

## Keyboard

The design of the F1 Keyboard is slightly different from the keyboards found on other business micros; being a full function keyboard (92 keys) which is linked to the Systems Unit by infra-red and also incorporates a real time clock calendar (implemented in software).

The key layout is divided into a number of well defined sections. These are, looking from left to right across the key tops:

1. The QWERTY section which includes cursor, scroll and general editing keys. This is an identical layout to the one found on the Apricot pc/xi range of computers.
2. A calculator keypad.
3. 10 general/fixed function keys.

These keys are square in design and feature a slightly sculptured keytop to ensure accurate user action.

Four machine function keys are located above the keyswitch array and are of an entirely different design. They are slightly recessed to avoid inadvertent user action.

The Keyboard is designed to be used with its spring-loaded feet extended. Buttons for releasing the feet from their storage position are provided on the side of the Keyboard.

The major advantage of using the infra-red link for transmission of keyboard data is that the user is free to site his Keyboard in the general vicinity of the Systems Unit but not necessarily directly in front of it. (Maximum practical distance for using the infra-red Keyboard is specified at up to 2 metres away from the Systems Unit).

To avoid the possibility of interference in multiple machine environments, a "light-pipe" is available for linking the Keyboard and Systems Unit together. This is a section of fibre optic cable which directs the infra-red keyboard transmissions to the receiver circuits of the parent Systems Unit.

To improve system reliability and ensure that the BIOS does not misinterpret data transmitted from the Keyboard, the keycode data is encoded using Hamming codes prior to transmission. This is an error correction/detection encoding technique which allows the BIOS to correct and detect errors in the transmitted key data.

The keycodes are transmitted in serial packets of data, each packet consisting of 32 bits. The information contained in the transmission packet signifies the X-Y co-ordinate of the pressed key and the key status. The key status identifies whether the key pressed is:

1. Shifted (SHIFT key + key pressed).
2. A control key sequence (CONTROL + key pressed).
3. In Auto-repeat mode (key was the last key to be transmitted and is being held down).

The use of keycodes rather than using the ASCII equivalent to represent the key(s) makes it particularly easy for the programmer to redefine the keycode. Support in the BIOS is provided to allow this to be done by simply loading a new keyboard table into RAM and modifying a pointer to point to it. A default keyboard table is stored in ROM.

Not all keys can be reassigned by the applications programmer. Certain of the keys are designed to perform specific functions and are therefore masked off by the BIOS and processed in an entirely different manner. These include the TIME/DATE key and the four button keys RESET, REPEAT RATE, SET TIME and KB LOCK.

The TIME/DATE key causes the time and date information generated by the real time clock/calendar software routines within the Keyboard to be transmitted to the Systems Unit.

This is used by the ROM BIOS to update the BIOS internal clock, (as used by MS-DOS for its time and date stamp). The time and date data is supplied to the Systems Unit in 15 separate contiguous data packets following the TIME/DATE keycode packet.

The key also serves another function at machine switch on, where it initiates the boot loading sequence, if a bootable disk is within the disk drive.

The function of the RESET key is self-explanatory, being the system reset key. It generates a hardware reset in the Systems Unit and must be held down for approximately one second before it functions. The delay is implemented to prevent the user accidentally resetting the system.

The REPEAT RATE key is a toggle switch which allows the user to set the auto-repeat rate of the keys to either one of two values; a fast or a slow rate. (The repeat rate is the rate the keyboard transmits the keycode to the Systems Unit, when a key is held down).

The SET TIME key is used to adjust the real time clock/calendar software within the keyboard. It can be actioned by the user anytime (before or after the system boot). Pressing the key displays a prompt on the 25th line of the display in the following format:

HH:MM DD/MM/YY

The user resets the time and date within the keyboard by typing in numerical values only using the numeric keypad (e.g. typing 1000011285 sets the keyboard clock to 10 am, 1st Dec 1985).

The key does not send the updated time and date information to the ROM BIOS. This function is actioned by the TIME/DATE key as described above.

The KB LOCK key is a toggle key which enables the user to deactivate the effect of all keys apart from RESET, SET TIME, TIME/DATE and KB LOCK itself, (i.e. it locks out the keyboard). Pressing the key again informs the BIOS to restore action to all the keys.

Another special key function on the Keyboard is the CALC key in the shifted mode (SHIFT key + F4) which can be redefined by applications software if required, but should generally not be reconfigured. The key sequence can be used prior to boot and can be also made available during applications or at the operating system level, to initiate the BIOS calculator software.

The calculator display appears on the 25th line of the display screen. The calculator keys are formed by:

1. The numeric keypad (1 to 9, the mathematical function keys, decimal point and ENTER).
2. The CLEAR key.
3. The function keys, STORE, RECALL, M+, M-.
4. The CALC key.

After boot an extra calculator key is available to the user. This is the function key, SEND (obtained by CONTROL + F5). It enables the user to send the results or operands of a calculation to the cursor position on the screen.

The Keyboard is powered by four AA batteries, which are located behind a panel on the base of the Unit. These provide enough power to keep the Keyboard operational (under normal everyday usage) for approximately 6 months.

## ***Drivers***

The ROM BIOS contains the following standard device drivers, listed below. The actual function of each driver is indicated by their titles.

1. Keyboard Driver
2. Screen Driver
3. Disk Driver
4. Parallel Port Driver
5. RS232 Driver
6. Clock Driver
7. Winchester Driver

### ***Keyboard Driver***

This routine receives all data transmitted to the machine via the infra-red input. This includes keyboard and mouse data.

Decoded mouse data is not handled by the keyboard driver. It is immediately passed onto another routine via an interrupt. The mouse data handling routine may be the loadable mouse device driver, or any other routine installed by the application writer.

