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# STLTX Manual

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# Safety note

**This equipment uses high voltages internally. Any servicing should be performed by competent individuals.**

**Prolonged exposure to high level RF radiation has been shown to pose a health risk. Whilst the equipment is intrinsically safe, its use in conjunction with an antenna system may generate large RF fields. Appropriate precautions should be taken by individuals that habitually work close to the transmitting antenna.**

**The RF power devices of this equipment employ Beryllium Oxide. This substance is extremely toxic if pulverised. On no account should any RF power devices be smashed. Please refer to attached Material Safety Data Sheet for further information.**

**WARNING**

**THIS EQUIPMENT IS SUPPLIED WITH A MAINS LEAD INCORPORATING AN EARTH WIRE. IT IS IMPERATIVE THAT THIS EQUIPMENT IS CONNECTED TO A MAINS OUTLET THAT HAS AN EARTH. IN COUNTRIES WHERE EARTHED OUTLETS ARE NOT MANDATORY, IT IS THE CUSTOMER'S RESPONSIBILITY TO ENSURE THAT THIS EQUIPMENT IS APPROPRIATELY EARTHED.**

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# 1 GENERAL DESCRIPTION

The STLTX is a high quality 5W UHF transmitter intended for point-to-point aural transmission.

Its features include:

- Frequency agile.
- Extensive self test and auto diagnostics.
- Rugged design.
- Conservatively rated.
- Excellent audio quality
- Audio limiter.
- Comprehensive telemetry.
- Flexible configuration.

Applications include low power broadcast, narrowcast, community broadcast, rebroadcast for tunnels, student radio stations and as a driver for high power transmitters.

The STLTX is designed and built in Australia.

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# 2 UNPACKING

This section details the way in which the STLTX should be unpacked upon receipt by the customer.

The STLTX should be removed from its packing, and the packing stored and used should it be necessary to return the STLTX to the manufacturer.

Along with the transmitter, the following items should also be present:

- This manual
- Mains lead
- Spare fuse

The customer should ensure that all items are present and then store them in a safe place.

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# 3 INSTALLATION

## 3.1 General

This section describes the installation and infrastructure requirements for the STLTX. Departure from the instructions contained herein may void any warranty provided by SRK.

The STLTX has been designed to be mounted in a standard 19" rack frame, where it will occupy 2 rack units.

However, the transmitter may also be used in a free standing situation, so long as all other requirements are met as below.

## 3.2 Environmental

The transmitter is intended for indoor use. The transmitter should be protected from rainfall and direct sunlight, extremes of temperature and humidity and from conditions of high dust levels. The transmitter shall not be operated at altitudes in excess of 3500m above sea level. The transmitter must be installed on a flat, stable surface. The transmitter must be installed in the upright position. The transmitter must be installed in a location free from vermin and the ingress of other animals. The transmitter shall not be installed in locations prone to flooding. All ventilation orifices must be clear to allow adequate air flow.

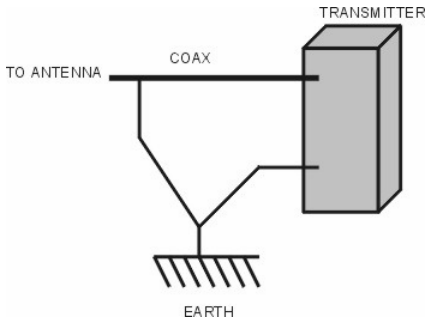
## 3.3 Electrical supply

The electrical supply to the transmitter must be of the voltage, form and frequency described in the specifications. All electrical wiring must be carried out in accordance with local laws, standards and regulations. If power supply voltages regularly fall outside specifications then a voltage regulator must be installed between the supply inlet and the transmitter.

## 3.4 Earthing

Adequate earthing of the transmitter is vital to ensure long term reliability and user safety. The electrical supply must be earthed, via the earthing pin of the IEC connector. In countries where power outlet earthing is merely optional, an earthed outlet **must** be used. See safety notice at the front of this manual. A separate, independent, earth is required for the transmitter/antenna system and must be connected to the earthing point indicated on the rear of the transmitter. The cable used to connect the earth should be as thick as possible, with 8 AWG being the smallest size acceptable. Where possible, broad earthing band should be used.

In addition to the earth connection to the transmitter, the outer conductor of the coax feed to the antenna should be connected to the earth, as indicated below.

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The earth itself must be of high quality buried copper, at least 1.5m deep and preferably in ground that is habitually humid (eg, the base of a gutter down pipe).

### 3.5 Antenna

The antenna load connected to the transmitter must be tuned to minimise reflections. Whilst the transmitter is designed to withstand high levels of reflection for short periods, continually high levels of reflected power will degrade the long term reliability of the transmitter. Operating SWR should be kept to below 1.9:1.

### 3.6 Audio feed

In situations where the audio feed to the transmitter is over any form of land line, suitable protection must be included external to the transmitter to ensure voltage transients do not enter the transmitter. These may be in the form of high power zener diodes and/or gas discharge tubes.

Where the transmitter is co-sited with an AM installation, suitable filtering must be included in the audio feed to ensure that excessive RF voltages do not enter the transmitter.

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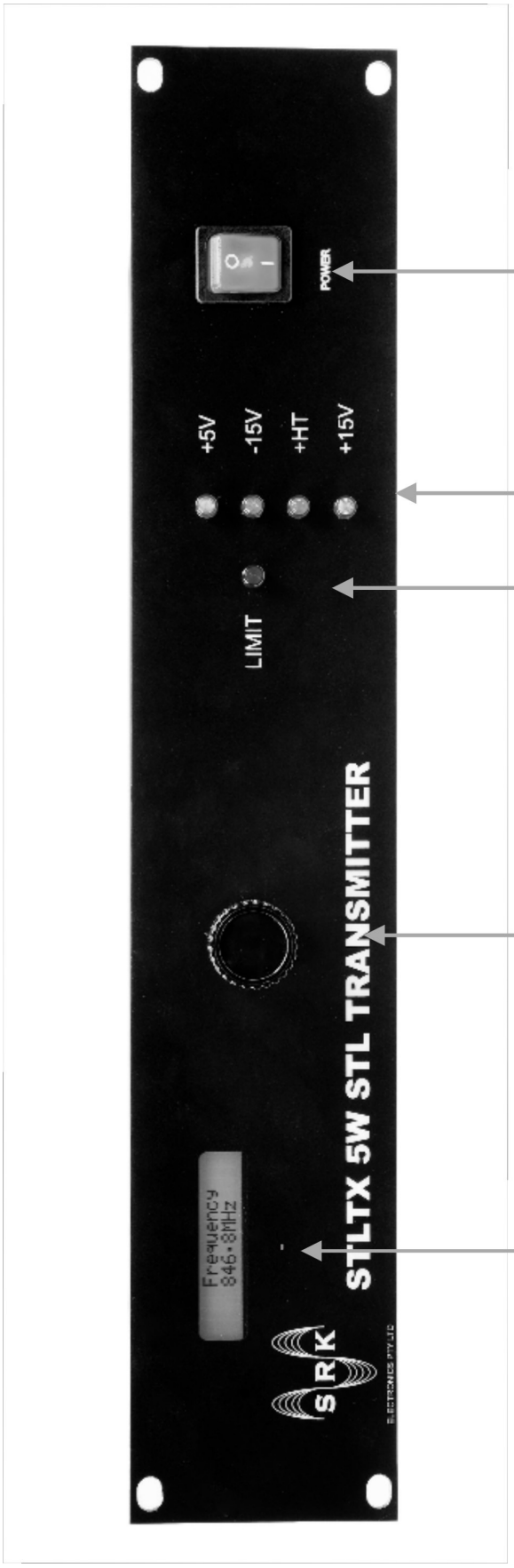


Fig 4.1 Front View

Fig 4.2 REAR VIEW

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# 4 OPERATION

## 4.1 Front Panel

Please refer to figure 4.1. The numbers of the following paragraphs refer to the controls shown in figure 4.1.

