

# **BCF TECHNOLOGY LTD**

## **OVISCAN 6 + DUOSCAN 3**

### **TECHNICAL MANUAL**



Copyright BCF 2006

All rights reserved. Reproduction in whole or part of all material in this publication, including drawings or diagrams is forbidden.

This manual is confidential to BCF Technology Ltd. and is supplied for use only in connection with the operation and/or maintenance of the OVISCAN 6 as supplied by BCF Technology Ltd. The contents must not be used for any other purposes, nor disclosed to any third party, without prior consent of BCF Technology Ltd.

This document contains information available at the time publication. BCF Technology Ltd. reserves the right to modify or revise its contents.

## **INTRODUCTION**

This manual is intended to supplement the operators manual for the BCF OVISCAN 6 giving more detailed technical information about the instrument and the data necessary to carry out servicing and repair procedures.

Full information is given for the control console and module with some information being supplied for the probes.

## ***EQUIPMENT WARRANTY***

The OVISCAN 6, including accessories is warranted against defects in design, materials or workmanship, for a period of 12 months, from the date of commencement of the warranty period.

If any defect in design, material, or workmanship appears within the period of warranty, BCF Technology Ltd. or its designated agent will in the case of all equipment, correct the defect by making any necessary repairs or at its option, replacing any defective parts.

This warranty does not apply to and the company assumes no responsibility for damage or deterioration due to any cause other than that specified above and in particular, but not by way of limitation, this warranty does not apply to and the company assumes no responsibility for normal wear and tear, or for damage or deterioration if the equipment has been subject to abnormal conditions.

## ***EQUIPMENT SERVICING***

BCF Technology's products are supported by a world-wide network of highly trained technical service representatives and engineers for prompt service of customer needs.

If required, rapid service assistance can be provided by contacting your local BCF Technology representative, or communicating directly to:

BCF Technology Ltd.  
3 Rutherford Square  
Brucefield Industrial Park  
Livingston  
West Lothian  
EH54 9BU

TEL: 44 (0) 1506 460023

FAX: 44 (0) 1506 460045

Email: [office@bcftechnology.co.uk](mailto:office@bcftechnology.co.uk)

# CONTENTS

<b>2DESCRIPTION AND OPERATION</b>	<b>4</b>
<b>Probe and Ultrasound Energy</b>	<b>4</b>
<b>OVISCAN 6</b>	<b>6</b>
Overview	6
Console	6
CIRCUIT DESCRIPTION : Console PCB	9
Module	13
CIRCUIT DESCRIPTION : System PCB	15
CIRCUIT DESCRIPTION : Supply PCB	19
CIRCUIT DESCRIPTION : Interface PCB	21
<b>MECHANICAL DISASSEMBLY</b>	<b>24</b>
<b>CONSOLE</b>	<b>24</b>
<b>MODULE</b>	<b>24</b>
<b>ANNUAL MAINTENANCE</b>	<b>25</b>
<b>CIRCUIT DIAGRAMS, PCB TEST AND LAYOUT</b>	<b>27</b>
<b>Console</b>	<b>27</b>
Console PCB	27
<b>Module</b>	<b>27</b>
System PCB	27
Interface PCB	27
Supply PCB	27
<b>WIRING SCHEDULES</b>	<b>27</b>
<b>Console</b>	<b>27</b>
<b>Module</b>	<b>27</b>
<b>Keypanel</b>	<b>27</b>
<b>APPENDIX : CONSOLE PCB DIAGNOSTIC INFORMATION</b>	<b>28</b>

## **Description and operation**

### ***Probe and Ultrasound Energy***

The standard probe has four transducers mounted in a drum which rotates in silicone fluid. Connection to the rotating transducers is via slip rings and brushes from which four coaxial cables carry the transducer signals to the receiver board. Only one transducer is used at any one time.

The transmitter pulse waveform is selected to give efficient transformation from electrical energy to ultrasound and a reduction of reverberation energy. The initial pulse at the transducer is negative with an amplitude between 25 V. and 200 V. depending on the transmit power selected. The negative voltage is held for a time equal to half the natural resonance period of the transducer then released for an equal period then re-applied for a further equal period.

The system normally operates with the transmitter pulse width at the natural resonant frequency of the transducer crystals and with the receiver filters set to the same frequency.

The system can be operated at other than the natural frequency, controlled from the menu settings.

The silicone fluid acts both as a lubricant for bearing surfaces and as a coupling medium for the transmission of ultrasound energy to and from the face of the transducers. Ultrasound energy of the frequency used in the OVISCAN 6 is strongly absorbed in air and will travel only a few millimeters through it.

When the probe is not in contact with an object a characteristic reverberation pattern is displayed on the screen. This happens because of the very large difference in acoustic impedance between the material of the probe window and the outside air resulting in a very strong echo from the face of the window. As this is close to the transducer, energy reflects back and forth between the window and the transducer. This continues until the energy is reduced to an insignificant level.

When the probe is held in contact with an object which readily conducts ultrasound the reverberation pattern disappears as the sound continues straight through the window and into the object. In the case of using an animal as a scanned subject a couplant must be used to exclude air from between the probe and the subject and prevent reverberation.

Because of the small distances involved in the generation of the reverberation pattern any small distortion in the window can appear as a large distortion in the pattern. These distortions too will disappear when the probe contacts a subject. Distortions in the window may occur as a result of manufacturing tolerances or as a result of accidental damage to the probe.

For a similar reason, small differences in angular alignment between the transducers may appear

as a "flicker" in the reverberation pattern when the probe is not in contact with a subject. This effect which shows a small random variation from probe to probe will also disappear when the probe is scanning normally in contact with a subject.

The probe head also contains the following:

- A dc motor and gear train to rotate the transducer drum.

- A magnetic pick up, the resolver, sensing teeth on one of the gears to provide a signal for rotational speed control and drum position feedback.

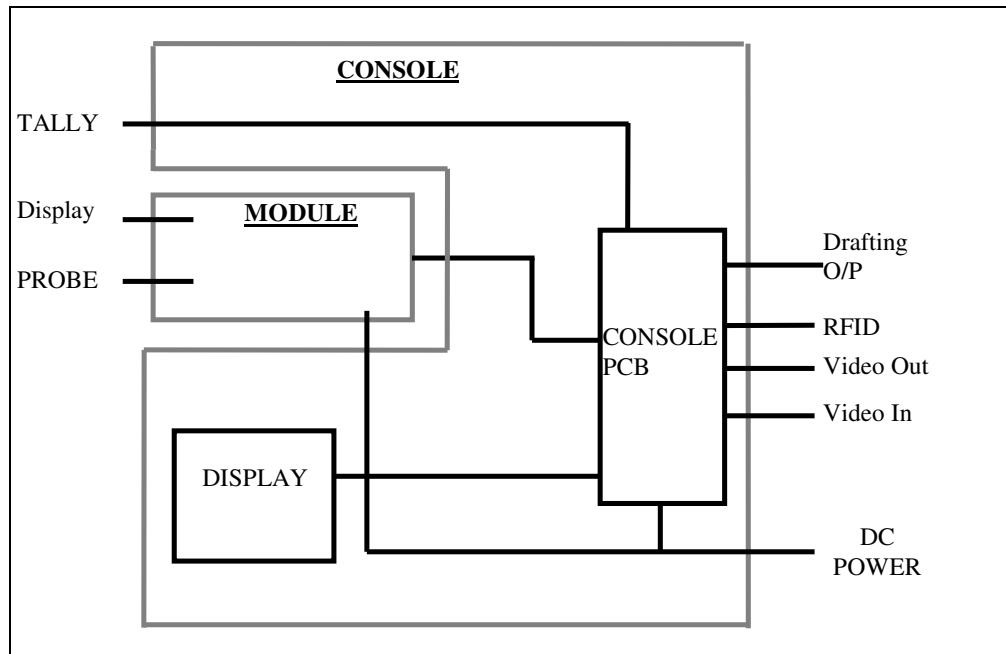
- A magnetic pick up, the index sensor, sensing a slot cut into one of the gears providing a signal to align the screen image with the transmitted sound.

- A magnetic coupling to transmit the rotating forces through to the sealed compartment containing the transducer drum.

- A capillary tube to accommodate normal expansion and contraction of the volume of silicone fluid without pressure changes.

# OVISCAN 6

## Overview



The CONSOLE provides the display and interface to tally, drafting gate, RFID reader and video monitor while the slide-in MODULE provides the ultrasound function.

Connection to and from the module is through the securing latches which provide power to the MODULE and 5 blind mating contacts which provide serial communication and pass video signals between the CONSOLE and MODULE.

The module can produce an ultrasound scan as a stand-alone unit when latched to a battery and a portable display connected.

