DIL45 Operation Manual

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August 22, 2002

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Introduction

This document is a general overview of the DiL45 probe. Specifically it describes use of the DIL45 probe with MSLog.

General Information

Overview

The DIL45 probe, manufactured by ALT (Advanced Logging Technology-Luxembourg) is a lightweight, state of the art induction probe providing a deep and medium formation conductivity response. It measures the total amplitude of the formation conductivity, which is comprised of both the real and complex portions of the formation conductivity response. Details on the DIL45 response follow in the section “Theory of Operation”.

The probe can be operated on the Mount Sopris MGXII logger, when equipped with the 2AMA-1000, ALT modem. This configuration of the MGXII requires MSlog Windows based log acquisition software.

Theory of Operation

The ALT DIL45 operates somewhat different than conventional EM probes, such as the Geonics EM-39. In order to understand the difference, it is useful to review in detail the electrical properties of earth formations.

The total electrical impedance Z best describes the conductivity of earth formations. Z is a complex number ($Z=A + iB$), where A is the real term, related to the resistance, and B is the imaginary term, related to capacitance and inductance. In addition, for a given frequency ω, $B=\omega L-1/\omega C$, where L is inductance and C is capacitance.

Most earth formations (within the reach of drill holes) are made up of non-conductive matrix material filled with conductive fluid. These rocks conform to Archie’s law, which relates the conductivity of the formation to the conductivity of the fluid in the matrix porosity. In such rocks, the capacitive and inductive contributions are very low, and the impedance of the rock is assumed to be resistive ($Z=R$). In general, all induction tools used in the general petroleum industry assume this relationship.

Known exceptions to the case of purely resistive impedance are found in rocks with disseminated conductive materials and some layered clays and shales. In general, the capacitive components of impedance in such rocks are non-zero. This means that Z really is a complex number, with both a resistive (real) and capacitive (imaginary) component.

Several methods are commonly employed to measure rock electrical properties:

1. Galvanic resistivity tools (E-logs, lateral logs, etc.)
2. IP tools
3. Induction conductivity tools

Galvanic resistivity tools operate in a “pseudo DC mode” where the survey frequency ω is zero. Thus, such tools will not see the imaginary component of the complex impedance. Even if a rock has capacitive characteristics, such devices will not be affected.

IP tools measure the decay time of a pulsed DC source (broadband frequency), and they are intentionally designed to measure the capacitive component of the rock impedance. The primary application for IP measurement is to locate disseminated conductors in mineral exploration.

Inductions tools, in a very simplified approach, following Doll's theories, assume that magnetic permeability, μ, is constant (true for most sedimentary, iron-free rocks). By imposing an electromagnetic field between a transmitter and receiver located in a fixed axial symmetry on a logging probe, electric currents are induced in the formation surrounding the probe. The strength of the induced currents is proportional to the conductivity of the formation. These induced current loops produce a secondary electromagnetic field called the R signal, phase shifted from the original survey frequency, which is picked up by the receiver coil. The strength of the received R signal is related to the conductivity of the formation. Thus, induction tools respond to both the resistive and capacitive components of the complex impedance.

Some induction tools in the field today record the two components. These are sometimes called the in-phase or X signal, and the quadrature or R signal. The R signal (quadrature) is resistivity dependent. The X signal is capacitance dependent.

The DIL45, produced by ALT, records the <u>magnitude of the impedance</u>, which is a function of both resistance and capacitance (SQRT((R*R)=(X*X))).

The response from the traditional tools and the DIL45 can vary because of this difference.

If the formation is purely resistive (typical sedimentary rocks), then the resistivity measured by galvanic and induction tools is the same. IP tools will measure zero.

If the formation has disseminated conductors, then the magnetic permeability, μ, is not a constant, then galvanic resistivity tool will respond to the resistivity, and induction tools will respond to both the resistivity and the magnetic permeability. The DIL45 reports the magnitude of these two components as a single measurement. Some induction tools report these components separately. IP tools do not respond to magnetic permeability. In this case, only the galvanic resistivity tools record resistivity, and the other tools are affected by μ variations.

