Remote.Aerial.System.Tuning.Unit. (RASTU)

While discussing among friends about aerials and their tuning, we went through these practical considerations:

a) remote-tuners, to-day in commerce, cost enough for the pocket of average “hams”;
b) those “hams” who still are interested in “electronic pieces construction”, deserved a further opportunity to build a modern product containing a first-level know-how;
c) such a piece, moreover, should feature testing and aligning procedure, without any special or expensive instruments.

Let us give a try. After having recalled our old and dusty radio-technique notions, a first QRP unit, configured as L-C network, was deviced, which allowed to face and solve a few problems, like “lay-out” and “ R.F. interferences” along with an extended “software debugging activity” which led, eventually, to develop an efficient “algo” capable of switching the L-C network to find-out a nearly perfect match, always very close to an S.W.R. of 1:1,1.

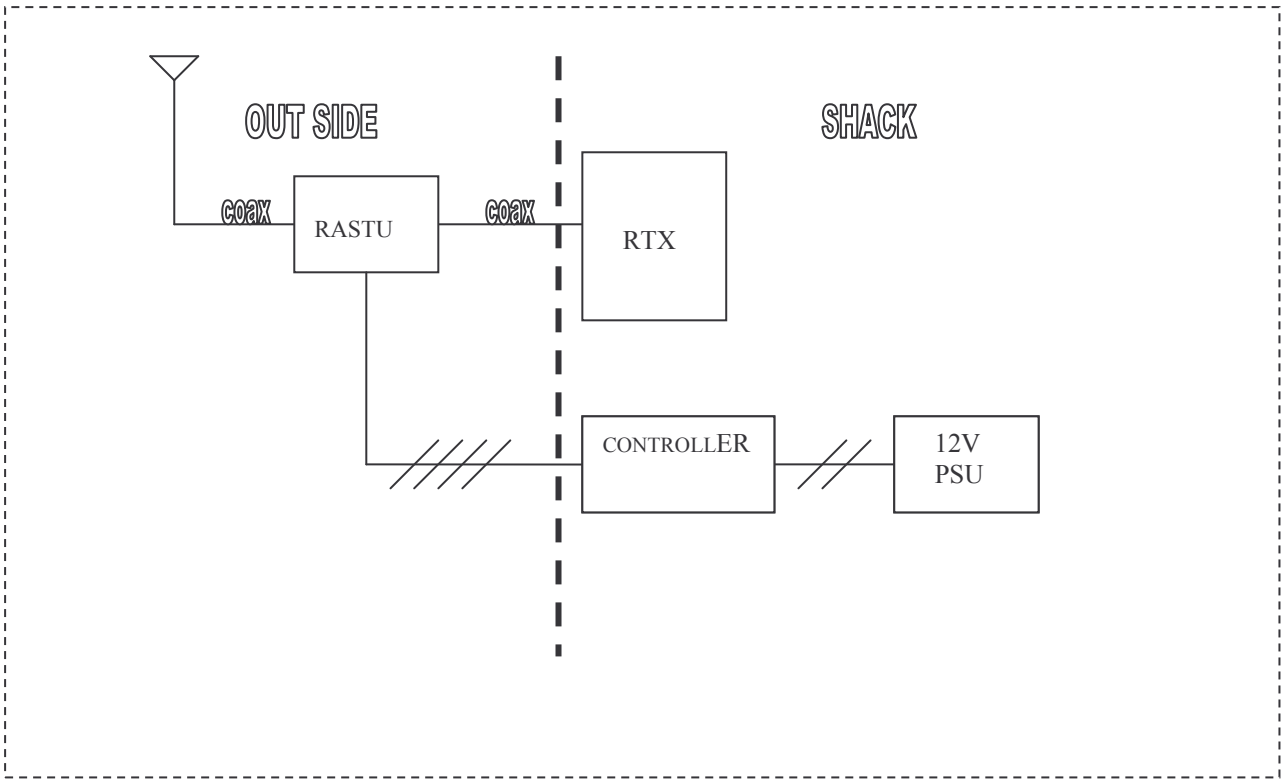
In this task, while I and others guys gave some help, Carlo-IK0GMM performed the biggest effort making the two controllers 18F452 & 14F876A to reliably govern the tuner unit.

After the QRP prototype worked properly, a final R.A.S.T.U. was approached which showed the capability of say 500W p.e.p.: worst case tuning time of 16 seconds, and an improved message handling with its CONTROLLER unit in the shack.

The final version of RASTU exhibits an L-C- network of n° 9 capacitors and n° 9 inductances, in order to achieve a wider range of impedance matching; additionally, the CONTROLLER, provides an uncommon function: it watches-over the aerial status, during normal Q.S.O., displaying measured values of irradiated frequency, current S.W.R. and transmitted power.

Hereunder is sketched a block-diagram which depicts the general wiring:

a) R.F. coax-cable
b) Two wires for supply; nominally 12V/400mA.
c) Three wires for two-way RS232 communication RASTU—CONTROLLER



With the aim to allow RASTU working with any commercial RTX, as well with home-built radio transmitters, the CONTROLLER provides a closed contact criteria to be possibly wired towards any generic RTX, in order, for the latter, to revert automatically a “C.W. Low Power (5-20 W) “ condition during the required tuning time.
If no such opportunity (of an automatic ALC) is offered by the “generic RTX”, then the operator will be required to manually reduce the R.F. Power, within the above quoted range, before pressing the “TUNE” button of the CONTROLLER.

Now a brief description of the overall operation.
When the CONTROLLER is “off”, RASTU-unit is in a by-pass condition.
When switched “on”, the PIC-microcontrollers perform a variety of internal checks like local & remote supply status; RS232 com. etc., summarizing on the display (2ln. X 16cha.) this message:
<Remote unit ready – reduce power 5-20 W>
At this moment, when the operator decide to, the RTX is put in transmission, mode C.W. and 5-20W;

=N.B.: Intentionally (further on this later) it's been decided not to give the RASTU an auto-starting command.=

then press (understand: press & release) the "TUNE" button on the CONTROLLER.