Keyboard data is always initially analysed for any special key depressions such as TIME/DATE, KB LOCK, SET TIME, REPEAT RATE. These keys are filtered off and sent off to the appropriate ROM BIOS routine to action a specific user function. They are therefore not accessible to the applications writer.

All other keys are converted to an Apricot compatible keycode (termed a downcode), which is normally used to select an entry from a keyboard table. The selected entry is then usually passed to MS-DOS via an 80 byte queue.

The keyboard table occupies a minimum of 1K of memory space and can be either the default keyboard table in ROM or any other keyboard table loaded into RAM by the programmer. The use of a software keyboard table allows the programmer to translate a user key depression to any code or sequence of codes as required.

A simple mechanism enables the programmer to specify the keyboard table in use. This is achieved by modifying a pointer (the active key table pointer) to point to the start of the desired table.

## Infra-red Mouse

The Mouse for the F1 is identical to the Mouse for the Portable (apart from the colour of the plastics). It has been designed to be used either as a Mouse (by tipping it forward and rolling it along the desk), or as a tracker ball (keeping the Mouse stationary and moving the ball by finger movements).

The mouse is normally employed for cursor movement control and menu selection in graphics environments, but can be used within other applications as required.

A mouse device driver is supplied with the standard release software to allow applications to use the features and facilities of the device. This is an installable device driver which is loaded into the system using the MS-DOS CONFIG.SYS file mechanism.

The Mouse uses infra-red technology in a similar way to the Keyboard. As with the Keyboard, the Mouse can be sited within the vicinity of the F1 but does not necessarily have to be directly in front of it. (The front edge of the mouse must of course point at all times during usage in the general direction of the front of the machine). The maximum practical range of the Mouse is specified at 2.5 metres away from the Systems Unit.

To avoid the possibility of interference in multiple machine environments, a "light pipe" is also available for linking the Mouse and Systems Unit together. This is a section of fibre optic cable (similar to the Keyboard cable) which directs the infra-red Mouse transmissions to the receiver circuits of the parent Systems Unit.

A two-position switch is located on the base of the unit. This should be set to the position towards the rear edge if using the light-pipe and the other position if not. The function of the switch, is to turn off one of the infra-red transmitting LEDs to conserve battery power.

To improve system reliability and ensure that the BIOS interprets the data transmitted from the Mouse correctly, the Mouse data is encoded using a similar format as used for the Keyboard. This employs a four byte synchronous data transmission format with each data byte encoded with Hamming codes.

Mouse data is transmitted in serial packets of data, with each packet consisting of a 32 bit code sequence. The information contained in the packet signifies the relative movement of the Mouse from its previous position, and the state of the two Mouse buttons (pressed or not pressed).

## Infra-Red Detector Board

The Infra-Red Detector Board is located above the System Board behind the transparent window in the front panel of the Systems Unit. It is linked to the System Board by a 4-wire cable assembly. This provides +12V and +5V dc regulated supplies to the board and also carries the decoded IR signal pulses to the System Board.

The Board incorporates three photodiode detectors, an amplifier section, and a timer circuit (see Circuit Diagram in Appendix D). It converts input infra-red pulses into a form suitable for use by the receiver circuits on the System Board.

Two of the photodiodes are fitted behind sockets on the right of the transparent window. These sockets are for connecting light pipes to the Systems Unit.

A third photodiode detector is surrounded by a lens, in order to optically amplify freespace infra-red transmissions.

Fitting a light-pipe into the right hand photo-diode socket operates a switch which switches the diode surrounded by the lens off. This action is necessary to reduce the chance of interference from other infra-red sources in multiple machine environments.

Detected infra-red pulses are converted into electrical pulses by the diodes. To account for the variations in signal strength of the input infra-red pulses, and to prevent saturation of the diodes, the current through the diodes is regulated by an a.g.c amplifier (Q1).

Following conversion to a voltage, the raw input pulses are amplified by a high gain amplifier circuit (Q2, Q3). This produces a pulse output with an amplitude of approximately 2 to 5 V which is then supplied to a 555 timer circuit.

The timer is wired in a non-retriggerable mode to prevent false triggering once a pulse is detected. The timer "squares" up the raw input pulses of 18 to 20  $\mu$ s duration and converts them into 25  $\mu$ s duration output pulses. These are supplied to the System Board.

On the System Board, the transmitted signal is separated into timing and data pulses, so that the data signal can be clocked into the Z80 SIO as a standard monosync transmission.

Of the 64 connections routed to the slot, 59 are compatible connections with the other products in the Apricot range mentioned above. There are minor differences in detail in these compatible connections. For example, the 15 Mhz clock output on the pc/xi corresponds to 14 MHz on the F1. The major differences are as follows:

1. There are no DMA facilities available on the F1 as provided on the pc/xi range of products.
2. The 8086 NMI line is not routed to the slot on the F1 since it is used within the system for disk transfers.

The external Expansion connector is a 60-way male IDC connector to which an external Expansion Unit can be connected. The connector is located on the right hand side panel of the Systems Unit, and mounted on the System Board.

The Expansion Unit is responsible for re-powering the Expansion Bus as necessary, to meet the drive capability of multiple Expansion Slots. Power supplies for the unit are not available on the connector apart from — 12V.

The connections wired to the Expansion connector are the same as the connections to the Expansion Slot apart from the supply lines + 12V and + 5V, which are not available.

## **Keyboard/Mouse Data**

The receive channel of channel A of the Z80 SIO is used for keyboard/mouse data input. It is programmed to operate in synchronous mode (Monosync) at a data rate determined by the incoming data stream.

It is supplied with keyboard/mouse data via the IR receiver board which decodes the incoming data and converts it into an acceptable serial waveform. (Details of the IR Receiver Board are discussed in the chapter headed Systems Unit).

A signal conditioning circuit then separates the serial waveform into data and clock signals. The data is supplied to the receive data input of channel A (RxDA) and the clock signal to the receive clock input (RxCKA) to clock each data bit into the Z80 SIO.

