any difficulty.

11.4 Assembler / disassembler

The assembler and disassembler are two independent modules which share the instruction definition tables.

11.5 QMON utilities

There are three QMON utility routines. One is the QDOS specific I/O routine, the other two are the general purpose routines for getting items from the buffer and putting them into the buffer.

11.6 SuperBASIC utilities

The SuperBASIC utilities are called from the QL setup routine only.

11.7 Impure code

There is only one instance of impure code. This is the auxiliary channel table embedded in the QDOS specific channel switching routine.

11.8 Register usage

D0 (together with the status register) is used for error code returns; also used for loop counters etc.

D1 is used to hold the next character or digit when unbuffering.

D2 is returned from GET with the value of a number or address expression. It also holds the value of the last or only parameter set by COMMAND before a command routine is called.

A0 is a running pointer to the buffer (used by COMMAND, GET, PUT, DIS and SING).

A1 is a pointer to the code to be assembled or disassembled by DIS and SING.

A3 is the address set as the first parameter of two by COMMAND, and then used by the command routines as a pointer to memory.

A5 always points to the QMON data area.

A6 is left alone.

Fed up of DIGITAL PRECISION telling you how very good their software is?

✓ "As you might surmise by this time, I am impressed by QMATHS's abilities. I have noted that DIGITAL PRECISION's advertising tends to be loaded with superlatives (Incredible, ultimate, superb come to mind), I had approached this evaluation with some scepticism. That scepticism has vanished." > INTERNATIONAL QL REPORT (IQLR, available from Miracle Systems) May/June 1993 issue, Official Review by M.Laverne commissioned by IQLR (who bought their review copy of the program).

✓ "PERFECTION is an exciting, full-flavoured, general purpose word processor of incredible capacity... PERFECTION has now been outshone by the recently released PERFECTION SPECIAL EDITION... The discoveries began to trip over themselves as PERFECTION SE responded to the keyboard with unexpected speed and intelligence... PERFECTION SE is blindingly fast at most things, and you are never left waiting for it. PERFECTION is everything that Quill never became: easy to use, very flexible, loaded with genuinely useful features, cleanly multi-tasking, capacious and incredibly fast. The SPECIAL EDITION offers 12 cylinder power and luxury to an already impressive package." > SINCLAIR QL WORLD magazine Official Review, April 1993 issue, by THE Mike Lloyd of Keyword Index / New QL User Guide fame.

✓ "I find PROFESSIONAL PUBLISHER an outstandingly good program that really does allow highly professional documents to be produced. For your interest I have included a few samples of work done for school using a combination of PERFECTION, PROFESSIONAL PUBLISHER, QUICKLASER and EYE-Q. You will be pleased to know that the quality has been rated so highly that people do not believe it can really have been done with just a QL... I must stress that I am already highly impressed with, and very satisfied by, the performance of PROFESSIONAL PUBLISHER and all the other DP programs that I use... I seem to learn something new that can be done almost each time I use the program. Very many thanks for helping to keep the QL ahead of the field." > Martin J Neave, Headteacher, Watton County Jnr School, Brandon Rd, Watton, Norfolk, IP25 6AL (unsolicited letter dated 18 May 1993 ordering more programs: Mr Neave had paid full price for everything).

✓ "LIGHTNING SPECIAL EDITION accelerates QL operation as nothing else does... more than 10x is achievable and 2x-4x is typical... I could not fault LIGHTNING SPECIAL EDITION on anything. It is a clear winner and a best buy at £49.95." > SINCLAIR QL WORLD magazine Official Review, April 1990 issue, by Ron Massey, who wrote EDITOR (bought full price) was "Superb" in an earlier review.

✓ "PERFECTION is well named" > R.H.Petford, Kingston Hill, Surrey, KT2 7LJ (unsolicited letter received May 25, 1993: another full price purchaser & upgrader).

