CWH013

Document: MN-CWH013-C

Capacitance Water Holdup Tool

CAPACITANCE WATER HOLDUP TOOL

$1^{11}/_{16}$", ULTRAWIRE™, SONDEX ENDS

Operational & Maintenance Manual

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0 ABOUT THIS MANUAL

0.1 MANUAL HISTORY

Date	Issue	Description	Auth	Chk	App
20/02/03	A	Initial release.	SA	DMO	RLH
25/08/04	B	Drawings updated as per ECR1466 & ECR1531.	SA	DMO	RLH
04/10/06	C	Manual Update. ECR: 3080, 3737, 3767, 2769, 2904, 3141, 3743, 3962.	FV	FV	RLH

0.2 UPDATES TO BE USED WITH THIS MANUAL

Consult the CD Directory for the appropriate Manual Updates to be used with this Manual.

0.3 TECHNICAL HELP

For further technical help, contact Sondex as follows:

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0.4 FEEDBACK

Please help us improve future issues of this manual by sending your comments or corrections to Documentation-UK@sondex.com, referencing the document number.

Thank You.

Photographs and sketches are for illustration purposes only. Depending on the tool model that you have, certain features or dimensions may differ from those shown.

Documents from external sources (i.e. MSDS), supplied with/referenced in this manual, are considered the latest version at time of manual issue. However, the document can be altered by the external source without prior notice to Sondex.

1 DESCRIPTION

The Sondex CWH013 (Capacitance Water Holdup Tool) measures the water volume fraction in fluid mixtures flowing in the borehole. It operates as part of a Ultrawire™ toolstring and derives power and control from a suitable system controller, e.g. MPL.

The tool is essentially an annular capacitor with the central probe and external cage acting as the capacitor plates. The well fluid, flowing between the plates, acts as the dielectric.

The capacitance measured depends on the dielectric constant and the distribution of the fluids between the electrodes. In well mixed fluids, the tool has a linear response from 0% to about 40% water volume fraction.

The difference in the dielectrics of water & oil are detected by the tool and output as a frequency change.

Figure 1.1 CWH

1.1 OPERATING PRINCIPLE

Hydrocarbons and water have different dielectric constants. The output frequency of the probe is in response to the average dielectric constant of the fluids between the cage of the tool and the inner probe. From this the downhole water - hydrocarbon ratio can be derived.

1.2 APPLICATIONS

- Multi-phase Production Profiling.
- Oil/Gas/Water Holdup Calculations.
- Qualitative Analysis of Water Loaded Up Wells.
- Qualitative Analysis of high Gas-Oil Ratio (GOR), Water Free Wells.

1.3 INTERFACING & TOOL COMBINATIONS

- Simultaneous operation with other Sondex PL Tools.
- $1^{3}/_{16}$″ UN 12 tpi Sondex, GO or other Heads.

1.4 SPECIFICATION

Parameters	CWH013	Remarks
Temperature (max):	177ºC (350°F)	
Pressure (max):	15,000psi (103.4MPa)	
Diameter:	$1^{11}/_{16}$″ (43mm)	
Make-up Length:	26.2″ (666mm)	
Shipping Length:	30″ (763mm)	
Depth offset:	8.6″ (218.5mm)	Measure point above lower tool joint.
Weight in air:	4.3kg (9.5lbs)	
Operating voltage:		
- Nominal:	+18V DC	
- Specified:	+13 to +23V DC	
- Absolute max.:	+24V DC	
Current consumption at +18V:	16-17mA	
Resolution:	0.1% External limitation	(MPL, 1 sec acquisition).
Accuracy:	±1.0%	(Yw < 40%).
Range (Yw - Water fraction):	0-100%	0-40% best operating range.
Acquisition time:	1 sec typical	External limitation.
End threads top/bottom:	$1^{3}/_{16}$″ UNF Sondex female/male.	
End connectors top/bottom:	4mm single conductor male pin/female socket.	

2 SAFETY

2.1 GENERAL

Warning!

HOT WORK! Sondex equipment may, under certain circumstances or failure modes, become a potential source of ignition. Using it must therefore be considered "HOT WORK" and appropriate precautionary procedures should be followed when testing at surface in areas where there is a risk of gas leaks or other potentially explosive atmospheres.

2.2 LUBRICANTS

Liquid O-ring

LOR101 is used for lubricating the tool during maintenance. Contact with skin or eyes can be harmful. For more details, refer to the Material Safety Data Sheet for Liquid O-ring.

Dow Corning Silicone Grease

Dow Corning Silicone Grease is used for lubricating the insulator. Contact with skin or eyes can be harmful. For more details see the Material Safety Data Sheet for Dow Corning.

2.3 ELECTRO STATIC DISCHARGE

Caution!

Electro Static Discharge (ESD)

All tools with electronic boards that contain solid state circuits (transistors, diodes, semiconductors) may become damaged when contacted with an electrostatic charge.

When handling tools, which contain electronic parts that are ESD sensitive, the following guidelines should be followed to reduce any possible electrostatic charge build-up on the user's body and the electronic parts:

- Always ensure proper ESD precautions are taken when handling electronic parts that are ESD sensitive during maintenance.
- Avoid touching the tool electronics, unless stated otherwise in this manual.

Note that ESD is less likely to affect tools when the housing is fitted.

3 THEORY OF OPERATION

3.1 BLOCK DIAGRAM

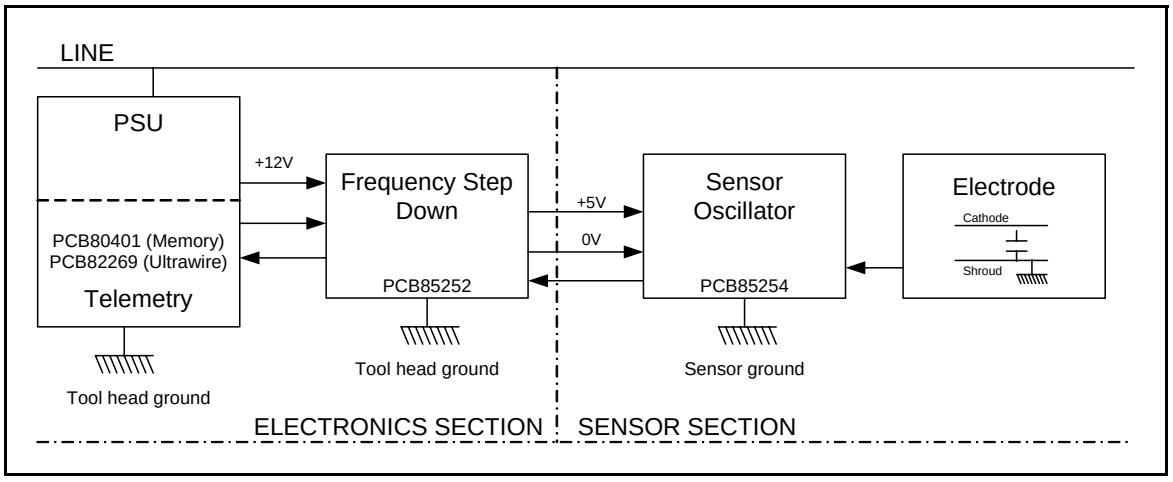


Figure 3.1 CWH Block Diagram

3.2 DESCRIPTION

3.2.1 DIELECTRIC MEASUREMENT

The dielectric constant of water is about 80 and those of air and oil are much lower at around 1 and 10 respectively. A measure of the dielectric constants can be made by introducing the well fluids between the plates of an electrical capacitor, whose value is then measured. The Capacitance Water Holdup tool is designed as an annular capacitor, with an insulated rod as the centre electrode and a cylindrical tube around it as the outer electrode. The frequency of a free running oscillator, which incorporates this capacitance, is measured. The frequency of the oscillator varies inversely with the effective capacitance of the fluid between the plates.

Changes in water salinity have a negligible effect on this measurement.

The frequency of the oscillator, with the tool immersed in water, is generally about 50-54.7kHz and in air about 62-64kHz. Varying the length of the tool electrode immersed in water varies the frequency inversely with the amount immersed. However, this condition is not usually of interest while logging. As long as water is evenly distributed throughout the volume of the measured fluid and the hydrocarbon phase is continuous, then the frequency of the tool varies almost linearly with the change in water fraction. This is usually true up to about 35-40% water, but depends slightly on the type of oil and other flow conditions met downhole. As soon as water becomes the continuous phase, the capacitor becomes progressively ‘short-circuited’ by the water and the tool response is no longer linear.

A typical tool response chart is given in *Section 3.3 Water Holdup Determination: Typical Response*.

3.2.2 ELECTRONICS

A regulator supplies +5V power to the Sensor Oscillator circuit, housed in the Sensor Section.

The sensor frequency is counted in the FPGA logic and is read out over the Ultrawire™ toolbus in response to requests from the Telemetry Controller, e.g. MPL or other crossover. Various commands are supplied in the protocol.

3.3 WATER HOLDUP DETERMINATION: TYPICAL RESPONSE

The following data is the response of a typical tool Oscillator Board. Similar tools will show the same characteristic although a scale factor and offset may be observed.

Actual Water Holdup (Fraction) [%]	Apparent Water Holdup YWA - (tending to) [%]
100	100
90	94.6
80	91.8
70	89.1
60	86.5
50	84.0
40	53.3
30	39.5
20	26.1
10	14.1
0	0

Note: The frequency in air is typically 62-64kHz and in water is 50-54.7kHz. Tool set up may vary.