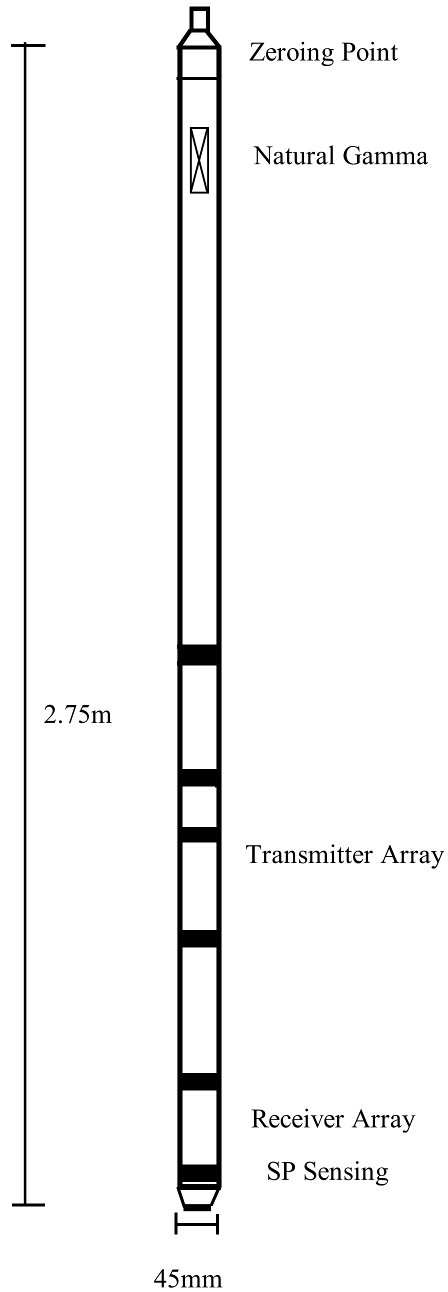
If the formation has capacitive laminated shales (μ variations are minor), then the galvanic resistivity tools will respond to the resistivity only. The induction tools will respond to both the resistivity and the capacitance. The DIL45 reports the magnitude of these two components as a single measurement. Some induction tools report these components separately. IP tool will respond to the formation capacitance only.

This explains how the DIL45 may show more "character" in laminated clay/shale sequences than the EM39. In the future, the DIL45 may be modified to produce an X signal free data stream, if user feedback indicates a need for this information.

Please note that the above discussion does not intend to cover induction tool theory in detail, but only help explain fundamental design differences between tools.

Specifications

Measured channels:	Medium induction (ILM), Deep induction ,(ILD), Natural gamma
Tool length:	275 cm
Tool max OD:	45mm
Tool weight:	approx. 18Kg
Electronic section housing:	Inox
Coil section housing:	Fiberglass
Pressure rating (T° < 200°C):	200 bars
Temperature rating:	70°C (125°C optional)
Numbers of coils:	4 coils dual focused array
Spacing:	ILM = 57 cm, ILD = 83cm
Operating frequency:	25.6 KHz
Conductivity range:	5 mmhos/m to 5 mho/m
Tool repeatability:	0.5 mmho/m
Accuracy:	Better than 5 mmhos/m over t° range
Power consumption	150mA / 100V



LOG PARAMETERS

Direct and secondary induction logs from the medium and long spaced receivers.

APPLICATIONS

Medium and Deep Spaced Induction
Formation Conductivity
Formation Resistivity
Natural Gamma (optional)

Operating Procedure

Operation

Follow the same procedure for operating the DIL45 as with all other probes operating under MSLog. The probe should be allowed to stabilize at well bore temperature before logging or calibrating. Normally this can be accomplished by lowering the probe into the borehole fluid, powering it up, and letting it stand for 10 - 20 minutes. This is necessary so that the probe is at the operating environment temperature when it is calibrated.