✓ "When my ideal program finally arrived in the form of PROFESSIONAL PUBLISHER, it surpassed all my expectations... PROFESSIONAL PUBLISHER (is) in a class of its own, and makes it the only QL desktop publishing program for the very serious user... Until Digital Precision released PROFESSIONAL PUBLISHER, my opinion was that the use I could make of desktop publishing was mainly restricted to short documents... PROFESSIONAL PUBLISHER is a very versatile program... The illustrations for this series of articles have all been produced on PROFESSIONAL PUBLISHER... My printer is a BROTHER 9-pin dot matrix printer. It does illustrate the very high quality that can be obtained from PROFESSIONAL PUBLISHER even when using a simple printer." > SINCLAIR QL WORLD magazine Guide to desktop publishing ("A Question of Dots"), January 1992 to December 1992 issues: the reviewer had bought PROFESSIONAL PUBLISHER, PERFECTION SE, FONT ENLARGER, TOOLBOXES, QUICKLASER etc from Digital Precision all at full price.

✓ "I am aware that over the years Digital Precision has given considerable support to the QL scene but seldom, if ever, can there have been such estimable service as I recently encountered with PERFECTION PLUS." > The Hon. W.D.R. Spens, Bridgewater, Somerset, TA5 1HG, QUANTA magazine, March 1992 issue. Mr Spens has bought a lot of his software from Digital Precision, all at full price of course.

✓ "The Digital Precision Desktop Publisher was rightly hailed as an extraordinary programming achievement when it was released two years ago. Mike Lloyd casts a professional eye over Digital Precision's latest page-making blockbuster (PROFESSIONAL PUBLISHER) and finds plenty to be pleased about... there is unlikely to be a single program of such magnitude and quality (as PROFESSIONAL PUBLISHER) written for the Sinclair QL." > SINCLAIR QL WORLD Official Review, August 1989 issue, by M.Lloyd, who personally bought all this at full price.

✓ "EDITOR is a liberation. After Quill, it was like jumping from an aquarium into the sea. It has become part of my professional life... Everyone is now writing about the excellence of PERFECTION. I have not tried it, not having any perceived need for it (having EDITOR)" > Suzanne Cronje, QUANTA magazine, May 1992 issue, page 2. Ms Cronje naturally had paid the full price for her copy of EDITOR SE etc.

✓ "I have found (PERFECTION) to be simply excellent, fast, packed with features and very well thought out. I can find little to say that will convey just how good this program is, except to quote Digital Precision's own advertising: PERFECTION will blow your socks off. PERFECTION is the program that Quill users have been waiting for." > SINCLAIR QL WORLD's first Official Review, May 1991 issue.

✓ "Digital Precision (DP) decided to begin work on a replacement for Quill which would be very quick, simple to use and contain lots of excellent features - something upon which DP have built a very strong reputation in the QL market... Overall, the speed-up (of just the first release of PERFECTION - it is much faster now) on even a humble QL with Trump Card is amazing when compared with Quill (or any other word processor). On top of this, the program provides many excellent and well thought out features, each of which is easy to use... (it) is certainly years ahead of the competition on the QL (and even on many PCs)." > R.Mellor, c/o CGH Services, Cwm Gwen Hall, Pencader, Dyfed, SA39 9HA; Official Review of the very first version of PERFECTION in QL TECHNICAL REVIEW issue 7: and the reviewer personally bought his own copy of this program, and many others at full price, from Digital Precision. Earlier QLTR reviews pronounced LIGHTNING (just the standard version) superior to the competition and ADVENTURE CREATION TOOL excellent.

✓ "PERFECTION SE is superb!! With Gold Card, it puts life in the fast lane. Thanks." > Leonard Singleton, Bletchley, MK3 6BP, June 1993, a full price purchaser (=fpp).

✓ "As a recent user of PERFECTION PLUS SE, may I add my thanks and praises to the ones I am sure you have already received... keep up the excellent work." > R Slawson, East Molesey, Surrey, KT8 0BP (unsolicited letter from full price purchaser).

