

## **ICL OPD - 'ONE PER DESK'**

### **INTRODUCTION**

The OPD computer was manufactured by ICL who badge engineered it as the MERLIN TONTO for BT and as the CP (COMPUTERPHONE) for Telcom. Australia (APT). The 3 models were released in late 1984/early 1985. A version for North America was produced in small quantity. The computer resulted from collaborative development by ICL, Sinclair and BT, with PSION providing the XCHANGE programs. The hardware skeleton is based on the Sinclair QL. This includes the 68008 CPU, the two main QL ULAs (Uncommitted Logic Arrays), the methods of Dynamic RAM (DRAM) and screen management, the real time clock and the microdrives.

### **1. HARDWARE SUMMARY**

#### **1.1 CPU**

The main processor is a Motorola 68008P8, 8/16 bit device with a 7.5 Mhz clock and a 1 Mbyte memory address capability. A second processor, an 8051 in the modem, controls the keyboard and the communications functions.

#### **1.2 MEMORY**

The memory map is shown in Fig.1. The main components of the map are :-

##### **1.2.1 RAM**

128K DRAM (2 banks of 64K x 8 bit, using 4164-15 ICs)  
2K Battery backed CMOS RAM. (The PERMANENT STORE: a TC5516AP-2 IC).  
32K of RAM is allocated to the screen. This, plus standard demands, leaves approximately 75K of 'ork space [ 150 blocks of 512 bytes ].

\* [ 128K is reserved for expansion RAM. (To allow a total of 256K of DRAM).]

##### **1.2.2 ROM, INTERNAL**

128K of Operating System (OS) (4 off 32K x 8 bit ROMs)  
16K of Speech Synthesiser ROM is controlled directly by the speech synthesiser 1C and is outwith the 68008's memory map.

\* [ 64K is reserved for expansion of the Operating System ].

##### **1.2.3 ROMPACK**

(The basic ROMPACK was supplied with the CALCULATOR ROM only. XCHANGE was an optional extra).

160K of ROM (144K XCHANGE + 14K Operating System, five 32K x 8 bit ROMs).

64K maximum in ROM capsules in a 2-slot ROMPACK.

The ROMPACK data above refers to the OPD as released in 1984, the following changes subsequently occurred:-

**a).** In 1985 ICL introduced the 4-slot ROMPACK. Space for the 2, additional, 'slots' was obtained by squeezing XCHANGE into 2 ROMs. Version 2.5 of XCHANGE plus the ICL firmware in the ROMPACK (CALCULATOR etc.) was contained in a 128K x 8 bit PROM (i.e. a 1 megabyte PROM) and a 32K x 8 bit PROM (27256 equivalent). These devices were the XFAA01 (ICL/PSION - 1M) and XBAJ02 (PSION - 256K). The 4-slot ROMPACK accepted a maximum of 128K in ROM capsules.

**b).** ICL then developed their memory expansion unit (MEU). This has XCHANGE 2.5 in the two PROMs (as above) and a further 8K x 8bit EPROM (27C64) containing the test/initialisation routines for the new memory and firmware for the MEU's slow RS232 port.

**c).** PCML produced a smaller, neater memory expansion, TELESTORE in a ROMPACK case. This had the test and patch code for the expanded memory, XCHANGE 2.5 and the ICL firmware (CALCULATOR etc.) in 2 ROMs. These were the XFAA01 PROM and a 27C512 EPROM.

The capsule addresses of the 2-slot ROMPACK are different from those of the 4-slot ROMPACK. 192K (6 x 32K) is reserved for the 6 capsule addresses of the 2 ROMPACK types. As a result, there is potential to operate the OPD with 6 capsules. PCML exploited this in the last version of their TELESTORE which accommodates 6 capsules in an extended ROMPACK.

Six capsules, if some are multi-program units, can be too much for the standard OS to accommodate. Appendix 1 shows how to alter the OS to accept a greater number of ROM programs if the INTERFILE ROMCAP is available.

There is no 'spare' space in the OPD memory map. Space not listed was 'reserved' by ICL for I/O and possible future applications.

The OPD DRAM REFRESH method is the same as the QL's i.e. there is no separate REFRESH circuitry. REFRESH is achieved by accessing the DRAM routinely to generate the VDU screen and for other regular, repetitive procedures. This results in delays and a loss of potential memory speed. The OPD has advantage over the QL because much of the OPD memory is allocated to ROM which is not subject to the same delays as DRAM.

### **1.3 MODEM**

The modem is a plug-in, BT approved (and designed), dual line, auto-dial/auto-answer unit based on the ADM79101C. The following facilities are provided:-

1200 bps half duplex,	(Bell 202, CCITT V23 mode 2)
600 bps half duplex,	(CCITT V23 mode 1)
75/1200 bps full duplex,	(Viewdata)
300 bps full duplex,	(Bell 103, CCITT V21)

Different modems are available for different operating locations e.g. Australia. Australian modems have distinctive 4 pin line plugs with the APT logo.

Pulse or DTFM (tone) dialling can be selected by DIL switches in the modem. The keyboard is inoperable if the modem is not present. Transmission format is configurable from internal firmware e.g. parity, stop bits, data bits and start bits.

There is 1 (or 2 depending on the model) ceramic 'sounders' in the modem. The Ring Equivalent Number (REN) of the OPD (modem plus telephone) is 1 per line. The maximum line loading, allowed by BT, to ensure reliable ringing, is REN 4

e.g. 4 OPDs or 1 OPD plus 3 normal phones of REN 1 etc..

A computer access directory with 'search-and—browse', short code dialling and a profile store is provided in similar format to the telephone directory (1.4 refers).

### **1.4 TELEPHONE**

The telephone handset is a standard BT 'Sceptre' type. There is an 8 ohm 250mW moving coil loudspeaker in the control unit but no in-built microphone. Facilities include 'hands— free' call initiation, loudspeaker call monitoring, auto-dial from memory or manual dial from the keyboard and store plus re-call/re-dial of the last 6 numbers used. The directory is capable of holding 500+ entries but at this level there is little memory left for other functions. The telephone directory has 'browse-and-search' facilities plus short code dialling. A single screen priority directory can be displayed by the LIST key and there is a facility to record the cost of calls.

The basic telephone functions for manual dialling are battery backed, allowing one line to make and receive voice calls if mains power is lost.

### **1.5 SPEECH SYNTHESISER**

This consists of a Texas TMP5220C 1C with a vocabulary in a separate, custom ROM of 152 words, plus letters and numbers. Facilities include limited text-to-voice conversion from keyboard entry and playback-to-test. Up to 16 messages can be pre-assembled and 2 used, automatically, by time-of-day selection, for auto-answer of incoming voice calls. Incoming voice messages cannot be recorded.

### **1.6 MICRODRIVES**

There are 2 microdrives each of 100K nominal capacity (95K minimum). They are not identical to the QL drives in mechanical construction, or operational protocol, but the blank microdrive cartridges can be used on either machine. An adjustable 'end-of-life' warning is provided for tape data quality/total number of seconds used.

\* [ The OPD micro drives have greater data packing density than the QL but more space between data blocks resulting in comparable overall capacity. The OPD cartridges have two, duplicated !CAT files (catalogue files) which are similar to the DIR and FAT files on an MSDOS disc. Certain metal components present on the QL microdrives have been replaced with plastic and the amount of lubrication on the tape has been changed.)

### **1.7 REAL TIME CLOCK**

The clock is the same as the QL except that the start date is 1/1/1970 while the QL start date is 1/1/1961. The clock output is displayed in the Notice Board at the bottom of the screen. XCHANGE 2.3 programs cannot access the clock.

### **1.8 VDU (Monitor)**

The OPD control unit is designed to be permanently powered and to blank the VDU screen if the keyboard is not used for 10 minutes. Operating any key recovers the display.

The ON/OFF switch on the monitor removes full voltage from the monitor, but maintains a reduced supply to pre-warm the tube heater for fast start-up. This switch does not affect supplies to the control unit. The intent was that the monitor should be switched OFF between sessions but the control unit should remain powered for MESSAGING and other, unattended, functions.

The VDU case contains the mains power supply which is an ASTEC 30 watt SMPS (Switched Mode Power Supply) card (types AA12630, AA12635, or similar). The colour monitor has its own power supply but the mono monitor is powered from the ASTEC card which has the following rating:—

+5 volts 3 to 3.5 Amps  
+12volts 1.5 Amps  
-5 volts 0.1 Amps

The power supply can be connected for 115 or 240 volts, both +/- 10% and draws a nominal mains current of 0.75 Amps.

The 9 inch mono monitor uses a Philip's chassis and contains an ICL composite video board. Colour and mono monitors have LED (or neon) indicators for 'Mains ON' and 'Monitor Power ON' plus a contrast control.

Power supplies and video signals are coupled from the monitor, via a multi-core cable, to a 15 way D plug on the control unit.

