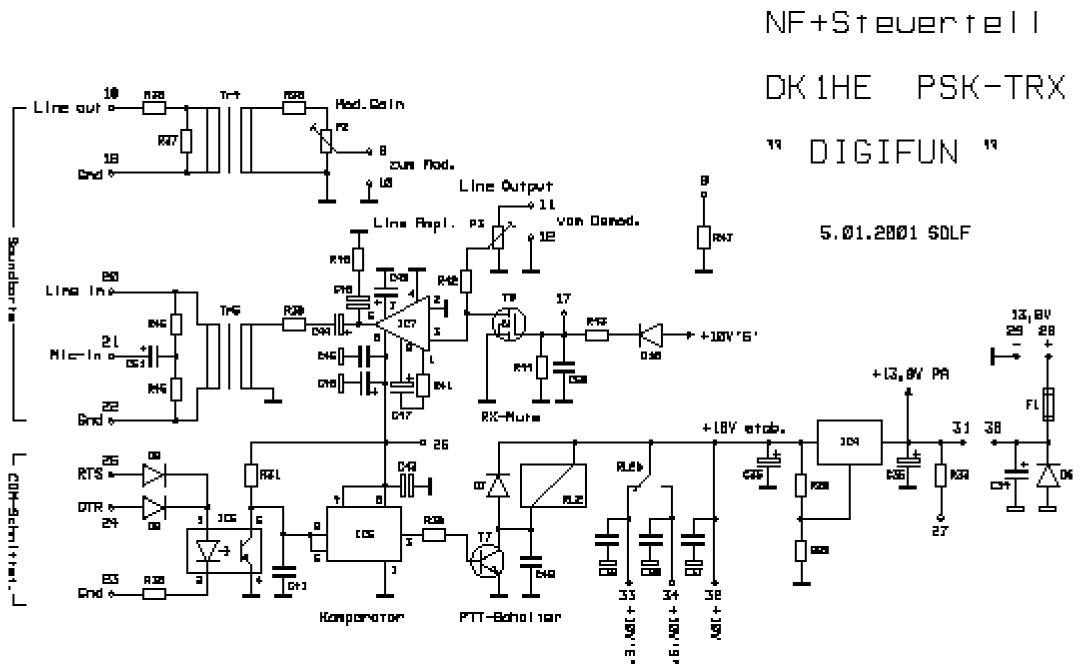
DL-QRP-AG



DigiFun PSK31 Transceiver

Version: 24.November 2003

Handbucherstellung: fiservice Peter Zenker DL2FI email:info@qrpidee.de

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The first steps
What you need to know

You don’t have to be an electronics expert, but you have to know some of the basics before you delve into this adventure.

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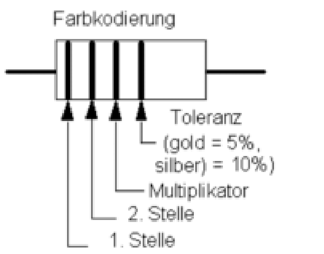
Colour coding: (Resistors, capacitors, inductances)



Farbe	Wert	Multiplikator
Schwarz	0	x 1
Braun	1	x 10
Rot	2	x 100
Orange	3	x 1k
Gelb	4	x 10k
Grün	5	x 100k
Blau	6	x 1M
Violett	7	
Grau	8	
Weiß	9	
Silber	–	x 0,01
Gold	–	x 0,1

You must be familiar with the standard colour coding of electronic components. If you’re not sure, measure with an ohmmeter.
Some 8% of the male populations is red/green colour blink. Many doesn’t even know. If you are one of these, you should measure all resistors with an ohmmeter before mounting them.
The color-code chart next page shows how to read the four color bands on 5% resistors. 1% resistors are similar, except that they use five bands (three significant digits, multiplier, and tolerance). For example, a 1,500 ohm (1.5 k) 5% resistor has color bands BROWN, GREEN, and RED. A 1.5 k, 1% resistor has color bands BROWN, GREEN, BLACK, BROWN. The multiplier value is 1 rather than 2 in the 1% case because of the third significant digit.

Because 1% resistors have color bands that are sometimes hard to distinguish clearly, you should always check their resistance using an ohmmeter.

The markings on RF chokes reflect their value in microhenries (µH). Like 5% resistors, chokes use two significant digits and a multiplier. Example: an RF choke with color bands RED, VIOLET, BLACK would have a value of 27 µH.

Soldering

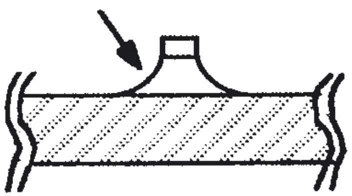
If this is not your first encounter with a soldering iron. If it is, or this is your first semiconductor project, read the following tips.

Soldering iron:

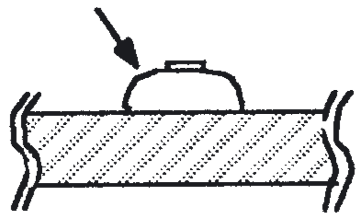
Use a 50 to 80 W soldering iron if possible. A 0,8 mm pencil tip is ideal. Keep the tip clean. Use a moist sponge or a moist cotton cloth to clean the tip regularly during work. On ground areas, you might need a larger soldering iron tip.

Only heat the soldering point enough for a good connection. A small vise for holding the pc board is a great help
The printed circuit board is double sided and all holes are plated-through. This means that you need not, and indeed should not, solder on the component side of the board.

How to recognize a good and a bad soldering:



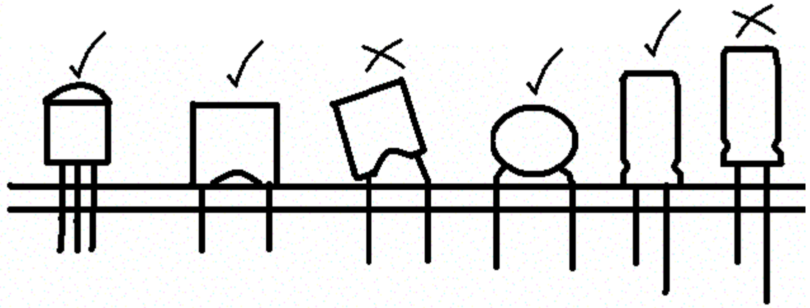
GOOD
Ideal: the soldering point is rounded and concave.



BAD
Too much solder has been added

Touch pc board and component at the same time with the soldering iron. Within one or two seconds add solder, to see solder flow at soldering point. Pull away solder and then pull away soldering iron.

Don’t try to fill up the soldering points with solder. Too much solder leads to trouble, as it can bride pc board or components. Press components as far into the board as possible. This is not a question of good looks, but an RF technical must. Resistors should be flush with the pc board, when not indicated, that they should be mounted standing. Capacitors have to be flush too. In other words: No components with long wires.



Please read the following, before removing components from the pc board

Oh Noooo! Sooner or later you have to remove components, that have been soldered into wrong places, or a parts has to be removed to locate malfunctions.
Get a roll of solder wick. Put the end of the solder wick on the soldering point to be removed, and push the soldering iron to the wick. After a few seconds, you pull, as the wick absorbs the solder. Remove the wick (vertically, never to the side!). Repeat this till the soldering point is clean. It can necessary to reheat the soldering point for the removal of the component. Only heat the soldering point for the necessary time; the copper foil can lift off from the pc board, if overheated.

If this doesn’t work, you have to cut the component connector and pull it with a pair of pliers. Contact DL2FI for replacement parts

If you have to remove a transistor, you are strongly advised to cut it on top of the pc board. The TO-92 soldering points are especially small, and attachments are removed more easily one at a time without damaging the board. After removal of the components, the pc board holes are probably filled with solder. Use a needle. Heat needle and board at the same time, till you can push the needle through the board. Steel needle don’t take the solder, so the hole is freed.

If you don’t know what to do?

Turn confidently to me. This is easy by email to support@qrpproject.biz by phone (+49) (0)30 859 61 323.

DL2FI, Peter, known as QRPeter. Ham radio operator since 1964.

I have built and used QRP equipment for several years, and am convinced, the the great opportunity for ham radio is the rediscovery of home brewing. My motto is Ham radio will be again, when it is what is was.

Based on this conviction I founded the DL-QRP-AG, a work group for QRP and home brew, in 1997. Since then, the group has grown to more than 2300 members, who have developed several excellent pieces of gear, adding to the international succes of QRP and home brewing. Since january 2002 I have spent a lot of time as chairman of the DARC Berlin Chapter, as I feel a lot better doing things, than just complaining. The international QRP movement has taking me on as their first german member of their Hall of Fame.

I wish you good luck in building the DigiFun and 73 de Peter, DL2FI.

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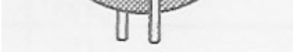

PSK31–DigiFun–Transceiver
DIGIFUN is an acronym for digital mode, giving fun!

Short data:

- All band function with interchangeable band modules
- Reciever with large dynamic range
- Heavy duty transmitter (max. output 10 Watt)
- Adjustable transmitter output
- Offset adjustment of transmission frequency
- S meter and transmitter power indicator
- Interface for sound card with optional line in or mic in (level)
- RS232 interface for PTT
- All pc ports are potential free
- Very low external wiring distance

Kit description:

The PSK transceiver consists of the following 3 pc boards:

Pc board 1:
Frequency control
Receiver input
T/R mixer
Transmitter with output filtering
T/R switch
Pc interface with LF coupler and optocoupler
PTT control and voltage regulator

Pc board 2:
Band module (band crystal and T/R band pass filters)

Pc board 3:
9 MHz IF section
Demodulator
AGC circuit
S meter/Power indicator circuit
9 MHz exciter (USB only)

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Note: Pc board 3 is the original "Hohentwiel" IF section, modified for 9 MHz. For changes see diagram and parts list.