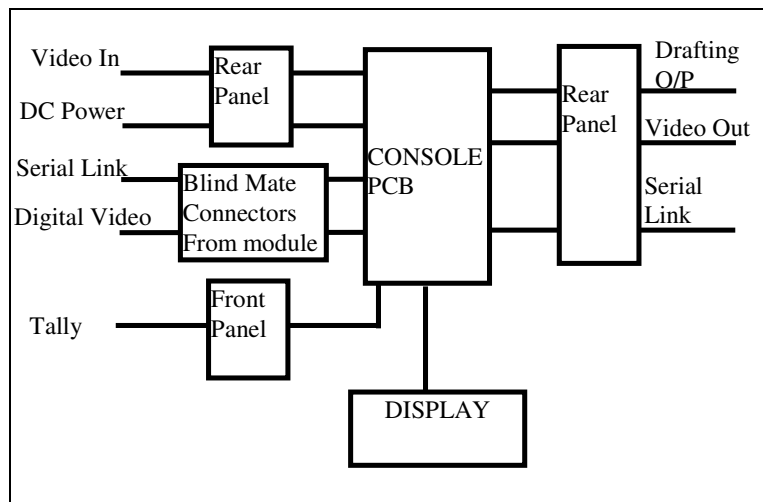
The console can also function as a stand-alone video monitor in the absence of a Duo-Scan.

## Console

Console components are built into an inner chassis which slides into the outer case. This provides good environmental and electromagnetic protection for system components. Further protection is provided by a protective carry case. The system is resistant to dust, vibration and water splash.

### DISPLAY

The LCD display normally displays the Ultrasound image



using digital Video output fed from the module to the console PCB via the blind mating contacts at the rear of the module. The video is a proprietary digital format, this is converted into a VGA signal for display on the LCD panel.

The LCD can alternatively be used in Video Monitor Mode to display NTSC analogue video input from either the console rear panel video input connector or from the internal RF Video receiver. Analogue video inputs are converted into a VGA signal.

## CONNECTIONS

The rear panel provides connectors for DC power in (2 pin Binder), video in & video out (BNC) and Drafting Gate output (5 pin Binder). The front panel connector is for the tally controller (6 pin Binder).

## CONTROLS

The only direct input control to the console is the Tally handpiece which is used to power the console on and select one of three video sources when the console is not connected to a Duo-scan. When connected to a Duoscan power-on commands and any setup information is transferred to the console via the serial link. Tally keypresses are handled by the console PCB which then transfers the information to the module via the serial link.

## POWER

The Console is powered with 12V DC via the 2 pin connector on the rear panel. The 12V DC input is distributed to;

The Module, wired to the latches on the side of the Console through a 2.5A polyfuse.

The Console PCB. Circuitry has a 2.5A polyfuse and is reverse polarity protected.

The drafting gate output (via the Console PCB) with separate 2.5A polyfuse.

Once power is applied to the console PCB it remains in a low power standby mode, waking briefly every second to check for serial data or tally command to power on in scanner mode or video monitor mode.

## VIDEO SWITCHING

If the console is powered without the Duo-Scan module present, pressing keys 1,2 or 3 on tally handpiece switches the console on in video monitor mode. In this mode, the tally switches between different video inputs; tally 1 switches to the Video Input BNC on the rear panel, tally 2 switches to the RF video receiver on the console PCB, each subsequent press of tally 2 cycles through the 4 RF channels, tally 3 selects the Digital Video Input on the blind mating connectors. Tally 0 returns the console into low-power, standby mode.

## POWER ON SEQUENCE

Following power on, the Console runs through the following sequence:

- 1) Checks the supply voltage, if less than 9 volts then the console will display a "Low Battery" message for approximately 6 seconds before switching into standby.
- 2) Configures its on board peripherals and switches to standby mode (LED 2 illuminates briefly).

## WAKEUP SEQUENCE

On waking from Standby, the Console performs the following operations:

- 1) Checks the supply voltage, if less than 9 volts then the console will display a "Low Battery" message for approximately 6 seconds before switching into standby.
- 2) Configures its on board peripherals and displays 'Software OK' message

3) Establish communications with the Duo-Scan module, if the appropriate response is received, the console displays a “Duo Scan OK” message and goes into Duo-Scan mode. If no (or an incorrect) response is received, the Console displays “Check Duo Comms” and switches into Video Monitor mode, defaulting to the digital video input.

#### OPERATION (DUO-SCAN MODE)

During normal operation the Console runs through the following sequence in a repeating loop.

1) Check battery voltage if less than 9 volts then the console will display a “Low Battery” message for approximately 6 seconds before switching into standby.

2) Poll Tally input to see if a button has been pressed.

If a button is pressed, the appropriate value is sent to the Duo-Scan module and the console waits for a reply.

If the correct reply is received, the console continues with the normal sequence.

If no (or incorrect) reply is received, the Console displays “Check Duo Comms” and switches into Video Monitor mode, defaulting to the digital video input.

3) Poll Duo-Scan serial link for any received data, if any commands are received, the Console executes the appropriate routine: Brightness/Contrast, Drafting Gate setup, Power Off and the store Brightness/Contrast commands.

#### OPERATION (VIDEO MONITOR MODE)

In Video Monitor Mode, the console polls the Tally input to check for button presses, the buttons have the following effects:

Tally 1: Console displays “External Video” and switches to the Video In BNC on the rear panel.

Tally 2: Console displays “RF Channel X” where X is the currently selected RF video channel, each press of the button cycles through the 4 available channels.

Tally 3: Console displays “Duo Scan Video” and switches to the Digital Video input on the blind mate connectors.

Tally 0: Console switches into standby mode.

#### OPERATION (STANDBY MODE)

In Standby mode, the Console goes into a low power ‘sleep’ mode, it wakes up every second and performs the following checks:

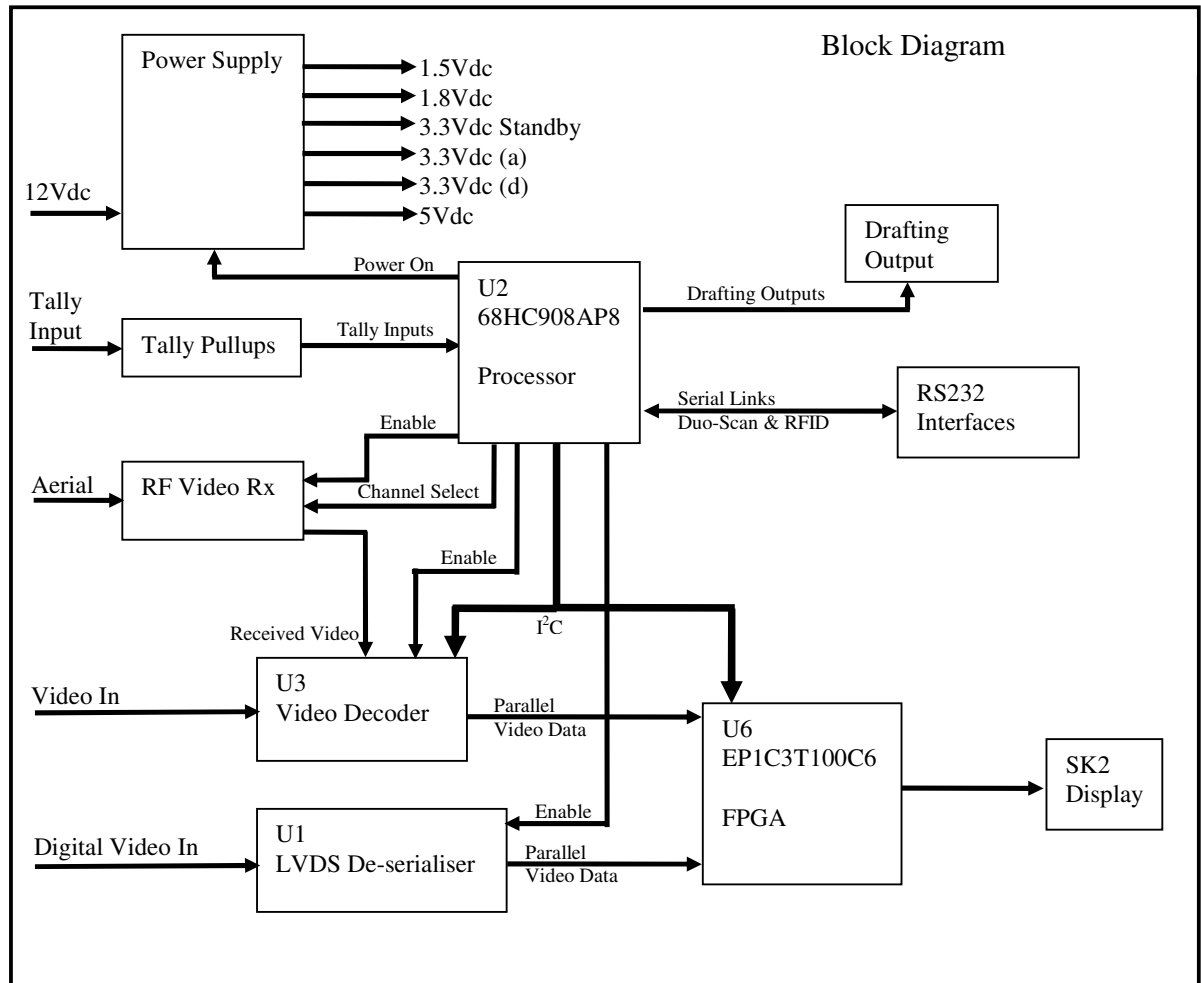
1) Check battery voltage, if the console entered standby due to a low battery, the console will not power up unless the voltage is more than 11V, otherwise the battery voltage has to be above 10V.