The Z80 SIO converts the serial data into parallel format. It then generates an interrupt and produces an associated interrupt vector to signify keyboard/mouse data available.

The Keyboard formats a valid key closure into a serial packet consisting of a four byte sequence. The format is the synchronous transmission mode Monosync and is operated at a fixed data rate of approximately 3.85 Kbits/sec.

The four byte sequence consists of the Sync header byte (5AH), a status byte and two data bytes. The status byte and keycode data bytes are encoded with a Hamming format.

Using Monosync means that the Z80 SIO has to first detect a valid data pattern, (the sync header byte) before it regards the data sent as being valid. This provides a high degree of protection from other infra-red sources, as they will not contain the sync header and will therefore be totally disregarded.

Using a Hamming format to encode the data enables the BIOS software to check the integrity of the data received from the Keyboard. It produces a highly reliable system for proving the validity of the Keyboard data, providing a measure of protection against a transmission which contains a valid sync byte, but invalid data (missing or corrupted data).

The Mouse transmits data in a similar four byte sequence to the Keyboard. It uses the same sync header byte, but the data bytes provide information on mouse movement and the state of the mouse switches. The Z80 SIO is unable to differentiate between mouse and keyboard data. The BIOS software determines this by reading a flag bit in the synchronous data packet.

## **System reset**

The system is reset by one of two methods; by powering the F1 off and on or by the System reset button on the Keyboard. Both methods produce the same effect on the circuitry. The reset control lines to the CPU and all peripheral circuitry are held active, setting all programmable elements to initialised status. When the reset line returns to it's inactive state, the CPU accesses the instruction stored at absolute address location FFFF0H to initiate the normal system start-up sequence.

The system reset button is located on the top edge of the Keyboard Unit. Holding the button down for approximately one second actions the reset circuitry on the System Board.



# Keyboard/Mouse Data

Transfer of data from the keyboard/mouse is handled by transmit channel A of the SIO. The channel is programmed to support synchronous communications at a fixed data rate (approximately 3.85 kbits per second).

The format of the data transmitted from both the keyboard and mouse is identical, both consisting of a 4 byte synchronous packet. The first byte in the packet is the sync byte (5AH). The remaining three contain data. (This is true in all cases apart from when the Keyboard System Reset button is pressed. In this case, contiguous sync bytes are transmitted to the Systems Unit instead. The function of this is to generate a hardware reset. This mechanism is discussed in the System Detail chapter).

The clock for the synchronous data is inherent in the data stream transmitted to the Systems Unit. This is split into separate Monosync data and clock waveforms by a signal conditioning circuit.

Reception of the incoming synchronous data consists of two separate phases. The first phase is the Hunt phase, where channel A of the SIO analyses all incoming data, searching for the sync byte 5AH. This is the header byte for all valid keyboard and mouse transmissions.

Detecting the sync byte automatically switches the SIO into the second phase, the Receive phase, where the three bytes of data following the header are loaded into the three-byte buffer of Channel A.

Every time the SIO transfers received data into the top register of the three-byte buffer, it generates an interrupt to the CPU.

The Systems Unit does not exercise control of data flow over the IR link (all transfer of information is one-way only). To prevent any loss of data, the CPU has to read the incoming data at a fast enough rate before it is overwritten in the receive FIFO stack.

The software must therefore be capable of processing data stored in the Channel A SIO receive data buffer at the maximum possible incoming receive data rate. This corresponds to the minimum time taken between the end of one packet and the beginning of the next consecutive four byte packet from the Keyboard and is of the order of 20 ms.

Encoding the data into a synchronous packet format provides a high degree of protection to interference from stray infra-red transmissions generated by other sources. It prevents the system being unnecessarily interrupted by other sources, since only transmissions which contain a sync byte of 5AH will be considered to be valid.

Further protection to sources of interference is provided in the coding of the bytes following the sync header. These three bytes are encoded using a Hamming format. This is totally transparent to the SIO. The SIO is only concerned with receiving bytes of data and is not concerned with the make-up of the bytes. All "de-hamming" is carried out by the BIOS.

A description of the format, character codes and their significance, supplied from the Keyboard is detailed in the Keyboard chapter. Details of the Mouse and its transmission format is packaged into a separate manual.

# Introduction

The Keyboard for the Apricot F1 is a full function keyboard featuring; 92 keytops, four "special" keys, a time and date clock implemented in software, and an infra-red interface for transmission of keycodes and data to the Systems Unit.

It is an identical design to the Keyboard found on the Apricot Portable and is directly compatible and interchangeable. It employs the same circuitry, the same key layout, and uses the same keycode encoding scheme/data transmission rate as found on the Portable keyboard. (The only difference is in the colour of the Keyboard plastics).

The maximum practical distance of operation is specified at 2 metres. The Keyboard will work at greater distances than this but the difficulties in viewing the screen so far away in any other mode apart from 40 column render this sort of usage of academic importance only.

A "light-pipe" is supplied with the F1 to connect the Keyboard and Systems Unit together in multiple machine environments where interference from other users may occur. One end of the pipe plugs into the recessed LED socket on the front edge of the Keyboard. The other end must be plugged into the right hand LED socket on the Systems Unit (as viewed from the front) to prevent interference from other infra-red sources.

The power supply for the Keyboard is provided by four AA cells. These are located behind a cover panel accessible from the underside of the Keyboard. The operational lifetime of the batteries is approximately 6 months under normal everyday usage.

# Details

## Mechanics

The mechanics of the Keyboard are of a comparatively simple design, consisting of a single circuit board, the main key switch array, the four fixed function keys and four AA batteries.

The batteries are located behind a removable cover panel in the base of the Unit. A coin or flat bladed tool is required to gain access to the battery compartment.