Circuit description of the individual stages:

1. LO/Frequency control

The local oscillator feeds the T/R mixer. It works straight, that is directly on the needed frequency. A crystal oscillator was chosen, as PSK is worked on fixed frequencies, demanding high stability. To provide for any future frequency changes, the oscillator is fitted with a fine tuning circuit that means, you may shift the frequency window by some kHz.
T1 works as a Colpitts oscillator with C1, C2, D1 and L4 as a parallel resonant circuit, tuned to the frequency of Q1. Q1 is working series resonant. By adjusting the voltage of D1, the working frequency can be adjusted slightly. R1 suppresses lower harmonics of Q1. From the 17 meter band upwards, 3. overtone crystals are used, with no problems in this setup. P1 adjust the level of the local oscillator signal at the mixer. The oscillator is followed by T2, an FET buffer. The broad band transformer TR1 in the drain of T2 serves to impedance match the 50 Ohm input of the following broad band amplifier IC1, raising the local oscillator signal to +7 dBm (measured at the local oscillator port of M1, M1 NOT installed and the port closed with 50 Ohm).

2. Receiver input:

The input signal is led from the antenna realy RL2a to the input circuit of L1/C8/C9 on the band module. The coupling to the RX preamplifier IC2 is dimensioned to give a high Q, and thus a high selectivity. IC2 has good large signal properties, and gives some 15 dB of amplification. The amplified signal is fed to the intermediate filter of L2, L3, C5, C6 and C7 via the T/R relay RL1. This filter is dimensioned to give high spurious image suppression. The input signal is finally fed from L3 to the RF input of the mixer M1, where it is mixed with the local oscillator signal to the 9 MHz IF, and fed out via pc board pins 1 and 2 to the IF section.

3. Transmitter:

The 9 MHz SSB signal from the exciter (on the IF board), the other way through M1, which now acts as a transmitter mixer. It is mixed with the local oscillator signal to the working frequency. L3, L2, C5, C6 and C7 now works as a band pass filter for the transmitter signal. The signal is fed via L3 to the T/R relay RL1, and on to the broad band transmitter preamplifier IC3. IC3 lifts the signal to the level required by the PA. The PA is a slightly modified DL-QRP-PA as created by DL2AVH: The PA quiet current is adjustable by P1, and is no longer dependent on the 13,8 V board voltage, nor the driver quiet current. The output transformer TR3 is larger than in the original, which definitely is necessary in PSK mode (to much dissipation). The maximum power consumption is some 10-12 Watt. TR3 is followed by a three stage low pass filter with a 35 MHz limit. This reduces TV band spurious by more than 60 dB. If the transmitter is kept below 5 Watt, it is so linear, that a band selective output filter is unnecessary. The power output of the harmonics is at least 35 dB below the carrier, and this can be further lowered by an antenna tuner, which is a must with broad band PA's anyhow.
If you like much better harmonic surpression, QRPproject can provide you with a special low pass filter module with on board Low pass filters switched by relais to keep the good IMD of the receiver concept. D3 works as a measuring rectifier for the relative output meter. The PIN diode D5 protects the RF input against his RF voltages during transmission. These voltages can develop in the low cost antenna relay RL2a.

4. IF section:

The IF section contains the following

- an 8 pole monolithic 9 MHz crystal filter with a band width of 2,4 kHz
- a three stage regulated IF amplifer
- low noise FET product detector
- an active AF low pass filter
- fast attack AGC voltage generator
- amplifier for S meter and transmitter output indicator
- microphone preamplifier
- balanced modulator
- sideband oscillator
- driver for the transmitter mixer
- DC regulation of transmitter output

The T/R switchin in this section is done by reed relays in DIL casings. This gives the following advantages over diode switching:
- lower Übersprechdämpfung
- precise switching conditions
- no intermodulation effects, especially at lower frequencies
- only power consumption on transmission
- no need for coupling and decoupling capacitors or current limiting resistors
- no more space demands on the pc board.

Receiver functional description:

The 9 MHz signal from the RF section goes via RL1 to the gate coupled T1. The low input impedance of T1 gives a broad band coupling for the receiver mixer. A separate diplexer can thus be left out. R2 regulates the working impedance of T1 and the input inpedance match for the crystal filter, QF1. R8 is the output load for the filter. The signal is then fed through a three stage selective 9 MHz amplifier. The basic amplification of this chain is set to some 70 dB by the dividers C21/C22 and C27/C28. By using MOSFETs and intermediate filtering, this is superior to broad band cascaded Ics. The amplification is often too large in such sections and the SSB modulator is flooded with noise. The product detector makes for an additive FET mixer with T8. R35 puts its working point in the curved part of the characteristic curve. The buffer T7 gives some 0,3 Veff RF side band signal via L6 to the source of T8. By using a FET, the noise is reduced significantly compared to an NE612. Intermodulation is no problem, thanks to preselection. The demodulated AF signal is taken from the drain of T8 and fed to the following low pass filter (IC3). The band limit is set to 3 kHz. The resulting steepness is about 18 dB/octave. C68 couples the AF signal to the line amplifier IC7, and to the AGC amplifier. To get the negative regulating voltage for the IF, the signal from the AF is amplified in IC4 and rectified by D3/D4 to the negative value required. To obtain fast attack, C75 is run on a high charging current. Normal op amps can't deliver the necessary currents fast enough, so an AF amplifier (LM386) was chosen. R58 dampens the regulator and avoids overregulation. R59 defines the decay time constant. To regulate the IF stages, we put gate 1 to negative voltages, only possible by using MOSFETs. This gives the further advantage over gate 2 regulation of lower distorsion. If the gate 2 voltage is reduced from +4 V to maybe negative values, the internal supply voltage of the lower cascade FET is lowered pulling the working point to the non-linear part of the characteristic curve. By the chosen regulating method, the supply voltage of the cascaded FETs are held, but the working point of the lower FET is pushed toward less steepness, just as in the good old days of vacuum tubes. T12 works as a voltage follower and feeds the output indicator amplifier (IC4b). P3 can be used to set the zero point of the meter. R67 serves to limit max. voltage for the output instrument. By using an op amp, close to any instrument can be used. IC4a works as a voltage amplifer for the relative output of the transmitter. R68 and R67 is determined experimentally (description follows). P4 adjust full scale value for max. output.

Transmitter functional description:
The AF signal from the sound card is coupled via TR4 to the microphone amplifier IC2, and fed on to the balanced modulator IC1 via C60/R44. T11 blocks IC2 when receiving. The side band oscillator contained in IC1 controlled by Q1 determines the side band carrier frequency. P1 is used to adjust the carrier suppression (balance). L5 couples the DSB signal from IC1 to the gate of T4 via RL2. R8 determines the working impedance of the stage. The DSB signal is led backwards through crystal filter QF1 and is fed to gate 1 of T2. The resulting 9 MHz SSB signal is fed via RL1 to the transmitter mixer at a level of –6dBm (some 100 mVeff). The transmitter output can be adjusted by regulating the DC voltage of gate 2 on T2 (pin 20).

5. PC interface:
Hooking up the sound card optimally for PSK, needs a special interface:

- full isolation of pc and transceiver ground to avoid hum
- correction of signal voltages between sound card and transceiver
- program control of T/R switching

A „real“ broadband AF transformer is used to isolate the inputs, with a maximum loss of 0,5 dB in the entire pass band (300 Hz to 3500 Hz). This means no cheap impuls- or light show transformers!

The AF signal from the RX demodulator is amplified to about 0 dBm = 770 mVeff in IC7 (adjustable by P3), and fed by 1:1 transformer TR5 to line in on the sound card. Older sound cards doesn’t have a line in, and for these cases the voltage can be divided by R45/R46 to some 8 mV and fed to the mic in instead. C51 serves to block the mic in DC supply voltage.

The AF voltage from the sound card is lowered by R36/R37 by some 40 dB and coupled via the 1:1 transformer TR4 to the input of the transmitter modulator. P2 is used to adjust the mic gain.

T/R switching is done via a free com port by the PSK program. The RTS/DTR of the port is activated. The Darlington optocoupler of IC5 gives a galvanic isolation. The comparator, IC6, serves to give a well defined switchin point (necessary because of the optocoupler parameters). T7 is activated over R32, which feeds RL2 to the switching proper.

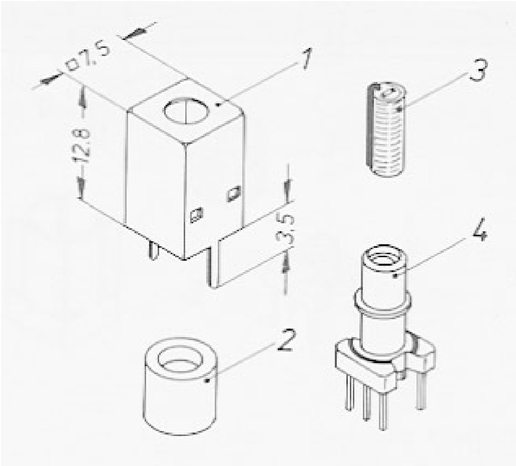
The analog switch of T8 eliminates voltage surges during T/R switching, to protect the sound card input.

6. Voltage stabilizing:
The low drop voltage controller IC4 gives a highly stable 10 V supply for the transceiver. It works within a supply range of 11 to 15 V.

Building

Let's start with the if. As the same pc board is used in our 2 meter CW/SSB transceiver, we have some experience to lean on. For the DigiFun some parts are left out! It is thus very important to keep to the parts list, as the numbering is identical. The diagram is found in the appendix.

Every coil set consists basically of the coil form with five leads, a can, a ferrite adjustable core and a ferrite covering core. For some coils the covering core is left out, but the adjustable cores are always used. An underlay disc is also supplied to avoid short from the can to the pc board. Many use these discs, others don't and solder the forms and cans to the board with a little distance instead.