2 VDU options were available when the OPD was introduced:—

A 9" white screen unit with levels of contrast matching the number of colours in a particular screen mode,

Or

A 14" Microvitec colour monitor available in medium resolution with high resolution as a later option.

### **Screen Format**

The screen format is similar to the QL. It is bit mapped and has 2 modes selectable from software:-

256 x 256 pixels, 40 characters per line, 24 lines plus a 2 line 'Notice Board' at the bottom of the screen. Green, red and blue can be displayed on a colour monitor, giving 8 shades (contrast levels), plus flashing, on a monochrome monitor.

512 x 256 pixels, 40 or 80 characters per line, 24 lines plus a 2 line 'Notice Board'. Red and green only are available on a colour monitor giving 4 shades on a monochrome monitor.

In BASIC the screen size available as display for the running program is less than the gross figures quoted above e.g. in the 512 x 256 mode the BASIC program display area is only 480 x 200.

### **1.3 PRINTER INTERFACE**

This is a single RS423 serial port which is compatible with RS232 for printer duty. The port consists of a 9 way female D connector on the OPD control unit, only 3 pins of the connector are used, as below:

Pin 1 — Data out  
Pin 2 — Common earth return  
Pin 3 — Printer busy/not available

The ICL package printer was an OKI thermal, colour printer with a draft printing speed of 80 cps and 40 cps in NLQ.

Epsom RX80 compatible printers are catered for in the software and printer configuration programs.

The normal BT Tonto printer is the Merlin M1880, described as a standard graphics printer. The K1880 appears to be MOA printer MP1711 (VJM80) and to be a Shinwa SP80 badged for BT. The MP1713 (WM100) DMP was also issued with some Tontos.

The daisywheel printer recommended for the Tonto was the Dyneer EW16.

### **1.10 BATTERIES**

The OPD has 2 batteries:-

BAT1 is a 9 volt, PP3, manganese battery which backs the telephone and the Real Time Clock. It is fitted under the microdrive cover and is user replaceable (approximately once per year). The operating system checks BAT1 voltage during power-up and under the HOUSEKEEPING function.

BAT2 is a 3 volt lithium unit (with a life of at least 5 years) which backs the PERMANENT STORE CMOS RAM. It is soldered to the motherboard; is not considered user replaceable and is not checked directly by the Operating System.

### **1.11 KEYBOARD**

The 73 key keyboard is QWERTY layout with 10 of the keys colour coded to act as function keys and double as a 'telephone style' numeric pad. The keyboard is manufactured by ALPS using individual switches of rubber membrane construction.

Keyboards with black QWERTY keys, and a red ENTER key, are export units intended for Australia.

Keyboards in standard OPD/Tonto colours but with inverted 'E' and '#' symbols, and 3 letter 'telephone' groups on the front faces of the number pad keys, are thought to be export units for North America. Later versions of all keyboards have blocking diodes on 5 keys.

### **1.12 ROMPACK**

The ROMPACK included, as an option, XCHANGE in ROM. The original 2-slot ROMPACK has 5 off 32K ROMs. Later, 4 slot versions, and TELESTORE, use a high capacity ROM to make room for the additional slots. ROM capsules mount in the slots and can be 8, 16 or 32K.

+5 volt supplies, address and data buses, plus READ/WRITE and EXTINT lines are available on the 30 pin 'slot' connectors to allow their use as a simple expansion ports. There is also provision on the ROMPACK connector to disable the internal OS ROMs to allow test and diagnostic hardware to be connected which over rides the Operating System.

### **1.13 ROM CAPSULES**

The ROM capsules are normally constructed on single sided PCS, with the ROM IC, a resistor and a supply decoupling capacitor surface mounted, to obtain minimal capsule thickness. The ROM IC must be de-soldered to remove it.

A capsule's presence is signalled by a link on its 30 way connector which enables that 'slot's' section of the PLA de-coding (in the ROMPACK). Capsule ROMs have a specific firmware header which the OS checks at Power-up. The System verifies that the capsule ROM is a valid OPD device and, if valid, 'logs' it onto the OS. The foil patterns of the capsule PCS alter depending on whether the ROM employed is an 8, 16 or 32K device.

### **1.14 PHYSICAL PRESENTATION**

The OPD is made up of 4 units :-

Control Unit  
Modem plus Telephone Handset  
ROMPACK  
VDU and Power Supply

The control unit includes the main PCB, 'piggy-back' CPU board, keyboard, telephone hookswitch, loudspeaker, 2 batteries and 2 microdrives.

The modem and the ROMPACK plug into the rear of the control unit.

The monitor includes the power supplies for itself and the other units.

Sizes  
Control unit 440mm x 250mm x 95 mm  
Mono Monitor 250mm x 280mm x 280mm

Weights  
Control unit 3 kg.  
Mono Monitor 4.75 kg.

### **1.15 SPECIAL COMPONENTS**

The OPD main board uses the 2 Sinclair QL ULAs (ZX8301 and ZX8302 or equivalents). Each microdrive uses a QL Ferranti/Sinclair 2G0075E5 device.

Two ICL 'ULAs' are employed. One is ULA3 on the main board which controls the non-QL functions i.e. telephone, speech synthesiser, battery backed static RAM etc.

The second ICL 'ULA' is the PLA device for address de-coding and interfacing in the ROMPACK. The ROMPACKs and the MEU have an ICL PLA for address decoding and control.

The 4 and 6 slot TELESTORE use a PCML CMOS PLA.

The Texas vocabulary ROM is an OPD special.

The modem uses six thick film, hybrid circuits.

Excluding capsules, there are ten ROM ICs in an original OPD with XCHANGE. Identified ICL ROMs and PLAs are listed in Appendix 3.

## **2. ICL/BT FIRMWARE (Software in PROM or EPROM)**

The design concept was that, for ease of operation, fast loading and optimisation of the relatively small RAM, 9 major applications programs would be provided in ROM. This was in keeping with the targeted, non-technical, executive market. The intent being that the OPD would not rival a desk-top PC for general computing. The following ROM firmware was produced for the OPD :-

### **2.1 OPERATING SYSTEM (OS)**

The OS is an ICL multi-tasking, 'special'. Up to 8 tasks can be run concurrently. A task will only run as a background activity if it does not require access to the screen or keyboard, otherwise it is suspended until re-selected. The OS is not QL QDOS nor is it an industry standard which can take advantage of existing software. The OS is contained in 4 x 32K ROMs on the CPU board. A further 14K is carried in the ROMPACK. ICL called the OS 'BFS' (Basic Functional Software).

The following make up the BFS: —

#### **a). KERNEL**

KERNEL manages the hardware, the memory map, input/output device control and also handles interrupts.

#### **b). DIRECTOR**

Higher level firmware handling applications and the telephone. It controls START, RESUME and REVIEW key functions and allocates resources.

#### **c) . TELEPHONE HANDLER**

This manages the 'nuts and bolts' of telephone usage.

#### **d) . TELEPHONE DIRECTORIES**

Two directories are managed; one for telephone voice calls and one for computer services.

#### **e). CALCULATOR**

A simple 16 digit calculator with memory. (CALCULATOR firmware is in the ROMPACK).

#### **f) . SCREEN IMAGE PRINTER**

A screen dump to printer on a single keystroke.

#### **g). FIELD EDITOR**

The field editor provides cursor and text editor control.

## **2.2 XCHANGE**

The PSION standard package (Quill - word processor: Archive - data base: Easel - business graphics and Abacus - spread sheet) is provided in ROM, as an option, and mounts in the ROMPACK. Version 2.5 was in service by mid 1985 but surplus units are generally the earlier version 2.3. On entering XCHANGE from the APPLICATIONS menu the version number is displayed. In general the 2-slot ROMPACK has version 2.3 and the 4-slot ROMPACK, TELESTORE and the MEU have version 2.5.

## **2.3 DATALINK (BT Reference M.824)**

A single capsule introduced to overcome, in part, the isolation of the XCHANGE programs from the communications facilities. It allows incoming communications data (from a computer service or mainframe) to be imported, 'via microdrive', to XCHANGE. It also allows QUILL format files to be exported, 'via microdrive', by the communications facilities of the OPD.

## **2.4 MESSAGING (BT Reference KL821)**

A single capsule which provides desk-to-desk text messaging between OPDs; unattended receipt; auto-send; dump to microdrives and a print or re-send option.

## **2.5 ADVANCED MESSAGING (BT Reference JO.822)**

An expansion of MESSAGING which occupies 2 capsule slots, providing all the facilities of MESSAGING plus auto-retry; multiple addressing and an interface facility with EXPORT format files.

## **2.6 INTERFILE (BT Reference KL823)**

Occupies 1 capsule slot allowing file transfer from OPD-to-OPD via the modem. Facilities include auto-retry and transmission at pre-set times. The INTERFILE ROM includes 'patch' code to permit more than 6 ROM applications to be connected to the OPD at the same time.