1 Power Switch
Switches the transmitter on and off.

2 Power Supply LEDs
Lights green to indicate the presence of internal power supply voltages

3 Limiter LED
Lights red if the modulation is being peak limited.

4 Control knob
This allows all parameters to be read or modified.

5 LCD
Displays current parameter value and any error messages.

## 4.2 Rear panel.

Please refer to figure 4.2. The numbers of the following paragraphs refer to the controls shown in figure 4.2.

6 Remote connector

Remote operation is performed by making connection to this DB9 socket. Please refer to section 4.12 for details

7 Audio input

This is a balanced audio input to the transmitter. Pin designation is as follows:

| | |
|---|---|
| 1 | GND (screen) |
| 2 | +ve audio |
| 3 | -ve audio |

The mating connector should be a male XLR (cannon) type.

Input impedance can either be 600Ω or high impedance, as shown on the LCD.

Note that should it be desired to use these inputs as un-balanced, pin1 should be connected to pin 3 in the mating connector. This will be the return, with pin 2 as signal.

8 Air inlet.

This is the inlet for the air cooling. On no account should this be obstructed.

9 Earth stud.

This is an M6 stud for connecting an earth. This is recommended for superior lightning protection.

10 Mains input.

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This is the mains input, 240V AC unless specified by the customer. Mating connector is IEC female. Any connection made to this socket must incorporate a safety earth.

11 RF out.

This is the RF output and is connected to either the antenna (for stand-alone applications), or the RF amplifier unit. Mating connector is N type male, 50Ω.

12 Fuse.

This is the primary mains fuse and is rated 2A slow blow. Use only ceramic cased replacements.

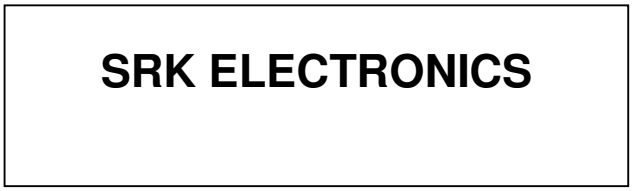
13 Remote

Completing this connection causes the transmitter to be enabled.

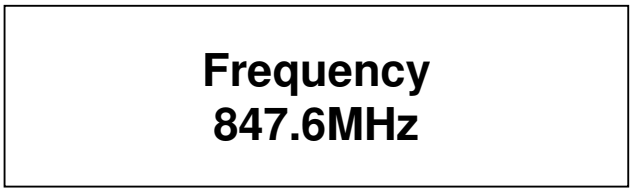
### 4.3 Switching on and off

The STLTX is switched on by depressing the power switch (1) to the down position.

If mains voltage is present then the switch should illuminate. The LCD display will initially show:




When self diagnostics have completed successfully the display will show the current operating frequency. For example:




The STLTX is now in operative mode. The user may set the unit's parameters by either the front panel or remote control.

The STLTX may be switched off at any time by depressing the power switch to the up position.

### 4.4 Setting output power

The RF output power of the STLTX may be read by rotating the front panel knob until the display reads "Forward Power". The current forward power is displayed in watts.

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Pressing the knob momentarily will make the “Forward Power” characters flash. Whilst they are flashing, rotating the knob clockwise will increase the power. Rotating the knob anticlockwise will decrease the power.

When finished adjusting the power, press the knob again momentarily. The “Forward Power” characters will stop flashing and the selected power will remain set.

The power setting is recorded in non-volatile RAM, so it is not necessary to set the power level each time the STLTX is switched on.

Reverse output power may be measured by rotating the knob until the display reads “Reflected Power”. The current reflected power is displayed in watts.

### 4.5 Setting Channel Frequency

The STLTX is fully frequency agile and may be set to any 200KHz channel in the range 845.2MHz to 851.8MHz. This is accomplished by rotating the knob until the display shows “Frequency”. The current frequency is shown on the second line of the display.

Pressing the knob momentarily will make the “Frequency” characters flash. Whilst they are flashing, rotating the knob clockwise will increase the frequency. Rotating the knob anticlockwise will decrease the frequency.

When finished adjusting the frequency, press the knob again momentarily. The “Frequency” characters will stop flashing and the selected frequency will be programmed into the PLL. The frequency will not change until the “Frequency” characters are not flashing.

Note that, whilst the STLTX can work at any frequency in the STL 850MHz band, it is generally not advisable to change the channel at full output power unless the antenna system is broadband. This is particularly true if the STLTX is being used to drive a high power amplifier. The correct procedure is to reduce RF power to zero, change to the new frequency, then slowly increase the RF power, whilst monitoring the reflected power from the antenna.

The channel frequency is stored in non-volatile RAM, so it is not necessary to set the frequency each time the STLTX is switched on.

### 4.6 Setting audio gain

The audio gain of the STLTX may be set between 0 and 100%.

The actual deviation is a function of the audio input level and the audio gain and can be measured by rotating the knob until the display shows “Gain/Deviation”.

Pressing the knob momentarily will make the “Gain/Deviation” characters flash. Whilst they are flashing, rotating the knob clockwise will increase the gain. Rotating the knob anticlockwise will decrease the gain.

When finished adjusting the gain, press the knob again momentarily. The “Gain/Deviation” characters will stop flashing and the selected gain will remain set.

Upon installation, the transmitter should be driven with program audio at the normal level, and the audio gain adjusted to give an approximate peak deviation reading of 100KHz.

The audio gain is stored in non-volatile RAM, so it is not necessary to set the gain each time the STLTX is switched on.

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## 4.7 Selecting pre-emphasis.

The STLTX allows the user to select either 75µS, 50µS or no pre-emphasis.

To view the current pre-emphasis setting, rotate the knob until the display shows “Pre-emphasis”. The current pre-emphasis setting is shown on the second line of the display.

Pressing the knob momentarily will make the “Pre-emphasis” characters flash. Whilst they are flashing, rotating the knob in either direction will sequence through the available pre-emphasis time constants.

When finished adjusting the pre-emphasis, press the knob again momentarily. The “Pre-emphasis” characters will stop flashing and the selected pre-emphasis will remain set.

Note that within Australia, 50µS pre-emphasis is standard.

The pre-emphasis setting is stored in non-volatile RAM.

## 4.8 Audio input impedance.

The audio input impedance may be set to either 600Ω or high impedance, depending upon the characteristics of the equipment providing the audio feed.

To view the current input impedance setting, rotate the knob until the display shows “Input Impedance”. The current input impedance setting is shown on the second line of the display.

Pressing the knob momentarily will make the “Input impedance” characters flash. Whilst they are flashing, rotating the knob clockwise will set the input impedance to high Z. Rotating the knob anticlockwise will set the input impedance to 600Ω.

When finished setting the impedance, press the knob again momentarily. The “Input impedance” characters will stop flashing and the selected impedance will remain set.