1=can
2=covering core
3=adjustable core
4=coil form

The coils are generally wound in the lower chamber of the form, and usually as one layers coils, closely wound. In coils with a symmetrical coupling winding, you always start with the coupling winding, and then winds the main winding on top of that. On top means on top. That is side by side, not in a second layer. It is important to have the cold end of the coil at the proper lead of the form. Which end is the cold end? The cold end of a coil is the one closest to ground. The connection to ground can be direct, or via a capacitor of e.g. 100 nF. This is equal in an RF sense, as such a capacitor has close to no RF impedance.
If the lower chamber of the coil form has insufficient room, the surplus has to be wound as a second layer from top to bottom.

- The turns are put in one layer in the lower chamber. The beginning is from the bottom of the form, close to the pc board. If the height of the chamber is insufficient, the surplus is wound from top to bottom as a second layer.
- If a coupling winding is necessary at the cold end, you will begin with that. For all coils, the cold end is the one closest to ground.
- The cold end hasn't allways to be grounded. Cold means RF cold. That means direct coupling or via a capacitor. The wire and hre capacitor can also be coupled to plus on the power supply. Look at L2 and L4, their cold ends are toward C20 and C25 respectively.
- L5 has a special status. In this the resonant winding is symmetrical, the electrical midpoint is at the midpoint of the coil. The coupling winding must be as precisely centered over the main coil as possible to avoid asymmetry. Any deviation from this will lower the carrier suppression.

The isolation lacquer of the copper wires doesn't need to be scratched off, when soldering the coils. Especially by the thin 0,1 mm wires, it should be quickly soldered. The lacquer layer evaporates. A common error is to "cook" the coils for too long, getting internal shorts in the coils.
Important notice: When using covering cores, they have to be glued to the coil form, e.g. with a drop of epoxy glue.
To avoid shorts between the can and the pc board, it is recommended to use an isolating disc as an underlay (Neosid IP7 nr.: 70411300).
The coil windings should be fixed by some UHU hart glue or equal.
One of the most common questions is, why we don't use prewound coils. The answer is simple: Prewound coils can be adjusted to the right frequency, but the transformation ratio is seldom optimal. We hams want to optimise our gear. This implies winding our own coils.
The IF board seldom presents any real problems. But it is advised to work from back to front, always being able to test stages during building. That is begin with the AF stage. This is relatively easy to test by giving an AF signal on the input. When this works, the product detector is built. Then

the IF amplifier and the crystal filter. Then the modulation amplifier and the balanced modulator. Last the AGC, to finish this board.

During building, it is recommended to mark the parts list as you build. The list is in parts number order.

[ ]	R1	470R			
[ ]	R2	1k=Filter impedance	[ ]	R3	3,3K
[ ]	R4	27R	[ ]	R5	68R
[ ]	R6	100K	[ ]	R7	100K
[ ]	R8	1k=Filter impedance	[ ]	R9	100K
[ ]	R10	68R	[ ]	R11	270R
[ ]	R12	220R	[ ]	R13	27R
[ ]	R14	150K	[ ]	R15	100K
[ ]	R16	100K	[ ]	R17	68R
[ ]	R18	27R	[ ]	R19	150K
[ ]	R20	100K	[ ]	R21	100K
[ ]	R22	68R	[ ]	R23	27R
[ ]	R24	1,8K	[ ]	R25	0R (short)
[ ]	R26	100K	[ ]	R27	150K
[ ]	R28	22K	[ ]	R29	100K
[ ]	R30	68R	[ ]	R31	27R
[ ]	R32	150K	[ ]	R33	100K
[ ]	R34	5,6K	[ ]	R35	68K
[ ]	R36	390R	[ ]	R37	100K
[ ]	R38	100K	[ ]	R39	left out
[ ]	R40	left out	[ ]	R41	left out
[ ]	R42	left out	[ ]	R43	left out
[ ]	R44	15K	[ ]	R45	220K
[ ]	R46	1K	[ ]	R47	10K
[ ]	R48	10K	[ ]	R49	47K
[ ]	R50	390R	[ ]	R51	560R
[ ]	R52	8,2K	[ ]	R53	120K metal film
[ ]	R54	120K metal film	[ ]	R55	4,7K
[ ]	R56	1K	[ ]	R57	4,7R
[ ]	R58	330R	[ ]	R59	33K
[ ]	R60	left out	[ ]	R61	18K

[ ]	R62	5,6K	[ ]	R63	68K
[ ]	R64	220K	[ ]	R65	12K
[ ]	R66	33K	[ ]	R67	tuning notes!
[ ]	R68	tuning notes	[ ]	R69	33R
[ ]	P1	10K trim pot PT10	[ ]	P2	10K trim pot PT10
[ ]	P3	10K trim pot PT10	[ ]	P4	10K trim pot PT10
[ ]	C1	10nF	[ ]	C2	10nF
[ ]	C3	10nF	[ ]	C4	47pF
[ ]	C5	10nF	[ ]	C6	100pF
[ ]	C7	10nF	[ ]	C8	10nF
[ ]	C9	10nF	[ ]	C10	10pF
[ ]	C11	12pF	[ ]	C12	22nF
[ ]	C13	10nF	[ ]	C14	10nF
[ ]	C15	100pF	[ ]	C16	10nF
[ ]	C17	10nF	[ ]	C18	10nF
[ ]	C19	10nF	[ ]	C20	10nF
[ ]	C21	47pF	[ ]	C22	220pF COG
[ ]	C23	10nF	[ ]	C24	10nF
[ ]	C25	10nF	[ ]	C26	10nF
[ ]	C27	47pF	[ ]	C28	220pF COG
[ ]	C29	10nF	[ ]	C30	10nF
[ ]	C31	47pF	[ ]	C32	100pF
[ ]	C33	47pF	[ ]	C34	220pF COG
[ ]	C35	220pF COG	[ ]	C36	3,3pF
[ ]	C37	10nF	[ ]	C38	10nF
[ ]	C39	10nF	[ ]	C40	10nF
[ ]	C41	47pF	[ ]	C42	10nF
[ ]	C43	10nF	[ ]	C44	10µF 16V rad.
[ ]	C45	4,7nF			
[ ]	C46	Film trimmer 30pF 7mm red	[ ]	C47	left out
[ ]	C48	left out	[ ]	C49	22pF
[ ]	C50	left out	[ ]	C51	22nF
[ ]	C52	10nF	[ ]	C53	10nF
[ ]	C54	left out	[ ]	C55	10µF 16V rad.
[ ]	C56	47µF 16V rad.	[ ]	C57	left out
[ ]	C58	left out	[ ]	C59	left out
[ ]	C60	0,033µF Film 63V RM5	[ ]	C61	100µF rad.

[ ] C62 100µF 16V rad.
[ ] C64 1nF
[ ] C66 820pF Styroflex 63V
[ ] C68 1µF 35V rad.
[ ] C70 10yF 25V rad.
[ ] C72 47µF 16V rad.
[ ] C74 0,1µF film
[ ] C76 left out
[ ] C78 0,1µF Folie
[ ] C80 22nF
[ ] DR1 47µH SMCC
[ ] DR3 100µH SMCC
[ ] DR5 100µH SMCC
[ ] IC1 NE612
[ ] IC3 TL071
[ ] IC5 LM358
[ ] T2 BF981
[ ] T4 BF245B
[ ] T6 BF981

[ ] C63 0,1µF film
[ ] C65 0,47µF film
[ ] C67 220pF Styroflex
[ ] C69 100µF rad
[ ] C71 10µF 25V rad.
[ ] C73 0,047µF film
[ ] C75 33µF 16V rad.
[ ] C77 1nF
[ ] C79 22nF
[ ] C81 100µF rad
[ ] DR2 100µH SMCC
[ ] DR4 100µH SMCC

[ ] IC2 TL071
[ ] IC4 LM386
[ ] T1 BF246A
[ ] T3 BF981
[ ] T5 BF981
[ ] T7 BF981

BF981 is sensitive to static voltages. Decharge your hand to ground before touching!
The BF981 (in ist SOT 103 casing) is found is wrapped in aluminum foil for this reason. One lead is longer, that is drain. One lead has a cross, that is source. The remaining leads are the gates. Hold the transistor with the print upwards, and bend all leads carefully down.

[ ] T8 BF245A
[ ] T10 left out
[ ] T12 BF244B
[ ] D2 left out
[ ] D4 AA143
[ ] Q1 crystal 9001,5KHz 30pF
[ ] RL1 Reed relay 12V 1XUm
[ ] RL2 Reed relay 12V 1XUm
[ ] RL3 left out, bridge instead!!

[ ] T9 left out
[ ] T11 BC546B
[ ] D1 ZPD6,8
[ ] D3 AA143
[ ] D5 1N4148
[ ] Q2 left out

[ ] QF1 crystal filter 9M22D or equal

Note:
The filter supplied is smaller than the originally intended, but discontinued filter. It is easily mounted, by inserting it with the leads bent a little outwards. Just push it into the pc board till the ground lugs are level with the pc board bottom. Solder in this position.

[ ] QF2 left out, bridge instead!!

[ ] L1 Neosid-7S, F10b cover and core, 32 turns 0,1mm lacquer isolated copper wire;secondary 4 Turns 0,1mm lacquer isolated copper wire at cold end

[ ] L2 Neosid-7S, F10b cover and core, 32 turns 0,1mm lacquer isolated copper wire; secondary 16 turns 0,1mm lacquer isolated copper wire at cold end

[ ] L3 Neosid-7S, F10b cover and core, 32 turns 0,1mm lacquer isolated copper wire; secondary 16 turns 0,1mm lacquer isolated copper wire at cold end

[ ] L4 Neosid-7S F10B cover and core, 32 turns 0,1 lLacquer isolated copper wire

[ ] L5 Neosid-7S, F10b cover and core, 32 turns 0,1mm lacquer isolated copper wire; secondary 8 Turns 0,1mm lacquer isolated copper wire symmetrically on the middle of the primary winding.

[ ] L6: Neosid-7S, F10b cover and core 32 turns 0,1mm lacquer isolated copper wire; secondary 2 Turns 0,1mm lacquer isolated copper wire at cold end of primary

Tuning of the IF board:
Important notice: to obtain stable function, the board has to be fixed to a metal plate with 5 mm stand offs.