✓ "At about 360,000 words, the Mega SPELLCHECKER dictionary does not have much competition, on any computer! (Spellchecking) is about four times as fast as the best figures I have seen with other checkers on QL and PC." > SINCLAIR QL WORLD magazine official review of PERFECTION spellchecker, September 1992 issue, by Bryan Davies of Troubleshooter repete (review copies of all the competing products supplied to SINCLAIR QL WORLD by their respective publishers).

✓ "In the past I have purchased a number of your programs and have never failed to be impressed by the quality of both product and documentation. (So) please send a list of your current products." > V.Negri, Hempton, Norfolk, NR21 7LF, June 1993, fpp.

✓ "This is my first letter with PERFECTION SE. I must say I'm impressed with it and it is certainly fast. Hooray, goodbye to Archive!" > P.H.Heilbron, Reigate, RH2 0DJ, a full price purchaser now using PERFECTION to replace not only Quill but Archive too.

✓ "I have been using PROFESSIONAL PUBLISHER for about eighteen months now... what you can do with it is colossal... I got Digital Precision's QUICKLASER. The results are as good as (Digital Precision) says in its advertisements..." > P.Hamill, Peterborough, Cambs, PE8 6RH, QUANTA magazine, Volume 9 issues 4/12. Mr Hamill (full price purchaser) then makes suggestions to users re optimal page sizes.

✓ "Once again I would like to say thank you for your help. I would like to tell the world what nice guys you are but unfortunately I have no contact with the outside world." > J.Bailey, Godshill, Ventnor, PO38 3JJ (full price purchaser, 24 May 1993).

✓ "PC CONQUEROR GOLD SPECIAL EDITION is an excellent product, accompanied, as so often with Digital Precision software, by a comprehensive and informative manual. The program does a difficult job, and does it well... Overall, this program is much faster, more compatible and capable..." > SINCLAIR QL WORLD Official Review, March 1993 issue, by M.Knight (bought many DP programs full price).

✓ "With printing of the quality that this page bears witness to, I am a very satisfied PERFECTION user. I hope that you continue to provide the software innovation and the accessible backup which is great. So, thank you very much again and may I wish you every good fortune." > P.Stewart, Temple, London, EC4Y 9BE, 10 May 1993, fpp.

✓ "Many thanks for the update of PERFECTION SPECIAL EDITION. I am suitably impressed. Congratulations on producing the only word processor that I know that offers the best of all worlds as far as formatting is concerned. After Quill, PERFECTION is like a breath of fresh air." > Geoff Wicks, 1097HL Amsterdam, Netherlands (unsolicited letter dated 13 June 1993: all software including LIGHTNING PERFECTION SE, PRO PUBLISHER, CONQUEROR SE etc. purchased at full price).

✓ "All I can say about QMATHS is: WOW!" > Robin Wyke-Holloway, Salisbury, SP5 4WG (unsolicited letter received April 1993: Mr Holloway is a full price purchaser).

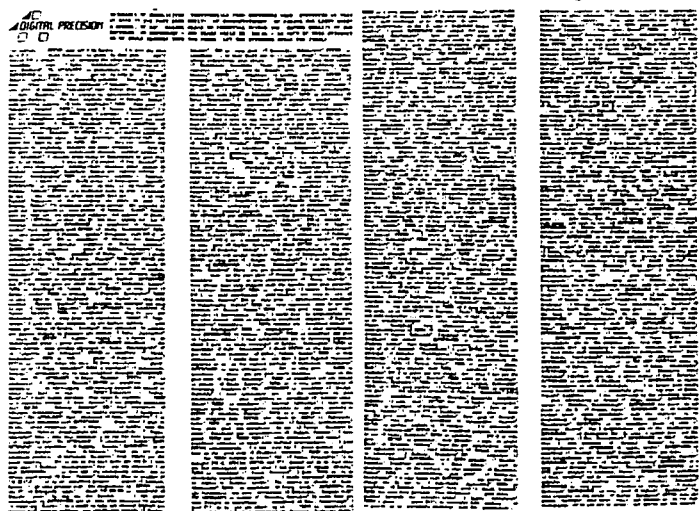
✓ "I have had PERFECTION from the early days and have had many hours pleasure finding out more and more of its brilliant features. May I offer my congratulations on such an easy to use program which does everything I want - and more besides." > F.Merrison, Pinner, HA5 5AZ, fpp, thanking us for fixing a printer problem he'd had.