Correct selection of input impedance is important to ensure a high level of audio fidelity. As a general rule of thumb, if the STLTX is being driven over land lines or from very old audio equipment, 600Ω should be selected. For all other applications use high Z

## 4.9 Enabling/disabling audio limiter.

The STLTX incorporates a peak deviation limiter which may be switched on or off as desired.

This limiter is preset to prevent deviation in excess of 100KHz.

To view the current limiter setting, rotate the knob until the display shows “Peak limiter”. The current limiter setting is shown on the second line of the display.

Pressing the knob momentarily will make the “Peak limiter” characters flash. Whilst they are flashing, rotating the knob clockwise will turn the limiter on. Rotating the knob anticlockwise will turn the limiter off.

When finished setting the limiter, press the knob again momentarily. The “Peak limiter” characters will stop flashing and the limiter will remain off or on as selected.

## 4.10 Audio Filter

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The STLTX incorporates an audio low pass filter which may be switched on or off as desired.

This is a Bessel filter with a cutoff of 15KHz.

To view the current filter setting, rotate the knob until the display shows “LPF”. The current filter setting is shown on the second line of the display.

Pressing the knob momentarily will make the “15KHz LPF” characters flash. Whilst they are flashing, rotating the knob clockwise will turn the filter on. Rotating the knob anticlockwise will turn the filter off.

When finished setting the filter, press the knob again momentarily. The “15KHz LPF” characters will stop flashing and the filter will remain off or on as selected

### 4.11 Protection

The STLTX incorporates a number of protective features that make it extremely rugged.

If the reflected power from the antenna exceeds 1W then the output RF power will be automatically reduced to bring the reflected power back to 1W. Under this condition the STLTX will continue to function, albeit at a reduced output power, indefinitely until the reflected power reduces. The LCD will show “SWR HIGH”.

If the temperature of the RF amplifier becomes excessive, then the RF output power will be reduced to zero until the amplifier temperature falls to an acceptable level. During this time the LCD will show “TEMPERATURE HIGH”.

If the RF output power cannot be made to equal the value demanded by the SBC then the LCD will show “RF FAILURE”.

### 4.12 Remote operation.

The STLTX may be monitored and controlled remotely via the “REMOTE” connector on the rear of the unit. This is an RS232 standard connection with the following characteristics:

| | |
|---|---|
| Baud rate: | 9600 |
| Data bits: | 8 |
| Parity: | NONE |
| Stop bits: | 1 |
| Flow control: | NONE |

The pinout for the DB9 connector is as follows: pin 2, transmit data, pin 3, receive data, pin 5, common (0V). All other pins are not connected.

The STLTX responds to the following commands. <CR> indicates the ASCII character 0D hex. All letters are upper case, spaces (20 hex) are indicated by “_”. All commands must be terminated by <CR>. Note that a line feed (0A hex) must not be sent before or after <CR>. After a response is sent, a carriage return, line feed and “>” are sent.

**FP?<CR>**
Returns forward power in the form X.XXW<LF><CR>>. For example:

**FP?<CR>** (command)
**5.00W<LF><CR>** (response from transmitter)
**>**

Note that for forward powers of 0.99W and below, the leading zero is replaced with a space

**RP?<CR>**

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Returns reflected power in the form X.XXW<LF><CR>>. For example:

**RP?<CR>** (command)
**_.00W<LF><CR>** (response from transmitter)
**>**

Note that for reflected powers of 0.99W and below, the leading zero is replaced with a space.

**CF?<CR>**
Returns channel frequency in the form XXX.XMHz<LF><CR>>. For example:

**CF?<CR>** (command)
**851.2MHz<LF><CR>** (response from transmitter)
**>**

**PD?<CR>**
Returns the measured peak deviation in the form XXXKHz<LF><CR>>. For example:

**PD?<CR>** (command)
**_45KHz<LF><CR>** (response from transmitter)
**>**

Note that any leading zeros are set to spaces, except for the special case of `0KHz`.

**AG?<CR>**
Returns the current audio gain in the form XX%<LF><CR>> or XX.XX%<LF><CR>>. For example:

**AG?<CR>** (command)
**95%<LF><CR>** (response from transmitter)
**>**

Note that any leading zeros are set to spaces.

**PE?<CR>**
Returns the current pre-emphasis time constant in the form None<LF><CR>>, 75uS<CR><LF>> or 50uS<CR><LF>>. For example:

**PE?<CR>** (command)
**None<LF><CR>** (response from transmitter)
**>**

**II?<CR>**
Returns the current audio input impedance in the form High_Z<CR><LF>> or 600_R<CR><LF>>. For example:

**II?<CR>** (command)
**High_Z<CR><LF>** (response from transmitter)
**>**

**AF?<CR>**
Returns the current audio LPF status in the form IN<CR><LF>> or OUT<CR><LF>>. For example:

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**AF?<CR>** (command)
**IN<CR><LF>** (response from transmitter)
**>**

**PL?<CR>**
Returns the current peak limiter status in the form On<CR><LF>> or Off<CR><LF>>. For example:

**PL?<CR>** (command)
**Off<CR><LF>** (response from transmitter)
**>**

**ST?<CR>**
Returns the current self test status in the form XXXX<LF><CR>>, where X can be either 0 or 1. A 1 indicates a failure, a 0 indicates a pass. The first byte indicates the locked/unlocked status of the PLL, the second indicates an RF failure, the third indicates a high SWR condition and the fourth indicates an over temperature condition. For further information consult the section on self test. For example:

**ST?<CR>** (command)
**0010<LF><CR>** (response from transmitter indicating a high SWR condition)
**>**
or
**0000<LF><CR>** (response from transmitter indicating no failures)
**>**

**FP=XX.X<CR>**
Allows the forward power to be set to the value X.XX, up to 5.00W. Valid range for X.XX is 00.0 to 5.00. For example:

**FP=3.06<CR>** (command, sets forward power to 3.06W))
**Ok<LF><CR>** (response from transmitter indicating that command has been executed)
**>**

**CF=XXX.X<CR>**
Allows the channel frequency to be set to the value XXX.X. Valid range for XXX.X is 845.2 to 851.8. For example:

**CF=848.8<CR>** (command, sets channel frequency to 848.8MHz)
**Ok<LF><CR>** (response from transmitter indicating that command has been executed)
**>**

**AG=XX<CR>**
Allows the audio gain to be set to the value XX. Valid range for XX is 00 to 99. For example:

**AG=67<CR>** (command, sets audio gain to 67%)
**Ok<LF><CR>** (response from transmitter indicating that command has been executed)
**>**

**PE=NONE<CR>, PE=75US<CR>, PE=50US<CR>**
Allows the pre-emphasis to be set. For example:

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**PE=75US<CR>** (command, sets pre-emphasis to 75µS)
**Ok<LF><CR>** (response from transmitter indicating that command has been executed)
**>**

**II=600R<CR>, II=HIGH_Z<CR>**
Allows the audio input impedance to be set. For example:

**II=600R<CR>** (command, sets input impedance to 600Ω)
**Ok<LF><CR>** (response from transmitter indicating that command has been executed)
**>**

**FE<CR>**
Unlocks the front panel to allow parameters to be altered locally. For example:

**FE<CR>** (command to enable the front panel)
**Ok<LF><CR>** (response from transmitter indicating that command has been executed)
**>**

**FD<CR>**
Locks front panel. Parameters can be measured but not changed locally. For example:

**FD<CR>** (command to disable front panel)
**Ok<LF><CR>** (response from transmitter indicating that command has been executed)
**>**

**HP?<CR>**
Returns a summery of the above commands.

Any data received by the transmitter, other than the commands listed above will generate the following error string:

**Invalid_command.__Send_HP?(CR)_for_command_syntax.<LF><CR>**
**>**

Any data outside the valid range for the parameter concerned will generate the following error string:

**Incorrect_value_or_syntax.__Send HP?(CR)_for_help.<LF><CR>**
**>**

Should it be necessary to make connection to the remote port using cables running external to the building housing the STLTX, it is recommended that external filtering and transient protection be installed on these lines.