Tuning of the receiver:
Turn in coil cores flush with upper limit of core.
Turn C46 half way in.
Turn AGC potentiometer P2 to ground stop, all other potentiometers to center position.
Don't forget to bridge pin 7/8 for AGC.
Apply +10V and +10V 'E' ("R")
Hook up an RF millivoltmete to the source of T8
Tune L6 to max RF voltage (some 300 mVeff)
Hook up a frequency counter loosely to the source of T8.
Activate RL3
Tune the carrier frequency to 9001,5 kHz with C46.
Deactivate RL3
Activate T9 (pin 19 put to +10V)
Unhook pin 19.
Hook up an AF amplifier to AF output (pin 9/10)
Hook up IF input (pin 1-2) to an unmodulated signal generator at ~ 9 MHz.
Tune generator to a side tone of about 700 Hz. Reduce its output till the IF signal is just perceptible and slightly noisy.
Tune L4, L3 and L2 to max. IF voltage. Reduce the generator signal further if necessary.
After succesfull tuning, a 0,5 µV signal should be well readable
Switch off signal generator
Turn up AGC potentiometer P2 three quarters. Connect pin 7 of IC5b to ground through 2,2 kOhm. Hook up analog volt meter in parallel to resistor (range ~12 V dc).
Gently tune P3 till reading is 0 V.
Reconnect 9 MHz signal generator and slowly turn up the RF voltage. The voltmeter should show a proportional increase. At a certain RF level, the voltage increase levels off. The side tone should remain approximately the same till this signal level is reached.
Note the max. voltage at this level. The S meter series resistor R67 is calculated as follows Rv = Ermax/I at full scale
R68 should have the same value as R67
Disconnect the 2,2 kOhm resistor

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Tuning of the transmitter:
Terminate the 9 MHz port (pin 1-2) with 50 Ohm, parallel to the RF millivoltmeter.
Hook up pin 20 to +4 V (transmitter level potentiometer)
Hook up supply voltage +10V 'S' ("T"); connect pin 19 to +10V; Relay RL3 should not be active; Pin 21 is connect to +10V.
Tune L5 + L1 to max. RF output voltage (~100 mVeff)
Tune P1 (balance) to best carrier suppression (with no modulation).

Building the main pc board.
The main pc board contains the RF section, the control logic and the AF section for connection to the computer, and should pose no problems. Note what was previously written about coils in the IF section. Some might not know the Ics 1 and 2. These are so called MMICS, integrated RF amplifier chips. In the diagram the inputs are shown with "FP", meaning that these leads will need a ferrite bead. A ferrite bead is a small ferrite tube. These should be slipped over the leads of the coupling capacitors, on the IC side. Capacitors and ferrite tubes are mounted as closely as possible to the pc board. The MMIC itself is mounted with as short leads as possible. Input and output are opposite, the other two leads are ground. The input is marked with a dot.
It is wise to mount the parts on the main board in order of their height. A few somewhat difficult steps will be described a little more in detail below. First you will see the usual parts check list.

[ ]	R1	22R	[ ]	R2	33K
[ ]	R3	33K	[ ]	R4	390R
[ ]	R5	15K	[ ]	R6	470R
[ ]	R7	220R	[ ]	R8	68R metal
[ ]	R9	270R	[ ]	R10	4,7R metal
[ ]	R11	1R metal	[ ]	R12	4,7R metal
[ ]	R13	68R metal	[ ]	R14	820R tuning
[ ]	R15	68R	[ ]	R16	56R
[ ]	R17	10R	[ ]	R18	10R
[ ]	R19	1R/metal	[ ]	R20	1R metal
[ ]	R21	1R/metal	[ ]	R22	1R/metal
[ ]	R23	1,2K/metal	[ ]	R24	330R/metall

[ ]	R25	5,6R/metal	[ ]	R26	220R metal 2W
[ ]	R27	1,5K	[ ]	R28	120R/metal
[ ]	R29	820R/metal	[ ]	R30	3,9K
[ ]	R31	10K	[ ]	R32	8,2K
[ ]	R33	820R	[ ]	R34	820R
[ ]	R35	15K	[ ]	R36	56K
[ ]	R37	560R	[ ]	R38	100R
[ ]	R39	560R	[ ]	R40	4,7R
[ ]	R41	left out	[ ]	R42	22K
[ ]	R43	68R	[ ]	R44	270K

R45 and R46 only, when the sound card doesn’t have a line in port

[ ]	R45	680R	[ ]	R46	10R tuning
[ ]	R47	3,9K	[ ]	P1	100R Cermet
[ ]	P2	500R trim pot PT10	[ ]	P3	2,5K PT10
[ ]	C1	1nF	[ ]	C2	22nF
[ ]	C3	47yF/16V/rad.	[ ]	C4	1nF
[ ]	C5	22nF	[ ]	C6	22nF
[ ]	C7	22nF+ferrite bead	[ ]	C8	22nF
[ ]	C9	22nF	[ ]	C10	47nF+ferrite bead
[ ]	C11	47nF	[ ]	C12	47nF
[ ]	C13	47nF	[ ]	C14	47nF+ferrite bead
[ ]	C15	47nF	[ ]	C16	2,2nF
[ ]	C17	47nF	[ ]	C18	47nF
[ ]	C19	0,47yF/63V/film/RM5	[ ]	C20	100nF
[ ]	C21	100nF	[ ]	C22	100nF
[ ]	C23	0,47yF/63V/film/RM5	[ ]	C24	100pF
[ ]	C25	100pF	[ ]	C26	100pF
[ ]	C27	100pF	[ ]	C28	100pF
[ ]	C29	100pF	[ ]	C30	47nF
[ ]	C31	47yF/16V/rad.	[ ]	C32	100yF rad.
[ ]	C33	47nF	[ ]	C34	470yF rad.
[ ]	C35	6,8yF/16V/Tantal	[ ]	C36	6,8yF Tantal
[ ]	C37	22nF	[ ]	C38	22nF
[ ]	C39	22nF	[ ]	C40	100nF
[ ]	C41	0,1yF/63V/film/RM5	[ ]	C42	47nF
[ ]	C43	0,1yF/63V/film RM5	[ ]	C44	10yF/16Vrad.
[ ]	C45	0,047yF/63V/film RM5	[ ]	C46	0,1yF film

[ ]	C47	left out	[ ]	C48	22yF/16V rad.
[ ]	C49	10yF/16Vrad.	[ ]	C50	0,22yF Folie
[ ]	C51	1yF/35V rad.	[ ]	C52	10yF/16V rad.
[ ]	DR1	10yH SMCC	[ ]	DR2	47yH SMCC
[ ]	DR3	47yH SMCC			

[ ] DR4 47yH/toroid FT37/43 12 turns 0,5mm lacquer isolated copper wire

[ ] DR5 47yH SMCC

[ ] RL1 Reed relay 1Xum 12V

[ ] RL2 Rel.Finder 2Xum 12V

[ ] L1 L2,L3

9,5 turns air wound 1mm lacquer isolated copper wire winding on winding wound on 7 mm drill.

[ ] TR4 transformer Conrad 516686

[ ] TR5 transformer Conrad 516686

[ ]	IC1	MSA0885	[ ]	IC2	MSA0785
[ ]	IC3	MSA0885			

IC 1/2 and 3 are MMICs, integrated RF amplifiers. You will find them in the 25x25 mm black containers. IC 1 and 3 are MSA0885 or MAR 8. They are pretty small and have 4 long leads. They are mounted with the printing facing upwards. **The lead with the dot is the input, the opposite is the output. The remaining two leads are ground.**

[ ] IC4 needs a heat sink, don’t forget the isolating disc!

[ ]	IC4	LT1086CT	[ ]	IC5	Optok. 4N33
[ ]	IC6	NE555	[ ]	IC7	LM386
[ ]	T1	BF314	[ ]	T2	BF246A
[ ]	T3	2SC1971	[ ]	T4	2SC1971
[ ]	T5	2SC1971	[ ]	T6	BD202

T3, 4, 5 should be mounted isolated on mica discs.

[ ]	T7	BC337-25	[ ]	T8	BS170
[ ]	D1	ZPD6,8	[ ]	D2	1N4148

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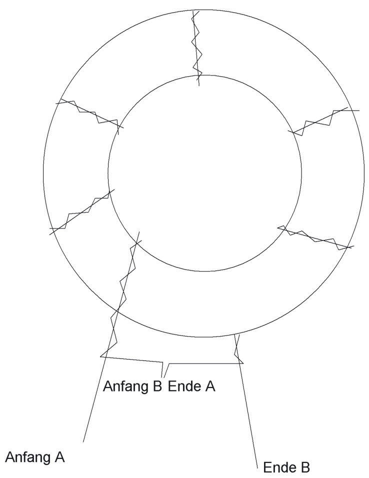
[ ] D3 1N4148
[ ] D5 BA479 S
[ ] D7 1N4148
[ ] D9 1N4148
[ ] D4 1N4148
[ ] D6 1N5402
[ ] D8 1N4148
[ ] D10 1N4148

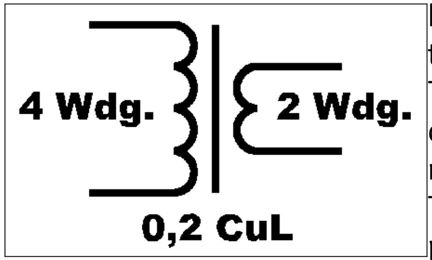
Don’t mount the mixer M1 yet!!!

