Schematic and functional description

This document describes the hardware and operation of the firmware on the repeaters internal circuit boards. The description is structured board by board and assumes the functionality of the microcontroller devices present on the boards has not been modified.

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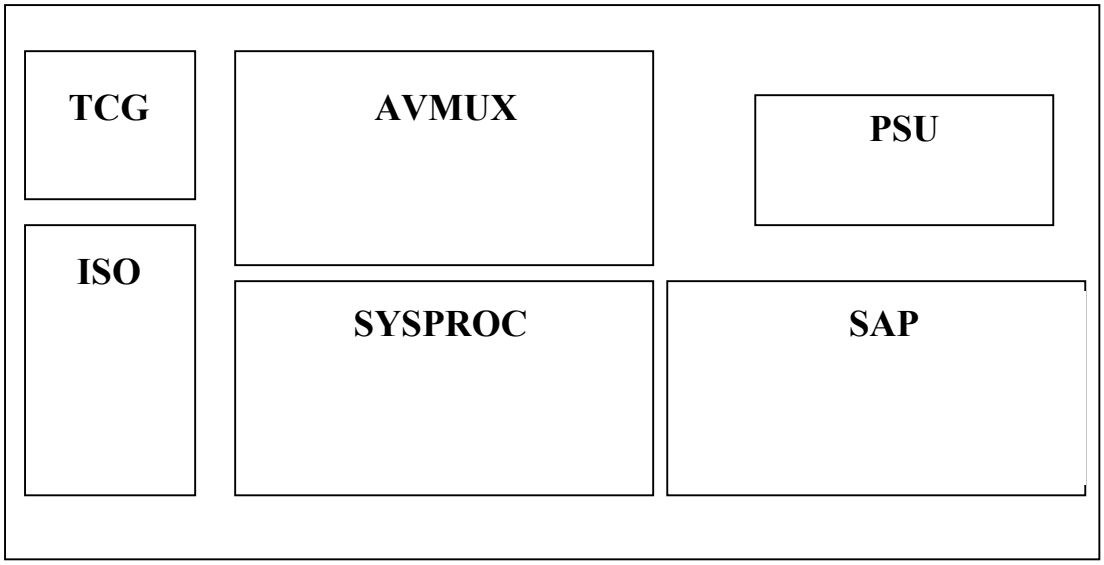
History:
Preliminary release: 31st March 2004.

Location of the boards within the repeater box:



Front Panel

Summary of board functions.

TCG – (Test Card Generator) Generates the testcard pattern used when the repeater is in idle mode.

ISO – (ISOlator) Provides an isolated bi-directional link for audio, video and control signals between the repeater and an externally connected computer.

AVMUX – (Audio Video MUltipleXer) Routes the audio and video signals from the TCG and the sockets on the outside of the box to the internal sync detector, computer interface and transmitter and monitor interfaces.

SYSPROC – (SYStem PROCessor) Is the decoder and 'distribution centre' for control signals to the ports around the system. It also houses the on-screen caption generator, the Morse ID generator, the relay driving ports, the antenna selector port, the weather satellite port , the infra-red VCR control port and the MF tone detector.

SAP – (Stand Alone Processor) Is the controlling computer when there is no external computer attached. It automatically goes into standby mode when a suitable plug is inserted into the computer interface socket on the front panel. The board also houses the infra-red modulator and power switching circuits for controlling the VCR.

PSU – (Power Supply Unit) Is an 'off the shelf' switch mode power supply providing the +5V, -5V and +12V power feeds to the other circuitry. There is also provision for an alternative linear power supply on an unused section of the SAP board.

Board Functional Descriptions

TCG

The test card generator is a single chip implementation of a design based on Colin Edwards' article in Wireless World magazine that later became know as the "Cropredy" board. The chip also includes a digital quadrature carrier generator; phase gating circuits and a burst timing generator.

Unlike the original design, the address generating dividers are synchronous which should remove the problem of some EPROMs not functioning correctly. Additionally, the signal to reset the generator at the end of each field of video is now synchronous so the 'blank page' symptom, which was common when EPROM pages were switched, is now removed.

A new feature, not present in the original design, is the ability to add colour to text and all graphics. Previously, text and all graphics except full character blocks had to be white.

Circuit description:

The timing chain for all screen layout, sync pulses and burst timing is driven from a 16MHz quartz clock module. Because of the high stability of these and the division ratios used, the horizontal sync frequency should be accurate to no more than +/- 0.5Hz.

The colour generating circuits are driven from a 17.7344MHz discrete component oscillator. This is 4 times the 4.433MHz colour subcarrier frequency. Internally, the frequency is divided by two to ensure it has equal mark/space ratio then fed to two further dividers, one clocked by the rising edge of the signal, one on the falling edge. The result is the two dividers produce outputs at 4.433MHz but with 90-degree phase shift between them. By inverting these signals, all the 0, 90, 180 and 270 degree phases that are needed for colour production are produced.

A signal at 7812.5Hz, (half horizontal sync frequency) derived from the 16MHz timing dividers is used to enable and disable the inversion of the 90 degrees carrier to produce the PAL 'ident' signal.

Signals taken from the data outputs of the EPROM are used to selectively enable the colour phase outputs during the horizontal scan, producing the colour image visible on a television screen.

The resistor network outside the PLD forms a crude but effective DAC (digital to analogue converter) to compose the analogue waveform. The resistor values are chosen so they also provide gamma correction. The resistors on the red, green and blue PLD outputs add luminance information to the DAC output. The transistor amplifier stages are to lessen the effect of the load impedance on output voltage.