Apparent Water Holdup is defined here as:

$$Ywa = \frac{(100\%\ \text{Oil Reading} - \text{Mixture Reading})}{(100\%\ \text{Oil Reading} - 100\%\ \text{Water Reading})}$$ **Equation 3.1**

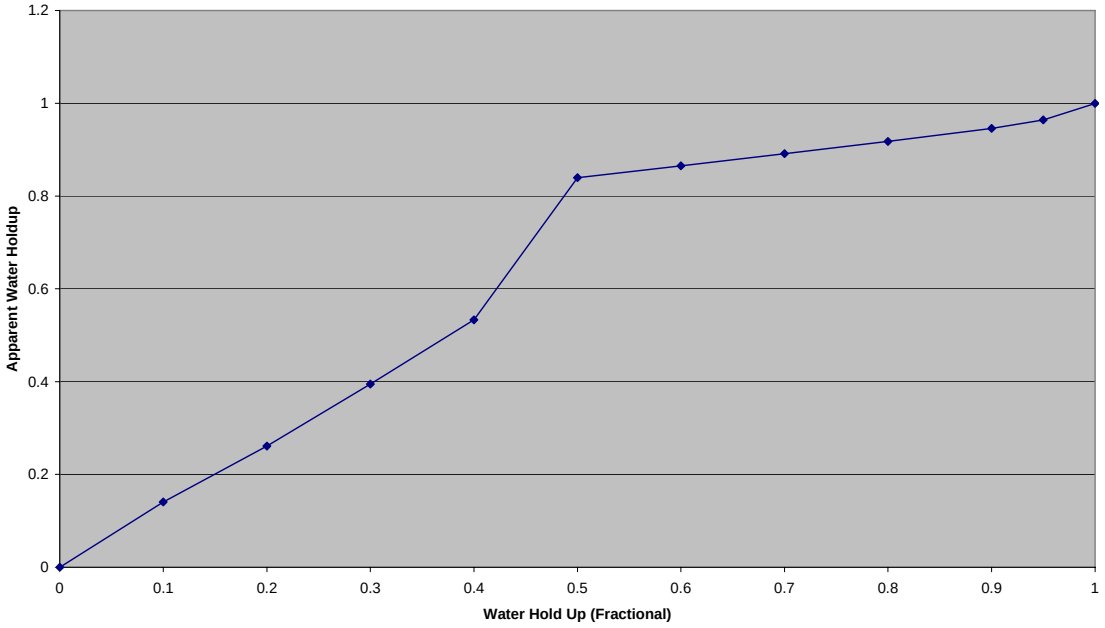


Figure 3.2 Typical Tool Response

4 OPERATING PROCEDURE

4.1 PRE-LOGGING CHECKS

4.1.1 MECHANICAL

Ref.: General Assembly 09513
Sensing Section 11540

1 Clean and grease upper and lower O-ring seals.

Note: It is recommended to replace all O-rings (items 7, 8 & 9, 09513) are replaced before every run.

2 Replace O-rings (item 3, 11540) if damaged.

3 Ensure that upper and lower electrical connectors are clean, dry and undamaged.

4.1.2 ELECTRICAL

1 Using a Multimeter, measure the upper to lower pin resistance. The reading should be less than 0.5Ω.

2 Using a Multimeter, measure the pin to housing resistance. Depending on the meter used, the reading should be:

- Pin +ve: 3-4MΩ approx.

4.1.3 OPERATING

The CHW013 must be electrically connected to a toolstring controller, e.g. MPL, from which power and control can be derived.

Readings in air and water should be:

- Air 62-64kHz
- Water 50-54.7kHz

Check with the latest Calibration Data or that supplied with the tool that these values are correct. Tool set up may vary.

4.2 CALIBRATION

Capacitance/Water-Holdup calibration data is supplied with the tool. However, for accuracy the tool needs to be calibrated in the pure fluids of the mixture to be logged. This is because the reading of gas or oil depends significantly on its density. This usually means that, at some stage during the survey, a downhole measurement of 100% water, and 100% oil (and/or gas) is required.

At surface, a full calibration at wellsite, using 2-phase mixtures, is not always practicable nor is it usually necessary. It should be noted that the extrapolation of the straight line section of the tool response (from 0 through 35% water holdup) ends at a nominal Yw value of about 56.5% at Ywa=100%. This is a characteristic of the tool design. Each tool would be expected to have its own calibration constant. As a consequence of this, it is only necessary to determine the tool constant for the tool.

Calibration constants, used to calibrate the tool, may depend on the fluids to be logged. Although it may be possible to calibrate the data for oil-water, it is probably wiser to always calibrate the tool between the air and water points to ensure that all data will be plotted. Knowing the tool constant, water holdup (Yw) can be determined.

Sondex software also supports a multipoint linear calibration calculation routine which may give a better value for water holdup across all of the operating range.

4.3 CONNECTING TO TOOLSTRING

Upper and lower tool joint O-rings and seal surfaces should be clean, undamaged and lightly greased.

The tool should be inserted into a suitable Ultrawire™ toolstring in any location below the system controller.

The tool may require centralising. Fluid away from the centre may be less representative of the flow especially in a multiphase environment.

The tool should not run in contact with casing, which will reduce the fluid flow through the sample volume, unless you specifically want to be sure of reading the heavy phase only.

In vertical wells the centre of the pipe or casing tends to contain a higher proportion of light phase than the average of the cross-section. In deviated wells, the light phase tends to rise along the high side of the pipe. If the fluid mixture velocity is low (as in some instances), there is insufficient mixing of the phases and the CWH may not read a representative sample of the mixture that is flowing. The tool may then indicate too high a water holdup.

4.4 LOGGING

The following are guidelines only and must be used in conjunction with local policy and specific well site conditions both downhole and at surface. The table below is appropriate for near vertical wells and must be adjusted accordingly when in deviated wells. Use of a Head Tension Unit is highly recommended.

Note: Do not exceed the calculated safe working load of your selected weakpoint. If in doubt, use a head tension unit, especially in deviated wells where calculation from surface tension is less accurate.

Depth (ft)	Speed Pulling Out of Hole	Speed Running in Hole
In/out of catcher (pressure rig up only)	Dead slow or manual.	
30 to 150	30ft/min	
150 to 400	60ft/min	
>400 clear cased hole	Surface tension not to exceed 120% of tension when tool stationary. Speed not to exceed 150ft/min.	Surface tension should not be less than 80% of tension when tool stationary. Speed not to exceed 150ft/min.
>400 clear open hole	Surface tension not to exceed 130% of tension when tool stationary. Speed not to exceed 150ft/min.	Surface tension should not be less than 70% of tension when tool stationary. Speed not to exceed 150ft/min.
Approaching potential obstacles[a]	30ft/min	
Logging Data	**Do not exceed the above speeds.** Recommended speed is <30ft/min.	

a. For example: Reduced diameters, gas lift mandrels, fluid levels, valves, tubing shoes, packers, cross overs and other downhole equipment.

Refer to <link>Section 3.3 Water Holdup Determination: Typical Response for conversion of raw counts into holdup.

In practice it is better to log the capacitance tool as raw counts and post process later to water holdup. Some logging companies plot the raw data with reversed scales so as to emulate density.

4.5 POST LOGGING DISASSEMBLY

The tool should be cleaned before the toolstring is disassembled. Ensure that well fluid does not reach the electrical connectors.

Disassemble in a horizontal position wherever possible.

Refit thread protectors.

4.6 TRANSPORT, HANDLING & STORAGE

Store with end threads lightly greased and with water tight thread protectors fitted.

Do not subject tool to extreme shock, such as dropping or hitting with a hard object.

5 MECHANICAL DESCRIPTION

5.1 DESCRIPTION

The tool comprises of two main units, which normally remain screwed together unless access to the interior is required.

The sensor is housed inside a metal tube through which borehole fluid is allowed to flow. This tube is the outer electrode of a capacitance cell. An inner insulated tube comprises the other electrode and houses the sensor electronics.

The principal elements of the two sections are as follows:

Electronics Section:

- Pressure housing.
- PSU/driver and telemetry circuit board.
- Frequency step down circuit board.
- Upper end fitted with monoconductor pin.
- Lower end with hole for through wiring to sensor section.

Sensor Section:

- Upper body, lower body & shroud tube.
- Insulated centre electrode, containing sensor oscillator circuit board.
- Lower head connector assembly.

5.2 DISASSEMBLY

5.2.1 ELECTRONICS SECTION

Ref.: General Assembly *09513*
Electronics Section *10505*

1 Unscrew housing (item 1, 09513) from sensor section (item 3, 09513).

Note: The electronics section internal chassis remains fixed to the sensor section with grub screws (3x item 4, 10505).

Caution! DO NOT remove these screws yet as wires are connecting the 2 sections.

2 Remove screws (4x item 5, 10505) and remove the larger/upper half shell (item 3, 10505).

Note: The smaller/lower half shell (item 3, 10505) is an integral part of the chassis and should not be removed, especially if the upper half shell is already removed.

3 For servicing the Pressure Isolation Head, refer to the manual *MN-PIH*.

5.2.2 SENSOR SECTION

Ref.:

General Assembly	*09513*
Sensor Section	*11540*
Electronics Section	*10505*
CWH Mechanical Assembly	*02434*

1 Gain access to the electronics section as described in *Section 5.2.1*.

2 Unsolder the following 4 wires connecting the electronics and sensor sections.

- The line wire, bronze coloured kapton-covered multistrand, shielded by white insulated coax.
- Black screen wire.
- The sensor power +5V, kapton wire idented red.
- The sensor frequency, kapton wire idented white.

3 Screw grub screws (3x item 4, 10505) **inwards** to release the electronics chassis lower end (item 2, 10505) from the sensor section (item 3, 09513). Remove wavy washer (item 14, 09513).

4 Remove circlip (item 11, 09513) and extract the lower head connector assembly (item 4, 09513). It is not necessary to remove the anti-rotation pin (item 10, 09513).

5 Screw the 3 grub screws (item 4, 02434), locking the lower body (item 3, 02434) to the shroud (item 2, 02434), 4 turns **inwards** and unscrew the lower body.

Caution! Do not attempt to screw the 3 grub screws into the central cavity of the shroud (item 2, 02434) until the body has been removed as they will hit the electrode insulator (item 1, 11540) and damage it.

6 Remove and discard the O-rings (2x item 3, 11540).

7 Screw the 3 grub screws (item 4, 02434), locking the upper body (item 1, 02434) to the shroud (item 2, 02434), 4 turns **inwards** and unscrew the shroud (item 2, 02434).

Caution! Do not attempt to screw the 3 grub screws into the central cavity of the shroud (item 2, 02434) until the body has been removed as they will hit the electrode insulator (item 1, 11540) and damage it.

8 Slide off insulator (item 1, 11540) and replace upper O-rings (2x item 3, 11540). If the insulator is tight, ensure a spare is available before proceeding.

Note: It is not necessary to remove the inner electrode assembly (item 2, 09513) in order to change O-rings.

9 Remove nut and washer (items 12 & 13, 09513) and slide the electrode assembly (item 2, 11540) down and out of the upper body (item 1, 02434).

Note: Should the electrode assembly (item 2, 11540) fail, it should be replaced by another unit. Return tool to Sondex for repair.

5.3 REASSEMBLY

5.3.1 SENSOR SECTION

Ref.:

General Assembly	*09513*
Sensor Section	*11540*
Electronics Section	*10505*
CWH Mechanical Assembly	*02434*

1 Inspect the following components for damage and replace if necessary:

- Circlip (item 10, 09513).
- Lower Head Connector Assembly (item 4, 09513).

2 Inspect all wires for damage and replace if necessary.

3 Ensure all inner spaces are free from debris.

4 Slide the electrode assembly (item 2, 11540) upwards into the upper body (item 1, 02434).

Note: Make sure that the anti-rotation pins on the upper rod of the electrode assembly (item 2, 11540) are correctly located in their slots on the upper body.