## **2.7 ICL-LINK**

Occupies 1 capsule slot, allowing communication with ICL mainframe computers and emulation of a full XBM Screen Mode Terminal. ICL-LINK requires a Desk Terminal Connection Unit (DTCU) for the link interface.

## **2.8 VT-LINK/VT-LINK2 (BT References KL825/M1826)**

Occupies 1 slot and provides terminal emulation for communication with Digital Equipment Corporation (DEC) VT series computers. VT-LINK covers VT52 and VT100 emulations. VT-LINK2 covers the VT52, and VT102. Its manual states it also covers VT100. VT-LINK allows 7 data bits only. VT-LINK2 allows the option of 7 or 8 data bits. The VT-LINK 2 capsule includes an improved printer configuration program CONPRIN allowing condensed 140 column printing in some applications. This CONPRIN can conflict with the disc based CONFIGURATION programs supplied for TELEDRIE.

## **2.9 ILLUSTRATOR EGO (Executive Graphics Option)**

Occupies 1 capsule slot, allowing connection of an OPD to an ICL mainframe (via ICL-LINK, and a DTCU) to view professional graphics on the OPD. Graphics may be viewed and stored on microdrive but cannot be altered or edited by the OPD. Access to the programme requires a password and EGO has no general graphics capabilities as a stand alone programme without an ICL mainframe.

## **2.10 COMBINED COMMS**

Combines ICL-LINK, VT-LINK and TERMILINK in a single capsule.

\* [COMBINED COMMS. is incompatible with VT-LINK2. If both capsules are fitted to the ROMPACK at the same time the OS will log-on only the VT-LINK\* program with the lowest memory address. {Both programs have the same name viz ~DD).]

## **3 ICL SOFTWARE (supplied on cartridge with the basic Machine or with XCHANGE)**

### **3.1 ICL OPD BASIC (BT MERBASIC Reference M.851 )**

BASIC is not resident in the OPD. It is loaded from microdrive and is a subset of Sinclair QL

SuperBASIC. It lacks SuperBASIC features especially graphics. (In multi-tasking, there is insufficient memory to store several complete graphics screens and recall them with the RESUME and REVIEW keys).

ICL BASIC was intended as a 'high level bridge' to QL software but, as such, it has limited capabilities. BASIC version 07 was available in 1986. The version in use can be displayed by the PRINT VER\$ command.

The BASIC cartridge contains the factory-set default values of the PERMANENT STORE plus configuration programs for the OPD, the printer and the telephone (CONFIG, CONPRIN and CONTEL respectively).

### **3.2 ICL - WELCOME** (BT Reference M1850)

This cartridge was supplied as part of the WELCOME package to provide information and to demonstrate the equipment's capabilities to the new user.

### **3.3 ICL/PSION - HELP** (BT Reference M1854)

HELP files for the XCHANGE programs are provided as a microdrive cartridge.

### **3.4 ICL - DEMO** (BT Reference M1853)

A demonstration program for XCHANGE including a '.dbf' file on geography for working through ARCHIVE.

## **4. HARDWARE EXPANSION**

The OPD was not provided with a dedicated expansion port. The ROMPACK connector, or a ROMPACK capsule slot, is used to link expansion hardware to the internal circuitry.

The connector on the main board, for the ROMPACK, (J5) is provided with a variety of interface connections which are not used by the ROMPACK (or fed through it) but can be used for comprehensive expansion if the ROMPACK is not in place. The socket pin-out is shown in Fig. 2.

### **4.1 MEMORY EXPANSION**

The memory map makes provision for only 128K of RAM expansion (256K total DRAM). A disc interface can include more RAM, generally in RAMDISK configuration, by incorporating a dedicated processor to manage the RAMDISK and the disc drives yet absorbing no more than one 32K 'slot' on the OPD memory map.

#### **4.1.1 MEMORY EXPANSION UNIT (MEU)**

ICL developed a 128K Memory Expansion Unit (MEU) [sometimes called a Store Expansion Unit (SEU)]. This was intended to be the main unit of an ICL expansion system. It had a slow RS232 port (for bar code reading, printers etc.), 4 capsule slots, a RESET button and a 60-pin expansion port. The MEU was large, approximately 10.5"x 7.2"x 1.5". The case was steel with a plastic overcover. Connection to the OPD was via a 6 inch length of ribbon cable and a modified ROMPACK case containing line drivers and receivers.

The MEU memory duplicates the basic arrangement in the OPD and is controlled by a ZX8301 with a 12Mhz crystal. The address lines to the ULA are modified to position the memory at the expansion addresses. Two 74HCT257s provide DRAM address multiplexing and a 74HCT245 acts as the data bus transceiver. The memory itself uses four 256K DRAM ICs (81464 devices, each 64K x 4 bit).

The serial port is based on the RCA CDP65C51E1 1C with a 1.8432 Mhz crystal. XCHANGE version 2.5 is provided in two PROMS. A third ROM, a 27C64-25 EPROM, carries firmware to test and initialise the new memory and service the RS232 port.

Two PLA devices provide the overall addressing and interfacing. The MEU design was bulky



and expensive. When PCML produced the smaller, cheaper TELESTORE, ICL terminated the MEU and adopted TELESTORE as the official memory expansion for the OPD.

#### **4.1.2. TELESTORE**

The PCML 128K memory expansion, TELESTORE, fits into a ROMPACK case. The original version had 4 'slots' plus version 2.5 of XCHANGE. A later, 1987 version, was built into an extended case and accommodated 6 capsules (in single line outwards from the case).

PCML designed the TELESTORE with a fairly standard ROMPACK base board plus a 'piggy-back' board containing the extra memory. Unlike the standard ROMPACK the main components are soldered into the board to cut down height and allow the assembly to fit into the standard case. The 'piggy-back' memory board is mounted on a 34 way, in-line header strip.

The 128K memory is 4 off 4464 ICs (64K X 4 bit each), controlled by a Toshiba TC17G014AP-12 CMOS gate array which is custom programmed and uses a 12 Mhz crystal. The 'piggy-back' board also contains two 74HCT257 address multiplexers and a DIL resistor network. The base board contains 2 PLA devices, buffers and XCHANGE 2.5 in two ROMs. The ROMs are the ICL/PSION XFAA01 and a 27C512 EPROM containing the remainder of XCHANGE plus the initialisation firmware for the extra memory.

\* [Both the MEU and TELESTORE included special initialisation and checking firmware for the memory expansion. When an OPD is powered-up with TELESTORE (or the MEU connected) the screen displays that an 'Invalid Capsule' is present and HOUSEKEEPING shows the standard free store capacity of about 150 blocks. The special initialisation routine then checks and logs—on the new memory and the updated HOUSEKEEPING Store Report shows the increased memory of about 400 blocks. This extra process takes about 15 seconds and does not cause illumination of the line LEDs, as in the normal initialisation].

### **4.2 DISC DRIVES**

#### **4.2.1 Computer One (C1.)**

Computer One supplied disc drives and an interface. This consists of a plastic cased 'L' shaped interface unit which plugs directly into a ROMPACK slot, is powered from the OPD supply and connects separately, via a 34 way ribbon cable to a standard, self-powered, disc drive unit. The disc unit could have 1 or 2 x 3.5 inch DS/DD drives (720K formatted capacity/drive) or, optionally, 5.25 inch drive/s could be provided. The operating system was claimed as being MSDOS. Tests on a 3.5" disc version could not produce discs that the TELEDRIIVE or IBM PCs could read and the interface could not read PC or TELEDRIIVE discs. The PC compatibility of the 5.25" version is unknown.

#### **4.2.2 TELEDRIIVE**

As an extension to their previous work on QL disc interfaces, PCML developed TELEDRIIVE, a dual, 3.5 inch disc drive unit with 720K per drive formatted capacity and a MSDOS operating system. The use of MSDOS allows TELEDRIIVE to exchange discs with PCs (Appendix 8 refers). The unit has 256K of DRAM (part of which can be configured as RAMDISC) and its own HD64180 (CMOS Z80) processor. It connects to the OPD via a ROMPACK capsule slot, is self-powered by a linear power supply and has provision to accept a further two external, Shugart compatible drives. Two RS232 ports for computer-to-computer communications were intended for later versions but no sign of this facility has been seen in the field. In 1986 PCML intended to expand further to include a 10Mb hard disc with a SASI interface. The status of this is unknown.

[Part of the 256K of memory is required to service the interface. 180K remains available for RAMDISC but this reduces to 72K if CP/M is running.]

The overall size is 10.6" long x 4.3"x 4.1".

To run the late issue PCML disc programs and CP/M the 27256 TELEDRIIVE EPROM must be Version 2.0 or later. CP/M is not an emulation but CP/M running concurrently on the TELEDRIIVE '280' CPU. (The Computer One disc drive is a standard drive interface without its own CPU and cannot run CP/M).