Operation of the DIL 45 induction probe is straightforward. Make sure that probe power is off, then connect the probe to the cable head by screwing the probe onto the cable head. Make sure that the cable head ‘O’ ring is clean, lubricated, and in good shape. Make sure that the cable head is screwed on tight by hand. Place the probe in the borehole and route the logging cable over the necessary rigging. Follow the procedure outlined below.

Logging Instructions for MSLog with the MGX II

- Select the correct tool driver from the Tool panel selection box. If the correct one is not available, run MSLConfig to install it.
- In the Tool panel, click the Power On button. **It is advisable to power the probe while it is in the hole for a few minutes to warm up the electronics before logging for optimum accuracy**.
- Place the tool in the borehole and position the top of the tool at the zero depth point. Click the Depth panel upper right corner icon. Click Zero Tool. If you can not place the tool top at depth reference, press the Change Depth button and enter the depth of the bottom of the tool.
- If you wish to fill out the header, in the Acquisition panel click Header button.
- In the Acquisition panel, click Record and select a file name.
- Place the probe at the beginning of the interval to be logged.
- Turn on the desired, Depth Sampling mode.
- If you are printing, turn on the printer in MCHCurve.
- Log to the desired interval as normal. Refer to the MSLog manual for additional information on logging.
- When done, in the Acquisition panel, click Stop.

Performance Checks and Calibrations

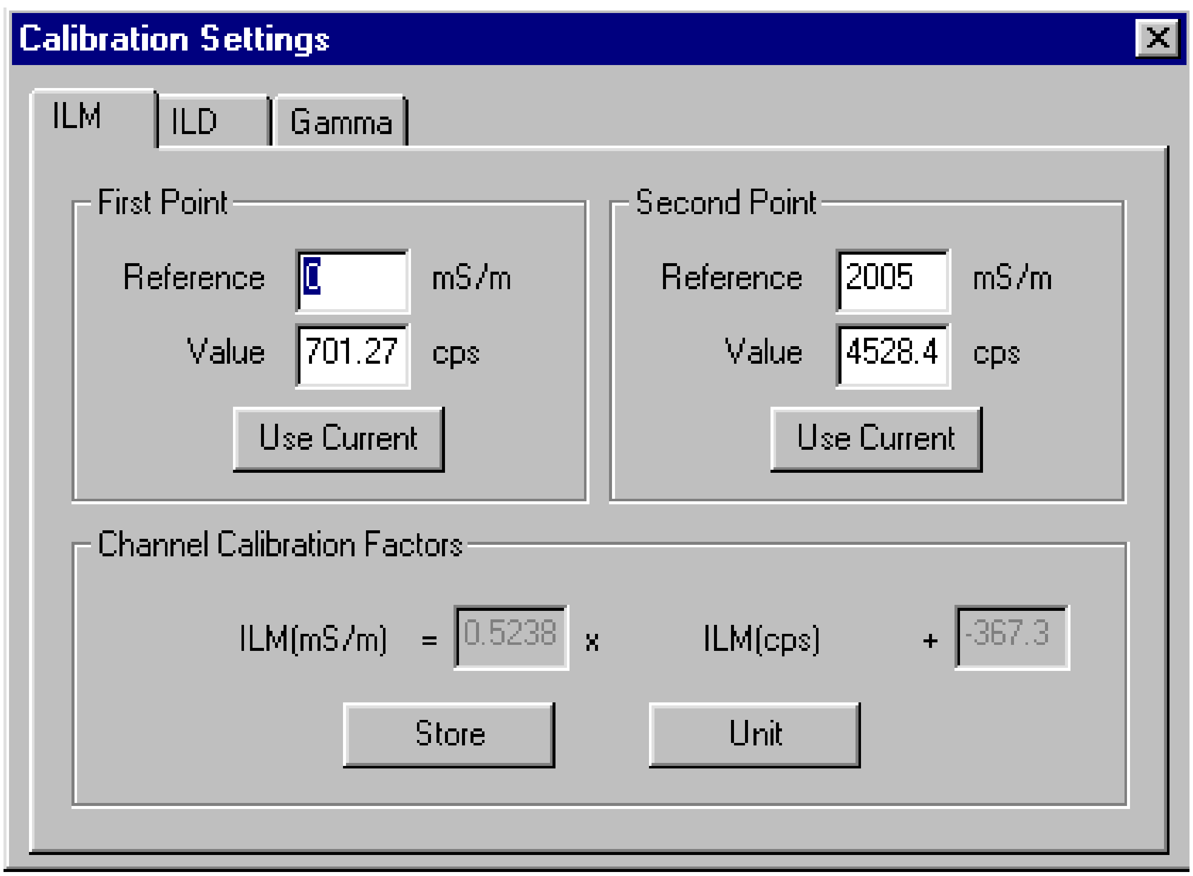
The probe is delivered with factory determined calibration numbers. Use these numbers if it is not possible to calibrate the probe in the field. To calibrate the probe in the field, power up the probe and wait a few minutes for the probe to temperature stabilize with the probe in the borehole.