ISO

The isolator board provides a barrier between the repeater electronics and an externally connected computer. Without it, there is a strong likelihood of ground carried noise from the computer and its power supply, reaching the video and audio outputs of the repeater. It also gives a degree of protection against voltage spikes that could be transmitted through the computer from a phone line.

The isolator has two digital inputs, two digital outputs, one video input, one audio input, one video output and one audio output.

The digital signals are used to convey command and response information to the RS-232 serial port on the front panel. This would normally be connected to a matching serial port on the computer. Data flows at 57,600bauds (bits per second) in both directions. Circuitry on the isolator board produces a non-ground referenced +5 supply which feeds the computer side of the isolation barrier. The higher voltages needed for the serial port are generated by charge pumps around the MAX232 device. The actual barrier is formed by four 6N139 high speed opto-couplers which are biased for maximum switching speed.

Analogue signals are isolated by HCPL4562 opto-couplers. These are linear devices and have their LED parts biased to mid operating range by single transistor driver stages. The efficiency of the couplers is quite low so their detector sides are fed to amplifier stages. The audio amplifiers utilise two transistor amplifiers, the video amplifiers use an additional stage to enable them to drive 75R loads.

The board is fed from a single +5V supply which directly feeds the repeater side of the data and analogue channels. It also feeds the isolated supply generator module through a filter network to minimise the amount of switching noise it generates reaching the other circuits.

The theoretical breakdown voltage between the repeater and computer interfaces is 1KV but in view of the possibility of arcing at the front panel socket and across the surface of the isolator board substrate, a more conservative rating of 750V is advised.

The intention of the analogue channels is to allow the computer to generate video and audio for transmission and to digitise incoming signals for time shifting or archiving on hard disk. The ability to perform this function depends on the specification of the computer.

AVMUX

This is the signal routing section of the repeater although some other functions are also located on this PCB.

A MAX459 video switch controls the video routing. This device has eight inputs, any one of which can be routed to one or more of its four outputs. Provision has been made on the PCB for all the video inputs to pass through low-pass filters although none are fitted at manufacture. Of the four outputs, one feeds the isolator (ISO) board for subsequent use in a computer application, one feeds the rear-panel monitor socket where it is anticipated it would connect to a local monitor screen. The third output feeds the transmitter output after passing through circuits to add the on-screen captions and to restore the picture black level. The last output is connected to the sync detection circuits. The switch is driven in parallel mode – see the MAXIM data sheet for the MAX459 device.

Audio selection is through an eight input to two-output switch. One output feeds the monitor socket, the other the transmitter socket. The audio paths include a mixer where the identification tones and beeps are added and a low-pass filter. The filter gives a flat response to about 10KHz then falls off rapidly. It is intended to remove remnants of horizontal sync that may be present on received signals. The transmitter and monitor outputs can be independently switched to any of the inputs but ID tones are added to both channels.

The sync detector is a two-stage device. The least significant bit (bit 0) of the sync status is derived from the 'video detected' output of an Elantec EL4583 device. This is an improved version of the industry standard 1881 device, incorporating additional circuits to filter out chrominance signals prior to sync stripping. The 'video detected' signal is produced by measuring the amplitude of the horizontal sync pulses in the video stream. This output will detect the presence of video or random noise. The second stage of the sync detector feeds bit 1 of the sync status. It monitors the horizontal sync output from the sync separator and uses it to lock an otherwise free-running oscillator. If sufficient signal at 15625Hz is seen in the sync output, the oscillator locks and this locked state is fed to the sync status. This PLL detector circuit is located on a small daughter board, mounted vertically on the main PCB.

Note: This daughter board has the only adjustable part in the repeater. To set the potentiometer, turn off the auto sync function and route the TCG signal to the sync detector. Using a dual-trace oscilloscope, monitor the horizontal sync input to the board and the only test point. Adjust the control so the horizontal sync pulse aligns with the middle of the low part of the signal on the test point.

Sync status is read on to the system data bus through a 74HCT573 latch. In addition to the two sync detector signals derived from the on-board circuits, two more inputs are available (bits 2 and 3). These could be used for example, to signal the presence of DATV signals if suitable additional hardware is attached.

The TCG paging signal is latched from the system data bus through a 74HCT574 device. It is connected to the TCG board where it selects which testcard page is to be displayed.

SYSPROC

This board houses six microcontroller devices. It is the coordinator for all the repeater functions.

The main controller and heart of the system is U2. It is responsible for decoding incoming commands and ensuring the selected port is activated and then written to or read from. It has one 5-bit port (Port A) and one 8-bit port (Port B).

Port A always carries the address of the port selected by incoming command. Bits 0 and 1 are fed 'raw' to some ports where they are decoded internally by the port device. All the bits, including bits 0 and 1 are fed to the PLD U1 which decodes the bit combinations into individual port select lines. These select lines are programmed to the appropriate logic states to enable the port only when it is selected and to disable it at all other times. A 'parking' position at address 1F is provided which disables all port select lines. This address is adopted at all time except during port accesses.