2) Poll Duo-Scan Serial link, if any data has been received, the console will exit standby and perform the Power On sequence.

3) Poll Tally, if any button on the tally controller is pressed, the console will exit standby and perform the Power On sequence.



## CIRCUIT DESCRIPTION : Console PCB



The Console PCB provides tally inputs, drafting outputs, communication with the Duo-Scan module, video decoding and display signals and power. The 68HC processor (U2) is in overall control of the operation of the Console PCB with the ability to disable parts of the circuit, as well as shutting off power to all components except the tally pullups and RS232 transceiver (U7). The processor reads the tally data, switches the drafting gate outputs, provides serial communications with the Duo-Scan and the RFID reader and selects which of the 3 video inputs is to be decoded and displayed.

### ***POWER SUPPLY***

The power supply section of the Console PCB provides power to all of the devices on the PCB and to the inverter board for the LCD display. The following supplies are generated:

**3.3Vdc Standby** – Supplied by linear regulator, U13, to the processor, U2, RS232 transceiver, U7, and tally inputs pull ups (RN1 & RN2). This supply is permanent and cannot be switched off, so that the processor remains powered in standby mode and can detect tally inputs or serial data.

**12Vdc** – Supplied by switching regulator, U5, to the LCD Display inverter board and to the other voltage regulators (except the 3.3Vdc standby). This supply is under processor control via the ‘Power on’ line (U2 pin 42 to U5 pin 6, active high). Disabling this supply also disables the other supplies, placing the Console in Standby mode. U5 is a Buck/Boost switching regulator which will generate regulated 12Vdc from a supply voltage of 9-18Vdc. External switching components M5-M8 are used in pairs according to whether the input voltage is above or below 12V; in step up mode, M5 is on, M6 is off and M7 & M8 are switched. In step down mode, M7 is on, M8 is off and M5 & M6 are switched. R26 provides current feedback to the device.

**5Vdc** – Supplied by switching regulator, U10, to the Airwave RF video receiver (RX2) and the video amplifier U11 via the linear regulator (U14).

The switching regulator steps down the 12 supply from U5 to 5.35Vdc, this is fed to linear regulator U14 which supplies a regulated 5Vdc supply to the RF video receiver. The output from U14 may be disabled by the processor via the ‘Vid RX On’ line (U2 pin 37 to U14 pin 7 Enable=High).

**3.3Vdc** – Supplied by switching regulator, U9, split into 2 supplies, 3.3VD and 3.3VA (digital and analogue) separated by filters. This regulator also supplies power to the 1.8 & 1.5V supplies. The 3.3VD supplies the analogue video converter and LVDS De-serialiser (U3 & U1), the crystal for the digital video converter (X2) and the FPGA (U6).

The 3.3VA supplies the digital video converter (U1).

**1.8Vdc** – Supplied by linear regulator, U12, this regulator is powered by the 3.3Vdc supply. The 1.8Vdc supplies the analogue video decoder (U3).

**1.5Vdc** - Supplied by linear regulator, U4, this regulator is powered by the 3.3Vdc supply. The 1.5Vdc supplies the FPGA (U6).

## ***Video Processing***

### **Analogue video inputs:**

The Console PCB accepts analogue video from 2 sources; RF, via the Airwave receiver and composite via the Molex connector J11.

RF Video: The Airwave receiver (RX2) receives RF video via the aerial connected to PCB, the receiver has 4 input selection lines (RF\_SEL\_0 to RF\_SEL\_3 all active low) which are controlled by the processor, U2, to select the desired channel. The power supply to the receiver (5Vdc) can be disabled by the processor, switching off the receiver.

The selected channel is fed to the External Video Out connector (J10) via the video amplifier U11 and to Input A (pin 1) of the Analogue Video Decoder.

External Video: The external video input is fed to connector J11 and from there to input B (pin 2) of the Analogue Video Decoder.

### **Analogue video decoding:**

The Analogue Video Decoder (U3) has 2 video inputs (A & B) which are connected to the RF

video receiver output and the external video input respectively. Control over which input is decoded is via the I<sup>2</sup>C bus from the processor. The decoder also has a single output (under I<sup>2</sup>C control) which is used to drive an LED (LD2), illuminated by the processor when the decoder is active.

The selected input is converted to a digital video signal to ITU-R BT.656 standards and fed to the FPGA (U6) via 8 data lines and 1 clock line.

The analogue decoder is powered by the 3.3V power supply and as such is shut down when the processor disables supplies in standby mode, the device also has a separate enable line (Vid\_Comp\_On) which is under direct processor control (U3 pin 28 to U2 pin 41 active high). When the device is active there should be data on all 8 lines and a clock on the clock line.

#### **Digital video input and decoding:**

The Console PCB accepts a single serial digital video source via the blind mate connectors in the console to Molex connector J4.

This signal is a differential serial signal using a proprietary video format, the LVDS De-Serialiser converts this signal into a 10-bit parallel signal, this is fed to the FPGA over 10 data lines and 1 clock line.

The de-serialiser is powered by the 3.3V power supply and as such is shut down when the processor is in standby mode, the device also has a separate enable line (LVDS\_On) which is under direct processor control (U1 pin 7 to U2 pin 17 active high).

The 'Lock' output of the device is connect to an LED (LD4), this illuminates when the device has locked onto a valid serial data stream.

#### **Video Conversion and display driver.**

The parallel digital video signals from the analogue video decoder and the deserialiser are fed to the FPGA, in addition, the FPGA has its own internal video source which is used to display the various system text messages. The appropriate source is selected by the processor via the I<sup>2</sup>C bus. The output is a 18 bit RGB digital video signal (6 bits per channel) with separate horizontal and vertical syncs and clock. In operation, there should be data present on the data lines (R0-R5, G0-G5 & B0-B5) as well as on the sync and clock lines.

When the FPGA is displaying its internal source (text messages), LED LD1 is illuminated.

### ***Interfacing and processing***

The processor (U2) controls the overall operation of the console, controlling the power supply to the other devices and display and handling the serial interfaces, tally input and drafting output switching.

The processor is attached to an LED (LD3) which is illuminated following processor configuration.

#### **Serial Interfaces:**

The processor provides 2 serial interfaces, both are configured at 9600 baud, 8bits, 1 stop bit, no parity. Both interfaces are routed from the processor to an RS232 Transceiver (U7) and from there to connectors J6 & J7. Connector J6 connects to the blind mate connectors on the console to provide communications with the Duo-Scan, J7 connects to the rear panel 9 way D-type connector for communications with the RFID reader.

#### **Tally input:**

The front panel tally connector on the console connects to J5 on the PCB, providing 4 discrete input lines for the tally input. Each line is pulled high by resistor RN2 and is pulled low when the appropriate tally button is pressed. These 4 lines are read by the processor (on pins 19-22) which then transfers the tally data to the Duo-Scan over the serial link.

If the processor receives the correct response from the Duo-Scan, it then switches the appropriate drafting outputs, if not or if an incorrect response is received from the Duo-scan, the console switches into Video Monitor Mode.