The Keyboard PCB is also fitted behind a removable cover panel. As user access is not necessary to this area, there is no easy coin-release slot.

The main key switch array is a single component which is clipped into the plastic moulding and cannot be removed once in position without damaging the array. It is linked to the circuit board by a multi-way ribbon cable connector.

The four fixed function keys are tracked directly onto the keyboard PCB.

The key tops of the key switch array are removable and can be easily repositioned for custom keyboard designs. Applying slight leverage underneath a key top releases it from its normal location, but care should be taken not to lose the springs.

Three infra-red LEDs are mounted on the Keyboard PCB and are located on the front edge of the Keyboard. The LEDs are spaced across the width of the Keyboard to provide a decent spread of infra-red signal. This removes any restriction on having to place the Keyboard directly in front of the Systems Unit, and thus allows the user the maximum degree of flexibility in siting the Keyboard.

Two of the LEDs are slightly proud of the front edge of the Keyboard, the third is recessed. The third LED is recessed to allow the light-pipe to be plugged in. Transmissions from the Keyboard are then supplied directly to Systems Unit down the fibre optic link.

The light-pipe does not switch off transmissions from the other two LEDs; these will continue to transmit infra-red when a key is pressed even though the light-pipe is in position. (Connecting the light-pipe into the right hand socket on the front of the Systems Unit switches off the infra-red receiver surrounded by the wide-angle lens, so that infra-red from other sources will not be detected - See Systems Unit chapter for more detail).

Two buttons are located on the sides of the Keyboard (one on each side). These release the spring-loaded feet which tilt the Keyboard for normal desk-top usage.

## **Circuitry**

The circuitry on the Keyboard PCB consists of an NEC 7507 microprocessor, three infra-red LEDs and assorted components for interfacing the 7507 processor to the keyswitch array and LEDs. A circuit diagram of the Keyboard is provided in an appendix to this manual.

The 7507 is a CMOS 4-bit single chip microcomputer which has its own internal ROM and RAM. It also contains an internal timer, a vectored interrupt structure and features 32 I/O lines. The I/O lines are organised into eight 4 bit ports. The ports are identified by a prefix which is the port number followed by the port line number. e.g. P2 1 is port 2, line 1).

## **Keyboard Scanning**

The 7507 uses the standard method of row/column scanning for detecting key closures in the keyswitch array and also the closure of the four fixed function keys. The four fixed function keys are mapped onto the bottom row of the keyswitch matrix (port P60).

The scanning method is as follows. The 7507 selects a row by setting the appropriate port output to logic low. It then sequentially scans through all the columns looking for a logic low input on the appropriate input ports which indicates a keyclosure.

The Shift and Control keys are not scanned in the same way and are treated as special keys. These are wired directly to input ports.

The keyboard processor is normally in a sleep mode and is awakened every 15.6 ms. The 15.6 ms timer routine performs two functions. It checks for key closures and also updates the software time/date clock.

If a key has been pressed, the keyboard remains awake and decodes the selected key, formats it, and then transmits it to the Systems Unit by pulsing the infra-red LEDs. If no other key has been pressed the keyboard re-enters sleep mode to conserve battery power.

When more than one key closure is detected in a single scan, the 7507 software checks the validity of the closures to prevent false key codes being issued. It does this by reducing the area to scan by searching a "closed" key switch map until it finds an unambiguous key closure.

Only keys which can be uniquely identified are encoded and transmitted.

The total time taken between detecting a key closure to the end of the keycode transmission is normally between 26 to 32 ms. At the end of the transmission, the processor rescans the key switch and then enters sleep mode if no further key is active.

The oscillator connected to the X1, X2 inputs of the processor sets the sleep mode cycle. The processor cycle time is set by the components connected to CL1/CL2.

## **Data Transmission Format**

The majority of the consumption of power on the keyboard is taken by the three LEDs. In order to extend the battery life, these are normally switched off and only pulsed on for the transmission of data.

All keycode data is encoded into serial packet format, consisting of 32 bits, prior to transmission (see below for more details on the actual encoding format used). The 32 bit serial data stream is sent via the data output (P31) to drive the three LEDs.

The data is converted into a pulsed waveform by a monostable circuit prior to forming the drive signal for switching the LEDs on. The duration of the pulses and thus the time the LEDs are switched on, is kept relatively short (of the order of 15  $\mu$ s) to minimise the amount of battery power consumed.

The monostable circuit translates the bit stream into the waveform format as shown in Figure 1. This is in effect a transmission packet consisting of an interleaved clock and data waveform. Encoding the data in this way allows the decoding circuits on the Systems Unit to easily compensate for variations in the data rate.

Data "1s" are signified by a pulse within the clock pulse time period and data "0s" signified by an empty time slot.