Port B has several roles. The port lines can be programmed to be inputs to the processor or outputs from it. During operation, the direction of the lines is set according to the type of command being requested and by the influence of port devices requesting attention.
Bit 0 is used as an interrupt input. Whenever a byte is received from the serial interface, an interrupt request is generated by the UART (U3). On seeing the interrupt, the data bus is configured to accept data transfers to and from the UART on bits 4 and 5. The UART has an SPI interface on its processor side, which uses synchronous data transfers.
Bit 1 is used to provide the clock for synchronising the transfer.
Bit 2 is used as a read/write control. While high, the data direction is from a port to the processor (read operation), when low the data flow is from the processor to the port (write operation).
Bit 3 is fed from the tone detect output of the MF tone decoder. When high, the processor is being advised that a tone has been received and decoded and is ready for use.
The data bus, which goes to all ports, comprises bits 4, 5, 6 and 7.

The highest priority for attention is the UART interrupt since missing its call for attention would cause data loss. The MF detector (U10) does not need such speedy response since its output will be active for at least 40mS, giving plenty of time for it to be polled in the normal cycling of the operating code.

Because there is a likelihood of bytes arriving at the serial port in rapid succession, faster than they could be processed in real time, a circular input buffer is implemented in software. Each received byte is added to the next empty space in a queue, the bytes are read out in the order they were entered as quickly as they can be dealt with. When the read position on the queue has caught up with the write position, the processor knows there is no more data available. The queue is eight bytes long and is a loop. In the unlikely event that so much data arrives that all eight positions are filled up, the oldest data is overwritten and lost. This scenario is unlikely to occur.

Also on the SYSPROC board are several of the peripheral ports:

All these ports are attached to the data bus to allow data transfer and to one line from the address decoder (U1) which activates only the one port being requested.

The OSG controller and generator. This provides the overlay text at the top of the screen. The special character generating device uPD6154 (U8) is driven from processor (U9) which translates the request for display into the special serial format used by the generator. In order to maintain a steady position on the screen, the generator is fed with horizontal and vertical sync pulses derived from the transmitter output signal.

The MF tone detector (U10) uses switched capacitor techniques to isolate two frequency bands from the receiver audio input socket. When appropriate tones fall within both these bands, the detector works out the keypad digit that created it and notifies the main processor that it has done so. When addressed, the device presents a number representing the digit to the data bus where it is read and appropriate action taken.

The VCR control port (U11) when addressed, reads data from the data bus and translates it into a signal approximating to the flash sequence of an infra-red remote control unit. This is used to modulate a carrier (see SAP board) and then used to control the VCR. The device also controls the mains switching and power-up sequencing of the VCR. Note: an alternative processor (PB-Ctrl) may be plugged into the socket to allow direct connection or relay operation of the VCR should this ever be necessary.

The ID generator (U12) is used to generate and key the tones used for audio identification. When addressed it reads the data on the data bus and converts it to a pattern of marks and spaces which in turn enable a tone at 1010Hz. The volume of the tone can be dropped by command, electrically this is achieved by grounding the lower of the resistors in the potential divider on the output pin. Normally, the bottom resistor is allowed to float so it does not effect the output voltage. An LED is connected to visually announce tones are present, it illuminates whenever the tone output is turned on.

User Ports A & B (U4 & U5) are used to control the state of the relay outputs. They are not used internally in the repeater and are available for controlling any other devices or equipment at the repeaters location. Although the devices are programmed only to turn individual relays on or off, they have the capability of producing any single, multiple or simultaneous relay operation if so programmed.

The Antenna control and Weather satellite control ports (U6 and U7) are simply latched copies of the data bus. They have no ‘intelligence’ of their own. When addressed they copy the data on the data bus onto their output pins.

SAP

The SAP holds the controlling processor, the infra-red carrier generator, the VCR power switching controller and the user port relay drivers.

The controlling processor (U15) is only used in stand alone mode. When a link is fitted between pins 8 & 9 of the computer interface socket on the front panel, the 'SEL' signal is grounded. This does two things, firstly it signals to the processor that a external computer has been attached, causing it to go into standby mode until the link is removed again. It also pulls the select pin on the PAL device (U13) to a logic low state which changes the signal routing so serial information from the UART (U14) is disconnected and the front panel socket is instead routed to the SYSPROC.

The SYSPROC has no knowledge of whether the SAP or external computer is in control since they use identical signalling protocols, however, should it ever be necessary to give it his knowledge, the RTS and CTS lines can be used to provide additional control signals.

The UART operation is identical to that on the SYSPROC except that the receive queue is only four bytes long. As the SAP initiates responses it has better control of the data flow so the queue does not need to be as long.

There are several sets of linkable pins on the SAP board. The three near the power connector are for system configuration and link 'east-west'. Only the two pairs nearest the power socket are used. Fitting a link to the pins nearest the socket causes a personality change, all the test card pages, identification messages and on-screen graphics become those for GB3XG instead of GB3ZZ. The middle pair of links are for controlling the start-up of the VCR. If the link is fitted, in addition to the power sequencing , standby and rewind when the system is started, a channel step down command is also issued. If the VCR requires it, this will step the channel from 1 (default at power-up) to 0 which is enables its scart inputs.

The pins between the UART and Processor, when linked put the processor into a reset state. Momentarily joining them will restart the SAP processor and if it is in control of the system (computer not plugged in) the whole repeater will re-initialise.

The pair of pins between the UART and its XTAL should NOT be joined. When a link is fitted it makes the UART share its clock with the processor. The UART clock must be 3.6864MHz or the baud rate of the serial link will be incorrect. If a link is fitted, the oscillator components X1, C3 and C4 must be removed and the processor clock must be slowed to 3.6864MHz.