#### **4.3 DATA COMMUNICATIONS ADAPTOR (DCA) – (BT Reference 1887)**

This unit was provided by BT to allow the TONTO to be hard wired to a mainframe. It connects via a ROMPACK capsule slot, is powered from the OPD and provides outputs (via a 25 way, female D connector) which are compatible with RS232C, RS423 and CCITT V24 standards. Emulation of the following terminal types is possible:-

DEC VT52 and VT100 (80 column mode only) and IBM 3278 via a suitable protocol converter. Baud rates from 50 to 9600 can be configured from software. 7 or 8 data bits can be configured.

The port design is based on a Hitachi HD63A03XP 1C with a 4915.2 khz crystal. Code for the HD63A03XP is contained in a 2732 EPROM. '232' or '423' port configurations are available by internal link selection. An Astec miniature SMPS provides the -12 volt supply for the port. Profiles are stored in a 2K CMOS SRAM (type TC5516APL-2) backed by a 3 volt lithium battery. The VT\* and ICL emulation code is stored in a 27256 EPROM.

#### **4.4 TONTO EXERCISER type VT100 (BT Reference M1887)**

This unit was built by Walkbury Consultants for use within BT to demonstrate the use of the DCA with the TONTO. The EXERCISER has an integral linear mains power supply and connects to the RS232C socket of the DCA. It contains a Hitachi HD63A03XP (as the DCA), a 2764 EPROM with control code for the Hitachi device and a 4.9152 Mhz crystal. A second EPROM, a 27256 contains the demonstration program for the TONTO plus DCA. This EPROM is mounted in a ZIP socket to allow easy exchange of EPROMs to substitute different demonstration programs.

#### **4.4 ASYNCHRONOUS COMMS. UNIT (ACU)**

The ACU was designed, by ICL, as part of the MEU expansion system but it will operate directly from the OPD without the MEU being present. It offers speeds of up to 19200 bps by, optionally, by-passing the OPD's integral modem, so allowing high speed communication and networking under control of one of the terminal emulation programs.

This unit's program is called a LOCAL COMMS. CONFIGURATOR and allows profiling of port parameters and operation by ACU or by modem. The ACU was designed to compliment the MEU, was contained in a steel case approximately 4.5"x 10.5"x 1.5" and powered from the OPD, either direct from a ROMPACK slot or, alternatively, it could sit on the MEU fed from that unit's 60 way expansion port. The ACU 'footprint' is the same as the TELEDRTVE's.

The ACU has a single 25 way D connector, RS232C port based on an 'intelligent', Intel P80C31BH processor with a 7.37280 Mhz crystal. A series of 74HCT257 multiplexers allow control of the port to be taken over from the OPD, by the P80C31. Firmware is provided in 2 EPROMs (a 27C256 and a 27C64). A small ASTEC encapsulated SMPS is powered from the +5 volt rails to generate standard RS232C port voltages which are not available via the ROMPACK slot (i.e. +12 and -12 volts). Two 2K 043S RAM ICs provide data buffering.

Transmission and reception speeds can be specified separately in the range from 50 to 19200 bps. Other adjustable parameters are word length, parity, input and output buffer size, buffer filling and emptying levels, X-ON and X-OFF and flow control.

Profiles/patterns for various port configurations can be setup, stored in the OPD PERMANENT STORE and recalled for particular applications.

#### **4.5 DESK TERMINAL CONNECTION UNIT (DTCU)**

A free standing, self-powered, adapter for connecting OPDs, running ICL-LINK, to ICL VME or TME mainframe computers at speeds up to 9600 bps. Full XBM (ICLC-03) terminal emulation is provided with dual screen capability and auto-answer from the OPD. The DTCU microcode (E13100/01) is teleloaded from the mainframe.

#### **4.6 ASYNCHRONOUS NETWORK COMMUNICATIONS ADAPTOR (ANCA)**

A free standing, self-powered unit that works with VT-LINK to provide OPD to IBM mainframe communications. Full screen working to the IBM host is available at speeds up to 9600 bps together with access to the host's applications. Security features are included with auto-answer from the OPD.

#### **4.7 DATEX 90**

This provides simultaneous voice and data communications on a single telephone line.

#### **4.8 DISTRIBUTED ASYNCHRONOUS TERMINAL SERVICES (DATS)**

This can connect the OPD to ICL DRS series computer systems via DRS model 110.

#### **4.9 INFORMER**

Allows files to be transferred between OPDs and IBM PCs.

#### **4.10 TELEBOX 3**

Allows the OPD to be used as a Telex station.

#### **4.11 TELELOCK**

A security device produced by PCML. It consists of an in-line plug/socket assembly which plugs into the 2 'D' connectors on the OPD control unit (the supplies/video and the printer connectors) and provides 2 new 'D' connectors, at its outboard end, for the original leads. There is a lock on the unit operated by a Yale type key. The OPD can be disabled, for security purposes, by locking and removing the key.

#### **4.12 TILT and SWIVEL STAND**

BT produced a tilt and swivel stand for the mono monitor.

#### **4.13 SERVIPACK/SERVPACK**

No confirmed information. SERVIPACK is understood to be an ICL/BT servicing aid in a ROMPACK type case containing test and diagnostic firmware which over rides the internal OS ROMs and performs diagnostic tests on the machine to locate component faults.

### **5. LITERATURE**

#### **5.1 BOOKS**

Century Communications Ltd. (Newtech Publishing Ltd.) produce 3 guides to the 'Merlin—Tonto' at a listed price of £12.95 each. These books are user orientated and contain no significant technical detail of the internals of the 'Tonto'. They are: —

"Business Communications with the Merlin Tonto"  
by Martin Gandoff ISBN 0-09-161681-6

"Introducing the Merlin Tonto" by Carry  
Marshall ISBN 0-09-161661-1

"Business Computing on the Merlin Tonto" by  
Stephen Morris ISBN 0-09-161671-9

#### **5.2 REVIEWS**

The OPD was reviewed, or discussed, in the following periodicals: —

'Personal Computer World'  
December 1984 'Which  
Computer?' February 1985  
'Practical Computing' January  
1985 'Practical Computing'  
April 1985 'Micro Decision'  
February 1985 'Byte' June 1985  
'Computing — The Newspaper'  
July 18, 1985 'Communications'

November 1985 'Accountancy'  
June 1986 'Surveyor' January 16,  
1985 'Computing Magazine' April  
25, 1985 'Informatics' December  
1984

The OKI printer, OKImate 20, was reviewed in 'Practical Computing' May 1985.

### **5.3 USERS' JOURNAL**

ICL issued a quarterly newsletter 'OPD - Today' which was distributed free to official users. The last issue was July 1987.

### **5.4 MANUALS**

#### **5.4.1 ICL/BT MANUALS**

The following user manuals were provided by ICL or BT :-

'INSTALLATION'	(BT REF: TPU12A)
'HANDBOOK'	(BT REF: TPU12B)
'BASIC'	(BT REF: TPU12C)
'MESSAGING'	(BT REF: TPU12D)
'XCHANGE'	(BT REF: TPU12E)
'WELCOME PACKAGE'	(BT REF: TPU12F)
'ADVANCED OPERATIONS'	(BT REF: TPU12G)
'INSTALLING TELEPHONE LINES AND SOCKETS'	(BT REF: TPU12H)
'INTERFILE'	(BT REF: TPU428)
'VT-LINK'	
'VT-LINK 2'	(BT REF: TPU730)
'ICL-LINK'	
'COMBINED COMMS.'	
'EGO ILLUSTRATOR'	Leaflet Only
'DATALINK'	
'ADVANCED MESSAGING'	
'Xchange quick reference'	(BT REF: TPU192)
'MP1887 DATACOMMS ADAPTOR'	(BT REF: TPU116)
'XCHANGE QUICK REF. CARD'	(BT REF: TPU242)
'M1880 PRINTER MANUAL'	(BT REF: TPU249)
'M1881/2 PRINTER MANUAL'	(BT REF: TPU332)
'OPD VT100 LINK'	(BT REF: TPU334)
'TILT AND SWIVEL STAND INSTALLATION'	(BT REF: TPU409)
'USING MP11881 WITH TONTO'	(BT REF: TPU439)
'14 INCH COLOUR MONITOR'	(BT REF: TPU12J)
'MERLIN TONTO' Some Questions and Answers'	(BT Staff Only)

### **5.5 ICL PUBLICATIONS**

The following are published by ICL for the OPD

#### **5.5.1 INTO ACTION MANUAL**

A workbook of data and instructions for the OPD giving an overview of equipment and facilities.

#### **5.5.2 OPD GUIDES**

A set of 4 guides:—

'Directory to Online Public Databases'

'Guide to Online Public Databases'

'Guide to Computer Access'

'Guide to Telephony'

## **5.6 ICL SUPPLEMENTS**

### **a) . PRINTER INTERFACING**

ICL issued a supplement giving guidance on interfacing various printers to the OPD. It detailed the parameters to be set by CONPRIN and which features of the standard OPD/OKI package are not available with other, identified printer types.