Note: The electrode assembly upper insulator has an indent at its upper edge which mates with an anti-rotation tongue on the upper body.

5 Refit nut and washer (items 12 & 13, 09513).

6 Slide insulator (item 1, 11540) over the electrode assembly (item 2, 11540).

7 Refit new upper O-rings (2x item 3, 11540). Clean and grease O-ring seals with Liquid O-ring.

8 Refit the shroud (item 2, 02434) onto the upper body (item 1, 02434) and lock in place by screwing the 3 grub screws (item 4, 02434) 4 turns **outwards**.

Note: If both upper and lower bodies are removed from the shroud tube, ensure that they are refitted in their original positions (A to A and B to B), otherwise the grub screw holes will not line up.

9 Refit new lower O-rings (2x item 3, 11540). Clean and grease O-ring seals with Liquid O-ring.

10 Refit the shroud (item 2, 02434) onto the lower body (item 3, 02434) and lock in place by screwing the 3 grub screws (item 4, 02434) 4 turns **outwards**.

11 Refit the lower head connector assembly (item 4, 09513) and secure with circlip (item 11, 09513).

Note: Ensure that lower head connector assembly (item 4, 09513) seats correctly against anti-rotation pin (item 11, 09513).

12 Refit new O-rings (2x item 8 & 2x item 9, 09513). Clean and grease O-ring seals with Liquid O-ring.

13 Refit wavy washer (item 14, 09513) and refit the electronics chassis lower end (item 2, 10505) to the sensor section (item 3, 09513). Secure by screwing grub screws (3x item 4, 10505) **outwards**.

Note: Loctite®242 (or other semi-permanent locking compound) may be used to secure the grub screws if vibration causes them to become loose.

14 Resolder the following 4 wires to connect the electronics and sensor sections.

- The line wire, bronze coloured kapton-covered multistrand, shielded by white insulated coax.
- Black screen wire.
- The sensor power +5V, kapton wire idented red.
- The sensor frequency, kapton wire idented white.

5.3.2 ELECTRONICS SECTION

Ref.: General Assembly *09513*
Electronics Section *10505*

1 Inspect the upper pressure isolation head (item 1, 10505) for damage and replace if necessary, see pressure isolation head manual *MN-PIH*.

2 Clean pressure seal surfaces at both ends of pressure housing. Ensure housing is free from debris.

3 Refit new O-ring (1x item 7, 09513). Clean and grease O-ring seals with Liquid O-ring.

4 Refit the larger/upper half shell (item 3, 10505)and secure with screws (4x item 5, 10505).

5 Screw housing (item 1, 09513) onto sensor section (item 3, 09513).

6 ELECTRICAL DESCRIPTION

6.1 TELEMETRY BOARD

Ref.: Circuit Diagram (PCB 82269) CD-82261

The Ultrawire™ Tool Telemetry Board is based on a common PCB (82260) which is populated and programmed according to the tool in which it is fitted. The main functional blocks of the circuit are the power supply, the Ultrawire™ interface (together with its drivers and receivers) and the sensor interface.

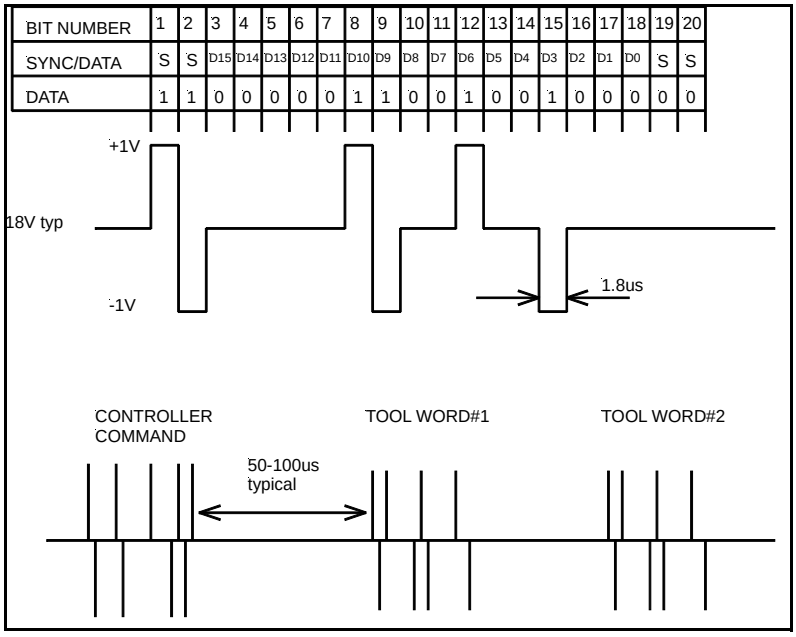
Control is implemented by a PIC microcontroller in conjunction with FPGA logic. The code in the PIC differs according to the tool.

Communication between the Telemetry Controller and the tool is via the Ultrawire™ toolbus. This is a single pin bus, which carries power to the tool in addition to its telemetry function. The return for both power and signal is via the chassis.

The Ultrawire™ line carries 18Vd.c. (nom). Power is supplied to the SMPS via Q7, which with associated components generates local power rails at 12V and 5V.

The tool is protected by fuse (F1), which in conjunction with diode (D1) gives overvoltage and reverse polarity protection.

The telemetry is modulated onto the line as 1V AMI (alternate mark inversion) pulses at 500kbaud, see below a typical tool response.



The Ultrawire™ telemetry is a master slave protocol. The controller, which is always the master, sends a command to the tool. This may be a global command (to all tools) or a tool specific command which contains the address of the target tool. Tool specific commands are acknowledged by the tool, global commands are executed but do not generate a response.

For rate-meter type tools, count pulses are collected from the sensor on inputs 1 - 7 of the PCB. These are counted in hardware by the FPGA logic, (U1) and accumulated by the PIC (U3).=

When the controller is in logging mode, it will periodically send a global sample command to all the tools and then poll each tool individually for data. The sample command causes the latest count to be frozen in a shadow register, and this count is then passed to the controller in response to the data request.

Electrically, the telemetry is a.c. coupled from the line to the drivers and receivers by capacitor (C7). The received data is removed from the line by a comparator (U4), and passed to the FPGA logic, which validates the address. The command is interpreted by the PIC which if necessary generates the response packet and passes it to the FPGA logic for placement on the line.

6.2 SENSOR OSCILLATOR CIRCUIT BOARD

The capacitance probe is part of an oscillator circuit, which outputs approximately 1MHz in air and drops slightly in water.

6.3 FREQUENCY STEP DOWN BOARD

Ref.: Circuit Diagram (PCB85253) *CD-85252*

The input from the Sensor Oscillator Board (PCB85254) is approximately 975-987.5kHz (FQS). U3 & U4 provide options to divide this frequency, typically by 16. Thus giving a frequency of approximately 64kHz, which is output on FQ0 to the telemetry board.

U2 provides a facility to subtract a reference clock from the sensor frequency, but this is normally not required on Ultrawire™.

The 12V input is regulated to 5V by U1 to give a constant supply to the IC's.

7 EXTENDED CHECKS

7.1 PREVENTATIVE MAINTENANCE

7.1.1 GREASE & LUBRICANTS

Sondex recommends the use of “Liquid O-ring type 101” (p/n LOR101) on threads and O-rings.

All O-rings and housing threads are assumed to be and must be lightly greased, unless specifically indicated otherwise.

Correct use of grease and lubricants is essential to the maintenance of all Sondex downhole equipment.

Note that some threads are internal, which can cause grease to get inside the tool. Do not use excessive quantities.

Sondex does not recommend Copper loaded greases since some types can cause electrical leaks. Some types for grease are not suitable for use on O-rings. Silicone grease may be used on O-rings, but must be kept clear of threads, especially stainless steel to stainless steel.
Cavities, e.g. spring housings, should be filled with a suitable heavy high melting point grease. like Castrol Spheerol L-EP2 or Castrol LMX.

Caution! The use of certain greases, which contain volatile content, (e.g. some types of Lubriplate) can cause electrical failure due to production of corrosive gasses inside the tool when burned off.

7.1.2 MECHANICAL

1 Check O-ring (item 7, 09513) is fitted.

2 Check connectors for cleanliness and loose/bent pins before replacing.

3 Check all fixings for tightness.

4 Check 3 grub screws (item 4, 10505) are tight.

5 Check insulator (item 1, 11540) is clean, inner surfaces smooth and silicone greased. Ensure spare insulators are available.

7.1.3 ELECTRICAL

1 Check through line resistance and tool current, see *Section 4.1.2*.

2 Tool current 16-17mA @ 18V.

3 Connect to Logging System and check for correct data. Should agree with previous test. Apply some gentle vibration, rotation and invert tool to expose potential failure.

4 With an oscilloscope, check line for +1V and -1V, 2µs pulses. Make sure to check tool pulses, not those from the controller which occur first, see *Section 6.1*.

Pulses should have no ringing, if ringing, also attach bottom tool (CTF, other bottom flowmeter or toolstring terminator).

7.1.4 AGEING OF ELECTRONICS

At 150°C, significant electronic ageing failures are expected after 4000hrs typical use, hence PCB replacement should be considered at this point. Every additional 10°C halves the time. Also accelerated by vibration and corrosive gas inside the chassis. Visual inspection and logging previous history is recommended, but is unlikely to predict premature failure.

Tools which may be suspected of reliability problems due to age or unusual log response may be heated to 120°C, which would not normally age the electronics, and then subjected to moderate vibration. A moderately hard blow from a wooden hammer is recommended. **DO NOT USE METAL HAMMERS.**

7.1.5 HEAT TESTING ABOVE 150°C

This is not generally recommended since it shortens tool life expectancy.

It may be required for contractual reasons, tool out of use for a long period or job with unusually high well temperature. The test should be carried out only slightly above expected well temperature and tool should not be kept at temperature for more than 1 hour.

7.2 EXTRAORDINARY MAINTENANCE

7.2.1 O-RINGS

Ref.:	General Assembly	*09513*
	Sensing Section	*11540*

If the tool experiences H_2S, gas or temperatures above 150°C, the following O-rings must be replaced:

- 2x item 8, 09513
- 2x item 9, 09513
- 1x item 7, 09513
- 4x item 3, 11540

It is recommended to replace all O-rings on the General Assembly are replaced before every run.

Check insulator tube (item 1, 11540) is clean and inner pressure seal surface is smooth and silicone greased, do not use other types of grease.

7.2.2 SENSOR ASSEMBLY

Other than simple wire damage, this assembly is not user serviceable. Replace complete if faulty.

Check readings agree with previous air and water calibrations. If not, service O-rings and clean tool.