**Drafting Output:**

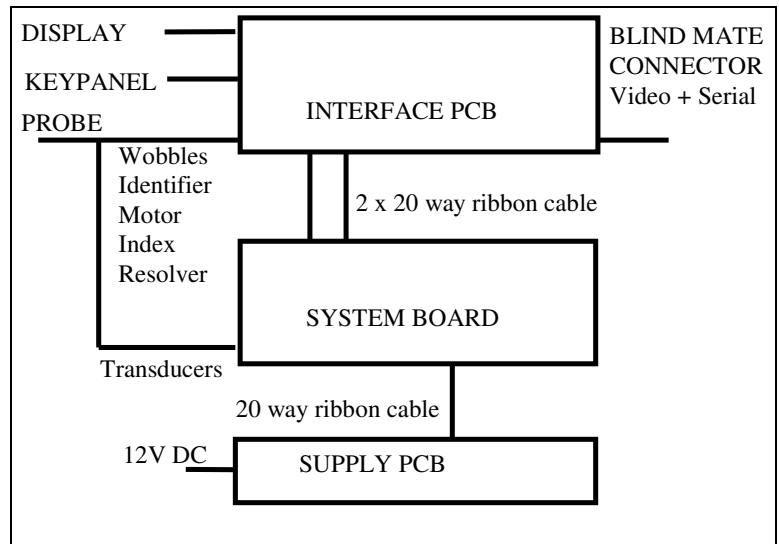
The console provides 4 drafting outputs and a 12Vdc supply line via the 5 pin Binder connector on the rear panel connected to J8 on the Console PCB. The 12Vdc output is unregulated 12 supply (9-18Vdc) fused with a 2.5A polyfuse.

Each output line is switched via a FET (M1 – M4 for Draft-1 to Draft-4 respectively). To switch the output on, the processor applies a logic 1 to its output, switching on the appropriate FET, this pulls the drafting output to 0vdc, completing the circuit.

## Module

The module forms a self contained scanner with basic functions and preset controls. Connections for probe and display are on the front panel. DC Power is supplied to the module through its latches.

Mounting in the Oviscan console connects I/O through the blind mate connector on the rear panel, providing further controls and video output.



### POWER

The DC power in from the latches is protected from reverse polarity and overcurrent by Diode and polyfuse. A High-Side switch IC (U105) Passes power to the Supply PCB under control of a logic level input. This power-on control line can be driven by one of three sources; the System PCB under Microprocessor control, the front panel 'POWER' key, or shorting link (J100) on Supply PCB.

Pressing the keypanel power switch powers up the system; once the System Board Core is loaded successfully the power switch control line is latched on and the front panel indicator is lit (Key can be released after a few 100uS). The 'POWER' key is also read as an input to the System Core, enabling detection of a long press (>2sec) to toggle power off. The Power switch IC provides current limiting and is overload protected.

### DISPLAY

Output connector provides +6.5V, +12V supplies and Video composite greyscale signal (with NTSC timing).

### PROBE

15 Way mixed coaxial and pin connector carries co-axial signals to/from the four transducers, probe resolver and index signals, motor drive and identifier resistor. Single pins are used for image wobble correction potentiometer connections and grounding.

### KEYPANEL

The five keys are read by the System core and used to control all settings through a menu system.

### CIRCUIT BOARDS

The module consists three PCBs:

- The Supply Board switches the incoming DC supply and provides all DC supplies for the display connector and PCBs including variable high voltage supply for the TX transmitter. In

addition there is an A-to-D converter reading DC input voltage, and drive to front panel LED.

- The System board combines Analogue Ultrasound functions (Crystal selection, Ultrasound transmit, Ultrasound receive processing and sampling) with scanner control and digital processing functions (Ultrasound digital processing, Scan conversion, Graphics generation and serial Digital video output, Probe control, scanner setup through control menu.
- The Interface board reads keypanel inputs, digitizes probe index, resolver, wobbles and identifier, sending digital values to the System Board. Video data from the System board is converted to composite video analogue signal to front panel and to PCB-mounted video transmitter module. The Interface board also generates the motor drive voltage under System board control.

#### SERVICE MENU

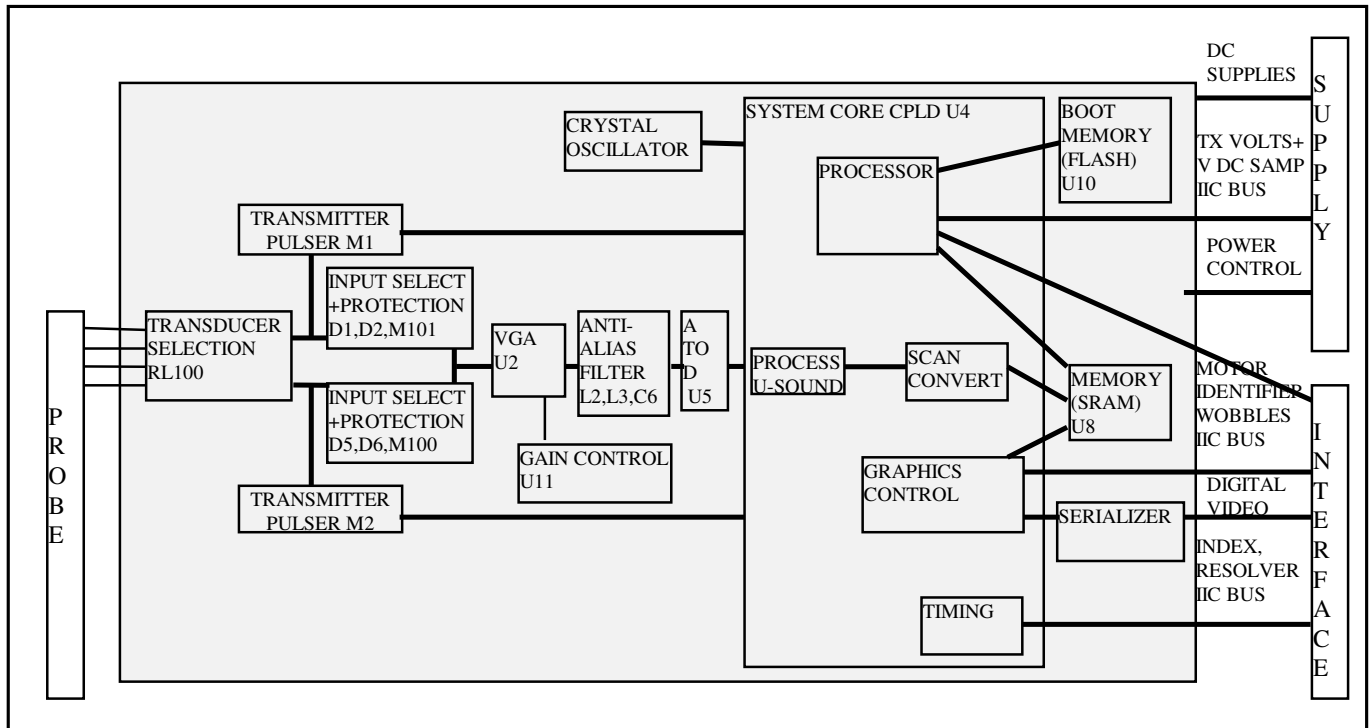
A service mode can be entered on the Duoscan enabling test routines and other data display. It can be used to display Index and resolver waveforms, and a total of all Tally batches that have been cleared.

To enter service mode, with the Duoscan connected to a console, press keypanel button 1 to scroll through to the 'foetal age' menu. With foetal age selection 'OFF' Press and hold buttons 3&4 until 'service' menu appears. Press button 4 to scroll through the series of tests or press button 3 to toggle between Total tally display and live display of digitized values of probe identifier and wobble correction pots. To exit service mode, remove power from the scanner.

#### INDEX, RESOLVER DISPLAY

Index and resolver waveforms may be displayed on-screen when the Duoscan is connected to a Console and a probe connected. Enter service mode and press button 4 to scroll through to test 1 or 2 (1 or 2 displayed in TALLY LATE column) for Index or Resolver display. In either of these two tests, an analogue version of the on-screen displayed values is provided on the video out connector in place of NTSC video signal.

## CIRCUIT DESCRIPTION : System PCB



### ***TRANSDUCER SELECTION***

The ultrasound is generated by pulsing the transducers in the probe. There may be either two or four transducers fitted to the probe; only one pair of transducers is used for any one imaging mode. From the selected pair of transducers only one is used at a time, with alternate transducers used on consecutive image frames. When a mode is selected the desired pair of transducers is connected to two separate transmit/input selection circuits selected by latching relay RL100 (DPCO). The relay has two coils, one to switch into each state. The coil is energized by a short pulse (few 100mS) when a change of selection is required, generated by core IC, buffered by U9 and driven by high side switch (M103 or M106) from the 6.5V supply. As alternate ultrasound frames are displayed, the appropriate transmitter is used and only one of the two input selection circuits is enabled.

### ***TRANSMITTER***

The Transmit pulse timing is generated digitally (Core IC) and fed through buffer U9 to one of two transmitters. Capacitively coupled transistor Q100 acts as a current source to drive the gate of power FET M1. Transistor Q101 provides gate voltage clamping for M1 and gate discharge for fast turnoff of M1. The Large negative transmit pulse is coupled to the selected transducer through diode D8. When not transmitting, D8 is biased off to isolate transmitter noise from the received signal path.

