TUNING TAPS TRANSDUCERS

Begin by measuring the voltage, current, and phase angle of the transducer, and calculate the series impedance:

$$Rs = (V/I) \cos(pi*phase/180)$$
$$Xs = (V/I) \sin(pi*phase/180)$$

If Rs is > 50 ohms, proceed with SERIES MATCHING.
If Rs is < 50 ohms, proceed with PARALLEL MATCHING.

SERIES MATCHING

In most cases, the series reactance will be negative (capacitive), requiring a series inductor. Compute the inductance corresponding to the measured reactance, |Xs|, from:

$$L = | Xs | / (2 * \pi * frequency).$$

If frequency in is MHz, L will be in μHenries (needed below).

Wind a suitable inductor to null out the series reactance. The cores we have available include :

T80-15:	.1-2 Mhz	Al = 170
T80-2:	1-30 Mhz	Al = 55
T106-15	.1-2 MHz	Al = 345
T106-2	1-30 MHz	Al = 135

Compute the approximate number of turns from

$$N = 100 * \sqrt{L / Al}.$$

Install the inductor in series with transducer and measure impedance again. Add or remove turns to obtain zero phase shift. The circuit should look like

```
---------------------------LLLLLLLLLL----------------
                                                     |
                                                     |
                                                     D
                                                     D
                                                     D
                                                     D
                                                     D
                                                     |
                                                     |
 ---------------------------------------------------------
```

Mark the inductor Z3. Measure the resulting impedance, Z = Rs.

Calculate the value of a parallel capacitor that will change the series resistance from Rs to 50 Ω. This value is found from:

$$Xp = \mathrm{sqrt}\ (\ 50 * Rs^{2} / (Rs - 50))$$

and

$$C = 1 / (2\ \pi\ f\ Xp).$$

Note: it may require two or three capacitors in parallel to obtain the correct value of capacitance.

Mark the capacitor ass'y Z2. Install the calculated capacitance in parallel with Z3 and the transducer (see below). Measure the series impedance again.

```
---------------------------LLLLLLLLL----------------
                 |                                   |
                 |                                   |
                C                                  D
                C                                  D
                C                                  D
                C                                  D
                C                                  D
                 |                                   |
                 |                                   |
-----------------------------------------------------------
```

With the correct parallel capacitor, the series resistance Rs will be 50 ± 5 Ω. Adjust the parallel capacitance until this value of series resistance is obtained.

3. Calculate the value of a series inductor that will null out whatever series reactance was measured in the step above. Use the procedures of step 1.

```
-----LLLLLLLLL--------------------LLLLLLLLL-----------
                        |                                     |
                        |                                     |
                       C                                    D
                       C                                    D
                       C                                    D
                       C                                    D
                       C                                    D
                        |                                     |
                        |                                     |
----------------------------------------------------------------------
```

The final impedance should be 50 ±5 Ω with a phase shift of <±10°.

PARALLEL MATCHING

2. Calculate the parallel resistance from

$$Rp = (Rs^2 + Xs^2)/Rs.$$

Note that with the proper value of series reactance, Xs, we can make Rp equal to 50Ω. Calculate the value of this equivalent series reactance from

$$Xe = \mathrm{sqrt}(50\ Rs - Rs^2)$$

and find the reactance of the series element, Z3, from

$$X3 = Xe – Xs.$$

X3 may be capacitive or inductive, depending upon whether we need to increase or decrease Xs to reach Xe.

Add this series reactance to the transducer and measure the series impedance. (Note that the phase will not, in general, be zero.)

$$Rs = (V/I) \cos(pi*phase/180)$$
$$Xs = (V/I) \sin(pi*phase/180)$$

Convert this to parallel impedance using

$$Rp = (Rs^2 + Xs^2)/Rs$$
$$Xp = (Rs^2 + Xs^2)/Xs.$$

The parallel resistance, Rp, should be close to 50Ω. Adjust the value of the series reactance to obtain Rp = 50Ω. The circuit will look like

```
---------------------------LLLLLLLLL----------------
                                                   |
                                                   |
                                                   D
                                                   D
                                                   D
                                                   D
                                                   D
                                                   |
                                                   |
----------------------------------------------------
```

where a series inductor has been assumed. Label this reactance Z3.

To cancel the parallel reactance, Xp, add an equal reactance (Z2) of opposite sign in parallel with the network. If the series element added above was a coil, the parallel element will probably be a capacitor. The final impedance should be 50 ±5 Ω with a phase shift of <±10°.

Note that Z1 is not used in this case; the pads should be shorted on the PCB. The final circuit looks like;

```
---------------------------LLLLLLLLLL----------------
               |                                  |
               |                                  |
              C                                  D
              C                                  D
              C                                  D
              C                                  D
              C                                  D
               |                                  |
               |                                  |
 ----------------------------------------------------------
```

where a series inductor and parallel capacitor have been assumed.