7.2.3 INNER ELECTRODE ASSEMBLY

Should the Inner Electrode Assembly fail it should be replaced by another unit and returned to Sondex for repair.

7.3 CALIBRATION

The performance of the Capacitance Water Holdup tool in the well is affected by the distribution of the fluid phases in the sampled volume. Water fractions above about 40% and regions of a continuous water phase cause a non-linear frequency response. Users may wish to perform their own calibrations with mixtures of particular oils and salt solutions at various temperatures. Fluids are most easily mixed by pouring smoothly from one container to another until the mixture is of an even consistency. Alternatively the readings may be taken with the tools submerged in a fluid mixture that is being agitated as to sustain a stable emulsion. Do not allow air bubbles to become trapped in the mixtures.

It is recommended that Water Holdup is determined as described in *Section 3.3*.

7.3.1 FULL CALIBRATION

The table of results in *Section 3.3* represent a full calibration where the tool response is measured for different fractions of water in oil.

7.3.2 PART CALIBRATION

This consists of checking the tool reading in 100% water and 100% oil (or air) and calculating a correction factor from the oil or water readings from the last full calibration or from the data in *Section 3.3*.

7.4 TROUBLESHOOTING

Refer to *Section 5.2 Disassembly* and <link>Appendix B Drawings & Parts Lists where necessary.

An Oscilloscope, Multimeter and other basic test equipment will be required.

Initial inspection	Check for: • Damaged wires. • Damaged components. • Electrical components shorting to chassis. • Heat or chemical damage (discoloured components). • Incorrect thread grease or excessive quantity. Check all fixings are tight.

Excessive current	Disconnect wires to isolate fault to: • Upper head isolation assembly. • Sensor Section. • Line wire through sensor, lower pressure feedthrough and connector. • PCB82269. • PCB85252. Apply Line Signal or 18V direct to PCB82269 Line connection. Fault find or replace PCB82269. Upper Head, sensor line wire and lower connector may be tested to 250V relative to chassis to check for electrical leak. **Line connection to PCB82269 circuit must be disconnected.** Resistance should exceed 100MΩ. Upper head, sensor line wire lower connector may be disassembled to locate fault.
Little or no current	On PCB82269 check LINE = 18V, 12V, 5V and 0V. Fault find or replace PCB82269.
No telemetry counts	On PCB82269 check LINE = 18V, 12V, 5V and 0V. Fault find or replace PCB82269. Check sensor frequency from PCB85252.
No telemetry reply	Check 0V, 5V and 12V on PCB82269. On PCB82269, check P6 for 4MHz >3V clock. Replace X1 if faulty. Reduce R14 value if clock <3V amplitude. Check Line for +1V and -1V, 2μs pulses from Controller and similar pulses from tool. Pulses should have no ringing. Logic pulses should be present on PCB82269 U1 pin 1. If no tool response words on Line, fault find or replace PCB82269.
No Sensor Frequency	Check +5V power and ground to Sensor assembly. Check nut is tight at top of Sensor rod. Isolate fault to Sensor or PCB85252. Fault find or replace PCB85252. ***Note:*** Apart form simple wiring faults, the Sensor is not user serviceable.

APPENDIX A EQUIPMENT & RECOMMENDED SPARES

Item	Part No	Description	Qty	Remarks
1	CWH013	Capacitance Water Holdup Tool, $1^{11}/_{16}$″, Ultrawire™	1	

A.1 ANCILLARY EQUIPMENT

Item	Part No	Description	Qty	Remarks
1	-	A suitable container, such as a plastic pipe, 2″ ID x 16″ long, with closed end for immersing the sensor in oil/water mixtures.	AR	Optional Shop Calibration.

A.2 MAINTENANCE EQUIPMENT

Item	Part No	Description	Qty	Remarks
1	*91050*	Tool Kit for all $1^{11}/_{16}$″ Tools SX and GO	1	
2	LOR101	Grease for O-rings & threads	1	5oz. pot.
3	LOR101L	Grease for O-rings & threads	AR	12oz. pot.

A.3 RECOMMENDED SPARES

Item	Part No	Description	Qty	Remarks
1	*KITB-CWH1 11/16*	Basic Spares Kit	1	To support run in hole.
2	*KITR-CWH1 11/16*	Recommended Spares Kit	1	To support 25 runs.
3	KITRem-PIH, SX	Remote Spares Kit for Pressure Isolation Head	1	See Pressure Isolation Head Manual *MN-PIH*.

Note: Spares kits suitable for remote logging operation can be supplied upon request.

PARTS LISTING

Part:	Issue:		Drawn:	Checked:	Approved:
91050	-		NGH	PD	DJF
			Date: 14/01/2002	Date: 14/01/2002	Date: 14/01/2002

Description: Tool Kit for all 1 11/16 Tools SX and GO

CHANGE HISTORY					RELATED DOCUMENTS		
Iss	Date	Remarks	Chkd	Appr	# Documents	Issue	Notes
-	14/01/2002	Initial Release	PD	DJF			

PARTS LIST

Item	Part No.	Issue	Description	Component Value	Qty	Units	Remarks
001	91005	-	Spanner Open Ended 42mmx38mm		2	ea	
002	91019	-	Spanner C 50mm 35mm		1	ea	
003	10038	A	Spanner Box 3/8 x 5/16 Modified		2	ea	
004	91028	-	Spanner 3/8x5/16		1	ea	
005	91027	-	Spanner Single Open End 18mm		1	ea	
006	91029	-	Key Hex Metric		1	ea	
007	91030	-	Punch Pin Parallel set		1	ea	
008	00615	A	Assy Spanner PKJ		1	ea	
009	91293	PT1	Screwdriver Parallel tip (3 0 x 75)		1	ea	
010	91105	-	Toolroll With SX Badge Large Black		1	ea	
011	91104	-	Screwdriver Parallel tip (5 5 x 200)		1	ea	
012	91103	-	Pliers Circlip 812 Chrome/Van		1	ea	
013	91102	-	Pliers Mini Flat Nose 5 Inch		1	ea	
014	10037	A	Bar Tommy		2	ea	
015	10051	A	Kemlon tool Sondex - 4BA Hex Socket		1	ea	
016	91280	-	Hammer, 4oz ball pein		1	ea	
017	91130	-	Pin C Spanner 35-50mm		1	ea	

(AR = As Required)

PARTS LISTING

Part:	Issue:		Drawn:	Checked:	Approved:
KITB-CWH1 11/16	A		MB	PJ	PJ
			Date: 03/04/2002	Date: 05/04/2002	Date: 05/04/2002

Description: Kit, Spares, Basic, CWH 1 11/16

CHANGE HISTORY					RELATED DOCUMENTS		
Iss	Date	Remarks	Chkd	Appr	# Documents	Issue	Notes
A	05/04/2002	Initial release	PJ	PJ			

PARTS LIST

Item	Part No.	Issue	Description	Component Value	Qty	Units	Remarks
001	99211	-	O Ring Viton 90 Type 211		2	ea	
002	99124	-	O Ring Viton 90 Type 124		2	ea	
003	95211	-	O Ring Viton 75 Type 211		1	ea	
004	99014	-	O Ring Viton 90 Type 014		2	ea	
005	01047	-	Circlip, Internal, 5/8, St/Steel		1	ea	
006	93051	-	Screw Grub Skt Hd M4x06mm Lg SS (Duplicate-Refer to 93036)		3	ea	

(AR = As Required)

PARTS LISTING

Part:	Issue:		Drawn:	Checked:	Approved:
KITR-CWH1 11/16	B		MB	PJ	PJ
			Date: 03/04/2002	Date: 05/04/2002	Date: 05/04/2002

Description:
Kit, Spares, Recommended(25Run), CWH(1 11/16)

CHANGE HISTORY

Iss	Date	Remarks	Chkd	Appr
A	05/04/2002	Initial release	PJ	PJ
B	25/07/2002	ECR1279. Items 12,13 added	RH	RH

RELATED DOCUMENTS

#	Documents	Issue	Notes

PARTS LIST

Item	Part No.	Issue	Description	Component Value	Qty	Units	Remarks
001	99211	-	O Ring Viton 90 Type 211		50	ea	
002	99124	-	O Ring Viton 90 Type 124		50	ea	
003	01030	-	Screw, Grub Skt Hd, M6 x 06mm Long, St/Steel		3	ea	
004	95211	-	O Ring Viton 75 Type 211		5	ea	
005	93068	-	Washer Star 10-32		1	ea	
006	93019	-	Pin, Spirol, 1mm x 8mm Lg, SS		2	ea	
007	99014	-	O Ring Viton 90 Type 014		50	ea	
008	01047	-	Circlip, Internal, 5/8, St/Steel		2	ea	
009	01026	-	Half-Nut, Hex, 10-32UNF, St/Steel		1	ea	
010	93051	-	Screw Grub Skt Hd M4x06mm Lg SS (Duplicate-Refer to 93036)		6	ea	
011	01029	-	Screw, Csk Hd(Slotted), M3 x 06mm Lg, St/Steel		4	ea	
012	01028	C	Assy, Banana Pin (4mm)		1	ea	
013	02405	D	Insulator (Assy Sensor)		3	ea	

(AR = As Required)