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# 5 MAINTENANCE

## 5.1 Recommended maintenance schedule

The STLTX will give many years of trouble free service with little or no attention

It is advisable to replace the fuse every 5 years. This will prevent un-expected failures due to fuse fatigue. Note that replacement fuses should be of the ceramic cased variety.

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# 6 CIRCUIT DESCRIPTION

## 6.1 Equipment Overview

The STLTX consists of the following assemblies.

- 12V Switch Mode PSU
- DC-DC converter board
- Main board
- RF Amplifier
- Front panel

## 6.2 12V SMPSU

The SMPSU is an OEM unit, rated 12V at 100W.

## 6.3 DC-DC Converter Board

This board takes in 12V from the SMPSU and generates +/-12V, 5V and +18V for the main board.

## 6.4 Main Board

Balanced audio enters on J4. Possible MF interference is attenuated by C28, C29, L4 and L5. R60 and R61 can be switched in by relay to set the audio impedance to 600Ω.

Transient protection is provided by D5-D8, D17-D20, R58 and R59.

U17 is a professional quality line receiving amplifier which turns the differential input signal to a single sided version for processing by the rest of the circuit.

Gain control is provided by U8 (a four quadrant multiplying DAC) and U19A. The output of U19A is directly proportional to the digital values held on the eight data lines. These are latched in from the front panel by U10 and level shifted by U9 and Q2.

Selectable pre-emphasis is provided by the network feeding U21. The control signals for this switch are provided by the front panel. In this way it is possible to set the pre-emphasis to 75, 50 or none.

Peak limiting is provided by the circuitry around U23 and U5B. This can be disabled by the switch formed by U27 going open. This is also controlled by the front panel.

U25 is a window comparator which detects when the limiter is clipping. This causes a pulse stretcher, formed by U26, to light the “LIMITING” LED. This provides a clear indication of the limiting action.

U22 forms an 8 pole Bessel low pass filter with a cutoff frequency of 15KHz. This can selectively be enabled or disabled by the front panel, using the change over switch formed by U27. U5A is a wide band amplifier of the same pass band gain as the filter so that when switching the filter in and out of circuit, no adjustment to audio is necessary.

This signal is then used to frequency modulate the PLL.

The PLL is based on a highly integrated device, U2. This takes in a highly stable 10MHz clock from J7 and divides it down to a 100KHz reference frequency.

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VR7 sets the carrier frequency to with 1KHz of nominal.

The PLL chip generates a control voltage for the low noise VCO (U13) which is filtered and level shifted by C15-18, R42, R44 and U1.

The VCO signal is fed back to the PLL chip to ensure a the carrier frequency is as programmed by the front panel.

## 6.5 Front Panel

The front panel allows the user to set and measure all of the parameters of the STLTX. Please refer to the appropriate schematic.

The heart of the front panel is U1, an MCU. This device generates all of the control signals and provides all of the metering for the STLTX, as well as the telemetry functions. It runs at a clock frequency of 8MHz, determined by X1. U1 performs the following functions:

The analogue signals on pins 37, 39 and 40 (forward volts, reverse volts and peak deviation) are digitised and processed so that these parameters can be read on the LCD or via telemetry.

The status of the digital line on pins 38,21, 20, 19 and 16 are monitored to allow the status of the various parts of the transmitter to be displayed on the LCD or via telemetry.

The LCD is controlled by the lines on pins 24, 26 and 27. The data bus for the LCD is on pins 1 to 8.

The audio input impedance is controlled by the level on pin 25.

The forward power is set by the average value on pin 18. This is a PWM signal running at approximately 20KHz. This signal is filtered by U4 to generate an analogue voltage between 0V and +5V.

As there are more signals required than available pins on the MCU, an external latch is used to give extra outputs., U3.

This device generates the signals to program the PLL, audio gain, pre-emphasis peak limiter and audio filter status.

Telemetry is provided by the internal USART of U1, and brought to RS232 levels by U2.

All parameters may be set manually using the rotary encoder, S1. The three lines from S1 are monitored by U1.

Power supply and limiter status are shown by the appropriate LEDs.

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# 7 TROUBLE SHOOTING

## 7.1 Auto diagnostics

The STLTX incorporates extensive self test and auto diagnostics. This section describes this.

The auto diagnostics is performed by the front panel, the results of which are displayed on the LCD. In addition to the protection functions, the following messages are able to be generated to aid the user in faultfinding, should it become necessary:

PLL FAILURE

This message indicates that the PLL is out of lock. This will mean that the carrier frequency is not correct. As this could lead to high reflections from the antenna system, the front panel reduces RF power to zero for the duration of this failure.

HIGH SWR

This message indicates that the reflected power is greater than 1W and is usually indicative of an antenna failure.

RF FAIL

This message indicates that the power control loop is unable to generate the required RF power. This usually indicates that the RF power amplifier has failed.

OVER TEMPERATURE

This message indicates that the amplifier temperature is in excess of 85ºC. RF power will be reduced until the amplifier temperature falls below 70ºC.