### ***PROTECTION\SELECTION***

Each of the two active transducers connects to a protection\selection circuit. Only one of the two

selection circuits is enabled by biasing the diode protection circuit on; Core IC, Level translate M105,M107, high side switch M100,M101. The unbiased circuit does not pass any small signal; D6, D5 do not conduct while the signal is less than +/- 0.5V. The selected diode protection circuit which is biased on passes small signals through D1,D2 but blocks any large (transmit) pulses.

### ***RECEIVE PROCESSING***

The small received echoes from the selected input are passed through lowpass filter L6, C13 and are amplified by U2. U2 is a variable gain amplifier with low noise preamplifier. The gain of the preamplifier and input impedance are set by feedback resistors R7, R8. The variable gain stage provides from -12dB to +36dB with a differential output. A ramp voltage between 0 and 1V generated by digital potentiometer U11 under core IC control varies the gain setting. L2, L3, C6 form a 2-pole anti-alias filter before coupling to the analogue-to-digital converter U5 through TF1 which provides dc level isolation between U2 output bias level of 2.5V and U5 input bias below 1V.

### ***SAMPLING***

U5 is a high-speed sigma-delta A-to-D converter with onboard DSP and clock generation providing a 14-bit output at 30 MHz and 80dB anti-alias filtering with a 2V p-p differential input. U5 is reset following power up and configured over SPI bus by the core IC. Parallel data is passed directly to the core IC. U5 requires a 1.2V supply filtered separately for analogue and digital internal functions, and a 2.1V supply for its output pin drive.

### ***CORE FUNCTIONS***

Internal to the Core IC, the digitized ultrasound is operated on by means of digital signal processing to provide filtering, compression, automatic Gain Control, and brightness mapping. The internal scan converter writes the processed ultrasound value and its corresponding screen location address to the graphics memory. The graphics generator reads the data back to produce both encoded VGA and composite NTSC timed digital video outputs. The encoded VGA digital video signal is passed to an on-board parallel to serial LVDS driver chip. Digital NTSC video data is passed to the interface PCB.

The probe index and resolver pulses are digitized on the Interface PCB along with Wobble correction pot settings and processed in the System core using a digital PLL to generate the digital frame and vector pulses related to precise crystal position with wobble correction, and used for the scan converter timing within the core. The drum position is decoded to select between the two transducers currently being used for imaging, appropriate input source and transmitter being selected. U4 runs on a 1.2V supply (with separate filtered feeds to internal PLLs), a 2.1V supply is used for interface to A/D converter connected (all pins 56 to 104) and a 3.3V supply is used for all other input/output pins.

### ***CONTROL***

Within the core IC is a processor which is responsible for system configuration and user interface (information display and menu) with access to display memory, probe identifier digital value and keypad data fed from the interface PCB. The resolver period is also monitored by the processor



to adjust the probe rotation motor speed, controlled over IIC Control bus to the Interface board which generates the motor drive DC voltage. The transmitter supply voltage on the supply PCB can be varied and the incoming 12V supply voltage can be monitored over the supply IIC bus. Control can be switched over to an alternate pair of crystals by a latching relay, for example if a dual-frequency probe is used.

### ***MEMORY***

All non-volatile data is stored in U10 serial Flash device. The three main sections are Firmware configuration data, Software, and System stored values (Running tally, overall tally, preferred startup mode, duoscan modes) System storage area can be read and re-written by the processor within the core IC.

IC U8 is 2Mx8bit SRAM. It is used as display memory for the 640x480 display area which can be written to by firmware and read or written by core processor. The remaining area is used for software storage.

### ***FIRMWARE STARTUP***

These steps are followed during system initialization on power-up:

core CPLD senses power-up and loads configuration data from serial flash Boot ROM device U10 to configure the CPLD firmware including the processor.

Successfully configured processor within CPLD logic transfers software program from boot ROM to SRAM.

Processor resets and runs from SRAM program and initializes the system as follows;

### ***SOFTWARE STARTUP***

Short delay (prevents accidental switch on) followed by core driving power enable line.

Sets up SPI for comms with flash memory.

First beep.

Sends ASCII data at low baud rate to wake up console.

Sends ASCII 'H' character at 9600 baud to establish console comms.

Sets motor speed to the lowest value.

Reads 'Total Tally' configuration byte from Flash, if the value is incorrect, the flash is then initialised. If the value is correct, the system calculates the total tally.

Reads 'Running Tally' configuration byte from Flash, if the value is incorrect, the flash is then initialised. If the value is correct, the system calculates the running tally.

Switches front panel LED on.

Reads Duo\_Mode 1 and configures Range, Frequency etc.

Writes menu data to display.

Configures Index /Resolver A/D.

Sets output power.

Sets motor speed.

Enable Index/Resolver sampling.

Enable Ultrasound scan.

Second Beep.

Enters mains loop.

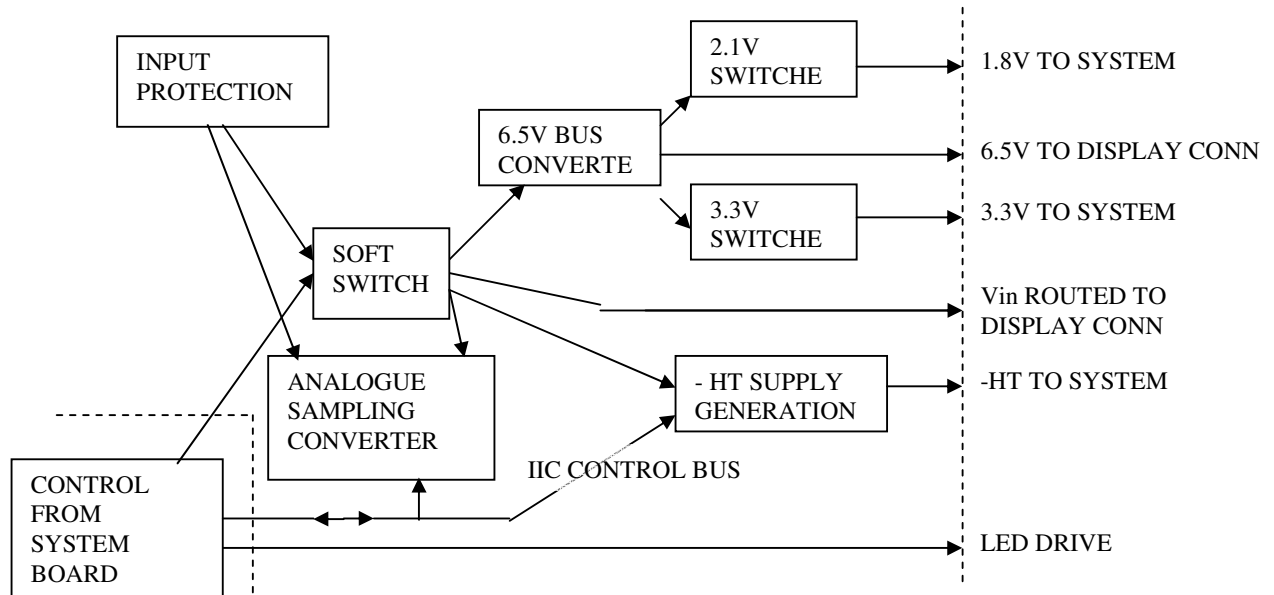
N.B. Once in the main loop, the Duo-Scan will poll the RS232, if it receives an 'H' character from the console, it undergoes the following process:

- Read Drafting Data from console.
- Read Brightness & Contrast values from Console.
- Read Ovi-Scan mode data from flash.
- Setup Range, Frequency etc.
- Write Ovi-Mode menu to display.

Once the system has initialized, the controller continually monitors the probe identifier for change, interrupted only by a keypress.

## CIRCUIT DESCRIPTION : Supply PCB

### SUPPLY BOARD



The Supply board accepts an input voltage range of 9 to 18 V and generates all system supplies required, passing them to the SYSTEM board through a 20 Way ribbon cable

#### ***Input protection***

The input supply is connected to the supply board through flying lead to CN1. Reverse polarity and overcurrent protection is provided by polyfuse F1 with trip current of approx. 2.5A. This device automatically resets following removal of fault condition, when it cools down. Diode D101 shorts a wrong polarity supply through F1, causing it to trip and limiting reversed circuit supply to less than 1V.