✓ "Having used a range of desktop publishers on the Atari ST & Amiga, I admit I am very impressed with the superior performance of PROFESSIONAL PUBLISHER. It contains everything required" > SINCLAIR QL WORLD January 1989 issue, article entitled "Six of the Best" which also praised five other new Digital Precision programs.

✓ "I find it difficult to express my gratitude for the speed of your response, and for the opportunity to see inside two excellent programs which I have long enjoyed using." > Richard Walker, Enniskillen, BT74 7LG, full price purchaser and QL expert.

✓ "May I take this opportunity to say that I have, in the past, found the software you have supplied me with (LIGHTNING etc.) to be of extremely high standard, on a par with that found in industry-standard PC packages. Keep up the good work. Without your quality software, I would be forced to abandon the QL and go to a PC." > G. Reynolds, Crosby, Liverpool, L23 0SS (unsolicited letter dated April 2 1993, placing a further order for DP software: all programs old & new were purchased at full price).

✓ This is but a casual selection, drawing only on extracts from recent letters and reviews. We could locate >1000 complimentary communications but we'd prefer to spend our time producing new programs! We refer potential customers (existing users of DP products already know how good they are) to pages 18/19 of the September 1988 issue of Sinclair QL World, which contained well over three hundred other unsolicited quotations from happy Digital Precision customers. That collection covered only three programs (and that too only partly - we ran out of space) and predated the release of what many consider to be our best software (LIGHTNING SE, PERFECTION SE, PROFESSIONAL PUBLISHER, CONQUEROR SE etc). We reproduce those pages below, duly reduced to fit. If you want a readable copy, consult the relevant back issue or send us an SAE or ask for a full-sized copy while ordering from us...



So hear it from their customers!

QMON and JMON Version 2.06

There are two additional facilities in QMON and a completely independent version of QMON called JMON which is specifically adapted for tracing and debugging jobs and has a new user interface using the Extended Environment.

QMON is in the file QMON.

JMON is in the file JMON.

In addition, QMON and JMON now detect the processor type (6800x, 68010, 68020, 68030 and 68040) and adapt their stack frame and cache handling appropriately. The assembler and disassembler are still limited to the 68000 instruction set.

Either QMON or JMON should be loaded as resident extensions (LRESPR or RESPR, LBYTES, CALL). It will not normally be necessary to load both.

New Facilities in QMON and JMON 2.06

TL Command

The traps #5 to #15 do not now necessarily cause the execution of a job monitored by QMON (JMON) to be halted. The trap number is checked against an internal mask and, if the trap number is higher than the mask level, the execution continues. The trap level is set by the TL command.

TL <i>level</i>	set trap mask to "level"
-----------------	--------------------------

```
TL D          set trap mask to $D (13) to ignore traps 14 and 15
```

The initial trap level is 0 - all traps are ignored.

Permanent Breakpoints

Permanent breakpoints may be put into a program by inserting the two words \$4AFB (the standard illegal instruction) and \$EDEB (enter debugger). On entry to QMON (JMON), the program counter is moved to the instruction after the \$EDEB.

JMON

JMON should only be invoked if both the Pointer Interface and the Window Manager have been installed.

JMON can be invoked from SuperBASIC with the command JMON.

JMON <i>jobnumber or filename</i>	monitor a job or start a new job with JMON
-----------------------------------	--

JMON 1 monitor job 1

JMON FRED execute FRED (data default) under JMON

The job is monitored within the windows of a separate monitoring job. This dependent job may be put to sleep or woken while the monitored job is executing or while it is halted under the control of JMON. Waking the monitoring job halts the monitored job. The monitoring job may also be woken by using the JMON command in SuperBASIC.

JMON *jobnumber* wakes the monitor for job "jobnumber"