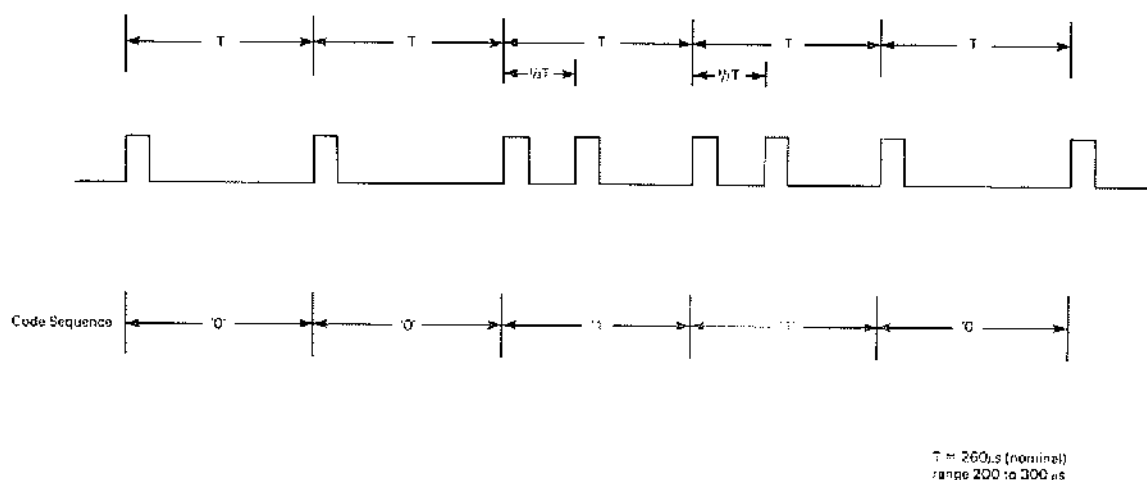


Figure 1. Keycode Transmission Format

## Keycode Data Encoding

To maximise system reliability, and ensure that data transmitted from the Keyboard is not misinterpreted on the Systems Unit, the keycode data is encoded into a special format.

The Keyboard formats the valid key closures into a serial packet consisting of a four byte sequence. The format is the synchronous transmission mode Monosync and is operated at a fixed data rate of approximately 3.85 Kbits/sec. The first byte is the sync header. All the following bytes are the actual data. These are encoded using Hamming codes (see Figure 2).

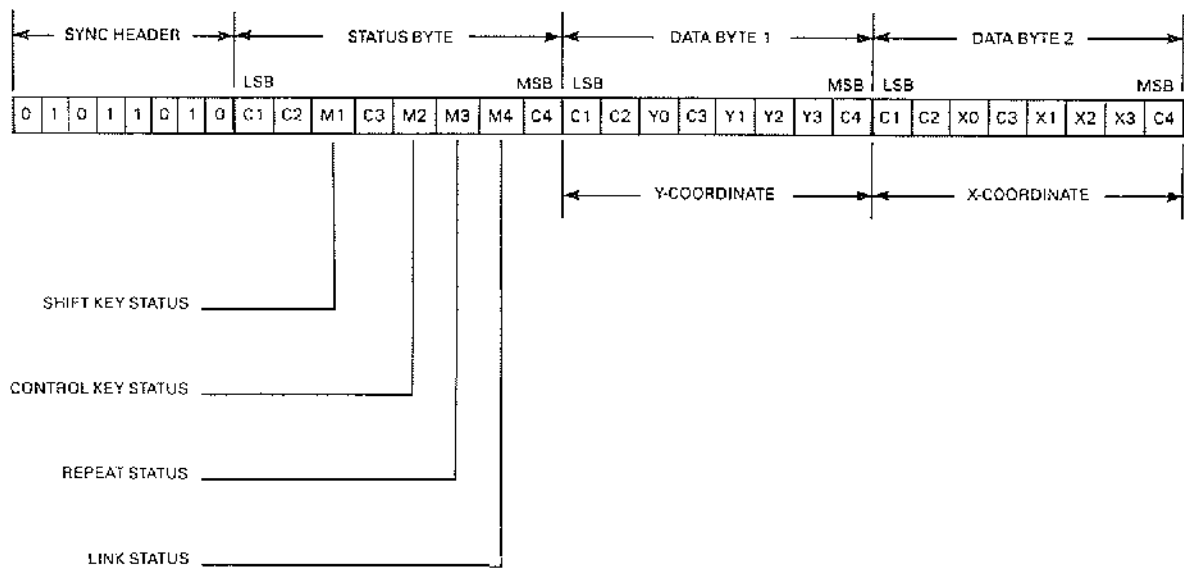


Figure 2. Synchronous Packet Format

This method enhances system reliability in two ways:

1. Using Monosync means that the receiver circuits on the Systems Unit (the Z80 SIO of the serial interface), have to first detect a valid data pattern, (the sync header byte) before it regards the data sent as being valid. This provides a high degree of protection from other infra-red sources, as they will not contain the sync header and will therefore be totally disregarded.
2. Using a Hamming format to encode the data enables the BIOS software in the Systems Unit to check the integrity of the data received from the Keyboard. It produces a highly reliable system for proving the validity of the Keyboard data, providing a measure of protection against a transmission which contains a valid sync byte, but invalid data (missing or corrupted data).

The four byte sequence consists of the Sync header byte (5AH), a status byte and two data bytes. The status byte and keycode data bytes are encoded with a Hamming format.



The status byte contains four bits (a nibble) of information as follows:

- bit 0 Whether the key pressed is pressed in conjunction with the SHIFT key. This state is indicated when the Shift bit is set high.
- bit 1 Whether the key pressed is pressed in conjunction with the CONTROL key. This state is indicated when the Control bit is set high.
- bit 2 Whether the key code transmitted was the same key code as transmitted immediately prior to the current transmission. The Repeat Status bit is set high to indicate that a key is being held down (repeated).
- bit 3 That the data transmitted to the Systems Unit is from the Keyboard. This bit is indicated by the Link Status bit and is always set low for a keyboard transmission. (This bit allows the BIOS to differentiate between Keyboard and Mouse data which uses a similar format but sets the Link Status bit high).

The first keycode data byte contains a data nibble (Nibble 1) which is the Y-coordinate of the selected key in the keyswitch matrix. The second data byte contains a data nibble (Nibble 2) which is the X-coordinate of the selected key in the keyswitch matrix.

The X-Y coordinates for each key are illustrated on Figure 3. The coordinates are identified by the numbers in the top left-hand corner of each key. For example, the CAPS LOCK key is located at X-coordinate 2H, Y-coordinate BH (i.e. the keyswitch matrix position 2, 11 in decimal format).