Calibration has two purposes. The first is to make sure that the probe is returning values as accurate as possible. The second is to verify the probe is functioning correctly before logging data. Calibrations should be performed routinely to assure quality logs.

When choosing a site for calibrating an induction tool there should be as little interference as possible from external electromagnetic fields generated, for example, by power lines, transformers, radio transmitters etc., and there should not be any significant steel or ironwork close by.

Calibration Instructions for MSLog

- Turn Probe power On.
- Turn Sampling to Time and On.
- Measure a calibration standard as described above.
- Allow the probe to warm up for 10-15 minutes in the borehole.
- Right click on MCHNum.
- Uncheck Use calibration
- Right click on the MCHNum title bar.
- Click Calibration Settings. Select the ILM tab.
- After the probe is temperature stabilized, remove the probe from the hole, and have an assistant raise the probe vertically in the air, holding it straight up, with the bottom of the probe pointing toward the sky.
- Enter a value of zero in the Reference edit box for the first point.
- Press the First Point Use Current button to capture the raw tool output for the first calibration point. Press the store button.
- Click the ILD tab. Enter a value of zero in the Reference edit box for the first point.
- Press the First Point Use Current button to capture the raw tool output for the first calibration point. Press the Store button.



- Continue with this calibration process if you have an induction tool calibration ring. Place the tool horizontally on wooden or other non-metallic structure as high above the ground as possible.
- Move the calibration ring on the sensor barrel to the position of maximum response for ILM. For both ILM and ILD, click the **Use Current Value** button next to the right

input value box. The right output (reference) value should be entered based on the value of the calibration coil for each of the ILM and ILD channels.

- Press Store to save the values to the tool driver file.
- Press the X in the upper right corner of the browser to close the dialog.
- On the MSLog Browsers and Processors menu press Close all.
- Select each Browser or Processor from the menu individually and press the Start button. Wait until the browser or processor Connects then select the next one in the list, press Start and so on until all the processors and browsers are running. This is necessary so that the browsers and processors can read the new calibration information stored in the tool driver file when the Store button was pressed.

Calibration Coil
As described above, if the user wishes to calibrate the probe conductivity using a loop coil (approximately 2 ohm), this can be purchased as an option from Mount Sopris. Contact the factory for details. Otherwise, the user should use the calibration values supplied by the manufacturer, as shown in the example below:

Calibration Values for Probe **S/N 2598**:

	Zero	2005 mS/m
ILM	990	4997
	Zero	606 ms/m
ILD	1760	5454

Construction & Maintenance

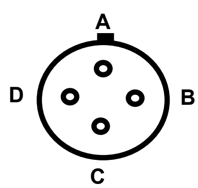
Tool Head

The cable head socket and connector pins of the tool head should be checked for cleanliness before each use of the tool. The tool head pin insert has a locating mark showing the position of WL1. This mark should line up with the slot in tool head provided for fixing the orientation of the cable head.