The last pair of pins is beside the PAL (U13), these replicate the connection at the computer socket on the front panel and are used for software debugging. When the link is fitted, the on-board processor is disabled and the PAL routes all serial information from the front panel socket to the SYSPROC.

The relay driver section of the PCB consists of 16 identical darlington transistor stages, each operating one relay. The relays are in two groups, each group has a common connection and eight switched connections. The common connections and all switched connection are isolated from each other and to ground. The relay contacts are rated at 100V 0.5A and the isolation to ground is rated to 1KV although it is recommended that no more than 750V is applied.

The infra-red carrier generator is a keyed 37KHz oscillator which produces a near square wave output suitable for driving two infra-red LEDS. One LED is mounted on the front panel, the other is available at the DIN front panel socket. The current from the latter is limited to approximately 50mA, allowing direct connection to an LED without requiring further current limiting.

VCR power switching is necessary as there is no way of telling whether the VCR is in standby mode or not. To ensure its state is known, the power must first be removed, then re-applied. This ensures the VCR starts in standby mode. IR commands to leave standby and rewind the tape are then issued by the IR controller on the SYSPROC board. As the power switching involves mains voltages, it is not done inside the repeater box, provision to control the power switching is provided instead.
Either a small relay can be used or preferably, an opto-isolated triac switch. The signal to operate the switch is a DC output which is close to 5V when on and near ground when off. For safety reasons, it is current limited to about 100mA although the suggested maximum load is 50mA. It can withstand continuous short circuit and up to 50mA reverse current (entering the output connection) without harm. The power output is ground referenced and should not be connected directly to any mains voltages.

Although not fitted to the SAP board, provision is made for an alternative, linear power supply. This consists of two bridge rectifiers and three voltage regulator ICs. The regulators may be bolted to the base of the box through suitable insulating washers so it can act as a heat sink. Note that the reservoir capacitors are not mounted on the PCB but can be connected to the pads provided.

PSU

This is a standard 'off-the-shelf' switch mode PSU providing +5, +12 and –5 Volt supplies.

The load on the +5V supply is approximately 300mA but this is dependant upon the number of user relays that are energised (10mA each) and the use of the infra-red LED and power switching on the VCR port. The maximum load is unlikely to exceed one Amp.

The –5V supply only feeds the AVMUX card where it allows the switch and amplifier stages to handle signals with voltages above and below ground potential. The current load is approximately 50mA and remains substantially constant during operation.

The +12V supply is not used at present.

All three supplies are monitored at LEDs on the front panel.

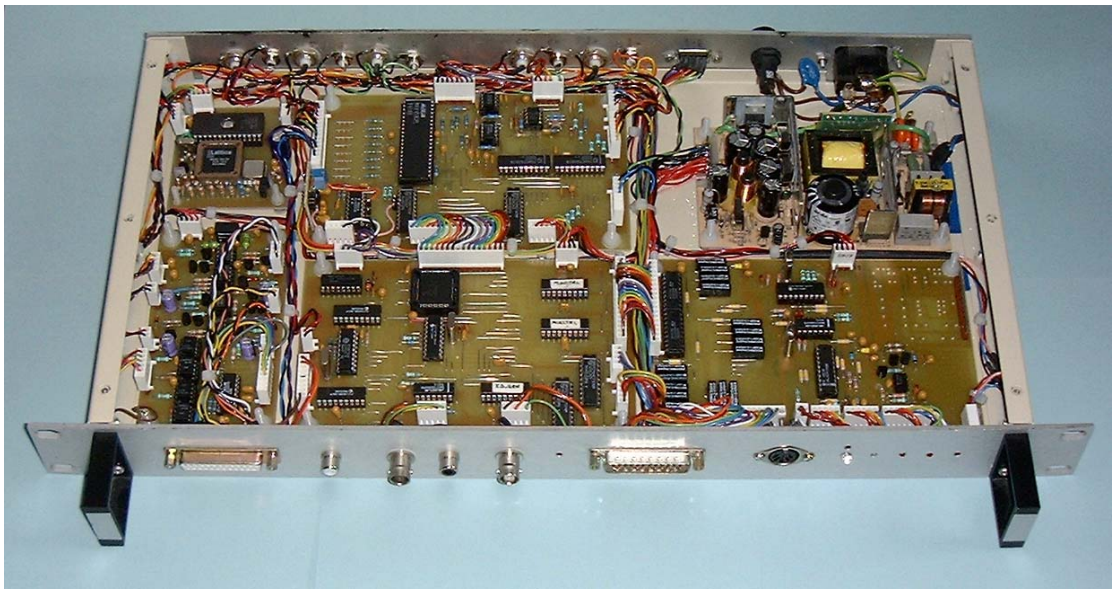
Components not on PCBs

The only parts not mounted on PCBs are the front panel LEDs, the signal and interface sockets, the mains socket, mains fuse and surge suppressor.

The front panel LEDs indicate presence of the three supply line voltages, the state of the VCR power control output, the run/standby mode of the SAP processor and the presence of audio ID tones. The clear plastic LED is an infra-red emitter.

On the back panel, the 20mm mains fuse is rated at 2A anti-surge. Note that there is also a 2A anti-surge fuse on the switch mode PSU board. Between them is a varistor surge suppressor which clips the mains voltage at 275V RMS. If voltage surges above this are encountered, the rear panel fuse may blow.