[ ] TR1 2X6 turns bifilar

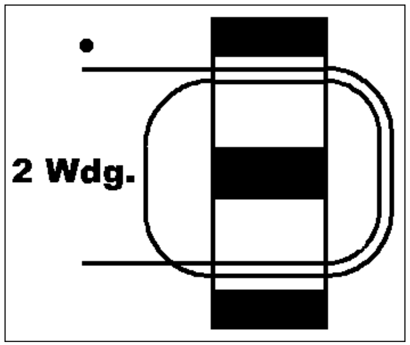


You will need two pieces oflacquer isolated copper wire 0,3 mm, some 20cm long. These should be twisted with 2-3 turns per cm.
Now wind 6 turns onto the FT37-43 toroid. (This is the smaller grey ring. Remember that the first turn is wound by just passing through the core!). Measure the beginning and end of both wires with an ohmmeter.
Connect the end of wire A with the beginning of wire B. This also gives the tap on the middle.

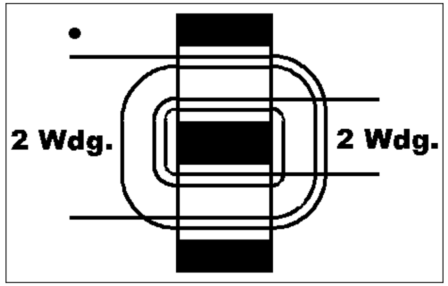
[ ] TR2 small double hole core (QRP-PA)
Put the pig nose core in front of you with both holes pointing from left to right and mark the left with e.g. a drop of nail lacquer. This marking is important, to avoid confusion of secondary and primary on mounting.



TR2 has a primary of 4 turns, and a secondary of 2 turns.
As in most other transformer diagrams, one turn is marked with a dot. The dot always marks the start of a coil winding.
Cut a piece of 0,2 mm wire 14 cm long, and put it through the pig nose as shown in the

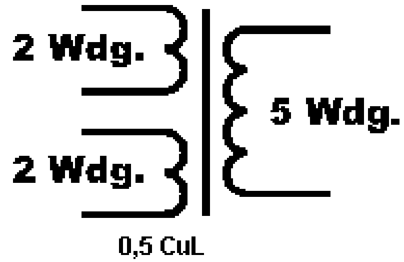


picture. One turn is finished, when the wire is returned through the other holes. Now wind two turns! From the upper left hole, right (leave about 2 cm of lead!), back through the lower hole from right to left.

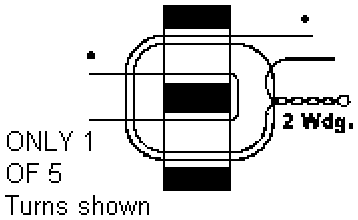


Don’t pull the wire to tightly, to avoid damage to the lacquer.
If you haven’t made any mistakes, two wires should come out from the marked side of the core. A short one on top, and a long one at the bottom (I hope you don’t mind me being so fussy about the instruction. But many mistakes are made on these transformers!).
Cut a 6 cm piece of wire, and put this through the pig nose from the other side, create two turns with this piece too. Now you have a transformer with 2:2 turns. In the next step, take the end of the first wire and wind on as you started, to put on two more turns. This will mean a primary of 4 turns, pointing left, and a secondary of 2 turns, facing right.
Now you have a symmetrical transformer, and just have to mount it. Put the pc board with the VFO section lower left in front of you. Check the wiring with the diagram. The start of the primary goes to the collector of T3, the rest goes clockwise into their respective holes. Cut the wire leads to an acceptable length, cover them in solder and solder the transformer into place. This works best, when you have enough wire too pull the transformer slightly to set it flush with the pc board.

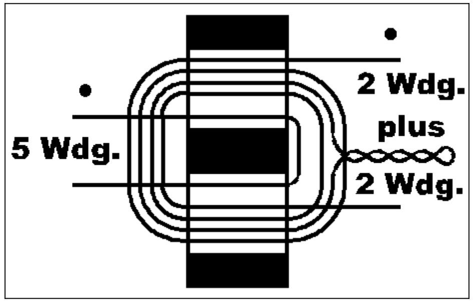
[ ] TR3 double hole core, large, BN43-202



TR3 is no more difficult. Please be careful not to scratch the wire over the edges.
TR3 has a primary of 2 by 2 turns, and a secondary of 5 turns. Cut two 15 cm pieces of 0,5 mm lacquer isolated copper wir. Start at the upper left and wind on 5 turns. This means from upper left to upper right and back from lower right to lower left equals one turn. Back through the upper left to the upper right, back through the lower right towards the lower left = 2 turns. Continue till you have 5 turns. Naturally you will have to wind closer than shown in the picture. Be careful,



when pulling the thin wire through the pig nose, to avoid scratching the lacquer.
Now comes the first of the primary. Take another 15 cm piece of wire, an start opposite to the secondary. That is from upper right to upper left, and back from lower left to lower right. Now the trick: Form a loop of some 30 mm and twist this and continue back through the pig nose. This should look like the picture.
Now continue till your'e through with the primary. At your left, you should now have two wires, and at your right, 3 wires (counting the twisted tap as one wire). Solder all wire ends, and mount the transformer on the pc board.



Now we only have two parts left
[ ] F1 to fuse holder parts + 2,5A

And the connector for the band module
[ ] BU1 31 pole DIN connector

Tuning of the RF board:
There isn't much to tune. The local oscillator level should be adjusted later on, on the band module. And the quiet current of the PA. This is best left till we have built the band module, and hooked up the complete DigiFun.

Build the 20 meter band module first
Building the band module:

[ ]	ST1	DIN connector 31			
[ ]	D1	BB109G	[ ]	Q1	23071,00 kHz
[ ]	R1	560R	[ ]	R2	68K
[ ]	P1	1K trim pot PT10	[ ]	C1	150pF
[ ]	C2	100pF	[ ]	C3	left out
[ ]	C4	10nF	[ ]	C5	47pF
[ ]	C6	47pF	[ ]	C7	1pF
[ ]	C8	39pF	[ ]	C9	10pF

[ ] L1 Neosid filter kit. Primary 24 turns 0,1mm lacquer isolated copper wire. Secondary 3 turns 0,1mm lacquer isolated copper wire at cold end of the primary. Covering and adjusting core, ferrite F40.

[ ] L2 Neosid filter kit. Primary 24 turns 0,1mm lacquer isolated copper wire. Secondary 2,5 turns 0,1mm lacquer isolated copper wire at cold end of the primary. Covering and adjustment core, ferrite F40

[ ] L3 Neosid filter kit. Primary 24 turns 0,1mm lacquer isolated copper wire. Secondary 2,5 turns 0,1mm lacquer isolated copper wire at cold of the primary. Covering and adjustment core, ferrite F40

[ ] L4 Neosid filter kit. 20 turns 0,1mm lacquer isolated copper wire. Covering and adjustment core, ferrite F.

Now the boards are wired together as shown in the diagram. When done, the local oscillator level should be adjusted.
Here we have to adjust the level for the ring mixer to +7 dBm. The problem is, that you can't sensibly measure the level of the used mixer. You have to remember how a ring mixer works, to understand the problem. In ring mixers you will find a diode bridge between to transformers. In the shown circuit, you will only measure the voltage of two Schottky diodes (times the transformation ratio of the transformer). When the local oscillator has to be sensibly adjusted, your will terminate the mixer end of C8 with 50 Ohms and cuts the mixer off from the rest of the circuit (which is why the mixer isn't soldered in yet!).

Pull L4 of the band module to the nominal frequency. Do this with the tuning potentiometer in center position, and then tuning L4. Check with a frequency counter or tunable receiver.

Now you can adjust P1 to +7dBm. That done, solder in the mixer (don't forget to remove the 50R resistor).
[ ] M1 IE500/HPF505
Note, when soldering, not to use too much solder. There is a definitive risk

that the solder will flow through the holes and flood the top side of the pc board, creating shorts. It is best to solder the mixer in a position elevated 0,5 to 1 mm above the pc board.

Last tuning chores:
Connect a weak 14 MHz signal on the reception frequency to the reciever. Tune L1, L2 and L3 in turn to a reception maximum. An analog instrument on the S meter amplifier can help. The signal should be weak enough for the receiver not to saturate.
With the transmitter keyed, but without modulation, the quiet current of the PA should be adjusted with P1 to 200 mA (100 mA per transistor): Measure voltage over R19/R20 and R21/R22. Adjust to 0,05 Volts with P1. (Rtot = 0,5 Ohm. E=R*I = 0,5*0,1). The voltage drop should be the same at both transistors.
With R14 you adjust the quiet current for the driver to som 80 mA. Standard values are about 820R. Only change this, when it is very different. Measure again over the emitter resistor.

Modulation gain potentiometer P2 is adjusted like this: Connect your sound card, and fire up the software. With software in tune mode (CW carrier), turn P2 to full RF output power, measure power consumption. Go to PSK mode to get an idle signal (signal with no characters). Now turn back P2 till the output power consumption goes down to one half.

In recieve mode adjust P3 so that band noise is just seen by the software, but not colouring it much. Weak signal should be noticeable.

That's all folks! DL2FI and DK1HE wish you fun with the DigiFun PSK31 transceiver.