		0000000000 ZERO										5000000000 FIFTY										1000000000 ONE										4000000000 FOUR																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
4B	1	38	2	3A	4	39	5	40	6	41	7	42	8	43	9	44	0	45	1	46	2	47	3	48	4	49	5	50	6	51	7	52	8	53	9	54	0	55	1	56	2	57	3	58	4	59	5	60	6	61	7	62	8	63	9	64	0	65	1	66	2	67	3	68	4	69	5	70	6	71	7	72	8	73	9	74	0	75	1	76	2	77	3	78	4	79	5	80	6	81	7	82	8	83	9	84	0	85	1	86	2	87	3	88	4	89	5	90	6	91	7	92	8	93	9	94	0	95	1	96	2	97	3	98	4	99	5	100	6	101	7	102	8	103	9	104	0	105	1	106	2	107	3	108	4	109	5	110	6	111	7	112	8	113	9	114	0	115	1	116	2	117	3	118	4	119	5	120	6	121	7	122	8	123	9	124	0	125	1	126	2	127	3	128	4	129	5	130	6	131	7	132	8	133	9	134	0	135	1	136	2	137	3	138	4	139	5	140	6	141	7	142	8	143	9	144	0	145	1	146	2	147	3	148	4	149	5	150	6	151	7	152	8	153	9	154	0	155	1	156	2	157	3	158	4	159	5	160	6	161	7	162	8	163	9	164	0	165	1	166	2	167	3	168	4	169	5	170	6	171	7	172	8	173	9	174	0	175	1	176	2	177	3	178	4	179	5	180	6	181	7	182	8	183	9	184	0	185	1	186	2	187	3	188	4	189	5	190	6	191	7	192	8	193	9	194	0	195	1	196	2	197	3	198	4	199	5	200	6	201	7	202	8	203	9	204	0	205	1	206	2	207	3	208	4	209	5	210	6	211	7	212	8	213	9	214	0	215	1	216	2	217	3	218	4	219	5	220	6	221	7	222	8	223	9	224	0	225	1	226	2	227	3	228	4	229	5	230	6	231	7	232	8	233	9	234	0	235	1	236	2	237	3	238	4	239	5	240	6	241	7	242	8	243	9	244	0	245	1	246	2	247	3	248	4	249	5	250	6	251	7	252	8	253	9	254	0	255	1	256	2	257	3	258	4	259	5	260	6	261	7	262	8	263	9	264	0	265	1	266	2	267	3	268	4	269	5	270	6	271	7	272	8	273	9	274	0	275	1	276	2	277	3	278	4	279	5	280	6	281	7	282	8	283	9	284	0	285	1	286	2	287	3	288	4	289	5	290	6	291	7	292	8	293	9	294	0	295	1	296	2	297	3	298	4	299	5	300	6	301	7	302	8	303	9	304	0	305	1	306	2	307	3	308	4	309	5	310	6	311	7	312	8	313	9	314	0	315	1	316	2	317	3	318	4	319	5	320	6	321	7	322	8	323	9	324	0	325	1	326	2	327	3	328	4	329	5	330	6	331	7	332	8	333	9	334	0	335	1	336	2	337	3	338	4	339	5	340	6	341	7	342	8	343	9	344	0	345	1	346	2	347	3	348	4	349	5	350	6	351	7	352	8	353	9	354	0	355	1	356	2	357	3	358	4	359	5	360	6	361	7	362	8	363	9	364	0	365	1	366	2	367	3	368	4	369	5	370	6	371	7	372	8	373	9	374	0	375	1	376	2	377	3	378	4	379	5	380	6	381	7	382	8	383	9	384	0	385	1	386	2	387	3	388	4	389	5	390	6	391	7	392	8	393	9	394	0	395	1	396	2	397	3	398	4	399	5	400	6	401	7	402	8	403	9	404	0	405	1	406	2	407	3	408	4	409	5	410	6	411	7	412	8	413	9	414	0	415	1	416	2	417	3	418	4	419	5	420	6	421	7	422	8	423	9	424	0	425	1	426	2	427	3	428	4	429	5	430	6	431	7	432	8	433	9	434	0	435	1	436	2	437	3	438	4	439	5	440	6	441	7	442	8	443	9	444	0	445	1	446	2	447	3	448	4	449	5	450	6	451	7	452	8	453	9	454	0	455	1	456	2	457	3	458	4	459	5	460	6	461	7	462	8	463	9	464	0	465	1	466	2	467	3	468	4	469	5	470	6	471	7	472	8	473	9	474	0	475	1	476	2	477	3	478	4	479	5	480	6	481	7	482	8	483	9	484	0	485	1	486	2	487	3	488	4	489	5	490	6	491	7	492	8	493	9	494	0	495	1	496	2	497	3	498	4	499	5	500	6	501	7	502	8	503	9	504	0	505	1	506	2	507	3	508	4	509	5	510	6	511	7	512	8	513	9	514	0	515	1	516	2	517	3	518	4	519	5	520	6	521	7	522	8	523	9	524	0	525	1	526	2	527	3	528	4	529	5	530	6	531	7	532	8	533	9	534	0	535	1	536	2	537	3	538	4	539	5	540	6	541	7	542	8	543	9	544	0	545	1	546	2	547	3	548	4	549	5	550	6	551	7	552	8	553	9	554	0	555	1	556	2	557	3	558	4	559	5	560	6	561	7	562	8	563	9	564	0	565	1	566	2	567	3	568	4	569	5	570	6	571	7	572	8	573	9	574	0	575	1	576	2	577	3	578	4	579	5	580	6	581	7	582	8	583	9	584	0	585	1	586	2	587	3	588	4	589	5	590	6	591	7	592	8	593	9	594	0	595	1	596	2	597	3	598	4	599	5	600	6	601	7	602	8	603	9	604	0	605	1	606	2	607	3	608	4	609	5	610	6	611	7	612	8	613	9	614	0	615	1	616	2	617	3	618	4	619	5	620	6	621	7	622	8	623	9	624	0	625	1	626	2	627	3	628	4	629	5	630	6	631	7	632	8	633	9	634	0	635	1	636	2	637	3	638	4	639	5	640	6	641	7	642	8	643	9	644	0	645	1	646	2	647	3	648	4	649	5	650	6	651	7	652	8	653	9	654	0	655	1	656	2	657	3	658	4	659	5	660	6	661	7	662	8	663	9	664	0	665	1	666	2	667	3	668	4	669	5	670	6	671	7	672	8	673	9	674	0	675	1	676	2	677	3	678	4	679	5	680	6	681	7	682	8	683	9	684	0	685	1	686	2	687	3	688	4	689	5	690	6	691	7	692	8	693	9	694	0	695	1	696	2	697	3	698	4	699	5	700	6	701	7	702	8	703	9	704	0	705	1	706	2	707	3	708	4	709	5	710	6	711	7	712	8	713	9	714	0	715	1	716	2	717	3	718	4	719	5	720	6	721	7	722	8	723	9	724	0	725	1	726	2	727	3	728	4	729	5	730	6	731	7	732	8	733	9	734	0	735	1	736	2	737	3	738	4	739	5	740	6	741	7	742	8	743	9	744	0	745	1	746	2	747	3	748	4	749	5	750	6	751	7	752	8	753	9	754	0	755	1	756	2	757	3	758	4	759	5	760	6	761	7	762	8	763	9	764	0	765	1	766	2	767	3	768	4	769	5	770	6	771	7	772	8	773	9	774	0	775	1	776	2	777	3	778	4	779	5	780	6	781	7	782	8	783	9	784	0	785	1	786	2	787	3	788	4	789	5	790	6	791	7	792	8	793	9	794	0	795	1	796	2	797	3	798	4	799	5	800	6	801	7	802	8	803	9	804	0	805	1	806	2	807	3	808	4	809	5	810	6	811	7	812	8	813	9	814	0	815	1	816	2	817	3	818	4	819	5	820	6	821	7	822	8	823	9	824	0	825	1	826	2	827	3	828	4	829	5	830	6	831	7	832	8	833	9	834	0	835	1	836	2	837	3	838	4	839	5	840	6	841	7	842	8	843	9	844	0	845	1	846	2	847	3	848	4	849	5	850	6	851	7	852	8	853	9	854	0	855	1	856	2	857	3	858	4	859	5	860	6	861	7	862	8	863	9	864	0	865	1	866	2	867	3	868	4	869	5	870	6	871	7	872	8	873	9	874	0