While RASTU begins its tuning process, the display writes the message of <tuning in progress>, the CONTROLLER lights an red-LED and makes available, on a dedicated jack-socket, a closed contact for an A.L.C. possible application.

If, by chance, RASTU, once received the "TUNE" command, doesn't detect any R.F.Power, then a message on the display is shown: <apply R.F. Power>. At the end of a tuning process, when RASTU has found a proper match, the display will write these parameters:

1- Antenna frequency in kHz: (+ - 2kHz)
2- S.W.R. : (+ - 5%)
3- Output power : (+ - 5%)

furthermore it resets the ALC-criteria and related red-LED; any kind of transmission can be initiated.

If the operator wishes, the current tuning-data may be stored in a non volatile memory, capable of n°20 matchings, by pressing a few seconds, the button " SAVE" on the CONTROLLER: the display will confirm with < data-saved>. Data saved in memory, of coarse, are automatically recalled and put in use only before having measured S.W.R. an found to be lower than 1:1,2: otherwise a new tuning process is automatically issued by RASTU; in this case, tuning time is a merely fraction of second.

Now let's introduce the uncommon function of RASTU. Once tuned, the latter keeps watching over the status of your radiating system, mainly its S.W.R. that, if found to be greater than 1:2 (say: the antenna wire has twisted/broken), the CONTROLLER activates a soft alarm-sound, as well writes this warning message:<S.W.R. out of limit>. It's up to the operator to stop his own transmission and give his antenna a glance.

Well: if no such a catastrophic condition is met, and a QSO is happily carried-on, you are aware that during prolonged modulation pauses, the display will show the message:<RX mode- no power input>, that is namely as: everything is O.K; the microcontrollers have gone in " sleep mode".

The QSO can be carried-on indefinitely, until the operator will want to change frequency or band. In this case the operator will have first press the "RESET" button, and as soon as he can read <remote unit ready> again, he has to apply the tuning power level (5-20 W), C.W. and press the "TUNE" button: a new tuning cycle will now begin.

= F.Y.I.: the use of a dedicated “TUNE” button on the CONTROLLER comes from a designing philosophy: it allows the operator, once the tuner has reached a matched load condition, to check the S.W.R. usable band-limits (i.e. normally S.W.R. 1:2),of the aerial at this particular frequency, simply by rotating the frequency knob of the RTX in use. RASTU, since doesn’t receive any “TUNE” command, cleverly shows on the display how S.W.R. changes and the exact value of the two frequency edges; with automatic “TUNE” restart, the above feature would have been not possible. Making these kind of experiments has appeared much too attractive for we hams.

Limits and operational characteristics:

RASTU belongs to that specific Tuner-category whose operation is based on the principle of S.W.R. successive approximations.

The chosen number of capacitors and inductances in connection with the two possible configurations of the network, L-C or C-L, make a total half million possible matchings, nearly. Extended tests on the field have proved using a minimum antenna wire length of 5 mt. only, that RASTU can provide a match starting 10 mt. band up to 160 mt. band , with no gap between these limits. The insertion loss of RASTU, once matched, has been measured in 0.1-0.3 dB for almost all of the cases: these low figures have been achieved thanks to components choice: over rated relays; low dissipation toroidal-cores; silver mica / ceramic capacitors with 1kV or more working-voltage. Also wires of 12 mt. length; 23 mt.; 45 mt. with & without counterpose, as well dipoles of 35 mt. and more, have been tested with similar good results.

A few closing words are now due, reminding those who might be headless after so mach reading. The matching process executed by RASTU, lengthens your RTX life by providing a good 50 ohm adaptation regardless of the aerial nature, but bear in mind no tuner can transform into an efficient radiator, what inherently is not; say: a short piece of wire equal to a 45° or less, of electrical length for a given “lambda” which exhibits an Ri= 5 ohms; a vertical wire with no radials affected by a very bad ground-losses; a dipole much too low in height, etc. The power irradiated into the electromagnetic field that generates the signal hams receive with their RTX, is always proportional to radiation-resistance (the Ri), while the non irradiated power is always proportional to total loss & ground-resistance; for more, refer to radiation efficiency law in the technical literature.

Assembling and alignment:

Printed board has been made available along with its relevant electric schematic; a few perspective photographs should make the overall assembling flawless. You can see one p.c.b. for CONTROLLER unit,and two p.c.b. for RASTU: the bigger-one will allocate the SWITCHING-

NETWORK, and the smaller-one will allocate the DIRECTIONAL HEAD plus PIC and logic circuitry.
During the assembling activity take all those general precautions you are used to: be careful while soldering; always check for accidental shorts between p.c.b. tracks; also make you sure all of the tracks go from and to where they are supposed to go, etc.
Check individually each assembled p.c.b.: apply 12V to the CONTROLLER unit; measured current drain should be included in 150 milliamps with the display normally lighted-up. Proceed similarly for the SWITCHING-NETWORK p.c.b.: with 12V applied only a few milliamps should be drained.
Finally, check the DIRECTIONAL-HEAD p.c.b. Right now,don't seat on their sockets any "chip"; apply 12 V and check for an almost zero current drain; look for 5V to be present where it's supposed to be; if passed, remove 12V for a while and put "chips" into work; reapply 12V: current should be a few tenths of milliamps; looking good, so far. In this p.c.b. there are allocated three pots that is all what must be aligned in this project. Let's deal, first, with that one (470 ohms) intended for the diode-biasing: turn it fully towards ground potential. With 12 V connected, adjust until read 4-5 milliVolts on the cathode of D1, using a digital-meter. (Such a biasing voltage is needed to increase the R.F. sensitivity of the "Reflected power-rectifier", mainly).
At this moment, aligning procedures says: switch-off power; put units on a bench; connect CONTROLLER to the RASTU; connect supply voltage to the CONTROLLER, (refer to the above shown wiring), and switch-on the CONTROLLER.
Hopefully, though I would say for sure, on the display will appear, now, the message < remote unit ready: reduce power 5-20W>. This means the RS232 com. is properly wired; should this fail, merely check cautiously the RS232 TX & RX wiring, according to the schematic.
The remaining two pots adjustments are carried-out by means of the following "setting-up-menu".