Front panel layout:



From left to right:
Computer Interface. This is where an external computer can be connected if required. It also carries audio and video signals to and from the computer.

External input 3 audio.

External input 3 video.

External input 4 audio.

External input 4 video.

LED indicating that ones are being inserted in the audio output stream.

User Port. Sixteen uncommitted relay outputs for controlling other equipment at the site.

VCR Control. A five-pin 180 degree DIN socket carrying signals to control the mains supply and infra-red remote controls to the VCR.

LED (top) indicating power to the VCR is enabled.
LED (bottom) an infra-red emitter carrying VCR commands.

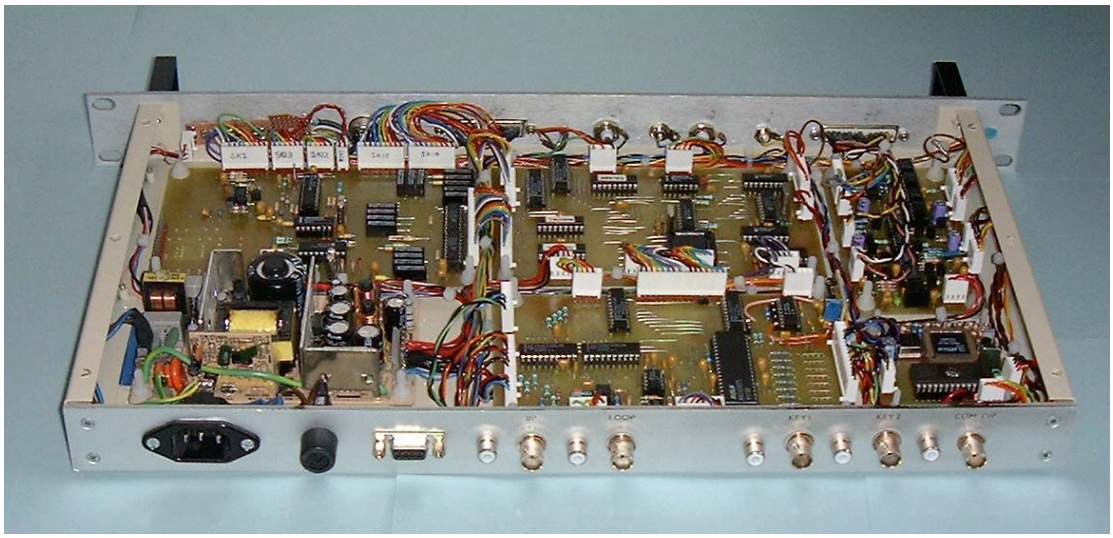
LED bi-coloured. Green indicates the SAP is in control, red indicates it is in standby mode and the external computer is in control.

LED indicating the presence of the –5V supply rail.

LED indicating the presence of the +5V supply rail.

LED indicating the presence of the +12V supply rail.

Rear panel layout:



from left to right: (note: the MF socket is not shown in the photograph)
Mains input socket. Three pin IEC socket. The unit must be earthed!

Fuse carrier. Use a 2.5A anti-surge fuse. There is also a 2A fuse on the PSU PCB.

9-Pin 'D' socket carrying TTL level control signals to the antenna selector and weather satellite interfaces.

TX-audio output. The audio feed to the transmitter.

TX-video output. The video feed to the transmitter.

Monitor-audio output. The audio feed to a locally sited monitor.

Monitor-video output. The video feed to a locally sited monitor.

MF input. An audio input directly from the receiver audio output. This should not be routed via any other equipment.

External input 2 audio.

External input 2 video.

External input 1 audio. Normally from the weather satellite receiver.

External input 1 video. Normally from the weather satellite receiver.

RX audio input. Audio from the stations main receiver.

RX video input. Video from the stations main receiver.

The RX inputs may be routed through the VCR but the MF input should come directly from the receiver otherwise any problem with the VCR could cause loss of remote MF commands to re-enable it.

In case of problems.

An MF keypad with keys A,B,C and D will be required. These keys are in the MF signalling specification but are not present on most keypads.

If the unit is under control of the SAP board, issuing the MF command '***1DC#**' (or '***2DC#**' if the ID link is fitted) will cause the SAP processor to restart and re-initialise the system. Note that during initialisation, the VCR is powered down then up again, during this period, which could last for eight seconds, it is possible that repeater access is lost. If the SAP is disabled by an external computer, it is the responsibility of that computer to monitor for the reset command and take appropriate action.

The VCR power and initialisation functions can also be controlled independently of the SAP by issuing the following MF commands:

***x7A#** causes an initialisation sequence – power down, power up, operate standby, rewind tape.

***x7B#** causes the VCR channel number to increase by one.

***x7C#** causes the VCR channel number to decrease by one.

***x7D#** causes the standby control to operate. This has toggle action.

It is vitally important that the receiver audio output is connected directly to the repeater MF input. If it is routed via the VCR and the VCR is not configured to pass the audio through it, the MF tone decoder will never see any signals. As a result, it will not be possible to regain control of the repeater by sending MF commands.

Transmitter control.

It is possible to use the relay ports to switch the transmitter carrier on or off. There is no command in the SAP to do this as it could enable unauthorised activation or de-activation of the station. Control is possible however, by external computer.