#### ***Soft Switch***

The incoming supply is switched by U101 which is a high-side FET with internal overcurrent and overvoltage protection. When power is first applied the 'POWER ON' control line is biased to 3.3V by pullup resistor R121, switching M100 on and pulling pin2 of U101 low (switch is OFF). The 'POWER ON' control line can be pulled low by the system board or by link J100. M100 is switched off and pin2 of U101 is pulled high by R127 (switch is ON). Switched, fused input voltage is routed to the rest of the supply board and to the front panel display connector

#### ***Supply Bus; 6.5V***

Switched, fused input supply feeds a high efficiency ISRs Integrated Switching Regulator SR1. Similar to a DC-DC converter, except the output supply is not isolated from the input. The converter has overload protection and can supply up to 2A.

The 6.5V bus feeds the two IC based converters which step down to 2.1V and 3.3V and is passed to the supply board for further distribution and regulation. It also supplies the front panel display connector via filter based around L103 and J101.

### ***Low Voltage switchers***

Based around switching regulator chips MAX887 (U3, U12) with integrated switching FET, the inductor and diode on the output are used to provide smoothed voltage across the output capacitor. A resistor network from the output feeds back to the chip to provide regulation. Output is short circuit protected. Further filtering is provided by inductors L104, L106 used to feed the System board.

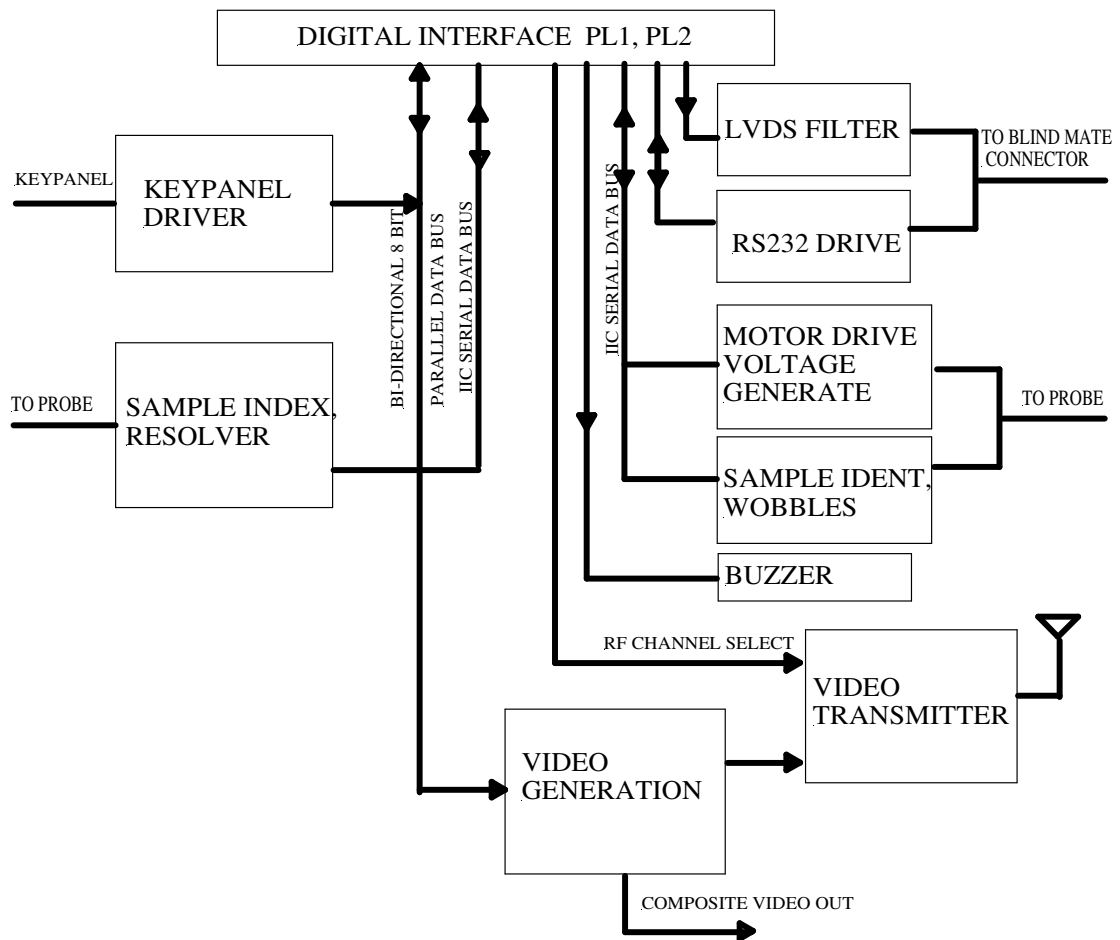
### ***- HT Generation***

A variable high voltage supply is generated by step-up switching regulator controller U102. Current in the primary of the planar transformer flows from the 12V supply through M101 until peak primary current is reached (U102 senses voltage rise across R118). M101 is switched off and the collapsing magnetic field generates a high (negative) voltage across the secondary (1:10 turns ratio). D102, D104 rectify the high voltage which is then stored on C5. R1, R2, C114 provide low pass filtering and limit the discharge current if the HT supply output pin is suddenly shorted. The HT voltage is regulated by U102 which alters the transformer pulse frequency to maintain a voltage of 1.2V at pin 3 (feedback) input. The negative high voltage output draws a small feedback current through R136+ R138 proportional to the output voltage. This small current is mirrored by transistor pair Q100, Q102, with R112 setting mirrored current 10x current in R111. The voltage at the controller feedback pin is a function of this mirrored current (proportional to output voltage) and the resistance from this pin to ground. The digitally controlled resistor U101 has a range from 0-10Kohm, giving an output voltage range from -25V to -200V. Q101 is wired as a diode to limit possible high negative voltage across the current mirror. The switching controller limits current in the transformer primary every cycle to prevent transformer saturation. The limited switching frequency ensures output supply is current limited at about 7mA at -200V with short circuit protection. Oscillations in the Switching circuit which could potentially interfere at ultrasound frequencies are minimized by snubber components L101, C108. Variable resistor U101 is controlled over the IIC bus from the system board.

### ***DC input voltage sensing***

The incoming DC supply voltage can be measured, and any step rise in the supply voltage due to the input switch being briefly switched off can be measured. These voltage readings taken over the IIC bus are used to calculate as accurately as possible the battery voltage while eliminating the effect of voltage drop over the varying resistance of the battery connection latches. U103 is a 4-channel 10bit A-to-D converter with an internal 2V reference. Ch1 reads any positive step increase in the DC input voltage up to 2V (readings taken after the power switch IC is briefly switched off), Channel 2 senses the switched input voltage scaled to read 0V to 22V, Channel 3 is used to read a scaled version of the unswitched DC input voltage (0-22V), Channel 4 input is not used.

## CIRCUIT DESCRIPTION : Interface PCB



The interface Board sits between the purely digital System board connections and the scanner input and output signals and probe. Functions include Keypanel decoding, output analogue video signal generation, Video Transmission and buzzer drive. There are two analogue-to-digital converters to sample the probe signals and a variable voltage supply for motor speed control.

### ***KEYPANEL***

The keypanel consists of 5 momentary switches all with a common connection implemented within the membrane panel. The resulting 6 connections are made through the keypanel tail to J103. The common connection is connected to ground and each switch contact is pulled to logic high level by a 10K pull-up resistor to the 3.3V supply. The resultant high or low logic levels on each of the switch circuits is monitored by U1. Configured as a Tri-state buffer, U1 drives the common 8-bit bi-directional bus between interface and system boards 'Interface Bus' under control of dedicated enable line to U1 pin 19.

During normal scanner operation this control line is pulsed low very briefly (two system-clock cycles = 40nS) six times per second, allowing the CPLD to monitor keypanel status while eliminating contact bounce etc.

One of the keys can also pull the 'power-on' line low through a 'wired OR' configuration using D4 to allow the key to double as a power switch. The 'power-on' line need only be pulled low by

holding the key until the core IC on the System PCB takes over and holds the line low.

### ***BUZZER***

The system board generates a logic level square wave to beep. The interface board buffers the logic signal to drive the sounder BZ100 through FET M1 from the 3.3V supply.

### ***VIDEO GENERATION***

The 8-bit 'interface bus' and dedicated clock line from the Beamformer Board feed Current output Digital to Analogue converter U5. The digital values sent to the DAC are the summation of video and composite syncs. The current output from the DAC generates a voltage across R19, R24. The Video voltage produced is buffered by video driver U2 with x2 gain 75ohm source resistors and protection diodes D1, D2 to give standard 1V p-p Composite video level into a 75 ohm terminated load. Video is distributed to front panel Video out and to Video transmitter module.

### ***SERIAL DIGITAL VIDEO***

Differential serial digital video is fed from the system board through the interface board where it is filtered before connection to blind mate connector on base of Duoscan case.