If you have problems, don't throw the transceiver into the corner, but contact support at either email Support@QrpProject.de or telephone 030 859 61 323

Construction of the 10 m band module:

[ ]	D1	BB109G	[ ]	Q1	37121,00KHz series
[ ]	R1	560R	[ ]	R2	68K
[ ]	P1	1K Piher PT10	[ ]	C1	100pF
[ ]	C2	68pF	[ ]	C3	left out
[ ]	C4	10nF	[ ]	C5	33pF
[ ]	C6	33pF	[ ]	C7	1pF
[ ]	C8	27pF	[ ]	C9	6,8pF

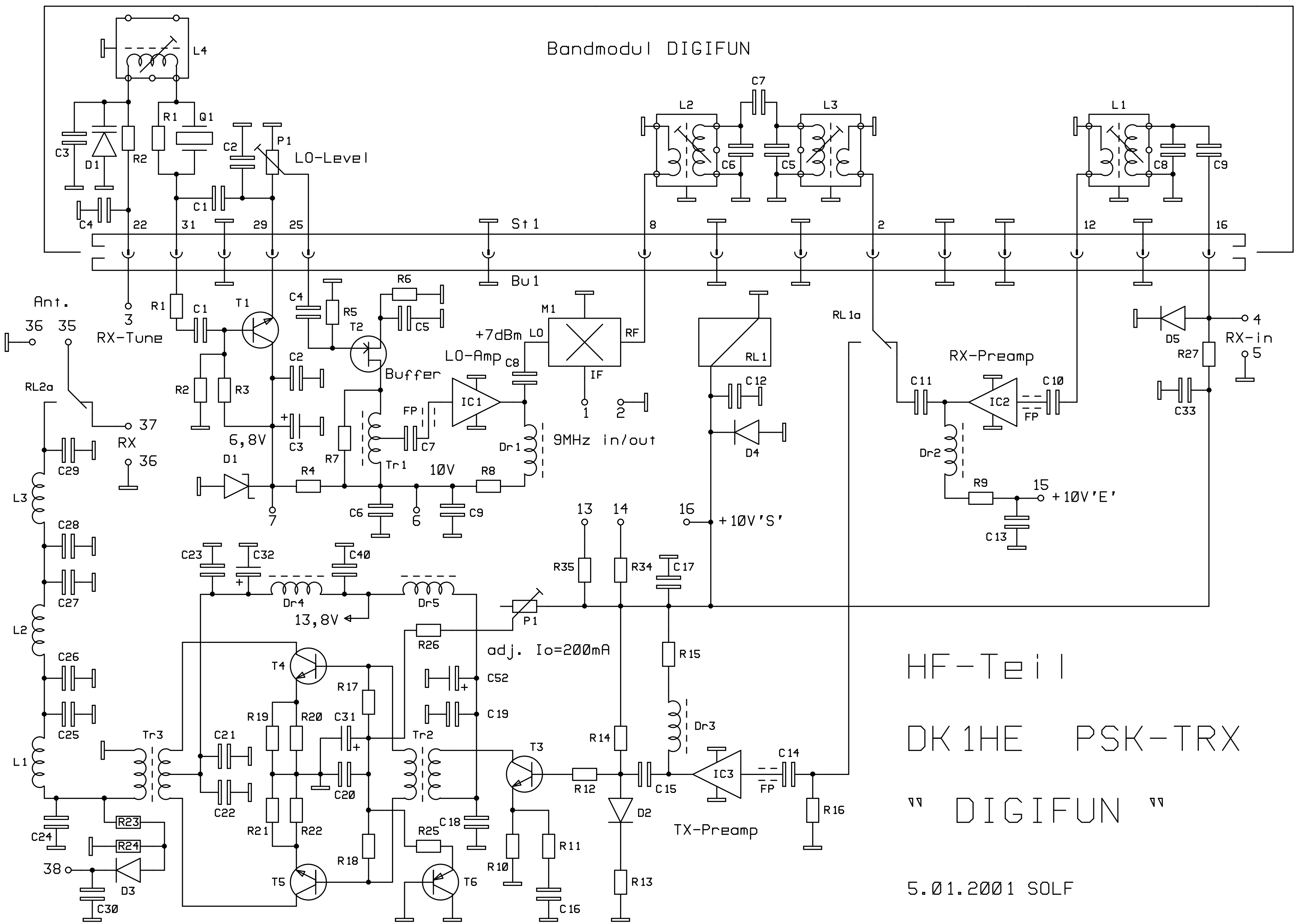
[ ] L1 Neosid filter kit. Primary 16 turns 0,2mm lacquer isolated copper wire;Secondary 2 turns 0,2mm lacquer isolated copper wire at cold end of the primary; Covering core left out. Adjustment core ferrite F40

[ ] L2 Neosid filter kit . Primary 16 turns 0,2mm lacquer isolated copper wire;Secondary 2 turns 0,2mm lacquer isolated copper wire at cold end of the primary;Covering core left out;Adjustment core ferrite F40

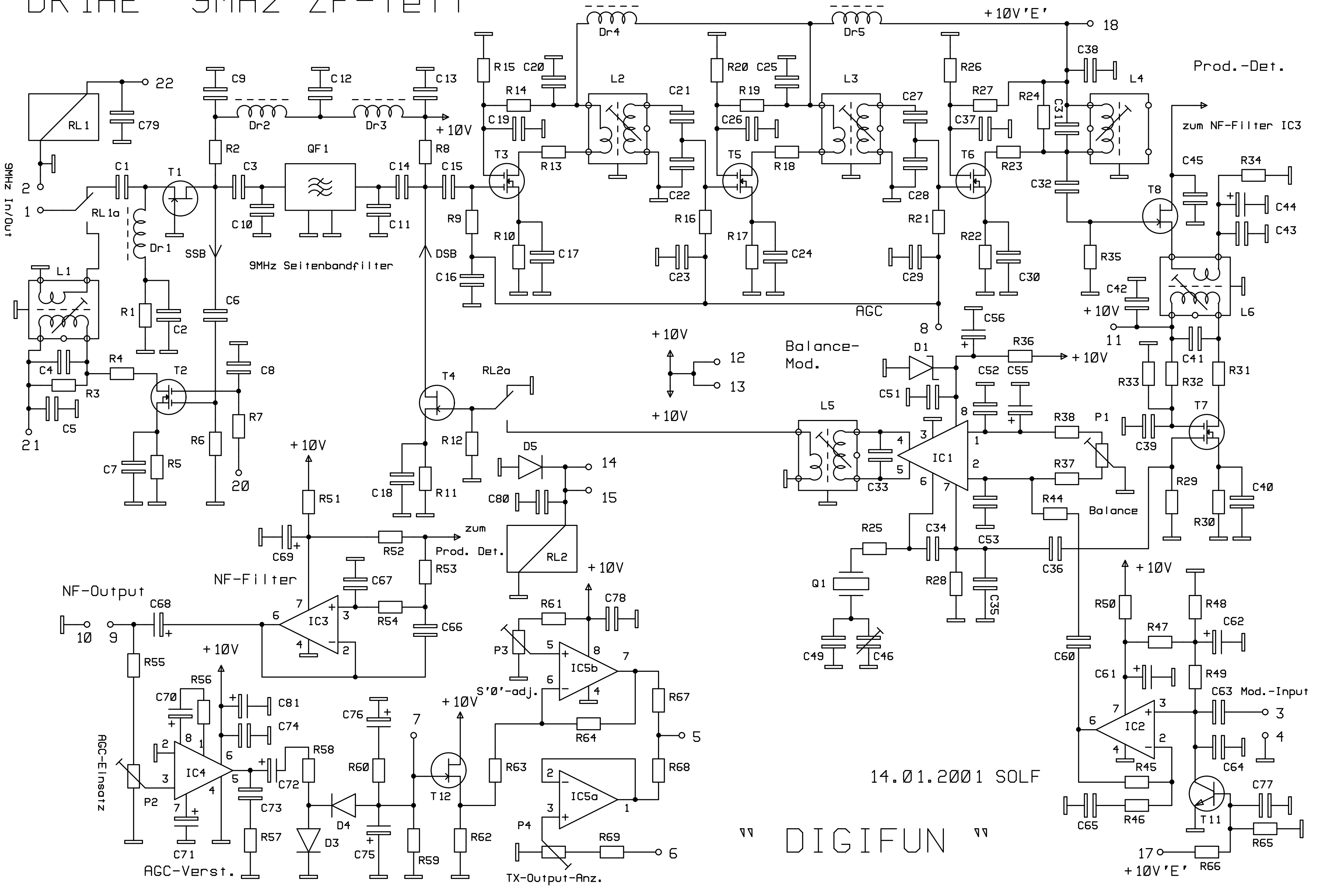
[ ] L3 Neosid filter kit. Primary 16 turns 0,2mm lacquer isolated copper wire;Secondary 2 turns 0,2mm lacquer isolated copper wire at cold end of the primary;Covering core left out;Adjustment core ferrite F40

[ ] L4 Neosid filter kit ??? turns 0,2mm lacquer isolated copper wire;Covering core, ferrite F40

[ ] ST1 DIN connector 31


Bandmodul DIGIFUN
L4
R1
Q1
C2
P1
LO-Level
C3
D1
R2
C1
C4
22
31
29
25
St1
Bu1
L2
C7
L3
C6
C5
L1
C8
C9
8
2
12
16
Ant.
36
35
RX-Tune
3
T1
T2
Buffer
+7dBm
LO
M1
RF
IF
LO-Amp
IC1
FP
9MHz in/out
Dr1
Tr1
10V
6,8V
RL2a
RX
37
RL1
RL1a
RX-Preamp
IC2
Dr2
R9
15
+10V'E'
RX-in
4
5
D5
R27
C33
+10V'S'
13
14
16
D4
C12
13,8V
Dr4
Dr5
adj. Io=200mA
T3
T4
T5
T6
Tr2
Tr3
IC3
TX-Preamp
Dr3
D2
D3
38
HF-Teil
DK1HE PSK-TRX
" DIGIFUN "
5.01.2001 SOLF