Front and Rear panel socket pin-outs:

Computer interface

Pin number	Purpose	Connects to
1	Not used	
2	TXD – serial data input	ISO SK6/6
3	RXD – serial data output	ISO SK6/5
4	RTS – control line input	ISO SK6/8
5	CTS – control line output	ISO SK6/7
6	Not used	
7	GND – serial data ground	ISO SK6/4
8	Not used	
9	Audio input ground return	ISO SK7/1
10	Audio input	ISO SK7/2
11	Audio output ground return	ISO SK7/3
12	Audio output	ISO SK7/4
13	Not used	
14	External processor select	SAP SK13/4
15	System ground	ISO SK1/1
16	Not used	
17	Not used	
18	Not used	
19	Not used	
20	Not used	
21	Not used	
22	Video output	ISO SK5/2
23	Video output ground return	ISO SK5/1
24	Video input	ISO SK2/2
25	Video input ground return	ISO SK2/1

Note: all pins are isolated from real ground except pins 14 and 15, linking these puts the SAP in standby mode and allows an external computer to take control.

VCR Control (5-pin 180º DIN)

Pin number	Purpose	Connects to
1	Positive supply to VCR power switch	SAP SK1/9
2	Not used	
3	Feed to Anode of external IR LED	SAP SK1/7
4	VCR power switch ground return	SAP SK1/8
5	Feed to Cathode (+) of external IR LED	SAP SK1/6

User Ports

Pin	Purpose	Connects to
1	UserA common	SAP SK14/1
2	UserA bit 0	SAP SK14/2
3	UserA bit 1	SAP SK14/3
4	UserA bit 2	SAP SK14/4
5	UserA bit 3	SAP SK14/5
6	UserA bit 4	SAP SK14/6
7	UserA bit 5	SAP SK14/7
8	UserA bit 6	SAP SK14/8
9	UserA bit 7	SAP SK14/9
10	Not used	
11	Not used	
12	Not used	
13	Not used	
14	Not used	
15	Not used	
16	Not used	
17	UserB Common	SAP SK15/1
18	UserB bit 4	SAP SK15/2
19	UserB bit 5	SAP SK15/3
20	UserB bit 6	SAP SK15/4
21	UserB bit 7	SAP SK15/5
22	UserB bit 0	SAP SK15/6
23	UserB bit 1	SAP SK15/7
24	UserB bit 2	SAP SK15/8
25	UserB bit 3	SAP SK15/9

Antenna / WXsat

Pin	Purpose	Connects to
1	Antenna & Wxsat common ground (0V)	SYSPROC SK5/1
2	Wxsat control bit 0	SYSPROC SK5/2
3	Wxsat control bit 1	SYSPROC SK5/3
4	Wxsat control bit 2	SYSPROC SK5/4
5	Wxsat control bit 3	SYSPROC SK5/5
6	Antenna control bit 0	SYSPROC SK4/2
7	Antenna control bit 1	SYSPROC SK4/3
8	Antenna control bit 2	SYSPROC SK4/4
9	Antenna control bit 3	SYSPROC SK4/5

Schematics

Notes:

All power supply decoupling capacitors have been omitted from the schematics for clarity. All electrolytic types are 10µF 10V tantalum beads and all non-electrolytic types are 100nF 50V ceramic plate.

If the switch-mode power supply is replaced with a linear type, using the area on the SAP for this purpose, the regulator heat tabs can be bolted to the base of the cabinet to dissipate heat. Note that the reservoir capacitors are not mounted on the PCB as they would be physically too large to fit. Provision has been made on the board for connecting wires to reach the capacitors. These wires should be kept as short as possible to minimise their resistance.

Warning:

The switch–mode power supply heatsinks are above ground potential. In particular, the primary side heatsink may reach a potential approaching peak mains voltage. Insulators are fitted below and above the power supply PCB to prevent it touching the base or lid of the cabinet. If the power supply is replaced, it is advised that insulators are fitted to the new unit as well.

The potentiometer on the PSU is for setting the over-voltage trip point should a fault occur in the regulation stages.

Inter-PCB connections

TCG

Pin	Purpose	Connects to
SK1/1	+5V supply	PSU
SK1/2	+5V supply	PSU
SK1/3	0V	PSU
SK1/4	0V	PSU
SK2/1	TCG page bit 3	AVMUX SK2/5
SK2/2	TCG page bit 2	AVMUX SK2/4
SK2/3	TCG page bit 0	AVMUX SK2/2
SK2/4	TCG page bit 1	AVMUX SK2/3
SK3/1	Video output ground return	AVMUX SK15/15
SK3/2	Not used	
SK3/3	Video output	AVMUX SK15/16

AVMUX

Pin	Purpose	Connects to
SK1/1	Audio ground return	
SK1/2	Audio input	Input socket
SK1/3	Audio ground return	
SK1/4	Audio input	Input socket
SK1/5	Audio ground return	
SK1/6	Audio input	
SK1/7	Audio ground return	
SK1/8	Audio input	
SK2/1	0V	
SK2/2	TCG page select bit 0	TCG SK2/3
SK2/3	TCG page select bit 1	TCG SK2/4
SK2/4	TCG page select bit 2	TCG SK2/2
SK2/5	TCG page select bit 3	TCG SK2/1
SK3/1	Audio ground return	ISO SK8/1
SK3/2	Audio input	ISO SK8/2
SK3/3	Audio ground return	
SK3/4	Audio input	Input socket
SK3/5	Audio ground return	
SK3/6	Audio input	Input socket
SK3/7	Audio ground return	
SK3/8	Audio input	Input socket
SK4/1	Isolator video output ground return	ISO SK4/1
SK4/2	Isolator video output	ISO SK4/2
SK4/3	Monitor video output ground return	Output socket
SK4/4	Monitor video output	Output socket
SK4/5	TX video output ground return	Output socket
SK4/6	TX video output	Output socket
SK4/7	TX channel syncs to OSG	SYSPROC SK7/3