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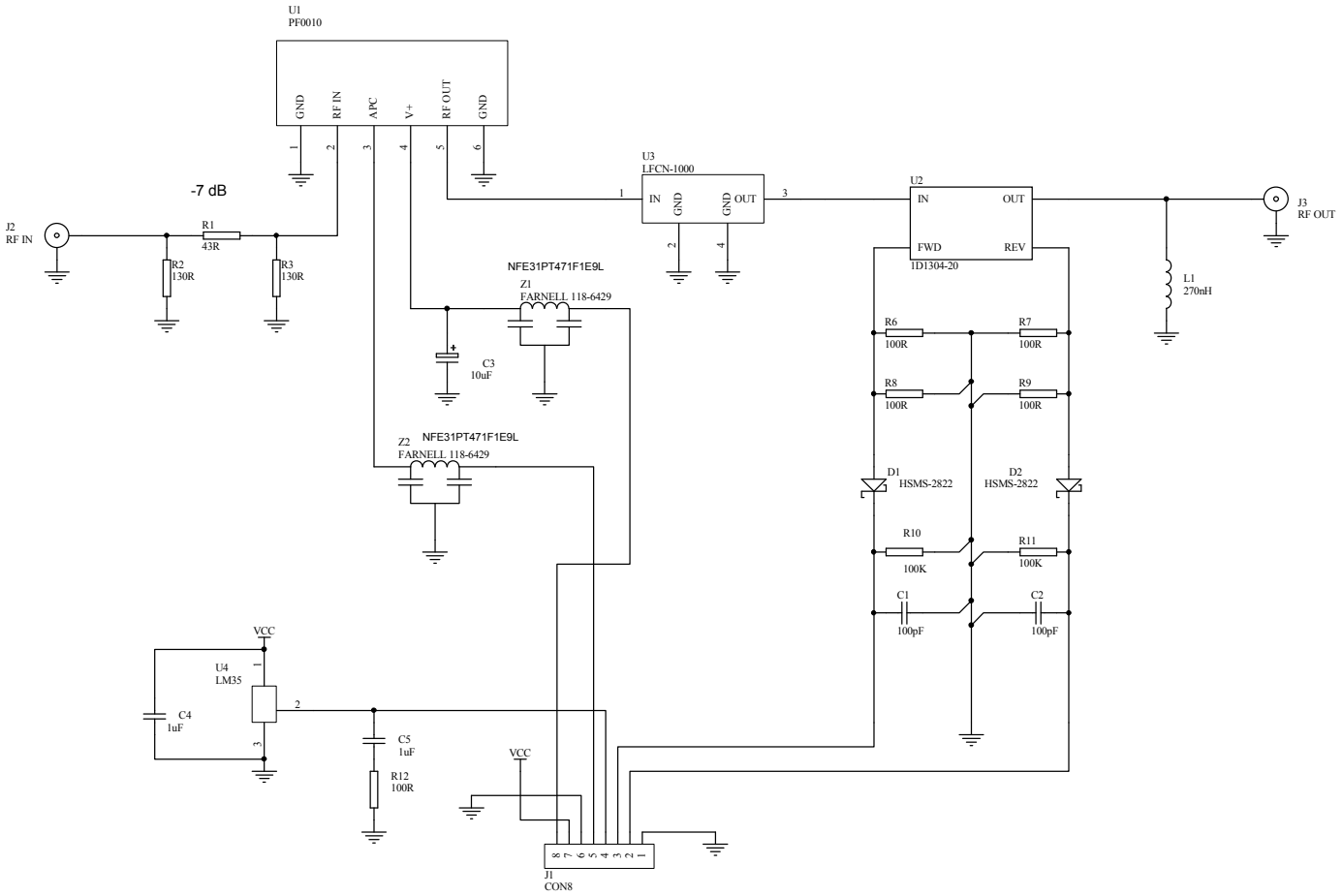
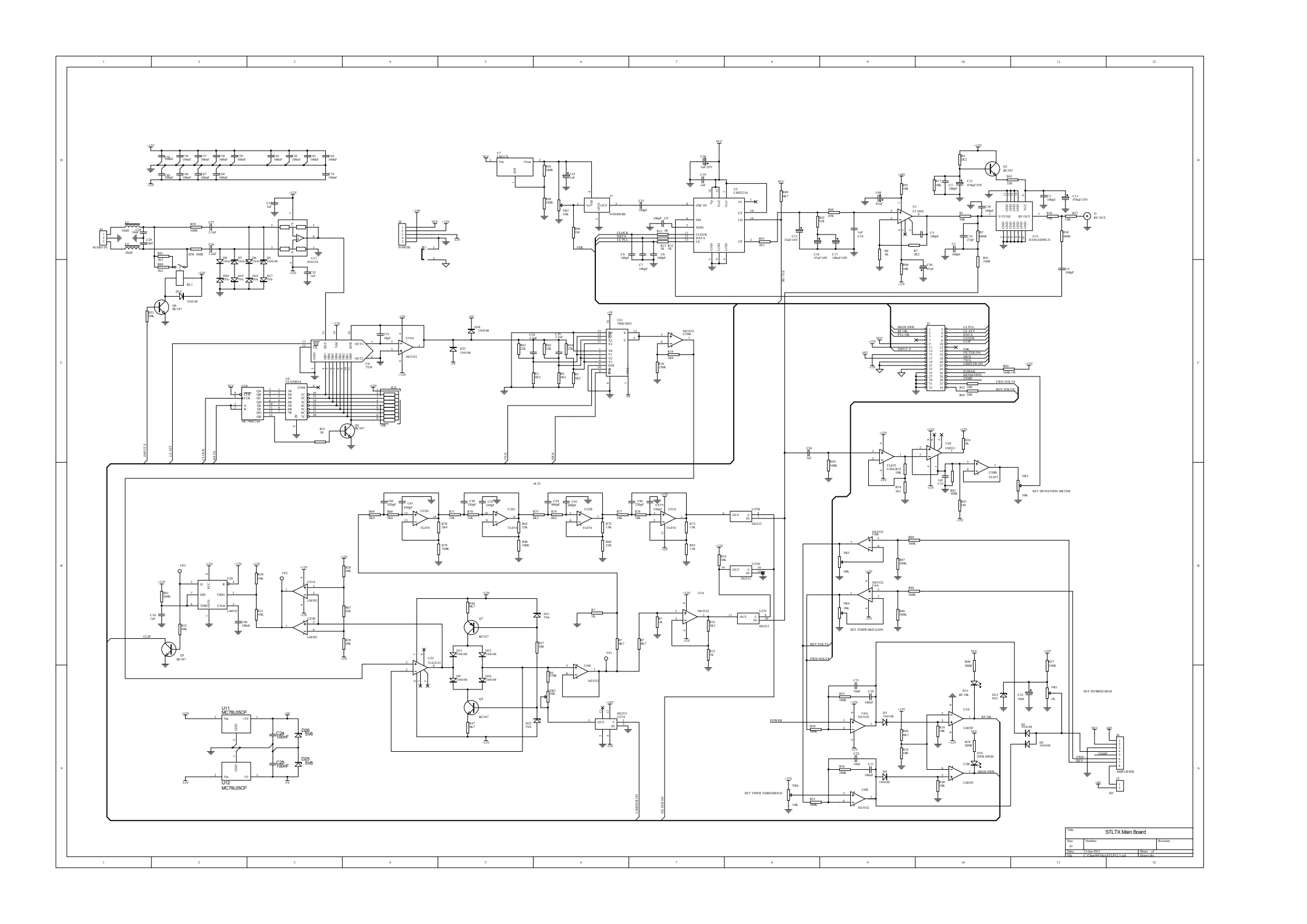



| | | | |
|---|---|---|---|
| Title | STL Power Amplifier | | |
| Size | Number | | Revision |
| A3 | | | |
| Date: | 13-Jan-2011 | Sheet of | |
| File: | C:\Client98\Files\STL amp 2.sch | Drawn By: | |