All keys apart from the RESET, REPEAT RATE, SET TIME, TIME/DATE (and SHIFT and CONTROL which are not in the matrix) are transmitted from the keyboard by encoding the X-Y position of the detected key with Hamming codes in the format as described above and perform no other function.

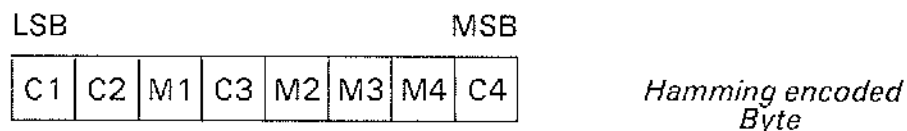
The handling of the RESET, REPEAT RATE, SET TIME and TIME/DATE keys are slightly different and are discussed under the section headed Special Keys. The SHIFT and CONTROL keys are encoded into the status byte only and are never transmitted as a X-Y keycode.

### ***Hamming Format***

The encoding of the status and keycode data nibbles uses a Hamming distance of four. (The definition of the Hamming distance equates to the fact that for all possible combinations of encoded bytes, each byte will have at least four bit positions different when compared with all other encoded bytes).

A Hamming distance of four allows the BIOS to detect any two-bit errors and also correct any single-bit errors in the transmitted data. Each data nibble is converted into a Hamming encoded byte by the addition of four check bits.

The Hamming encoded bytes are produced by generating the check bits and then combining them with the nibble of data in the format detailed below.



C\* corresponds to a check bit

M\* is a bit within the data nibble. The position of the LSB is specified by M1, the MSB by M4.

The check bits are generated using the algorithms detailed below.

$$C1 = M1 \oplus M2 \oplus M3$$

$$C2 = M1 \oplus M3 \oplus M4$$

$$C3 = M2 \oplus M3 \oplus M4$$

$$\overline{C4} = C1 \oplus C2 \oplus M1 \oplus C3 \oplus M2 \oplus M3 \oplus M4$$

Since a nibble of data can only have one of 16 values (0H to FH), the data nibbles can be translated into the corresponding Hamming encoded bytes by using a simple look-up table. This is as follows:

<b>Data Nibble</b>	<b>Encoded Byte</b>
0H	80H
1H	07H
2H	19H
3H	9EH
4H	2AH
5H	ADH
6H	B3H
7H	34H
8H	CBH
9H	4CH
AH	52H
BH	D5H
CH	61H
DH	E6H
EH	F8H
FH	7FH

## **Special Keys**

Some of the keys are not transmitted from the Keyboard in the same way as described above. These are the four keys RESET, REPEAT RATE, SET TIME and TIME/DATE.

### ***Reset***

When the 7507 microprocessor detects that the RESET key has been pressed it does not transmit a hamming encoded keycode. Instead, it sends sync characters (the byte value 5AH) at a set rate of one sync character every 15.6 ms for as long as the key is held down.

If the key is held down for approximately one second, the accumulative effect of receiving the multiple sync bytes on the Systems Unit generates a hardware reset. This mechanism is discussed in the System Detail chapter.