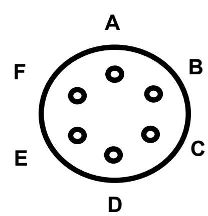
The tool head is fixed to the steel pressure housing by four hex screws and can be withdrawn from the pressure housing with a straight pull. The internal end of the tool head is fitted with a 6-way MIL socket. The internal electronic chassis is connected to this by a short flexible lead and plug, which is disconnected to remove the tool head. When removing the tool head, care must be taken not to over pull the head and damage this wire link.

Check seals and apply silicon grease before re-assembly. Silicon grease of a type similar to Dow Corning DC-4 or DC-111 is suitable for this and other "O" ring seals.

Tool Head Wiring – Mono / 4 Conductor as Mono



Pin Insert
(Viewed towards tool)



Cannon Connector
(as marked)

Pin Insert	Function	Colour Code	Cannon Connector
A	Tool Power/Data	Red	A
B	SP	White	B
C	nc		C
D	nc		D
Gnd/Armour		Green	E
Gnd/Armour		Green	F

Pressure Housing

After removal of the tool head, the pressure housing can be removed by undoing the four hex socket screws fixing it to the brass sub at the top of the induction coil barrel.

Sensor Barrel

The sensor barrel carrying transmitter and receiver coils is manufactured from a glass resin compound in a two-stage process. After manufacture the barrel is impregnated at high pressure with oil to fill remaining pore spaces and prevent water seepage into the compound. As a result of this process there may over a period of time be some oil seepage into the electronic chassis but this will not affect electronic performance. The outer surface of the barrel is protected by a heat shrink polymer, which can be replaced as necessary when damaged through continuous use of the tool in an abrasive environment. When carrying out this operation, direct heat evenly over the barrel to reduce thermal stressing of the material and ideally use two heat guns applied to opposite sides of the barrel.

Electronic Chassis

The electronic chassis is two stainless steel flat 10x3mm bars with intermediate spacers mounted between the circuit board.

Electronic Details

The ALT Dual Induction tool uses a combination of conventional and surface mount technology in the design of the circuit boards. Circuits are designed for over voltage and current protection. For this reason, if a failure does occur, it is probable that several components will be affected and it is generally preferred to exchange circuit boards rather than individual components. **Any work carried out on the tool without prior consultation with either ALT or an approved service agent is done entirely at the owners risk.**

Provision of circuit details is restricted to the power supply and communications.

Alimsond 3 - LV Tool Power Supply

Circuit Description

The Alimsond power supply board is a fly back DC-DC converter accommodating an input ranging from 80-150V, and producing regulated output voltages of +5V and ±15V with a total output power of up to 15 watts.

The heart of the converter is IC1, a UC3845 dedicated fly back converter IC, working in current mode. IC1 takes control of Q1, a high voltage MOSFET which drives ferrite transformer TR1. Current through TR1 is sensed on pin3 of IC1 across R11//R12. The peak amplitude of this current is adjusted by IC1 feedback circuitry by comparing the internal reference at Pin8 and the feed back voltage sensed from +15V main output to IC1 pin2 (Vfb). IC1 adjusts the current through TR1 by changing the pulse width of the drive signal to Q1. Pulse frequency is set by R4/C3 to about 26kHz. At startup IC1 is powered through R5/R6 from the converter input voltage. Once started it is self powered through R7/D1 by use of a dedicated winding on TR1, pin6&7.

On the secondary side of TR1 rectification is made by D3-D5 ultra fast diodes. Storage capacitors are followed by L-C noise filters to ensure a clean output. Linear post-regulator, IC2, is provided on the +5V output.

+5V output is dedicated to digital circuitry and has a ground connection referred to the converter's input ground.

±15V outputs are dedicated to analog circuitry and are left fully floating, i.e. no common connection with the rest of the PSU, to avoid ground loops and associated noise problems.

Test and Adjustment Procedure

Connect a 10ohm/5watt resistor between DGND and +5V output.
Connect a 330ohm/1watt resistor between AGND and +15V output.
Connect a 330ohm/1watt resistor between AGND and -15V output.