STLTX Main Board
Size
A1
Number
Revision
Date: 1-Jan-2011
File: C:\Sam2PCB\ex\STLPLL3.sch
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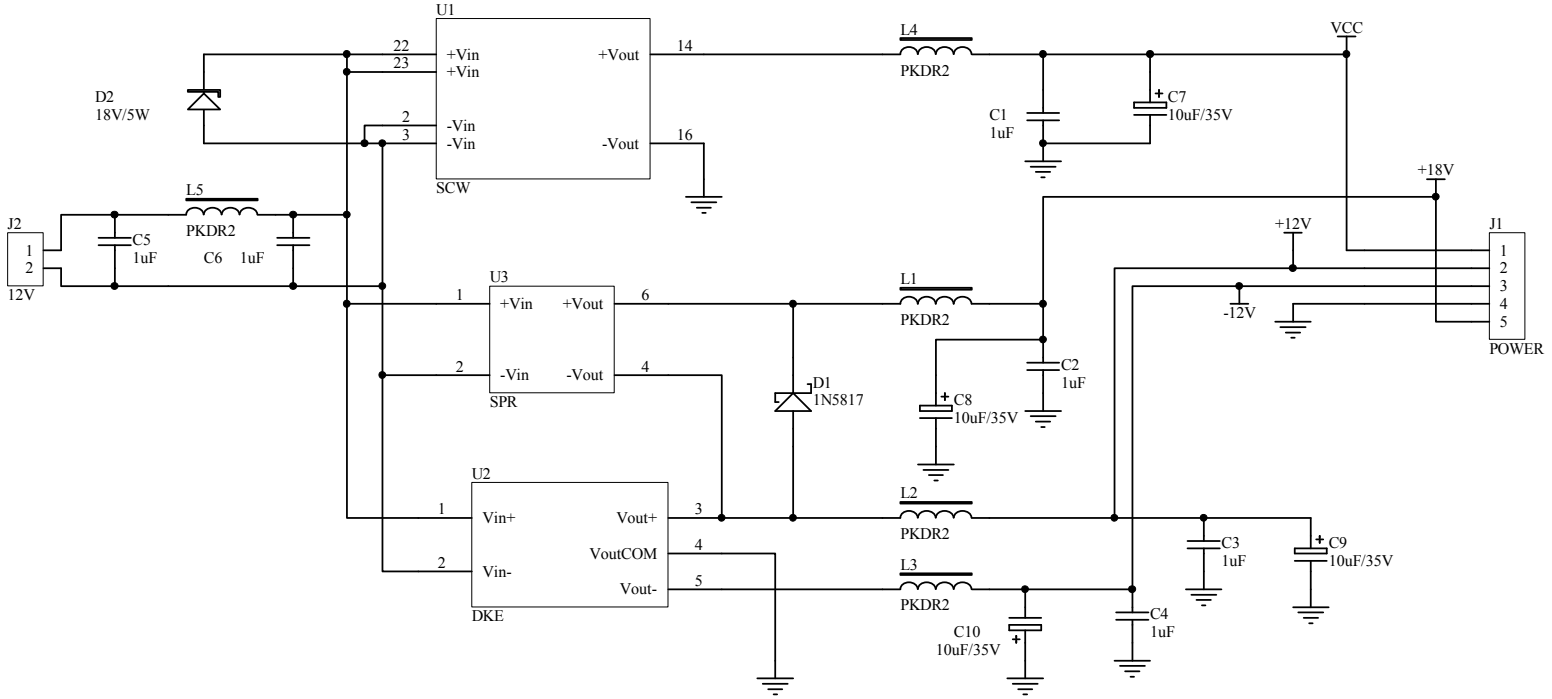


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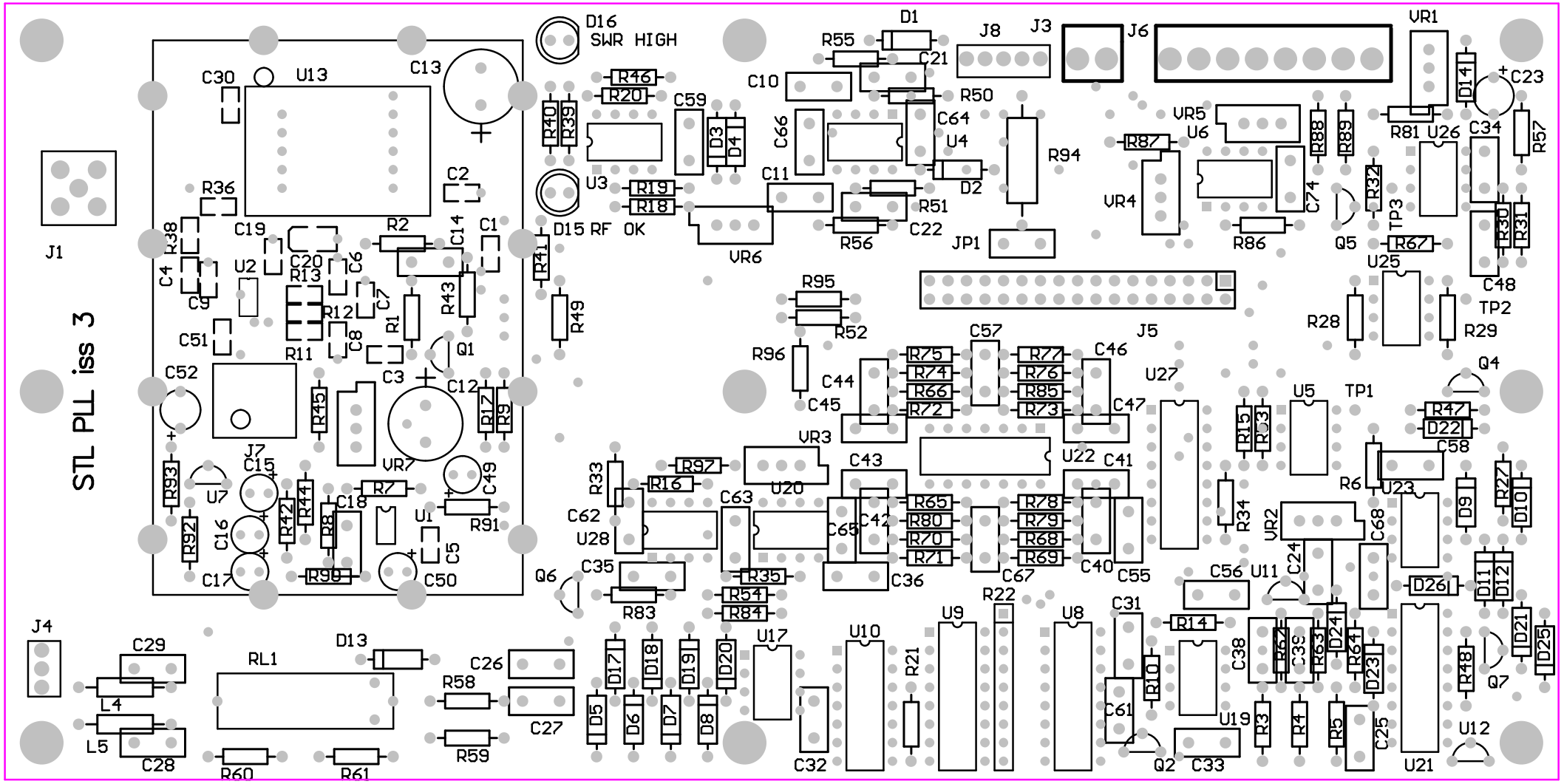
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# MATERIAL SAFETY DATA SHEET

## I PRODUCT IDENTIFICATION

**Trade Name**: Beryllia Ceramic
**Synonym**: Beryllium Oxide, Beryllia, Thermalox, Super Beryllia
**Chemical Family**: Beryllium Compound

## II HAZARDOUS INGREDIENTS

| Constituents | OSHA(1995)* | ACGIH(1994-95)* | CAS # | NIOSH/ RTECS # |
|---|---|---|---|---|
| Beryllium | PEL: 0.002 | TLV: 0.002 | 7440-41-7 (Be) | DS1750000 |
| | Ceiling: 0.005 | TLV-STEL: NA | 1304-56-8 (BeO) | DS4025000 |
| | Peak: 0.025 | | | |

*All concentrations are in $mg/m^3$ (at the concentrations noted above, this constituent may not be visible to the human eye).

ESPI recommends the following good industrial hygiene practice which includes reducing airborne exposures to the lowest feasible level for all constituents in this product. A leading scientific body recommending occupational standards is the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH recommends standards for all listed substances. The ACGIH defines a threshold limit value (standards) as follows: "Threshold Limit Values refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects."

Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit; a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness. "Individuals may also be hyper-susceptible or otherwise unusually responsive to some industrial chemicals because of genetic factors, age, personal habits (smoking, alcohol, or other drugs), medication, or previous exposures. Such workers may not be adequately protected from adverse health effects from certain chemicals at concentrations at or below the threshold limits."