### **b). MESSAGING**

A supplement was issued on MESSAGING giving greater detail of error messages and expansion of information on turning the T-LINK protocol ON and OFF.

## **5.7 OPD PROGRAMERS'REFERENCE MANUAL**

The above manual runs to 700 pages.

## **5.8 OPD/TONTO SERVICE MANUAL**

ICL/BT confidential - no data available.

## **5.9 SCHEMATICS and DRAWINGS**

Circuit diagrams are not on general release but are available from surplus outlets. Some 30 drawings are required to cover the full schematic of the OPD and its board layouts.

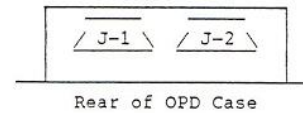
## **5.10 PRODUCT SPECIFICATIONS**

ICL confidential — no data available

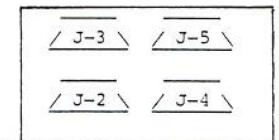
Fig 1. OPD MEMORY MAP

HEX ADDRESS	FUNCTION
\$FFFF — — — —	
\$F8000	32K reserved
\$F0000	32K Romcap 2 (original 2-slot ROMPACK)
\$E8000	32K Romcap 1 (original 2-slot ROMPACK)
\$C0000	144K Xchange + 14K Base Operating System
\$80000	64K Rom Operating System expansion
\$A0000	64K Rom Base Operating System
\$80000	128K reserved for expansion DRAM
\$78000	32K 4-slot ROMPACK
\$70000	32K reserved
\$68000	32K 4-slot ROMPACK
\$60000	32K reserved
\$58000	32K 4-slot ROMPACK
\$50000	32K reserved
\$48000	32K 4-slot ROMPACK
\$46000	8K reserved
\$44800	6KI/O
\$44000	2K CMOS RAM
\$40000	16K ULA3 registers
\$28000	96K DRAM 128K TOTAL DRAM
\$20000	32K Screen DRAM
\$10000	64K ULA1 I/O space
\$00000	64K base operating system

HEX	Address Bits					N	'Slot' Content
	15	16	17	18	19		
<del>\$F0000</del>							
\$F8000						31	Reserved
\$F0000						30	2-slot Rompack slot J2
\$E8000						29	2-slot Rompack slot J1
						28	
						27	XCHANGE
						26	plus
						25	Operating System
\$C0000						24	
						23	Operating System
\$B0000						22	Expansion
						21	Operating
\$A0000						20	System
						19	
						18	128K
						17	Memory (DRAM)
\$80000						16	Expansion
\$78000						15	4-slot Rompack slot J5
\$70000						14	Reserved
\$68000						13	4-slot Rompack slot J4
\$60000						12	Reserved
\$58000						11	4-slot Rompack slot J3
\$50000						10	Reserved
\$48000						9	4-slot Rompack slot J2
\$40000						8	ULA3*2K static RAM*I/O
						7	
						6	128K
						5	Memory (DRAM)
\$20000						4	Standard
						3	ULA1
\$10000						2	I/O
						1	Operating
\$00000						0	System

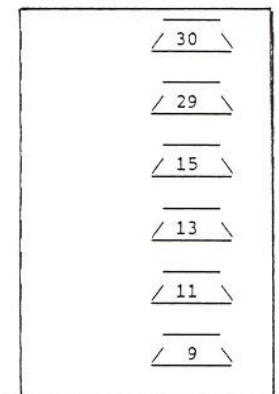
2-Slot ROMPACK  
Slot - (29) (30)

Rear of OPD Case

4-Slot ROMPACK/TELESTORE  
Slot - (11) (15)

Slot - (9) (13)

Rear of OPD Case

6-Slot TELESTORE  
Slots

Rear of OPD Case

## Notes:

1. The memory map above is represented as 32 off 32K 'slots'. (The original design was based on the use of 27256, or equivalent, ROMs).
2. The address decode of each slot is given by address bits A15 to A19. A boxed block in the appropriate column indicates a logical '1' on the corresponding address line.
3. The column 'N' allocates a number to each 32K slot. The start address of a 'slot' is given by  $Q \times 32768$  where  $Q = N$ .
4. The content of a ROM in a particular 'slot' can be dumped to microdrive or disc from BASIC by the command: `SBYTES mdvl_prog,Q,32768` (prog is the chosen name of the dump file).
5. There appears to be a limitation to the dumping of the Operating System ROM in slot 1.

## APPENDIX 1

### INCREASING THE NUMBER OF APPLICATIONS

There is a limit to the number of cartridge and capsule applications that the OPD can handle. If the capsule limit is exceeded the error message TOO MANY PROGRAMS appears on the initialisation display. The INTERFILE capsule includes a 'patch' to correct this. The special code runs automatically at power-up and normally causes a second initialisation.

This code does not cater for multiple applications on a cartridge. The error code for this is TOO MANY and appears when a cartridge menu is requested. To correct carry out the following :-

Load BASIC

Enter the following command

**set\_pse 28,n**

n should be a number from 2 to 5. If n = 2, approximately 20 cartridge applications can be handled; if n = 3 approximately 30 etc..

The 'set\_pse' command changes the application handling instructions in the PERMANENT STORE but the changes are only recognised during the Power-up INITIALISATION of the computer. To activate the changes the computer must be switched off AFTER using the 'set\_pse' command and then powered-up again so that the changes are recognised.

### SETTING UP FOR INTERFILE

The INTERFILE capsule contains an enhanced version of the T—LINK protocol and this requires the Data Auto-answer application to be reset to ~LF and the Auto-answer Protocol to ~LI so that INTERFILE can function correctly. The factory default values of these are ~CTXTR and ~L respectively. To set for INTERFILE, run the CONFIG program on the BASIC cartridge, change to the above values on the MAIN SYSTEM CONFIGURATION SCREEN and reset the PERMANENT STORE to retain the new data. If the INTERFILE capsule is removed the above values should be returned to the factory default settings via the CONFIG program, as above.



## **APPENDIX 2**

### **HINTS AND GENERAL INFORMATION**

#### **1. Power Supply Problems**

Batches of the OPD SMPSs are prone to early failure. The first symptom is a failure to achieve regulated voltage when switched ON. When first encountered satisfactory operation can normally be achieved by repeated ON/OFF switching until the output voltage becomes established. As the fault worsens the supply fails to respond to multiple switching and remains permanently at low voltage. The problem can usually be corrected by replacing C10 in the SMPS with a 220 MFD, 16 volt 85 degree capacitor.

#### **2. TELEDRIE Power Supply Problems**

Early model TELEDRTVEs had a weakness in the design of their power supply which could allow some disc drives to pull the 5 volt rail to the electronics below acceptable operational limits. This caused the two disc drives to run simultaneously and lock in that condition. The fault could corrupt data on the discs and in extreme cases disc and drive damage could occur.

The problem can be corrected by doubling the size of the reservoir capacitor on the 5 volt supply and replacing its 7805 voltage regulator with a low dropout type (National Semiconductor LM2904CT/Radio Spares Pt.No.648—551).

#### **3. BASIC Undocumented Features**

ICLBasic has undocumented features:

##### **a) . TK\_SAVE and TK\_PUBLISH**

These are tokenised versions of the standard SAVE and PUBLISH commands. TK\_SAVE and TK\_PUBLISH save a file in a tokenised version that loads approximately 3 times faster than a conventional file. This is achieved at the expense of increased file length and memory usage.

##### **b). TRACE**

TRACE is a de—bugging aid for BASIC programs. It prints the program line numbers to screen as they are executed. TRACE 1 turns the TRACE facility ON and TRACE 0 turns it OFF ].

#### **4. BASIC in ROM**

Unlike the QL the OPD ROM and cartridge formats are similar making it possible to transfer the ICLBasic interpreter to EPROM. The file length of version 05 BASIC is approximately 38K. Version 07 is shorter ].

#### **5. Operating System Version**

The version of BFS (the Operating System) fitted to a machine can be displayed from the TOP LEVEL MENU by keying <Alt> <Z> simultaneously. The latest known version displays 'F1.2 2.1' in the bottom left hand side of the Notice Board.

#### **6. Access to 'Phone Base'**

Phone Base is BT's on—line telephone directory. At the time of writing (June '91) there is no charge for the service other than the call charge of 6p/minute cheap rate and 13p/minute peak. The service needs VT100 emulation and 8 data bits. The standard OPD can only provide 7 data bits but the VT-LINK2 capsule can provide the machine with a suitable emulation plus 8 data bits so allowing access to 'Phone Base'. Information is available from BT on 0800 800 802.

## **APPENDIX 3**

### **THIRD PARTY SOFTWARE**

The following listing is alphabetic by program name and is not exhaustive. The source listed is the selling agent who may not be the originator:—

#### **1. SOFTWARE FOR THE STANDARD OPD**

##### **1.1 ABACUS TEMPLATES**

Special spreadsheet templates for income tax, budgeting, financial reports etc. Patrick and Leach.