Connect a supply of about 100VDC to the converter board input and check the output voltages are within ±10% of the nominal values.

Adjust +15V output with AJ1 potentiometer and check the regulation by varying the board input supply voltage between 80 and 150VDC.

Troubleshooting

If the PSU is not functioning correctly check the following:

- IC1 input voltage (pin7) >12V
- IC1 reference (pin8) 2.5V
- IC1 output pulse frequency 26kHz
- TR1 current by measuring voltage across R11/R12 with an oscilloscope.

Depending on the load the peak has to be between a few hundred milli-volts and 1 volt which is the maximum allowed value limited by IC1

- Q1,D3-D5
- Short circuited capacitor or defective linear regulator.

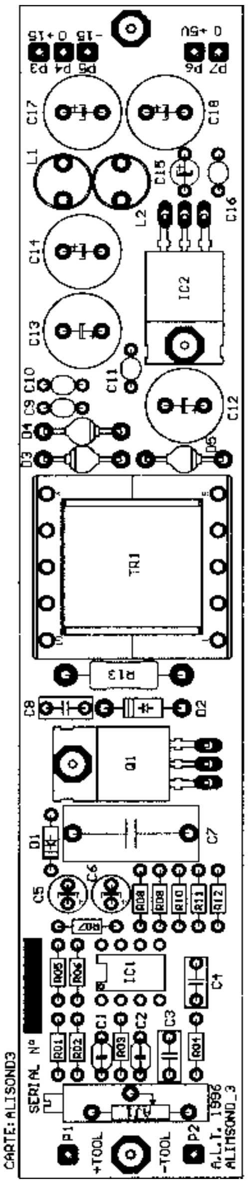
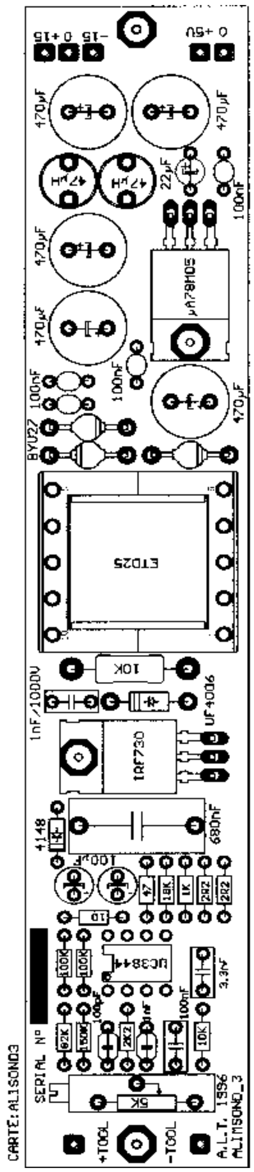