Forward & Reflected power setting-up menu:

Before initiating this procedure, connect a suitable dummy load 50 ohms at the output R.F. connector of DIRECTIONAL HEAD unit; apply 12V supply.
Set-up menu is thus accessed: maintain pressed SAVE button while switching "ON"; the display will write <SET POWER LEVEL: RASTU 2007>. At the input R.F. connector apply a *well known power-level* at a generic frequency (i.e.: 14 Mhz).Press again the "SAVE" button: the display will now show current readings of FREQUENCY: SWR: WATT. Adjust P101 until the display shows the exact known power level applied at the input. Alternatively, you can reach a correct setting by

connecting in series to the input R.F. connector an external & reliable Power-Meter and adjusting P101 for the two readings to be equal. Remove R.F. power.

At the output R.F. connector of DIRECTIONAL HEAD, put a second 50 ohms dummy load in parallel with the previous-one, thus manually producing a perfect S.W.R.=1: 2.

Apply a generic R.F. power level and adjust P102 until the display will show the exact S.W.R. wanted reading, that is < S.W.R. = 2.00 >.

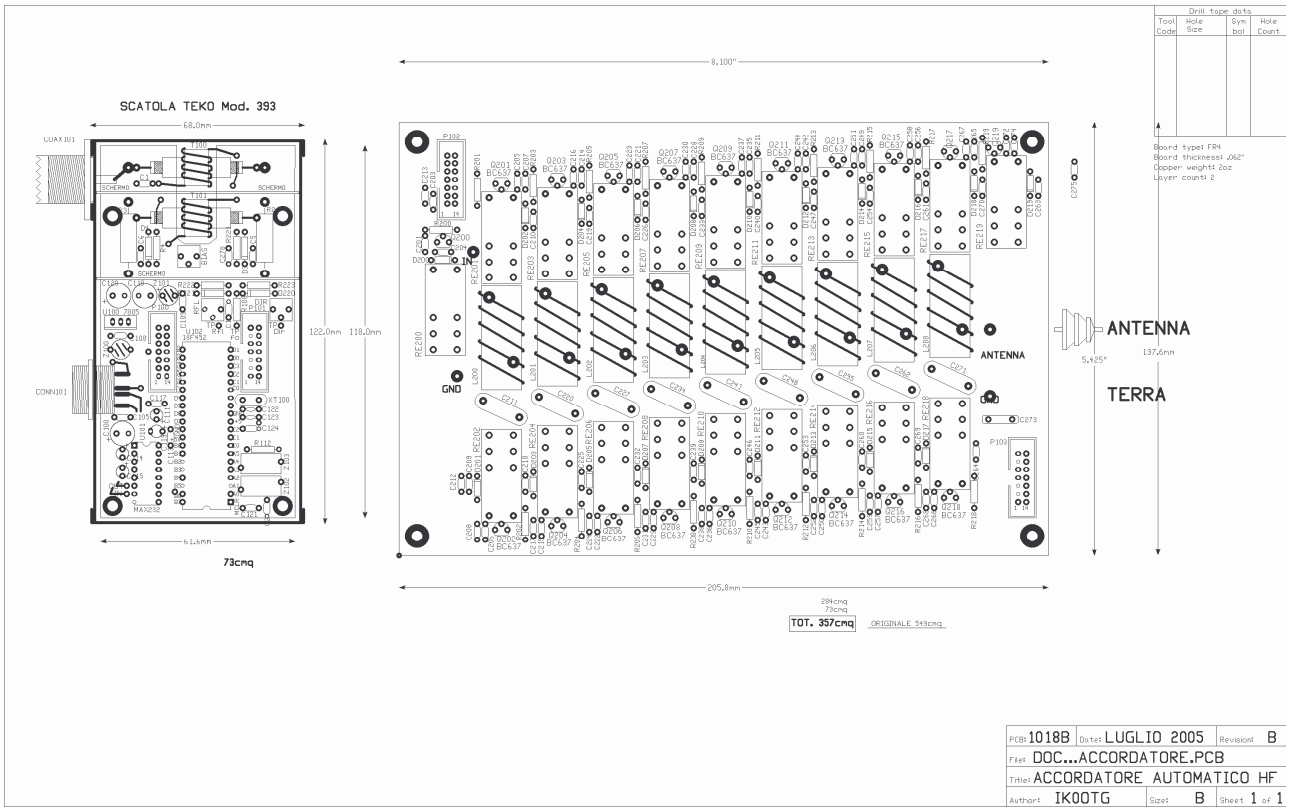
The whole adjustment procedure is now made complete. Switch “OFF” the CONTROLLER.