##### **1.2 ACTION DIARY/ACTION DIARY 2**

Satelite Computing produce an ACTION DIARY.

##### **1.3 ARCHIVIST**

A program to simplify basic ARCHIVE application which the user can then tailor to his individual needs. It requires XCHANGE vers. 2.5. Ark Distribution.

##### **1.4 BANKS OF PLANTS**

An ARCHIVE/ACHIVIST database detailing over 950 plants. Ark Distribution.

##### **1.5 BASIC TELEPHONY INTERFACE**

A Satellite Computing Romcap linking Basic programs and the telephone.

##### **1.6 'C' COMPILER and ASSEMBLER**

A 3 capsule set from Computer One was scheduled for release in mid-1986. The Compiler was in 2 capsules and the Assembler in one. These were to be supplied with a 4-slot ROMPACK containing XCHANGE with QUILL being used to prepare and edit program

##### **1.7 BASIC COMPILER and INTERPRETER**

This also was from Computer One and intended for release as a special ROMPACK assembly. XCHANGE was not available with this ROMPACK but the system included an editor for program preparation.

##### **1.8 BRAINSTORM+**

A program for jotting down ideas which can be refined at a later date. Control-C Software.

##### **1.9 CHESS**

Chess for the OPD with 28 levels of play. PSION.

##### **1.10 CROSS-DEVELOPMENT PACKAGE**

Metacomco supply a cross-development package which allows OPD software to be developed on an ICL or IBM PC.

##### **1.11 DB-LINK**

A capsule which allows the OPD to 'auto-log-on' and

'auto-answer' when used in conjunction with the MGB Dialback Security System. MGB Micro Products.

### **1.12 MGB-LINK**

A capsule including all the facilities of DB-LINK plus the ICL-LINK terminal emulation package (1.11, above, refers). MGB Micro Products

### **1.13 MINDER/REMINDER**

A program produced for the Australian Computer Phone similar to Action Diary.

### **1.14 MINI ACCOUNTS 2**

Abacus templates for simple business spreadsheets for ledger, budget account, cashbook and payroll. PennLine Systems.

### **1.15 OPD FORCASTER**

A Business Forecasting Program – Control-C Software

### **1.16 PRESENTER**

A Satellite Computing Romcap providing a graphics display system for producing transparencies and designing, and running, flipchart style presentations using a rolling, on-screen display.

### **1.17 PLANT DATABASE SYSTEM**

A database system which uses ARCHIVE to help with tree and plant selection and care. Superplant Systems.

### **1.18 PROJECT PLANNER**

Originated by Triptych Publishing this project planner allows up to 700 activities to be included in one project. Satellite Computing.

### **1.19 ROLLAPAGE**

A computer access page store with enhanced facilities including archiving, organizing and merging of stored pages and self-running displays – Satellite Computing.

### **1.20 STOCKMARKET MILLIONAIRE**

A game. PCML.

### **1.21 TELESALLES**

A program to control telesales campaigns. PCML.

### **1.22 TELETOOLKIT (Requires the TELEDRIE)**

A general utilities disc for inspecting and altering the content of files. The later versions of TELETOOLKIT included improved versions of the configuration programs.

### **1.23 TELELOADER (Requires the TELEDRIE)**

Allows the standard top level menu to be replaced by a menu offering up to 20 applications.

### **1.24 TOP DESK**

A small business accounting package. A.M. Programmers.

### **1.25 TYPING TUTOR**

Produced by Computer One.

## **2.0 CP/M SOFTWARE**

CP/M Software requires the TELEDRIE and the CP/M Operating System. It runs on the CMOS Z80 processor of the TELEDRIE.

### **2.1 CP/M OPERATING SYSTEM (PCML)**

This allowed CP/M+ (version 3.0, 56K TPA) to be run on the OPD, via the disc drive, and so take advantage of CP/M commercial and public domain software. The CP/M system includes two discs; a LOADER and the CP/M system disc. The system disc contains programs to import and export files from CP/M.

Two versions of PCML CP/M are known to have been released. The first BIOS D 1.1 allowed external drives C and D to be attached and operate in formats QX10UK and QX10US respectively. This allowed the import of files. The second release was BIOS D 1.2 which did not provide the QX10 facility but had the ability to import CP/M files from MSDOS discs.

### **2.2 CP/M PUBLIC DOMAIN (PD) SOFTWARE**

This can be obtained on 3.5" MSDOS discs from:

PCW World,  
Cotswold House,  
Cradley Heath,  
Warley,  
West Midlands,  
B64 7NF Tel. 0384 66269

### **2.3 CBASIC**

BASIC programming language. Control-C Software.

### **2.4 SUPERCALC 2**

A version of the well known spreadsheet. Patrick and Leach.

### **2.5 PASCAL MT+**

A Pascal programming package including speed programming. Control-C Software.

### **2.6 DR ASSEMBLER AND TOOLS**

An assembly language programming package. Control—C Software.

## **2.7 OPD WORDSTAR ('POCKET' WORDSTAR)**

A cut down version of Wordstar and Mailmerge. Control-C Software.

### **PROGRAMS**

These programs which run on the Sinclair QL and are of interest to OPD/QL users are produced by:

D.J. Walker, 22,  
Kimptons Mead,  
Potters Bar, Herts.,  
EN6 3HZ Tel. 0707  
52791

### **3.1 DISCOVER**

A program to allow the QL to read and write discs in MSDOS that can be exchanged with OPD TELEDRIE discs.

### **3.2 QL/OPD FILE INTERCHANGE PROGRAM**

This program allows the QL to read and write microdrives in OPD format so that they can be exchanged between machines. Successful transfer is limited to ASCII and XCHANGE files. Machine code can, theoretically be transferred but there serious are pitfalls for all but experienced programmers.

### **3.3 QL/OPD DIRECT I/O TOOLKIT**

This program allows direct sector access to QL and OPD microdrive cartridges and discs so allowing editing or recovery of corrupt sectors.

## APPENDIX 4

### REVIEW CRITICISMS

These relate to the OPD as released in 1984. The references in brackets refer to subsequent introductions of hardware, or software, to correct, or reduce, the identified deficiency.

- 1 Serious memory shortage and fragmentation of the available memory as the work session proceeds.(5.1 and 5.2 refer).
- 2 PSION XCHANGE is not integrated with the Operating System. QUILL cannot access the modem etc.. (2.3 and 2.6 refer).
- 3 BASIC is not in ROM and has to be loaded from microdrive, absorbing scarce RAM. (Memory expansion of 5.1 and 5.2 refer; see also the note in 3.1).
- 4 Multi-tasking is limited by memory shortage and the Operating System e.g. incoming telephone calls can abort operations in progress such as microdrive formatting. (Memory expansion of 5.1 and 5.2 refer).
- 5 The OS is an ICL 'special', so preventing the use of standard software. (The CP/M facilities of 5.2.1 refer).
- 6 ICLBasic is a curtailed subset of Sinclair SuperBASIC but is not compatible with it e.g. ICLBasic does not include SuperBASIC graphics such as LINE, CIRCLE and ARC.
- 7 The standard mono monitor is not of high quality. It has no brightness control, in consequence, the display can be difficult to optimise. (The optional colour monitors provide an improved display and are preferred by most business users).
- 8 PSION XCHANGE, in ROM, is not fully developed and is inflexible regarding update and improvement by third party software e.g. QUILL cannot be modified for spelling checkers and cursor acceleration programs such as SPELLBOUND, FILEBOUND and TURBOQUILL+ while ARCHIVE cannot save the faster 'pro' programs.
- 9 The numerical routines for access by menu, together with the hierarchical menu structures, are cumbersome and lack mnemonics or similar logical features to help the operator remember them.
- 10 The keyboard has a number of multi-function/shifted keys; some keytops having 3 legends.
- 11 Device names, such as the microdrives, change between normal OPD operation and operation in BASIC.
- 12 An OPD (with 4 ROM capsules) can have over 400K of firmware in ROM (14 ROM ICs). This yields benefits in speed and simplicity of operating but up-dating to later, improved versions of the firmware can be expensive when PROMs rather than re-programmable EPROMs are used i.e. new ROM devices have to be obtained and the old devices discarded. [ In general early OPDs used EPROMs but the bulk of the main OPD production used PROMs. ]
- 13 Many of the OPD functions have a raw, unfinished feel as if they needed refining to reach release standard.

## **APPENDIX 4**

### **OPD ROM FORMAT**

#### **1. Block Header**

OPD ROM is divided into blocks. Each block starts (at its lowest address) with a 4 byte header. The header allows the Operating System (OS) to recognise an OPD ROM as valid firmware. The header must start on an even address byte.

Bytes 0, 1 and 3 of the block header are always the same being hex AS, 4F and 00 respectively. Byte 2 is the block size in multiples of 8 K. e.g. A 32 K block of OPD ROM starts with the header:

AS 4F 04 00

#### **2. Block Trailer**

The block ends with a Trailer of 16 bytes.