Fig 0-i   Alimsond 3 Board Layout



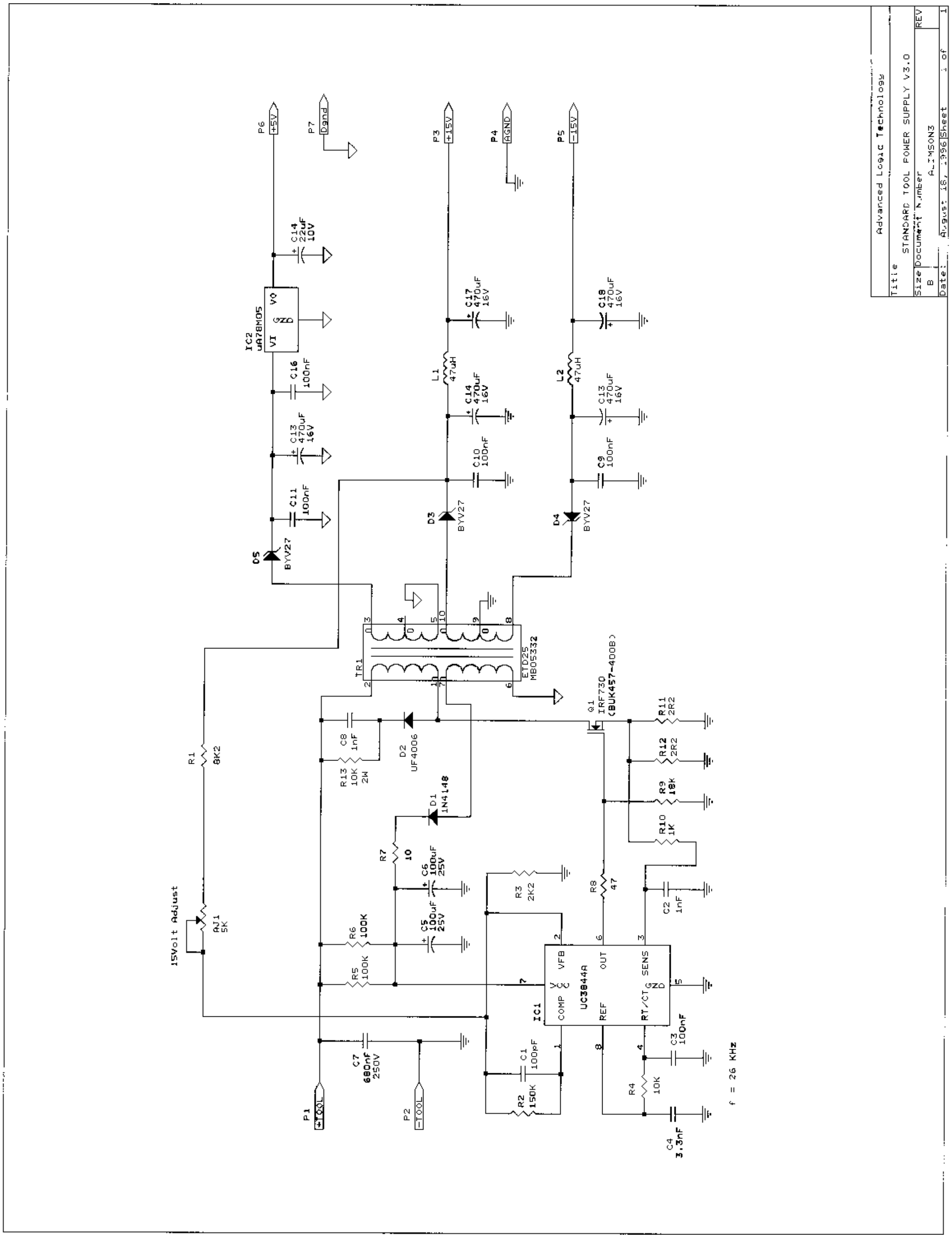


Fig 0-ii Alimsond 3 Schematic

Analog Chain

The signal injection and analog measuring chain make extensive use of surface mount components and may only be maintained by approved ALT service agents. Information on this section is restricted.

Potentiometers on the analog section must on no account be adjusted.

Analog Card Connector

The arrangement for the pin-out of the analog card is as follows

Pin	Function
1	GND
2	ILD o/p –
3	nc
4	ILDi o/p
5	nc
6	ILM o/p
7	nc
8	ILMi o/p
9	nc
10	GND

Electronics

The design of the ALT DIL45 induction tool is such that the electronics of the tool should not require any recalibration after manufacture. In the event of a major tool failure such as caused by serious over voltage/current supply and short circuits the tool should be returned to ALT or to an approved servicing agent. In normal use the tool electronics are protected against such events.

Natural Gamma Detector (optional)

The natural gamma detector uses a NaI scintillation crystal 100mm x 25ø with Thorn Photonics PMT9224B and HV generator socket. TTL Pulse output is from a standard discriminator circuit based around an LM311 comparator. Discrimination level adjustment is made by turning a 1kohm trim pot accessed through the chassis connector sub. Pulse output is fed to the Processor board via pin10 header H2. This is factory adjusted during a plateau procedure where the Photo-multiplier tube high voltage is adjusted for the most stable tube response at background.