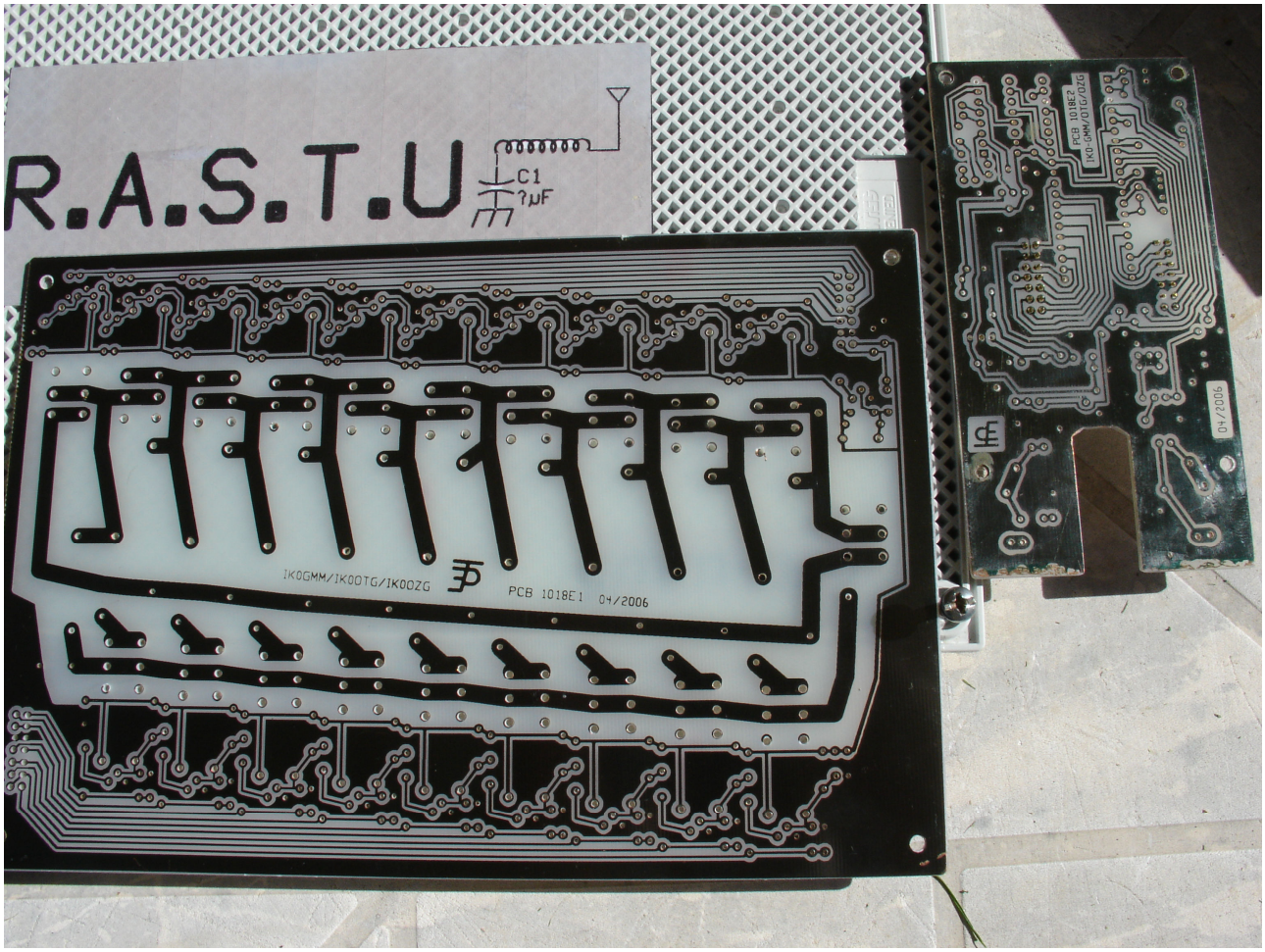
At the next normal switch-on of the latter, you’ll have the RASTU system quite ready for use.

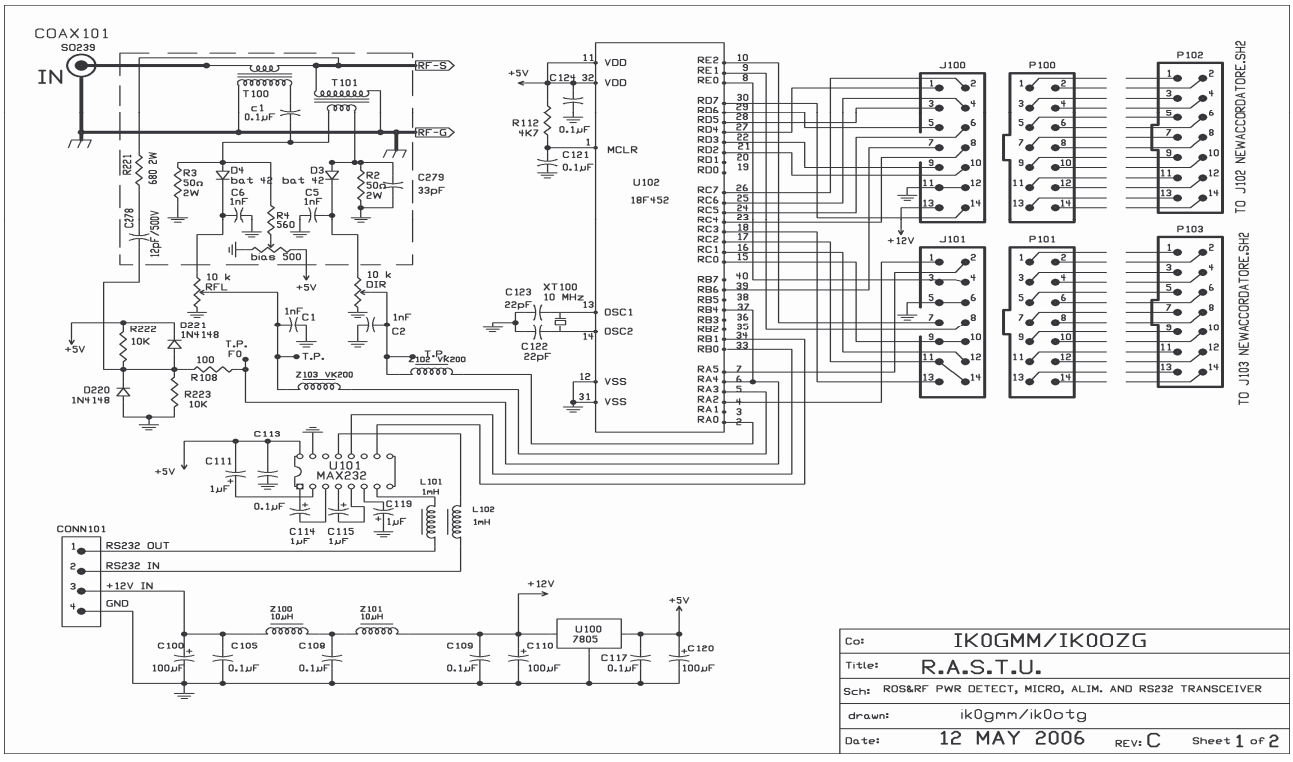
Therefore put RASTU unit (of coarse in its weather-proof enclosure), externally in a convenient allocation; connect to it whatever radiator you wish to; lay-down required wirings towards your shack, and enjoy going on the air, whatever band you choose, using only a single antenna.