## III PHYSICAL DATA

| | | | |
|---|---|---|---|
| **Boiling Point**: | N/A | **Sublimes At**: | N/A |
| **Evaporation Rate**: | N/A | **Vapor Density (Air=1)**: | N/A |
| **Freezing Point**: | N/A | **Vapor Pressure (mm Hg)**: | N/A |
| **Odor**: | None | **% Volatile By Volume**: | None |
| **pH**: | N/A | **Color**: | White |
| **Physical State**: | Solid | **Melting Point (°F)**: | 2547 (BeO) |
| **Radioactivity**: | N/A | **Molecular Weight**: | 25.01 (BeO) |
| **Solubility**: | None | **Density (g/cc)**: | 2.86 (BeO) |

## IV FIRE AND EXPLOSION HAZARDS DATA

**Flash Point**: N/A
**Explosive Limits**: N/A
**Extinguishing Media**: N/A

**Unusual Fire and Explosion Hazards**: N/A
**Special Fire Fighting Procedures**: If this material becomes airborne as a respirable particulate during a fire situation, pressure-demand self-contained breathing apparatus must be worn by firefighters or any other persons potentially exposed.

## V HEALTH HAZARD INFORMATION

**Emergency Overview**: If this material is involved in a fire, pressure-demand self-contained breathing apparatus and protective clothing must be worn by persons potentially exposed to the metal fumes or airborne particulate.

**Primary Routes of Exposure**:
**Inhalation**: An exposure to airborne beryllium in excess of the occupational standard can occur when sintering, machining, grinding, sanding, abrasive cutting, polishing, laser scribing and trimming, chemical etching, crushing, or otherwise abrading the surface of this material in a manner which generates finely divided particles.

Volatile beryllium hydroxide can be formed when firing solid BeO parts at temperature greater than 900 $^{o}$C in a moist atmosphere such as in a hydrogen atmosphere sintering furnace.

Machining operations conducted under a flood of liquid coolant usually require complete hooded containment and local exhaust ventilation. Openings into the hood must be baffled to prevent release of fast moving particles. The cycling through a machine of liquid lubricant/coolant containing finely divided beryllium in suspension can result in the concentration building to a point where the particulate may become airborne during use. The coolant reservoir should be enclosed and ventilated. A coolant filtering system is recommended.

**The Potential for Exposure Also May Occur During Repair or Maintenance Activities on Contaminated Equipment Such as**: furnace rebuilding, maintenance or repair of air cleaning equipment, structural renovation, etc.

**Ingestion**: There are no known cases of illness resulting from ingestion of this material. Ingestion can occur from hand, clothing, food, and drink contact with metal dust, fume or powder during hand to mouth activities such as eating, drinking, smoking, nail biting, etc. This product is not intended for internal consumption. As a standard hygiene practice, hands should be washed before eating or smoking.

**Skin**: Skin abrasion may cause irritation. Imbedded material may lead to localized granuloma. The beryllium in this material is in an insoluble form and does not pose a potential for an allergic dermal response.

**Eyes**: Injury can result form particulate irritation or mechanical injury to the eyes by dust or particulate. Exposure may result from direct contact with airborne particulate (chips, dust, or powder) or contact to the eye if contaminated hands or clothing.

**Effects of Overexposure**:

**Acute**: (immediate or near-term health effects): The beryllium fraction of this product is insoluble and does not cause acute beryllium disease. The beryllium in this product does not pose a potential for allergic dermal response.

**Chronic**: (long-term health effects): Inhaling dust fumes containing beryllium may cause serious, chronic lung disease called Chronic Beryllium Disease (CBD) in some individuals. Over time lung disease can be fatal. Symptoms may include cough, chest pain, shortness of breath, weight loss, weakness, and fatigue. Long-term effects may include loss of lung function, fibrosis, or subsequent secondary effects on the heart with eventual permanent impairment. Chronic beryllium disease is a hypersensitivity of allergic condition in which tissues of the lungs become inflamed with a cellular nodular reaction. This inflammation, sometimes with accompanying fibrosis, may restrict the exchange of oxygen between the lungs and the bloodstream. This allergic response to beryllium is limited to susceptible studies and animal experimentation, the International Agency for Research on Cancer and the National Toxicology Program lists beryllium as a carcinogen.

**Medical Conditions Generally Aggravated by Exposure**: Persons with impaired pulmonary function, airway diseases, or conditions such as asthma, emphysema, chronic bronchitis, etc. may incur further impairment if dust of fume are inhaled. If prior damage or disease to the neurological (nervous), circulatory, hematologic (blood), or urinary (kidney) systems has occurred, proper screening or examinations should be conducted on individuals who may be exposed to further risk where handling and use of this material may cause exposure.

**EMERGENCY AND FIRST AID PRODCEDURES:**

**INHALATION**: Breathing difficulty cause by inhalation of dust or fume requires immediate removal to fresh air. There are no known cases in which a person stopped breathing as a result of exposure. If breathing has stopped, perform artificial respiration and obtain medical help.

**INGESTION**: Swallowing beryllium oxide dust can be treated by having the affected person drink large quantities of water and attempting to induce vomiting, if conscious. Obtain medical help.
**SKIN**: Skin cuts and abrasions should be treated by standard first aid. Skin contamination can be removed by washing with soap and water. Obtain medical help if irritation persists. Accidental implementation of this material beneath the skin requires it be removed to prevent infection or development of a corn-like lesion.
**EYES**: Dust should be flushed from the eyes with a lot of clean water. Obtain medical help if irritation persists. Contact lenses should not be worn when working with metal dusts and powders because the contact lens must be removed to provide adequate treatment.

**Treatment of Chronic Beryllium Disease**: There is not known treatment which will cure chronic beryllium disease. Prednisone or the corticosteroids are the most specific treatment available. They are directed at suppressing the immunological reaction and have been effective in diminishing many signs and symptoms of chronic beryllium disease. In cases where steroid therapy has had only a partial or minimal effectiveness, other immuno-suppressive agents, such as cyclophospharnide, cyclosporine, or methotrexate, have been used. These latter agents remain investigational. Further, in view of the potential side effects of all the immuno-suppressive medications, including steroids such as prednisone, they should be used only under the direct care of a physician. In general, these medications should be reserved for cases with significant symptoms and/or significant loss of lung function. Other symptomatic treatment, such as oxygen, inhaled steroids or bronchodilatores, may be used by some physicians and are effective in selected cases.

The decision about when and with what medication to treat is judgement situation for individual physicians. For the most part, treatment is reserved for those persons with symptoms and measurable loss of lung function. The value of starting oral steroid treatment, before signs or symptoms are evident, remains a medically unresolved issue currently under study. Some physicians are concerned that their patients may develop a resistance to medication if it is started too soon.

The effects of continued low exposure to beryllium are unknown for individuals who are sensitized to beryllium or who have diagnosis of chronic beryllium disease. This uncertainty leads some physicians to advise a reduction or elimination of further exposure to beryllium. However, some individuals have developed CBD or have gradually become worse after removal from further exposure. Others have continued to work in the beryllium industry without any additional, or accelerated, loss of lung function.

## VI REACTIVITY DATA

**General Reactivity**: This material is stable
**Incompatibility (Materials to avoid)**: NA

**Hazardous Decomposition Products**: None under normal conditions of use
**Hazardous Polymerization**: Will not occur
**Ecological Information**: This material is insoluble in water. This material can be recycled.