Bytes 0 to 11 are spaces

Bytes 12 to 15 are zeros

#### **3. Programs**

One ROM block can contain several programs between its block header and the block trailer. Each program must be a multiple of 2 bytes in length and must start on an even byte number. There must be no spaces between the block header and the first program, between programs or between the last program and the block trailer

#### **4. Programs Header**

Each program has a header consisting of 26 or more bytes. The total header format is complex but for the manipulation of existing programs knowledge of two aspects of the program header are generally sufficient i.e.

- a). Bytes 0 to 11 give the program name
- b). Bytes 12 to 15 give the total program length in bytes including the program header

#### **5. Cartridge Programs**

The format of a machine code program on cartridge is similar to a ROM program. The cartridge program does not have a ROM block header or trailer. It is possible to convert some machine code cartridge programs to ROM programs by adding a ROM block header and trailer. This can be done with the ICLBasic cartridge to provide improvements in memory workspace and speed when working in Basic.

The length of the ICL Basic program varies depending on the version. Version 5.02 and 7.00 are approximately 38K and 36K respectively. All versions exceed the capacity of a 27256 EPROM (32K). ICLBasic, therefore, requires to be contained in two 27256s. These must be mounted, in correct order, in two consecutive slots in the memory map. The obvious location is the 64K reserved for expansion of the OS.

Additional firmware such as VT-LINK and the MEU programs can be used to fill the remaining space in the EPROMs carrying Basic.

## APPENDIX 5

### OPD ROM LIST

BOM				
Item	Location	PROM	EPROM	Remark
1	IC4/pb	XBAA03	CCAN0	OPERATING SYSTEM Id.
2	ic5/pb	XBAB04	QCAP0	OPERATING SYSTEM
3	IC6/pb	XBAC03	OCAQ0	OPERATING SYSTEM
4	IC7/pb	XBAD03	QCAR05	OPERATING SYSTEM
5	IC7/rpk	XBAF01	QCAU02	XCHANGE 2.3 PSION
6	IC8/rpk	XBAG01	QCAV02	XCHANGE 2.3 PSION
7	IC9/rpk	XBAH01	QCAW02	XCHANGE 2.3 PSION
8	IC10/rpk	XBAJ01	QCAX0	XCHANGE 2.3 PSION
9	IC6/rpk	XBAK02	QCAT0	XCHANGE/OS 2.3 PS I
10	IC19/mb			OPERATING SYSTEM
11	IC20/mb			OPERATING SYSTEM
12	IC28/mb	XDAA02		VOCABULARY ROM
13		XEAA01	QCAZ02	MESSAGING CAP.
14			QCCC01	INTERFILE CAP.
15				COMBINED COMMS.
16				ICL-LINK CAP.
17	128		PSBS04	VT-LINK CAP.
18	256			VT-LINK 2 CAP.
19				DATALINK CAP.
20			QCCB0	ILLUSTRATOR EGO
21				ADVANCED
22				ADVANCED MESSAGING
23	64		QXAB0	ACU Firmware
24	256		SBAA01	ACT Patch Code
25	64		QXAA01	MEU RAM/initialisation
26	LM024	XFAA01		XCHANGE 2.5
27	256	XBAI02		XCHANGE 2.5 PSION

### NOTES:

1. The final digit in the ROM identification is the issue number.
2. There are 2 series of identifications, an initial 'Q' series for EPROMs which carried on to the first PROMs and a later 'X' series for PROMs only.
3. Location abbreviations are:—  
 mb = main board  
 rpk = ROMPACK  
 pb = 'piggy-back' CPU board MEU = Memory expansion unit/ICL  
 ACU = Asynchronous Comms. Unit/ICL
4. ROMs from special BT ancillary equipment (e.g.the DCA) have a different identification system from the ICL devices listed above
5. Five types of ICL PLA have been identified :-

KVAB02 - Standard 2-slot ROMPACK  
 KVAD01 - Standard 4-slot ROMPACK  
 KVAE01 - MEU  
 KVAG01 - MEU  
 KVAL01 - TELESTORE 4-slot



## APPENDIX 6

### OPD CAPSULES

OPD Capsules provide optional ROM firmware and connect to the computer via 30 pin 'slots' in the ROMPACK. The original ROMPACK has provision for connecting 2 capsules. The later design of ROMPACK accepts 4 and the latest TELESTORE memory expansion accepts 6. The 30 pin 'slots' also serve as expansion ports for the OPD e.g. for connecting disk drives etc.

Each capsule contains a ROM 1C which can be 8, 16 or 32K. The 1C is normally an EPROM, surface mounted to obtain minimal capsule thickness. A typical capsule schematic is shown in Fig. 1. The capsule includes a supply de-coupling capacitor C1 and a 3K3 bias resistor H1. There is a link in the capsule between its pin B15 (ground, 0 volts) and pin A14 (HSD\*:L). When a capsule is inserted into the ROMPACK this link enables the appropriate section of the ROMPACK programmable logic array (PLA) IC5. The PLA is a peripheral management IC. When the 'link' is in place PLA generates an enable signal for the capsule ROM (RC\*:EN:L) at the appropriate memory address. The link also enables related CPU interface signals, DTACK:L and VAPA:L, which advise the CPU that data is available at the capsule address and that the address is a valid peripheral address.

The PLA pin connections associated with capsule control on a 2-slot ROMPACK are :-

PLA Pin   Function	
15	RC1 :EN:L
16	RC2 :EN:L
8	HSD1:L
17	HSD2:L

## APPENDIX 6

### Identified OPD Drawings

Drg. No	Sheet	Subject
5400063	1/2/3/4	Modem schematic
5400076	1	Rompack PCB layout
5400078	1/2/3	Rompack schematic
5400112	1 only	CPU PCB layout
5400119	1/2	CPU schematic
5400132	1	Mono monitor video board
5400144	1	Main PCB layout
5400146	1/2/3/4/5/6/7	Main PCB schematic
5400168	1 only	Modem PCB layout
5400170	1/2/3/4	Modem schematic
-----		Colour monitor std. res. PCB layout
-----		Colour monitor std. res. schematic
-----		Colour monitor high res. PCB layout
-----		Colour monitor high res. schematic
-----		Mono monitor chassis schematic
-----		AA12630 SMPS card (unreadable)

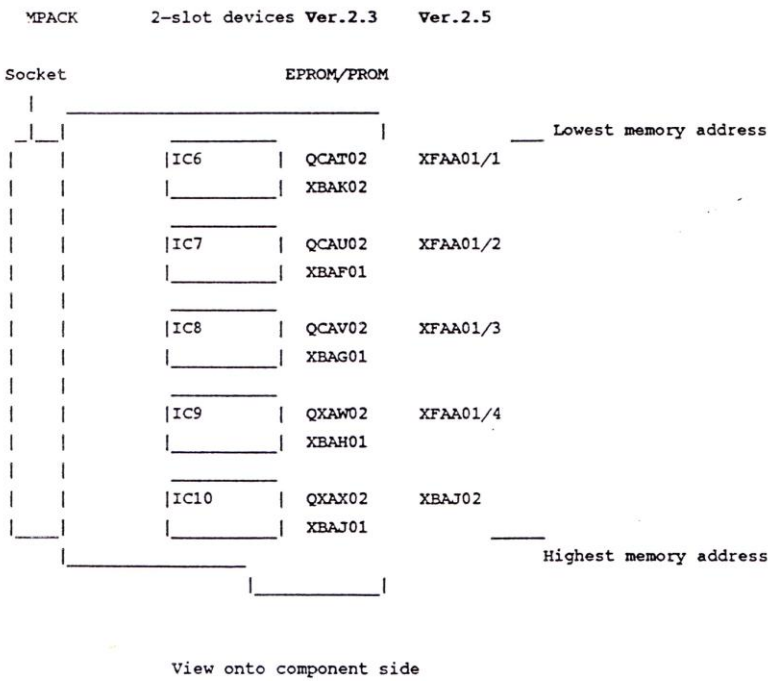
APPENDIX 7

Using XCHANGE 2.5 in a 2-Slot ROMPACK

XCHANGE 2.5 was released for use in the 4-slot ROMPACK and the MEU/SEU memory expansion. It was also employed in all versions of TELESTORE. For the 4-slot ROMPACK, and the MEU, XCHANGE 2.5 was in the form of a LM PROM (XFAA01) and a 256K PROM (XBAJ02). There was no general release of version 2.5 for the original 2-slot ROMPACK. However, some scrap, non-working KEUs and 4-slot ROMPACKs have appeared on the surplus market. These generally have faulty PLA ICs for which replacements are difficult to obtain. However, the ROM/PROMs can be in good condition and their XCHANGE programs re-useable if a means can be found to use them.