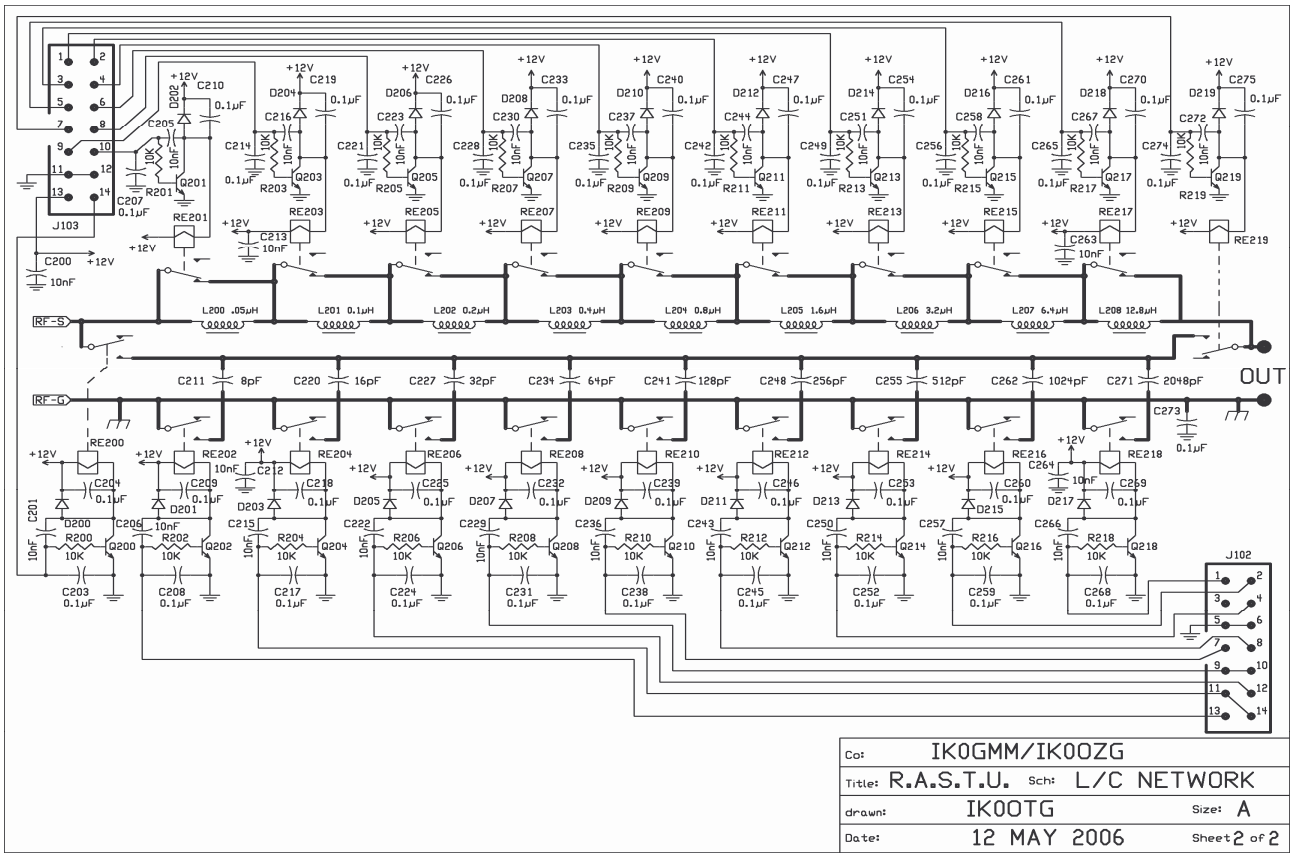
Good DX & best 73 by the whole project gang.