## VII SPILL OR LEAK PROCEDURES

**Steps to be Taken in Case Material is Released or Spilled**: In solid form this material poses no health or environmental risk. If this material is in powder or dust form, establish a restricted entry zone based on the severity of the spill. Persons entering the restricted zone must wear adequate respiratory protection and protective clothing appropriate for the severity of the spill. Cleanup should be conducted with a vacuum system utilizing a high efficiency particulate air filtration system followed by wet cleaning methods. Special care must be taken when changing filters on HEPA vacuum cleaners when used to clean up potentially toxic materials. Caution should be taken to minimize airborne generation of powder or dust and avoid contamination of air and water. Depending upon the quantity of material released, fine powder or dust spills to the environment may require reporting the National Response Center at (800) 424-8802 as well as the State Emergency Response Commission and Local Emergency Planning Committee.

**Handling and Storage**: Wear gloves when handling to prevent cuts and skin abrasions. Store in a dry area.

**Ventilation and Engineering Controls**: Whenever possible, the use of local exhaust ventilation or other engineering controls is the preferred method of controlling exposure to airborne dust and fume. Where utilized, pickups on flexible ventilation lines should be positioned as close to the source of airborne contamination as possible. Disruption of the airflow in the area of a local exhaust inlet, such as by a man cooling fan, should be avoided. Ventilation equipment should be checked regularly to ensure it is functioning properly. Ventilation training is recommended for all users. Ventilation systems designed and installed by qualified professionals.

**Respiratory Protection**: When potential exposures are above the occupational limits shown in this MSDS, approved respirators must be used as specified by an Industrial Hygienist of other qualified professional. Respirator users must be medically evaluated to determine if they are physically capable of wearing a respirator. Quantitative an/or qualitative fit testing and respirator training must be satisfactorily completed by all personnel prior to respirator use. Users of any style respirator training must be clean shaven on those areas of the face where the respirator seal contacts the face. Exposure to unknown concentrations of fumes or dusts requires the wearing of a pressure-demand airline respirator or pressure-demand self-contained breathing apparatus. Pressure-demand airline respirators are recommended when performing jobs with high potential exposures such as changing filters in a bag house air cleaning device.

**Housekeeping**: Vacuum and wet cleaning methods are recommended for dust removal. Be certain to de-energize electrical systems, as necessary, before beginning wet cleaning. Vacuum cleaners with high efficiency particulate air (HEPA) filters are the recommended type. The use of compressed air or brooms to remove dusts should be avoided as such an activity can result in unnecessary short-term elevated exposures to airborne dusts.

**Maintenance**: During repair or maintenance activities the potential exists for exposures in excess of the occupational standard. Under these circumstances, protecting workers can require the use of specific work practices or procedures involving the combined use of ventilation, wet methods, respiratory protection, decontamination, special protection clothing, and when necessary, restricted work zones.

**Other Protective Equipment**: No special protective equipment or clothing is requires when handling solid forms. Protective over garments or work clothing must be worn by persons who may become contaminated with dusts, fumes, or powders during activities such as machining, furnace rebuilding, air cleaning equipment filter changes, maintenance, etc. Contaminated work clothing and over garments must be managed in such a manner so as to prevent secondary exposure to persons such as laundry operators and to prevent contamination to personal clothing. Never use compressed air to clean work clothing.

**Protective Gloves**: Wear gloves to prevent cuts and skin abrasions during handling.
**Eye Protection**: Wear safety glasses, goggles, or face shield when risk of eye injury is present, particularly during machining, grinding, etc.

**Recommended Monitoring Procedures**:

**Environmental Surveillance**: Exposure to airborne materials should be determined by having air samples taken in the employee breathing zone, work area, and department. The frequency and type of air sampling should be as specified by an Industrial Hygienist or other qualified professional. Air sample results should be make available to employees.

**Medical Surveillance**: Persons exposed to airborne concentrations of this material should be included in a periodic medical surveillance program. The program should include examination of the skin and respiratory systems. Non-specific findings of skin rash, skin granulomata, or respiratory signs or symptoms may indicate a reaction to this material. A minimum medical surveillance program should include (1) skin examination, (2) respiratory history, (3) auscultation of the lungs, (4) spirometry (FVC and FEV), and (5) periodic chest x-ray. In addition, a specialized, specific, immunological blood test, the beryllium blood lymphocyte proliferation test (BLPT), is available ( on a limited basis to assist in the diagnosis) to screen beryllium-exposed persons for beryllium reactions. Note: It should be recognized that BLPT has limited sensitivity for chronic beryllium disease. Individuals who have an abnormal BLPT are normally referred to a lung specialist for additional specific tests to determine if chronic beryllium disease is present.

## VIII SPECIAL PROTECTION INFORMATION

**Transport Information**: There are nor U.S. Department of Transportation hazardous material regulations which apply to the packaging and labeling of this product as shipped by ESPI. Hazard Communication regulations of the U.S. Occupational Safety and Health Administration require that this material be labeled.

**Regulatory Information**: OSHA Hazard Communications Standard, 29 CFR 1910.1200: Beryllium is considered a hazardous ingredient.

**Ambient Air Emissions**: Beryllium-containing materials are subject to the National Emission Standard for Beryllium as promulgated by EPA (40 CFR 61, Subpart (C). The National Emission Standard for beryllium is 0.01 micrograms per cubic meter (30 day average) in ambient air for those production facilities which have been qualified to be regulated through ambient air monitoring. Other facilities must meet a 10 gram per 24-hour total site emission limit. Most process air emission sources will require an air permit from a local and/or state air pollution control agency. The use of air cleaning equipment may be necessary to achieve a permissible emission. Tempered makeup air should be provided to prevent excessive negative pressure in a building. Direct recycling of cleaned process exhaust air is not recommended. Plant exhausts should be located so as not to re-enter the plant through makeup air or other inlets. Regular maintenance and inspection of air cleaning equipment and monitoring of operating parameters is recommended to ensure adequate efficiency is maintained.

**Wastewater**: Wastewater regulations can vary considerably. Contact your local and state governments to determine their requirements.

**Toxic Substances Control Act**: Beryllium is listed on the TSCA Chemical Substance Inventory of Existing Chemical Substances.

**Sara Title III Reporting Requirements**: On February 16, 1988 the U.S. Environmental Protection Agency (EPA) issued a final rule that implements the requirements of the Superfund Amendments and Re-authorization Act (SARA) Title III, Section 313 (53) Federal Register 4525. Title III is the portion of SARA concerning reporting on specific chemicals which are manufactured, processed or used at certain U.S. Industrial facilities.

Beryllium is reportable under Section 313. The Chemical Abstracts Services number is provided in this MSDS. SARA Title Hotline 1-800-535-0202 or 202-555-1411

This MSDS has been revised following the guidelines outlined in the American National Standard for Hazardous Chemicals Z400.1-1993 “Material Safety Data Sheets-Preparation.”

## IX SPECIAL PRECAUTIONS

**Disposal Considerations**:

**Byproduct Recycling**: When recycled (used in a process to recover metals), this material is not classified as hazardous waste under federal law. Dusty or dust-like materials should be sealed inside two plastic bags, placed in a DOT approved container, and appropriately labeled.

**Solid Waste Management**: When spent products are declared solid wastes (no longer recyclable), they must be labeled, managed and disposed of, in accordance with federal, state and local requirements. This material is not classified a hazardous waste under federal law.

Prepared by: S. Dierks
Dated: January 1996