SK4/8	TX channel syncs to OSG	SYSPROC SK7/2
SK5/1	Monitor audio ground return	
SK5/2	Monitor audio output	Output socket
SK5/3	TX audio ground return	O/P skt & ISO SK8/3
SK5/4	TX audio output	O/P skt & ISO SK8/4
SK5/5	Not used	
SK5/6	ID tone input	SYSPROC SK11/5
SK6/1	-5V	PSU
SK6/2	0V	PSU
SK6/3	0V	PSU
SK6/4	+5V	PSU
SK12/1	Sync detector port enable	SYSPROC SK1/1
SK12/2	TCG page register port enable	SYSPROC SK1/2
SK12/3	Address bus parked (not used)	SYSPROC SK1/3
SK12/4	0V	SYSPROC SK1/4
SK12/5	Video selector 2 port enable (not used)	SYSPROC SK1/5
SK12/6	Video selector 1 port enable	SYSPROC SK1/6
SK12/7	Audio selector 1 port enable	SYSPROC SK1/7
SK12/8	Audio selector 2 port enable	SYSPROC SK1/8
SK12/9	0V	SYSPROC SK1/9
SK12/10	+5V	SYSPROC SK1/10
SK12/11	Address line 1	SYSPROC SK1/11
SK12/12	Address line 0	SYSPROC SK1/12
SK12/13	Data line 3	SYSPROC SK1/13
SK12/14	Data line 2	SYSPROC SK1/14
SK12/15	Data line 1	SYSPROC SK1/15
SK12/16	Data line 0	SYSPROC SK1/16
SK13/1	0V	
SK13/2	Sync detector CS output	
SK13/3	Sync detector VS output	
SK13/4	0V	SYSPROC SK7/4
SK13/5	OSG video input	SYSPROC SK7/5
SK15/1	Video input ground	
SK15/2	Video input (not used)	
SK15/3	Video input ground	
SK15/4	Video input	Input socket
SK15/5	Video input ground	
SK15/6	Video input	Input socket
SK15/7	Video input ground	
SK15/8	Video input	Input socket
SK15/9	Video input ground	
SK15/10	Video input	Input socket
SK15/11	Video input ground	
SK15/12	Video input	Input socket
SK15/13	Video input ground	ISO SK3/1
SK15/14	ISO video input	ISO SK3/2
SK15/15	Video input ground	TCG SK3/1
SK15/16	TCG video input	TCG SK3/3

SYSPROC

Pin	Purpose	Connects to
SK1/1	Sync detector port enable	AVMUX SK12/1
SK1/2	TCG page register port enable	AVMUX SK12/2
SK1/3	Address bus parked (not used)	AVMUX SK12/3
SK1/4	0V	AVMUX SK12/4
SK1/5	Video selector 2 port enable (not used)	AVMUX SK12/5
SK1/6	Video selector 1 port enable	AVMUX SK12/6
SK1/7	Audio selector 1 port enable	AVMUX SK12/7
SK1/8	Audio selector 2 port enable	AVMUX SK12/8
SK1/9	0V	AVMUX SK12/9
SK1/10	+5V	AVMUX SK12/10
SK1/11	Address line 1	AVMUX SK12/11
SK1/12	Address line 0	AVMUX SK12/12
SK1/13	Data line 3	AVMUX SK12/13
SK1/14	Data line 2	AVMUX SK12/14
SK1/15	Data line 1	AVMUX SK12/15
SK1/16	Data line 0	AVMUX SK12/16
SK2/1	User port drive	SAP SK18/1
SK2/2	User port drive	SAP SK18/2
SK2/3	User port drive	SAP SK18/3
SK2/4	User port drive	SAP SK18/4
SK2/5	User port drive	SAP SK18/5
SK2/6	User port drive	SAP SK18/6
SK2/7	User port drive	SAP SK18/7
SK2/8	User port drive	SAP SK18/8
SK2/9	User port drive	SAP SK18/9
SK3/1	User port drive	SAP SK17/1
SK3/2	User port drive	SAP SK17/2
SK3/3	User port drive	SAP SK17/3
SK3/4	User port drive	SAP SK17/4
SK3/5	User port drive	SAP SK17/5
SK3/6	User port drive	SAP SK17/6
SK3/7	User port drive	SAP SK17/7
SK3/8	User port drive	SAP SK17/8
SK3/9	User port drive	SAP SK17/9
SK4/1	Antenna selector 0V	
SK4/2	Antenna selector bit 0	Output socket
SK4/3	Antenna selector bit 1	Output socket
SK4/4	Antenna selector bit 2	Output socket
SK4/5	Antenna selector bit 3	Output socket
SK5/1	Wxsat control 0V	Output socket
SK5/2	Wxsat control bit 0	Output socket
SK5/3	Wxsat control bit 1	Output socket
SK5/4	Wxsat control bit 2	Output socket
SK5/5	Wxsat control bit 3	Output socket
SK6/1	0V	SAP SK12/1