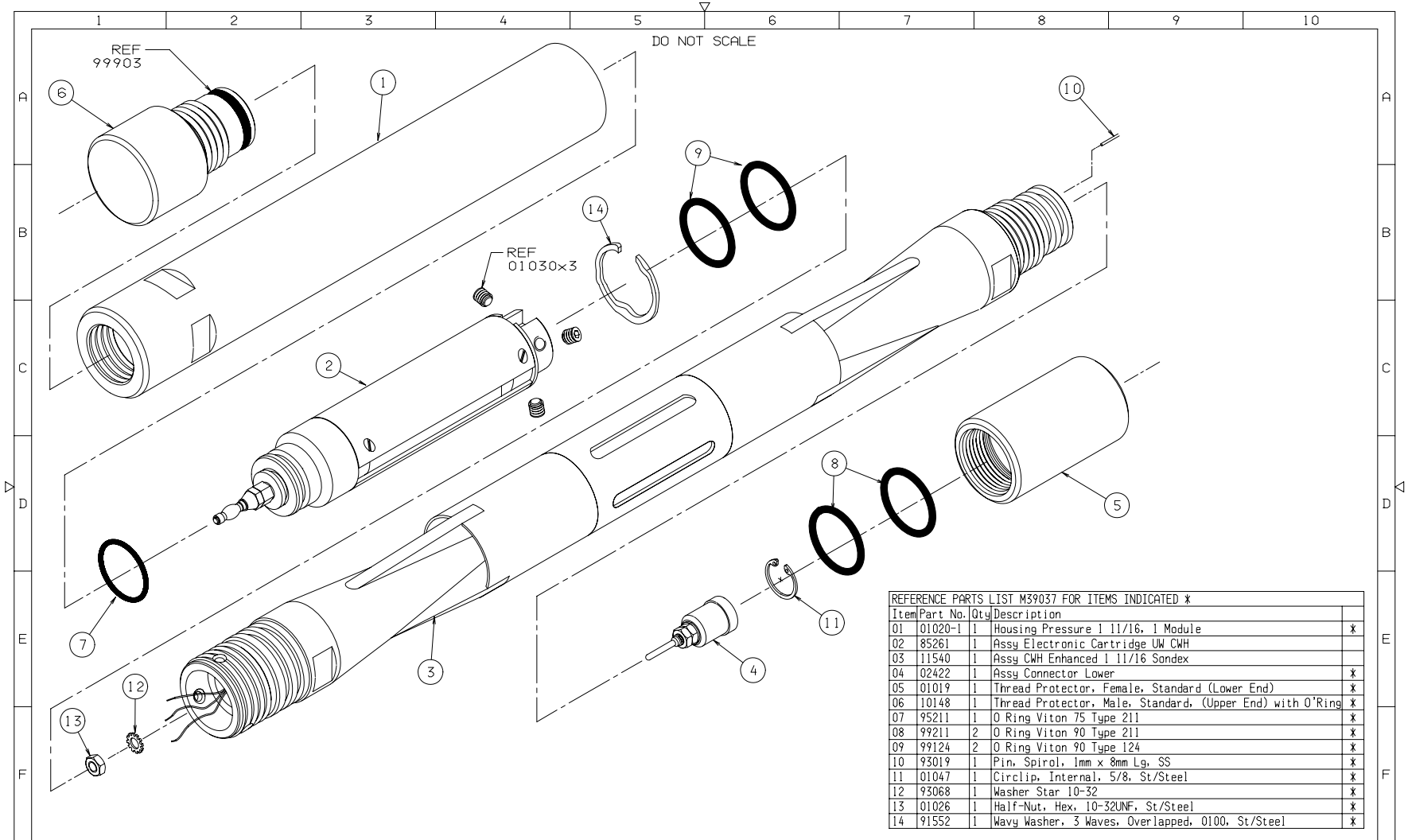
APPENDIX B DRAWINGS & PARTS LISTS

B.1 MECHANICAL DRAWINGS

Description	Drawing	Parts List
General Assembly	*09513-D*	See Drawing.
Sensor Section	*11540-B*	*11540-B*
Electronics Section	*10505-D*	*10505-D*
CWH Mechanical Assembly	*02434-F*	*02434-F*

B.2 ELECTRICAL DIAGRAMS

Description	Type	Drawing
Electronics Assembly	Wiring Diagram	*WD-85261-E*
Telemetry Board (PCB82269) - 2 sheets	Circuit Diagram	*CD-82261-D02x*
Frequency Step Down Board	Circuit Diagram	*CD-85252-C00*



REFERENCE PARTS LIST M39037 FOR ITEMS INDICATED ✱				
Item	Part No.	Qty	Description	
01	01020-1	1	Housing Pressure 1 11/16, 1 Module	✱
02	85261	1	Assy Electronic Cartridge UW CWH	
03	11540	1	Assy CWH Enhanced 1 11/16 Sondex	
04	02422	1	Assy Connector Lower	✱
05	01019	1	Thread Protector, Female, Standard (Lower End)	✱
06	10148	1	Thread Protector, Male, Standard, (Upper End) with O'Ring	✱
07	95211	1	O Ring Viton 75 Type 211	✱
08	99211	2	O Ring Viton 90 Type 211	✱
09	99124	2	O Ring Viton 90 Type 124	✱
10	93019	1	Pin, Spirol, 1mm x 8mm Lg, SS	✱
11	01047	1	Circlip, Internal, 5/8, St/Steel	✱
12	93068	1	Washer Star 10-32	✱
13	01026	1	Half-Nut, Hex, 10-32UNF, St/Steel	✱
14	91552	1	Wavy Washer, 3 Waves, Overlapped, 0100, St/Steel	✱

DRAWN	CHECKED	APPROVED
AJB	IH	RLH
DATE 14/03/02	DATE 12/09/02	DATE 12/09/02
DIM IN INCHES	MATL: SEE PARTS LIST	
SCALE NTS	A2	

SONDEX FM No: F0022

ISS	DESCRIPTION	APPD	DATE
D	ECR 3767 REFERS - P/L ADDED	GT	15/05/06
C	REF ECR 3080	GC	01/02/06
B	REFER ECR 1531	DJF	12/03/03
A	INITIAL RELEASE	RLH	12/09/02

Sondex

Tel. 0118 932 6755

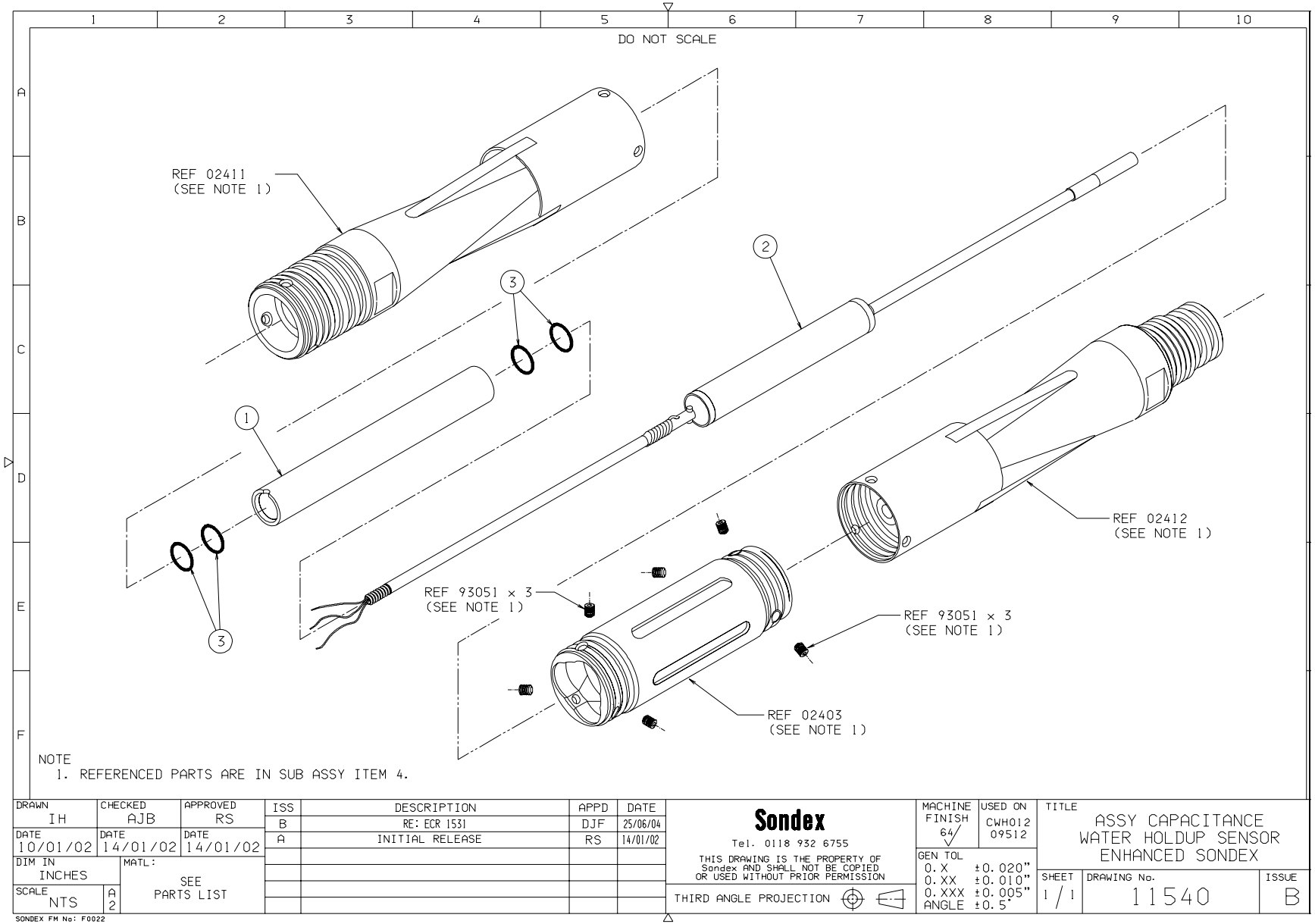
THIRD ANGLE PROJECTION

MACHINE FINISH 64√ | USED ON CWH013

GEN TOL
0.X ±0.020"
0.XX ±0.010"
0.XXX ±0.005"
ANGLE ±0.5°

TITLE: CAPACITANCE WATER HOLD-UP 1 11/16 UW SX (ENHANCED)

SHEET	DRAWING No.	ISSUE
1/1	09513	D



DRAWN	CHECKED	APPROVED
IH	AJB	RS
DATE 10/01/02	DATE 14/01/02	DATE 14/01/02
DIM IN INCHES	MATL: SEE PARTS LIST	
SCALE NTS	A2	

ISS	DESCRIPTION	APPD	DATE
B	RE: ECR 1531	DJF	25/06/04
A	INITIAL RELEASE	RS	14/01/02

Sondex
Tel. 0118 932 6755

THIRD ANGLE PROJECTION

MACHINE FINISH 64√	USED ON CWH012 09512

GEN TOL
0.X ±0.020"
0.XX ±0.010"
0.XXX ±0.005"
ANGLE ±0.5°

TITLE: ASSY CAPACITANCE WATER HOLDUP SENSOR ENHANCED SONDEX

SHEET	DRAWING No.	ISSUE
1/1	11540	B

SONDEX FM No: F0022

PARTS LISTING

Part:	Issue:		Drawn:	Checked:	Approved:
11540	B		IH	AJB	RS
			Date: 10/01/2002	Date: 10/01/2002	Date: 14/01/2002

Description:

Assy CWH Enhanced 1 11/16 Sondex

CHANGE HISTORY

Iss	*Date*	*Remarks*	*Chkd*	*Appr*
A	14/01/2002	Initial issue.	AJB	RS
B	25/06/2004	Re: ECR 1531	GJS	DJF