XCHANGE 2.5 is suitable for 'breaking-down' into 5 x 27256 EPROMs and mounting in a 2-slot ROMPACK. 'XFAA01/1' is the lowest 32K address block of the 1M XFAA01 PROM and 'XFAA01/4' is the highest 32K address block.

The OPD/TONTO memory map allocates 160K for XCHANGE plus that part of the Operating System which mounts in the ROMPACK (CALCULATOR etc.). 'XFAA01/1' should start at the lowest address in the 160K block and 'XBAJ02' finish at the highest address in the 160K block. To achieve this the 5 EPROMs carrying XCHANGE 2.5 should be mounted in the ROMPACK as shown below.



## OPD/TONTO FIRMWARE

KERNAL is the basic (lowest level) OPD/Tonto Operating System. It provides the logical map of the hardware and controls input/output; memory allocation; device control and interrupts.

DIRECTOR — is higher level software and has 2 elements:  
— Applications Handler  
— Telephone Handler

Application Handler schedules tasks so that they do not clash. It controls what application is where, what resources are being used and what resources were being used in previous (but still active) tasks.

START, RESUME and REVIEW keys are controlled by DIRECTOR. Add-on

hardware has to be linked with KERNEL and to DIRECTOR.

An attempt has been made to identify the major sub-programs in the ROMs of the Operating System, XCHANGE, the ICL, ROM CAPSULES and add-on hardware (TELEDRIIVE etc.).

The lower level code (KERNEL and DIRECTOR) has not been identified. This appears to reside in OS1 and OS2 with spill-over into OS4.

Higher level programs and the application firmware generally starts with a ~ (tilde, HEX 7E) followed by a letter string. The first letter of the string identifies the area of application and the area of low level code with which the program links. For menus etc. the programs are sorted alphabetically.

In the following listings program identifications marked with a star (\*) are inferred/unconfirmed.

The total program length listed (i.e. the end address) includes the ROM header but does not include the ROM trailer. THE PROGRAM LENGTHS ARE VERSION SPECIFIC AND SHOULD ONLY BE USED AS A GUIDE.

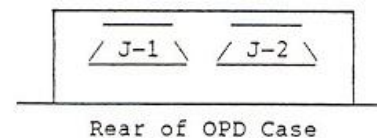
Application identification:-

- ~A — Telephone Directory
- ~B — Telephone Control
- ~C — Messaging
- ~D - Computer Access
- ~E — Calculator
- ~G - Housekeeping
- ~1 \* Voice Response
- ~J \* Library
- ~L - T-Link
- ~M \* Permanent Store Control
- ~N \* Printer Manager
- ~T \* DIRECTOR

# HEX Addresses, Slot Decode Key plus ROM Program Dumps from BASIC

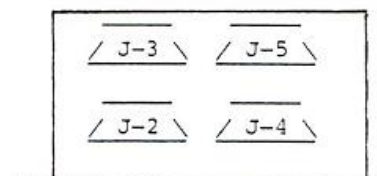
HEX	Address Bits					N	'Slot' Content
	15	16	17	18	19		
\$F0000-							
\$F8000						31	Reserved
\$F0000						30	2-slot Rompack slot J2
\$E8000						29	2-slot Rompack slot J1
						28	
						27	XCHANGE
						26	plus
						25	Operating System
\$C0000						24	
						23	Operating System
\$B0000						22	Expansion
						21	Operating
\$A0000						20	System
						19	
						18	128K
						17	Memory (DRAM)
\$80000						16	Expansion
\$78000						15	4-slot Rompack slot J5
\$70000						14	Reserved
\$68000						13	4-slot Rompack slot J4
\$60000						12	Reserved
\$58000						11	4-slot Rompack slot J3
\$50000						10	Reserved
\$48000						9	4-slot Rompack slot J2
\$40000						8	ULA3*2K static RAM*I/O
						7	
						6	128K
						5	Memory (DRAM)
\$20000						4	Standard
						3	ULA1
\$10000						2	I/O
						1	Operating
\$00000						0	System

## 2-Slot ROMPACK Slot - (29) (30)



Rear of OPD Case

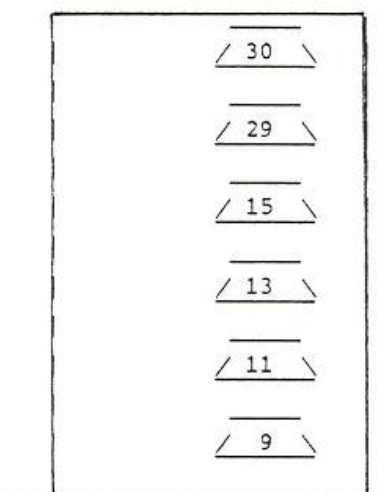
## 4-Slot ROMPACK/TELESTORE Slot - (11) (15)



Slot - (9) (13)

Rear of OPD Case

## 6-Slot TELESTORE Slots



Rear of OPD Case

## OPD MAIN BOARD

### 1. DEVICE LISTING

1CNo.	Type	Remark
1 to 16	4164-3	64K x 1 bit 150 ns DRAMs
17		Not used.
18	74LS38	Part Address Decode ULA3
19		Not used.
20		Not used.
21	PCF 0455 P/002	ULA3 ICL
22	74HCT245	DRAM DATA bus Transceiver
23	74HCT257	DRAH Address Multiplexer
24	74HCT257	DRAM Address Multiplexer
25	ZX8301/CLA 230	ULA1 Sinclair
26	TC5516AP	2K x 8 bit Static RAM
27		
28	XDA A02	Not used. Speech synthesizer ROM
29	ZX 8302	ULA2 Sinclair
30	74LS175	Check ccts. and Tel. line LEDs
31	74LS164	K/bd DATA OUT 8bit Shift/Register
32	74HC165	K/bd DATA IN 8bit Shift/Register
33	TBA820M	A.F. Amplifier
34	74LS240	VDU Buffer
35	74LS86	HSYNC extract logic
36	74LS123	Delay/CPU interrupt cct.
37	26LS29	Ser. Data OUTPUT Driver
38	74S00	ULA3 peripheral logic

**1.1** ULA1 and 2 (1C 25 and 29) are Sinclair custom ICs for the QL.

**1.2** ULA1 (CLA 230/ZX 8301). Performs the following functions:-

- VDU picture generation
- Master clock
- DRAM control
- DATA bus Transceiver control

**1.3** ULA2 (CLA2345/ZX8302). Peripheral control device providing:-

- Real time clock I
- Interrupt control
- Microdrive control
- RS432 serial data for printer

**1.4.** ULA3 is an ICL custom device for control of peripheral functions not present in the QL. These are: Voice

- Synthesizer 2K static RAM Telephone/modem

### 1.5 PRE-SET CONTROLS

- VR1** - Speech Synthesiser Oscillator Tuning.
- VC1** - Real Time Clock fast/slow trim.

## 2. PLUGS and SOCKETS.

The following connections are taken from the main board:-

J1	Keyboard
J2	Modem
J3	VDU/PSU
J4	Printer
J5	ROMPAK
J6	Microdrives
J7	9 volt telephone battery
J8	Loudspeaker connector, only on early boards
J9	Hookswitch/Loudspeaker

## 3. CONNECTOR

### PIN-OUTS

3.

### J3 - POWER AND VIDEO

15 way miniature 'D' Plug on the Motherboard	Pin	Function
	1	Earth (video)
	2	Red
	3	Green
	4	Blue
	5	Horiz. Sync.
	6	Vert. Sync.
	7	Earth Not connected
	8	-5 volts
	9	Earth
	10	Monitor Power
	11	+5 volts
	12	+5 volts
	13	+12 volts
	14	Powerdown
	15	Csync.

Notes:

a). Hold Pin 14 (Powerdown) at +5 volts for operation.

3.2.

### J4 - PRINTER

(9 way miniature 'D' socket on motherboard) Connections for Epsom, or compatible, serial printer

OPD Pin	Printer Pin	Function
1	3	TX00
2	1 and 7	Earth
3	20	DTR

## APPENDIX 8

### COPYING OPD/TONTO DISK FILES FROM TELEDRIE TO PC DOS DISKS

1. Re-name TONTO files to DOS format using TELETOOLKIT as follows:

a). Pad the main name to 8 characters with spaces

b). Remove the 'dot'

c). End with the 3 character file extension e.g. FILE.DOC becomes FILE\*\*\*\*DOC ('\*' is used to indicate a space in the example).

2. Format a 720K 3.5" disk on the target PC. (A disk formatted on the OPD would have 2 CAT! files which can give problems on some PCs).

3. Put the formatted disk into the TELEDRIE and use TELETOOLKIT to copy the re-named Tonto files onto the formatted disc.

4. If necessary use a PC or PCs to transfer files from the 3.5" 720K disc to a 360K 5.25" disc.

NB. A disk formatted on a PC will lack the two CAT! files normally supplied during formatting on an OPD and though the disk can be operated on by TELETOOLKIT, TELETOOLKIT will not provide an accurate read out of the free space remaining on the disk.