### ***SERIAL DATA***

Logic level RS232 system board data is fed to and from Driver U3 which translates the signals to RS232 standard voltage levels. Signals are further protected from ESD and filtered by capacitors C1,C2 before connection to the blind mate connector on base of Duoscan case.

### ***VIDEO TRANSMITTER MODULE***

Video transmitter module TX100 uses frequency modulation to transmit a low power RF signal in the 2.4GHz ISM band. A regulated clean supply is provided for the video transmitter module by voltage regulator U9. Three active low channel selection lines from the System board select the module tx channel, defaulting to channel 4 if none of the three lines are pulled low. A specially prepared short coax soldered directly to the PCB acts as an antenna for the module.

### ***INDEX, RESOLVER SAMPLING***

The index signal comes from a magnetic pick-up in the probe sensing a slot cut into a steel gear. A pulse is generated once per revolution of the transducer drum and is used to zero the drum position counter. Loss of this signal will result in a screen image which is not correctly oriented and sometimes described as "the image pointing in the wrong direction" or "the image coming from the wrong part of the window". If the loss is intermittent, the image will suddenly jump to the correct position. Excessive noise on this signal may cause the image to jump to the wrong orientation.

The resolver signal comes from a pick-up head in the probe sensing the passage of teeth on a gear wheel.

A 4-channel A-to-D converter U10 is configured to sample channels 1 & 2, and make its internal 2V reference available on channel 4. This reference is buffered by U11 with a current limited output. This 2V reference is divided by a resistor chain to give a DC bias to the index and resolver signals at the A-to-D channel 1 and 2 inputs. Capacitors DC26, DC29 in conjunction with R39, R33 provide ESD protection and high frequency filtering above a few kHz. The DC bias seen at the A-to-D input is approx 180mV with a probe connected, or switching between 340mV and 180mV on the index input with probe fitted with remote switch. The ADC must be initialized

over the IIC bus by the system core IC (on system initialization and on every range change) before Data is continuously sampled to 10 bit accuracy at a 10kHz rate on each channel, with the data from alternate channels sent over IIC serial bus to system board. Index and resolver data is processed within the system core IC to provide filtering and extract timing and level information. DC level sensing is used on the index input to detect reed switch closure in a suitably modified probe, enabling scanner mode selection by applying an external magnet to the probe.

***PROBE VALUES SAMPLING***

A 4-channel A-to-D converter U4 in turn samples the identifier resistor and each of the wobble pot wiper connections on connector J102. The buffered reference generated for Index and resolver sampling is used as a reference voltage connected directly to the common connection to the wobble pot dividers, and connected through R21(10K) to the probe ID resistor to create a potential divider.

The identifier value and corresponding system setup are determined by the software according to the following table.

<u>I.D. Resistor</u>	<u>Identity</u>	<u>Display</u>	<u>Resistance range</u>	<u>Hex Reading</u>
Short circuit	No Probe	ERROR	< 990 Ohms	< 16
2K2	5.0MHz, Xtals 2&4	5↑0	990-2670	17-36
3K9	3.5MHz, Xtals 2&4	3↑5	2670-4140	37-4B
5K1	Split 3.5MHz/5MHz	3+5	4140-6100	4C-61
7K5	5.0MHz	5 . 0	6100-8550	62-76
10K0	3.5Mhz	3 . 5	8550-22K	77-B0
Open circuit	No Probe	No Probe	> 22k	> B1

***MOTOR DRIVE***

An efficient variable 7V to 12V 75mA supply is generated from the 6.5V bus, with a 300mA current limit and shutdown control. U6, L100, D3 form a step-up switching regulator. Digital resistor U1 in the feedback path enables variable control of the output voltage under IIC serial control from the system board. At motor drive voltages above 6V the current output is limited by switching regulator internal switch at 150mA max, 75mA typ. If the output is pulled below 6V the output current is limited by the overcurrent limit of linear regulator U8 at 300mA max. U8 also acts as a switch to stop the motor drive, activated by shutdown driver Q1 which is biased on when the digital resistor normally used to control the output voltage is set to maximum value.

Range (cm)	Frame rate (Hz)	Lines per sector	Vector period (uS)	resolver freq. (Hz)	Drum speed(Hz)
3	17.4	200	220	930.1	8.7
6	17.4	200	220	930.1	8.7
9	17.4	200	220	930.1	8.7
12	17.4	200	220	930.1	8.7
15	17.4	200	220	930.1	8.7
19	16.9	200	264	902.8	8.4
22	14.3	200	308	766.7	7.2
25	12.6	200	352	672.1	6.3
28	11.2	200	396	598.3	5.6
32	10.6	200	440	566.1	5.3

# **MECHANICAL DISASSEMBLY**

## ***CONSOLE***

To perform any electrical tests or service procedures the outer case must be removed.

Remove any connected leads, and remove the Duoscan Module. Turn the system on its side and remove the three M3x8 stainless steel button head screws on the underside at the rear using a 2.0mm Allen key. On the upper part of the rear panel there are seven M3x8 stainless steel button head screws with serrated washers; remove these using a 2.0mm Allen key.

The outer casing can then be slide off the chassis to the front. With the chassis half-way off, the Tally cable to the outer case front panel connector must be unplugged from the console PCB before removing the outer case completely.

Care should be taken to protect the LCD screen which becomes vulnerable when the chassis is removed from the outer case.

The Duoscan module can be reconnected to the chassis once the outer case has been removed, taking care to ensure that the module is positioned centrally for blind mate connectors to make good connection (the module is normally held central by a guide on the bottom of the outer case).

Access to the rear panel connectors, the blind mate connectors and the latch connections can be made by removing the 6 M3x8 stainless steel button head screws on the lower half of the rear panel, allowing the connector cover to be removed.

On re-assembly check that all connectors are secure and the system is fully functional by testing with a module connected. Insert the internal chassis into the outer case from the rear. Connect the tally cable and ensure that cables are tucked in to avoid them becoming trapped between the rear panel and the outer case flange. Feed the antenna wire into the hole behind the front fascia as the chassis is nearly fully engaged in the outer case.

On reassembly ensure any crinkle or serrated washers are used in the correct place for continued electrical continuity. Where there is no spring washer used, screw lock must be used.

## ***MODULE***

The duoscan module can be slid out of the outer plastic case after releasing the two bolts on the rear of the case. Power and blind mate connector leads must be disconnected from the module for complete removal.



## ANNUAL MAINTENANCE

Once a year the instrument should be returned for a service to the BCF approved service agent who will use special test equipment to thoroughly check out the instrument and advise of any work which appears necessary.

The following list indicates the procedures which will be followed.

### Scanner functional test

All control and tally buttons function correctly  
Correct probe operation at all ranges

### Performance test - Ultrasound

- On a static target
  - probe wobble correction.
- On a tissue target
  - penetration.
  - resolution.
  - gain operation.
  - Transmit power variation

### Console Service

Strip and clean, check all PCBs, internal cables and Connectors and LCD condition. LCD Backlight brightness Check.

### Duoscan Service

Strip and clean, check all PCBs, internal cables and Connectors and clean and check front panel connectors, blind mate connectors.

Switch on and note any irregularities for rectification.

## MODULE

Remove the plastic outer case and PCB covers.

Re-connect the module case to a console and connect the module outside its case. Switch on and check all supplies on the system board as detailed in initial PCB test procedure. Check transmitter voltage varies from 30V to 200V under panel control.

Check the Transmitter pulse output on the System board (both channels).

Run the system and check the following:-

Remove each PCB in turn and examine each PCB for signs of dampness or corrosion. Take corrective action if any is found.

### System Board

- consider software update.
- check ribbon cables and connector contacts for deterioration.

### Supply Board

- remove the PCB, check all connectors – remove and refit the connectors to exercise.

### Interface Board

- remove the PCB, check all connectors, – remove and refit all connectors including the keypanel tail to exercise.

Clean the probe connector crimps by squirting in switch cleaner fluid or Methylated spirits and use a tooth brush to clean excess dirt, use a compressor to blow out any debris. Inspect the probe connector housing and crimps, replacing as necessary.

Reassemble the module, fitting a new front panel seal if damaged.

### **MODULE CASE**

Ensure the external blind mate connector faces are clean. Inspect the internal connector PCB and wiring. Check the external Latch condition and check internal brass tags for corrosion.

### **CONSOLE**

Remove the console from the outer case. Check case for signs of damage. Clean any dust inside of case to prevent collection of moisture and wipe clean exterior. Check tally connector condition and replace as necessary.

Inspect inside the connector cover for any corrosion or dirt on any of the rear panel connectors, brass power tags, or blind mate PCB. Remove cover and clean/repair as necessary.

Remove all connectors to Console PCB, inspect PCB for signs of dampness or corrosion. Refit the PCB and reconnect all leads.