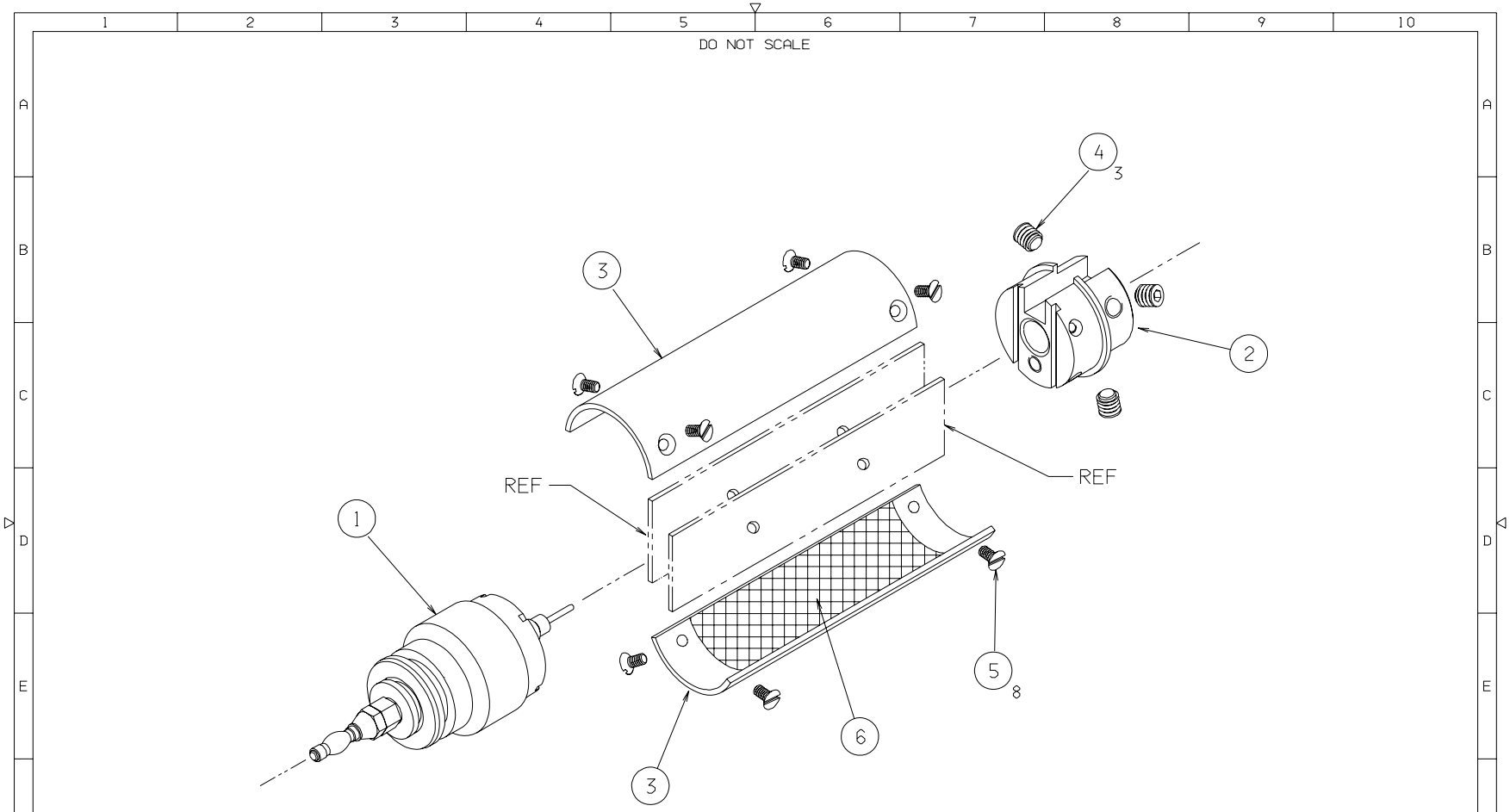
RELATED DOCUMENTS

#	*Documents*	*Issue*	*Notes*
01	AD-11540	B	Assembly Drawing

PARTS LIST

Item	*Part No.*	*Issue*	*Description*	*Component Value*	*Qty*	*Units*	*Remarks*
001	02405	D	Insulator (Assy Sensor)		1	ea	
002	02441	D	Assy Sensor CWH 1 11/16 Enhanced		1	ea	
003	99014	-	O Ring Viton 90 Type 014		4	ea	
004	02434	F	Assy Mechanical CWH 1 11/16 Inc 02403, 02411, 02412		1	ea	

(AR = As Required)



DRAWN TLS	CHECKED AJB	APPROVED DJF	ISS	DESCRIPTION	APPD	DATE	Sondex	USED ON COM	TITLE ASSY ELECTRONICS 1 MODULE SONDEX ISOLATION WIRED CONNECTION MEMORY		
DATE 10/01/91	DATE 03/05/96	DATE 10/05/96	D	RE: ECR 1526, 1530 & 1531	DJF	04/06/03	Tel. 0118 932 6755				
DIM IN INCHES	MATL: SEE DETAIL DRAWINGS		C	COMPONENTS RATIONALISED	DJF	10-05-96	THIS DRAWING IS THE PROPERTY OF Sondex AND SHALL NOT BE COPIED OR USED WITHOUT PRIOR PERMISSION	MACHINE FINISH 63	GEN TOL 0.X ±0.020" 0.XX ±0.010" 0.XXX ±0.005" ANGLE ±0.5°	SHEET 1/1	DRAWING No. 10505 ISSUE D
SCALE NTS	A3		B	PRESSURE ISOLATION HEAD UPGRADED	JB	22/03/95					
			A	INITIAL RELEASE			THIRD ANGLE PROJECTION				

SONDEX FM No: F0023

PARTS LISTING

Part:	Issue:		Drawn:	Checked:	Approved:
10505	D		TLS	AJB	DJF
			Date: 10/01/1991	Date: 03/05/1996	Date: 10/05/1996

Description:
Assy, Chassis, 1 Module, Memory, SX (Mechanical)

CHANGE HISTORY

Iss	Date	Remarks	Chkd	Appr
C	--/--/--			
D	04/06/2003	Re: ECR1526	GJS	DJF

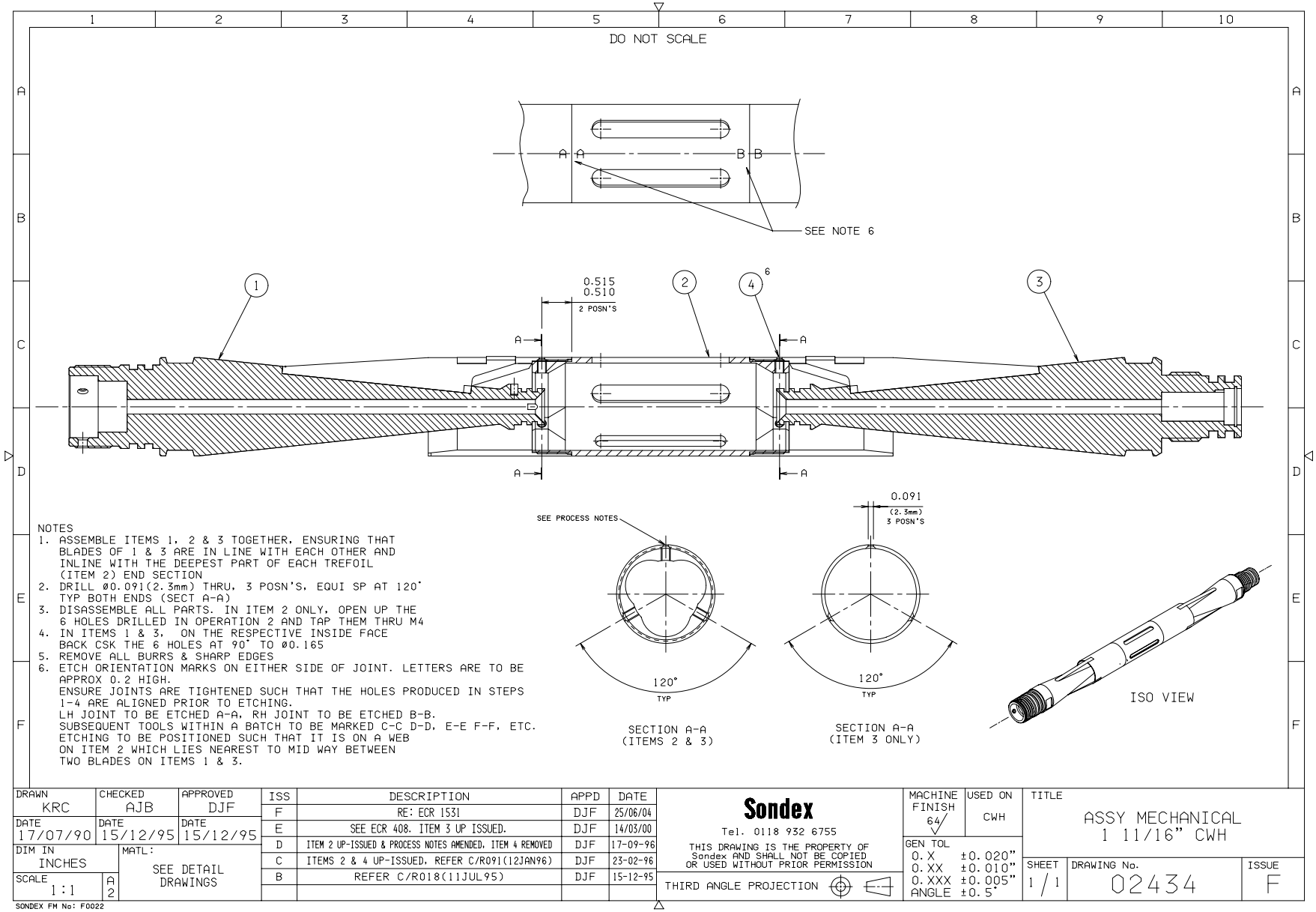
RELATED DOCUMENTS

#	Documents	Issue	Notes
01	AD10505	D	Assembly Drawing
02	PL10505	D	Parts List
03	AI10505	PT1	Assembly Instructions
04	AR10505	PT1	Assembly Record

PARTS LIST

Item	Part No.	Issue	Description	Component Value	Qty	Units	Remarks
001	10537	G	Assy, Upper Electronics Bulkhead, Memory, SX (Isolation)		1	ea	
002	01006	G	Bulkhead, Electronics, Lower, Standard (Non-Lemo)		1	ea	
003	01015	D	Halfshells, Chassis & Cover, Electronics, 1 Module		1	pr	
004	01030	A	Screw, Grub Skt Hd, M6 x 6mm Long, St/Steel		3	ea	
005	01029	A	Screw, Csk Hd(Slotted), M3 x 06mm Lg, St/Steel		8	ea	
006	T004-008AP	-	Tape Tygaflor 208AP/03T 80mm x 30M	Tygaflor Tape		(AR)	

(AR = As Required)