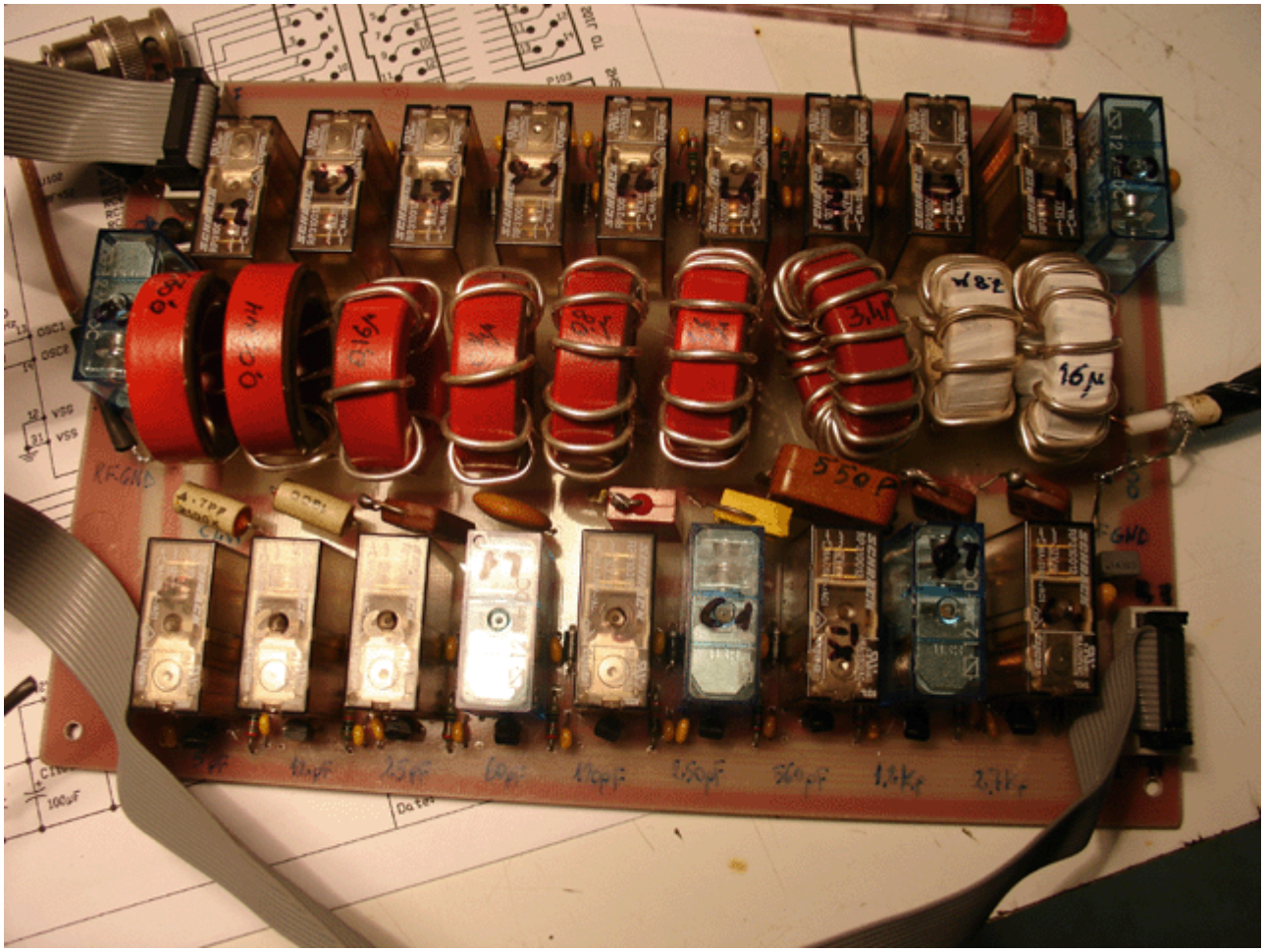
For the programmed PIC (18F452 and 16F876) write to : ik0gmm@tin.it