SK6/2	Internal serial data	SAP SK12/3
SK6/3	Internal serial data	SAP SK12/4
SK6/4	Internal serial data	SAP SK12/2
SK6/5	Internal serial data	SAP SK12/5
SK7/1	0V	
SK7/2	Sync input to OSG	AVMUX SK4/8
SK7/3	Sync input to OSG	AVMUX SK4/7
SK7/4	0V	AVMUX SK13/4
SK7/5	OSG video out	AVMUX SK13/5
SK8/1	MF input ground	
SK8/2	MF input	Input socket
SK9/1	0V	SAP SK1/1
SK9/2	Reserved for VCR control	
SK9/3	Reserved for VCR control	
SK9/4	Reserved for VCR control	
SK9/5	Reserved for VCR control	
SK9/6	Reserved for VCR control	
SK9/7	Reserved for VCR control	
SK9/8	IR modulation signal	SAP SK1/3
SK9/9	VCR power switching	SAP SK1/2
SK10/1	0V	PSU
SK10/2	0V	PSU
SK10/3	+5	PSU
SK10/4	+5	PSU
SK11/1	0V	ID LED -
SK11/2	Not used	
SK11/3	Tone envelope	ID LED +
SK11/4	Not used	
SK11/5	ID tone output	AVMUX SK5/6

SAP

Pin	**Purpose**	**Connects to**
SK1/1	0V	SYSPROC SK9/1
SK1/2	VCR power switching	SYSPROC SK9/9
SK1/3	IR modulation signal	SYSPROC SK9/8
SK1/4	Internal IR emitter -	IR LED -
SK1/5	Internal IR emitter +	IR LED +
SK1/6	External IR emitter -	DIN socket
SK1/7	External IR emitter +	DIN socket
SK1/8	0V	DIN socket
SK1/9	VCR power switching	DIN socket
SK12/1	0V	SYSPROC SK6/1
SK12/2	Internal serial data	SYSPROC SK6/4
SK12/3	Internal serial data	SYSPROC SK6/2
SK12/4	Internal serial data	SYSPROC SK6/3
SK12/5	Internal serial data	SYSPROC SK6/5

SK13/1	0V (not used)	
SK13/2	External serial data	ISO SK1/6
SK13/3	External serial data	ISO SK1/2
SK13/4	Int/ext switching	Computer interface
SK13/5	External serial data	ISO SK1/5
SK13/6	External serial data	ISO SK1/3
SK14/1	UserA common	User port ‘D’ 1
SK14/2	UserA bit 0	User port ‘D’ 2
SK14/3	UserA bit 1	User port ‘D’ 3
SK14/4	UserA bit 2	User port ‘D’ 4
SK14/5	UserA bit 3	User port ‘D’ 5
SK14/6	UserA bit 4	User port ‘D’ 6
SK14/7	UserA bit 5	User port ‘D’ 7
SK14/8	UserA bit 6	User port ‘D’ 8
SK14/9	UserA bit 7	User port ‘D’ 9
SK15/1	UserB common	User port ‘D’ 17
SK15/2	UserB bit 0	User port ‘D’ 22
SK15/3	UserB bit 1	User port ‘D’ 23
SK15/4	UserB bit 2	User port ‘D’ 24
SK15/5	UserB bit 3	User port ‘D’ 25
SK15/6	UserB bit 4	User port ‘D’ 18
SK15/7	UserB bit 5	User port ‘D’ 19
SK15/8	UserB bit 6	User port ‘D’ 20
SK15/9	UserB bit 7	User port ‘D’ 21
SK16/1	Run LED	Front panel LED
SK16/2	Run LED	Front panel LED
SK17/1	User port drive	SYSPROC SK3/1
SK17/2	User port drive	SYSPROC SK3/2
SK17/3	User port drive	SYSPROC SK3/3
SK17/4	User port drive	SYSPROC SK3/4
SK17/5	User port drive	SYSPROC SK3/5
SK17/6	User port drive	SYSPROC SK3/6
SK17/7	User port drive	SYSPROC SK3/7
SK17/8	User port drive	SYSPROC SK3/8
SK17/9	User port drive	SYSPROC SK3/9
SK18/1	User port drive	SYSPROC SK2/1
SK18/2	User port drive	SYSPROC SK2/2
SK18/3	User port drive	SYSPROC SK2/3
SK18/4	User port drive	SYSPROC SK2/4
SK18/5	User port drive	SYSPROC SK2/5
SK18/6	User port drive	SYSPROC SK2/6
SK18/7	User port drive	SYSPROC SK2/7
SK18/8	User port drive	SYSPROC SK2/8
SK18/9	User port drive	SYSPROC SK2/9
SK19/1	0V	PSU
SK19/2	0V	PSU
SK19/3	+5	PSU
SK19/4	+5	PSU

Programmed Devices

The following generic devices are programmed with specific codes:

Board	Designator	Device	Code
TCG	IC1	27C512	(testcard data)
TCG	IC3	MACH4A5 64/32	Tcg3.jdc
SYSPROC	U1	MACH210-15	3100dec.jed
SYSPROC	U2	PIC16F84	3100.hex
SYSPROC	U4 & U5	PIC16C84 or PIC16F84	Misctrl.hex
SYSPROC	U9	PIC16C84 or PIC16F84	Osg_ctrl.hex
SYSPROC	U11	PIC16C84 or PIC16F84	Ir_ctrl.hex
SYSPROC	U12	PIC16C84 or PIC16F84	Id_gen.hex
SAP	U13	GAL16V8-25	232switch.jed
SAP	U15	PIC16F84	Sa_proc.hex