NOTES
1. ASSEMBLE ITEMS 1, 2 & 3 TOGETHER, ENSURING THAT BLADES OF 1 & 3 ARE IN LINE WITH EACH OTHER AND INLINE WITH THE DEEPEST PART OF EACH TREFOIL (ITEM 2) END SECTION
2. DRILL Ø0.091(2.3mm) THRU, 3 POSN'S, EQUI SP AT 120° TYP BOTH ENDS (SECT A-A)
3. DISASSEMBLE ALL PARTS. IN ITEM 2 ONLY, OPEN UP THE 6 HOLES DRILLED IN OPERATION 2 AND TAP THEM THRU M4
4. IN ITEMS 1 & 3, ON THE RESPECTIVE INSIDE FACE BACK CSK THE 6 HOLES AT 90° TO Ø0.165
5. REMOVE ALL BURRS & SHARP EDGES
6. ETCH ORIENTATION MARKS ON EITHER SIDE OF JOINT. LETTERS ARE TO BE APPROX 0.2 HIGH. ENSURE JOINTS ARE TIGHTENED SUCH THAT THE HOLES PRODUCED IN STEPS 1-4 ARE ALIGNED PRIOR TO ETCHING. LH JOINT TO BE ETCHED A-A, RH JOINT TO BE ETCHED B-B. SUBSEQUENT TOOLS WITHIN A BATCH TO BE MARKED C-C D-D, E-E F-F, ETC. ETCHING TO BE POSITIONED SUCH THAT IT IS ON A WEB ON ITEM 2 WHICH LIES NEAREST TO MID WAY BETWEEN TWO BLADES ON ITEMS 1 & 3.

DRAWN	CHECKED	APPROVED
KRC	AJB	DJF
DATE 17/07/90	DATE 15/12/95	DATE 15/12/95
DIM IN INCHES	MATL: SEE DETAIL DRAWINGS	
SCALE 1:1	A2	

ISS	DESCRIPTION	APPD	DATE
F	RE: ECR 1531	DJF	25/06/04
E	SEE ECR 408. ITEM 3 UP ISSUED.	DJF	14/03/00
D	ITEM 2 UP-ISSUED & PROCESS NOTES AMENDED, ITEM 4 REMOVED	DJF	17-09-96
C	ITEMS 2 & 4 UP-ISSUED, REFER C/R091(12JAN96)	DJF	23-02-96
B	REFER C/R018(11JUL95)	DJF	15-12-95

Sondex
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THIRD ANGLE PROJECTION

MACHINE FINISH 64	USED ON CWH
GEN TOL	
0.X ±0.020"	
0.XX ±0.010"	
0.XXX ±0.005"	
ANGLE ±0.5°	

TITLE: ASSY MECHANICAL 1 11/16" CWH

SHEET	DRAWING No.	ISSUE
1/1	02434	F

SONDEX FM No: F0022

PARTS LISTING

Part:	Issue:		Drawn:	Checked:	Approved:
			KRC	AJB	DJF
02434	F		Date: 17/07/1990	Date: 15/12/1995	Date: 15/12/1995

Description:

Assy Mechanical CWH 1 11/16 Inc 02403, 02411, 02412

CHANGE HISTORY

Iss	*Date*	*Remarks*	*Chkd*	*Appr*
D	17/09/1996	Item 2 Up-Issued & Process notes amended, Item 4 Removed		DJF
E	11/06/1999	See ECR408	IH	DJF
F	12/05/2003	RE: ECR 1531	GJS	DJF

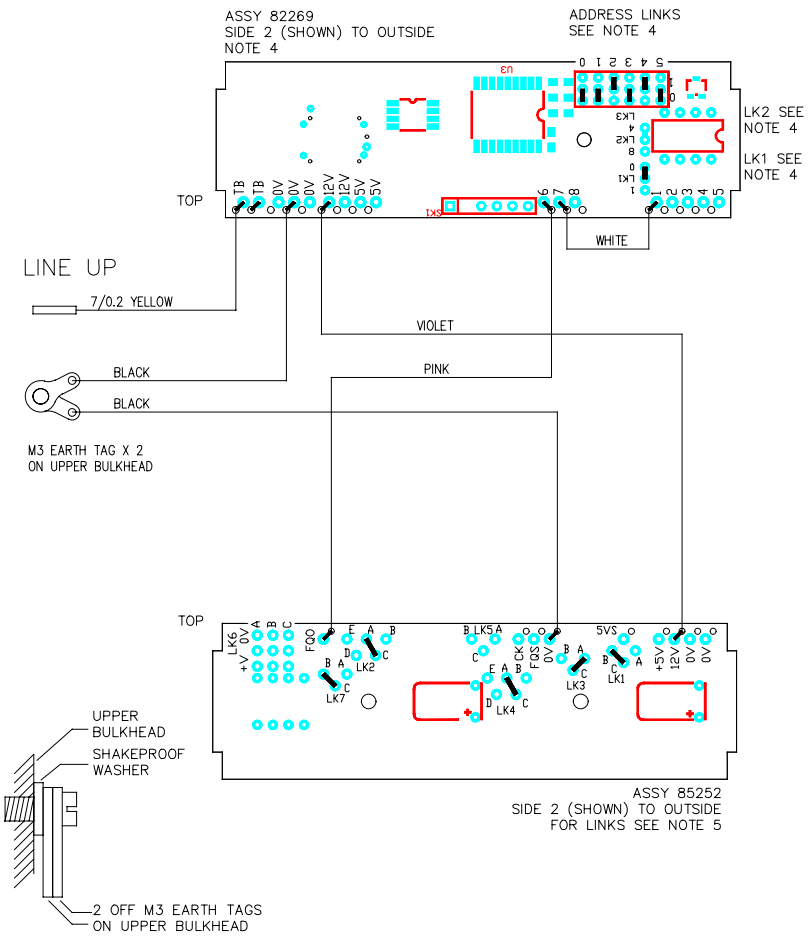
RELATED DOCUMENTS

#	*Documents*	*Issue*	*Notes*

PARTS LIST

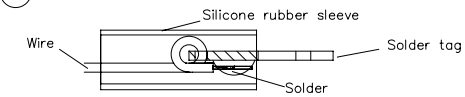
Item	*Part No.*	*Issue*	*Description*	*Component Value*	*Qty*	*Units*	*Remarks*
001	02411	C	Assy Upper Blades Shroud & Sub (Welding)		1	ea	
002	02403	G	Nut Union 1 11/16 (Screw Type, Slotted)		1	ea	
003	02412	D	Assy Lower Blades Shroud & Sub (Welding)		1	ea	
004	93051	-	Screw Grub Skt Hd M4x06mm LG SS (Duplicate-Refer to 93036)		6	ea	

(AR = As Required)

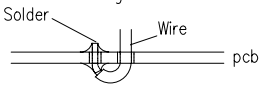


NOTES:

1. Wires PTFE 7/0.12 unless otherwise stated.
2. Strain relief of solder tag.



3. Strain relief of wiring.



4. Assy 82269 is 82261
   Programmed SON076
   Fit Link LK1 – 0
   LK2 tracked to 4 on PCB
   LK3 set to Address 20 as shown
5. On Assy 85252
   Fit the following Links

   LK1 fit link B–C
   LK2 fit link A–C
   LK3 fit link A–C
   LK4 S.O.T. fit link A–C as standard
   LK7 fit link B–C
   LK5, LK6 No links fitted

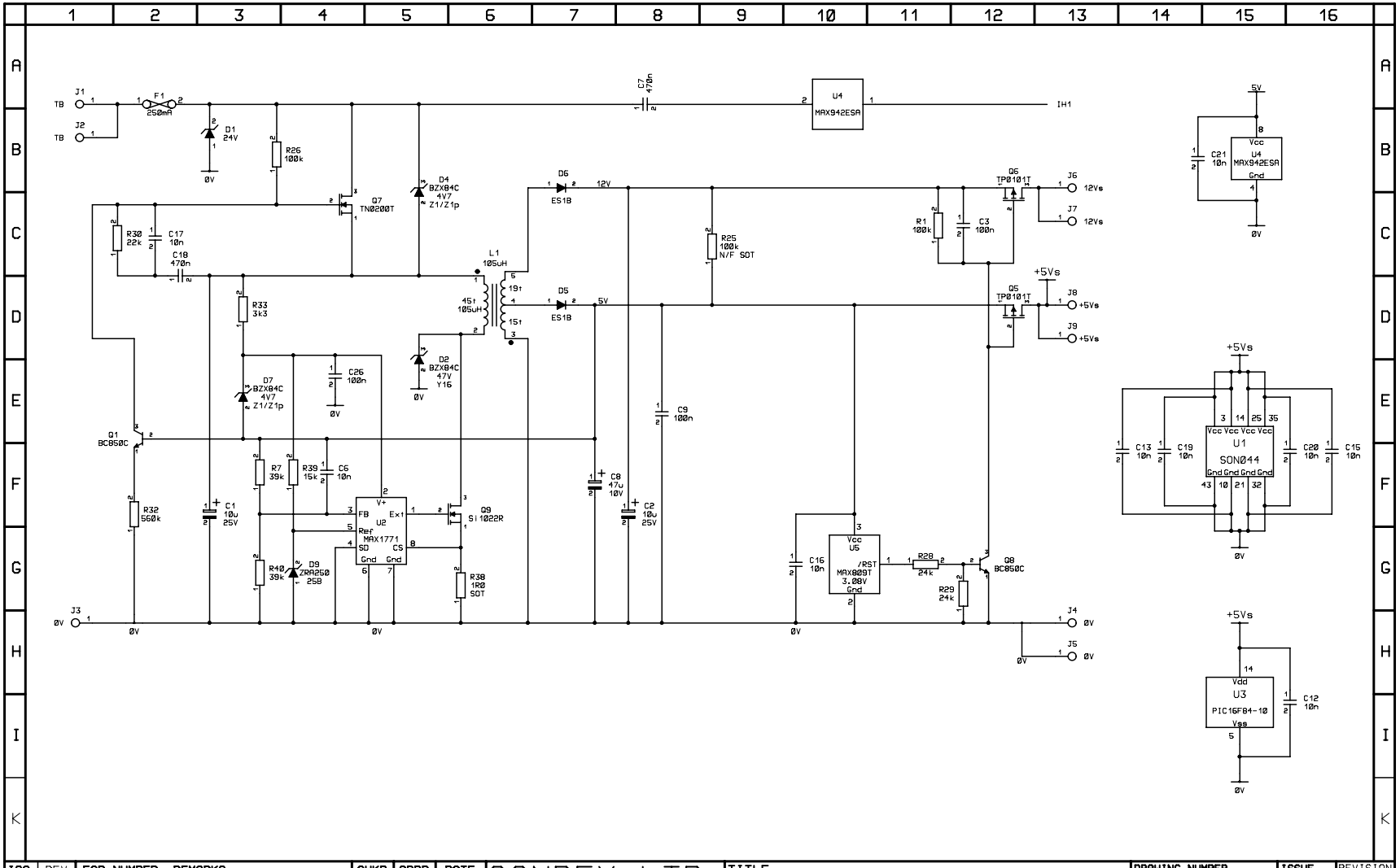
ISS	REV	DATE	CHANGES	CHKD	APPD
B		29.11.02	ECR1332. Updated to show Iss B version 85290	(RS)	(RH)
C		6.11.03	ECR1466.Assy 85252 was 85290. Note 5 updated	(RH)	(RH)
D		05/10/05	ECR1692. 82269 was 82224. Wiring from CWH deleted	(RH)	(RH)
E		21/04/06	ECR3743 Mod to show 2 earth tags	BET	(RH)