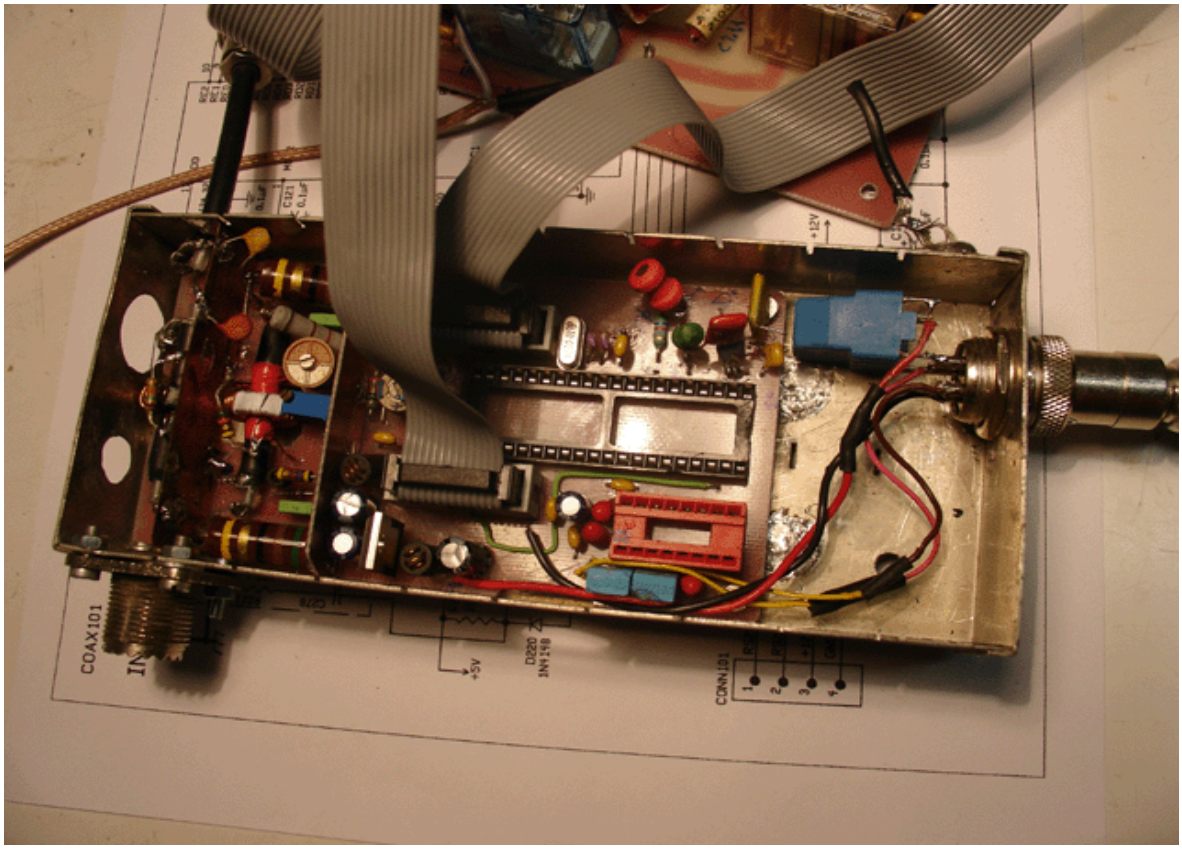


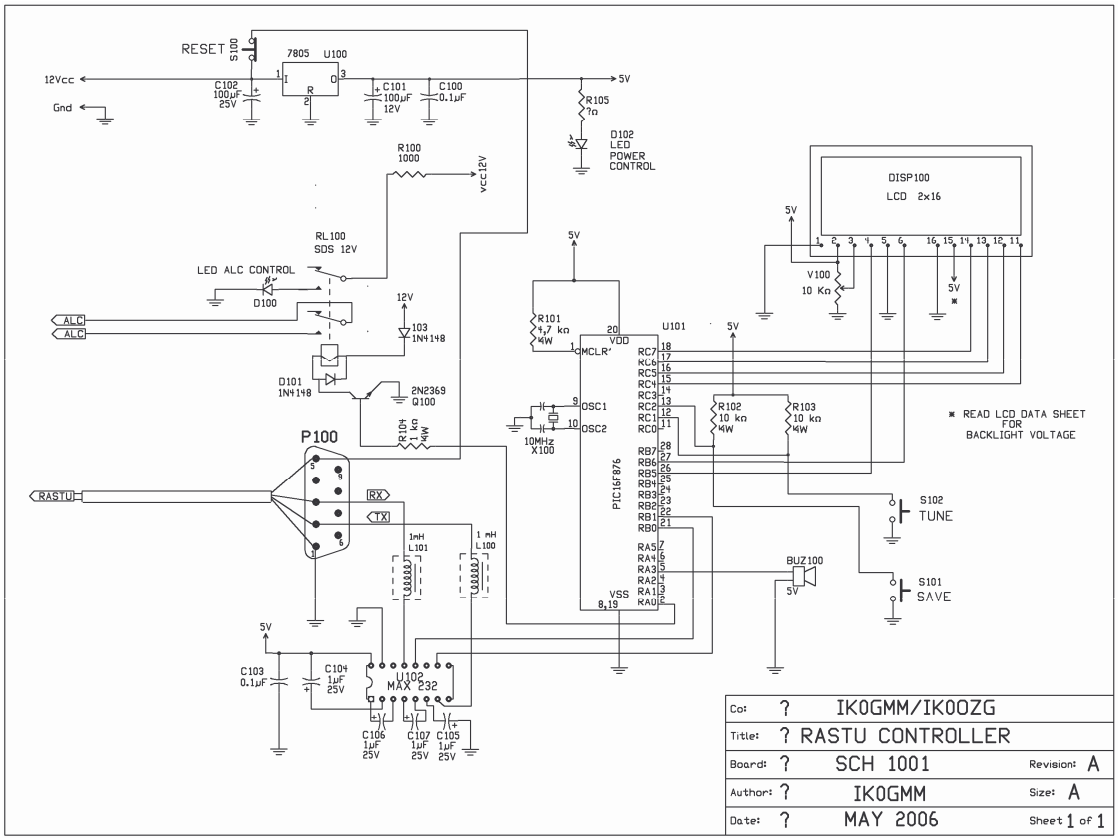

R.A.S.T.U
C1
?µF
IK0GMM/IK0OTG/IK0OZG
PCB 1018E1 04/2006

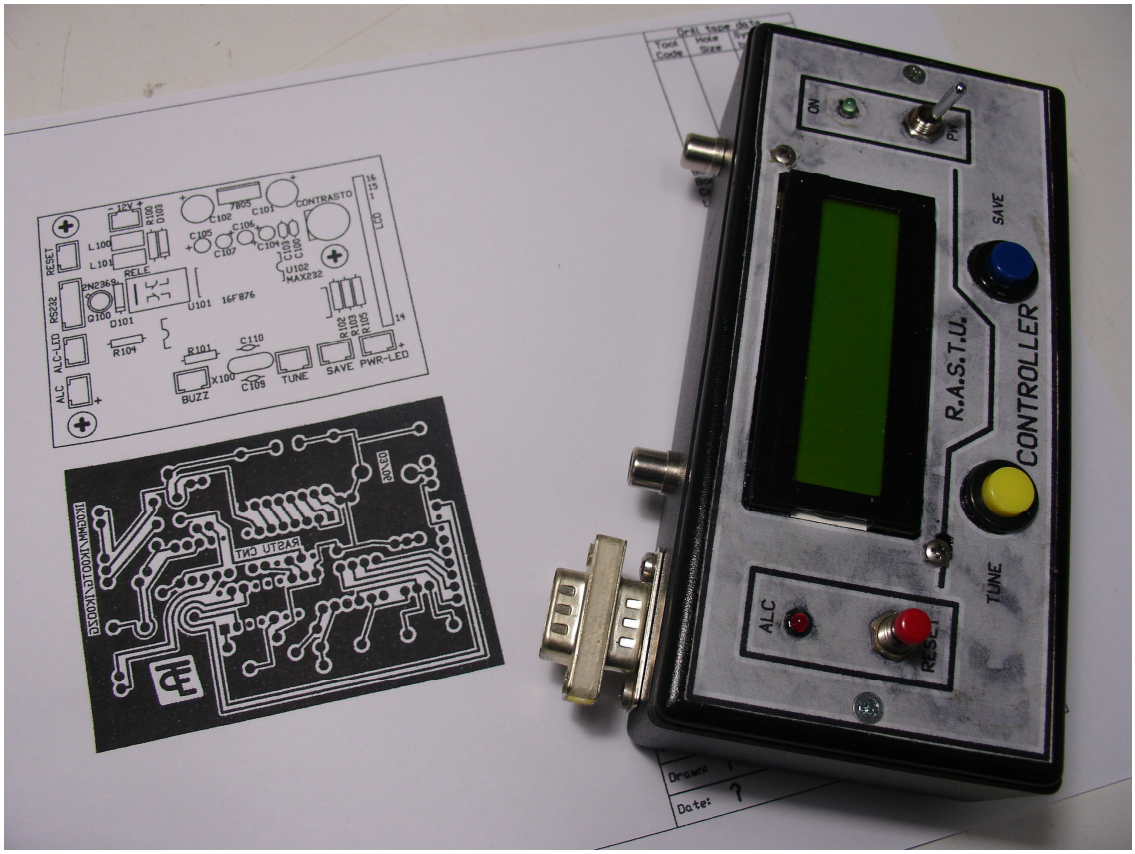

COAX101
SO239
IN
RF-S
RF-G
T100
T101
C1
0.1µF
R221
680 2W
R3
50Ω
2W
D4
bat 42
D3
bat 42
R2
50Ω
2W
C279
33pF
C278
12pF/500V
C6
1nF
C5
1nF
R4
560
bias 500
10 k
RFL
10 k
DIR
+5V
1nF
C1
1nF
C2
T.P.
FO
T.P.
Z102 VK200
Z103 VK200
R222
10K
D221
1N4148
100
R108
R223
10K
D220
1N4148
U102
18F452
VDD
VDD
MCLR
OSC1
OSC2
VSS
VSS
C124
0.1µF
R112
4K7
C121
0.1µF
C123
22pF
XT100
10 MHz
C122
22pF
RE2
RE1
RE0
RD7
RD6
RD5
RD4
RD3
RD2
RD1
RD0
RC7
RC6
RC5
RC4
RC3
RC2
RC1
RC0
RB7
RB6
RB5
RB4
RB3
RB2
RB1
RB0
RA5
RA4
RA3
RA2
RA1
RA0
J100
P100
P102
J101
P101
P103
+12V
TO J102 NEWACCORDATORE.SH2
TO J103 NEWACCORDATORE.SH2
C113
C111
1µF
0.1µF
U101
MAX232
L101
1mH
L102
1mH
C119
1µF
C114
1µF
C115
1µF
CONN101
RS232 OUT
RS232 IN
+12V IN
GND
Z100
10µH
Z101
10µH
C100
100µF
C105
0.1µF
C109
0.1µF
C109
0.1µF
C110
100µF
U100
7805
C117
0.1µF
C120
100µF
Co: IK0GMM/IK0OZG
Title: R.A.S.T.U.
Sch: ROS&RF PWR DETECT, MICRO, ALIM. AND RS232 TRANSCEIVER
drawn: ik0gmm/ik0otg
Date: 12 MAY 2006
REV: C
Sheet 1 of 2


J103
J102
RF-S
RF-G
OUT
L200 .05µH
L201 0.1µH
L202 0.2µH