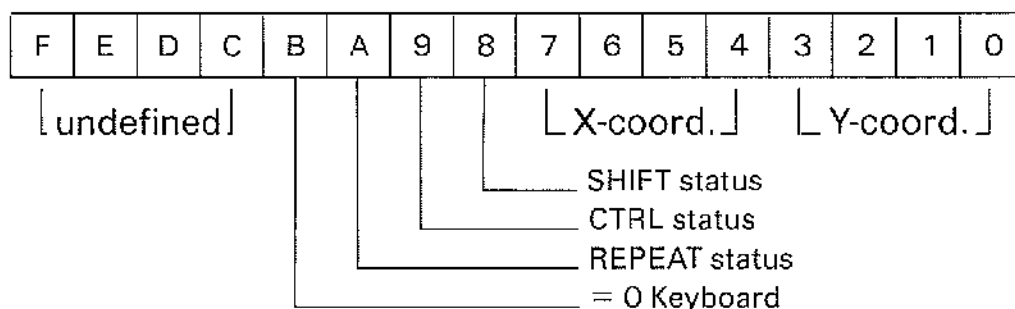
# Overview

The Keyboard driver software handles communications between the SIO and MS-DOS. Serial data is received by the SIO from both the Keyboard and the Mouse.

The driver distinguishes between the two and vectors to the appropriate routine. The Mouse driver is of sufficient importance to be treated as a separate section of the drivers. Here we will concentrate on the keyboard.

Applications running under MS-DOS receive data from the keyboard via normal MS-DOS CALL (INT 21H).

The action of pressing a key or combination of keys, e.g. SHIFT + or CTRL +, will result in the SIO generating an interrupt and passing a packet of data in Hamming coded format to the SIO interrupt handler. The data is then converted and presented to the driver in the AX register in the following format:



A similar packet is sent for the Mouse except that bit B = 1.

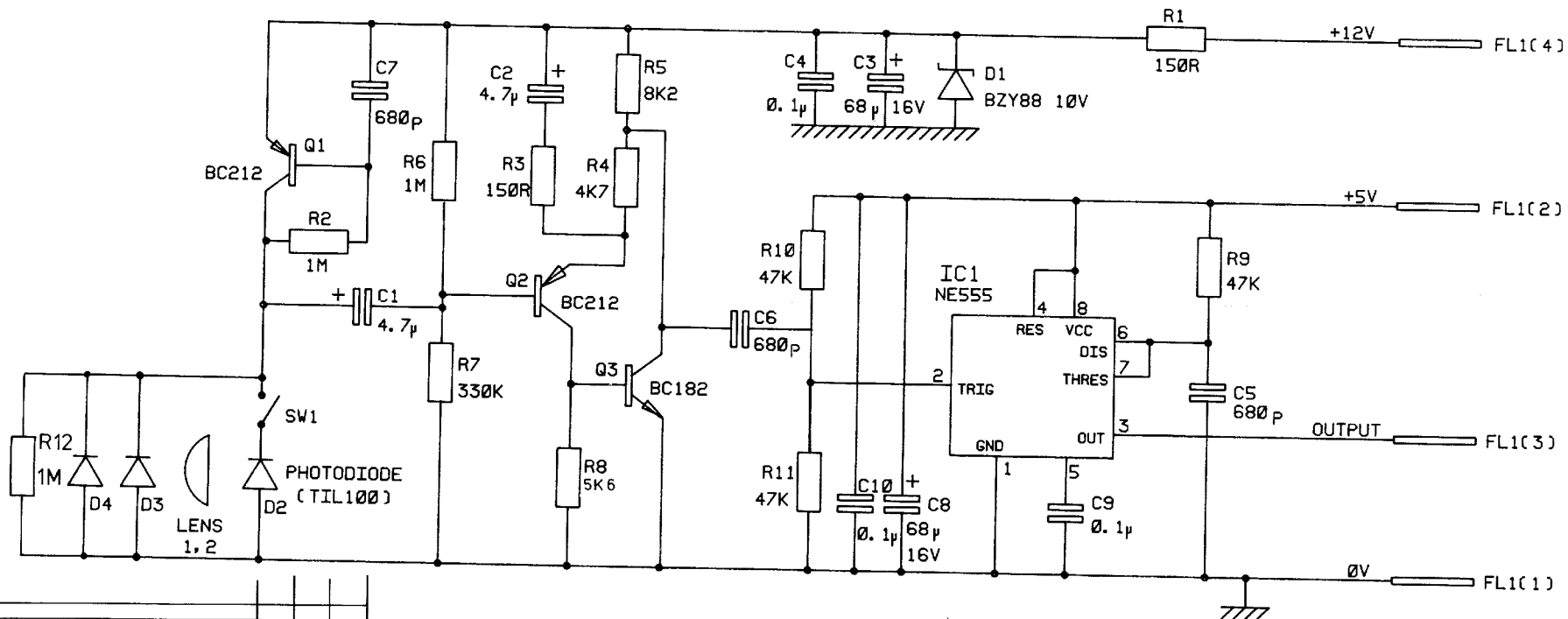
The X and Y coordinates are converted into an offset within the soft keyboard table. The generic keyboard has 104 keys and the offset is in the range 0 to 103. Each of these is referred to as a "down-code".

The keyboard table is divided into sections, each of 104 words, to facilitate the following:

- Normal - key without SHIFT or CTRL
- Shifted - SHIFT + key
- Control - CTRL + key

The attribute bits 8 and 9 of the packet determines which section of the table is to be used to translate the down-code.





7	CN 137	JJS	10-1-85
6	REDRAWN	TB	12-7-84
5	CHANGE NOTE No. 065		28-6-84
4	CHANGE NOTE No. 051		13-6-84
3	CHANGE NOTE No. 036		12-4-84
2	CHANGE NOTE No. 035		11-4-84
1			17-11-83
REVISIONS		DESCRIPTION	CHK D APP D DATE

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SCALE THPD	TITLE <b>INFRA RED DETECTOR</b>
DRAWN RD	CHECKED RD
DATE 22/2/85	SHI 1 OF SHIS 1