Remove the Backlight inverter PCB and clean any deposits attracted to the high voltage area.

Remove ribbon cable from LCD.

Power the Console taking care around the backlight inverter high voltages. LCD screen should be brightly lit. Compare to brightness of a new LCD. LCD or Backlight CCFL tubes should be replaced if there is any appreciable deterioration of backlight intensity. Check screen for unacceptable scratching or corrosion around perimeter. Clean or replace as necessary. Use only LCD wet screen wipes, as the screen is easily scratched. Refit Ribbon connector.

Refit Console into its case – see notes in ‘Mechanical disassembly’ section.

Check protective screen condition and clean or replace if badly marked.

### **PROBE**

Visual check.

Audible check .

Clean coaxial inserts by squirting in switch cleaner fluid or Methylated spirits and use a tooth brush to clean excess dirt, use a compressor to blow out any debris.

Check transducers for on screen matching and output.

From time to time small improvements may be made to the design of the OVISCAN 6 and DUOSCAN 3 which might advantageously be carried out on existing customers equipment. The service agent will take the opportunity of the annual service to see if this is possible and will advise if so.

# CIRCUIT DIAGRAMS, PCB Test and Layout

## ***Console***

### **Console PCB**

[Circuit Diagram](#)

[PCB Test](#)

[PCB layout – topside](#)

[PCB Layout - bottomside](#)

## ***Module***

### **System PCB**

[Circuit Diagram](#)

[PCB Test](#)

[PCB layout – topside](#)

[PCB Layout - bottomside](#)

### **Interface PCB**

[Circuit Diagram](#)

[PCB Test](#)

[Test Matrix](#)

[PCB layout – topside](#)

[PCB Layout - bottomside](#)

### **Supply PCB**

[Circuit Diagram](#)

[PCB Test](#)

[Test Matrix](#)

[PCB layout – topside](#)

[PCB Layout - bottomside](#)

## **WIRING SCHEDULES**

### **[Console](#)**

### **[Module](#)**

### **[Keypanel](#)**

## **APPENDIX : Console PCB Diagnostic Information**

### LEDs

#### LED 1

Connected to the FPGA, this LED illuminates when the FPGA is displaying internal text messages on the LCD display. This LED will illuminate during power up and extinguish when a video source is being displayed, or when the system is in standby mode.

#### LED2

Connected to the analogue video decoder, this LED illuminates when the decoder is active, this occurs when one of the external video sources is being viewed (Ext Video or RF Video in Video Monitor Mode). The LED is also briefly illuminated during power on to indicated that the processor has established communications with the decoder. This LED is extinguished in standby mode.

#### LED3

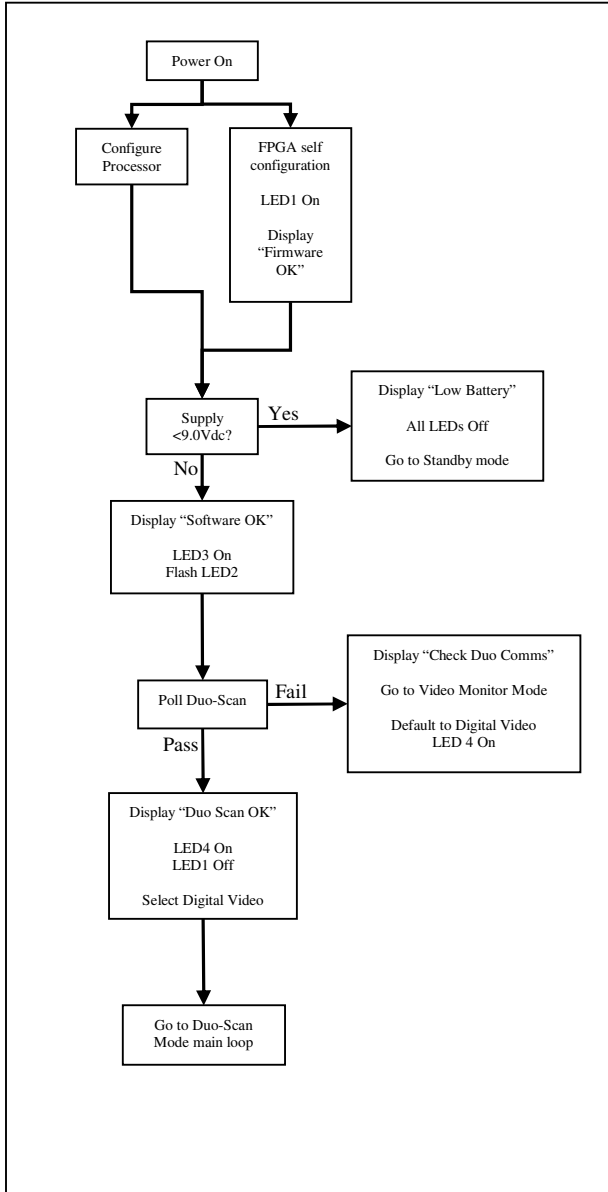
Connected to the processor, this LED illuminates once the processor has completed its configuration and remains illuminated during operation. The LED will extinguish when the processor is in standby mode.

#### LED4

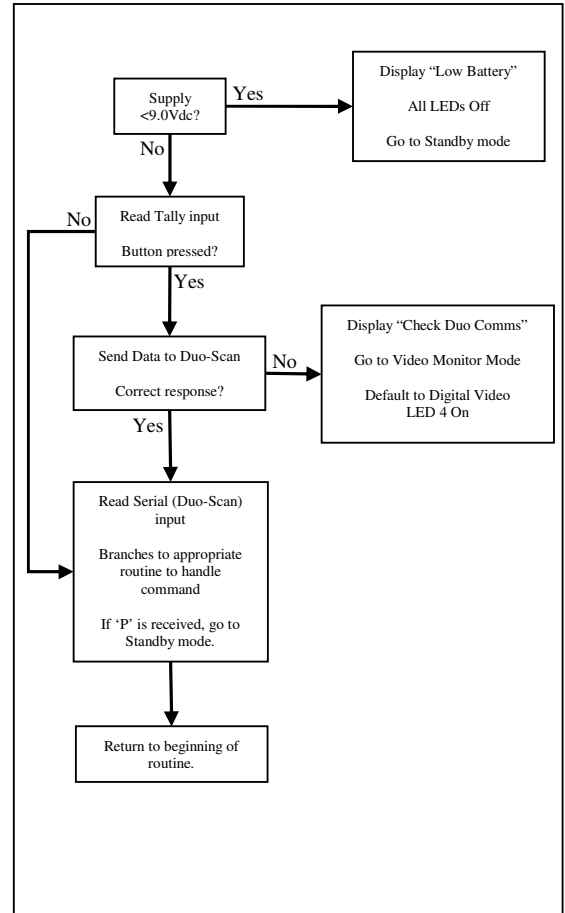
Connected to the digital video decoder, this LED illuminates when the decoder is enabled and receiving a valid signal, this occurs when the Duo-Scan video input is selected. During normal operation, this LED will illuminated once the Duo-Scan starts transmitting, in Video Monitor Mode, the LED will illuminate when Duo-Scan video is selected. This LED is extinguished in standby mode.

## Sequence of operation

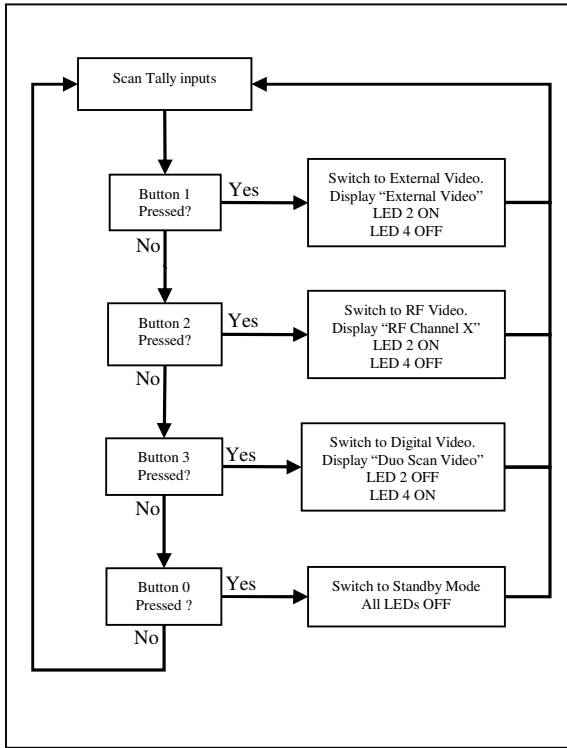
### Power Up.



### Normal Operation (Duo-Scan Mode)



### Operation (Video Monitor Mode)



### Standby Mode