L203 0.4µH
L204 0.8µH
L205 1.6µH
L206 3.2µH
L207 6.4µH
L208 12.8µH
C211 8pF
C220 16pF
C227 32pF
C234 64pF
C241 128pF
C248 256pF
C255 512pF
C262 1024pF
C271 2048pF
C273 0.1µF
Co: IK0GMM/IK0OZG
Title: R.A.S.T.U. Sch: L/C NETWORK
drawn: IK0OTG Size: A
Date: 12 MAY 2006 Sheet 2 of 2


RF GND
GND
550P
16µ


COAX101
CONN101
D220
1N4148
+5V
+12V


RESET
S100
7805
U100
12Vcc
Gnd
C102
100µF
25V
C101
100µF
12V
C100
0.1µF
5V
R105
7Ω
D102
LED
POWER
CONTROL
R100
1000
vcc12V
RL100
SDS 12V
LED ALC CONTROL
D100
ALC
ALC
12V
103
1N4148
D101
1N4148
2N2369
Q100
R104
1 kΩ
4W
P100
RASTU
RX
TX
1mH
L101
1 mH
L100
5V
C103
0.1µF
C104
1µF
25V
U102
MAX 232
C106
1µF
25V
C107
1µF
25V
C105
1µF
25V
R101
4,7 kΩ
4W
MCLR
20
VDD
OSC1
OSC2
10MHz
X100
U101
PIC16F876
VSS
8,19
RC7
RC6
RC5
RC4
RC3
RC2
RC1
RC0
RB7
RB6
RB5
RB4
RB3
RB2
RB1
RB0
RA5
RA4
RA3
RA2
RA1
RA0
R102
10 kΩ
4W
R103
10 kΩ
4W
DISP100
LCD 2x16
V100
10 KΩ
* READ LCD DATA SHEET
FOR
BACKLIGHT VOLTAGE
S102
TUNE
S101
SAVE
BUZ100
Co: ? IK0GMM/IK00ZG
Title: ? RASTU CONTROLLER
Board: ? SCH 1001
Revision: A
Author: ? IK0GMM
Size: A
Date: ? MAY 2006
Sheet 1 of 1


ON
PWR
SAVE
R.A.S.T.U.
CONTROLLER
TUNE
ALC
RESET


PWR-ON
A.L.C.-ON
ON -
RESET
SAVE -
TUNE -
R.A.S.T.U. - CONTROLLER

End of file.