DK1HE 9MHz ZF-Teil



14.01.2001 SOLF

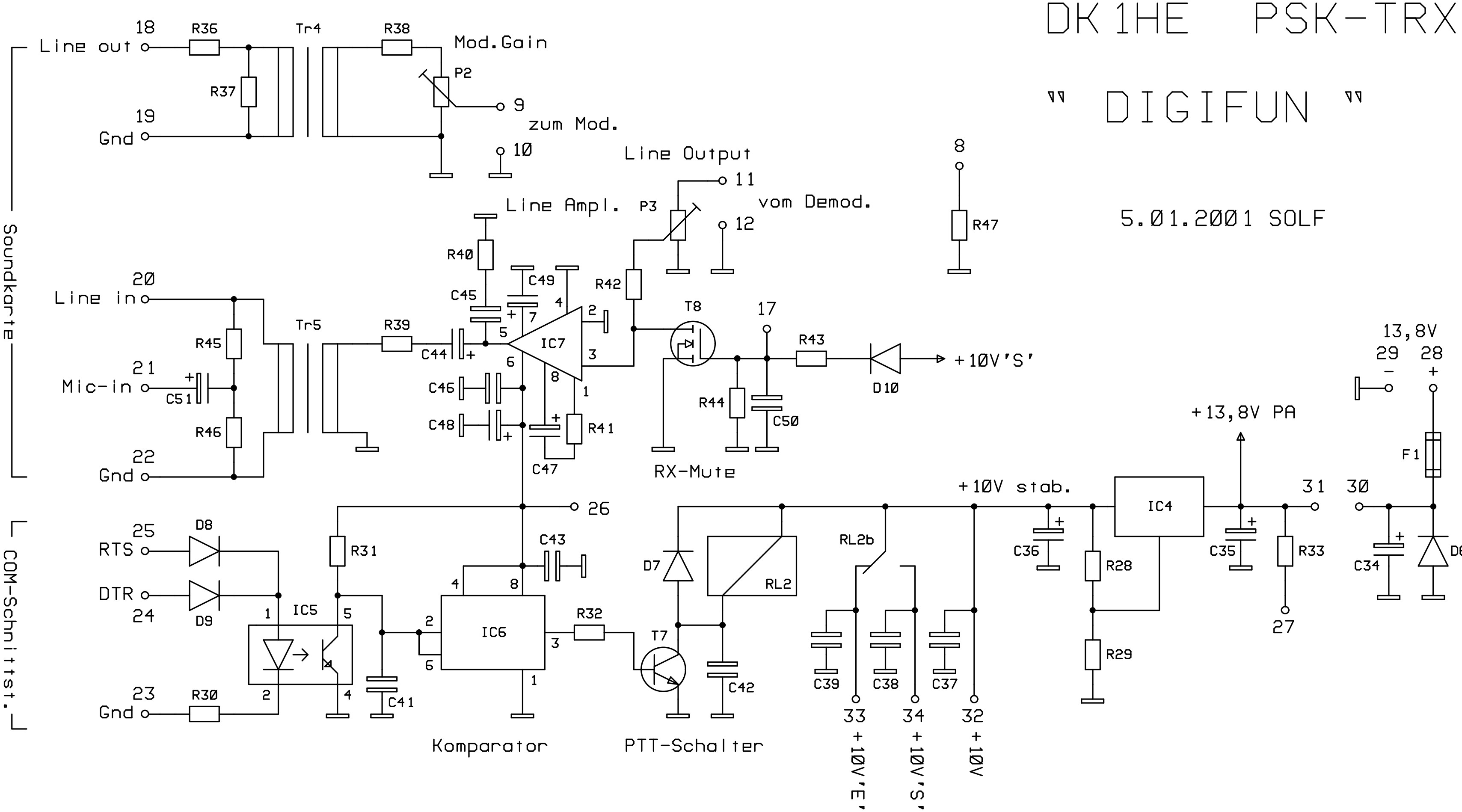
" DIGIFUN "

NF+Steuerteil

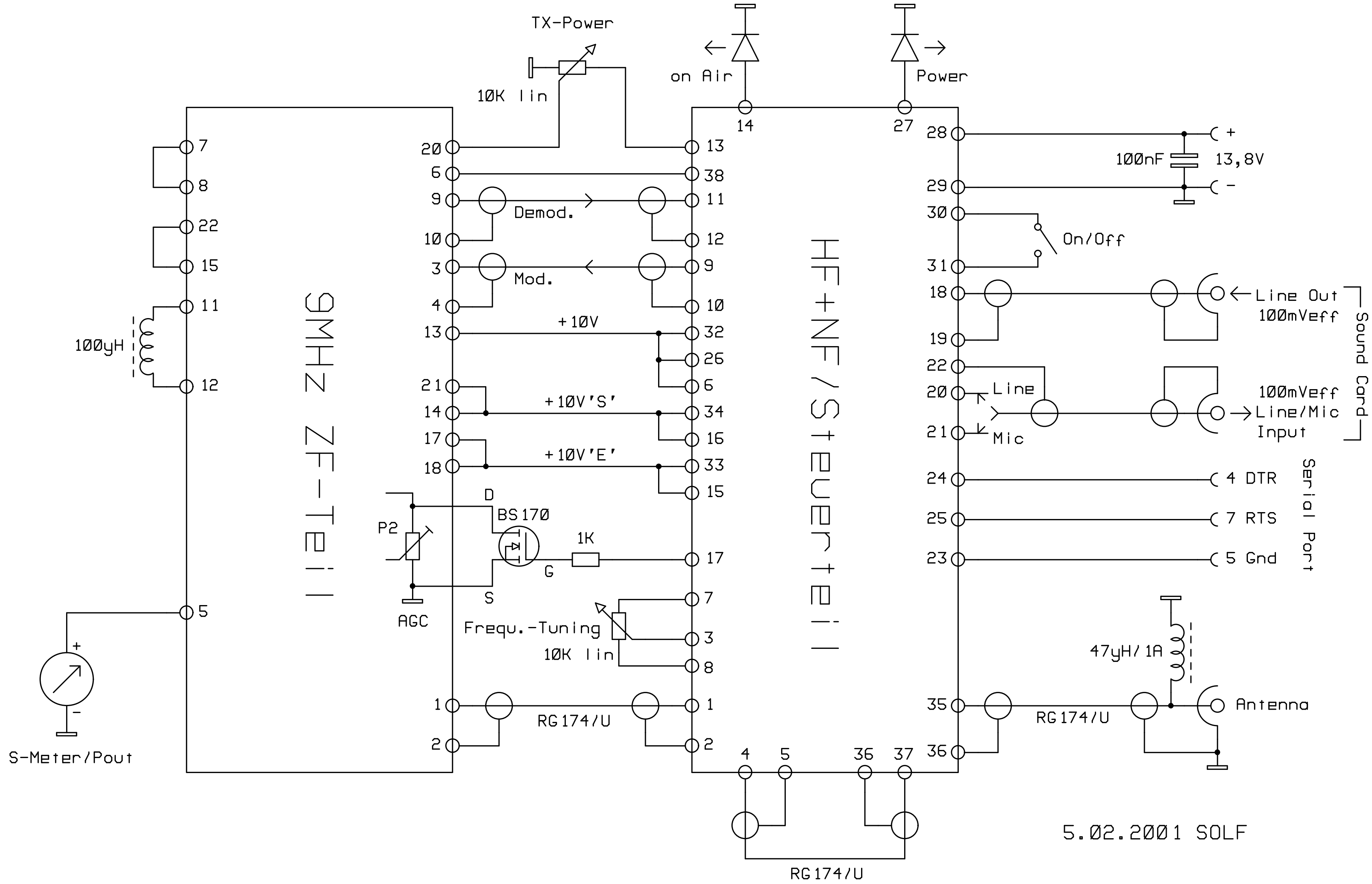
DK1HE PSK-TRX

" DIGIFUN "