SONDEX
FORD LANE, BRAMSHILL,
HOOK RG27 0RH,
ENGLAND.
tel 44 118 9326755 fax 9326704

TITLE:
WIRING DIAGRAM
TOOL ELECTRONICS
ULTRAWIRE CWH

DRAWN	CHECKED	APPROVED
D.Jackson	(RH)	(RH)
DATE 16.8.02	DATE 11.9.02	DATE 11.9.02

DRAWING No. WD 85261 | ISSUE E | REVISION



ISS.	REV.	ECR NUMBER, REMARKS	CHKD	APPR	DATE
D	00x		PR	PR	08/09/04
D	02x		PEJR	PEJR	03/8/05
D	02xx	ECR3141 Drawing correction	PEJR	PEJR	19/09/05

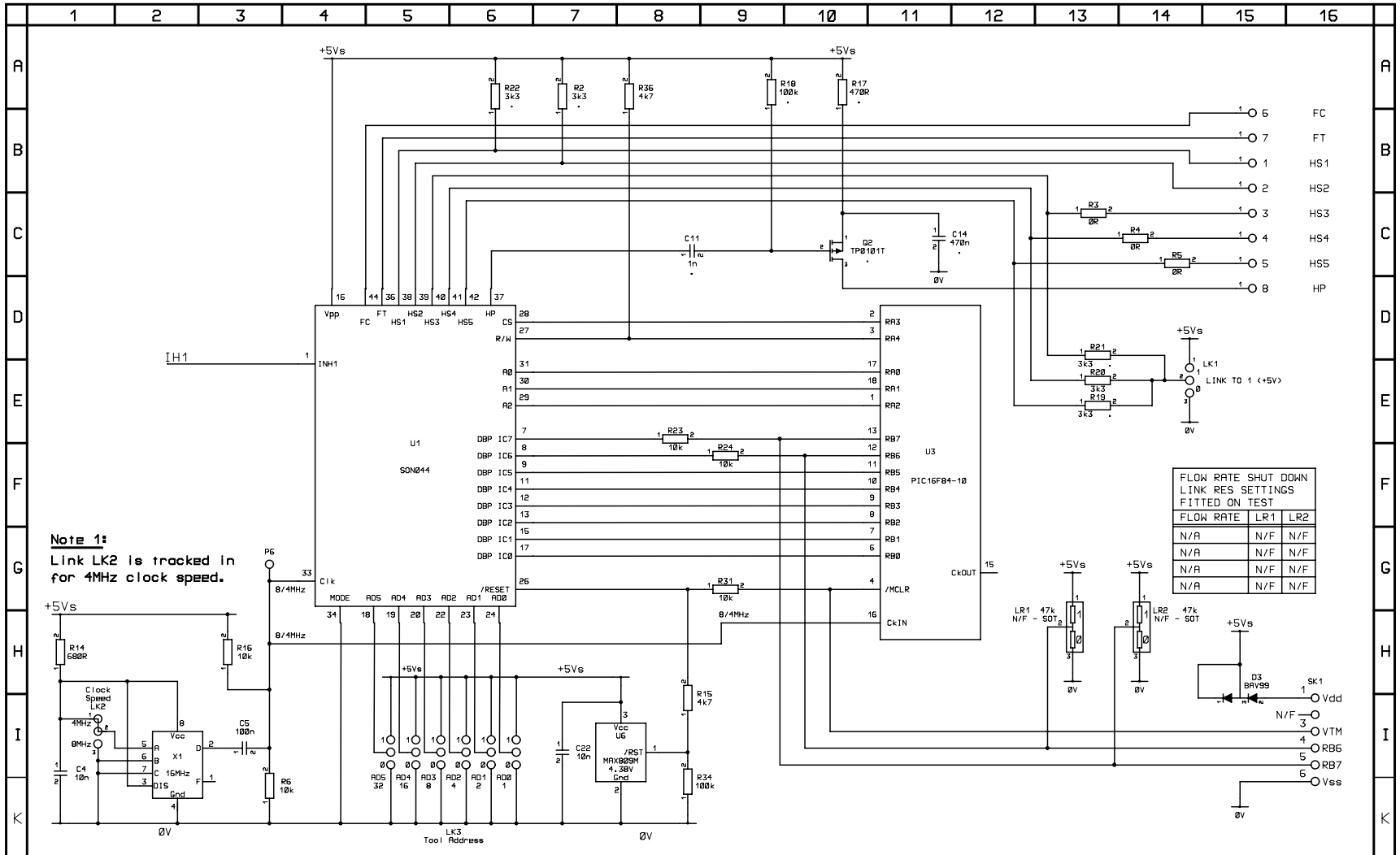
SONDEX LTD
FORD LANE, BRAMSHILL,
HOOK, HAMPSHIRE,
RG27 0RH, ENGLAND
TEL: +44 (0) 118 932 6755
FAX: +44 (0) 118 932 6704

TITLE
Ultrawire PSU & Telemetry
CTF Tool
Circuit Diagram

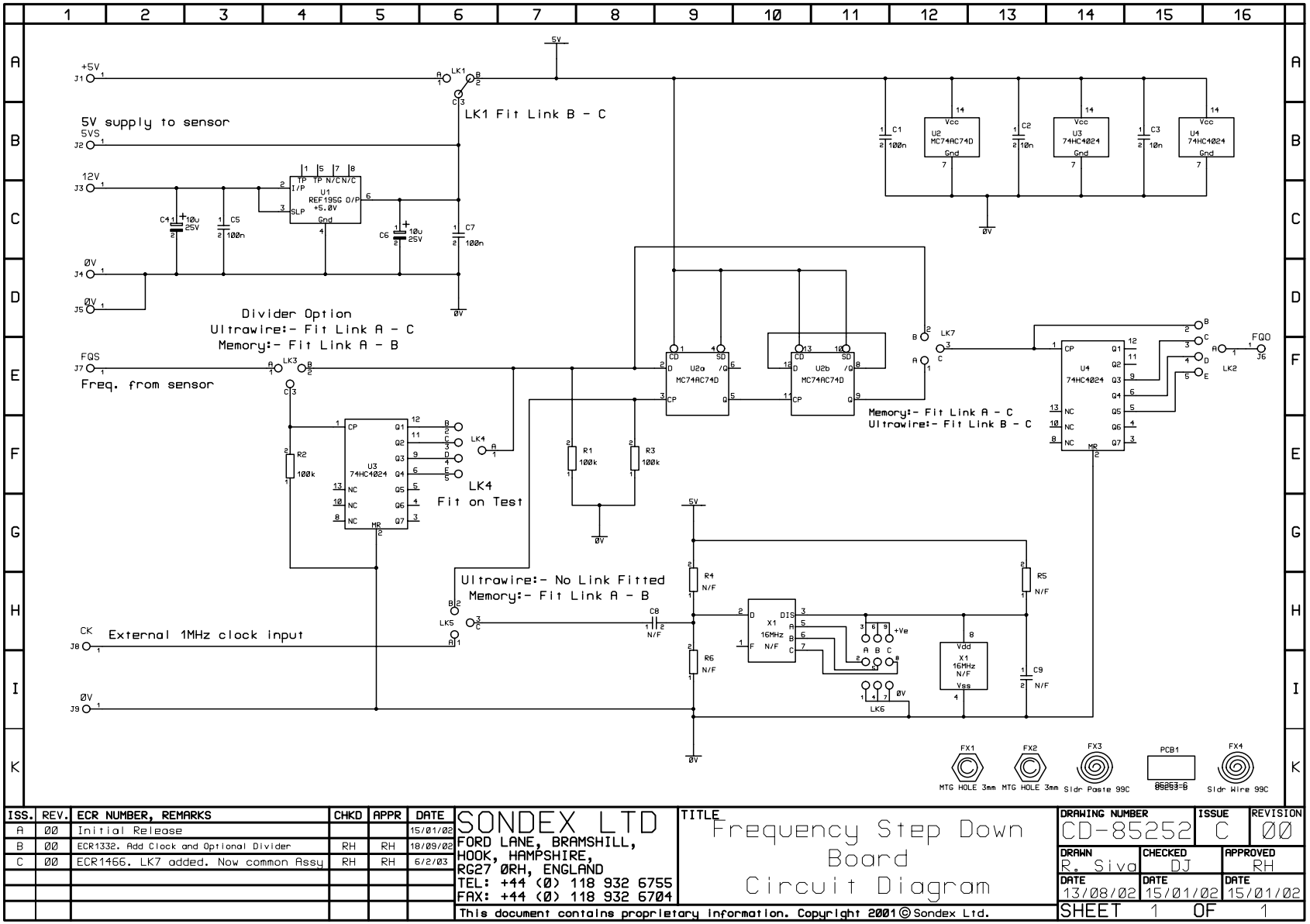
DRAWING NUMBER	ISSUE	REVISION
CD-82261	D	02xx

DRAWN	CHECKED	APPROVED
DJ	DJ	PR
DATE 08/09/04	DATE 05/08/03	DATE 05/08/03

SHEET 1 OF 2



ISS.	REV.	ECR NUMBER, REMARKS	CHKD	APPR	DATE
D	00x		PR	PR	08/09/04
D	02x		PEJR	PEJR	03/8/05
D	02xx	ECR3141 Drawing correction	PEJR	PEJR	19/09/05



ISS.	REV.	ECR NUMBER, REMARKS	CHKD	APPR	DATE
A	ØØ	Initial Release			15/01/02
B	ØØ	ECR1332. Add Clock and Optional Divider	RH	RH	18/09/02
C	ØØ	ECR1466. LK7 added. Now common Assy	RH	RH	6/2/03

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HOOK, HAMPSHIRE,
RG27 ØRH, ENGLAND
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