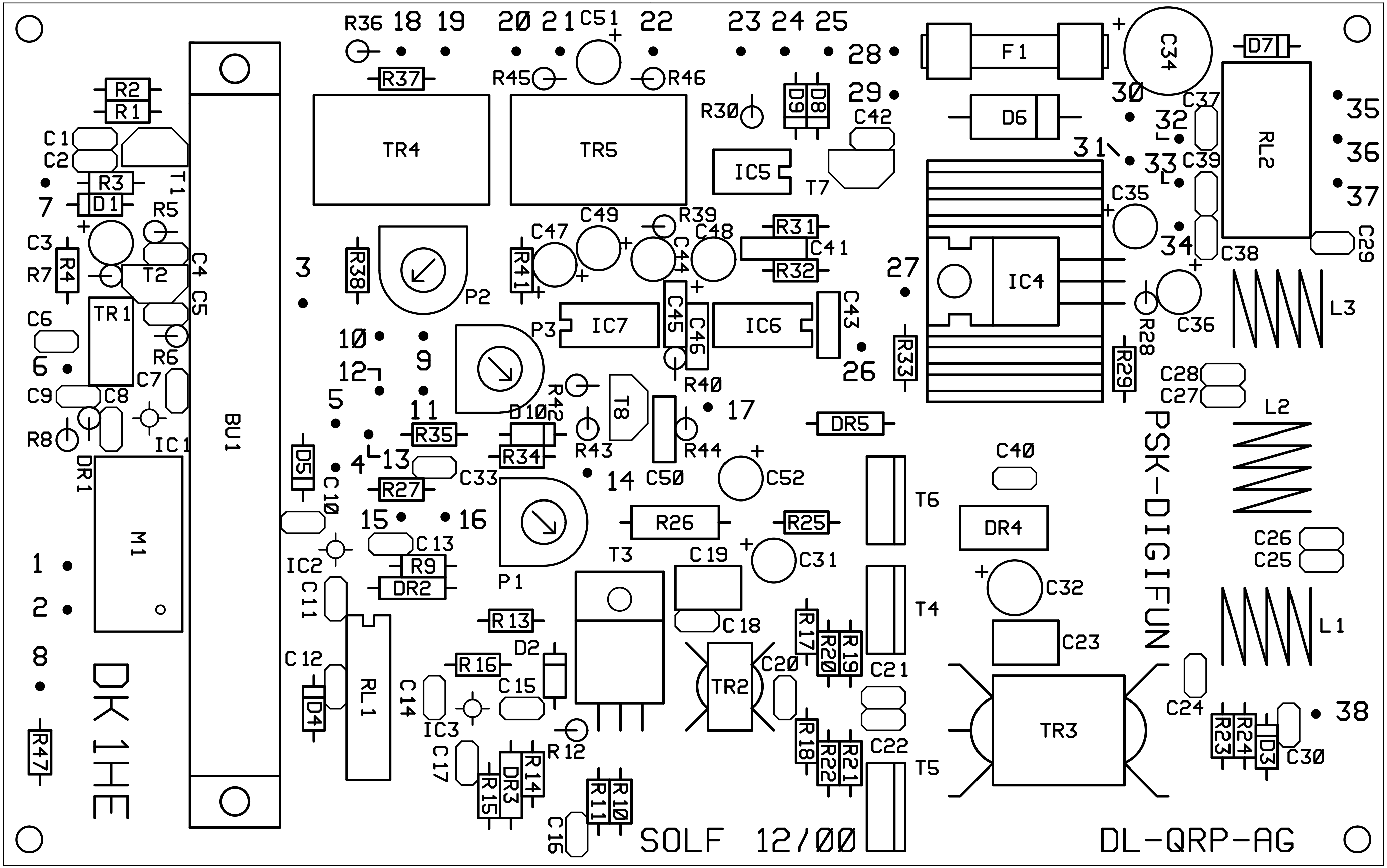
5.01.2001 SOLF

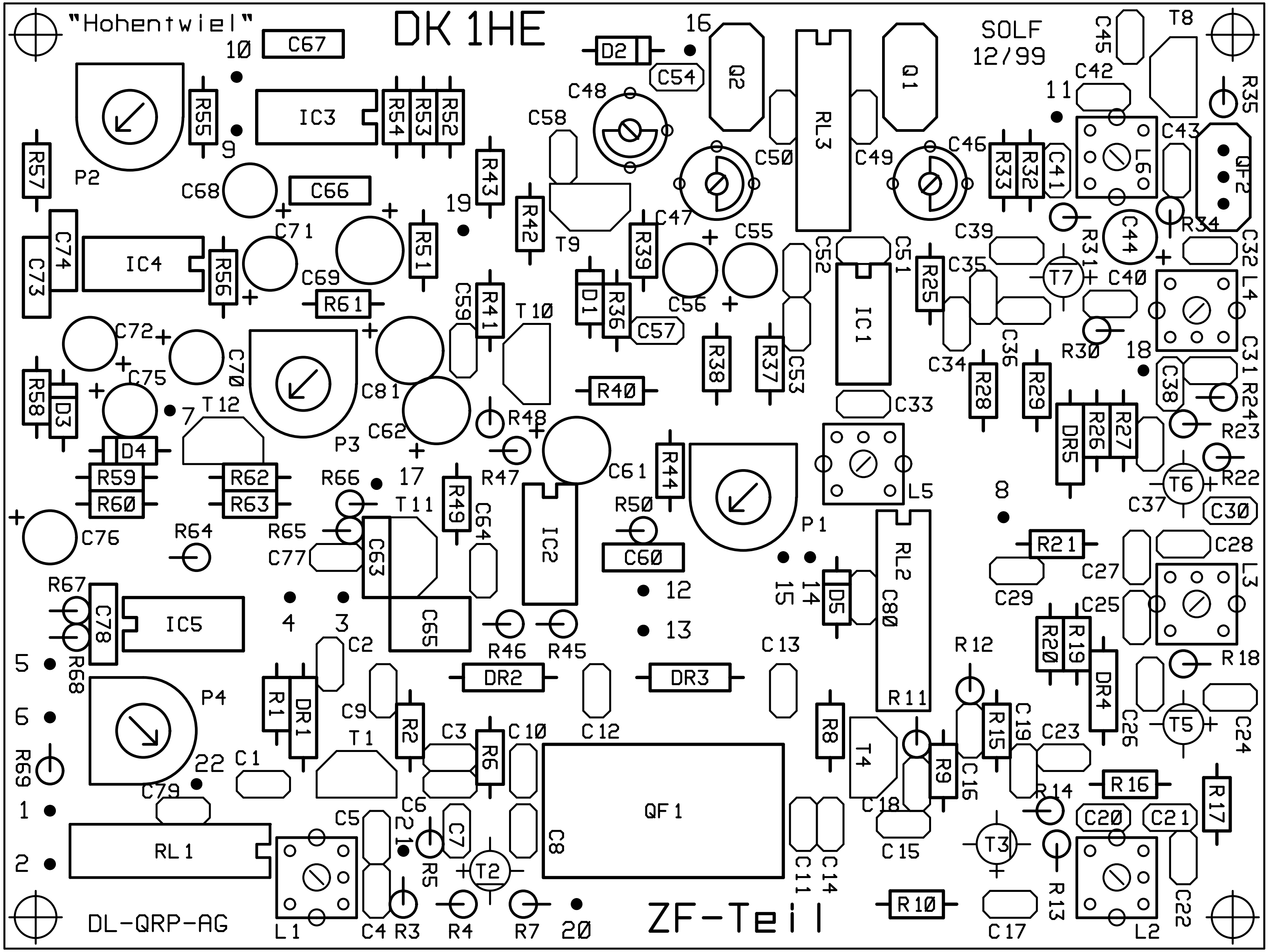


Gesamtverdrahtung DK1HE-"DIGIFUN"



5.02.2001 SOLF


PSK-DIGIFUN
DK1HE
SOLF 12/00
DL-QRP-AG
R36 18 19 20 21 C51 22 23 24 25 28
F1 C34 D7
R37 R45 R46 R30 D9 D8 29 C42
TR4 TR5 IC5 T7 D6 30 32 C37 RL2 35
R2 R1 C1 C2 T1 R3 D1 7 R5 C3 R7 R4 T2 C4 C5
31 33 C39 36 37
R39 C47 C49 C48 C44 R31 C41 R32 C35 34 C38 C29
3 R38 P2 R41 27 IC4 R28 C36 L3
TR1 C6 R6 6 C7 C9 C8 R8 IC1 DR1
10 9 12 5 P3 IC7 C45 C46 IC6 C43 26 R33 R29
11 R42 D10 T8 R40 17 C28 C27 L2
BU1 D5 C10 4 13 R35 R34 R43 R44 DR5
C33 R27 14 C50 C52 C40 T6
15 16 R26 R25 DR4
IC2 C13 R9 DR2 P1 T3 C19 C31 C32 C26 C25
M1 1 2 8
C11 C18 T4 L1
R13 R17 R20 R19 C23
C12 RL1 C14 D2 R16 C15 TR2 C20 C21 C24
D4 IC3 R12 C17 R14 DR3 R15 R18 R22 R21 C22 TR3 R23 R24 D3 C30 38
R47 R11 R10 C16 T5


"Hohentwiel"
DK 1HE
SOLF
12/99
DL-QRP-AG
ZF-Teil
IC1 IC2 IC3 IC4 IC5
RL1 RL2 RL3
QF1 QF2
Q1 Q2
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12
P1 P2 P3 P4
L1 L2 L3 L4 L5 L6
D1 D2 D3 D4 D5
DR1 DR2 DR3 DR4 DR5
R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 R27 R28 R29 R30 R31 R32 R33 R34 R35 R36 R37 R38 R39 R40 R41 R42 R43 R44 R45 R46 R47 R48 R49 R50 R51 R52 R53 R54 R55 R56 R57 R58 R59 R60 R61 R62 R63 R64 R65 R66 R67 R68 R69
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14 C15 C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32 C33 C34 C35 C36 C37 C38 C39 C40 C41 C42 C43 C44 C45 C46 C47 C48 C49 C50 C51 C52 C53 C54 C55 C56 C57 C58 C59 C60 C61 C62 C63 C64 C65 C66 C67 C68 C69 C70 C71 C72 C73 C74 C75 C76 C77 C78 C79 C80 C81
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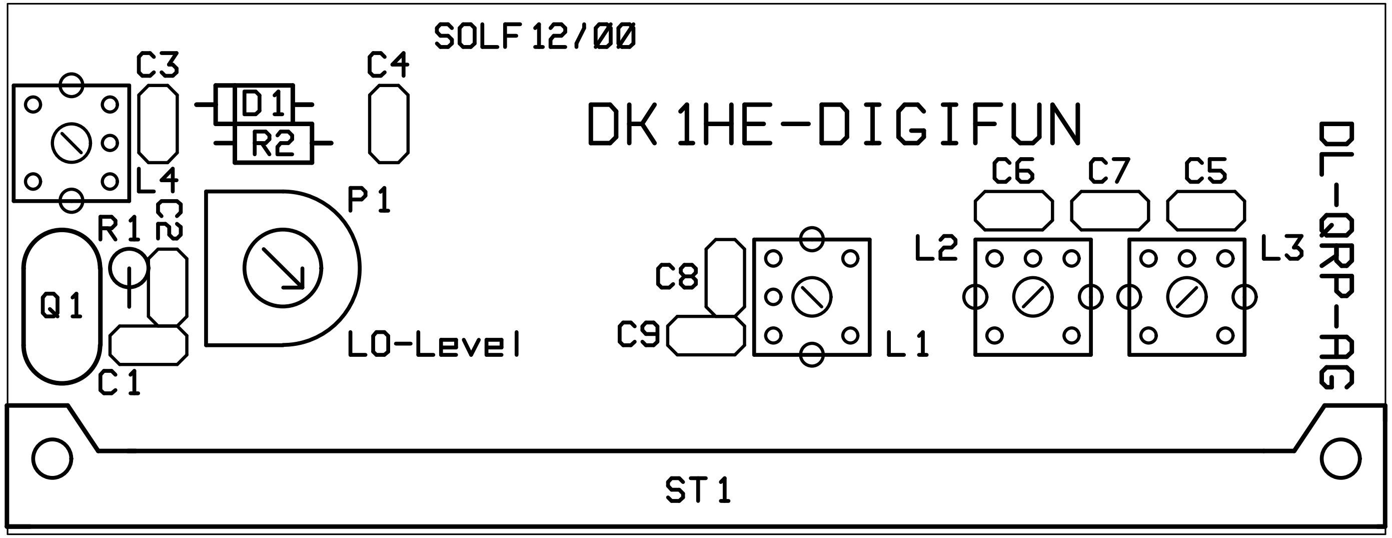
SOLF 12/00
C3
D1
R2
C4
DK 1HE-DIGIFUN
DL-QRP-AG
L4
C2
P1
C6
C7
C5
R1
L2
L3
C8
Q1
C9
L1
LO-Level
C1
ST1